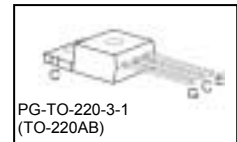
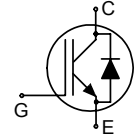


Fast IGBT in NPT-technology with soft, fast recovery anti-parallel EmCon diode

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

- 40% lower E_{off} compared to previous generation
- Short circuit withstand time – 10 μ s
- Designed for:
 - Motor controls
 - Inverter
 - SMPS
- NPT-Technology offers:
 - very tight parameter distribution
 - high ruggedness, temperature stable behaviour
 - parallel switching capability
- Qualified according to JEDEC¹ for target applications
- Pb-free lead plating; RoHS compliant
- Complete product spectrum and PSpice Models : <http://www.infineon.com/igbt/>



Type	V_{CE}	I_C	E_{off}	T_j	Marking	Package
SKP02N120	1200V	2A	0.11mJ	150°C	K02N120	PG-TO-220-3-1

Maximum Ratings

Parameter	Symbol	Value	Unit
Collector-emitter voltage	V_{CE}	1200	V
DC collector current	I_C	6.2	A
$T_C = 25^\circ\text{C}$		2.8	
$T_C = 100^\circ\text{C}$			
Pulsed collector current, t_p limited by T_{jmax}	I_{Cpuls}	9.6	
Turn off safe operating area	-	9.6	
$V_{CE} \leq 1200\text{V}$, $T_j \leq 150^\circ\text{C}$			
Diode forward current	I_F	4.5	
$T_C = 25^\circ\text{C}$		2	
$T_C = 100^\circ\text{C}$			
Diode pulsed current, t_p limited by T_{jmax}	I_{Fpuls}	9	
Gate-emitter voltage	V_{GE}	± 20	V
Short circuit withstand time ²	t_{SC}	10	μ s
$V_{GE} = 15\text{V}$, $100\text{V} \leq V_{CC} \leq 1200\text{V}$, $T_j \leq 150^\circ\text{C}$			
Power dissipation	P_{tot}	62	W
$T_C = 25^\circ\text{C}$			
Operating junction and storage temperature	T_j , T_{stg}	-55...+150	$^\circ\text{C}$
Soldering temperature, wavesoldering, 1.6mm (0.063 in.) from case for 10s	T_s	260	

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}		2.0	K/W
Diode thermal resistance, junction – case	R_{thJCD}		4.5	
Thermal resistance, junction – ambient	R_{thJA}		62	

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	$V_{(BR)CES}$	$V_{GE}=0V, I_C=100\mu A$	1200	-	-	V
Collector-emitter saturation voltage	$V_{CE(sat)}$	$V_{GE} = 15V, I_C=2A$ $T_j=25^{\circ}C$ $T_j=150^{\circ}C$	2.5 -	3.1 3.7	3.6 4.3	
Diode forward voltage	V_F	$V_{GE}=0V, I_F=2A$ $T_j=25^{\circ}C$ $T_j=150^{\circ}C$	-	2.0 1.75	2.5	
Gate-emitter threshold voltage	$V_{GE(th)}$	$I_C=100\mu A, V_{CE}=V_{GE}$	3	4	5	
Zero gate voltage collector current	I_{CES}	$V_{CE}=1200V, V_{GE}=0V$ $T_j=25^{\circ}C$ $T_j=150^{\circ}C$	- -	- -	25 100	μA
Gate-emitter leakage current	I_{GES}	$V_{CE}=0V, V_{GE}=20V$	-	-	100	
Transconductance	g_{fs}	$V_{CE}=20V, I_C=2A$		1.5	-	S
Dynamic Characteristic						
Input capacitance	C_{iss}	$V_{CE}=25V,$ $V_{GE}=0V,$ $f=1MHz$	-	205	250	pF
Output capacitance	C_{oss}		-	28	34	
Reverse transfer capacitance	C_{rss}		-	12	15	
Gate charge	Q_{Gate}	$V_{CC}=960V, I_C=2A$ $V_{GE}=15V$	-	11	-	nC
Internal emitter inductance measured 5mm (0.197 in.) from case	L_E		-	7	-	nH
Short circuit collector current ²⁾	$I_{C(SC)}$	$V_{GE}=15V, t_{SC}\leq 10\mu s$ $100V\leq V_{CC}\leq 1200V,$ $T_j\leq 150^{\circ}C$	-	24	-	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	$t_{d(on)}$	$T_j=25^{\circ}\text{C}$, $V_{CC}=800\text{V}$, $I_C=2\text{A}$, $V_{GE}=15\text{V}/0\text{V}$, $R_G=91\Omega$, $L_{\sigma}^{(1)}=180\text{nH}$, $C_{\sigma}^{(1)}=40\text{pF}$	-	23	30	ns
Rise time	t_r		-	16	21	
Turn-off delay time	$t_{d(off)}$		-	260	340	
Fall time	t_f		-	61	80	
Turn-on energy	E_{on}	Energy losses include “tail” and diode reverse recovery.	-	0.16	0.21	mJ
Turn-off energy	E_{off}		-	0.06	0.08	
Total switching energy	E_{ts}		-	0.22	0.29	

Anti-Parallel Diode Characteristic

Diode reverse recovery time	t_{rr}	$T_j=25^\circ\text{C}$, $V_R=800\text{V}$, $I_F=2\text{A}$, $di_F/dt=250\text{A}/\mu\text{s}$	-	50		ns
	t_s		-			
	t_F		-			
Diode reverse recovery charge	Q_{rr}		-	0.10		μC
Diode peak reverse recovery current	I_{rrm}		-	4.2		A
Diode peak rate of fall of reverse recovery current during t_F	di_{rr}/dt		-	400		A/ μs

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	$t_{d(on)}$	$T_j=150^{\circ}\text{C}$ $V_{CC}=800\text{V}$, $I_C=2\text{A}$, $V_{GE}=15\text{V}/0\text{V}$, $R_G=91\Omega$, $L_{\sigma}^{(1)}=180\text{nH}$, $C_{\sigma}^{(1)}=40\text{pF}$	-	26	31	ns
Rise time	t_r		-	14	17	
Turn-off delay time	$t_{d(off)}$		-	290	350	
Fall time	t_f		-	85	102	
Turn-on energy	E_{on}	Energy losses include “tail” and diode reverse recovery.	-	0.27	0.33	mJ
Turn-off energy	E_{off}		-	0.11	0.15	
Total switching energy	E_{ts}		-	0.38	0.48	

Anti-Parallel Diode Characteristic

Diode reverse recovery time	t_{rr}	$T_j=150^\circ\text{C}$ $V_R=800\text{V}$, $I_F=2\text{A}$, $di_F/dt=300\text{A}/\mu\text{s}$	-	90		ns
	t_s		-			
	t_F		-			
Diode reverse recovery charge	Q_{rr}		-	0.30		μC
Diode peak reverse recovery current	I_{rrm}		-	6.7		A
Diode peak rate of fall of reverse recovery current during t_F	di_{rr}/dt		-	110		A/ μs

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

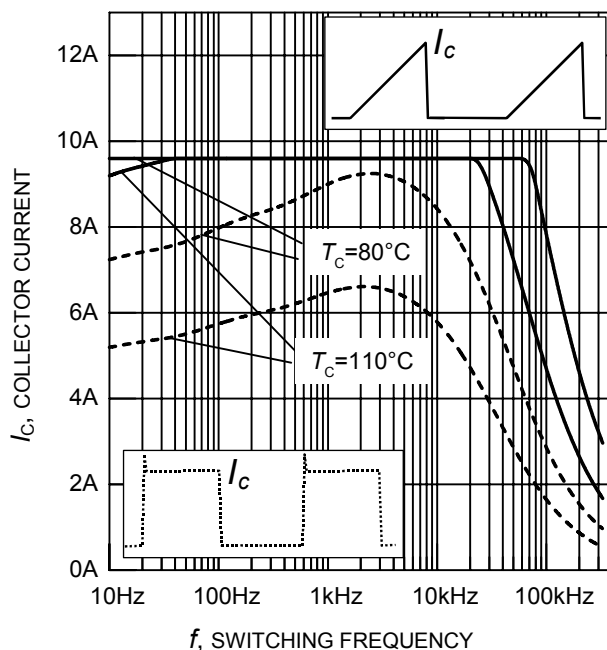


Figure 1. Collector current as a function of switching frequency

($T_j \leq 150^\circ\text{C}$, $D = 0.5$, $V_{CE} = 800\text{V}$, $V_{GE} = +15\text{V}/0\text{V}$, $R_G = 91\Omega$)

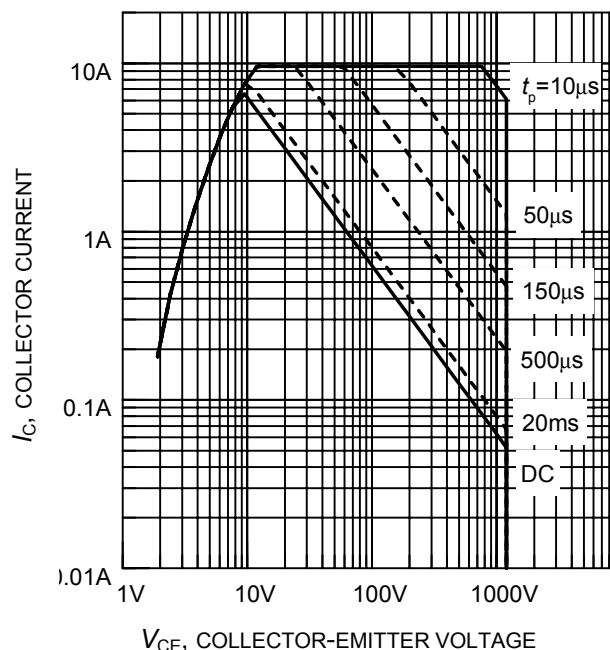


Figure 2. Safe operating area

($D = 0$, $T_C = 25^\circ\text{C}$, $T_j \leq 150^\circ\text{C}$)

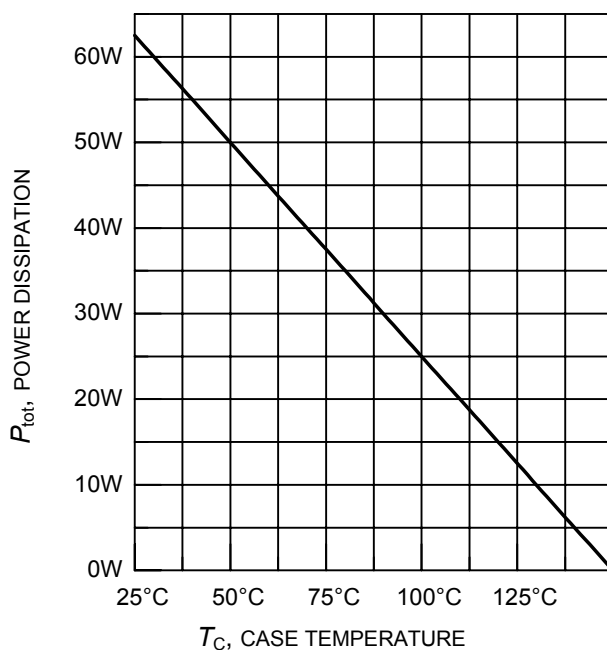


Figure 3. Power dissipation as a function of case temperature

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

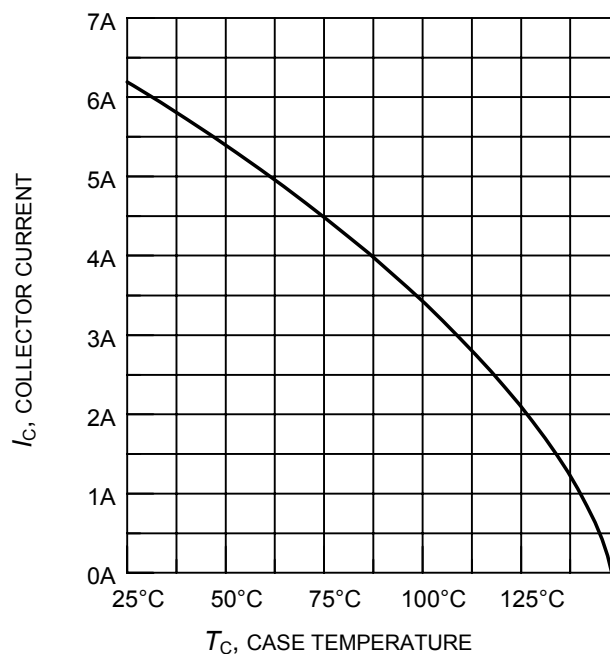


Figure 4. Collector current as a function of case temperature

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

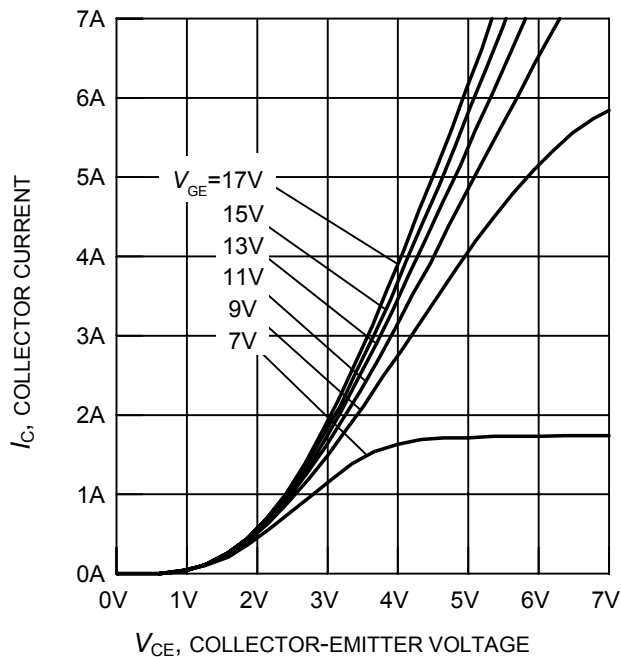


Figure 5. Typical output characteristics
($T_j = 25^\circ\text{C}$)

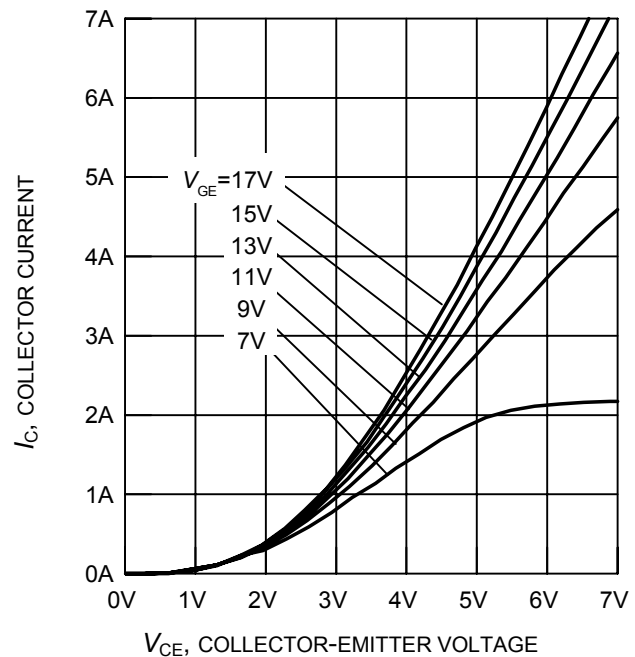


Figure 6. Typical output characteristics
($T_j = 150^\circ\text{C}$)

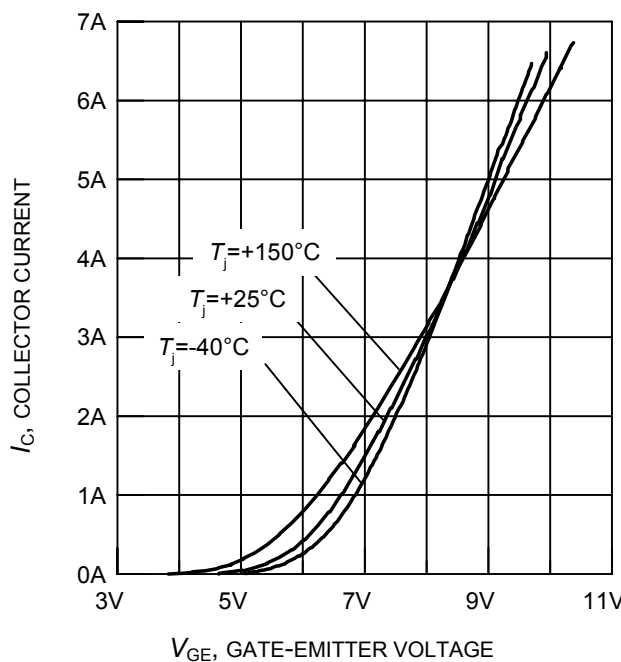


Figure 7. Typical transfer characteristics
($V_{CE} = 20\text{V}$)

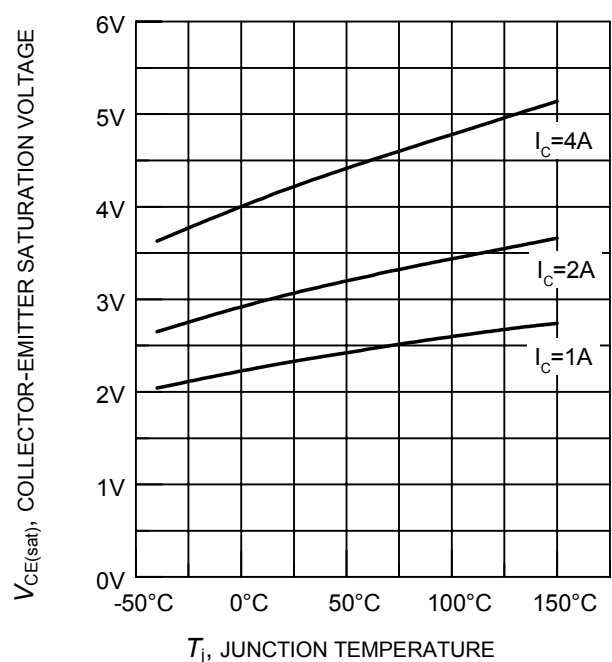


Figure 8. Typical collector-emitter saturation voltage as a function of junction temperature
($V_{GE} = 15\text{V}$)

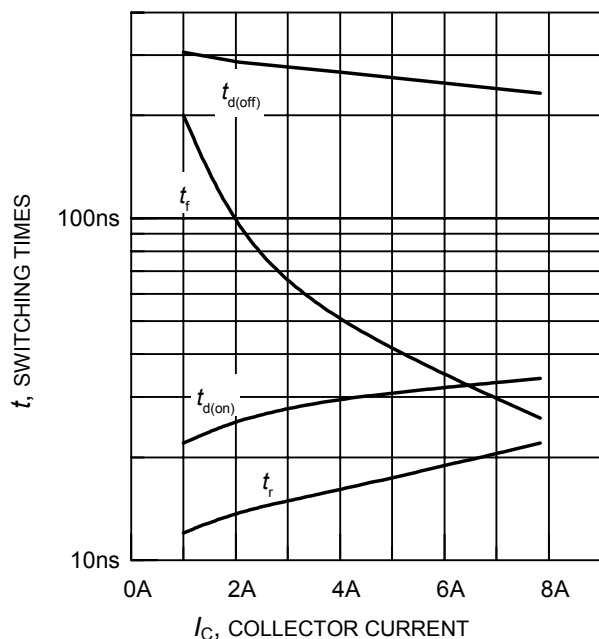


Figure 9. Typical switching times as a function of collector current
(inductive load, $T_j = 150^\circ\text{C}$,
 $V_{CE} = 800\text{V}$, $V_{GE} = +15\text{V}/0\text{V}$, $R_G = 91\Omega$,
dynamic test circuit in Fig.E)

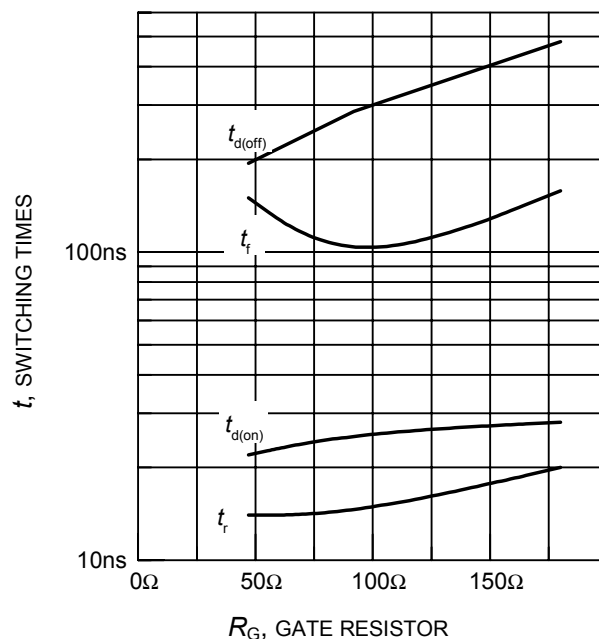


Figure 10. Typical switching times as a function of gate resistor
(inductive load, $T_j = 150^\circ\text{C}$,
 $V_{CE} = 800\text{V}$, $V_{GE} = +15\text{V}/0\text{V}$, $I_C = 2\text{A}$,
dynamic test circuit in Fig.E)

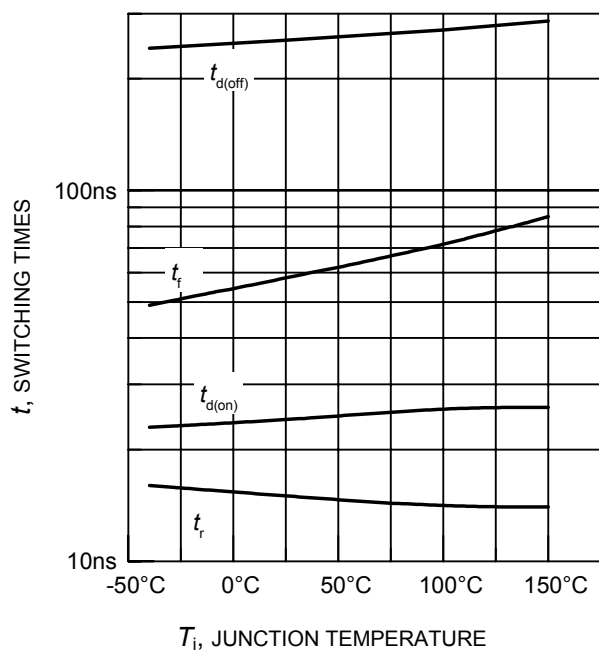


Figure 11. Typical switching times as a function of junction temperature
(inductive load, $V_{CE} = 800\text{V}$,
 $V_{GE} = +15\text{V}/0\text{V}$, $I_C = 2\text{A}$, $R_G = 91\Omega$,
dynamic test circuit in Fig.E)

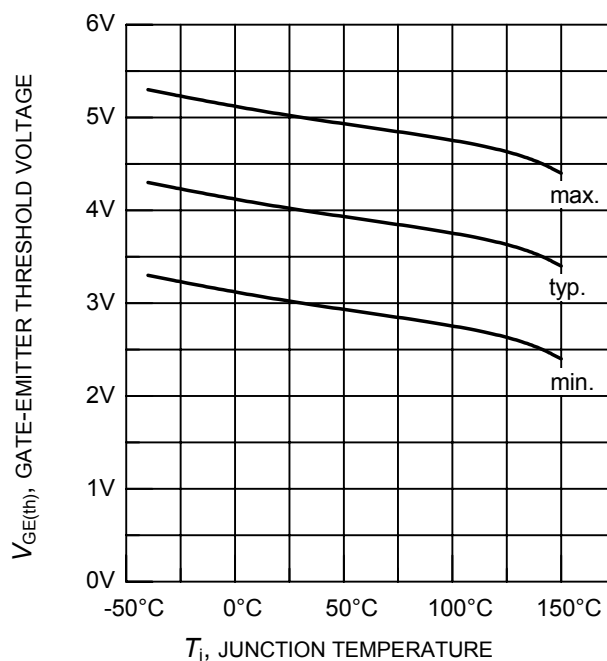


Figure 12. Gate-emitter threshold voltage as a function of junction temperature
($I_C = 0.3\text{mA}$)

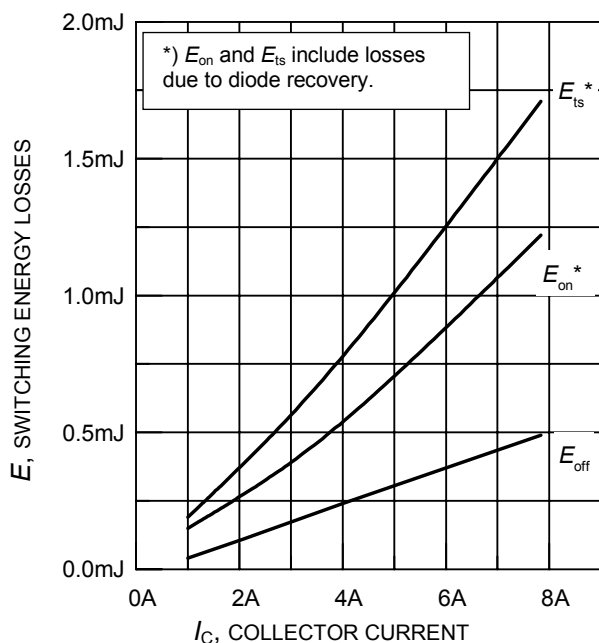


Figure 13. Typical switching energy losses as a function of collector current
(inductive load, $T_j = 150^\circ\text{C}$,
 $V_{CE} = 800\text{V}$, $V_{GE} = +15\text{V}/0\text{V}$, $R_G = 91\Omega$,
dynamic test circuit in Fig.E)

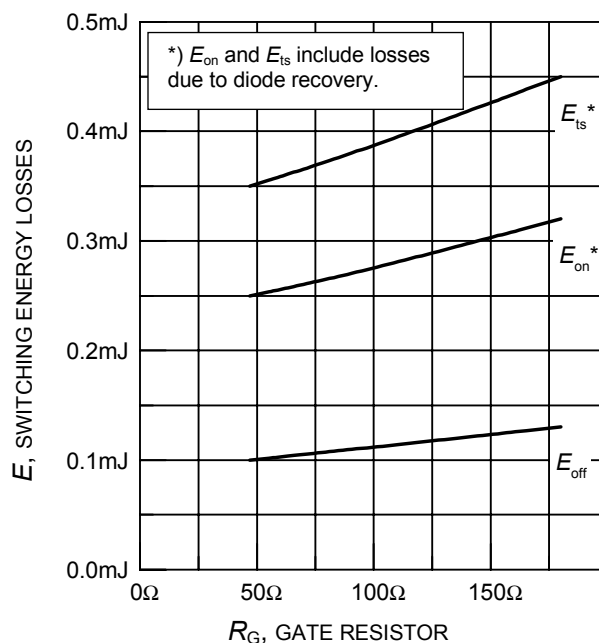


Figure 14. Typical switching energy losses as a function of gate resistor
(inductive load, $T_j = 150^\circ\text{C}$,
 $V_{CE} = 800\text{V}$, $V_{GE} = +15\text{V}/0\text{V}$, $I_C = 2\text{A}$,
dynamic test circuit in Fig.E)

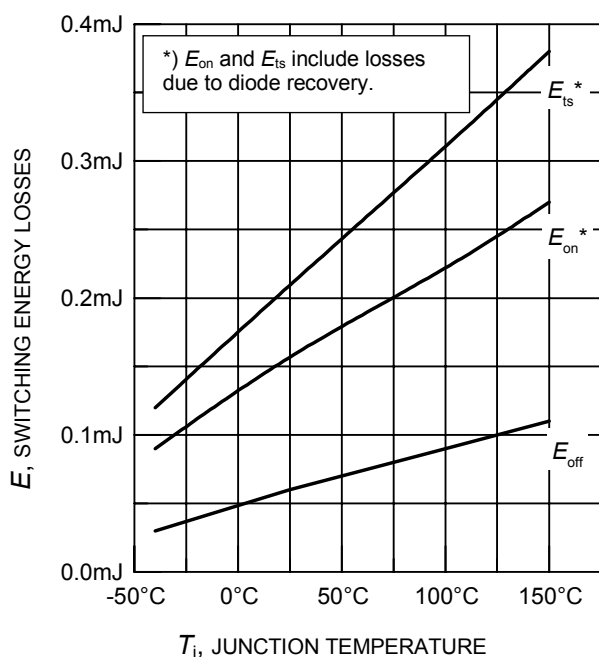


Figure 15. Typical switching energy losses as a function of junction temperature
(inductive load, $V_{CE} = 800\text{V}$,
 $V_{GE} = +15\text{V}/0\text{V}$, $I_C = 2\text{A}$, $R_G = 91\Omega$,
dynamic test circuit in Fig.E)

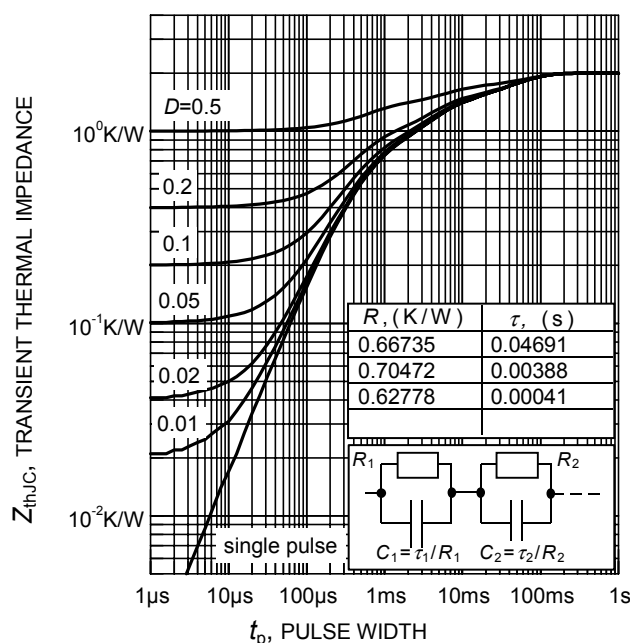


Figure 16. IGBT transient thermal impedance as a function of pulse width
($D = t_p / T$)

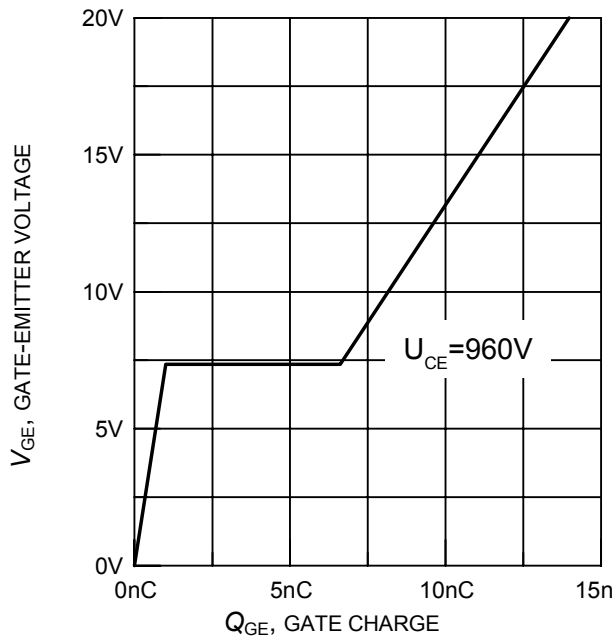


Figure 17. Typical gate charge
($I_C = 2A$)

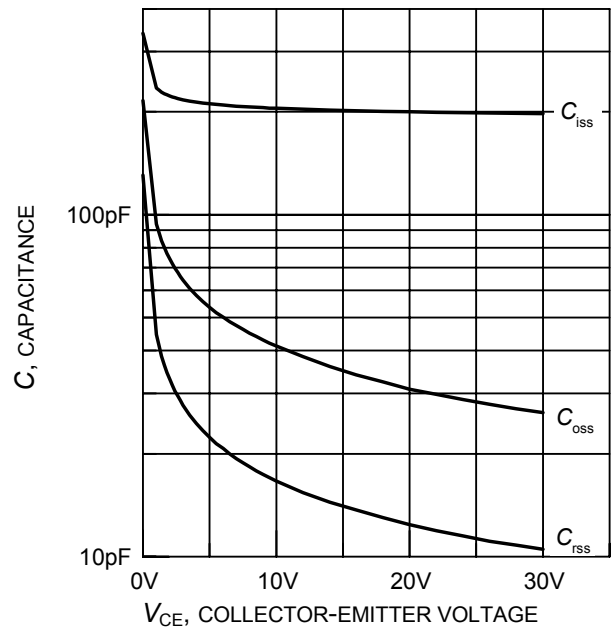


Figure 18. Typical capacitance as a function of collector-emitter voltage
($V_{GE} = 0V$, $f = 1MHz$)

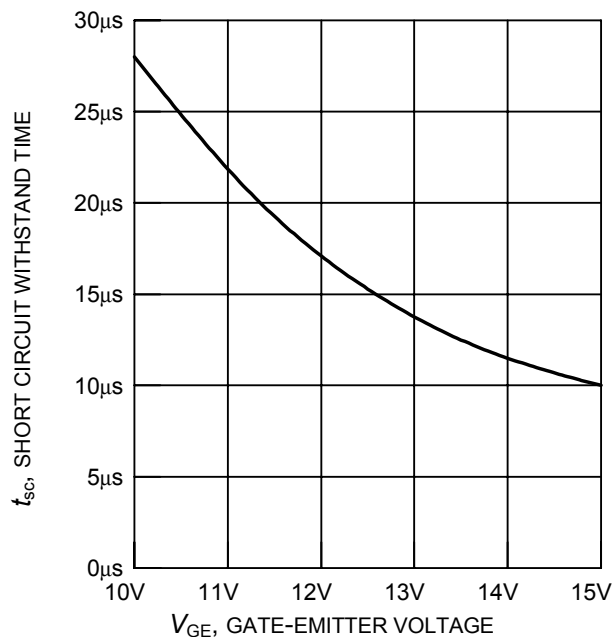


Figure 19. Short circuit withstand time as a function of gate-emitter voltage
($V_{CE} = 1200V$, start at $T_j = 25^\circ C$)

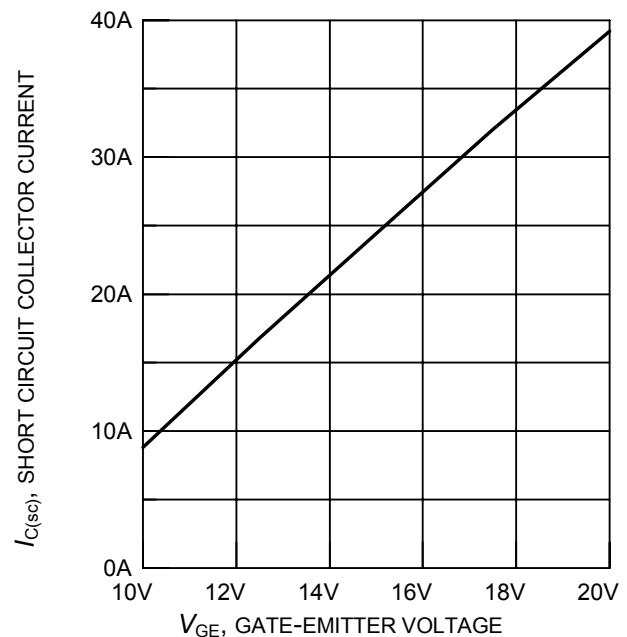


Figure 20. Typical short circuit collector current as a function of gate-emitter voltage
($100V \leq V_{CE} \leq 1200V$, $T_C = 25^\circ C$, $T_j \leq 150^\circ C$)

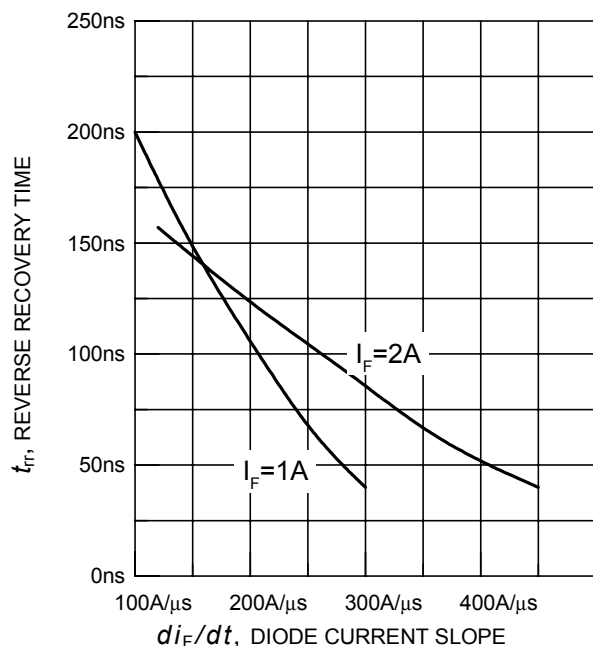


Figure 21. Typical reverse recovery time as a function of diode current slope

($V_R = 800V$, $T_j = 150^\circ C$, dynamic test circuit in Fig.E)

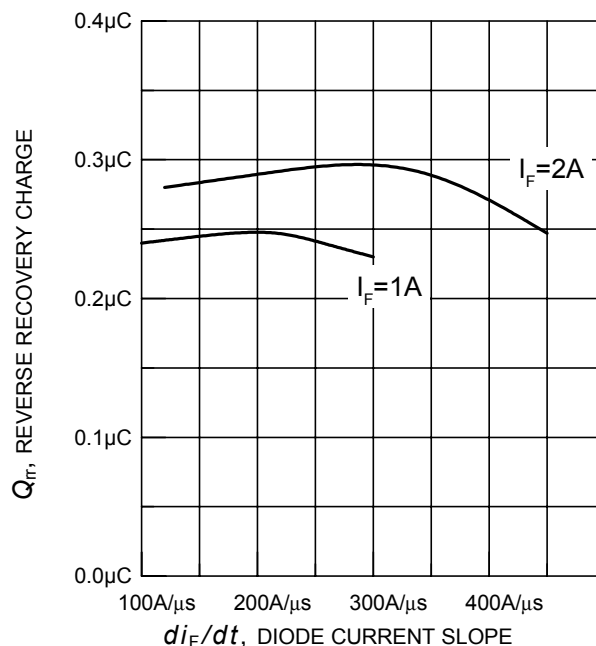


Figure 22. Typical reverse recovery charge as a function of diode current slope

($V_R = 800V$, $T_j = 150^\circ C$, dynamic test circuit in Fig.E)

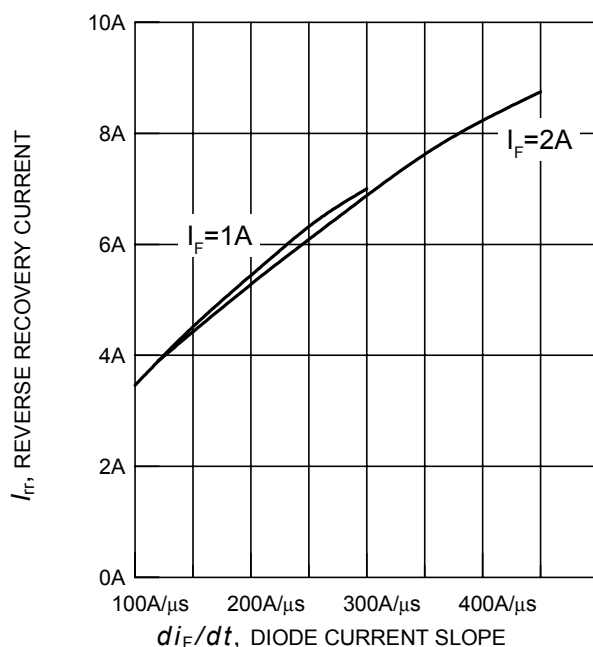


Figure 23. Typical reverse recovery current as a function of diode current slope

($V_R = 800V$, $T_j = 150^\circ C$, dynamic test circuit in Fig.E)

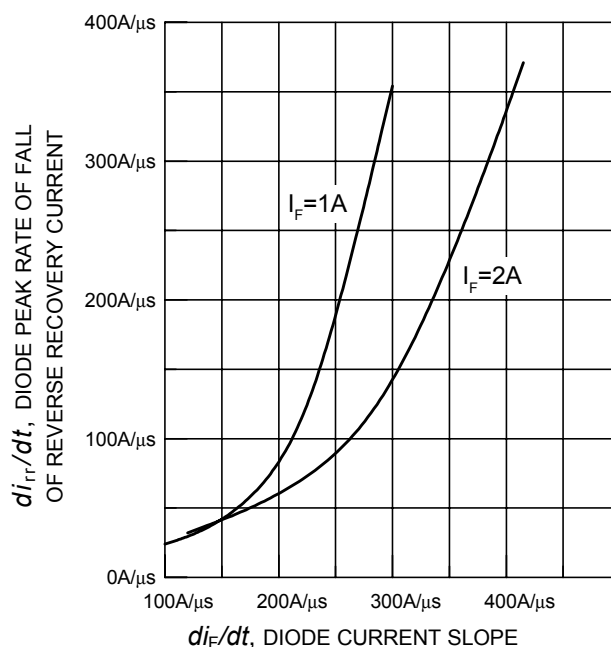


Figure 24. Typical diode peak rate of fall of reverse recovery current as a function of diode current slope

($V_R = 800V$, $T_j = 150^\circ C$, dynamic test circuit in Fig.E)

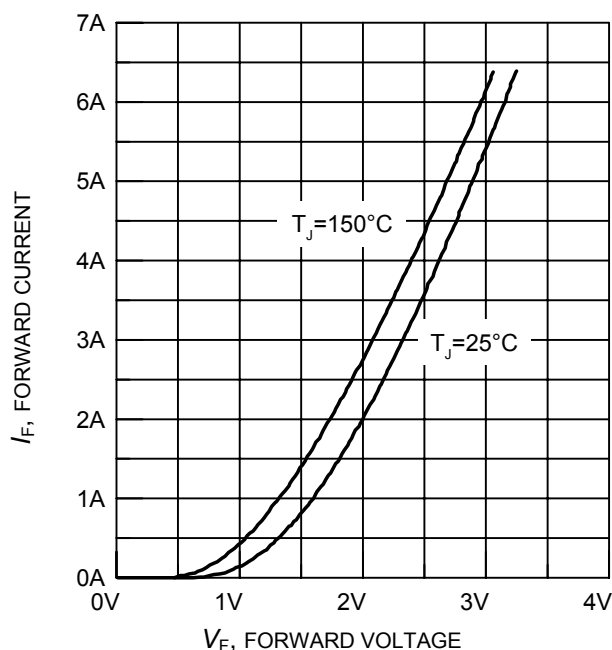


Figure 25. Typical diode forward current as a function of forward voltage

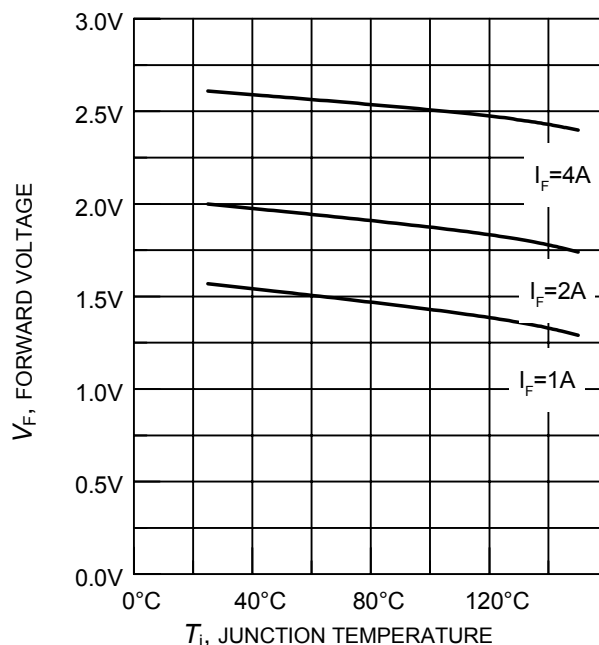


Figure 26. Typical diode forward voltage as a function of junction temperature

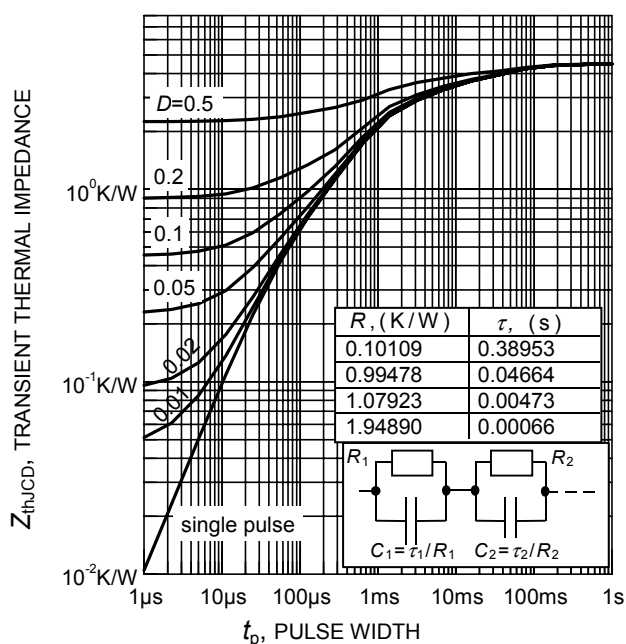
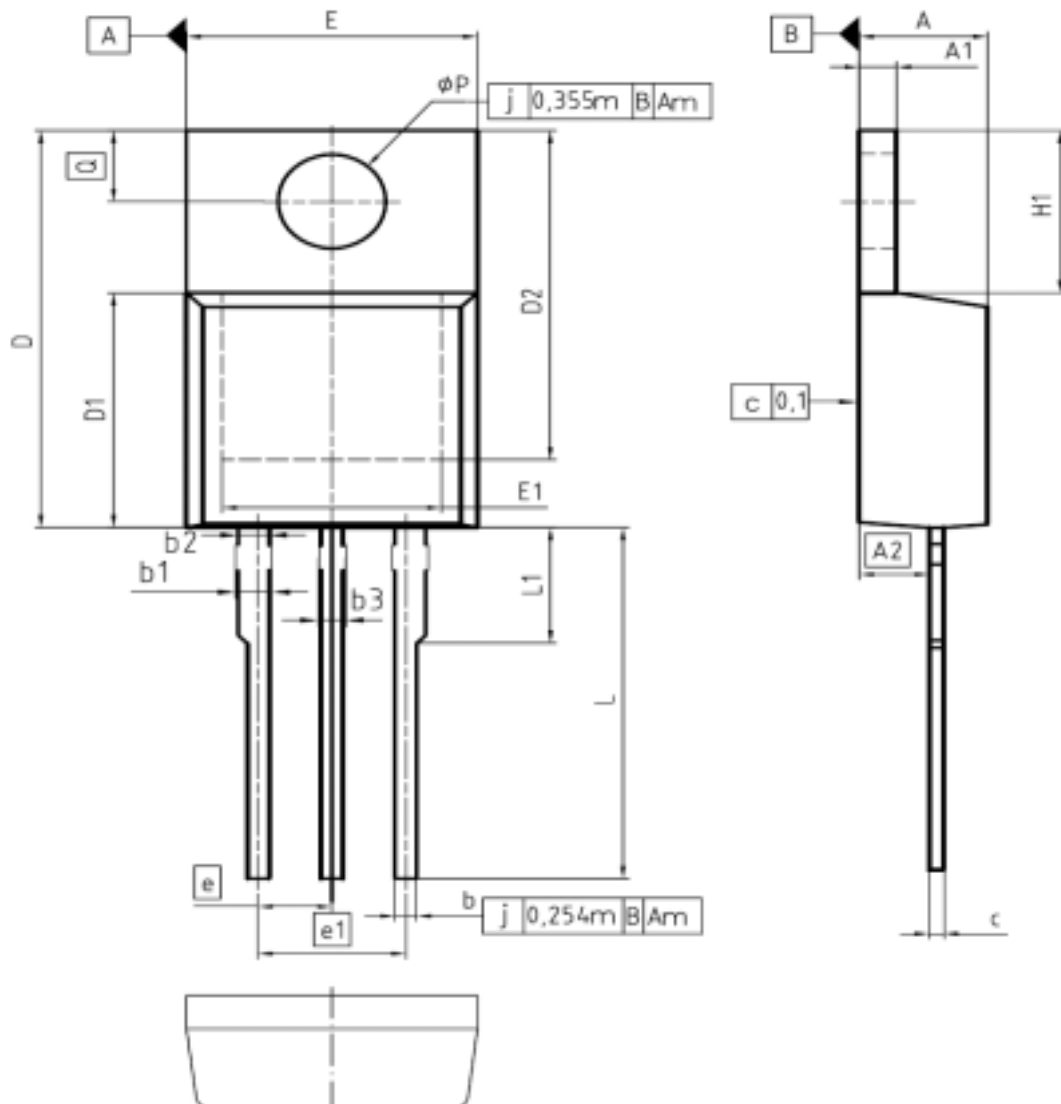


Figure 27. Diode transient thermal impedance as a function of pulse width
 $(D = t_p / T)$

PG-TO220-3-1



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



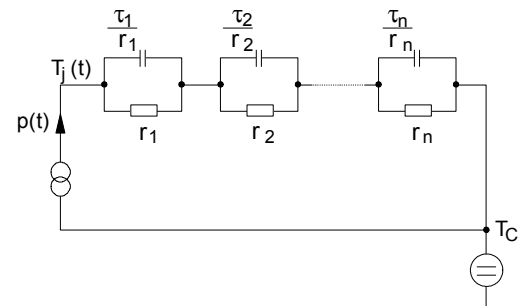
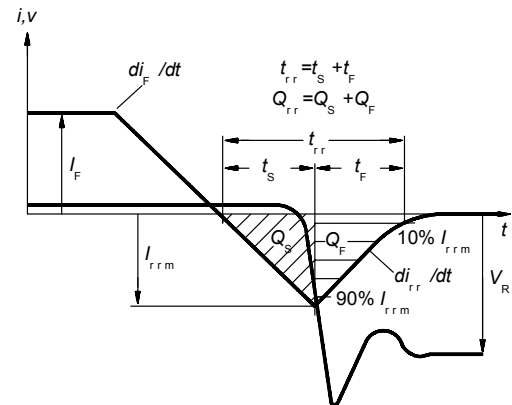
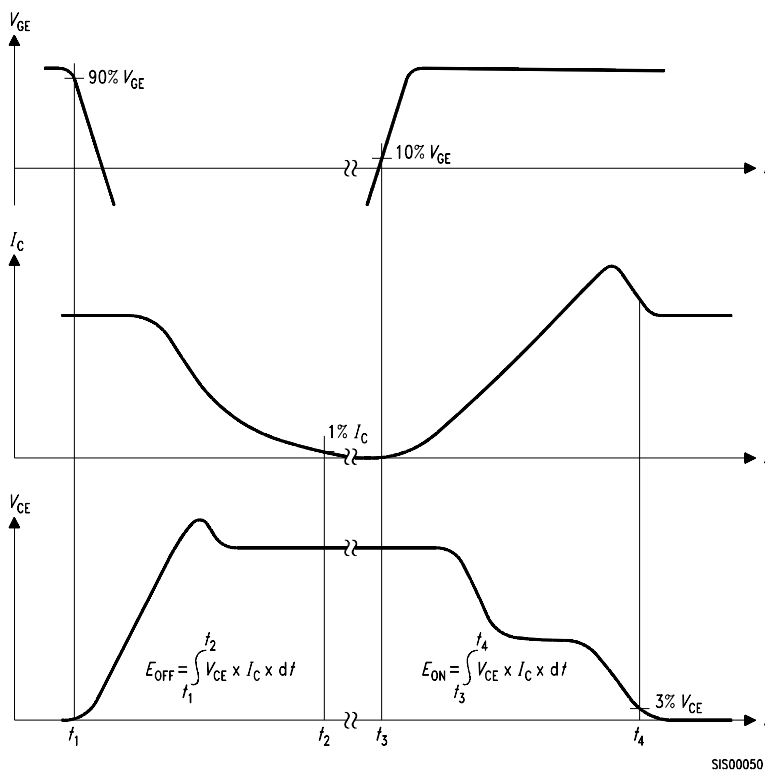
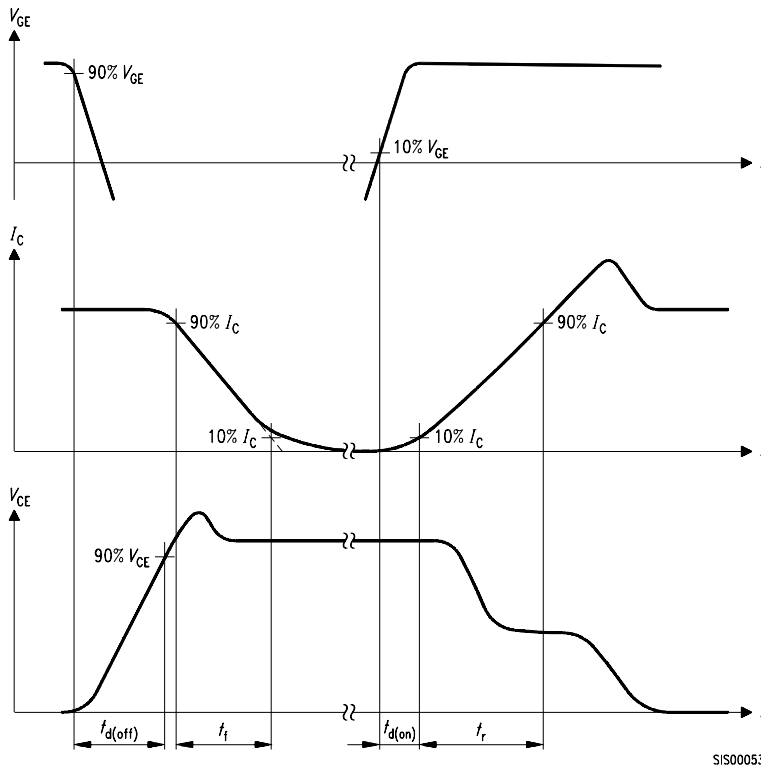


Figure D. Thermal equivalent circuit

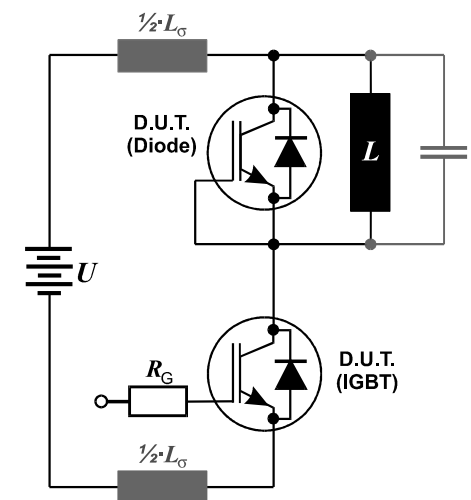


Figure E. Dynamic test circuit
Leakage inductance $L_\sigma = 180\text{nH}$, and stray capacity $C_\sigma = 40\text{pF}$.

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