

Final datasheet

CoolSiC™ Hybrid Discrete with TRENCHSTOP™ 5 Fast-Switching IGBT and CoolSiC™ Schottky Diode G5 for Automotive

Features

- $V_{CE} = 650\text{ V}$
- $I_C = 50\text{ A}$
- Best-in-class efficiency in hard switching and resonant topologies
- 650 V breakdown voltage
- Trenchstop™ 5 fast-switching IGBT
- CoolSiC™ Schottky diode G5
- Low gate charge Q_G
- Maximum junction temperature $T_{vjmax} = 175^\circ\text{C}$
- Kelvin emitter connection for optimized switching performance

Potential applications

- On-board charger
- DC/DC converter

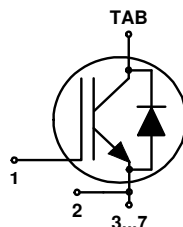
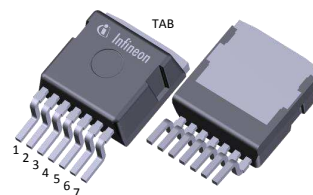
Product validation

- Qualified for Automotive Applications. Product Validation according to AEC-Q100/101

Description

Pin definition:

- Pin 1 - Gate
- Pin 2 - Kelvin Emitter
- Pin 3...7 - Emitter
- Tab - Collector



Type	Package	Marking
AIKBE50N65RF5	PG-TO263-7-HV-ND4.2	AKE5ERF

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1 Package

Table 1 Characteristic values

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Storage temperature	T_{stg}		-55		150	°C
Soldering temperature	T_{sold}				260	°C
IGBT thermal resistance, junction-case	$R_{th(j-c)}$			0.35	0.46	K/W
Diode thermal resistance, junction-case	$R_{th(j-c)}$			0.48	0.62	K/W

2 IGBT

Table 2 Maximum rated values

Parameter	Symbol	Note or test condition		Values	Unit
Collector-emitter voltage	V_{CE}	$T_{vj} = -40...175\text{ °C}$		650	V
DC collector current, limited by T_{vjmax}	I_C		$T_c = 25\text{ °C}$	96	A
			$T_c = 100\text{ °C}$	65	
Pulsed collector current, t_p limited by T_{vjmax} ¹⁾	I_{Cpulse}			150	A
Turn-off safe operating area ¹⁾		$V_{CE} \leq 650\text{ V}, T_{vj} \leq 175\text{ °C}$		150	A
Gate-emitter voltage ¹⁾	V_{GE}			±20	V
Transient gate-emitter voltage	V_{GE}	$t_p \leq 10\text{ }\mu\text{s}, D < 0.01$		±30	V
Power dissipation ¹⁾	P_{tot}		$T_c = 25\text{ °C}$	326	W
			$T_c = 100\text{ °C}$	163	

1) Not subject to production test. Parameter verified by design/characterization.

Table 3 Characteristic values

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Collector-emitter breakdown voltage	V_{BRCES}	$I_C = 0.2\text{ mA}, V_{GE} = 0\text{ V}$	650			V
Collector-emitter saturation voltage	V_{CEsat}	$I_C = 50\text{ A}, V_{GE} = 15\text{ V}$	$T_{vj} = 25\text{ °C}$	1.66	2.1	V
			$T_{vj} = 125\text{ °C}$	1.9		
			$T_{vj} = 175\text{ °C}$	2.03		
Gate-emitter threshold voltage	V_{GETh}	$I_C = 0.5\text{ mA}, V_{CE} = V_{GE}$	3.2	4	4.8	V

(table continues...)

Table 3 (continued) Characteristic values

Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
Zero gate-voltage collector current	I_{CES}	$V_{CE} = 650 \text{ V}, V_{GE} = 0 \text{ V}$	$T_{vj} = 25 \text{ °C}$		16	120	μA
			$T_{vj} = 175 \text{ °C}$		1600		
Transconductance	g_{fs}	$I_C = 50 \text{ A}, V_{CE} = 20 \text{ V}$			62		S
Input capacitance	C_{ies}	$V_{CE} = 25 \text{ V}, V_{GE} = 0 \text{ V}, f = 100 \text{ kHz}$			2700		pF
Output capacitance	C_{oes}	$V_{CE} = 25 \text{ V}, V_{GE} = 0 \text{ V}, f = 100 \text{ kHz}$			340		pF
Reverse transfer capacitance	C_{res}	$V_{CE} = 25 \text{ V}, V_{GE} = 0 \text{ V}, f = 100 \text{ kHz}$			10		pF
Gate charge	Q_G	$I_C = 50 \text{ A}, V_{CC} = 520 \text{ V}, V_{GE} = 15 \text{ V}$			108		nC
Turn-on delay time	$t_{d(on)}$	$V_{CC} = 400 \text{ V}, V_{GE} = 0/15 \text{ V}, R_{G(on)} = 9 \text{ }\Omega, R_{G(off)} = 9 \text{ }\Omega, L_\sigma = 30 \text{ nH}, C_\sigma = 30 \text{ pF}$	$T_{vj} = 25 \text{ °C}, I_C = 25 \text{ A}$		16.8		ns
			$T_{vj} = 100 \text{ °C}, I_C = 25 \text{ A}$		16.8		
			$T_{vj} = 150 \text{ °C}, I_C = 25 \text{ A}$		16.5		
			$T_{vj} = 175 \text{ °C}, I_C = 25 \text{ A}$		16.2		
Rise time (inductive load)	t_r	$V_{CC} = 400 \text{ V}, V_{GE} = 0/15 \text{ V}, R_{G(on)} = 9 \text{ }\Omega, R_{G(off)} = 9 \text{ }\Omega, L_\sigma = 30 \text{ nH}, C_\sigma = 30 \text{ pF}$	$T_{vj} = 25 \text{ °C}, I_C = 25 \text{ A}$		7.6		ns
			$T_{vj} = 100 \text{ °C}, I_C = 25 \text{ A}$		8.4		
			$T_{vj} = 150 \text{ °C}, I_C = 25 \text{ A}$		9.2		
			$T_{vj} = 175 \text{ °C}, I_C = 25 \text{ A}$		9.6		
Turn-off delay time	$t_{d(off)}$	$V_{CC} = 400 \text{ V}, V_{GE} = 0/15 \text{ V}, R_{G(on)} = 9 \text{ }\Omega, R_{G(off)} = 9 \text{ }\Omega, L_\sigma = 30 \text{ nH}, C_\sigma = 30 \text{ pF}$	$T_{vj} = 25 \text{ °C}, I_C = 25 \text{ A}$		136		ns
			$T_{vj} = 100 \text{ °C}, I_C = 25 \text{ A}$		153		
			$T_{vj} = 150 \text{ °C}, I_C = 25 \text{ A}$		167		
			$T_{vj} = 175 \text{ °C}, I_C = 25 \text{ A}$		176		

(table continues...)

Table 3 (continued) Characteristic values

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Fall time (inductive load)	t_f	$V_{CC} = 400 \text{ V}$, $V_{GE} = 0/15 \text{ V}$, $R_{G(on)} = 9 \text{ } \Omega$, $R_{G(off)} = 9 \text{ } \Omega$, $L_\sigma = 30 \text{ nH}$, $C_\sigma = 30 \text{ pF}$	$T_{vj} = 25 \text{ }^\circ\text{C}$, $I_C = 25 \text{ A}$	14		ns
			$T_{vj} = 100 \text{ }^\circ\text{C}$, $I_C = 25 \text{ A}$	14		
			$T_{vj} = 150 \text{ }^\circ\text{C}$, $I_C = 25 \text{ A}$	13.6		
			$T_{vj} = 175 \text{ }^\circ\text{C}$, $I_C = 25 \text{ A}$	13.4		
Turn-on energy	E_{on}	$V_{CC} = 400 \text{ V}$, $V_{GE} = 0/15 \text{ V}$, $R_{G(on)} = 9 \text{ } \Omega$, $R_{G(off)} = 9 \text{ } \Omega$, $L_\sigma = 30 \text{ nH}$, $C_\sigma = 30 \text{ pF}$	$T_{vj} = 25 \text{ }^\circ\text{C}$, $I_C = 25 \text{ A}$	0.12		mJ
			$T_{vj} = 100 \text{ }^\circ\text{C}$, $I_C = 25 \text{ A}$	0.14		
			$T_{vj} = 150 \text{ }^\circ\text{C}$, $I_C = 25 \text{ A}$	0.15		
			$T_{vj} = 175 \text{ }^\circ\text{C}$, $I_C = 25 \text{ A}$	0.16		
Turn-off energy	E_{off}	$V_{CC} = 400 \text{ V}$, $V_{GE} = 0/15 \text{ V}$, $R_{G(on)} = 9 \text{ } \Omega$, $R_{G(off)} = 9 \text{ } \Omega$, $L_\sigma = 30 \text{ nH}$, $C_\sigma = 30 \text{ pF}$	$T_{vj} = 25 \text{ }^\circ\text{C}$, $I_C = 25 \text{ A}$	0.09		mJ
			$T_{vj} = 100 \text{ }^\circ\text{C}$, $I_C = 25 \text{ A}$	0.14		
			$T_{vj} = 150 \text{ }^\circ\text{C}$, $I_C = 25 \text{ A}$	0.19		
			$T_{vj} = 175 \text{ }^\circ\text{C}$, $I_C = 25 \text{ A}$	0.22		
Total switching energy	E_{ts}	$V_{CC} = 400 \text{ V}$, $V_{GE} = 0/15 \text{ V}$, $R_{G(on)} = 9 \text{ } \Omega$, $R_{G(off)} = 9 \text{ } \Omega$, $L_\sigma = 30 \text{ nH}$, $C_\sigma = 30 \text{ pF}$	$T_{vj} = 25 \text{ }^\circ\text{C}$, $I_C = 25 \text{ A}$	0.21		mJ
			$T_{vj} = 100 \text{ }^\circ\text{C}$, $I_C = 25 \text{ A}$	0.27		
			$T_{vj} = 150 \text{ }^\circ\text{C}$, $I_C = 25 \text{ A}$	0.34		
			$T_{vj} = 175 \text{ }^\circ\text{C}$, $I_C = 25 \text{ A}$	0.38		
Operating junction temperature	T_{vj}		-40		175	$^\circ\text{C}$

Note: Electrical Characteristic, at $T_{vj} = 25^\circ\text{C}$, unless otherwise specified.
Energy losses include “tail” and diode reverse recovery.

3 Diode

Table 4 Maximum rated values

Parameter	Symbol	Note or test condition		Values	Unit
Repetitive peak reverse voltage	V_{RRM}	$T_{vj} \geq 25\text{ °C}$		650	V
Diode forward current, limited by T_{vjmax}	I_F		$T_c = 25\text{ °C}$	57	A
			$T_c = 100\text{ °C}$	40	
Diode pulsed current, t_p limited by T_{vjmax}	I_{Fpulse}			120	A

Table 5 Characteristic values

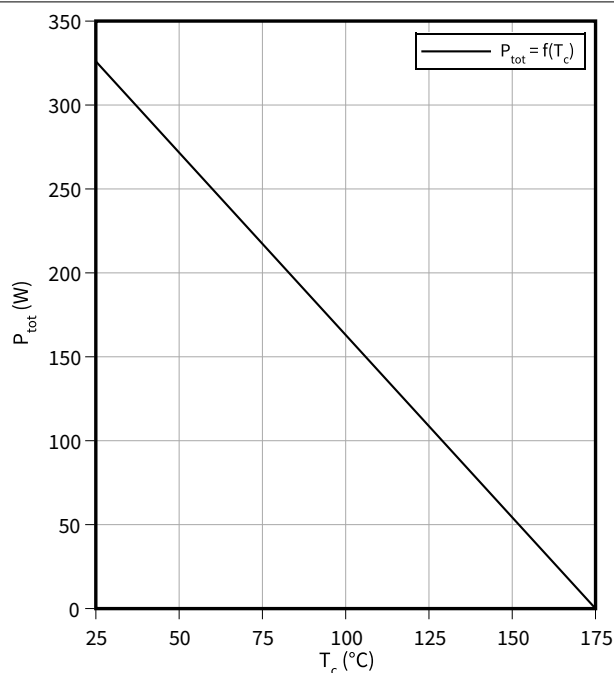
Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
Diode forward voltage	V_F	$I_F = 30\text{ A}$	$T_{vj} = 25\text{ °C}$		1.45	1.7	V
			$T_{vj} = 125\text{ °C}$		1.6		
			$T_{vj} = 175\text{ °C}$		1.8		
Operating junction temperature	T_{vj}			-40		175	°C

4 Characteristics diagrams

Power dissipation as a function of case temperature

$$P_{\text{tot}} = f(T_c)$$

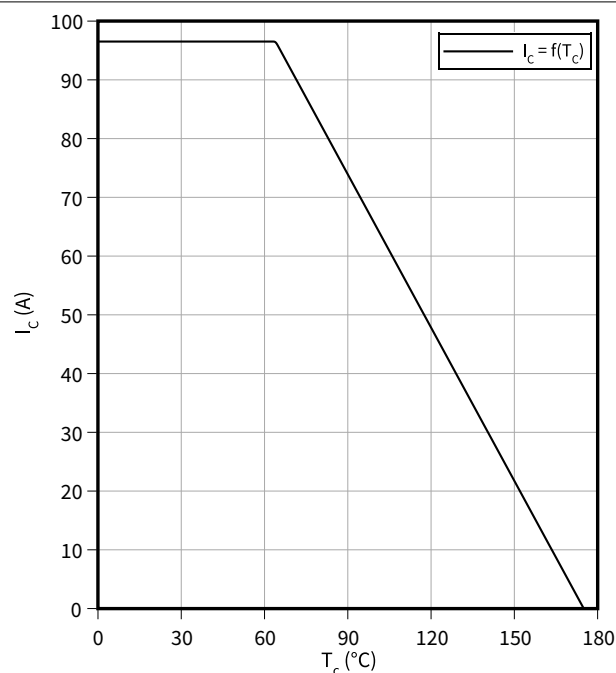
$$T_{vj} \leq 175\text{ °C}$$



Collector current as a function of case temperature

$$I_c = f(T_c)$$

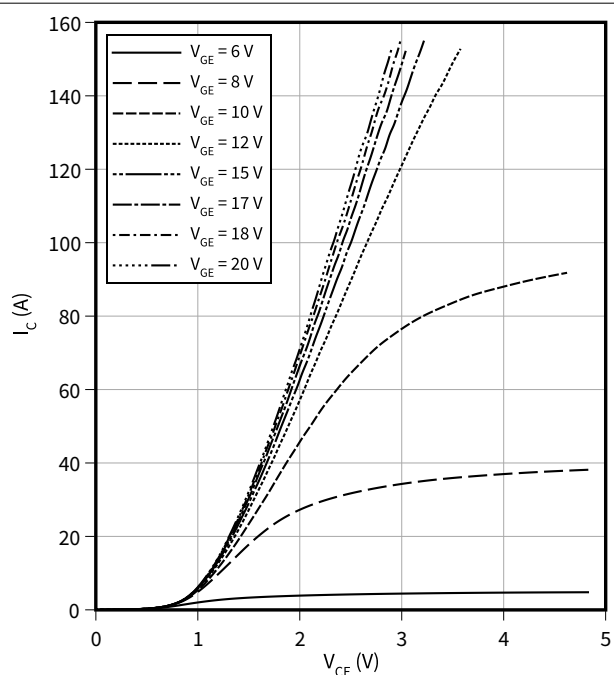
$$T_{vj} \leq 175\text{ °C}, V_{GE} \geq 15\text{ V}$$



Typical output characteristic

$$I_c = f(V_{CE})$$

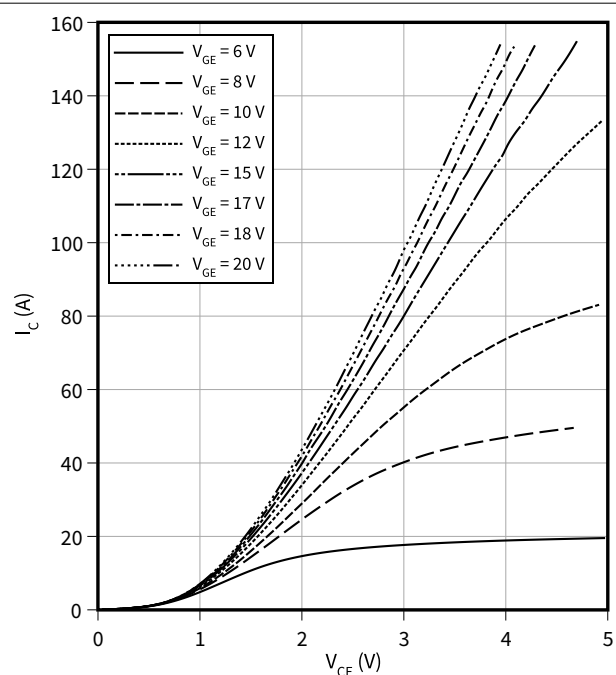
$$T_{vj} = 25\text{ °C}$$



Typical output characteristic

$$I_c = f(V_{CE})$$

$$T_{vj} = 175\text{ °C}$$

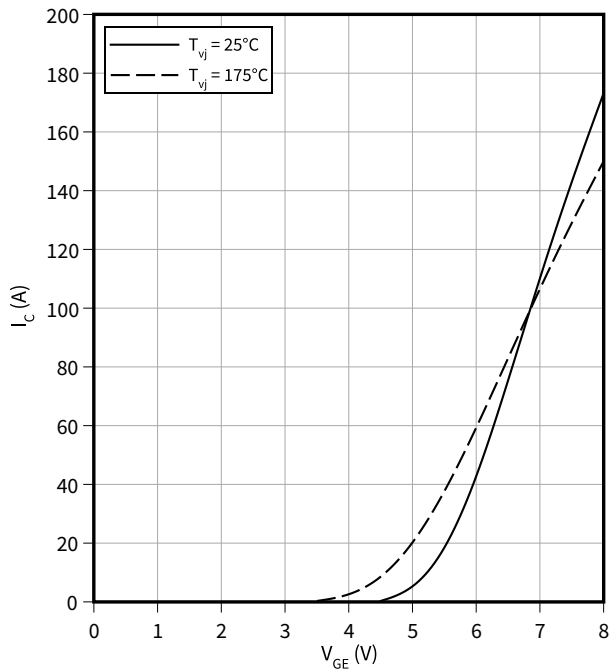


4 Characteristics diagrams

Typical transfer characteristic

$$I_C = f(V_{GE})$$

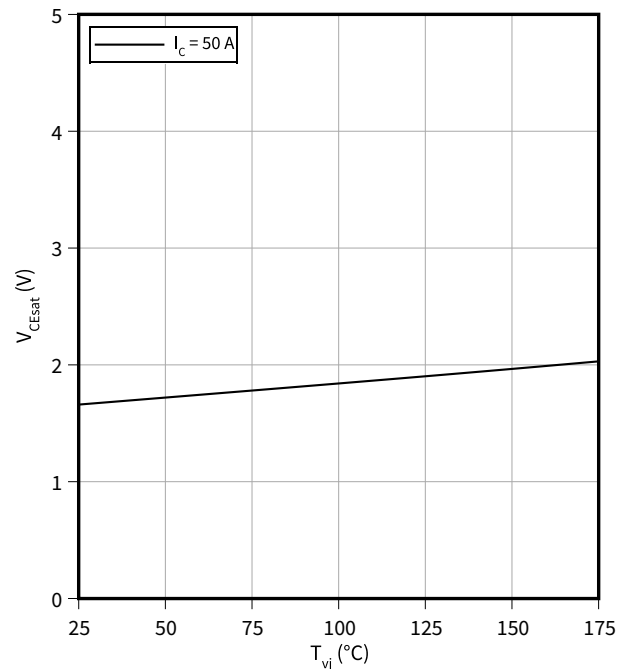
$$V_{CE} = 20 \text{ V}$$



Typical collector-emitter saturation voltage as a function of junction temperature

$$V_{CEsat} = f(T_{vj})$$

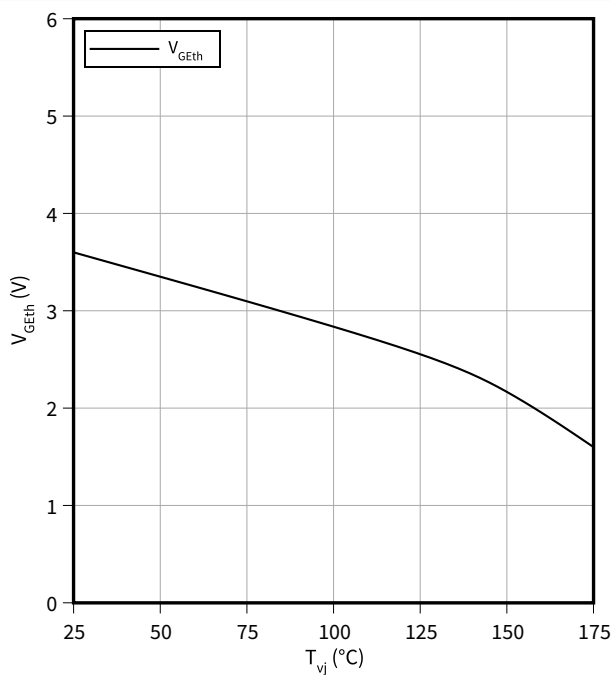
$$V_{GE} = 15 \text{ V}$$



Gate-emitter threshold voltage as a function of junction temperature

$$V_{GEth} = f(T_{vj})$$

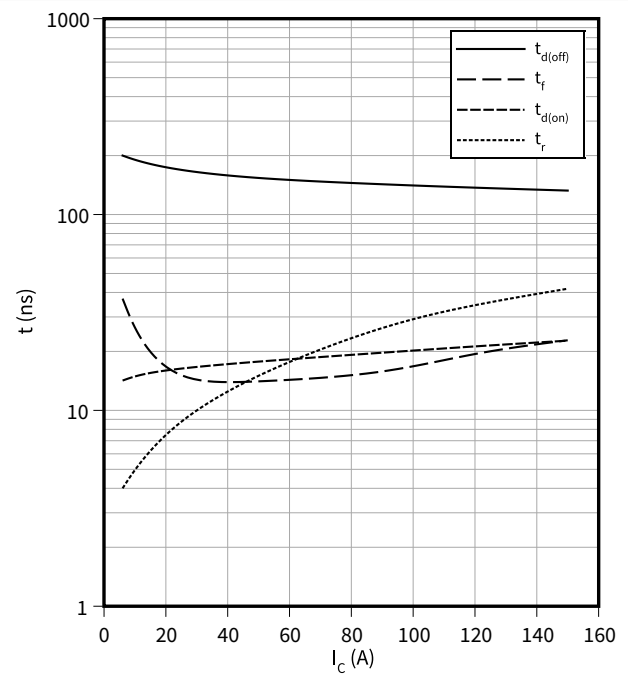
$$I_C = 0.5 \text{ mA}$$



Typical switching times as a function of collector current

$$t = f(I_C)$$

$$V_{CC} = 400 \text{ V}, T_{vj} = 150^\circ\text{C}, V_{GE} = 0/15 \text{ V}, R_G = 9 \Omega$$

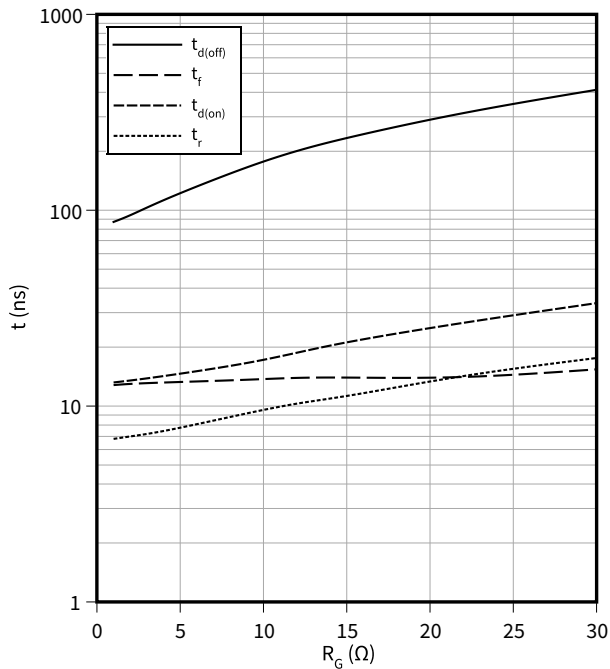


4 Characteristics diagrams

Typical switching times as a function of gate resistor

$$t = f(R_G)$$

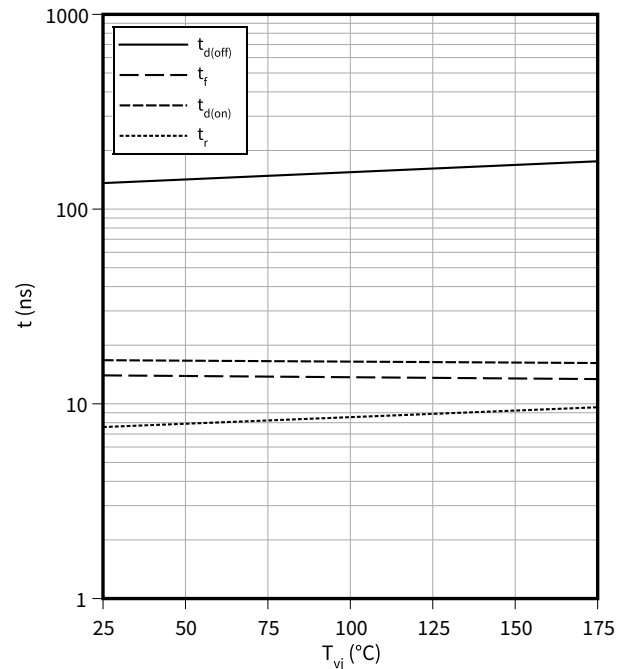
$I_C = 25 \text{ A}$, $V_{CC} = 400 \text{ V}$, $T_{vj} = 150 \text{ °C}$, $V_{GE} = 0/15 \text{ V}$



Typical switching times as a function of junction temperature

$$t = f(T_{vj})$$

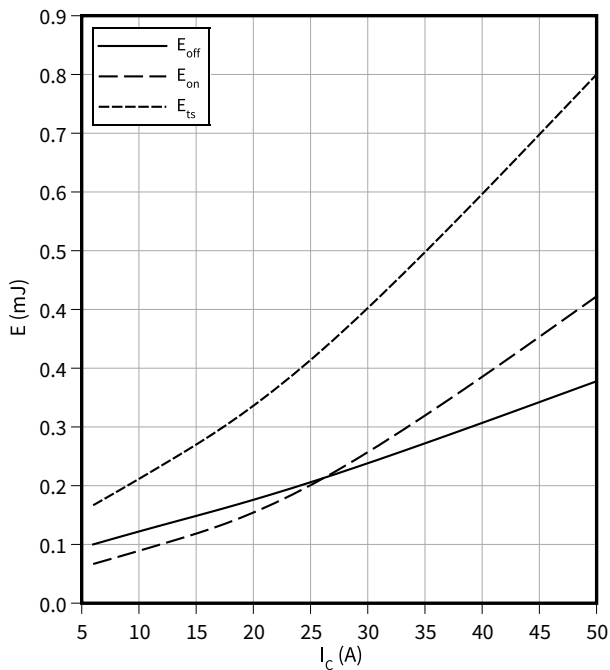
$I_C = 25 \text{ A}$, $V_{CC} = 400 \text{ V}$, $V_{GE} = 0/15 \text{ V}$, $R_G = 9 \text{ Ω}$



Typical switching energy losses as a function of collector current

$$E = f(I_C)$$

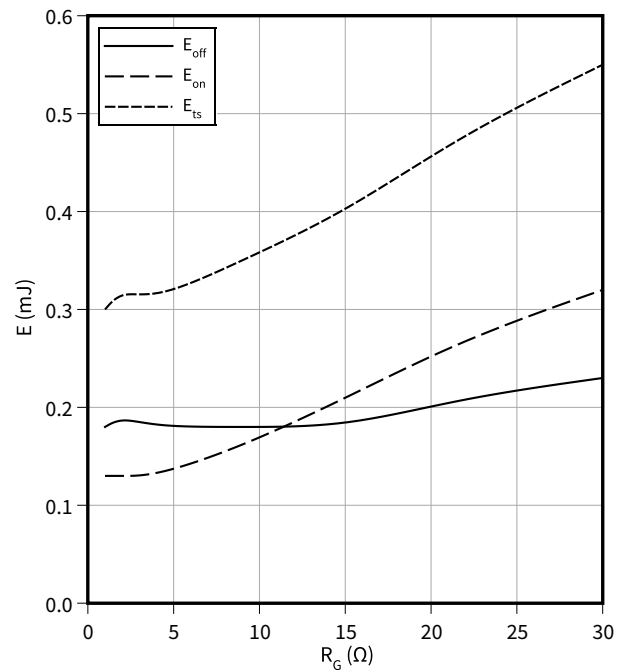
$V_{CC} = 400 \text{ V}$, $T_{vj} = 150 \text{ °C}$, $V_{GE} = 0/15 \text{ V}$, $R_G = 9 \text{ Ω}$



Typical switching energy losses as a function of gate resistor

$$E = f(R_G)$$

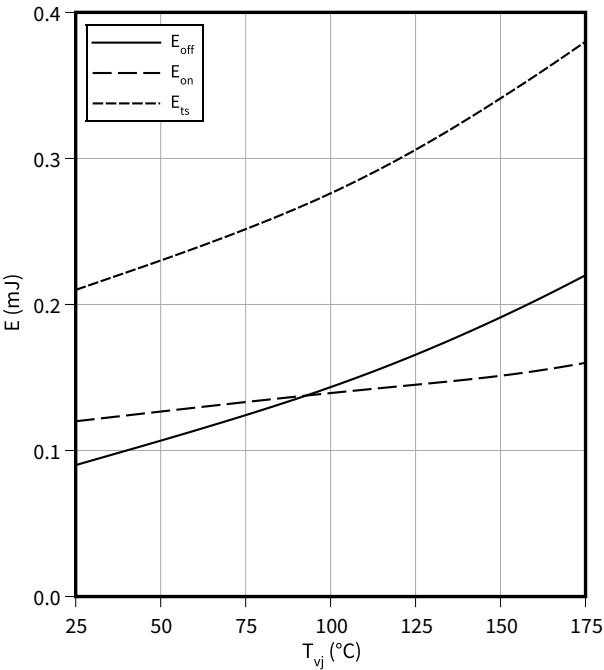
$I_C = 25 \text{ A}$, $V_{CC} = 400 \text{ V}$, $T_{vj} = 150 \text{ °C}$, $V_{GE} = 0/15 \text{ V}$



4 Characteristics diagrams

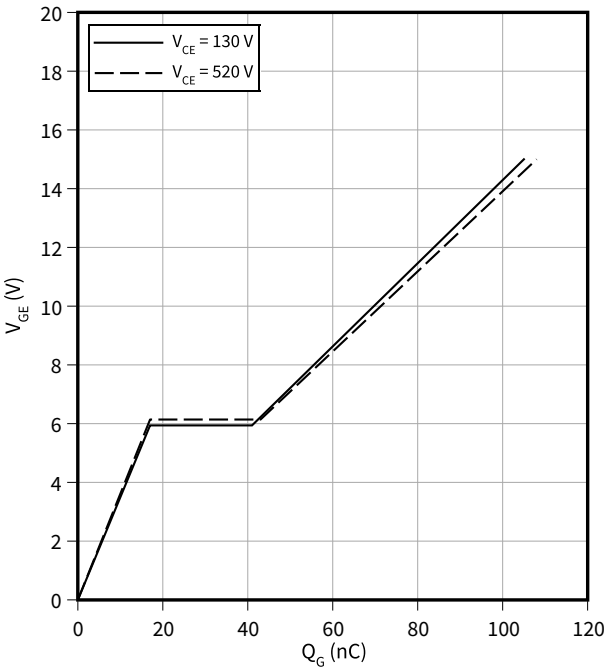
Typical switching energy losses as a function of junction temperature

$E = f(T_{vj})$
 $I_C = 25\text{ A}$, $V_{CC} = 400\text{ V}$, $V_{GE} = 0/15\text{ V}$, $R_G = 9\ \Omega$



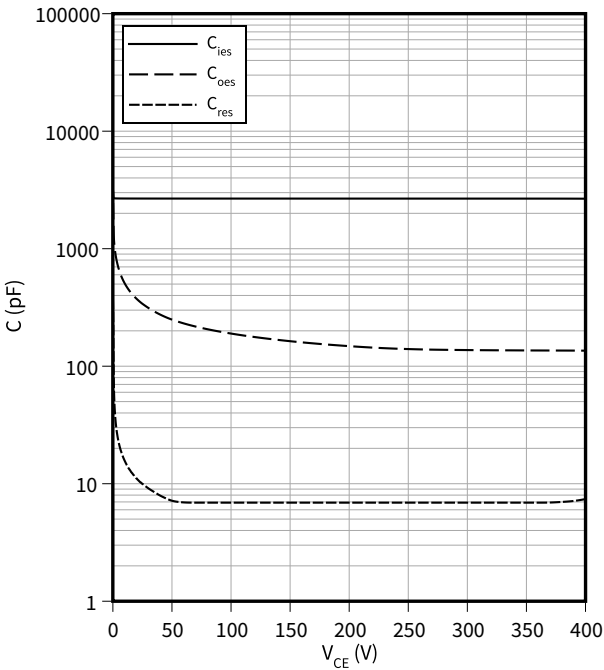
Typical gate charge

$V_{GE} = f(Q_G)$
 $I_C = 50\text{ A}$



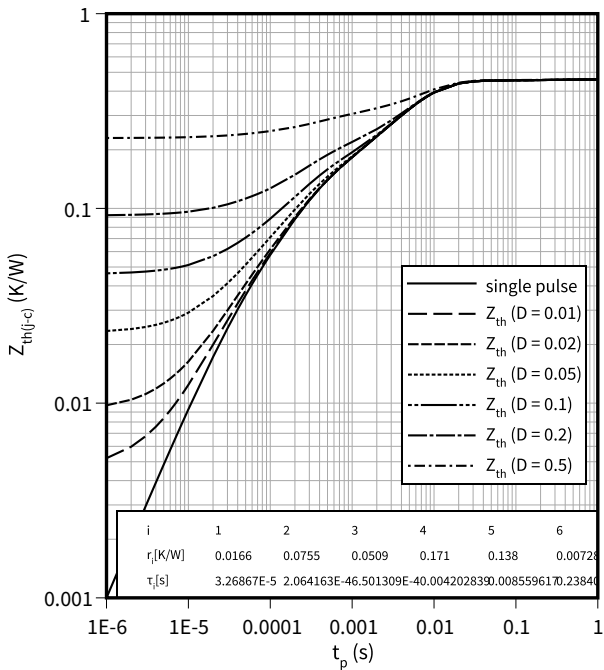
Typical capacitance as a function of collector-emitter voltage

$C = f(V_{CE})$
 $f = 100\text{ kHz}$, $V_{GE} = 0\text{ V}$



IGBT transient thermal impedance as a function of pulse width

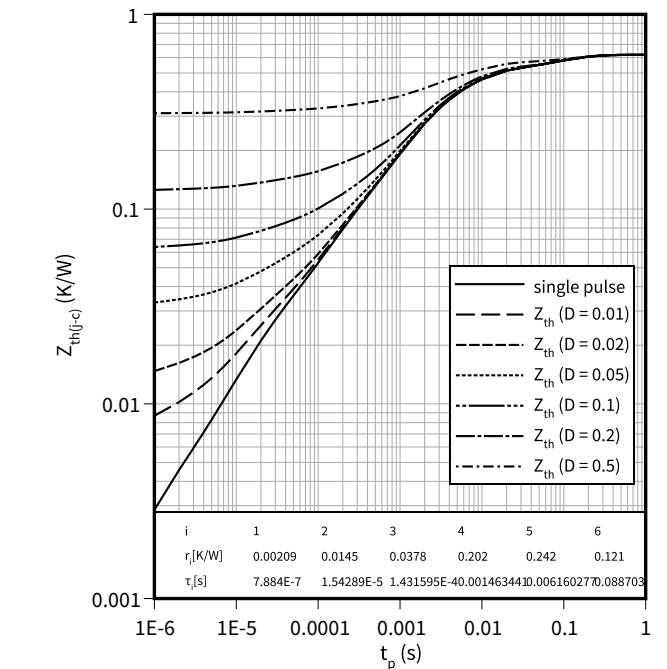
$Z_{th(j-c)} = f(t_p)$
 $D = t_p/T$



4 Characteristics diagrams

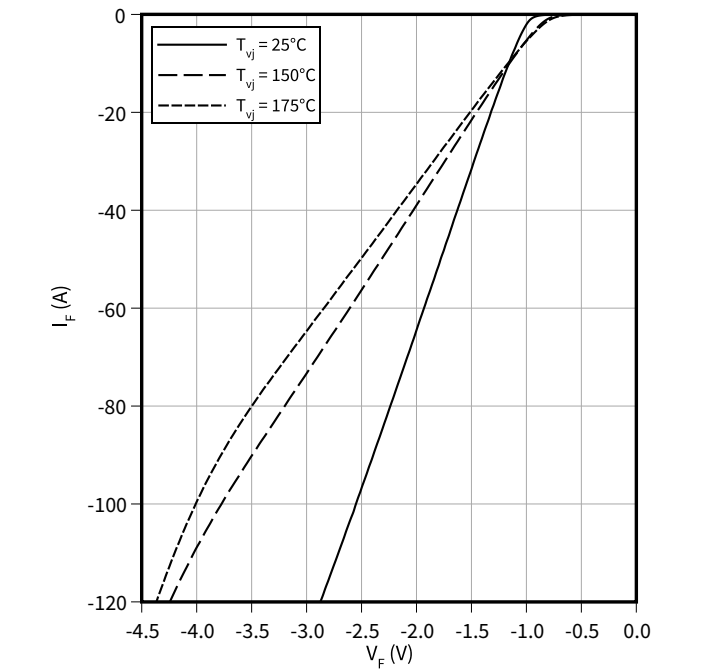
Diode transient thermal impedance as a function of pulse width

$Z_{th(j-c)} = f(t_p)$
 $D = t_p/T$



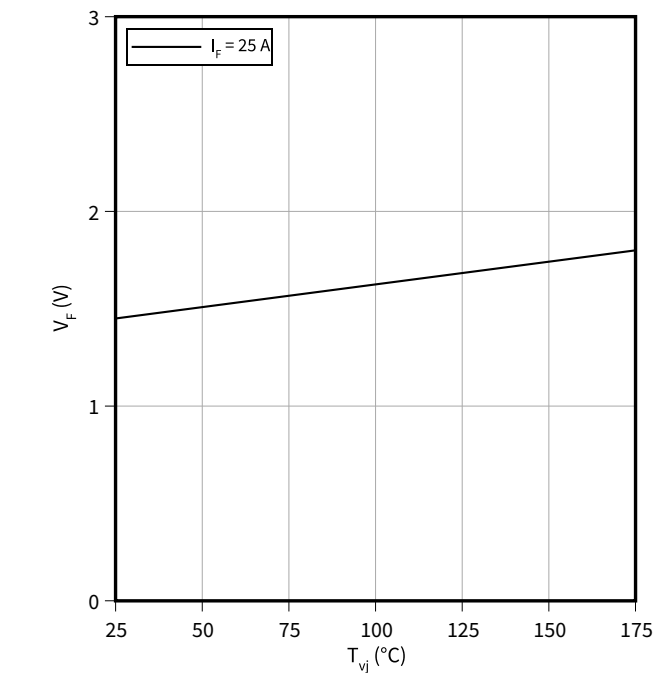
Typical diode forward current as a function of forward voltage

$I_F = f(V_F)$



Typical diode forward voltage as a function of junction temperature

$V_F = f(T_{vj})$



5 Package outlines

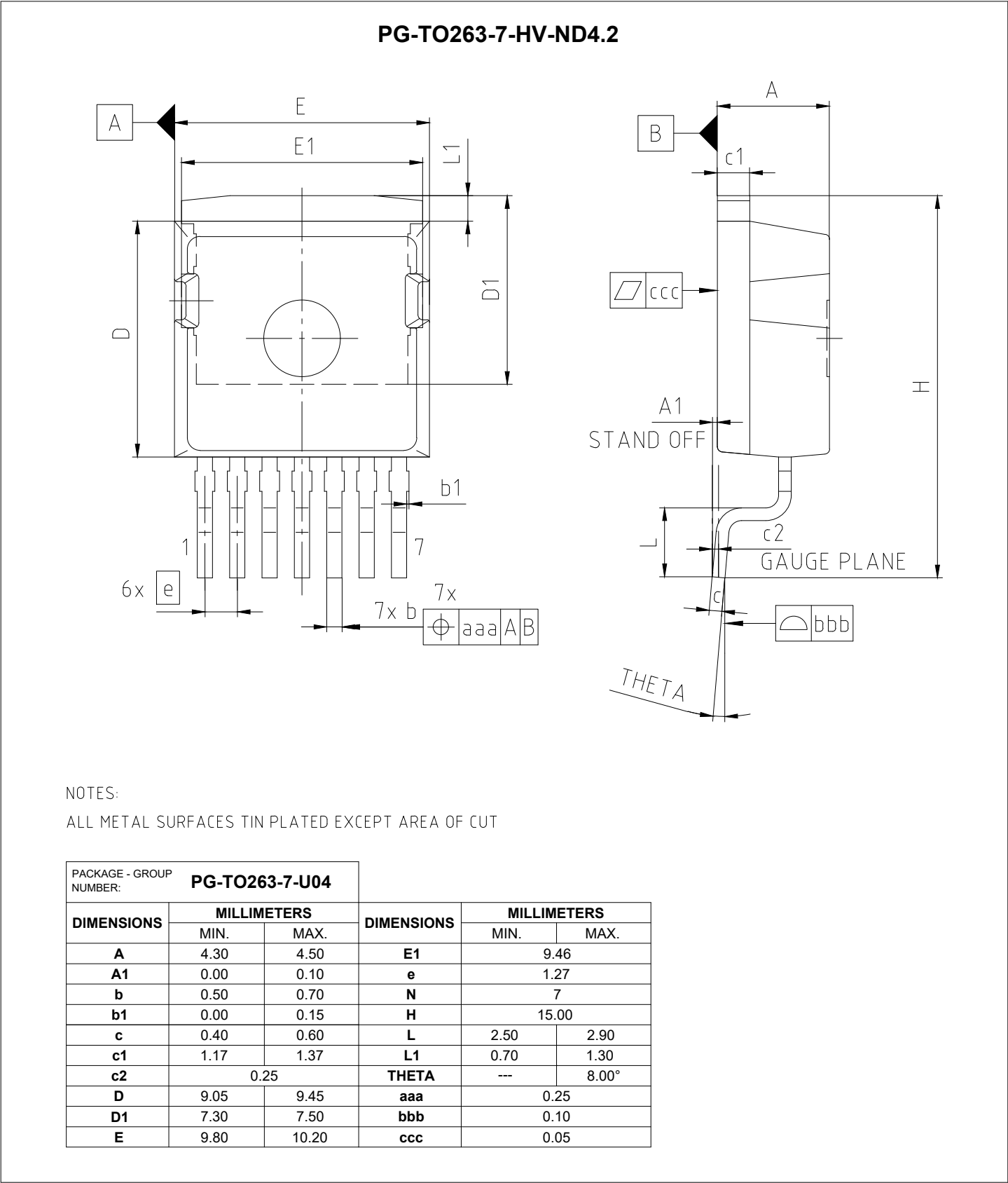


Figure 1

6 Testing conditions

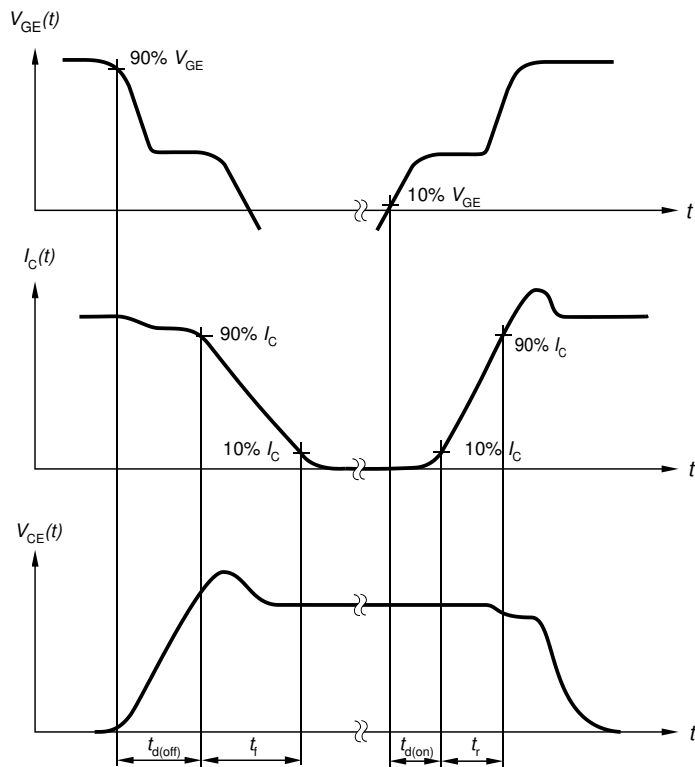


Figure A. Definition of switching times

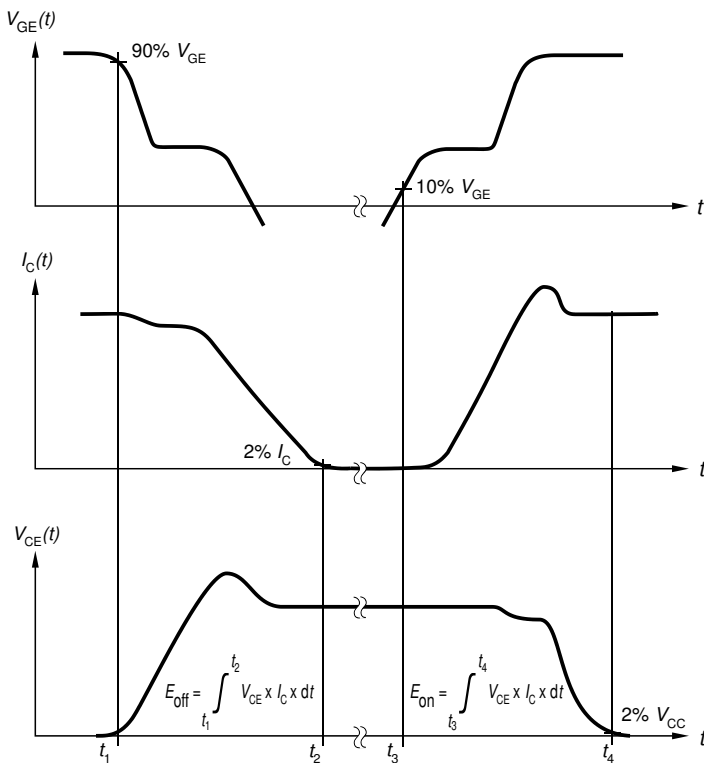


Figure B. Definition of switching losses

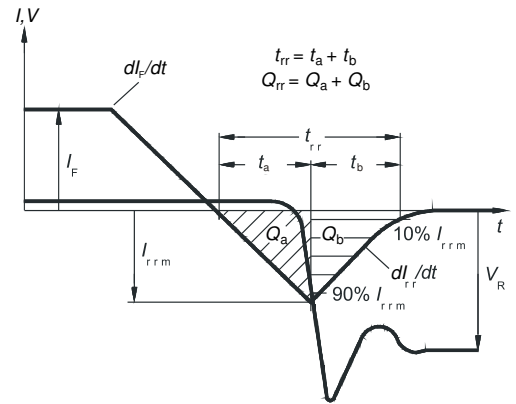


Figure C. Definition of diode switching characteristics

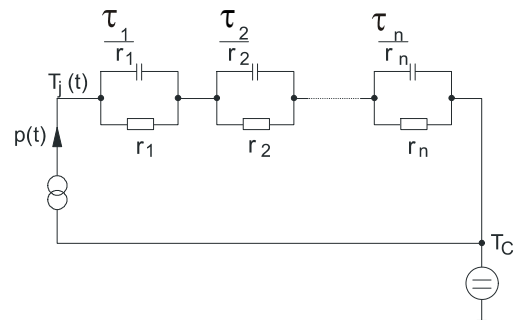


Figure D. Thermal equivalent circuit

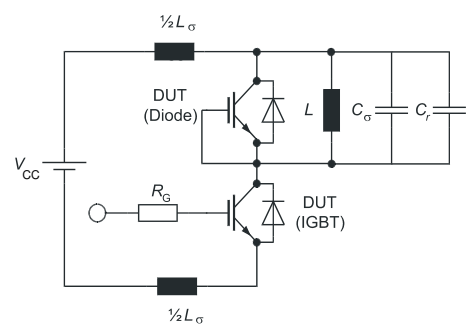


Figure E. **Dynamic test circuit**
Parasitic inductance L_{σ} ,
parasitic capacitor C_{σ} ,
relief capacitor C_r ,
(only for ZVT switching)

Revision history

Document revision	Date of release	Description of changes
0.10	2022-03-17	Target datasheet
0.20	2023-05-10	Preliminary datasheet
0.30	2023-06-07	Preliminary datasheet
0.40	2023-08-24	Update Marking Update $I_f(V_f)$ graph Update graph scaling and test conditions
1.00	2023-10-24	Final datasheet

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Edition 2023-10-26

Published by

Infineon Technologies AG
81726 Munich, Germany

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Document reference
IFX-ABD083-005

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