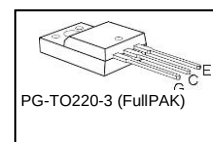
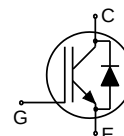


Low Loss DuoPack : IGBT in TRENCHSTOP™ and Fieldstop technology with soft, fast recovery anti-parallel Emitter Controlled HE diode



Features

- Very low $V_{CE(sat)}$ 1.5V (typ.)
- Maximum Junction Temperature 175°C
- Short circuit withstand time 5μs
- TRENCHSTOP™ and Fieldstop technology for 600V applications offers :
 - very tight parameter distribution
 - high ruggedness, temperature stable behavior
 - very high switching speed
- Low EMI
- Very soft, fast recovery anti-parallel Emitter Controlled HE diode
- Qualified according to JEDEC¹ for target applications
- Pb-free lead plating; RoHS compliant
- Complete product spectrum and PSpice Models : <http://www.infineon.com/igbt/>



Applications

- Washing Machine
- Inverter and Variable Speed Drive

Type	V_{CE}	I_C	$V_{CE(sat)}, T_j=25^\circ\text{C}$	$T_{j,max}$	Marking Code	Package
IKA06N60T	600V	6A	1.5V	175°C	K06T60	PG-TO220-3 (FullPAK)

Maximum Ratings

Parameter	Symbol	Value	Unit
Collector-emitter voltage, $T_j \geq 25^\circ\text{C}$	V_{CE}	600	V
DC collector current, limited by $T_{j,max}$			
$T_C = 25^\circ\text{C}$	I_C	10	A
$T_C = 100^\circ\text{C}$		6.2	
Pulsed collector current, t_p limited by $T_{j,max}$	$I_{C,puls}$	18	
Turn off safe operating area, $V_{CE} = 600\text{V}$, $T_j = 175^\circ\text{C}$, $t_p = 1\mu\text{s}$	-	18	
Diode forward current, limited by $T_{j,max}$			
$T_C = 25^\circ\text{C}$	I_F	10.2	A
$T_C = 100^\circ\text{C}$		6.5	
Diode pulsed current, t_p limited by $T_{j,max}$	$I_{F,puls}$	18	
Gate-emitter voltage	V_{GE}	± 20	V
Short circuit withstand time ²⁾			
$V_{GE} = 15\text{V}$, $V_{CC} \leq 400\text{V}$, $T_j \leq 150^\circ\text{C}$	t_{SC}	5	μs
Power dissipation			
$T_C = 25^\circ\text{C}$	P_{tot}	28	W
Operating junction temperature	T_j	-40...+175	°C
Storage temperature	T_{stg}	-55...+150	
Isolation voltage	V_{isol}	2500	V_{rms}

¹ J-STD-020 and JEDEC-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}		5.3	K/W
Diode thermal resistance, junction – case	R_{thJCD}		6.5	
Thermal resistance, junction – ambient	R_{thJA}		80	

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	$V_{(BR)CES}$	$V_{GE}=0V$, $I_C=0.25mA$	600	-	-	V
Collector-emitter saturation voltage	$V_{CE(sat)}$	$V_{GE} = 15V$, $I_C=6A$ $T_j=25^{\circ}C$ $T_j=175^{\circ}C$	- -	1.5 1.8	2.05	
Diode forward voltage	V_F	$V_{GE}=0V$, $I_F=6A$ $T_j=25^{\circ}C$ $T_j=175^{\circ}C$	- -	1.6 1.6	2.05 -	
Gate-emitter threshold voltage	$V_{GE(th)}$	$I_C=0.18mA$, $V_{CE}=V_{GE}$	4.1	4.6	5.7	
Zero gate voltage collector current	I_{CES}	$V_{CE}=600V$, $V_{GE}=0V$ $T_j=25^{\circ}C$ $T_j=175^{\circ}C$	- -	- -	40 700	μA
Gate-emitter leakage current	I_{GES}	$V_{CE}=0V$, $V_{GE}=20V$	-	-	100	nA
Transconductance	g_{fs}	$V_{CE}=20V$, $I_C=6A$	-	3.6	-	S
Integrated gate resistor	R_{Gint}		none			Ω

Dynamic Characteristic

Input capacitance	C_{iss}	$V_{CE}=25V, V_{GE}=0V, f=1MHz$	-	368	-	pF
Output capacitance	C_{oss}		-	28	-	
Reverse transfer capacitance	C_{rss}		-	11	-	
Gate charge	Q_{Gate}	$V_{CC}=480V, I_C=6A, V_{GE}=15V$	-	42	-	nC
Internal emitter inductance measured 5mm (0.197 in.) from case	L_E		-	7	-	nH
Short circuit collector current ¹⁾	$I_{C(SC)}$	$V_{GE}=15V, t_{SC}\leq 5\mu s, V_{CC}=400V, T_j=25^\circ\text{C}$	-	55	-	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	$t_{d(on)}$	$T_j=25^{\circ}\text{C}$, $V_{CC}=400\text{V}$, $I_C=6\text{A}$, $V_{GE}=0/15\text{V}$, $r_G=23\Omega$, $L_{\sigma}=60\text{nH}$, $C_{\sigma}=40\text{pF}$	-	9.4	-	ns
Rise time	t_r		-	5.6	-	
Turn-off delay time	$t_{d(off)}$		-	130	-	
Fall time	t_f		-	58	-	
Turn-on energy	E_{on}	L_{σ} , C_{σ} from Fig. E Energy losses include “tail” and diode reverse recovery.	-	0.09	-	mJ
Turn-off energy	E_{off}		-	0.11	-	
Total switching energy	E_{ts}		-	0.2	-	

Anti-Parallel Diode Characteristic

Diode reverse recovery time	t_{rr}	$T_j=25^\circ\text{C}$, $V_R=400\text{V}$, $I_F=6\text{A}$, $di_F/dt=550\text{A}/\mu\text{s}$	-	123	-	ns
Diode reverse recovery charge	Q_{rr}		-	190	-	nC
Diode peak reverse recovery current	I_{rrm}		-	5.3	-	A
Diode peak rate of fall of reverse recovery current during t_b	di_{rr}/dt		-	450	-	A/ μs

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	$t_{d(on)}$	$T_j=175^{\circ}\text{C}$, $V_{CC}=400\text{V}$, $I_C=6\text{A}$, $V_{GE}=0/15\text{V}$, $r_G=23\Omega$, $L_{\sigma}=60\text{nH}$, $C_{\sigma}=40\text{pF}$	-	8.8	-	ns
Rise time	t_r		-	8.2	-	
Turn-off delay time	$t_{d(off)}$		-	165	-	
Fall time	t_f		-	84	-	
Turn-on energy	E_{on}	L_{σ} , C_{σ} from Fig. E Energy losses include “tail” and diode reverse recovery.	-	0.14	-	mJ
Turn-off energy	E_{off}		-	0.18	-	
Total switching energy	E_{ts}		-	0.335	-	

Anti-Parallel Diode Characteristic

Diode reverse recovery time	t_{rr}	$T_j=175^\circ\text{C}$, $V_R=400\text{V}$, $I_F=6\text{A}$, $di_F/dt=550\text{A}/\mu\text{s}$	-	180	-	ns
Diode reverse recovery charge	Q_{rr}		-	500	-	nC
Diode peak reverse recovery current	I_{rrm}		-	7.6	-	A
Diode peak rate of fall of reverse recovery current during t_b	di_{rr}/dt		-	285	-	A/ μs

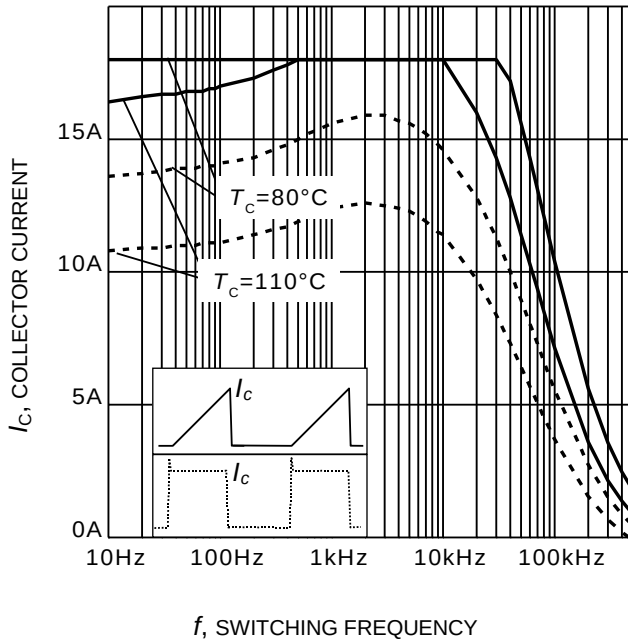


Figure 1. Collector current as a function of switching frequency
 $(T_j \leq 175^\circ\text{C}, D = 0.5, V_{CE} = 400\text{V}, V_{GE} = 0/15\text{V}, r_G = 23\Omega)$

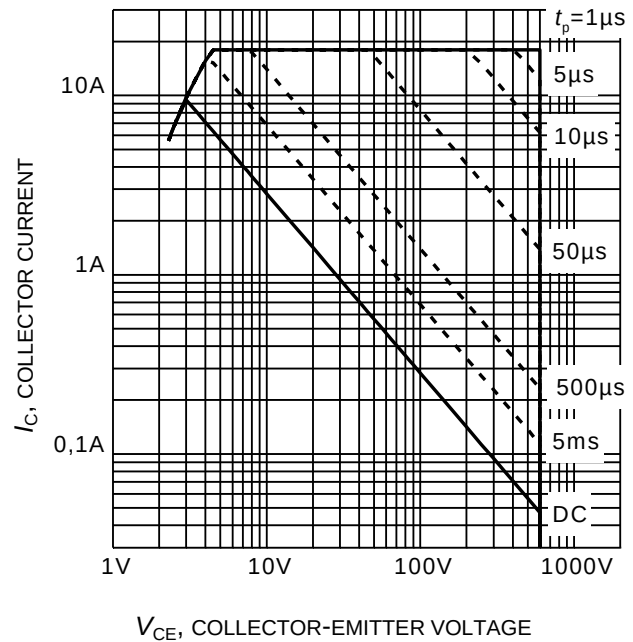


Figure 2. Safe operating area
 $(D = 0, T_C = 25^\circ\text{C}, T_j \leq 175^\circ\text{C}; V_{GE} = 0/15\text{V})$

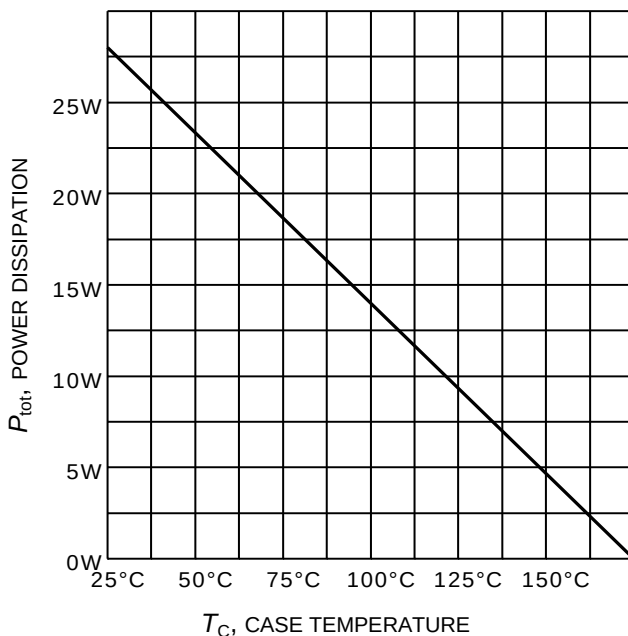


Figure 3. Power dissipation as a function of case temperature
 $(T_j \leq 175^\circ\text{C})$

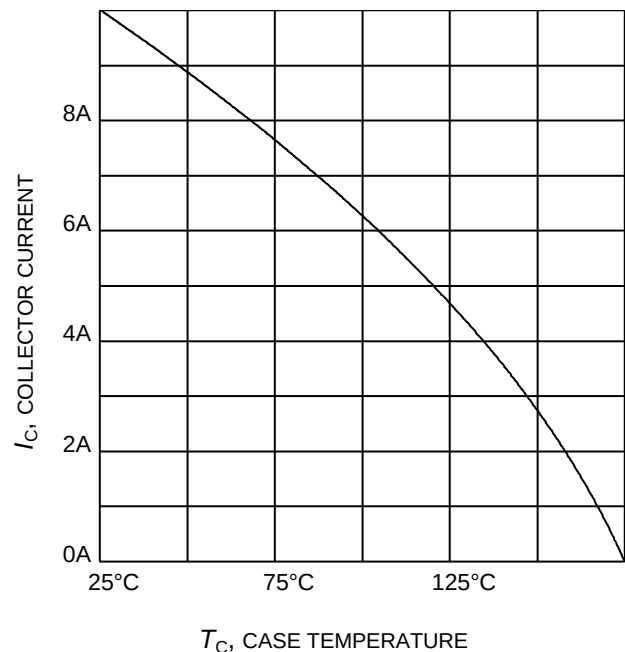


Figure 4. Collector current as a function of case temperature
 $(V_{GE} \geq 15\text{V}, T_j \leq 175^\circ\text{C})$

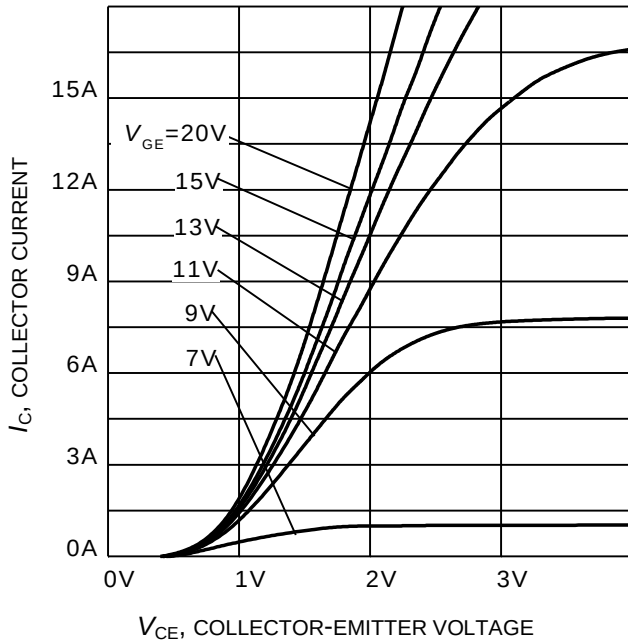


Figure 5. Typical output characteristic
($T_j = 25^\circ\text{C}$)

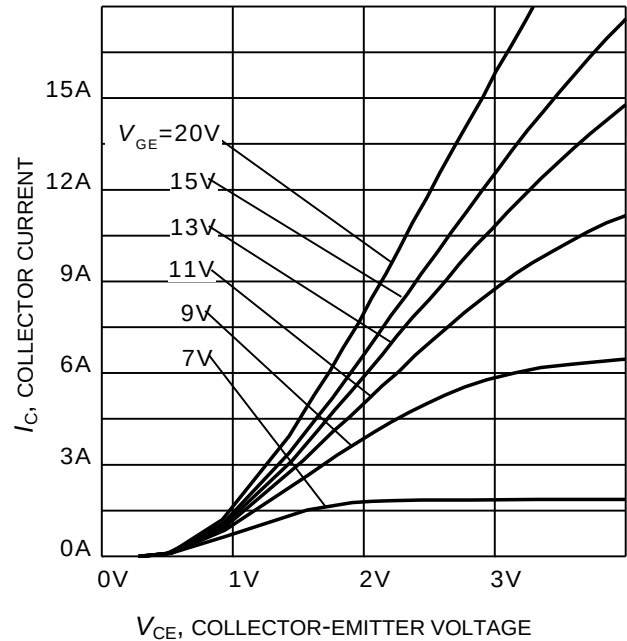


Figure 6. Typical output characteristic
($T_j = 175^\circ\text{C}$)

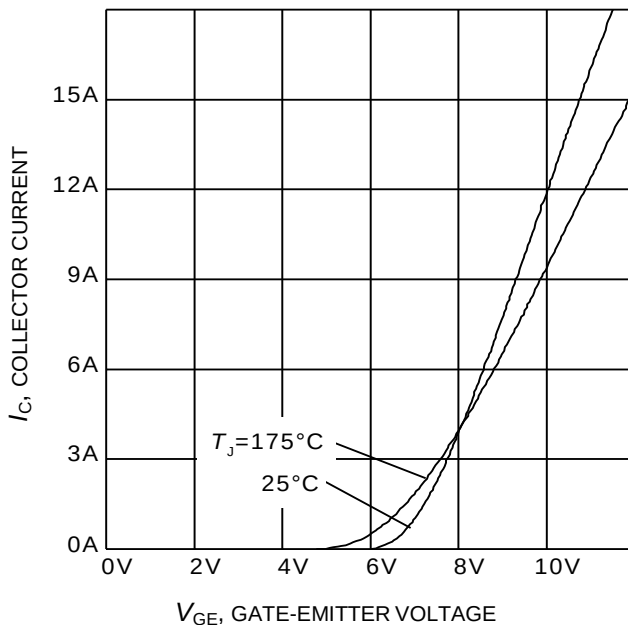


Figure 7. Typical transfer characteristic
($V_{CE}=20\text{V}$)

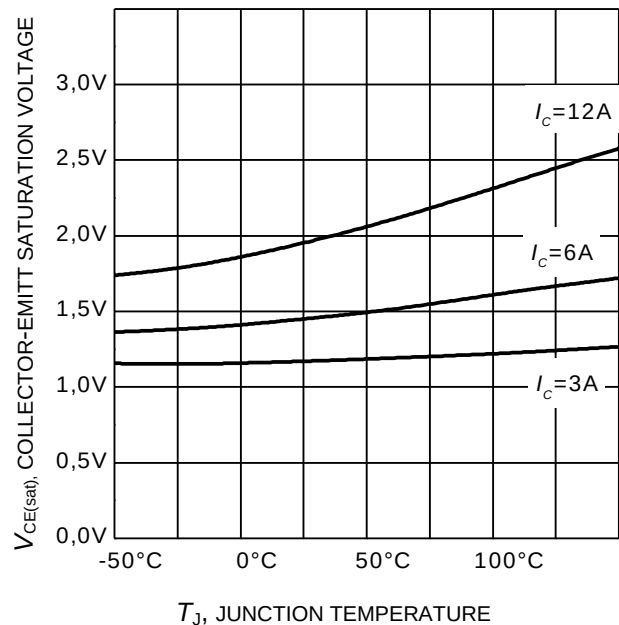


Figure 8. Typical collector-emitter saturation voltage as a function of junction temperature
($V_{GE} = 15\text{V}$)

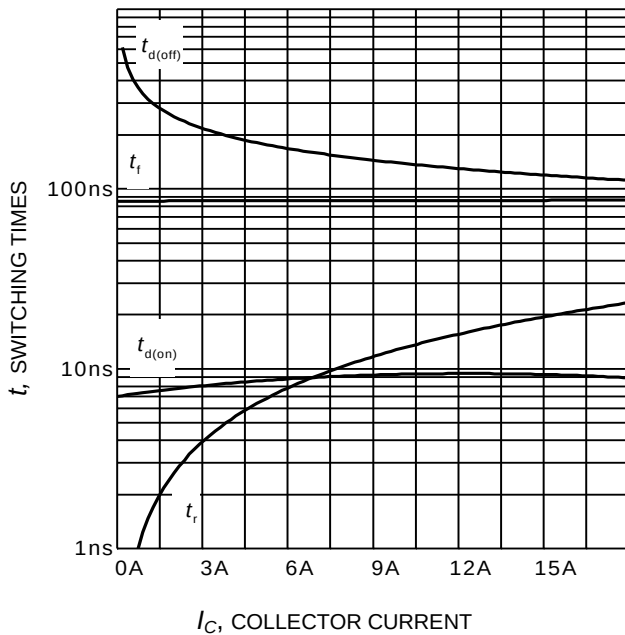


Figure 9. Typical switching times as a function of collector current
(inductive load, $T_J=175^\circ\text{C}$,
 $V_{CE} = 400\text{V}$, $V_{GE} = 0/15\text{V}$, $r_G = 23\Omega$,
Dynamic test circuit in Figure E)

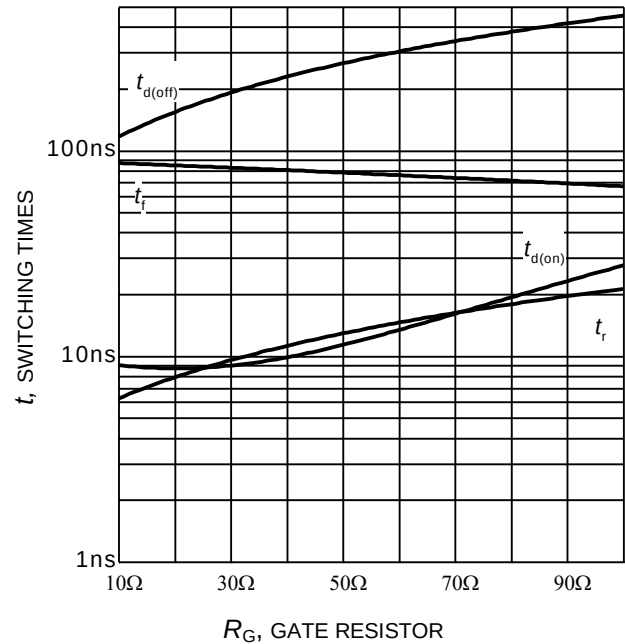


Figure 10. Typical switching times as a function of gate resistor
(inductive load, $T_J=175^\circ\text{C}$,
 $V_{CE} = 400\text{V}$, $V_{GE} = 0/15\text{V}$, $I_C = 6\text{A}$,
Dynamic test circuit in Figure E)

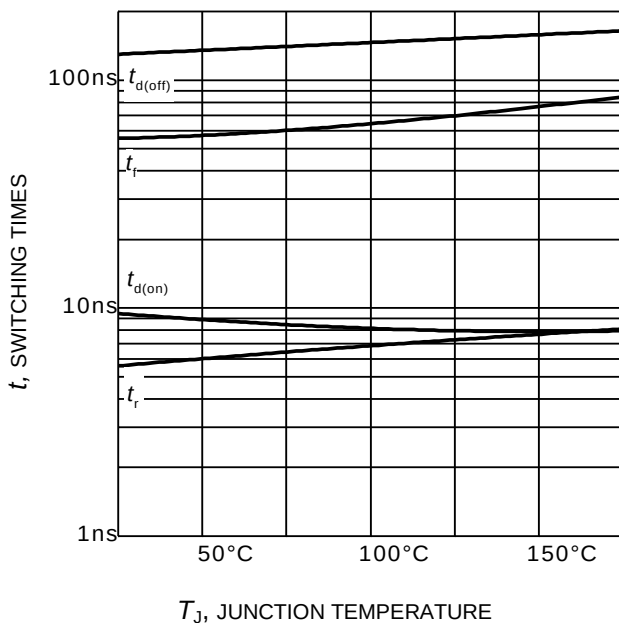


Figure 11. Typical switching times as a function of junction temperature
(inductive load, $V_{CE} = 400\text{V}$,
 $V_{GE} = 0/15\text{V}$, $I_C = 6\text{A}$, $r_G = 23\Omega$,
Dynamic test circuit in Figure E)

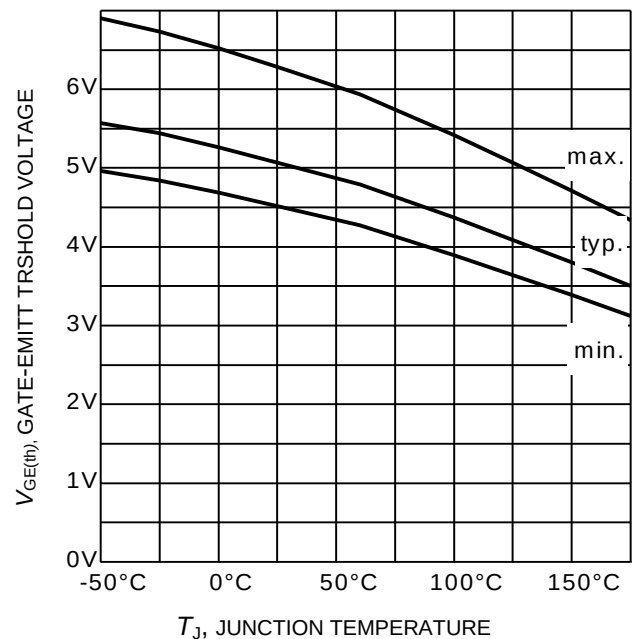


Figure 12. Gate-emitter threshold voltage as a function of junction temperature
($I_C = 0.18\text{mA}$)

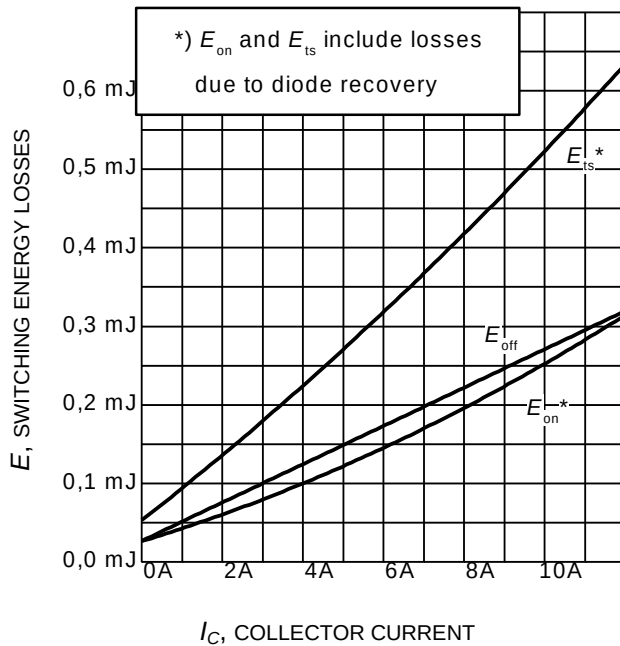


Figure 13. Typical switching energy losses as a function of collector current
(inductive load, $T_J=175^\circ\text{C}$, $V_{CE}=400\text{V}$, $V_{GE}=0/15\text{V}$, $r_G=23\Omega$, Dynamic test circuit in Figure E)

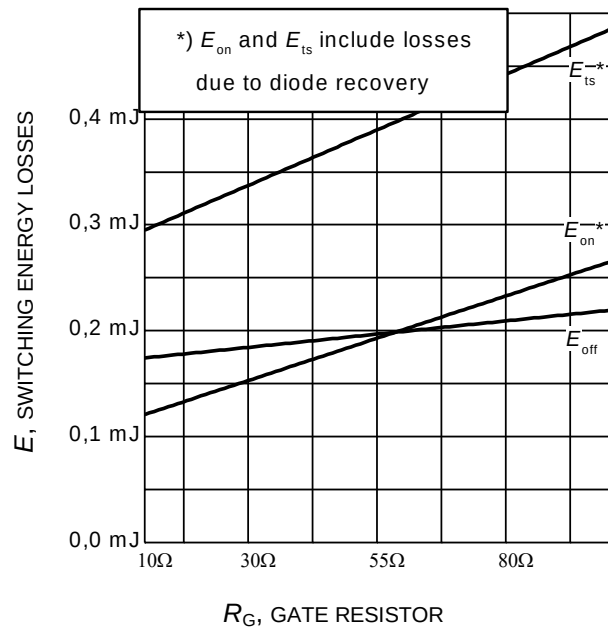


Figure 14. Typical switching energy losses as a function of gate resistor
(inductive load, $T_J=175^\circ\text{C}$, $V_{CE}=400\text{V}$, $V_{GE}=0/15\text{V}$, $I_C=6\text{A}$, $r_G=23\Omega$, Dynamic test circuit in Figure E)

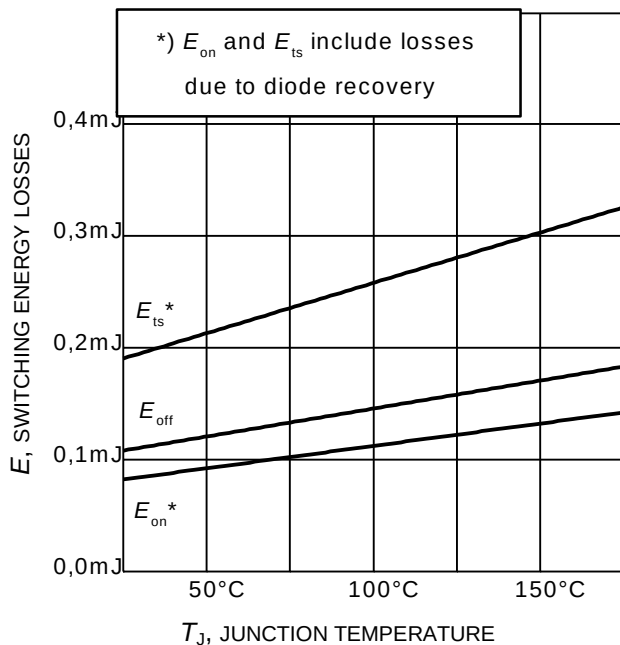


Figure 15. Typical switching energy losses as a function of junction temperature
(inductive load, $V_{CE}=400\text{V}$, $V_{GE}=0/15\text{V}$, $I_C=6\text{A}$, $r_G=23\Omega$, Dynamic test circuit in Figure E)

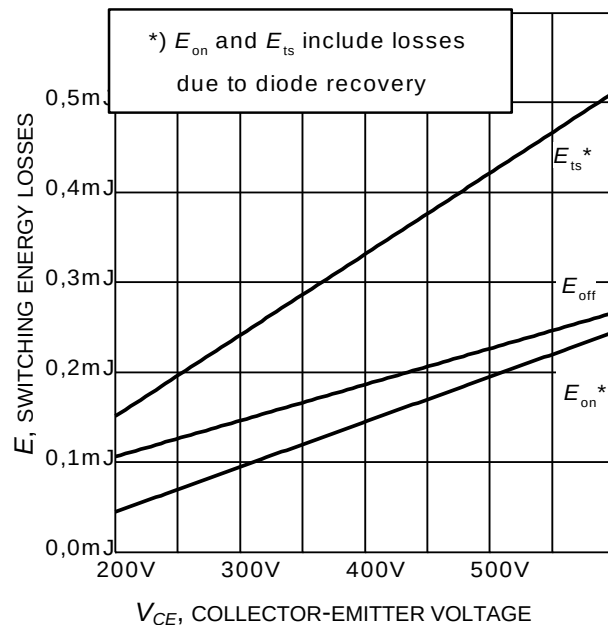


Figure 16. Typical switching energy losses as a function of collector emitter voltage
(inductive load, $T_J=175^\circ\text{C}$, $V_{GE}=0/15\text{V}$, $I_C=6\text{A}$, $r_G=23\Omega$, Dynamic test circuit in Figure E)

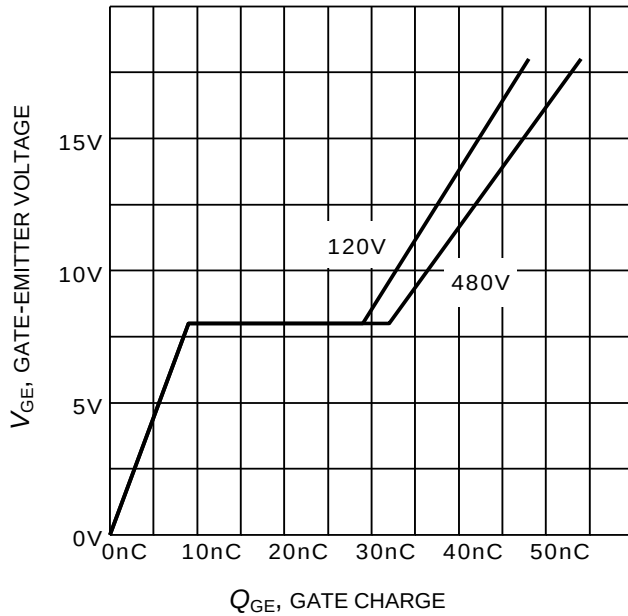


Figure 17. Typical gate charge
($I_C=6\text{ A}$)

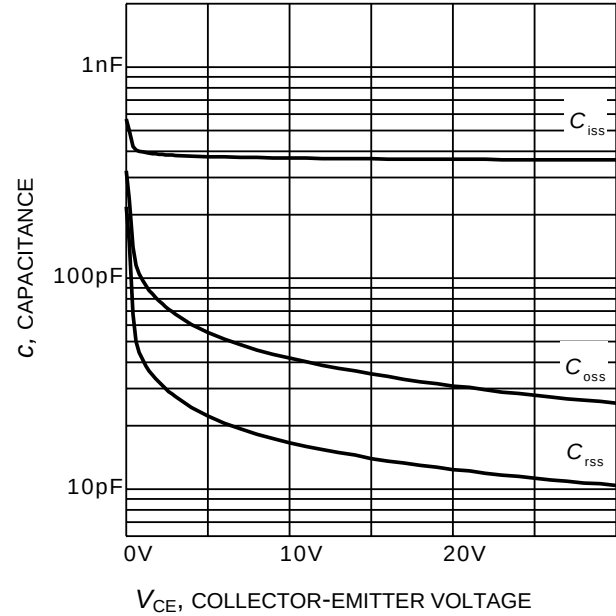


Figure 18. Typical capacitance as a function of collector-emitter voltage
($V_{GE}=0\text{V}$, $f = 1\text{ MHz}$)

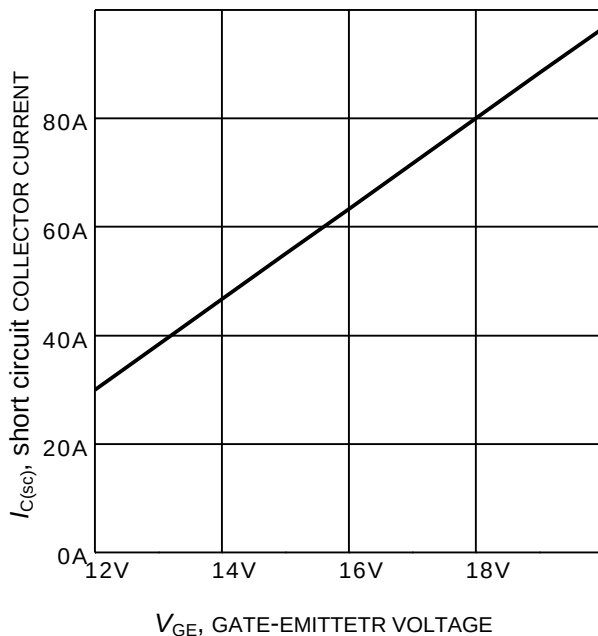


Figure 19. Typical short circuit collector current as a function of gate-emitter voltage
($V_{CE} \leq 400\text{V}$, $T_j \leq 150^\circ\text{C}$)

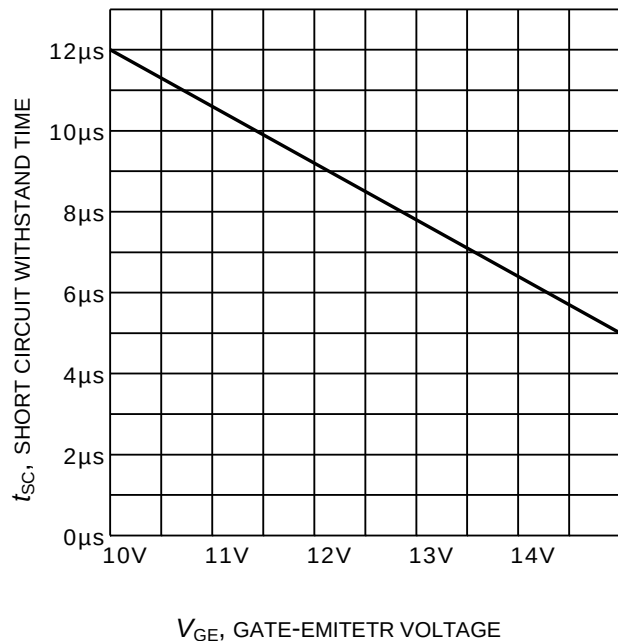


Figure 20. Short circuit withstand time as a function of gate-emitter voltage
($V_{CE}=400\text{V}$, start at $T_j=25^\circ\text{C}$, $T_{Jmax}<150^\circ\text{C}$)

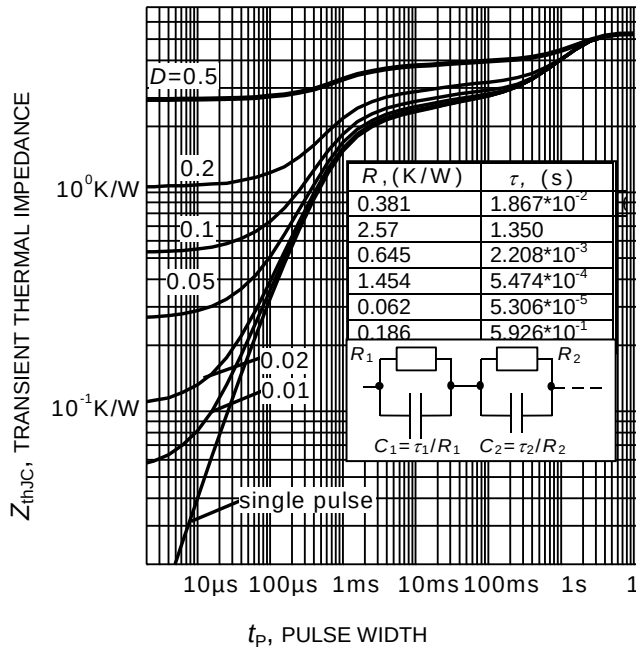


Figure 21. IGBT transient thermal impedance
($D = t_p / T$)

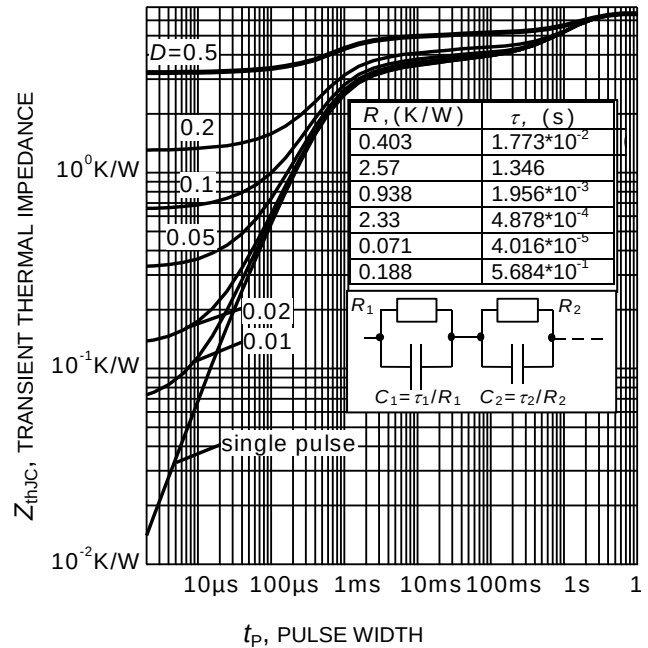


Figure 22. Diode transient thermal impedance as a function of pulse width
($D = t_p / T$)

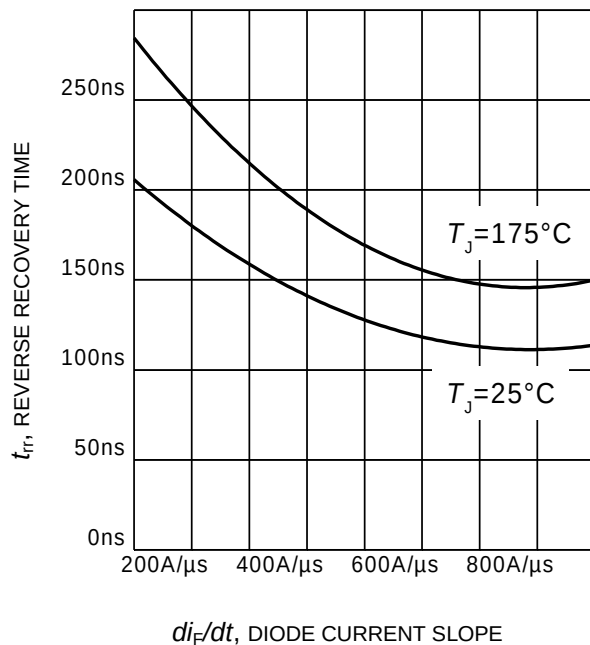


Figure 23. Typical reverse recovery time as a function of diode current slope
($V_R = 400V$, $I_F = 6A$,
Dynamic test circuit in Figure E)

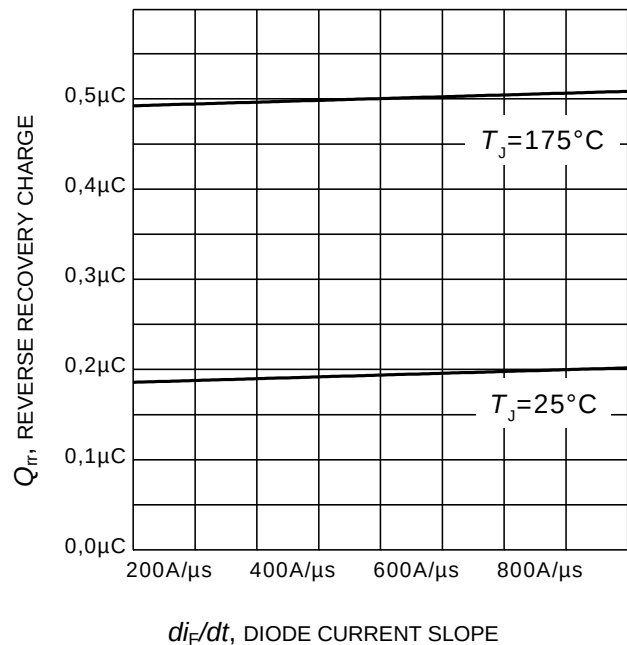


Figure 24. Typical reverse recovery charge as a function of diode current slope
($V_R = 400V$, $I_F = 6A$,
Dynamic test circuit in Figure E)

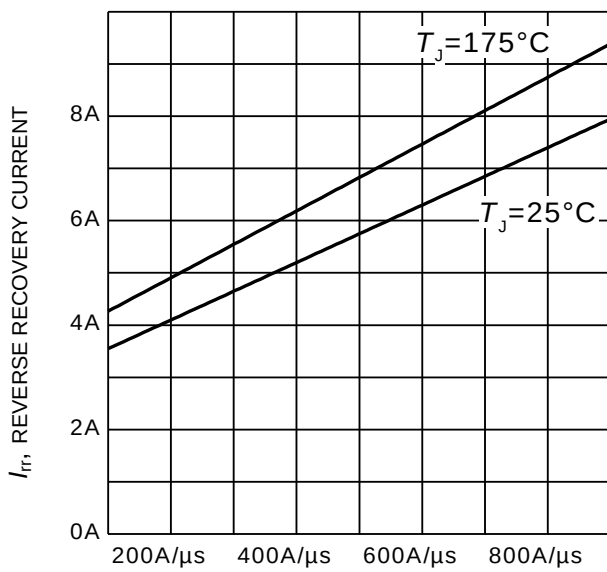

 di_F/dt , DIODE CURRENT SLOPE

Figure 25. Typical reverse recovery current as a function of diode current slope

($V_R = 400V$, $I_F = 6A$,
Dynamic test circuit in Figure E)

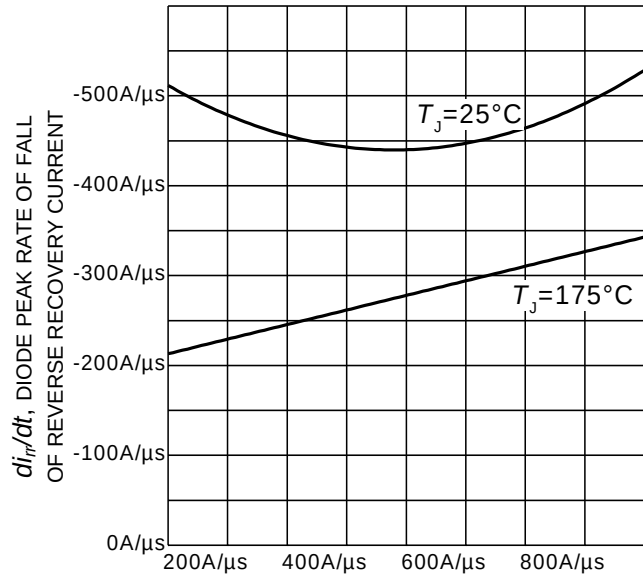

 di_F/dt , DIODE CURRENT SLOPE

Figure 26. Typical diode peak rate of fall of reverse recovery current as a function of diode current slope

($V_R = 400V$, $I_F = 6A$,
Dynamic test circuit in Figure E)

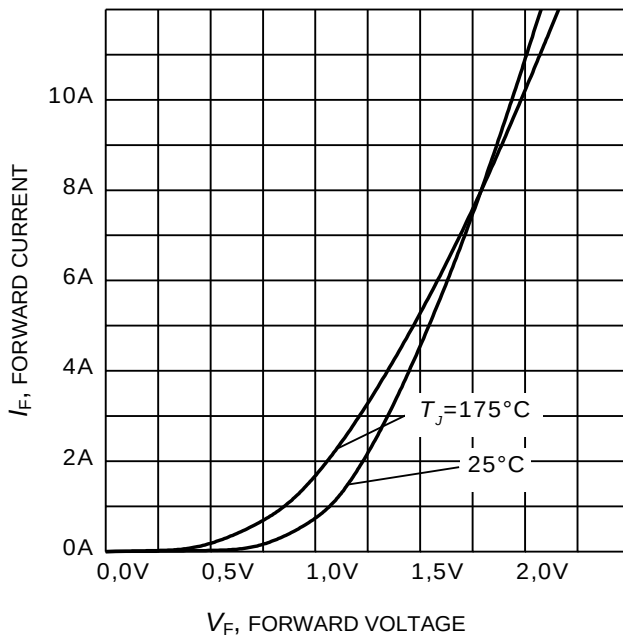

 V_F , FORWARD VOLTAGE

Figure 27. Typical diode forward current as a function of forward voltage

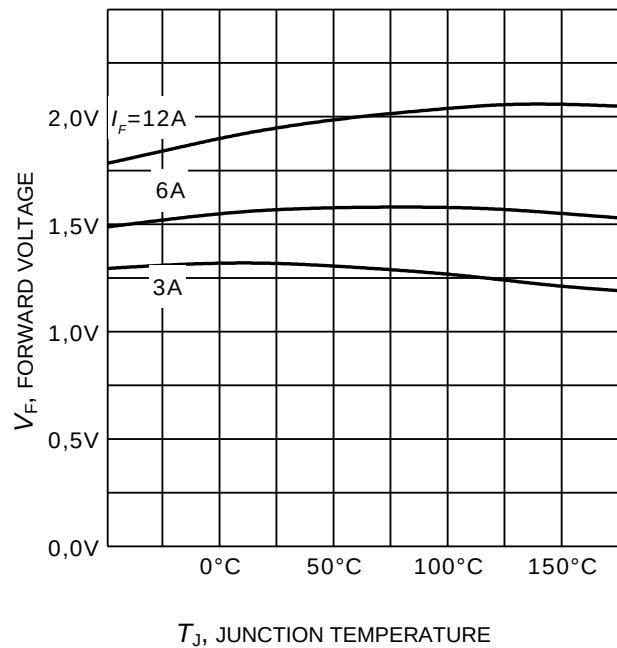
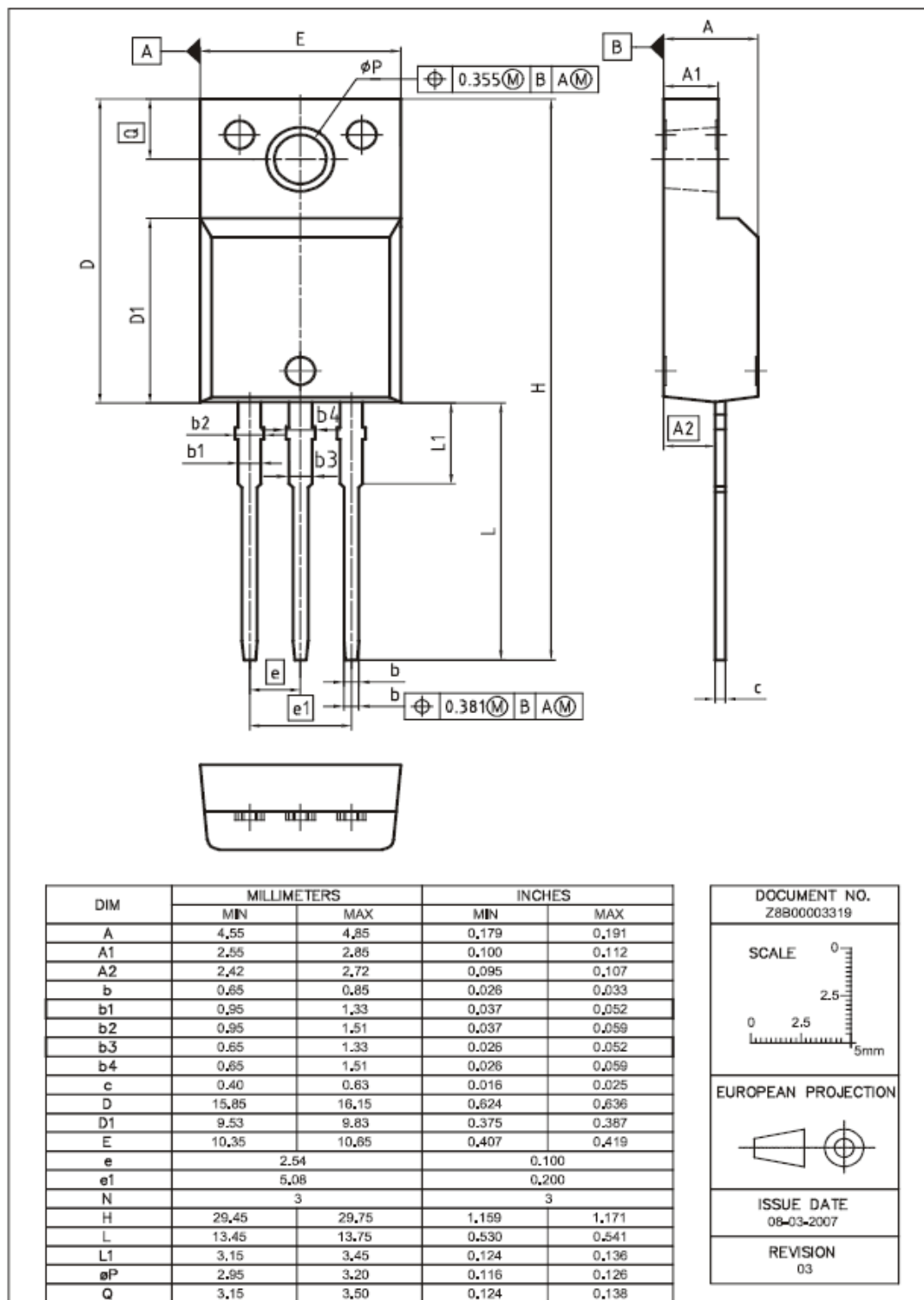

 T_j , JUNCTION TEMPERATURE

Figure 28. Typical diode forward voltage as a function of junction temperature

PG-TO220-3 (FullPAK)



Please refer to mounting instructions

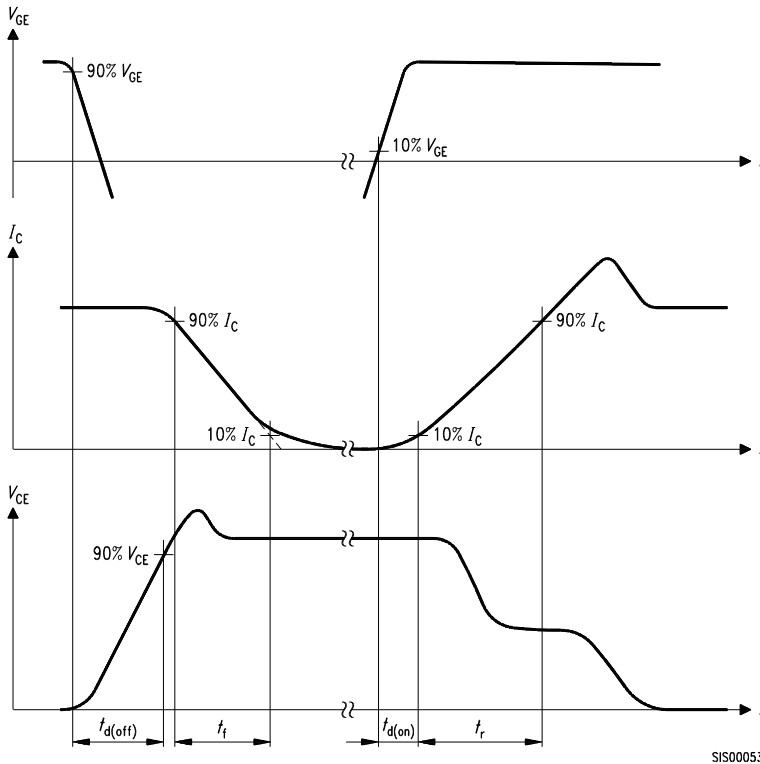


Figure A. Definition of switching times

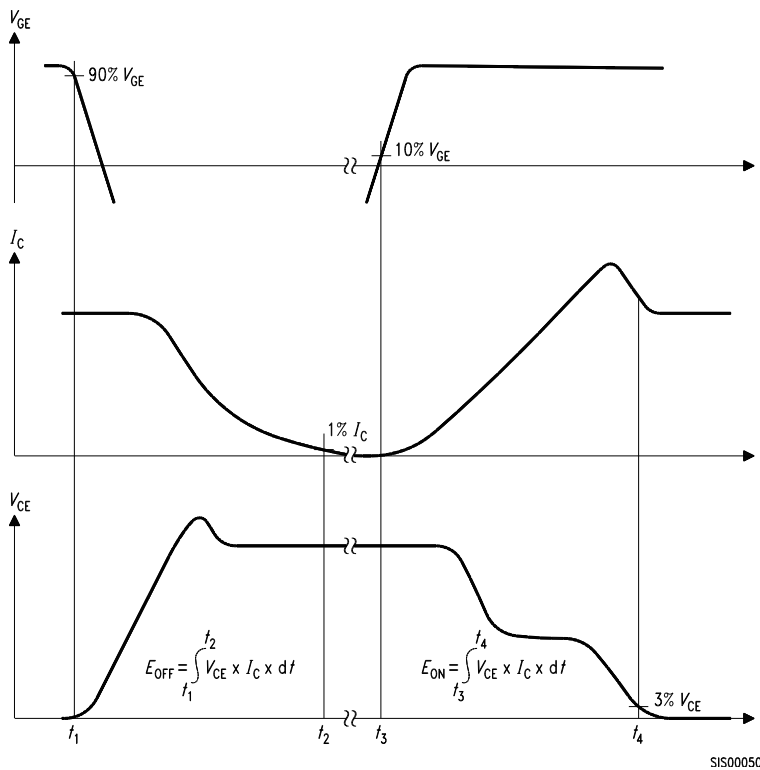
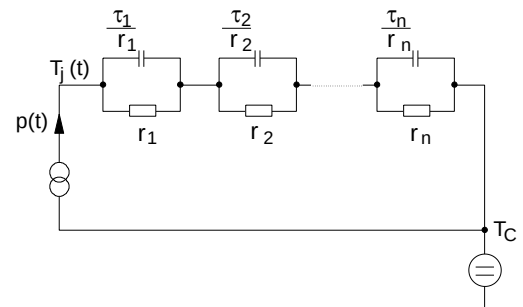
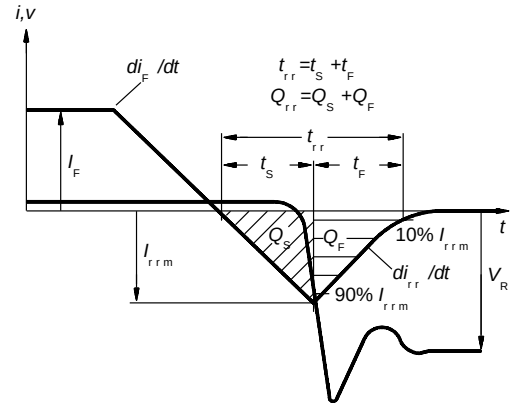
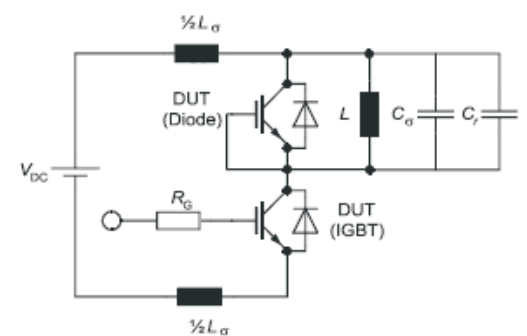


Figure B. Definition of switching losses



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