# IGU04N60T

TRENCHSTOP™ Series

Low Loss IGBT : IGBT in TRENCHSTOP™ technology
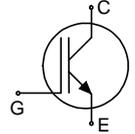
- Very low $V_{CE(sat)}$ 1.5 V (typ.)
- Maximum Junction Temperature 175°C
- Short circuit withstand time 5µs
- Designed for :
    - frequency inverters
    - drives
- TRENCHSTOP™ technology for 600V applications offers :
    - very tight parameter distribution
    - high ruggedness, temperature stable 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/
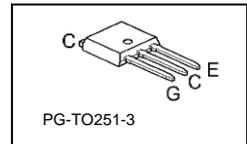
PG-TO251-3

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

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	$V_{CE(sat)}$	$V_{GE} = 15V$, $I_C=4A$				
		$T_j=25°C$	-	1.5	2.05	
		$T_j=175°C$	-	1.9	-	
Gate-emitter threshold voltage	$V_{GE(th)}$	$I_C= 60\mu A, V_{CE}= V_{GE}$	4.1	4.9	5.7	
Zero gate voltage collector current	I_{CES}	$V_{CE}=600V$, $V_{GE}=0V$				µA
		$T_j=25°C$	-	-	40	
		$T_j=175°C$	-	40	-	
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	Value			Unit
			min.	Typ.	max.	
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]	$I_{C(SC)}$	$V_{GE}=15V, t_{SC}\leq5\mu s$ $V_{CC} = 400V$, $T_j \leq 150°C$	-	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 min.	Value Typ.	Value max.	Unit
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 min.	Value Typ.	Value max.	Unit
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	-	
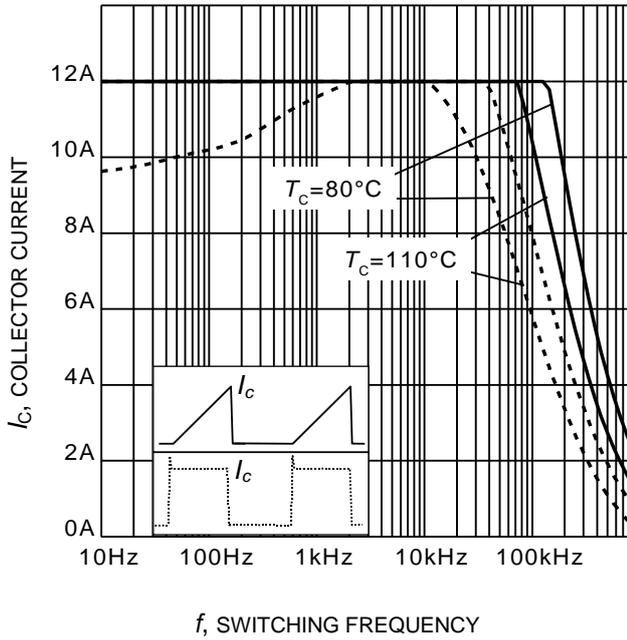
Figure 1. Collector current as a function of switching frequency
($T_j \leq 175°C$, $D = 0.5$, $V_{CE} = 400V$, $V_{GE} = 0/15V$, $r_G = 47\Omega$)

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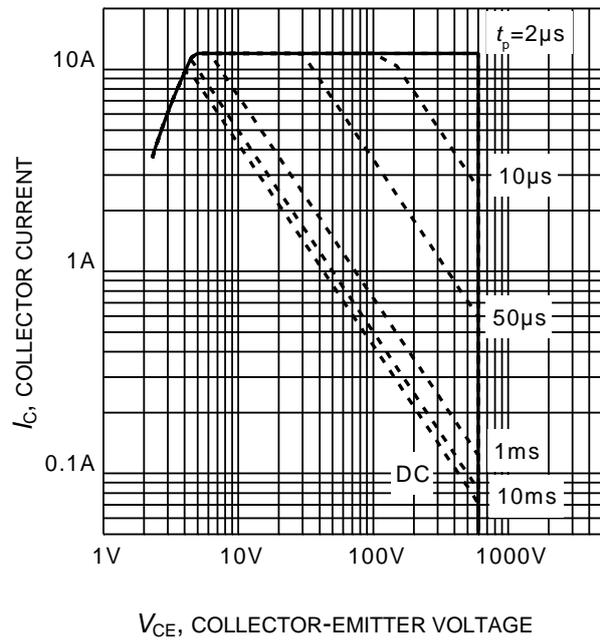
Figure 2. Safe operating area
($D = 0$, $T_C = 25°C$, $T_j \leq 175°C$; $V_{GE}=0/15V$)

V_{CE}, COLLECTOR-EMITTER VOLTAGE
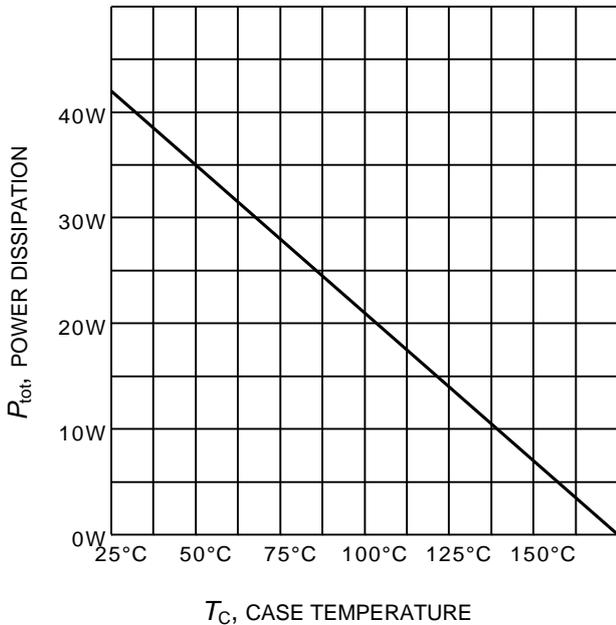
Figure 3. Power dissipation as a function of case temperature
($T_j \leq 175°C$)

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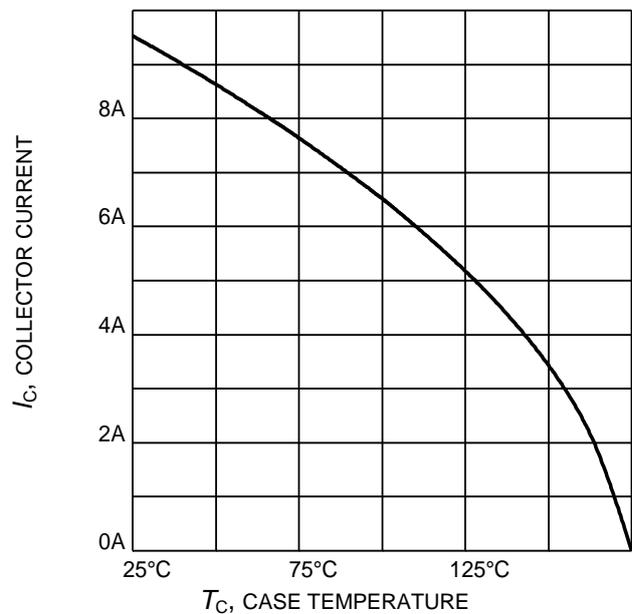
Figure 4. Collector current as a function of case temperature
($V_{GE} \geq 15V$, $T_j \leq 175°C$)

T_C, CASE TEMPERATURE
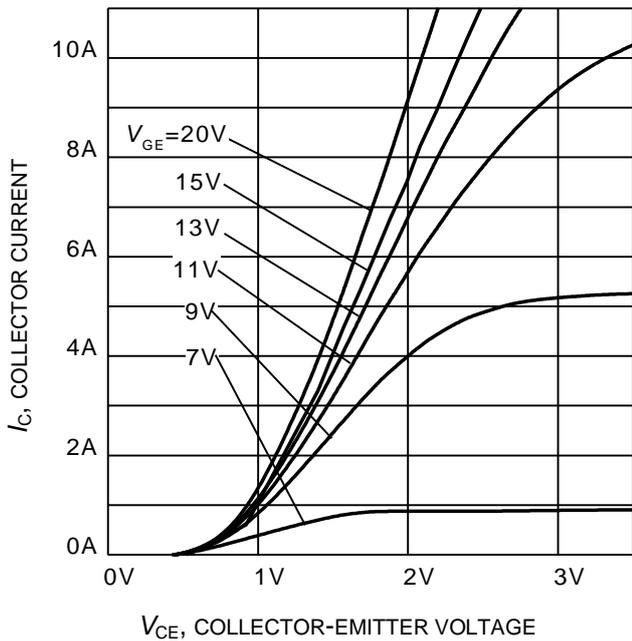
Figure 5. Typical output characteristic
(T_j = 25°C)
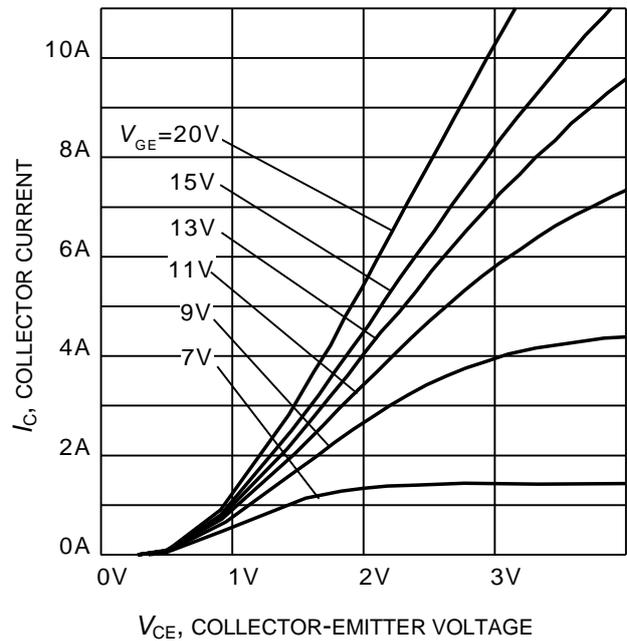
Figure 6. Typical output characteristic
(T_j = 175°C)
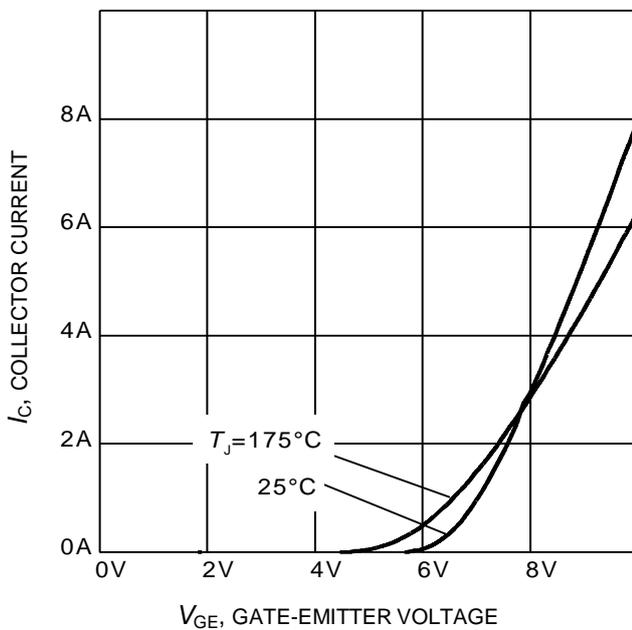
Figure 7. Typical transfer characteristic
(V_{CE}=20V)
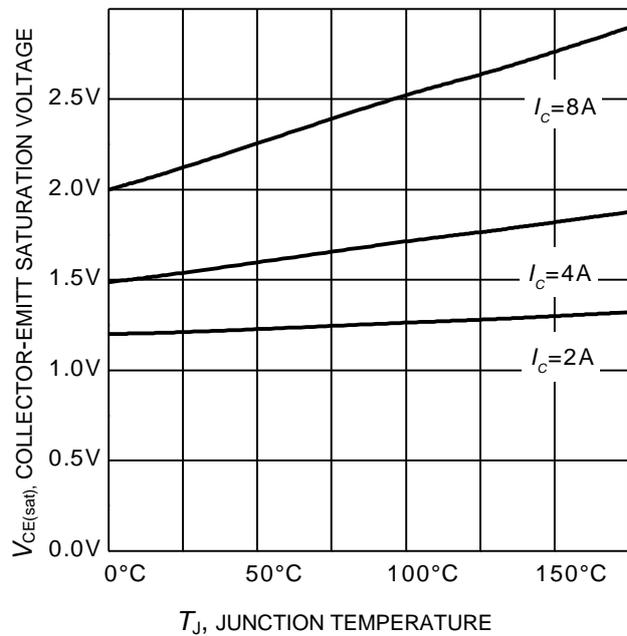
Figure 8. Typical collector-emitter saturation voltage as a function of junction temperature
(V_{GE} = 15V)
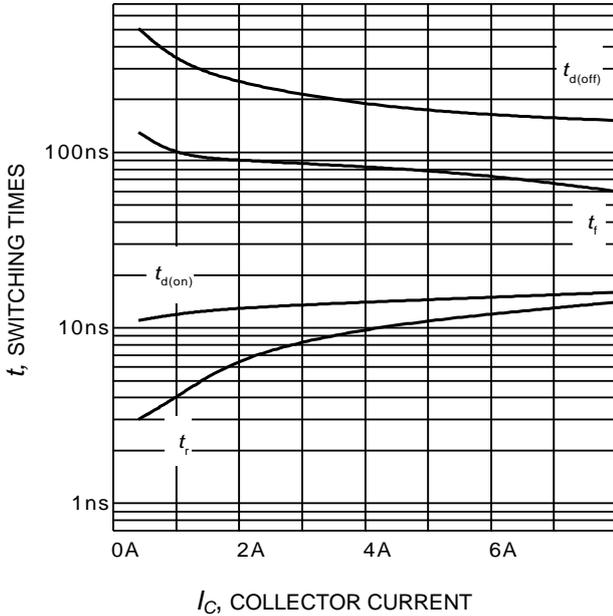
Figure 9. Typical switching times as a function of collector current
(inductive load, T_J=175°C, V_{CE} = 400V, V_{GE} = 0/15V, r_G = 47Ω, Dynamic test circuit in Figure E)
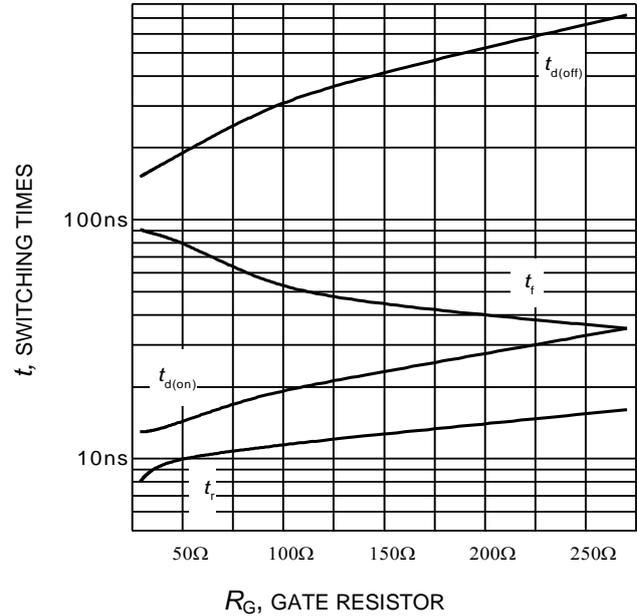
Figure 10. Typical switching times as a function of gate resistor
(inductive load, T_J = 175°C, V_{CE}= 400V, V_{GE} = 0/15V, I_C = 4A, Dynamic test circuit in Figure E)
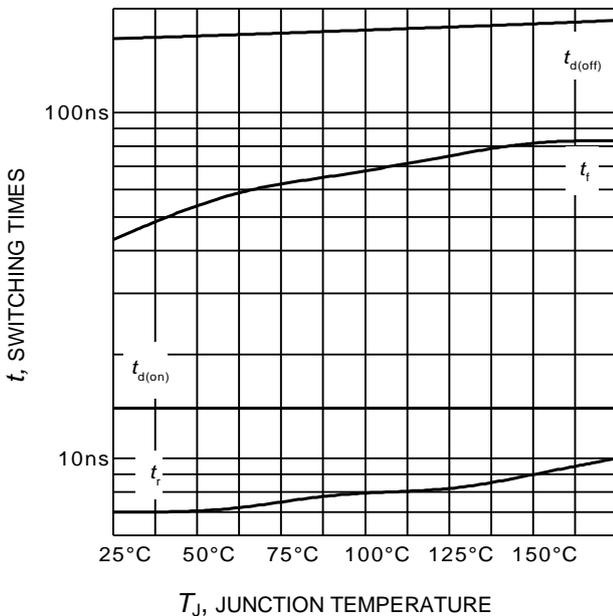
Figure 11. Typical switching times as a function of junction temperature
(inductive load, V_{CE} = 400V, V_{GE} = 0/15V, I_C = 4A, r_G=47Ω, Dynamic test circuit in Figure E)
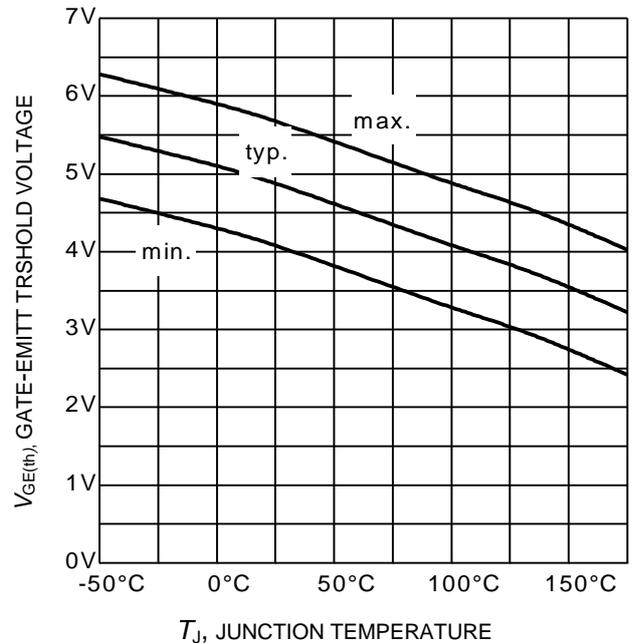
Figure 12. Gate-emitter threshold voltage as a function of junction temperature
(I_C = 60 µA)
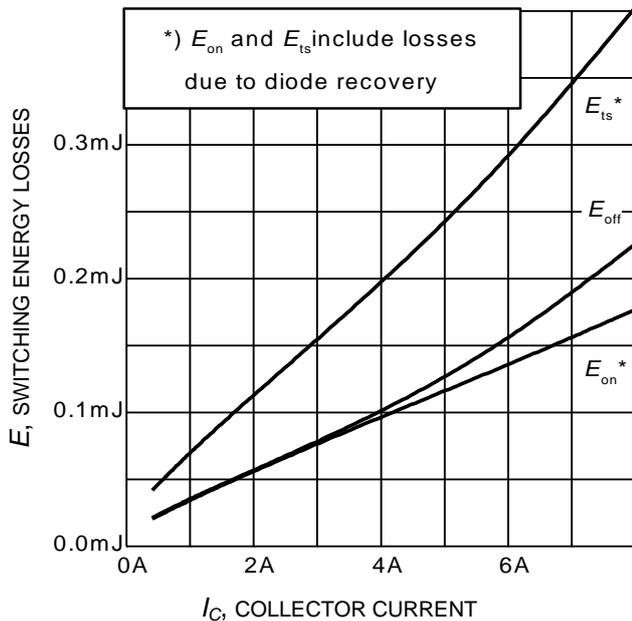
Figure 13. Typical switching energy losses as a function of collector current
(inductive load, T_J = 175°C,
V_{CE} = 400V, V_{GE} = 0/15V, r_G = 47Ω,
Dynamic test circuit in Figure E)
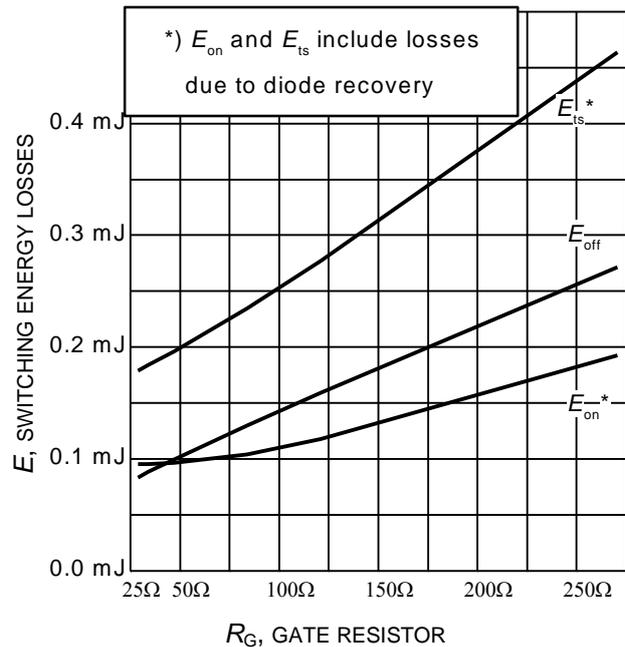
Figure 14. Typical switching energy losses as a function of gate resistor
(inductive load, T_J = 175°C,
V_{CE} = 400V, V_{GE} = 0/15V, I_C = 4A,
Dynamic test circuit in Figure E)
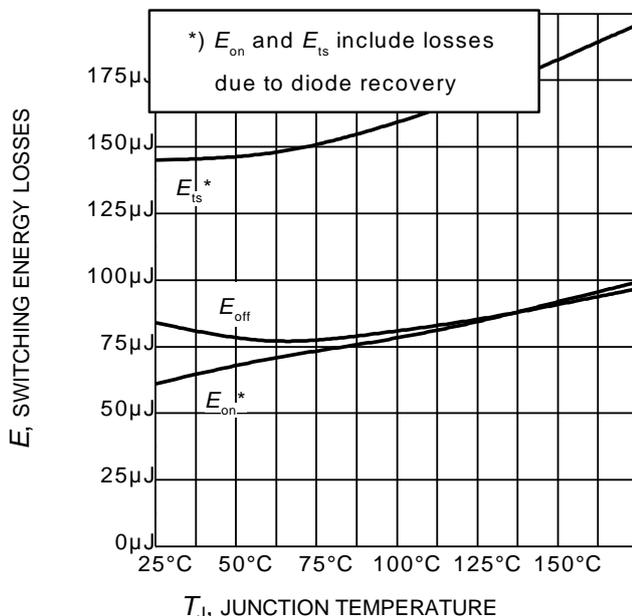
Figure 15. Typical switching energy losses as a function of junction temperature
(inductive load, V_{CE} = 400V,
V_{GE} = 0/15V, I_C = 4A, r_G = 47Ω,
Dynamic test circuit in Figure E)
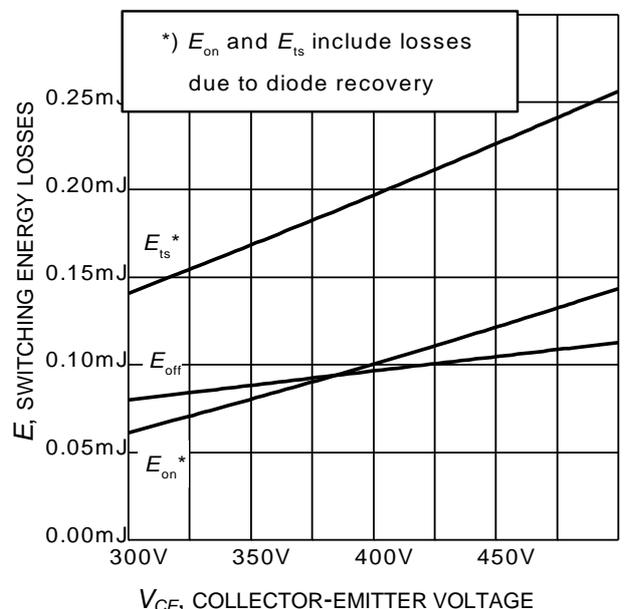
Figure 16. Typical switching energy losses as a function of collector emitter voltage
(inductive load, T_J = 175°C,
V_{GE} = 0/15V, I_C = 4A, r_G = 47Ω,
Dynamic test circuit in Figure E)
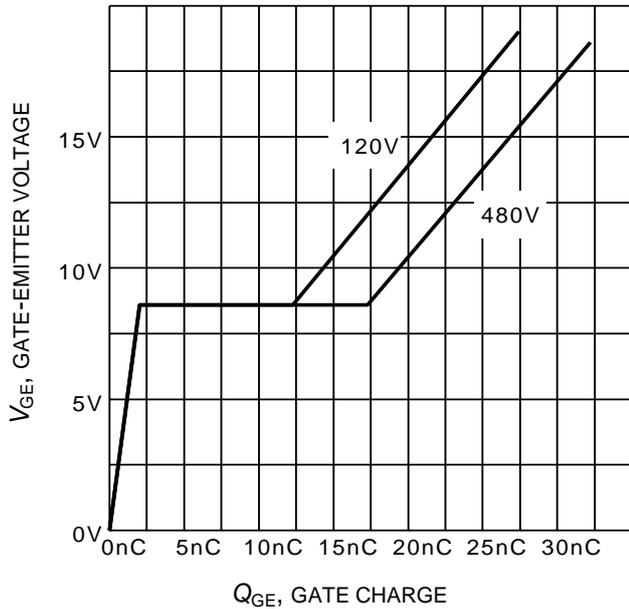
Figure 17. Typical gate charge
(I_C=4 A)
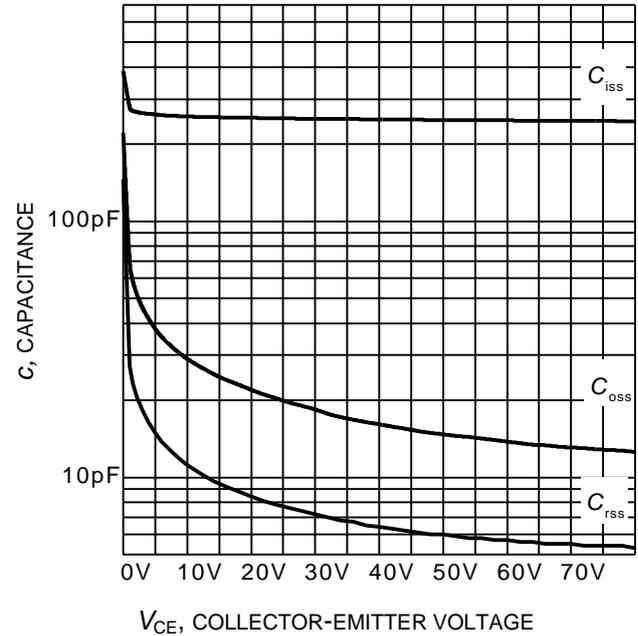
Figure 18. Typical capacitance as a function of collector-emitter voltage
(V_{GE}=0V, f = 1 MHz)
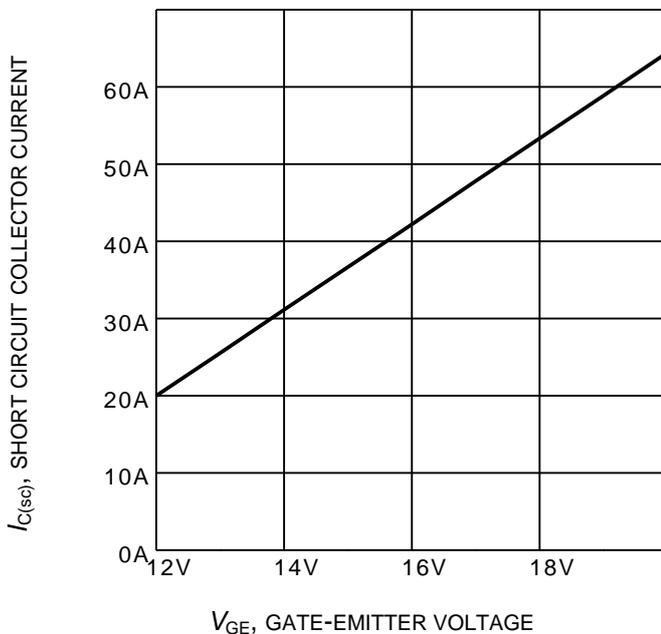
**Figure 19. Typical short circuit collector current as a function of gate-emitter voltage**
($V_{CE} \leq 400V$, $T_j \leq 150°C$)
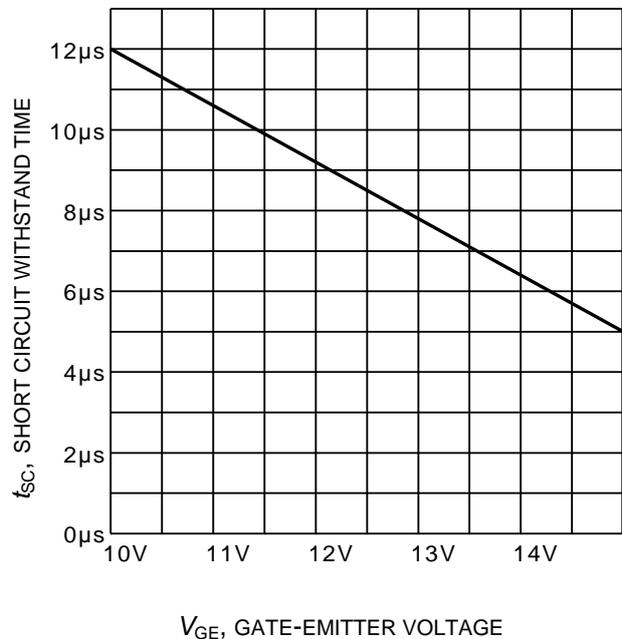
**Figure 20. Short circuit withstand time as a function of gate-emitter voltage**
(V_{CE}=400V, start at T_j=25°C, $T_{j,max}$<150°C)
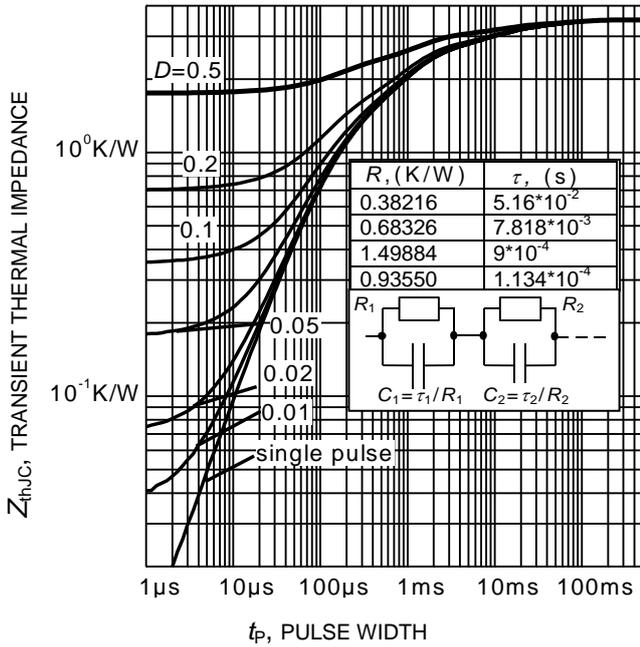
Figure 21. IGBT transient thermal impedance
$(D = t_p / T)$

PG-TO251-3
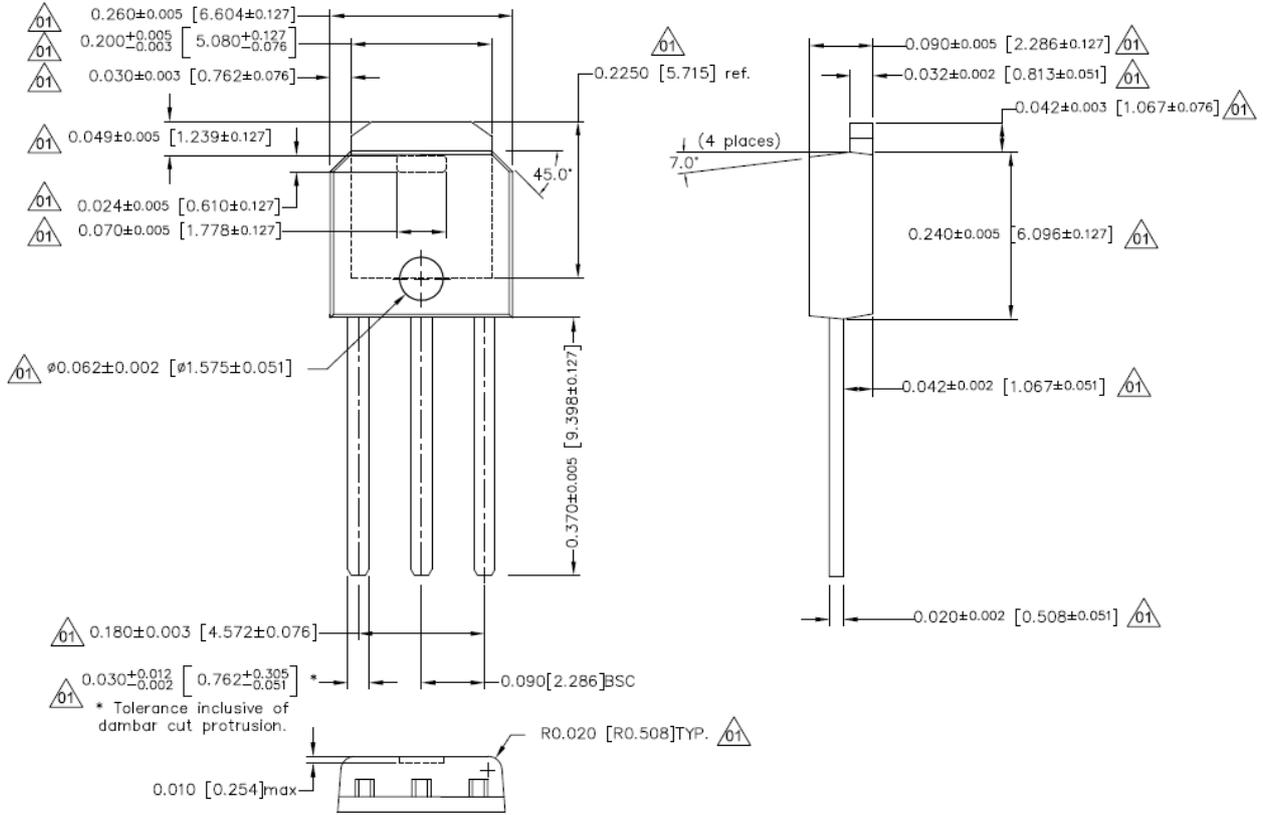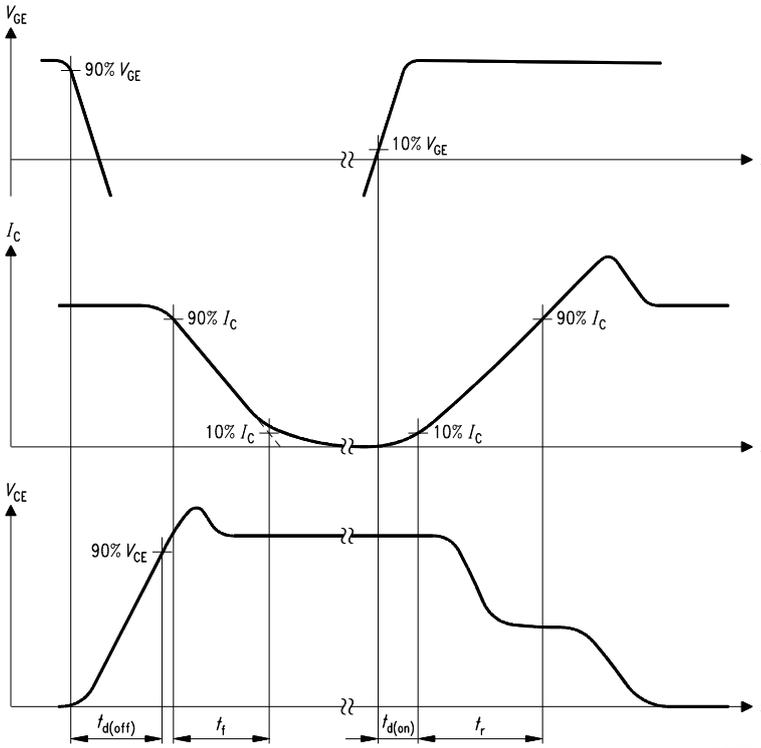
**Figure A. Definition of switching times**

Figure B. Definition of switching losses
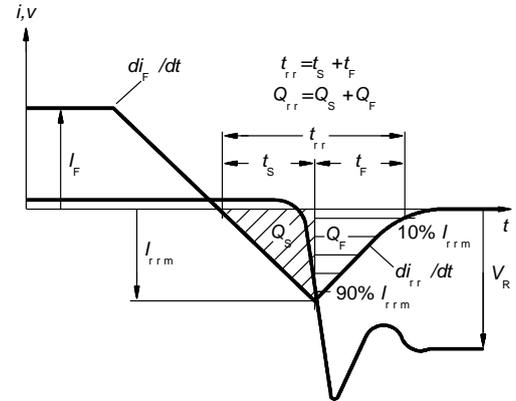
Figure C. Definition of diodes switching characteristics
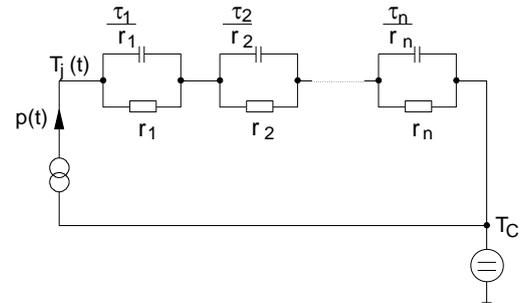

Figure D. Thermal equivalent circuit
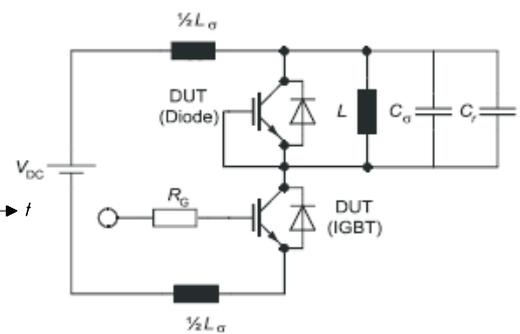
Figure E. Dynamic test circuit
Parasitic inductance L_σ,
Parasitic capacitor C_σ,
Relief capacitor C_r
(only for ZVT switching)