Thermal Resistance

Parameter	Symbol	Conditions	Max. Value	Unit
Characteristic				
IGBT thermal resistance, junction – case	R_{thJC}		4.2	K/W
Thermal resistance, junction – ambient	R_{thJA}	PG-TO-220-3-1	62	
SMD version, device on PCB[1]	R_{thJA}	PG-TO-252-3-1	50	

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=2A				
		T_j=25°C	1.7	1.9	2.4	
		T_j=150°C	-	2.2	2.7	
Gate-emitter threshold voltage	$V_{GE(th)}$	I_C=150µA, $V_{CE}=V_{GE}$	3	4	5	
Zero gate voltage collector current	I_{CES}	V_{CE}=600V, V_{GE}=0V				µA
		T_j=25°C	-	-	20	
		T_j=150°C	-	-	250	
Gate-emitter leakage current	I_{GES}	V_{CE}=0V, V_{GE}=20V	-	-	100	nA
Transconductance	g_{fs}	V_{CE}=20V, I_C=2A	-	1.6	-	S
Dynamic Characteristic						
Input capacitance	C_{iss}	V_{CE}=25V,	-	142	170	pF
Output capacitance	C_{oss}	V_{GE}=0V,	-	18	22	
Reverse transfer capacitance	C_{rss}	f=1MHz	-	10	12	
Gate charge	Q_{Gate}	V_{CC}=480V, I_C=2A V_{GE}=15V	-	14	18	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	-	20	-	A

[1] Device on 50mm*50mm*1.5mm epoxy PCB FR4 with 6cm[2] (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=2A, V_{GE}=0/15V, R_G=118Ω, $L_\sigma^{1)}$ =180nH, $C_\sigma^{1)}$ =180pF Energy losses include "tail" and diode reverse recovery.	-	20	24	ns
Rise time	t_r		-	13	16	
Turn-off delay time	$t_{d(off)}$		-	259	311	
Fall time	t_f		-	52	62	
Turn-on energy	E_{on}		-	0.036	0.041	mJ
Turn-off energy	E_{off}		-	0.028	0.036	
Total switching energy	E_{ts}		-	0.064	0.078	

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=2A, V_{GE}=0/15V, R_G=118Ω, $L_\sigma^{1)}$ =180nH, $C_\sigma^{1)}$ =180pF Energy losses include "tail" and diode reverse recovery.	-	20	24	ns
Rise time	t_r		-	14	17	
Turn-off delay time	$t_{d(off)}$		-	287	344	
Fall time	t_f		-	67	80	
Turn-on energy	E_{on}		-	0.054	0.062	mJ
Turn-off energy	E_{off}		-	0.043	0.056	
Total switching energy	E_{ts}		-	0.097	0.118	

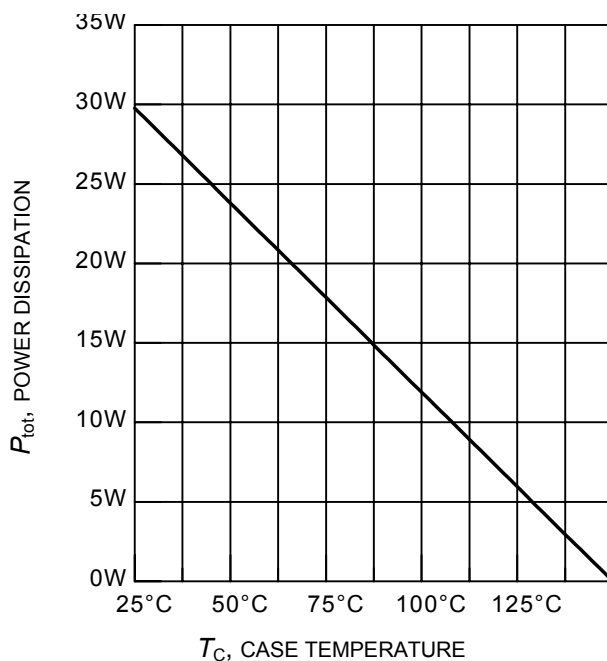[1] Leakage inductance L_σ and Stray capacity C_σ due to dynamic test circuit in Figure E.
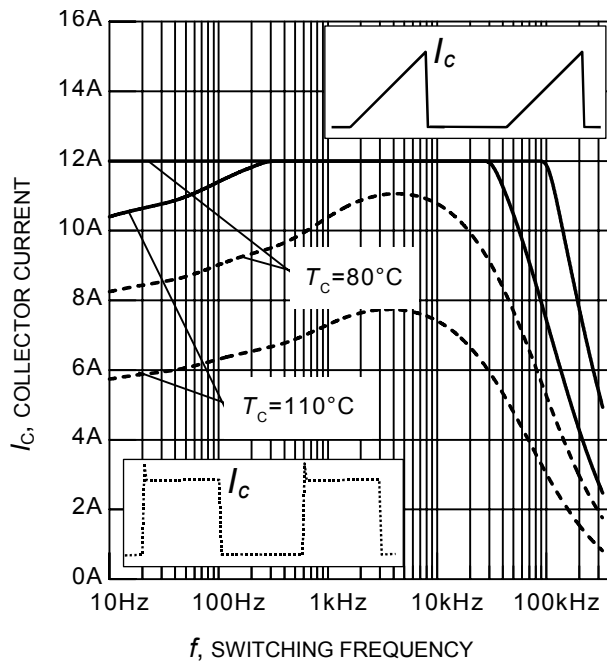
Figure 1. Collector current as a function of switching frequency
($T_j \le 150°C$, D = 0.5, V_{CE} = 400V, V_{GE} = 0/+15V, R_G = 118Ω)
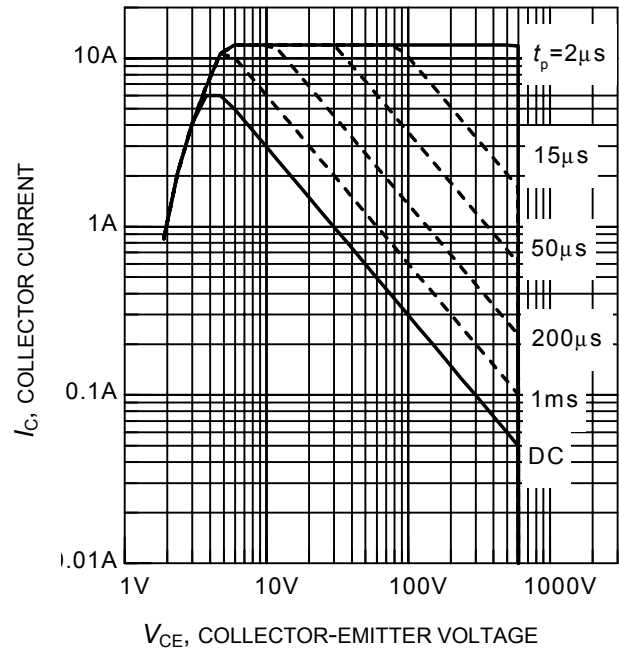
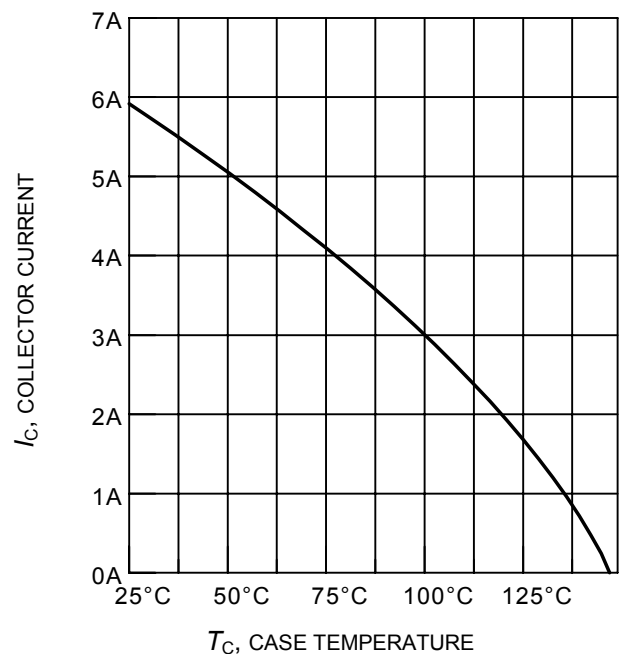

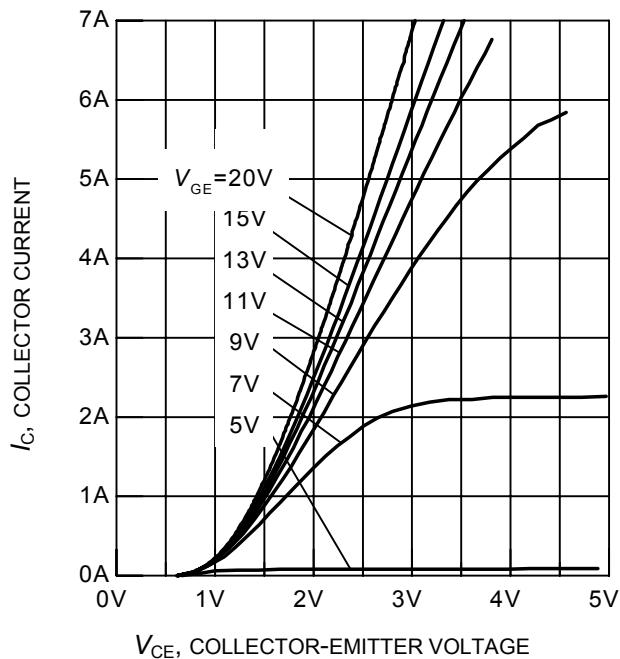**Figure 2. Safe operating area**
(D = 0, T_C = 25°C, $T_j \le 150°C$)

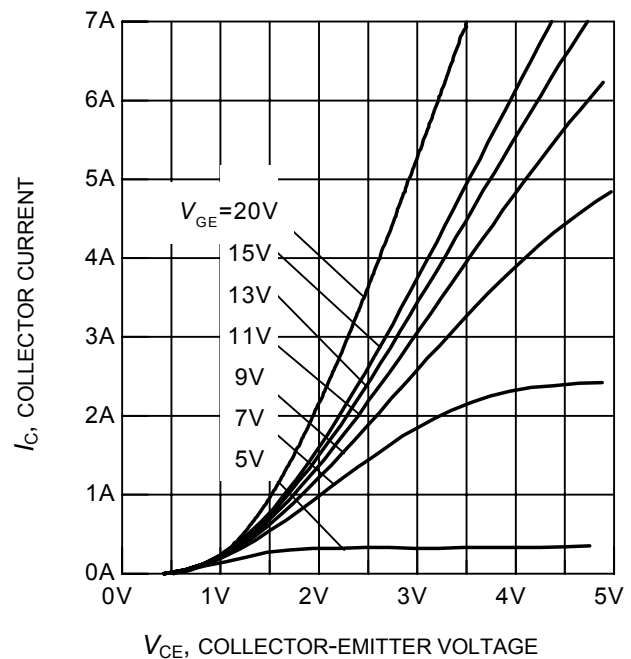**Figure 3. Power dissipation (IGBT) as a function of case temperature**
($T_j \le 150°C$)

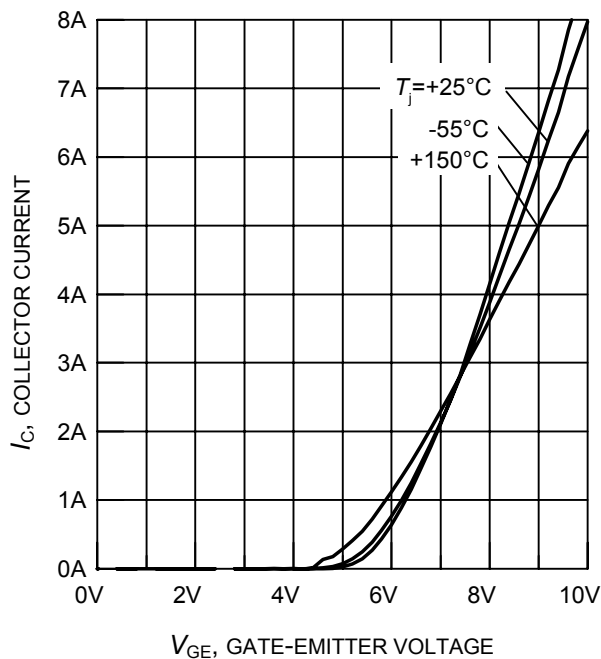**Figure 4. Collector current as a function of case temperature**
($V_{GE} \le 15V$, $T_j \le 150°C$)
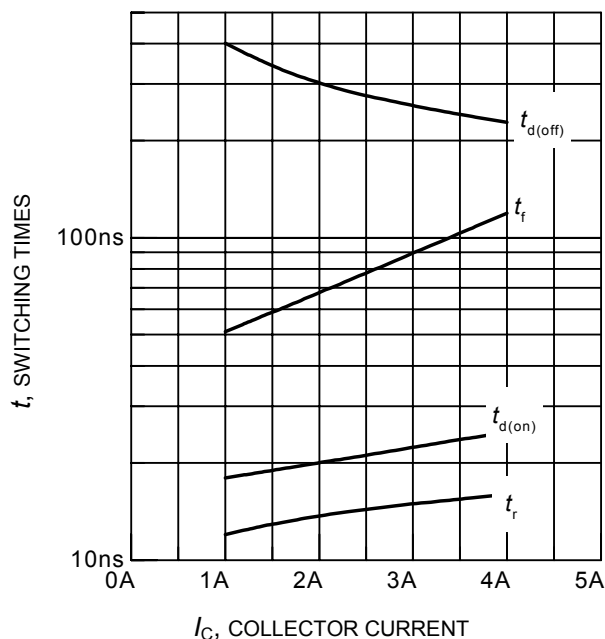
Figure 5. Typical output characteristics
(T_j = 25°C)

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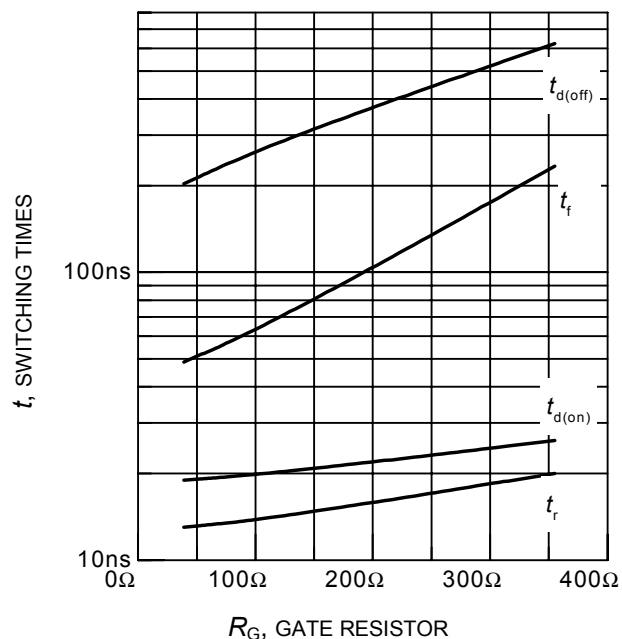

**Figure 7. Typical transfer characteristics**
(V_{CE} = 10V)
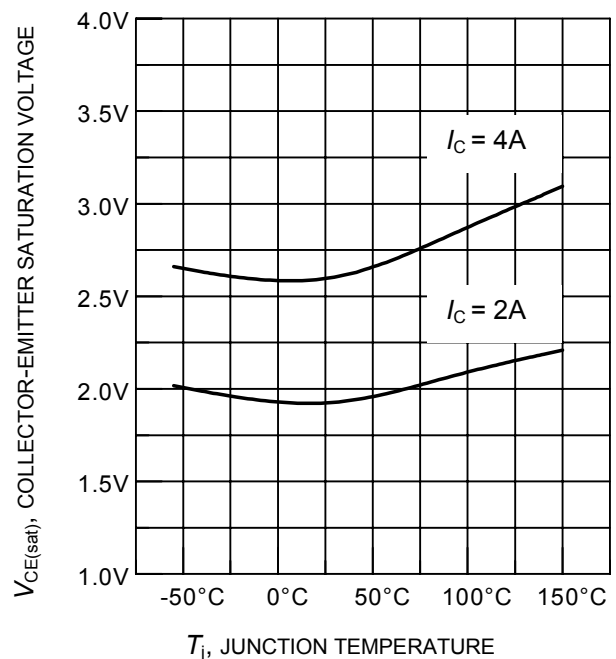
Figure 8. Typical collector-emitter saturation voltage as a function of junction temperature
(V_{GE} = 15V)

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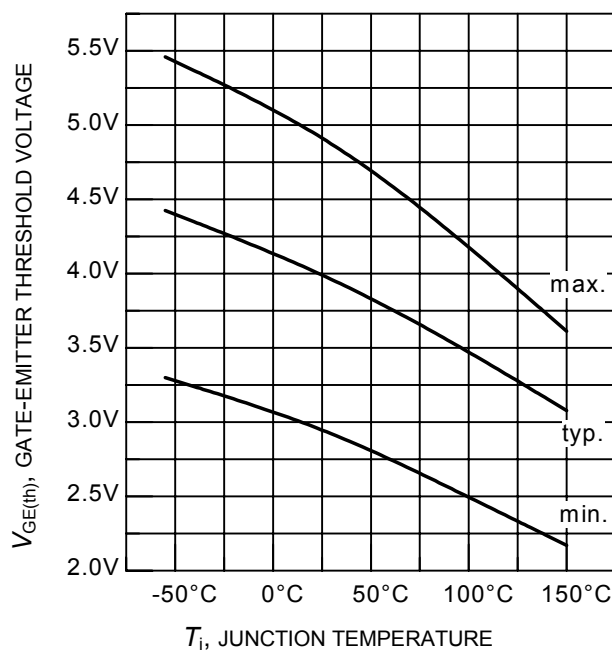
Figure 9. Typical switching times as a function of collector current
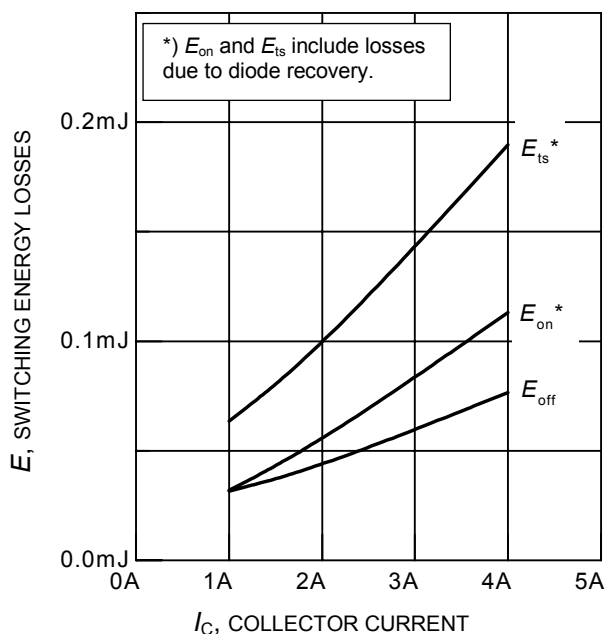(inductive load, T_j = 150°C, V_{CE} = 400V, V_{GE} = 0/+15V, R_G = 118Ω, Dynamic test circuit in Figure E)

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 = 2A, Dynamic test circuit in Figure E)
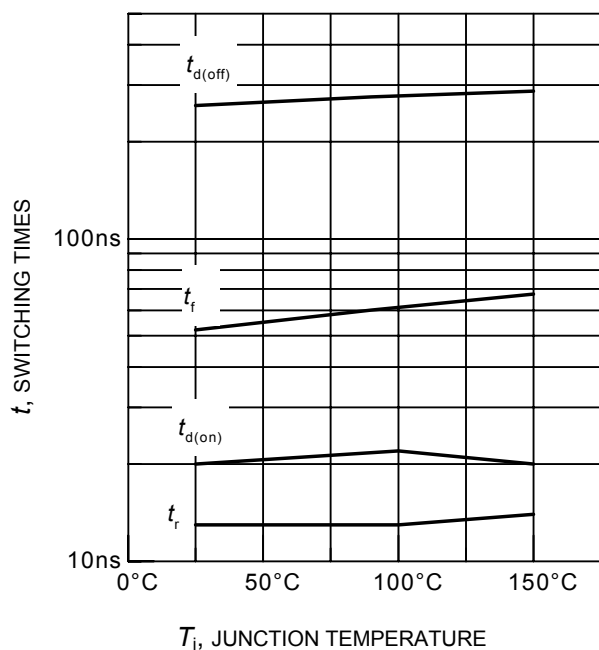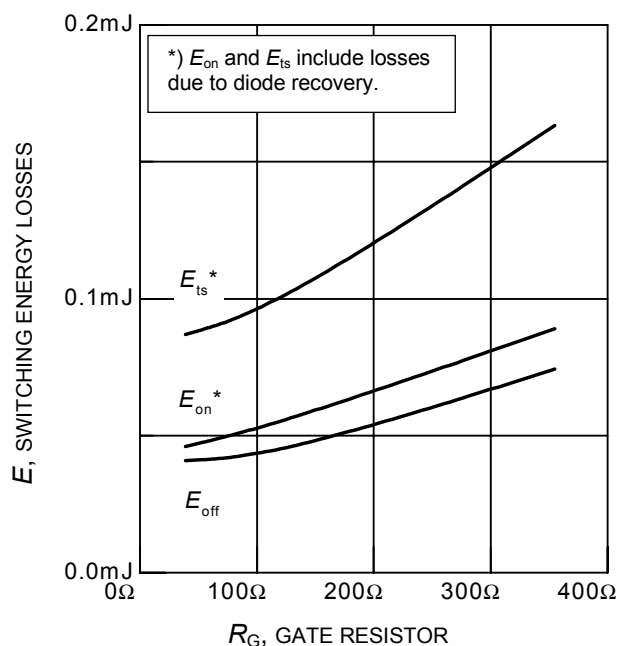

Figure 11. Typical switching times as a function of junction temperature
(inductive load, V_{CE} = 400V, V_{GE} = 0/+15V, I_C = 2A, R_G = 118Ω, Dynamic test circuit in Figure E)
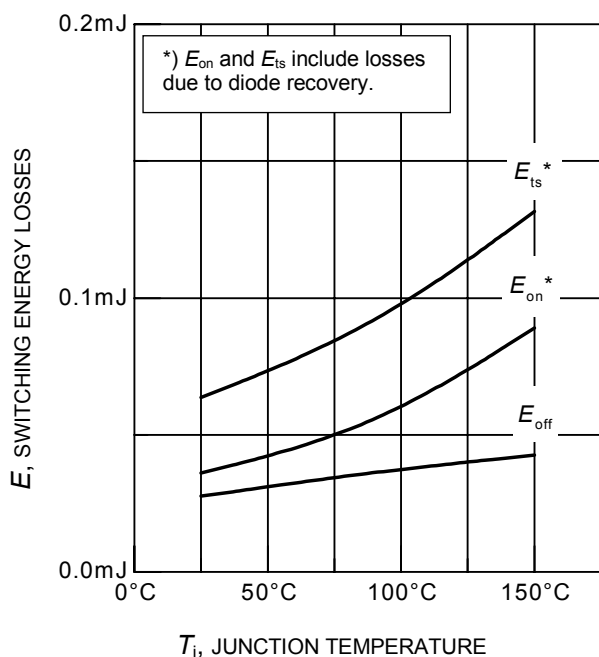

Figure 12. Gate-emitter threshold voltage as a function of junction temperature
(I_C = 0.15mA)

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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 = 118Ω, 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 = 2A, 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 = 2A, R_G = 118Ω, Dynamic test circuit in Figure E)

R, (K/W)	τ, (s)
1.026	0.035
1.3	$3.62*10^{-3}$
1.69	$4.02*10^{-4}$
0.183	$4.21*10^{-5}$
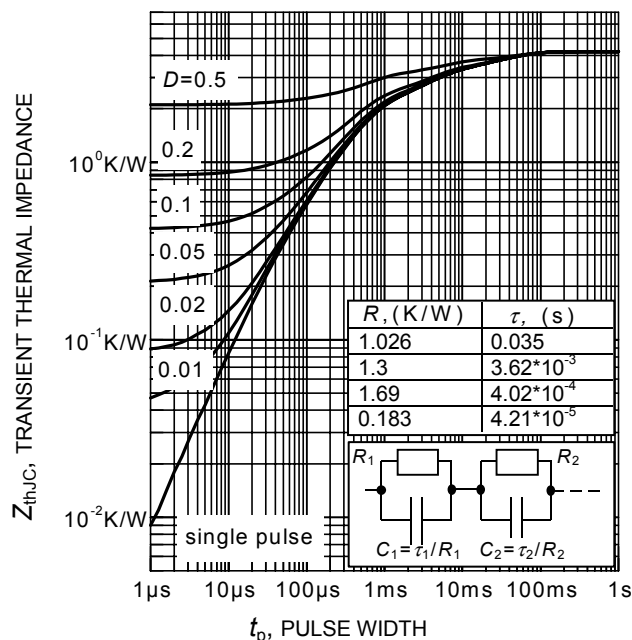
Figure 16. IGBT transient thermal impedance as a function of pulse width
($D = t_p / T$)

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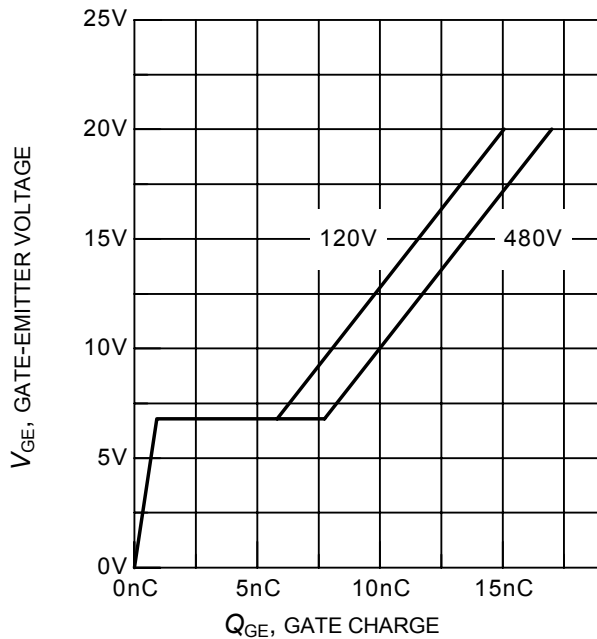
Figure 17. Typical gate charge
(I_C = 2A)
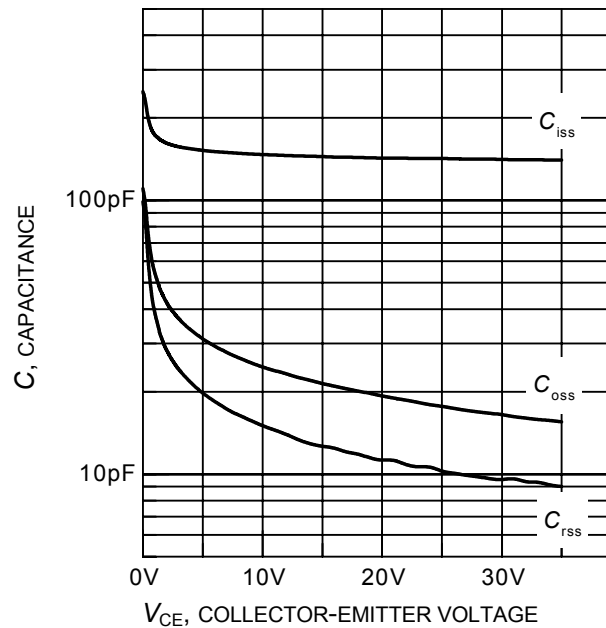
Figure 18. Typical capacitance as a function of collector-emitter voltage
(V_{GE} = 0V, f = 1MHz)
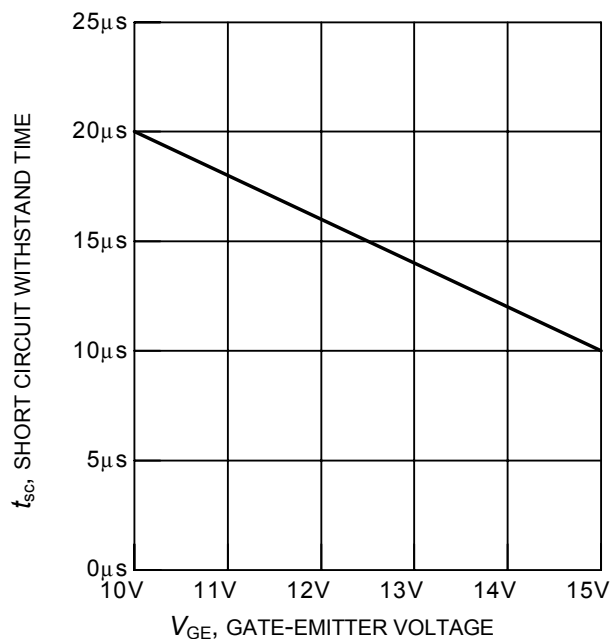
Figure 19. Short circuit withstand time as a function of gate-emitter voltage
(V_{CE} = 600V, start at T_j = 25°C)
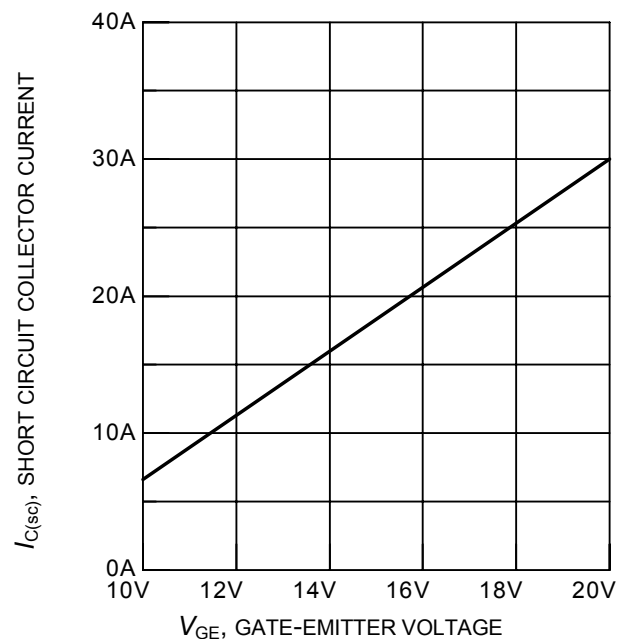
Figure 20. Typical short circuit collector current as a function of gate-emitter voltage
(V_{CE} ≤ 600V, T_j = 150°C)

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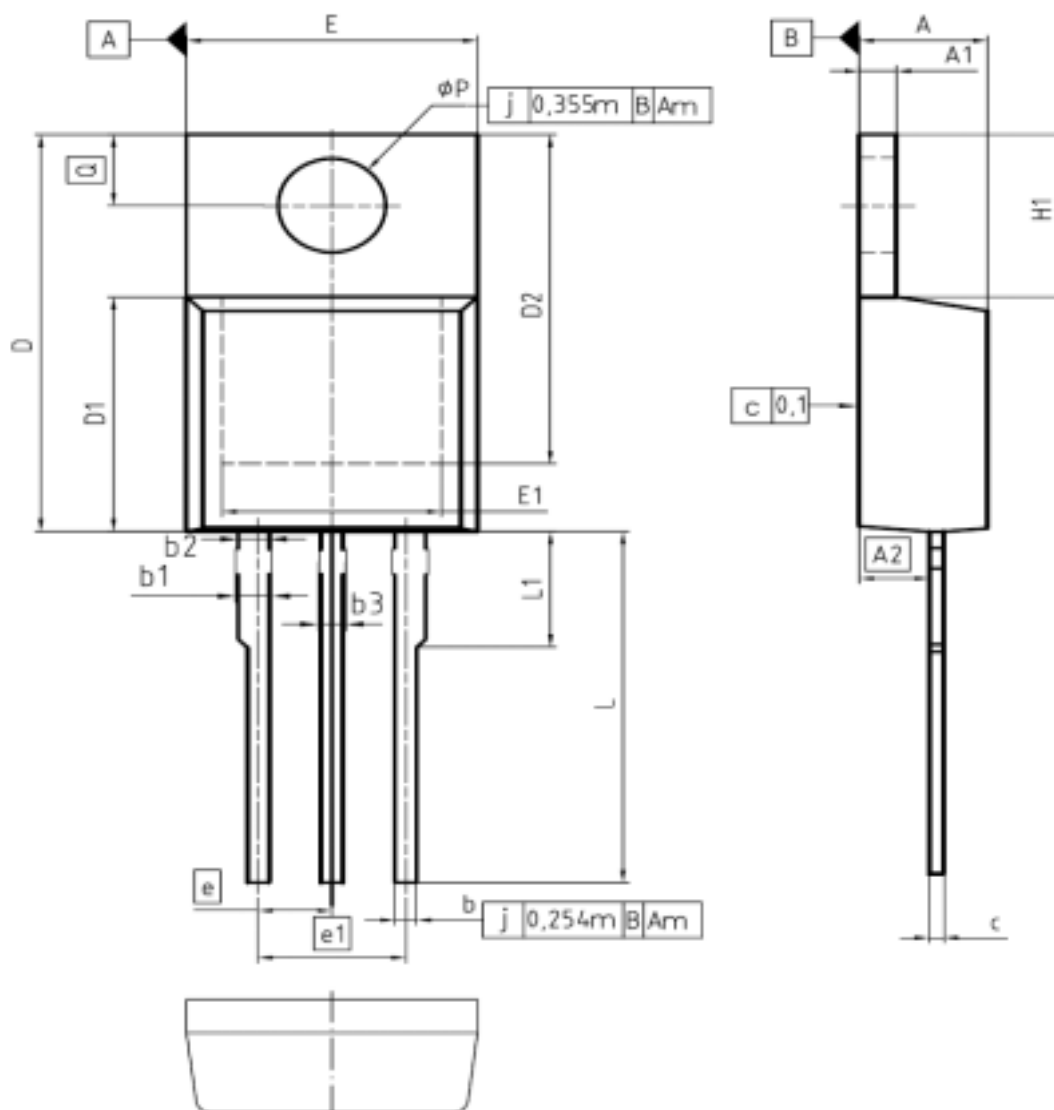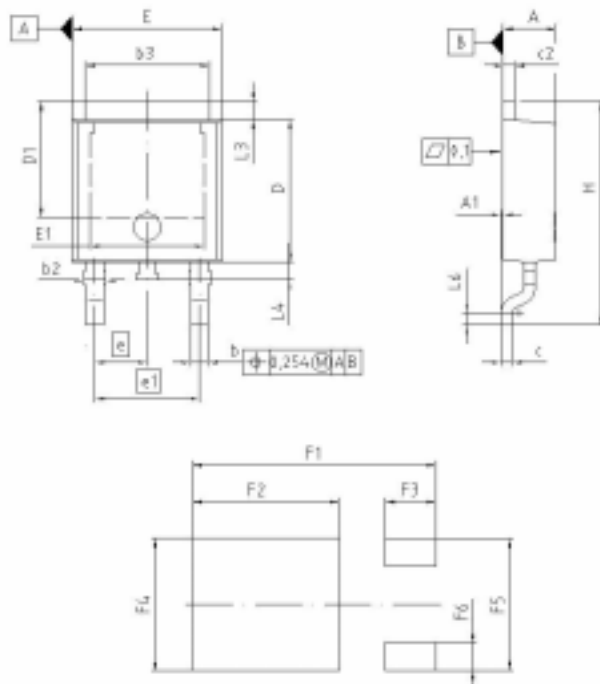| DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.30	4.57	0.169	0.180
A1	1.17	1.40	0.046	0.055
A2	2.15	2.72	0.085	0.107
b	0.65	0.86	0.026	0.034
b1	0.95	1.40	0.037	0.055
b2	0.95	1.15	0.037	0.045
b3	0.65	1.15	0.026	0.045
c	0.33	0.60	0.013	0.024
D	14.81	15.95	0.583	0.628
D1	8.51	9.45	0.335	0.372
D2	12.19	13.10	0.480	0.516
E	9.70	10.36	0.382	0.408
E1	6.50	8.60	0.256	0.339
e	2.54		0.100	
e1	5.08		0.200	
N	3		3	
H1	5.90	6.90	0.232	0.272
L	13.00	14.00	0.512	0.551
L1	-	4.80	-	0.189
øP	3.60	3.89	0.142	0.153
Q	2.60	3.00	0.102	0.118

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SCALE

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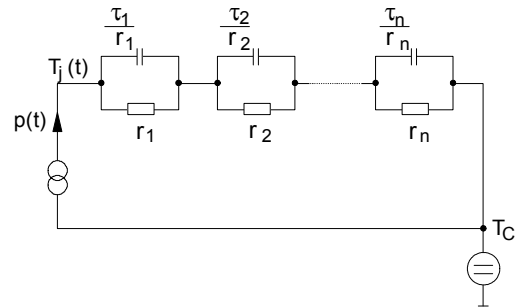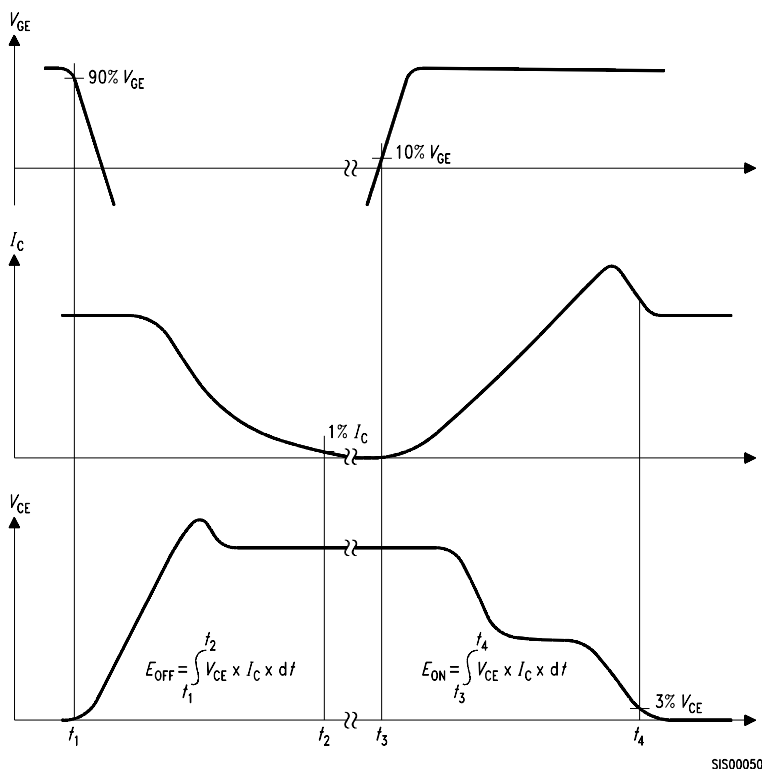
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DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	2.184	2.388	0.086	0.094
A1	0.000	0.150	0.000	0.006
b	0.635	0.889	0.025	0.035
b2	0.650	1.150	0.025	0.045
b3	5.004	5.500	0.197	0.217
c	0.460	0.580	0.018	0.023
c2	0.460	0.980	0.018	0.039
D	5.969	6.223	0.235	0.245
D1	5.020	5.320	0.198	0.209
E	6.400	6.731	0.252	0.265
E1	4.900	5.100	0.193	0.201
e	2.286		0.090	
e1	4.572		0.180	
N	3		3	
H	9.400	10.084	0.370	0.397
L3	0.900	1.118	0.035	0.044
L4	0.650	1.016	0.026	0.040
L6	0.510	0.686	0.020	0.027
F1	10.500	10.700	0.413	0.421
F2	6.300	6.500	0.248	0.256
F3	2.100	2.300	0.083	0.091
F4	5.700	5.900	0.224	0.232
F5	5.660	5.860	0.222	0.231
F6	1.100	1.300	0.043	0.051

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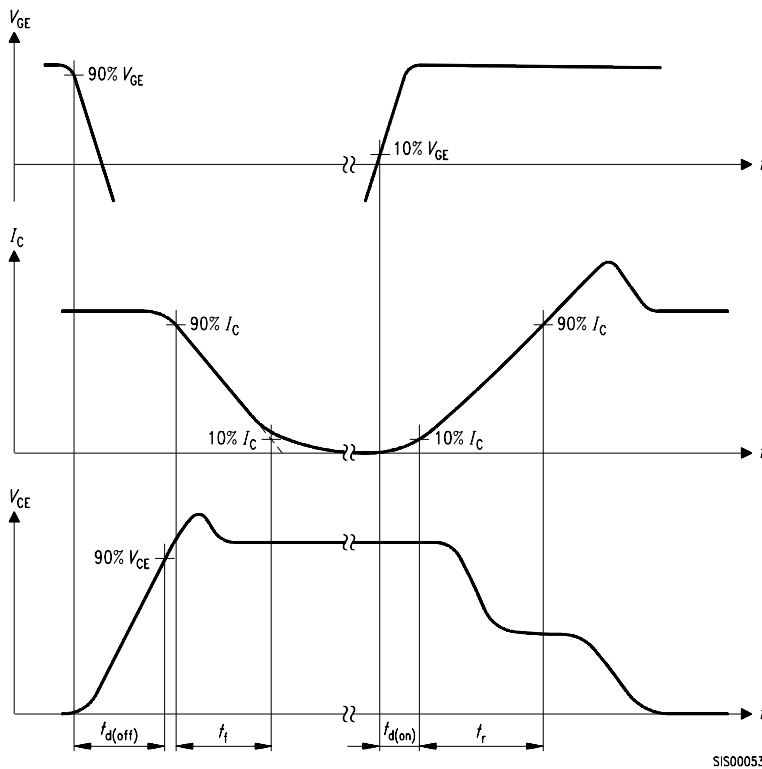
Figure A. Definition of switching times

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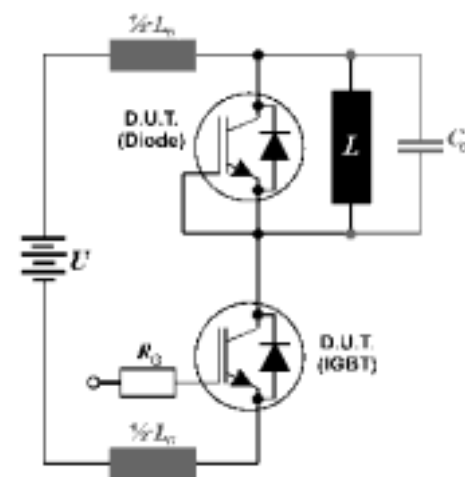
Figure E. Dynamic test circuit
Leakage inductance L_σ =180nH
and Stray capacity C_σ =180pF.

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