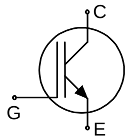
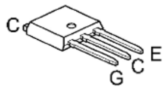
Low Loss IGBT : IGBT in TRENCHSTOP™ technology



- Very low $V_{CE(sat)}$ 1.5 V (typ.)
- Maximum Junction Temperature 175°C
- Short circuit withstand time 5µs
- Designed for :
  - frequency inverters
  - drives
- TRENCHSTOP™ technology for 600V applications offers :
  - very tight parameter distribution
  - high ruggedness, temperature stable behavior
  - very high switching speed
  - low $V_{CE(sat)}$
- Positive temperature coefficient in $V_{CE(sat)}$
- Low EMI
- Low Gate Charge
  Qualified according to JEDEC[1] for target applications
- Complete product spectrum and PSpice Models : http://www.infineon.com/igbt/



PG-TO251-3

Type	V_{CE}	I_C	$V_{CE(sat),Tj=25°C}$	$T_{j,max}$	Marking	Package
IGU04N60T	600 V	4 A	1.5 V	175 °C	G04T60	PG-TO251-3

Maximum Ratings

Parameter	Symbol	Value	Unit
Collector-emitter voltage	V_{CE}	600	V
DC collector current, limited by T_{jmax} T_C = 25°C T_C = 100°C	I_C	 9.5 6.5	A
Pulsed collector current, t_p limited by T_{jmax}	I_{Cpuls}	12	
Turn off safe operating area ($V_{CE} \leq$ 600V, $T_j \leq$ 175°C)	-	12	
Gate-emitter voltage	V_{GE}	±20	V
Short circuit withstand time[2)] V_{GE} = 15V, $V_{CC} \leq$ 400V, $T_j \leq$ 150°C	t_{SC}	5	µs
Power dissipation T_C = 25°C	P_{tot}	42	W
Operating junction temperature	T_j	-40...+175	°C
Storage temperature	T_{stg}	-55...+150	
Soldering temperature, wave soldering, 1.6mm (0.063 in.) from case for 10s.	T_s	260	°C

[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}		3.5	K/W
Thermal resistance, junction – ambient	R_{thJA}		75	

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=0.2mA	600	-	-	V
Collector-emitter saturation voltage	$V_{CE(sat)}$	V_{GE} = 15V, I_C=4A T_j=25°C T_j=175°C	 - -	 1.5 1.9	 2.05 -	
Gate-emitter threshold voltage	$V_{GE(th)}$	I_C= 60µA, V_{CE}=V_{GE}	4.1	4.9	5.7	
Zero gate voltage collector current	I_{CES}	V_{CE}=600V, V_{GE}=0V T_j=25°C T_j=175°C	 - -	 - 40	 40 -	µA
Gate-emitter leakage current	I_{GES}	V_{CE}=0V, V_{GE}=20V	-	-	100	nA
Transconductance	g_{fs}	V_{CE}=20V, I_C=4A	-	2.2	-	S

Dynamic Characteristic

Parameter	Symbol	Conditions	min.	Typ.	max.	Unit
Input capacitance	C_{iss}	V_{CE}=25V,	-	252	-	pF
Output capacitance	C_{oss}	V_{GE}=0V,	-	20	-	
Reverse transfer capacitance	C_{rss}	f=1MHz	-	7.5	-	
Gate charge	Q_{Gate}	V_{CC}=480V, I_C=4A V_{GE}=15V	-	27	-	nC
Internal emitter inductance measured 5mm (0.197 in.) from case	L_E		-	7	-	nH
Short circuit collector current[1)]	$I_{C(SC)}$	V_{GE}=15V, t_{SC}≤5µs V_{CC} = 400V, T_j ≤ 150°C	-	36	-	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}=400V, I_C=4A, V_{GE}=0/15V, r_G=47Ω, L_σ=150nH, C_σ=47pF L_σ, C_σ from Fig. E Energy losses include "tail" and diode reverse recovery.	-	14	-	ns
Rise time	t_r		-	7	-	
Turn-off delay time	$t_{d(off)}$		-	164	-	
Fall time	t_f		-	43	-	
Turn-on energy	E_{on}		-	61	-	µJ
Turn-off energy	E_{off}		-	84	-	
Total switching energy	E_{ts}		-	145	-	

Switching Characteristic, Inductive Load, at T_j=175 °C

Parameter	Symbol	Conditions	Value			Unit
			min.	Typ.	max.	
IGBT Characteristic						
Turn-on delay time	$t_{d(on)}$	T_j=175°C, V_{CC}=400V, I_C=4A, V_{GE}=0/15V, r_G=47Ω, L_σ=150nH, C_σ=47pF L_σ, C_σ from Fig. E Energy losses include "tail" and diode reverse recovery.	-	14	-	ns
Rise time	t_r		-	10	-	
Turn-off delay time	$t_{d(off)}$		-	185	-	
Fall time	t_f		-	83	-	
Turn-on energy	E_{on}		-	99	-	µJ
Turn-off energy	E_{off}		-	97	-	
Total switching energy	E_{ts}		-	196	-	

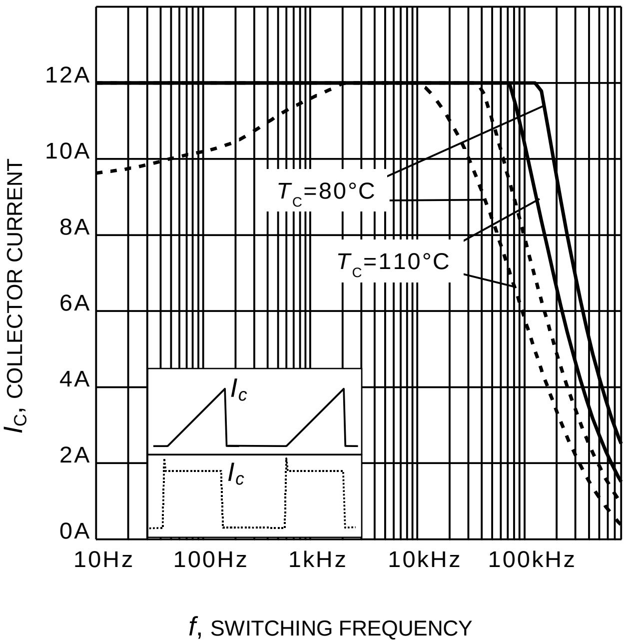


Figure 1. Collector current as a function of switching frequency
($T_j \leq 175°C$, $D = 0.5$, $V_{CE} = 400V$, $V_{GE} = 0/15V$, $r_G = 47\Omega$)

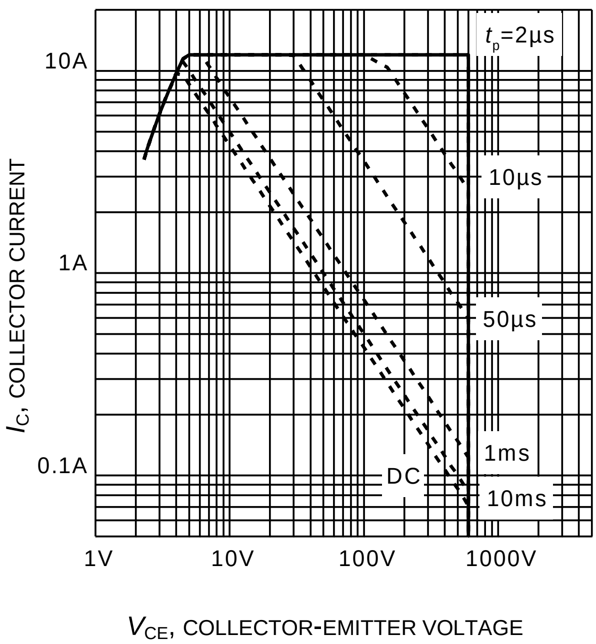


Figure 2. Safe operating area
($D = 0$, $T_C = 25°C$, $T_j \leq 175°C$; V_{GE}=0/15V)

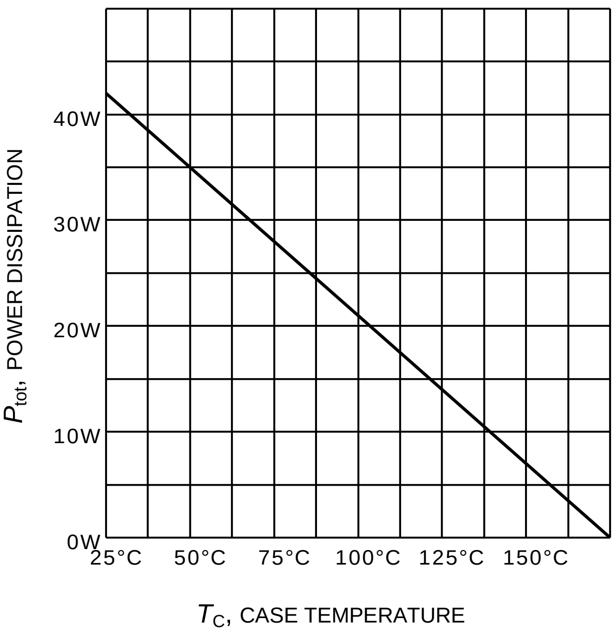


Figure 3. Power dissipation as a function of case temperature
($T_j \leq 175°C$)

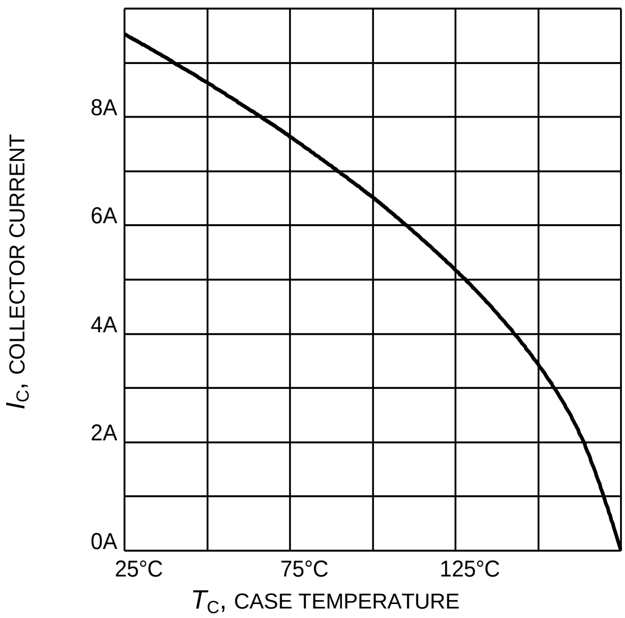


Figure 4. Collector current as a function of case temperature
($V_{GE} \geq 15V$, $T_j \leq 175°C$)

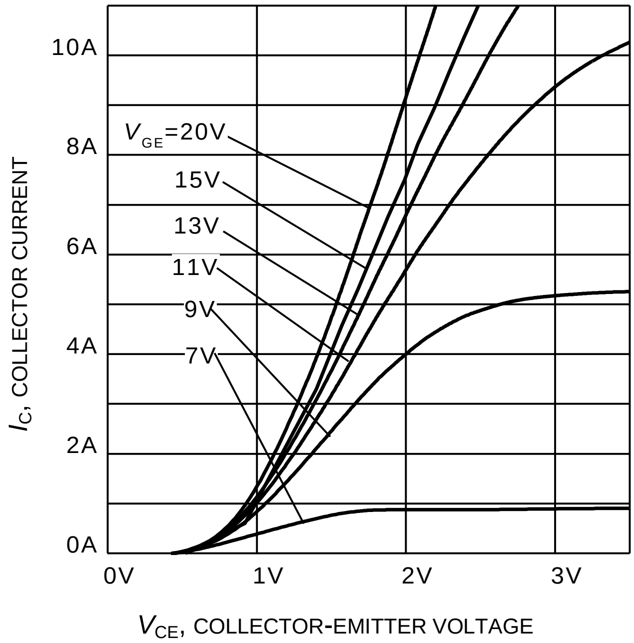


Figure 5. Typical output characteristic
(T_j = 25°C)

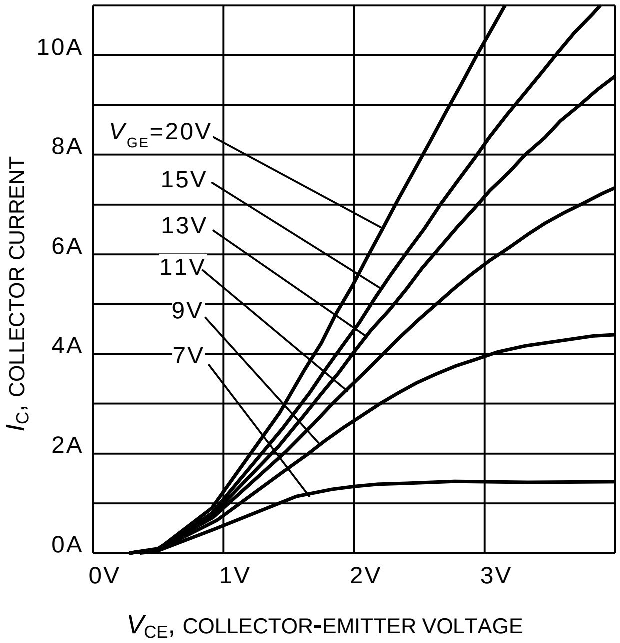


Figure 6. Typical output characteristic
(T_j = 175°C)

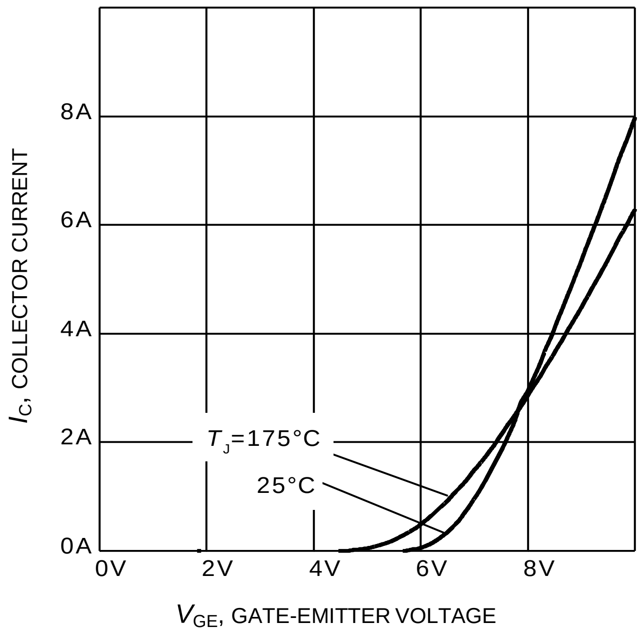


Figure 7. Typical transfer characteristic
(V_{CE}=20V)

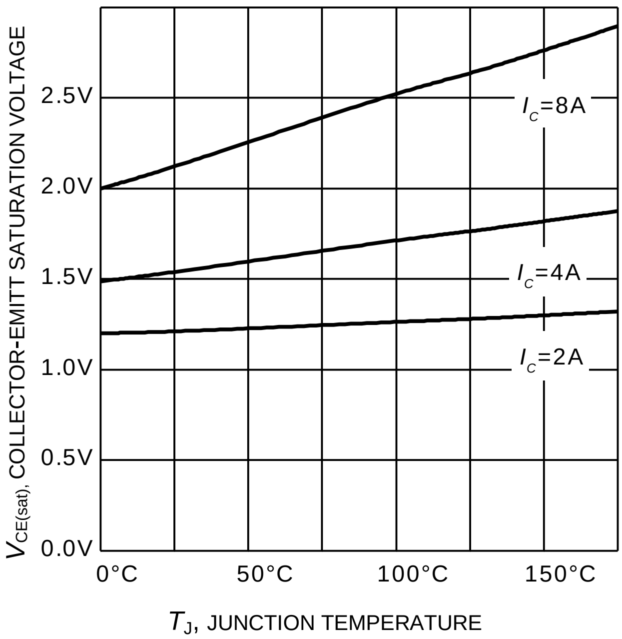


Figure 8. Typical collector-emitter saturation voltage as a function of junction temperature
(V_{GE} = 15V)

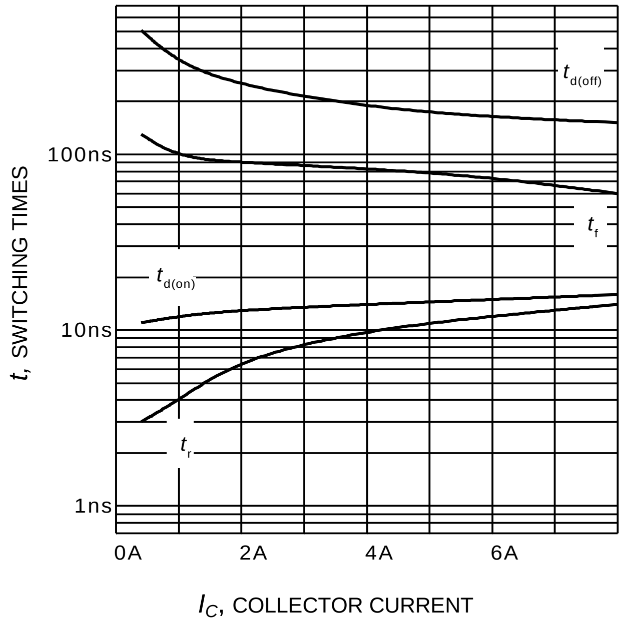


Figure 9. Typical switching times as a function of collector current
(inductive load, T_J=175°C, V_{CE} = 400V, V_{GE} = 0/15V, r_G = 47Ω, Dynamic test circuit in Figure E)

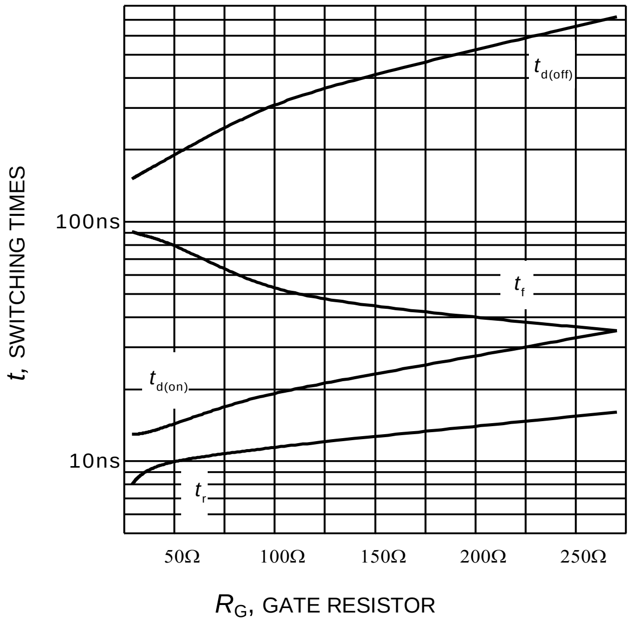


Figure 10. Typical switching times as a function of gate resistor
(inductive load, T_J = 175°C, V_{CE}= 400V, V_{GE} = 0/15V, I_C = 4A, Dynamic test circuit in Figure E)

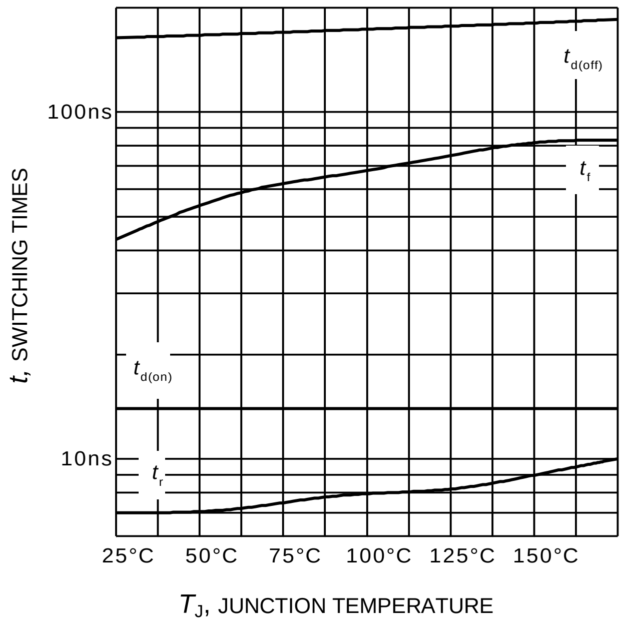


Figure 11. Typical switching times as a function of junction temperature
(inductive load, V_{CE} = 400V, V_{GE} = 0/15V, I_C = 4A, r_G=47Ω, Dynamic test circuit in Figure E)

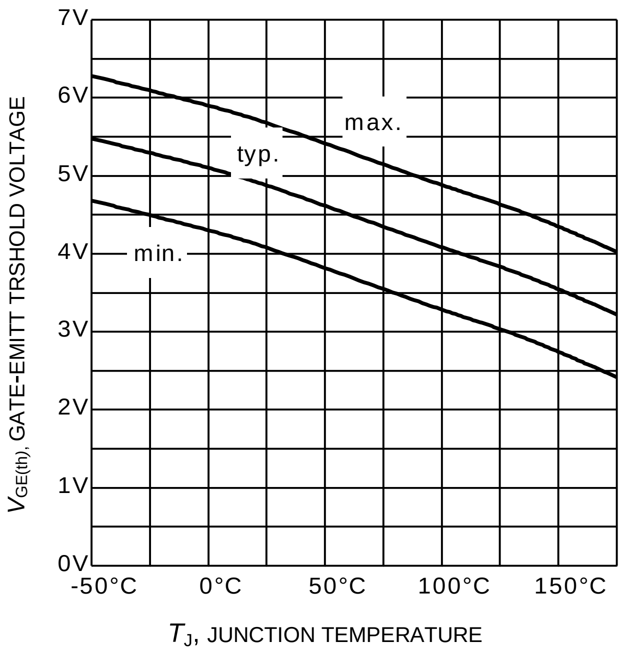


Figure 12. Gate-emitter threshold voltage as a function of junction temperature
(I_C = 60 µA)

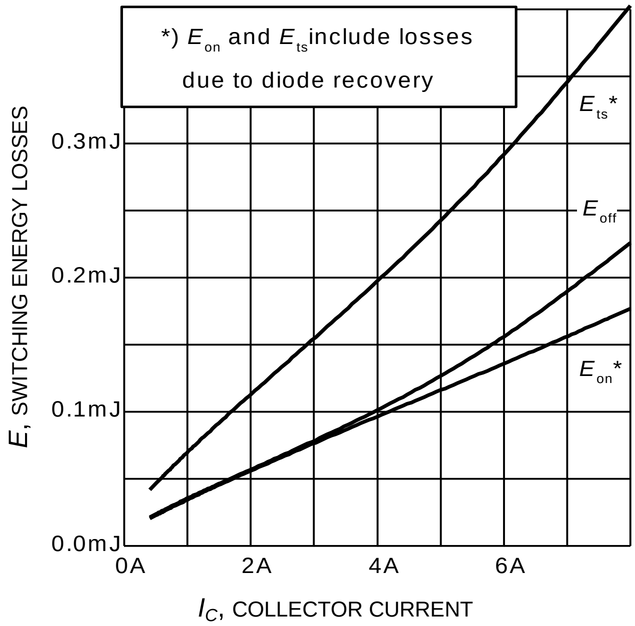


Figure 13. Typical switching energy losses as a function of collector current
(inductive load, T_J = 175°C,
V_{CE} = 400V, V_{GE} = 0/15V, r_G = 47Ω,
Dynamic test circuit in Figure E)

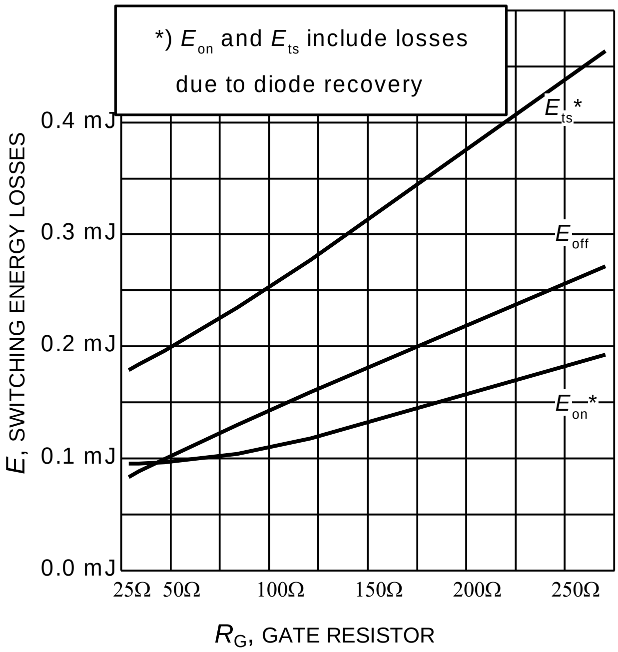


Figure 14. Typical switching energy losses as a function of gate resistor
(inductive load, T_J = 175°C,
V_{CE} = 400V, V_{GE} = 0/15V, I_C = 4A,
Dynamic test circuit in Figure E)

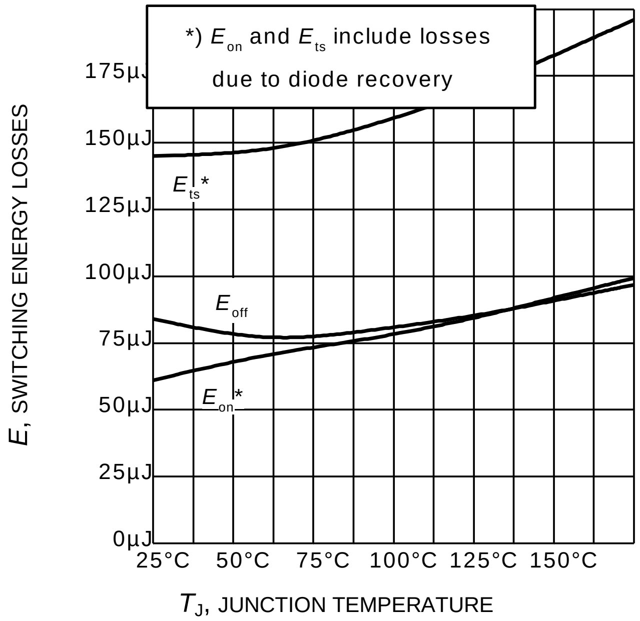


Figure 15. Typical switching energy losses as a function of junction temperature
(inductive load, V_{CE} = 400V,
V_{GE} = 0/15V, I_C = 4A, r_G = 47Ω,
Dynamic test circuit in Figure E)

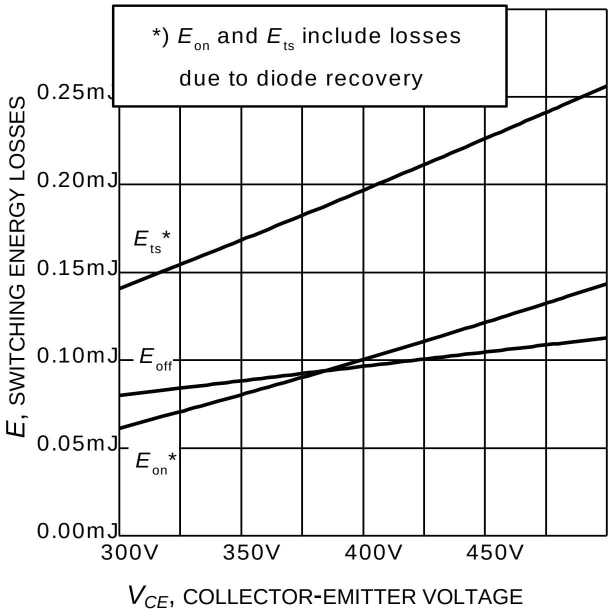


Figure 16. Typical switching energy losses as a function of collector emitter voltage
(inductive load, T_J = 175°C,
V_{GE} = 0/15V, I_C = 4A, r_G = 47Ω,
Dynamic test circuit in Figure E)

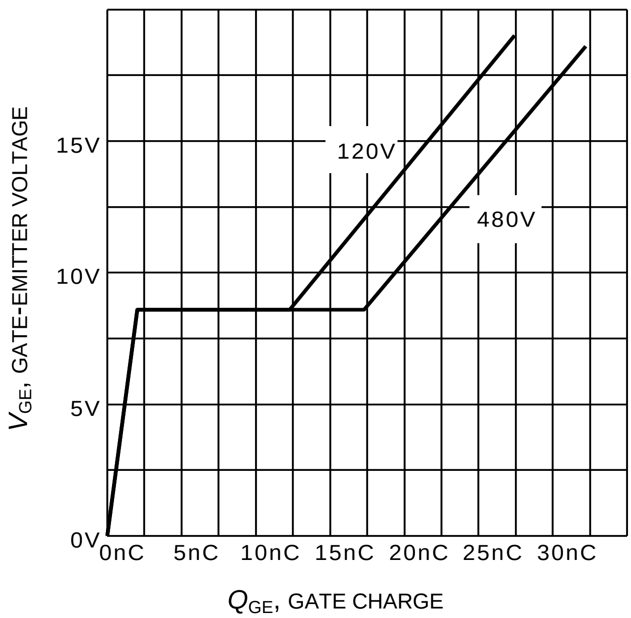


Figure 17. Typical gate charge
(I_C=4 A)

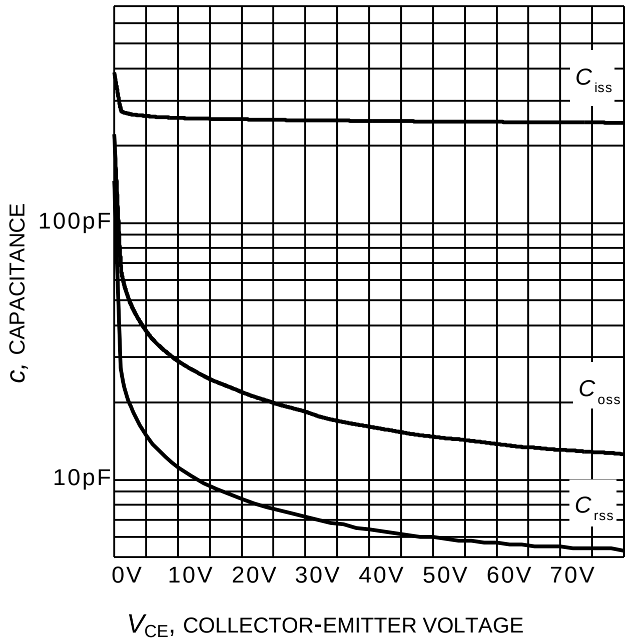


Figure 18. Typical capacitance as a function of collector-emitter voltage
(V_{GE}=0V, f = 1 MHz)

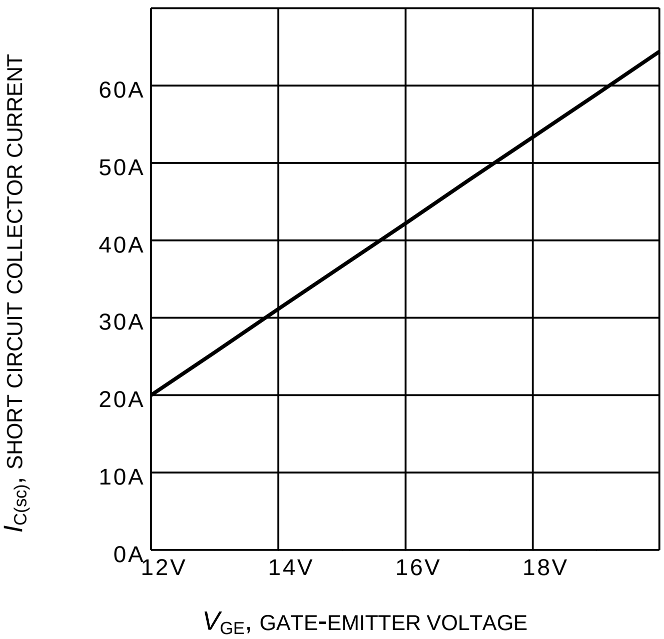


Figure 19. Typical short circuit collector current as a function of gate-emitter voltage
($V_{CE} \leq$ 400V, $T_j \leq$ 150°C)

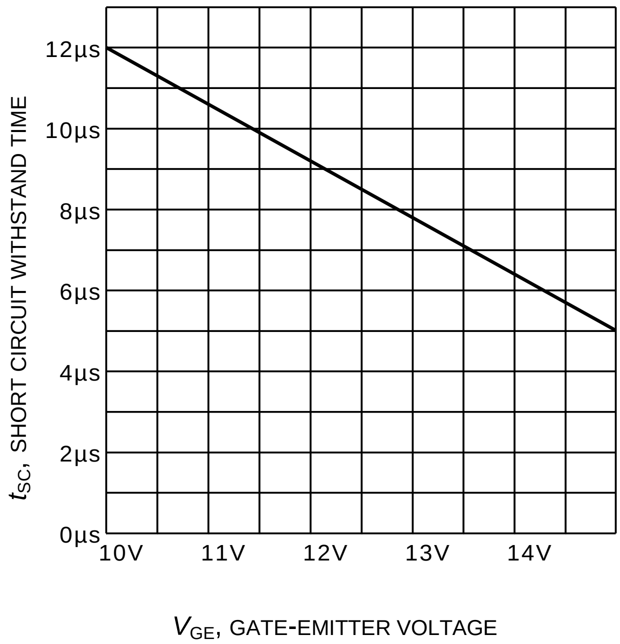


Figure 20. Short circuit withstand time as a function of gate-emitter voltage
(V_{CE}=400V, start at T_j=25°C, $T_{j,max}$<150°C)

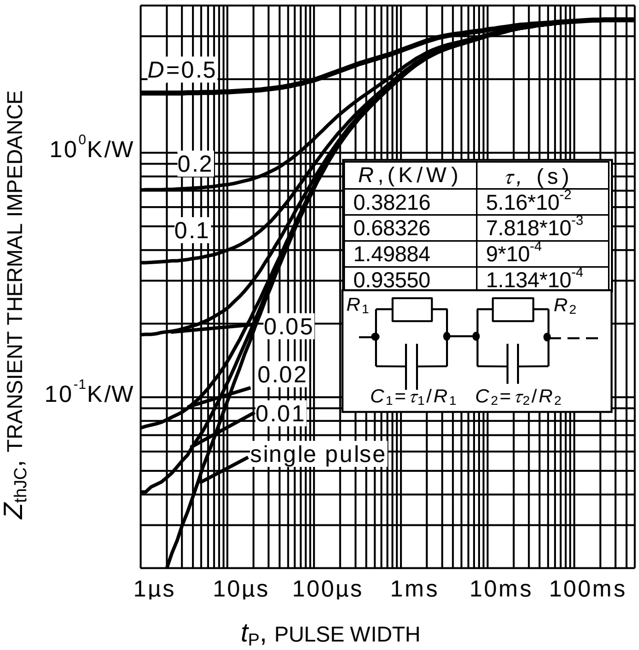
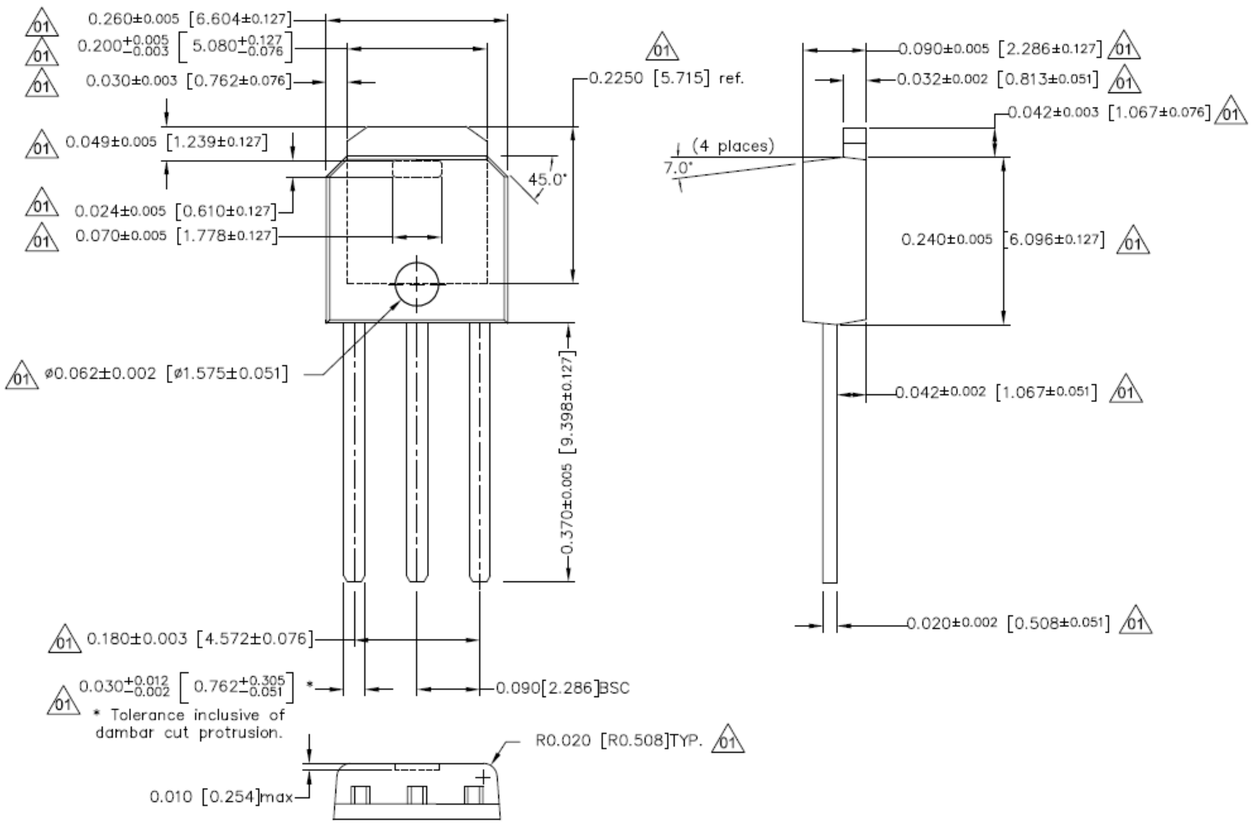


Figure 21. IGBT transient thermal impedance
($D = t_p / T$)

PG-TO251-3


0.260±0.005 [6.604±0.127]
0.200+0.005−0.003 [5.080+0.127−0.076]
0.030±0.003 [0.762±0.076]
0.049±0.005 [1.239±0.127]
0.024±0.005 [0.610±0.127]
0.070±0.005 [1.778±0.127]
ø0.062±0.002 [ø1.575±0.051]
0.2250 [5.715] ref.
45.0°
0.370±0.005 [9.398±0.127]
0.180±0.003 [4.572±0.076]
0.030+0.012−0.002 [0.762+0.305−0.051] *
* Tolerance inclusive of dambar cut protrusion.
0.090[2.286]BSC
R0.020 [R0.508]TYP.
0.010 [0.254]max
0.090±0.005 [2.286±0.127]
0.032±0.002 [0.813±0.051]
0.042±0.003 [1.067±0.076]
(4 places)
7.0°
0.240±0.005 [6.096±0.127]
0.042±0.002 [1.067±0.051]
0.020±0.002 [0.508±0.051]
01

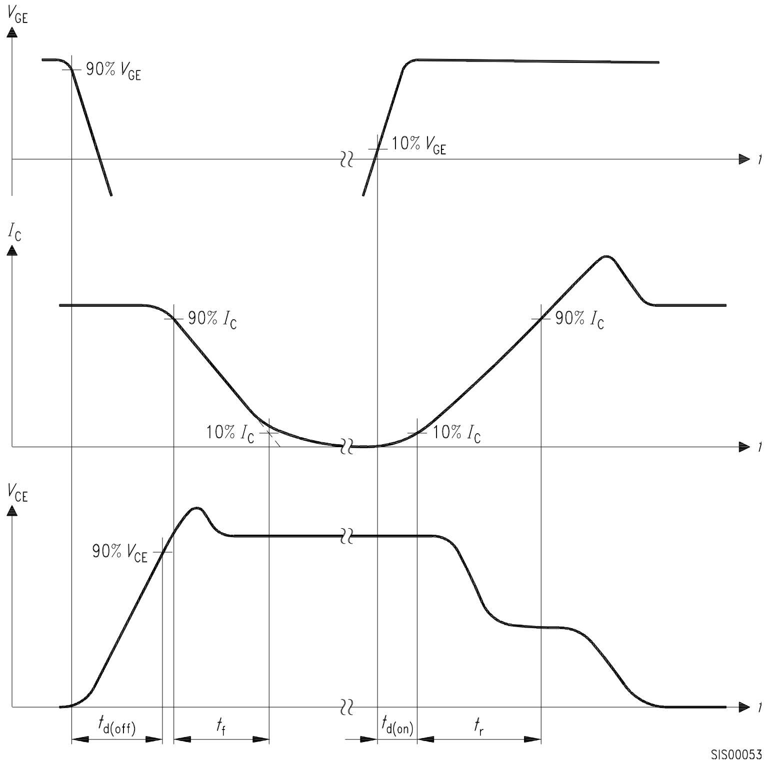


Figure A. Definition of switching times

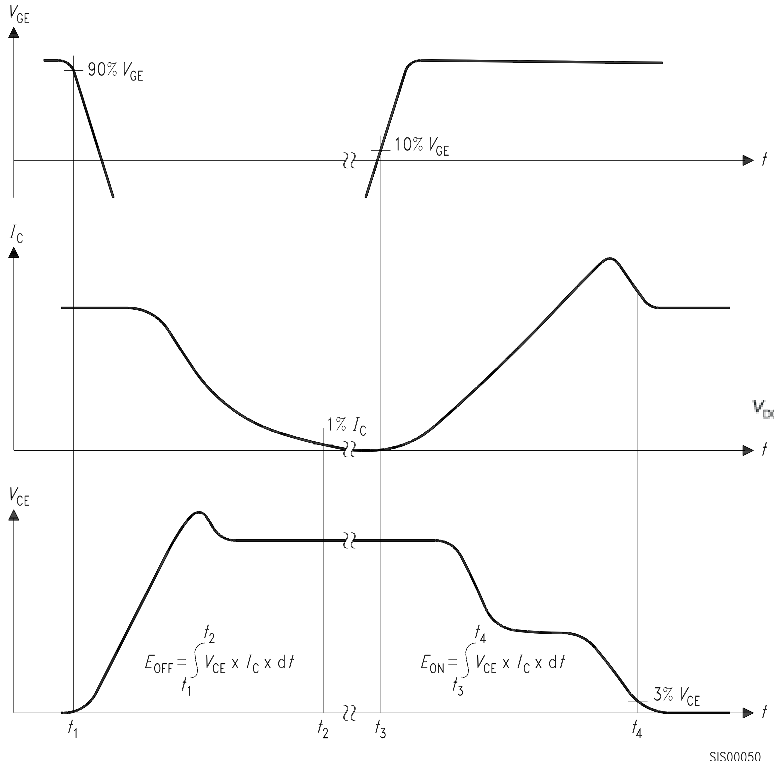


Figure B. Definition of switching losses

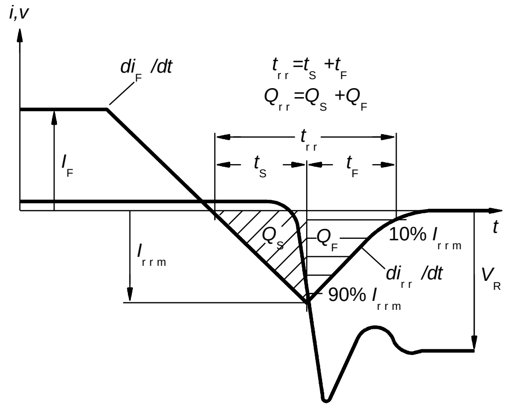


Figure C. Definition of diodes switching characteristics

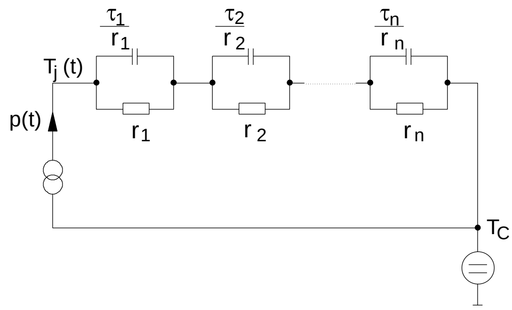


Figure D. Thermal equivalent circuit

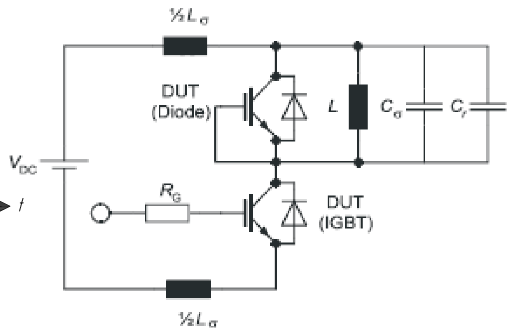


Figure E. Dynamic test circuit
Parasitic inductance L_σ,
Parasitic capacitor C_σ,
Relief capacitor C_r,
(only for ZVT switching)

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