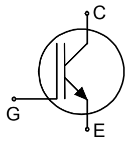
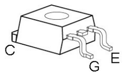
Fast IGBT in NPT-technology



- 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
- Qualified according to JEDEC[2] for target applications
- Pb-free lead plating; RoHS compliant
- Complete product spectrum and PSpice Models : http://www.infineon.com/igbt/



PG-TO-263-3-2 (D²-PAK) (TO-263AB)

Type	V_{CE}	I_C	$V_{CE(sat)150°C}$	T_j	Marking	Package
SGB04N60	600V	4A	2.3V	150°C	G04N60	PG-TO-263-3-2

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	 9.4 4.9	A
Pulsed collector current, t_p limited by T_{jmax}	I_{Cpuls}	19	
Turn off safe operating area $V_{CE} \leq$ 600V, $T_j \leq$ 150°C	-	19	
Gate-emitter voltage	V_{GE}	±20	V
Avalanche energy, single pulse I_C = 4 A, V_{CC} = 50 V, R_{GE} = 25 Ω, start at T_j = 25°C	E_{AS}	25	mJ
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}	50	W
Operating junction and storage temperature	T_j , T_{stg}	-55...+150	°C
Soldering temperature: (reflow soldering, MSL1)	T_s	245	

[2] J-STD-020 and JESD-022
[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}		2.5	K/W
Thermal resistance, junction – ambient	R_{thJA}		62	
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=4A T_j=25°C T_j=150°C	 1.7 -	 2.0 2.3	 2.4 2.8	
Gate-emitter threshold voltage	$V_{GE(th)}$	I_C=200µA, 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	 - -	 - -	 20 500	µA
Gate-emitter leakage current	I_{GES}	V_{CE}=0V, V_{GE}=20V	-	-	100	nA
Transconductance	g_{fs}	V_{CE}=20V, I_C=4A		3.1	-	S
Dynamic Characteristic						
Input capacitance	C_{iss}	V_{CE}=25V,	-	264	317	pF
Output capacitance	C_{oss}	V_{GE}=0V,	-	29	35	
Reverse transfer capacitance	C_{rss}	f=1MHz	-	17	20	
Gate charge	Q_{Gate}	V_{CC}=480V, I_C=4A V_{GE}=15V	-	24	31	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	-	40	-	A

[1)] Device on 50mm*50mm*1.5mm epoxy PCB FR4 with 6cm² (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=4A, V_{GE}=0/15V, R_G=67Ω, L_σ[1)] =180nH, C_σ[1)] =180pF Energy losses include “tail” and diode reverse recovery.	-	22	26	ns
Rise time	t_r		-	15	18	
Turn-off delay time	$t_{d(off)}$		-	237	284	
Fall time	t_f		-	70	84	
Turn-on energy	E_{on}		-	0.070	0.081	mJ
Turn-off energy	E_{off}		-	0.061	0.079	
Total switching energy	E_{ts}		-	0.131	0.160	

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=4A, V_{GE}=0/15V, R_G=67Ω, L_σ[1)] =180nH, C_σ[1)] =180pF Energy losses include “tail” and diode reverse recovery.	-	22	26	ns
Rise time	t_r		-	16	19	
Turn-off delay time	$t_{d(off)}$		-	264	317	
Fall time	t_f		-	104	125	
Turn-on energy	E_{on}		-	0.115	0.132	mJ
Turn-off energy	E_{off}		-	0.111	0.144	
Total switching energy	E_{ts}		-	0.226	0.277	

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

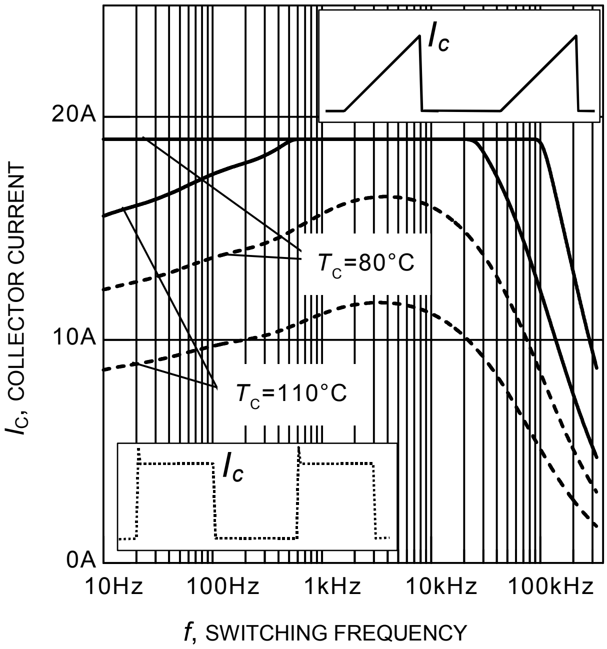


Figure 1. Collector current as a function of switching frequency
($T_j \le 150$°C, $D = 0.5$, $V_{CE} = 400$V, $V_{GE} = 0/+15$V, $R_G = 67\Omega$)

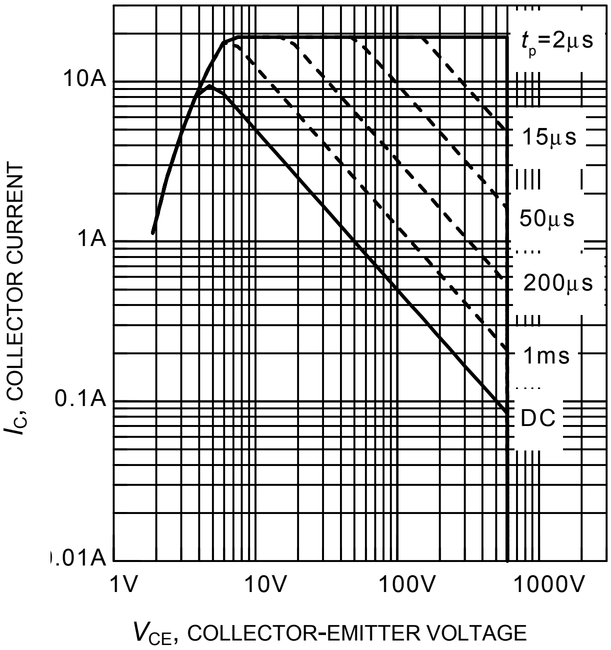


Figure 2. Safe operating area
($D = 0$, $T_C = 25$°C, $T_j \le 150$°C)

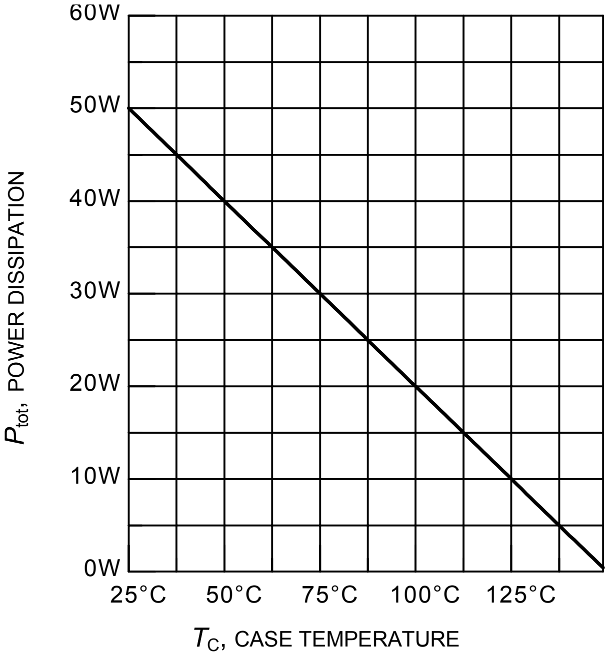


Figure 3. Power dissipation as a function of case temperature
($T_j \le 150$°C)

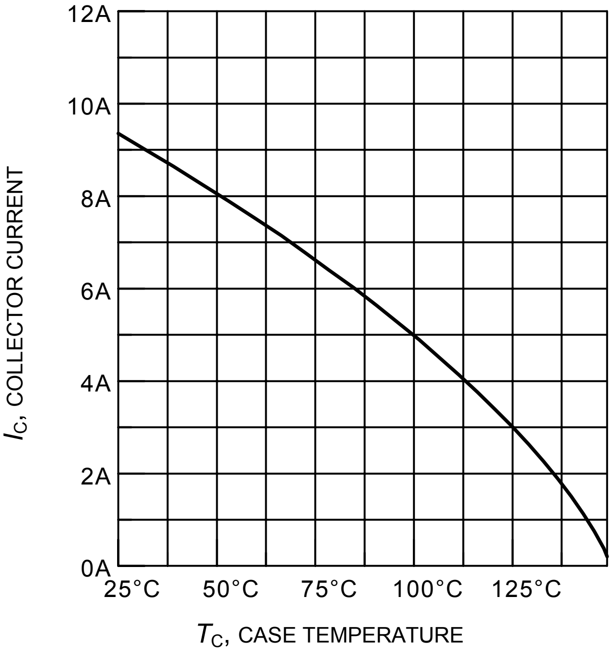


Figure 4. Collector current as a function of case temperature
($V_{GE} \le 15$V, $T_j \le 150$°C)

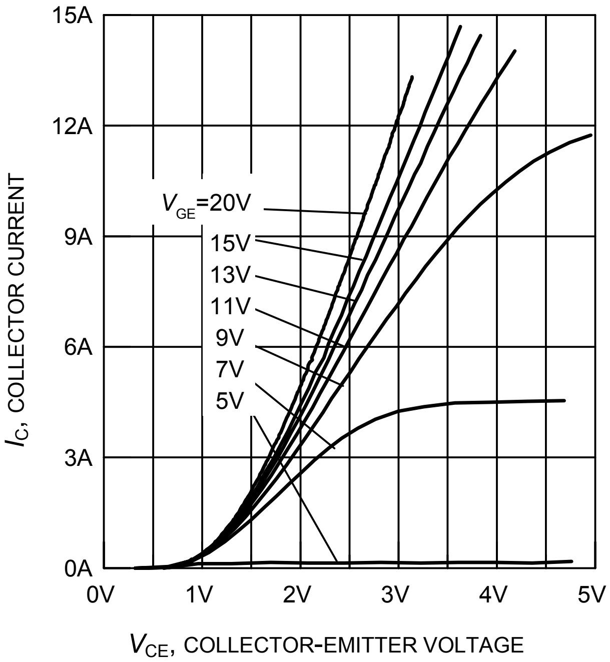


Figure 5. Typical output characteristics
(T_j = 25°C)

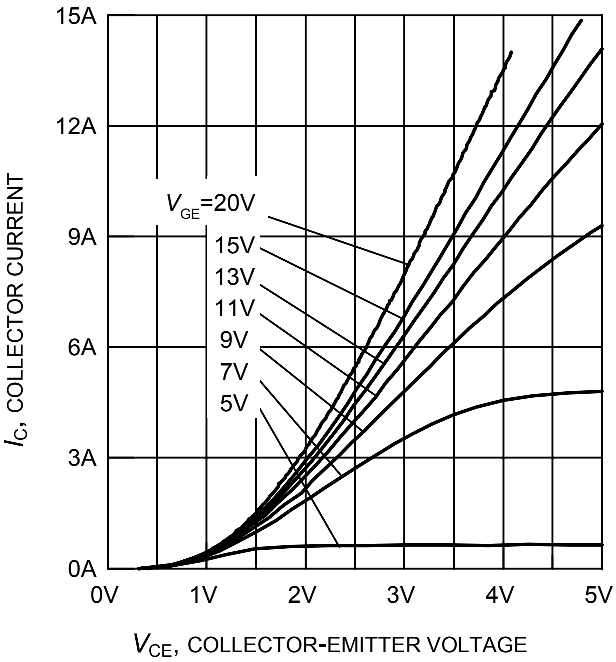


Figure 6. Typical output characteristics
(T_j = 150°C)

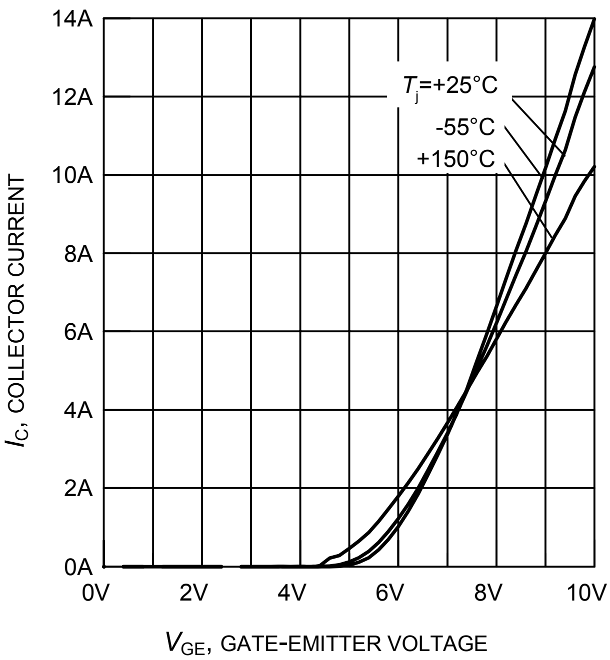


Figure 7. Typical transfer characteristics
(V_{CE} = 10V)

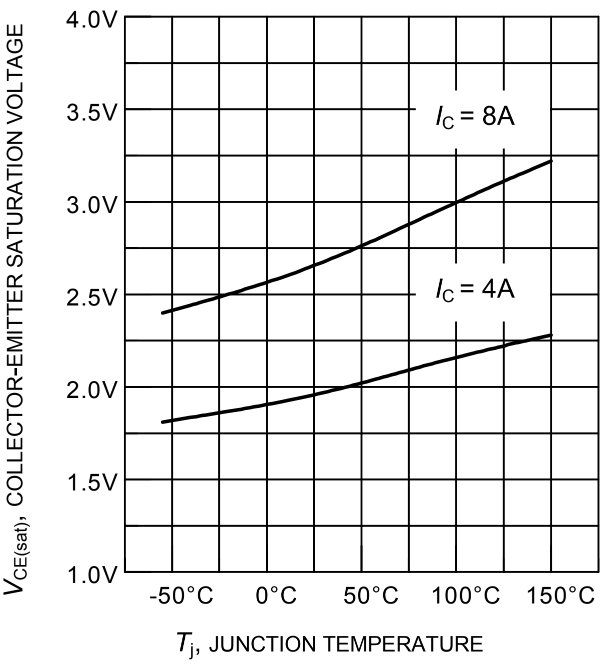


Figure 8. Typical collector-emitter saturation voltage as a function of junction temperature
(V_{GE} = 15V)

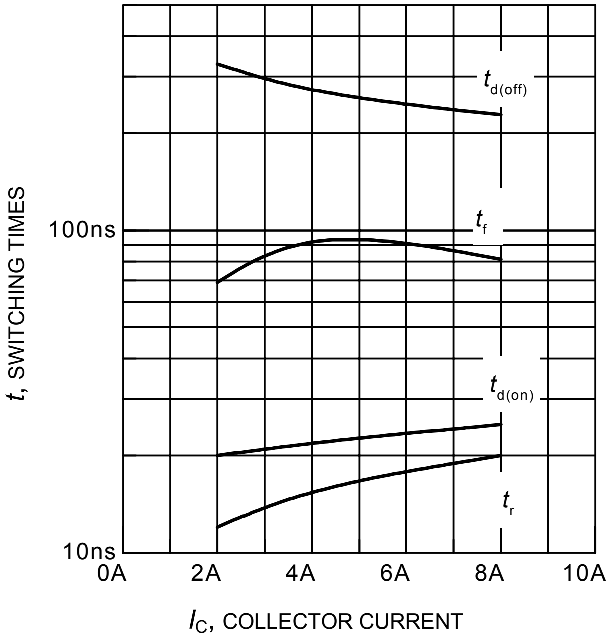


Figure 9. Typical switching times as a function of collector current
(inductive load, T_j = 150°C, V_{CE} = 400V, V_{GE} = 0/+15V, R_G = 67Ω, Dynamic test circuit in Figure E)

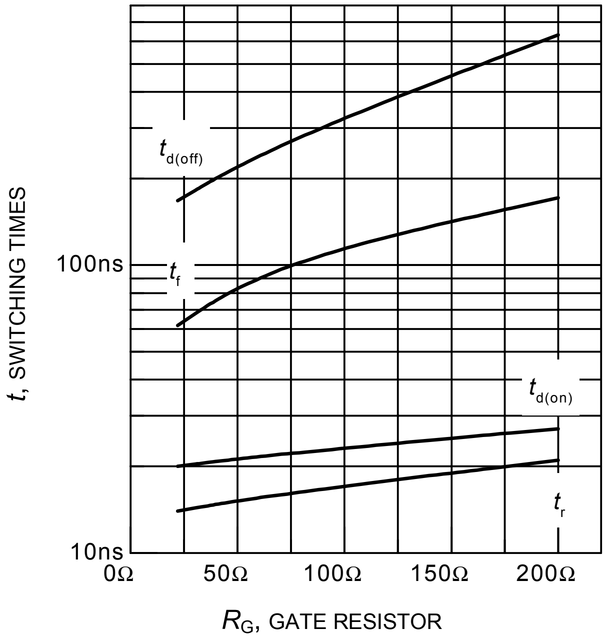


Figure 10. Typical switching times as a function of gate resistor
(inductive load, T_j = 150°C, V_{CE} = 400V, V_{GE} = 0/+15V, I_C = 4A, Dynamic test circuit in Figure E)

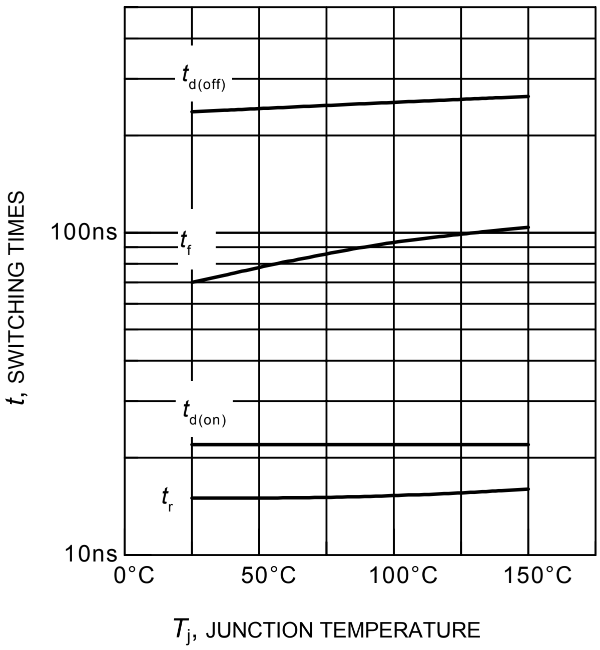


Figure 11. Typical switching times as a function of junction temperature
(inductive load, V_{CE} = 400V, V_{GE} = 0/+15V, I_C = 4A, R_G = 67Ω, Dynamic test circuit in Figure E)

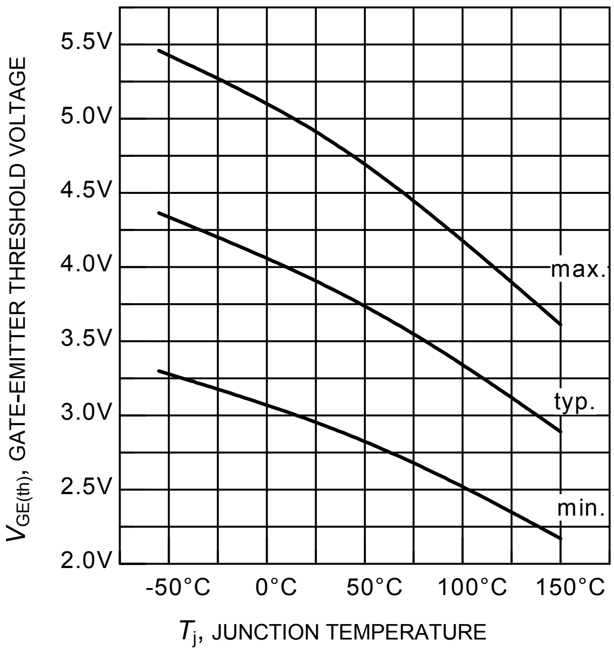


Figure 12. Gate-emitter threshold voltage as a function of junction temperature
(I_C = 0.2mA)

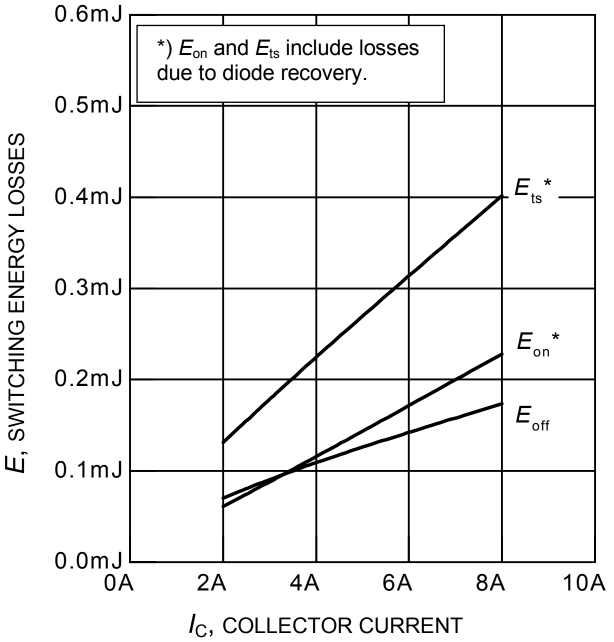


Figure 13. Typical switching energy losses as a function of collector current
(inductive load, T_j = 150°C, V_{CE} = 400V, V_{GE} = 0/+15V, R_G = 67Ω, Dynamic test circuit in Figure E)

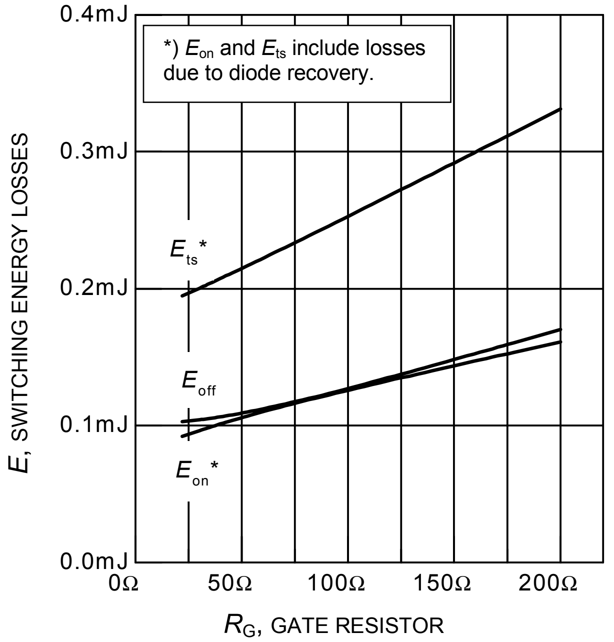


Figure 14. Typical switching energy losses as a function of gate resistor
(inductive load, T_j = 150°C, V_{CE} = 400V, V_{GE} = 0/+15V, I_C = 4A, Dynamic test circuit in Figure E)

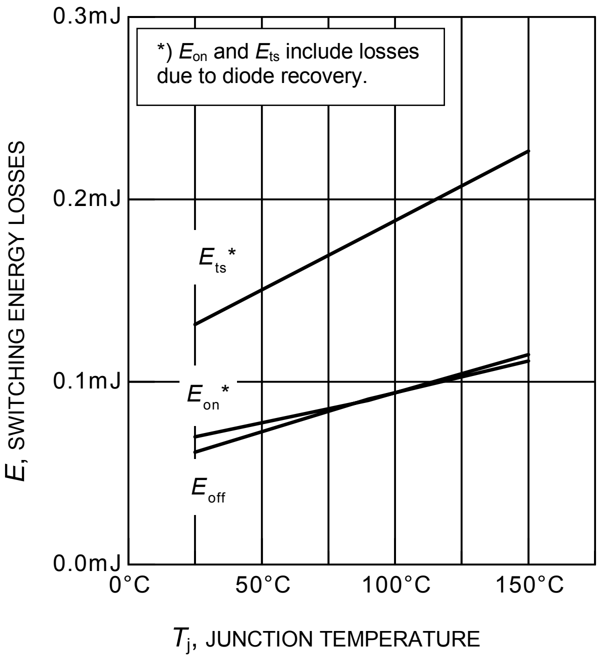
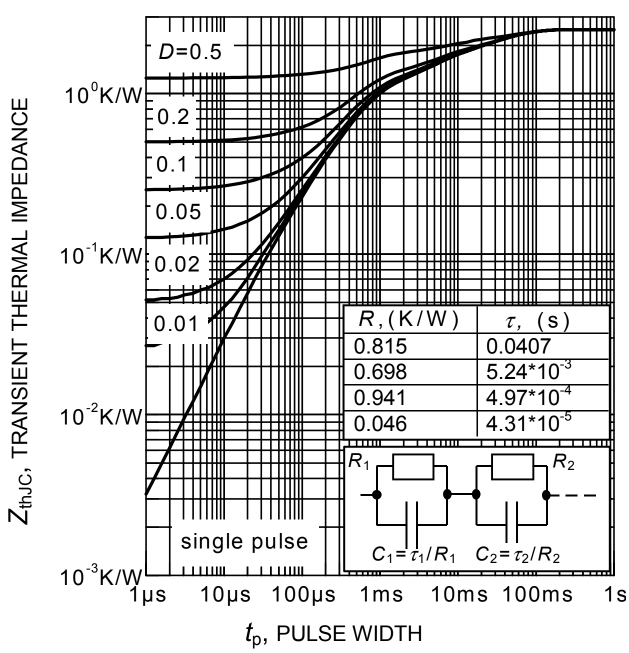


Figure 15. Typical switching energy losses as a function of junction temperature
(inductive load, V_{CE} = 400V, V_{GE} = 0/+15V, I_C = 4A, R_G = 67Ω, Dynamic test circuit in Figure E)



R, (K/W)	τ, (s)
0.815	0.0407
0.698	$5.24 \cdot 10^{-3}$
0.941	$4.97 \cdot 10^{-4}$
0.046	$4.31 \cdot 10^{-5}$

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

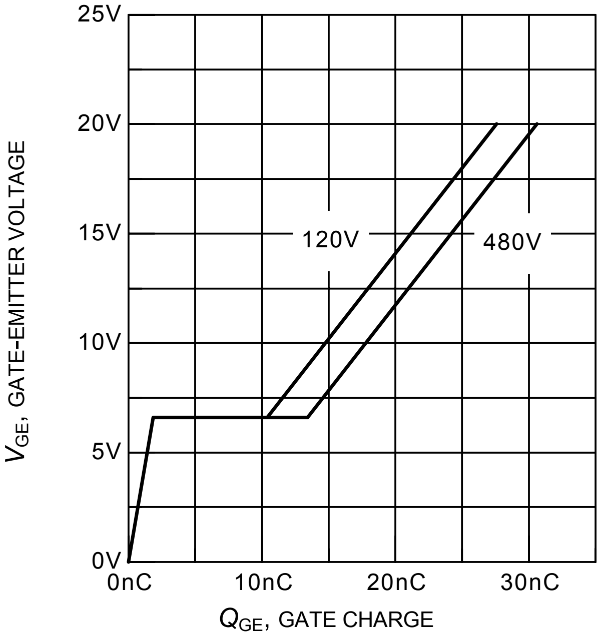


Figure 17. Typical gate charge
(I_C = 4A)

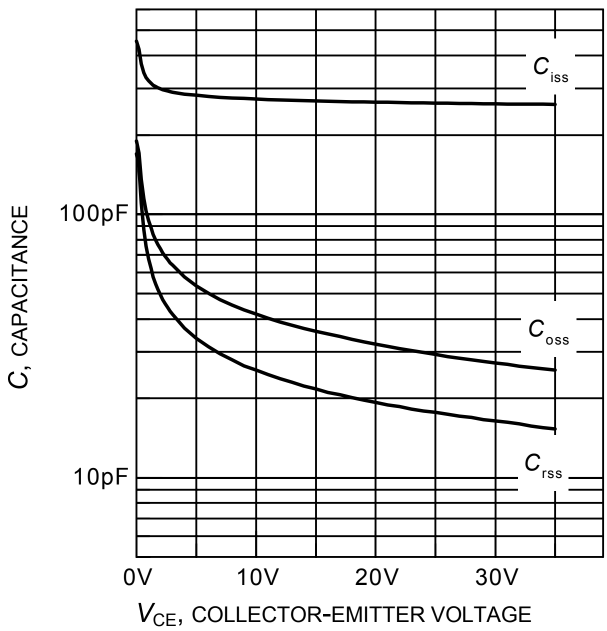


Figure 18. Typical capacitance as a function of collector-emitter voltage
(V_{GE} = 0V, f = 1MHz)

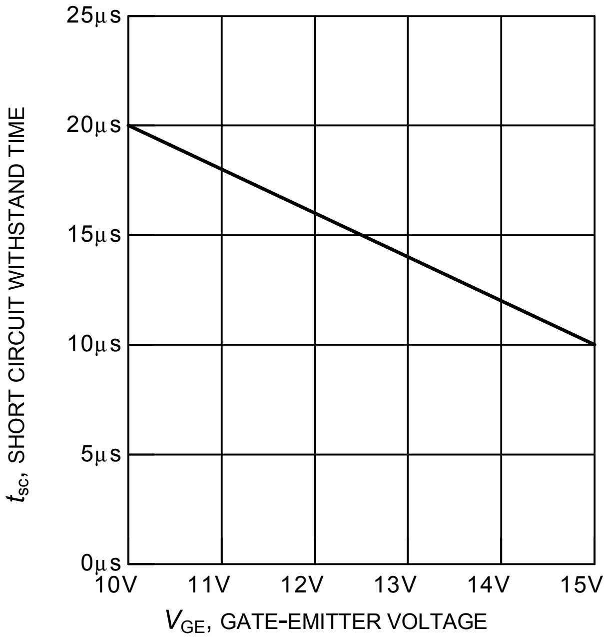


Figure 19. Short circuit withstand time as a function of gate-emitter voltage
(V_{CE} = 600V, start at T_j = 25°C)

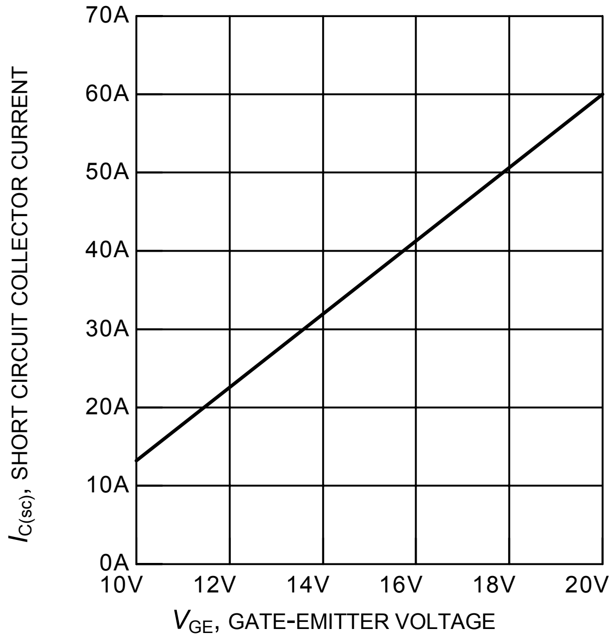


Figure 20. Typical short circuit collector current as a function of gate-emitter voltage
($V_{CE} \leq$ 600V, T_j = 150°C)

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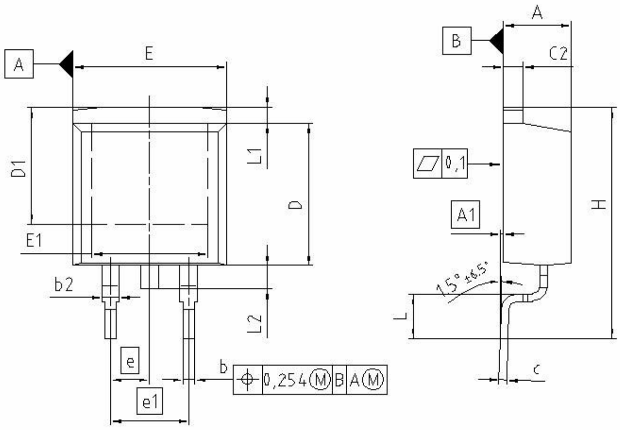
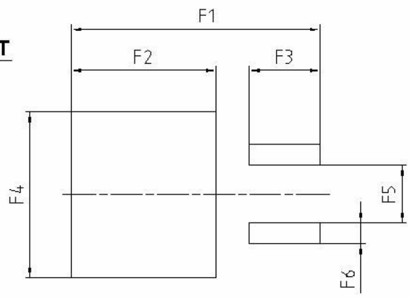


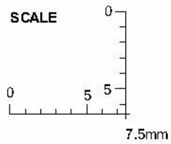
FOOTPRINT



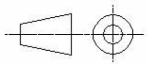
DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.300	4.572	0.169	0.180
A1	0.000	0.254	0.000	0.010
b	0.650	0.850	0.026	0.033
b2	0.950	1.321	0.037	0.052
c	0.330	0.650	0.013	0.026
c2	0.170	1.400	0.046	0.055
D	8.509	9.450	0.335	0.372
D1	7.100	-	0.280	-
E	9.800	10.312	0.386	0.406
E1	6.500		0.256	
e	2.540		0.100	
e1	5.080		0.200	
N	2		2	
H	14.605	15.875	0.575	0.625
L	2.200	3.000	0.087	0.118
L1	-	1.600	-	0.063
L2	1.000	1.778	0.039	0.070
F1	16.050	16.250	0.632	0.640
F2	9.300	9.500	0.366	0.374
F3	4.500	4.700	0.177	0.185
F4	10.700	10.900	0.421	0.429
F5	3.630	3.830	0.143	0.151
F6	1.100	1.300	0.043	0.051

REFERENCE
JEDEC TO263

SCALE



EUROPEAN PROJECTION



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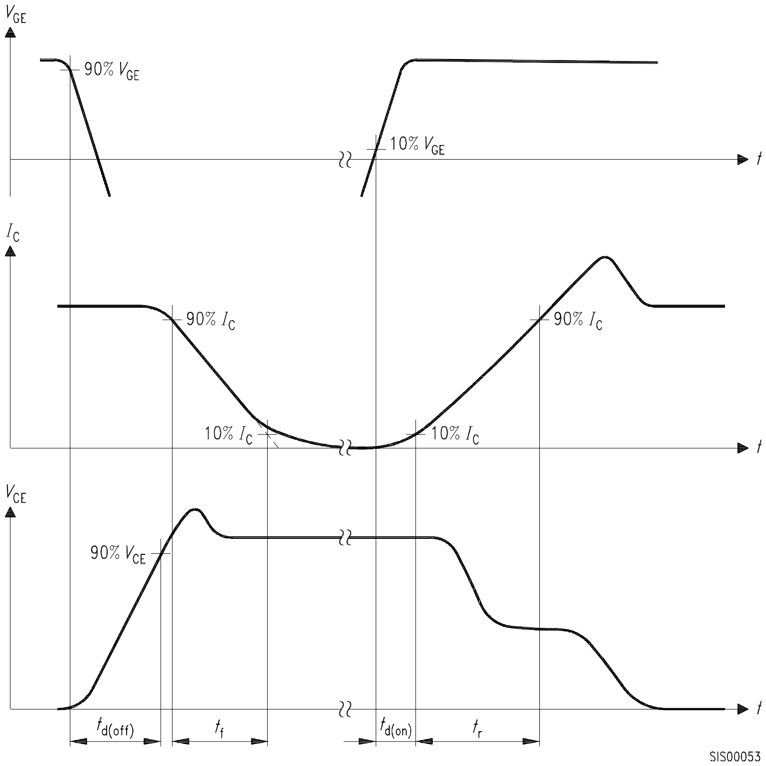

Figure A. Definition of switching times

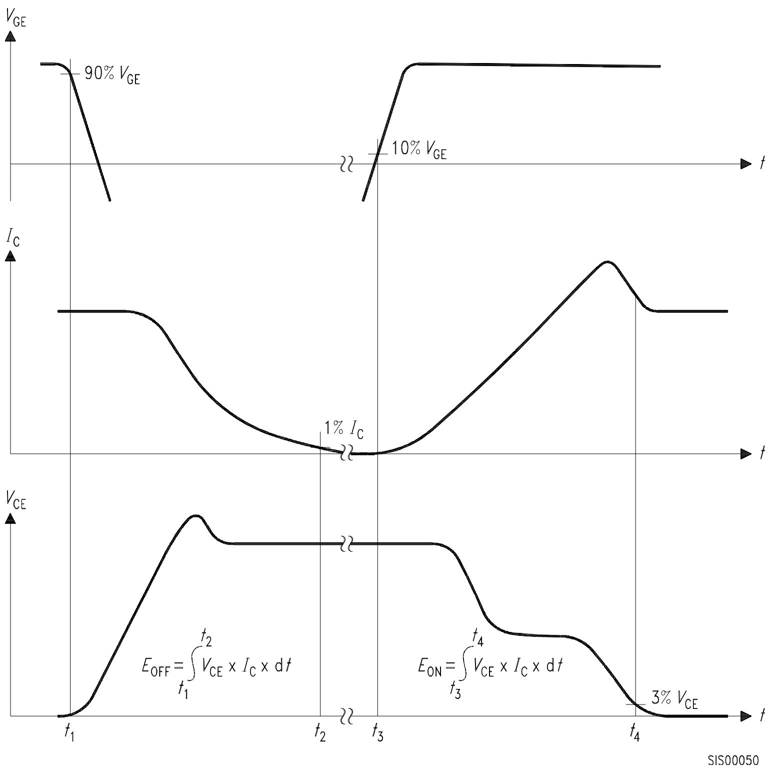

Figure B. Definition of switching losses

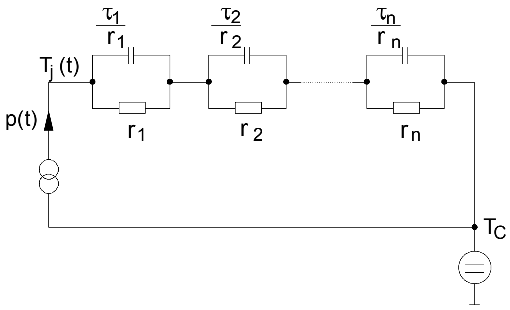

Figure D. Thermal equivalent circuit

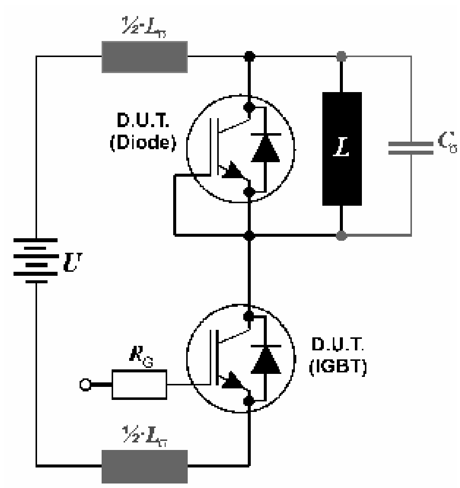

Figure E. Dynamic test circuit
Leakage inductance L_σ =180nH
and Stray capacity C_σ =180pF.

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