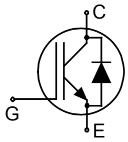
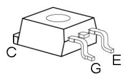
High Speed IGBT in NPT-technology



- 30% lower E_{off} compared to previous generation
- Short circuit withstand time – 10 µs
- Designed for operation above 30 kHz
- NPT-Technology for 600V applications offers:
  - parallel switching capability
  - moderate E_{off} increase with temperature
  - very tight parameter distribution
- High ruggedness, temperature stable behaviour
- Complete product spectrum and PSpice Models : http://www.infineon.com/igbt/



P-TO-263-3-2 (D²-PAK)
(TO-263AB)

Type	V_{CE}	I_C	E_{off}	T_j	Package	Ordering Code
SKB15N60HS	600V	15A	200µJ	150°C	TO-263AB	Q67040-S4543

Maximum Ratings

Parameter	Symbol	Value	Unit
Collector-emitter voltage	V_{CE}	600	V
DC collector current	I_C		A
T_C = 25°C		27	
T_C = 100°C		15	
Pulsed collector current, t_p limited by T_{jmax}	I_{Cpuls}	60	
Turn off safe operating area $V_{CE} \leq$ 600V, $T_j \leq$ 150°C	-	60	
Diode forward current	I_F		
T_C = 25°C		40	
T_C = 100°C		20	
Diode pulsed current, t_p limited by T_{jmax}	I_{Fpuls}	80	
Gate-emitter voltage static transient (t_p<1µs, D<0.05)	V_{GE}	±20 ±30	V
Short circuit withstand time[1)] V_{GE} = 15V, $V_{CC} \leq$ 400V, $T_j \leq$ 150°C	t_{SC}	10	µs
Power dissipation T_C = 25°C	P_{tot}	138	W
Operating junction and storage temperature	T_j , T_{stg}	-55...+150	°C
Time limited operating junction temperature for t < 150h	$T_{j(tl)}$	175	
Soldering temperature, 1.6mm (0.063 in.) from case for 10s	-	260	

[1)] Allowed number of short circuits: <1000; time between short circuits: >1s.

Thermal Resistance

Parameter	Symbol	Conditions	Max. Value	Unit
Characteristic				
IGBT thermal resistance, junction – case	R_{thJC}		0.9	K/W
Diode thermal resistance, junction – case	R_{thJCD}		1.7	
Thermal resistance, junction – ambient	R_{thJA}	TO-263AB	62	
SMD version, device on PCB[1)]	R_{thJA}	TO-263AB	40	

Electrical Characteristic, at T_j = 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=500µA	600	-	-	V
Collector-emitter saturation voltage	$V_{CE(sat)}$	V_{GE} = 15V, I_C=15A T_j=25°C T_j=150°C		 2.8 3.5	 3.15 4.00	
Diode forward voltage	V_F	V_{GE}=0V, I_F=15A T_j=25°C T_j=150°C	 -	 1.5 1.5	 2.0 2.0	
Gate-emitter threshold voltage	$V_{GE(th)}$	I_C=400µA,V_{CE}=V_{GE}	3	4	5	
Zero gate voltage collector current	I_{CES}	V_{CE}=600V,V_{GE}=0V T_j=25°C T_j=150°C	 - -	 - -	 40 2000	µA
Gate-emitter leakage current	I_{GES}	V_{CE}=0V,V_{GE}=20V	-	-	100	nA
Transconductance	g_{fs}	V_{CE}=20V, I_C=15A	-	10		S

1) Device on 50mm*50mm*1.5mm epoxy PCB FR4 with 6cm^2 (one layer, 70µm thick) copper area for collector connection. PCB is vertical without blown air.

Dynamic Characteristic

Input capacitance	C_{iss}	V_{CE}=25V, V_{GE}=0V, f=1MHz	-	810		pF
Output capacitance	C_{oss}		-	123		
Reverse transfer capacitance	C_{rss}		-	51		
Gate charge	Q_{Gate}	V_{CC}=480V, I_C=15A V_{GE}=15V	-	80		nC
Internal emitter inductance measured 5mm (0.197 in.) from case	L_E	TO-263AB	-	7		nH
Short circuit collector current[1]	$I_{C(SC)}$	V_{GE}=15V,$t_{SC}\le$10µs $V_{CC}\le$ 400V, $T_j\le$ 150°C	-	135		A

Switching Characteristic, Inductive Load, at T_j=25 °C

Parameter	Symbol	Conditions	Value			Unit
			min.	typ.	max.	
IGBT Characteristic						
Turn-on delay time	$t_{d(on)}$	T_j=25°C, V_{CC}=400V,I_C=15A, V_{GE}=0/15V, R_G=23Ω L_σ[2] =60nH, C_σ[2] =40pF Energy losses include "tail" and diode reverse recovery.	-	13		ns
Rise time	t_r		-	14		
Turn-off delay time	$t_{d(off)}$		-	209		
Fall time	t_f		-	15		
Turn-on energy	E_{on}		-	0.32		mJ
Turn-off energy	E_{off}		-	0.21		
Total switching energy	E_{ts}		-	0.53		

Anti-Parallel Diode Characteristic

Diode reverse recovery time	t_{rr} t_S t_F	T_j=25°C, V_R=400V, I_F=15A, di_F/dt=980A/µs	- - -	111 27 83		ns
Diode reverse recovery charge	Q_{rr}		-	580		nC
Diode peak reverse recovery current	I_{rrm}		-	14		A
Diode peak rate of fall of reverse recovery current during t_b	di_{rr}/dt		-	520		A/µs

[1] Allowed number of short circuits: <1000; time between short circuits: >1s.
[2] Leakage inductance L_σ and Stray capacity C_σ due to test circuit in Figure E.

Switching Characteristic, Inductive Load, at T_j=150 °C

Parameter	Symbol	Conditions	Value			Unit
			min.	typ.	max.	
IGBT Characteristic						
Turn-on delay time	$t_{d(on)}$	T_j=150°C V_{CC}=400V,I_C=15A, V_{GE}=0/15V, R_G= 3.6Ω L_σ[1)] =60nH, C_σ[1)] =40pF Energy losses include "tail" and diode reverse recovery.	-	11		ns
Rise time	t_r		-	6		
Turn-off delay time	$t_{d(off)}$		-	72		
Fall time	t_f		-	26		
Turn-on energy	E_{on}		-	0.38		mJ
Turn-off energy	E_{off}		-	0.20		
Total switching energy	E_{ts}		-	0.58		
Turn-on delay time	$t_{d(on)}$	T_j=150°C V_{CC}=400V,I_C=15A, V_{GE}=0/15V, R_G= 23Ω L_σ[1)] =60nH, C_σ[1)] =40pF Energy losses include "tail" and diode reverse recovery.	-	12		ns
Rise time	t_r		-	15		
Turn-off delay time	$t_{d(off)}$		-	235		
Fall time	t_f		-	17		
Turn-on energy	E_{on}		-	0.48		mJ
Turn-off energy	E_{off}		-	0.30		
Total switching energy	E_{ts}		-	0.78		

Anti-Parallel Diode Characteristic

Parameter	Symbol	Conditions	min.	typ.	max.	Unit
Diode reverse recovery time	t_{rr} t_S t_F	T_j=150°C V_R=400V, I_F=15A, di_F/dt=1070A/µs	- - -	184 30 155		ns
Diode reverse recovery charge	Q_{rr}		-	1320		nC
Diode peak reverse recovery current	I_{rrm}		-	18		A
Diode peak rate of fall of reverse recovery current during t_b	di_{rr}/dt		-	360		A/µs

[1)] Leakage inductance L_σ and Stray capacity C_σ due to test circuit in Figure E.

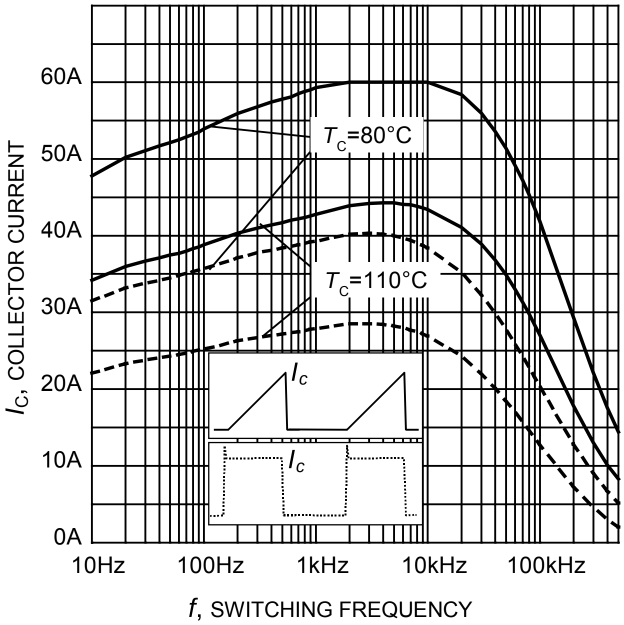


Figure 1. Collector current as a function of switching frequency
($T_j \le 150°C$, $D = 0.5$, $V_{CE} = 400V$, $V_{GE} = 0/+15V$, $R_G = 23\Omega$)

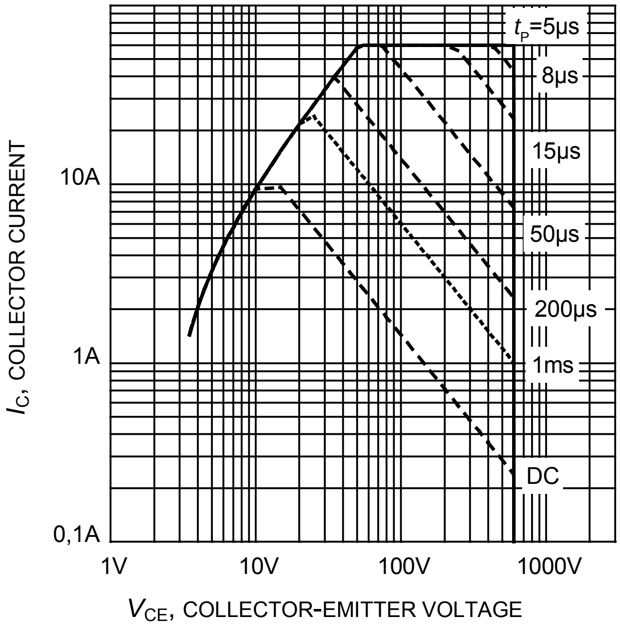


Figure 2. Safe operating area
($D = 0$, $T_C = 25°C$, $T_j \le 150°C$; $V_{GE}=15V$)

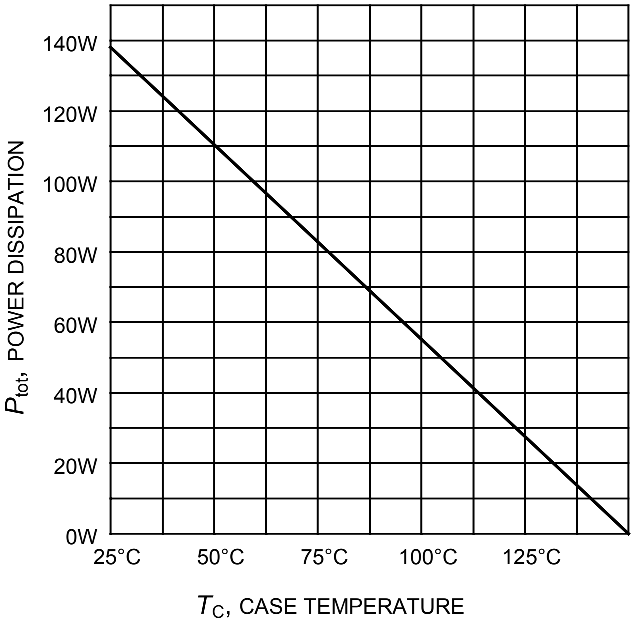


Figure 3. Power dissipation as a function of case temperature
($T_j \le 150°C$)

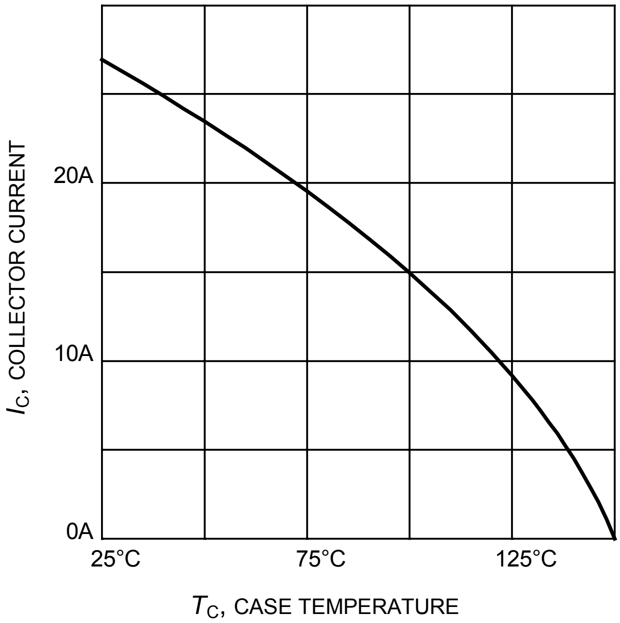


Figure 4. Collector current as a function of case temperature
($V_{GE} \le 15V$, $T_j \le 150°C$)

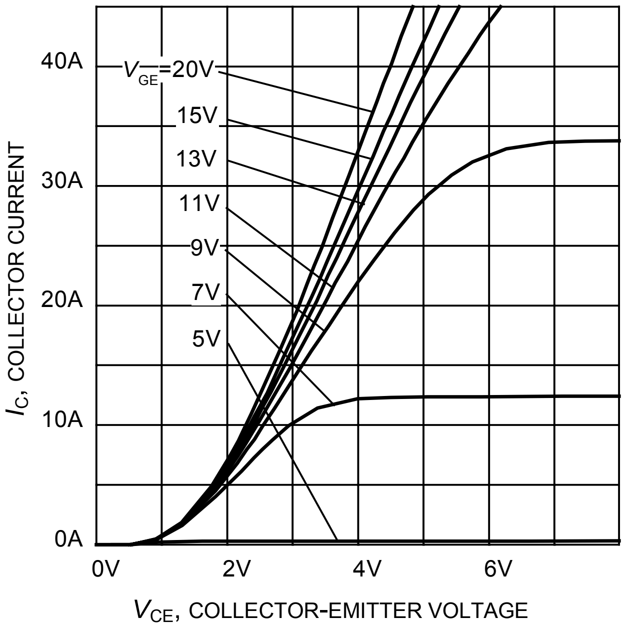


Figure 5. Typical output characteristic
(T_j = 25°C)

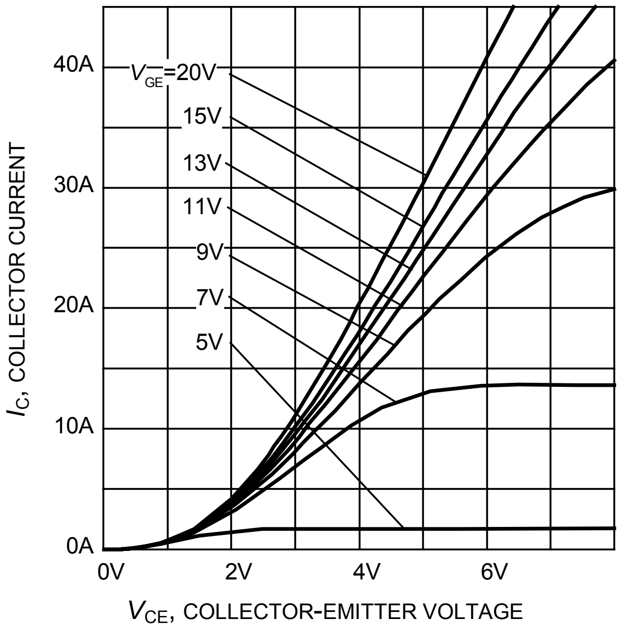


Figure 6. Typical output characteristic
(T_j = 150°C)

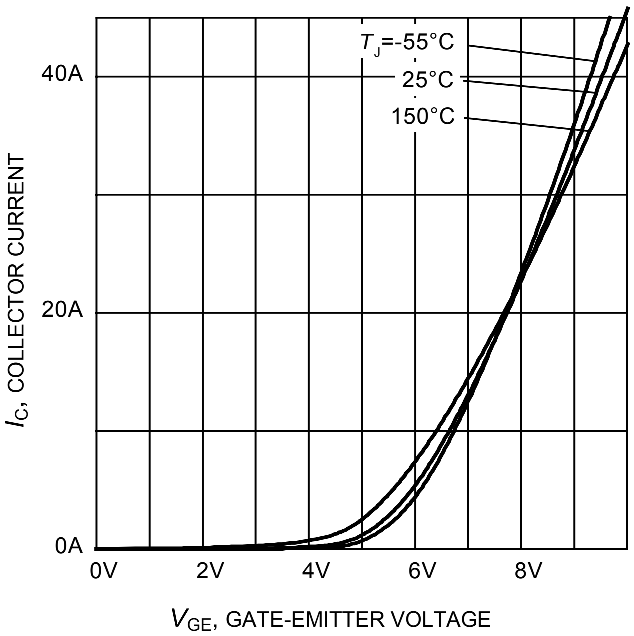


Figure 7. Typical transfer characteristic
(V_{CE}=10V)

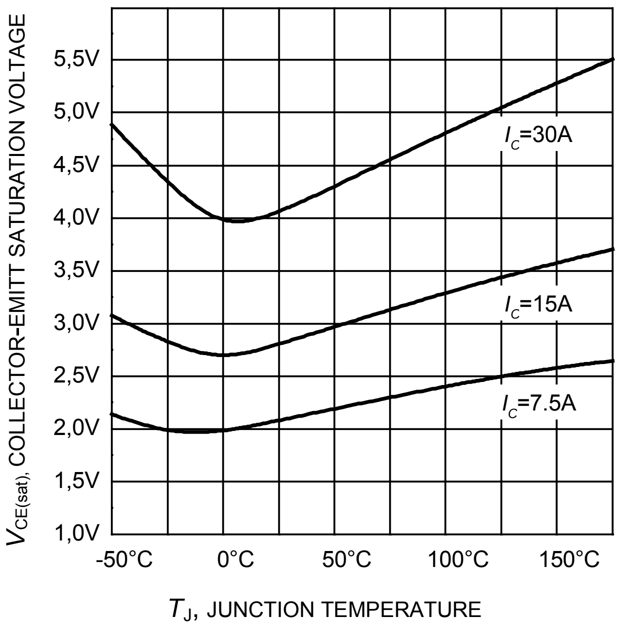


Figure 8. Typical collector-emitter saturation voltage as a function of junction temperature
(V_{GE} = 15V)

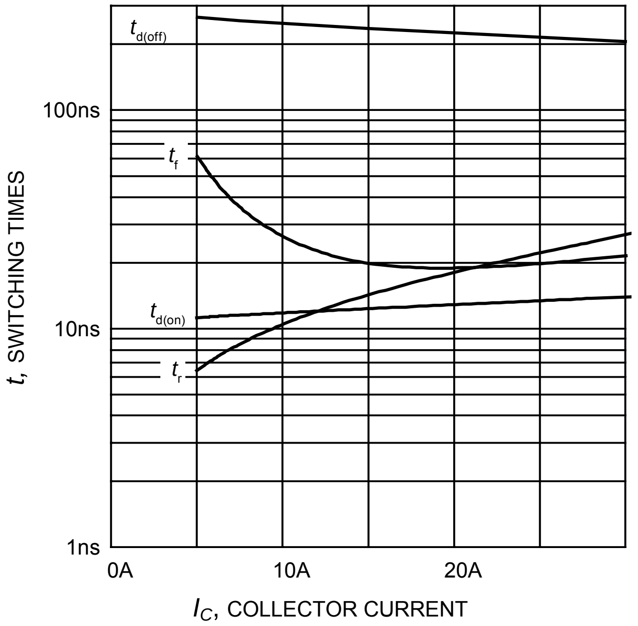


Figure 9. Typical switching times as a function of collector current
(inductive load, T_J=150°C, V_{CE}=400V, V_{GE}=0/15V, R_G=23Ω, Dynamic test circuit in Figure E)

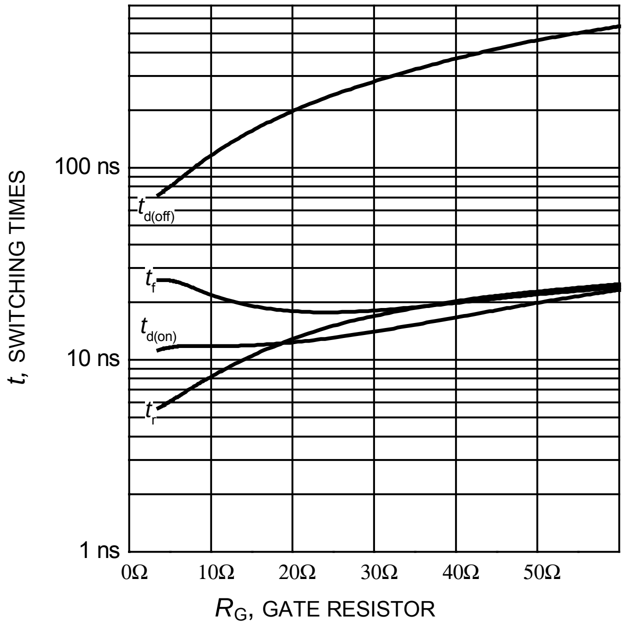


Figure 10. Typical switching times as a function of gate resistor
(inductive load, T_J=150°C, V_{CE}=400V, V_{GE}=0/15V, I_C=15A, Dynamic test circuit in Figure E)

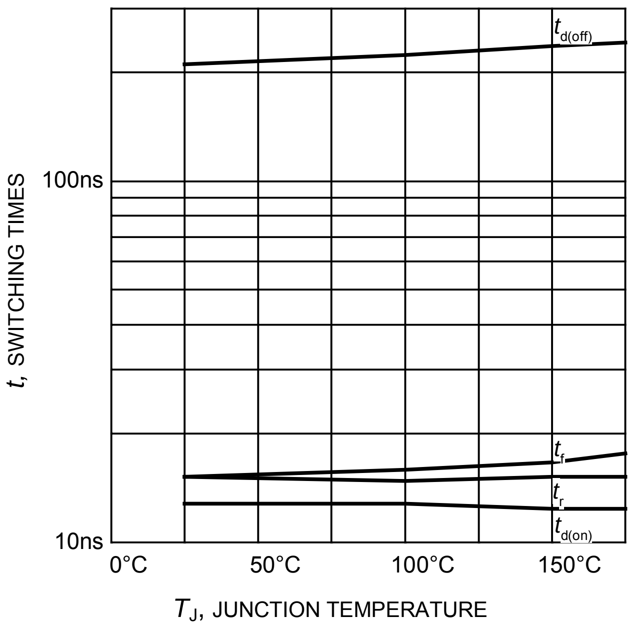


Figure 11. Typical switching times as a function of junction temperature
(inductive load, V_{CE}=400V, V_{GE}=0/15V, I_C=15A, R_G=23Ω, Dynamic test circuit in Figure E)

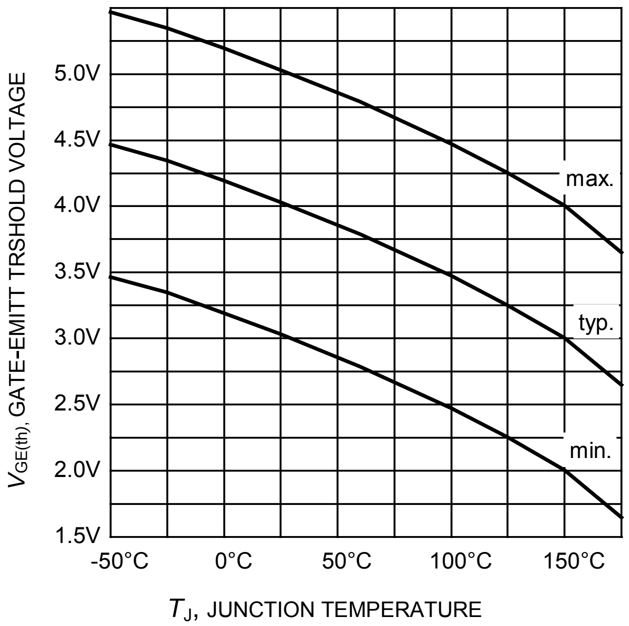


Figure 12. Gate-emitter threshold voltage as a function of junction temperature
(I_C = 0.5mA)

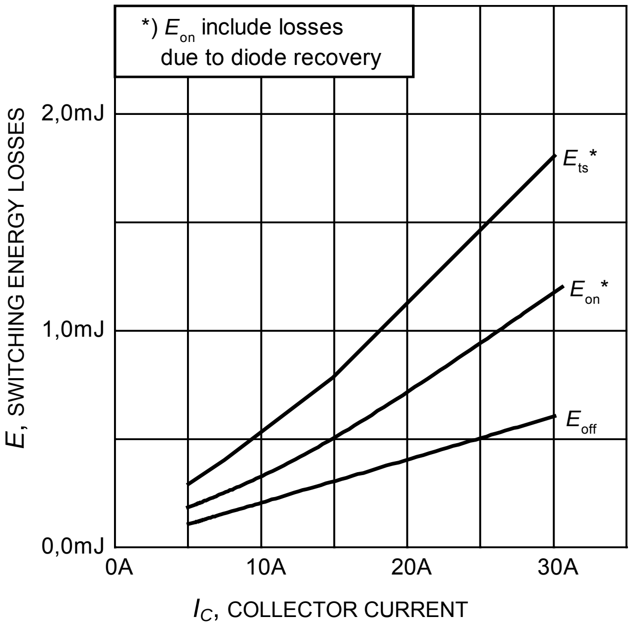


Figure 13. Typical switching energy losses as a function of collector current
(inductive load, T_J=150°C, V_{CE}=400V, V_{GE}=0/15V, R_G=23Ω, Dynamic test circuit in Figure E)

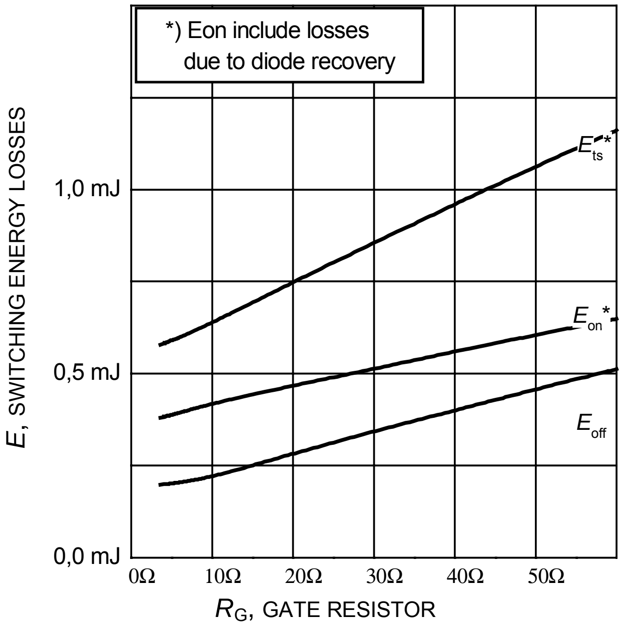


Figure 14. Typical switching energy losses as a function of gate resistor
(inductive load, T_J=150°C, V_{CE}=400V, V_{GE}=0/15V, I_C=15A, Dynamic test circuit in Figure E)

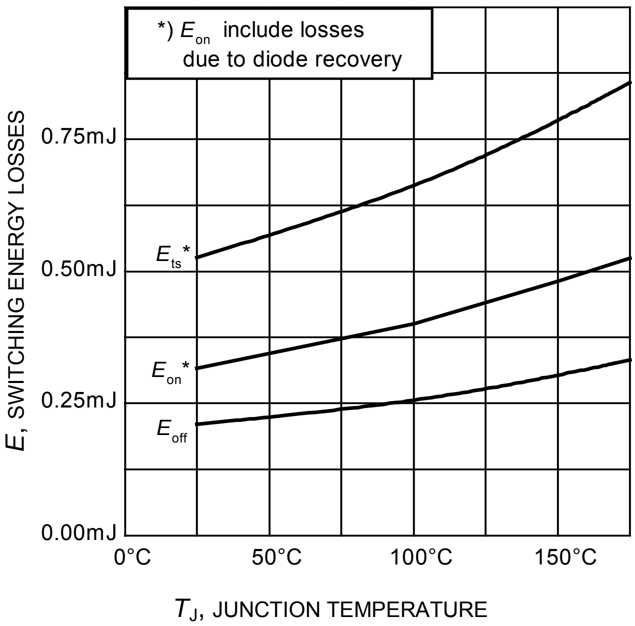


Figure 15. Typical switching energy losses as a function of junction temperature
(inductive load, V_{CE}=400V, V_{GE}=0/15V, I_C=20A, R_G=23Ω, Dynamic test circuit in Figure E)

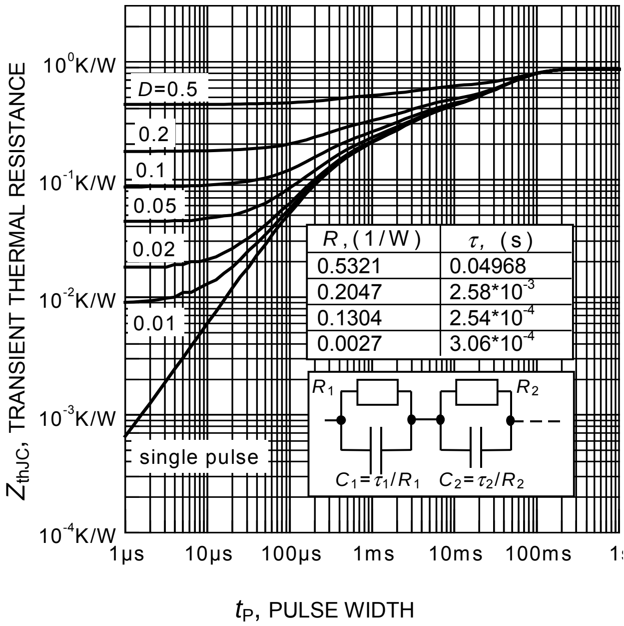


Figure 16. IGBT transient thermal resistance
($D = t_p / T$)

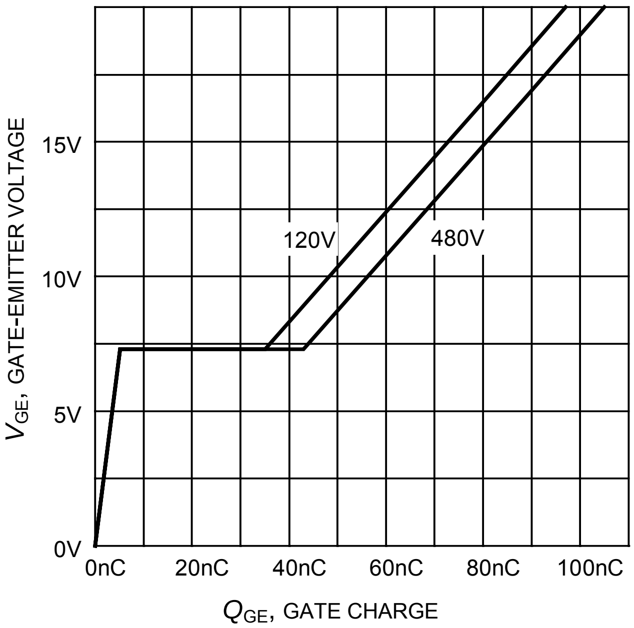


Figure 17. Typical gate charge
(I_C=15 A)

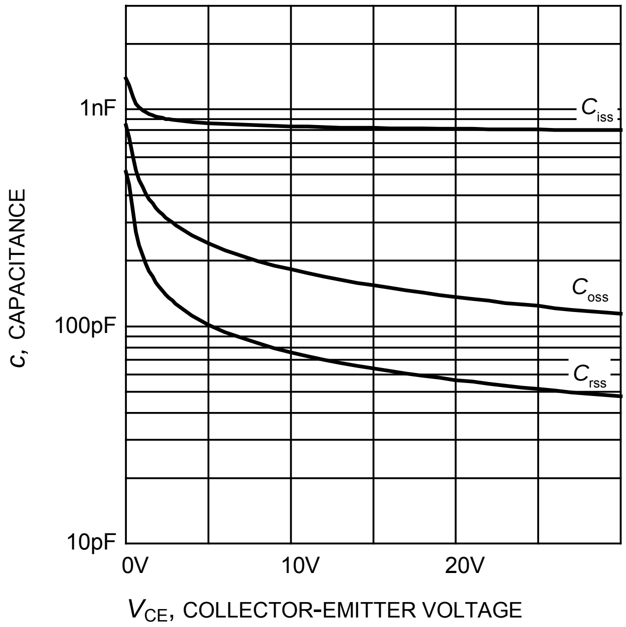


Figure 18. Typical capacitance as a function of collector-emitter voltage
(V_{GE}=0V, f = 1 MHz)

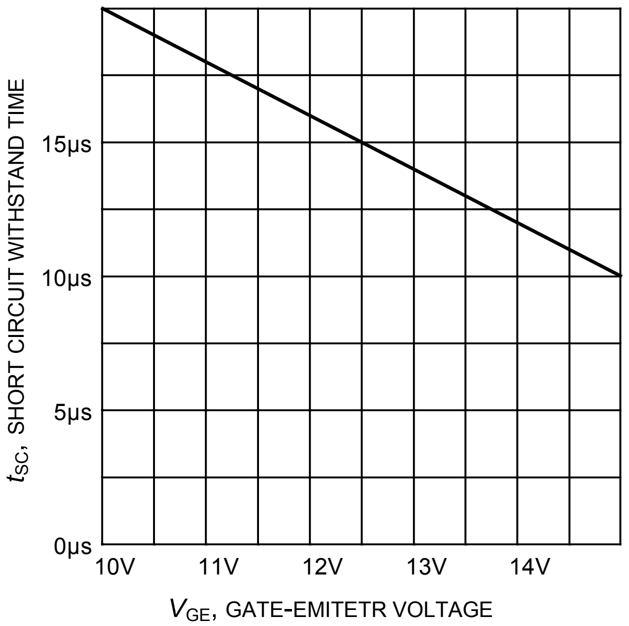


Figure 19. Short circuit withstand time as a function of gate-emitter voltage
(V_{CE}=600V, start at T_J=25°C)

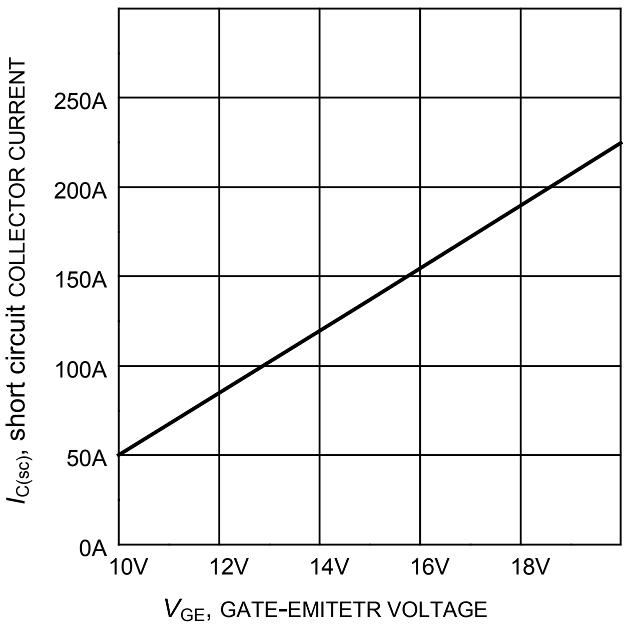


Figure 20. Typical short circuit collector current as a function of gate-emitter voltage
($V_{CE} \leq$ 400V, $T_j \leq$ 150°C)

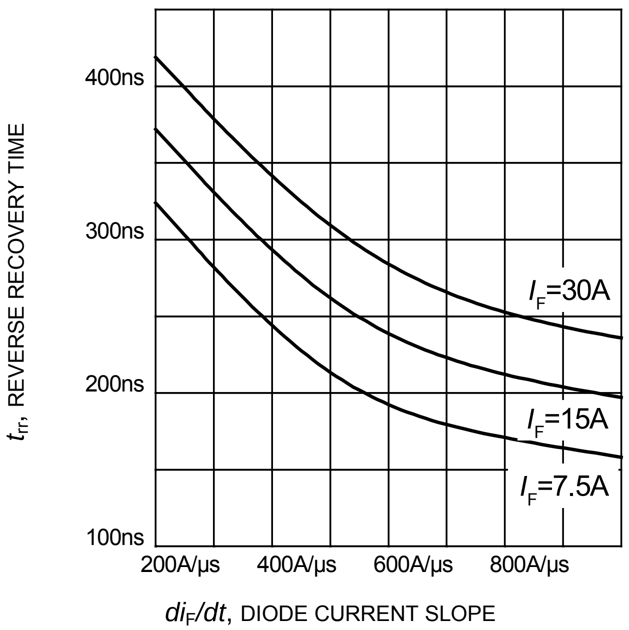


Figure 21. Typical reverse recovery time as a function of diode current slope
(V_R=400V, T_J=150°C,
Dynamic test circuit in Figure E)

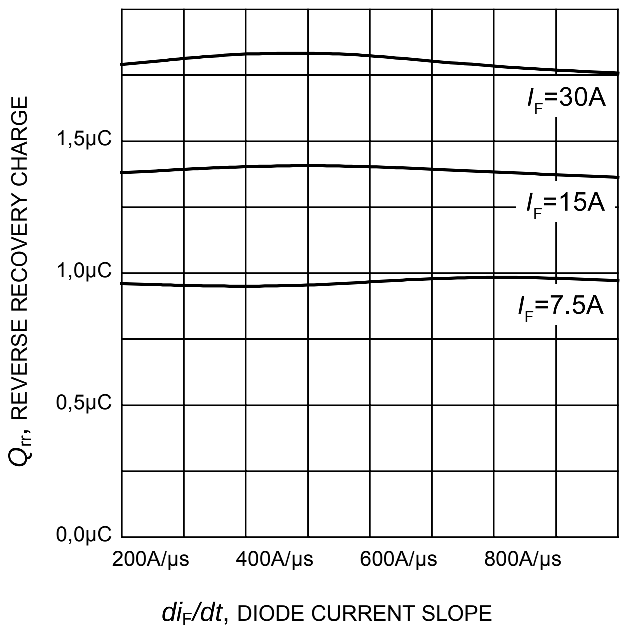


Figure 22. Typical reverse recovery charge as a function of diode current slope
(V_R=400V, T_J=150°C,
Dynamic test circuit in Figure E)

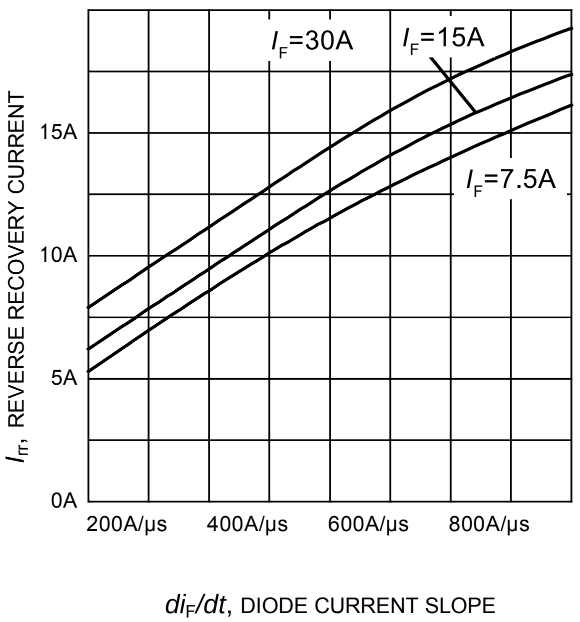


Figure 23. Typical reverse recovery current as a function of diode current slope
(V_R=400V, T_J=150°C,
Dynamic test circuit in Figure E)

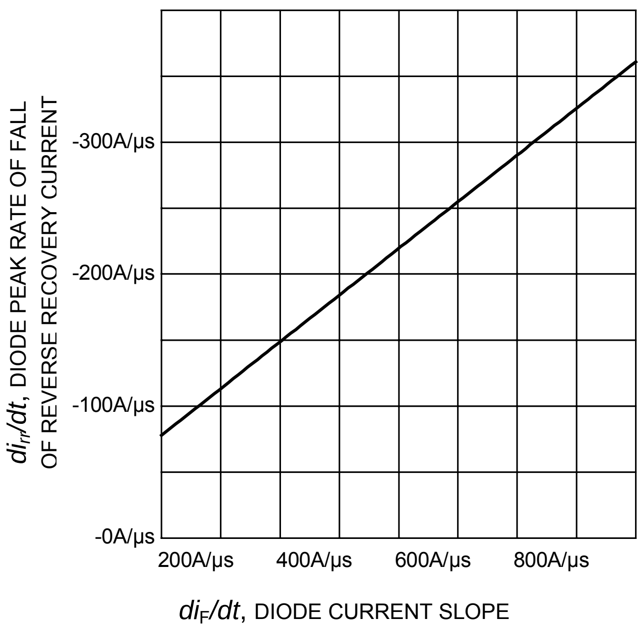


Figure 24. Typical diode peak rate of fall of reverse recovery current as a function of diode current slope
(V_R=400V, T_J=150°C,
Dynamic test circuit in Figure E)

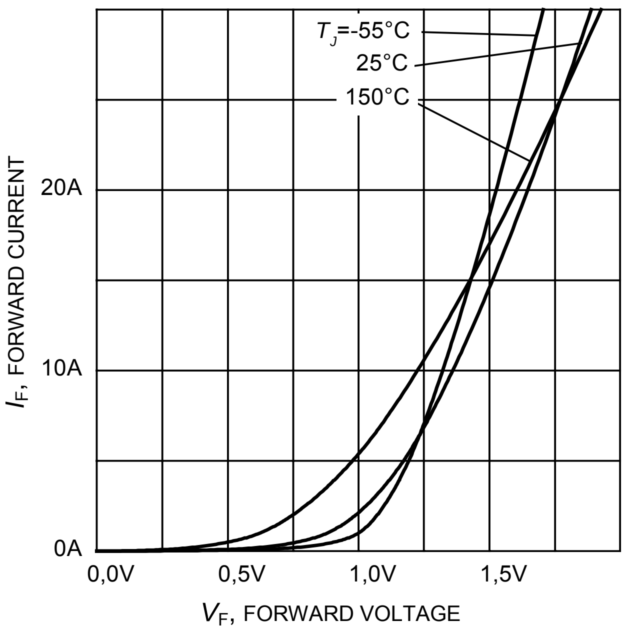


Figure 25. Typical diode forward current as a function of forward voltage

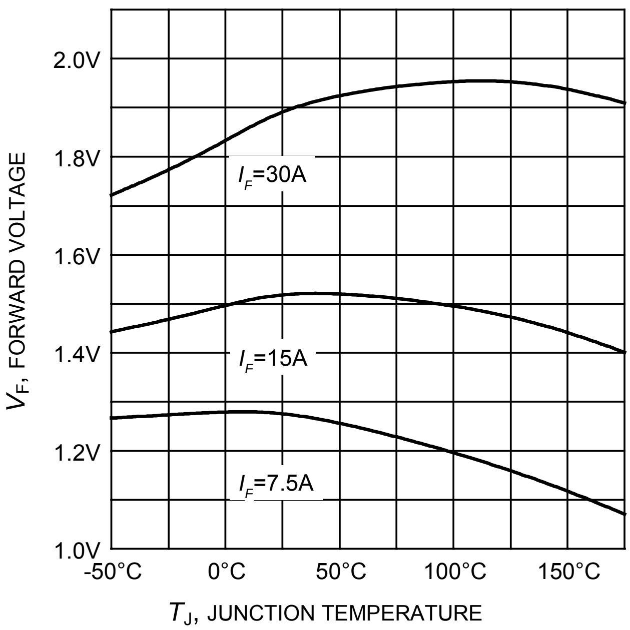


Figure 26. Typical diode forward voltage as a function of junction temperature

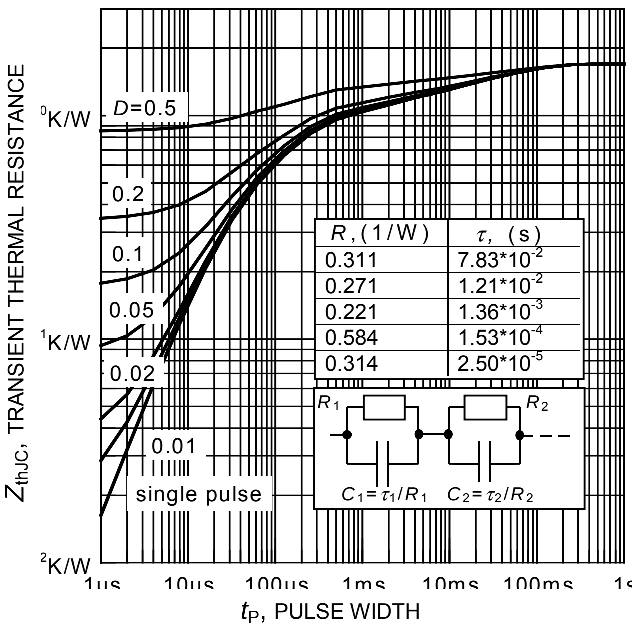
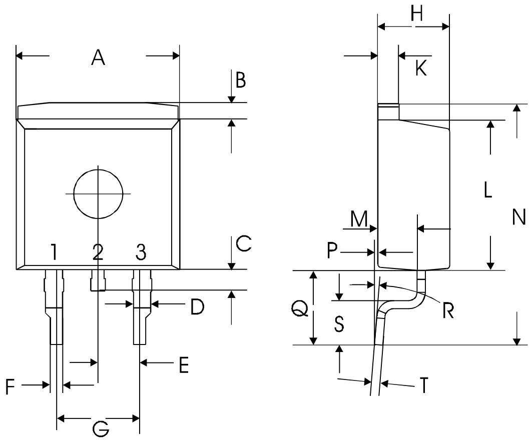
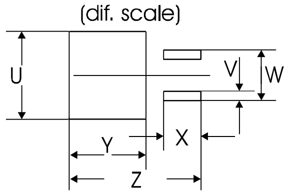


Figure 27. Diode transient thermal impedance as a function of pulse width
(D=t_P/T)

TO-263AB (D^{2}Pak)



Footprint
(dif. scale)



symbol	dimensions			
	[mm]		[inch]	
	min	max	min	max
A	9.80	10.20	0.3858	0.4016
B	0.70	1.30	0.0276	0.0512
C	1.00	1.60	0.0394	0.0630
D	1.03	1.07	0.0406	0.0421
E	2.54 typ.		0.1 typ.	
F	0.65	0.85	0.0256	0.0335
G	5.08 typ.		0.2 typ.	
H	4.30	4.50	0.1693	0.1772
K	1.17	1.37	0.0461	0.0539
L	9.05	9.45	0.3563	0.3720
M	2.30	2.50	0.0906	0.0984
N	15 typ.		0.5906 typ.	
P	0.00	0.20	0.0000	0.0079
Q	4.20	5.20	0.1654	0.2047
R	8° max		8° max	
S	2.40	3.00	0.0945	0.1181
T	0.40	0.60	0.0157	0.0236
U	10.80		0.4252	
V	1.15		0.0453	
W	6.23		0.2453	
X	4.60		0.1811	
Y	9.40		0.3701	
Z	16.15		0.6358	

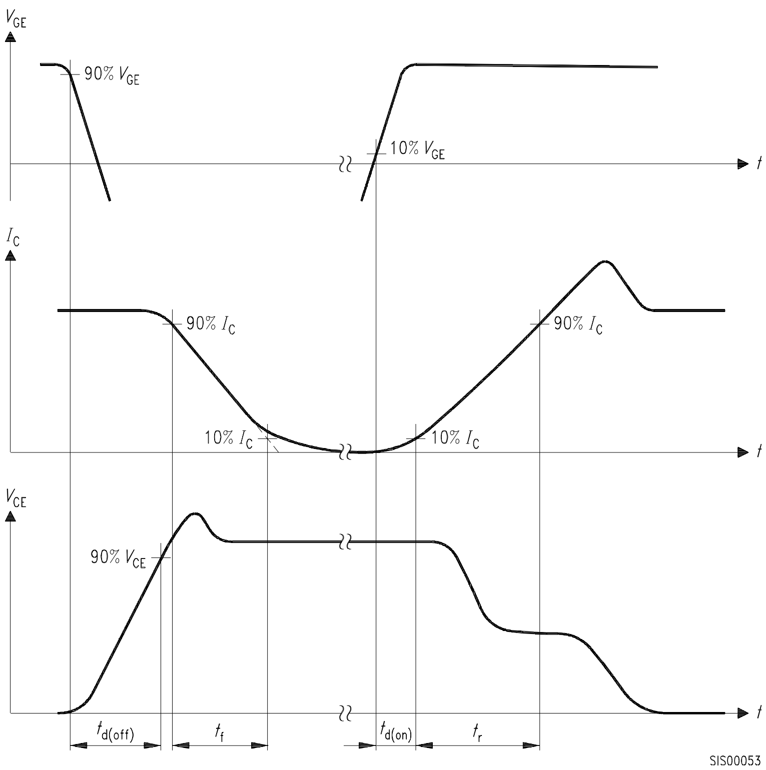


Figure A. Definition of switching times

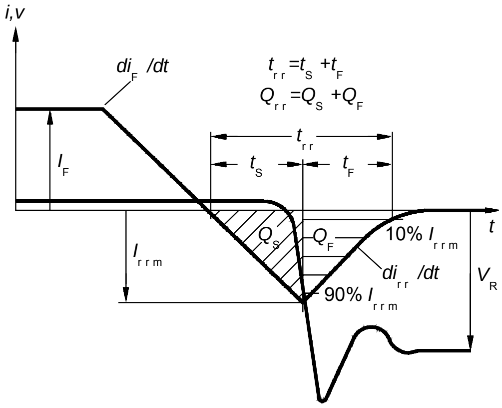


Figure C. Definition of diodes switching characteristics

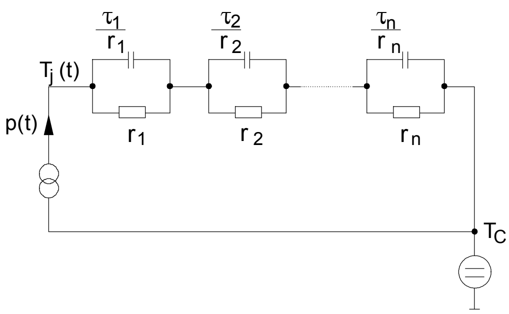


Figure D. Thermal equivalent circuit

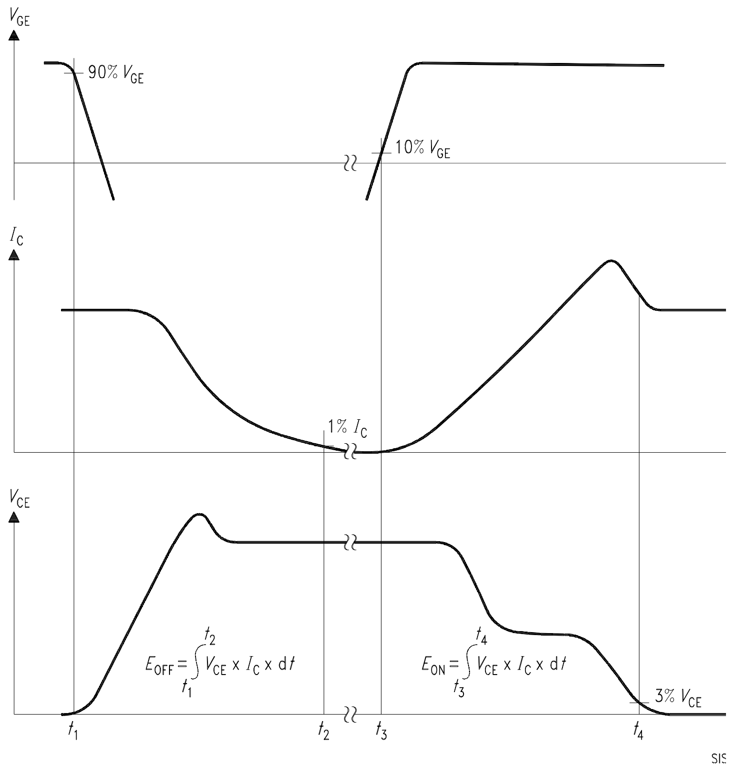


Figure B. Definition of switching losses

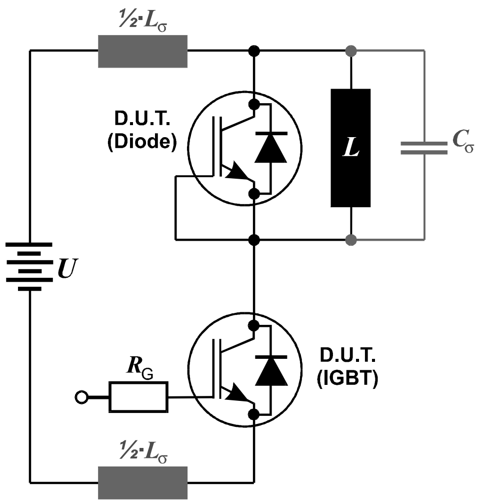


Figure E. Dynamic test circuit
Leakage inductance L_σ =60nH
and Stray capacity C_σ =40pF.

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