

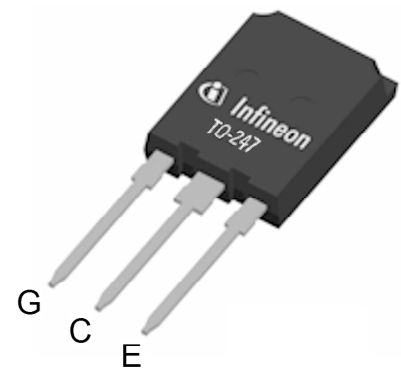
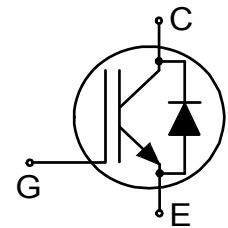
High speed switching series third generation IGBT

Low switching losses IGBT in Highspeed3 technology copacked with soft, fast recovery full current rated anti-parallel Emitter Controlled diode

**Features:**

High speed H3 technology offers:

- High efficiency in hard switching and resonant topologies
- 10µsec short circuit withstand time at  $T_{vj}=175^{\circ}\text{C}$
- Easy paralleling capability due to positive temperature coefficient in  $V_{CEsat}$
- Low EMI
- Low Gate Charge  $Q_G$
- Very soft, fast recovery full current anti-parallel diode
- Maximum junction temperature  $T_{vjmax}=175^{\circ}\text{C}$
- Pb-free lead plating; RoHS compliant
- Complete product spectrum and PSpice Models:  
<http://www.infineon.com/igbt/>



**Applications:**

- Industrial UPS
- Charger
- Energy Storage
- Three-level Solar String Inverter
- Welding

**Product Validation:**

Qualified for industrial applications according to the relevant tests of JEDEC47/20/22



**Key Performance and Package Parameters**

Type	$V_{CE}$	$I_C$	$V_{CEsat}, T_{vj}=25^{\circ}\text{C}$	$T_{vjmax}$	Marking	Package
IKQ40N120CH3	1200V	40A	2V	175°C	K40MCH3	PG-TO247-3-46

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## High speed switching series third generation IGBT

**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, $T_{vj} \geq 25^{\circ}\text{C}$	$V_{CE}$	1200	V
DC collector current, limited by $T_{vjmax}$ $T_c = 25^{\circ}\text{C}$ value limited by bondwire $T_c = 134^{\circ}\text{C}$	$I_C$	80.0 40.0	A
Pulsed collector current, $t_p$ limited by $T_{vjmax}$	$I_{Cpuls}$	160.0	A
Turn off safe operating area $V_{CE} \leq 1200\text{V}$ , $T_{vj} \leq 175^{\circ}\text{C}$ , $t_p = 1\mu\text{s}$	-	160.0	A
Diode forward current, limited by $T_{vjmax}$ $T_c = 25^{\circ}\text{C}$ value limited by bondwire $T_c = 100^{\circ}\text{C}$	$I_F$	80.0 40.0	A
Diode pulsed current, $t_p$ limited by $T_{vjmax}$	$I_{Fpuls}$	160.0	A
Gate-emitter voltage Transient Gate-emitter voltage ( $t_p \leq 10\mu\text{s}$ , $D < 0.010$ )	$V_{GE}$	$\pm 20$ $\pm 30$	V
Short circuit withstand time $V_{GE} = 15.0\text{V}$ , $V_{CC} \leq 600\text{V}$ Allowed number of short circuits < 1000 Time between short circuits: $\geq 1.0\text{s}$ $T_{vj} = 175^{\circ}\text{C}$	$t_{SC}$	10	$\mu\text{s}$
Power dissipation $T_c = 25^{\circ}\text{C}$ Power dissipation $T_c = 134^{\circ}\text{C}$	$P_{tot}$	500.0 136.0	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	$^{\circ}\text{C}$

**Thermal Resistance**

Parameter	Symbol	Conditions	Value			Unit
			min.	typ.	max.	

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

IGBT thermal resistance, junction - case	$R_{th(j-c)}$		-	-	0.30	K/W
Diode thermal resistance, junction - case	$R_{th(j-c)}$		-	-	0.50	K/W
Thermal resistance junction - ambient	$R_{th(j-a)}$		-	-	40	K/W

## High speed switching series third generation IGBT

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	$V_{(BR)CES}$	$V_{GE} = 0\text{V}, I_C = 0.50\text{mA}$	1200	-	-	V
Collector-emitter saturation voltage	$V_{CEsat}$	$V_{GE} = 15.0\text{V}, I_C = 40.0\text{A}$ $T_{vj} = 25^{\circ}\text{C}$ $T_{vj} = 175^{\circ}\text{C}$	- -	2.00 2.50	2.35 -	V
Diode forward voltage	$V_F$	$V_{GE} = 0\text{V}, I_F = 40.0\text{A}$ $T_{vj} = 25^{\circ}\text{C}$ $T_{vj} = 175^{\circ}\text{C}$	- -	1.90 1.85	2.30 -	V
Gate-emitter threshold voltage	$V_{GE(th)}$	$I_C = 1.50\text{mA}, V_{CE} = V_{GE}$	5.1	5.8	6.5	V
Zero gate voltage collector current	$I_{CES}$	$V_{CE} = 1200\text{V}, V_{GE} = 0\text{V}$ $T_{vj} = 25^{\circ}\text{C}$ $T_{vj} = 175^{\circ}\text{C}$	- -	- 3000	250 -	$\mu\text{A}$
Gate-emitter leakage current	$I_{GES}$	$V_{CE} = 0\text{V}, V_{GE} = 20\text{V}$	-	-	100	nA
Transconductance	$g_{fs}$	$V_{CE} = 20\text{V}, I_C = 40.0\text{A}$	-	14.0	-	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	$C_{ies}$	$V_{CE} = 25\text{V}, V_{GE} = 0\text{V}, f = 1\text{MHz}$	-	2385	-	pF
Output capacitance	$C_{oes}$		-	235	-	
Reverse transfer capacitance	$C_{res}$		-	132	-	
Gate charge	$Q_G$	$V_{CC} = 960\text{V}, I_C = 40.0\text{A},$ $V_{GE} = 15\text{V}$	-	190.0	-	nC
Internal emitter inductance measured 5mm (0.197 in.) from case	$L_E$		-	13.0	-	nH

## 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	$t_{d(on)}$	$T_{vj} = 25^{\circ}\text{C},$ $V_{CC} = 600\text{V}, I_C = 40.0\text{A},$ $V_{GE} = 0.0/15.0\text{V},$ $R_{G(on)} = 12.0\Omega, R_{G(off)} = 12.0\Omega,$ $L_{\sigma} = 90\text{nH}, C_{\sigma} = 67\text{pF}$ $L_{\sigma}, C_{\sigma}$ from Fig. E Energy losses include "tail" and diode reverse recovery.	-	30	-	ns
Rise time	$t_r$		-	46	-	ns
Turn-off delay time	$t_{d(off)}$		-	300	-	ns
Fall time	$t_f$		-	31	-	ns
Turn-on energy	$E_{on}$		-	3.30	-	mJ
Turn-off energy	$E_{off}$		-	1.30	-	mJ
Total switching energy	$E_{ts}$		-	4.60	-	mJ

## High speed switching series third generation IGBT

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

Diode reverse recovery time	$t_{rr}$	$T_{vj} = 25^{\circ}\text{C}$ , $V_R = 600\text{V}$ , $I_F = 40.0\text{A}$ , $di_F/dt = 600\text{A}/\mu\text{s}$	-	340	-	ns
Diode reverse recovery charge	$Q_{rr}$		-	3.60	-	$\mu\text{C}$
Diode peak reverse recovery current	$I_{rrm}$		-	19.0	-	A
Diode peak rate of fall of reverse recovery current during $t_b$	$di_{rr}/dt$		-	-134	-	$\text{A}/\mu\text{s}$

## 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	$t_{d(on)}$	$T_{vj} = 175^{\circ}\text{C}$ , $V_{CC} = 600\text{V}$ , $I_C = 40.0\text{A}$ , $V_{GE} = 0.0/15.0\text{V}$ , $R_{G(on)} = 12.0\Omega$ , $R_{G(off)} = 12.0\Omega$ , $L\sigma = 90\text{nH}$ , $C\sigma = 67\text{pF}$ $L\sigma$ , $C\sigma$ from Fig. E Energy losses include "tail" and diode reverse recovery.	-	30	-	ns
Rise time	$t_r$		-	46	-	ns
Turn-off delay time	$t_{d(off)}$		-	375	-	ns
Fall time	$t_f$		-	69	-	ns
Turn-on energy	$E_{on}$		-	4.50	-	mJ
Turn-off energy	$E_{off}$		-	2.50	-	mJ
Total switching energy	$E_{ts}$		-	7.00	-	mJ

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

Diode reverse recovery time	$t_{rr}$	$T_{vj} = 175^{\circ}\text{C}$ , $V_R = 600\text{V}$ , $I_F = 40.0\text{A}$ , $di_F/dt = 600\text{A}/\mu\text{s}$	-	500	-	ns
Diode reverse recovery charge	$Q_{rr}$		-	7.10	-	$\mu\text{C}$
Diode peak reverse recovery current	$I_{rrm}$		-	27.0	-	A
Diode peak rate of fall of reverse recovery current during $t_b$	$di_{rr}/dt$		-	-97	-	$\text{A}/\mu\text{s}$

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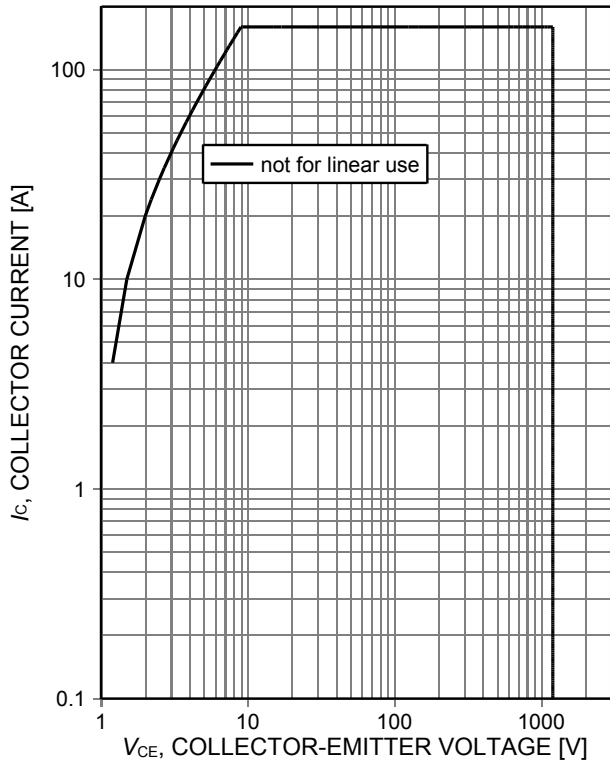


Figure 1. **Forward bias safe operating area**  
( $D=0$ ,  $T_C=25^\circ\text{C}$ ,  $T_{vj}\leq 175^\circ\text{C}$ ;  $V_{GE}=15\text{V}$ )

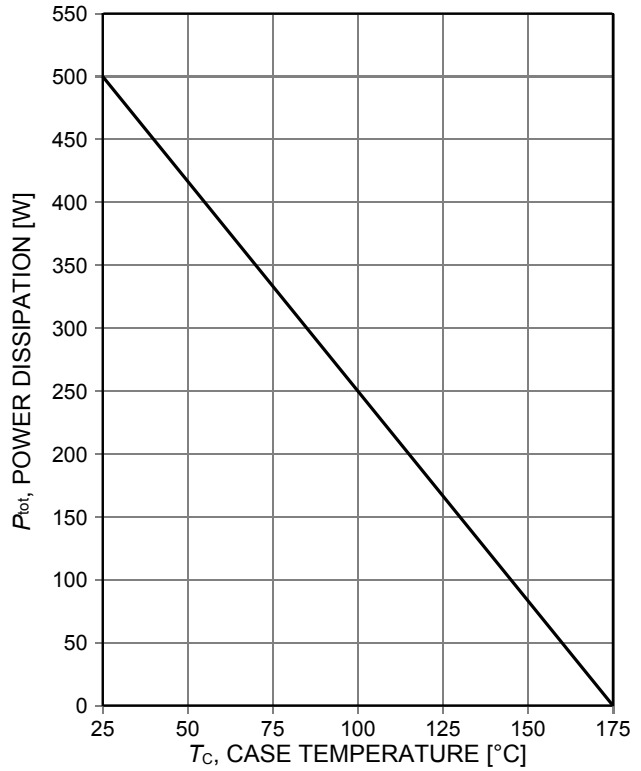


Figure 2. **Power dissipation as a function of case temperature**  
( $T_{vj}\leq 175^\circ\text{C}$ )

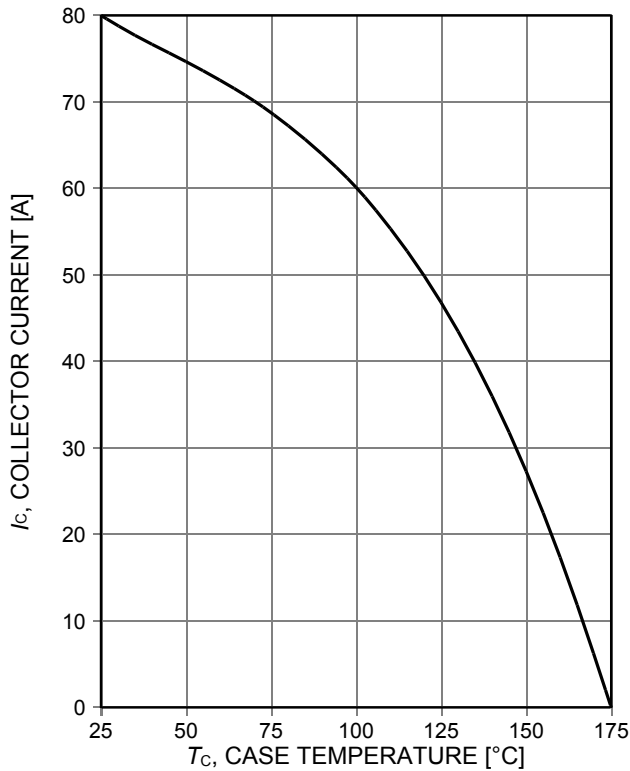


Figure 3. **Collector current as a function of case temperature**  
( $V_{GE}\geq 15\text{V}$ ,  $T_{vj}\leq 175^\circ\text{C}$ )

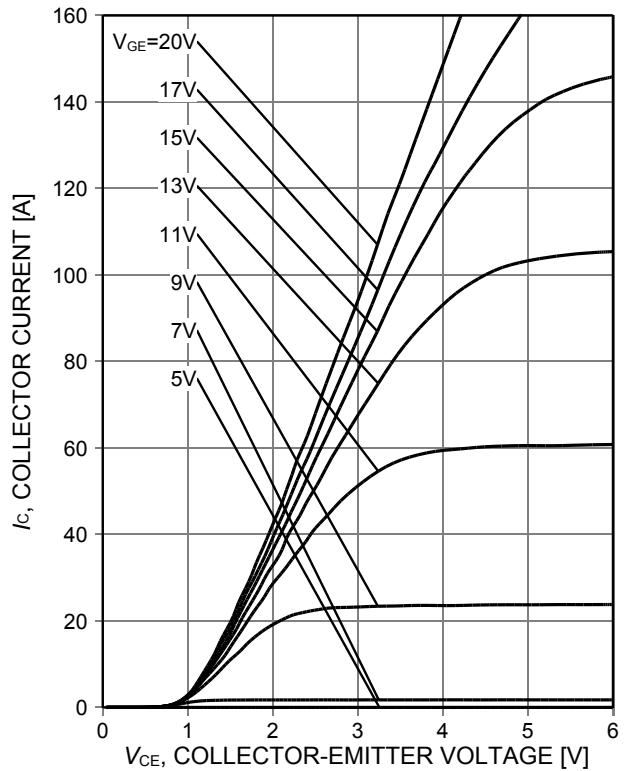


Figure 4. **Typical output characteristic**  
( $T_{vj}=25^\circ\text{C}$ )

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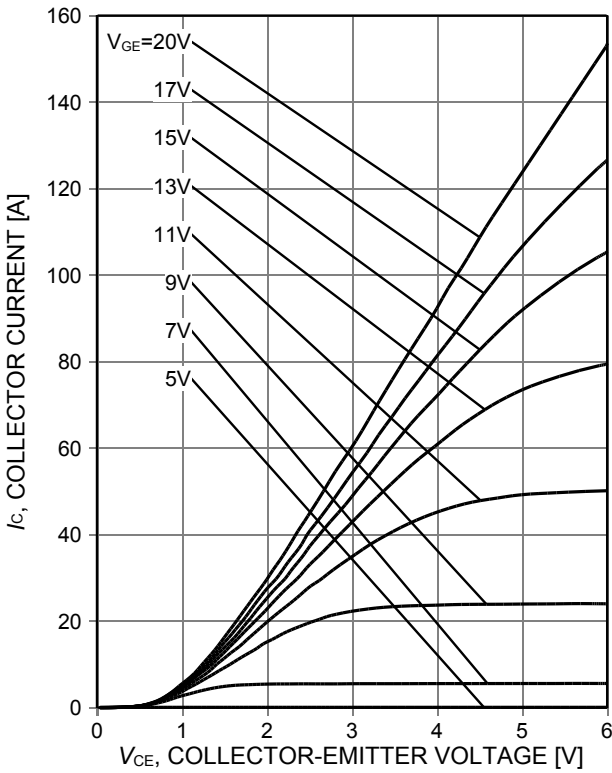


Figure 5. Typical output characteristic ( $T_{vj}=175^{\circ}\text{C}$ )

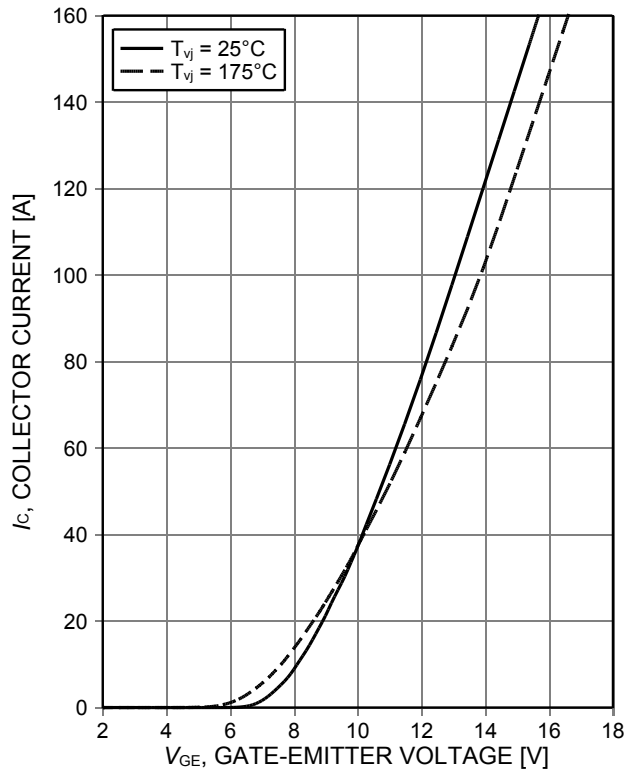


Figure 6. Typical transfer characteristic ( $V_{CE}=20\text{V}$ )

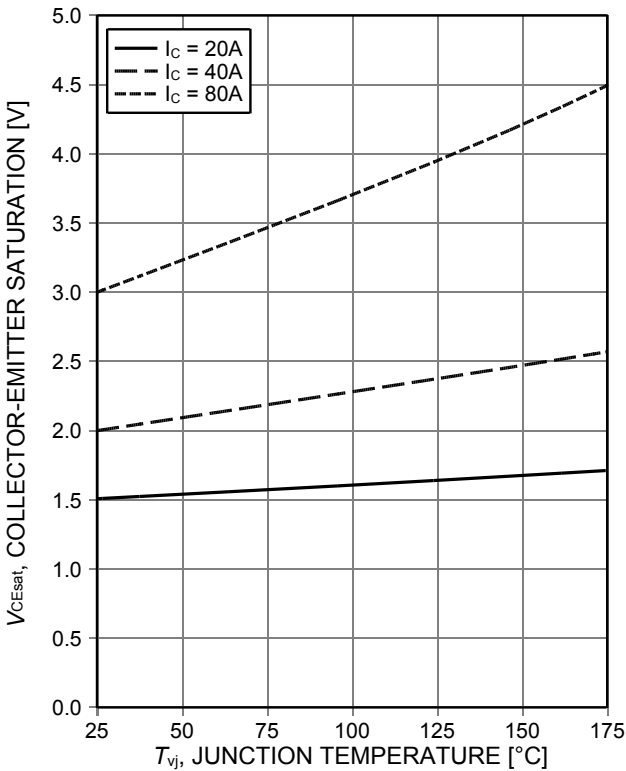


Figure 7. Typical collector-emitter saturation voltage as a function of junction temperature ( $V_{GE}=15\text{V}$ )

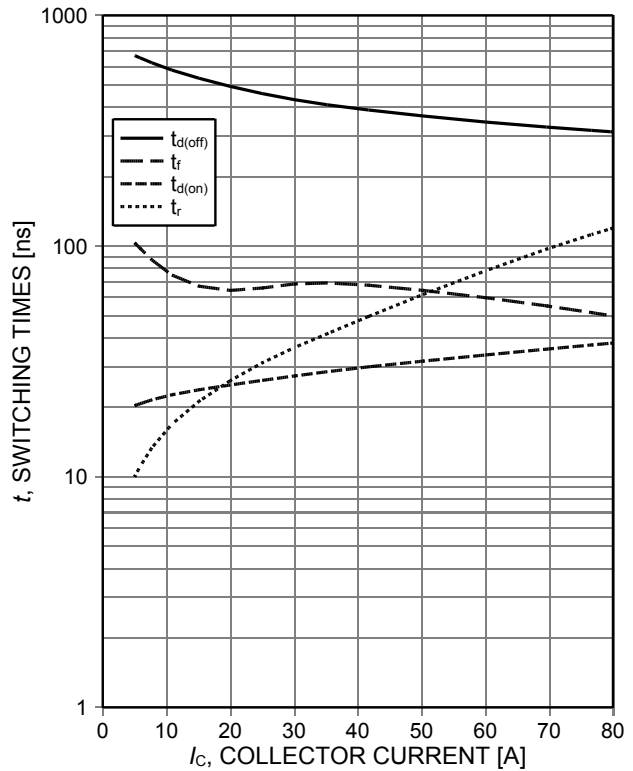


Figure 8. Typical switching times as a function of collector current (inductive load,  $T_{vj}=175^{\circ}\text{C}$ ,  $V_{CE}=600\text{V}$ ,  $V_{GE}=0/15\text{V}$ ,  $R_G=12\Omega$ , Dynamic test circuit in Figure E)

High speed switching series third generation IGBT

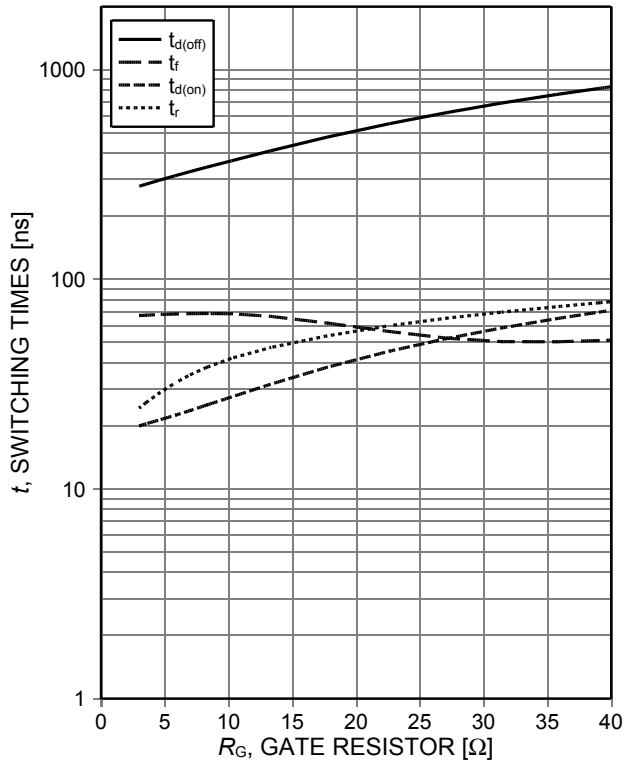


Figure 9. Typical switching times as a function of gate resistor (inductive load,  $T_{vj}=175^{\circ}\text{C}$ ,  $V_{CE}=600\text{V}$ ,  $V_{GE}=0/15\text{V}$ ,  $I_C=40\text{A}$ , Dynamic test circuit in Figure E)

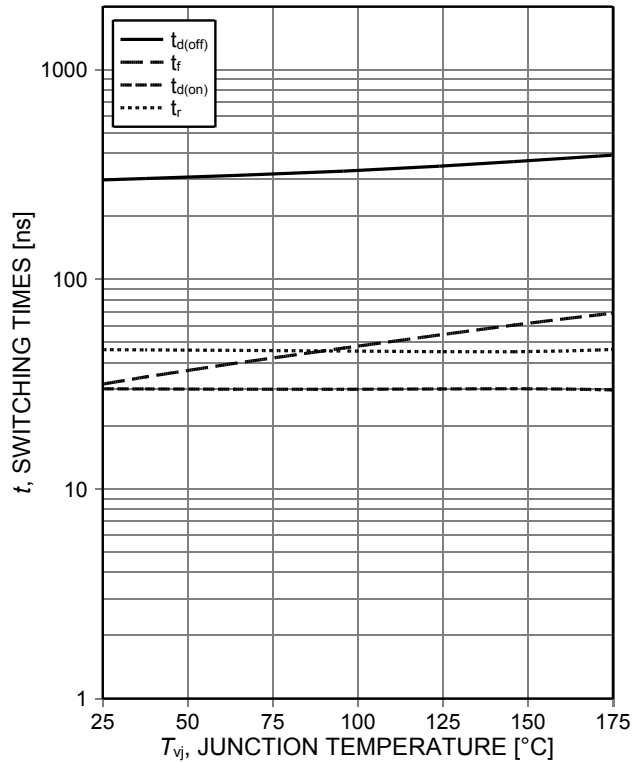


Figure 10. Typical switching times as a function of junction temperature (inductive load,  $V_{CE}=600\text{V}$ ,  $V_{GE}=0/15\text{V}$ ,  $I_C=40\text{A}$ ,  $R_G=12\Omega$ , Dynamic test circuit in Figure E)

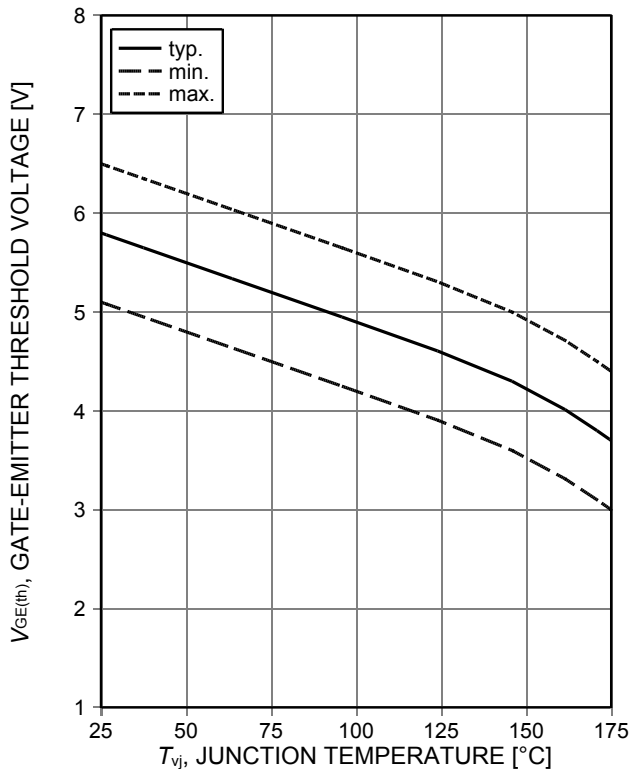


Figure 11. Gate-emitter threshold voltage as a function of junction temperature ( $I_C=1.5\text{mA}$ )

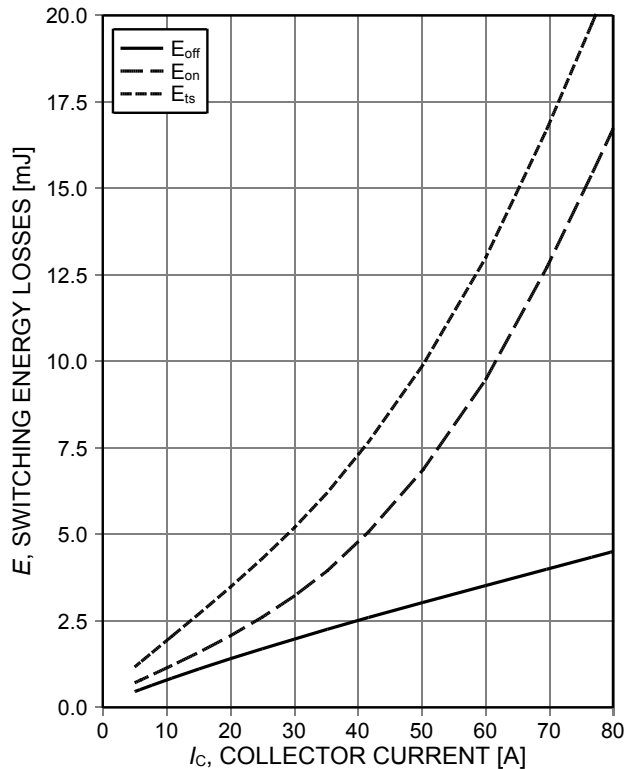


Figure 12. Typical switching energy losses as a function of collector current (inductive load,  $T_{vj}=175^{\circ}\text{C}$ ,  $V_{CE}=600\text{V}$ ,  $V_{GE}=0/15\text{V}$ ,  $R_G=12\Omega$ , Dynamic test circuit in Figure E)



High speed switching series third generation IGBT

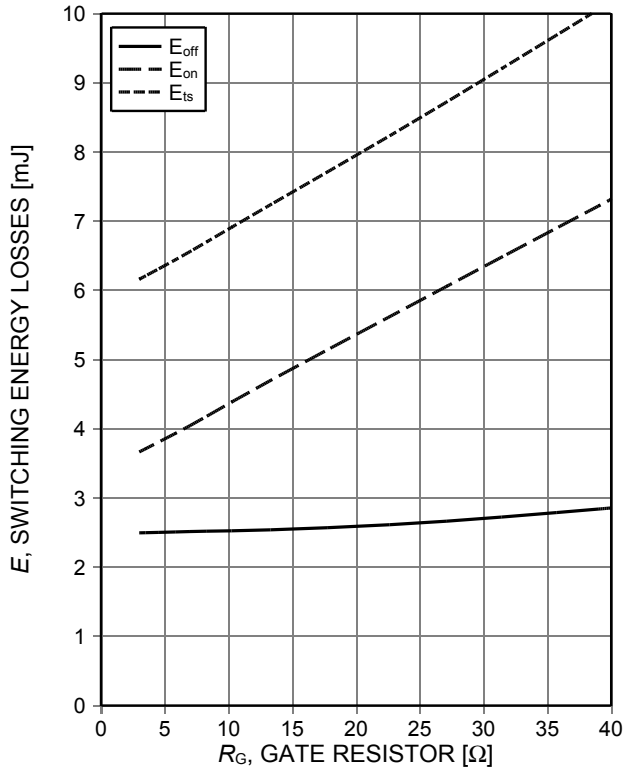


Figure 13. **Typical switching energy losses as a function of gate resistor**  
 (inductive load,  $T_{vj}=175^{\circ}\text{C}$ ,  $V_{CE}=600\text{V}$ ,  $V_{GE}=0/15\text{V}$ ,  $I_C=40\text{A}$ , Dynamic test circuit in Figure E)

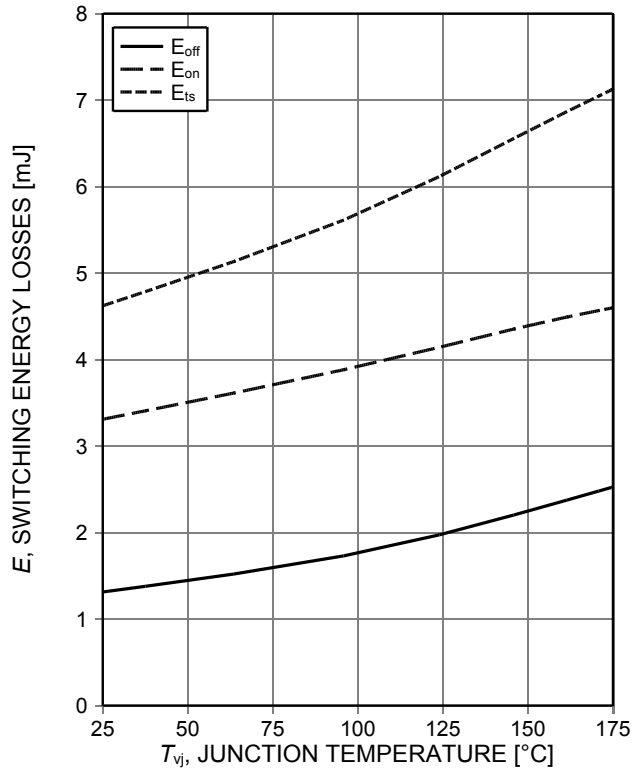


Figure 14. **Typical switching energy losses as a function of junction temperature**  
 (inductive load,  $V_{CE}=600\text{V}$ ,  $V_{GE}=0/15\text{V}$ ,  $I_C=40\text{A}$ ,  $R_G=12\Omega$ , Dynamic test circuit in Figure E)

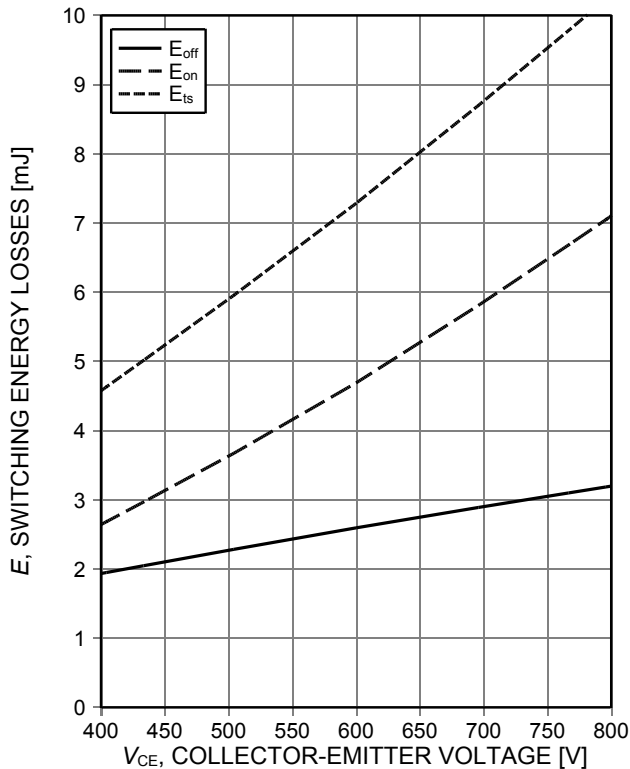


Figure 15. **Typical switching energy losses as a function of collector emitter voltage**  
 (inductive load,  $T_{vj}=175^{\circ}\text{C}$ ,  $V_{GE}=0/15\text{V}$ ,  $I_C=40\text{A}$ ,  $R_G=12\Omega$ , Dynamic test circuit in Figure E)

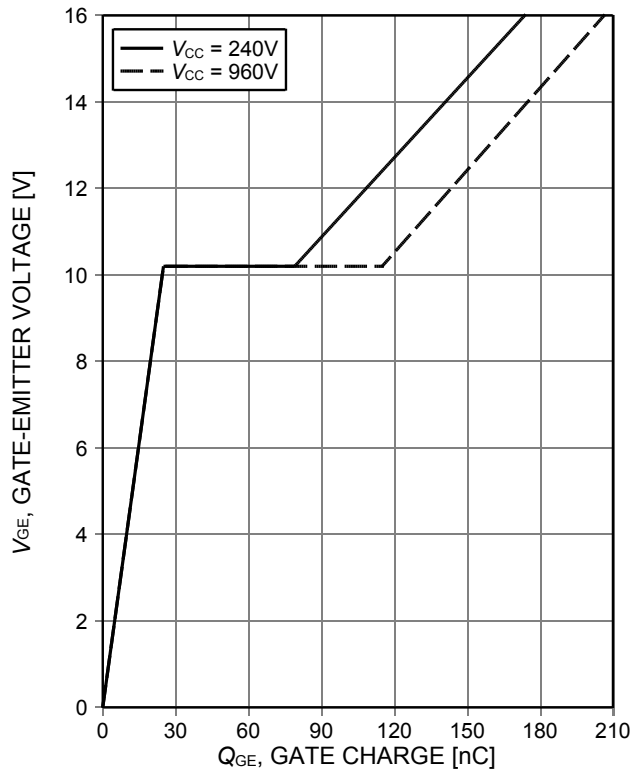


Figure 16. **Typical gate charge**  
 ( $I_C=40\text{A}$ )

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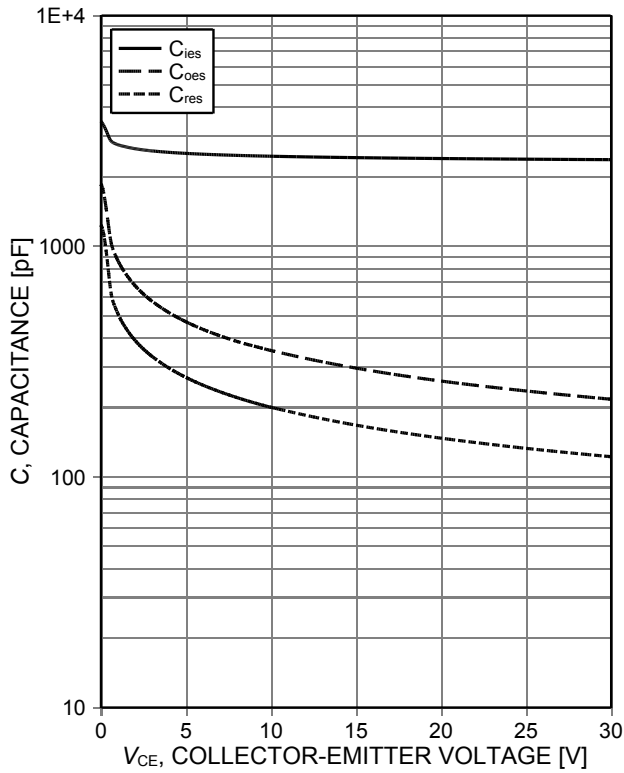


Figure 17. Typical capacitance as a function of collector-emitter voltage ( $V_{GE}=0V$ ,  $f=1MHz$ )

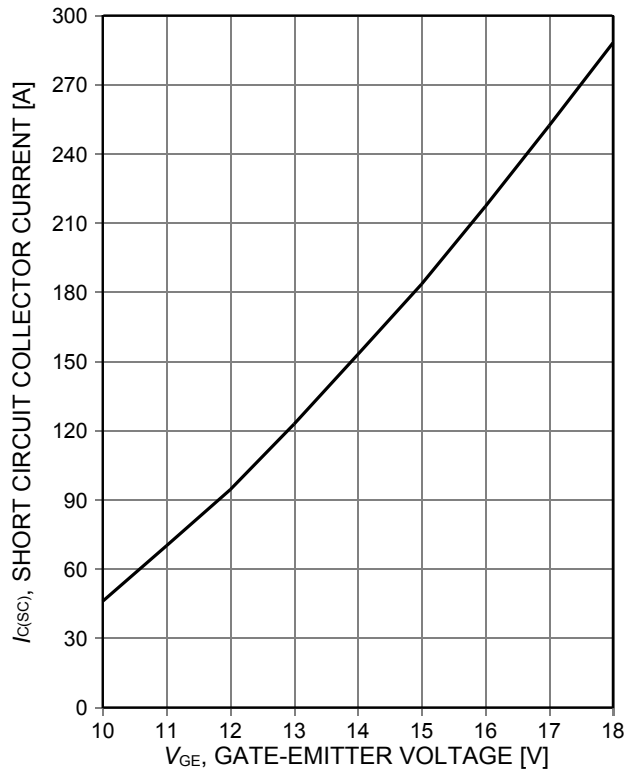


Figure 18. Typical short circuit collector current as a function of gate-emitter voltage ( $V_{CE}\leq 600V$ ,  $T_{vj}\leq 175^\circ C$ )

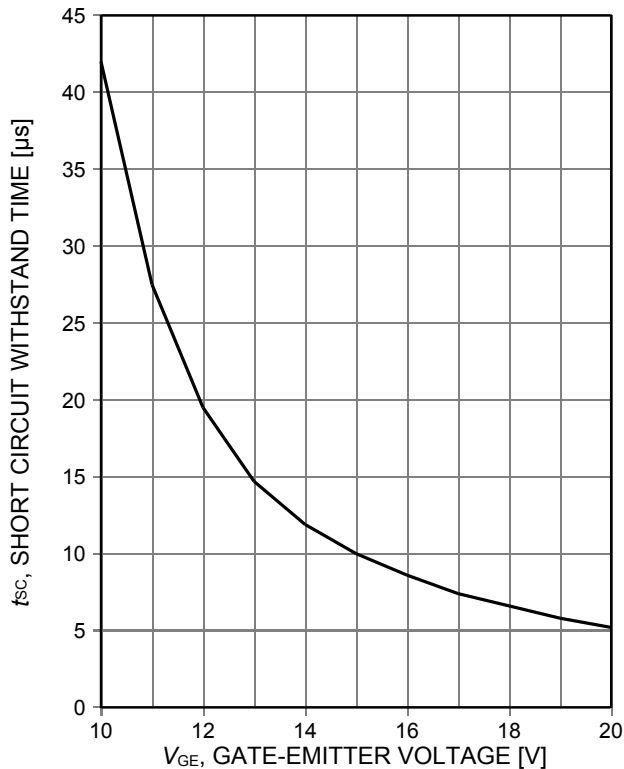


Figure 19. Short circuit withstand time as a function of gate-emitter voltage ( $V_{CE}\leq 600V$ , start at  $T_{vj}\leq 175^\circ C$ )

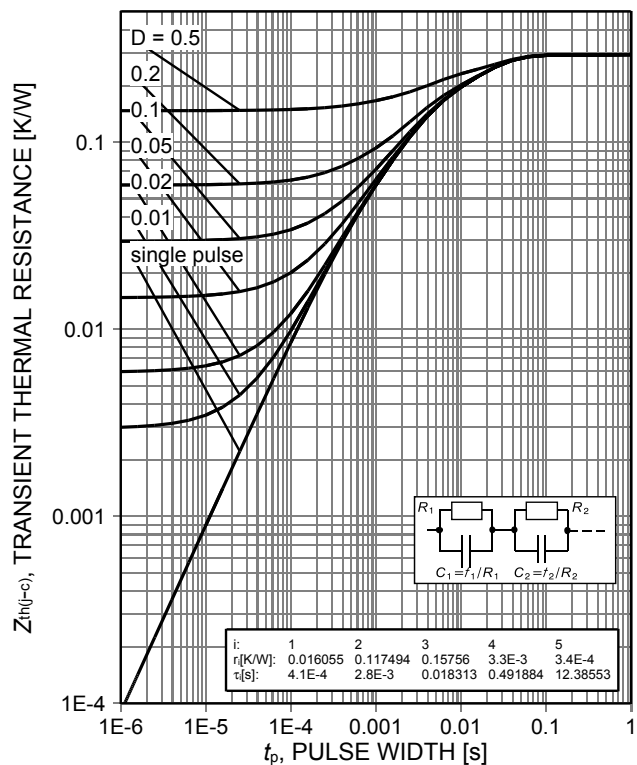


Figure 20. IGBT transient thermal resistance ( $D=t_p/T$ )

High speed switching series third generation IGBT

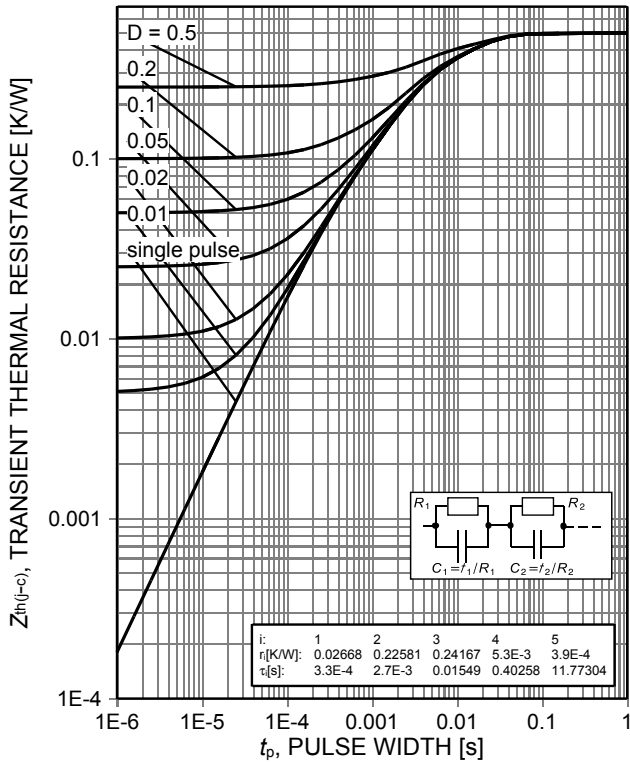


Figure 21. Diode transient thermal impedance as a function of pulse width ( $D=t_p/T$ )

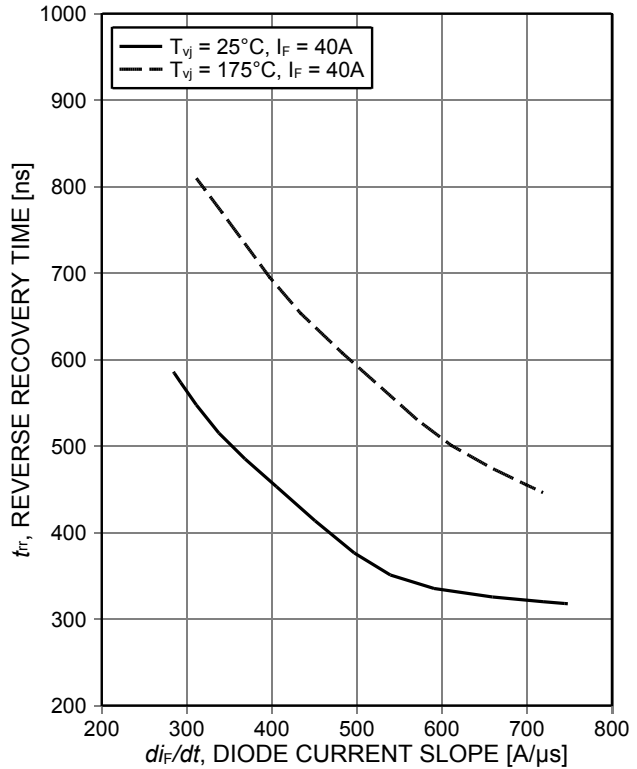


Figure 22. Typical reverse recovery time as a function of diode current slope ( $V_R=600V$ )

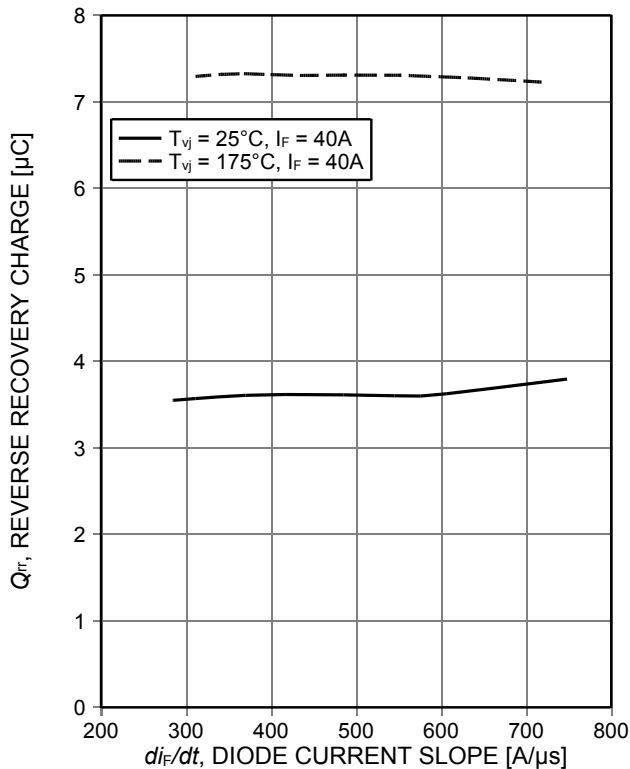


Figure 23. Typical reverse recovery charge as a function of diode current slope ( $V_R=600V$ )

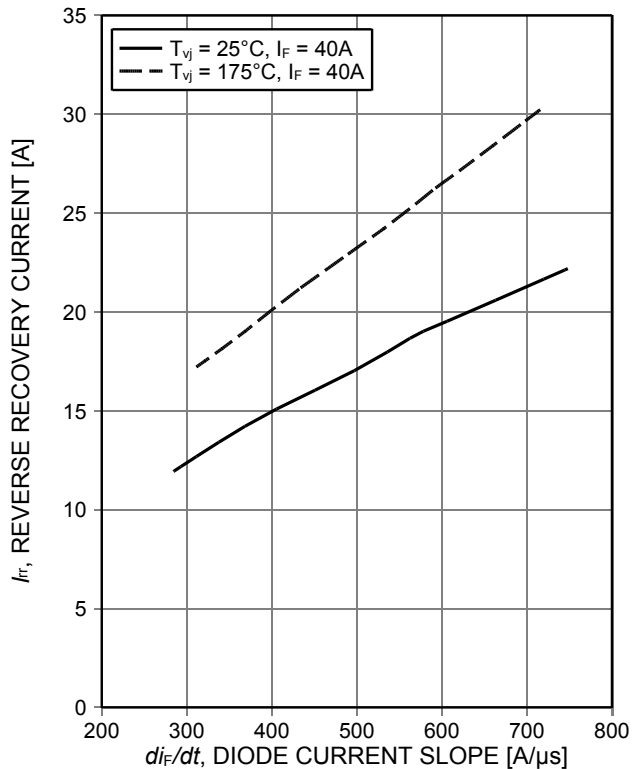


Figure 24. Typical reverse recovery current as a function of diode current slope ( $V_R=600V$ )

High speed switching series third generation IGBT

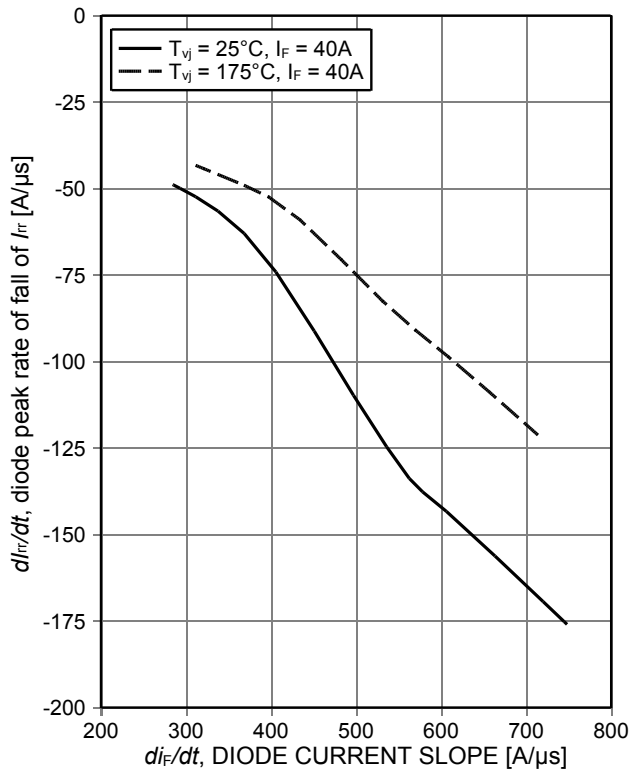


Figure 25. Typical diode peak rate of fall of reverse recovery current as a function of diode current slope ( $V_R=600V$ )

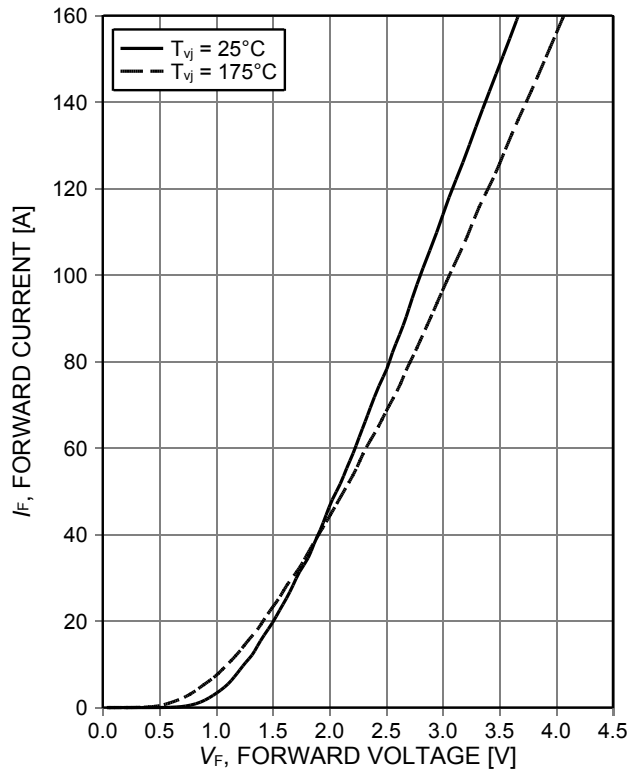


Figure 26. Typical diode forward current as a function of forward voltage

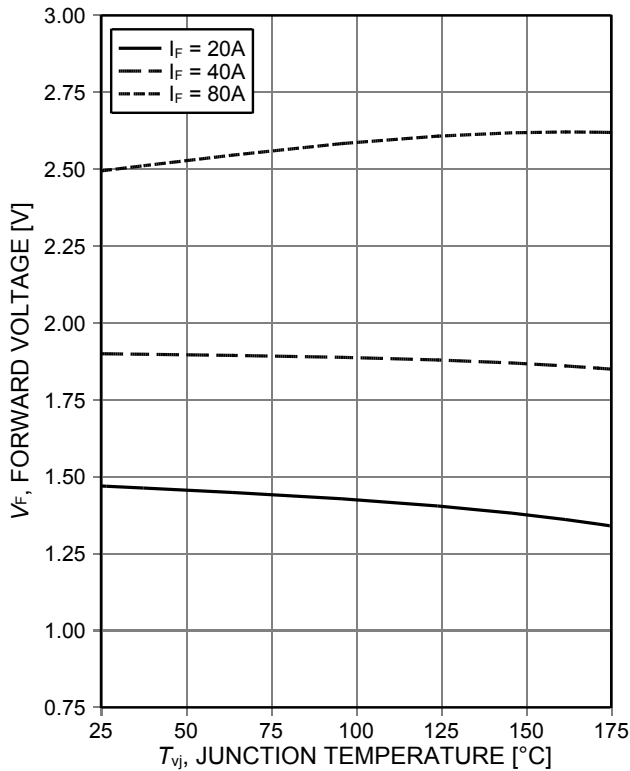
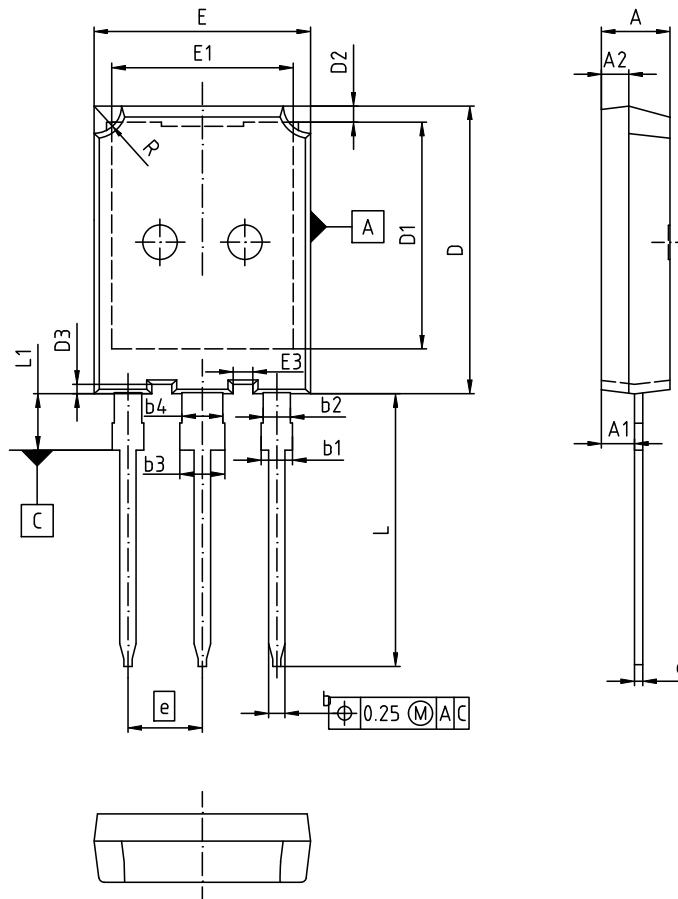


Figure 27. Typical diode forward voltage as a function of junction temperature

Package Drawing PG-TO247-3-46



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
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

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SCALE

EUROPEAN PROJECTION

ISSUE DATE  
13-08-2014

REVISION  
01

High speed switching series third generation IGBT

Testing Conditions

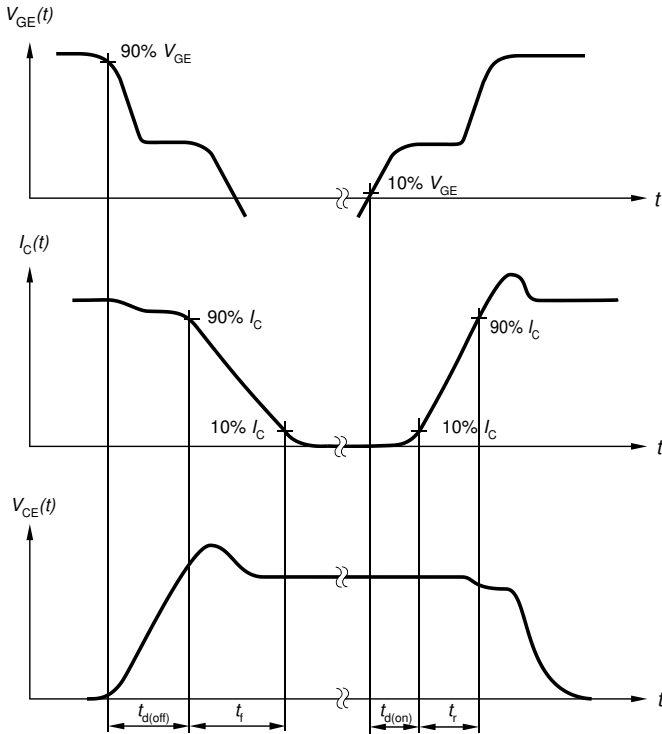


Figure A. Definition of switching times

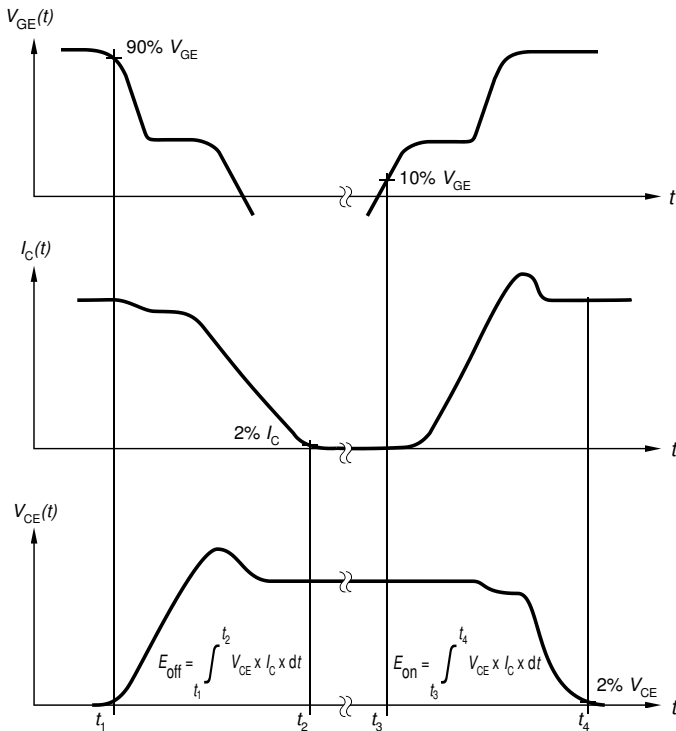


Figure B. Definition of switching losses

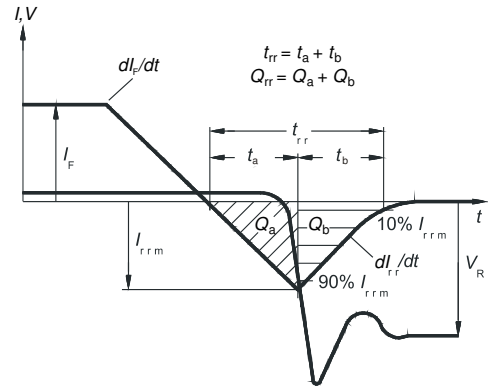


Figure C. Definition of diode switching characteristics

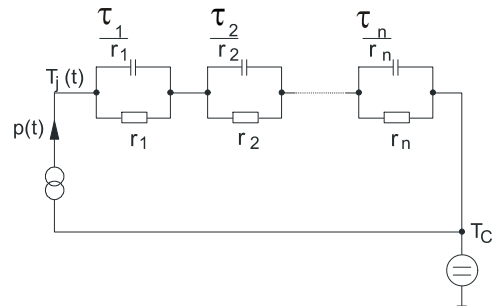


Figure D. Thermal equivalent circuit

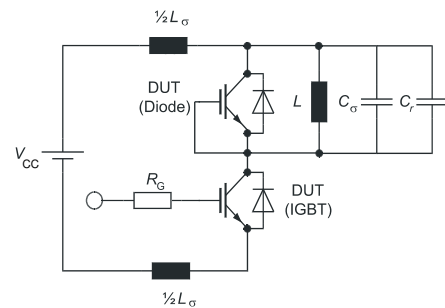


Figure E. Dynamic test circuit  
Parasitic inductance  $L_{\sigma}$ ,  
parasitic capacitor  $C_{\sigma}$ ,  
relief capacitor  $C_r$ ,  
(only for ZVT switching)

## Revision History

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IKQ40N120CH3

**Revision: 2019-04-15, Rev. 2.3**

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Previous Revision

Revision	Date	Subjects (major changes since last revision)
2.1	2017-04-26	Final data sheet
2.2	2017-06-09	Update Figure 26
2.3	2019-04-15	Update condition for V <sub>geth</sub> page 4 and Fig. 11

## Trademarks

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