

## IGBT

Low Loss DuoPack : IGBT in TRENCHSTOP™ and Fieldstop technology with soft, fast recovery antiparallel Emitter Controlled diode

## IKQ120N60TA

600V low loss switching series third generation

Data sheet

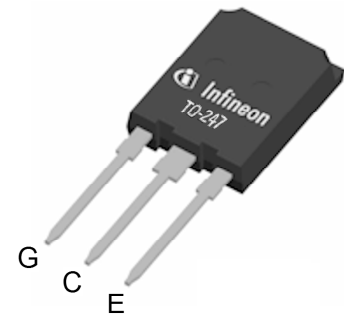
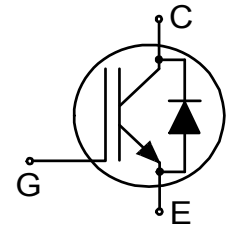
Low Loss DuoPack : IGBT in TRENCHSTOP™ and Fieldstop technology with soft, fast recovery antiparallel Emitter Controlled diode

**Features:**

- Automotive AEC-Q101 qualified
- Designed for DC/AC converters for Automotive Application
- Very low  $V_{CE(sat)}$  1.5 V (typ.)
- Maximum junction temperature 175°C
- Short circuit withstand time 5μs
- 100% short circuit tested
- 100% of the parts are dynamically tested
- TRENCHSTOP™ and Fieldstop technology for 600V

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  $Q_G$
- Green package
- Very soft, fast recovery antiparallel Emitter Controlled HE diode



**Applications:**

- Main inverter
- Air-Con compressor
- PTC heater
- Motor drives



**Key Performance and Package Parameters**

Type	$V_{CE}$	$I_C$	$V_{CEsat}, T_{vj}=25^{\circ}C$	$T_{vjmax}$	Marking	Package
IKQ120N60TA	600V	120A	1.5V	175°C	K120T60A	PG-TO247-3



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**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 $T_{vjmax}$ $T_C = 25^{\circ}\text{C}$ value limited by bondwire $T_C = 135^{\circ}\text{C}$	$I_C$	160.0 120.0	A
Pulsed collector current, $t_p$ limited by $T_{vjmax}$	$I_{Cpuls}$	480.0	A
Turn off safe operating area $V_{CE} \leq 600\text{V}$ , $T_{vj} \leq 175^{\circ}\text{C}$ , $t_p = 1\mu\text{s}$	-	480.0	A
Diode forward current, limited by $T_{vjmax}$ $T_C = 25^{\circ}\text{C}$ value limited by bondwire $T_C = 124^{\circ}\text{C}$	$I_F$	160.0 120.0	A
Diode pulsed current, $t_p$ limited by $T_{vjmax}$	$I_{Fpuls}$	480.0	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 $T_C = 25^{\circ}\text{C}$	$P_{tot}$	833.0	W
Operating junction temperature	$T_{vj}$	-40...+175	$^{\circ}\text{C}$
Storage temperature	$T_{stg}$	-55...+150	$^{\circ}\text{C}$
Soldering temperature, <sup>1)</sup> 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	Max. Value	Unit
<b>Characteristic</b>				
IGBT thermal resistance, <sup>2)</sup> junction - case	$R_{th(j-c)}$		0.18	K/W
Diode thermal resistance, <sup>2)</sup> junction - case	$R_{th(j-c)}$		0.30	K/W
Thermal resistance junction - ambient	$R_{th(j-a)}$		40	K/W

<sup>1)</sup> Package not recommended for surface mount application

<sup>2)</sup> Thermal resistance of thermal grease  $R_{th(c-s)}$  (case to heat sink) of more than 0.1K/W not included.

**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	$V_{(BR)CES}$	$V_{GE} = 0\text{V}, I_C = 0.20\text{mA}$	600	-	-	V
Collector-emitter saturation voltage	$V_{CESat}$	$V_{GE} = 15.0\text{V}, I_C = 120.0\text{A}$ $T_{vj} = 25^{\circ}\text{C}$ $T_{vj} = 175^{\circ}\text{C}$	- -	1.50 1.90	2.00 -	V
Diode forward voltage	$V_F$	$V_{GE} = 0\text{V}, I_F = 120.0\text{A}$ $T_{vj} = 25^{\circ}\text{C}$ $T_{vj} = 175^{\circ}\text{C}$	- -	1.65 1.60	2.05 -	V
Gate-emitter threshold voltage	$V_{GE(th)}$	$I_C = 1.90\text{mA}, V_{CE} = V_{GE}$	4.1	4.9	5.7	V
Zero gate voltage collector current	$I_{CES}$	$V_{CE} = 600\text{V}, V_{GE} = 0\text{V}$ $T_{vj} = 25^{\circ}\text{C}$ $T_{vj} = 175^{\circ}\text{C}$	- -	- 3000.0	40.0 -	$\mu\text{A}$
Gate-emitter leakage current	$I_{GES}$	$V_{CE} = 0\text{V}, V_{GE} = 20\text{V}$	-	-	100	nA
Transconductance	$g_{fs}$	$V_{CE} = 20\text{V}, I_C = 120.0\text{A}$	-	75.0	-	S
Integrated gate resistor	$r_G$			none		$\Omega$

**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	$C_{ies}$	$V_{CE} = 25\text{V}, V_{GE} = 0\text{V}, f = 1\text{MHz}$	-	7530	-	pF
Output capacitance	$C_{oes}$		-	446	-	
Reverse transfer capacitance	$C_{res}$		-	206	-	
Gate charge	$Q_G$	$V_{CC} = 480\text{V}, I_C = 120.0\text{A},$ $V_{GE} = 15\text{V}$	-	772.0	-	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: $\geq 1.0\text{s}$	$I_{C(SC)}$	$V_{GE} = 15.0\text{V}, V_{CC} \leq 400\text{V},$ $t_{SC} \leq 5\mu\text{s}$ $T_{vj} = 150^{\circ}\text{C}$	-	846	-	A

**Switching Characteristic, Inductive Load**

Parameter	Symbol	Conditions	Value			Unit
			min.	typ.	max.	
<b>IGBT Characteristic, at <math>T_{vj} = 25^{\circ}\text{C}</math></b>						
Turn-on delay time	$t_{d(on)}$	$T_{vj} = 25^{\circ}\text{C}$ , $V_{CC} = 400\text{V}$ , $I_C = 120.0\text{A}$ , $V_{GE} = 0.0/15.0\text{V}$ , $R_{G(on)} = 3.0\Omega$ , $R_{G(off)} = 3.0\Omega$ , $L\sigma = 63\text{nH}$ , $C\sigma = 31\text{pF}$ $L\sigma$ , $C\sigma$ from Fig. E Energy losses include "tail" and diode reverse recovery.	-	33	-	ns
Rise time	$t_r$		-	43	-	ns
Turn-off delay time	$t_{d(off)}$		-	310	-	ns
Fall time	$t_f$		-	33	-	ns
Turn-on energy	$E_{on}$		-	4.10	-	mJ
Turn-off energy	$E_{off}$		-	2.80	-	mJ
Total switching energy	$E_{ts}$		-	6.90	-	mJ

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

Diode reverse recovery time	$t_{rr}$	$T_{vj} = 25^{\circ}\text{C}$ , $V_R = 400\text{V}$ , $I_F = 120.0\text{A}$ , $di_F/dt = 1100\text{A}/\mu\text{s}$	-	280	-	ns
Diode reverse recovery charge	$Q_{rr}$		-	3.50	-	$\mu\text{C}$
Diode peak reverse recovery current	$I_{rrm}$		-	25.0	-	A
Diode peak rate of fall of reverse recovery current during $t_b$	$di_{rr}/dt$		-	-500	-	$\text{A}/\mu\text{s}$

**Switching Characteristic, Inductive Load**

Parameter	Symbol	Conditions	Value			Unit
			min.	typ.	max.	
<b>IGBT Characteristic, at <math>T_{vj} = 175^{\circ}\text{C}</math></b>						
Turn-on delay time	$t_{d(on)}$	$T_{vj} = 175^{\circ}\text{C}$ , $V_{CC} = 400\text{V}$ , $I_C = 120.0\text{A}$ , $V_{GE} = 0.0/15.0\text{V}$ , $R_{G(on)} = 3.0\Omega$ , $R_{G(off)} = 3.0\Omega$ , $L\sigma = 63\text{nH}$ , $C\sigma = 31\text{pF}$ $L\sigma$ , $C\sigma$ from Fig. E Energy losses include "tail" and diode reverse recovery.	-	33	-	ns
Rise time	$t_r$		-	51	-	ns
Turn-off delay time	$t_{d(off)}$		-	355	-	ns
Fall time	$t_f$		-	43	-	ns
Turn-on energy	$E_{on}$		-	6.70	-	mJ
Turn-off energy	$E_{off}$		-	4.10	-	mJ
Total switching energy	$E_{ts}$		-	10.80	-	mJ

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

Diode reverse recovery time	$t_{rr}$	$T_{vj} = 175^{\circ}\text{C}$ , $V_R = 400\text{V}$ , $I_F = 120.0\text{A}$ , $di_F/dt = 1000\text{A}/\mu\text{s}$	-	410	-	ns
Diode reverse recovery charge	$Q_{rr}$		-	10.80	-	$\mu\text{C}$
Diode peak reverse recovery current	$I_{rrm}$		-	45.0	-	A
Diode peak rate of fall of reverse recovery current during $t_b$	$di_{rr}/dt$		-	-520	-	$\text{A}/\mu\text{s}$

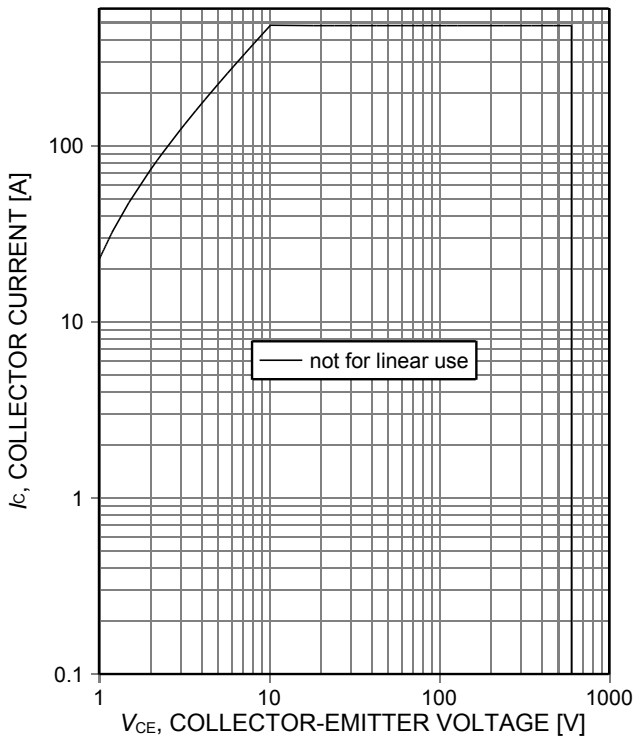


Figure 1. **Safe operating area**  
 ( $D=0$ ,  $T_C=25^\circ\text{C}$ ,  $T_J\leq 175^\circ\text{C}$ ,  $V_{GE}=0/15\text{V}$ ,  
 $t_p=1\mu\text{s}$ . Proven by production test.)

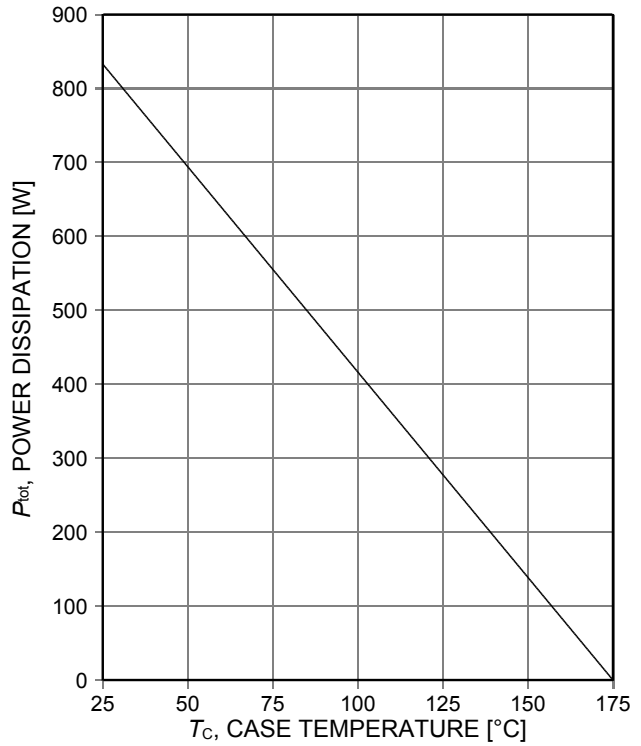


Figure 2. **Power dissipation as a function of case temperature**  
 ( $T_J\leq 175^\circ\text{C}$ )

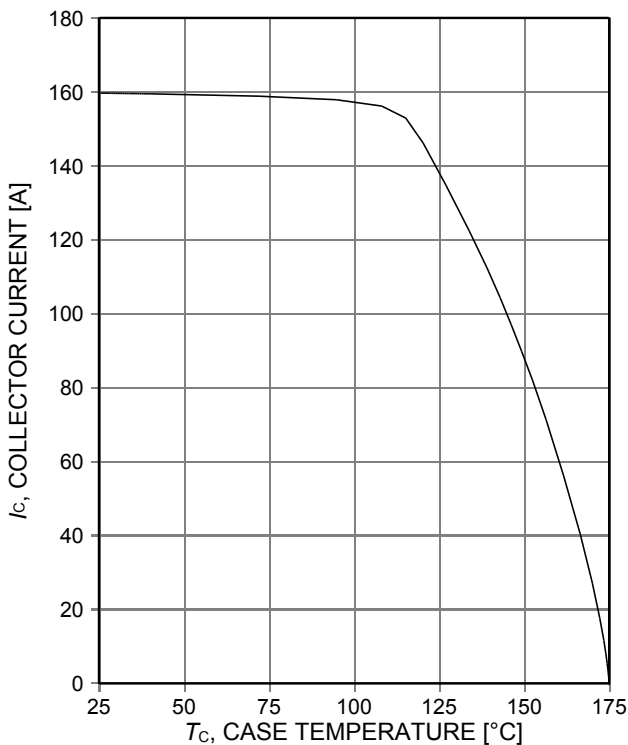


Figure 3. **Collector current as a function of case temperature**  
 ( $V_{GE}\geq 15\text{V}$ ,  $T_J\leq 175^\circ\text{C}$ )

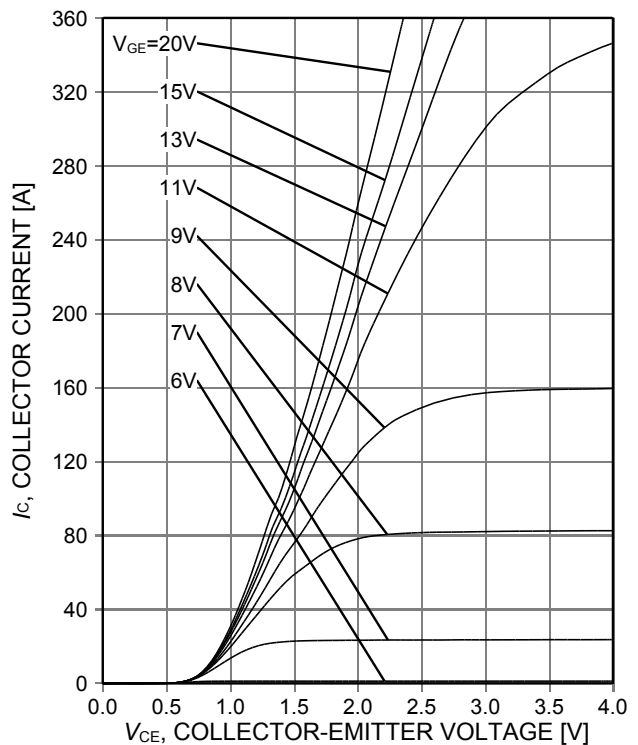


Figure 4. **Typical output characteristic**  
 ( $T_J=25^\circ\text{C}$ )

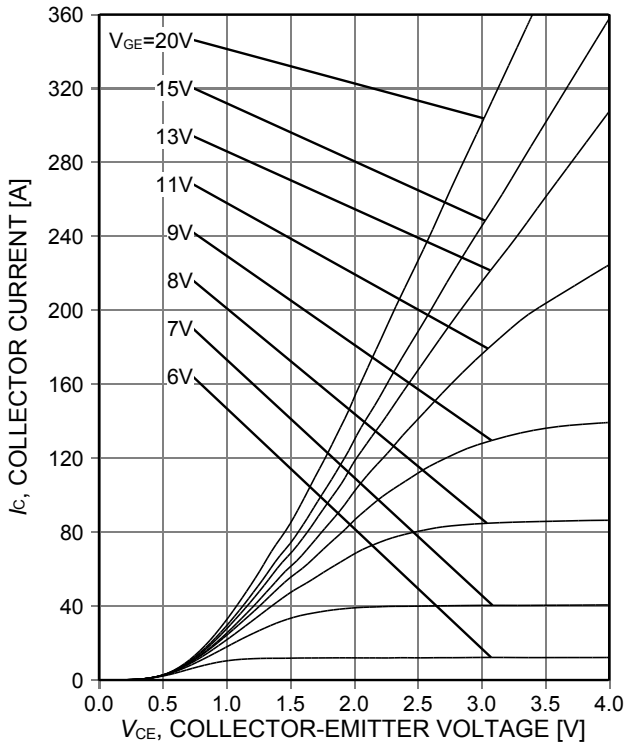


Figure 5. **Typical output characteristic**  
( $T_j=175^\circ\text{C}$ )

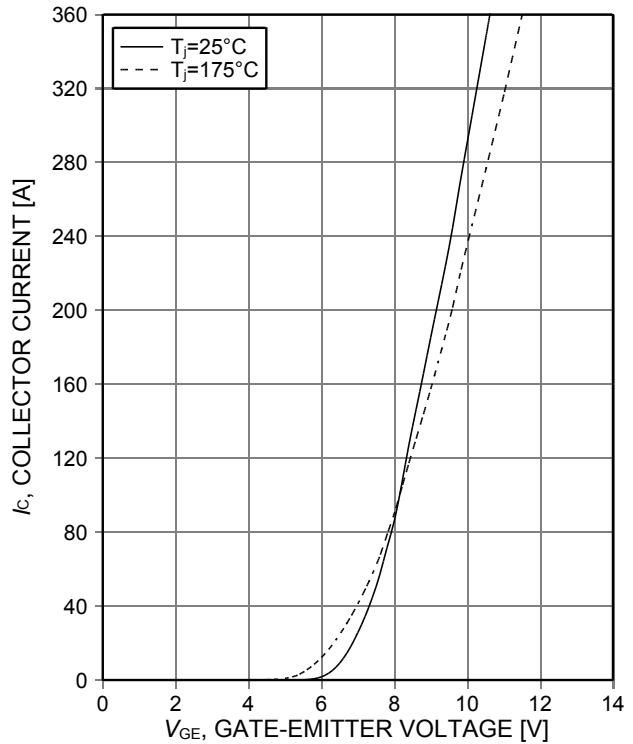


Figure 6. **Typical transfer characteristic**  
( $V_{CE}=20\text{V}$ )

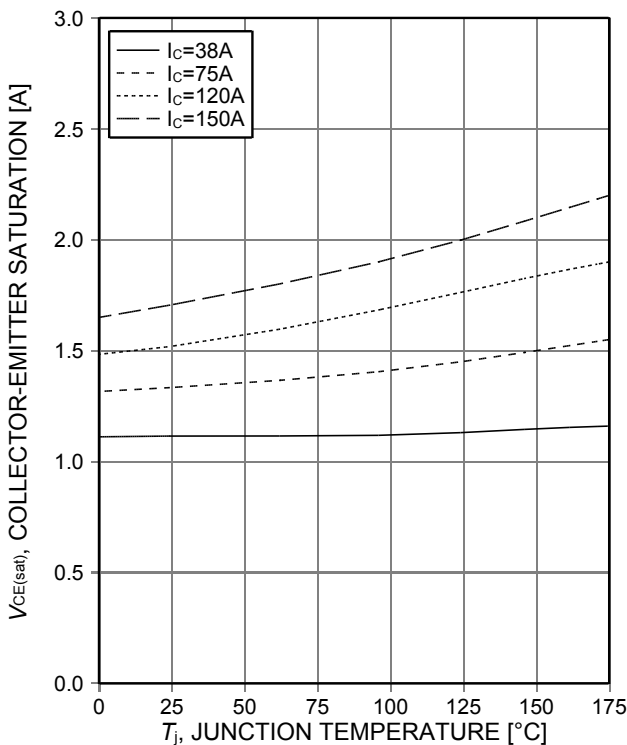


Figure 7. **Typical collector-emitter saturation voltage as a function of junction temperature**  
( $V_{GE}=15\text{V}$ )

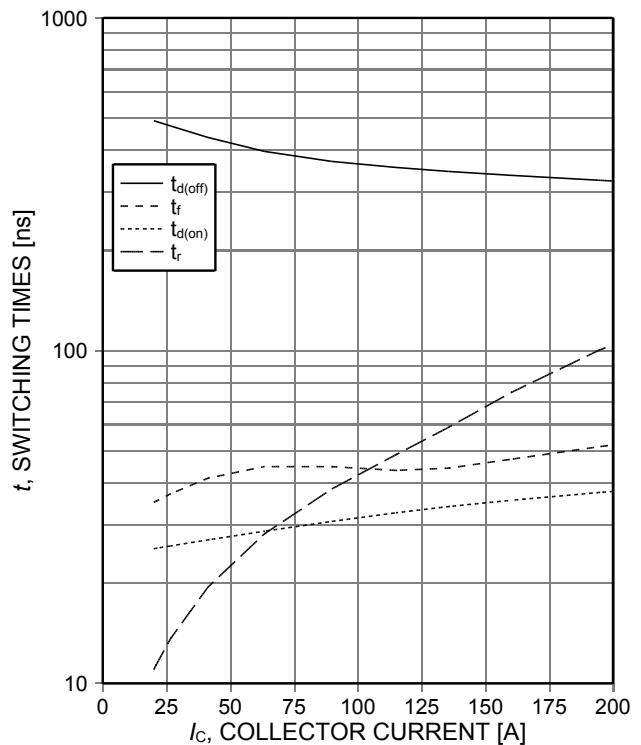


Figure 8. **Typical switching times as a function of collector current**  
(inductive load,  $T_j=175^\circ\text{C}$ ,  $V_{CE}=400\text{V}$ ,  $V_{GE}=15/0\text{V}$ ,  $r_G=3\Omega$ , Dynamic test circuit in Figure E)



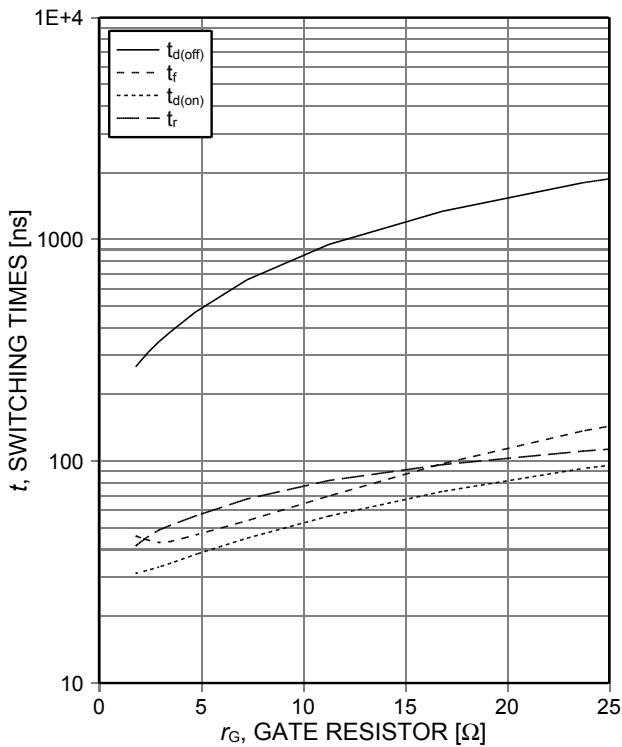


Figure 9. **Typical switching times as a function of gate resistor**  
 (inductive load,  $T_j=175^\circ\text{C}$ ,  $V_{CE}=400\text{V}$ ,  $V_{GE}=15/0\text{V}$ ,  $I_C=120\text{A}$ , Dynamic test circuit in Figure E)

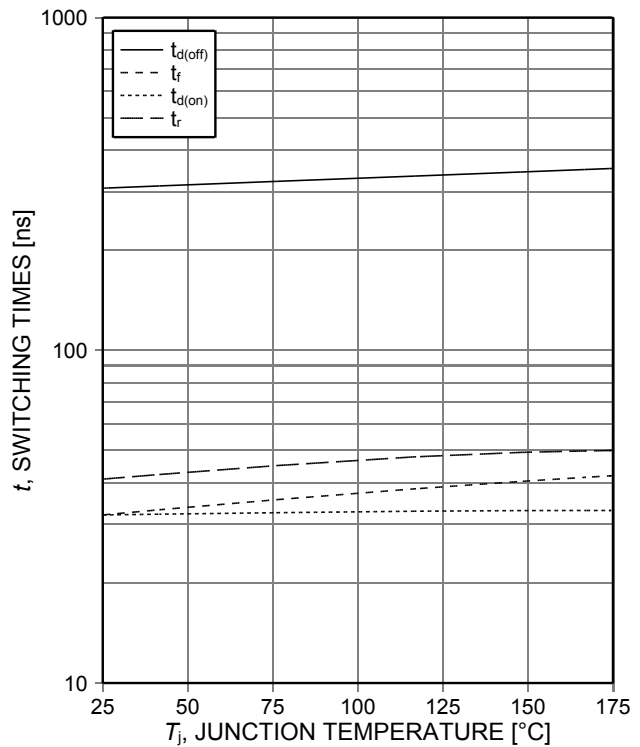


Figure 10. **Typical switching times as a function of junction temperature**  
 (inductive load,  $V_{CE}=400\text{V}$ ,  $V_{GE}=15/0\text{V}$ ,  $I_C=120\text{A}$ ,  $r_G=3\Omega$ , Dynamic test circuit in Figure E)

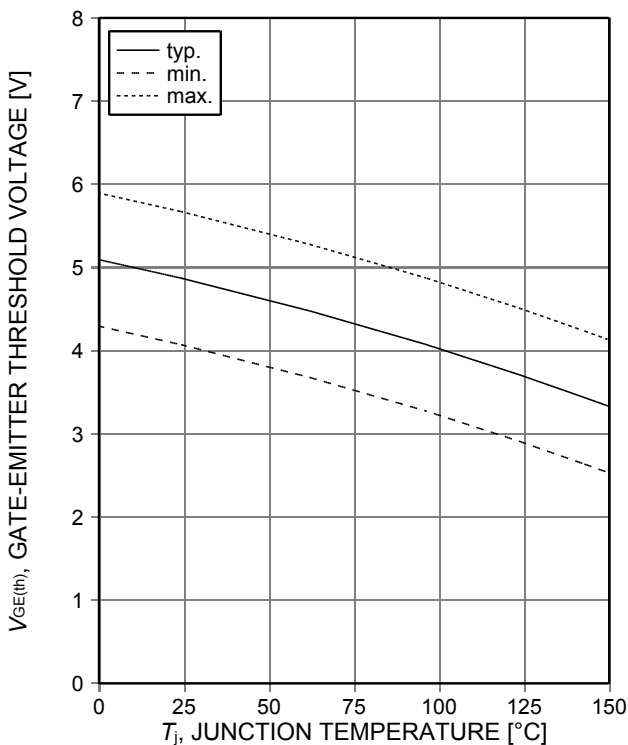


Figure 11. **Gate-emitter threshold voltage as a function of junction temperature**  
 ( $I_C=1,9\text{mA}$ )

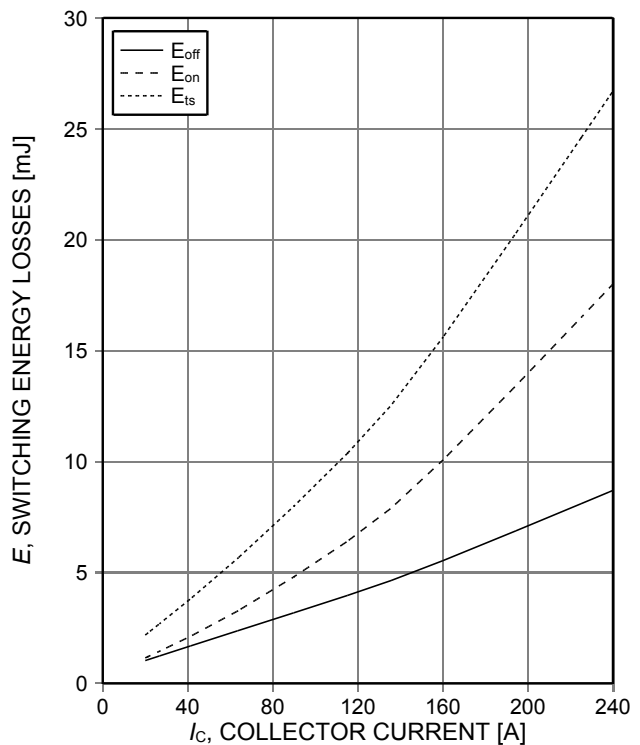


Figure 12. **Typical switching energy losses as a function of collector current**  
 (inductive load,  $T_j=175^\circ\text{C}$ ,  $V_{CE}=400\text{V}$ ,  $V_{GE}=15/0\text{V}$ ,  $r_G=3\Omega$ , Dynamic test circuit in Figure E)

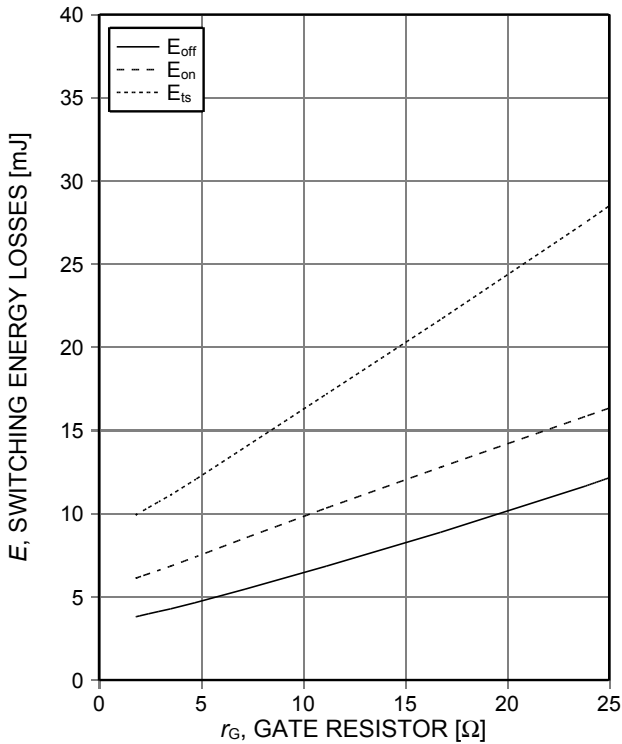


Figure 13. **Typical switching energy losses as a function of gate resistor**  
 (inductive load,  $T_j=175^\circ\text{C}$ ,  $V_{CE}=400\text{V}$ ,  $V_{GE}=15/0\text{V}$ ,  $I_C=120\text{A}$ , Dynamic test circuit in Figure E)

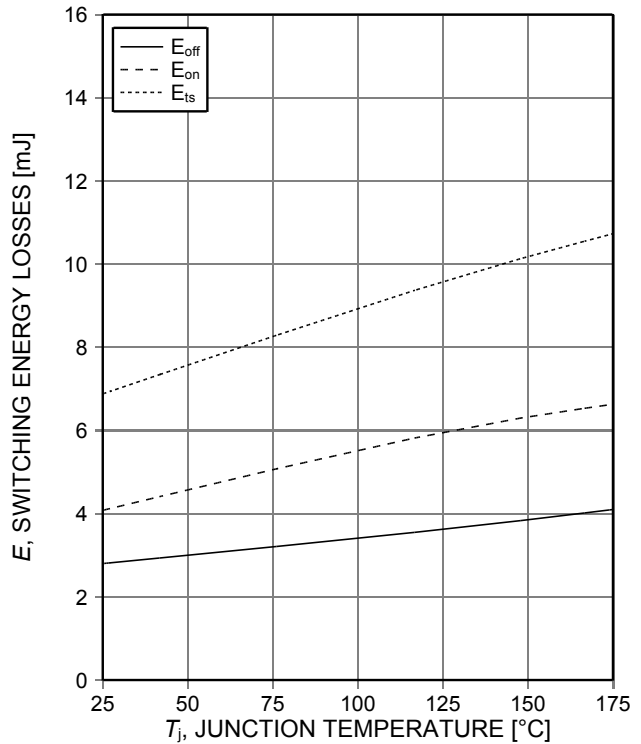


Figure 14. **Typical switching energy losses as a function of junction temperature**  
 (inductive load,  $V_{CE}=400\text{V}$ ,  $V_{GE}=15/0\text{V}$ ,  $I_C=120\text{A}$ ,  $r_G=3\Omega$ , Dynamic test circuit in Figure E)

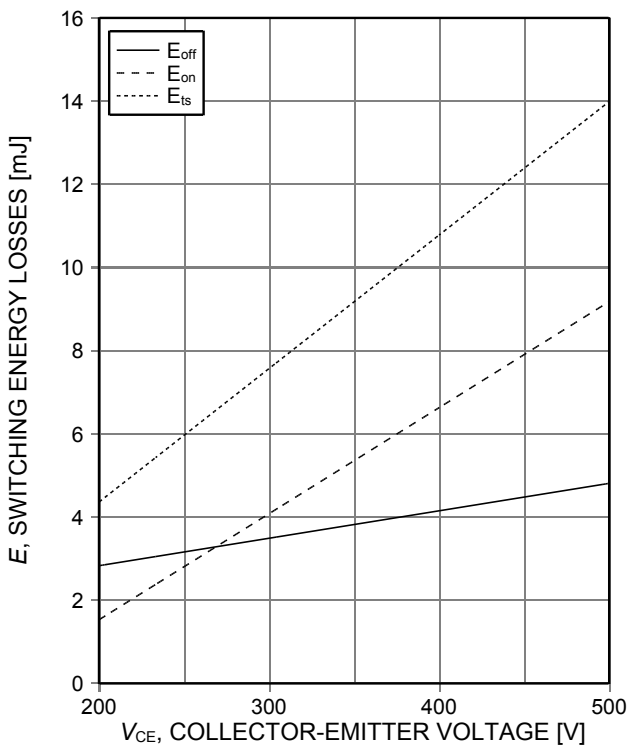


Figure 15. **Typical switching energy losses as a function of collector emitter voltage**  
 (inductive load,  $T_j=175^\circ\text{C}$ ,  $V_{GE}=15/0\text{V}$ ,  $I_C=120\text{A}$ ,  $R_G=3\Omega$ , Dynamic test circuit in Figure E)

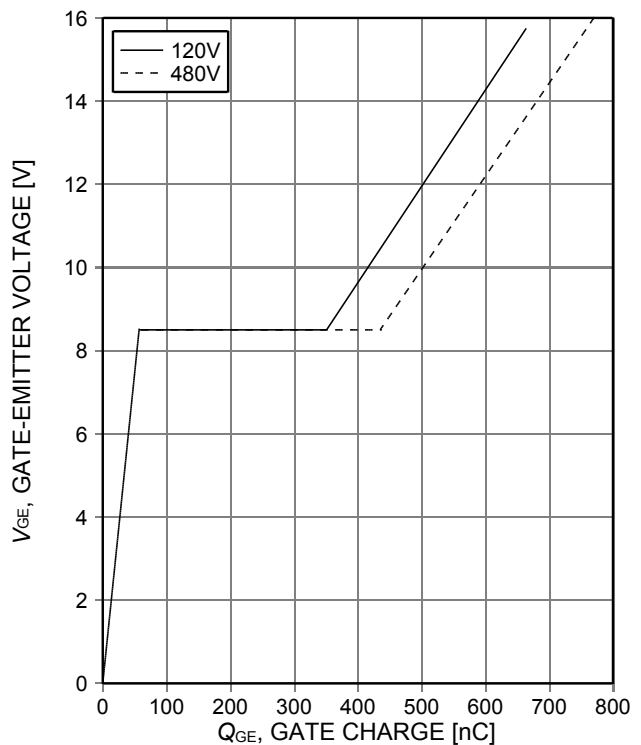


Figure 16. **Typical gate charge**  
 ( $I_C=120\text{A}$ )

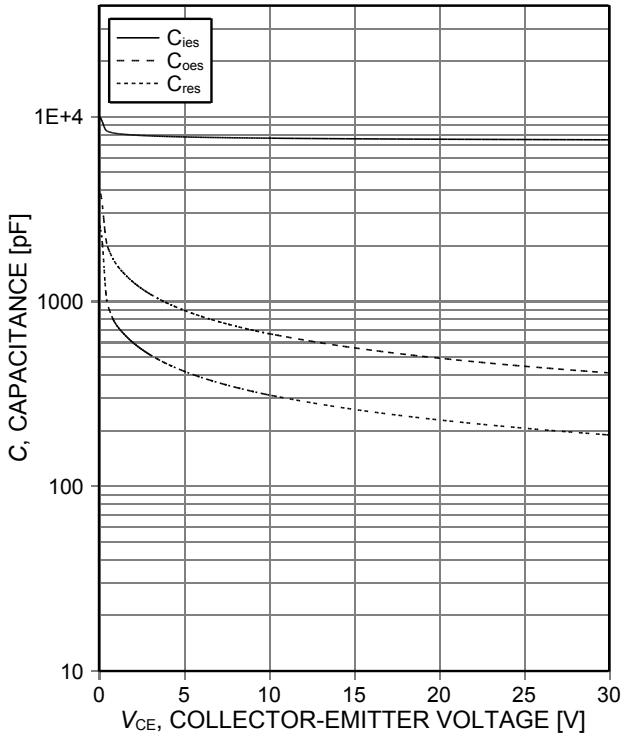


Figure 17. Typical capacitance as a function of collector-emitter voltage ( $V_{GE}=0V$ ,  $f=1MHz$ )

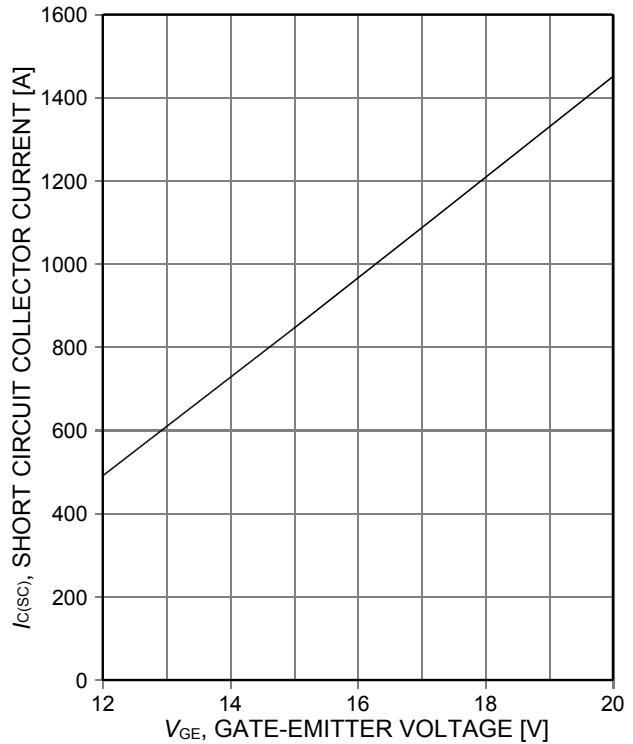


Figure 18. Typical short circuit collector current as a function of gate-emitter voltage ( $V_{CE}\leq 400V$ , start at  $T_J\leq 150^\circ C$ )

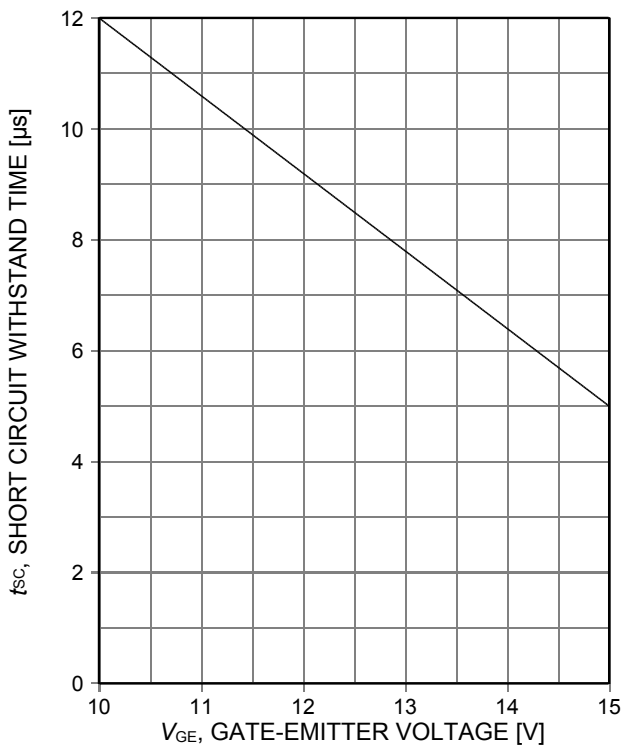


Figure 19. Short circuit withstand time as a function of gate-emitter voltage ( $V_{CE}=400V$ , start at  $T_J=25^\circ C$ ,  $T_{Jmax}\leq 150^\circ C$ )

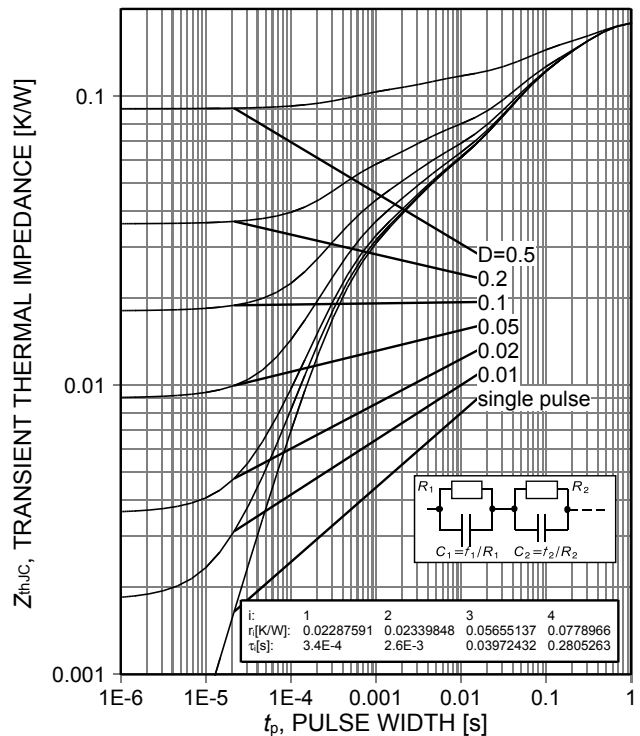


Figure 20. IGBT transient thermal impedance as a function of pulse width for different duty cycles  $D$  ( $D=t_p/T$ )

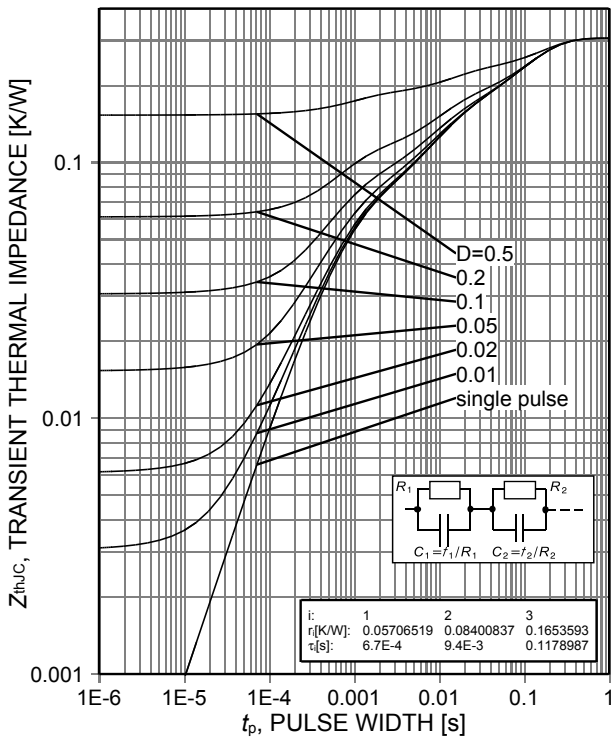


Figure 21. Diode transient thermal impedance as a function of pulse width for different duty cycles  $D$  ( $D=t_p/T$ )

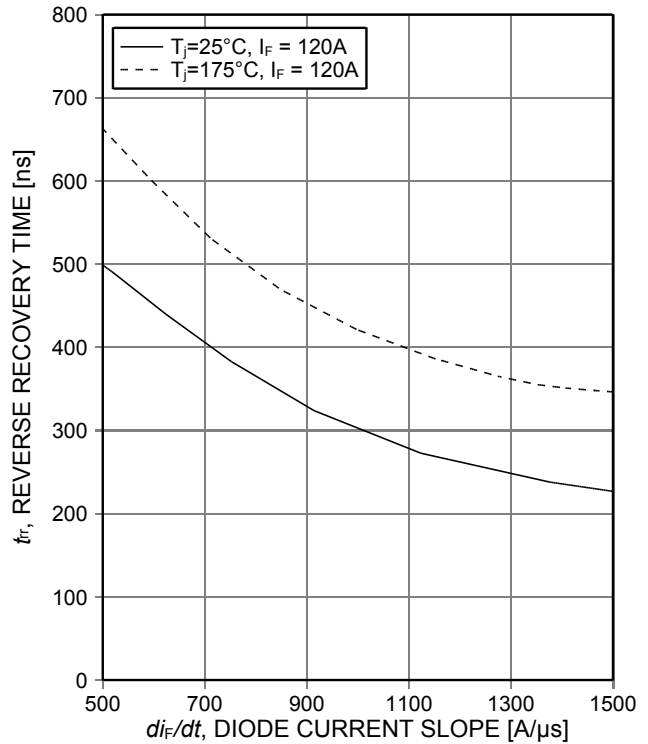


Figure 22. Typical reverse recovery time as a function of diode current slope ( $V_R=400V$ , Dynamic test circuit in Figure E)

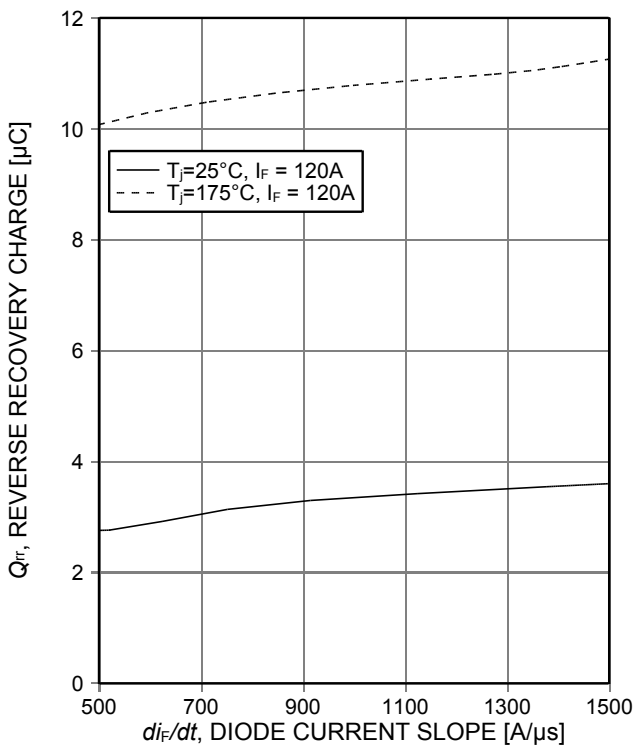


Figure 23. Typical reverse recovery charge as a function of diode current slope ( $V_R=400V$ , Dynamic test circuit in Figure E)

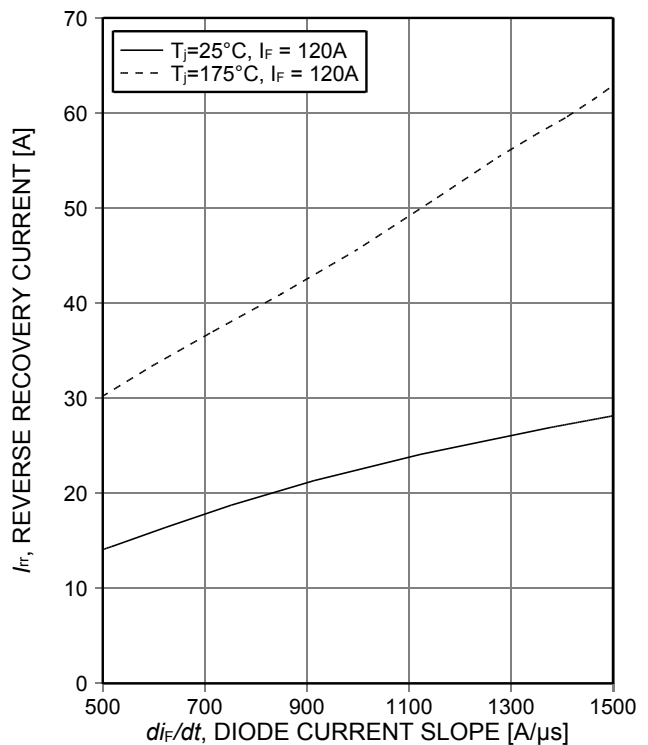


Figure 24. Typical reverse recovery current as a function of diode current slope ( $V_R=400V$ , Dynamic test circuit in Figure E)

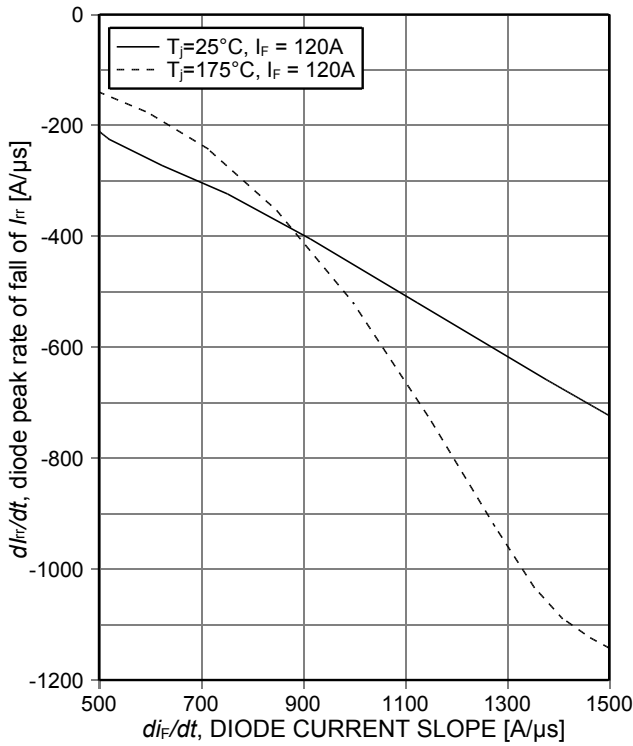


Figure 25. **Typical diode peak rate of fall of reverse recovery current as a function of diode current slope**  
( $V_R=400V$ , Dynamic test circuit in Figure E)

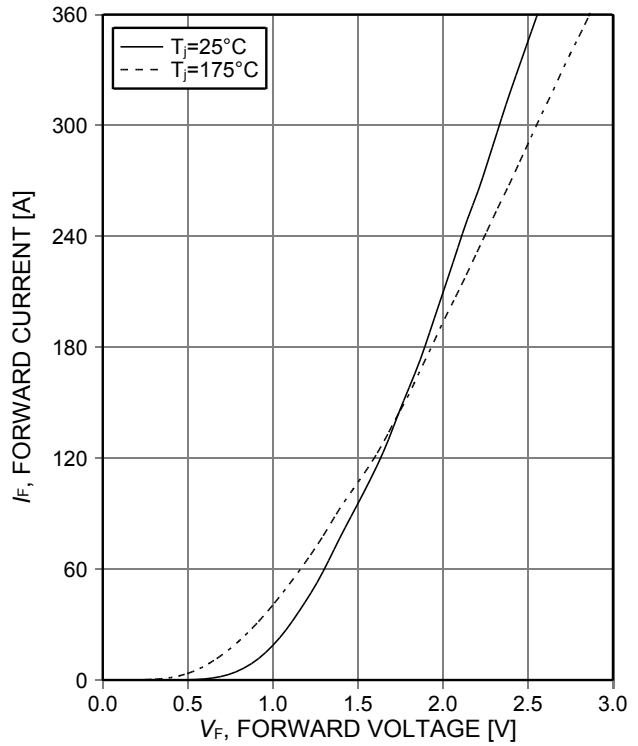


Figure 26. **Typical diode forward current as a function of forward voltage**

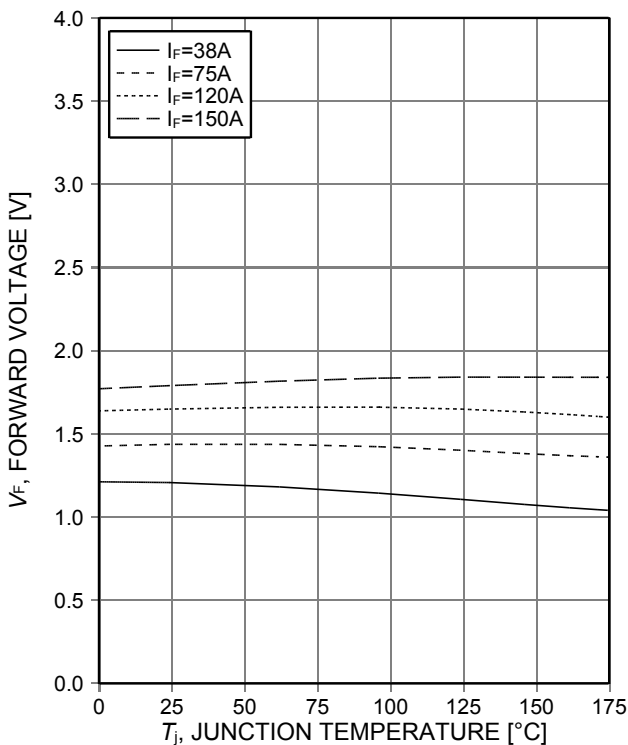
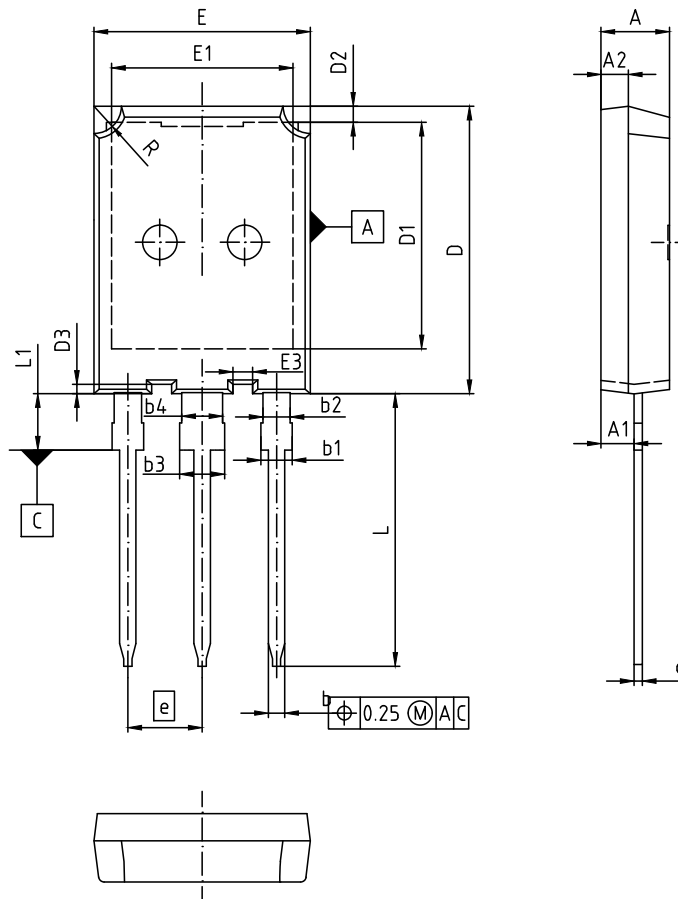


Figure 27. **Typical diode forward voltage as a function of junction temperature**

PG-TO247-3-46



Mold Flash or Protrusions not included

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.90	5.10	0.193	0.201
A1	2.31	2.51	0.091	0.099
A2	1.90	2.10	0.075	0.083
b	1.16	1.26	0.046	0.050
b1	1.96	2.25	0.077	0.089
b2	1.96	2.06	0.077	0.081
b3	2.96	3.25	0.117	0.128
b4	2.96	3.06	0.117	0.120
c	0.59	0.66	0.023	0.026
D	20.90	21.10	0.823	0.831
D1	16.25	16.85	0.640	0.663
D2	1.05	1.35	0.041	0.053
D3	0.58	0.78	0.023	0.031
E	15.70	15.90	0.618	0.626
E1	13.10	13.50	0.516	0.531
E3	1.35	1.55	0.053	0.061
e	5.44 (BSC)		0.214 (BSC)	
N	3		3	
L	19.80	20.10	0.780	0.791
L1	-	4.30	-	0.169
R	1.90	2.10	0.075	0.083

**DOCUMENT NO.**  
Z8B00174295

**SCALE**

**EUROPEAN PROJECTION**

**ISSUE DATE**  
13-08-2014

**REVISION**  
01

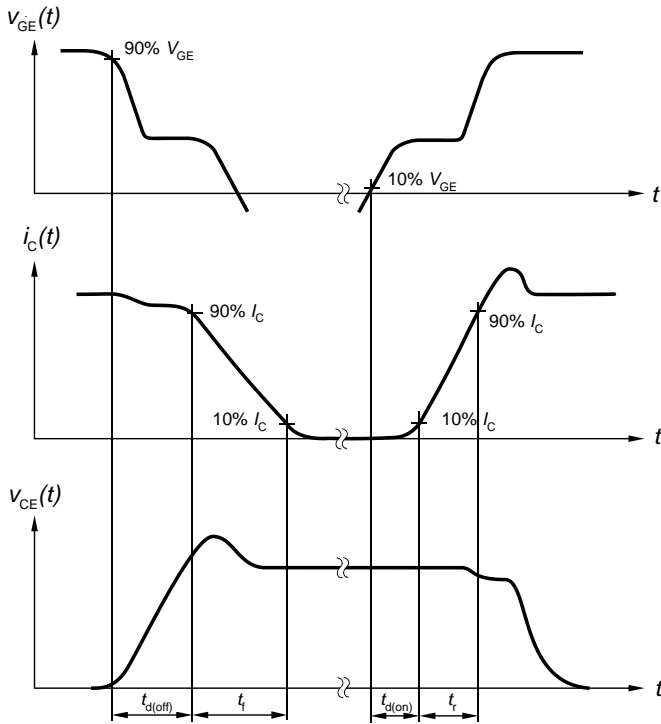


Figure A. Definition of switching times

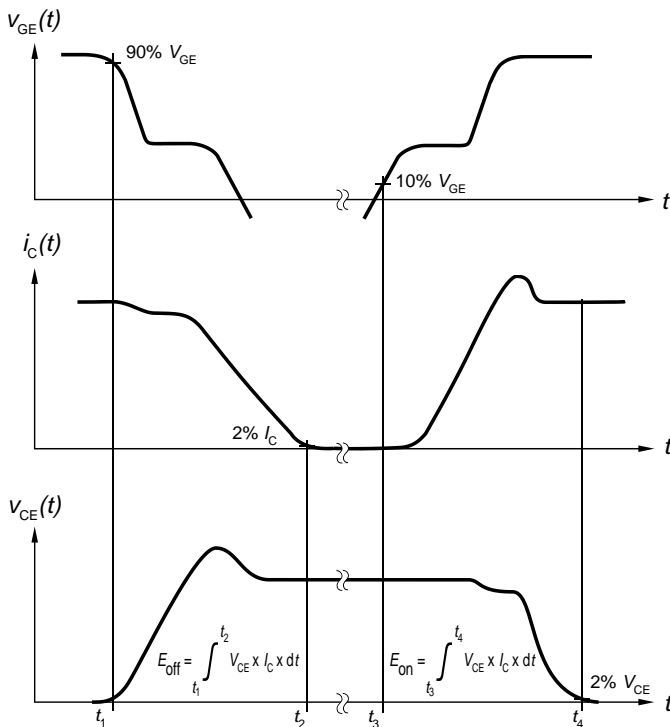


Figure B. Definition of switching losses

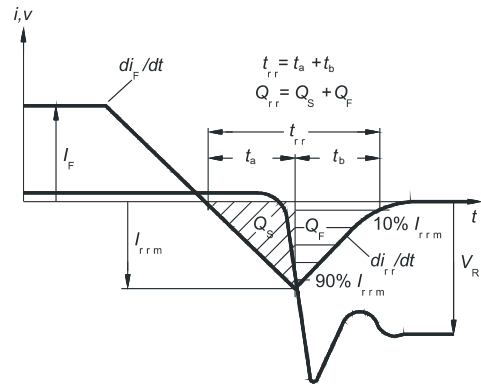


Figure C. Definition of diodes switching characteristics

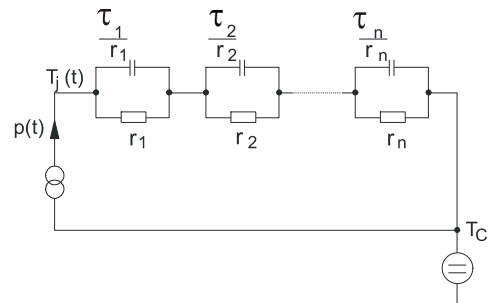


Figure D. Thermal equivalent circuit

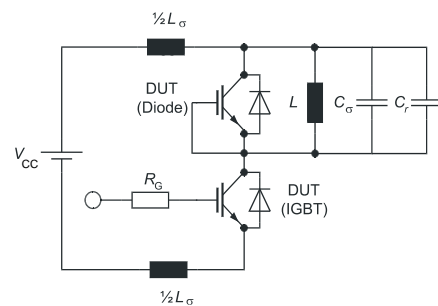


Figure E. Dynamic test circuit  
Parasitic inductance  $L_\sigma$ ,  
parasitic capacitor  $C_\sigma$ ,  
relief capacitor  $C_r$   
(only for ZVT switching)

## Revision History

IKQ120N60TA

Revision: 2014-11-21, Rev. 2.2

## Previous Revision

Revision	Date	Subjects (major changes since last revision)
1.1	2014-07-31	Preliminary data sheet
2.1	2014-10-17	Final data sheet
2.2	2014-11-21	Update of Transconductance gfs

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## Published by

Infineon Technologies AG

81726 Munich, Germany

81726 München, Germany

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