CoolSiC™ Hybrid Discrete - TRENCHSTOP™ 5 H5 IGBT co-packed with half-rated 6th generation CoolSiC™ diode

Features

- V_{CE} = 650 V
- I_C = 40 A
- Ultra-low switching losses due to the combination of TRENCHSTOP™ 5 and CoolSiC™ technology
- Benchmark efficiency in hard switching topologies
- Plug-and-play replacement of pure silicon devices
- Maximum junction temperature T_{vjmax} = 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/

Lead-free
Green
Halogen-free
RoHS

Potential applications

- Industrial SMPS
- Industrial UPS
- Solar string inverter
- Energy storage
- Charger

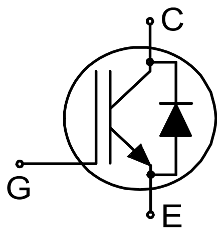
Product validation

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

Description

Package pin definition:

- Pin G - gate
- Pin C & backside - collector
- Pin E - emitter



Type	Package	Marking
IKW40N65RH5	PG-TO247-3	K40ERH5

Table of contents

1 Package

Table 1 Characteristic values

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Internal emitter inductance measured 5 mm (0.197 in.) from case	L_E			13.0		nH
Storage temperature	T_{stg}		-55		150	°C
Soldering temperature		wave soldering 1.6 mm (0.063 in.) from case for 10 s			260	°C
Mounting torque	M	M3 screw Maximum of mounting process: 3			0.6	Nm
Thermal resistance, junction-ambient	$R_{th(j-a)}$				40	K/W

2 IGBT

Table 2 Maximum rated values

Parameter	Symbol	Note or test condition		Values	Unit
Collector-emitter voltage	V_{CE}	$T_{vj} \geq 25$ °C		650	V
DC collector current, limited by T_{vjmax}	I_C		$T_c = 25$ °C	74	A
			$T_c = 100$ °C	46	
Pulsed collector current, t_p limited by T_{vjmax}	I_{Cpulse}			160	A
Turn-off safe operating area		$V_{CE} \leq 650$ V, $t_p = 1$ μs, $T_{vj} \leq 175$ °C		160	A
Gate-emitter voltage	V_{GE}			±20	V
Transient gate-emitter voltage	V_{GE}	$t_p \leq 10$ μs, $D < 0.01$		±30	V
Power dissipation	P_{tot}		$T_c = 25$ °C	250	W
			$T_c = 100$ °C	125	

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		1.65	2.1	V
			$T_{vj} = 125$ °C		1.85		
			$T_{vj} = 175$ °C		1.95		
Gate-emitter threshold voltage	V_{GEth}	$I_C = 0.4$ 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			600	µA
			T_{vj} = 175 °C		2000		
Zero gate-voltage collector current	I_{CES}	V_{CE} = 480 V, V_{GE} = 0 V	T_{vj} = 25 °C			16	µA
Gate-emitter leakage current	I_{GES}	V_{CE} = 0 V, V_{GE} = 20 V				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 = 250 kHz			2190		pF
Output capacitance	C_{oes}	V_{CE} = 25 V, V_{GE} = 0 V, f = 250 kHz			265		pF
Reverse transfer capacitance	C_{res}	V_{CE} = 25 V, V_{GE} = 0 V, f = 250 kHz			8		pF
Gate charge	Q_G	I_C = 40 A, V_{GE} = 15 V, V_{CC} = 520 V			95		nC
Turn-on delay time	$t_{d(on)}$	V_{CC} = 400 V, V_{GE} = 15 V, R_{Gon} = 15 Ω, R_{Goff} = 15 Ω, L_σ = 30 nH, C_σ = 30 pF	T_{vj} = 25 °C, I_C = 20 A		18		ns
			T_{vj} = 25 °C, I_C = 5 A		17		
			T_{vj} = 150 °C, I_C = 20 A		18		
			T_{vj} = 150 °C, I_C = 5 A		17		
Rise time (inductive load)	t_r	V_{CC} = 400 V, V_{GE} = 15 V, R_{Gon} = 15 Ω, R_{Goff} = 15 Ω, L_σ = 30 nH, C_σ = 30 pF	T_{vj} = 25 °C, I_C = 20 A		8		ns
			T_{vj} = 25 °C, I_C = 5 A		4		
			T_{vj} = 150 °C, I_C = 20 A		9		
			T_{vj} = 150 °C, I_C = 5 A		4		
Turn-off delay time	$t_{d(off)}$	V_{CC} = 400 V, V_{GE} = 15 V, R_{Gon} = 15 Ω, R_{Goff} = 15 Ω, L_σ = 30 nH, C_σ = 30 pF	T_{vj} = 25 °C, I_C = 20 A		165		ns
			T_{vj} = 25 °C, I_C = 5 A		190		
			T_{vj} = 150 °C, I_C = 20 A		195		
			T_{vj} = 150 °C, I_C = 5 A		240		

(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} = 15 V, R_{Gon} = 15 Ω, R_{Goff} = 15 Ω, $L_σ$ = 30 nH, $C_σ$ = 30 pF	T_{vj} = 25 °C, I_C = 20 A		13		ns
			T_{vj} = 25 °C, I_C = 5 A		25		
			T_{vj} = 150 °C, I_C = 20 A		22		
			T_{vj} = 150 °C, I_C = 5 A		35		
Turn-on energy	E_{on}	V_{CC} = 400 V, V_{GE} = 15 V, R_{Gon} = 15 Ω, R_{Goff} = 15 Ω, $L_σ$ = 30 nH, $C_σ$ = 30 pF	T_{vj} = 25 °C, I_C = 20 A		0.16		mJ
			T_{vj} = 25 °C, I_C = 5 A		0.03		
			T_{vj} = 150 °C, I_C = 20 A		0.18		
			T_{vj} = 150 °C, I_C = 5 A		0.05		
Turn-off energy	E_{off}	V_{CC} = 400 V, V_{GE} = 15 V, R_{Gon} = 15 Ω, R_{Goff} = 15 Ω, $L_σ$ = 30 nH, $C_σ$ = 30 pF	T_{vj} = 25 °C, I_C = 20 A		0.12		mJ
			T_{vj} = 25 °C, I_C = 5 A		0.05		
			T_{vj} = 150 °C, I_C = 20 A		0.22		
			T_{vj} = 150 °C, I_C = 5 A		0.07		
Total switching energy	E_{ts}	V_{CC} = 400 V, V_{GE} = 15 V, R_{Gon} = 15 Ω, R_{Goff} = 15 Ω, $L_σ$ = 30 nH, $C_σ$ = 30 pF	T_{vj} = 25 °C, I_C = 20 A		0.28		mJ
			T_{vj} = 25 °C, I_C = 5 A		0.08		
			T_{vj} = 150 °C, I_C = 20 A		0.4		
			T_{vj} = 150 °C, I_C = 5 A		0.12		
IGBT thermal resistance, junction-case	$R_{th(j-c)}$					0.6	K/W
Operating junction temperature	T_{vj}			-40		175	°C

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	27.5	A
			$T_c = 100$ °C	18.5	
Diode pulsed current, t_p limited by T_{vjmax} [1)]	I_{Fpulse}			60	A

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

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		1.35	1.5	V
			$T_{vj} = 125$ °C		1.55		
			$T_{vj} = 175$ °C		1.65		
Diode thermal resistance, junction-case	$R_{th(j-c)}$					1.8	K/W
Operating junction temperature	T_{vj}			-40		175	°C

Note: *For optimum lifetime and reliability, Infineon recommends operating conditions that do not exceed 80% of the maximum ratings stated in this datasheet.*

Electrical Characteristic at T_{vj} = 25°C, unless otherwise specified.

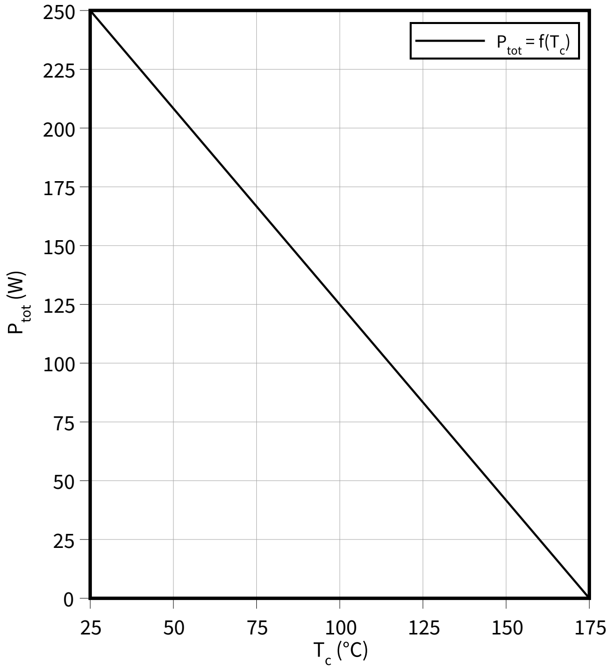
Dynamic test circuit, parasitic inductance L_σ, parasitic capacitor C_σ from Fig. E. Energy losses include “tail” and diode reverse recovery.

4 Characteristics diagrams

Power dissipation as a function of case temperature

$P_{tot} = f(T_c)$

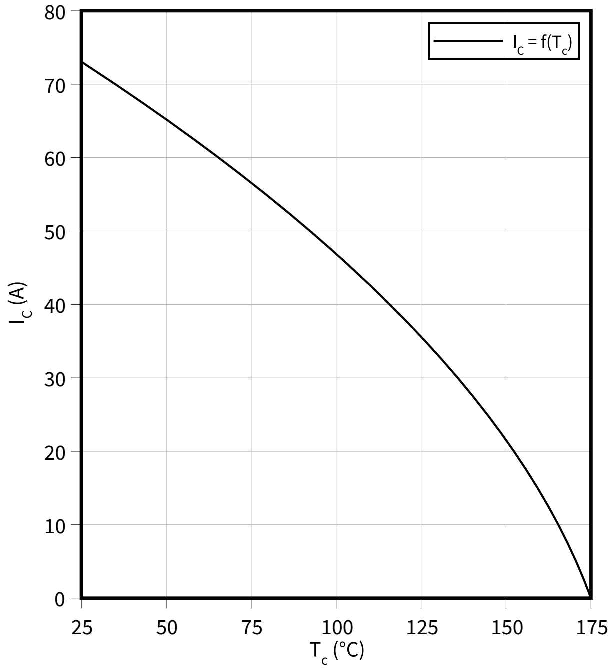
$T_{vj} \leq 175\ °C$



Collector current as a function of case temperature

$I_C = f(T_c)$

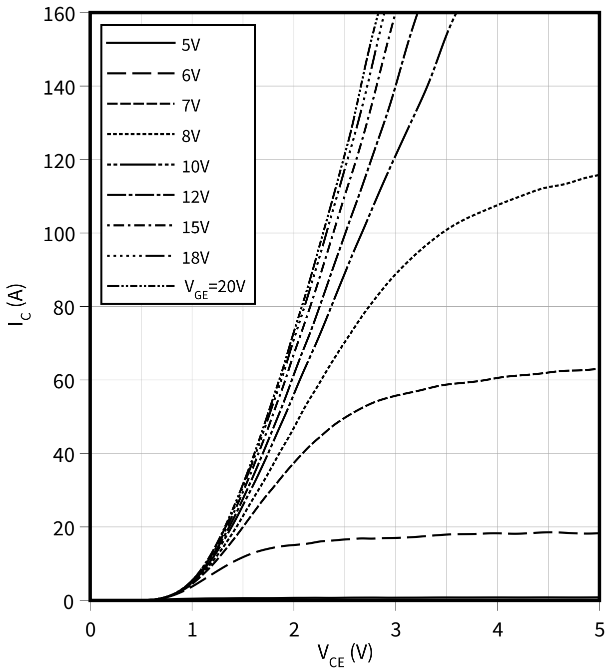
$T_{vj} \leq 175\ °C$, $V_{GE} \geq 15\ V$



Typical output characteristic

$I_C = f(V_{CE})$

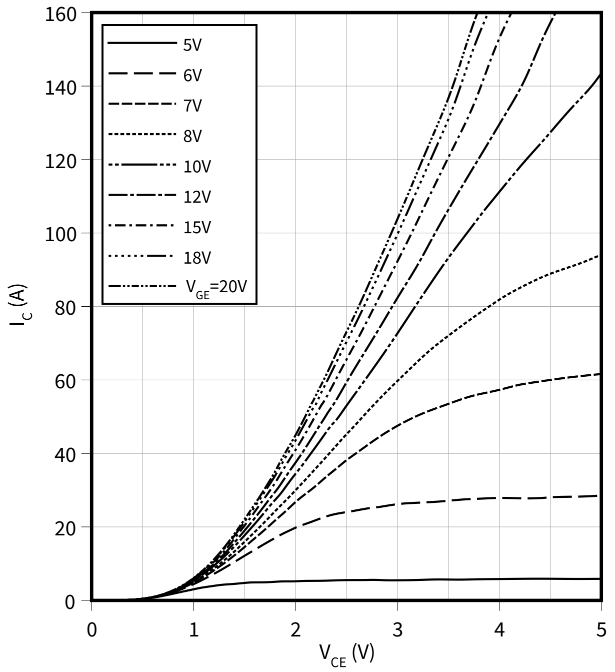
$T_{vj} = 25\ °C$



Typical output characteristic

$I_C = f(V_{CE})$

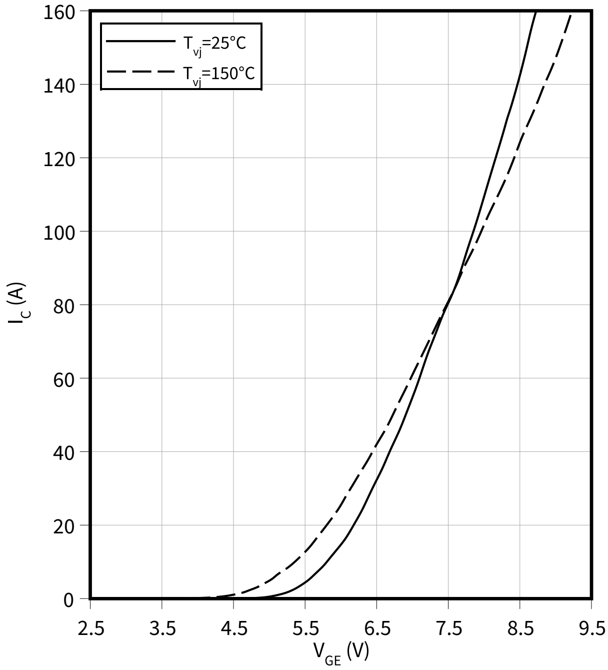
$T_{vj} = 150\ °C$



Typical transfer characteristic

$I_C = f(V_{GE})$

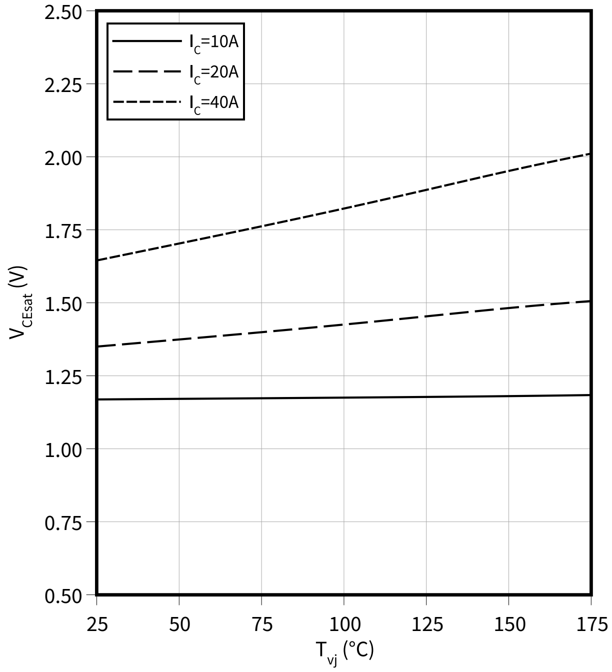
$V_{CE} = 20$ V



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

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

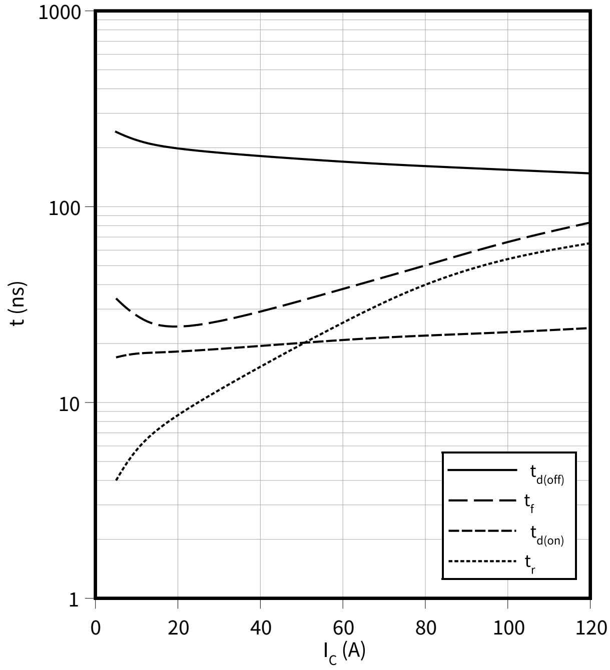
$V_{GE} = 15$ V



Typical switching times as a function of collector current

$t = f(I_C)$

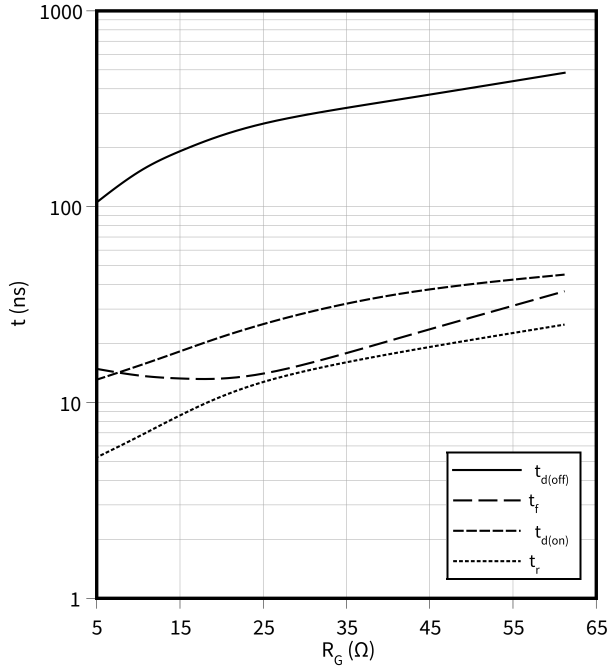
$V_{CC} = 400$ V, $T_{vj} = 150$ °C, $V_{GE} = 0/15$ V, $R_G = 15\ \Omega$



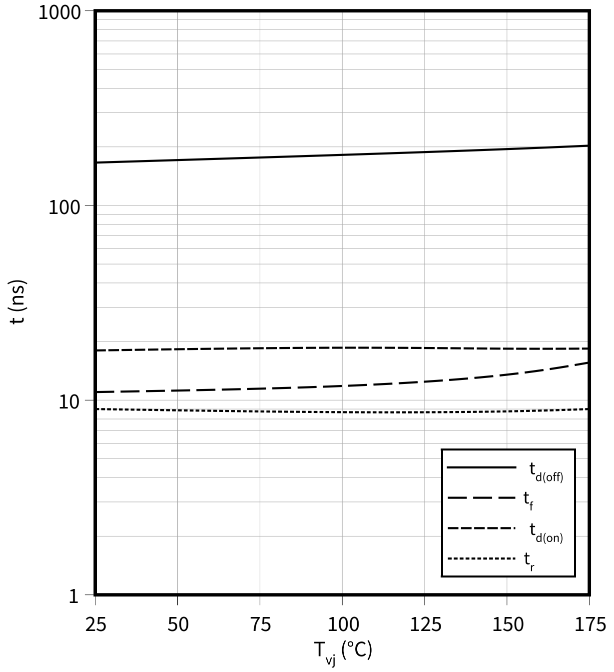
Typical switching times as a function of gate resistor

$t = f(R_G)$

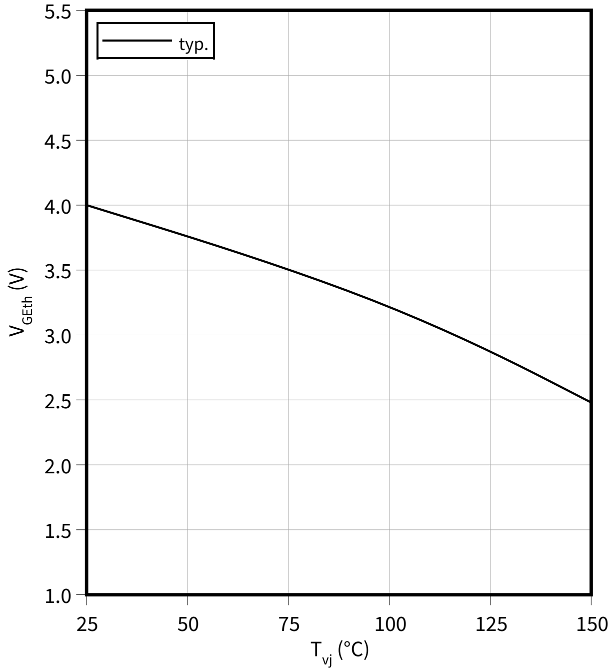
$I_C = 20$ A, $V_{CC} = 400$ V, $T_{vj} = 150$ °C, $V_{GE} = 0/15$ V



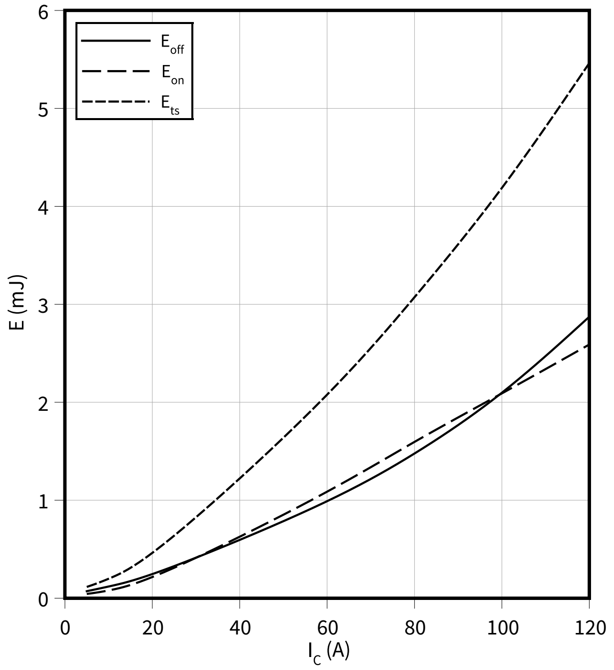
Typical switching times as a function of junction temperature
$t = f(T_{vj})$
$I_C = 20$ A, $V_{CC} = 400$ V, $V_{GE} = 0/15$ V, $R_G = 15\ \Omega$



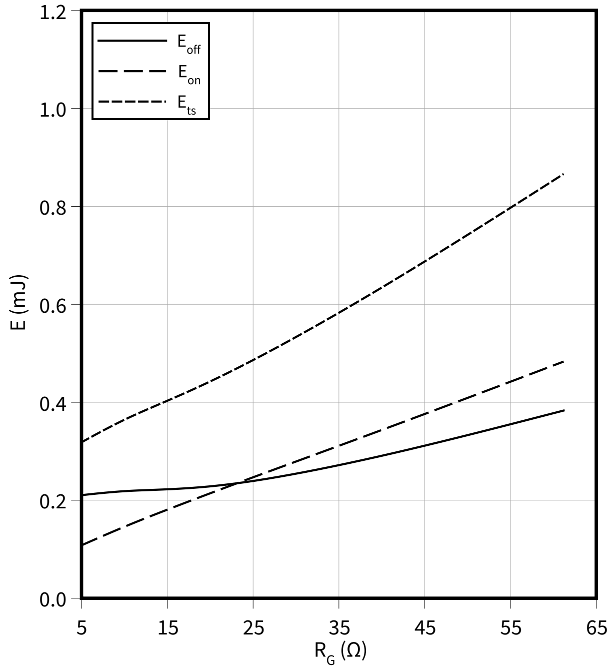
Gate-emitter threshold voltage as a function of junction temperature
$V_{GEth} = f(T_{vj})$
$I_C = 0.4$ mA



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, $R_G = 15\ \Omega$



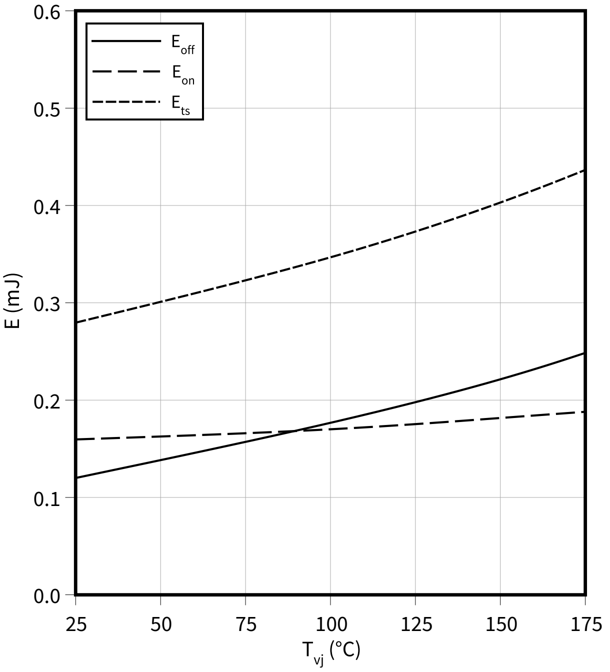
Typical switching energy losses as a function of gate resistor
$E = f(R_G)$
$I_C = 20$ A, $V_{CC} = 400$ V, $T_{vj} = 150$ °C, $V_{GE} = 0/15$ V



Typical switching energy losses as a function of junction temperature

$E = f(T_{vj})$

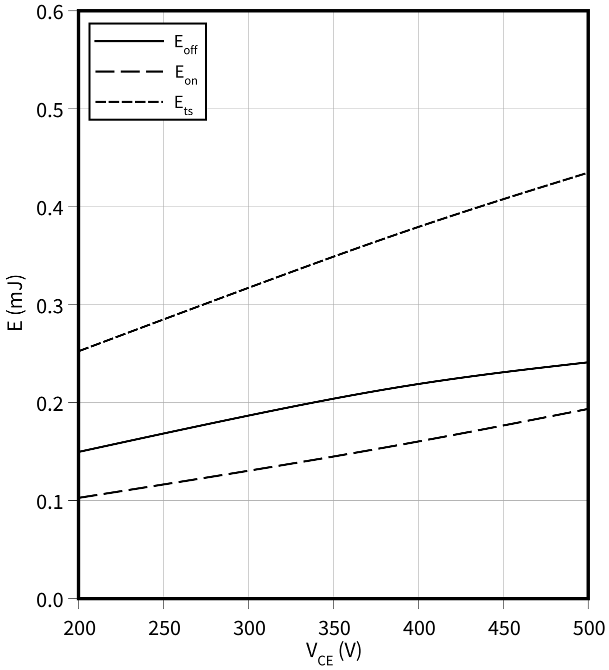
$I_C = 20$ A, $V_{CC} = 400$ V, $V_{GE} = 0/15$ V, $R_G = 15\ \Omega$



Typical switching energy losses as a function of collector emitter voltage

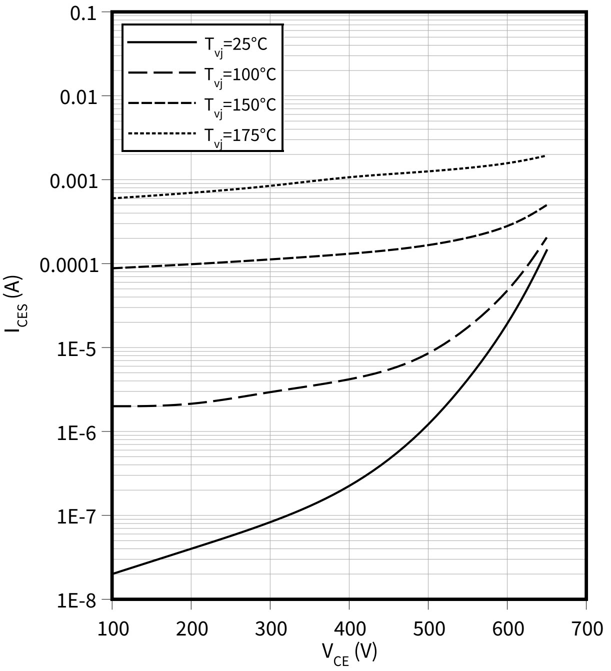
$E = f(V_{CE})$

$I_C = 20$ A, $V_{GE} = 0/15$ V, $T_{vj} = 150$ °C, $R_G = 15\ \Omega$



Typ. reverse current vs. reverse voltage as a function of Tvj

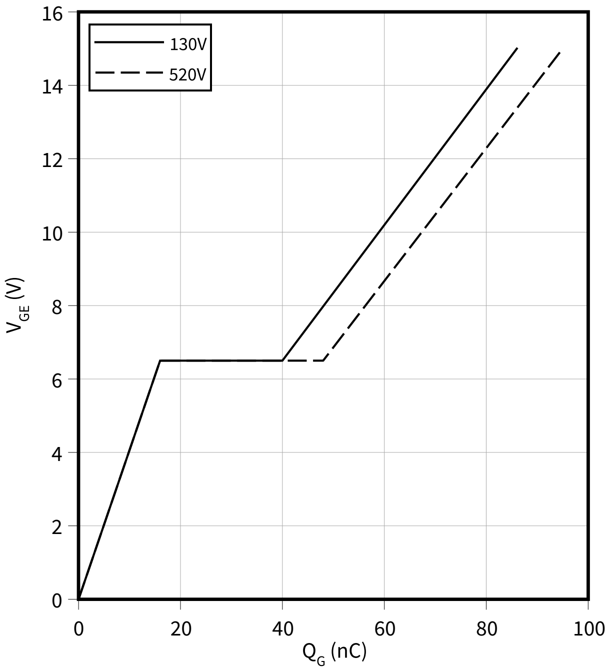
$I_{CES} = f(V_{CE})$



Typical gate charge

$V_{GE} = f(Q_G)$

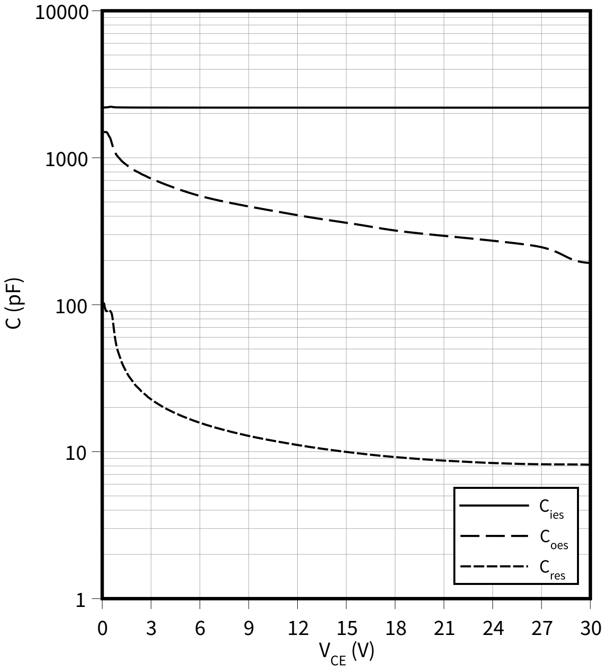
$I_C = 40$ A



Typical capacitance as a function of collector-emitter voltage

$C = f(V_{CE})$

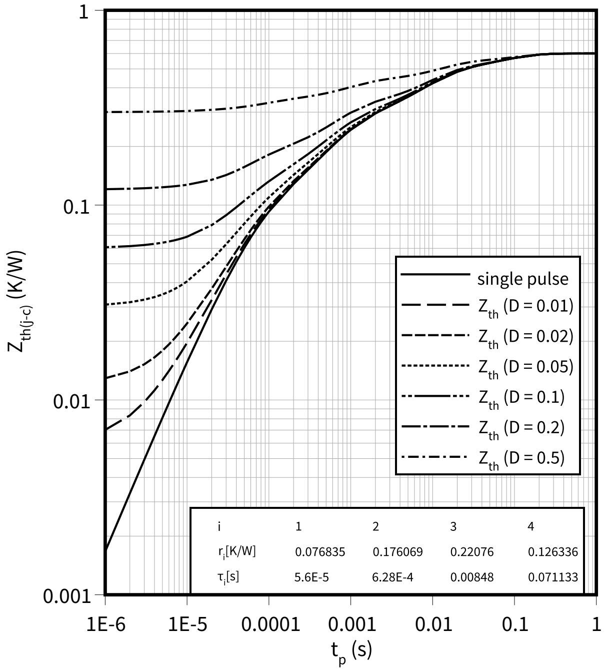
$f = 250\ \text{kHz}, V_{GE} = 0\ \text{V}$



IGBT transient thermal impedance as a function of pulse width

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

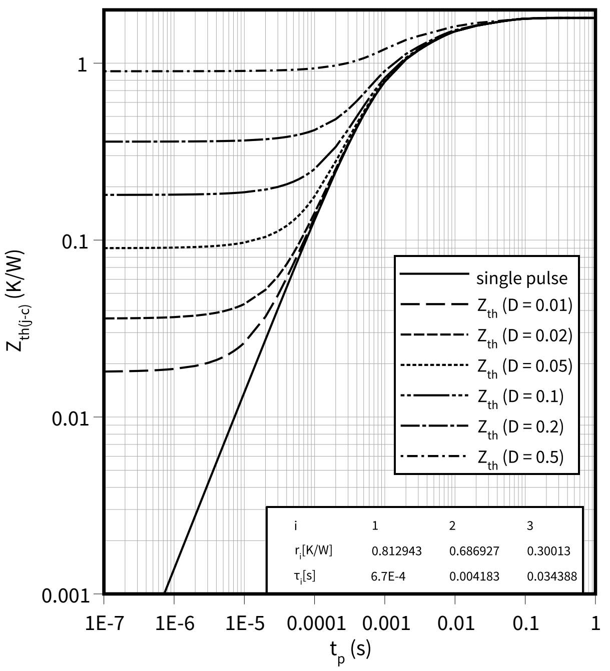
$D = t_p/T$



Diode transient thermal impedance as a function of pulse width

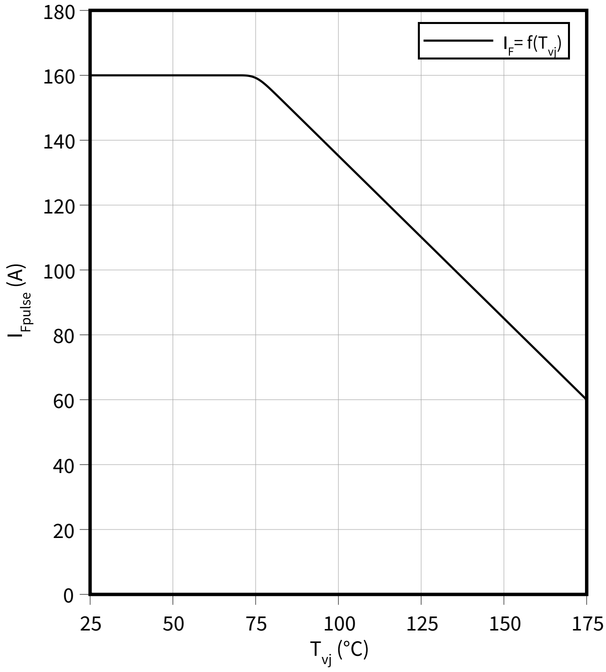
$Z_{th(j-c)} = f(t_p)$

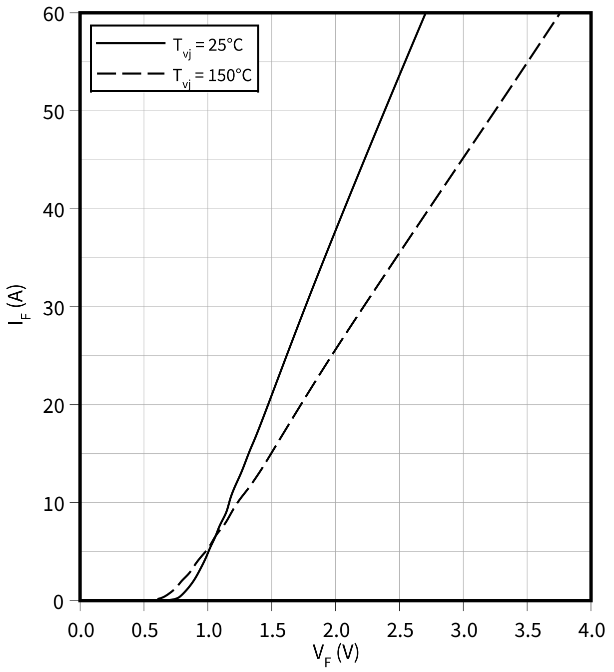
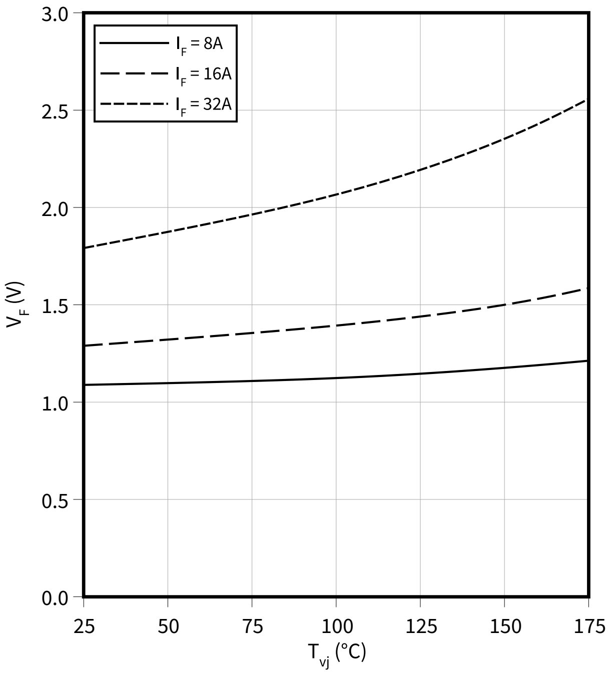
$D = t_p/T$



Maximum pulse current as a function of junction temperature

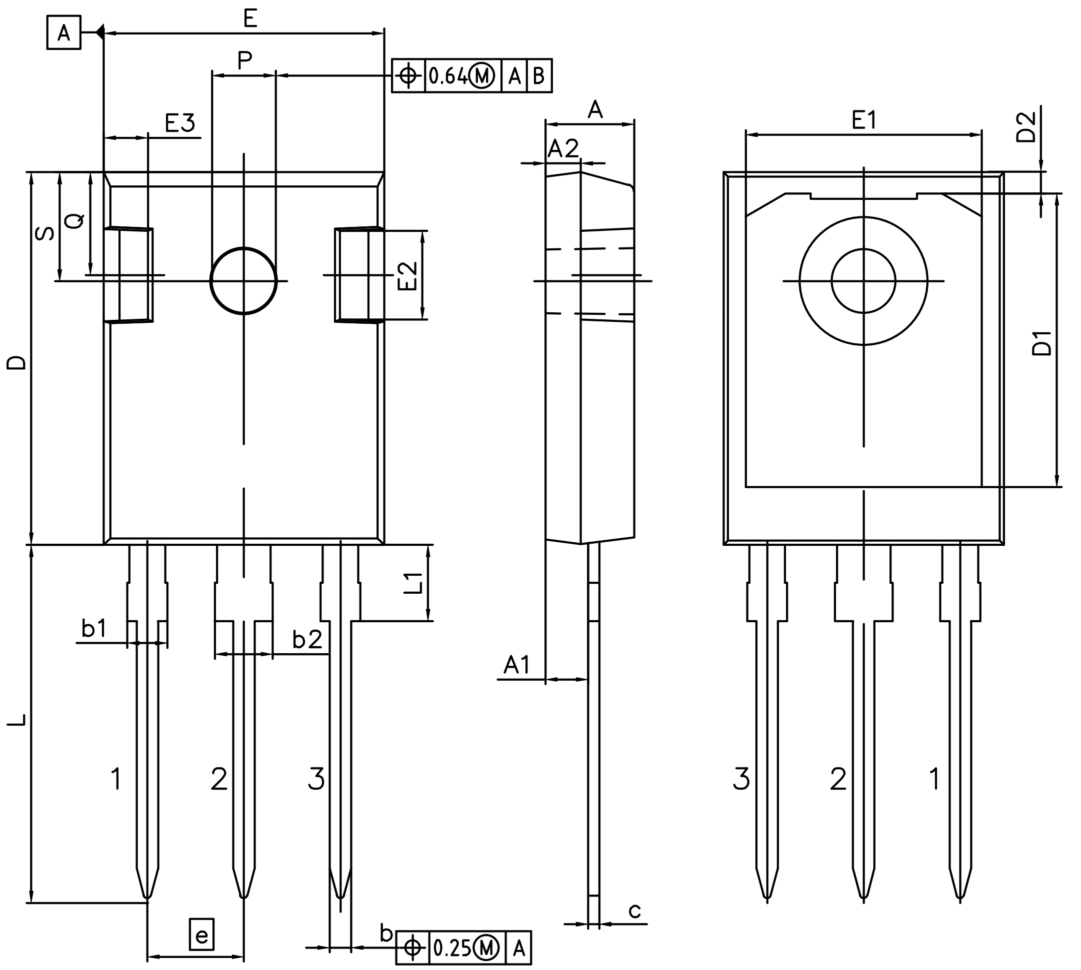
$I_{Fpulse} = f(T_{vj})$



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

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

DOCUMENT NO.
Z8B00003327

REVISION
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SCALE 3:1
0 1 2 3 4 5mm

EUROPEAN PROJECTION

ISSUE DATE
25.07.2018

Figure 1

6 Testing conditions

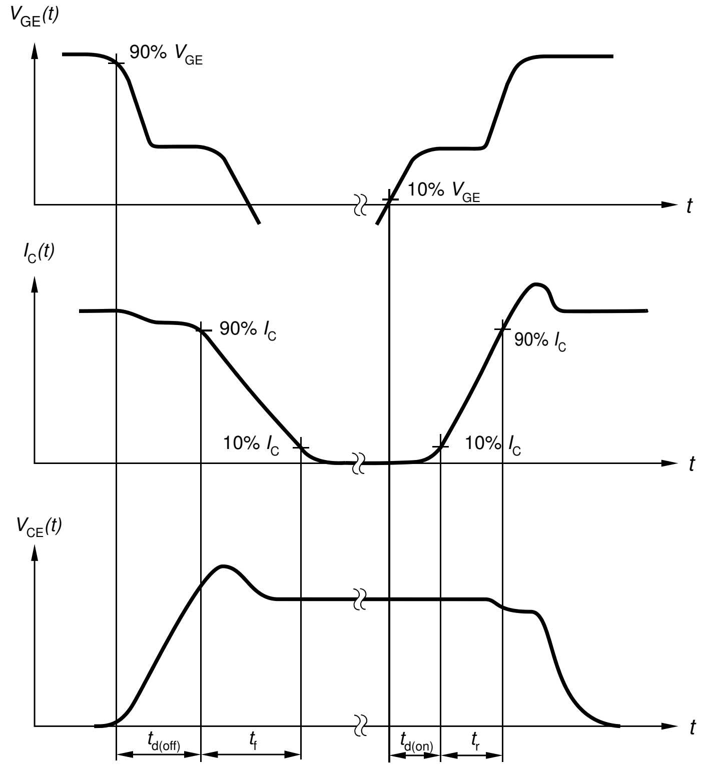

Figure A. **Definition of switching times**

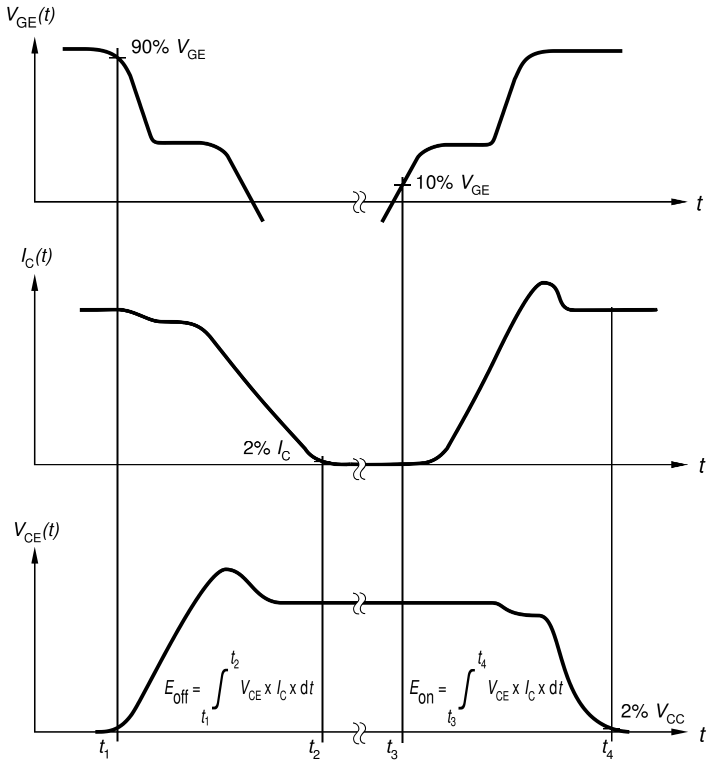

Figure B. **Definition of switching losses**

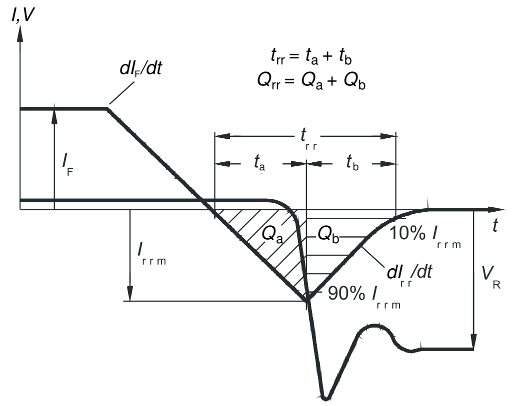

Figure C. **Definition of diode switching characteristics**

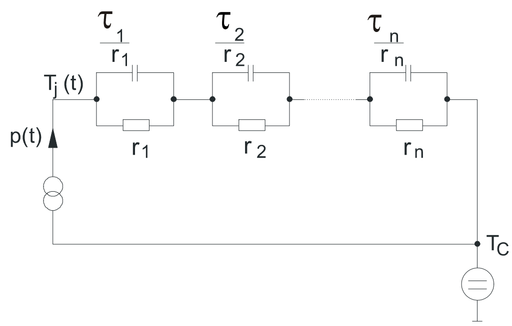

Figure D. **Thermal equivalent circuit**

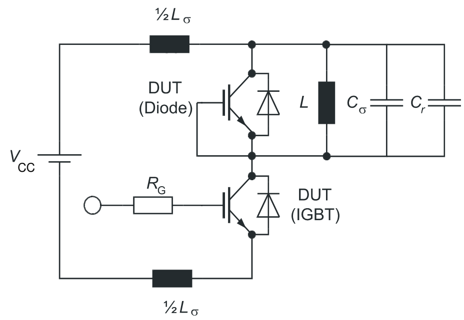

Figure E. **Dynamic test circuit**
Parasitic inductance L_σ,
parasitic capacitor C_σ,
relief capacitor C_r,
(only for ZVT switching)

Figure 2

Revision history

Document revision	Date of release	Description of changes
V1.1	2020-03-20	Preliminary data sheet
V2.1	2020-07-27	Final Data Sheet
n/a	2020-11-30	Datasheet migrated to a new system with a new layout and new revision number schema: target or preliminary datasheet = 0.xy; final datasheet = 1.xy
1.10	2022-09-22	Rename of product family name from “Hybrid CoolSiC™ IGBT” to “CoolSiC™ hybrid discrete”

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Edition 2022-09-22

Published by

Infineon Technologies AG

81726 Munich, Germany

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Document reference
IFX-AAL362-003