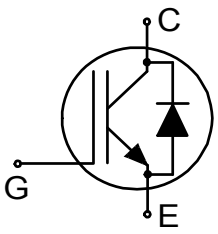
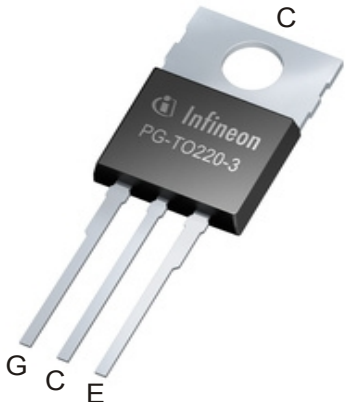
TRENCHSTOP™ Series

Low Loss DuoPack: IGBT in TRENCHSTOP™ and Fieldstop technology with soft, fast recovery anti-parallel 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 150°C
- Dynamically stress tested
- Short circuit withstand time 5µs
- Positive temperature coefficient in $V_{CE(sat)}$
- Low EMI
- Low Gate Charge
- Green Package
- 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

Pb

Green

RoHS

Key Performance and Package Parameters

Type	V_{CE}	I_C	V_{CEsat}, T_{vj}=25°C	T_{vjmax}	Marking	Package
AIKP20N60CT	600V	20A	1.5V	150°C	AK20DCT	PG-TO220-3

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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, 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	Value			Unit
			min.	typ.	max.	
R_{th} Characteristics						
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 junction - ambient	$R_{th(j-a)}$		-	-	62	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	- -	- 550	40 -	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
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} = 400V, I_C = 20.0A, V_{GE} = 0.0/15.0V, $R_{G(on)}$ = 12.0Ω, $R_{G(off)}$ = 12.0Ω, Lσ = 131nH, Cσ = 31pF Lσ, Cσ 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 = 400V, 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} = 400V, I_C = 20.0A, V_{GE} = 0.0/15.0V, $R_{G(on)}$ = 12.0Ω, $R_{G(off)}$ = 12.0Ω, Lσ = 131nH, Cσ = 31pF Lσ, Cσ 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 = 400V, 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

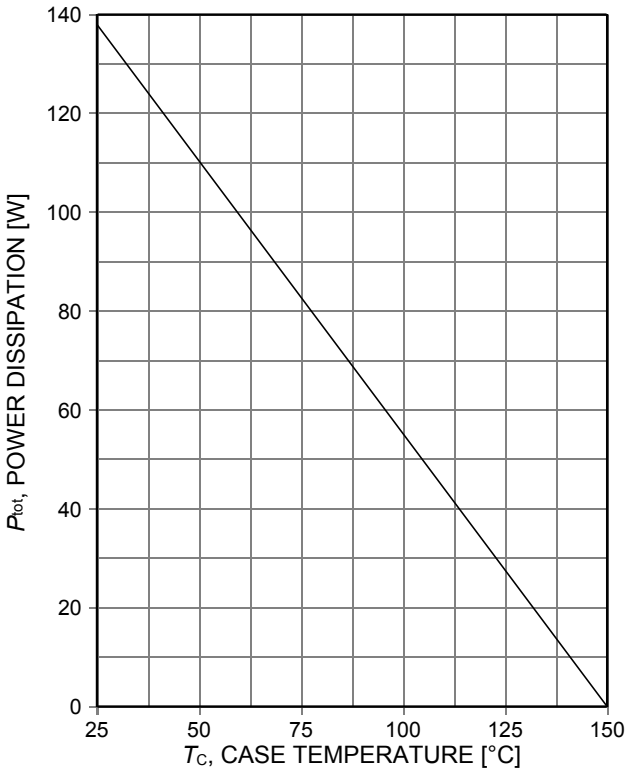


Figure 1. **Power dissipation as a function of case temperature**
($T_j \leq 150°C$)

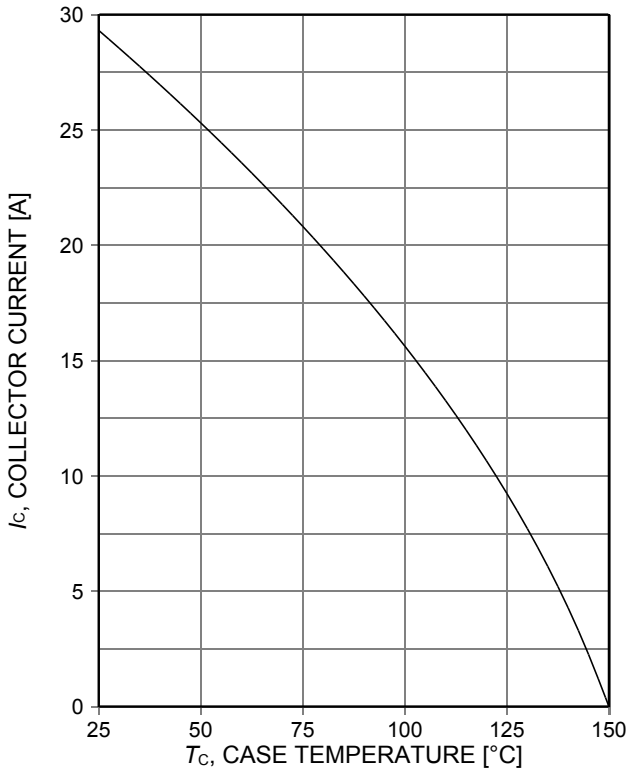


Figure 2. **Collector current as a function of case temperature**
($V_{GE} \geq 15V$, $T_j \leq 150°C$)

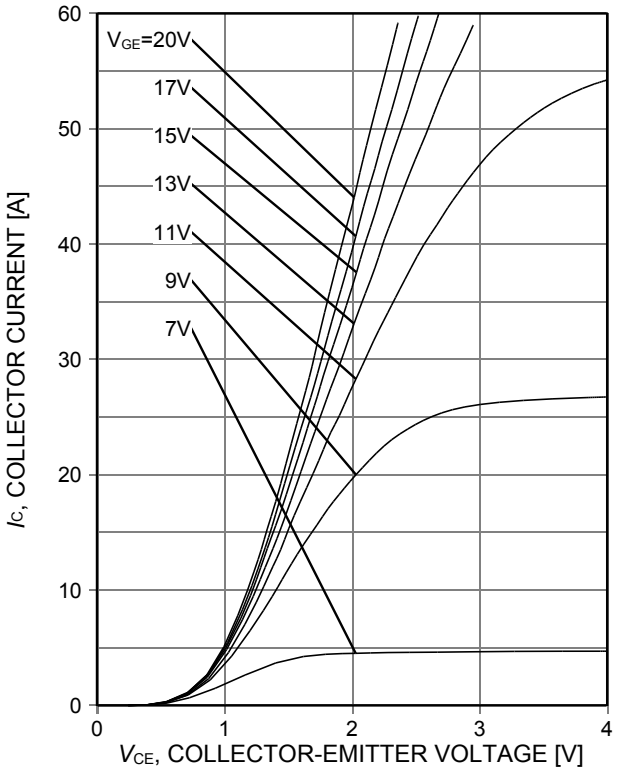


Figure 3. **Typical output characteristic**
(T_j=25°C)

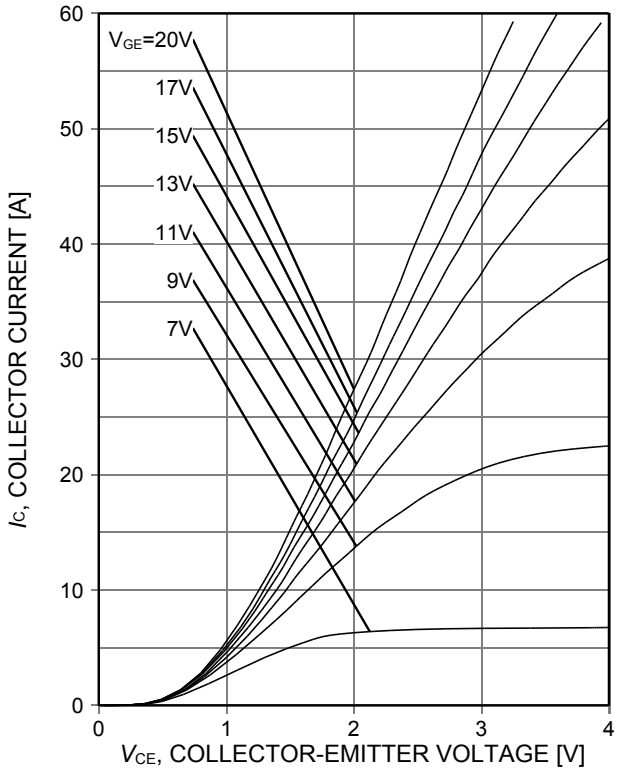


Figure 4. **Typical output characteristic**
(T_j=150°C)

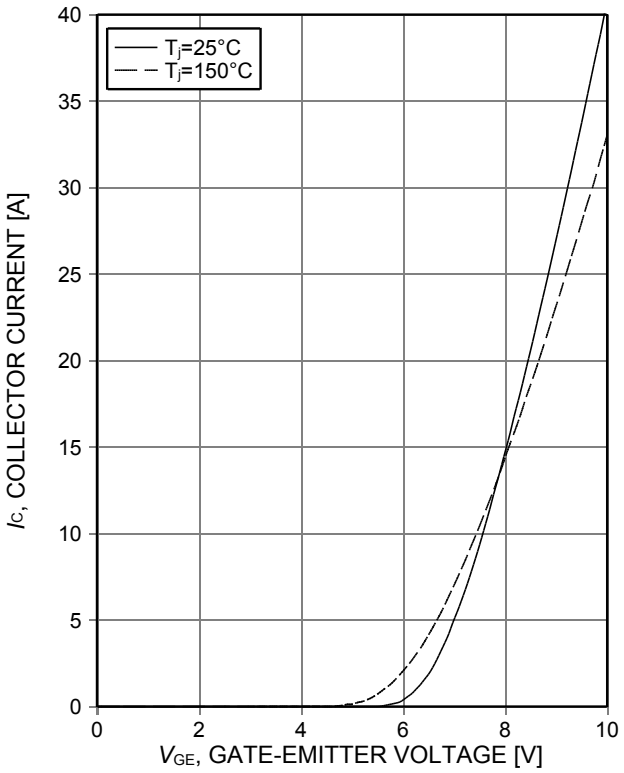


Figure 5. **Typical transfer characteristic**
(V_{CE}=10V)

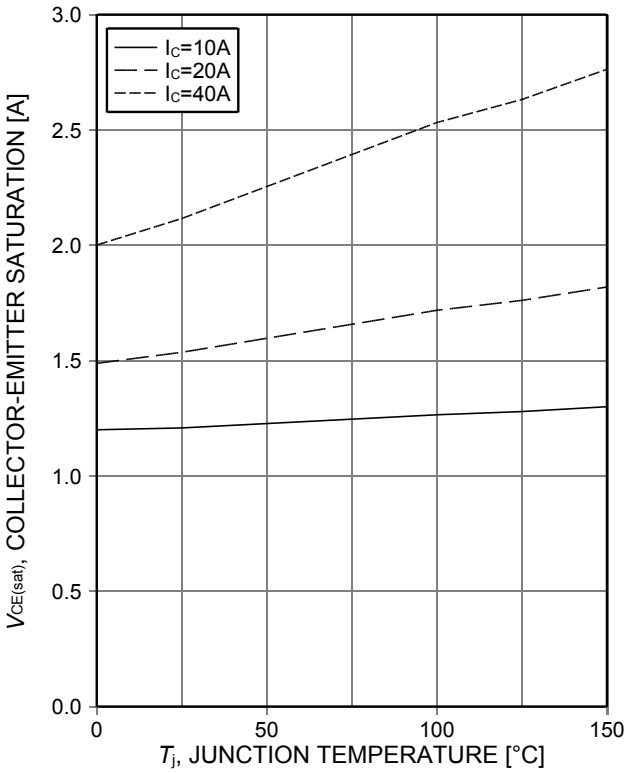


Figure 6. **Typical collector-emitter saturation voltage as a function of junction temperature**
(V_{GE}=15V)

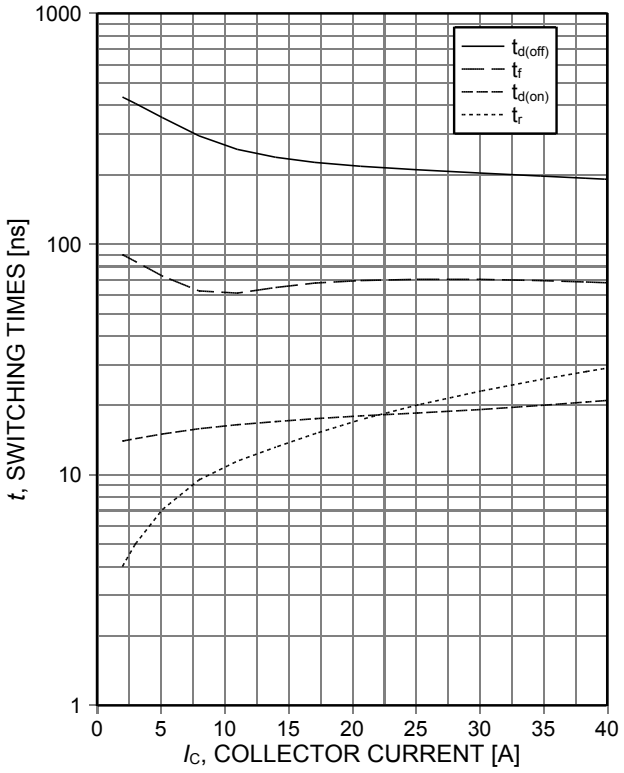


Figure 7. **Typical switching times as a function of collector current**
(inductive load, T_j=150°C, V_{CE}=400V, V_{GE}=15/0V, R_G=12Ω,Dynamic test circuit in Figure E)

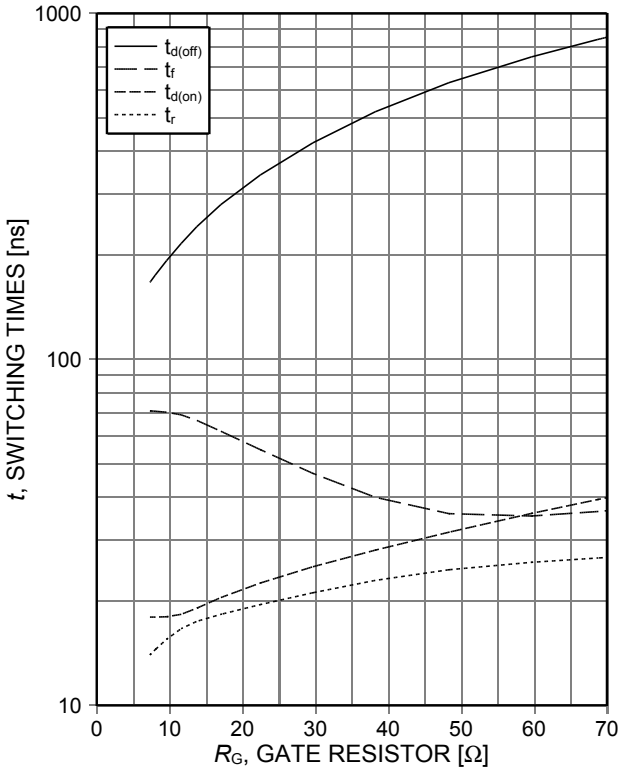


Figure 8. **Typical switching times as a function of gate resistor**
(inductive load, T_j=150°C, V_{CE}=400V, V_{GE}=15/0V, I_C=20A,Dynamic test circuit in Figure E)

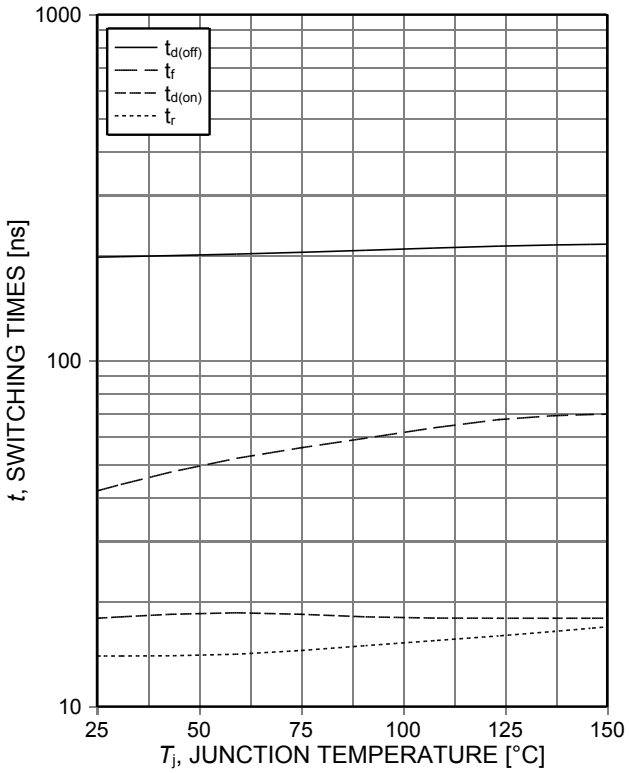


Figure 9. **Typical switching times as a function of junction temperature**
(inductive load, V_{CE}=400V, V_{GE}=15/0V, I_C=20A, R_G=12Ω,Dynamic test circuit in Figure E)

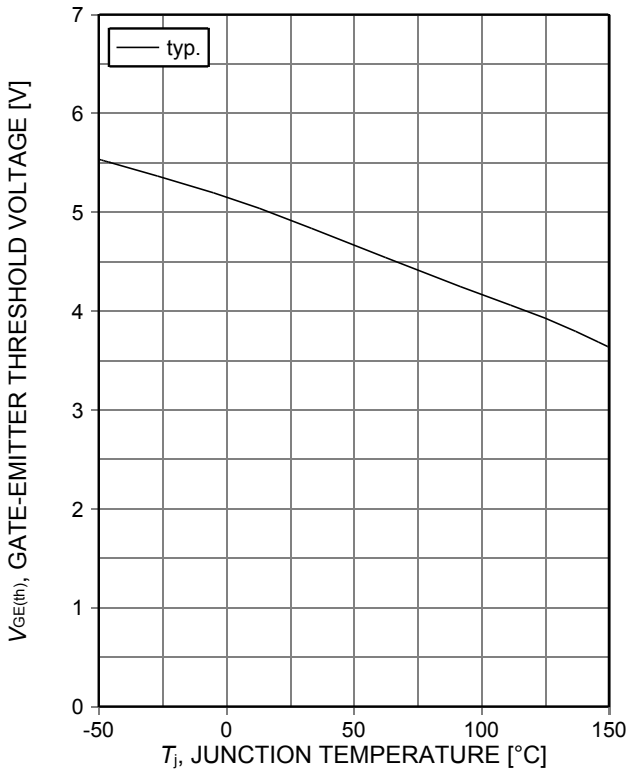


Figure 10. **Gate-emitter threshold voltage as a function of junction temperature**
(I_C=0.29mA)

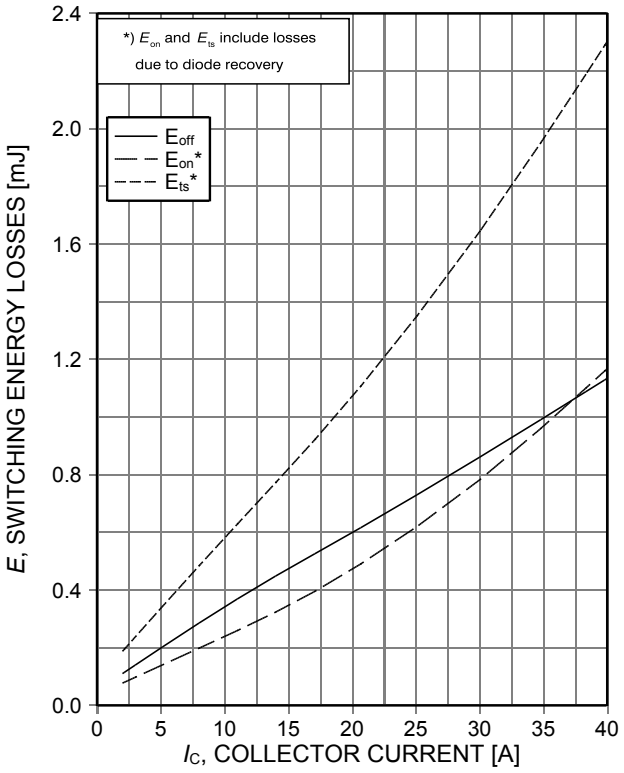


Figure 11. **Typical switching energy losses as a function of collector current**
(inductive load, T_j=150°C, V_{CE}=400V, V_{GE}=15/0V, R_G=12Ω,Dynamic test circuit in Figure E)

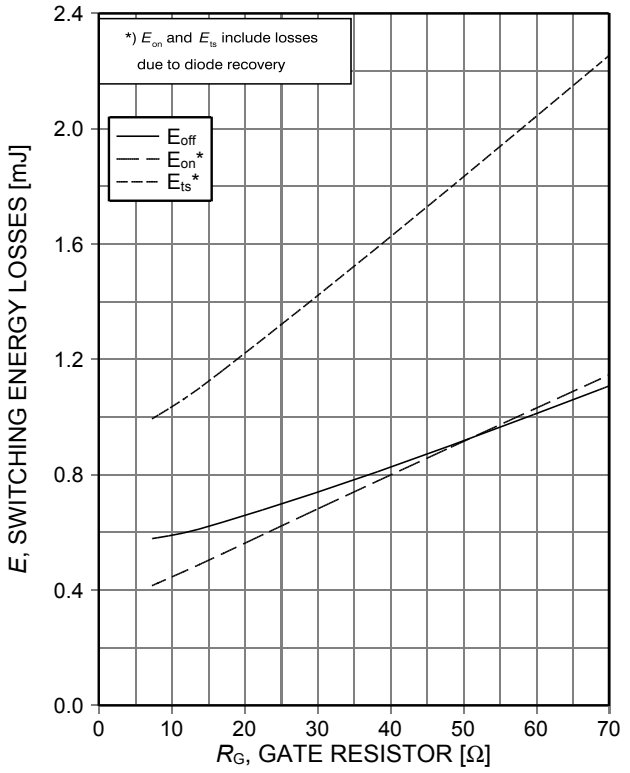


Figure 12. **Typical switching energy losses as a function of gate resistor**
(inductive load, T_j=150°C, V_{CE}=400V, V_{GE}=15/0V, I_C=20A,Dynamic test circuit in Figure E)

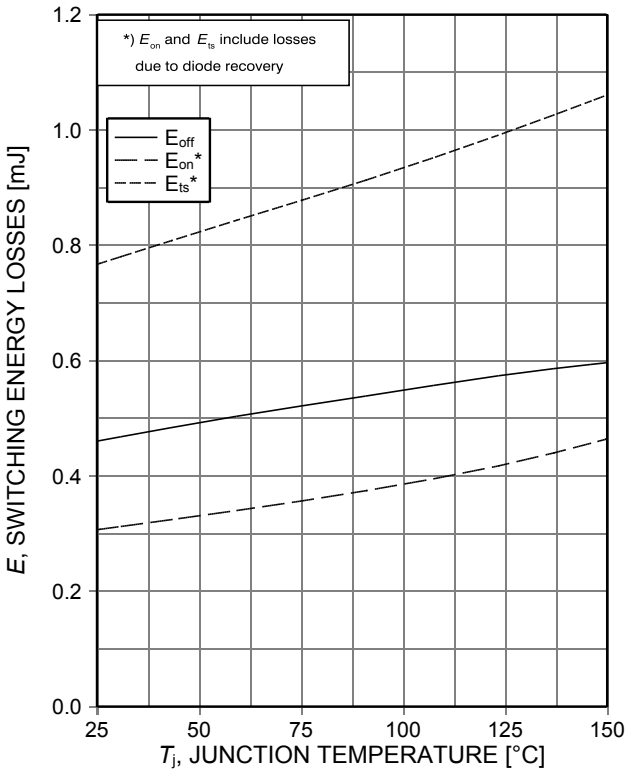


Figure 13. **Typical switching energy losses as a function of junction temperature** (inductive load, V_{CE}=400V, V_{GE}=15/0V, I_C=20A, R_G=12Ω,Dynamic test circuit in Figure E)

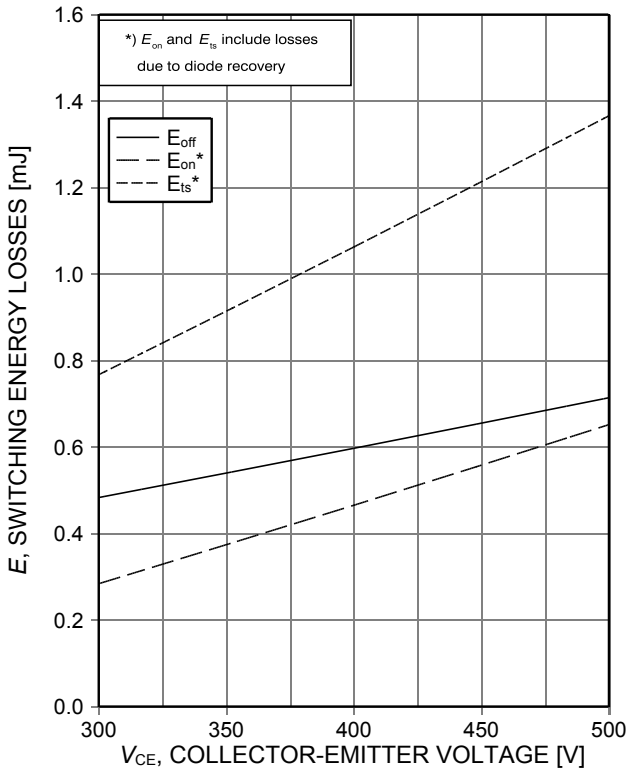


Figure 14. **Typical switching energy losses as a function of collector emitter voltage** (inductive load, T_j=150°C, V_{GE}=15/0V, I_C=20A, R_G=12Ω, Dynamic test circuit in Figure E)

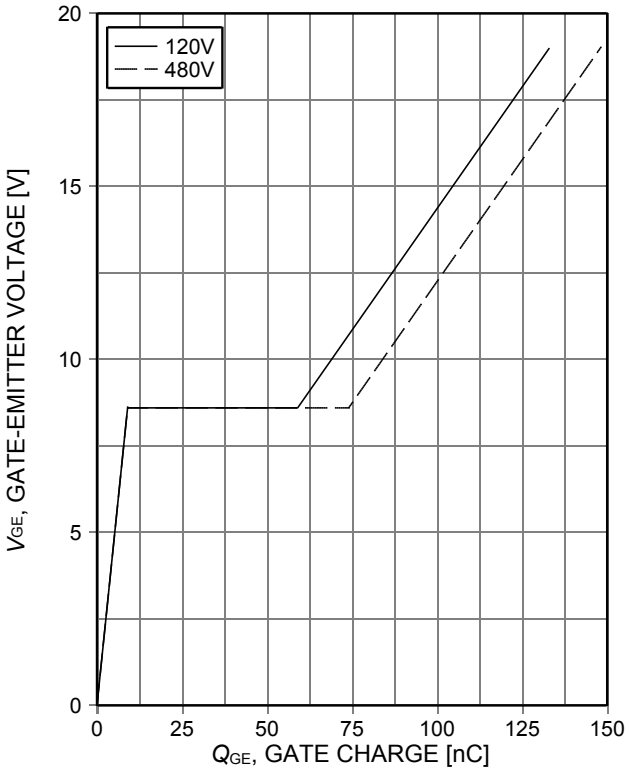


Figure 15. **Typical gate charge** (I_C=20A)

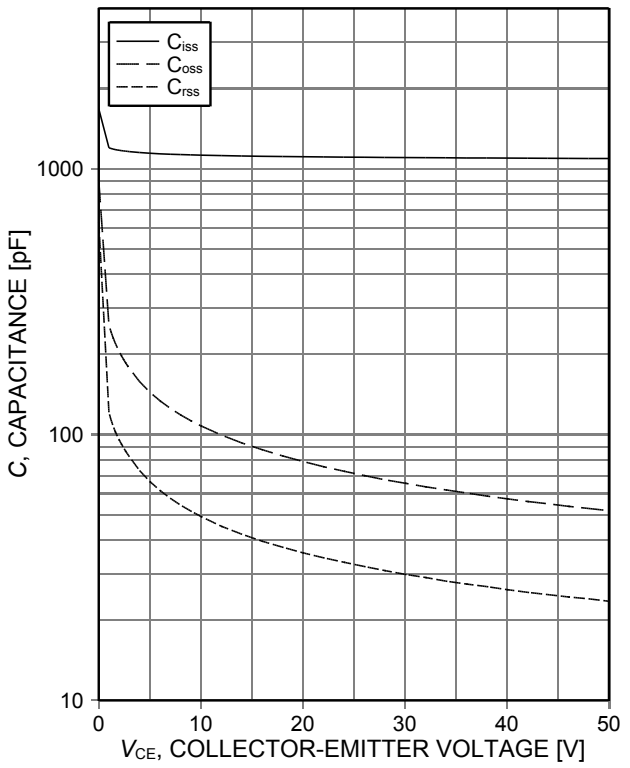


Figure 16. **Typical capacitance as a function of collector-emitter voltage** (V_{GE}=0V, f=1MHz)

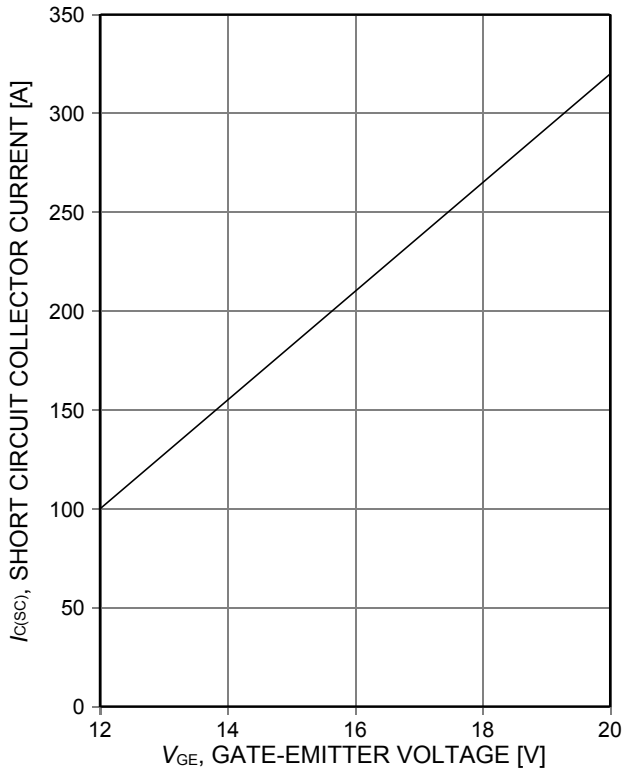


Figure 17. **Typical short circuit collector current as a function of gate-emitter voltage**
(V_{CE}≤400V, T_j≤150°C)

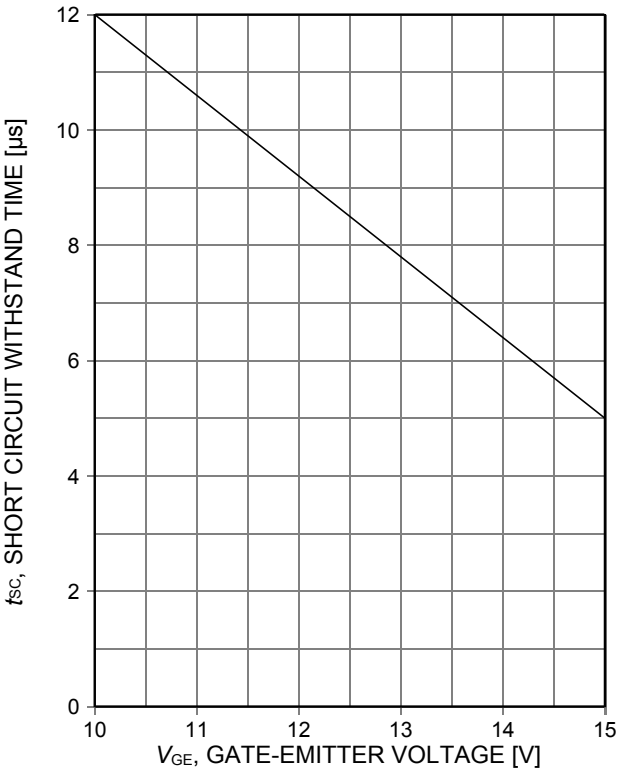


Figure 18. **Short circuit withstand time as a function of gate-emitter voltage**
(V_{CE}=400V, start at T_j=25°C, $T_j$max≤150°C)

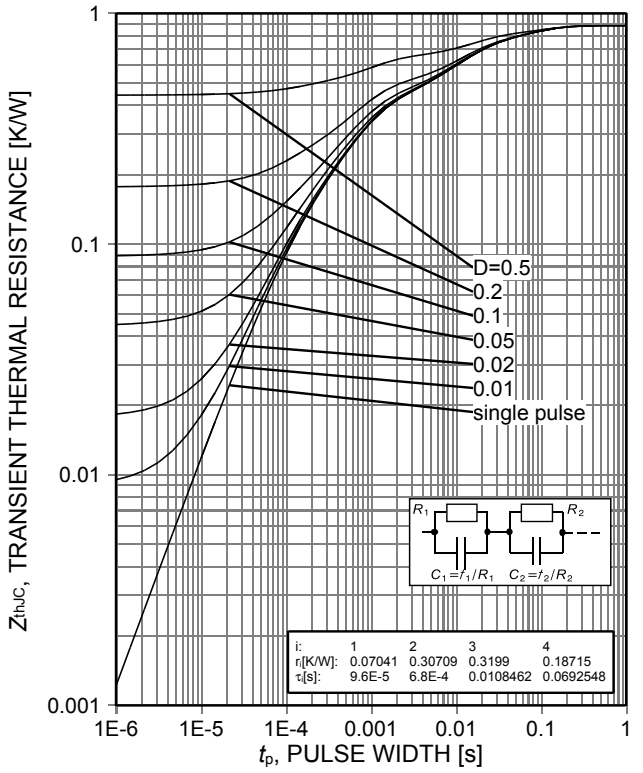


Figure 19. **IGBT transient thermal resistance as a function of pulse width for different duty cycles *D***
($D=t_p/T$)

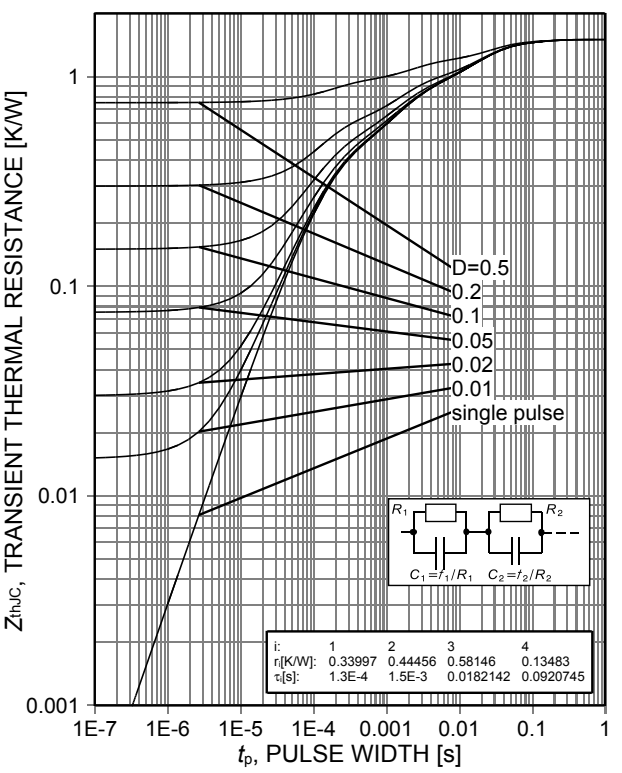


Figure 20. **Diode transient thermal impedance as a function of pulse width for different duty cycles *D***
($D=t_p/T$)

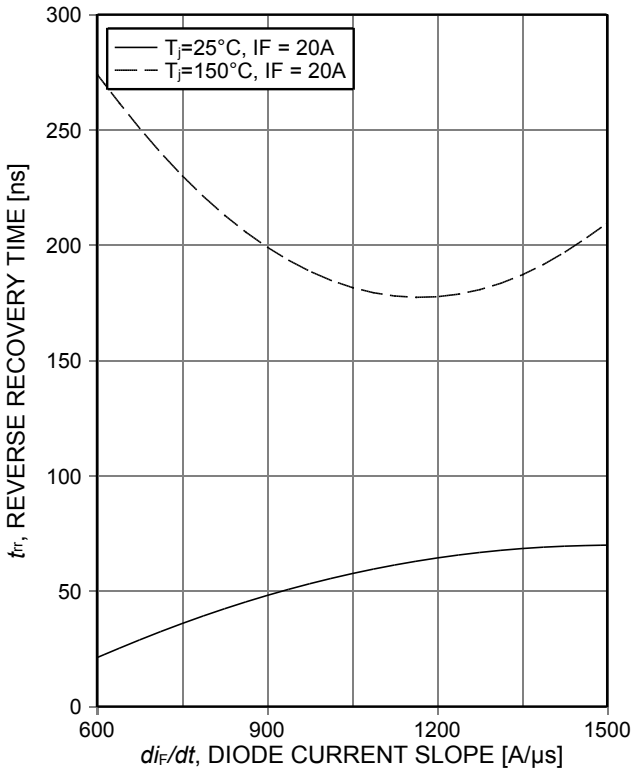


Figure 21. **Typical reverse recovery time as a function of diode current slope**
(V_R=400V, Dynamic test circuit in Figure E)

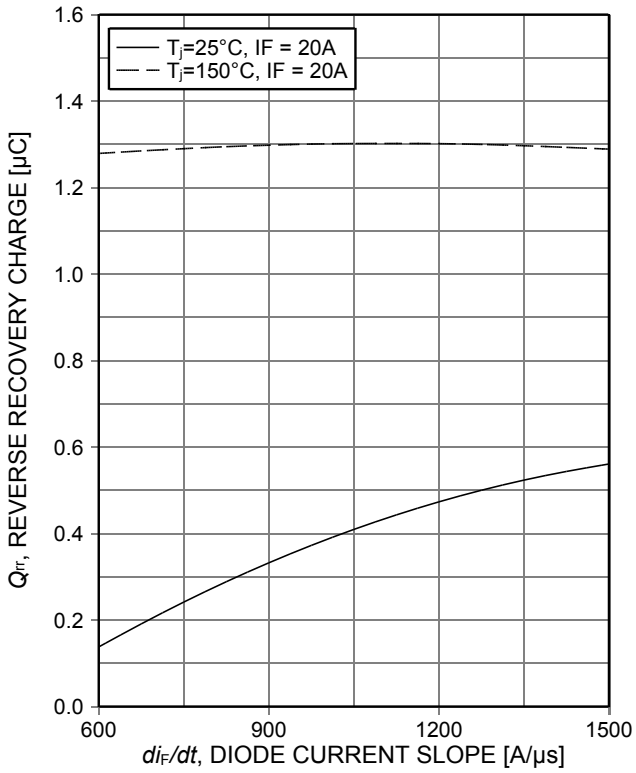


Figure 22. **Typical reverse recovery charge as a function of diode current slope**
(V_R=400V, Dynamic test circuit in Figure E)

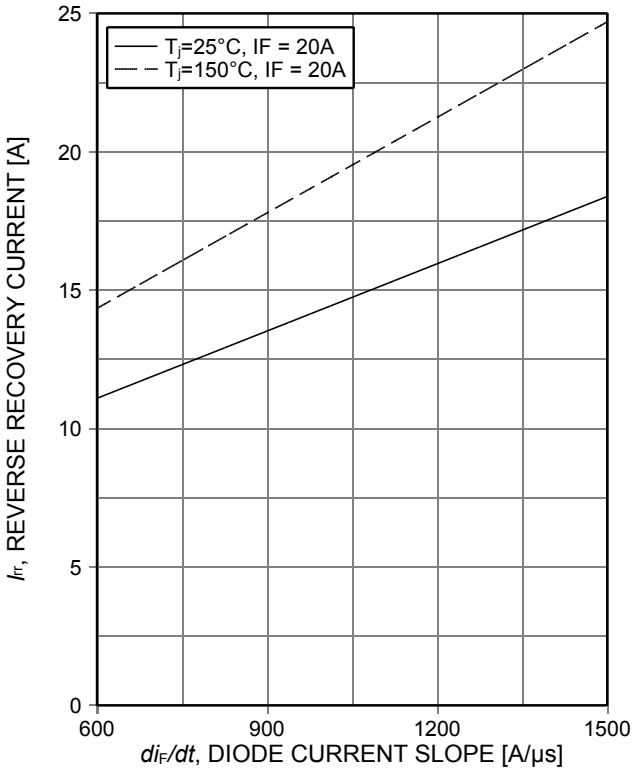


Figure 23. **Typical reverse recovery current as a function of diode current slope**
(V_R=400V, Dynamic test circuit in Figure E)

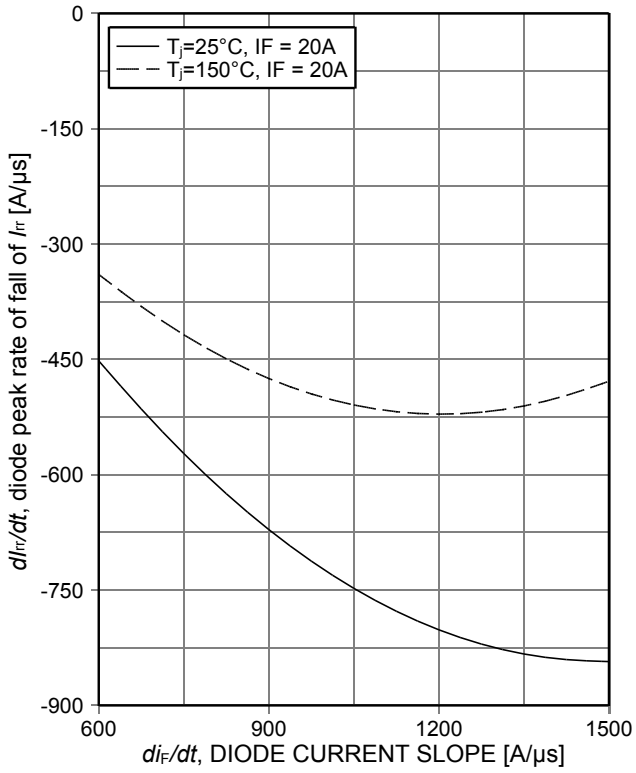


Figure 24. **Typical diode peak rate of fall of reverse recovery current as a function of diode current slope**
(V_R=400V, Dynamic test circuit in Figure E)

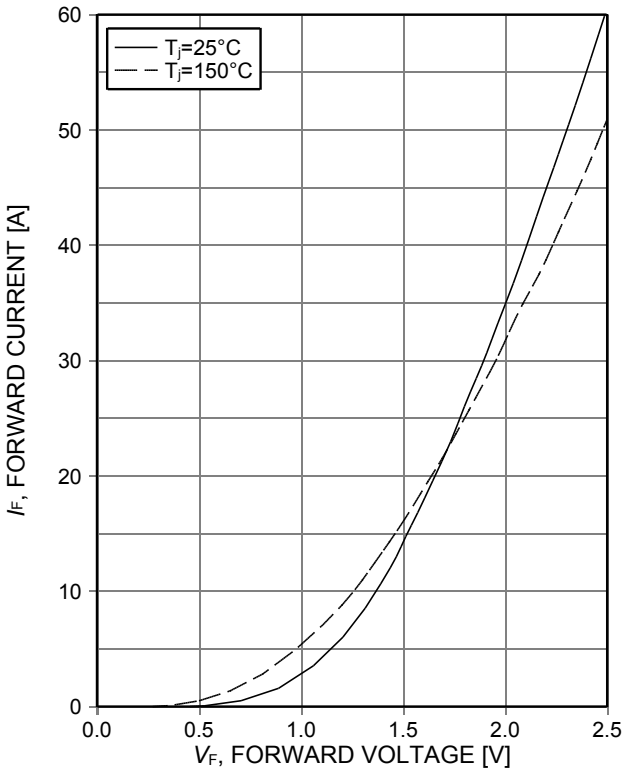


Figure 25. **Typical diode forward current as a function of forward voltage**

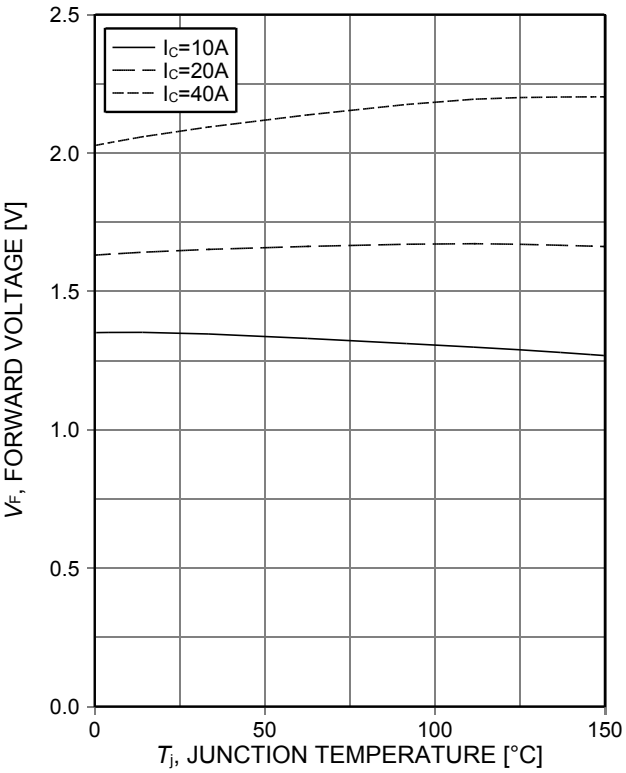
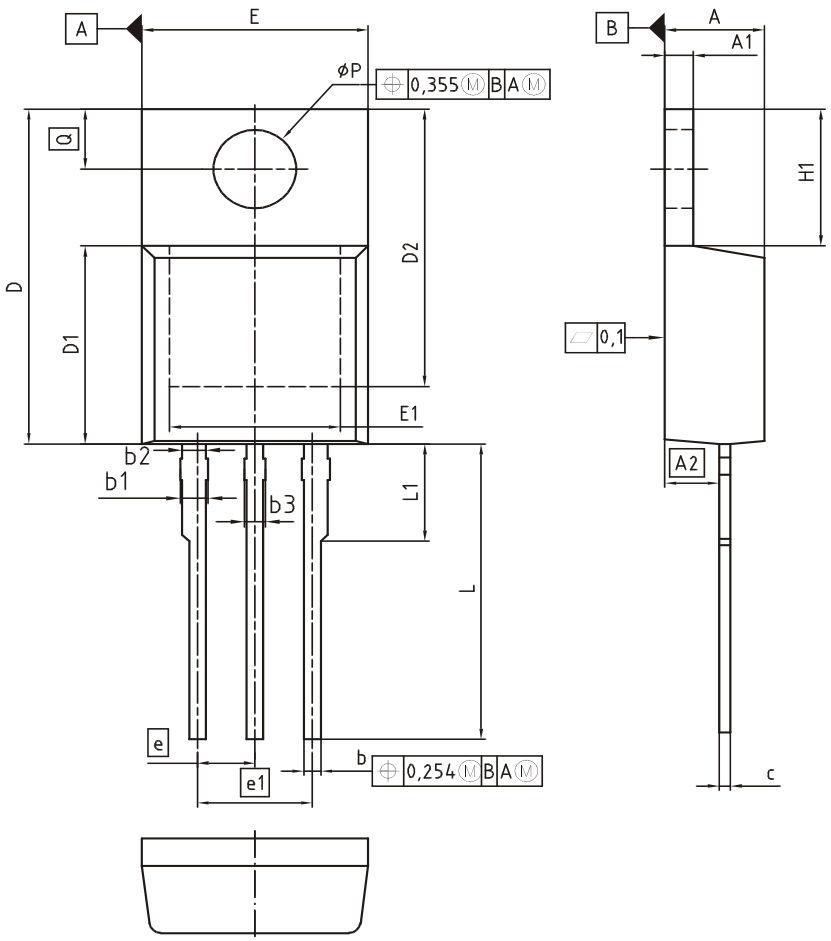


Figure 26. **Typical diode forward voltage as a function of junction temperature**

Package Drawing PG-TO220-3



DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.30	4.57	0.169	0.180
A1	1.17	1.40	0.046	0.055
A2	2.15	2.72	0.085	0.107
b	0.65	0.86	0.026	0.034
b1	0.95	1.40	0.037	0.055
b2	0.95	1.15	0.037	0.045
b3	0.65	1.15	0.026	0.045
c	0.33	0.60	0.013	0.024
D	14.81	15.95	0.583	0.628
D1	8.51	9.45	0.335	0.372
D2	12.19	13.10	0.480	0.516
E	9.70	10.36	0.382	0.408
E1	6.50	8.60	0.256	0.339
e	2.54		0.100	
e1	5.08		0.200	
N	3		3	
H1	5.90	6.90	0.232	0.272
L	13.00	14.00	0.512	0.551
L1	-	4.80	-	0.189
øP	3.60	3.89	0.142	0.153
Q	2.60	3.00	0.102	0.118

DOCUMENT NO.
Z8B00003318

SCALE
0 2.5 5mm

EUROPEAN PROJECTION

ISSUE DATE
30-07-2009

REVISION
06

Testing Conditions

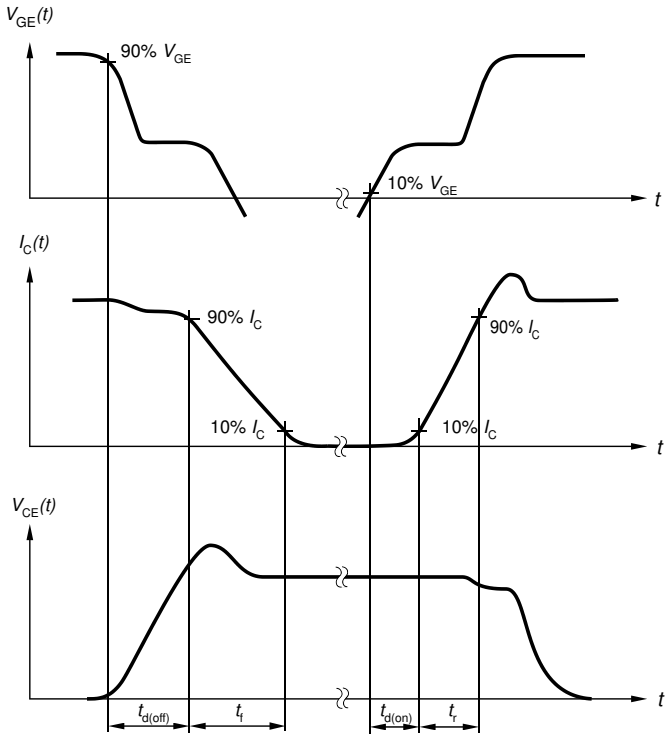


Figure A. **Definition of switching times**

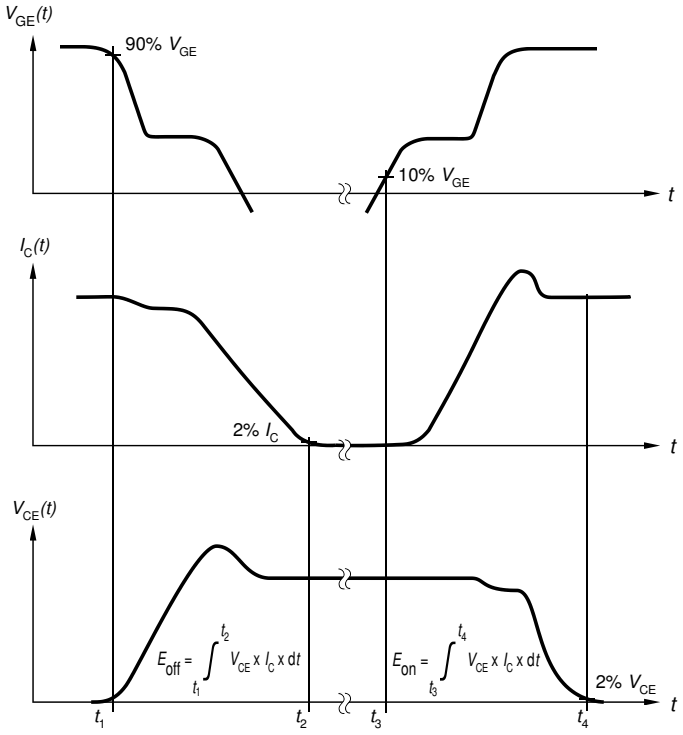


Figure B. **Definition of switching losses**

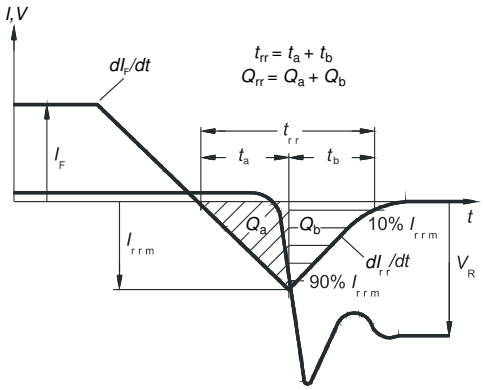


Figure C. **Definition of diode switching characteristics**

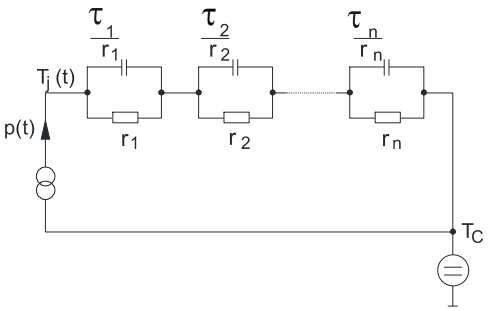


Figure D. **Thermal equivalent circuit**

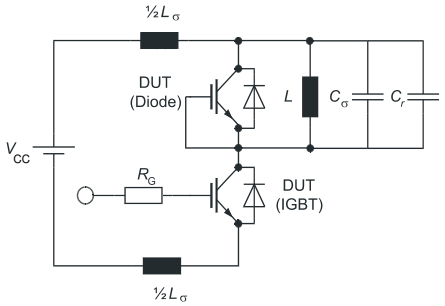


Figure E. **Dynamic test circuit**
Parasitic inductance L_σ,
parasitic capacitor C_σ,
relief capacitor C_r,
(only for ZVT switching)

Revision History

AIKP20N60CT

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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