IGBT

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

IKQ120N60TA

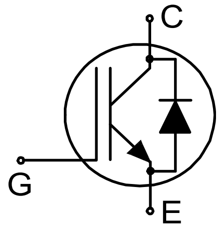
600V low loss switching series third generation

Data sheet

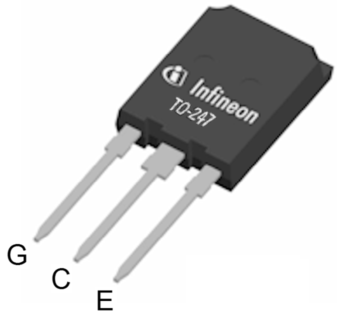
Industrial Power Control

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°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, $T_{vj} \geq 25°C$	V_{CE}	600	V
DC collector current, limited by T_{vjmax} $T_C = 25°C$ value limited by bondwire $T_C = 135°C$	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 $V_{CE} \leq 600V$, $T_{vj} \leq 175°C$, $t_p = 1\mu s$	-	480.0	A
Diode forward current, limited by T_{vjmax} $T_C = 25°C$ value limited by bondwire $T_C = 124°C$	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}	±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}	833.0	W
Operating junction temperature	T_{vj}	-40...+175	°C
Storage temperature	T_{stg}	-55...+150	°C
Soldering temperature,[1] wave soldering 1.6mm (0.063in.) from case for 10s		 260	°C
Mounting torque, M3 screw Maximum of mounting processes: 3	M	0.6	Nm

Thermal Resistance

Parameter	Symbol	Conditions	Max. Value	Unit
Characteristic				
IGBT thermal resistance,[2] junction - case	$R_{th(j-c)}$		0.18	K/W
Diode thermal resistance,[2] junction - case	$R_{th(j-c)}$		0.30	K/W
Thermal resistance junction - ambient	$R_{th(j-a)}$		40	K/W

[1] Package not recommended for surface mount application
[2] 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°C, unless otherwise specified

Parameter	Symbol	Conditions	Value min.	Value typ.	Value max.	Unit
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 = 120.0A T_{vj} = 25°C T_{vj} = 175°C	- -	1.50 1.90	2.00 -	V
Diode forward voltage	V_F	V_{GE} = 0V, I_F = 120.0A T_{vj} = 25°C T_{vj} = 175°C	- -	1.65 1.60	2.05 -	V
Gate-emitter threshold voltage	$V_{GE(th)}$	I_C = 1.90mA, 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} = 175°C	- -	- 3000.0	40.0 -	µA
Gate-emitter leakage current	I_{GES}	V_{CE} = 0V, V_{GE} = 20V	-	-	100	nA
Transconductance	g_{fs}	V_{CE} = 20V, I_C = 120.0A	-	75.0	-	S
Integrated gate resistor	r_G			none		Ω

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

Parameter	Symbol	Conditions	Value min.	Value typ.	Value max.	Unit
Dynamic Characteristic						
Input capacitance	C_{ies}	V_{CE} = 25V, V_{GE} = 0V, f = 1MHz	-	7530	-	pF
Output capacitance	C_{oes}	V_{CE} = 25V, V_{GE} = 0V, f = 1MHz	-	446	-	pF
Reverse transfer capacitance	C_{res}	V_{CE} = 25V, V_{GE} = 0V, f = 1MHz	-	206	-	pF
Gate charge	Q_G	V_{CC} = 480V, I_C = 120.0A, V_{GE} = 15V	-	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: ≥ 1.0s	$I_{C(SC)}$	V_{GE} = 15.0V, V_{CC} ≤ 400V, t_{SC} ≤ 5µs T_{vj} = 150°C	-	846	-	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} = 400V, I_C = 120.0A, V_{GE} = 0.0/15.0V, $R_{G(on)}$ = 3.0Ω, $R_{G(off)}$ = 3.0Ω, $L\sigma$ = 63nH, $C\sigma$ = 31pF $L\sigma$, $C\sigma$ 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°C

Parameter	Symbol	Conditions	min.	typ.	max.	Unit
Diode reverse recovery time	t_{rr}	T_{vj} = 25°C, V_R = 400V, I_F = 120.0A, di_F/dt = 1100A/µs	-	280	-	ns
Diode reverse recovery charge	Q_{rr}		-	3.50	-	µC
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	-	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} = 400V, I_C = 120.0A, V_{GE} = 0.0/15.0V, $R_{G(on)}$ = 3.0Ω, $R_{G(off)}$ = 3.0Ω, $L\sigma$ = 63nH, $C\sigma$ = 31pF $L\sigma$, $C\sigma$ 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°C

Parameter	Symbol	Conditions	min.	typ.	max.	Unit
Diode reverse recovery time	t_{rr}	T_{vj} = 175°C, V_R = 400V, I_F = 120.0A, di_F/dt = 1000A/µs	-	410	-	ns
Diode reverse recovery charge	Q_{rr}		-	10.80	-	µC
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	-	A/µs

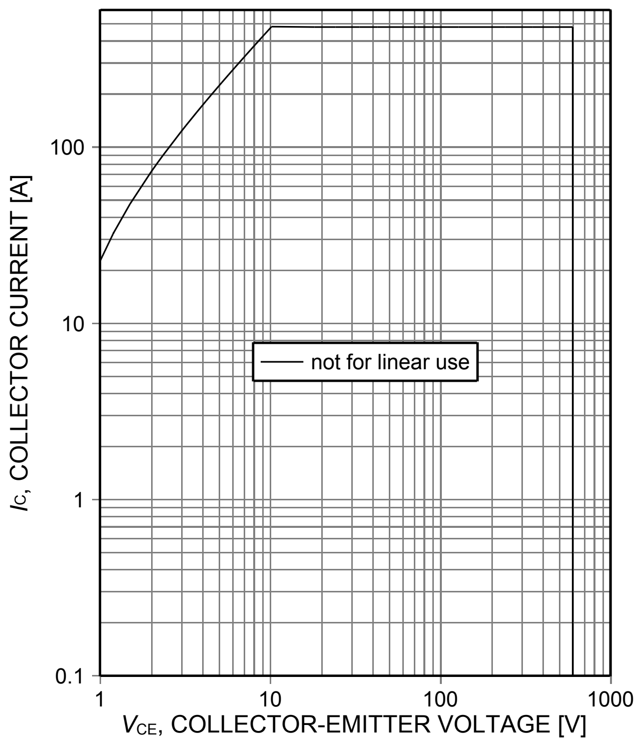

Figure 1. **Safe operating area**
(D=0, T_C=25°C, T_j≤175°C, V_{GE}=0/15V, t_p=1µs. Proven by production test.)

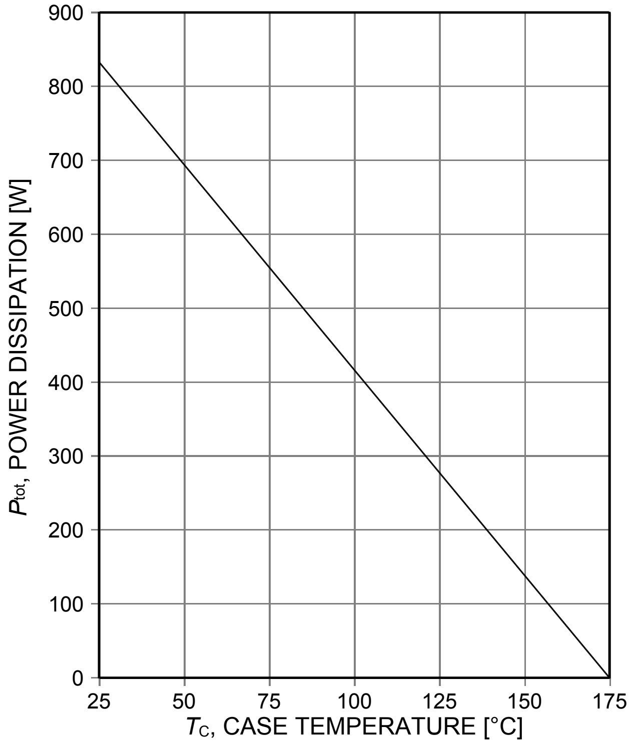

Figure 2. **Power dissipation as a function of case temperature**
(T_j≤175°C)

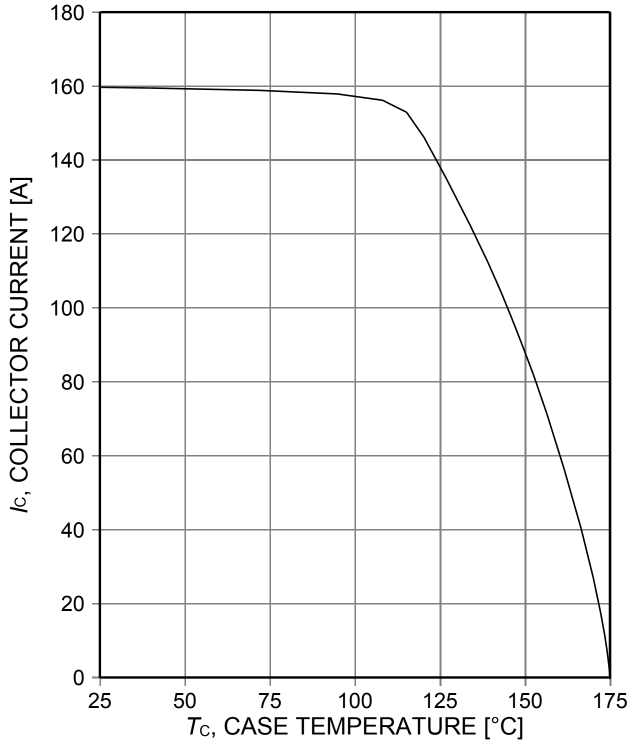

Figure 3. **Collector current as a function of case temperature**
(V_{GE}≥15V, T_j≤175°C)

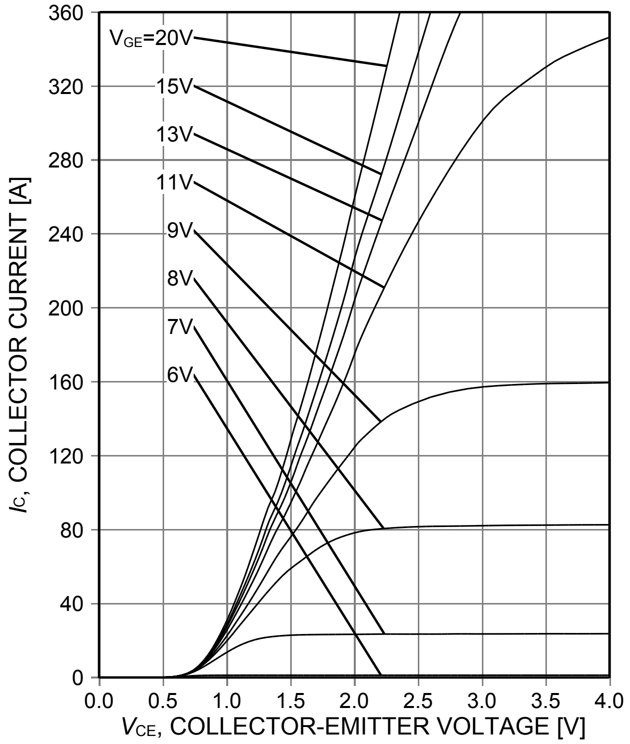

Figure 4. **Typical output characteristic**
(T_j=25°C)

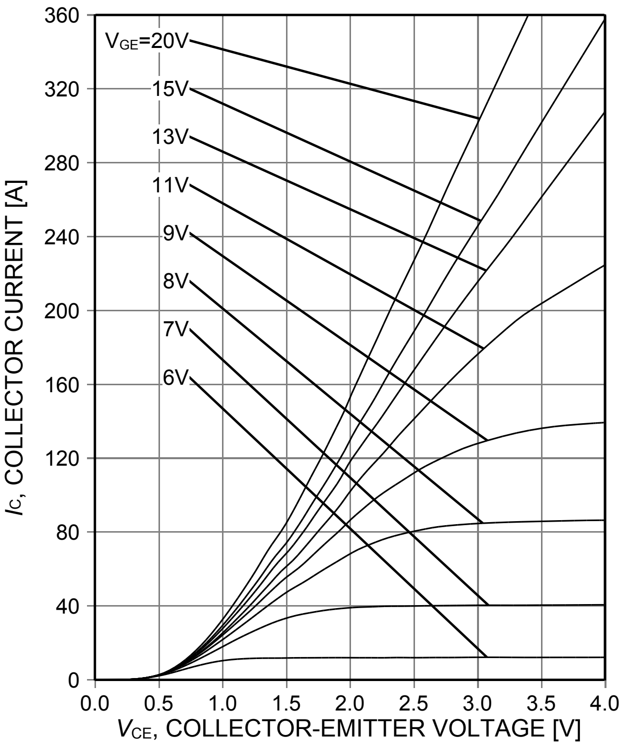

Figure 5. **Typical output characteristic**
(T_j=175°C)

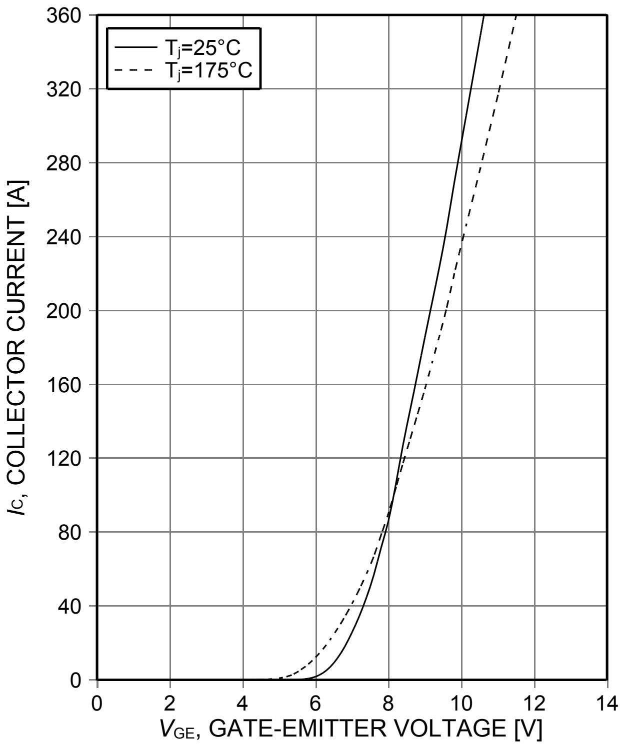

Figure 6. **Typical transfer characteristic**
(V_{CE}=20V)

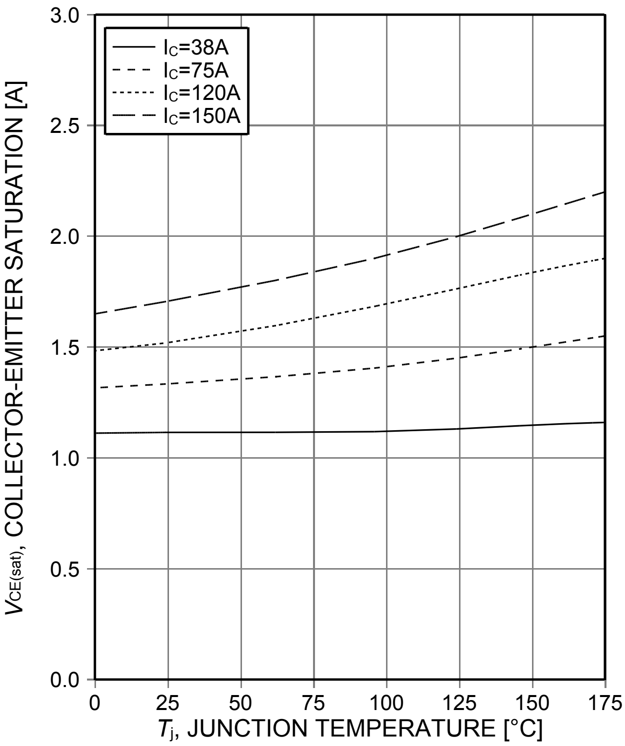

Figure 7. **Typical collector-emitter saturation voltage as a function of junction temperature**
(V_{GE}=15V)

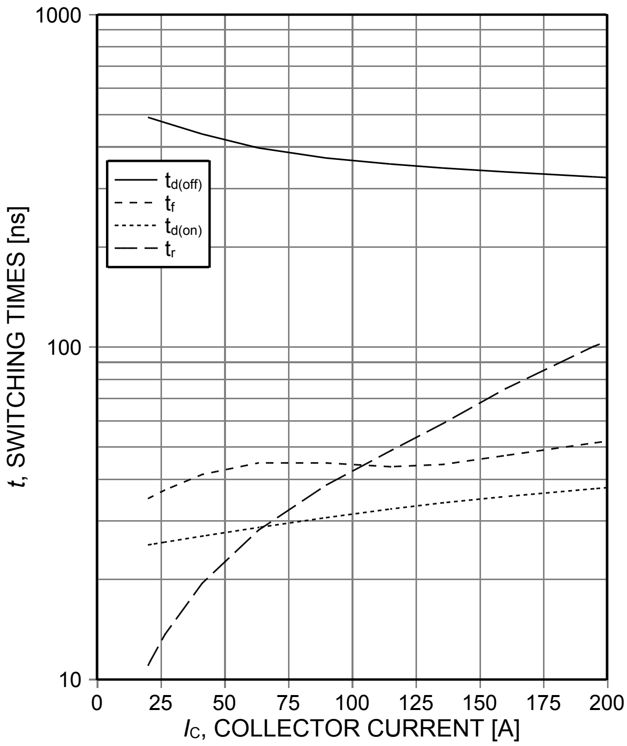

Figure 8. **Typical switching times as a function of collector current**
(inductive load, T_j=175°C, V_{CE}=400V, V_{GE}=15/0V, r_G=3Ω,Dynamic test circuit in Figure E)

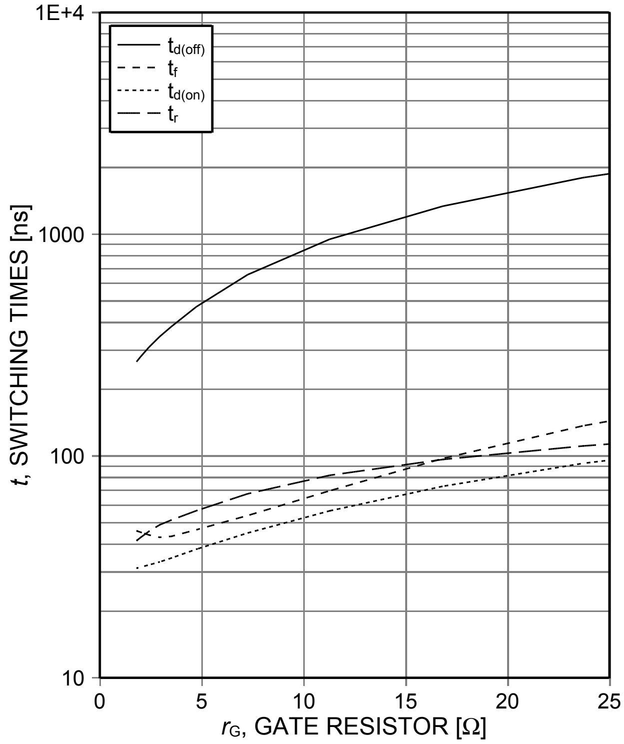

Figure 9. **Typical switching times as a function of gate resistor**
(inductive load, T_j=175°C, V_{CE}=400V, V_{GE}=15/0V, I_C=120A,Dynamic test circuit in Figure E)

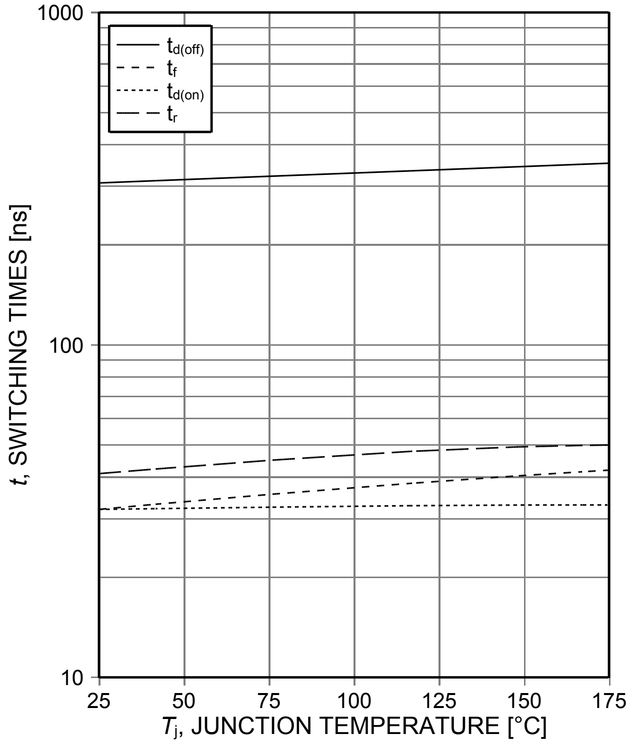

Figure 10. **Typical switching times as a function of junction temperature**
(inductive load, V_{CE}=400V, V_{GE}=15/0V, I_C=120A, r_G=3Ω,Dynamic test circuit in Figure E)

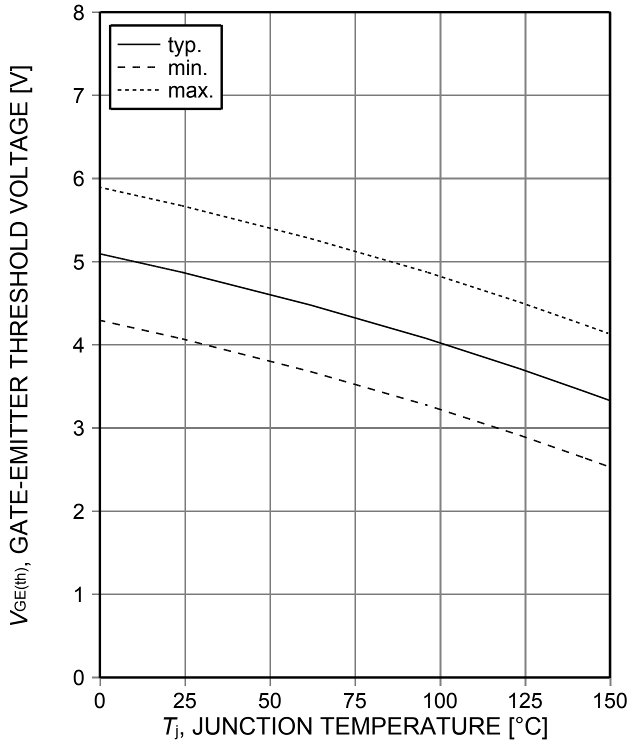

Figure 11. **Gate-emitter threshold voltage as a function of junction temperature**
(I_C=1,9mA)

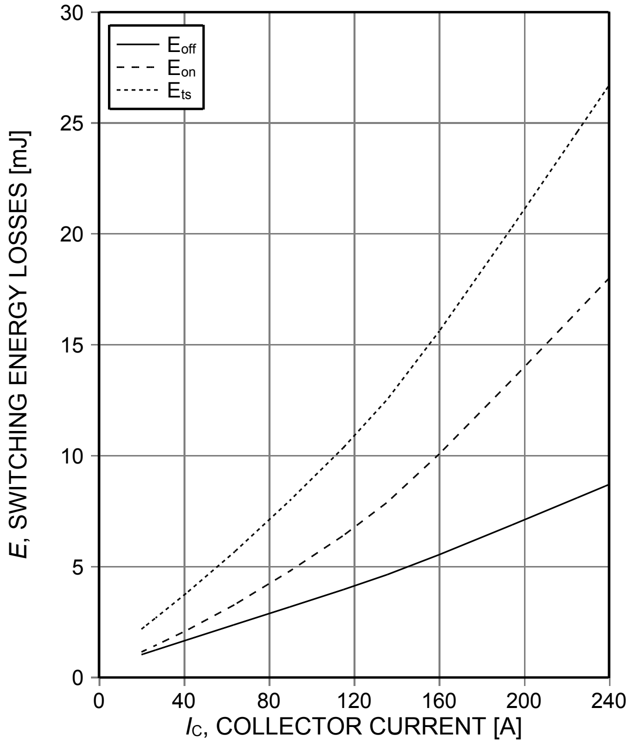

Figure 12. **Typical switching energy losses as a function of collector current**
(inductive load, T_j=175°C, V_{CE}=400V, V_{GE}=15/0V, r_G=3Ω,Dynamic test circuit in Figure E)

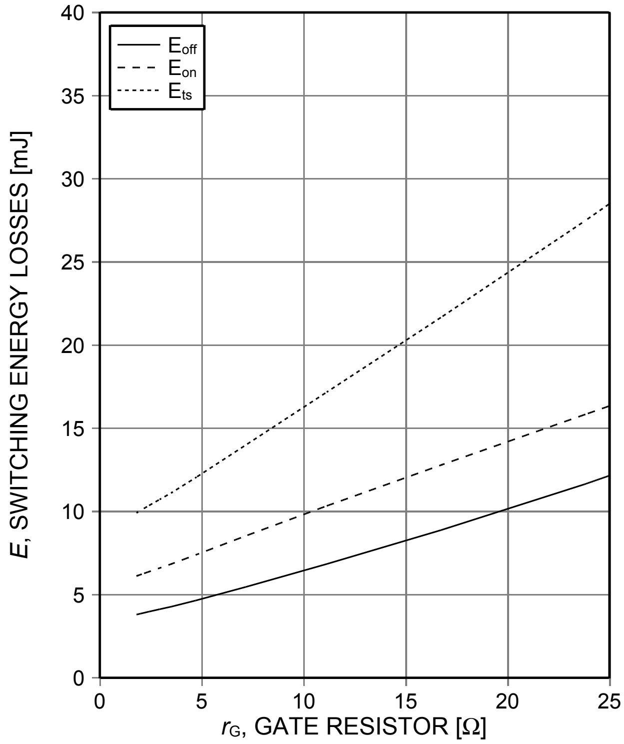

Figure 13. **Typical switching energy losses as a function of gate resistor**
(inductive load, T_j=175°C, V_{CE}=400V, V_{GE}=15/0V, I_C=120A,Dynamic test circuit in Figure E)

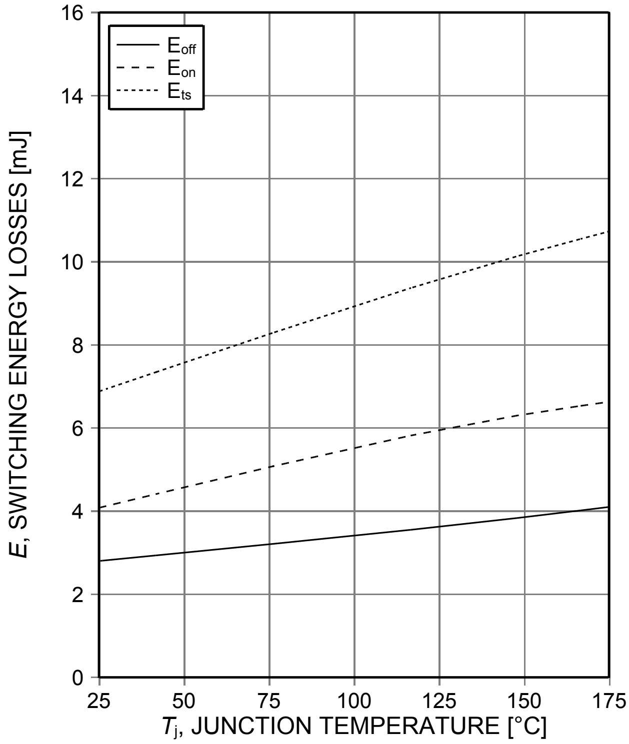

Figure 14. **Typical switching energy losses as a function of junction temperature**
(inductive load, V_{CE}=400V, V_{GE}=15/0V, I_C=120A, r_G=3Ω,Dynamic test circuit in Figure E)

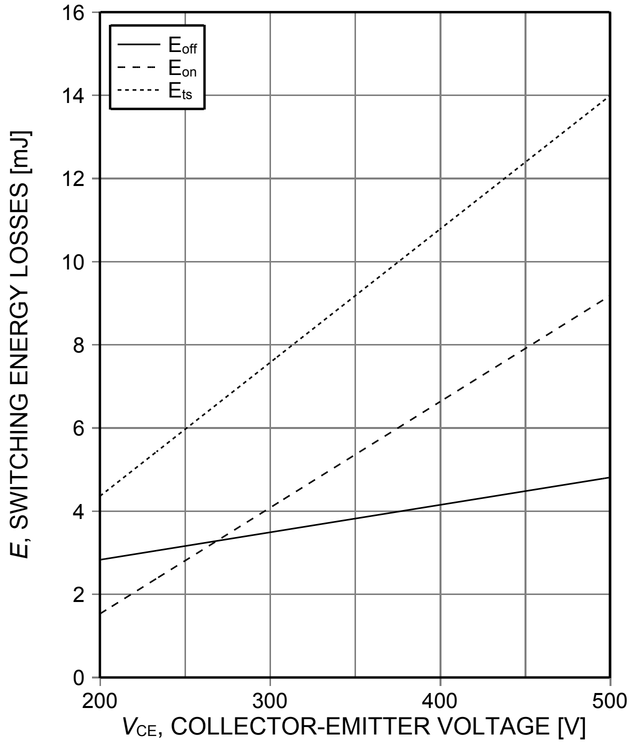

Figure 15. **Typical switching energy losses as a function of collector emitter voltage**
(inductive load, T_j=175°C, V_{GE}=15/0V, I_C=120A, R_G=3Ω, Dynamic test circuit in Figure E)

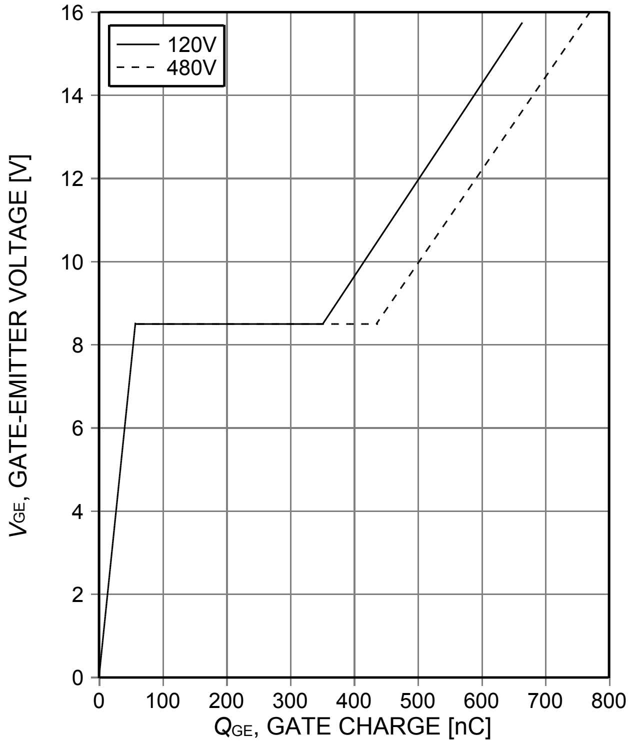

Figure 16. **Typical gate charge**
(I_C=120A)

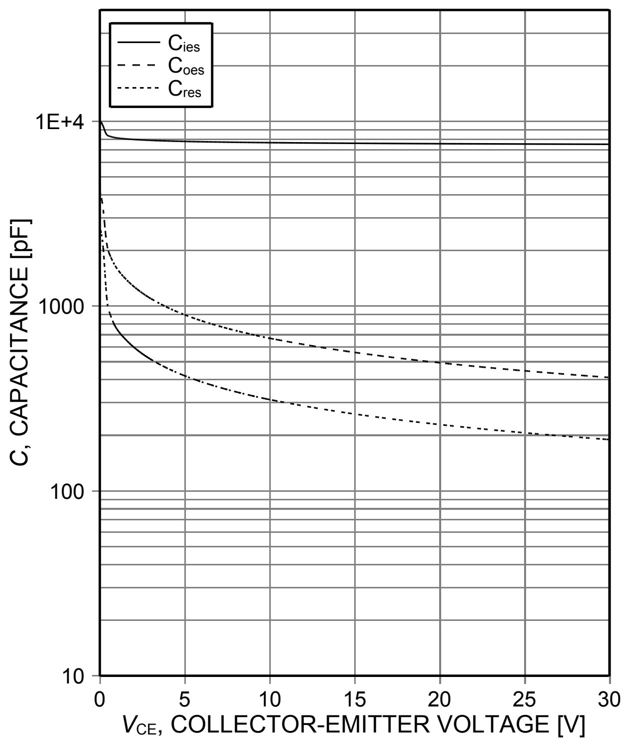

Figure 17. **Typical capacitance as a function of collector-emitter voltage**
(V_{GE}=0V, f=1MHz)

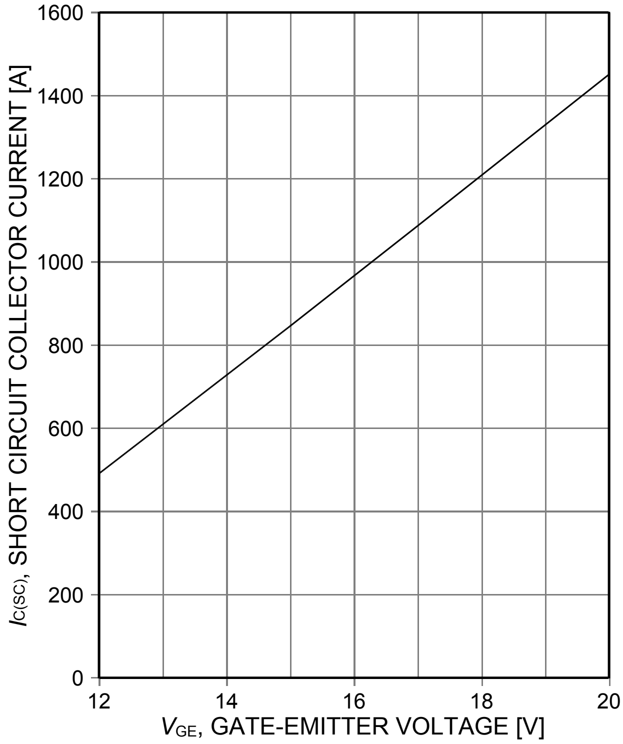

Figure 18. **Typical short circuit collector current as a function of gate-emitter voltage**
(V_{CE}≤400V, start at T_j≤150°C)

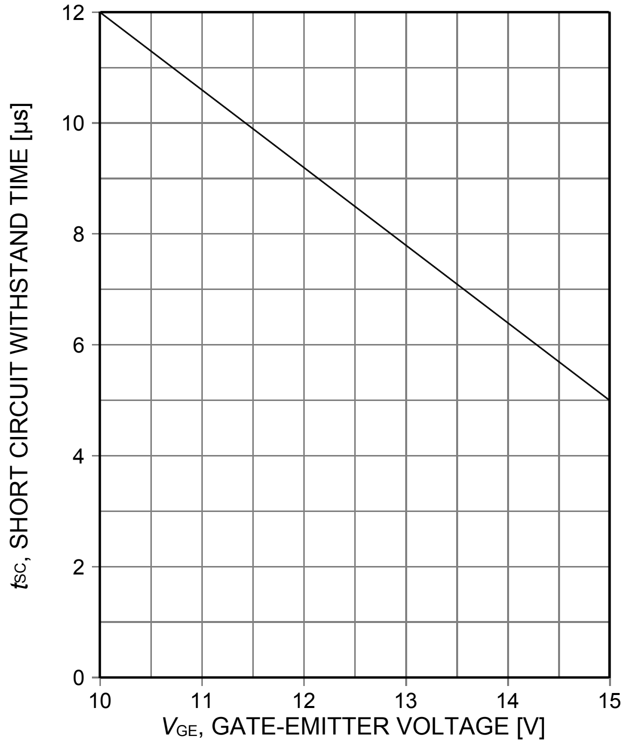

Figure 19. **Short circuit withstand time as a function of gate-emitter voltage**
(V_{CE}=400V, start at T_j=25°C, $T_j$max≤150°C)

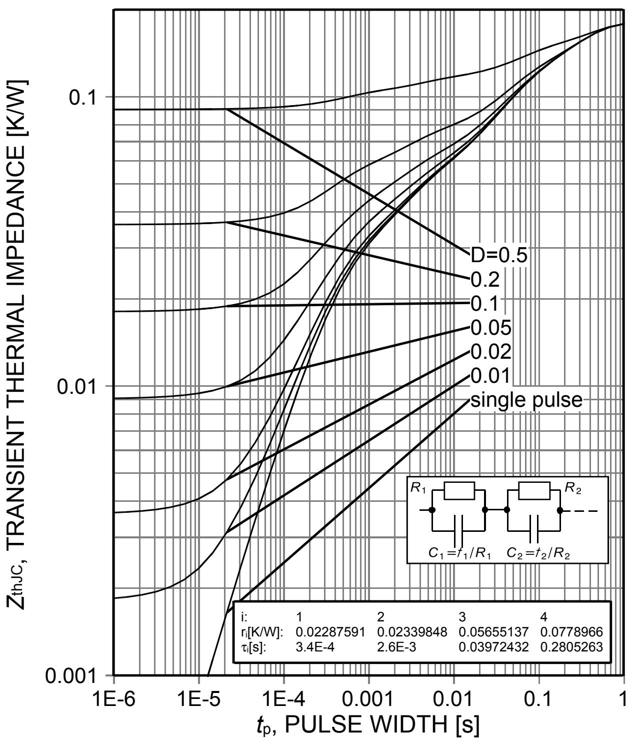

Figure 20. **IGBT transient thermal impedance as a function of pulse width for different duty cycles *D***
(D=t_p/T)

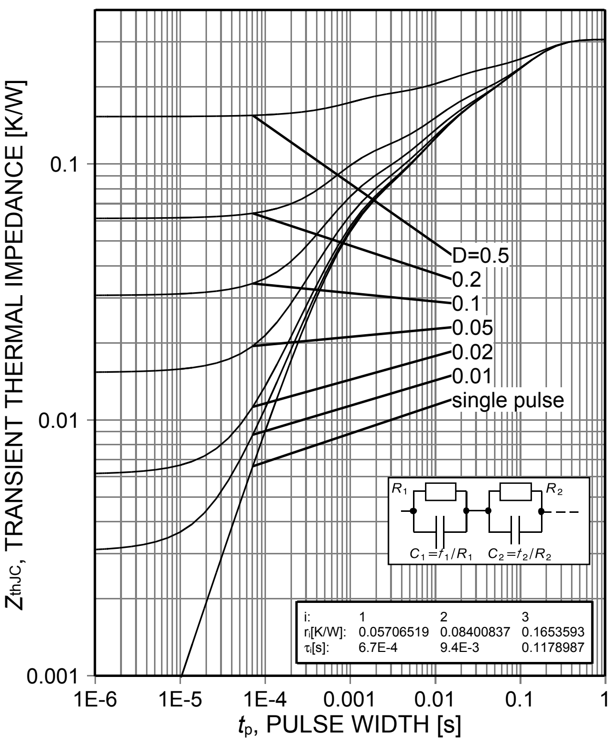

Figure 21. **Diode transient thermal impedance as a function of pulse width for different duty cycles *D***
($D=t_p/T$)

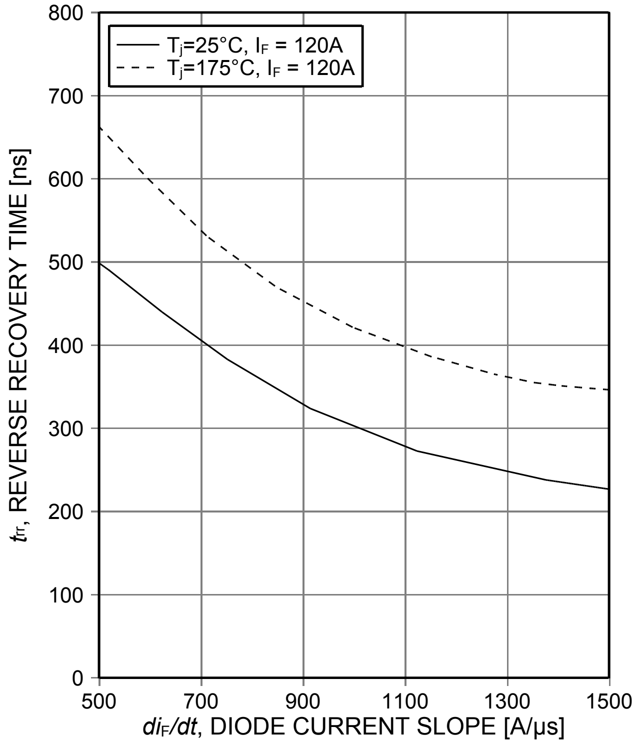

Figure 22. **Typical reverse recovery time as a function of diode current slope**
(V_R=400V,Dynamic test circuit in Figure E)

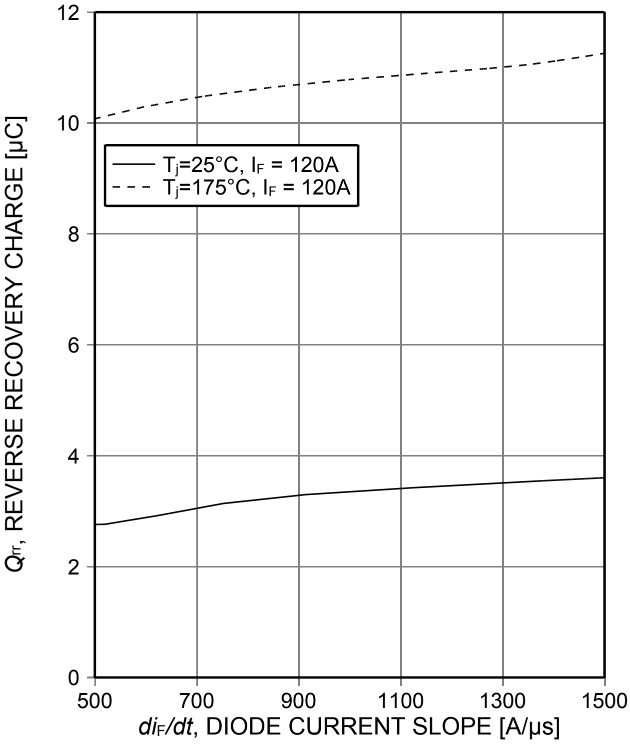

Figure 23. **Typical reverse recovery charge as a function of diode current slope**
(V_R=400V, Dynamic test circuit in Figure E)

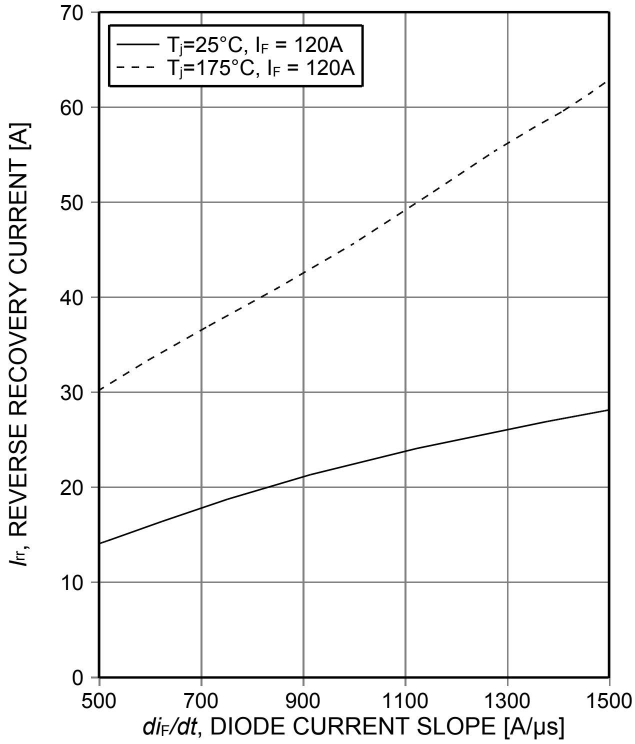

Figure 24. **Typical reverse recovery current as a function of diode current slope**
(V_R=400V, Dynamic test circuit in Figure E)

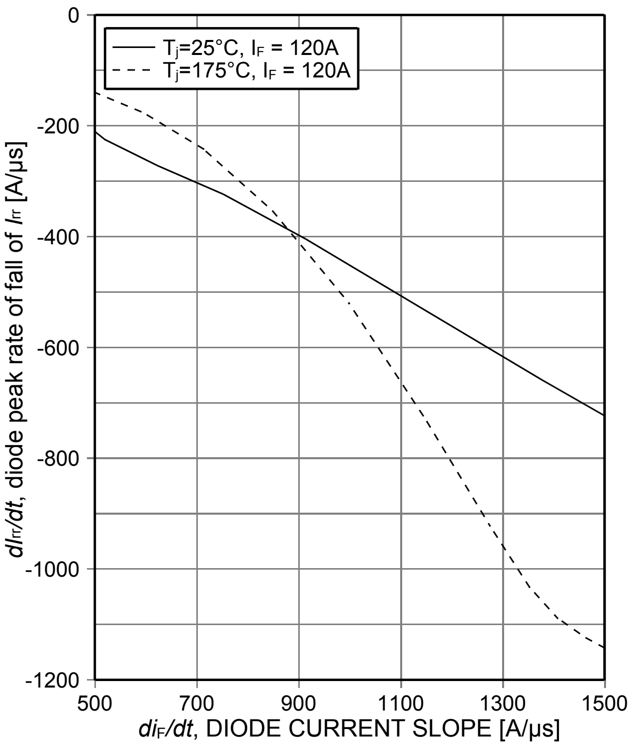

Figure 25. **Typical diode peak rate of fall of reverse recovery current as a function of diode current slope**
(V_R=400V, Dynamic test circuit in Figure E)

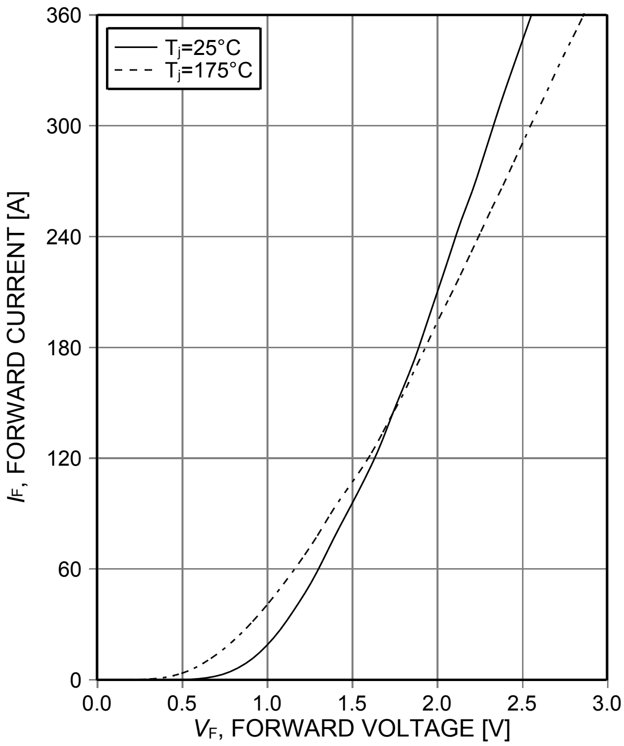

Figure 26. **Typical diode forward current as a function of forward voltage**

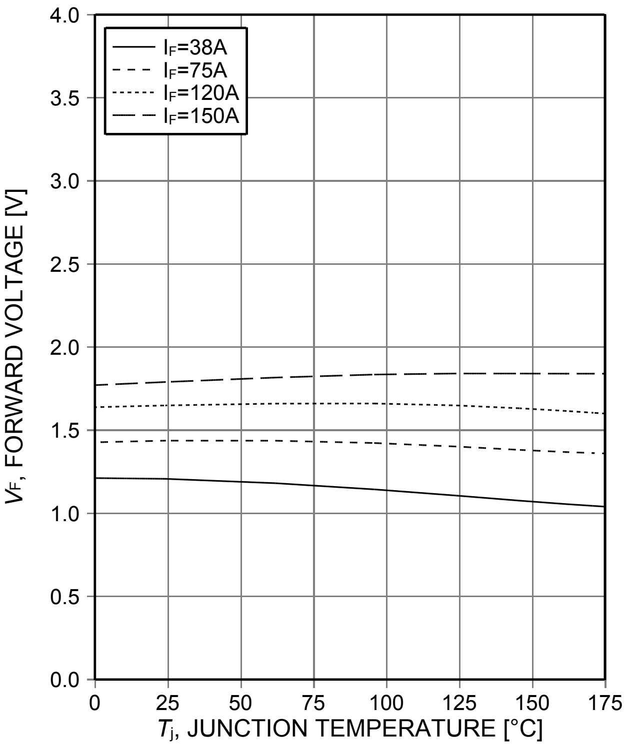

Figure 27. **Typical diode forward voltage as a function of junction temperature**

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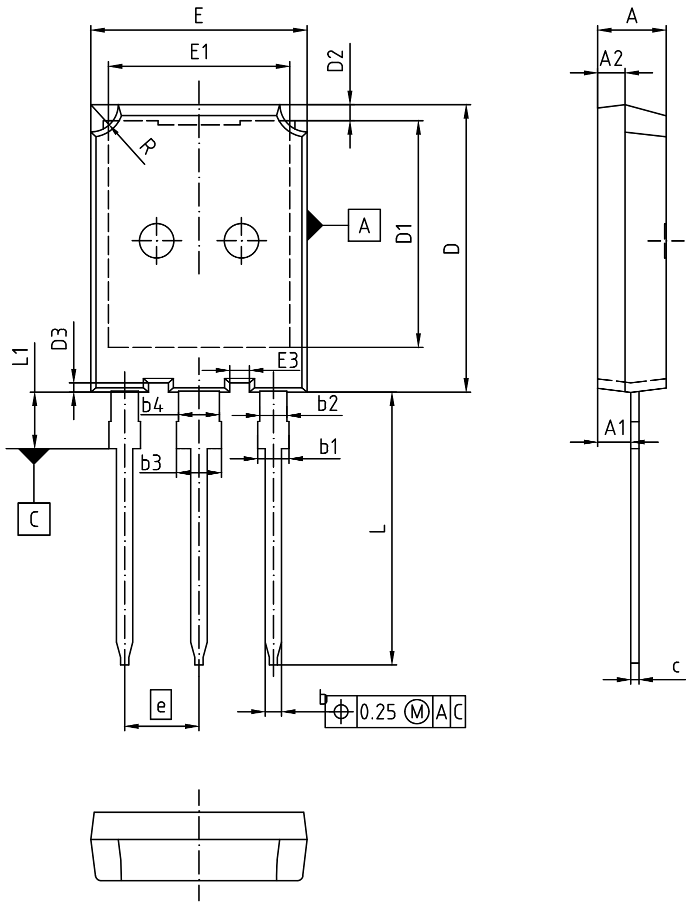

Mold Flash or Protrusions not included

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

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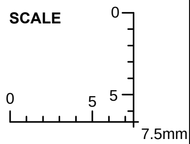
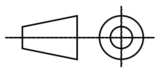
SCALE



EUROPEAN PROJECTION



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REVISION
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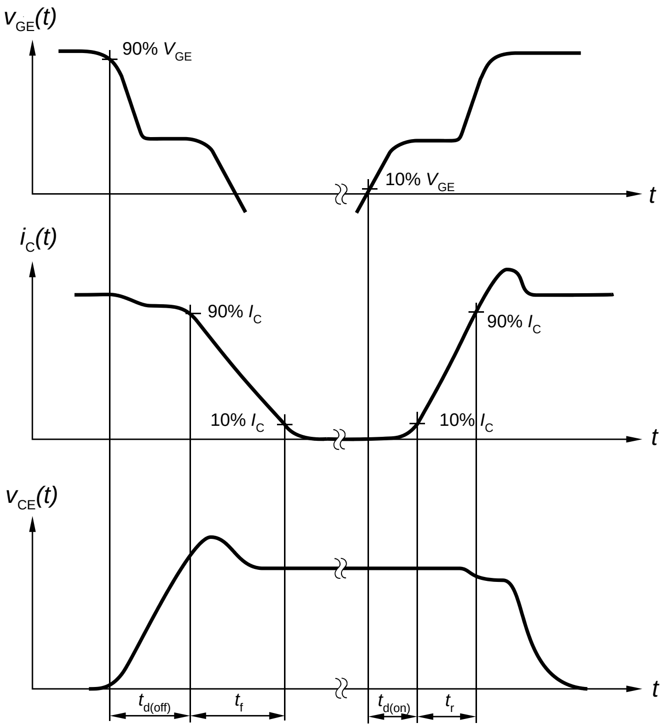

Figure A. Definition of switching times

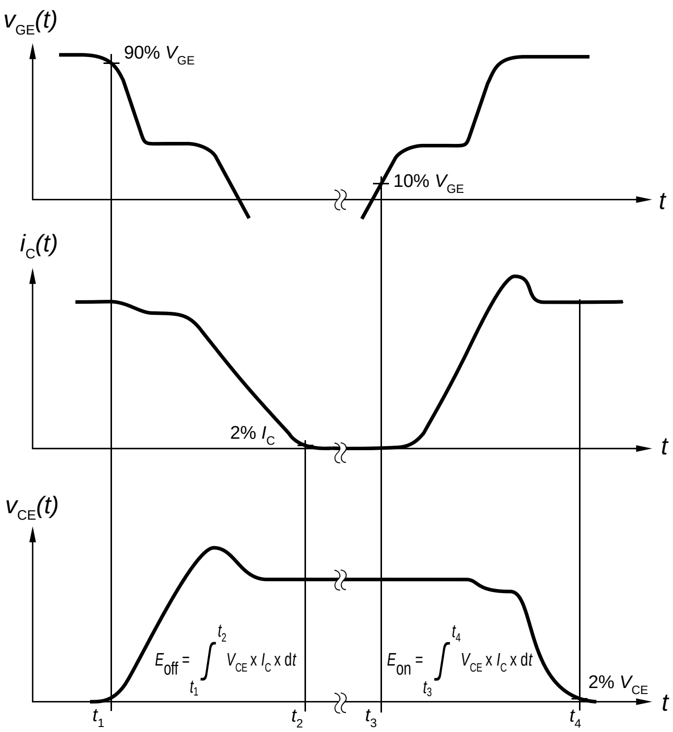

Figure B. Definition of switching losses

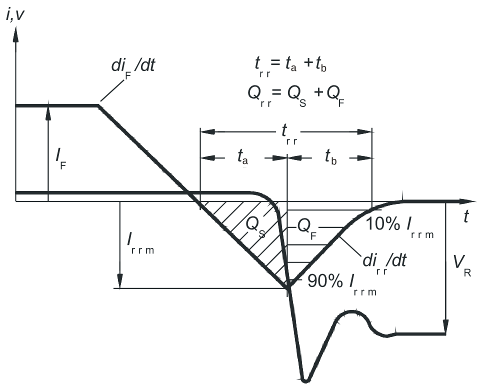

Figure C. Definition of diodes switching characteristics

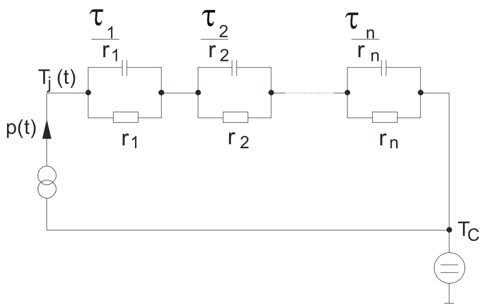

Figure D. Thermal equivalent circuit

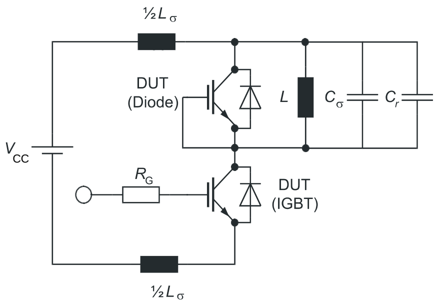

Figure E. Dynamic test circuit
Parasitic inductance L_{σ},
parasitic capacitor C_{σ},
relief capacitor C_r
(only for ZVT switching)

Revision History

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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