60A 650V Trench Fieldstop IGBT with anti-parallel diode SRE60N065FSU2DG

General Description

The SRE60N065FSU2DG 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 SRE60N065FSU2DG package is TO-247.

Features

- High Breakdown Voltage to 650V
- Advanced Trench Fieldstop technology
  - Smooth Switching Off with Lower Spike
  - 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

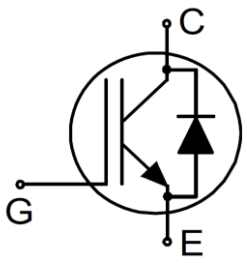
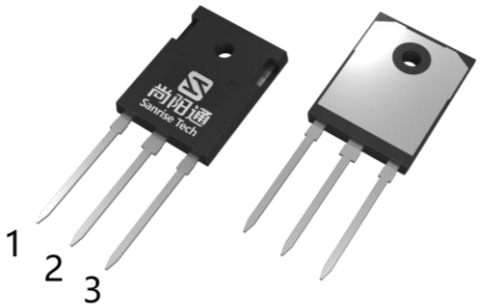


Figure 1 Symbol of SRE60N065FSU2DG

Package Type



TO-247

Pin 1- gate
Pin 2&backside-collector
Pin 3-emitter

Figure 2 Package Type of SRE60N065FSU2DG

Ordering Information

SRE60N065FSU2DG□□–□

Circuit Type
Package
T: TO-247

G: Green
Blank: Tube
TR: Tape & Reel

Package	Part Number	Marking ID	Packing Type
TO-247	SRE60N065FSU2DGT-G1	SRE60N065FSU2DGTG1	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	120	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	70	A
	T_C=100ºC		40(1)	
Diode Pulsed Current, Limited by T_{Jmax}		I_{FM}	120	A
Power Dissipation	T_C=25ºC	P_{tot}	306	W
	T_C=100ºC		153	
Operating Junction Temperature Range		T_J	-40 ~ 175(2)	ºC
Storage Temperature Range		T_{STG}	-55 ~ 150	ºC
Lead Temperature (Soldering, 10 sec)		T_{LEAD}	260	ºC

Note:
1. Current level is limited by Tj_max.
2. Reliability testing conducted at T_{Jmax}=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}	-	-	1.0	
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	4.2	4.8	5.4	V
Collector-emitter saturation voltage		V_{CEsat}	V_{GE}=15V, I_C=60A, T_J=25ºC	1.45	1.51	1.68	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		2460		pF
Output Capacitance		C_{OES}			247		
Reverse Transfer Capacitance		C_{RES}			48		
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=60A R_G=10Ω, V_{GE}=0/15V Energy losses include "tail" and diode reverse recovery		21		ns
Rise Time		t_r			38		ns
Turn-off Delay Time		$t_{d(off)}$			122		ns
Fall Time		t_f			70		ns
Turn-on energy		E_{on}			1.34		mJ
Turn-off energy		E_{off}			0.63		mJ
Total switching energy		E_{ts}			1.97		mJ
Turn-on Delay Time		$t_{d(on)}$	T_J=150ºC V_{CC}=400V, I_C=60A R_G=10Ω,V_{GE}=0/15V Energy losses include "tail" and diode reverse recovery		18		ns
Rise Time		t_r			39		ns
Turn-off Delay Time		$t_{d(off)}$			149		ns
Fall Time		t_f			118		ns
Turn-on energy		E_{on}			2.43		mJ
Turn-off energy		E_{off}			0.92		mJ
Total switching energy		E_{ts}			3.35		mJ
Gate to Emitter Charge		Q_{GE}	V_{CC}=400V, I_C=60A V_{GE}=0 to 15V		28		nC
Gate to Collector Charge		Q_{GC}			91		
Gate Charge Total		Q_G			190		

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Parameter	Symbol	Test Conditions	Min.	Typ.	Max.	Unit
Reverse Diode Characteristics						
Diode Forward Voltage	V_F	I_F=30A T_J=25ºC		1.61	1.89	V
		I_F=30A T_J=125ºC		1.44		
		I_F=30A T_J=175ºC		1.34		
		I_F=60A T_J=25ºC		1.89	2.22	V
		I_F=60A T_J=125ºC		1.79		
		I_F=60A T_J=175ºC		1.68		
Reverse Recovery Time	t_{rr}	T_J=25ºC V_R=400V, I_F=30A dI_F/dt=1100A/us		130		ns
Reverse Recovery Charge	Q_{rr}			0.72		uC
Peak Reverse Recovery Current	I_{rrm}			18		A
Diode peak rate of fall of reverse Recovery current during tb	dirr/dt			-456		A/us
Reverse Recovery Time	t_{rr}	T_J=25ºC V_R=400V, I_F=60A dI_F/dt=1000A/us		179		ns
Reverse Recovery Charge	Q_{rr}			0.84		uC
Peak Reverse Recovery Current	I_{rrm}			19		A
Diode peak rate of fall of reverse Recovery current during tb	dirr/dt			-375		A/us
Reverse Recovery Time	t_{rr}	T_J=150ºC V_R=400V, I_F=30A dI_F/dt=1100A/us		143		ns
Reverse Recovery Charge	Q_{rr}			1.34		nC
Peak Reverse Recovery Current	I_{rrm}			25		A
Diode peak rate of fall of reverse Recovery current during tb	dirr/dt			-523		A/us
Reverse Recovery Time	t_{rr}	T_J=150ºC V_R=400V, I_F=60A dI_F/dt=1000A/us		223		ns
Reverse Recovery Charge	Q_{rr}			1.93		uC
Peak Reverse Recovery Current	I_{rrm}			26		A
Diode peak rate of fall of reverse Recovery current during tb	dirr/dt			-394		A/us

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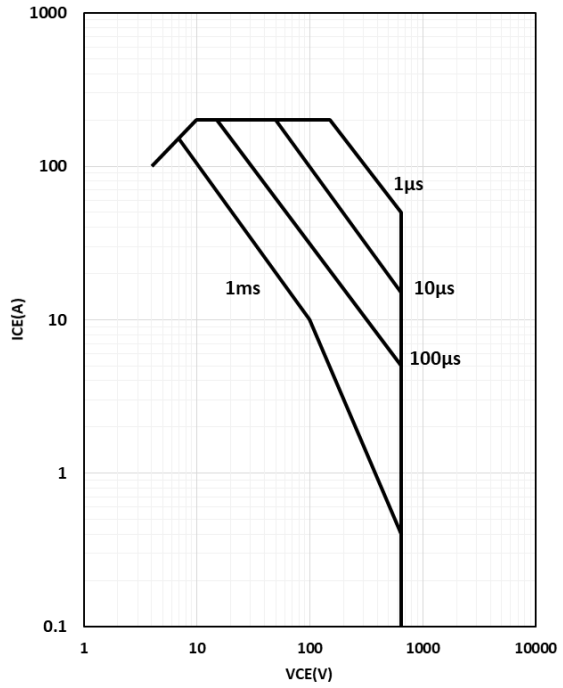
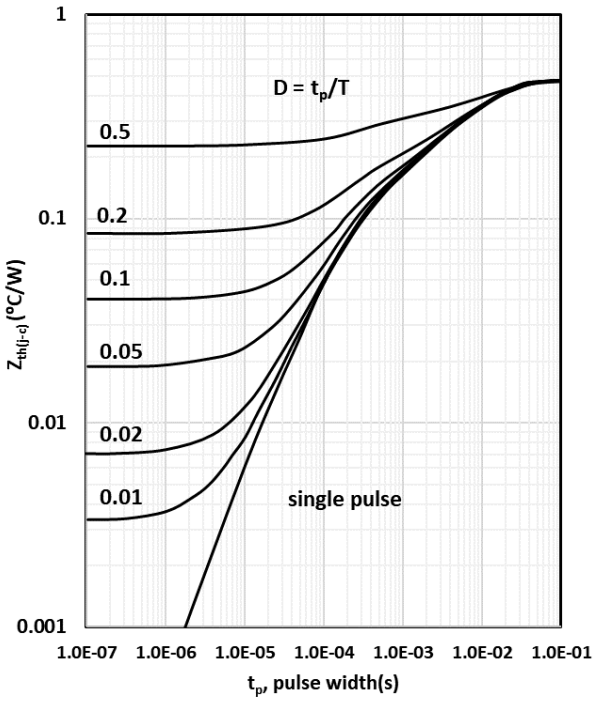
Typical Performance Characteristics

Figure 3: IGBT FBSOA



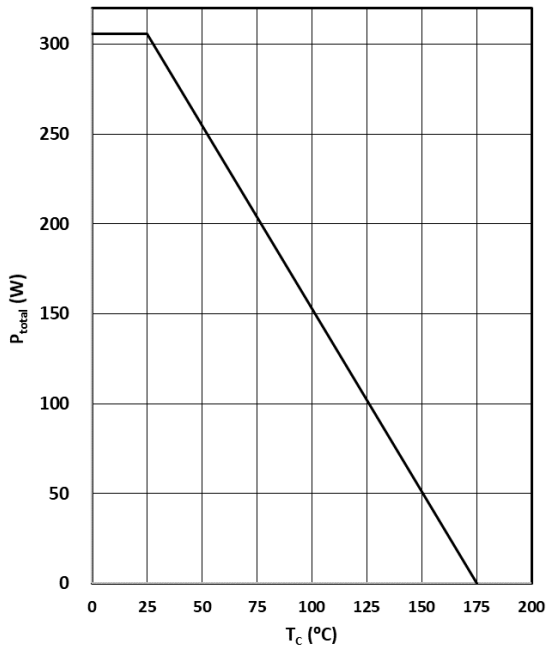
$I_C = f(V_{CE})$; $V_{GE} \geq 15/0V$; $Tj \leq 175^oC$

Figure 4: IGBT transient thermal impedance



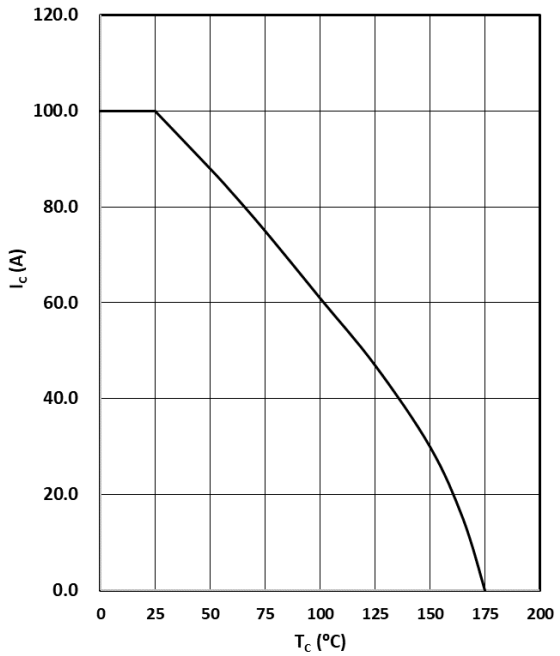
$R_{th(J-C)} = f(t_p)$; duty cycle: $D = t_p/T$

Figure 5: Power dissipation



Ptot= f(Tc);

Figure 6: Collector current vs. temperature



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

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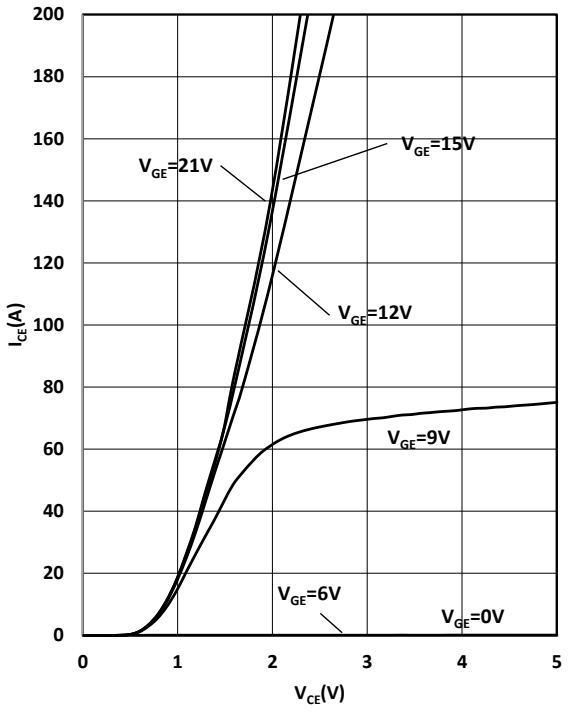
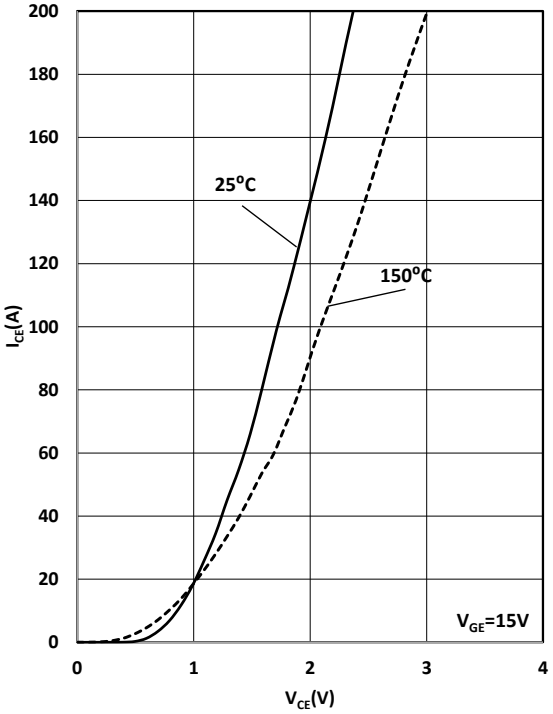
Figure 7: Typical Output Characteristics



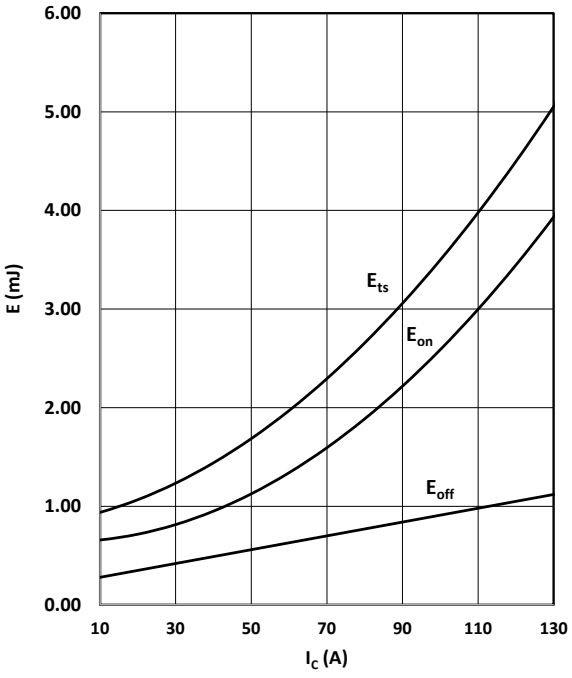
$I_C = f(V_{CE})$; Tj= 25ºC; parameter: V_{GE}

Figure 8: Typical transfer characteristic



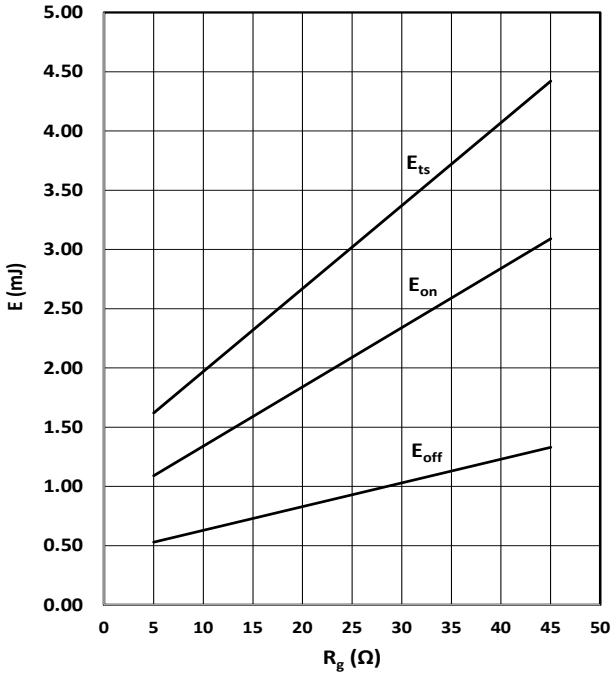
$I_C = f(V_{CE})$; Tj= 25ºC vs 150ºC

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



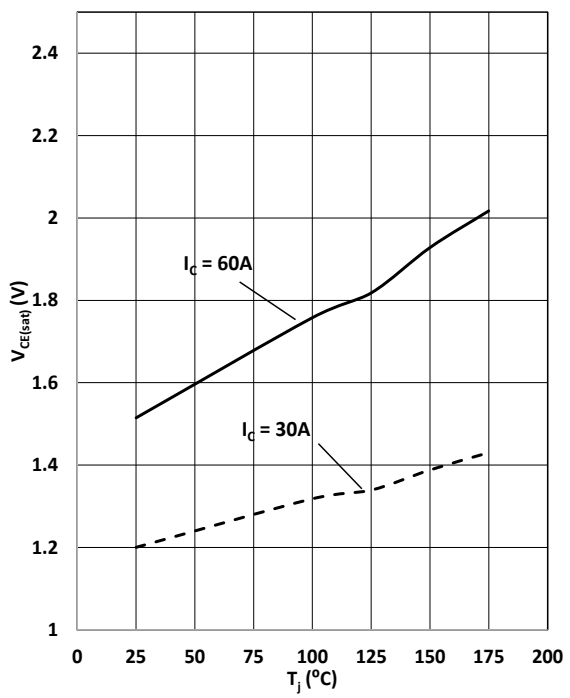
E=f(Ic); V_{CE}=400V; Tj=25ºC; R_G=10Ω

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



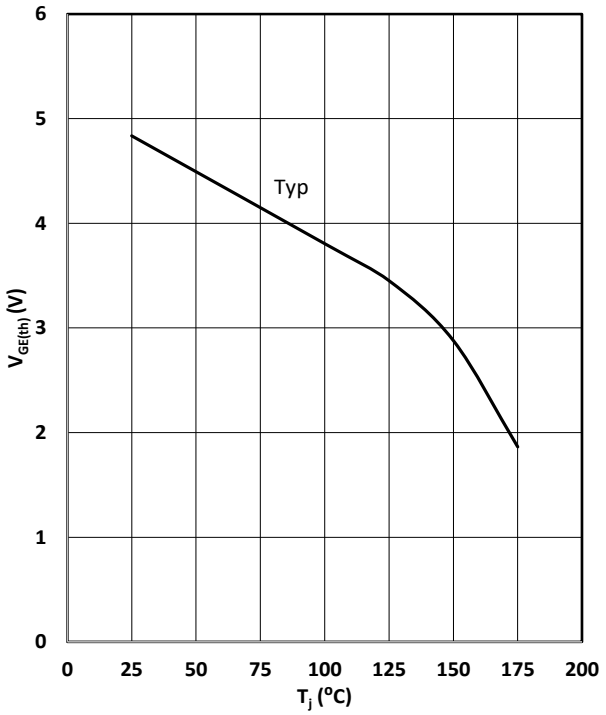
E=f(R_G); V_{CE}=400V; Tj=25ºC; Ic=60A

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



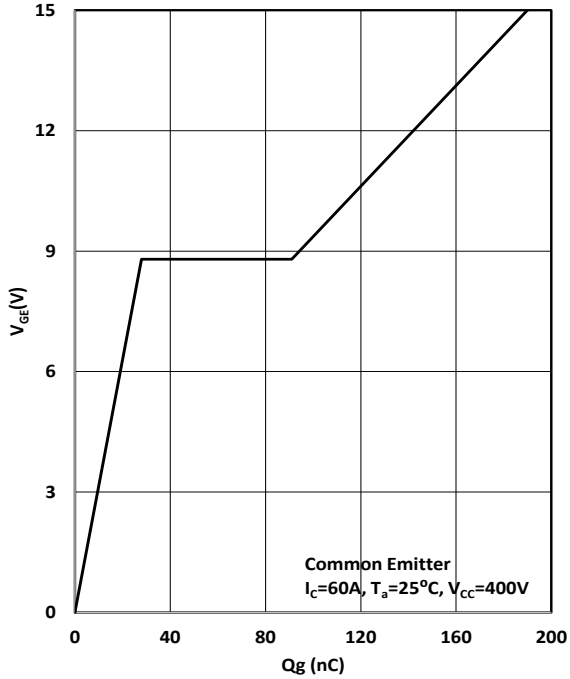
V_{CE} =f(T_j); V_{GE}=15V

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



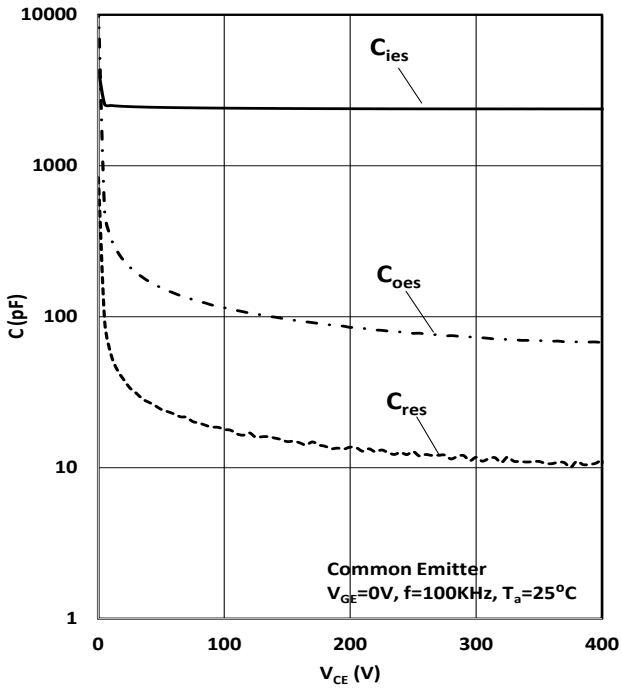
V_{GE} =f(T_j); I_{CE} = 250μA

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

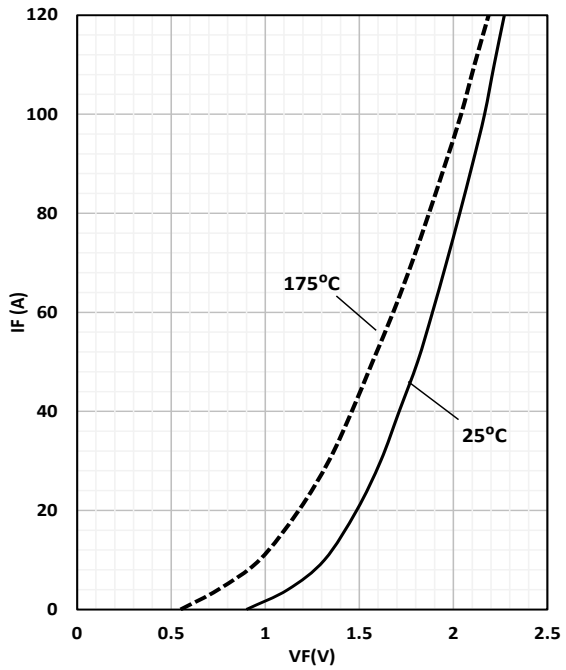
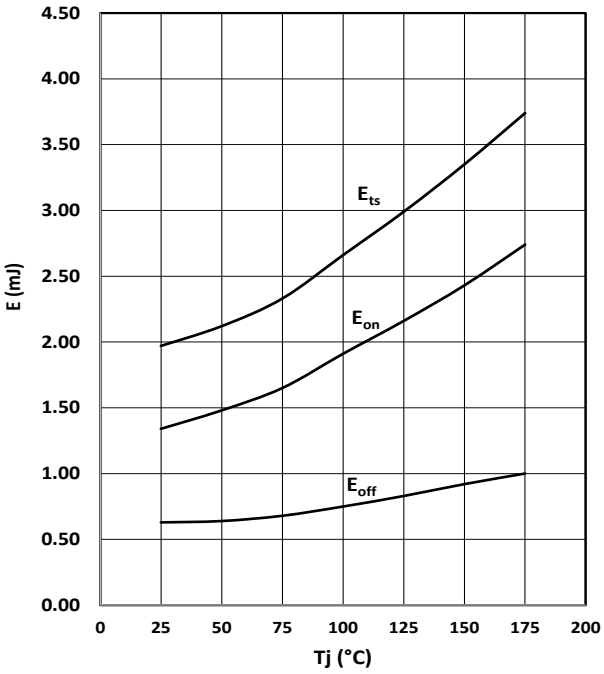
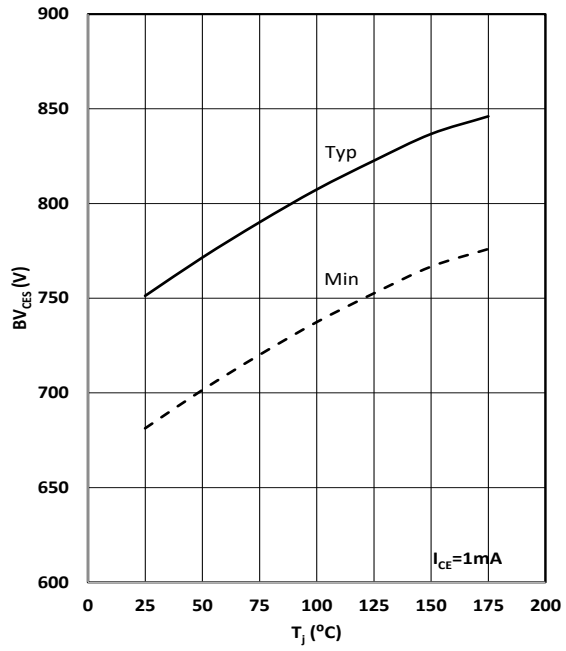
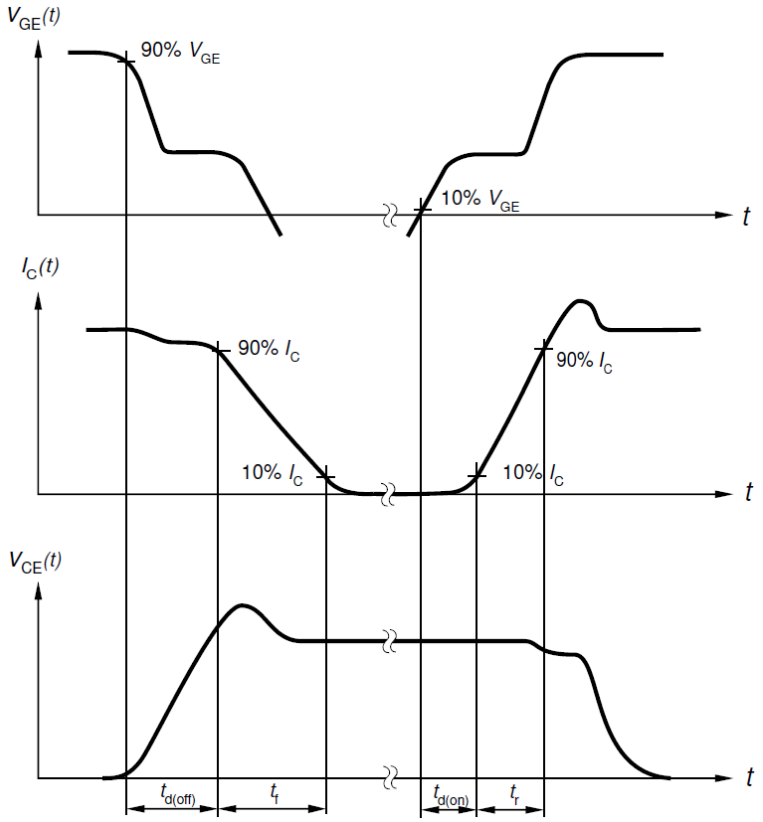
Figure 15: Typical diode forward current as a function of forward voltage	Figure 16: Typical switching energy losses as a function of junction temperature
	
I_F= f(V_{EC});	E=f(Tj); V_{CE}=400V; Ic=60A; R_G=10Ω

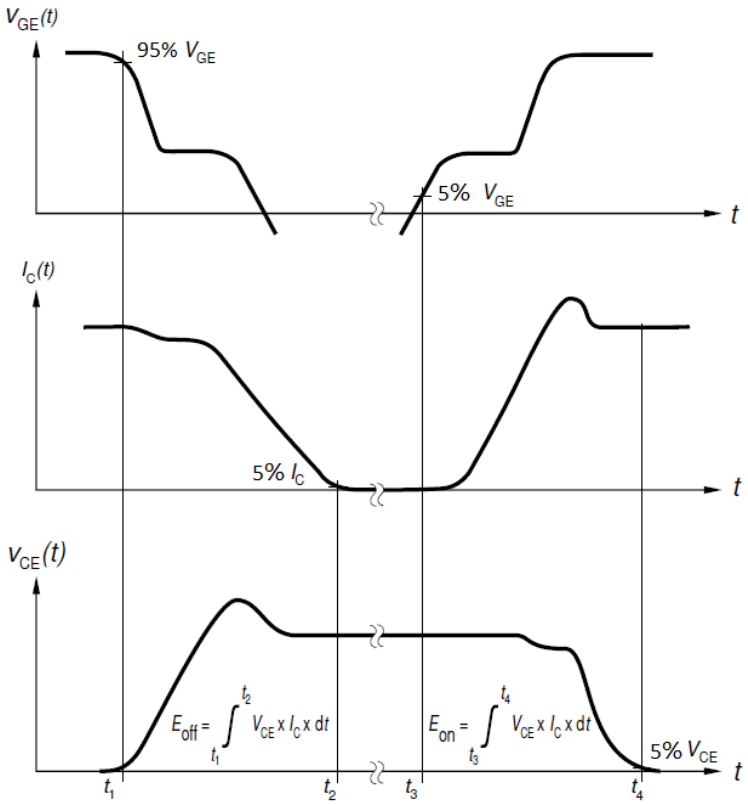
Figure17: Collector-emitter Breakdown Voltage vs. temperature

BVces= f(Tj);

Test Circuits

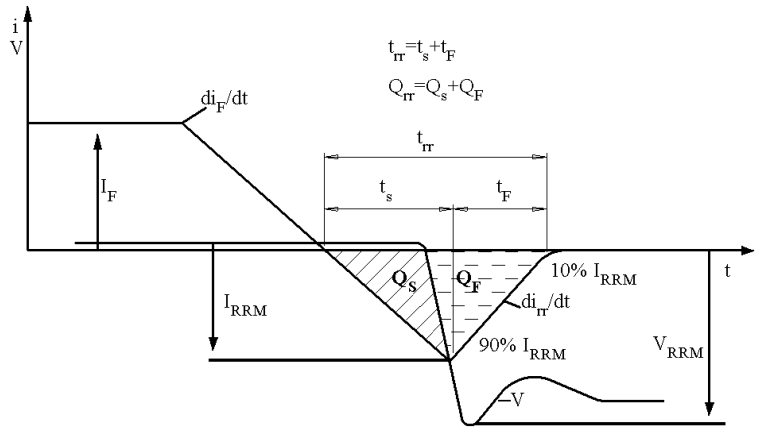
1. Definition Switching times



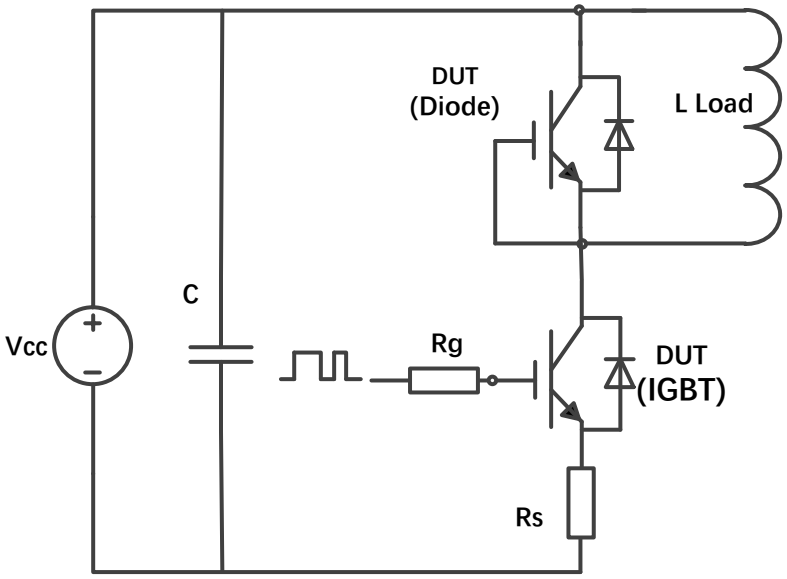
2. Definition Switching losses



3. Definition Diode Switching Characteristics



4. Dynamic test circuit



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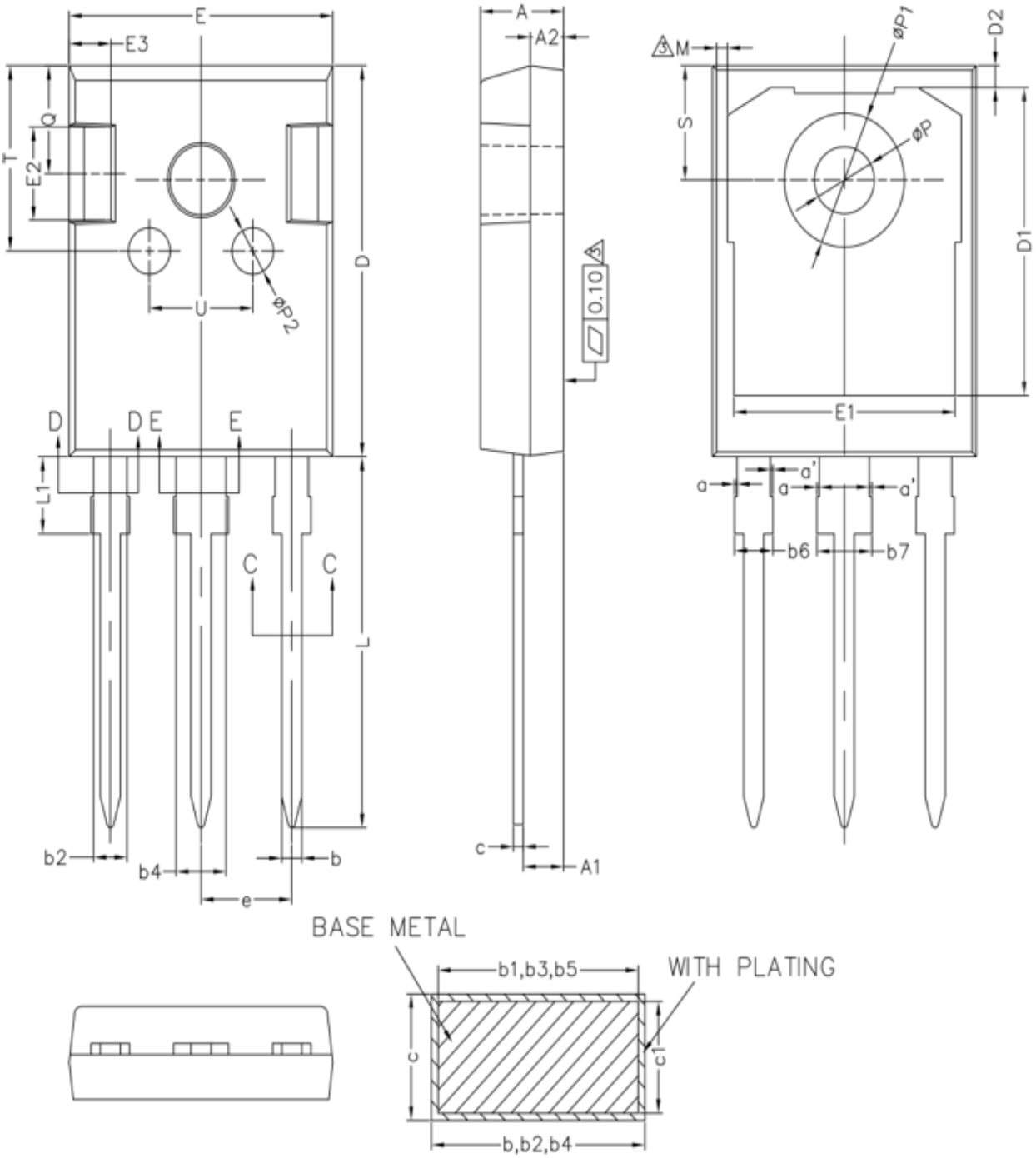
Mechanical Dimensions

TO-247 **Unit: mm**



60A 650V Trench Fieldstop IGBT with anti-parallel diode SRE60N065FSU2DG

Mechanical Dimensions

Symbol	Dimensions(mm)			Symbol	Dimensions(mm)		
	Min.	Typ.	Max.		Min.	Typ.	Max.
A	4.90	5.00	5.10	D2	1.05	1.20	1.35
A1	2.31	2.41	2.51	E	15.70	15.80	15.90
A2	1.90	2.00	2.10	E1	13.10	13.30	13.50
a	0	-	0.15	E2	4.90	5.00	5.10
a’	0	-	0.15	E3	2.40	2.50	2.60
b	1.16	-	1.26	e	5.34	5.44	5.54
b1	1.15	1.2	1.22	L	19.80	19.92	20.10
b2	1.96	-	2.06	L1	-	-	4.30
b3	1.95	2.00	2.02	M	0.35	-	0.95
b4	2.96	-	3.06	P	3.50	3.60	3.70
b5	2.95	3.00	3.02	P1	7.00	-	7.40
b6	-	-	2.25	P2	2.40	2.50	2.60
b7	-	-	3.25	Q	5.60	-	6.00
c	0.59	-	0.66	S	6.05	6.15	6.25
c1	0.58	0.60	0.62	T	9.80	-	10.20
D	20.90	21.00	21.10	U	6.00	-	6.40
D1	16.25	16.55	16.85	-	-	-	-

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Sanrise Technology Co., LTD

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