60A 650V Trench Fieldstop IGBT with anti-parallel diode SRE60N065FSUD6

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

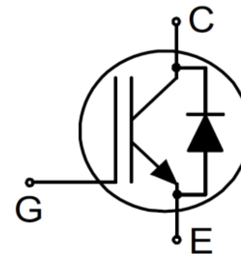
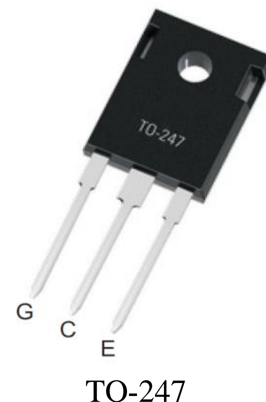


Figure 1 Symbol of SRE60N065FSUD6

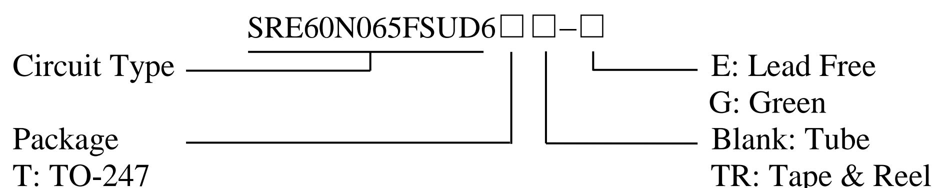
Package Type



TO-247

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 ℃	I_C	100	A
	T_C=100 ℃		60	
Pulsed Collector Current, Limited by T_{Jmax}		I_{CM}	240	A
Diode Continuous Collector Current	T_C=25 ℃	I_F	80	A
	T_C=100 ℃		50	
Diode Pulsed Current, Limited by T_{Jmax}		I_{FM}	200	A
Power Dissipation	T_C=25 ℃	P_{tot}	306	W
	T_C=100 ℃		153	
Operating Junction Temperature Range		T_J	-40 ~ 175(1)	℃
Storage Temperature Range		T_{STG}	-55 ~ 150	℃
Lead Temperature (Soldering, 10 sec)		T_{LEAD}	260	℃

Note:

1. Reliability testing conducted at Tj=175℃.

Thermal Resistance

Parameter	Symbol	Min.	Typ.	Max.	Unit
IGBT Thermal Resistance， Junction-to-Case	R_{thJC}	-	-	0.49	℃/W
Diode Thermal Resistance， Junction-to-Case	R_{thJC}	-	-	0.62	
Thermal Resistance， Junction-to-Ambient	R_{thJA}	-	-	40	

Electrical Characteristics

T_J = 25 ℃, 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	6.0	V
Collector-emitter saturation voltage		V_{CEsat}	V_{GE}=15V, I_C=60A, T_J=25 ℃		1.45	2.0	V
			T_J=125 ℃		1.64		V
			T_J=175 ℃		1.8		V
Zero Gate Voltage Collector Current		I_{CES}	V_{CE}=650V,V_{GE}=0V T_J=25 ℃		0.1	40	μA
			T_J=175 ℃			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 MHz		2350		pF
Output Capacitance		C_{OES}			220		
Reverse Transfer Capacitance		C_{RES}			25		
Gate Resistance		R_G	f=1 MHz, Open Drain		1.7		Ω
Turn-on Delay Time		$t_{d(on)}$	T_J=25 ℃ V_{CC}=400V, I_C=60A R_G=20Ω, 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 ℃ V_{CC}=400V, I_C=60A R_G=20Ω,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 to 15V		32		nC
Gate to Collector Charge		Q_{GC}			39		
Gate Charge Total		Q_G			90		

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 ℃		1.51	2.0	V
		T_J=125 ℃		1.41		
		T_J=175 ℃		1.27		
Reverse Recovery Time	t_{rr}	T_J=25 ℃ V_R=400V, I_F=50A dI_F/dt=700A/µs		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 ℃ V_R=400V, I_F=50A dI_F/dt=700A/µs		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

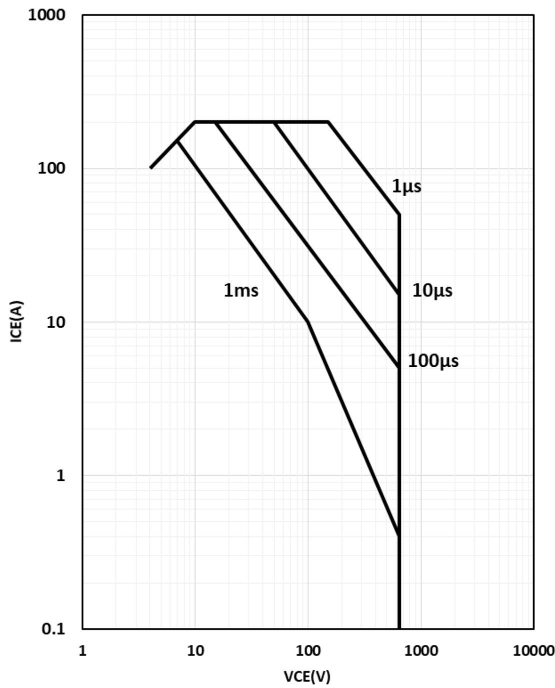
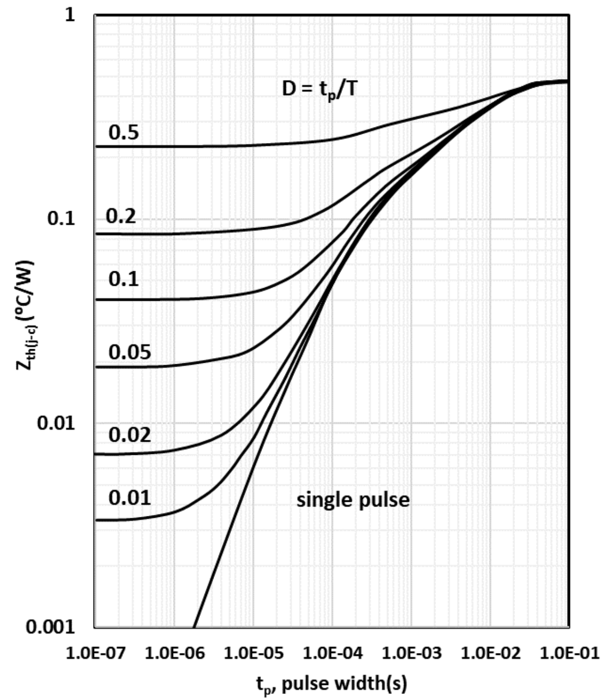
Figure 3: IGBT FBSOA	Figure 4: IGBT transient thermal impedance
	
$I_C = f(V_{CE})$; $V_{GE} \geq 15/0V$; $Tj \leq 175$ ℃	$R_{th(J\text{-}C)} = f(t_p)$; duty cycle: $D = t_p/T$

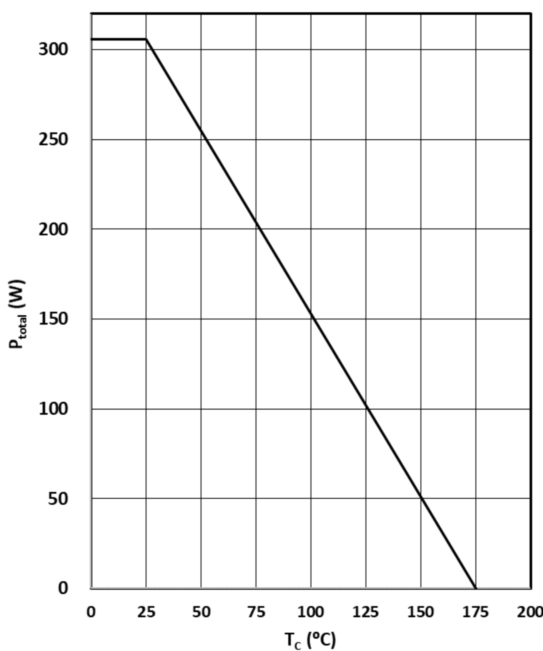
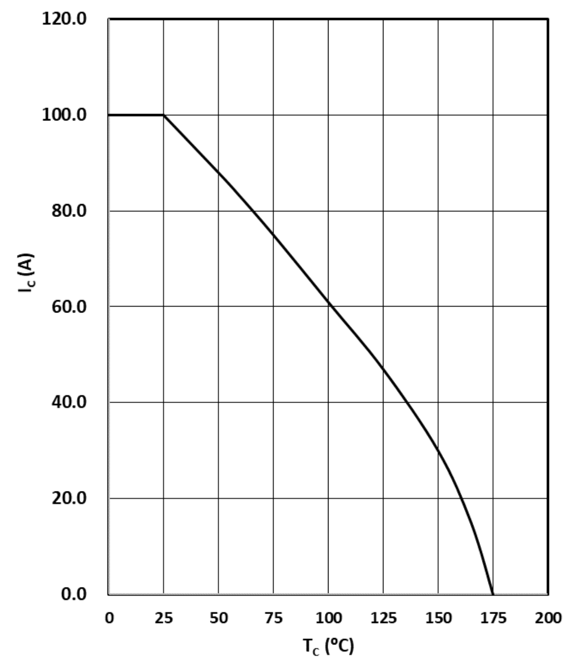
Figure 5: Power dissipation	Figure 6: Collector current vs. temperature
	
Ptot= f(Tc);	$I_c = f(Tj)$; $V_{GE} \geq 15V$; $Tj \leq 175$ ℃

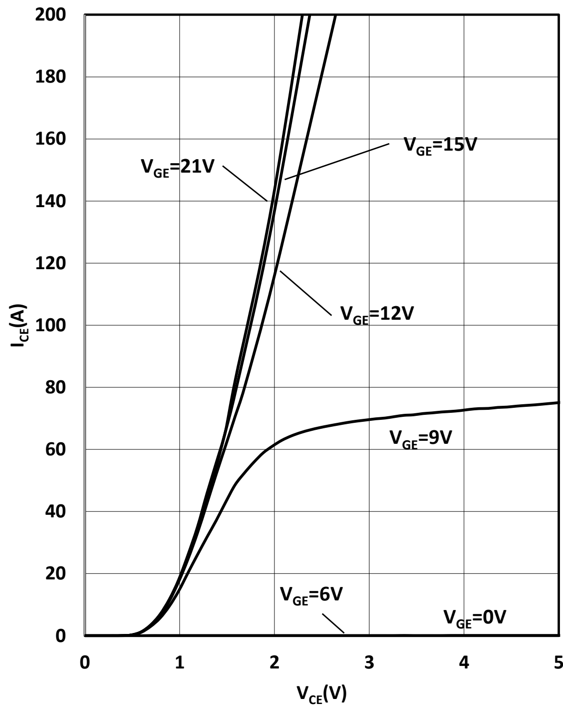
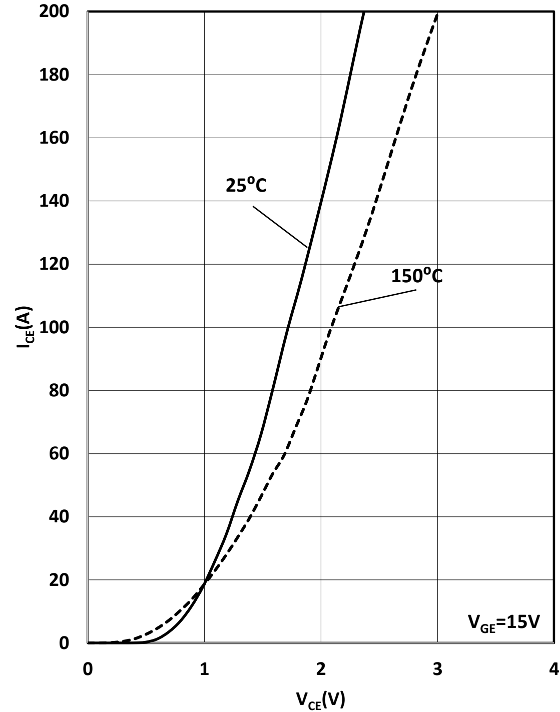
Figure 7: Typ. Output Characteristics	Figure 8: Saturation Voltage Characteristics
	
$I_C = f(V_{CE})$; Tj= 25 ℃; parameter: V_{GE}	$I_C = f(V_{CE})$; Tj= 25 ℃ vs 150 ℃

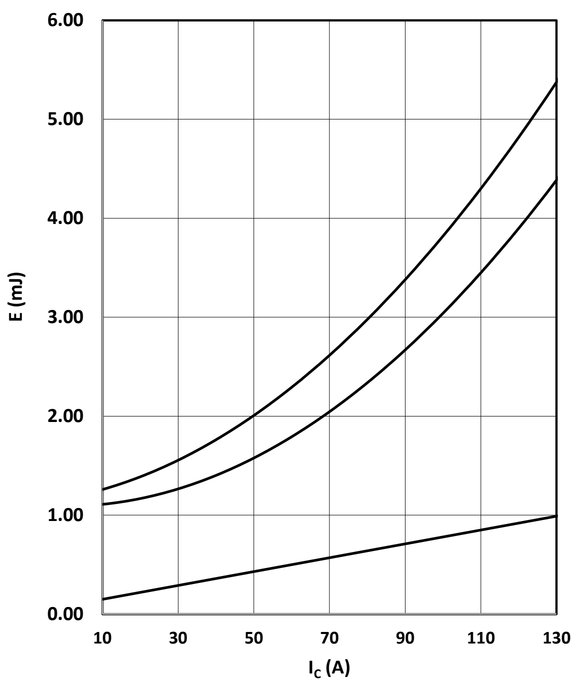
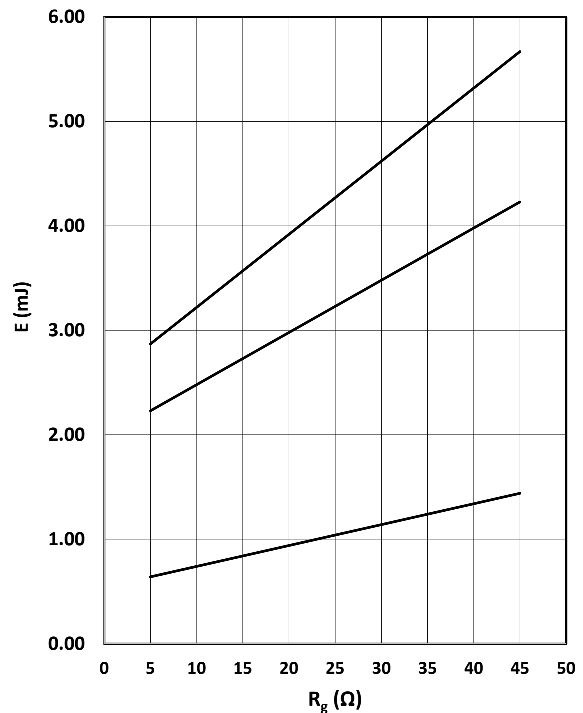
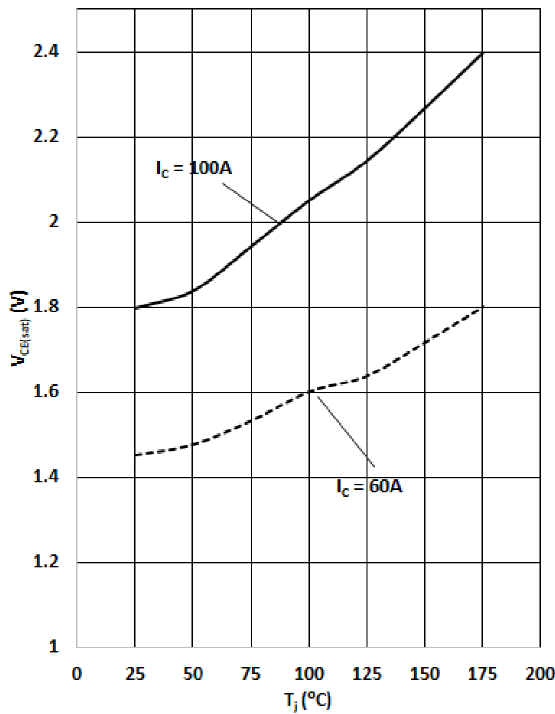
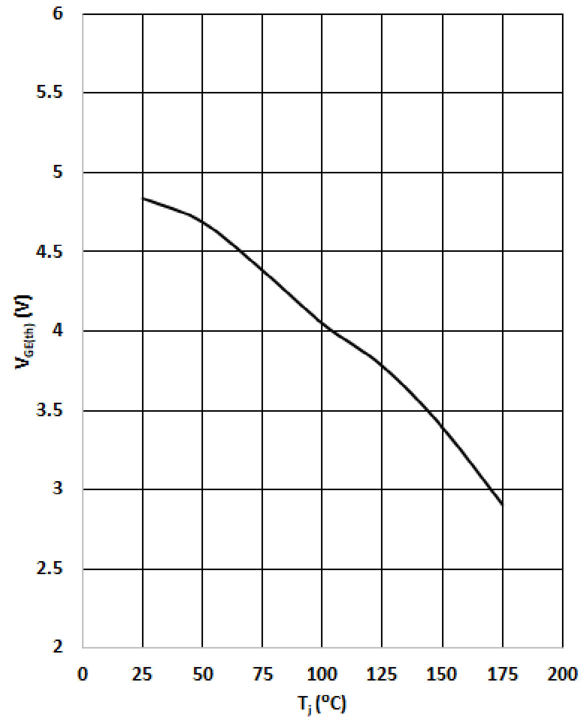
Figure 9: IGBT switching energy losses	Figure10: IGBT switching energy losses
	
E=f(Ic); V_{CE}=400V; Tj=25 ℃; R_G=20Ω	E=f(R_G); V_{CE}=400V; Tj=25 ℃; Ic=60A

Figure 11: Typ. Collector Voltage vs. Temperature



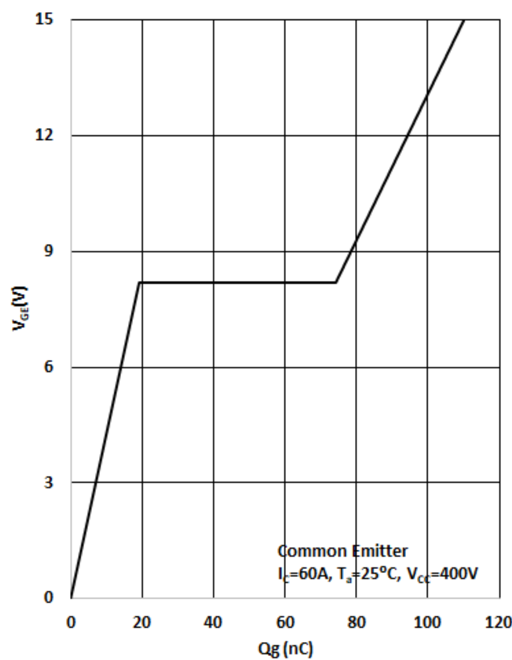
$V_{CE} = f(T_j)$; V_{GE}=15V

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



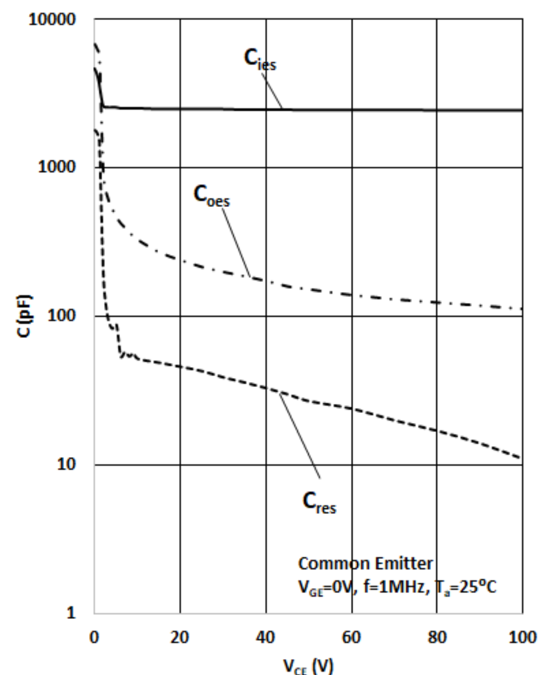
$V_{GE} = f(T_j)$; I_{CE} = 250 µA

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

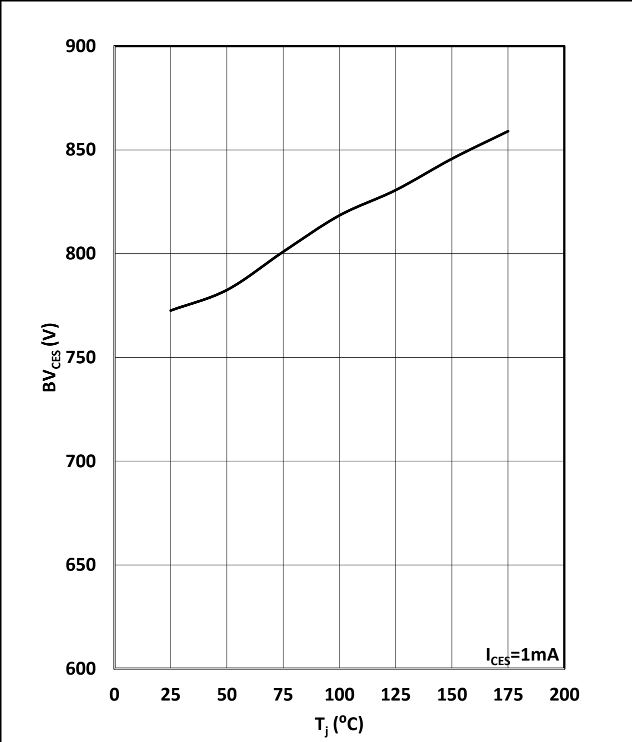
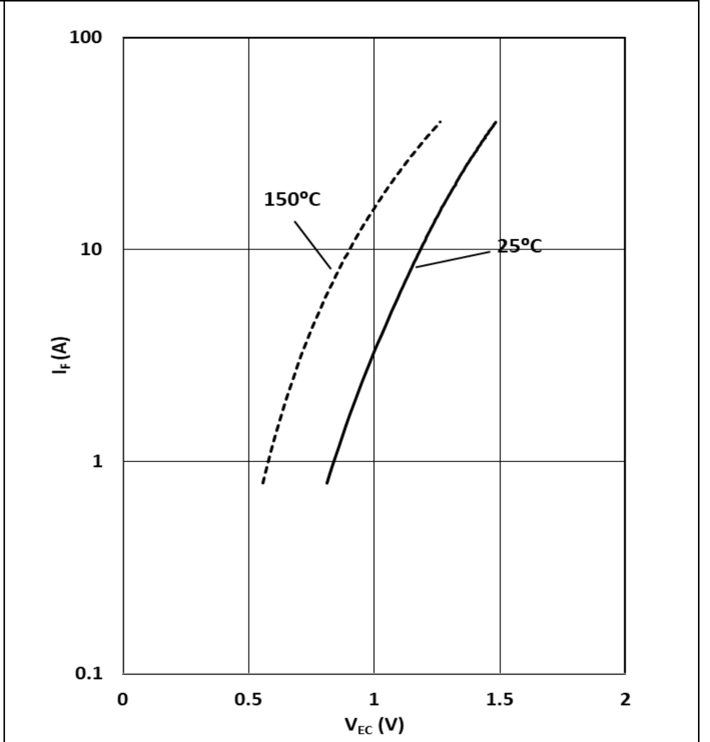
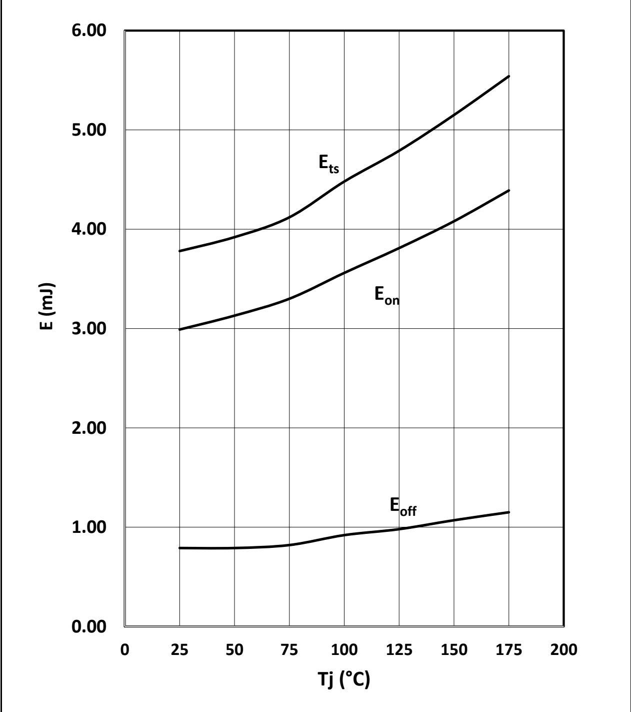
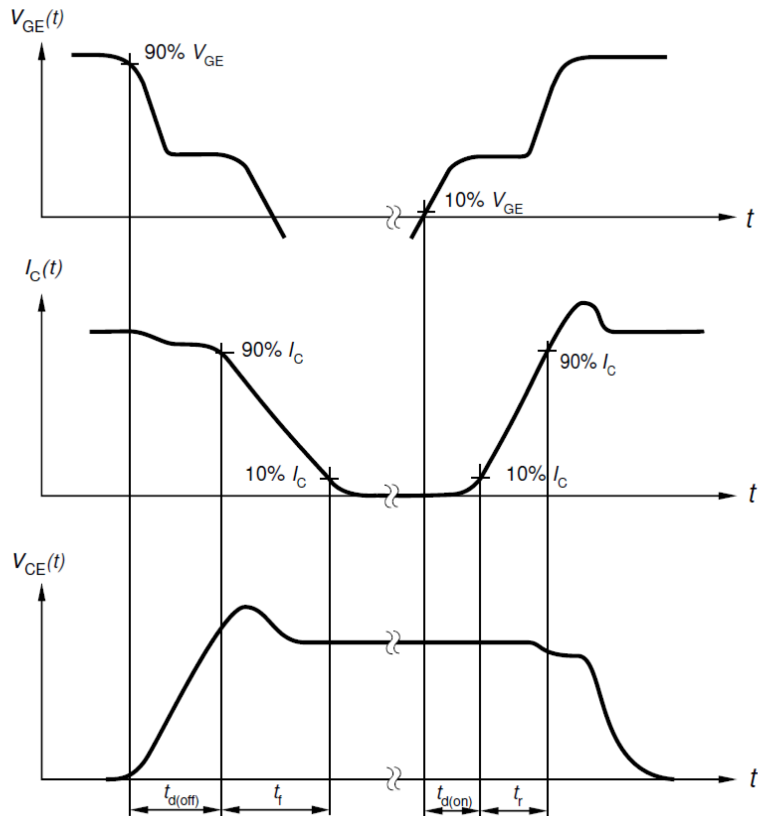
Figure 15: Collector-emitter Breakdown Voltage vs. temperature	Figure 16: Typ. diode forward current as a function of forward voltage
	
BVces= f(Tj);	I_F= f(V_{EC});

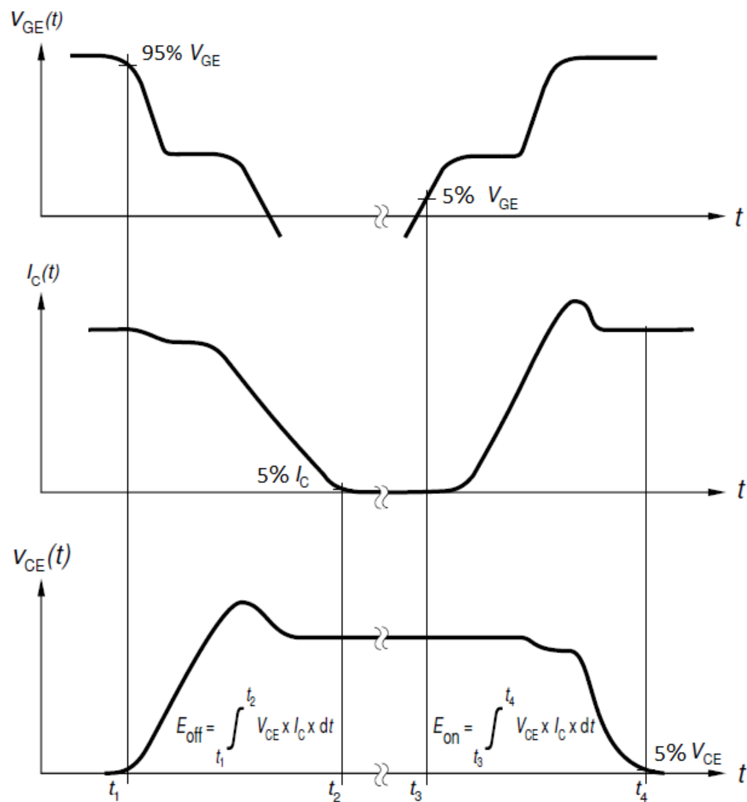
Figure 17: IGBT switching energy losses

E=f(Tj); V_{CE}=400V; Ic=60A; R_G=20Ω

Test Circuits

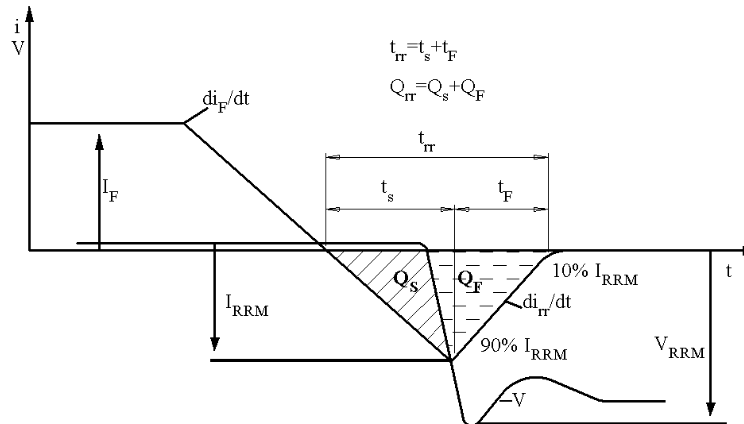
1. Definition Switching times



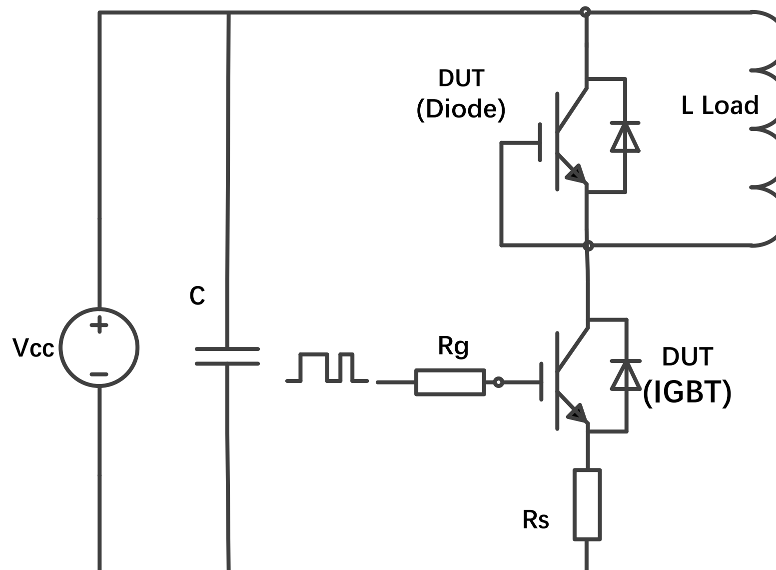
2. Definition Switching losses



3. Definition Diode Switching Characteristics

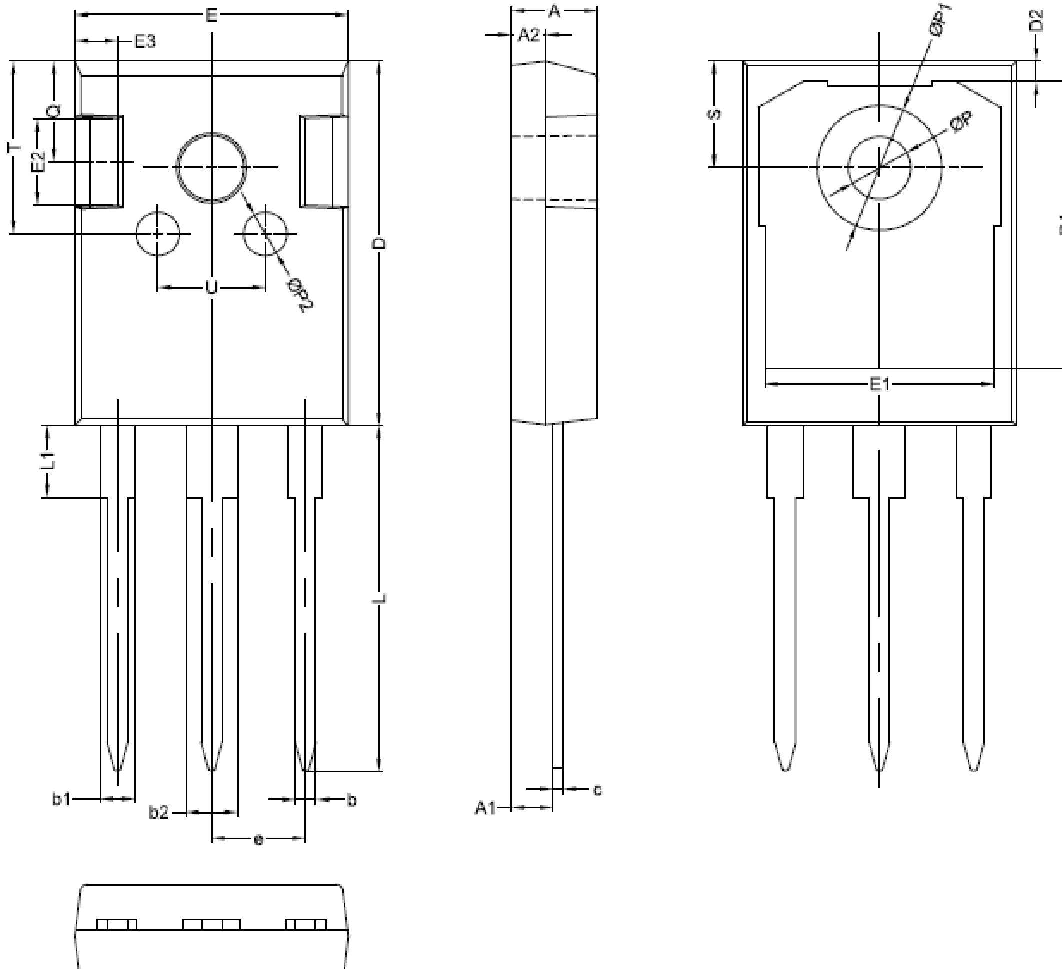


3. Dynamic test circuit



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