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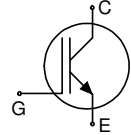
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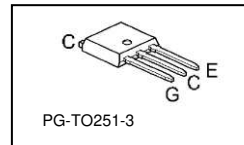
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Low Loss IGBT : IGBT in TRENCHSTOP™ technology



- Very low $V_{CE(sat)}$ 1.5 V (typ.)
- Maximum Junction Temperature 175°C
- Short circuit withstand time 5 μ s
- 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 JEDEC¹ for target applications
- Complete product spectrum and PSpice Models : <http://www.infineon.com/igbt/>



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

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 $T_j = 25\text{ °C}$, 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	$V_{CE(sat)}$	$V_{GE} = 15V, I_C=4A$ $T_j=25\text{ °C}$ $T_j=175\text{ °C}$	- -	1.5 1.9	2.05 -	
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}	$V_{CE}=600V,$ $V_{GE}=0V$ $T_j=25\text{ °C}$ $T_j=175\text{ °C}$	- -	- 40	40 -	μA
Gate-emitter leakage current	I_{GES}	$V_{CE}=0V, V_{GE}=20V$	-	-	100	
Transconductance	g_{fs}	$V_{CE}=20V, I_C=4A$	-	2.2	-	S

Dynamic Characteristic

Input capacitance	C_{iss}	$V_{CE}=25V,$ $V_{GE}=0V,$ $f=1MHz$	-	252	-	pF
Output capacitance	C_{oss}		-	20	-	
Reverse transfer capacitance	C_{rss}		-	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⁾	$I_{C(SC)}$	$V_{GE}=15V, t_{SC}\leq 5\mu s$ $V_{CC} = 400V,$ $T_j \leq 150\text{ °C}$	-	36	-	A

¹⁾ Allowed number of short circuits: <1000; time between short circuits: >1s.

Switching Characteristic, Inductive Load, at $T_j=25^\circ\text{C}$

Parameter	Symbol	Conditions	Value			Unit
			min.	Typ.	max.	
IGBT Characteristic						
Turn-on delay time	$t_{d(on)}$	$T_j=25^\circ\text{C}$, $V_{CC}=400\text{V}$, $I_C=4\text{A}$, $V_{GE}=0/15\text{V}$, $r_G=47\Omega$, $L_\sigma=150\text{nH}$, $C_\sigma=47\text{pF}$ 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 $T_j=175^\circ\text{C}$

Parameter	Symbol	Conditions	Value			Unit
			min.	Typ.	max.	
IGBT Characteristic						
Turn-on delay time	$t_{d(on)}$	$T_j=175^\circ\text{C}$, $V_{CC}=400\text{V}$, $I_C=4\text{A}$, $V_{GE}=0/15\text{V}$, $r_G=47\Omega$, $L_\sigma=150\text{nH}$, $C_\sigma=47\text{pF}$ 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	-	

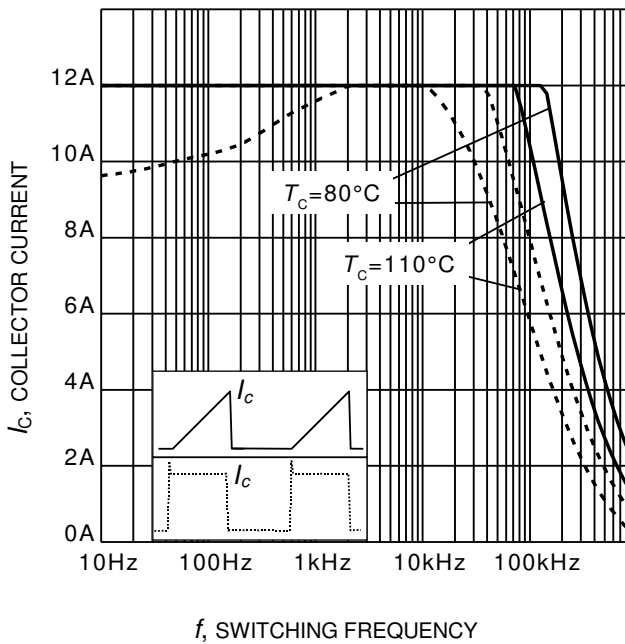


Figure 1. Collector current as a function of switching frequency
 ($T_j \leq 175^\circ\text{C}$, $D = 0.5$, $V_{CE} = 400\text{V}$, $V_{GE} = 0/15\text{V}$, $r_G = 47\Omega$)

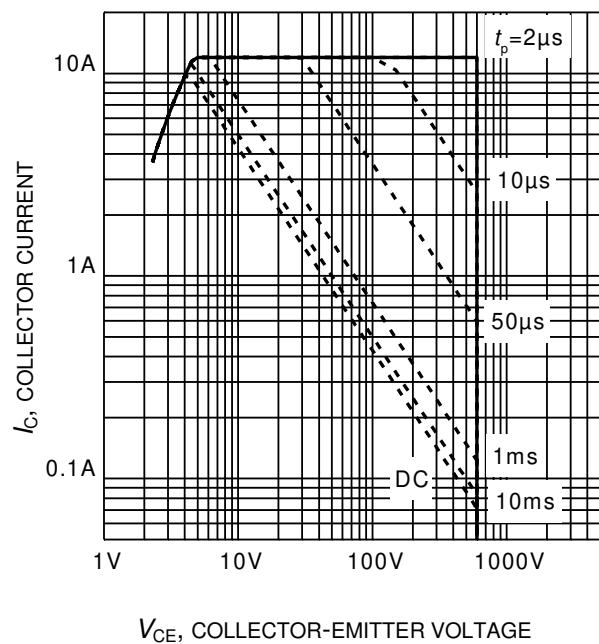


Figure 2. Safe operating area
 ($D = 0$, $T_C = 25^\circ\text{C}$, $T_j \leq 175^\circ\text{C}$; $V_{GE} = 0/15\text{V}$)

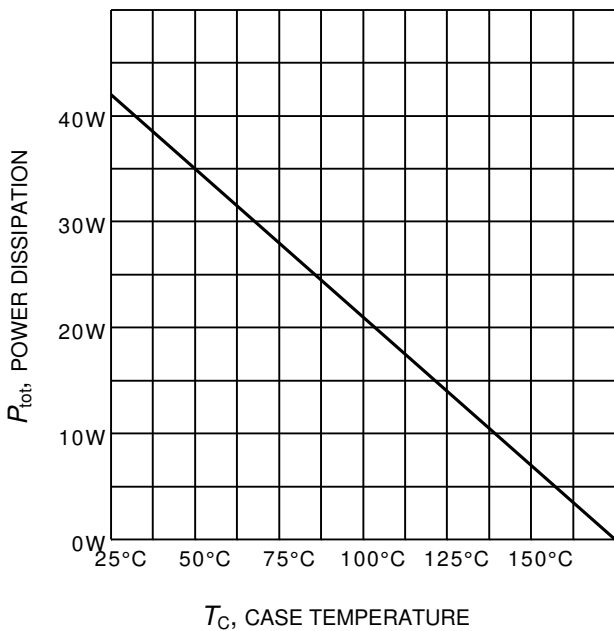


Figure 3. Power dissipation as a function of case temperature
 ($T_j \leq 175^\circ\text{C}$)

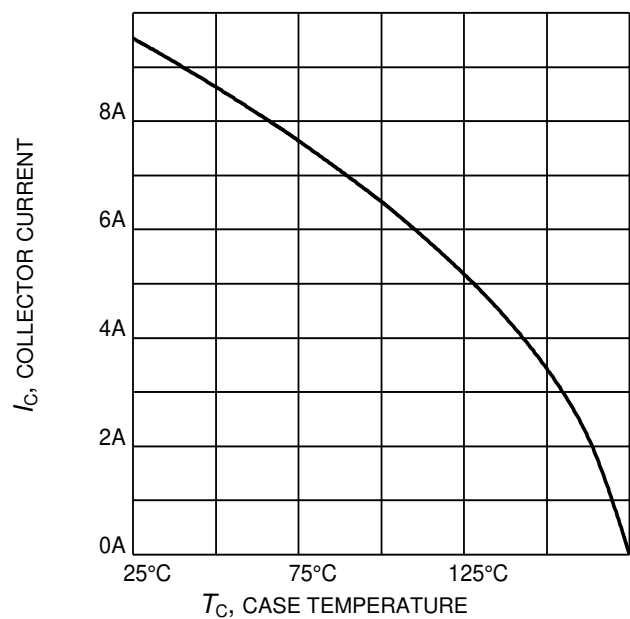


Figure 4. Collector current as a function of case temperature
 ($V_{GE} \geq 15\text{V}$, $T_j \leq 175^\circ\text{C}$)

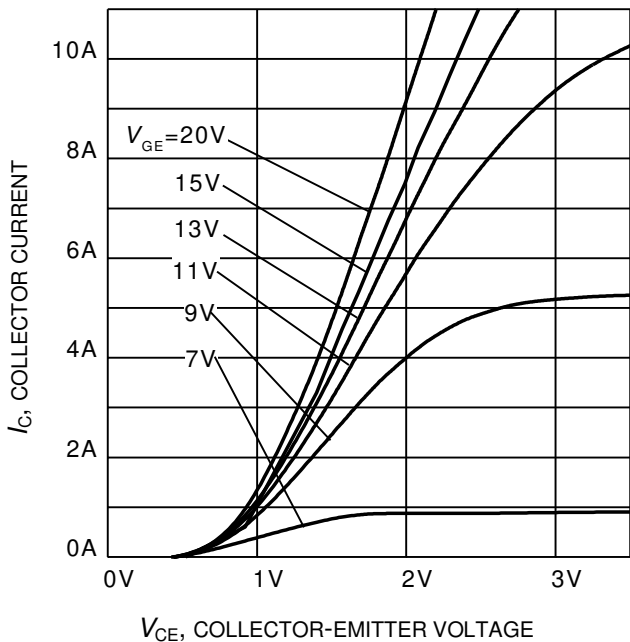


Figure 5. Typical output characteristic
($T_j = 25^\circ\text{C}$)

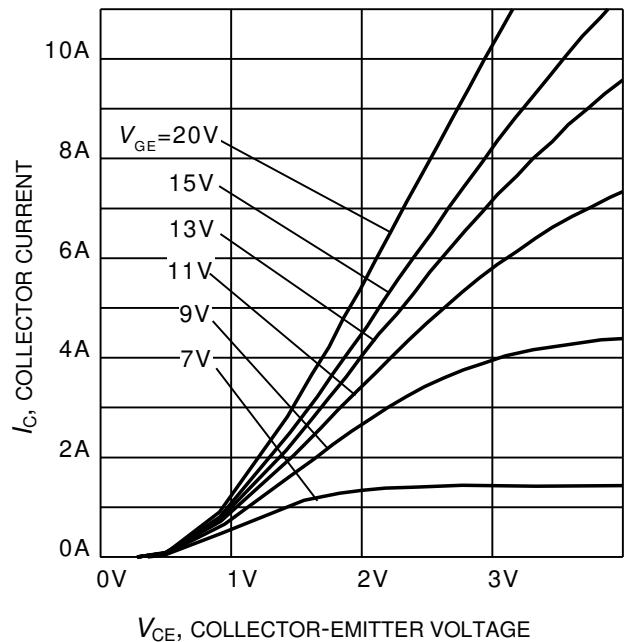


Figure 6. Typical output characteristic
($T_j = 175^\circ\text{C}$)

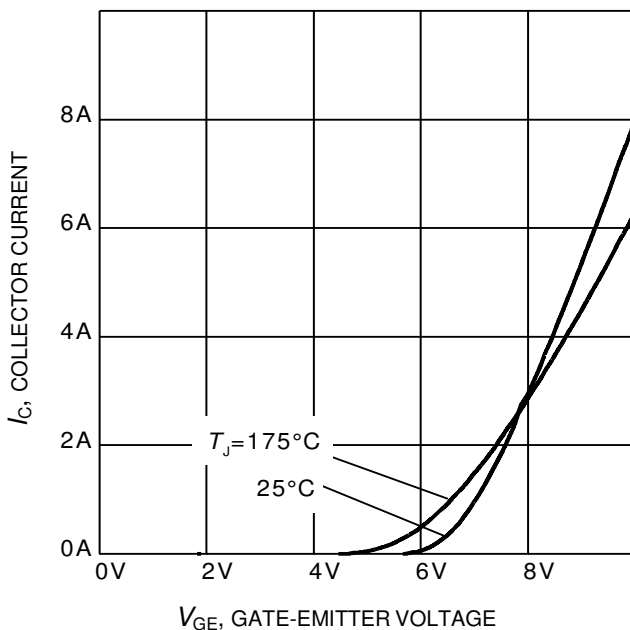


Figure 7. Typical transfer characteristic
($V_{CE} = 20\text{V}$)

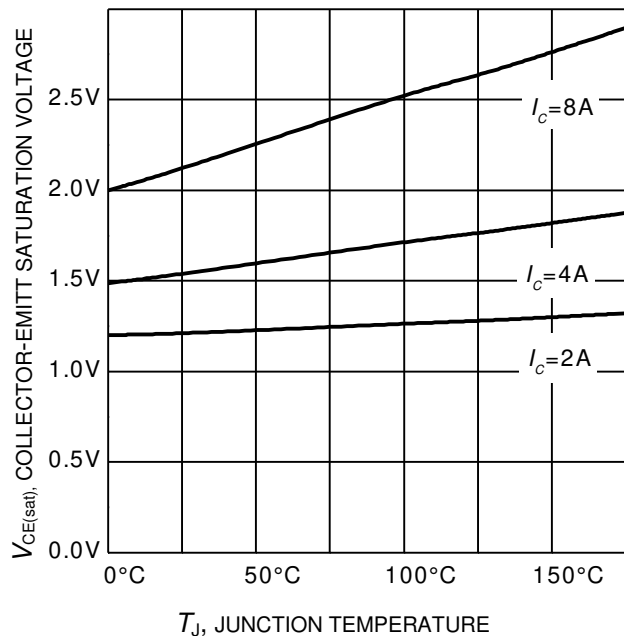


Figure 8. Typical collector-emitter saturation voltage as a function of junction temperature
($V_{GE} = 15\text{V}$)

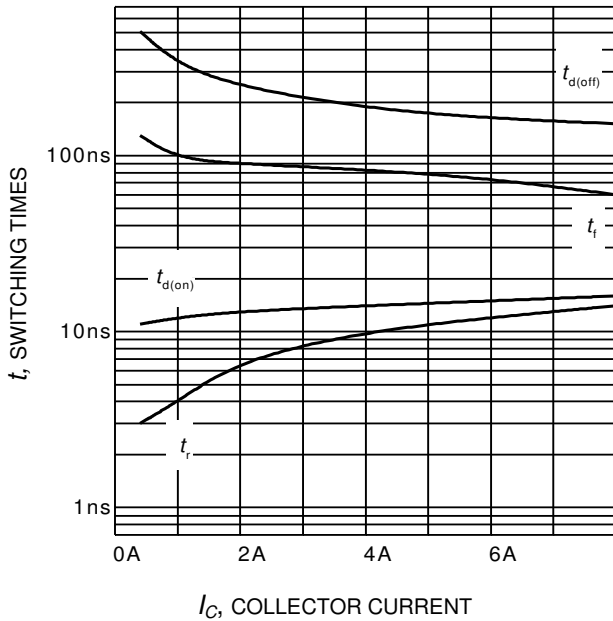


Figure 9. Typical switching times as a function of collector current
 (inductive load, $T_J = 175^\circ\text{C}$, $V_{CE} = 400\text{V}$, $V_{GE} = 0/15\text{V}$, $r_G = 47\Omega$, Dynamic test circuit in Figure E)

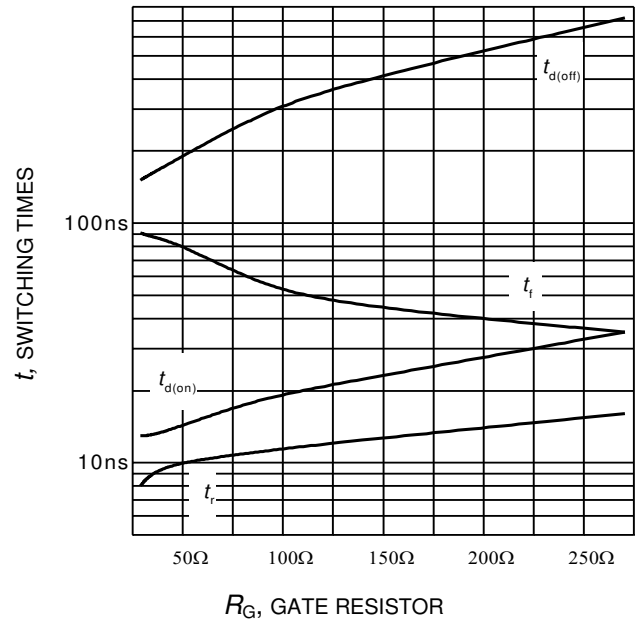


Figure 10. Typical switching times as a function of gate resistor
 (inductive load, $T_J = 175^\circ\text{C}$, $V_{CE} = 400\text{V}$, $V_{GE} = 0/15\text{V}$, $I_C = 4\text{A}$, Dynamic test circuit in Figure E)

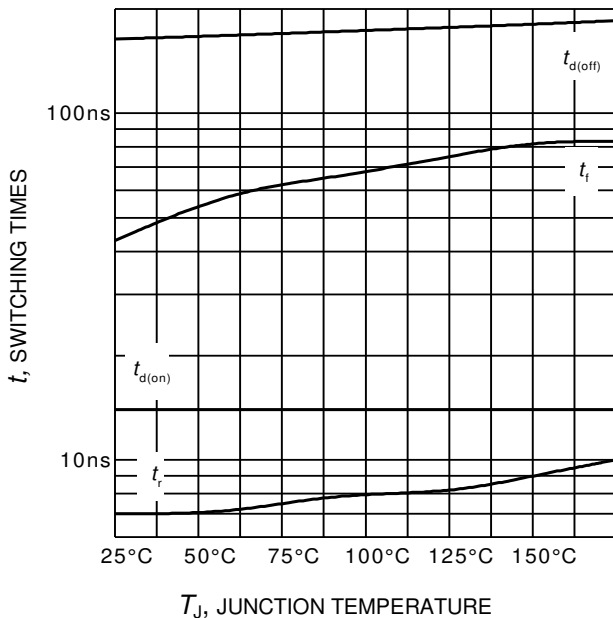


Figure 11. Typical switching times as a function of junction temperature
 (inductive load, $V_{CE} = 400\text{V}$, $V_{GE} = 0/15\text{V}$, $I_C = 4\text{A}$, $r_G = 47\Omega$, Dynamic test circuit in Figure E)

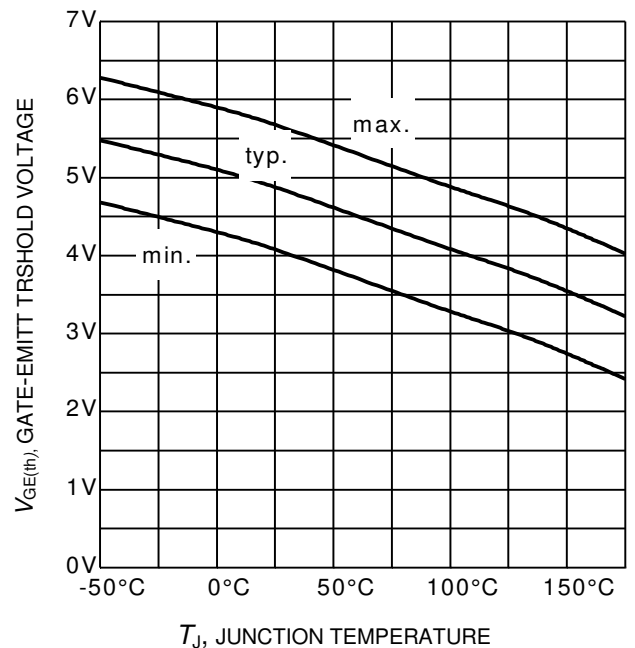


Figure 12. Gate-emitter threshold voltage as a function of junction temperature
 ($I_C = 60\ \mu\text{A}$)

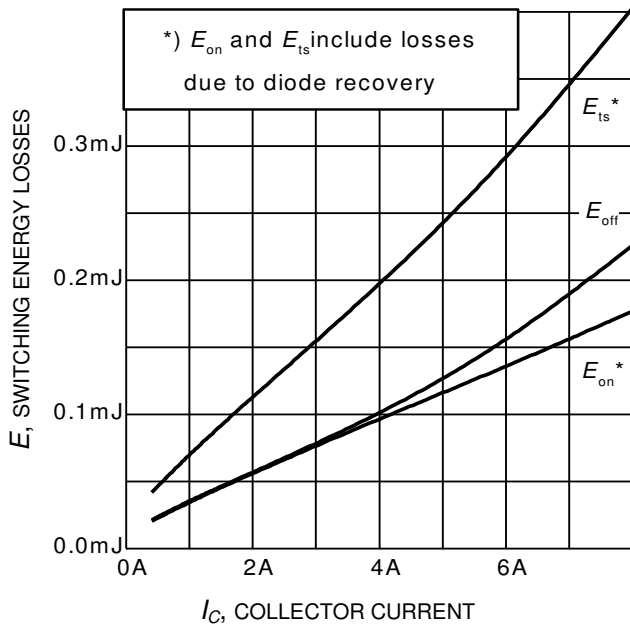


Figure 13. Typical switching energy losses as a function of collector current
 (inductive load, $T_J = 175^\circ\text{C}$,
 $V_{CE} = 400\text{V}$, $V_{GE} = 0/15\text{V}$, $r_G = 47\Omega$,
 Dynamic test circuit in Figure E)

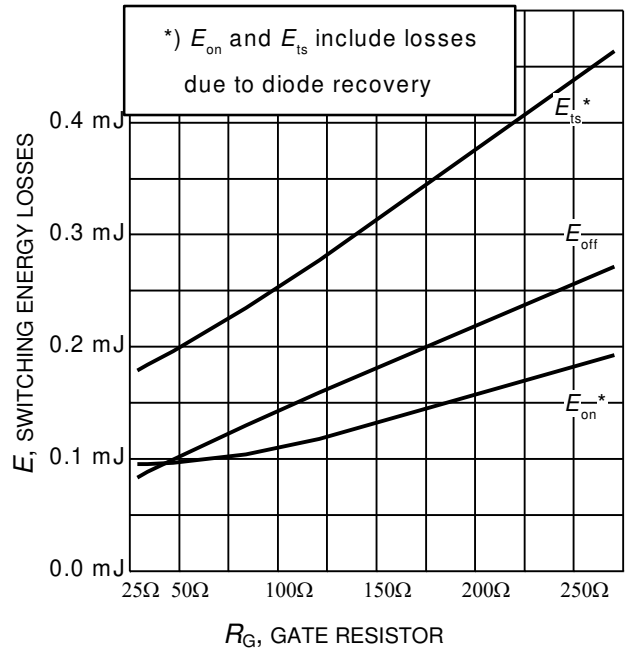


Figure 14. Typical switching energy losses as a function of gate resistor
 (inductive load, $T_J = 175^\circ\text{C}$,
 $V_{CE} = 400\text{V}$, $V_{GE} = 0/15\text{V}$, $I_C = 4\text{A}$,
 Dynamic test circuit in Figure E)

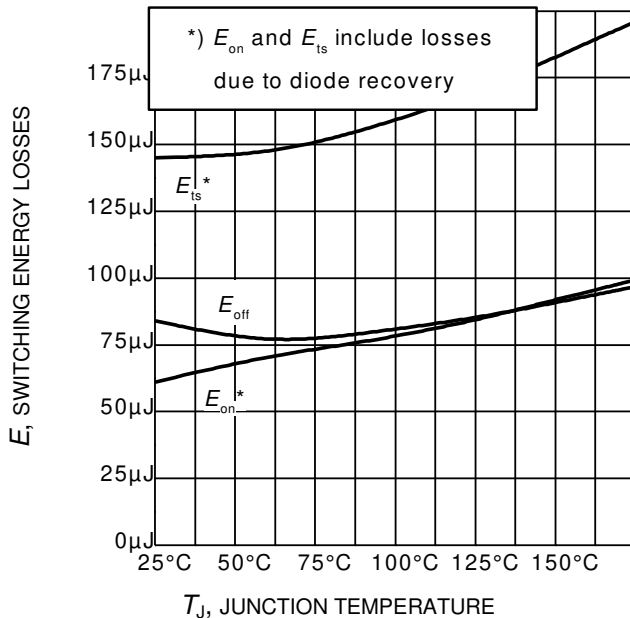


Figure 15. Typical switching energy losses as a function of junction temperature
 (inductive load, $V_{CE} = 400\text{V}$,
 $V_{GE} = 0/15\text{V}$, $I_C = 4\text{A}$, $r_G = 47\Omega$,
 Dynamic test circuit in Figure E)

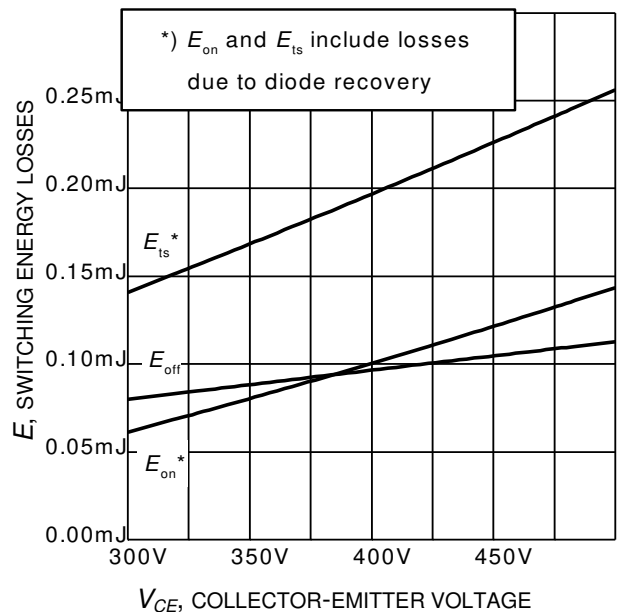


Figure 16. Typical switching energy losses as a function of collector emitter voltage
 (inductive load, $T_J = 175^\circ\text{C}$,
 $V_{GE} = 0/15\text{V}$, $I_C = 4\text{A}$, $r_G = 47\Omega$,
 Dynamic test circuit in Figure E)

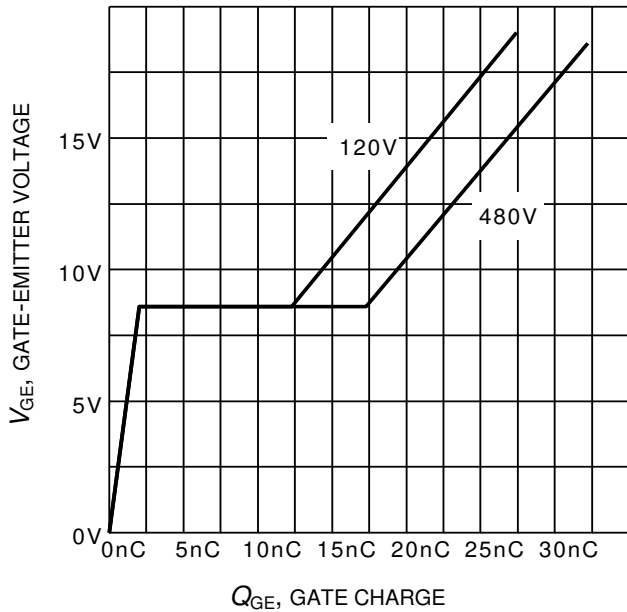


Figure 17. Typical gate charge
($I_C=4\text{ A}$)

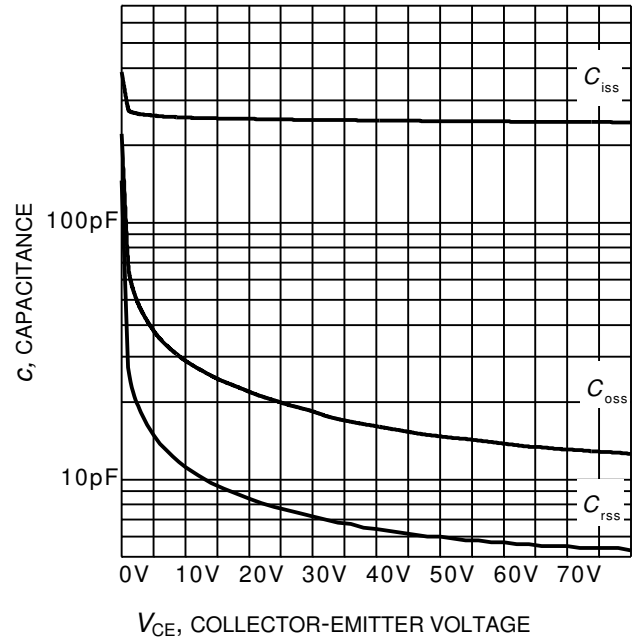


Figure 18. Typical capacitance as a function of collector-emitter voltage
($V_{GE}=0\text{V}$, $f = 1\text{ MHz}$)

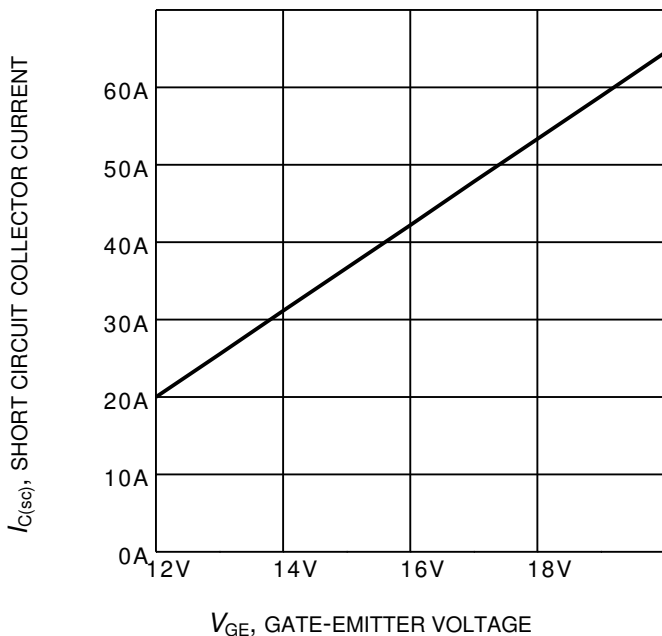


Figure 19. Typical short circuit collector current as a function of gate-emitter voltage
($V_{CE} \leq 400\text{V}$, $T_j \leq 150^\circ\text{C}$)

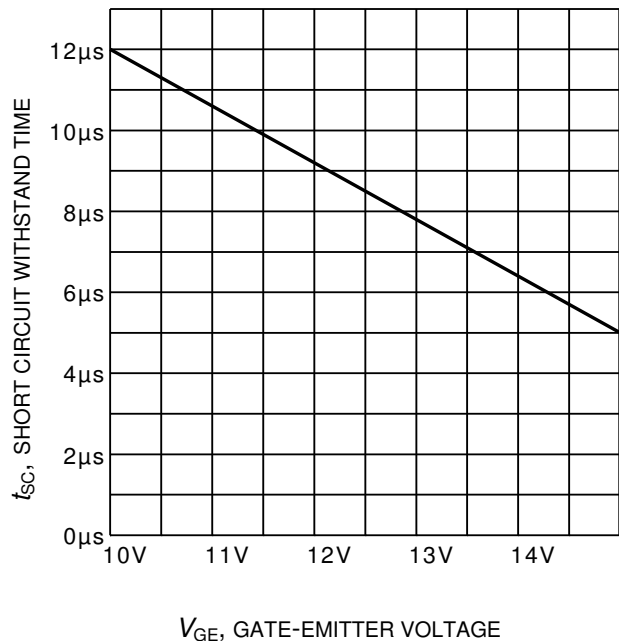


Figure 20. Short circuit withstand time as a function of gate-emitter voltage
($V_{CE}=400\text{V}$, start at $T_j=25^\circ\text{C}$, $T_{j,max}<150^\circ\text{C}$)

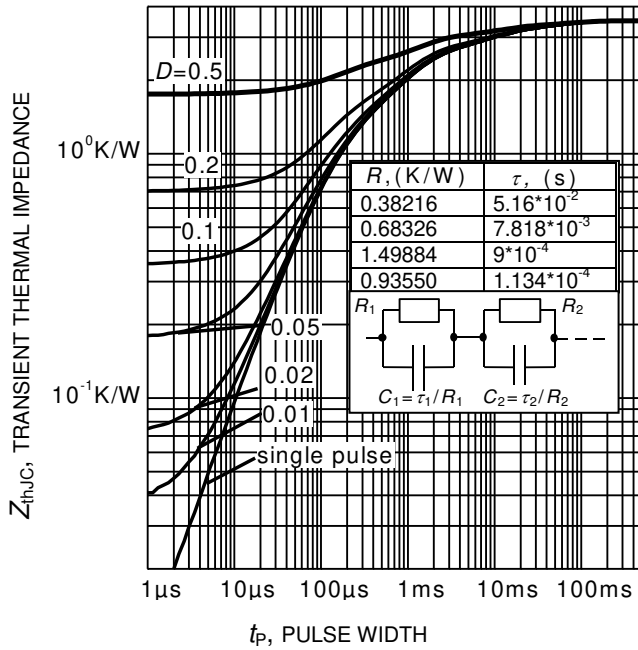
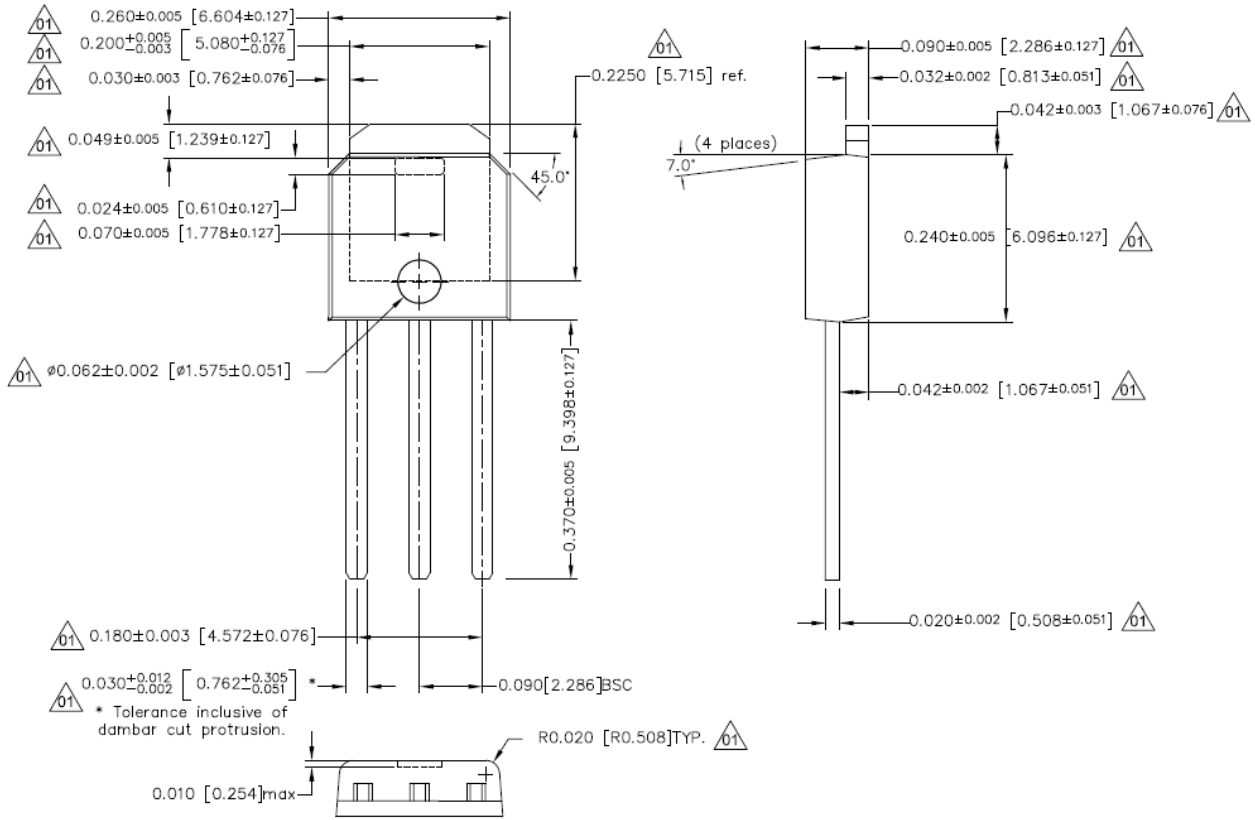


Figure 21. IGBT transient thermal impedance
 $(D = t_p / T)$

PG-TO251-3



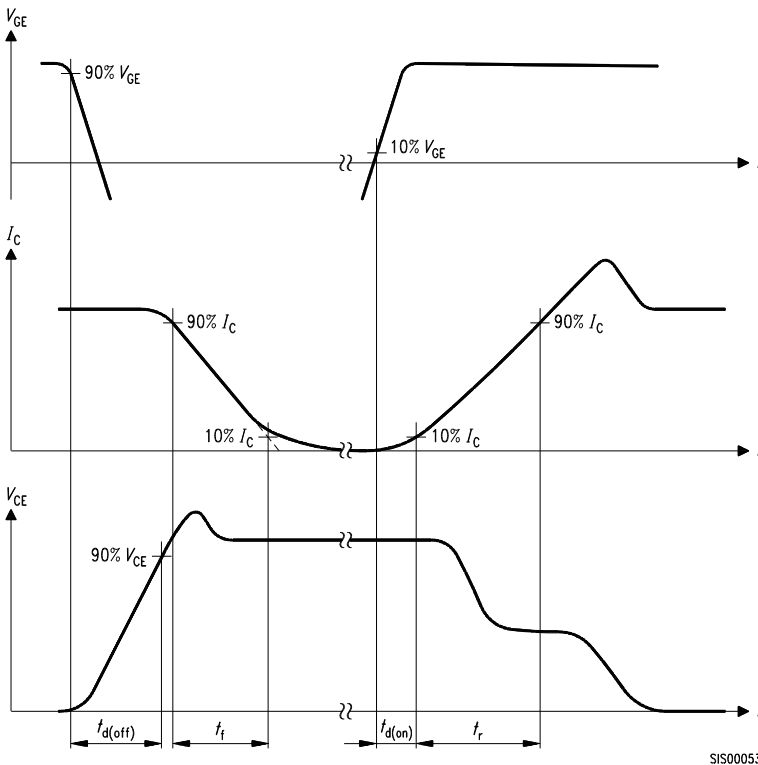


Figure A. Definition of switching times

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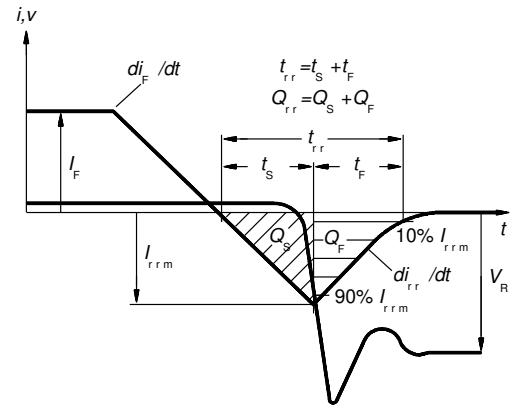


Figure C. Definition of diodes switching characteristics

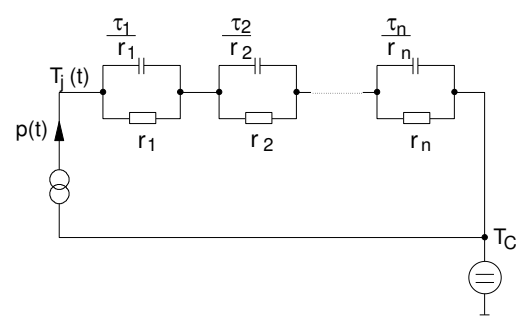


Figure D. Thermal equivalent circuit

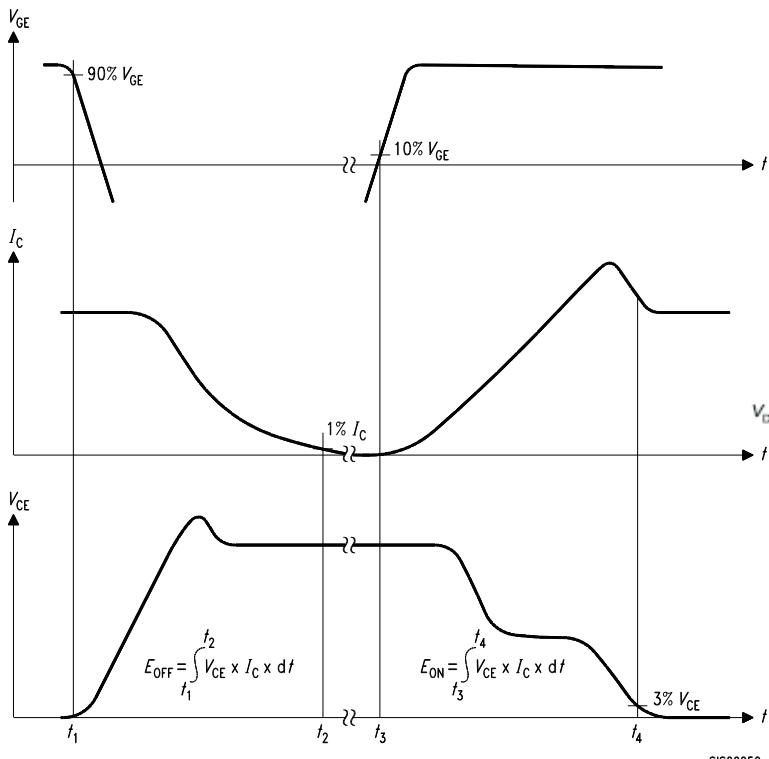


Figure B. Definition of switching losses

SIS00050

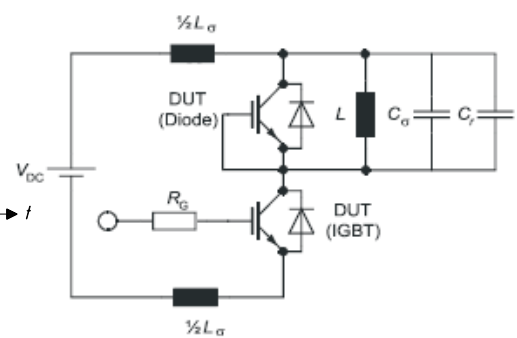


Figure E. Dynamic test circuit
Parasitic inductance L_σ ,
Parasitic capacitor C_σ ,
Relief capacitor C_r
(only for ZVT switching)

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