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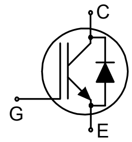
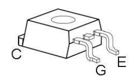
SKB06N60HS

High Speed IGBT in NPT-technology





PG-TO-263-3-2

- 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
- Pb-free lead plating; RoHS compliant
- Qualified according to JEDEC[1] for target applications
- Complete product spectrum and PSpice Models : http://www.infineon.com/igbt/

Type	V_{CE}	I_C	E_{off}	T_j	Marking	Package
SKB06N60HS	600V	6A	80µJ	150°C	K06N60HS	PG-TO-263-3-2

Maximum Ratings

Parameter	Symbol	Value	Unit
Collector-emitter voltage	V_{CE}	600	V
DC collector current T_C = 25°C T_C = 100°C	I_C	 12 6	A
Pulsed collector current, t_p limited by T_{jmax}	I_{Cpuls}	24	
Turn off safe operating area $V_{CE} \leq$ 600V, $T_j \leq$ 150°C	-	24	
Diode forward current T_C = 25°C T_C = 100°C	I_F	 12 6	
Diode pulsed current, t_p limited by T_{jmax}	I_{Fpuls}	24	
Gate-emitter voltage static transient (t_p<1µs, D<0.05)	V_{GE}	±20 ±30	V
Short circuit withstand time[2)] V_{GE} = 15V, $V_{CC} \leq$ 400V, $T_j \leq$ 150°C	t_{SC}	10	µs
Power dissipation T_C = 25°C	P_{tot}	68	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 (reflow soldering, MSL1)	-	245	

[1] J-STD-020 and JESD-022
[2)] 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}		1.85	K/W
Diode thermal resistance, junction – case	R_{thJCD}		4.5	
Thermal resistance, junction – ambient	R_{thJA}		62	
SMD version, device on PCB[1]	R_{thJA}		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=6A 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=6A T_j=25°C T_j=150°C	 -	 1.5 1.55	 2.05 2.05	
Gate-emitter threshold voltage	$V_{GE(th)}$	I_C=200µA, 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=6A	-	4		S

Dynamic Characteristic

Parameter	Symbol	Conditions	min.	Typ.	max.	Unit
Input capacitance	C_{iss}	V_{CE}=25V,	-	350		pF
Output capacitance	C_{oss}	V_{GE}=0V,	-	50		
Reverse transfer capacitance	C_{rss}	f=1MHz	-	23		
Gate charge	Q_{Gate}	V_{CC}=480V, I_C=6A V_{GE}=15V	-	33		nC
Internal emitter inductance measured 5mm (0.197 in.) from case	L_E		-	7		nH
Short circuit collector current[2]	$I_{C(SC)}$	V_{GE}=15V, t_{SC}≤10µs V_{CC} ≤ 400V, T_j ≤ 150°C	-	48		A

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

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=6A, V_{GE}=0/15V, R_G=50Ω L_σ[2] =60nH, C_σ[2] =40pF Energy losses include "tail" and diode reverse recovery.	-	11		ns
Rise time	t_r		-	11		
Turn-off delay time	$t_{d(off)}$		-	196		
Fall time	t_f		-	41		
Turn-on energy	E_{on}		-	0.10		mJ
Turn-off energy	E_{off}		-	0.09		
Total switching energy	E_{ts}		-	0.19		

Anti-Parallel Diode Characteristic

Parameter	Symbol	Conditions	min.	typ.	max.	Unit
Diode reverse recovery time	t_{rr} t_S t_F	T_j=25°C, V_R=400V, I_F=6A, di_F/dt=626A/µs	- - -	100 24 76		ns
Diode reverse recovery charge	Q_{rr}		-	220		nC
Diode peak reverse recovery current	I_{rrm}		-	7		A
Diode peak rate of fall of reverse recovery current during t_b	di_{rr}/dt		-	315		A/µs

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=6A, V_{GE}=0/15V, R_G= 8Ω L_σ[1] =60nH, C_σ[1] =40pF Energy losses include "tail" and diode reverse recovery.	-	8		ns
Rise time	t_r		-	3		
Turn-off delay time	$t_{d(off)}$		-	63		
Fall time	t_f		-	59		
Turn-on energy	E_{on}		-	0.11		mJ
Turn-off energy	E_{off}		-	0.08		
Total switching energy	E_{ts}		-	0.19		
Turn-on delay time	$t_{d(on)}$	T_j=150°C V_{CC}=400V, I_C=6A, V_{GE}=0/15V, R_G= 50Ω L_σ[1] =60nH, C_σ[1] =40pF Energy losses include "tail" and diode reverse recovery.	-	10		ns
Rise time	t_r		-	13		
Turn-off delay time	$t_{d(off)}$		-	216		
Fall time	t_f		-	29		
Turn-on energy	E_{on}		-	0.15		mJ
Turn-off energy	E_{off}		-	0.12		
Total switching energy	E_{ts}		-	0.27		

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

Anti-Parallel Diode Characteristic

Diode reverse recovery time	t_{rr} t_S t_F	T_j=150°C V_R=400V, I_F=6A, di_F/dt=673A/µs	- - -	150 27 123		ns
Diode reverse recovery charge	Q_{rr}		-	500		nC
Diode peak reverse recovery current	I_{rrm}		-	8.8		A
Diode peak rate of fall of reverse recovery current during t_b	di_{rr}/dt		-	280		A/µs

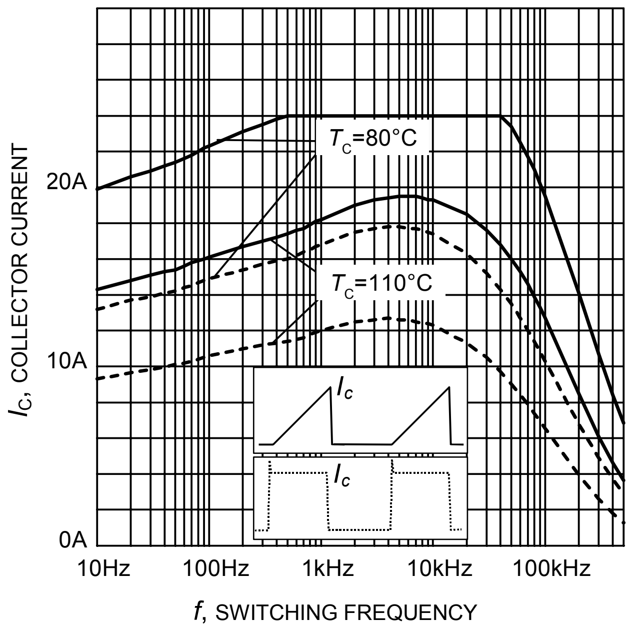


Figure 1. Collector current as a function of switching frequency
($T_j \leq 150°C$, $D = 0.5$, $V_{CE} = 400V$, $V_{GE} = 0/+15V$, $R_G = 50\Omega$)

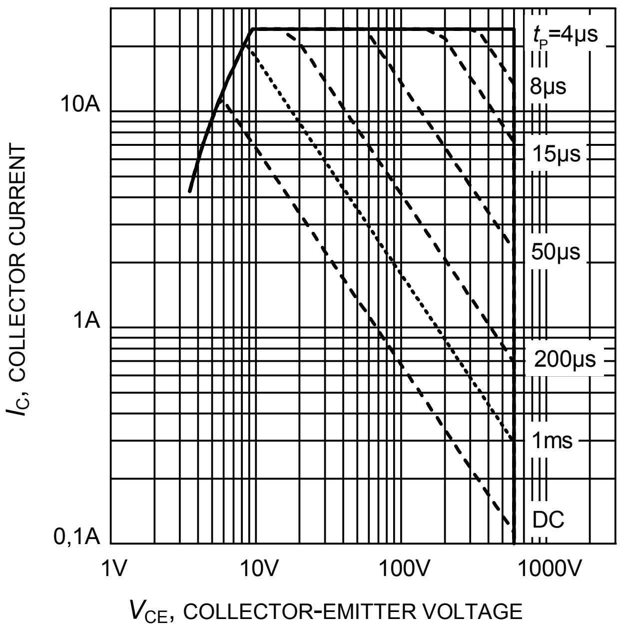


Figure 2. Safe operating area
($D = 0$, $T_C = 25°C$, $T_j \leq 150°C; V_{GE}=15V$)

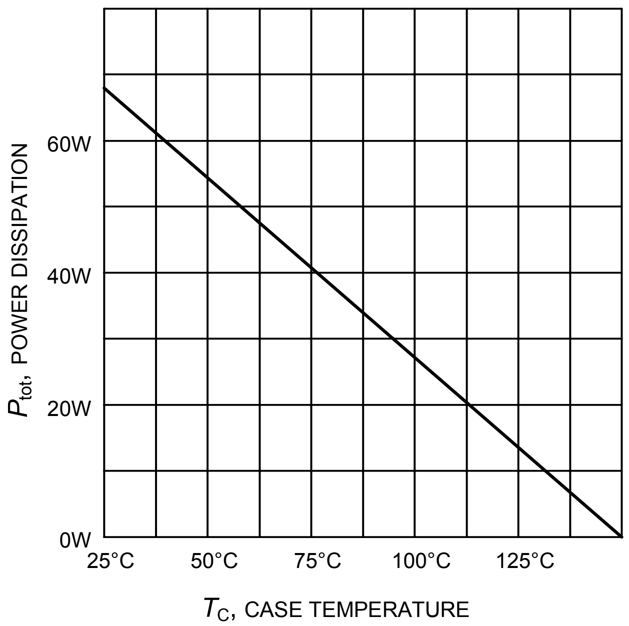


Figure 3. Power dissipation as a function of case temperature
($T_j \leq 150°C$)

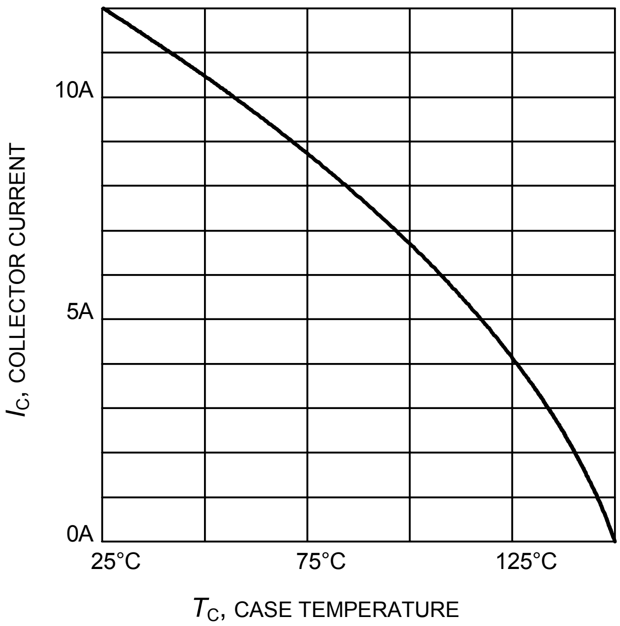


Figure 4. Collector current as a function of case temperature
($V_{GE} \leq 15V$, $T_j \leq 150°C$)

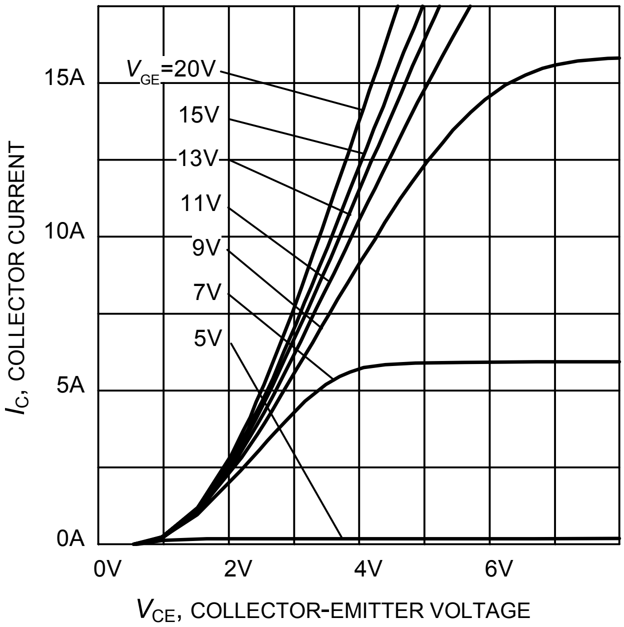


Figure 5. Typical output characteristic
(T_j = 25°C)

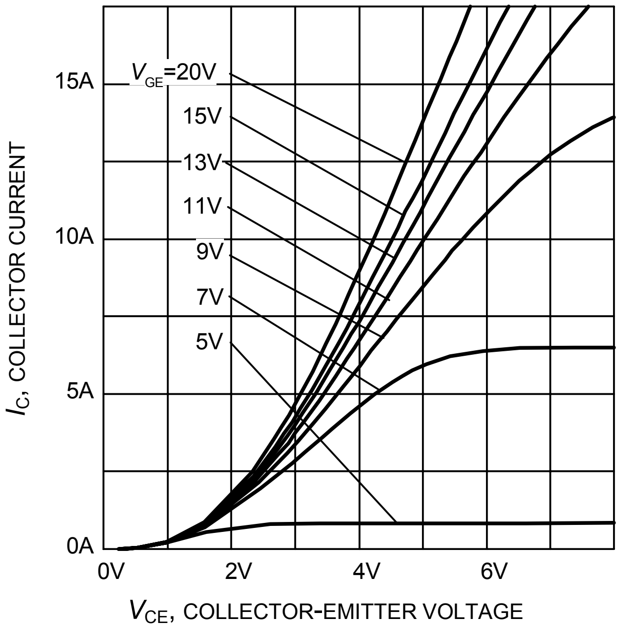


Figure 6. Typical output characteristic
(T_j = 150°C)

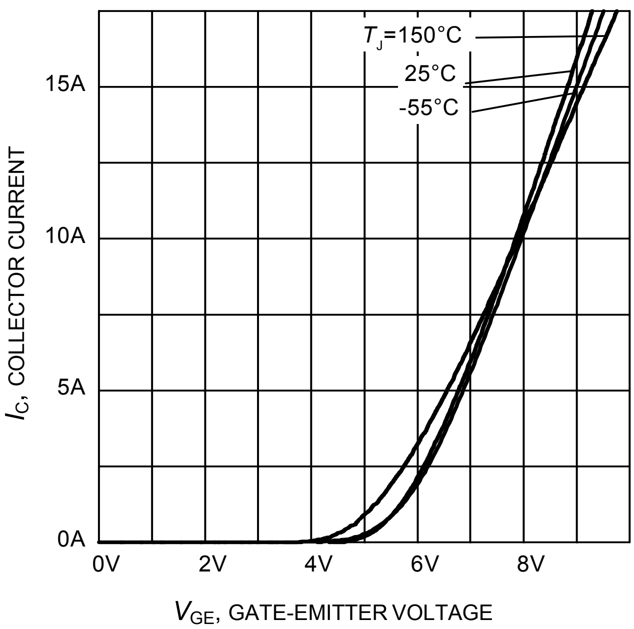


Figure 7. Typical transfer characteristic
(V_{CE}=10V)

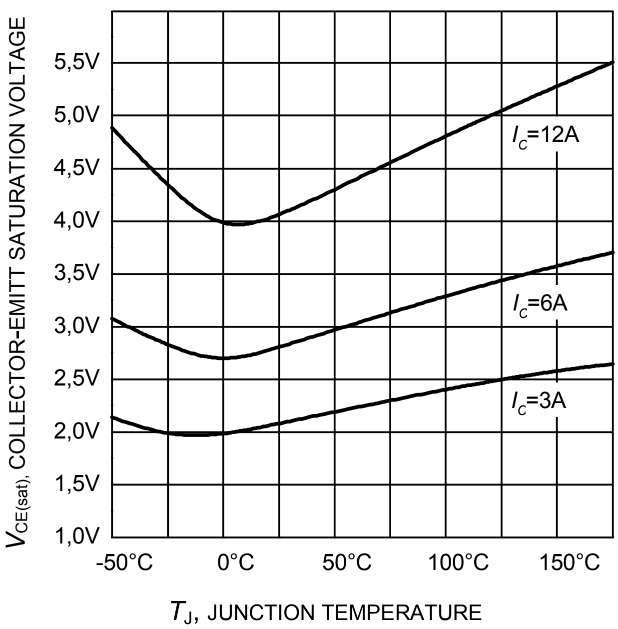


Figure 8. Typical collector-emitter saturation voltage as a function of junction temperature
(V_{GE} = 15V)

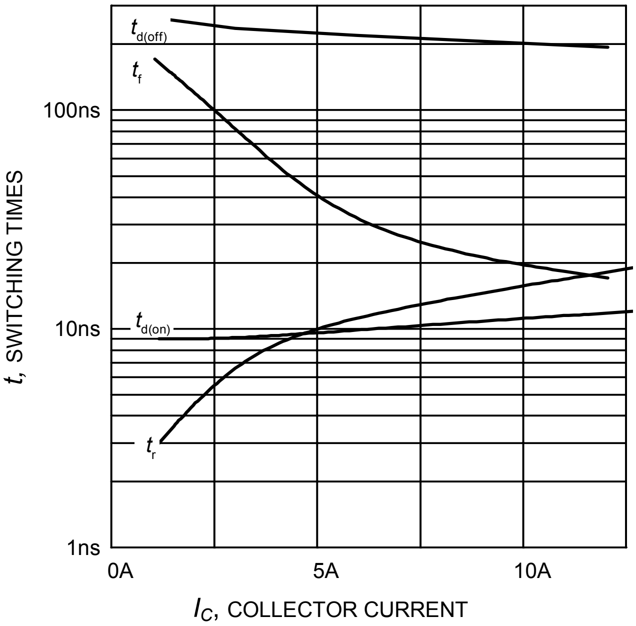


Figure 9. Typical switching times as a function of collector current
(inductive load, T_J=150°C, V_{CE}=400V, V_{GE}=0/15V, R_G=50Ω, Dynamic test circuit in Figure E)

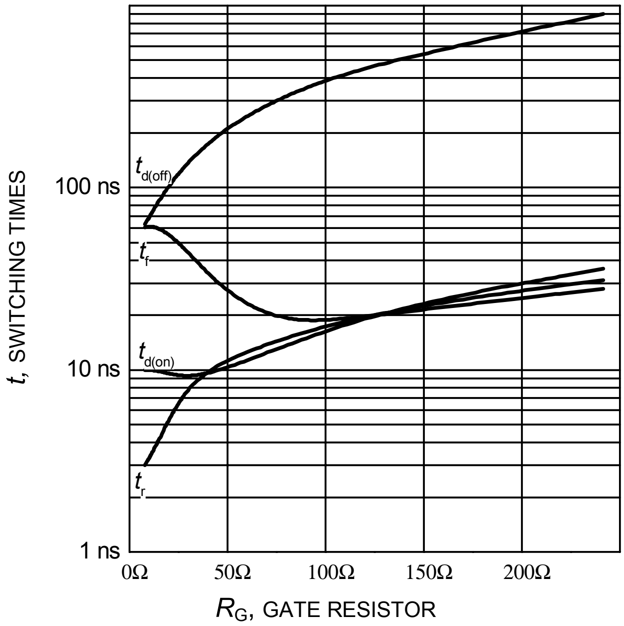


Figure 10. Typical switching times as a function of gate resistor
(inductive load, T_J=150°C, V_{CE}=400V, V_{GE}=0/15V, I_C=6A, Dynamic test circuit in Figure E)

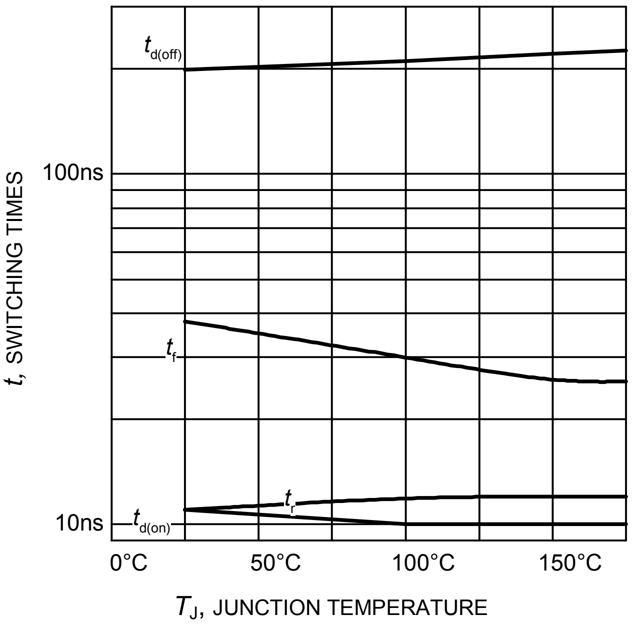


Figure 11. Typical switching times as a function of junction temperature
(inductive load, V_{CE}=400V, V_{GE}=0/15V, I_C=6A, R_G=50Ω, Dynamic test circuit in Figure E)

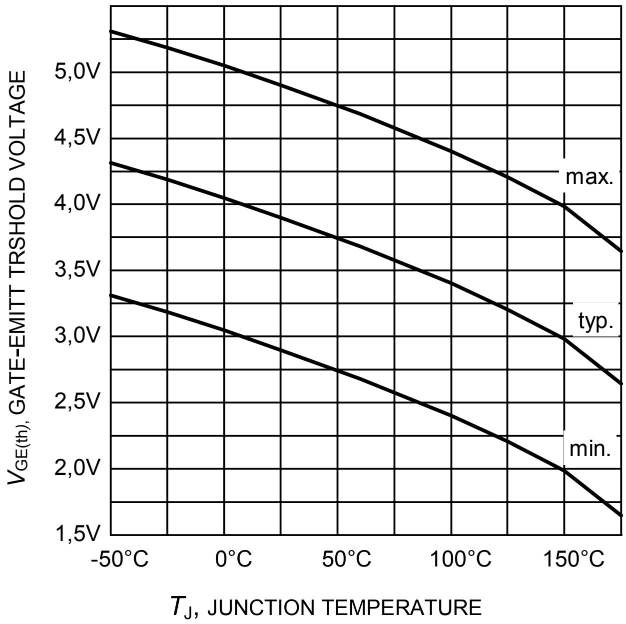


Figure 12. Gate-emitter threshold voltage as a function of junction temperature
(I_C = 0.5mA)

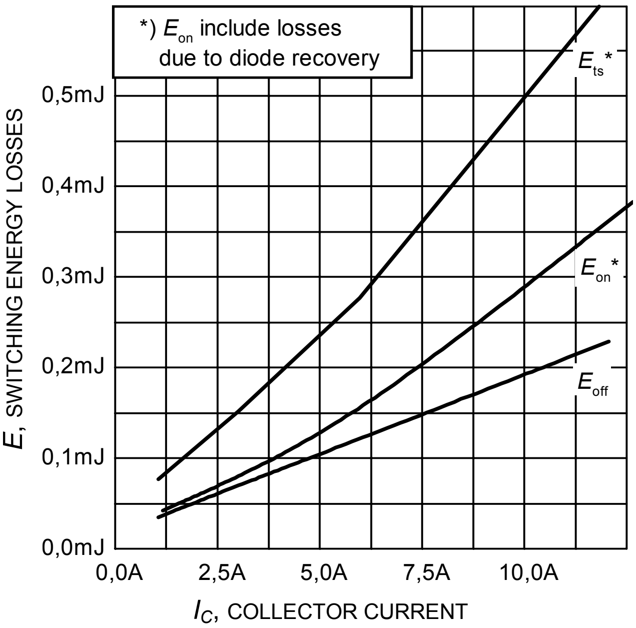


Figure 13. Typical switching energy losses as a function of collector current
(inductive load, T_J=150°C, V_{CE}=400V, V_{GE}=0/15V, R_G=50Ω, Dynamic test circuit in Figure E)

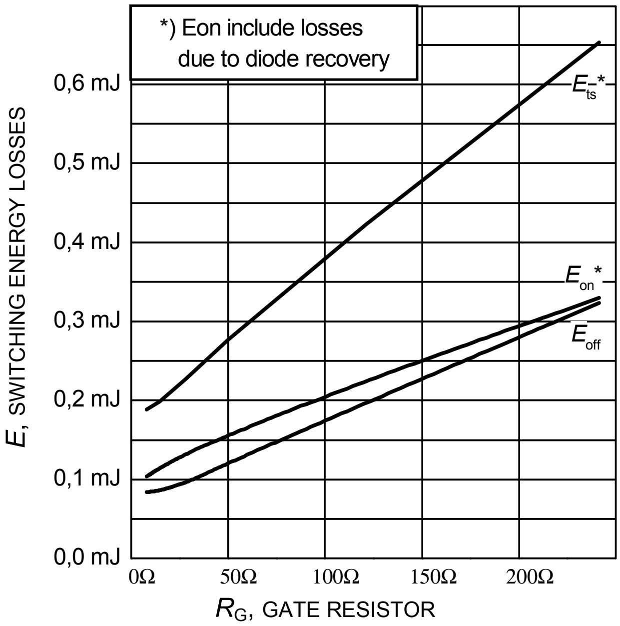


Figure 14. Typical switching energy losses as a function of gate resistor
(inductive load, T_J=150°C, V_{CE}=400V, V_{GE}=0/15V, I_C=6A, Dynamic test circuit in Figure E)

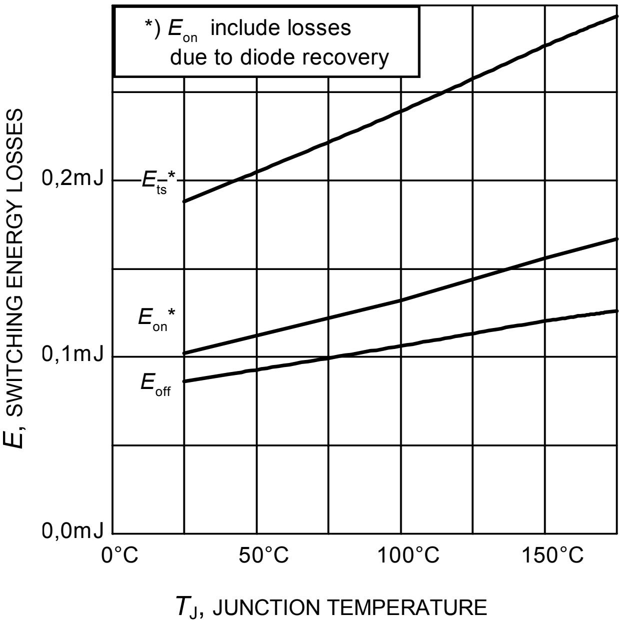


Figure 15. Typical switching energy losses as a function of junction temperature
(inductive load, V_{CE}=400V, V_{GE}=0/15V, I_C=6A, R_G=50Ω, Dynamic test circuit in Figure E)

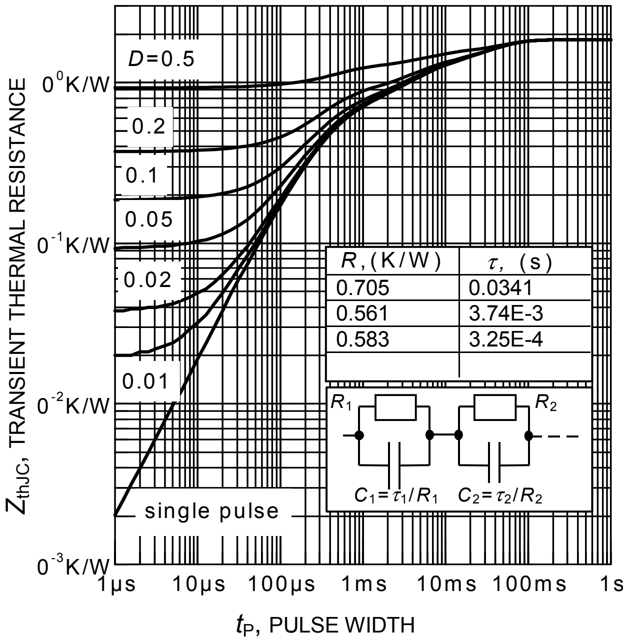


Figure 16. IGBT transient thermal resistance
($D = t_p / T$)

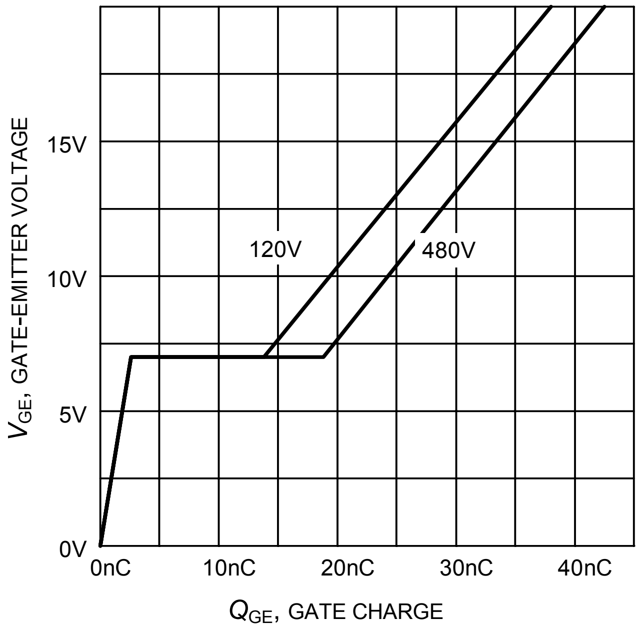


Figure 17. Typical gate charge
(I_C=6 A)

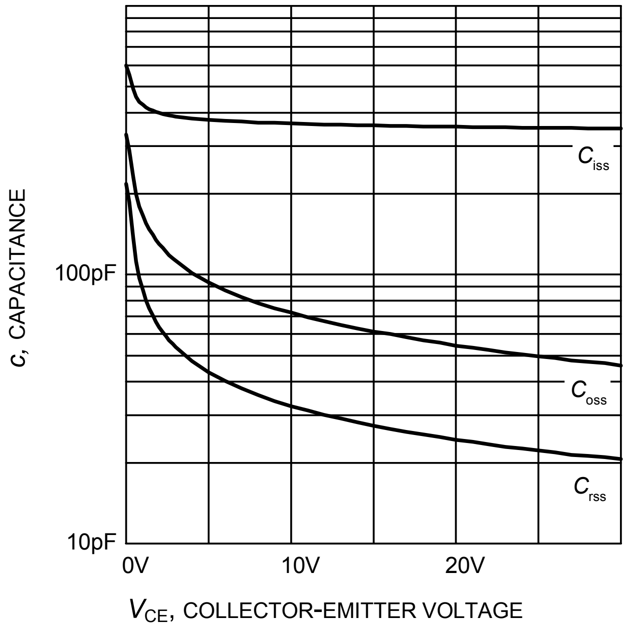


Figure 18. Typical capacitance as a function of collector-emitter voltage
(V_{GE}=0V, f = 1 MHz)

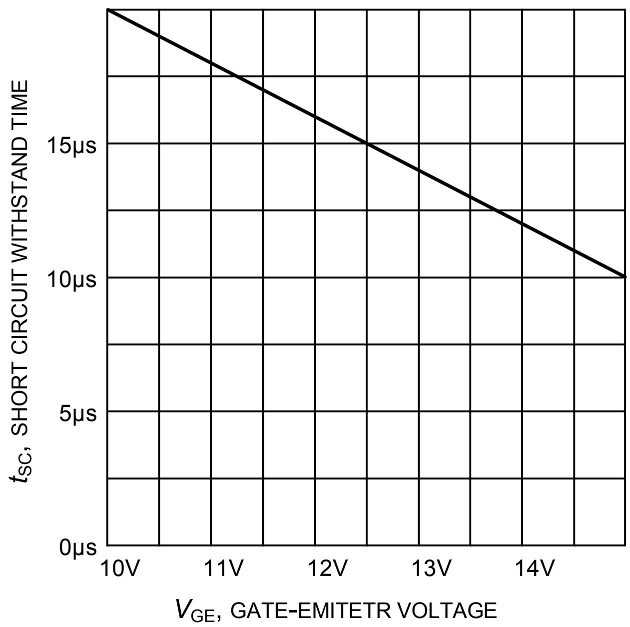


Figure 19. Short circuit withstand time as a function of gate-emitter voltage
(V_{CE}=600V, start at T_J=25°C)

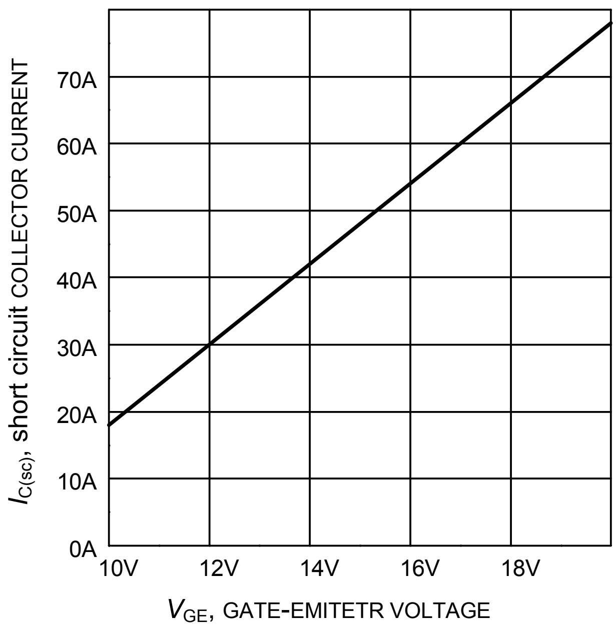


Figure 20. Typical short circuit collector current as a function of gate-emitter voltage
($V_{CE} \leq$ 400V, $T_j \leq$ 150°C)

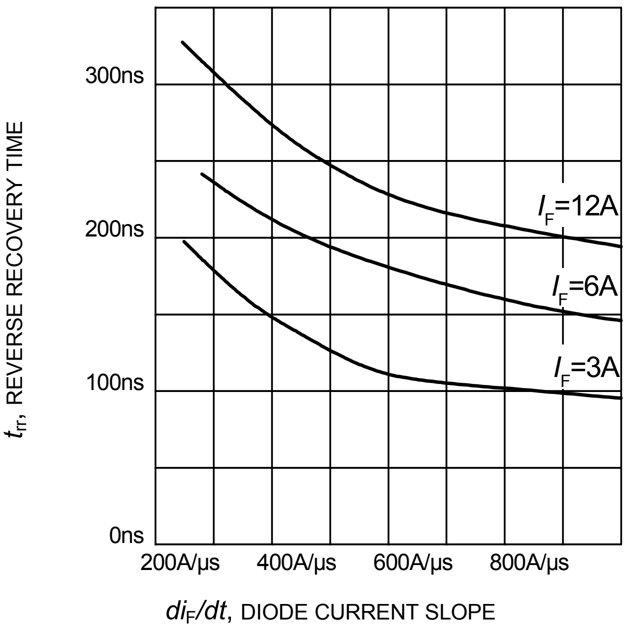


Figure 21. Typical reverse recovery time as a function of diode current slope
(V_R=400V, T_J=150°C,
Dynamic test circuit in Figure E)

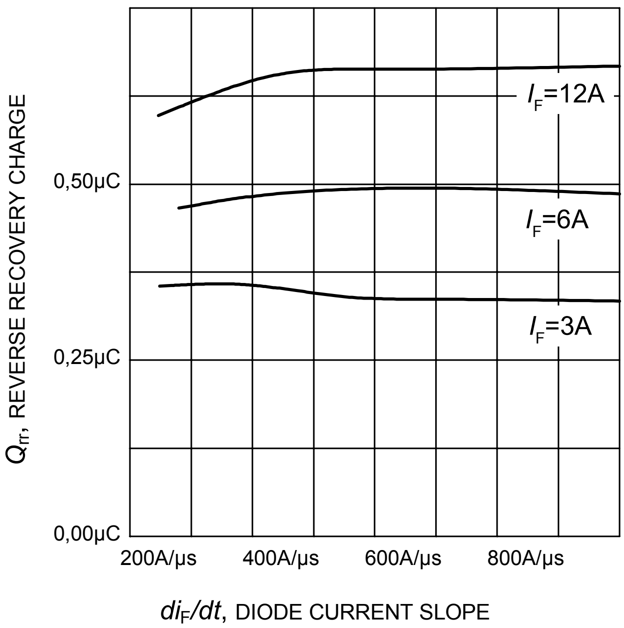


Figure 22. Typical reverse recovery charge as a function of diode current slope
(V_R=400V, T_J=150°C,
Dynamic test circuit in Figure E)

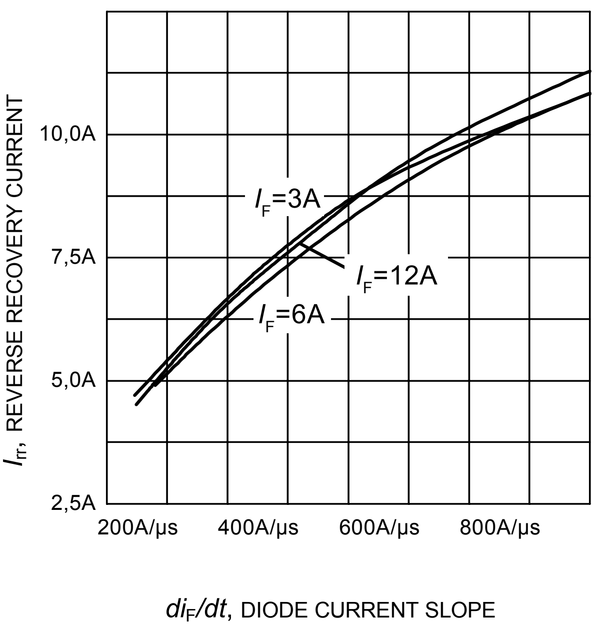


Figure 23. Typical reverse recovery current as a function of diode current slope
(V_R=400V, T_J=150°C,
Dynamic test circuit in Figure E)

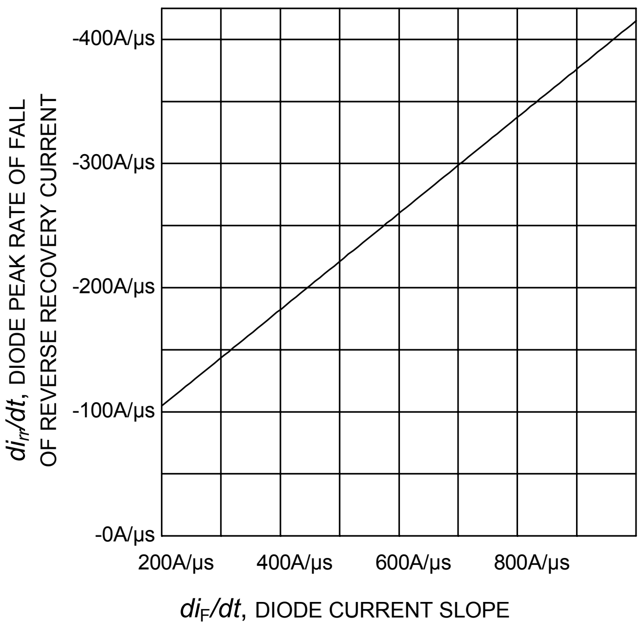


Figure 24. Typical diode peak rate of fall of reverse recovery current as a function of diode current slope
(V_R=400V, T_J=150°C,
Dynamic test circuit in Figure E)

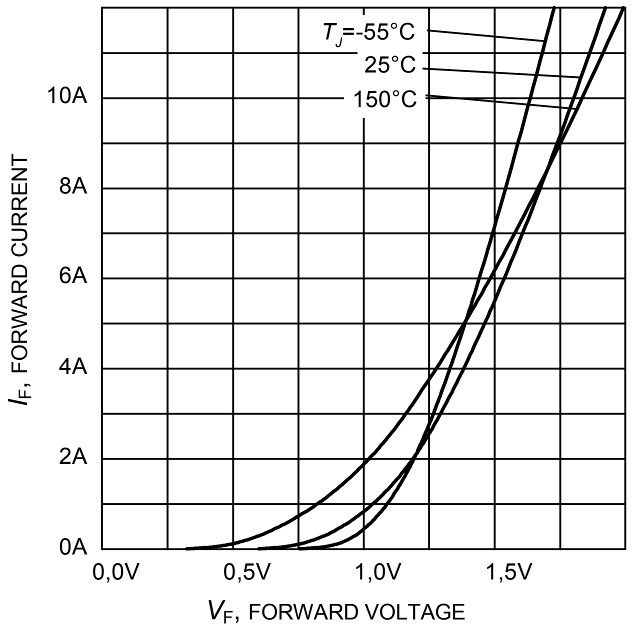


Figure 25. Typical diode forward current as a function of forward voltage

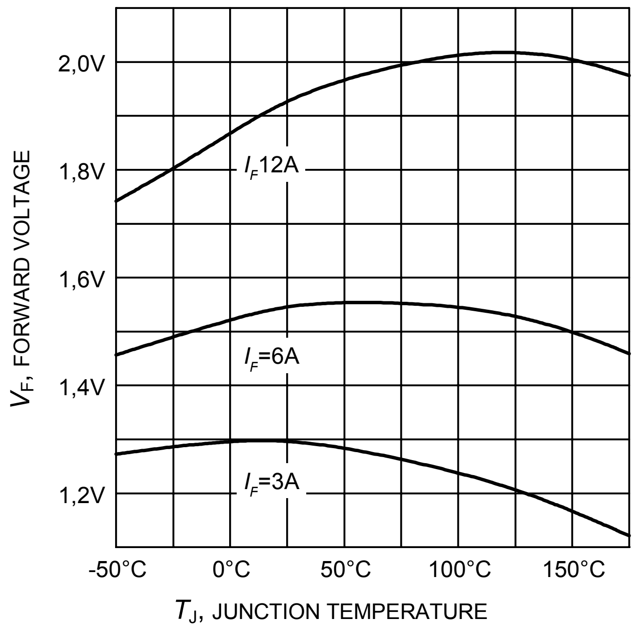


Figure 26. Typical diode forward voltage as a function of junction temperature

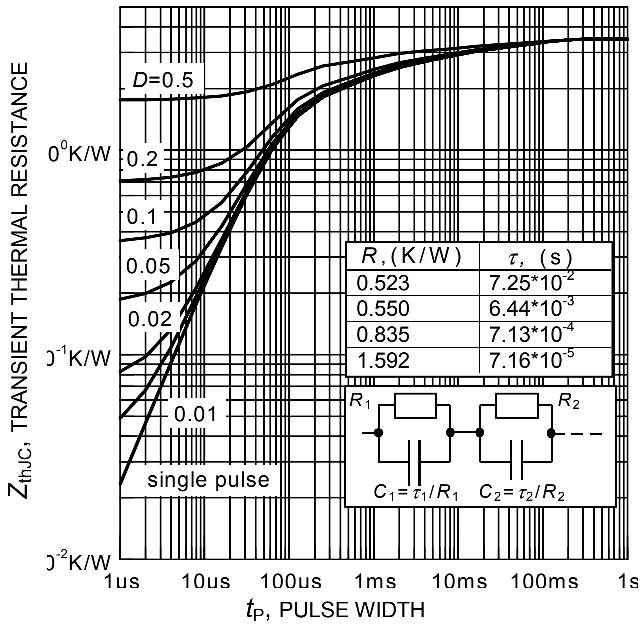


Figure 27. Diode transient thermal impedance as a function of pulse width
($D=t_P/T$)

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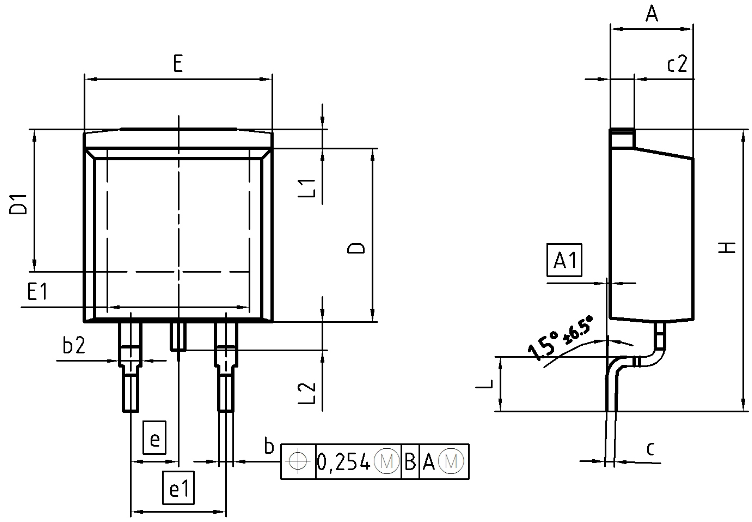
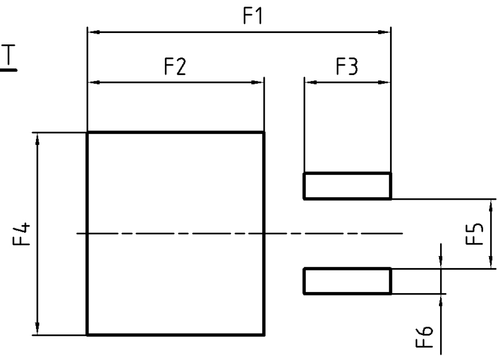


FOOTPRINT

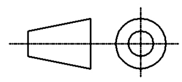


DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.30	4.57	0.169	0.180
A1	0.00	0.25	0.000	0.010
b	0.65	0.85	0.026	0.033
b2	0.95	1.15	0.037	0.045
c	0.33	0.65	0.013	0.026
c2	1.17	1.40	0.046	0.055
D	8.51	9.45	0.335	0.372
D1	7.10	7.90	0.280	0.311
E	9.80	10.31	0.386	0.406
E1	6.50	8.60	0.256	0.339
e	2.54		0.100	
e1	5.08		0.200	
N	2		2	
H	14.61	15.88	0.575	0.625
L	2.29	3.00	0.090	0.118
L1	0.70	1.60	0.028	0.063
L2	1.00	1.78	0.039	0.070
F1	16.05	16.25	0.632	0.640
F2	9.30	9.50	0.366	0.374
F3	4.50	4.70	0.177	0.185
F4	10.70	10.90	0.421	0.429
F5	3.65	3.85	0.144	0.152
F6	1.25	1.45	0.049	0.057

DOCUMENT NO.
Z8B00003324

SCALE 0 5 0 5 7.5mm

EUROPEAN PROJECTION



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REVISION
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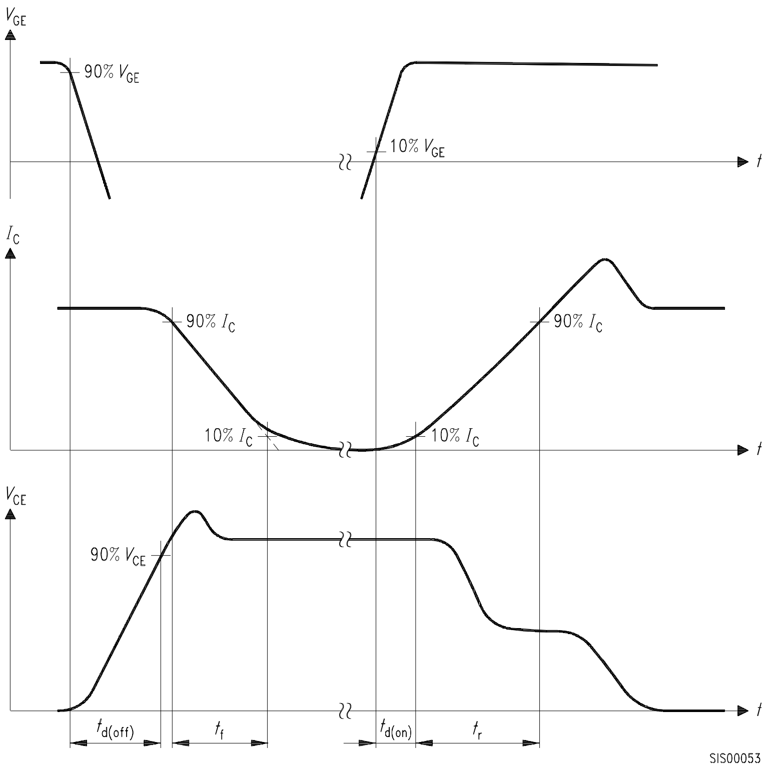

Figure A. Definition of switching times

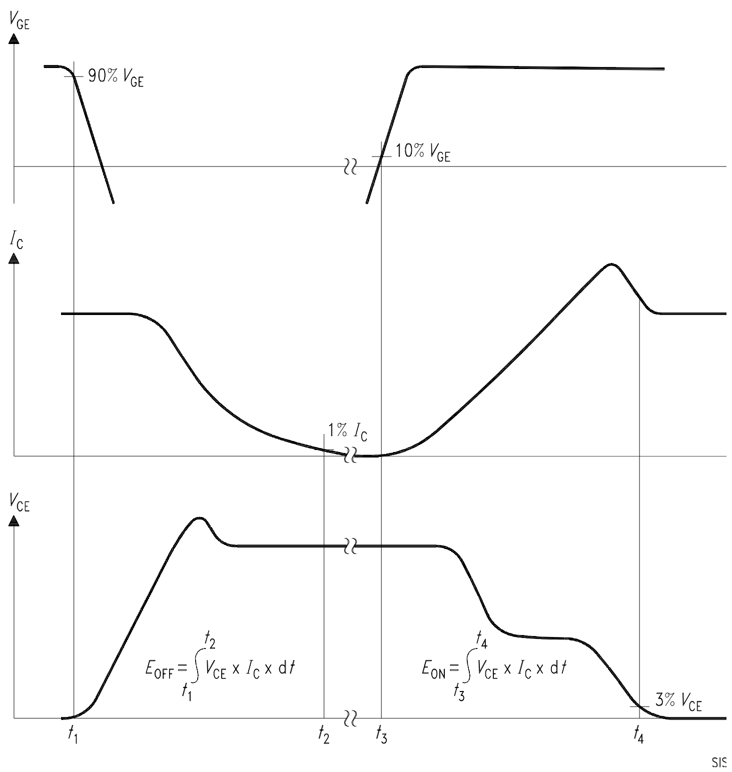

Figure B. Definition of switching losses

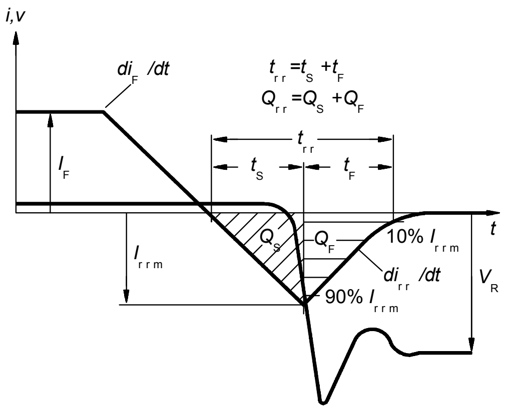

Figure C. Definition of diodes switching characteristics

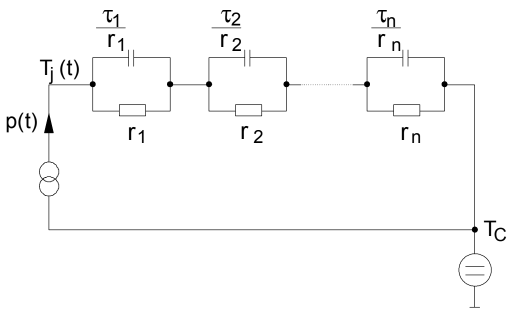

Figure D. Thermal equivalent circuit

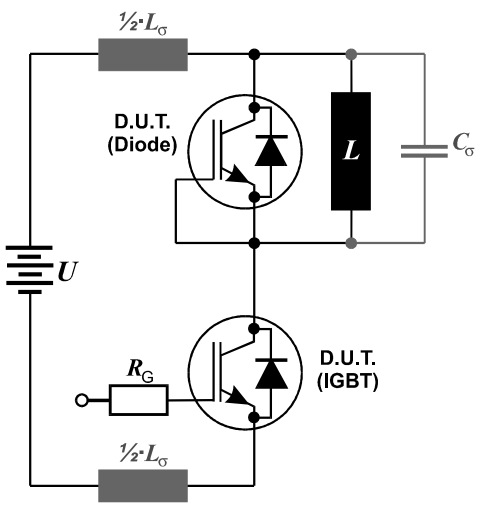

Figure E. Dynamic test circuit
Leakage inductance L_σ =60nH
and Stray capacity C_σ =40pF.

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