

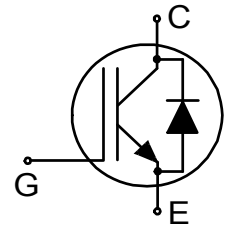
TRENCHSTOP™ 5 Advanced Isolation

Reverse-Conducting IGBT in TRENCHSTOP™ 5 technology with monolithic body diode in fully isolated package

Features and Benefits:

TRENCHSTOP™ 5 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
- Very soft, fast recovery antiparallel diode
- Maximum junction temperature 175°C
- 2500V_{RMS} electrical isolation, 50/60Hz, $t=1\text{min}$
- 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:

- Induction cooking
- Inverterized microwave ovens
- Resonant converters

Product Validation:

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

**Key Performance and Package Parameters**

Type	V_{CE}	I_C	$V_{CEsat}, T_{vj}=25^\circ\text{C}$	T_{vjmax}	Marking	Package
IHFW40N65R5S	650V	40A	1.5V	175°C	H40ER5S	PG-HSIP247-3-2

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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, $T_{vj} \geq 25^{\circ}\text{C}$	V_{CE}	650	V
DC collector current, limited by T_{vjmax} $T_h = 25^{\circ}\text{C}$ $T_h = 65^{\circ}\text{C}$ $T_h = 65^{\circ}\text{C}$	I_C	61.0 49.0 52.0 ¹⁾	A
Pulsed collector current, t_p limited by T_{vjmax}	I_{Cpuls}	120.0	A
Turn off safe operating area $V_{CE} \leq 650\text{V}$, $T_{vj} \leq 175^{\circ}\text{C}$, $t_p = 1\mu\text{s}$	-	120.0	A
Diode forward current, limited by T_{vjmax} $T_h = 25^{\circ}\text{C}$ $T_h = 65^{\circ}\text{C}$	I_F	44.0 40.0	A
Diode pulsed current, t_p limited by T_{vjmax}	I_{Fpuls}	120.0	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 $T_h = 25^{\circ}\text{C}$ Power dissipation $T_h = 65^{\circ}\text{C}$	P_{tot}	108.0 79.0	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
Isolation voltage RMS, $f = 50/60\text{Hz}$, $t = 1\text{min}^{2)}$	V_{isol}	2500	V

Thermal Resistance

Parameter	Symbol	Conditions	Value			Unit
			min.	typ.	max.	
R_{th} Characteristics						
IGBT thermal resistance, ³⁾ junction - heatsink	$R_{th(j-h)}$		-	1.19	1.39	K/W
Diode thermal resistance, ³⁾ junction - heatsink	$R_{th(j-h)}$		-	3.32	3.90	K/W
Thermal resistance junction - ambient	$R_{th(j-a)}$		-	-	65	K/W

¹⁾ Equivalent current rating in TO-247-3 at $T_h = 65^{\circ}\text{C}$ using reference insulation material: 152 μm , 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 $F = 500\text{N}$, $T_a = 25^{\circ}\text{C}$

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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	$V_{(BR)CES}$	$V_{GE} = 0\text{V}, I_C = 0.50\text{mA}$	650	-	-	V
Collector-emitter saturation voltage	V_{CESat}	$V_{GE} = 15.0\text{V}, I_C = 40.0\text{A}$ $T_{vj} = 25^{\circ}\text{C}$ $T_{vj} = 175^{\circ}\text{C}$	- -	1.50 1.85	2.00 -	V
Diode forward voltage	V_F	$V_{GE} = 0\text{V}, I_F = 40.0\text{A}$ $T_{vj} = 25^{\circ}\text{C}$ $T_{vj} = 175^{\circ}\text{C}$	- -	2.00 2.60	2.40 -	V
Gate-emitter threshold voltage	$V_{GE(th)}$	$I_C = 0.40\text{mA}, V_{CE} = V_{GE}$	3.2	4.0	4.8	V
Zero gate voltage collector current	I_{CES}	$V_{CE} = 650\text{V}, V_{GE} = 0\text{V}$ $T_{vj} = 25^{\circ}\text{C}$ $T_{vj} = 175^{\circ}\text{C}$	- -	- 1000	40 -	μA
Gate-emitter leakage current	I_{GES}	$V_{CE} = 0\text{V}, V_{GE} = 20\text{V}$	-	-	100	nA
Transconductance	g_{fs}	$V_{CE} = 20\text{V}, I_C = 40.0\text{A}$	-	88.0	-	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}	$V_{CE} = 25\text{V}, V_{GE} = 0\text{V}$ $f = 1000\text{kHz}$	-	3428	-	pF
Output capacitance	C_{oes}		-	34	-	
Reverse transfer capacitance	C_{res}		-	13	-	
Gate charge	Q_G	$V_{CC} = 520\text{V}, I_C = 40.0\text{A},$ $V_{GE} = 15\text{V}$	-	142.0	-	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	$t_{d(on)}$	$T_{vj} = 25^{\circ}\text{C},$ $V_{CC} = 400\text{V}, I_C = 40.0\text{A},$ $V_{GE} = 0.0/15.0\text{V},$ $R_{G(on)} = 23.1\Omega, R_{G(off)} = 23.1\Omega,$ $L_{\sigma} = 40\text{nH}, C_{\sigma} = 50\text{pF}$ L_{σ}, C_{σ} from Fig. E Energy losses include "tail" and diode reverse recovery.	-	44	-	ns
Rise time	t_r		-	38	-	ns
Turn-off delay time	$t_{d(off)}$		-	363	-	ns
Fall time	t_f		-	27	-	ns
Turn-on energy	E_{on}		-	1.52	-	mJ
Turn-off energy	E_{off}		-	0.70	-	mJ
Total switching energy	E_{ts}		-	2.22	-	mJ

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

Diode reverse recovery time	t_{rr}	$T_{vj} = 25^{\circ}\text{C},$ $V_R = 400\text{V},$ $I_F = 40.0\text{A},$ $di_F/dt = 900\text{A}/\mu\text{s}$	-	103	-	ns
Diode reverse recovery charge	Q_{rr}		-	2.48	-	μC
Diode peak reverse recovery current	I_{rrm}		-	39.0	-	A
Diode peak rate of fall of reverse recovery current during t_b	di_{rr}/dt		-	-1493	-	$\text{A}/\mu\text{s}$

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	$t_{d(on)}$	$T_{vj} = 150^{\circ}\text{C},$ $V_{CC} = 400\text{V}, I_C = 40.0\text{A},$ $V_{GE} = 0.0/15.0\text{V},$ $R_{G(on)} = 23.1\Omega, R_{G(off)} = 23.1\Omega,$ $L\sigma = 40\text{nH}, C\sigma = 50\text{pF}$ $L\sigma, C\sigma$ from Fig. E Energy losses include "tail" and diode reverse recovery.	-	40	-	ns
Rise time	t_r		-	39	-	ns
Turn-off delay time	$t_{d(off)}$		-	424	-	ns
Fall time	t_f		-	30	-	ns
Turn-on energy	E_{on}		-	1.64	-	mJ
Turn-off energy	E_{off}		-	0.86	-	mJ
Total switching energy	E_{ts}		-	2.50	-	mJ

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

Diode reverse recovery time	t_{rr}	$T_{vj} = 150^{\circ}\text{C},$ $V_R = 400\text{V},$ $I_F = 40.0\text{A},$ $di_F/dt = 900\text{A}/\mu\text{s}$	-	149	-	ns
Diode reverse recovery charge	Q_{rr}		-	4.49	-	μC
Diode peak reverse recovery current	I_{rrm}		-	51.0	-	A
Diode peak rate of fall of reverse recovery current during t_b	di_{rr}/dt		-	-905	-	$\text{A}/\mu\text{s}$

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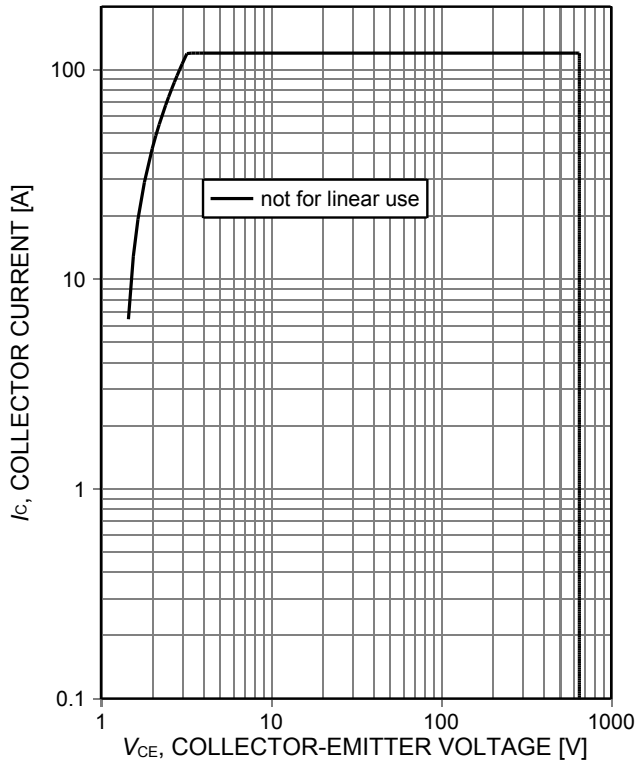


Figure 1. **Forward bias safe operating area**
 ($D=0$, $T_h=25^\circ\text{C}$, $T_j \leq 175^\circ\text{C}$, $V_{GE}=15\text{V}$, $t_p \leq 1\mu\text{s}$)

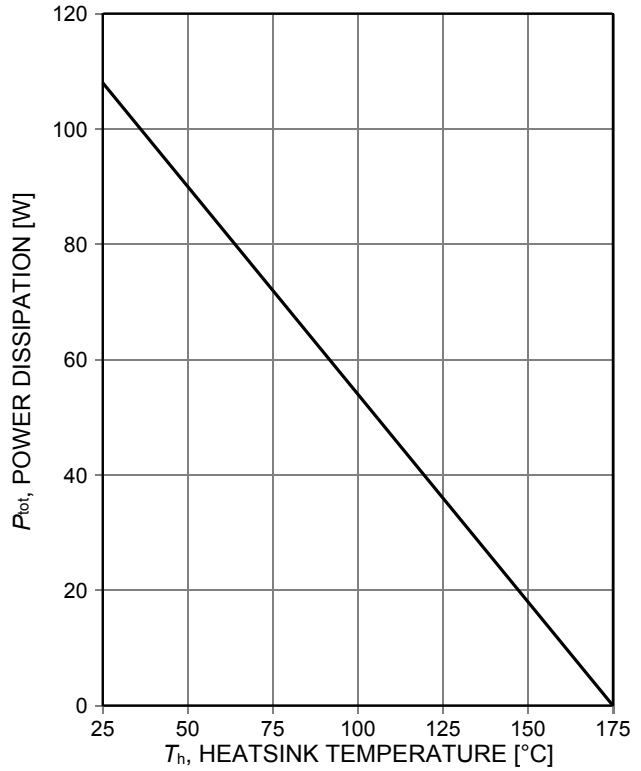


Figure 2. **Power dissipation as a function of heatsink temperature**
 ($T_j \leq 175^\circ\text{C}$)

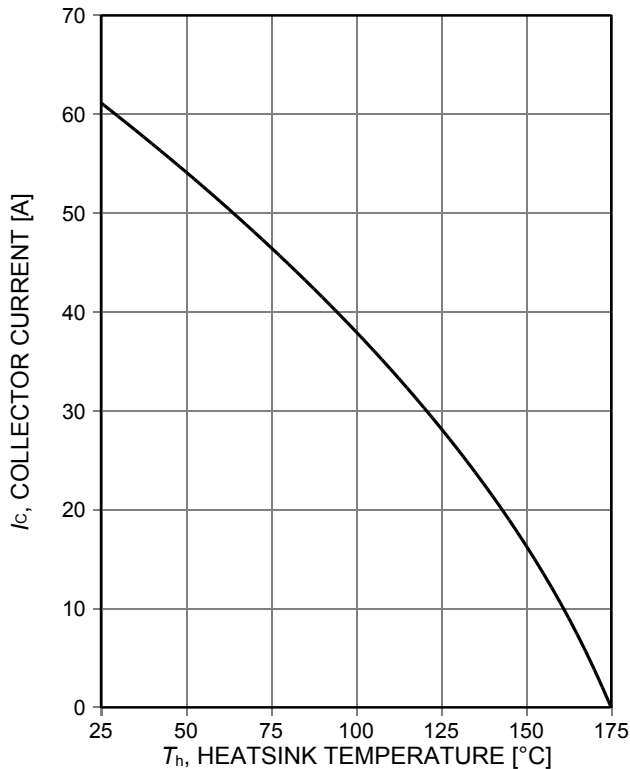


Figure 3. **Collector current as a function of heatsink temperature**
 ($V_{GE} \geq 15\text{V}$, $T_j \leq 175^\circ\text{C}$)

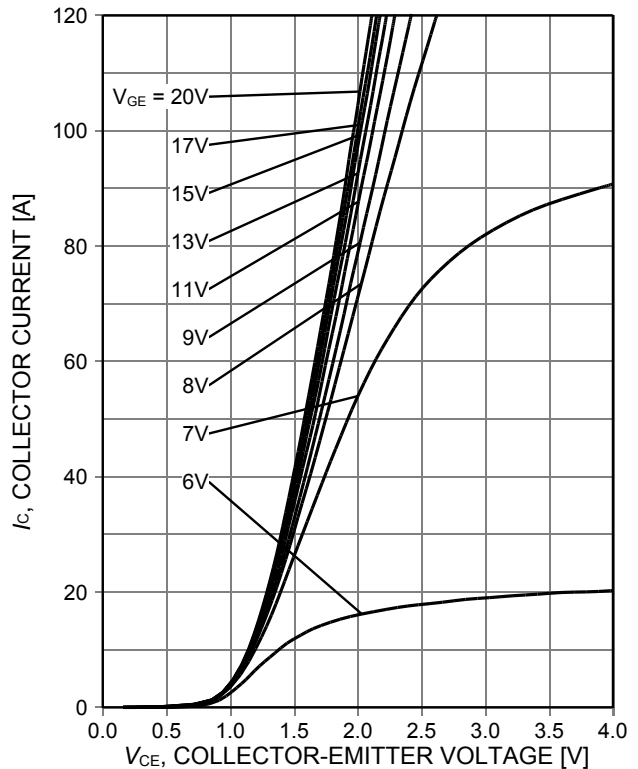


Figure 4. **Typical output characteristic**
 ($T_j=25^\circ\text{C}$)

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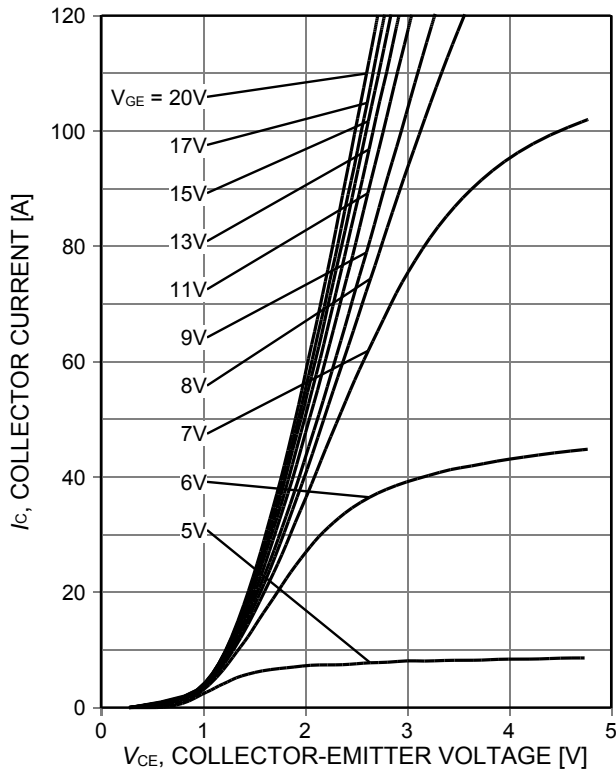


Figure 5. Typical output characteristic ($T_j=150^{\circ}\text{C}$)

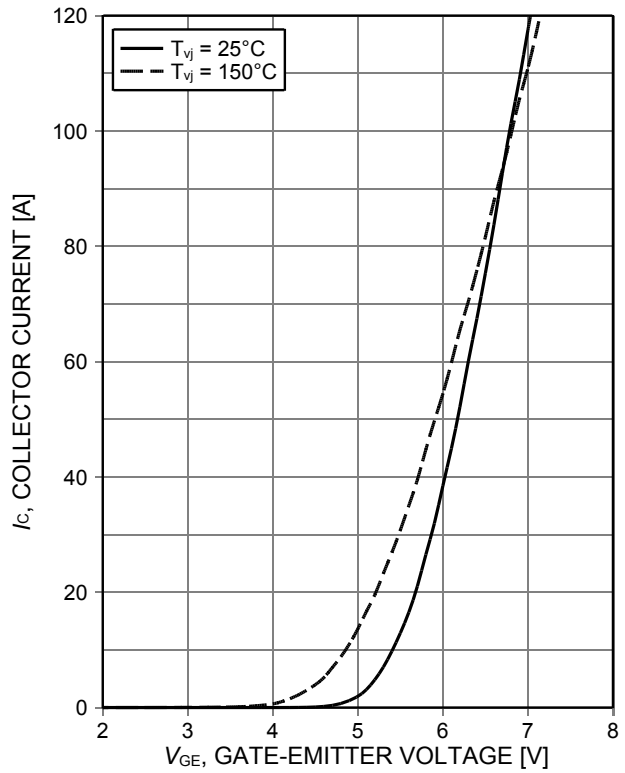


Figure 6. Typical transfer characteristic ($V_{CE}=20\text{V}$)

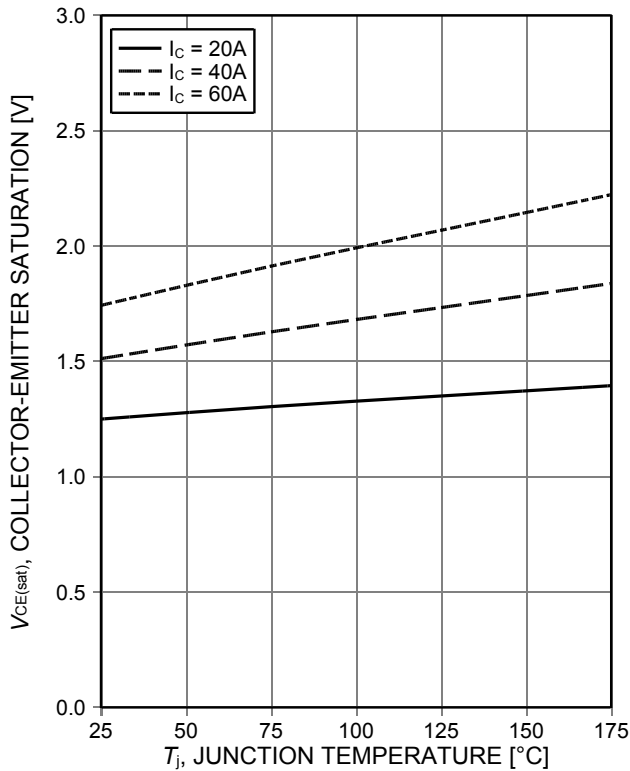


Figure 7. Typical collector-emitter saturation voltage as a function of junction temperature ($V_{GE}=15\text{V}$)

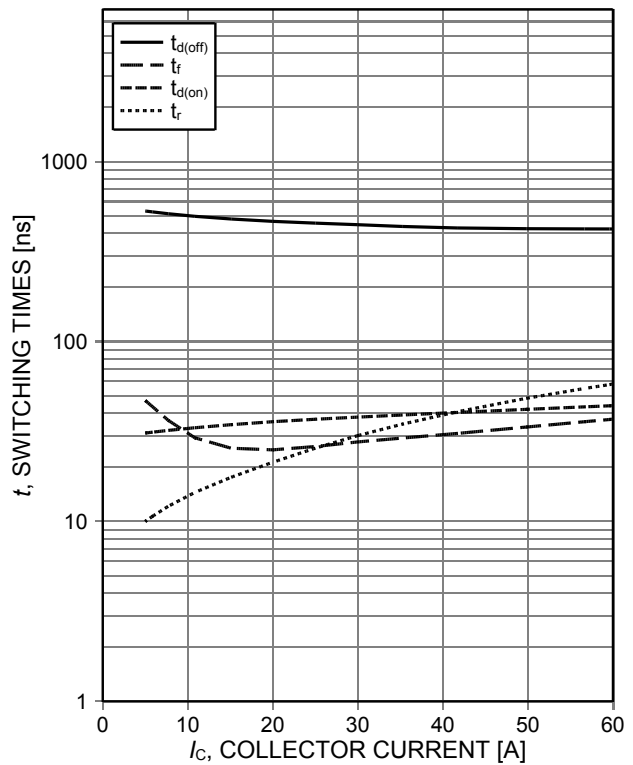


Figure 8. Typical switching times as a function of collector current (ind. load, $T_j=150^{\circ}\text{C}$, $V_{CE}=400\text{V}$, $V_{GE}=0/15\text{V}$, $R_G=23.1\Omega$, test circuit in Fig. E)

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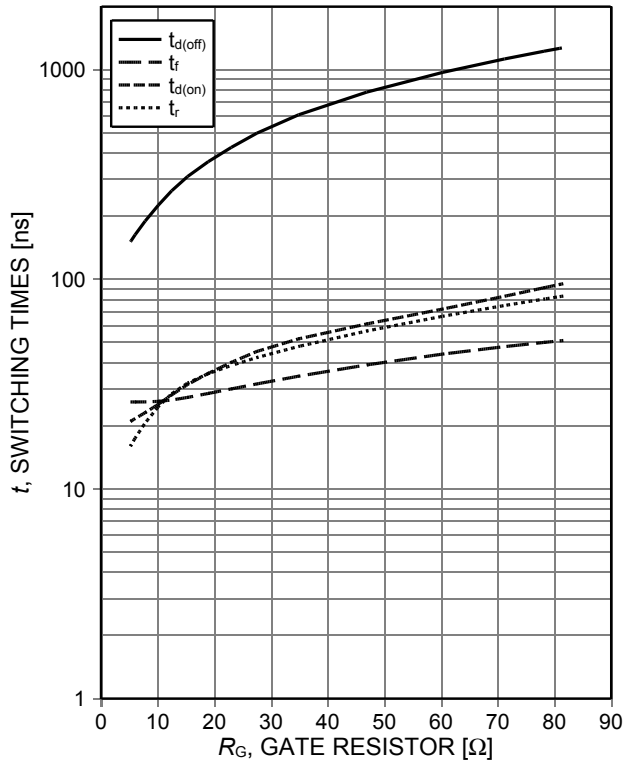


Figure 9. Typical switching times as a function of gate resistor
(ind. load, $T_j=150^{\circ}\text{C}$, $V_{CE}=400\text{V}$, $V_{GE}=0/15\text{V}$, $I_C=40\text{A}$, test circuit in Fig. E)

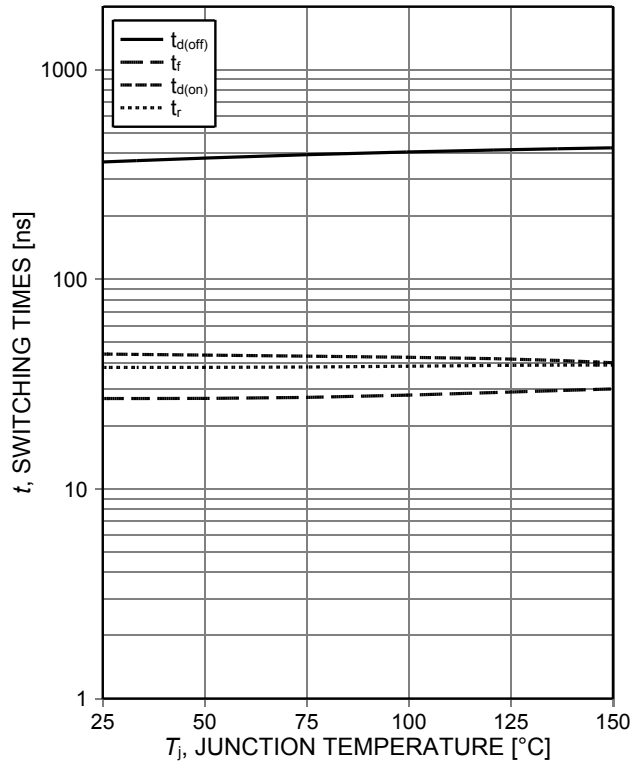


Figure 10. Typical switching times as a function of junction temperature
(ind. load, $V_{CE}=400\text{V}$, $V_{GE}=0/15\text{V}$, $I_C=40\text{A}$, $r_G=23.1\Omega$, test circuit in Fig. E)

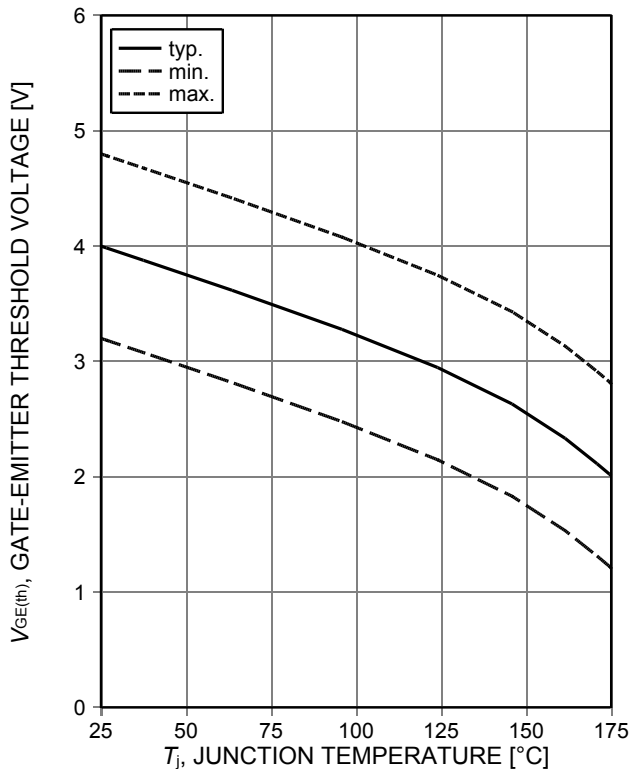


Figure 11. Gate-emitter threshold voltage as a function of junction temperature
($I_C=0.4\text{mA}$)

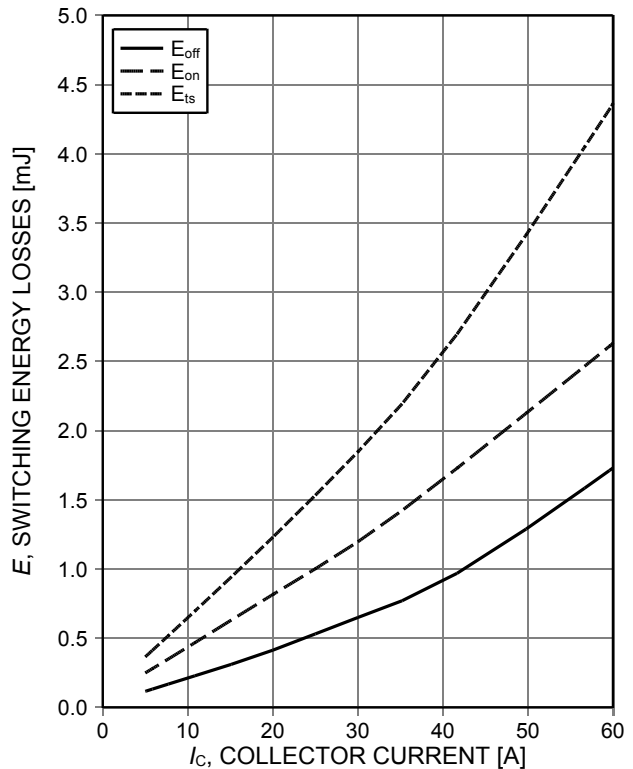


Figure 12. Typical switching energy losses as a function of collector current
(ind. load, $T_j=150^{\circ}\text{C}$, $V_{CE}=400\text{V}$, $V_{GE}=0/15\text{V}$, $R_G=23.1\Omega$, test circuit in Fig. E)

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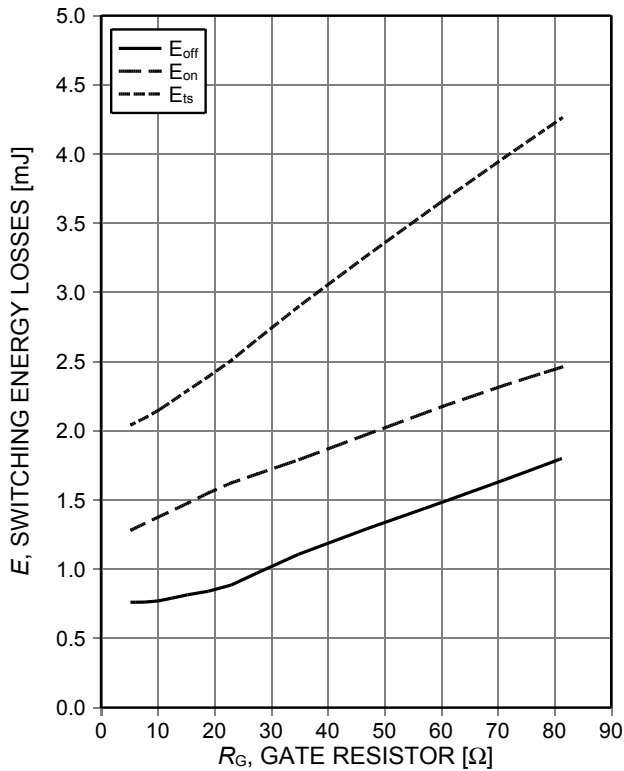


Figure 13. **Typical switching energy losses as a function of gate resistor**
 (ind. load, $T_j=150^\circ\text{C}$, $V_{CE}=400\text{V}$, $V_{GE}=0/15\text{V}$, $I_C=40\text{A}$, test circuit in Fig. E)

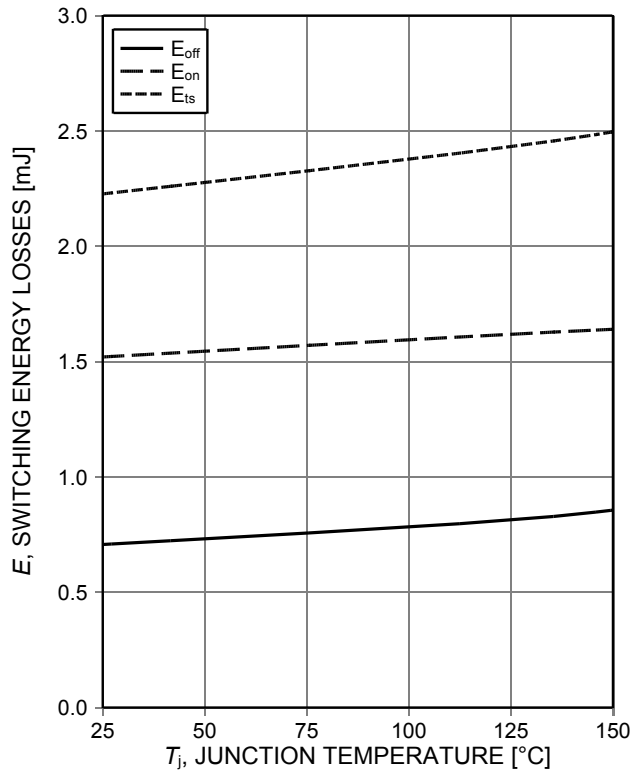


Figure 14. **Typical switching energy losses as a function of junction temperature**
 (ind. load, $V_{CE}=400\text{V}$, $V_{GE}=0/15\text{V}$, $I_C=40\text{A}$, $R_G=23.1\Omega$, test circuit in Fig. E)

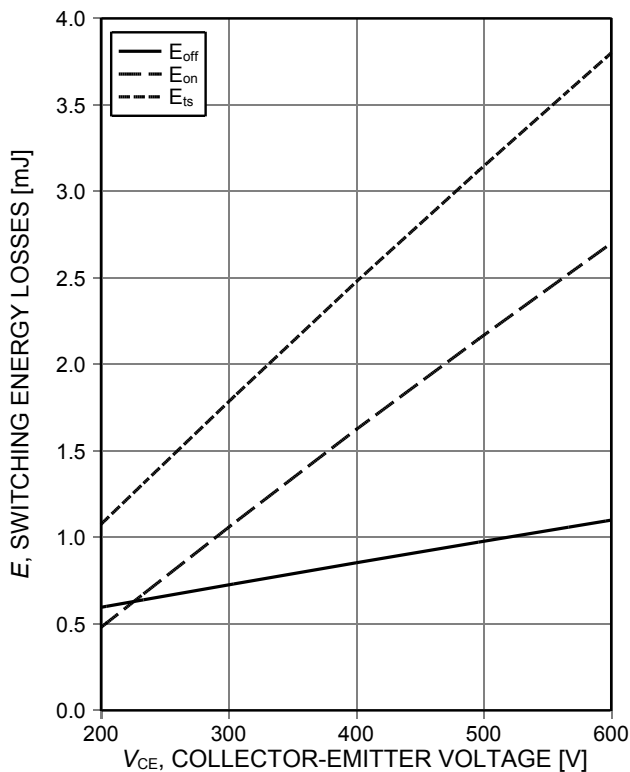


Figure 15. **Typical switching energy losses as a function of collector emitter voltage**
 (ind. load, $T_j=150^\circ\text{C}$, $V_{GE}=0/15\text{V}$, $I_C=40\text{A}$, $R_G=23.1\Omega$, test circuit in Fig. E)

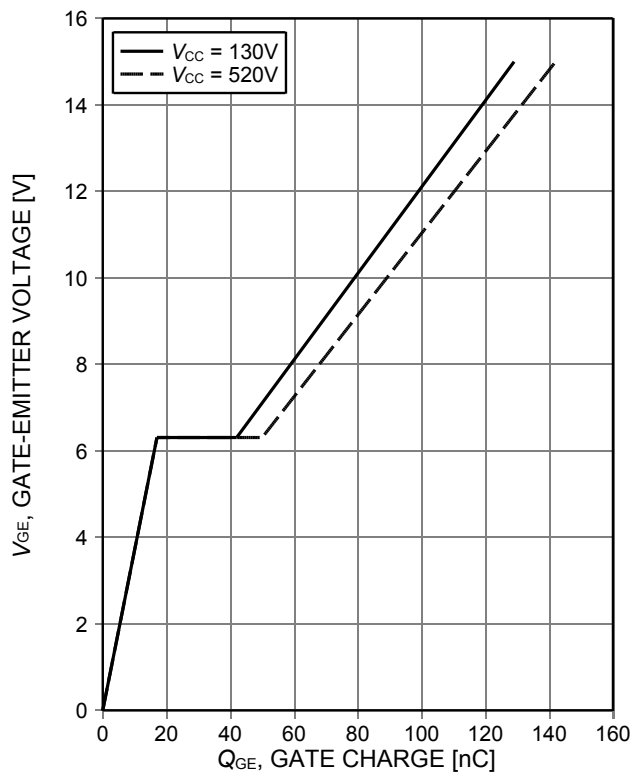


Figure 16. **Typical gate charge**
 ($I_C=40\text{A}$)

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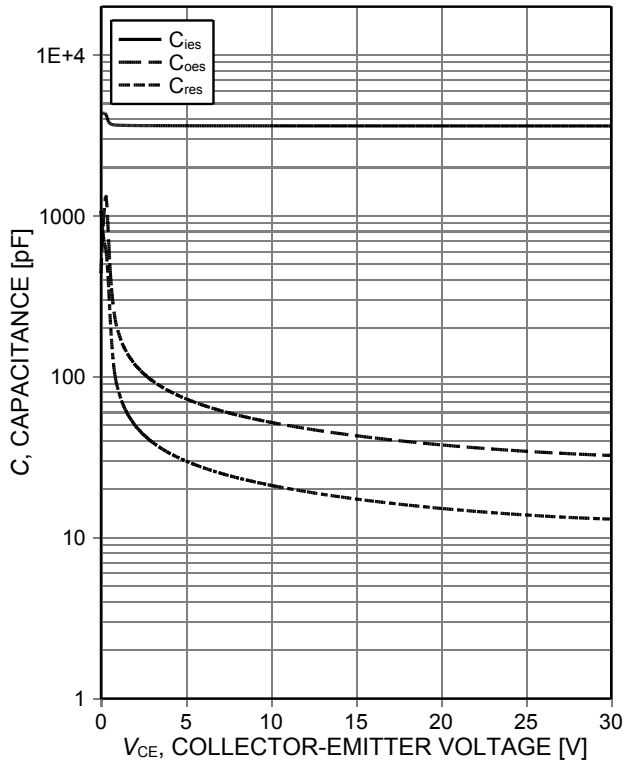


Figure 17. Typical capacitance as a function of collector-emitter voltage ($V_{GE}=0V$, $f=1MHz$)

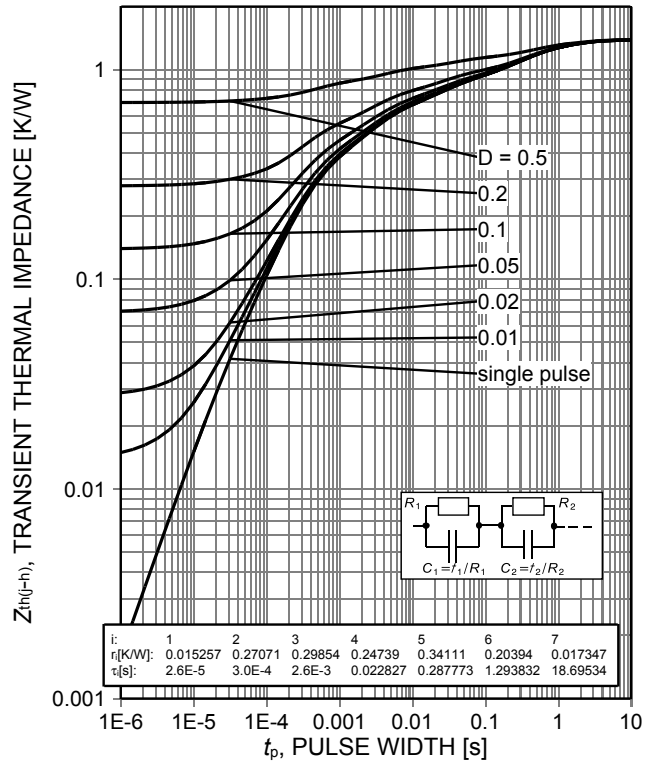


Figure 18. IGBT transient thermal impedance as a function of pulse width ($D=t_p/T$)

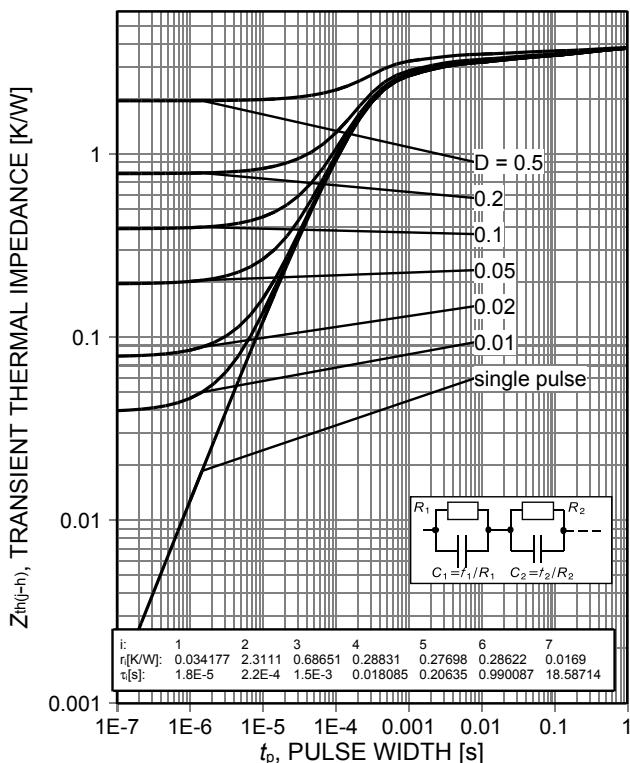


Figure 19. Diode transient thermal impedance as a function of pulse width ($D=t_p/T$)

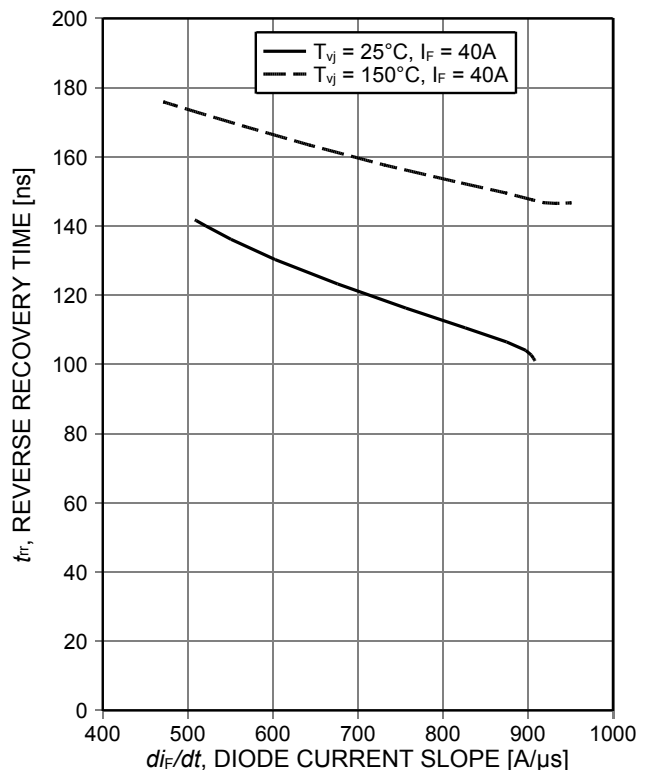


Figure 20. Typical reverse recovery time as a function of diode current slope ($V_R=400V$)

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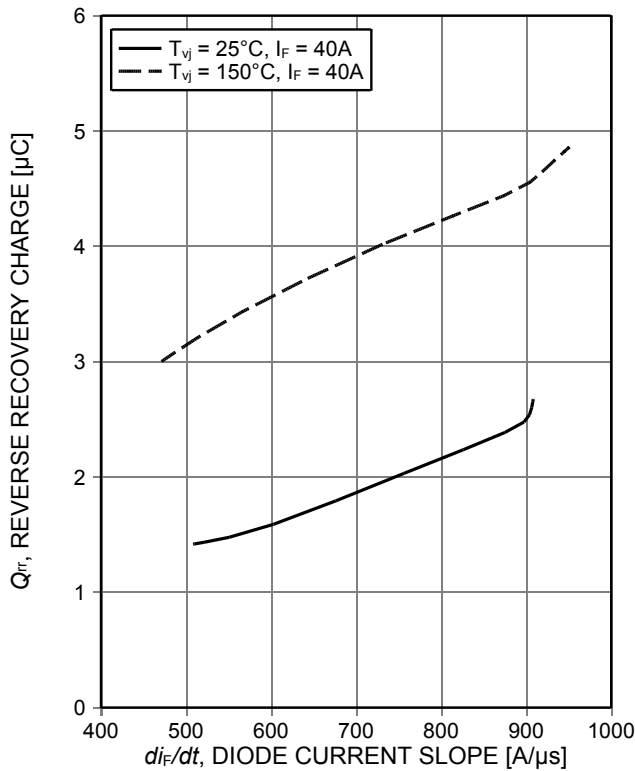


Figure 21. Typical reverse recovery charge as a function of diode current slope (VR=400V)

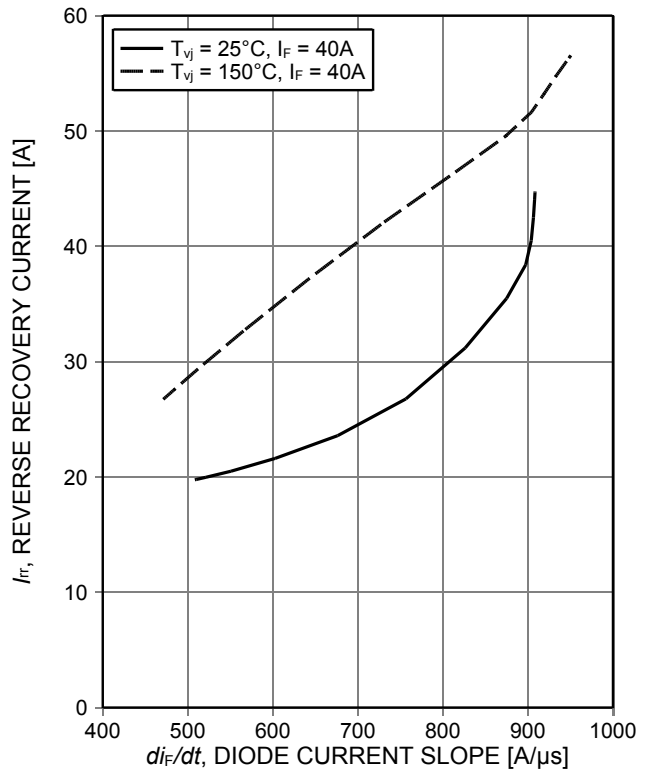


Figure 22. Typical reverse recovery current as a function of diode current slope (VR=400V)

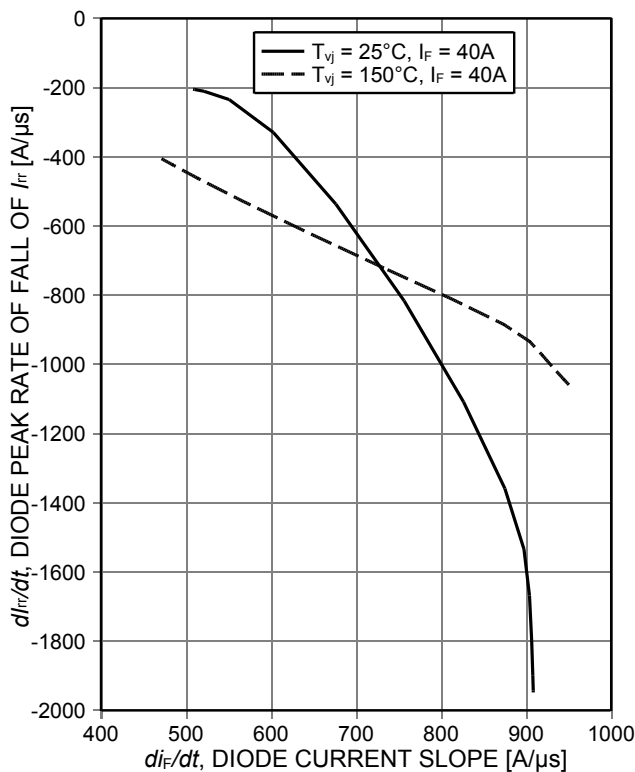


Figure 23. Typical diode peak rate of fall of reverse recovery current as a function of diode current slope (VR=400V)

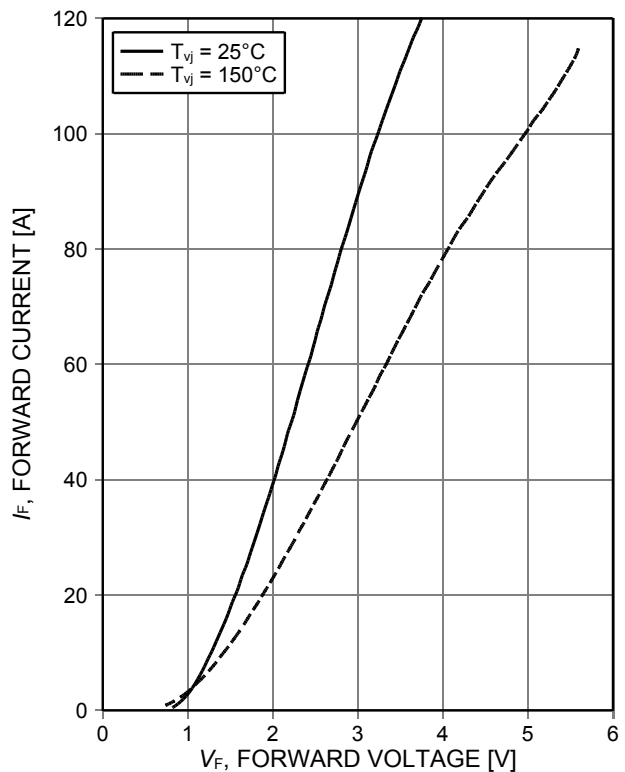


Figure 24. Typical diode forward current as a function of forward voltage

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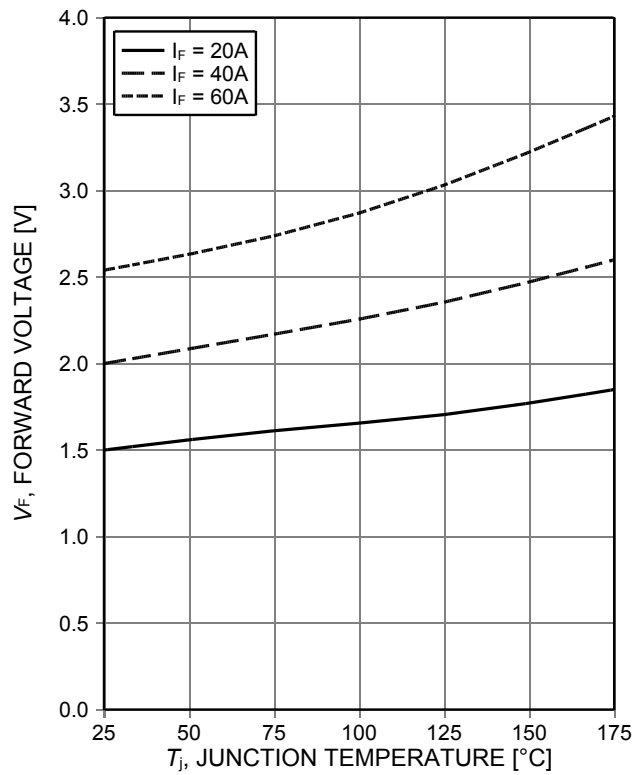
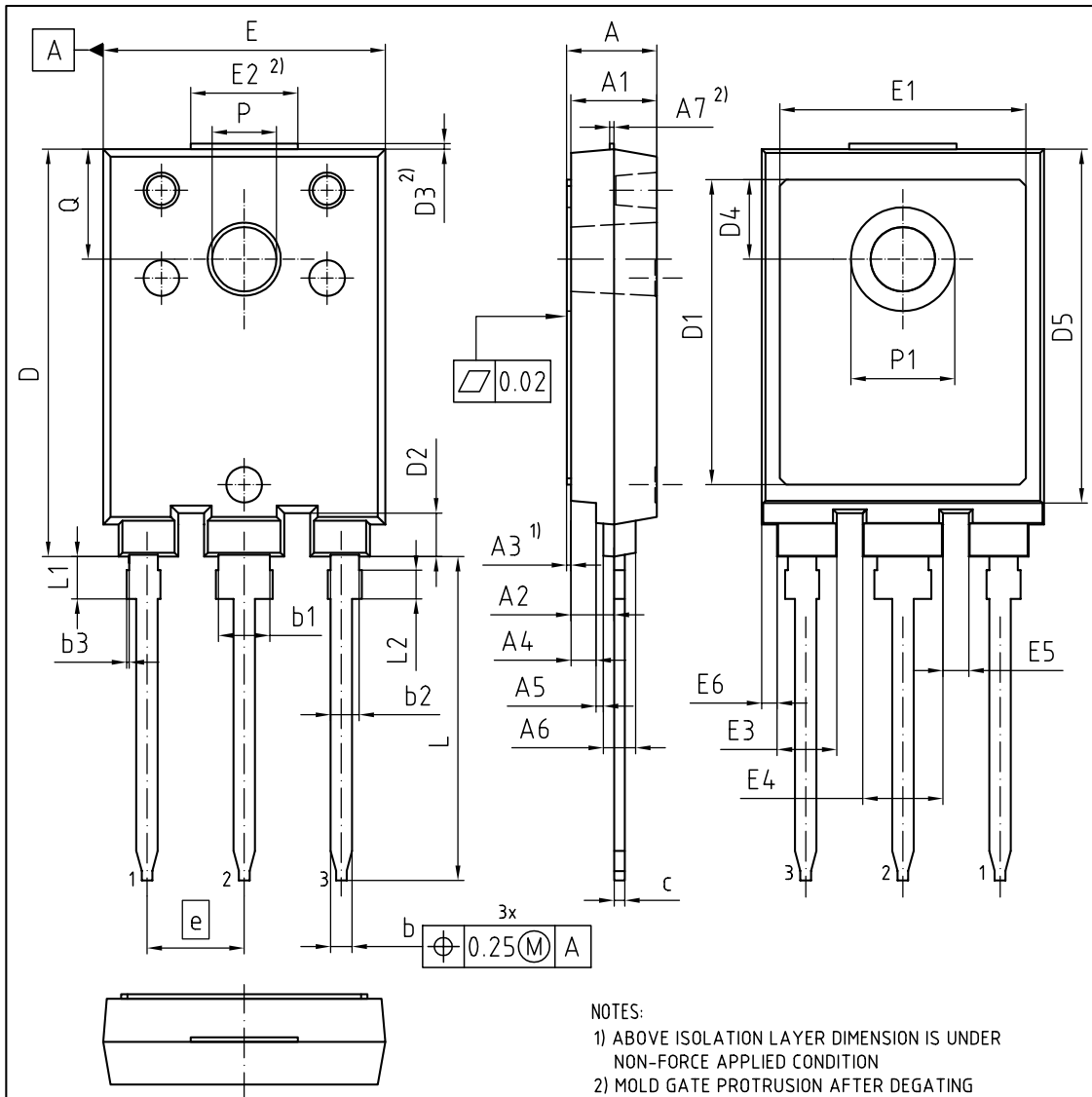


Figure 25. Typical diode forward voltage as a function of junction temperature

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		DIMENSIONS	MILLIMETERS	
	MIN.	MAX.		MIN.	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			

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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

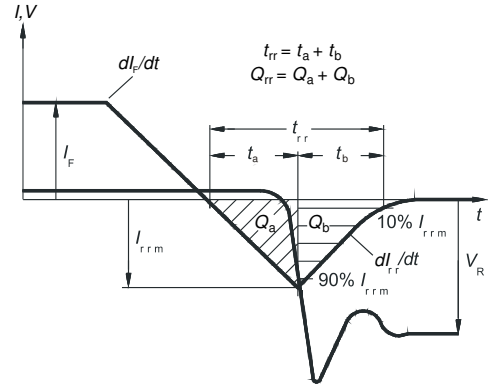


Figure C. Definition of diode switching characteristics



Figure D. Thermal equivalent circuit

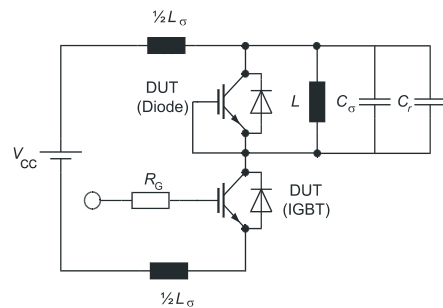


Figure E. Dynamic test circuit
Parasitic inductance L_{σ} ,
parasitic capacitor C_{σ} ,
relief capacitor C_r ,
(only for ZVT switching)

Revision History

IHFW40N65R5S

Revision: 2020-07-10, Rev. 2.1

Previous Revision

Revision	Date	Subjects (major changes since last revision)
1.1	2020-05-07	Preliminary Data Sheet
2.1	2020-07-10	Final data sheet

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