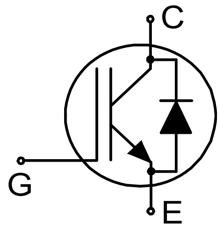
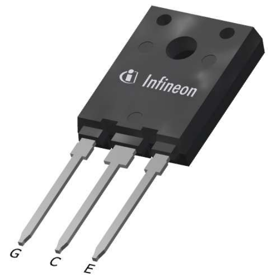
TRENCHSTOP™ Advanced Isolation

High speed switching series third generation IGBT copacked with Rapid 1 fast and soft antiparallel diode in fully isolated package



Features:

TRENCHSTOP™ technology offers :
- Short circuit withstand time 5µs at T_{vj} = 175°C
- Positive temperature coefficient in $V_{CE(sat)}$
- Low EMI
- Very soft, fast recovery anti-parallel diode
- Maximum junction temperature 175°C
- 2500 V_{RMS} electrical isolation, 50/60 Hz, t = 1 min
- 100 % tested isolated mounting surface
- Pb-free lead plating; RoHS compliant
- Complete product spectrum and PSpice Models : http://www.infineon.com/igbt



Fully isolated package TO-247

Potential Applications:

- Air Conditioning PFC
- General Purpose Drives (GPD)
- Servo Drives

Product Validation:

Qualified for industrial applications according to the relevant tests of JEDEC 47/20/22

Key Performance and Package Parameters

Type	V_{CE}	I_C	V_{CEsat}, T_{vj}=25°C	T_{vjmax}	Marking	Package
IKFW60N60DH3E	600V	50A	2.2V	175°C	K60DDH3E	PG-TO247-3-AI

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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}	600	V
DC collector current, limited by T_{vjmax} $T_h = 25°C$ $T_h = 65°C$ $T_h = 65°C$	I_C	 53.0 44.0 74.0[1]	A
Pulsed collector current, t_p limited by T_{vjmax}	I_{Cpuls}	150.0	A
Turn off safe operating area $V_{CE} \leq 600V$, $T_{vj} \leq 175°C$, $t_p = 1µs$	-	150.0	A
Diode forward current, limited by T_{vjmax} $T_h = 25°C$ value limited by bondwire $T_h = 65°C$	I_F	 40.0 32.0	A
Diode pulsed current, t_p limited by T_{vjmax}	I_{Fpuls}	150.0	A
Gate-emitter voltage Transient Gate-emitter voltage ($t_p \leq 10µs$, $D < 0.010$)	V_{GE}	±20 ±30	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 $T_h = 25°C$ Power dissipation $T_h = 65°C$	P_{tot}	141.0 104.0	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 Maximum of mounting processes: 3	M	0.6	Nm
Isolation voltage RMS, $f = 50/60Hz$, $t = 1min$[2]	V_{isol}	2500	V

Thermal Resistance

Parameter	Symbol	Conditions	Value			Unit
			min.	typ.	max.	
R_{th} Characteristics						
IGBT thermal resistance,[3] junction - heatsink	$R_{th(j-h)}$		-	0.90	1.06	K/W
Diode thermal resistance,[3] junction - heatsink	$R_{th(j-h)}$		-	1.75	1.96	K/W
Thermal resistance junction - ambient	$R_{th(j-a)}$		-	-	65	K/W

[1] Equivalent current rating in TO-247-3 at $T_h = 65°C$ using reference insulation material: 152µm, 0.9 W/mK, standard polyimide based reinforced carrier insulator
[2] For a proper handling and assembly of the advanced isolation device in the application refer to the note at the package drawing.
[3] At force on body F = 500N, $T_a = 25°C$

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 = 0.50mA	600	-	-	V
Collector-emitter saturation voltage	V_{CEsat}	V_{GE} = 15.0V, I_C = 50.0A T_{vj} = 25°C T_{vj} = 175°C	- -	2.20 2.80	2.70 -	V
Diode forward voltage	V_F	V_{GE} = 0V, I_F = 25.0A T_{vj} = 25°C T_{vj} = 175°C	- -	1.50 1.45	1.90 -	V
Gate-emitter threshold voltage	$V_{GE(th)}$	I_C = 0.58mA, 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	- -	- 600	40 -	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	-	19.0	-	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	-	2301	-	pF
Output capacitance	C_{oes}		-	98	-	
Reverse transfer capacitance	C_{res}		-	67	-	
Gate charge	Q_G	V_{CC} = 480V, I_C = 50.0A, V_{GE} = 15V	-	210.0	-	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	-	245	-	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 = 50.0A, V_{GE} = 0.0/15.0V, $R_{G(on)}$ = 7.0Ω, $R_{G(off)}$ = 7.0Ω, $L\sigma$ = 75nH, $C\sigma$ = 30pF $L\sigma$, $C\sigma$ from Fig. E Energy losses include “tail” and diode reverse recovery.	-	23	-	ns
Rise time	t_r		-	39	-	ns
Turn-off delay time	$t_{d(off)}$		-	170	-	ns
Fall time	t_f		-	19	-	ns
Turn-on energy	E_{on}		-	1.57	-	mJ
Turn-off energy	E_{off}		-	0.72	-	mJ
Total switching energy	E_{ts}		-	2.29	-	mJ

Diode reverse recovery time	t_{rr}	T_{vj} = 25°C, V_R = 400V, I_F = 25.0A, di_F/dt = 1000A/µs	-	68	-	ns
Diode reverse recovery charge	Q_{rr}		-	0.55	-	µC
Diode peak reverse recovery current	I_{rrm}		-	12.0	-	A
Diode peak rate of fall of reverse recovery current during t_b	di_{rr}/dt		-	-834	-	A/µs

Switching Characteristic, Inductive Load

Parameter	Symbol	Conditions	Value			Unit
			min.	typ.	max.	
IGBT Characteristic, at T_{vj} = 175°C						
Turn-on delay time	$t_{d(on)}$	T_{vj} = 175°C, V_{CC} = 400V, I_C = 50.0A, V_{GE} = 0.0/15.0V, $R_{G(on)}$ = 7.0Ω, $R_{G(off)}$ = 7.0Ω, $L\sigma$ = 75nH, $C\sigma$ = 30pF $L\sigma$, $C\sigma$ from Fig. E Energy losses include “tail” and diode reverse recovery.	-	23	-	ns
Rise time	t_r		-	37	-	ns
Turn-off delay time	$t_{d(off)}$		-	198	-	ns
Fall time	t_f		-	21	-	ns
Turn-on energy	E_{on}		-	2.18	-	mJ
Turn-off energy	E_{off}		-	0.95	-	mJ
Total switching energy	E_{ts}		-	3.13	-	mJ

Diode reverse recovery time	t_{rr}	T_{vj} = 175°C, V_R = 400V, I_F = 25.0A, di_F/dt = 1000A/µs	-	104	-	ns
Diode reverse recovery charge	Q_{rr}		-	1.43	-	µC
Diode peak reverse recovery current	I_{rrm}		-	19.8	-	A
Diode peak rate of fall of reverse recovery current during t_b	di_{rr}/dt		-	-637	-	A/µs

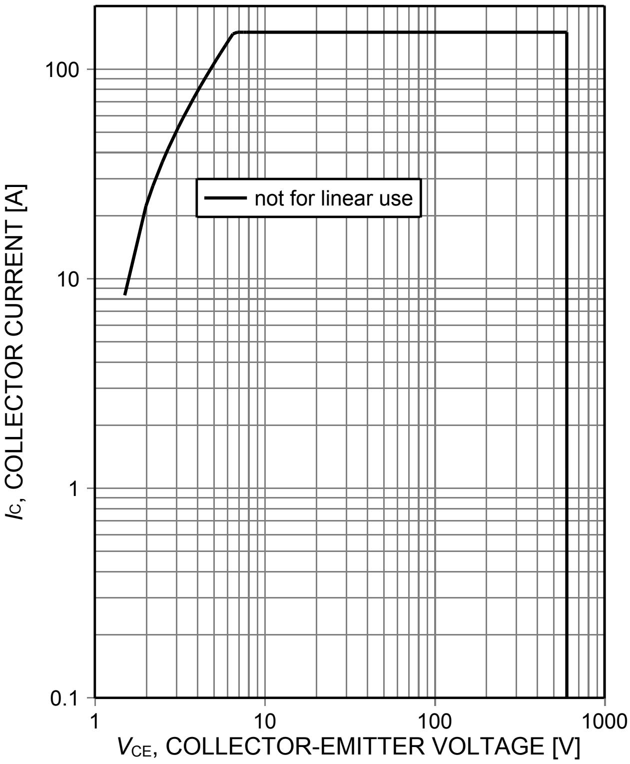


Figure 1. **Forward bias safe operating area**
(D=0, T_h=25°C, T_j≤175°C, V_{GE}=15V, t_p≤1µs)

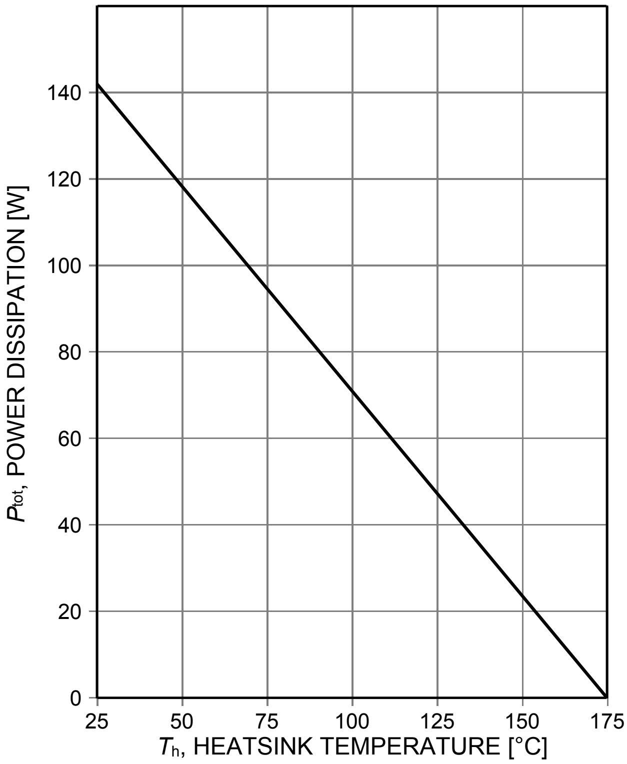


Figure 2. **Power dissipation as a function of heatsink temperature**
(T_j≤175°C)

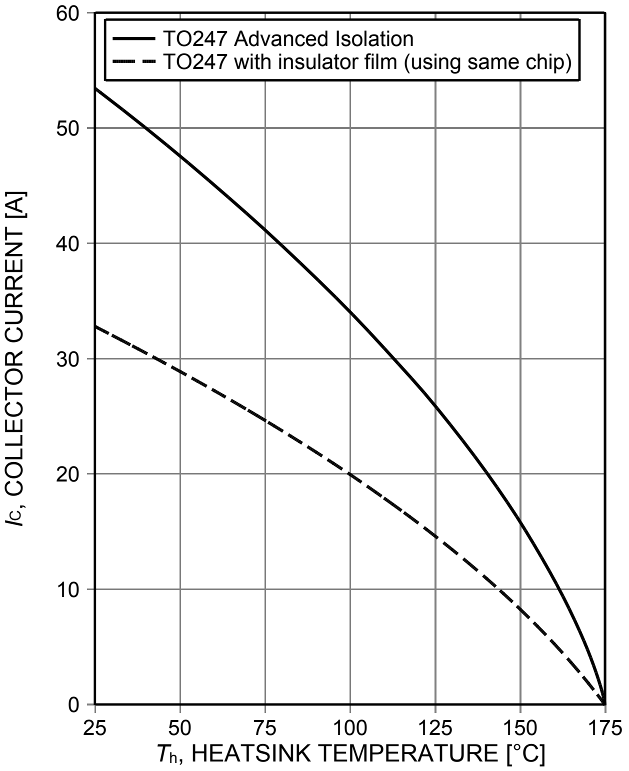


Figure 3. **Collector current as a function of heatsink temperature**
(V_{GE}≥15V, T_j≤175°C, insulator film: 152µm, 0.9W/mK)

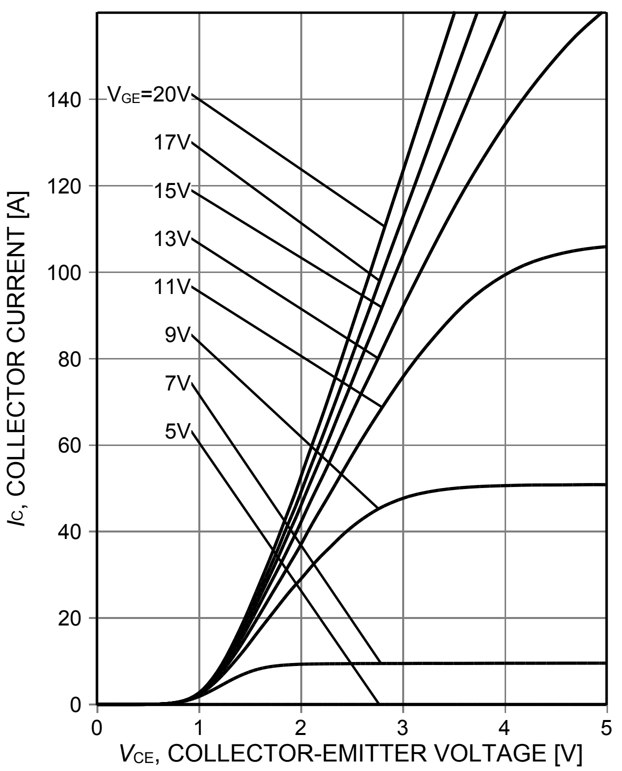


Figure 4. **Typical output characteristic**
(T_j=25°C)

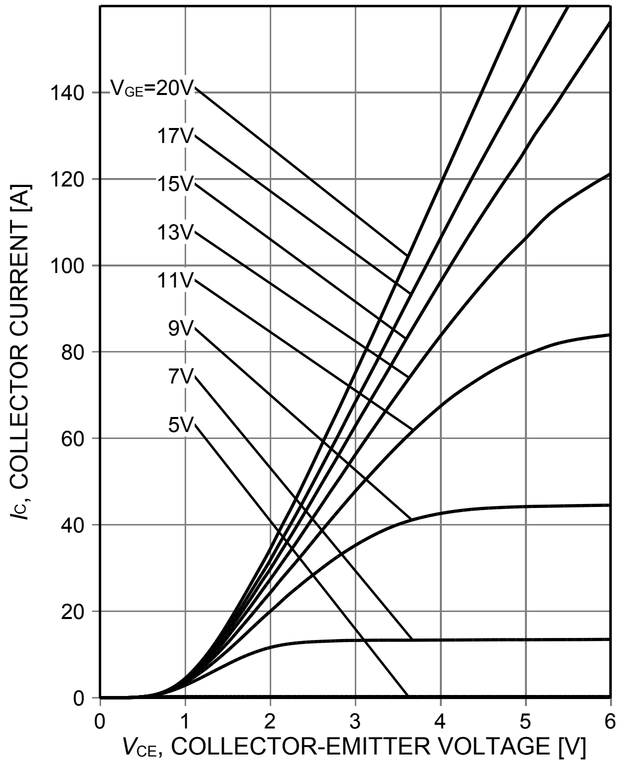


Figure 5. **Typical output characteristic**
(T_j=175°C)

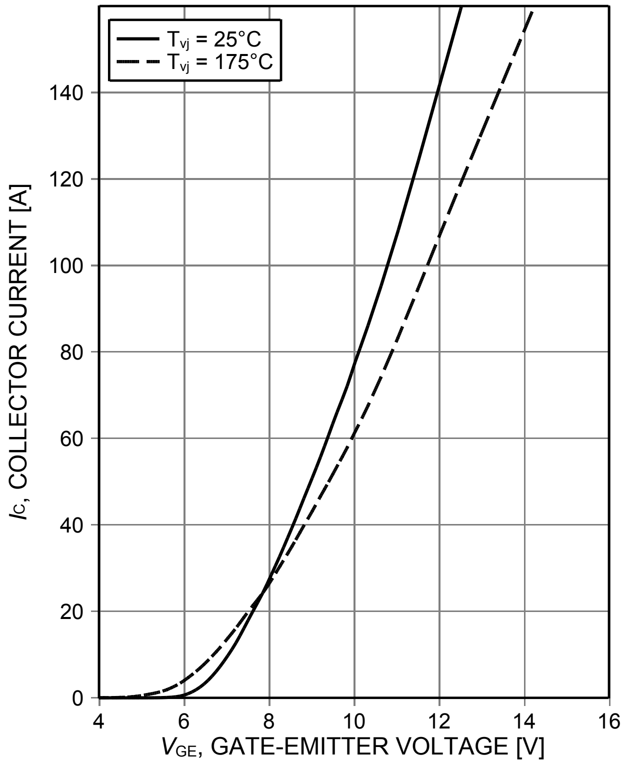


Figure 6. **Typical transfer characteristic**
(V_{CE}=20V)

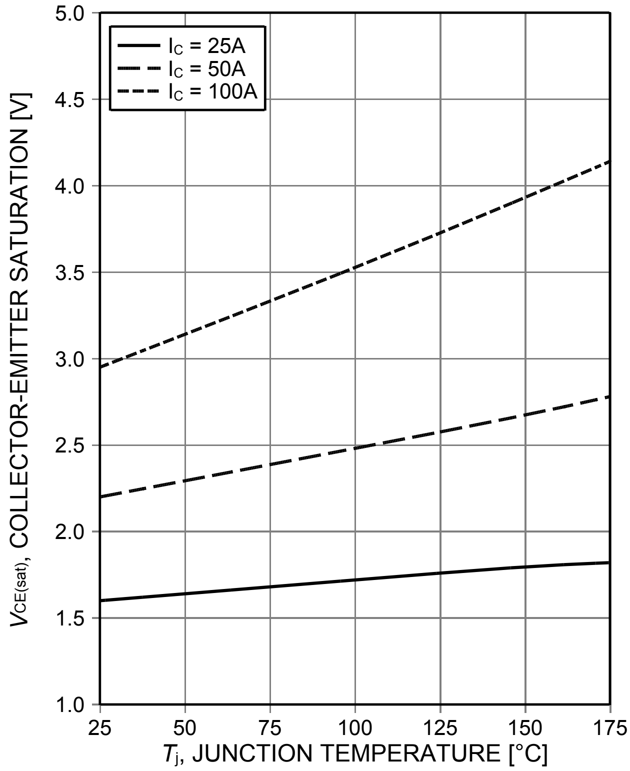


Figure 7. **Typical collector-emitter saturation voltage as a function of junction temperature**
(V_{GE}=15V)

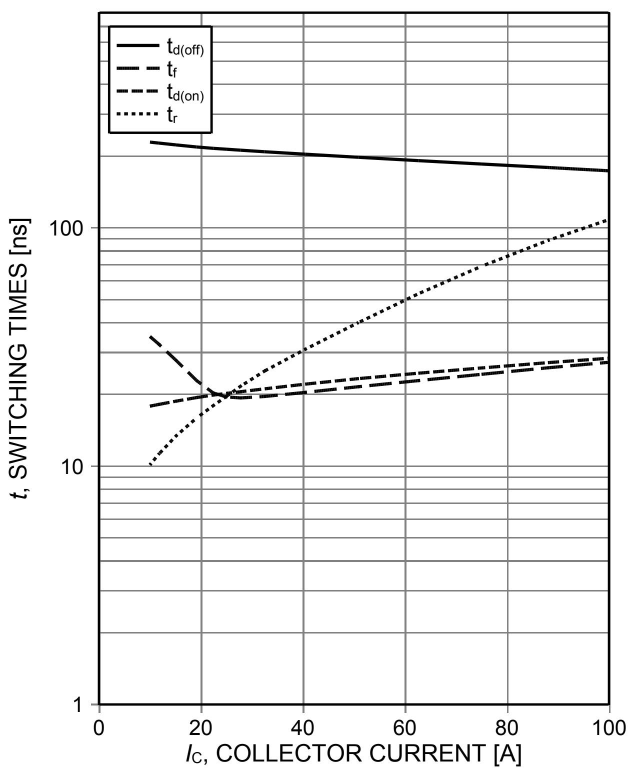


Figure 8. **Typical switching times as a function of collector current**
(ind. load, T_j=175°C, V_{CE}=400V, V_{GE}=0/15V, R_G=7Ω, test circuit in Fig. E)

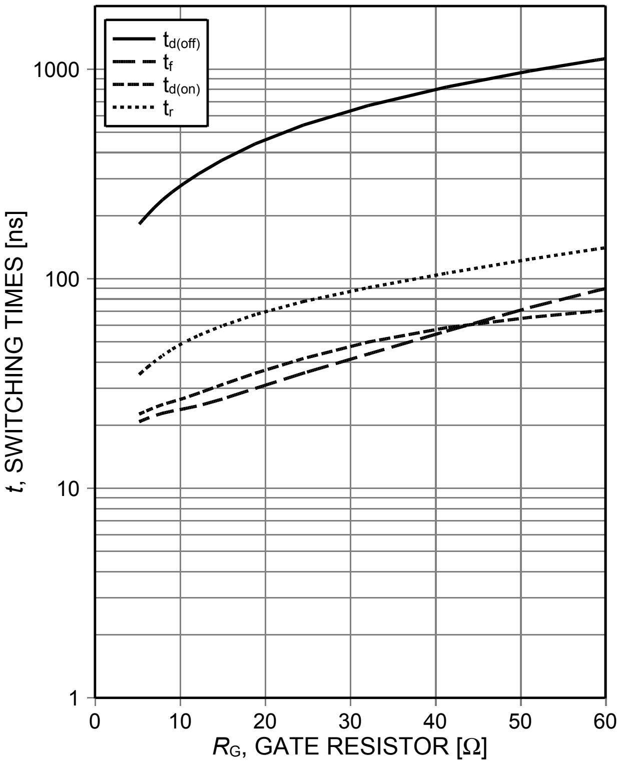


Figure 9. **Typical switching times as a function of gate resistor**
(ind. load, T_j=175°C, V_{CE}=400V, V_{GE}=0/15V, I_C=50A, test circuit in Fig. E)

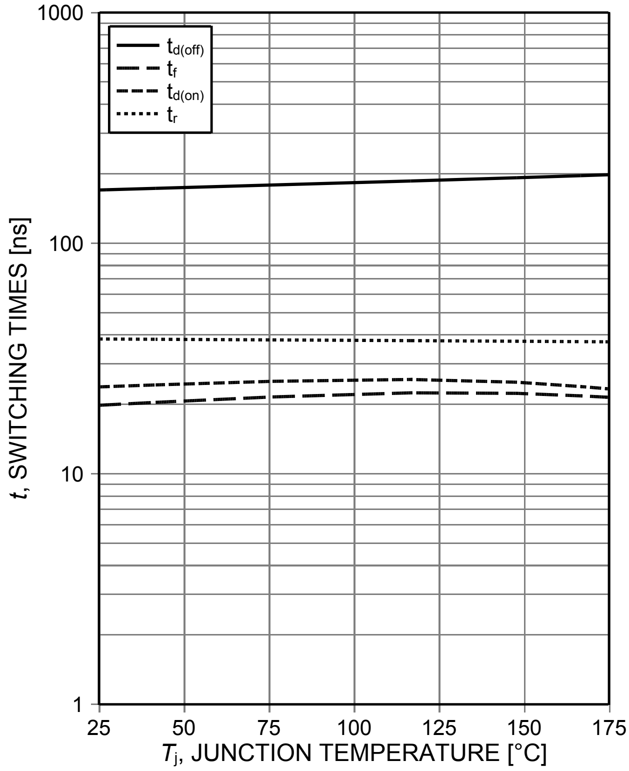


Figure 10. **Typical switching times as a function of junction temperature**
(ind. load, V_{CE}=400V, V_{GE}=0/15V, I_C=50A, r_G=7Ω, test circuit in Fig. E)

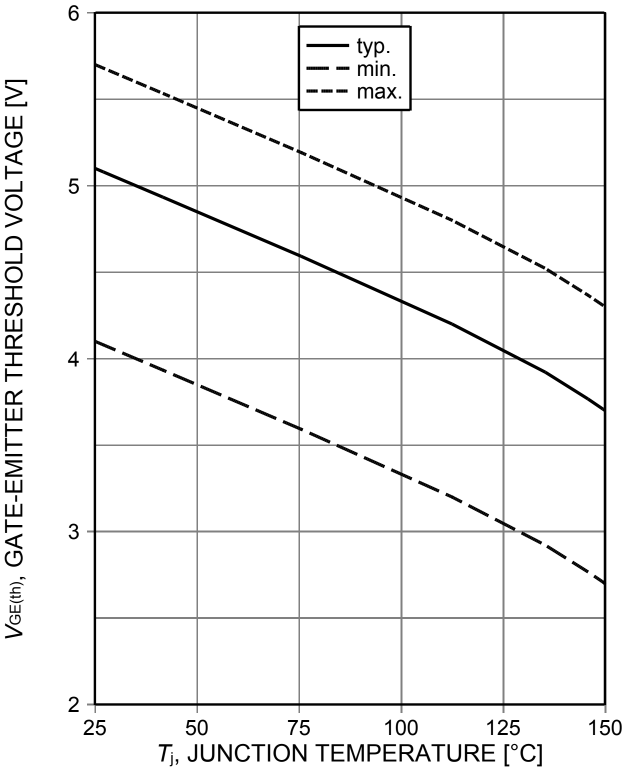


Figure 11. **Gate-emitter threshold voltage as a function of junction temperature**
(I_C=0.58mA)

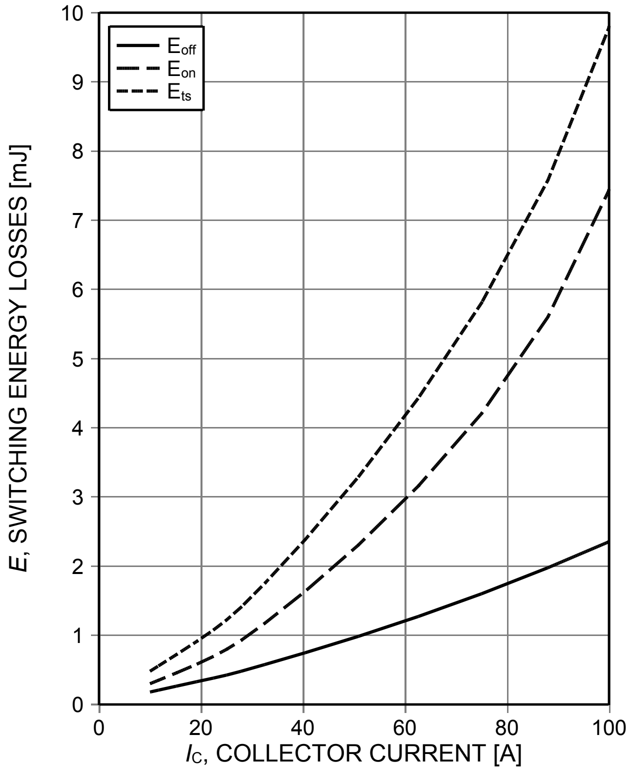


Figure 12. **Typical switching energy losses as a function of collector current**
(ind. load, T_j=175°C, V_{CE}=400V, V_{GE}=0/15V, R_G=7Ω, test circuit in Fig. E)

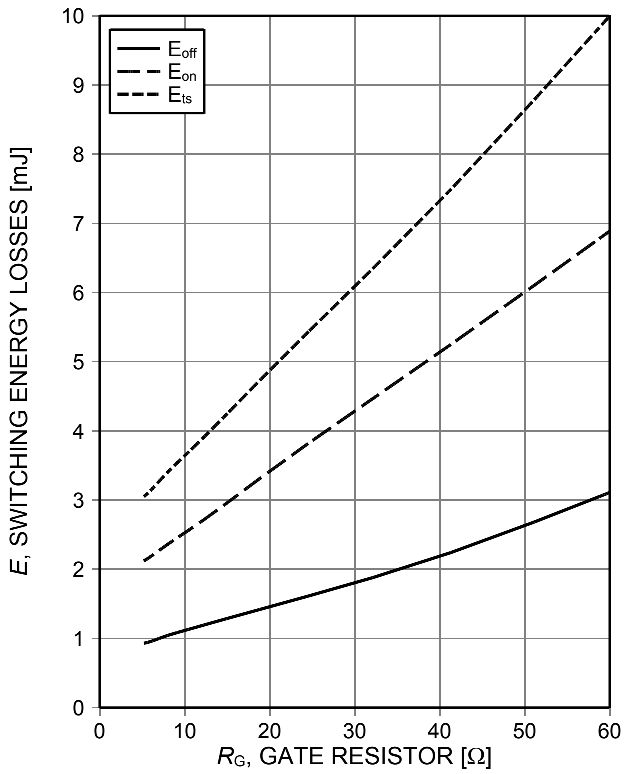


Figure 13. **Typical switching energy losses as a function of gate resistor**
(ind. load, T_j=175°C, V_{CE}=400V, V_{GE}=0/15V, I_C=50A, test circuit in Fig. E)

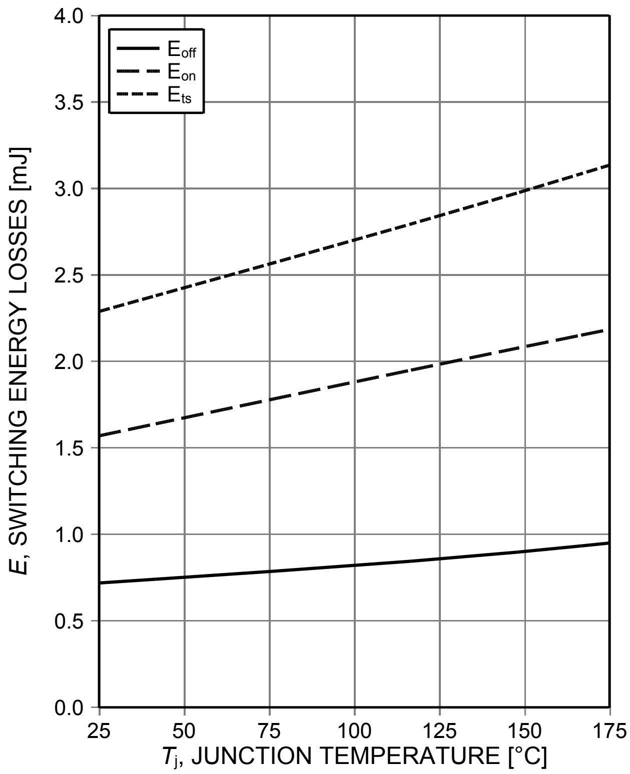


Figure 14. **Typical switching energy losses as a function of junction temperature**
(ind load, V_{CE}=400V, V_{GE}=0/15V, I_C=50A, R_G=7Ω, test circuit in Fig. E)

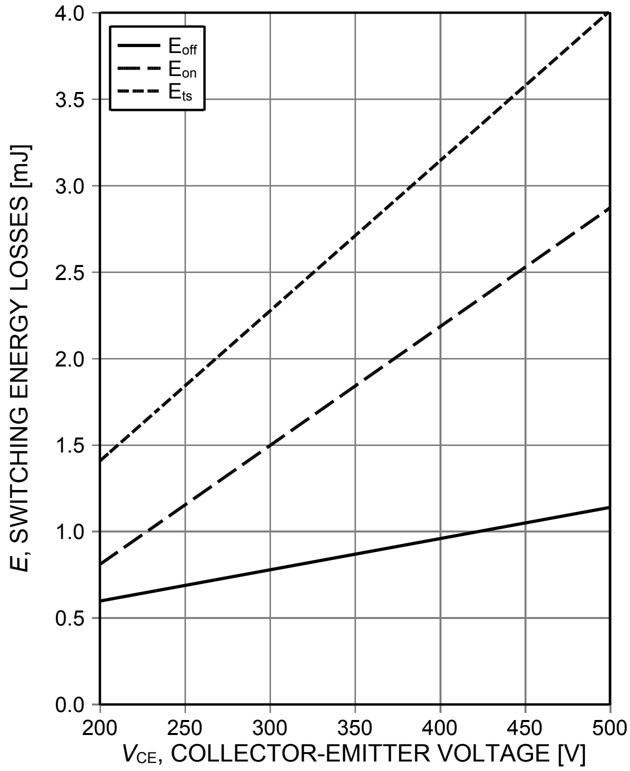


Figure 15. **Typical switching energy losses as a function of collector emitter voltage**
(ind. load, T_j=175°C, V_{GE}=0/15V, I_C=50A, R_G=7Ω, test circuit in Fig. E)

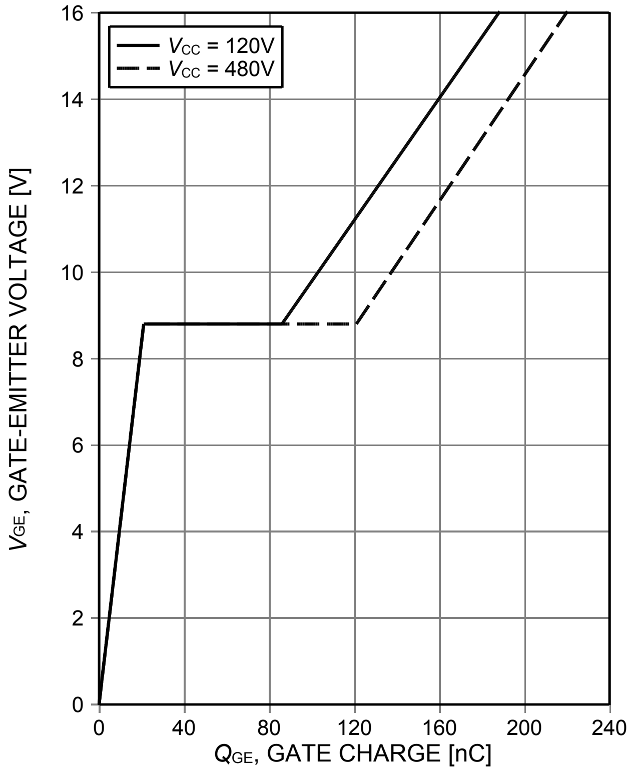


Figure 16. **Typical gate charge**
(I_C=50A)

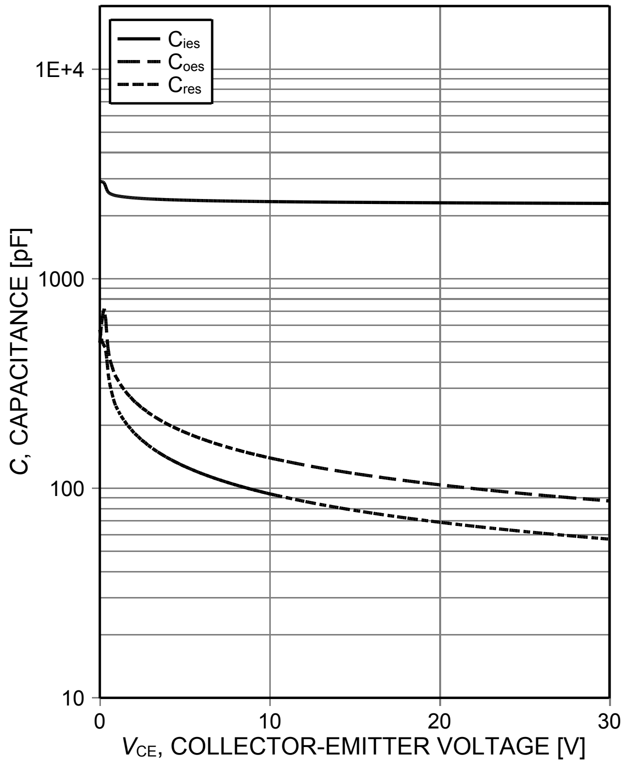


Figure 17. **Typical capacitance as a function of collector-emitter voltage**
(V_{GE}=0V, f=1MHz)

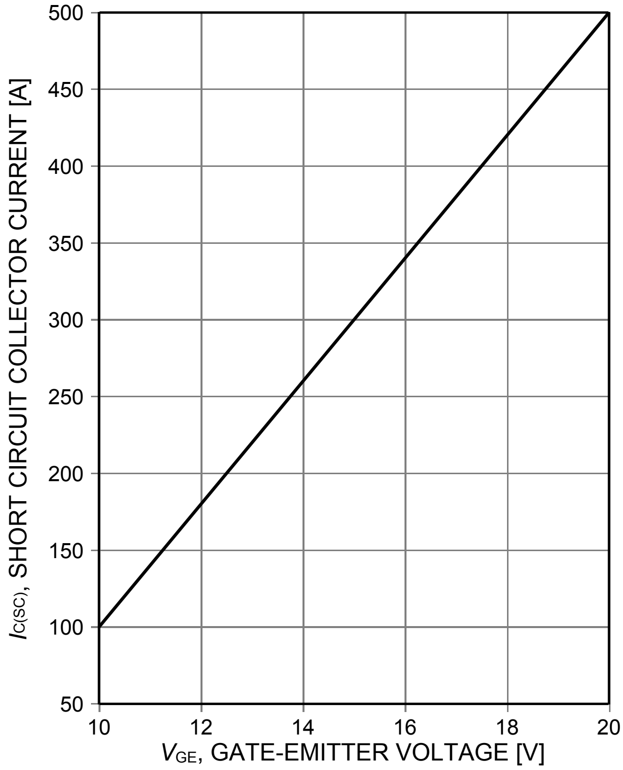


Figure 18. **Typical short circuit collector current as a function of gate-emitter voltage**
(V_{CE}≤400V, start at T_j=25°C)

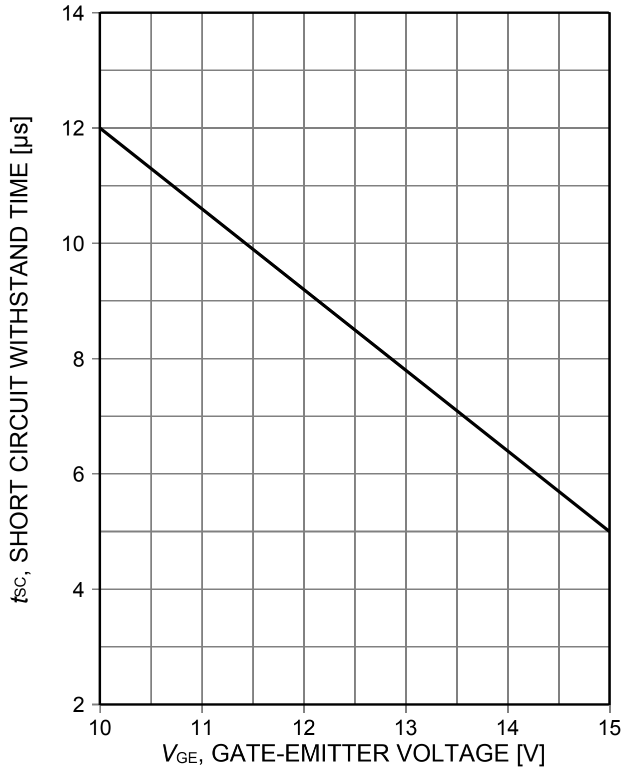
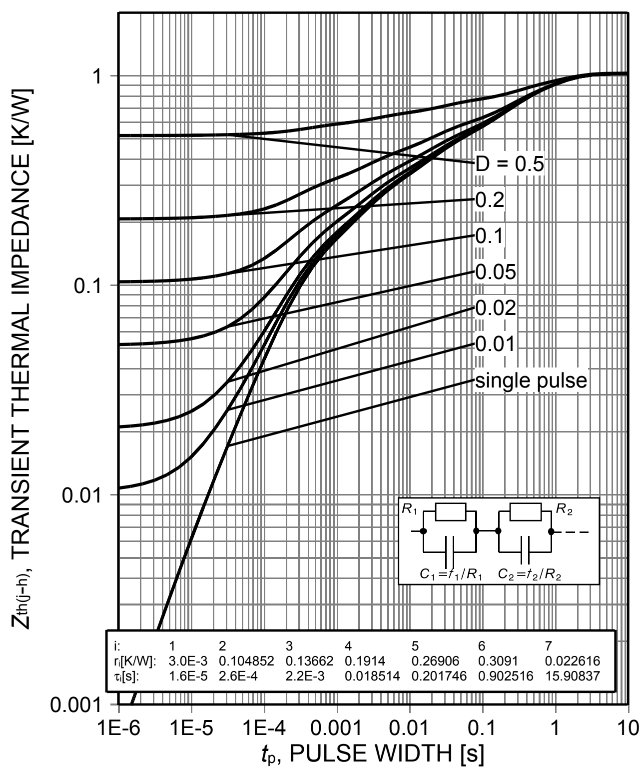


Figure 19. **Short circuit withstand time as a function of gate-emitter voltage**
(V_{CE}≤400V, start at T_j≤150°C)



i:	1	2	3	4	5	6	7
r_i[K/W]:	3.0E-3	0.104852	0.13662	0.1914	0.26906	0.3091	0.022616
τ_i[s]:	1.6E-5	2.6E-4	2.2E-3	0.018514	0.201746	0.902516	15.90837

Figure 20. **IGBT transient thermal impedance as a function of pulse width**
(D=t_p/T)

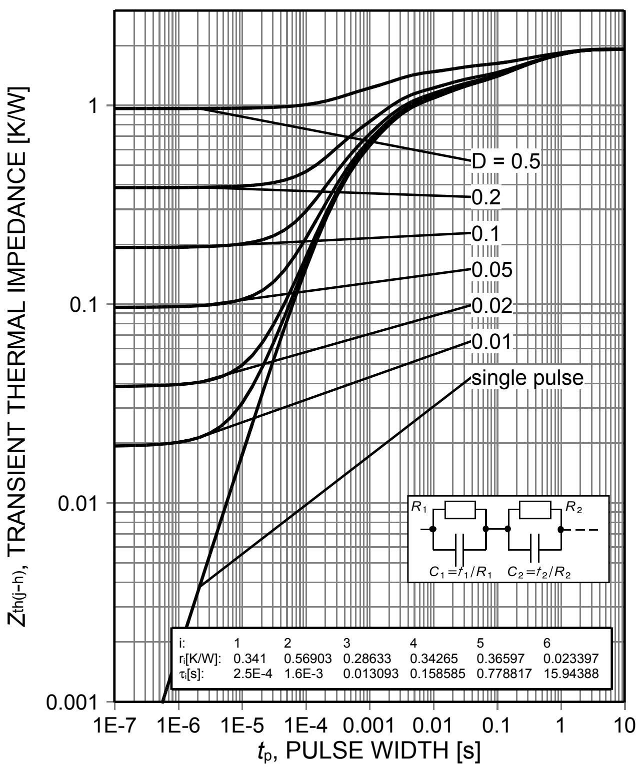


Figure 21. **Diode transient thermal impedance as a function of pulse width**
($D=t_p/T$)

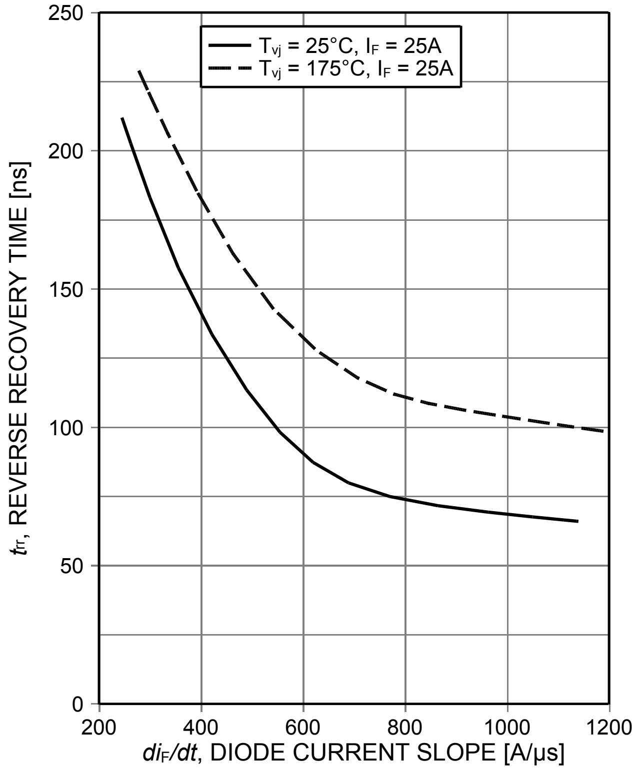


Figure 22. **Typical reverse recovery time as a function of diode current slope**
(V_R=400V)

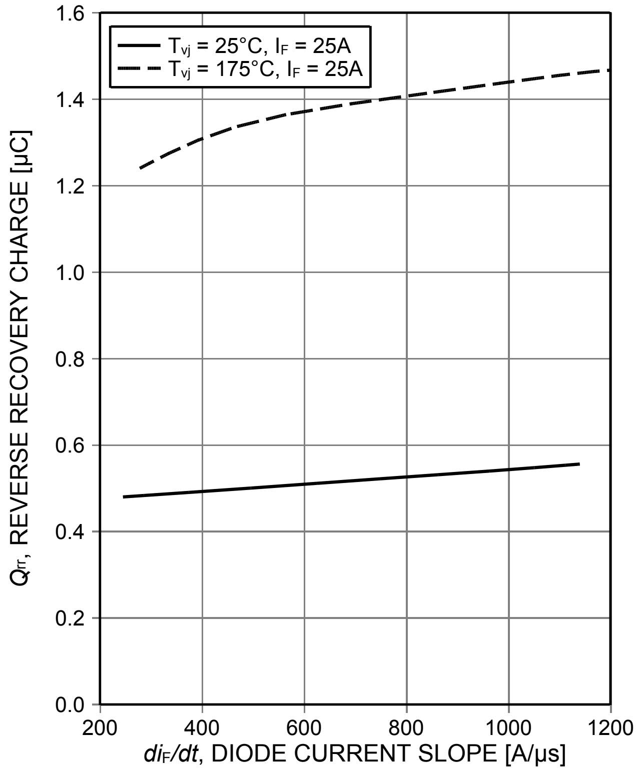


Figure 23. **Typical reverse recovery charge as a function of diode current slope**
(V_R=400V)

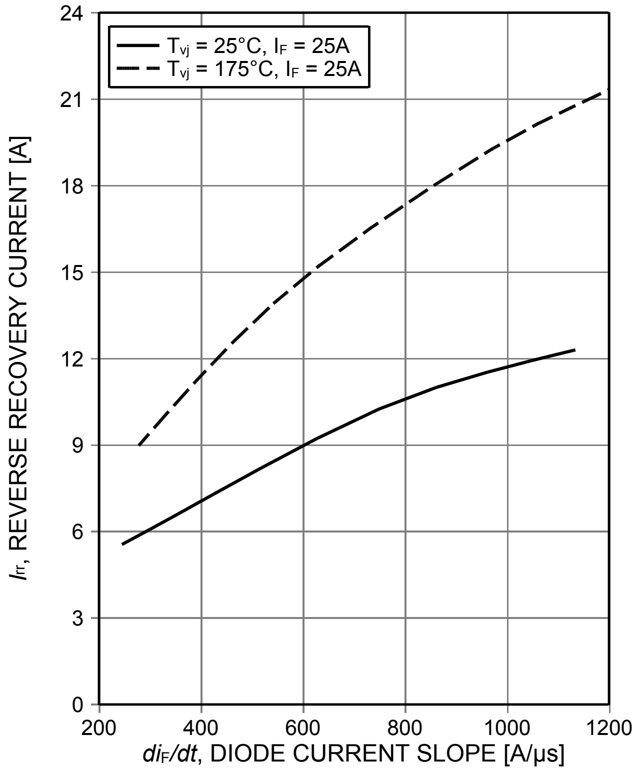


Figure 24. **Typical reverse recovery current as a function of diode current slope**
(V_R=400V)

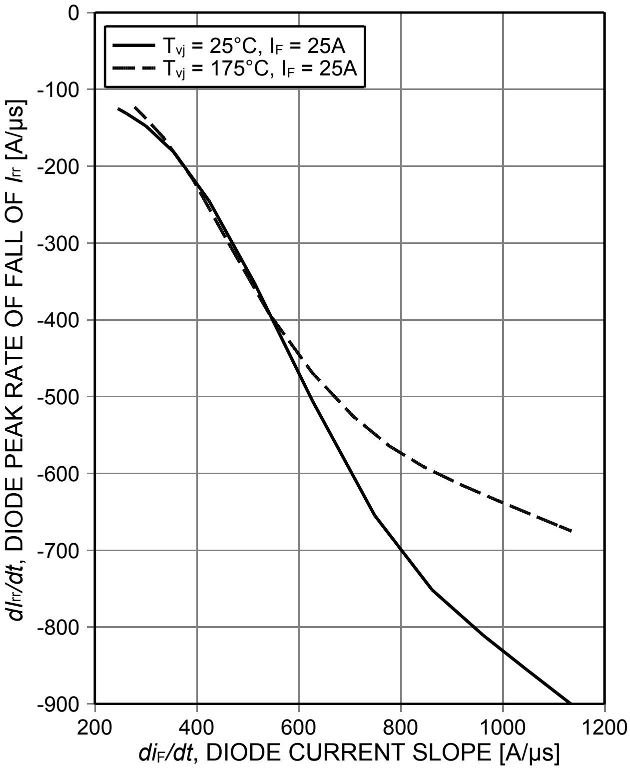


Figure 25. **Typical diode peak rate of fall of reverse recovery current as a function of diode current slope**
(V_R=400V)

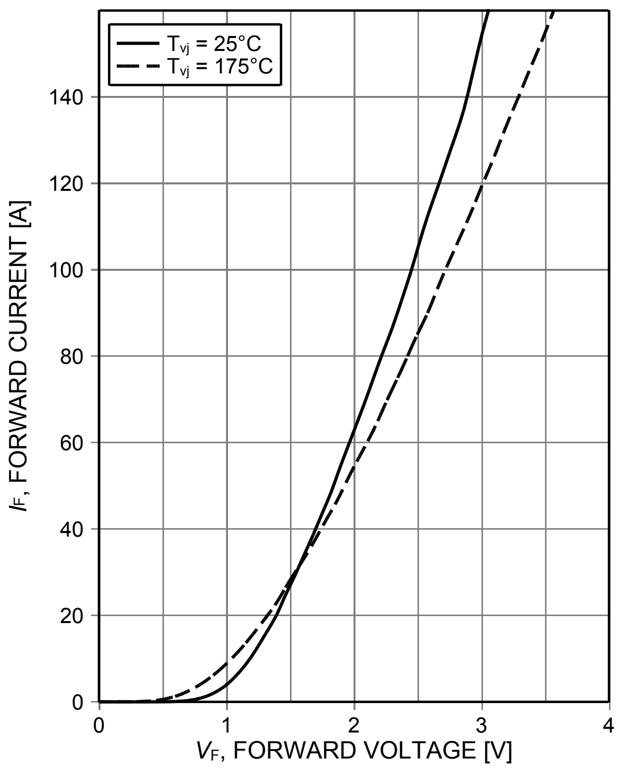


Figure 26. **Typical diode forward current as a function of forward voltage**

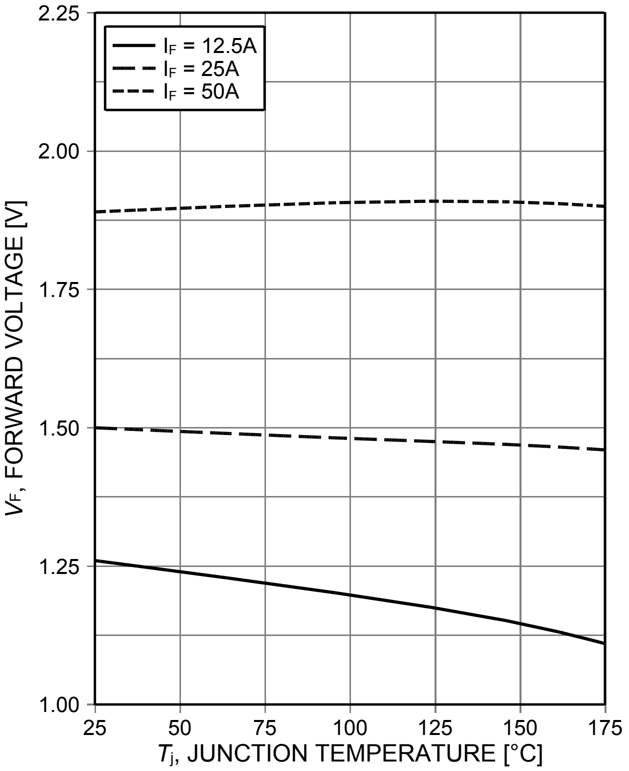
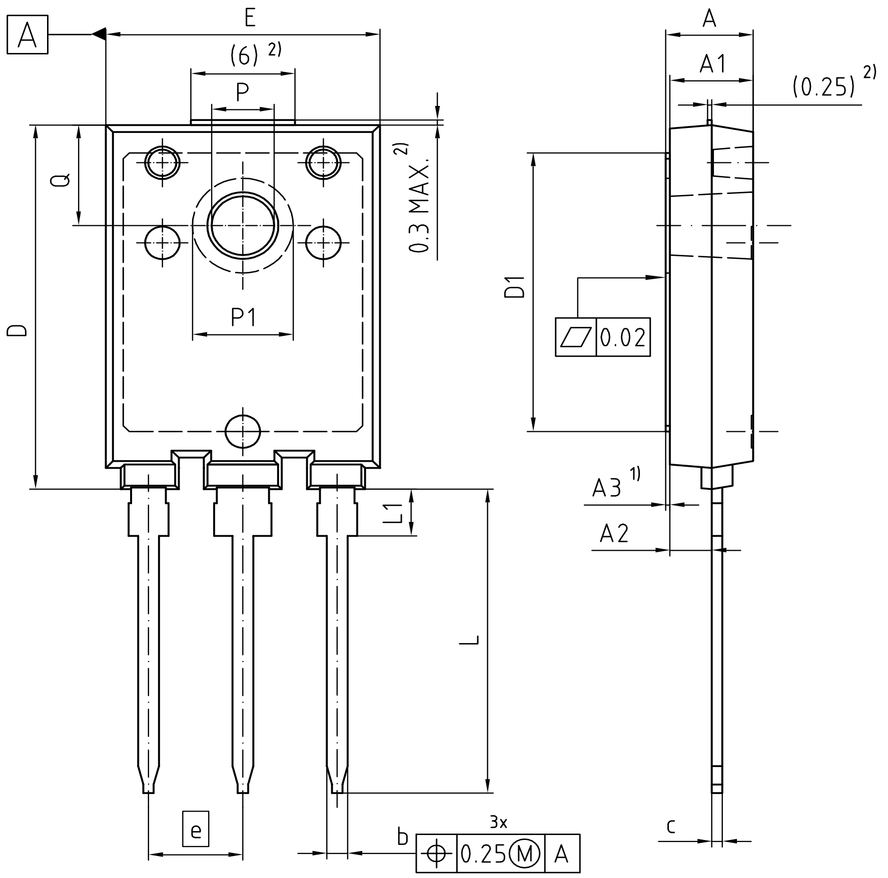
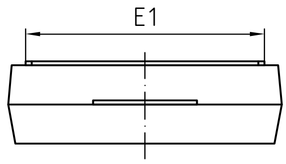


Figure 27. **Typical diode forward voltage as a function of junction temperature**

PG-TO247-3-AI (PG-HSIP247-3)





NOTES:
1) ABOVE ISOLATION LAYER DIMENSION IS UNDER NON-FORCE APPLIED CONDITION
2) MOLD GATE PROTRUSION AFTER DEGATING
ALL METAL SURFACES TIN PLATED EXCEPT AREA OF CUT

DIMENSIONS	MILLIMETERS	
	MIN.	MAX.
A	-	5.18
A1	4.70	4.90
A2	2.23	2.59
A3	0.20	0.28
b	1.10	1.30
c	0.50	0.70
D	22.20	22.40
D1	16.96	17.16
E	15.70	15.90
E1	13.68	13.88
e	5.44	
L	18.31	18.91
L1	2.76	2.96
øP	3.50	3.70
øP1	5.70	5.90
Q	5.96	6.36

DOCUMENT NO.
Z8B00186434

REVISION
02

SCALE 3:1
0 1 2 3 4 5 6 7 8mm

EUROPEAN PROJECTION

ISSUE DATE
05.06.2018

Note: For a proper handling and assembly of the advanced isolation device in the application the isolation layer must not be exposed to potential penetration via sharp implements or mechanical impacts/shocks, which exceed levels indicated in International Standard (IEC60068-2-6 and IEC60068-2-27). The advanced isolation device is intended only to be used assembled on an appropriate heatsink with recommended flatness of <20µm per 100mm and roughness of <10µm.

Testing Conditions

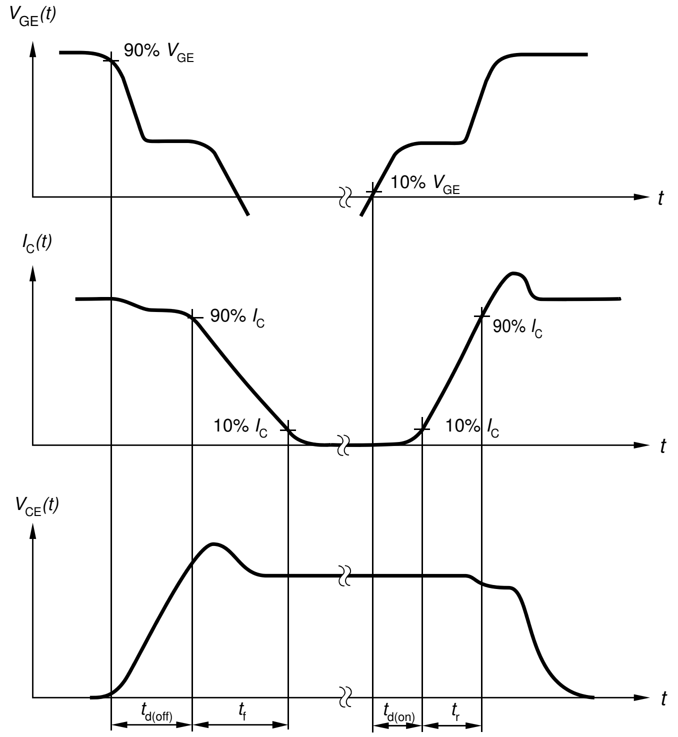


Figure A. **Definition of switching times**

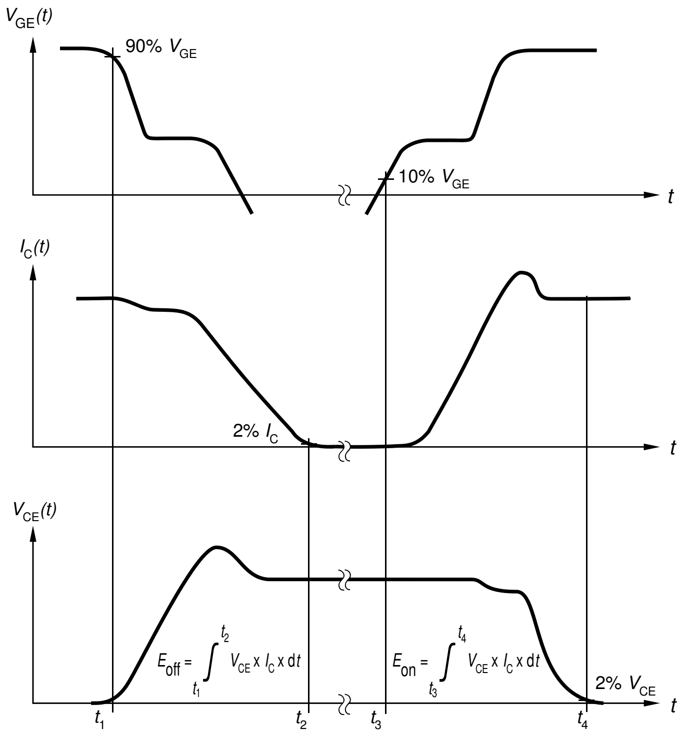


Figure B. **Definition of switching losses**

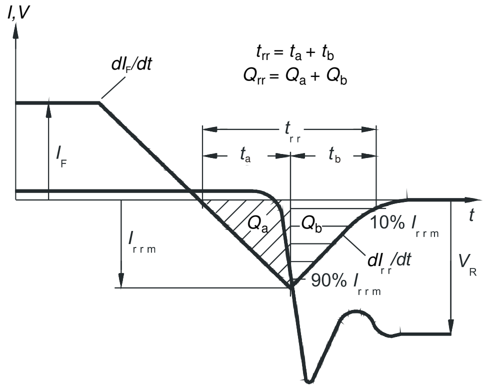


Figure C. **Definition of diode switching characteristics**

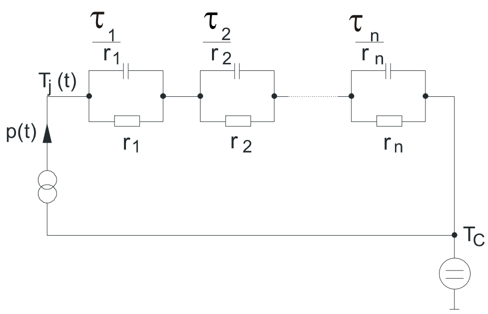


Figure D. **Thermal equivalent circuit**

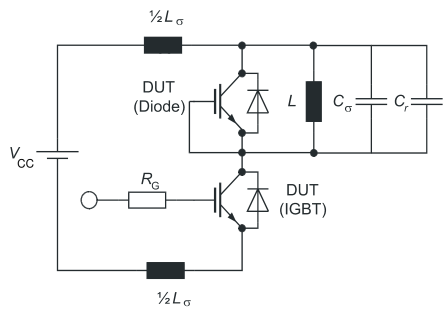


Figure E. **Dynamic test circuit**

Parasitic inductance L_{σ},
parasitic capacitor C_{σ},
relief capacitor C_r,
(only for ZVT switching)

Revision History

IKFW60N60DH3E

Revision: 2017-09-21, Rev. 2.1

Previous Revision		
Revision	Date	Subjects (major changes since last revision)
2.1	2017-09-21	Final data sheet

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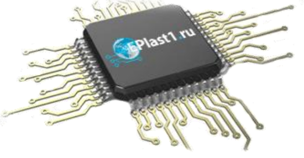

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