60A 650V Trench Fieldstop IGBT with SiC SBD SRE60N065FSU2S8

General Description

The SRE60N065FSU2S8 is a Field Stop Trench IGBT with SiC SBD, which offers ultra-low switching losses, high energy efficiency for switching applications such as PFC, Power Supply, Inverter, etc.

The SRE60N065FSU2S8 package is TO-247-4.

Features

- High Breakdown Voltage to 650V
- Advanced Trench Fieldstop technology
  - Ultra low E_{off}
  - High Ruggedness, Temperature Stability
  - Easy Parallel Switching Capability due to Positive Temperature Coefficient in $V_{CE(SAT)}$
- Low $V_{CE(SAT)}$
- Enhanced Avalanche Capability
- Non-Automotive Qualified

Application

- Inverter
- Uninterruptible power supplies
- PFC application
- Converter with high switching frequency

Symbol

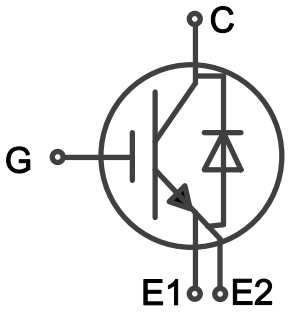
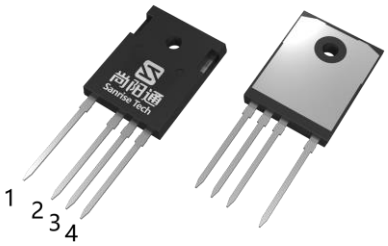


Figure 1 Symbol of SRE60N065FSU2S8

Package Type



TO-247-4

Pin 1- &backside-Collector； Pin 2-Emitter2

Pin 3- Kelvin Emitter1； Pin 4- Gate

Figure 2 Package Type of SRE60N065FSU2S8

Ordering Information

SRE60N065FSU2S8□□–□

Circuit Type

Package

T4: TO-247-4

G: Green

Blank: Tube

TR: Tape & Reel

Package	Part Number	Marking ID	Packing Type
TO-247-4	SRE60N065FSU2S8T4-G1	SRE60N065FSU2S8T4G1	Tube

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Absolute Maximum Ratings

Parameter		Symbol	Rating	Unit
Collector-emitter Voltage		V_{CES}	650	V
Gate-emitter Voltage		V_{GES}	±20	V
Transient Gate-emitter Voltage			±30	V
Continuous Collector Current	T_C=25ºC	I_C	100	A
	T_C=100ºC		60	
Pulsed Collector Current,Limited by T_{Jmax}		I_{CM}	240	A
Diode Continuous Collector Current	T_C=25ºC	I_F	60	A
	T_C=100ºC		30	
Diode Pulsed Current, Limited by T_{Jmax}		I_{FM}	180	A
Power Dissipation	T_C=25ºC	P_{tot}	306	W
	T_C=100ºC		153	
Operating Junction Temperature Range		T_J	-40 ~ 175(1)	ºC
Storage Temperature Range		T_{STG}	-55 ~ 150	ºC
Lead Temperature (Soldering, 10 sec)		T_{LEAD}	260	ºC

Note:
1. Reliability testing conducted at Tj_max=175℃.

Thermal Resistance

Parameter	Symbol	Min.	Typ.	Max.	Unit
IGBT Thermal Resistance，Junction-to-Case	R_{thJC}	-	-	0.49	ºC/W
Diode Thermal Resistance，Junction-to-Case	R_{thJC}	-	-	0.9	
Thermal Resistance，Junction-to-Ambient	R_{thJA}	-	-	40	

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Electrical Characteristics

T_J = 25ºC, unless otherwise specified.

Parameter		Symbol	Test Conditions	Min.	Typ.	Max.	Unit
Statistic Characteristics							
Collector-emitter Breakdown Voltage		BV_{CES}	V_{GE}=0V, I_C=250μA	650			V
Gate Threshold Voltage		$V_{GE(th)}$	V_{CE}=V_{GE}, I_C=250μA	4.0	4.8	5.6	V
Collector-emitter saturation voltage		V_{CEsat}	V_{GE}=15V, I_C=60A, T_J=25ºC		1.51	1.81	V
			T_J=125ºC		1.81		V
			T_J=175ºC		2.02		V
Zero Gate Voltage Collector Current		I_{CES}	V_{CE}=650V,V_{GE}=0V T_J=25ºC		0.1	40	μA
			T_J=175ºC			1	mA
Gate-emitter Leakage Current	Forward	I_{GESF}	V_{GE}=20V, V_{CE}=0V			100	nA
	Reverse	I_{GESR}	V_{GE}=-20V, V_{CE}=0V			-100	nA
Dynamic Characteristics							
Input Capacitance		C_{IES}	V_{CE}=25V, V_{GE}=0V, f=100KHz		2597		pF
Output Capacitance		C_{OES}			432		
Reverse Transfer Capacitance		C_{RES}			35		
Gate Resistance		R_G	f=1 MHz, Open Drain		1.7		Ω
Turn-on Delay Time		$t_{d(on)}$	T_J=25ºC V_{CC}=400V, I_C=30A R_G=10Ω, V_{GE}=0/15V Energy losses include "tail" and diode reverse recovery		22		ns
Rise Time		t_r			9		ns
Turn-off Delay Time		$t_{d(off)}$			93		ns
Fall Time		t_f			59		ns
Turn-on energy		E_{on}			0.3		mJ
Turn-off energy		E_{off}			0.35		mJ
Total switching energy		E_{ts}			0.65		mJ
Turn-on Delay Time		$t_{d(on)}$	T_J=25ºC V_{CC}=400V, I_C=60A R_G=10Ω,V_{GE}=0/15V Energy losses include "tail" and diode reverse recovery		20		ns
Rise Time		t_r			20		ns
Turn-off Delay Time		$t_{d(off)}$			80		ns
Fall Time		t_f			66		ns
Turn-on energy		E_{on}			0.6		mJ
Turn-off energy		E_{off}			0.6		mJ
Total switching energy		E_{ts}			1.2		mJ
Gate to Emitter Charge		Q_{GE}	V_{CC}=400V, I_C=60A V_{GE}=0 to 15V		17		nC
Gate to Collector Charge		Q_{GC}			21		
Gate Charge Total		Q_G			60		

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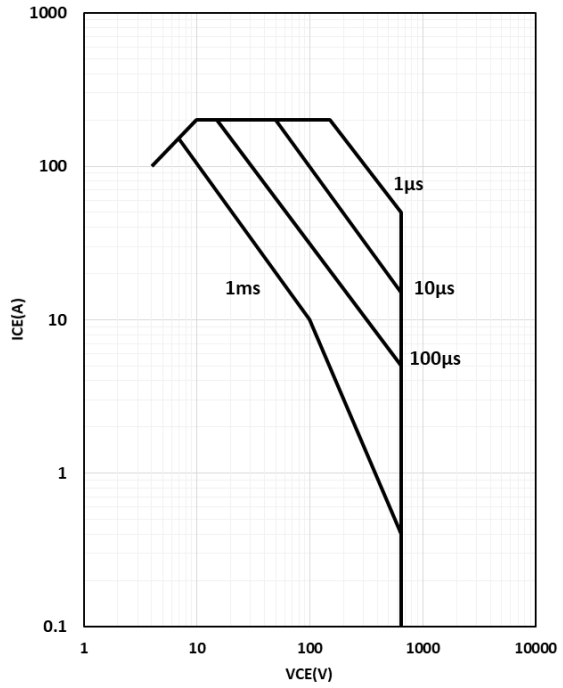
Parameter	Symbol	Test Conditions	Min.	Typ.	Max.	Unit
Reverse Diode Characteristics						
Forward Voltage	VF	IF=30A, T_J=25ºC	-	1.45	1.90	V
		IF=30A, T_J=125ºC	-	1.68	-	
		IF=30A, T_J =175ºC	-	1.85	-	
		IF=60A, T_J=25ºC	-	1.89	2.30	V
		IF=60A, T_J=125ºC	-	2.40	-	
		IF=60A, T_J =175ºC	-	2.84	-	
Total Capacitance	C	VR=1V, f=1MHz	-	1210	-	pF
		VR=200V, f=1MHz	-	124	-	
		VR=400V, f=1MHz	-	90	-	
Total Capacitive Charge	Q_C	VR=400V, IF=30A dIF/dt=200A/us	-	45	-	nC
Reverse Recovery Time	t_{rr}	T_J=25ºC V_R=400V, I_F=30A dI_F/dt=2400A/μs		9.6		ns
Reverse Recovery Charge	Q_{rr}			0.045		uC
Peak Reverse Recovery Current	I_{rrm}			8.3		A
Diode peak rate of fall of reverse recovery current during t_b	di_{rr}/dt			-2300		A/μs
Reverse Recovery Time	t_{rr}	T_J=25ºC V_R=400V, I_F=60A dI_F/dt=2700A/μs		16.8		ns
Reverse Recovery Charge	Q_{rr}			0.056		uC
Peak Reverse Recovery Current	I_{rrm}			9.6		A
Diode peak rate of fall of reverse recovery current during t_b	di_{rr}/dt			-2600		A/μs

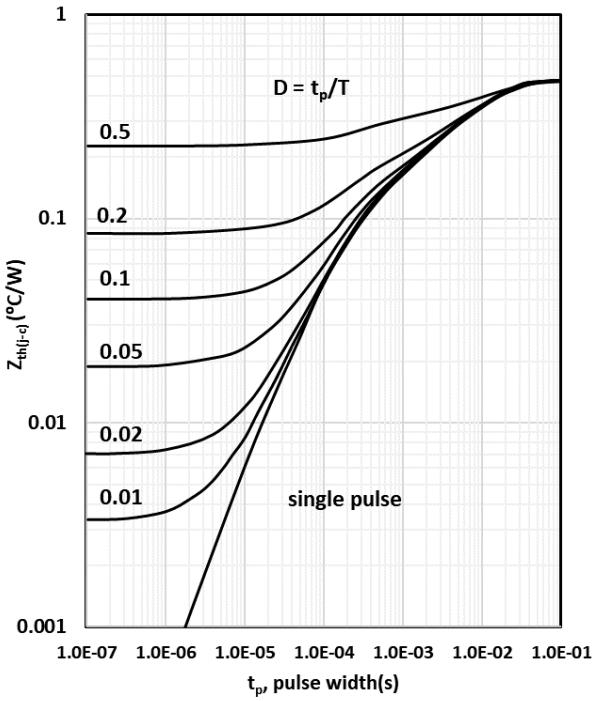
Typical Performance Characteristics

Figure 3: IGBT FBSOA



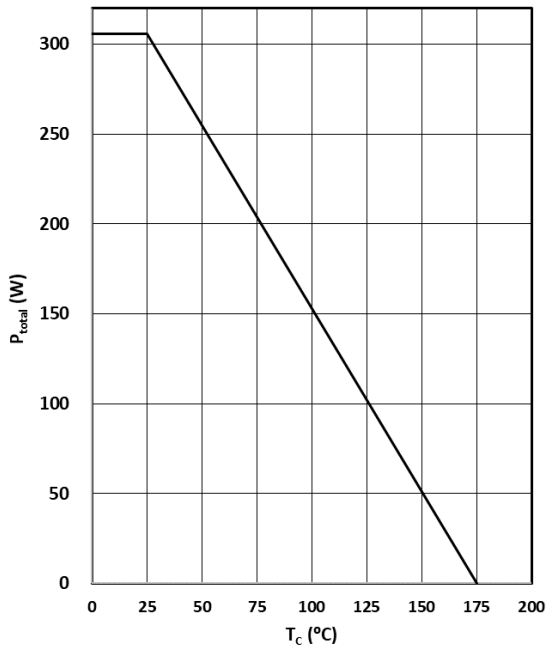
$I_C = f(V_{CE})$; $V_{GE} \geq 15/0V$; $Tj \leq 175^oC$

Figure 4: IGBT transient thermal impedance



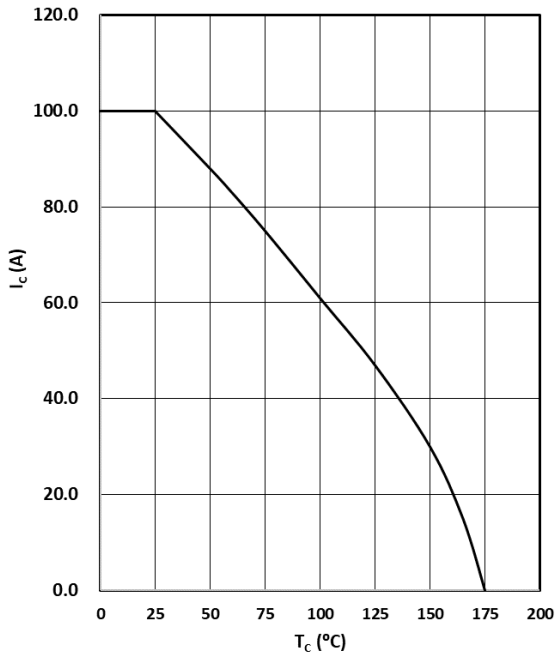
$R_{th(J-C)} = f(t_p)$; duty cycle: $D = t_p/T$

Figure 5: Power dissipation



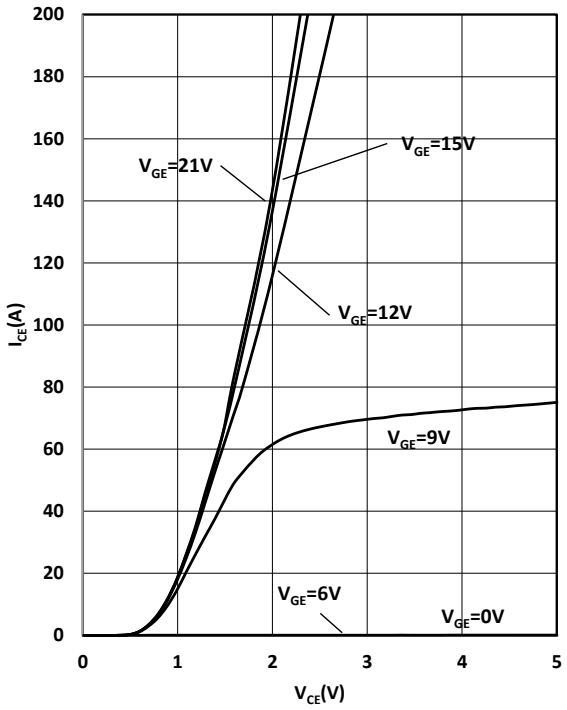
Ptot= f(Tc);

Figure 6: Collector current vs. temperature



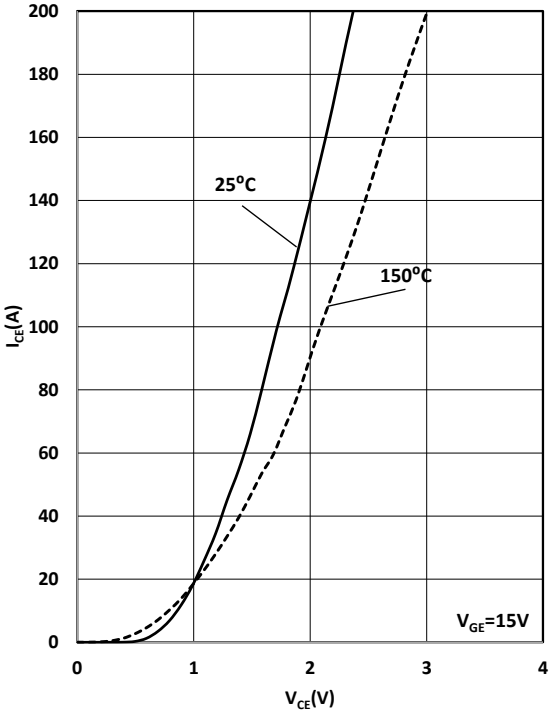
$Ic = f(Tj)$; $V_{GE} \geq 15V$; $Tj \leq 175^oC$

Figure 7: Typical Output Characteristics



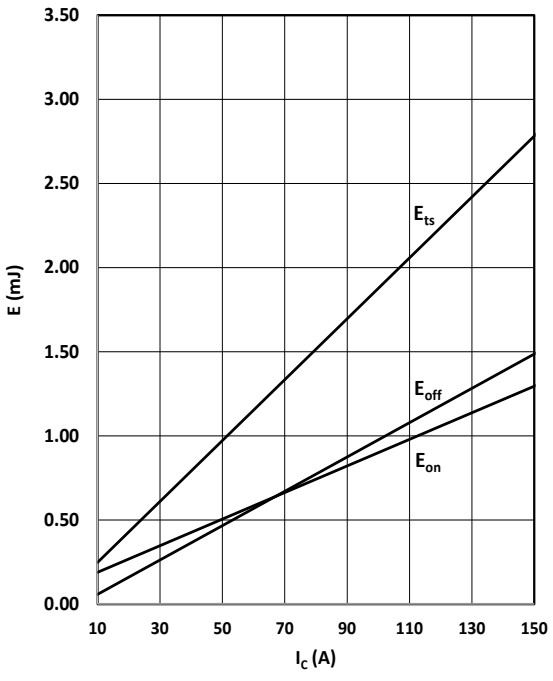
$I_C = f(V_{CE})$; Tj= 25ºC; parameter: V_{GE}

Figure 8: Typical transfer characteristic



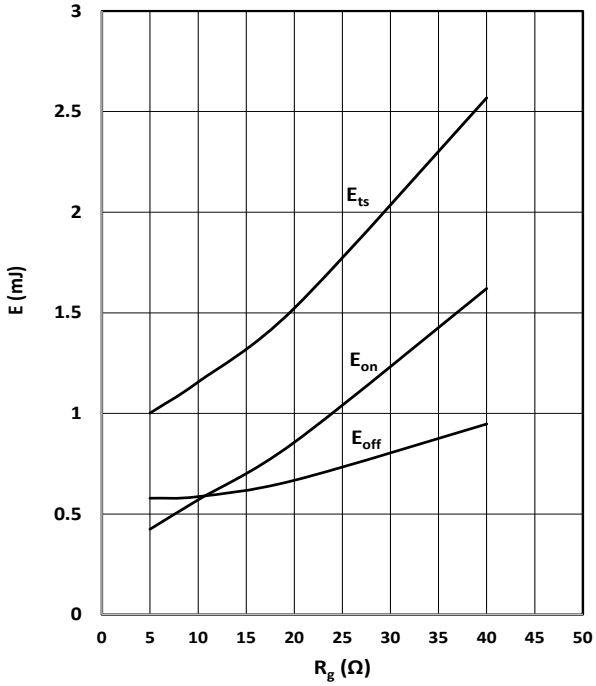
$I_C = f(V_{CE})$; Tj= 25ºC vs 150ºC

Figure 9: Typical switching energy losses as a function of collector current



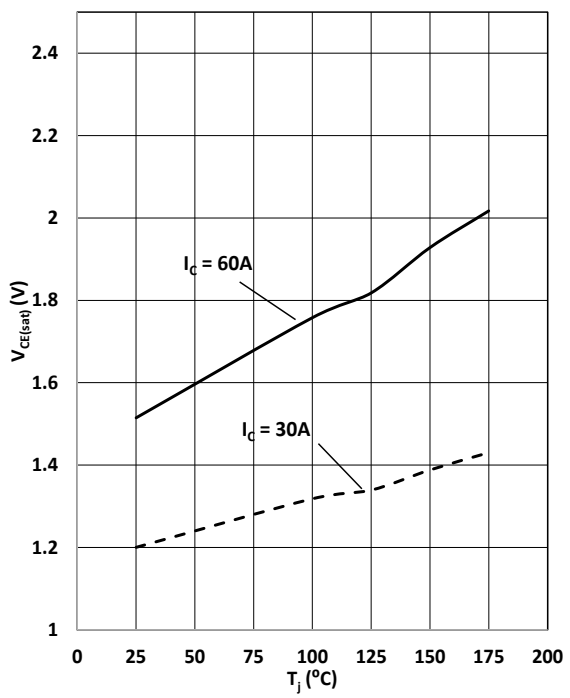
$E=f(Ic)$; V_{CE}=400V; Tj=25ºC; R_G=10Ω

Figure10: Typical switching energy losses as a function of gate resistor



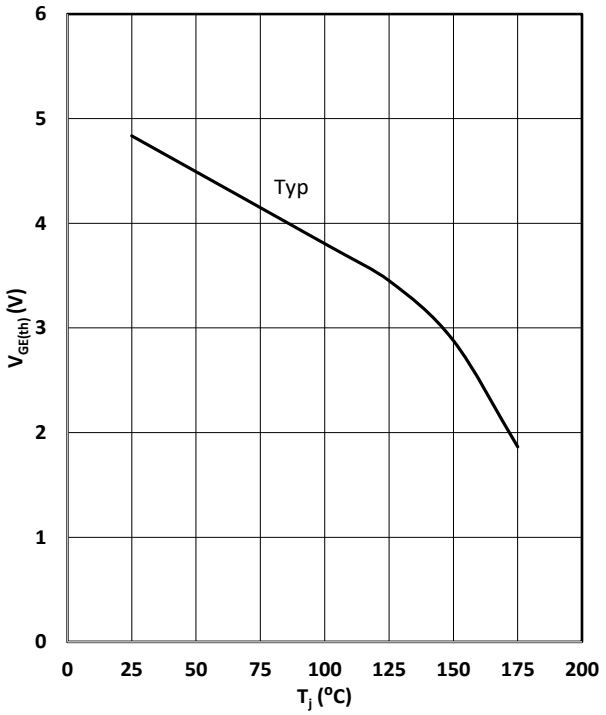
$E=f(R_G)$; V_{CE}=400V; Tj=25ºC; Ic=60A

Figure 11: Typical collector-emitter saturation voltage as a function of junction temperature



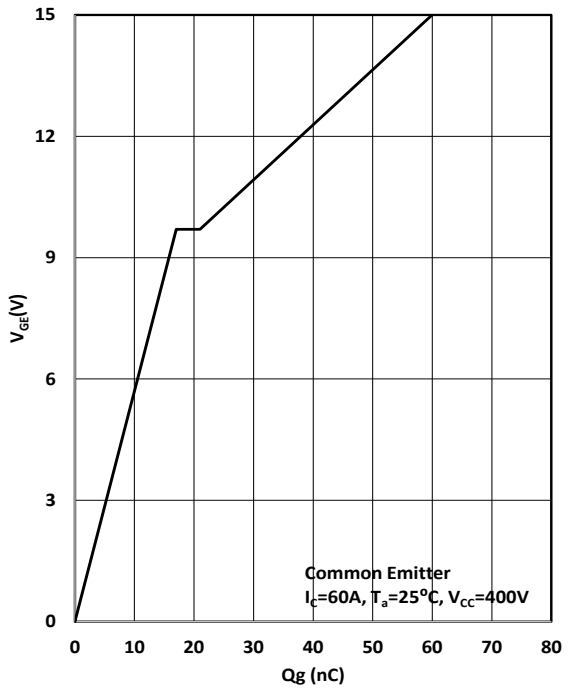
V_{CE} =f(T_j); V_{GE}=15V

Figure 12: Gate-emitter threshold voltage as a function of junction temperature



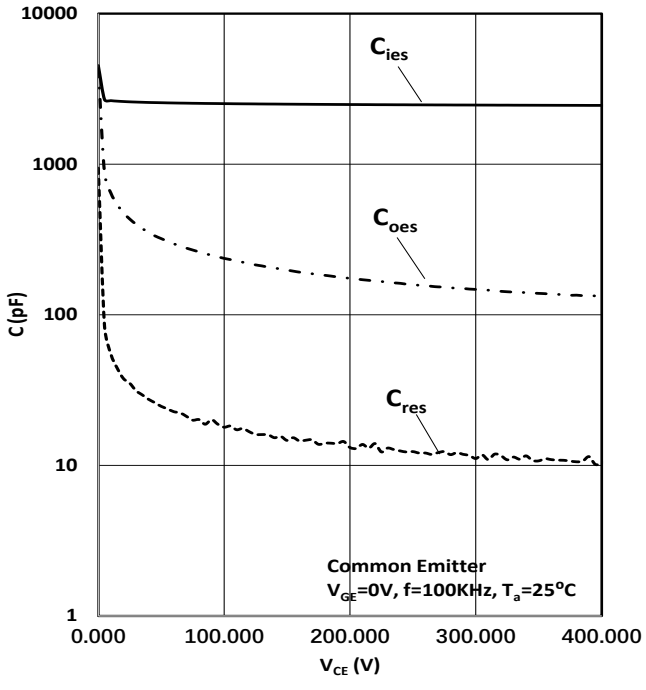
V_{GE} =f(T_j); I_{CE} = 250μA

Figure 13: Typical Gate Charge



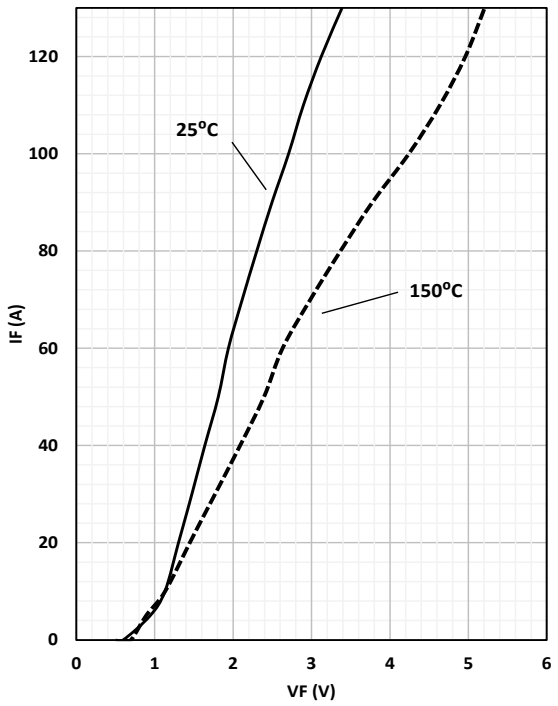
V_{GE}= f(Q_{gate}); I_C= 60A

Figure 14: Typical Capacitances



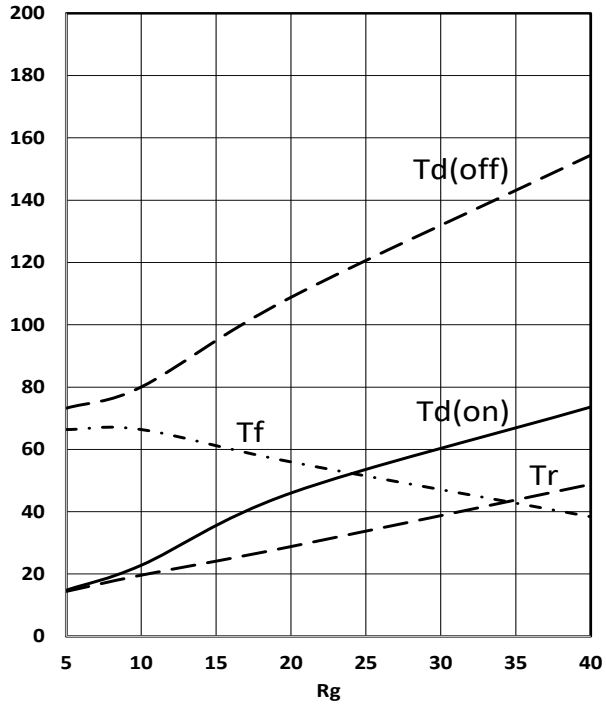
C=f(V_{CE}); V_{GE}=0; f=100KHz

Figure 15: Typical diode forward current as a function of forward voltage



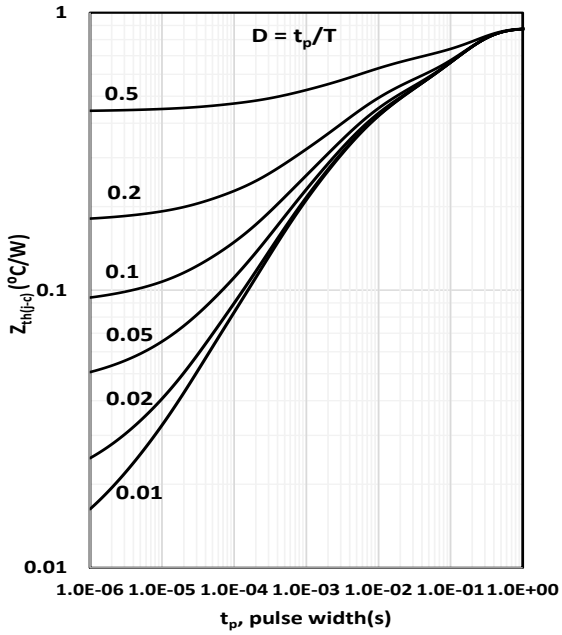
I_F= f(V_F);

Figure 16： Typical Switching time as a function of gate resistance



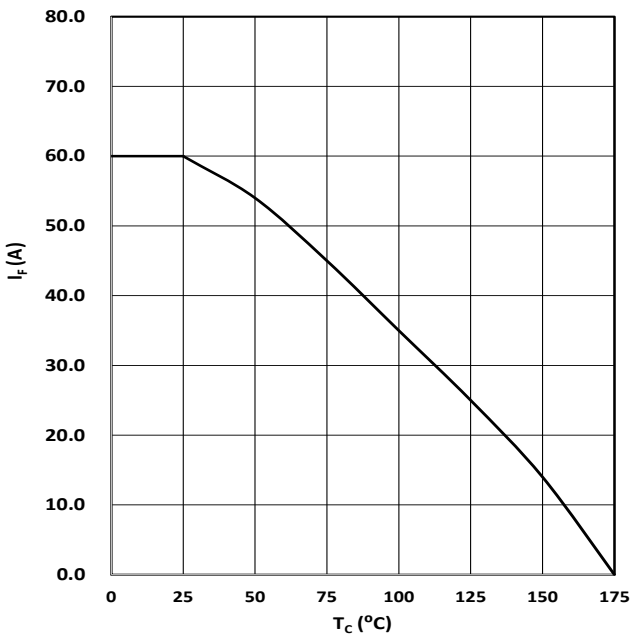
V_{CE}=400V; I_C= 60A; Tj=25°C

Figure 17: Diode transient thermal impedance



$R_{th(J-C)}$= f(t_p); duty cycle: D= t_p/T

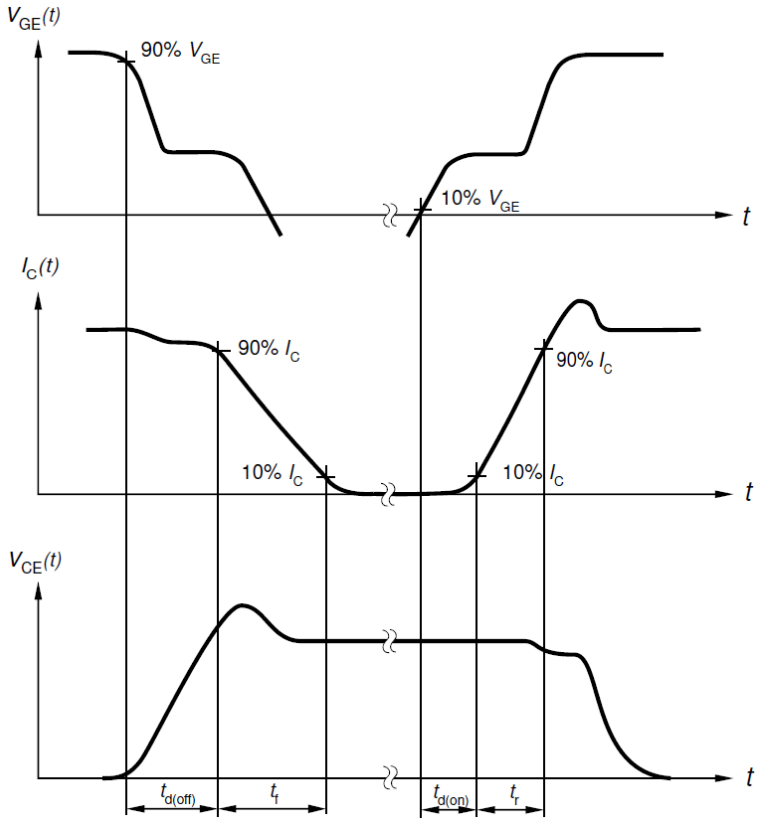
Figure 18： Diode current vs. temperature



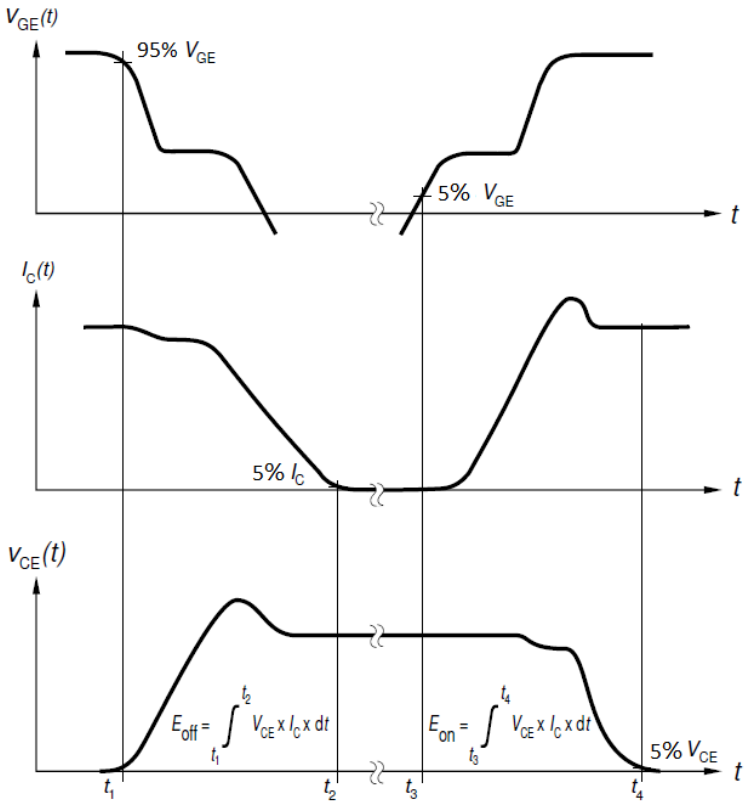
I_F= f(Tc); Tj≤175°C

Test Circuits

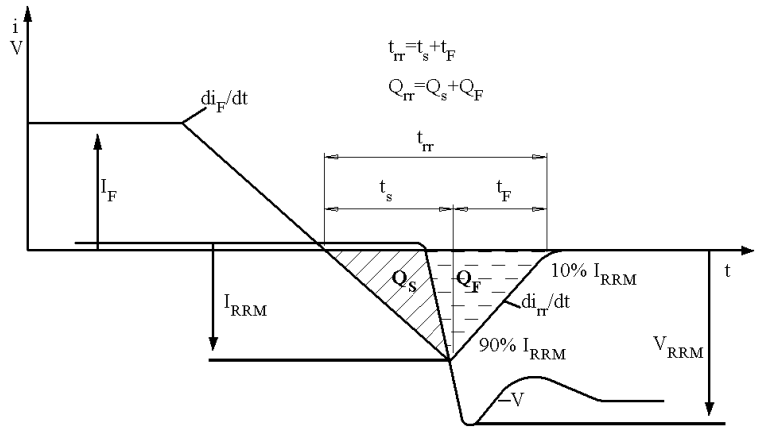
1. Definition Switching times



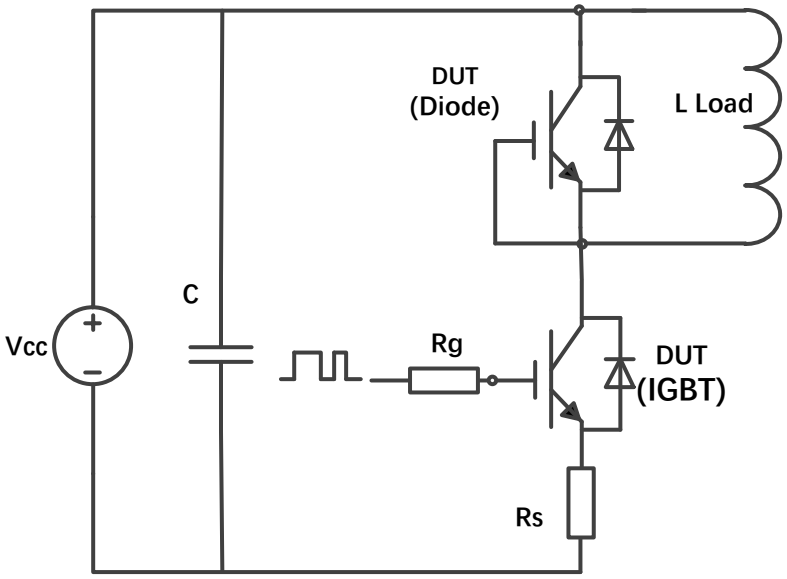
2. Definition Switching losses



3. Definition Diode Switching Characteristics



4. Dynamic test circuit



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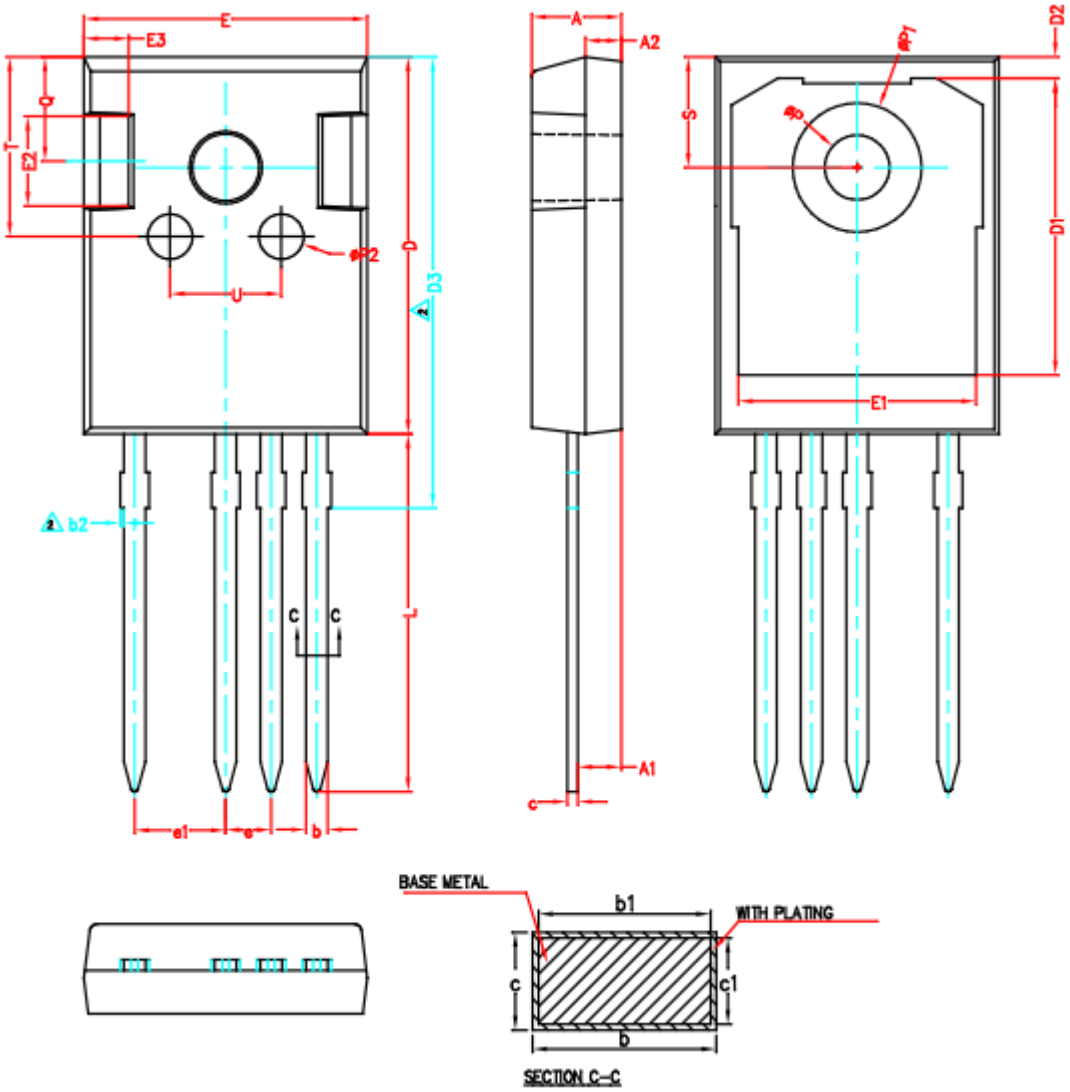
Mechanical Dimensions

TO-247-4 **Unit: mm**



60A 650V Trench Fieldstop IGBT with SiC SBD SRE60N065FSU2S8

Mechanical Dimensions

Symbol	Dimensions (mm)			Symbol	Dimensions (mm)		
	Min.	Typ.	Max.		Min.	Typ.	Max.
A	4.90	5.00	5.10	E1	13.10	13.30	13.50
A1	2.31	2.41	2.51	E2	4.90	5.00	5.10
A2	1.90	2.00	2.10	E3	2.40	2.50	2.60
b	1.16	–	1.29	e	2.44	2.54	2.64
b1	1.15	1.2	1.25	e1	4.98	5.08	5.18
b2	0.00	–	0.20	L	19.80	19.92	20.10
c	0.59	–	0.66	P	3.50	3.60	3.70
c1	0.58	0.60	0.62	P1	–	–	7.40
D	20.90	21.00	21.10	P2	2.40	2.50	2.60
D1	16.25	16.55	16.85	Q	5.60	–	6.00
D2	1.05	1.20	1.35	S	–	6.15BSC	–
D3	24.97	25.12	25.27	T	9.80	–	10.20
E	15.70	15.80	15.90	U	6.00	–	6.40

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Main Site:

- Headquarter

Shenzhen Sanrise Technology Co., LTD.

A1206, Skyworth building, No. 008, gaoxinnan 1st Road, Gaoxin District, Yuehai street, Nanshan District, ShenZhen, P.R. China

Tel: +86-755-22953335

Fax: +86-755-22916878

- Shanghai Office

Shenzhen Sanrise Technology Co., LTD.

Rm.401, Building B, No. 666, Zhangheng Road, Zhangjiang Hi-Tech Park, Shanghai, P.R.China

Tel: +86-21-68825918