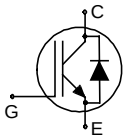
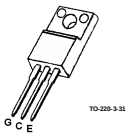
Preliminary

SKA06N60

Fast S-IGBT in NPT-technology with soft, fast recovery anti-parallel EmCon diode

- 75% lower E_{off} compared to previous generation combined with low conduction losses
- Short circuit withstand time – 10 µs
- Designed for:
  - Motor controls
  - Inverter
- NPT-Technology for 600V applications offers:
  - very tight parameter distribution
  - high ruggedness, temperature stable behaviour
  - parallel switching capability
- Very soft, fast recovery anti-parallel EmCon diode
- Isolated TO-220, 2.5kV, 60s





Type	V_{CE}	I_C	$V_{CE(sat)}$	T_j	Package	Ordering Code
SKA06N60	600V	5A	2.3V	150°C	TO-220-3-31	Q67040-S4340

Maximum Ratings

Parameter	Symbol	Value	Unit
Collector-emitter voltage	V_{CE}	600	V
DC collector current	I_C		A
T_C = 25°C		9.0	
T_C = 100°C		5.0	
Pulsed collector current, t_p limited by T_{jmax}	I_{Cpuls}	24	
Turn off safe operating area	-	24	
$V_{CE} \le 600V$, $T_j \le 150°C$			
Diode forward current	I_F		
T_C = 25°C		12	
T_C = 100°C		6	
Diode pulsed current, t_p limited by T_{jmax}	I_{Fpuls}	24	
Gate-emitter voltage	V_{GE}	±20	V
Short circuit withstand time[1)]	t_{SC}	10	µs
V_{GE} = 15V, $V_{CC} \le 600V$, $T_j \le 150°C$			
Power dissipation	P_{tot}	32	W
T_C = 25°C			
Operating junction and storage temperature	T_j , T_{stg}	-55...+150	°C

[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}		3.80	K/W
Diode thermal resistance, junction – case	R_{thJCD}		5.0	
Thermal resistance, junction – ambient	R_{thJA}	TO-220-3-31	65	

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	1.7	2.0	2.4	
		T_j=150°C	-	2.3	2.8	
Diode forward voltage	V_F	V_{GE}=0V, I_F=6A				
		T_j=25°C	1.2	1.4	1.8	
		T_j=150°C	-	1.25	1.65	
Gate-emitter threshold voltage	$V_{GE(th)}$	I_C=250µA, V_{CE}=V_{GE}	3	4	5	
Zero gate voltage collector current	I_{CES}	V_{CE}=600V, V_{GE}=0V				µA
		T_j=25°C	-	-	20	
		T_j=150°C	-	-	700	
Gate-emitter leakage current	I_{GES}	V_{CE}=0V, V_{GE}=20V	-	-	100	nA
Transconductance	g_{fs}	V_{CE}=20V, I_C=6A	-	4.2	-	S
Dynamic Characteristic						
Input capacitance	C_{iss}	V_{CE}=25V,	-	350	420	pF
Output capacitance	C_{oss}	V_{GE}=0V,	-	38	46	
Reverse transfer capacitance	C_{rss}	f=1MHz	-	23	28	
Gate charge	Q_{Gate}	V_{CC}=480V, I_C=6A	-	32	42	nC
		V_{GE}=15V				
Internal emitter inductance measured 5mm (0.197 in.) from case	L_E	TO-220-3-31	-	7	-	nH
Short circuit collector current[2)]	$I_{C(SC)}$	V_{GE}=15V, t_{SC}≤10µs V_{CC} ≤ 600V, T_j ≤ 150°C	-	60	-	A

[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,	-	25	30	ns
Rise time	t_r	V_{CC}=400V,I_C=6A,	-	18	22	
Turn-off delay time	$t_{d(off)}$	V_{GE}=0/15V,	-	220	264	
Fall time	t_f	R_G=50Ω,	-	54	65	
Turn-on energy	E_{on}	Energy losses include	-	0.110	0.127	mJ
Turn-off energy	E_{off}	“tail” and diode	-	0.105	0.137	
Total switching energy	E_{ts}	reverse recovery.	-	0.215	0.263	
Anti-Parallel Diode Characteristic						
Diode reverse recovery time	t_{rr}	T_j=25°C,	-	200	-	ns
	t_S	V_R=200V, I_F=6A,	-	17	-	
	t_F	di_F/dt=200A/µs	-	183	-	
Diode reverse recovery charge	Q_{rr}		-	200	-	nC
Diode peak reverse recovery current	I_{rrm}		-	2.8	-	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	-	24	29	ns
Rise time	t_r	V_{CC}=400V,	-	17	20	
Turn-off delay time	$t_{d(off)}$	I_C=6A,	-	248	298	
Fall time	t_f	V_{GE}=0/15V,	-	70	84	
Turn-on energy	E_{on}	R_G=50Ω	-	0.167	0.192	mJ
Turn-off energy	E_{off}	Energy losses include	-	0.153	0.199	
Total switching energy	E_{ts}	“tail” and diode reverse recovery.	-	0.320	0.391	
Anti-Parallel Diode Characteristic						
Diode reverse recovery time	t_{rr}	T_j=150°C	-	290	-	ns
	t_S	V_R=200V, I_F=6A,	-	27	-	
	t_F	di_F/dt=200A/µs	-	263	-	
Diode reverse recovery charge	Q_{rr}		-	500	-	nC
Diode peak reverse recovery current	I_{rrm}		-	5.0	-	A
Diode peak rate of fall of reverse recovery current during t_b	di_{rr}/dt		-	200	-	A/µs

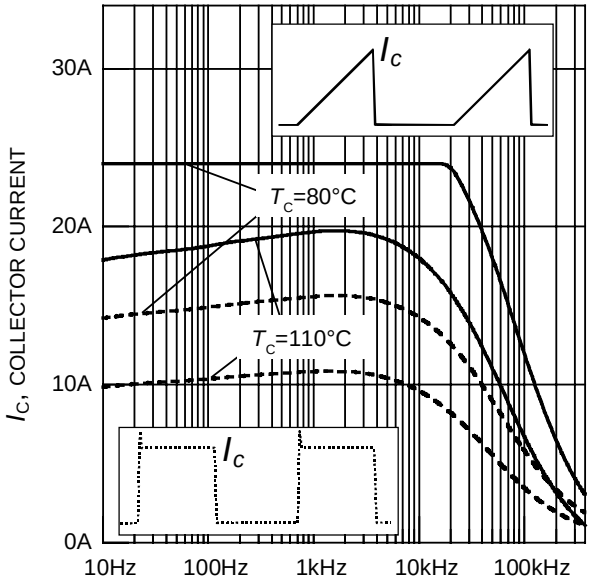


Figure 1. Collector current as a function of switching frequency
($T_j \le 150°C$, $D = 0.5$, $V_{CE} = 400V$, $V_{GE} = 0/+15V$, $R_G = 50\Omega$)

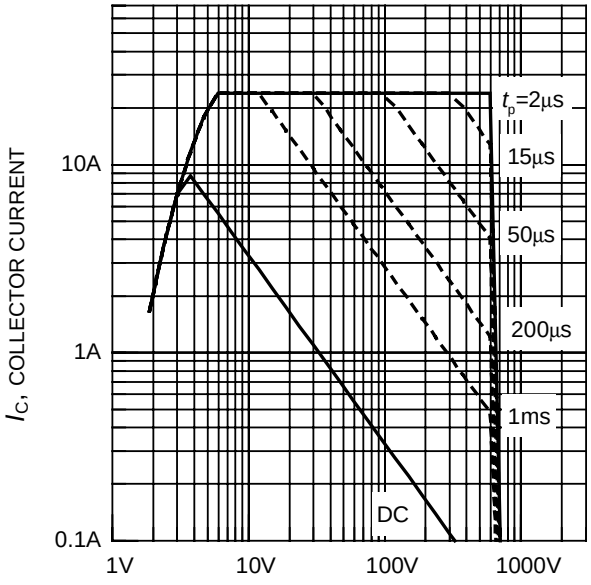


Figure 2. Safe operating area
($D = 0$, $T_C = 25°C$, $T_j \le 150°C$)

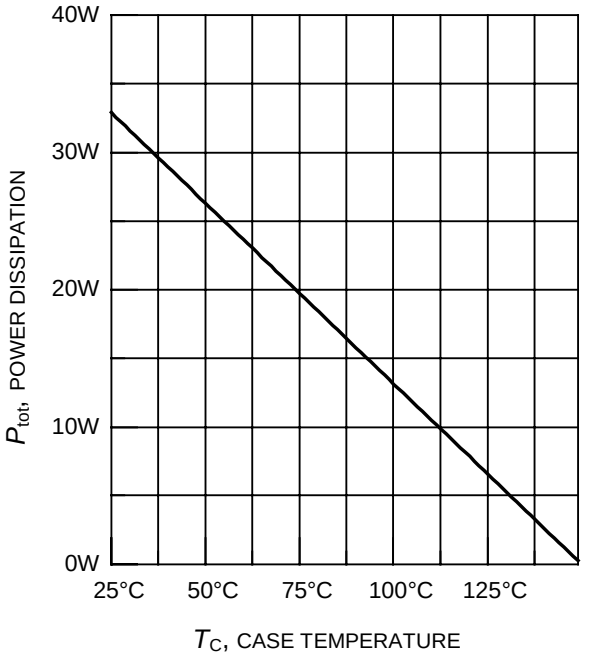


Figure 3. Power dissipation as a function of case temperature
($T_j \le 150°C$)

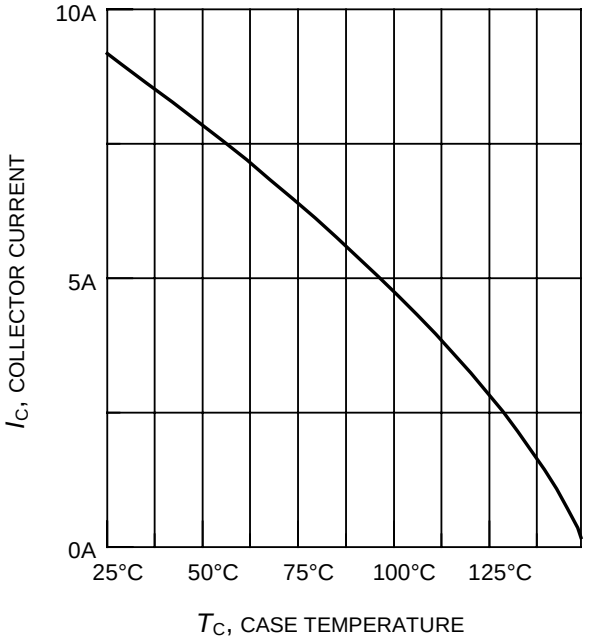


Figure 4. Collector current as a function of case temperature
($V_{GE} \le 15V$, $T_j \le 150°C$)

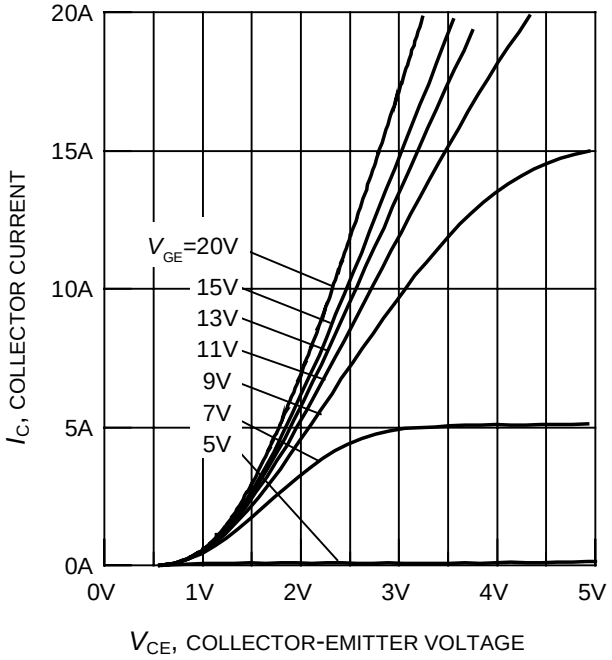


Figure 5. Typical output characteristics
(T_j = 25°C)

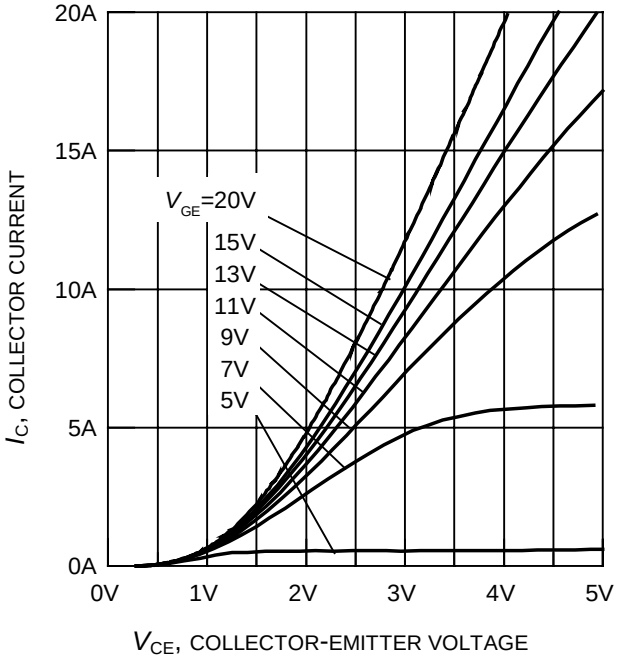


Figure 6. Typical output characteristics
(T_j = 150°C)

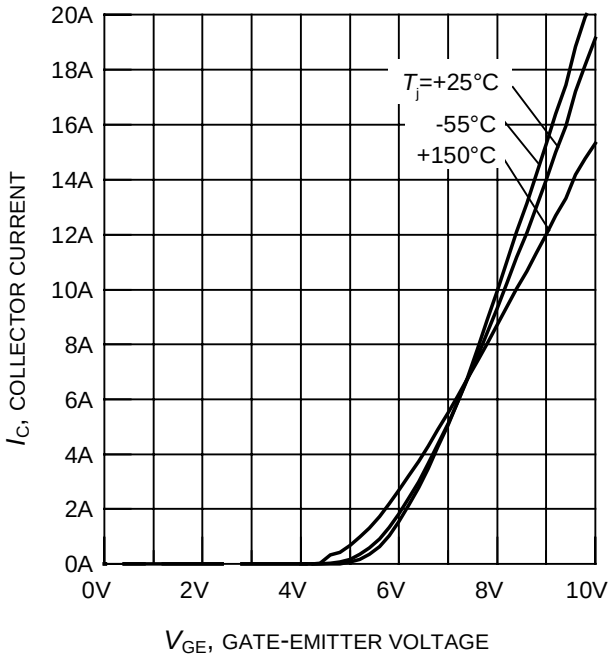


Figure 7. Typical transfer characteristics
(V_{CE} = 10V)

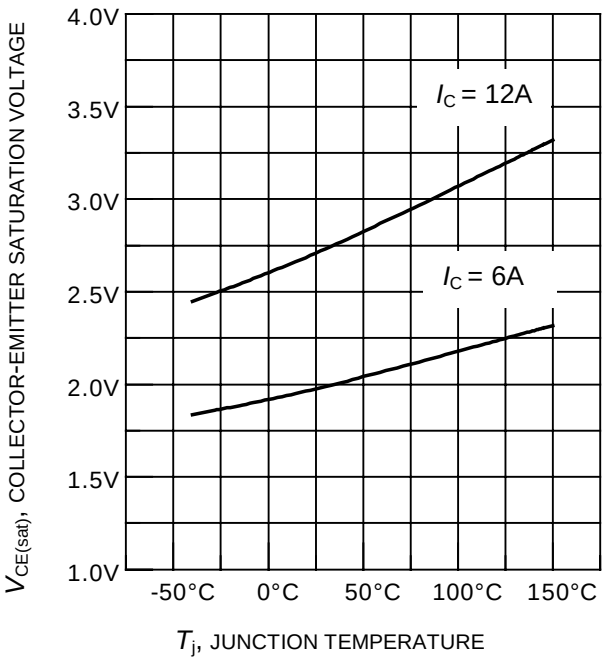


Figure 8. Typical collector-emitter saturation voltage as a function of junction temperature
(V_{GE} = 15V)

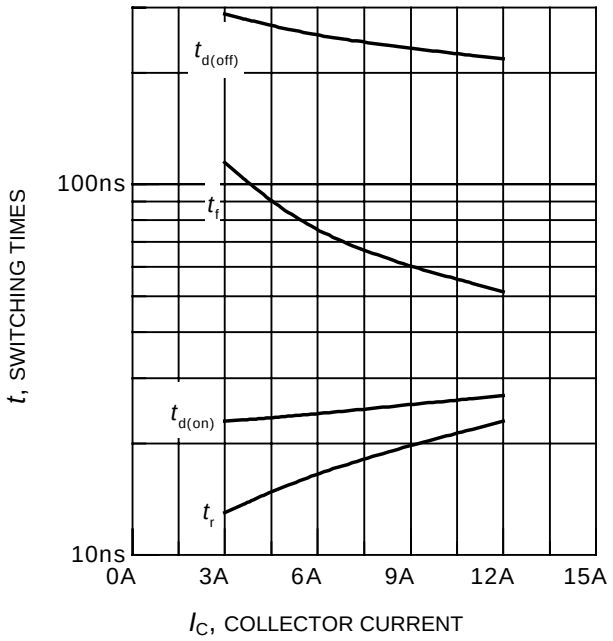


Figure 9. Typical switching times as a function of collector current
(inductive load, T_j = 150°C, V_{CE} = 400V, V_{GE} = 0/+15V, R_G = 50Ω)

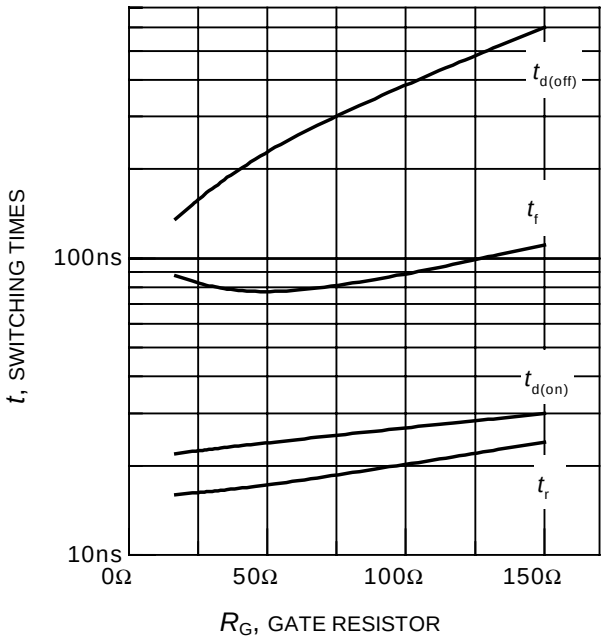


Figure 10. Typical switching times as a function of gate resistor
(inductive load, T_j = 150°C, V_{CE} = 400V, V_{GE} = 0/+15V, I_C = 6A)

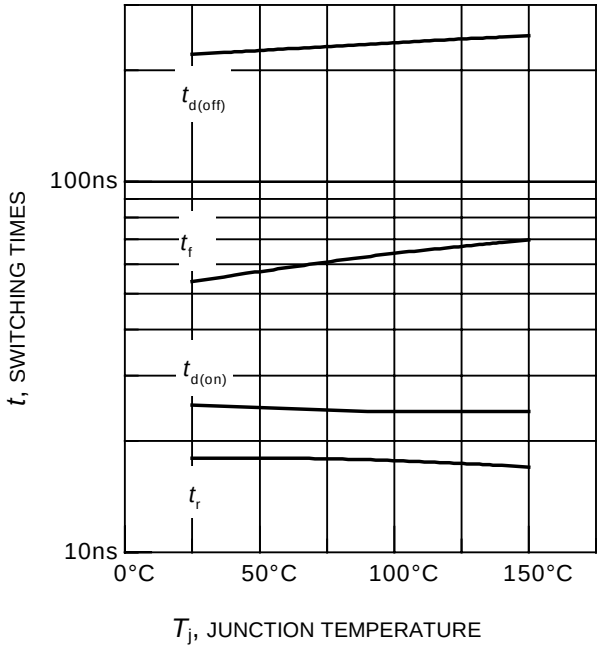


Figure 11. Typical switching times as a function of junction temperature
(inductive load, V_{CE} = 400V, V_{GE} = 0/+15V, I_C = 6A, R_G = 50Ω)

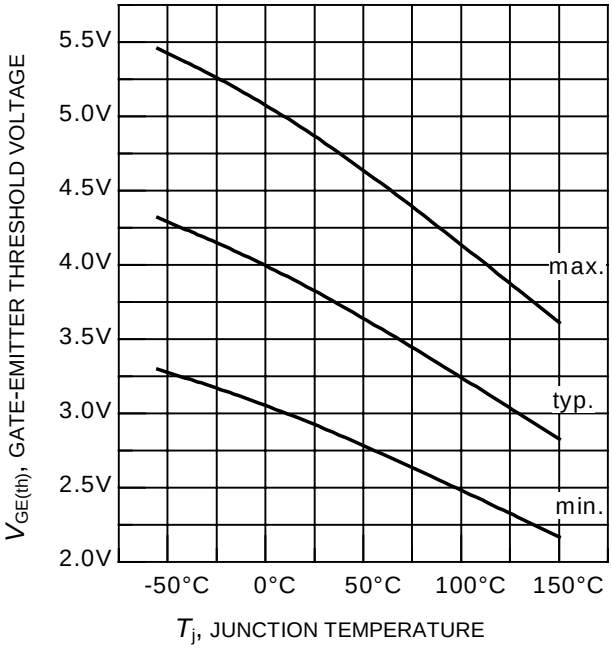


Figure 12. Gate-emitter threshold voltage as a function of junction temperature
(I_C = 0.25mA)

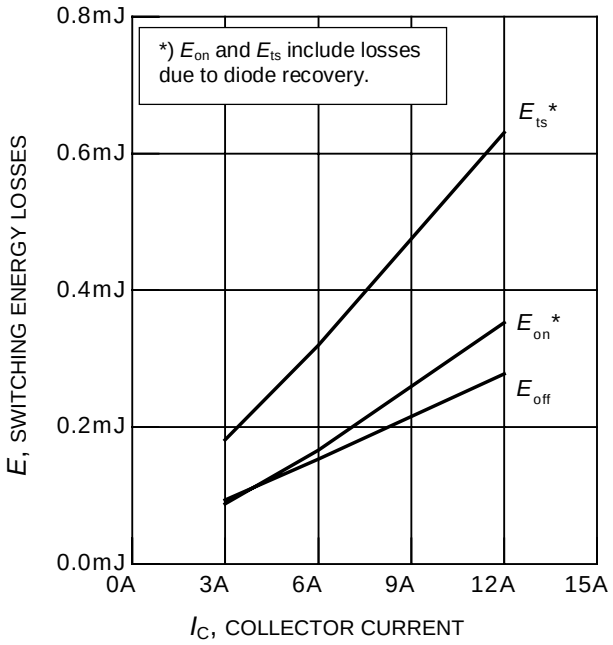


Figure 13. Typical switching energy losses as a function of collector current
(inductive load, T_j = 150°C, V_{CE} = 400V, V_{GE} = 0/+15V, R_G = 50Ω)

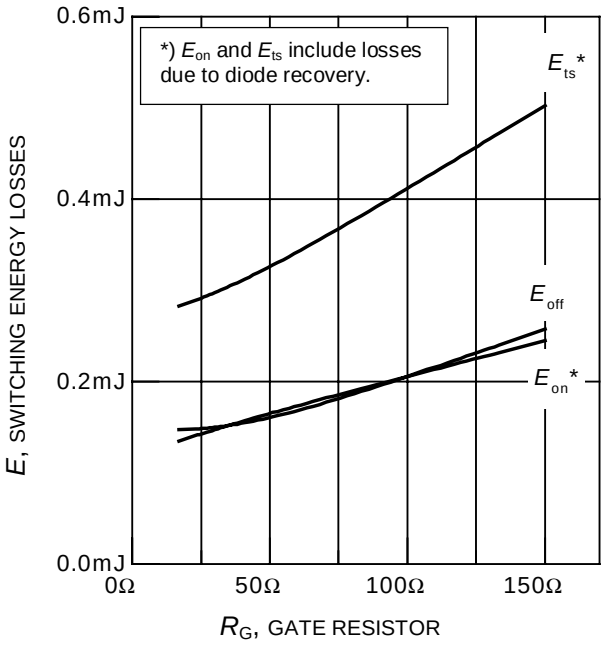


Figure 14. Typical switching energy losses as a function of gate resistor
(inductive load, T_j = 150°C, V_{CE} = 400V, V_{GE} = 0/+15V, I_C = 6A)

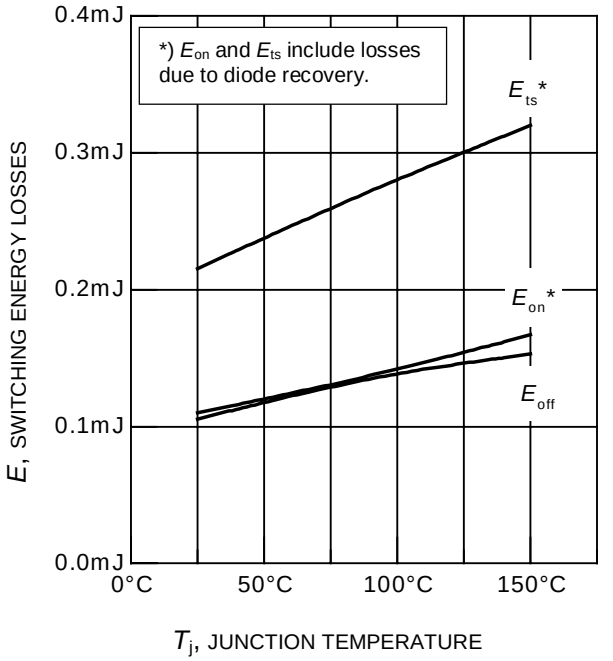


Figure 15. Typical switching energy losses as a function of junction temperature
(inductive load, V_{CE} = 400V, V_{GE} = 0/+15V, I_C = 6A, R_G = 50Ω)

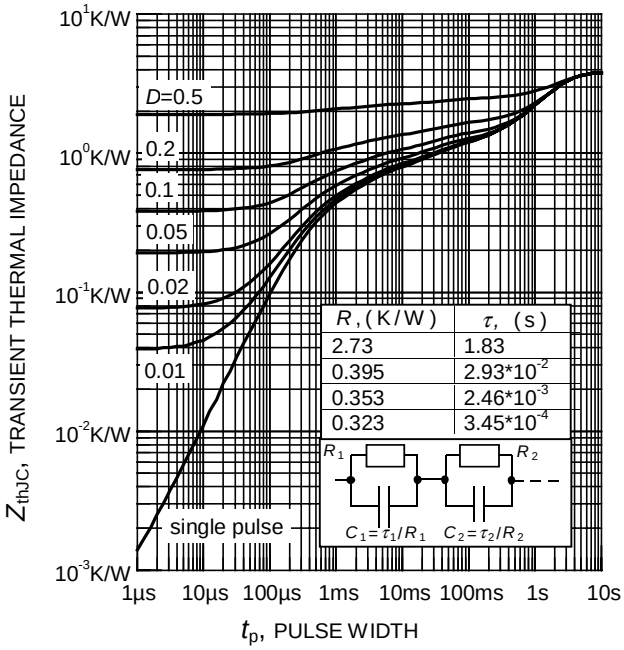


Figure 16. IGBT transient thermal impedance as a function of pulse width
($D = t_p / T$)

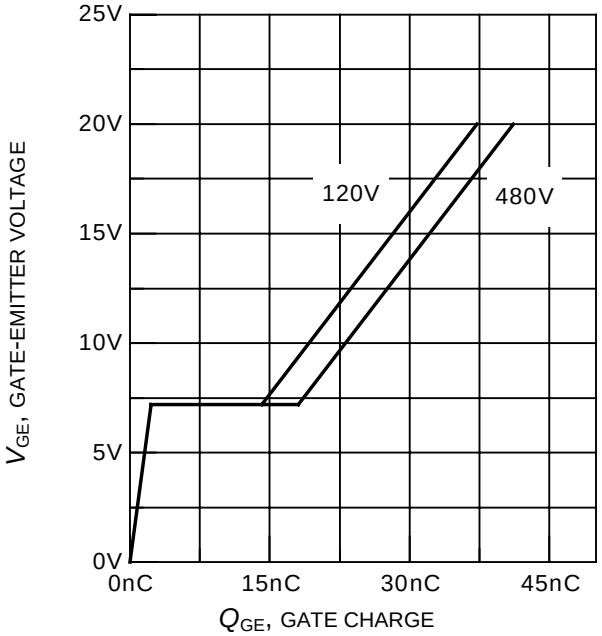


Figure 17. Typical gate charge
(I_C = 6A)

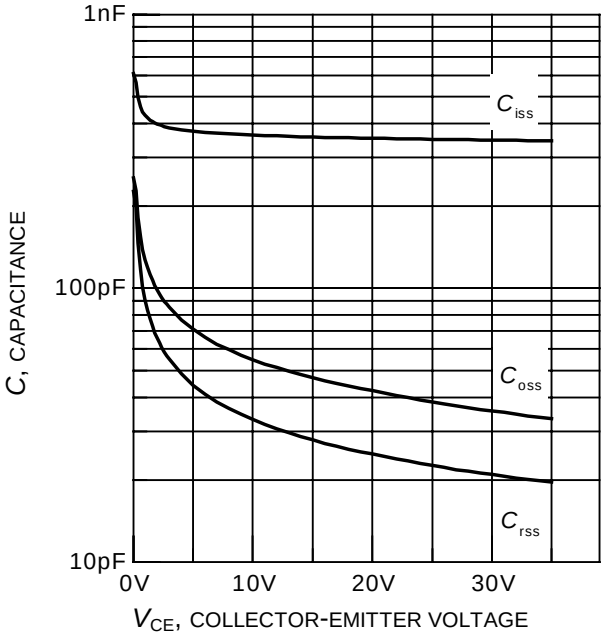


Figure 18. Typical capacitance as a function of collector-emitter voltage
(V_{GE} = 0V, f = 1MHz)

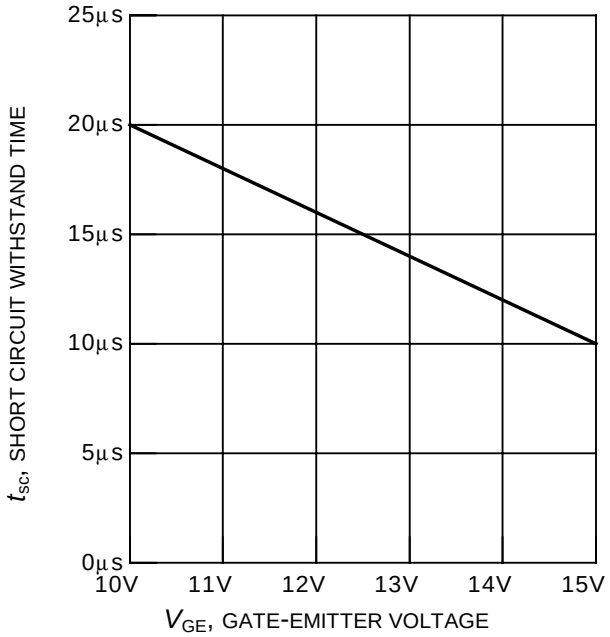


Figure 19. Short circuit withstand time as a function of gate-emitter voltage
(V_{CE} = 600V, start at T_j = 25°C)

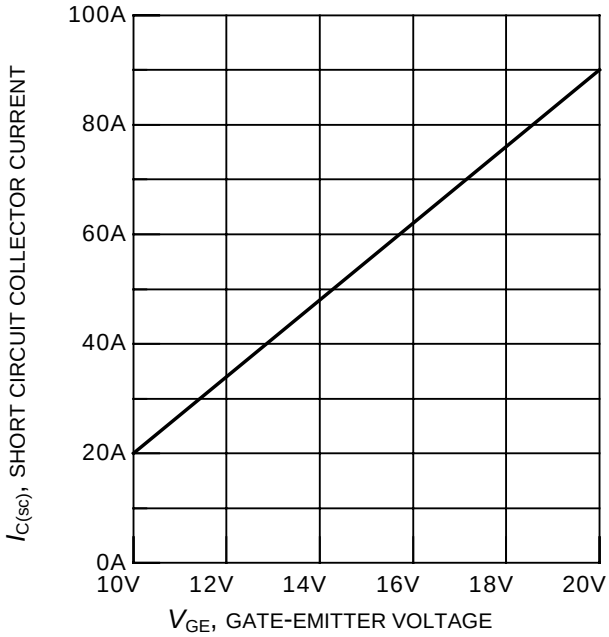


Figure 20. Typical short circuit collector current as a function of gate-emitter voltage
($V_{CE} \le$ 600V, T_j = 150°C)

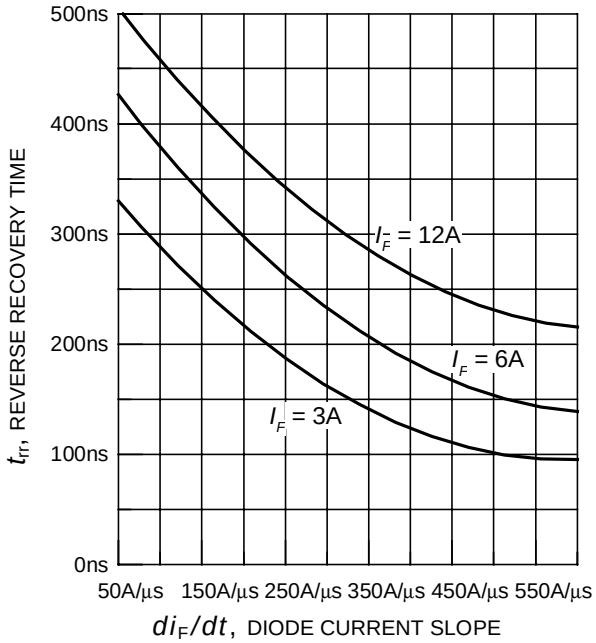


Figure 21. Typical reverse recovery time as a function of diode current slope
(V_R = 200V, T_j = 125°C)

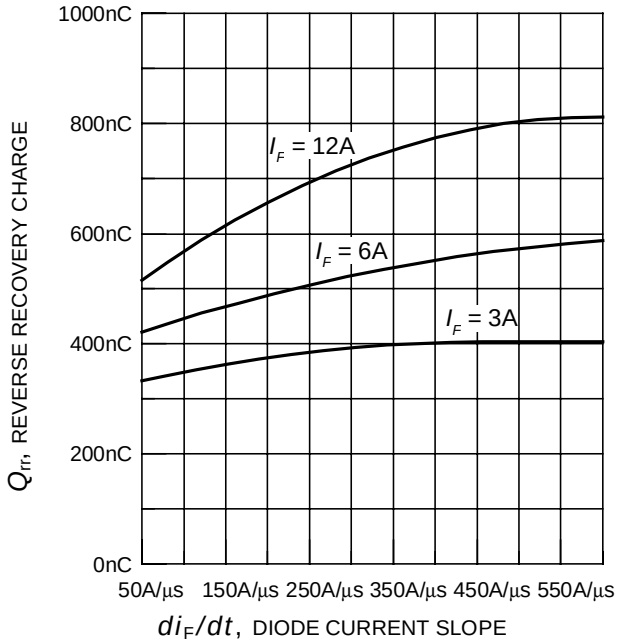


Figure 22. Typical reverse recovery charge as a function of diode current slope
(V_R = 200V, T_j = 125°C)

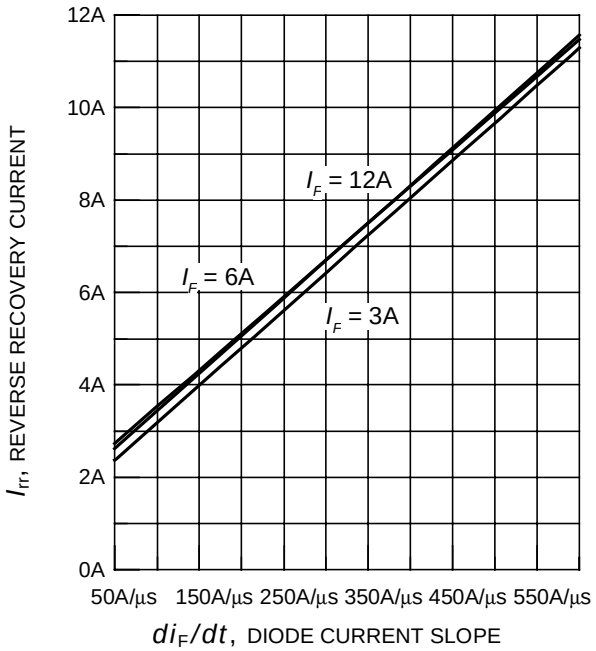


Figure 23. Typical reverse recovery current as a function of diode current slope
(V_R = 200V, T_j = 125°C)

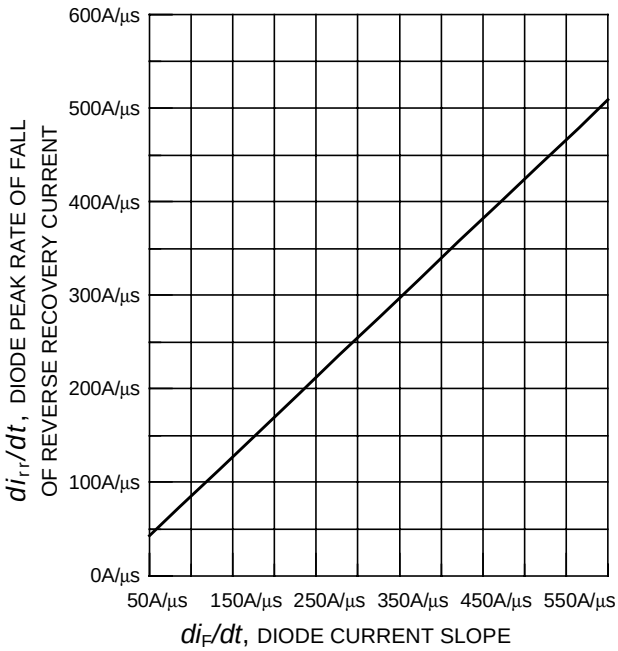


Figure 24. Typical diode peak rate of fall of reverse recovery current as a function of diode current slope
(V_R = 200V, T_j = 125°C)

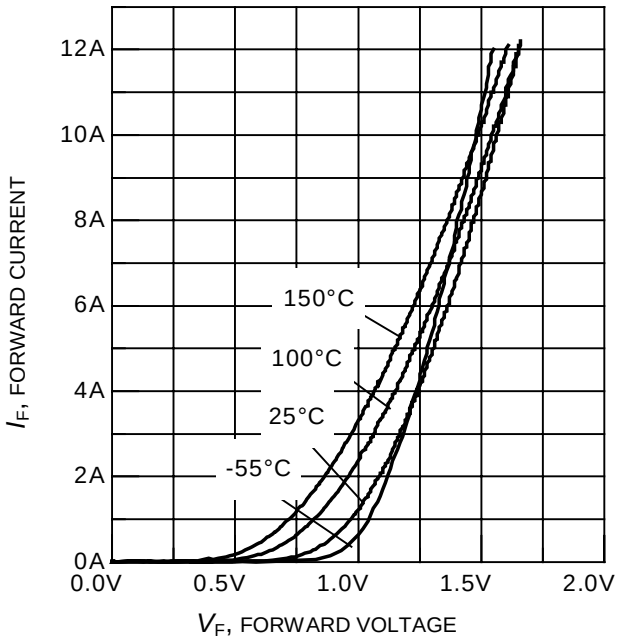


Figure 25. Typical diode forward current as a function of forward voltage

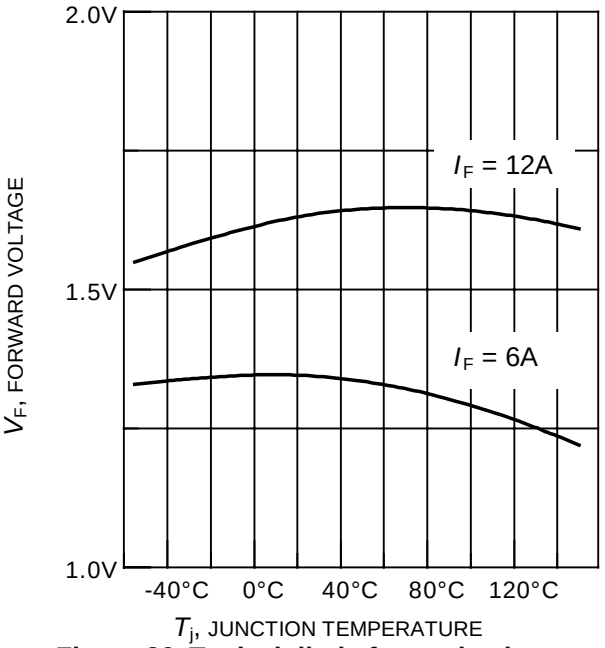


Figure 26. Typical diode forward voltage as a function of junction temperature

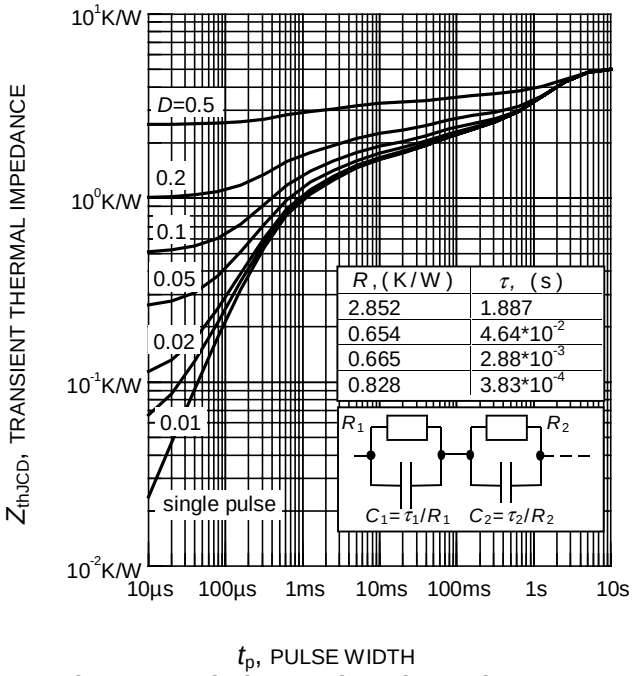
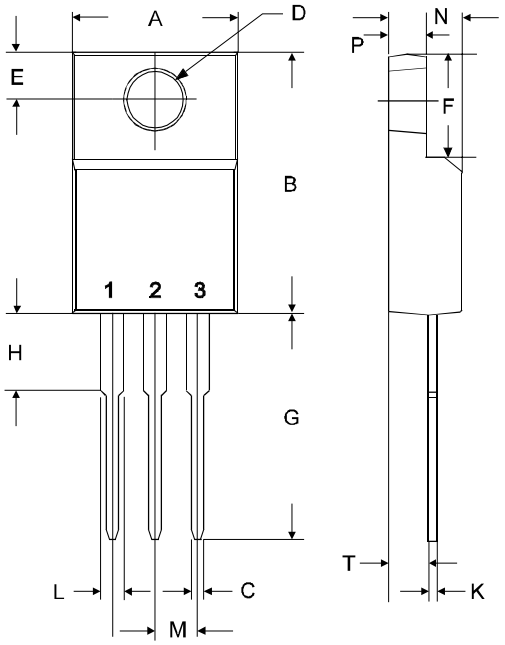


Figure 27. Diode transient thermal impedance as a function of pulse width
($D = t_p / T$)

P-TO220-3-31



symbol	dimensions			
	[mm]		[inch]	
	min	max	min	max
A	10.37	10.63	0.4084	0.4184
B	15.86	16.12	0.6245	0.6345
C	0.65	0.78	0.0256	0.0306
D	2.95 typ.		0.1160 typ.	
E	3.15	3.25	0.124	0.128
F	6.05	6.56	0.2384	0.2584
G	13.47	13.73	0.5304	0.5404
H	3.18	3.43	0.125	0.135
K	0.45	0.63	0.0177	0.0247
L	1.23	1.36	0.0484	0.0534
M	2.54 typ.		0.100 typ.	
N	4.57	4.83	0.1800	0.1900
P	2.57	2.83	0.1013	0.1113
T	2.51	2.62	0.0990	0.1030

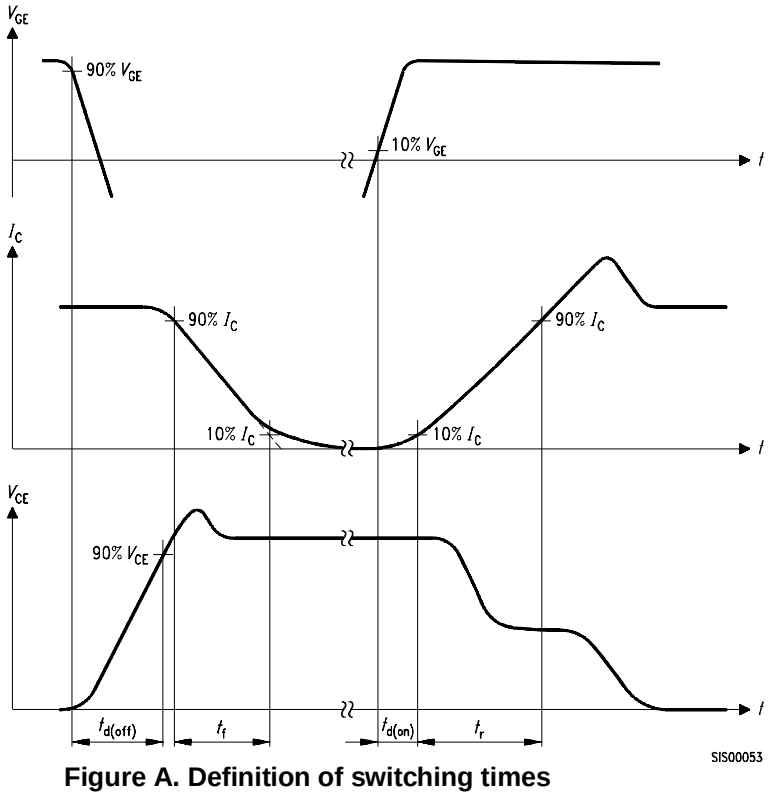


Figure A. Definition of switching times

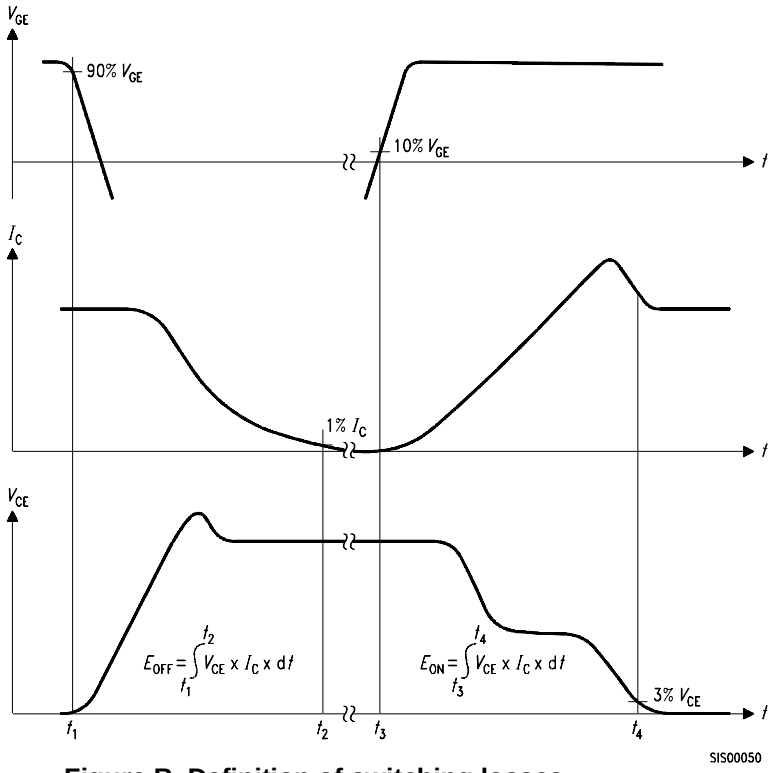


Figure B. Definition of switching losses

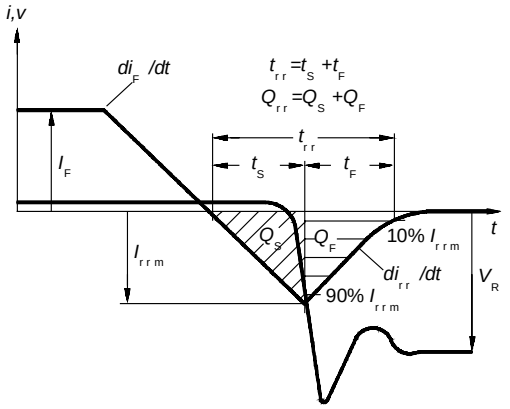


Figure C. Definition of diodes switching characteristics

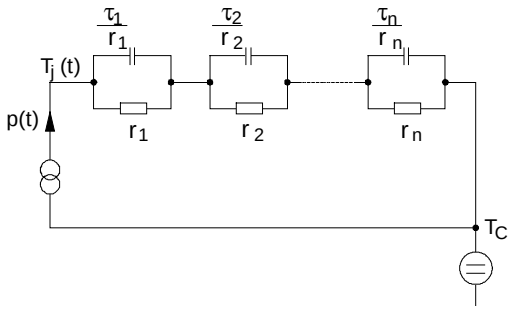


Figure D. Thermal equivalent circuit

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Warnings

Due to technical requirements components may contain dangerous substances. For information on the types in question please contact your nearest Infineon Technologies Office.

Infineon Technologies Components may only be used in life-support devices or systems with the express written approval of Infineon Technologies, if a failure of such components can reasonably be expected to cause the failure of that life-support device or system, or to affect the safety or effectiveness of that device or system. Life support devices or systems are intended to be implanted in the human body, or to support and/or maintain and sustain and/or protect human life. If they fail, it is reasonable to assume that the health of the user or other persons may be endangered.