

60A 650V Trench Fieldstop IGBT with anti-parallel diode SRE60N065FSU2DH
General Description

The SRE60N065FSU2DH 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 SRE60N065FSU2DH 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

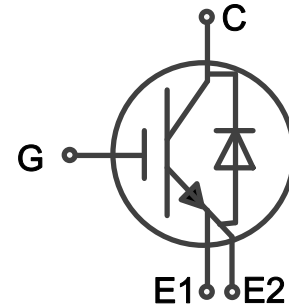
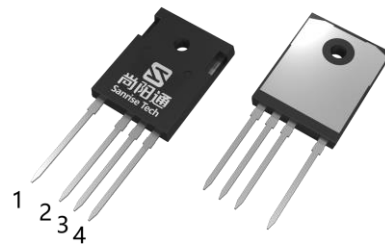
Symbol


Figure 1 Symbol of SRE60N065FSU2DH

Package Type


TO-247-4

Pin 1- &backside-Collector; Pin 2-Emitter2
 Pin 3- Kelvin Emitter1; Pin 4- Gate

Figure 2 Package Type of SRE60N065FSU2DH

Ordering Information

SRE60N065FSU2DH□□-□

Circuit Type _____
 Package _____
 T4: TO-247-4

G: Green
 Blank: Tube
 TR: Tape & Reel

Package	Part Number	Marking ID	Packing Type
TO-247-4	SRE60N065FSU2DHT4-G1	SRE60N065FSU2DHT4G1	Tube

60A 650V Trench Fieldstop IGBT with anti-parallel diode SRE60N065FSU2DH
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	$T_C=25^\circ\text{C}$	I_C	100	A
	$T_C=100^\circ\text{C}$		60	
Pulsed Collector Current, Limited by T_{Jmax}		I_{CM}	240	A
Diode Continuous Collector Current	$T_C=25^\circ\text{C}$	I_F	80	A
	$T_C=100^\circ\text{C}$		60	
Diode Pulsed Current, Limited by T_{Jmax}		I_{FM}	120	200
Power Dissipation	$T_C=25^\circ\text{C}$	P_{tot}	306	W
	$T_C=100^\circ\text{C}$		153	
Operating Junction Temperature Range		T_J	$-40 \sim 175^{(1)}$	$^\circ\text{C}$
Storage Temperature Range		T_{STG}	$-55 \sim 150$	$^\circ\text{C}$
Lead Temperature (Soldering, 10 sec)		T_{LEAD}	260	$^\circ\text{C}$

Note:

 1. Reliability testing conducted at $T_{j_max}=175^\circ\text{C}$.

Thermal Resistance

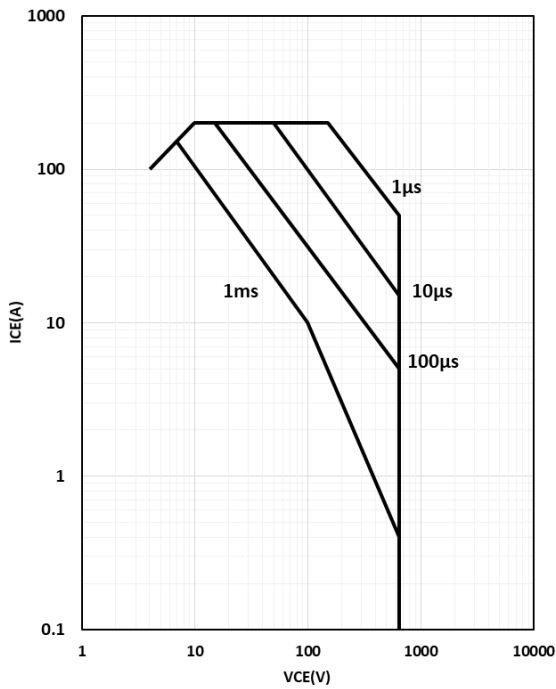
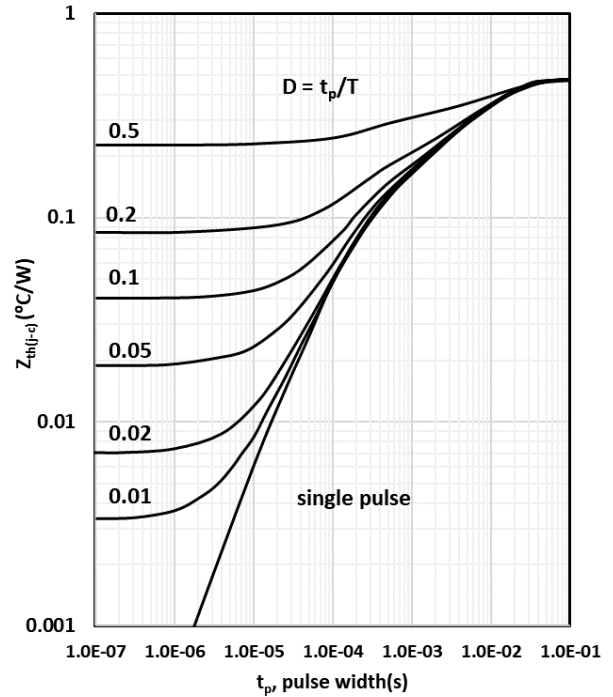
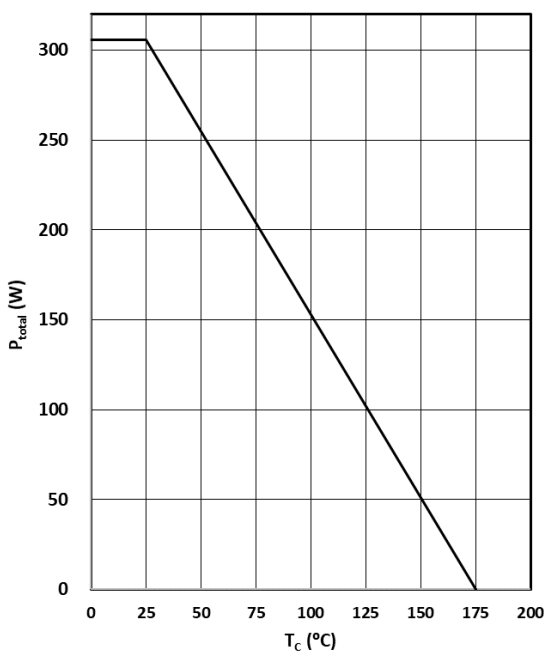
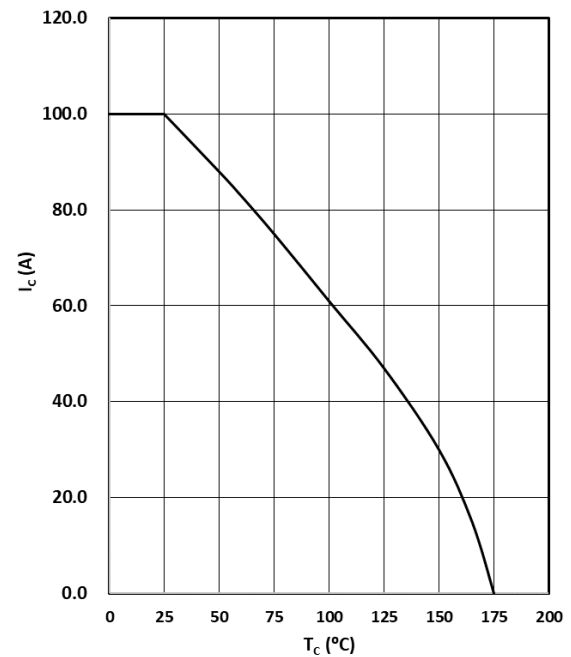
Parameter	Symbol	Min.	Typ.	Max.	Unit
IGBT Thermal Resistance, Junction-to-Case	R_{thJC}	-	-	0.49	$^\circ\text{C/W}$
Diode Thermal Resistance, Junction-to-Case	R_{thJC}	-	-	0.62	
Thermal Resistance, Junction-to-Ambient	R_{thJA}	-	-	40	

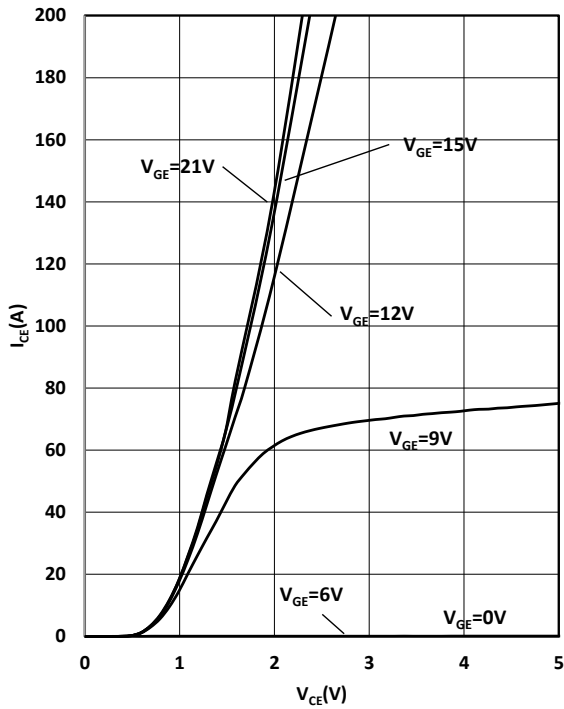
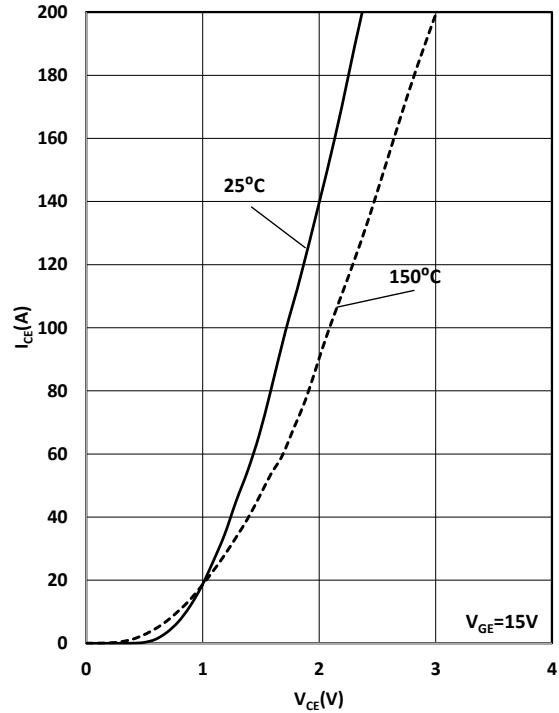
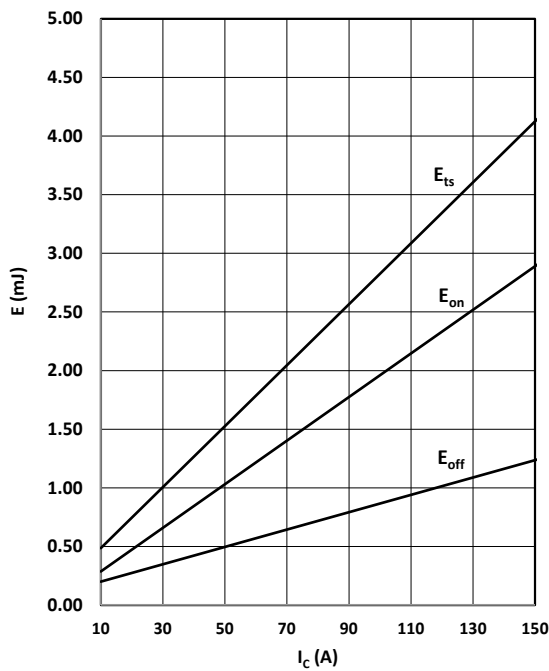
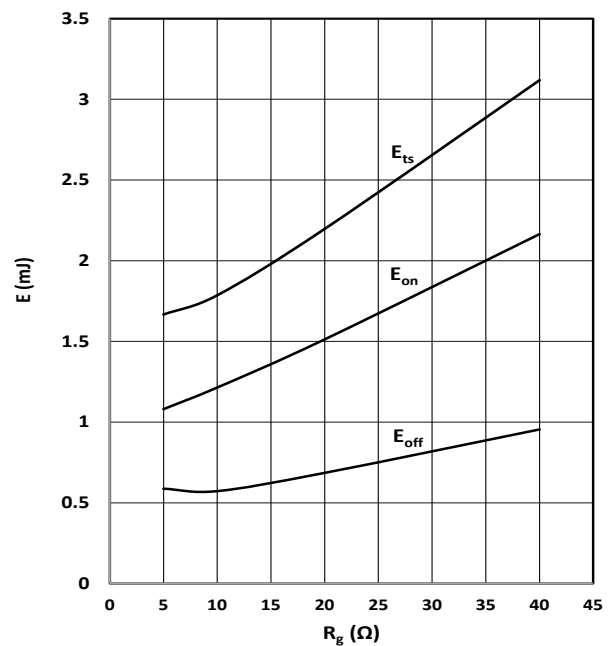
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Electrical Characteristics
 $T_J = 25^\circ\text{C}$, unless otherwise specified.

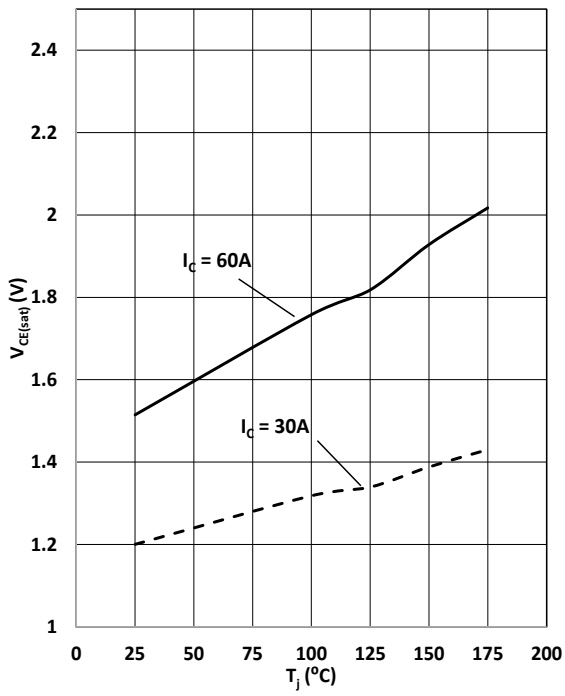
Parameter	Symbol	Test Conditions	Min.	Typ.	Max.	Unit
Statistic Characteristics						
Collector-emitter Breakdown Voltage	BV_{CES}	$V_{GE}=0V, I_C=250\mu A$	650			V
Gate Threshold Voltage	$V_{GE(th)}$	$V_{CE}=V_{GE}, I_C=250\mu A$	4.0	4.8	5.6	V
Collector-emitter saturation voltage	V_{CEsat}	$V_{GE}=15V, I_C=60A,$ $T_J=25^\circ\text{C}$		1.51	1.85	V
		$T_J=125^\circ\text{C}$		1.81		V
		$T_J=175^\circ\text{C}$		2.05		V
Zero Gate Voltage Collector Current	I_{CES}	$V_{CE}=650V, V_{GE}=0V$ $T_J=25^\circ\text{C}$		0.1	40	μA
		$T_J=175^\circ\text{C}$			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}	$V_{CE}=25V, V_{GE}=0V,$ $f=100\text{KHz}$		2460		pF
Output Capacitance	C_{OES}			247		
Reverse Transfer Capacitance	C_{RES}			48		
Gate Resistance	R_G	$f=1\text{ MHz, Open Drain}$		1.53		Ω
Turn-on Delay Time	$t_{d(on)}$	$T_J=25^\circ\text{C}$ $V_{CC}=400V, I_C=30A$ $R_G=10\Omega, V_{GE}=0/15V$ Energy losses include "tail" and diode reverse recovery		19		ns
Rise Time	t_r			12		ns
Turn-off Delay Time	$t_{d(off)}$			95		ns
Fall Time	t_f			56		ns
Turn-on energy	E_{on}			0.7		mJ
Turn-off energy	E_{off}			0.35		mJ
Total switching energy	E_{ts}			1.05		mJ
Turn-on Delay Time	$t_{d(on)}$			21		ns
Rise Time	t_r			19		ns
Turn-off Delay Time	$t_{d(off)}$			76		ns
Fall Time	t_f			66		ns
Turn-on energy	E_{on}			1.2		mJ
Turn-off energy	E_{off}			0.6		mJ
Total switching energy	E_{ts}		1.8		mJ	
Gate to Emitter Charge	Q_{GE}	$V_{CC}=400V, I_C=60A$ $V_{GE}=0\text{ to }15V$		17		nC
Gate to Collector Charge	Q_{GC}			21		
Gate Charge Total	Q_G			60		

60A 650V Trench Fieldstop IGBT with anti-parallel diode SRE60N065FSU2DH

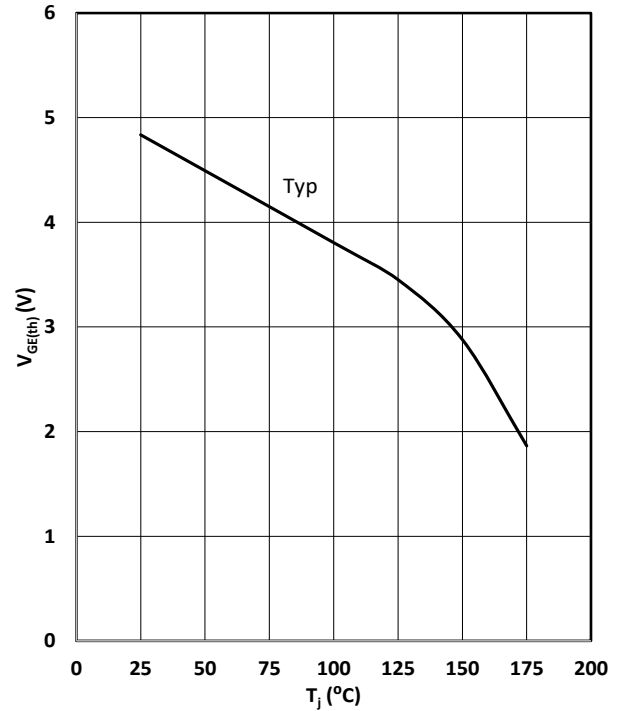
Parameter	Symbol	Test Conditions	Min.	Typ.	Max.	Unit
Reverse Diode Characteristics						
Drain-Source Diode Forward Voltage	V_F	$I_F=30A$ $T_J=25^\circ C$		1.38	1.9	V
		$I_F=30A$ $T_J=125^\circ C$		1.23		
		$I_F=30A$ $T_J=175^\circ C$		1.12		
		$I_F=60A$ $T_J=25^\circ C$		1.62	2.1	V
		$I_F=60A$ $T_J=125^\circ C$		1.52		
		$I_F=60A$ $T_J=175^\circ C$		1.36		
Reverse Recovery Time	t_{rr}	$T_J=25^\circ C$ $V_R=400V, I_F=30A$ $dI_F/dt=1000A/\mu s$		92		ns
Reverse Recovery Charge	Q_{rr}			0.88		uC
Peak Reverse Recovery Current	I_{rrm}			20.6		A
Diode peak rate of fall of reverse recovery current during t_b	di_{rr}/dt			-534		A/ μs
Reverse Recovery Time	t_{rr}	$T_J=25^\circ C$ $V_R=400V, I_F=60A$ $dI_F/dt=990A/\mu s$		132		ns
Reverse Recovery Charge	Q_{rr}			1.2		uC
Peak Reverse Recovery Current	I_{rrm}			21		A
Diode peak rate of fall of reverse recovery current during t_b	di_{rr}/dt			-450		A/ μs

60A 650V Trench Fieldstop IGBT with anti-parallel diode SRE60N065FSU2DH
Typical Performance Characteristics
Figure 3: IGBT FBSOA

 $I_C = f(V_{CE}); V_{GE} \geq 15/0V; T_j \leq 175^\circ C$
Figure 4: IGBT transient thermal impedance

 $R_{th(j-c)} = f(t_p); \text{ duty cycle: } D = t_p/T$
Figure 5: Power dissipation

 $P_{tot} = f(T_c);$
Figure 6: Collector current vs. temperature

 $I_c = f(T_j); V_{GE} \geq 15V; T_j \leq 175^\circ C$

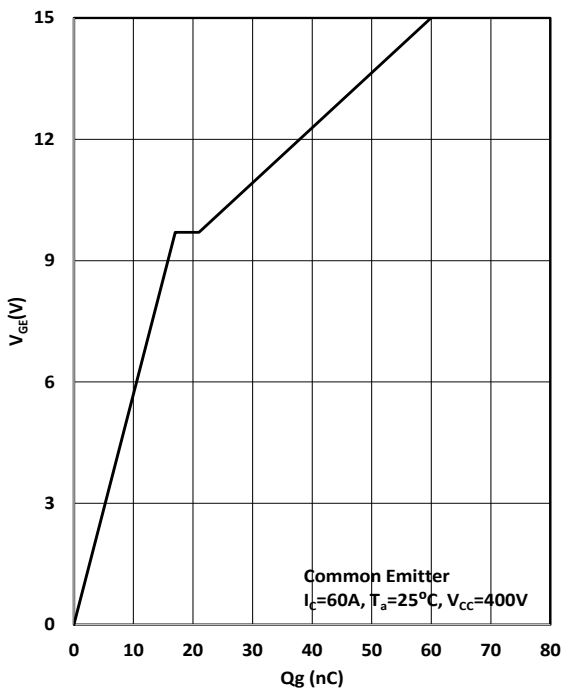
60A 650V Trench Fieldstop IGBT with anti-parallel diode SRE60N065FSU2DH
Figure 7: Typical Output Characteristics

 $I_C = f(V_{CE}); T_j = 25^\circ\text{C}; \text{parameter: } V_{GE}$
Figure 8: Typical transfer characteristic

 $I_C = f(V_{CE}); T_j = 25^\circ\text{C vs } 150^\circ\text{C}$
Figure 9: Typical switching energy losses as a function of collector current

 $E = f(I_c); V_{CE} = 400\text{V}; T_j = 25^\circ\text{C}; R_G = 10\Omega$
Figure 10: Typical switching energy losses as a function of gate resistor

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

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


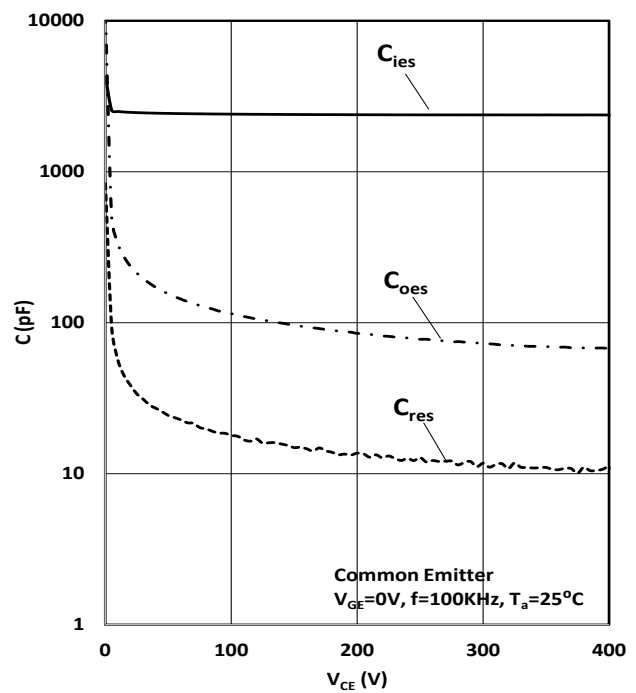
$$V_{CE} = f(T_j); V_{GE} = 15V$$

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


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

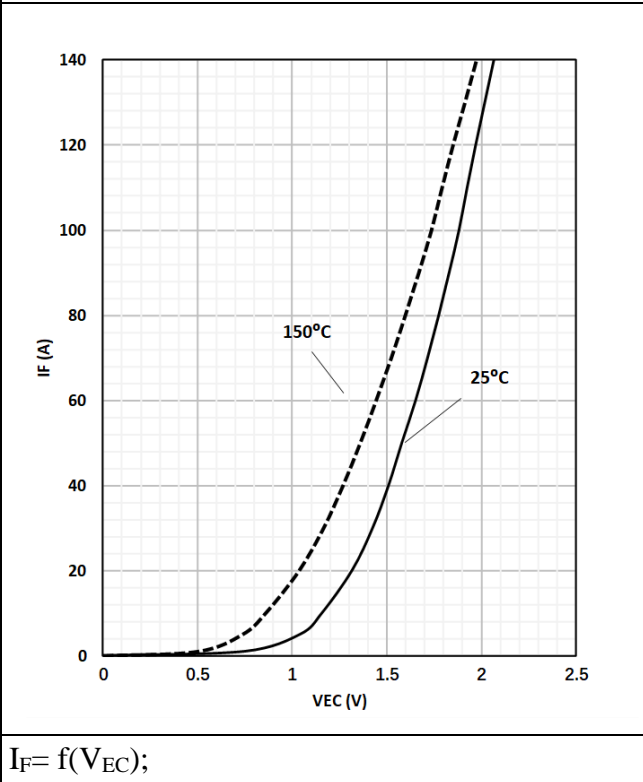
Figure 13: Typical Gate Charge


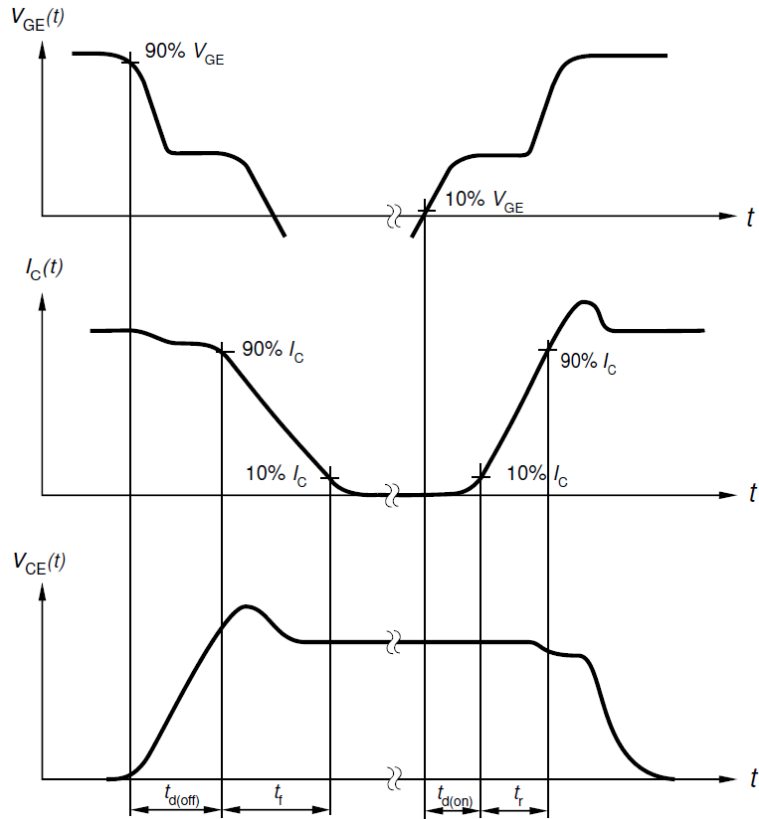
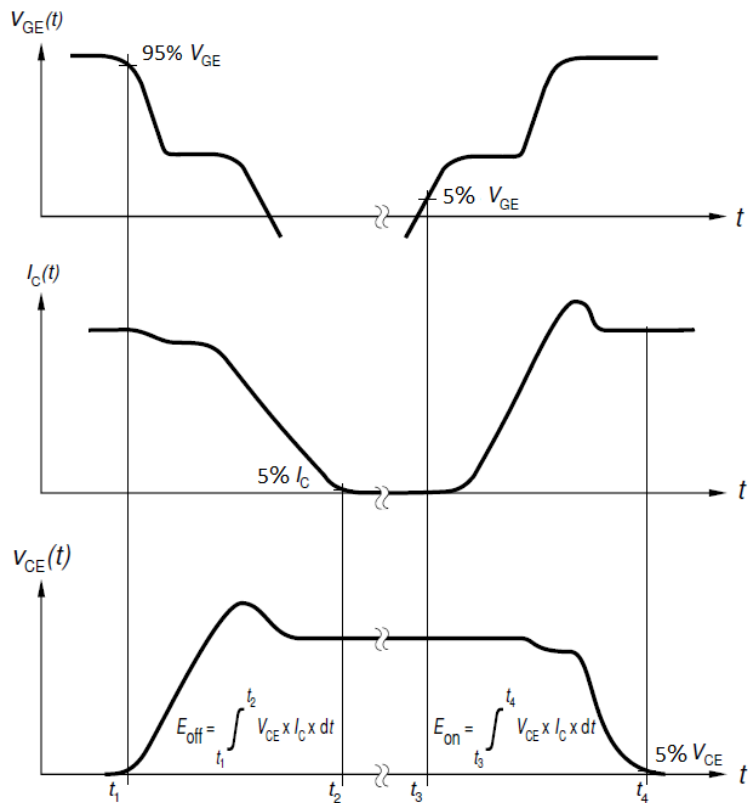
$$V_{GE} = f(Q_{gate}); I_C = 60A$$

Figure 14: Typical Capacitances


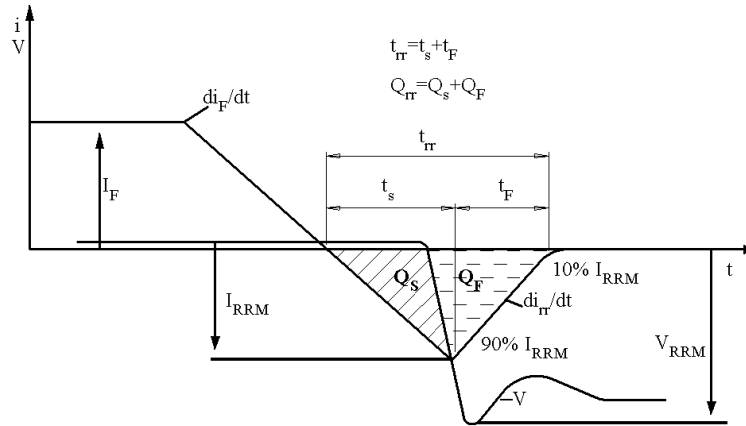
$$C = f(V_{CE}); V_{GE} = 0; f = 100KHz$$

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

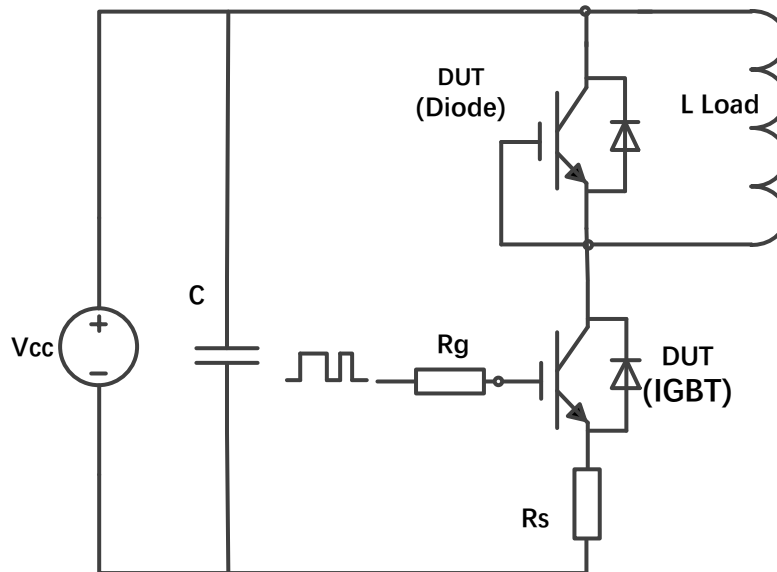


Test Circuits
1. Definition Switching times

2. Definition Switching losses


3. Definition Diode Switching Characteristics



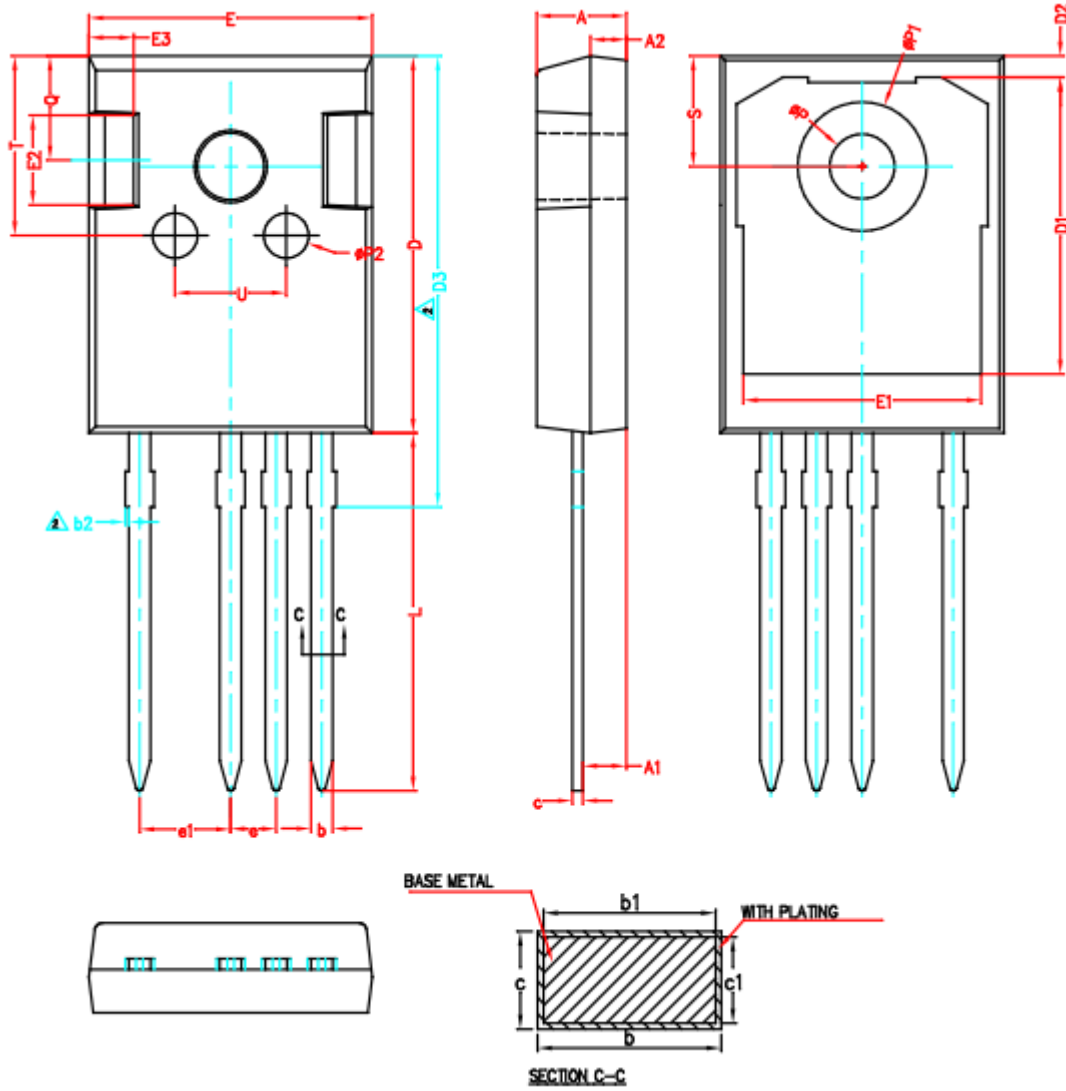
4. Dynamic test circuit



Mechanical Dimensions

TO-247-4

Unit: mm



60A 650V Trench Fieldstop IGBT with anti-parallel diode SRE60N065FSU2DH
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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