IGBT

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

IKB20N60TA

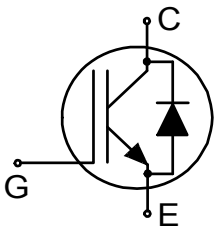
600V low loss switching series third generation

Data sheet

Industrial Power Control

Low Loss DuoPack : IGBT in TrenchStop® and Fieldstop technology with soft, fast recovery anti-parallel 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 150 °C
- Short circuit withstand time 5µs
- 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
- Green Package



Key Performance and Package Parameters

Type	V_{CE}	I_C	V_{CEsat}, T_{vj}=25°C	T_{vjmax}	Marking	Package
IKB20N60TA	600V	20A	1.5V	150°C	K20T60A	PG-TO263-3

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Maximum ratings

Parameter	Symbol	Value	Unit
Collector-emitter voltage, $T_{vj} \geq 25°C$	V_{CE}	600	V
DC collector current, limited by T_{vjmax} $T_C = 25°C$ $T_C = 100°C$	I_C	 40.0 20.0	A
Pulsed collector current, t_p limited by T_{vjmax}	I_{Cpuls}	60.0	A
Turn off safe operating area $V_{CE} \leq 600V$, $T_{vj} \leq 150°C$[1)]	-	60.0	A
Diode forward current, limited by T_{vjmax} $T_C = 25°C$ $T_C = 100°C$	I_F	 40.0 20.0	A
Diode pulsed current, t_p limited by T_{vjmax}	I_{Fpuls}	60.0	A
Gate-emitter voltage	V_{GE}	±20	V
Short circuit withstand time $V_{GE} = 15.0V$, $V_{CC} \leq 400V$ Allowed number of short circuits < 1000 Time between short circuits: ≥ 1.0s $T_{vj} = 150°C$	t_{SC}	 5	µs
Power dissipation $T_C = 25°C$	P_{tot}	156.0	W
Operating junction temperature	T_{vj}	-40...+150	°C
Storage temperature	T_{stg}	-40...+150	°C
Soldering temperature, reflow soldering (MSL1 according to JEDEC J-STA-020)		260	°C

Thermal Resistance

Parameter	Symbol	Conditions	Max. Value	Unit
Characteristic				
IGBT thermal resistance, junction - case	$R_{th(j-c)}$		0.90	K/W
Diode thermal resistance, junction - case	$R_{th(j-c)}$		1.50	K/W
Thermal resistance, min. footprint junction - ambient	$R_{th(j-a)}$		65	K/W
Thermal resistance, 6cm² Cu on PCB junction - ambient	$R_{th(j-a)}$		40	K/W

[1)] $t_p \leq 1µs$

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 = 0.20mA	600	-	-	V
Collector-emitter saturation voltage	V_{CEsat}	V_{GE} = 15.0V, I_C = 20.0A T_{vj} = 25°C T_{vj} = 150°C	 - -	 1.50 1.85	 2.05 -	V
Diode forward voltage	V_F	V_{GE} = 0V, I_F = 20.0A T_{vj} = 25°C T_{vj} = 150°C	 - -	 1.65 1.65	 2.05 -	V
Gate-emitter threshold voltage	$V_{GE(th)}$	I_C = 0.29mA, V_{CE} = V_{GE}	4.1	4.9	5.7	V
Zero gate voltage collector current	I_{CES}	V_{CE} = 600V, V_{GE} = 0V T_{vj} = 25°C T_{vj} = 150°C	 - -	 - -	 40.0 1500.0	µA
Gate-emitter leakage current	I_{GES}	V_{CE} = 0V, V_{GE} = 20V	-	-	100	nA
Transconductance	g_{fs}	V_{CE} = 20V, I_C = 20.0A	-	11.0	-	S
Integrated gate resistor	r_G			none		Ω

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	-	1100	-	pF
Output capacitance	C_{oes}		-	71	-	
Reverse transfer capacitance	C_{res}		-	32	-	
Gate charge	Q_G	V_{CC} = 480V, I_C = 20.0A, V_{GE} = 15V	-	120.0	-	nC
Internal emitter inductance measured 5mm (0.197 in.) from case	L_E		-	7.0	-	nH
Short circuit collector current Max. 1000 short circuits Time between short circuits: ≥ 1.0s	$I_{C(SC)}$	V_{GE} = 15.0V, V_{CC} ≤ 400V, t_{SC} ≤ 5µs T_{vj} = 150°C	-	 183	-	A

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 = 20.0A, V_{GE} = 0.0/15.0V, r_G = 12.0Ω, $L\sigma$ = 131nH, $C\sigma$ = 31pF $L\sigma$, $C\sigma$ from Fig. E Energy losses include “tail” and diode reverse recovery.	-	18	-	ns
Rise time	t_r		-	14	-	ns
Turn-off delay time	$t_{d(off)}$		-	199	-	ns
Fall time	t_f		-	42	-	ns
Turn-on energy	E_{on}		-	0.31	-	mJ
Turn-off energy	E_{off}		-	0.46	-	mJ
Total switching energy	E_{ts}		-	0.77	-	mJ

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

Diode reverse recovery time	t_{rr}	T_{vj} = 25°C, V_R = 600V, I_F = 20.0A, di_F/dt = 880A/µs	-	41	-	ns
Diode reverse recovery charge	Q_{rr}		-	0.31	-	µC
Diode peak reverse recovery current	I_{rrm}		-	13.3	-	A
Diode peak rate of fall of reverse recovery current during t_b	di_{rr}/dt		-	711	-	A/µs

Switching Characteristic, Inductive Load

Parameter	Symbol	Conditions	Value			Unit
			min.	typ.	max.	
IGBT Characteristic, at T_{vj} = 150°C						
Turn-on delay time	$t_{d(on)}$	T_{vj} = 150°C, V_{CC} = 600V, I_C = 20.0A, V_{GE} = 0.0/15.0V, r_G = 12.0Ω, $L\sigma$ = 131nH, $C\sigma$ = 31pF $L\sigma$, $C\sigma$ from Fig. E Energy losses include “tail” and diode reverse recovery.	-	18	-	ns
Rise time	t_r		-	17	-	ns
Turn-off delay time	$t_{d(off)}$		-	217	-	ns
Fall time	t_f		-	70	-	ns
Turn-on energy	E_{on}		-	0.47	-	mJ
Turn-off energy	E_{off}		-	0.60	-	mJ
Total switching energy	E_{ts}		-	1.07	-	mJ

Diode Characteristic, at T_{vj} = 150°C

Diode reverse recovery time	t_{rr}	T_{vj} = 150°C, V_R = 600V, I_F = 20.0A, di_F/dt = 800A/µs	-	201	-	ns
Diode reverse recovery charge	Q_{rr}		-	1.28	-	µC
Diode peak reverse recovery current	I_{rrm}		-	16.6	-	A
Diode peak rate of fall of reverse recovery current during t_b	di_{rr}/dt		-	481	-	A/µs

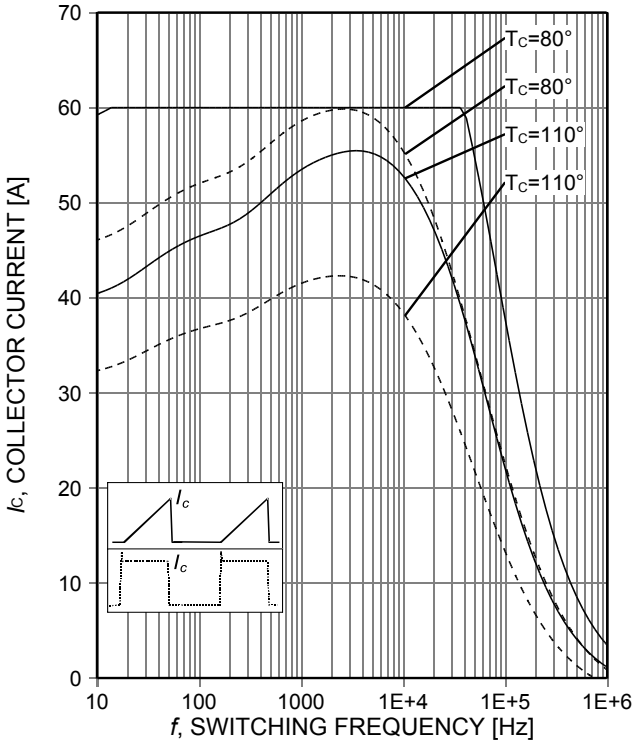


Figure 1. **Collector current as a function of switching frequency**
(T_j≤150°C, D=0.5, V_{CE}=400V, V_{GE}=15/0V, R_G=12Ω)

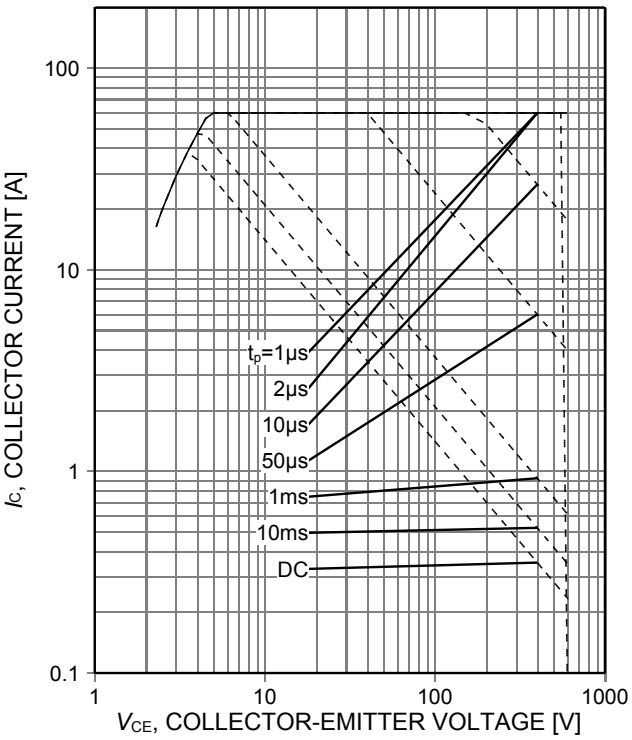


Figure 2. **Safe operating area**
(D=0, T_C=25°C, T_j≤150°C; V_{GE}=15V)

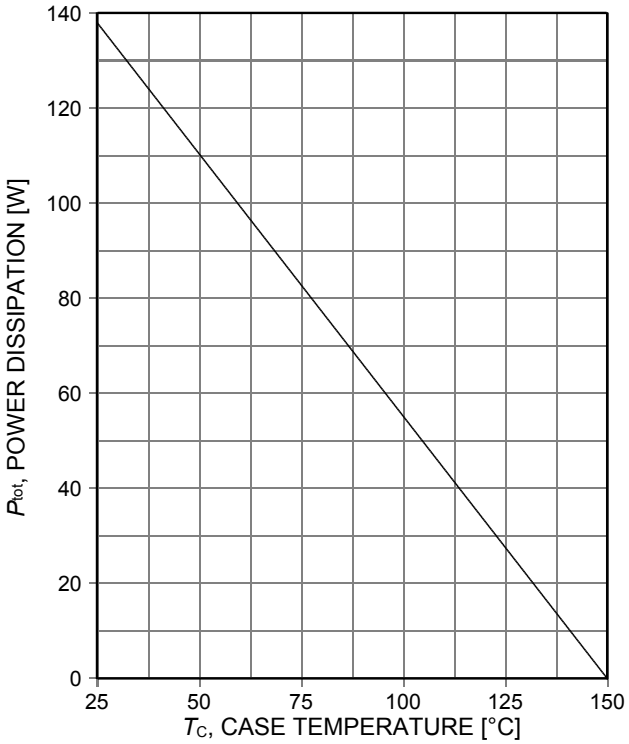


Figure 3. **Power dissipation as a function of case temperature**
(T_j≤150°C)

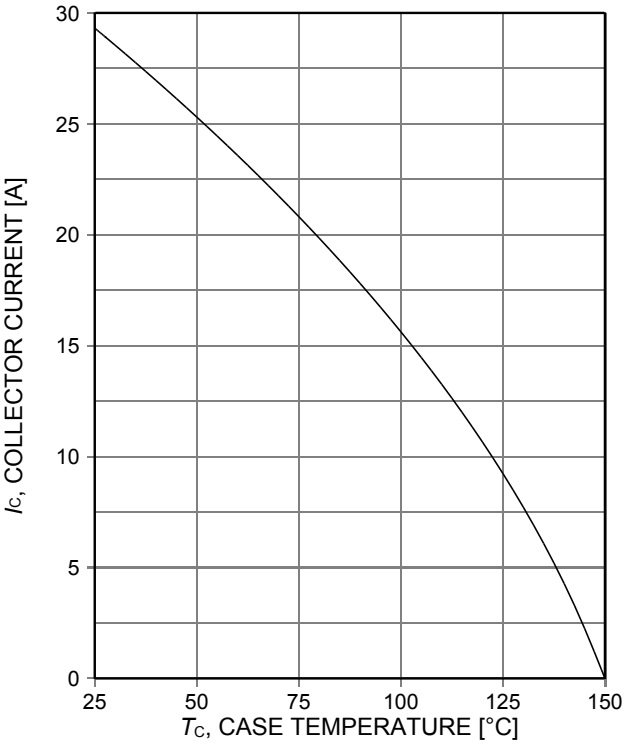


Figure 4. **Collector current as a function of case temperature**
(V_{GE}≥15V, T_j≤150°C)

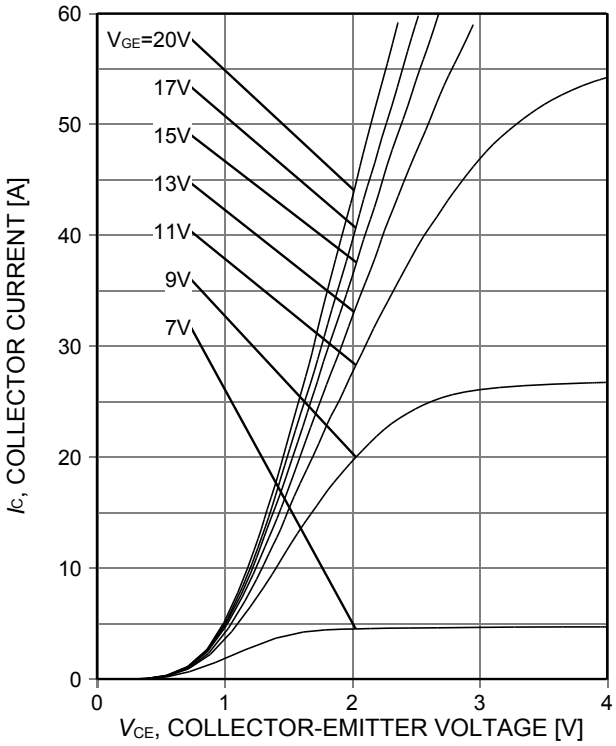


Figure 5. **Typical output characteristic** (T_j=25°C)

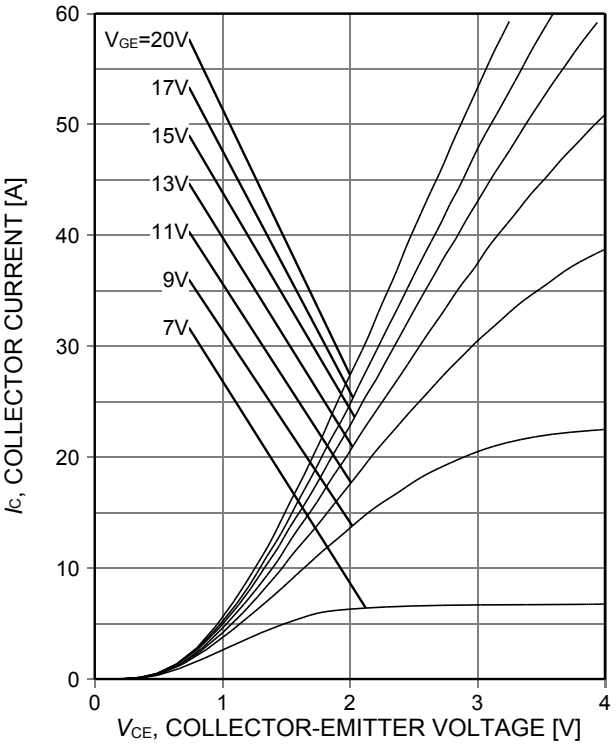


Figure 6. **Typical output characteristic** (T_j=150°C)

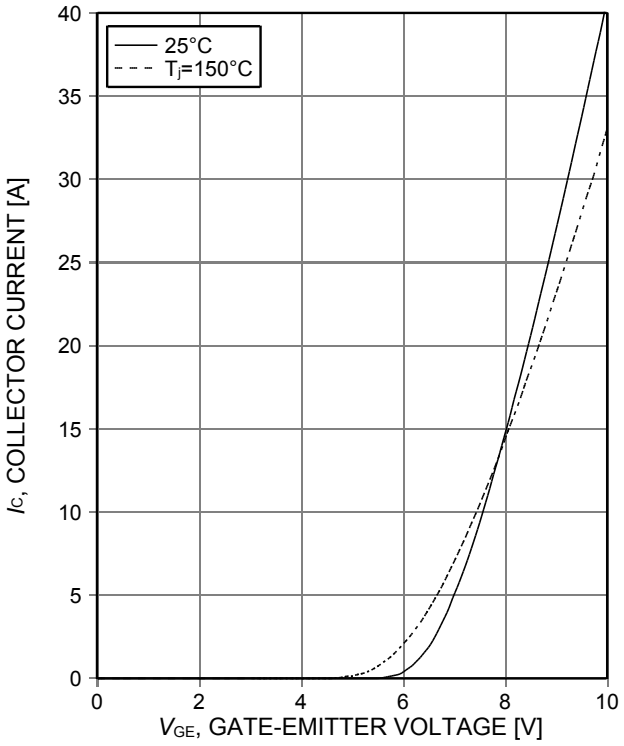


Figure 7. **Typical transfer characteristic** (V_{CE}=10V)

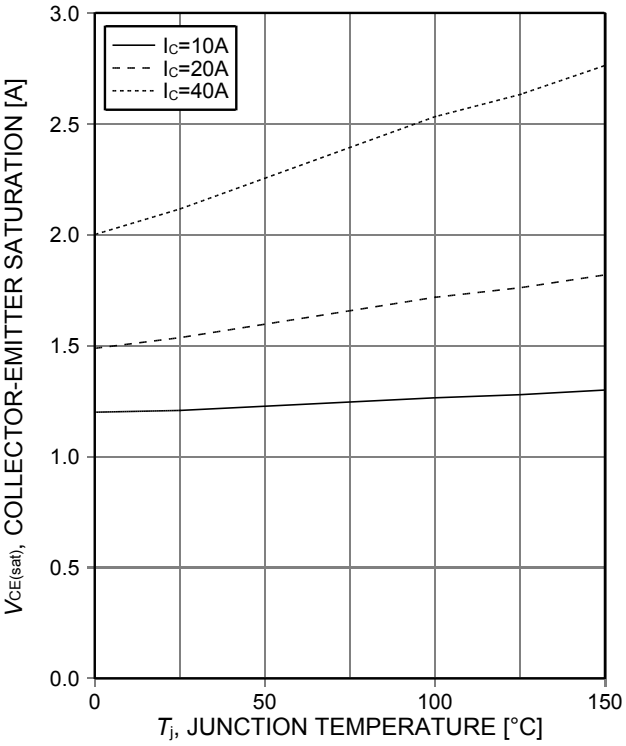


Figure 8. **Typical collector-emitter saturation voltage as a function of junction temperature** (V_{GE}=15V)

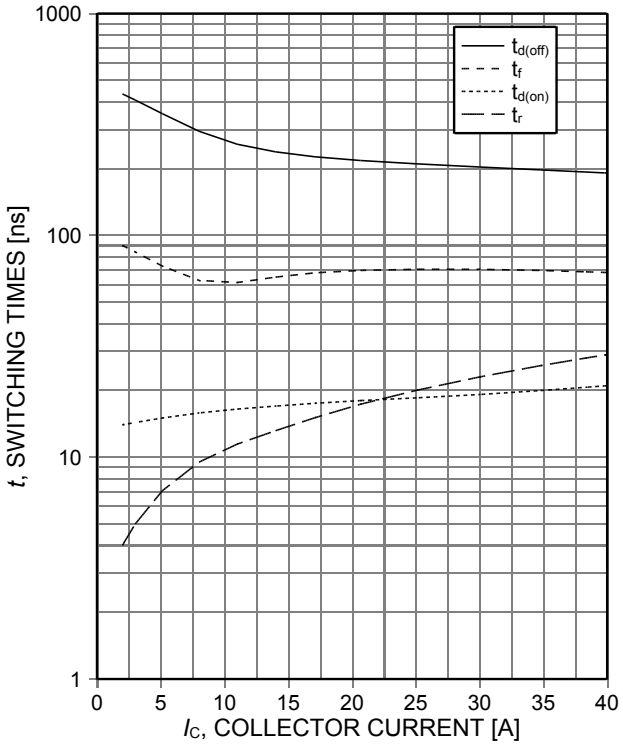


Figure 9. **Typical switching times as a function of collector current**
(inductive load, T_j=150°C, V_{CE}=400V, V_{GE}=15/0V, R_G=12Ω,Dynamic test circuit in Figure E)

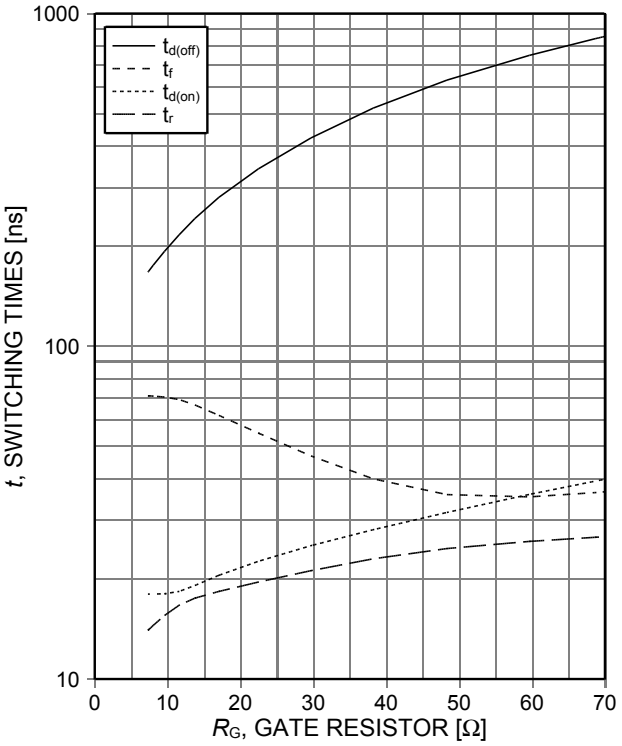


Figure 10. **Typical switching times as a function of gate resistor**
(inductive load, T_j=150°C, V_{CE}=400V, V_{GE}=15/0V, I_C=20A,Dynamic test circuit in Figure E)

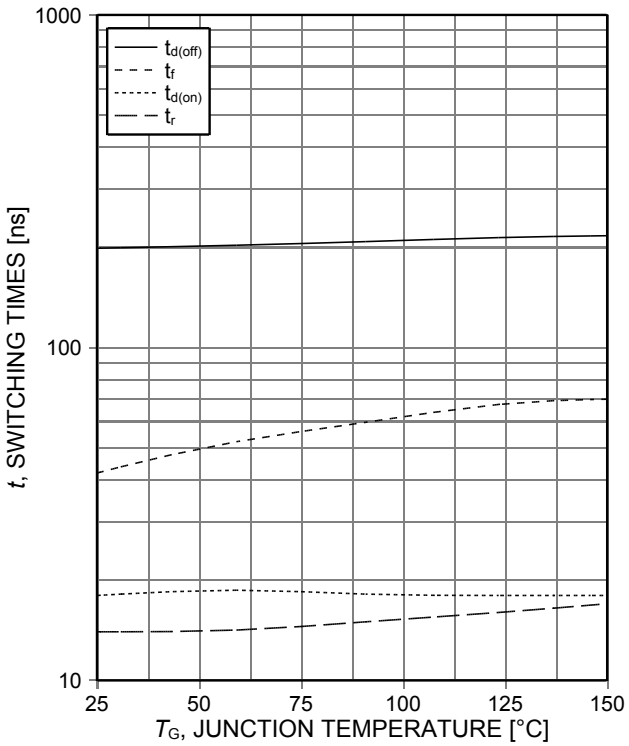


Figure 11. **Typical switching times as a function of junction temperature**
(inductive load, V_{CE}=400V, V_{GE}=15/0V, I_C=20A, R_G=12Ω,Dynamic test circuit in Figure E)

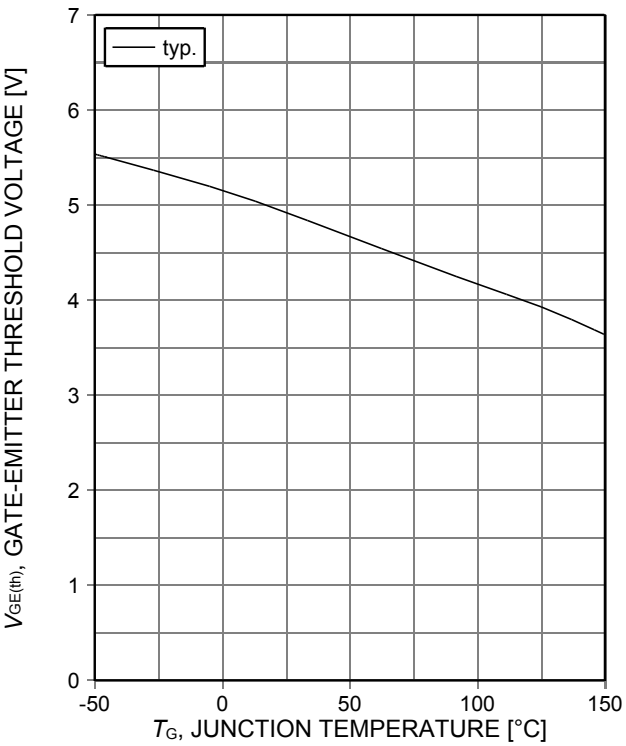


Figure 12. **Gate-emitter threshold voltage as a function of junction temperature**
(I_C=0.29mA)

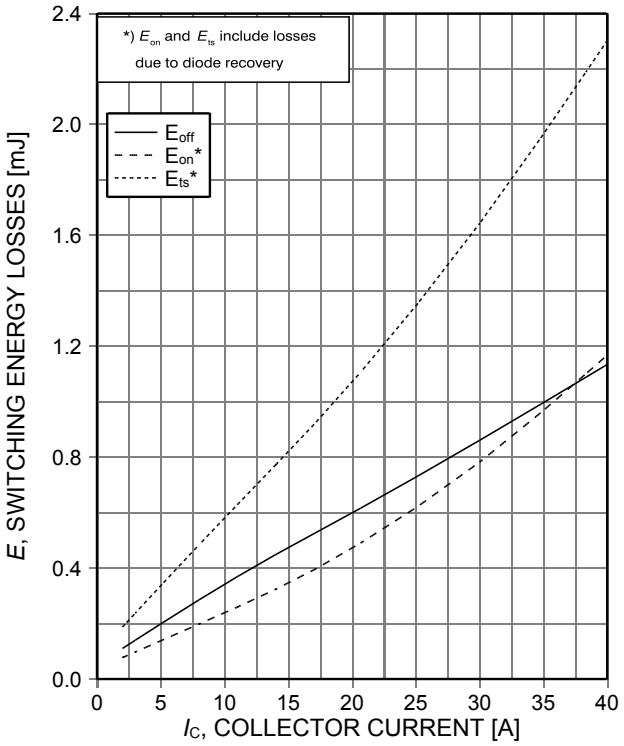


Figure 13. **Typical switching energy losses as a function of collector current** (inductive load, T_j=150°C, V_{CE}=400V, V_{GE}=15/0V, R_G=12Ω,Dynamic test circuit in Figure E)

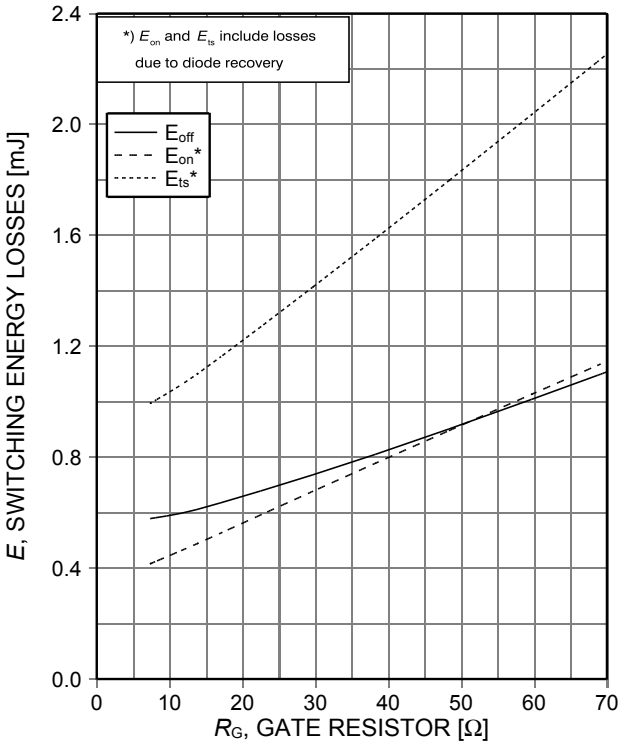


Figure 14. **Typical switching energy losses as a function of gate resistor** (inductive load, T_j=150°C, V_{CE}=400V, V_{GE}=15/0V, I_C=20A,Dynamic test circuit in Figure E)

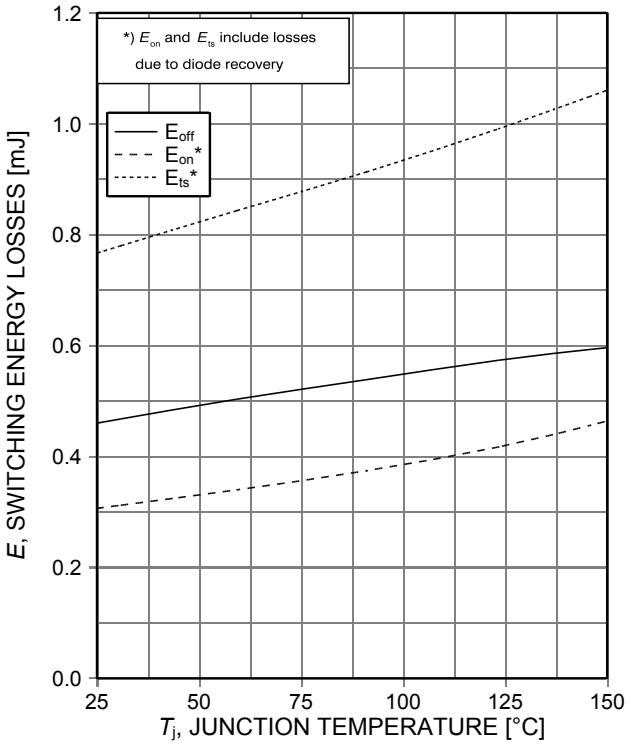


Figure 15. **Typical switching energy losses as a function of junction temperature** (inductive load, V_{CE}=400V, V_{GE}=15/0V, I_C=20A, R_G=12Ω,Dynamic test circuit in Figure E)

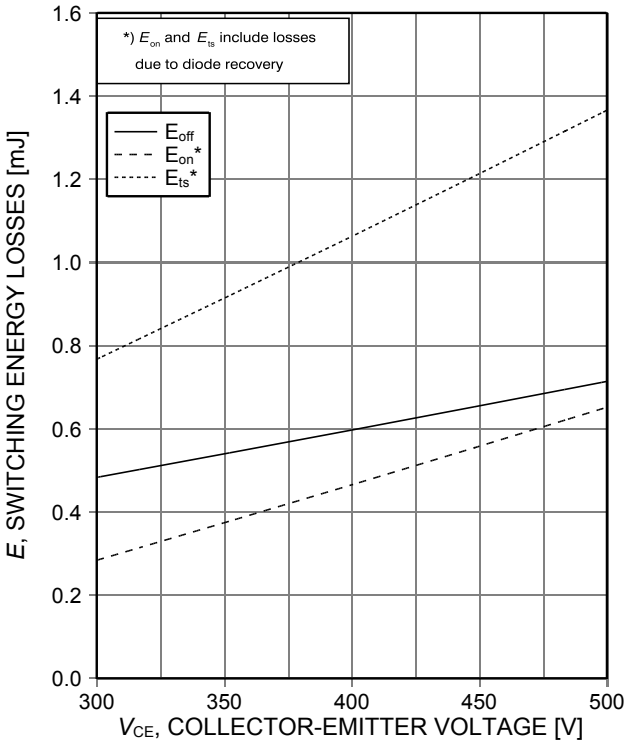


Figure 16. **Typical switching energy losses as a function of collector emitter voltage** (inductive load, T_j=150°C, V_{GE}=15/0V, I_C=20A, R_G=12Ω, Dynamic test circuit in Figure E)

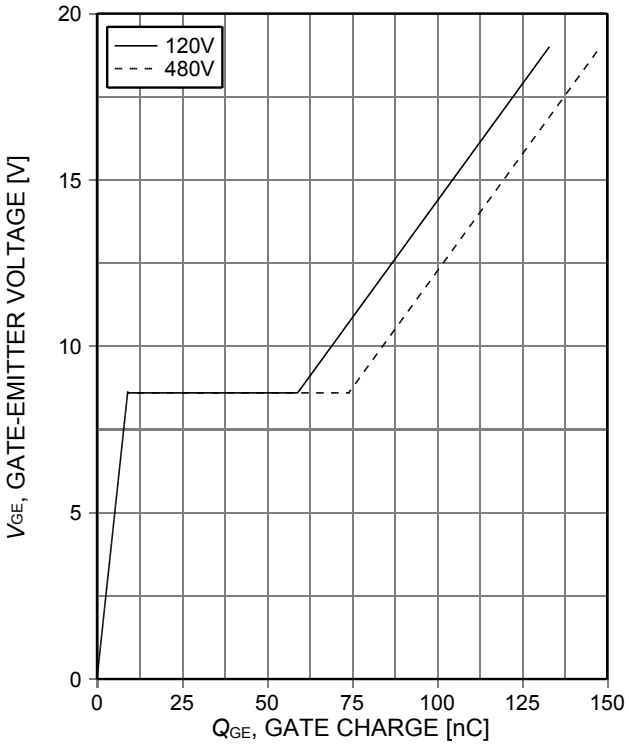


Figure 17. **Typical gate charge**
(I_C=20A)

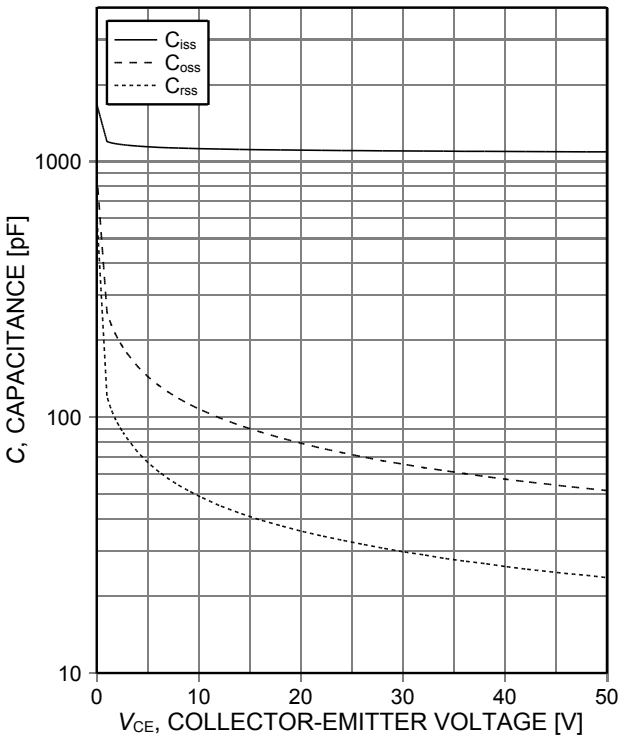


Figure 18. **Typical capacitance as a function of collector-emitter voltage**
(V_{GE}=0V, f=1MHz)

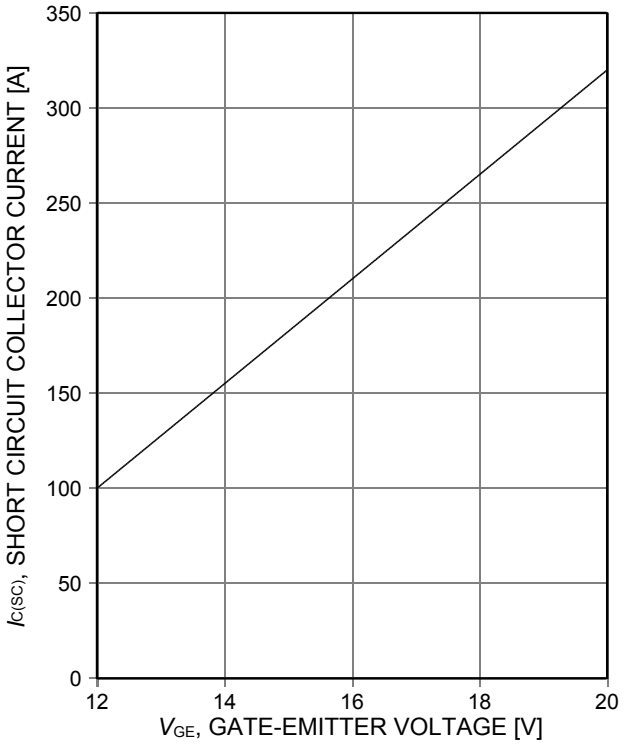


Figure 19. **Typical short circuit collector current as a function of gate-emitter voltage**
(V_{CE}≤400V, T_j≤150°C)

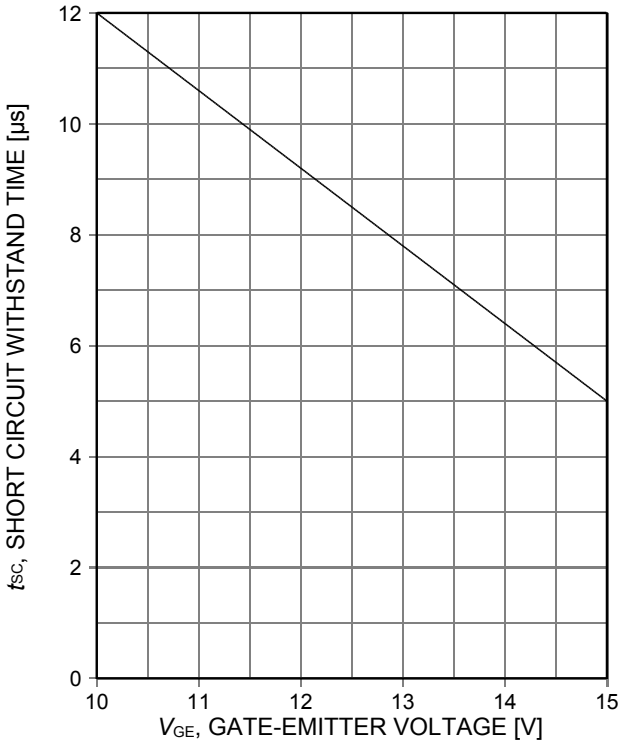


Figure 20. **Short circuit withstand time as a function of gate-emitter voltage**
(V_{CE}=400V, start at T_j=25°C, $T_j$max≤150°C)

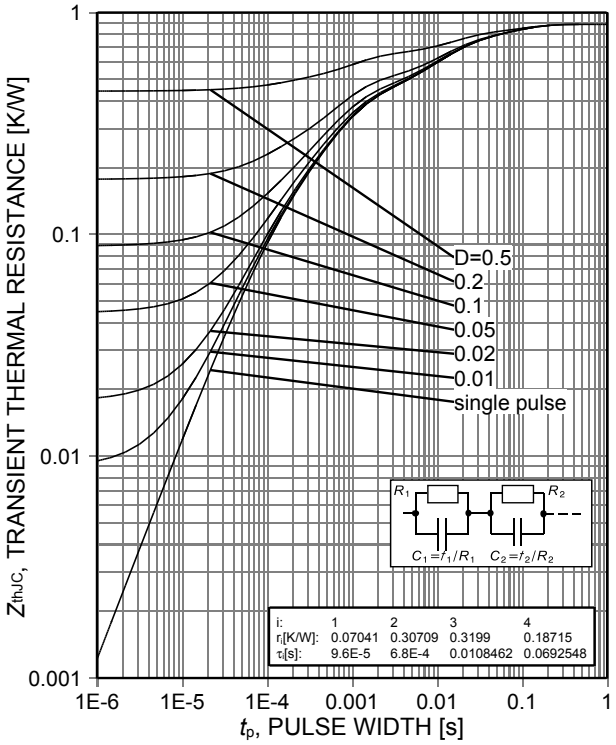


Figure 21. **IGBT transient thermal resistance as a function of pulse width for different duty cycles *D***
($D=t_p/T$)

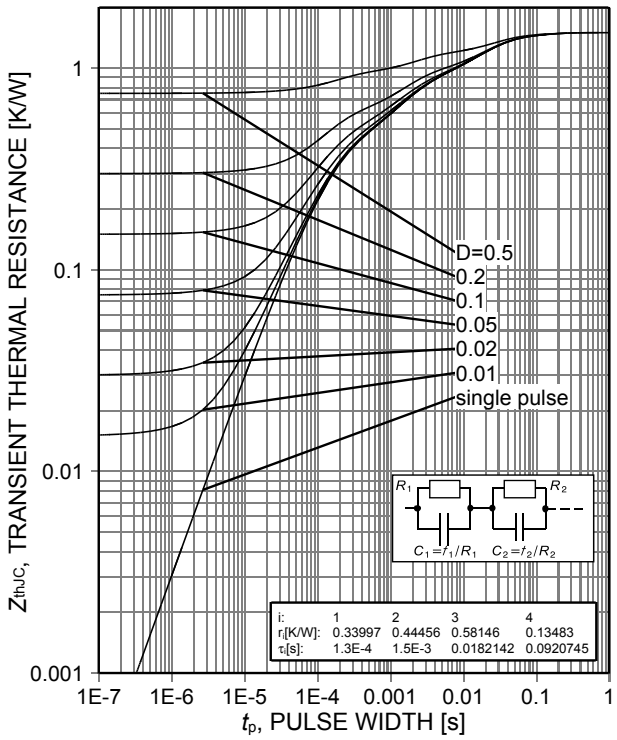


Figure 22. **Diode transient thermal impedance as a function of pulse width for different duty cycles *D***
($D=t_p/T$)

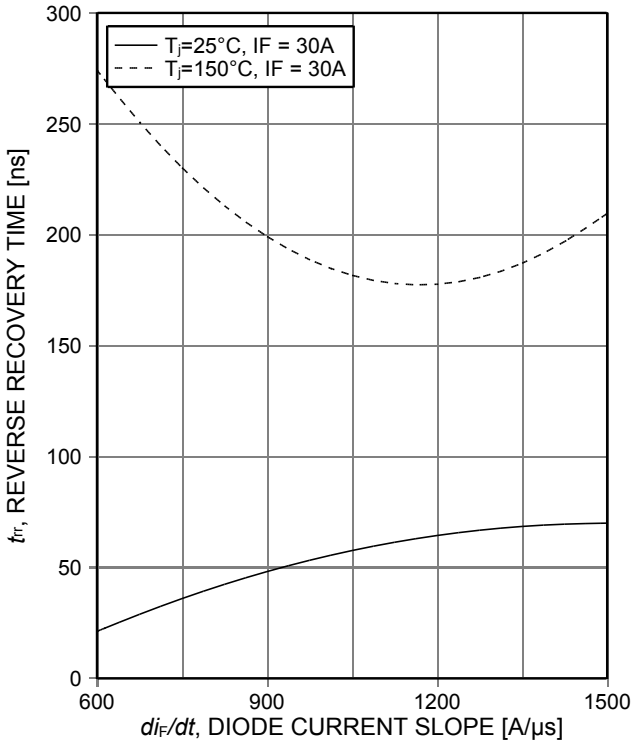


Figure 23. **Typical reverse recovery time as a function of diode current slope**
(V_R=400V,Dynamic test circuit in Figure E)

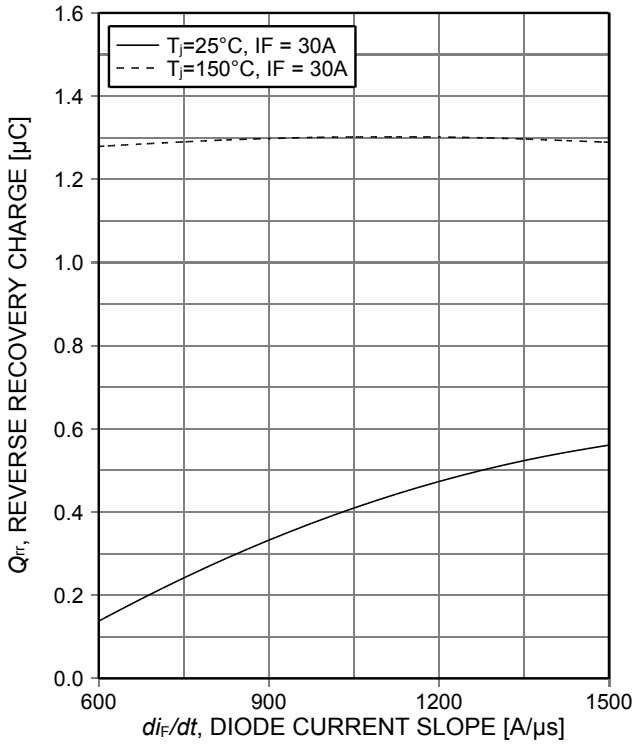


Figure 24. **Typical reverse recovery charge as a function of diode current slope**
(V_R=400V, Dynamic test circuit in Figure E)

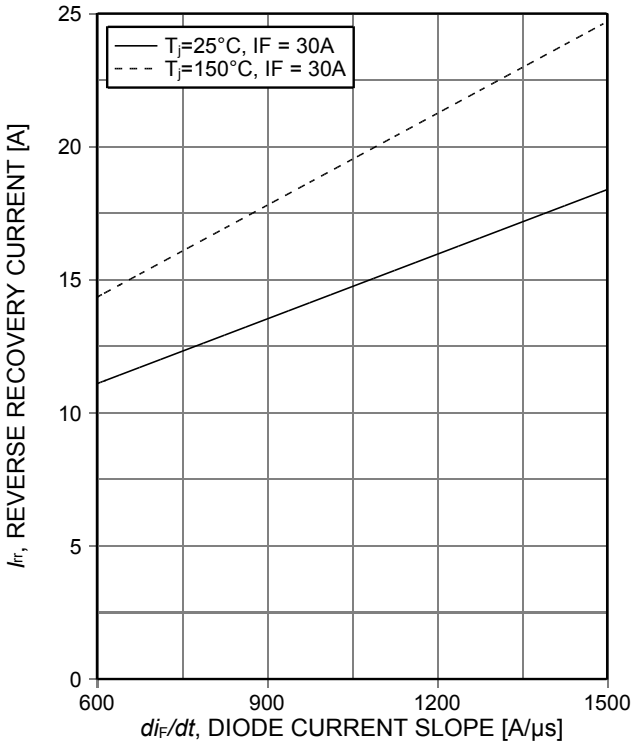


Figure 25. **Typical reverse recovery current as a function of diode current slope**
(V_R=400V, Dynamic test circuit in Figure E)

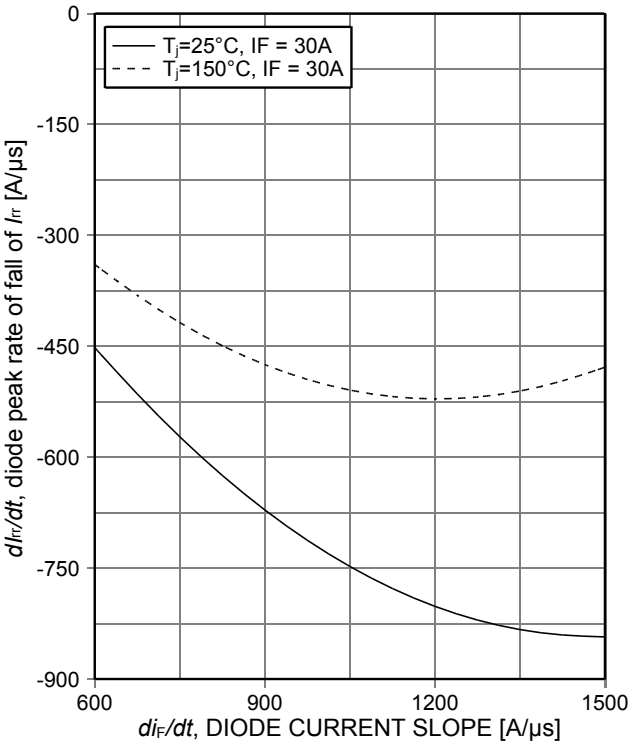


Figure 26. **Typical diode peak rate of fall of reverse recovery current as a function of diode current slope**
(V_R=400V, Dynamic test circuit in Figure E)

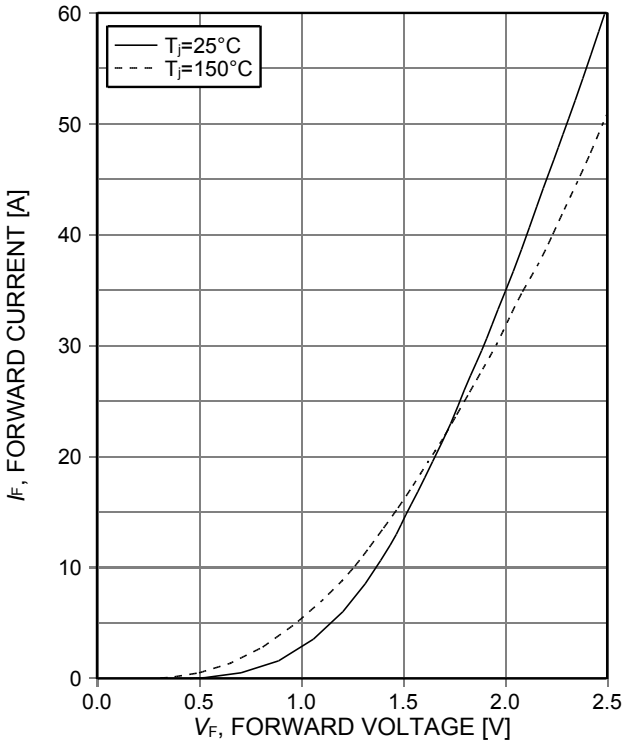


Figure 27. **Typical diode forward current as a function of forward voltage**

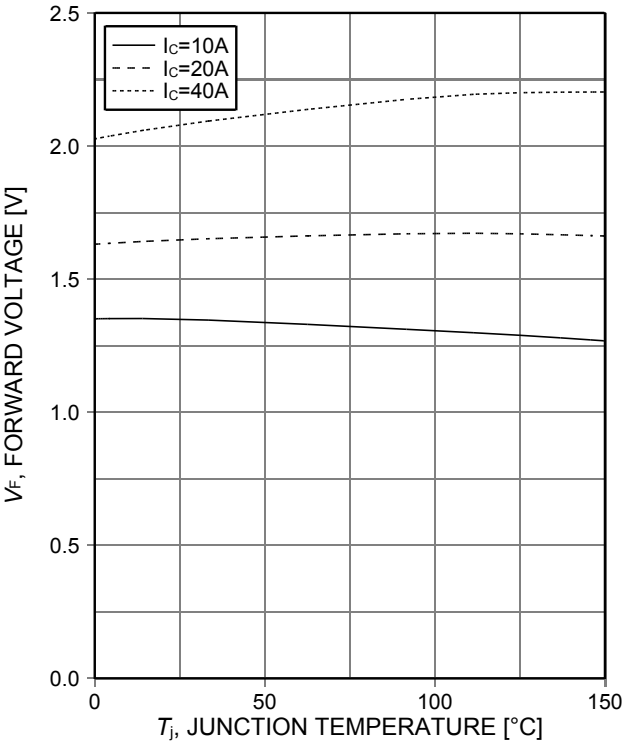
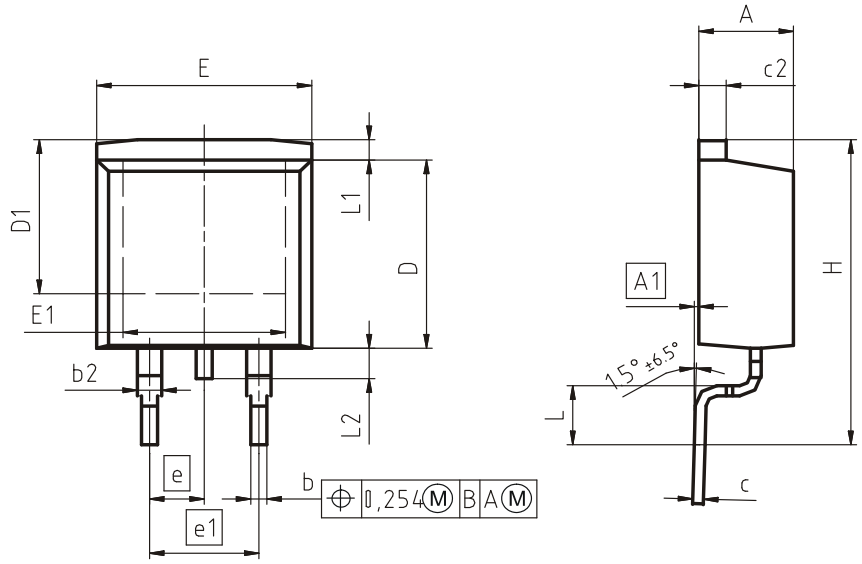
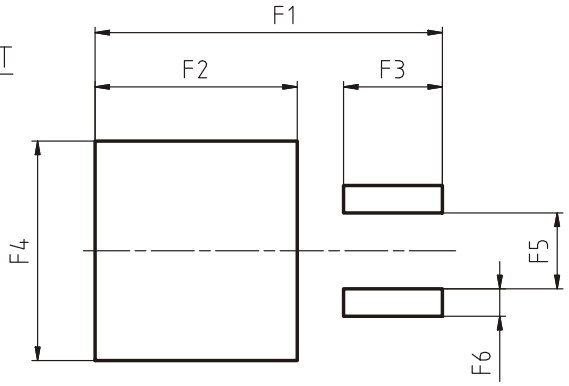


Figure 28. **Typical diode forward voltage as a function of junction temperature**

PG-TO263-3



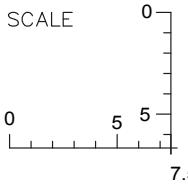
FOOTPRINT



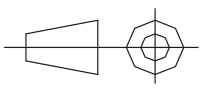
DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.30	4.57	0.169	0.180
A1	0.00	0.25	0.000	0.010
b	0.65	0.85	0.026	0.033
b2	0.95	1.15	0.037	0.045
c	0.33	0.65	0.013	0.026
c2	1.17	1.40	0.046	0.055
D	8.51	9.45	0.335	0.372
D1	7.10	7.90	0.280	0.311
E	9.80	10.31	0.386	0.406
E1	6.50	8.60	0.256	0.339
e	2.54		0.100	
e1	5.08		0.200	
N	2		2	
H	14.61	15.88	0.575	0.625
L	2.29	3.00	0.090	0.118
L1	0.70	1.60	0.028	0.063
L2	1.00	1.78	0.039	0.070
F1	16.05	16.25	0.632	0.640
F2	9.30	9.50	0.366	0.374
F3	4.50	4.70	0.177	0.185
F4	10.70	10.90	0.421	0.429
F5	3.65	3.85	0.144	0.152
F6	1.25	1.45	0.049	0.057

DOCUMENT NO.
Z8B00003324

SCALE



EUROPEAN PROJECTION



ISSUE DATE
30-08-2007

REVISION
01

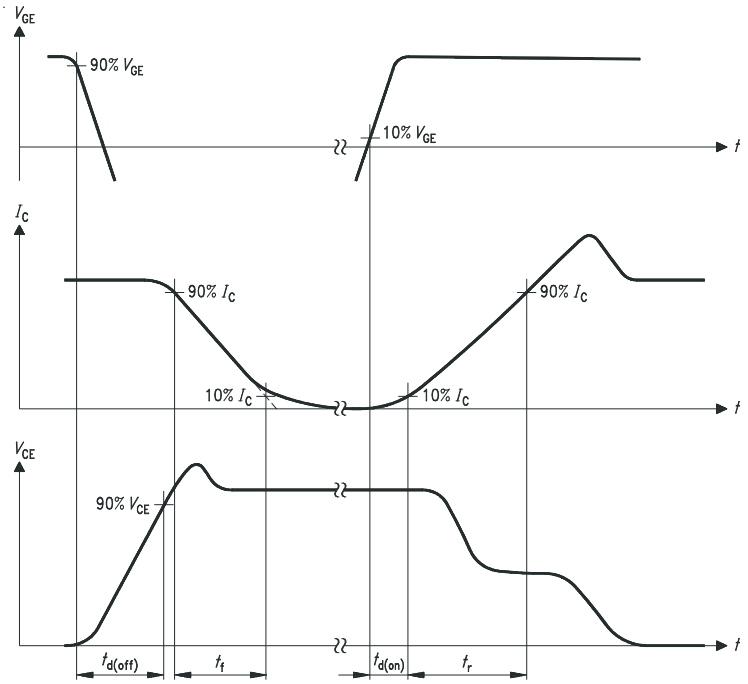


Figure A. Definition of switching times

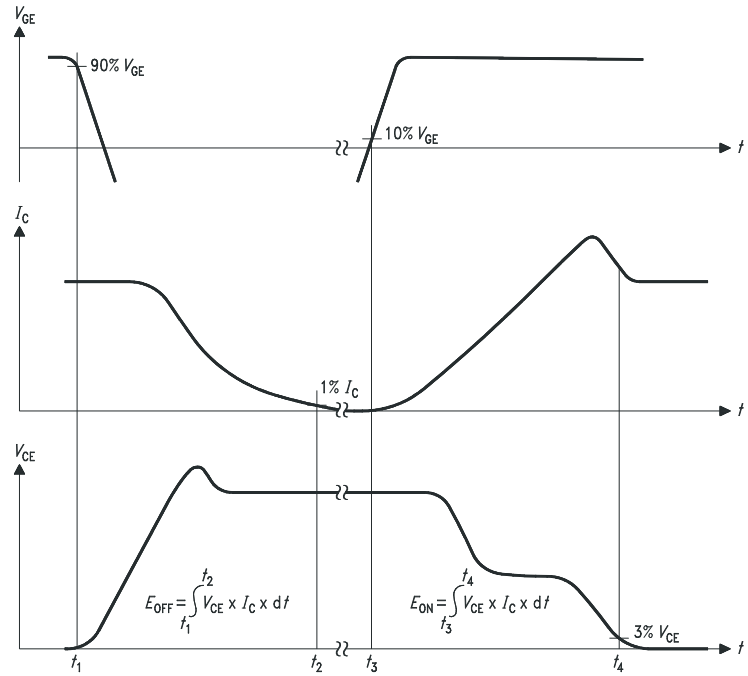


Figure B. Definition of switching losses

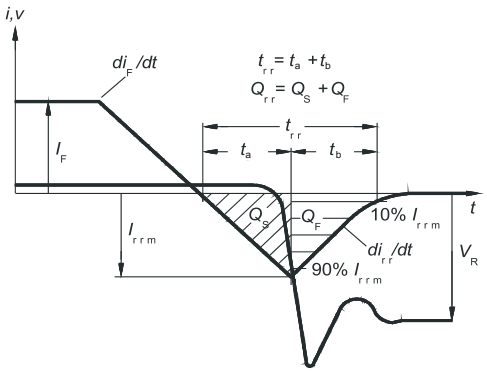


Figure C. Definition of diodes switching characteristics

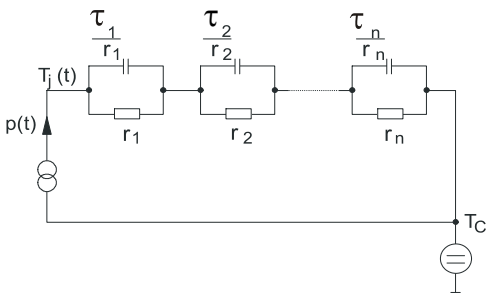


Figure D. Thermal equivalent circuit

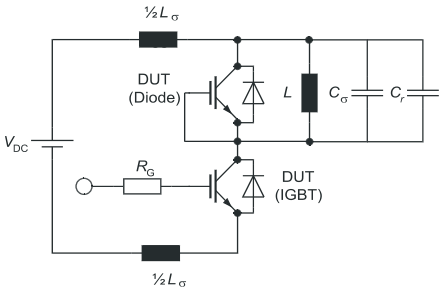


Figure E. Dynamic test circuit
Parasitic inductance L_σ,
Parasitic capacitor C_σ,
Relief capacitor C_r
(only for ZVT switching)

Revision History

IKB20N60TA

Revision: 2013-08-21, Rev. 2.2

Previous Revision

Revision	Date	Subjects (major changes since last revision)
0.1	2009-06-03	-
1.0	2009-07-23	-
2.0	2010-03-22	-
2.1	2010-03-22	-
2.2	2013-08-21	Minor changes

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81726 München, Germany
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