# IGB10N60T

TrenchStop® Series

Low Loss IGBT in **TrenchStop®** and Fieldstop technology

- Very low $V_{CE(sat)}$ 1.5 V (typ.)
- Maximum Junction Temperature 175 °C
- Short circuit withstand time – 5µs
- Designed for frequency inverters for washing machines, fans, pumps and vacuum cleaners
- **TrenchStop®** technology for 600 V applications offers :
  - very tight parameter distribution
  - high ruggedness, temperature stable behavior
- NPT technology offers easy parallel switching capability due to positive temperature coefficient in $V_{CE(sat)}$
- Low EMI
- Low Gate Charge
- 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/
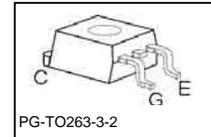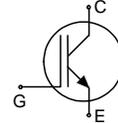
PG-TO263-3-2

Type	V_{CE}	I_C	$V_{CE(sat),Tj=25°C}$	$T_{j,max}$	Marking Code	Package
IGB10N60T	600V	10A	1.5V	175°C	G10T60	PG-TO263-3-2

Maximum Ratings

Parameter	Symbol	Value	Unit
Collector-emitter voltage	V_{CE}	600	V
DC collector current, limited by T_{jmax}	I_C		A
T_C = 25°C		20	
T_C = 100°C		10	
Pulsed collector current, t_p limited by T_{jmax}	I_{Cpuls}	30	
Turn off safe operating area $V_{CE} \leq 600V$, $T_j \leq 175°C$	-	30	
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}	110	W
Operating junction temperature	T_j	-40...+175	°C
Storage temperature	T_{stg}	-55...+175	
Soldering temperature (reflow soldering, MSL1)		260	

[1] J-STD-020 and JESD-022
[2] Allowed number of short circuits: <1000; time between short circuits: >1s.

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Thermal Resistance

Parameter	Symbol	Conditions	Max. Value	Unit
Characteristic				
IGBT thermal resistance, junction – case	R_{thJC}		1.35	K/W
Thermal resistance, junction – ambient	R_{thJA}	Footprint 6cm² Cu	65 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	$V_{(BR)CES}$	$V_{GE}=0V$, $I_C=0.2mA$	600	-	-	V
Collector-emitter saturation voltage	$V_{CE(sat)}$	$V_{GE} = 15V$, $I_C=10A$				
		$T_j=25°C$	-	1.5	2.05	
		$T_j=175°C$	-	1.8	-	
Gate-emitter threshold voltage	$V_{GE(th)}$	$I_C=0.3mA$, $V_{CE}=V_{GE}$	4.1	4.6	5.7	
Zero gate voltage collector current	I_{CES}	$V_{CE}=600V$, $V_{GE}=0V$				µA
		$T_j=25°C$	-	-	40	
		$T_j=175°C$	-	-	1000	
Gate-emitter leakage current	I_{GES}	$V_{CE}=0V$, $V_{GE}=20V$	-	-	100	nA
Transconductance	g_{fs}	$V_{CE}=20V$, $I_C=10A$	-	6	-	S
Integrated gate resistor	R_{Gint}		none			Ω

Dynamic Characteristic

Parameter	Symbol	Conditions	Value			Unit
			min.	typ.	max.	
Input capacitance	C_{iss}	$V_{CE}=25V$,	-	551	-	pF
Output capacitance	C_{oss}	$V_{GE}=0V$,	-	24	-	
Reverse transfer capacitance	C_{rss}	$f=1MHz$	-	17	-	
Gate charge	Q_{Gate}	$V_{CC}=480V$, $I_C=10A$ $V_{GE}=15V$	-	62	-	nC
Internal emitter inductance measured 5mm (0.197 in.) from case	L_E		-	7	-	nH
Short circuit collector current[1]	$I_{C(SC)}$	$V_{GE}=15V$, $t_{SC}\leq5\mu s$ $V_{CC} = 400V$, $T_j = 25°C$	-	100	-	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=10A, V_{GE}=0/15V, R_G=23Ω, $L_\sigma^{2)}$=60nH, $C_\sigma^{2)}$=40pF Energy losses include "tail" and diode reverse recovery.	-	12	-	ns
Rise time	t_r		-	8	-	
Turn-off delay time	$t_{d(off)}$		-	215	-	
Fall time	t_f		-	38	-	
Turn-on energy	E_{on}		-	0.16	-	mJ
Turn-off energy	E_{off}		-	0.27	-	
Total switching energy	E_{ts}		-	0.43	-	

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=10A, V_{GE}=0/15V, R_G= 23Ω $L_\sigma^{1)}$=60nH, $C_\sigma^{1)}$=40pF Energy losses include "tail" and diode reverse recovery.	-	10	-	ns
Rise time	t_r		-	11	-	
Turn-off delay time	$t_{d(off)}$		-	233	-	
Fall time	t_f		-	63	-	
Turn-on energy	E_{on}		-	0.26	-	mJ
Turn-off energy	E_{off}		-	0.35	-	
Total switching energy	E_{ts}		-	0.61	-	

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

f, SWITCHING FREQUENCY
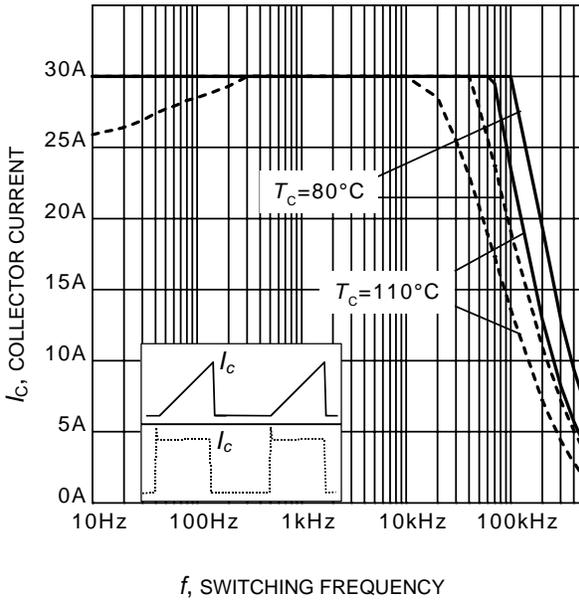
Figure 1. **Collector current as a function of switching frequency**
($T_j \leq 175°C$, $D = 0.5$, $V_{CE} = 400V$, $V_{GE} = 0/+15V$, $R_G = 23\Omega$)

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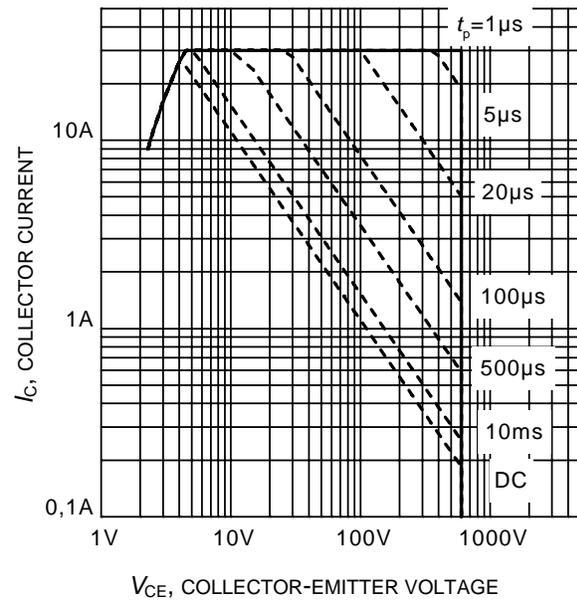
Figure 2. **Safe operating area**
($D = 0$, $T_C = 25°C$, $T_j \leq 175°C$; $V_{GE} = 15V$)

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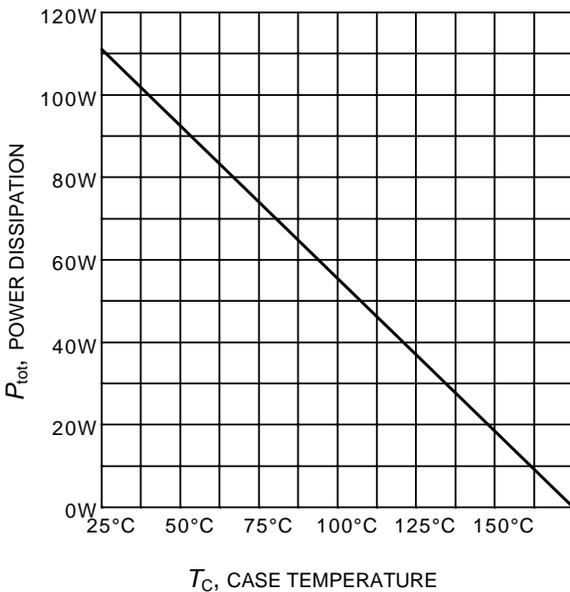
Figure 3. **Power dissipation as a function of case temperature**
($T_j \leq 175°C$)

T_C, CASE TEMPERATURE
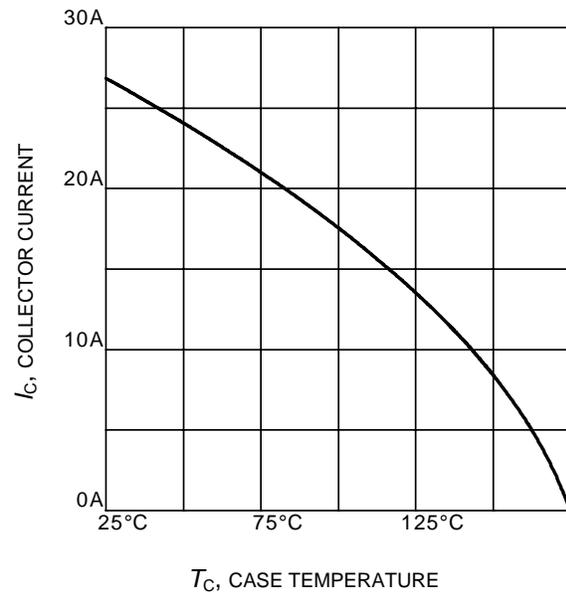
Figure 4. **Collector current as a function of case temperature**
($V_{GE} \geq 15V$, $T_j \leq 175°C$)
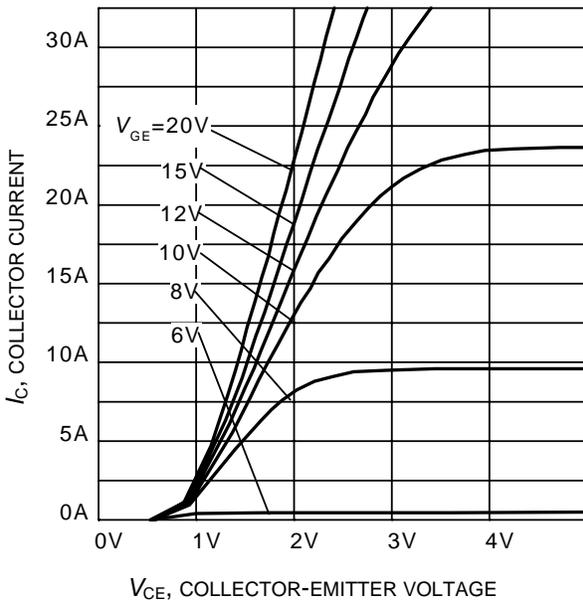
Figure 5. Typical output characteristic
(T_j = 25°C)
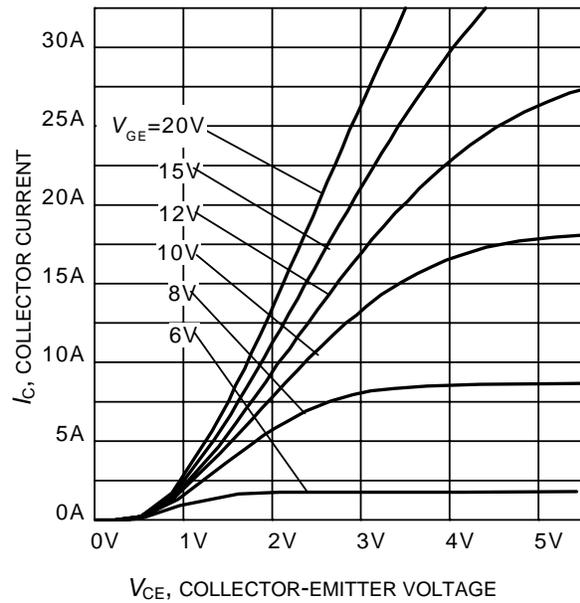
Figure 6. Typical output characteristic
(T_j = 175°C)
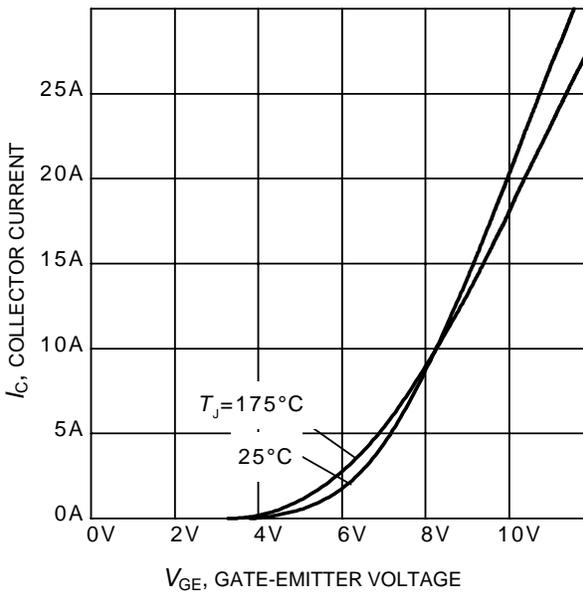
Figure 7. Typical transfer characteristic
(V_{CE}=20V)
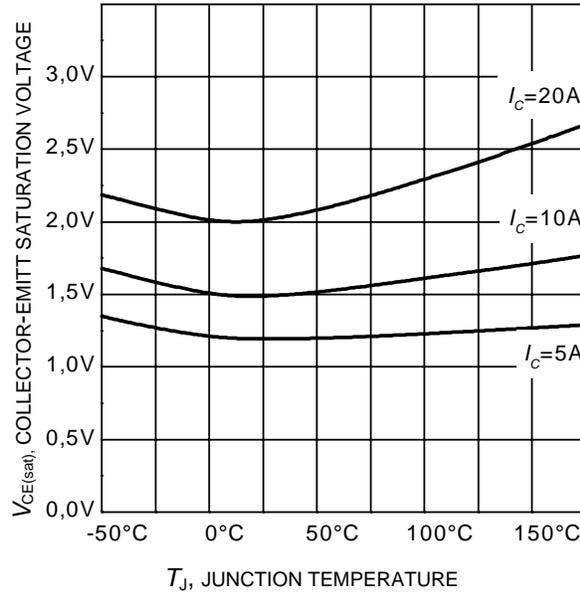
Figure 8. Typical collector-emitter saturation voltage as a function of junction temperature
(V_{GE} = 15V)

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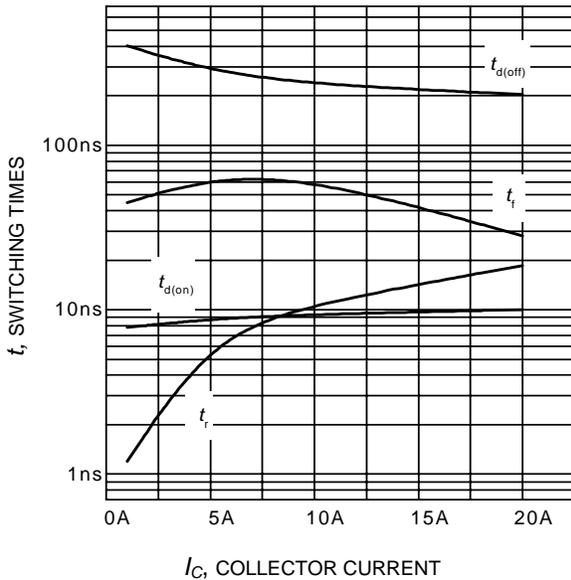
Figure 9. Typical switching times as a function of collector current (inductive load, T_J=175°C, V_{CE} = 400V, V_{GE} = 0/15V, R_G = 23Ω, Dynamic test circuit in Figure E)
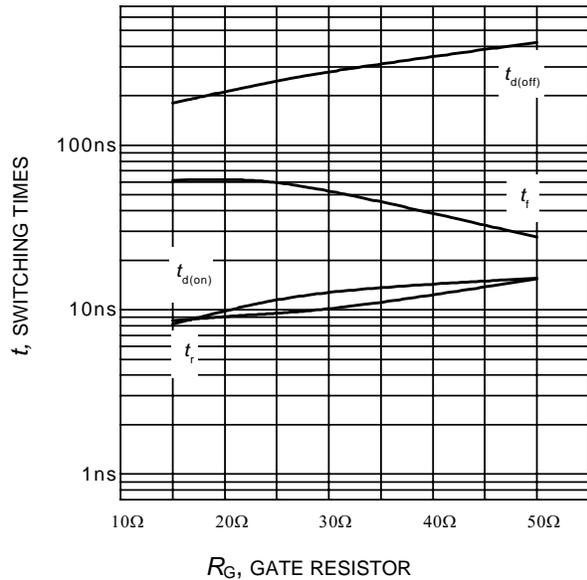
Figure 10. Typical switching times as a function of gate resistor (inductive load, T_J = 175°C, V_{CE}= 400V, V_{GE} = 0/15V, I_C = 10A, Dynamic test circuit in Figure E)
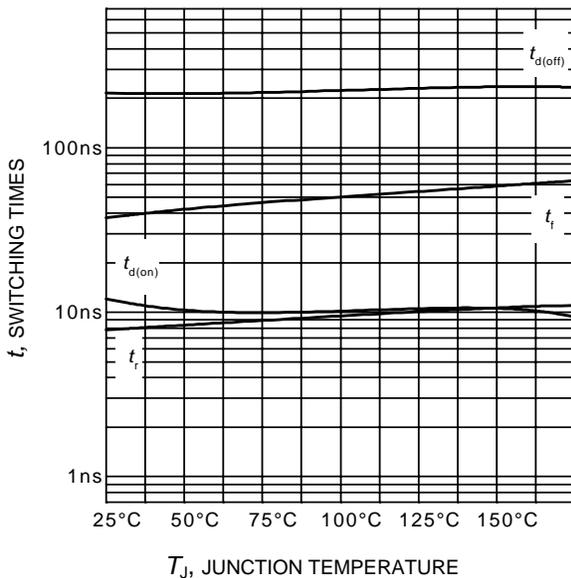
Figure 11. Typical switching times as a function of junction temperature (inductive load, V_{CE} = 400V, V_{GE} = 0/15V, I_C = 10A, R_G=23Ω, Dynamic test circuit in Figure E)
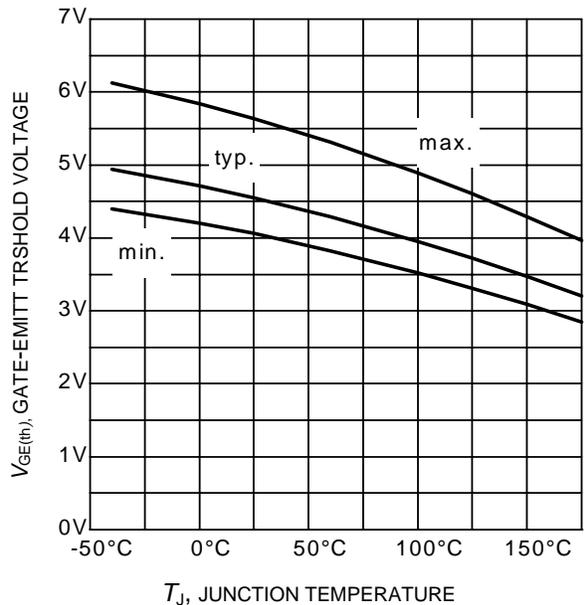

**Figure 12. Gate-emitter threshold voltage as a function of junction temperature** (I_C = 0.3mA)

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*) E_{on} and E_{ts} include losses due to diode recovery

E_{ts} *

E_{off}

E_{on} *

E, SWITCHING ENERGY LOSSES

I_C, COLLECTOR CURRENT
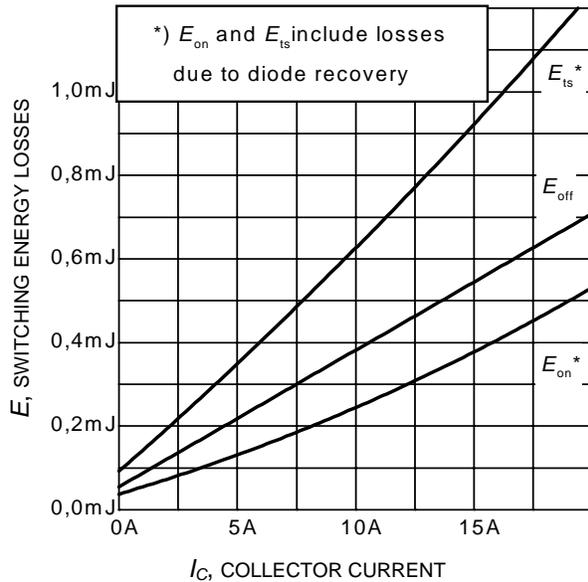
Figure 13. Typical switching energy losses as a function of collector current
(inductive load, T_J = 175°C, V_{CE} = 400V, V_{GE} = 0/15V, R_G = 23Ω, Dynamic test circuit in Figure E)

*) E_{on} and E_{ts} include losses due to diode recovery

E_{ts} *

E_{off}

E_{on} *

E, SWITCHING ENERGY LOSSES
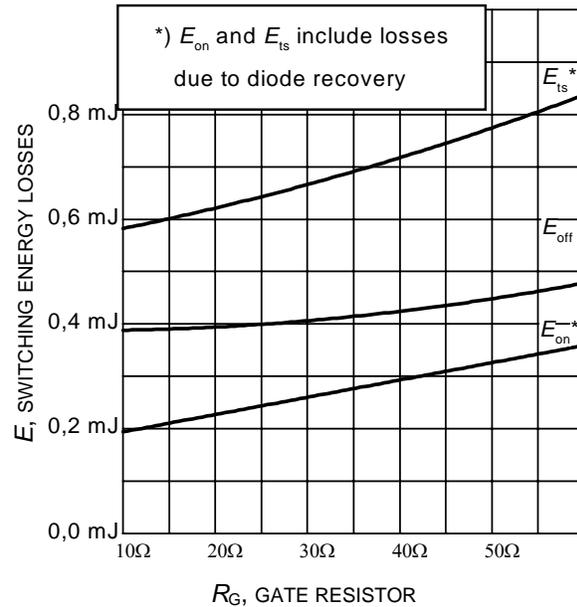
R_G, GATE RESISTOR

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 = 10A, Dynamic test circuit in Figure E)

*) E_{on} and E_{ts} include losses due to diode recovery

E_{ts} *

E_{off}

E_{on} *

E, SWITCHING ENERGY LOSSES

T_J, JUNCTION TEMPERATURE
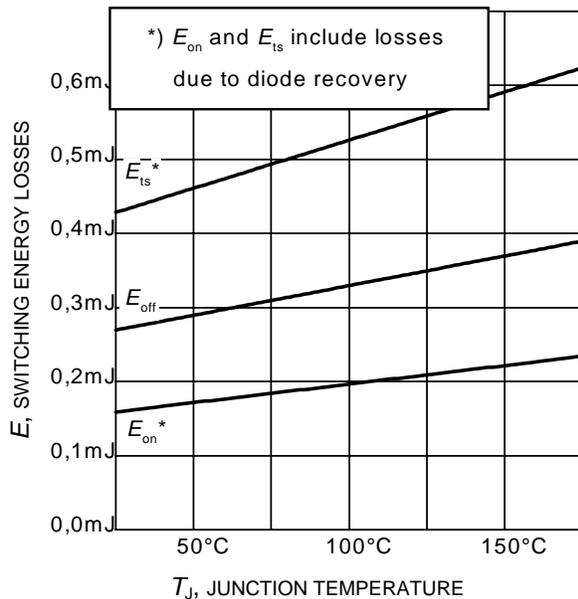
Figure 15. Typical switching energy losses as a function of junction temperature
(inductive load, V_{CE} = 400V, V_{GE} = 0/15V, I_C = 10A, R_G = 23Ω, Dynamic test circuit in Figure E)

*) E_{on} and E_{ts} include losses due to diode recovery

E_{ts} *

E_{off}

E_{on} *

E, SWITCHING ENERGY LOSSES

V_{CE}, COLLECTOR-EMITTER VOLTAGE
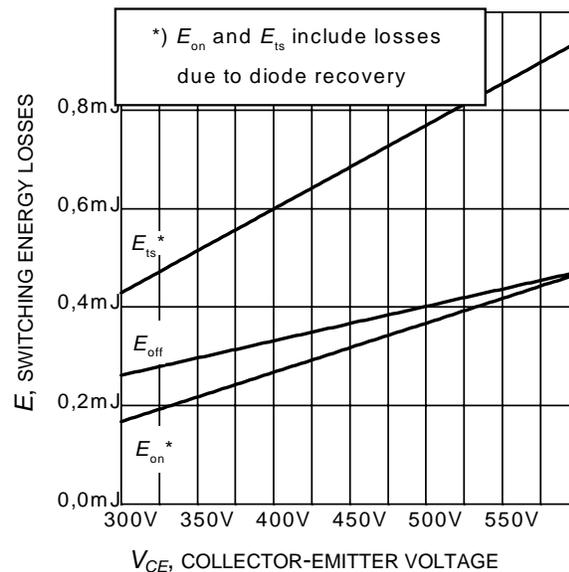
Figure 16. Typical switching energy losses as a function of collector emitter voltage
(inductive load, T_J = 175°C, V_{GE} = 0/15V, I_C = 10A, R_G = 23Ω, Dynamic test circuit in Figure E)

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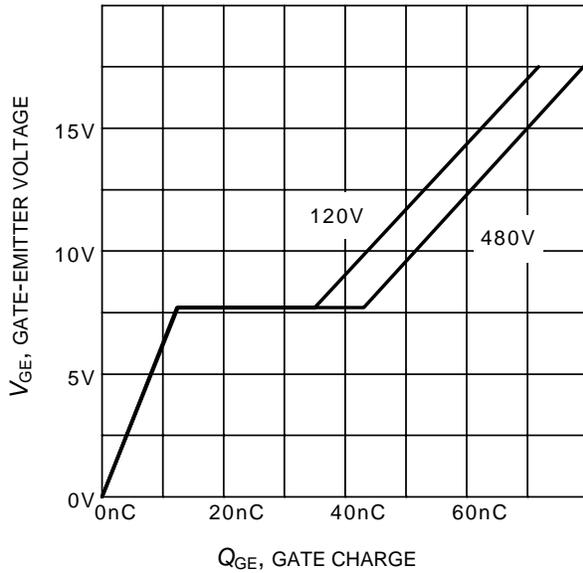
Figure 17. Typical gate charge
(I_C=10 A)
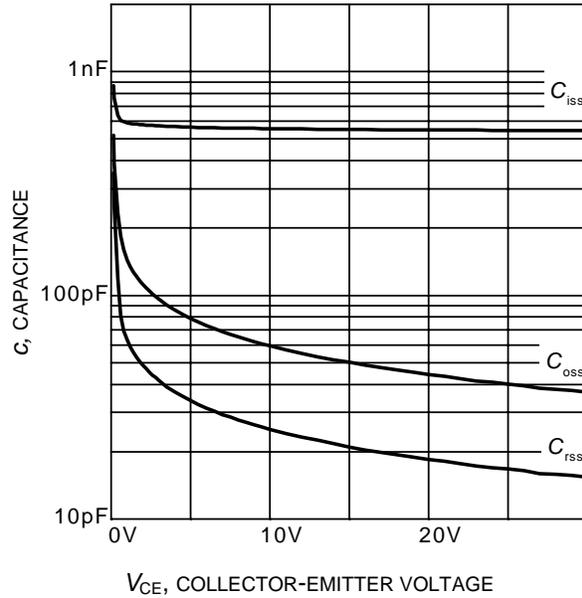
**Figure 18. Typical capacitance as a function
of collector-emitter voltage**
(V_{GE}=0V, f = 1 MHz)
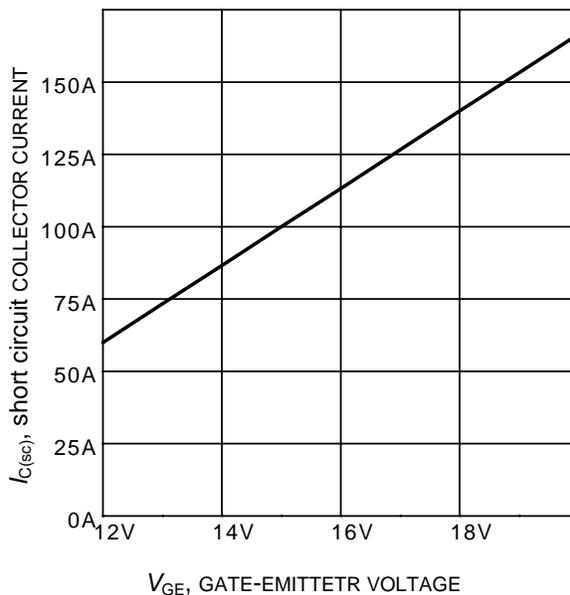
**Figure 19. Typical short circuit collector
current as a function of gate-
emitter voltage**
($V_{CE} \leq$ 400V, $T_j \leq$ 150°C)
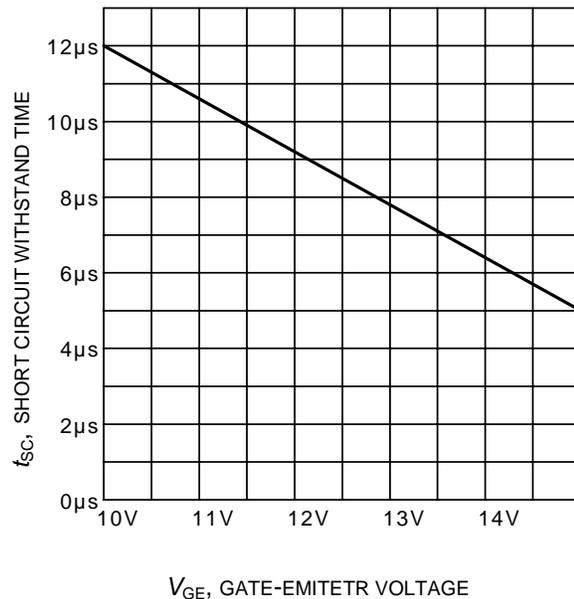
**Figure 20. Short circuit withstand time as a
function of gate-emitter voltage**
(V_{CE}=600V, start at T_J=25°C,
T_{Jmax}<150°C)

| R, (K/W)	τ, (s)
0.2911	6.53×10^{-2}
0.4092	8.33×10^{-3}
0.5008	7.37×10^{-4}
0.1529	7.63×10^{-5}
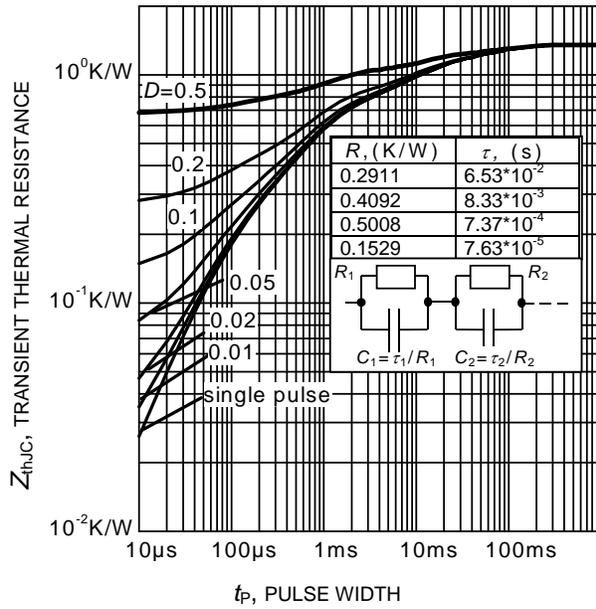
Figure 21. IGBT transient thermal resistance
$(D = t_\text{p} / T)$

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FOOTPRINT
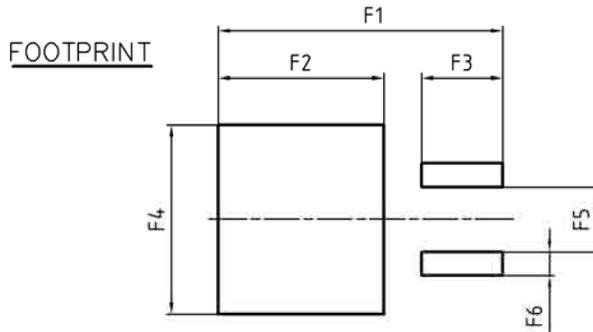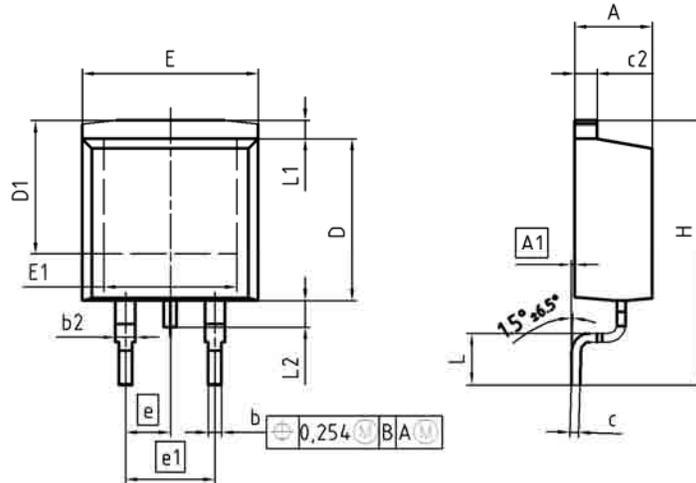
DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.30	4.57	0.169	0.180
A1	0.00	0.25	0.000	0.010
b	0.65	0.85	0.026	0.033
b2	0.95	1.15	0.037	0.045
c	0.33	0.65	0.013	0.026
c2	1.17	1.40	0.046	0.055
D	8.51	9.45	0.335	0.372
D1	7.10	7.90	0.280	0.311
E	9.80	10.31	0.386	0.406
E1	6.50	8.60	0.256	0.339
e	2.54		0.100	
e1	5.08		0.200	
N	2		2	
H	14.61	15.88	0.575	0.625
L	2.29	3.00	0.090	0.118
L1	0.70	1.60	0.028	0.063
L2	1.00	1.78	0.039	0.070
F1	16.05	16.25	0.632	0.640
F2	9.30	9.50	0.366	0.374
F3	4.50	4.70	0.177	0.185
F4	10.70	10.90	0.421	0.429
F5	3.65	3.85	0.144	0.152
F6	1.25	1.45	0.049	0.057

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SCALE

7.5mm

EUROPEAN PROJECTION

ISSUE DATE
30-08-2007

REVISION
01
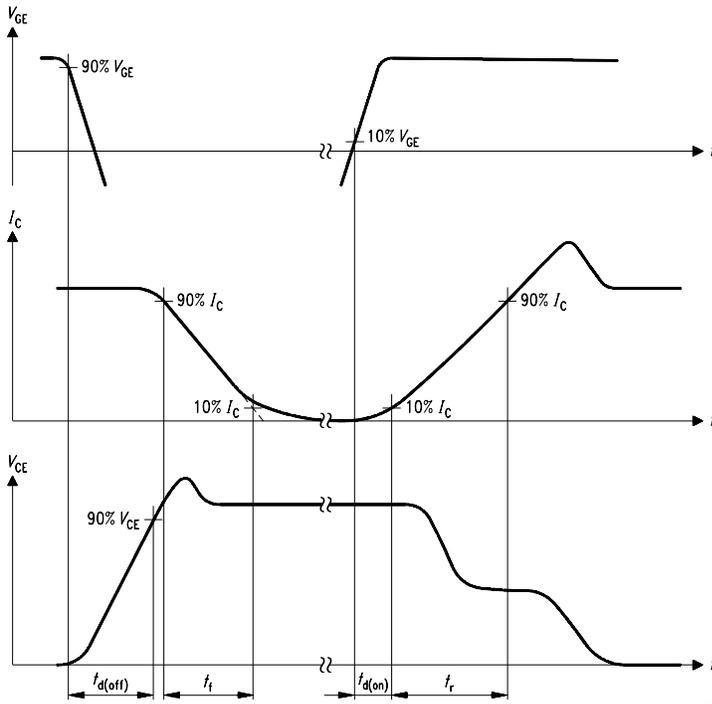
Figure A. Definition of switching times


Figure B. Definition of switching losses

$$E_{OFF} = \int_{t_1}^{t_2} V_{CE} \times I_C \times dt$$

$$E_{ON} = \int_{t_3}^{t_4} V_{CE} \times I_C \times dt$$
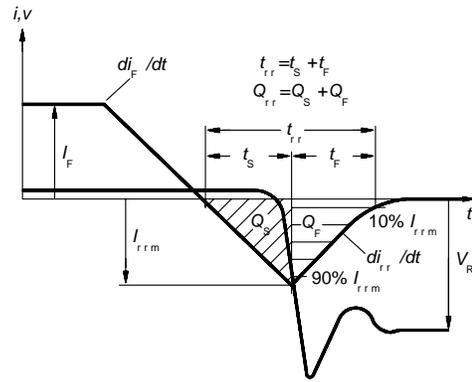
Figure C. Definition of diodes switching characteristics

$$t_{rr} = t_S + t_F$$
$$Q_{rr} = Q_S + Q_F$$
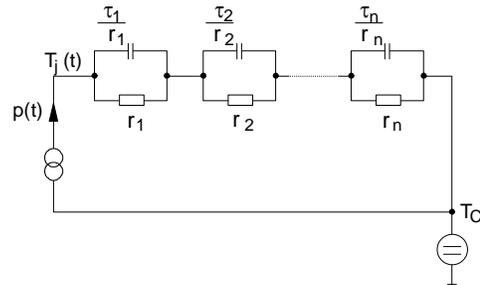
Figure D. Thermal equivalent circuit
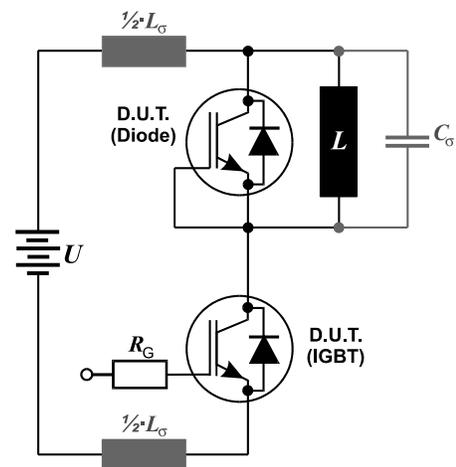
Figure E. Dynamic test circuit
Leakage inductance L_σ =60nH
and Stray capacity C_σ =40pF.

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