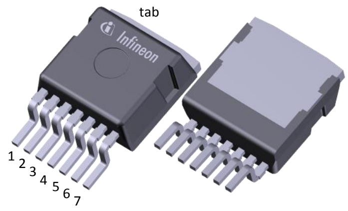
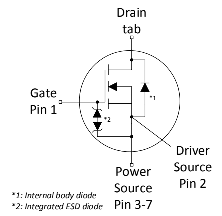
# MOSFET

## 650V CoolMOS™ CFD7A SJ Power Device

650V CoolMOS™ CFD7A is Infineon's latest generation of market leading automotive qualified high voltage CoolMOS™ MOSFETs. In addition to the well-known attributes of high quality and reliability required by the automotive industry, the new CoolMOS™ CFD7A series provides for an integrated fast body diode and can be used for PFC and resonant switching topologies like the ZVS phase-shift full-bridge and LLC.

D²-PAK 7pin




### Features

- Latest 650V automotive qualified technology with integrated fast body diode on the market featuring ultra low $Q_{rr}$
- Lowest FOM $R_{DS(on)}$*$Q_g$ and $R_{DS(on)}$*$E_{oss}$
- 100% avalanche tested
- Kelvin source contact available
- Best-in-class $R_{DS(on)}$ in SMD and THD packages

### Benefits

- Optimized for higher battery voltages up to 475 V thanks to further improved robustness
- Lower switching losses enabling higher switching frequencies
- High quality and reliability
- Advanced controllability due to kelvin source
- Increased package creepage distance
- Increased efficiency in light load and full load conditions

### Potential applications

Suitable for PFC and DC-DC stages for:
- Unidirectional and bidirectional DC-DC converters,
- On-Board battery Chargers

### Product validation

Qualified according to AEC Q101

*Please note: The source and sense source pins are not exchangeable. Their exchange might lead to malfunction. For production part approval process (PPAP) release we propose to share application related information during an early design phase to avoid delays in PPAP release. Please contact Infineon sales office.*

### Table 1 Key Performance Parameters

| Parameter | Value | Unit |
|---|---|---|
| $V_{DS}$ | 650 | V |
| $R_{DS(on),max}$ | 190 | mΩ |
| $Q_{g,typ}$ | 28 | nC |
| $I_{D,pulse}$ | 55 | A |
| $E_{oss}$ @ 400V | 3.7 | µJ |
| Body diode $di_F/dt$ | 1300 | A/µs |

| Type / Ordering Code | Package | Marking | Related Links |
|---|---|---|---|
| IPBE65R190CFD7A | PG-TO263-7-11 | 65A190F7 | see Appendix A |

## Table of Contents

# 1 Maximum ratings

at $T_j$ = 25°C, unless otherwise specified

## Table 2 Maximum ratings

| Parameter | Symbol | Values | | | Unit | Note / Test Condition |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| Continuous drain current[1] | $I_D$ | -<br>- | -<br>- | 14<br>9 | A | $T_C$=25°C<br>$T_C$=100°C |
| Pulsed drain current[2] | $I_{D,pulse}$ | - | - | 55 | A | $T_C$=25°C |
| Avalanche energy, single pulse | $E_{AS}$ | - | - | 64 | mJ | $I_D$=3.6A; $V_{DD}$=50V; see table 10 |
| Avalanche current, single pulse | $I_{AS}$ | - | - | 3.6 | A | - |
| MOSFET dv/dt ruggedness | dv/dt | - | - | 120 | V/ns | $V_{DS}$=0...400V |
| Gate source voltage (static) | $V_{GS}$ | -20 | - | 20 | V | static; |
| Gate source voltage (dynamic) | $V_{GSk,pulse}$ | -30 | - | 30 | V | $f_{repetition}$<=100kHz, $t_{pulse}$ <= 2ns |
| Power dissipation | $P_{tot}$ | - | - | 77 | W | $T_C$=25°C |
| Storage temperature | $T_{stg}$ | -55 | - | 150 | °C | - |
| Operating junction temperature | $T_j$ | -40 | - | 150 | °C | - |
| Mounting torque | - | - | - | - | Ncm | - |
| Continuous diode forward current | $I_S$ | - | - | 14 | A | $T_C$=25°C |
| Diode pulse current[2] | $I_{S,pulse}$ | - | - | 55 | A | $T_C$=25°C |
| Reverse diode dv/dt[3] | dv/dt | - | - | 70 | V/ns | $V_{DS}$=0...400V, $I_{SD}$<=6.4A, $T_j$=25°C see table 8 |
| Maximum diode commutation speed | $di_F/dt$ | - | - | 1300 | A/µs | $V_{DS}$=0...400V, $I_{SD}$<=6.4A, $T_j$=25°C see table 8 |

[1] Limited by $T_{j\,max}$.
[2] Pulse width $t_p$ limited by $T_{j,max}$
[3] Identical low side and high side switch with identical $R_G$

## 2 Thermal characteristics

**Table 3 Thermal characteristics**

| Parameter | Symbol | Values | | | Unit | Note / Test Condition |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| Thermal resistance, junction - case | $R_{thJC}$ | - | - | 1.62 | °C/W | - |
| Soldering temperature, reflow soldering allowed | $T_{sold}$ | - | - | 260 | °C | reflow MSL1 |

# 3 Electrical characteristics

at $T_j$=25°C, unless otherwise specified

## Table 4 Static characteristics

| Parameter | Symbol | Values | | | Unit | Note / Test Condition |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| Drain-source breakdown voltage[1] | $V_{(BR)DSS}$ | 650 | - | - | V | $V_{GS}$=0V, $I_D$=1mA |
| Gate threshold voltage[2] | $V_{(GS)th}$ | 3.5 | 4 | 4.5 | V | $V_{DS}$=$V_{GS}$, $I_D$=0.32mA |
| Zero gate voltage drain current | $I_{DSS}$ | -<br>- | -<br>25 | 1<br>- | µA | $V_{DS}$=650V, $V_{GS}$=0V, $T_j$=25°C<br>$V_{DS}$=650V, $V_{GS}$=0V, $T_j$=150°C |
| Gate-source leakage current incl. protection diode | $I_{GSS}$ | - | - | 1 | µA | $V_{GS}$=20V, $V_{DS}$=0V |
| Drain-source on-state resistance | $R_{DS(on)}$ | -<br>- | 0.159<br>0.355 | 0.190<br>- | Ω | $V_{GS}$=10V, $I_D$=6.4A, $T_j$=25°C<br>$V_{GS}$=10V, $I_D$=6.4A, $T_j$=150°C |
| Gate resistance | $R_G$ | - | 10.0 | - | Ω | $f$=250kHz, open drain |

## Table 5 Dynamic characteristics

External parasitic elements (PCB layout) influence switching behavior significantly.
Stray inductances and coupling capacitances must be minimized.
For layout recommendations please use provided application notes or contact Infineon sales office.

| Parameter | Symbol | Values | | | Unit | Note / Test Condition |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| Input capacitance | $C_{iss}$ | - | 1291 | - | pF | $V_{GS}$=0V, $V_{DS}$=400V, $f$=250kHz |
| Output capacitance | $C_{oss}$ | - | 20 | - | pF | $V_{GS}$=0V, $V_{DS}$=400V, $f$=250kHz |
| Effective output capacitance, energy related[3] | $C_{o(er)}$ | - | 46 | - | pF | $V_{GS}$=0V, $V_{DS}$=0...400V |
| Effective output capacitance, time related[4] | $C_{o(tr)}$ | - | 479 | - | pF | $I_D$=constant, $V_{GS}$=0V, $V_{DS}$=0...400V |
| Turn-on delay time | $t_{d(on)}$ | - | 19 | - | ns | $V_{DD}$=400V, $V_{GS}$=13V, $I_D$=6.4A, $R_G$=10.2Ω; see table 9 |
| Rise time | $t_r$ | - | 4 | - | ns | $V_{DD}$=400V, $V_{GS}$=13V, $I_D$=6.4A, $R_G$=10.2Ω; see table 9 |
| Turn-off delay time | $t_{d(off)}$ | - | 86 | - | ns | $V_{DD}$=400V, $V_{GS}$=13V, $I_D$=6.4A, $R_G$=10.2Ω; see table 9 |
| Fall time | $t_f$ | - | 5 | - | ns | $V_{DD}$=400V, $V_{GS}$=13V, $I_D$=6.4A, $R_G$=10.2Ω; see table 9 |

[1] For applications with applied blocking voltage > 475 V, we recommend to evaluate the impact of the cosmic radiation effect in early design phase. For assessment, please contact local Infineon sales office.
[2] We do not recommend using the CoolMOS mentioned in this datasheet to operate in “linear mode”. For assessment of potential “linear mode”, please contact Infineon sales office.
[3] $C_{o(er)}$ is a fixed capacitance that gives the same stored energy as $C_{oss}$ while $V_{DS}$ is rising from 0 to 400V
[4] $C_{o(tr)}$ is a fixed capacitance that gives the same charging time as $C_{oss}$ while $V_{DS}$ is rising from 0 to 400V

## Table 6 Gate charge characteristics

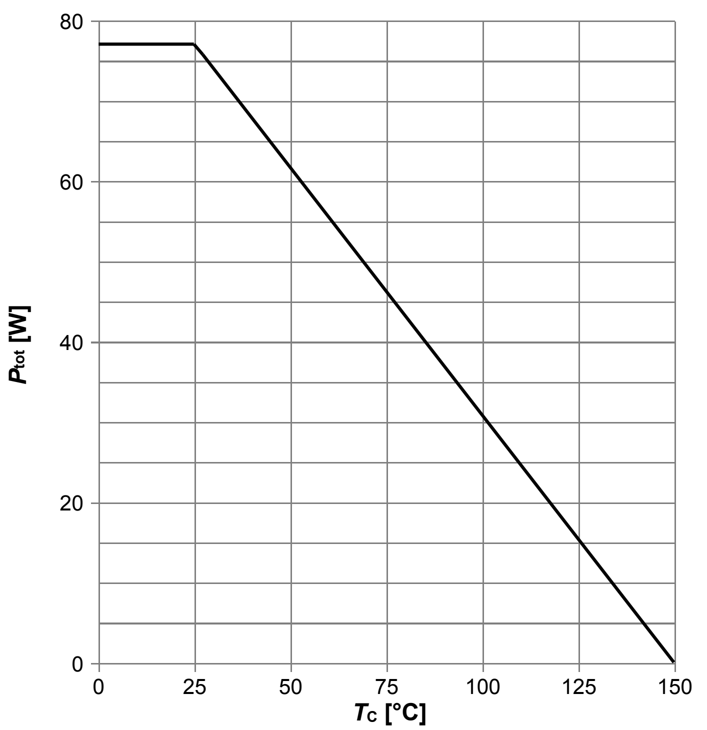
| Parameter | Symbol | Values | | | Unit | Note / Test Condition |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| Gate to source charge | $Q_{gs}$ | - | 7 | - | nC | $V_{DD}$=400V, $I_D$=6.4A, $V_{GS}$=0 to 10V |
| Gate to drain charge | $Q_{gd}$ | - | 9 | - | nC | $V_{DD}$=400V, $I_D$=6.4A, $V_{GS}$=0 to 10V |
| Gate charge total | $Q_g$ | - | 28 | - | nC | $V_{DD}$=400V, $I_D$=6.4A, $V_{GS}$=0 to 10V |
| Gate plateau voltage | $V_{plateau}$ | - | 5.7 | - | V | $V_{DD}$=400V, $I_D$=6.4A, $V_{GS}$=0 to 10V |

## Table 7 Reverse diode characteristics

| Parameter | Symbol | Values | | | Unit | Note / Test Condition |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| Diode forward voltage | $V_{SD}$ | - | 1.1 | - | V | $V_{GS}$=0V, $I_F$=6.4A, $T_j$=25°C |
| Reverse recovery time | $t_{rr}$ | - | 97 | - | ns | $V_R$=400V, $I_F$=6.4A, $di_F/dt$=100A/µs; see table 8 |
| Reverse recovery charge | $Q_{rr}$ | - | 0.46 | - | µC | $V_R$=400V, $I_F$=6.4A, $di_F/dt$=100A/µs; see table 8 |
| Peak reverse recovery current | $I_{rrm}$ | - | 8.4 | - | A | $V_R$=400V, $I_F$=6.4A, $di_F/dt$=100A/µs; see table 8 |

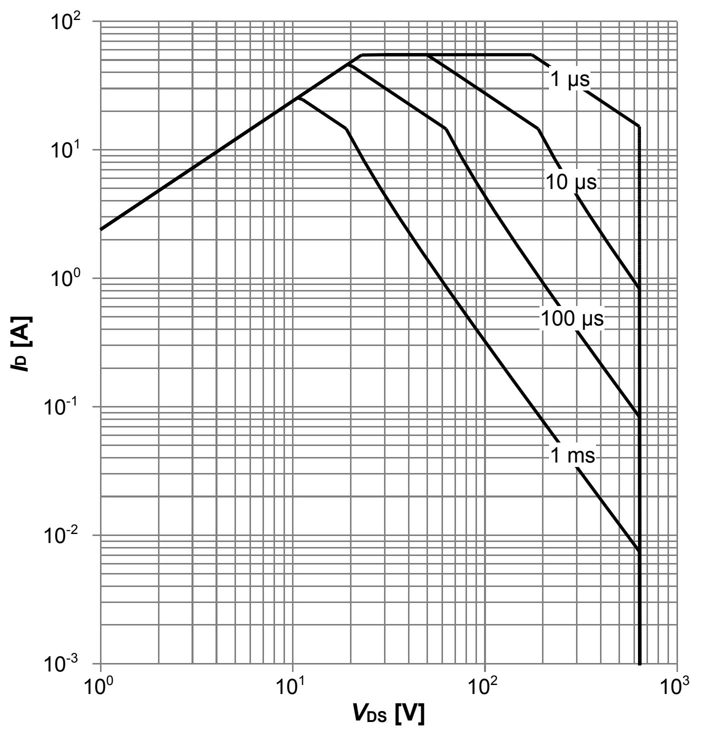
# 4 Electrical characteristics diagrams

**Diagram 1: Power dissipation**



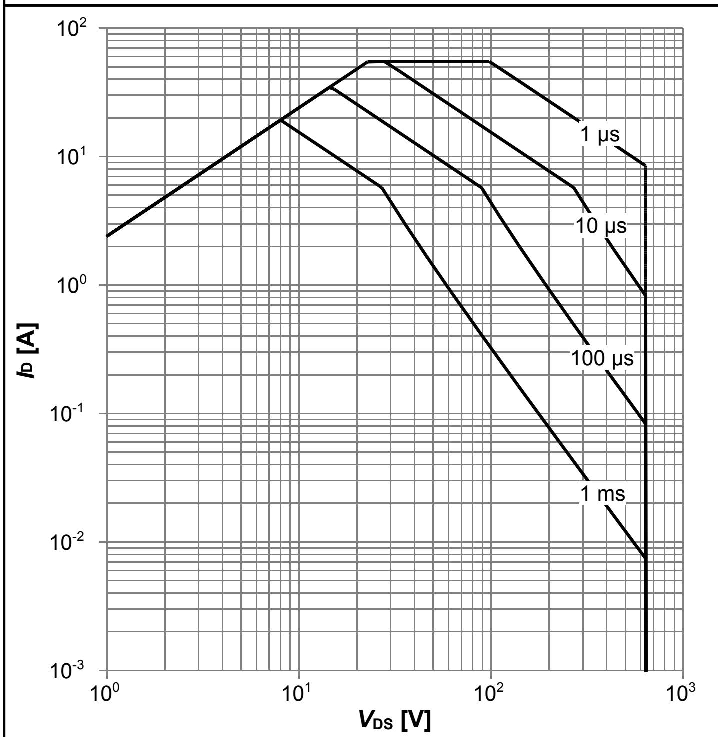

$P_{tot}$=f($T_C$)

**Diagram 2: Safe operating area**



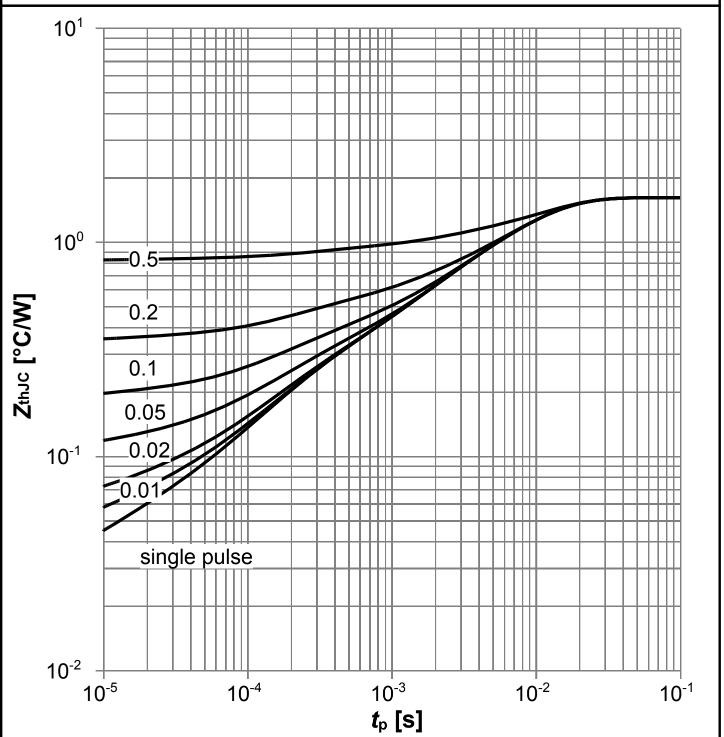

$I_D$=f($V_{DS}$); $T_C$=25 °C; $D$=0; parameter: $t_p$

**Diagram 3: Safe operating area**



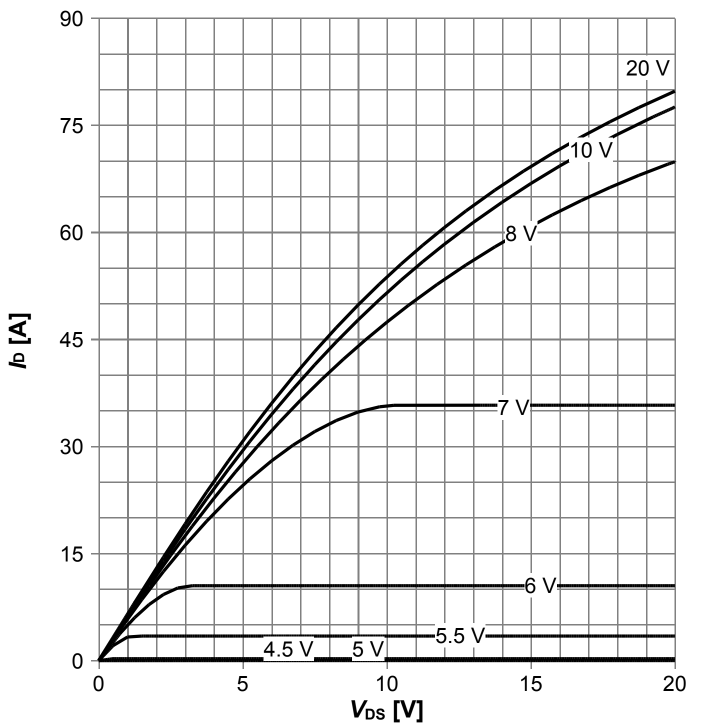

$I_D$=f($V_{DS}$); $T_C$=80 °C; $D$=0; parameter: $t_p$

**Diagram 4: Max. transient thermal impedance**



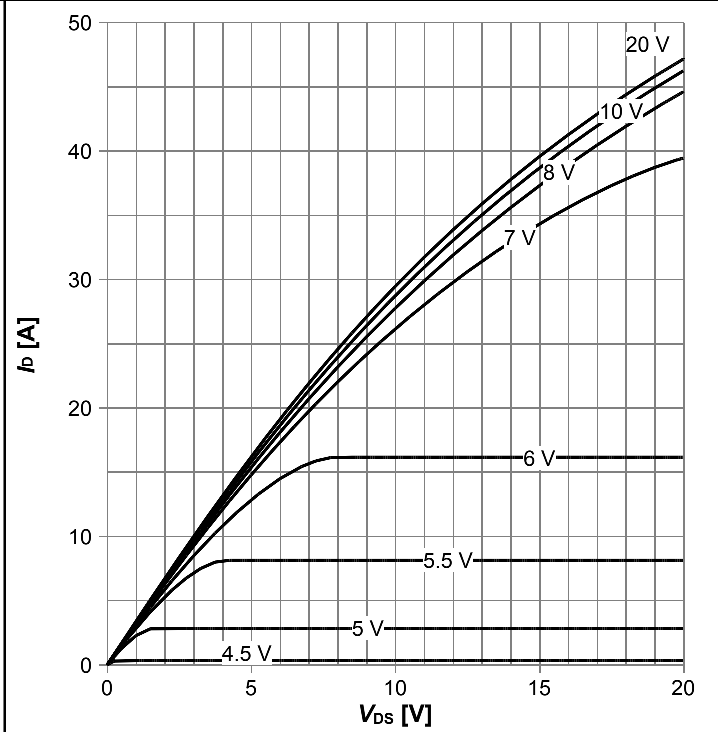

$Z_{thJC}$ =f($t_P$); parameter: $D$=$t_p$/$T$

**Diagram 5: Typ. output characteristics**



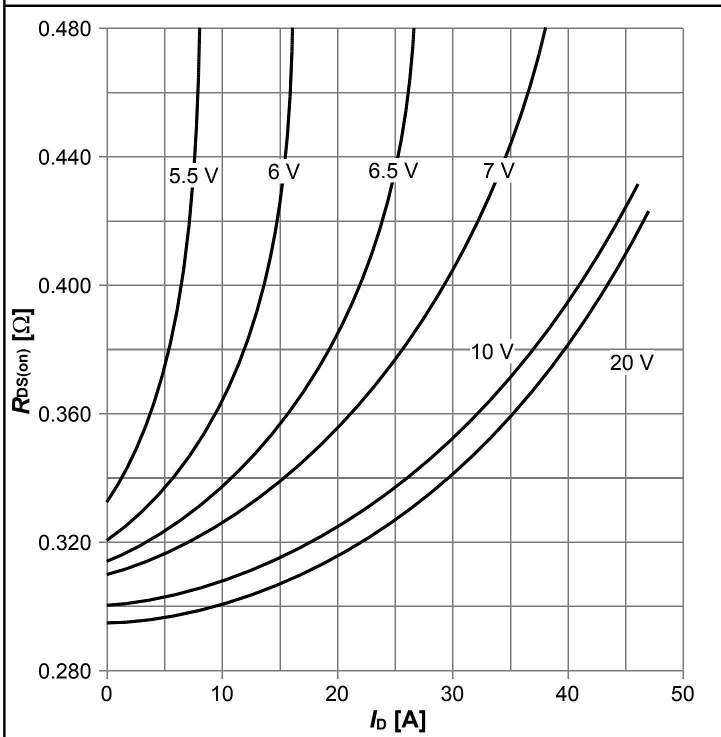

$I_D$=f($V_{DS}$); $T_j$=25 °C; parameter: $V_{GS}$

**Diagram 6: Typ. output characteristics**



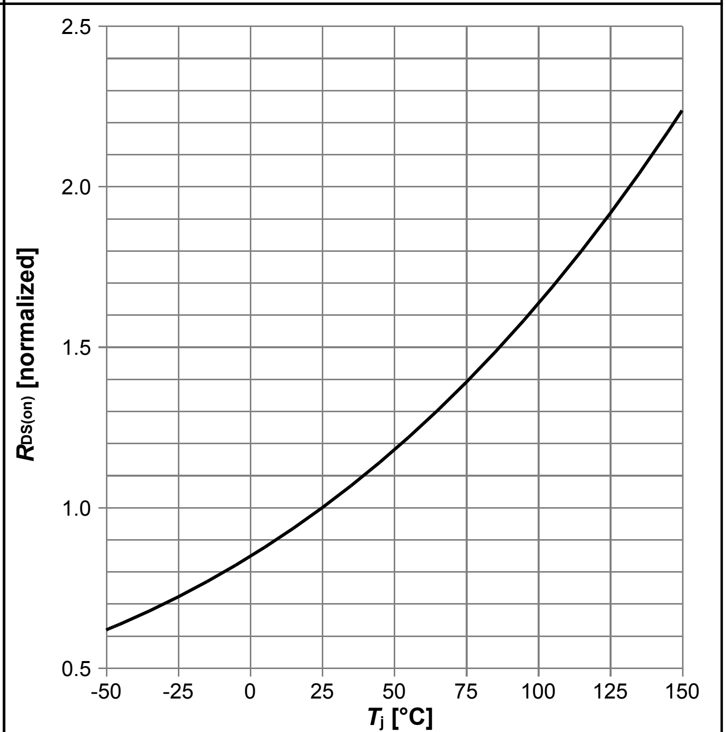

$I_D$=f($V_{DS}$); $T_j$=125 °C; parameter: $V_{GS}$

**Diagram 7: Typ. drain-source on-state resistance**



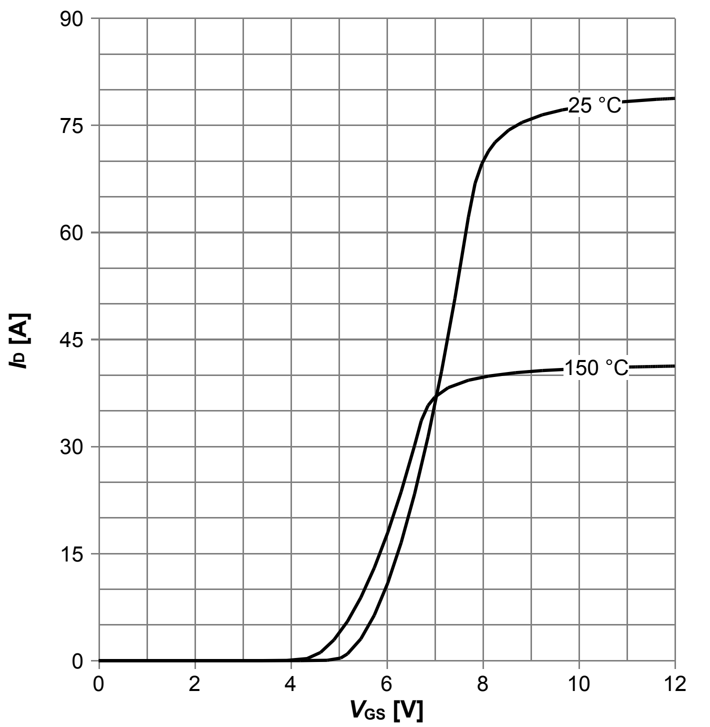

$R_{DS(on)}$=f($I_D$); $T_j$=125 °C; parameter: $V_{GS}$

**Diagram 8: Drain-source on-state resistance**



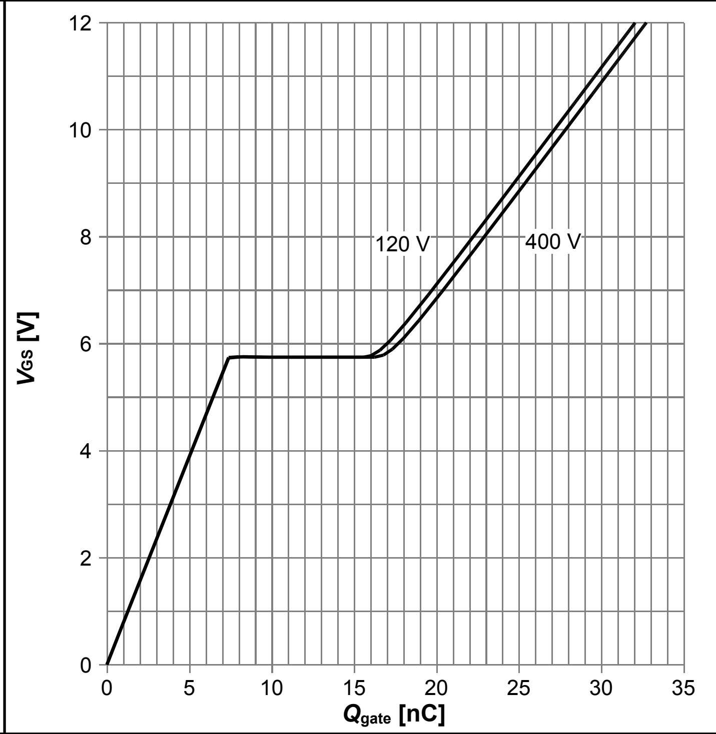

$R_{DS(on)}$=f($T_j$); $I_D$=6.4 A; $V_{GS}$=10 V

**Diagram 9: Typ. transfer characteristics**



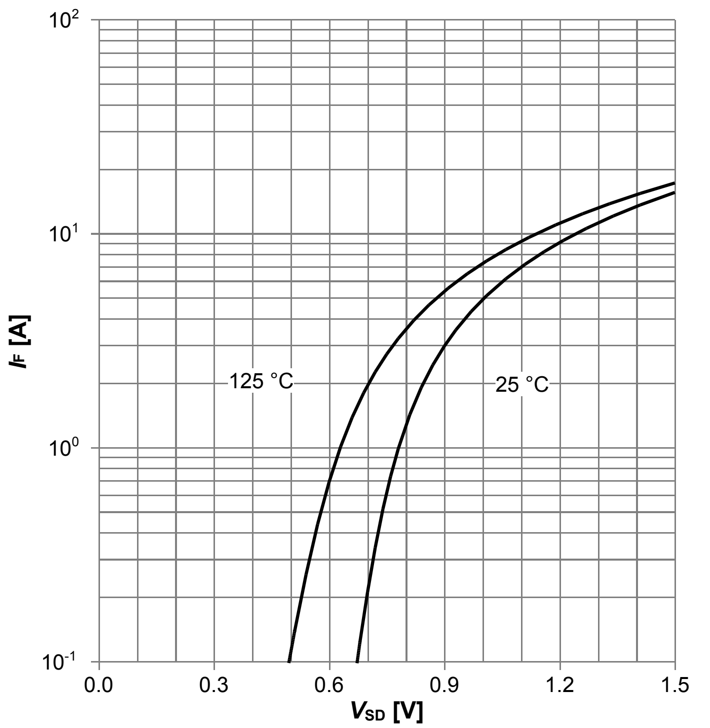

$I_D$=f($V_{GS}$); $V_{DS}$=20V; parameter: $T_j$

**Diagram 10: Typ. gate charge**



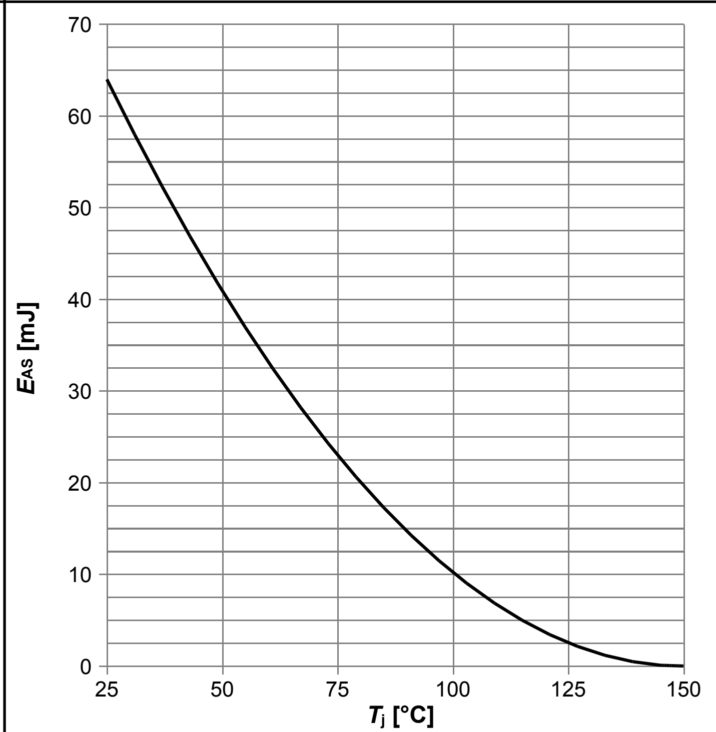

$V_{GS}$=f($Q_{gate}$); $I_D$=6.4 A pulsed; parameter: $V_{DD}$

**Diagram 11: Forward characteristics of reverse diode**



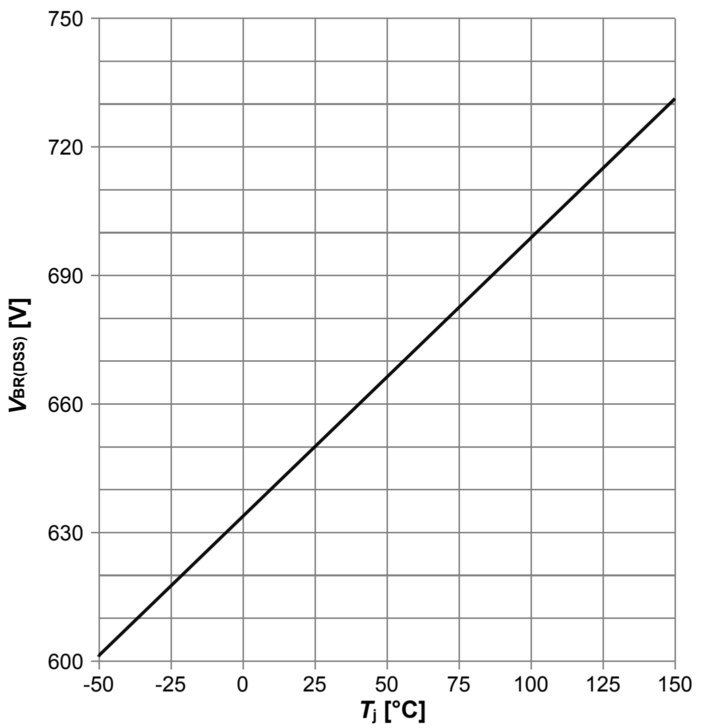

$I_F$=f($V_{SD}$); parameter: $T_j$

**Diagram 12: Avalanche energy**



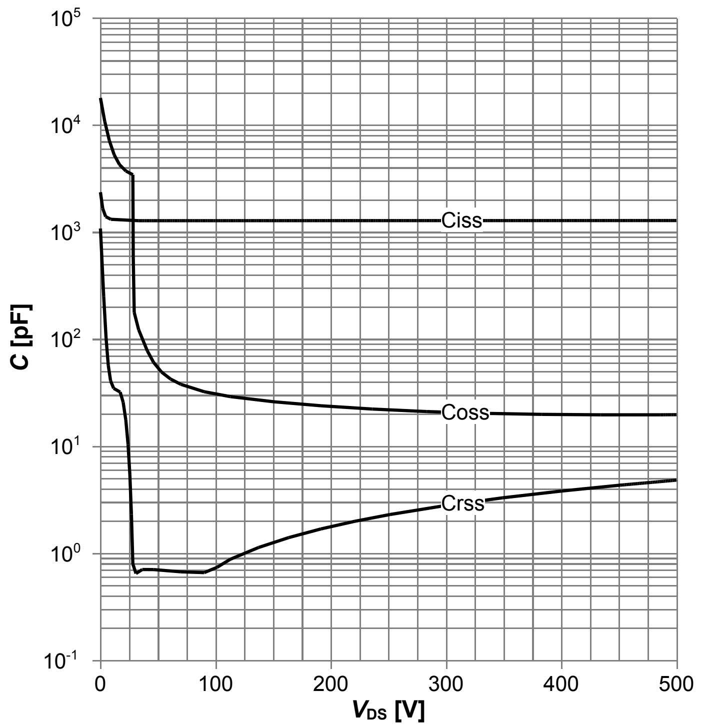

$E_{AS}$=f($T_j$); $I_D$=3.6 A; $V_{DD}$=50 V

**Diagram 13: Drain-source breakdown voltage**



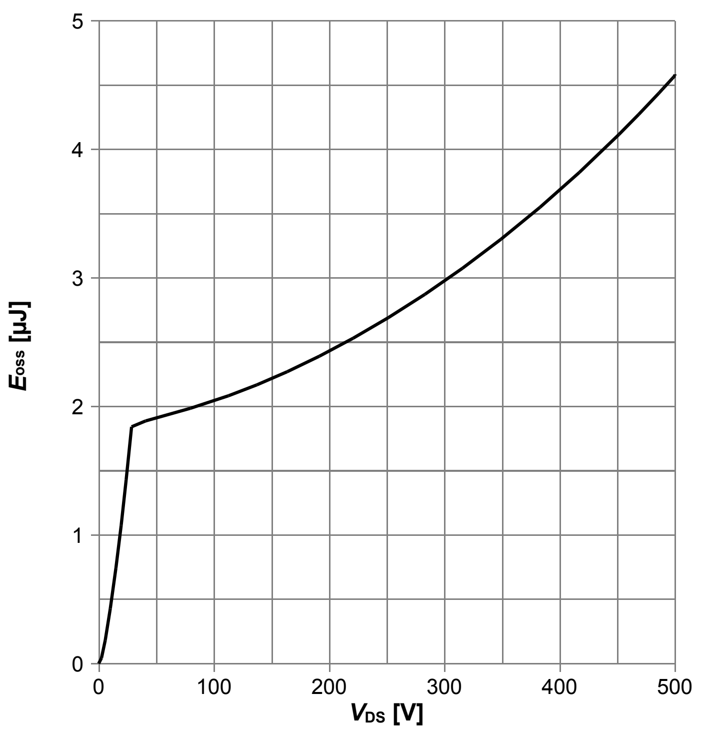

$V_{BR(DSS)}$=f($T_j$); $I_D$=1 mA

**Diagram 14: Typ. capacitances**




$C$=f($V_{DS}$); $V_{GS}$=0 V; $f$=250 kHz

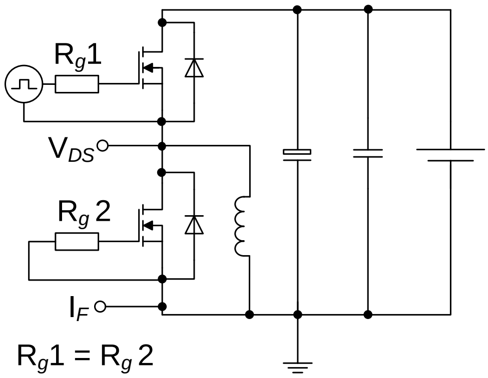
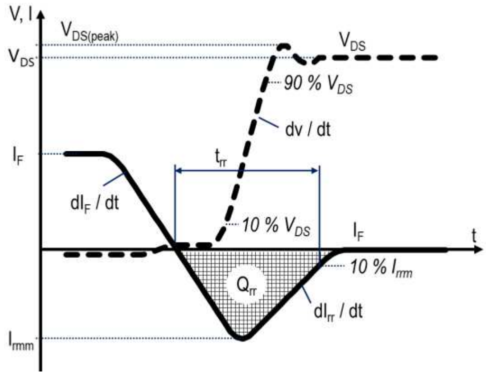
**Diagram 15: Typ. Coss stored energy**



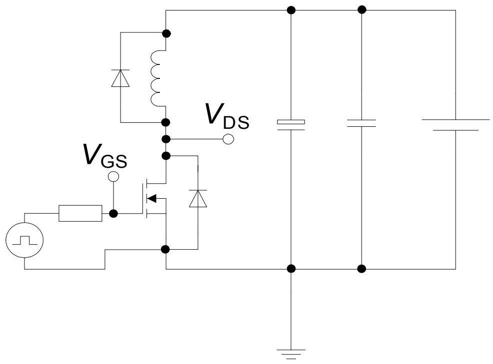
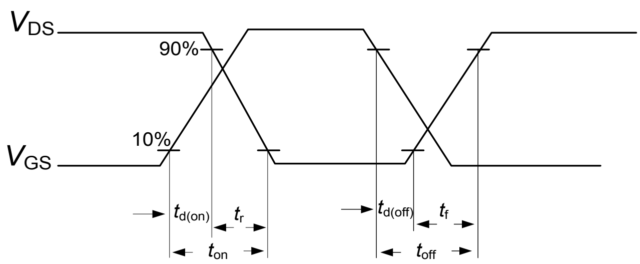

$E_{oss}$=f($V_{DS}$)

# 5 Test Circuits

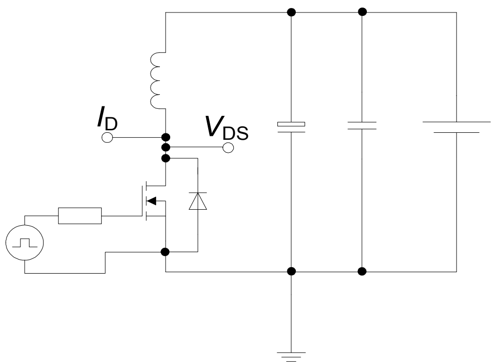
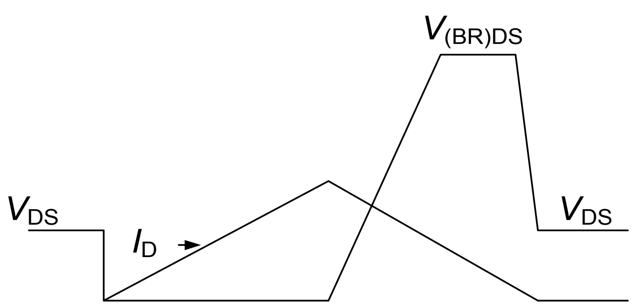
## Table 8 Diode characteristics

| Test circuit for diode characteristics | Diode recovery waveform |
|---|---|
|  |  |

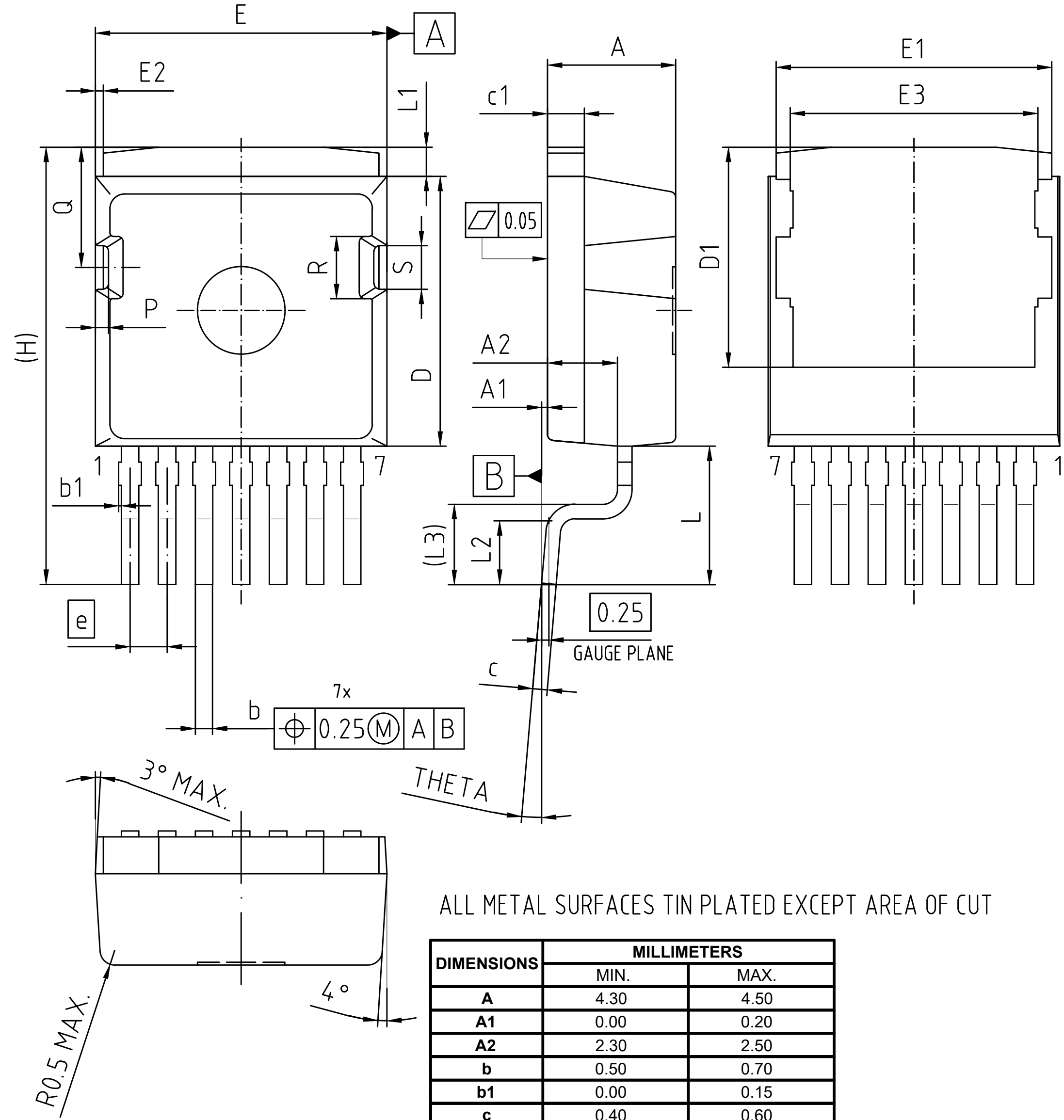
## Table 9 Switching times (ss)

| Switching times test circuit for inductive load | Switching times waveform |
|---|---|
|  |  |

## Table 10 Unclamped inductive load (ss)

| Unclamped inductive load test circuit | Unclamped inductive waveform |
|---|---|
|  |  |

# 6 Package Outlines




| DIMENSIONS | MILLIMETERS | |
|---|---|---|
| | MIN. | MAX. |
| **A** | 4.30 | 4.50 |
| **A1** | 0.00 | 0.20 |
| **A2** | 2.30 | 2.50 |
| **b** | 0.50 | 0.70 |
| **b1** | 0.00 | 0.15 |
| **c** | 0.40 | 0.60 |
| **c1** | 1.17 | 1.37 |
| **D** | 9.05 | 9.45 |
| **D1** | 7.30 | 7.50 |
| **E** | 9.80 | 10.20 |
| **E1** | 9.36 | 9.56 |
| **E2** | 0.00 | 0.30 |
| **E3** | 8.40 | 8.60 |
| **e** | 1.27 | |
| **H** | 15.00 | |
| **L** | 4.20 | 5.20 |
| **L1** | 0.70 | 1.30 |
| **L2** | 1.70 | 2.30 |
| **L3** | 2.70 | |
| **P** | 0.35 | 0.55 |
| **Q** | 4.02 | 4.22 |
| **R** | 2.03 | 2.23 |
| **S** | 1.40 | 1.60 |
| **THETA** | 0.00° | 8.00° |

| |
|---|
| **DOCUMENT NO.** Z8B00189665 |
| **REVISION** 01 |
| **SCALE 5:1** 0 1 2 3 4 5mm |
| **EUROPEAN PROJECTION** |
| **ISSUE DATE** 20.09.2018 |

**Figure 1 Outline PG-TO263-7-11, dimensions in mm**

# 7 Appendix A

## Table 11 Related Links

- **IFX CoolMOS CFD7A Webpage:** www.infineon.com
- **IFX CoolMOS CFD7A application note:** www.infineon.com
- **IFX CoolMOS CFD7A simulation model:** www.infineon.com
- **IFX Design tools:** www.infineon.com

## Revision History

IPBE65R190CFD7A

**Revision: 2020-08-27, Rev. 2.0**

Previous Revision

| Revision | Date | Subjects (major changes since last revision) |
|---|---|---|
| 2.0 | 2020-08-27 | Release of final version |

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**Published by**
**Infineon Technologies AG**
**81726 München, Germany**


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