

## IGBT

TRENCHSTOP™ Performance technology copacked with RAPID 1  
fast anti-parallel diode

## IKW40N60DTP

600V DuoPack IGBT and diode  
TRENCHSTOP™ Performance series

Data sheet

600V DuoPack IGBT and diode  
TRENCHSTOP™ Performance series

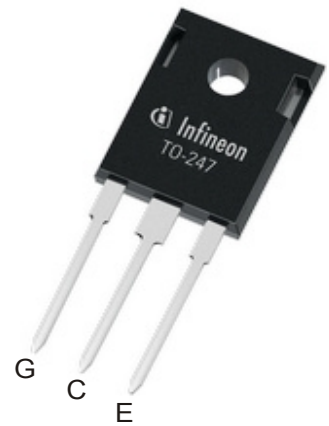
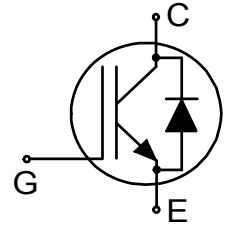
**Features:**

TRENCHSTOP™ technology offering

- very low  $V_{CEsat}$
- low turn-off losses
- short tail current
- low EMI
- Very soft, fast recovery anti-parallel diode
- maximum junction temperature 175°C
- qualified according to JEDEC for target applications
- Pb-free lead plating; RoHS compliant
- complete product spectrum and PSpice Models:  
<http://www.infineon.com/igbt/>

**Applications:**

- drives
- solar inverters
- uninterruptible power supplies
- converters with medium switching frequency



**Key Performance and Package Parameters**

Type	$V_{CE}$	$I_C$	$V_{CEsat}, T_{vj}=25^{\circ}C$	$T_{vjmax}$	Marking	Package
IKW40N60DTP	600V	40A	1.6V	175°C	K40DDTP	PG-TO247-3



**Table of Contents**

Description ..... 2

Table of Contents ..... 3

Maximum Ratings ..... 4

Thermal Resistance ..... 4

Electrical Characteristics ..... 5

Electrical Characteristics Diagrams ..... 7

Package Drawing .....14

Testing Conditions .....15

Revision History .....16

Disclaimer .....16

**Maximum Ratings**

For optimum lifetime and reliability, Infineon recommends operating conditions that do not exceed 80% of the maximum ratings stated in this datasheet.

Parameter	Symbol	Value	Unit
Collector-emitter voltage, $T_{vj} \geq 25^{\circ}\text{C}$	$V_{CE}$	600	V
DC collector current, limited by $T_{vjmax}$ $T_C = 25^{\circ}\text{C}$ $T_C = 100^{\circ}\text{C}$	$I_C$	67.0 48.0	A
Pulsed collector current, $t_p$ limited by $T_{vjmax}^{1)}$	$I_{Cpuls}$	120.0	A
Turn off safe operating area $V_{CE} \leq 600\text{V}$ , $T_{vj} \leq 175^{\circ}\text{C}$ , $t_p = 1\mu\text{s}^{1)}$	-	120.0	A
Diode forward current, limited by $T_{vjmax}$ $T_C = 25^{\circ}\text{C}$ $T_C = 100^{\circ}\text{C}$	$I_F$	58.0 35.0	A
Diode pulsed current, $t_p$ limited by $T_{vjmax}^{1)}$	$I_{Fpuls}$	120.0	A
Gate-emitter voltage	$V_{GE}$	$\pm 20$	V
Short circuit withstand time $V_{GE} = 15.0\text{V}$ , $V_{CC} \leq 400\text{V}$ Allowed number of short circuits < 1000 Time between short circuits: $\geq 1.0\text{s}$ $T_{vj} = 150^{\circ}\text{C}$	$t_{SC}$	5	$\mu\text{s}$
Power dissipation $T_C = 25^{\circ}\text{C}$ Power dissipation $T_C = 100^{\circ}\text{C}$	$P_{tot}$	246.0 123.0	W
Operating junction temperature	$T_{vj}$	-40...+175	$^{\circ}\text{C}$
Storage temperature	$T_{stg}$	-55...+150	$^{\circ}\text{C}$
Soldering temperature, wave soldering 1.6mm (0.063in.) from case for 10s		260	$^{\circ}\text{C}$
Mounting torque, M3 screw Maximum of mounting processes: 3	$M$	0.6	Nm

**Thermal Resistance**

Parameter	Symbol	Conditions	Value			Unit
			min.	typ.	max.	

**R<sub>th</sub> Characteristics**

IGBT thermal resistance, junction - case	$R_{th(j-c)}$		-	0.41	0.61	K/W
Diode thermal resistance, junction - case	$R_{th(j-c)}$		-	0.83	1.29	K/W

<sup>1)</sup> Defined by design. Not subject to production test.

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

Parameter	Symbol	Conditions	Value			Unit
			min.	typ.	max.	
<b>Static Characteristic</b>						
Collector-emitter breakdown voltage	$V_{(BR)CES}$	$V_{GE} = 0\text{V}, I_C = 2.00\text{mA}$	600	-	-	V
Collector-emitter saturation voltage	$V_{CESat}$	$V_{GE} = 15.0\text{V}, I_C = 40.0\text{A}$ $T_{vj} = 25^{\circ}\text{C}$ $T_{vj} = 175^{\circ}\text{C}$	- -	1.60 1.94	1.80 -	V
Diode forward voltage	$V_F$	$V_{GE} = 0\text{V}, I_F = 20.0\text{A}$ $T_{vj} = 25^{\circ}\text{C}$ $T_{vj} = 175^{\circ}\text{C}$	- -	1.45 1.39	1.70 -	V
Gate-emitter threshold voltage	$V_{GE(th)}$	$I_C = 0.64\text{mA}, V_{CE} = V_{GE}$	4.1	5.1	5.7	V
Zero gate voltage collector current	$I_{CES}$	$V_{CE} = 600\text{V}, V_{GE} = 0\text{V}$ $T_{vj} = 25^{\circ}\text{C}$ $T_{vj} = 175^{\circ}\text{C}$	- -	- -	40 -	$\mu\text{A}$
Gate-emitter leakage current	$I_{GES}$	$V_{CE} = 0\text{V}, V_{GE} = 20\text{V}$	-	-	100	nA
Transconductance	$g_{fs}$	$V_{CE} = 20\text{V}, I_C = 40.0\text{A}$	-	40.0	-	S

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

Parameter	Symbol	Conditions	Value			Unit
			min.	typ.	max.	
<b>Dynamic Characteristic</b>						
Input capacitance	$C_{ies}$	$V_{CE} = 25\text{V}, V_{GE} = 0\text{V}, f = 1\text{MHz}$	-	1400	-	pF
Output capacitance	$C_{oes}$		-	76	-	
Reverse transfer capacitance	$C_{res}$		-	48	-	
Gate charge	$Q_G$	$V_{CC} = 480\text{V}, I_C = 40.0\text{A},$ $V_{GE} = 15\text{V}$	-	177.0	-	nC
Internal emitter inductance measured 5mm (0.197 in.) from case	$L_E$		-	13.0	-	nH
Short circuit collector current Max. 1000 short circuits Time between short circuits: $\geq 1.0\text{s}$	$I_{C(SC)}$	$V_{GE} = 15.0\text{V}, V_{CC} \leq 400\text{V},$ $t_{SC} \leq 5\mu\text{s}$ $T_{vj} = 150^{\circ}\text{C}$	-	183	-	A

**Switching Characteristic, Inductive Load**

Parameter	Symbol	Conditions	Value			Unit
			min.	typ.	max.	

**IGBT Characteristic, at  $T_{vj} = 25^{\circ}\text{C}$** 

Turn-on delay time	$t_{d(on)}$	$T_{vj} = 25^{\circ}\text{C},$ $V_{CC} = 400\text{V}, I_C = 40.0\text{A},$ $V_{GE} = 0.0/15.0\text{V},$ $R_{G(on)} = 10.1\Omega, R_{G(off)} = 10.1\Omega,$ $L_{\sigma} = 32\text{nH}, C_{\sigma} = 60\text{pF}$ $L_{\sigma}, C_{\sigma}$ from Fig. E Energy losses include "tail" and diode reverse recovery.	-	18	-	ns
Rise time	$t_r$		-	30	-	ns
Turn-off delay time	$t_{d(off)}$		-	222	-	ns
Fall time	$t_f$		-	18	-	ns
Turn-on energy	$E_{on}$		-	1.06	-	mJ
Turn-off energy	$E_{off}$		-	0.61	-	mJ
Total switching energy	$E_{ts}$	-	1.67	-	mJ	

Diode reverse recovery time	$t_{rr}$	$T_{vj} = 25^{\circ}\text{C}$ , $V_R = 400\text{V}$ , $I_F = 20.0\text{A}$ , $di_F/dt = 1175\text{A}/\mu\text{s}$	-	87	-	ns
Diode reverse recovery charge	$Q_{rr}$		-	0.56	-	$\mu\text{C}$
Diode peak reverse recovery current	$I_{rrm}$		-	11.5	-	A
Diode peak rate of fall of reverse recovery current during $t_b$	$di_{rr}/dt$		-	144	-	$\text{A}/\mu\text{s}$

**Switching Characteristic, Inductive Load**

Parameter	Symbol	Conditions	Value			Unit
			min.	typ.	max.	

**IGBT Characteristic, at  $T_{vj} = 175^{\circ}\text{C}$** 

Turn-on delay time	$t_{d(on)}$	$T_{vj} = 175^{\circ}\text{C}$ , $V_{CC} = 400\text{V}$ , $I_C = 40.0\text{A}$ , $V_{GE} = 0.0/15.0\text{V}$ , $R_{G(on)} = 10.1\Omega$ , $R_{G(off)} = 10.1\Omega$ , $L\sigma = 32\text{nH}$ , $C\sigma = 60\text{pF}$ $L\sigma$ , $C\sigma$ from Fig. E Energy losses include "tail" and diode reverse recovery.	-	19	-	ns
Rise time	$t_r$		-	30	-	ns
Turn-off delay time	$t_{d(off)}$		-	273	-	ns
Fall time	$t_f$		-	47	-	ns
Turn-on energy	$E_{on}$		-	1.63	-	mJ
Turn-off energy	$E_{off}$		-	1.05	-	mJ
Total switching energy	$E_{ts}$		-	2.68	-	mJ

Diode reverse recovery time	$t_{rr}$	$T_{vj} = 175^{\circ}\text{C}$ , $V_R = 400\text{V}$ , $I_F = 20.0\text{A}$ , $di_F/dt = 1175\text{A}/\mu\text{s}$	-	144	-	ns
Diode reverse recovery charge	$Q_{rr}$		-	1.52	-	$\mu\text{C}$
Diode peak reverse recovery current	$I_{rrm}$		-	18.3	-	A
Diode peak rate of fall of reverse recovery current during $t_b$	$di_{rr}/dt$		-	142	-	$\text{A}/\mu\text{s}$

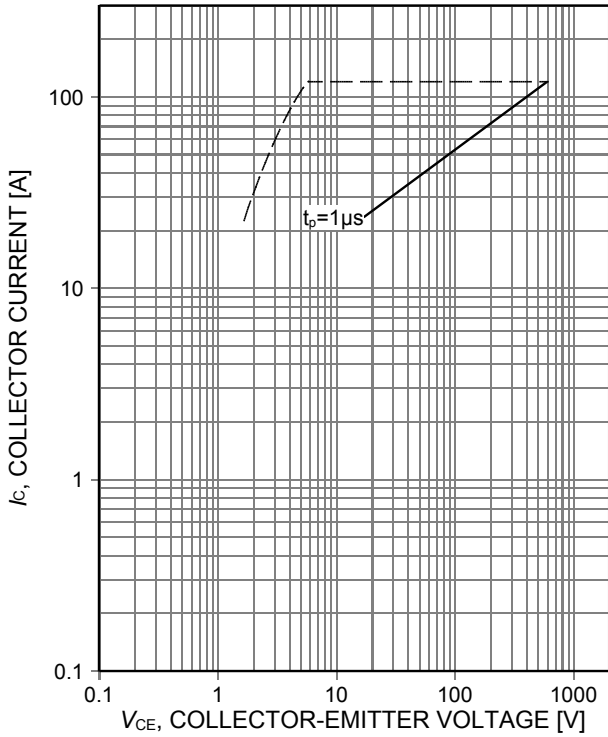


Figure 1. **Forward bias safe operating area**  
( $D=0$ ,  $T_C=25^\circ\text{C}$ ,  $T_J\leq 175^\circ\text{C}$ ;  $V_{GE}=15\text{V}$ )

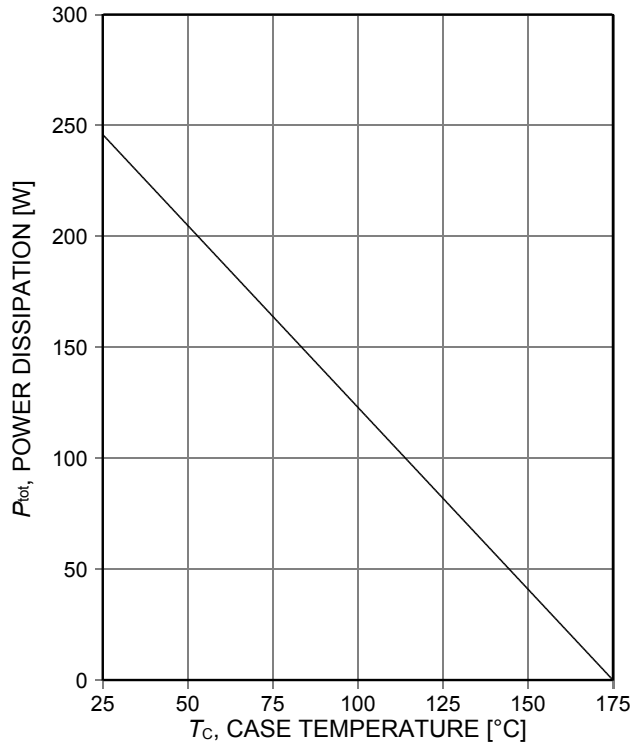


Figure 2. **Power dissipation as a function of case temperature**  
( $T_J\leq 175^\circ\text{C}$ )

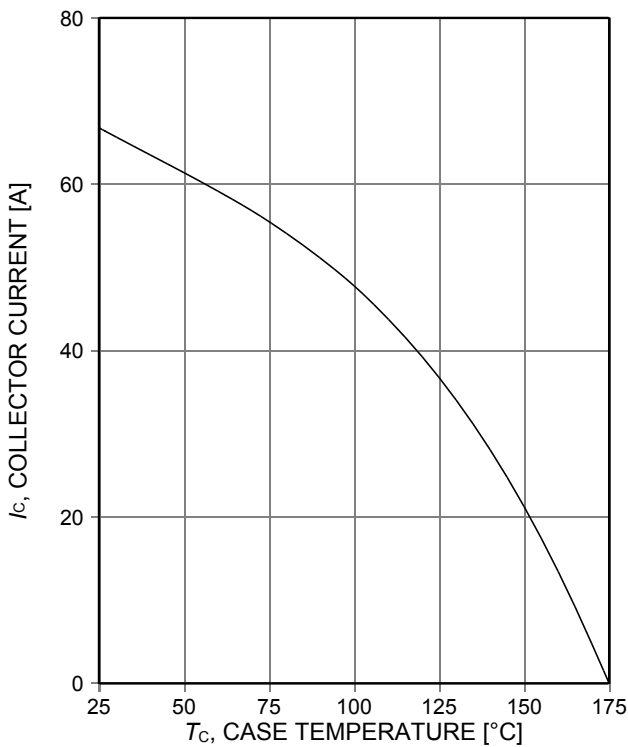


Figure 3. **Collector current as a function of case temperature**  
( $V_{GE}\geq 15\text{V}$ ,  $T_J\leq 175^\circ\text{C}$ )

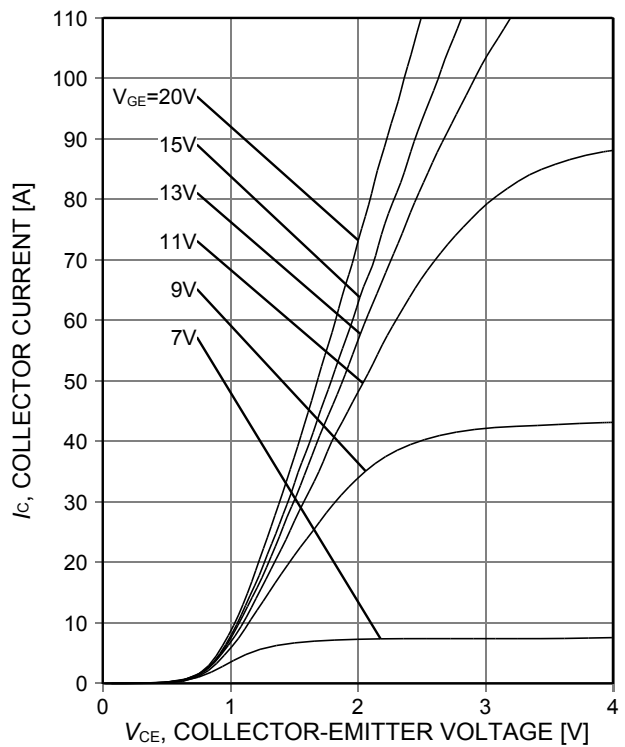


Figure 4. **Typical output characteristic**  
( $T_J=25^\circ\text{C}$ )

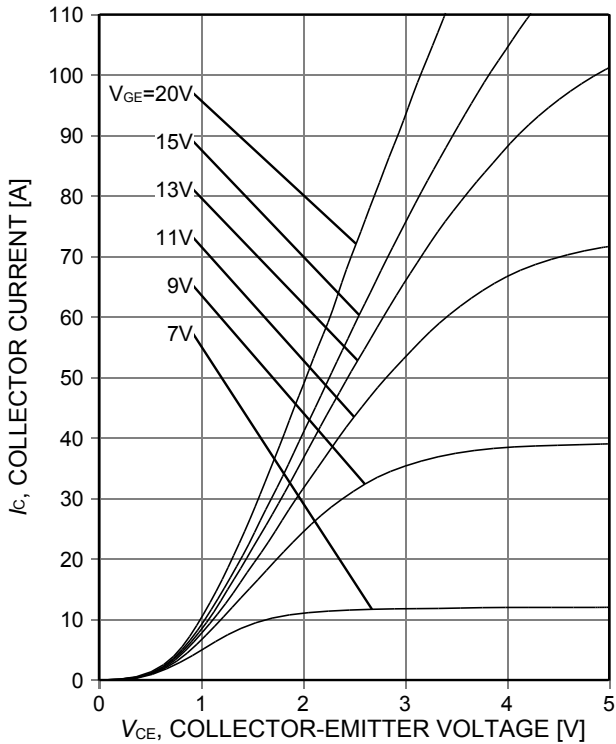


Figure 5. **Typical output characteristic**  
( $T_j=175^\circ\text{C}$ )

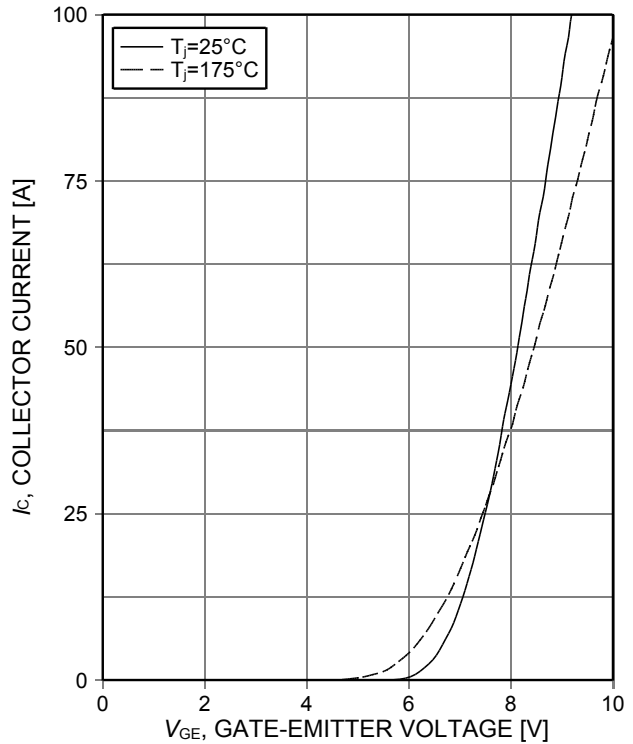


Figure 6. **Typical transfer characteristic**  
( $V_{CE}=20\text{V}$ )

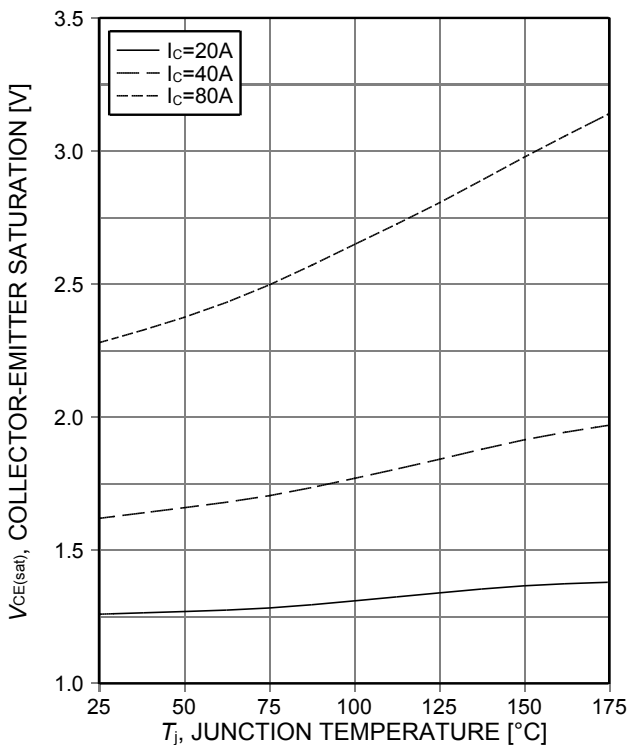


Figure 7. **Typical collector-emitter saturation voltage as a function of junction temperature**  
( $V_{GE}=15\text{V}$ )

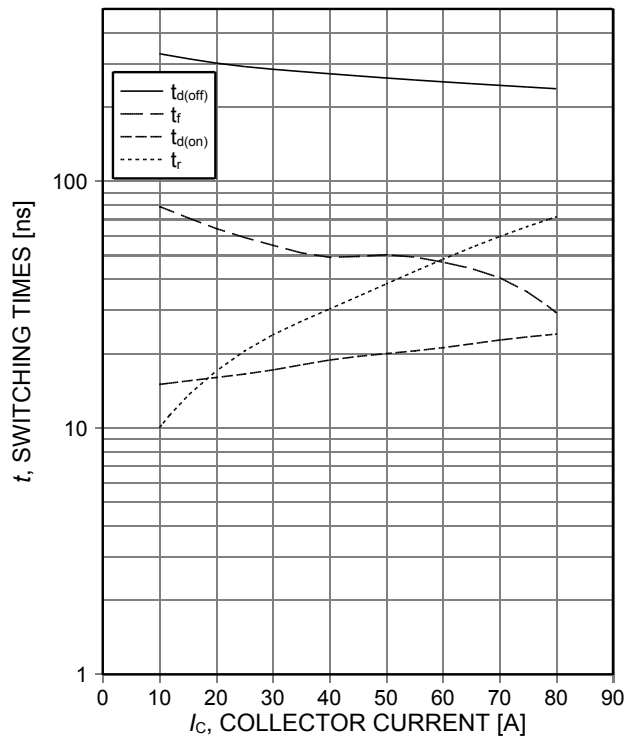


Figure 8. **Typical switching times as a function of collector current**  
(ind. load,  $T_j=175^\circ\text{C}$ ,  $V_{CE}=400\text{V}$ ,  $V_{GE}=15/0\text{V}$ ,  $r_G=10,1\Omega$ , test circuit in Fig. E)



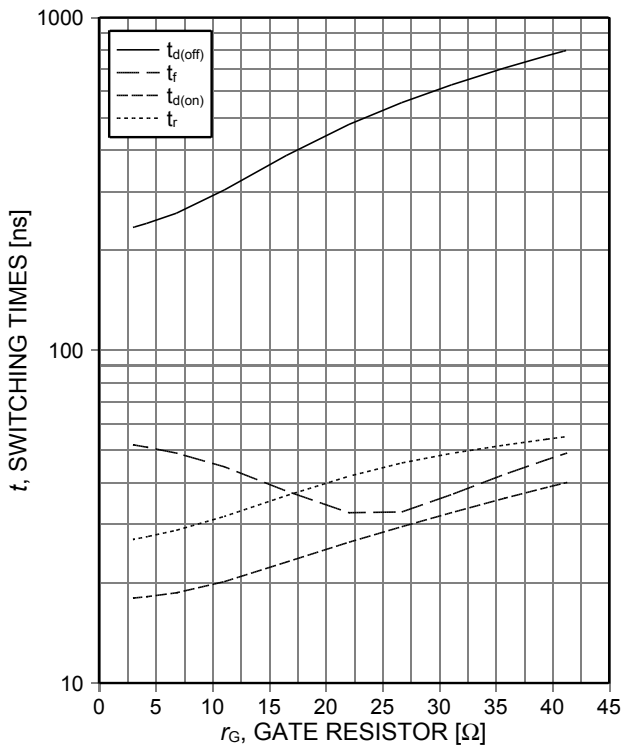


Figure 9. **Typical switching times as a function of gate resistor**  
(ind. load,  $T_j=175^\circ\text{C}$ ,  $V_{CE}=400\text{V}$ ,  $V_{GE}=15/0\text{V}$ ,  $I_C=40\text{A}$ , test circuit in Fig. E)

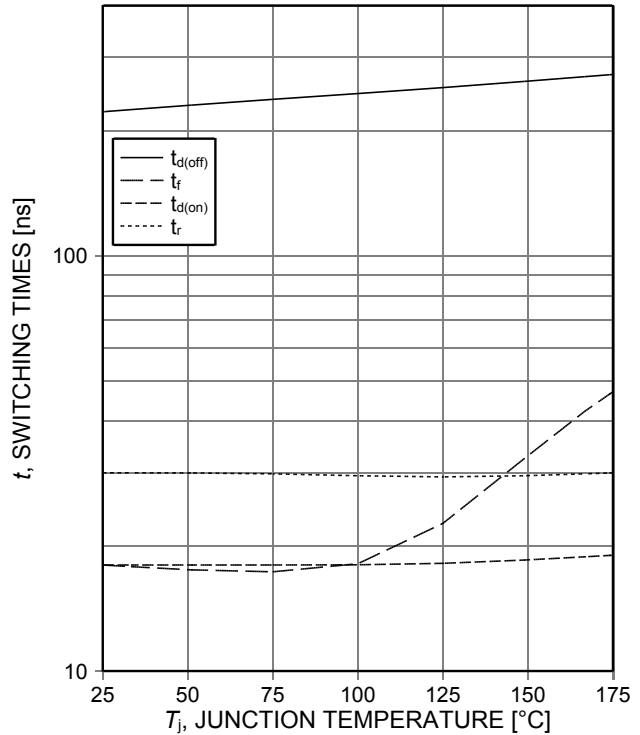


Figure 10. **Typical switching times as a function of junction temperature**  
(ind. load,  $V_{CE}=400\text{V}$ ,  $V_{GE}=15/0\text{V}$ ,  $I_C=40\text{A}$ ,  $r_G=10,1\Omega$ , test circuit in Fig. E)

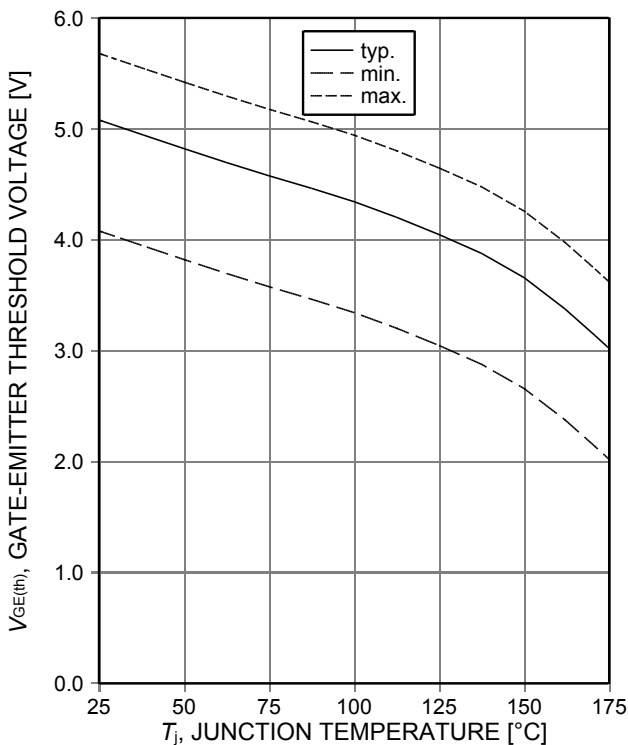


Figure 11. **Gate-emitter threshold voltage as a function of junction temperature**  
( $I_C=0,64\text{mA}$ )

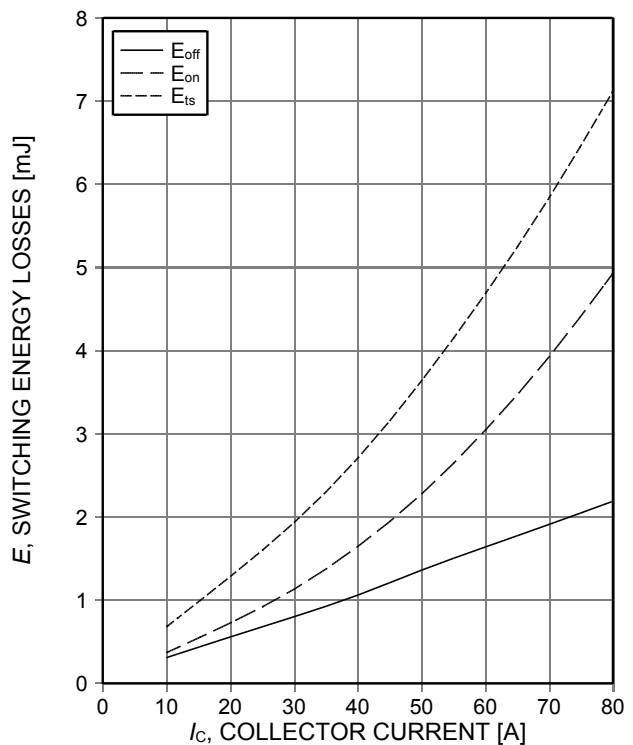


Figure 12. **Typical switching energy losses as a function of collector current**  
(ind. load,  $T_j=175^\circ\text{C}$ ,  $V_{CE}=400\text{V}$ ,  $V_{GE}=15/0\text{V}$ ,  $r_G=10,1\Omega$ , test circuit in Fig. E)

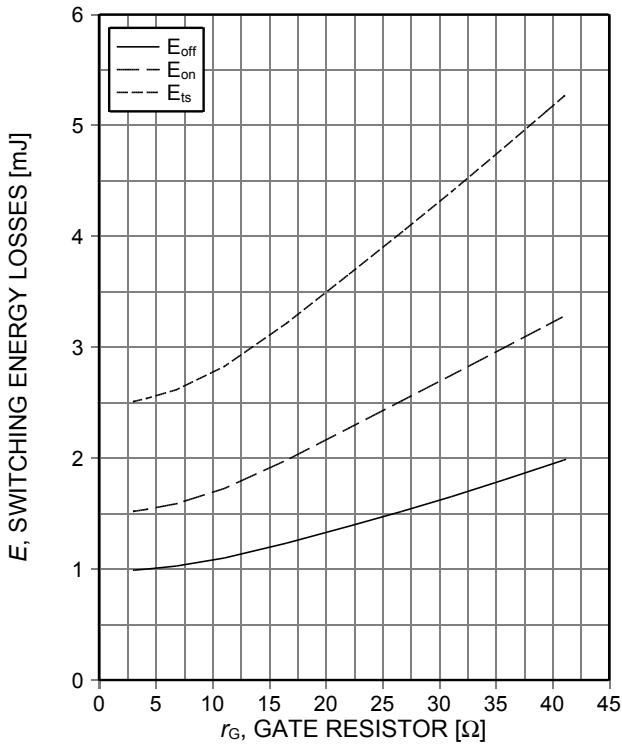


Figure 13. **Typical switching energy losses as a function of gate resistor**  
 (ind. load,  $T_j=175^\circ\text{C}$ ,  $V_{CE}=400\text{V}$ ,  $V_{GE}=15/0\text{V}$ ,  $I_C=40\text{A}$ , test circuit in Fig. E)

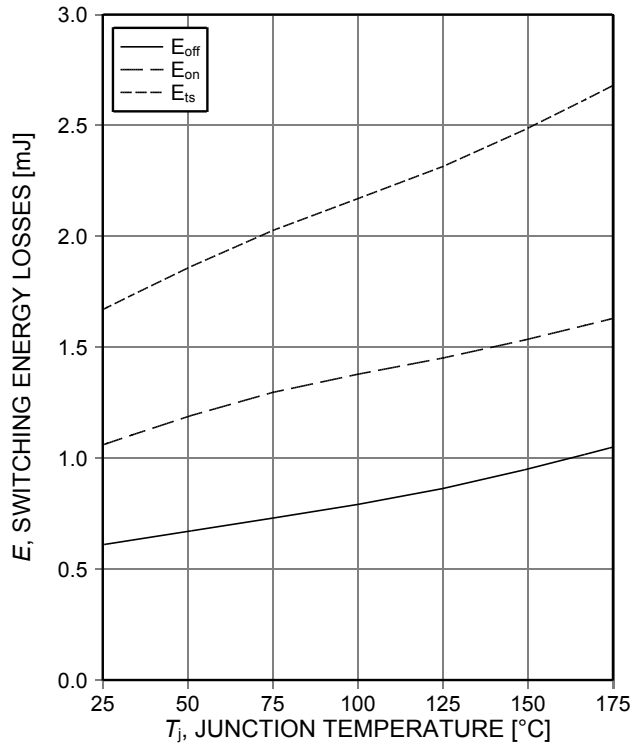


Figure 14. **Typical switching energy losses as a function of junction temperature**  
 (ind load,  $V_{CE}=400\text{V}$ ,  $V_{GE}=15/0\text{V}$ ,  $I_C=40\text{A}$ ,  $r_G=10,1\Omega$ , test circuit in Fig. E)

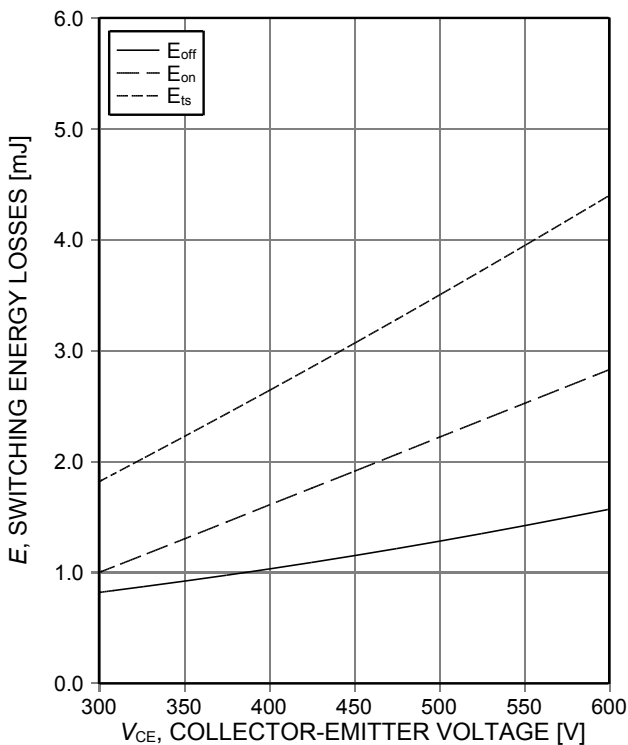


Figure 15. **Typical switching energy losses as a function of collector emitter voltage**  
 (ind. load,  $T_j=175^\circ\text{C}$ ,  $V_{GE}=15/0\text{V}$ ,  $I_C=40\text{A}$ ,  $r_G=10,1\Omega$ , test circuit in Fig. E)

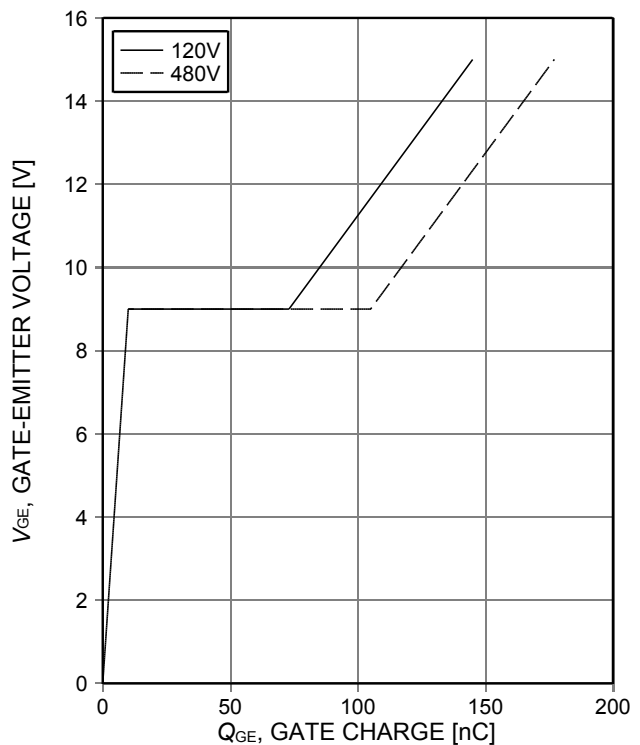


Figure 16. **Typical gate charge**  
 ( $I_C=40\text{A}$ )

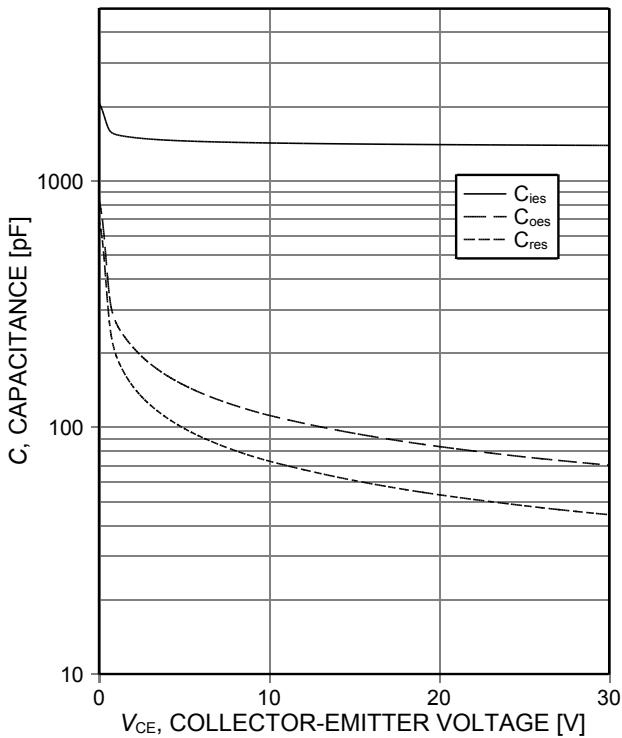


Figure 17. Typical capacitance as a function of collector-emitter voltage ( $V_{GE}=0V$ ,  $f=1MHz$ )

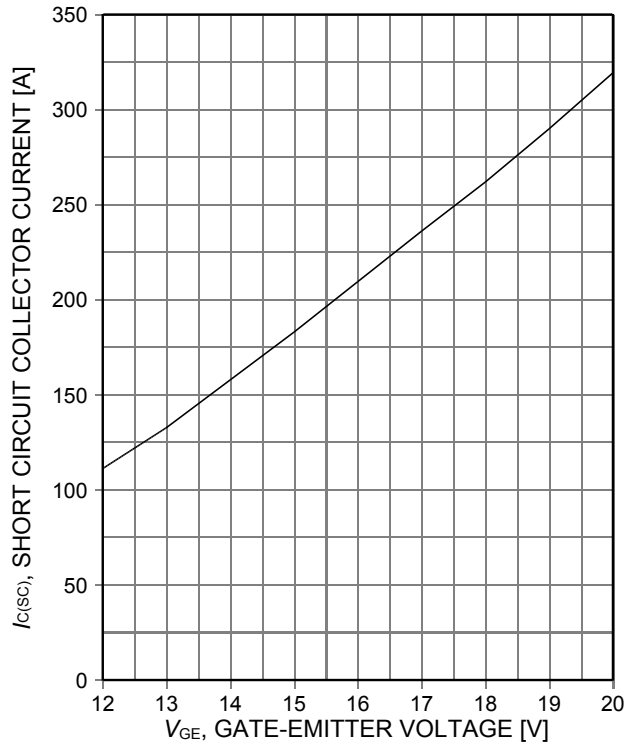


Figure 18. Typical short circuit collector current as a function of gate-emitter voltage ( $V_{CE}\leq 400V$ , start at  $T_J=25^\circ C$ )



Figure 19. Short circuit withstand time as a function of gate-emitter voltage ( $V_{CE}\leq 400V$ , start at  $T_J\leq 150^\circ C$ )

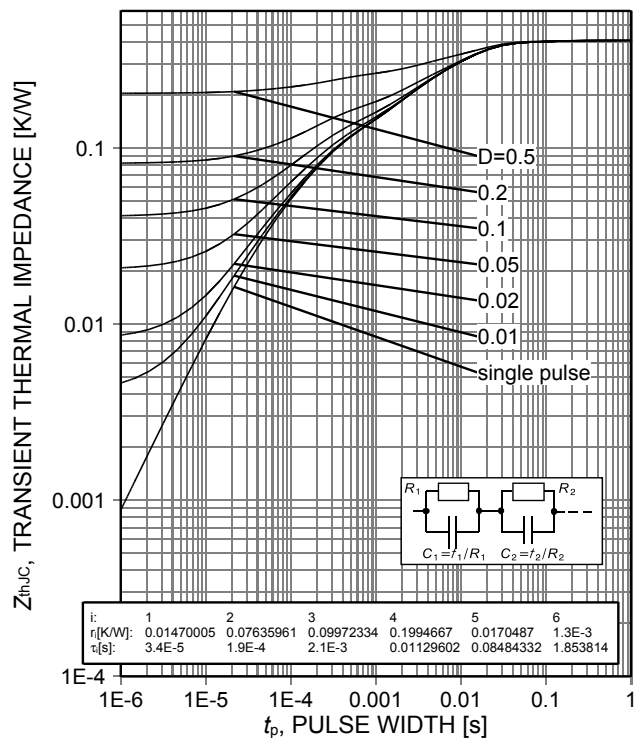


Figure 20. Typical IGBT transient thermal impedance ( $D=t_p/T$ )

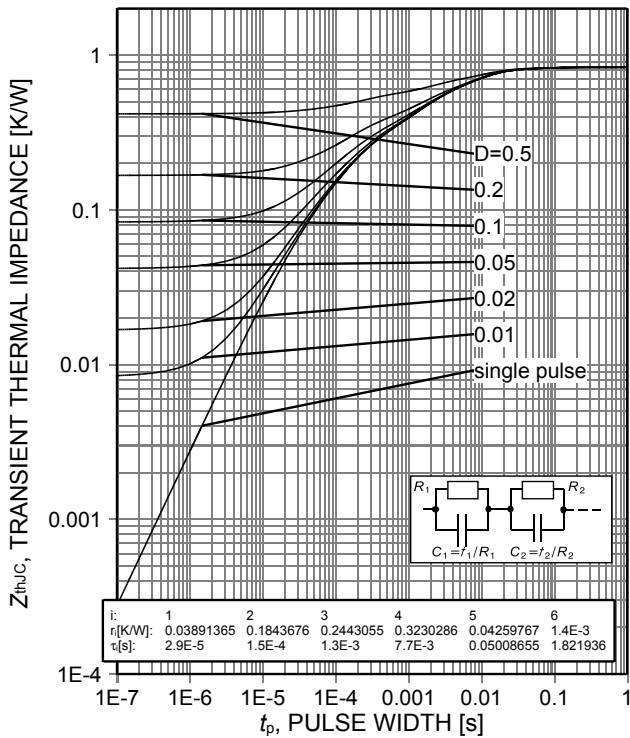


Figure 21. Typical diode transient thermal impedance as a function of pulse width ( $D=t_p/T$ )

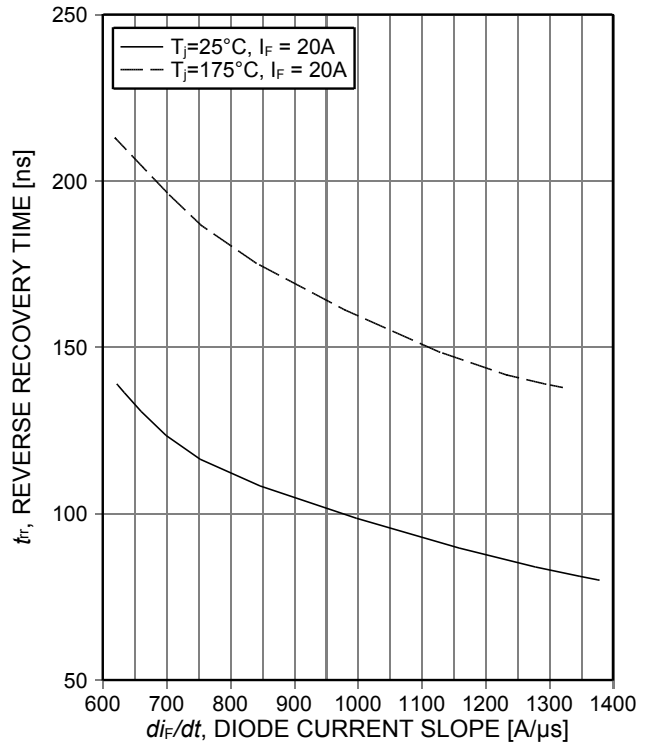


Figure 22. Typical reverse recovery time as a function of diode current slope ( $V_R=400V$ )

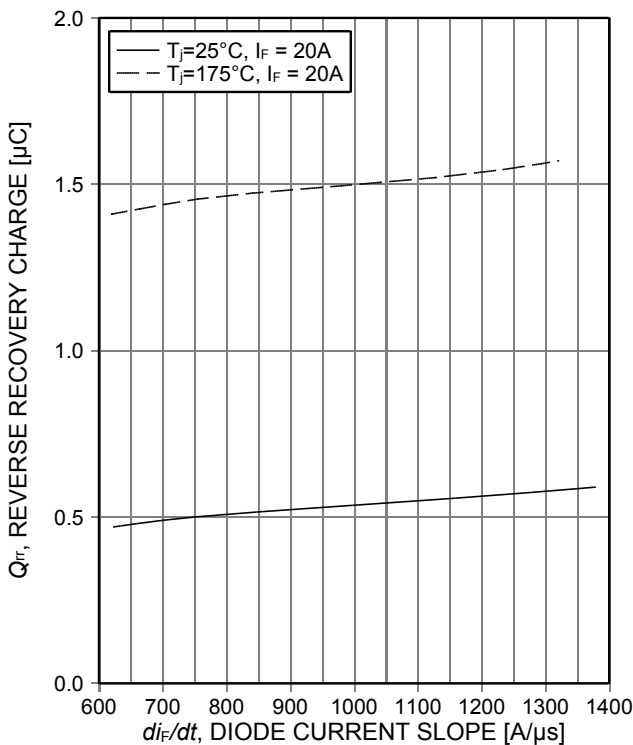


Figure 23. Typical reverse recovery charge as a function of diode current slope ( $V_R=400V$ )

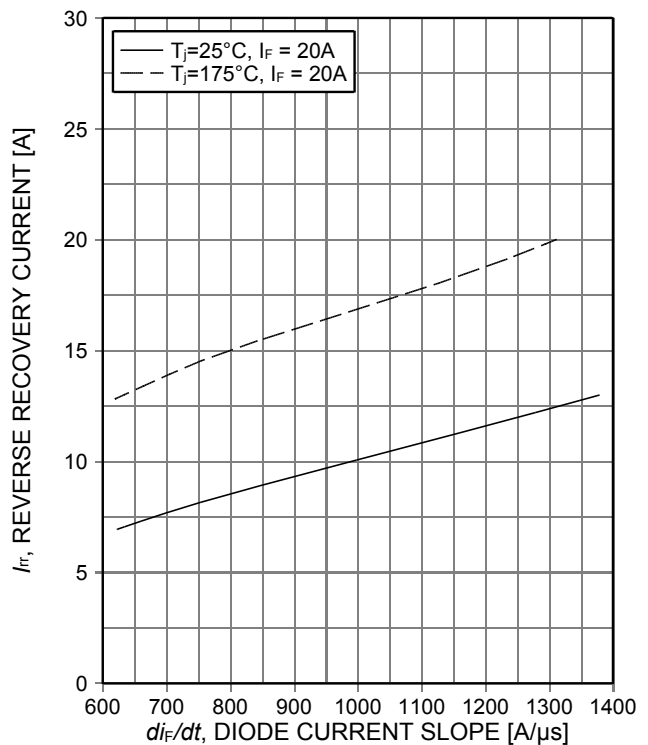


Figure 24. Typical reverse recovery current as a function of diode current slope ( $V_R=400V$ )

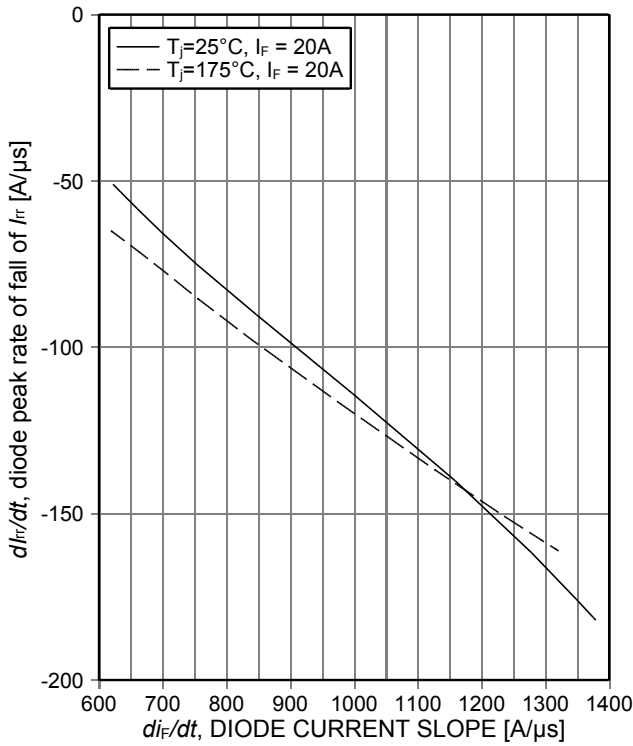


Figure 25. Typical diode peak rate of fall of reverse recovery current as a function of diode current slope ( $V_R=400V$ )

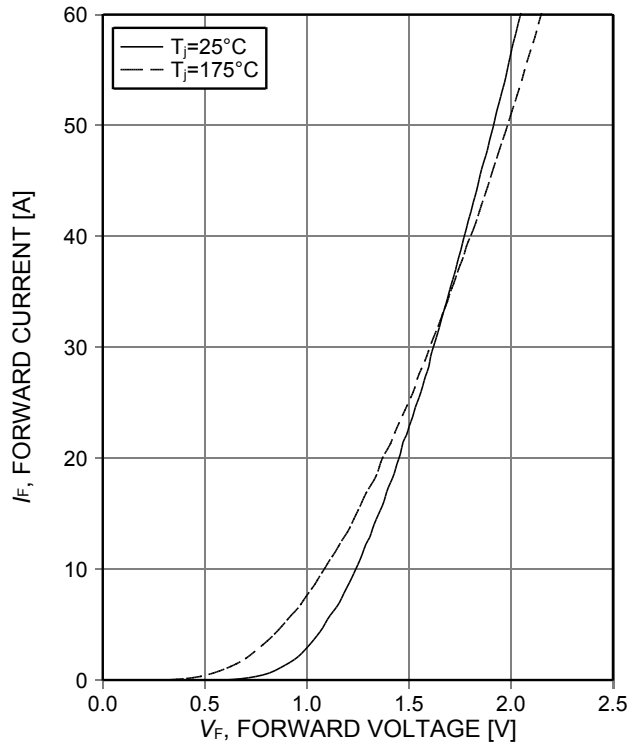


Figure 26. Typical diode forward current as a function of forward voltage

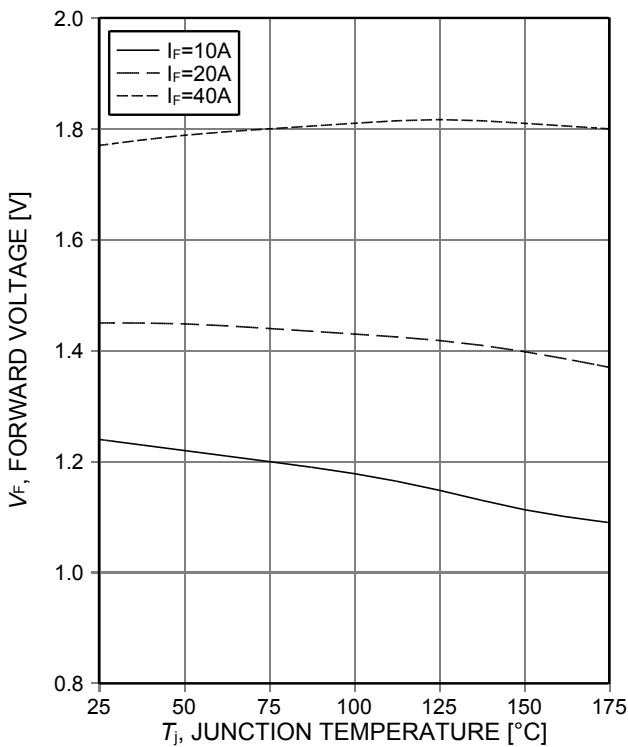


Figure 27. Typical diode forward voltage as a function of junction temperature

Package Drawing PG-TO247-3



DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.83	5.21	0.190	0.205
A1	2.27	2.54	0.089	0.100
A2	1.85	2.16	0.073	0.085
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	20.80	21.10	0.819	0.831
D1	16.25	17.65	0.640	0.695
D2	0.95	1.35	0.037	0.053
E	15.70	16.13	0.618	0.635
E1	13.10	14.15	0.516	0.557
E2	3.68	5.10	0.145	0.201
E3	1.00	2.60	0.039	0.102
e	5.44 (BSC)		0.214 (BSC)	
N	3		3	
L	19.80	20.32	0.780	0.800
L1	4.10	4.47	0.161	0.176
øP	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

DOCUMENT NO.  
Z8B00003327

SCALE  
0 5 5 7.5mm

EUROPEAN PROJECTION

ISSUE DATE  
09-07-2010

REVISION  
05

Testing Conditions

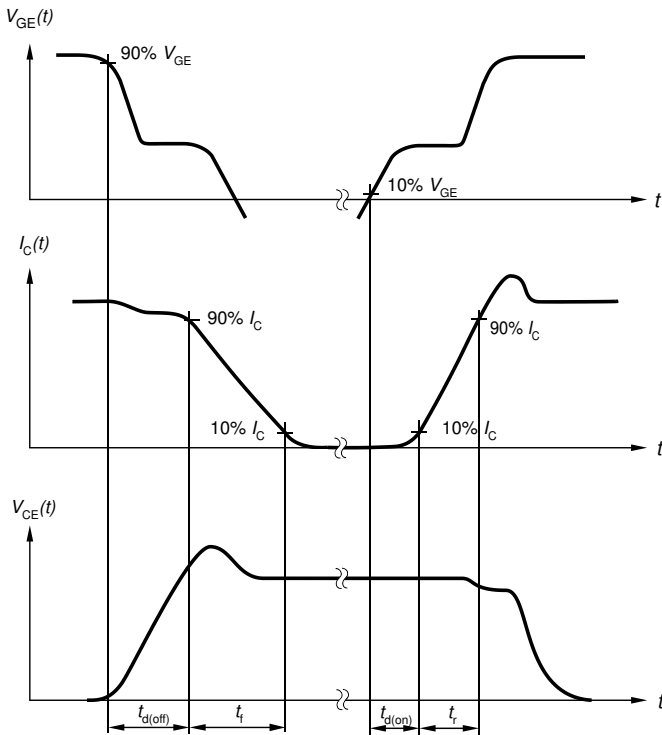


Figure A. Definition of switching times

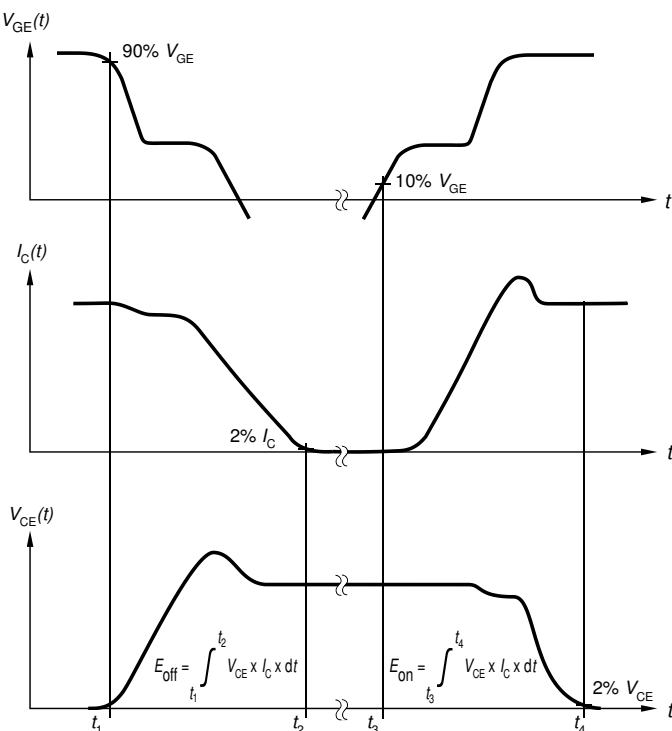


Figure B. Definition of switching losses

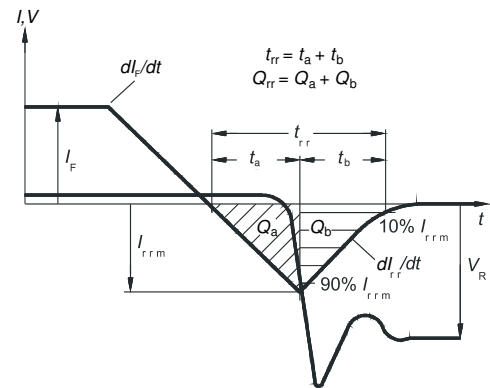


Figure C. Definition of diode switching characteristics



Figure D. Thermal equivalent circuit



Figure E. Dynamic test circuit  
Parasitic inductance  $L_\sigma$ ,  
parasitic capacitor  $C_\sigma$ ,  
relief capacitor  $C_r$ ,  
(only for ZVT switching)