IGBT

High speed DuoPack: IGBT in Trench and Fieldstop technology with soft, fast recovery anti-parallel diode

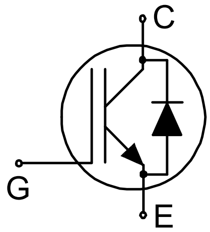
IKW60N60H3

600V high speed switching series third generation

Data sheet

Industrial Power Control

High speed IGBT in Trench and Fieldstop technology



Features:

TRENCHSTOP™ technology offering
- very low turn-off energy
- low V_{CEsat}
- low EMI
- maximum junction temperature 175°C
- qualified according to JEDEC for target applications
- Pb-free lead plating, halogen-free mould compound, RoHS compliant
- complete product spectrum and PSpice Models: http://www.infineon.com/igbt/

Applications:

- uninterruptible power supplies
- welding converters
- converters with high switching frequency

Package pin definition:

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

Green
Halogen-Free
RoHS

Key Performance and Package Parameters

Type	V_{CE}	I_C	V_{CEsat}, T_{vj}=25°C	T_{vjmax}	Marking	Package
IKW60N60H3	600V	60A	1.85V	175°C	K60H603	PG-TO247-3

Table of Contents

Maximum ratings

Parameter	Symbol	Value	Unit
Collector-emitter voltage	V_{CE}	600	V
DC collector current, limited by T_{vjmax}[1] T_C = 25°C T_C = 115°C	I_C	 80.0 60.0	A
Pulsed collector current, t_p limited by T_{vjmax}	I_{Cpuls}	180.0	A
Turn off safe operating area $V_{CE} \leq$ 600V, $T_{vj} \leq$ 175°C	-	180.0	A
Diode forward current, limited by T_{vjmax} T_C = 25°C T_C = 115°C	I_F	 80.0 30.0	A
Diode pulsed current, t_p limited by T_{vjmax}	I_{Fpuls}	90.0	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}	416.0	W
Operating junction temperature	T_{vj}	-40...+175	°C
Storage temperature	T_{stg}	-55...+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	$R_{th(j-c)}$		0.36	K/W
Diode thermal resistance, junction - case	$R_{th(j-c)}$		1.05	K/W
Thermal resistance junction - ambient	$R_{th(j-a)}$		40	K/W

[1] 80A value limited by bondwire

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 = 2.00mA	600	-	-	V
Collector-emitter saturation voltage	V_{CEsat}	V_{GE} = 15.0V, I_C = 60.0A T_{vj} = 25°C T_{vj} = 175°C	- -	1.85 2.25	2.30 -	V
Diode forward voltage	V_F	V_{GE} = 0V, I_F = 30.0A T_{vj} = 25°C T_{vj} = 175°C	- -	1.65 1.60	2.00	V
Gate-emitter threshold voltage	$V_{GE(th)}$	I_C = 1.00mA, V_{CE} = V_{GE}	4.1	5.1	5.7	V
Zero gate voltage collector current	I_{CES}	V_{CE} = 600V, V_{GE} = 0V T_{vj} = 25°C T_{vj} = 175°C	- -	- -	40.0 5000.0	µA
Gate-emitter leakage current	I_{GES}	V_{CE} = 0V, V_{GE} = 20V	-	-	100	nA
Transconductance	g_{fs}	V_{CE} = 20V, I_C = 60.0A	-	32.0	-	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	-	3680	-	pF
Output capacitance	C_{oes}		-	160	-	
Reverse transfer capacitance	C_{res}		-	100	-	
Gate charge	Q_G	V_{CC} = 480V, I_C = 60.0A, V_{GE} = 15V	-	375.0	-	nC
Internal emitter inductance measured 5mm (0.197 in.) from case	L_E		-	13.0	-	nH
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	-	534	-	A

Switching Characteristic, Inductive Load, at T_{vj} = 25°C

Parameter	Symbol	Conditions	Value min.	Value typ.	Value max.	Unit
IGBT Characteristic						
Turn-on delay time	$t_{d(on)}$	T_{vj} = 25°C, V_{CC} = 400V, I_C = 60.0A, V_{GE} = 0.0/15.0V, r_G = 6.0Ω, L_σ = 90nH, C_σ = 50pF L_σ, C_σ from Fig. E Energy losses include “tail” and diode (IKW60N60H3) reverse recovery. Switching test with minimized Emitter Stray inductance, see High Speed 3 App Note on www.infineon.com.	-	27	-	ns
Rise time	t_r		-	44	-	ns
Turn-off delay time	$t_{d(off)}$		-	252	-	ns
Fall time	t_f		-	27	-	ns
Turn-on energy	E_{on}		-	2.10	-	mJ
Turn-off energy	E_{off}		-	1.13	-	mJ
Total switching energy	E_{ts}		-	3.23	-	mJ

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

Diode reverse recovery time	t_{rr}	T_{vj} = 25°C, V_R = 400V, I_F = 60.0A, di_F/dt = 1000A/µs	-	143	-	ns
Diode reverse recovery charge	Q_{rr}		-	1.20	-	µC
Diode peak reverse recovery current	I_{rrm}		-	13.0	-	A
Diode peak rate of fall of reverse recovery current during t_b	di_{rr}/dt		-	-108	-	A/µs

Switching Characteristic, Inductive Load, at T_{vj} = 175°C

Parameter	Symbol	Conditions	Value			Unit
			min.	typ.	max.	
IGBT Characteristic						
Turn-on delay time	$t_{d(on)}$	T_{vj} = 175°C, V_{CC} = 400V, I_C = 60.0A, V_{GE} = 0.0/15.0V, r_G = 6.0Ω, L_σ = 90nH, C_σ = 50pF L_σ, C_σ from Fig. E Energy losses include “tail” and diode (IKW60N60H3) reverse recovery. Switching test with minimized Emitter Stray inductance, see High Speed 3 App Note on www.infineon.com.	-	25	-	ns
Rise time	t_r		-	39	-	ns
Turn-off delay time	$t_{d(off)}$		-	291	-	ns
Fall time	t_f		-	23	-	ns
Turn-on energy	E_{on}		-	2.63	-	mJ
Turn-off energy	E_{off}		-	1.46	-	mJ
Total switching energy	E_{ts}		-	4.09	-	mJ

Diode Characteristic, at T_{vj} = 175°C

Diode reverse recovery time	t_{rr}	T_{vj} = 175°C, V_R = 400V, I_F = 60.0A, di_F/dt = 1000A/µs	-	255	-	ns
Diode reverse recovery charge	Q_{rr}		-	2.80	-	µC
Diode peak reverse recovery current	I_{rrm}		-	23.0	-	A
Diode peak rate of fall of reverse recovery current during t_b	di_{rr}/dt		-	-108	-	A/µs

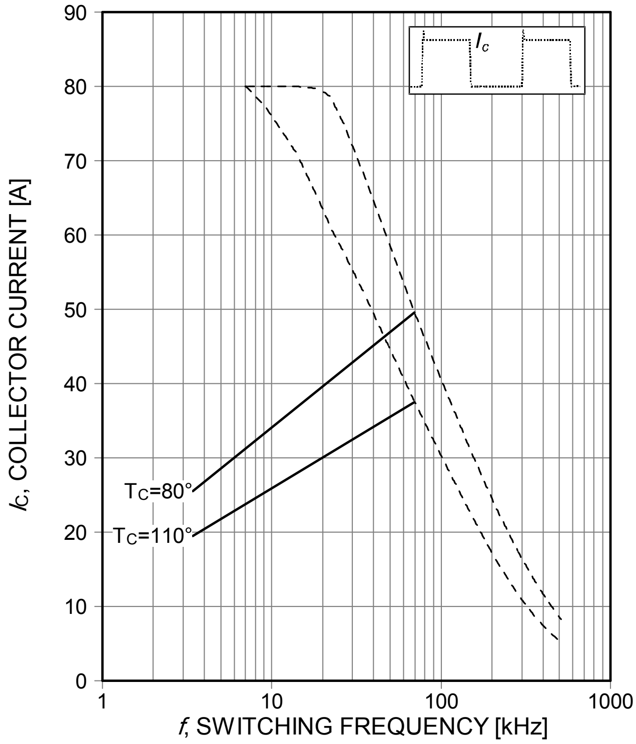


Figure 1. Collector current as a function of switching frequency
(T_j≤175°C, D=0.5, V_{CE}=400V, V_{GE}=15/0V, r_G=6Ω)

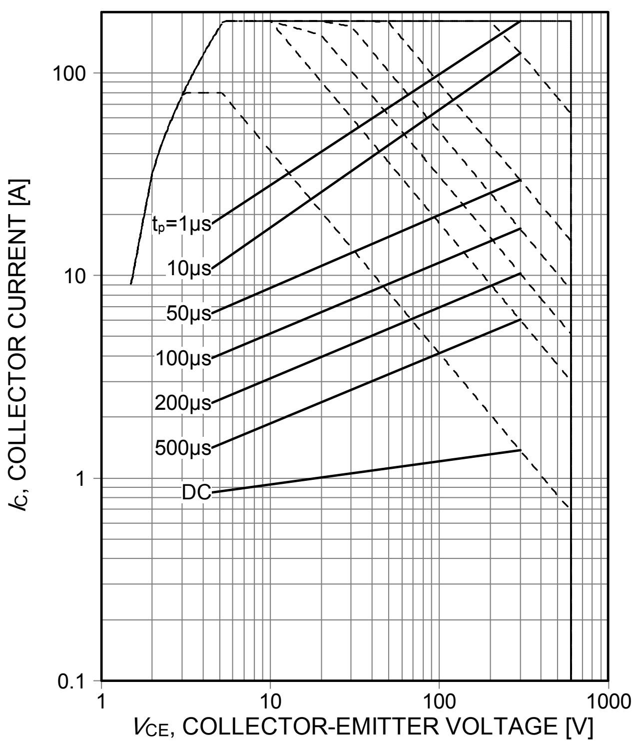


Figure 2. Forward bias safe operating area
(D=0, T_C=25°C, T_j≤175°C; V_{GE}=15V)

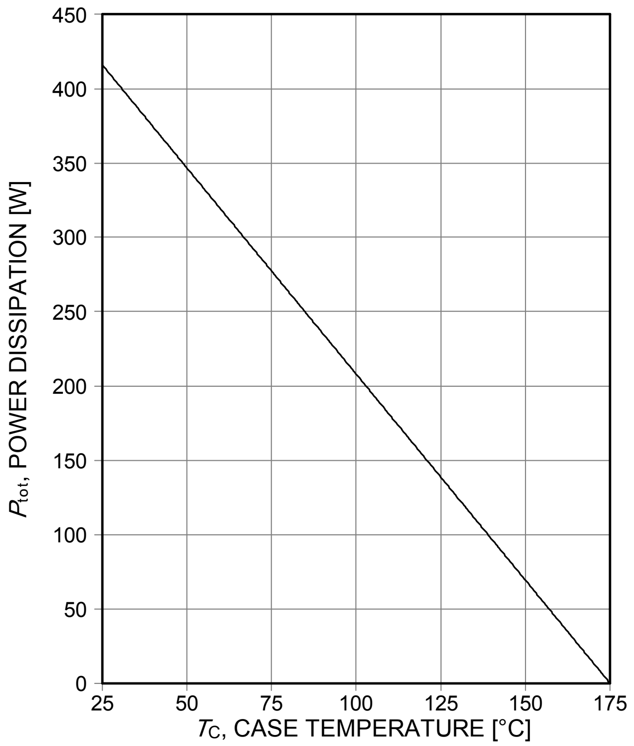


Figure 3. Power dissipation as a function of case temperature
(T_j≤175°C)

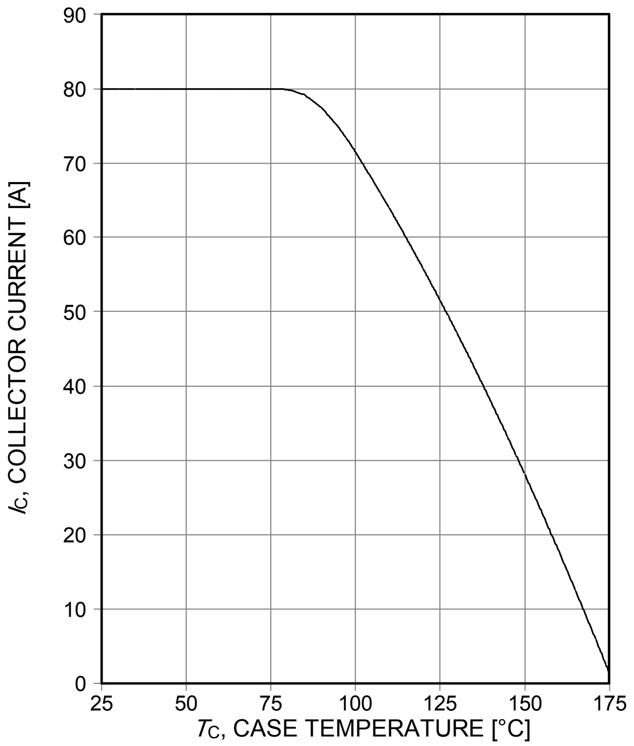


Figure 4. Collector current as a function of case temperature
(V_{GE}≥15V, T_j≤175°C)

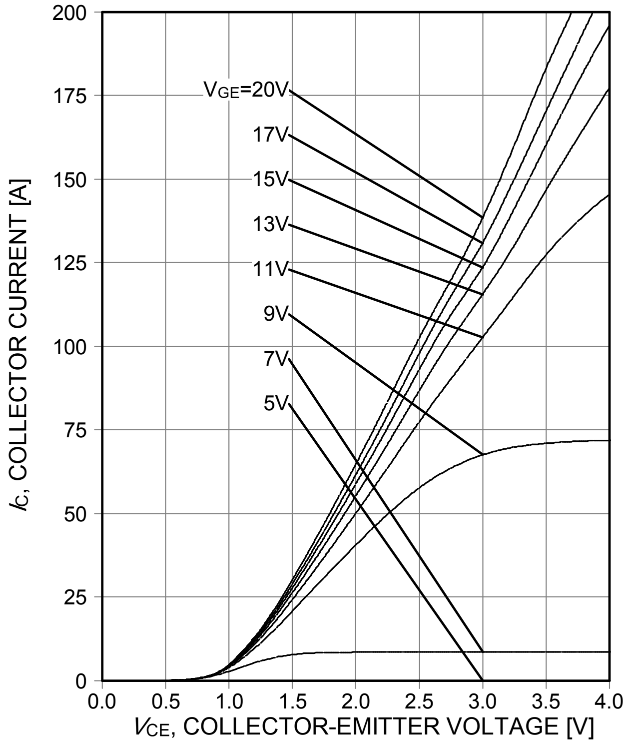


Figure 5. Typical output characteristic
(T_j=25°C)

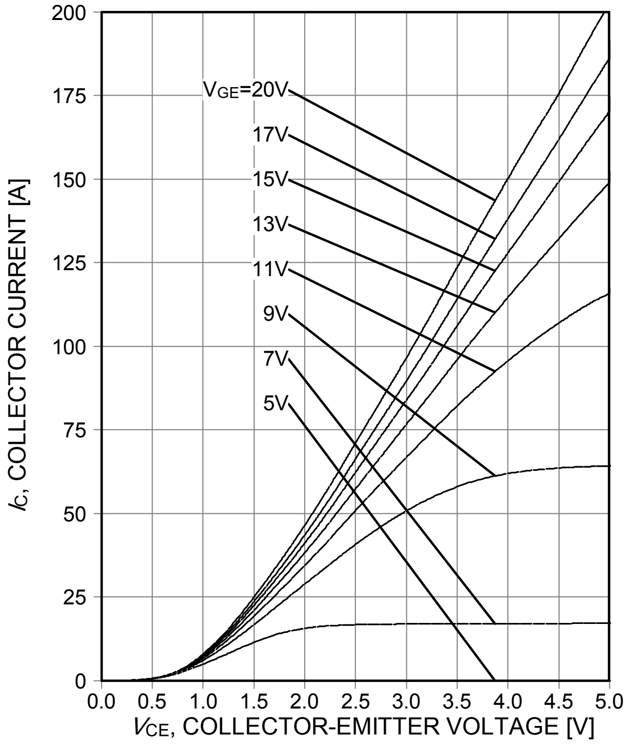


Figure 6. Typical output characteristic
(T_j=175°C)

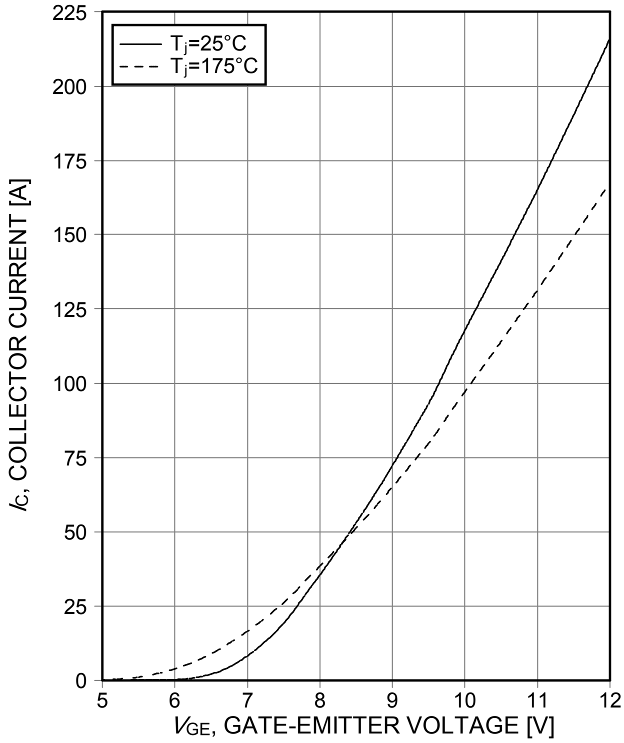


Figure 7. Typical transfer characteristic
(V_{CE}=20V)

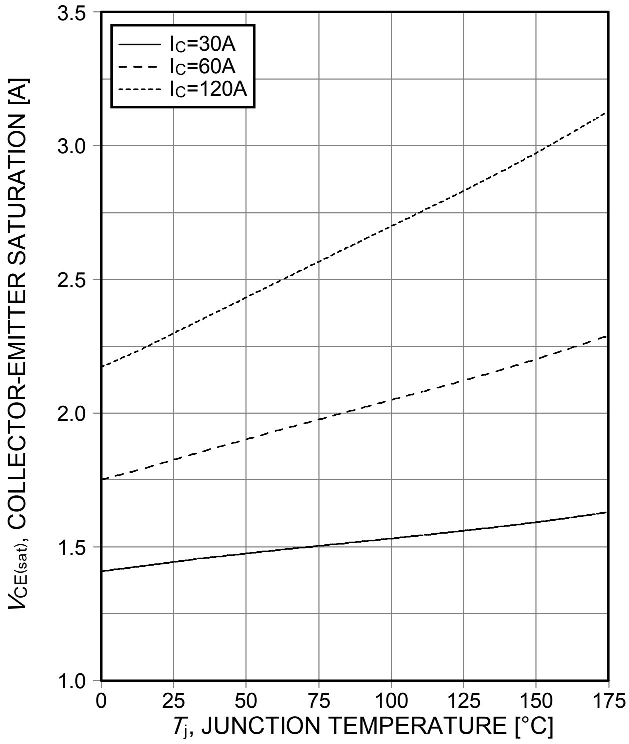


Figure 8. Typical collector-emitter saturation voltage as a function of junction temperature
(V_{GE}=15V)

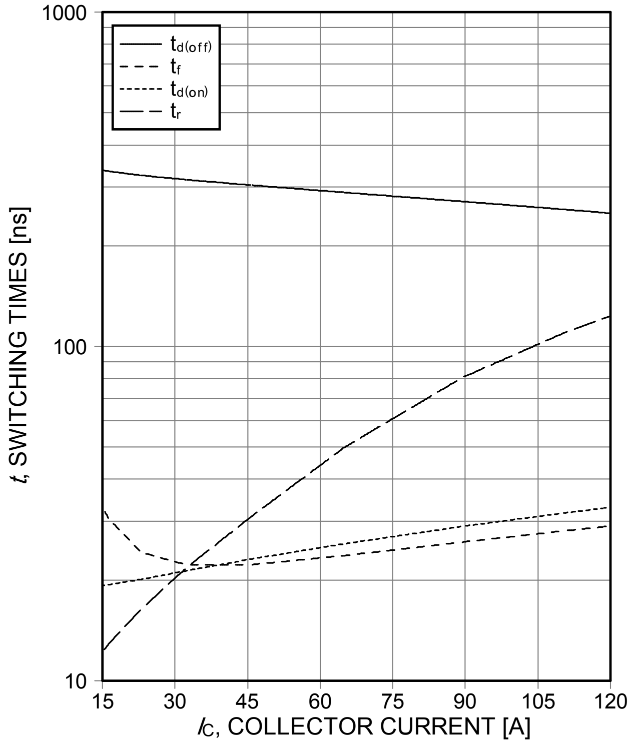


Figure 9. Typical switching times as a function of collector current
(ind. load, T_j=175°C, V_{CE}=400V, V_{GE}=15/0V, r_G=6Ω, test circuit in Fig. E)

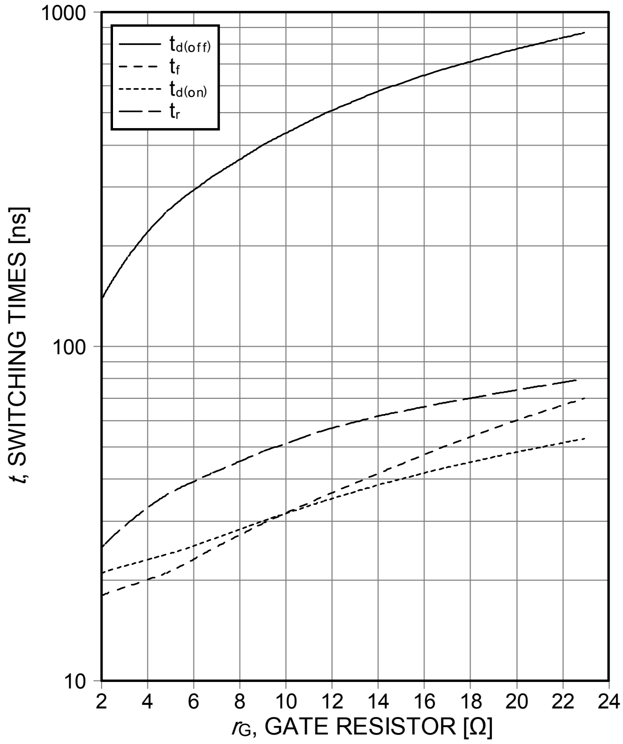


Figure 10. Typical switching times as a function of gate resistor
(ind. load, T_j=175°C, V_{CE}=400V, V_{GE}=15/0V, I_C=60A, test circuit in Fig. E)

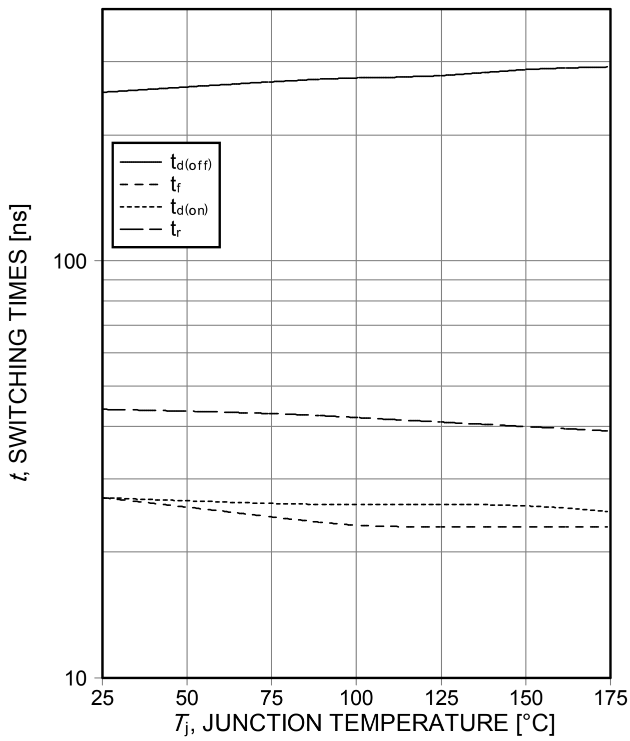


Figure 11. Typical switching times as a function of junction temperature
(ind. load, V_{CE}=400V, V_{GE}=15/0V, I_C=60A, r_G=6Ω, test circuit in Fig. E)

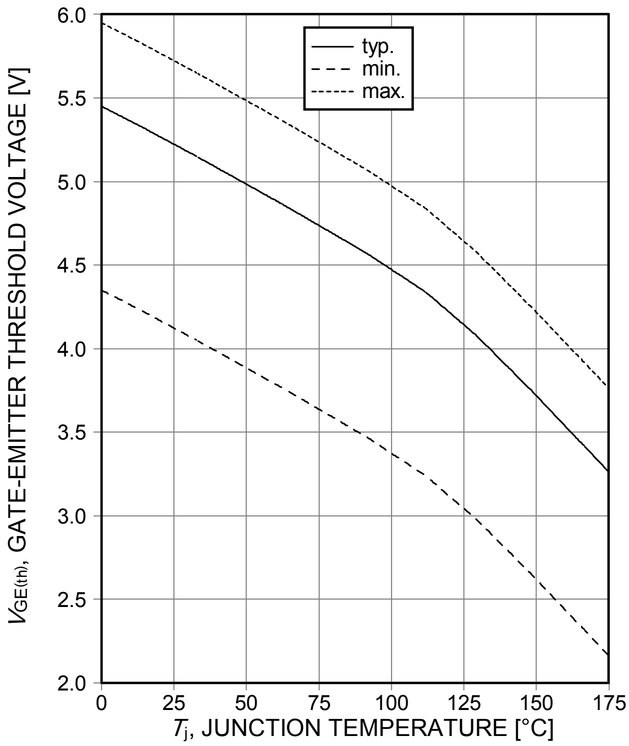


Figure 12. Gate-emitter threshold voltage as a function of junction temperature
(I_C=1mA)

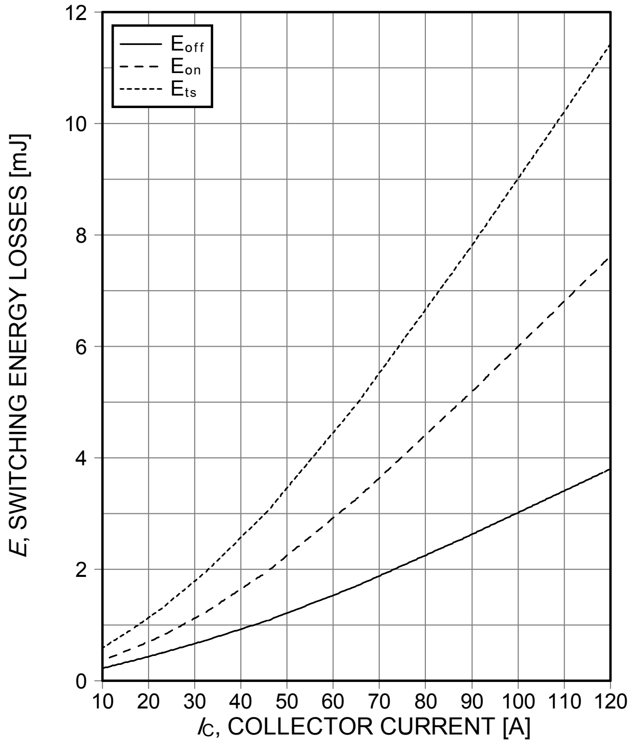


Figure 13. Typical switching energy losses as a function of collector current
(ind. load, T_j=175°C, V_{CE}=400V, V_{GE}=15/0V, r_G=6Ω, test circuit in Fig. E)

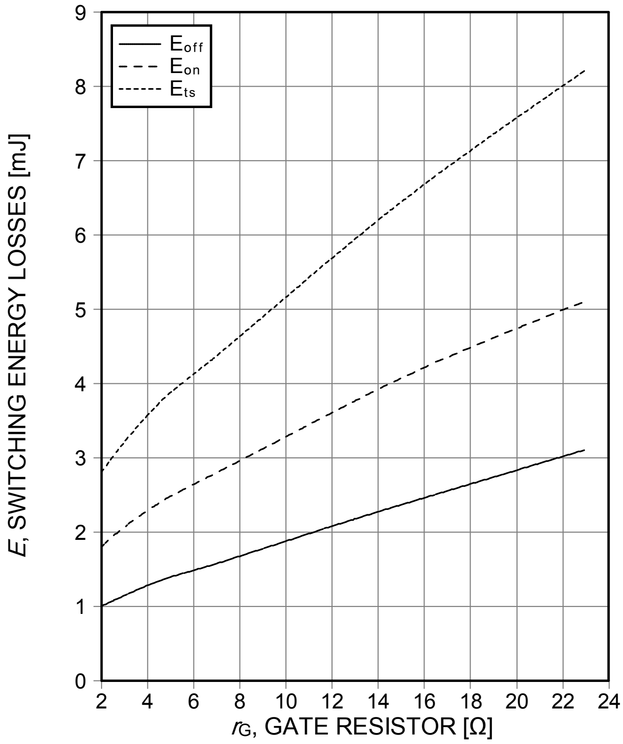


Figure 14. Typical switching energy losses as a function of gate resistor
(ind. load, T_j=175°C, V_{CE}=400V, V_{GE}=15/0V, I_C=60A, test circuit in Fig. E)

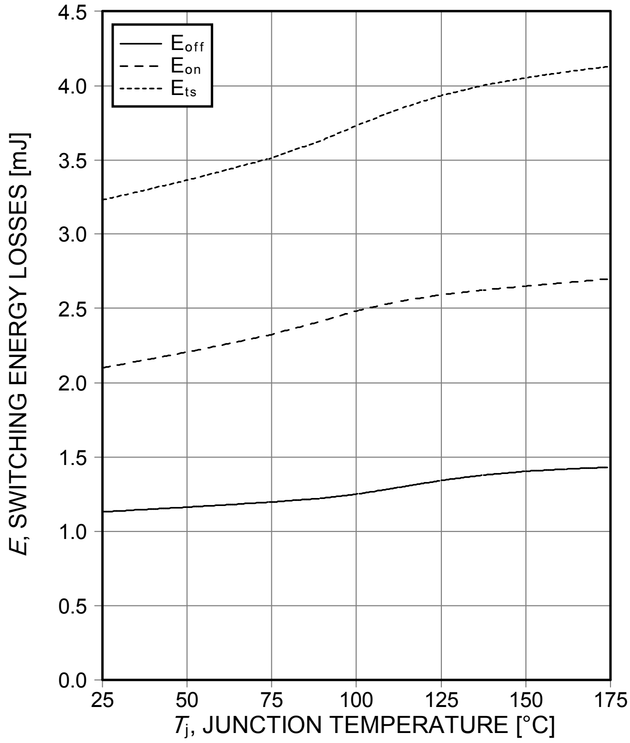


Figure 15. Typical switching energy losses as a function of junction temperature
(ind load, V_{CE}=400V, V_{GE}=15/0V, I_C=60A, r_G=6Ω, test circuit in Fig. E)

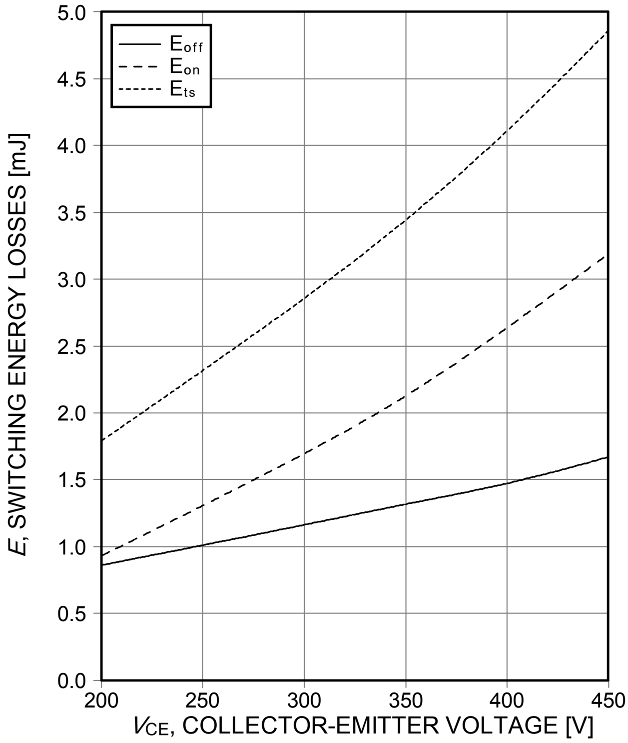


Figure 16. Typical switching energy losses as a function of collector emitter voltage
(ind. load, T_j=175°C, V_{GE}=15/0V, I_C=60A, r_G=6Ω, test circuit in Fig. E)

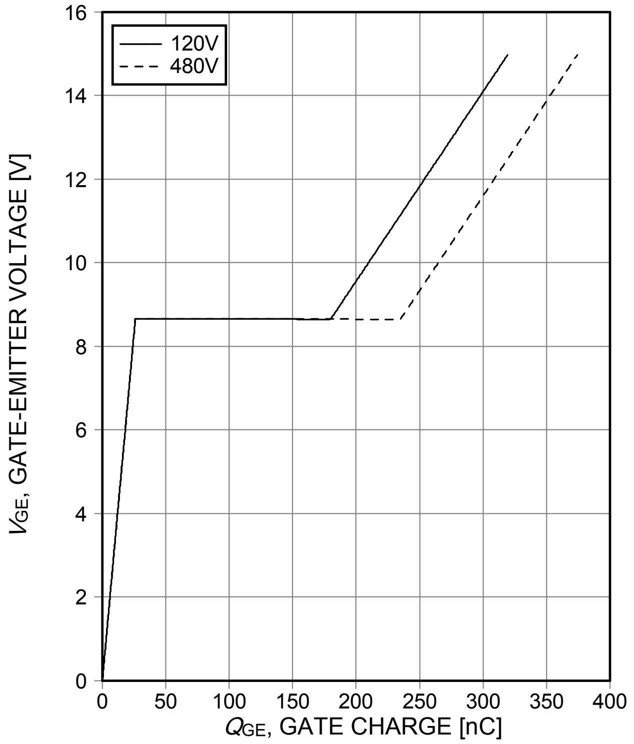


Figure 17. Typical gate charge
(I_C=60A)

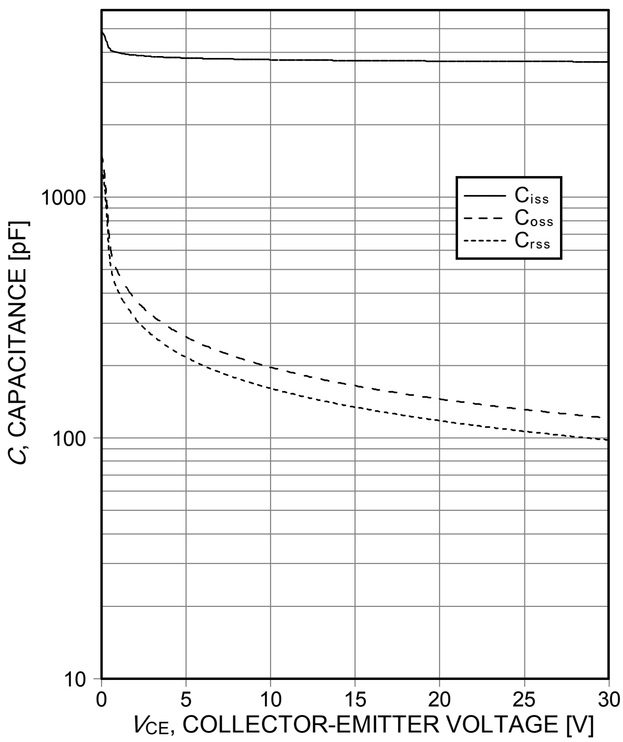


Figure 18. Typical capacitance as a function of collector-emitter voltage
(V_{GE}=0V, f=1MHz)

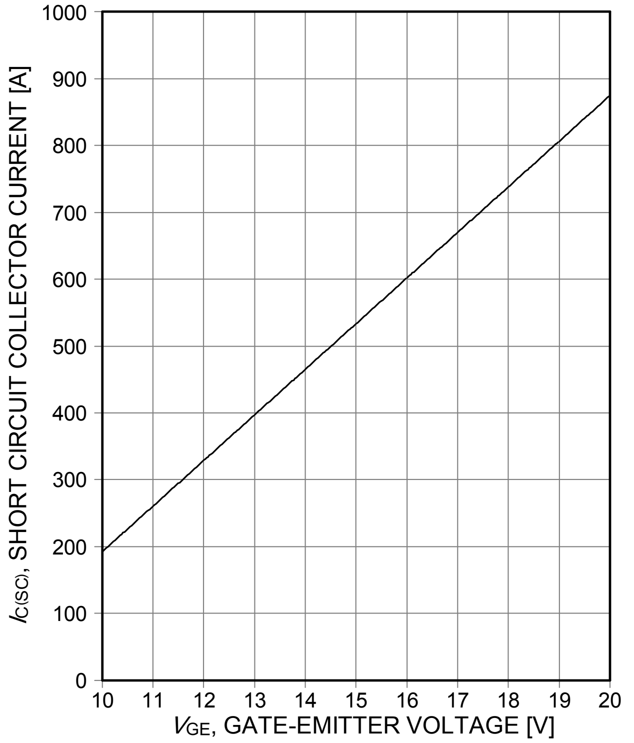


Figure 19. Typical short circuit collector current as a function of gate-emitter voltage
(V_{CE}≤400V, start at T_j=25°C)

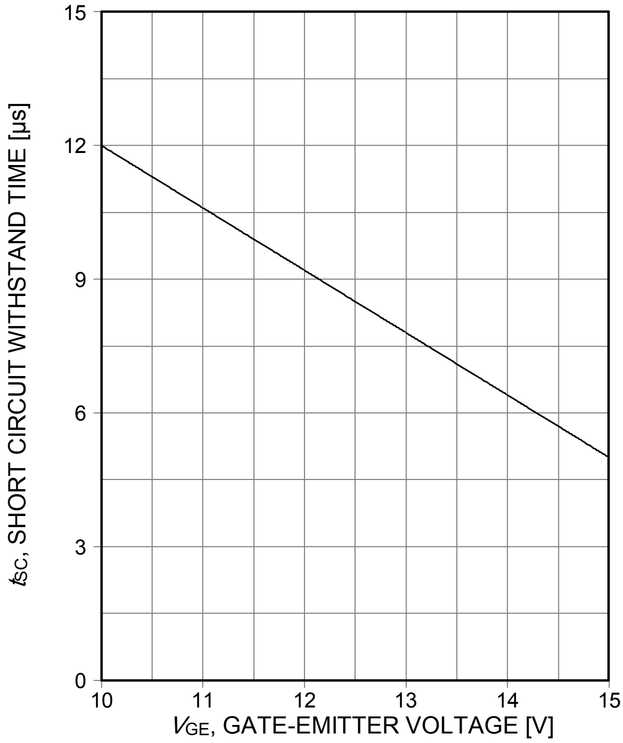


Figure 20. Short circuit withstand time as a function of gate-emitter voltage
(V_{CE}≤400V, start at T_j≤150°C)

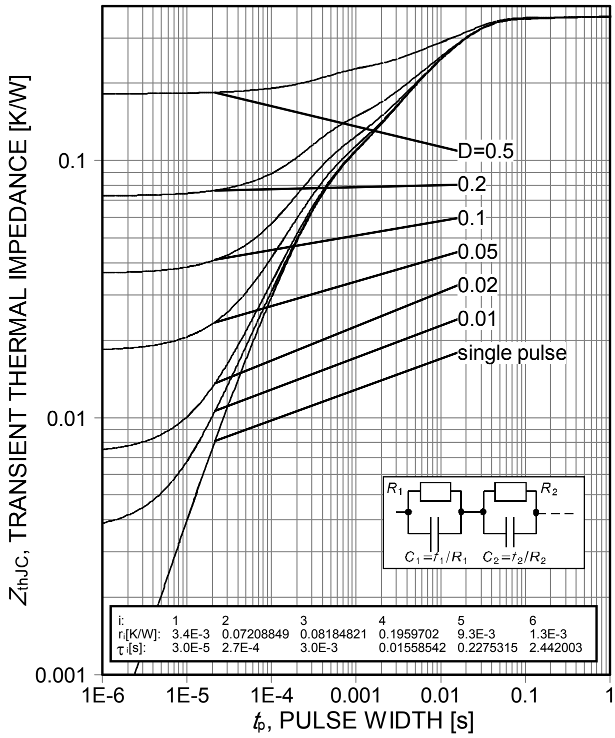


Figure 21. IGBT transient thermal impedance
($D=t_p/T$)

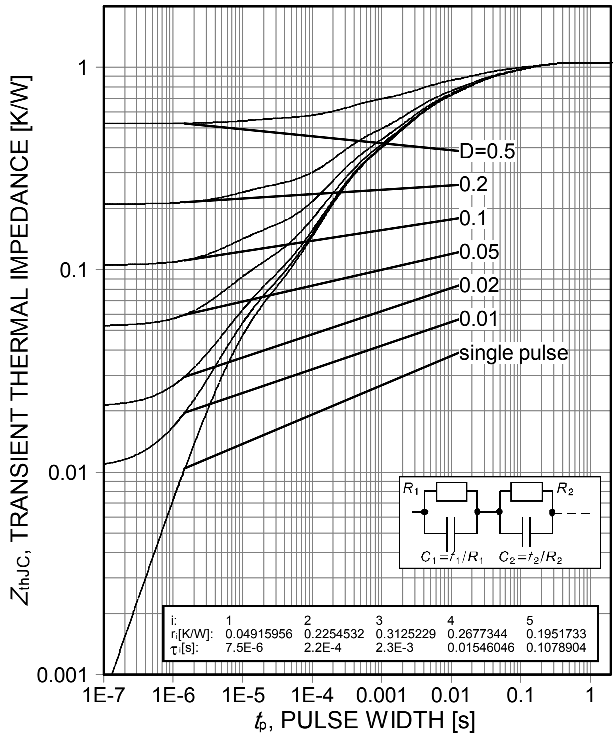


Figure 22. Diode transient thermal impedance as a function of pulse width
($D=t_p/T$)

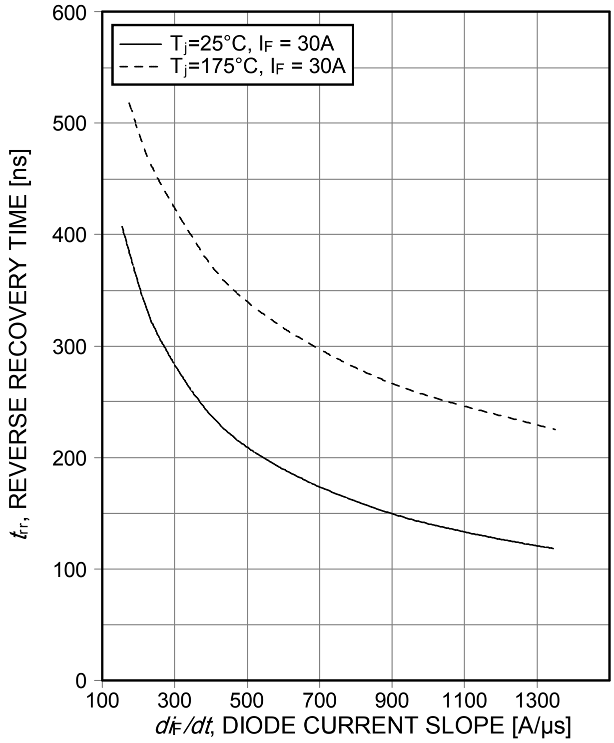


Figure 23. Typical reverse recovery time as a function of diode current slope
(V_R=400V)

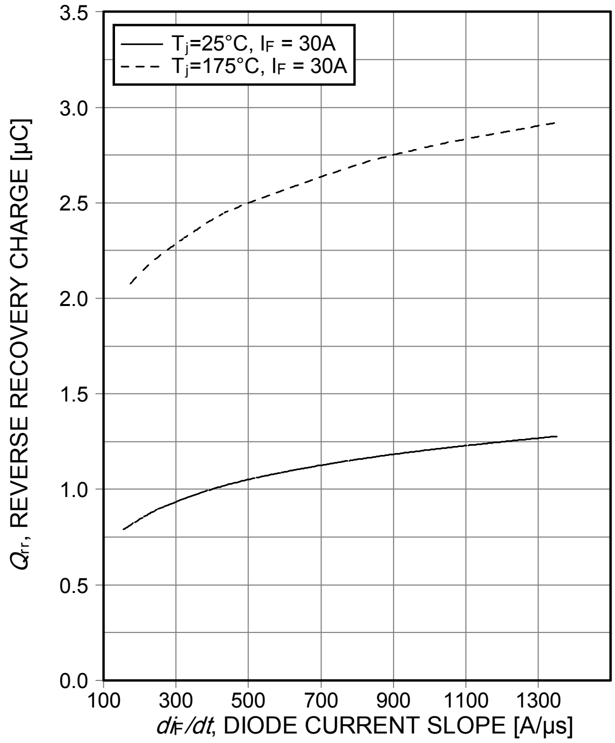


Figure 24. Typical reverse recovery charge as a function of diode current slope
(V_R=400V)

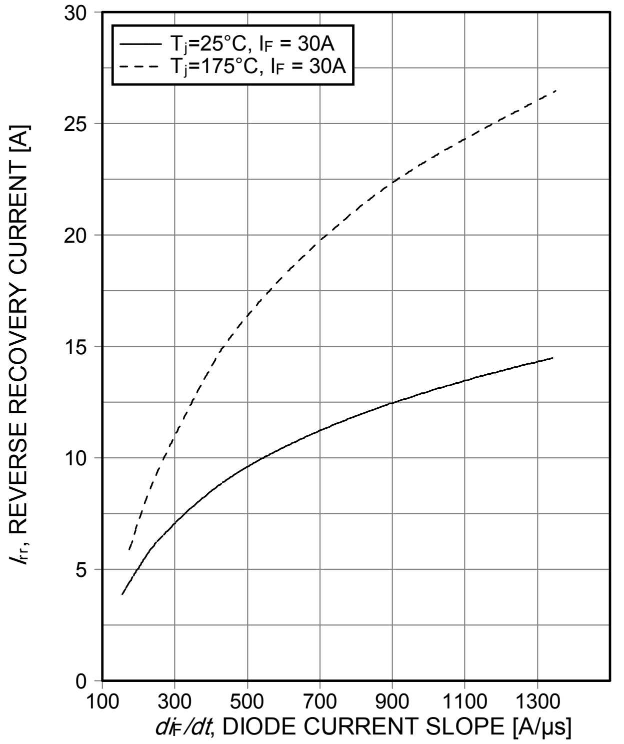


Figure 25. Typical reverse recovery current as a function of diode current slope
(V_R=400V)

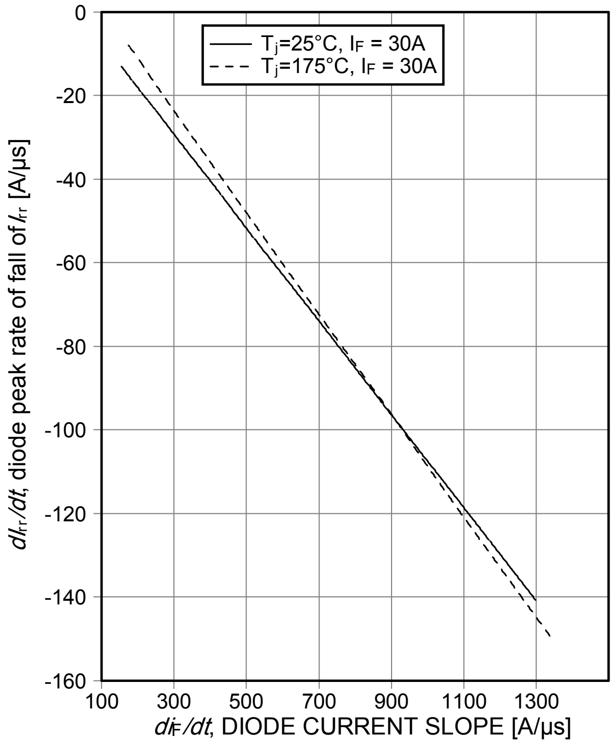


Figure 26. Typical diode peak rate of fall of reverse recovery current as a function of diode current slope
(V_R=400V)

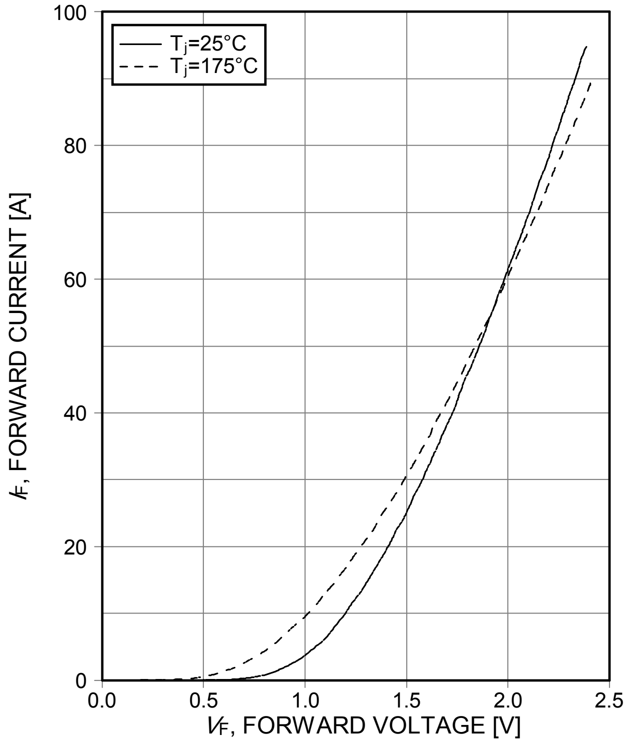


Figure 27. Typical diode forward current as a function of forward voltage

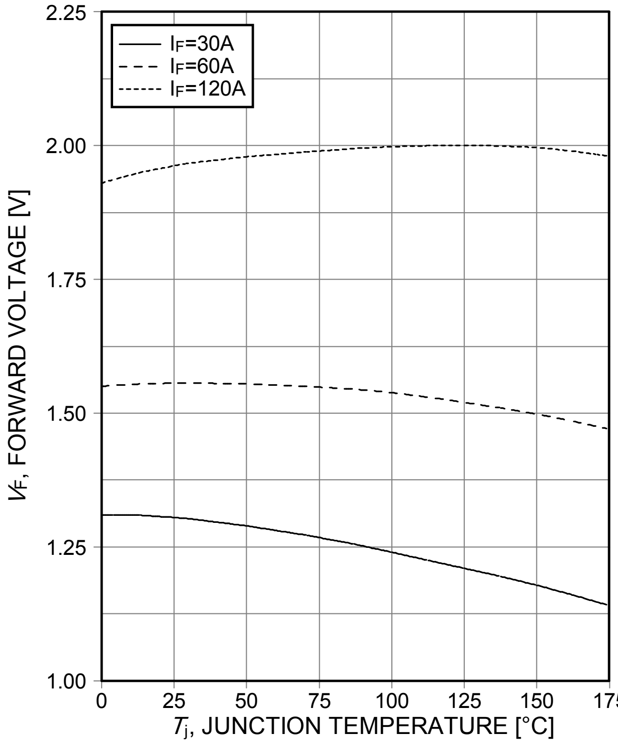


Figure 28. Typical diode forward voltage as a function of junction temperature

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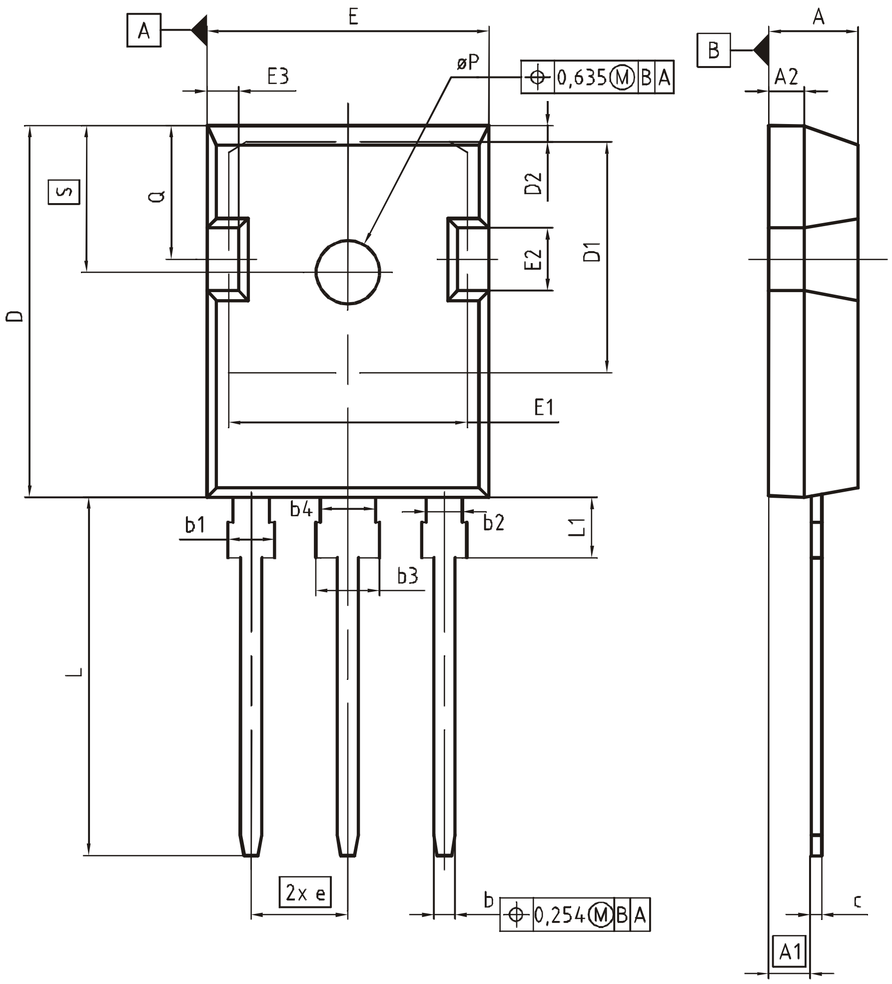
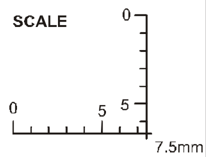


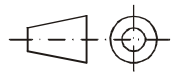
DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.83	5.21	0.190	0.205
A1	2.27	2.54	0.089	0.100
A2	1.85	2.16	0.073	0.085
b	1.07	1.33	0.042	0.052
b1	1.90	2.41	0.075	0.095
b2	1.90	2.16	0.075	0.085
b3	2.87	3.38	0.113	0.133
b4	2.87	3.13	0.113	0.123
c	0.55	0.68	0.022	0.027
D	20.80	21.10	0.819	0.831
D1	16.25	17.65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

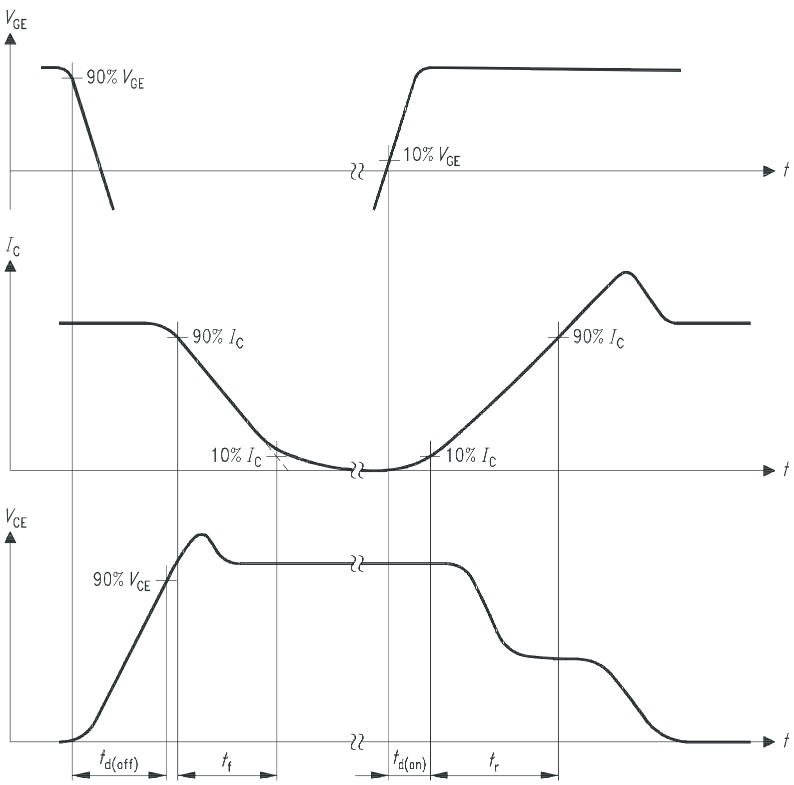


Figure A. Definition of switching times

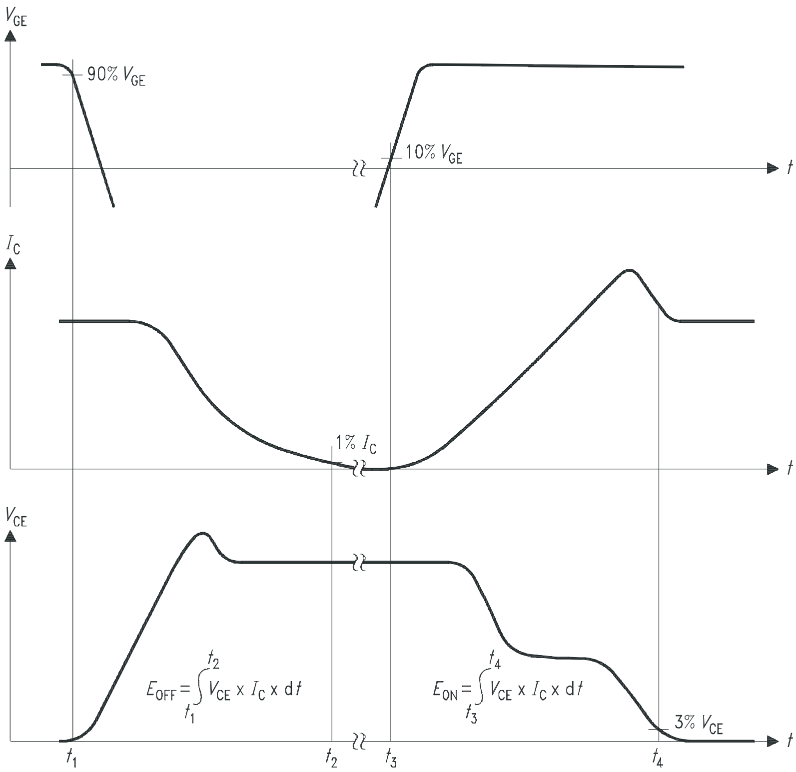


Figure B. Definition of switching losses

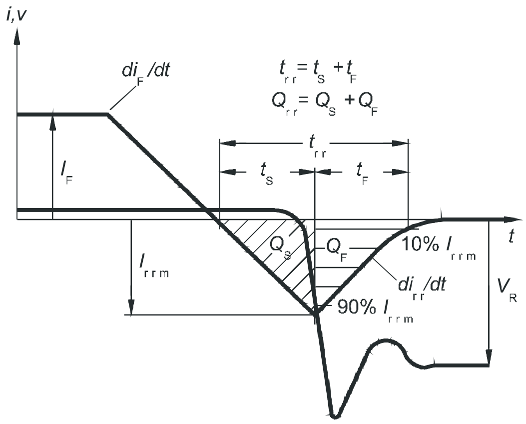


Figure C. Definition of diodes switching characteristics

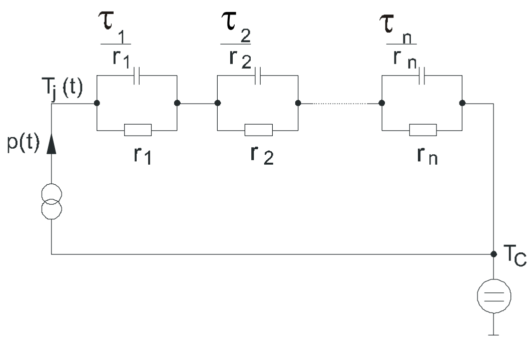


Figure D. Thermal equivalent circuit

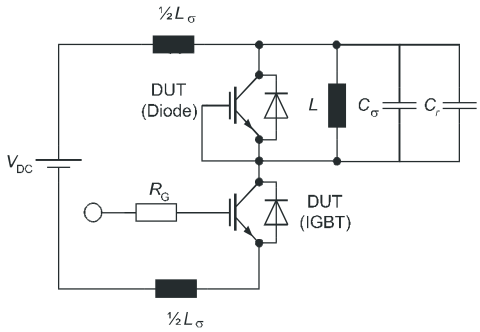


Figure E. Dynamic test circuit

Parasitic inductance L_σ,
Parasitic capacitor C_σ,
Relief capacitor C_r,
(only for ZVT switching)

Revision History

IKW60N60H3

Revision: 2012-05-29, Rev. 1.2

Previous Revision

Revision	Date	Subjects (major changes since last revision)
1.1	2012-04-23	Preliminary data sheet
1.2	2012-05-29	Prelim. switching conditions Ic=60A

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For further information on technology, delivery terms and conditions and prices, please contact the nearest Infineon Technologies Office (www.infineon.com).

Warnings
Due to technical requirements, components may contain dangerous substances. For information on the types in question, please contact the nearest Infineon Technologies Office.
The Infineon Technologies component described in this Data Sheet may be used in life-support devices or systems and/or automotive, aviation and aerospace applications or systems only with the express written approval of Infineon Technologies, if a failure of such components can reasonably be expected to cause the failure of that life-support, automotive, aviation and aerospace device or system or to affect the safety or effectiveness of that device or system. Life support devices or systems are intended to be implanted in the human body or to support and/or maintain and sustain and/or protect human life. If they fail, it is reasonable to assume that the health of the user or other persons may be endangered.