

## Hybrid CoolSiC™ IGBT

TRENCHSTOP™ 5 S5 IGBT co-packed with full-rated 6<sup>th</sup> generation CoolSiC™ Schottky barrier diode**Features and Benefits:**

- Ultra-low switching losses due to the combination of TRENCHSTOP™ 5 and CoolSiC™ technology
- Very low on-state losses
- Benchmark efficiency in hard switching topologies
- Plug-and-play replacement of pure silicon devices
- 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/>

**Potential Applications:**

- Industrial Power Supplies
  - Industrial SMPS
  - Industrial UPS
- Energy Generation
  - Solar String Inverter
- Energy Distribution
  - Energy Storage
- Infrastructure – Charge
  - Charger

**Product Validation:**

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

**Package pin definition:**

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

**Key Performance and Package Parameters**

Type	V <sub>CE</sub>	I <sub>C</sub>	V <sub>CEsat</sub> , T <sub>vj</sub> =25°C	T <sub>vjmax</sub>	Marking	Package
IKW50N65SS5	650V	50A	1.35V	175°C	K50ESS5	PG-TO247-3

## Table of Contents

Description .....	1
Table of Contents .....	2
Maximum Ratings .....	3
Thermal Resistance .....	3
Electrical Characteristics .....	4
Electrical Characteristics Diagrams .....	6
Package Drawing .....	12
Testing Conditions .....	13
Revision History .....	14
Disclaimer .....	15

## Hybrid CoolSiC™ 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 $T_{vjmax}$ $T_c = 25^{\circ}\text{C}$ 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 $T_{vjmax}$ $T_c = 25^{\circ}\text{C}$ $T_c = 100^{\circ}\text{C}$	$I_F$	57.5 38.5	A
Diode pulsed current, $t_p$ limited by $T_{vjmax}$ <sup>1)</sup>	$I_{Fpuls}$	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 $T_c = 100^{\circ}\text{C}$	$P_{tot}$	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.	
<b>R<sub>th</sub> Characteristics</b>						
IGBT thermal resistance, junction - case	$R_{th(j-c)}$		-	-	0.55	K/W
Diode thermal resistance, junction - case	$R_{th(j-c)}$		-	-	1.00	K/W
Thermal resistance junction - ambient	$R_{th(j-a)}$		-	-	40	K/W

<sup>1)</sup> Pulse current level depends on  $T_{vj}$  of diode chip, see also Fig. "Maximum pulse current as a function of junction temperature"

## Hybrid CoolSiC™ IGBT

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 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 1.55 1.65	1.70 - -	V
Diode forward voltage	$V_F$	$V_{GE} = 0\text{V}$ , $I_F = 40.0\text{A}$ $T_{vj} = 25^{\circ}\text{C}$ $T_{vj} = 125^{\circ}\text{C}$ $T_{vj} = 175^{\circ}\text{C}$	- - -	1.35 1.55 1.65	1.50 - -	V
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	$I_{CES}$	$V_{CE} = 650\text{V}$ , $V_{GE} = 0\text{V}$ $T_{vj} = 25^{\circ}\text{C}$ $T_{vj} = 175^{\circ}\text{C}$	- -	- 2000	1300 -	$\mu\text{A}$
Zero gate voltage collector current	$I_{CES}$	$V_{CE} = 480\text{V}$ , $V_{GE} = 0\text{V}$ $T_{vj} = 25^{\circ}\text{C}$	-	-	40	$\mu\text{A}$
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.	
<b>Dynamic Characteristic</b>						
Input capacitance	$C_{ies}$	$V_{CE} = 25\text{V}$ , $V_{GE} = 0\text{V}$ $f = 250\text{kHz}$	-	2660	-	pF
Output capacitance	$C_{oes}$		-	530	-	
Reverse transfer capacitance	$C_{res}$		-	10	-	
Gate charge	$Q_G$	$V_{CC} = 520\text{V}$ , $I_C = 50.0\text{A}$ , $V_{GE} = 15\text{V}$	-	110.0	-	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	$t_{d(on)}$	$T_{vj} = 25^{\circ}\text{C}$ ,	-	20	-	ns
Rise time	$t_r$	$V_{CC} = 400\text{V}$ , $I_C = 50.0\text{A}$ , $V_{GE} = 0.0/15.0\text{V}$ ,	-	10	-	ns
Turn-off delay time	$t_{d(off)}$	$R_{G(on)} = 9.0\Omega$ , $R_{G(off)} = 9.0\Omega$ ,	-	140	-	ns
Fall time	$t_f$	$L\sigma = 30\text{nH}$ , $C\sigma = 30\text{pF}$ $L\sigma$ , $C\sigma$ from Fig. E	-	20	-	ns
Turn-on energy	$E_{on}$	Energy losses include "tail" and diode reverse recovery.	-	0.32	-	mJ
Turn-off energy	$E_{off}$		-	0.55	-	mJ
Total switching energy	$E_{ts}$		-	0.87	-	mJ

## Hybrid CoolSiC™ IGBT

Turn-on delay time	$t_{d(on)}$	$T_{vj} = 25^{\circ}\text{C}$ , $V_{CC} = 400\text{V}$ , $I_C = 25.0\text{A}$ , $V_{GE} = 0.0/15.0\text{V}$ , $R_{G(on)} = 9.0\Omega$ , $R_{G(off)} = 9.0\Omega$ , $L\sigma = 30\text{nH}$ , $C\sigma = 30\text{pF}$ $L\sigma$ , $C\sigma$ from Fig. E Energy losses include "tail" and diode reverse recovery.	-	19	-	ns
Rise time	$t_r$		-	5	-	ns
Turn-off delay time	$t_{d(off)}$		-	155	-	ns
Fall time	$t_f$		-	25	-	ns
Turn-on energy	$E_{on}$		-	0.14	-	mJ
Turn-off energy	$E_{off}$		-	0.30	-	mJ
Total switching energy	$E_{ts}$		-	0.44	-	mJ

## 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	$t_{d(on)}$	$T_{vj} = 150^{\circ}\text{C}$ , $V_{CC} = 400\text{V}$ , $I_C = 50.0\text{A}$ , $V_{GE} = 0.0/15.0\text{V}$ , $R_{G(on)} = 9.0\Omega$ , $R_{G(off)} = 9.0\Omega$ , $L\sigma = 30\text{nH}$ , $C\sigma = 30\text{pF}$ $L\sigma$ , $C\sigma$ from Fig. E Energy losses include "tail" and diode reverse recovery.	-	20	-	ns
Rise time	$t_r$		-	11	-	ns
Turn-off delay time	$t_{d(off)}$		-	163	-	ns
Fall time	$t_f$		-	20	-	ns
Turn-on energy	$E_{on}$		-	0.39	-	mJ
Turn-off energy	$E_{off}$		-	0.90	-	mJ
Total switching energy	$E_{ts}$		-	1.29	-	mJ

Turn-on delay time	$t_{d(on)}$	$T_{vj} = 150^{\circ}\text{C}$ , $V_{CC} = 400\text{V}$ , $I_C = 25.0\text{A}$ , $V_{GE} = 0.0/15.0\text{V}$ , $R_{G(on)} = 9.0\Omega$ , $R_{G(off)} = 9.0\Omega$ , $L\sigma = 30\text{nH}$ , $C\sigma = 30\text{pF}$ $L\sigma$ , $C\sigma$ from Fig. E Energy losses include "tail" and diode reverse recovery.	-	18	-	ns
Rise time	$t_r$		-	6	-	ns
Turn-off delay time	$t_{d(off)}$		-	191	-	ns
Fall time	$t_f$		-	25	-	ns
Turn-on energy	$E_{on}$		-	0.17	-	mJ
Turn-off energy	$E_{off}$		-	0.50	-	mJ
Total switching energy	$E_{ts}$		-	0.67	-	mJ

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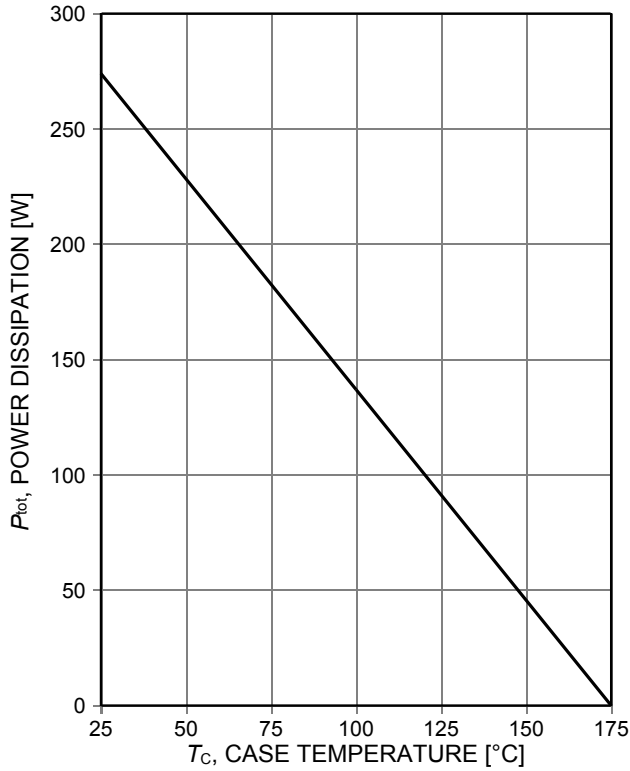


Figure 1. Power dissipation as a function of case temperature ( $T_{vj} \leq 175^\circ\text{C}$ )

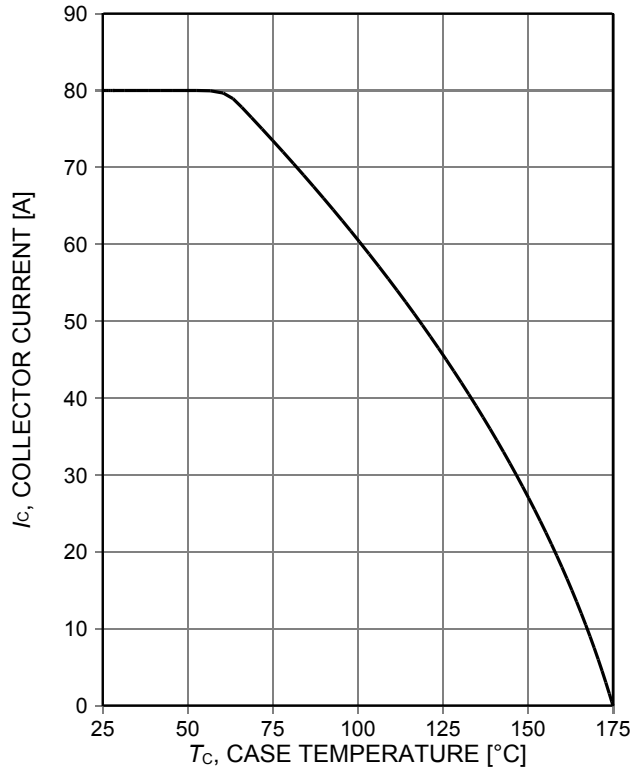


Figure 2. Collector current as a function of case temperature ( $V_{GE} \geq 15\text{V}$ ,  $T_{vj} \leq 175^\circ\text{C}$ )

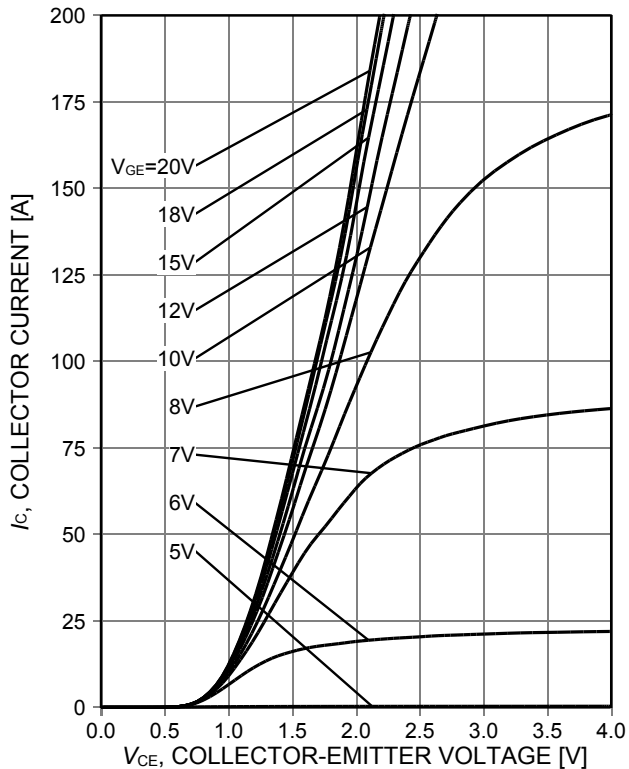


Figure 3. Typical output characteristic ( $T_{vj} = 25^\circ\text{C}$ )

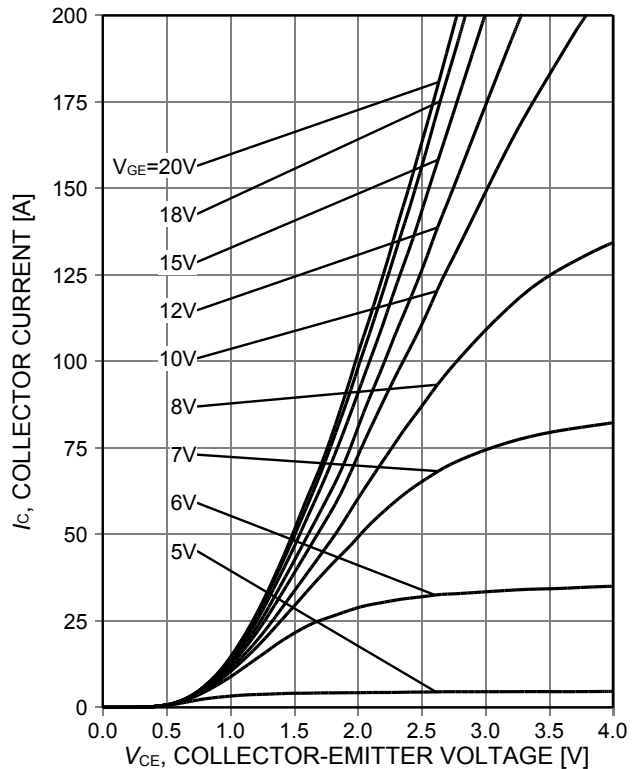


Figure 4. Typical output characteristic ( $T_{vj} = 150^\circ\text{C}$ )

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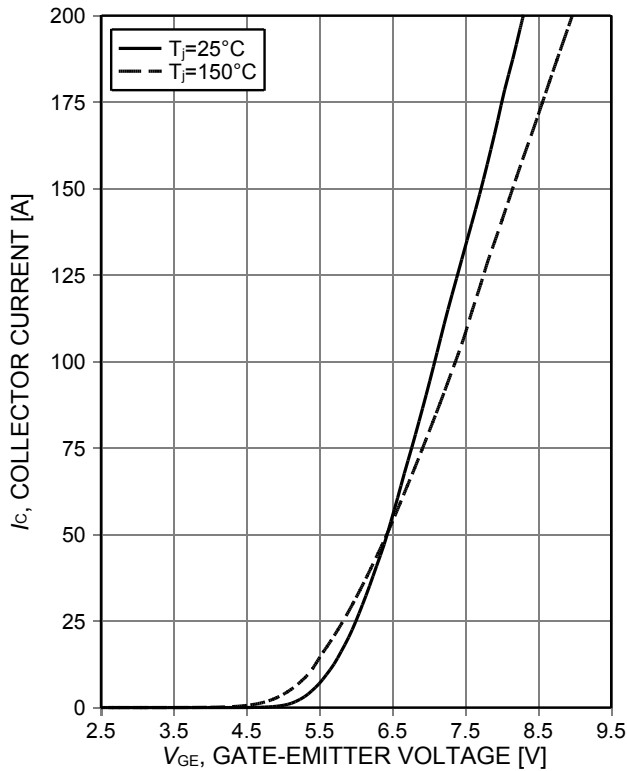


Figure 5. Typical transfer characteristic ( $V_{CE}=20V$ )

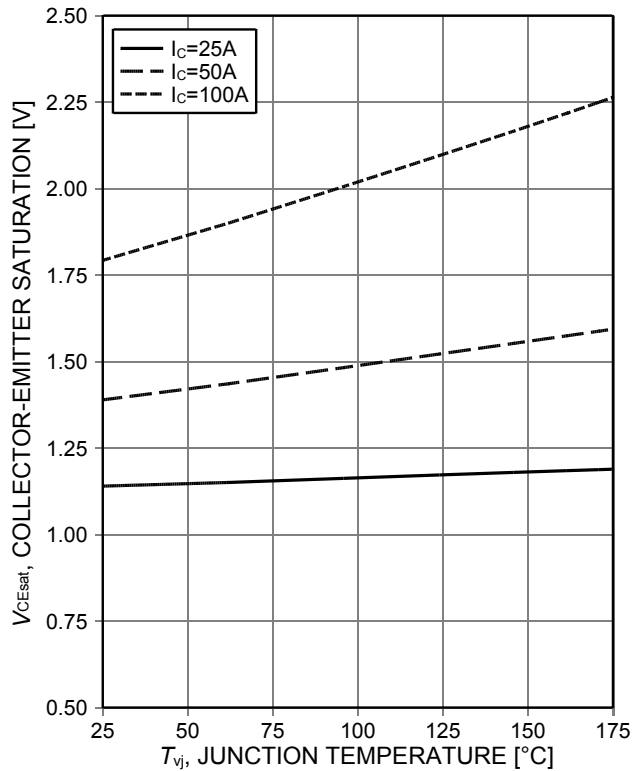


Figure 6. Typical collector-emitter saturation voltage as a function of junction temperature ( $V_{GE}=15V$ )

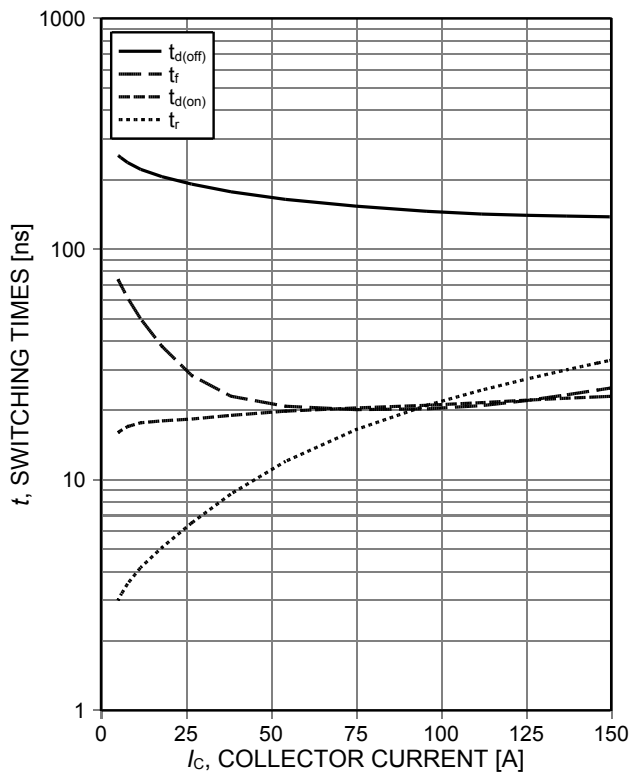


Figure 7. Typical switching times as a function of collector current (inductive load,  $T_{vj}=150^{\circ}C$ ,  $V_{CE}=400V$ ,  $V_{GE}=15/0V$ ,  $R_G=9\Omega$ , Dynamic test circuit in Figure E)

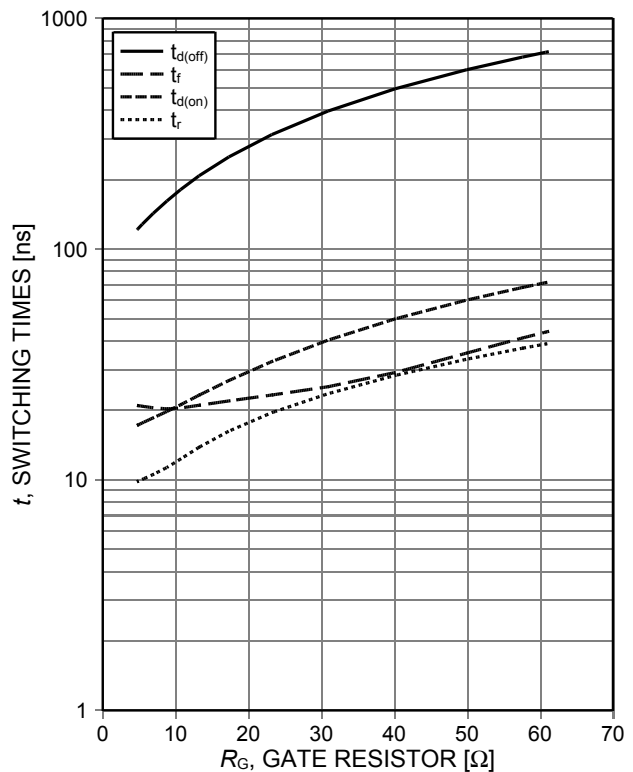


Figure 8. Typical switching times as a function of gate resistor (inductive load,  $T_{vj}=150^{\circ}C$ ,  $V_{CE}=400V$ ,  $V_{GE}=15/0V$ ,  $I_c=50A$ , Dynamic test circuit in Figure E)

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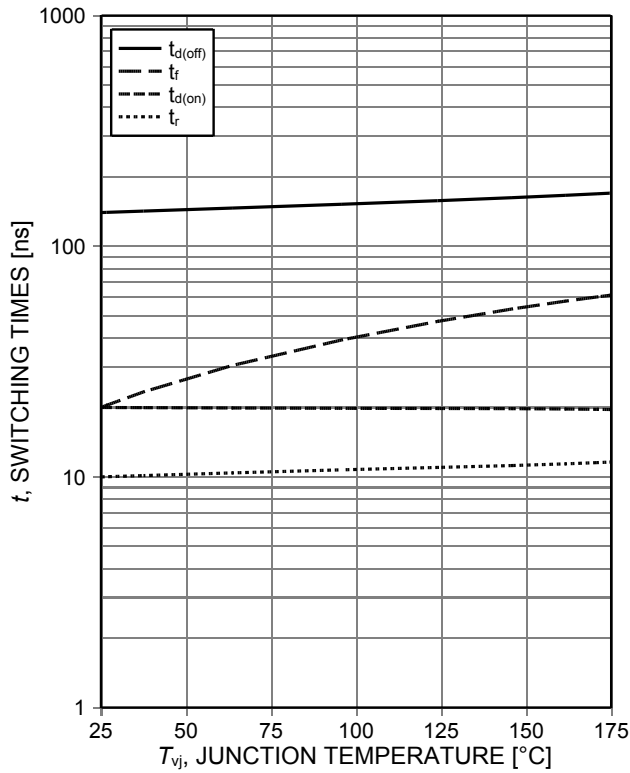


Figure 9. Typical switching times as a function of junction temperature (inductive load,  $V_{CE}=400V$ ,  $V_{GE}=15/0V$ ,  $I_C=50A$ ,  $R_G=9\Omega$ , Dynamic test circuit in Figure E)

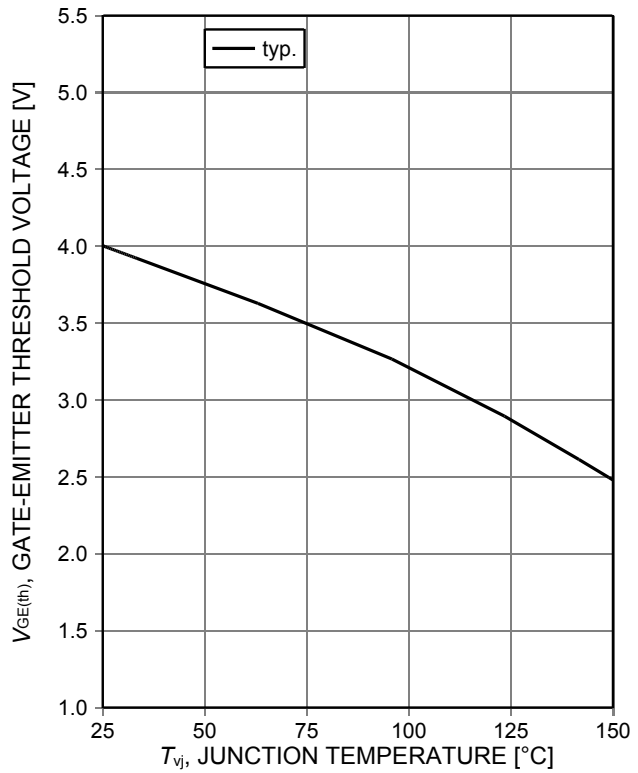


Figure 10. Gate-emitter threshold voltage as a function of junction temperature ( $I_C=0.50mA$ )

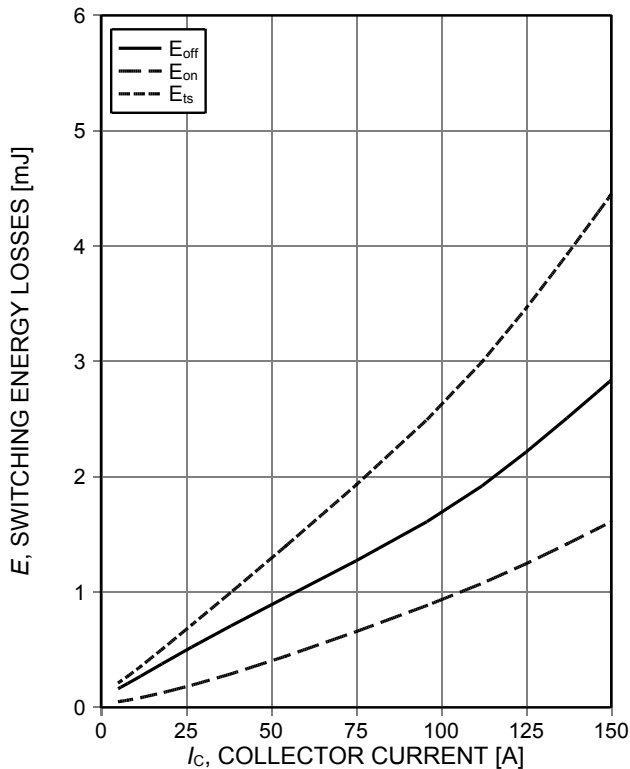


Figure 11. Typical switching energy losses as a function of collector current (inductive load,  $T_{vj}=150^\circ C$ ,  $V_{CE}=400V$ ,  $V_{GE}=15/0V$ ,  $R_G=9\Omega$ , Dynamic test circuit in Figure E)

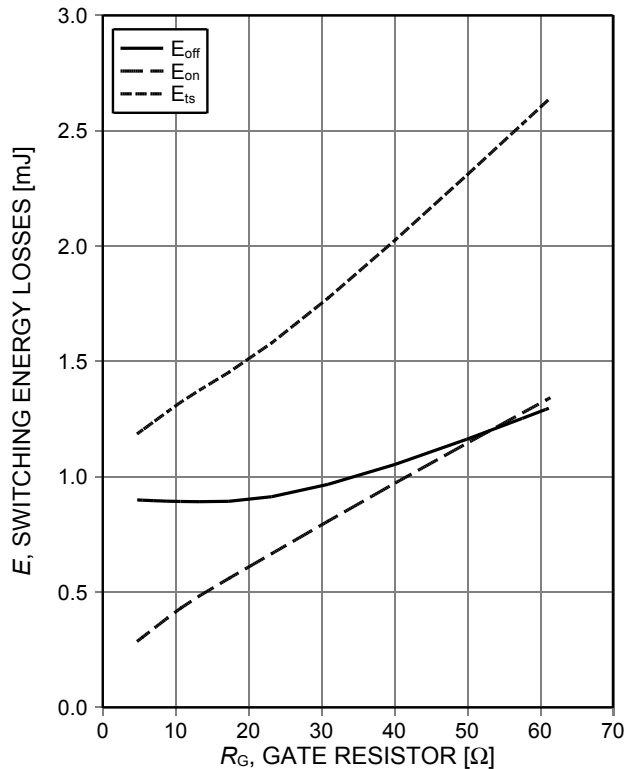


Figure 12. Typical switching energy losses as a function of gate resistor (inductive load,  $T_{vj}=150^\circ C$ ,  $V_{CE}=400V$ ,  $V_{GE}=15/0V$ ,  $I_C=50A$ , Dynamic test circuit in Figure E)



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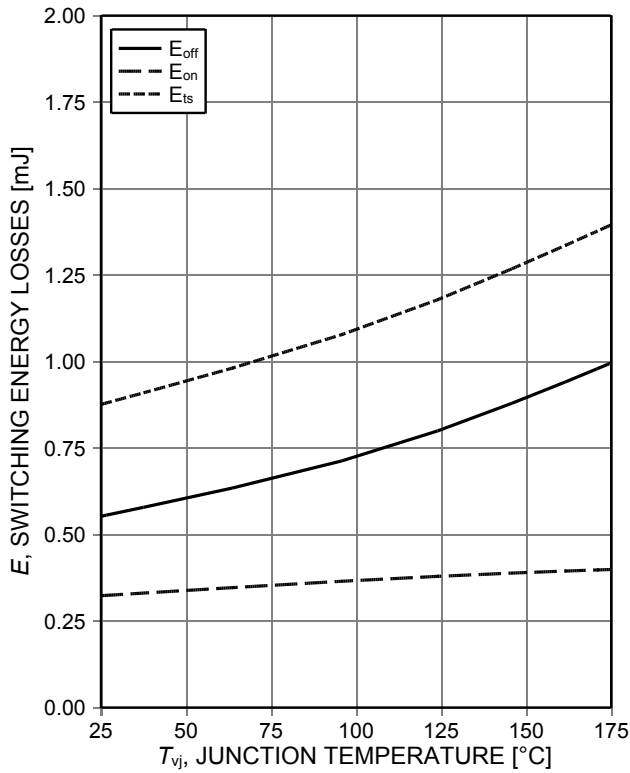


Figure 13. **Typical switching energy losses as a function of junction temperature** (inductive load,  $V_{CE}=400V$ ,  $V_{GE}=15/0V$ ,  $I_C=50A$ ,  $R_G=9\Omega$ , Dynamic test circuit in Figure E)

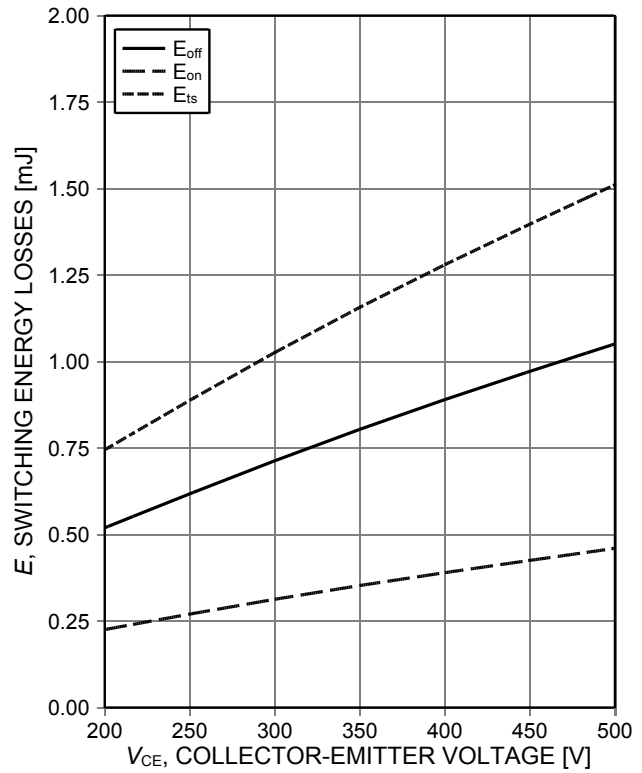


Figure 14. **Typical switching energy losses as a function of collector emitter voltage** (inductive load,  $T_{vj}=150^\circ C$ ,  $V_{GE}=15/0V$ ,  $I_C=50A$ ,  $R_G=9\Omega$ , Dynamic test circuit in Figure E)

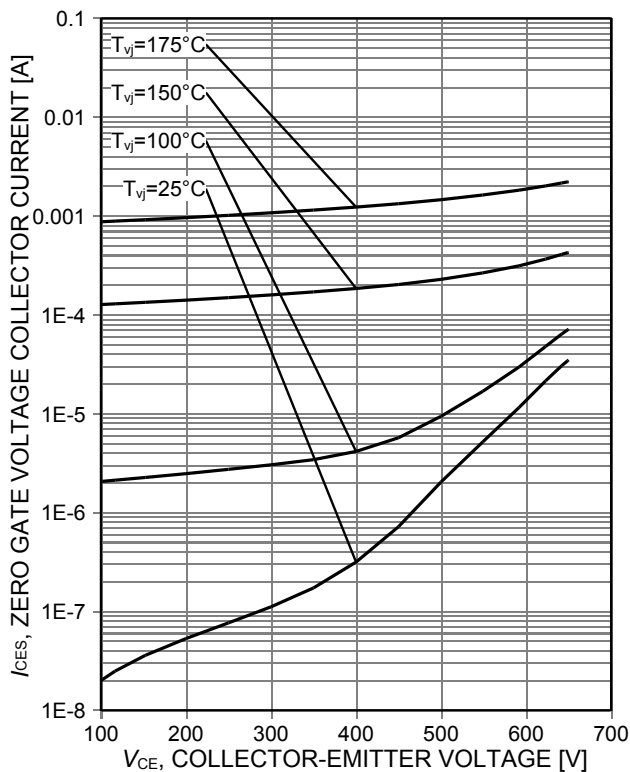


Figure 15. **Typ. reverse current vs. reverse voltage as a function of  $T_{vj}$**

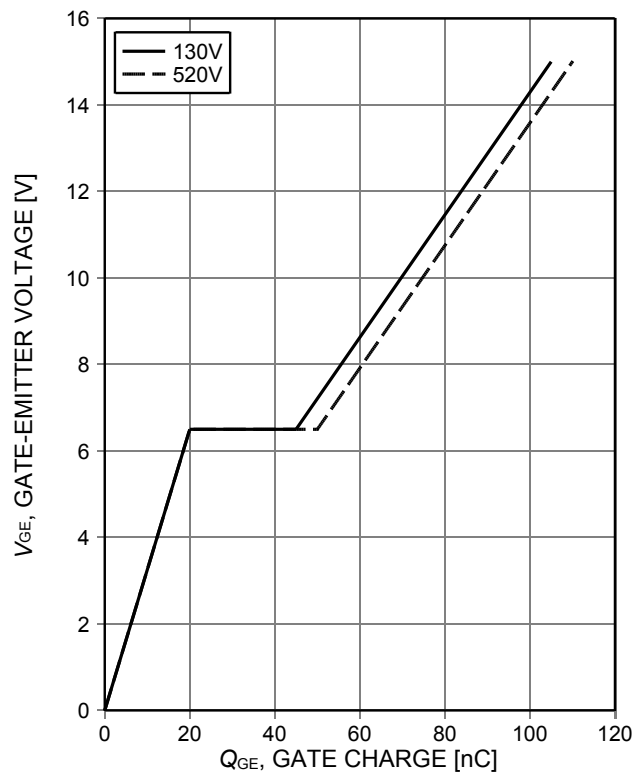


Figure 16. **Typical gate charge** ( $I_C=50A$ )

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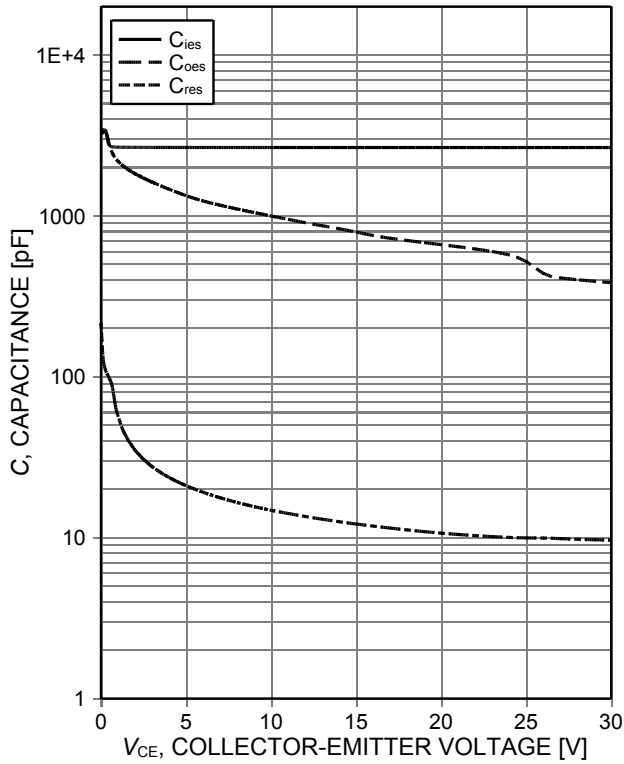


Figure 17. Typical capacitance as a function of collector-emitter voltage ( $V_{GE}=0V, f=250kHz$ )

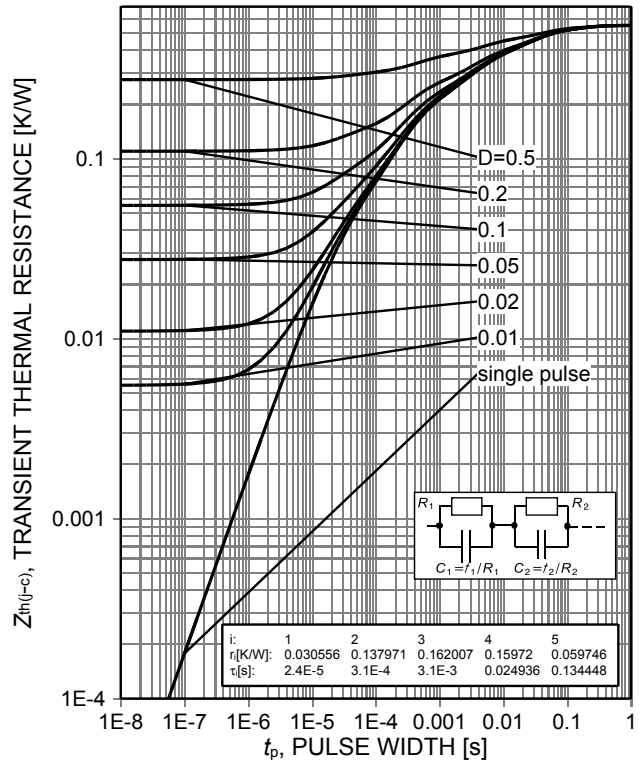


Figure 18. IGBT transient thermal resistance ( $D=t_p/T$ )

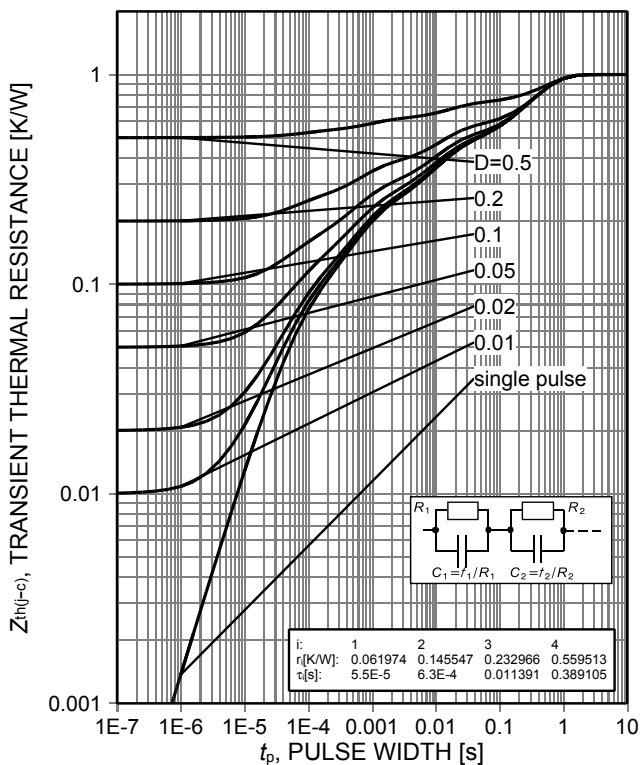


Figure 19. Diode transient thermal impedance as a function of pulse width ( $D=t_p/T$ )

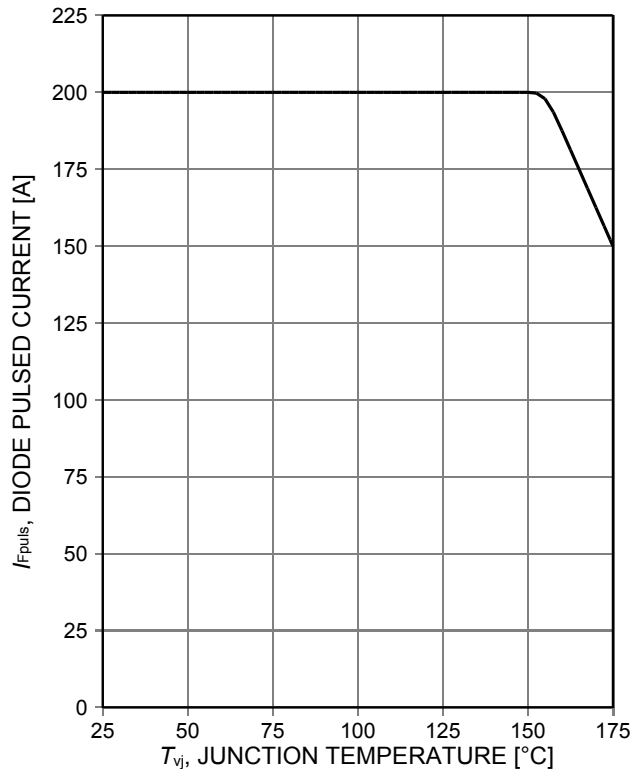


Figure 20. Maximum pulse current as a function of junction temperature

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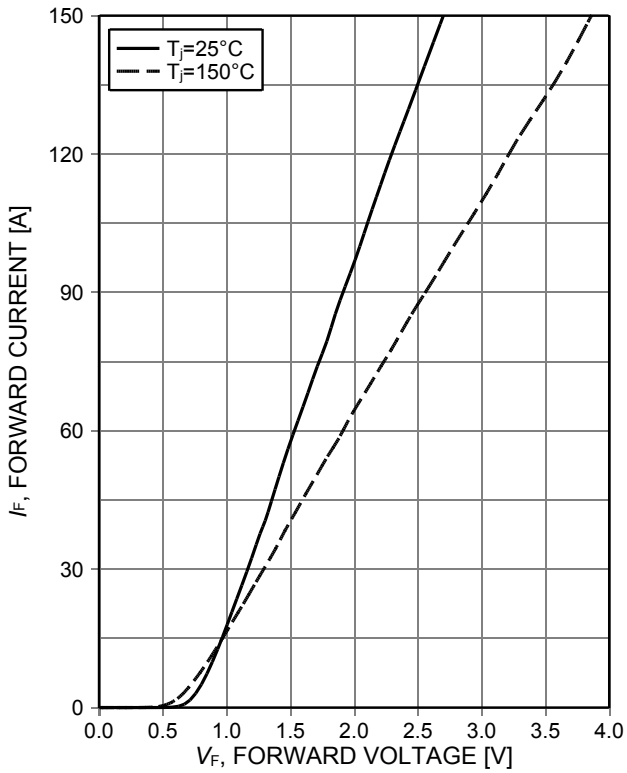


Figure 21. Typical diode forward current as a function of forward voltage

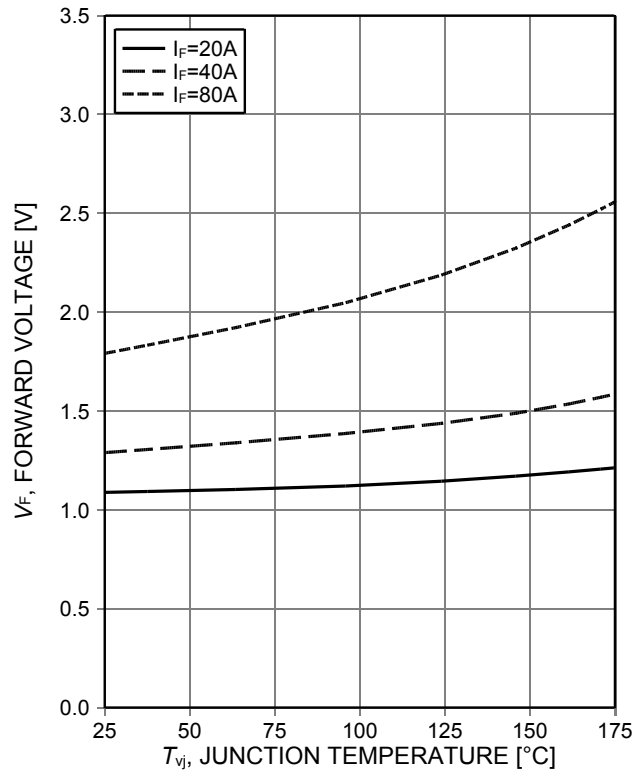
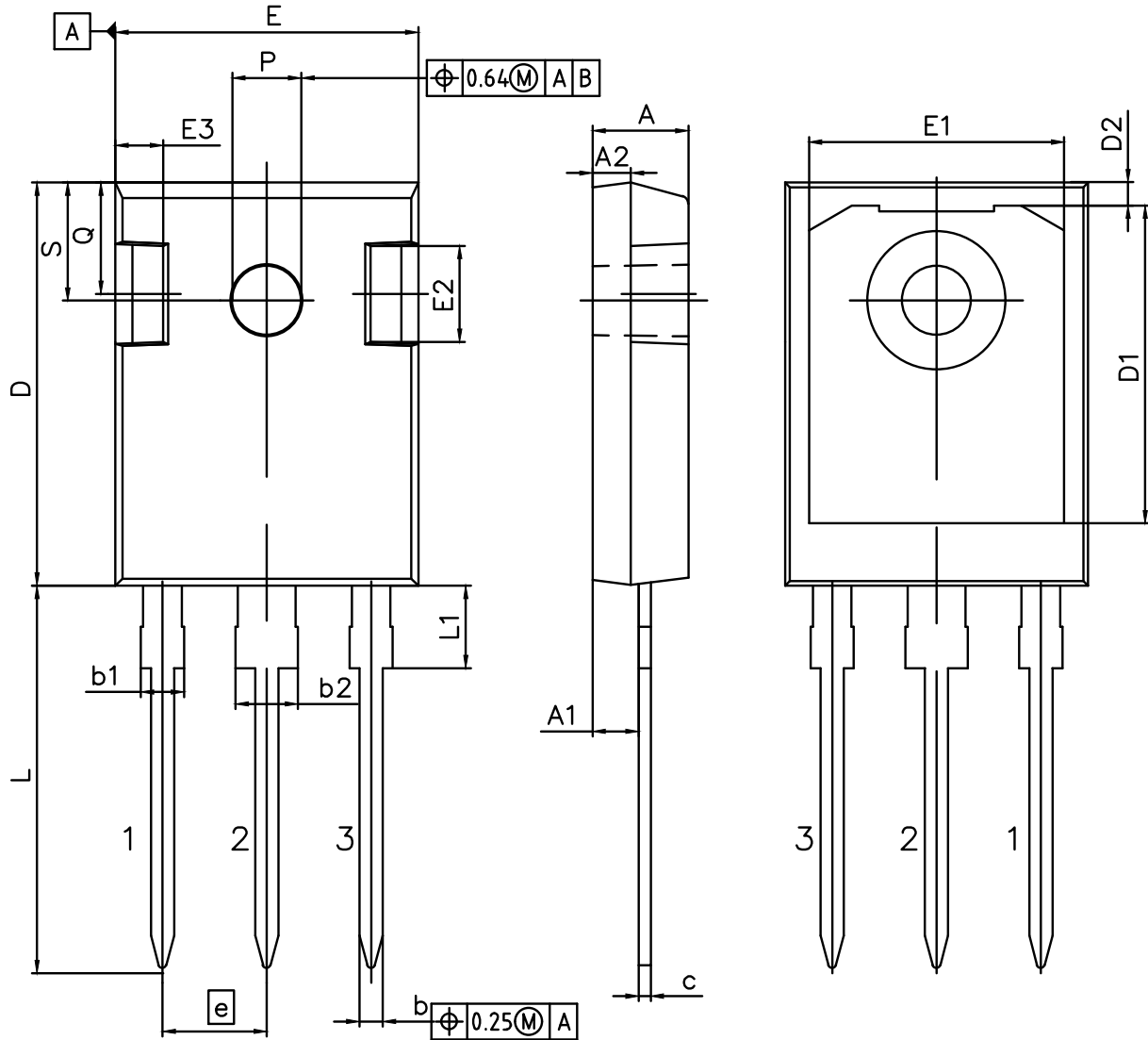


Figure 22. Typical diode forward voltage as a function of junction temperature

Package Drawing PG-TO247-3



DIMENSIONS	MILLIMETERS	
	MIN.	MAX.
A	4.70	5.30
A1	2.20	2.60
A2	1.50	2.50
b	1.00	1.40
b1	1.60	2.41
b2	2.57	3.43
c	0.38	0.89
D	20.70	21.50
D1	13.08	17.65
D2	0.51	1.35
E	15.50	16.30
E1	12.38	14.15
E2	3.40	5.10
E3	1.00	2.60
e	5.44	
L	19.80	20.40
L1	3.85	4.50
P	3.50	3.70
Q	5.35	6.25
S	6.04	6.30

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Testing Conditions

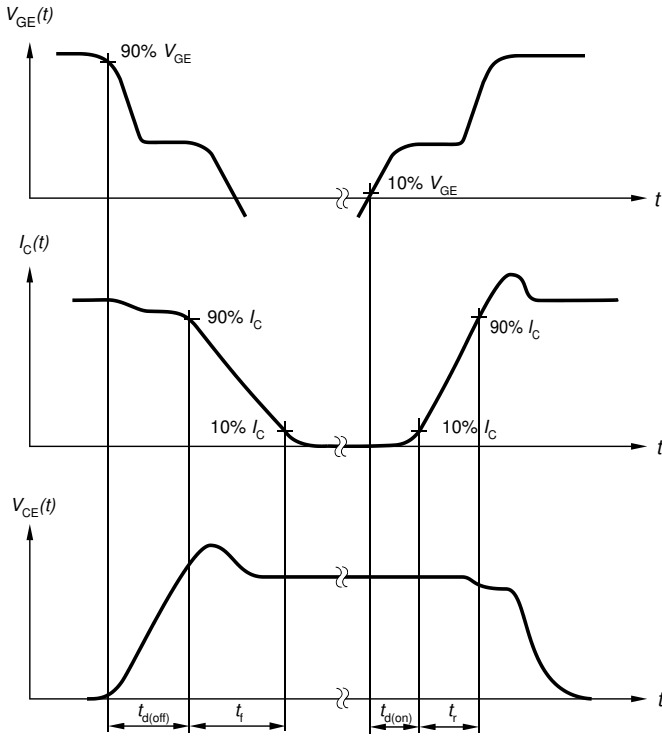


Figure A. Definition of switching times

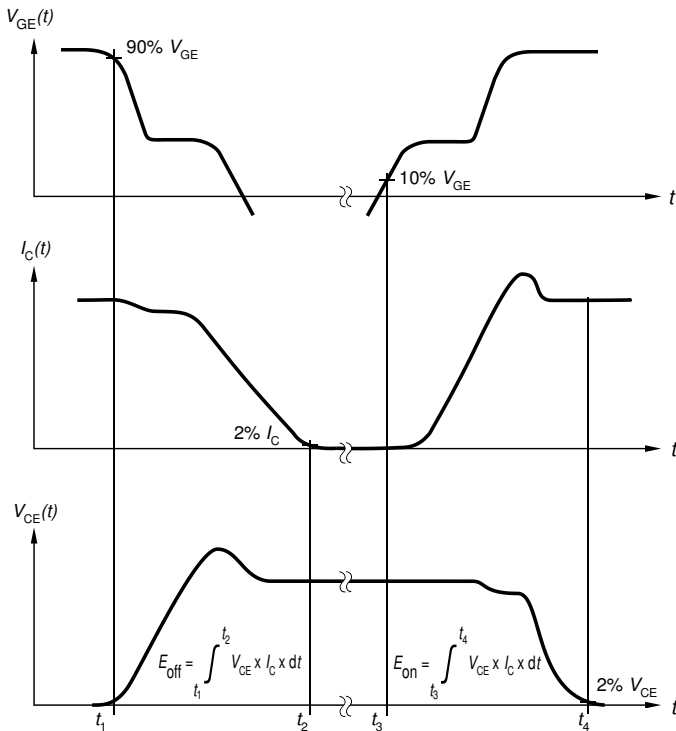


Figure B. Definition of switching losses

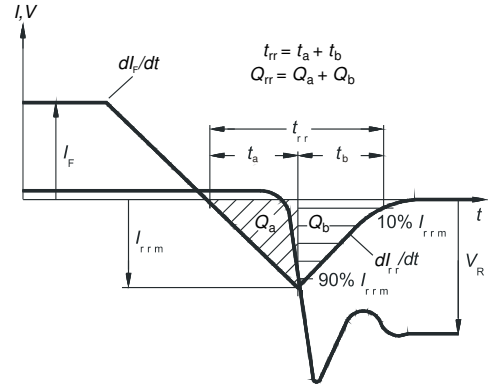


Figure C. Definition of diode switching characteristics

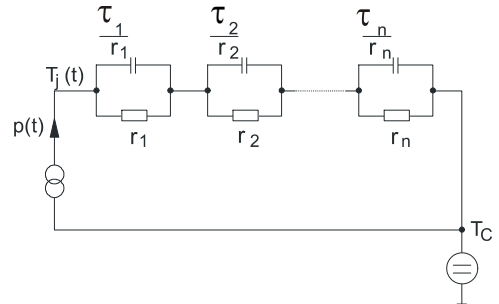


Figure D. Thermal equivalent circuit

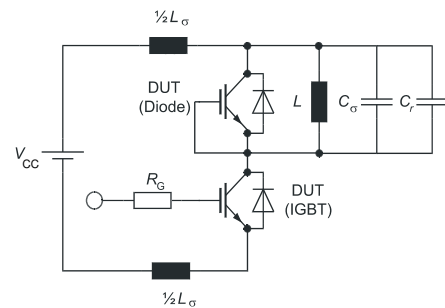


Figure E. Dynamic test circuit  
Parasitic inductance  $L_{\sigma}$ ,  
parasitic capacitor  $C_{\sigma}$ ,  
relief capacitor  $C_r$ ,  
(only for ZVT switching)

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Hybrid CoolSiC™ IGBT

## Revision History

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IKW50N65SS5

**Revision: 2020-07-27, Rev. 2.1**

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Previous Revision

Revision	Date	Subjects (major changes since last revision)
1.1	2020-03-20	Preliminary Data Sheet
2.1	2020-07-27	Final Data Sheet

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