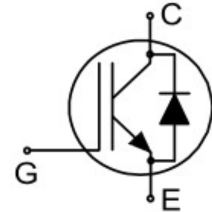
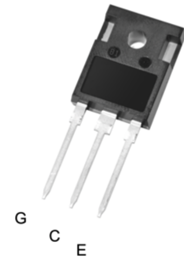
HC40N120

40A/1200V
Trench FS IGBT

Features :

1200V IGBT technology offering：
- High efficiency in hard switching and resonant topologies
- Low EMI
- Low Gate Charge Q_g
- Very soft, fast recovery full current anti-parallel diode
- Maximum junction temperature 175°C





Applications:

- Industrial UPS
- Charger
- Energy storage
- Three-level Solar String Inverter
- Welding

Key Performance and Package Parameters

Type	V_{CE}	I_C	V_{CEsat} , T_{vj} =25°C	T_{vjmax}	Marking	Package
	1200V	40A	1.84V	175°C		TO-247

Absolute maximum ratings

Parameter	Symbol	Value	Unit
Collector-emitter voltage, T_{vj} ≥25°C	V_{CE}	1200	V

Parameter	Symbol	Value	Unit
DC collector current, limited by T vjmax T_C = 25°C T_C = 100°C	I_C	80 40	A
Pulsed collector current, t_p limited by T_{vjmax}	I_{Cpuls}	160	A
Turn off safe operating area V_{CE} ≤ 1200V, T_{vj} ≤175°C	-	160	A
Diode forward current, limited by T_{vjmax} T_C=25°C T_C=100°C	I_F	80 40	A
Diode pulsed current, t_p limited by T_{vjmax}	I_{Fpuls}	160	A
Gate-emitter voltage Transient Gate-emitter voltage (t_p ≤ 0.5μs, D < 0.001)	V_{GE}	±20 25	V
Short circuit withstand time V_{GE}=15.0V, V_{CC} ≤ 500V Allowed number of short circuits < 1000 Time between short circuits: ≥ 1.0s T_{vj} =125°C	t_{SC}	10	μs
Power dissipation T_C = 25°C Power dissipation T_C =100°C	P_{tot}	395 197	W
Operating junction temperature	T_{vj}	-40...+175	°C
Storage temperature	T_{stg}	-55...+150	°C
Soldering temperature, wave soldering 1.6mm (0.063in.) from case for 10s		270	°C
Mounting torque, M3 screw Maximum of mounting processes: 3	M	0.6	Nm

Thermal Resistance

Parameter	Symbol	Conditions	Value			Unit
			min.	typ.	max.	
R_{th} Characteristics						
IGBT thermal resistance, junction - case	$R_{th(j-C)}$		-	0.38	-	°C/W
Diode thermal resistance, junction - case	$R_{th(j-C)}$		-	0.74	-	°C/W
Thermal resistance junction - ambient	$R_{th(j-a)}$		-	32	-	°C/W

[1)] Defined by design. Not subject to production test.

Electrical Characteristic, at T_{vj} = 25°C,unless otherwise specified

Parameter	Symbol	Conditions	Value			Unit
			min.	typ.	max.	
Static Characteristic						
Collector-emitter breakdown voltage	$V_{(BR)CES}$	V_{GE}=0V, I_C=0.85mA	1200	-	-	V
Collector-emitter saturation voltage	V_{CEsat}	V_{GE}=15V,I_C=40A T_{vj}=25°C T_{vj}=125°C T_{vj}=175°C	- - -	1.84 2.27 2.49	2.15 - -	V
Diode forward voltage	V_F	V_{GE}=0V,I_F=40.0A T_{vj}=25°C T_{vj}=175°C	- -	2.30 1.86	2.55 -	V
Gate-emitter threshold voltage	$V_{GE(th)}$	I_C=1.9mA,V_{CE}=V_{GE}	5.1	5.9	6.3	V
Zero gate voltage collector current	I_{CES}	V_{CE}=1200V,V_{GE}=0V T_{vj}=25°C T_{vj}=175°C	- -	- 1600	850 -	μA
Gate-emitter leakage current	I_{GES}	V_{CE}=0V,V_{GE}=20V	-	-	600	nA
Transconductance	g_{fs}	V_{CE}=20V,I_C=40A	-	23.7	-	S

Electrical Characteristic, at T_{vj} =25°C,unless otherwise pecified

Parameter	Symbol	Conditions	Value			Unit
			min.	typ.	max.	
Dynamic Characteristic						
Input capacitance	C_{ies}	V_{CE}=25V,V_{GE}=0V,f=1MHz	-	2468	-	pF
Output capacitance	C_{oes}		-	124	-	
Reverse transfer capacitance	C_{res}		-	20	-	
Gate charge	Q_G	V_{CC}=960V,I_C=40A,V_{GE}=15V	-	119	-	nC

Switching Characteristic, Inductive Load

Parameter	Symbol	Conditions	Value			Unit
			min.	typ.	max.	
Dynamic Characteristic						
Turn-on delay time	$t_{d(on)}$	T_{vj}=25°C, V_{CC}=600V,I_C=40A, V_{GE}=0.0/15.0V, $R_{G(on)}$=9.0Ω,$R_{G(off)}$ =9.0Ω	-	24	-	ns
Rise time	t_r		-	95	-	ns
Turn-off delay time	$t_{d(off)}$		-	156	-	ns
Fall time	t_f		-	109	-	ns
Turn-on energy	E_{on}		-	3.2	-	mJ
Turn-off energy	E_{off}		-	1.6	-	mJ
Total switching energy	E_{ts}		-	4.8	-	mJ

Diode Characteristic, at T_{vj} =25°C

Parameter	Symbol	Conditions	Value			Unit
			min.	typ.	max.	
Dynamic Characteristic						
Diode reverse recovery time	t_{rr}	T_{vj}=25°C, V_R=600V, I_F=40A, di_F/dt=500A/μs	-	353	-	ns
Diode reverse recovery charge	Q_{rr}		-	2.1	-	μC
Diode peak reverse recovery current	I_{rrm}		-	16	-	A

Switching Characteristic, Inductive Load

Parameter	Symbol	Conditions	Value			Unit
			min.	typ.	max.	
IGBT Characteristic, at T_{vj}=175°C						
Turn-on delay time	$t_{d(on)}$	T_{vj}=175°C, V_{CC}=600V,I_C=40A, V_{GE}=0.0/15.0V, $R_{G(on)}$=9.0Ω,$R_{G(off)}$ =9.0Ω	-	23	-	ns
Rise time	t_r		-	88	-	ns
Turn-off delay time	$t_{d(off)}$		-	215	-	ns
Fall time	t_f		-	227	-	ns
Turn-on energy	E_{on}		-	3.3	-	mJ
Turn-off energy	E_{off}		-	2.8	-	mJ
Total switching energy	E_{ts}		-	6.1	-	mJ

Diode Characteristic, at T_{vj} =175°C

Parameter	Symbol	Conditions	Value			Unit
			min.	typ.	max.	
Dynamic Characteristic						
Diode reverse recovery time	t_{rr}	T_{vj}=175°C, V_R=600V, I_F=40A, di_F/dt=500A/μs	-	416	-	ns
Diode reverse recovery charge	Q_{rr}		-	6.4	-	μC
Diode peak reverse recovery current	I_{rrm}		-	33	-	A

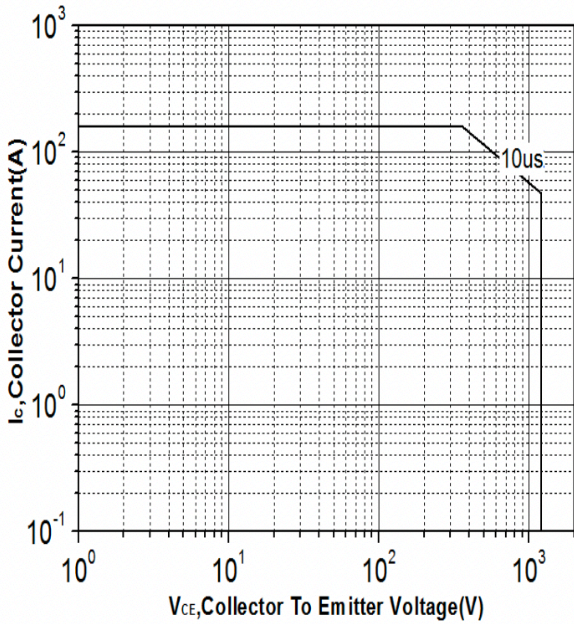


Figure 1. Forward bias safe operating area
(D=0,T_j≤175°C,V_{GE}=15V, pulse width Limited by T_{vjmax})

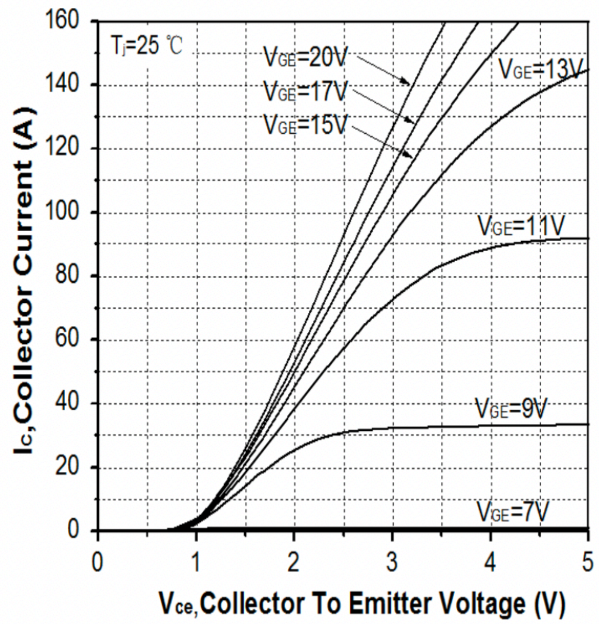


Figure 2. Typical output characteristic
(T_j =25°C)

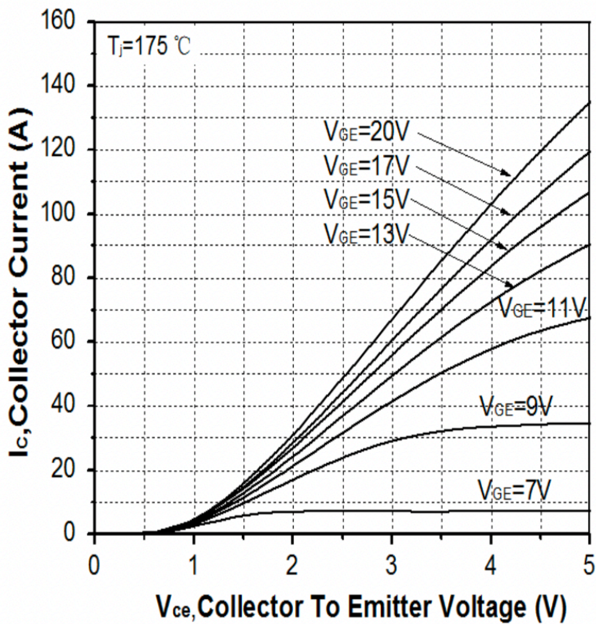


Figure 3. Typical output characteristic
(T_j =175°C)

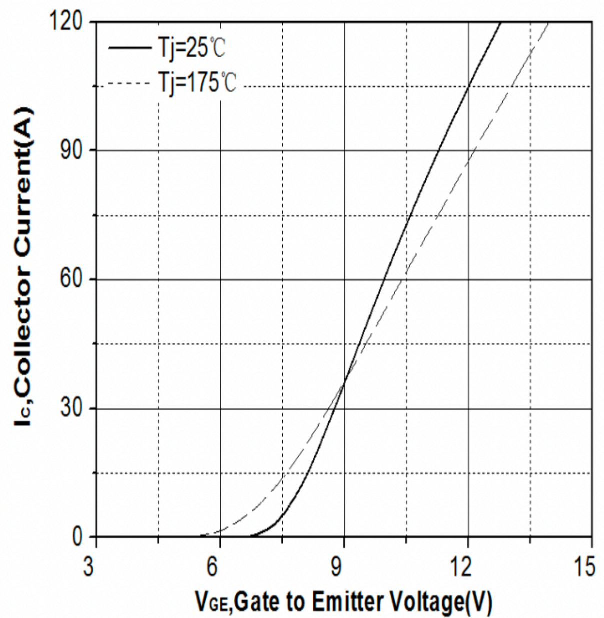


Figure 4. Typical transfer characteristic
(V_{CE} =20V)

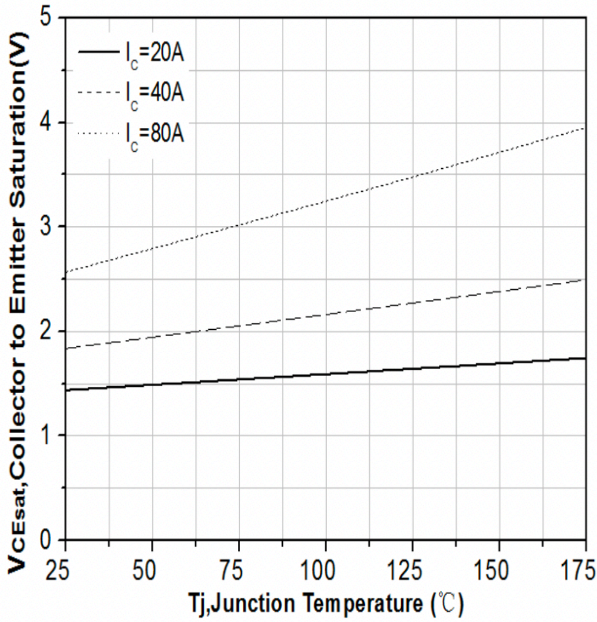


Figure 5. Typical collector-emitter saturation voltage as a function of junction temperature
(V_{GE} =15V)

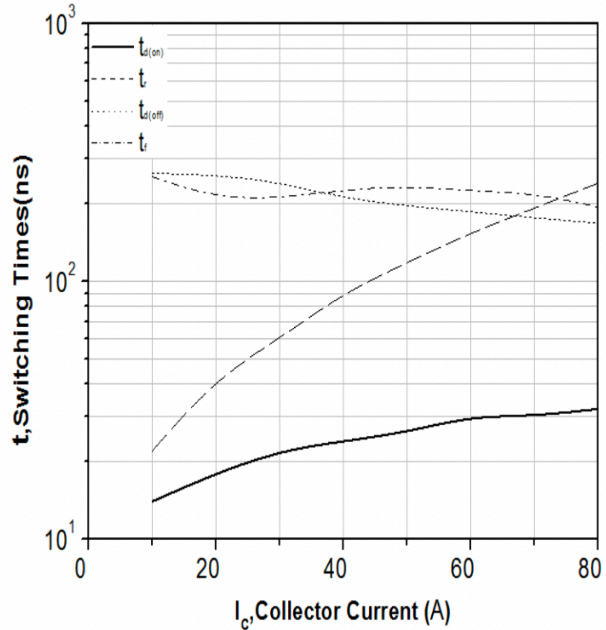


Figure 6. Typical switching times as a function of collector current
(inductive load,T_j =175°C,V_{CE} =600V, V_{GE} =0/15V,R_G =9Ω,dynamic test circuit in Figure E)

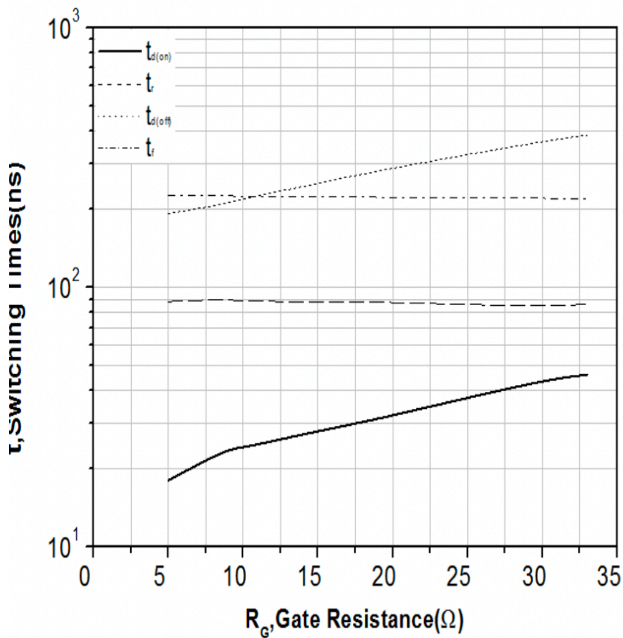


Figure 7. Typical switching times as a function of gate resistance
(inductive load, T_j =175°C,V_{CE}=600V, V_{GE}=0/15V,I_C=40A,dynamic test circuit in Figure E)

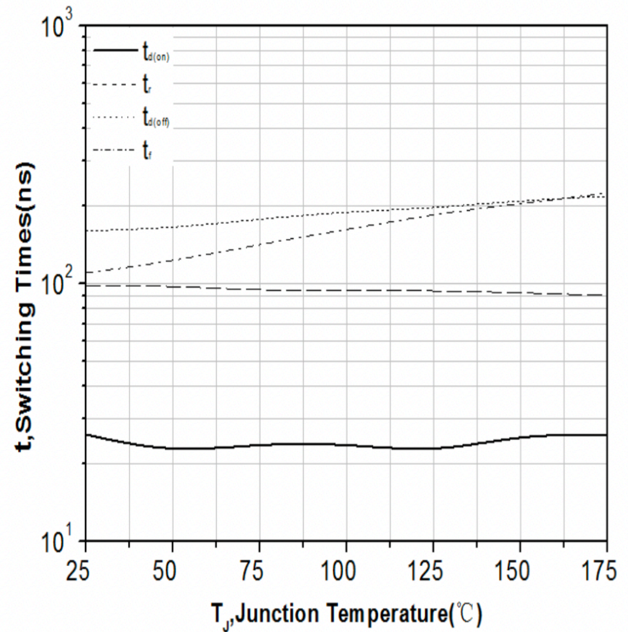


Figure 8. Typical switching times as a function of Junction temperature
(inductive load, V_{CE} =600V,V_{GE} =0/15V, I_C =40A,R_G=9Ω,dynamic test circuit in Figure E)

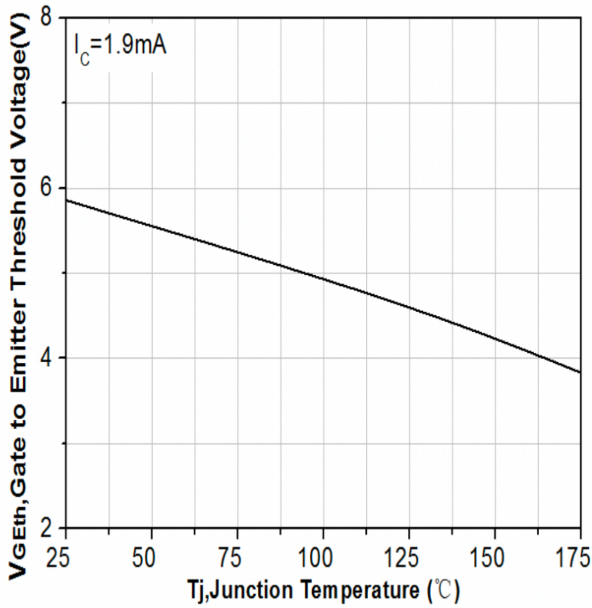


Figure 9. Gate-emitter threshold voltage as a function of junction temperature
(I_C =1.9mA)

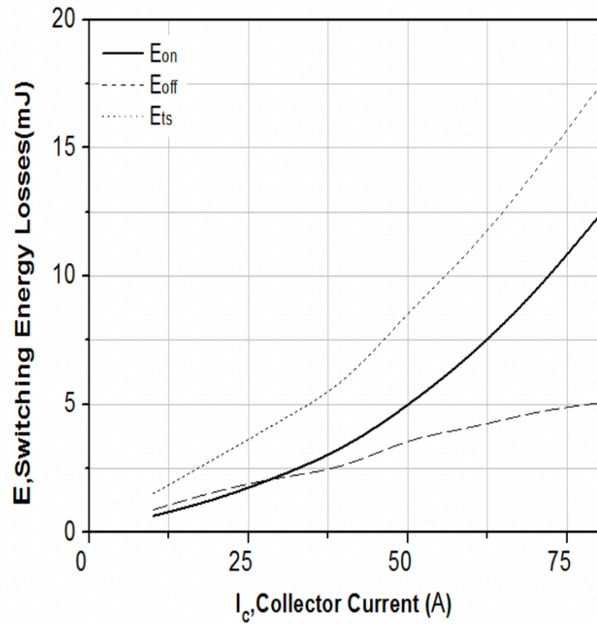


Figure 10. Typical switching energy losses as a function of collector current
(inductive load,T_j=175°C,V_{CE}=600V, V_{GE} =0/15V,R_G =9Ω,dynamic test circuit in Figure E)

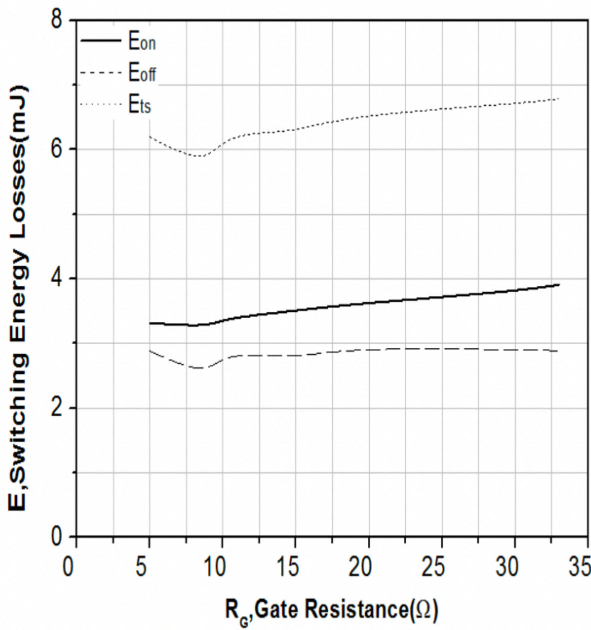


Figure 11. Typical switching energy losses as a function of gate resistance
(inductive load,T_j=175°C,V_{CE}=600V, V_{GE}=0/15V,I_C =40A,dynamic test circuit in Figure E)

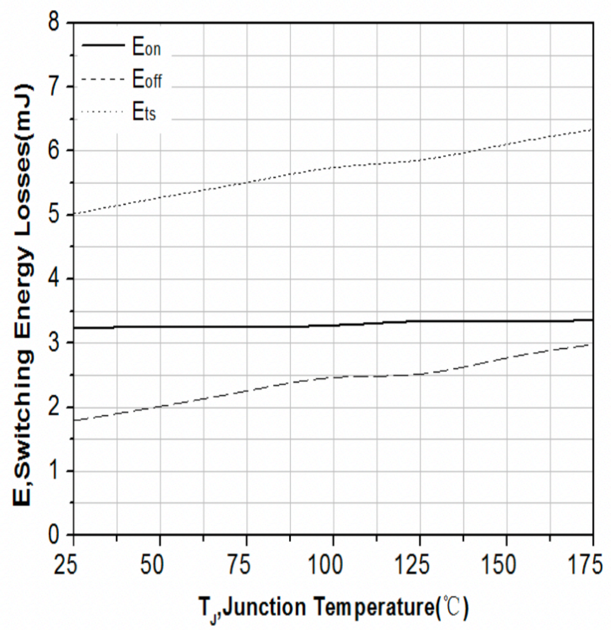


Figure 12. Typical switching energy losses as a function of junction temperature
(inductive load,V_{CE} =600V,V_{GE}=0/15V, I_C=40A,R_G=9Ω,dynamic test circuit in Figure E)

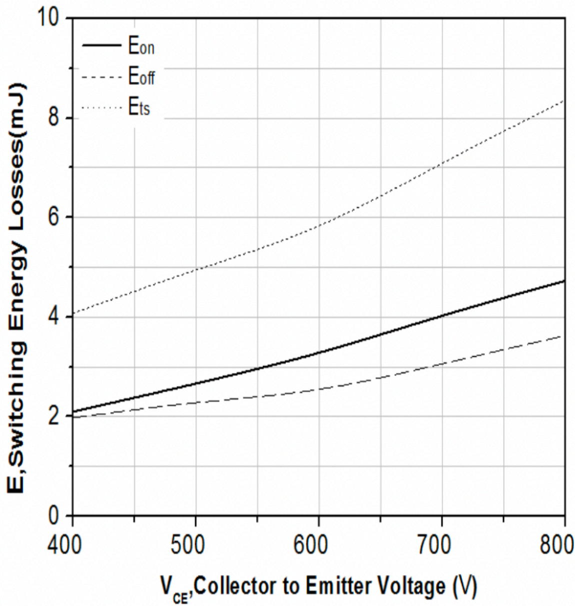


Figure 13. Typical switching energy losses as a function of collector emitter voltage
(inductive load,T_j=175°C,V_{GE}=0/15V, I_C=40A,R=9Ω,dynamic test circuit in Figure E)

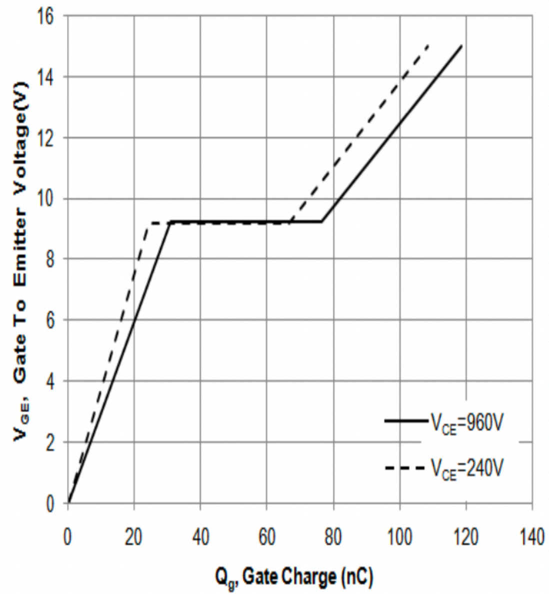


Figure 14. Typical gate charge
(I_C=40A)

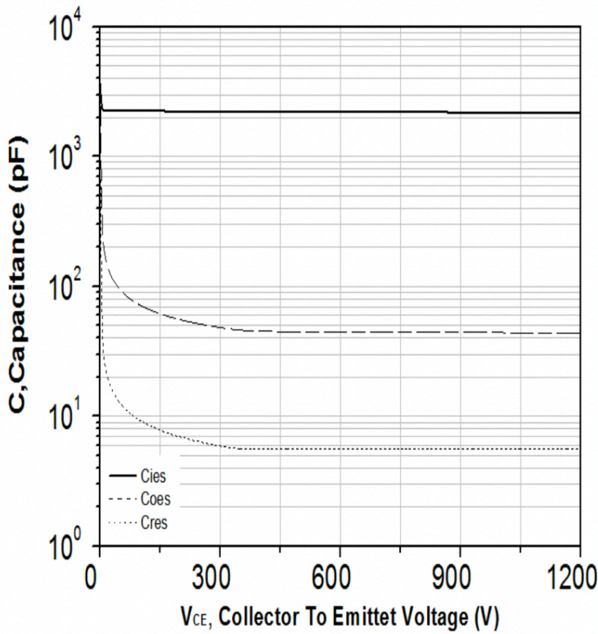


Figure 15. Typical capacitance as a function of collector-emitter voltage
(V_{GE}=0V,f=1MHz)

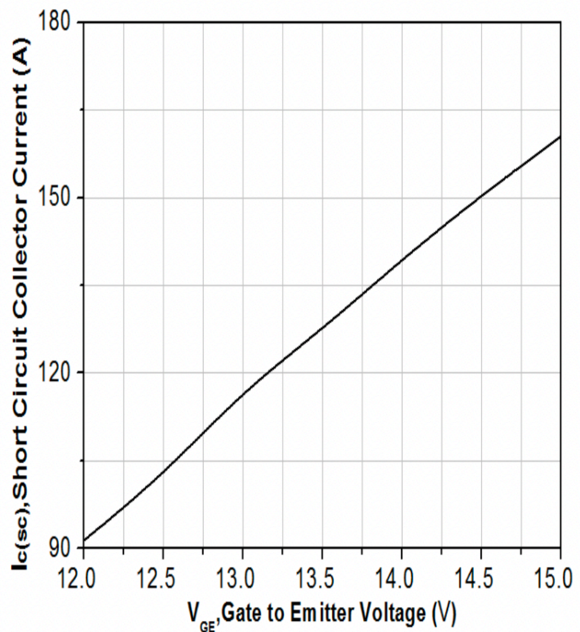


Figure 16. Typical short circuit collector current as a function of gate-emitter voltage
(V_{CE}≤500V, T_j ≤125°C)

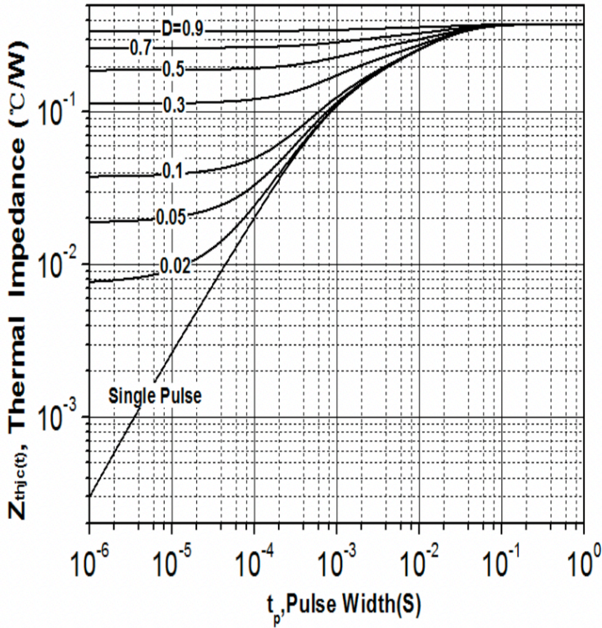


Figure 17. IGBT transient thermal resistance
($D=t_p/T$)

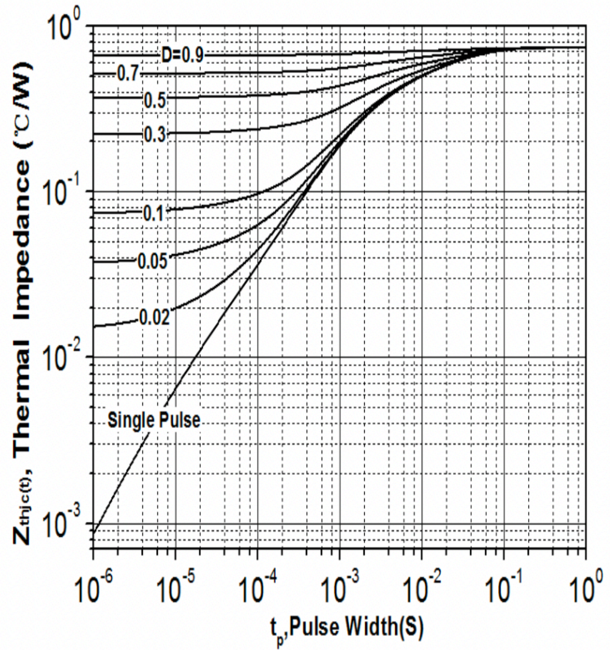


Figure 18. Diode transient thermal impedance as a function of pulse width
($D=t_p/T$)

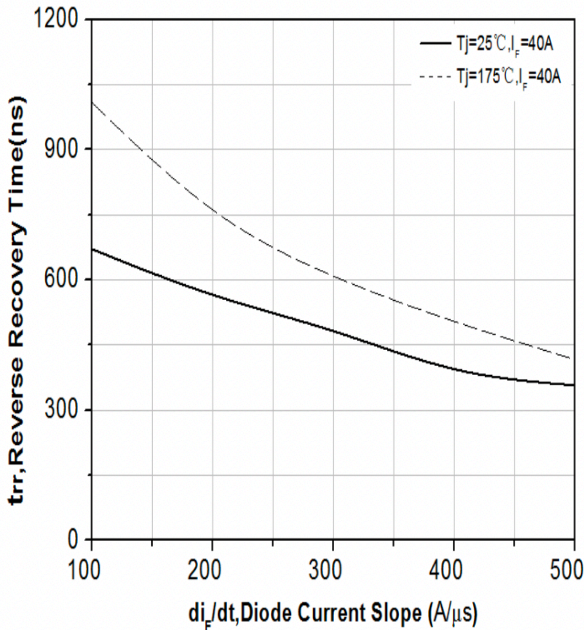


Figure 19. Typical reverse recovery time as a function of diode current slope
(V_R =600V)

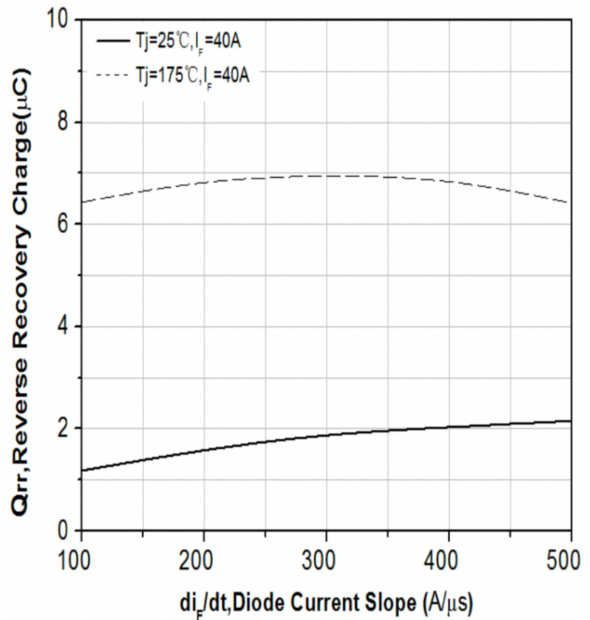


Figure 20. Typical reverse recovery charge as a function of diode current slope
(V_R =600V)

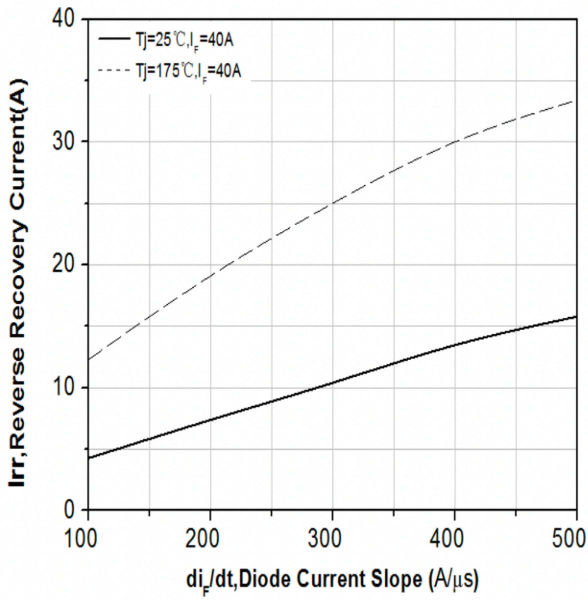


Figure 21. Typical reverse recovery current as a function of diode current slope (V_R =600V)

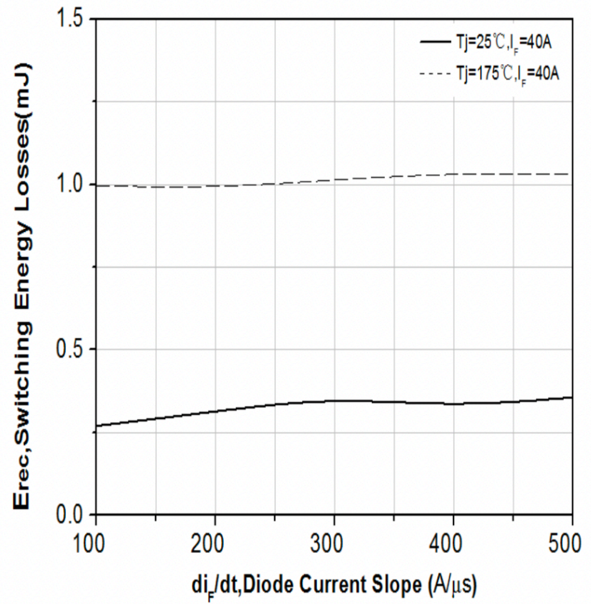


Figure 22. Typical reverse energy losses as a function of diode current slope (V_R=600V)

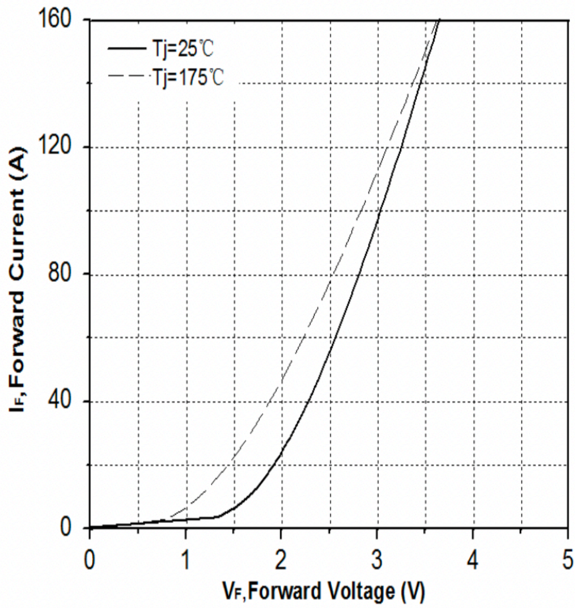


Figure 23. Typical diode forward current as a function of forward voltage

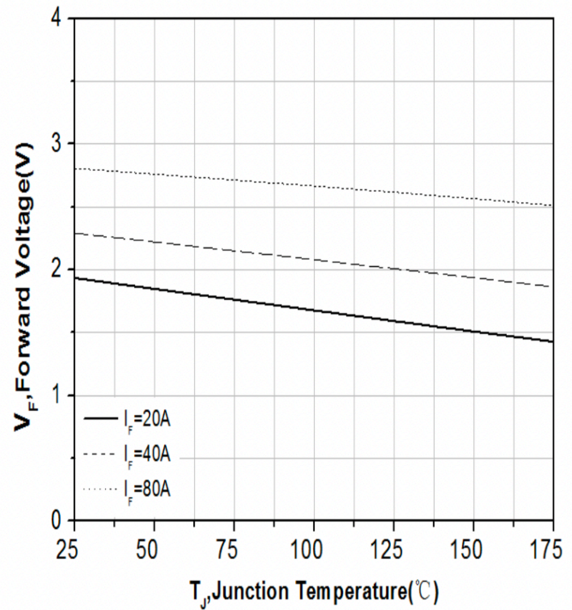


Figure 24. Typical diode forward voltage as a function of junction temperature

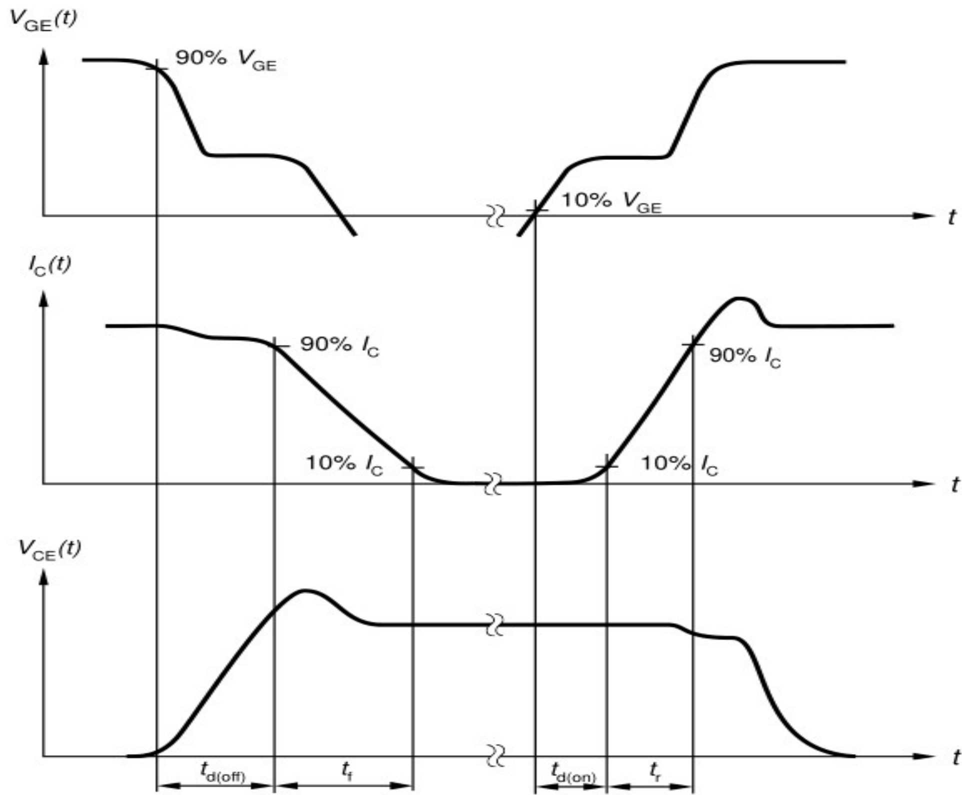


Figure A. Definition of switching times

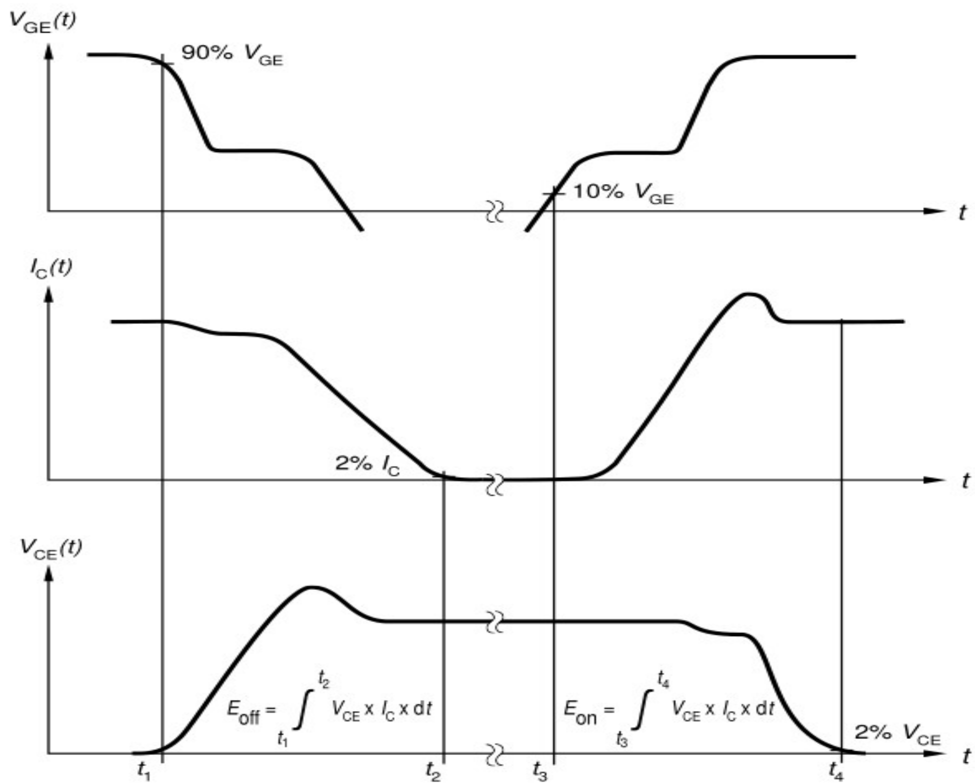


Figure B. Definition of switching losses

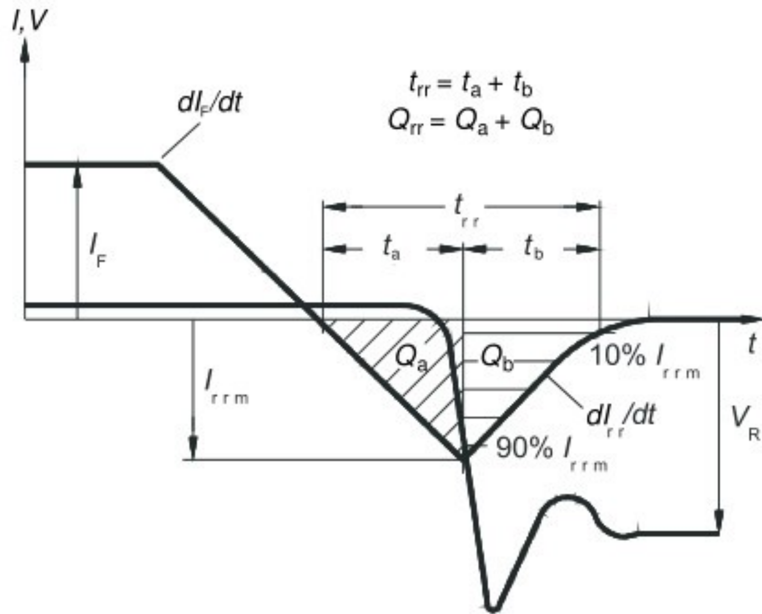


Figure C. Definition of diode switching characteristics

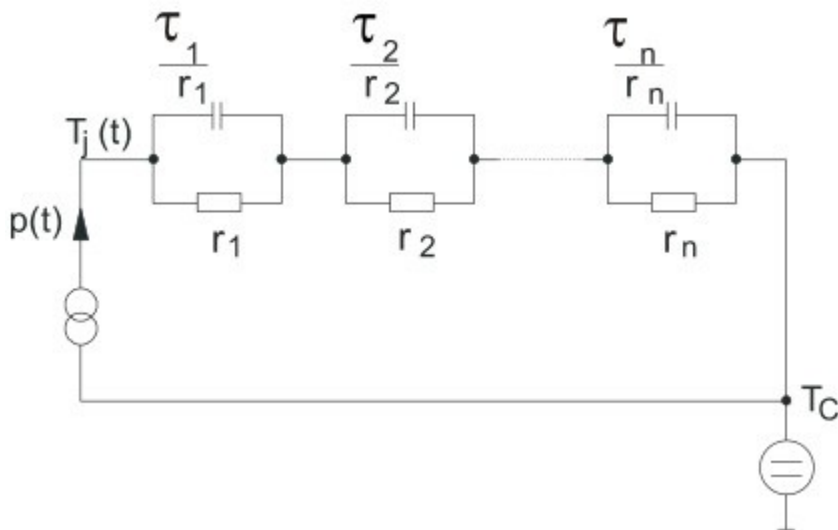


Figure D. Thermal equivalent circuit

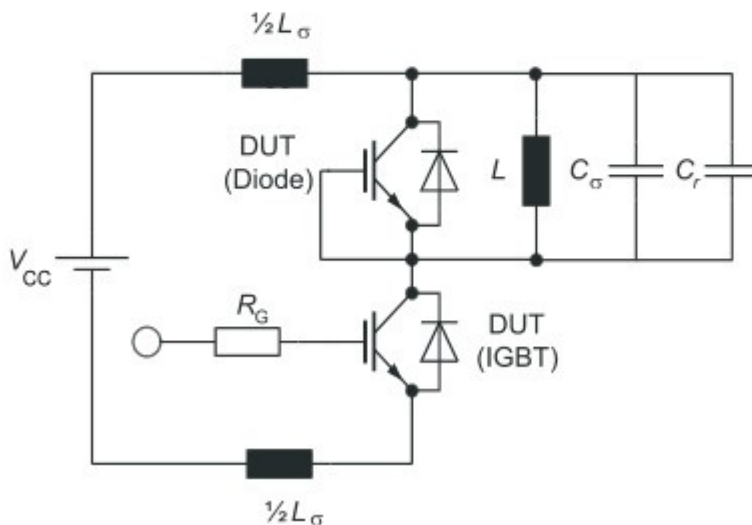


Figure E. Dynamic test circuit Parasitic inductance $L_σ$, parasitic capacitor $C_σ$, relief capacitor C_r, (only for ZVT switching)