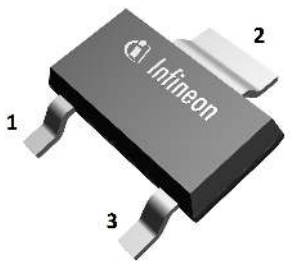
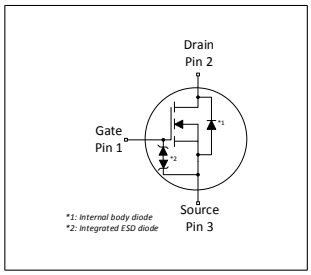
# MOSFET

## 600V CoolMOS™ PFD7 SJ Power Device

PG-SOT223




CoolMOS™ is a revolutionary technology for high voltage power MOSFETs, designed according to the superjunction (SJ) principle and pioneered by Infineon Technologies.
The latest CoolMOS™ PFD7 is an optimized platform tailored to target cost sensitive applications in consumer markets such as charger, adapter, motor drive, lighting, etc.
The new series provides all the benefits of a fast switching Superjunction MOSFET, combined with an excellent price/performance ratio and state of the art ease-of-use level. The technology meets highest efficiency standards and supports high power density, enabling customers going towards very slim designs.




## Features

- Extremely low losses due to very low FOM $R_{DS(on)}$*$Q_g$ and $R_{DS(on)}$*$E_{oss}$
- Low switching losses $E_{oss}$, excellent thermal behavior
- Fast body diode
- Wide range portfolio of $R_{DS(on)}$ and package variations
- Integrated zener diode

## Benefits

- Enables high power density designs and small form factors
- Enables efficiency gains at higher switching frequencies
- Excellent commutation ruggedness
- Easy to select right parts and optimize the design
- High ESD ruggedness

## Potential applications

Recommended for ZVS topologies used in high density chargers, adapters, lighting and motor drives applications, etc.

## Product validation

Qualified according to JEDEC Standard

*Please note: For MOSFET paralleling the use of ferrite beads on the gate or separate totem poles is generally recommended.*

### Table 1 Key Performance Parameters

| Parameter | Value | Unit |
|---|---|---|
| $V_{DS}$ @ $T_{j,max}$ | 650 | V |
| $R_{DS(on),max}$ | 600 | mΩ |
| $Q_{g,typ}$ | 8.5 | nC |
| $I_{D,pulse}$ | 14 | A |
| $E_{oss}$ @ 400V | 1.1 | µJ |
| Body diode $di_F/dt$ | 1300 | A/µs |
| ESD Class (HBM) | 2 | - |

| Type / Ordering Code | Package | Marking | Related Links |
|---|---|---|---|
| IPN60R600PFD7S | PG-SOT223 | 60S600D7 | 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>- | 6<br>4 | A | $T_C$=25°C<br>$T_C$=100°C |
| Pulsed drain current[2] | $I_{D,pulse}$ | - | - | 14 | A | $T_C$=25°C |
| Avalanche energy, single pulse | $E_{AS}$ | - | - | 17 | mJ | $I_D$=1.4A; $V_{DD}$=50V; see table 10 |
| Avalanche energy, repetitive | $E_{AR}$ | - | - | 0.08 | mJ | $I_D$=1.4A; $V_{DD}$=50V; see table 10 |
| Avalanche current, single pulse | $I_{AS}$ | - | - | 1.4 | 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) | $V_{GS}$ | -30 | - | 30 | V | AC (f>1 Hz) |
| Power dissipation | $P_{tot}$ | - | - | 7 | W | $T_C$=25°C |
| Storage temperature | $T_{stg}$ | -40 | - | 150 | °C | - |
| Operating junction temperature | $T_j$ | -40 | - | 150 | °C | - |
| Mounting torque | - | - | - | - | Ncm | - |
| Continuous diode forward current[1] | $I_S$ | - | - | 6 | A | $T_C$=25°C |
| Diode pulse current[2] | $I_{S,pulse}$ | - | - | 14 | A | $T_C$=25°C |
| Reverse diode dv/dt[3] | dv/dt | - | - | 70 | V/ns | $V_{DS}$=0...400V, $I_{SD}$<=4.7A, $T_j$=25°C see table 8 |
| Maximum diode commutation speed | $di_F/dt$ | - | - | 1300 | A/µs | $V_{DS}$=0...400V, $I_{SD}$<=4.7A, $T_j$=25°C see table 8 |
| Insulation withstand voltage | $V_{ISO}$ | - | - | n.a. | V | $V_{rms}$, $T_C$=25°C, $t$=1min |

[1] Limited by $T_{j,max}$. Maximum Duty Cycle D = 0.50; DPAK / IPAK equivalent.
[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 - solder point | $R_{thJS}$ | - | - | 18.2 | °C/W | - |
| Thermal resistance, junction - ambient | $R_{thJA}$ | - | - | 160 | °C/W | device on PCB, minimal footprint |
| Thermal resistance, junction - ambient for SMD version | $R_{thJA}$ | - | 35 | 75 | °C/W | Device on 40mm*40mm*1.5mm epoxy PCB FR4 with 6cm² (one layer, 70µm thickness) copper area for drain connection and cooling. PCB is vertical without air stream cooling. |
| Soldering temperature, wavesoldering only allowed at leads | $T_{sold}$ | - | - | 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 | $V_{(BR)DSS}$ | 600 | - | - | V | $V_{GS}$=0V, $I_D$=1mA |
| Gate threshold voltage | $V_{(GS)th}$ | 3.5 | 4 | 4.5 | V | $V_{DS}$=$V_{GS}$, $I_D$=0.08mA |
| Zero gate voltage drain current[1] | $I_{DSS}$ | -<br>- | -<br>2 | 1<br>37 | µA | $V_{DS}$=600V, $V_{GS}$=0V, $T_j$=25°C<br>$V_{DS}$=600V, $V_{GS}$=0V, $T_j$=125°C |
| Gate-source leakage current | $I_{GSS}$ | - | - | 1000 | nA | $V_{GS}$=20V, $V_{DS}$=0V |
| Drain-source on-state resistance | $R_{DS(on)}$ | -<br>- | 0.517<br>1.219 | 0.600<br>- | Ω | $V_{GS}$=10V, $I_D$=1.7A, $T_j$=25°C<br>$V_{GS}$=10V, $I_D$=1.7A, $T_j$=150°C |
| Gate resistance | $R_G$ | - | 11.0 | - | Ω | $f$=1MHz, open drain |

## Table 5 Dynamic characteristics

| Parameter | Symbol | Values | | | Unit | Note / Test Condition |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| Input capacitance | $C_{iss}$ | - | 344 | - | pF | $V_{GS}$=0V, $V_{DS}$=400V, $f$=250kHz |
| Output capacitance | $C_{oss}$ | - | 8 | - | pF | $V_{GS}$=0V, $V_{DS}$=400V, $f$=250kHz |
| Effective output capacitance, energy related[2] | $C_{o(er)}$ | - | 13 | - | pF | $V_{GS}$=0V, $V_{DS}$=0...400V |
| Effective output capacitance, time related[3] | $C_{o(tr)}$ | - | 120 | - | pF | $I_D$=constant, $V_{GS}$=0V, $V_{DS}$=0...400V |
| Turn-on delay time | $t_{d(on)}$ | - | 9.2 | - | ns | $V_{DD}$=400V, $V_{GS}$=10V, $I_D$=1.7A, $R_G$=10.2Ω; see table 9 |
| Rise time | $t_r$ | - | 10 | - | ns | $V_{DD}$=400V, $V_{GS}$=10V, $I_D$=1.7A, $R_G$=10.2Ω; see table 9 |
| Turn-off delay time | $t_{d(off)}$ | - | 43.5 | - | ns | $V_{DD}$=400V, $V_{GS}$=10V, $I_D$=1.7A, $R_G$=10.2Ω; see table 9 |
| Fall time | $t_f$ | - | 23 | - | ns | $V_{DD}$=400V, $V_{GS}$=10V, $I_D$=1.7A, $R_G$=10.2Ω; see table 9 |

## Table 6 Gate charge characteristics

| Parameter | Symbol | Values | | | Unit | Note / Test Condition |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| Gate to source charge | $Q_{gs}$ | - | 2.0 | - | nC | $V_{DD}$=400V, $I_D$=1.7A, $V_{GS}$=0 to 10V |
| Gate to drain charge | $Q_{gd}$ | - | 3.0 | - | nC | $V_{DD}$=400V, $I_D$=1.7A, $V_{GS}$=0 to 10V |
| Gate charge total | $Q_g$ | - | 8.5 | - | nC | $V_{DD}$=400V, $I_D$=1.7A, $V_{GS}$=0 to 10V |
| Gate plateau voltage | $V_{plateau}$ | - | 5.6 | - | V | $V_{DD}$=400V, $I_D$=1.7A, $V_{GS}$=0 to 10V |

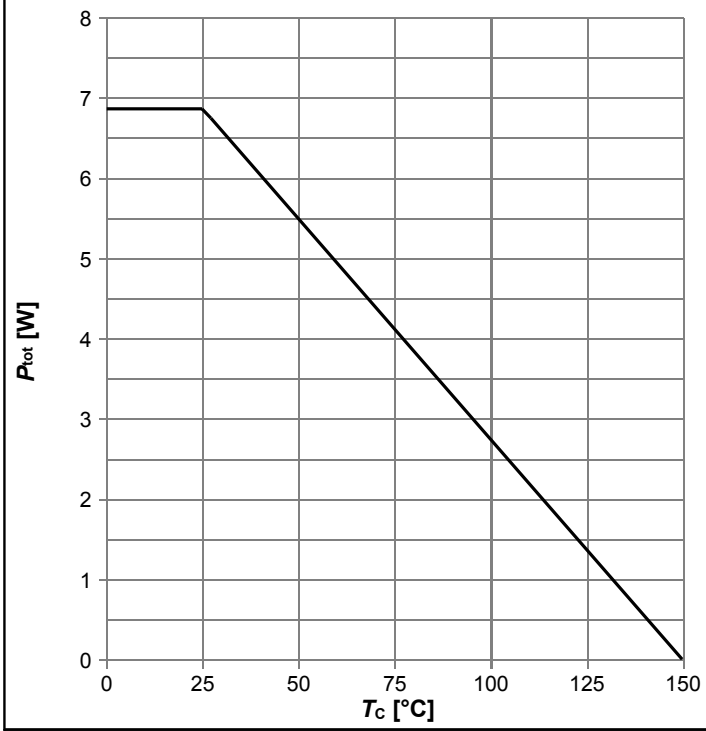
[1] Maximum specification is defined by calculated six sigma upper confidence bound
[2] $C_{o(er)}$ is a fixed capacitance that gives the same stored energy as $C_{oss}$ while $V_{DS}$ is rising from 0 to 400V
[3] $C_{o(tr)}$ is a fixed capacitance that gives the same charging time as $C_{oss}$ while $V_{DS}$ is rising from 0 to 400V

## Table 7 Reverse diode characteristics

| Parameter | Symbol | Values | | | Unit | Note / Test Condition |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| Diode forward voltage | $V_{SD}$ | - | 1.0 | - | V | $V_{GS}$=0V, $I_F$=1.7A, $T_j$=25°C |
| Reverse recovery time | $t_{rr}$ | - | 47 | 71 | ns | $V_R$=400V, $I_F$=1.7A, d$i_F$/d$t$=100A/µs; see table 8 |
| Reverse recovery charge | $Q_{rr}$ | - | 0.10 | 0.20 | µC | $V_R$=400V, $I_F$=1.7A, d$i_F$/d$t$=100A/µs; see table 8 |
| Peak reverse recovery current | $I_{rrm}$ | - | 3.8 | - | A | $V_R$=400V, $I_F$=1.7A, d$i_F$/d$t$=100A/µs; see table 8 |

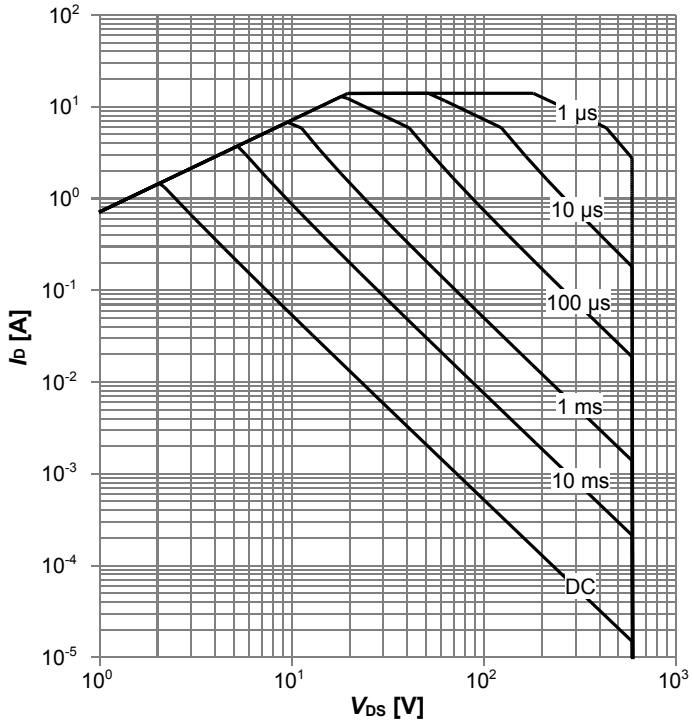
# 4 Electrical characteristics diagrams

**Diagram 1: Power dissipation**



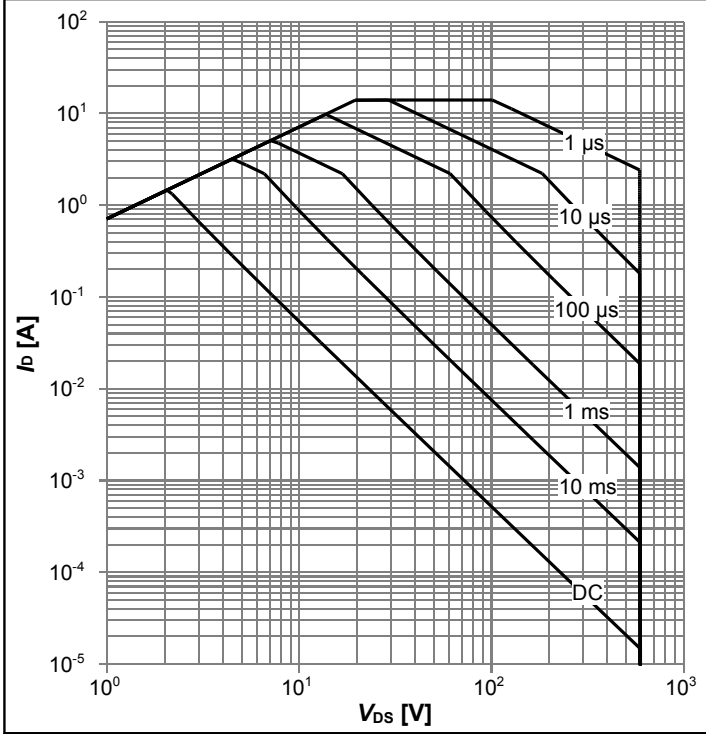

$P_{tot}=f(T_C)$

**Diagram 2: Safe operating area**



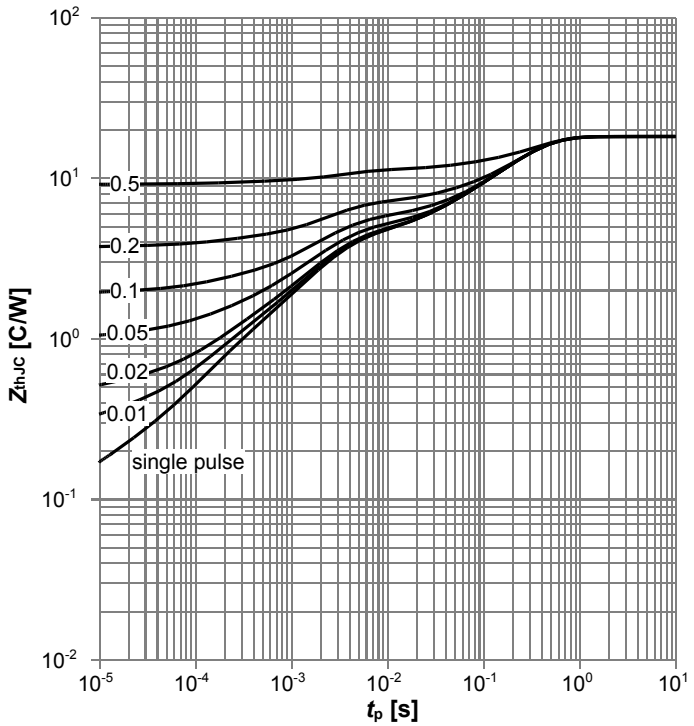

$I_D=f(V_{DS})$; $T_C$=25 °C; $D$=0; parameter: $t_p$

**Diagram 3: Safe operating area**



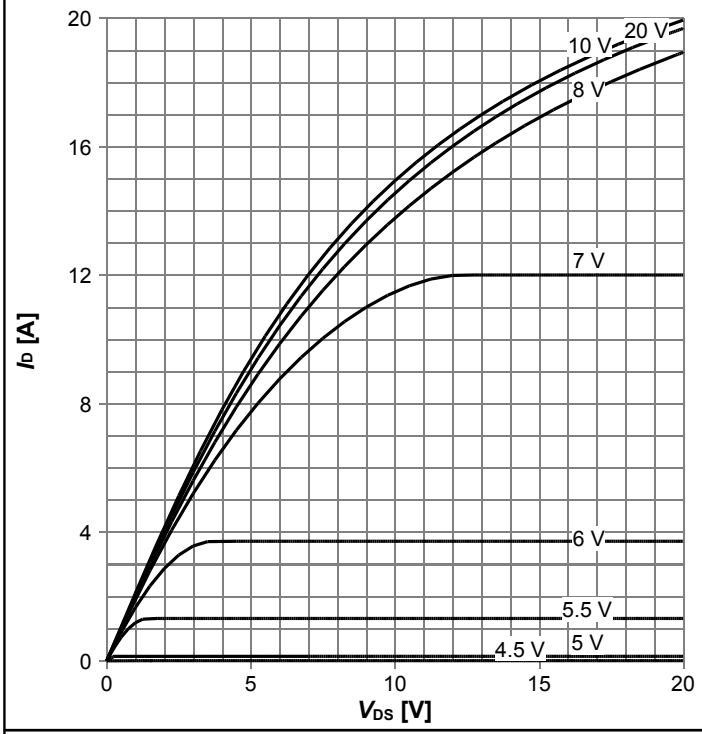

$I_D=f(V_{DS})$; $T_C$=80 °C; $D$=0; parameter: $t_p$

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



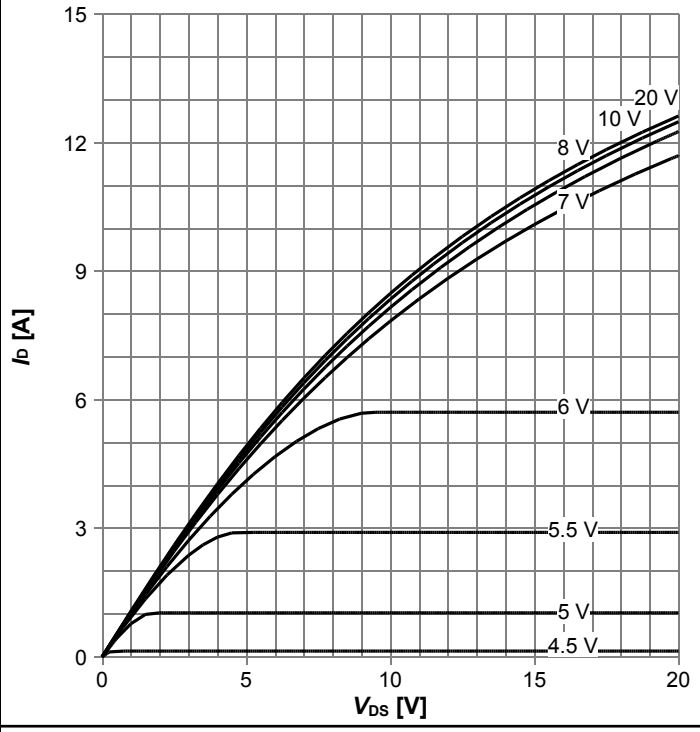

$Z_{thJC}=f(t_P)$; parameter: $D=t_p/T$

**Diagram 5: Typ. output characteristics**



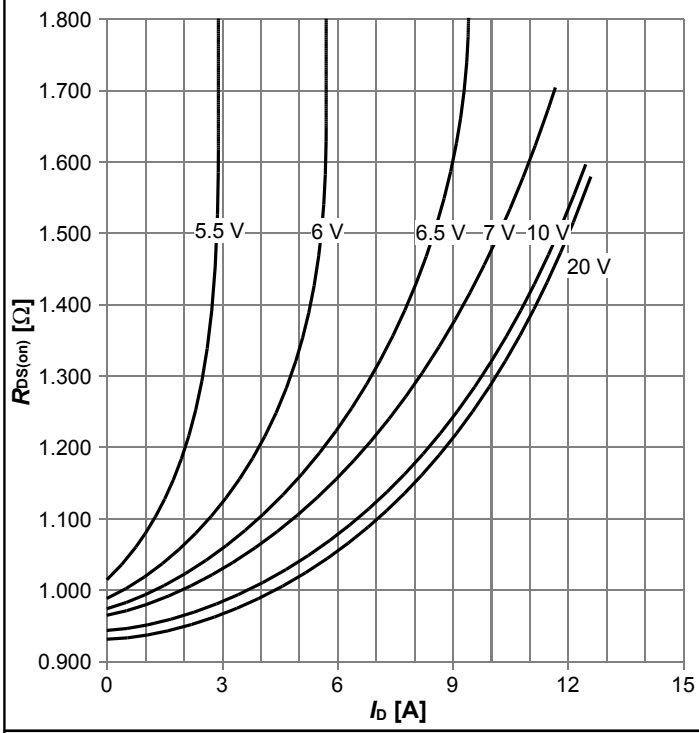

$I_D=f(V_{DS})$; $T_j=25$ °C; parameter: $V_{GS}$

**Diagram 6: Typ. output characteristics**



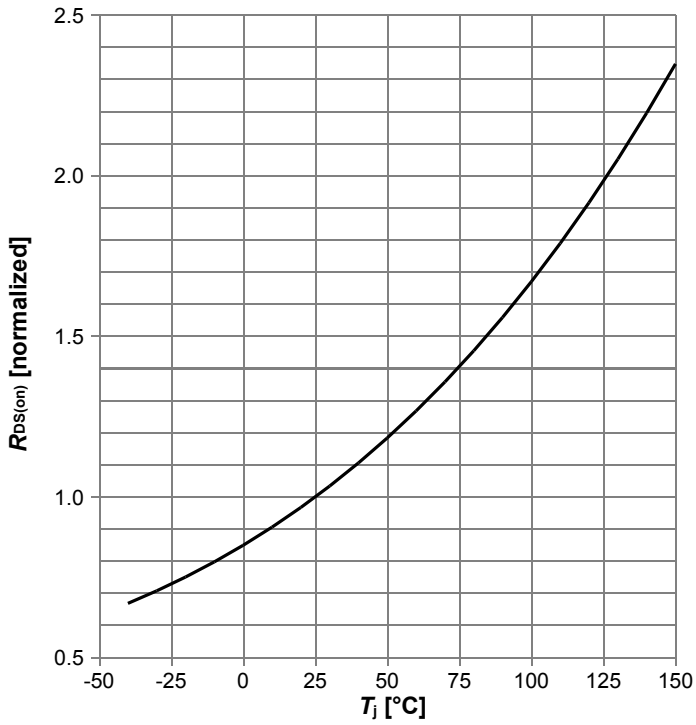

$I_D=f(V_{DS})$; $T_j=125$ °C; parameter: $V_{GS}$

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



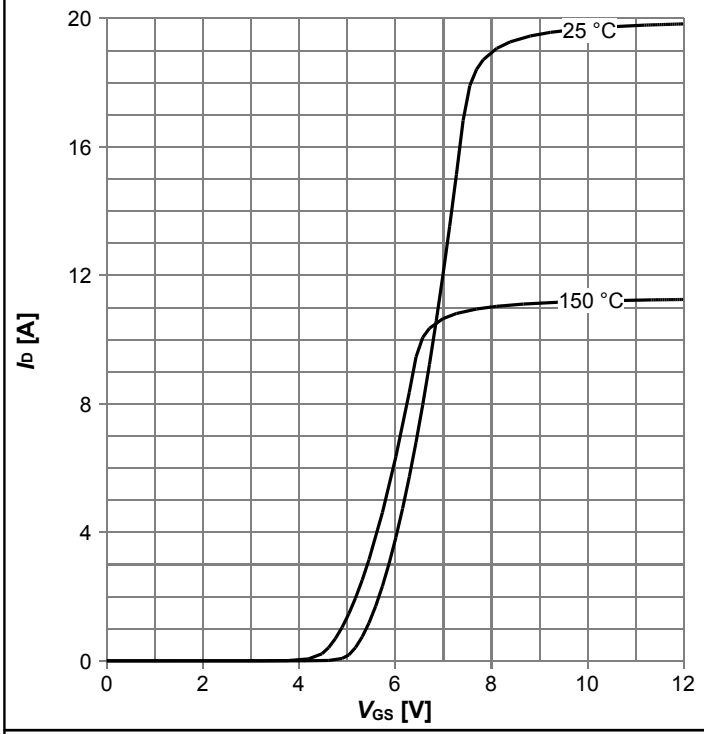

$R_{DS(on)}=f(I_D)$; $T_j=125$ °C; parameter: $V_{GS}$

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



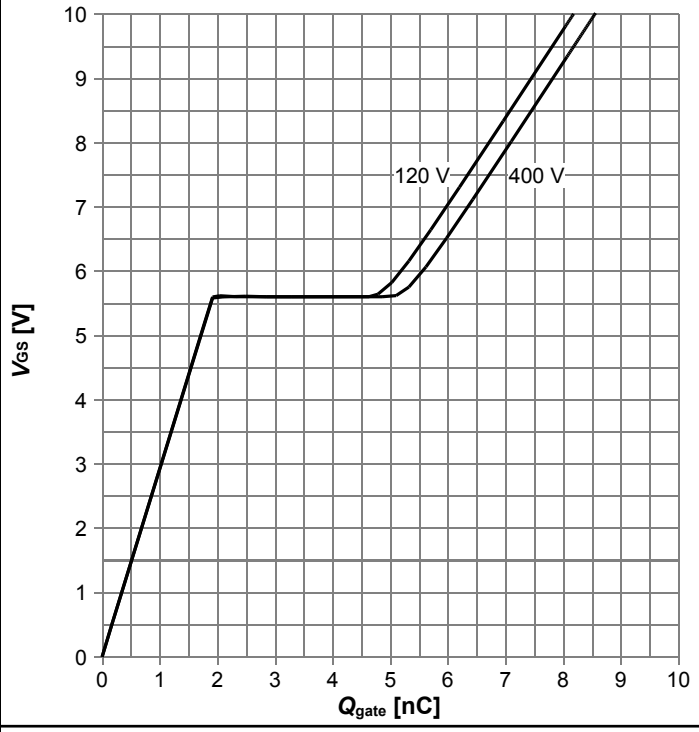

$R_{DS(on)}=f(T_j)$; $I_D=1.7$ A; $V_{GS}=10$ V

**Diagram 9: Typ. transfer characteristics**



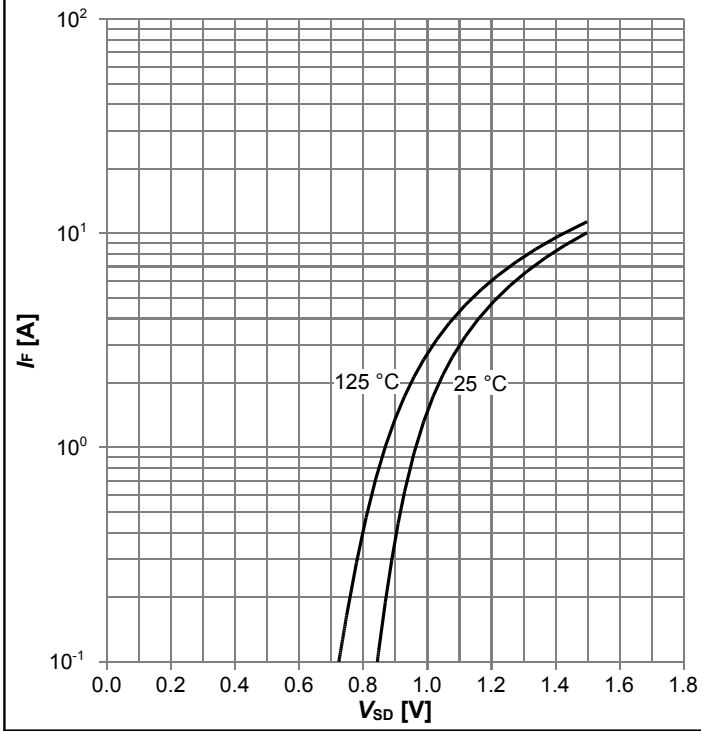

$I_D$=f($V_{GS}$); $V_{DS}$=20V; parameter: $T_j$

**Diagram 10: Typ. gate charge**



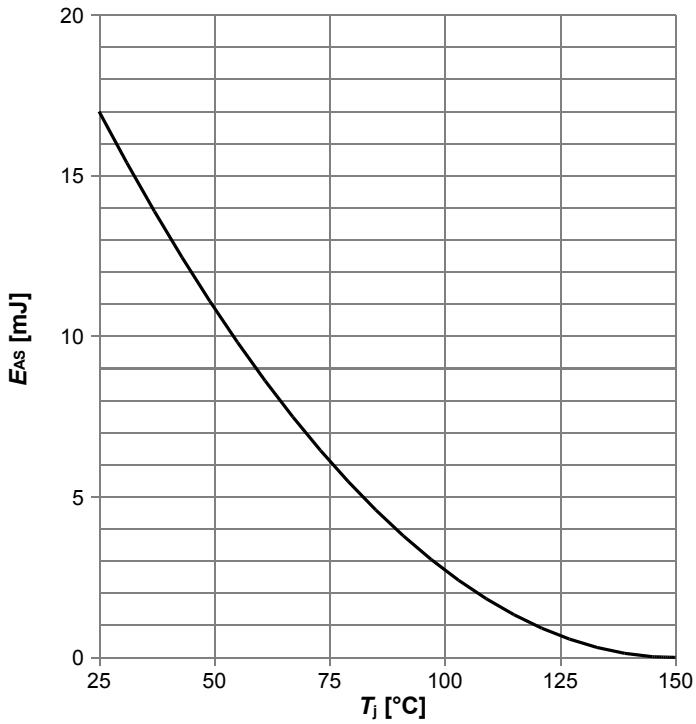

$V_{GS}$=f($Q_{gate}$); $I_D$=1.7 A pulsed; parameter: $V_{DD}$

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



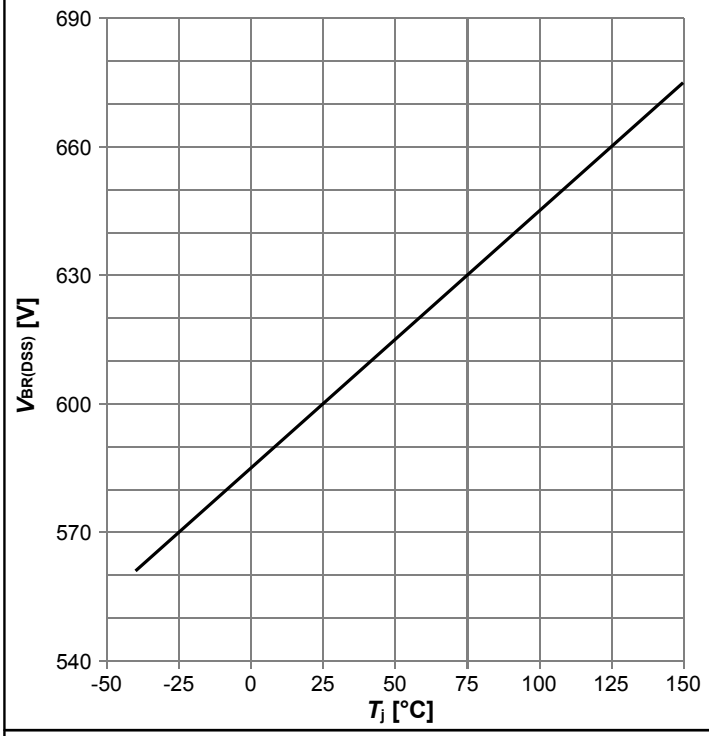

$I_F$=f($V_{SD}$); parameter: $T_j$

**Diagram 12: Avalanche energy**



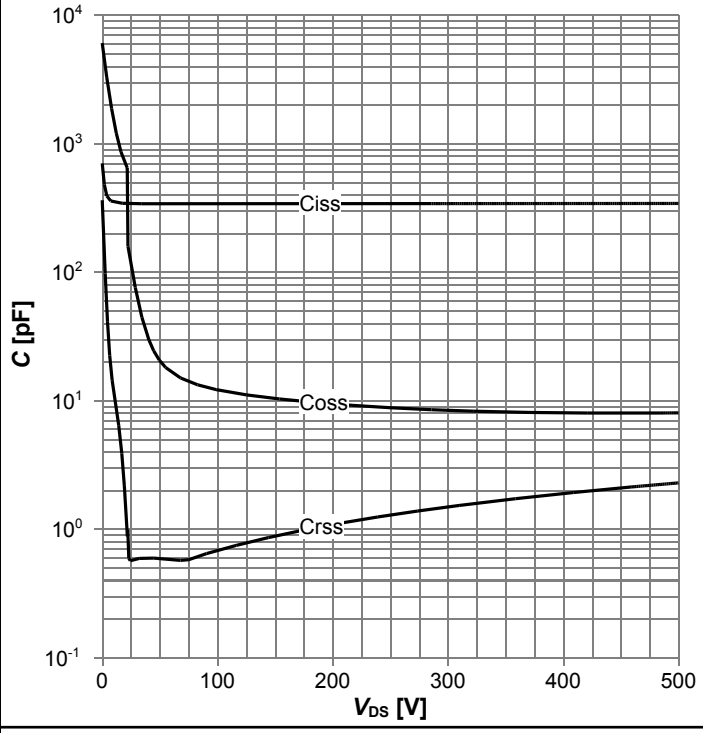

$E_{AS}$=f($T_j$); $I_D$=1.4 A; $V_{DD}$=50 V

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



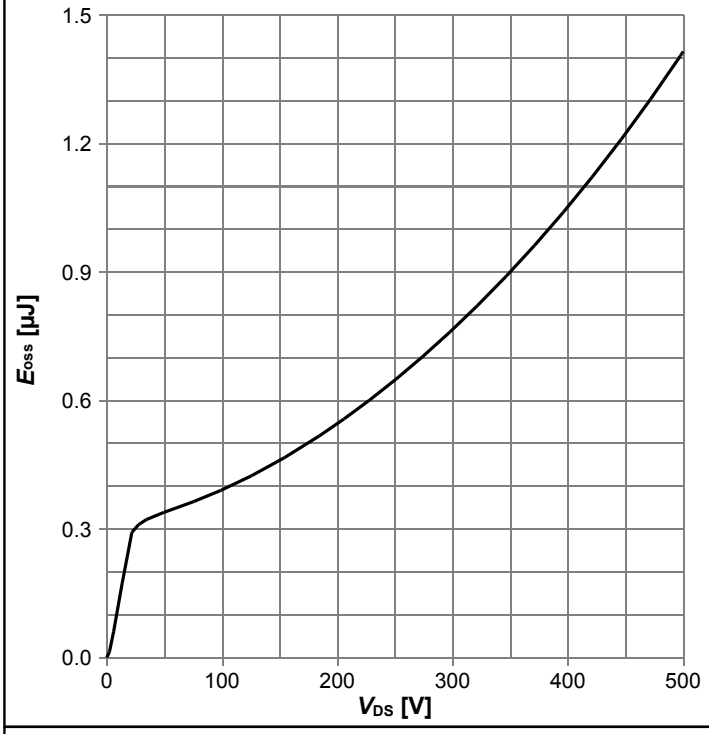

$V_{BR(DSS)}$=f($T_j$); $I_D$=1 mA

**Diagram 14: Typ. capacitances**




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

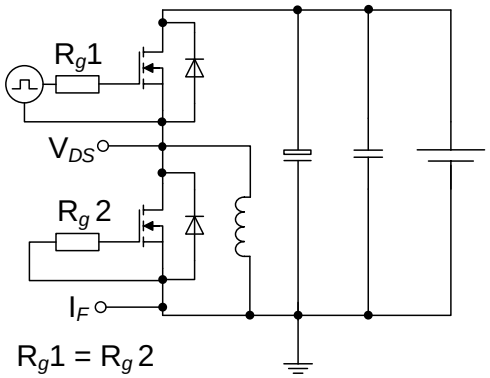
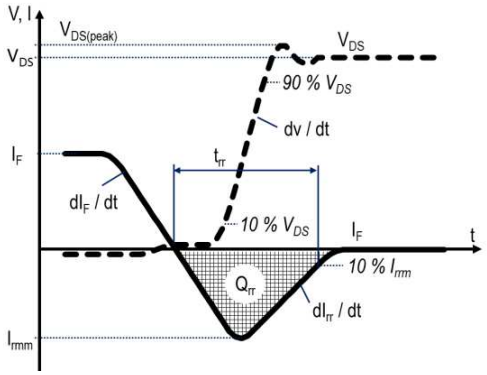
**Diagram 15: Typ. Coss stored energy**




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

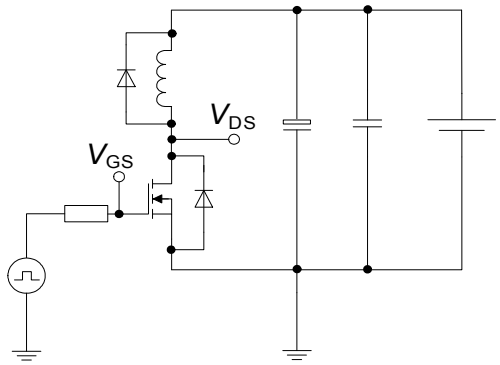
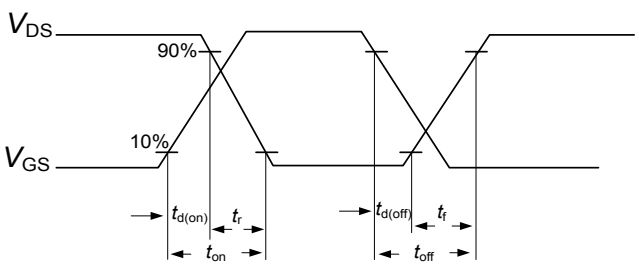
# 5 Test Circuits

## Table 8 Diode characteristics

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

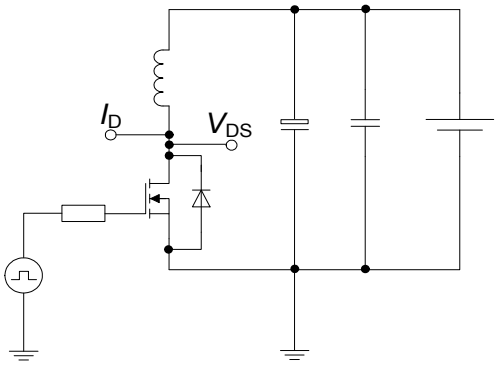
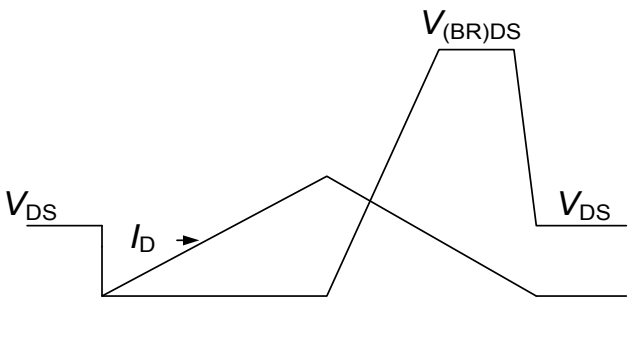


## Table 9 Switching times

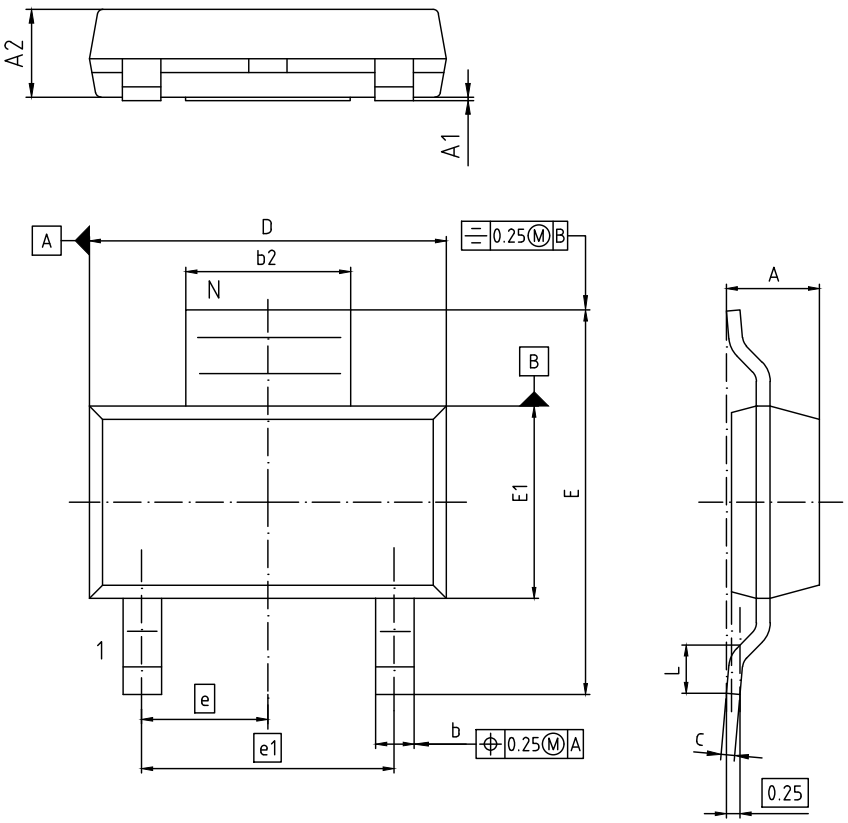
| Switching times test circuit for inductive load | Switching times waveform |
|---|---|
|  |  |



## Table 10 Unclamped inductive load

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

# 6 Package Outlines




NOTES:

1. ALL DIMENSIONS REFER TO JEDEC STANDARD TO-261

| DIM | MILLIMETERS | | INCHES | |
|---|---|---|---|---|
| | MIN | MAX | MIN | MAX |
| **A** | 1.52 | 1.80 | 0.060 | 0.071 |
| **A1** | - | 0.10 | - | 0.004 |
| **A2** | 1,50 | 1.70 | 0.059 | 0.067 |
| **b** | 0.60 | 0.80 | 0.024 | 0.031 |
| **b2** | 2.95 | 3.10 | 0.116 | 0.122 |
| **c** | 0.24 | 0.32 | 0.009 | 0.013 |
| **D** | 6.30 | 6.70 | 0.248 | 0.264 |
| **E** | 6.70 | 7.30 | 0.264 | 0.287 |
| **E1** | 3.30 | 3.70 | 0.130 | 0.146 |
| **e** | 2.3 BASIC | | 0.091 BASIC | |
| **e1** | 4.6 BASIC | | 0.181 BASIC | |
| **L** | 0.75 | 1.10 | 0.030 | 0.043 |
| **N** | 3 | | 3 | |
| **O** | 0° | 10° | 0° | 10° |
| | | | | |

**DOCUMENT NO.**
Z8B00180553

**SCALE** 0 2.5 0 2.5 5mm

**EUROPEAN PROJECTION**

**ISSUE DATE**
24-02-2016

**REVISION**
01

**Figure 1 Outline PG-SOT223, dimensions in mm/inches**

# 7 Appendix A

## Table 11 Related Links

- **IFX CoolMOS PFD7 Webpage:** www.infineon.com
- **IFX CoolMOS PFD7 application note:** www.infineon.com
- **IFX CoolMOS PFD7 simulation model:** www.infineon.com
- **IFX Design tools:** www.infineon.com

## Revision History

IPN60R600PFD7S

**Revision: 2019-10-14, Rev. 2.0**

| Previous Revision | | |
|---|---|---|
| Revision | Date | Subjects (major changes since last revision) |
| 2.0 | 2019-10-14 | Release of final version |



**We Listen to Your Comments**
Any information within this document that you feel is wrong, unclear or missing at all? Your feedback will help us to continuously improve the quality of this document. Please send your proposal (including a reference to this document) to:
**erratum@infineon.com**

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


**Legal Disclaimer**
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.

**Information**
For further information on technology, delivery terms and conditions and prices please contact your nearest Infineon Technologies Office (**www.infineon.com**).

**Warnings**
Due to technical requirements, components may contain dangerous substances. For information on the types in question, please contact the nearest Infineon Technologies Office.
The Infineon Technologies component described in this Data Sheet may be used in life-support devices or systems and/or automotive, aviation and aerospace applications or systems only with the express written approval of Infineon Technologies, if a failure of such components can reasonably be expected to cause the failure of that life-support, automotive, aviation and aerospace device or system or to affect the safety or effectiveness of that device or system. Life support devices or systems are intended to be implanted in the human body or to support and/or maintain and sustain and/or protect human life. If they fail, it is reasonable to assume that the health of the user or other persons may be endangered.