IGBT

High speed 5 FAST IGBT in TRENCHSTOP™ 5 technology copacked with RAPID 1 fast and soft antiparallel diode

IKW40N65F5A

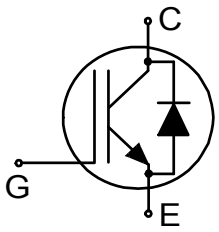
650V DuoPack IGBT and diode
High speed switching series fifth generation

Data sheet

Industrial Power Control

High speed 5 FAST IGBT in TRENCHSTOP™ 5 technology copacked with RAPID 1 fast and soft antiparallel diode

Features and Benefits:



High speed F5 technology offering
• Best-in-Class efficiency in hard switching and resonant topologies
• 650V breakdown voltage
• Low gate charge Q_G
• IGBT copacked with RAPID 1 fast and soft antiparallel diode
• Maximum junction temperature 175°C
• Qualified according to AEC-Q101
• Green package (RoHS compliant)
• Complete product spectrum and PSpice Models: http://www.infineon.com/igbt/



Applications:

• Battery charger
• DC/DC converter

Package pin definition:

• Pin 1 - gate
• Pin 2 & backside - collector
• Pin 3 - emitter

Key Performance and Package Parameters

Type	V_{CE}	I_C	V_{CEsat}, T_{vj}=25°C	T_{vjmax}	Marking	Package
IKW40N65F5A	650V	40A	1.6V	175°C	K40EF5A	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}	650	V
DC collector current, limited by T_{vjmax} $T_C = 25°C$ $T_C = 100°C$	I_C	 74.0 46.0	A
Pulsed collector current, t_p limited by T_{vjmax} [1]	I_{Cpuls}	120.0	A
Turn off safe operating area $V_{CE} \leq 650V$, $T_{vj} \leq 175°C$, $t_p = 1\mu s$ [1]	-	120.0	A
Diode forward current, limited by T_{vjmax} $T_C = 25°C$ $T_C = 100°C$	I_F	 36.0 21.0	A
Diode pulsed current, t_p limited by T_{vjmax} [1]	I_{Fpuls}	120.0	A
Gate-emitter voltage Transient Gate-emitter voltage ($t_p \leq 10\mu s$, D < 0.010)	V_{GE}	±20 ±30	V
Power dissipation $T_C = 25°C$ Power dissipation $T_C = 100°C$	P_{tot}	250.0 125.0	W
Operating junction temperature	T_{vj}	-40...+175	°C
Storage temperature	T_{stg}	-55...+150	°C
Soldering temperature, [2] 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, junction - case	$R_{th(j-c)}$		0.60	K/W
Diode thermal resistance, junction - case	$R_{th(j-c)}$		1.80	K/W
Thermal resistance junction - ambient	$R_{th(j-a)}$		40	K/W

[1] Defined by design. Not subject to production test.
[2] Package not recommended for surface mount applications

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	650	-	-	V
Collector-emitter saturation voltage	V_{CEsat}	V_{GE} = 15.0V, I_C = 40.0A T_{vj} = 25°C T_{vj} = 125°C T_{vj} = 175°C	 - - -	 1.60 1.80 1.90	 2.10 - -	V
Diode forward voltage	V_F	V_{GE} = 0V, I_F = 20.0A T_{vj} = 25°C T_{vj} = 125°C T_{vj} = 175°C	 - - -	 1.55 1.53 1.49	 1.80 - -	V
Gate-emitter threshold voltage	$V_{GE(th)}$	I_C = 0.40mA, V_{CE} = V_{GE}	3.2	4.0	4.8	V
Zero gate voltage collector current	I_{CES}	V_{CE} = 650V, V_{GE} = 0V T_{vj} = 25°C T_{vj} = 175°C	 - -	 - 1000.0	 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 = 40.0A	-	50.0	-	S

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	-	2500	-	pF
Output capacitance	C_{oes}		-	50	-	
Reverse transfer capacitance	C_{res}		-	9	-	
Gate charge	Q_G	V_{CC} = 520V, I_C = 40.0A, V_{GE} = 15V	-	95.0	-	nC
Internal emitter inductance measured 5mm (0.197 in.) from case	L_E		-	13.0	-	nH

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, $R_{G(on)}$ = 15.0Ω, $R_{G(off)}$ = 15.0Ω, $L\sigma$ = 30nH, $C\sigma$ = 30pF $L\sigma$, $C\sigma$ from Fig. E Energy losses include “tail” and diode reverse recovery.	-	19	-	ns
Rise time	t_r		-	11	-	ns
Turn-off delay time	$t_{d(off)}$		-	165	-	ns
Fall time	t_f		-	13	-	ns
Turn-on energy	E_{on}		-	0.35	-	mJ
Turn-off energy	E_{off}		-	0.10	-	mJ
Total switching energy	E_{ts}		-	0.45	-	mJ

Turn-on delay time	$t_{d(on)}$	T_{vj} = 25°C, V_{CC} = 400V, I_C = 5.0A, V_{GE} = 0.0/15.0V, $R_{G(on)}$ = 15.0Ω, $R_{G(off)}$ = 15.0Ω, $L\sigma$ = 30nH, $C\sigma$ = 30pF $L\sigma$, $C\sigma$ from Fig. E Energy losses include “tail” and diode reverse recovery.	-	18	-	ns
Rise time	t_r		-	4	-	ns
Turn-off delay time	$t_{d(off)}$		-	175	-	ns
Fall time	t_f		-	12	-	ns
Turn-on energy	E_{on}		-	0.07	-	mJ
Turn-off energy	E_{off}		-	0.03	-	mJ
Total switching energy	E_{ts}		-	0.10	-	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 = 1230A/µs	-	73	-	ns
Diode reverse recovery charge	Q_{rr}		-	0.54	-	µC
Diode peak reverse recovery current	I_{rrm}		-	13.7	-	A
Diode peak rate of fall of reverse recovery current during t_b	di_{rr}/dt		-	-220	-	A/µs

Diode reverse recovery time	t_{rr}	T_{vj} = 25°C, V_R = 400V, I_F = 5.0A, di_F/dt = 1530A/µs	-	31	-	ns
Diode reverse recovery charge	Q_{rr}		-	0.25	-	µC
Diode peak reverse recovery current	I_{rrm}		-	12.5	-	A
Diode peak rate of fall of reverse recovery current during t_b	di_{rr}/dt		-	-640	-	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, $R_{G(on)}$ = 15.0Ω, $R_{G(off)}$ = 15.0Ω, $L\sigma$ = 30nH, $C\sigma$ = 30pF $L\sigma$, $C\sigma$ from Fig. E Energy losses include “tail” and diode reverse recovery.	-	18	-	ns
Rise time	t_r		-	12	-	ns
Turn-off delay time	$t_{d(off)}$		-	195	-	ns
Fall time	t_f		-	5	-	ns
Turn-on energy	E_{on}		-	0.46	-	mJ
Turn-off energy	E_{off}		-	0.16	-	mJ
Total switching energy	E_{ts}		-	0.62	-	mJ

Turn-on delay time	$t_{d(on)}$	T_{vj} = 150°C, V_{CC} = 400V, I_C = 5.0A, V_{GE} = 0.0/15.0V, $R_{G(on)}$ = 15.0Ω, $R_{G(off)}$ = 15.0Ω, $L\sigma$ = 30nH, $C\sigma$ = 30pF $L\sigma$, $C\sigma$ from Fig. E Energy losses include “tail” and diode reverse recovery.	-	16	-	ns
Rise time	t_r		-	5	-	ns
Turn-off delay time	$t_{d(off)}$		-	225	-	ns
Fall time	t_f		-	13	-	ns
Turn-on energy	E_{on}		-	0.14	-	mJ
Turn-off energy	E_{off}		-	0.05	-	mJ
Total switching energy	E_{ts}		-	0.19	-	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 = 1250A/µs	-	98	-	ns
Diode reverse recovery charge	Q_{rr}		-	1.06	-	µC
Diode peak reverse recovery current	I_{rrm}		-	18.0	-	A
Diode peak rate of fall of reverse recovery current during t_b	di_{rr}/dt		-	-195	-	A/µs

Diode reverse recovery time	t_{rr}	T_{vj} = 150°C, V_R = 400V, I_F = 5.0A, di_F/dt = 1330A/µs	-	55	-	ns
Diode reverse recovery charge	Q_{rr}		-	0.55	-	µC
Diode peak reverse recovery current	I_{rrm}		-	17.0	-	A
Diode peak rate of fall of reverse recovery current during t_b	di_{rr}/dt		-	-425	-	A/µs

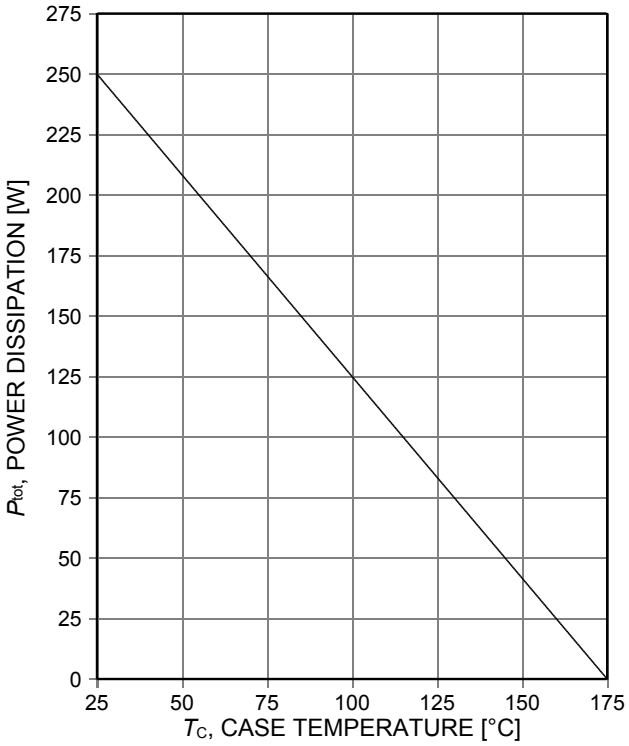


Figure 1. **Power dissipation as a function of case temperature**
(T_{vj}≤175°C)

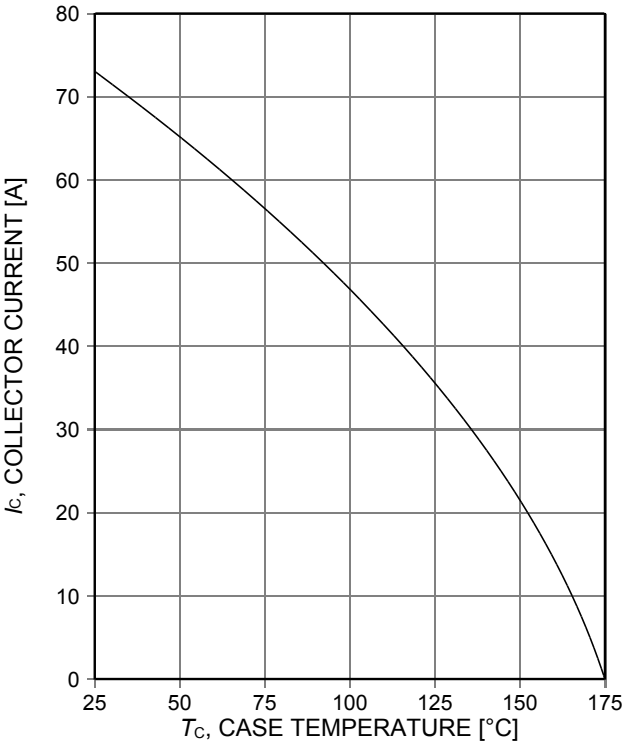


Figure 2. **Collector current as a function of case temperature**
(V_{GE}≥15V, T_{vj}≤175°C)

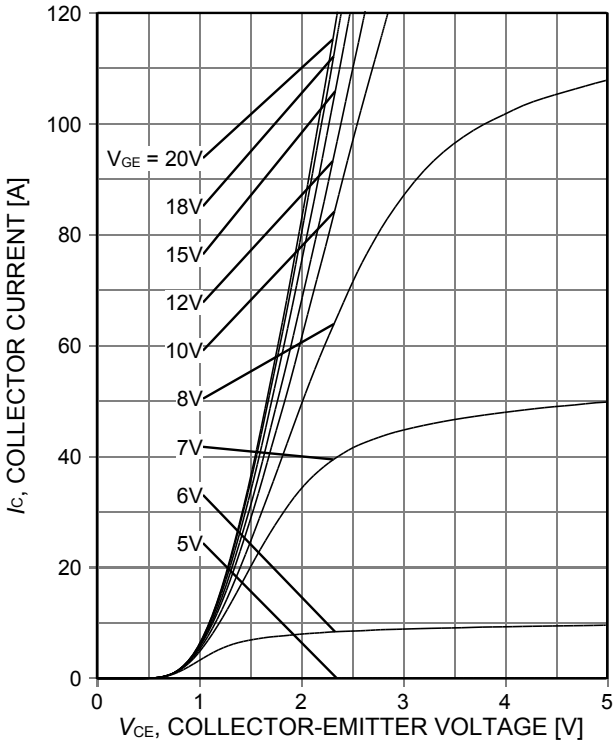


Figure 3. **Typical output characteristic**
(T_{vj}=25°C)

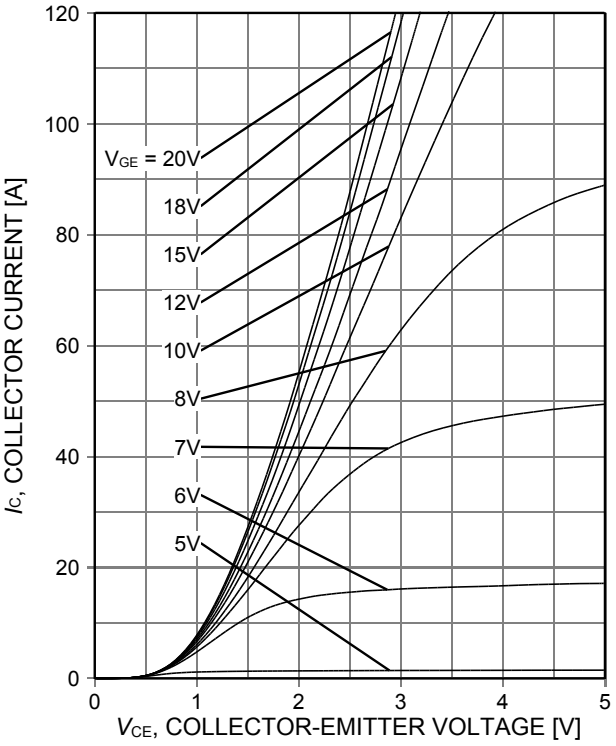


Figure 4. **Typical output characteristic**
(T_{vj}=150°C)

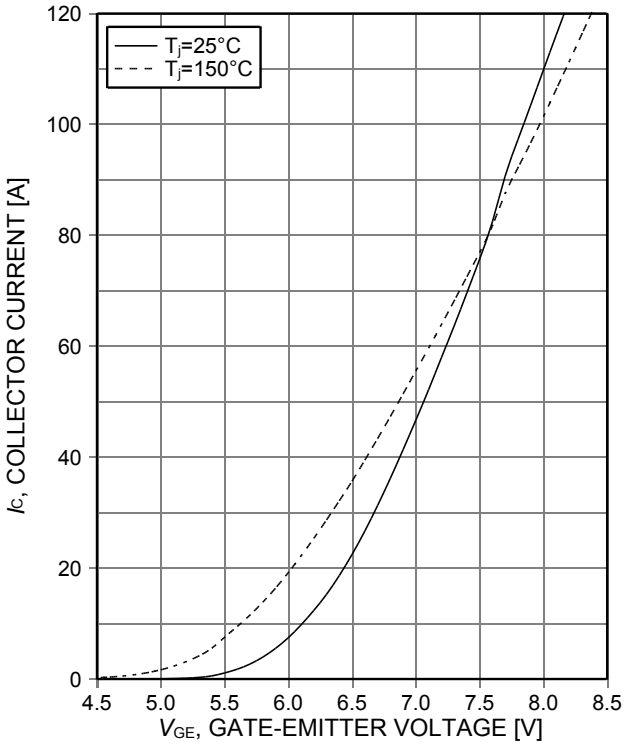


Figure 5. **Typical transfer characteristic** (V_{CE}=20V)

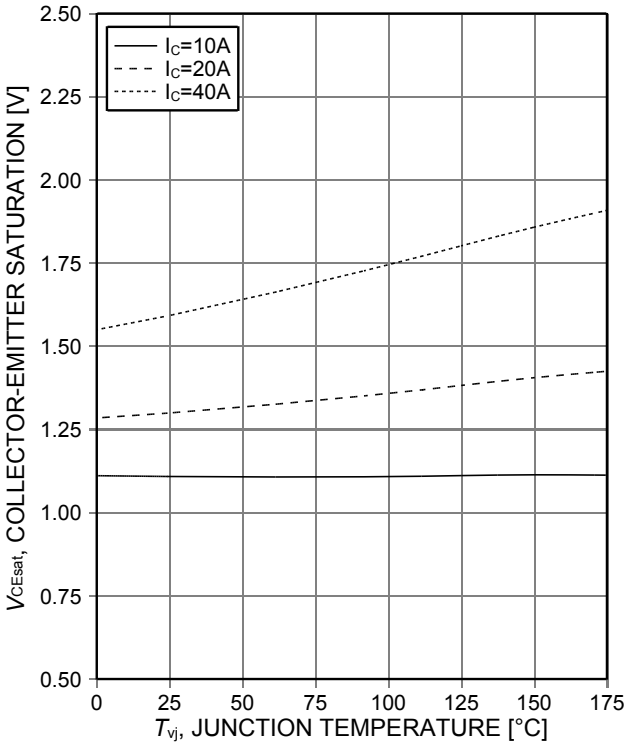


Figure 6. **Typical collector-emitter saturation voltage as a function of junction temperature** (V_{GE}=15V)

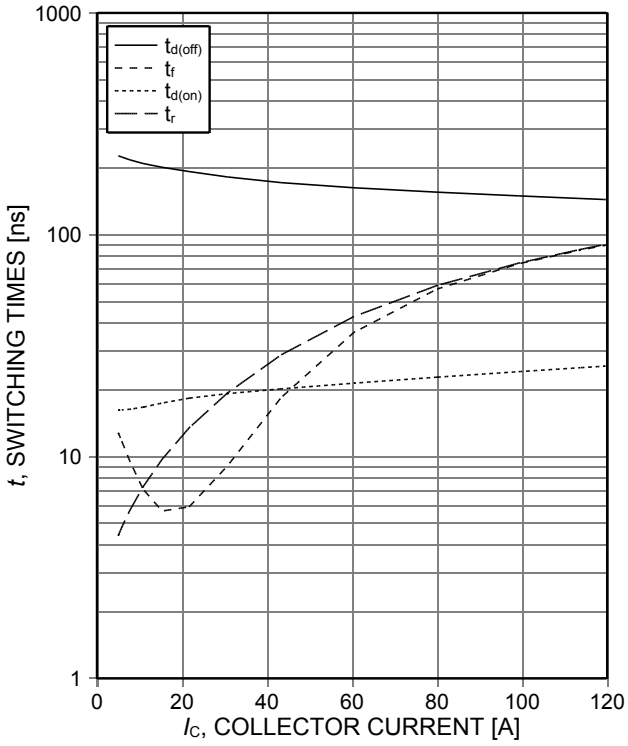


Figure 7. **Typical switching times as a function of collector current** (inductive load, T_{vj}=150°C, V_{CE}=400V, V_{GE}=15/0V, r_G=15Ω, Dynamic test circuit in Figure E)

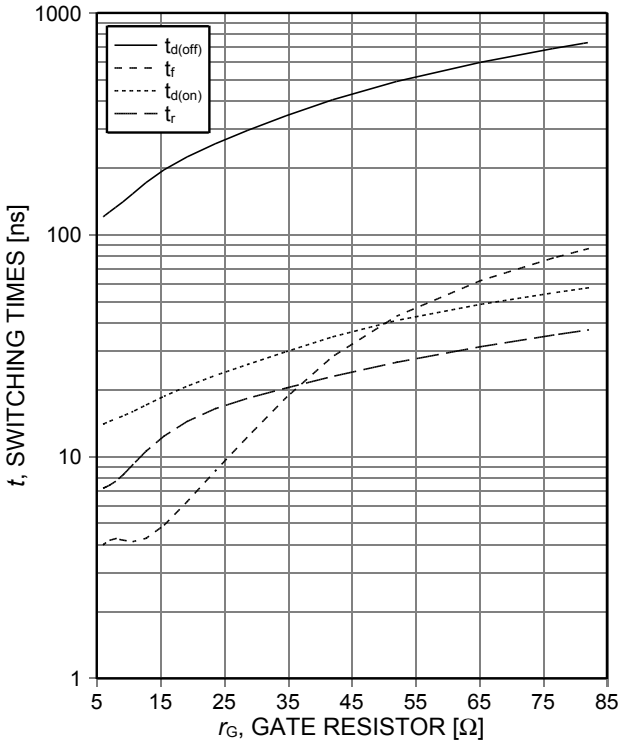


Figure 8. **Typical switching times as a function of gate resistor** (inductive load, T_{vj}=150°C, V_{CE}=400V, V_{GE}=15/0V, I_C=20A,Dynamic test circuit in Figure E)

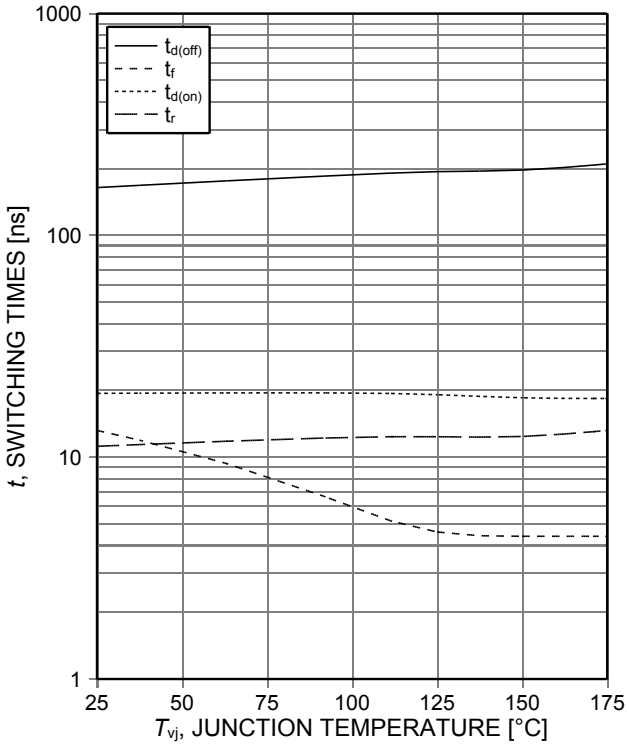


Figure 9. **Typical switching times as a function of junction temperature**
(inductive load, V_{CE}=400V, V_{GE}=15/0V, I_C=20A, r_G=15Ω,Dynamic test circuit in Figure E)

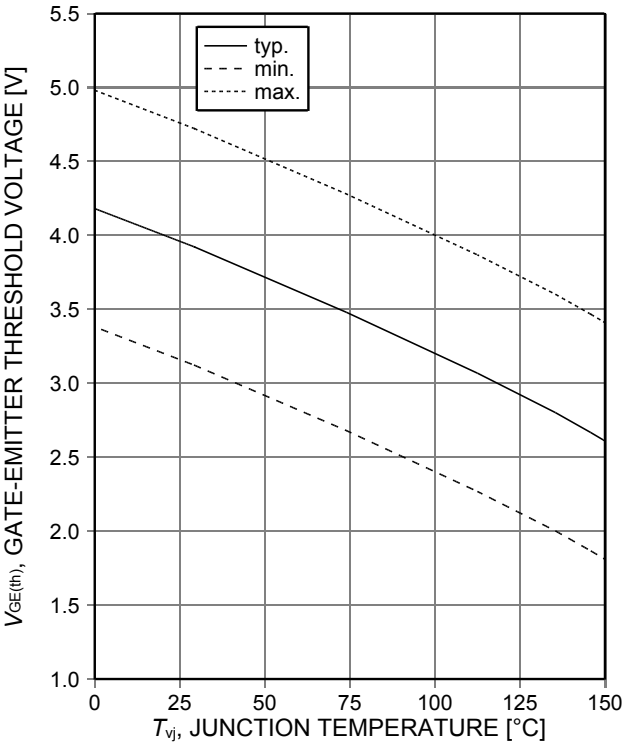


Figure 10. **Gate-emitter threshold voltage as a function of junction temperature**
(I_C=0.4mA)

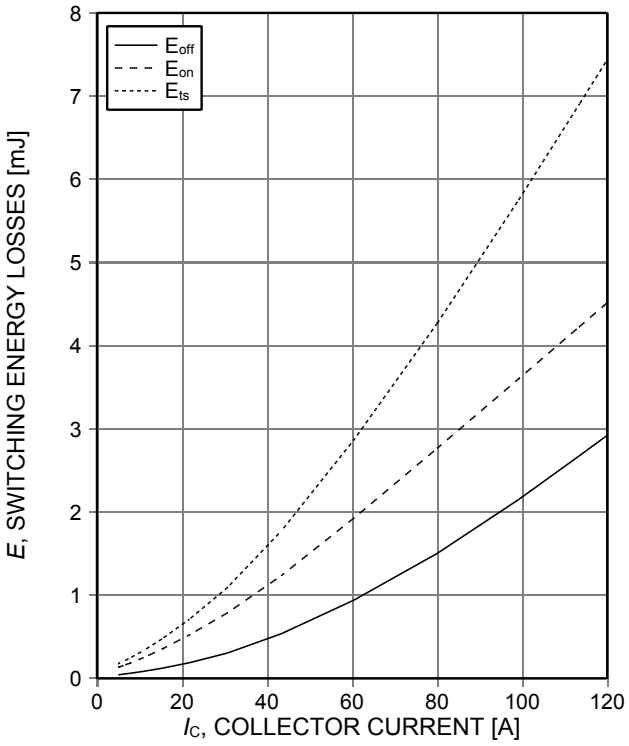


Figure 11. **Typical switching energy losses as a function of collector current**
(inductive load, T_{vj}=150°C, V_{CE}=400V, V_{GE}=15/0V, r_G=15Ω,Dynamic test circuit in Figure E)

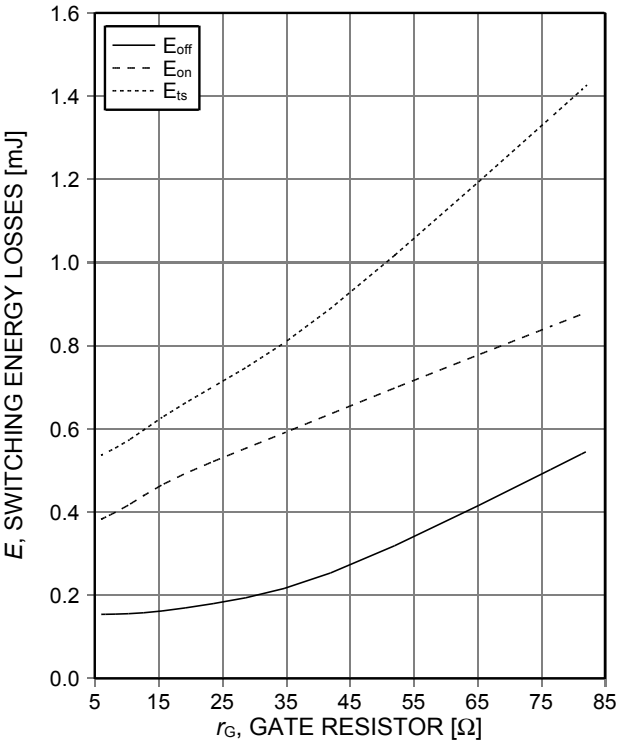


Figure 12. **Typical switching energy losses as a function of gate resistor**
(inductive load, T_{vj}=150°C, V_{CE}=400V, V_{GE}=15/0V, I_C=20A, Dynamic test circuit in Figure E)

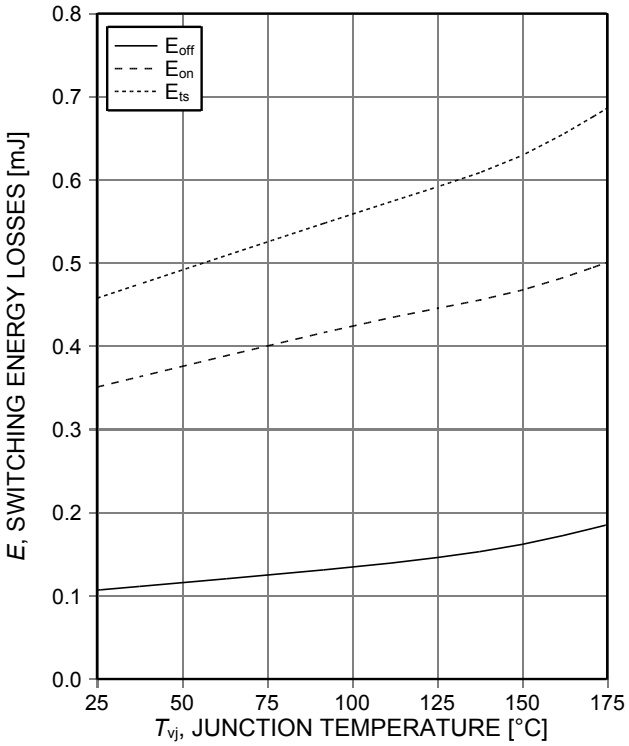


Figure 13. **Typical switching energy losses as a function of junction temperature** (inductive load, V_{CE}=400V, V_{GE}=15/0V, I_C=20A, r_G=15Ω,Dynamic test circuit in Figure E)

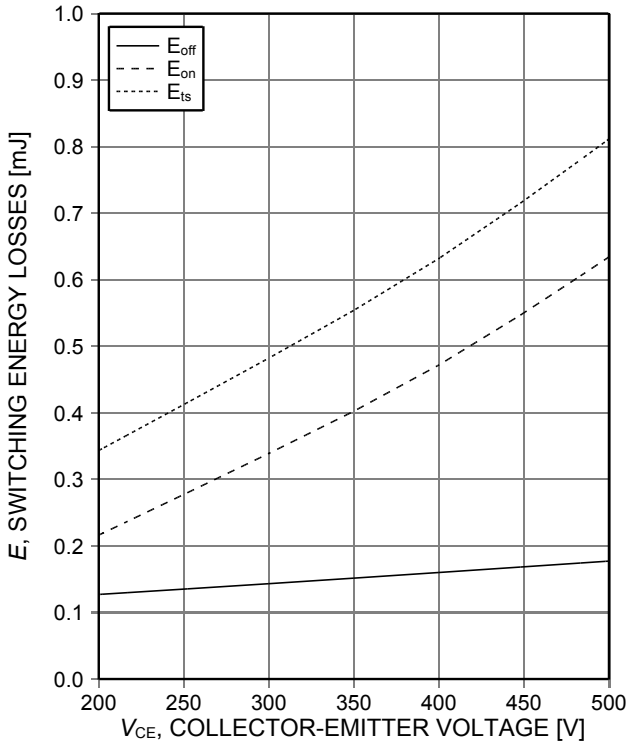


Figure 14. **Typical switching energy losses as a function of collector emitter voltage** (inductive load, T_{vj}=150°C, V_{GE}=15/0V, I_C=20A, r_G=15Ω,Dynamic test circuit in Figure E)

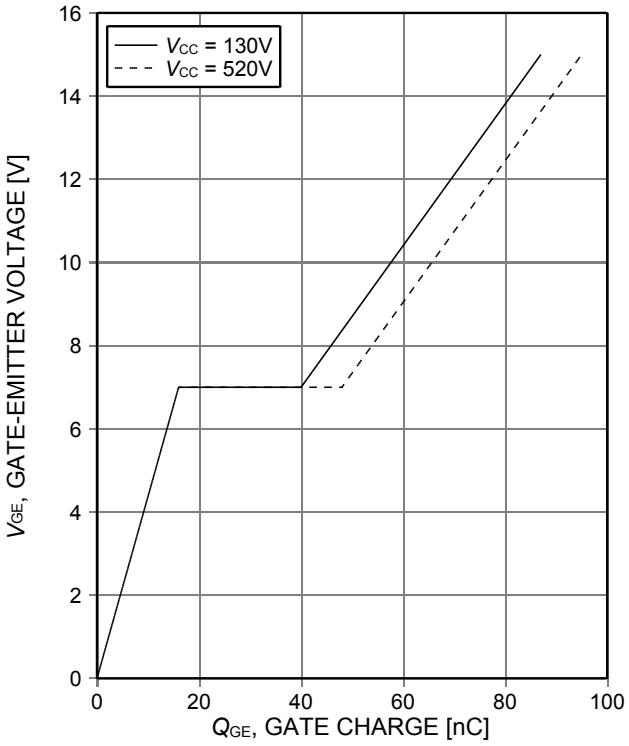


Figure 15. **Typical gate charge** (I_C=40A)

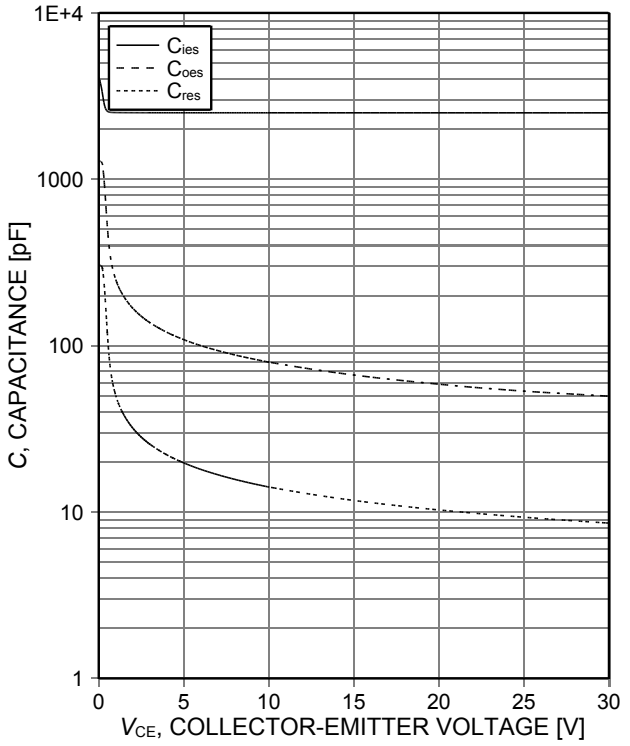


Figure 16. **Typical capacitance as a function of collector-emitter voltage** (V_{GE}=0V, f=1MHz)

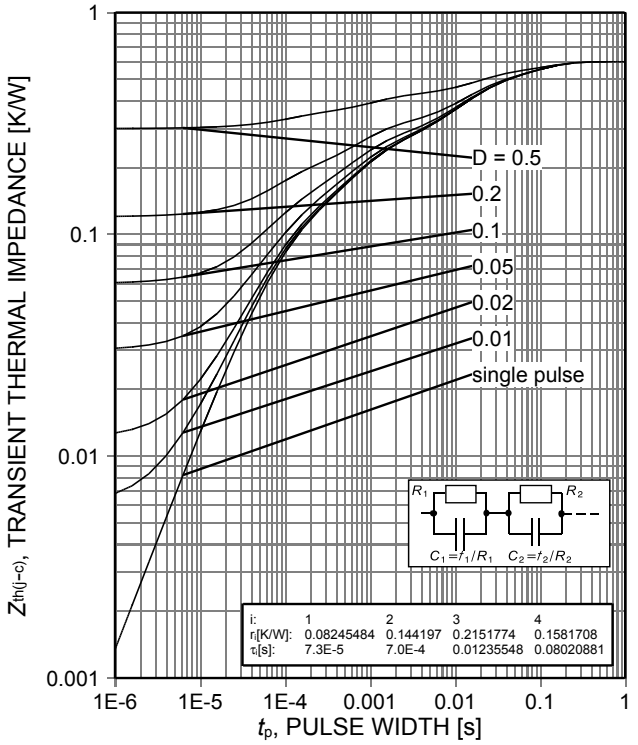


Figure 17. **IGBT transient thermal impedance** ($D=t_p/T$)

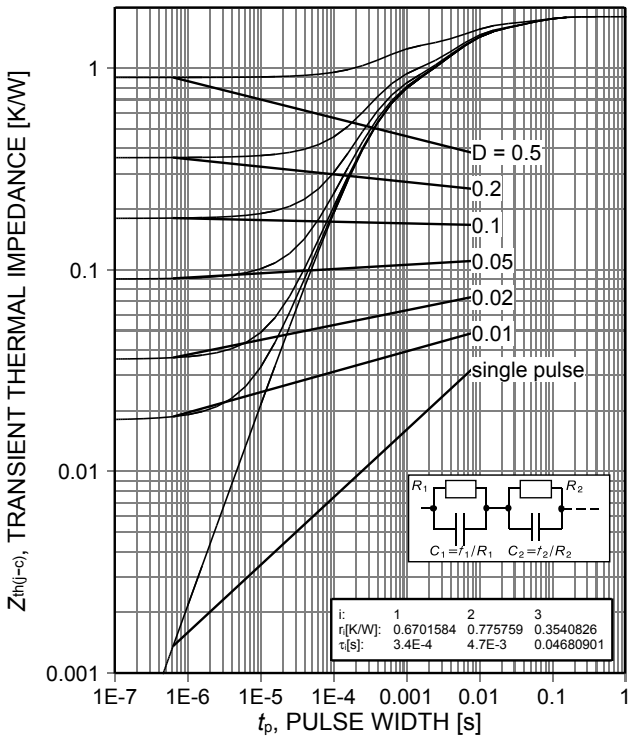


Figure 18. **Diode transient thermal impedance as a function of pulse width** ($D=t_p/T$)

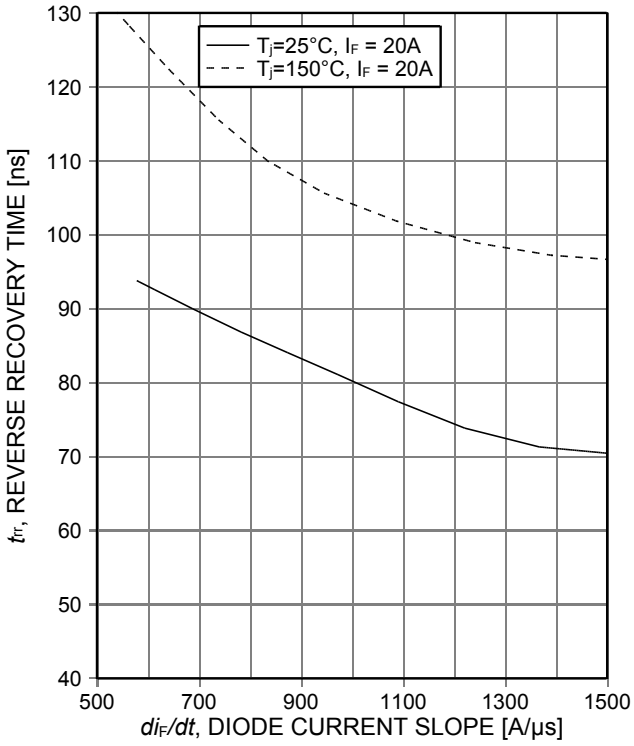


Figure 19. **Typical reverse recovery time as a function of diode current slope** (V_R=400V)

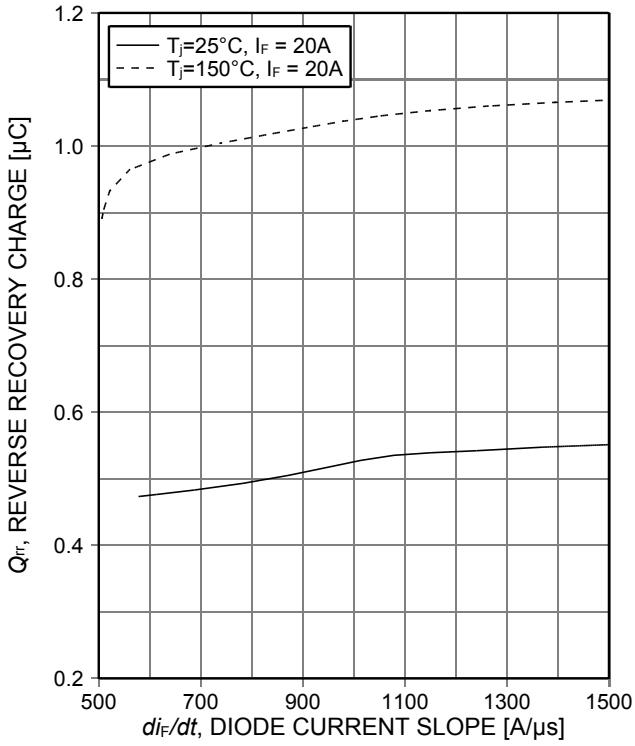


Figure 20. **Typical reverse recovery charge as a function of diode current slope** (V_R=400V)

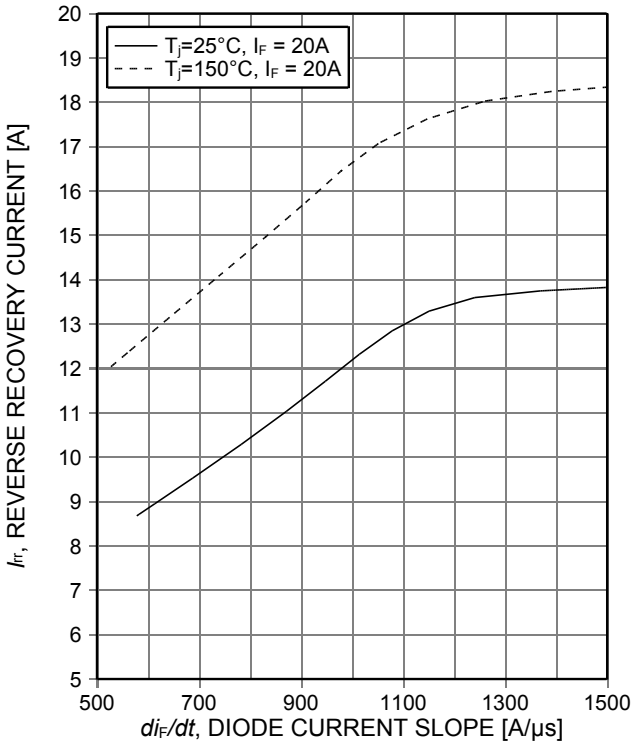


Figure 21. **Typical reverse recovery current as a function of diode current slope** (V_R=400V)

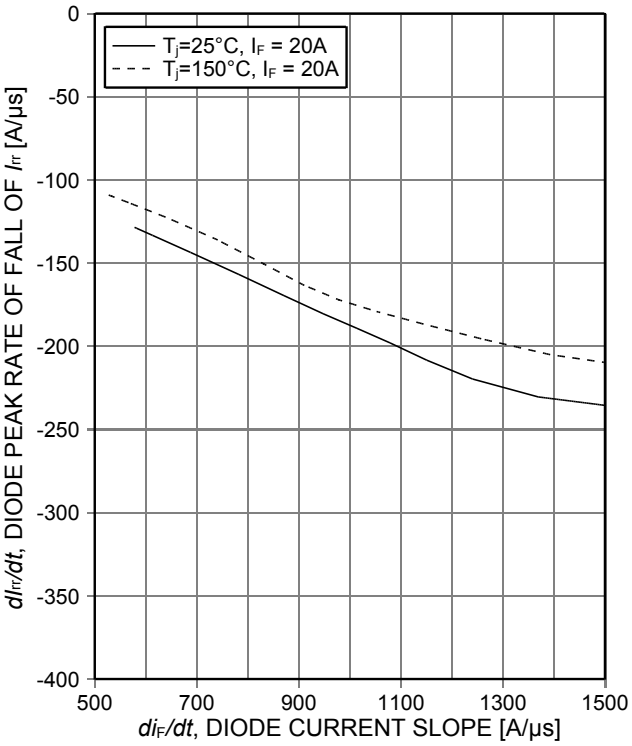


Figure 22. **Typical diode peak rate of fall of reverse recovery current as a function of diode current slope** (V_R=400V)

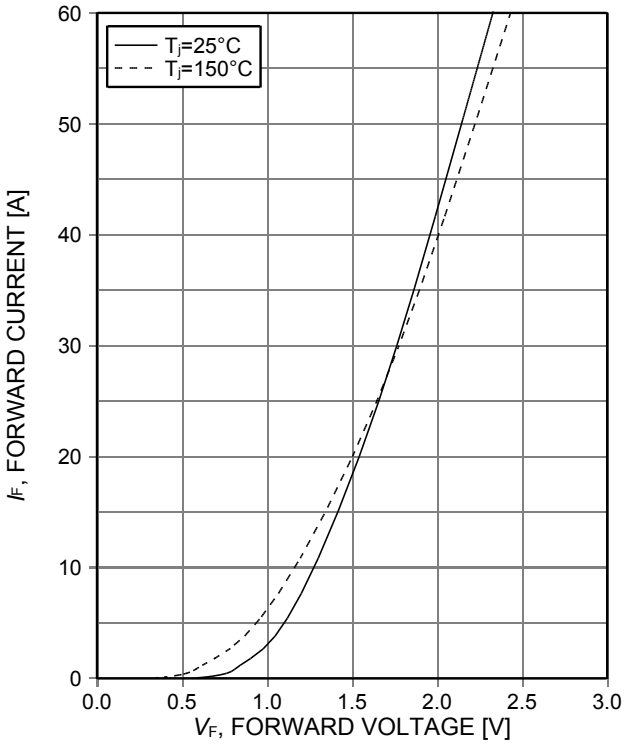


Figure 23. **Typical diode forward current as a function of forward voltage**

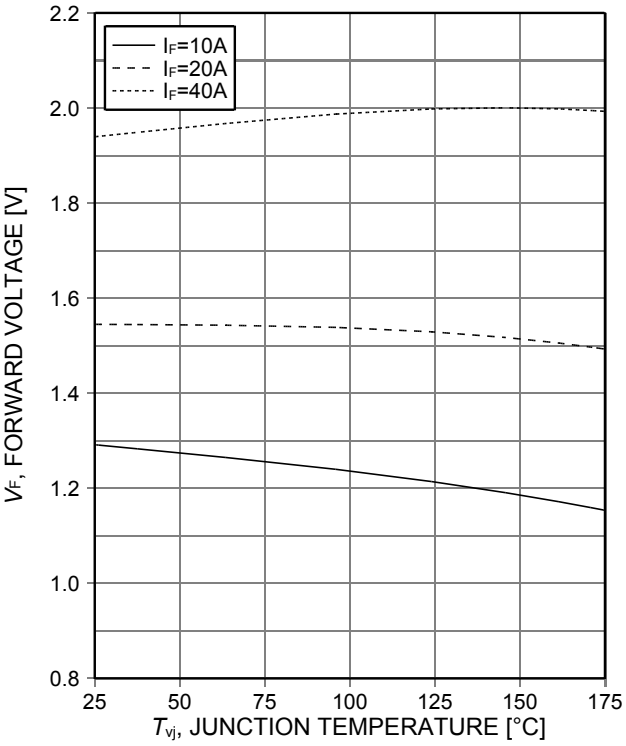
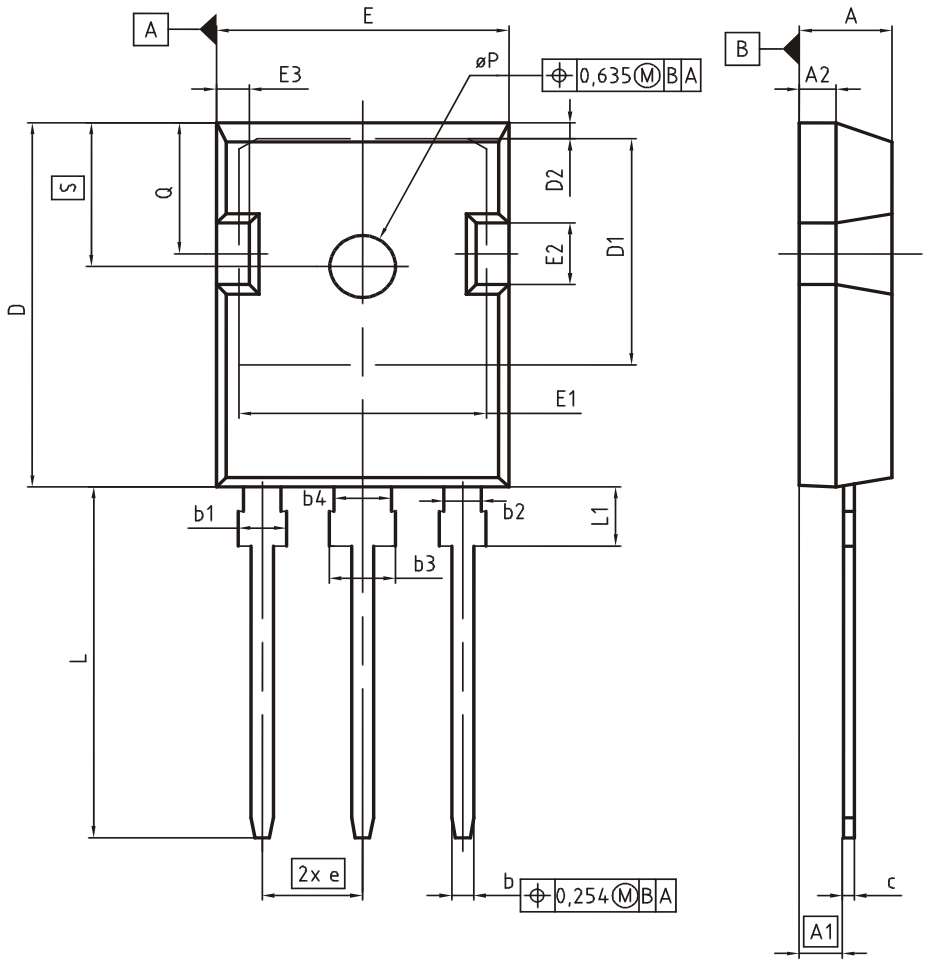


Figure 24. **Typical diode forward voltage as a function of junction temperature**

PG-TO247-3



DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.83	5.21	0.190	0.205
A1	2.27	2.54	0.089	0.100
A2	1.85	2.16	0.073	0.085
b	1.07	1.33	0.042	0.052
b1	1.90	2.41	0.075	0.095
b2	1.90	2.16	0.075	0.085
b3	2.87	3.38	0.113	0.133
b4	2.87	3.13	0.113	0.123
c	0.55	0.68	0.022	0.027
D	20.80	21.10	0.819	0.831
D1	16.25	17.65	0.640	0.695
D2	0.95	1.35	0.037	0.053
E	15.70	16.13	0.618	0.635
E1	13.10	14.15	0.516	0.557
E2	3.68	5.10	0.145	0.201
E3	1.00	2.60	0.039	0.102
e	5.44 (BSC)		0.214 (BSC)	
N	3		3	
L	19.80	20.32	0.780	0.800
L1	4.10	4.47	0.161	0.176
øP	3.50	3.70	0.138	0.146
Q	5.49	6.00	0.216	0.236
S	6.04	6.30	0.238	0.248

DOCUMENT NO.	Z8B00003327
SCALE	0 5 5 7.5mm
EUROPEAN PROJECTION	
ISSUE DATE	09-07-2010
REVISION	05

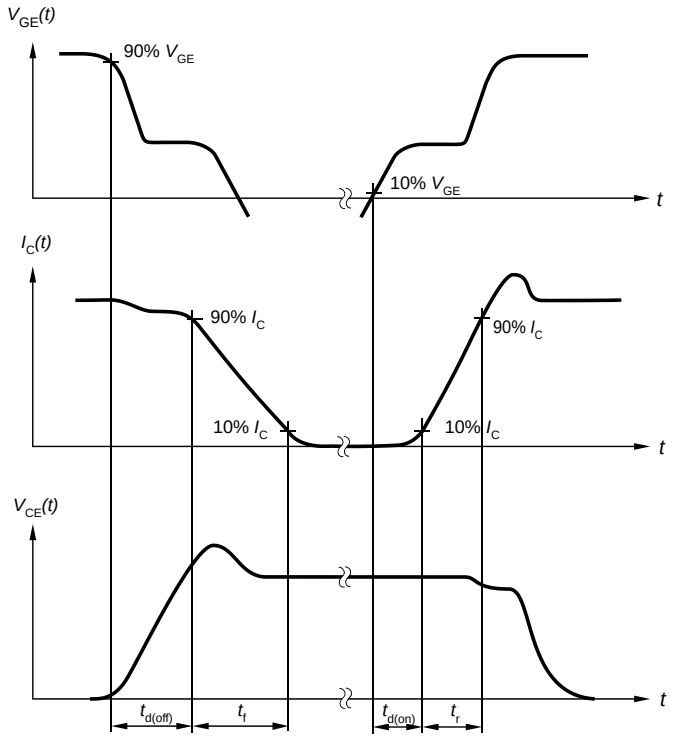


Figure A. **Definition of switching times**

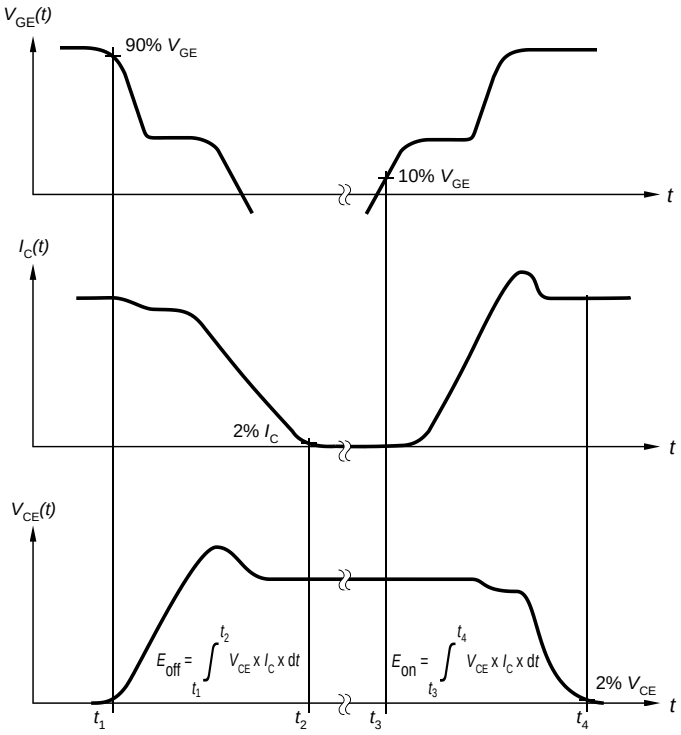


Figure B. **Definition of switching losses**

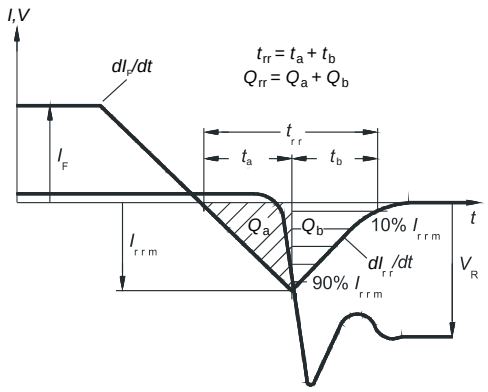


Figure C. **Definition of diode switching characteristics**

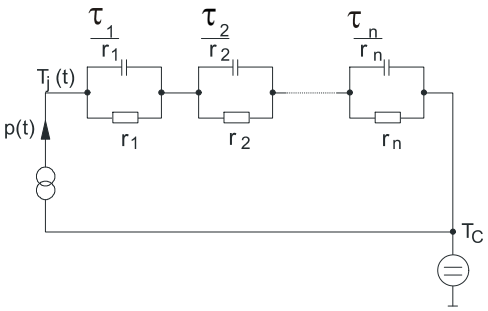


Figure D. **Thermal equivalent circuit**

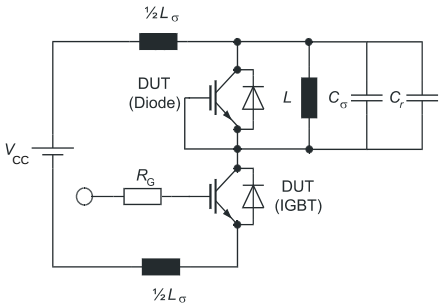


Figure E. **Dynamic test circuit**
Parasitic inductance L_σ,
parasitic capacitor C_σ,
relief capacitor C_r,
(only for ZVT switching)

Revision History

IKW40N65F5A

Revision: 2014-12-15, Rev. 2.1

Previous Revision

Revision	Date	Subjects (major changes since last revision)
2.1	2014-12-15	Final data sheet

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