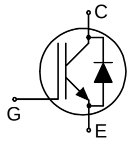
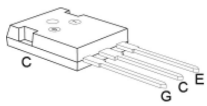
Fast IGBT in NPT-technology with soft, fast recovery anti-parallel Emitter Controlled Diode



- Lower E_{off} compared to previous generation
- Short circuit withstand time – 10 µs
- Designed for:
  - Motor controls
  - Inverter
  - SMPS
- NPT-Technology offers:
  - very tight parameter distribution
  - high ruggedness, temperature stable behaviour
  - parallel switching capability
- Qualified according to JEDEC[1] for target applications
- Pb-free lead plating; RoHS compliant
- Complete product spectrum and PSpice Models : http://www.infineon.com/igbt/



PG-TO-247-3

Type	V_{CE}	I_C	E_{off}	T_j	Marking	Package
SKW15N120	1200V	15A	1.5mJ	150°C	K15N120	PG-TO-247-3

Maximum Ratings

Parameter	Symbol	Value	Unit
Collector-emitter voltage	V_{CE}	1200	V
DC collector current	I_C		A
T_C = 25°C		30	
T_C = 100°C		15	
Pulsed collector current, t_p limited by T_{jmax}	I_{Cpuls}	52	
Turn off safe operating area	-	52	
$V_{CE} \leq$ 1200V, $T_j \leq$ 150°C			
Diode forward current	I_F		
T_C = 25°C		32	
T_C = 100°C		15	
Diode pulsed current, t_p limited by T_{jmax}	I_{Fpuls}	50	
Gate-emitter voltage	V_{GE}	±20	V
Short circuit withstand time[2]	t_{SC}	10	µs
V_{GE} = 15V, 100V≤ V_{CC} ≤1200V, $T_j \leq$ 150°C			
Power dissipation	P_{tot}	198	W
T_C = 25°C			
Operating junction and storage temperature	T_j , T_{stg}	-55...+150	°C
Soldering temperature, wavesoldering, 1.6mm (0.063 in.) from case for 10s	T_s	260	

[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}		0.63	K/W
Diode thermal resistance, junction – case	R_{thJCD}		1.5	
Thermal resistance, junction – ambient	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=1000µA	1200	-	-	V
Collector-emitter saturation voltage	$V_{CE(sat)}$	V_{GE} = 15V, I_C=15A T_j=25°C T_j=150°C	 2.5 -	 3.1 3.7	 3.6 4.3	
Diode forward voltage	V_F	V_{GE}=0V, I_F=15A T_j=25°C T_j=150°C	 -	 2.0 1.75	 2.5 	
Gate-emitter threshold voltage	$V_{GE(th)}$	I_C=600µA, V_{CE}=V_{GE}	3	4	5	
Zero gate voltage collector current	I_{CES}	V_{CE}=1200V, V_{GE}=0V T_j=25°C T_j=150°C	 - -	 - -	 200 800	µA
Gate-emitter leakage current	I_{GES}	V_{CE}=0V, V_{GE}=20V	-	-	100	nA
Transconductance	g_{fs}	V_{CE}=20V, I_C=15A		11	-	S
Dynamic Characteristic						
Input capacitance	C_{iss}	V_{CE}=25V,	-	1250	1500	pF
Output capacitance	C_{oss}	V_{GE}=0V,	-	155	185	
Reverse transfer capacitance	C_{rss}	f=1MHz	-	65	80	
Gate charge	Q_{Gate}	V_{CC}=960V, I_C=15A V_{GE}=15V	-	130	175	nC
Internal emitter inductance measured 5mm (0.197 in.) from case	L_E		-	13	-	nH
Short circuit collector current[1)]	$I_{C(SC)}$	V_{GE}=15V, t_{SC}≤10µs 100V≤V_{CC}≤1200V, T_j ≤ 150°C	-	145	-	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, V_{CC}=800V, I_C=15A, V_{GE}=15V/0V, R_G=33Ω, L_σ[1)]=180nH, C_σ[1)]=40pF Energy losses include "tail" and diode reverse recovery.	-	18	24	ns
Rise time	t_r		-	23	30	
Turn-off delay time	$t_{d(off)}$		-	580	750	
Fall time	t_f		-	22	29	
Turn-on energy	E_{on}		-	1.1	1.5	mJ
Turn-off energy	E_{off}		-	0.8	1.1	
Total switching energy	E_{ts}		-	1.9	2.6	
Anti-Parallel Diode Characteristic						
Diode reverse recovery time	t_{rr} t_S t_F	T_j=25°C, V_R=800V, I_F=15A, di_F/dt=650A/µs	- - -	65		ns
Diode reverse recovery charge	Q_{rr}		-	0.5		µC
Diode peak reverse recovery current	I_{rrm}		-	15		A
Diode peak rate of fall of reverse recovery current during t_F	di_{rr}/dt		-	500		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}=800V, I_C=15A, V_{GE}=15V/0V, R_G=33Ω, L_σ[1)]=180nH, C_σ[1)]=40pF Energy losses include "tail" and diode reverse recovery.	-	38	46	ns
Rise time	t_r		-	30	36	
Turn-off delay time	$t_{d(off)}$		-	652	780	
Fall time	t_f		-	31	37	
Turn-on energy	E_{on}		-	1.9	2.3	mJ
Turn-off energy	E_{off}		-	1.5	2.0	
Total switching energy	E_{ts}		-	3.4	4.3	
Anti-Parallel Diode Characteristic						
Diode reverse recovery time	t_{rr} t_S t_F	T_j=150°C V_R=800V, I_F=15A, di_F/dt=650A/µs	- - -	200		ns
Diode reverse recovery charge	Q_{rr}		-	2.0		µC
Diode peak reverse recovery current	I_{rrm}		-	23		A
Diode peak rate of fall of reverse recovery current during t_F	di_{rr}/dt		-	140		A/µs

1) Leakage inductance L_σ and stray capacity C_σ due to dynamic test circuit in figure E.

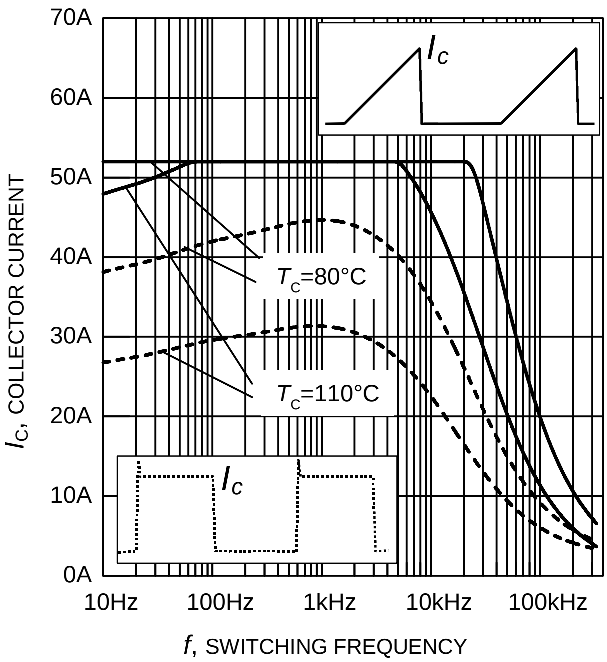


Figure 1. Collector current as a function of switching frequency
($T_j \leq 150°C$, $D = 0.5$, $V_{CE} = 800V$, $V_{GE} = +15V/0V$, $R_G = 33\Omega$)

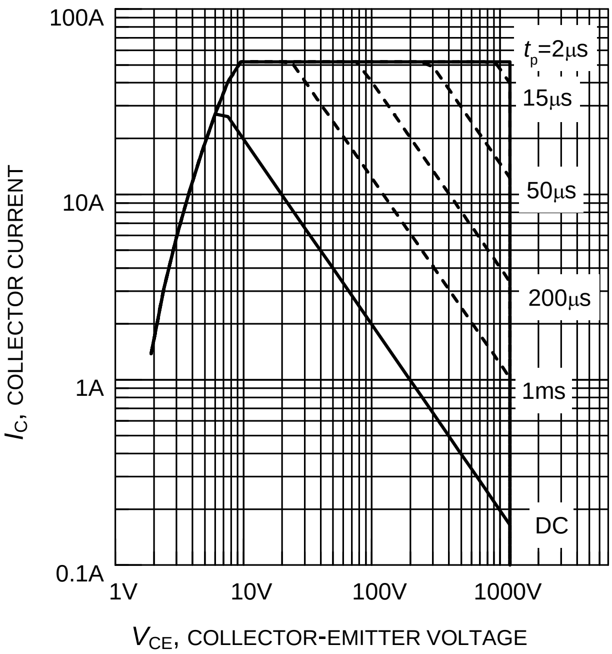


Figure 2. Safe operating area
($D = 0$, $T_C = 25°C$, $T_j \leq 150°C$)

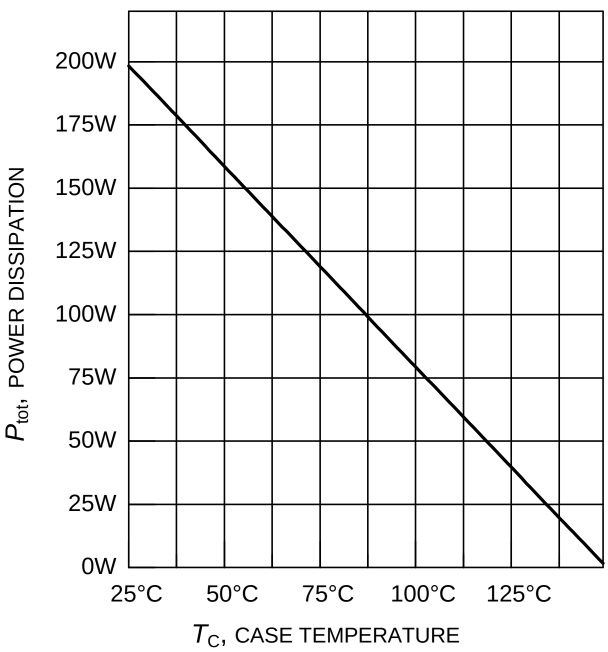


Figure 3. Power dissipation as a function of case temperature
($T_j \leq 150°C$)

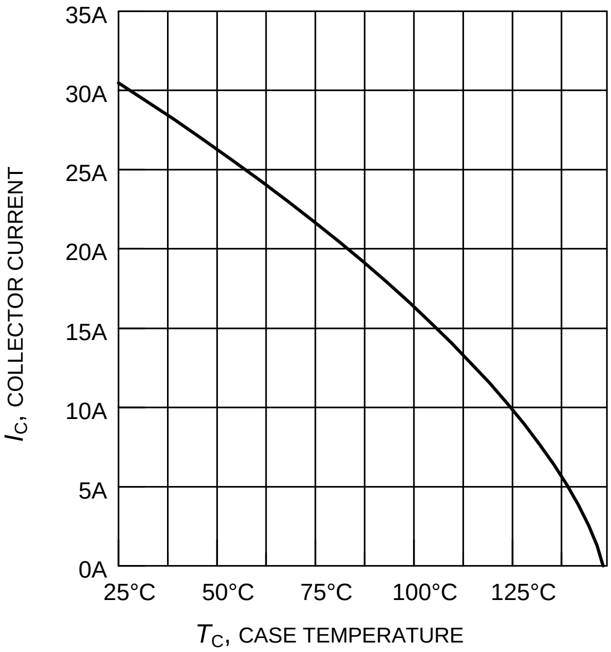


Figure 4. Collector current as a function of case temperature
($V_{GE} \leq 15V$, $T_j \leq 150°C$)

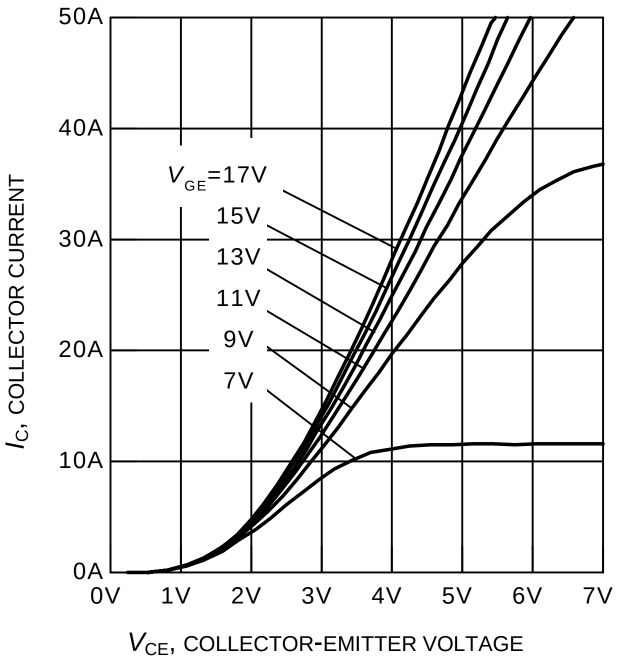


Figure 5. Typical output characteristics
(T_i = 25°C)

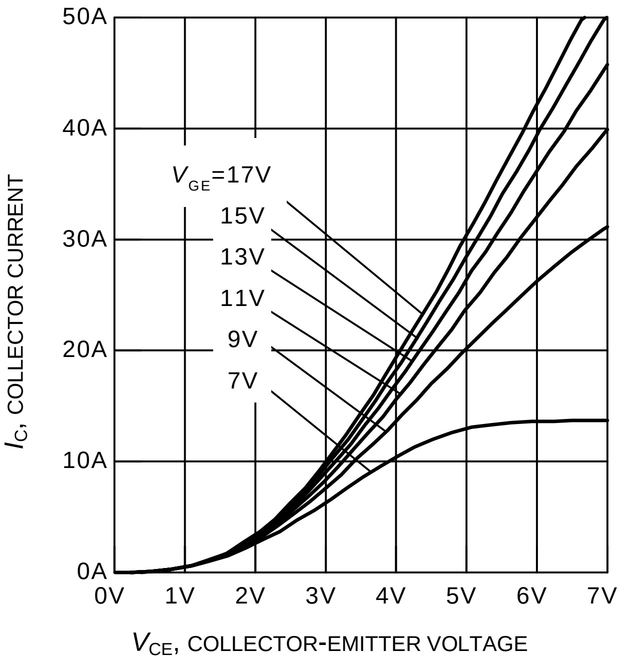


Figure 6. Typical output characteristics
(T_i = 150°C)

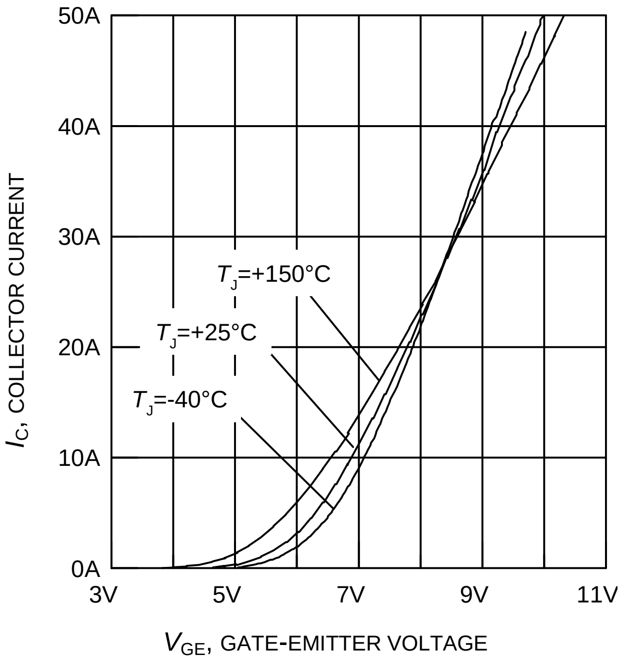


Figure 7. Typical transfer characteristics
(V_{CE} = 20V)

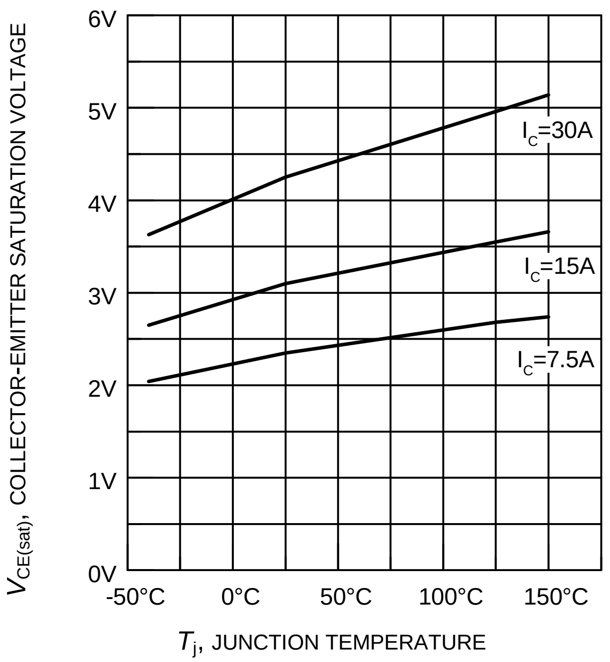


Figure 8. Typical collector-emitter saturation voltage as a function of junction temperature
(V_{GE} = 15V)

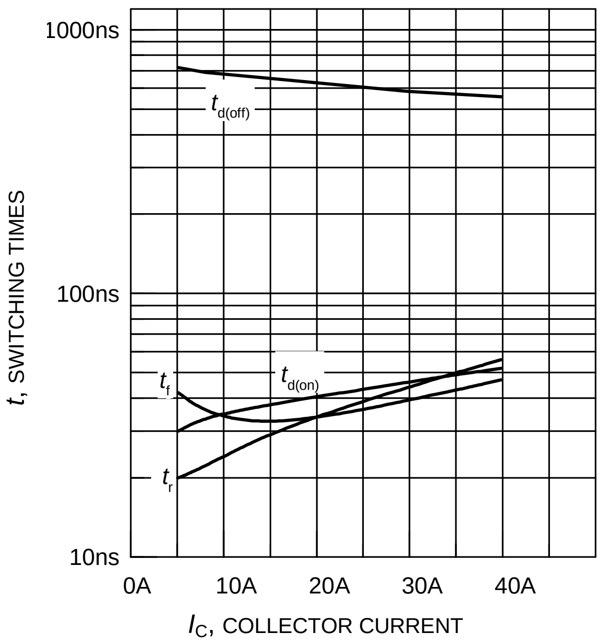


Figure 9. Typical switching times as a function of collector current
(inductive load, T_j = 150°C,
V_{CE} = 8600V, V_{GE} = +15V/0V, R_G = 33Ω,
dynamic test circuit in Fig.E)

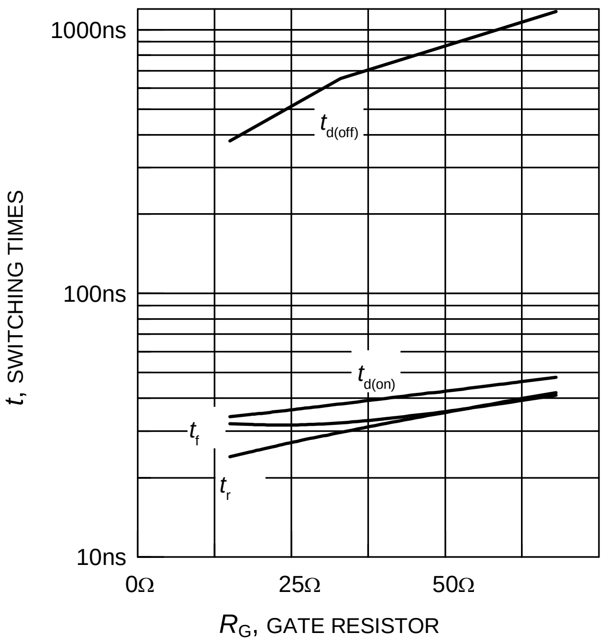


Figure 10. Typical switching times as a function of gate resistor
(inductive load, T_j = 150°C,
V_{CE} = 800V, V_{GE} = +15V/0V, I_C = 15A,
dynamic test circuit in Fig.E)

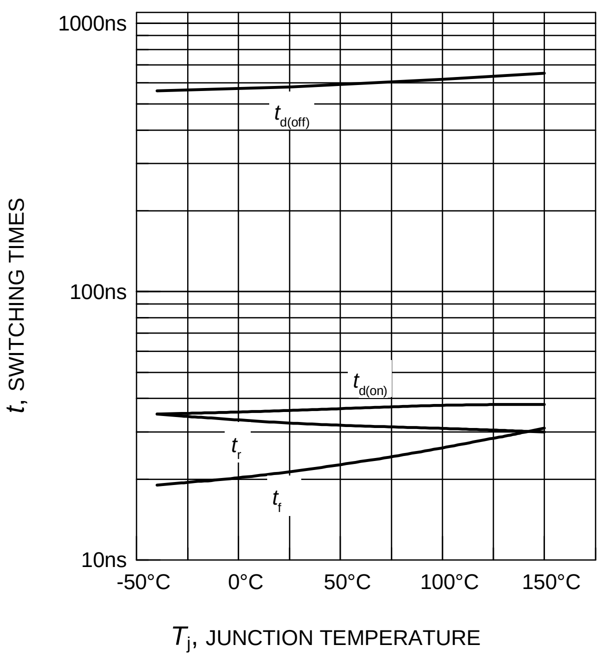


Figure 11. Typical switching times as a function of junction temperature
(inductive load, V_{CE} = 800V,
V_{GE} = +15V/0V, I_C = 15A, R_G = 33Ω,
dynamic test circuit in Fig.E)

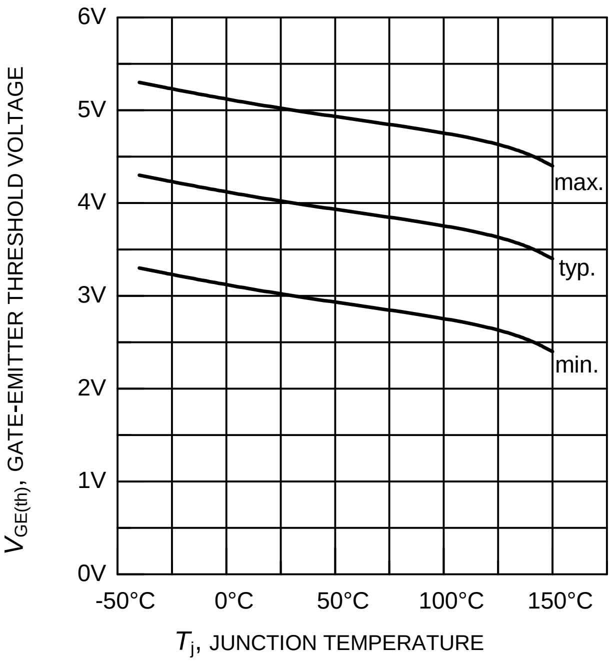


Figure 12. Gate-emitter threshold voltage as a function of junction temperature
(I_C = 0.3mA)

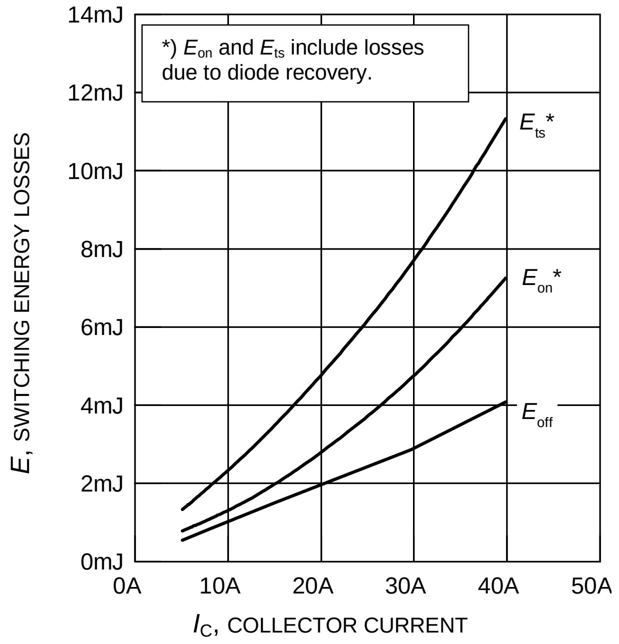


Figure 13. Typical switching energy losses as a function of collector current
(inductive load, T_j = 150°C,
V_{CE} = 800V, V_{GE} = +15V/0V, R_G = 33Ω,
dynamic test circuit in Fig.E)

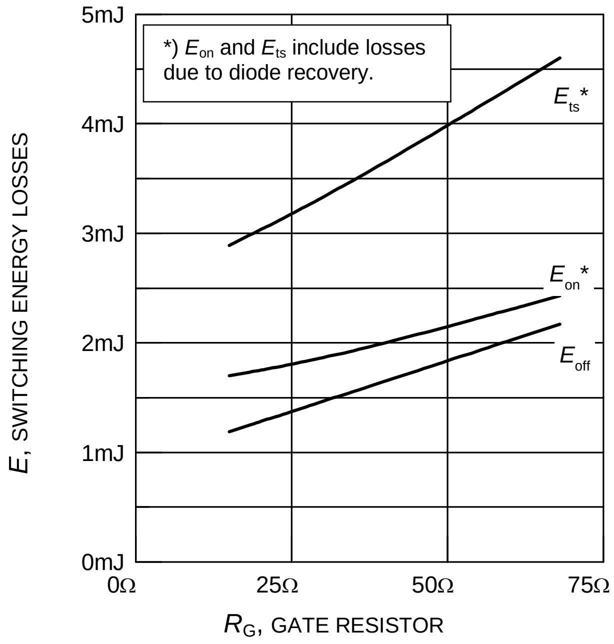


Figure 14. Typical switching energy losses as a function of gate resistor
(inductive load, T_j = 150°C,
V_{CE} = 800V, V_{GE} = +15V/0V, I_C = 15A,
dynamic test circuit in Fig.E)

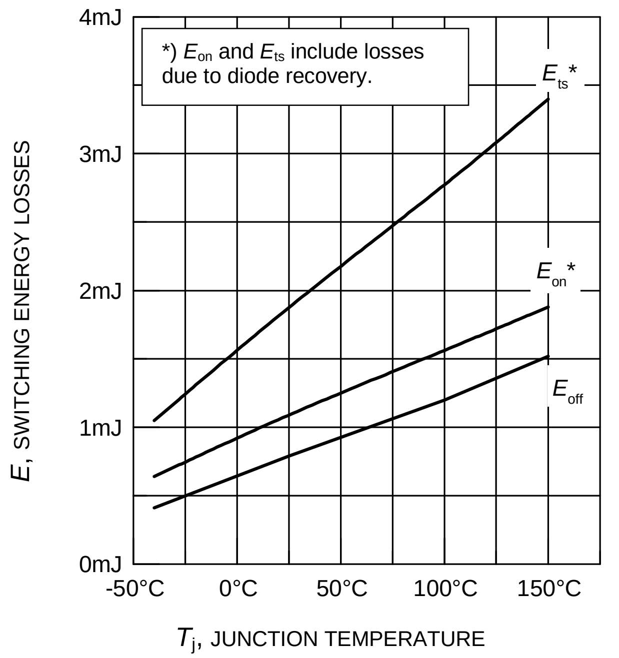


Figure 15. Typical switching energy losses as a function of junction temperature
(inductive load, V_{CE} = 800V,
V_{GE} = +15V/0V, I_C = 15A, R_G = 33Ω,
dynamic test circuit in Fig.E)

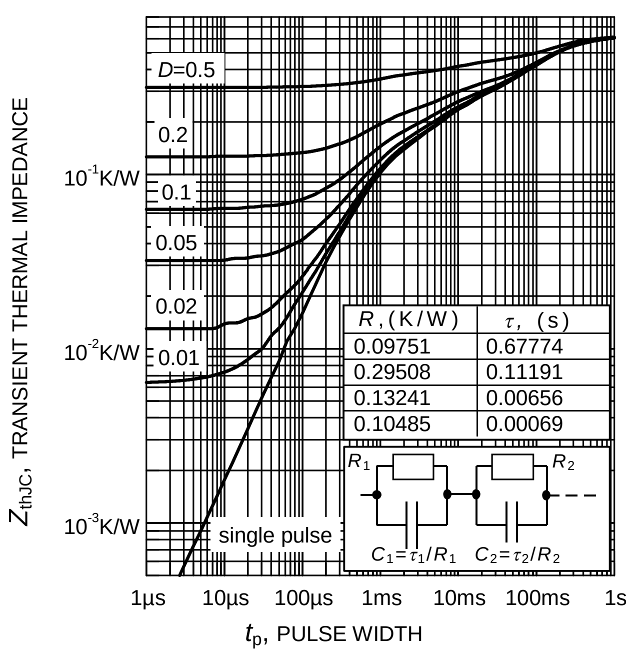


Figure 16. IGBT transient thermal impedance as a function of pulse width
($D = t_p / T$)

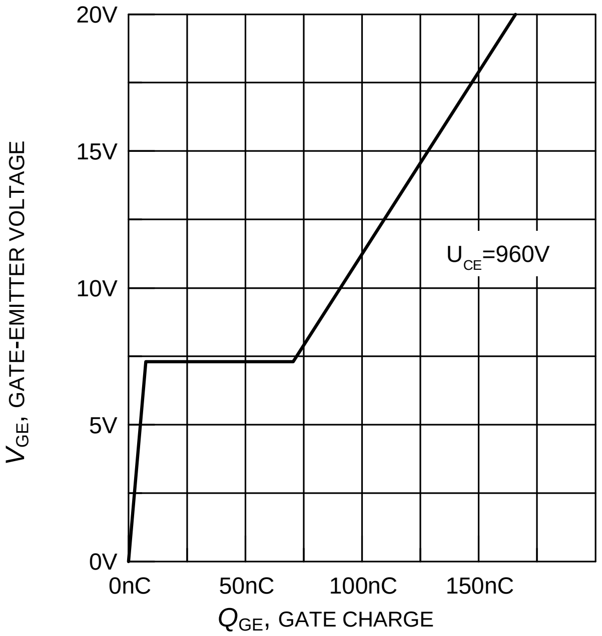


Figure 17. Typical gate charge
(I_C = 15A)

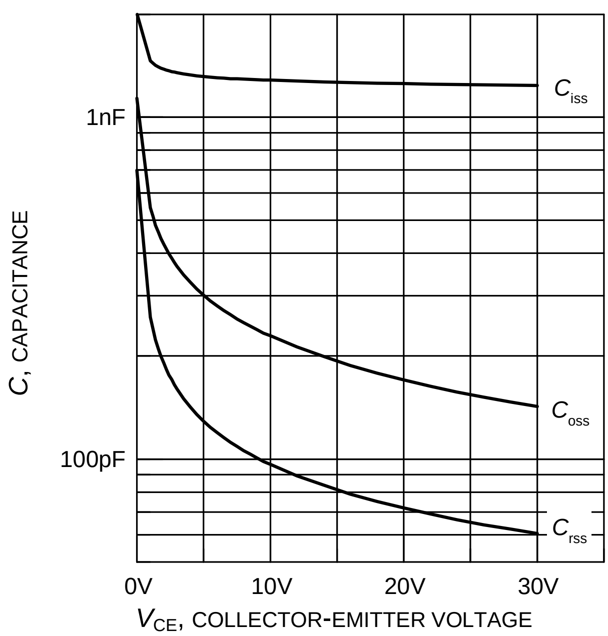


Figure 18. Typical capacitance as a function of collector-emitter voltage
(V_{GE} = 0V, f = 1MHz)

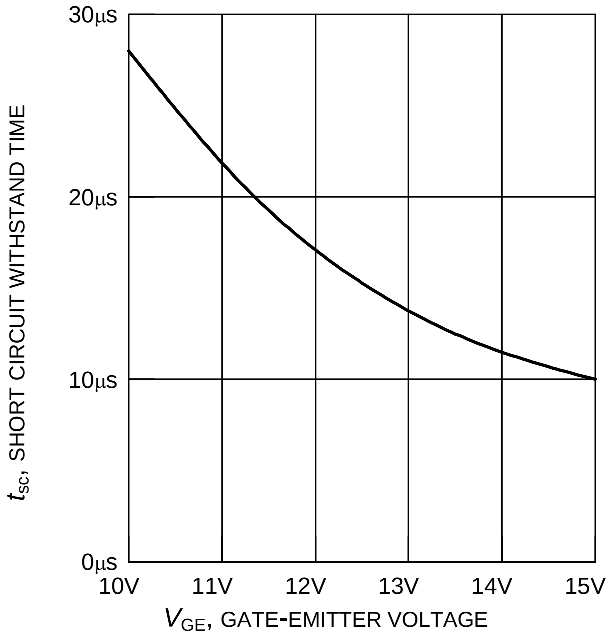


Figure 19. Short circuit withstand time as a function of gate-emitter voltage
(V_{CE} = 1200V, start at T_j = 25°C)

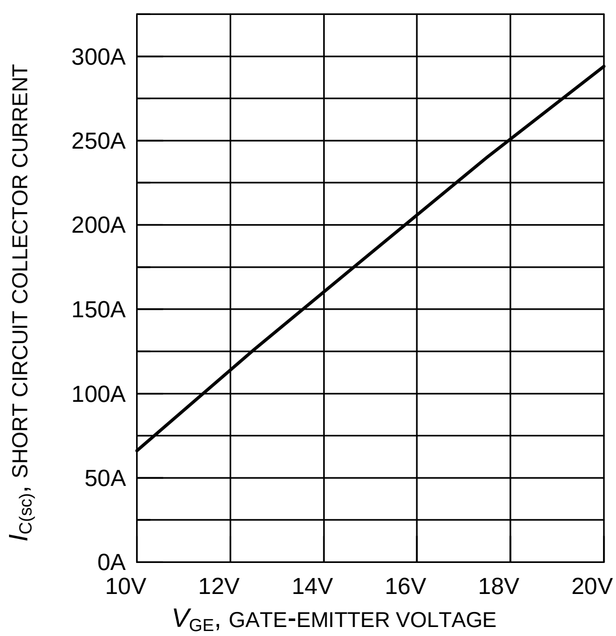


Figure 20. Typical short circuit collector current as a function of gate-emitter voltage
(100V $\leq V_{CE} \leq$1200V, T_C = 25°C, $T_j \leq$ 150°C)

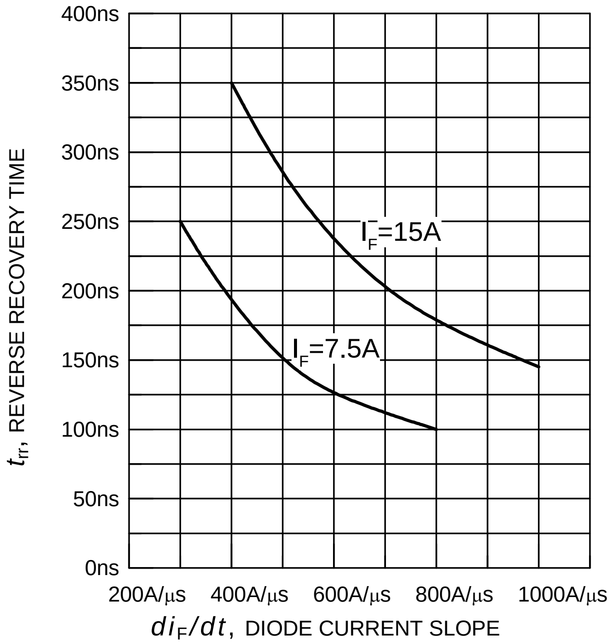


Figure 21. Typical reverse recovery time as a function of diode current slope
(V_R = 800V, T_j = 150°C,
dynamic test circuit in Fig.E)

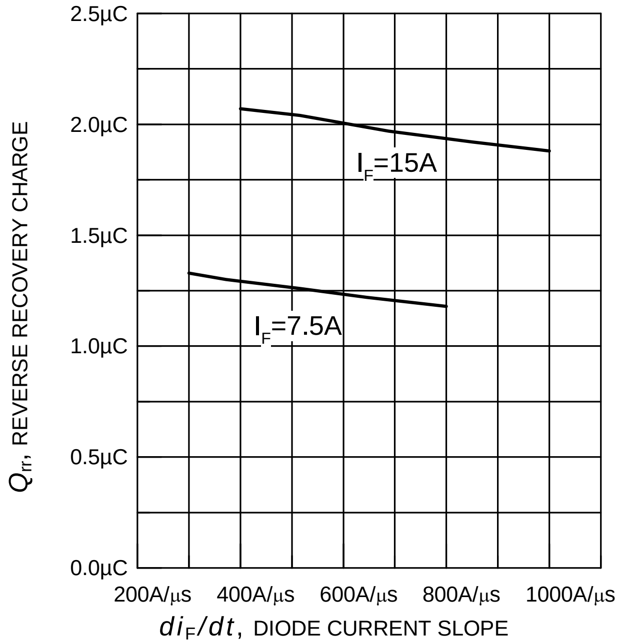


Figure 22. Typical reverse recovery charge as a function of diode current slope
(V_R = 800V, T_j = 150°C,
dynamic test circuit in Fig.E)

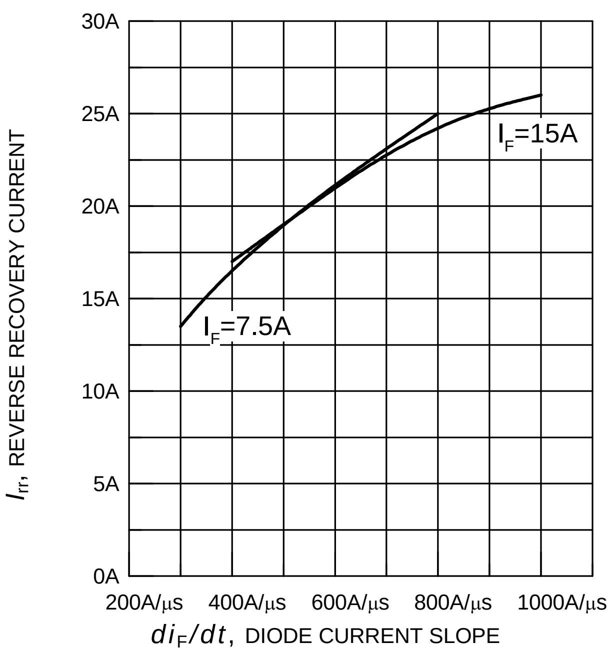


Figure 23. Typical reverse recovery current as a function of diode current slope
(V_R = 800V, T_j = 150°C,
dynamic test circuit in Fig.E)

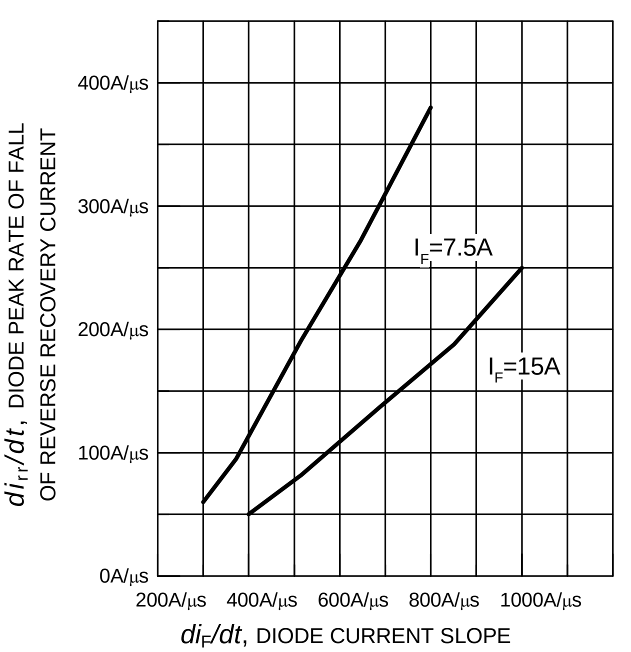


Figure 24. Typical diode peak rate of fall of reverse recovery current as a function of diode current slope
(V_R = 800V, T_j = 150°C,
dynamic test circuit in Fig.E)

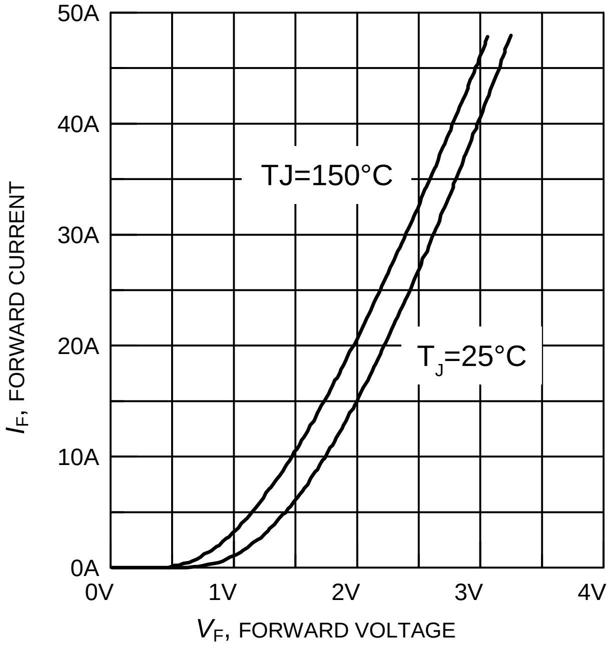


Figure 25. Typical diode forward current as a function of forward voltage

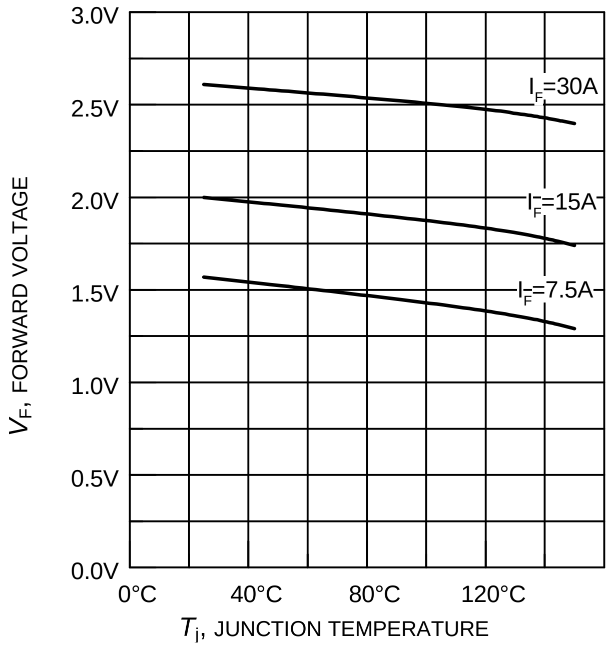


Figure 26. Typical diode forward voltage as a function of junction temperature

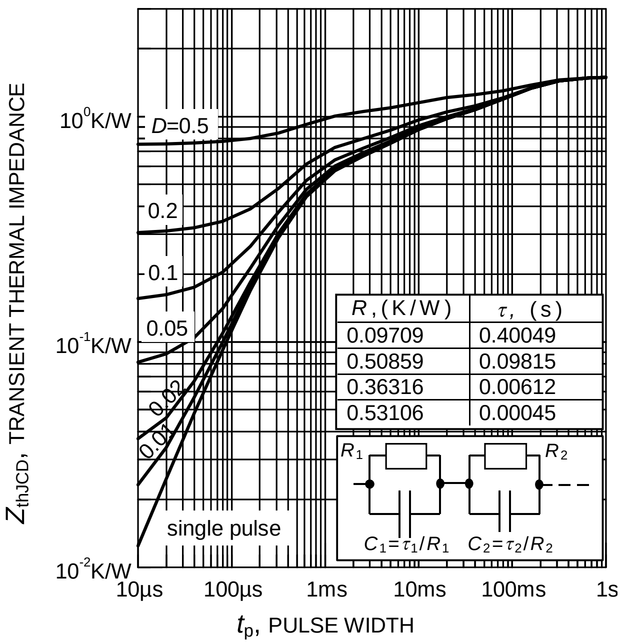


Figure 27. Diode transient thermal impedance as a function of pulse width
($D = t_p / T$)

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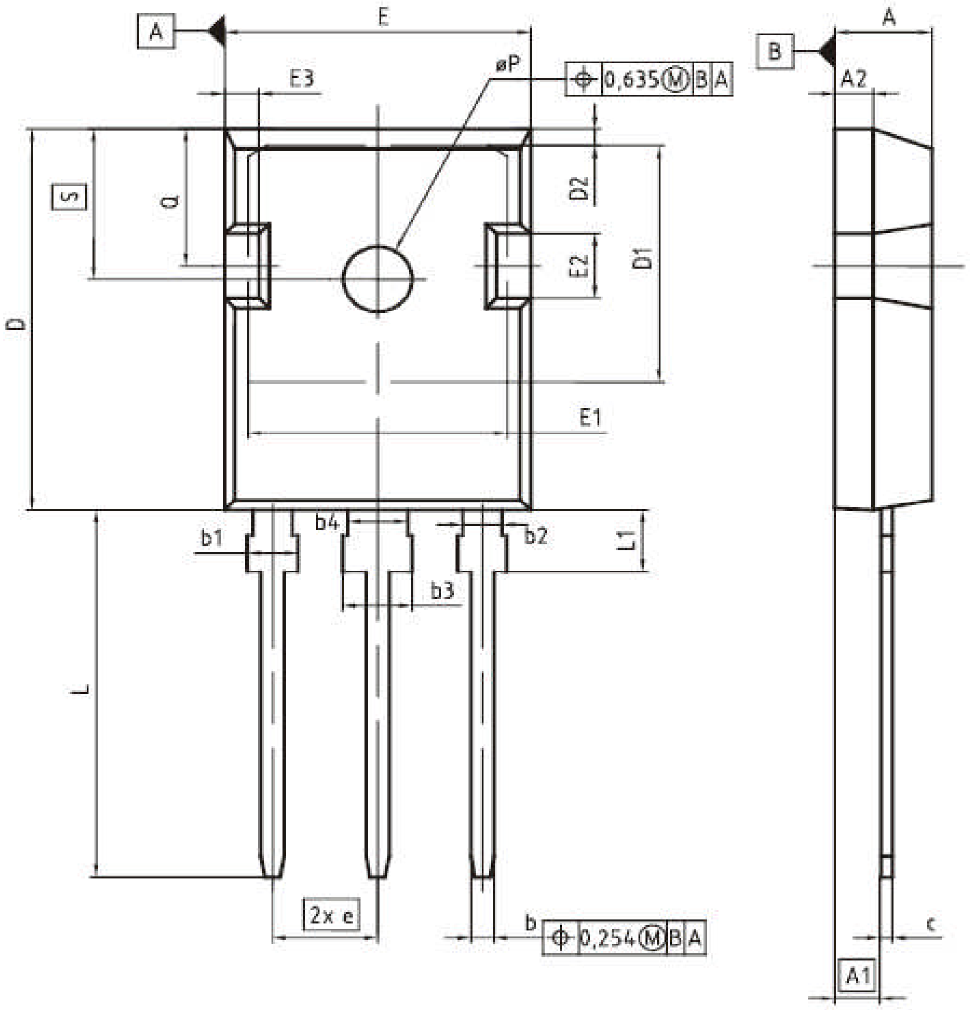

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.83	5.21	0.190	0.205
A1	2.27	2.54	0.089	0.100
A2	1.85	2.16	0.073	0.085
b	1.07	1.33	0.042	0.052
b1	1.90	2.41	0.075	0.095
b2	1.90	2.16	0.075	0.085
b3	2.87	3.38	0.113	0.133
b4	2.87	3.13	0.113	0.123
c	0.55	0.68	0.022	0.027
D	20.80	21.10	0.819	0.831
D1	16.25	17.65	0.640	0.695
D2	0.95	1.35	0.037	0.053
E	15.70	16.13	0.618	0.635
E1	13.10	14.15	0.516	0.557
E2	3.68	5.10	0.145	0.201
E3	1.00	2.60	0.039	0.102
e	5.44 (BSC)		0.214 (BSC)	
N	3		3	
L	19.80	20.32	0.780	0.800
L1	4.10	4.47	0.161	0.176
øP	3.50	3.70	0.138	0.146
Q	5.49	6.00	0.216	0.236
S	6.04	6.30	0.238	0.248

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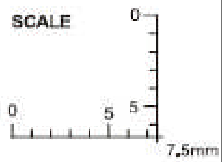
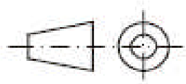
SCALE



EUROPEAN PROJECTION



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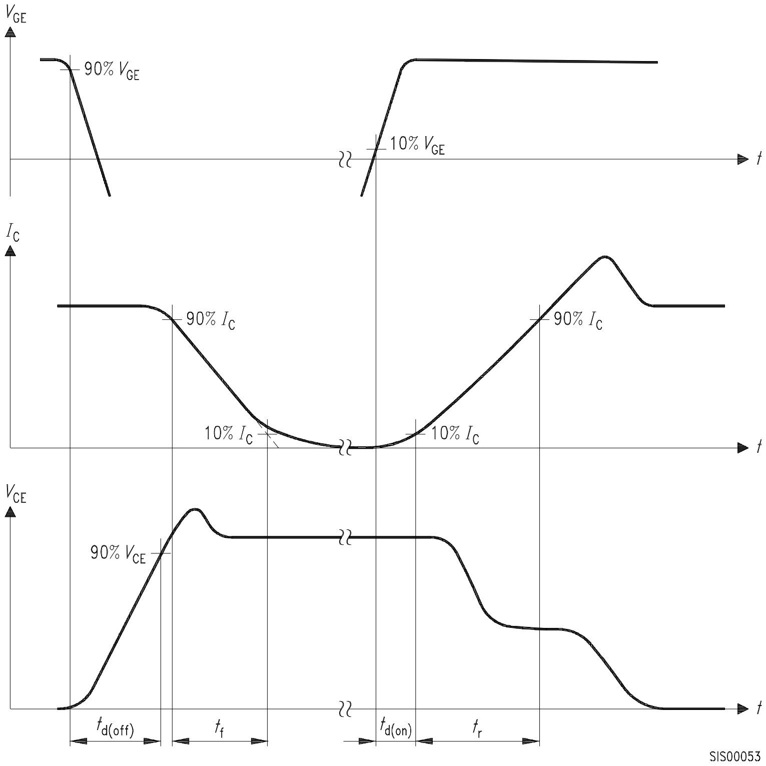

Figure A. Definition of switching times

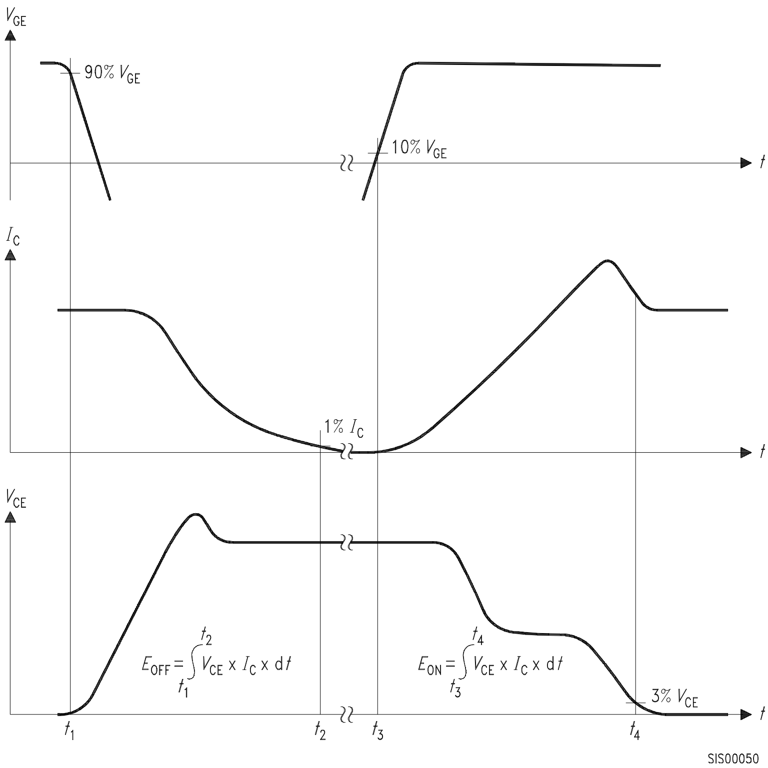

Figure B. Definition of switching losses

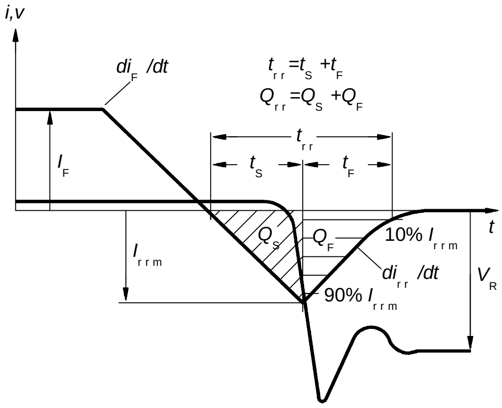

Figure C. Definition of diodes switching characteristics

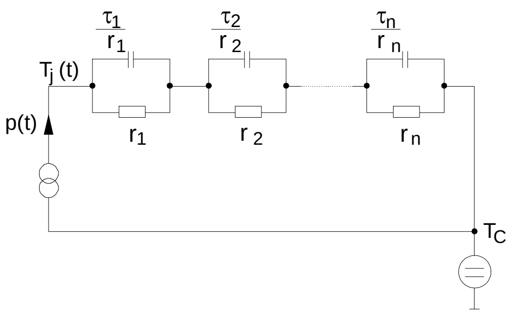

Figure D. Thermal equivalent circuit

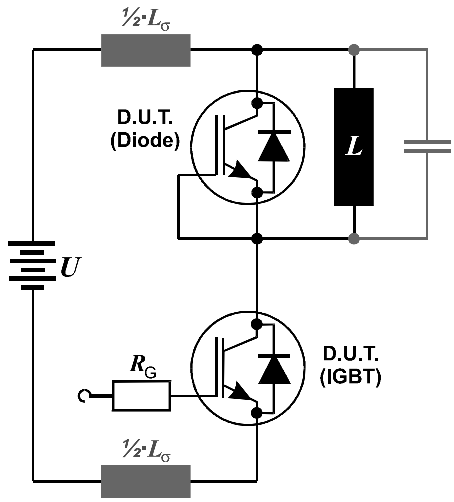

Figure E. Dynamic test circuit
Leakage inductance L_σ=180nH, and stray capacity C_σ =40pF.

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