IGBT

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

IKP20N60TA

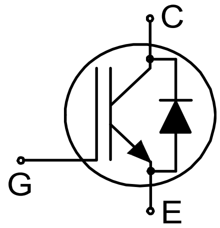
600V low loss switching series third generation

Data sheet

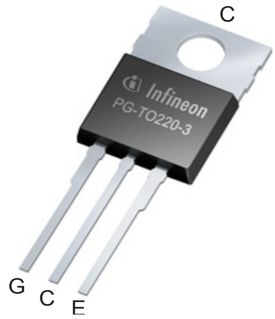
Industrial Power Control

Low Loss DuoPack : IGBT in TrenchStop® and Fieldstop technology with soft, fast recovery anti-parallel 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 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
IKP20N60TA	600V	20A	1.5V	150°C	K20T60A	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 1.6 mm (0.063 in.) 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, 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	- -	- -	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
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 = 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 = 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 = 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 = 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

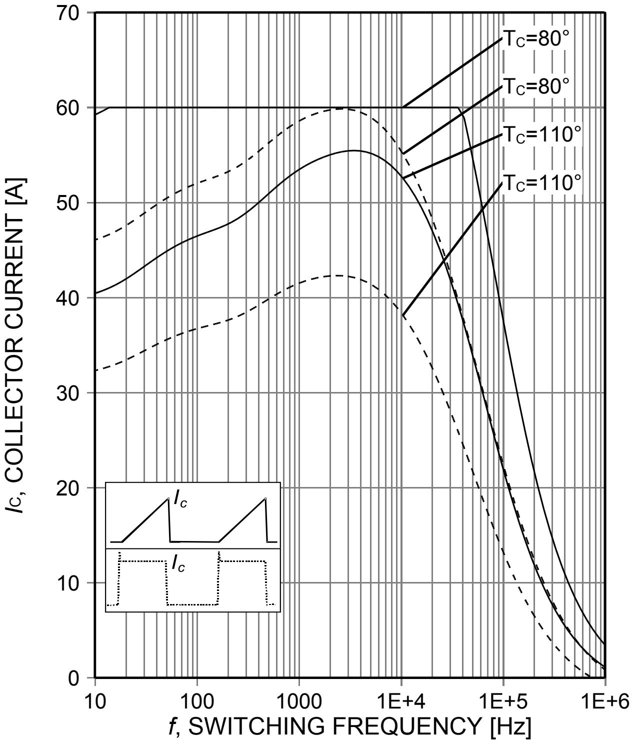


Figure 1. **Collector current as a function of switching frequency**
($T_j \leq 150°C$, D=0.5, V_{CE}=400V, V_{GE}=15/0V, R_G=12Ω)

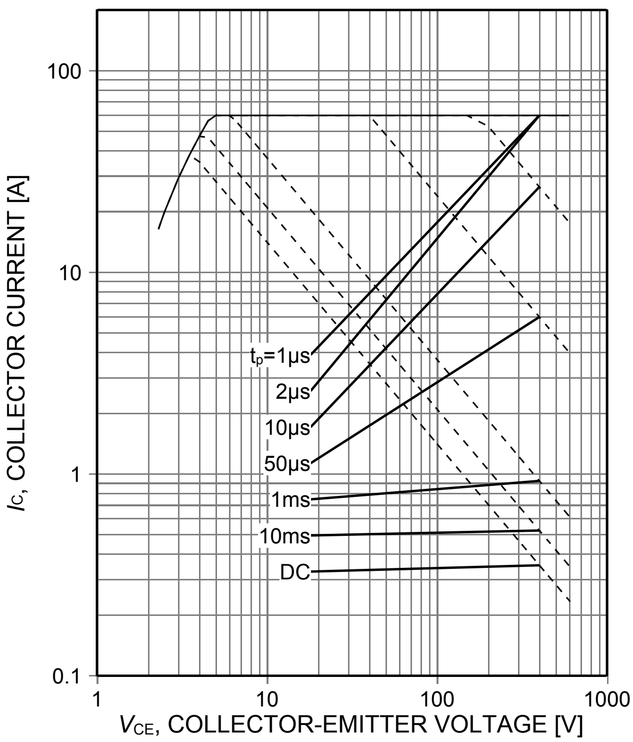


Figure 2. **Safe operating area**
(D=0, T_C=25°C, $T_j \leq 150°C$; V_{GE}=15V)

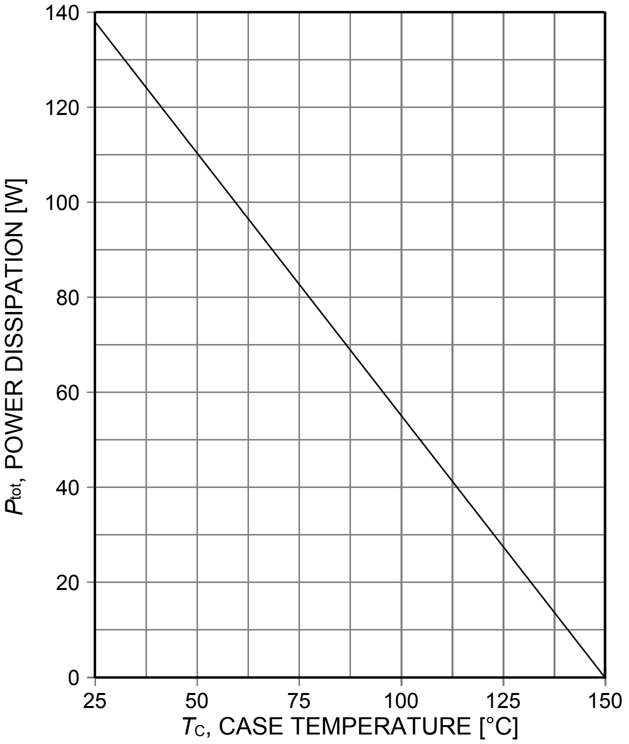


Figure 3. **Power dissipation as a function of case temperature**
($T_j \leq 150°C$)

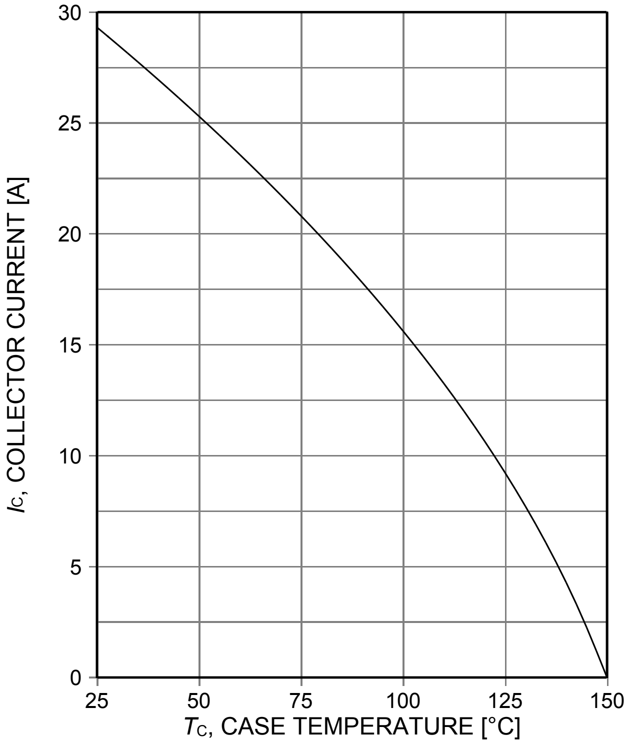


Figure 4. **Collector current as a function of case temperature**
($V_{GE} \geq 15V$, $T_j \leq 150°C$)

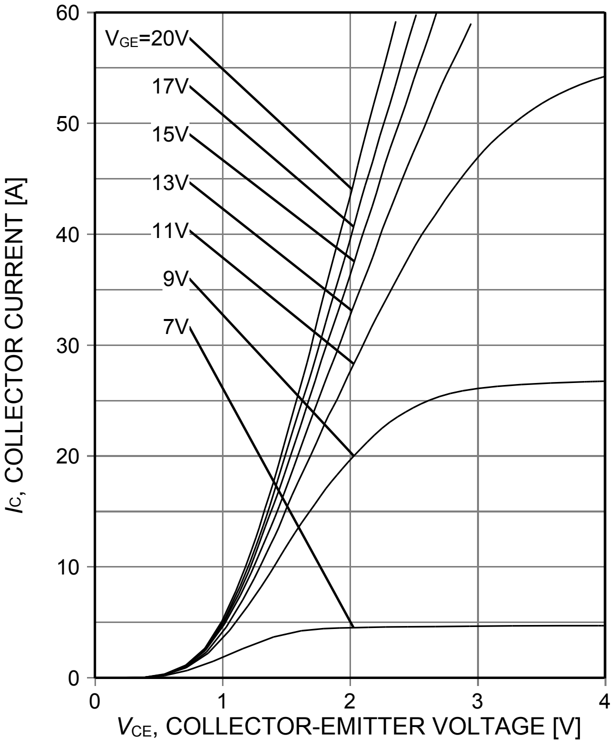


Figure 5. **Typical output characteristic** (T_j=25°C)

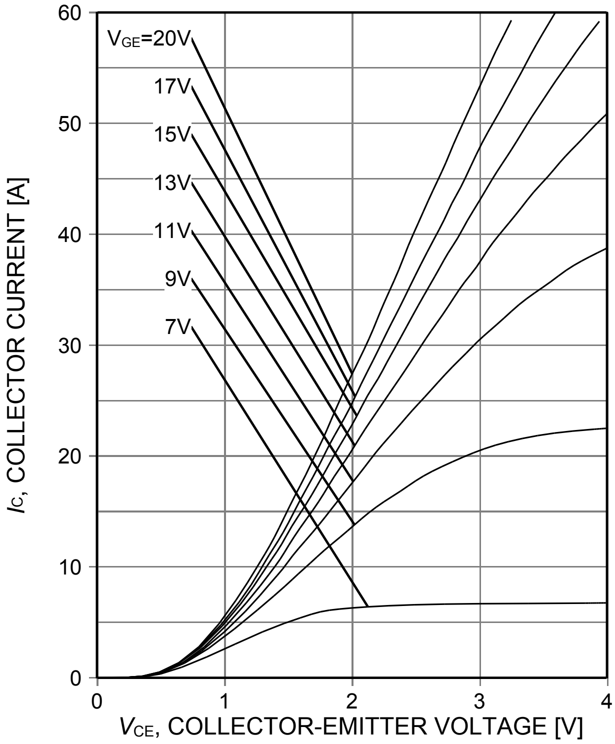


Figure 6. **Typical output characteristic** (T_j=150°C)

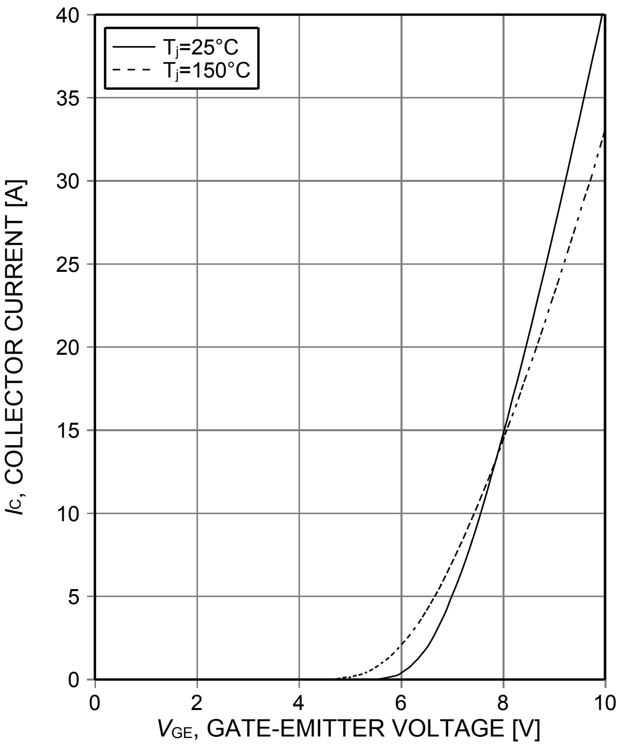


Figure 7. **Typical transfer characteristic** (V_{CE}=10V)

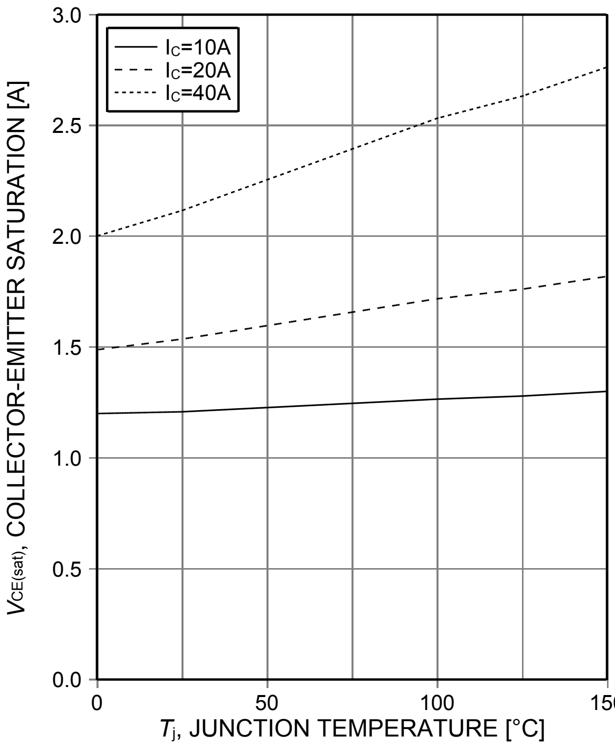


Figure 8. **Typical collector-emitter saturation voltage as a function of junction temperature** (V_{GE}=15V)

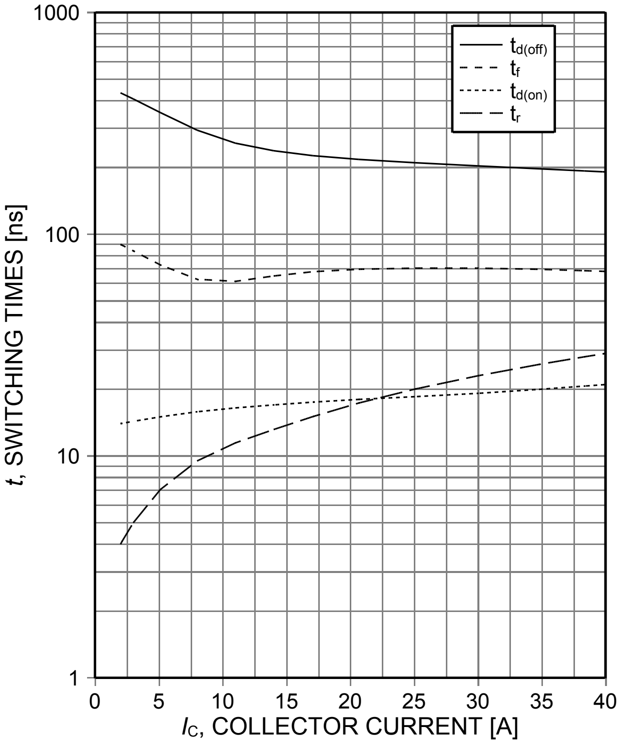


Figure 9. **Typical switching times as a function of collector current**
(inductive load, T_j=150°C, V_{CE}=400V, V_{GE}=15/0V, R_G=12Ω,Dynamic test circuit in Figure E)

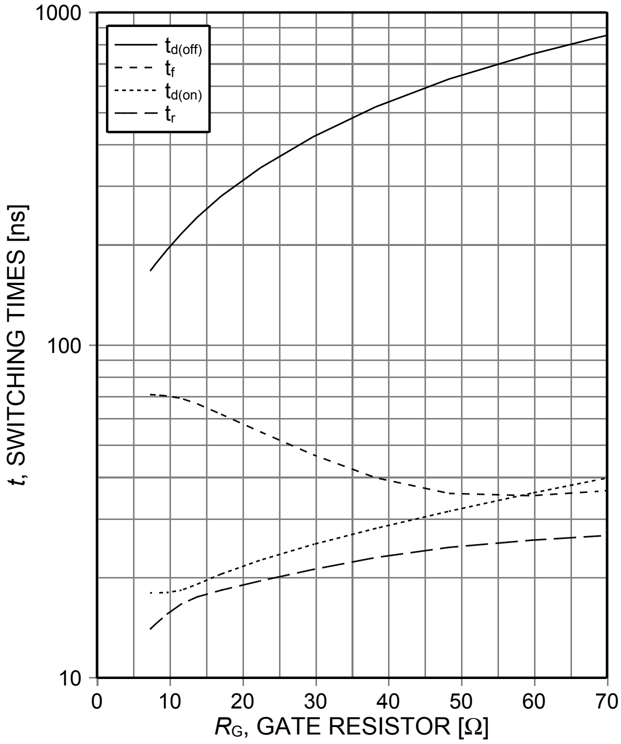


Figure 10. **Typical switching times as a function of gate resistor**
(inductive load, T_j=150°C, V_{CE}=400V, V_{GE}=15/0V, I_C=20A,Dynamic test circuit in Figure E)

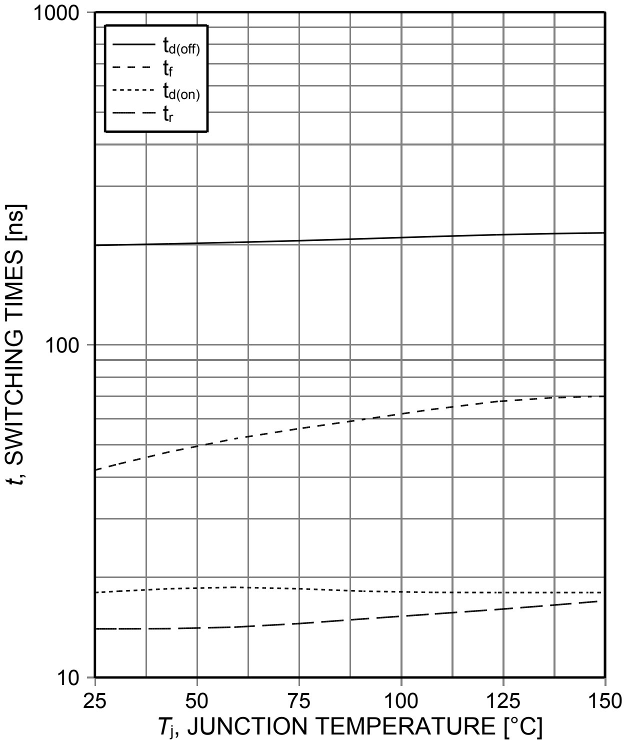


Figure 11. **Typical switching times as a function of junction temperature**
(inductive load, V_{CE}=400V, V_{GE}=15/0V, I_C=20A, R_G=12Ω,Dynamic test circuit in Figure E)

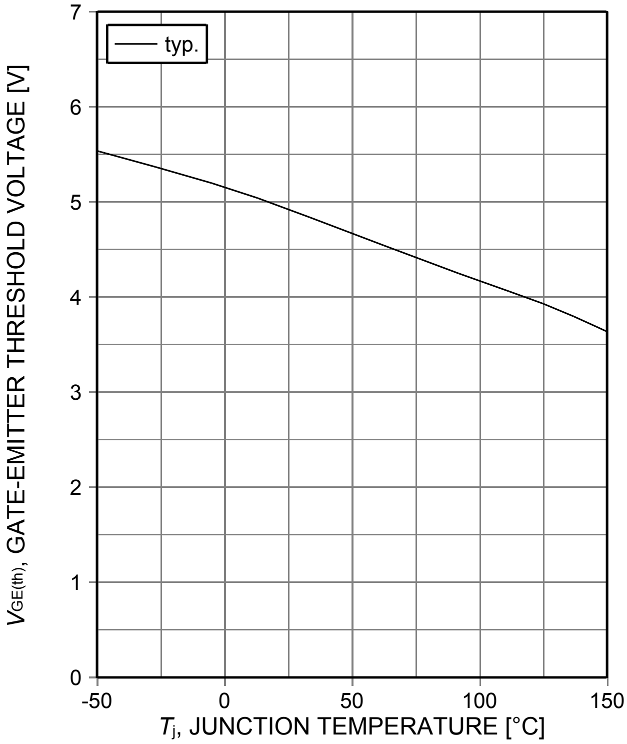


Figure 12. **Gate-emitter threshold voltage as a function of junction temperature**
(I_C=0.29mA)

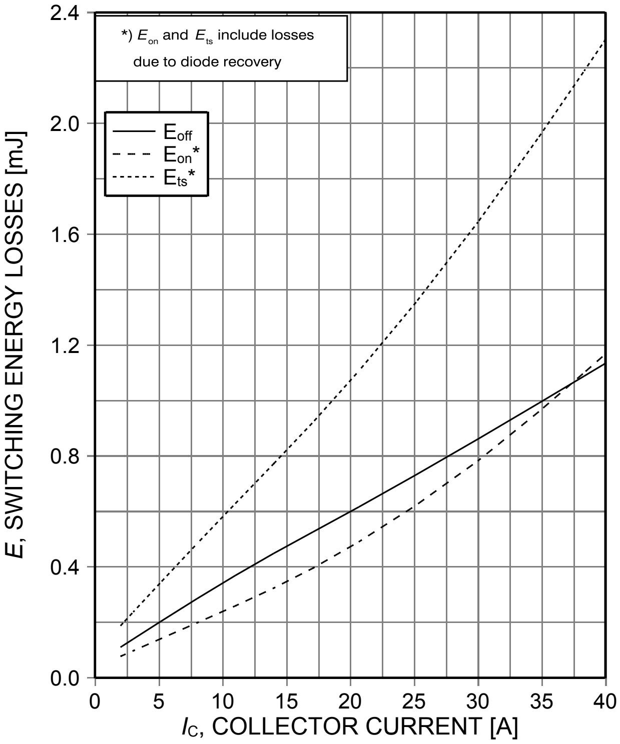


Figure 13. **Typical switching energy losses as a function of collector current**
(inductive load, T_j=150°C, V_{CE}=400V, V_{GE}=15/0V, R_G=12Ω,Dynamic test circuit in Figure E)

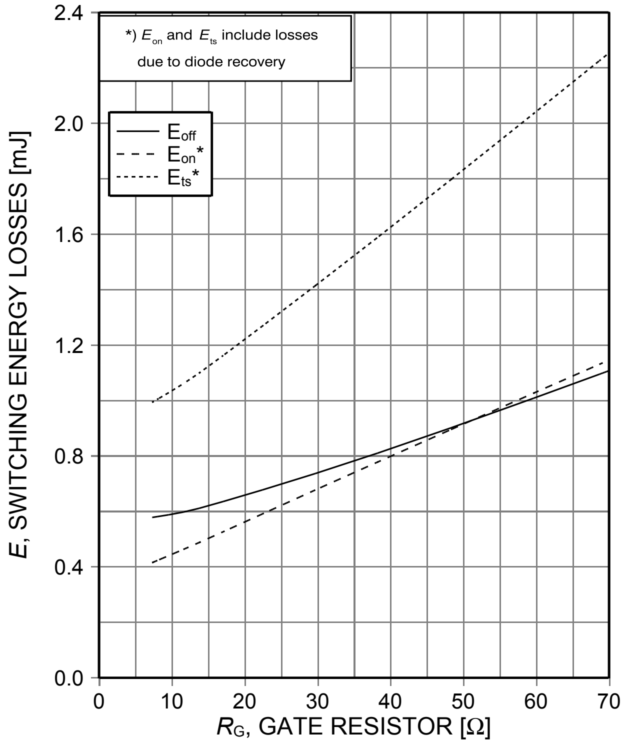


Figure 14. **Typical switching energy losses as a function of gate resistor**
(inductive load, T_j=150°C, V_{CE}=400V, V_{GE}=15/0V, I_C=20A,Dynamic test circuit in Figure E)

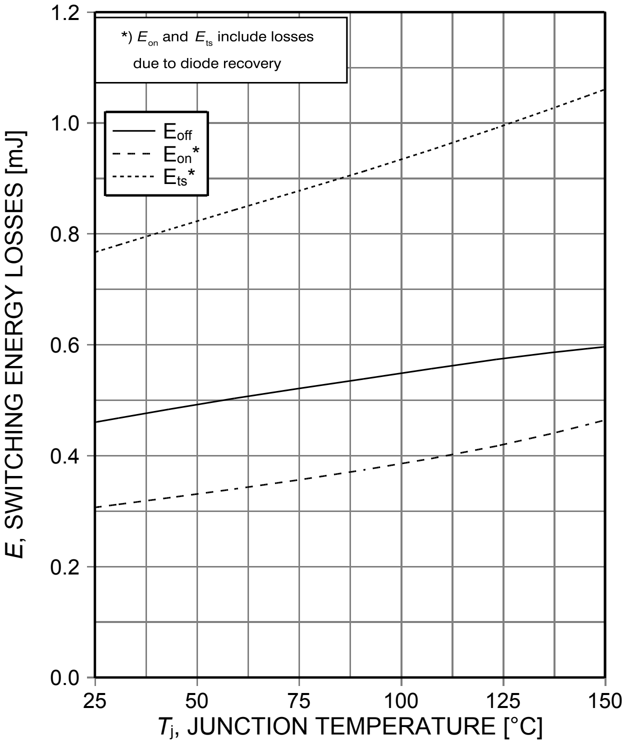


Figure 15. **Typical switching energy losses as a function of junction temperature**
(inductive load, V_{CE}=400V, V_{GE}=15/0V, I_C=20A, R_G=12Ω,Dynamic test circuit in Figure E)

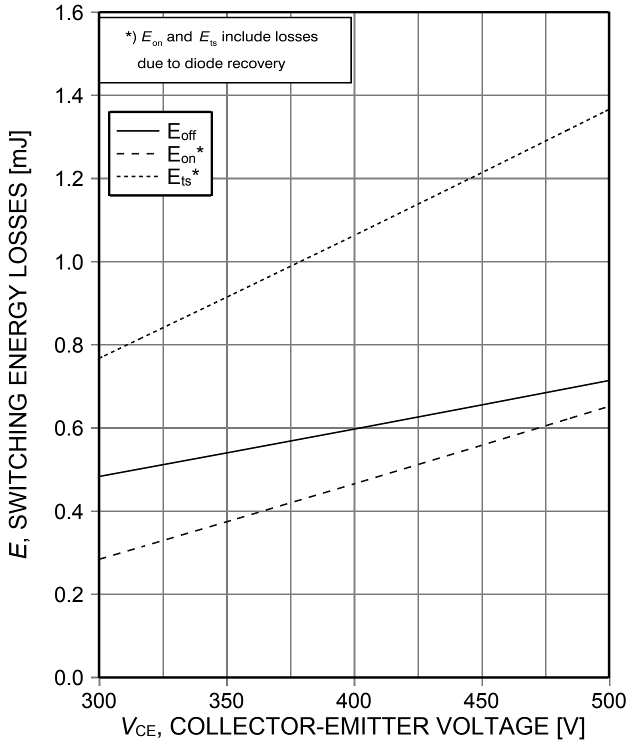


Figure 16. **Typical switching energy losses as a function of collector emitter voltage**
(inductive load, T_j=150°C, V_{GE}=15/0V, I_C=20A, R_G=12Ω, Dynamic test circuit in Figure E)

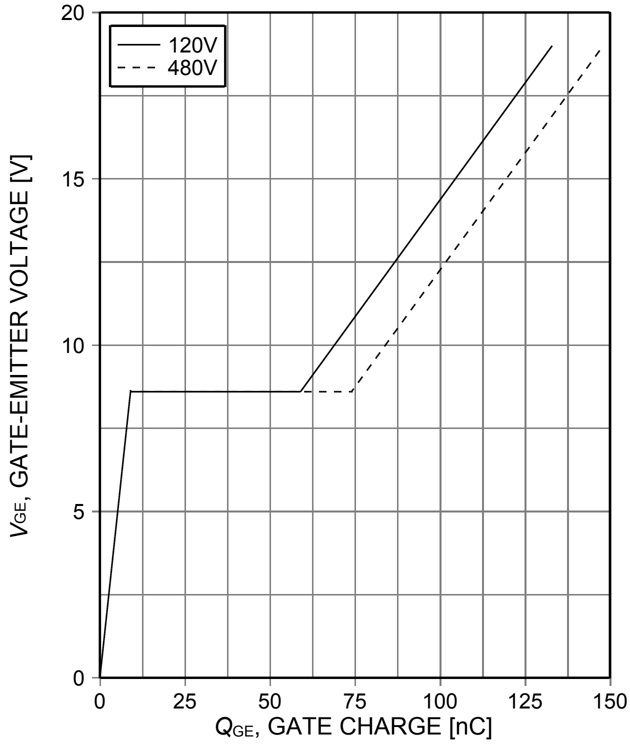


Figure 17. **Typical gate charge**
(I_C=20A)

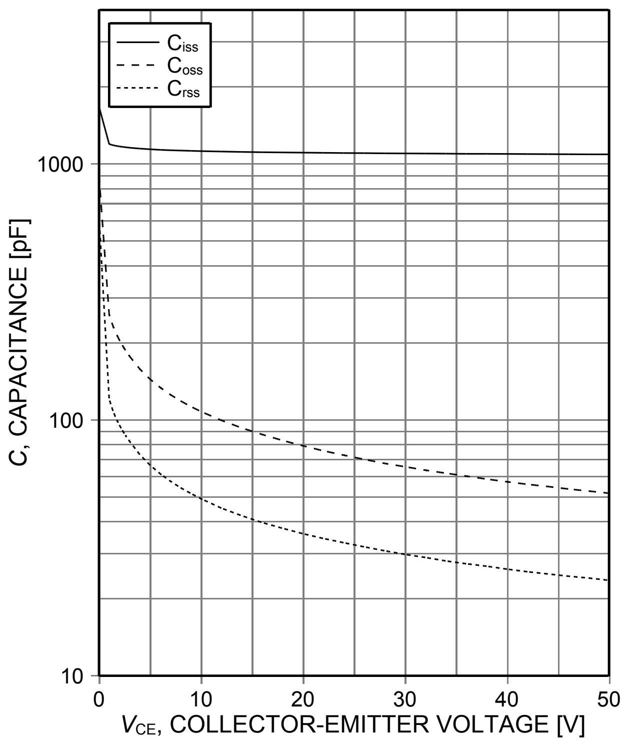


Figure 18. **Typical capacitance as a function of collector-emitter voltage**
(V_{GE}=0V, f=1MHz)

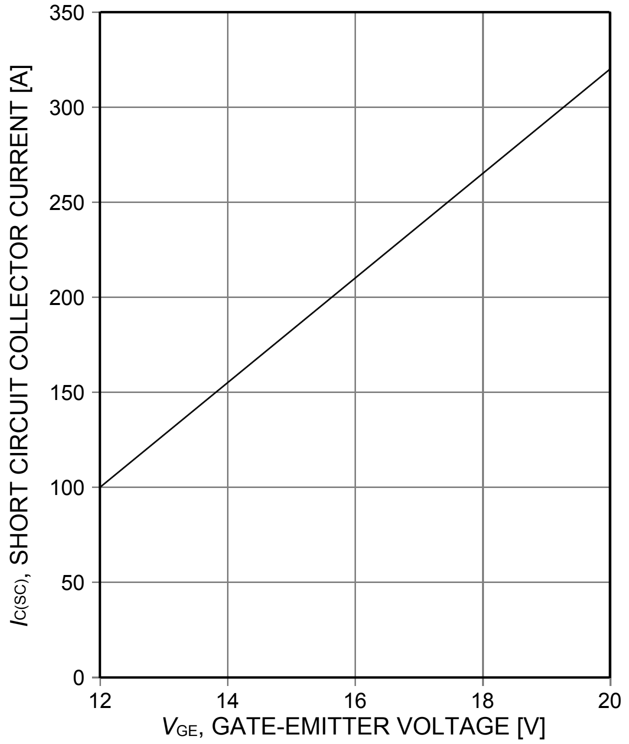


Figure 19. **Typical short circuit collector current as a function of gate-emitter voltage**
(V_{CE}≤400V, T_j≤150°C)

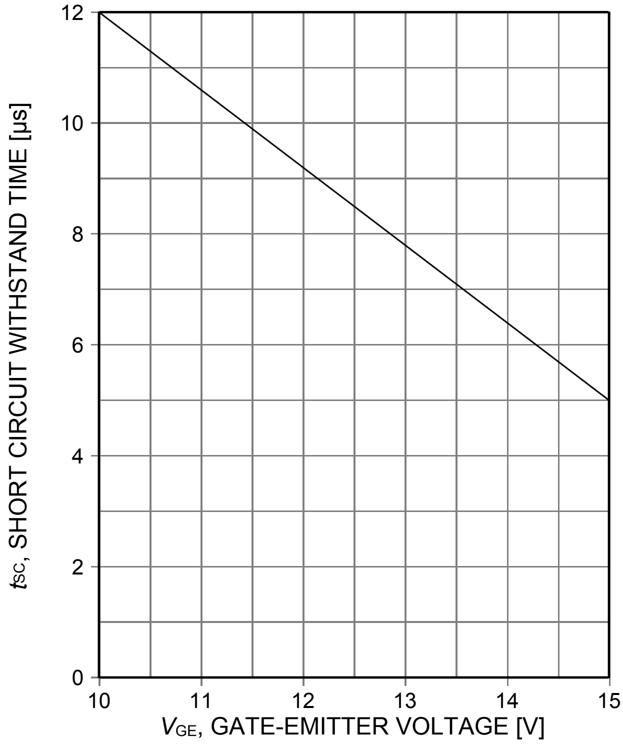


Figure 20. **Short circuit withstand time as a function of gate-emitter voltage**
(V_{CE}=400V, start at T_j=25°C, $T_j$max≤150°C)

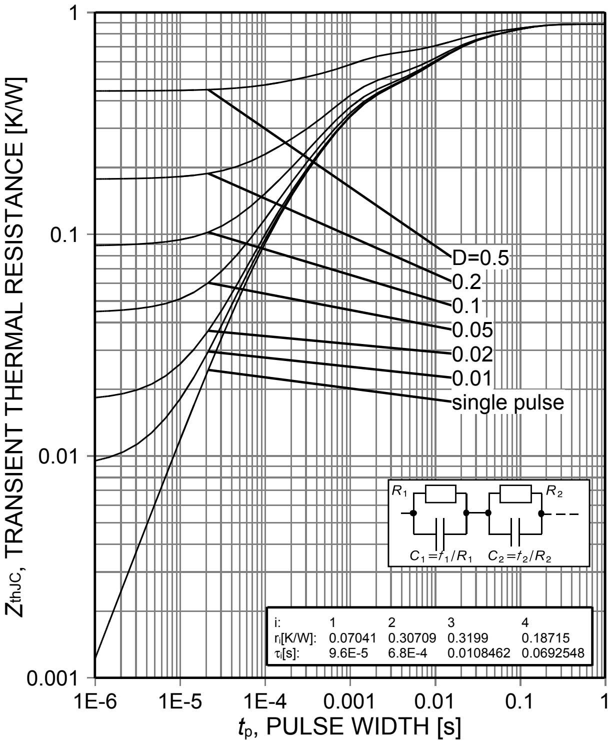


Figure 21. **IGBT transient thermal resistance as a function of pulse width for different duty cycles *D***
($D=t_p/T$)

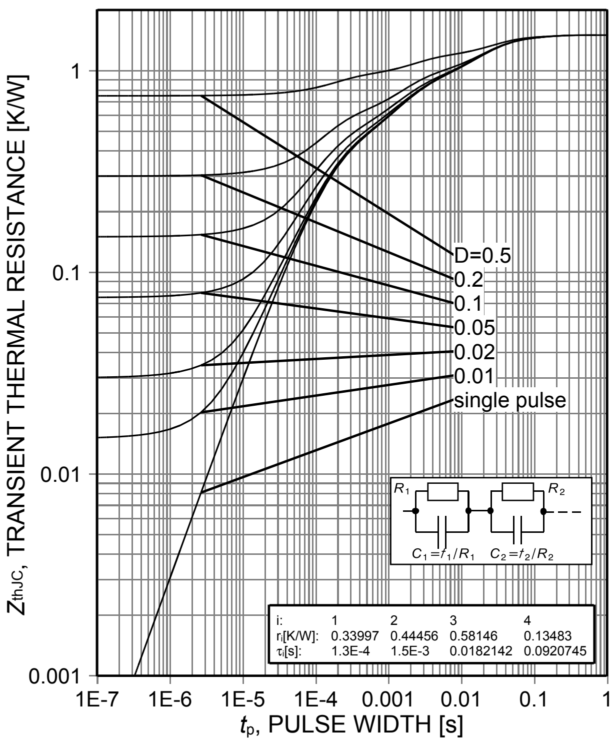


Figure 22. **Diode transient thermal impedance as a function of pulse width for different duty cycles *D***
($D=t_p/T$)

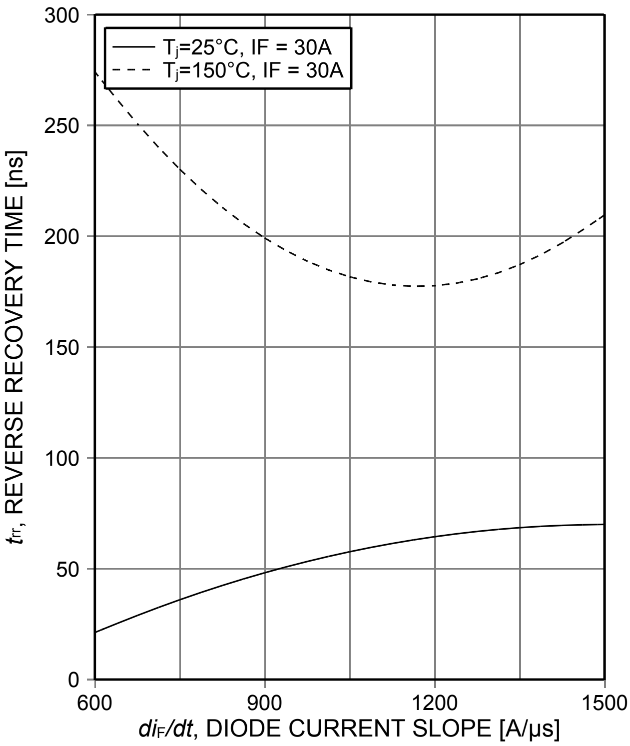


Figure 23. **Typical reverse recovery time as a function of diode current slope**
(V_R=400V,Dynamic test circuit in Figure E)

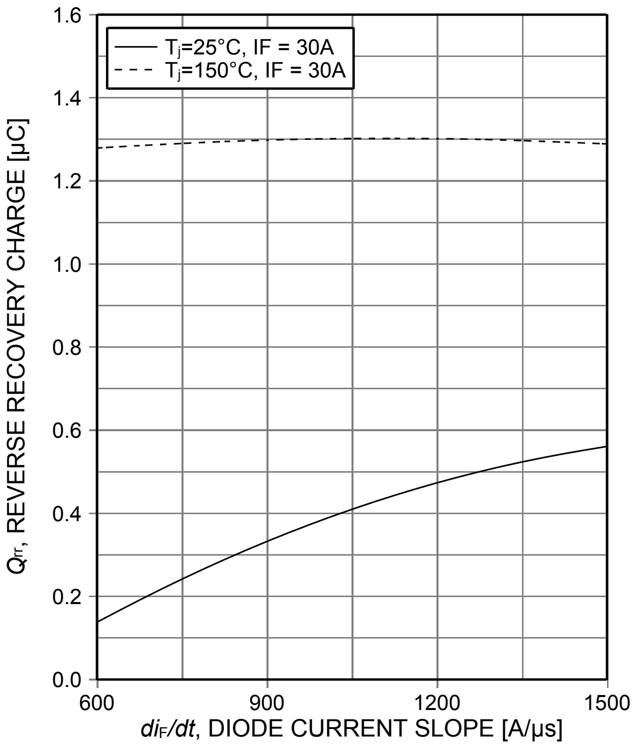


Figure 24. **Typical reverse recovery charge as a function of diode current slope**
(V_R=400V, Dynamic test circuit in Figure E)

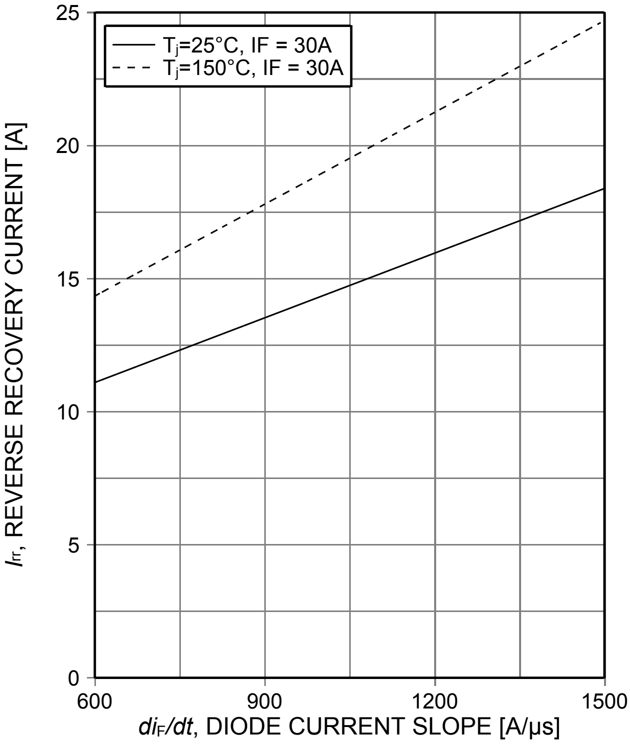


Figure 25. **Typical reverse recovery current as a function of diode current slope**
(V_R=400V, Dynamic test circuit in Figure E)

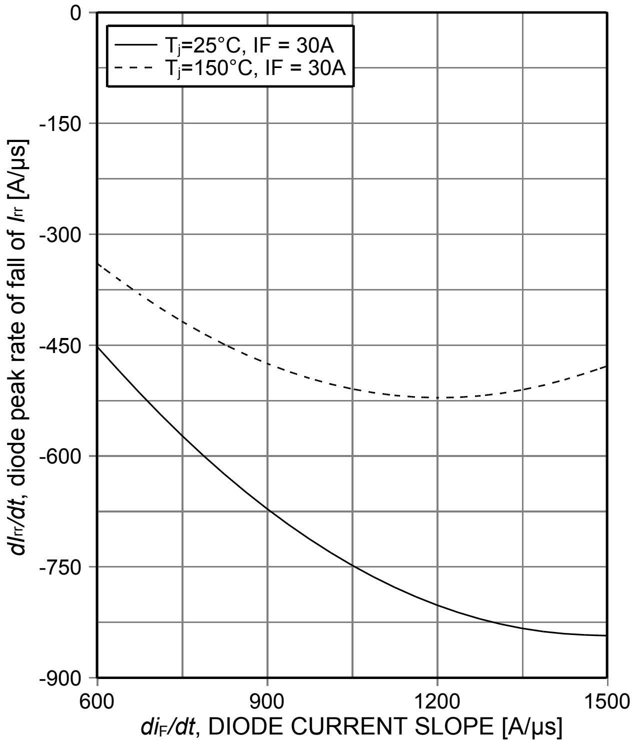


Figure 26. **Typical diode peak rate of fall of reverse recovery current as a function of diode current slope**
(V_R=400V, Dynamic test circuit in Figure E)

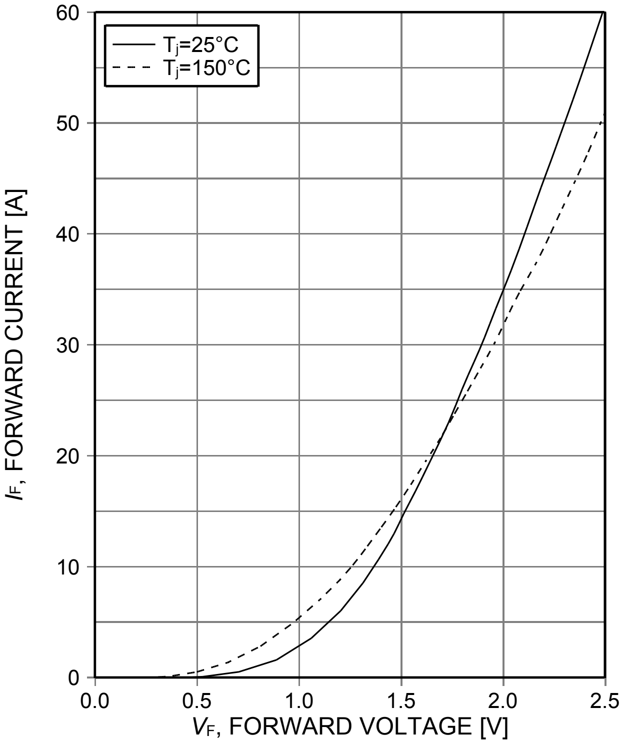


Figure 27. **Typical diode forward current as a function of forward voltage**

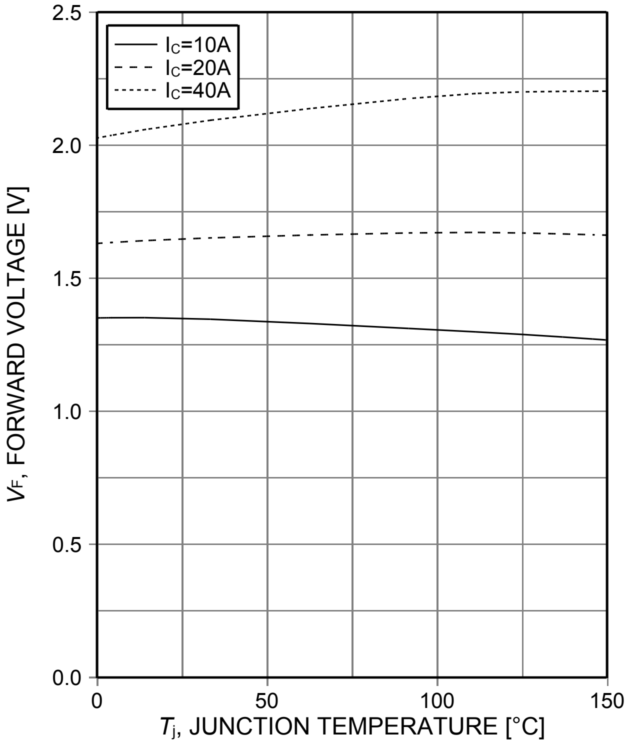
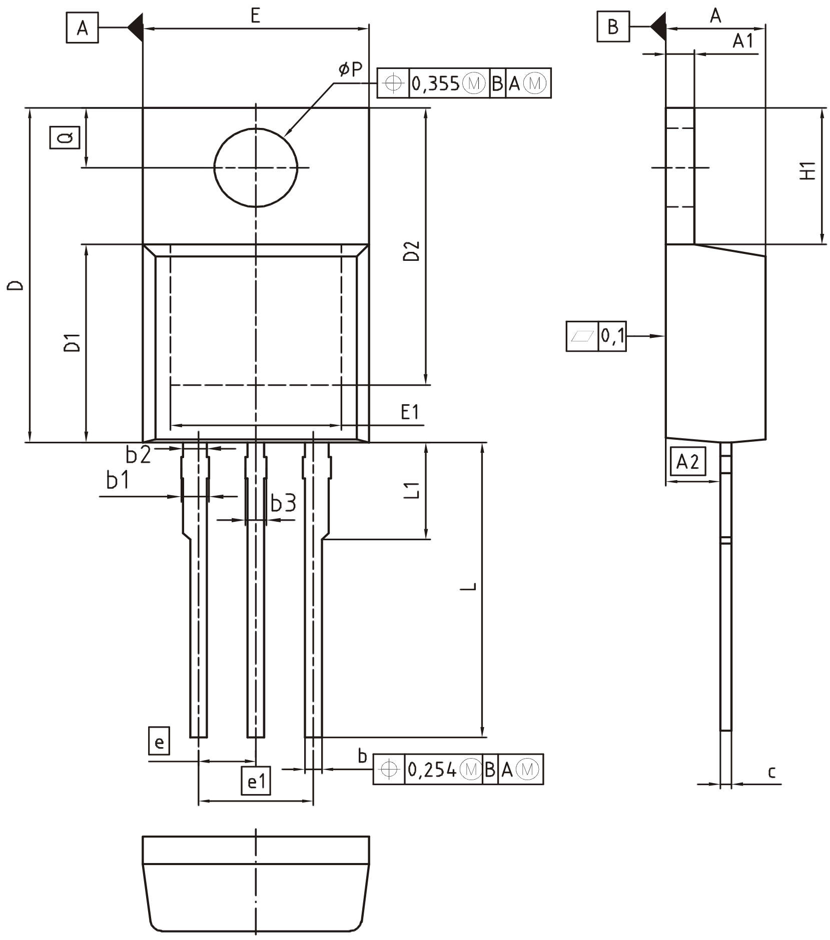


Figure 28. **Typical diode forward voltage as a function of junction temperature**

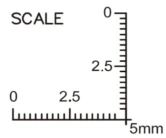
PG-TO220-3



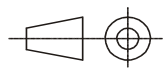
DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.30	4.57	0.169	0.180
A1	1.17	1.40	0.046	0.055
A2	2.15	2.72	0.085	0.107
b	0.65	0.86	0.026	0.034
b1	0.95	1.40	0.037	0.055
b2	0.95	1.15	0.037	0.045
b3	0.65	1.15	0.026	0.045
c	0.33	0.60	0.013	0.024
D	14.81	15.95	0.583	0.628
D1	8.51	9.45	0.335	0.372
D2	12.19	13.10	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



EUROPEAN PROJECTION



ISSUE DATE
30-07-2009

REVISION
06

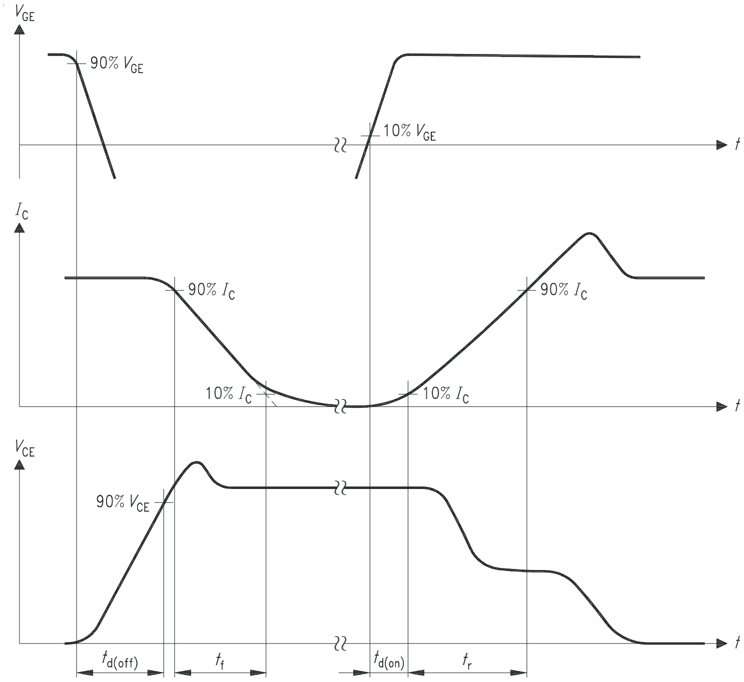


Figure A. Definition of switching times

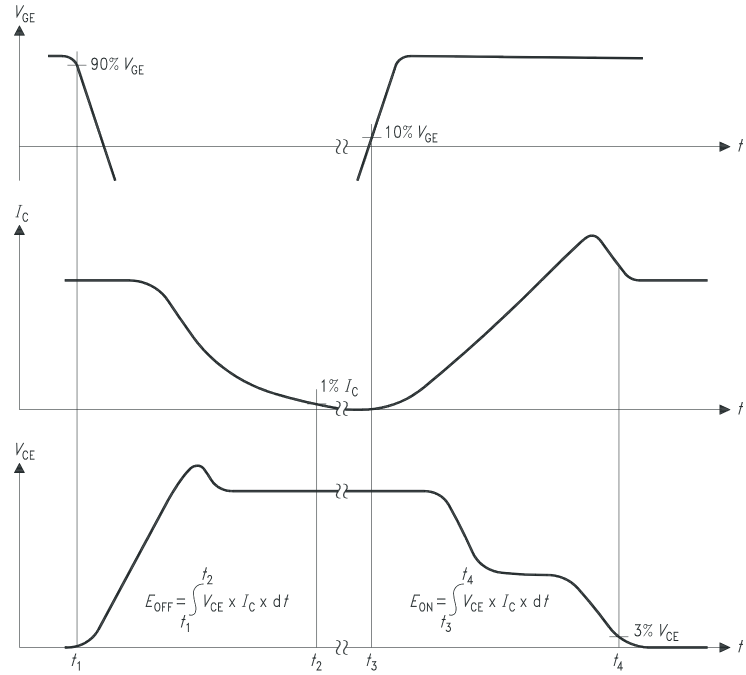


Figure B. Definition of switching losses

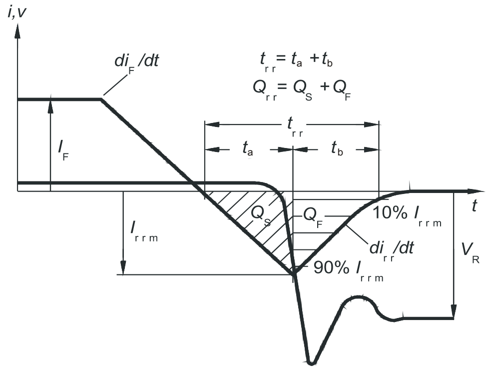


Figure C. Definition of diodes switching characteristics

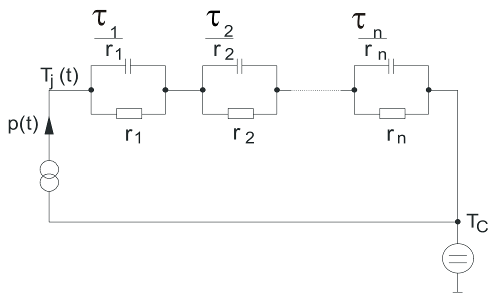


Figure D. Thermal equivalent circuit

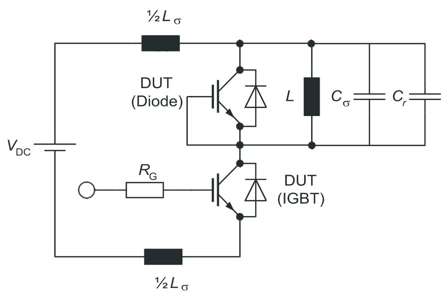


Figure E. Dynamic test circuit
Parasitic inductance L_σ,
Parasitic capacitor C_σ,
Relief capacitor C_r,
(only for ZVT switching)

Revision History

IKP20N60TA

Revision: 2013-08-27, Rev. 2.2

Previous Revision

Revision	Date	Subjects (major changes since last revision)
0.9	2009-07-23	-
1.0	2009-07-23	-
2.0	2010-03-22	-
2.1	2013-08-21	Minor changes
2.2	2013-08-27	Minor changes

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