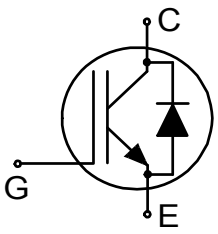
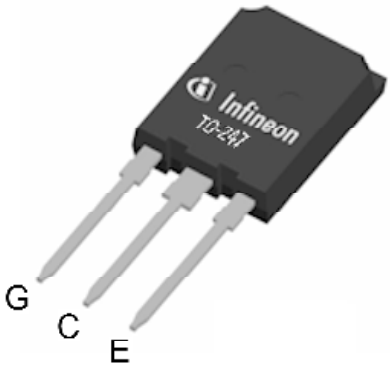
TRENCHSTOP™ Series

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 $V_{CE(sat)}$ 1.5V (typ.)
- Maximum junction temperature 175°C
- Dynamically stress tested
- Short circuit withstand time 5µs
- 100% short circuit tested
- 100% of the parts are dynamically tested
- 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
- TRENCHSTOP™ and Fieldstop technology for 600V applications offers:
  - very tight parameter distribution
  - high ruggedness, temperature stable behavior
  - very high switching speed





Applications:

- Main inverter
- Climate compressor
- PTC heater
- Motor drives

AEC Qualified

Green

Halogen-Free

RoHS

Key Performance and Package Parameters

Type	V_{CE}	I_C	V_{CEsat}, T_{vj}=25°C	T_{vjmax}	Marking	Package
AIKQ120N60CT	600V	120A	1.5V	175°C	AK120DCT	PG-TO247-3-46

Table of Contents

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 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 = 1µs	-	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

Thermal Resistance

Parameter	Symbol	Conditions	Value			Unit
			min.	typ.	max.	
R_{th} Characteristics						
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			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 = 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	 40 -	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			Unit
			min.	typ.	max.	
Dynamic Characteristic						
Input capacitance	C_{ies}	V_{CE} = 25V, V_{GE} = 0V, f = 1MHz	-	7530	-	pF
Output capacitance	C_{oes}		-	446	-	
Reverse transfer capacitance	C_{res}		-	206	-	
Gate charge	Q_G	V_{CC} = 480V, I_C = 120.0A, V_{GE} = 15V	-	772.0	-	nC
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, Lσ = 63nH, Cσ = 31pF Lσ, Cσ 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

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, Lσ = 63nH, Cσ = 31pF Lσ, Cσ 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

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

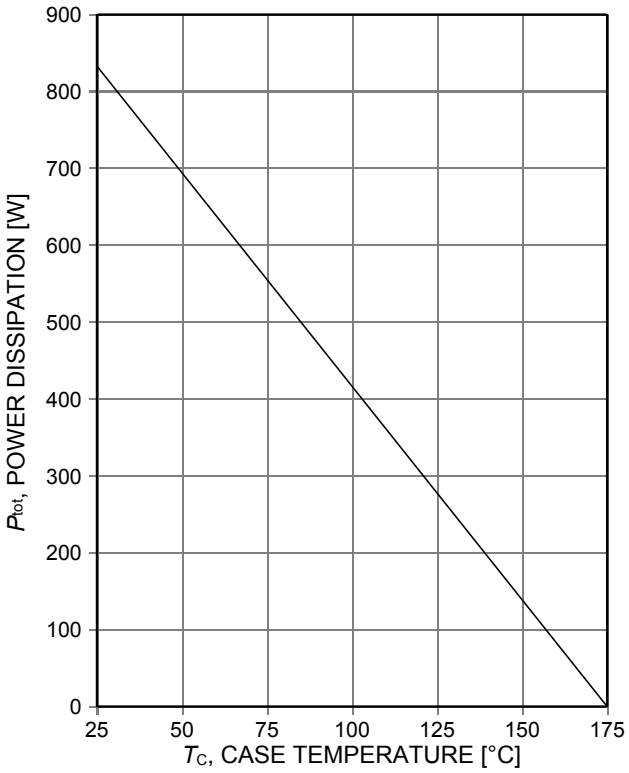


Figure 1. **Power dissipation as a function of case temperature**
($T_j \leq 175°C$)

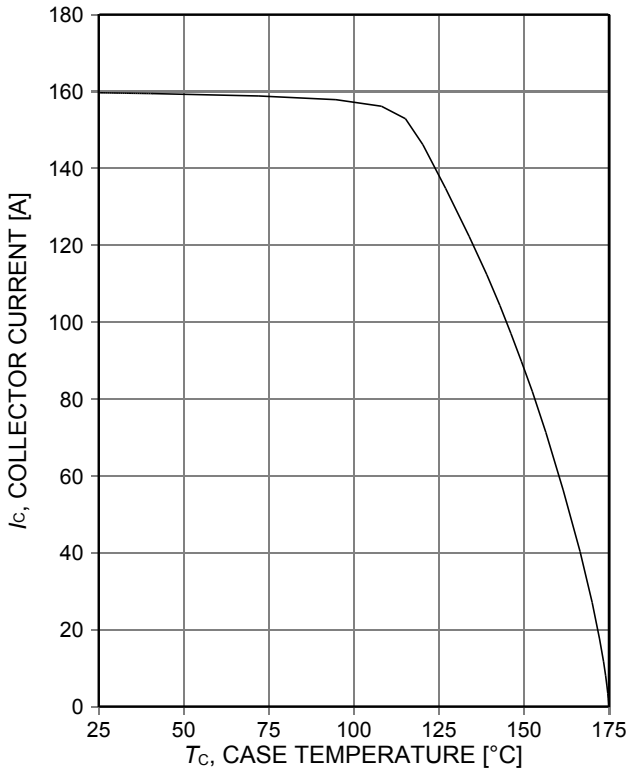


Figure 2. **Collector current as a function of case temperature**
($V_{GE} \geq 15V$, $T_j \leq 175°C$)

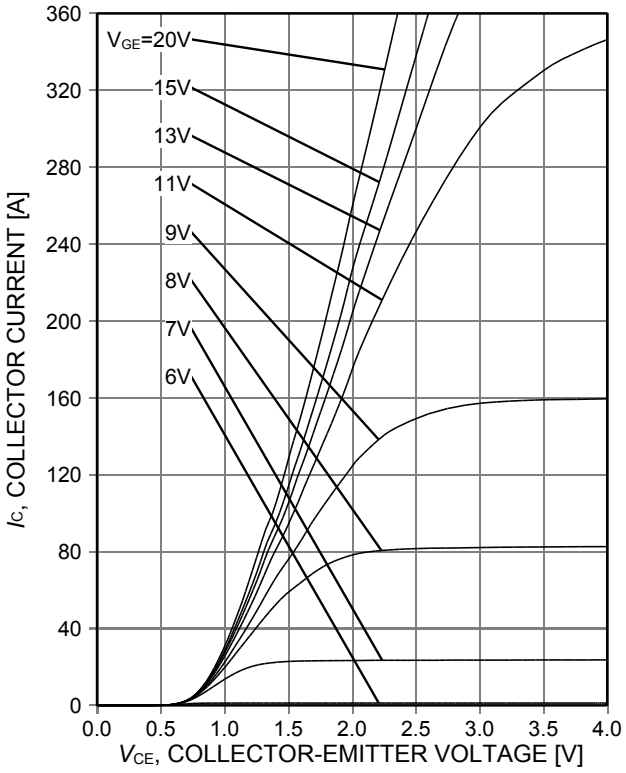


Figure 3. **Typical output characteristic**
(T_j=25°C)

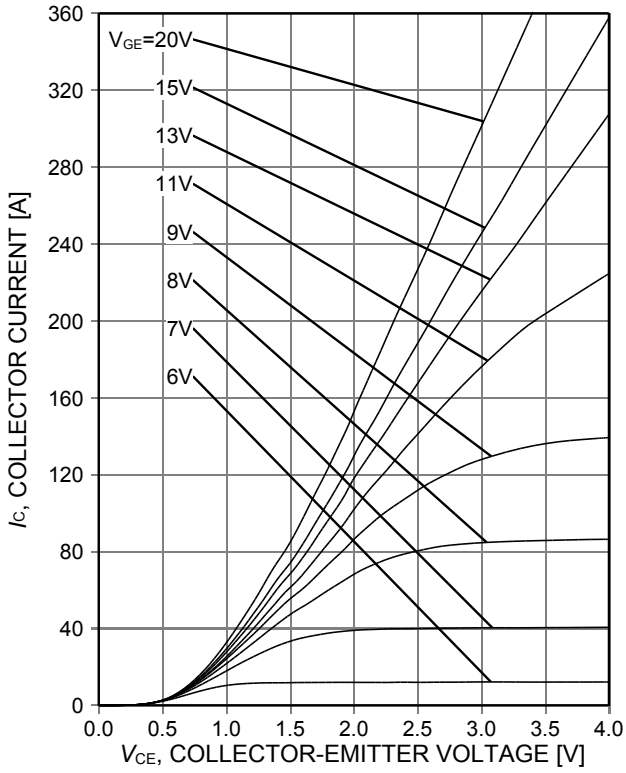


Figure 4. **Typical output characteristic**
(T_j=175°C)

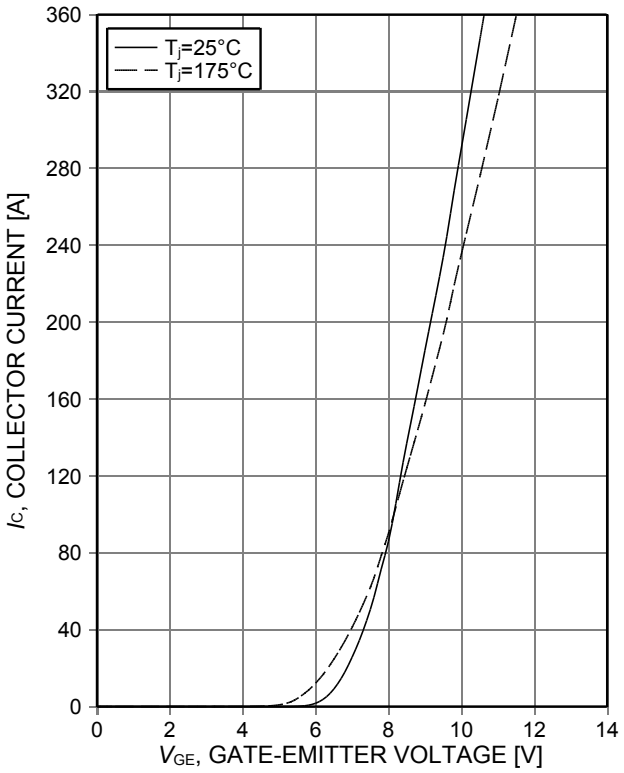


Figure 5. **Typical transfer characteristic**
(V_{CE}=20V)

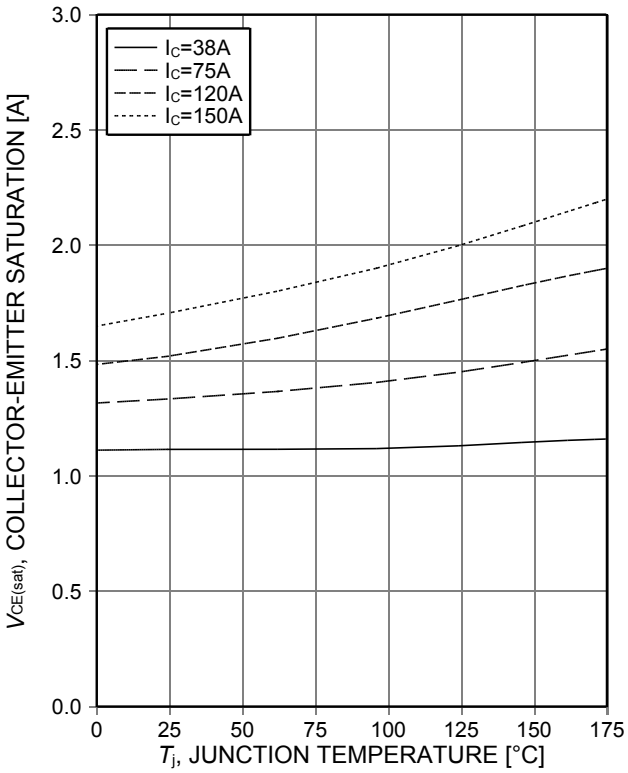


Figure 6. **Typical collector-emitter saturation voltage as a function of junction temperature**
(V_{GE}=15V)

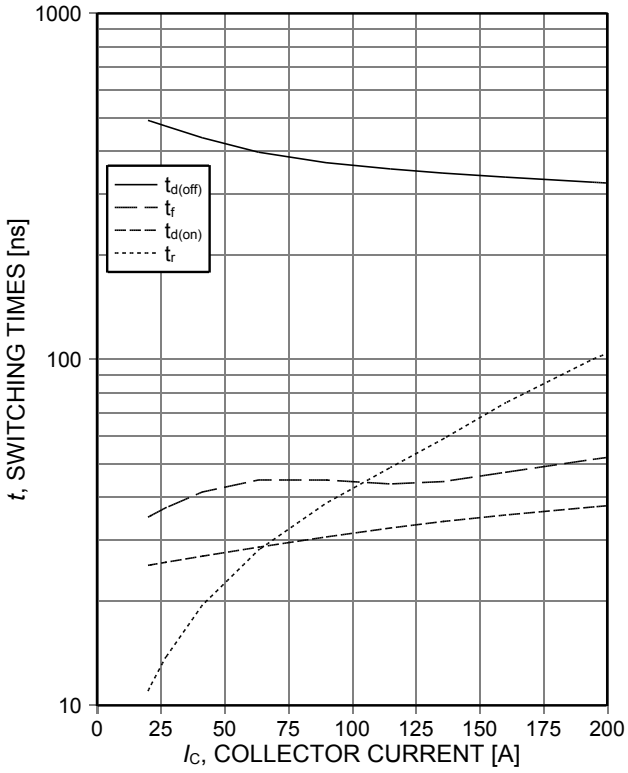


Figure 7. **Typical switching times as a function of collector current**
(inductive load, T_j=175°C, V_{CE}=400V, V_{GE}=15/0V, r_G=3Ω,Dynamic test circuit in Figure E)

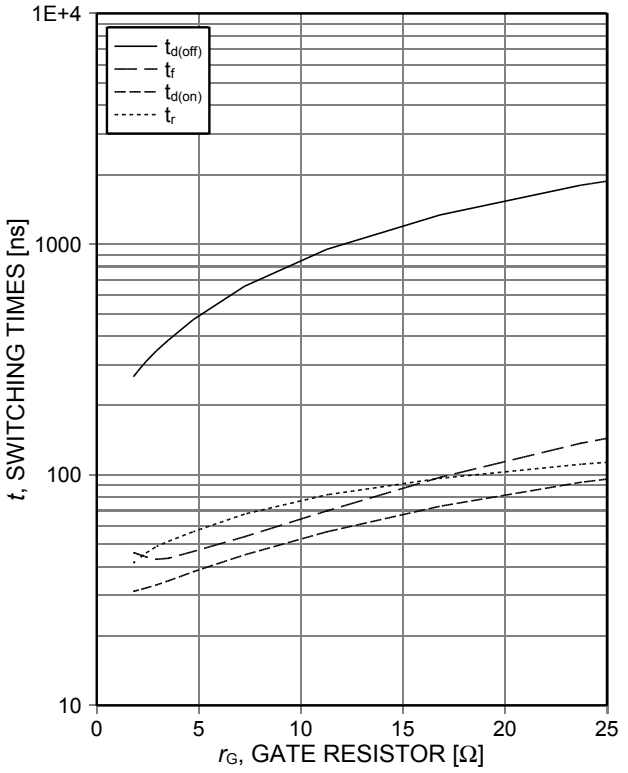


Figure 8. **Typical switching times as a function of gate resistor**
(inductive load, T_j=175°C, V_{CE}=400V, V_{GE}=15/0V, I_C=120A,Dynamic test circuit in Figure E)

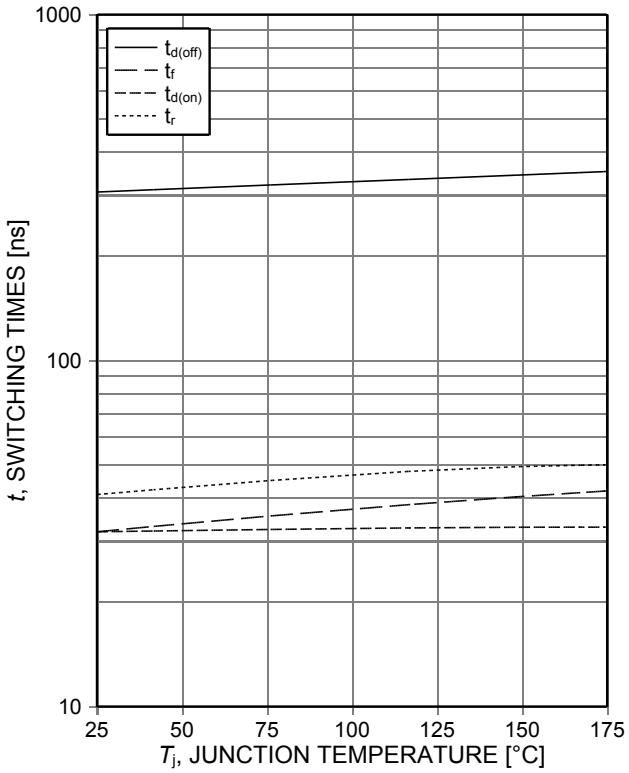


Figure 9. **Typical switching times as a function of junction temperature**
(inductive load, V_{CE}=400V, V_{GE}=15/0V, I_C=120A, r_G=3Ω,Dynamic test circuit in Figure E)

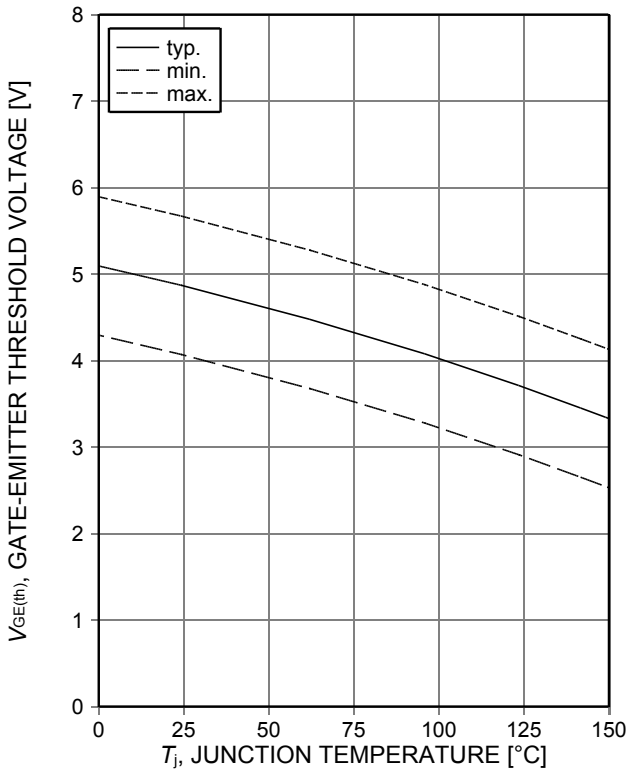


Figure 10. **Gate-emitter threshold voltage as a function of junction temperature**
(I_C=1,9mA)

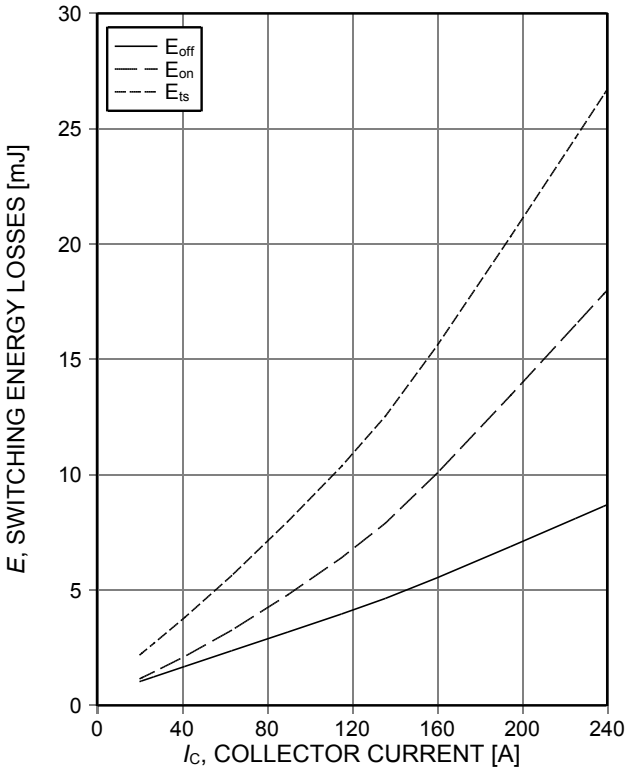


Figure 11. **Typical switching energy losses as a function of collector current**
(inductive load, T_j=175°C, V_{CE}=400V, V_{GE}=15/0V, r_G=3Ω,Dynamic test circuit in Figure E)

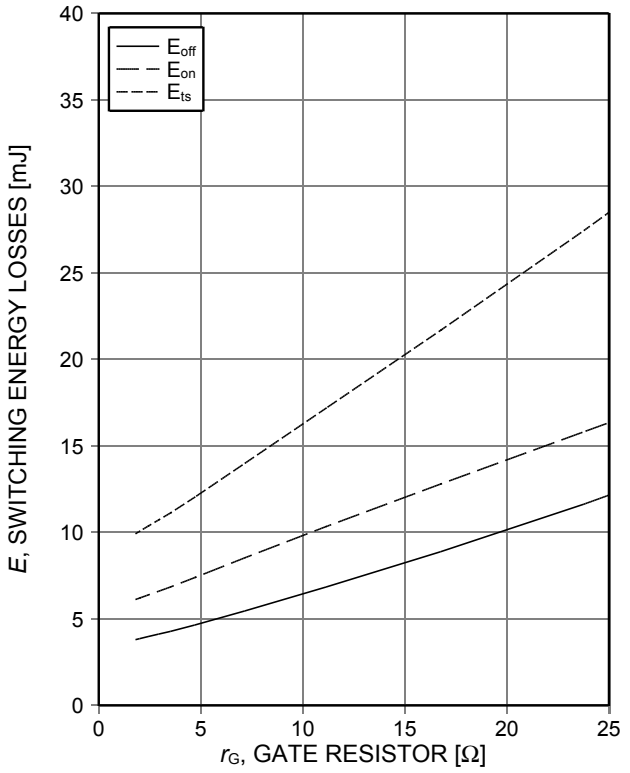


Figure 12. **Typical switching energy losses as a function of gate resistor**
(inductive load, T_j=175°C, V_{CE}=400V, V_{GE}=15/0V, I_C=120A,Dynamic test circuit in Figure E)

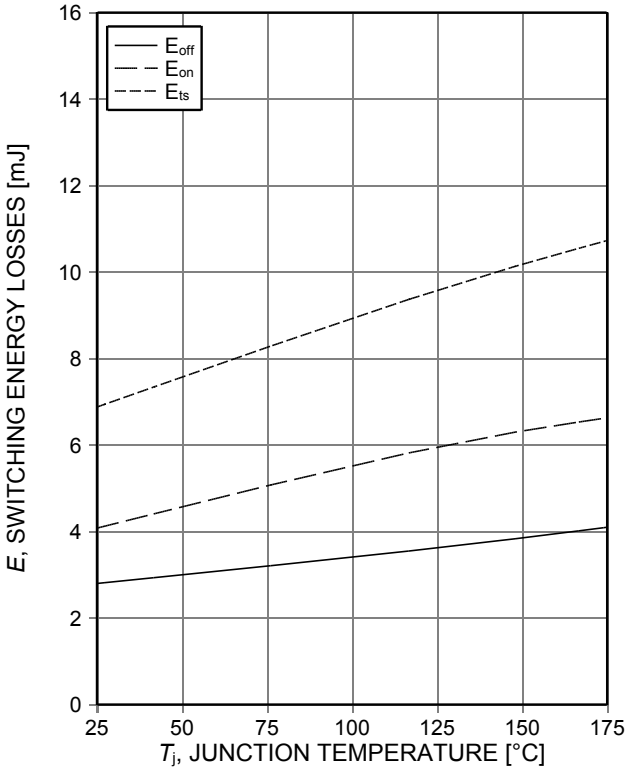


Figure 13. **Typical switching energy losses as a function of junction temperature** (inductive load, V_{CE}=400V, V_{GE}=15/0V, I_C=120A, r_G=3Ω,Dynamic test circuit in Figure E)

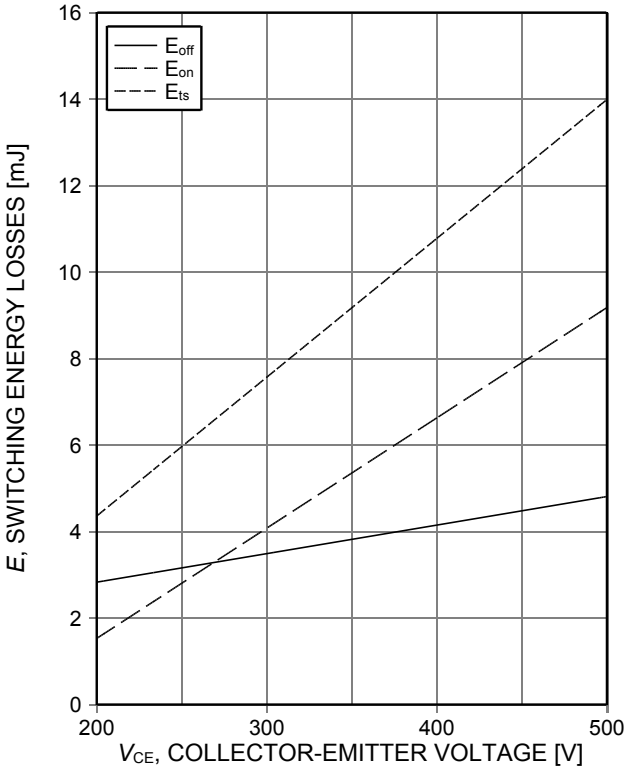


Figure 14. **Typical switching energy losses as a function of collector emitter voltage** (inductive load, T_j=175°C, V_{GE}=15/0V, I_C=120A, R_G=3Ω, Dynamic test circuit in Figure E)

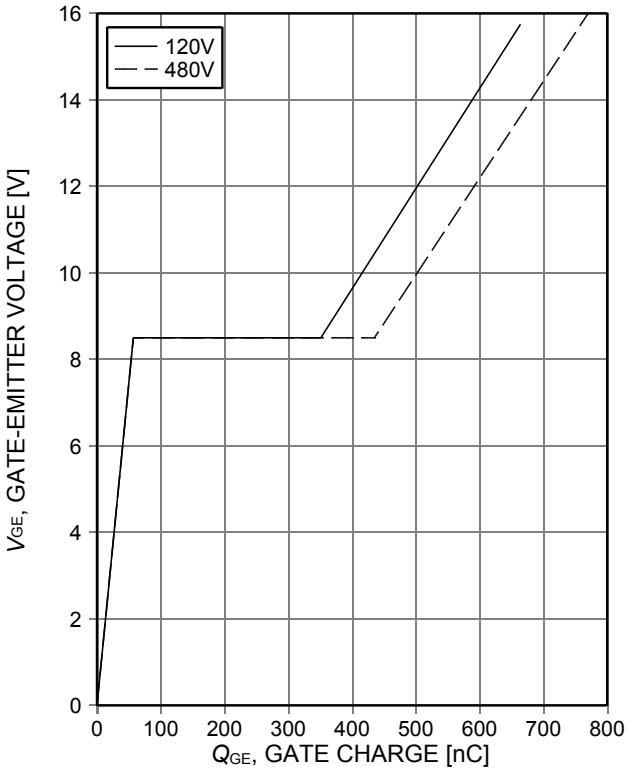


Figure 15. **Typical gate charge** (I_C=120A)

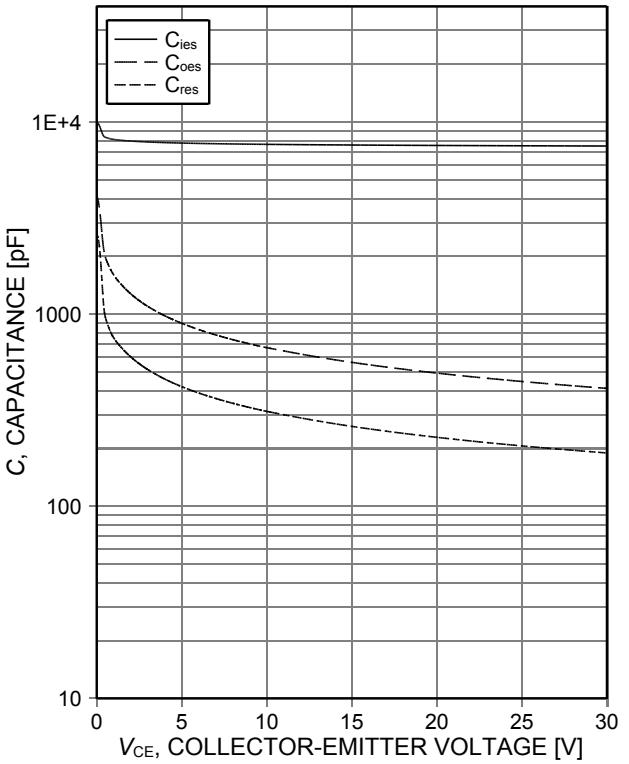


Figure 16. **Typical capacitance as a function of collector-emitter voltage** (V_{GE}=0V, f=1MHz)

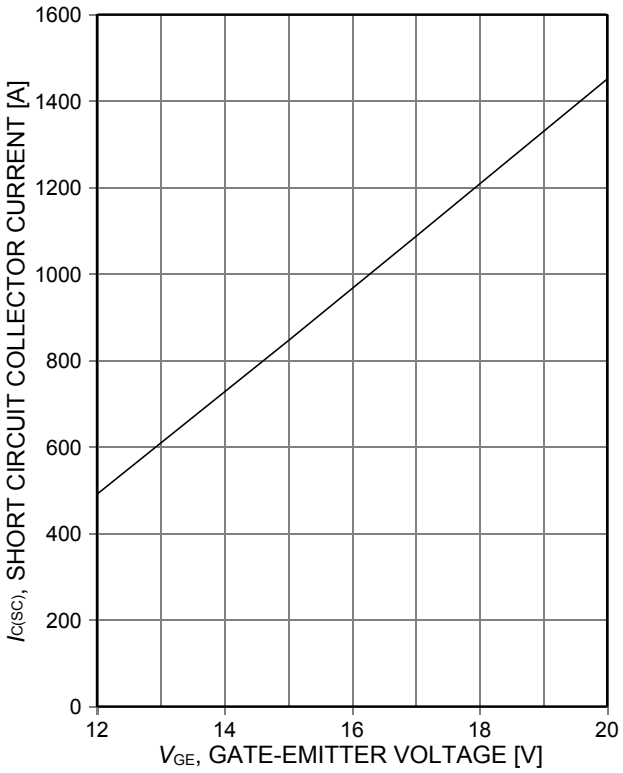


Figure 17. **Typical short circuit collector current as a function of gate-emitter voltage**
(V_{CE}≤400V, start at T_j≤150°C)

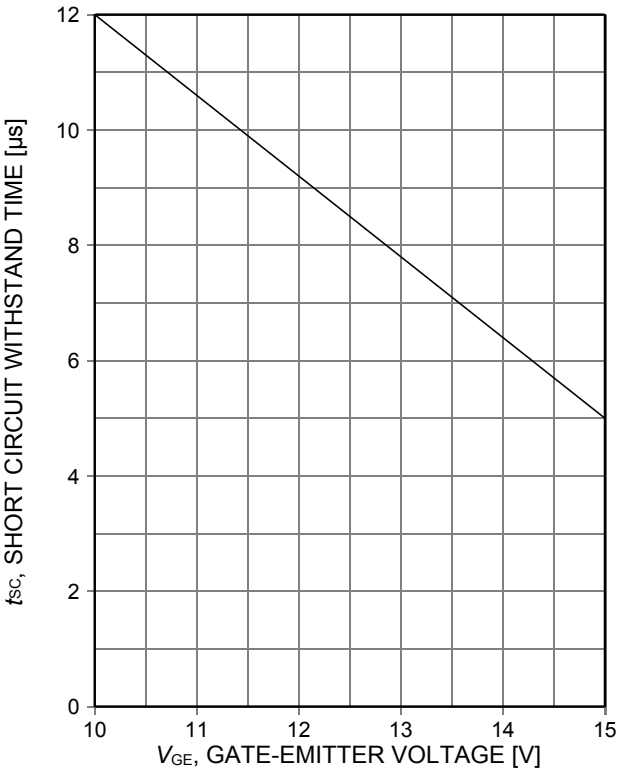


Figure 18. **Short circuit withstand time as a function of gate-emitter voltage**
(V_{CE}=400V, start at T_j=25°C, $T_j$max≤150°C)

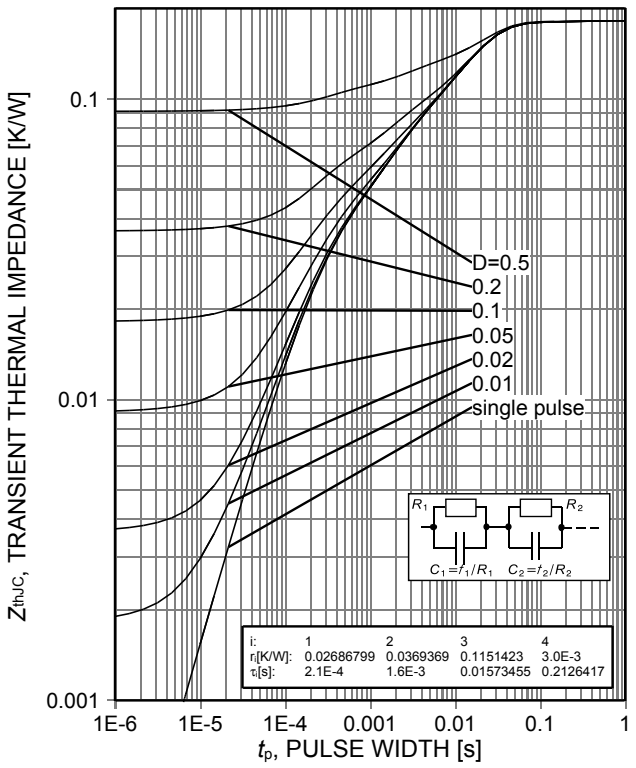


Figure 19. **IGBT transient thermal impedance as a function of pulse width for different duty cycles *D***
(*D*=t_p/T)

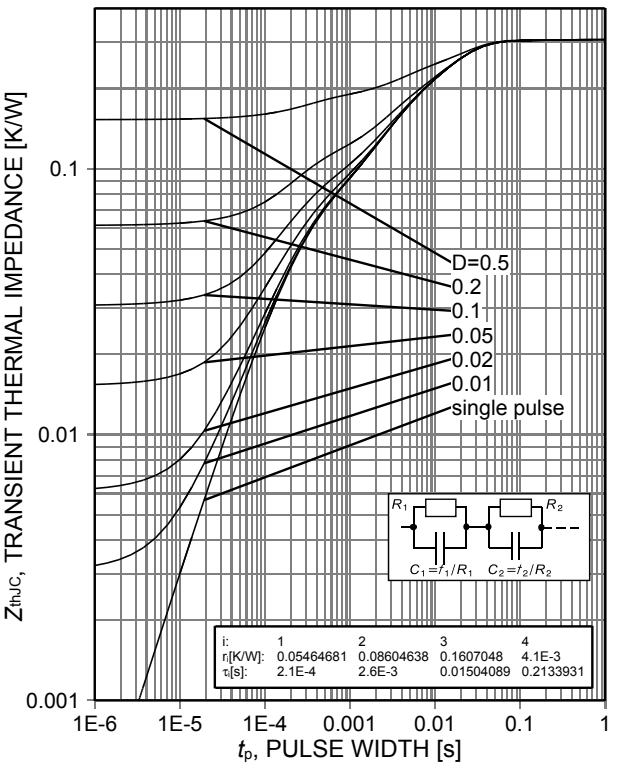


Figure 20. **Diode transient thermal impedance as a function of pulse width for different duty cycles *D***
(*D*=t_p/T)

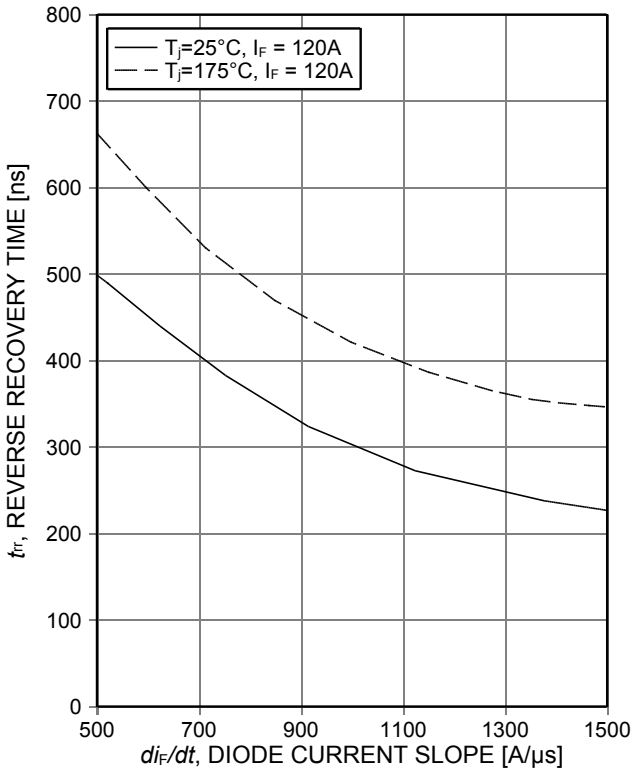


Figure 21. **Typical reverse recovery time as a function of diode current slope**
(V_R=400V,Dynamic test circuit in Figure E)

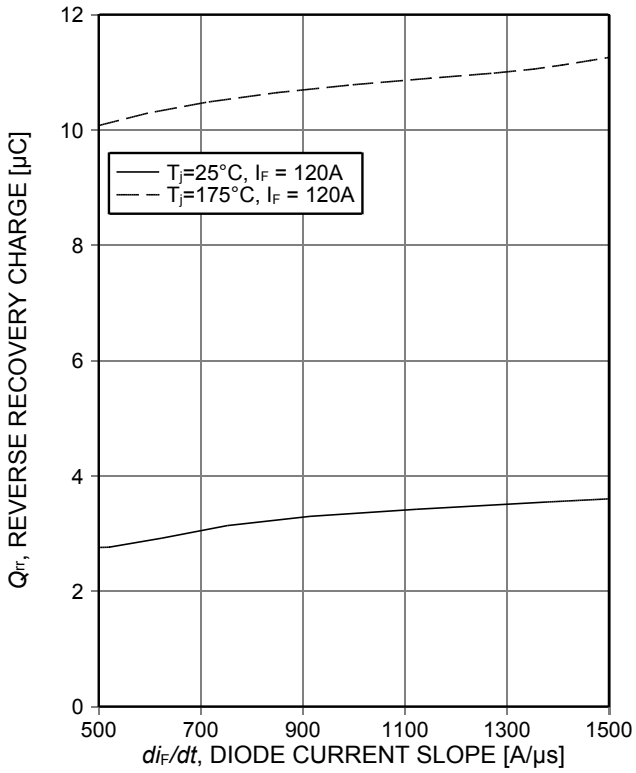


Figure 22. **Typical reverse recovery charge as a function of diode current slope**
(V_R=400V, Dynamic test circuit in Figure E)

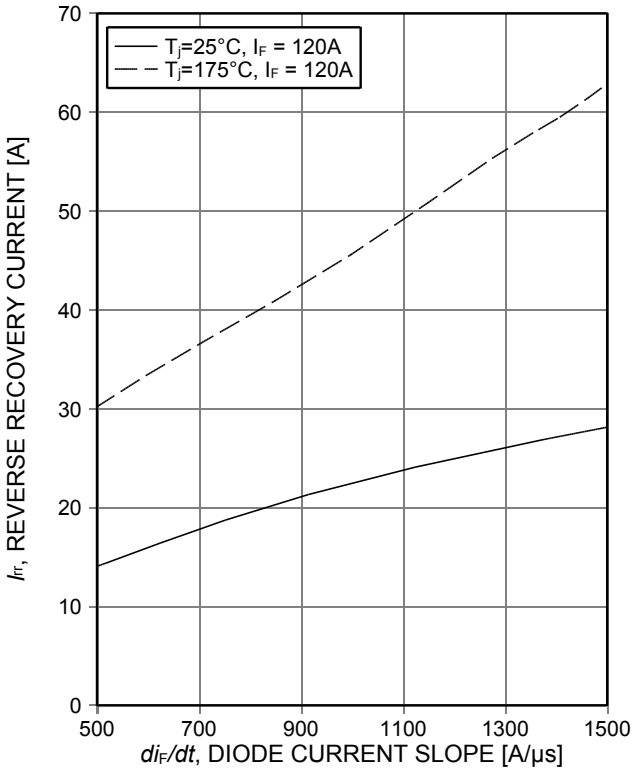


Figure 23. **Typical reverse recovery current as a function of diode current slope**
(V_R=400V, Dynamic test circuit in Figure E)

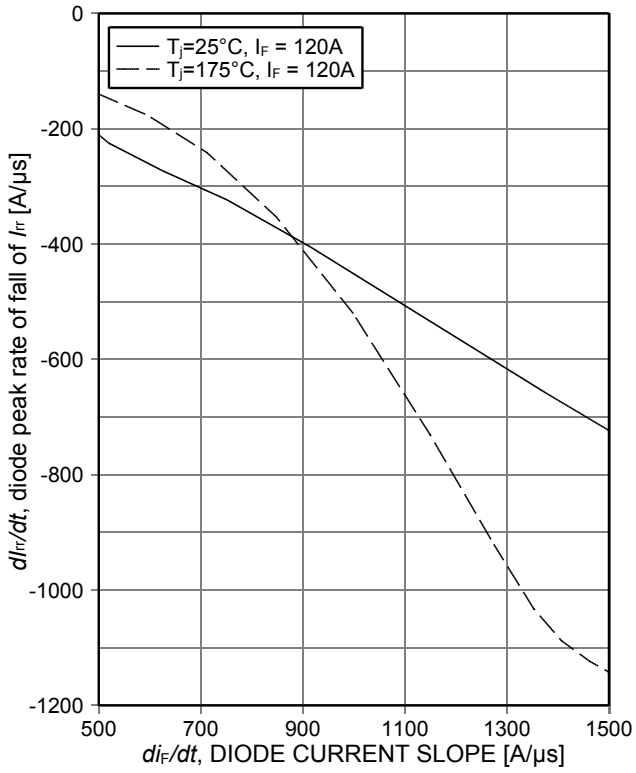


Figure 24. **Typical diode peak rate of fall of reverse recovery current as a function of diode current slope**
(V_R=400V, Dynamic test circuit in Figure E)

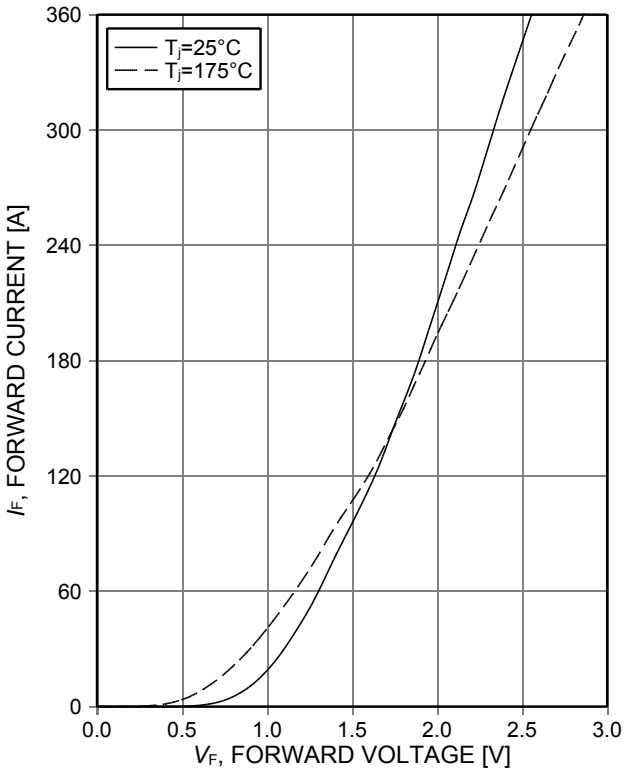


Figure 25. **Typical diode forward current as a function of forward voltage**

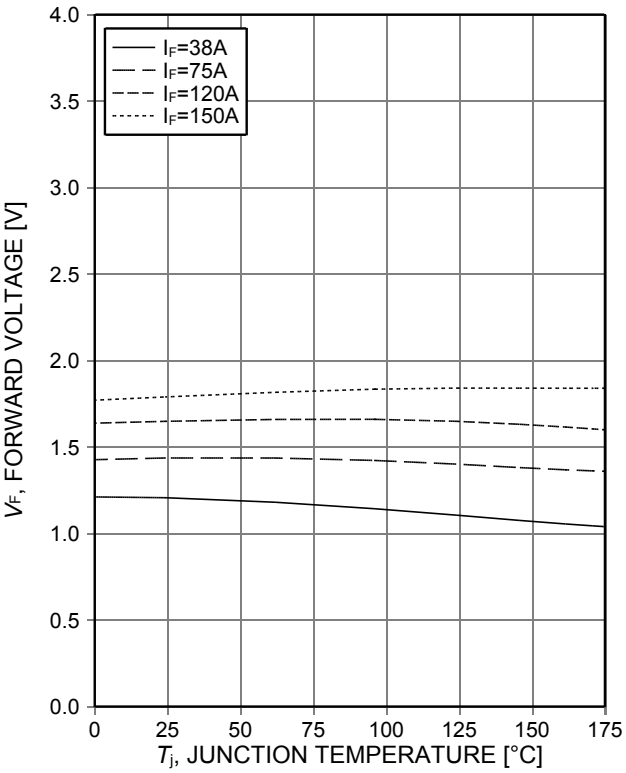
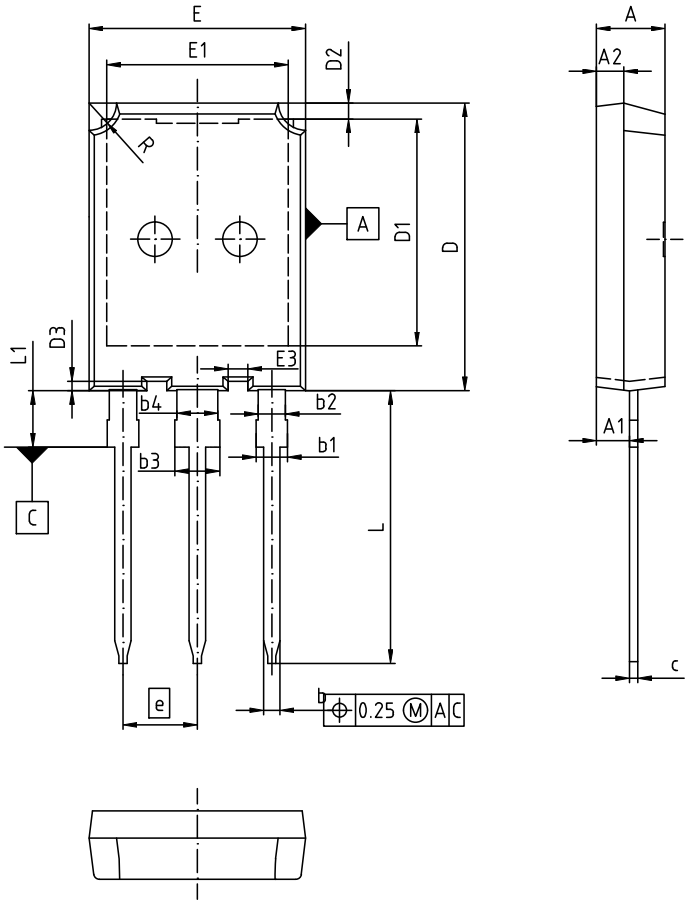


Figure 26. **Typical diode forward voltage as a function of junction temperature**

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 5 7.5mm
EUROPEAN PROJECTION	
ISSUE DATE	13-08-2014
REVISION	01

Testing Conditions

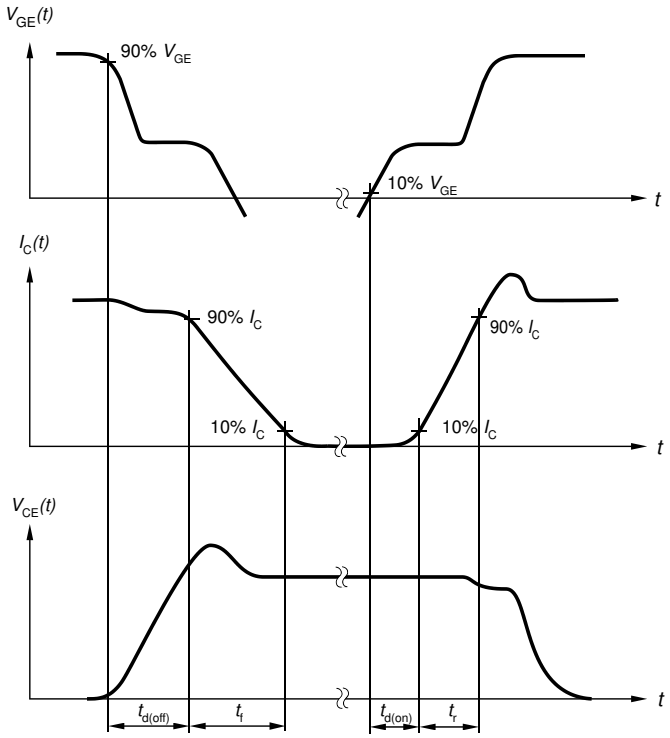


Figure A. **Definition of switching times**

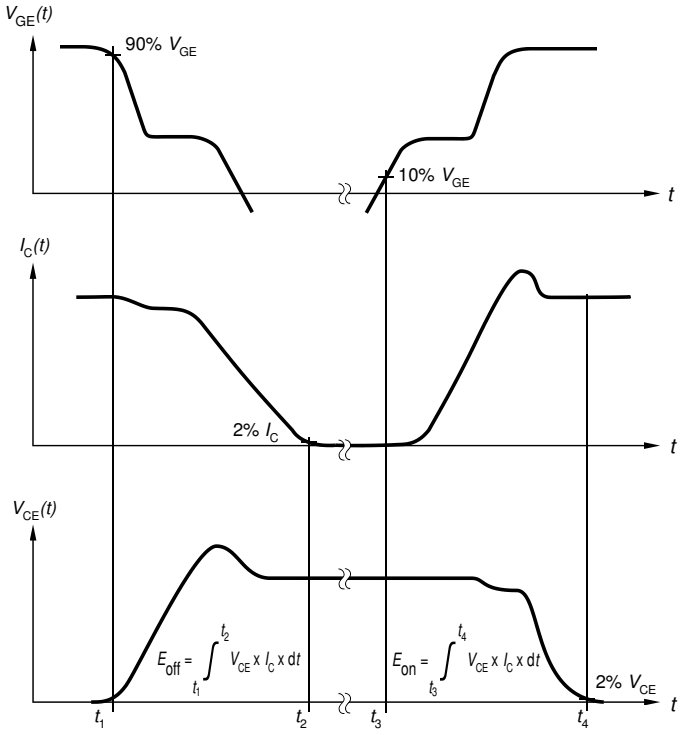


Figure B. **Definition of switching losses**

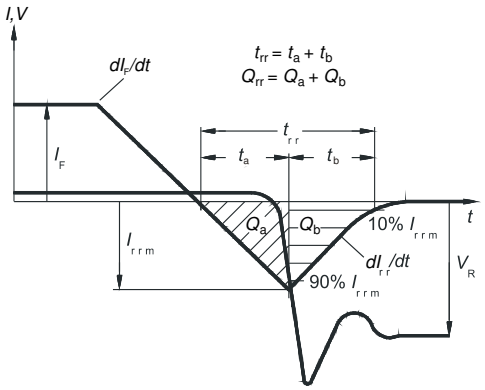


Figure C. **Definition of diode switching characteristics**

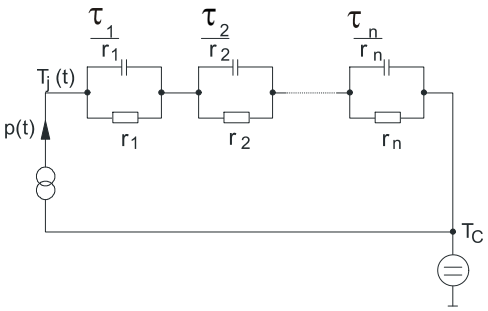


Figure D. **Thermal equivalent circuit**

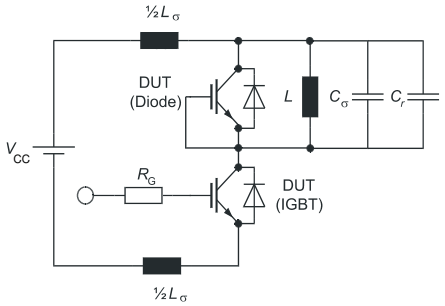


Figure E. **Dynamic test circuit**
Parasitic inductance L_σ,
parasitic capacitor C_σ,
relief capacitor C_r,
(only for ZVT switching)

Revision History

AIKQ120N60CT

Revision: 2017-02-09, Rev. 2.1

Previous Revision

Revision	Date	Subjects (major changes since last revision)
2.1	2017-02-09	Data sheet created

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