Datasheet

40A 650V Trench Field stop IGBT with anti-parallel diode SRE40N065FSU2DG

General Description

The SRE40N065FSU2DG 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 SRE40N065FSU2DG is available in TO-263 and TO-247 packages.

Features

- High Breakdown Voltage to 650V
- Advanced Trench Fieldstop technology
  - Ultra low E_{off}
  - Short circuit withstand time 6 us
  - 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

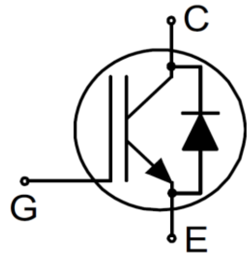
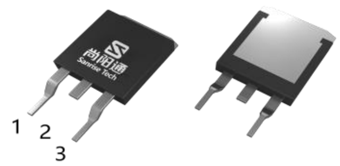
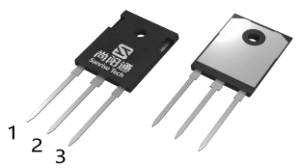


Figure 1 Symbol of SRE40N065FSU2DG

Package Type



TO-263



TO-247

Pin 1- Gate

Pin 2&backside- Collector

Pin 3-Emitter

Figure 2 Package Type of SRE40N065FSU2DG

Ordering Information

SRE40N065FSU2DG□□–□

Circuit Type

Package

S2: TO-263 T: TO-247

G: Green

Blank: Tube

TR: Tape & Reel

Package	Part Number	Marking ID	Packing Type
TO-263	SRE40N065FSU2DGS2TR-G1	SRE40N065FSU2DGS2G1	Tape & Reel
TO-247	SRE40N065FSU2DGT-G1	SRE40N065FS2UDGTG1	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		V_{GES}	±30	V
Continuous Collector Current	T_C=25ºC	I_C	60	A
	T_C=100ºC		40	
Pulsed Collector Current, Limited by T_{Jmax}		I_{CM}	160	A
Diode Continuous Collector Current	T_C=25ºC	I_F	60	A
	T_C=100ºC		40	
Diode Pulsed Current, Limited by T_{Jmax}		I_{FM}	160	A
Power Dissipation	T_C=25ºC	P_{tot}	227	W
	T_C=100ºC		113	
Short Circuit withstand time: V_{GE}≤15V,Vcc≤400V,Tj_start=25℃; Allow number of short circuits<1000; Time between short circuits:1.0s;		tsc	6	us
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}	-	-	0.65	ºC/W
Diode Thermal Resistance，Junction-to-Case	R_{thJC}	-	-	1.0	
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	3.2	3.8	4.4	V
Collector-emitter saturation voltage	V_{CEsat}	V_{GE}=15V, I_C=40A, T_J=25°C	1.50	1.57	1.65	V
		T_J=125°C		1.95		V
		T_J=175°C		2.11		V
Zero Gate Voltage Collector Current	I_{CES}	V_{CE}=650V, V_{GE}=0V T_J=25°C		0.1	40	uA
		T_J=175°C			1	mA
Gate-emitter Leakage Current — Forward	I_{GESF}	V_{GE}=20V, V_{CE}=0V			100	nA
Gate-emitter Leakage Current — 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		1422		pF
Output Capacitance	C_{OES}			157		pF
Reverse Transfer Capacitance	C_{RES}			27		pF
Gate Resistance	R_G	f=1 MHz, Open Drain		1.03		Ω
Turn-on Delay Time	$t_{d(on)}$	T_J=25°C V_{CC}=400V, I_C=40A R_G=10Ω, V_{GE}=0/15V Energy losses include "tail" and diode reverse recovery		8.8		ns
Rise Time	t_r			22		ns
Turn-off Delay Time	$t_{d(off)}$			55		ns
Fall Time	t_f			62		ns
Turn-on energy	E_{on}			1.0		mJ
Turn-off energy	E_{off}			0.39		mJ
Total switching energy	E_{ts}			1.39		mJ
Turn-on Delay Time	$t_{d(on)}$	T_J=150°C V_{CC}=400V, I_C=40A R_G=10Ω, V_{GE}=0/15V Energy losses include "tail" and diode reverse recovery		9.2		ns
Rise Time	t_r			22		ns
Turn-off Delay Time	$t_{d(off)}$			65		ns
Fall Time	t_f			95		ns
Turn-on energy	E_{on}			1.29		mJ
Turn-off energy	E_{off}			0.62		mJ
Total switching energy	E_{ts}			1.91		mJ
Gate to Emitter Charge	Q_{GE}	V_{CC}=400V, I_C=40A V_{GE}=0 to 15V		9.7		nC
Gate to Collector Charge	Q_{GC}			19.7		nC
Gate Charge Total	Q_G			38		nC

Parameter	Symbol	Test Conditions	Min.	Typ.	Max.	Unit
Reverse Diode Characteristics						
Diode Forward Voltage	V_F	I_F=20A T_J=25°C		1.49	1.9	V
		I_F=20A T_J=125°C		1.29		
		I_F=20A T_J=175°C		1.18		
		I_F=40A T_J=25°C		1.74	2.15	
		I_F=40A T_J=125°C		1.61		
		I_F=40A T_J=175°C		1.51		
Reverse Recovery Time	t_{rr}	T_J=25°C V_R=400V, I_F=40A dI_F/dt=700A/us		162		ns
Reverse Recovery Charge	Q_{rr}			610		nC
Peak Reverse Recovery Current	I_{rrm}			7.9		A
Diode peak rate of fall of reverse Recovery current during tb	dirr/dt			-240		A/us
Reverse Recovery Time	t_{rr}	T_J=150°C V_R=400V, I_F=40A dI_F/dt=700A/us		346		ns
Reverse Recovery Charge	Q_{rr}			2.5		uC
Peak Reverse Recovery Current	I_{rrm}			17		A
Diode peak rate of fall of reverse Recovery current during tb	dirr/dt			-150		A/us

Typical Performance Characteristics

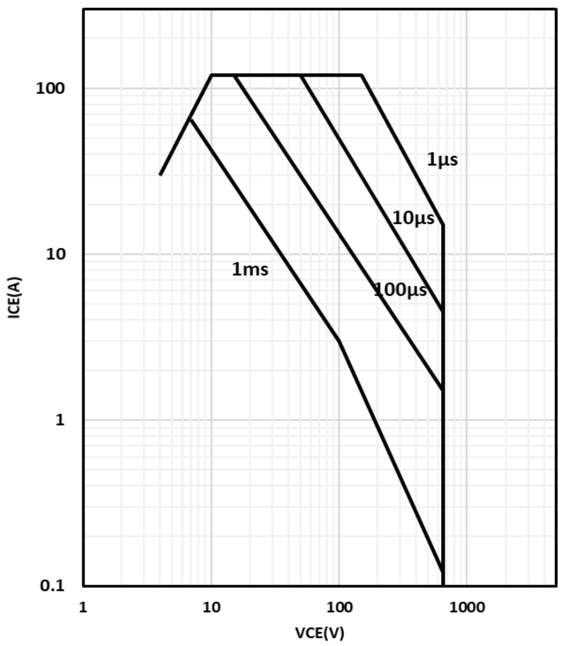
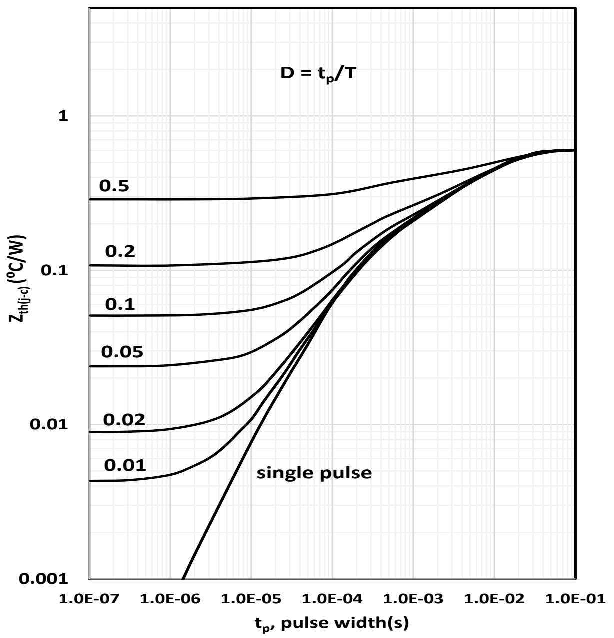
Figure 3: IGBT FBSOA	Figure 4: IGBT transient thermal impedance
	
$I_C = f(V_{CE})$; $V_{GE} \geq 15/0V$; $Tj \leq 175^oC$	$R_{th(J\text{-}C)} = f(t_p)$; duty cycle: $D = t_p/T$

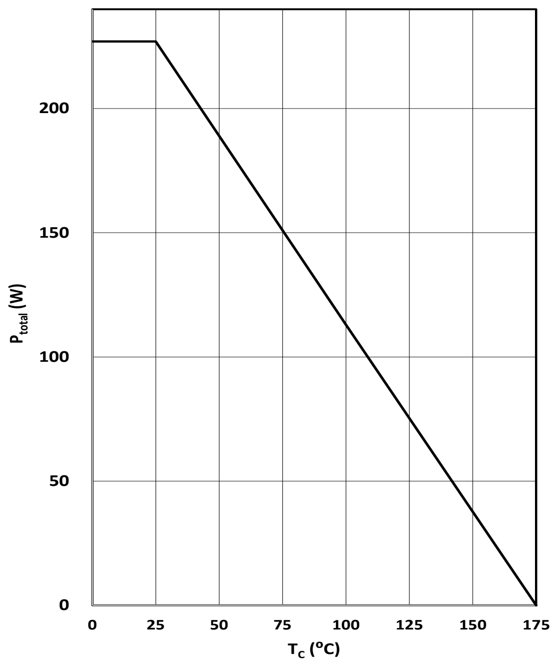
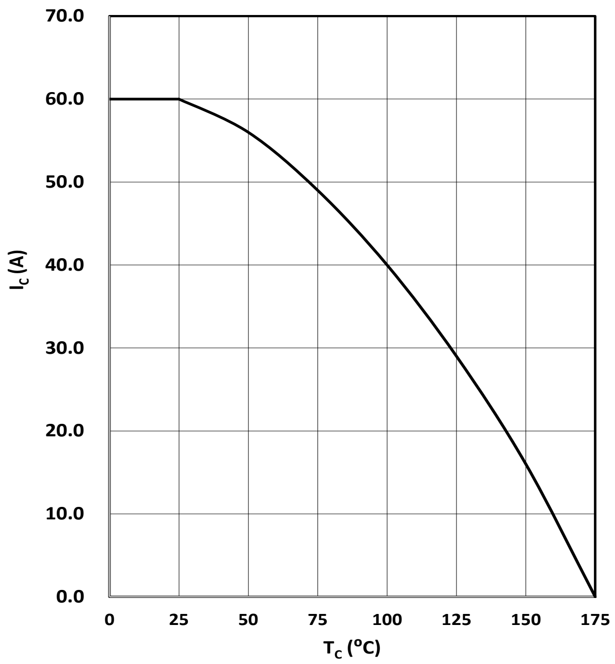
Figure 5: Power dissipation	Figure 6: Collector current vs. temperature
	
Ptot= f(Tc);	$I_c = f(Tj)$; $V_{GE} \geq 15V$; $Tj \leq 175^oC$

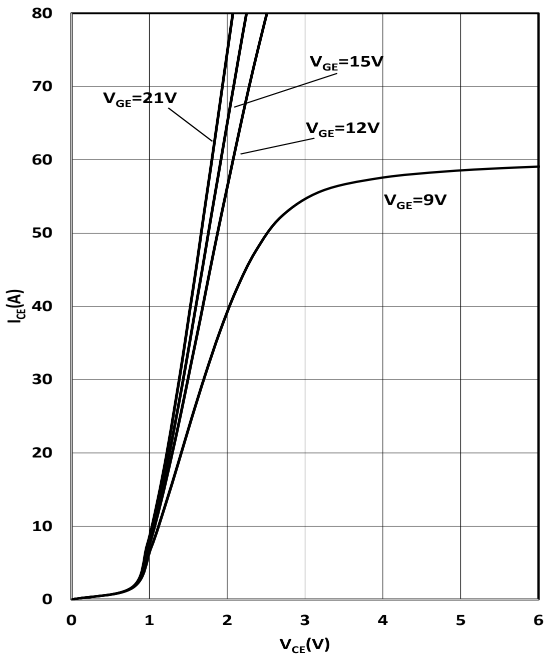
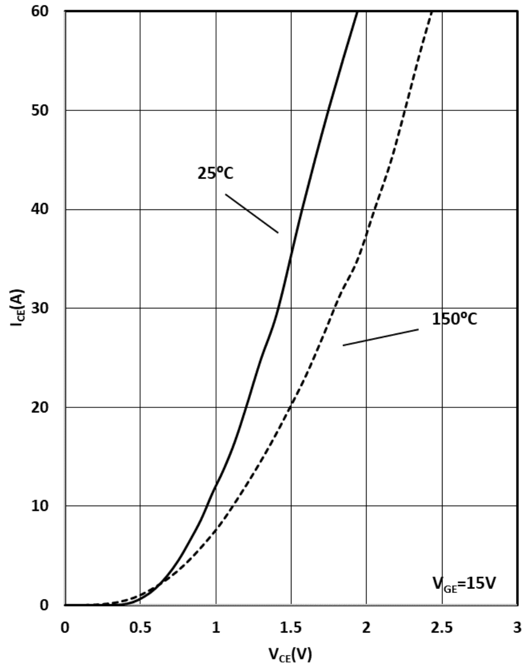
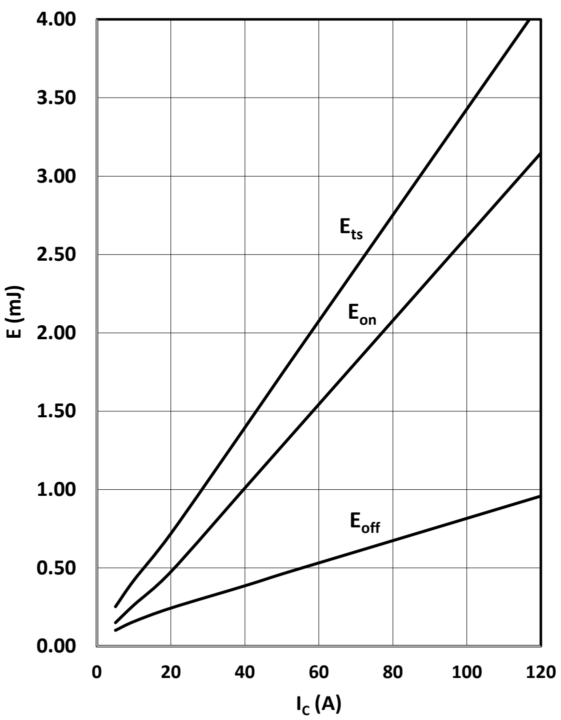
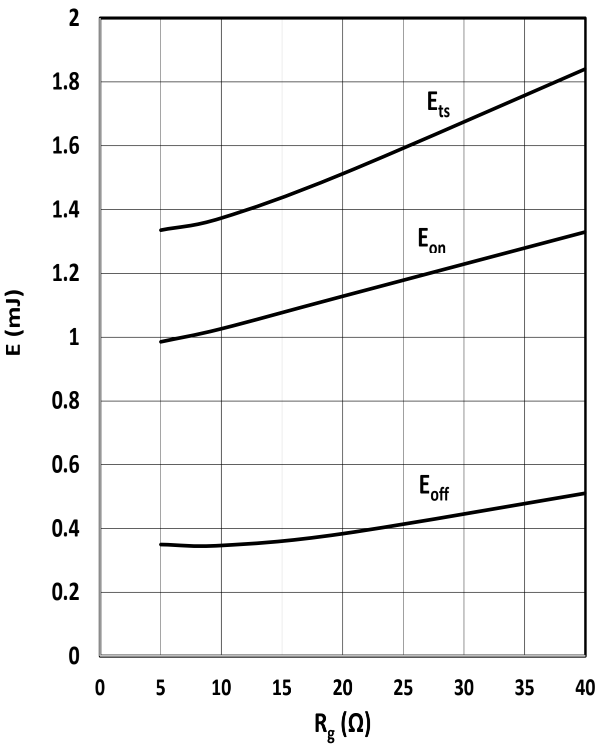
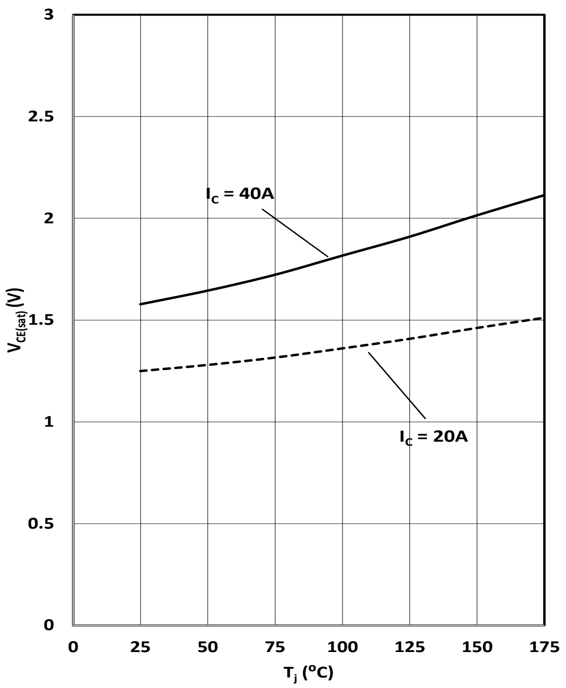
Figure 7: Typical Output Characteristics	Figure 8: Typical transfer characteristic
	
$I_C = f(V_{CE})$; Tj= 25ºC; parameter: V_{GE}	$I_{C\_typ.} = f(V_{CE})$; Tj= 25ºC vs 150ºC

Figure 9: Typical switching energy losses as a function of collector current	Figure10: Typical switching energy losses as a function of gate resistor
	
E=f(Ic); V_{CE}=400V; Tj=25ºC; R_G=10Ω	E=f(R_G); V_{CE}=400V; Tj=25ºC; Ic=40A

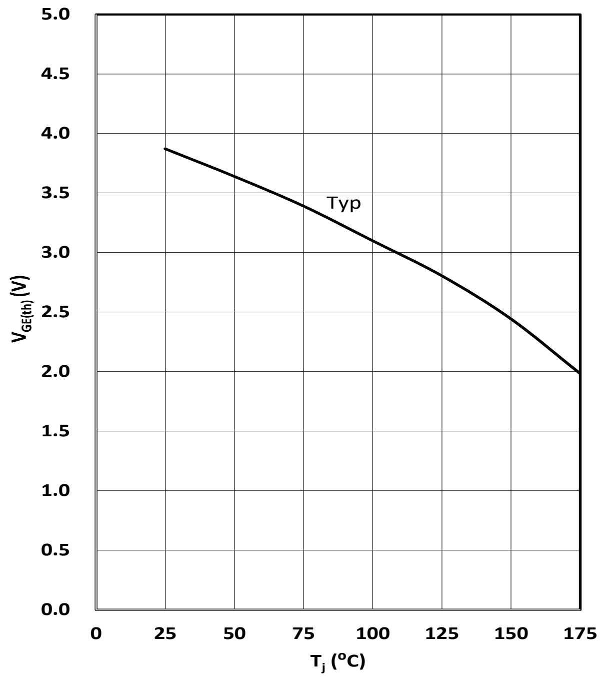
40A 650V Trench Field stop IGBT with anti-parallel diode SRE40N065FS2UDG

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



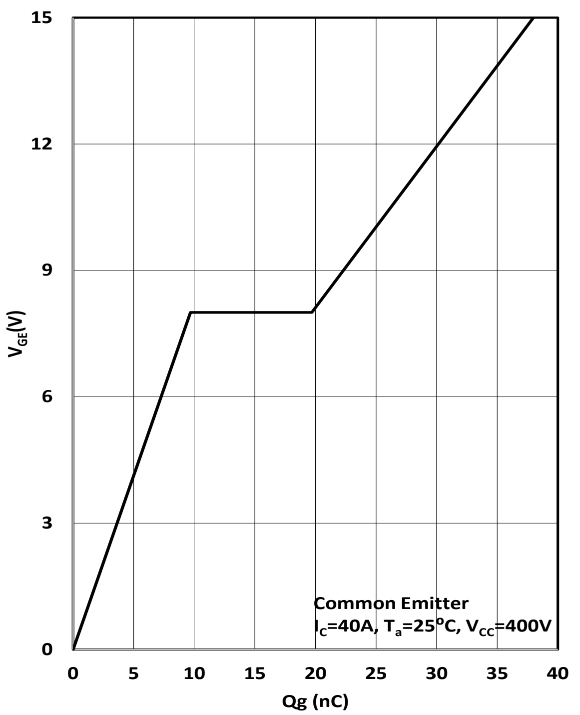
V_{CE} =f(T_j); V_{GE}=15V

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



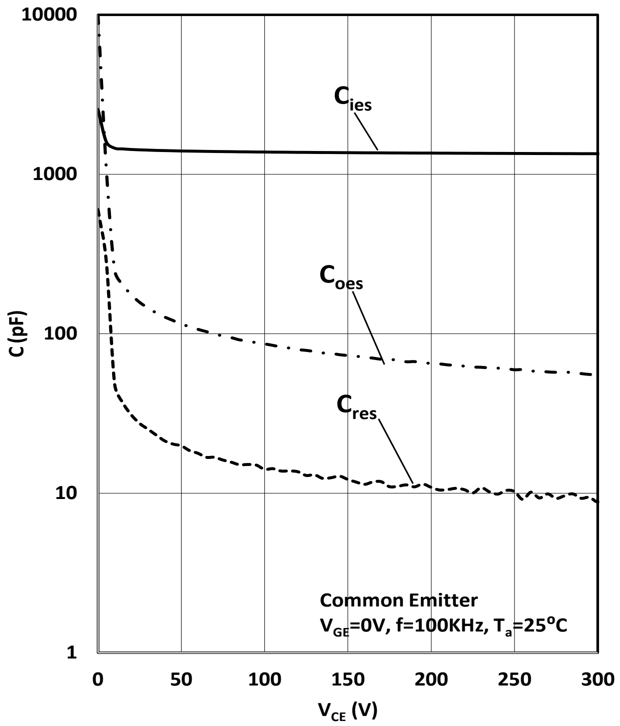
V_{GE} =f(T_j); I_{CE} = 250µA

Figure 13: Typical Gate Charge



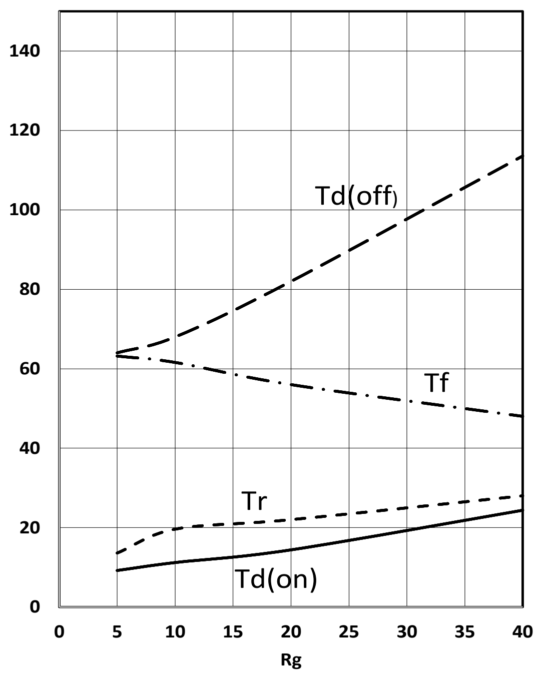
V_{GE}= f(Q_{gate}); I_C= 40A

Figure 14: Typical Capacitances



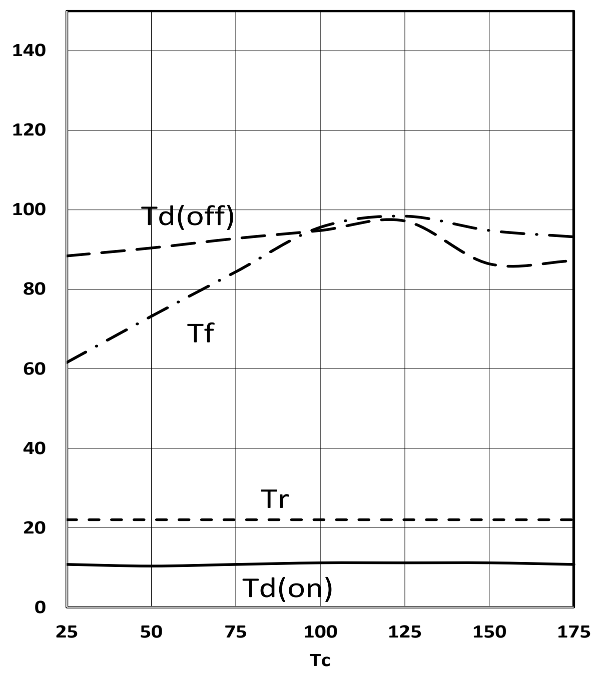
C=f(V_{CE}); V_{GE}=0; f=100KHz

Figure 15 : Typical Switching time as a function of gate resistor



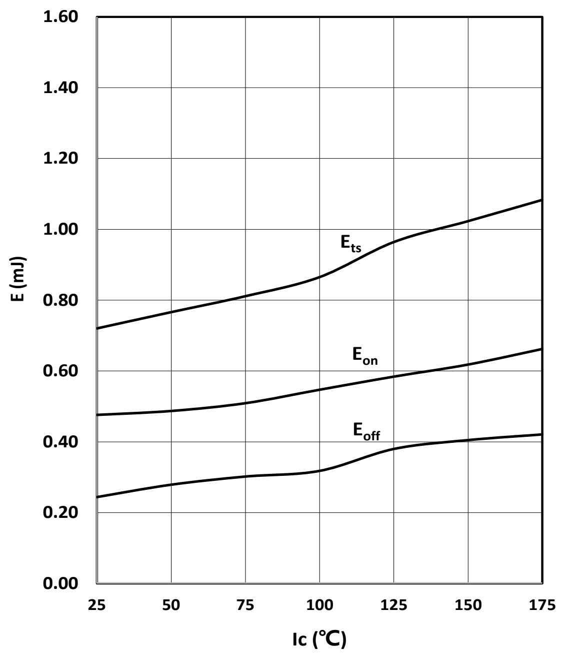
V_{CE}=400V;I_C= 40A; Tj=25ºC

Figure 16: Typical Switching time as a function of junction temperature



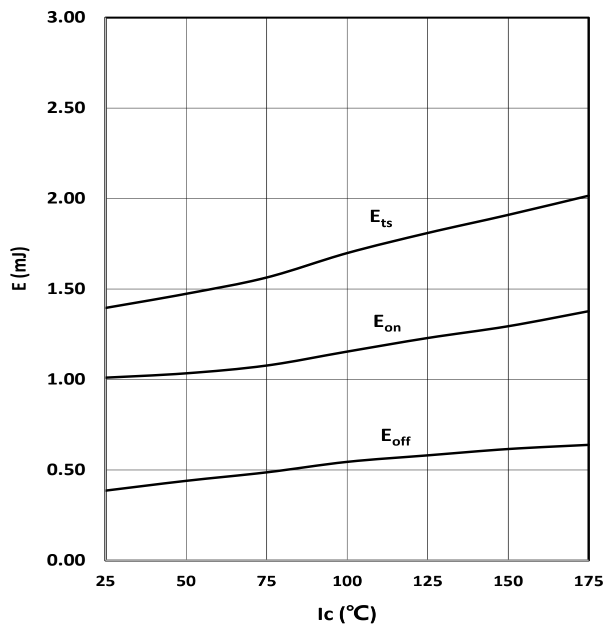
V_{CE}=400V;I_C= 40A;R_G=10Ω

Figure 17: Typical switching energy losses as a function of junction temperature



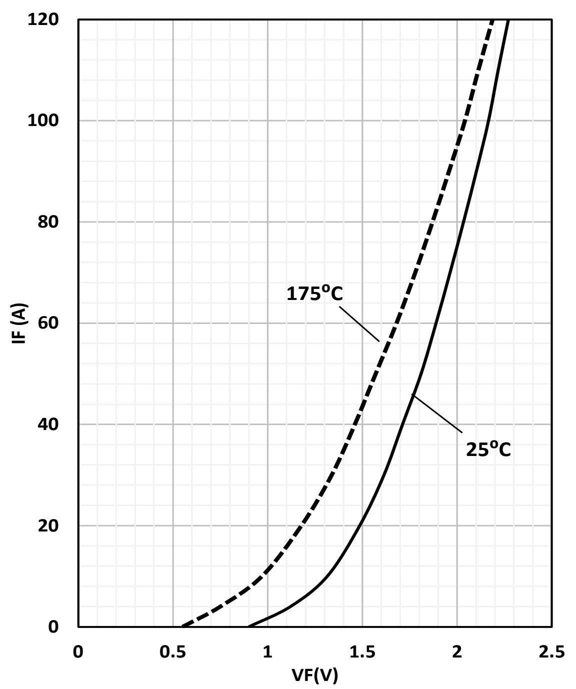
E= f(Tj); V_{CE}=400V;I_C= 20A;R_G=10Ω

Figure 18: Typical switching energy losses as a function of junction temperature



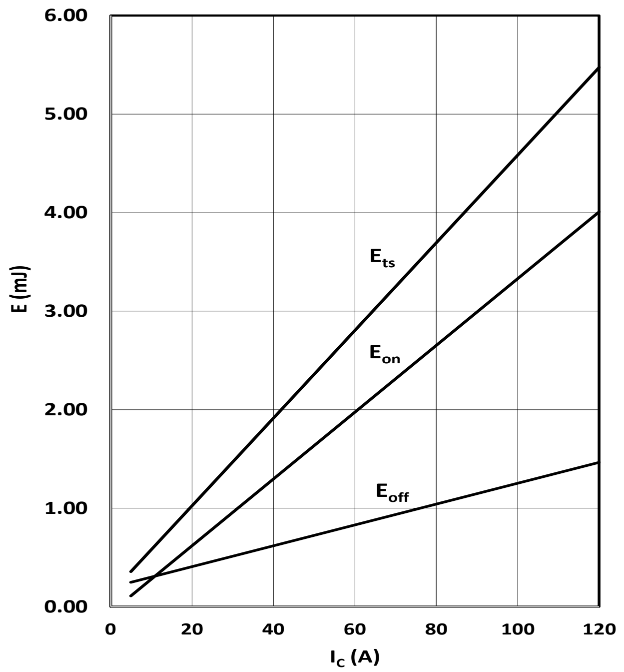
E= f(Tj); V_{CE}=400V;I_C= 40A;R_G=10Ω

Figure 19: Typical diode forward current as a function of forward voltage



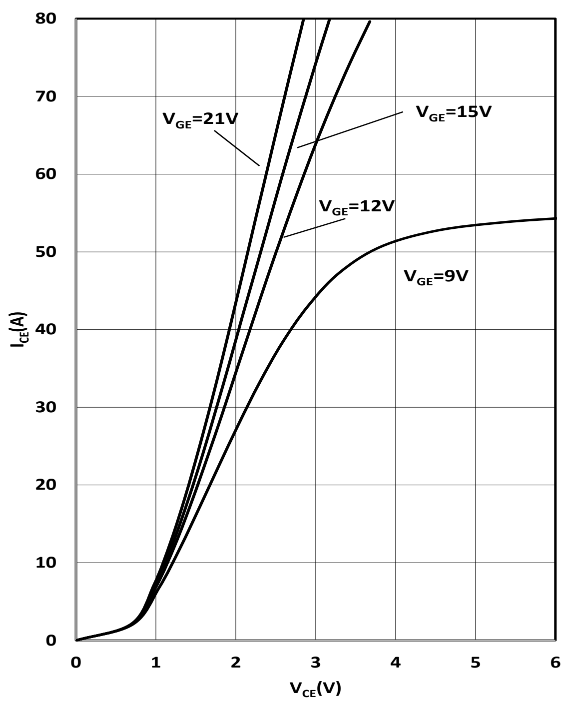
IF= f(V_F);

Figure 20: Typical switching energy losses as a function of collector current



E=f(Ic); V_{CE}=400V; Tj=150°C; R_G=10Ω

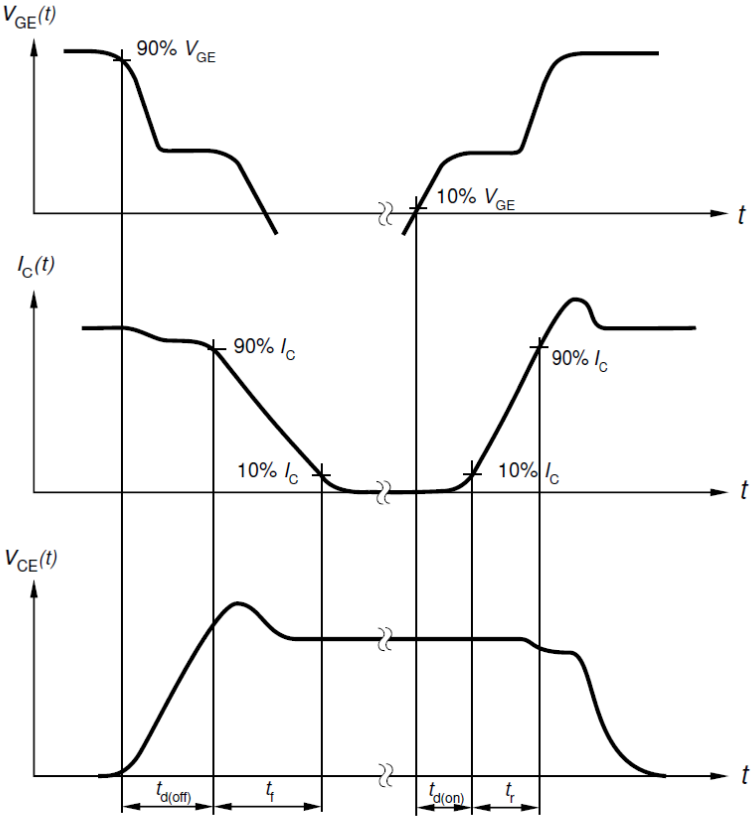
Figure 21: Typical Output Characteristics



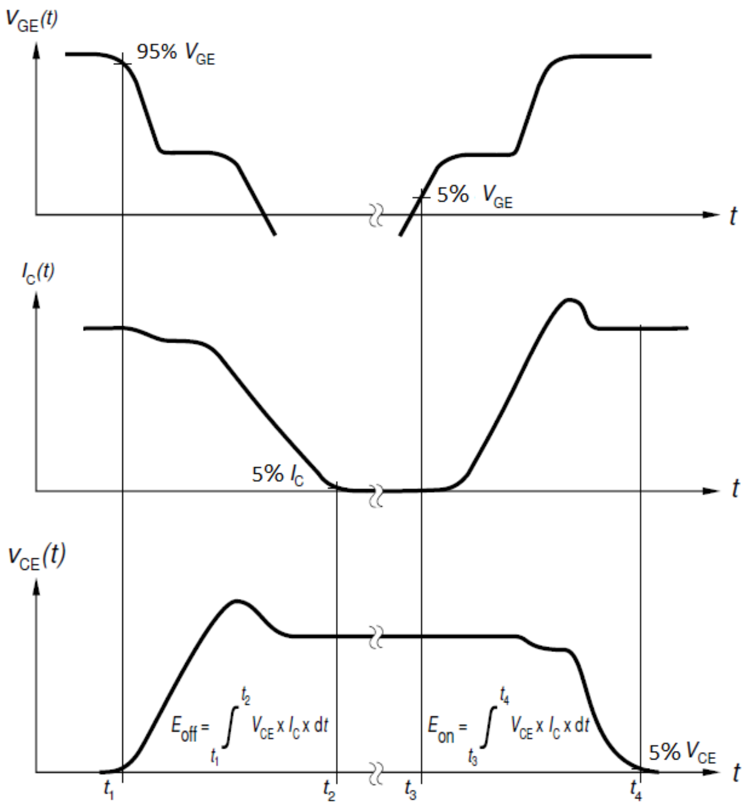
I_C = f(V_{CE}); Tj= 150°C; parameter: V_{GE}

Test Circuits

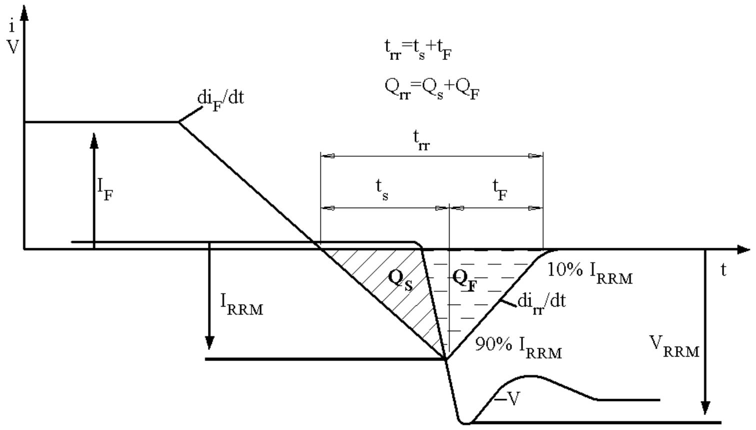
1. Definition Switching times



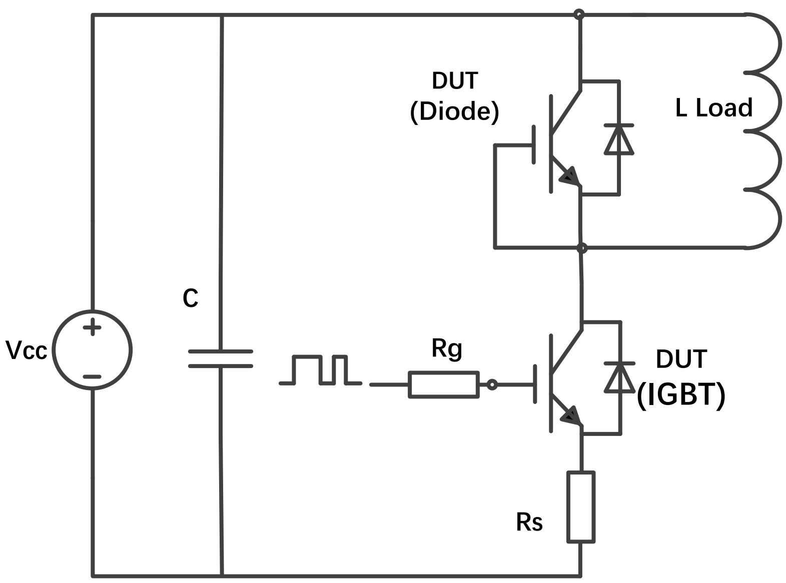
2. Definition Switching losses



3. Definition Diode Switching Characteristics



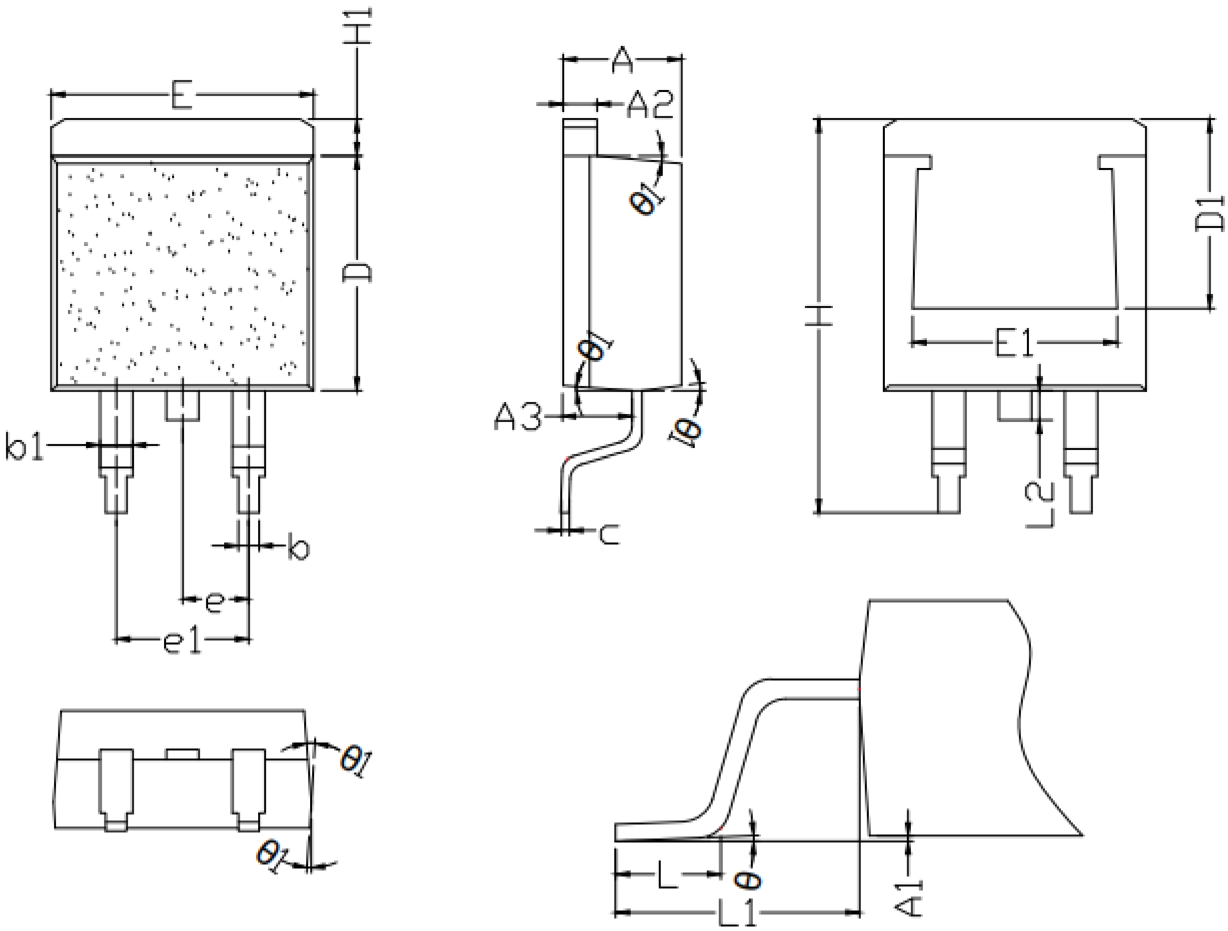
4. Dynamic test circuit



Mechanical Dimensions

TO-263

Unit: mm

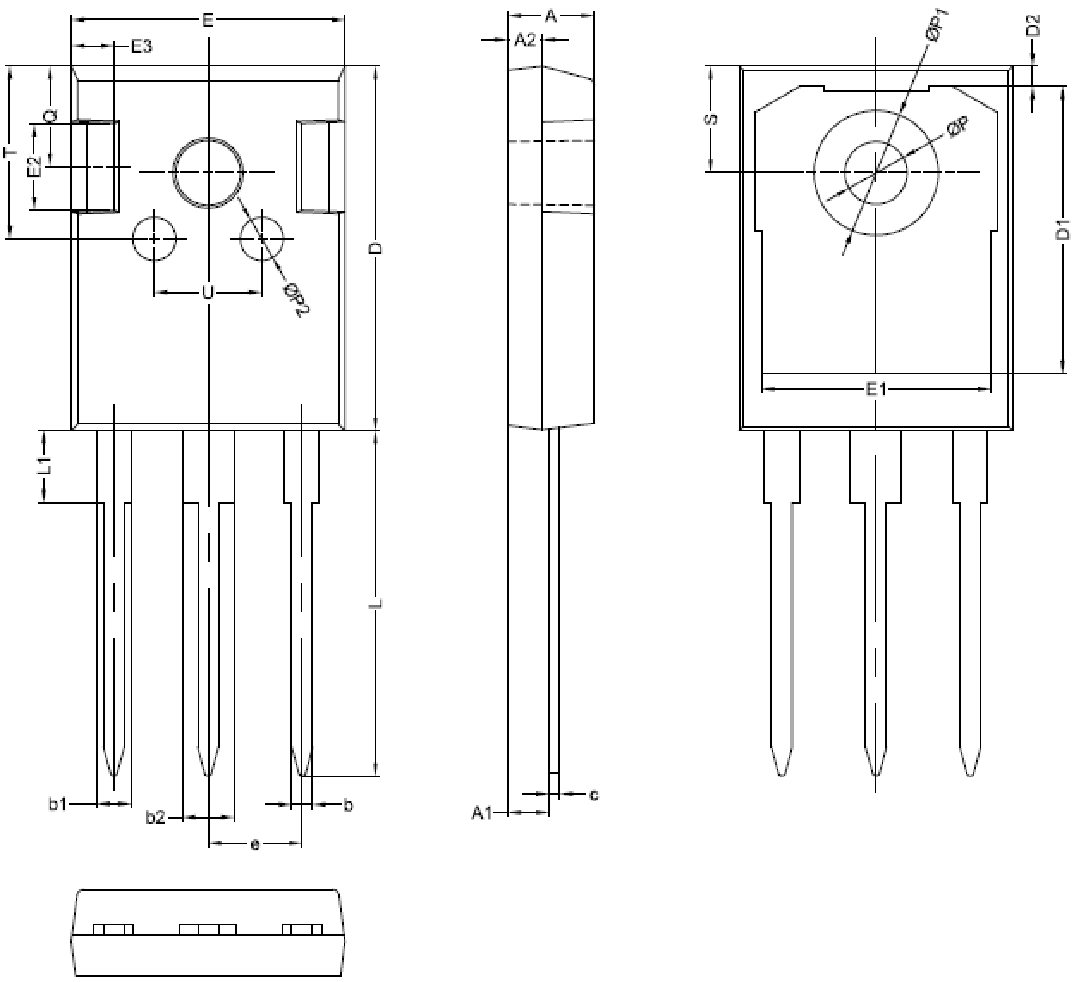


Symbol	Dimensions (mm)			Symbol	Dimensions (mm)		
	Min.	Typ.	Max.		Min.	Typ.	Max.
A	4.42	4.52	4.62	E1	–	7.85REF	–
A1	0.00	0.10	0.20	e	2.50	2.54	2.58
A2	1.24	1.27	1.32	e1	–	5.08REF	–
A3	2.50	2.60	2.70	H	14.80	15.10	15.30
b	0.77	0.81	0.84	H1	1.12	1.28	1.42
b1	1.23	1.28	1.41	L	2.10	2.23	2.36
c	0.33	0.38	0.43	L1	4.55	4.75	4.95
D	8.80	8.95	9.10	L2	1.10	1.30	1.50
D1	–	7.25REF	–	**Θ**	0°	2°	5°
E	9.92	10.07	10.22	**Θ1**	3°	–	9°

40A 650V Trench Field stop IGBT with anti-parallel diode SRE40N065FS2UDG

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	-

Sanrise Tech
尚阳通

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IMPORTANT NOTICE

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