

General Description

The SRE60N065FSUD6 is a Field Stop Trench IGBT with anti-parallel diode, which offers ultra-low switching losses, high energy efficiency for switching applications such as PFC, Power Supply, Inverter, etc.

The SRE60N065FSUD6 package is TO-247.

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

Application

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

Symbol

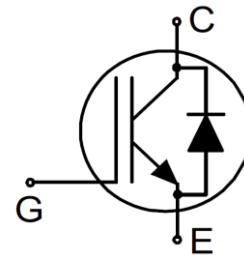


Figure 1 Symbol of SRE60N065FSUD6

Package Type

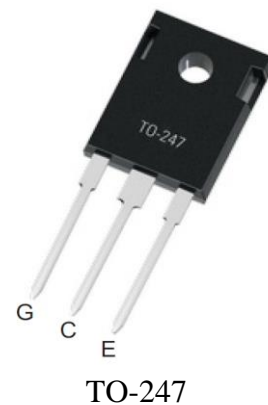
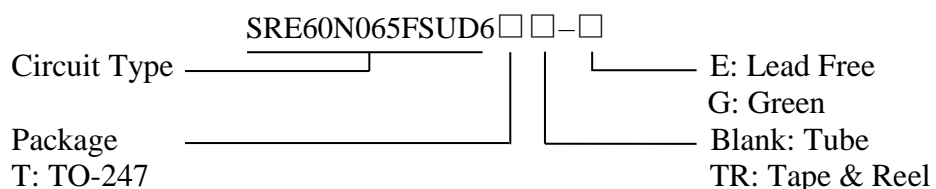


Figure 2 Package Type of SRE60N065FSUD6

Ordering Information



Package	Part Number	Marking ID	Packing Type
	Green	Green	
TO-247	SRE60N065FSUD6T-G	SRE60N065FSUD6TG	Tube

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 ($t_p \leq 10\mu s$)			± 30	V
Continuous Collector Current	$T_C=25\text{ }^\circ\text{C}$	I_C	100	A
	$T_C=100\text{ }^\circ\text{C}$		60	
Pulsed Collector Current, Limited by T_{Jmax}		I_{CM}	240	A
Diode Continuous Collector Current	$T_C=25\text{ }^\circ\text{C}$	I_F	80	A
	$T_C=100\text{ }^\circ\text{C}$		50	
Diode Pulsed Current, Limited by T_{Jmax}		I_{FM}	200	A
Power Dissipation	$T_C=25\text{ }^\circ\text{C}$	P_{tot}	255	W
	$T_C=100\text{ }^\circ\text{C}$		102	
Operating Junction Temperature Range		T_J	-40 ~ 150	$^\circ\text{C}$
Storage Temperature Range		T_{STG}	-55 ~ 150	$^\circ\text{C}$
Lead Temperature (Soldering, 10 sec)		T_{LEAD}	260	$^\circ\text{C}$

Thermal Resistance

Parameter	Symbol	Min.	Typ.	Max.	Unit
IGBT Thermal Resistance, Junction-to-Case	R_{thJC}	-	-	0.49	$^\circ\text{C/W}$
Diode Thermal Resistance, Junction-to-Case	R_{thJC}	-	-	0.62	
Thermal Resistance, Junction-to-Ambient	R_{thJA}	-	-	40	

60A 650V Trench Fieldstop IGBT with anti-parallel diode SRE60N065FSUD6
Electrical Characteristics
 $T_J = 25\text{ }^\circ\text{C}$, unless otherwise specified.

Parameter	Symbol	Test Conditions	Min.	Typ.	Max.	Unit	
Statistic Characteristics							
Collector-emitter Breakdown Voltage	BV_{CES}	$V_{GE}=0V, I_C=250\mu A$	650			V	
Gate Threshold Voltage	$V_{GE(th)}$	$V_{CE}=V_{GE}, I_C=250\mu A$	4.0	4.8	6.0	V	
Collector-emitter saturation voltage	V_{CEsat}	$V_{GE}=15V, I_C=60A,$ $T_J=25\text{ }^\circ\text{C}$		1.45	2.0	V	
		$T_J=125\text{ }^\circ\text{C}$		1.64		V	
		$T_J=150\text{ }^\circ\text{C}$		1.75		V	
Zero Gate Voltage Collector Current	I_{CES}	$V_{CE}=650V, V_{GE}=0V$ $T_J=25\text{ }^\circ\text{C}$		0.1	40	μA	
		$T_J=150\text{ }^\circ\text{C}$			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}	$V_{CE}=25V, V_{GE}=0V,$ $f=1\text{ MHz}$		2350		pF	
Output Capacitance	C_{OES}			220			
Reverse Transfer Capacitance	C_{RES}			25			
Gate Resistance	R_G	$f=1\text{ MHz, Open Drain}$		1.7		Ω	
Turn-on Delay Time	$t_{d(on)}$	$T_J=25\text{ }^\circ\text{C}$ $V_{CC}=400V, I_C=60A$ $R_G=20\Omega, V_{GE}=0/15V$		35		ns	
Rise Time	t_r			73		ns	
Turn-off Delay Time	$t_{d(off)}$			223		ns	
Fall Time	t_f			16		ns	
Turn-on energy	E_{on}			3.0		mJ	
Turn-off energy	E_{off}			0.80		mJ	
Total switching energy	E_{ts}			3.80		mJ	
Turn-on Delay Time	$t_{d(on)}$		$T_J=150\text{ }^\circ\text{C}$ $V_{CC}=400V, I_C=60A$ $R_G=20\Omega, V_{GE}=0/15V$		30		ns
Rise Time	t_r				75		ns
Turn-off Delay Time	$t_{d(off)}$				272		ns
Fall Time	t_f			32		ns	
Turn-on energy	E_{on}			4.05		mJ	
Turn-off energy	E_{off}			1.05		mJ	
Total switching energy	E_{ts}			5.1		mJ	
Gate to Emitter Charge	Q_{GE}	$V_{CC}=400V, I_C=60A$ $V_{GE}=0\text{ to }15V$		32		nC	
Gate to Collector Charge	Q_{GC}			39			
Gate Charge Total	Q_G			90			

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Parameter	Symbol	Test Conditions	Min.	Typ.	Max.	Unit
Reverse Diode Characteristics						
Drain-Source Diode Forward Voltage	V_F	$V_{GE}=0V, I_F=60A$ $T_J=25\text{ }^\circ\text{C}$		1.51	2.0	V
		$T_J=125\text{ }^\circ\text{C}$		1.41		
		$T_J=150\text{ }^\circ\text{C}$		1.39		
Reverse Recovery Time	t_{rr}	$T_J=25\text{ }^\circ\text{C}$ $V_R=400V, I_F=50A$ $dI_F/dt=700A/\mu s$		70		ns
Reverse Recovery Charge	Q_{rr}			860		nC
Peak Reverse Recovery Current	I_{rrm}			20.0		A
Diode peak rate of fall of reverse recovery current during t_b	di_{rr}/dt			-590		A/ μs
Reverse Recovery Time	t_{rr}	$T_J=150\text{ }^\circ\text{C}$ $V_R=400V, I_F=50A$ $dI_F/dt=700A/\mu s$		250		ns
Reverse Recovery Charge	Q_{rr}			5.3		μC
Peak Reverse Recovery Current	I_{rrm}			46.0		A
Diode peak rate of fall of reverse recovery current during t_b	di_{rr}/dt			-330		A/ μs

Typical Performance Characteristics

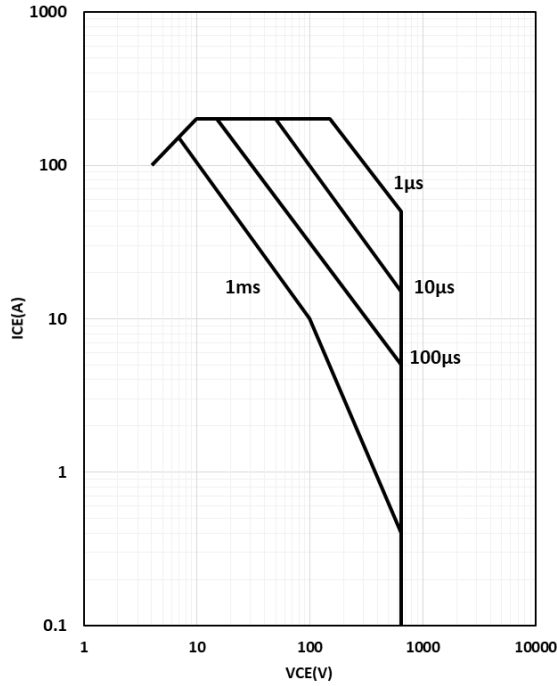
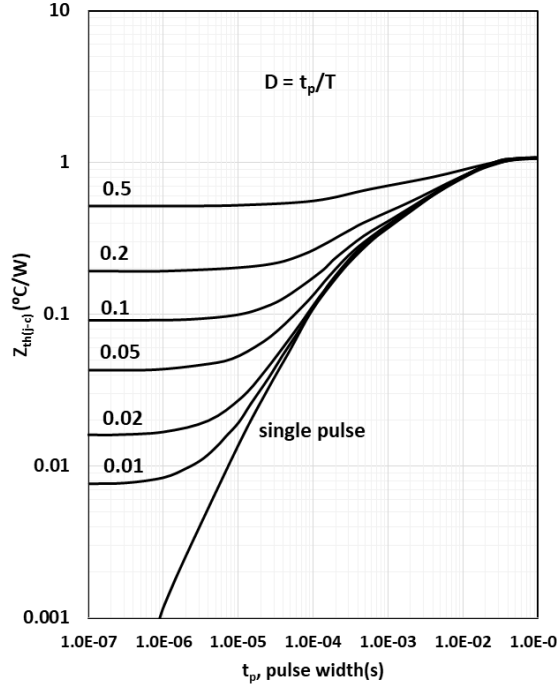
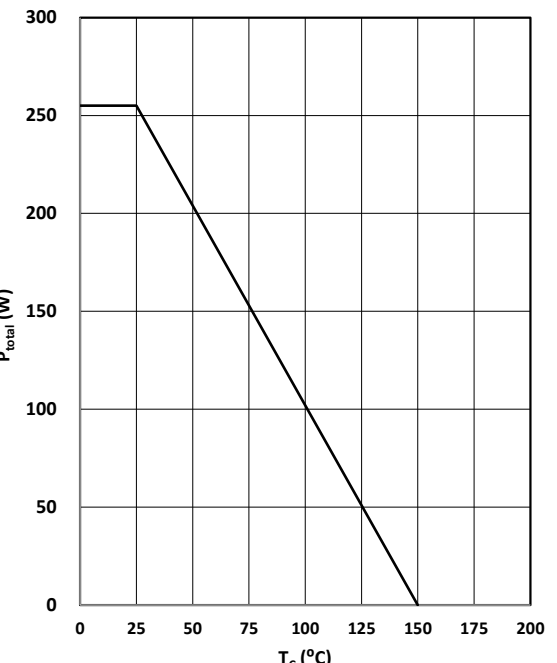
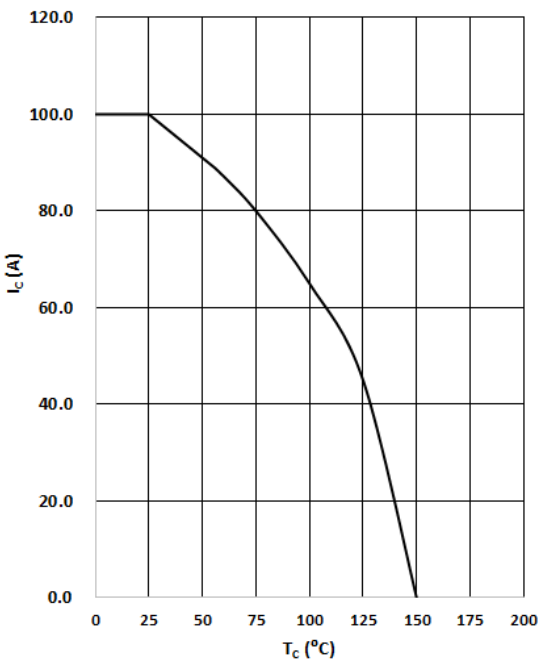
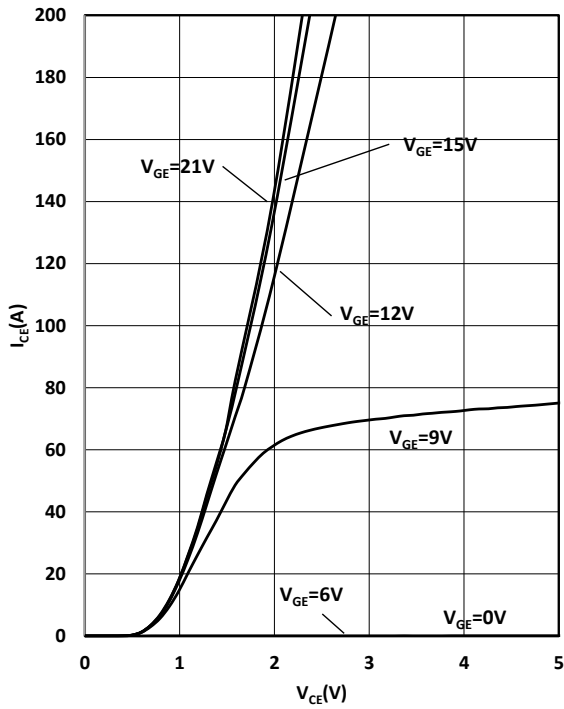
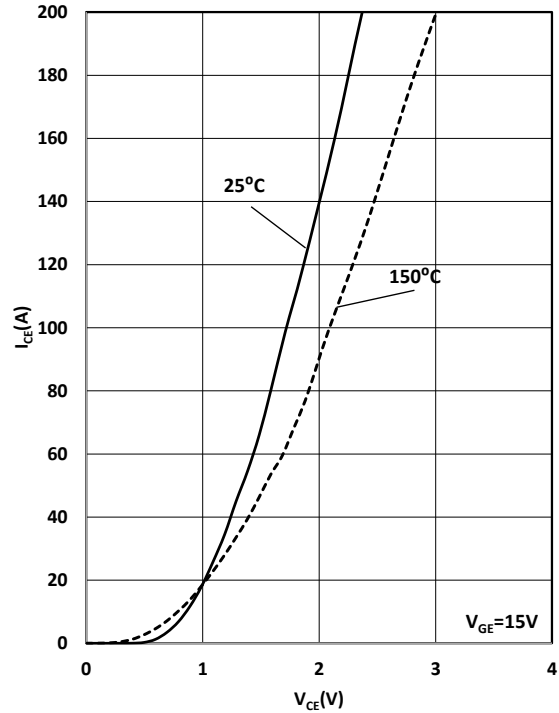
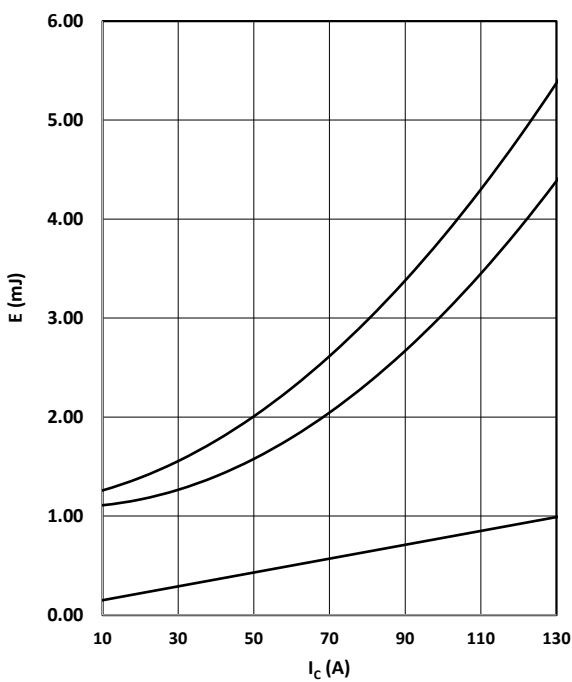
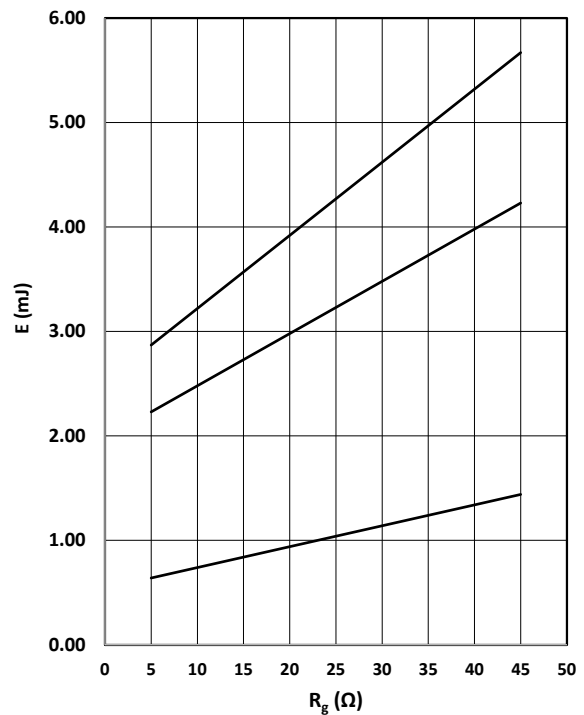
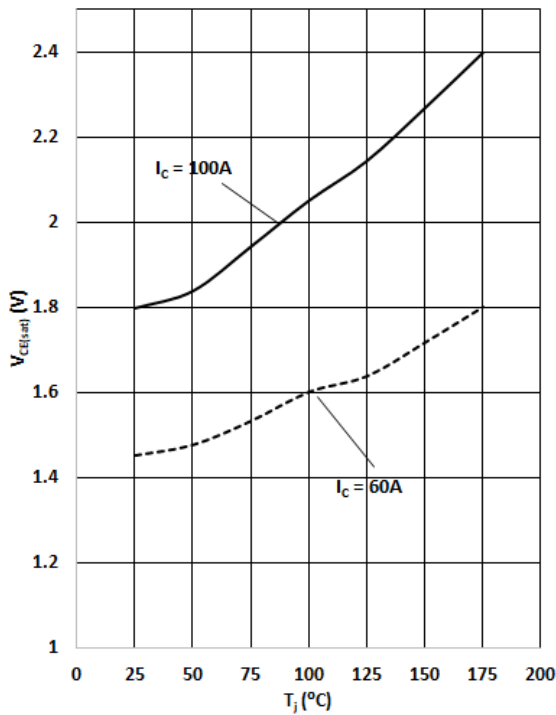
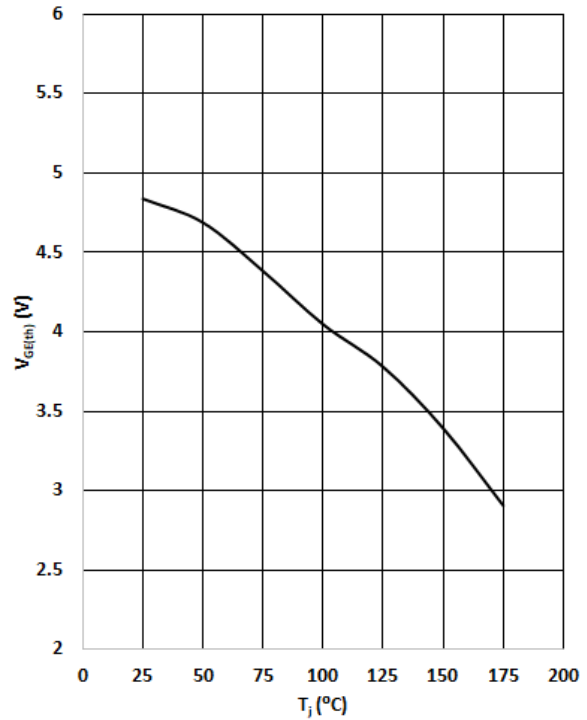
<p>Figure 3: IGBT FBSOA</p>  <p>$I_C = f(V_{CE}); V_{GE} \geq 15/0V; T_j \leq 150\text{ }^\circ\text{C}$</p>	<p>Figure 4: IGBT transient thermal impedance</p>  <p>$R_{th(j-c)} = f(t_p); \text{duty cycle: } D = t_p/T$</p>
<p>Figure 5: Power dissipation</p>  <p>$P_{tot} = f(T_c);$</p>	<p>Figure 6: Collector current vs. temperature</p>  <p>$I_C = f(T_j); V_{GE} \geq 15V; T_j \leq 150\text{ }^\circ\text{C}$</p>

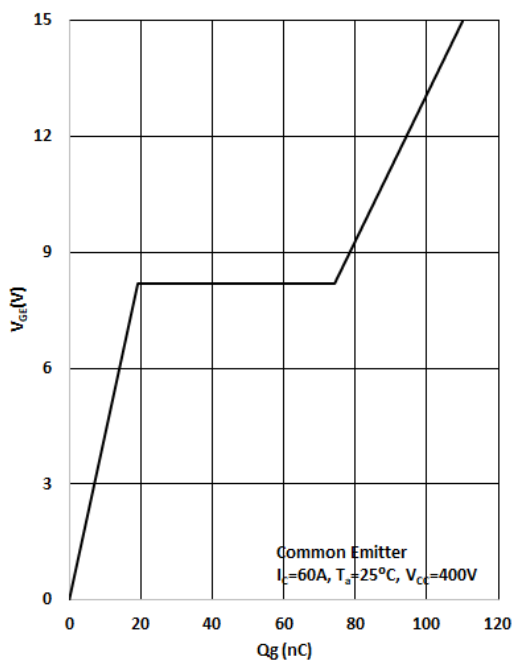
Figure 7: Typ. Output Characteristics

 $I_C = f(V_{CE}); T_j = 25\text{ }^\circ\text{C}; \text{parameter: } V_{GE}$
Figure 8: Saturation Voltage Characteristics

 $I_C = f(V_{CE}); T_j = 25\text{ }^\circ\text{C vs } 150\text{ }^\circ\text{C}$
Figure 9: IGBT switching energy losses

 $E = f(I_C); V_{CE} = 400\text{V}; T_j = 25\text{ }^\circ\text{C}; R_G = 20\Omega$
Figure 10: IGBT switching energy losses

 $E = f(R_G); V_{CE} = 400\text{V}; T_j = 25\text{ }^\circ\text{C}; I_C = 60\text{A}$

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Figure 11: Typ. Collector Voltage vs. Temperature


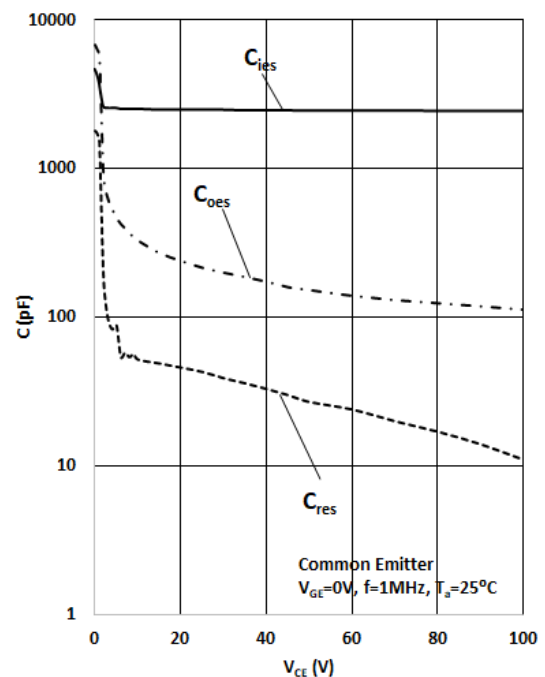
$$V_{CE} = f(T_j); V_{GE} = 15V$$

Figure 12: Typ. emitter threshold voltage as a function of junction temperature


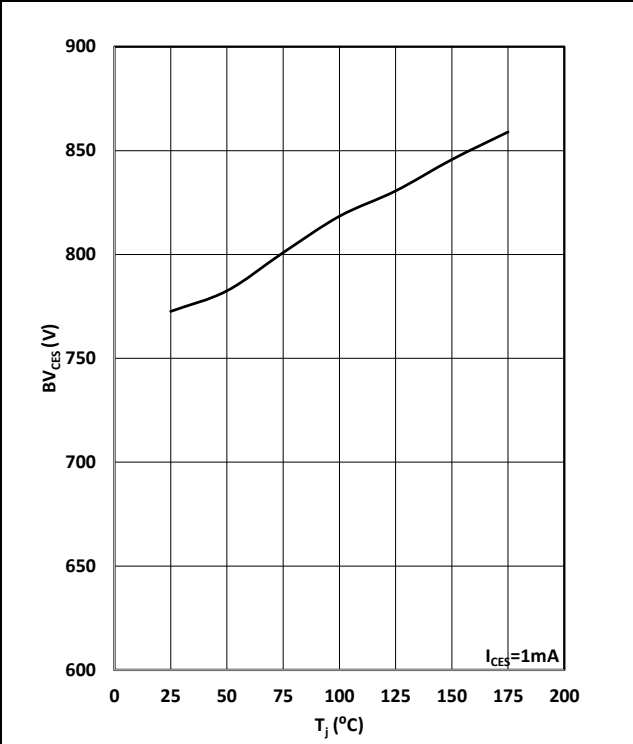
$$V_{GE} = f(T_j); I_{CE} = 250\mu A$$

Figure 13: Typ. Gate Charge


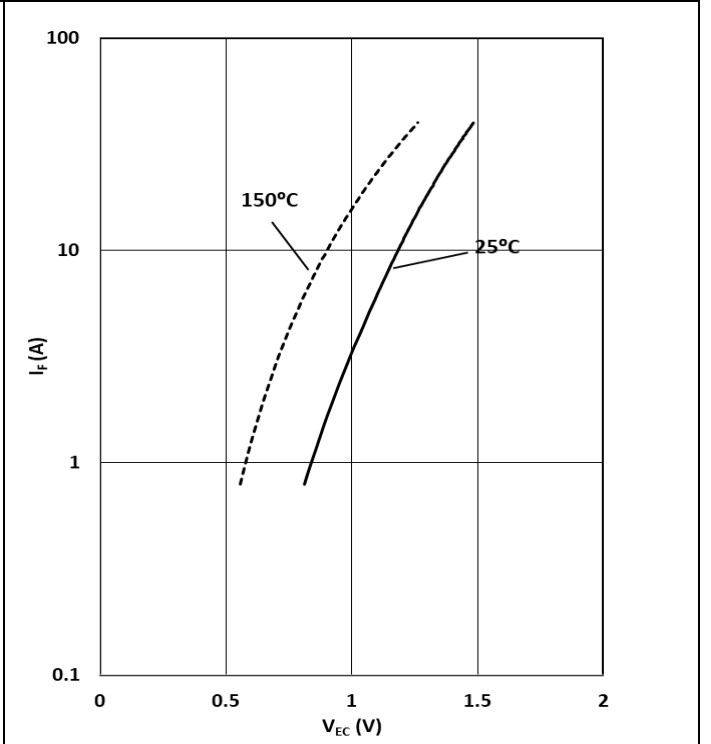
$$V_{GE} = f(Q_{gate}); I_C = 60A$$

Figure 14: Typ. Capacitances


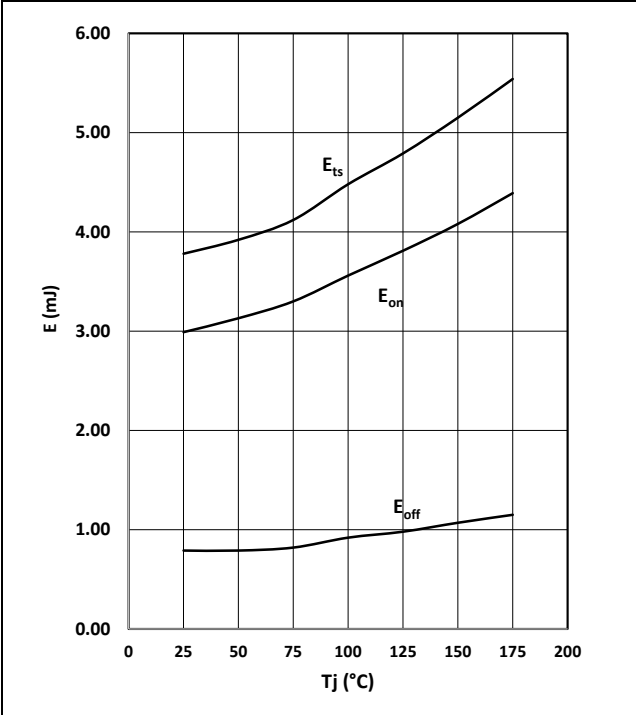
$$C = f(V_{CE}); V_{GE} = 0; f = 1MHz$$

60A 650V Trench Fieldstop IGBT with anti-parallel diode SRE60N065FSUD6
Figure 15: Collector-emitter Breakdown Voltage vs. temperature


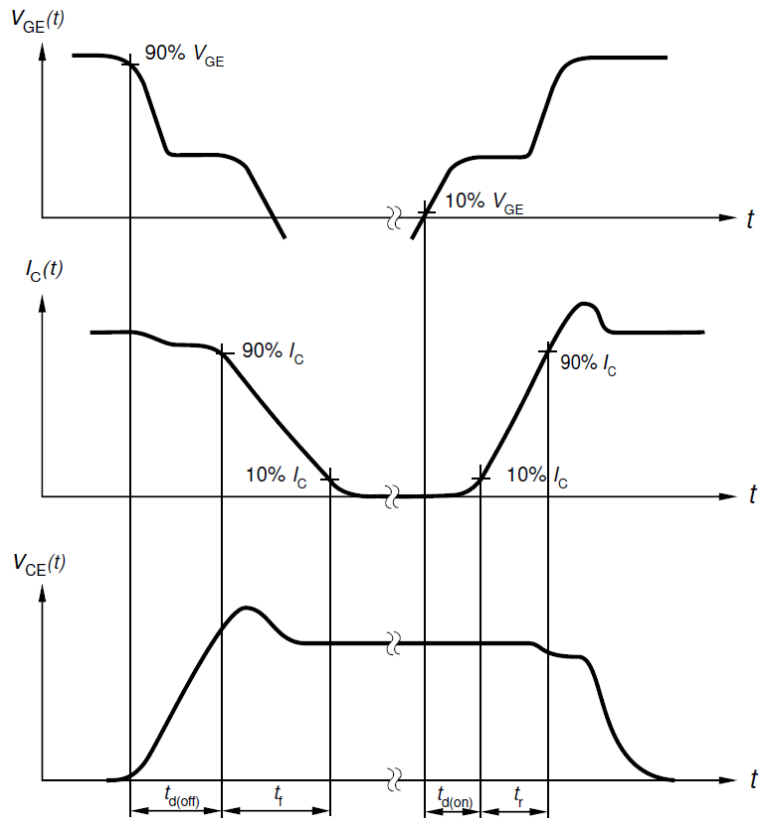
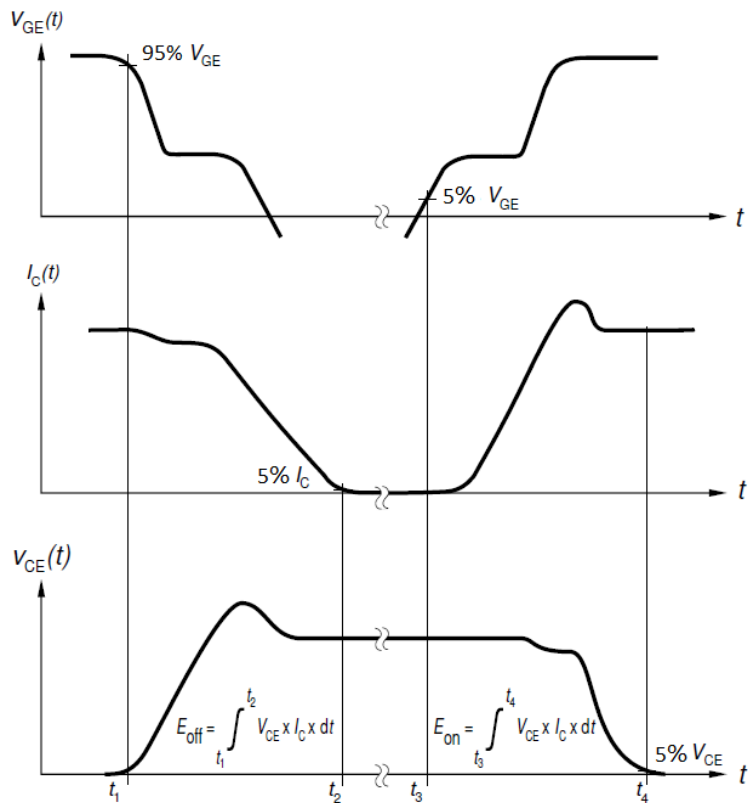
$$BV_{ces} = f(T_j);$$

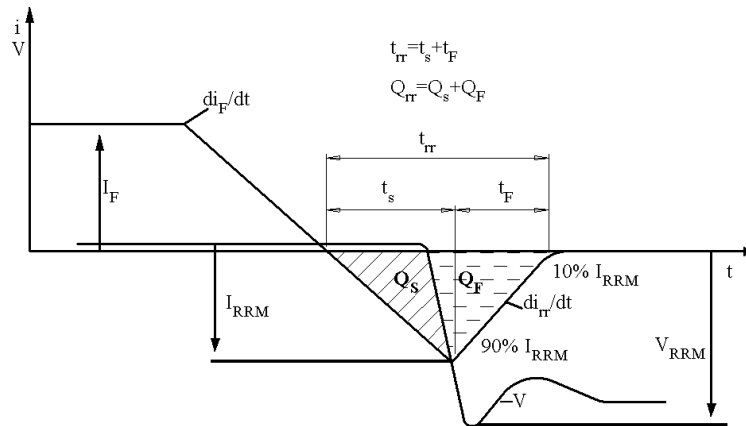
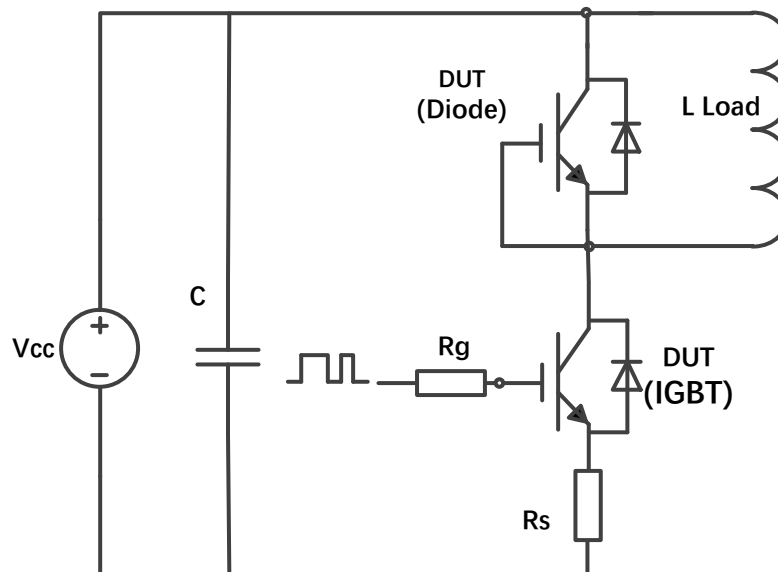
Figure 16: Typ. diode forward current as a function of forward voltage


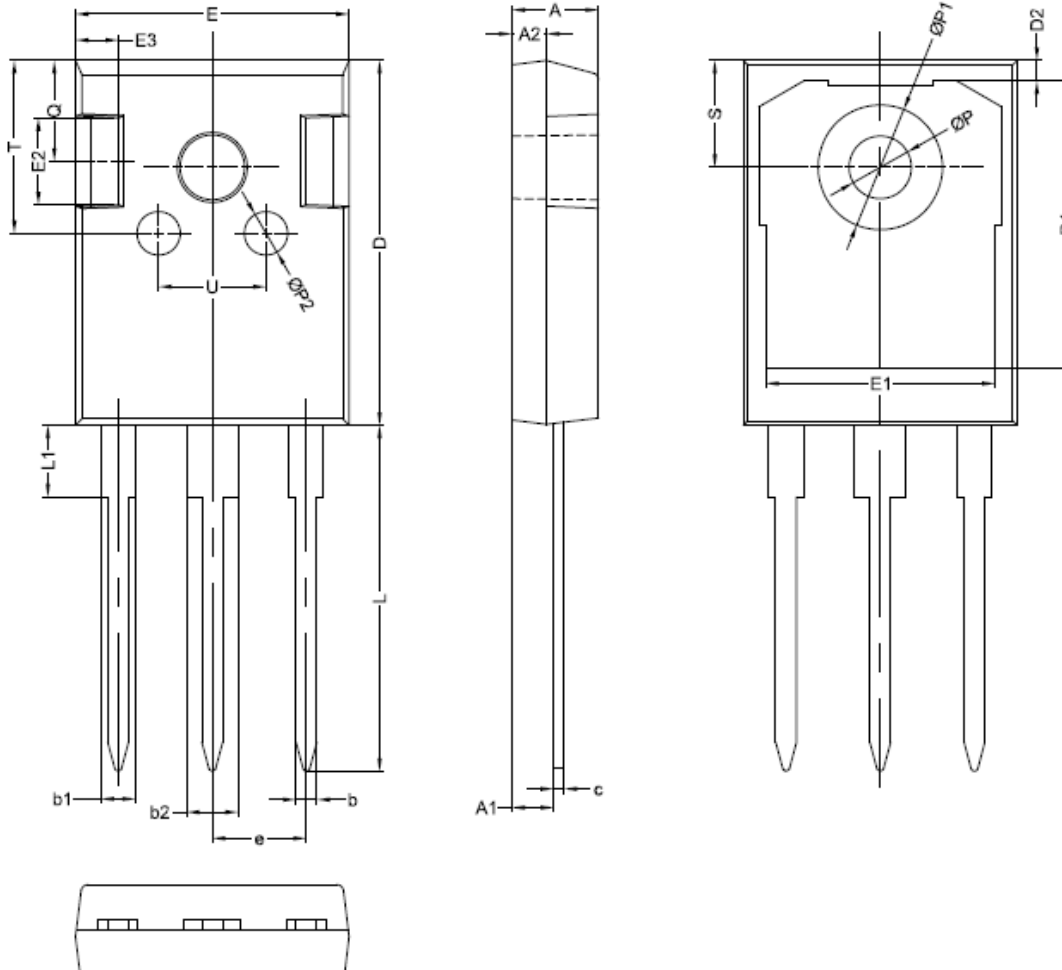
$$I_F = f(V_{EC});$$

Figure 17: IGBT switching energy losses


$$E = f(T_j); V_{CE} = 400V; I_c = 60A; R_G = 20\Omega$$

Test Circuits
1. Definition Switching times

2. Definition Switching losses


3. Definition Diode Switching Characteristics

4. Dynamic test circuit


Mechanical Dimensions
TO-247
Unit: mm


Symbol	Dimensions(mm)			Symbol	Dimensions(mm)		
	Min.	Typ.	Max.		Min.	Typ.	Max.
A	4.80	5.00	5.20	E2	-	5.00	-
A1	2.21	2.41	2.61	E3	-	2.50	-
A2	1.90	2.00	2.10	e	5.44(BSC)		
b	1.10	1.20	1.35	L	19.42	19.92	20.42
b1	-	2.00	-	L1	-	4.13	-
b2	-	3.00	-	P	3.50	3.60	3.70
c	0.55	0.60	0.75	P1	-	-	7.40
D	20.80	21.00	21.20	P2	-	2.50	-
D1	-	16.55	-	Q	-	5.80	-
D2	-	1.20	-	S	6.05	6.15	6.25
E	15.60	15.80	16.00	T	-	10.00	-
E1	-	13.30	-	U	-	6.20	-



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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.609, Building A, No. 666, Zhangheng Road,
Zhangjiang Hi-Tech Park, Shanghai, P.R.China

Tel: +86-21-68825918