

MOSFET

950V CoolMOS™ P7 SJ Power Device

The latest 950V CoolMOS™ P7 series sets a new benchmark in 950V super junction technologies and combines best-in-class performance with state of the art ease-of-use, resulting from Infineon's over 18 years pioneering super junction technology innovation.

Features

- Best-in-class FOM $R_{DS(on)} * E_{oss}$; reduced Q_g , C_{iss} , and C_{oss}
- Best-in-class SOT-223 $R_{DS(on)}$
- Best-in-class $V_{(GS)th}$ of 3V and smallest $V_{(GS)th}$ variation of $\pm 0.5V$
- Integrated Zener Diode ESD protection
- Best-in-class CoolMOS™ quality and reliability
- Fully optimized portfolio

Benefits

- Best-in-class performance
- Enabling higher power density designs, BOM savings and lower assembly costs
- Easy to drive and to parallel
- Better production yield by reducing ESD related failures
- Less production issues and reduced field returns
- Easy to select right parts for fine tuning of designs

Potential applications

Recommended for flyback topologies for LED Lighting, low power Chargers and Adapters, Smart Meter, AUX power and Industrial power. Also suitable for PFC stage in Consumer and Solar applications.

Product Validation: Fully qualified acc. JEDEC for Industrial Applications

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

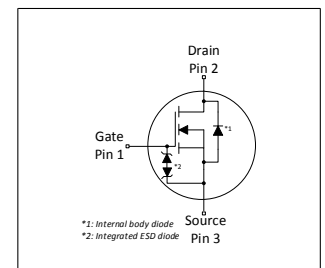
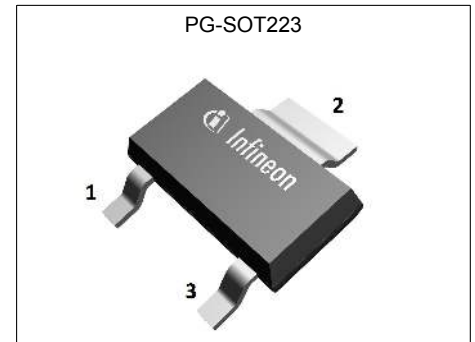


Table 1 Key Performance Parameters

| Parameter | Value | Unit |
|----------------------------|-------|----------|
| $V_{DS} @ T_J=25^{\circ}C$ | 950 | V |
| $R_{DS(on),max}$ | 2 | Ω |
| $Q_{g,typ}$ | 10 | nC |
| I_D | 4 | A |
| $E_{oss} @ 500V$ | 0.9 | μJ |
| $V_{GS(th),typ}$ | 3 | V |
| ESD class (HBM) | 2 | - |

| Type / Ordering Code | Package | Marking | Related Links |
|----------------------|-----------|---------|----------------|
| IPN95R2K0P7 | PG-SOT223 | 95R2K0 | see Appendix A |

Table of Contents

| | |
|---|----|
| Description | 1 |
| Maximum ratings | 3 |
| Thermal characteristics | 4 |
| Electrical characteristics | 5 |
| Electrical characteristics diagrams | 7 |
| Test Circuits | 11 |
| Package Outlines | 12 |
| Appendix A | 13 |
| Revision History | 14 |
| Trademarks | 14 |
| Disclaimer | 14 |

1 Maximum ratings

at $T_j = 25^\circ\text{C}$, unless otherwise specified

Table 2 Maximum ratings

| Parameter | Symbol | Values | | | Unit | Note / Test Condition |
|--|---------------------|--------|------|----------|------------------|---|
| | | Min. | Typ. | Max. | | |
| Continuous drain current ¹⁾ | I_D | - | - | 4 2.4 | A | $T_C=25^\circ\text{C}$ $T_C=100^\circ\text{C}$ |
| Pulsed drain current ²⁾ | $I_{D,pulse}$ | - | - | 10 | A | $T_C=25^\circ\text{C}$ |
| Avalanche energy, single pulse | E_{AS} | - | - | 6 | mJ | $I_D=0.4\text{A}$; $V_{DD}=50\text{V}$; see table 10 |
| Avalanche energy, repetitive | E_{AR} | - | - | 0.08 | mJ | $I_D=0.4\text{A}$; $V_{DD}=50\text{V}$; see table 10 |
| Application (Flyback) relevant avalanche current, single pulse ³⁾ | I_{AS} | - | 2.0 | - | A | measured with standard leakage inductance of transformer of $10\mu\text{H}$ |
| MOSFET dv/dt ruggedness | dv/dt | - | - | 100 | V/ns | $V_{DS}=0\dots400\text{V}$ |
| Gate source voltage (static) | V_{GS} | -20 | - | 20 | V | static; |
| Gate source voltage (dynamic) | V_{GS} | -30 | - | 30 | V | AC ($f>1\text{Hz}$) |
| Power dissipation | P_{tot} | - | - | 7 | W | $T_C=25^\circ\text{C}$ |
| Storage temperature | T_{stg} | -55 | - | 150 | $^\circ\text{C}$ | - |
| Operating junction temperature | T_j | -55 | - | 150 | $^\circ\text{C}$ | - |
| Mounting torque | - | - | - | - | Ncm | - |
| Continuous diode forward current | I_S | - | - | 1.1 | A | $T_C=25^\circ\text{C}$ |
| Diode pulse current ²⁾ | $I_{S,pulse}$ | - | - | 10 | A | $T_C=25^\circ\text{C}$ |
| Reverse diode dv/dt ⁴⁾ | dv/dt | - | - | 1 | V/ns | $V_{DS}=0\dots400\text{V}$, $I_{SD}\leq 0.8\text{A}$, $T_j=25^\circ\text{C}$ see table 8 |
| Maximum diode commutation speed | di _F /dt | - | - | 50 | A/ μs | $V_{DS}=0\dots400\text{V}$, $I_{SD}\leq 0.8\text{A}$, $T_j=25^\circ\text{C}$ see table 8 |
| Insulation withstand voltage | V_{ISO} | - | - | n.a. | V | V_{rms} , $T_C=25^\circ\text{C}$, $t=1\text{min}$ |

¹⁾ Limited by $T_{j,max}$. Maximum Duty Cycle $D = 0.5$; IPAK equivalent.

²⁾ Pulse width t_p limited by $T_{j,max}$

³⁾ For further explanation please read AN - CoolMOS™ 700V P7 & 950V P7

⁴⁾ 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} | - | - | 18.29 | °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 6cm ² (one layer, 70µm thickness) copper area for drain connection and cooling. PCB is vertical without air stream cooling. |
| Soldering temperature, wave- & reflow soldering allowed | T_{sold} | - | - | 260 | °C | reflow MSL1 |

3 Electrical characteristics

at $T_j=25^\circ\text{C}$, unless otherwise specified

Table 4 Static characteristics

| Parameter | Symbol | Values | | | Unit | Note / Test Condition |
|----------------------------------|---------------|--------|---------------|------|---------------|---|
| | | Min. | Typ. | Max. | | |
| Drain-source breakdown voltage | $V_{(BR)DSS}$ | 950 | - | - | V | $V_{GS}=0V, I_D=1mA$ |
| Gate threshold voltage | $V_{(GS)th}$ | 2.5 | 3 | 3.5 | V | $V_{DS}=V_{GS}, I_D=0.08mA$ |
| Zero gate voltage drain current | I_{DSS} | - | - | 1 | μA | $V_{DS}=950V, V_{GS}=0V, T_j=25^\circ\text{C}$ $V_{DS}=950V, V_{GS}=0V, T_j=150^\circ\text{C}$ |
| Gate-source leakage current | I_{GSS} | - | - | 1000 | nA | $V_{GS}=20V, V_{DS}=0V$ |
| Drain-source on-state resistance | $R_{DS(on)}$ | - | 1.71 3.817 | 2 | Ω | $V_{GS}=10V, I_D=1.7A, T_j=25^\circ\text{C}$ $V_{GS}=10V, I_D=1.7A, T_j=150^\circ\text{C}$ |
| Gate resistance | R_G | - | 1 | - | Ω | $f=250kHz$, open drain |

Table 5 Dynamic characteristics

| Parameter | Symbol | Values | | | Unit | Note / Test Condition |
|--|--------------|--------|------|------|------|--|
| | | Min. | Typ. | Max. | | |
| Input capacitance | C_{iss} | - | 330 | - | pF | $V_{GS}=0V, V_{DS}=400V, f=250kHz$ |
| Output capacitance | C_{oss} | - | 5 | - | pF | $V_{GS}=0V, V_{DS}=400V, f=250kHz$ |
| Effective output capacitance, energy related ¹⁾ | $C_{o(er)}$ | - | 8 | - | pF | $V_{GS}=0V, V_{DS}=0...400V$ |
| Effective output capacitance, time related ²⁾ | $C_{o(tr)}$ | - | 81 | - | pF | $I_D=\text{constant}, V_{GS}=0V, V_{DS}=0...400V$ |
| Turn-on delay time | $t_{d(on)}$ | - | 6 | - | ns | $V_{DD}=400V, V_{GS}=13V, I_D=1.7A,$ $R_G=23.1\Omega$; see table 9 |
| Rise time | t_r | - | 13 | - | ns | $V_{DD}=400V, V_{GS}=13V, I_D=1.7A,$ $R_G=23.1\Omega$; see table 9 |
| Turn-off delay time | $t_{d(off)}$ | - | 41 | - | ns | $V_{DD}=400V, V_{GS}=13V, I_D=1.7A,$ $R_G=23.1\Omega$; see table 9 |
| Fall time | t_f | - | 18 | - | ns | $V_{DD}=400V, V_{GS}=13V, I_D=1.7A,$ $R_G=23.1\Omega$; 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 | - | nC | $V_{DD}=760V, I_D=1.7A, V_{GS}=0$ to 10V |
| Gate to drain charge | Q_{gd} | - | 3 | - | nC | $V_{DD}=760V, I_D=1.7A, V_{GS}=0$ to 10V |
| Gate charge total | Q_g | - | 10 | - | nC | $V_{DD}=760V, I_D=1.7A, V_{GS}=0$ to 10V |
| Gate plateau voltage | $V_{plateau}$ | - | 4.4 | - | V | $V_{DD}=760V, I_D=1.7A, V_{GS}=0$ to 10V |

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 400V

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 400V

Table 7 Reverse diode characteristics

| Parameter | Symbol | Values | | | Unit | Note / Test Condition |
|-------------------------------|-----------|--------|------|------|---------|--|
| | | Min. | Typ. | Max. | | |
| Diode forward voltage | V_{SD} | - | 0.9 | - | V | $V_{GS}=0V, I_F=1.7A, T_j=25^\circ C$ |
| Reverse recovery time | t_{rr} | - | 337 | - | ns | $V_R=400V, I_F=0.8A, di_F/dt=50A/\mu s$; see table 8 |
| Reverse recovery charge | Q_{rr} | - | 2 | - | μC | $V_R=400V, I_F=0.8A, di_F/dt=50A/\mu s$; see table 8 |
| Peak reverse recovery current | I_{rrm} | - | 9 | - | A | $V_R=400V, I_F=0.8A, di_F/dt=50A/\mu s$; see table 8 |

4 Electrical characteristics diagrams

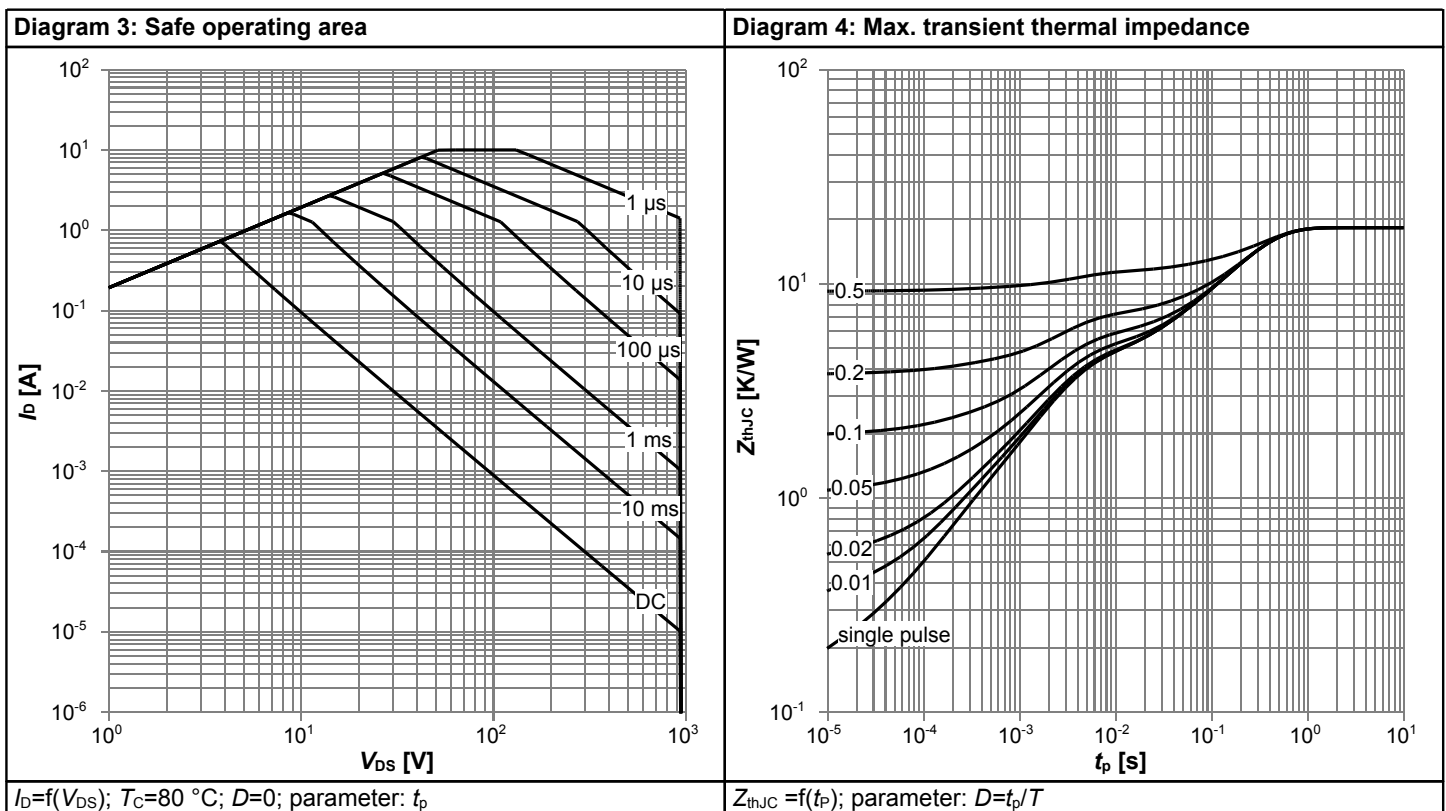
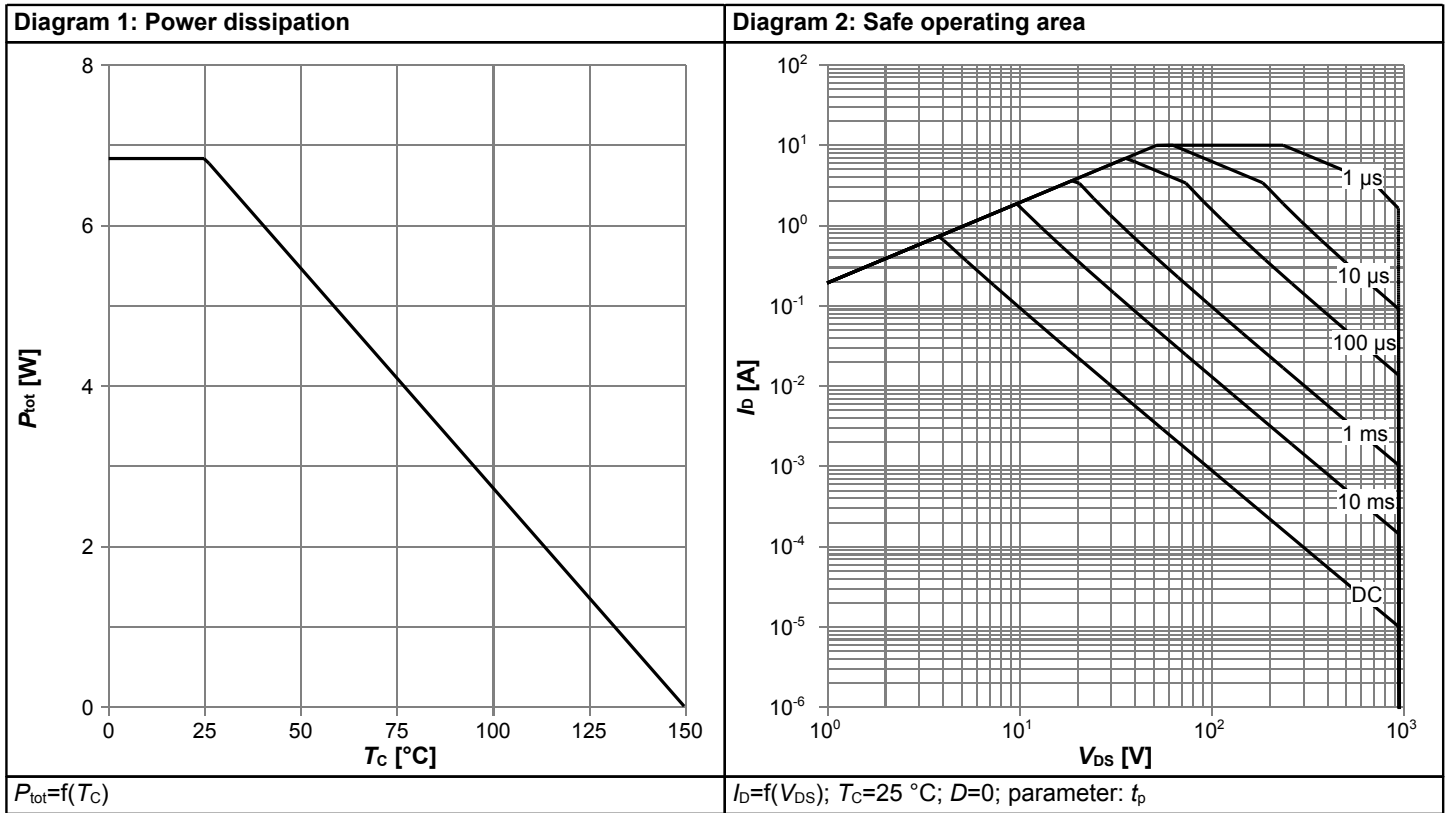
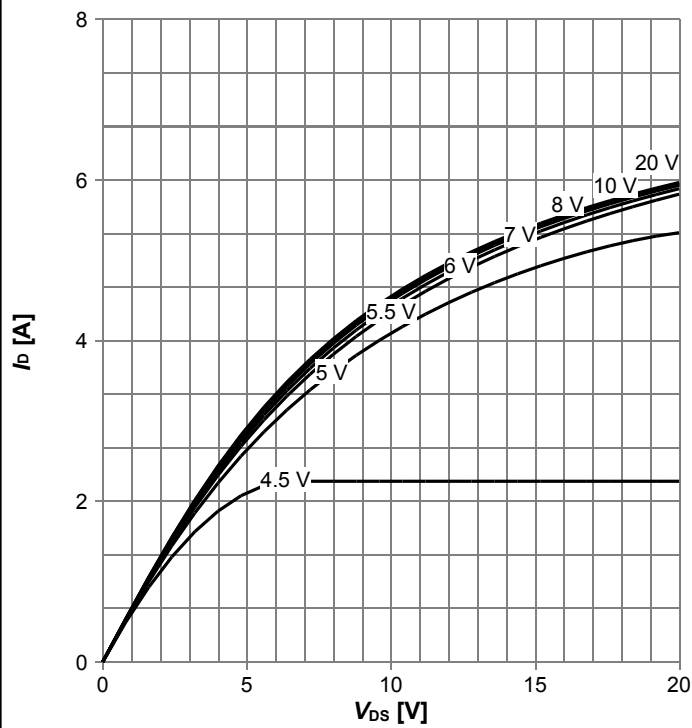
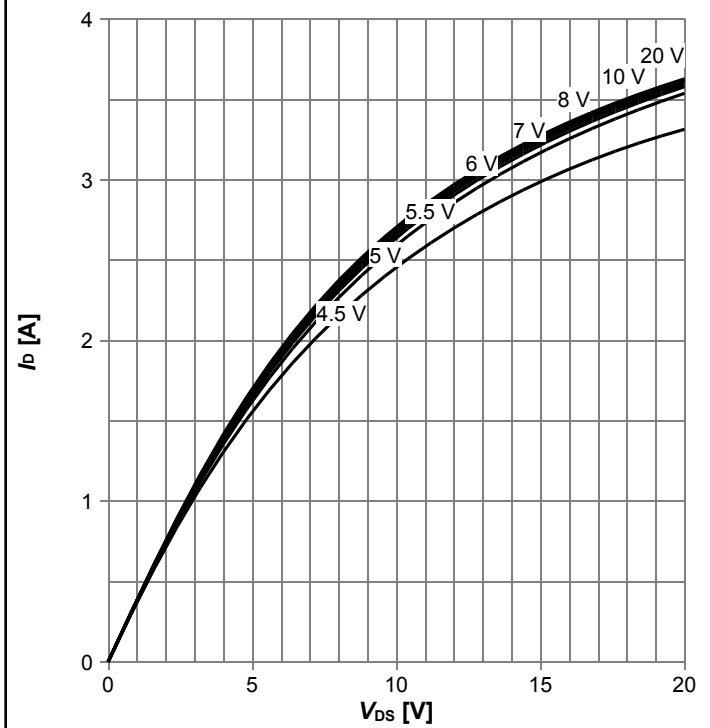


Diagram 5: Typ. output characteristics



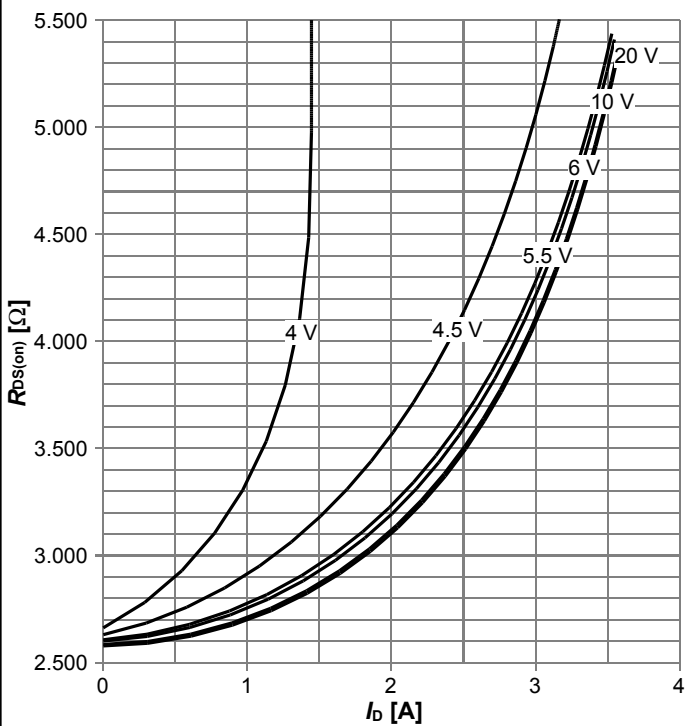
$I_D=f(V_{DS}); T_j=25\text{ °C};$ parameter: V_{GS}

Diagram 6: Typ. output characteristics



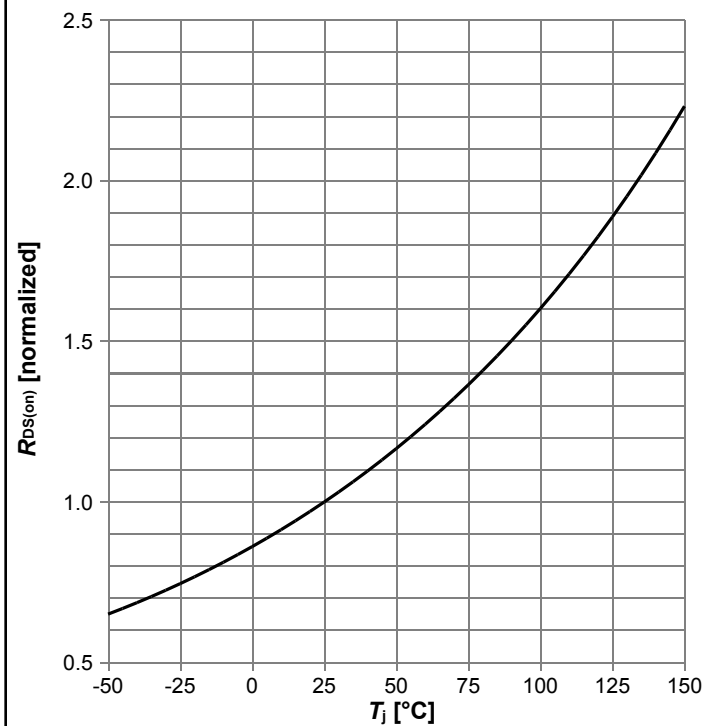
$I_D=f(V_{DS}); T_j=125\text{ °C};$ parameter: V_{GS}

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



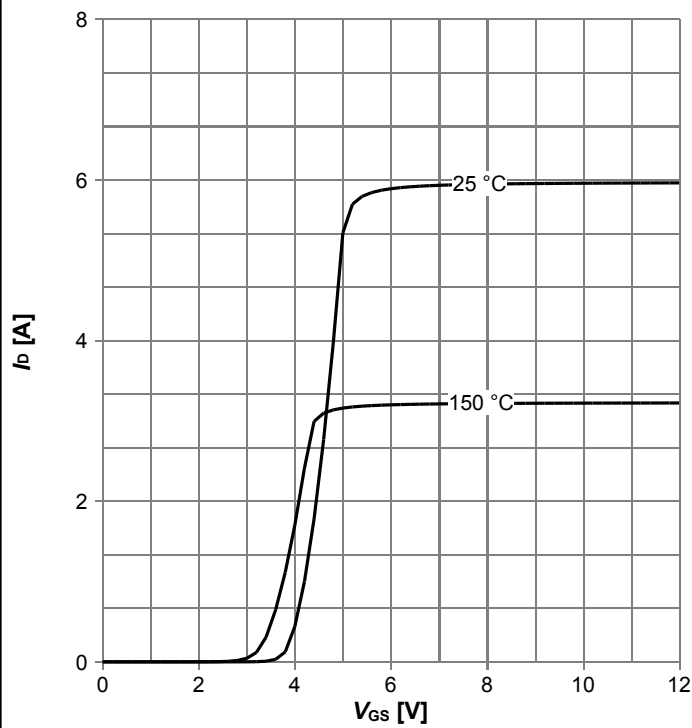
$R_{DS(on)}=f(I_D); T_j=125\text{ °C};$ parameter: V_{GS}

Diagram 8: Drain-source on-state resistance



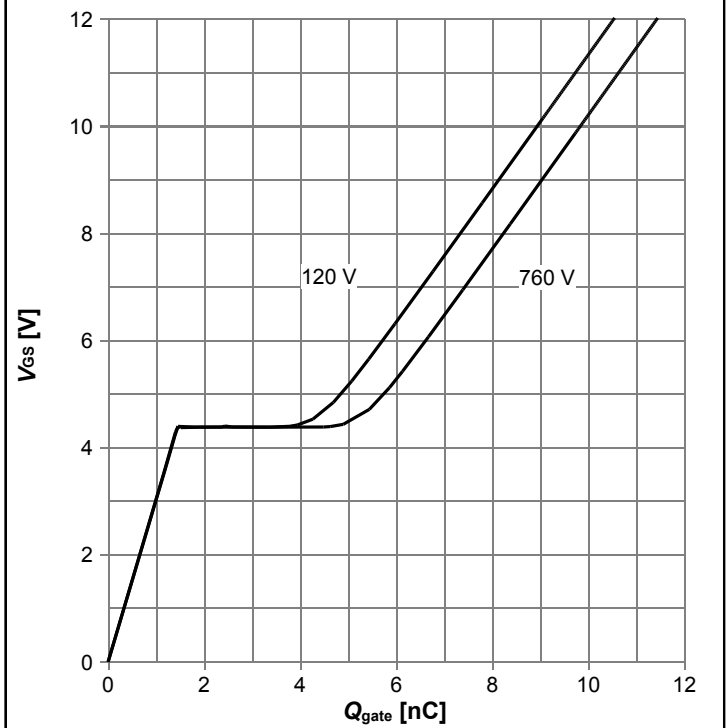
$R_{DS(on)}=f(T_j); I_D=1.7\text{ A}; V_{GS}=10\text{ V}$

Diagram 9: Typ. transfer characteristics



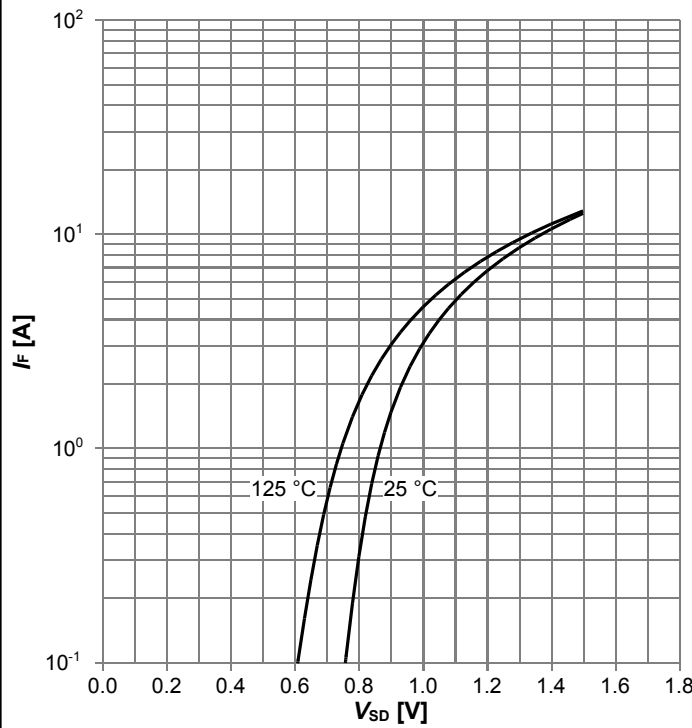
$I_D=f(V_{GS}); V_{DS}=20V; \text{parameter: } T_j$

Diagram 10: Typ. gate charge



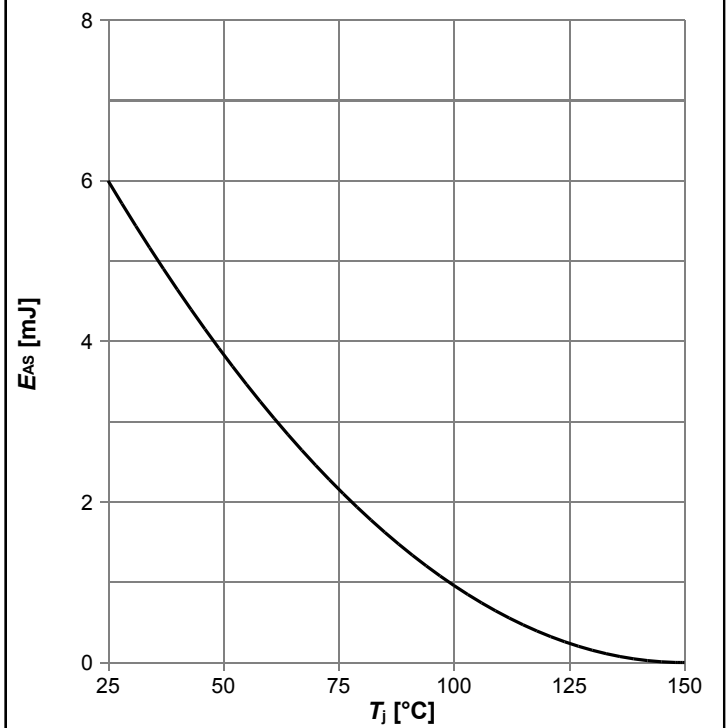
$V_{GS}=f(Q_{gate}); I_D=1.7 \text{ A pulsed}; \text{parameter: } V_{DD}$

Diagram 11: Forward characteristics of reverse diode



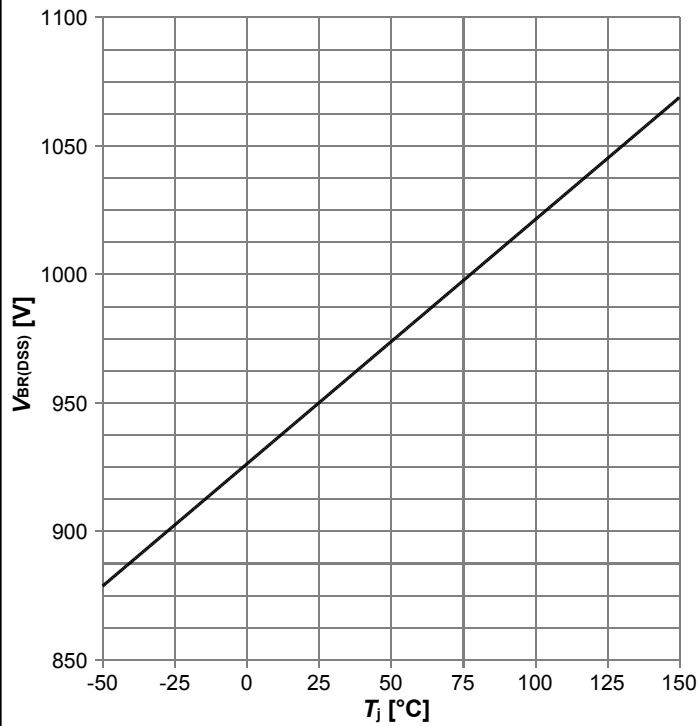
$I_F=f(V_{SD}); \text{parameter: } T_j$

Diagram 12: Avalanche energy



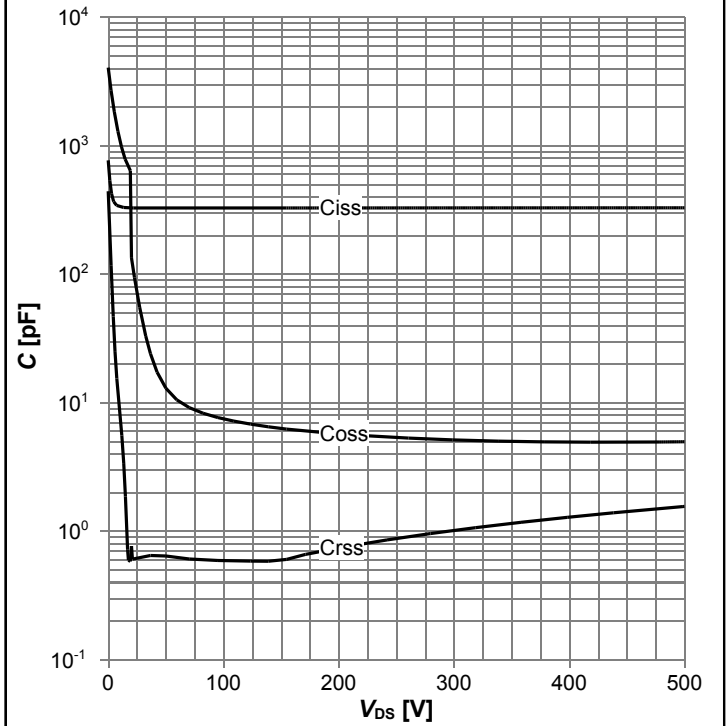
$E_{AS}=f(T_j); I_D=0.4 \text{ A}; V_{DD}=50 \text{ V}$

Diagram 13: Drain-source breakdown voltage



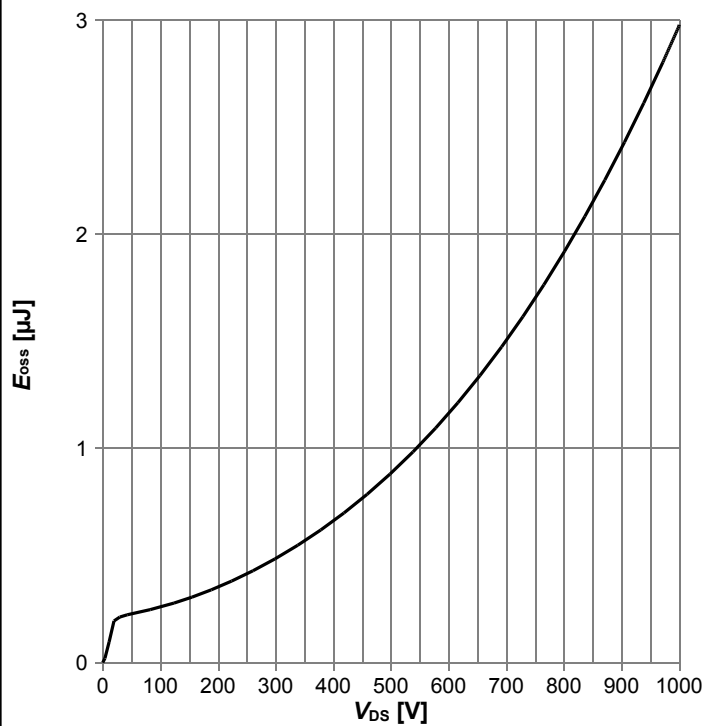
$V_{BR(DSS)}=f(T_j); I_D=1 \text{ mA}$

Diagram 14: Typ. capacitances



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

Diagram 15: Typ. Coss stored energy



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

5 Test Circuits

Table 8 Diode characteristics

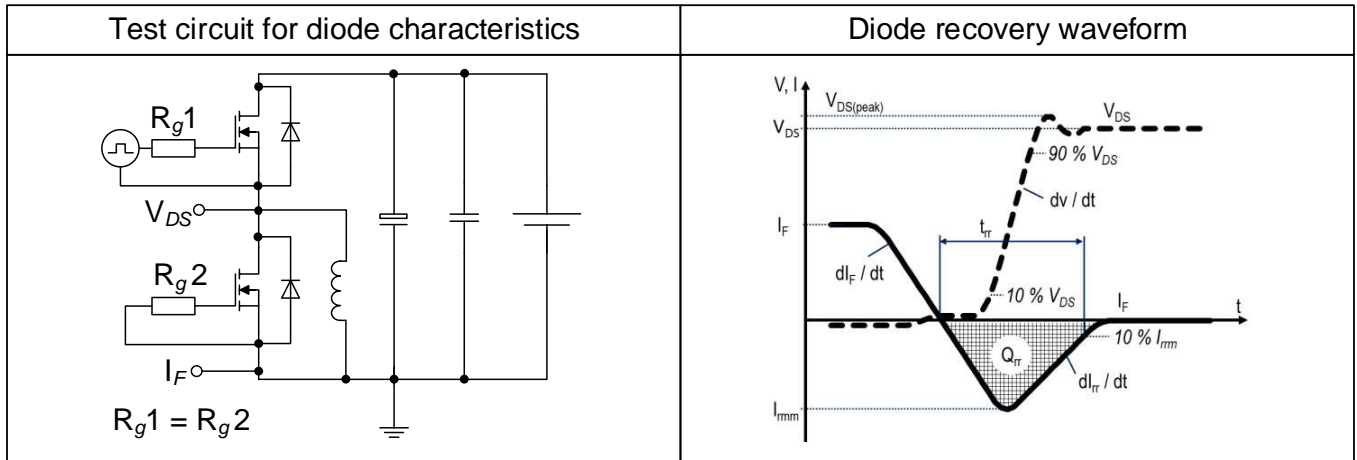


Table 9 Switching times

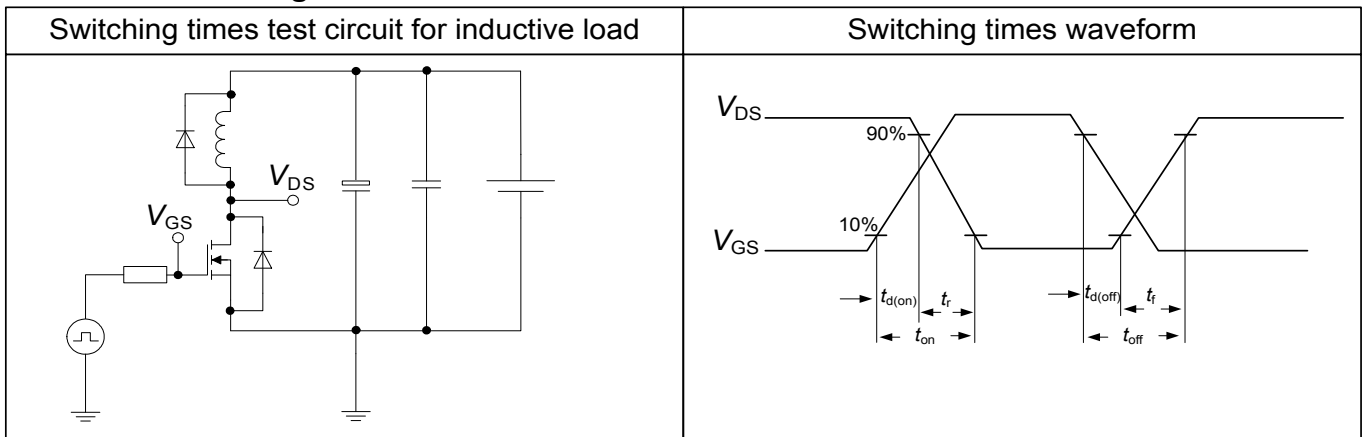
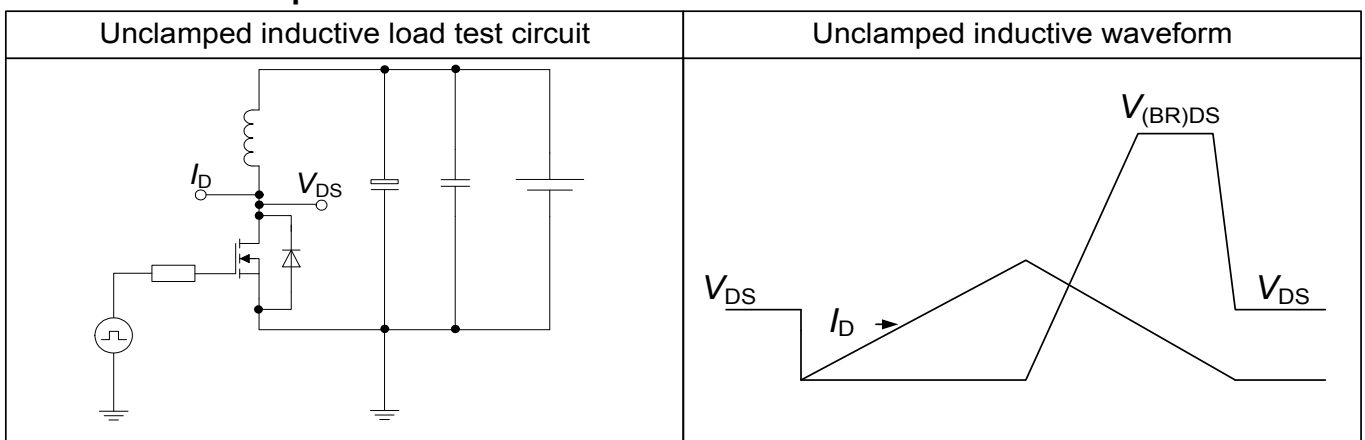
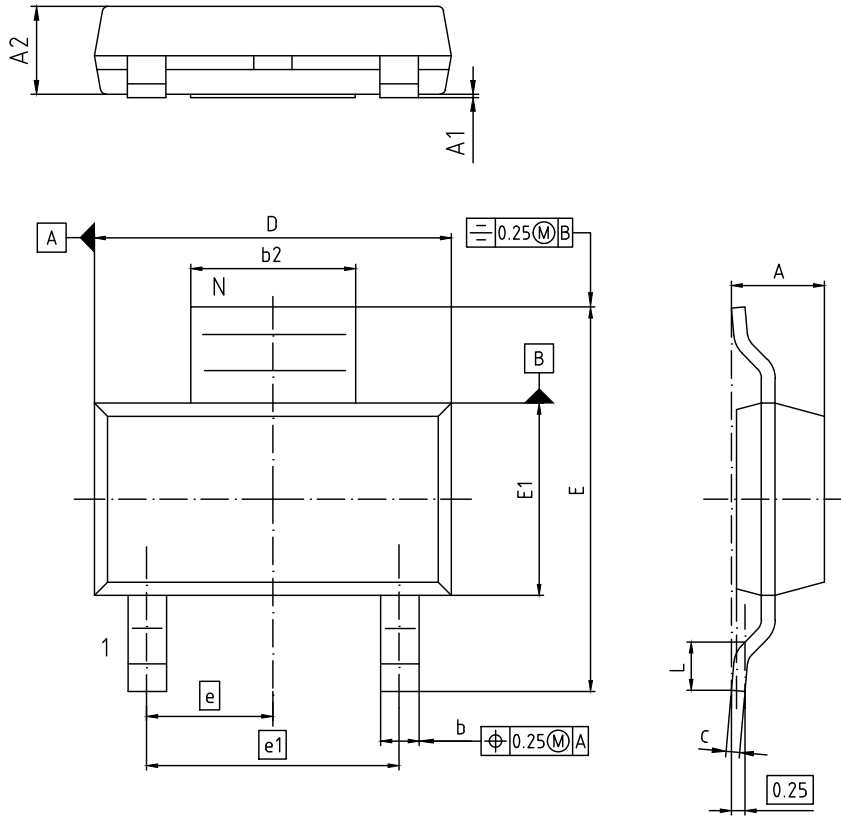


Table 10 Unclamped inductive load



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° |

| |
|------------------------------------|
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| EUROPEAN PROJECTION |
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| REVISION 01 |

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

7 Appendix A

Table 11 Related Links

- IFX CoolMOS P7 Webpage: www.infineon.com
- IFX CoolMOS P7 application note: www.infineon.com
- IFX CoolMOS P7 simulation model: www.infineon.com
- IFX Design tools: www.infineon.com

Revision History

IPN95R2K0P7

Revision: 2018-06-01, Rev. 2.0

Previous Revision

| Revision | Date | Subjects (major changes since last revision) |
|----------|------------|--|
| 2.0 | 2018-06-01 | Release of final version |

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