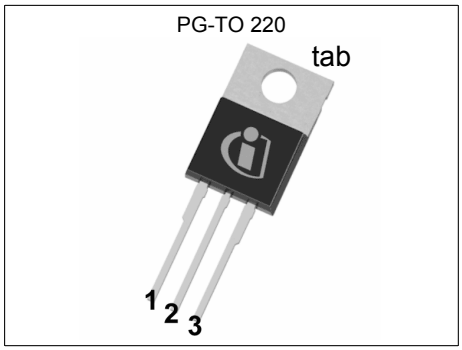
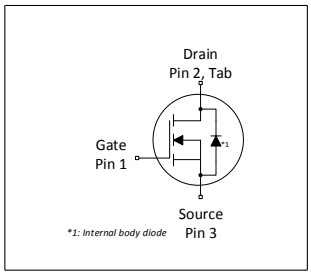
# MOSFET

## 600V CoolMOS™ SJ S7 Power Device




IPP60R040S7 enables the best price performance for low frequency switching applications. CoolMOS™ S7 boasts the lowest Rdson values for a HV SJ MOSFET, with distinctive increase of energy efficiency.

CoolMOS™ S7 is optimized for “static switching” and high current applications. It is an ideal fit for solid state relay and circuit breaker designs as well as for line rectification in SMPS and inverter topologies.




## Features

- CoolMOS™ S7 technology enables 40mΩ $R_{DS(on)}$ in the smallest footprint
- Optimized price performance in low frequency switching applications
- High pulse current capability
- TO220 package with total Pb-free die attach

## Benefits

- Minimized conduction losses (eliminate / reduce heat sink)
- Increased system performance
- More compact and easier design
- Lower BOM or/and TCO over prolonged life time

Compared to electromechanical devices:
- Faster switching times
- More reliability and longer system life time
- Shock & Vibration resistance
- No contact arcing, bouncing or degradation over life time

## Potential applications

- Solid state relays and circuit breakers
- Line rectification in high power/performance applications e.g. Computing, Telecom, UPS and Solar

## Product validation

Fully qualified according to JEDEC for Industrial Applications

*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 |
|---|---|---|
| $R_{DS(on),max}$ | 40 | mΩ |
| $Q_{g,typ}$ | 83 | nC |
| $V_{SD}$ | 0.82 | V |
| Pulsed $I_{SD}$, $I_{DS}$ | 207 | A |

| Type / Ordering Code | Package | Marking | Related Links |
|---|---|---|---|
| IPP60R040S7 | PG-TO220-3 | 60R040S7 | 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. | | |
| Drain current rating | $I_D$ | - | - | 13 | A | $T_C$=140°C<br>Current is limited by $T_{j\,max}$ = 150°C;<br>Lower case temp does increase current capability |
| Pulsed drain current[1] | $I_{D,pulse}$ | - | - | 207 | A | $T_C$=25°C |
| Avalanche energy, single pulse | $E_{AS}$ | - | - | 159 | mJ | $I_D$=2.8A; $V_{DD}$=50V; see table 10 |
| Avalanche current, single pulse | $I_{AS}$ | - | - | 2.8 | A | - |
| MOSFET dv/dt ruggedness[2] | dv/dt | - | - | 20 | V/ns | $V_{DS}$= 0V to 300V |
| 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 | $P_{tot}$ | - | - | 245 | W | $T_C$=25°C |
| Storage temperature | $T_{stg}$ | -55 | - | 150 | °C | - |
| Operating junction temperature | $T_j$ | -55 | - | 150 | °C | - |
| Mounting torque | - | - | - | 60 | Ncm | M3 and M3.5 screws |
| Diode forward current rating | $I_S$ | - | - | 13 | A | $T_C$=140°C<br>Current is limited by $T_{j\,max}$ = 150°C;<br>Lower case temp does increase current capability |
| Diode pulse current[1] | $I_{S,pulse}$ | - | - | 207 | A | $T_C$=25°C |
| Reverse diode dv/dt[3] | dv/dt | - | - | 5 | V/ns | $V_{DS}$=0 to 300V, $I_{SD}$<=13A, $T_j$=25°C see table 8 |
| Maximum diode commutation speed | $di_f/dt$ | - | - | 820 | A/µs | $V_{DS}$=0 to 300V, $I_{SD}$<=13A, $T_j$=25°C see table 8 |
| Insulation withstand voltage | $V_{ISO}$ | - | - | n.a. | V | $V_{rms}$, $T_C$=25°C, $t$=1min |

[1] Pulse width $t_p$ limited by $T_{j,max}$
[2] The dv/dt has to be limited by appropriate gate resistor
[3] Identical low side and high side switch

## 2 Thermal characteristics

**Table 3 Thermal characteristics**

| Parameter | Symbol | Values | | | Unit | Note / Test Condition |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| Thermal resistance, junction - case | $R_{thJC}$ | - | - | 0.51 | °C/W | - |
| Thermal resistance, junction - ambient | $R_{thJA}$ | - | - | 62 | °C/W | leaded |
| Thermal resistance, junction - ambient for SMD version | $R_{thJA}$ | - | - | - | °C/W | n.a. |
| Soldering temperature, wavesoldering only allowed at leads | $T_{sold}$ | - | - | 260 | °C | 1.6mm (0.063 in.) from case for 10s |

# 3 Electrical characteristics

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

## Table 4 Static characteristics

For applications with applied blocking voltage >70% of the specified blocking voltage, it is required that the customer evaluates the impact of cosmic radiation effect in early design phase and contacts the Infineon sales office for the necessary technical support by Infineon

| 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 | 4.0 | 4.5 | V | $V_{DS}$=$V_{GS}$, $I_D$=0.79mA |
| Zero gate voltage drain current | $I_{DSS}$ | -<br>- | -<br>20 | 2<br>- | µA | $V_{DS}$=600V, $V_{GS}$=0V, $T_j$=25°C<br>$V_{DS}$=600V, $V_{GS}$=0V, $T_j$=150°C |
| Gate-source leakage current | $I_{GSS}$ | - | - | 100 | nA | $V_{GS}$=20V, $V_{DS}$=0V |
| Drain-source on-state resistance | $R_{DS(on)}$ | -<br>- | 0.036<br>0.085 | 0.040<br>- | Ω | $V_{GS}$=12V, $I_D$=13A, $T_j$=25°C<br>$V_{GS}$=12V, $I_D$=13A, $T_j$=150°C |
| Gate resistance | $R_G$ | - | 0.8 | - | Ω | $f$=1MHz, open drain |

## Table 5 Dynamic characteristics

| Parameter | Symbol | Values | | | Unit | Note / Test Condition |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| Input capacitance | $C_{iss}$ | - | 3127 | - | pF | $V_{GS}$=0V, $V_{DS}$=300V, $f$=250kHz |
| Output capacitance | $C_{oss}$ | - | 50 | - | pF | $V_{GS}$=0V, $V_{DS}$=300V, $f$=250kHz |
| Effective output capacitance, energy related[1)] | $C_{o(er)}$ | - | 168 | - | pF | $V_{GS}$=0V, $V_{DS}$=0 to 300V |
| Effective output capacitance, time related[2)] | $C_{o(tr)}$ | - | 1475 | - | pF | $I_D$=constant, $V_{GS}$=0V, $V_{DS}$=0 to 300V |
| Output charge | $Q_{oss}$ | - | 443 | - | nC | $V_{GS}$=0V, $V_{DS}$=0 to 300V |
| Turn-on delay time | $t_{d(on)}$ | - | 25 | - | ns | $V_{DD}$=300V, $V_{GS}$=13V, $I_D$=13A, $R_G$=8Ω; see table 9 |
| Rise time | $t_r$ | - | 10 | - | ns | $V_{DD}$=300V, $V_{GS}$=13V, $I_D$=13A, $R_G$=8Ω; see table 9 |
| Turn-off delay time | $t_{d(off)}$ | - | 138 | - | ns | $V_{DD}$=300V, $V_{GS}$=13V, $I_D$=13A, $R_G$=8Ω; see table 9 |
| Fall time | $t_f$ | - | 9 | - | ns | $V_{DD}$=300V, $V_{GS}$=13V, $I_D$=13A, $R_G$=8Ω; see table 9 |

## Table 6 Gate charge characteristics

| Parameter | Symbol | Values | | | Unit | Note / Test Condition |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| Gate to source charge | $Q_{gs}$ | - | 17 | - | nC | $V_{DD}$=300V, $I_D$=13A, $V_{GS}$=0 to 12V |
| Gate to drain charge | $Q_{gd}$ | - | 28 | - | nC | $V_{DD}$=300V, $I_D$=13A, $V_{GS}$=0 to 12V |
| Gate charge total | $Q_g$ | - | 83 | - | nC | $V_{DD}$=300V, $I_D$=13A, $V_{GS}$=0 to 12V |
| Gate plateau voltage | $V_{plateau}$ | - | 5.4 | - | V | $V_{DD}$=300V, $I_D$=13A, $V_{GS}$=0 to 12V |

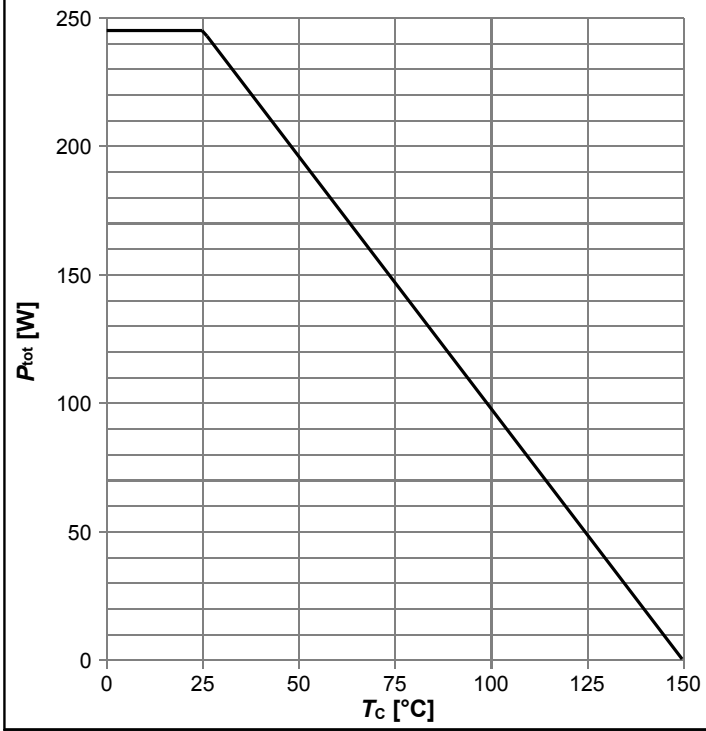
[1)] $C_{o(er)}$ is a fixed capacitance that gives the same stored energy as $C_{oss}$ while $V_{DS}$ is rising from 0 to 300V
[2)] $C_{o(tr)}$ is a fixed capacitance that gives the same charging time as $C_{oss}$ while $V_{DS}$ is rising from 0 to 300V

## Table 7 Reverse diode characteristics

| Parameter | Symbol | Values | | | Unit | Note / Test Condition |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| Diode forward voltage | $V_{SD}$ | - | 0.82 | - | V | $V_{GS}$=0V, $I_F$=13A, $T_j$=25°C |
| Reverse recovery time | $t_{rr}$ | - | 360 | - | ns | $V_R$=300V, $I_F$=13A, d$i_F$/d$t$=100A/µs; see table 8 |
| Reverse recovery charge | $Q_{rr}$ | - | 5.5 | - | µC | $V_R$=300V, $I_F$=13A, d$i_F$/d$t$=100A/µs; see table 8 |
| Peak reverse recovery current | $I_{rrm}$ | - | 32 | - | A | $V_R$=300V, $I_F$=13A, d$i_F$/d$t$=100A/µs; see table 8 |

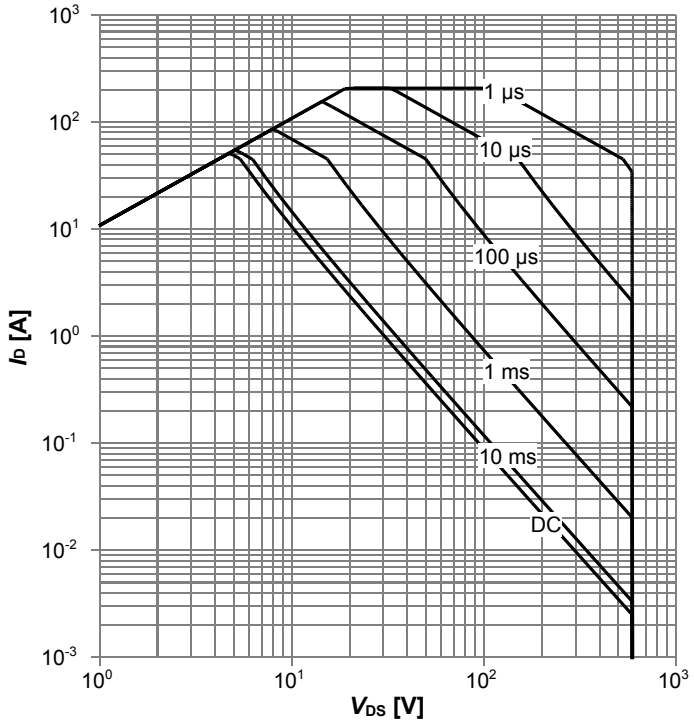
# 4 Electrical characteristics diagrams

**Diagram 1: Power dissipation**



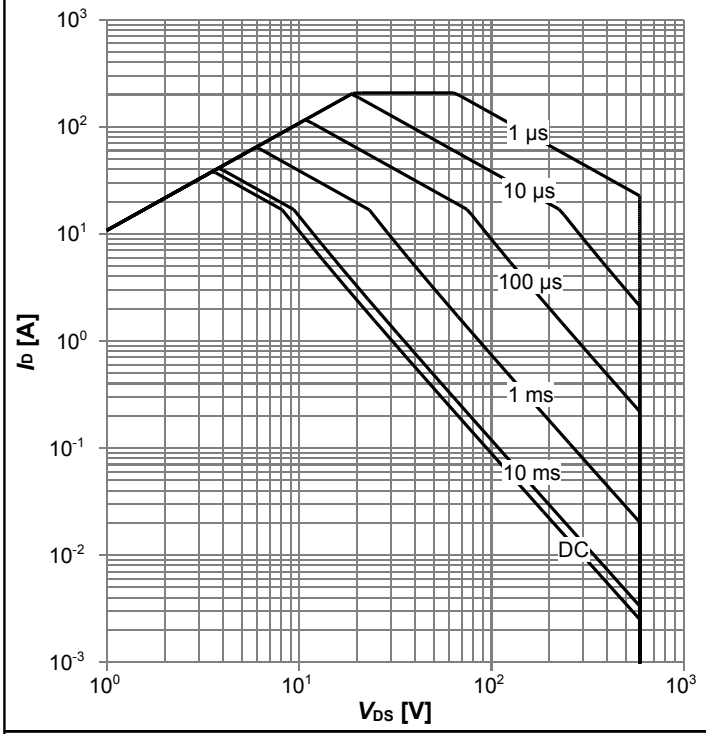

$P_{tot}=f(T_C)$

**Diagram 2: Safe operating area**



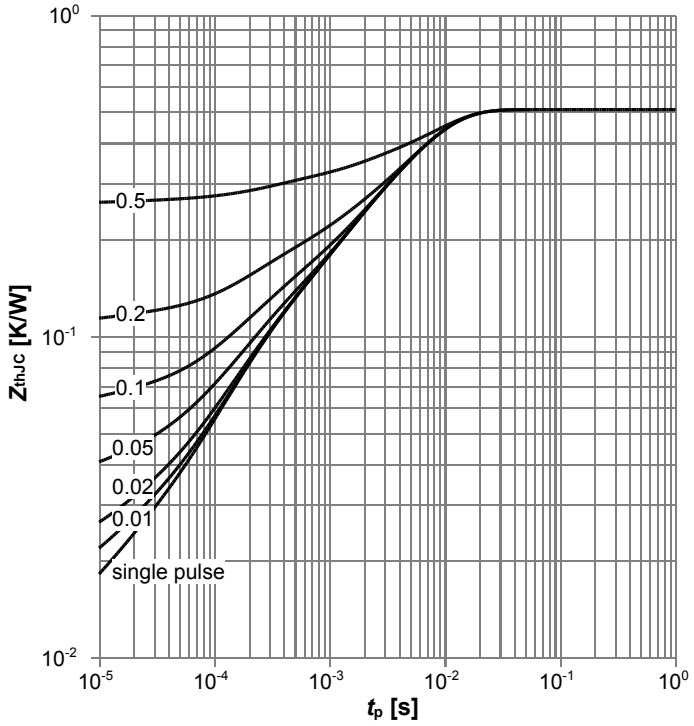

$I_D=f(V_{DS})$; $T_C=25$ °C; $D=0$; parameter: $t_p$

**Diagram 3: Safe operating area**



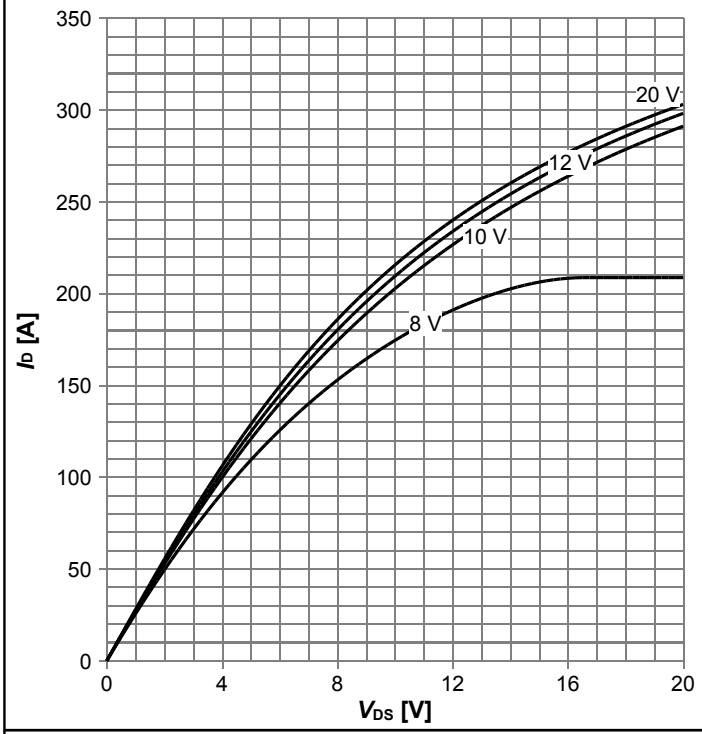

$I_D=f(V_{DS})$; $T_C=80$ °C; $D=0$; parameter: $t_p$

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



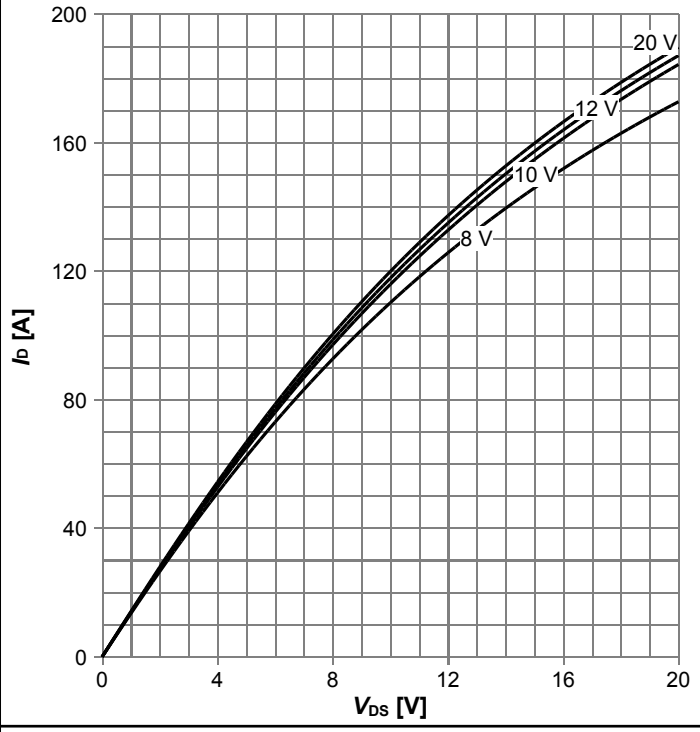

$Z_{thJC}=f(t_P)$; parameter: $D=t_p/T$

**Diagram 5: Typ. output characteristics**



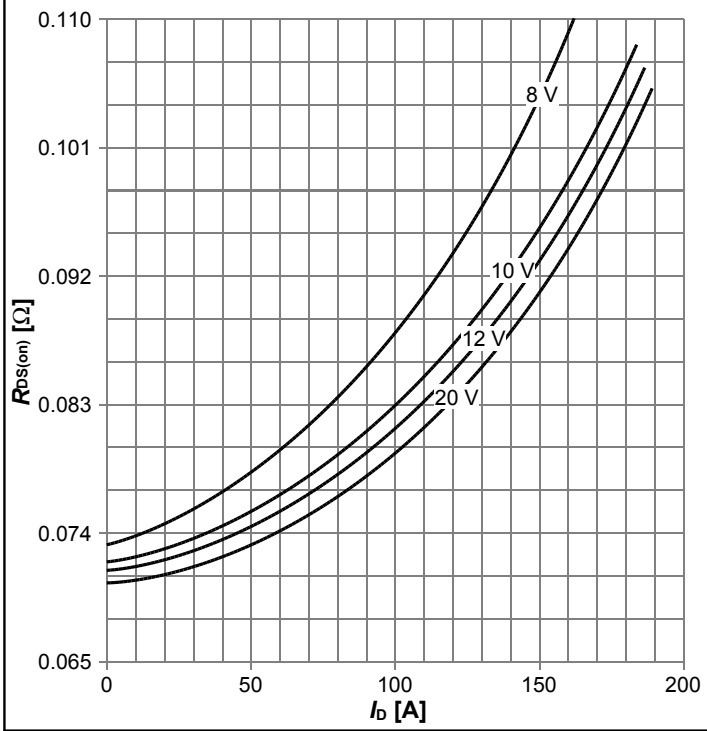

$I_D=f(V_{DS})$; $T_j=25$ °C; parameter: $V_{GS}$

**Diagram 6: Typ. output characteristics**



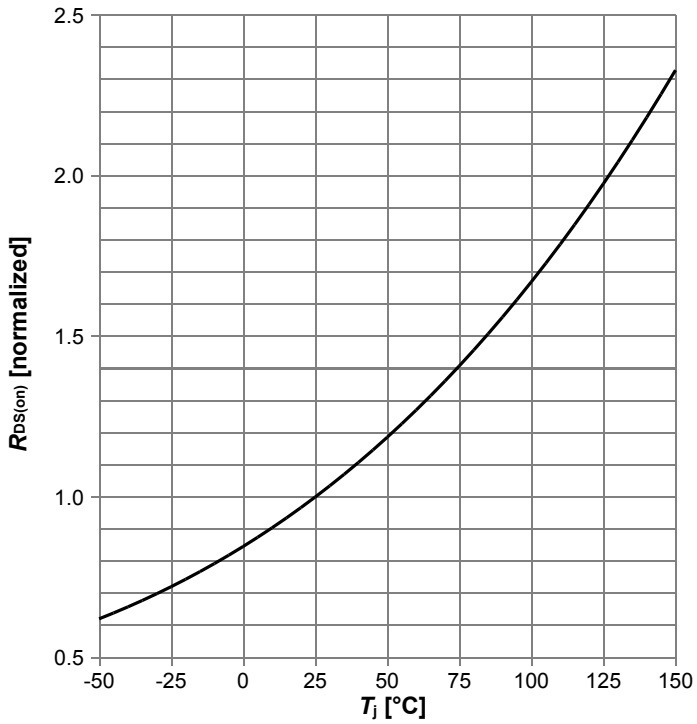

$I_D=f(V_{DS})$; $T_j=125$ °C; parameter: $V_{GS}$

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



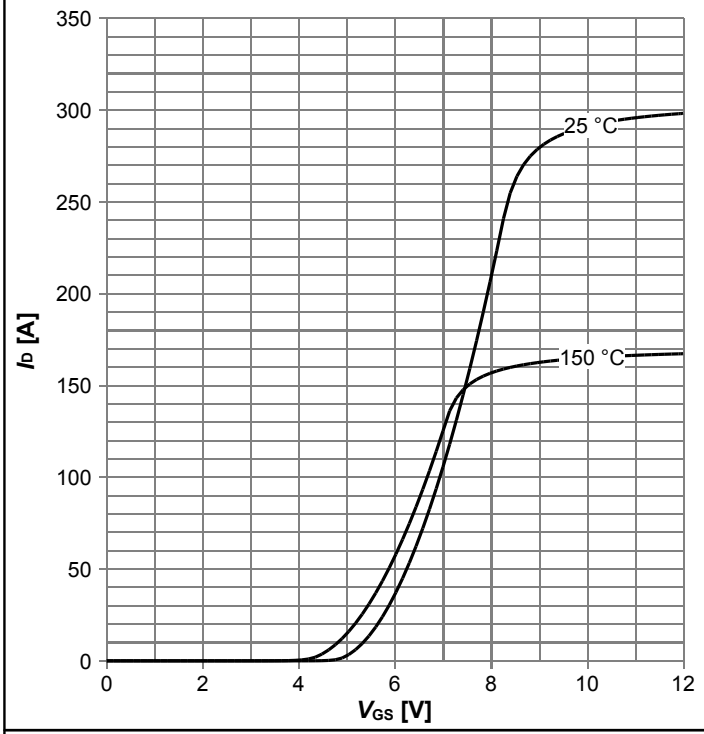

$R_{DS(on)}=f(I_D)$; $T_j=125$ °C; parameter: $V_{GS}$

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



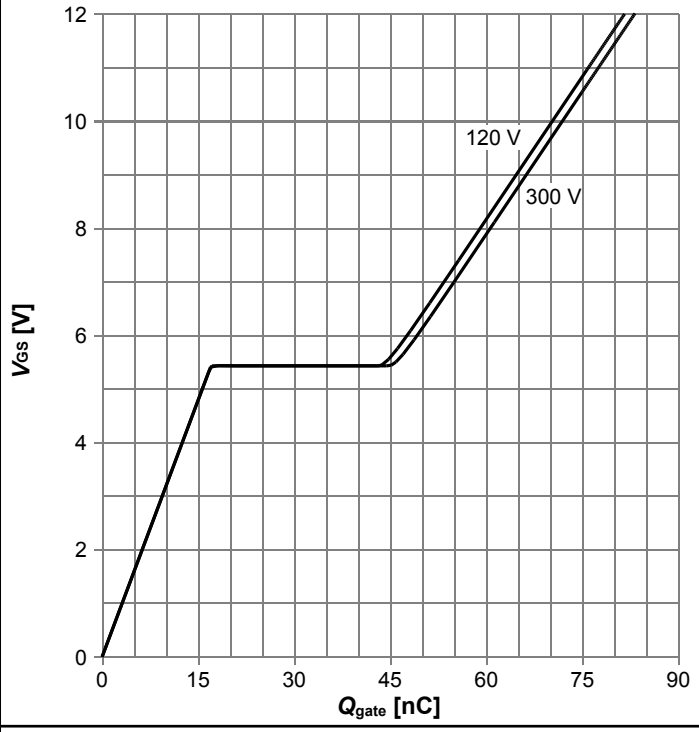

$R_{DS(on)}=f(T_j)$; $I_D=13$ A; $V_{GS}=12$ V

**Diagram 9: Typ. transfer characteristics**



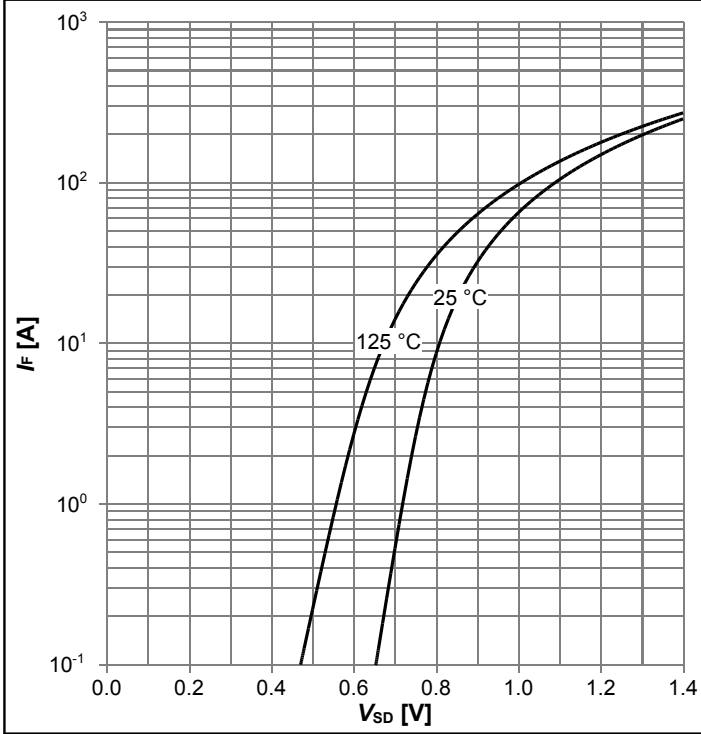

$I_D$=f($V_{GS}$); $V_{DS}$=20V; parameter: $T_j$

**Diagram 10: Typ. gate charge**



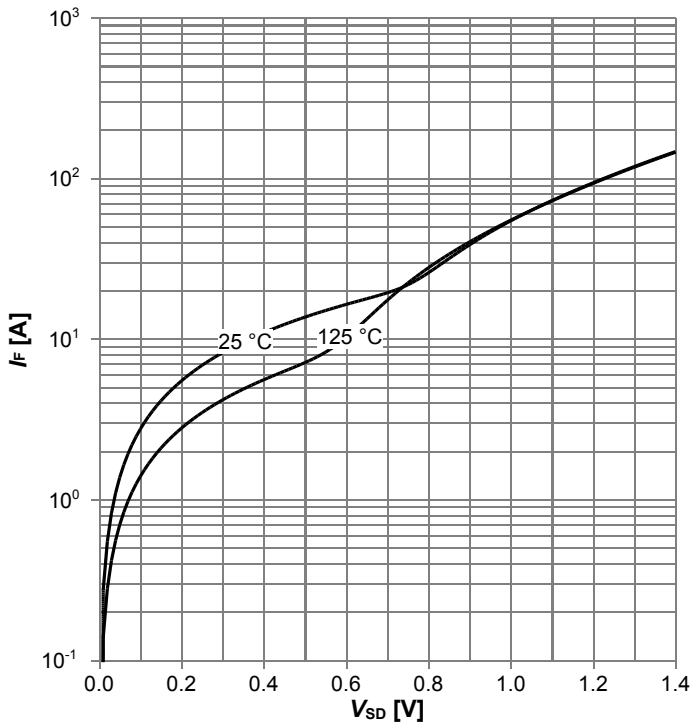

$V_{GS}$=f($Q_{gate}$); $I_D$=13 A pulsed; parameter: $V_{DD}$

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



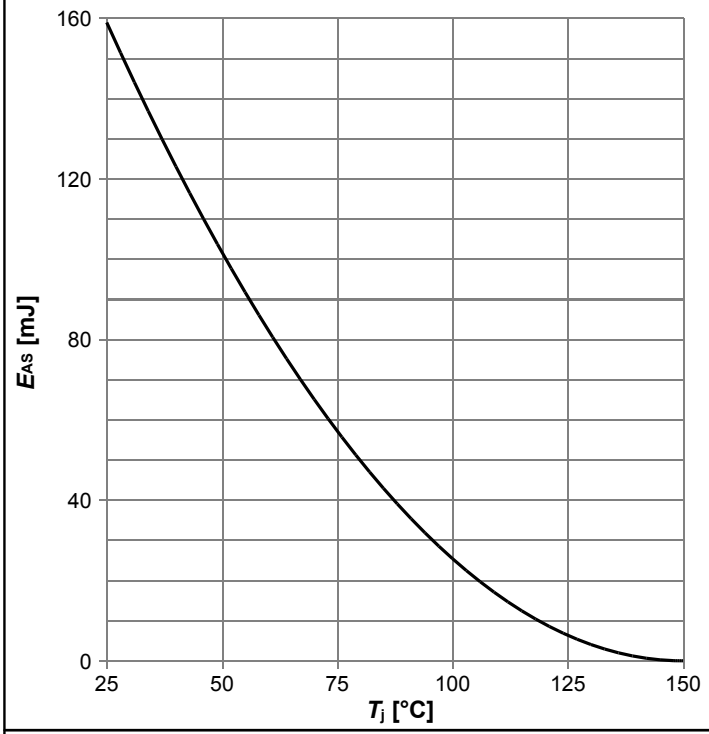

$I_F$=f($V_{SD}$); $V_{GS}$=0 V; parameter: $T_j$

**Diagram 12: Forward characteristics of reverse diode**



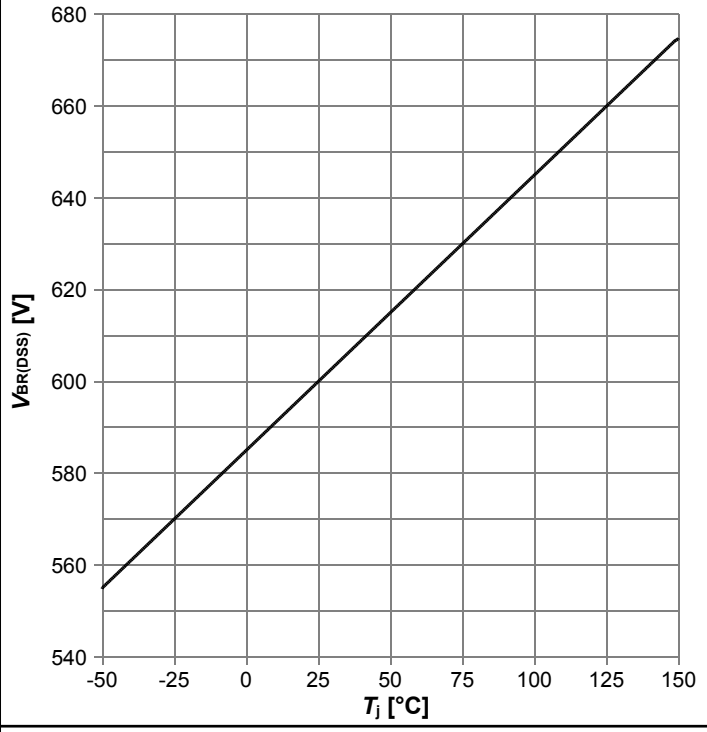

$I_F$=f($V_{SD}$); $V_{GS}$=12 V; parameter: $T_j$

**Diagram 13: Avalanche energy**



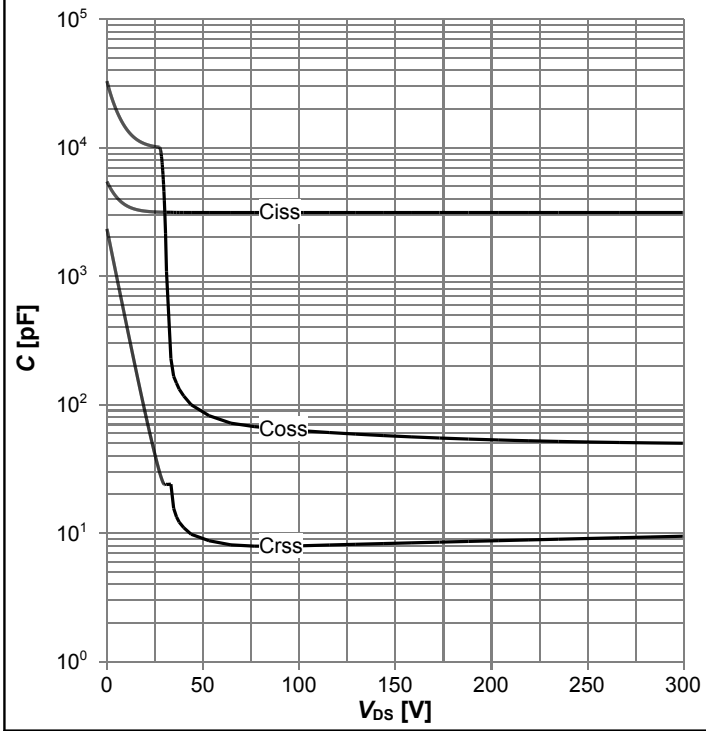

$E_{AS}=f(T_j)$; $I_D$=2.8 A; $V_{DD}$=50 V

**Diagram 14: Drain-source breakdown voltage**



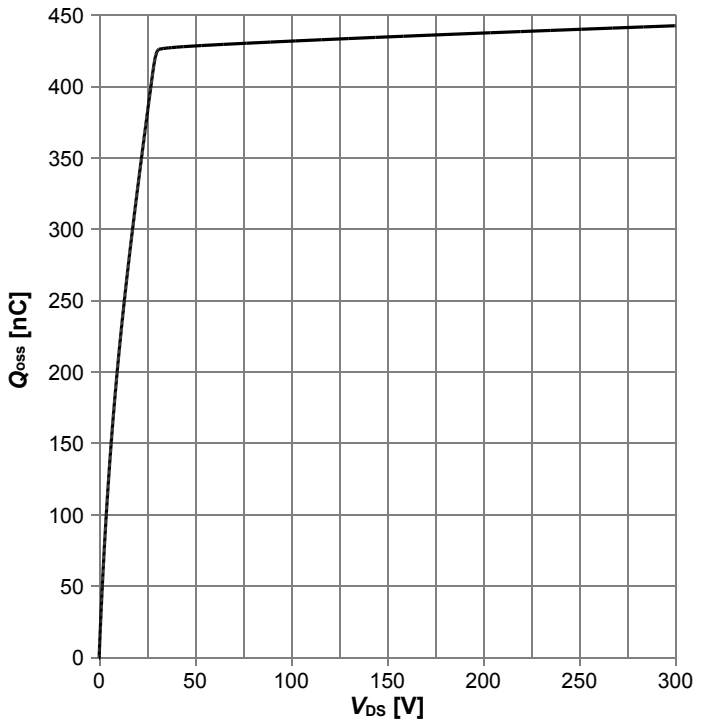

$V_{BR(DSS)}=f(T_j)$; $I_D$=1 mA

**Diagram 15: Typ. capacitances**




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

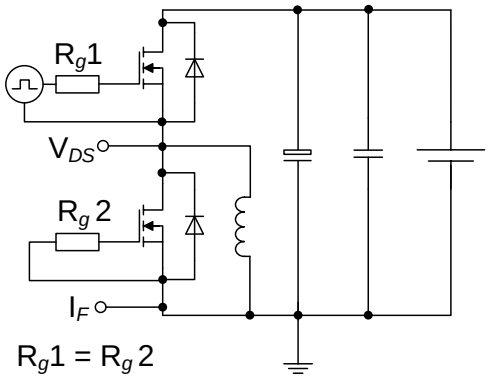
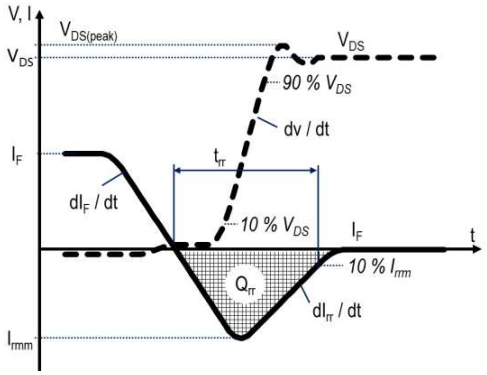
**Diagram 17: Typ. Qoss output charge**




$Q_{oss}=f(V_{DS})$; $V_{GS}$=0 V

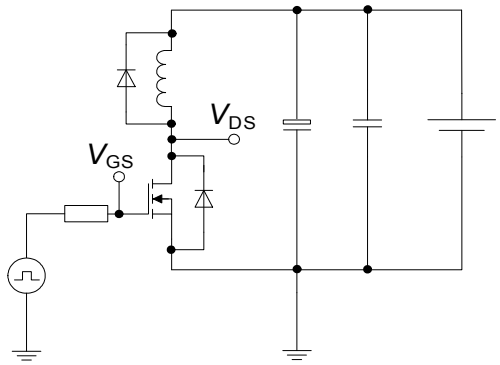
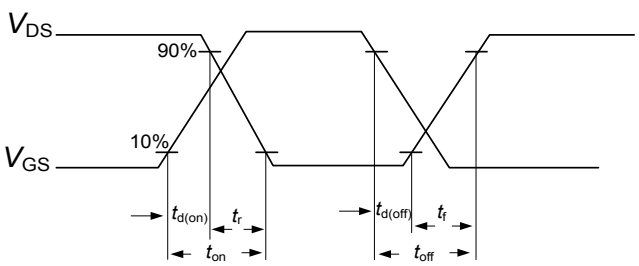
# 5 Test Circuits

## Table 8 Diode characteristics

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

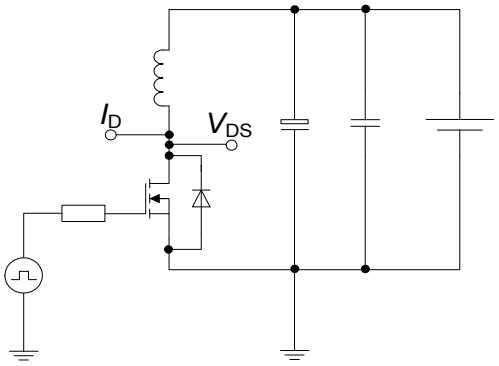
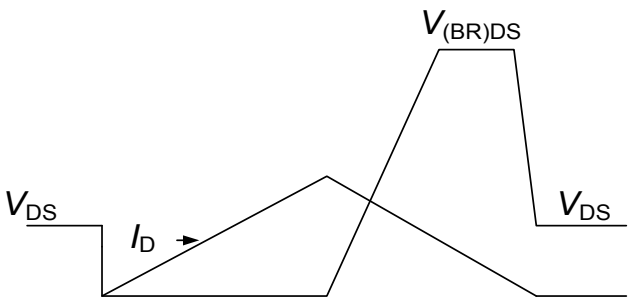


## Table 9 Switching times

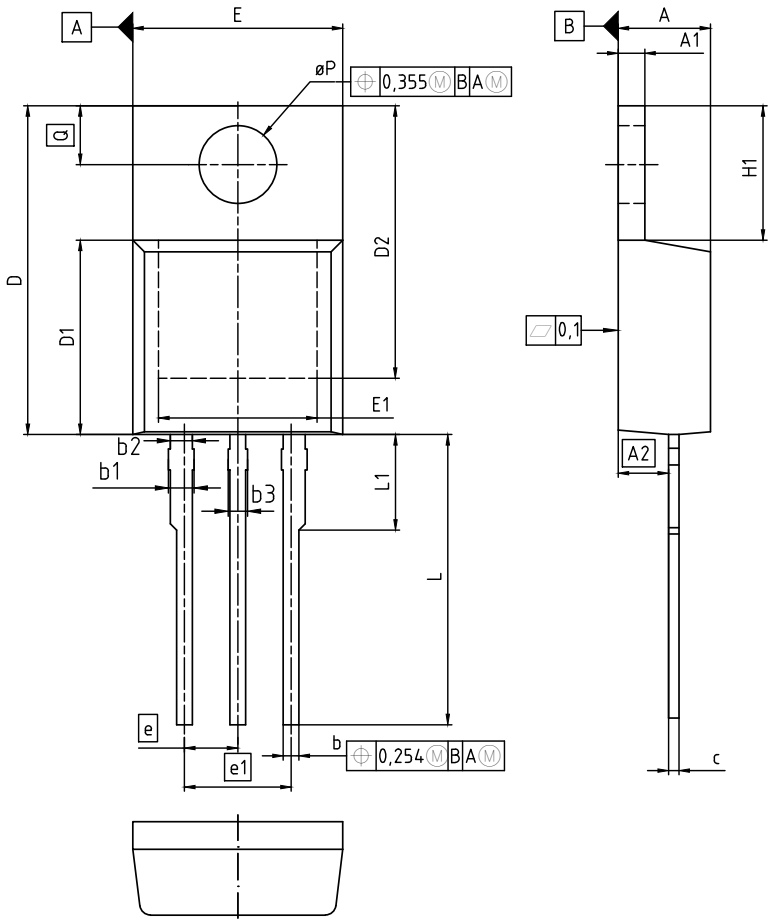
| Switching times test circuit for inductive load | Switching times waveform |
|---|---|
|  |  |



## Table 10 Unclamped inductive load

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

# 6 Package Outlines




| DIM | MILLIMETERS | | INCHES | |
|---|---|---|---|---|
| | MIN | MAX | MIN | MAX |
| **A** | 4.30 | 4.57 | 0.169 | 0.180 |
| **A1** | 1.17 | 1.40 | 0.046 | 0.055 |
| **A2** | 2.15 | 2.72 | 0.085 | 0.107 |
| **b** | 0.65 | 0.86 | 0.026 | 0.034 |
| **b1** | 0.95 | 1.40 | 0.037 | 0.055 |
| **b2** | 0.95 | 1.15 | 0.037 | 0.045 |
| **b3** | 0.65 | 1.15 | 0.026 | 0.045 |
| **c** | 0.33 | 0.60 | 0.013 | 0.024 |
| **D** | 14.81 | 15.95 | 0.583 | 0.628 |
| **D1** | 8.51 | 9.45 | 0.335 | 0.372 |
| **D2** | 12.19 | 13.10 | 0.480 | 0.516 |
| **E** | 9.70 | 10.36 | 0.382 | 0.408 |
| **E1** | 6.50 | 8.60 | 0.256 | 0.339 |
| **e** | 2.54 | | 0.100 | |
| **e1** | 5.08 | | 0.200 | |
| **N** | 3 | | 3 | |
| **H1** | 5.90 | 6.90 | 0.232 | 0.272 |
| **L** | 13.00 | 14.00 | 0.512 | 0.551 |
| **L1** | - | 4.80 | - | 0.189 |
| **øP** | 3.60 | 3.89 | 0.142 | 0.153 |
| **Q** | 2.60 | 3.00 | 0.102 | 0.118 |

**DOCUMENT NO.**
Z8B00003318

**SCALE**
0 2.5 0 2.5 5mm

**EUROPEAN PROJECTION**

**ISSUE DATE**
30-07-2009

**REVISION**
06

**Figure 1 Outline PG-TO220-3, dimensions in mm/inches**

# 7 Appendix A

## Table 11 Related Links

- **IFX CoolMOS S7 Webpage:** www.infineon.com
- **IFX CoolMOS S7 application note:** www.infineon.com
- **IFX CoolMOS S7 simulation model:** www.infineon.com
- **IFX Design tools:** www.infineon.com

## Revision History

IPP60R040S7

**Revision: 2021-08-20, Rev. 2.1**

| Previous Revision | | |
|---|---|---|
| Revision | Date | Subjects (major changes since last revision) |
| 2.0 | 2021-08-10 | Release of final version |
| 2.1 | 2021-08-20 | Change of wording regarding breakdown voltage / cosmic ray |



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