

Thermal Resistance

Parameter	Symbol	Conditions	Max. Value	Unit
Characteristic				
IGBT thermal resistance, junction – case	R_{thJC}		0.5	K/W
Thermal resistance, junction – ambient	R_{thJA}	PG-TO-220-3-1	62	
		PG-TO-247-3-21	40	

Electrical Characteristic, at $T_j = 25^\circ\text{C}$, unless otherwise specified

Parameter	Symbol	Conditions	Value			Unit
			min.	Typ.	max.	
Static Characteristic						
Collector-emitter breakdown voltage	$V_{(BR)CES}$	$V_{GE}=0V, I_C=500\mu A$	600	-	-	V
Collector-emitter saturation voltage	$V_{CE(sat)}$	$V_{GE} = 15V, I_C=30A$ $T_j=25^{\circ}C$ $T_j=150^{\circ}C$	1.7 -	2.1 2.5	2.4 3.0	
Gate-emitter threshold voltage	$V_{GE(th)}$	$I_C=700\mu A, V_{CE}=V_{GE}$	3	4	5	
Zero gate voltage collector current	I_{CES}	$V_{CE}=600V, V_{GE}=0V$ $T_j=25^{\circ}C$ $T_j=150^{\circ}C$	- -	- -	40 3000	μA
Gate-emitter leakage current	I_{GES}	$V_{CE}=0V, V_{GE}=20V$	-	-	100	nA
Transconductance	g_{fs}	$V_{CE}=20V, I_C=30A$	-	20	-	S
Dynamic Characteristic						
Input capacitance	C_{iss}	$V_{CE}=25V,$	-	1600	1920	pF
Output capacitance	C_{oss}	$V_{GE}=0V,$	-	150	180	
Reverse transfer capacitance	C_{rss}	$f=1MHz$	-	92	110	
Gate charge	Q_{Gate}	$V_{CC}=480V, I_C=30A$ $V_{GE}=15V$	-	140	182	nC
Internal emitter inductance	L_E	PG-TO-220-3-1	-	7	-	nH
measured 5mm (0.197 in.) from case		PG-TO-247-3-21	-	13		
Short circuit collector current ²⁾	$I_{C(SC)}$	$V_{GE}=15V, t_{SC}\leq 10\mu s$ $V_{CC}\leq 600V,$ $T_j\leq 150^{\circ}C$	-	300	-	A

²⁾ 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	$t_{d(on)}$	$T_j=25^{\circ}\text{C}$, $V_{CC}=400\text{V}$, $I_C=30\text{A}$, $V_{GE}=0/15\text{V}$, $R_G=11\Omega$, $L_{\sigma}^{1)}=180\text{nH}$, $C_{\sigma}^{1)}=900\text{pF}$	-	44	53	ns
Rise time	t_r		-	34	40	
Turn-off delay time	$t_{d(off)}$		-	291	349	
Fall time	t_f		-	58	70	
Turn-on energy	E_{on}	Energy losses include “tail” and diode reverse recovery.	-	0.64	0.77	mJ
Turn-off energy	E_{off}		-	0.65	0.85	
Total switching energy	E_{ts}		-	1.29	1.62	

Switching Characteristic, Inductive Load, at $T_j=150^\circ\text{C}$

Parameter	Symbol	Conditions	Value			Unit
			min.	typ.	max.	
IGBT Characteristic						
Turn-on delay time	$t_{d(on)}$	$T_j=150^{\circ}\text{C}$ $V_{CC}=400\text{V}, I_C=30\text{A},$ $V_{GE}=0/15\text{V},$ $R_G=11\Omega,$ $L_{\sigma}^{1)}=180\text{nH},$ $C_{\sigma}^{1)}=900\text{pF}$ Energy losses include “tail” and diode reverse recovery.	-	44	53	ns
Rise time	t_r		-	34	40	
Turn-off delay time	$t_{d(off)}$		-	324	389	
Fall time	t_f		-	67	80	
Turn-on energy	E_{on}		-	0.98	1.18	mJ
Turn-off energy	E_{off}		-	0.92	1.19	
Total switching energy	E_{ts}		-	1.90	2.38	

¹⁾ Leakage inductance L_{σ} and Stray capacity C_{σ} due to dynamic test circuit in Figure E.

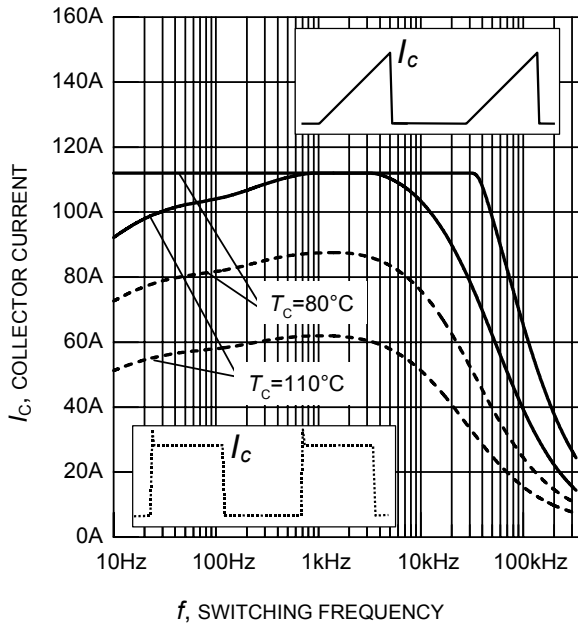


Figure 1. Collector current as a function of switching frequency

($T_j \leq 150^\circ\text{C}$, $D = 0.5$, $V_{CE} = 400\text{V}$, $V_{GE} = 0/+15\text{V}$, $R_G = 11\Omega$)

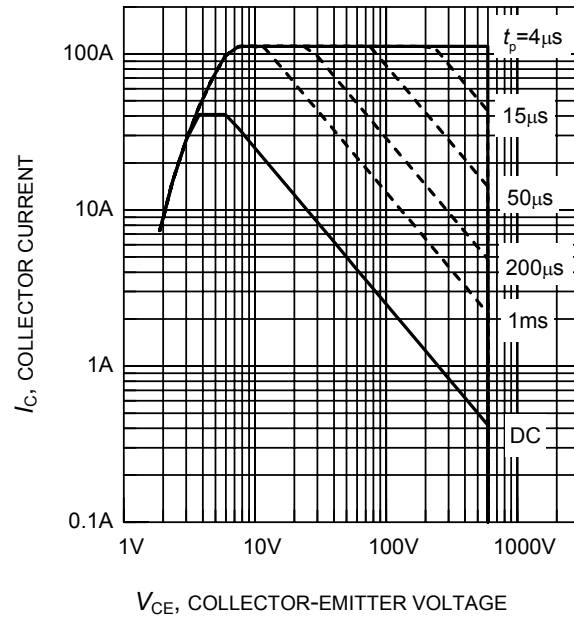


Figure 2. Safe operating area
($D = 0$, $T_C = 25^\circ\text{C}$, $T_j \leq 150^\circ\text{C}$)

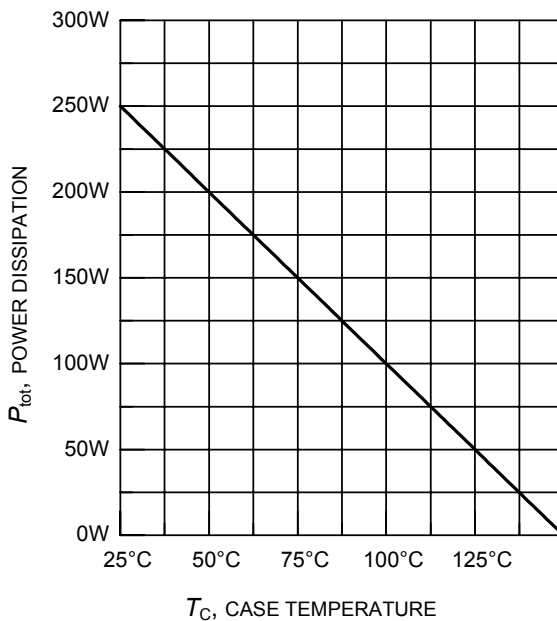


Figure 3. Power dissipation as a function of case temperature

($T_j \leq 150^\circ\text{C}$)

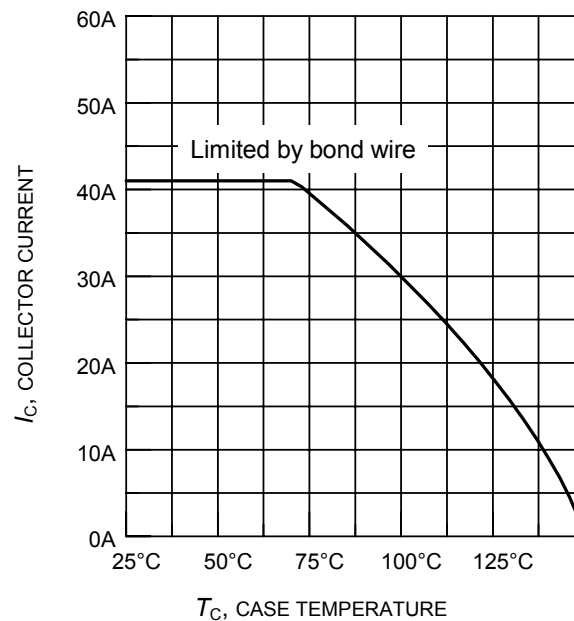


Figure 4. Collector current as a function of case temperature

($V_{GE} \leq 15\text{V}$, $T_j \leq 150^\circ\text{C}$)

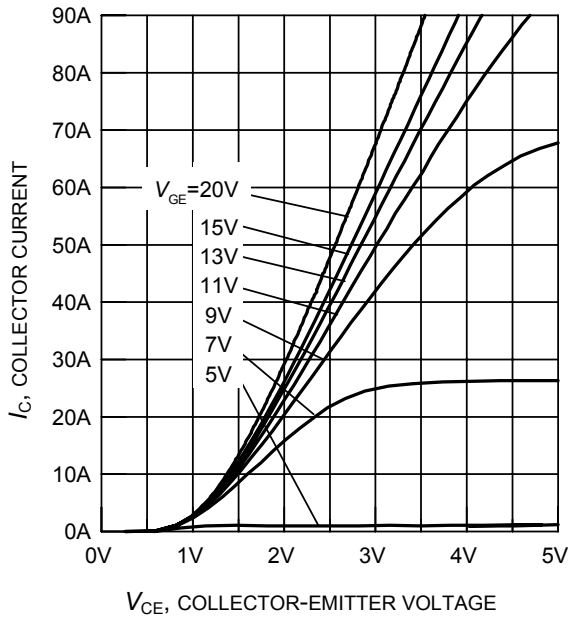


Figure 5. Typical output characteristics
($T_j = 25^\circ\text{C}$)

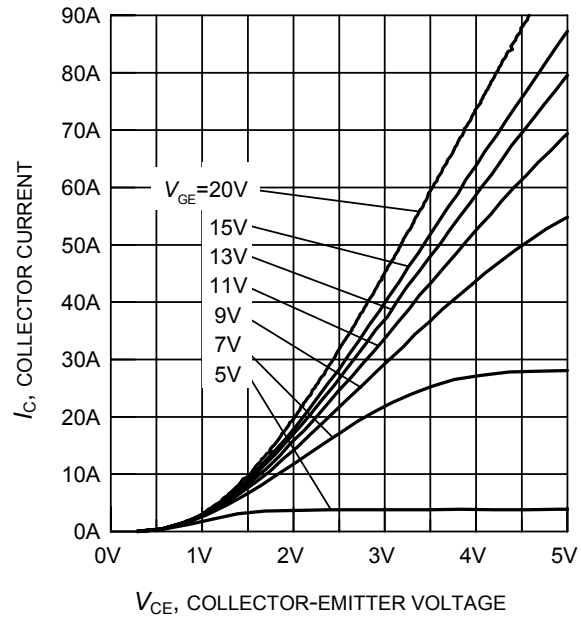


Figure 6. Typical output characteristics
($T_j = 150^\circ\text{C}$)

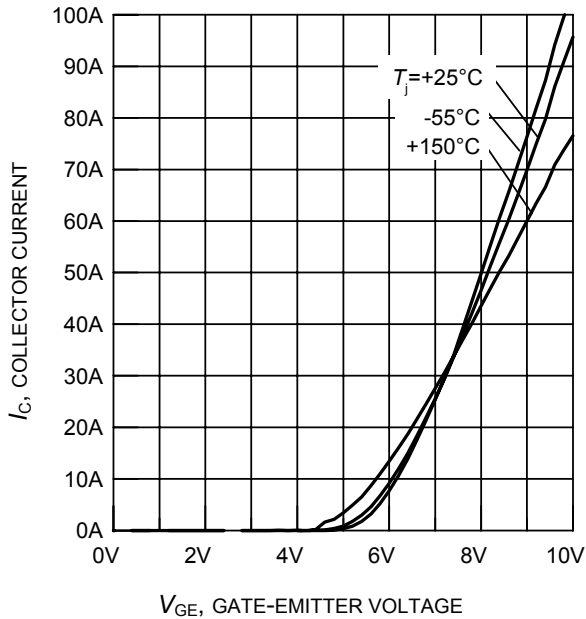


Figure 7. Typical transfer characteristics
($V_{CE} = 10\text{V}$)

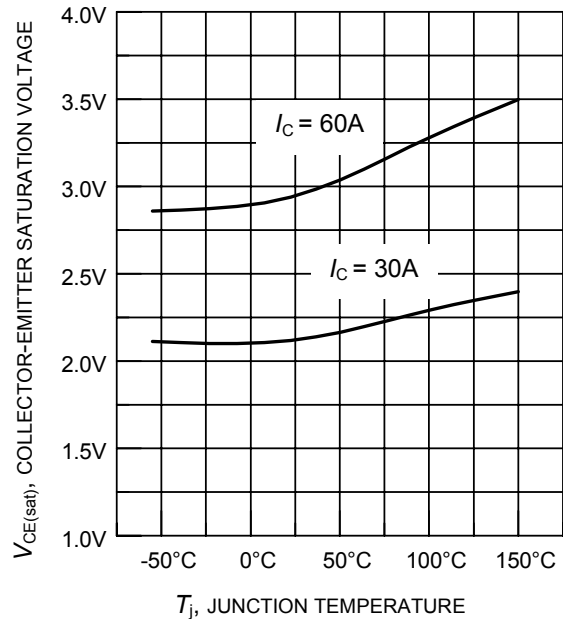


Figure 8. Typical collector-emitter saturation voltage as a function of junction temperature
($V_{GE} = 15\text{V}$)

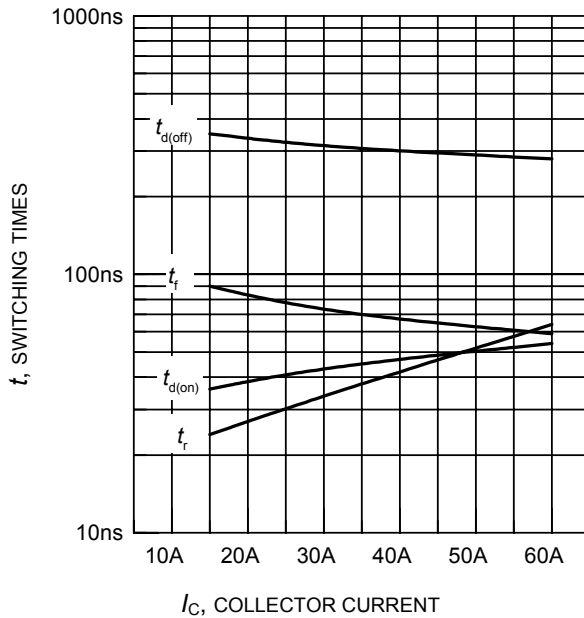


Figure 9. Typical switching times as a function of collector current
(inductive load, $T_j = 150^\circ\text{C}$, $V_{CE} = 400\text{V}$, $V_{GE} = 0/+15\text{V}$, $R_G = 11\Omega$, Dynamic test circuit in Figure E)

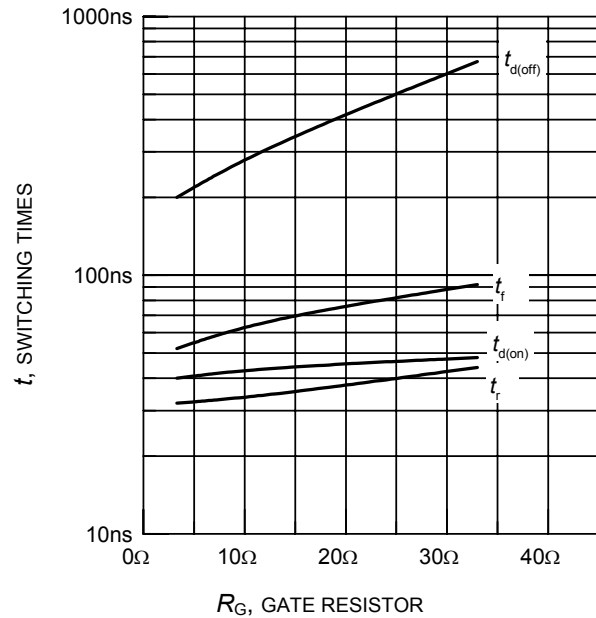


Figure 10. Typical switching times as a function of gate resistor
(inductive load, $T_j = 150^\circ\text{C}$, $V_{CE} = 400\text{V}$, $V_{GE} = 0/+15\text{V}$, $I_C = 30\text{A}$, Dynamic test circuit in Figure E)

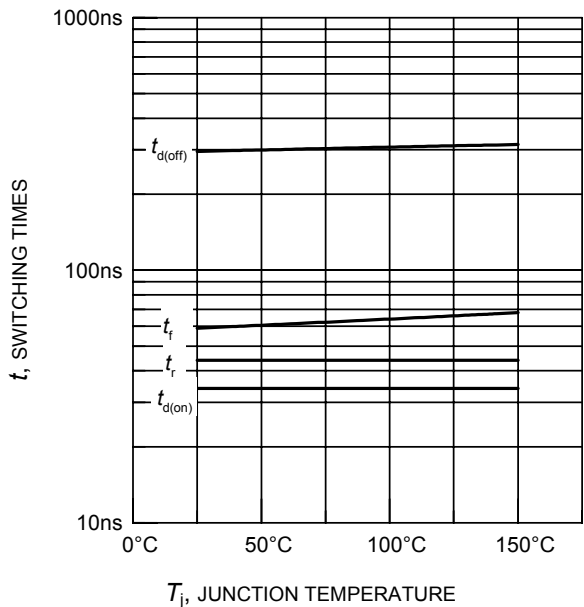


Figure 11. Typical switching times as a function of junction temperature
(inductive load, $V_{CE} = 400\text{V}$, $V_{GE} = 0/+15\text{V}$, $I_C = 30\text{A}$, $R_G = 11\Omega$, Dynamic test circuit in Figure E)

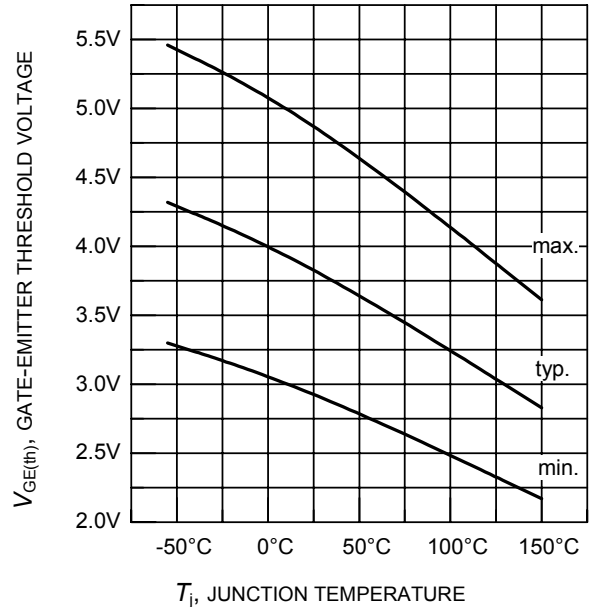


Figure 12. Gate-emitter threshold voltage as a function of junction temperature
($I_C = 0.7\text{mA}$)

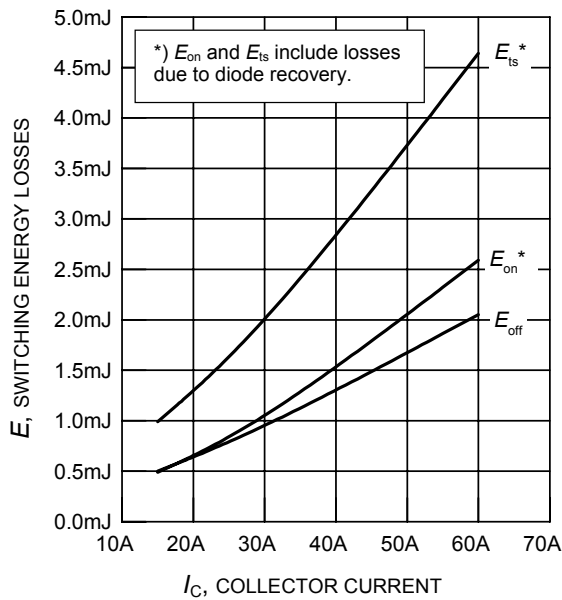


Figure 13. Typical switching energy losses as a function of collector current
(inductive load, $T_j = 150^\circ\text{C}$, $V_{CE} = 400\text{V}$, $V_{GE} = 0/+15\text{V}$, $R_G = 11\Omega$, Dynamic test circuit in Figure E)

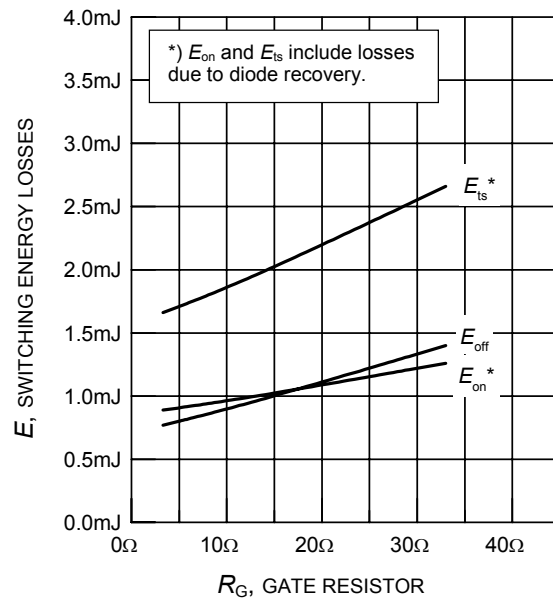


Figure 14. Typical switching energy losses as a function of gate resistor
(inductive load, $T_j = 150^\circ\text{C}$, $V_{CE} = 400\text{V}$, $V_{GE} = 0/+15\text{V}$, $I_C = 30\text{A}$, Dynamic test circuit in Figure E)

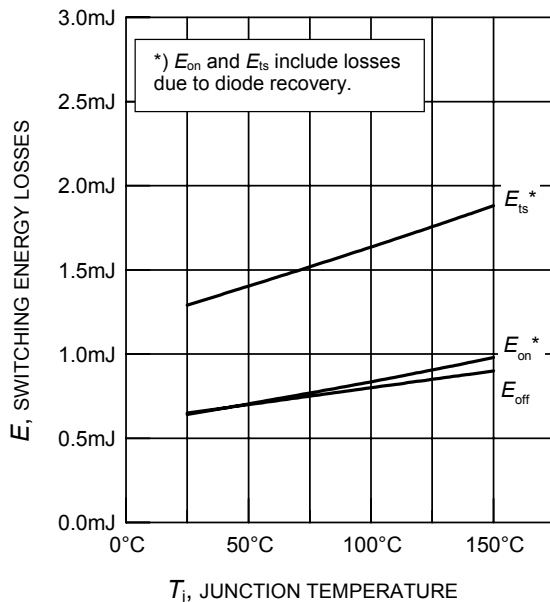


Figure 15. Typical switching energy losses as a function of junction temperature
(inductive load, $V_{CE} = 400\text{V}$, $V_{GE} = 0/+15\text{V}$, $I_C = 30\text{A}$, $R_G = 11\Omega$, Dynamic test circuit in Figure E)

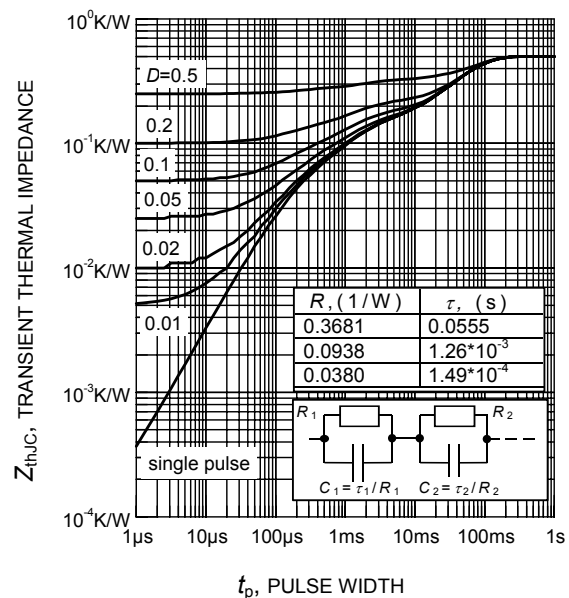


Figure 16. IGBT transient thermal impedance as a function of pulse width
($D = t_p / T$)

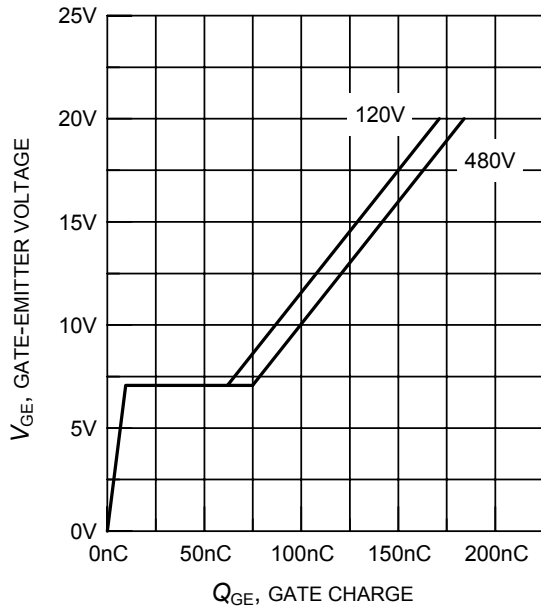


Figure 17. Typical gate charge
($I_C = 30A$)

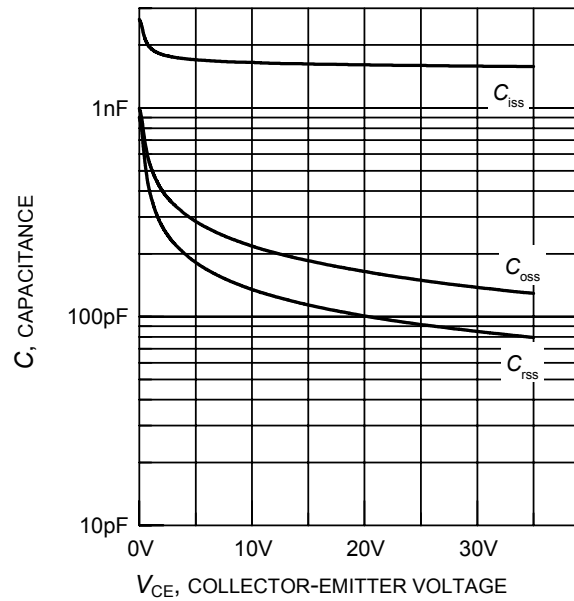


Figure 18. Typical capacitance as a function of collector-emitter voltage
($V_{GE} = 0V$, $f = 1MHz$)

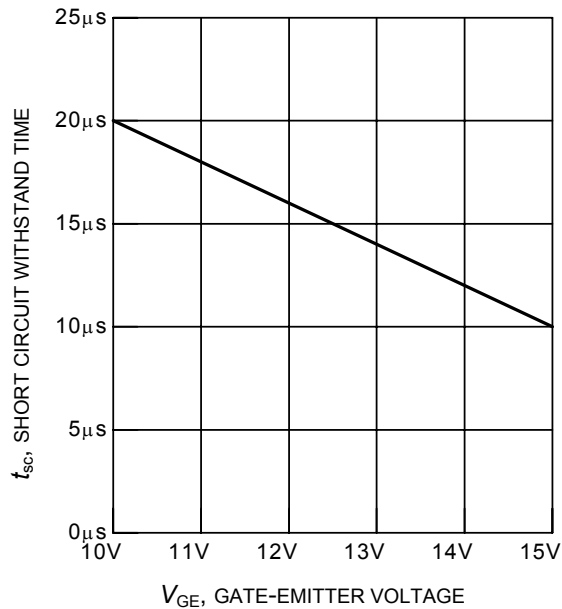


Figure 19. Short circuit withstand time as a function of gate-emitter voltage
($V_{CE} = 600V$, start at $T_j = 25^\circ C$)

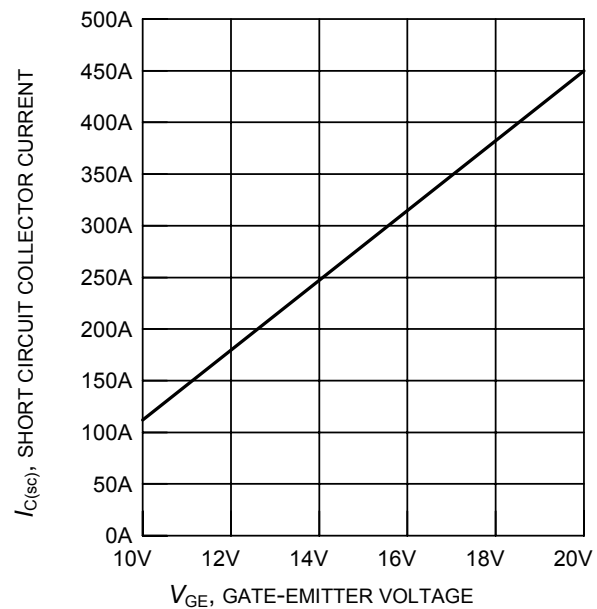
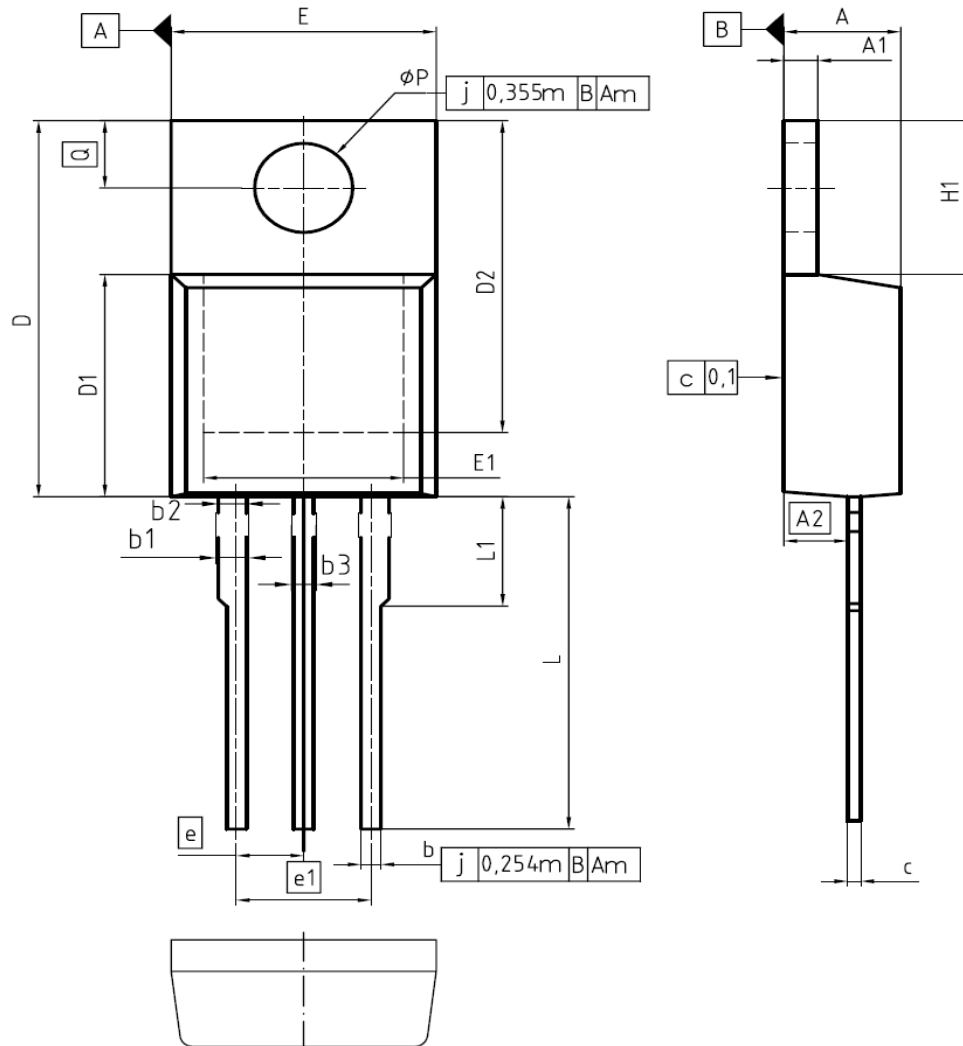


Figure 20. Typical short circuit collector current as a function of gate-emitter voltage
($V_{CE} \leq 600V$, $T_j = 150^\circ C$)

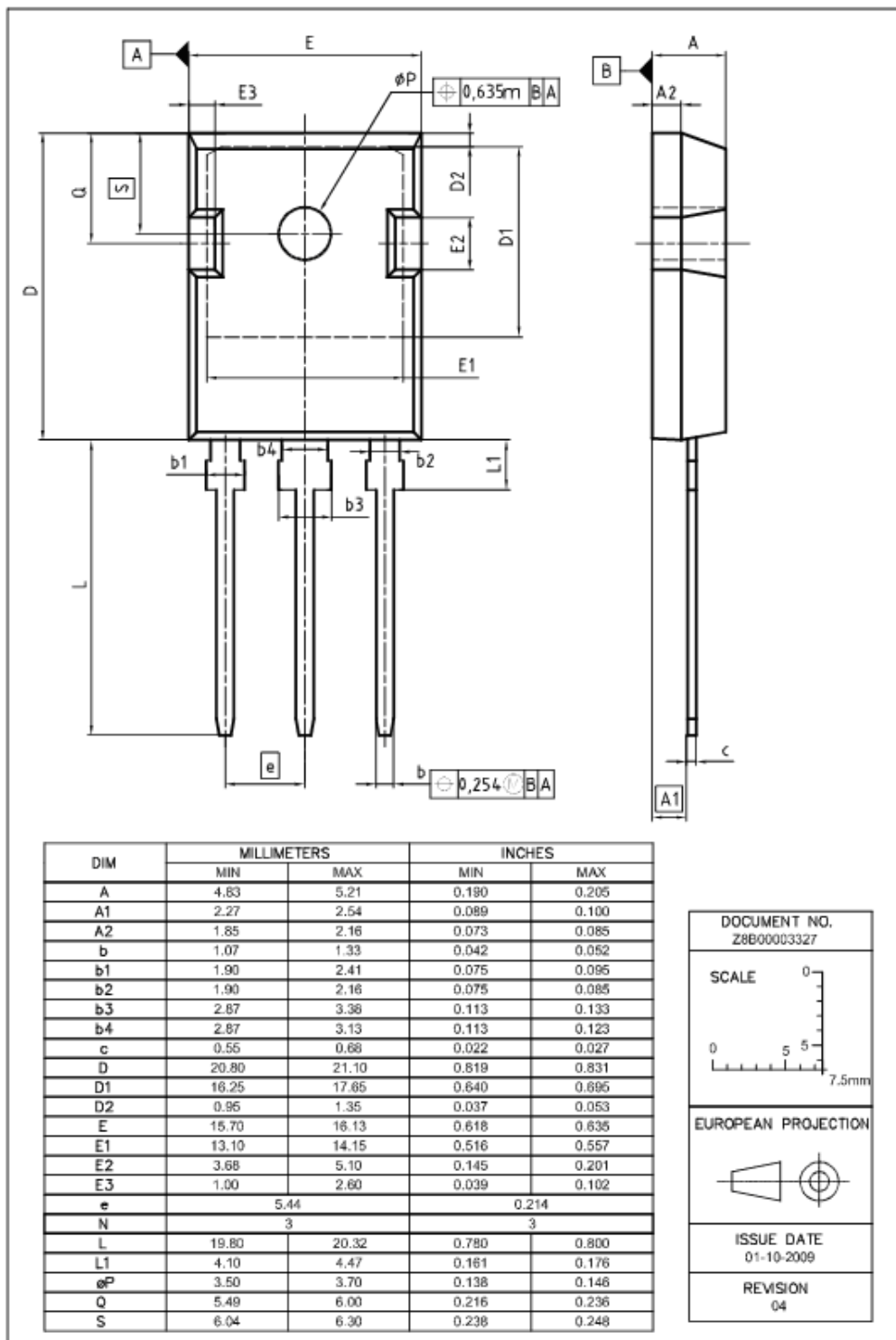
PG-TO-220-3-1



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
ϕP	3.60	3.89	0.142	0.153
Q	2.60	3.00	0.102	0.118

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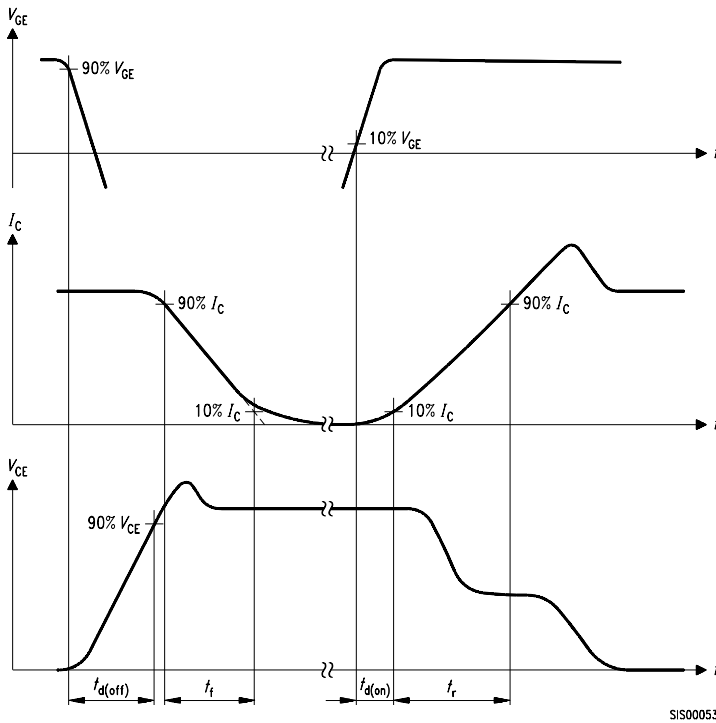


Figure A. Definition of switching times

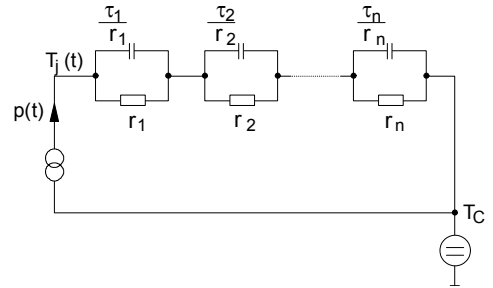


Figure D. Thermal equivalent circuit

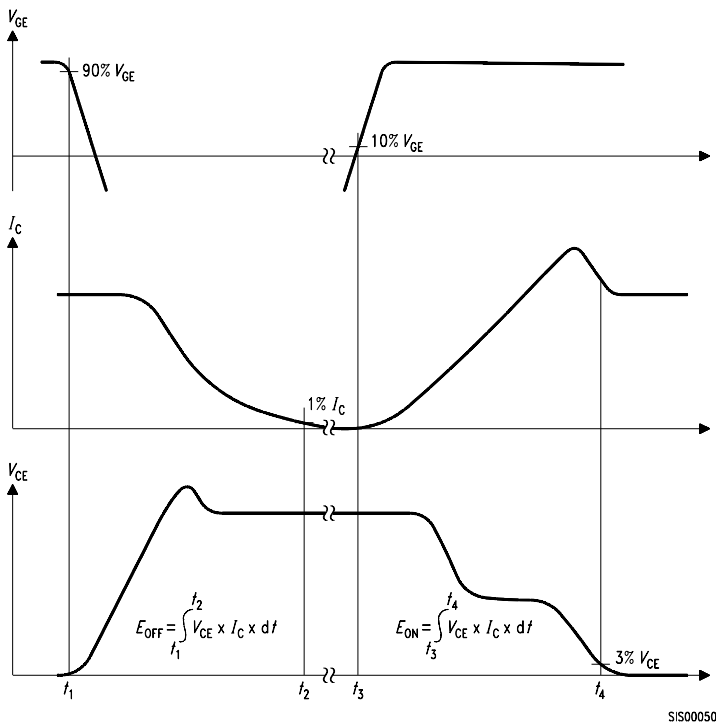


Figure B. Definition of switching losses

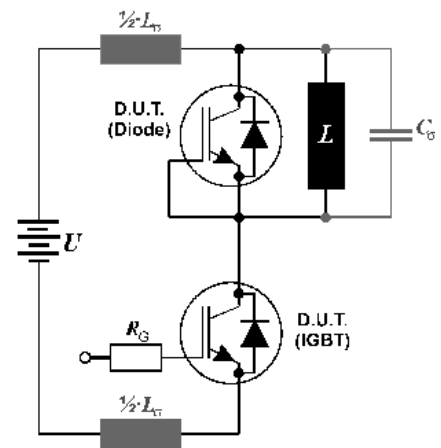


Figure E. Dynamic test circuit
Leakage inductance $L_{\sigma} = 180\text{nH}$
and Stray capacity $C_{\sigma} = 900\text{pF}$.

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