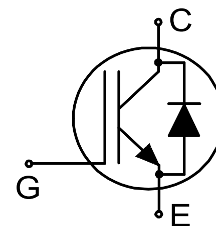
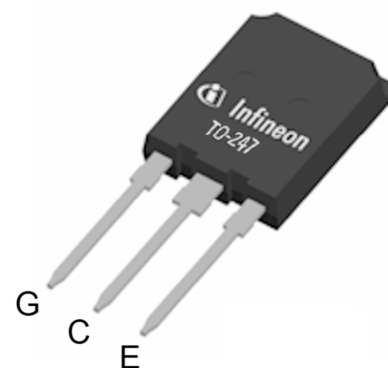
High speed switching series third generation IGBT

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°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°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°C	T_{vjmax}	Marking	Package
IKQ50N120CH3	1200V	50A	2V	175°C	K50MCH3	PG-TO247-3-46

Please read the Important Notice and Warnings at the end of this document

Table of Contents

Description 1
Table of Contents 2
Maximum Ratings 3
Thermal Resistance 3
Electrical Characteristics 4
Electrical Characteristics Diagrams 6
Package Drawing 13
Testing Conditions 14
Revision History 15
Disclaimer 16

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, $T_{vj} \geq 25°C$	V_{CE}	1200	V
DC collector current, limited by T_{vjmax} $T_C = 25°C$ $T_C = 135°C$	I_C	100.0 50.0	A
Pulsed collector current, t_p limited by T_{vjmax}	I_{Cpuls}	200.0	A
Turn off safe operating area $V_{CE} \leq 1200V$, $T_{vj} \leq 175°C$, $t_p = 1µs$	-	200.0	A
Diode forward current, limited by T_{vjmax} $T_C = 25°C$ $T_C = 100°C$	I_F	100.0 50.0	A
Diode pulsed current, t_p limited by T_{vjmax}	I_{Fpuls}	200.0	A
Gate-emitter voltage Transient Gate-emitter voltage ($t_p \leq 10µs$, $D < 0.010$)	V_{GE}	±20 ±30	V
Short circuit withstand time $V_{GE} = 15.0V$, $V_{CC} \leq 600V$ Allowed number of short circuits < 1000 Time between short circuits: ≥ 1.0s $T_{vj} = 175°C$	t_{SC}	10	µs
Power dissipation $T_C = 25°C$ Power dissipation $T_C = 135°C$	P_{tot}	652.0 173.0	W
Operating junction temperature	T_{vj}	-40...+175	°C
Storage temperature	T_{stg}	-55...+150	°C
Soldering temperature, wave soldering 1.6mm (0.063in.) from case for 10s		260	°C

Thermal Resistance

Parameter	Symbol	Conditions	Value			Unit
			min.	typ.	max.	
R_{th} Characteristics						
IGBT thermal resistance,[1] junction - case	$R_{th(j-C)}$		-	-	0.23	K/W
Diode thermal resistance,[1] junction - case	$R_{th(j-C)}$		-	-	0.42	K/W
Thermal resistance junction - ambient	$R_{th(j-a)}$		-	-	40	K/W

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

High speed switching series third generation IGBT

Electrical Characteristic, at T_{vj} = 25°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 = 0.50mA	1200	-	-	V
Collector-emitter saturation voltage	V_{CEsat}	V_{GE} = 15.0V, I_C = 50.0A T_{vj} = 25°C T_{vj} = 175°C	- -	2.00 2.50	2.35 -	V
Diode forward voltage	V_F	V_{GE} = 0V, I_F = 50.0A T_{vj} = 25°C T_{vj} = 175°C	- -	1.90 1.85	2.30 -	V
Gate-emitter threshold voltage	$V_{GE(th)}$	I_C = 1.25mA, V_{CE} = V_{GE}	5.1	5.8	6.5	V
Zero gate voltage collector current	I_{CES}	V_{CE} = 1200V, V_{GE} = 0V T_{vj} = 25°C T_{vj} = 175°C	- -	- 4000	350 -	µA
Gate-emitter leakage current	I_{GES}	V_{CE} = 0V, V_{GE} = 20V	-	-	100	nA
Transconductance	g_{fs}	V_{CE} = 20V, I_C = 50.0A	-	17.0	-	S

Electrical Characteristic, at T_{vj} = 25°C, unless otherwise specified

Parameter	Symbol	Conditions	Value			Unit
			min.	typ.	max.	
Dynamic Characteristic						
Input capacitance	C_{ies}	V_{CE} = 25V, V_{GE} = 0V, f = 1MHz	-	3269	-	pF
Output capacitance	C_{oes}		-	355	-	
Reverse transfer capacitance	C_{res}		-	199	-	
Gate charge	Q_G	V_{CC} = 960V, I_C = 40.0A, V_{GE} = 15V	-	235.0	-	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.	
IGBT Characteristic, at T_{vj} = 25°C						
Turn-on delay time	$t_{d(on)}$	T_{vj} = 25°C, V_{CC} = 600V, I_C = 50.0A, V_{GE} = 0.0/15.0V, $R_{G(on)}$ = 10.0Ω, $R_{G(off)}$ = 10.0Ω, $L\sigma$ = 90nH, $C\sigma$ = 67pF $L\sigma$, $C\sigma$ from Fig. E Energy losses include “tail” and diode reverse recovery.	-	34	-	ns
Rise time	t_r		-	32	-	ns
Turn-off delay time	$t_{d(off)}$		-	297	-	ns
Fall time	t_f		-	30	-	ns
Turn-on energy	E_{on}		-	3.00	-	mJ
Turn-off energy	E_{off}		-	1.90	-	mJ
Total switching energy	E_{ts}		-	4.90	-	mJ

High speed switching series third generation IGBT

Diode Characteristic, at T_{vj} = 25°C

Diode reverse recovery time	t_{rr}	T_{vj} = 25°C, V_R = 600V, I_F = 50.0A, di_F/dt = 1200A/µs	-	240	-	ns
Diode reverse recovery charge	Q_{rr}		-	3.50	-	µC
Diode peak reverse recovery current	I_{rrm}		-	34.0	-	A
Diode peak rate of fall of reverse recovery current during t_b	di_{rr}/dt		-	-403	-	A/µs

Switching Characteristic, Inductive Load

Parameter	Symbol	Conditions	Value			Unit
			min.	typ.	max.	
IGBT Characteristic, at T_{vj} = 175°C						
Turn-on delay time	$t_{d(on)}$	T_{vj} = 175°C, V_{CC} = 600V, I_C = 50.0A, V_{GE} = 0.0/15.0V, $R_{G(on)}$ = 10.0Ω, $R_{G(off)}$ = 10.0Ω, $L\sigma$ = 90nH, $C\sigma$ = 67pF $L\sigma$, $C\sigma$ from Fig. E Energy losses include “tail” and diode reverse recovery.	-	32	-	ns
Rise time	t_r		-	36	-	ns
Turn-off delay time	$t_{d(off)}$		-	400	-	ns
Fall time	t_f		-	66	-	ns
Turn-on energy	E_{on}		-	5.30	-	mJ
Turn-off energy	E_{off}		-	4.10	-	mJ
Total switching energy	E_{ts}		-	9.40	-	mJ

Diode Characteristic, at T_{vj} = 175°C

Diode reverse recovery time	t_{rr}	T_{vj} = 175°C, V_R = 600V, I_F = 50.0A, di_F/dt = 1200A/µs	-	390	-	ns
Diode reverse recovery charge	Q_{rr}		-	8.60	-	µC
Diode peak reverse recovery current	I_{rrm}		-	46.0	-	A
Diode peak rate of fall of reverse recovery current during t_b	di_{rr}/dt		-	-210	-	A/µs

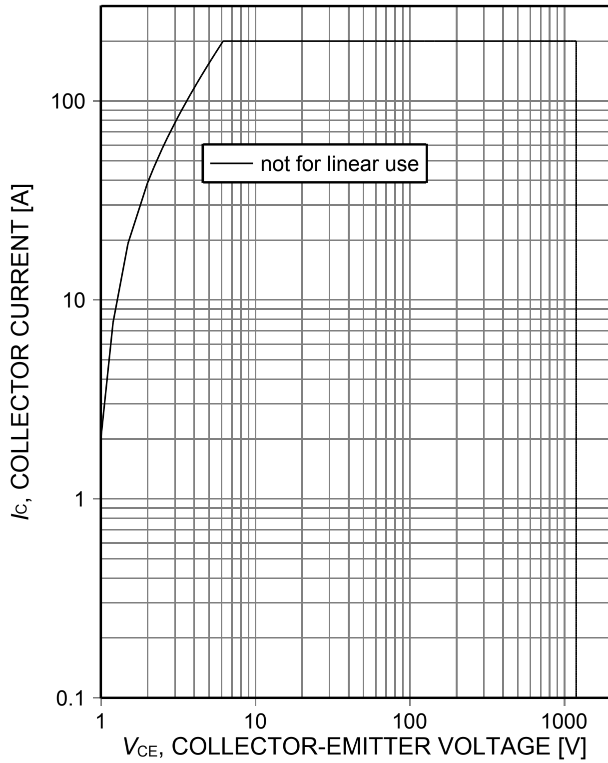


Figure 1. **Forward bias safe operating area**
(D=0, T_C=25°C, T_{vj}≤175°C; V_{GE}=15V)

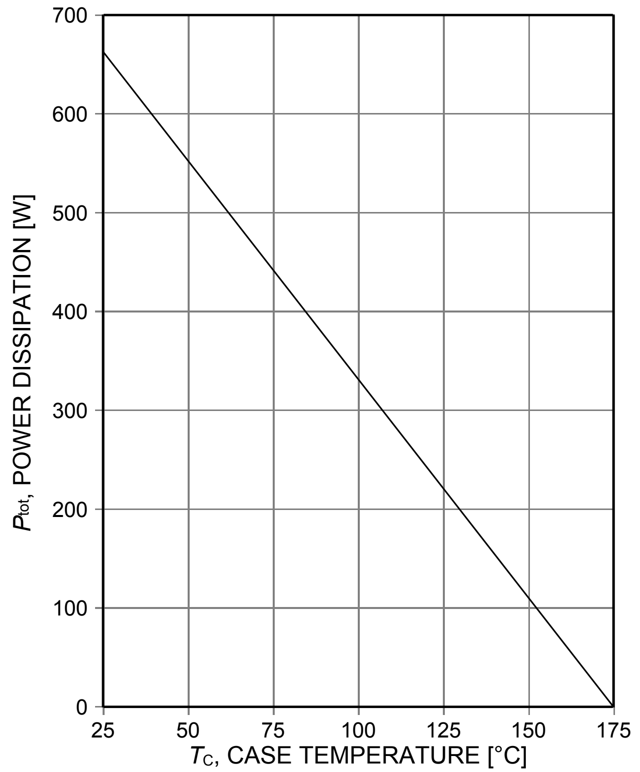


Figure 2. **Power dissipation as a function of case temperature**
(T_{vj}≤175°C)

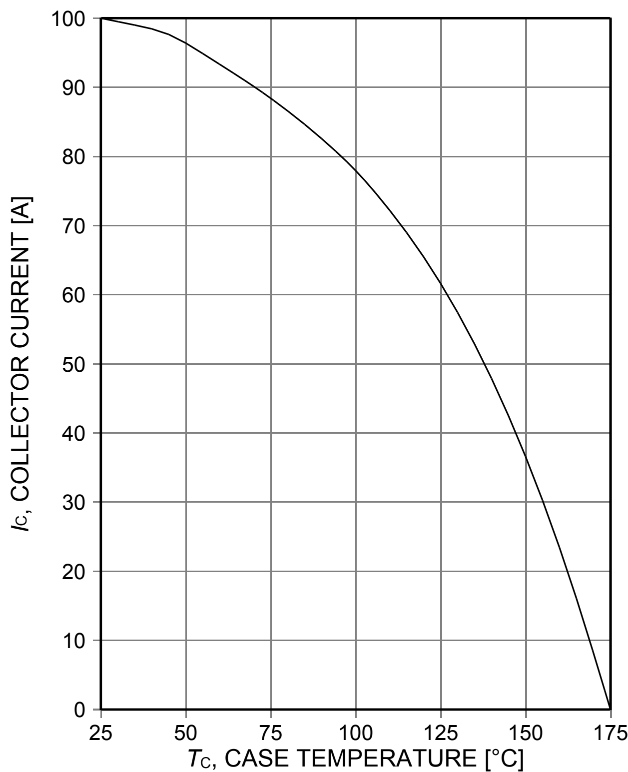


Figure 3. **Collector current as a function of case temperature**
(V_{GE}≥15V, T_{vj}≤175°C)

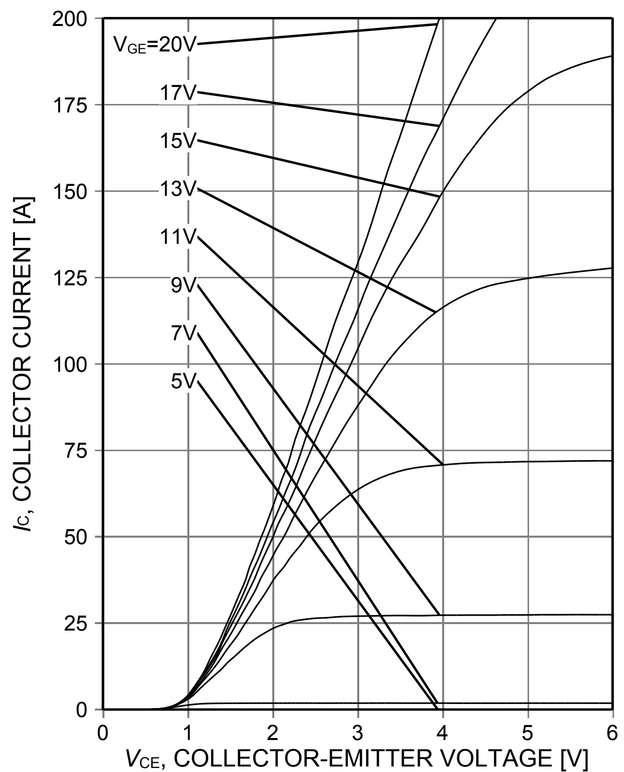


Figure 4. **Typical output characteristic**
(T_{vj}=25°C)

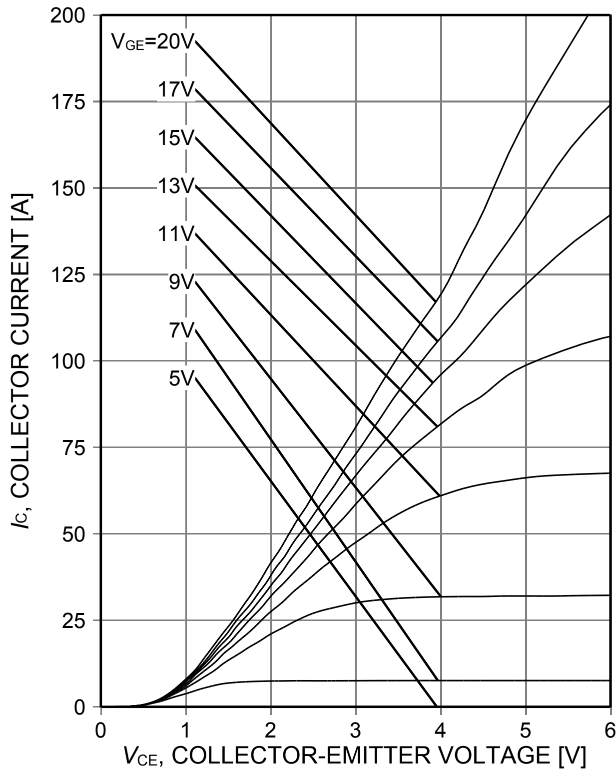


Figure 5. **Typical output characteristic**
(T_{vj}=175°C)

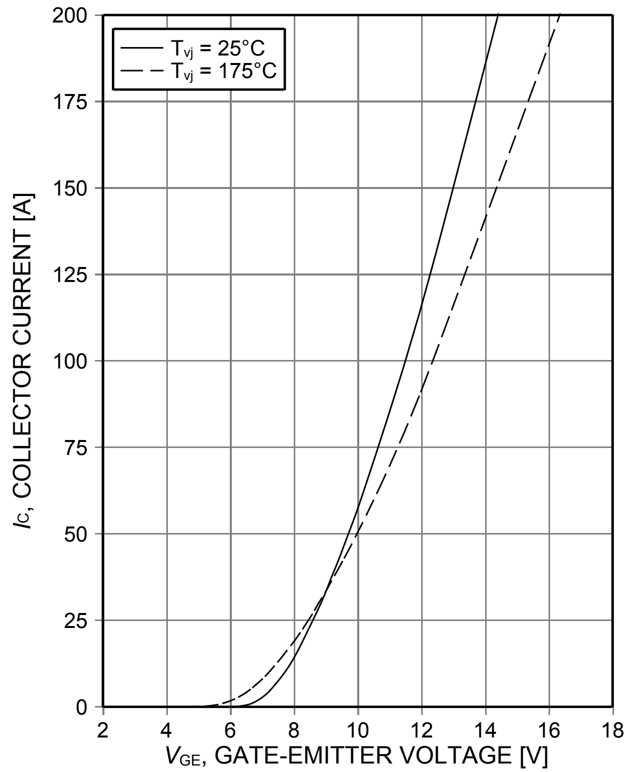


Figure 6. **Typical transfer characteristic**
(V_{CE}=20V)

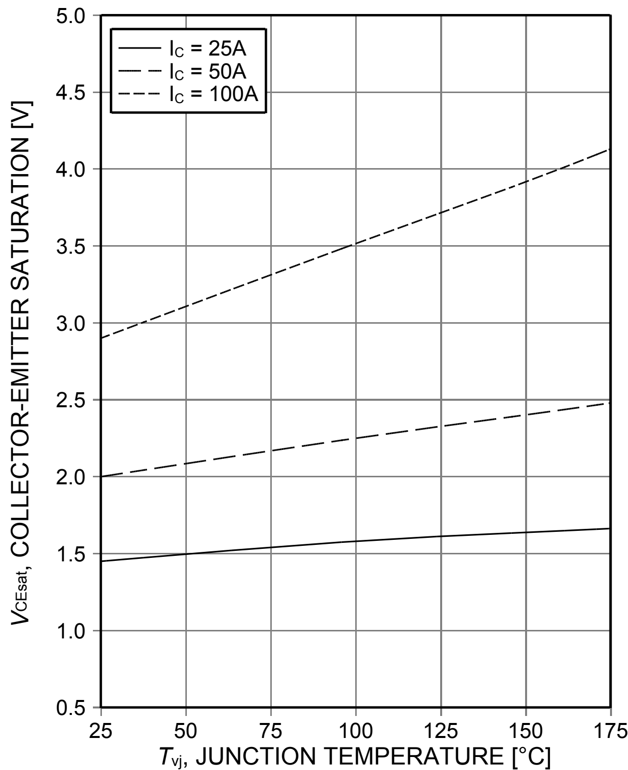


Figure 7. **Typical collector-emitter saturation voltage as a function of junction temperature**
(V_{GE}=15V)

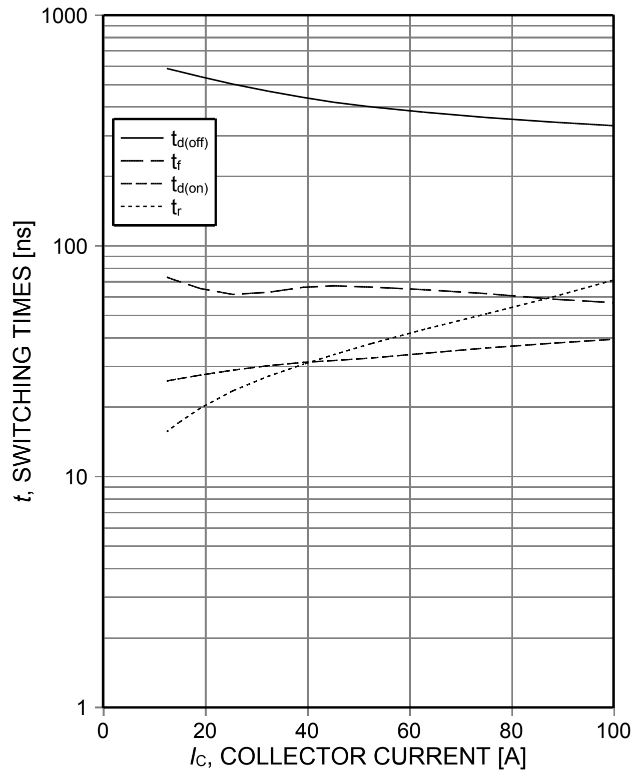


Figure 8. **Typical switching times as a function of collector current**
(inductive load, T_{vj}=175°C, V_{CE}=600V, V_{GE}=0/15V, R_G=10Ω, Dynamic test circuit in Figure E)

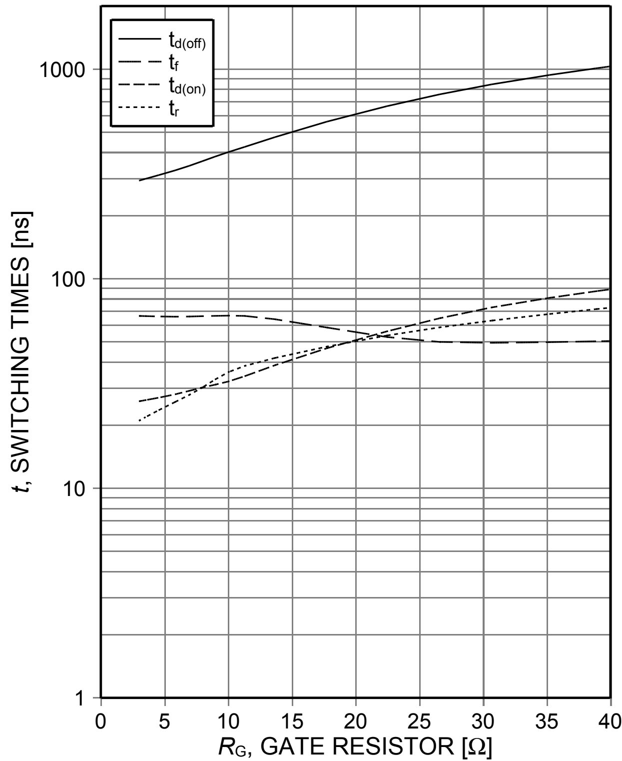


Figure 9. **Typical switching times as a function of gate resistor**
(inductive load, T_{vj}=175°C, V_{CE}=600V, V_{GE}=0/15V, I_C=50A, Dynamic test circuit in Figure E)

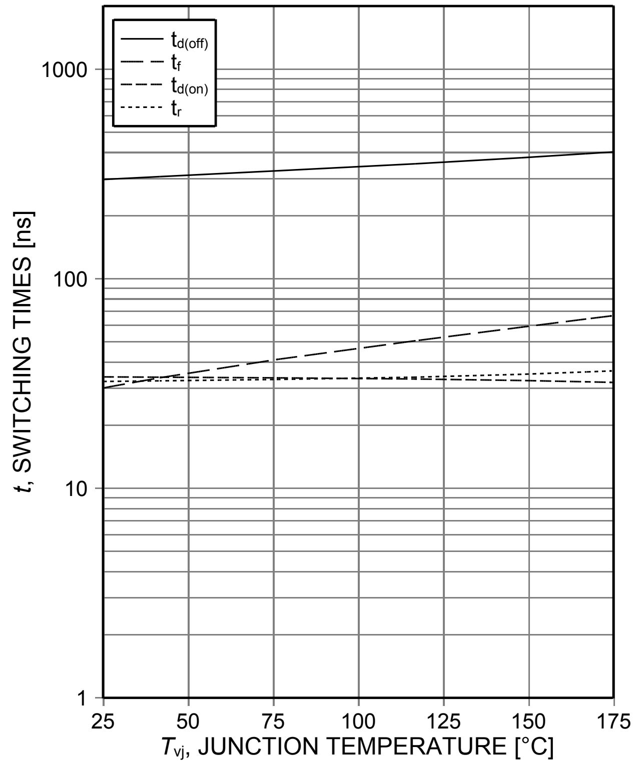


Figure 10. **Typical switching times as a function of junction temperature**
(inductive load, V_{CE}=600V, V_{GE}=0/15V, I_C=50A, R_G=10Ω, Dynamic test circuit in Figure E)

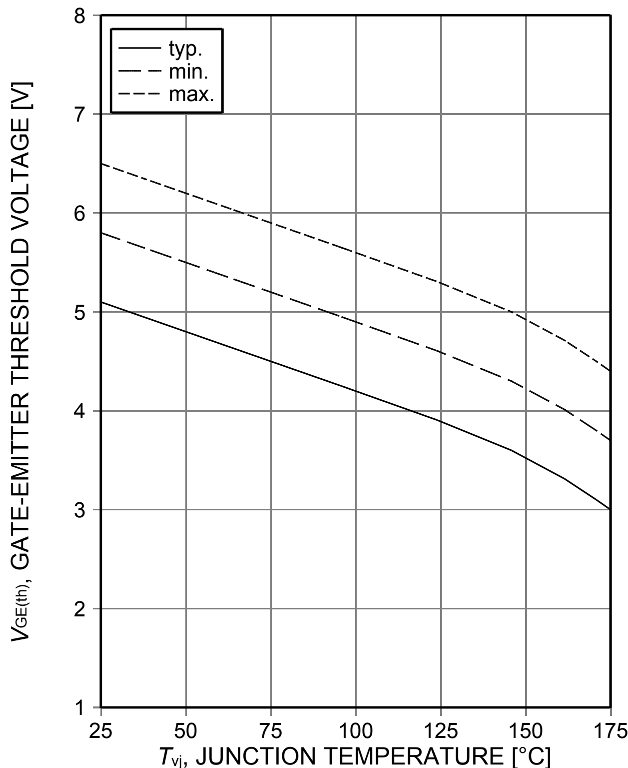


Figure 11. **Gate-emitter threshold voltage as a function of junction temperature**
(I_C=1,25 mA)

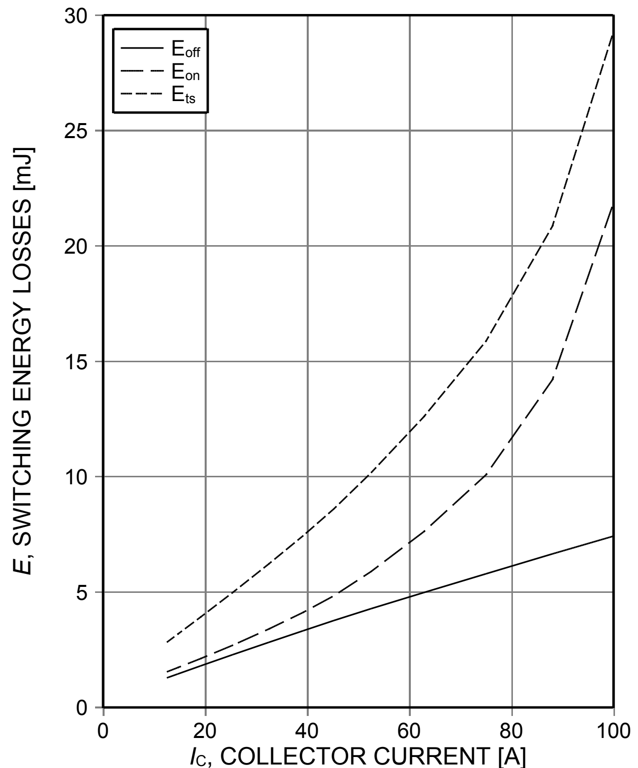


Figure 12. **Typical switching energy losses as a function of collector current**
(inductive load, T_{vj}=175°C, V_{CE}=600V, V_{GE}=0/15V, R_G=10Ω, Dynamic test circuit in Figure E)

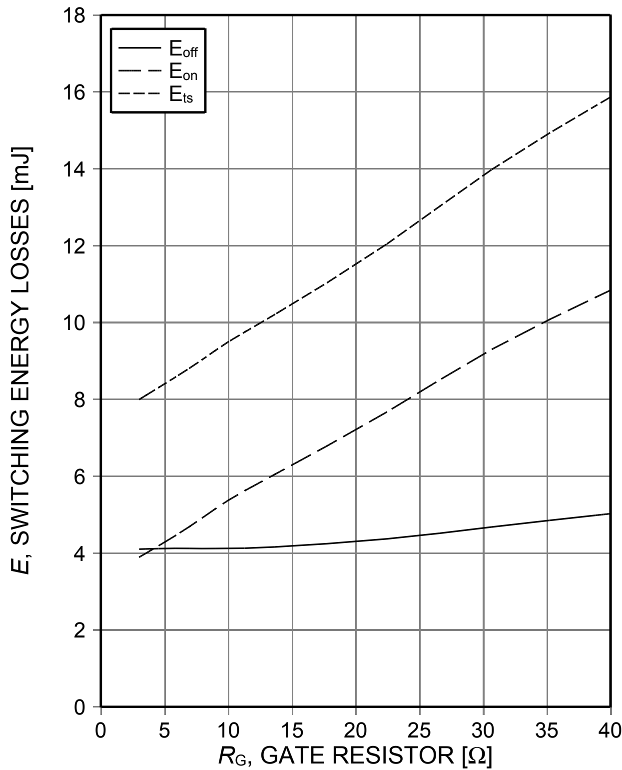


Figure 13. **Typical switching energy losses as a function of gate resistor**
(inductive load, T_{vj}=175°C, V_{CE}=600V, V_{GE}=0/15V, I_C=50A, Dynamic test circuit in Figure E)

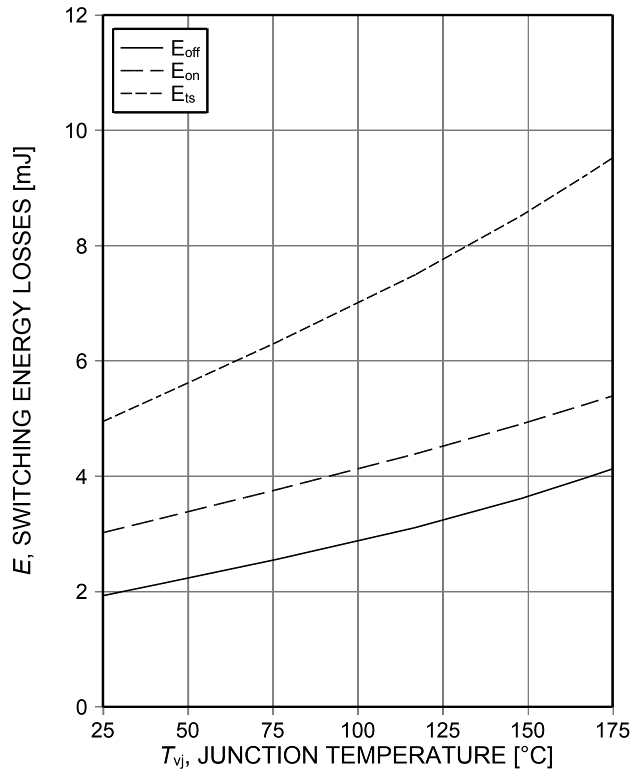


Figure 14. **Typical switching energy losses as a function of junction temperature**
(inductive load, V_{CE}=600V, V_{GE}=0/15V, I_C=50A, R_G=10Ω, Dynamic test circuit in Figure E)

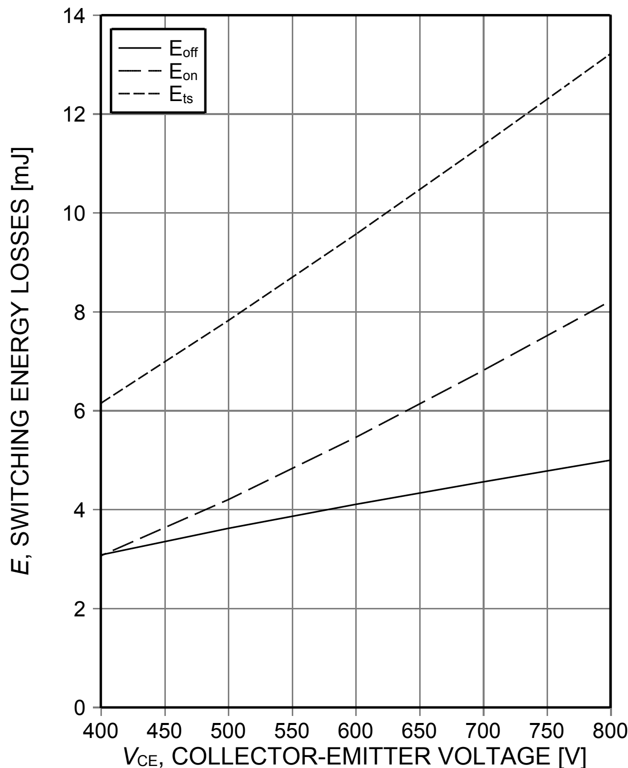


Figure 15. **Typical switching energy losses as a function of collector emitter voltage**
(inductive load, T_{vj}=175°C, V_{GE}=0/15V, I_C=50A, R_G=10Ω, Dynamic test circuit in Figure E)

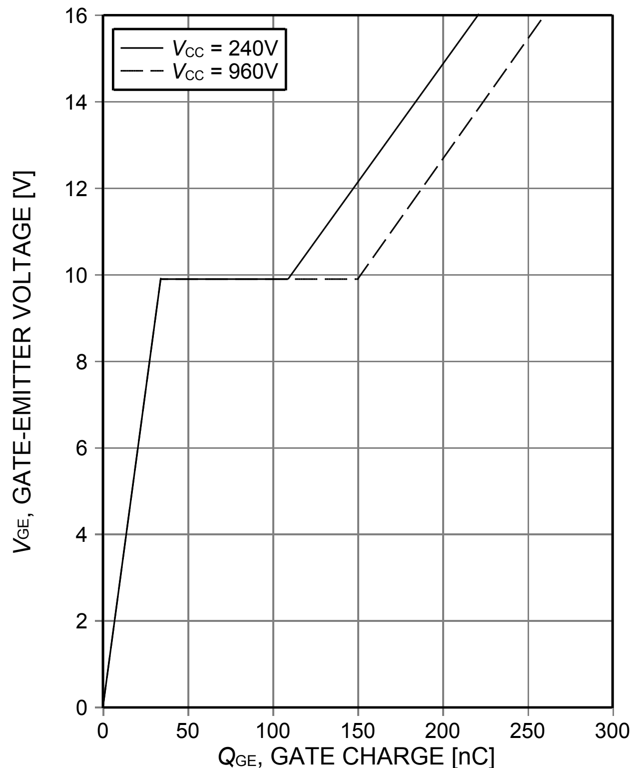


Figure 16. **Typical gate charge**
(I_C=50A)

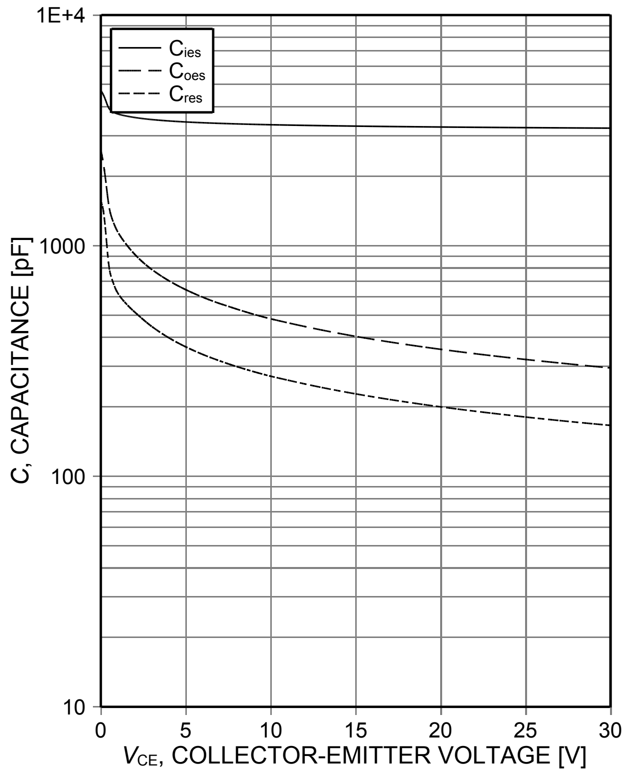


Figure 17. **Typical capacitance as a function of collector-emitter voltage**
(V_{GE}=0V, f=1MHz)

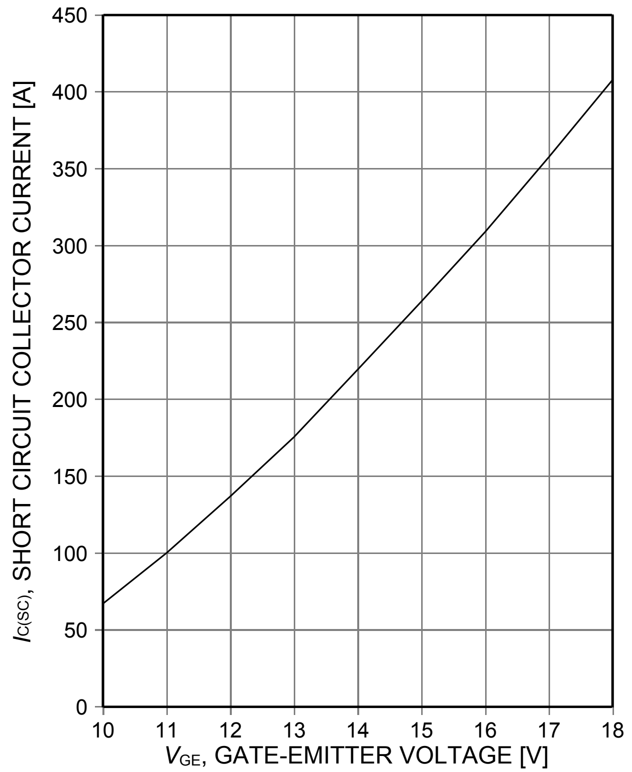


Figure 18. **Typical short circuit collector current as a function of gate-emitter voltage**
(V_{CE}≤600V, T_{vj}≤175°C)

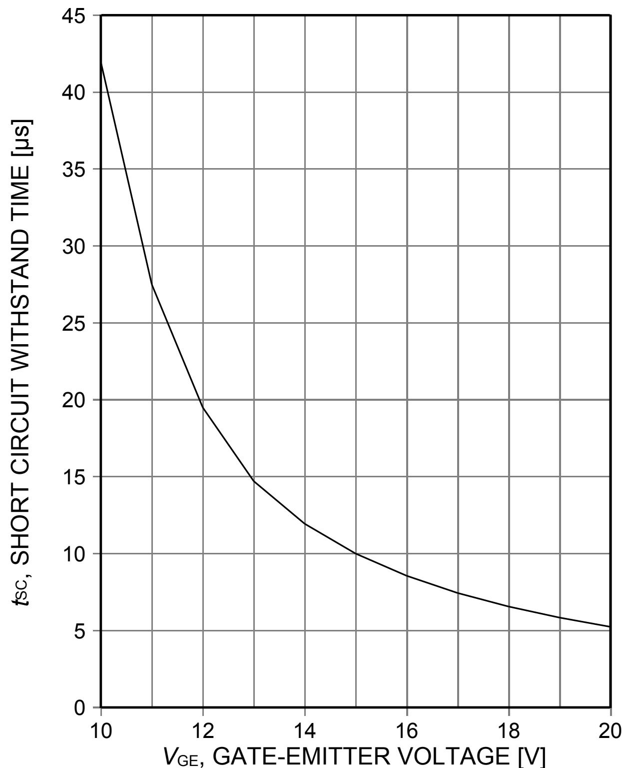
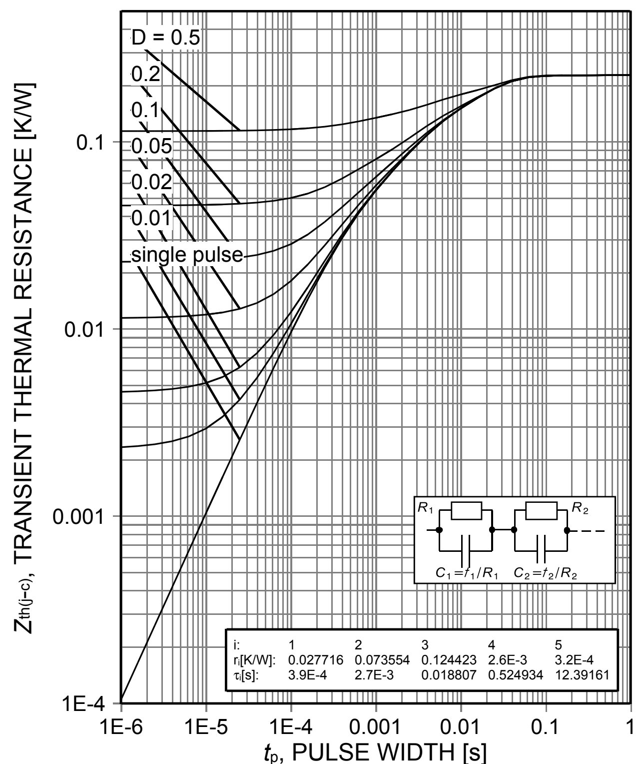


Figure 19. **Short circuit withstand time as a function of gate-emitter voltage**
(V_{CE}≤600V, start at T_{vj}≤175°C)



i:	1	2	3	4	5
r_i[K/W]:	0.027716	0.073554	0.124423	2.6E-3	3.2E-4
τ_i[s]:	3.9E-4	2.7E-3	0.018807	0.524934	12.39161

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

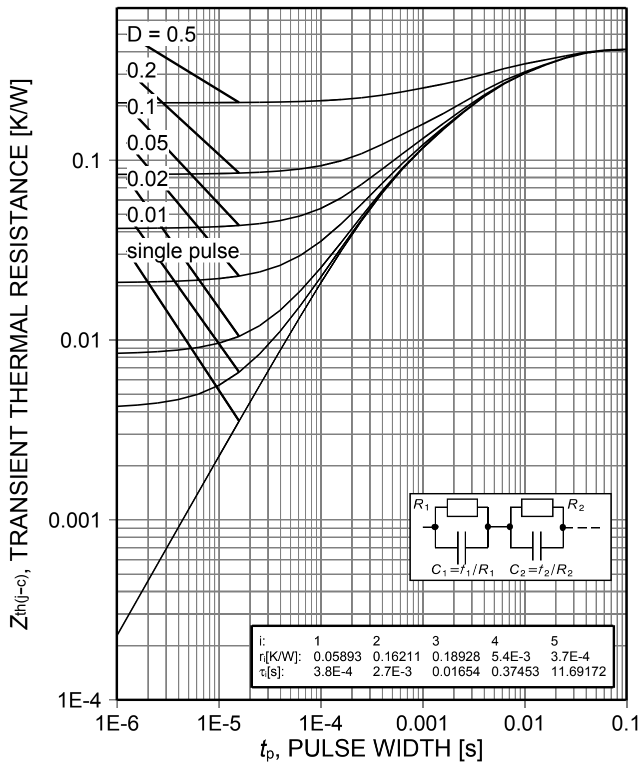


Figure 21. **Diode transient thermal impedance as a function of pulse width**
($D=t_p/T$)

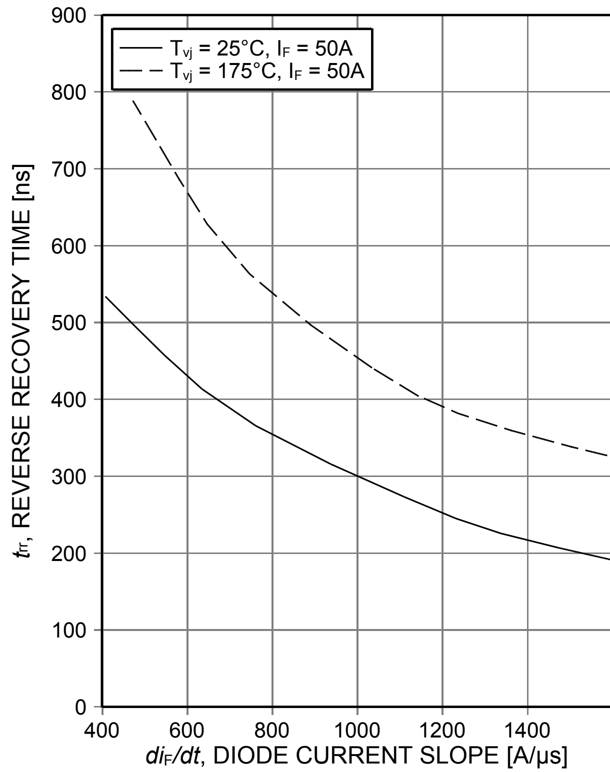


Figure 22. **Typical reverse recovery time as a function of diode current slope**
(V_R=600V)

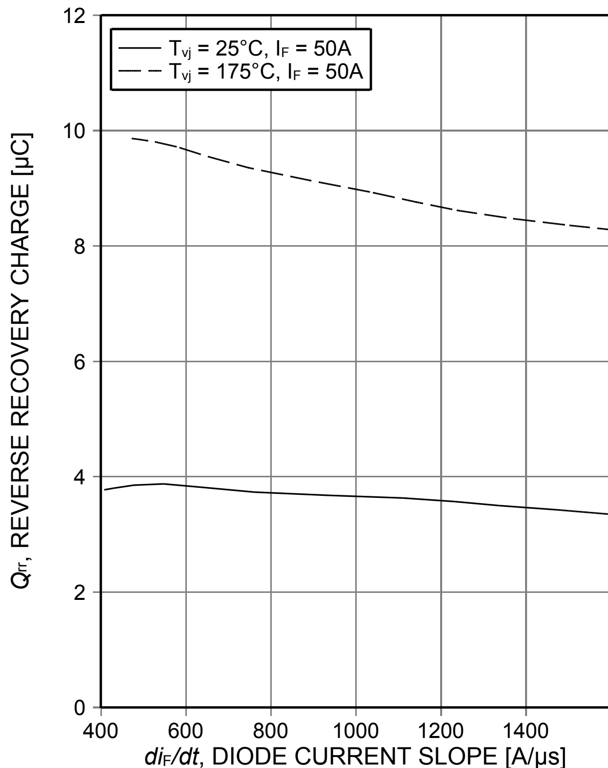


Figure 23. **Typical reverse recovery charge as a function of diode current slope**
(V_R=600V)

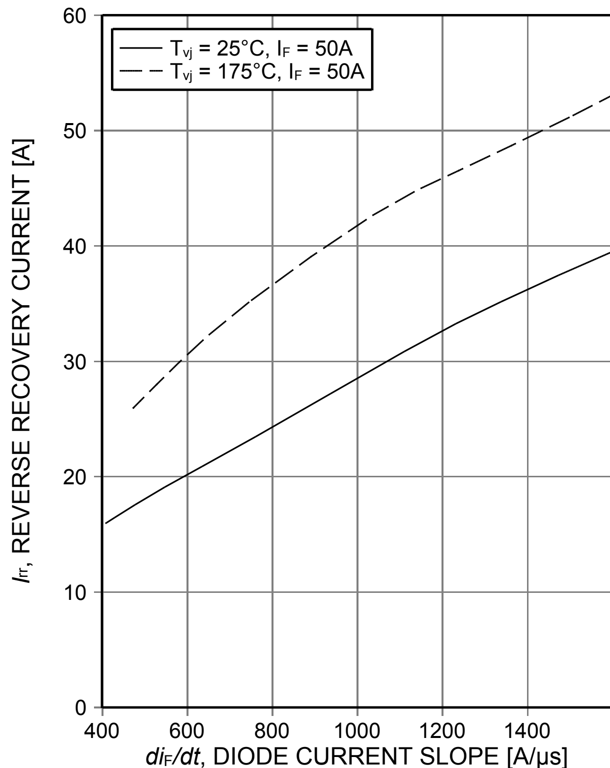


Figure 24. **Typical reverse recovery current as a function of diode current slope**
(V_R=600V)

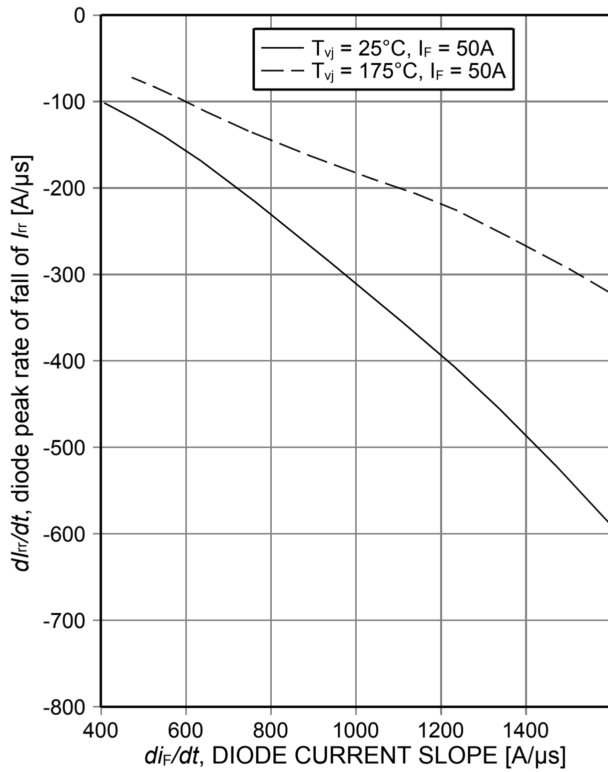


Figure 25. **Typical diode peak rate of fall of reverse recovery current as a function of diode current slope**
(V_R=600V)

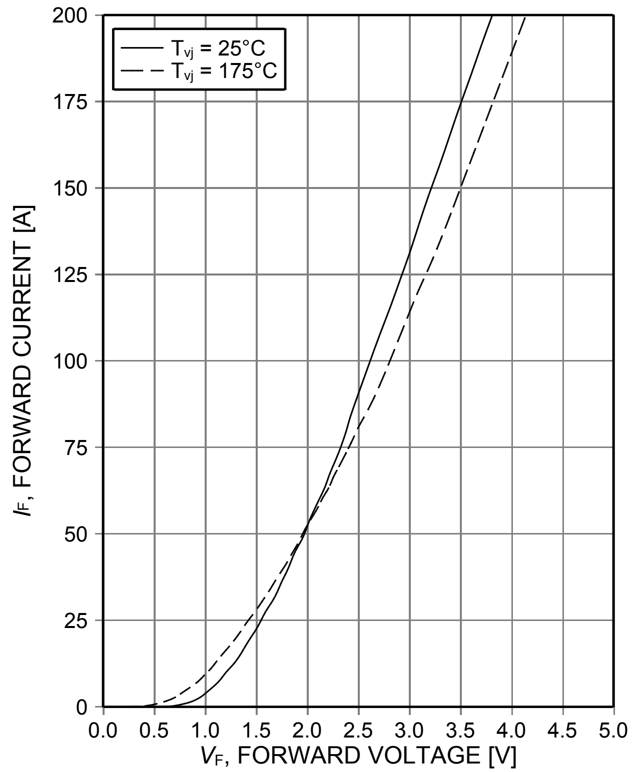


Figure 26. **Typical diode forward current as a function of forward voltage**

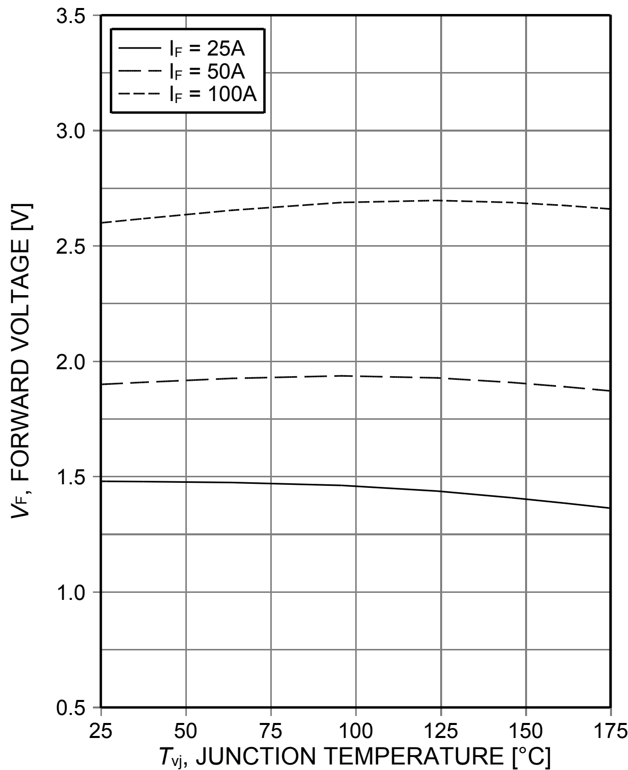
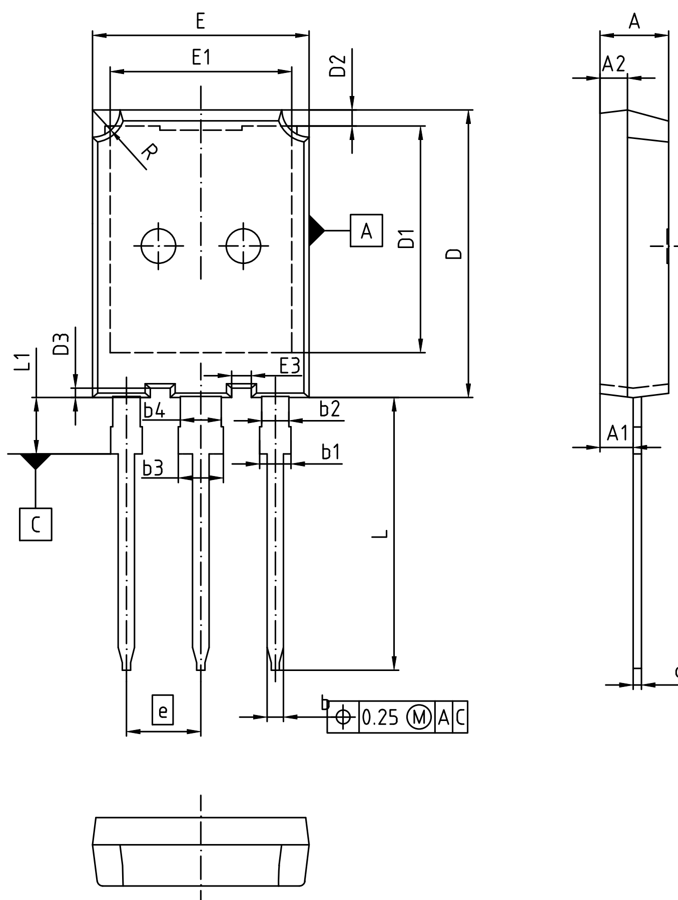


Figure 27. **Typical diode forward voltage as a function of junction temperature**

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

DOCUMENT NO.
Z8B00174295
SCALE 0 5 0 5 7.5mm
EUROPEAN PROJECTION
ISSUE DATE 13-08-2014
REVISION 01

Testing Conditions

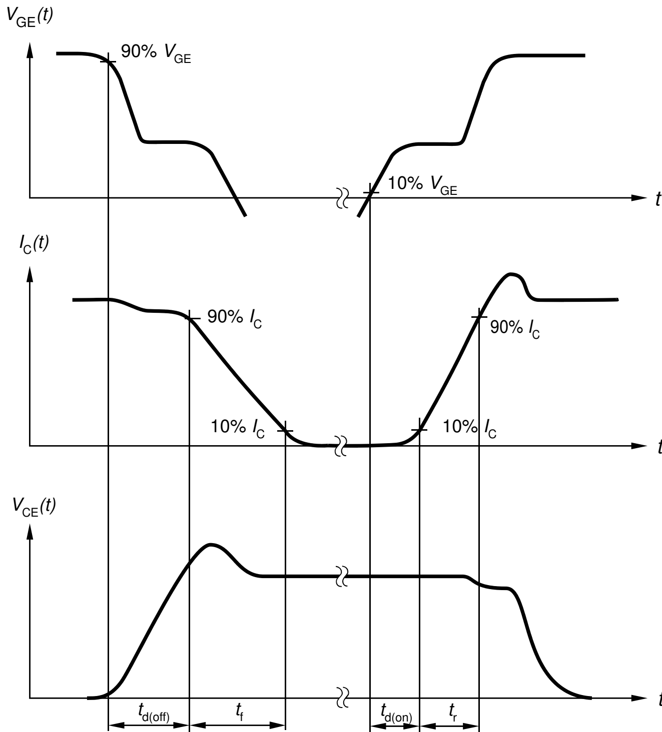


Figure A. **Definition of switching times**

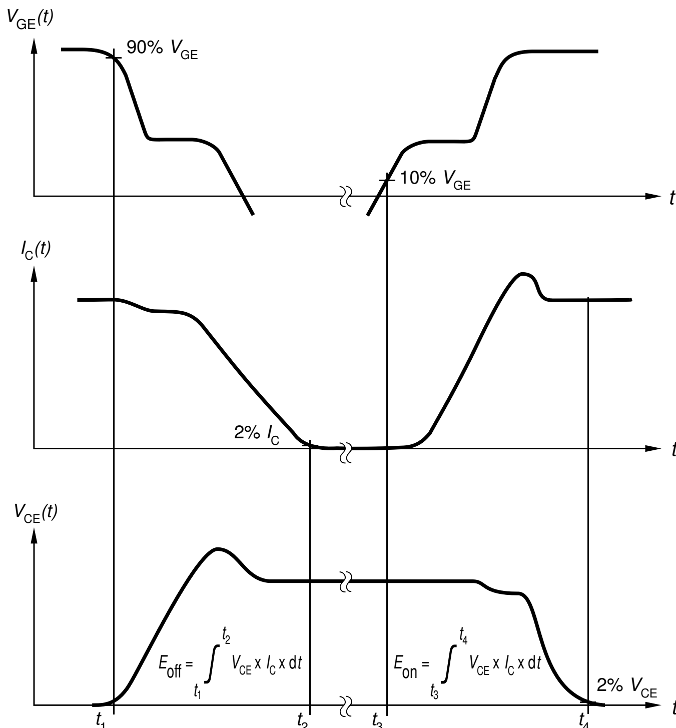


Figure B. **Definition of switching losses**

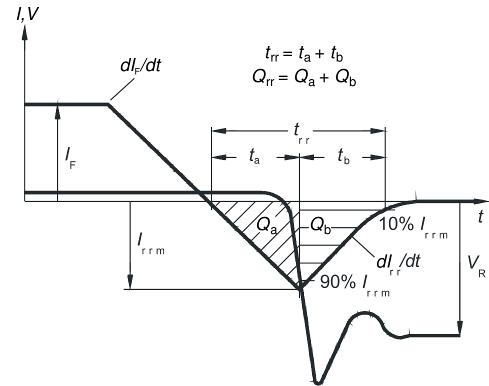


Figure C. **Definition of diode switching characteristics**

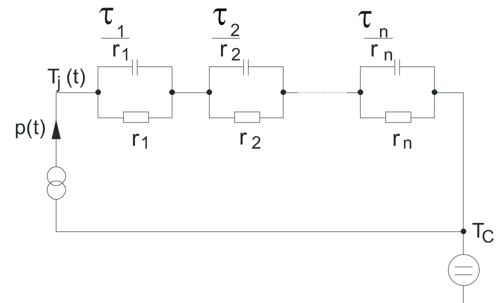


Figure D. **Thermal equivalent circuit**

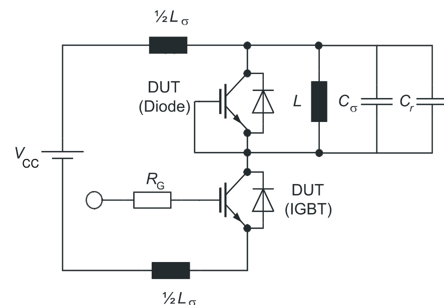


Figure E. **Dynamic test circuit**
Parasitic inductance L_σ,
parasitic capacitor C_σ,
relief capacitor C_r,
(only for ZVT switching)

Revision History

IKQ50N120CH3

Revision: 2017-06-09, Rev. 2.3

Previous Revision

Revision	Date	Subjects (major changes since last revision)
2.1	2017-04-26	Final data sheet
2.2	2017-05-10	Minor change Conditions Diode Characteristic
2.3	2017-06-09	Update Figure 26

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