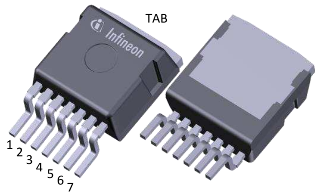
Final datasheet

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



Lead-free

Green

Halogen-free

RoHS

AEC Qualified

Features

- V_{CE} = 650 V
- I_C = 50 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

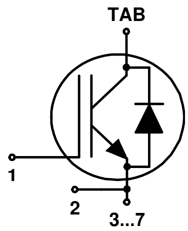
Product validation

- 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
AIKBE50N65RF5	PG-TO263-7-HV-ND4.2	AKE5ERF

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	$R_{th(j-c)}$			0.35	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 °C		650	V
DC collector current, limited by T_{vjmax}	I_C		T_c = 25 °C	96	A
			T_c = 100 °C	65	
Pulsed collector current, t_p limited by T_{vjmax} [1)]	I_{Cpulse}			150	A
Turn-off safe operating area[1)]		$V_{CE} \leq 650$ V, $T_{vj} \leq 175$ °C		150	A
Gate-emitter voltage[1)]	V_{GE}			±20	V
Transient gate-emitter voltage	V_{GE}	$t_p \leq 10$ µs, $D < 0.01$		±30	V
Power dissipation[1)]	P_{tot}		T_c = 25 °C	326	W
			T_c = 100 °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 mA, V_{GE} = 0 V		650			V
Collector-emitter saturation voltage	V_{CEsat}	I_C = 50 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 = 0.5 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 V, V_{GE} = 0 V	T_{vj} = 25 °C		16	120	µA
			T_{vj} = 175 °C		1600		
Transconductance	g_{fs}	I_C = 50 A, V_{CE} = 20 V			62		S
Input capacitance	C_{ies}	V_{CE} = 25 V, V_{GE} = 0 V, f = 100 kHz			2700		pF
Output capacitance	C_{oes}	V_{CE} = 25 V, V_{GE} = 0 V, f = 100 kHz			340		pF
Reverse transfer capacitance	C_{res}	V_{CE} = 25 V, V_{GE} = 0 V, f = 100 kHz			10		pF
Gate charge	Q_G	I_C = 50 A, V_{CC} = 520 V, V_{GE} = 15 V			108		nC
Turn-on delay time	$t_{d(on)}$	V_{CC} = 400 V, V_{GE} = 0/15 V, $R_{G(on)}$ = 9 Ω, $R_{G(off)}$ = 9 Ω, L_σ = 30 nH, C_σ = 30 pF	T_{vj} = 25 °C, I_C = 25 A		16.8		ns
			T_{vj} = 100 °C, I_C = 25 A		16.8		
			T_{vj} = 150 °C, I_C = 25 A		16.5		
			T_{vj} = 175 °C, I_C = 25 A		16.2		
Rise time (inductive load)	t_r	V_{CC} = 400 V, V_{GE} = 0/15 V, $R_{G(on)}$ = 9 Ω, $R_{G(off)}$ = 9 Ω, L_σ = 30 nH, C_σ = 30 pF	T_{vj} = 25 °C, I_C = 25 A		7.6		ns
			T_{vj} = 100 °C, I_C = 25 A		8.4		
			T_{vj} = 150 °C, I_C = 25 A		9.2		
			T_{vj} = 175 °C, I_C = 25 A		9.6		
Turn-off delay time	$t_{d(off)}$	V_{CC} = 400 V, V_{GE} = 0/15 V, $R_{G(on)}$ = 9 Ω, $R_{G(off)}$ = 9 Ω, L_σ = 30 nH, C_σ = 30 pF	T_{vj} = 25 °C, I_C = 25 A		136		ns
			T_{vj} = 100 °C, I_C = 25 A		153		
			T_{vj} = 150 °C, I_C = 25 A		167		
			T_{vj} = 175 °C, I_C = 25 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 V, V_{GE} = 0/15 V, $R_{G(on)}$ = 9 Ω, $R_{G(off)}$ = 9 Ω, L_σ = 30 nH, C_σ = 30 pF	T_{vj} = 25 °C, I_C = 25 A		14		ns
			T_{vj} = 100 °C, I_C = 25 A		14		
			T_{vj} = 150 °C, I_C = 25 A		13.6		
			T_{vj} = 175 °C, I_C = 25 A		13.4		
Turn-on energy	E_{on}	V_{CC} = 400 V, V_{GE} = 0/15 V, $R_{G(on)}$ = 9 Ω, $R_{G(off)}$ = 9 Ω, L_σ = 30 nH, C_σ = 30 pF	T_{vj} = 25 °C, I_C = 25 A		0.12		mJ
			T_{vj} = 100 °C, I_C = 25 A		0.14		
			T_{vj} = 150 °C, I_C = 25 A		0.15		
			T_{vj} = 175 °C, I_C = 25 A		0.16		
Turn-off energy	E_{off}	V_{CC} = 400 V, V_{GE} = 0/15 V, $R_{G(on)}$ = 9 Ω, $R_{G(off)}$ = 9 Ω, L_σ = 30 nH, C_σ = 30 pF	T_{vj} = 25 °C, I_C = 25 A		0.09		mJ
			T_{vj} = 100 °C, I_C = 25 A		0.14		
			T_{vj} = 150 °C, I_C = 25 A		0.19		
			T_{vj} = 175 °C, I_C = 25 A		0.22		
Total switching energy	E_{ts}	V_{CC} = 400 V, V_{GE} = 0/15 V, $R_{G(on)}$ = 9 Ω, $R_{G(off)}$ = 9 Ω, L_σ = 30 nH, C_σ = 30 pF	T_{vj} = 25 °C, I_C = 25 A		0.21		mJ
			T_{vj} = 100 °C, I_C = 25 A		0.27		
			T_{vj} = 150 °C, I_C = 25 A		0.34		
			T_{vj} = 175 °C, I_C = 25 A		0.38		
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**

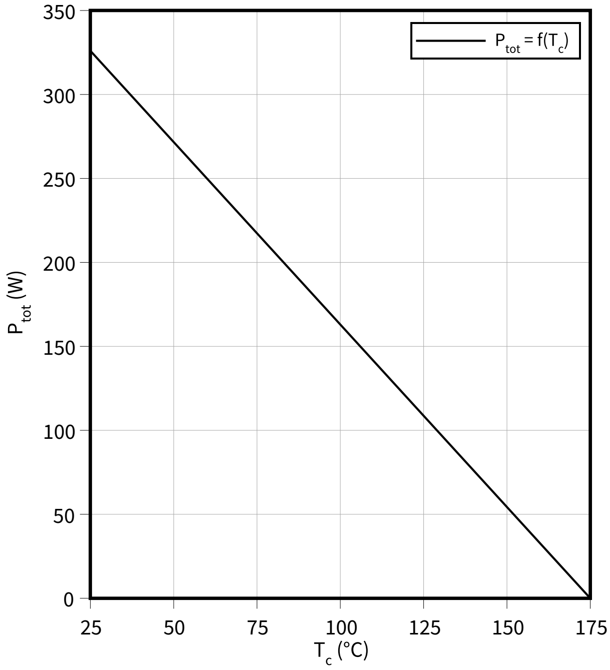
Parameter	Symbol	Note or test condition		Values	Unit
Repetitive peak reverse voltage	V_{RRM}	$T_{vj} \geq 25$ °C		650	V
Diode forward current, limited by T_{vjmax}	I_F		$T_c = 25$ °C	57	A
			$T_c = 100$ °C	40	
Diode pulsed current, t_p limited by T_{vjmax}	I_{Fpulse}			120	A

Table 5 **Characteristic values**

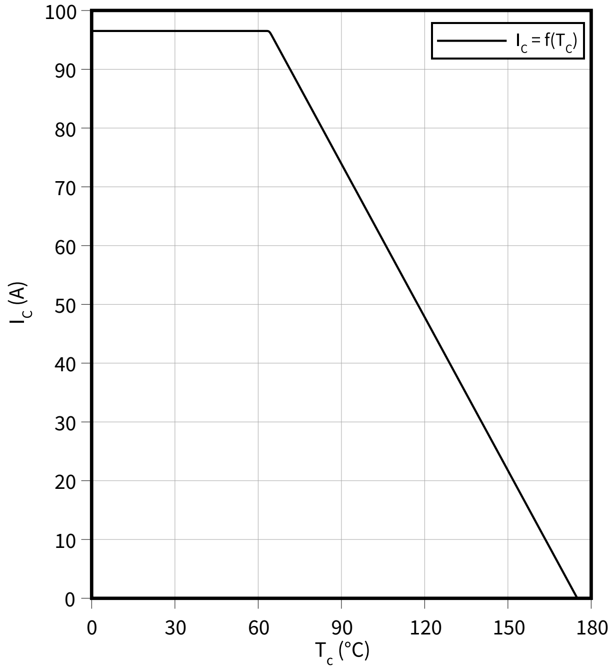
Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
Diode forward voltage	V_F	$I_F = 30$ A	$T_{vj} = 25$ °C		1.45	1.7	V
			$T_{vj} = 125$ °C		1.6		
			$T_{vj} = 175$ °C		1.8		
Operating junction temperature	T_{vj}			-40		175	°C

4 Characteristics diagrams

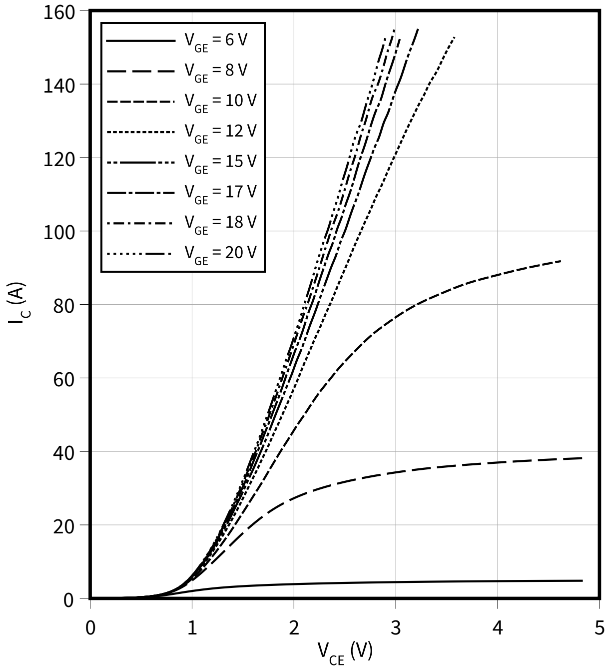
Power dissipation as a function of case temperature
$P_{tot} = f(T_c)$
$T_{vj} \leq 175$ °C



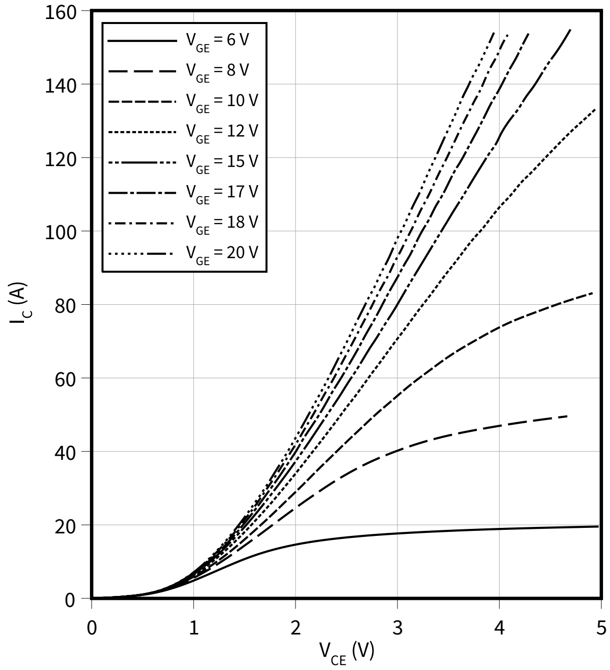
Collector current as a function of case temperature
$I_C = f(T_c)$
$T_{vj} \leq 175$ °C, $V_{GE} \geq 15$ V



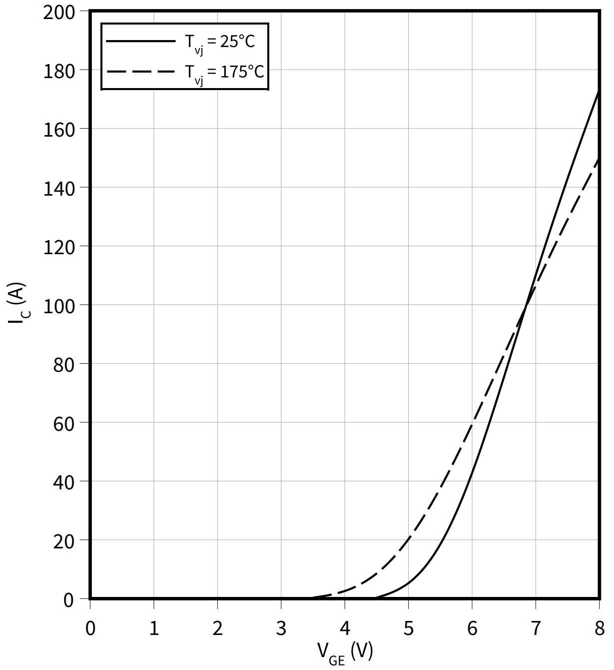
Typical output characteristic
$I_C = f(V_{CE})$
$T_{vj} = 25$ °C



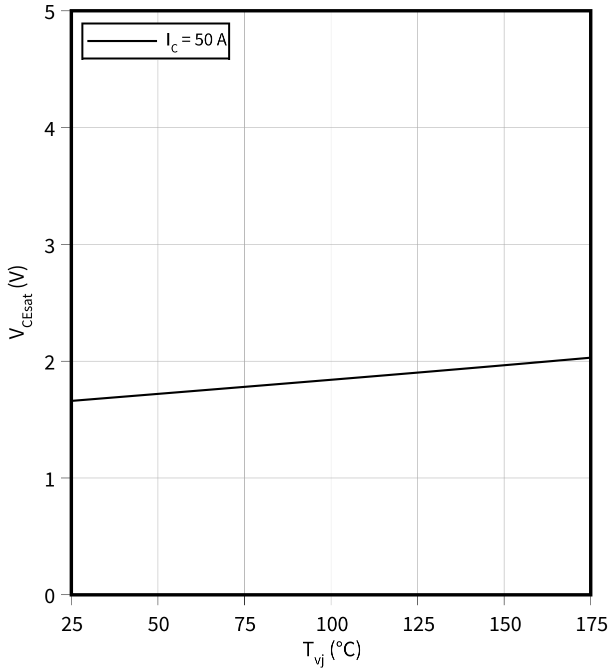
Typical output characteristic
$I_C = f(V_{CE})$
$T_{vj} = 175$ °C



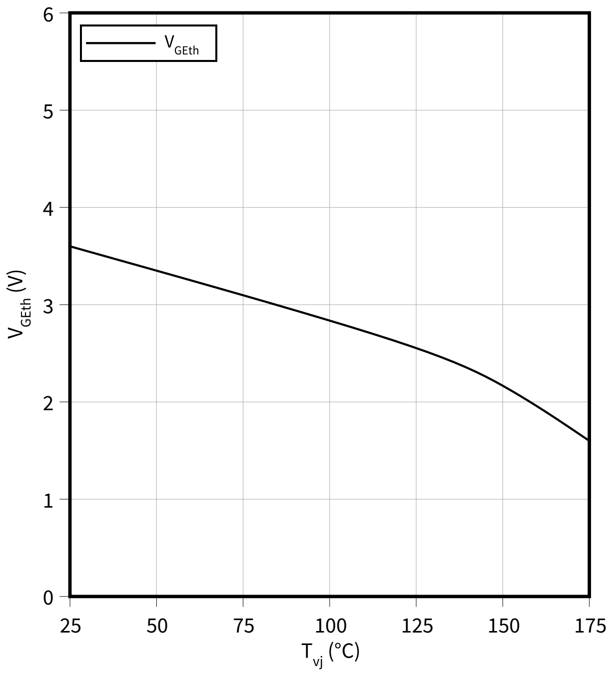
Typical transfer characteristic
$I_C = f(V_{GE})$
$V_{CE} = 20$ V



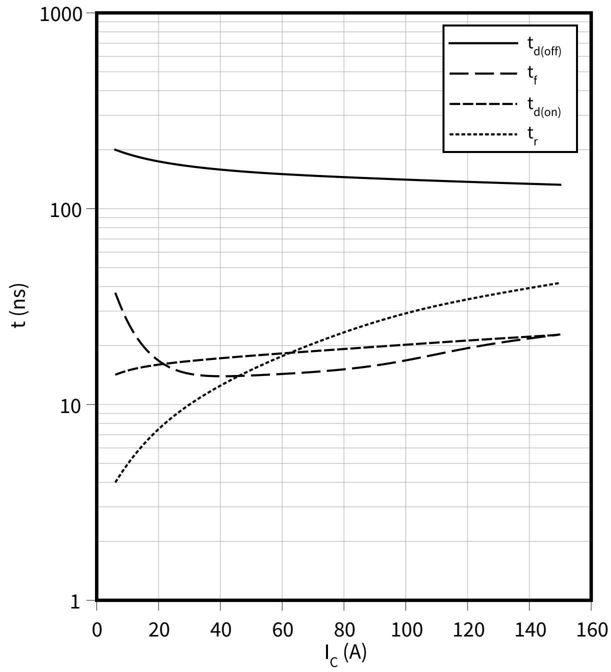
Typical collector-emitter saturation voltage as a function of junction temperature
$V_{CEsat} = f(T_{vj})$
$V_{GE} = 15$ V



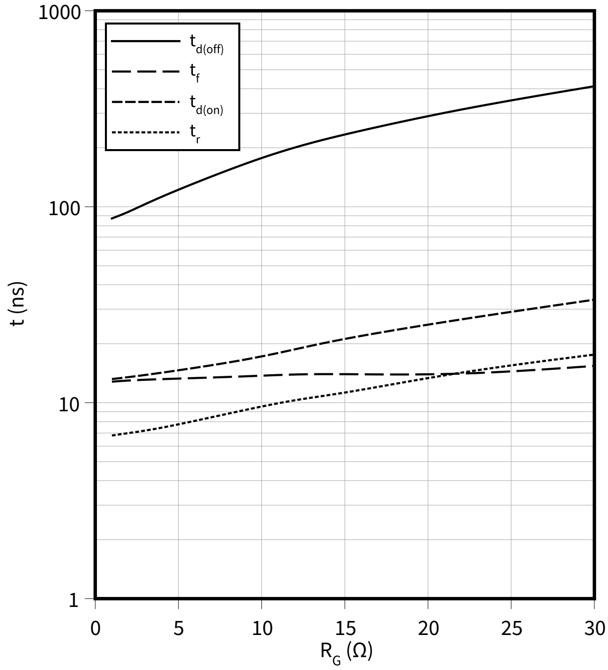
Gate-emitter threshold voltage as a function of junction temperature
$V_{GEth} = f(T_{vj})$
$I_C = 0.5$ mA

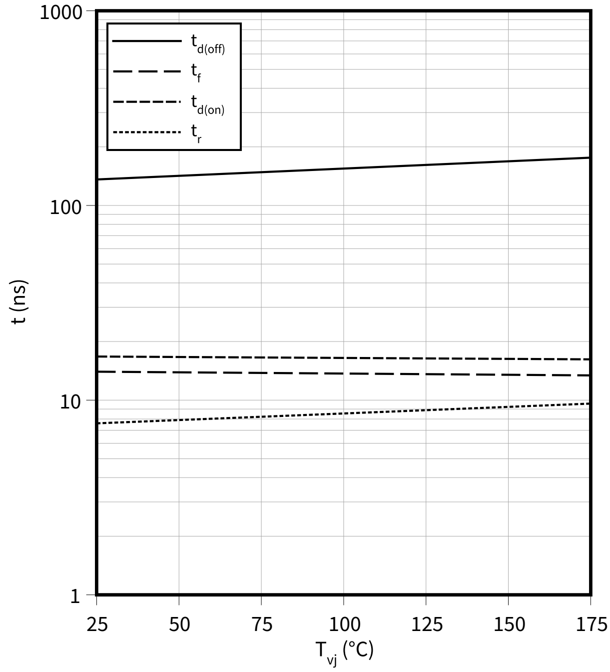


Typical switching times as a function of collector current
$t = f(I_C)$
$V_{CC} = 400$ V, $T_{vj} = 150$ °C, $V_{GE} = 0/15$ V, $R_G = 9\ \Omega$

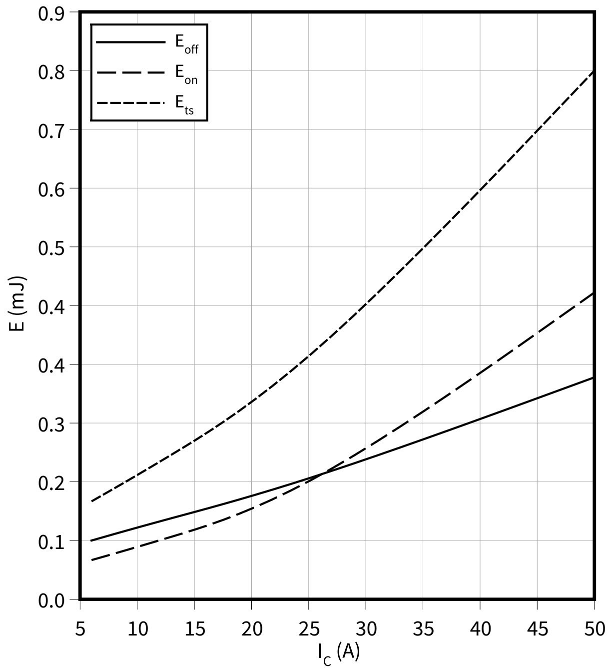


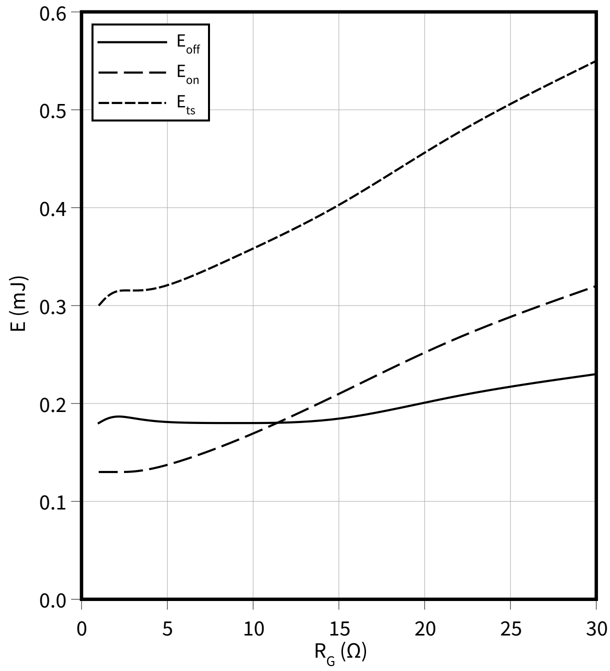
Typical switching times as a function of gate resistor $t = f(R_G)$ I_C = 25 A, V_{CC} = 400 V, T_{vj} = 150 °C, V_{GE} = 0/15 V	**Typical switching times as a function of junction temperature** $t = f(T_{vj})$ I_C = 25 A, V_{CC} = 400 V, V_{GE} = 0/15 V, R_G = 9 Ω





Typical switching energy losses as a function of collector current $E = f(I_C)$ V_{CC} = 400 V, T_{vj} = 150 °C, V_{GE} = 0/15 V, R_G = 9 Ω	**Typical switching energy losses as a function of gate resistor** $E = f(R_G)$ I_C = 25 A, V_{CC} = 400 V, T_{vj} = 150 °C, V_{GE} = 0/15 V

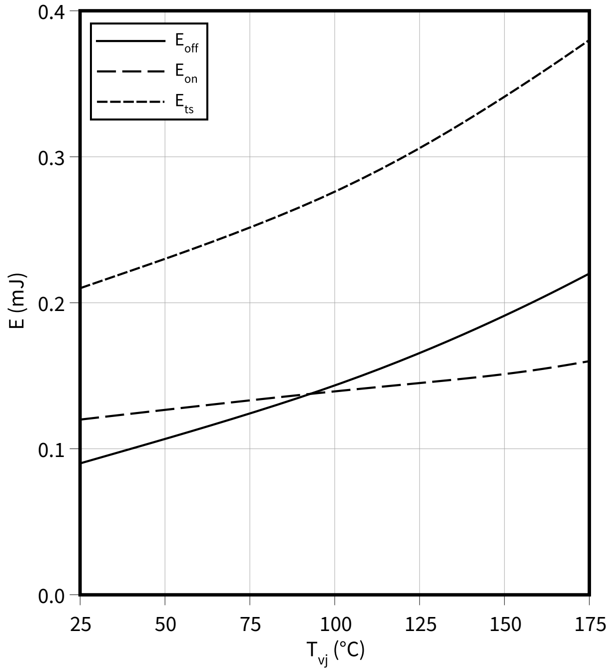




Typical switching energy losses as a function of junction temperature

$E = f(T_{vj})$

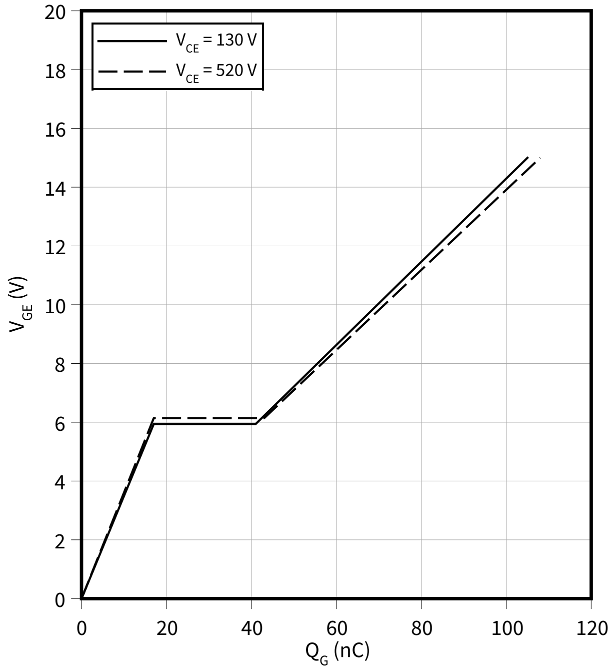
$I_C = 25$ A, $V_{CC} = 400$ V, $V_{GE} = 0/15$ V, $R_G = 9\ \Omega$



Typical gate charge

$V_{GE} = f(Q_G)$

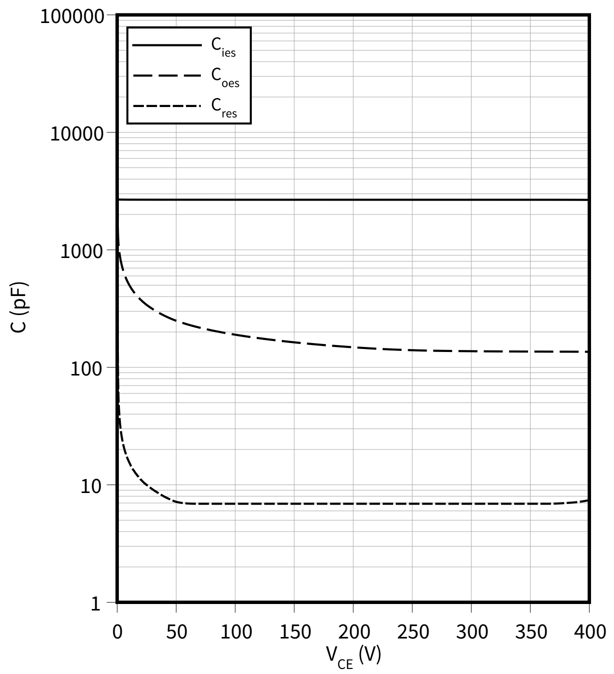
$I_C = 50$ A



Typical capacitance as a function of collector-emitter voltage

$C = f(V_{CE})$

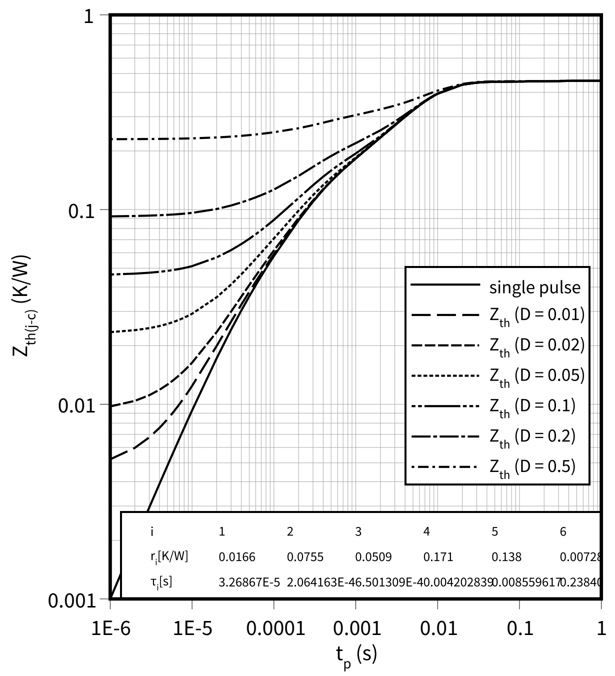
f = 100 kHz, $V_{GE} = 0$ V



IGBT transient thermal impedance as a function of pulse width

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

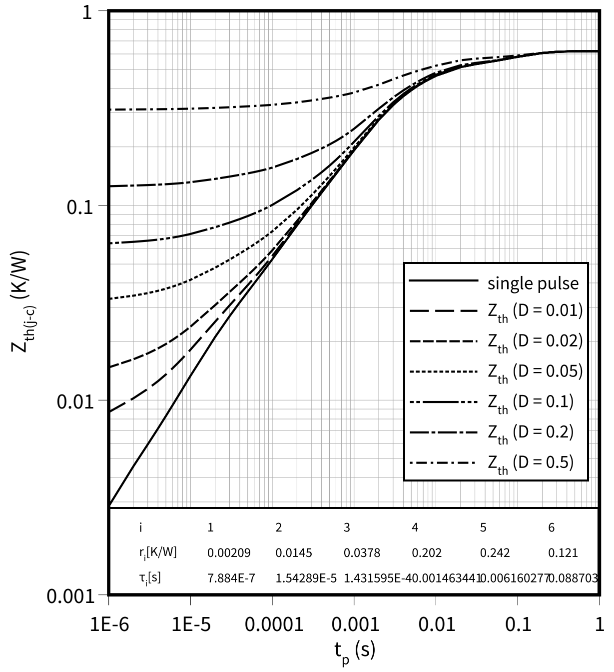
$D = t_p/T$



Diode transient thermal impedance as a function of pulse width

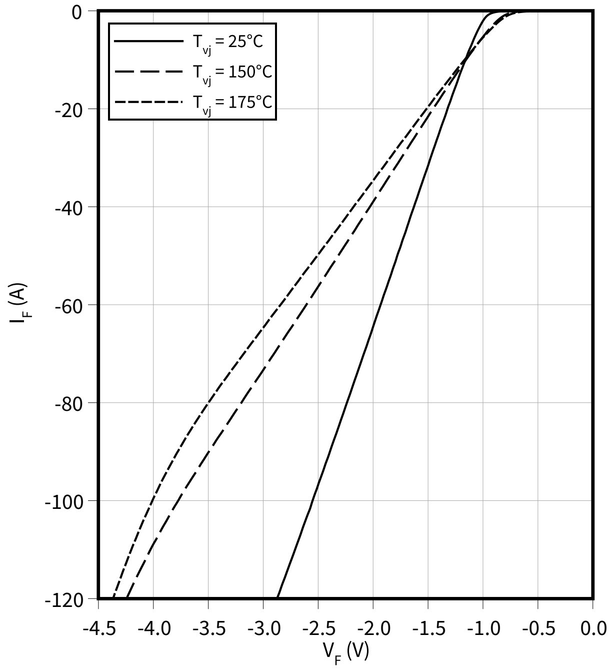
$Z_{th(j-c)} = f(t_p)$

$D = t_p/T$



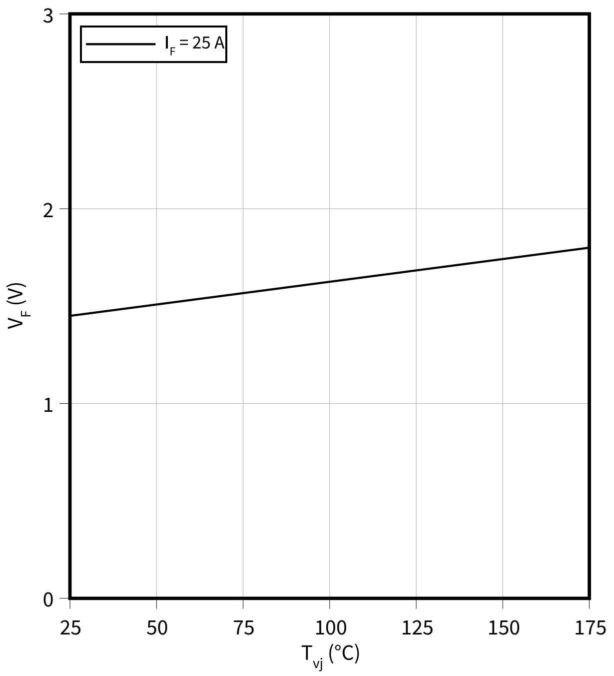
Typical diode forward current as a function of forward voltage

$I_F = f(V_F)$



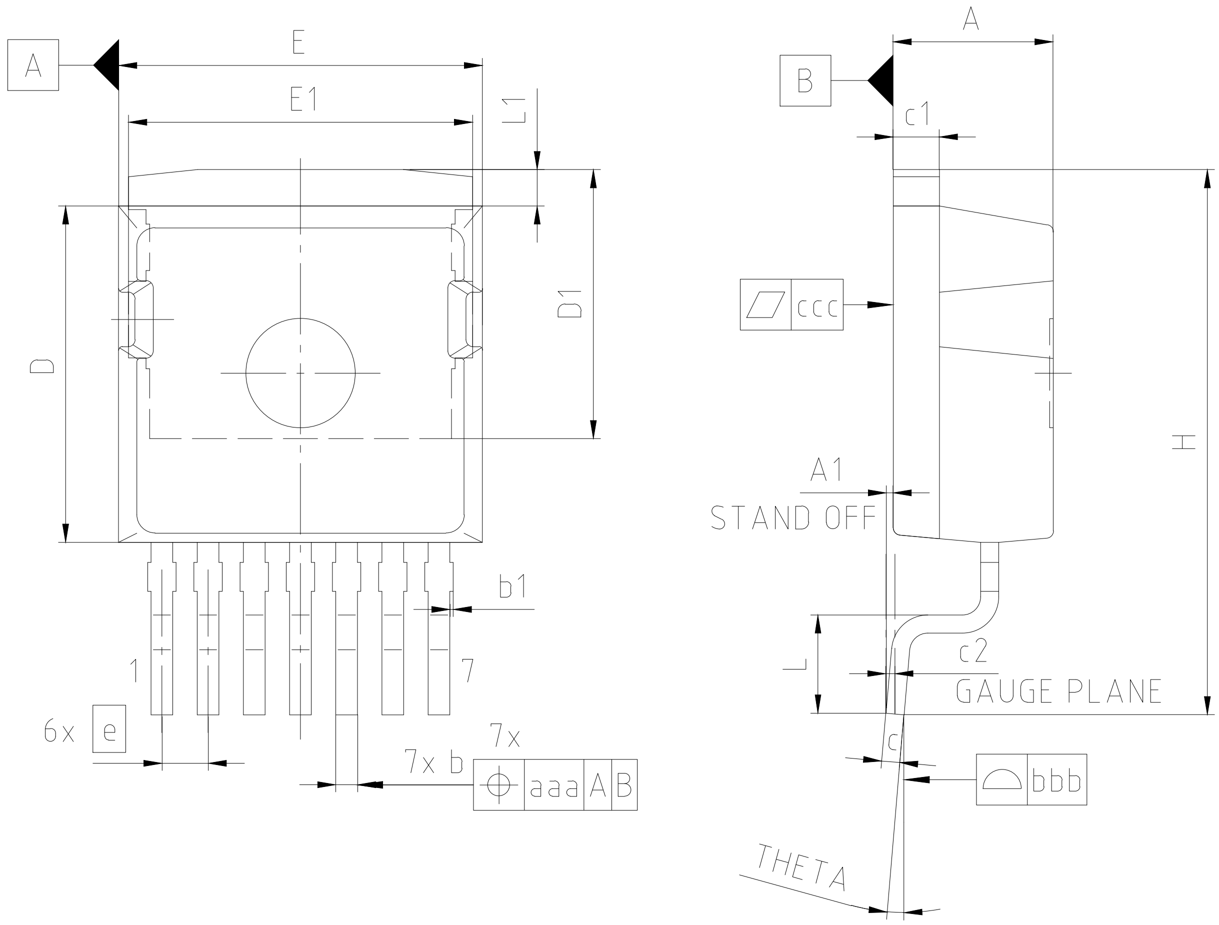
Typical diode forward voltage as a function of junction temperature

$V_F = f(T_{vj})$



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

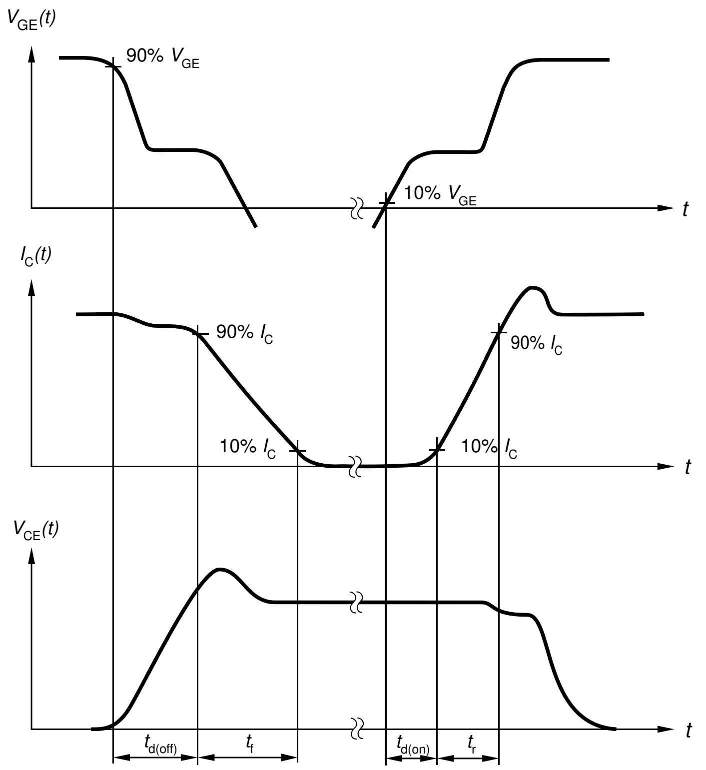


Figure A. **Definition of switching times**

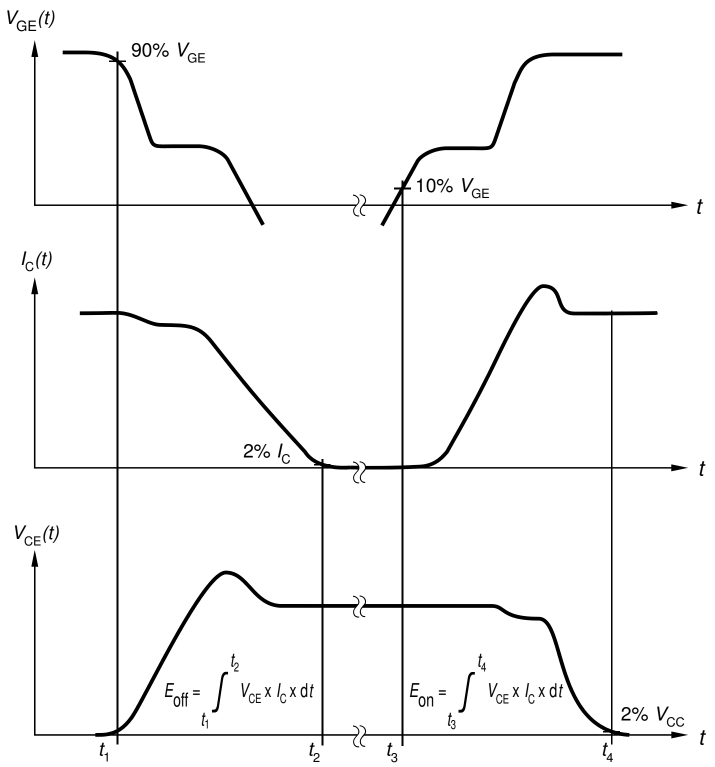


Figure B. **Definition of switching losses**

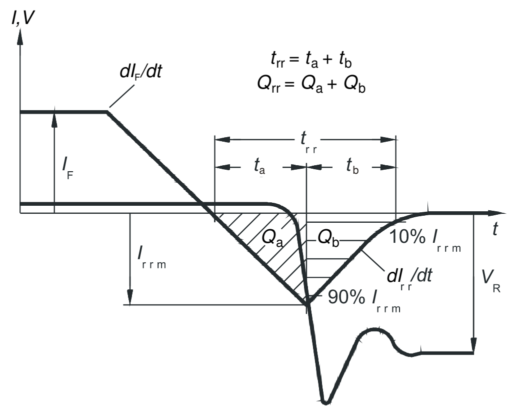


Figure C. **Definition of diode switching characteristics**

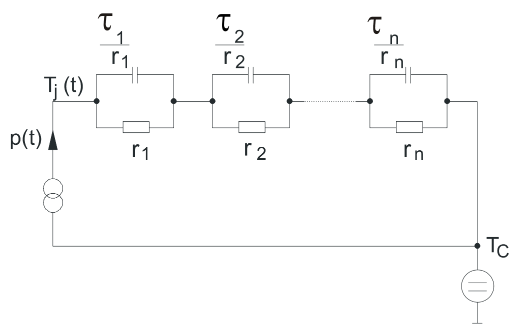


Figure D. **Thermal equivalent circuit**

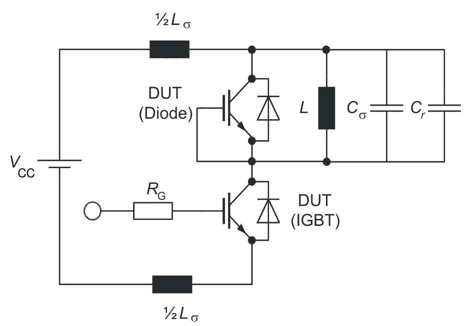


Figure E. **Dynamic test circuit**
Parasitic inductance L_σ,
parasitic capacitor C_σ,
relief capacitor C_r,
(only for ZVT switching)

Figure 2

Revision history

Document revision	Date of release	Description of changes
0.10	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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