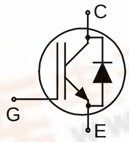
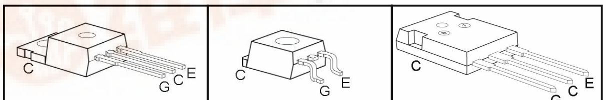
SKP15N60, SKB15N60 SKW15N60

Fast 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





P-TO-220-3-1 (TO-220AB) | P-TO-263-3-2 (D²-PAK) (TO-263AB) | P-TO-247-3-1 (TO-247AC)

- Complete product spectrum and PSpice Models : http://www.infineon.com/igbt/

Type	V_{CE}	I_C	$V_{CE(sat)}$	T_j	Package	Ordering Code
SKP15N60	600V	15A	2.3V	150°C	TO-220AB	Q67040-S4251
SKB15N60					TO-263AB	Q67040-S4252
SKW15N60					TO-247AC	Q67040-S4243

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	 31 15	A
Pulsed collector current, t_p limited by T_{jmax}	I_{Cpuls}	62	
Turn off safe operating area $V_{CE} \leq$ 600V, $T_j \leq$ 150°C	-	62	
Diode forward current T_C = 25°C T_C = 100°C	I_F	 31 15	
Diode pulsed current, t_p limited by T_{jmax}	I_{Fpuls}	62	
Gate-emitter voltage	V_{GE}	±20	V
Short circuit withstand time[1)] V_{GE} = 15V, $V_{CC} \leq$ 600V, $T_j \leq$ 150°C	t_{SC}	10	µs
Power dissipation T_C = 25°C	P_{tot}	139	W
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}		0.9	K/W
Diode thermal resistance, junction – case	R_{thJCD}		1.7	
Thermal resistance, junction – ambient	R_{thJA}	TO-220AB TO-247AC	62 40	
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	 1.7 -	 2 2.3	 2.4 2.8	
Diode forward voltage	V_F	V_{GE}=0V, I_F=15A 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=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	3	10.9	-	S
Dynamic Characteristic						
Input capacitance	C_{iss}	V_{CE}=25V,	-	800	960	pF
Output capacitance	C_{oss}	V_{GE}=0V,	-	84	101	
Reverse transfer capacitance	C_{rss}	f=1MHz	-	52	62	
Gate charge	Q_{Gate}	V_{CC}=480V, I_C=15A V_{GE}=15V	-	76	99	nC
Internal emitter inductance measured 5mm (0.197 in.) from case	L_E	TO-220AB TO-247AC	- -	7 13	- -	nH
Short circuit collector current[2)]	$I_{C(SC)}$	V_{GE}=15V,t_{SC}≤10µs V_{CC} ≤ 600V, T_j ≤ 150°C	-	150	-	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 min.	Value typ.	Value max.	Unit
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=21Ω, L_σ 1) =180nH, C_σ 1) =250pF Energy losses include "tail" and diode reverse recovery.	-	32	38	ns
Rise time	t_r		-	23	28	
Turn-off delay time	$t_{d(off)}$		-	234	281	
Fall time	t_f		-	46	55	
Turn-on energy	E_{on}		-	0.30	0.36	mJ
Turn-off energy	E_{off}		-	0.27	0.35	
Total switching energy	E_{ts}		-	0.57	0.71	
Anti-Parallel Diode Characteristic						
Diode reverse recovery time	t_{rr} t_S t_F	T_j=25°C, V_R=200V, I_F=15A, di_F/dt=200A/µs	- - -	279 28 254	- - -	ns
Diode reverse recovery charge	Q_{rr}		-	390	-	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		-	180	-	A/µs

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

Parameter	Symbol	Conditions	Value min.	Value typ.	Value max.	Unit
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=21Ω, L_σ 1) =180nH, C_σ 1) =250pF Energy losses include "tail" and diode reverse recovery.	-	31	38	ns
Rise time	t_r		-	23	28	
Turn-off delay time	$t_{d(off)}$		-	261	313	
Fall time	t_f		-	54	65	
Turn-on energy	E_{on}		-	0.45	0.54	mJ
Turn-off energy	E_{off}		-	0.41	0.53	
Total switching energy	E_{ts}		-	0.86	1.07	
Anti-Parallel Diode Characteristic						
Diode reverse recovery time	t_{rr} t_S t_F	T_j=150°C V_R=200V, I_F=15A, di_F/dt=200A/µs	- - -	360 40 320	- - -	ns
Diode reverse recovery charge	Q_{rr}		-	1020	-	nC
Diode peak reverse recovery current	I_{rrm}		-	7.5	-	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.

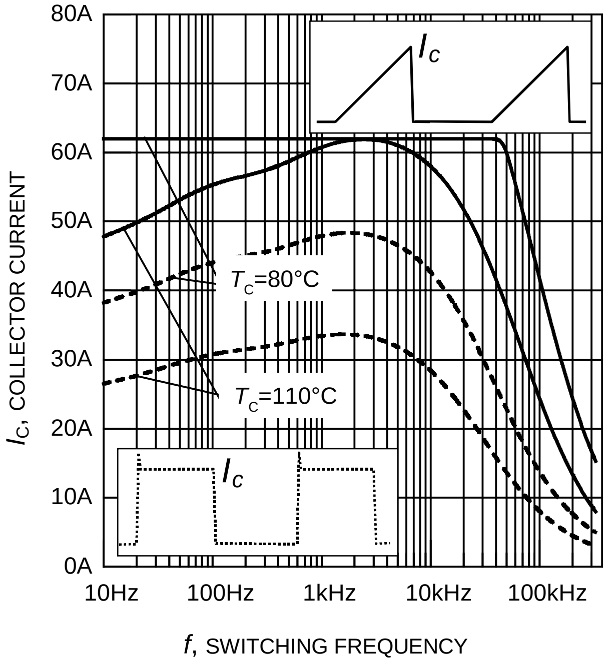


Figure 1. Collector current as a function of switching frequency
($T_j \leq 150°C$, $D = 0.5$, $V_{CE} = 400V$, $V_{GE} = 0/+15V$, $R_G = 21\Omega$)

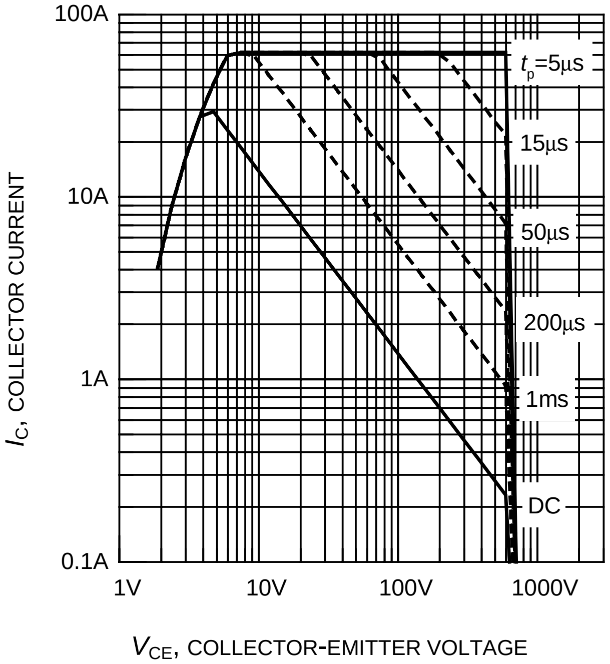


Figure 2. Safe operating area
($D = 0$, $T_C = 25°C$, $T_j \leq 150°C$)

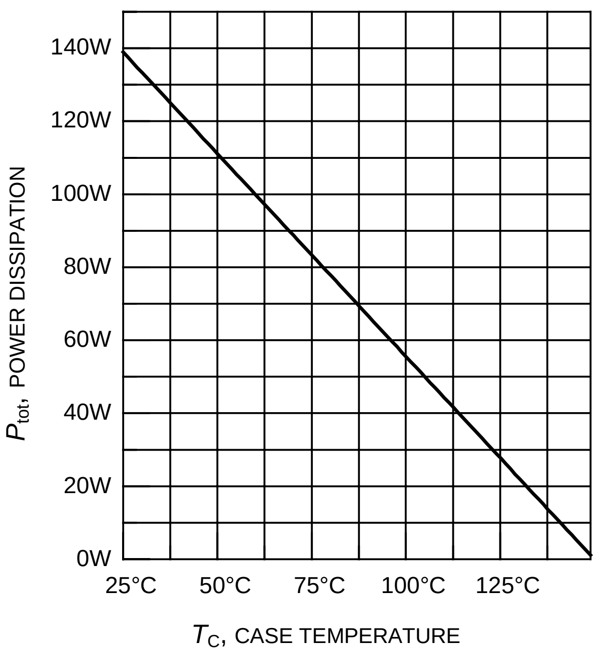


Figure 3. Power dissipation as a function of case temperature
($T_j \leq 150°C$)

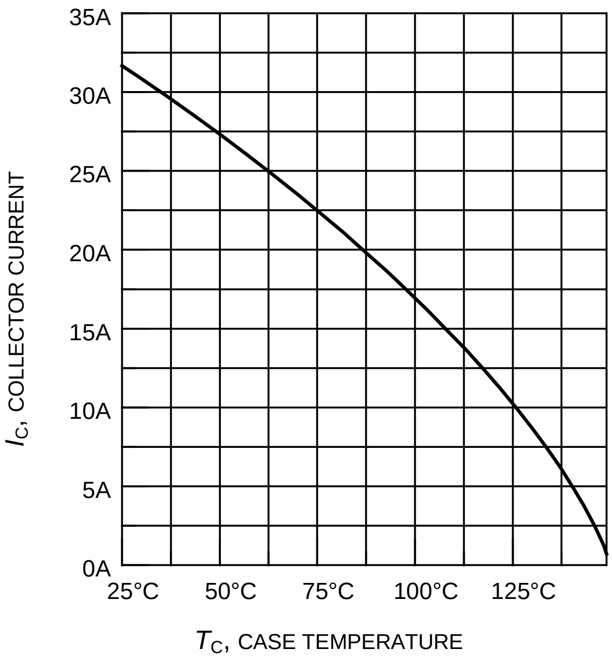


Figure 4. Collector current as a function of case temperature
($V_{GE} \leq 15V$, $T_j \leq 150°C$)

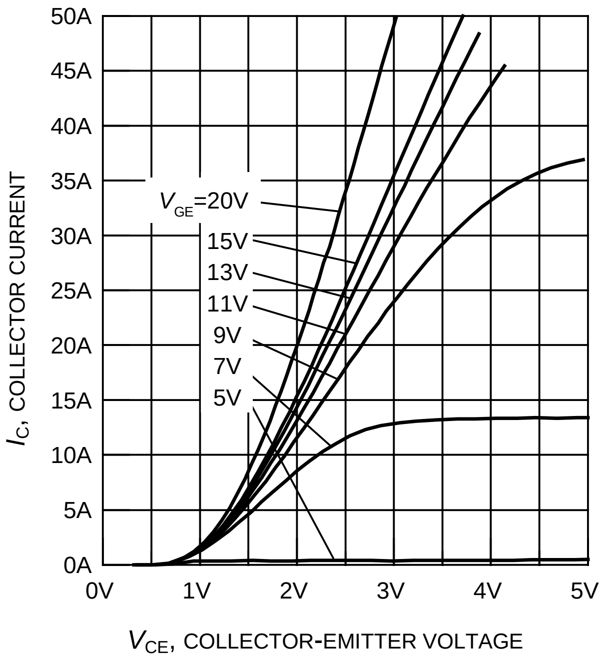


Figure 5. Typical output characteristics
(T_j = 25°C)

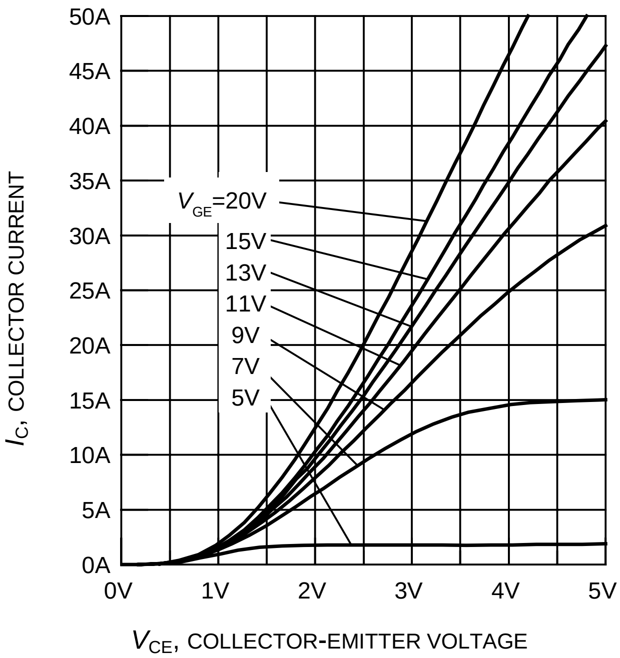


Figure 6. Typical output characteristics
(T_j = 150°C)

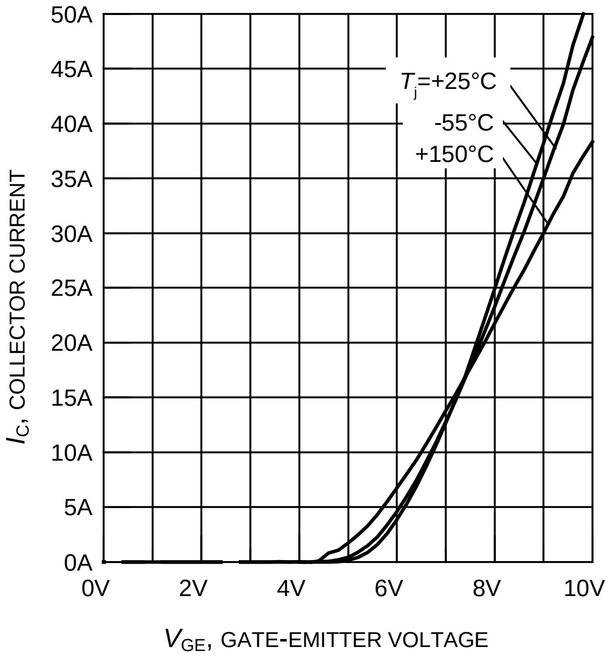


Figure 7. Typical transfer characteristics
(V_{CE} = 10V)

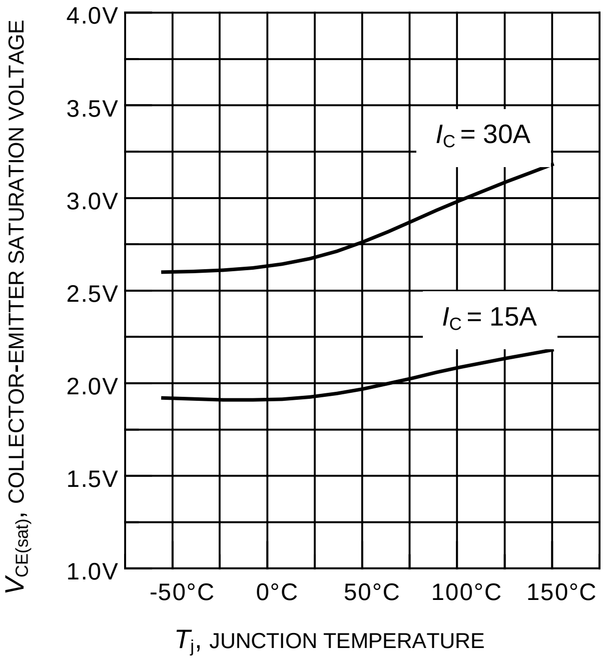


Figure 8. Typical collector-emitter saturation voltage as a function of junction temperature
(V_{GE} = 15V)

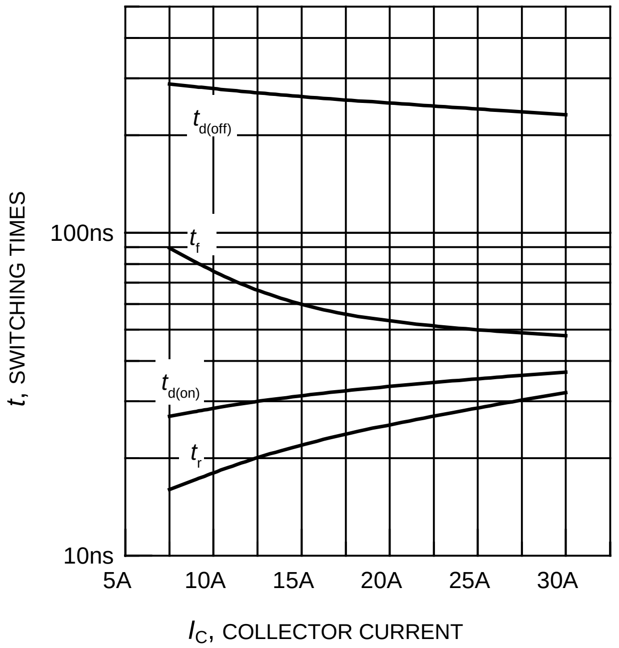


Figure 9. Typical switching times as a function of collector current
(inductive load, T_j = 150°C, V_{CE} = 400V, V_{GE} = 0/+15V, R_G = 21Ω, Dynamic test circuit in Figure E)

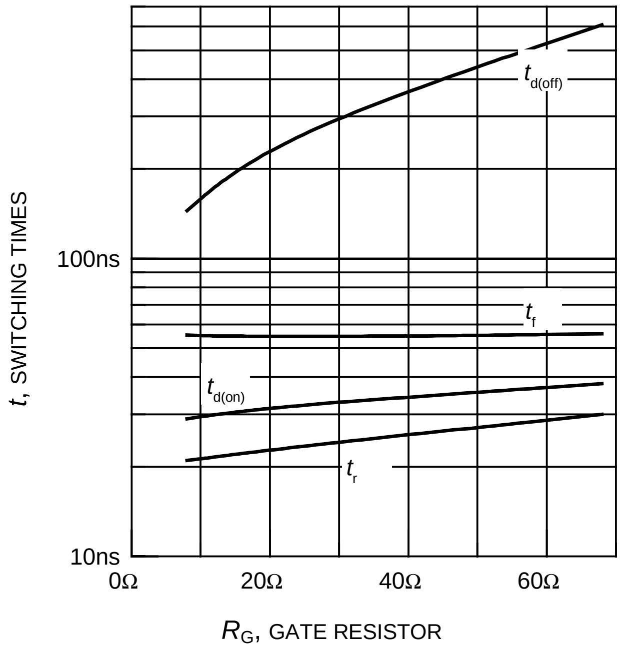


Figure 10. Typical switching times as a function of gate resistor
(inductive load, T_j = 150°C, V_{CE} = 400V, V_{GE} = 0/+15V, I_C = 15A, Dynamic test circuit in Figure E)

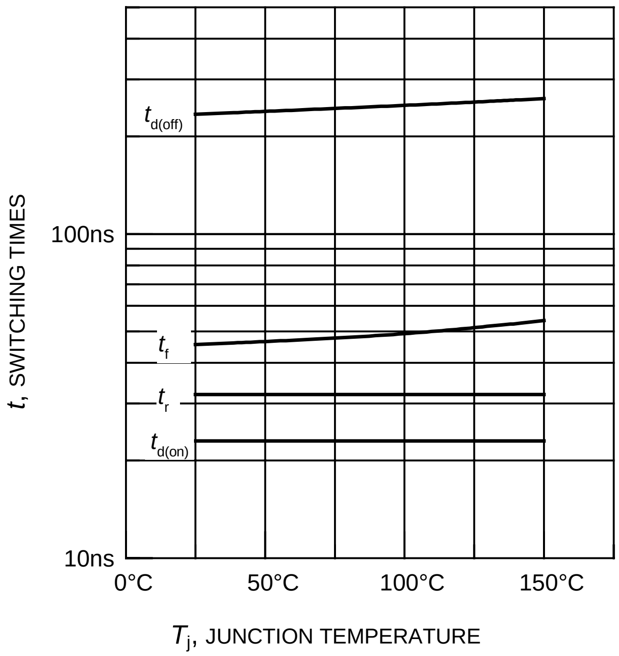


Figure 11. Typical switching times as a function of junction temperature
(inductive load, V_{CE} = 400V, V_{GE} = 0/+15V, I_C = 15A, R_G = 21Ω, Dynamic test circuit in Figure E)

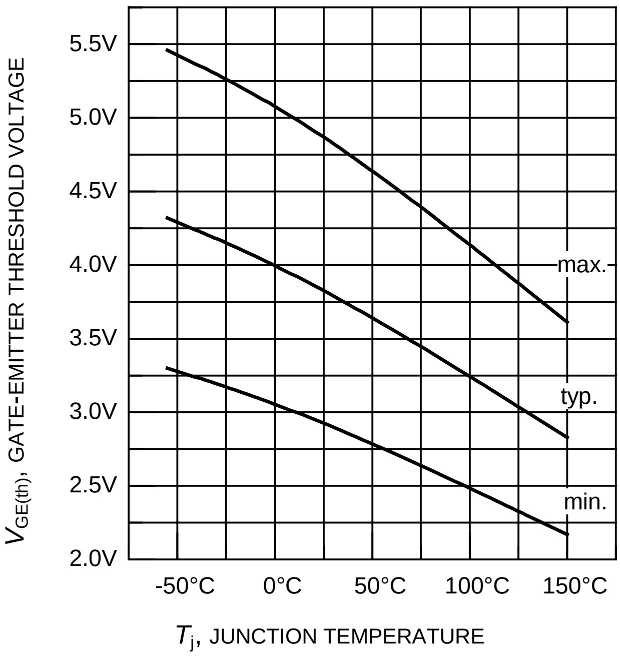


Figure 12. Gate-emitter threshold voltage as a function of junction temperature
(I_C = 0.4mA)

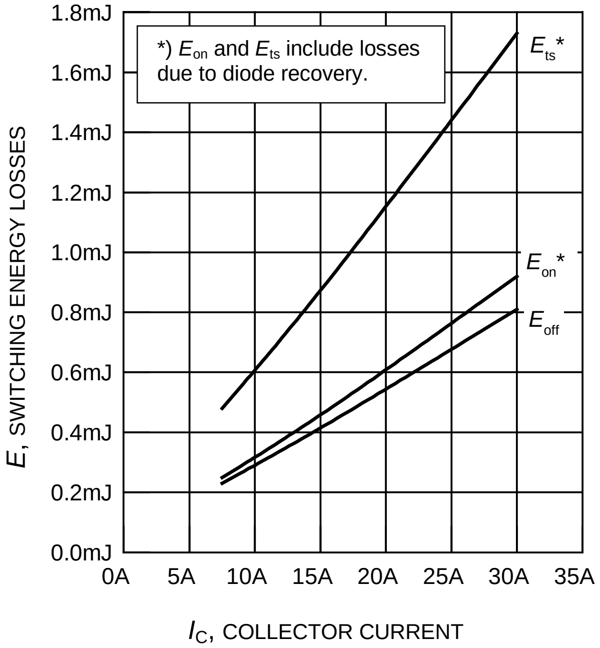


Figure 13. Typical switching energy losses as a function of collector current
(inductive load, T_j = 150°C, V_{CE} = 400V, V_{GE} = 0/+15V, R_G = 21Ω, Dynamic test circuit in Figure E)

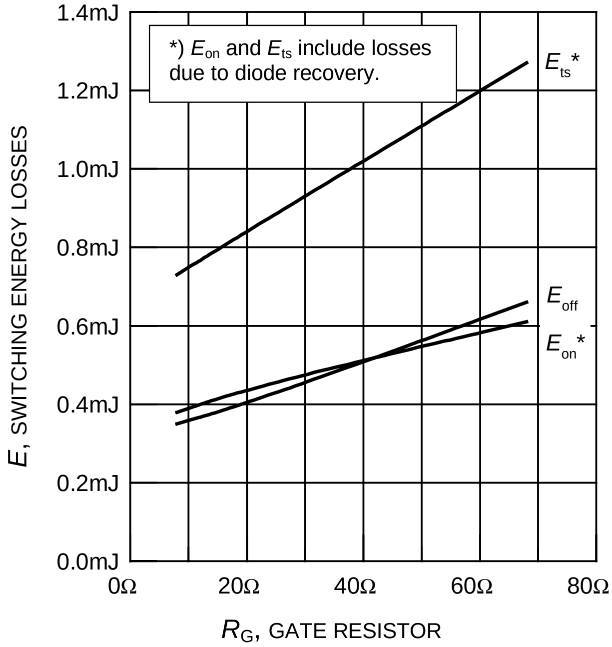


Figure 14. Typical switching energy losses as a function of gate resistor
(inductive load, T_j = 150°C, V_{CE} = 400V, V_{GE} = 0/+15V, I_C = 15A, Dynamic test circuit in Figure E)

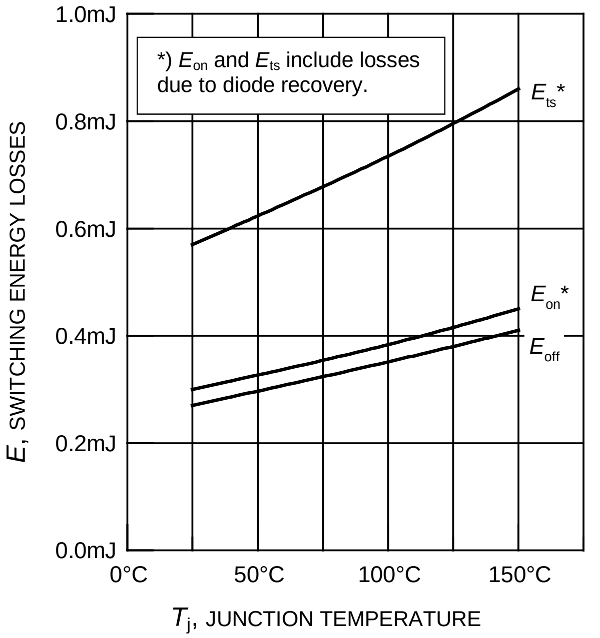


Figure 15. Typical switching energy losses as a function of junction temperature
(inductive load, V_{CE} = 400V, V_{GE} = 0/+15V, I_C = 15A, R_G = 21Ω, Dynamic test circuit in Figure E)

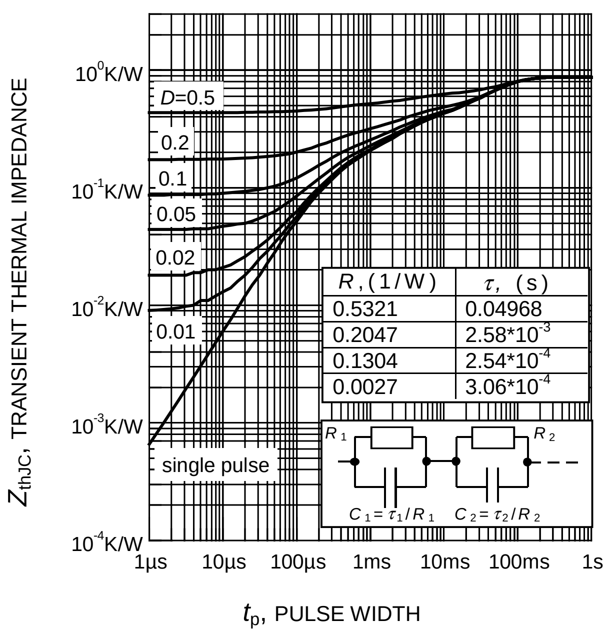


Figure 16. IGBT transient thermal impedance as a function of pulse width
($D = t_p / T$)

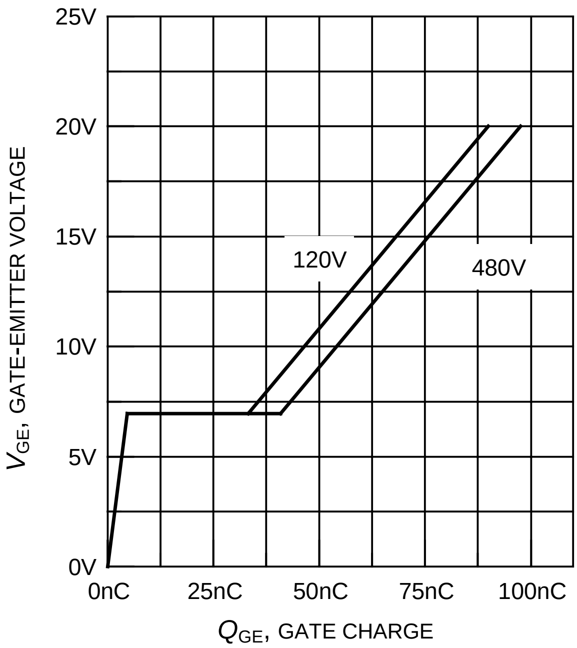


Figure 17. Typical gate charge
(I_C = 15A)

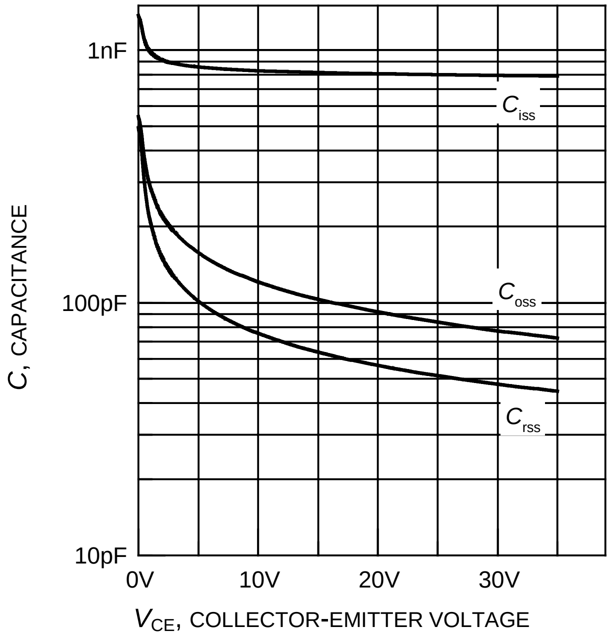


Figure 18. Typical capacitance as a function of collector-emitter voltage
(V_{GE} = 0V, f = 1MHz)

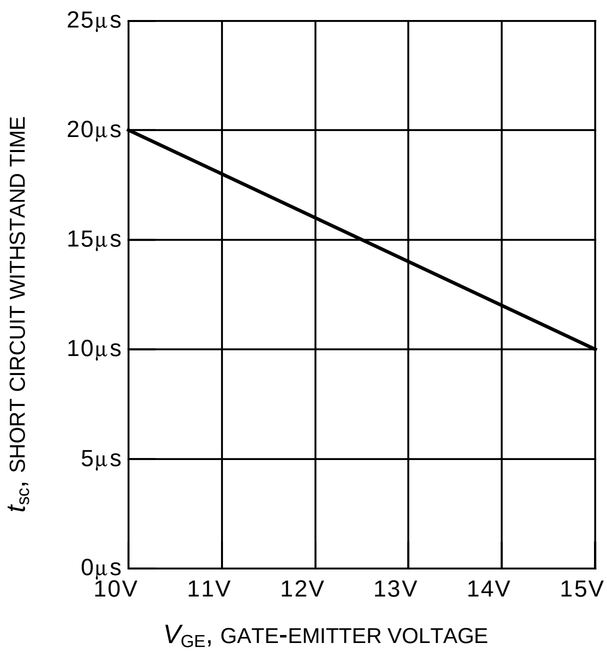


Figure 19. Short circuit withstand time as a function of gate-emitter voltage
(V_{CE} = 600V, start at T_j = 25°C)

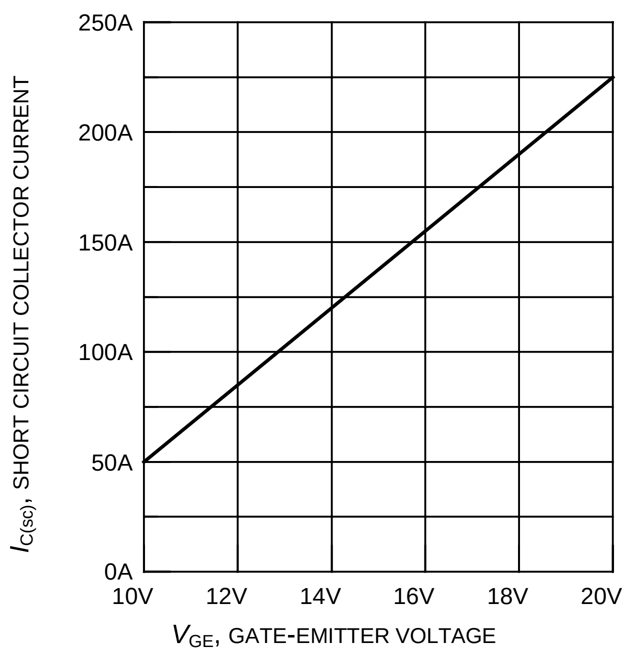


Figure 20. Typical short circuit collector current as a function of gate-emitter voltage
($V_{CE} \leq$ 600V, T_j = 150°C)

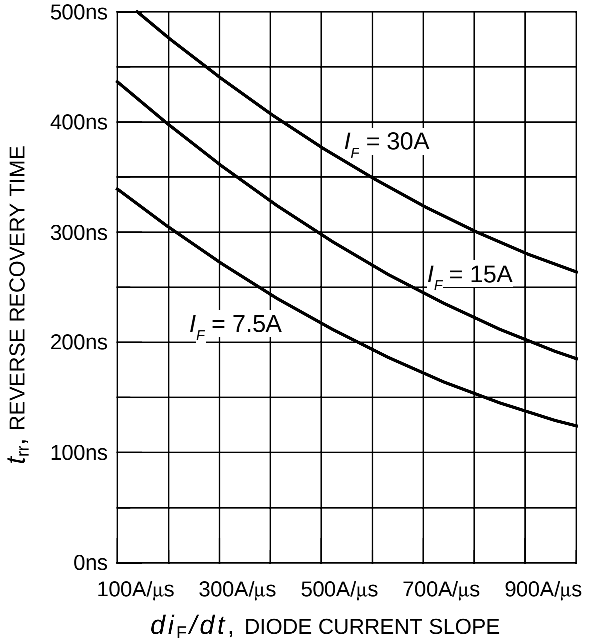


Figure 21. Typical reverse recovery time as a function of diode current slope
(V_R = 200V, T_j = 125°C,
Dynamic test circuit in Figure E)

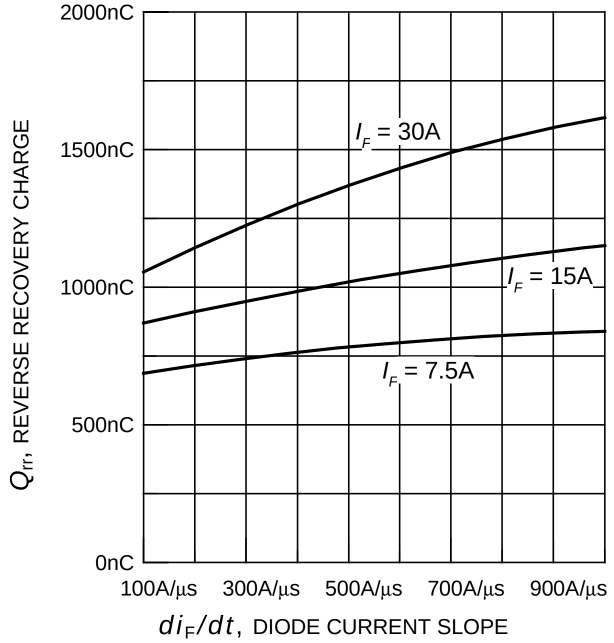


Figure 22. Typical reverse recovery charge as a function of diode current slope
(V_R = 200V, T_j = 125°C,
Dynamic test circuit in Figure E)

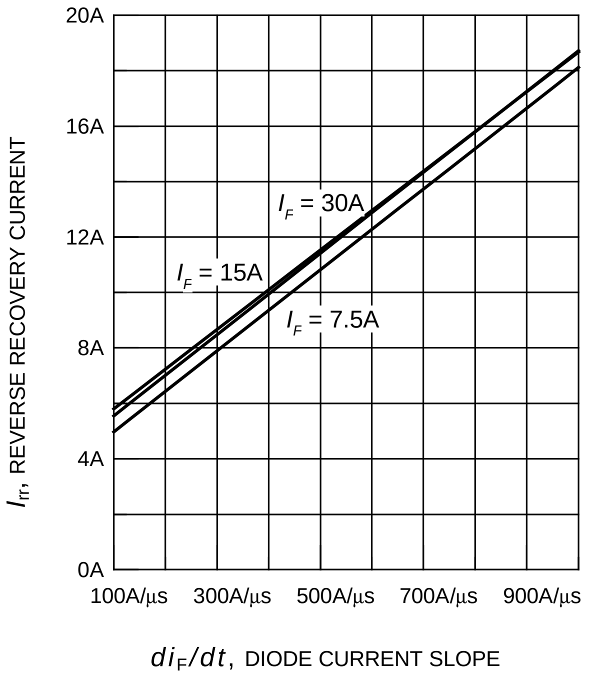


Figure 23. Typical reverse recovery current as a function of diode current slope
(V_R = 200V, T_j = 125°C,
Dynamic test circuit in Figure E)

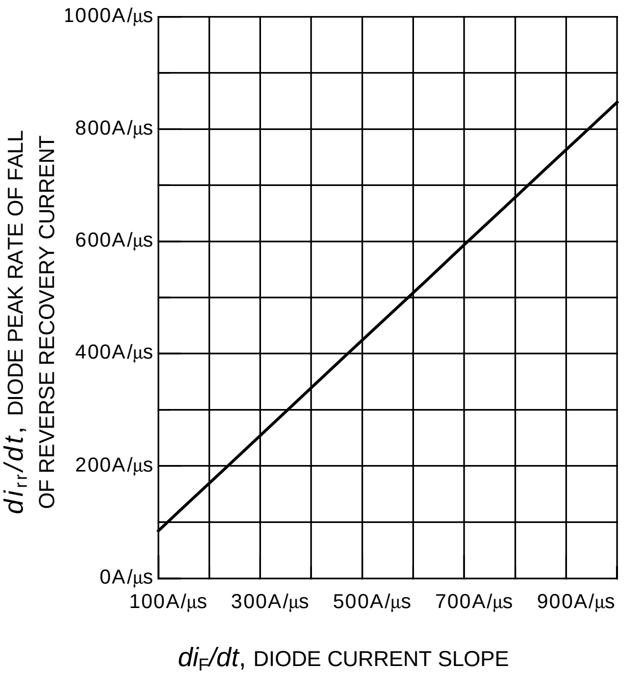


Figure 24. Typical diode peak rate of fall of reverse recovery current as a function of diode current slope
(V_R = 200V, T_j = 125°C,
Dynamic test circuit in Figure E)

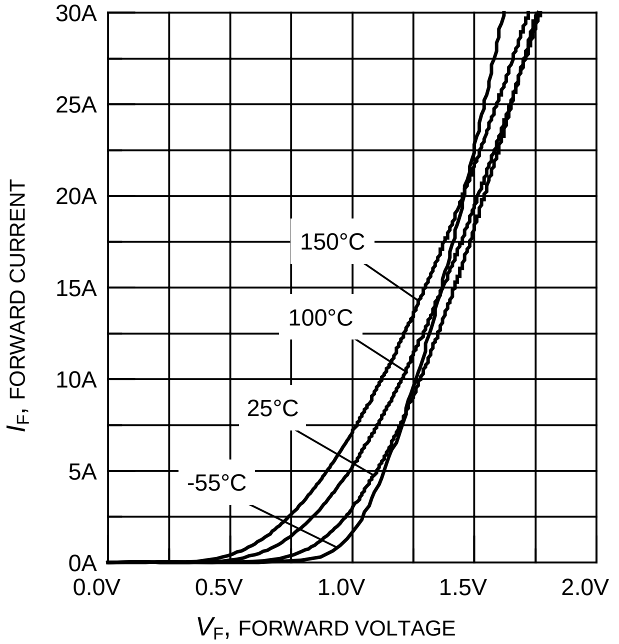


Figure 25. Typical diode forward current as a function of forward voltage

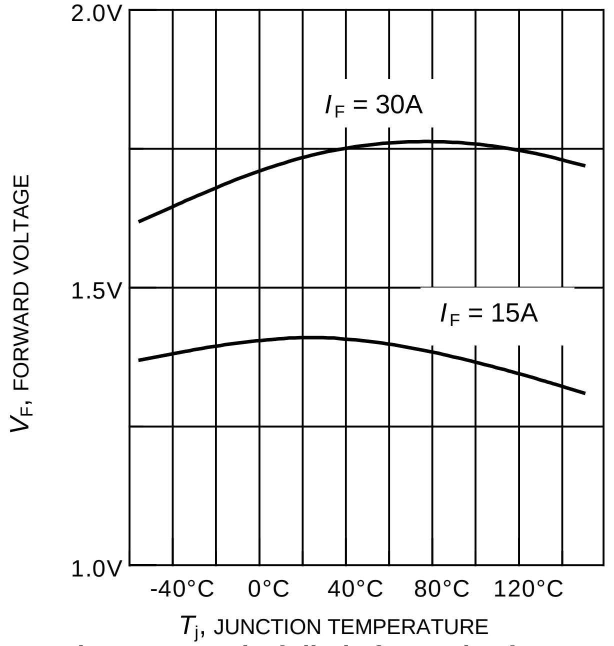
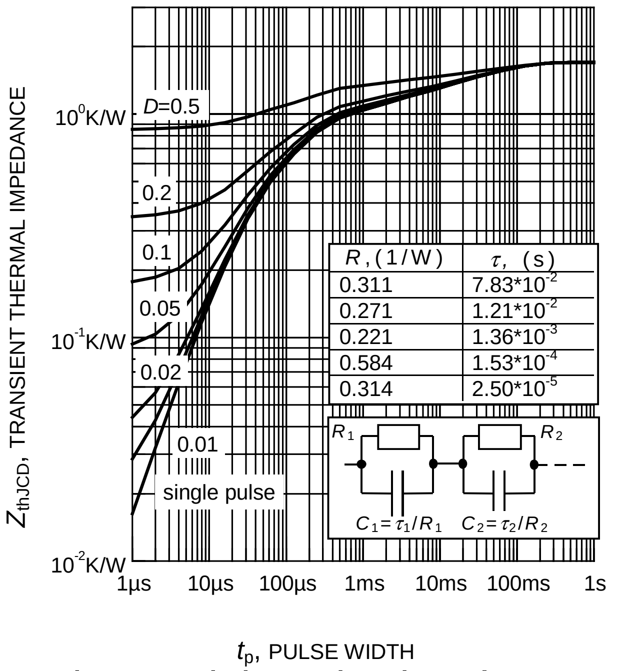


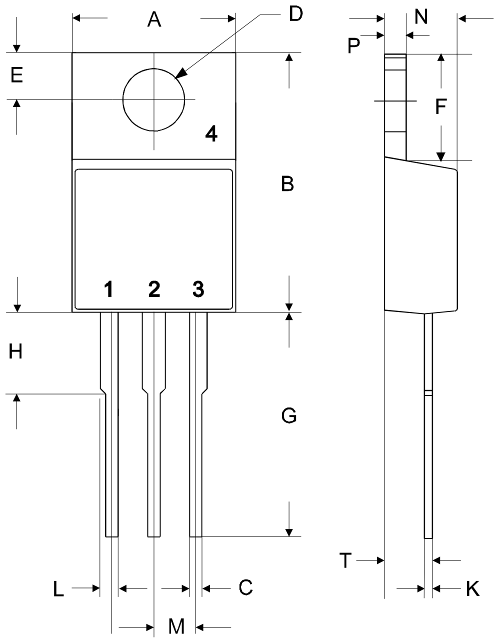
Figure 26. Typical diode forward voltage as a function of junction temperature



R, (1/W)	τ, (s)
0.311	$7.83 \cdot 10^{-2}$
0.271	$1.21 \cdot 10^{-2}$
0.221	$1.36 \cdot 10^{-3}$
0.584	$1.53 \cdot 10^{-4}$
0.314	$2.50 \cdot 10^{-5}$

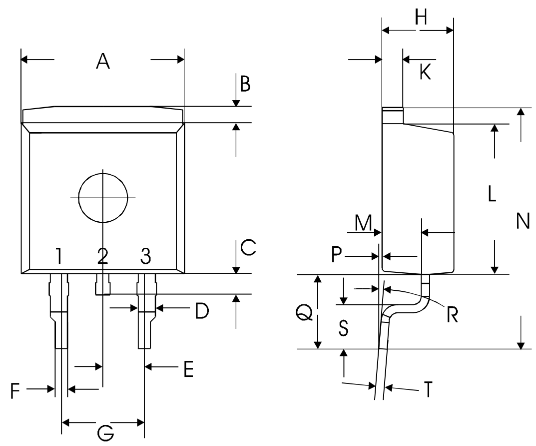
Figure 27. Diode transient thermal impedance as a function of pulse width
($D = t_p / T$)

TO-220AB

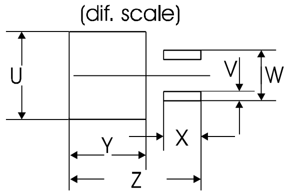


symbol	dimensions			
	[mm]		[inch]	
	min	max	min	max
A	9.70	10.30	0.3819	0.4055
B	14.88	15.95	0.5858	0.6280
C	0.65	0.86	0.0256	0.0339
D	3.55	3.89	0.1398	0.1531
E	2.60	3.00	0.1024	0.1181
F	6.00	6.80	0.2362	0.2677
G	13.00	14.00	0.5118	0.5512
H	4.35	4.75	0.1713	0.1870
K	0.38	0.65	0.0150	0.0256
L	0.95	1.32	0.0374	0.0520
M	2.54 typ.		0.1 typ.	
N	4.30	4.50	0.1693	0.1772
P	1.17	1.40	0.0461	0.0551
T	2.30	2.72	0.0906	0.1071

TO-263AB (D^2Pak)

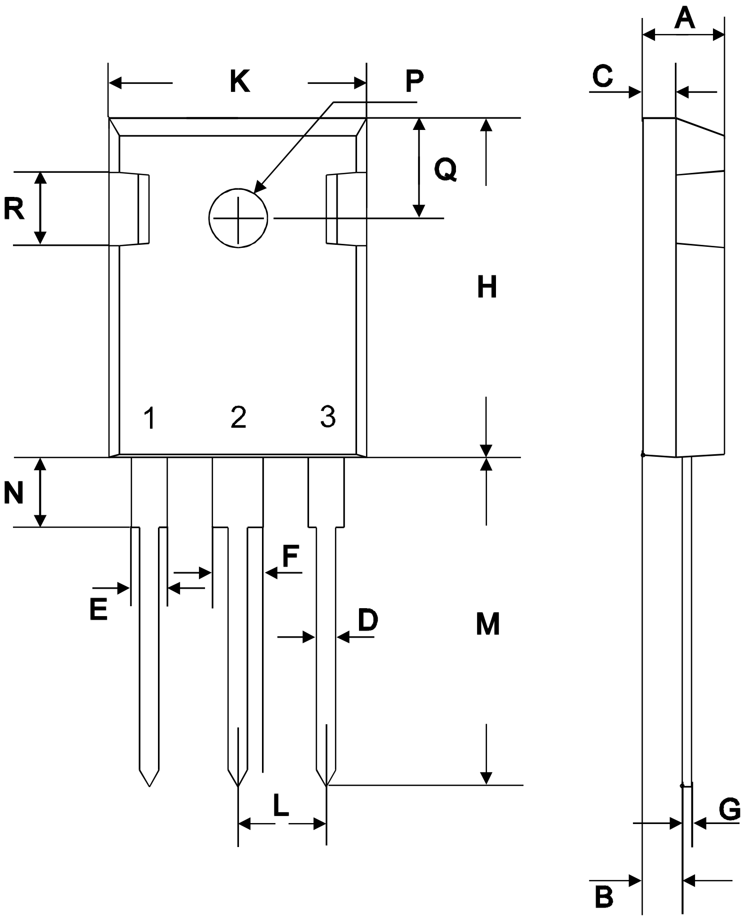


Footprint
(dif. scale)



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	

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

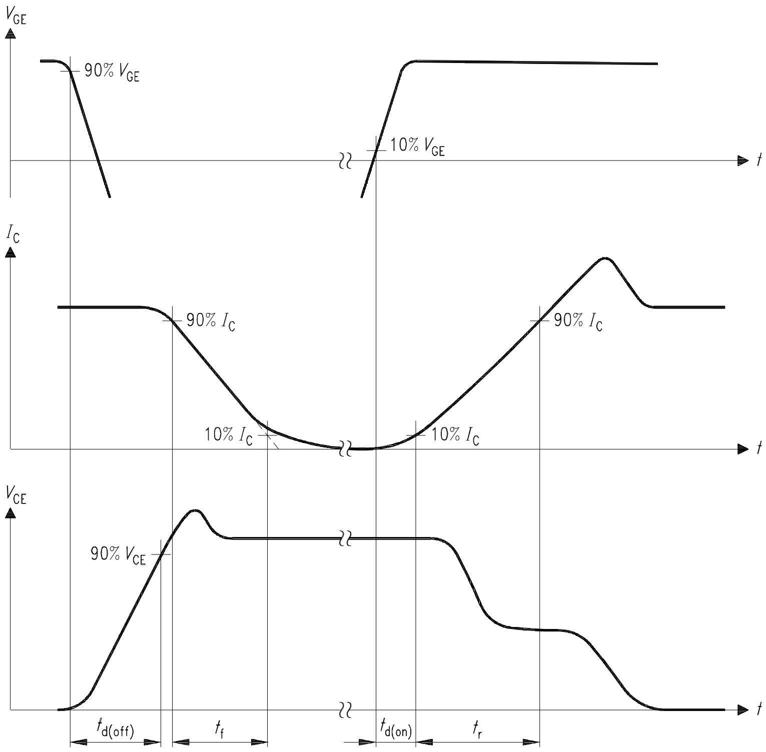


Figure A. Definition of switching times

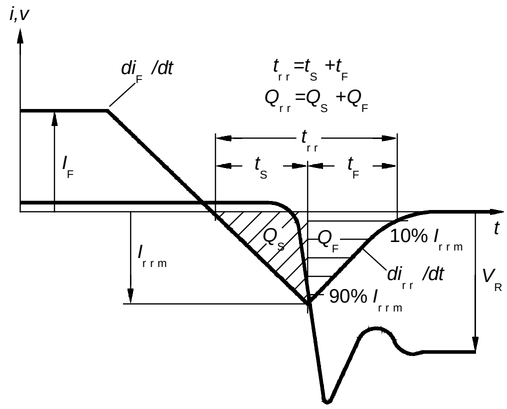


Figure C. Definition of diodes switching characteristics

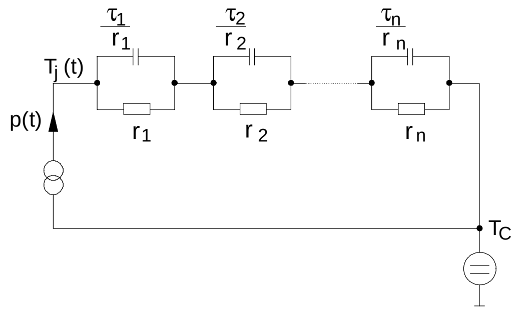


Figure D. Thermal equivalent circuit

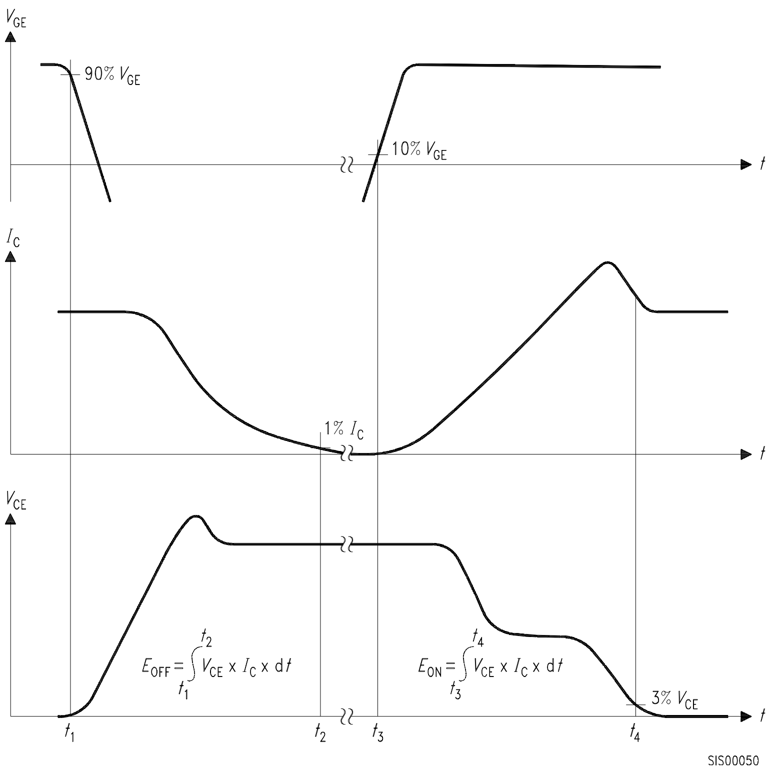


Figure B. Definition of switching losses

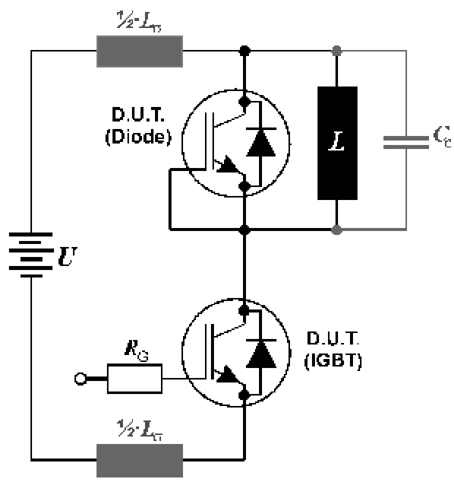


Figure E. Dynamic test circuit
Leakage inductance L_σ =180nH
and Stray capacity C_σ =250pF.

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