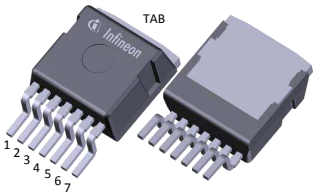
Final datasheet

Automotive CoolSiC™ 650V Hybrid Discrete with TRENCHSTOP™ 5 fast-switching IGBT and CoolSiC™ Schottky Diode G5



Lead-free

Green

Halogen-free

RoHS

AEC Qualified

Features

- V_{CE} = 650 V
- I_C = 40 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°C
- Kelvin emitter connection for optimized switching performance

Potential applications

- On-board charger
- DC/DC converter

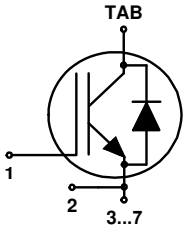
Product validation

- 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
AIKBE40N65RF5	PG-TO263-7-U04	AKE4ERF

Table of contents

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	$R_{th(j-c)}$			0.4	0.52	K/W
Diode thermal resistance, junction-case	$R_{th(j-c)}$			0.81	1.05	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 °C		650	V
DC collector current, limited by T_{vjmax}	I_C		T_c = 25 °C	96	A
			T_c = 100 °C	62	
Pulsed collector current, t_p limited by T_{vjmax}[1)]	I_{Cpulse}			120	A
Turn-off safe operating area[1)]		V_{CE} ≤ 650 V, T_{vj} ≤ 175 °C		120	A
Gate-emitter voltage[1)]	V_{GE}			±20	V
Transient gate-emitter voltage	V_{GE}	t_p ≤ 10 µs, D < 0.01		±30	V
Power dissipation[1)]	P_{tot}		T_c = 25 °C	288	W
			T_c = 100 °C	144	

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 saturation voltage	V_{CEsat}	I_C = 40 A, V_{GE} = 15 V	T_{vj} = 25 °C		1.66	2.1	V
			T_{vj} = 125 °C		1.9		
			T_{vj} = 175 °C		2.03		
Gate-emitter threshold voltage	V_{GEth}	I_C = 0.4 mA, V_{CE} = V_{GE}	T_{vj} = 25 °C	3.2	4	4.8	V
			T_{vj} = 175 °C		2.4		

(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}	$V_{CE} \le 650$ V, $V_{GE} = 0$ V	$T_{vj} = 25$ °C		16	120	µA
			$T_{vj} = 175$ °C		1000		
Gate-emitter leakage current	I_{GES}	$V_{CE} = 0$ V, $V_{GE} = 20$ V			0.1	100	nA
Transconductance	g_{fs}	$I_C = 40$ A, $V_{CE} = 20$ V			50		S
Input capacitance	C_{ies}	$V_{CE} = 25$ V, $V_{GE} = 0$ V, $f = 100$ kHz			2200		pF
Output capacitance	C_{oes}	$V_{CE} = 25$ V, $V_{GE} = 0$ V, $f = 100$ kHz			200		pF
Reverse transfer capacitance	C_{res}	$V_{CE} = 25$ V, $V_{GE} = 0$ V, $f = 100$ kHz			8.5		pF
Gate charge	Q_G	$I_C = 40$ A, $V_{CC} = 520$ V, $V_{GE} = 15$ V			90		nC
Turn-on delay time	$t_{d(on)}$	$V_{CC} = 400$ V, $V_{GE} = 0/15$ V, $R_{G(on)} = 9.5$ Ω, $R_{G(off)} = 9.5$ Ω, $L_\sigma = 30$ nH, $C_\sigma = 30$ pF	$T_{vj} = 25$ °C, $I_C = 20$ A		14		ns
			$T_{vj} = 175$ °C, $I_C = 20$ A		13.8		
Rise time (inductive load)	t_r	$V_{CC} = 400$ V, $V_{GE} = 0/15$ V, $R_{G(on)} = 9.5$ Ω, $R_{G(off)} = 9.5$ Ω, $L_\sigma = 30$ nH, $C_\sigma = 30$ pF	$T_{vj} = 25$ °C, $I_C = 20$ A		6		ns
			$T_{vj} = 175$ °C, $I_C = 20$ A		7.6		
Turn-off delay time	$t_{d(off)}$	$V_{CC} = 400$ V, $V_{GE} = 0/15$ V, $R_{G(on)} = 9.5$ Ω, $R_{G(off)} = 9.5$ Ω, $L_\sigma = 30$ nH, $C_\sigma = 30$ pF	$T_{vj} = 25$ °C, $I_C = 20$ A		112		ns
			$T_{vj} = 175$ °C, $I_C = 20$ A		144		
Fall time (inductive load)	t_f	$V_{CC} = 400$ V, $V_{GE} = 0/15$ V, $R_{G(on)} = 9.5$ Ω, $R_{G(off)} = 9.5$ Ω, $L_\sigma = 30$ nH, $C_\sigma = 30$ pF	$T_{vj} = 25$ °C, $I_C = 20$ A		14		ns
			$T_{vj} = 175$ °C, $I_C = 20$ A		10		
Turn-on energy	E_{on}	$V_{CC} = 400$ V, $V_{GE} = 0/15$ V, $R_{G(on)} = 9.5$ Ω, $R_{G(off)} = 9.5$ Ω, $L_\sigma = 30$ nH, $C_\sigma = 30$ pF	$T_{vj} = 25$ °C, $I_C = 20$ A		0.1		mJ
			$T_{vj} = 175$ °C, $I_C = 20$ A		0.13		
Turn-off energy	E_{off}	$V_{CC} = 400$ V, $V_{GE} = 0/15$ V, $R_{G(on)} = 9.5$ Ω, $R_{G(off)} = 9.5$ Ω, $L_\sigma = 30$ nH, $C_\sigma = 30$ pF	$T_{vj} = 25$ °C, $I_C = 20$ A		0.09		mJ
			$T_{vj} = 175$ °C, $I_C = 20$ A		0.16		

(table continues...)

Table 3 (continued) Characteristic values

Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
Total switching energy	E_{ts}	V_{CC} = 400 V, V_{GE} = 0/15 V, $R_{G(on)}$ = 9.5 Ω, $R_{G(off)}$ = 9.5 Ω, L_σ = 30 nH, C_σ = 30 pF	T_{vj} = 25 °C, I_C = 20 A		0.19		mJ
			T_{vj} = 175 °C, I_C = 20 A		0.29		
Operating junction temperature	T_{vj}			-40		175	°C

***Note**: Electrical Characteristic, at T_{vj} = 25°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}			650	V
Diode forward current, limited by T_{vjmax}	I_F		T_c = 25 °C	46	A
			T_c = 100 °C	30	
Diode pulsed current, t_p limited by T_{vjmax}	I_{Fpulse}			90	A

Table 5 Characteristic values

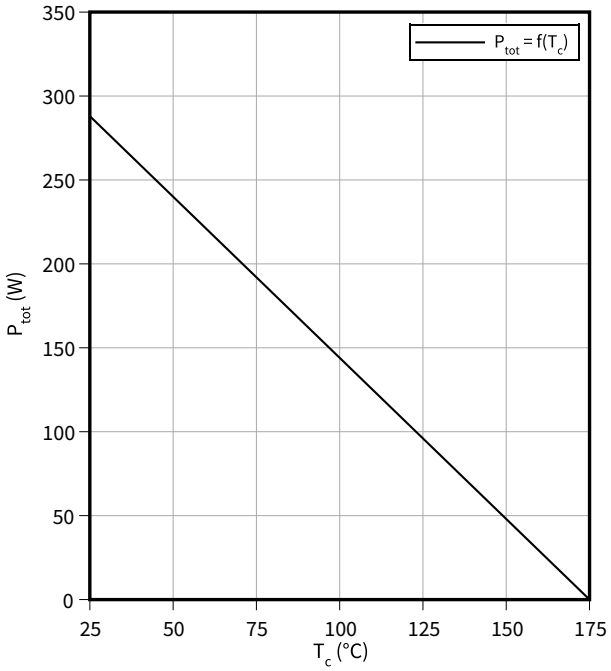
Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
Diode forward voltage	V_F	I_F = 16 A	T_{vj} = 25 °C		1.45	1.7	V
			T_{vj} = 125 °C		1.6		
			T_{vj} = 175 °C		1.8		
Operating junction temperature	T_{vj}			-40		175	°C

4 Characteristics diagrams

Power dissipation as a function of case temperature

$P_{tot} = f(T_c)$

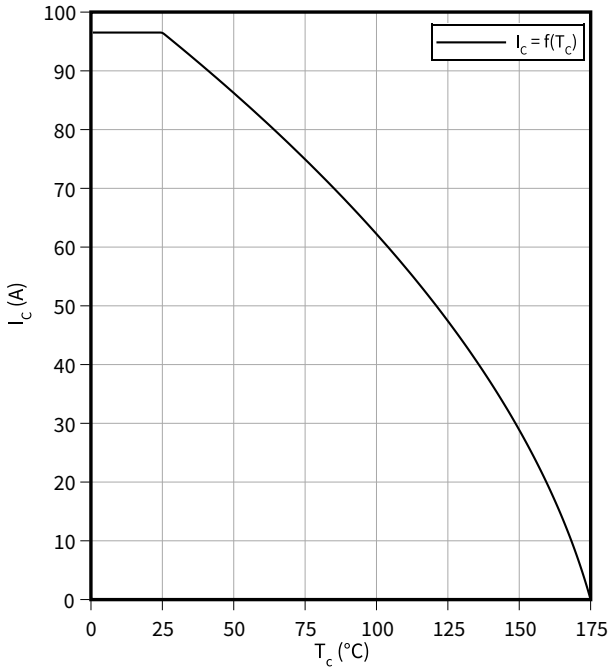
$T_{vj} \leq 175$ °C



Collector current as a function of case temperature

$I_C = f(T_c)$

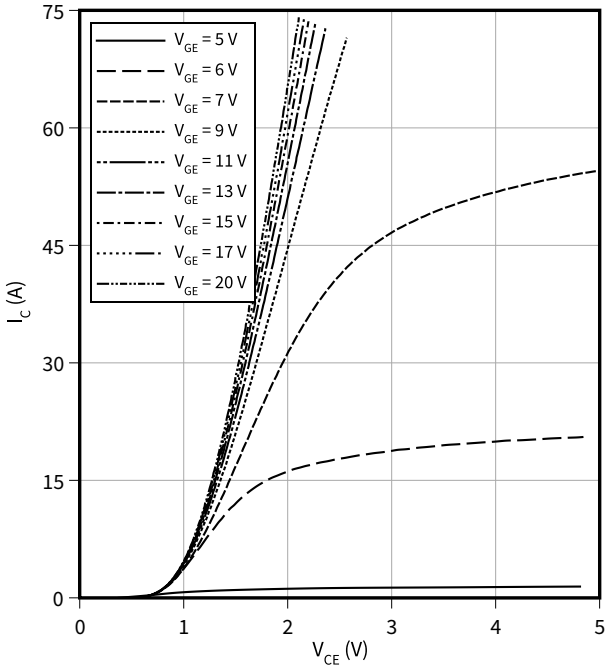
$T_{vj} \leq 175$ °C, $V_{GE} \geq 15$ V



Typical output characteristic

$I_C = f(V_{CE})$

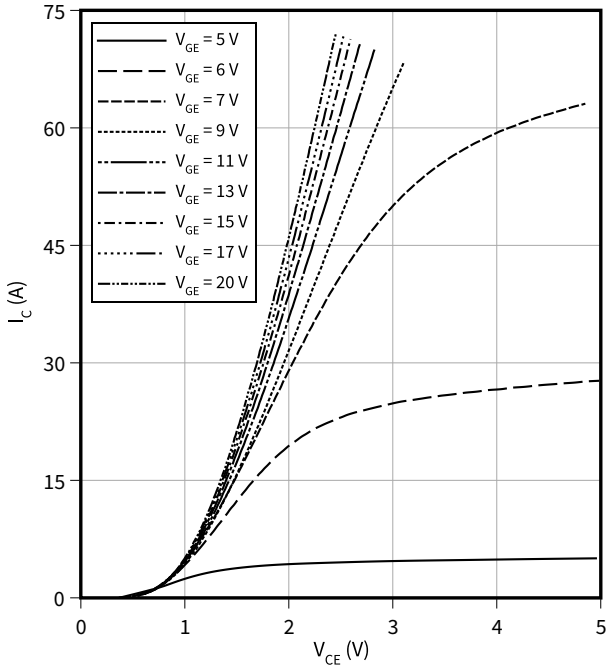
$T_{vj} = 25$ °C



Typical output characteristic

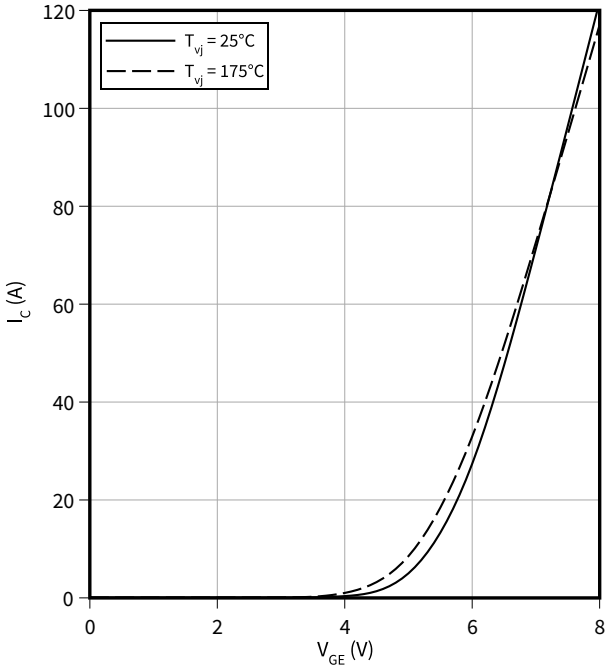
$I_C = f(V_{CE})$

$T_{vj} = 175$ °C



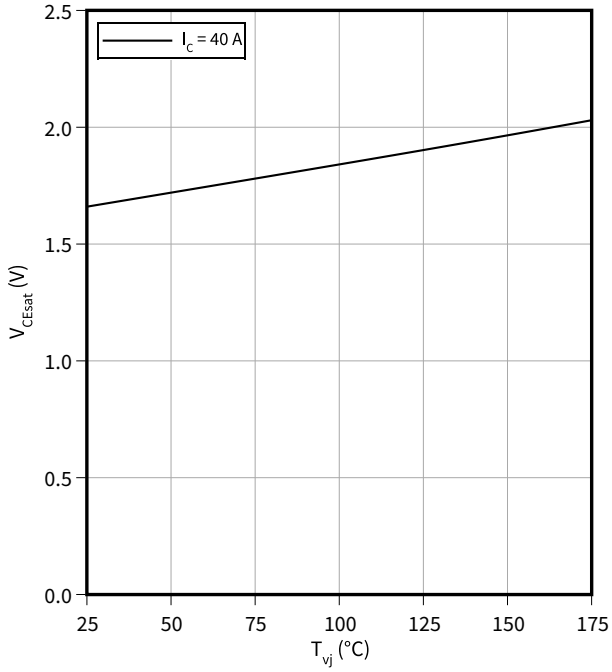
Typical transfer characteristic

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



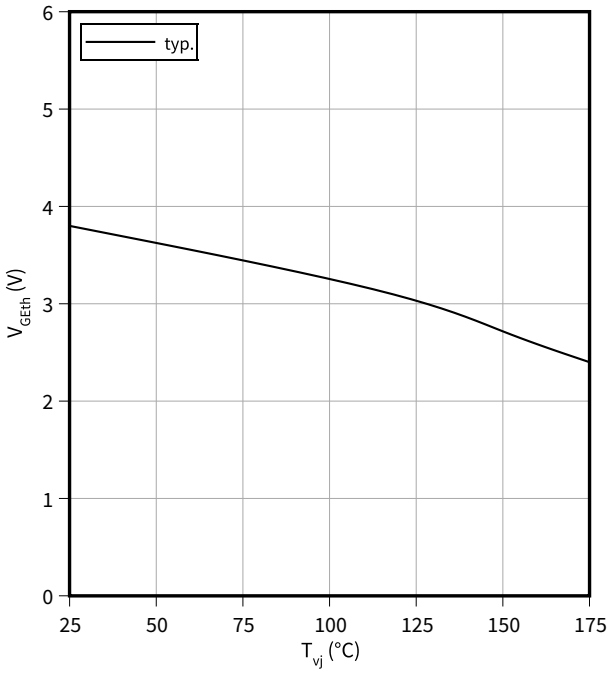
Typical collector-emitter saturation voltage as a function of junction temperature

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



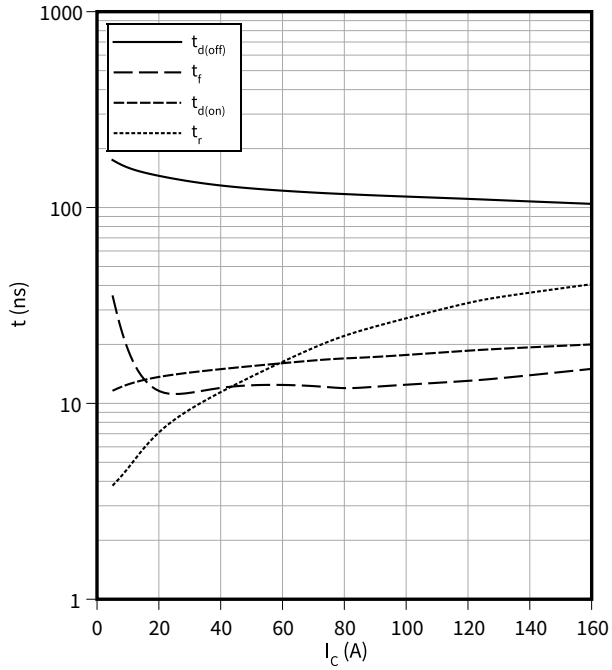
Gate-emitter threshold voltage as a function of junction temperature

$V_{GEth} = f(T_{vj})$
$I_C = 0.4$ mA



Typical switching times as a function of collector current

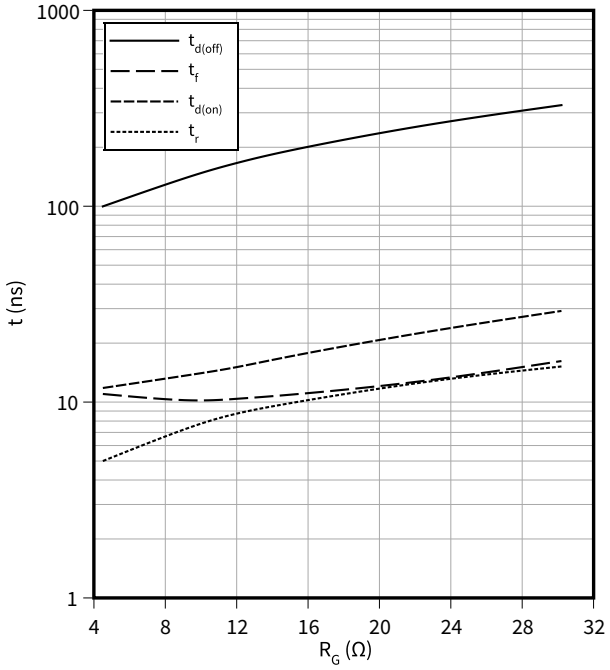
$t = f(I_C)$
$V_{CE} = 400$ V, $T_{vj} = 175$ °C, $V_{GE} = 0/15$ V, $R_G = 9.5\ \Omega$



Typical switching times as a function of gate resistor

$t = f(R_G)$

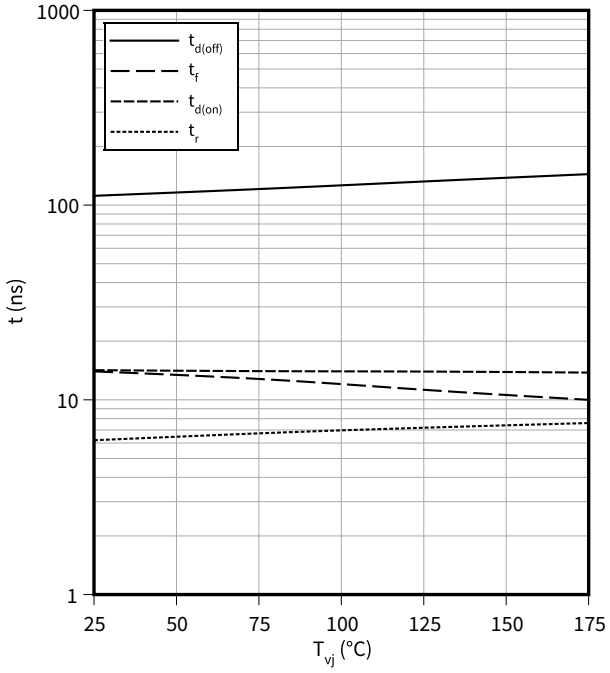
$I_C = 20\ A$, $T_{vj} = 175\ °C$, $V_{CE} = 400\ V$, $V_{GE} = 0/15\ V$



Typical switching times as a function of junction temperature

$t = f(T_{vj})$

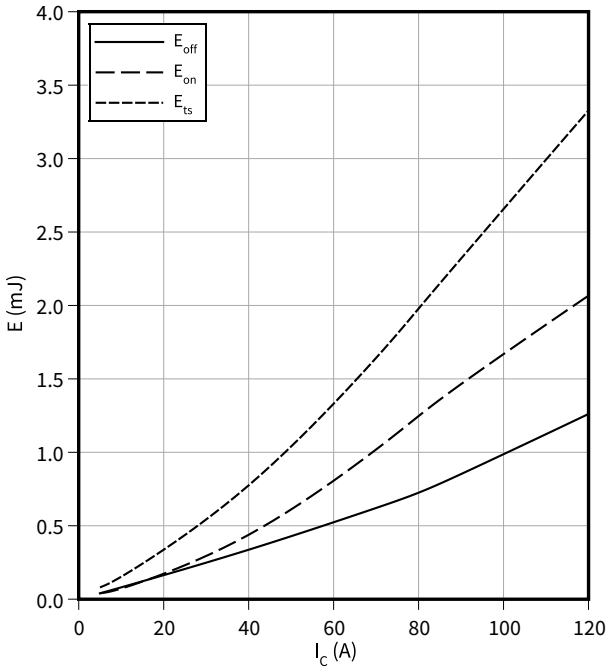
$I_C = 20\ A$, $V_{CE} = 400\ V$, $V_{GE} = 0/15\ V$, $R_G = 9.5\ Ω$



Typical switching energy losses as a function of collector current

$E = f(I_C)$

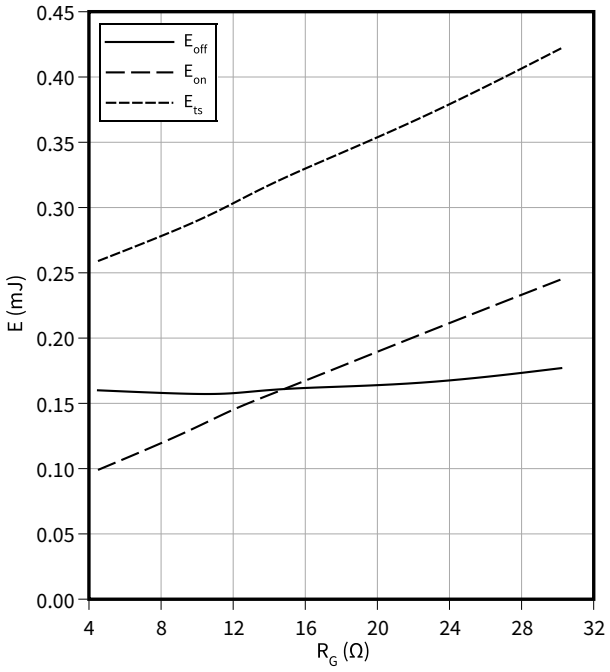
$V_{CE} = 400\ V$, $T_{vj} = 175\ °C$, $V_{GE} = 0/15\ V$, $R_G = 9.5\ Ω$



Typical switching energy losses as a function of gate resistor

$E = f(R_G)$

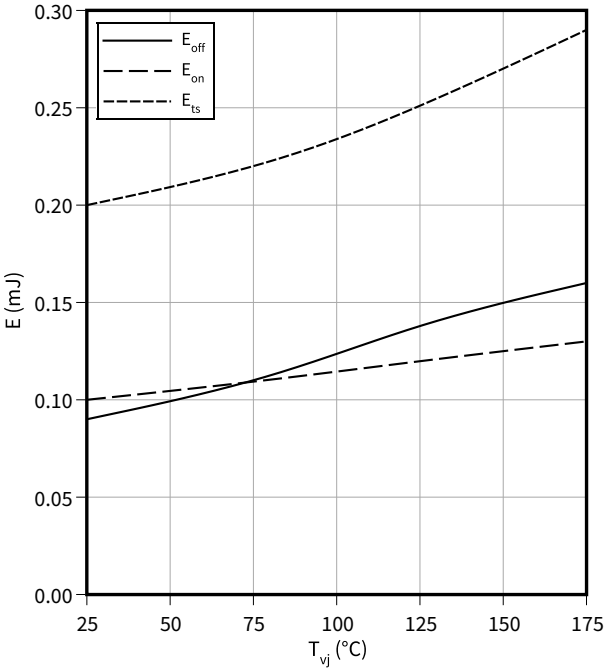
$I_C = 20\ A$, $T_{vj} = 175\ °C$, $V_{CE} = 400\ V$, $V_{GE} = 0/15\ V$



Typical switching energy losses as a function of junction temperature

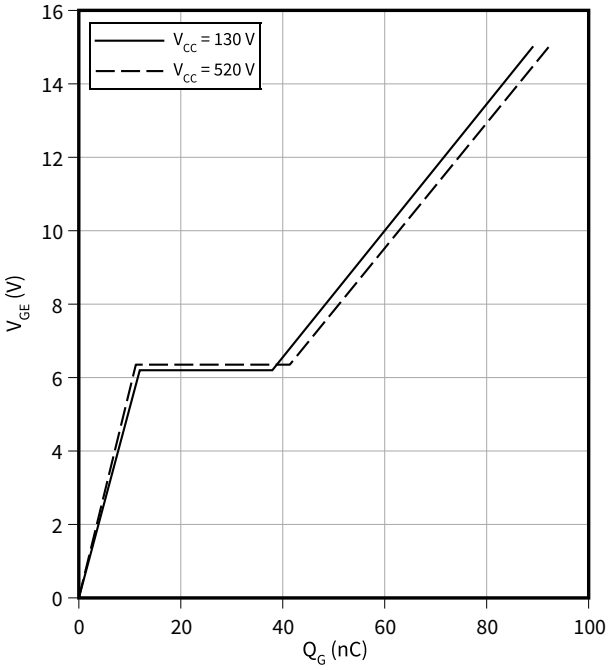
$E = f(T_{vj})$

$I_C = 20$ A, $V_{CE} = 400$ V, $V_{GE} = 0/15$ V, $R_G = 9.5\ \Omega$



Typical gate charge

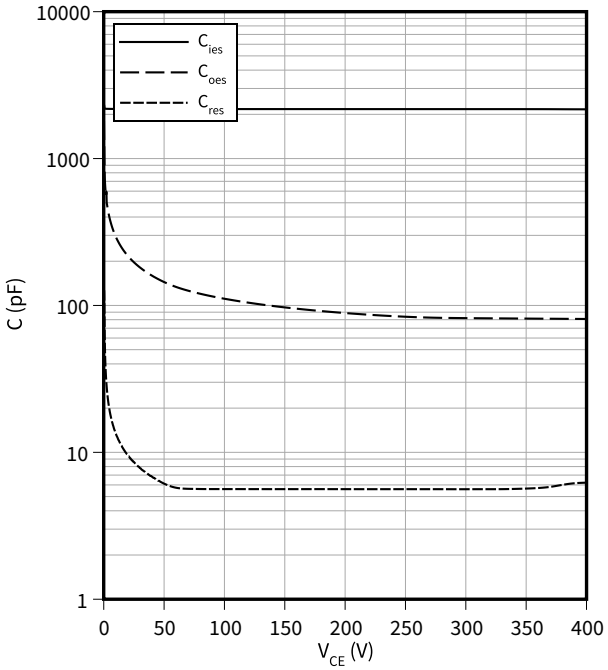
$V_{GE} = f(Q_G)$



Typical capacitance as a function of collector-emitter voltage

$C = f(V_{CE})$

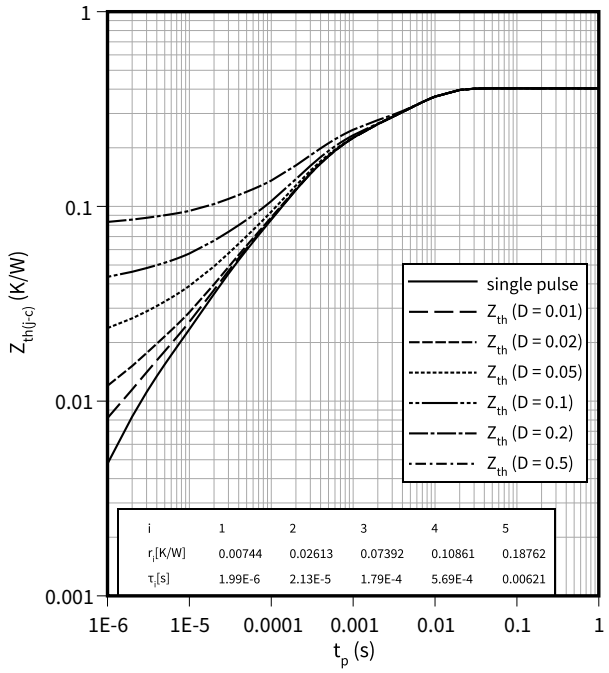
$f = 1000$ kHz, $V_{GE} = 0$ V



Typical IGBT transient thermal impedance as a function of pulse width

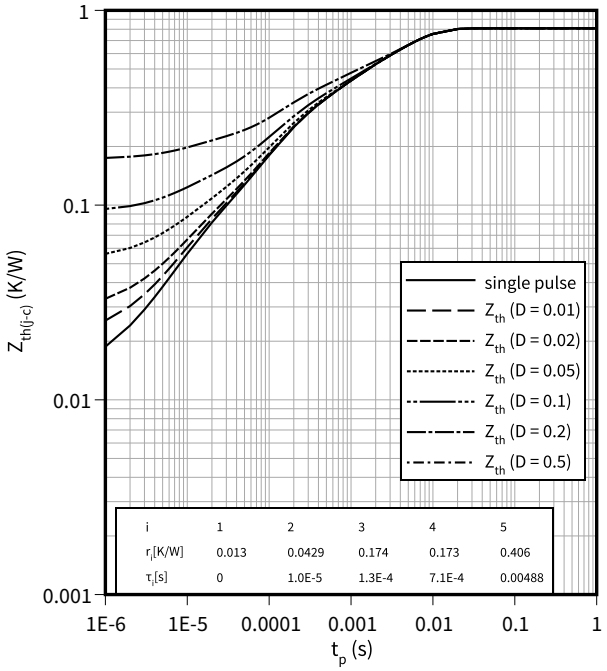
$Z_{th(j\text{-}c)} = f(t_p)$

$D = t_p/T$



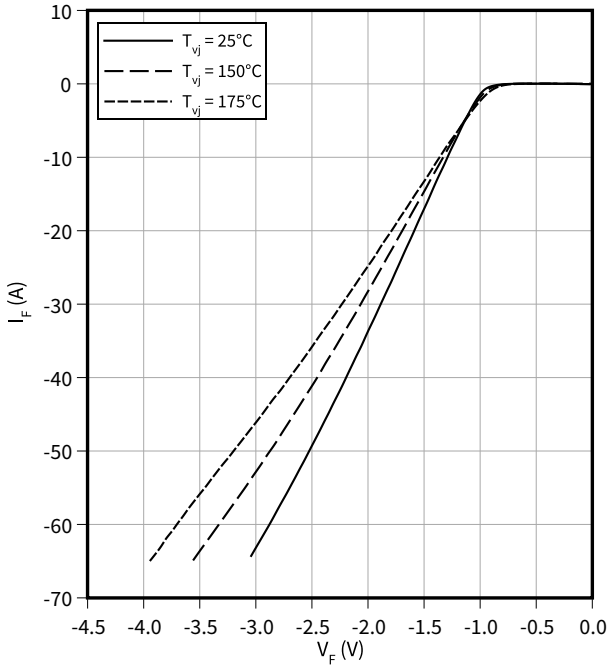
Typical diode transient thermal impedance as a function of pulse width

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



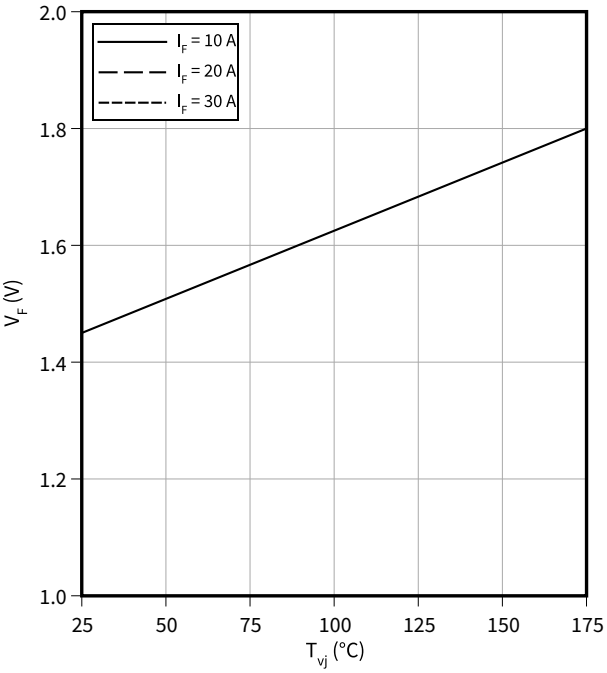
Typical diode forward current as a function of forward voltage

$I_F = f(V_F)$

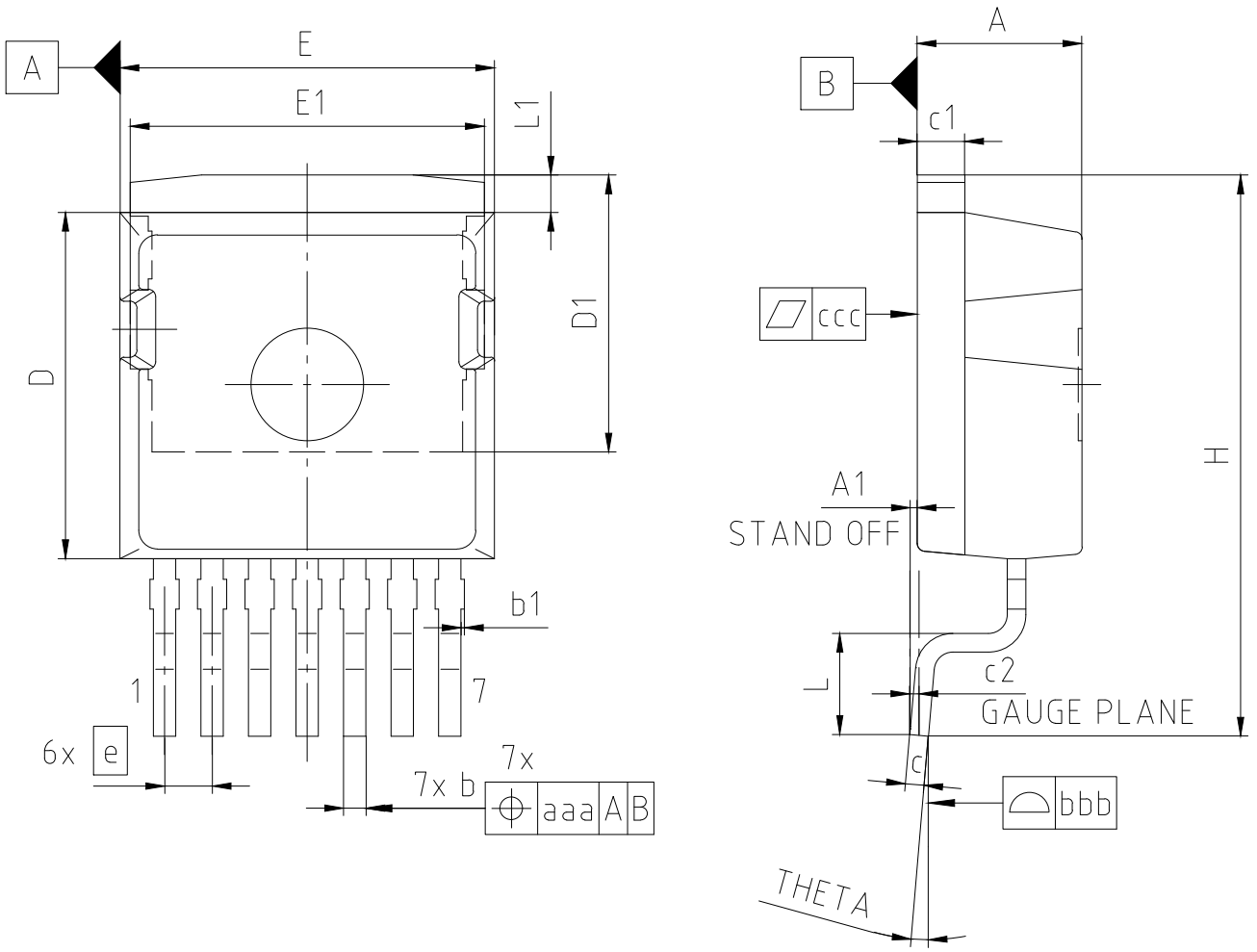


Typical diode forward voltage as a function of junction temperature

$V_F = f(T_{vj})$



5 Package outlines



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

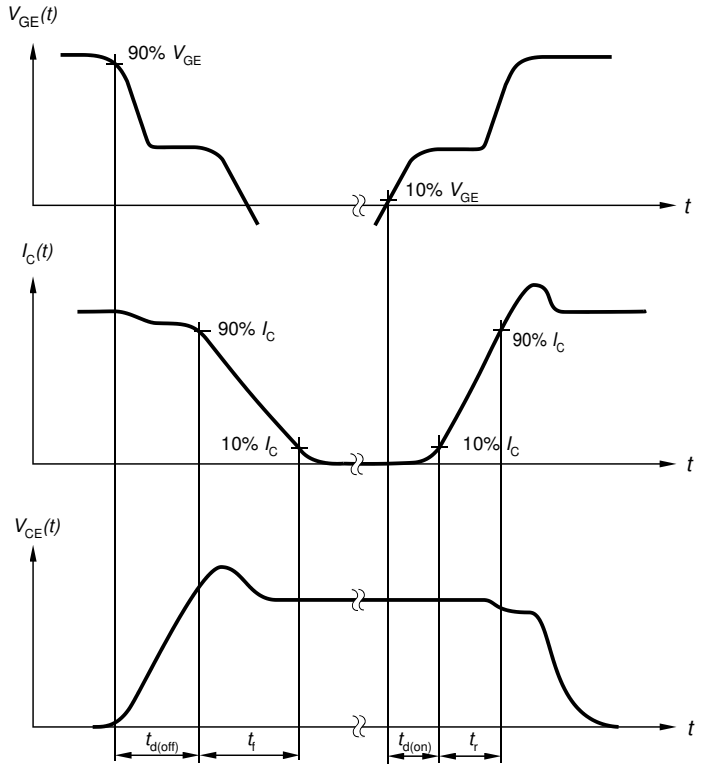


Figure A. **Definition of switching times**

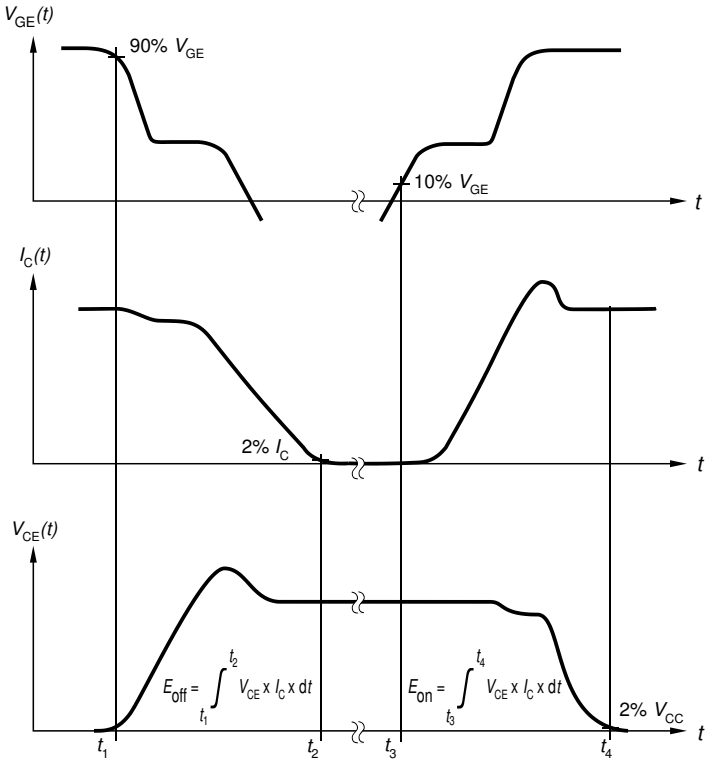


Figure B. **Definition of switching losses**

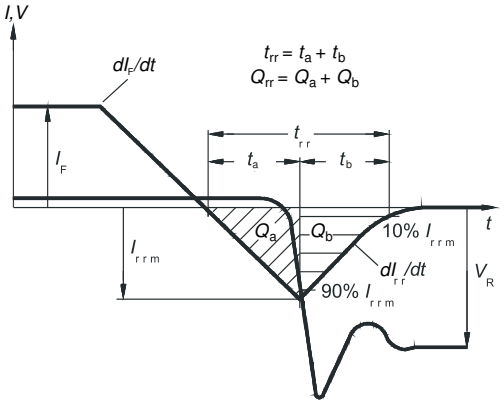


Figure C. **Definition of diode switching characteristics**

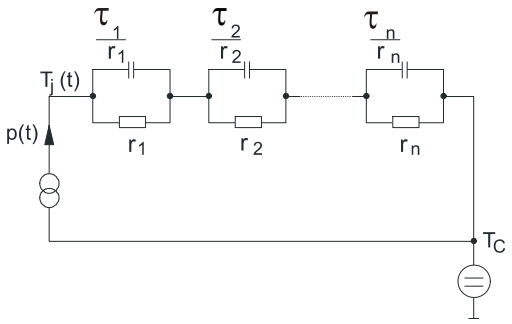


Figure D. **Thermal equivalent circuit**

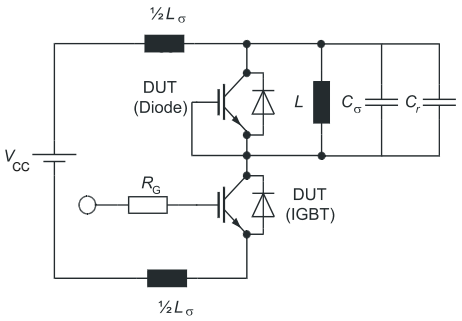


Figure E. **Dynamic test circuit**
Parasitic inductance L_σ,
parasitic capacitor C_σ,
relief capacitor C_r,
(only for ZVT switching)

Figure 2

Revision history

Document revision	Date of release	Description of changes
0.10	2024-11-04	Target datasheet
0.20	2025-04-16	Preliminary datasheet
1.00	2025-06-03	IGBT output and Gate charge plots updated

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Edition 2025-06-10

Published by

Infineon Technologies AG

81726 Munich, Germany

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Document reference
IFX-ABD043-003

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