



## IGBT

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

### IKW50N65H5

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

### Data sheet

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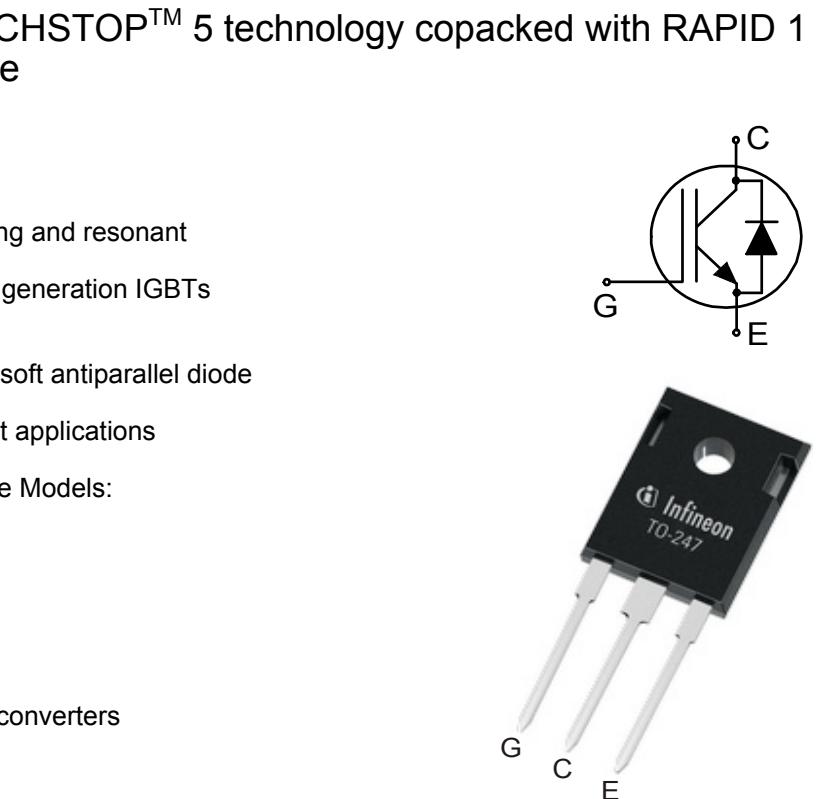
#### Features and Benefits:

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 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:

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



#### Key Performance and Package Parameters

Type	$V_{CE}$	$I_C$	$V_{CEsat}, T_{vj}=25^\circ\text{C}$	$T_{vjmax}$	Marking	Package
IKW50N65H5	650V	50A	1.65V	175°C	K50EH5	PG-T0247-3

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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	$V_{CE}$	650	V
DC collector current, limited by $T_{vjmax}$ $T_C = 25^\circ\text{C}$ value limited by bondwire $T_C = 100^\circ\text{C}$	$I_C$	80.0 56.0	A
Pulsed collector current, $t_p$ limited by $T_{vjmax}$	$I_{Cpuls}$	150.0	A
Turn off safe operating area $V_{CE} \leq 650\text{V}$ , $T_{vj} \leq 175^\circ\text{C}$	-	150.0	A
Diode forward current, limited by $T_{vjmax}$ $T_C = 25^\circ\text{C}$ value limited by bondwire $T_C = 100^\circ\text{C}$	$I_F$	40.0 27.0	A
Diode pulsed current, $t_p$ limited by $T_{vjmax}$	$I_{Fpuls}$	150.0	A
Gate-emitter voltage Transient Gate-emitter voltage ( $t_p \leq 10\mu\text{s}$ , D < 0.010)	$V_{GE}$	$\pm 20$ $\pm 30$	V
Power dissipation $T_C = 25^\circ\text{C}$ Power dissipation $T_C = 100^\circ\text{C}$	$P_{tot}$	305.0 152.5	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

### Thermal Resistance

Parameter	Symbol	Conditions	Max. Value	Unit
<b>Characteristic</b>				
IGBT thermal resistance, junction - case	$R_{th(j-c)}$		0.50	K/W
Diode thermal resistance, junction - case	$R_{th(j-c)}$		1.50	K/W
Thermal resistance junction - ambient	$R_{th(j-a)}$		40	K/W

**Electrical Characteristic, at  $T_{vj} = 25^\circ\text{C}$ , unless otherwise specified**

Parameter	Symbol	Conditions	Value			Unit
			min.	typ.	max.	
<b>Static Characteristic</b>						
Collector-emitter breakdown voltage	$V_{(\text{BR})\text{CES}}$	$V_{\text{GE}} = 0\text{V}, I_{\text{C}} = 0.20\text{mA}$	650	-	-	V
Collector-emitter saturation voltage	$V_{\text{CEsat}}$	$V_{\text{GE}} = 15.0\text{V}, I_{\text{C}} = 50.0\text{A}$ $T_{vj} = 25^\circ\text{C}$ $T_{vj} = 125^\circ\text{C}$ $T_{vj} = 175^\circ\text{C}$	-	1.65	2.10	V
Diode forward voltage	$V_F$	$V_{\text{GE}} = 0\text{V}, I_F = 27.0\text{A}$ $T_{vj} = 25^\circ\text{C}$ $T_{vj} = 125^\circ\text{C}$ $T_{vj} = 175^\circ\text{C}$	-	1.45	1.80	V
Gate-emitter threshold voltage	$V_{\text{GE}(\text{th})}$	$I_{\text{C}} = 0.50\text{mA}, V_{\text{CE}} = V_{\text{GE}}$	3.2	4.0	4.8	V
Zero gate voltage collector current	$I_{\text{CES}}$	$V_{\text{CE}} = 650\text{V}, V_{\text{GE}} = 0\text{V}$ $T_{vj} = 25^\circ\text{C}$ $T_{vj} = 175^\circ\text{C}$	-	-	40.0	$\mu\text{A}$
Gate-emitter leakage current	$I_{\text{GES}}$	$V_{\text{CE}} = 0\text{V}, V_{\text{GE}} = 20\text{V}$	-	-	100	nA
Transconductance	$g_{\text{fs}}$	$V_{\text{CE}} = 20\text{V}, I_{\text{C}} = 50.0\text{A}$	-	62.0	-	S

**Electrical Characteristic, at  $T_{vj} = 25^\circ\text{C}$ , unless otherwise specified**

Parameter	Symbol	Conditions	Value			Unit
			min.	typ.	max.	
<b>Dynamic Characteristic</b>						
Input capacitance	$C_{\text{ies}}$		-	3000	-	pF
Output capacitance	$C_{\text{oes}}$	$V_{\text{CE}} = 25\text{V}, V_{\text{GE}} = 0\text{V}, f = 1\text{MHz}$	-	65	-	
Reverse transfer capacitance	$C_{\text{res}}$		-	11	-	
Gate charge	$Q_G$	$V_{\text{CC}} = 520\text{V}, I_{\text{C}} = 50.0\text{A}, V_{\text{GE}} = 15\text{V}$	-	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			Unit
			min.	typ.	max.	
<b>IGBT Characteristic, at <math>T_{vj} = 25^\circ\text{C}</math></b>						
Turn-on delay time	$t_{d(\text{on})}$	$T_{vj} = 25^\circ\text{C}, V_{\text{CC}} = 400\text{V}, I_{\text{C}} = 25.0\text{A}, V_{\text{GE}} = 0.0/15.0\text{V}, R_{G(\text{on})} = 12.0\Omega, R_{G(\text{off})} = 12.0\Omega, L_{\sigma} = 30\text{nH}, C_{\sigma} = 30\text{pF}$	-	21	-	ns
Rise time	$t_r$		-	15	-	ns
Turn-off delay time	$t_{d(\text{off})}$		-	180	-	ns
Fall time	$t_f$		-	18	-	ns
Turn-on energy	$E_{\text{on}}$	Energy losses include "tail" and diode reverse recovery.	-	0.52	-	mJ
Turn-off energy	$E_{\text{off}}$		-	0.18	-	mJ
Total switching energy	$E_{\text{ts}}$		-	0.70	-	mJ

Turn-on delay time	$t_{d(on)}$	$T_{vj} = 25^\circ\text{C}$ , $V_{CC} = 400\text{V}$ , $I_C = 6.0\text{A}$ , $V_{GE} = 0.0/15.0\text{V}$ , $R_{G(on)} = 12.0\Omega$ , $R_{G(off)} = 12.0\Omega$ , $L_\sigma = 30\text{nH}$ , $C_\sigma = 30\text{pF}$ $L_\sigma$ , $C_\sigma$ from Fig. E Energy losses include "tail" and diode reverse recovery.	-	20	-	ns
Rise time	$t_r$		-	4	-	ns
Turn-off delay time	$t_{d(off)}$		-	200	-	ns
Fall time	$t_f$		-	25	-	ns
Turn-on energy	$E_{on}$		-	0.11	-	mJ
Turn-off energy	$E_{off}$		-	0.05	-	mJ
Total switching energy	$E_{ts}$		-	0.16	-	mJ

**Diode Characteristic, at  $T_{vj} = 25^\circ\text{C}$** 

Diode reverse recovery time	$t_{rr}$	$T_{vj} = 25^\circ\text{C}$ , $V_R = 400\text{V}$ , $I_F = 25.0\text{A}$ , $di_F/dt = 1200\text{A}/\mu\text{s}$	-	57	-	ns
Diode reverse recovery charge	$Q_{rr}$		-	0.57	-	$\mu\text{C}$
Diode peak reverse recovery current	$I_{frm}$		-	16.7	-	A
Diode peak rate of fall of reverse recovery current during $t_b$	$di_{rr}/dt$		-	-415	-	$\text{A}/\mu\text{s}$
Diode reverse recovery time	$t_{rr}$	$T_{vj} = 25^\circ\text{C}$ , $V_R = 400\text{V}$ , $I_F = 6.0\text{A}$ , $di_F/dt = 1200\text{A}/\mu\text{s}$	-	32	-	ns
Diode reverse recovery charge	$Q_{rr}$		-	0.27	-	$\mu\text{C}$
Diode peak reverse recovery current	$I_{frm}$		-	13.0	-	A
Diode peak rate of fall of reverse recovery current during $t_b$	$di_{rr}/dt$		-	-1150	-	$\text{A}/\mu\text{s}$

**Switching Characteristic, Inductive Load**

Parameter	Symbol	Conditions	Value			Unit
			min.	typ.	max.	

**IGBT Characteristic, at  $T_{vj} = 150^\circ\text{C}$** 

Turn-on delay time	$t_{d(on)}$	$T_{vj} = 150^\circ\text{C}$ , $V_{CC} = 400\text{V}$ , $I_C = 25.0\text{A}$ , $V_{GE} = 0.0/15.0\text{V}$ , $R_{G(on)} = 12.0\Omega$ , $R_{G(off)} = 12.0\Omega$ , $L_\sigma = 30\text{nH}$ , $C_\sigma = 30\text{pF}$ $L_\sigma$ , $C_\sigma$ from Fig. E Energy losses include "tail" and diode reverse recovery.	-	20	-	ns
Rise time	$t_r$		-	15	-	ns
Turn-off delay time	$t_{d(off)}$		-	205	-	ns
Fall time	$t_f$		-	26	-	ns
Turn-on energy	$E_{on}$		-	0.75	-	mJ
Turn-off energy	$E_{off}$		-	0.27	-	mJ
Total switching energy	$E_{ts}$		-	1.02	-	mJ
Turn-on delay time	$t_{d(on)}$	$T_{vj} = 150^\circ\text{C}$ , $V_{CC} = 400\text{V}$ , $I_C = 6.0\text{A}$ , $V_{GE} = 0.0/15.0\text{V}$ , $R_{G(on)} = 12.0\Omega$ , $R_{G(off)} = 12.0\Omega$ , $L_\sigma = 30\text{nH}$ , $C_\sigma = 30\text{pF}$ $L_\sigma$ , $C_\sigma$ from Fig. E Energy losses include "tail" and diode reverse recovery.	-	18	-	ns
Rise time	$t_r$		-	5	-	ns
Turn-off delay time	$t_{d(off)}$		-	250	-	ns
Fall time	$t_f$		-	35	-	ns
Turn-on energy	$E_{on}$		-	0.20	-	mJ
Turn-off energy	$E_{off}$		-	0.08	-	mJ
Total switching energy	$E_{ts}$		-	0.28	-	mJ

**Diode Characteristic, at  $T_{vj} = 150^\circ\text{C}$** 

Diode reverse recovery time	$t_{rr}$	$T_{vj} = 150^\circ\text{C}$ , $V_R = 400\text{V}$ , $I_F = 25.0\text{A}$ , $di_F/dt = 1200\text{A}/\mu\text{s}$	-	90	-	ns
Diode reverse recovery charge	$Q_{rr}$		-	1.31	-	$\mu\text{C}$
Diode peak reverse recovery current	$I_{rrm}$		-	22.6	-	A
Diode peak rate of fall of reverse recovery current during $t_b$	$di_{rr}/dt$		-	-300	-	$\text{A}/\mu\text{s}$
Diode reverse recovery time	$t_{rr}$	$T_{vj} = 150^\circ\text{C}$ , $V_R = 400\text{V}$ , $I_F = 6.0\text{A}$ , $di_F/dt = 1200\text{A}/\mu\text{s}$	-	50	-	ns
Diode reverse recovery charge	$Q_{rr}$		-	0.64	-	$\mu\text{C}$
Diode peak reverse recovery current	$I_{rrm}$		-	19.8	-	A
Diode peak rate of fall of reverse recovery current during $t_b$	$di_{rr}/dt$		-	-600	-	$\text{A}/\mu\text{s}$

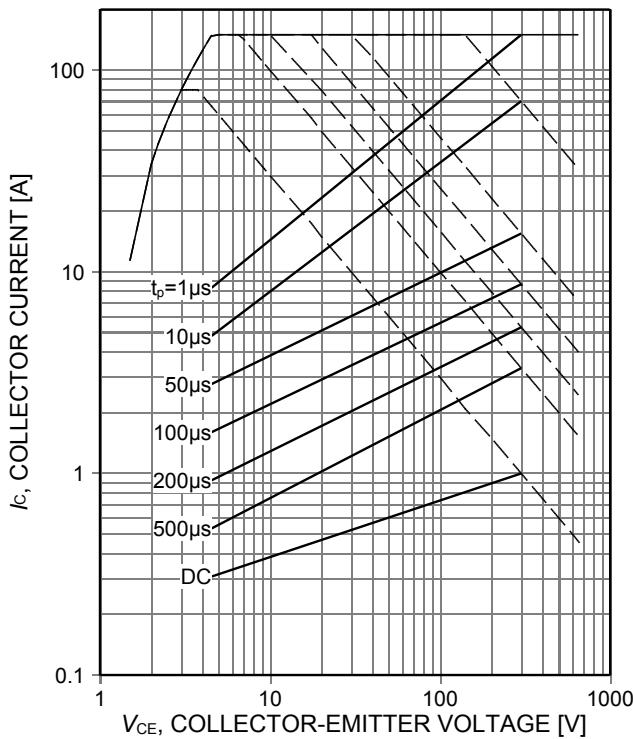


Figure 1. **Forward bias safe operating area**  
 $(D=0, T_C=25^\circ C, T_{vj}\leq 175^\circ C; V_{GE}=15V.$   
 Recommended use at  $V_{GE}\geq 7.5V)$

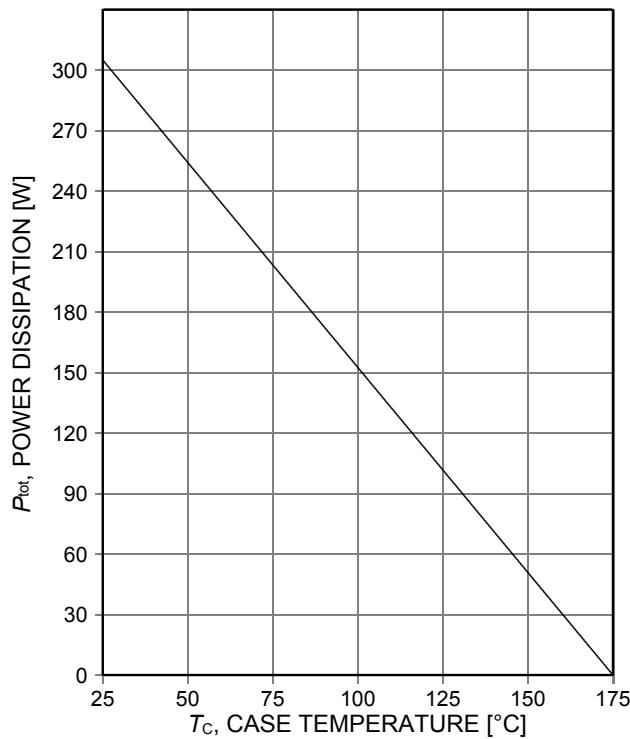


Figure 2. **Power dissipation as a function of case temperature**  
 $(T_{vj}\leq 175^\circ C)$

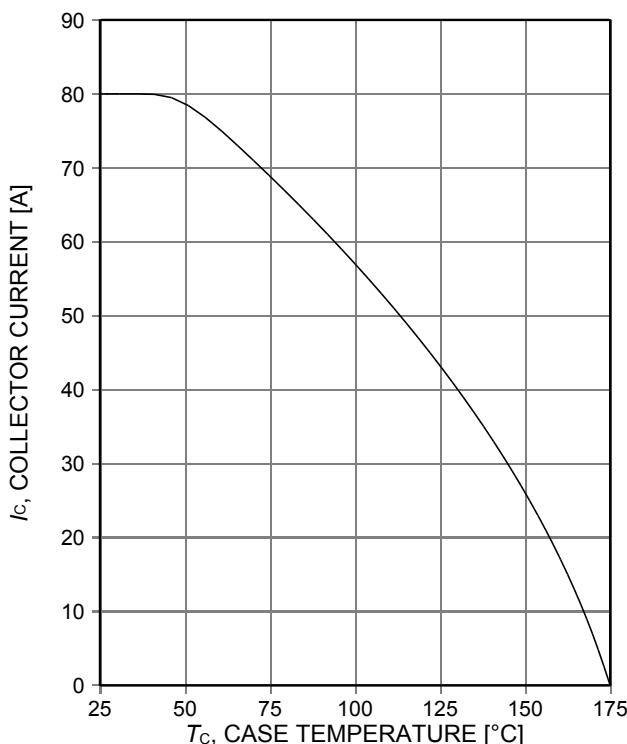


Figure 3. **Collector current as a function of case temperature**  
 $(V_{GE}\geq 15V, T_{vj}\leq 175^\circ C)$

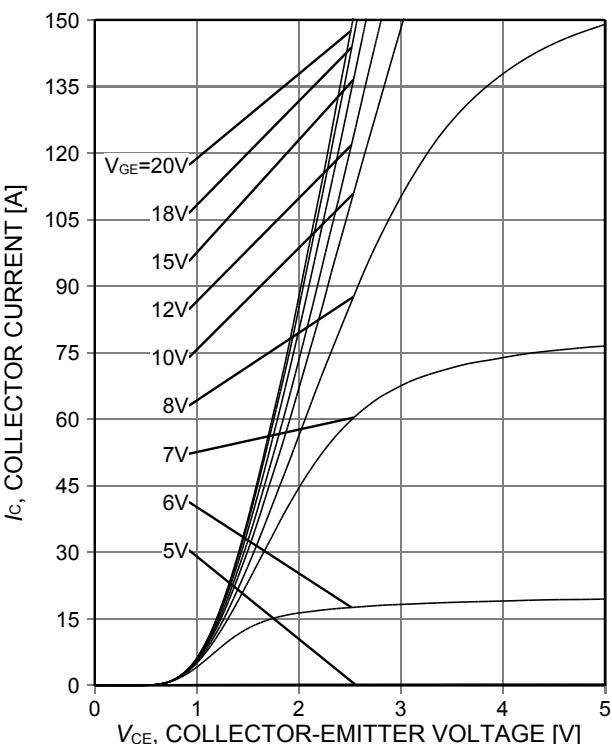
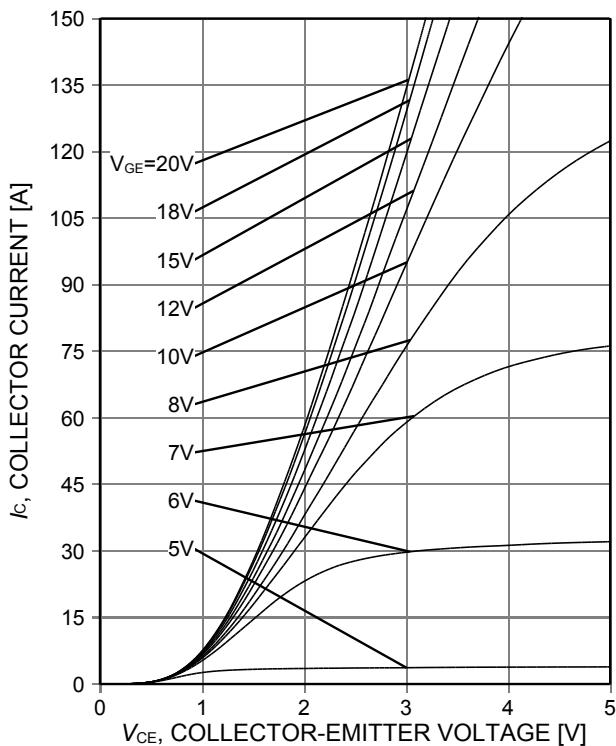
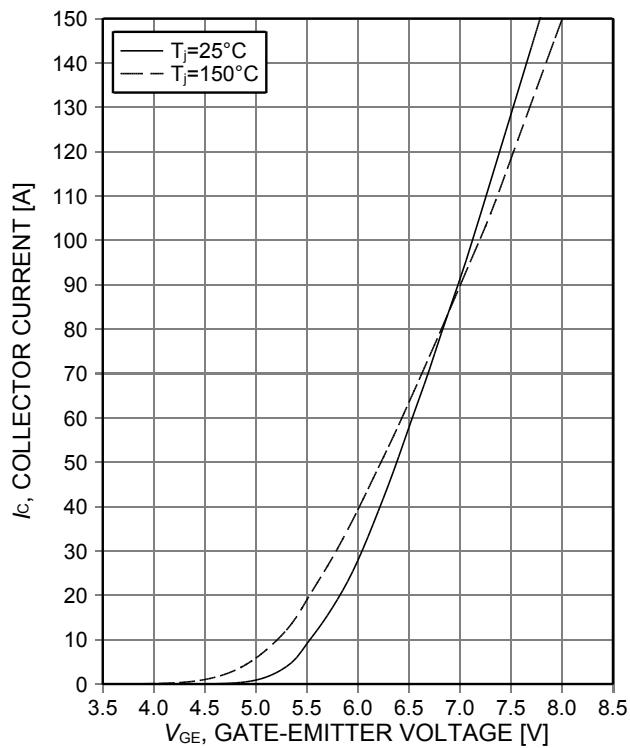


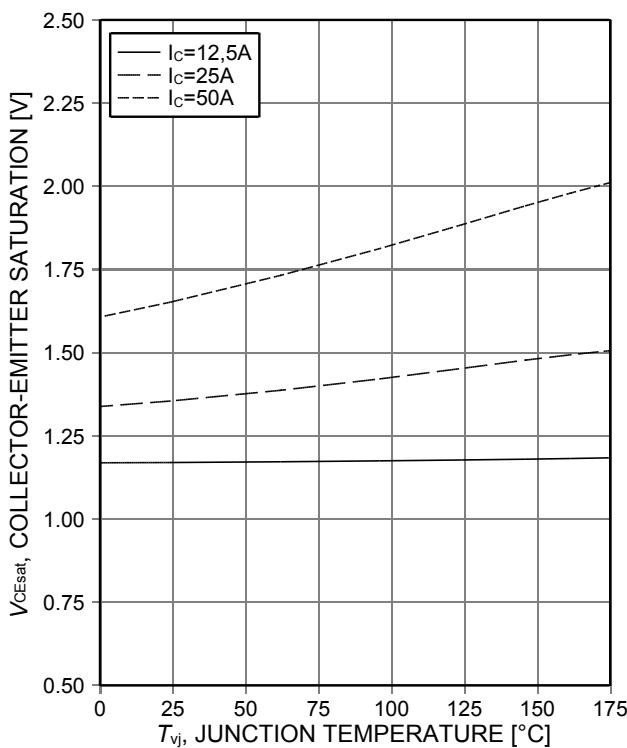
Figure 4. **Typical output characteristic**  
 $(T_{vj}=25^\circ C)$



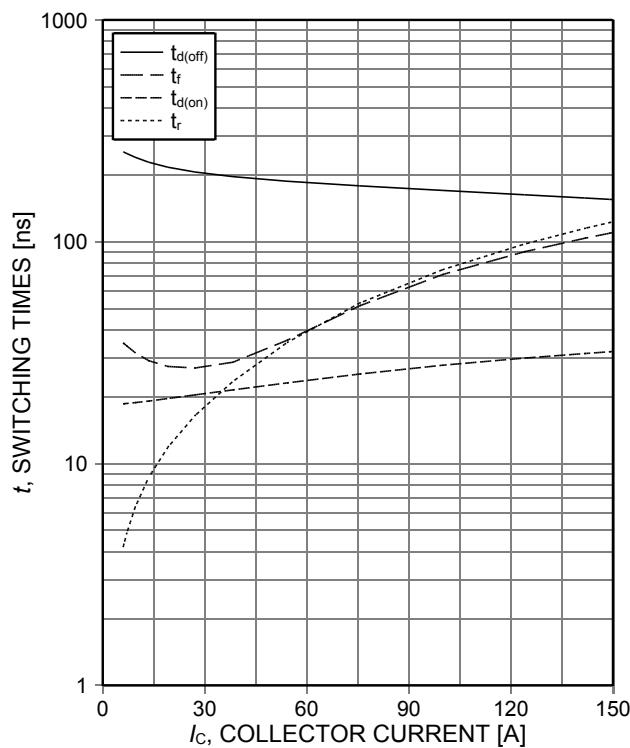
**Figure 5. Typical output characteristic**  
( $T_{vj}=150^{\circ}\text{C}$ )



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



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



**Figure 8. Typical switching times as a function of collector current**  
(inductive load,  $T_{vj}=150^{\circ}\text{C}$ ,  $V_{CE}=400\text{V}$ ,  
 $V_{GE}=15/0\text{V}$ ,  $r_G=12\Omega$ , Dynamic test circuit in  
Figure E)

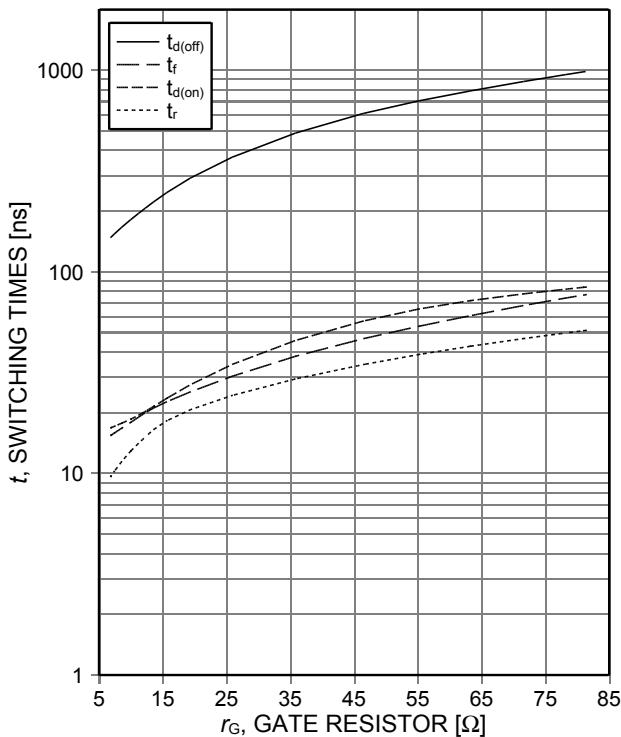


Figure 9. Typical switching times as a function of gate resistor

(inductive load,  $T_{vj}=150^\circ\text{C}$ ,  $V_{CE}=400\text{V}$ ,  $V_{GE}=15/0\text{V}$ ,  $I_c=25\text{A}$ , Dynamic test circuit in Figure E)

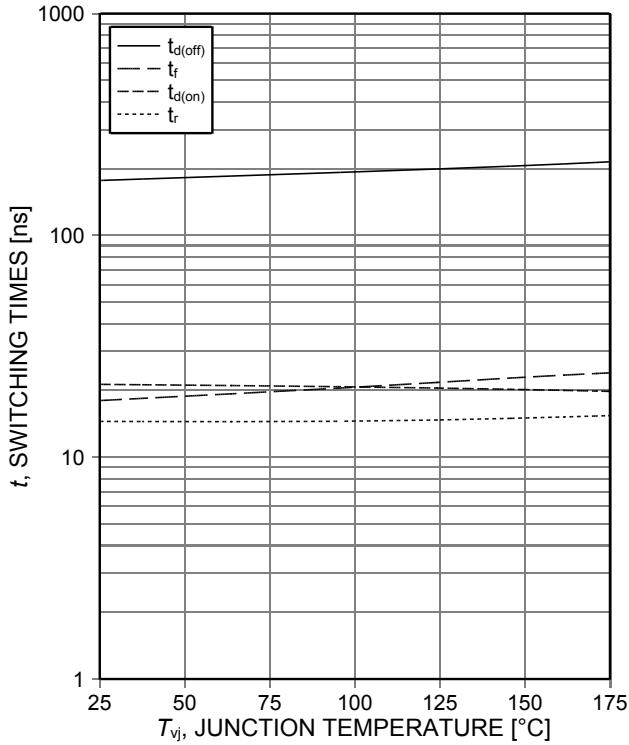


Figure 10. Typical switching times as a function of junction temperature

(inductive load,  $V_{CE}=400\text{V}$ ,  $V_{GE}=15/0\text{V}$ ,  $I_c=25\text{A}$ ,  $r_G=12\Omega$ , Dynamic test circuit in Figure E)

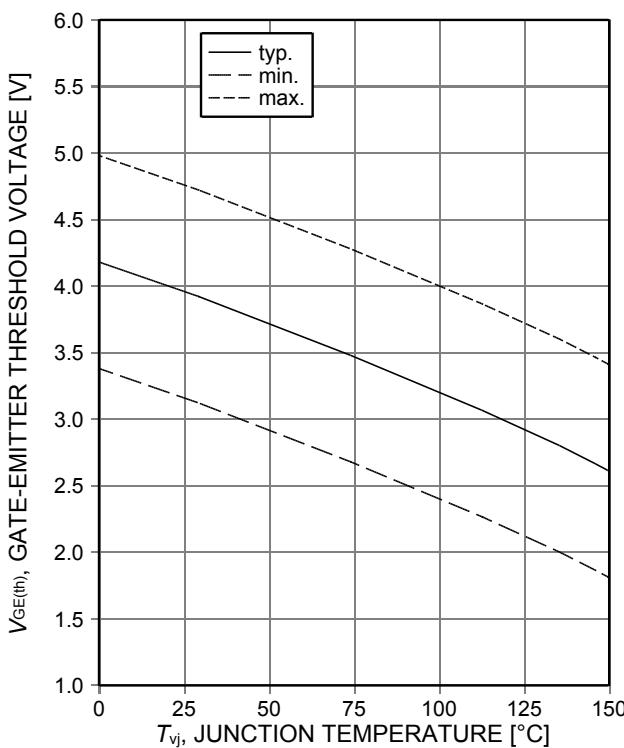


Figure 11. Gate-emitter threshold voltage as a function of junction temperature ( $I_c=0.5\text{mA}$ )

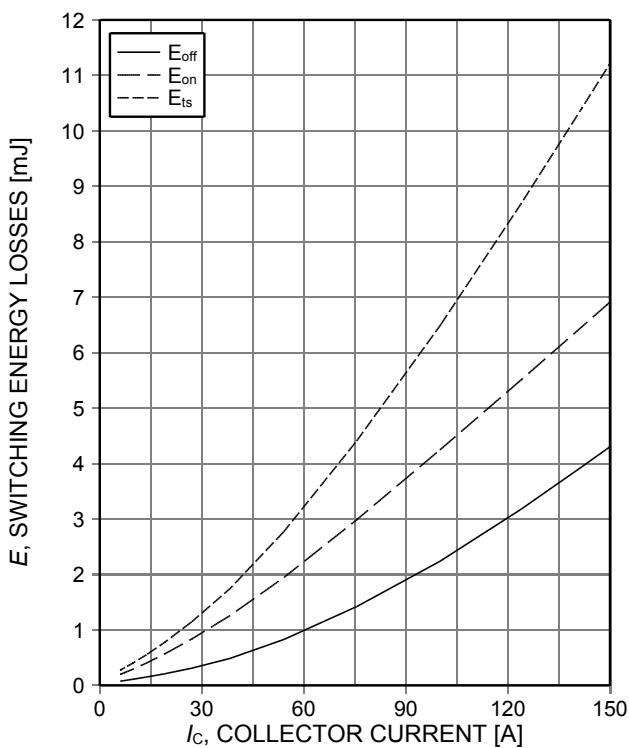


Figure 12. Typical switching energy losses as a function of collector current (inductive load,  $T_{vj}=150^\circ\text{C}$ ,  $V_{CE}=400\text{V}$ ,  $V_{GE}=15/0\text{V}$ ,  $r_G=12\Omega$ , Dynamic test circuit in Figure E)

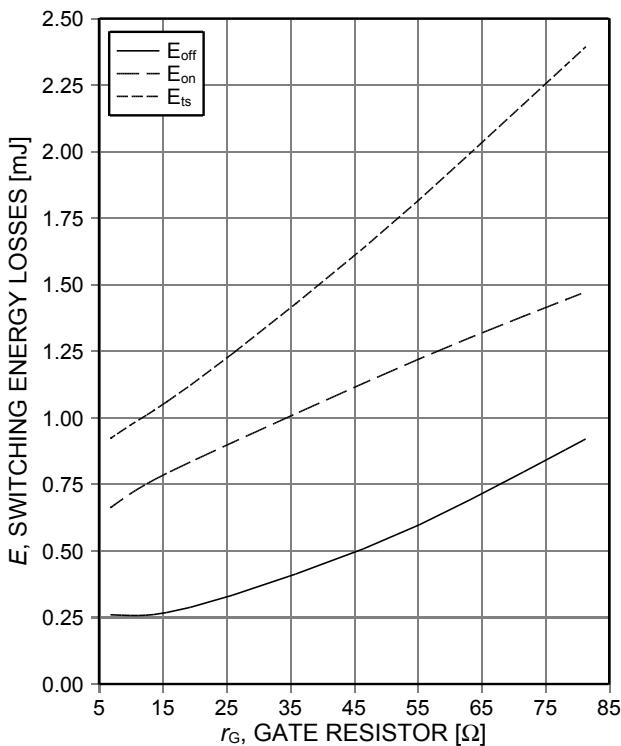


Figure 13. **Typical switching energy losses as a function of gate resistor**  
(inductive load,  $T_{vj}=150^{\circ}\text{C}$ ,  $V_{CE}=400\text{V}$ ,  $V_{GE}=15/0\text{V}$ ,  $I_c=25\text{A}$ , Dynamic test circuit in Figure E)

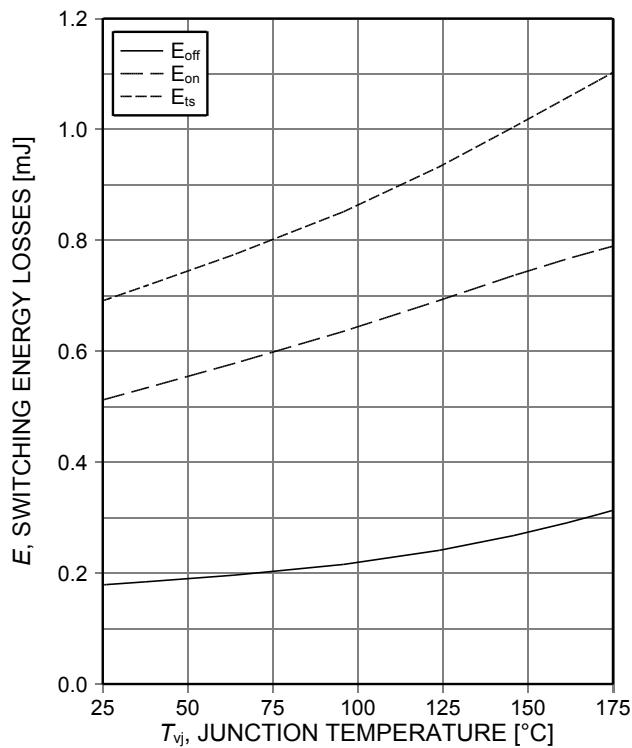


Figure 14. **Typical switching energy losses as a function of junction temperature**  
(inductive load,  $V_{CE}=400\text{V}$ ,  $V_{GE}=15/0\text{V}$ ,  $I_c=25\text{A}$ ,  $r_G=12\Omega$ , Dynamic test circuit in Figure E)

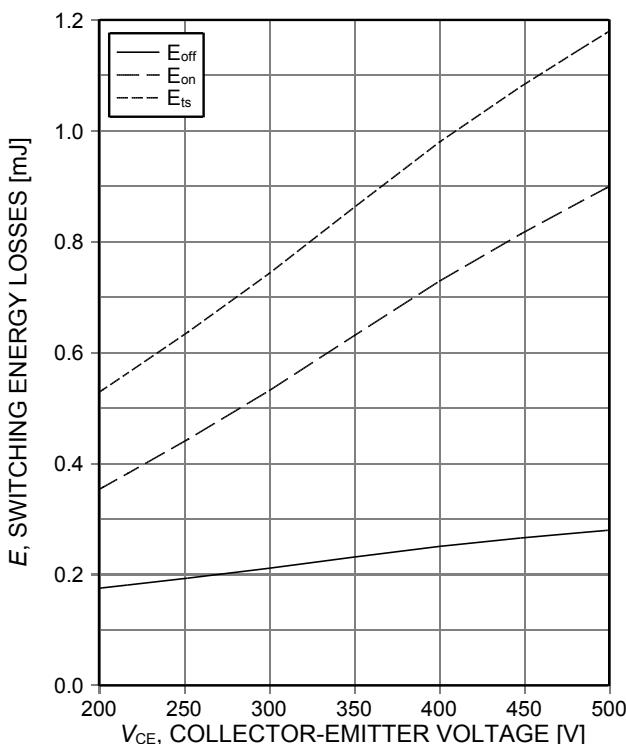


Figure 15. **Typical switching energy losses as a function of collector-emitter voltage**  
(inductive load,  $T_{vj}=150^{\circ}\text{C}$ ,  $V_{GE}=15/0\text{V}$ ,  $I_c=25\text{A}$ ,  $r_G=12\Omega$ , Dynamic test circuit in Figure E)

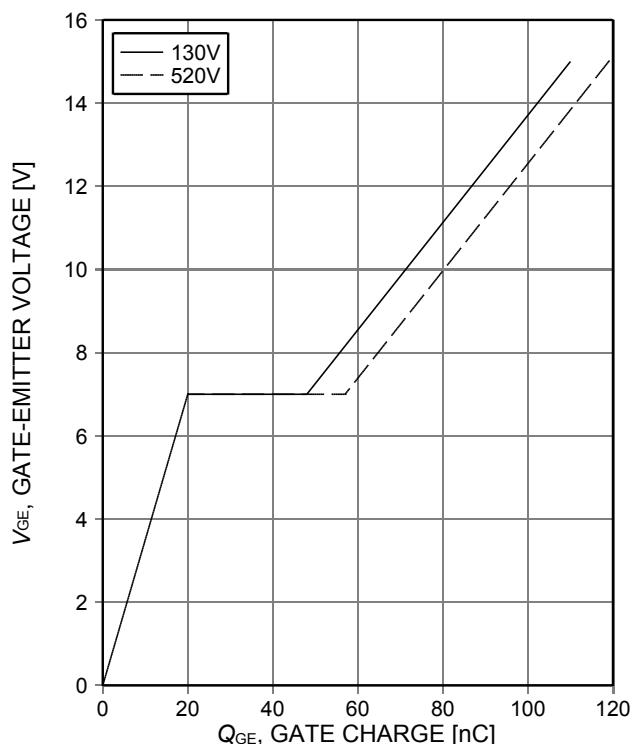


Figure 16. **Typical gate charge**  
( $I_c=50\text{A}$ )

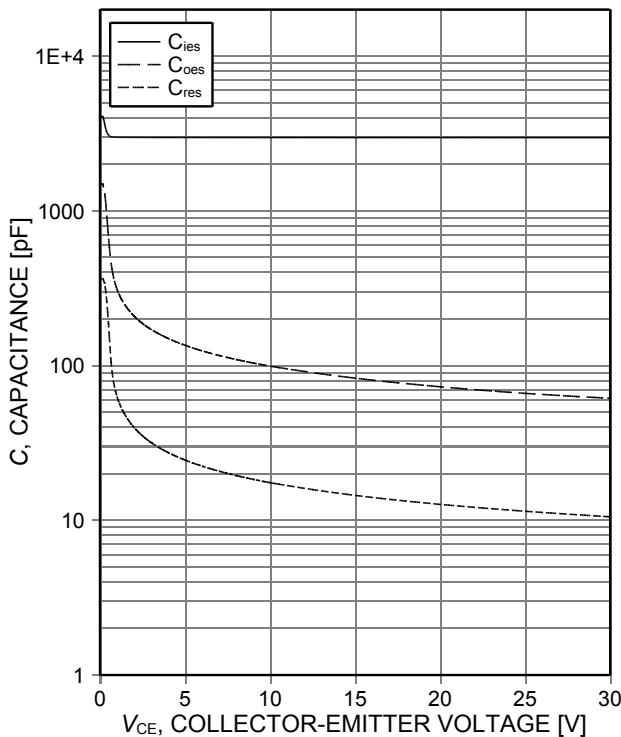


Figure 17. Typical capacitance as a function of collector-emitter voltage  
( $V_{GE}=0V$ ,  $f=1MHz$ )

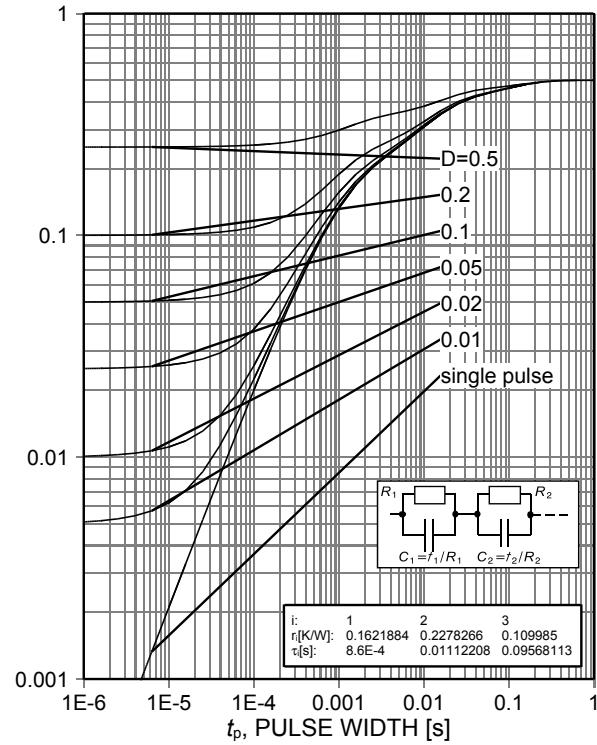


Figure 18. IGBT transient thermal resistance  
( $D=t_p/T$ )

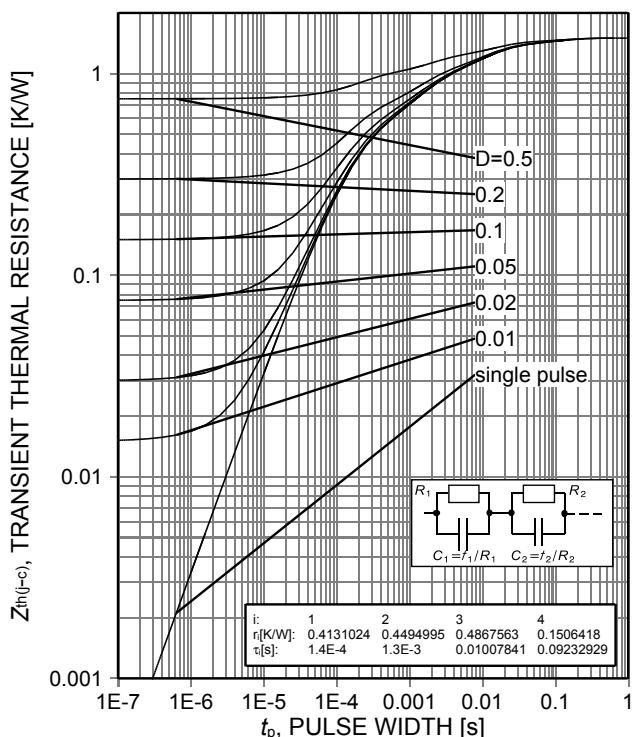


Figure 19. Diode transient thermal impedance as a function of pulse width  
( $D=t_p/T$ )

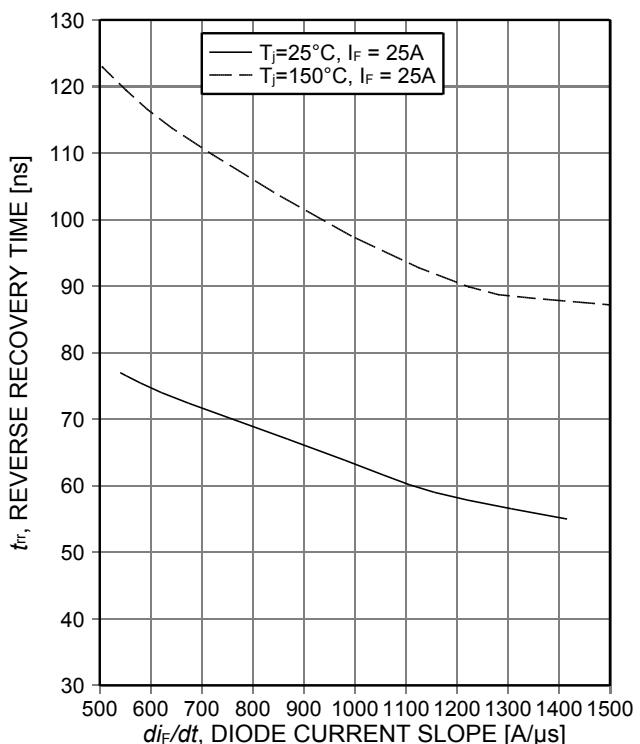


Figure 20. Typical reverse recovery time as a function of diode current slope  
( $V_R=400V$ )

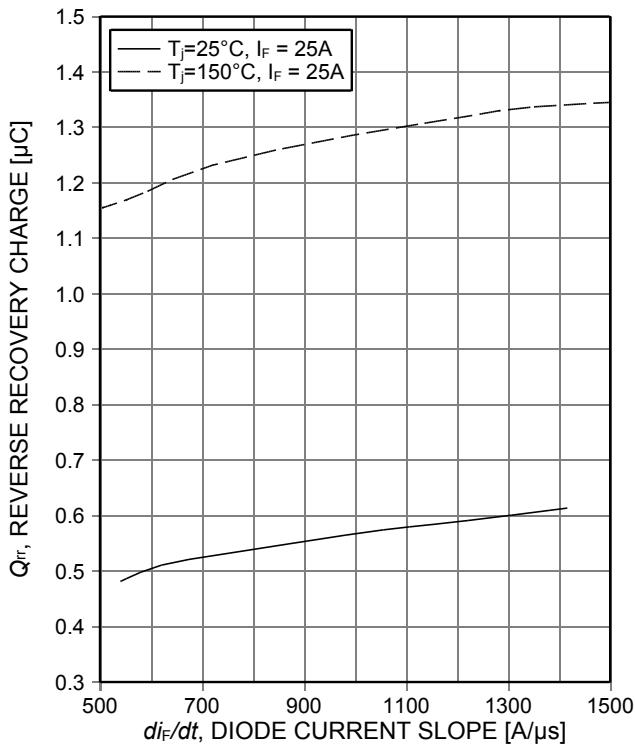


Figure 21. Typical reverse recovery charge as a function of diode current slope ( $V_R=400\text{V}$ )

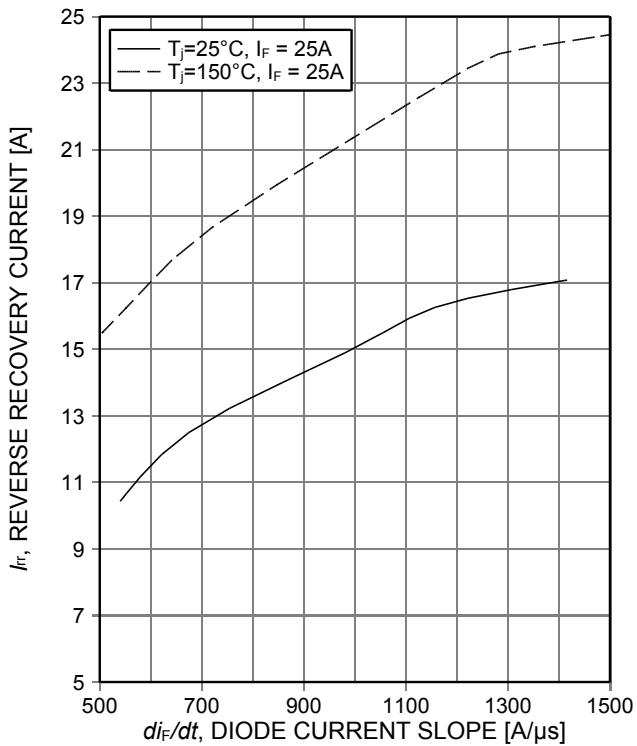


Figure 22. Typical reverse recovery current as a function of diode current slope ( $V_R=400\text{V}$ )

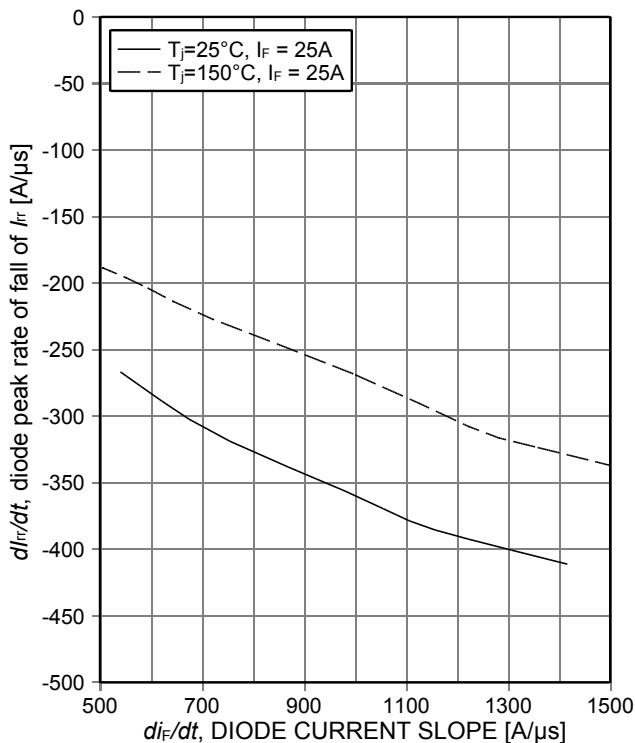


Figure 23. Typical diode peak rate of fall of reverse recovery current as a function of diode current slope ( $V_R=400\text{V}$ )

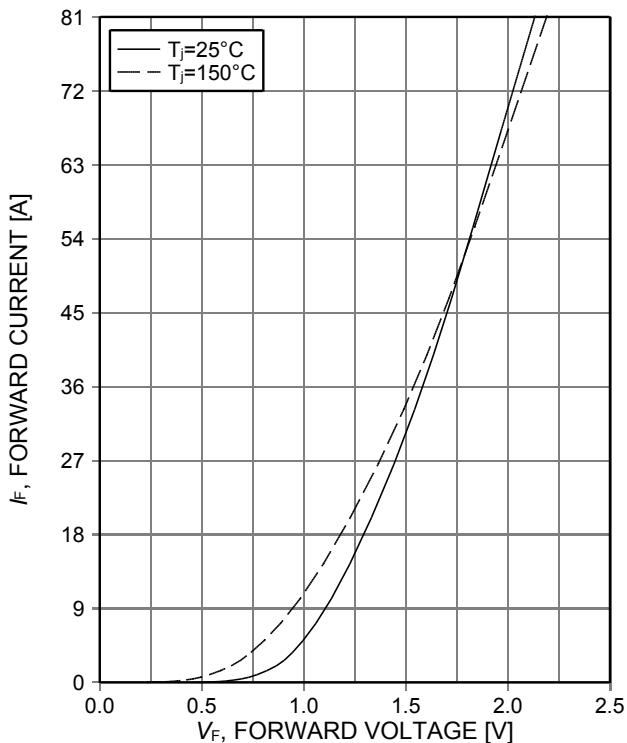


Figure 24. Typical diode forward current as a function of forward voltage

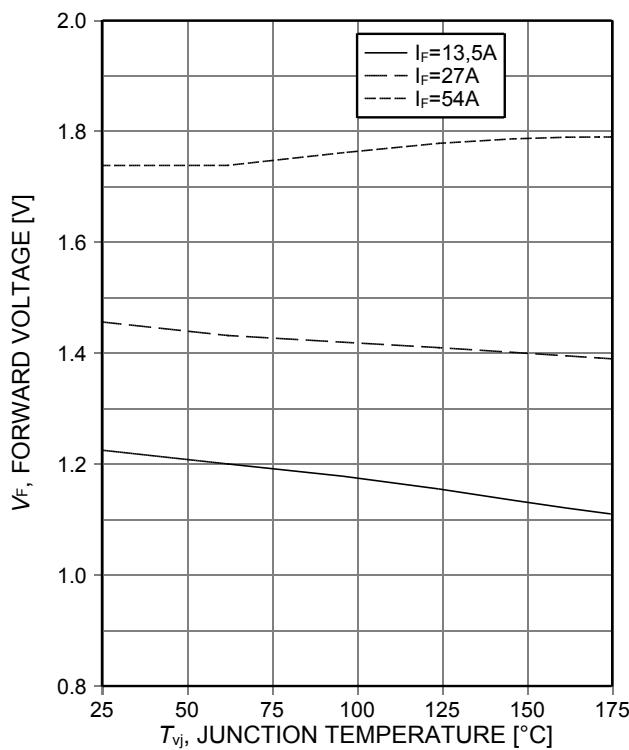
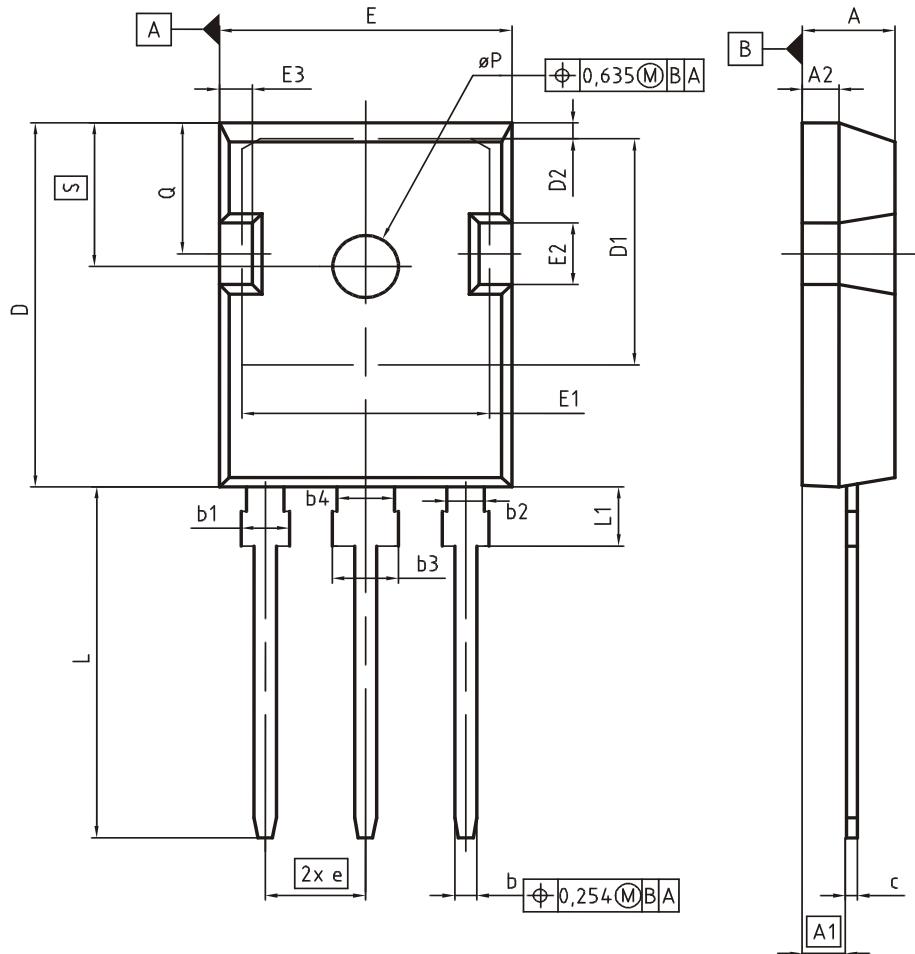


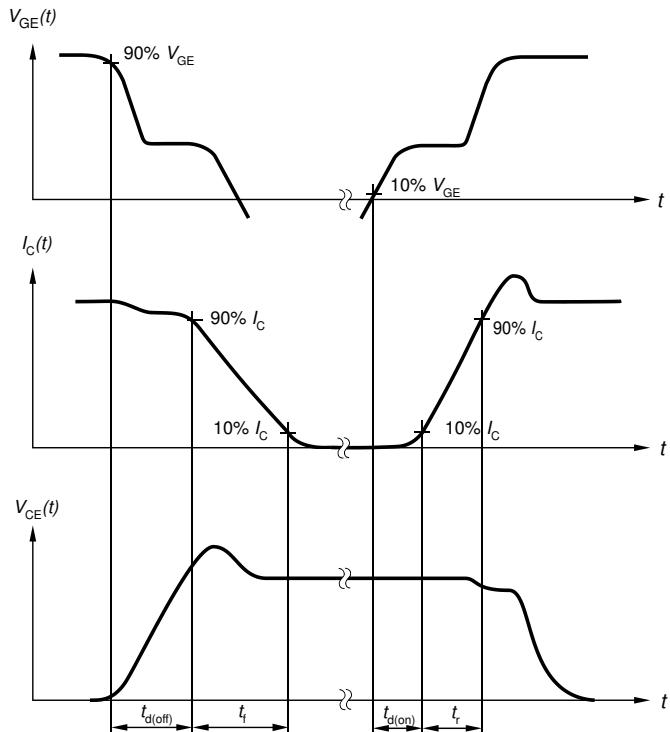
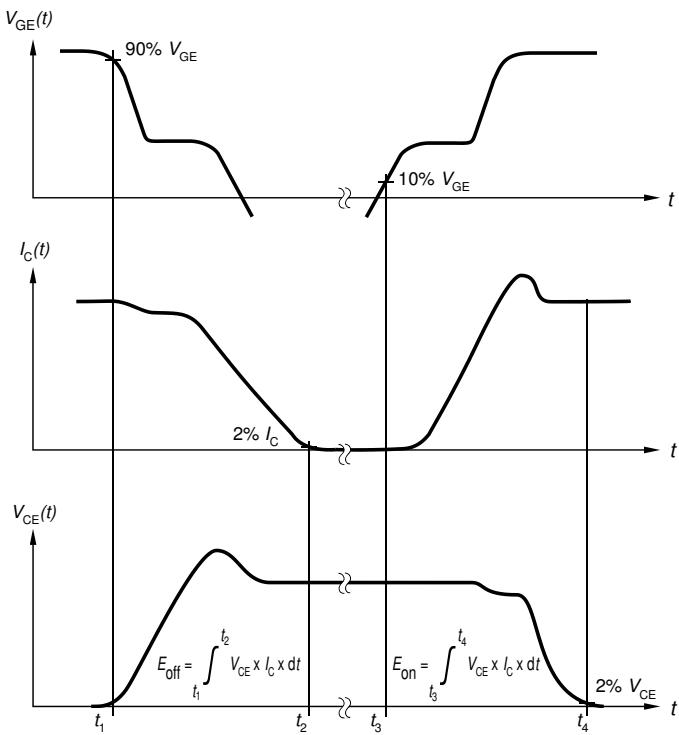
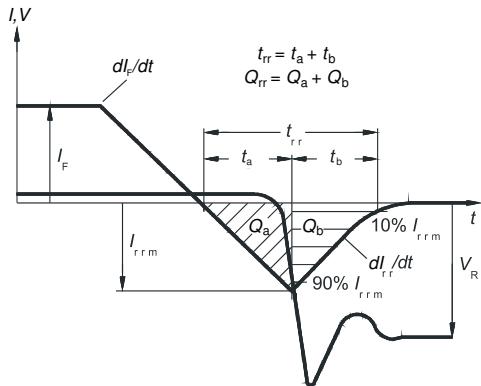
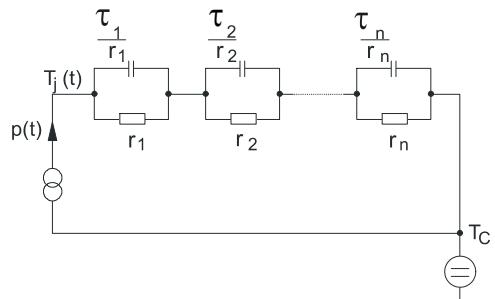
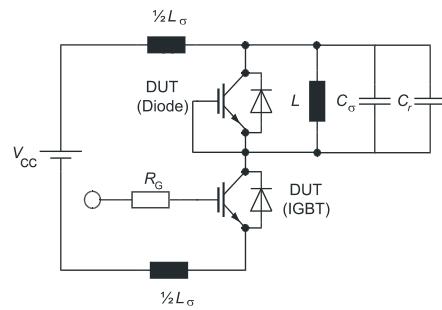
Figure 25. Typical diode forward voltage as a function of junction temperature

## Package Drawing PG-T0247-3



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 0 5 5 7.5mm
EUROPEAN PROJECTION	
ISSUE DATE	09-07-2010
REVISION	05

**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  $L_\sigma$ ,  
parasitic capacitor  $C_\sigma$ ,  
relief capacitor  $C_r$ ,  
(only for ZVT switching)

**Revision History**

IKW50N65H5

**Revision: 2015-05-06, Rev. 2.1****Previous Revision**

Revision	Date	Subjects (major changes since last revision)
1.1	2012-11-09	Preliminary data sheet
1.2	2013-12-18	New Marking Pattern
2.1	2015-05-06	Final data sheet

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**Published by**

Infineon Technologies AG

81726 Munich, Germany

81726 München, Germany

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