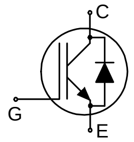
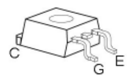
SKB10N60A

Fast IGBT in NPT-technology with soft, fast recovery anti-parallel Emitter Controlled Diode



- 75% lower E_{off} compared to previous generation combined with low conduction losses
- Short circuit withstand time – 10 µs
- Designed for frequency inverters for washing machines, fans, pumps and vacuum cleaners
- NPT-Technology for 600V applications offers:
  - very tight parameter distribution
  - high ruggedness, temperature stable behaviour
  - parallel switching capability
- Very soft, fast recovery anti-parallel Emitter Controlled Diode
- 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/



PG-TO-263-3-2

Type	V_{CE}	I_C	$V_{CE(sat)}$	T_j	Marking	Package
SKB10N60A	600V	10A	2.3V	150°C	K10N60	PG-TO-263-3-2

Maximum Ratings

Parameter	Symbol	Value	Unit
Collector-emitter voltage	V_{CE}	600	V
DC collector current	I_C		A
T_C = 25°C		20	
T_C = 100°C		10.6	
Pulsed collector current, t_p limited by T_{jmax}	I_{Cpuls}	40	
Turn off safe operating area $V_{CE} \leq$ 600V, $T_j \leq$ 150°C	-	40	
Diode forward current	I_F		
T_C = 25°C		21	
T_C = 100°C		10	
Diode pulsed current, t_p limited by T_{jmax}	I_{Fpuls}	42	
Gate-emitter voltage	V_{GE}	±20	V
Short circuit withstand time[2] V_{GE} = 15V, $V_{CC} \leq$ 600V, $T_j \leq$ 150°C	t_{SC}	10	µs
Power dissipation T_C = 25°C	P_{tot}	92	W
Operating junction and storage temperature	T_j , T_{stg}	-55...+150	°C
Soldering temperature (reflow soldering, MSL1)	T_s	245	°C

[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}		1.35	K/W
Diode thermal resistance, junction – case	R_{thJCD}		2.4	
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=10A T_j=25°C T_j=150°C	 1.7 -	 2 2.3	 2.4 2.8	
Diode forward voltage	V_F	V_{GE}=0V, I_F=10A T_j=25°C T_j=150°C	 1.2 -	 1.4 1.25	 1.8 1.65	
Gate-emitter threshold voltage	$V_{GE(th)}$	I_C=300µA, 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 1500	µA
Gate-emitter leakage current	I_{GES}	V_{CE}=0V, V_{GE}=20V	-	-	100	nA
Transconductance	g_{fs}	V_{CE}=20V, I_C=10A	-	6.7	-	S
Dynamic Characteristic						
Input capacitance	C_{iss}	V_{CE}=25V,	-	550	660	pF
Output capacitance	C_{oss}	V_{GE}=0V,	-	62	75	
Reverse transfer capacitance	C_{rss}	f=1MHz	-	42	51	
Gate charge	Q_{Gate}	V_{CC}=480V, I_C=10A V_{GE}=15V	-	52	68	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} ≤ 600V, T_j ≤ 150°C	-	100	-	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=10A, V_{GE}=0/15V, R_G=25Ω, L_σ[1)]=180nH, C_σ[1)]=55pF Energy losses include "tail" and diode reverse recovery.	-	28	34	ns
Rise time	t_r		-	12	15	
Turn-off delay time	$t_{d(off)}$		-	178	214	
Fall time	t_f		-	24	29	
Turn-on energy	E_{on}		-	0.15	0.173	mJ
Turn-off energy	E_{off}		-	0.17	0.221	
Total switching energy	E_{ts}		-	0.320	0.394	
Anti-Parallel Diode Characteristic						
Diode reverse recovery time	t_{rr} t_S t_F	T_j=25°C, V_R=200V, I_F=10A, di_F/dt=200A/µs	- - -	220 20 200	- - -	ns
Diode reverse recovery charge	Q_{rr}		-	310	-	nC
Diode peak reverse recovery current	I_{rrm}		-	4.5	-	A
Diode peak rate of fall of reverse recovery current during t_b	di_{rr}/dt		-	180	-	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=10A, V_{GE}=0/15V, R_G=25Ω L_σ[1)]=180nH, C_σ[1)]=55pF Energy losses include "tail" and diode reverse recovery.	-	28	34	ns
Rise time	t_r		-	12	15	
Turn-off delay time	$t_{d(off)}$		-	198	238	
Fall time	t_f		-	26	32	
Turn-on energy	E_{on}		-	0.260	0.299	mJ
Turn-off energy	E_{off}		-	0.280	0.364	
Total switching energy	E_{ts}		-	0.540	0.663	
Anti-Parallel Diode Characteristic						
Diode reverse recovery time	t_{rr} t_S t_F	T_j=150°C V_R=200V, I_F=10A, di_F/dt=200A/µs	- - -	350 36 314	- - -	ns
Diode reverse recovery charge	Q_{rr}		-	690	-	nC
Diode peak reverse recovery current	I_{rrm}		-	6.3	-	A
Diode peak rate of fall of reverse recovery current during t_b	di_{rr}/dt		-	200	-	A/µs

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

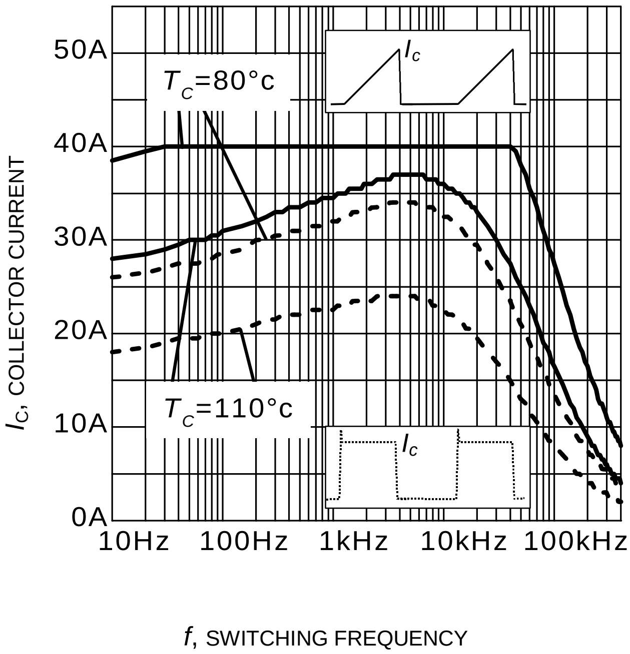


Figure 1. Collector current as a function of switching frequency
($T_j \leq 150°C$, $D = 0.5$, $V_{CE} = 400V$, $V_{GE} = 0/+15V$, $R_G = 25\Omega$)

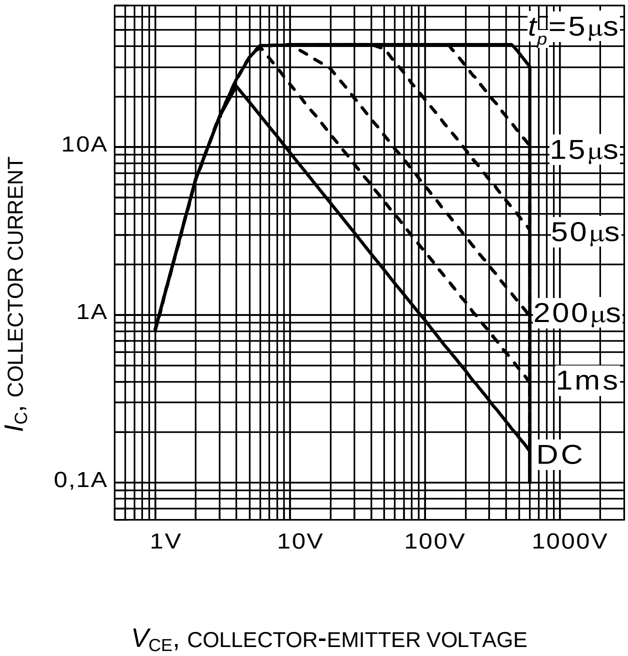


Figure 2. Safe operating area
($D = 0$, $T_C = 25°C$, $T_j \leq 150°C$)

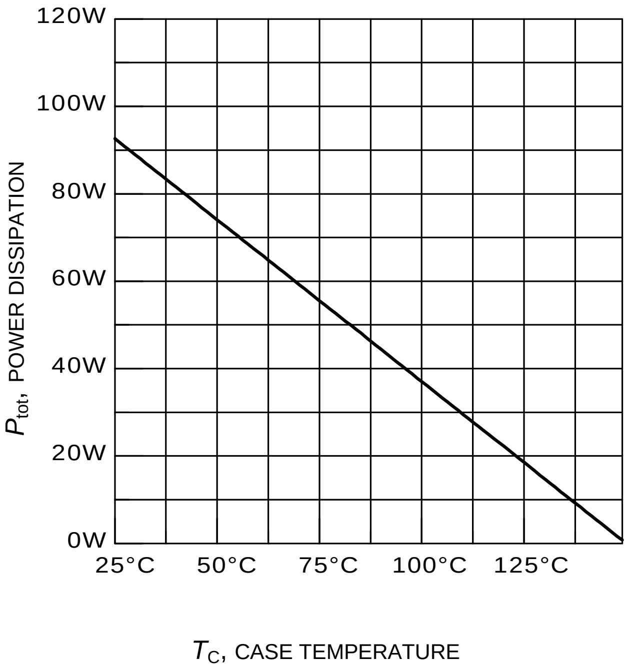


Figure 3. Power dissipation as a function of case temperature
($T_j \leq 150°C$)

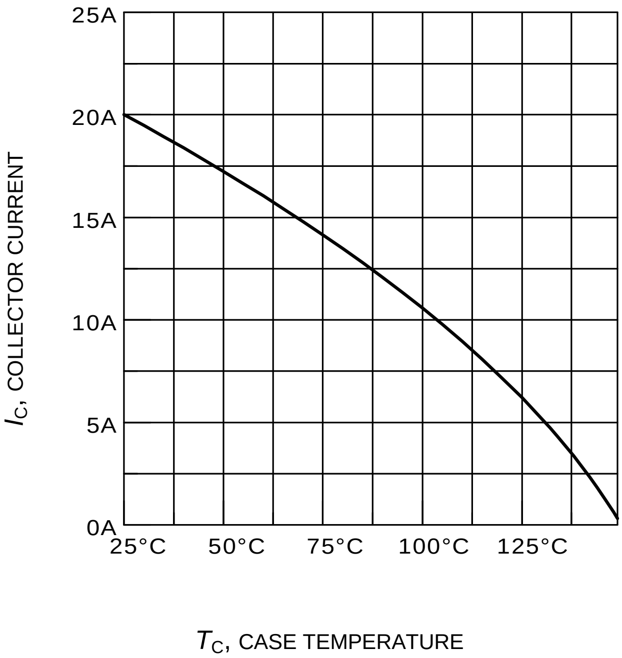


Figure 4. Collector current as a function of case temperature
($V_{GE} \leq 15V$, $T_j \leq 150°C$)

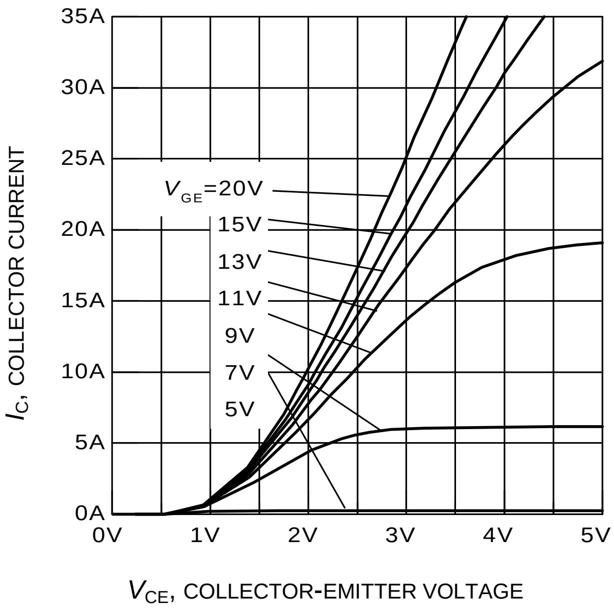


Figure 5. Typical output characteristics
(T_j = 25°C)

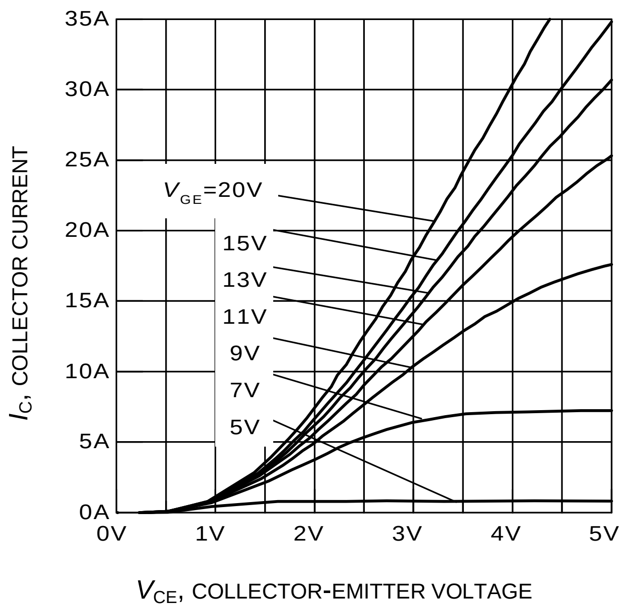


Figure 6. Typical output characteristics
(T_j = 150°C)

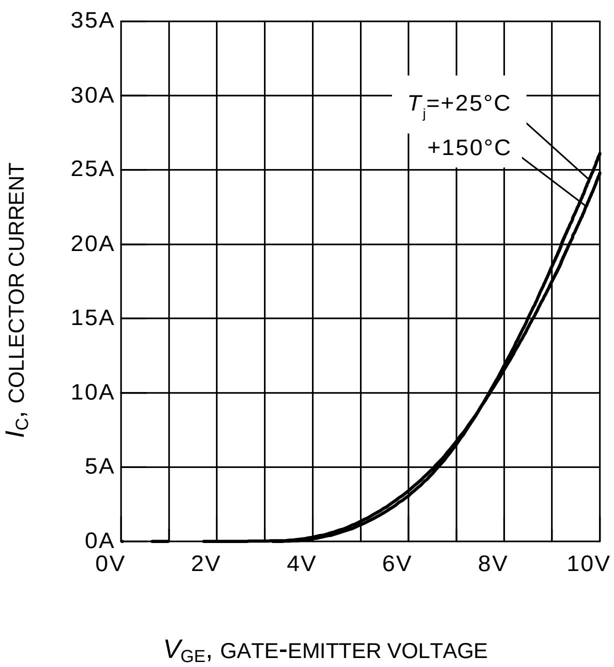


Figure 7. Typical transfer characteristics
(V_{CE} = 10V)

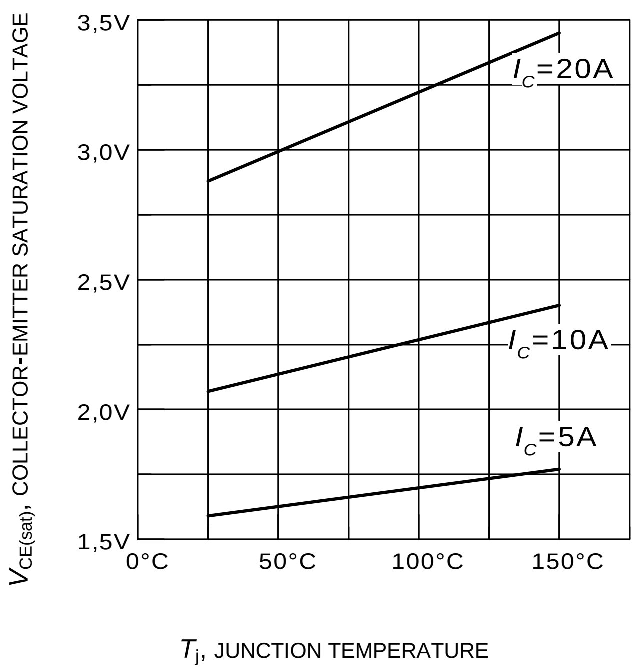


Figure 8. Typical collector-emitter saturation voltage as a function of junction temperature
(V_{GE} = 15V)

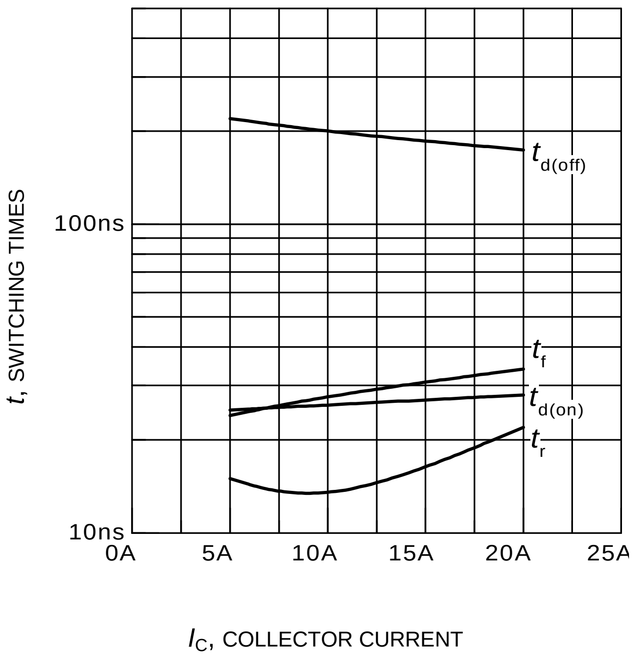


Figure 9. Typical switching times as a function of collector current
(inductive load, T_j = 150°C, V_{CE} = 400V, V_{GE} = 0/+15V, R_G = 25Ω, Dynamic test circuit in Figure E)

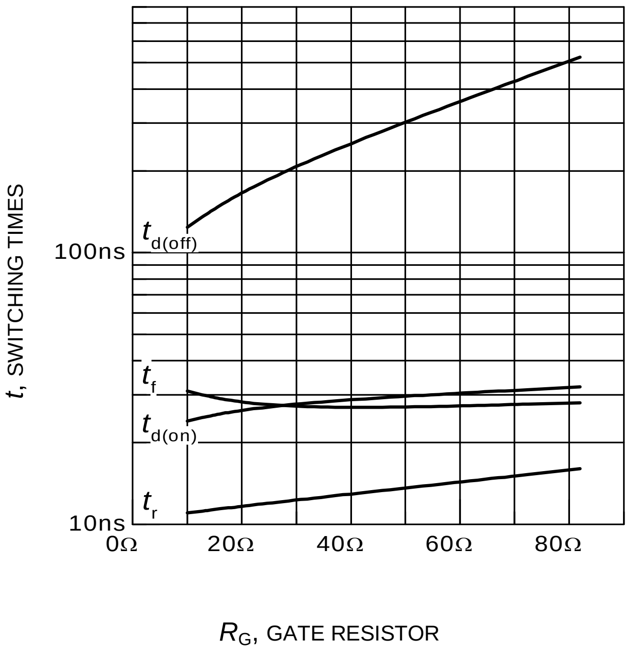


Figure 10. Typical switching times as a function of gate resistor
(inductive load, T_j = 150°C, V_{CE} = 400V, V_{GE} = 0/+15V, I_C = 10A, Dynamic test circuit in Figure E)

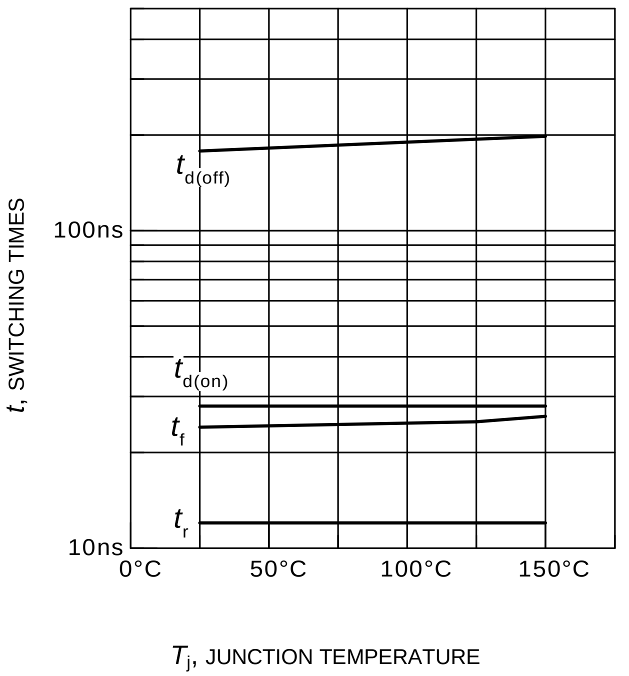


Figure 11. Typical switching times as a function of junction temperature
(inductive load, V_{CE} = 400V, V_{GE} = 0/+15V, I_C = 10A, R_G = 25Ω, Dynamic test circuit in Figure E)

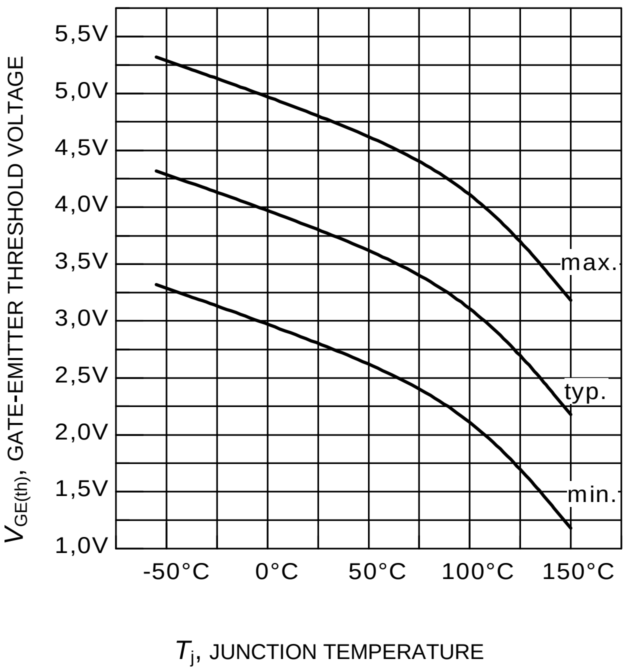
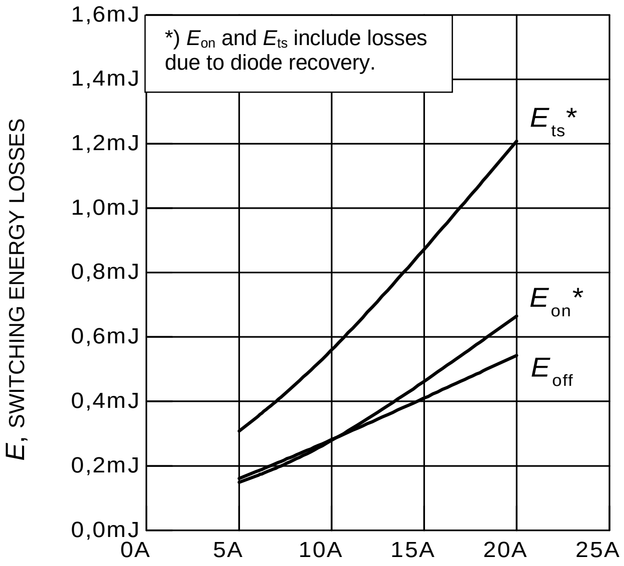
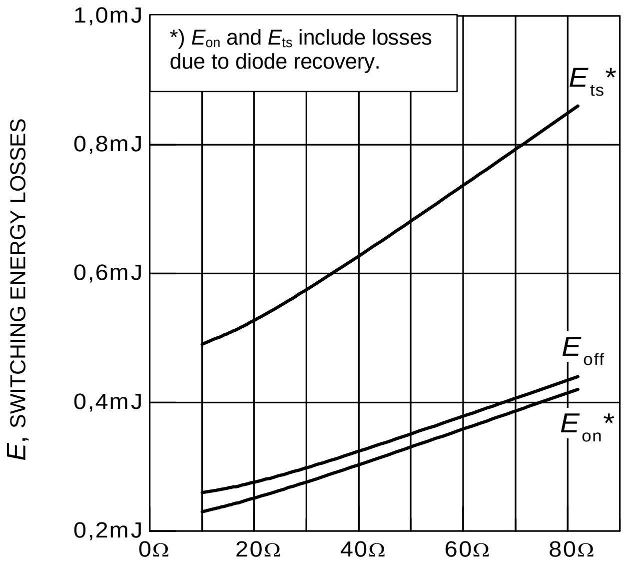


Figure 12. Gate-emitter threshold voltage as a function of junction temperature
(I_C = 0.3mA)



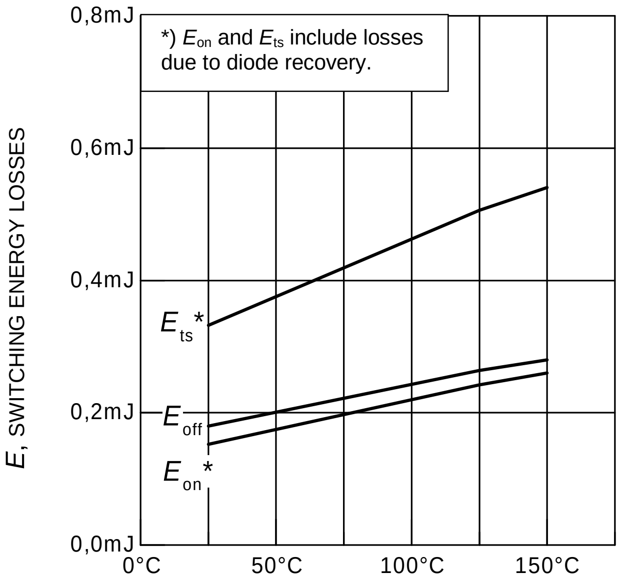
I_C, COLLECTOR CURRENT

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 = 25Ω, Dynamic test circuit in Figure E)



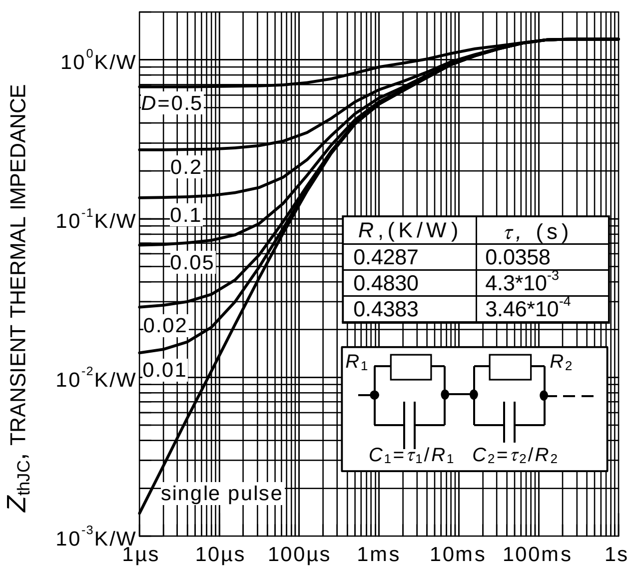
R_G, GATE RESISTOR

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 = 10A, Dynamic test circuit in Figure E)



T_j, JUNCTION TEMPERATURE

Figure 15. Typical switching energy losses as a function of junction temperature
(inductive load, V_{CE} = 400V, V_{GE} = 0/+15V, I_C = 10A, R_G = 25Ω, Dynamic test circuit in Figure E)



t_p, PULSE WIDTH

Figure 16. IGBT transient thermal impedance as a function of pulse width
($D = t_p / T$)

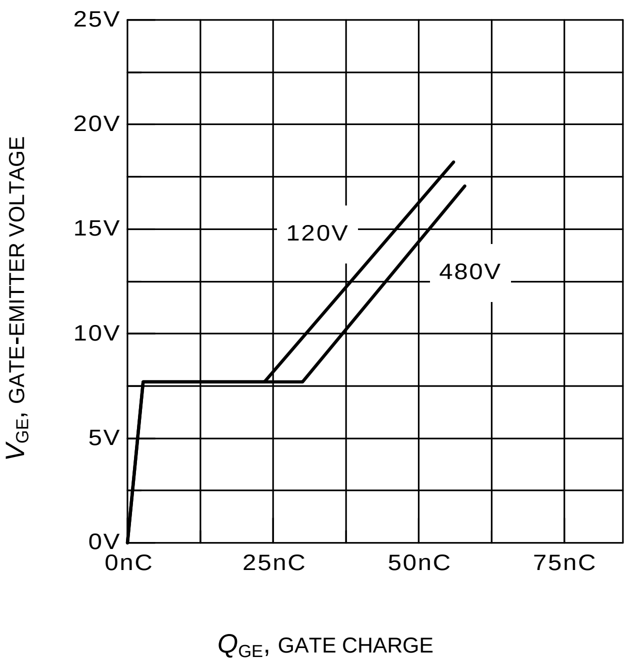


Figure 17. Typical gate charge
(I_C = 10A)

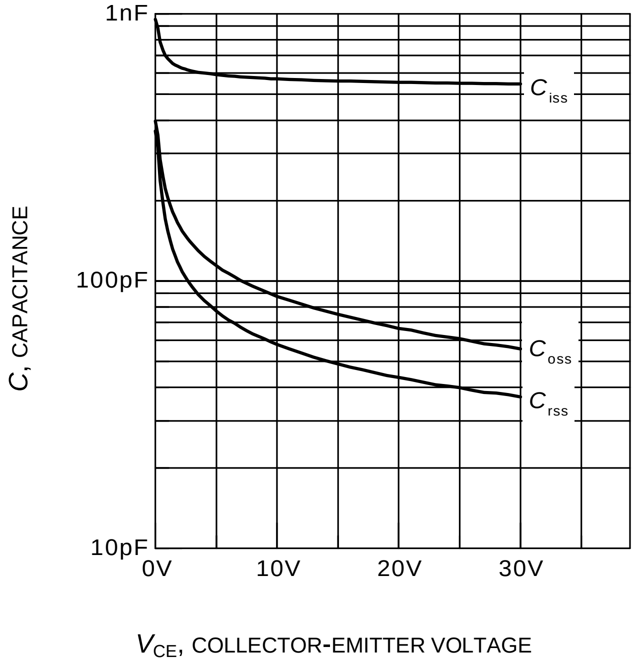


Figure 18. Typical capacitance as a function of collector-emitter voltage
(V_{GE} = 0V, f = 1MHz)

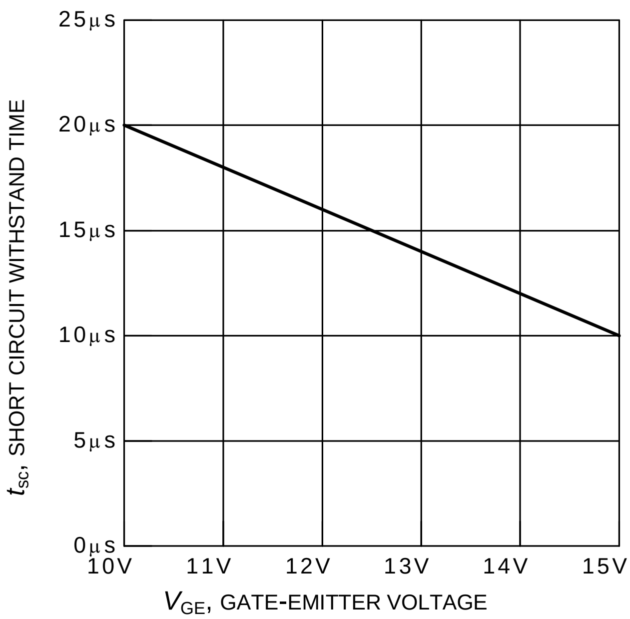


Figure 19. Short circuit withstand time as a function of gate-emitter voltage
(V_{CE} = 600V, start at T_j = 25°C)

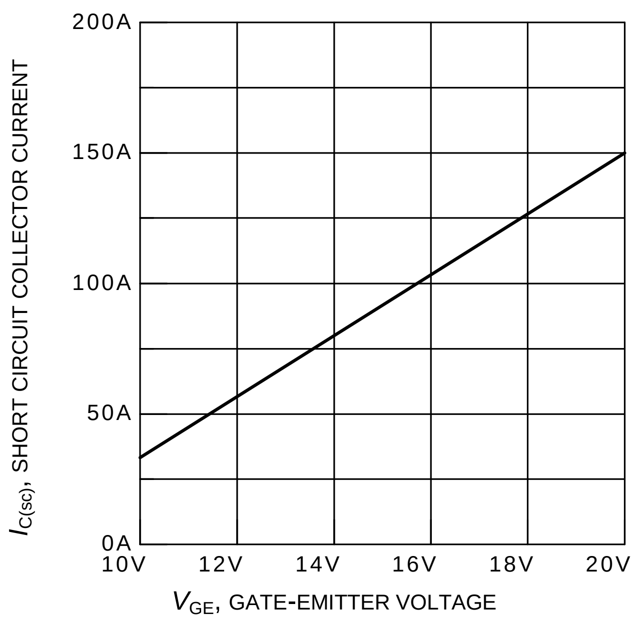


Figure 20. Typical short circuit collector current as a function of gate-emitter voltage
($V_{CE} \leq$ 600V, T_j = 150°C)

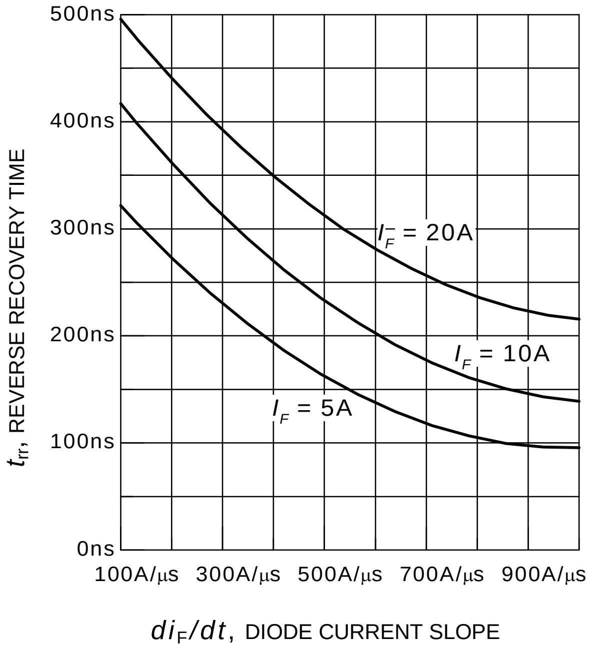


Figure 21. Typical reverse recovery time as a function of diode current slope
(V_R = 200V, T_j = 125°C,
Dynamic test circuit in Figure E)

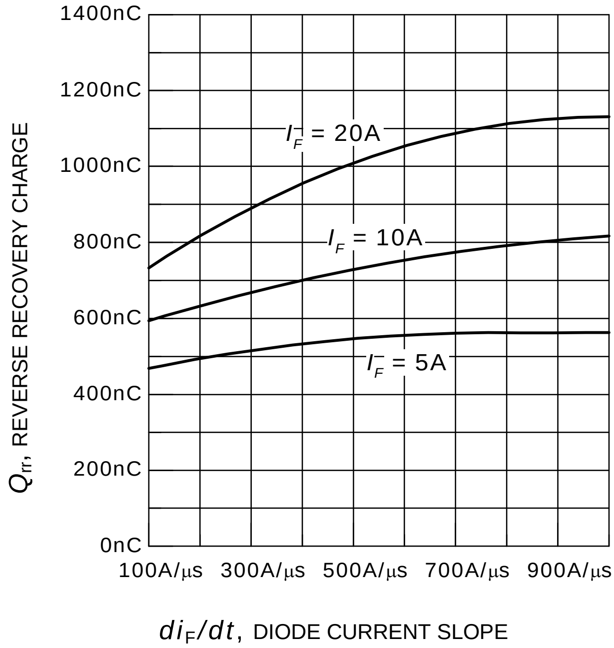


Figure 22. Typical reverse recovery charge as a function of diode current slope
(V_R = 200V, T_j = 125°C,
Dynamic test circuit in Figure E)

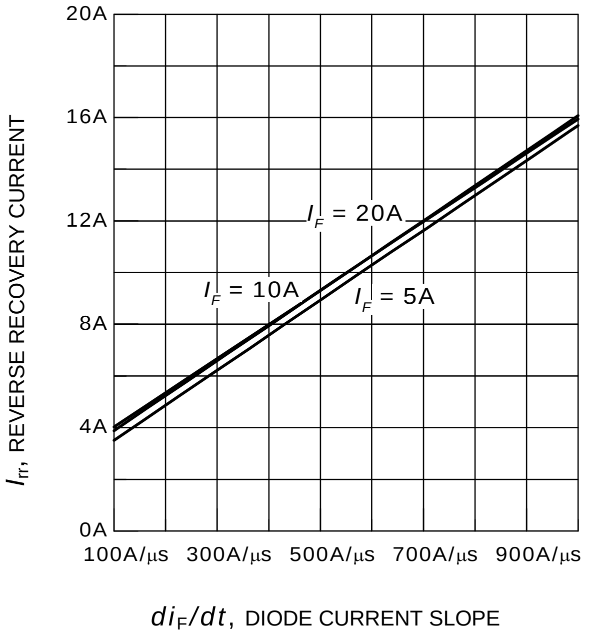


Figure 23. Typical reverse recovery current as a function of diode current slope
(V_R = 200V, T_j = 125°C,
Dynamic test circuit in Figure E)

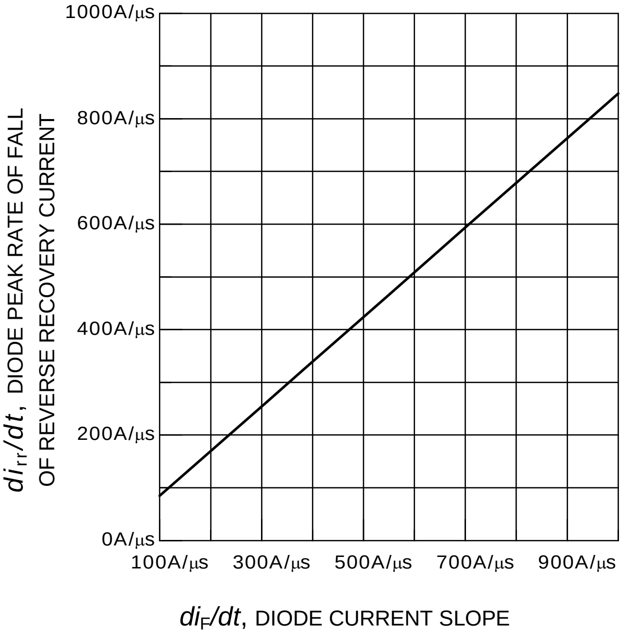


Figure 24. Typical diode peak rate of fall of reverse recovery current as a function of diode current slope
(V_R = 200V, T_j = 125°C,
Dynamic test circuit in Figure E)

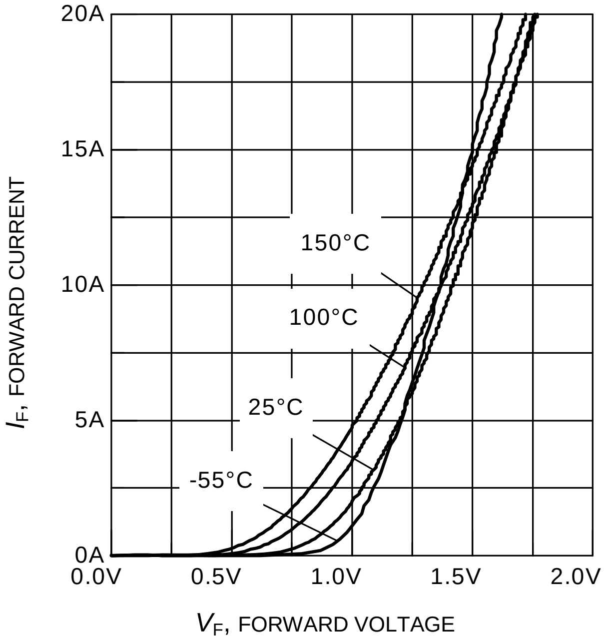


Figure 25. Typical diode forward current as a function of forward voltage

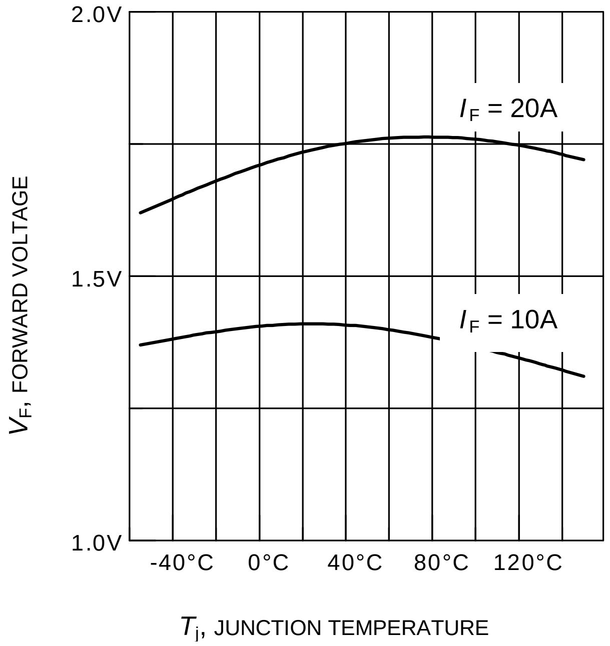


Figure 26. Typical diode forward voltage as a function of junction temperature

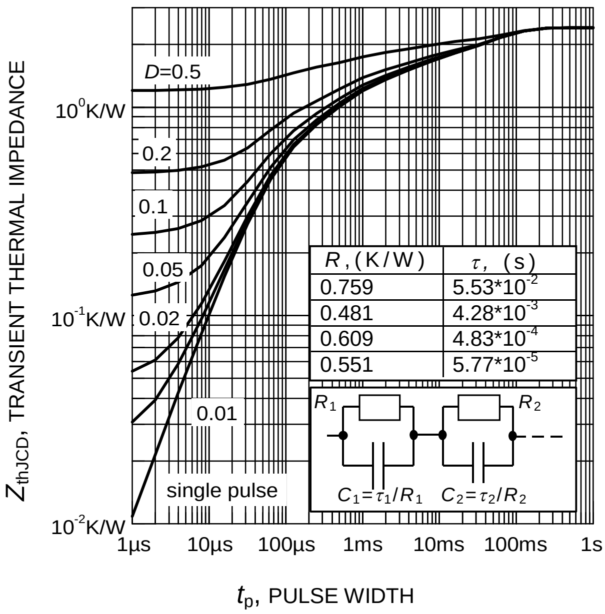


Figure 27. Diode transient thermal impedance as a function of pulse width
($D = t_p / T$)

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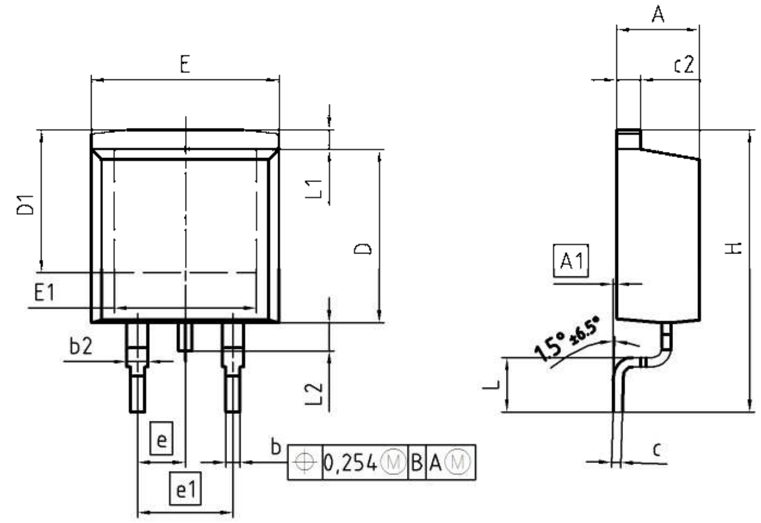

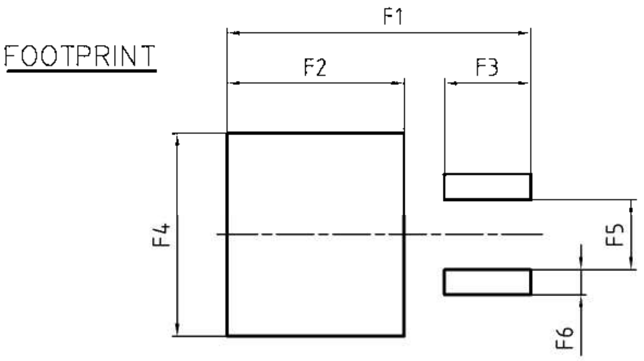

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.30	4.57	0.169	0.180
A1	0.00	0.25	0.000	0.010
b	0.65	0.85	0.026	0.033
b2	0.95	1.15	0.037	0.045
c	0.33	0.65	0.013	0.026
c2	1.17	1.40	0.046	0.055
D	8.51	9.45	0.335	0.372
D1	7.10	7.90	0.280	0.311
E	9.80	10.31	0.386	0.406
E1	6.50	8.60	0.256	0.339
e	2.54		0.100	
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

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SCALE 0 5 0 5 7.5mm

EUROPEAN PROJECTION

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REVISION
01

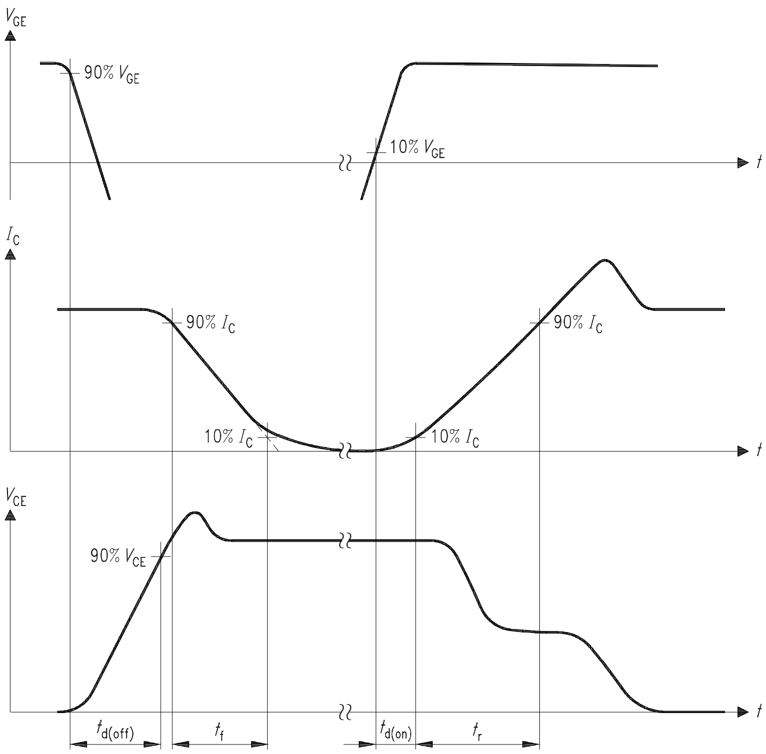

Figure A. Definition of switching times

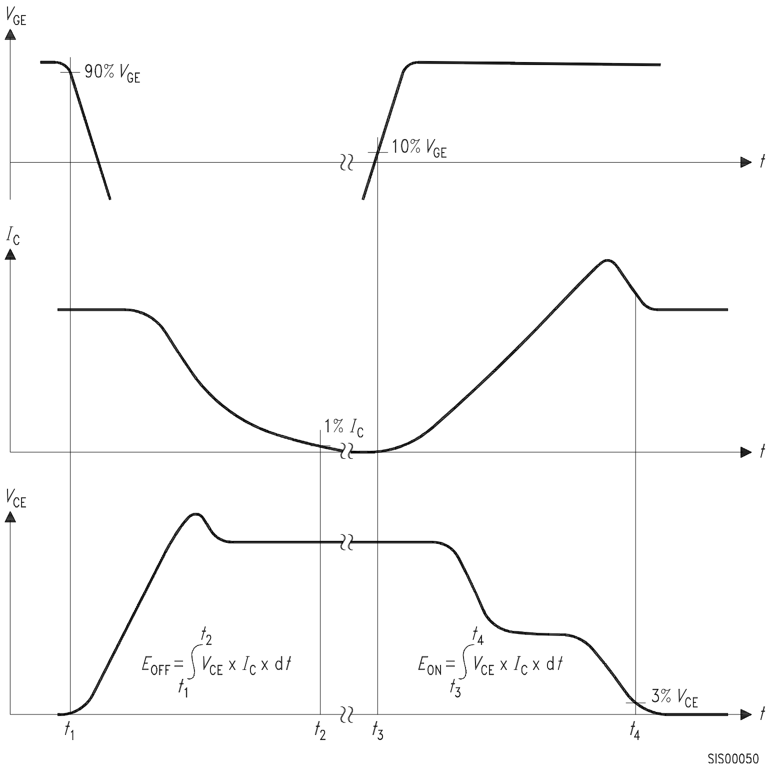

Figure B. Definition of switching losses

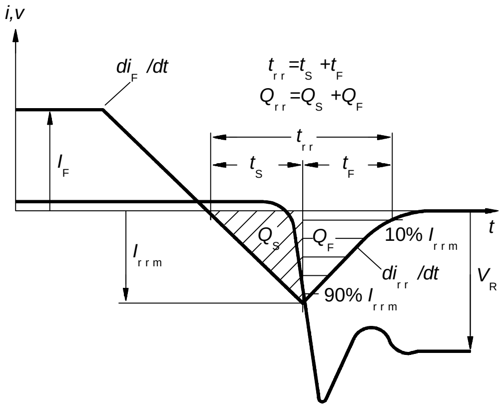

Figure C. Definition of diodes switching characteristics

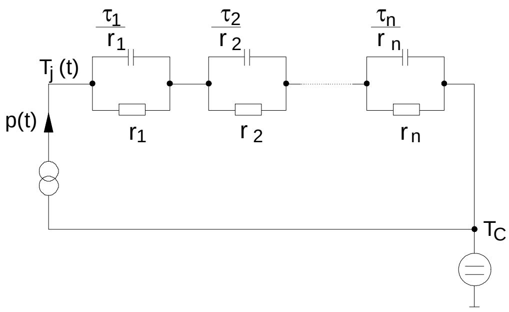

Figure D. Thermal equivalent circuit

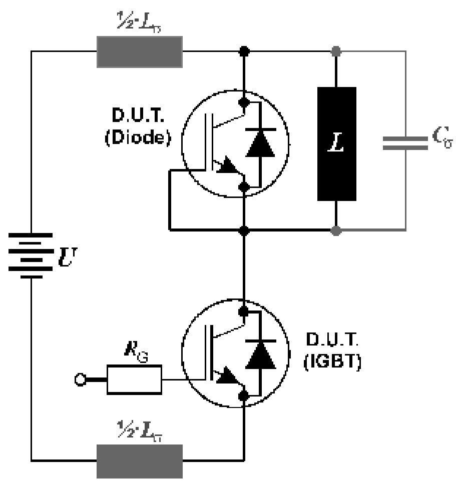

Figure E. Dynamic test circuit
Leakage inductance L_σ =180nH
and Stray capacity C_σ =55pF.

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