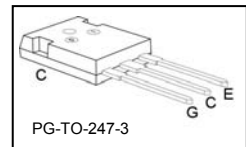
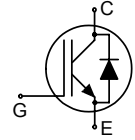


Low Loss DuoPack : IGBT in TrenchStop® and Fieldstop technology
with soft, fast recovery anti-parallel EmCon HE diode

- 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
- 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
IKW50N60T	600V	50A	1.5V	175°C	K50T60	PG-TO-247-3

Maximum Ratings

Parameter	Symbol	Value	Unit
Collector-emitter voltage	V_{CE}	600	V
DC collector current, limited by T_{jmax} $T_C = 25^\circ C$ $T_C = 100^\circ C$	I_C	80 ²⁾ 50	A
Pulsed collector current, t_p limited by T_{jmax}	$I_{C,puls}$	150	
Turn off safe operating area ($V_{CE} \leq 600V, T_j \leq 175^\circ C$)	-	150	
Diode forward current, limited by T_{jmax} $T_C = 25^\circ C$ $T_C = 100^\circ C$	I_F	100 50	
Diode pulsed current, t_p limited by T_{jmax}	$I_{F,puls}$	150	
Gate-emitter voltage	V_{GE}	± 20	V
Short circuit withstand time ³⁾ $V_{GE} = 15V, V_{CC} \leq 400V, T_j \leq 150^\circ C$	t_{SC}	5	µs
Power dissipation $T_C = 25^\circ C$	P_{tot}	333	W
Operating junction temperature	T_j	-40...+175	°C
Storage temperature	T_{stg}	-55...+175	
Soldering temperature, 1.6mm (0.063 in.) from case for 10s	-	260	

¹ J-STD-020 and JESD-022

²⁾ Value limited by bond wire

³⁾ 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}		0.45	K/W
Diode thermal resistance, junction – case	R_{thJCD}		0.8	
Thermal resistance, junction – ambient	R_{thJA}		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	$V_{(BR)CES}$	$V_{GE}=0V, I_C=0.2mA$	600	-	-	V
Collector-emitter saturation voltage	$V_{CE(sat)}$	$V_{GE} = 15V, I_C=50A$ $T_j=25^\circ\text{C}$ $T_j=175^\circ\text{C}$	-	1.5	2	
Diode forward voltage	V_F	$V_{GE}=0V, I_F=50A$ $T_j=25^\circ\text{C}$ $T_j=175^\circ\text{C}$	-	1.65	2.05	
Gate-emitter threshold voltage	$V_{GE(th)}$	$I_C=0.8mA, V_{CE}=V_{GE}$	4.1	4.9	5.7	
Zero gate voltage collector current	I_{CES}	$V_{CE}=600V, V_{GE}=0V$ $T_j=25^\circ\text{C}$ $T_j=175^\circ\text{C}$	-	-	40	μA
Gate-emitter leakage current	I_{GES}	$V_{CE}=0V, V_{GE}=20V$	-	-	100	
Transconductance	g_{fs}	$V_{CE}=20V, I_C=50A$	-	31	-	S
Integrated gate resistor	R_{Gint}			-		Ω

Dynamic Characteristic

Input capacitance	C_{iss}	$V_{CE}=25V,$ $V_{GE}=0V,$ $f=1MHz$	-	3140	-	μF
Output capacitance	C_{oss}		-	200	-	
Reverse transfer capacitance	C_{riss}		-	93	-	
Gate charge	Q_{Gate}	$V_{CC}=480V, I_C=50A$ $V_{GE}=15V$	-	310	-	nC
Internal emitter inductance measured 5mm (0.197 in.) from case	L_E		-	13	-	nH
Short circuit collector current ¹⁾	$I_{C(SC)}$	$V_{GE}=15V, t_{SC}\leq 5\mu s$ $V_{CC} = 400V,$ $T_j \leq 150^\circ\text{C}$	-	458.3	-	A

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

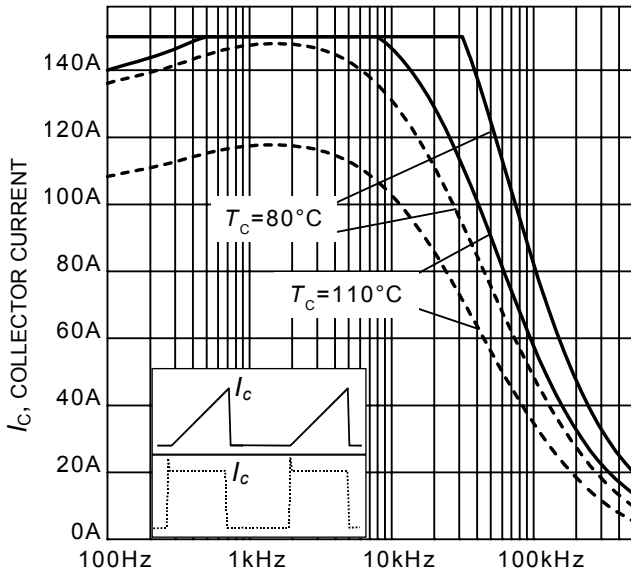
Switching Characteristic, Inductive Load, at $T_j=25^\circ\text{C}$

Parameter	Symbol	Conditions	Value			Unit
			min.	Typ.	max.	
IGBT Characteristic						
Turn-on delay time	$t_{d(on)}$	$T_j=25^\circ\text{C}$, $V_{CC}=400\text{V}$, $I_C=50\text{A}$, $V_{GE}=0/15\text{V}$, $R_G=7\ \Omega$, $L_{\sigma}^{(1)}=103\text{nH}$, $C_{\sigma}^{(1)}=39\text{pF}$ Energy losses include "tail" and diode reverse recovery.	-	26	-	ns
Rise time	t_r		-	29	-	
Turn-off delay time	$t_{d(off)}$		-	299	-	
Fall time	t_f		-	29	-	
Turn-on energy	E_{on}		-	1.2	-	mJ
Turn-off energy	E_{off}		-	1.4	-	
Total switching energy	E_{ts}		-	2.6	-	
Anti-Parallel Diode Characteristic						
Diode reverse recovery time	t_{rr}	$T_j=25^\circ\text{C}$, $V_R=400\text{V}$, $I_F=50\text{A}$, $di_F/dt=1280\text{A}/\mu\text{s}$	-	143	-	ns
Diode reverse recovery charge	Q_{rr}		-	1.8	-	μC
Diode peak reverse recovery current	I_{rrm}		-	27.7	-	A
Diode peak rate of fall of reverse recovery current during t_b	di_{rr}/dt		-	671	-	$\text{A}/\mu\text{s}$

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

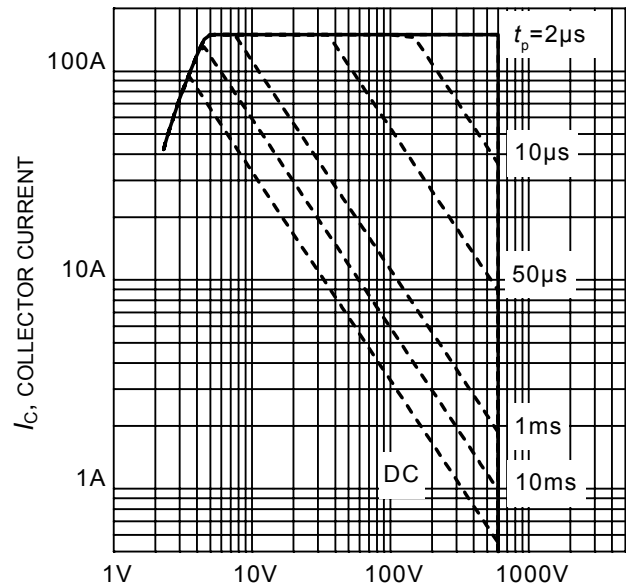
Parameter	Symbol	Conditions	Value			Unit
			min.	Typ.	max.	
IGBT Characteristic						
Turn-on delay time	$t_{d(on)}$	$T_j=175^\circ\text{C}$, $V_{CC}=400\text{V}$, $I_C=50\text{A}$, $V_{GE}=0/15\text{V}$, $R_G=7\ \Omega$, $L_{\sigma}^{(1)}=103\text{nH}$, $C_{\sigma}^{(1)}=39\text{pF}$ Energy losses include "tail" and diode reverse recovery.	-	27	-	ns
Rise time	t_r		-	33	-	
Turn-off delay time	$t_{d(off)}$		-	341	-	
Fall time	t_f		-	55	-	
Turn-on energy	E_{on}		-	1.8	-	mJ
Turn-off energy	E_{off}		-	1.8	-	
Total switching energy	E_{ts}		-	3.6	-	
Anti-Parallel Diode Characteristic						
Diode reverse recovery time	t_{rr}	$T_j=175^\circ\text{C}$ $V_R=400\text{V}$, $I_F=50\text{A}$, $di_F/dt=1280\text{A}/\mu\text{s}$	-	205	-	ns
Diode reverse recovery charge	Q_{rr}		-	4.3	-	μC
Diode peak reverse recovery current	I_{rrm}		-	40.7	-	A
Diode peak rate of fall of reverse recovery current during t_b	di_{rr}/dt		-	449	-	$\text{A}/\mu\text{s}$

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



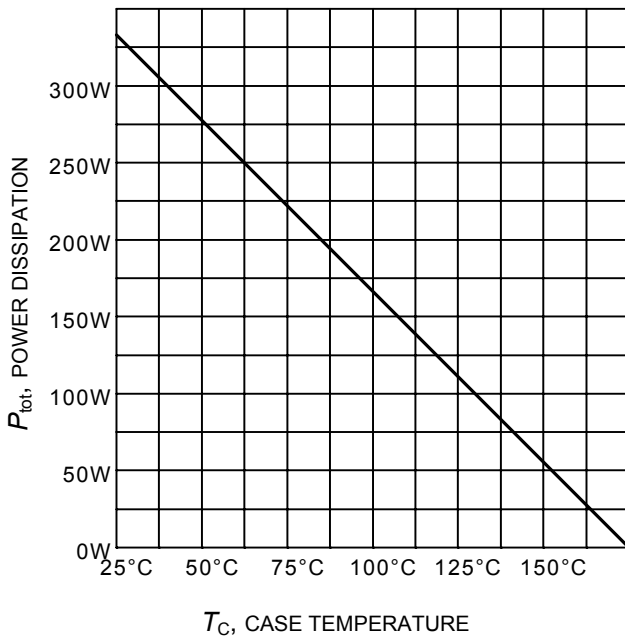
f , SWITCHING FREQUENCY

Figure 1. Collector current as a function of switching frequency
 ($T_j \leq 175^\circ\text{C}$, $D = 0.5$, $V_{CE} = 400\text{V}$,
 $V_{GE} = 0/+15\text{V}$, $R_G = 7\Omega$)



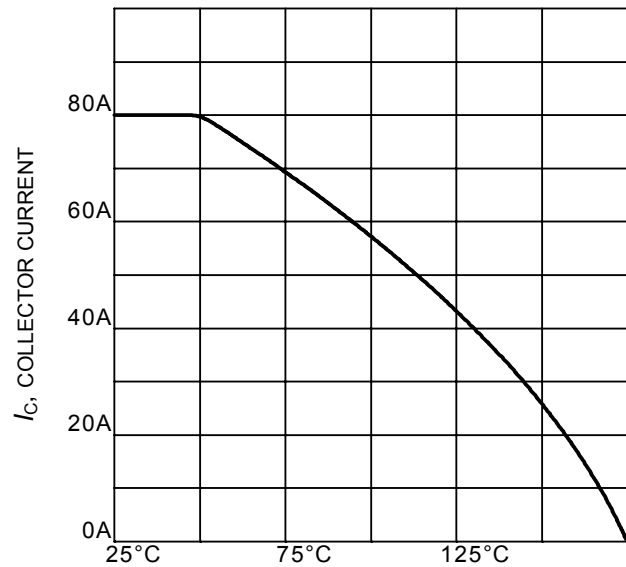
V_{CE} , COLLECTOR-EMITTER VOLTAGE

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
 ($V_{GE} \geq 15\text{V}$, $T_j \leq 175^\circ\text{C}$)

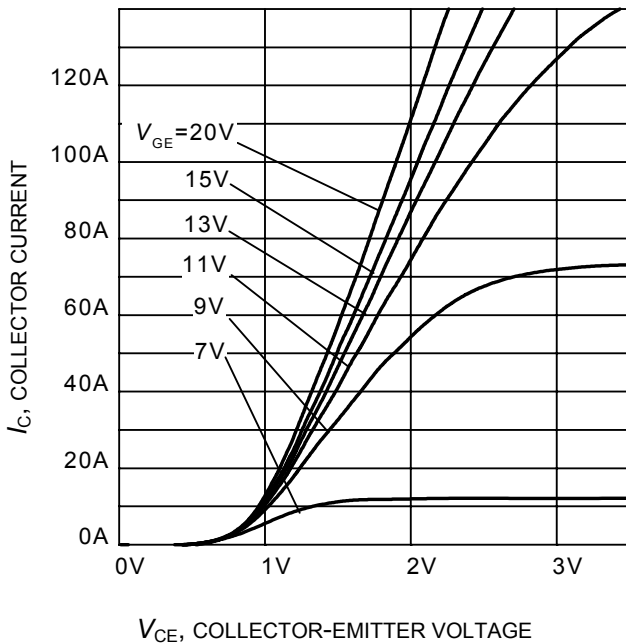


Figure 5. Typical output characteristic
($T_j = 25^\circ\text{C}$)

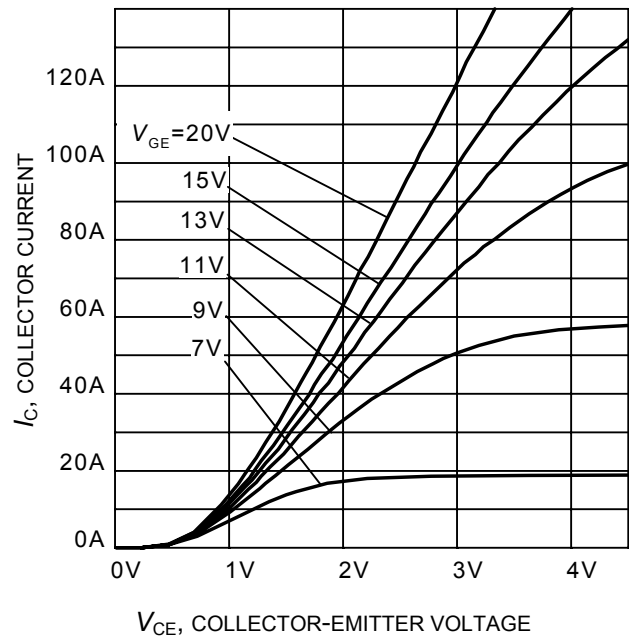


Figure 6. Typical output characteristic
($T_j = 175^\circ\text{C}$)

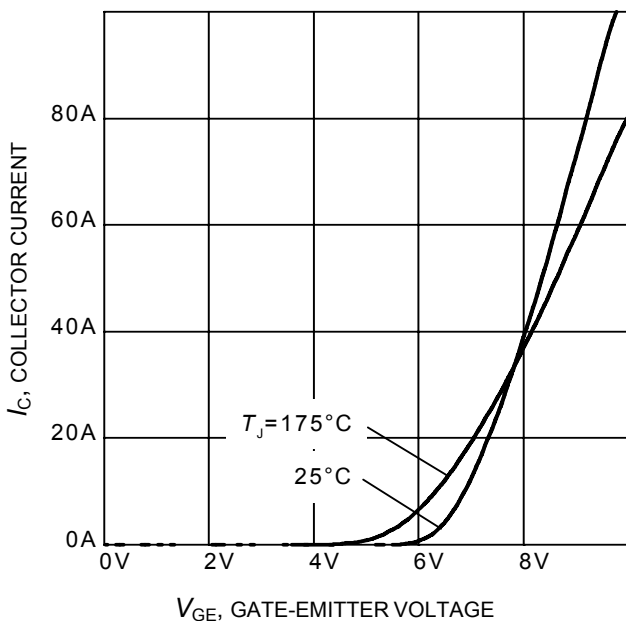


Figure 7. Typical transfer characteristic
($V_{CE} = 10\text{V}$)

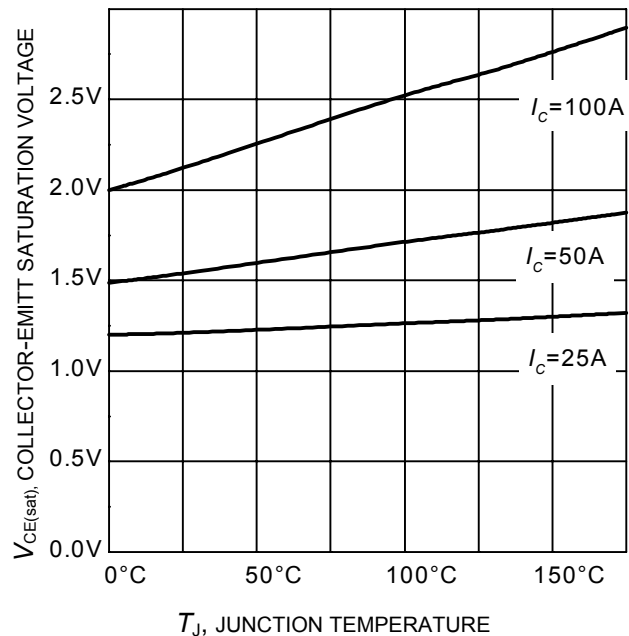
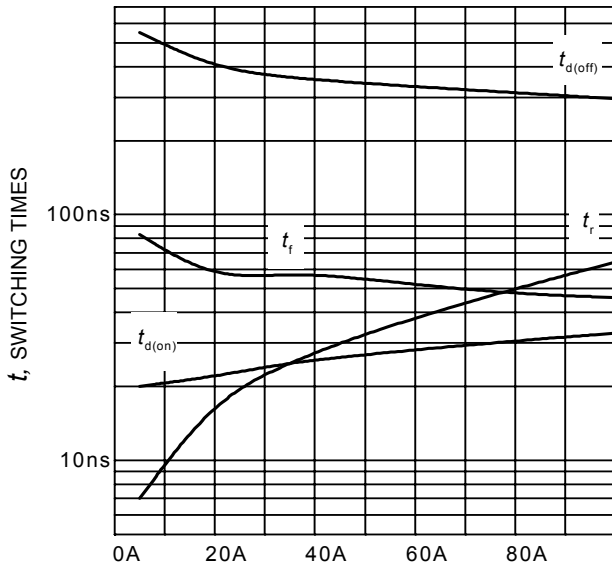
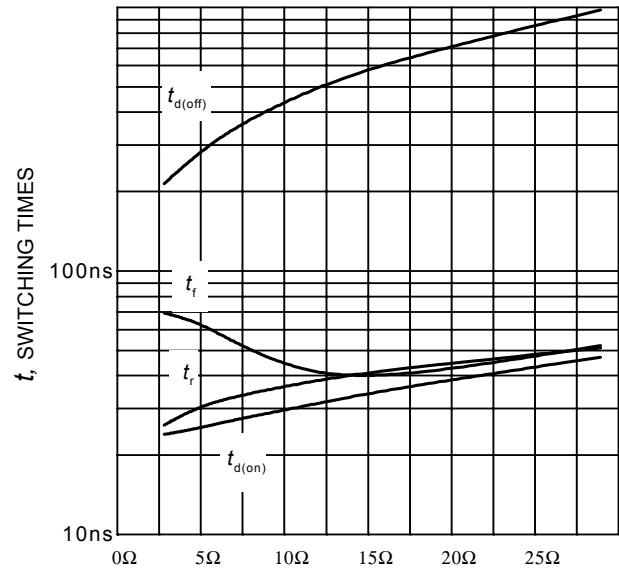


Figure 8. Typical collector-emitter saturation voltage as a function of junction temperature
($V_{GE} = 15\text{V}$)



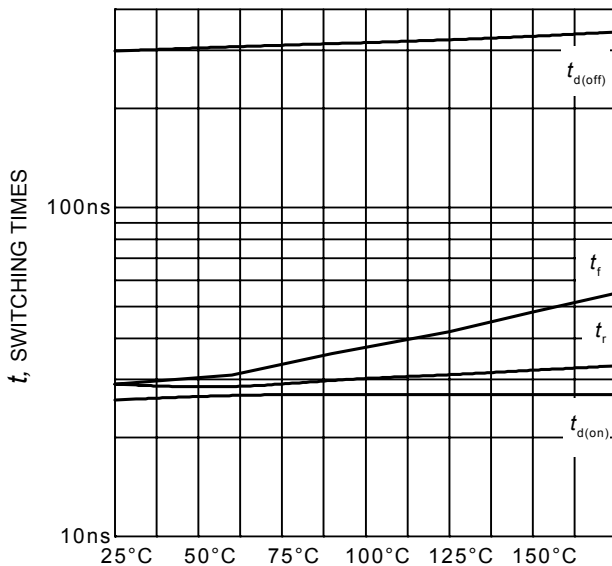
I_C , COLLECTOR CURRENT

Figure 9. Typical switching times as a function of collector current
(inductive load, $T_J=175^\circ\text{C}$, $V_{CE} = 400\text{V}$, $V_{GE} = 0/15\text{V}$, $R_G = 7\Omega$, Dynamic test circuit in Figure E)



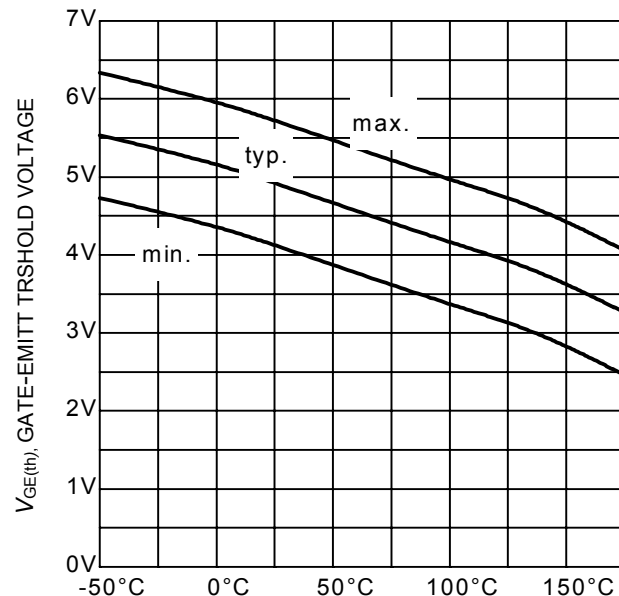
R_G , GATE RESISTOR

Figure 10. Typical switching times as a function of gate resistor
(inductive load, $T_J = 175^\circ\text{C}$, $V_{CE} = 400\text{V}$, $V_{GE} = 0/15\text{V}$, $I_C = 50\text{A}$, Dynamic test circuit in Figure E)



T_J , JUNCTION TEMPERATURE

Figure 11. Typical switching times as a function of junction temperature
(inductive load, $V_{CE} = 400\text{V}$, $V_{GE} = 0/15\text{V}$, $I_C = 50\text{A}$, $R_G=7\Omega$, Dynamic test circuit in Figure E)



T_J , JUNCTION TEMPERATURE

Figure 12. Gate-emitter threshold voltage as a function of junction temperature
($I_C = 0.8\text{mA}$)

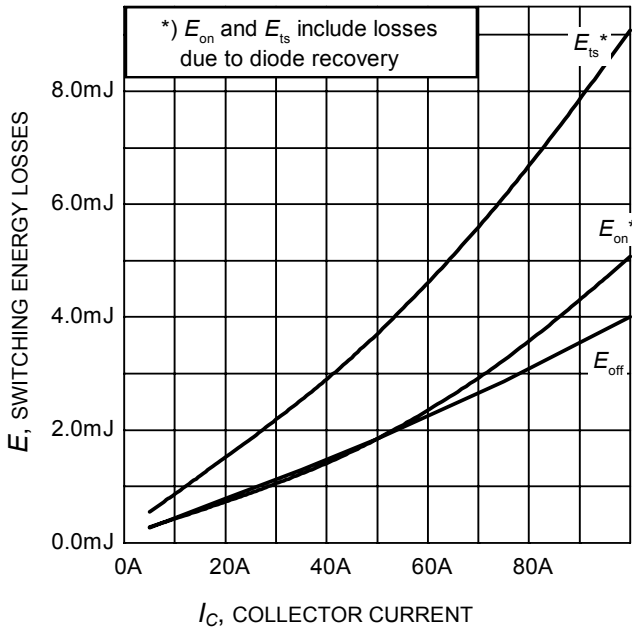


Figure 13. Typical switching energy losses as a function of collector current
 (inductive load, $T_J = 175^\circ\text{C}$, $V_{CE} = 400\text{V}$, $V_{GE} = 0/15\text{V}$, $R_G = 7\Omega$, Dynamic test circuit in Figure E)

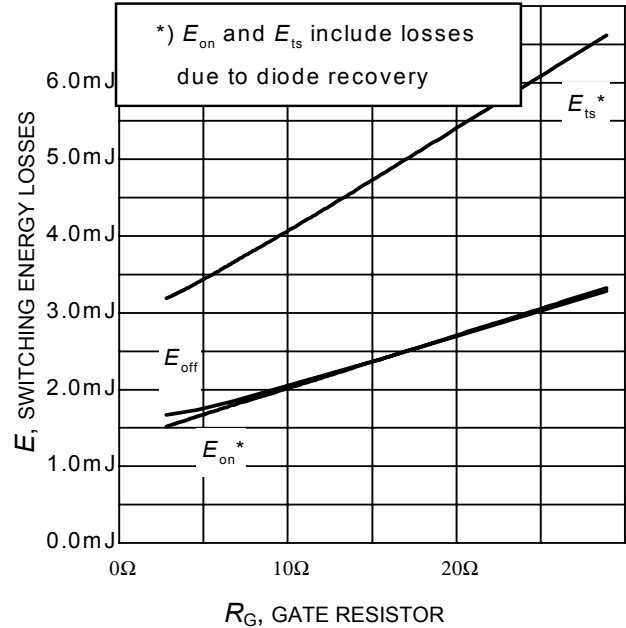


Figure 14. Typical switching energy losses as a function of gate resistor
 (inductive load, $T_J = 175^\circ\text{C}$, $V_{CE} = 400\text{V}$, $V_{GE} = 0/15\text{V}$, $I_C = 50\text{A}$, Dynamic test circuit in Figure E)

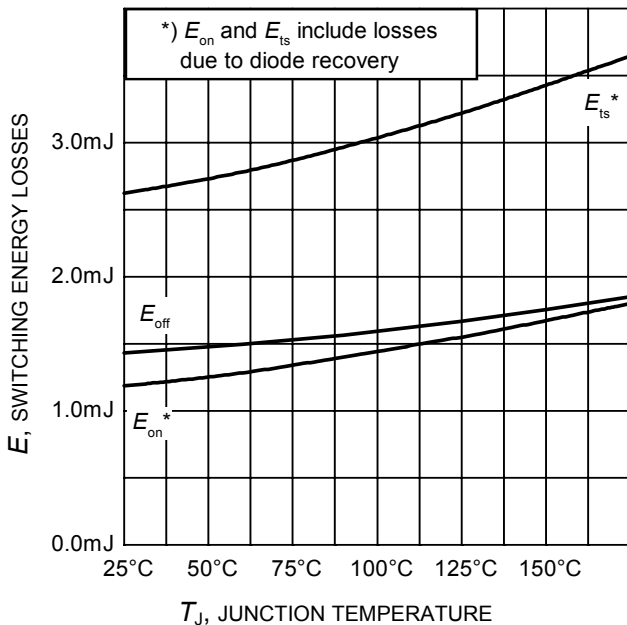


Figure 15. Typical switching energy losses as a function of junction temperature
 (inductive load, $V_{CE} = 400\text{V}$, $V_{GE} = 0/15\text{V}$, $I_C = 50\text{A}$, $R_G = 7\Omega$, Dynamic test circuit in Figure E)

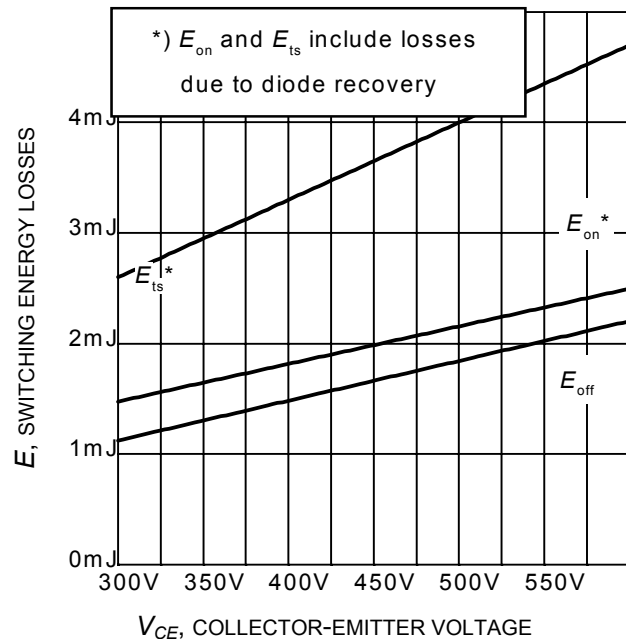


Figure 16. Typical switching energy losses as a function of collector emitter voltage
 (inductive load, $T_J = 175^\circ\text{C}$, $V_{GE} = 0/15\text{V}$, $I_C = 50\text{A}$, $R_G = 7\Omega$, Dynamic test circuit in Figure E)

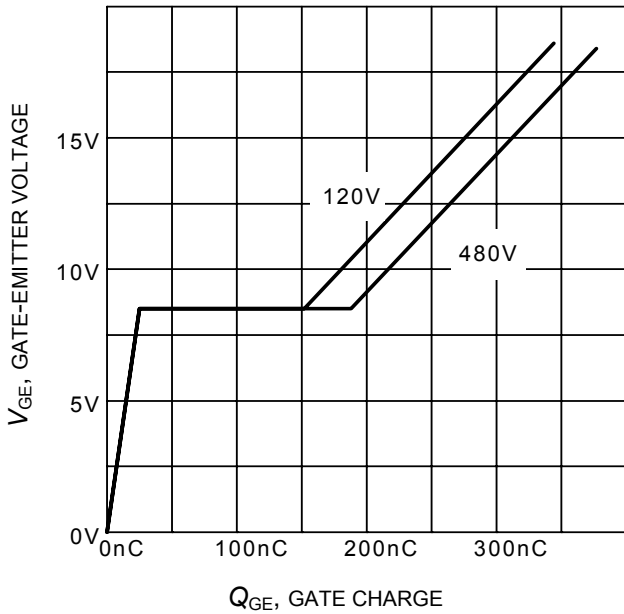


Figure 17. Typical gate charge
($I_C=50\text{ A}$)

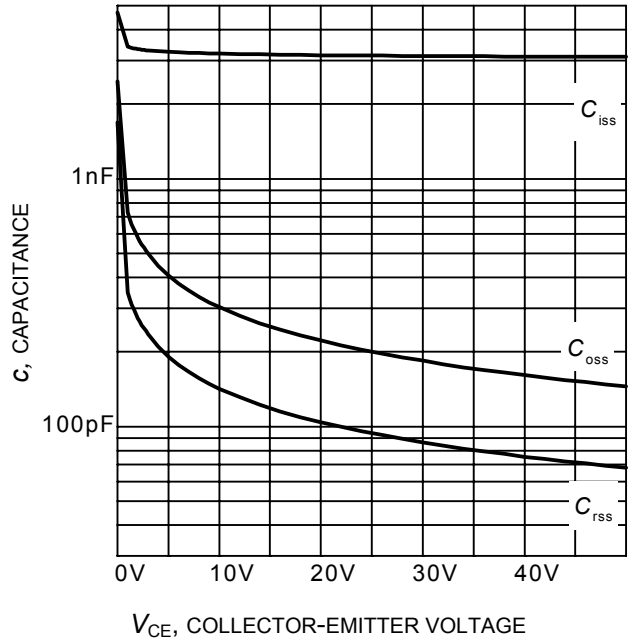


Figure 18. Typical capacitance as a function of collector-emitter voltage
($V_{GE}=0\text{V}$, $f = 1\text{ MHz}$)

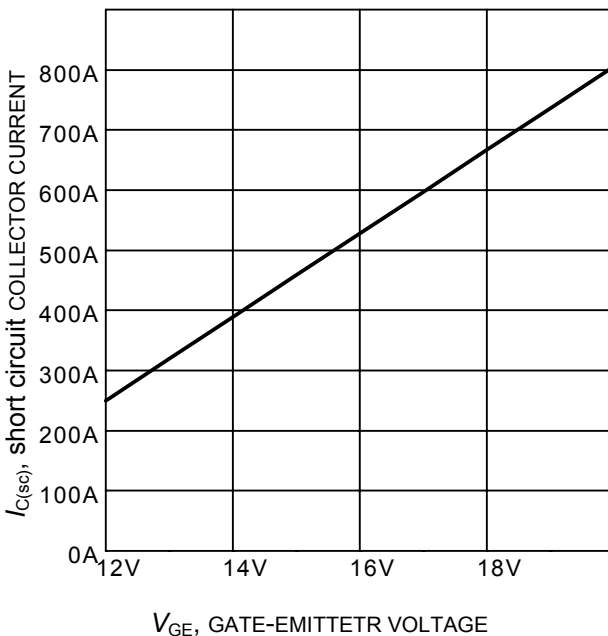


Figure 19. Typical short circuit collector current as a function of gate-emitter voltage
($V_{CE} \leq 400\text{V}$, $T_J \leq 150^\circ\text{C}$)

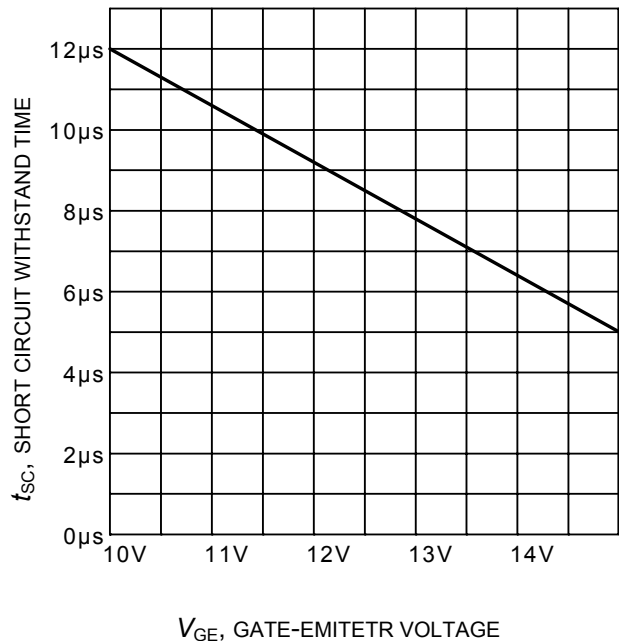


Figure 20. Short circuit withstand time as a function of gate-emitter voltage
($V_{CE}=600\text{V}$, start at $T_J=25^\circ\text{C}$, $T_{Jmax}<150^\circ\text{C}$)

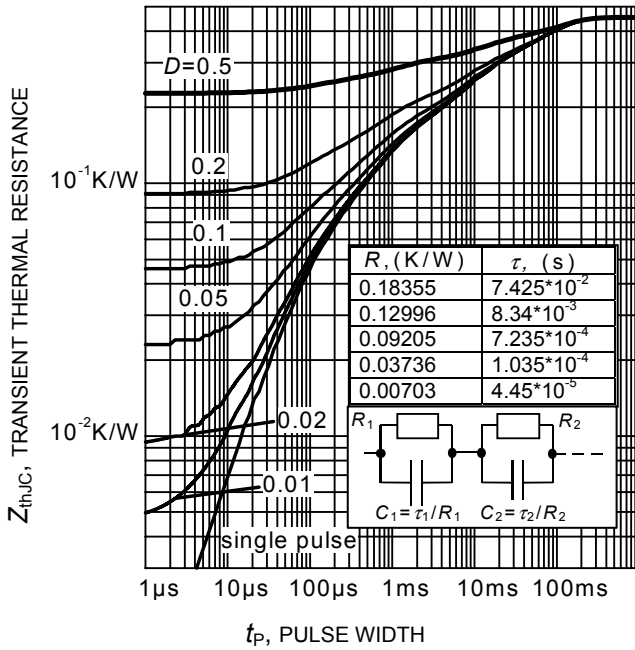


Figure 21. IGBT transient thermal resistance
($D = t_p / T$)

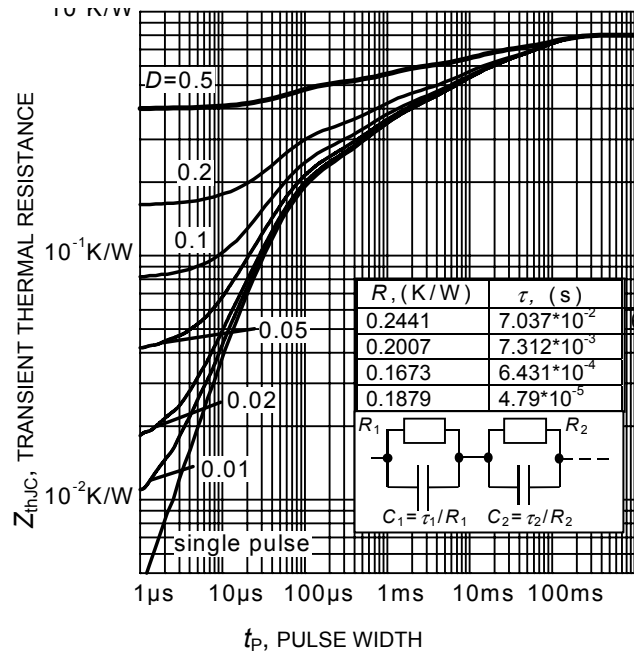


Figure 22. Diode transient thermal impedance as a function of pulse width
($D = t_p / T$)

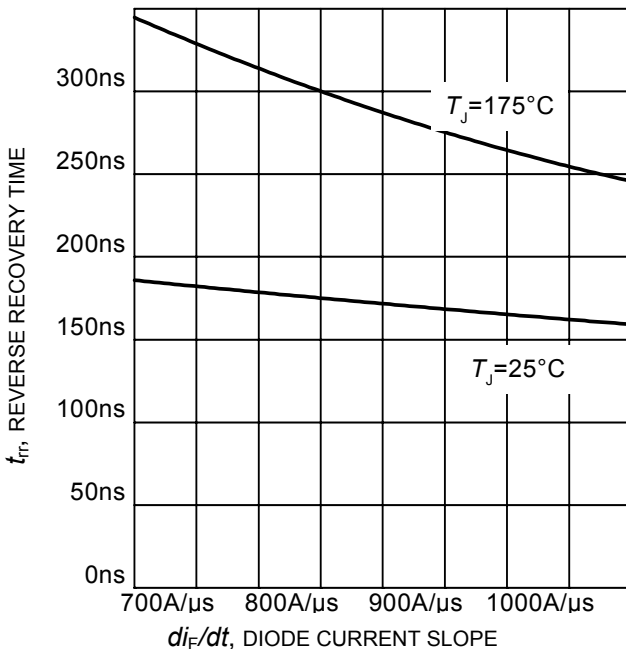


Figure 23. Typical reverse recovery time as a function of diode current slope
($V_R = 400V$, $I_F = 50A$,
Dynamic test circuit in Figure E)

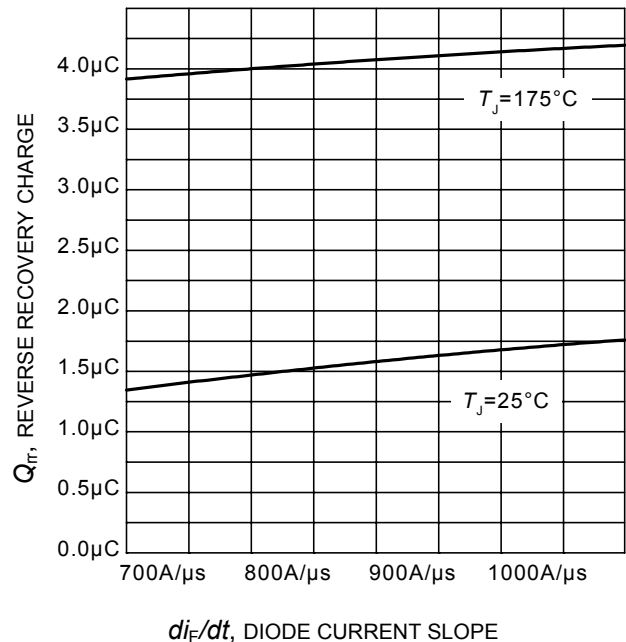
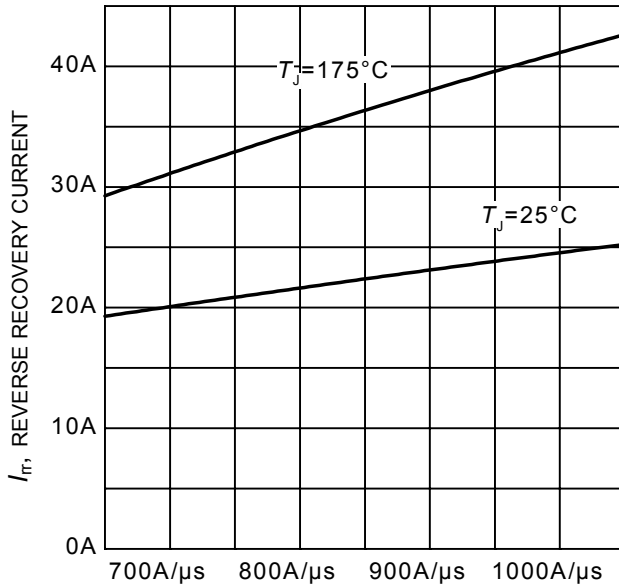


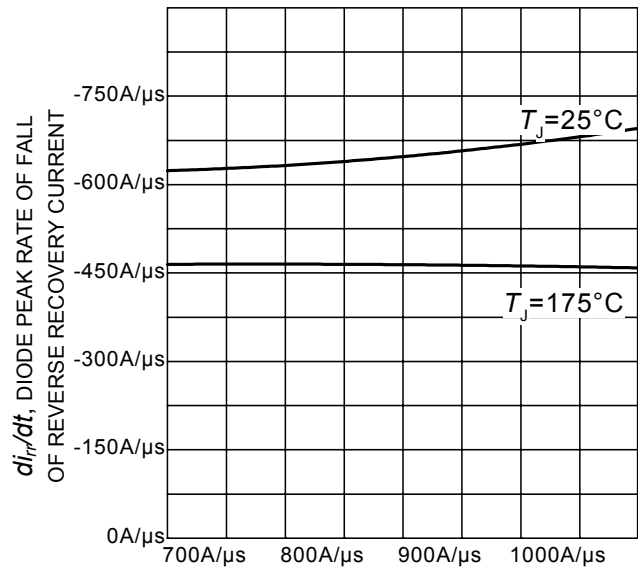
Figure 24. Typical reverse recovery charge as a function of diode current slope
($V_R = 400V$, $I_F = 50A$,
Dynamic test circuit in Figure E)



di_F/dt , DIODE CURRENT SLOPE

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

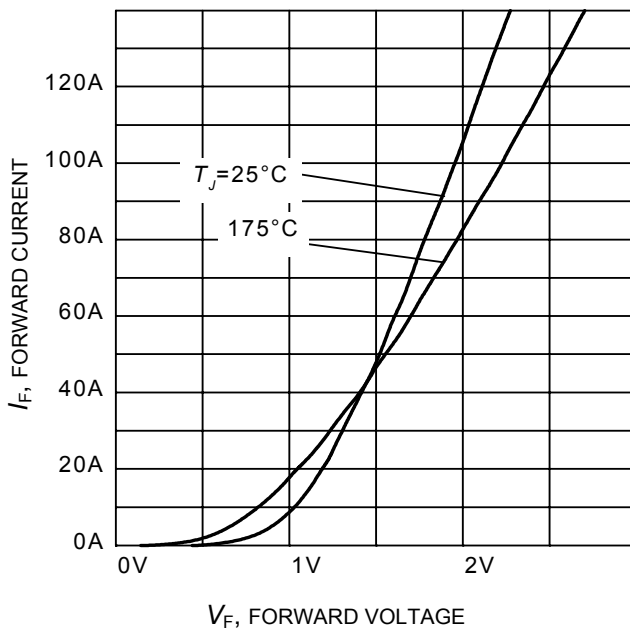
($V_R = 400V$, $I_F = 50A$,
Dynamic test circuit in Figure E)



di_F/dt , DIODE CURRENT SLOPE

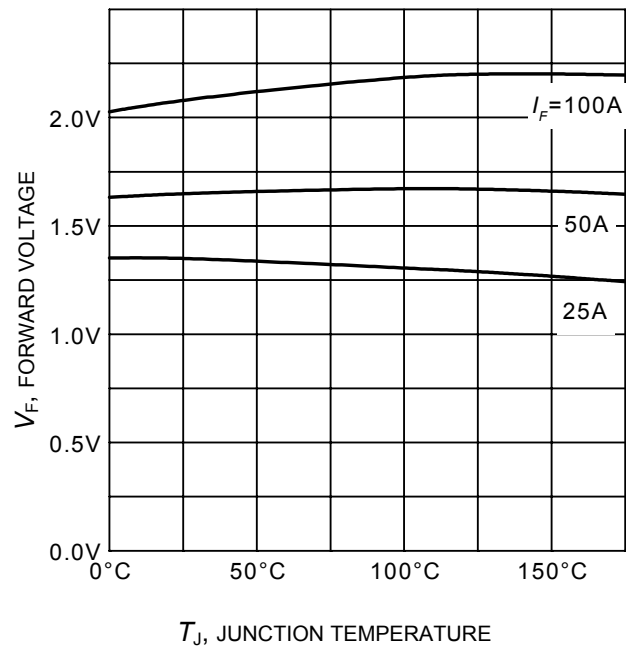
Figure 26. Typical diode peak rate of fall of reverse recovery current as a function of diode current slope

($V_R = 400V$, $I_F = 50A$,
Dynamic test circuit in Figure E)



V_F , FORWARD VOLTAGE

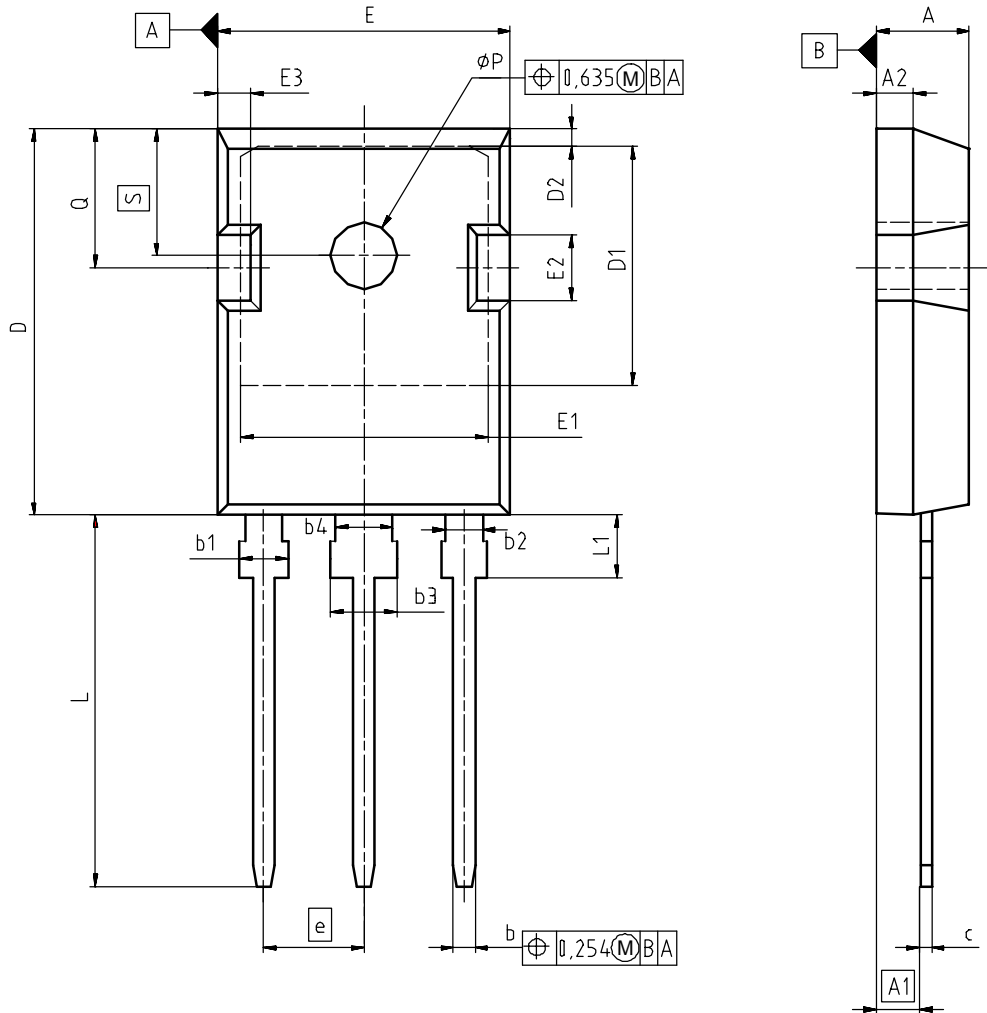
Figure 27. Typical diode forward current as a function of forward voltage



T_J , JUNCTION TEMPERATURE

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

PG-TO247-3



DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.90	5.16	0.193	0.203
A1	2.27	2.53	0.089	0.099
A2	1.85	2.11	0.073	0.083
b	1.07	1.33	0.042	0.052
b1	1.90	2.41	0.075	0.095
b2	1.90	2.16	0.075	0.085
b3	2.87	3.38	0.113	0.133
b4	2.87	3.13	0.113	0.123
c	0.55	0.68	0.022	0.027
D	20.82	21.10	0.820	0.831
D1	16.25	17.65	0.640	0.695
D2	1.05	1.35	0.041	0.053
E	15.70	16.03	0.618	0.631
E1	13.10	14.15	0.516	0.557
E2	3.68	5.10	0.145	0.201
E3	1.68	2.60	0.066	0.102
e	5.44		0.214	
N	3		3	
L	19.80	20.31	0.780	0.799
L1	4.17	4.47	0.164	0.176
$\varnothing P$	3.50	3.70	0.138	0.146
Q	5.49	6.00	0.216	0.236
S	6.04	6.30	0.238	0.248

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SCALE

EUROPEAN PROJECTION

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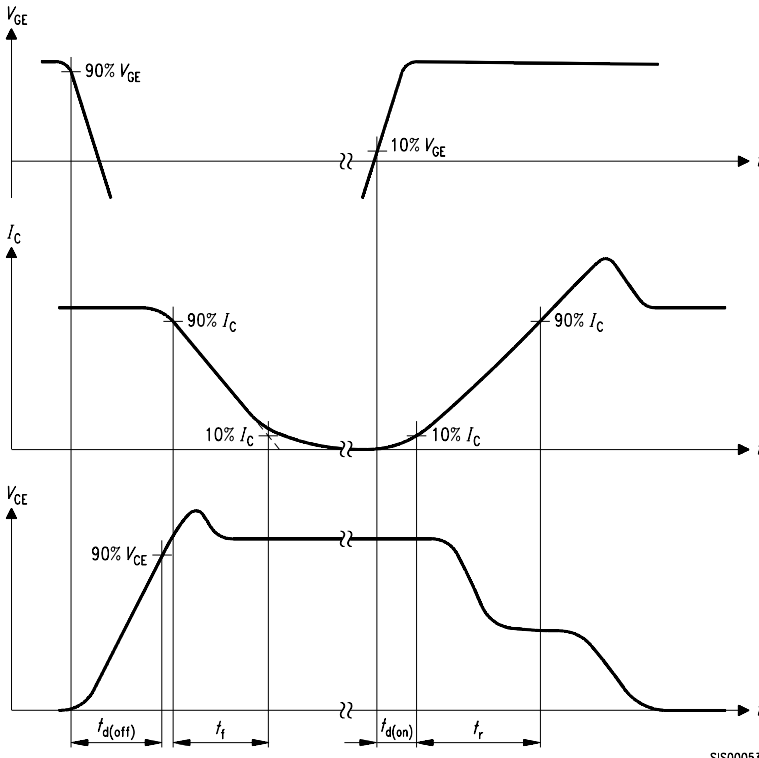


Figure A. Definition of switching times

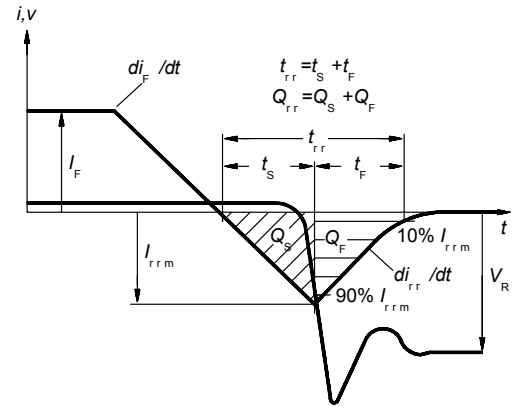


Figure C. Definition of diodes switching characteristics

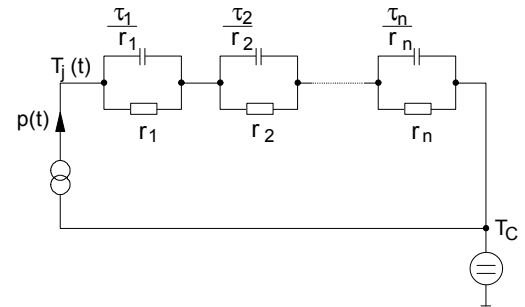


Figure D. Thermal equivalent circuit

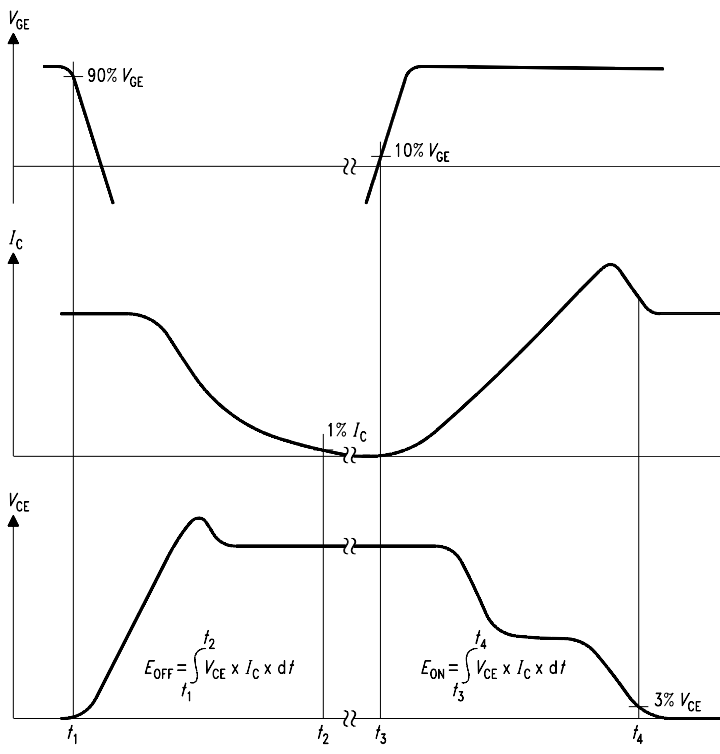


Figure B. Definition of switching losses

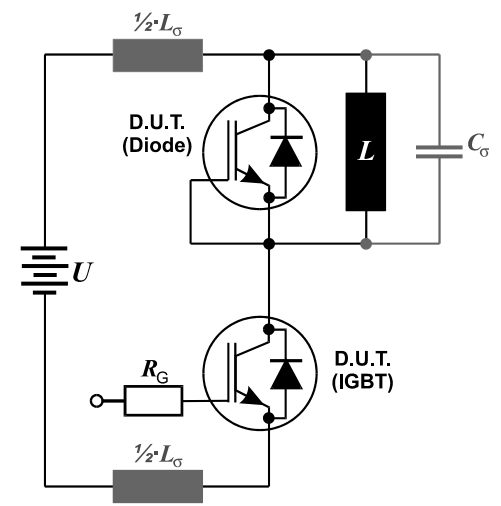


Figure E. Dynamic test circuit

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