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

## Features


- $V_{CE}$ = 650 V
- $I_C$ = 50 A
- Ultra-low switching losses due to the combination of TRENCHSTOP™ 5 and CoolSiC™ technology as well as the Kelvin emitter pin
- Benchmark efficiency in hard switching topologies
- Plug-and-play replacement of pure silicon devices
- Simplified PCB design due to the optimized pin-out of the four-pin package
- Improved wave soldering quality due to the increased clearance of the Kelvin emitter and gate pins
- 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

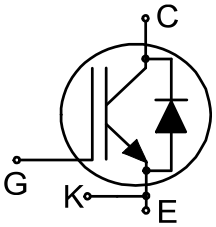
## Product validation

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

## Description

Package pin definition:

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




| Type | Package | Marking |
|---|---|---|
| IKZA50N65RH5 | PG-TO247-4-3 | K50ERH5 |

# 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 | | 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 $T_{vjmax}$ | $I_C$ | limited by bondwire | $T_c = 25$ °C | 80 | A |
| | | | $T_c = 100$ °C | 56 | |
| Pulsed collector current, $t_p$ limited by $T_{vjmax}$ | $I_{Cpulse}$ | | | 200 | A |
| Turn-off safe operating area | | $V_{CE} \leq 650$ V, $t_p = 1$ µs, $T_{vj} \leq 175$ °C | | 200 | 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 | 305 | W |
| | | | $T_c = 100$ °C | 152.5 | |

**Table 3 Characteristic values**

| Parameter | Symbol | Note or test condition | | Values | | | Unit |
|---|---|---|---|---|---|---|---|
| | | | | Min. | Typ. | Max. | |
| Collector-emitter saturation voltage | $V_{CEsat}$ | $I_C = 50$ 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 | $V_{GEth}$ | $I_C = 0.5$ 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 | | | 700 | 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 | | | 25 | µA |
| Gate-emitter leakage current | $I_{GES}$ | $V_{CE}$ = 0 V, $V_{GE}$ = 20 V | | | | 100 | nA |
| 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, $f$ = 250 kHz | | | 2660 | | pF |
| Output capacitance | $C_{oes}$ | $V_{CE}$ = 25 V, $V_{GE}$ = 0 V, $f$ = 250 kHz | | | 320 | | pF |
| Reverse transfer capacitance | $C_{res}$ | $V_{CE}$ = 25 V, $V_{GE}$ = 0 V, $f$ = 250 kHz | | | 10 | | pF |
| Gate charge | $Q_G$ | $I_C$ = 50 A, $V_{GE}$ = 15 V, $V_{CC}$ = 520 V | | | 120 | | nC |
| Turn-on delay time | $t_{d(on)}$ | $V_{CC}$ = 400 V, $V_{GE}$ = 0/15 V, $R_{Gon}$ = 12 Ω, $R_{Goff}$ = 12 Ω, $L_\sigma$ = 30 nH, $C_\sigma$ = 30 pF | $T_{vj}$ = 25 °C, $I_C$ = 25 A | | 21 | | ns |
| | | | $T_{vj}$ = 25 °C, $I_C$ = 5 A | | 19 | | |
| | | | $T_{vj}$ = 150 °C, $I_C$ = 25 A | | 20 | | |
| | | | $T_{vj}$ = 150 °C, $I_C$ = 5 A | | 18 | | |
| Rise time (inductive load) | $t_r$ | $V_{CC}$ = 400 V, $V_{GE}$ = 0/15 V, $R_{Gon}$ = 12 Ω, $R_{Goff}$ = 12 Ω, $L_\sigma$ = 30 nH, $C_\sigma$ = 30 pF | $T_{vj}$ = 25 °C, $I_C$ = 25 A | | 6 | | ns |
| | | | $T_{vj}$ = 25 °C, $I_C$ = 5 A | | 3 | | |
| | | | $T_{vj}$ = 150 °C, $I_C$ = 25 A | | 7 | | |
| | | | $T_{vj}$ = 150 °C, $I_C$ = 5 A | | 3 | | |
| Turn-off delay time | $t_{d(off)}$ | $V_{CC}$ = 400 V, $V_{GE}$ = 0/15 V, $R_{Gon}$ = 12 Ω, $R_{Goff}$ = 12 Ω, $L_\sigma$ = 30 nH, $C_\sigma$ = 30 pF | $T_{vj}$ = 25 °C, $I_C$ = 25 A | | 180 | | ns |
| | | | $T_{vj}$ = 25 °C, $I_C$ = 5 A | | 200 | | |
| | | | $T_{vj}$ = 150 °C, $I_C$ = 25 A | | 200 | | |
| | | | $T_{vj}$ = 150 °C, $I_C$ = 5 A | | 250 | | |

**(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, $R_{Gon}$ = 12 Ω, $R_{Goff}$ = 12 Ω, $L_\sigma$ = 30 nH, $C_\sigma$ = 30 pF | $T_{vj}$ = 25 °C, $I_C$ = 25 A | | 18 | | ns |
| | | | $T_{vj}$ = 25 °C, $I_C$ = 5 A | | 25 | | |
| | | | $T_{vj}$ = 150 °C, $I_C$ = 25 A | | 25 | | |
| | | | $T_{vj}$ = 150 °C, $I_C$ = 5 A | | 35 | | |
| Turn-on energy | $E_{on}$ | $V_{CC}$ = 400 V, $V_{GE}$ = 0/15 V, $R_{Gon}$ = 12 Ω, $R_{Goff}$ = 12 Ω, $L_\sigma$ = 30 nH, $C_\sigma$ = 30 pF | $T_{vj}$ = 25 °C, $I_C$ = 25 A | | 0.2 | | mJ |
| | | | $T_{vj}$ = 25 °C, $I_C$ = 5 A | | 0.05 | | |
| | | | $T_{vj}$ = 150 °C, $I_C$ = 25 A | | 0.27 | | |
| | | | $T_{vj}$ = 150 °C, $I_C$ = 5 A | | 0.08 | | |
| Turn-off energy | $E_{off}$ | $V_{CC}$ = 400 V, $V_{GE}$ = 0/15 V, $R_{Gon}$ = 12 Ω, $R_{Goff}$ = 12 Ω, $L_\sigma$ = 30 nH, $C_\sigma$ = 30 pF | $T_{vj}$ = 25 °C, $I_C$ = 25 A | | 0.18 | | mJ |
| | | | $T_{vj}$ = 25 °C, $I_C$ = 5 A | | 0.05 | | |
| | | | $T_{vj}$ = 150 °C, $I_C$ = 25 A | | 0.27 | | |
| | | | $T_{vj}$ = 150 °C, $I_C$ = 5 A | | 0.08 | | |
| Total switching energy | $E_{ts}$ | $V_{CC}$ = 400 V, $V_{GE}$ = 0/15 V, $R_{Gon}$ = 12 Ω, $R_{Goff}$ = 12 Ω, $L_\sigma$ = 30 nH, $C_\sigma$ = 30 pF | $T_{vj}$ = 25 °C, $I_C$ = 25 A | | 0.38 | | mJ |
| | | | $T_{vj}$ = 25 °C, $I_C$ = 5 A | | 0.1 | | |
| | | | $T_{vj}$ = 150 °C, $I_C$ = 25 A | | 0.54 | | |
| | | | $T_{vj}$ = 150 °C, $I_C$ = 5 A | | 0.16 | | |
| IGBT thermal resistance, junction-case | $R_{th(j\text{-}c)}$ | | | | | 0.5 | 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 | 33.7 | A |
| | | | $T_c = 100$ °C | 22.8 | |
| Diode pulsed current, $t_p$ limited by $T_{vjmax}$ [1)] | $I_{Fpulse}$ | | | 75 | 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 | $V_F$ | $I_F = 20$ 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 | $R_{th(j-c)}$ | | | | | 1.5 | 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.*

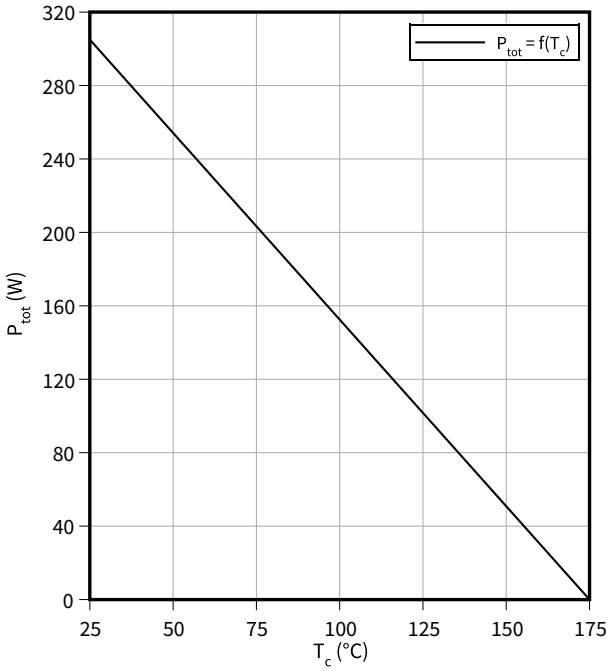
*Dynamic test circuit, parasitic inductance $L_\sigma$, parasitic capacitor $C_\sigma$ from Fig. E. Energy losses include "tail" and diode reverse recovery.*

# 4 Characteristics diagrams

**Power dissipation as a function of case temperature**

$P_{tot} = f(T_c)$

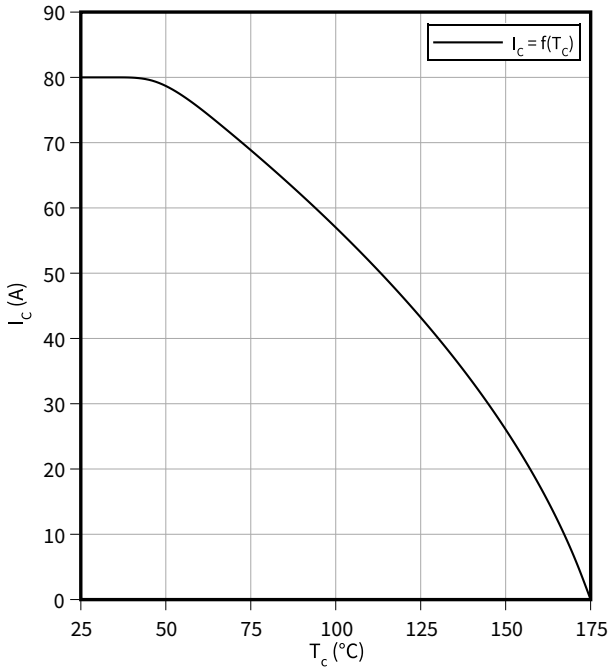
$T_{vj} \leq 175\ °C$




**Collector current as a function of case temperature**

$I_C = f(T_c)$

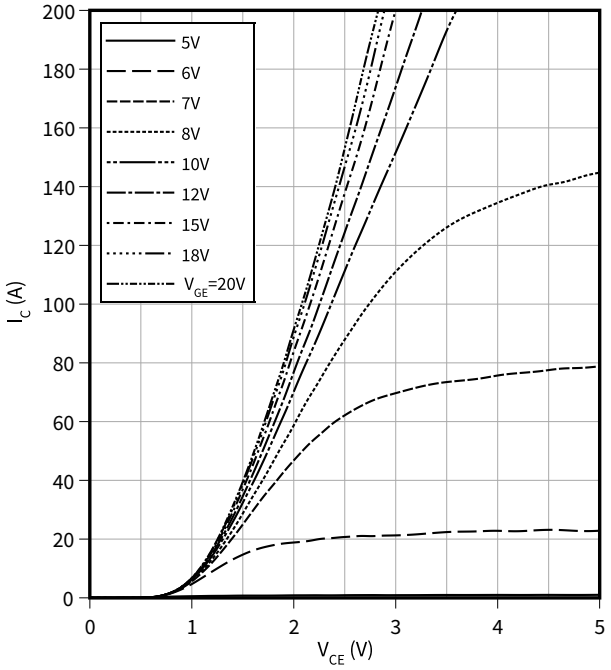
$T_{vj} \leq 175\ °C, V_{GE} \geq 15\ V$




**Typical output characteristic**

$I_C = f(V_{CE})$

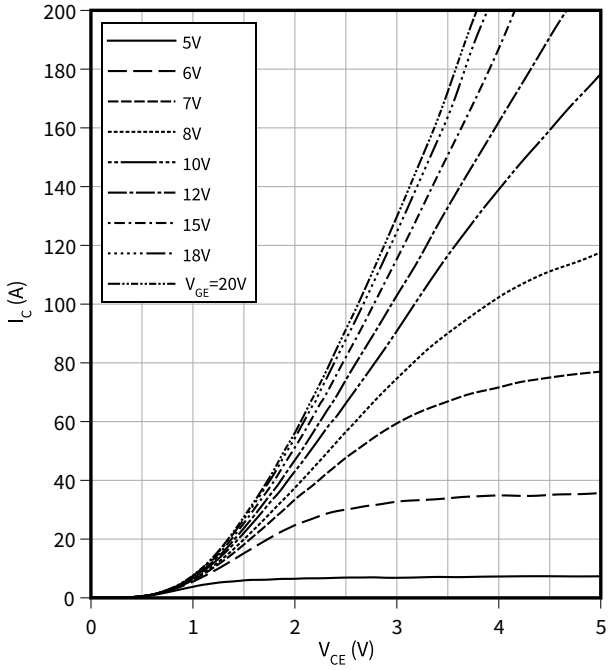
$T_{vj} = 25\ °C$




**Typical output characteristic**

$I_C = f(V_{CE})$

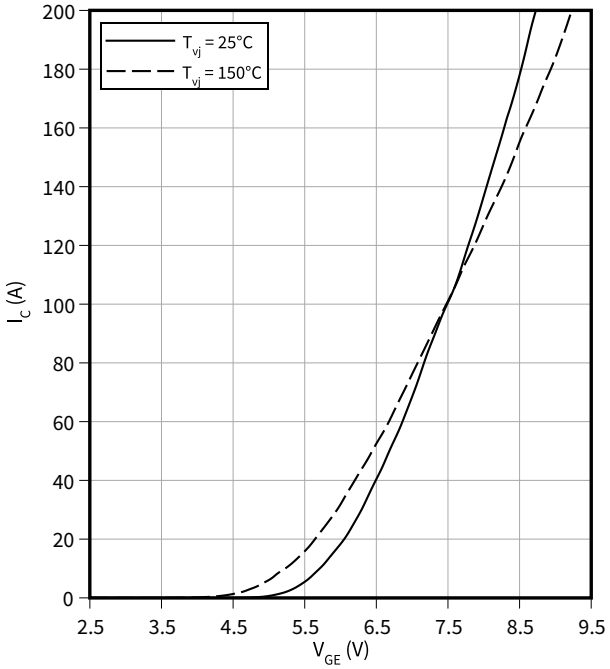
$T_{vj} = 150\ °C$



### Typical transfer characteristic

$I_C = f(V_{GE})$

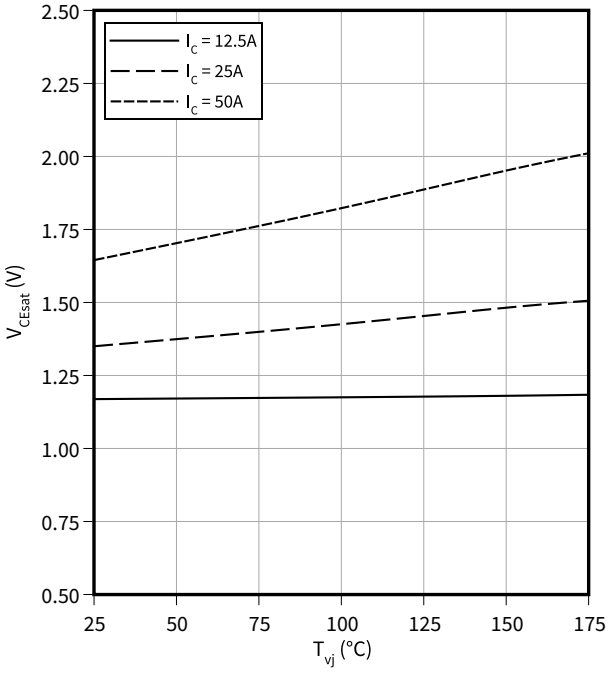
$V_{CE}$ = 20 V




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

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

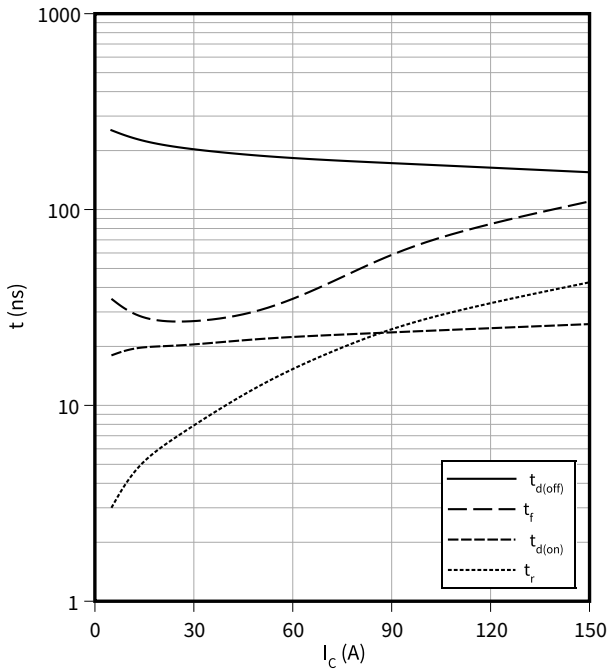
$V_{GE}$ = 15 V




### Typical switching times as a function of collector current

$t = f(I_C)$

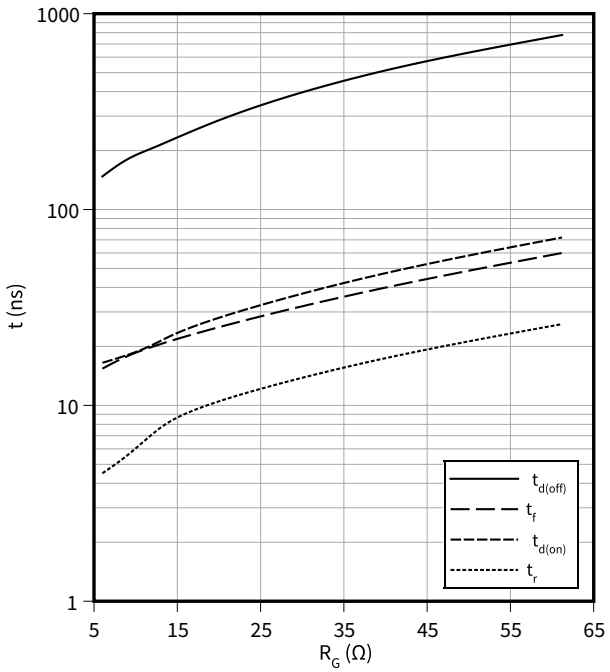
$V_{CC}$ = 400 V, $T_{vj}$ = 150 °C, $V_{GE}$ = 0/15 V, $R_G$ = 12 Ω




### Typical switching times as a function of gate resistor

$t = f(R_G)$

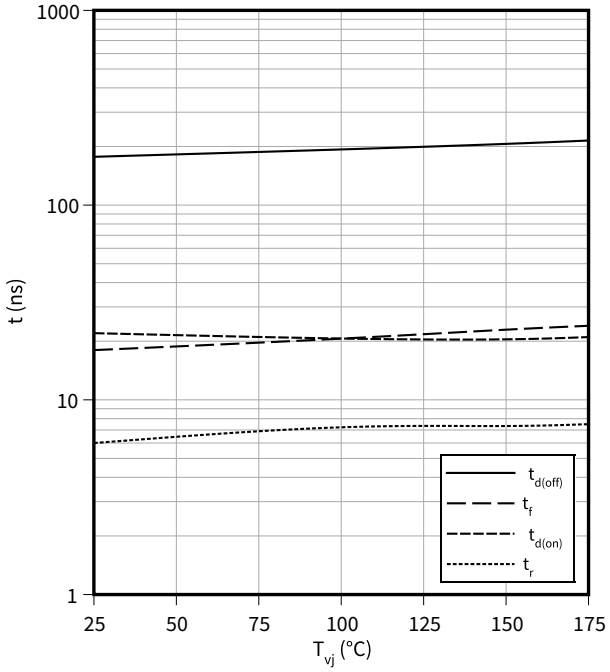
$I_C$ = 25 A, $V_{CC}$ = 400 V, $T_{vj}$ = 150 °C, $V_{GE}$ = 0/15 V



### Typical switching times as a function of junction temperature

$t = f(T_{vj})$

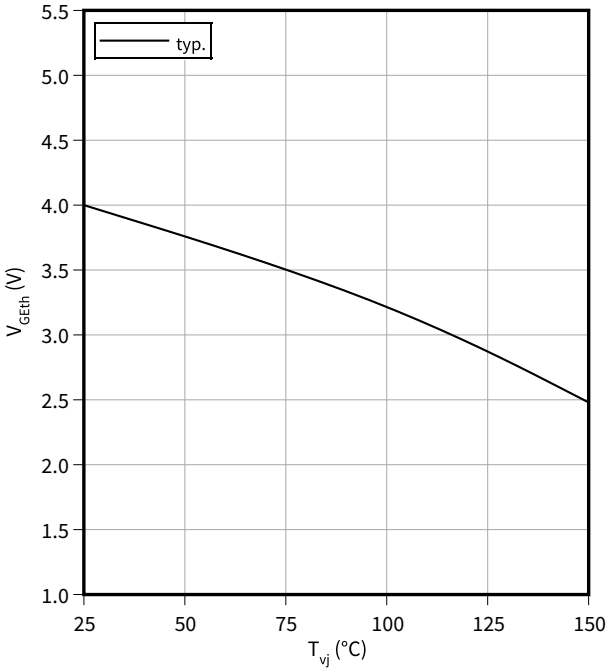
$I_C$ = 25 A, $V_{CC}$ = 400 V, $V_{GE}$ = 0/15 V, $R_G$ = 12 Ω




### Gate-emitter threshold voltage as a function of junction temperature

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

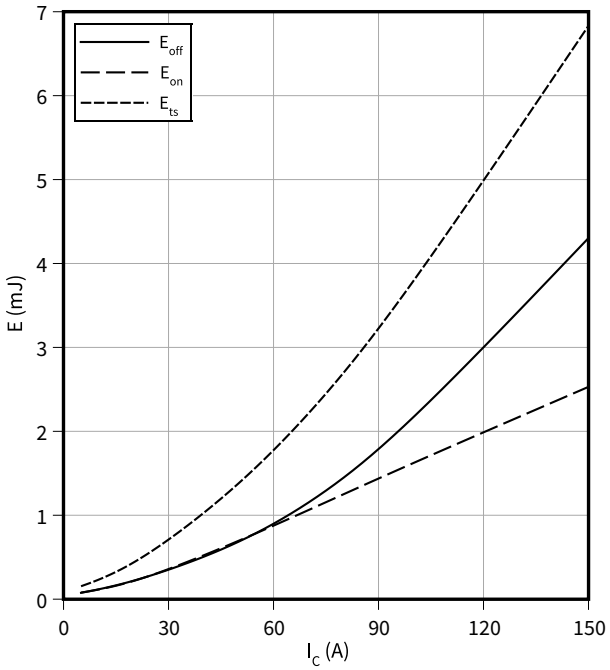
$I_C$ = 0.5 mA




### Typical switching energy losses as a function of collector current

$E = f(I_C)$

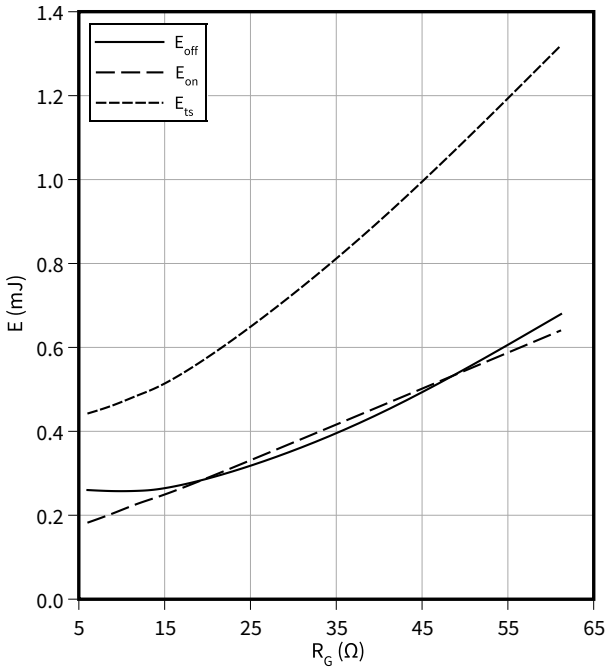
$V_{CC}$ = 400 V, $T_{vj}$ = 150 °C, $V_{GE}$ = 0/15 V, $R_G$ = 12 Ω




### Typical switching energy losses as a function of gate resistor

$E = f(R_G)$

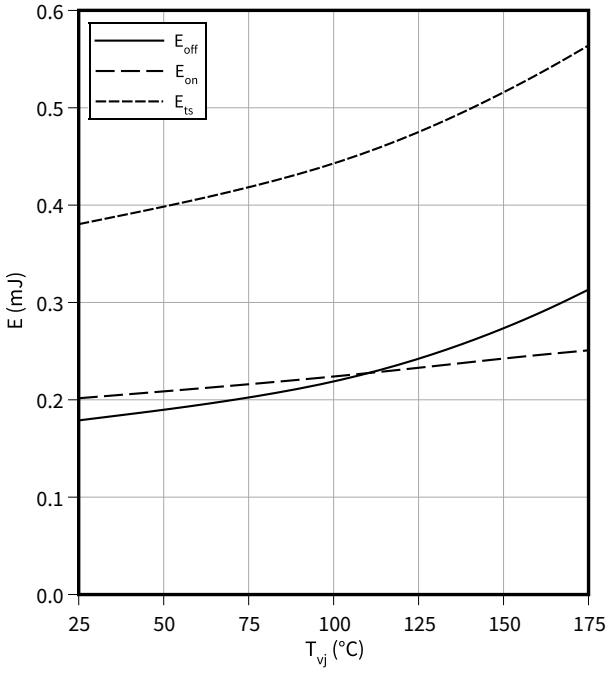
$I_C$ = 25 A, $V_{CC}$ = 400 V, $T_{vj}$ = 150 °C, $V_{GE}$ = 0/15 V



### Typical switching energy losses as a function of junction temperature

$E = f(T_{vj})$

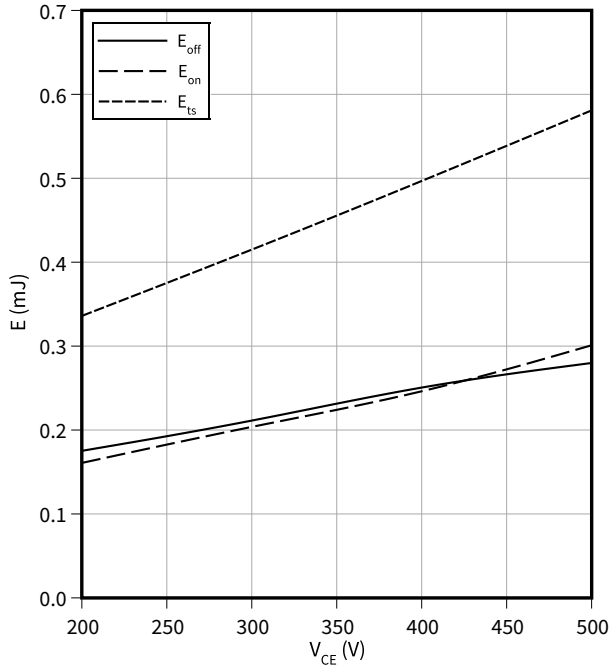
$I_C = 25\ A$, $V_{CC} = 400\ V$, $V_{GE} = 0/15\ V$, $R_G = 12\ \Omega$




### Typical switching energy losses as a function of collector emitter voltage

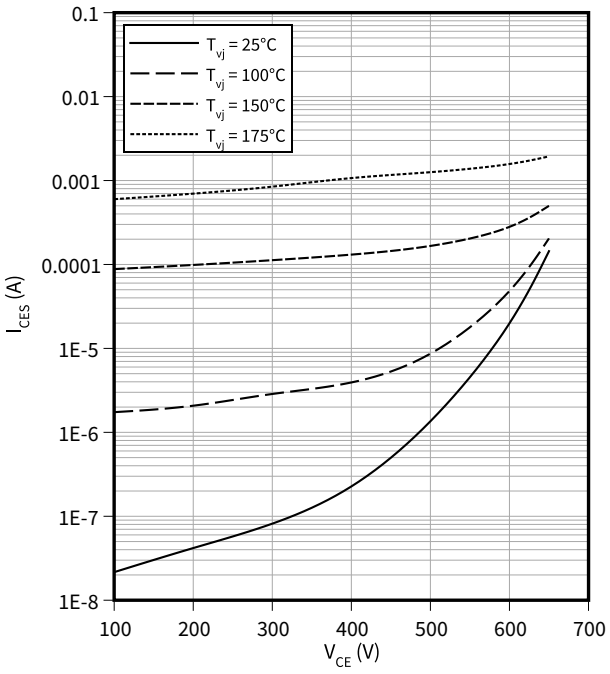
$E = f(V_{CE})$

$I_C = 25\ A$, $T_{vj} = 150\ °C$, $V_{GE} = 0/15\ V$, $R_G = 12\ \Omega$




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

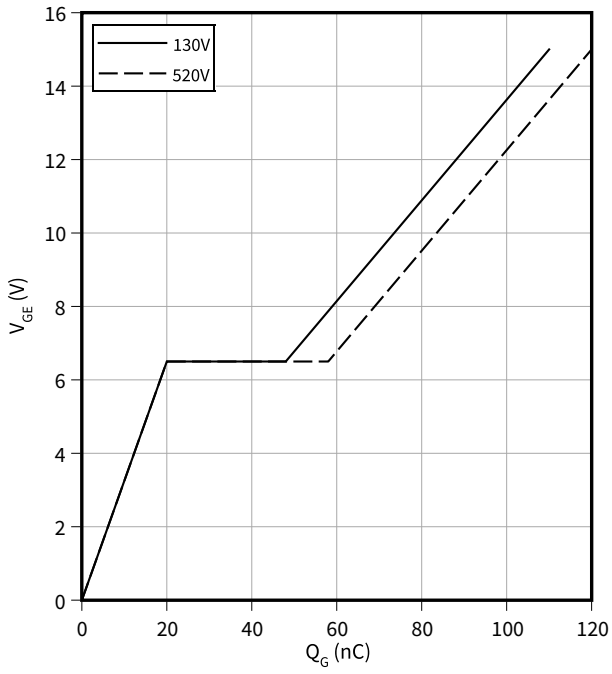
$I_{CES} = f(V_{CE})$




### Typical gate charge

$V_{GE} = f(Q_G)$

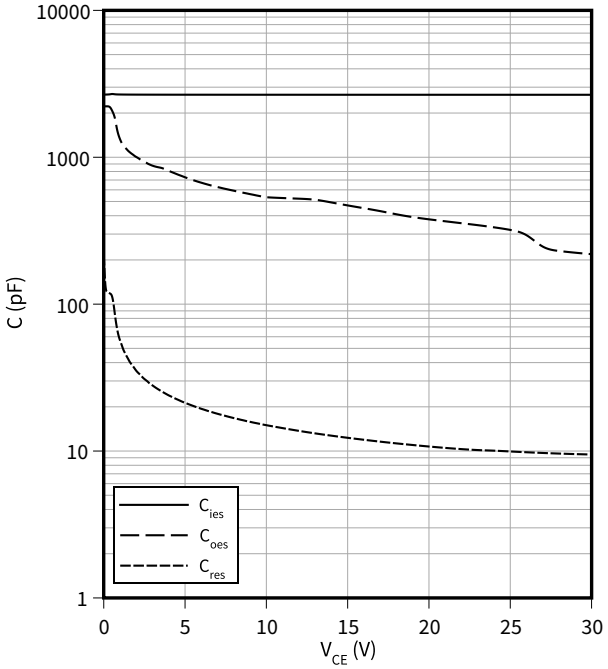
$I_C = 50\ A$



### Typical capacitance as a function of collector-emitter voltage

$C = f(V_{CE})$

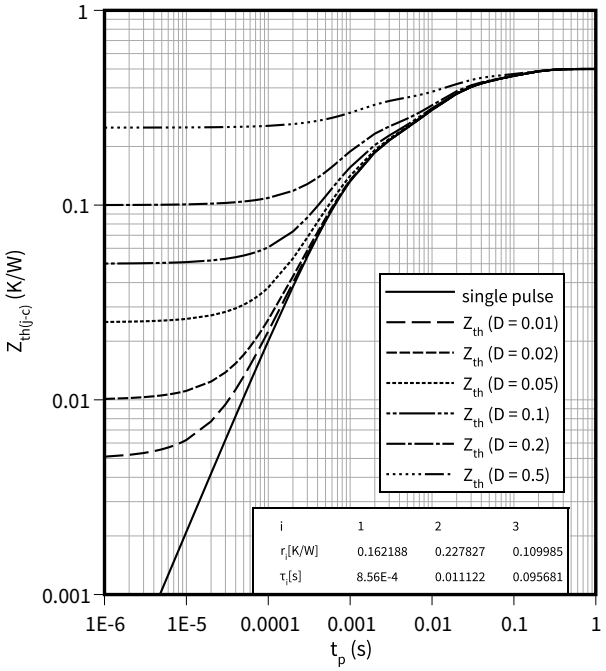
$f = 250\ kHz, V_{GE} = 0\ V$




### IGBT transient thermal impedance as a function of pulse width

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

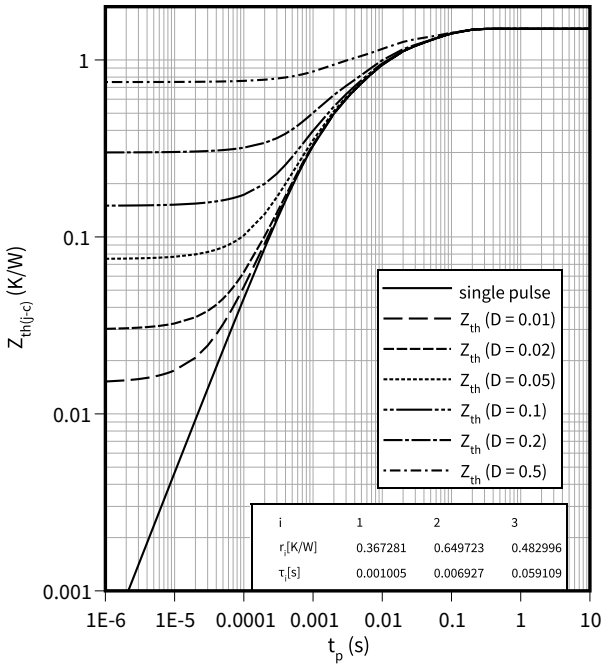
$D = t_p/T$




### Diode transient thermal impedance as a function of pulse width

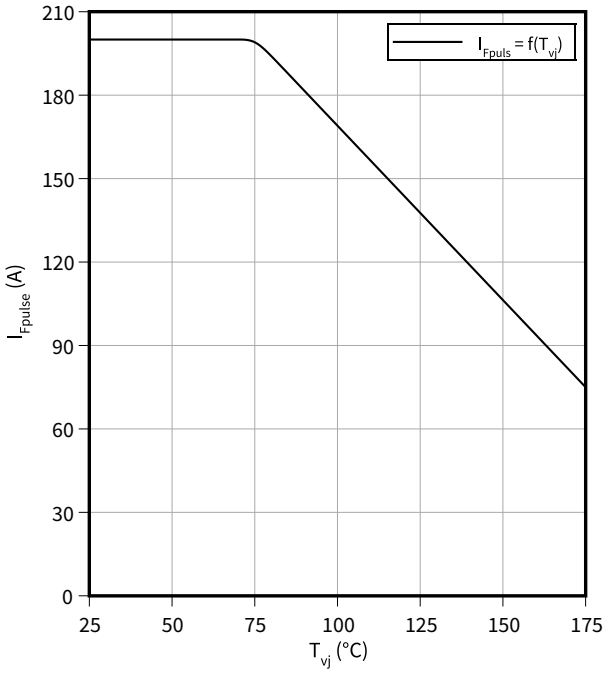
$Z_{th(j-c)} = f(t_p)$

$D = t_p/T$



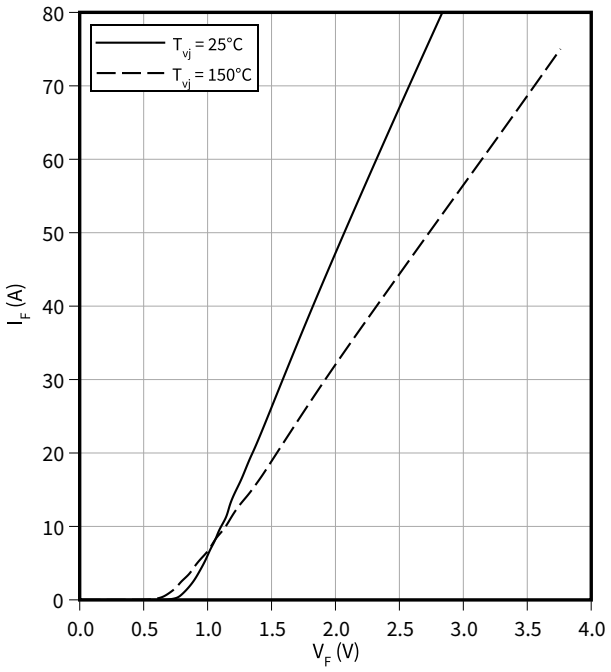

### Maximum pulse current as a function of junction temperature

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



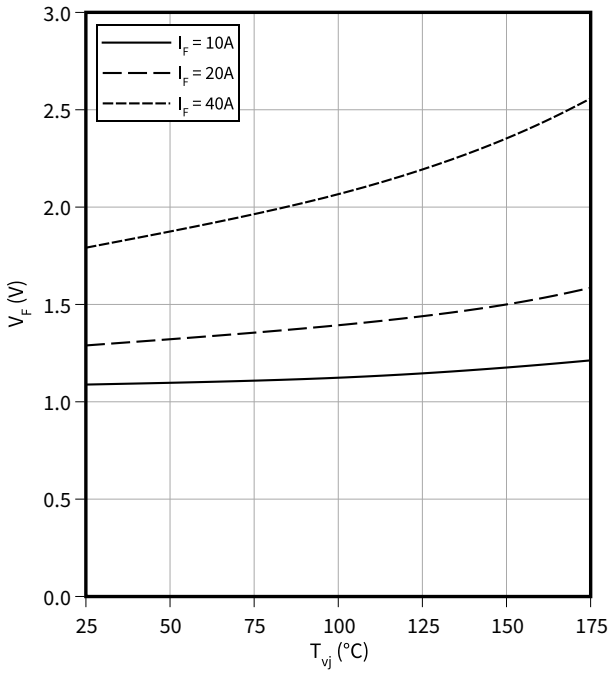
### Typical diode forward current as a function of forward voltage

$I_F = f(V_F)$



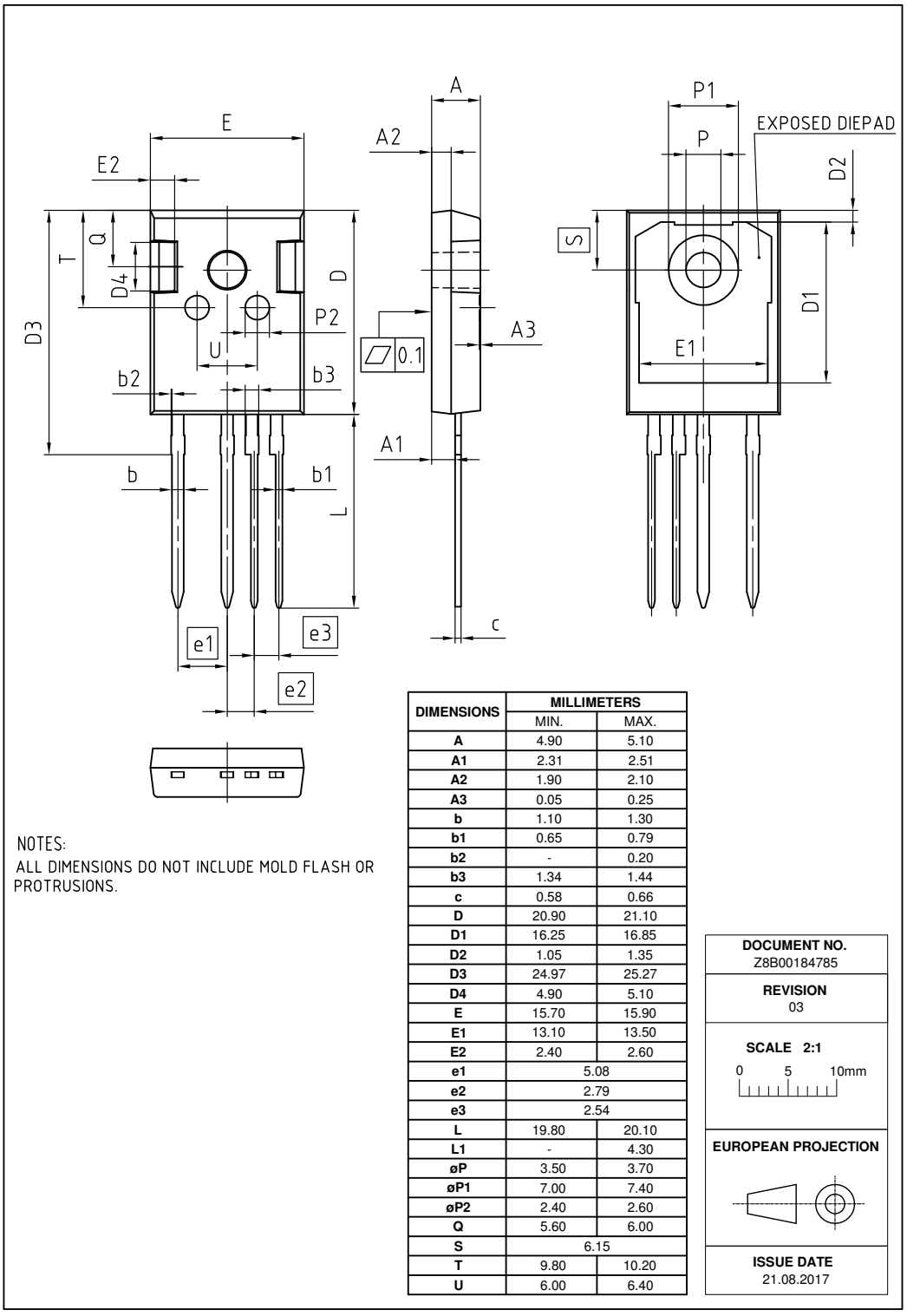

### Typical diode forward voltage as a function of junction temperature

$V_F = f(T_{vj})$



# 5 Package outlines

## PG-TO247-4-3




NOTES:
ALL DIMENSIONS DO NOT INCLUDE MOLD FLASH OR PROTRUSIONS.

| DIMENSIONS | MILLIMETERS | |
|---|---|---|
| | MIN. | MAX. |
| **A** | 4.90 | 5.10 |
| **A1** | 2.31 | 2.51 |
| **A2** | 1.90 | 2.10 |
| **A3** | 0.05 | 0.25 |
| **b** | 1.10 | 1.30 |
| **b1** | 0.65 | 0.79 |
| **b2** | - | 0.20 |
| **b3** | 1.34 | 1.44 |
| **c** | 0.58 | 0.66 |
| **D** | 20.90 | 21.10 |
| **D1** | 16.25 | 16.85 |
| **D2** | 1.05 | 1.35 |
| **D3** | 24.97 | 25.27 |
| **D4** | 4.90 | 5.10 |
| **E** | 15.70 | 15.90 |
| **E1** | 13.10 | 13.50 |
| **E2** | 2.40 | 2.60 |
| **e1** | 5.08 | |
| **e2** | 2.79 | |
| **e3** | 2.54 | |
| **L** | 19.80 | 20.10 |
| **L1** | - | 4.30 |
| **øP** | 3.50 | 3.70 |
| **øP1** | 7.00 | 7.40 |
| **øP2** | 2.40 | 2.60 |
| **Q** | 5.60 | 6.00 |
| **S** | 6.15 | |
| **T** | 9.80 | 10.20 |
| **U** | 6.00 | 6.40 |

**DOCUMENT NO.**
Z8B00184785

**REVISION**
03

**SCALE 2:1**
0 5 10mm

**EUROPEAN PROJECTION**

**ISSUE DATE**
21.08.2017

**Figure 1**

# 6 Testing conditions

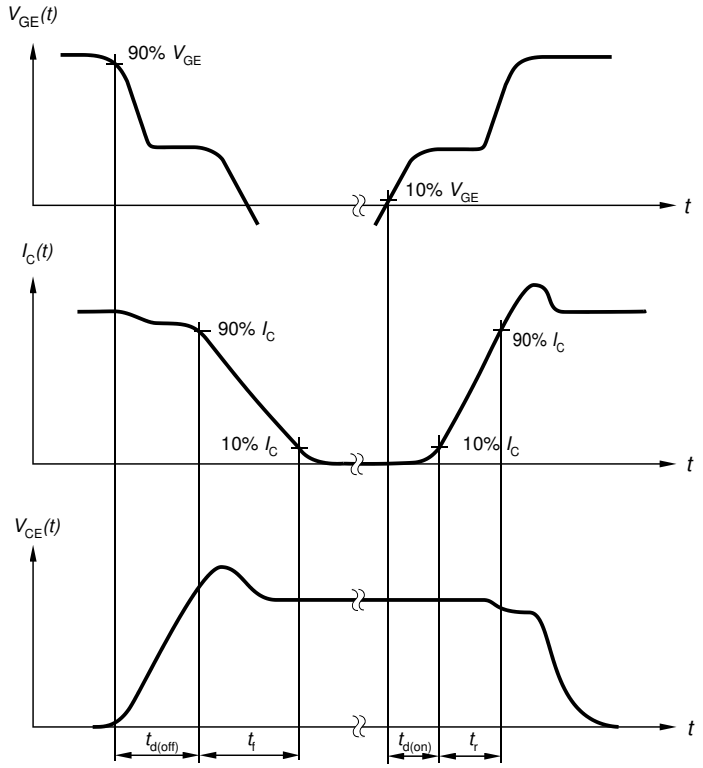



Figure A. **Definition of switching times**

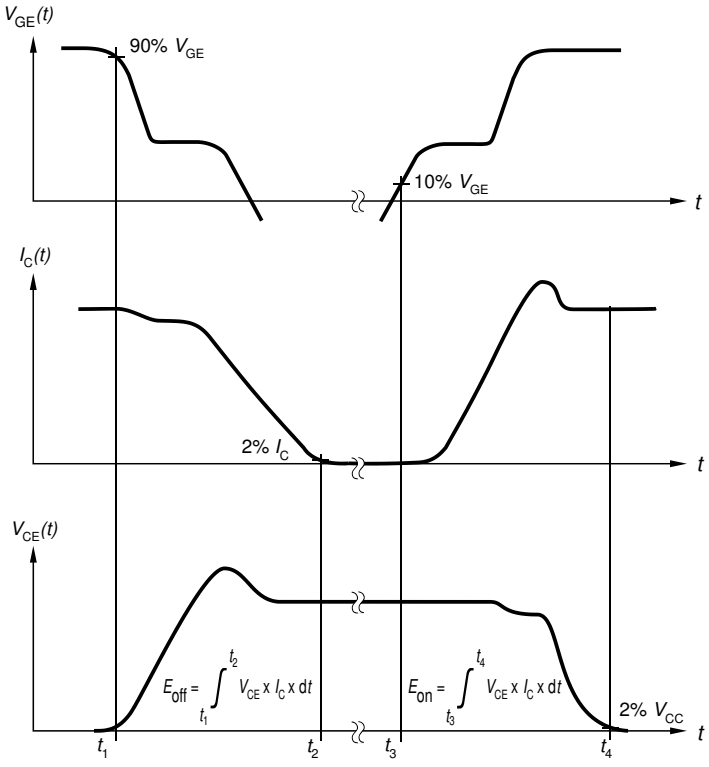



Figure B. **Definition of switching losses**

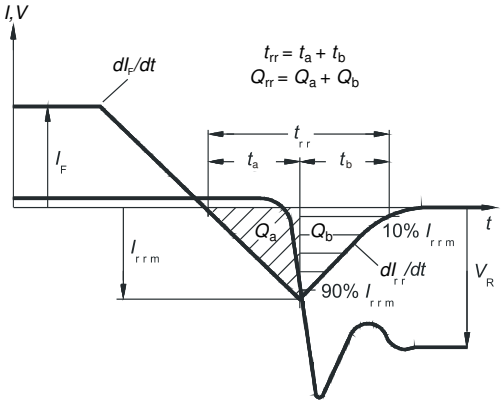



Figure C. **Definition of diode switching characteristics**

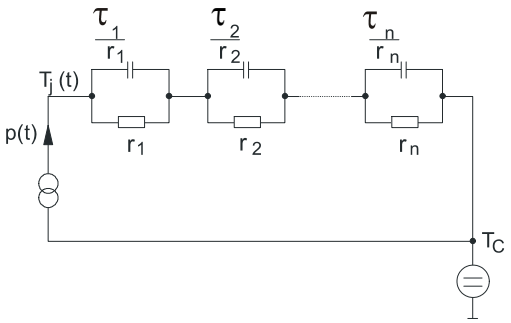



Figure D. **Thermal equivalent circuit**

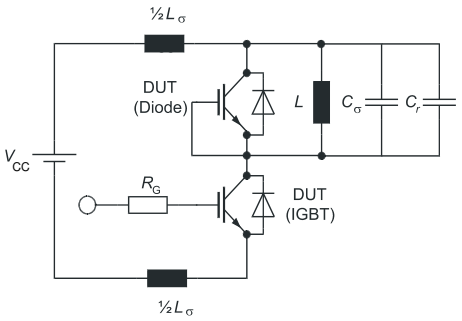



Figure E. **Dynamic test circuit**
Parasitic inductance $L_\sigma$,
parasitic capacitor $C_\sigma$,
relief capacitor $C_r$,
(only for ZVT switching)

**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”<br>Corrected the values in table of $Z_{th} = f(t_p)$ diode diagram |

**Trademarks**

All referenced product or service names and trademarks are the property of their respective owners.

**Edition 2022-09-22**

**Published by**

**Infineon Technologies AG**

**81726 Munich, Germany**



**Do you have a question about any aspect of this document?**

**Email: erratum@infineon.com**

**Document reference**
**IFX-AAL367-003**

**Important notice**

The information given in this document shall in no event be regarded as a guarantee of conditions or characteristics ("Beschaffenheitsgarantie").

With respect to any examples, hints or any typical values stated herein and/or any information regarding the application of the product, Infineon Technologies hereby disclaims any and all warranties and liabilities of any kind, including without limitation warranties of non-infringement of intellectual property rights of any third party.

In addition, any information given in this document is subject to customer's compliance with its obligations stated in this document and any applicable legal requirements, norms and standards concerning customer's products and any use of the product of Infineon Technologies in customer's applications.

The data contained in this document is exclusively intended for technically trained staff. It is the responsibility of customer's technical departments to evaluate the suitability of the product for the intended application and the completeness of the product information given in this document with respect to such application.

Please note that this product is not qualified according to the AEC Q100 or AEC Q101 documents of the Automotive Electronics Council.

**Warnings**

Due to technical requirements products may contain dangerous substances. For information on the types in question please contact your nearest Infineon Technologies office.

Except as otherwise explicitly approved by Infineon Technologies in a written document signed by authorized representatives of Infineon Technologies, Infineon Technologies' products may not be used in any applications where a failure of the product or any consequences of the use thereof can reasonably be expected to result in personal injury.