

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

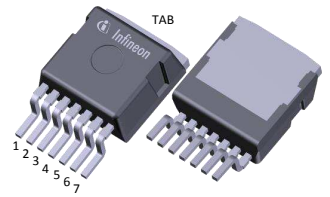
Product validation

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

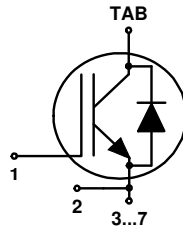
Description

Pin definition:

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



- Lead-free
- Green
- Halogen-free
- RoHS
- AEC-Q100/101 Qualified



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	$t_{d(on)}$	$V_{CC} = 400\text{ V}, V_{GE} = 0/15\text{ V}, R_{G(on)} = 9\ \Omega, R_{G(off)} = 9\ \Omega, L_\sigma = 30\text{ nH}, C_\sigma = 30\text{ pF}$	$T_{vj} = 25\text{ °C}, I_C = 25\text{ A}$		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	$V_{CC} = 400\text{ V}, V_{GE} = 0/15\text{ V}, R_{G(on)} = 9\ \Omega, R_{G(off)} = 9\ \Omega, L_\sigma = 30\text{ nH}, C_\sigma = 30\text{ pF}$	$T_{vj} = 25\text{ °C}, I_C = 25\text{ A}$		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	$t_{d(off)}$	$V_{CC} = 400\text{ V}, V_{GE} = 0/15\text{ V}, R_{G(on)} = 9\ \Omega, R_{G(off)} = 9\ \Omega, L_\sigma = 30\text{ nH}, C_\sigma = 30\text{ pF}$	$T_{vj} = 25\text{ °C}, I_C = 25\text{ A}$		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	$V_{CC} = 400\text{ V}, V_{GE} = 0/15\text{ V},$ $R_{G(on)} = 9\ \Omega, R_{G(off)} = 9\ \Omega,$ $L_\sigma = 30\text{ nH}, C_\sigma = 30\text{ pF}$	$T_{vj} = 25\text{ }^\circ\text{C},$ $I_C = 25\text{ A}$		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}	$V_{CC} = 400\text{ V}, V_{GE} = 0/15\text{ V},$ $R_{G(on)} = 9\ \Omega, R_{G(off)} = 9\ \Omega,$ $L_\sigma = 30\text{ nH}, C_\sigma = 30\text{ pF}$	$T_{vj} = 25\text{ }^\circ\text{C},$ $I_C = 25\text{ A}$		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}	$V_{CC} = 400\text{ V}, V_{GE} = 0/15\text{ V},$ $R_{G(on)} = 9\ \Omega, R_{G(off)} = 9\ \Omega,$ $L_\sigma = 30\text{ nH}, C_\sigma = 30\text{ pF}$	$T_{vj} = 25\text{ }^\circ\text{C},$ $I_C = 25\text{ A}$		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}	$V_{CC} = 400\text{ V}, V_{GE} = 0/15\text{ V},$ $R_{G(on)} = 9\ \Omega, R_{G(off)} = 9\ \Omega,$ $L_\sigma = 30\text{ nH}, C_\sigma = 30\text{ pF}$	$T_{vj} = 25\text{ }^\circ\text{C},$ $I_C = 25\text{ A}$		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	

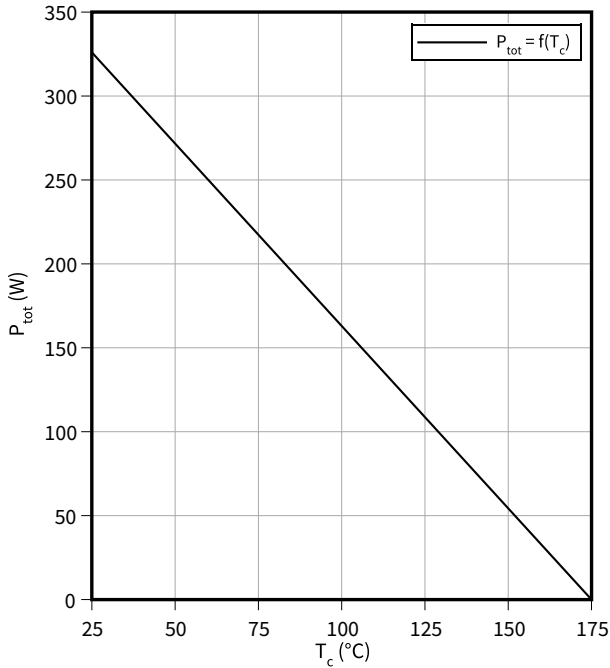
Table 5 Characteristic values

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

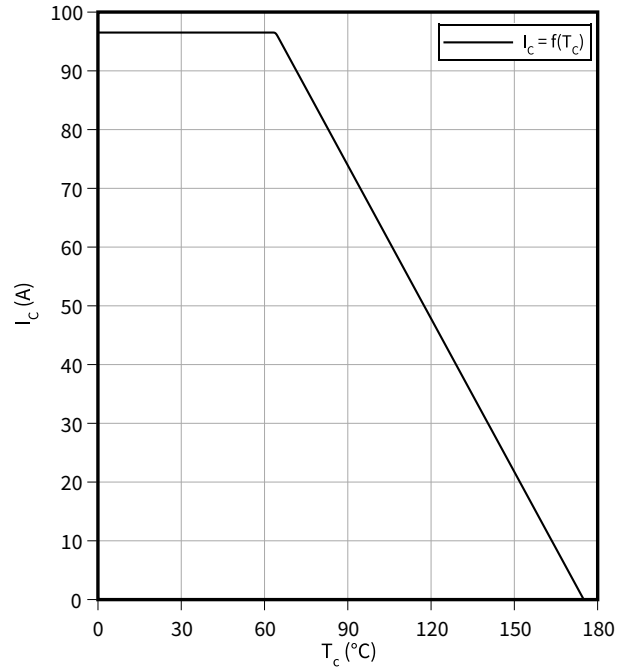
Power dissipation as a function of case temperature

$P_{\text{tot}} = f(T_C)$
 $T_{\text{vj}} \leq 175^\circ\text{C}$



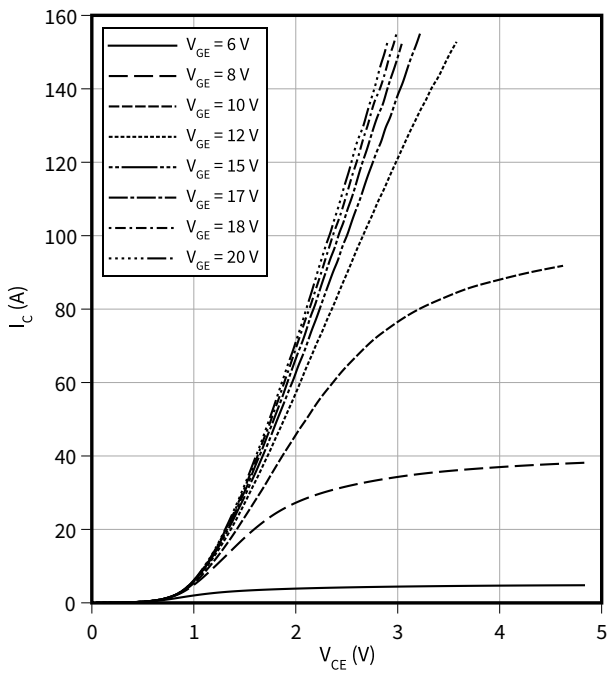
Collector current as a function of case temperature

$I_C = f(T_C)$
 $T_{\text{vj}} \leq 175^\circ\text{C}, V_{\text{GE}} \geq 15\text{ V}$



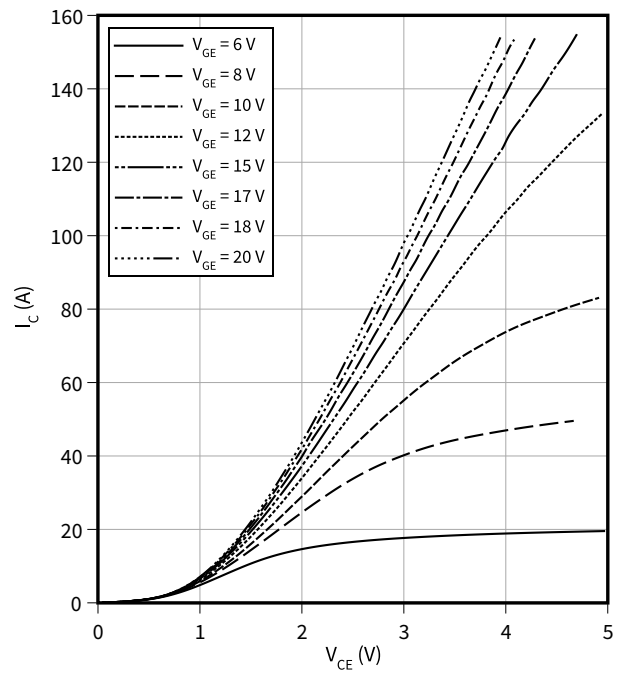
Typical output characteristic

$I_C = f(V_{\text{CE}})$
 $T_{\text{vj}} = 25^\circ\text{C}$



Typical output characteristic

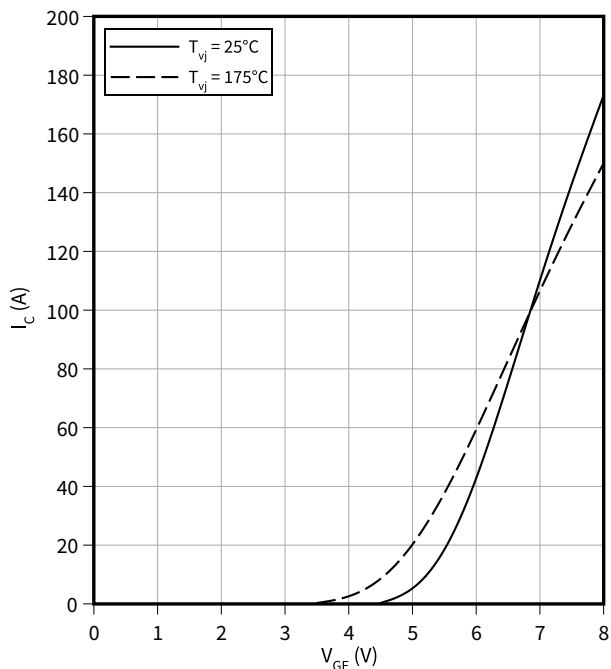
$I_C = f(V_{\text{CE}})$
 $T_{\text{vj}} = 175^\circ\text{C}$



4 Characteristics diagrams

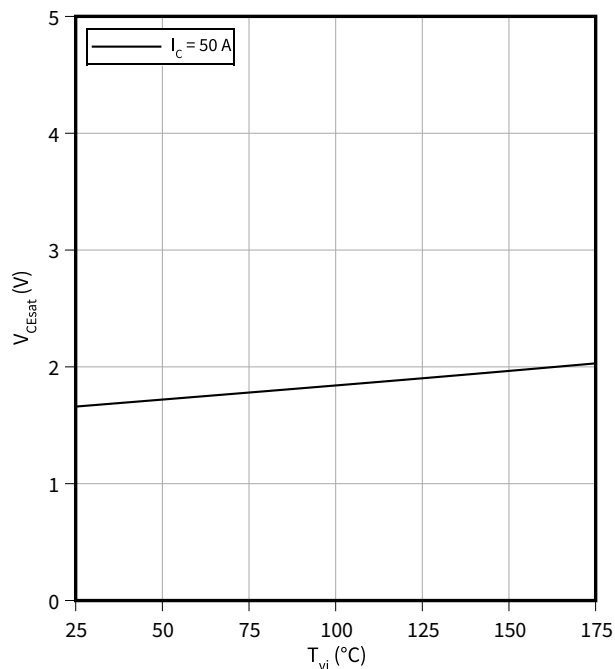
Typical transfer characteristic

$I_C = f(V_{GE})$
 $V_{CE} = 20\text{ V}$



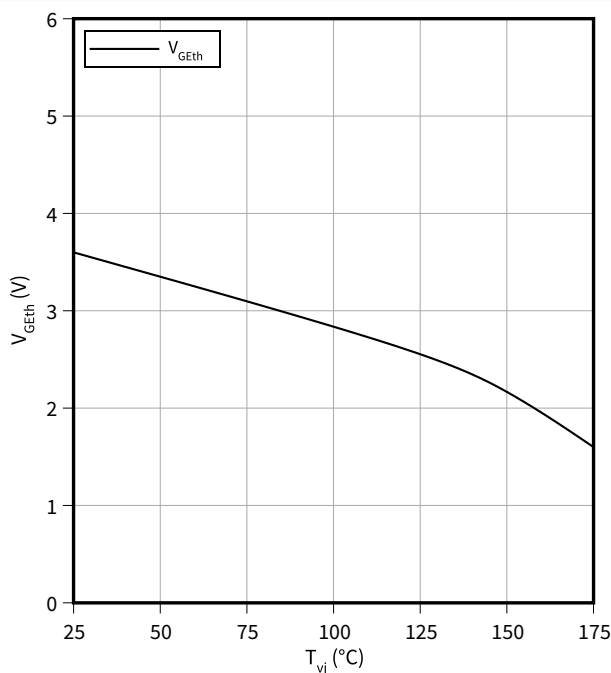
Typical collector-emitter saturation voltage as a function of junction temperature

$V_{CEsat} = f(T_{vj})$
 $V_{GE} = 15\text{ V}$



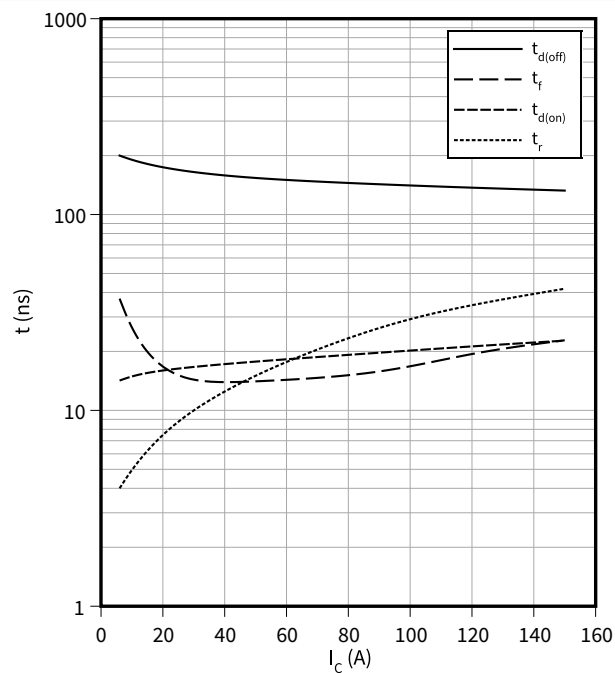
Gate-emitter threshold voltage as a function of junction temperature

$V_{GEth} = f(T_{vj})$
 $I_C = 0.5\text{ mA}$



Typical switching times as a function of collector current

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

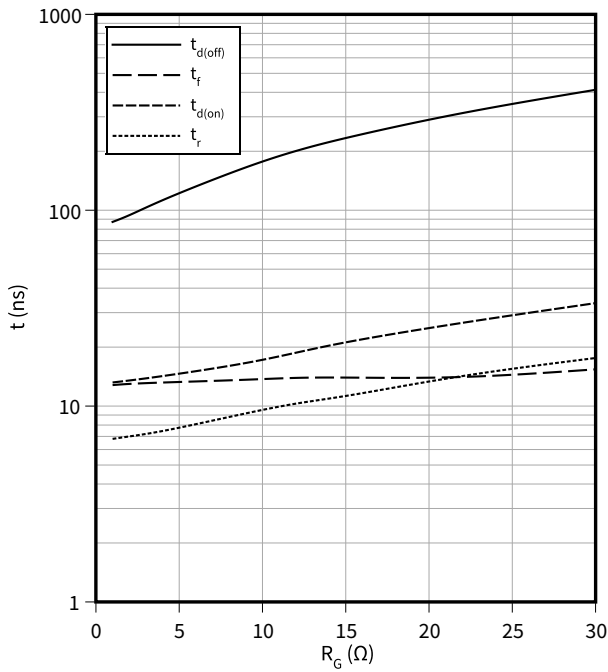


4 Characteristics diagrams

Typical switching times as a function of gate resistor

$t = f(R_G)$

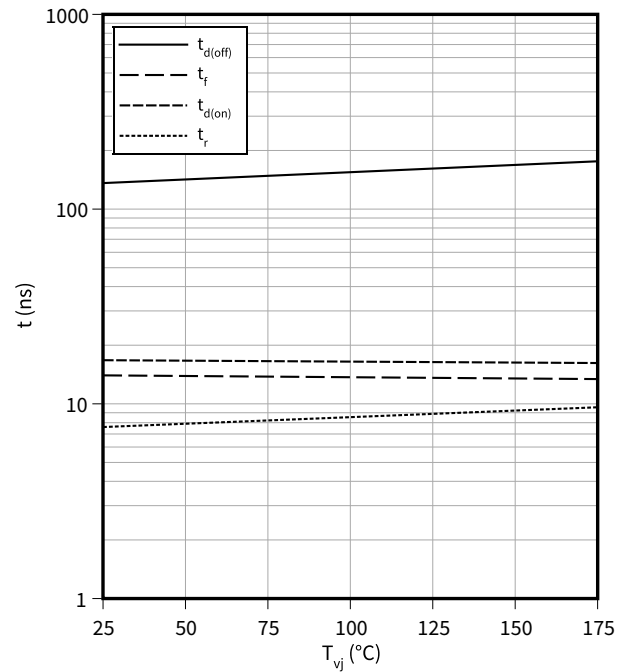
$I_C = 25\text{ A}, V_{CC} = 400\text{ V}, T_{vj} = 150\text{ °C}, V_{GE} = 0/15\text{ V}$



Typical switching times as a function of junction temperature

$t = f(T_{vj})$

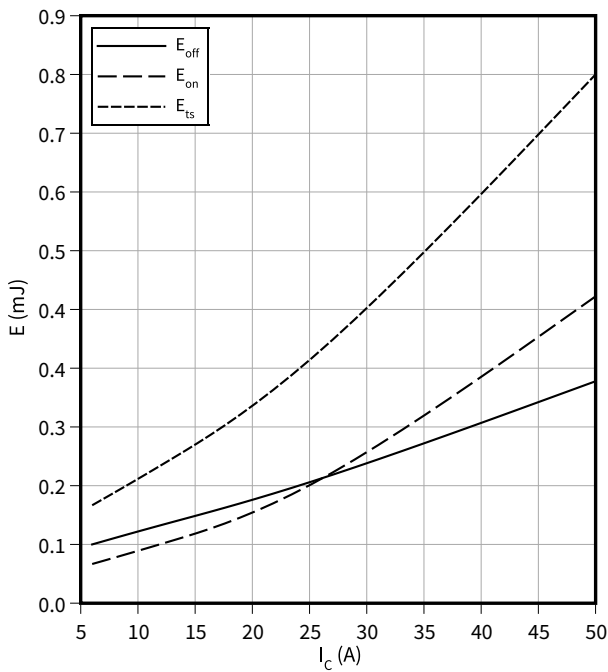
$I_C = 25\text{ A}, V_{CC} = 400\text{ V}, V_{GE} = 0/15\text{ V}, R_G = 9\text{ }\Omega$



Typical switching energy losses as a function of collector current

$E = f(I_C)$

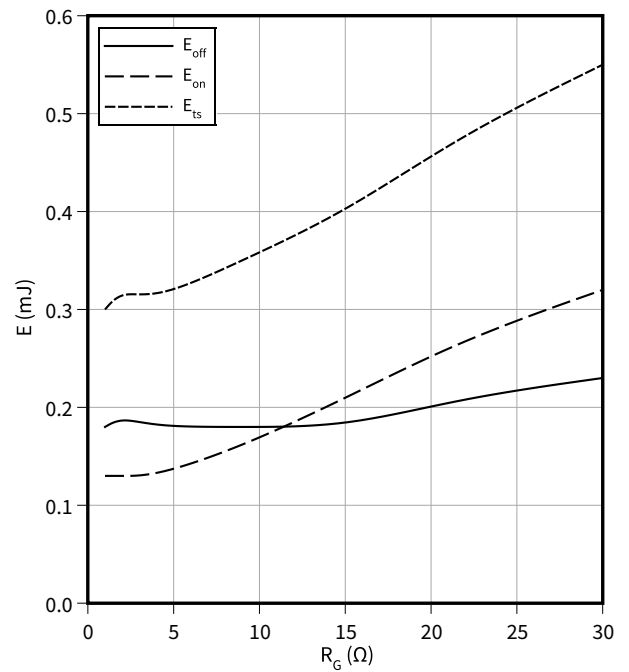
$V_{CC} = 400\text{ V}, T_{vj} = 150\text{ °C}, V_{GE} = 0/15\text{ V}, R_G = 9\text{ }\Omega$



Typical switching energy losses as a function of gate resistor

$E = f(R_G)$

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

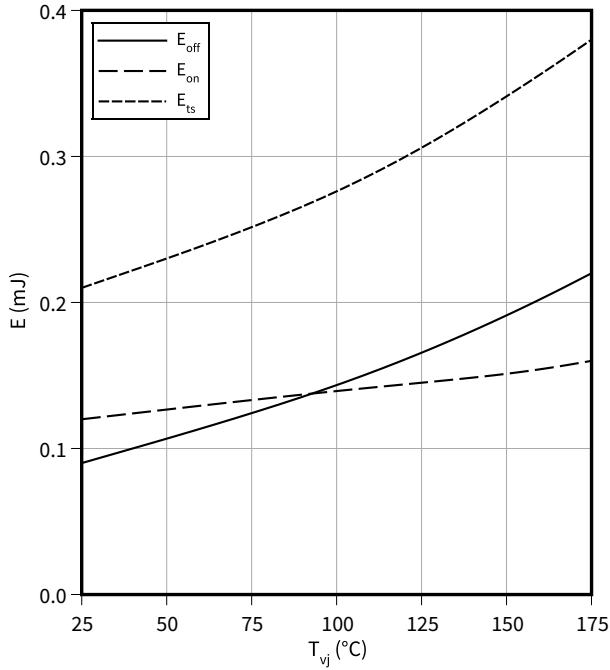


4 Characteristics diagrams

Typical switching energy losses as a function of junction temperature

$E = f(T_{vj})$

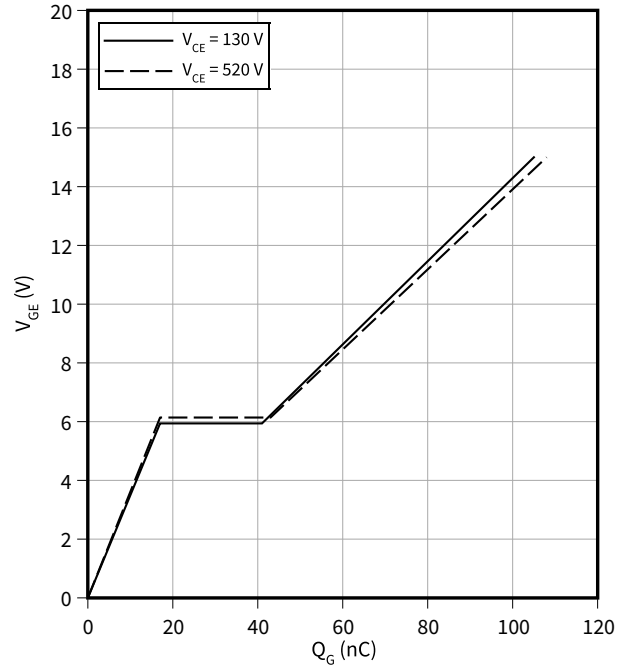
$I_C = 25\text{ A}$, $V_{CC} = 400\text{ V}$, $V_{GE} = 0/15\text{ V}$, $R_G = 9\ \Omega$



Typical gate charge

$V_{GE} = f(Q_G)$

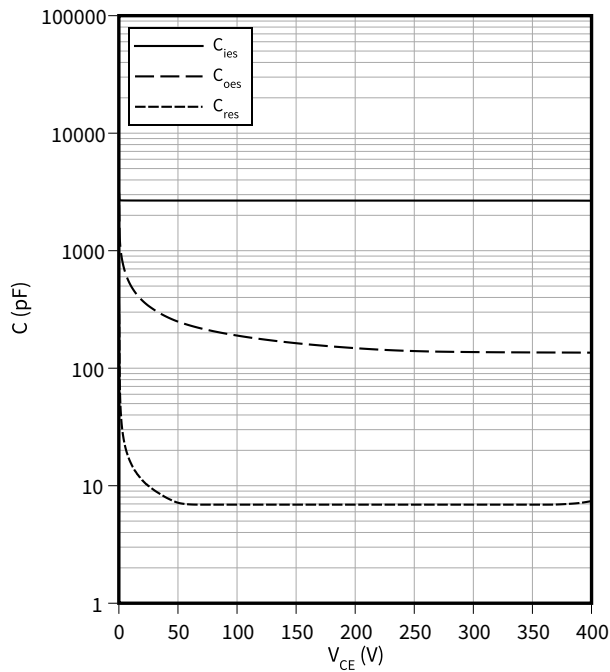
$I_C = 50\text{ A}$



Typical capacitance as a function of collector-emitter voltage

$C = f(V_{CE})$

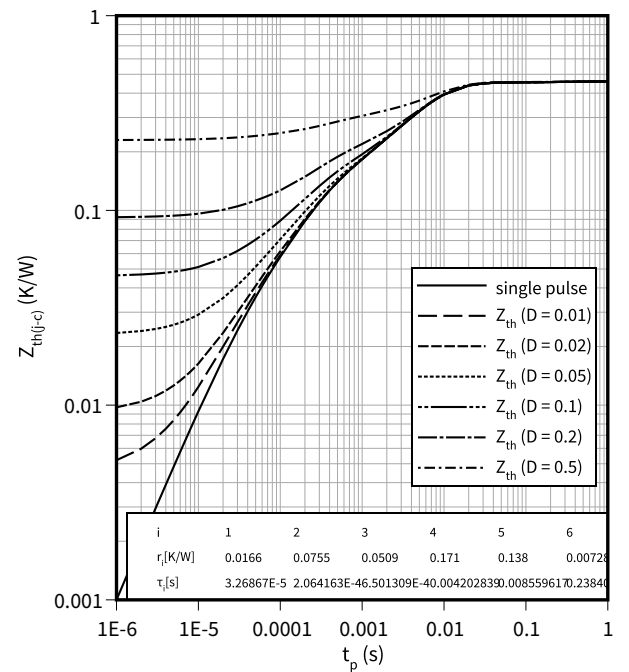
$f = 100\text{ kHz}$, $V_{GE} = 0\text{ V}$



IGBT transient thermal impedance as a function of pulse width

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

$D = t_p/T$

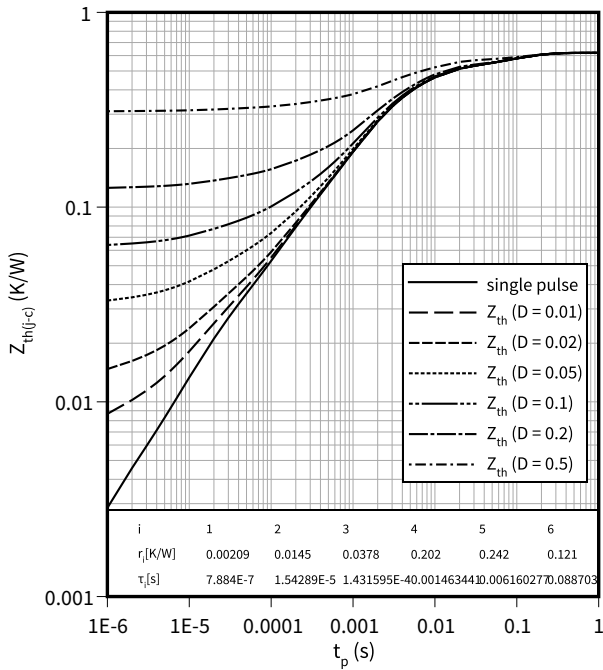


4 Characteristics diagrams

Diode transient thermal impedance as a function of pulse width

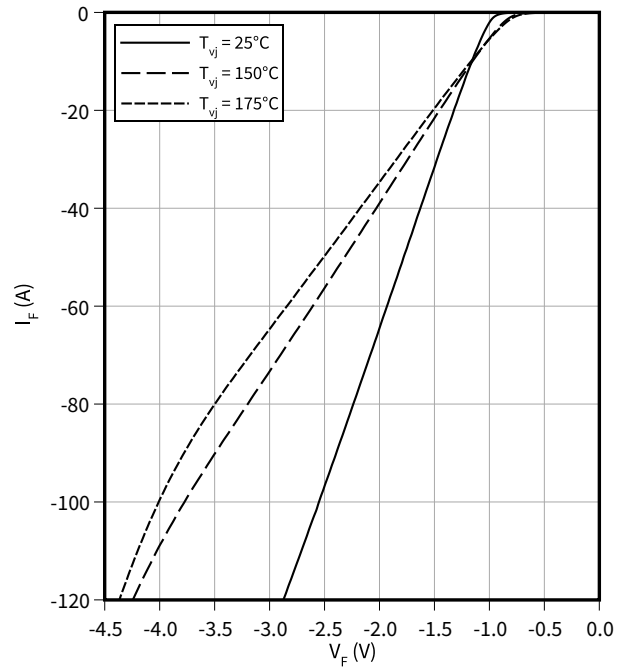
$$Z_{th(j-c)} = f(t_p)$$

$$D = t_p/T$$



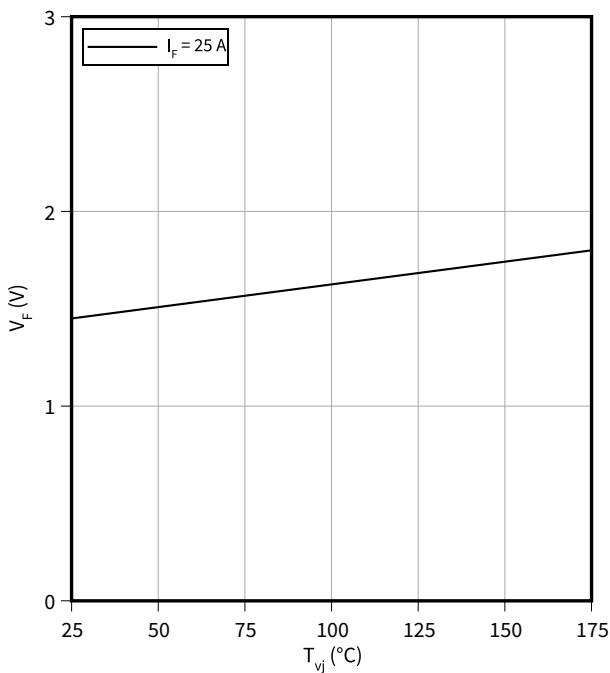
Typical diode forward current as a function of forward voltage

$$I_F = f(V_F)$$



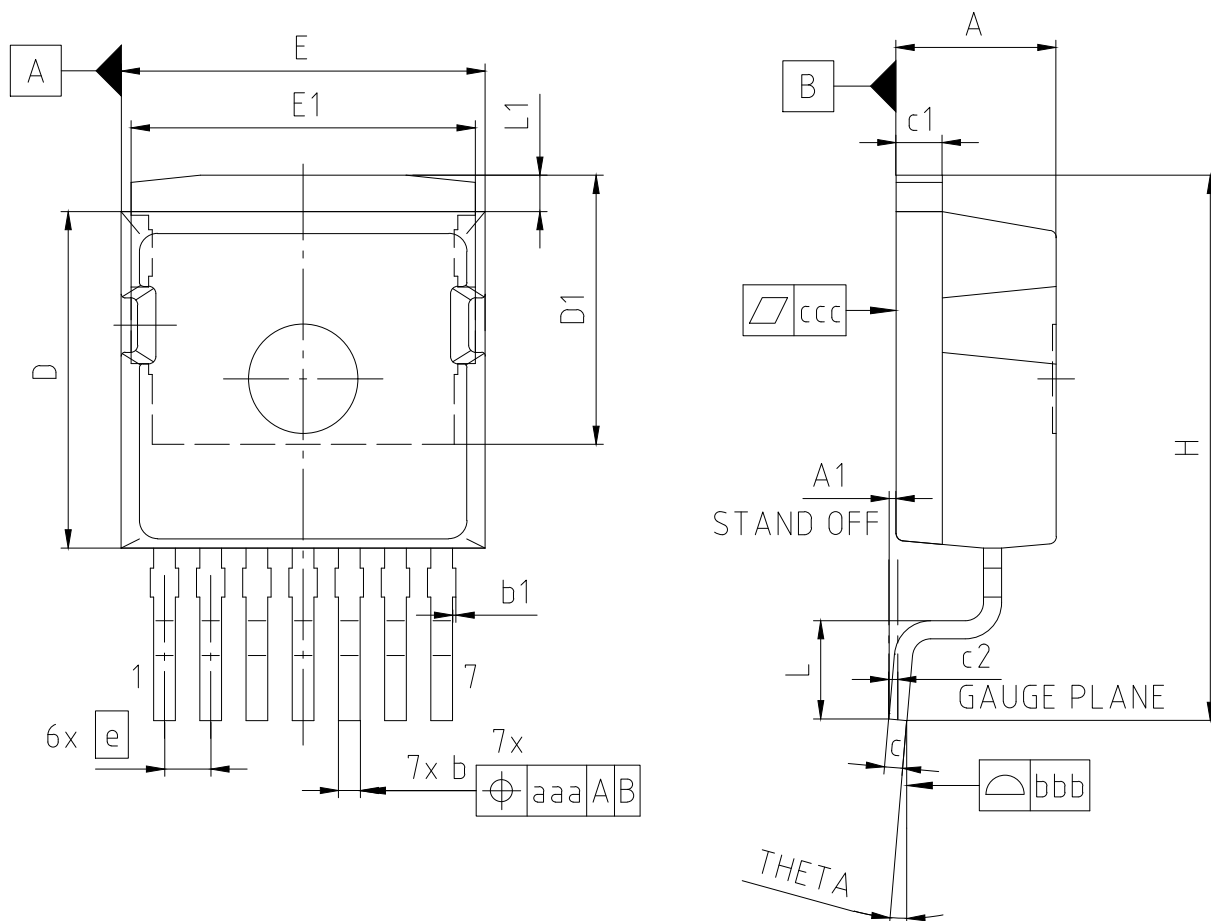
Typical diode forward voltage as a function of junction temperature

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



5 Package outlines

PG-TO263-7-HV-ND4.2



NOTES:

ALL METAL SURFACES TIN PLATED EXCEPT AREA OF CUT

PACKAGE - GROUP NUMBER:		PG-TO263-7-U04			
DIMENSIONS	MILLIMETERS		DIMENSIONS	MILLIMETERS	
	MIN.	MAX.		MIN.	MAX.
A	4.30	4.50	E1	9.46	
A1	0.00	0.10	e	1.27	
b	0.50	0.70	N	7	
b1	0.00	0.15	H	15.00	
c	0.40	0.60	L	2.50	2.90
c1	1.17	1.37	L1	0.70	1.30
c2	0.25		THETA	---	8.00°
D	9.05	9.45	aaa	0.25	
D1	7.30	7.50	bbb	0.10	
E	9.80	10.20	ccc	0.05	

Figure 1

6 Testing conditions

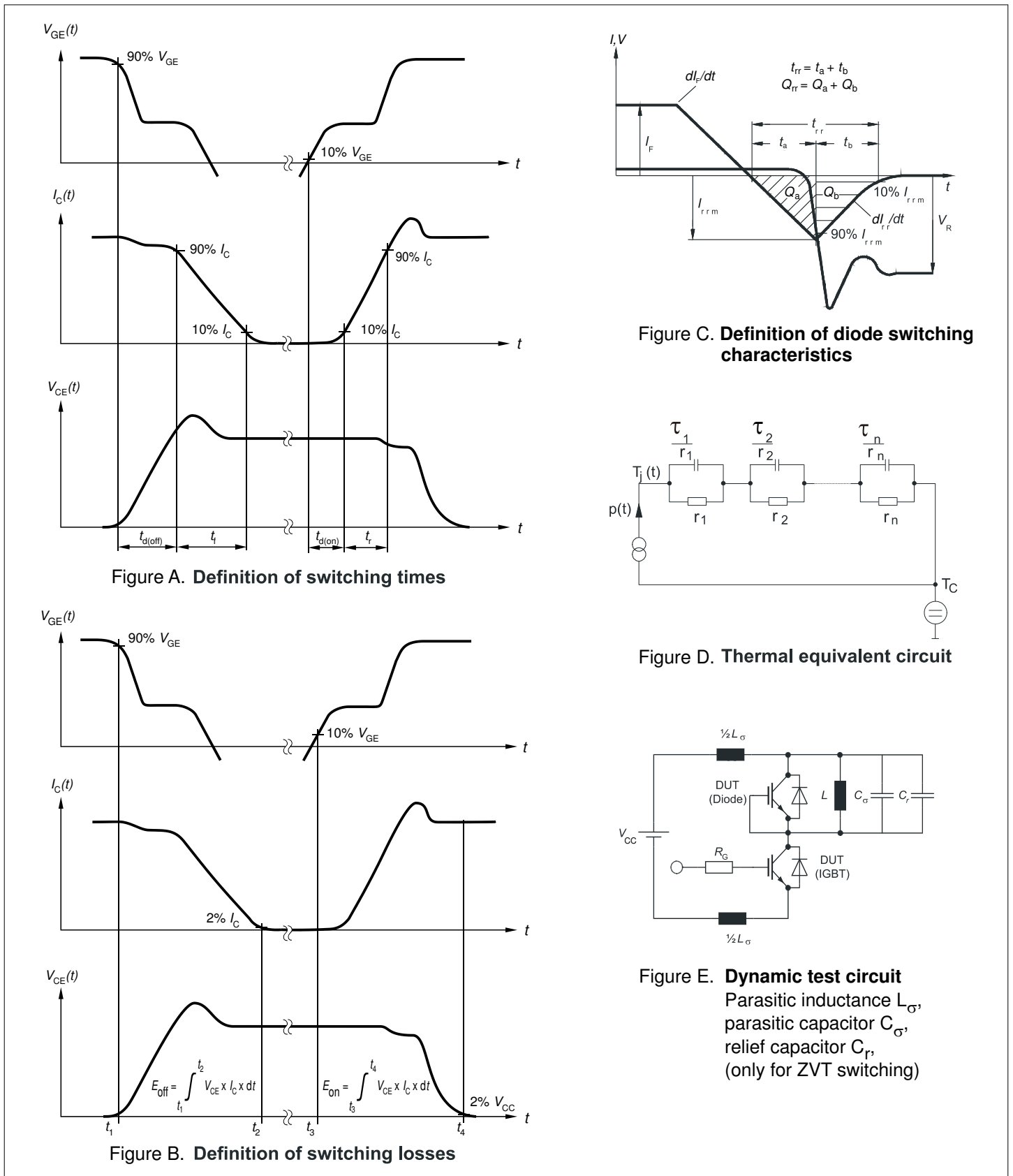


Figure 2

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 If(Vf) 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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