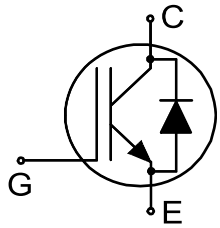
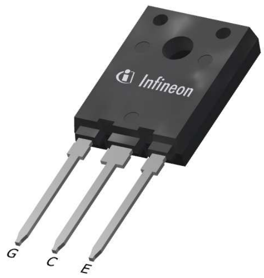
TRENCHSTOP™ 5 high speed soft switching IGBT copacked with full current rated RAPID 1 fast and soft antiparallel diode





Fully isolated package TO-247

Features and Benefits:

High speed S5 technology offering
- High speed smooth switching device for hard & soft switching
- Very Low V_{CEsat}, 1.35V 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
- Pb-free lead plating; RoHS compliant
- Complete product spectrum and PSpice Models:

http://www.infineon.com/igbt/

Applications:

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

Product Validation:

Qualified for industrial applications according to the relevant tests of JEDEC47/20/22

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°C	T_{vjmax}	Marking	Package
IKFW50N65ES5	650V	40A	1.35V	175°C	K50EES5	PG-HSIP247-3-2

Table of Contents

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}	650	V
DC collector current, limited by T_{vjmax} $T_h = 25°C$ $T_h = 65°C$ $T_h = 65°C$	I_C	74.0 59.0 69.0[1]	A
Pulsed collector current, t_p limited by T_{vjmax}	I_{Cpuls}	160.0	A
Turn off safe operating area $V_{CE} \leq 650V$, $T_{vj} \leq 175°C$, $t_p = 1µs$	-	160.0	A
Diode forward current, limited by T_{vjmax} $T_h = 25°C$ $T_h = 65°C$	I_F	74.0 59.0	A
Diode pulsed current, t_p limited by T_{vjmax}	I_{Fpuls}	160.0	A
Gate-emitter voltage Transient Gate-emitter voltage ($t_p \leq 10µs$, $D < 0.010$)	V_{GE}	±20 ±30	V
Power dissipation $T_h = 25°C$ Power dissipation $T_h = 65°C$	P_{tot}	127.0 93.0	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	$R_{th(j-h)}$		-	1.01	1.19	K/W
Diode thermal resistance,[3] junction - heatsink	$R_{th(j-h)}$		-	1.14	1.34	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, 1.3 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 min.	Value typ.	Value max.	Unit
Static Characteristic						
Collector-emitter breakdown voltage	$V_{(BR)CES}$	V_{GE} = 0V, I_C = 0.50mA	650	-	-	V
Collector-emitter saturation voltage	V_{CEsat}	V_{GE} = 15.0V, I_C = 40.0A T_{vj} = 25°C T_{vj} = 175°C	 - -	 1.35 1.60	 1.70 -	V
Diode forward voltage	V_F	V_{GE} = 0V, I_F = 40.0A T_{vj} = 25°C T_{vj} = 175°C	 - -	 1.45 1.39	 1.70 -	V
Gate-emitter threshold voltage	$V_{GE(th)}$	I_C = 0.40mA, V_{CE} = V_{GE}	3.2	4.0	4.8	V
Zero gate voltage collector current	I_{CES}	V_{CE} = 650V, V_{GE} = 0V T_{vj} = 25°C T_{vj} = 175°C	 - -	 - 1700	 50 -	µA
Gate-emitter leakage current	I_{GES}	V_{CE} = 0V, V_{GE} = 20V	-	-	100	nA
Transconductance	g_{fs}	V_{CE} = 20V, I_C = 40.0A	-	44.0	-	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 = 1000kHz	-	2510	-	pF
Output capacitance	C_{oes}		-	70	-	pF
Reverse transfer capacitance	C_{res}		-	9	-	pF
Gate charge	Q_G	V_{CC} = 520V, I_C = 40.0A, V_{GE} = 15V	-	95.0	-	nC
Internal emitter inductance measured 5mm (0.197 in.) from case	L_E		-	13.0	-	nH

Switching Characteristic, Inductive Load

Parameter	Symbol	Conditions	Value min.	Value typ.	Value max.	Unit
IGBT Characteristic, at T_{vj} = 25°C						
Turn-on delay time	$t_{d(on)}$	T_{vj} = 25°C, V_{CC} = 400V, I_C = 40.0A, V_{GE} = 0.0/15.0V, $R_{G(on)}$ = 10.0Ω, $R_{G(off)}$ = 10.0Ω, $L\sigma$ = 30nH, $C\sigma$ = 30pF $L\sigma$, $C\sigma$ from Fig. E Energy losses include “tail” and diode reverse recovery.	-	19	-	ns
Rise time	t_r		-	18	-	ns
Turn-off delay time	$t_{d(off)}$		-	130	-	ns
Fall time	t_f		-	23	-	ns
Turn-on energy	E_{on}		-	0.86	-	mJ
Turn-off energy	E_{off}		-	0.40	-	mJ
Total switching energy	E_{ts}		-	1.26	-	mJ

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

Diode reverse recovery time	t_{rr}	T_{vj} = 25°C, V_R = 400V, I_F = 40.0A, di_F/dt = 980A/µs	-	69	-	ns
Diode reverse recovery charge	Q_{rr}		-	1.11	-	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		-	-2000	-	A/µs

Switching Characteristic, Inductive Load

Parameter	Symbol	Conditions	Value			Unit
			min.	typ.	max.	
IGBT Characteristic, at T_{vj} = 150°C						
Turn-on delay time	$t_{d(on)}$	T_{vj} = 150°C, V_{CC} = 400V, I_C = 40.0A, V_{GE} = 0.0/15.0V, $R_{G(on)}$ = 10.0Ω, $R_{G(off)}$ = 10.0Ω, $L\sigma$ = 30nH, $C\sigma$ = 30pF $L\sigma$, $C\sigma$ from Fig. E Energy losses include “tail” and diode reverse recovery.	-	20	-	ns
Rise time	t_r		-	16	-	ns
Turn-off delay time	$t_{d(off)}$		-	156	-	ns
Fall time	t_f		-	48	-	ns
Turn-on energy	E_{on}		-	1.20	-	mJ
Turn-off energy	E_{off}		-	0.69	-	mJ
Total switching energy	E_{ts}		-	1.89	-	mJ

Diode Characteristic, at T_{vj} = 150°C

Diode reverse recovery time	t_{rr}	T_{vj} = 150°C, V_R = 400V, I_F = 40.0A, di_F/dt = 980A/µs	-	115	-	ns
Diode reverse recovery charge	Q_{rr}		-	2.62	-	µC
Diode peak reverse recovery current	I_{rrm}		-	38.0	-	A
Diode peak rate of fall of reverse recovery current during t_b	di_{rr}/dt		-	-1350	-	A/µs

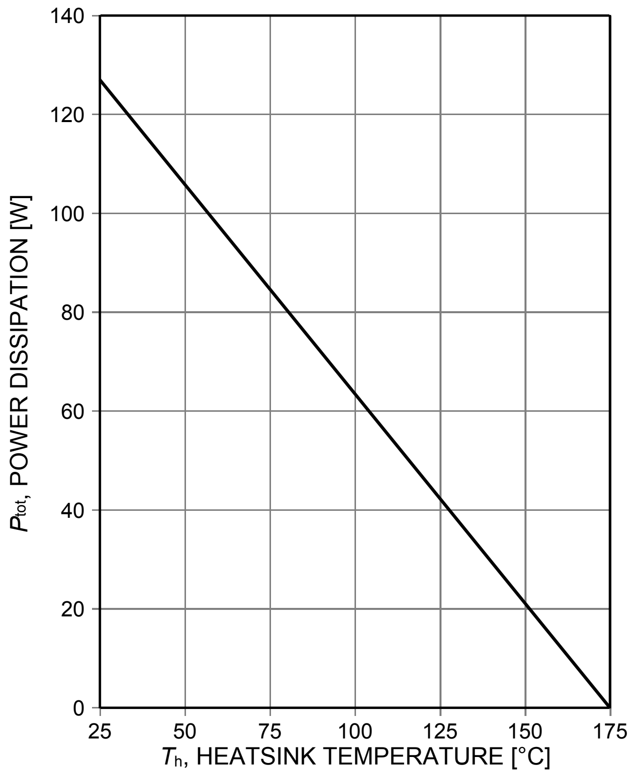


Figure 1. **Power dissipation as a function of heatsink temperature**
(T_j≤175°C)

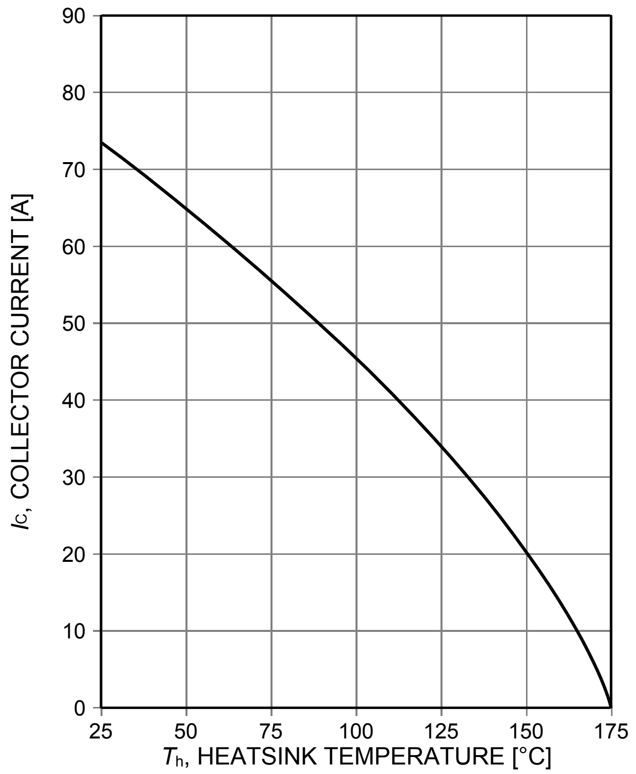


Figure 2. **Collector current as a function of heatsink temperature**
(V_{GE}≥15V, T_j≤175°C)

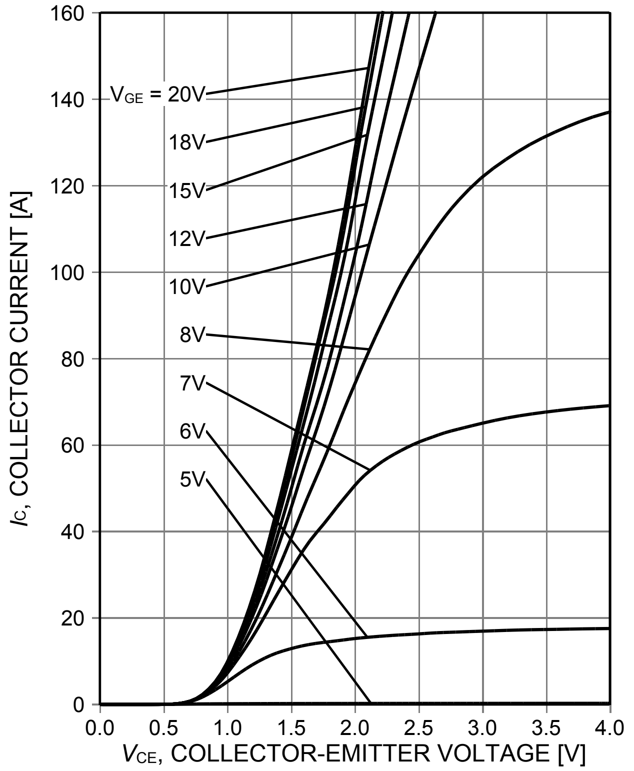


Figure 3. **Typical output characteristic**
(T_j=25°C)

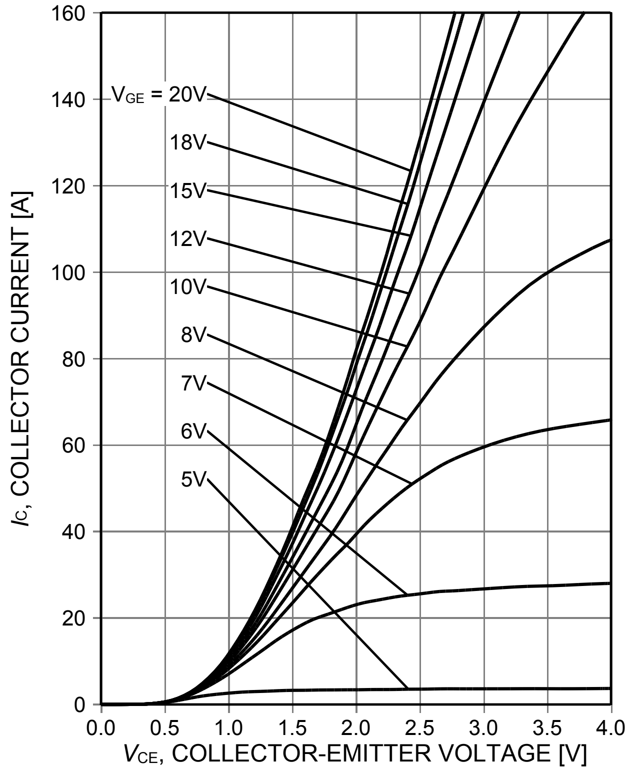


Figure 4. **Typical output characteristic**
(T_j=175°C)

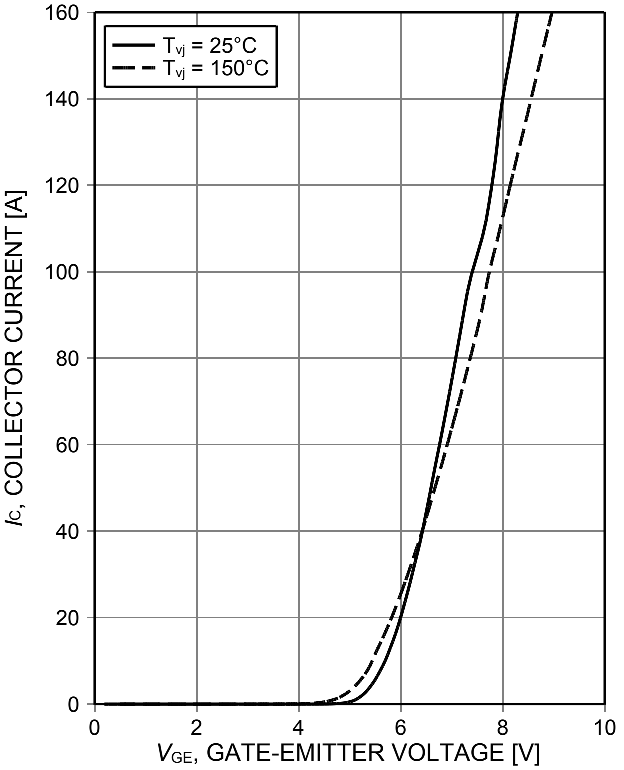


Figure 5. **Typical transfer characteristic**
(V_{CE}=20V)

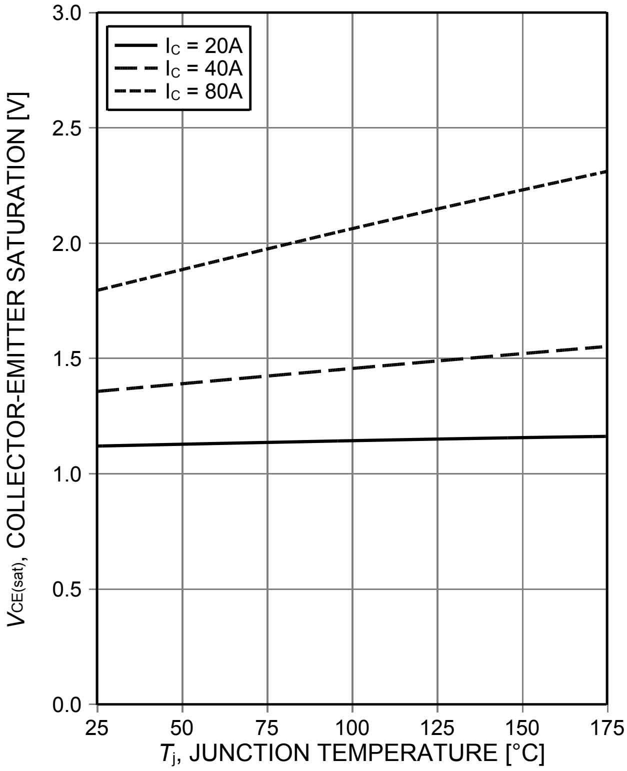


Figure 6. **Typical collector-emitter saturation voltage as a function of junction temperature**
(V_{GE}=15V)

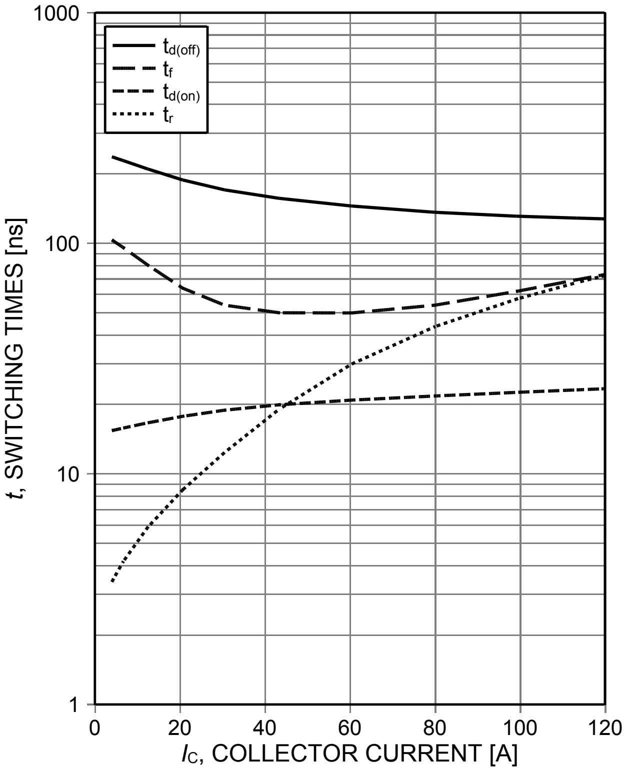


Figure 7. **Typical switching times as a function of collector current**
(ind. load, T_j=150°C, V_{CE}=400V, V_{GE}=0/15V, R_G=10Ω, test circuit in Fig. E)

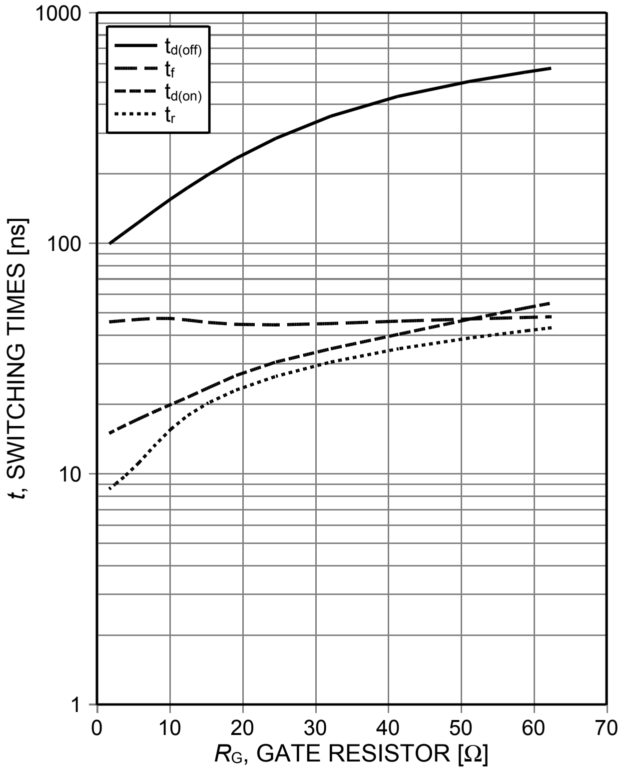


Figure 8. **Typical switching times as a function of gate resistor**
(ind. load, T_j=150°C, V_{CE}=400V, V_{GE}=0/15V, I_C=40A, test circuit in Fig. E)

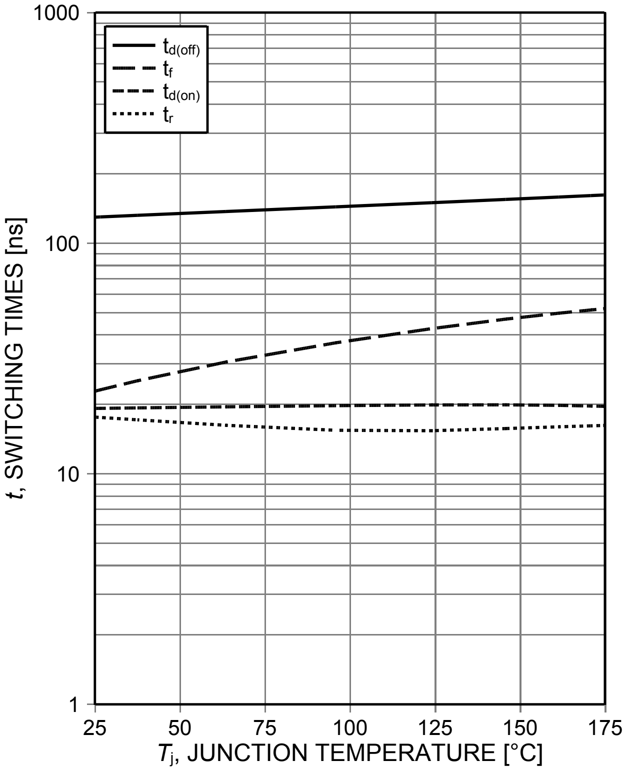


Figure 9. **Typical switching times as a function of junction temperature**
(ind. load, V_{CE}=400V, V_{GE}=0/15V, I_C=40A, r_G=10Ω, test circuit in Fig. E)

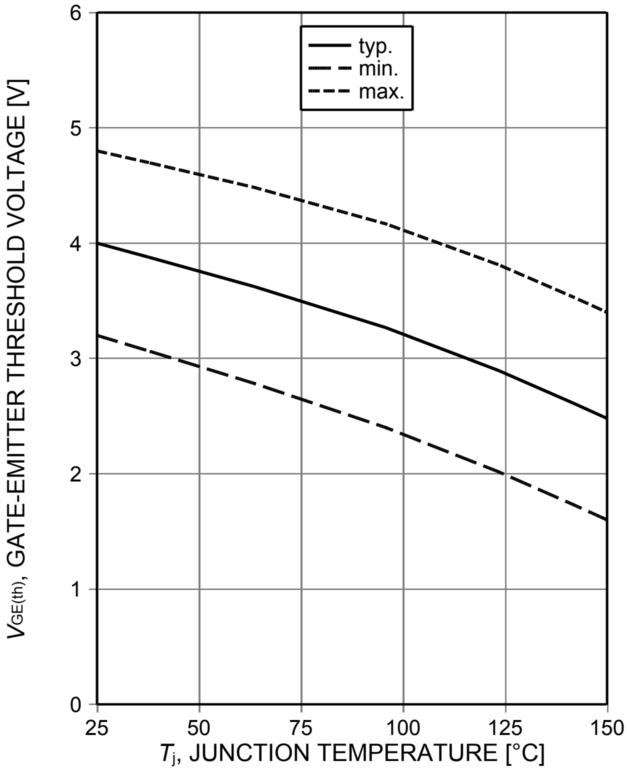


Figure 10. **Gate-emitter threshold voltage as a function of junction temperature**
(I_C=0.40mA)

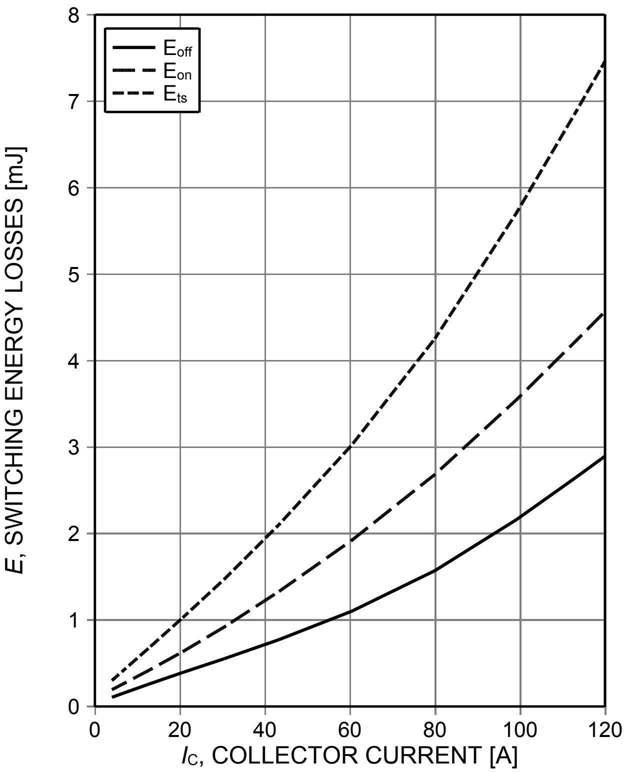


Figure 11. **Typical switching energy losses as a function of collector current**
(ind. load, T_j=150°C, V_{CE}=400V, V_{GE}=0/15V, R_G=10Ω, test circuit in Fig. E)

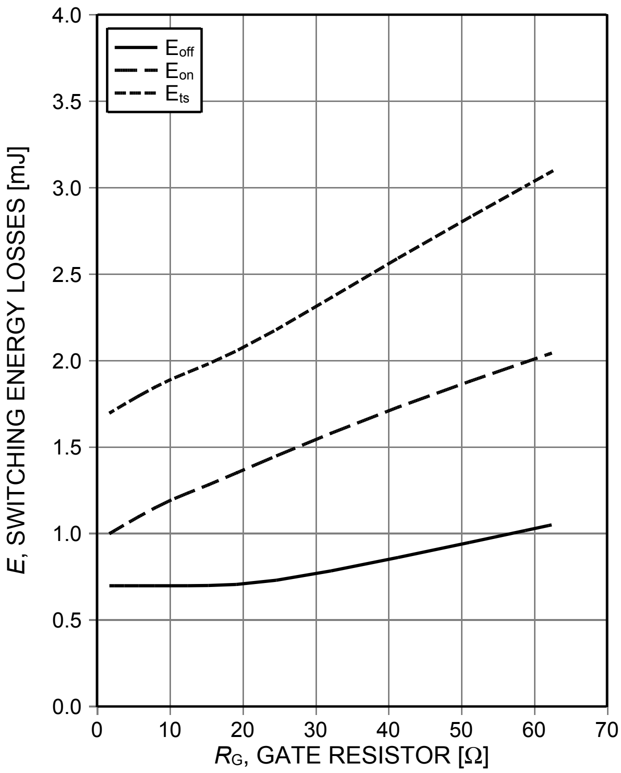


Figure 12. **Typical switching energy losses as a function of gate resistor**
(ind. load, T_j=150°C, V_{CE}=400V, V_{GE}=0/15V, I_C=40A, test circuit in Fig. E)

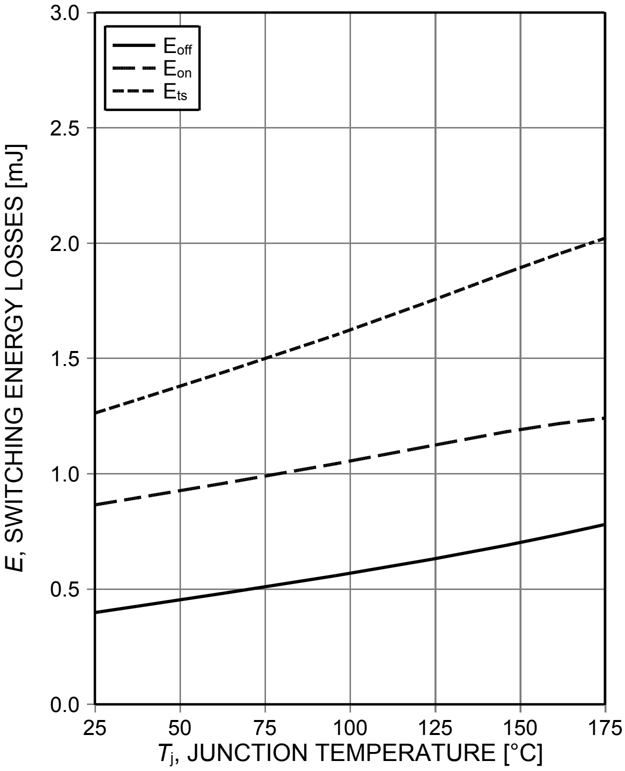


Figure 13. **Typical switching energy losses as a function of junction temperature**
(ind load, V_{CE}=400V, V_{GE}=0/15V, I_C=40A, R_G=10Ω, test circuit in Fig. E)

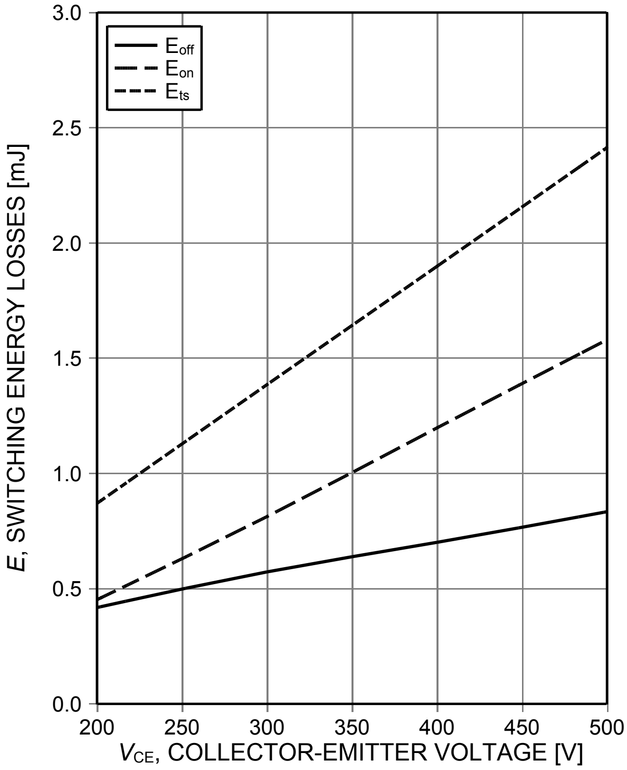


Figure 14. **Typical switching energy losses as a function of collector emitter voltage**
(ind. load, T_j=150°C, V_{GE}=0/15V, I_C=40A, R_G=10Ω, test circuit in Fig. E)

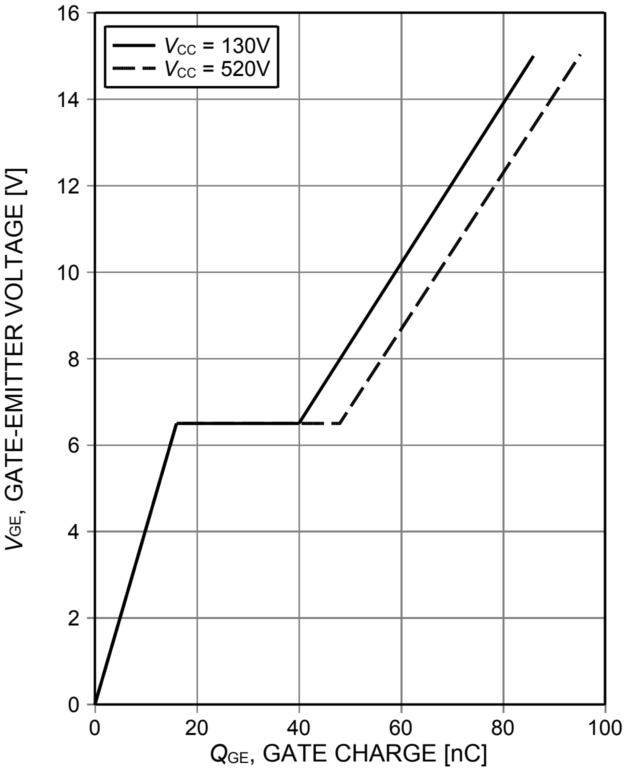


Figure 15. **Typical gate charge**
(I_C=40A)

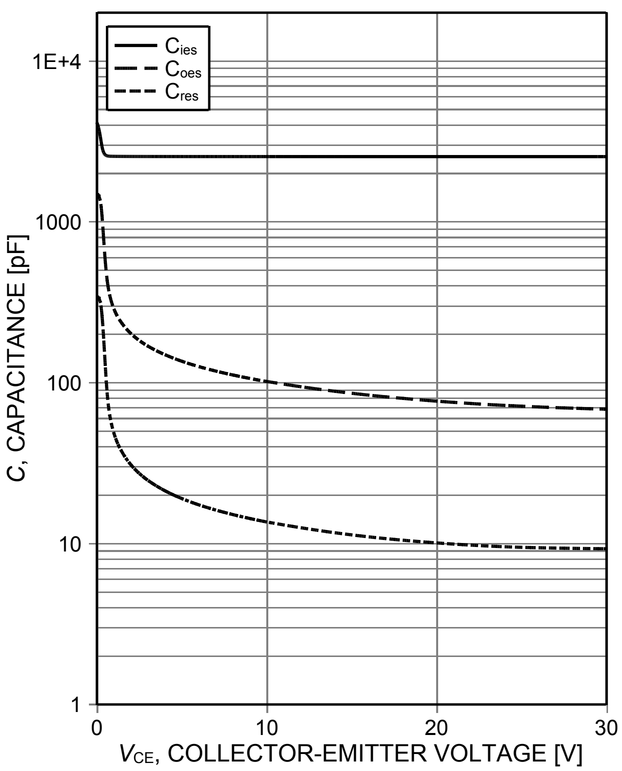


Figure 16. **Typical capacitance as a function of collector-emitter voltage**
(V_{GE}=0V, f=1MHz)

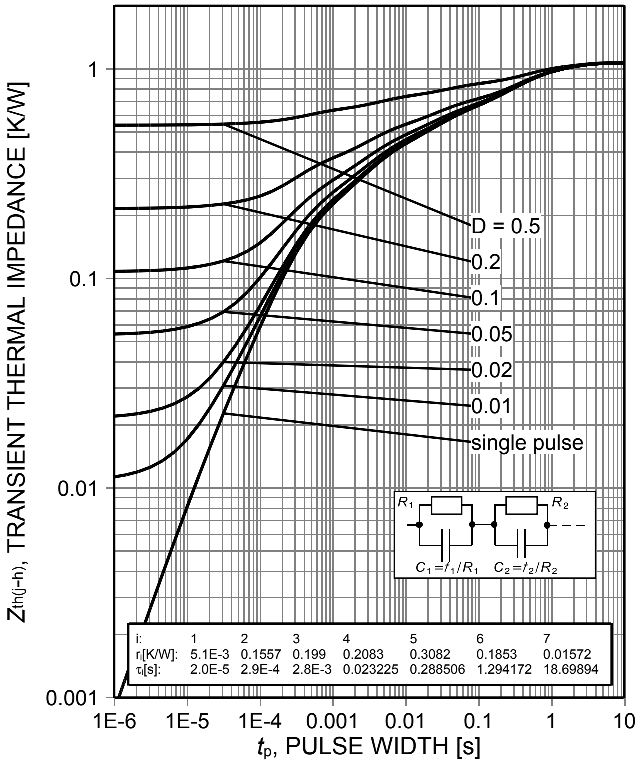


Figure 17. **IGBT transient thermal impedance as a function of pulse width** ($D=t_p/T$)

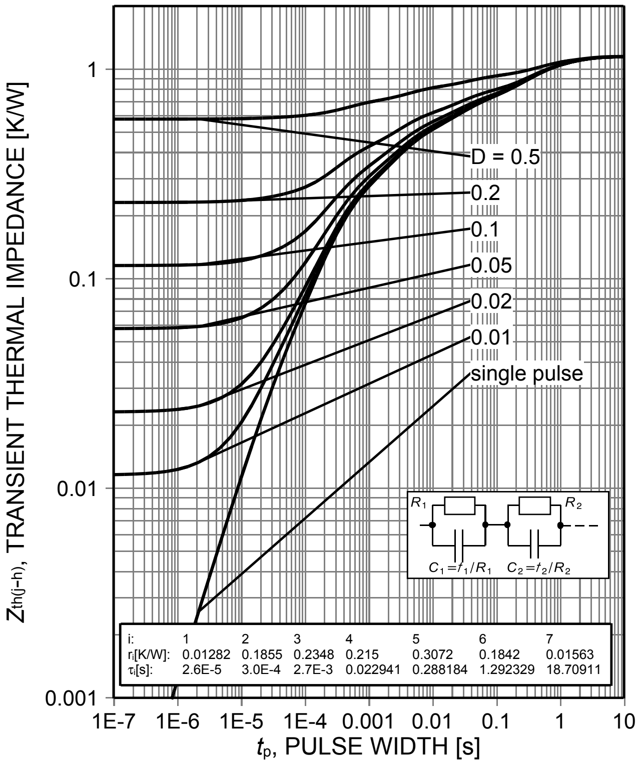


Figure 18. **Diode transient thermal impedance as a function of pulse width** ($D=t_p/T$)

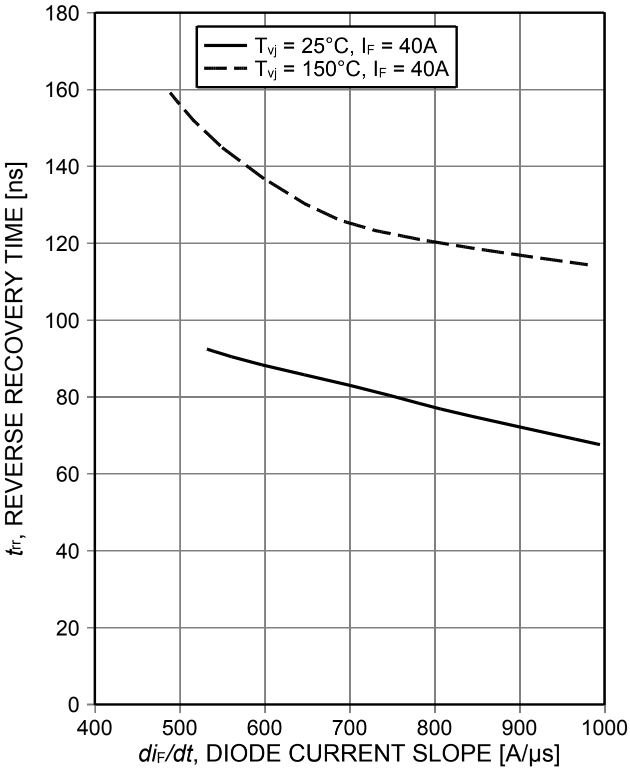


Figure 19. **Typical reverse recovery time as a function of diode current slope** (V_R=400V)

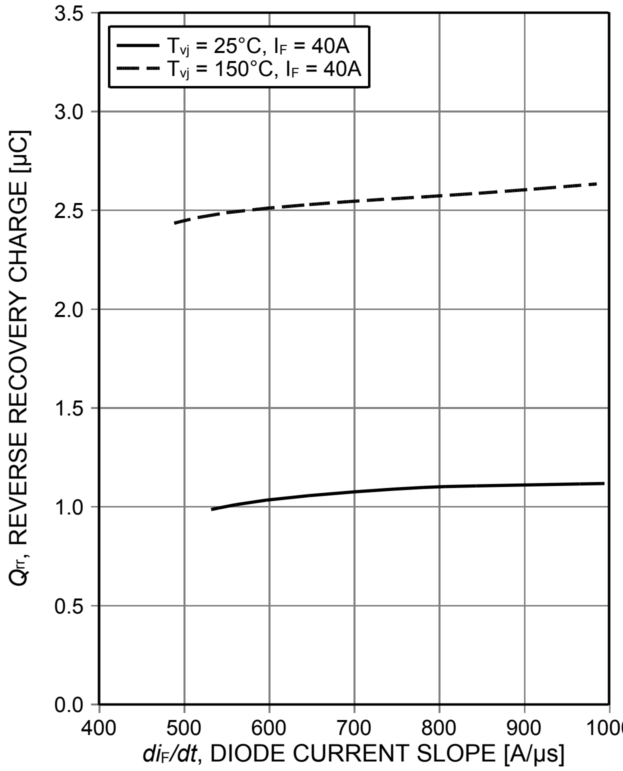


Figure 20. **Typical reverse recovery charge as a function of diode current slope** (V_R=400V)

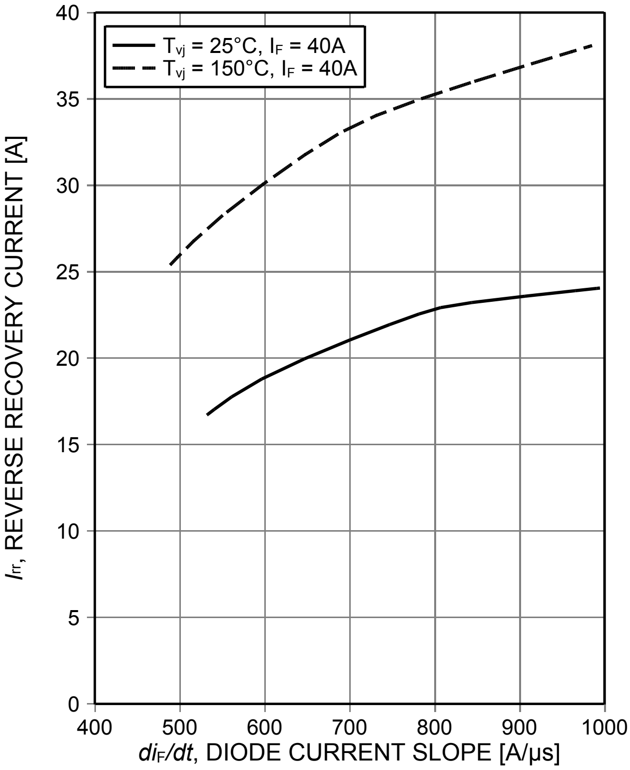


Figure 21. **Typical reverse recovery current as a function of diode current slope**
(V_R=400V)

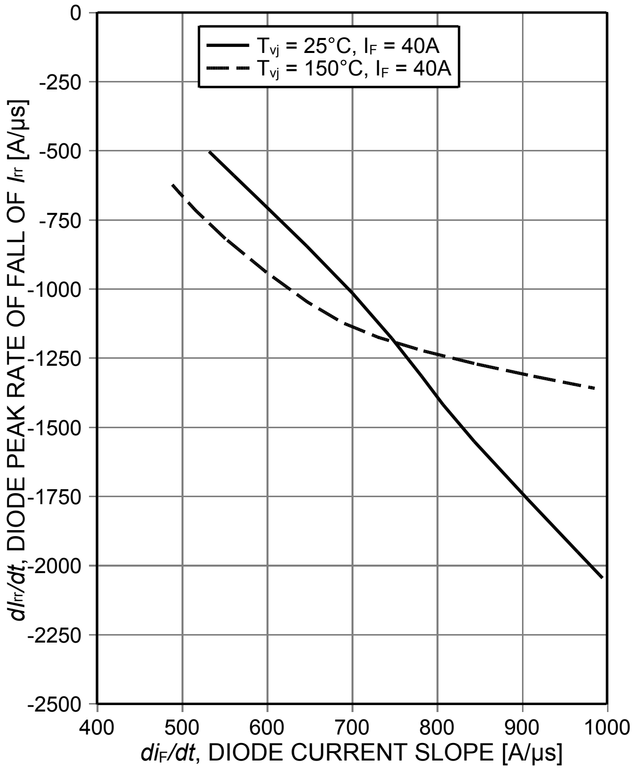


Figure 22. **Typical diode peak rate of fall of reverse recovery current as a function of diode current slope**
(V_R=400V)

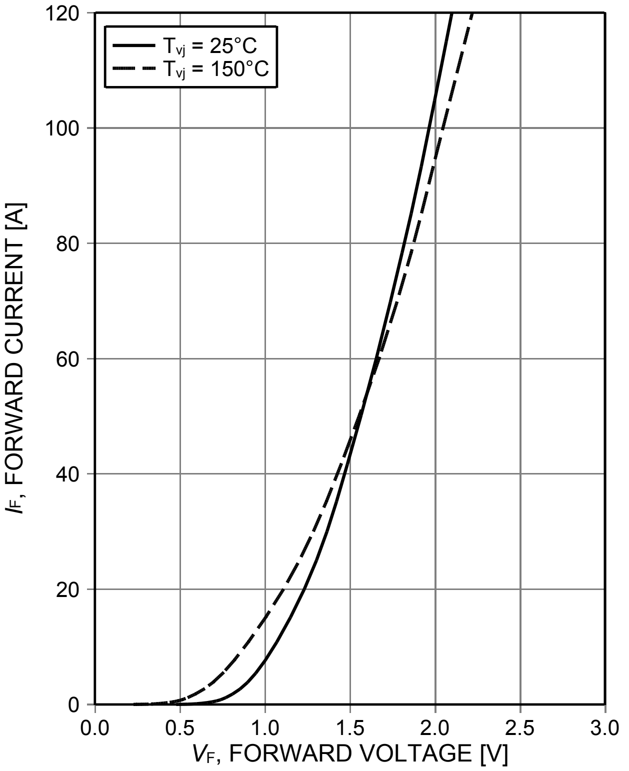


Figure 23. **Typical diode forward current as a function of forward voltage**

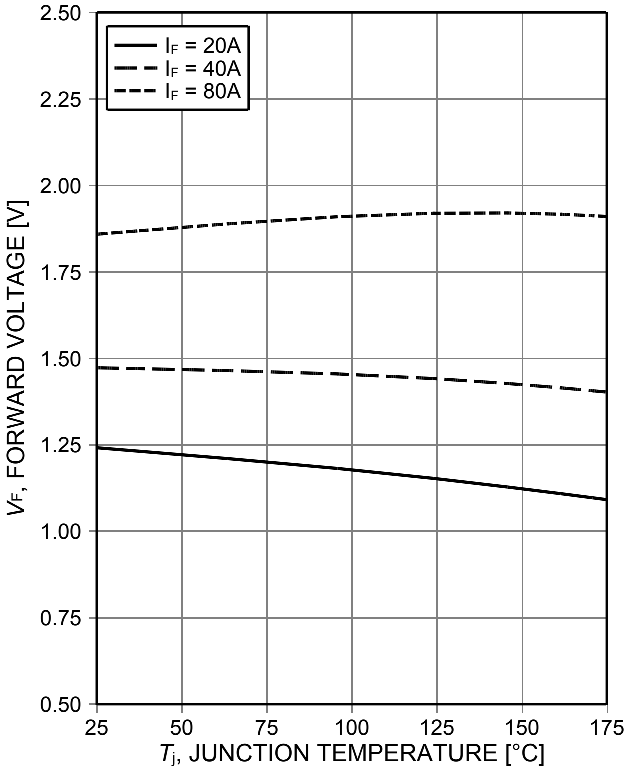
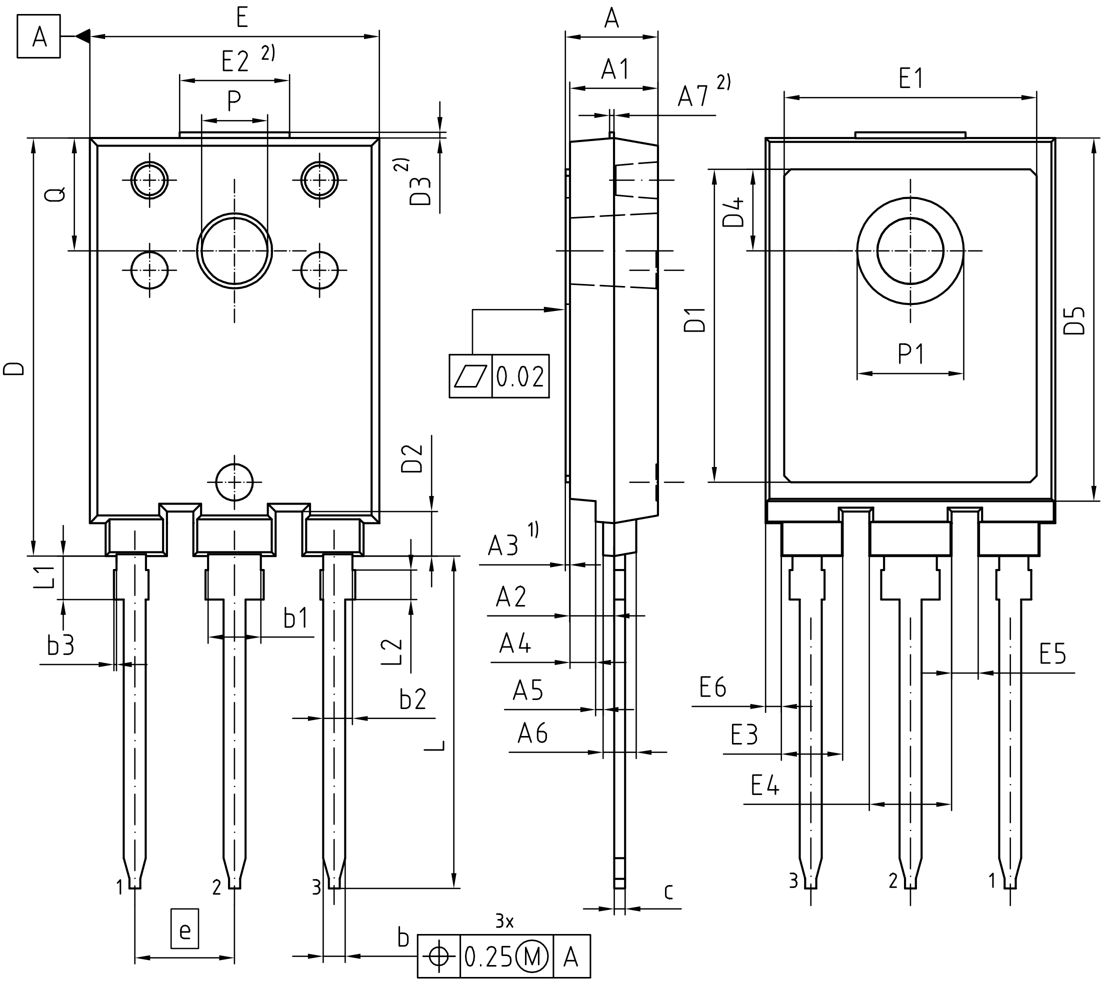
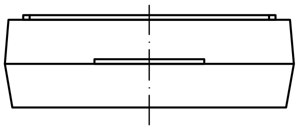


Figure 24. **Typical diode forward voltage as a function of junction temperature**

PG-HSIP247-3-2





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

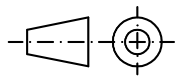
DIMENSIONS	MILLIMETERS MIN.	MILLIMETERS MAX.	DIMENSIONS	MILLIMETERS MIN.	MILLIMETERS MAX.
A	-	5.18	e	5.44	
A1	4.70	4.90	E	15.70	15.90
A2	2.16	2.66	E1	13.68	13.88
A3	0.20	0.28	E2	(6.00)	
A4	1.30	1.50	E3	3.24	3.44
A5	0.31	0.51	E4	4.39	4.59
A6	1.70	1.90	E5	(1.45)	
A7	(0.25)		E6	0.76	0.96
b	1.10	1.30	L	18.01	18.21
b1	(2.88)		L1	2.26	2.46
b2	(1.60)		L2	1.50	1.70
b3	-	0.15	P	3.50	3.70
c	0.50	0.70	P1	5.70	5.90
D	22.70	22.90	Q	6.06	6.26
D1	16.96	17.16			
D2	2.34	2.54			
D3	-	0.30			
D4	4.35	4.55			
D5	19.70	19.90			

DOCUMENT NO.
Z8B00195711

REVISION
01

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

EUROPEAN PROJECTION



ISSUE DATE
28.06.2019

Testing Conditions

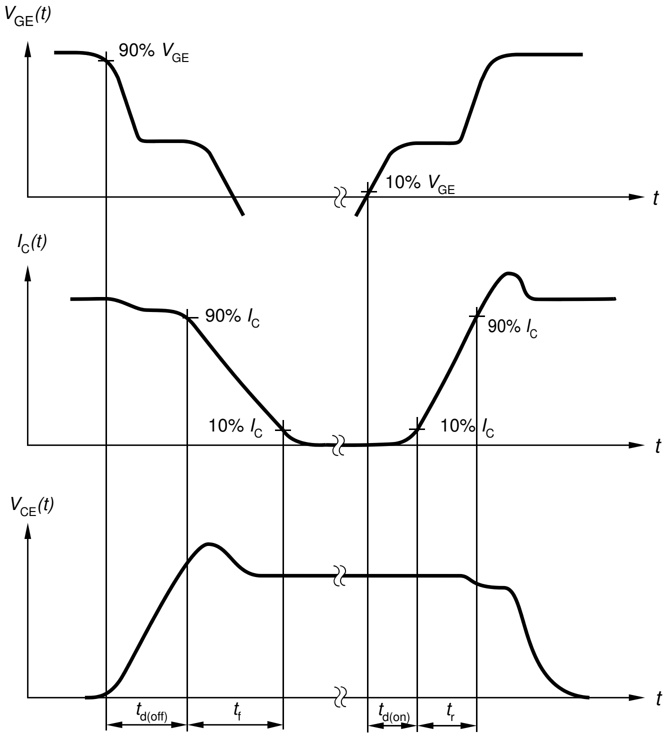


Figure A. **Definition of switching times**

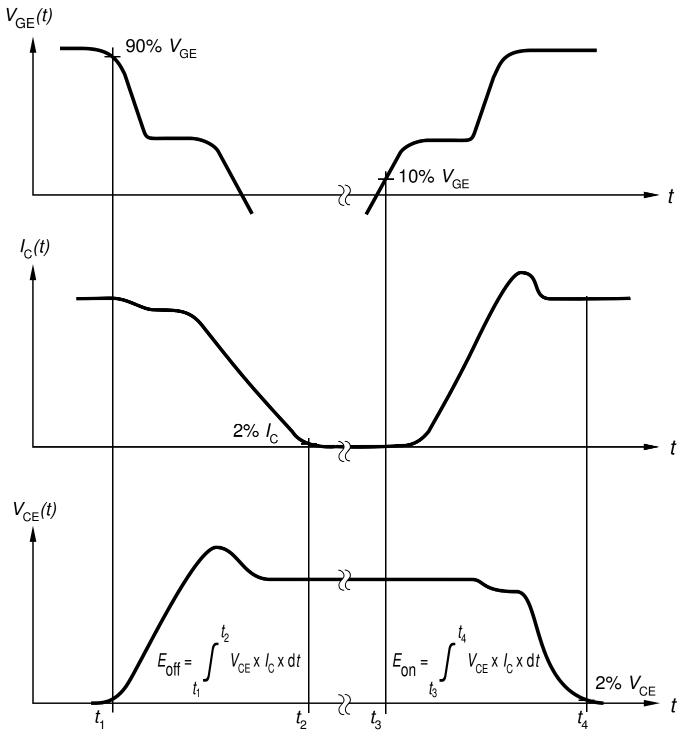


Figure B. **Definition of switching losses**

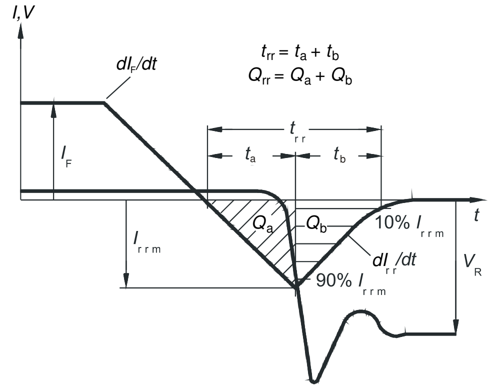


Figure C. **Definition of diode switching characteristics**

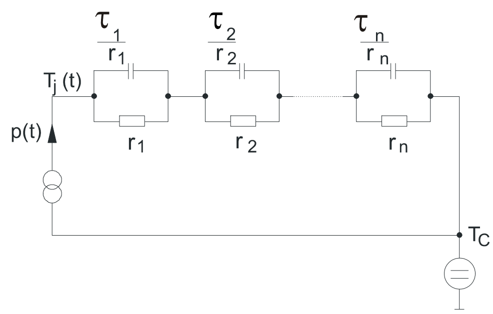


Figure D. **Thermal equivalent circuit**

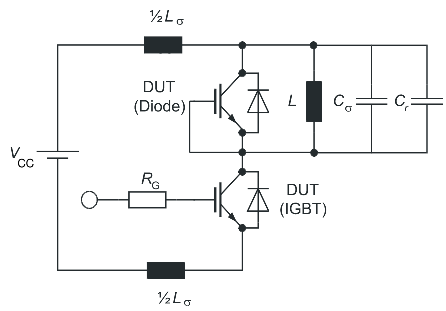


Figure E. **Dynamic test circuit**

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

Revision History

IKFW50N65ES5

Revision: 2020-07-09, Rev. 2.1

Previous Revision

Revision	Date	Subjects (major changes since last revision)
2.1	2020-07-09	Final Data Sheet