50A 650V Trench Fieldstop IGBT with anti-parallel diode SRE50N065FSGDH

General Description

The SRE50N065FSGDH 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 SRE50N065FSGDH package is TO-247.

Symbol

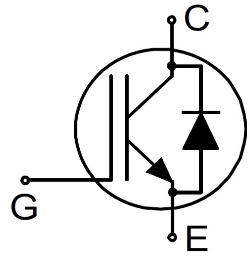
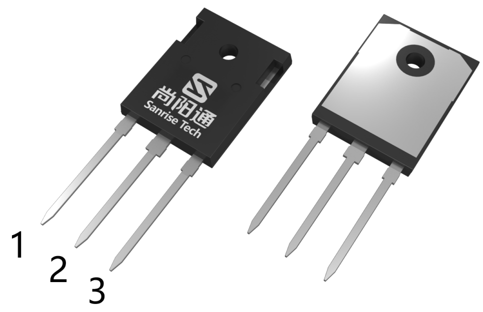


Figure 1 Symbol of SRE50N065FSGDH

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 $V_{CE(SAT)}$
- Non-automotive Qualified
- Enhanced Avalanche Capability

Package Type



TO-247

Pin 1- gate

Pin 2&backside-collector

Pin 3-emitter

Figure 2 Package Type of SRE50N065FSGDH

Application

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

Ordering Information

SRE50N065FSGDH□ □–□

Circuit Type — G: Green

Package — Blank: Tube

T: TO-247 — TR: Tape & Reel

Package	Part Number	Marking ID	Packing Type
TO-247	SRE50N065FSGDHT-G2	SRE50N065FSGDHTG2	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			±30	V
Continuous Collector Current	T_C=25ºC	I_C	90	A
	T_C=120ºC		50	
Pulsed Collector Current,Limited by T_{Jmax}		I_{CM}	200	A
Diode Continuous Collector Current	T_C=25ºC	I_F	90	A
	T_C=110ºC		50	
Diode Pulsed Current, Limited by T_{Jmax}		I_{FM}	200	A
Power Dissipation	T_C=25ºC	P_{tot}	326	W
	T_C=100ºC		163	
Operating Junction Temperature Range		T_J	-40 ~ 175	ºC
Storage Temperature Range		T_{STG}	-55 ~ 150	ºC
Lead Temperature (Soldering, 10 sec)		T_{LEAD}	260	ºC

Thermal Resistance

Parameter	Symbol	Min.	Typ.	Max.	Unit
IGBT Thermal Resistance， Junction-to-Case	R_{thJC}	-	-	0.46	ºC/W
Diode Thermal Resistance， Junction-to-Case	R_{thJC}	-	-	0.65	
Thermal Resistance， Junction-to-Ambient	R_{thJA}	-	-	40	

Electrical Characteristics

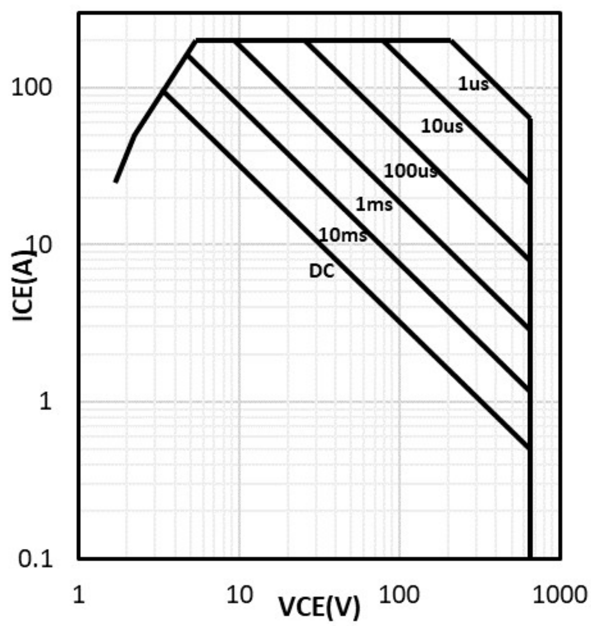
T_J = 25ºC, unless otherwise specified.

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	3.8	4.5	5.3	V
Collector-emitter saturation voltage		V_{CEsat}	V_{GE}=15V, I_C=50A, T_J=25ºC		1.58	2.00	V
			T_J=125ºC		2.05		V
			T_J=175ºC		2.23		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=100 KHz		2480		pF
Output Capacitance		C_{OES}			148		
Reverse Transfer Capacitance		C_{RES}			21		
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=50A R_G=10Ω, V_{GE}=0/15V Energy losses include “tail” and diode reverse recovery		20		ns
Rise Time		t_r			39		ns
Turn-off Delay Time		$t_{d(off)}$			117		ns
Fall Time		t_f			33		ns
Turn-on energy		E_{on}			1.87		mJ
Turn-off energy		E_{off}			0.51		mJ
Total switching energy		E_{ts}			2.38		mJ
Turn-on Delay Time		$t_{d(on)}$	T_J=175ºC V_{CC}=400V, I_C=50A R_G=10Ω,V_{GE}=0/15V Energy losses include “tail” and diode reverse recovery		19		ns
Rise Time		t_r			39		ns
Turn-off Delay Time		$t_{d(off)}$			139		ns
Fall Time		t_f			34		ns
Turn-on energy		E_{on}			2.70		mJ
Turn-off energy		E_{off}			0.61		mJ
Total switching energy		E_{ts}			3.31		mJ
Gate to Emitter Charge		Q_{GE}	V_{CC}=400V, I_C=50A V_{GE}=0 to 15V		21		nC
Gate to Collector Charge		Q_{GC}			47		
Gate Charge Total		Q_G			115		

Parameter	Symbol	Test Conditions	Min.	Typ.	Max.	Unit
Reverse Diode Characteristics						
Diode Forward Voltage	V_F	I_F=25A T_J=25°C		1.38	1.8	V
		I_F=25A T_J=125°C		1.63		
		I_F=25A T_J=175°C		1.05		
		I_F=50A T_J=25°C		1.51	2.0	
		I_F=50A T_J=125°C		1.34		
		I_F=50A T_J=175°C		1.22		
Reverse Recovery Time	t_{rr}	T_J=25°C V_R=400V, I_F=50A dI_F/dt=1000A/μs		109		ns
Reverse Recovery Charge	Q_{rr}			1.35		uC
Peak Reverse Recovery Current	I_{rrm}			23.8		A
Diode peak rate of fall of reverse recovery current during t_b	di_{rr}/dt			-286		A/μs
Reverse recovery energy	Erec			0.20		mJ
Reverse Recovery Time	t_{rr}	T_J=175°C V_R=400V, I_F=50A dI_F/dt=1000A/μs		211		ns
Reverse Recovery Charge	Q_{rr}			5.44		uC
Peak Reverse Recovery Current	I_{rrm}			44		A
Diode peak rate of fall of reverse recovery current during t_b	di_{rr}/dt			-276		A/μs
Reverse recovery energy	Erec			0.82		mJ

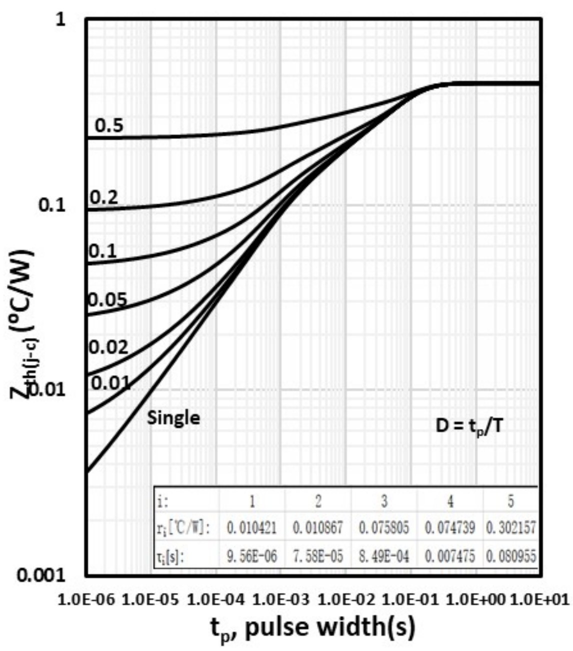
Typical Performance Characteristics

Figure 3: IGBT FBSOA



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

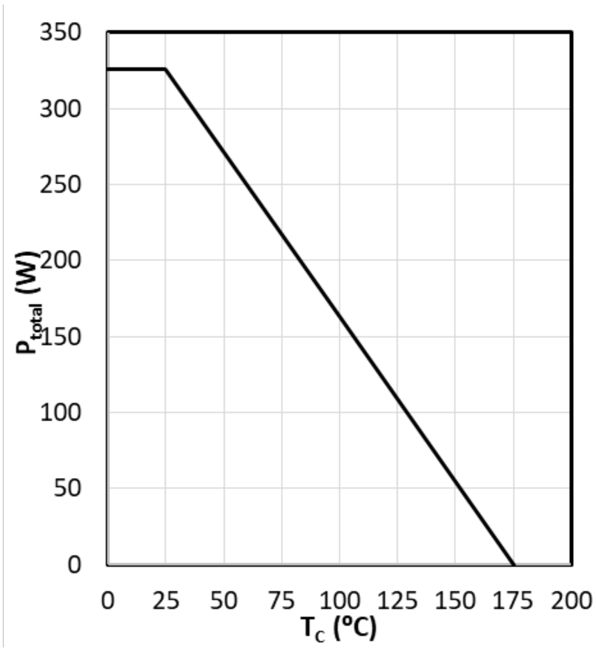
Figure 4: IGBT transient thermal impedance



i:	1	2	3	4	5
r_i[℃/W]:	0.010421	0.010867	0.075805	0.074739	0.302157
τ_i[s]:	9.56E-06	7.58E-05	8.49E-04	0.007475	0.080955

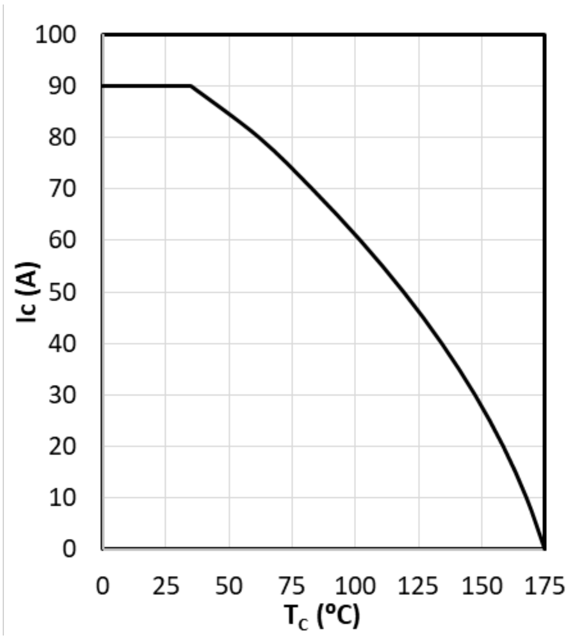
$R_{th(J-C)} = f(t_p)$; duty cycle: $D = t_p/T$

Figure 5: Power dissipation



Ptot= f(Tc);

Figure 6: Collector current vs. temperature



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

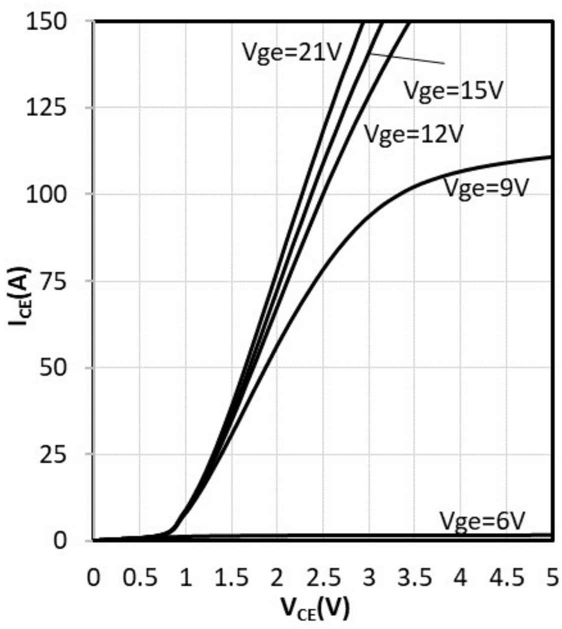
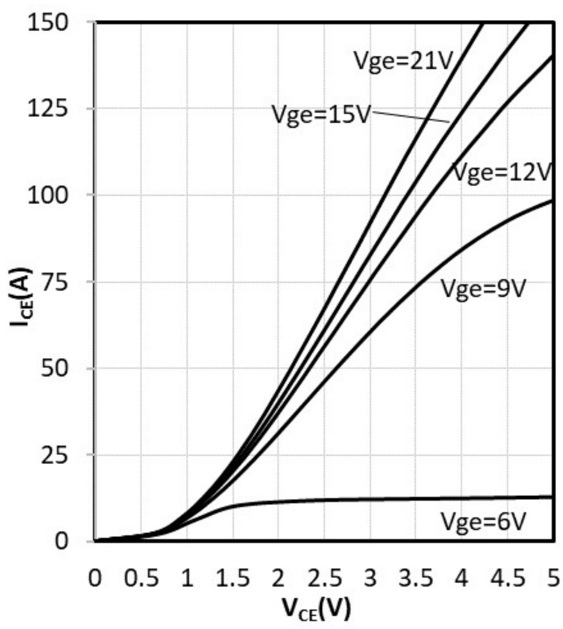
Figure 7: Typical Output Characteristics	Figure 8: Typical Output Characteristics
	
$I_C = f(V_{CE})$; Tj= 25ºC; parameter: V_{GE}	$I_C = f(V_{CE})$; Tj= 175ºC; parameter: V_{GE}

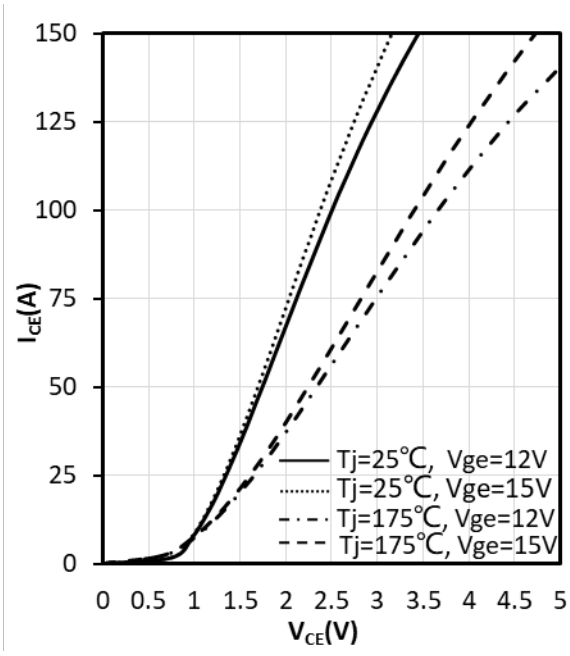
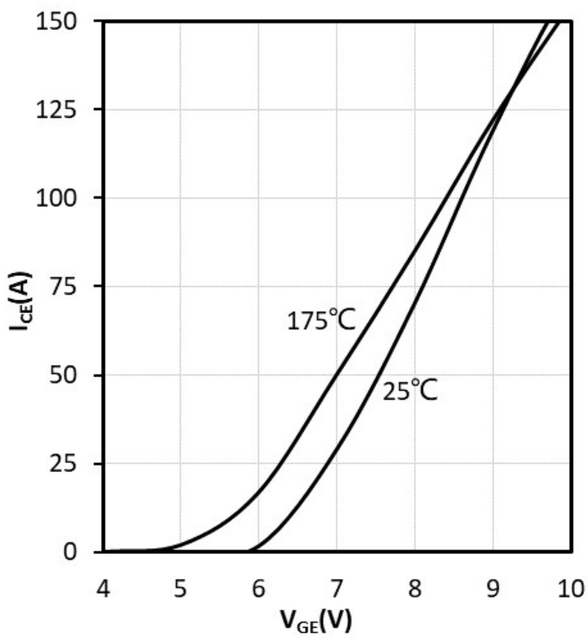
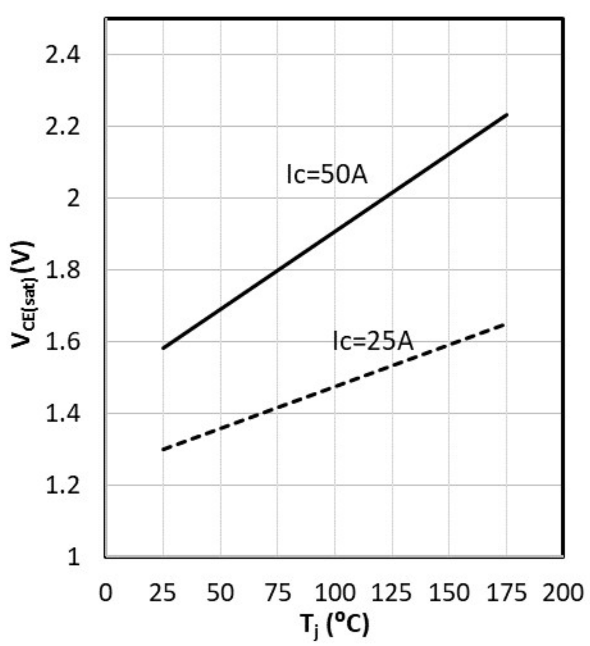
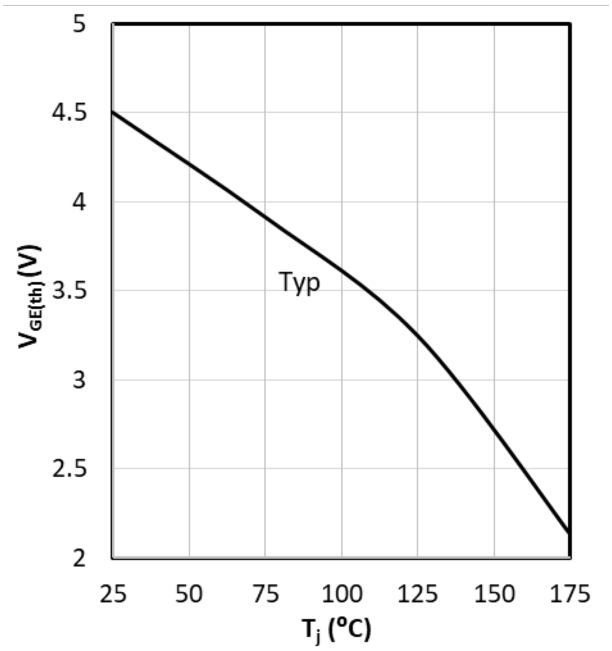
Figure 9: Typical Output Characteristics	Figure 10: Typical transfer characteristic
	
$I_C = f(V_{CE})$; parameter: V_{GE}	$I_C = f(V_{CE})$; Tj= 25ºC vs 175ºC

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



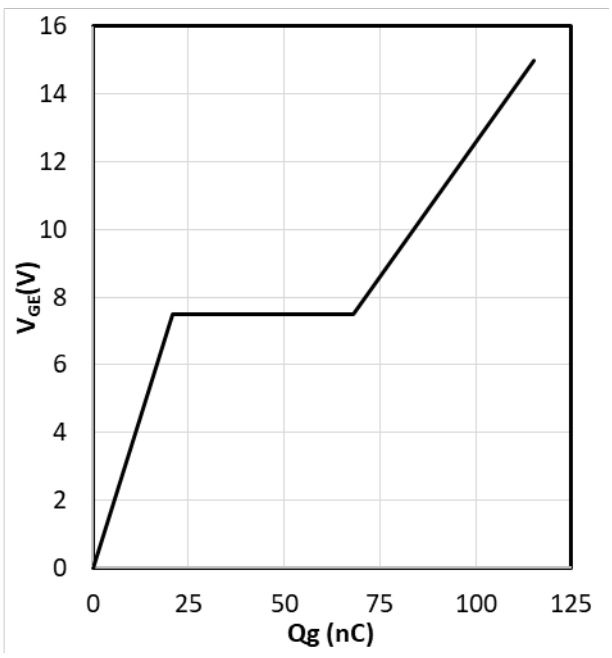
V_{CE} =f(Tj); V_{GE}=15V

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



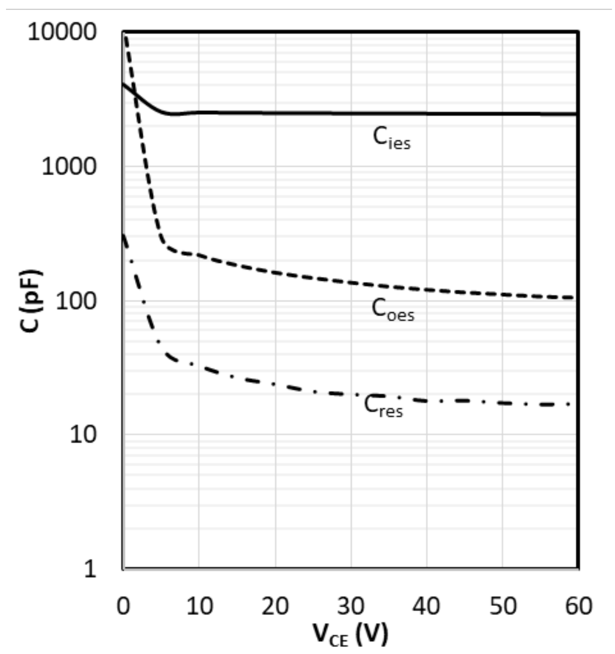
V_{GE} =f(Tj); I_{CE} = 250µA

Figure 13: Typical Gate Charge



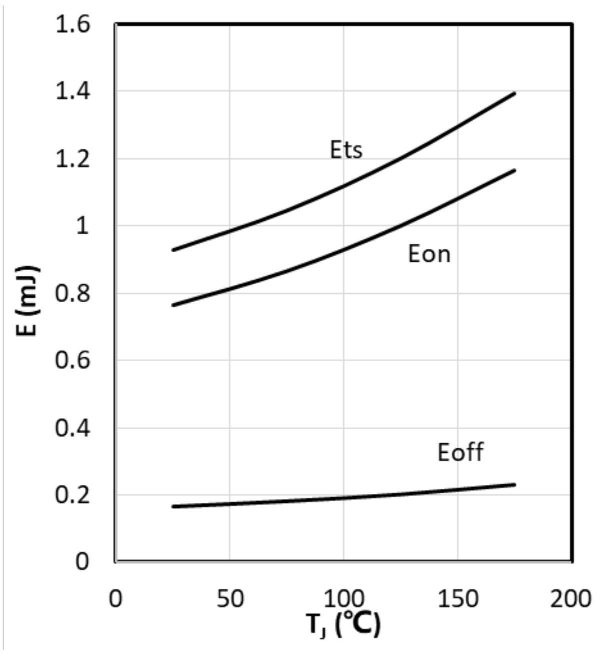
V_{GE}= f(Qgate); I_C= 50A

Figure 14: Typical Capacitances



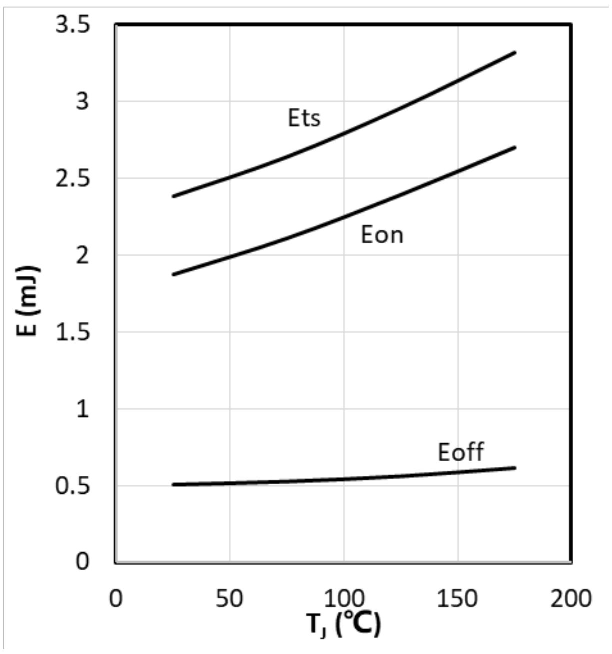
C=f(V_{CE}); V_{GE}=0; f=100 KHz

Figure 15: Typical switching energy losses as a function of junction temperature



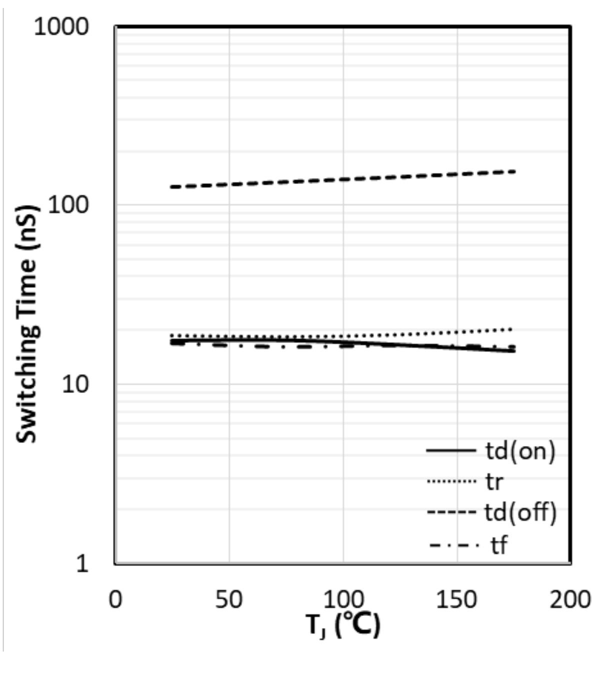
E=f(Tj); V_{CE}=400V; Ic=25A; R_G=10Ω

Figure16: Typical switching energy losses as a function of junction temperature



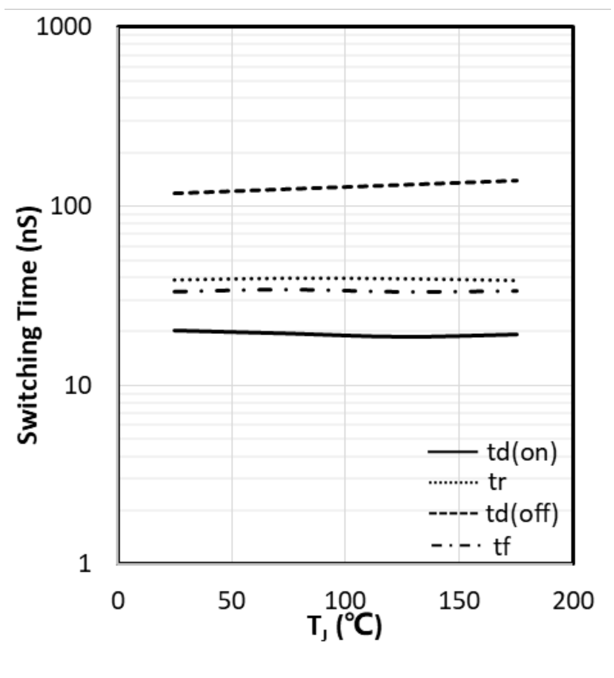
E=f(Tj); V_{CE}=400V; Ic=50A; R_G=10Ω

Figure 17: Typical Switching time as a function of junction temperature



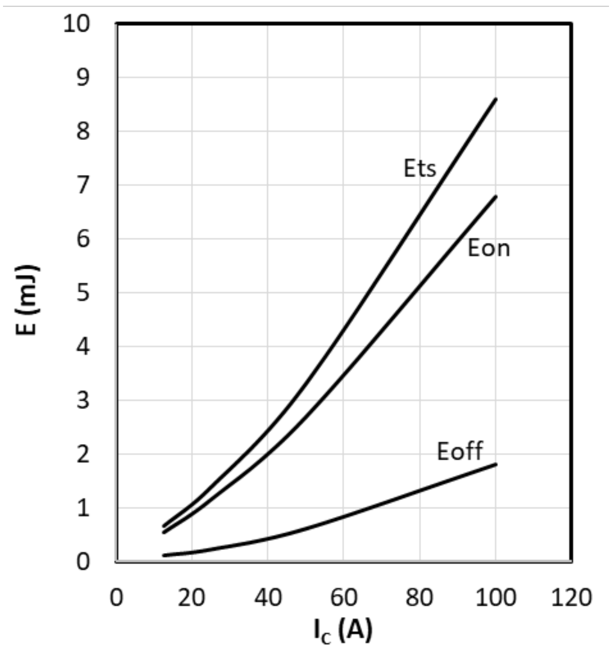
t=f(Tj); V_{CE}=400V; Ic=25A; R_G=10Ω

Figure 18: Typical Switching time as a function of junction temperature



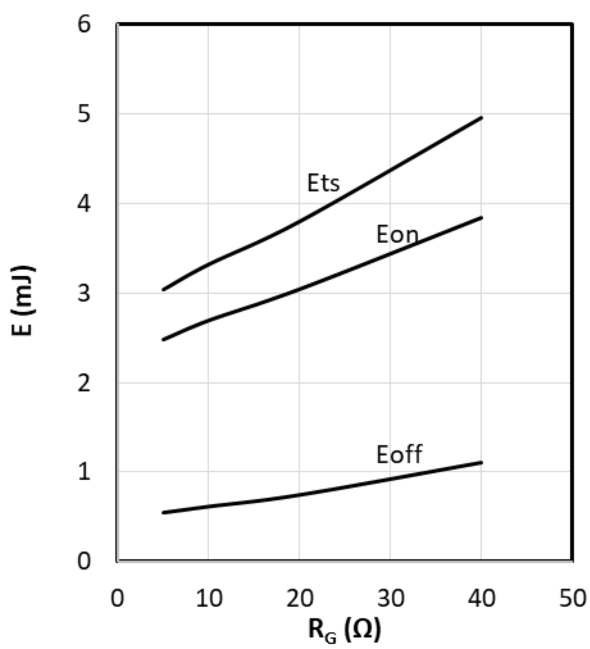
t=f(Tj); V_{CE}=400V; Ic=50A; R_G=10Ω

Figure 19: Typical switching energy losses as a function of collector current



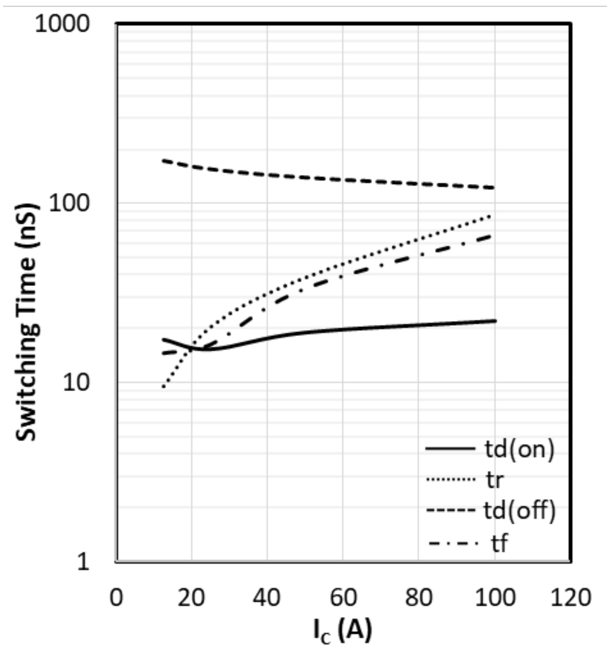
$E=f(Ic)$; $V_{CE}=400V$; $Tj=175°C$; $R_G=10\Omega$

Figure 20: Typical switching energy losses as a function of gate resistor



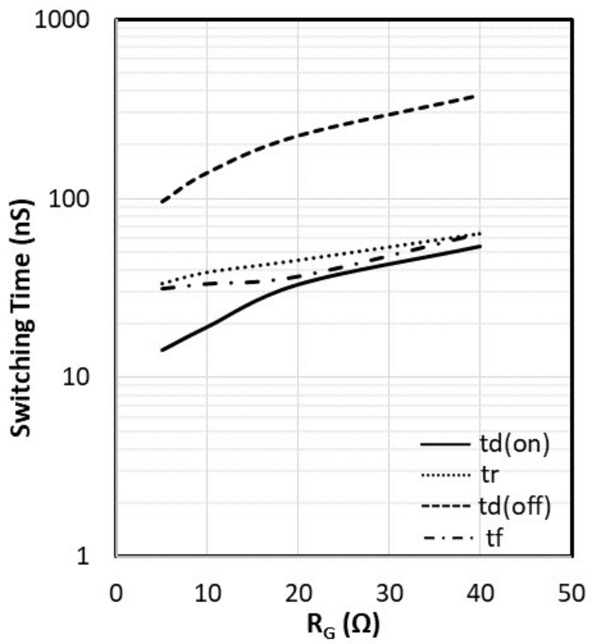
$E=f(R_G)$; $V_{CE}=400V$; $Tj=175°C$; $Ic=50A$

Figure 21: Typical Switching time as a function of collector current



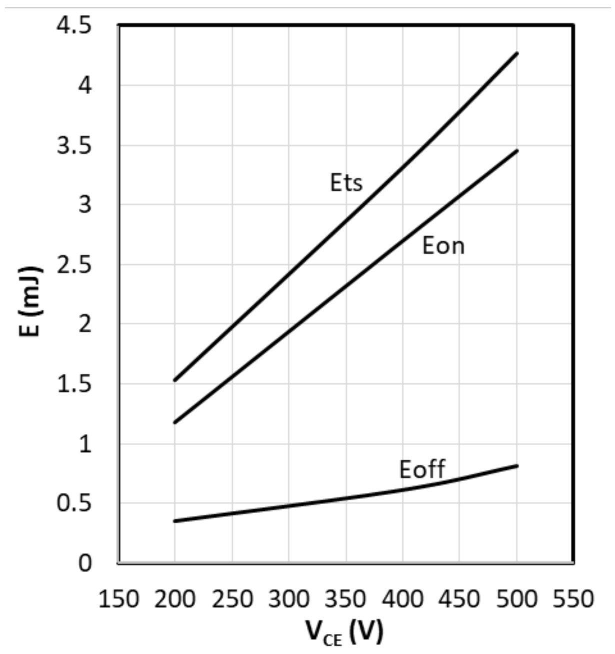
$t=f(Ic)$; $V_{CE}=400V$; $Tj=175°C$; $R_G=10\Omega$

Figure 22: Typical Switching time as a function of gate resistor



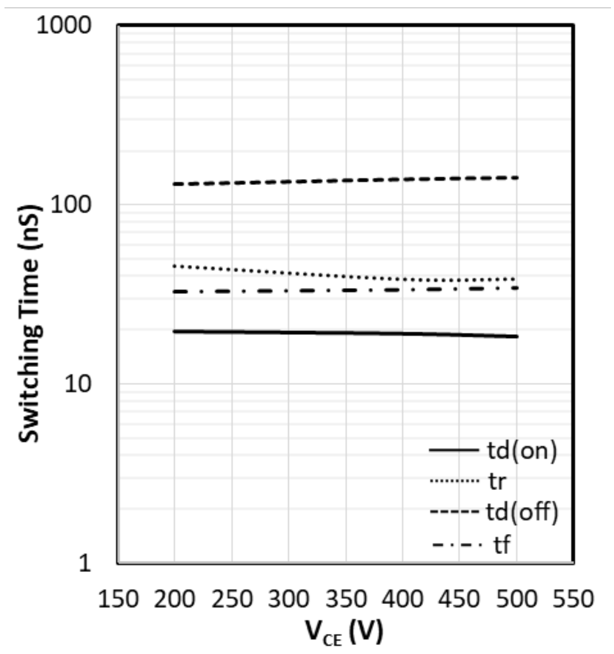
$t=f(R_G)$; $V_{CE}=400V$; $Tj=175°C$; $Ic=50A$

Figure 23: Typical switching energy losses as a function of collector voltage



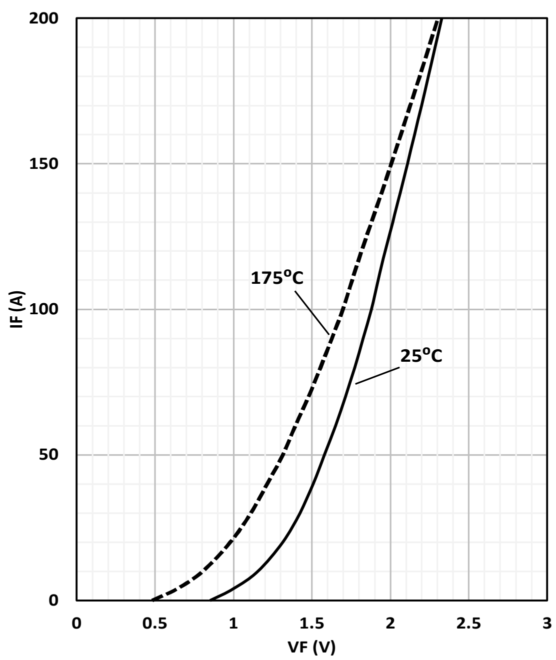
E=f(Vce); Ic=50A; Tj=175°C; R_G=10Ω

Figure 24: Typical Switching time as a function of collector voltage



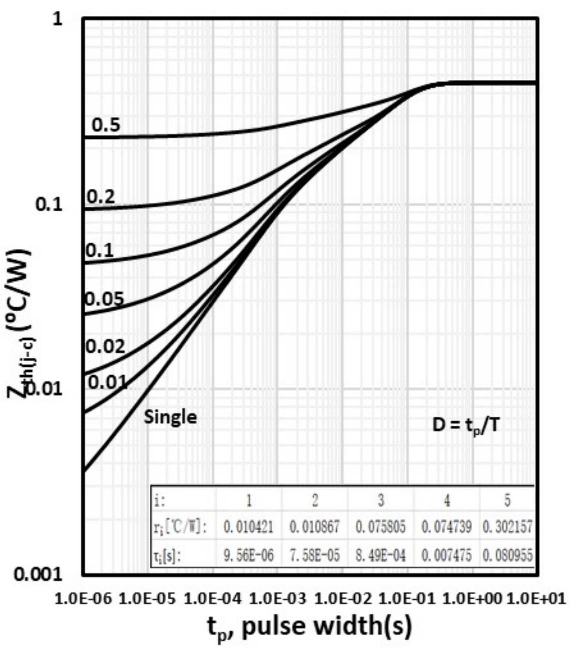
t=f(Vce); Ic=50A; Tj=175°C; R_G=10Ω

Figure 25: Typical diode forward current as a function of forward voltage



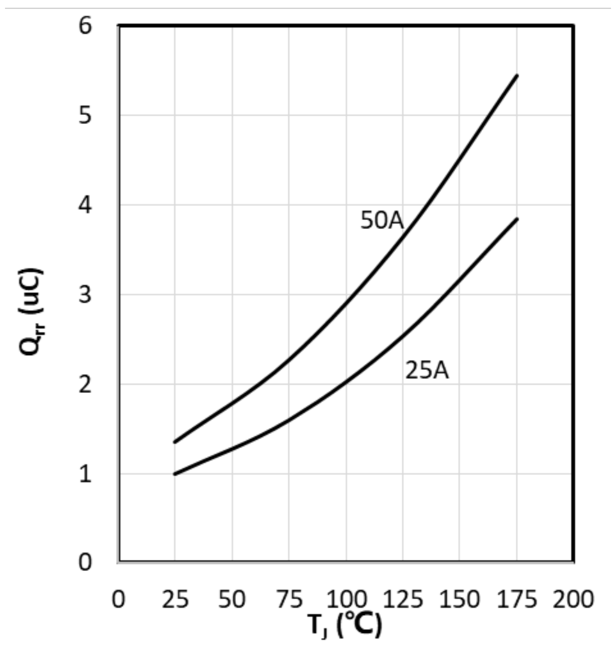
I_F= f(V_F);

Figure 26: Diode transient thermal impedance



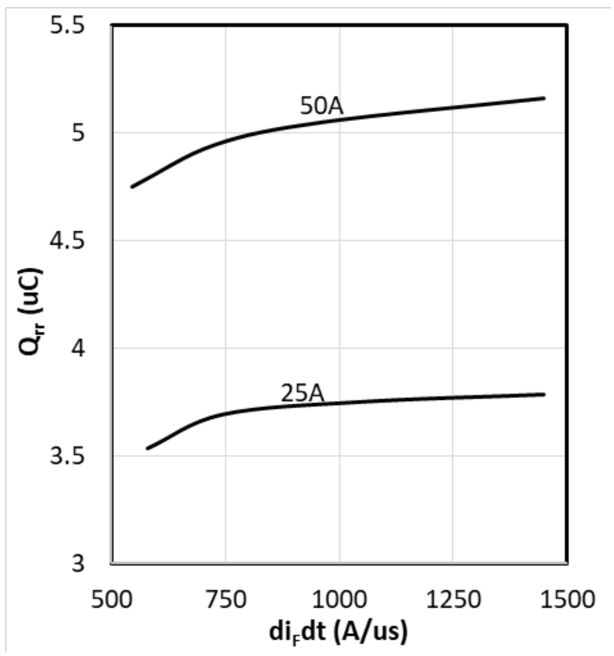
$R_{th(J-C)}$= f(t_p); duty cycle: D= t_p/T

Figure 27: Typical reverse recovery charge as a function of junction temperature



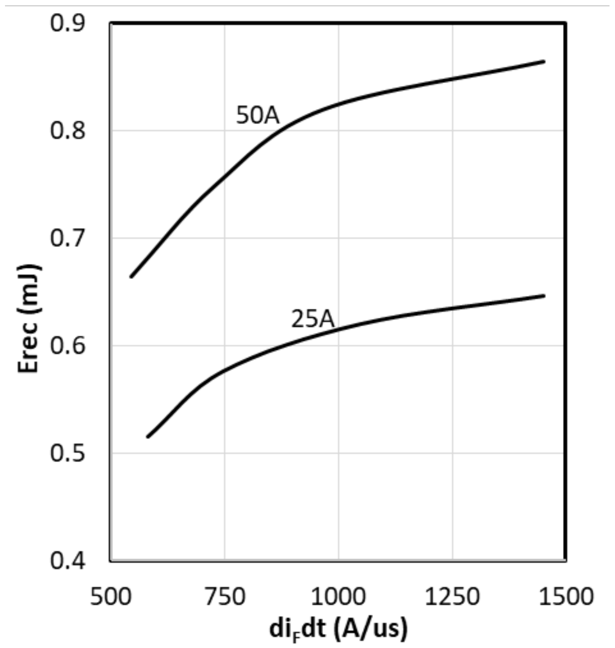
Qrr=f(Tj); V_{CE}=400V; Tj=175°C; di_F/dt=1A/ns

Figure 28: Typical reverse recovery charge as a function of diode current slope



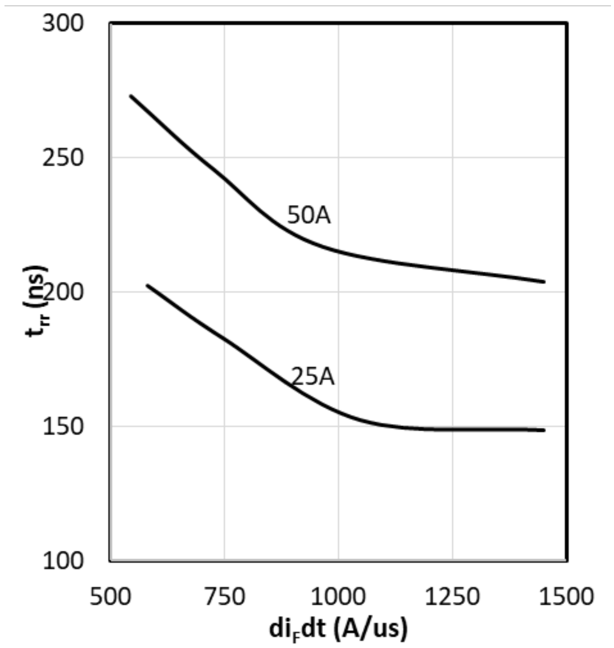
Qrr=f(di_F/dt); V_{CE}=400V; Tj=175°C

Figure 29: Typical reverse recovery energy as a function of diode current slope

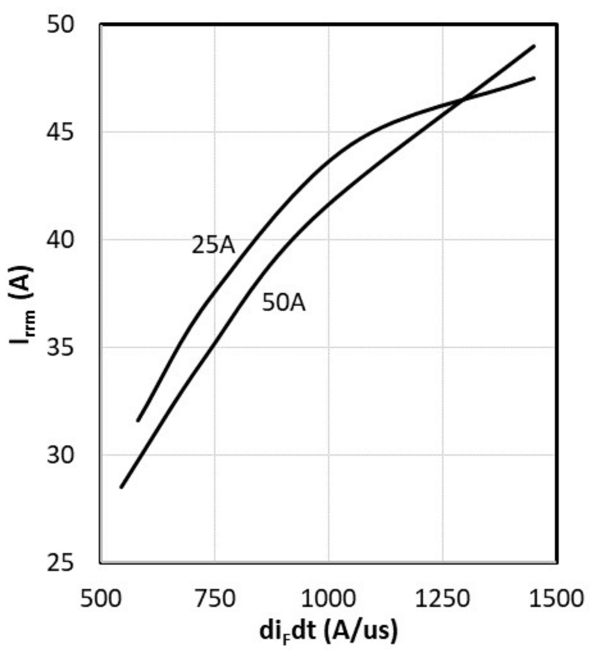
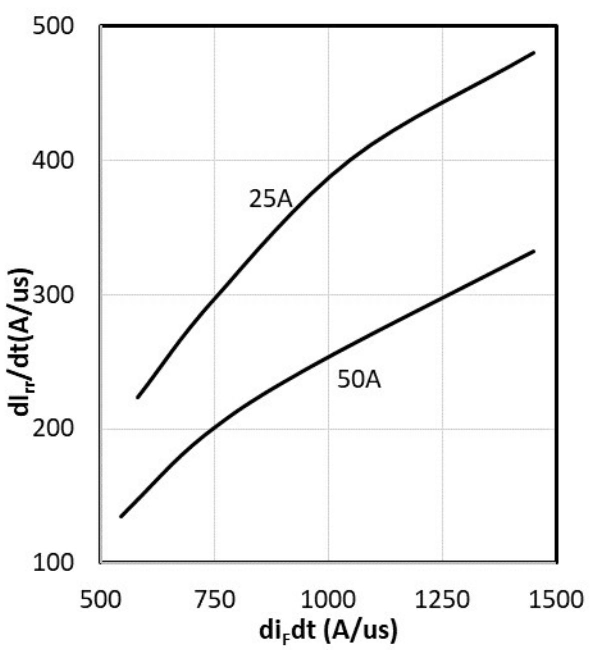


Erec= f(di_F/dt); V_{CE}=400V; Tj=175°C

Figure 30: Typical reverse recovery time as a function of diode current slope

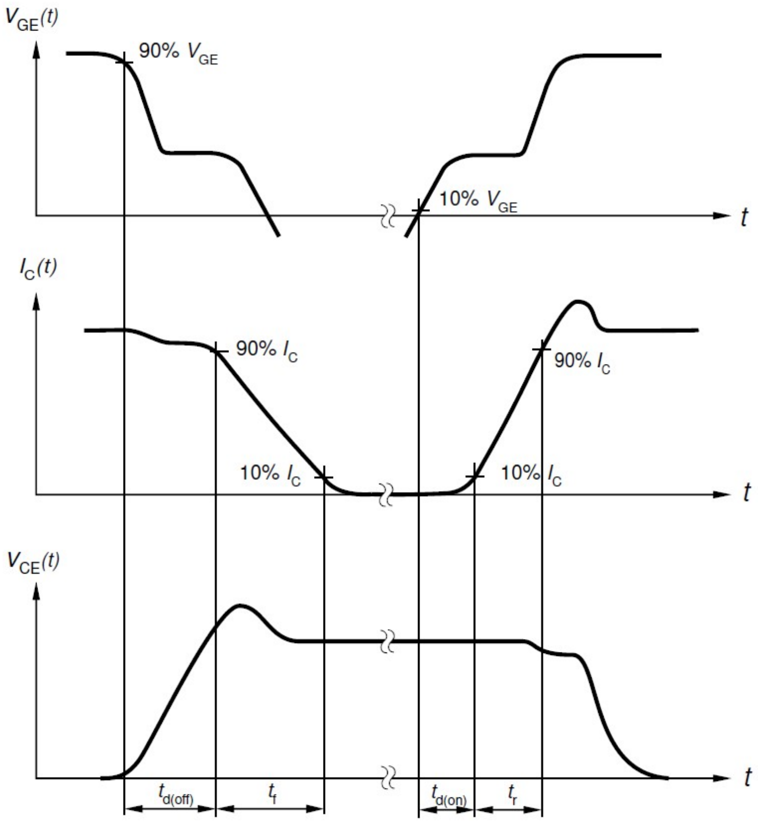


trr=f(di_F/dt); V_{CE}=400V; Tj=175°C

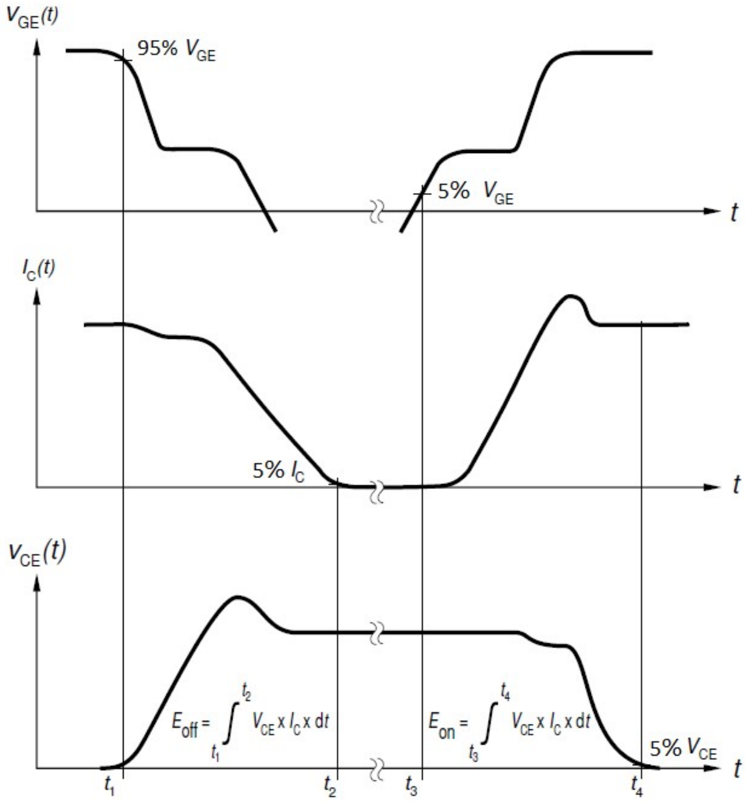
Figure 31: Typical reverse recovery current as a function of diode current slope	Figure 32: Typical diode peak rate of fall of reverse recovery current as a function of diode current slope
	
Irrm= f(di_F/dt); V_{CE}=400V; Tj=175°C	di_{rr}/dt =f(di_F/dt); V_{CE}=400V; Tj=175°C

Test Circuits

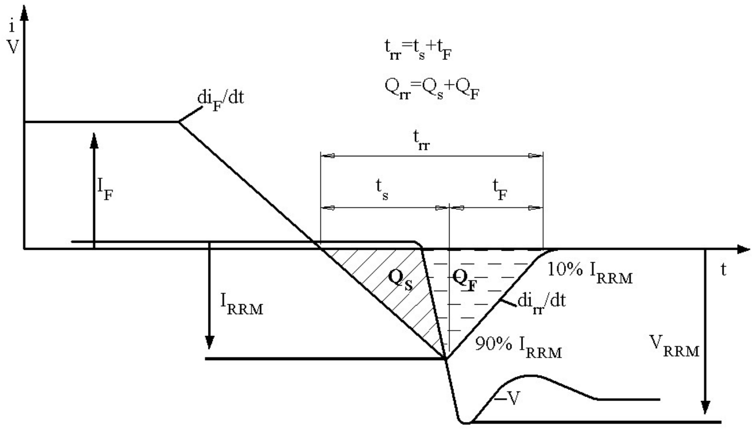
1. Definition Switching times



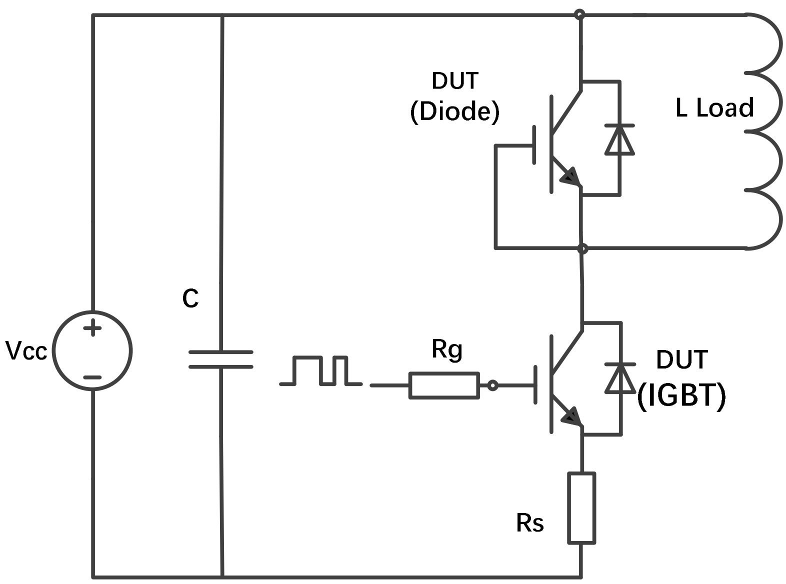
2. Definition Switching losses



3. Definition Diode Switching Characteristics

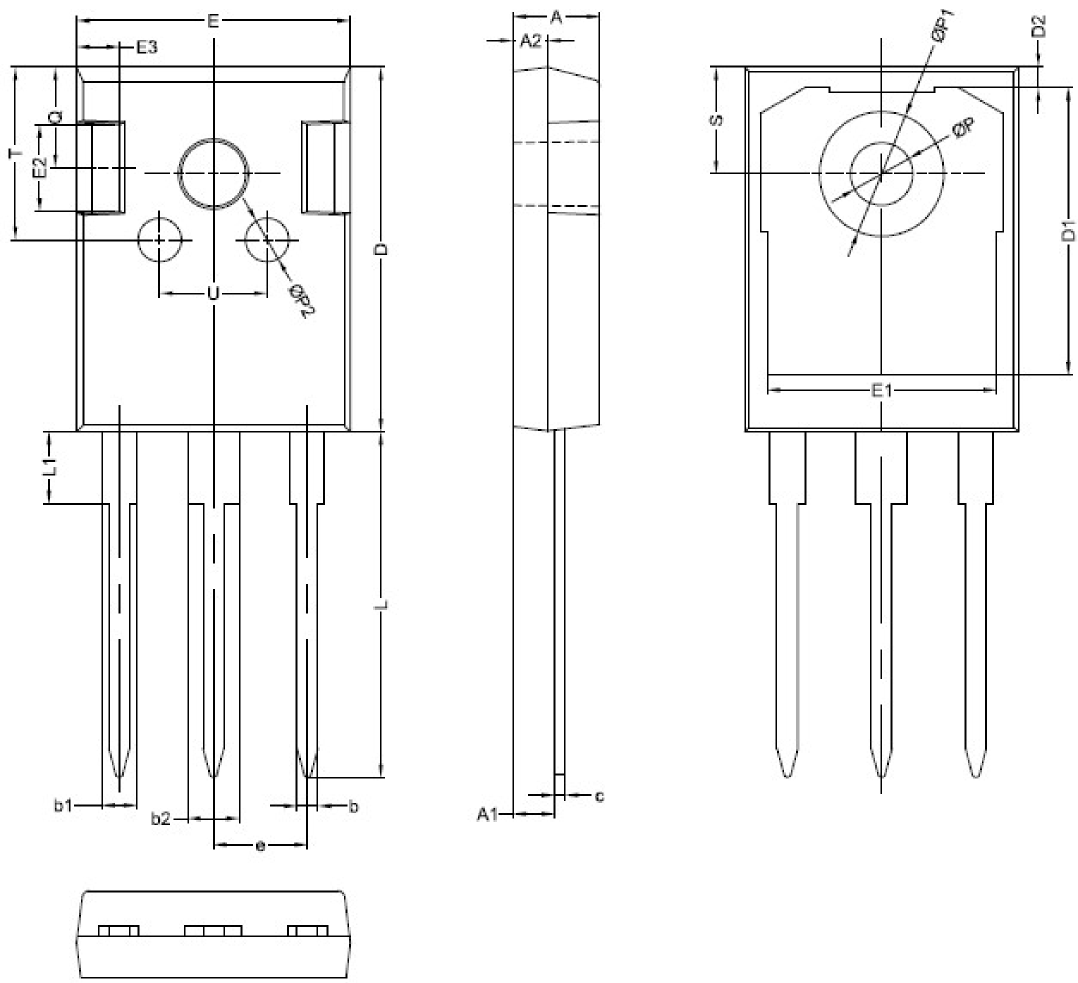


4. Dynamic test circuit



Mechanical Dimensions

TO-247 **Unit: mm**



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	-

TM
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尚阳通

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