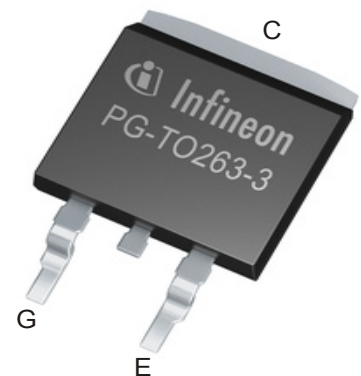
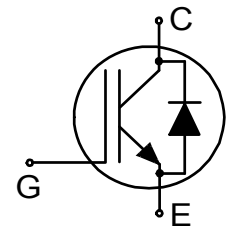


High speed switching series fifth generation

High speed 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
  - Dynamically stress tested
  - Qualified according to AEC-Q101
  - Green package (RoHS compliant)
  - Complete product spectrum and PSpice Models:  
<http://www.infineon.com/igbt/>



#### Applications:

- Off-board charger
- On-board charger
- DC/DC converter
- Power-Factor correction

#### Package pin definition:

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



#### Key Performance and Package Parameters

Type	$V_{CE}$	$I_C$	$V_{CEsat}, T_{vj}=25^\circ\text{C}$	$T_{vjmax}$	Marking	Package
AIKB50N65DF5	650V	50A	1.6V	175°C	AK50EDF5	PG-TO263-3



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## High speed switching series fifth generation

## Maximum Ratings

Parameter	Symbol	Value	Unit
Collector-emitter voltage, $T_{vj} \geq 25^{\circ}\text{C}$	$V_{CE}$	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 $T_{vjmax}^{1)}$	$I_{Cpuls}$	150.0	A
Turn off safe operating area $V_{CE} \leq 650\text{V}$ , $T_{vj} \leq 175^{\circ}\text{C}$ , $t_p = 1\mu\text{s}^{1)}$	-	150.0	A
Diode forward current, limited by $T_{vjmax}$ $T_c = 25^{\circ}\text{C}$ value limited by bondwire $T_c = 100^{\circ}\text{C}$	$I_F$	42.0 26.0	A
Diode pulsed current, $t_p$ limited by $T_{vjmax}^{1)}$	$I_{Fpuls}$	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	$^{\circ}\text{C}$
Storage temperature	$T_{stg}$	-55...+150	$^{\circ}\text{C}$
Soldering temperature, reflow soldering (MSL1 according to JEDEC J-STA-020)		260	$^{\circ}\text{C}$

## Thermal Resistance

Parameter	Symbol	Conditions	Value			Unit
			min.	typ.	max.	

 $R_{th}$  Characteristics

IGBT thermal resistance, junction - case	$R_{th(j-c)}$		-	-	0.50	K/W
Diode thermal resistance, junction - case	$R_{th(j-c)}$		-	-	1.60	K/W
Thermal resistance, min. footprint junction - ambient	$R_{th(j-a)}$		-	-	65	K/W
Thermal resistance, 6cm <sup>2</sup> Cu on PCB junction - ambient	$R_{th(j-a)}$		-	-	40	K/W

<sup>1)</sup> Defined by design. Not subject to production test.

## High speed switching series fifth generation

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	$V_{(BR)CES}$	$V_{GE} = 0\text{V}, I_C = 0.20\text{mA}$	650	-	-	V
Collector-emitter saturation voltage	$V_{CESat}$	$V_{GE} = 15.0\text{V}, I_C = 50.0\text{A}$ $T_{vj} = 25^{\circ}\text{C}$ $T_{vj} = 125^{\circ}\text{C}$ $T_{vj} = 175^{\circ}\text{C}$	-	1.60	2.10	V
			-	1.80	-	
			-	1.90	-	
Diode forward voltage	$V_F$	$V_{GE} = 0\text{V}, I_F = 27.0\text{A}$ $T_{vj} = 25^{\circ}\text{C}$ $T_{vj} = 125^{\circ}\text{C}$ $T_{vj} = 175^{\circ}\text{C}$	-	1.45	1.80	V
			-	1.40	-	
			-	1.40	-	
Gate-emitter threshold voltage	$V_{GE(th)}$	$I_C = 0.50\text{mA}, V_{CE} = V_{GE}$	3.2	4.0	4.8	V
Zero gate voltage collector current	$I_{CES}$	$V_{CE} = 650\text{V}, V_{GE} = 0\text{V}$ $T_{vj} = 25^{\circ}\text{C}$ $T_{vj} = 175^{\circ}\text{C}$	-	-	40	$\mu\text{A}$
			-	1000	-	
Gate-emitter leakage current	$I_{GES}$	$V_{CE} = 0\text{V}, V_{GE} = 20\text{V}$	-	-	100	nA
Transconductance	$g_{fs}$	$V_{CE} = 20\text{V}, I_C = 50.0\text{A}$	-	50.0	-	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	$C_{ies}$	$V_{CE} = 25\text{V}, V_{GE} = 0\text{V}, f = 1\text{MHz}$	-	3000	-	pF
Output capacitance	$C_{oes}$		-	65	-	
Reverse transfer capacitance	$C_{res}$		-	11	-	
Gate charge	$Q_G$	$V_{CC} = 520\text{V}, I_C = 50.0\text{A},$ $V_{GE} = 15\text{V}$	-	115.0	-	nC
Internal emitter inductance measured 5mm (0.197 in.) from case	$L_E$		-	7.0	-	nH

## Switching Characteristic, Inductive Load

Parameter	Symbol	Conditions	Value			Unit
			min.	typ.	max.	

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

Turn-on delay time	$t_{d(on)}$	$T_{vj} = 25^{\circ}\text{C},$ $V_{CC} = 400\text{V}, I_C = 25.0\text{A},$ $V_{GE} = 0.0/15.0\text{V},$ $R_{G(on)} = 12.0\Omega, R_{G(off)} = 12.0\Omega,$ $L_{\sigma} = 30\text{nH}, C_{\sigma} = 30\text{pF}$ $L_{\sigma}, C_{\sigma}$ from Fig. E Energy losses include "tail" and diode reverse recovery.	-	23	-	ns
Rise time	$t_r$		-	16	-	ns
Turn-off delay time	$t_{d(off)}$		-	166	-	ns
Fall time	$t_f$		-	13	-	ns
Turn-on energy	$E_{on}$		-	0.55	-	mJ
Turn-off energy	$E_{off}$		-	0.11	-	mJ
Total switching energy	$E_{ts}$		-	0.66	-	mJ

## High speed switching series fifth generation

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	$t_r$		-	5	-	ns
Turn-off delay time	$t_{d(off)}$		-	172	-	ns
Fall time	$t_f$		-	28	-	ns
Turn-on energy	$E_{on}$		-	0.13	-	mJ
Turn-off energy	$E_{off}$		-	0.04	-	mJ
Total switching energy	$E_{ts}$		-	0.17	-	mJ

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

Diode reverse recovery time	$t_{rr}$	$T_{vj} = 25^{\circ}\text{C}$ , $V_R = 400\text{V}$ , $I_F = 25.0\text{A}$ , $di_F/dt = 1225\text{A}/\mu\text{s}$	-	79	-	ns
Diode reverse recovery charge	$Q_{rr}$		-	0.65	-	$\mu\text{C}$
Diode peak reverse recovery current	$I_{rrm}$		-	14.9	-	A
Diode peak rate of fall of reverse recovery current during $t_b$	$di_{rr}/dt$		-	-235	-	$\text{A}/\mu\text{s}$
Diode reverse recovery time	$t_{rr}$	$T_{vj} = 25^{\circ}\text{C}$ , $V_R = 400\text{V}$ , $I_F = 6.0\text{A}$ , $di_F/dt = 1335\text{A}/\mu\text{s}$	-	36	-	ns
Diode reverse recovery charge	$Q_{rr}$		-	0.32	-	$\mu\text{C}$
Diode peak reverse recovery current	$I_{rrm}$		-	14.3	-	A
Diode peak rate of fall of reverse recovery current during $t_b$	$di_{rr}/dt$		-	-805	-	$\text{A}/\mu\text{s}$

## Switching Characteristic, Inductive Load

Parameter	Symbol	Conditions	Value			Unit
			min.	typ.	max.	
<b>IGBT Characteristic, at <math>T_{vj} = 150^{\circ}\text{C}</math></b>						
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.	-	22	-	ns
Rise time	$t_r$		-	17	-	ns
Turn-off delay time	$t_{d(off)}$		-	179	-	ns
Fall time	$t_f$		-	9	-	ns
Turn-on energy	$E_{on}$		-	0.74	-	mJ
Turn-off energy	$E_{off}$		-	0.15	-	mJ
Total switching energy	$E_{ts}$		-	0.89	-	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.	-	19	-	ns
Rise time	$t_r$		-	6	-	ns
Turn-off delay time	$t_{d(off)}$		-	205	-	ns
Fall time	$t_f$		-	19	-	ns
Turn-on energy	$E_{on}$		-	0.21	-	mJ
Turn-off energy	$E_{off}$		-	0.06	-	mJ
Total switching energy	$E_{ts}$		-	0.27	-	mJ

## High speed switching series fifth generation

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

Diode reverse recovery time	$t_{rr}$	$T_{vj} = 150^{\circ}\text{C},$ $V_R = 400\text{V},$ $I_F = 25.0\text{A},$ $di_F/dt = 1190\text{A}/\mu\text{s}$	-	117	-	ns
Diode reverse recovery charge	$Q_{rr}$		-	1.35	-	$\mu\text{C}$
Diode peak reverse recovery current	$I_{rrm}$		-	20.9	-	A
Diode peak rate of fall of reverse recovery current during $t_b$	$di_{rr}/dt$		-	-224	-	$\text{A}/\mu\text{s}$
Diode reverse recovery time	$t_{rr}$	$T_{vj} = 150^{\circ}\text{C},$ $V_R = 400\text{V},$ $I_F = 6.0\text{A},$ $di_F/dt = 1268\text{A}/\mu\text{s}$	-	63	-	ns
Diode reverse recovery charge	$Q_{rr}$		-	0.70	-	$\mu\text{C}$
Diode peak reverse recovery current	$I_{rrm}$		-	20.3	-	A
Diode peak rate of fall of reverse recovery current during $t_b$	$di_{rr}/dt$		-	-514	-	$\text{A}/\mu\text{s}$

High speed switching series fifth generation

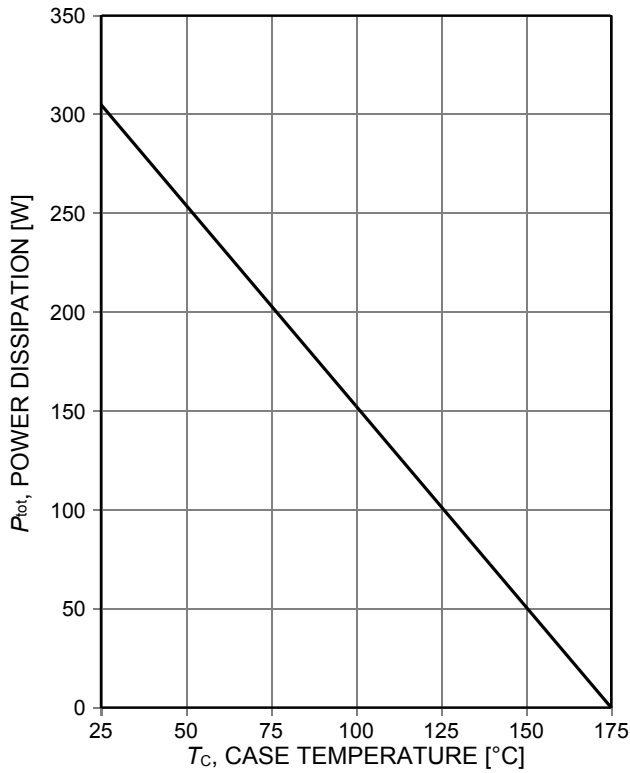


Figure 1. Power dissipation as a function of case temperature ( $T_{vj} \leq 175^\circ\text{C}$ )

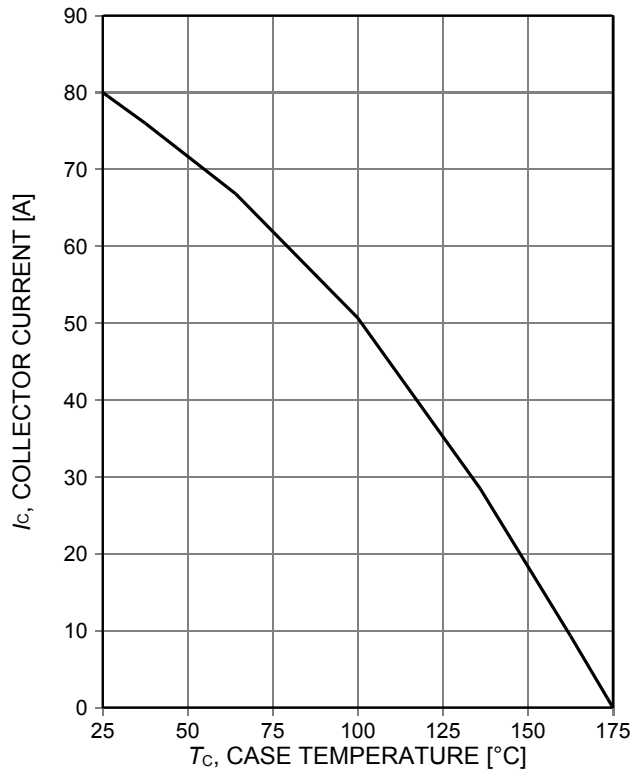


Figure 2. Collector current as a function of case temperature ( $V_{GE} \geq 15\text{V}$ ,  $T_{vj} \leq 175^\circ\text{C}$ )

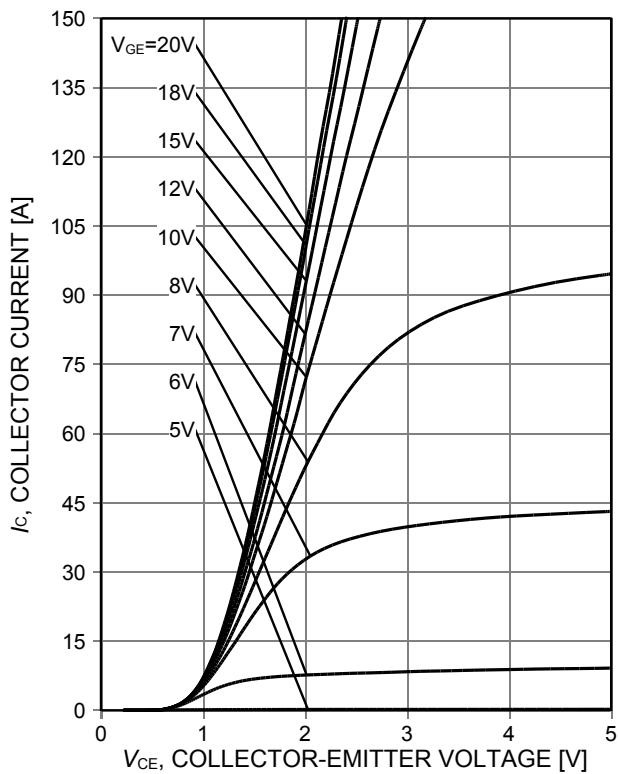


Figure 3. Typical output characteristic ( $T_{vj} = 25^\circ\text{C}$ )

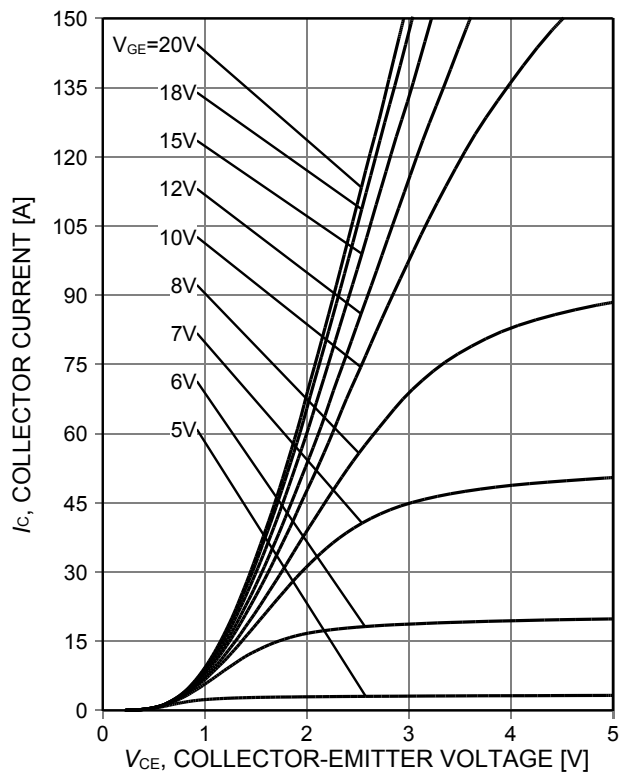


Figure 4. Typical output characteristic ( $T_{vj} = 150^\circ\text{C}$ )

High speed switching series fifth generation

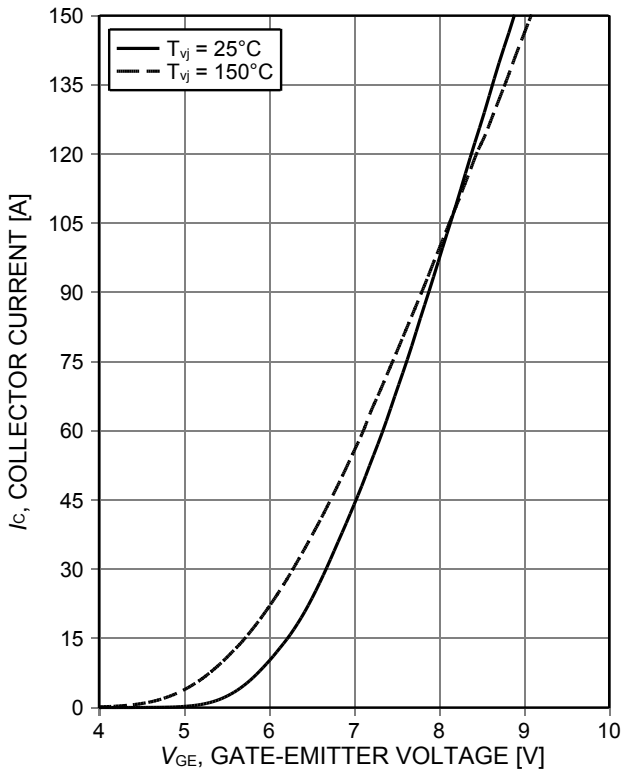


Figure 5. Typical transfer characteristic (V<sub>CE</sub>=20V)

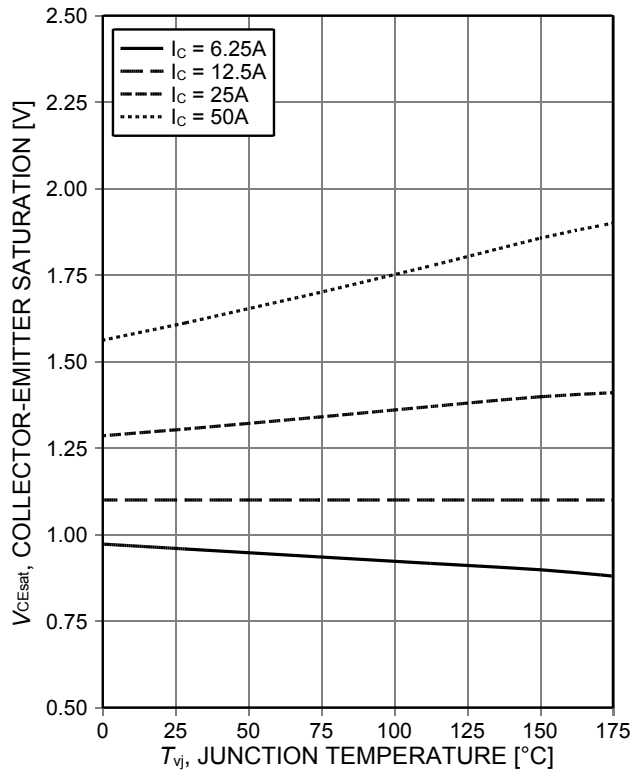


Figure 6. Typical collector-emitter saturation voltage as a function of junction temperature (V<sub>GE</sub>=15V)

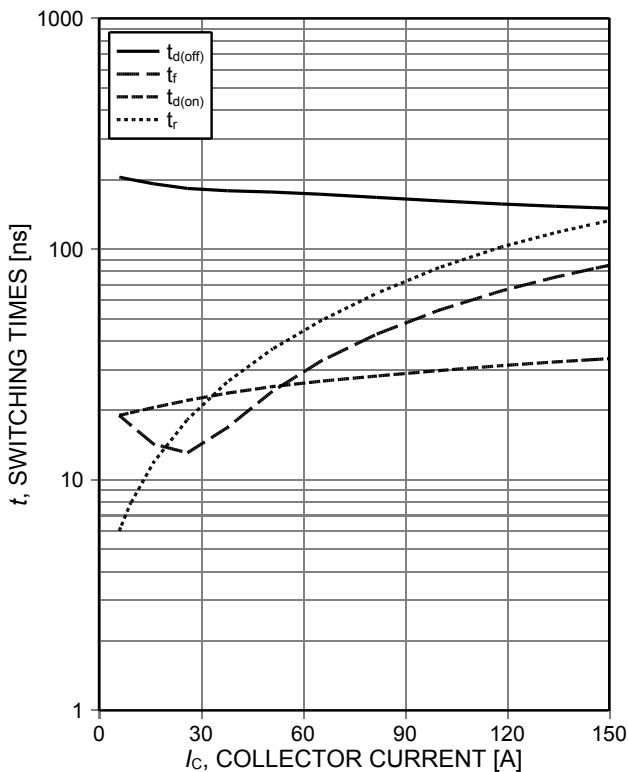


Figure 7. Typical switching times as a function of collector current (inductive load, T<sub>vj</sub>=150°C, V<sub>CE</sub>=400V, V<sub>GE</sub>=15/0V, r<sub>G</sub>=12Ω, Dynamic test circuit in Figure E)

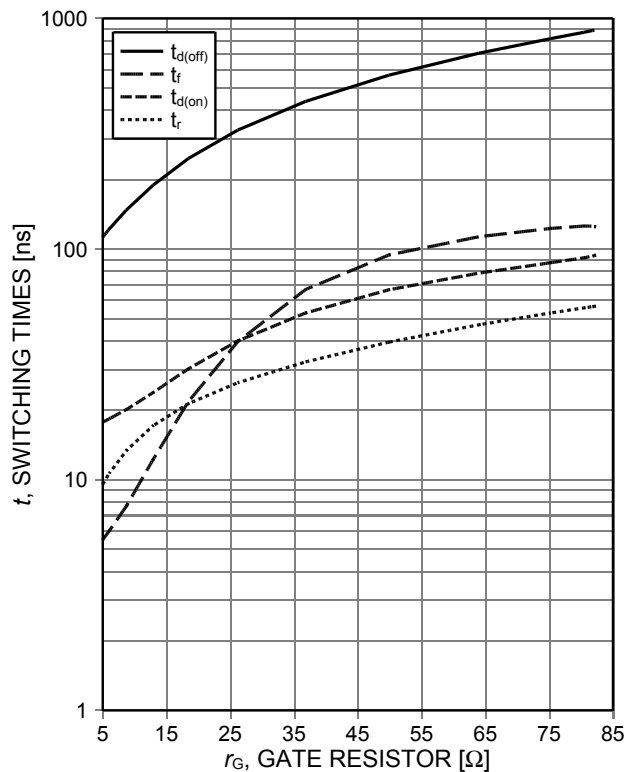


Figure 8. Typical switching times as a function of gate resistor (inductive load, T<sub>vj</sub>=150°C, V<sub>CE</sub>=400V, V<sub>GE</sub>=15/0V, Ic=25A, Dynamic test circuit in Figure E)



High speed switching series fifth generation

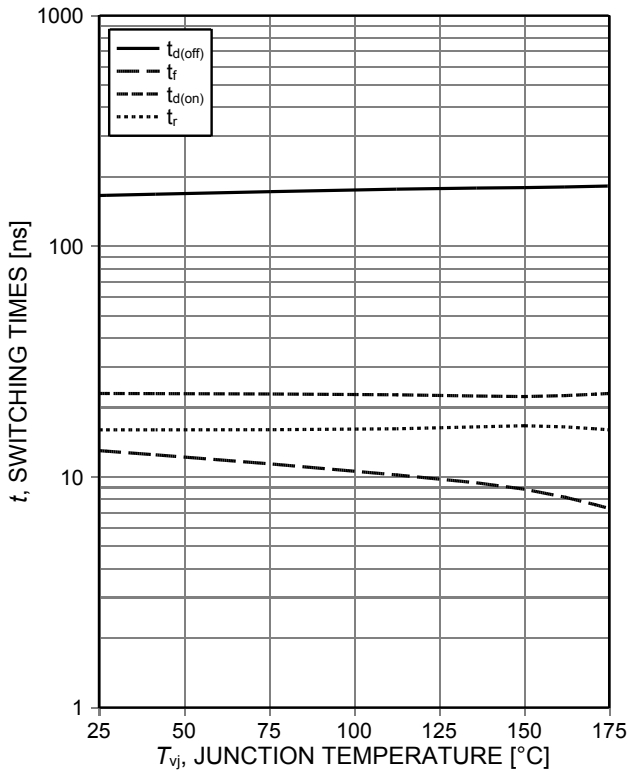


Figure 9. Typical switching times as a function of junction temperature (inductive load,  $V_{CE}=400V$ ,  $V_{GE}=15/0V$ ,  $I_C=25A$ ,  $r_G=12\Omega$ , Dynamic test circuit in Figure E)

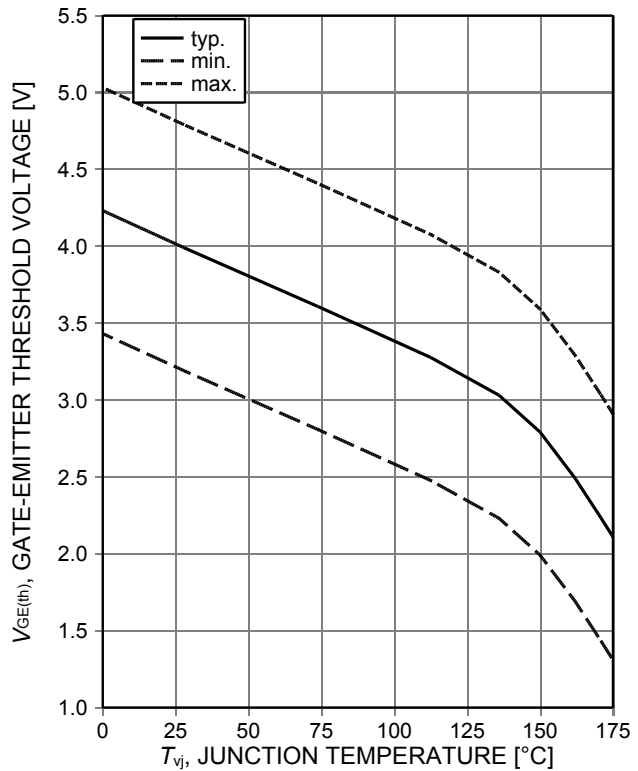


Figure 10. Gate-emitter threshold voltage as a function of junction temperature ( $I_C=0.5mA$ )

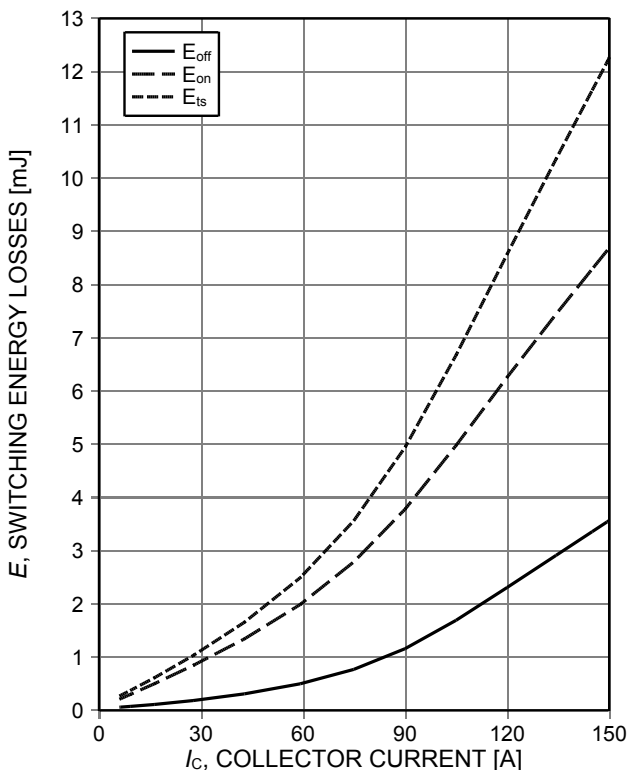


Figure 11. Typical switching energy losses as a function of collector current (inductive load,  $T_{vj}=150^\circ C$ ,  $V_{CE}=400V$ ,  $V_{GE}=15/0V$ ,  $r_G=12\Omega$ , Dynamic test circuit in Figure E)

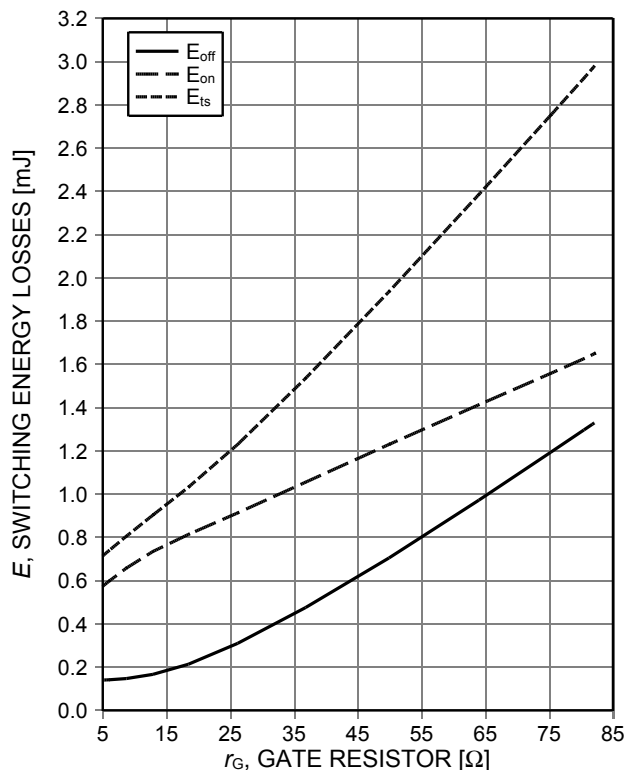


Figure 12. Typical switching energy losses as a function of gate resistor (inductive load,  $T_{vj}=150^\circ C$ ,  $V_{CE}=400V$ ,  $V_{GE}=15/0V$ ,  $I_C=25A$ , Dynamic test circuit in Figure E)

High speed switching series fifth generation

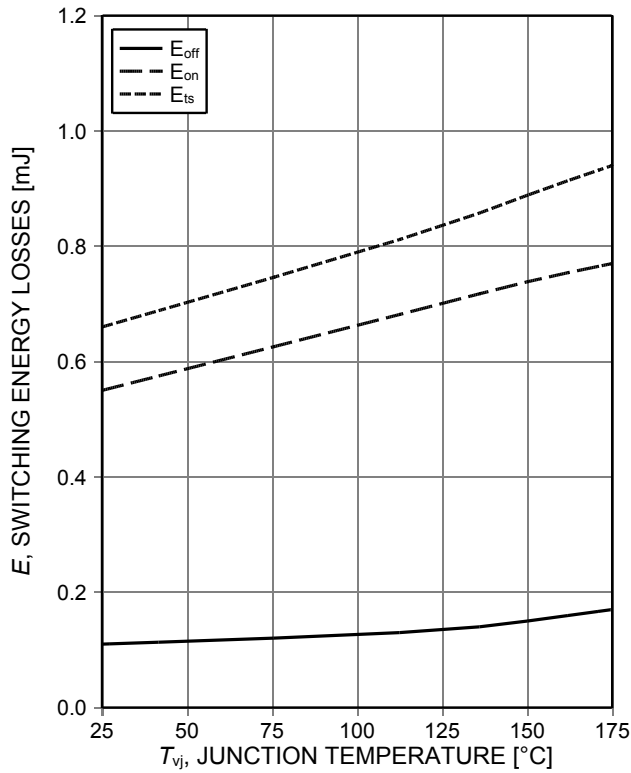


Figure 13. **Typical switching energy losses as a function of junction temperature** (inductive load,  $V_{CE}=400V$ ,  $V_{GE}=15/0V$ ,  $I_C=25A$ ,  $r_G=12\Omega$ , Dynamic test circuit in Figure E)

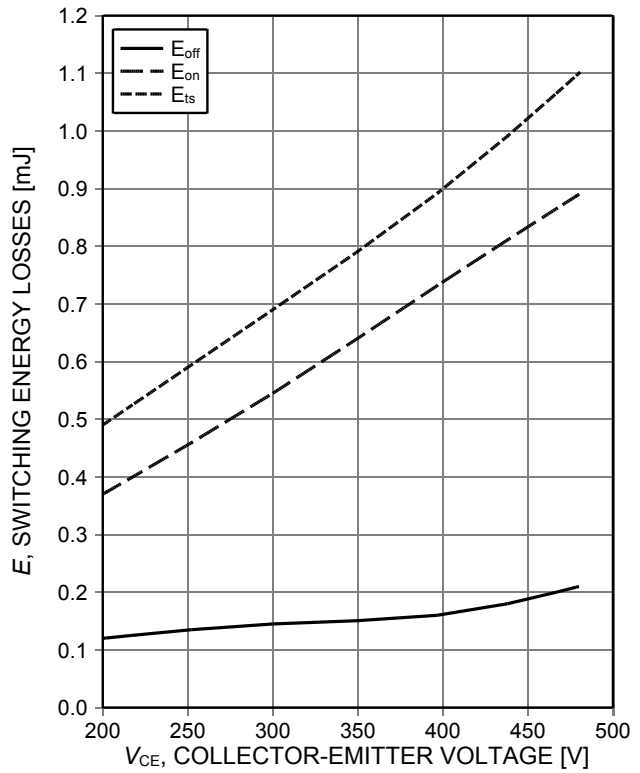


Figure 14. **Typical switching energy losses as a function of collector emitter voltage** (inductive load,  $T_{vj}=150^\circ C$ ,  $V_{GE}=15/0V$ ,  $I_C=25A$ ,  $r_G=12\Omega$ , Dynamic test circuit in Figure E)

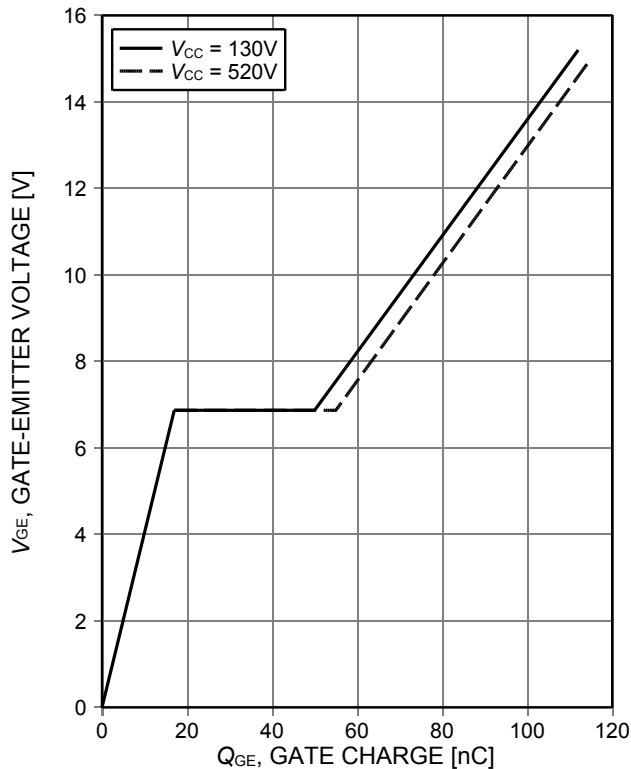


Figure 15. **Typical gate charge** ( $I_C=50A$ )

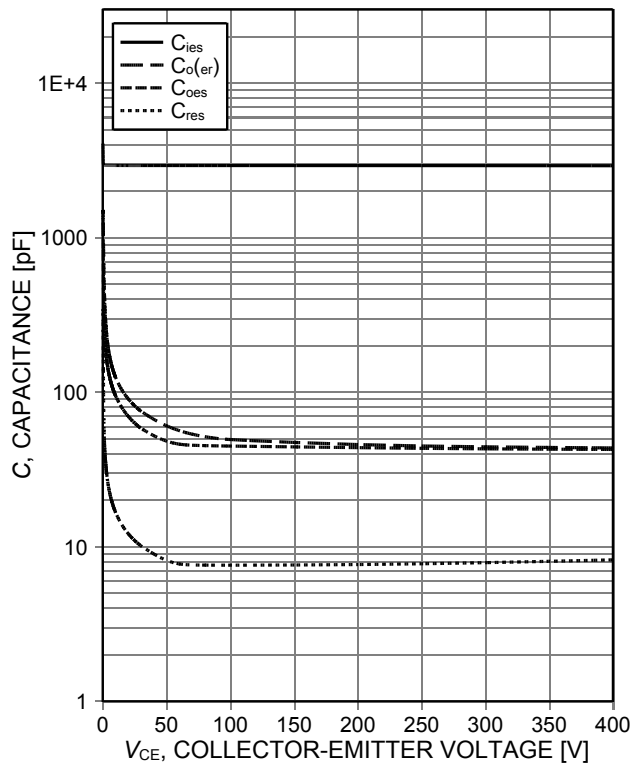


Figure 16. **Typical capacitance as a function of collector-emitter voltage** ( $V_{GE}=0V$ ,  $f=1MHz$ )

High speed switching series fifth generation

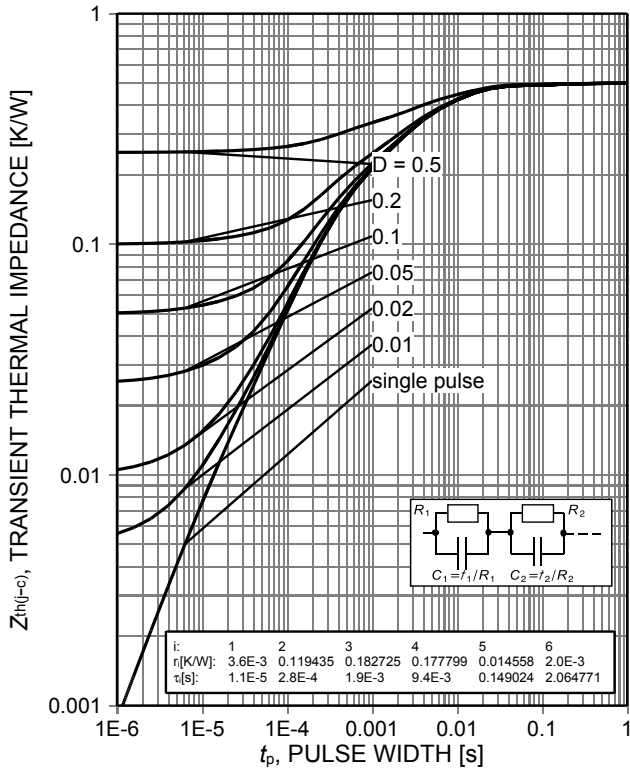


Figure 17. IGBT transient thermal impedance ( $D=t_p/T$ )

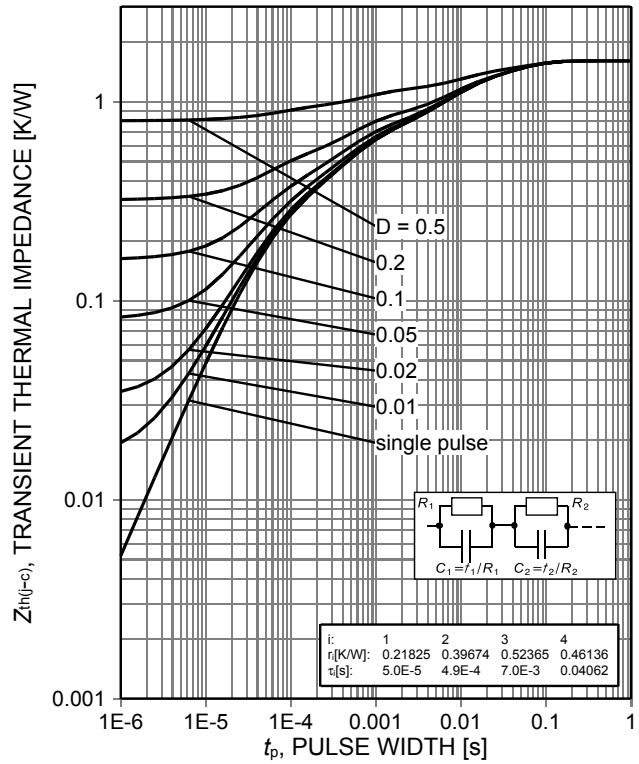


Figure 18. Diode transient thermal impedance as a function of pulse width ( $D=t_p/T$ )

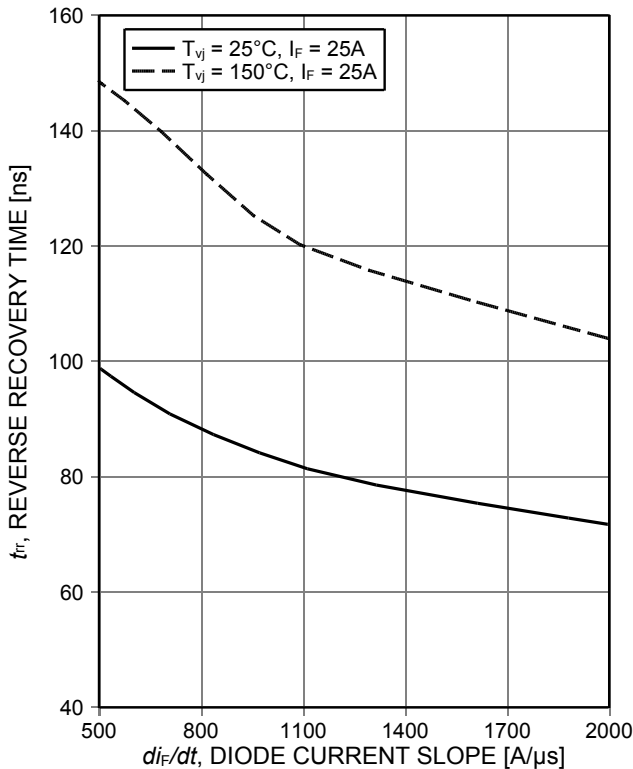


Figure 19. Typical reverse recovery time as a function of diode current slope ( $V_R=400V$ )

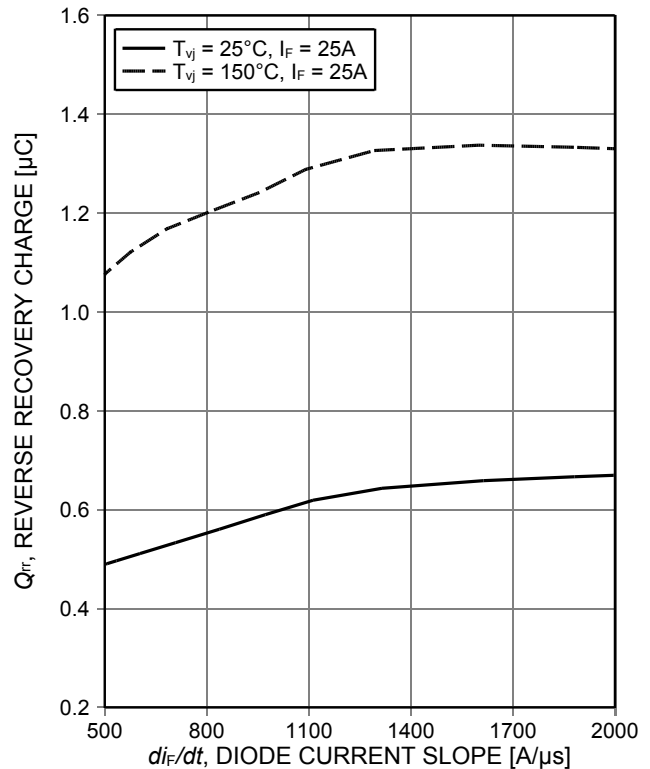


Figure 20. Typical reverse recovery charge as a function of diode current slope ( $V_R=400V$ )

High speed switching series fifth generation

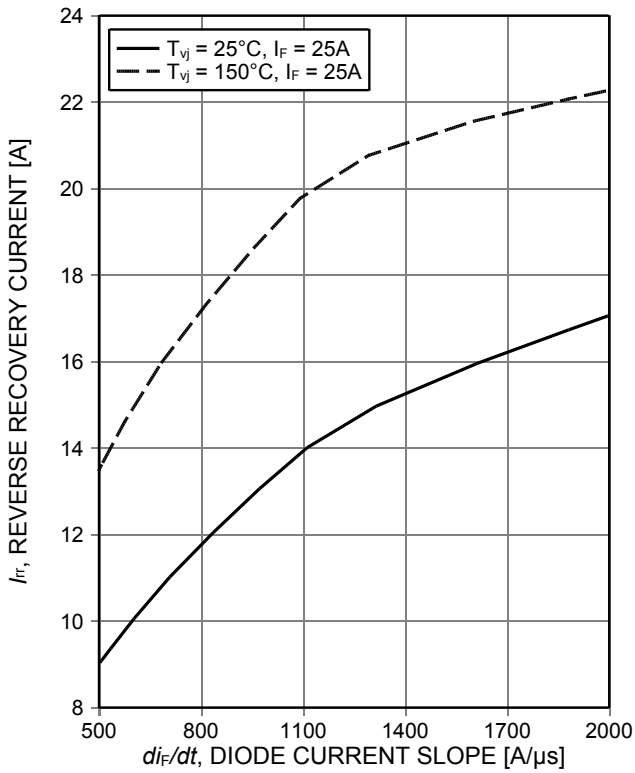


Figure 21. Typical reverse recovery current as a function of diode current slope ( $V_R=400V$ )

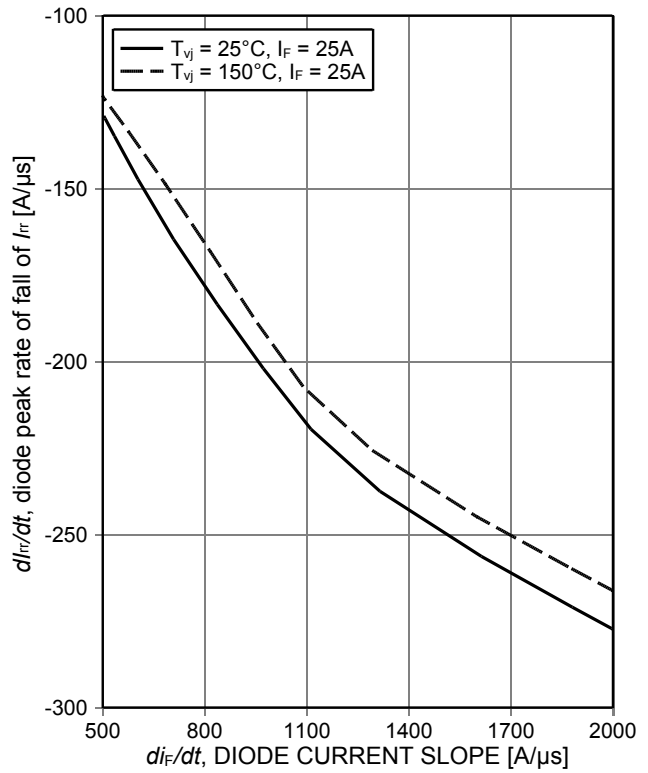


Figure 22. Typical diode peak rate of fall of reverse recovery current as a function of diode current slope ( $V_R=400V$ )

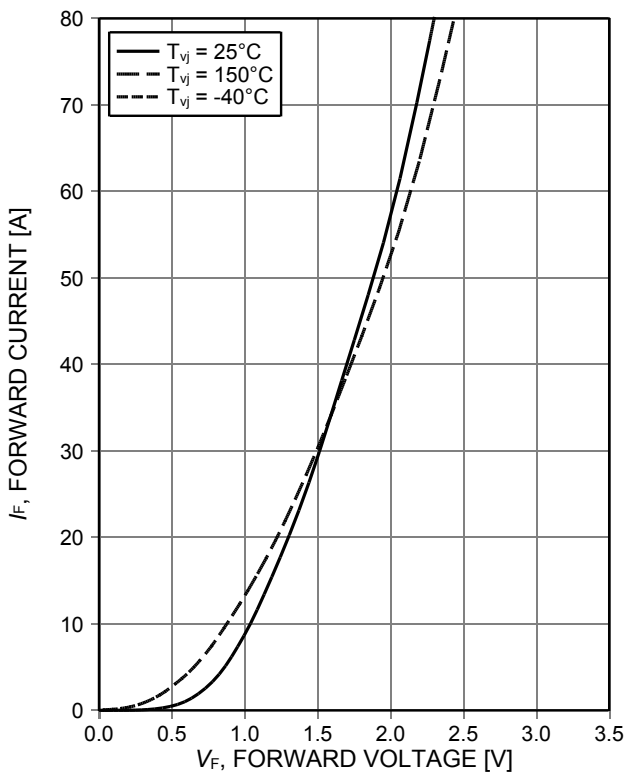


Figure 23. Typical diode forward current as a function of forward voltage

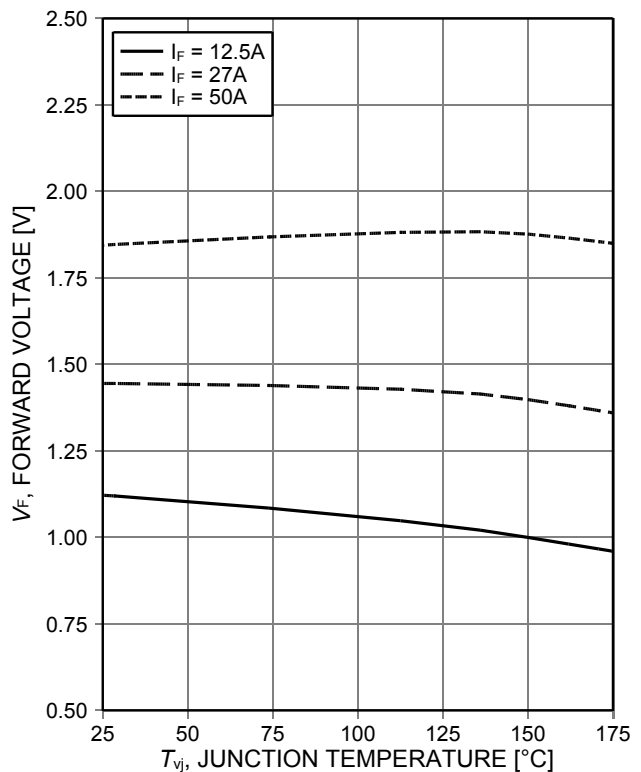
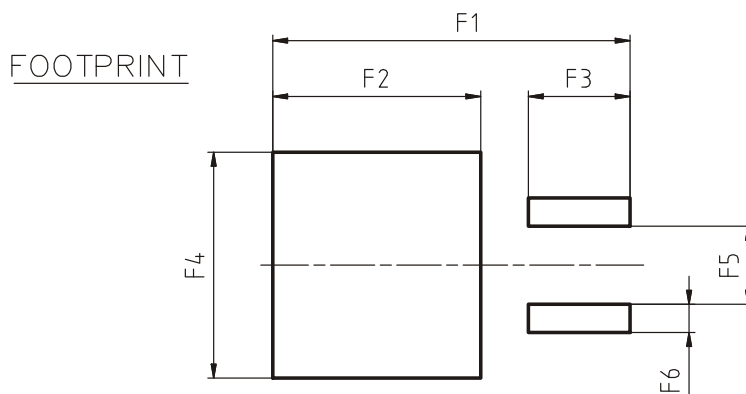
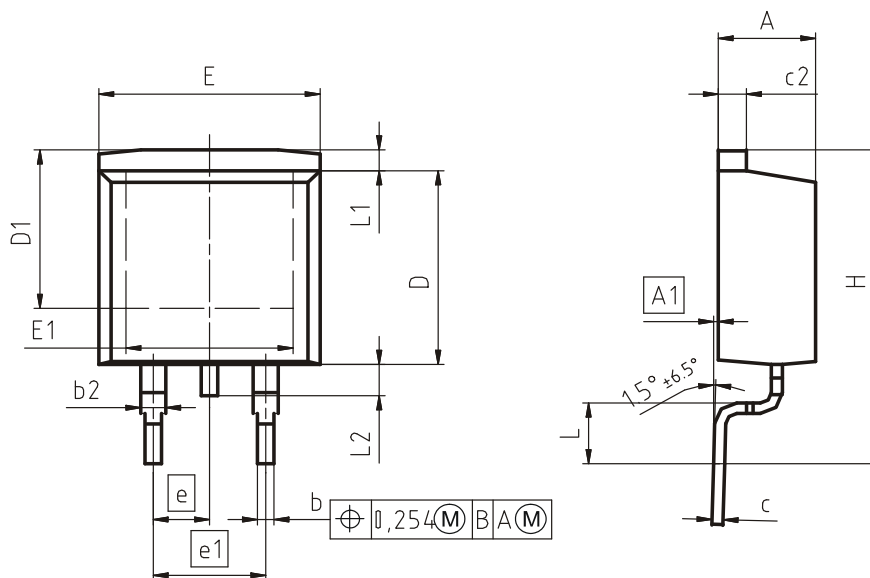


Figure 24. Typical diode forward voltage as a function of junction temperature

Package Drawing PG-TO263-3



DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.30	4.57	0.169	0.180
A1	0.00	0.25	0.000	0.010
b	0.65	0.85	0.026	0.033
b2	0.95	1.15	0.037	0.045
c	0.33	0.65	0.013	0.026
c2	1.17	1.40	0.046	0.055
D	8.51	9.45	0.335	0.372
D1	7.10	7.90	0.280	0.311
E	9.80	10.31	0.386	0.406
E1	6.50	8.60	0.256	0.339
e	2.54		0.100	
e1	5.08		0.200	
N	2		2	
H	14.61	15.88	0.575	0.625
L	2.29	3.00	0.090	0.118
L1	0.70	1.60	0.028	0.063
L2	1.00	1.78	0.039	0.070
F1	16.05	16.25	0.632	0.640
F2	9.30	9.50	0.366	0.374
F3	4.50	4.70	0.177	0.185
F4	10.70	10.90	0.421	0.429
F5	3.65	3.85	0.144	0.152
F6	1.25	1.45	0.049	0.057

DOCUMENT NO.  
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SCALE

7.5mm

EUROPEAN PROJECTION

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REVISION  
01

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)

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High speed switching series fifth generation

## Revision History

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AIKB50N65DF5

**Revision: 2019-10-17, Rev. 2.1**

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Previous Revision

Revision	Date	Subjects (major changes since last revision)
2.1	2019-10-17	Final Datasheet

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