High speed series fifth generation

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

Features and Benefits:

High speed H5 technology offering
• Best-in-Class efficiency in hard switching and resonant topologies
• Plug and play replacement of previous generation IGBTs
• 650V breakdown voltage
• Low gate charge Q_G
• IGBT copacked with full-rated RAPID 1 fast and soft antiparallel diode
• Maximum junction temperature 175°C
• Qualified according to JEDEC for target applications
• Pb-free lead plating; RoHS compliant
• Complete product spectrum and PSpice Models: http://www.infineon.com/igbt/
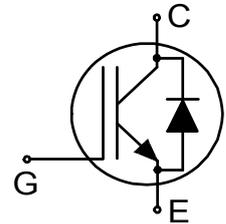
Applications:

• Uninterruptible power supplies
• Solar converters
• Welding converters
• Mid to high range switching frequency converters

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
IKW50N65EH5	650V	50A	1.65V	175°C	K50EEH5	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 value limited by bondwire T_C = 100°C	I_C	80.0 50.0	A
Pulsed collector current, t_p limited by T_{vjmax}[1]	I_{Cpuls}	200.0	A
Turn off safe operating area $V_{CE} \leq 650V$, $T_{vj} \leq 175°C$, t_p = 1µs[1]	-	200.0	A
Diode forward current, limited by T_{vjmax} T_C = 25°C value limited by bondwire T_C = 100°C	I_F	80.0 50.0	A
Diode pulsed current, t_p limited by T_{vjmax}[1]	I_{Fpuls}	200.0	A
Gate-emitter voltage Transient Gate-emitter voltage ($t_p \leq 10µs$, $D < 0.010$)	V_{GE}	±20 ±30	V
Power dissipation T_C = 25°C Power dissipation T_C = 100°C	P_{tot}	275.0 138.0	W
Operating junction temperature	T_{vj}	-40...+175	°C
Storage temperature	T_{stg}	-55...+150	°C
Soldering temperature, wave soldering 1.6mm (0.063in.) from case for 10s		260	°C
Mounting torque, M3 screw, PG-TO247-pin123 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	$R_{th(j-C)}$		-	-	0.55	K/W
Diode thermal resistance, junction - case	$R_{th(j-C)}$		-	-	0.63	K/W
Thermal resistance junction - ambient	$R_{th(j-a)}$		-	-	40	K/W

[1] Defined by design. Not subject to production test.

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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	650	-	-	V
Collector-emitter saturation voltage	V_{CEsat}	V_{GE} = 15.0V, I_C = 50.0A T_{vj} = 25°C T_{vj} = 125°C T_{vj} = 175°C	- - -	1.65 1.85 1.95	2.10 - -	V
Diode forward voltage	V_F	V_{GE} = 0V, I_F = 50.0A T_{vj} = 25°C T_{vj} = 125°C T_{vj} = 175°C	- - -	1.35 1.33 1.30	1.70 - -	V
Gate-emitter threshold voltage	$V_{GE(th)}$	I_C = 0.50mA, 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	- -	1 2000	50 -	µA
Gate-emitter leakage current	I_{GES}	V_{CE} = 0V, V_{GE} = 20V	-	-	100	nA
Transconductance	g_{fs}	V_{CE} = 20V, I_C = 50.0A	-	62.0	-	S

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	-	3000	-	pF
Output capacitance	C_{oes}		-	90	-	pF
Reverse transfer capacitance	C_{res}		-	12	-	pF
Gate charge	Q_G	V_{CC} = 520V, I_C = 50.0A, V_{GE} = 15V	-	120.0	-	nC
Internal emitter inductance measured 5mm (0.197 in.) from case	L_E		-	13.0	-	nH

Switching Characteristic, Inductive Load

Parameter	Symbol	Conditions	Value min.	Value typ.	Value max.	Unit
IGBT Characteristic, at T_{vj} = 25°C						
Turn-on delay time	$t_{d(on)}$	T_{vj} = 25°C, V_{CC} = 400V, I_C = 50.0A, V_{GE} = 0.0/15.0V, $R_{G(on)}$ = 12.0Ω, $R_{G(off)}$ = 12.0Ω, $L\sigma$ = 30nH, $C\sigma$ = 25pF $L\sigma$, $C\sigma$ from Fig. E Energy losses include "tail" and diode reverse recovery.	-	25	-	ns
Rise time	t_r		-	29	-	ns
Turn-off delay time	$t_{d(off)}$		-	172	-	ns
Fall time	t_f		-	35	-	ns
Turn-on energy	E_{on}		-	1.50	-	mJ
Turn-off energy	E_{off}		-	0.50	-	mJ
Total switching energy	E_{ts}		-	2.00	-	mJ

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Turn-on delay time	$t_{d(on)}$	T_{vj} = 25°C, V_{CC} = 400V, I_C = 25.0A, V_{GE} = 0.0/15.0V, $R_{G(on)}$ = 12.0Ω, $R_{G(off)}$ = 12.0Ω, $L\sigma$ = 30nH, $C\sigma$ = 25pF $L\sigma$, $C\sigma$ from Fig. E Energy losses include "tail" and diode reverse recovery.	-	24	-	ns
Rise time	t_r		-	12	-	ns
Turn-off delay time	$t_{d(off)}$		-	173	-	ns
Fall time	t_f		-	15	-	ns
Turn-on energy	E_{on}		-	0.57	-	mJ
Turn-off energy	E_{off}		-	0.16	-	mJ
Total switching energy	E_{ts}		-	0.73	-	mJ

Diode Characteristic, at T_{vj} = 25°C

Diode reverse recovery time	t_{rr}	T_{vj} = 25°C, V_R = 400V, I_F = 50.0A, di_F/dt = 1000A/μs, $L\sigma$ = 30nH, $C\sigma$ = 25pF	-	81	-	ns
Diode reverse recovery charge	Q_{rr}		-	1.10	-	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		-	-1000	-	A/μs

Diode reverse recovery time	t_{rr}	T_{vj} = 25°C, V_R = 400V, I_F = 25.0A, di_F/dt = 1000A/μs, $L\sigma$ = 30nH, $C\sigma$ = 25pF	-	56	-	ns
Diode reverse recovery charge	Q_{rr}		-	0.70	-	μC
Diode peak reverse recovery current	I_{rrm}		-	19.7	-	A
Diode peak rate of fall of reverse recovery current during t_b	di_{rr}/dt		-	-1500	-	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 = 50.0A, V_{GE} = 0.0/15.0V, $R_{G(on)}$ = 12.0Ω, $R_{G(off)}$ = 12.0Ω, $L\sigma$ = 30nH, $C\sigma$ = 25pF $L\sigma$, $C\sigma$ from Fig. E Energy losses include "tail" and diode reverse recovery.	-	24	-	ns
Rise time	t_r		-	30	-	ns
Turn-off delay time	$t_{d(off)}$		-	190	-	ns
Fall time	t_f		-	30	-	ns
Turn-on energy	E_{on}		-	2.00	-	mJ
Turn-off energy	E_{off}		-	0.60	-	mJ
Total switching energy	E_{ts}		-	2.60	-	mJ

Turn-on delay time	$t_{d(on)}$	T_{vj} = 150°C, V_{CC} = 400V, I_C = 25.0A, V_{GE} = 0.0/15.0V, $R_{G(on)}$ = 12.0Ω, $R_{G(off)}$ = 12.0Ω, $L\sigma$ = 30nH, $C\sigma$ = 25pF $L\sigma$, $C\sigma$ from Fig. E Energy losses include "tail" and diode reverse recovery.	-	23	-	ns
Rise time	t_r		-	14	-	ns
Turn-off delay time	$t_{d(off)}$		-	203	-	ns
Fall time	t_f		-	20	-	ns
Turn-on energy	E_{on}		-	0.95	-	mJ
Turn-off energy	E_{off}		-	0.25	-	mJ
Total switching energy	E_{ts}		-	1.20	-	mJ

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Diode Characteristic, at T_{vj} = 150°C

Diode reverse recovery time	t_{rr}	T_{vj} = 150°C, V_R = 400V, I_F = 50.0A, di_F/dt = 1000A/µs, $L\sigma$ = 30nH, $C\sigma$ = 25pF	-	108	-	ns
Diode reverse recovery charge	Q_{rr}		-	2.60	-	µC
Diode peak reverse recovery current	I_{rrm}		-	36.0	-	A
Diode peak rate of fall of reverse recovery current during t_b	di_{rr}/dt		-	-2000	-	A/µs
Diode reverse recovery time	t_{rr}	T_{vj} = 150°C, V_R = 400V, I_F = 25.0A, di_F/dt = 1000A/µs, $L\sigma$ = 30nH, $C\sigma$ = 25pF	-	98	-	ns
Diode reverse recovery charge	Q_{rr}		-	1.80	-	µC
Diode peak reverse recovery current	I_{rrm}		-	28.8	-	A
Diode peak rate of fall of reverse recovery current during t_b	di_{rr}/dt		-	-1500	-	A/µs

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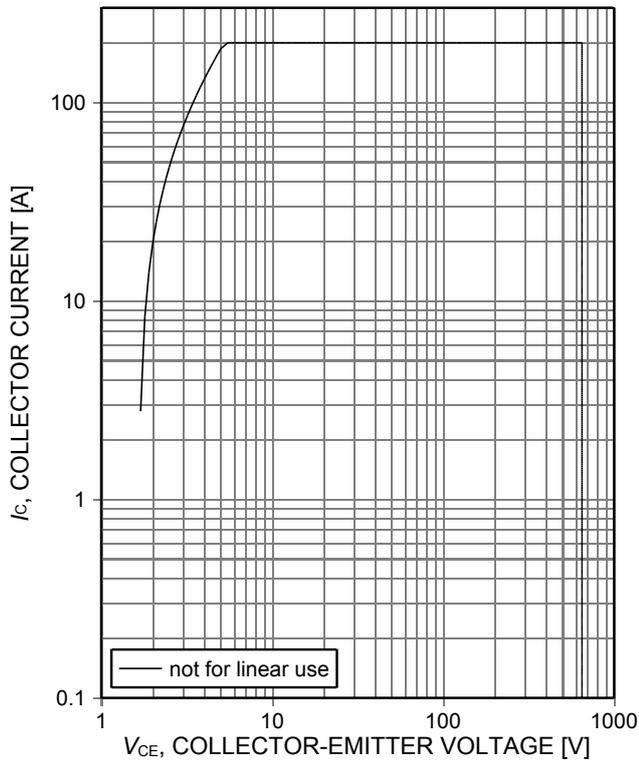
Figure 1. **Forward bias safe operating area**
(D=0, T_C=25°C, T_{vj}≤175°C, V_{GE}=15V, t_p=1µs, I_{Cmax} defined by design - not subject to production test)
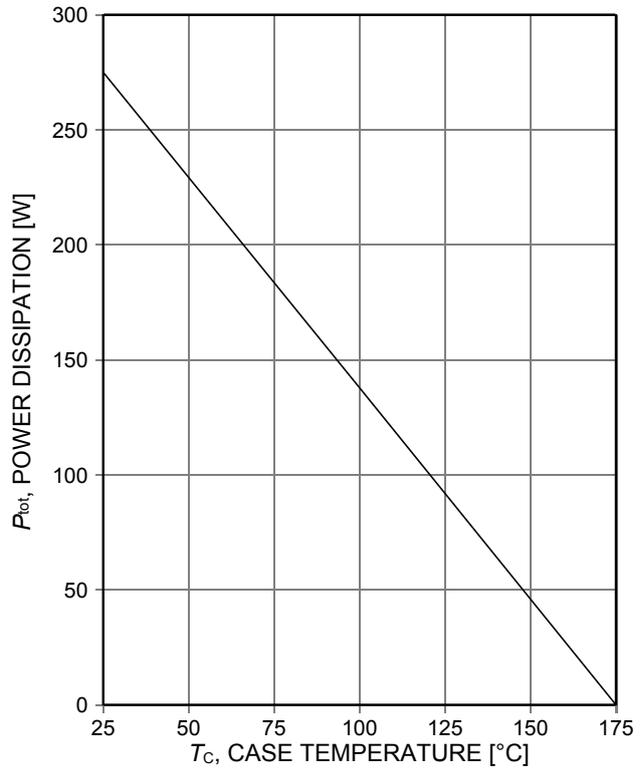
Figure 2. **Power dissipation as a function of case temperature**
(T_{vj}≤175°C)
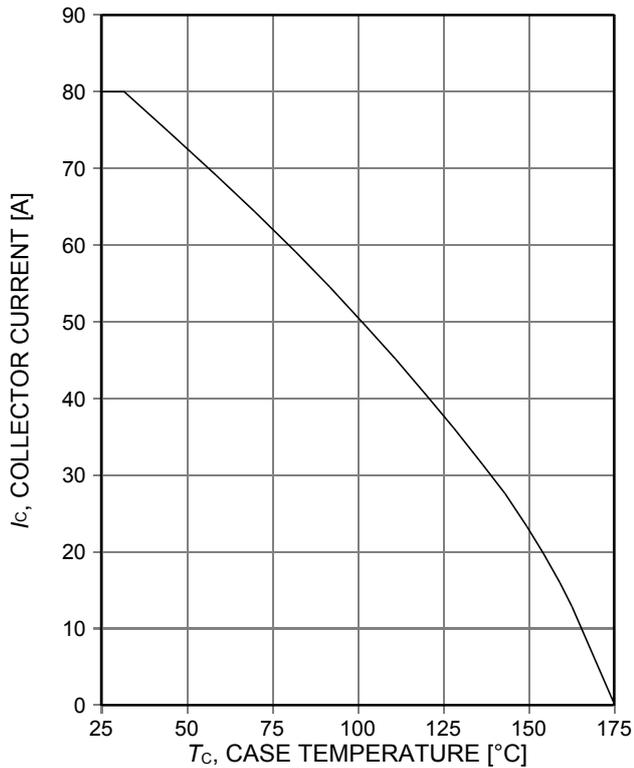
Figure 3. **Collector current as a function of case temperature**
(V_{GE}≥15V, T_{vj}≤175°C)
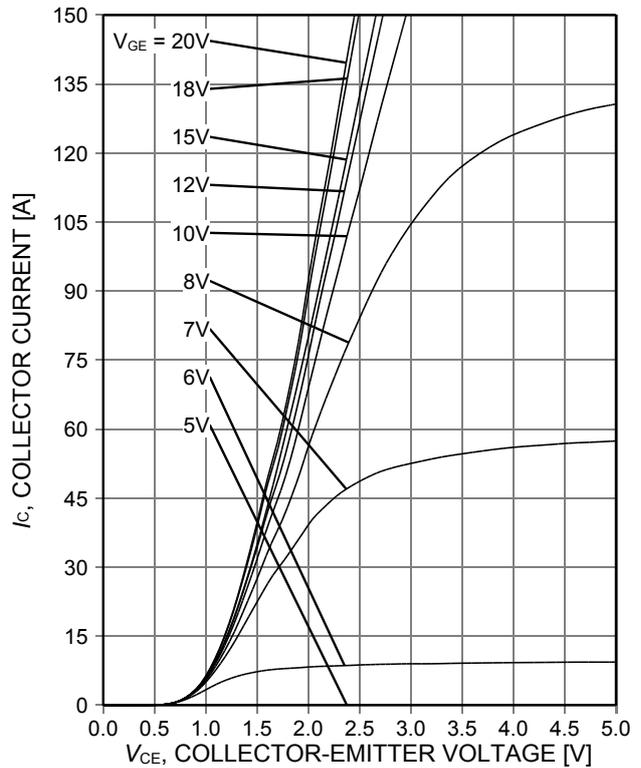
Figure 4. **Typical output characteristic**
(T_{vj}=25°C)

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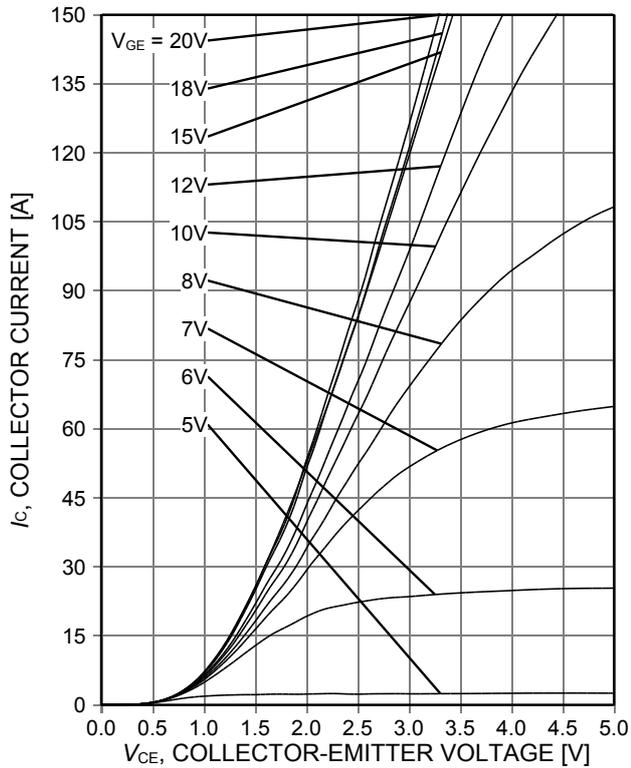
Figure 5. **Typical output characteristic**
(T_{vj}=150°C)
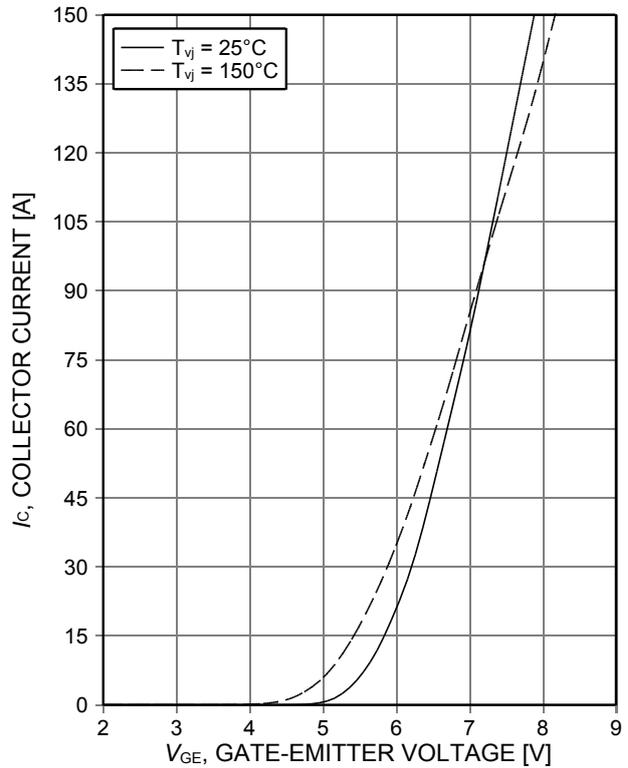
Figure 6. **Typical transfer characteristic**
(V_{CE}=20V)
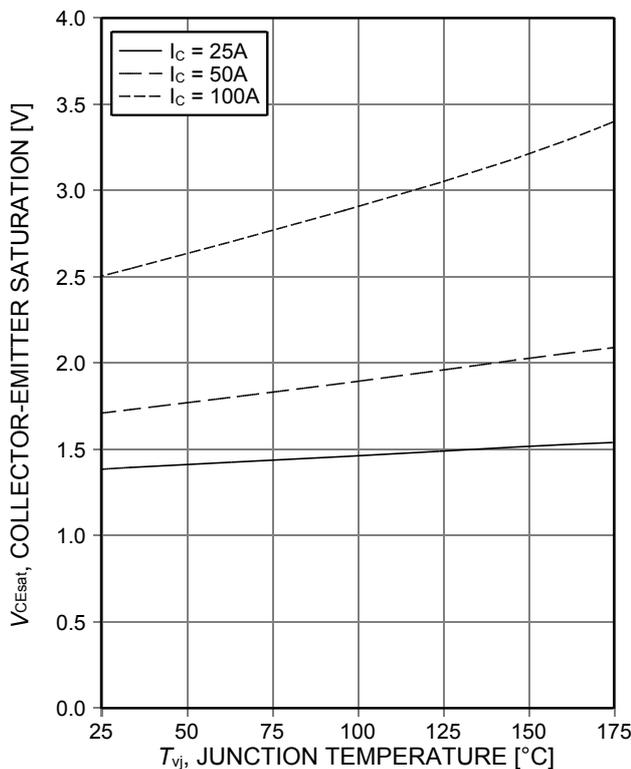
Figure 7. **Typical collector-emitter saturation voltage as a function of junction temperature**
(V_{GE}=15V)
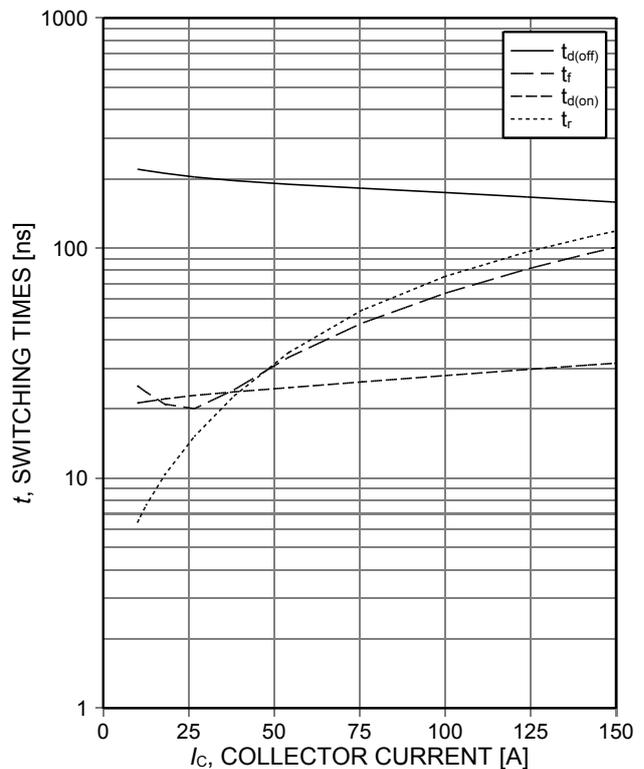
Figure 8. **Typical switching times as a function of collector current**
(inductive load, T_{vj}=150°C, V_{CE}=400V, V_{GE}=0/15V, $R_{G(on)}$=12Ω, $R_{G(off)}$=12Ω, dynamic test circuit in Figure E)

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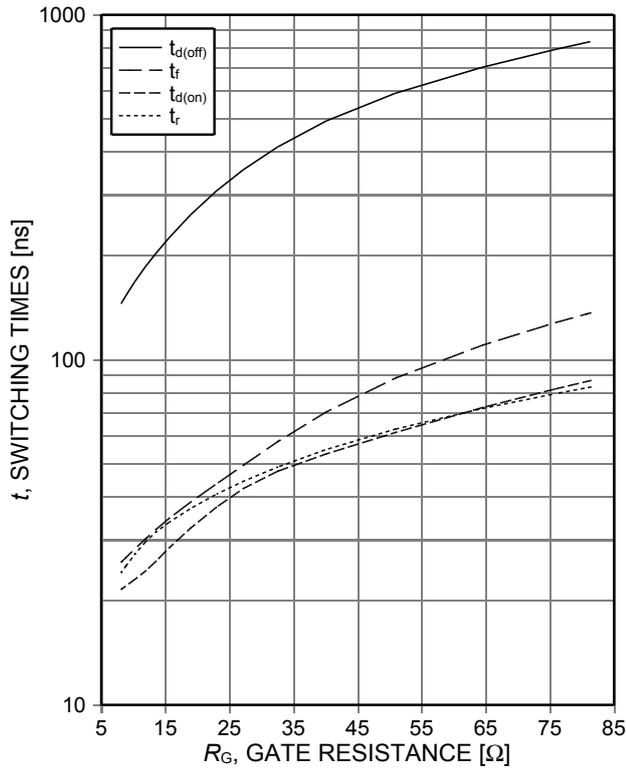
Figure 9. **Typical switching times as a function of gate resistance**
(inductive load, T_{vj}=150°C, V_{CE}=400V, V_{GE}=0/15V, I_C=50A, dynamic test circuit in Figure E)
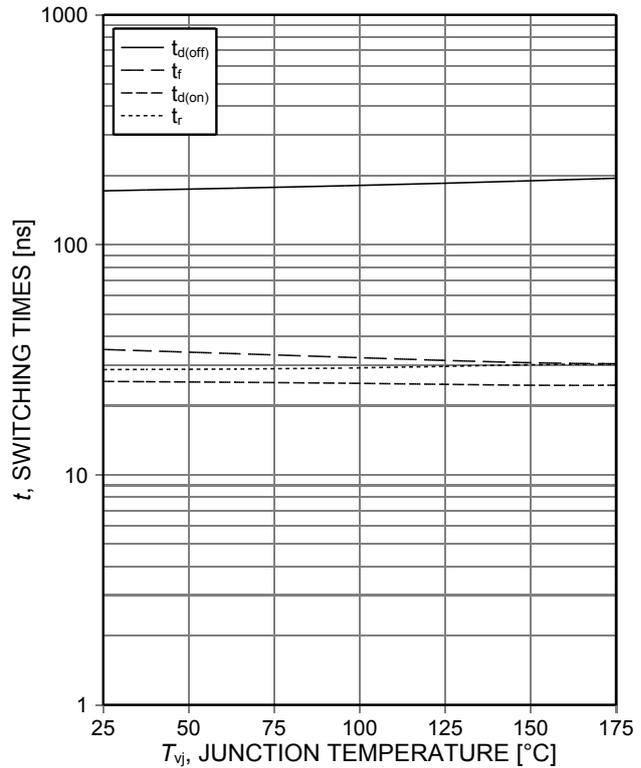
Figure 10. **Typical switching times as a function of junction temperature**
(inductive load, V_{CE}=400V, V_{GE}=0/15V, I_C=50A, $R_{G(on)}$=12Ω, $R_{G(off)}$=12Ω, dynamic test circuit in Figure E)
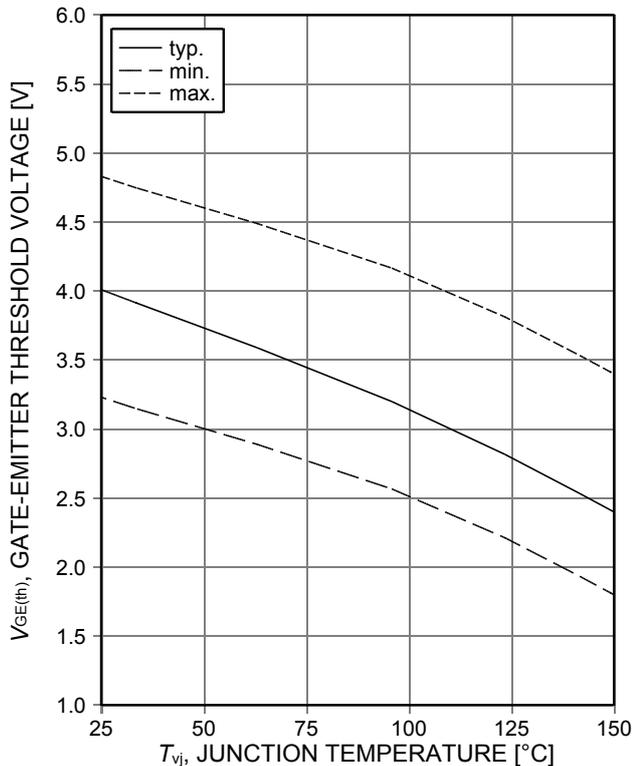
Figure 11. **Gate-emitter threshold voltage as a function of junction temperature**
(I_C=0.5mA)
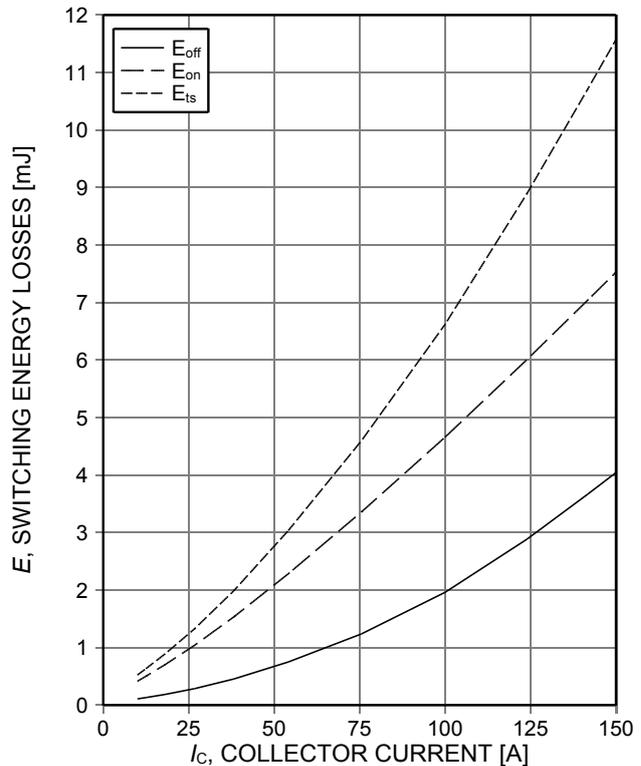
Figure 12. **Typical switching energy losses as a function of collector current**
(inductive load, T_{vj}=150°C, V_{CE}=400V, V_{GE}=0/15V, $R_{G(on)}$=12Ω, $R_{G(off)}$=12Ω, dynamic test circuit in Figure E)

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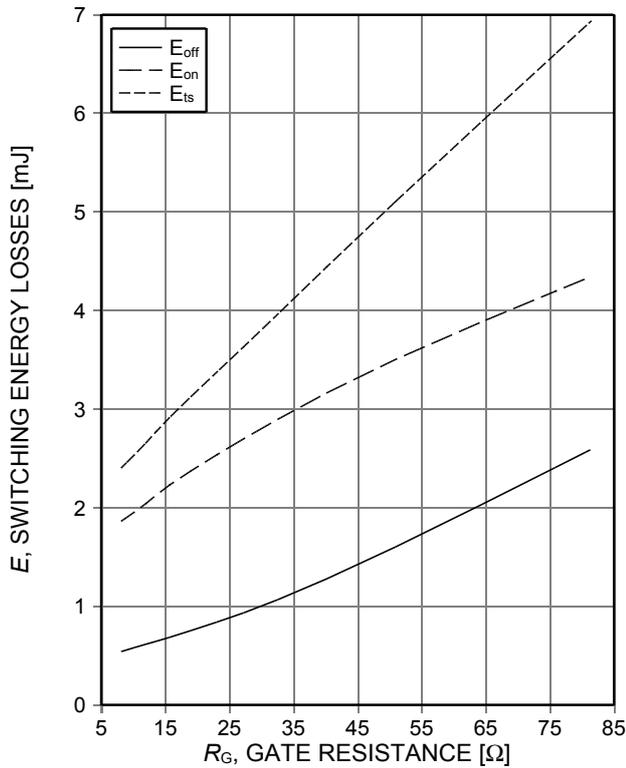
Figure 13. **Typical switching energy losses as a function of gate resistance** (inductive load, T_{vj}=150°C, V_{CE}=400V, V_{GE}=0/15V, I_C=50A, dynamic test circuit in Figure E)
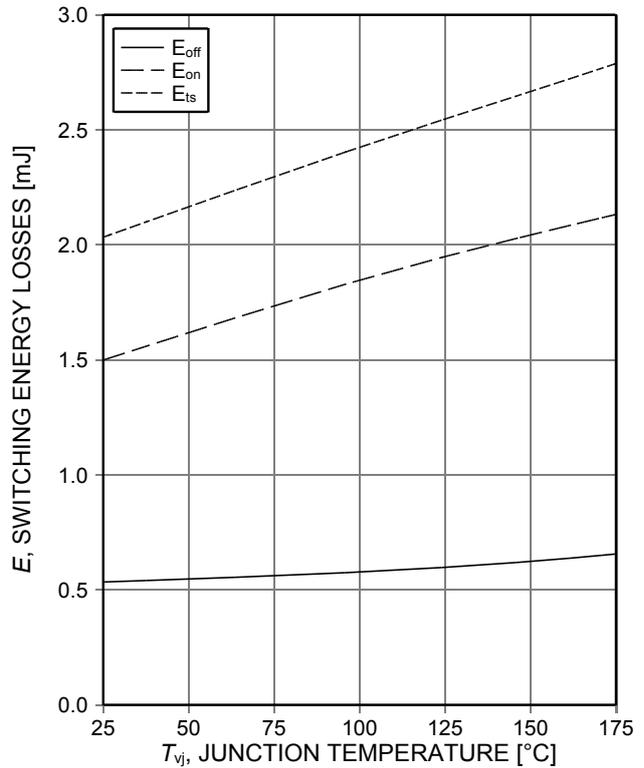
Figure 14. **Typical switching energy losses as a function of junction temperature** (inductive load, V_{CE}=400V, V_{GE}=0/15V, I_C=50A, $R_{G(on)}$=12Ω, $R_{G(off)}$=12Ω, dynamic test circuit in Figure E)
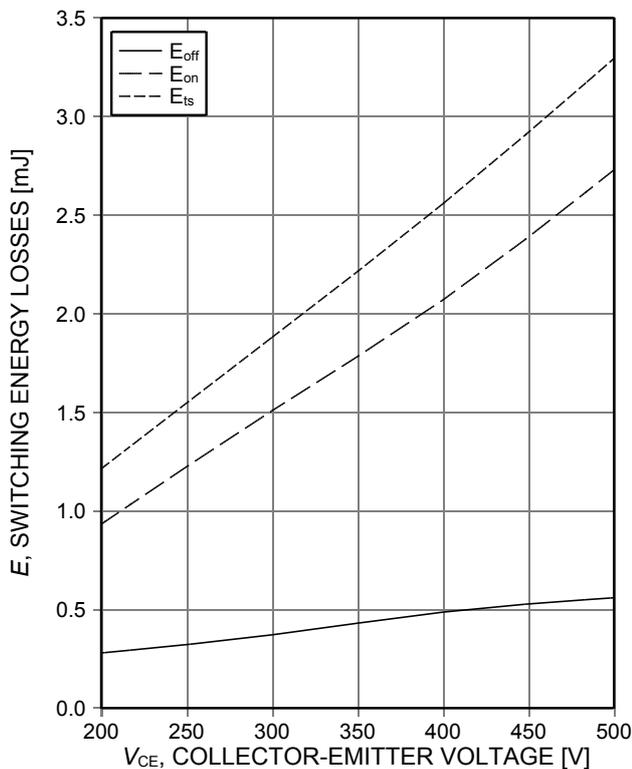
Figure 15. **Typical switching energy losses as a function of collector emitter voltage** (inductive load, T_{vj}=150°C, V_{GE}=0/15V, I_C=50A, $R_{G(on)}$=12Ω, $R_{G(off)}$=12Ω, dynamic test circuit in Figure E)
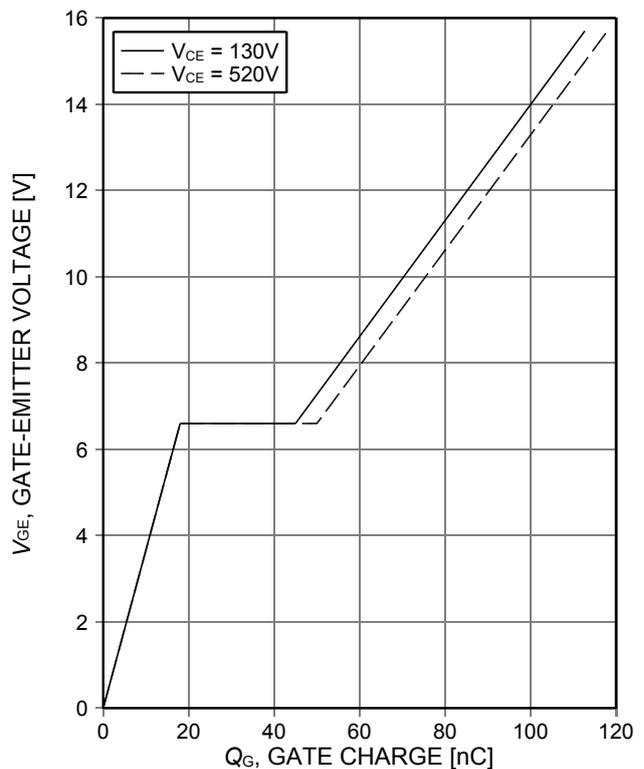
Figure 16. **Typical gate charge** (I_C=50A)

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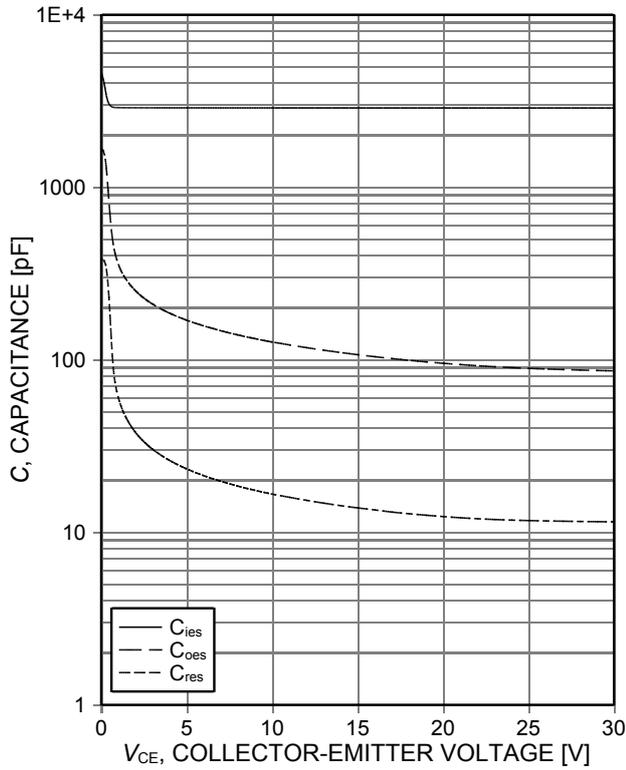
Figure 17. **Typical capacitance as a function of collector-emitter voltage**
(V_{GE}=0V, f=1MHz)
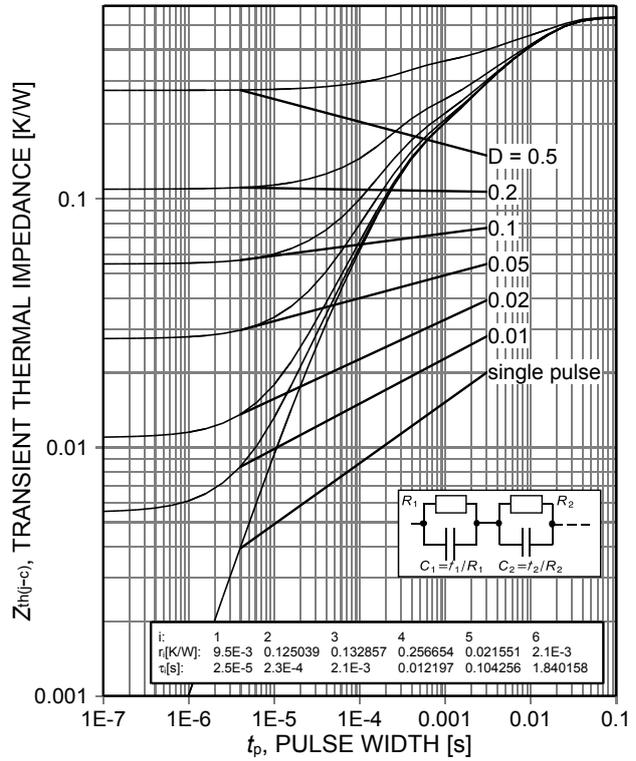
Figure 18. **IGBT transient thermal impedance**
($D=t_p$/T)
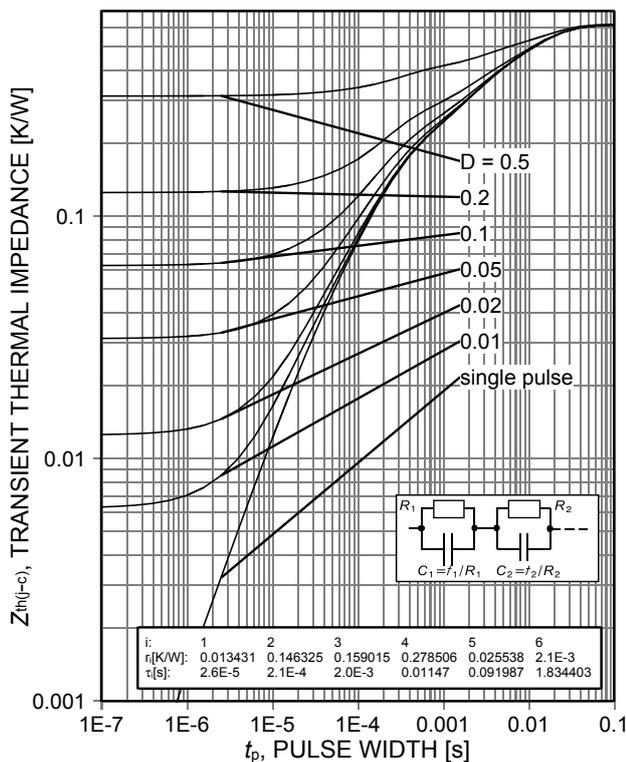
Figure 19. **Diode transient thermal impedance as a function of pulse width**
($D=t_p$/T)
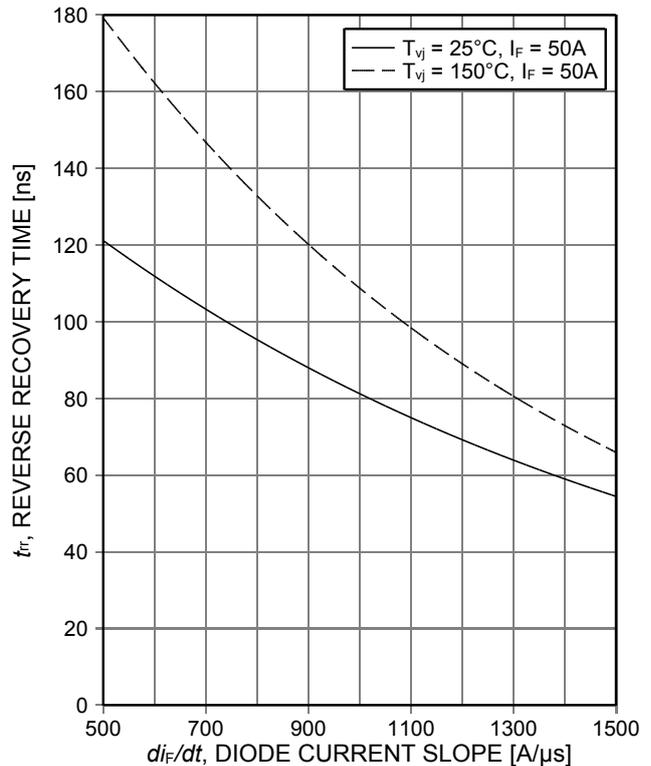
Figure 20. **Typical reverse recovery time as a function of diode current slope**
(V_R=400V)

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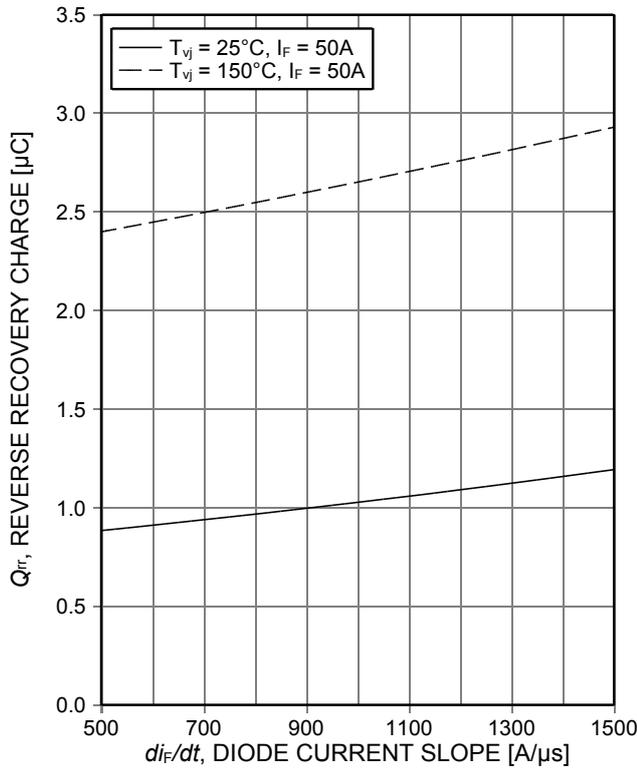
Figure 21. **Typical reverse recovery charge as a function of diode current slope** (V_R=400V)
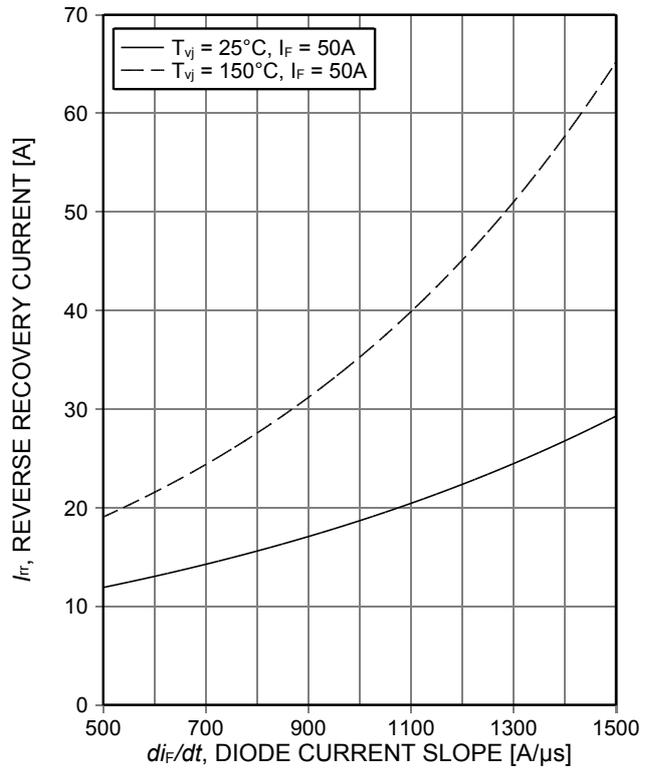
Figure 22. **Typical reverse recovery current as a function of diode current slope** (V_R=400V)
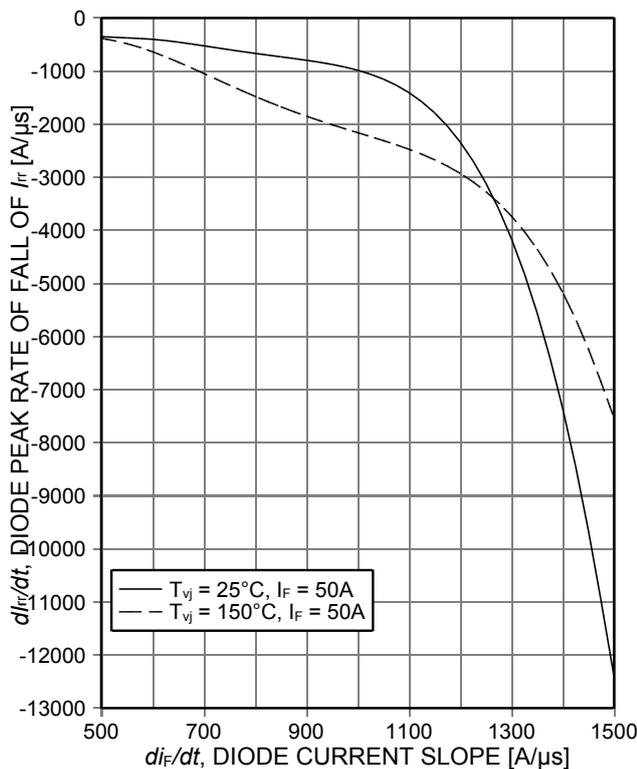
Figure 23. **Typical diode peak rate of fall of reverse recovery current as a function of diode current slope** (V_R=400V)
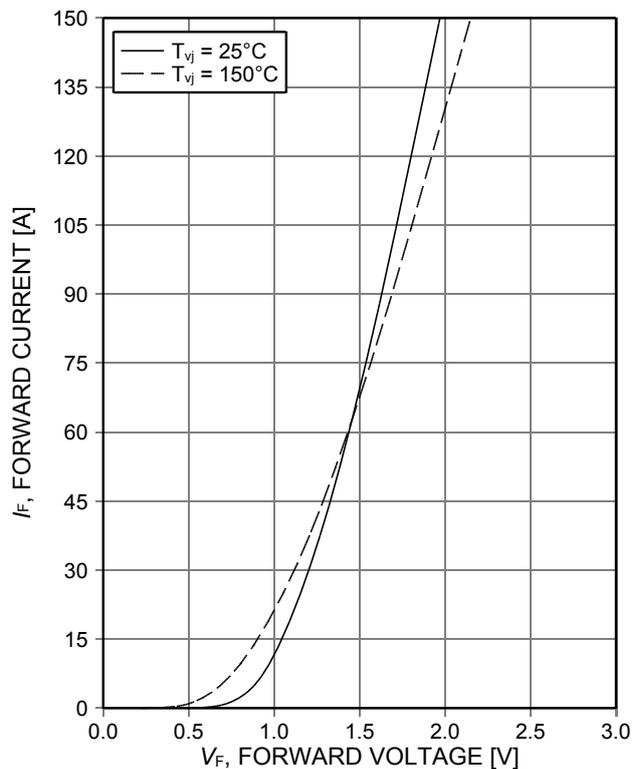
Figure 24. **Typical diode forward current as a function of forward voltage**

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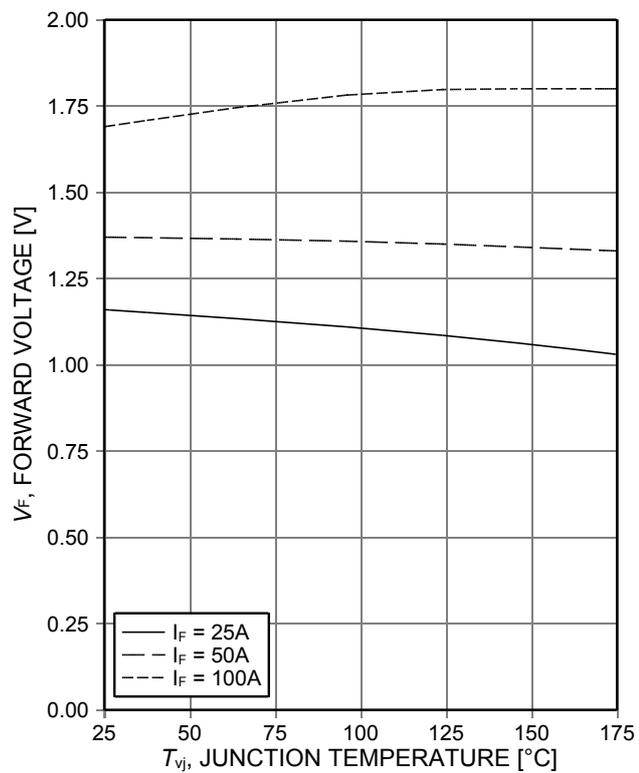
Figure 25. **Typical diode forward voltage as a function of junction temperature**

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Package Drawing PG-TO247-3
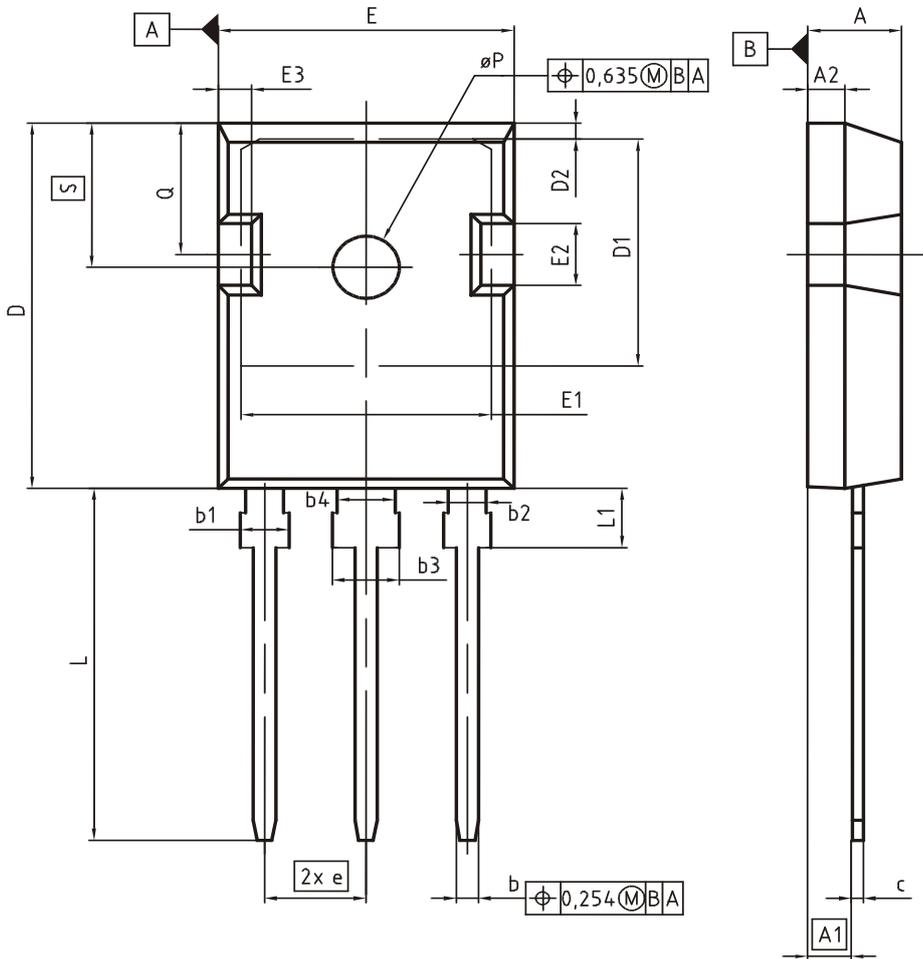
DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.83	5.21	0.190	0.205
A1	2.27	2.54	0.089	0.100
A2	1.85	2.16	0.073	0.085
b	1.07	1.33	0.042	0.052
b1	1.90	2.41	0.075	0.095
b2	1.90	2.16	0.075	0.085
b3	2.87	3.38	0.113	0.133
b4	2.87	3.13	0.113	0.123
c	0.55	0.68	0.022	0.027
D	20.80	21.10	0.819	0.831
D1	16.25	17.65	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

EUROPEAN PROJECTION

ISSUE DATE
09-07-2010

REVISION
05

IKW50N65EH5

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Testing Conditions
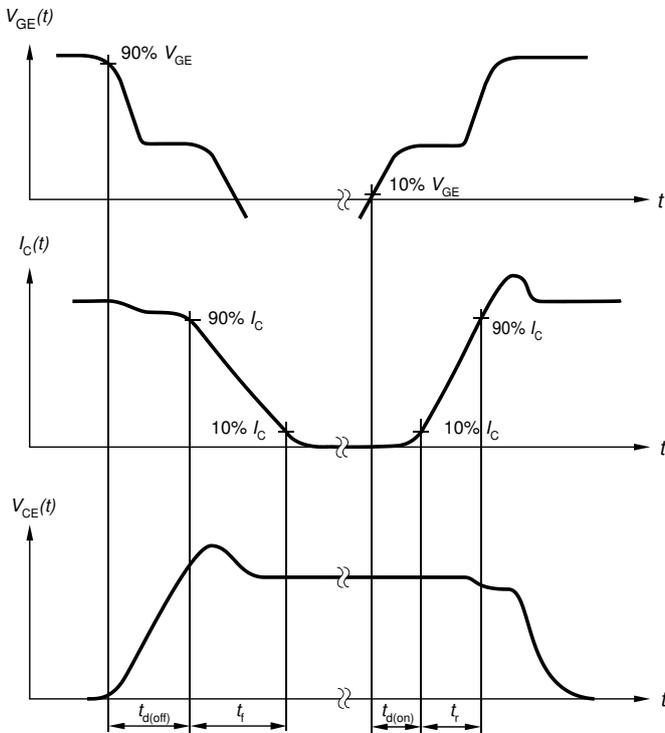
Figure A. **Definition of switching times**

$$E_{off} = \int_{t_1}^{t_2} V_{CE} \times I_C \times dt$$

$$E_{on} = \int_{t_3}^{t_4} V_{CE} \times I_C \times dt$$
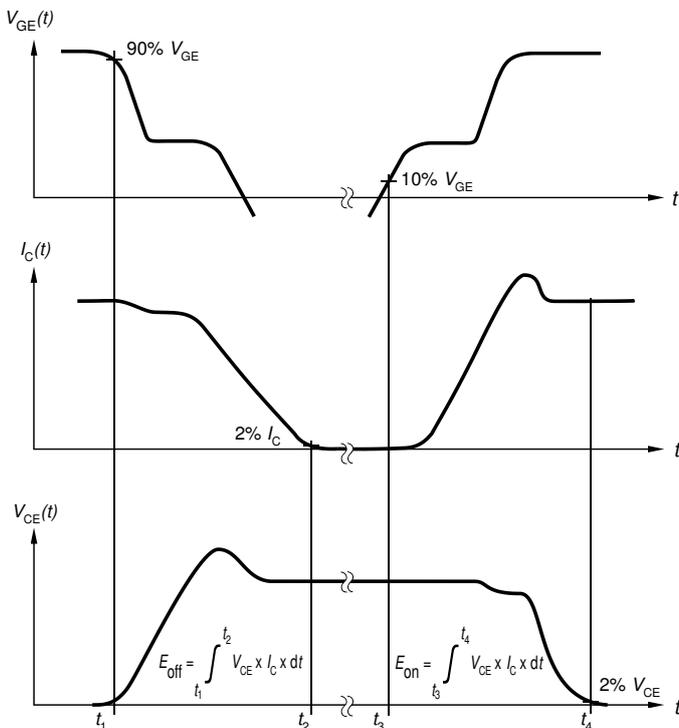
Figure B. **Definition of switching losses**

$t_{rr} = t_a + t_b$

$Q_{rr} = Q_a + Q_b$
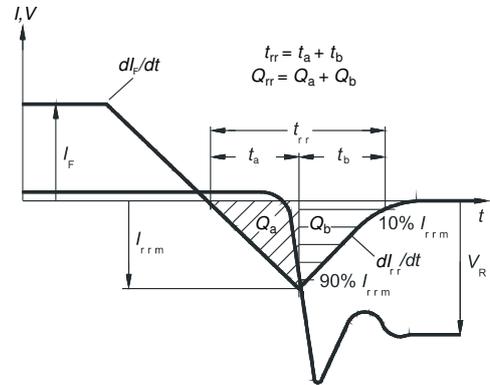
Figure C. **Definition of diode switching characteristics**
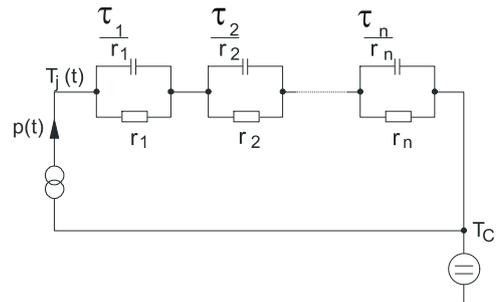
Figure D. **Thermal equivalent circuit**
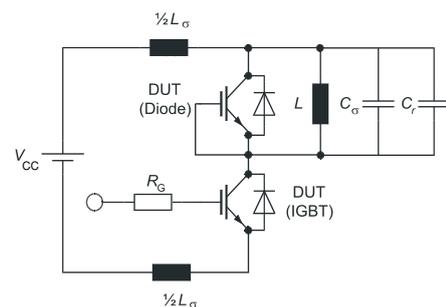
Figure E. **Dynamic test circuit**
Parasitic inductance L_σ,
parasitic capacitor C_σ,
relief capacitor C_r,
(only for ZVT switching)

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Revision History

IKW50N65EH5

Revision: 2017-07-27, Rev. 2.2

Previous Revision

Revision	Date	Subjects (major changes since last revision)
2.1	2015-05-20	Final data sheet
2.2	2017-07-27	Correction Fig.1

Trademarks

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