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.

Symbol

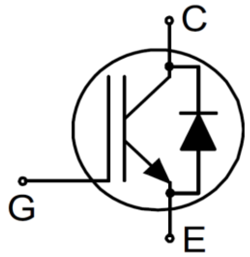
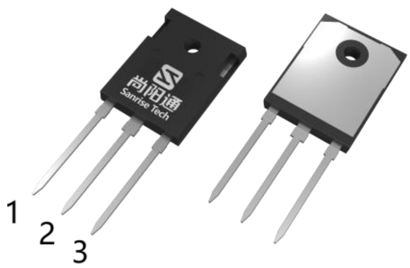


Figure 1 Symbol of SRE60N065FSU2S8

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

Package Type



TO-247

Pin 1- gate

Pin 2&backside-collector

Pin 3-emitter

Figure 2 Package Type of SRE60N065FSU2S8

Application

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

Ordering Information

SRE60N065FSU2S8□□–□

Circuit Type
Package
T: TO-247

G: Green
Blank: Tube
TR: Tape & Reel

Package	Part Number	Marking ID	Packing Type
TO-247	SRE60N065FSU2S8T-G1	SRE60N065FSU2S8TG1	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=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	

Electrical Characteristics

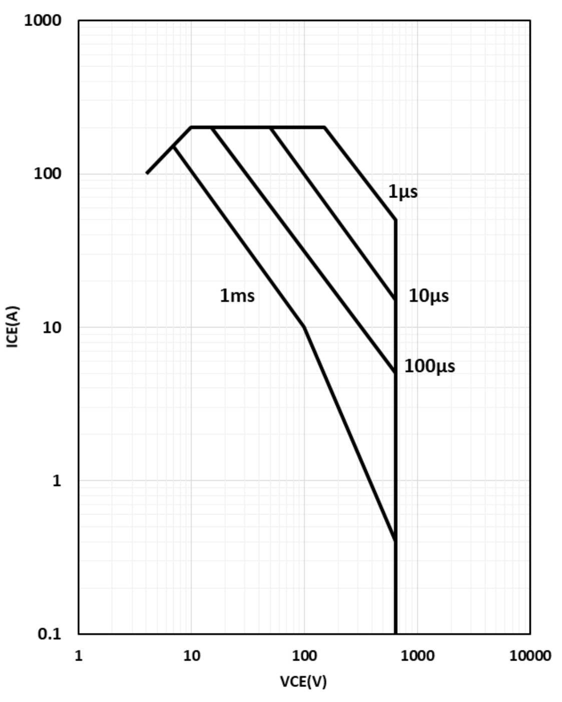
T_J = 25°C, unless otherwise specified.

Parameter		Symbol	Test Conditions	Min.	Typ.	Max.	Unit
Statistic Characteristics							
Collector-emitter Breakdown Voltage		BV_{CES}	V_{GE}=0V, I_C=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°C		1.51	2.0	V
			T_J=125°C		1.81		V
			T_J=175°C		2.02		V
Zero Gate Voltage Collector Current		I_{CES}	V_{CE}=650V,V_{GE}=0V T_J=25°C		0.1	40	μA
			T_J=175°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=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=25°C 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			42		ns
Turn-off Delay Time		$t_{d(off)}$			122		ns
Fall Time		t_f			70		ns
Turn-on energy		E_{on}			1.1		mJ
Turn-off energy		E_{off}			0.63		mJ
Total switching energy		E_{ts}			1.73		mJ
Turn-on Delay Time		$t_{d(on)}$	T_J=150°C 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			45		ns
Turn-off Delay Time		$t_{d(off)}$			149		ns
Fall Time		t_f			118		ns
Turn-on energy		E_{on}			2.26		mJ
Turn-off energy		E_{off}			0.99		mJ
Total switching energy		E_{ts}			3.25		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		

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

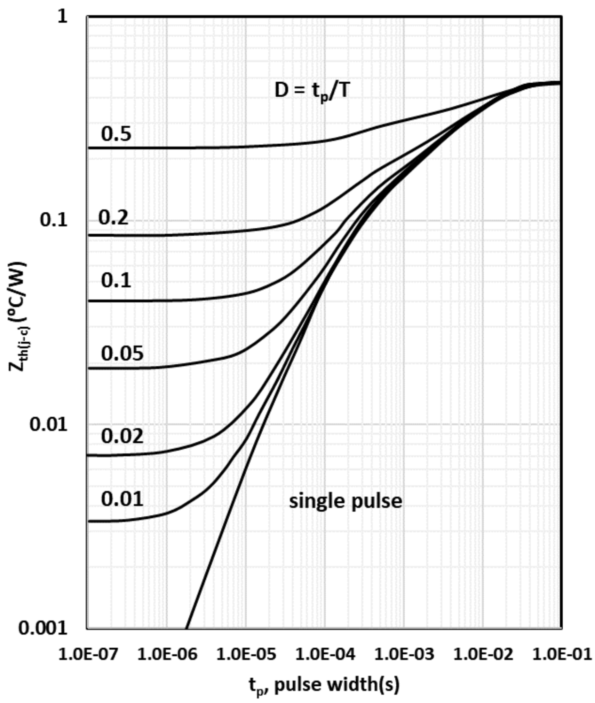
Typical Performance Characteristics

Figure 3: IGBT FBSOA



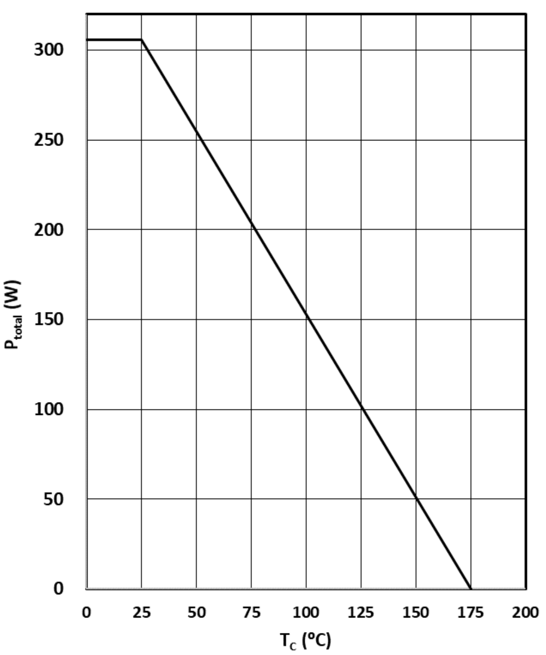
$I_C = f(V_{CE})$; $V_{GE} \geq 15/0V$; $Tj \leq 175°C$

Figure 4: IGBT transient thermal impedance



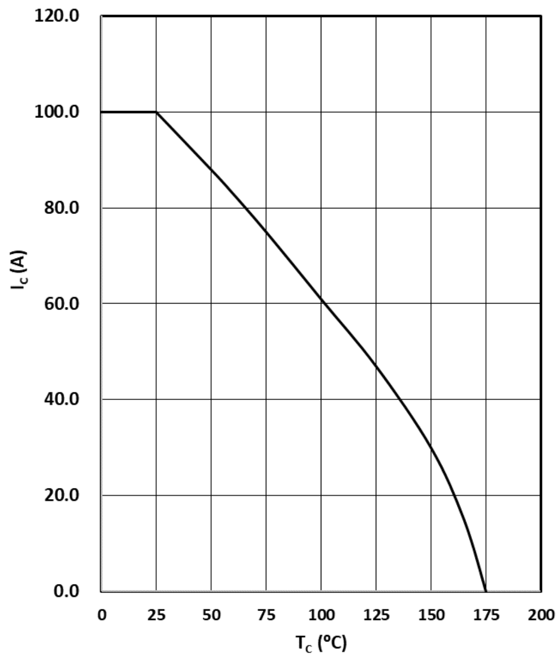
$R_{th(J\text{-}C)} = f(t_p)$; duty cycle: $D = t_p/T$

Figure 5: Power dissipation



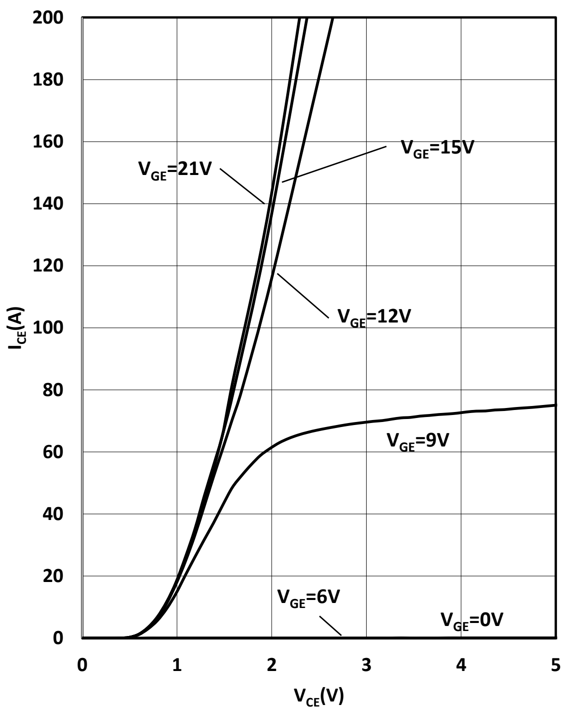
Ptot= f(Tc);

Figure 6: Collector current vs. temperature



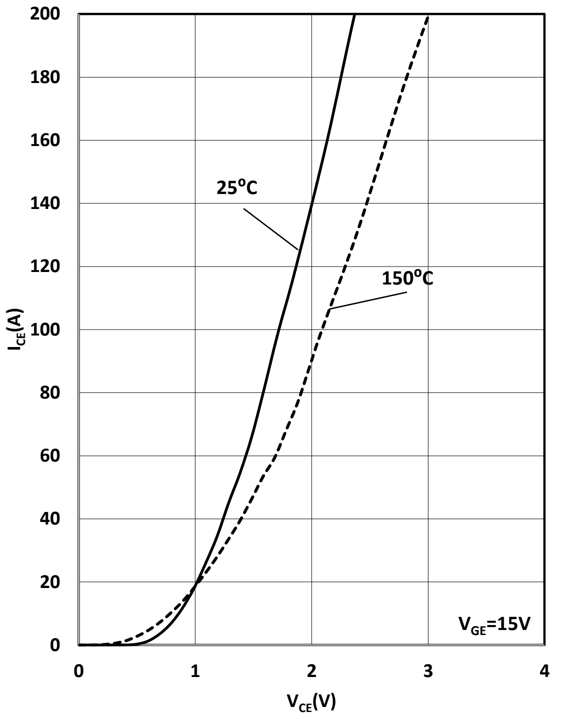
$Ic = f(Tj)$; $V_{GE} \geq 15V$; $Tj \leq 175°C$

Figure 7: Typical Output Characteristics



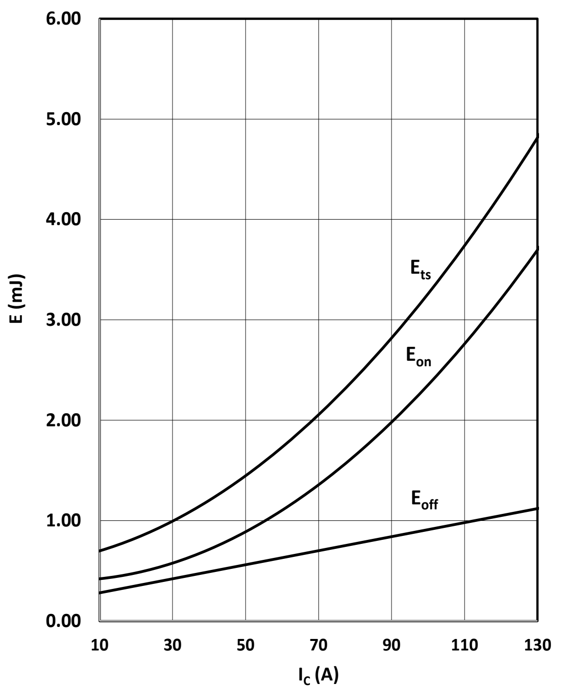
$I_C = f(V_{CE})$; Tj= 25ºC; parameter: V_{GE}

Figure 8: Typical transfer characteristic



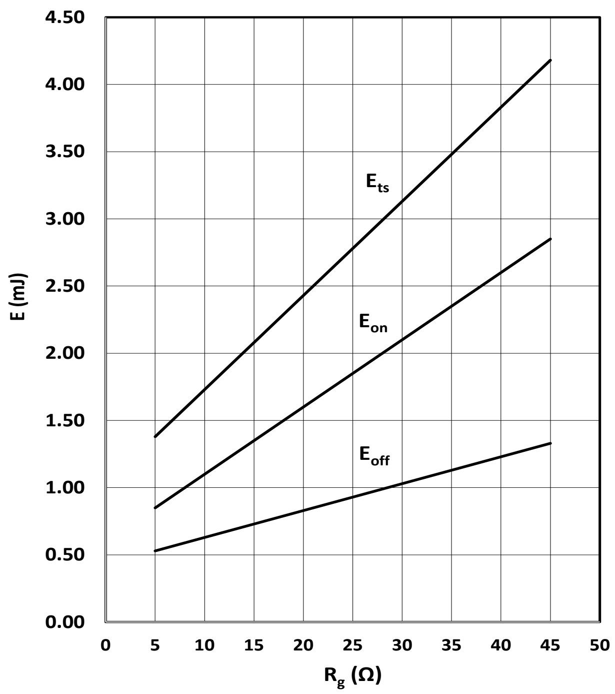
$I_C = f(V_{CE})$; Tj= 25ºC vs 150ºC

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



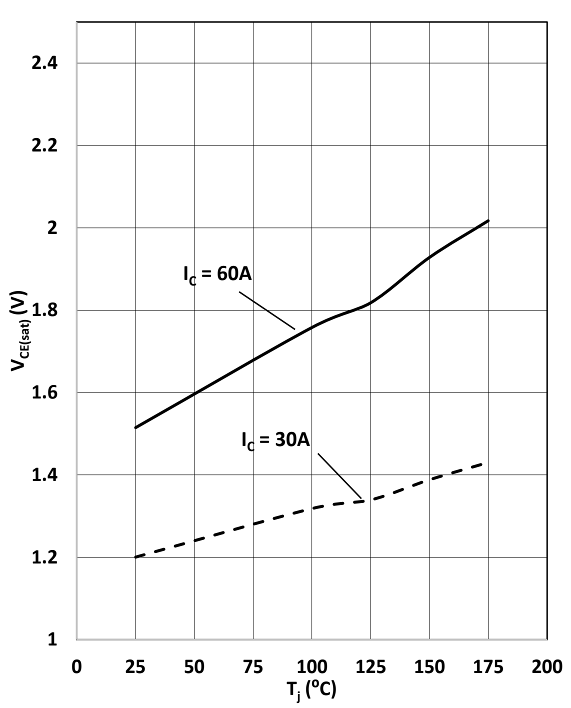
$E=f(Ic)$; V_{CE}=400V; Tj=25ºC; R_G=10Ω

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



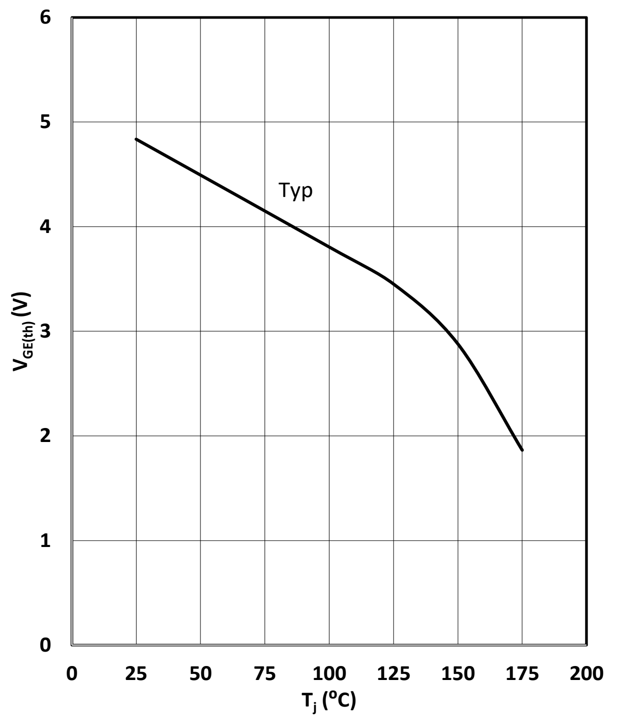
$E=f(R_G)$; V_{CE}=400V; Tj=25ºC; Ic=60A

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



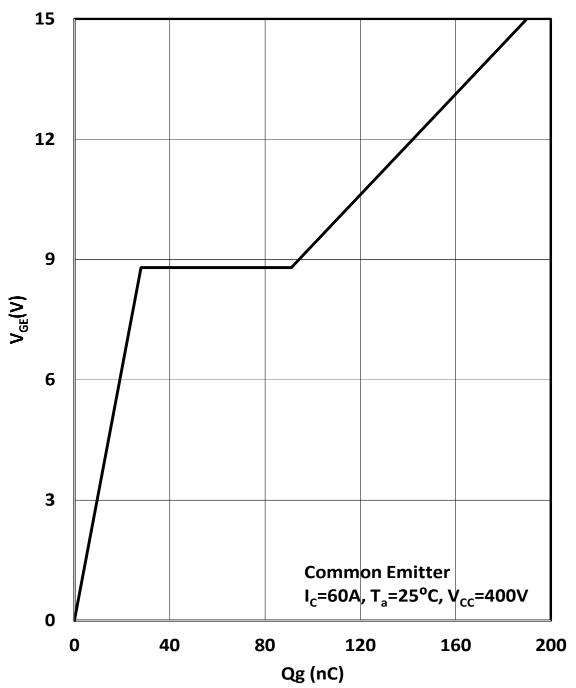
V_{CE} =f(T_j); V_{GE}=15V

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



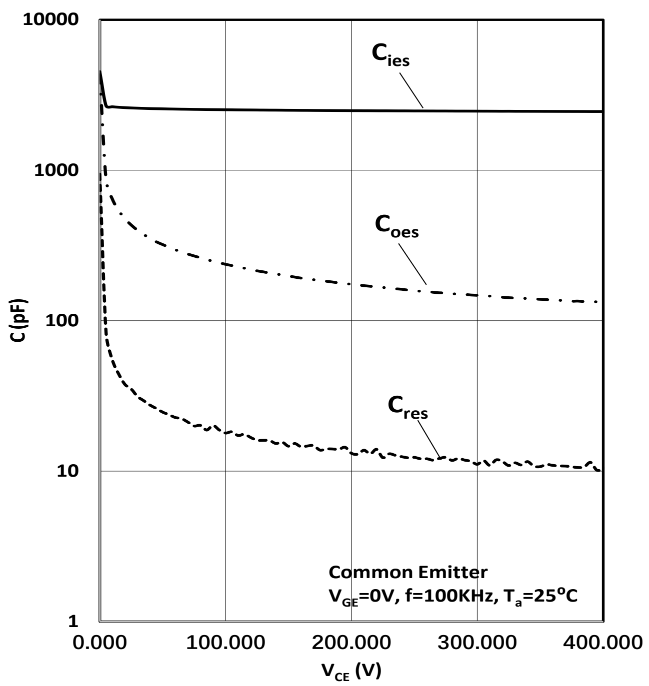
V_{GE} =f(T_j); I_{CE} = 250μA

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

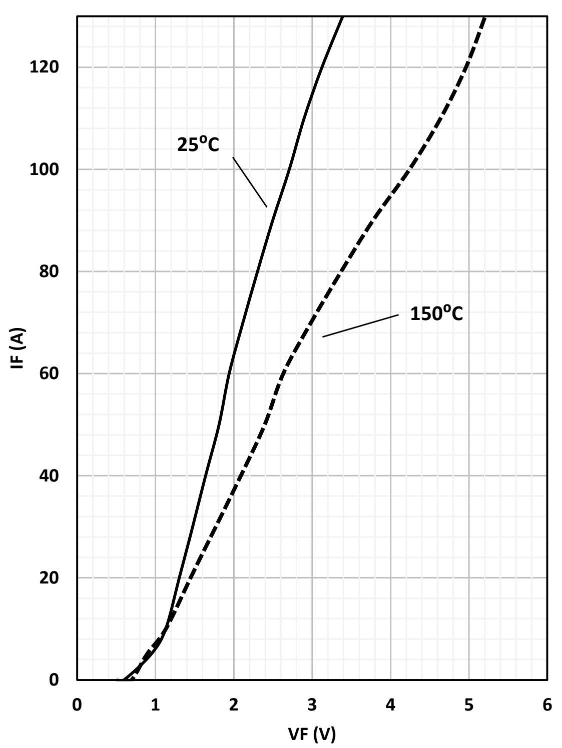
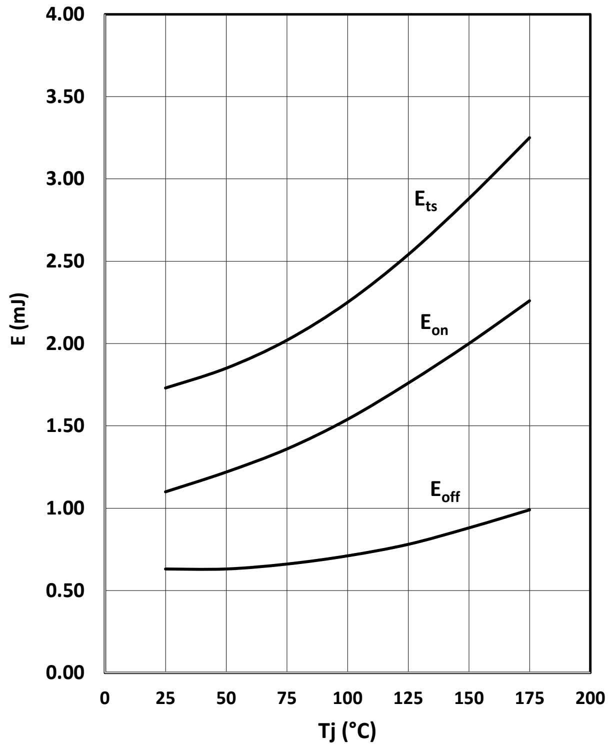
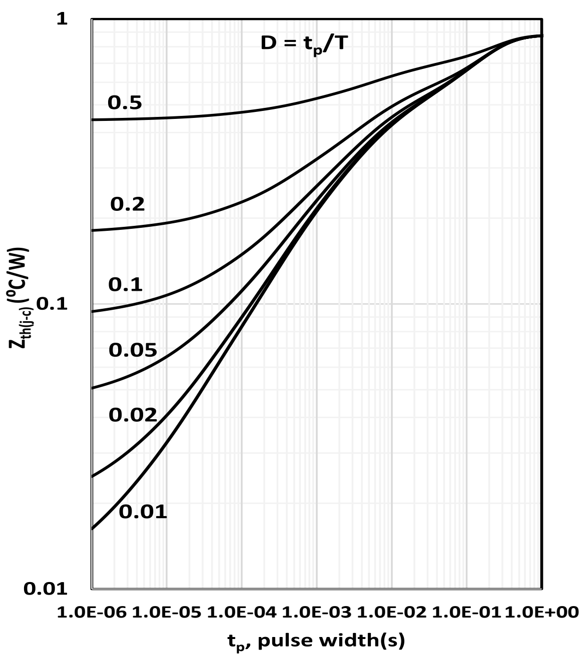
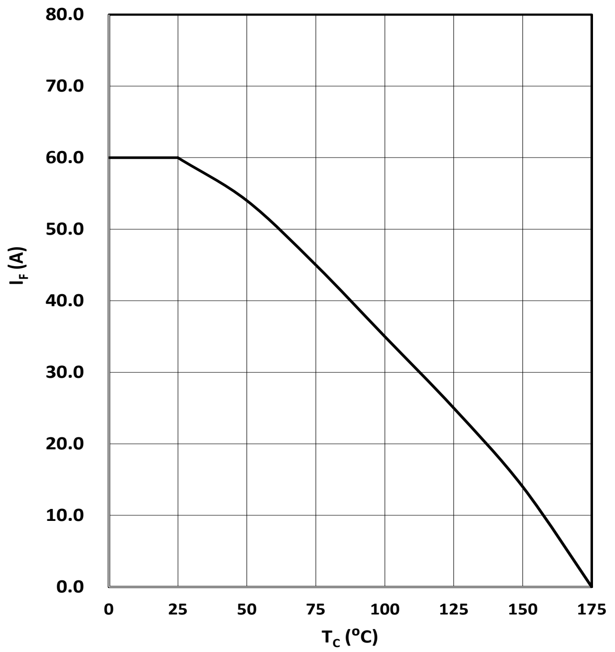
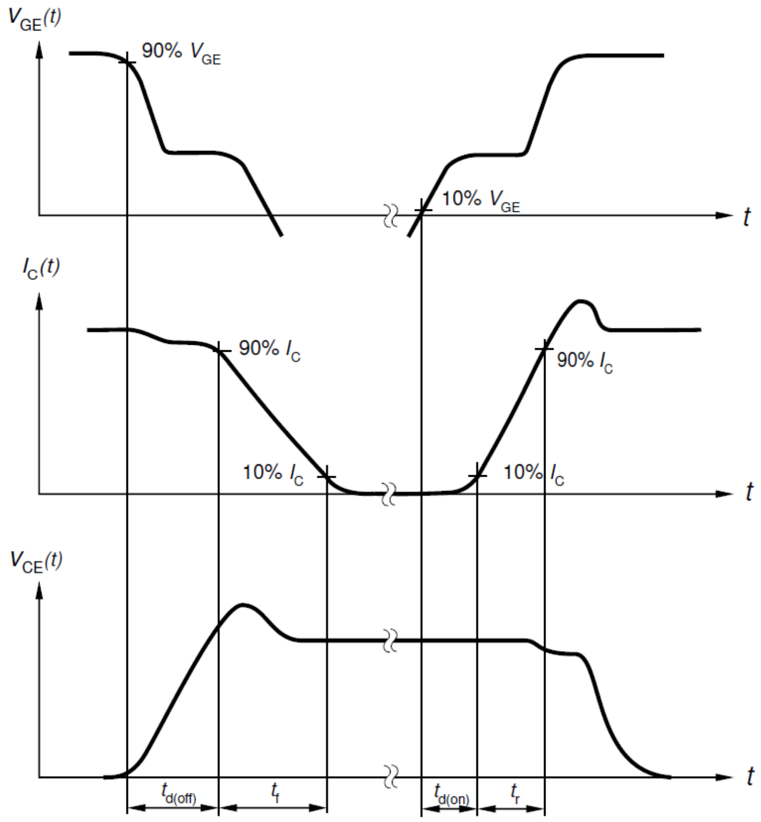
Figure 15: Typical diode forward current as a function of forward voltage	Figure 16: Typical switching energy losses as a function of junction temperature
	
$I_F = f(V_F)$;	$E = f(Tj)$; $V_{CE}=400V$; $Ic=60A$; $R_G=10\Omega$

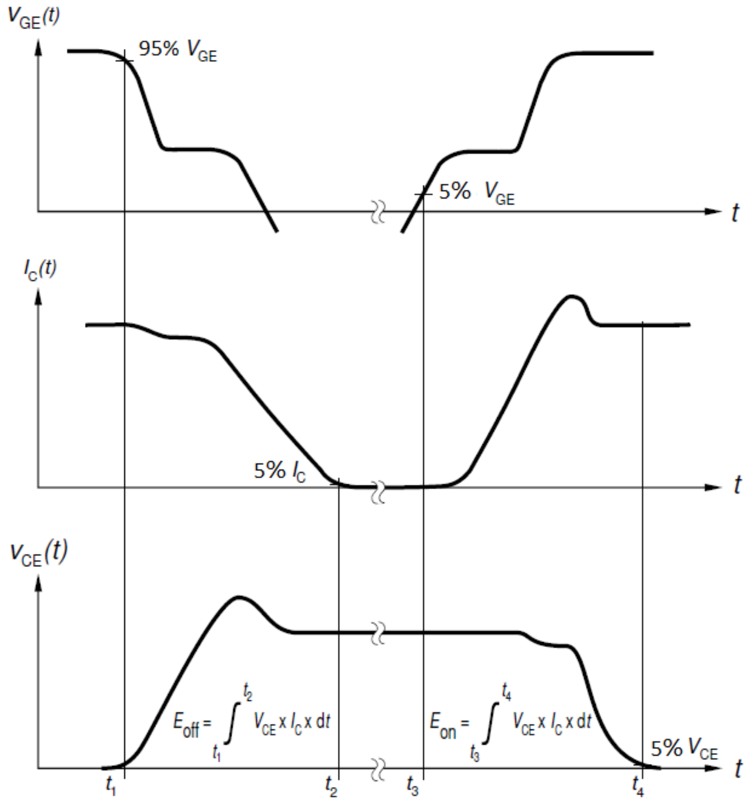
Figure 17: Diode transient thermal impedance	Figure 18: Diode current vs. temperature
	
$R_{th(J-C)} = f(t_p)$; duty cycle: $D = t_p/T$	$I_F = f(Tc)$; $Tj \leq 175°C$

Test Circuits

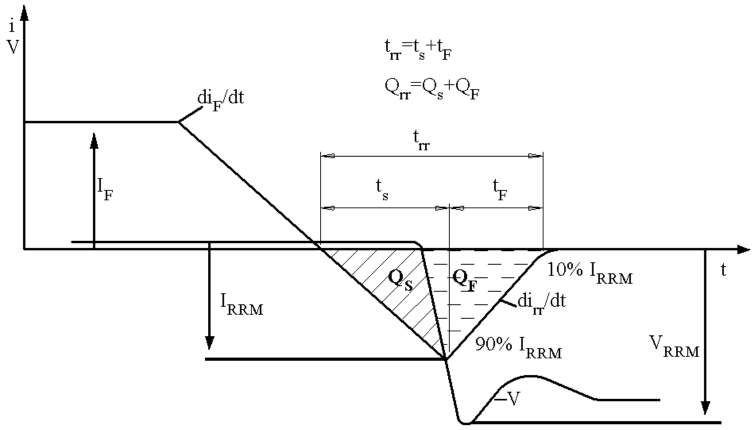
1. Definition Switching times



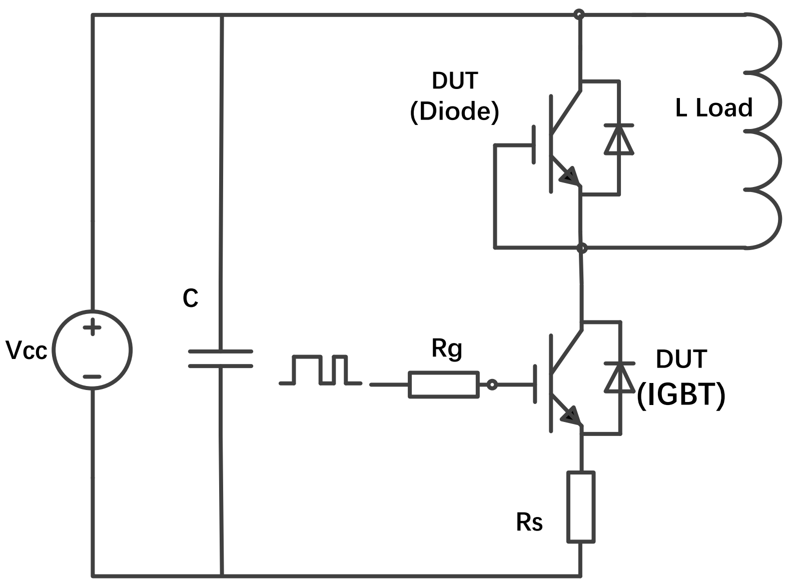
2. Definition Switching losses



3. Definition Diode Switching Characteristics

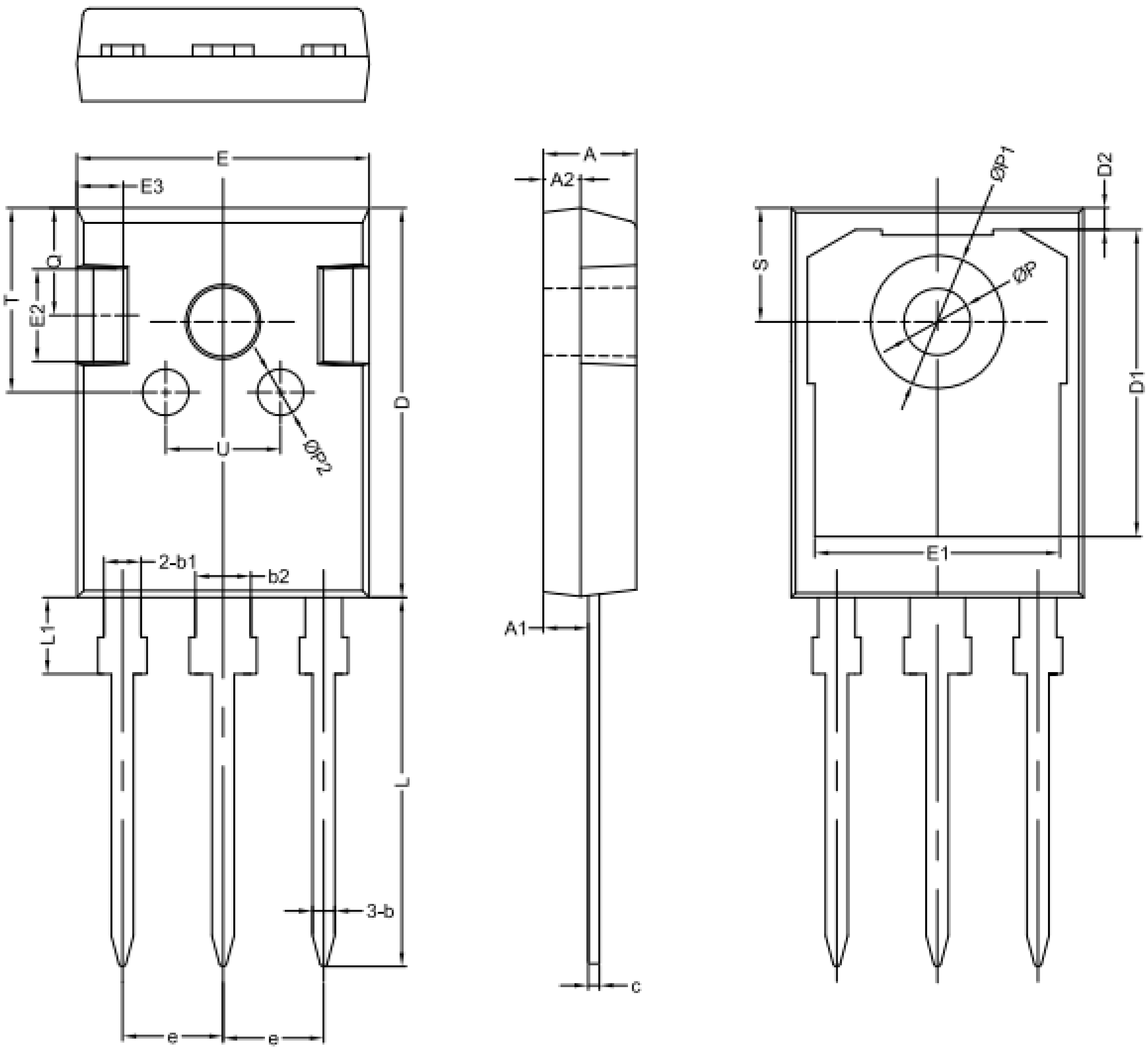


4. Dynamic test circuit



Mechanical Dimensions

TO-247 **Unit: mm**



Mechanical Dimensions

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	–
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	–	7.19	–
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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