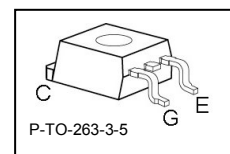
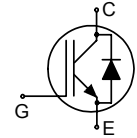


Low Loss DuoPack : IGBT in TrenchStop® and Fieldstop technology
with soft, fast recovery anti-parallel EmCon HE diode

- Very low $V_{CE(sat)}$ 1.5 V (typ.)
- Maximum Junction Temperature 175 °C
- Short circuit withstand time – 5µs
- Designed for :
 - Frequency Converters
 - Uninterrupted Power Supply
- TrenchStop® and Fieldstop technology for 600 V applications offers :
 - very tight parameter distribution
 - high ruggedness, temperature stable behavior
 - very high switching speed
 - low $V_{CE(sat)}$
- Positive temperature coefficient in $V_{CE(sat)}$
- Low EMI
- Low Gate Charge
- Very soft, fast recovery anti-parallel EmCon 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/>



Type	V_{CE}	I_C	$V_{CE(sat), T_j=25^\circ C}$	$T_{j,max}$	Marking	Package
IKB20N60T	600V	20A	1.5V	175°C	K20T60	P-TO-263-3-5

Maximum Ratings

Parameter	Symbol	Value	Unit
Collector-emitter voltage	V_{CE}	600	V
DC collector current, limited by $T_{j,max}$	I_C		A
$T_C = 25^\circ C$		40	
$T_C = 100^\circ C$		20	
Pulsed collector current, t_p limited by $T_{j,max}$	$I_{C,puls}$	60	
Turn off safe operating area ($V_{CE} \leq 600V, T_j \leq 175^\circ C$)	-	60	
Diode forward current, limited by $T_{j,max}$	I_F		
$T_C = 25^\circ C$		40	
$T_C = 100^\circ C$		20	
Diode pulsed current, t_p limited by $T_{j,max}$	$I_{F,puls}$	60	
Gate-emitter voltage	V_{GE}	± 20	V
Short circuit withstand time ²⁾	t_{SC}	5	µs
$V_{GE} = 15V, V_{CC} \leq 400V, T_j \leq 150^\circ C$			
Power dissipation $T_C = 25^\circ C$	P_{tot}	166	W
Operating junction temperature	T_j	-40...+175	°C
Storage temperature	T_{stg}	-55...+175	
Soldering temperature (reflow soldering, MSL1)	-	220	

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}		0.9	K/W
Diode thermal resistance, junction – case	R_{thJCD}		1.5	
Thermal resistance, junction – ambient	R_{thJA}	PG-TO-263-3-2 (6cm ² Cu)	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	$V_{(BR)CES}$	$V_{GE}=0\text{V}, I_C=0.2\text{mA}$	600	-	-	V
Collector-emitter saturation voltage	$V_{CE(sat)}$	$V_{GE} = 15\text{V}, I_C=20\text{A}$ $T_j=25^\circ\text{C}$ $T_j=175^\circ\text{C}$	-	1.5	2.05	
			-	1.9	-	
Diode forward voltage	V_F	$V_{GE}=0\text{V}, I_F=20\text{A}$ $T_j=25^\circ\text{C}$ $T_j=175^\circ\text{C}$	-	1.65	2.05	
			-	1.6	-	
Gate-emitter threshold voltage	$V_{GE(th)}$	$I_C=290\mu\text{A}, V_{CE}=V_{GE}$	4.1	4.9	5.7	
Zero gate voltage collector current	I_{CES}	$V_{CE}=600\text{V}, V_{GE}=0\text{V}$ $T_j=25^\circ\text{C}$ $T_j=175^\circ\text{C}$	-	-	40	μA
			-	-	1000	
Gate-emitter leakage current	I_{GES}	$V_{CE}=0\text{V}, V_{GE}=20\text{V}$	-	-	100	nA
Transconductance	g_{fs}	$V_{CE}=20\text{V}, I_C=20\text{A}$	-	11	-	S
Integrated gate resistor	R_{Gint}			-		Ω

Dynamic Characteristic

Input capacitance	C_{iss}	$V_{CE}=25\text{V}, V_{GE}=0\text{V}, f=1\text{MHz}$	-	1100	-	pF
Output capacitance	C_{oss}		-	71	-	
Reverse transfer capacitance	C_{riss}		-	32	-	
Gate charge	Q_{Gate}	$V_{CC}=480\text{V}, I_C=20\text{A}$ $V_{GE}=15\text{V}$	-	120	-	nC
Internal emitter inductance measured 5mm (0.197 in.) from case	L_E		-	7	-	nH
Short circuit collector current ¹⁾	$I_{C(SC)}$	$V_{GE}=15\text{V}, t_{SC}\leq 5\mu\text{s}$ $V_{CC}=400\text{V}, T_j\leq 150^\circ\text{C}$	-	183.3	-	A

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

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

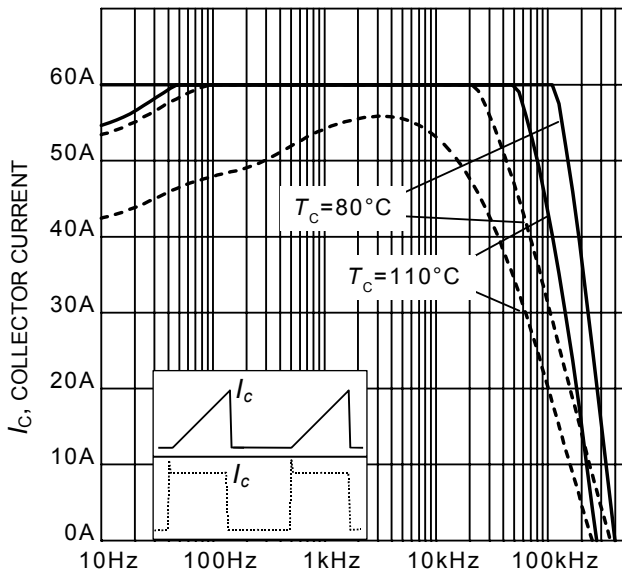
Switching Characteristic, Inductive Load, at $T_j=25^\circ\text{C}$

Parameter	Symbol	Conditions	Value			Unit
			min.	Typ.	max.	
IGBT Characteristic						
Turn-on delay time	$t_{d(on)}$	$T_j=25^\circ\text{C}$, $V_{CC}=400\text{V}$, $I_C=20\text{A}$, $V_{GE}=0/15\text{V}$, $R_G=12\ \Omega$, $L_{\sigma}^{(2)}=131\text{nH}$, $C_{\sigma}^{(2)}=31\text{pF}$ Energy losses include "tail" and diode reverse recovery.	-	18	-	ns
Rise time	t_r		-	14	-	
Turn-off delay time	$t_{d(off)}$		-	199	-	
Fall time	t_f		-	42	-	mJ
Turn-on energy	E_{on}		-	0.31	-	
Turn-off energy	E_{off}		-	0.46	-	
Total switching energy	E_{ts}		-	0.77	-	
Anti-Parallel Diode Characteristic						
Diode reverse recovery time	t_{rr}	$T_j=25^\circ\text{C}$, $V_R=400\text{V}$, $I_F=20\text{A}$, $di_F/dt=880\text{A}/\mu\text{s}$	-	41	-	ns
Diode reverse recovery charge	Q_{rr}		-	0.31	-	μC
Diode peak reverse recovery current	I_{rrm}		-	13.3	-	A
Diode peak rate of fall of reverse recovery current during t_b	di_{rr}/dt		-	711	-	$\text{A}/\mu\text{s}$

Switching Characteristic, Inductive Load, at $T_j=175^\circ\text{C}$

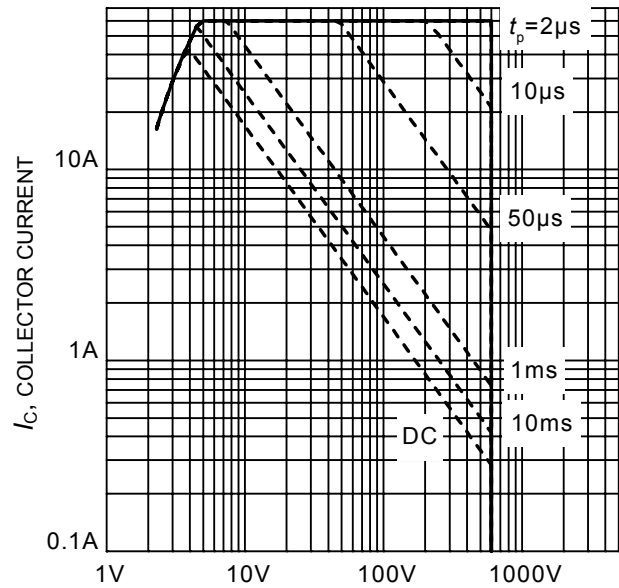
Parameter	Symbol	Conditions	Value			Unit
			min.	Typ.	max.	
IGBT Characteristic						
Turn-on delay time	$t_{d(on)}$	$T_j=175^\circ\text{C}$, $V_{CC}=400\text{V}$, $I_C=20\text{A}$, $V_{GE}=0/15\text{V}$, $R_G=12\ \Omega$, $L_{\sigma}^{(1)}=131\text{nH}$, $C_{\sigma}^{(1)}=31\text{pF}$ Energy losses include "tail" and diode reverse recovery.	-	18	-	ns
Rise time	t_r		-	18	-	
Turn-off delay time	$t_{d(off)}$		-	223	-	
Fall time	t_f		-	76	-	mJ
Turn-on energy	E_{on}		-	0.51	-	
Turn-off energy	E_{off}		-	0.64	-	
Total switching energy	E_{ts}		-	1.15	-	
Anti-Parallel Diode Characteristic						
Diode reverse recovery time	t_{rr}	$T_j=175^\circ\text{C}$ $V_R=400\text{V}$, $I_F=20\text{A}$, $di_F/dt=880\text{A}/\mu\text{s}$	-	176	-	ns
Diode reverse recovery charge	Q_{rr}		-	1.46	-	μC
Diode peak reverse recovery current	I_{rrm}		-	18.9	-	A
Diode peak rate of fall of reverse recovery current during t_b	di_{rr}/dt		-	467	-	$\text{A}/\mu\text{s}$

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



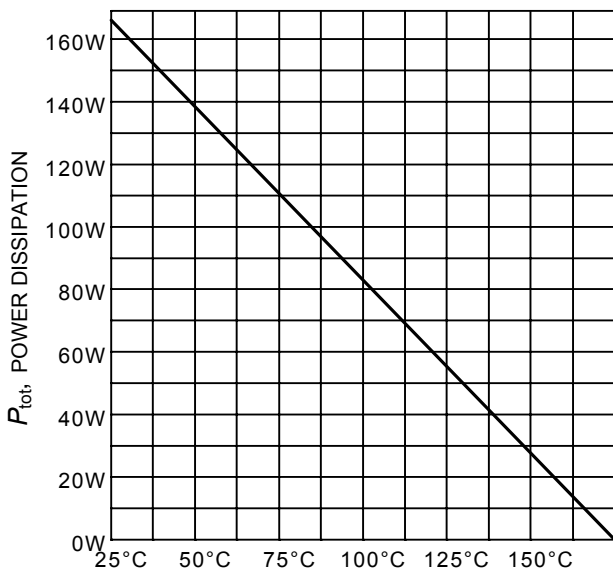
f , SWITCHING FREQUENCY

Figure 1. Collector current as a function of switching frequency
 ($T_j \leq 175^\circ\text{C}$, $D = 0.5$, $V_{CE} = 400\text{V}$,
 $V_{GE} = 0/+15\text{V}$, $R_G = 12\Omega$)



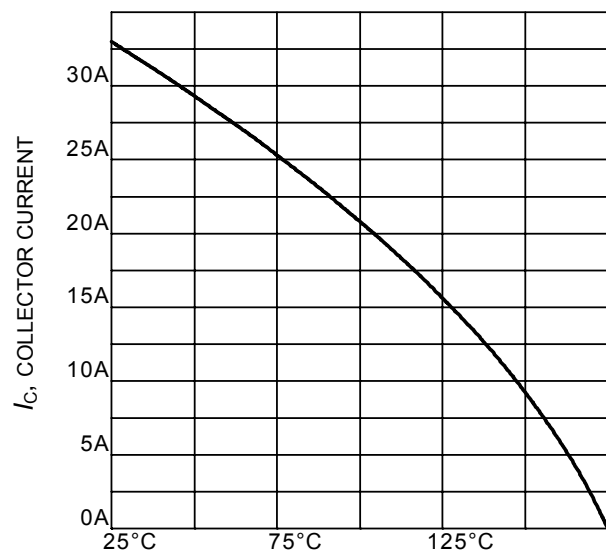
V_{CE} , COLLECTOR-EMITTER VOLTAGE

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



T_C , CASE TEMPERATURE

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



T_C , CASE TEMPERATURE

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

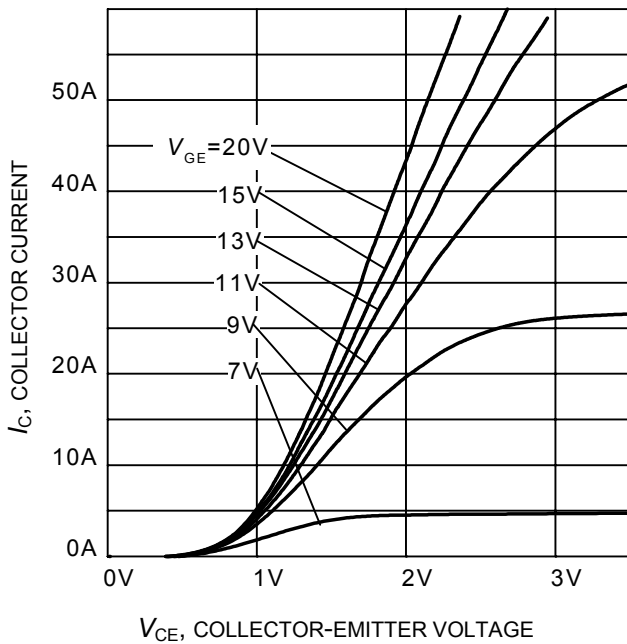


Figure 5. Typical output characteristic
($T_j = 25^\circ\text{C}$)

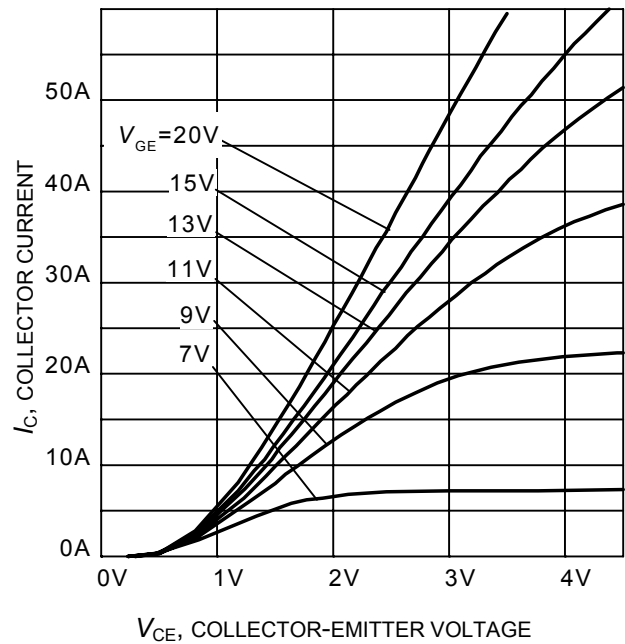


Figure 6. Typical output characteristic
($T_j = 175^\circ\text{C}$)

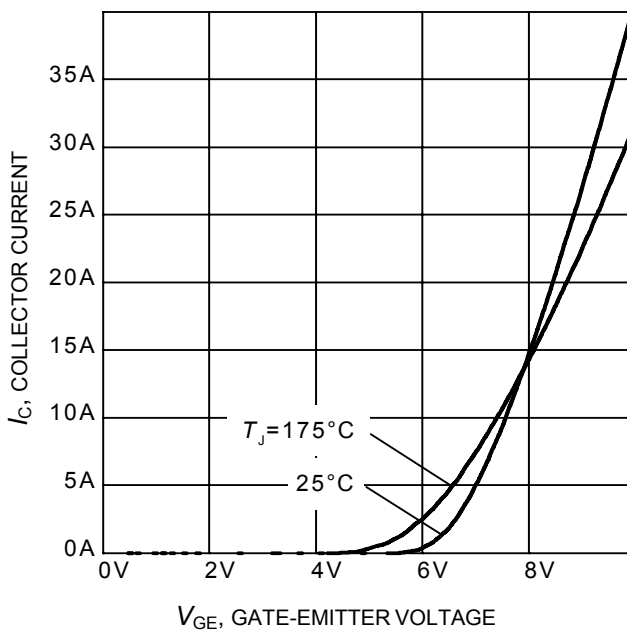


Figure 7. Typical transfer characteristic
($V_{CE} = 10\text{V}$)

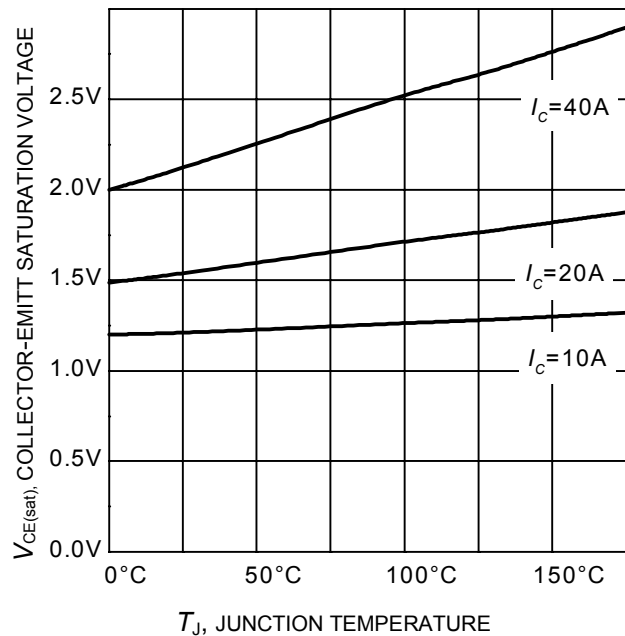
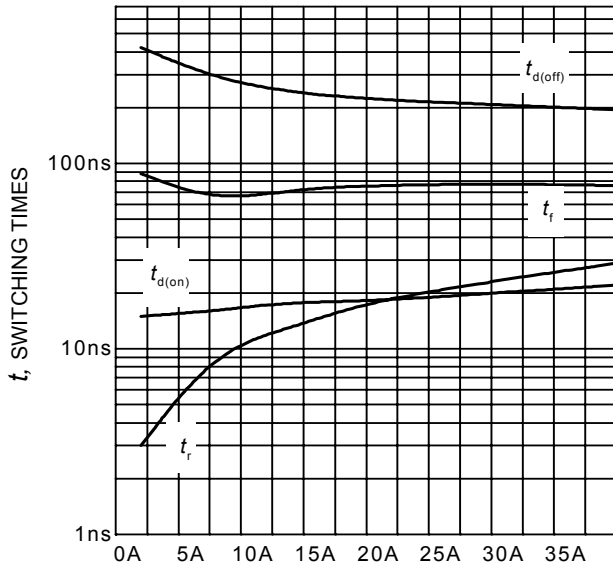
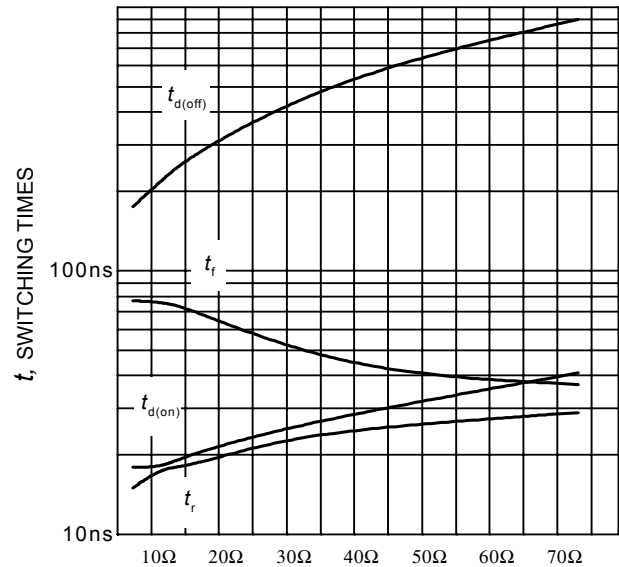


Figure 8. Typical collector-emitter saturation voltage as a function of junction temperature
($V_{GE} = 15\text{V}$)



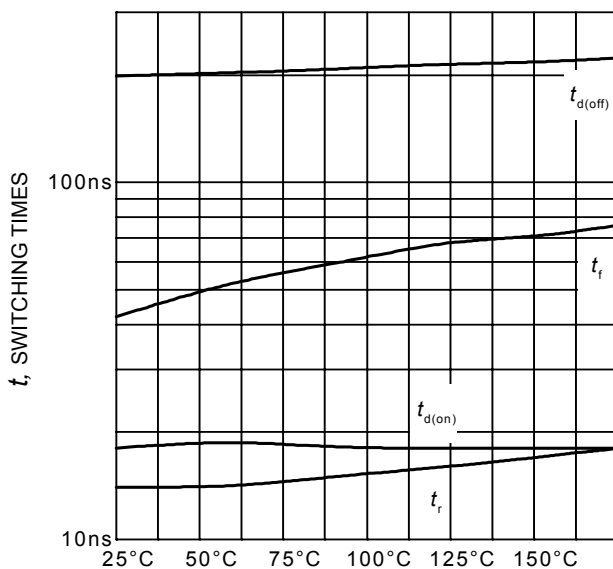
I_C , COLLECTOR CURRENT

Figure 9. Typical switching times as a function of collector current
(inductive load, $T_J=175^\circ\text{C}$, $V_{CE} = 400\text{V}$, $V_{GE} = 0/15\text{V}$, $R_G = 12\Omega$, Dynamic test circuit in Figure E)



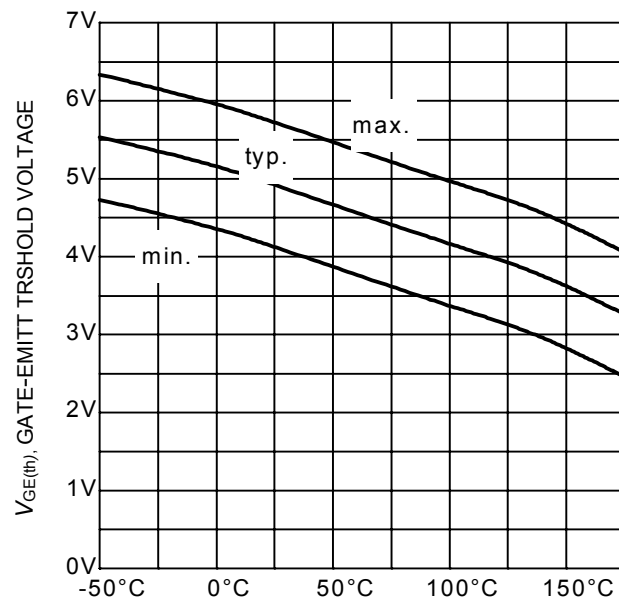
R_G , GATE RESISTOR

Figure 10. Typical switching times as a function of gate resistor
(inductive load, $T_J = 175^\circ\text{C}$, $V_{CE} = 400\text{V}$, $V_{GE} = 0/15\text{V}$, $I_C = 20\text{A}$, Dynamic test circuit in Figure E)



T_J , JUNCTION TEMPERATURE

Figure 11. Typical switching times as a function of junction temperature
(inductive load, $V_{CE} = 400\text{V}$, $V_{GE} = 0/15\text{V}$, $I_C = 20\text{A}$, $R_G=12\Omega$, Dynamic test circuit in Figure E)



T_J , JUNCTION TEMPERATURE

Figure 12. Gate-emitter threshold voltage as a function of junction temperature
($I_C = 0.29\text{mA}$)

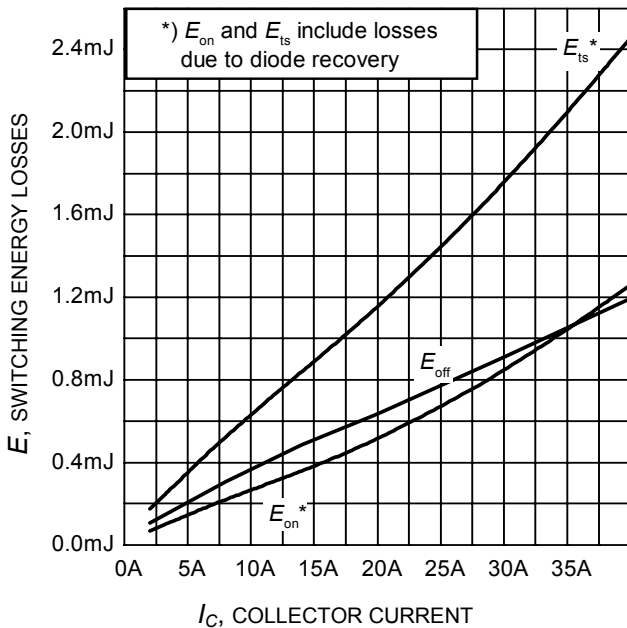


Figure 13. Typical switching energy losses as a function of collector current
(inductive load, $T_J = 175^\circ\text{C}$, $V_{CE} = 400\text{V}$, $V_{GE} = 0/15\text{V}$, $R_G = 12\Omega$, Dynamic test circuit in Figure E)

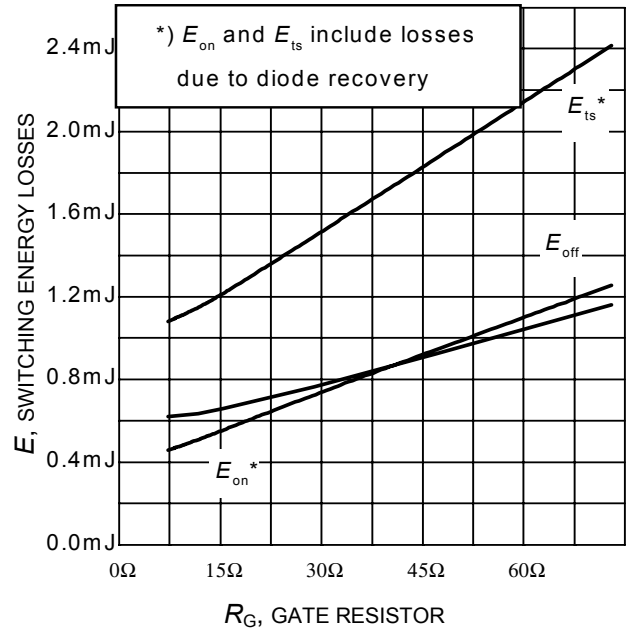


Figure 14. Typical switching energy losses as a function of gate resistor
(inductive load, $T_J = 175^\circ\text{C}$, $V_{CE} = 400\text{V}$, $V_{GE} = 0/15\text{V}$, $I_C = 20\text{A}$, Dynamic test circuit in Figure E)

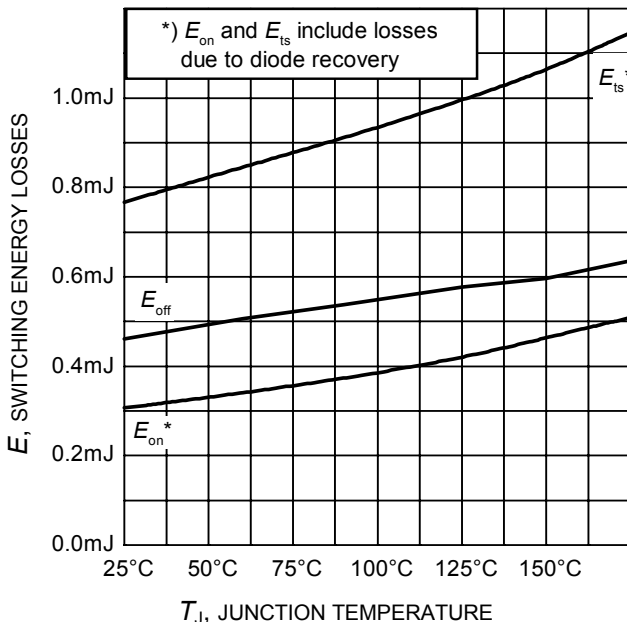


Figure 15. Typical switching energy losses as a function of junction temperature
(inductive load, $V_{CE} = 400\text{V}$, $V_{GE} = 0/15\text{V}$, $I_C = 20\text{A}$, $R_G = 12\Omega$, Dynamic test circuit in Figure E)

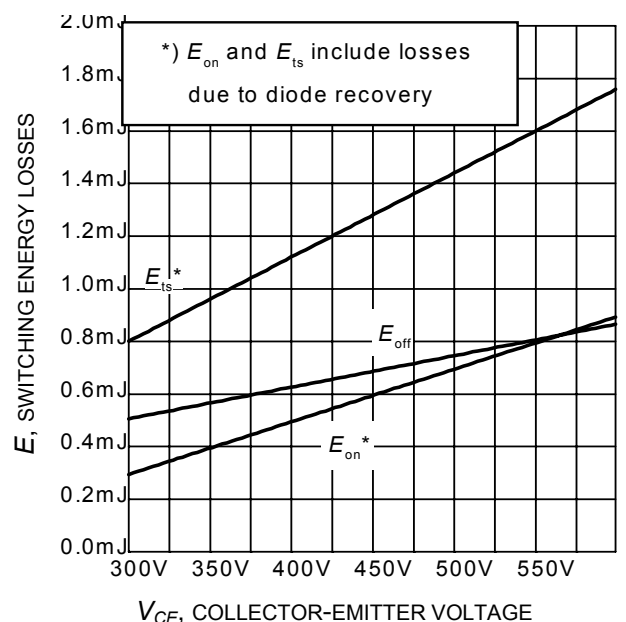


Figure 16. Typical switching energy losses as a function of collector emitter voltage
(inductive load, $T_J = 175^\circ\text{C}$, $V_{GE} = 0/15\text{V}$, $I_C = 20\text{A}$, $R_G = 12\Omega$, Dynamic test circuit in Figure E)

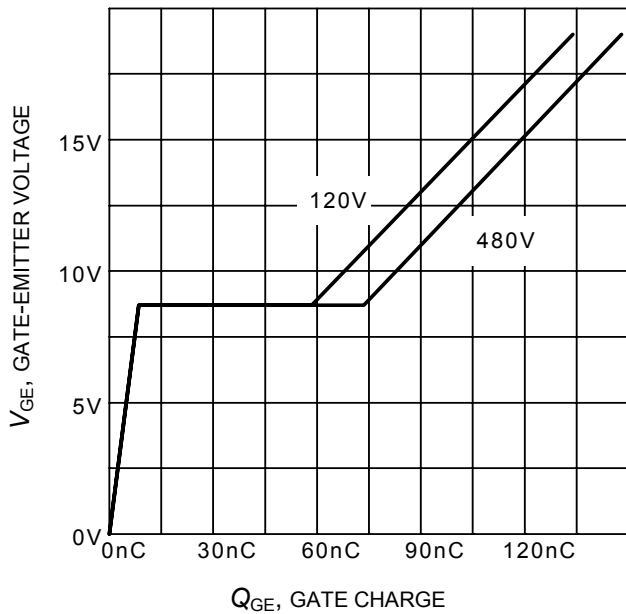


Figure 17. Typical gate charge
($I_C=20\text{ A}$)

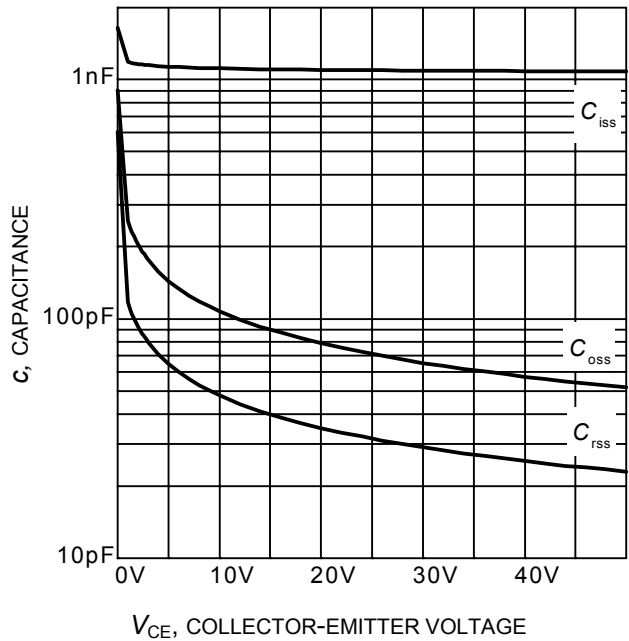


Figure 18. Typical capacitance as a function of collector-emitter voltage
($V_{GE}=0\text{V}$, $f = 1\text{ MHz}$)

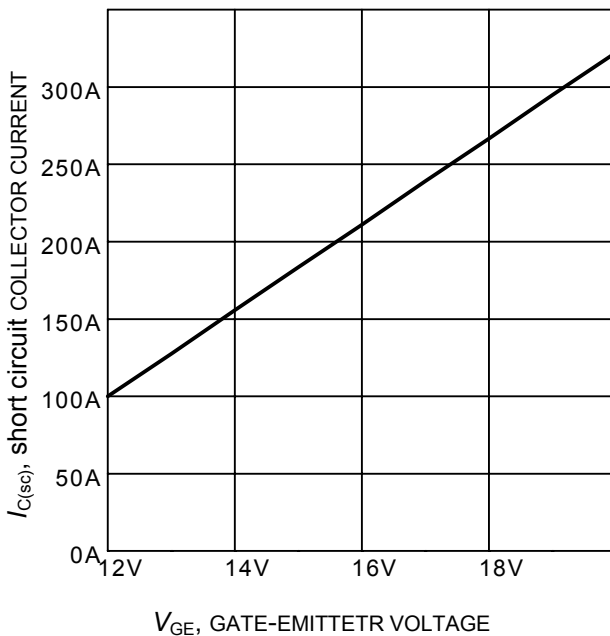


Figure 19. Typical short circuit collector current as a function of gate-emitter voltage
($V_{CE} \leq 400\text{V}$, $T_j \leq 150^\circ\text{C}$)

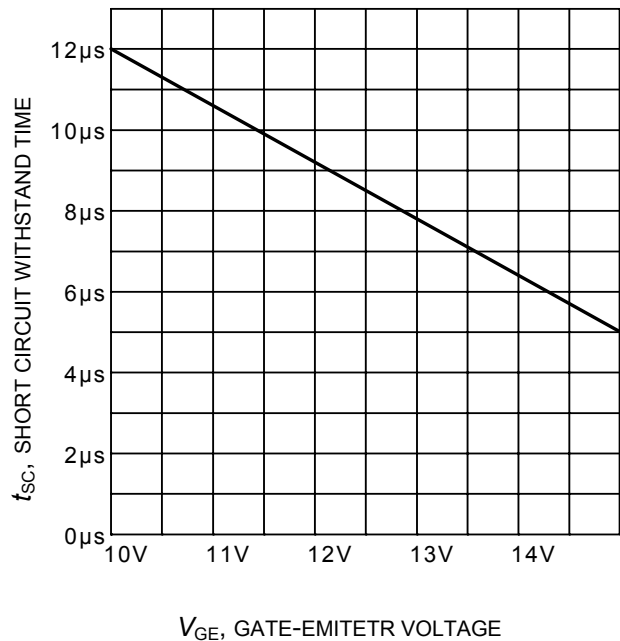


Figure 20. Short circuit withstand time as a function of gate-emitter voltage
($V_{CE}=600\text{V}$, start at $T_j=25^\circ\text{C}$, $T_{jmax}<150^\circ\text{C}$)

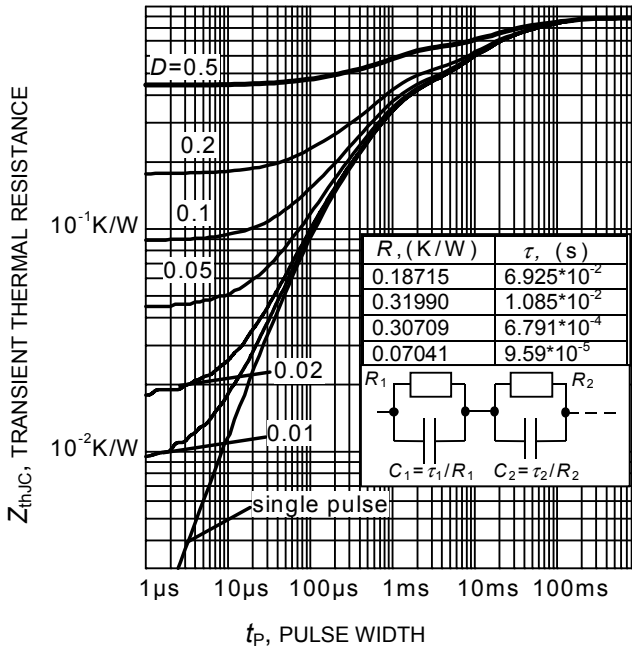


Figure 21. IGBT transient thermal resistance
($D = t_p / T$)

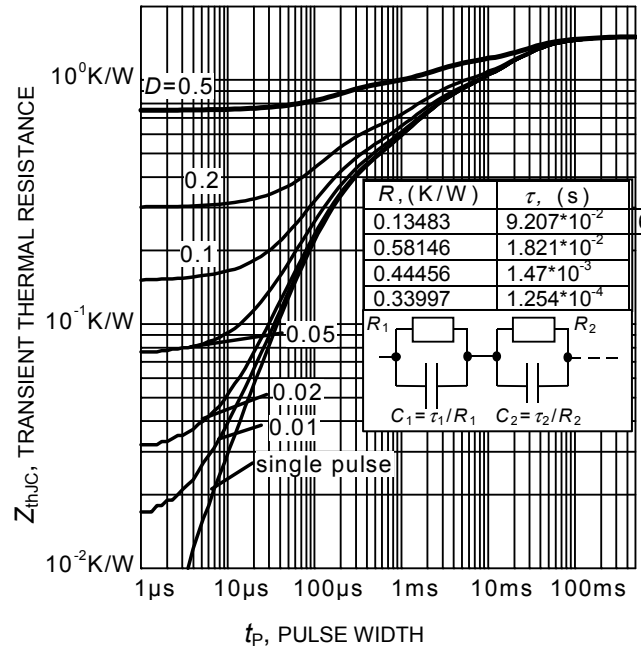


Figure 22. Diode transient thermal impedance as a function of pulse width
($D = t_p / T$)

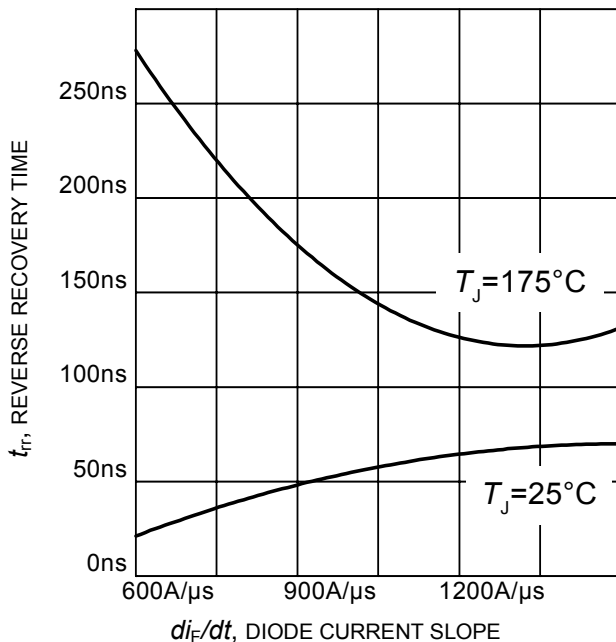


Figure 23. Typical reverse recovery time as a function of diode current slope
($V_R = 400V$, $I_F = 20A$,
Dynamic test circuit in Figure E)

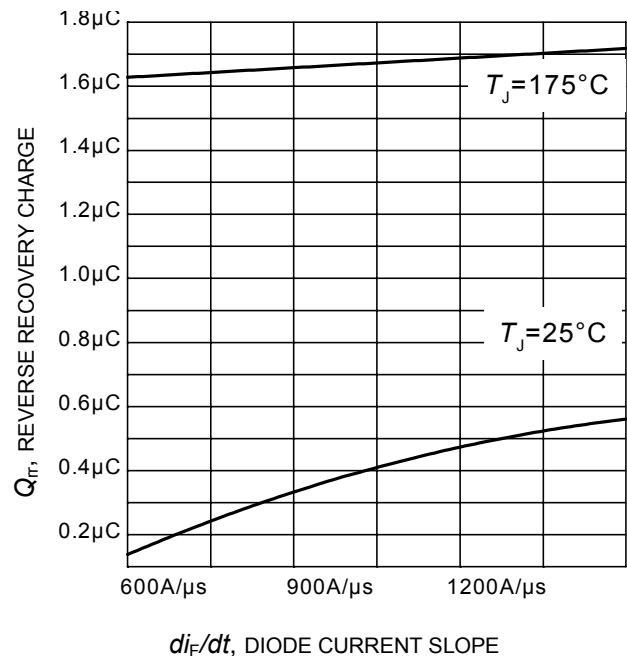
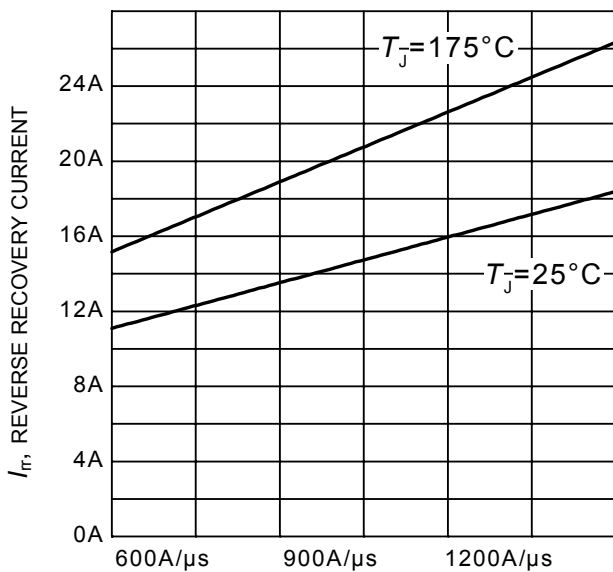


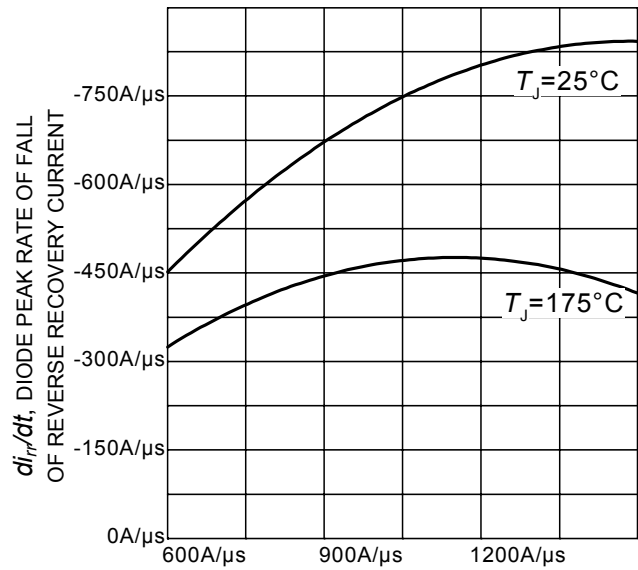
Figure 24. Typical reverse recovery charge as a function of diode current slope
($V_R = 400V$, $I_F = 20A$,
Dynamic test circuit in Figure E)



di_F/dt , DIODE CURRENT SLOPE

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

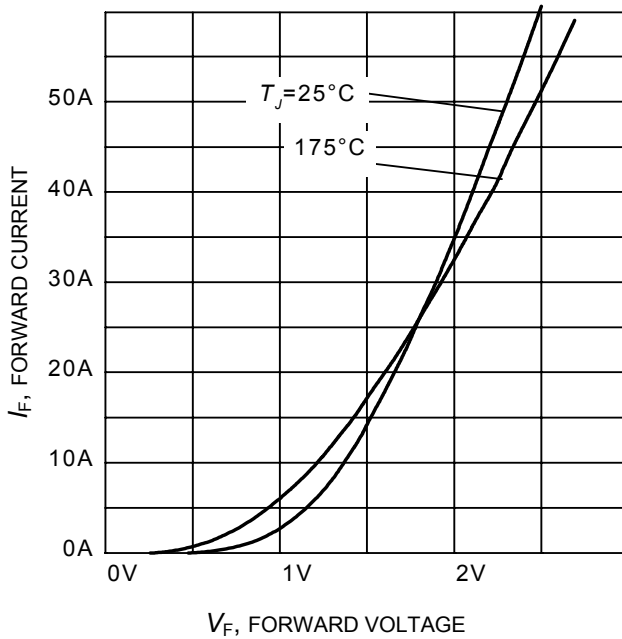
($V_R = 400V$, $I_F = 20A$,
Dynamic test circuit in Figure E)



di_F/dt , DIODE CURRENT SLOPE

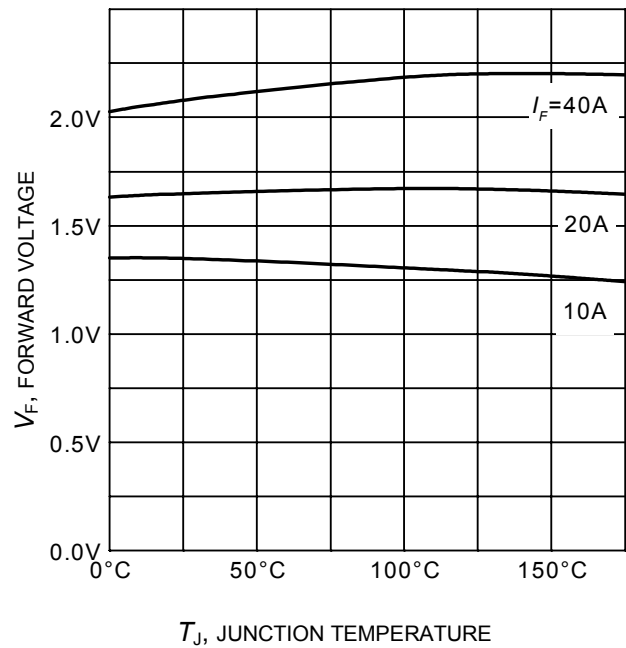
Figure 26. Typical diode peak rate of fall of reverse recovery current as a function of diode current slope

($V_R = 400V$, $I_F = 20A$,
Dynamic test circuit in Figure E)



V_F , FORWARD VOLTAGE

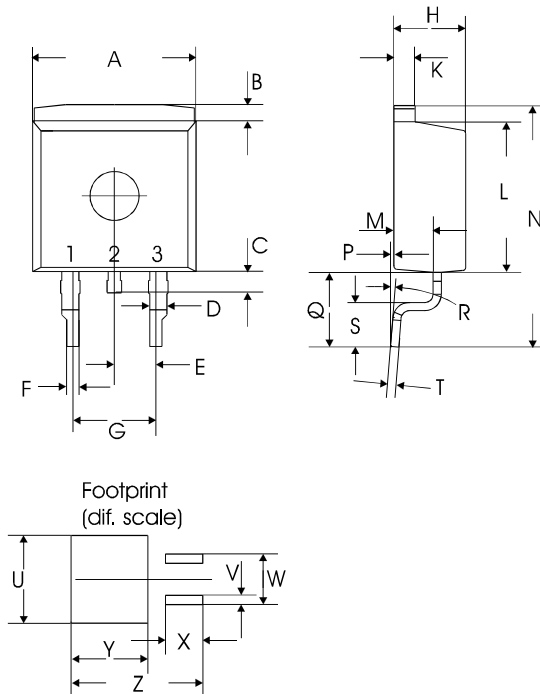
Figure 27. Typical diode forward current as a function of forward voltage



T_J , JUNCTION TEMPERATURE

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

PG-TO263-3-5



symbol	dimensions			
	[mm]		[inch]	
	min	max	min	max
A	9.80	10.20	0.3858	0.4016
B	0.70	1.30	0.0276	0.0512
C	1.00	1.60	0.0394	0.0630
D	1.03	1.07	0.0406	0.0421
E	2.54 typ.		0.1 typ.	
F	0.65	0.85	0.0256	0.0335
G	5.08 typ.		0.2 typ.	
H	4.30	4.50	0.1693	0.1772
K	1.17	1.37	0.0461	0.0539
L	9.05	9.45	0.3563	0.3720
M	2.30	2.50	0.0906	0.0984
N	15 typ.		0.5906 typ.	
P	0.00	0.20	0.0000	0.0079
Q	4.20	5.20	0.1654	0.2047
R	8° max		8° max	
S	2.40	3.00	0.0945	0.1181
T	0.40	0.60	0.0157	0.0236
U	10.80		0.4252	
V	1.15		0.0453	
W	6.23		0.2453	
X	4.60		0.1811	
Y	9.40		0.3701	
Z	16.15		0.6358	

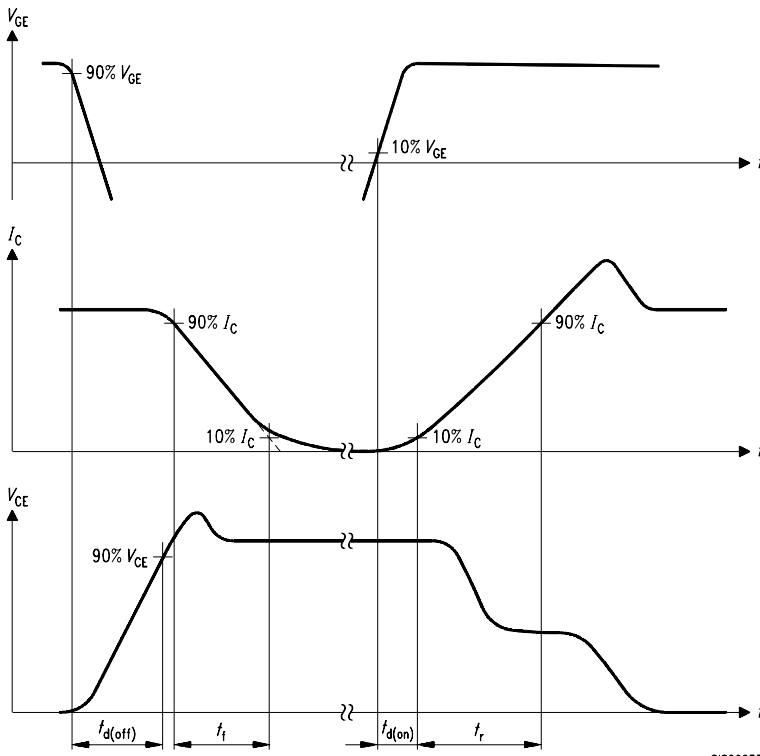


Figure A. Definition of switching times

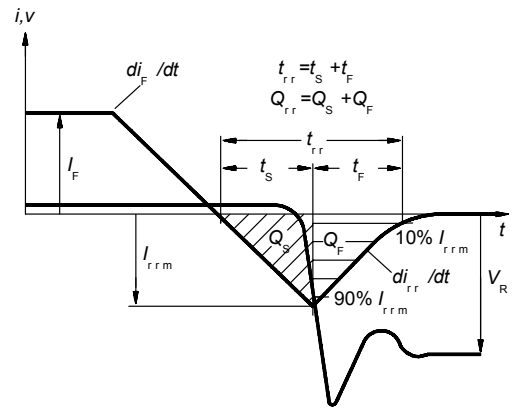


Figure C. Definition of diodes switching characteristics

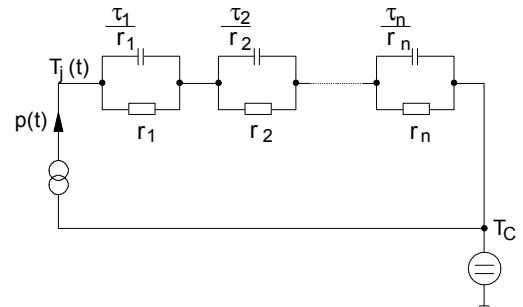


Figure D. Thermal equivalent circuit

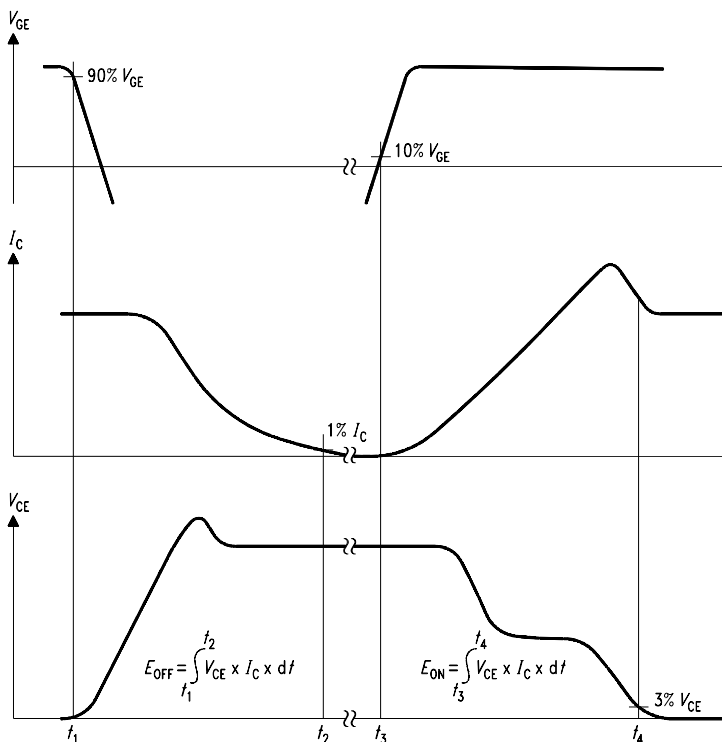


Figure B. Definition of switching losses

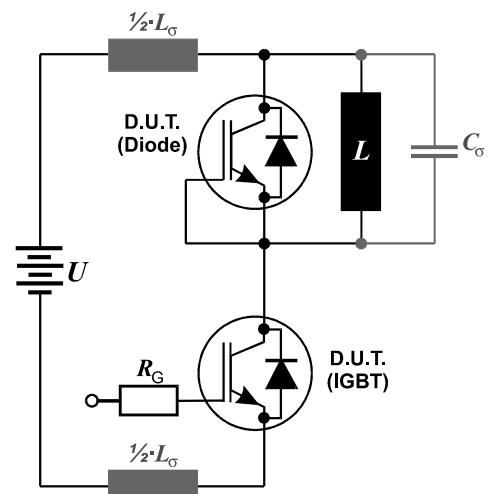


Figure E. Dynamic test circuit

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