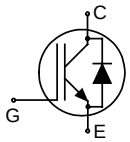
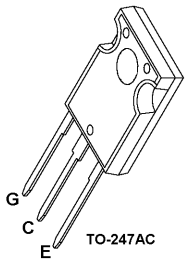
SKW20N60

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





Type	V_{CE}	I_C	$V_{CE(sat)}$	T_j	Package	Ordering Code
SKW20N60	600V	20A	2.4V	150°C	TO-247AC	Q67040-S4242

Maximum Ratings

Parameter	Symbol	Value	Unit
Collector-emitter voltage	V_{CE}	600	V
DC collector current	I_C		A
T_C = 25°C		40	
T_C = 100°C		20	
Pulsed collector current, t_p limited by T_{jmax}	I_{Cpuls}	80	
Turn off safe operating area	-	80	
$V_{CE} \le$ 600V, $T_j \le$ 150°C			
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	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}	179	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}		0.7	K/W
Diode thermal resistance, junction – case	R_{thJCD}		1.3	
Thermal resistance, junction – ambient	R_{thJA}	TO-247AC	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=20A				
		T_j=25°C	1.7	2	2.4	
		T_j=150°C	-	2.4	2.9	
Diode forward voltage	V_F	V_{GE}=0V, I_F=20A				
		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=700µA, 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	-	-	40	
		T_j=150°C	-	-	2500	
Gate-emitter leakage current	I_{GES}	V_{CE}=0V, V_{GE}=20V	-	-	100	nA
Transconductance	g_{fs}	V_{CE}=20V, I_C=20A	-	14	-	S
Dynamic Characteristic						
Input capacitance	C_{iss}	V_{CE}=25V,	-	1100	1320	pF
Output capacitance	C_{oss}	V_{GE}=0V,	-	107	128	
Reverse transfer capacitance	C_{rss}	f=1MHz	-	63	76	
Gate charge	Q_{Gate}	V_{CC}=480V, I_C=20A	-	100	130	nC
		V_{GE}=15V				
Internal emitter inductance measured 5mm (0.197 in.) from case	L_E	TO-247AC	-	13	-	nH
Short circuit collector current[1)]	$I_{C(SC)}$	V_{GE}=15V, t_{SC}≤10µs V_{CC} ≤ 600V, T_j ≤ 150°C	-	200	-	A

[1)] 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,	-	36	46	ns
Rise time	t_r	V_{CC}=400V,I_C=20A,	-	30	36	
Turn-off delay time	$t_{d(off)}$	V_{GE}=0/15V,	-	225	270	
Fall time	t_f	R_G=16Ω,	-	54	65	
Turn-on energy	E_{on}	Energy losses include	-	0.44	0.53	mJ
Turn-off energy	E_{off}	“tail” and diode	-	0.33	0.43	
Total switching energy	E_{ts}	reverse recovery.	-	0.77	0.96	
Anti-Parallel Diode Characteristic						
Diode reverse recovery time	t_{rr}	T_j=25°C,	-	300	-	ns
	t_S	V_R=200V, I_F=20A,	-	30	-	
	t_F	di_F/dt=200A/µs	-	270	-	
Diode reverse recovery charge	Q_{rr}		-	490	-	nC
Diode peak reverse recovery current	I_{rrm}		-	5.5	-	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	-	36	46	ns
Rise time	t_r	V_{CC}=400V,	-	30	36	
Turn-off delay time	$t_{d(off)}$	I_C=20A,	-	250	300	
Fall time	t_f	V_{GE}=0/15V,	-	63	76	
Turn-on energy	E_{on}	R_G=16Ω	-	0.67	0.81	mJ
Turn-off energy	E_{off}	Energy losses include	-	0.49	0.64	
Total switching energy	E_{ts}	“tail” and diode reverse recovery.	-	1.12	1.45	
Anti-Parallel Diode Characteristic						
Diode reverse recovery time	t_{rr}	T_j=150°C	-	410	-	ns
	t_S	V_R=200V, I_F=20A,	-	45	-	
	t_F	di_F/dt=200A/µs	-	365	-	
Diode reverse recovery charge	Q_{rr}		-	1270	-	nC
Diode peak reverse recovery current	I_{rrm}		-	8.5	-	A
Diode peak rate of fall of reverse recovery current during t_b	di_{rr}/dt		-	200	-	A/µs

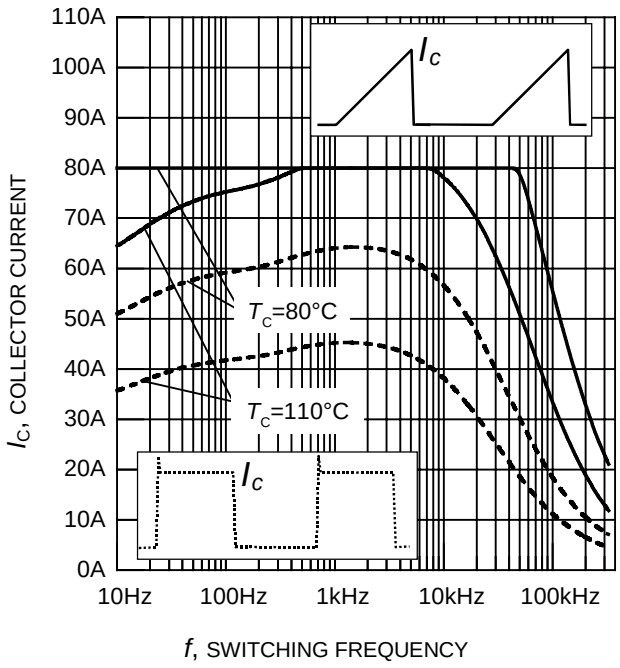


Figure 1. Collector current as a function of switching frequency
($T_j \le 150°C$, $D = 0.5$, $V_{CE} = 400V$, $V_{GE} = 0/+15V$, $R_G = 16\Omega$)

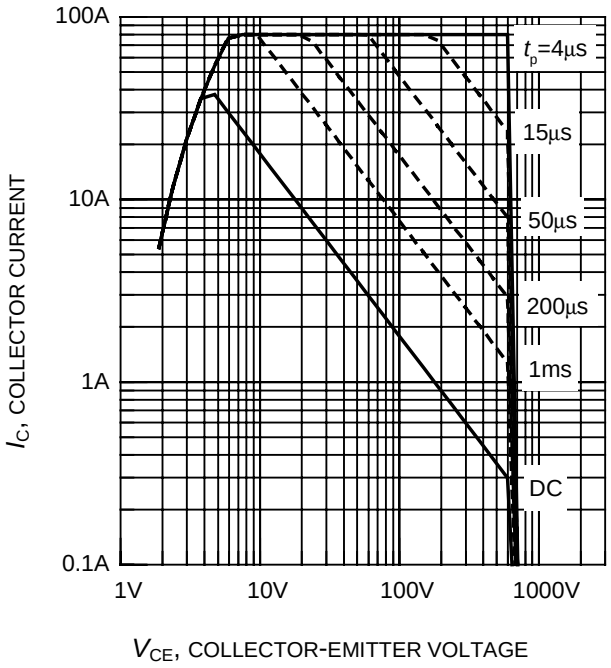


Figure 2. Safe operating area
($D = 0$, $T_C = 25°C$, $T_j \le 150°C$)

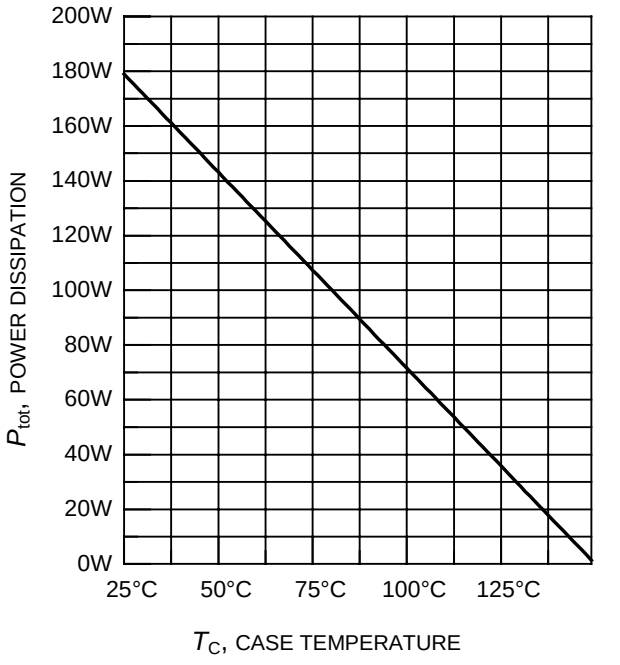


Figure 3. Power dissipation as a function of case temperature
($T_j \le 150°C$)

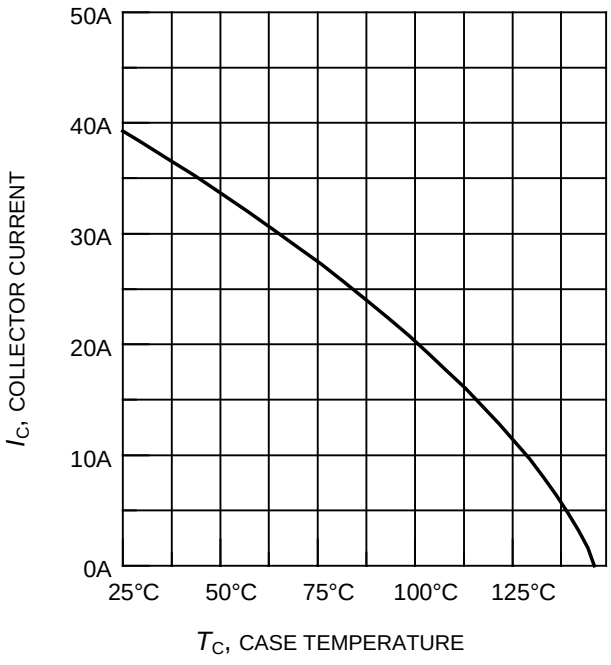


Figure 4. Collector current as a function of case temperature
($V_{GE} \le 15V$, $T_j \le 150°C$)

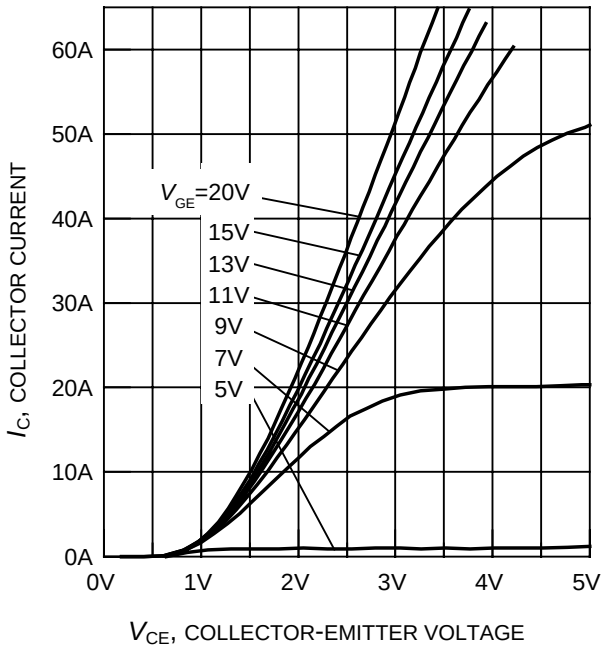


Figure 5. Typical output characteristics
(T_j = 25°C)

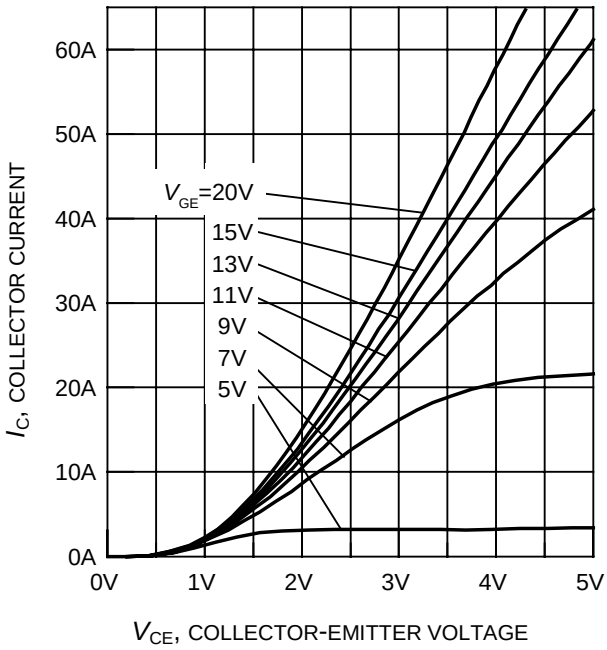


Figure 6. Typical output characteristics
(T_j = 150°C)

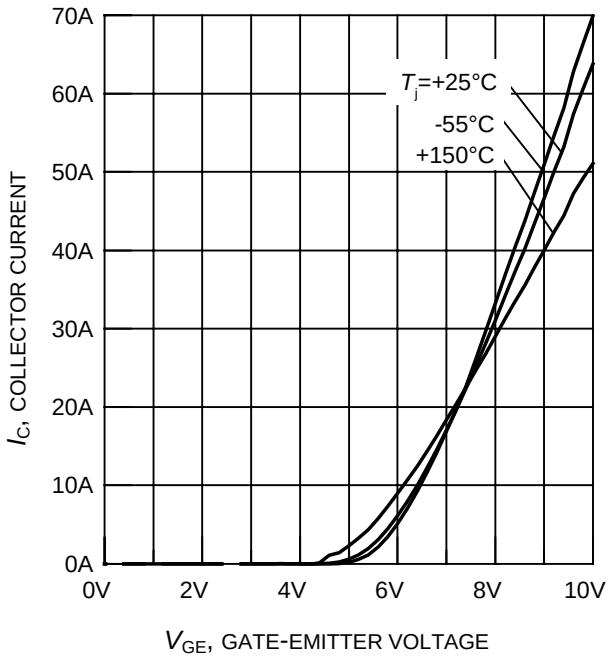


Figure 7. Typical transfer characteristics
(V_{CE} = 10V)

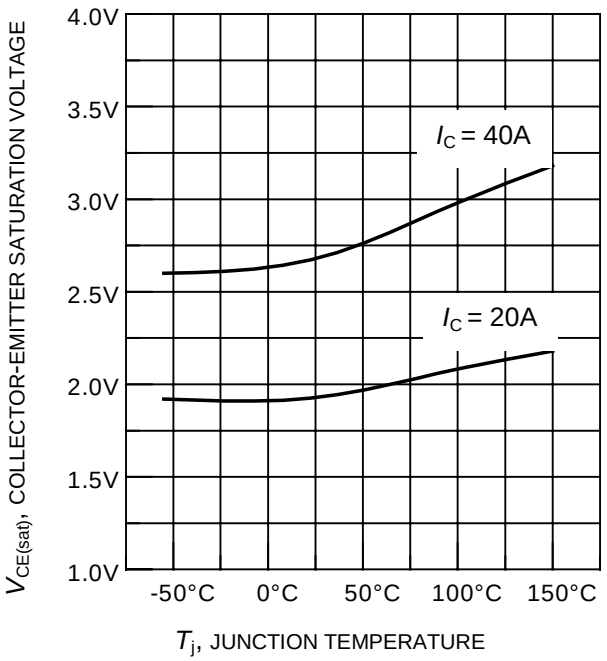


Figure 8. Typical collector-emitter saturation voltage as a function of junction temperature
(V_{GE} = 15V)

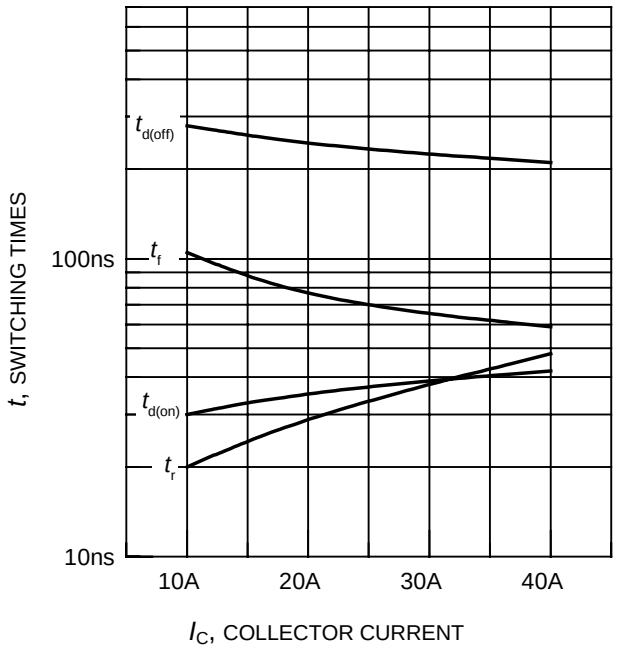


Figure 9. Typical switching times as a function of collector current
(inductive load, T_j = 150°C, V_{CE} = 400V, V_{GE} = 0/+15V, R_G = 16Ω)

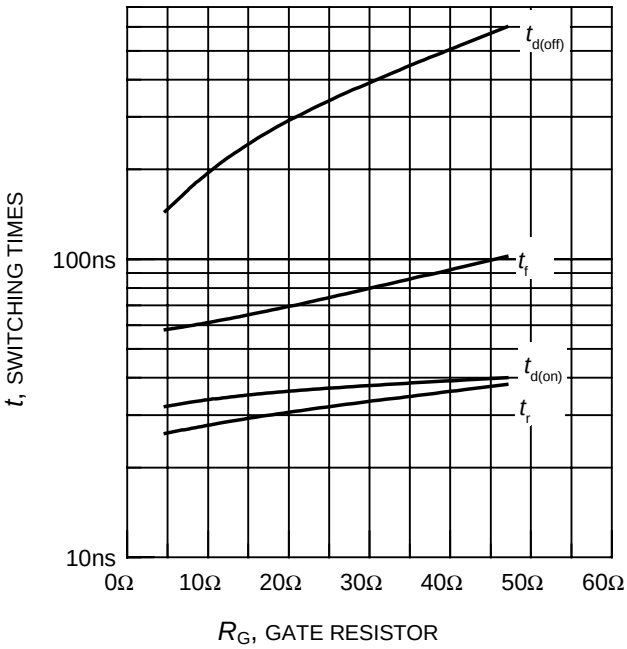


Figure 10. Typical switching times as a function of gate resistor
(inductive load, T_j = 150°C, V_{CE} = 400V, V_{GE} = 0/+15V, I_C = 20A)

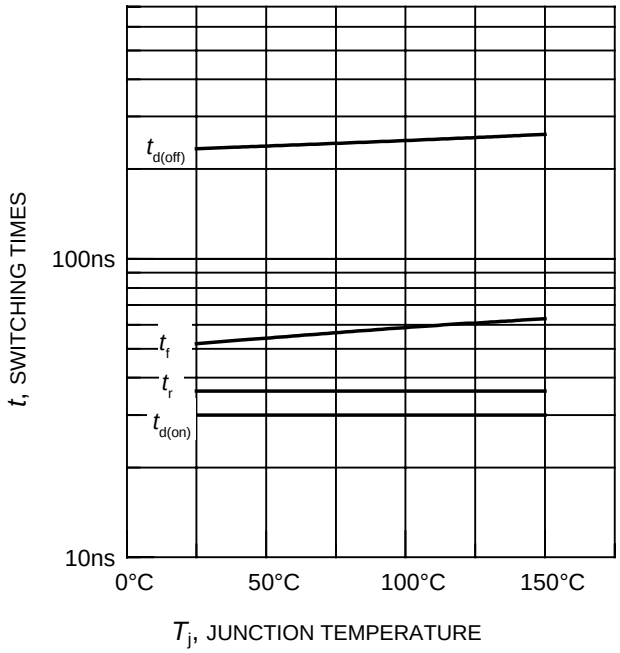


Figure 11. Typical switching times as a function of junction temperature
(inductive load, V_{CE} = 400V, V_{GE} = 0/+15V, I_C = 20A, R_G = 16Ω)

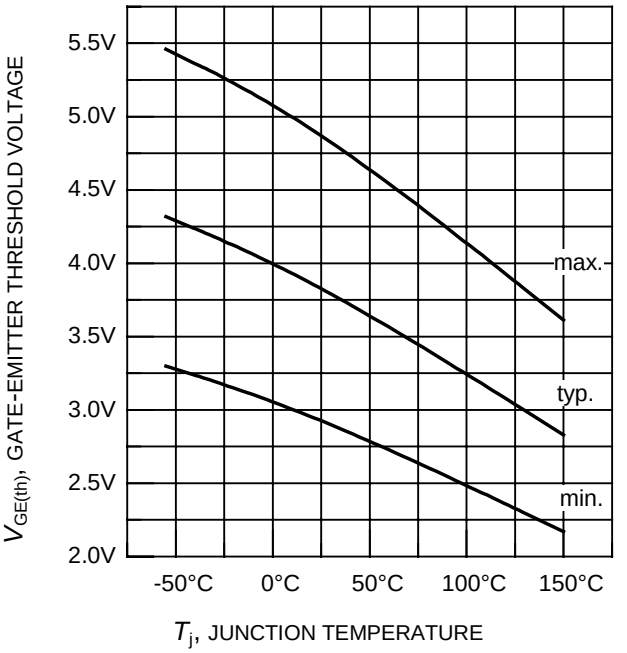


Figure 12. Gate-emitter threshold voltage as a function of junction temperature
(I_C = 0.7mA)

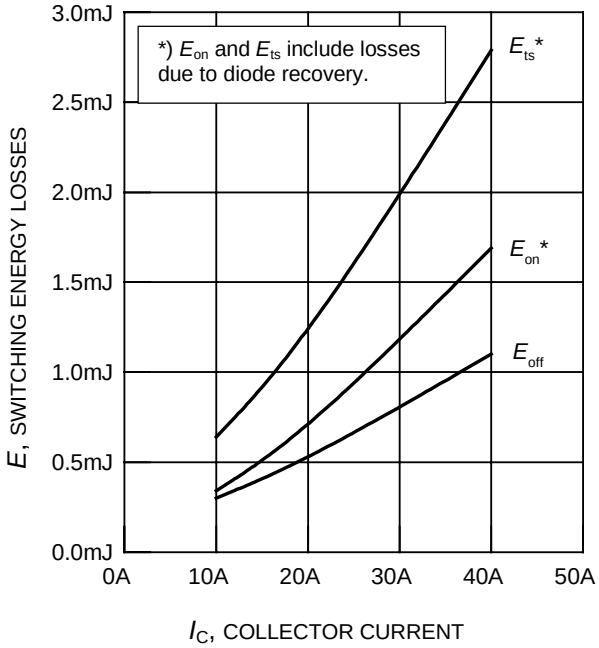


Figure 13. Typical switching energy losses as a function of collector current
(inductive load, T_j = 150°C, V_{CE} = 400V, V_{GE} = 0/+15V, R_G = 16Ω)

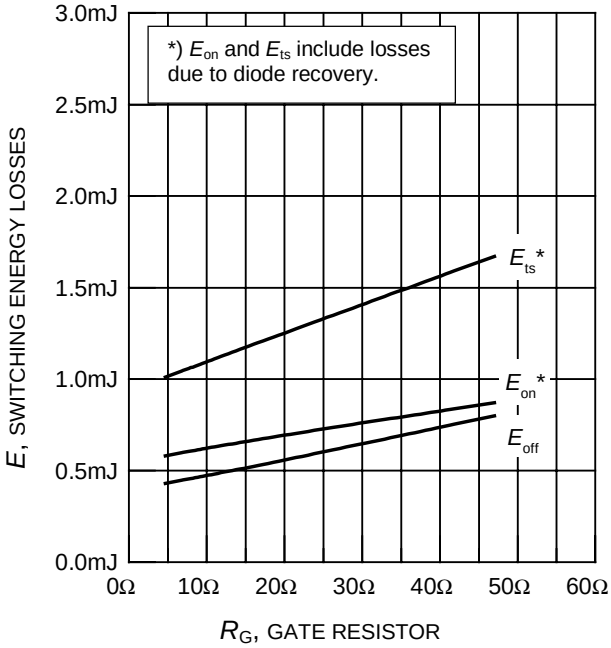


Figure 14. Typical switching energy losses as a function of gate resistor
(inductive load, T_j = 150°C, V_{CE} = 400V, V_{GE} = 0/+15V, I_C = 20A)

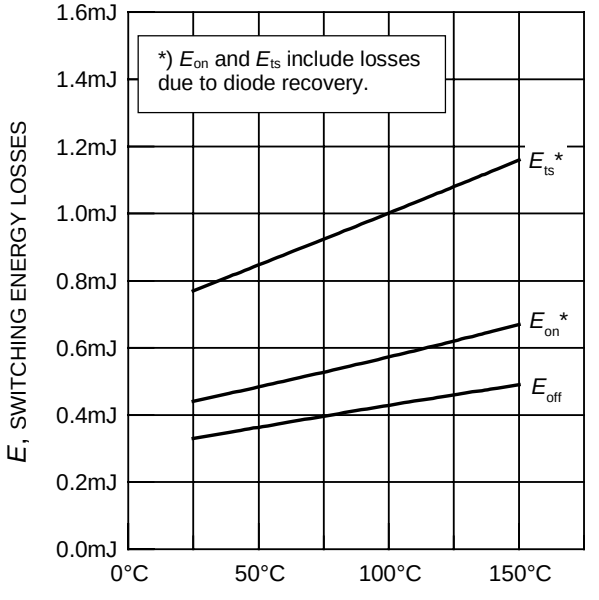


Figure 15. Typical switching energy losses as a function of junction temperature
(inductive load, V_{CE} = 400V, V_{GE} = 0/+15V, I_C = 20A, R_G = 16Ω)

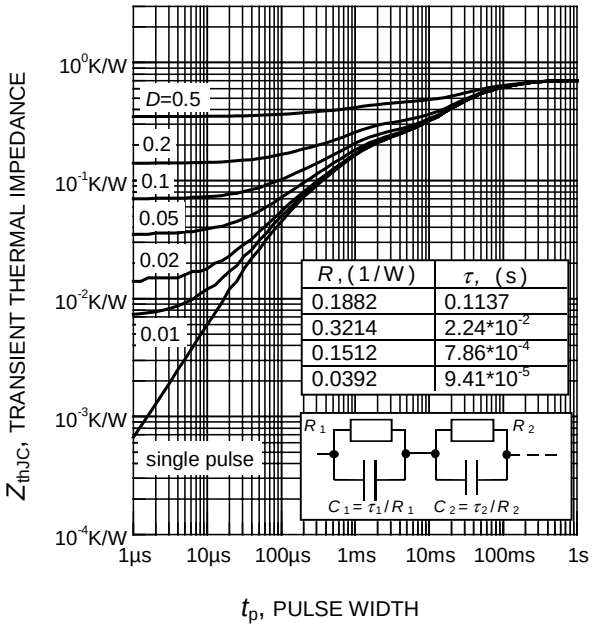


Figure 16. IGBT transient thermal impedance as a function of pulse width
($D = t_p / T$)

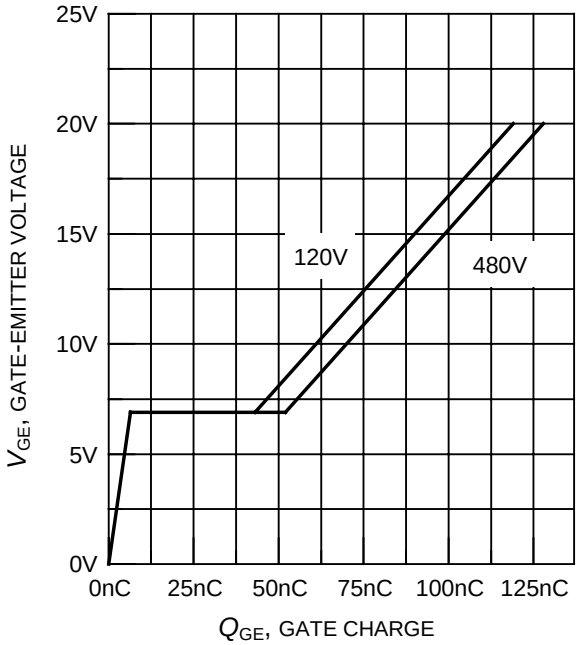


Figure 17. Typical gate charge
(I_C = 20A)

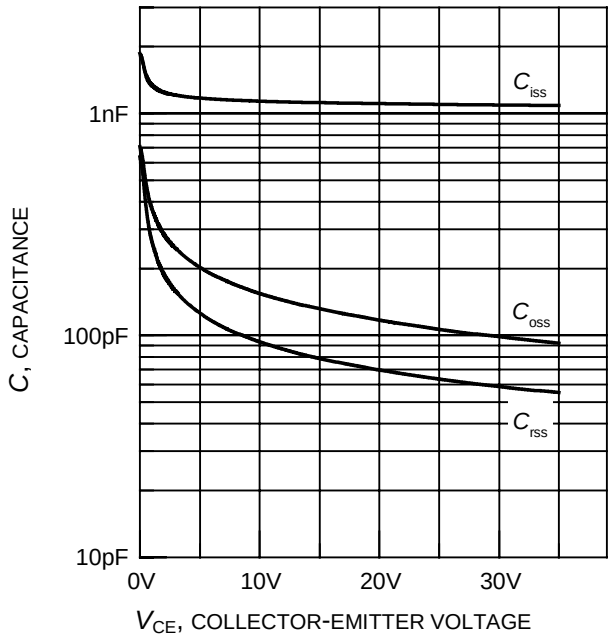


Figure 18. Typical capacitance as a function of collector-emitter voltage
(V_{GE} = 0V, f = 1MHz)

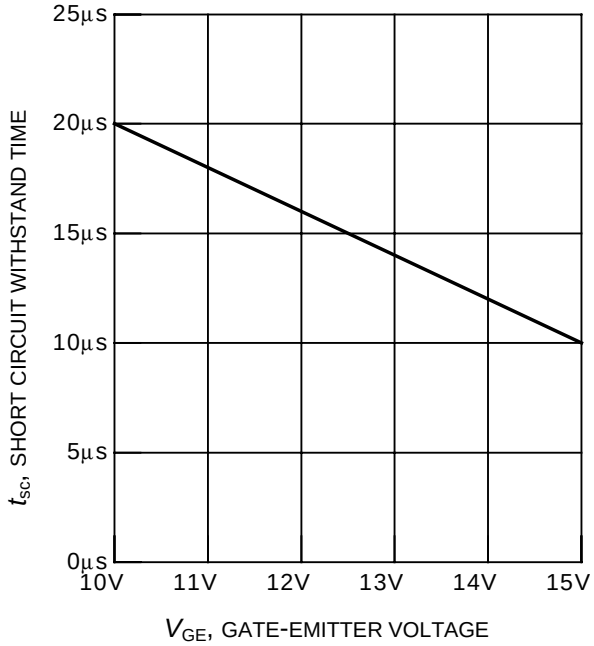


Figure 19. Short circuit withstand time as a function of gate-emitter voltage
(V_{CE} = 600V, start at T_j = 25°C)

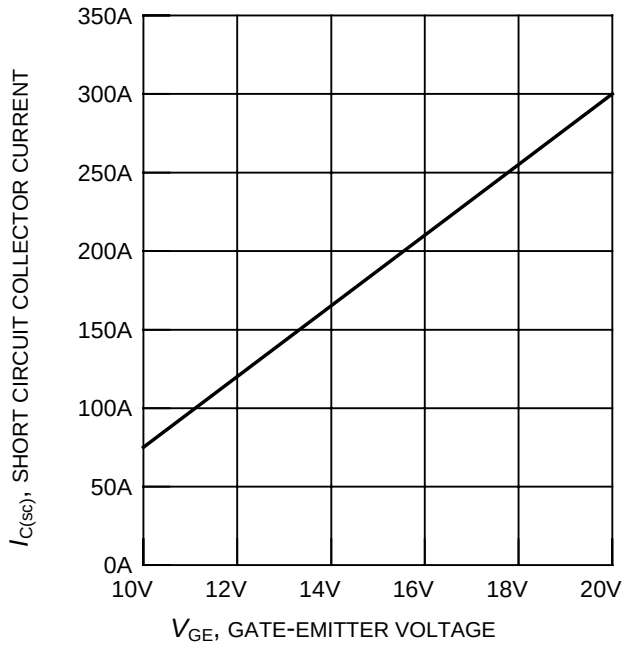


Figure 20. Typical short circuit collector current as a function of gate-emitter voltage
($V_{CE} \le$ 600V, T_j = 150°C)

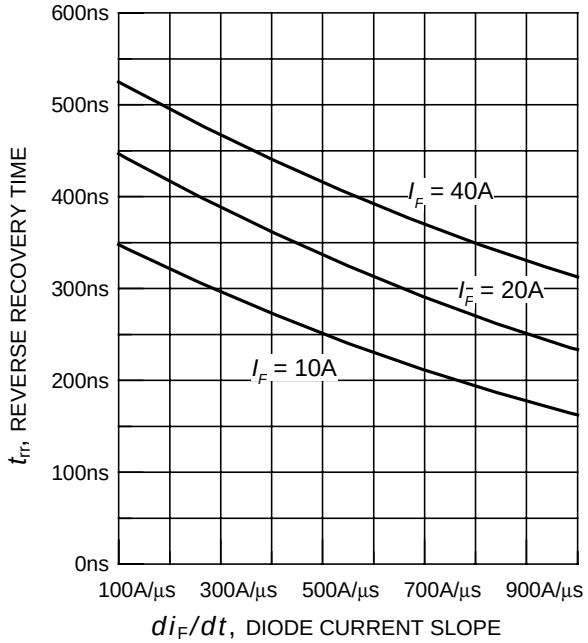


Figure 21. Typical reverse recovery time as a function of diode current slope
(V_R = 200V, T_j = 125°C)

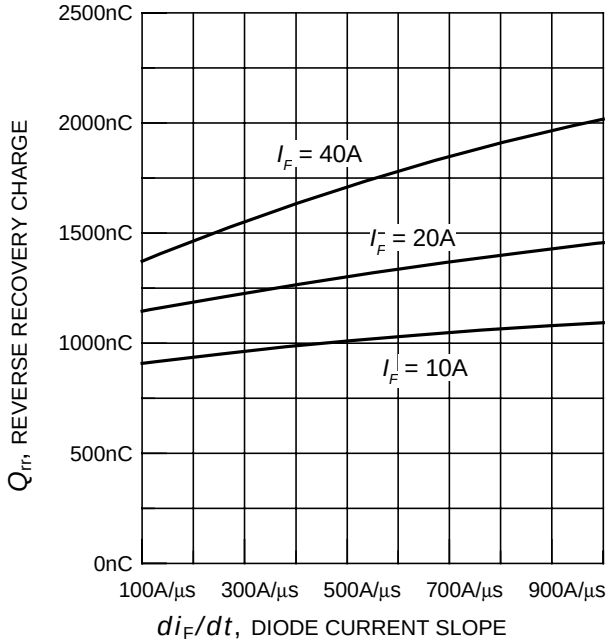


Figure 22. Typical reverse recovery charge as a function of diode current slope
(V_R = 200V, T_j = 125°C)

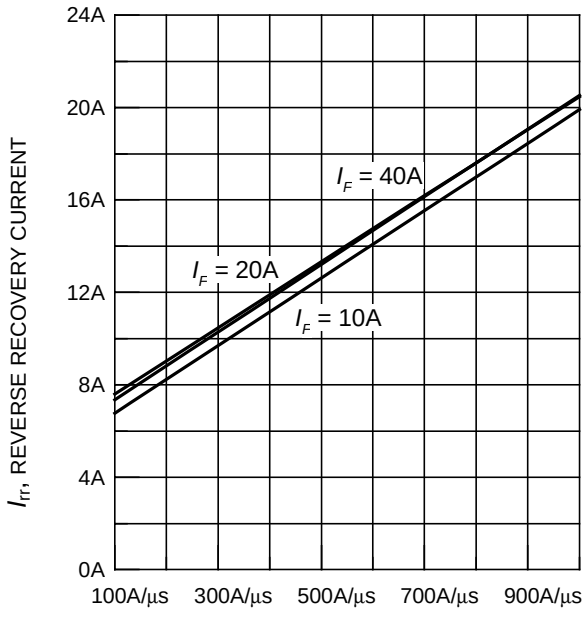


Figure 23. Typical reverse recovery current as a function of diode current slope
(V_R = 200V, T_j = 125°C)

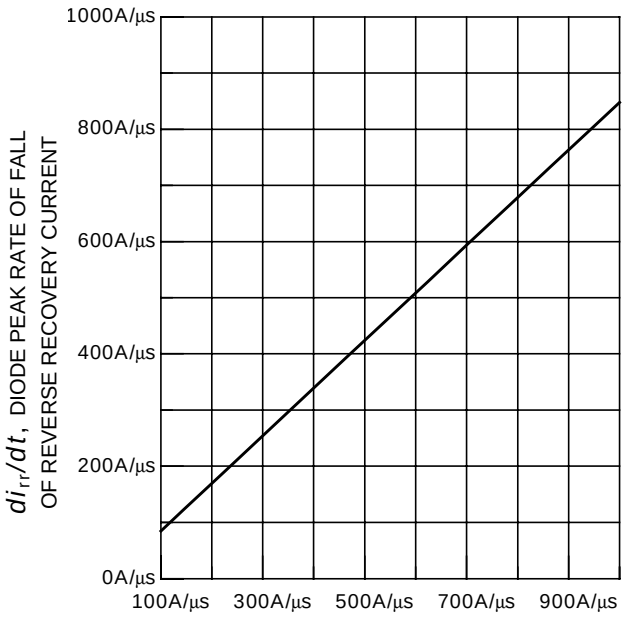


Figure 24. Typical diode peak rate of fall of reverse recovery current as a function of diode current slope
(V_R = 200V, T_j = 125°C)

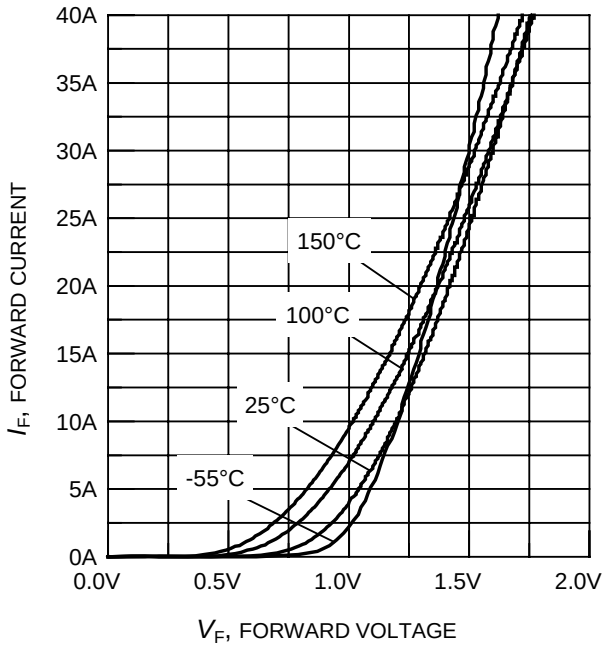


Figure 25. Typical diode forward current as a function of forward voltage

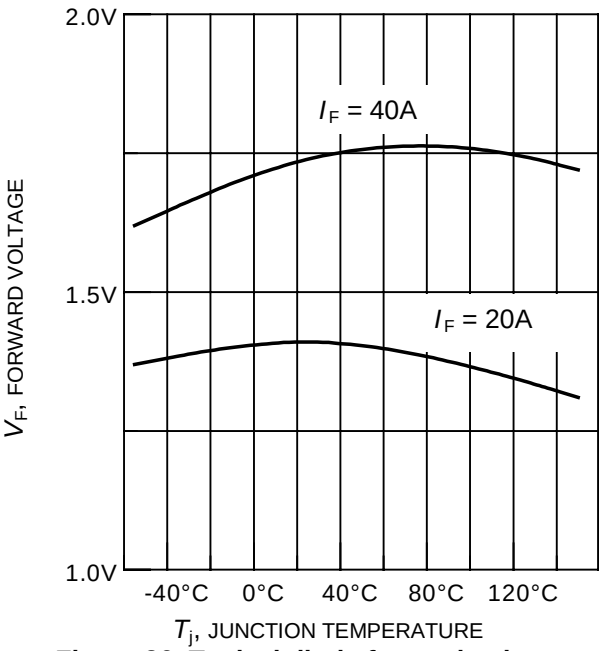


Figure 26. Typical diode forward voltage as a function of junction temperature

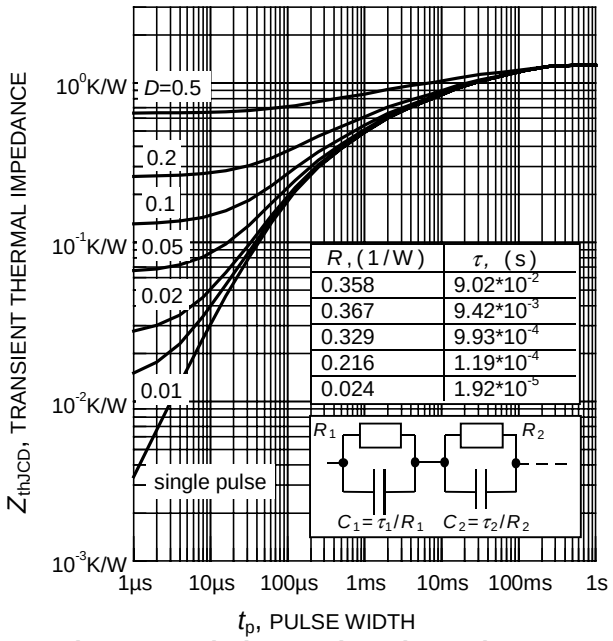
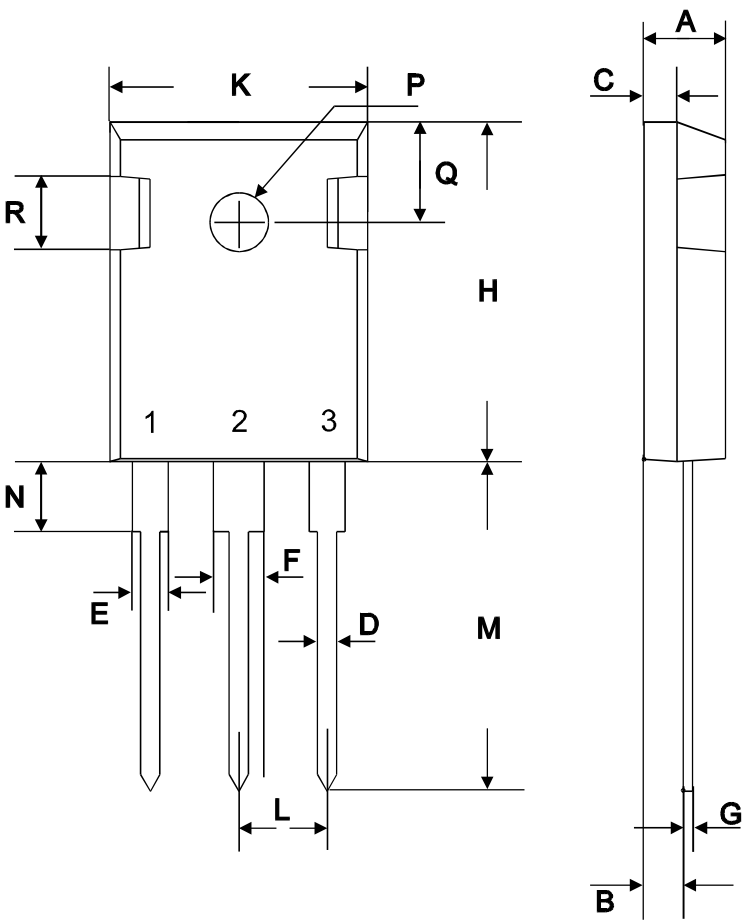


Figure 27. Diode transient thermal impedance as a function of pulse width
($D = t_p / T$)

TO-247AC



symbol	dimensions			
	[mm]		[inch]	
	min	max	min	max
A	4.78	5.28	0.1882	0.2079
B	2.29	2.51	0.0902	0.0988
C	1.78	2.29	0.0701	0.0902
D	1.09	1.32	0.0429	0.0520
E	1.73	2.06	0.0681	0.0811
F	2.67	3.18	0.1051	0.1252
G	0.76 max		0.0299 max	
H	20.80	21.16	0.8189	0.8331
K	15.65	16.15	0.6161	0.6358
L	5.21	5.72	0.2051	0.2252
M	19.81	20.68	0.7799	0.8142
N	3.560	4.930	0.1402	0.1941
∅P	3.61		0.1421	
Q	6.12	6.22	0.2409	0.2449

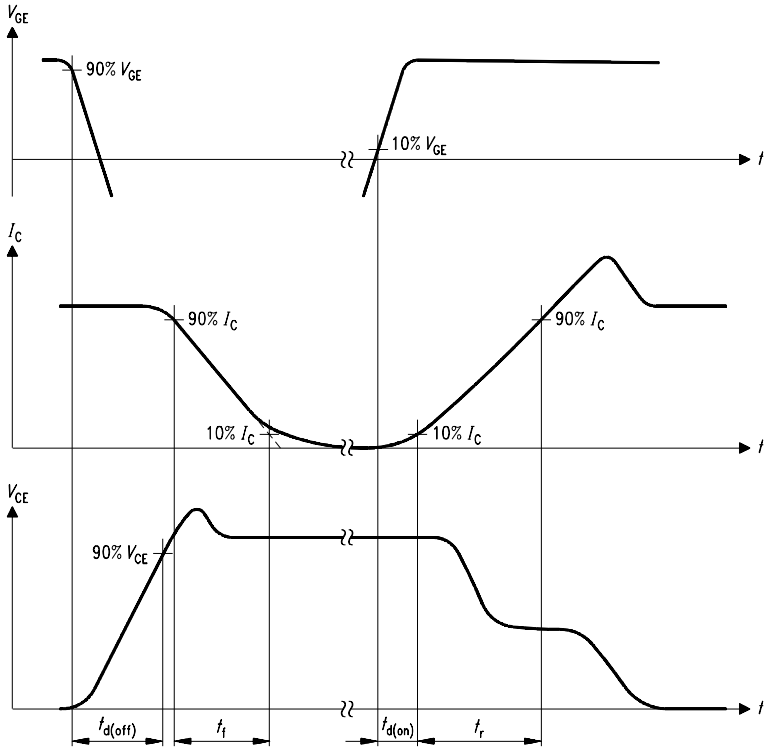


Figure A. Definition of switching times

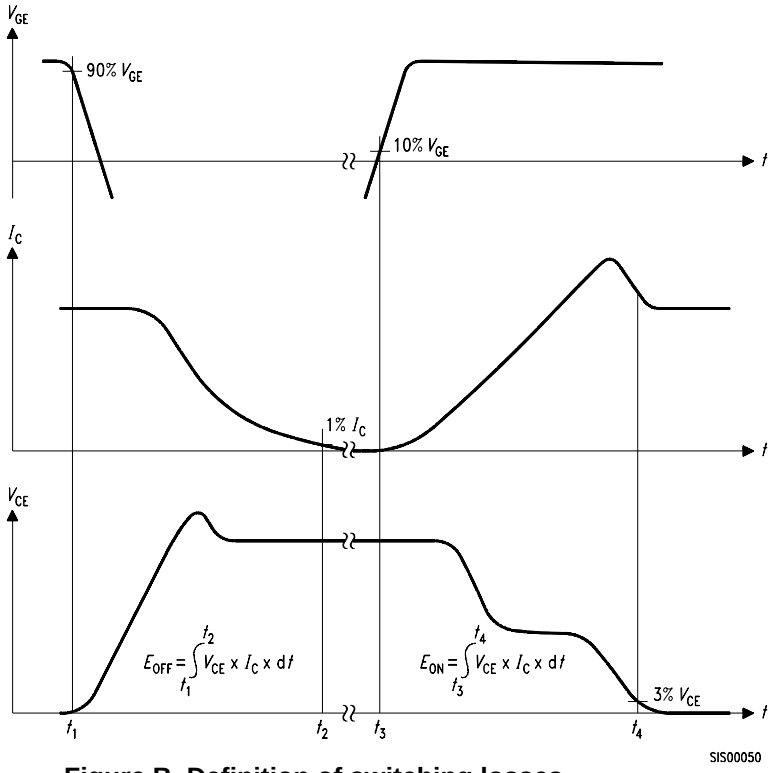


Figure B. Definition of switching losses

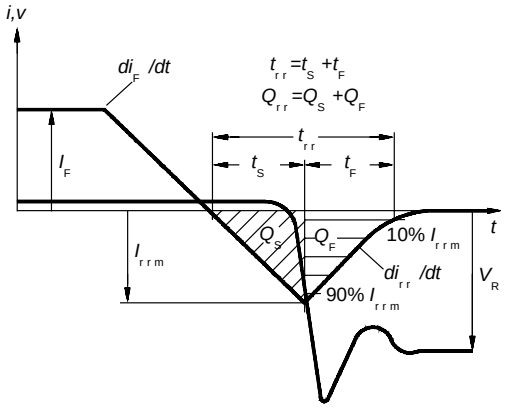


Figure C. Definition of diodes switching characteristics

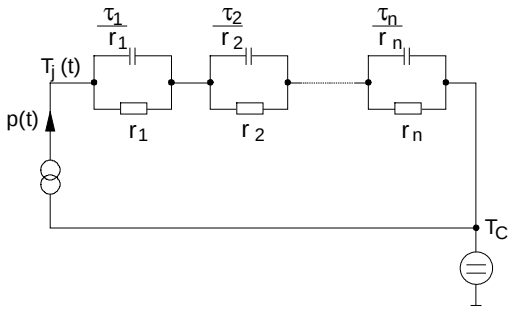


Figure D. Thermal equivalent circuit

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