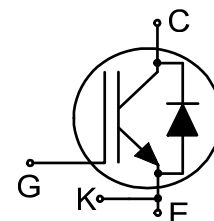


TRENCHSTOP™ 5 soft switching IGBT

TRENCHSTOP™ 5 high speed soft switching IGBT copacked with full current rated RAPID 1 fast and soft antiparallel diode

Features and Benefits:

- High speed S5 technology offering
- High speed smooth switching device for hard & soft switching
- Very Low V_{CEsat} , 1.42V at nominal current
- Plug and play replacement of previous generation IGBTs
- 650V breakdown voltage
- Low gate charge Q_G
- IGBT copacked with full rated RAPID 1 fast 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:

- Industrial UPS
- Industrial SMPS
- Energy Storage
- Charger
- Welding

Product Validation:

Qualified for applications listed above based on the test conditions in the relevant tests of JEDEC20/22

Package pin definition:

- Pin C & backside - collector
- Pin E - emitter
- Pin K - Kelvin emitter
- Pin G - gate

Please note: The emitter and Kelvin emitter pins are not exchangeable. Their exchange might lead to malfunction.



Key Performance and Package Parameters

Type	V_{CE}	I_C	V_{CEsat} , $T_{vj}=25^\circ\text{C}$	T_{vjmax}	Marking	Package
IKZ50N65ES5	650V	50A	1.35V	175°C	K50EES5	PG-TO247-4

Table of Contents

Description	1
Table of Contents	2
Maximum Ratings	3
Thermal Resistance	3
Electrical Characteristics	4
Electrical Characteristics Diagrams	7
Package Drawing	13
Testing Conditions	14
Revision History	15
Disclaimer	16

TRENCHSTOP™ 5 soft switching IGBT

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, $T_{vj} \geq 25^{\circ}\text{C}$	V_{CE}	650	V
DC collector current, limited by $T_{vjmax}^{1)}$ $T_C = 25^{\circ}\text{C}$ value limited by bondwire $T_C = 100^{\circ}\text{C}$	I_C	80.0 60.5	A
Pulsed collector current, t_p limited by T_{vjmax}	I_{Cpuls}	200.0	A
Turn off safe operating area $V_{CE} \leq 650\text{V}$, $T_{vj} \leq 175^{\circ}\text{C}$, $t_p = 1\mu\text{s}$	-	200.0	A
Diode forward current, limited by $T_{vjmax}^{1)}$ $T_C = 25^{\circ}\text{C}$ value limited by bondwire $T_C = 100^{\circ}\text{C}$	I_F	80.0 60.5	A
Diode pulsed current, t_p limited by T_{vjmax}	I_{Fpuls}	200.0	A
Gate-emitter voltage Transient Gate-emitter voltage ($t_p \leq 10\mu\text{s}$, $D < 0.010$)	V_{GE}	± 20 ± 30	V
Power dissipation $T_C = 25^{\circ}\text{C}$ Power dissipation $T_C = 100^{\circ}\text{C}$	P_{tot}	274.0 137.0	W
Operating junction temperature	T_{vj}	-40...+175	$^{\circ}\text{C}$
Storage temperature	T_{stg}	-55...+150	$^{\circ}\text{C}$
Soldering temperature, wave soldering 1.6mm (0.063in.) from case for 10s		260	$^{\circ}\text{C}$
Mounting torque, M3 screw 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⁾ value limited by bondwire

TRENCHSTOP™ 5 soft switching IGBT

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

Parameter	Symbol	Conditions	Value			Unit
			min.	typ.	max.	
Static Characteristic						
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}	$V_{GE} = 15.0\text{V}, I_C = 50.0\text{A}$ $T_{vj} = 25^{\circ}\text{C}$ $T_{vj} = 125^{\circ}\text{C}$ $T_{vj} = 175^{\circ}\text{C}$	-	1.35	1.70	V
			-	1.50	-	
			-	1.60	-	
Diode forward voltage	V_F	$V_{GE} = 0\text{V}, I_F = 50.0\text{A}$ $T_{vj} = 25^{\circ}\text{C}$ $T_{vj} = 125^{\circ}\text{C}$ $T_{vj} = 175^{\circ}\text{C}$	-	1.45	1.70	V
			-	1.42	-	
			-	1.39	-	
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}	$V_{CE} = 650\text{V}, V_{GE} = 0\text{V}$ $T_{vj} = 25^{\circ}\text{C}$ $T_{vj} = 175^{\circ}\text{C}$	-	-	50	μA
			-	2000	-	
Gate-emitter leakage current	I_{GES}	$V_{CE} = 0\text{V}, V_{GE} = 20\text{V}$	-	-	100	nA
Transconductance	g_{fs}	$V_{CE} = 20\text{V}, I_C = 50.0\text{A}$	-	62.0	-	S

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

Parameter	Symbol	Conditions	Value			Unit
			min.	typ.	max.	
Dynamic Characteristic						
Input capacitance	C_{ies}	$V_{CE} = 25\text{V}, V_{GE} = 0\text{V}, f = 1\text{MHz}$	-	3100	-	pF
Output capacitance	C_{oes}		-	88	-	
Reverse transfer capacitance	C_{res}		-	12	-	
Gate charge	Q_G	$V_{CC} = 520\text{V}, I_C = 50.0\text{A},$ $V_{GE} = 15\text{V}$	-	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.	

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

Turn-on delay time	$t_{d(on)}$	$T_{vj} = 25^{\circ}\text{C},$ $V_{CC} = 400\text{V}, I_C = 50.0\text{A},$ $V_{GE} = 0.0/15.0\text{V},$ $R_{G(on)} = 23.1\Omega, R_{G(off)} = 23.1\Omega,$ $L_{\sigma} = 30\text{nH}, C_{\sigma} = 30\text{pF}$ L_{σ}, C_{σ} from Fig. E Energy losses include "tail" and diode reverse recovery.	-	36	-	ns
Rise time	t_r		-	22	-	ns
Turn-off delay time	$t_{d(off)}$		-	294	-	ns
Fall time	t_f		-	32	-	ns
Turn-on energy	E_{on}		-	0.77	-	mJ
Turn-off energy	E_{off}		-	0.88	-	mJ
Total switching energy	E_{ts}	-	1.65	-	mJ	

TRENCHSTOP™ 5 soft switching IGBT

Turn-on delay time	$t_{d(on)}$	$T_{vj} = 25^{\circ}\text{C}$, $V_{CC} = 400\text{V}$, $I_C = 25.0\text{A}$, $V_{GE} = 0.0/15.0\text{V}$, $R_{G(on)} = 23.1\Omega$, $R_{G(off)} = 23.1\Omega$, $L\sigma = 30\text{nH}$, $C\sigma = 30\text{pF}$ $L\sigma$, $C\sigma$ from Fig. E Energy losses include "tail" and diode reverse recovery.	-	33	-	ns
Rise time	t_r		-	14	-	ns
Turn-off delay time	$t_{d(off)}$		-	304	-	ns
Fall time	t_f		-	33	-	ns
Turn-on energy	E_{on}		-	0.36	-	mJ
Turn-off energy	E_{off}		-	0.32	-	mJ
Total switching energy	E_{ts}		-	0.68	-	mJ

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

Diode reverse recovery time	t_{rr}	$T_{vj} = 25^{\circ}\text{C}$, $V_R = 400\text{V}$, $I_F = 50.0\text{A}$, $di_F/dt = 2500\text{A}/\mu\text{s}$	-	62	-	ns
Diode reverse recovery charge	Q_{rr}		-	1.40	-	μC
Diode peak reverse recovery current	I_{rrm}		-	40.0	-	A
Diode peak rate of fall of reverse recovery current during t_b	di_{rr}/dt		-	-1100	-	$\text{A}/\mu\text{s}$
Diode reverse recovery time	t_{rr}	$T_{vj} = 25^{\circ}\text{C}$, $V_R = 400\text{V}$, $I_F = 25.0\text{A}$, $di_F/dt = 2500\text{A}/\mu\text{s}$	-	44	-	ns
Diode reverse recovery charge	Q_{rr}		-	1.00	-	μC
Diode peak reverse recovery current	I_{rrm}		-	38.5	-	A
Diode peak rate of fall of reverse recovery current during t_b	di_{rr}/dt		-	-2200	-	$\text{A}/\mu\text{s}$

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	$t_{d(on)}$	$T_{vj} = 150^{\circ}\text{C}$, $V_{CC} = 400\text{V}$, $I_C = 50.0\text{A}$, $V_{GE} = 0.0/15.0\text{V}$, $R_{G(on)} = 23.1\Omega$, $R_{G(off)} = 23.1\Omega$, $L\sigma = 30\text{nH}$, $C\sigma = 30\text{pF}$ $L\sigma$, $C\sigma$ from Fig. E Energy losses include "tail" and diode reverse recovery.	-	34	-	ns
Rise time	t_r		-	26	-	ns
Turn-off delay time	$t_{d(off)}$		-	328	-	ns
Fall time	t_f		-	38	-	ns
Turn-on energy	E_{on}		-	1.00	-	mJ
Turn-off energy	E_{off}		-	1.20	-	mJ
Total switching energy	E_{ts}		-	2.20	-	mJ
Turn-on delay time	$t_{d(on)}$	$T_{vj} = 150^{\circ}\text{C}$, $V_{CC} = 400\text{V}$, $I_C = 25.0\text{A}$, $V_{GE} = 0.0/15.0\text{V}$, $R_{G(on)} = 23.1\Omega$, $R_{G(off)} = 23.1\Omega$, $L\sigma = 30\text{nH}$, $C\sigma = 30\text{pF}$ $L\sigma$, $C\sigma$ from Fig. E Energy losses include "tail" and diode reverse recovery.	-	32	-	ns
Rise time	t_r		-	16	-	ns
Turn-off delay time	$t_{d(off)}$		-	354	-	ns
Fall time	t_f		-	44	-	ns
Turn-on energy	E_{on}		-	0.64	-	mJ
Turn-off energy	E_{off}		-	0.56	-	mJ
Total switching energy	E_{ts}		-	1.20	-	mJ

TRENCHSTOP™ 5 soft switching IGBT

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

Diode reverse recovery time	t_{rr}	$T_{vj} = 150^{\circ}\text{C},$ $V_R = 400\text{V},$ $I_F = 50.0\text{A},$ $di_F/dt = 2500\text{A}/\mu\text{s}$	-	92	-	ns
Diode reverse recovery charge	Q_{rr}		-	3.20	-	μC
Diode peak reverse recovery current	I_{rrm}		-	63.0	-	A
Diode peak rate of fall of reverse recovery current during t_b	di_{rr}/dt		-	-1100	-	$\text{A}/\mu\text{s}$
Diode reverse recovery time	t_{rr}	$T_{vj} = 150^{\circ}\text{C},$ $V_R = 400\text{V},$ $I_F = 25.0\text{A},$ $di_F/dt = 2500\text{A}/\mu\text{s}$	-	68	-	ns
Diode reverse recovery charge	Q_{rr}		-	2.30	-	μC
Diode peak reverse recovery current	I_{rrm}		-	59.0	-	A
Diode peak rate of fall of reverse recovery current during t_b	di_{rr}/dt		-	-1850	-	$\text{A}/\mu\text{s}$

TRENCHSTOP™ 5 soft switching IGBT

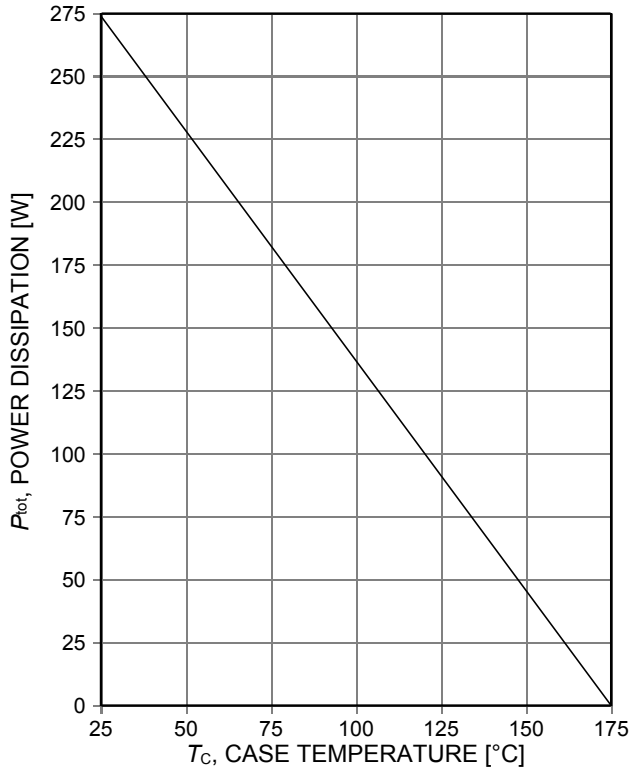


Figure 1. Power dissipation as a function of case temperature ($T_{vj} \leq 175^\circ\text{C}$)

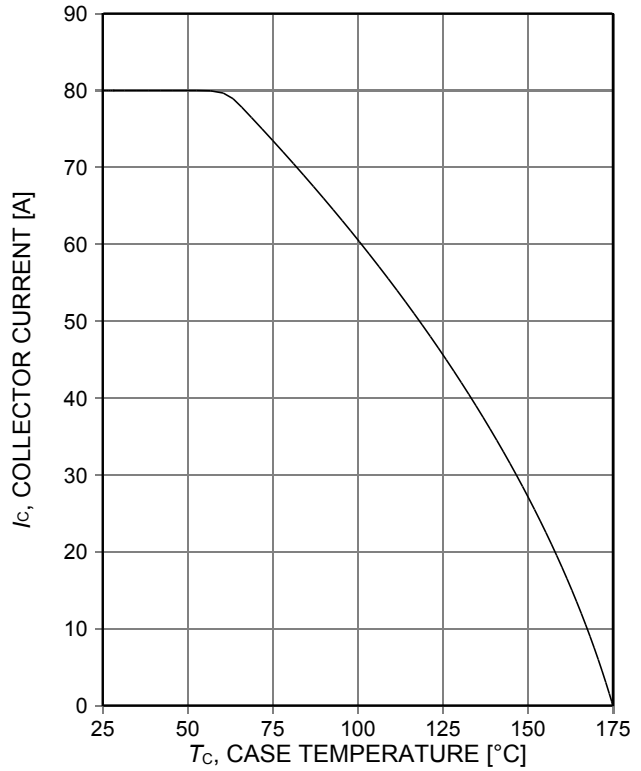


Figure 2. Collector current as a function of case temperature ($V_{GE} \geq 15\text{V}$, $T_{vj} \leq 175^\circ\text{C}$)

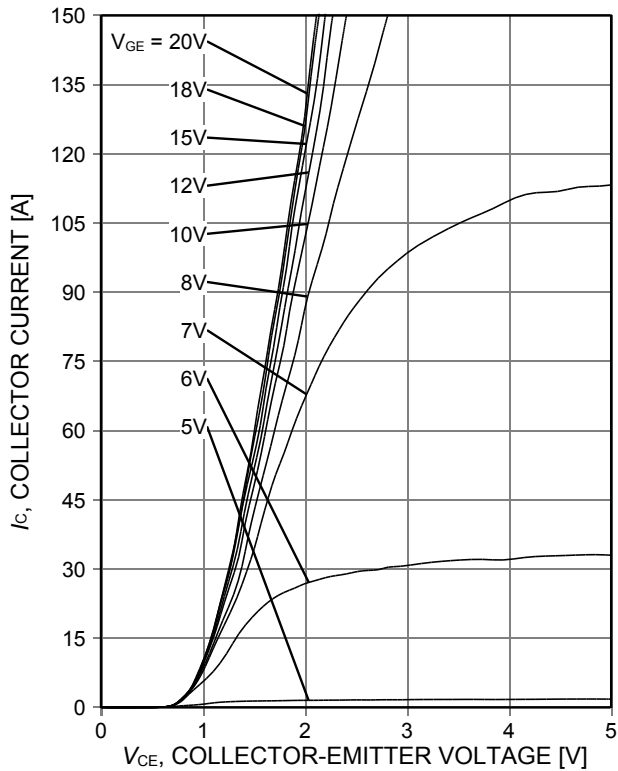


Figure 3. Typical output characteristic ($T_{vj} = 25^\circ\text{C}$)

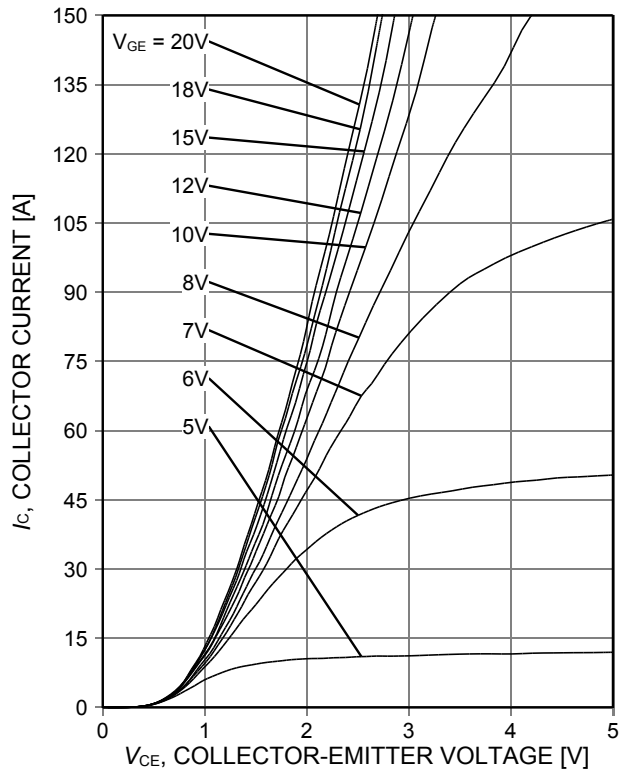


Figure 4. Typical output characteristic ($T_{vj} = 175^\circ\text{C}$)

TRENCHSTOP™ 5 soft switching IGBT

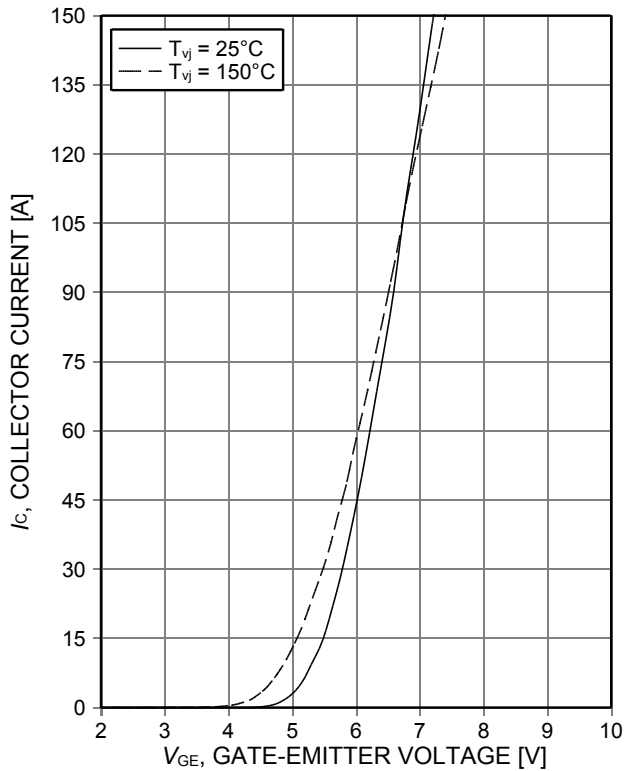


Figure 5. Typical transfer characteristic (V_{CE}=20V)

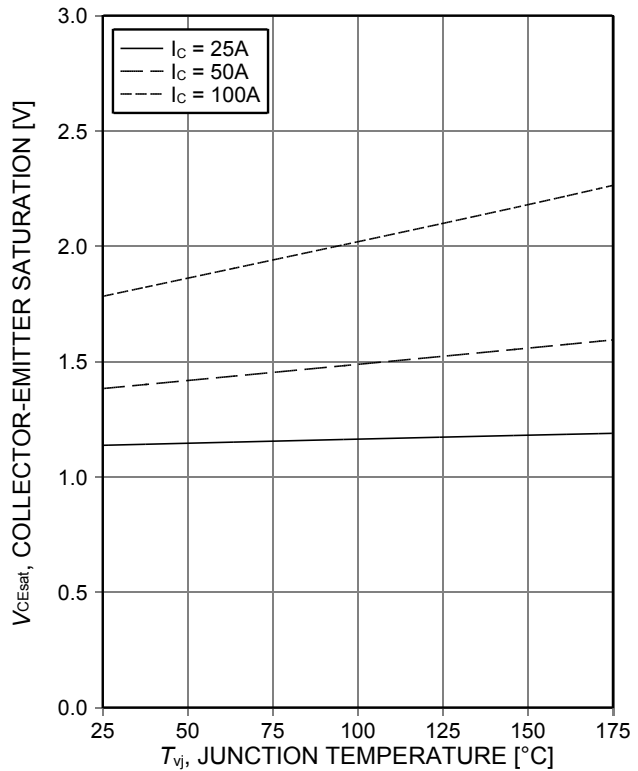


Figure 6. Typical collector-emitter saturation voltage as a function of junction temperature (V_{GE}=15V)

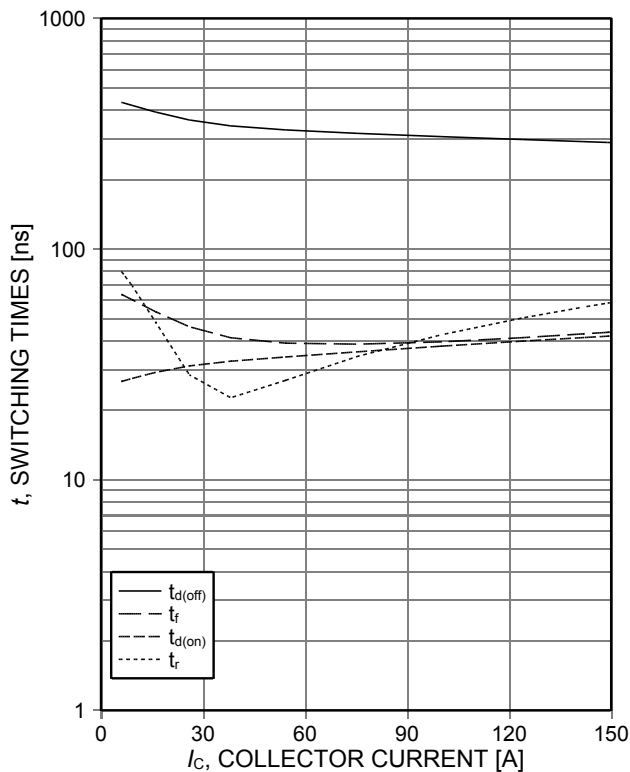


Figure 7. Typical switching times as a function of collector current (inductive load, T_{vj}=150°C, V_{CE}=400V, V_{GE}=0/15V, R_{Gon}=23,1Ω, R_{Goff}=23,1Ω, dynamic test circuit in Figure E)

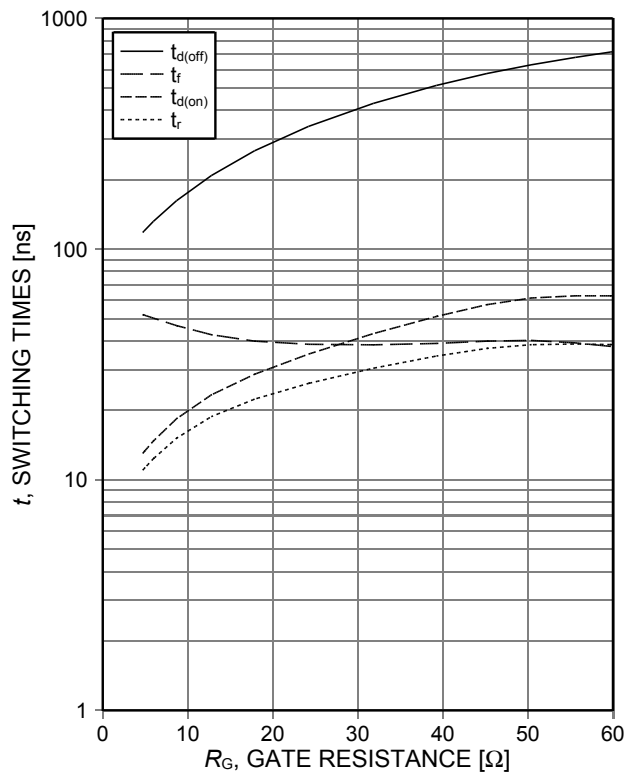


Figure 8. Typical switching times as a function of gate resistance (inductive load, T_{vj}=150°C, V_{CE}=400V, V_{GE}=0/15V, I_C=75A, dynamic test circuit in Figure E)

TRENCHSTOP™ 5 soft switching IGBT

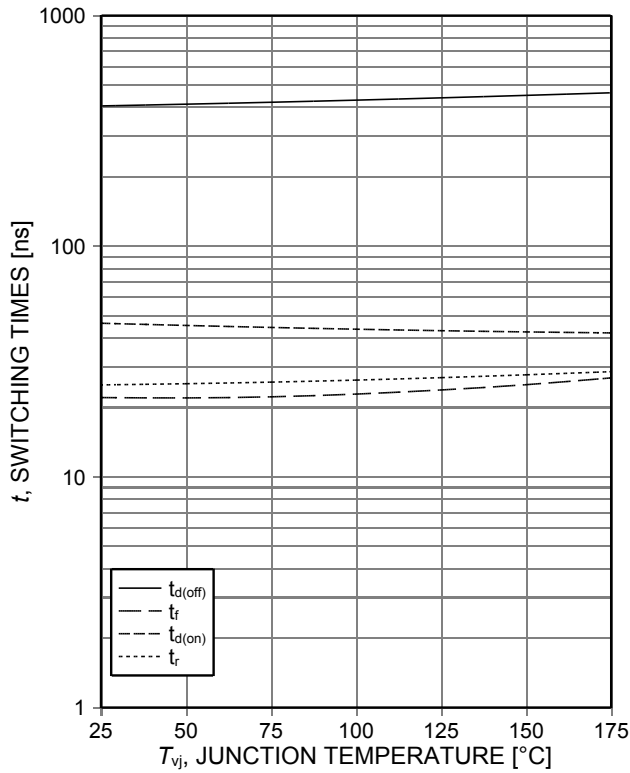


Figure 9. **Typical switching times as a function of junction temperature**
 (inductive load, $V_{CE}=400V$, $V_{GE}=0/15V$, $I_C=75A$, $R_{Gon}=23,1\Omega$, $R_{Goff}=23,1\Omega$, dynamic test circuit in Figure E)

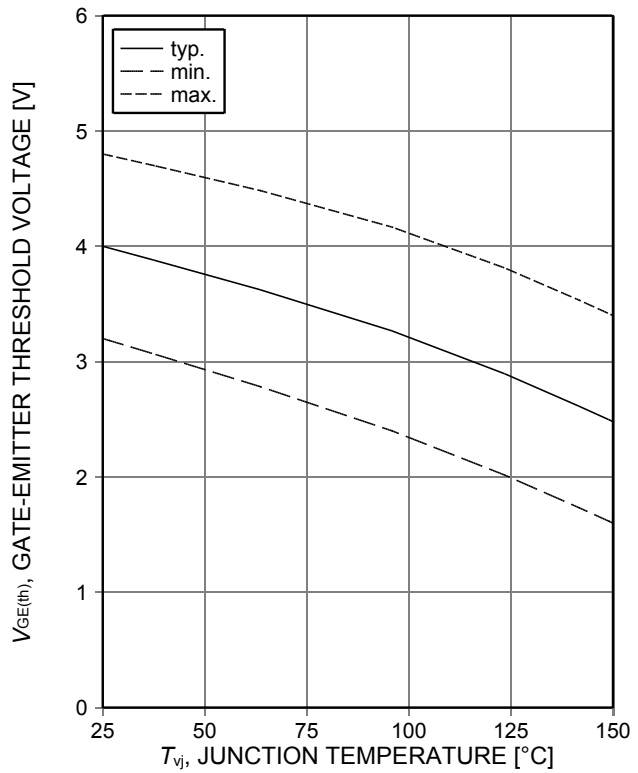


Figure 10. **Gate-emitter threshold voltage as a function of junction temperature**
 ($I_C=0.5mA$)

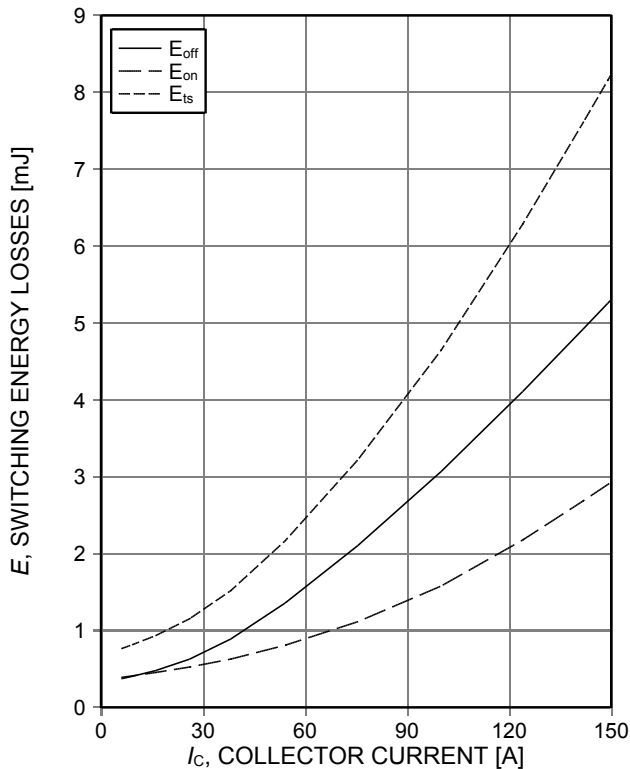


Figure 11. **Typical switching energy losses as a function of collector current**
 (inductive load, $T_{vj}=150^\circ C$, $V_{CE}=400V$, $V_{GE}=0/15V$, $R_{Gon}=23,1\Omega$, $R_{Goff}=23,1\Omega$, dynamic test circuit in Figure E)

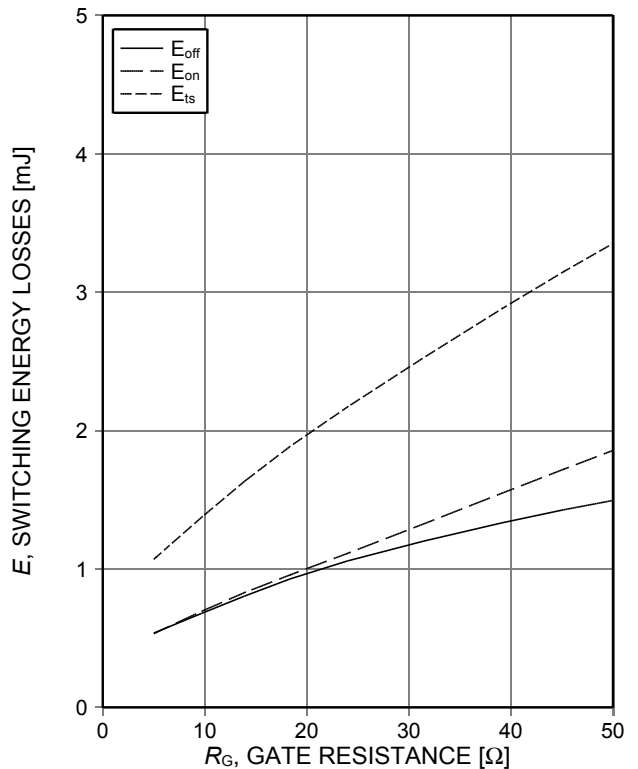


Figure 12. **Typical switching energy losses as a function of gate resistance**
 (inductive load, $T_{vj}=150^\circ C$, $V_{CE}=400V$, $V_{GE}=0/15V$, $I_C=75A$, dynamic test circuit in Figure E)

TRENCHSTOP™ 5 soft switching IGBT

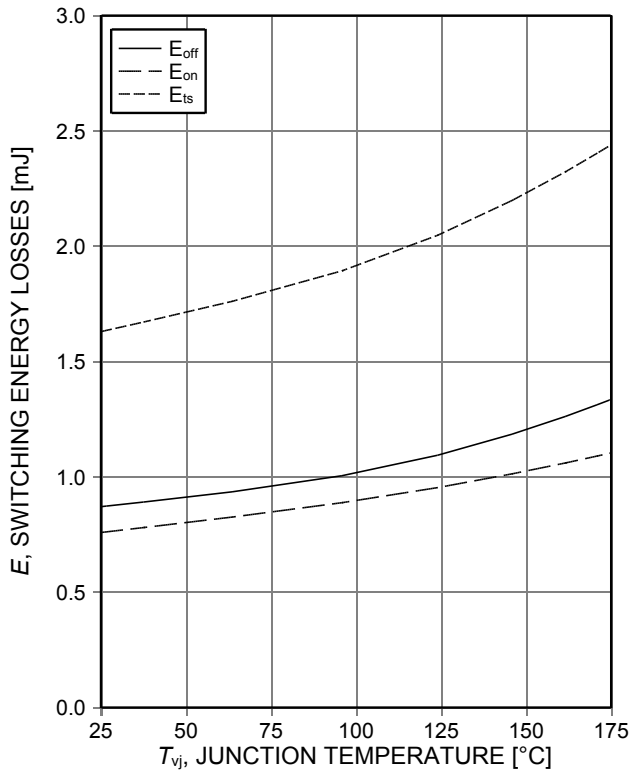


Figure 13. **Typical switching energy losses as a function of junction temperature** (inductive load, $V_{CE}=400V$, $V_{GE}=0/15V$, $I_C=75A$, $R_{Gon}=23,1\Omega$, $R_{Goff}=23,1\Omega$, dynamic test circuit in Figure E)

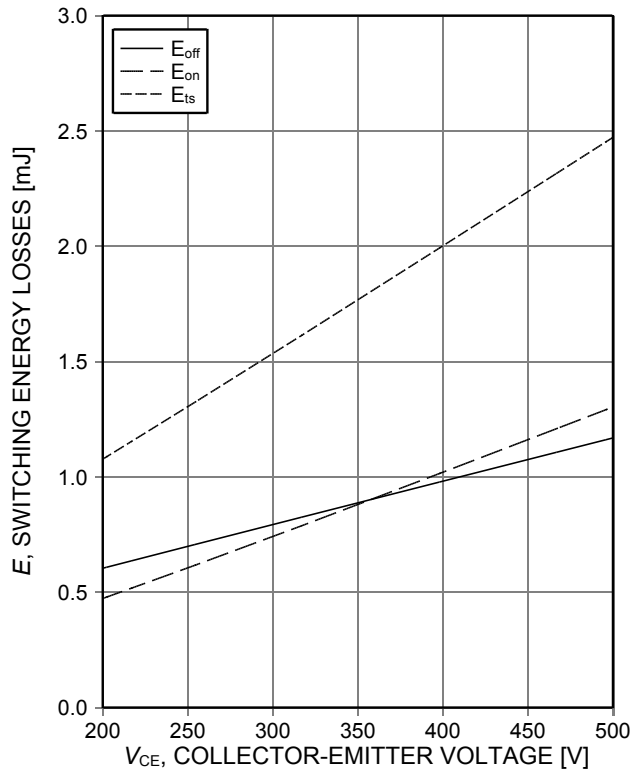


Figure 14. **Typical switching energy losses as a function of collector emitter voltage** (inductive load, $T_{vj}=150^\circ C$, $V_{GE}=0/15V$, $I_C=75A$, $R_{Gon}=23,1\Omega$, $R_{Goff}=23,1\Omega$, dynamic test circuit in Figure E)

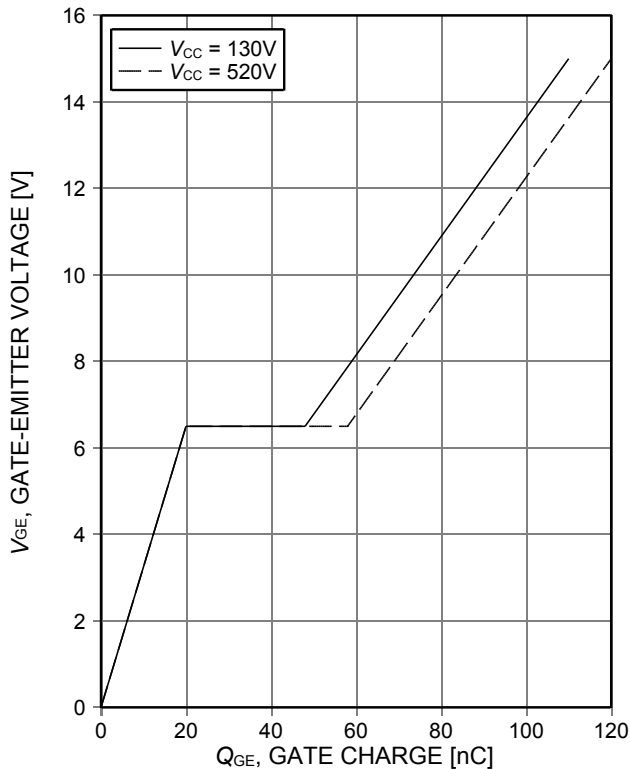


Figure 15. **Typical gate charge** ($I_C=75A$)

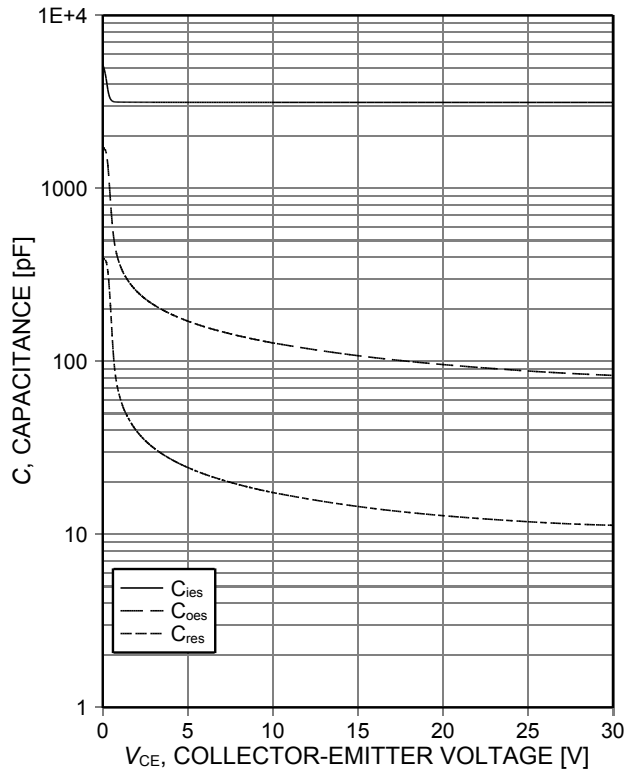


Figure 16. **Typical capacitance as a function of collector-emitter voltage** ($V_{GE}=0V$, $f=1MHz$)

TRENCHSTOP™ 5 soft switching IGBT

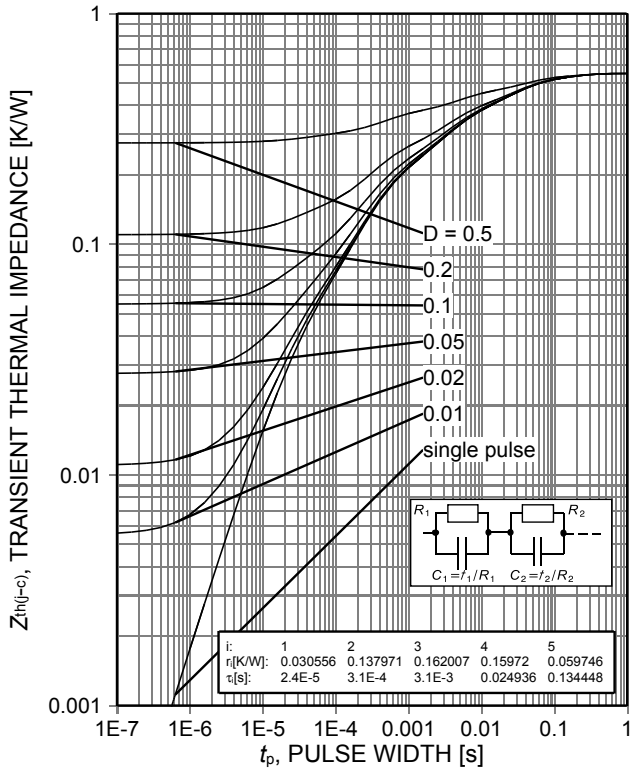


Figure 17. IGBT transient thermal impedance ($D=t_p/T$)

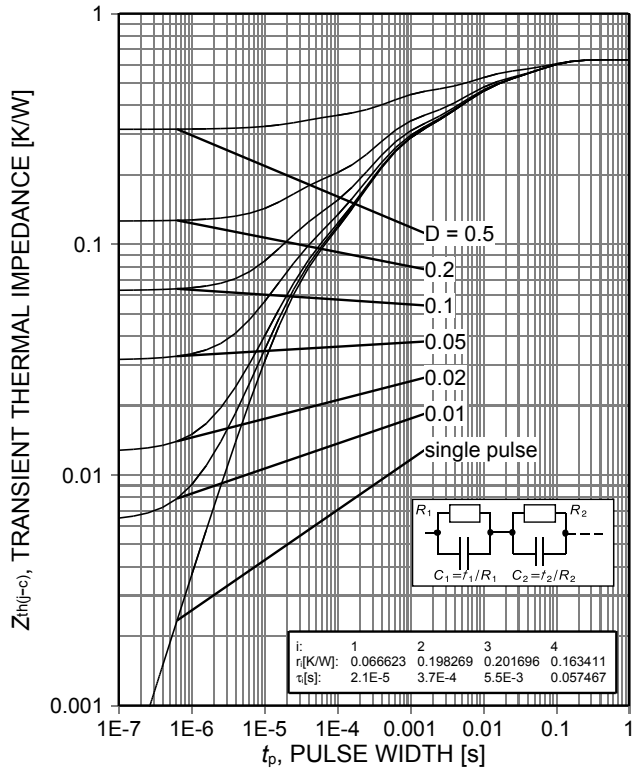


Figure 18. Diode transient thermal impedance as a function of pulse width ($D=t_p/T$)

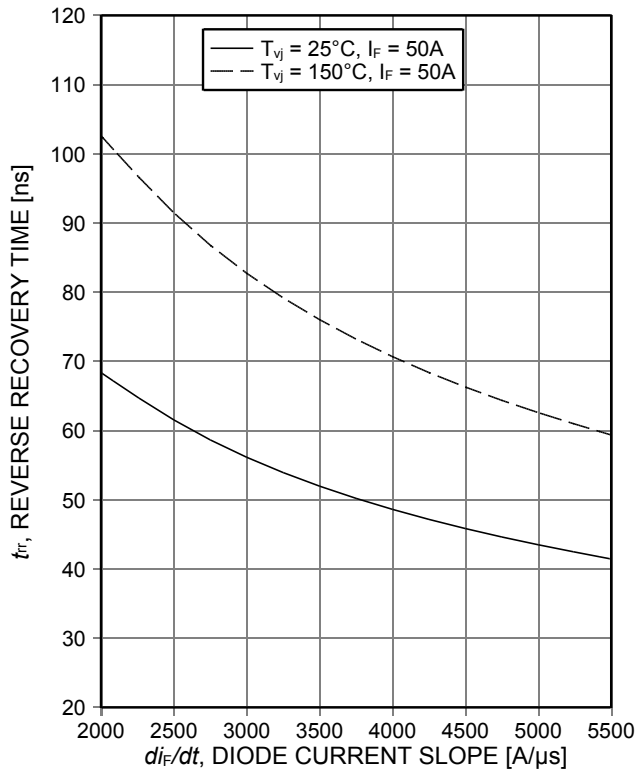


Figure 19. Typical reverse recovery time as a function of diode current slope ($V_R=400V$)

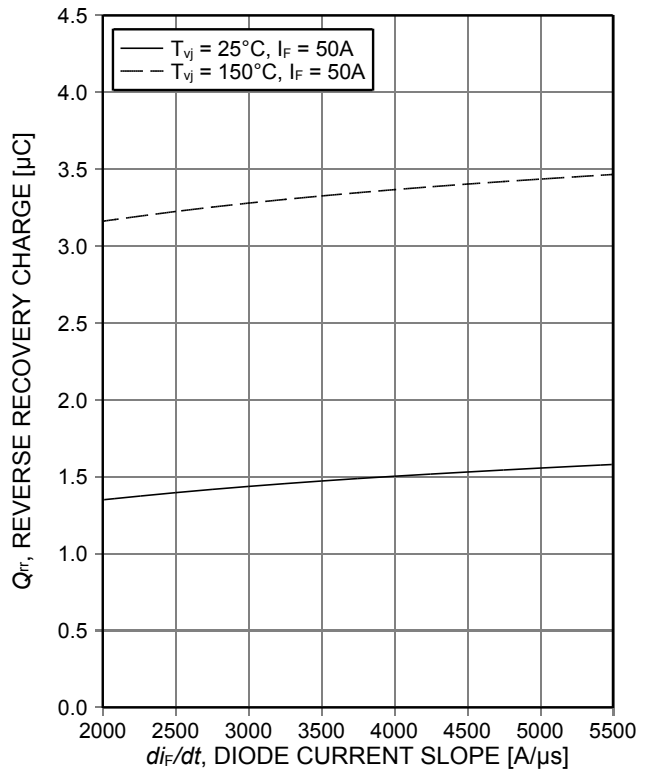


Figure 20. Typical reverse recovery charge as a function of diode current slope ($V_R=400V$)

TRENCHSTOP™ 5 soft switching IGBT

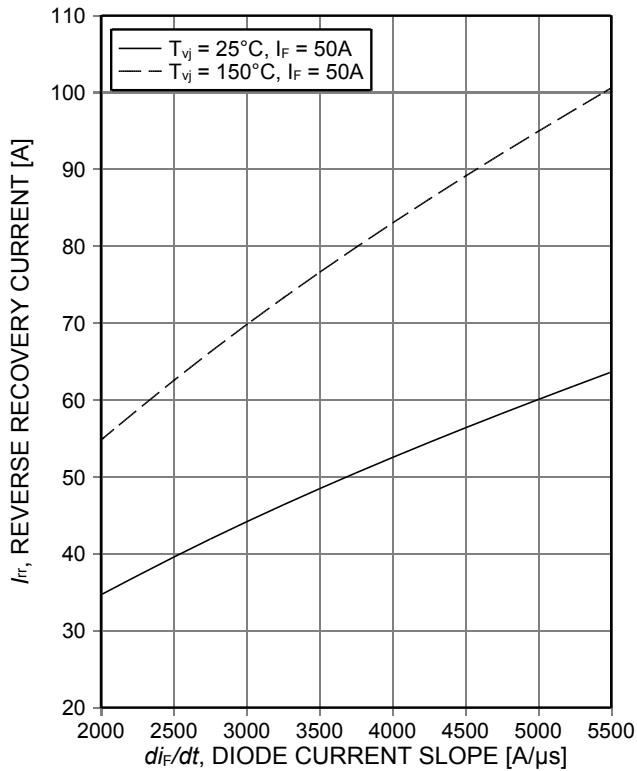


Figure 21. Typical reverse recovery current as a function of diode current slope ($V_R=400V$)

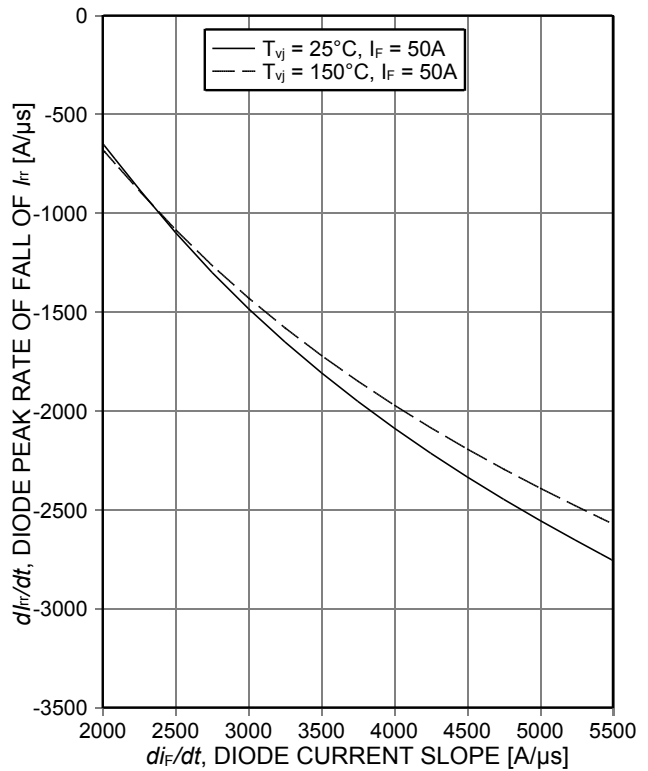


Figure 22. Typical diode peak rate of fall of reverse recovery current as a function of diode current slope ($V_R=400V$)

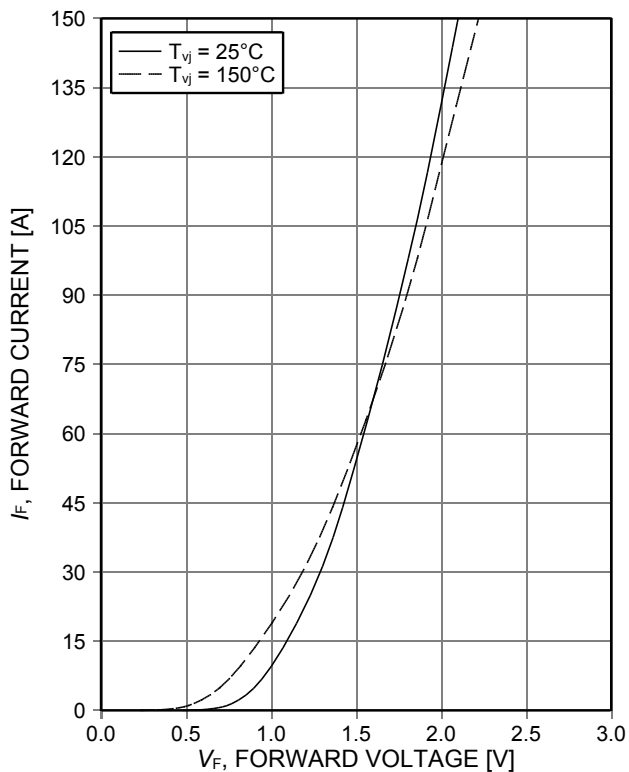


Figure 23. Typical diode forward current as a function of forward voltage

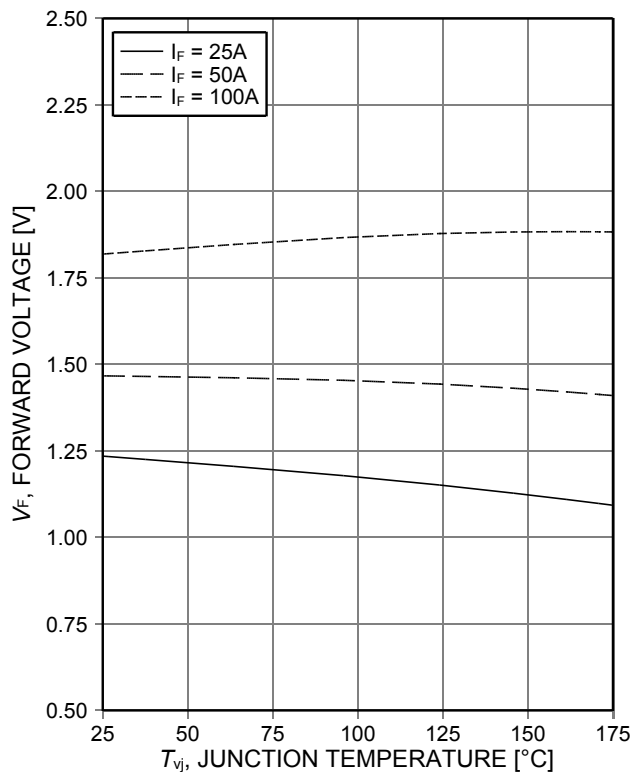
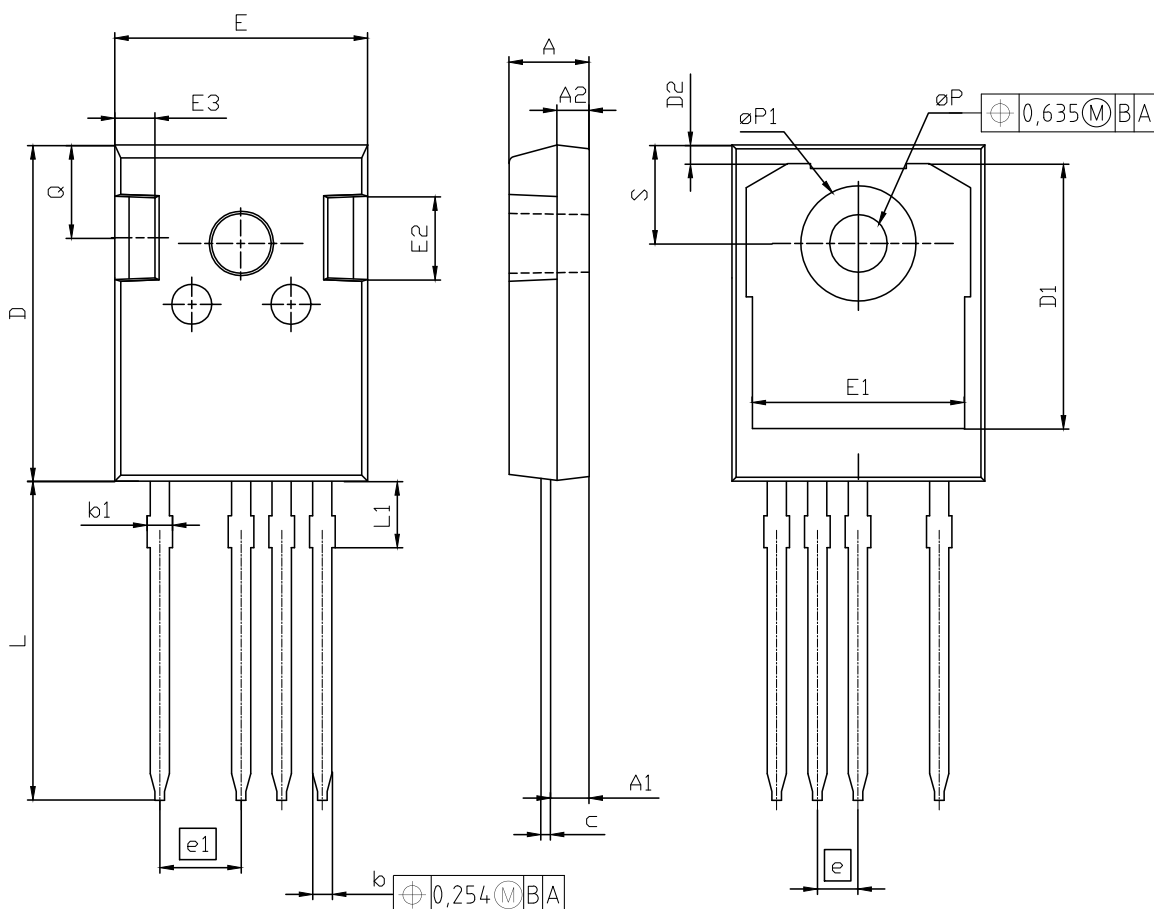


Figure 24. Typical diode forward voltage as a function of junction temperature

TRENCHSTOP™ 5 soft switching IGBT

Package Drawing PG-TO247-4



DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.83	5.21	0.190	0.205
A1	2.29	2.54	0.090	0.100
A2	1.90	2.16	0.075	0.085
b	1.07	1.33	0.042	0.052
b1	1.10	1.70	0.043	0.067
c	0.50	0.70	0.020	0.028
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	2.54 (BSC)		0.100 (BSC)	
e1	5.08		0.200	
N	4		4	
L	19.72	20.32	0.776	0.800
L1	4.02	4.40	0.158	0.173
øP	3.50	3.70	0.138	0.146
øP1	7.00	7.40	0.276	0.291
Q	5.49	6.00	0.216	0.236
S	6.04	6.30	0.238	0.248

DOCUMENT NO.
Z8B00168124

SCALE

EUROPEAN PROJECTION

ISSUE DATE
29-01-2013

REVISION
1

TRENCHSTOP™ 5 soft switching IGBT

Testing Conditions

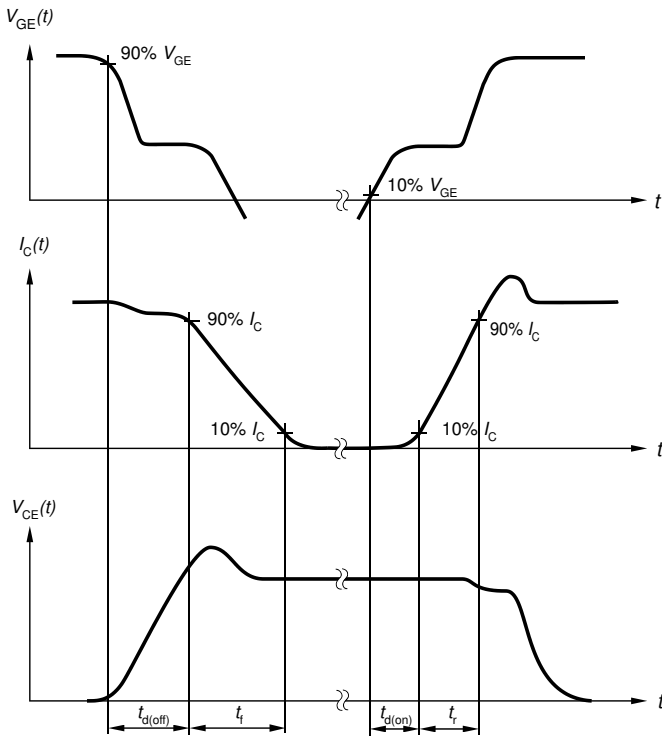


Figure A. Definition of switching times

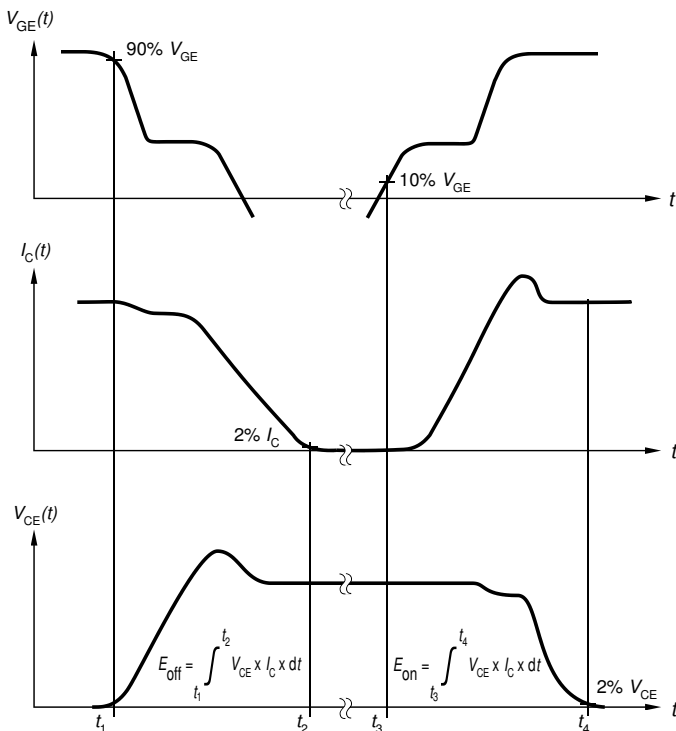


Figure B. Definition of switching losses

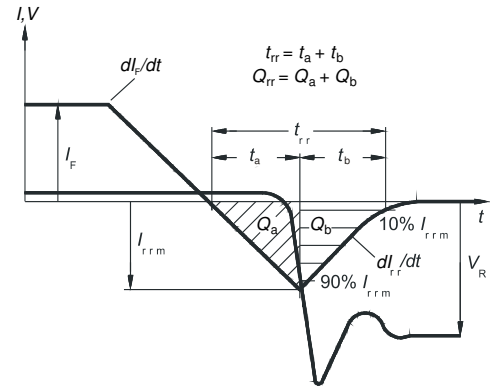


Figure C. Definition of diode switching characteristics

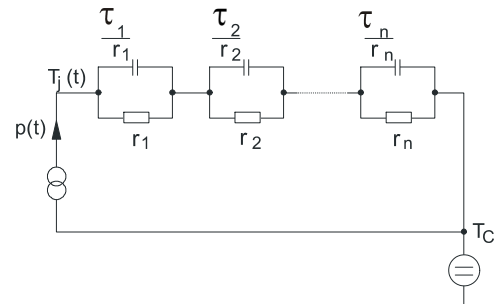


Figure D. Thermal equivalent circuit

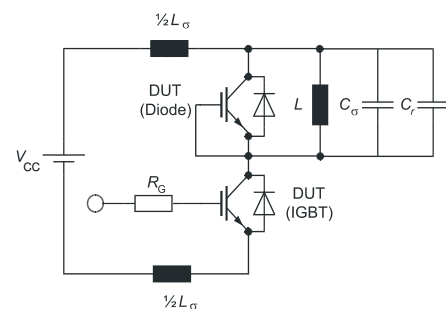


Figure E. Dynamic test circuit
Parasitic inductance L_{σ} ,
parasitic capacitor C_{σ} ,
relief capacitor C_r ,
(only for ZVT switching)

TRENCHSTOP™ 5 soft switching IGBT

Revision History

IKZ50N65ES5

Revision: 2017-04-26, Rev. 2.1

Previous Revision

Revision	Date	Subjects (major changes since last revision)
2.1	2017-04-26	Final data sheet

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