

MOSFET

600V CoolMOS™ PFD7 SJ Power Device

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 |
| $R_{DS(on),max}$ | 360 | mΩ |
| $Q_{g,typ}$ | 12.7 | nC |
| $I_{D,pulse}$ | 24 | A |
| $E_{oss} @ 400V$ | 1.6 | μJ |
| Body diode di_f/dt | 1300 | A/μs |
| ESD Class (HBM) | 2 | - |

| Type / Ordering Code | Package | Marking | Related Links |
|----------------------|-------------|----------|----------------|
| IPS60R360PFD7S | PG-TO 251-3 | 60S360D7 | see Appendix A |

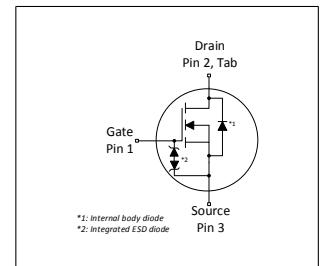


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1 Maximum ratings

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 | - | - | 10 6 | A | $T_C=25^\circ\text{C}$ $T_C=100^\circ\text{C}$ |
| Pulsed drain current ²⁾ | $I_{D,pulse}$ | - | - | 24 | A | $T_C=25^\circ\text{C}$ |
| Avalanche energy, single pulse | E_{AS} | - | - | 29 | mJ | $I_D=2.1\text{A}$; $V_{DD}=50\text{V}$; see table 10 |
| Avalanche energy, repetitive | E_{AR} | - | - | 0.14 | mJ | $I_D=2.1\text{A}$; $V_{DD}=50\text{V}$; see table 10 |
| Avalanche current, single pulse | I_{AS} | - | - | 2.1 | A | - |
| MOSFET dv/dt ruggedness | dv/dt | - | - | 120 | 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} | - | - | 43 | W | $T_C=25^\circ\text{C}$ |
| Storage temperature | T_{stg} | -40 | - | 150 | $^\circ\text{C}$ | - |
| Operating junction temperature | T_j | -40 | - | 150 | $^\circ\text{C}$ | - |
| Mounting torque | - | - | - | - | Ncm | - |
| Continuous diode forward current ¹⁾ | I_S | - | - | 10 | A | $T_C=25^\circ\text{C}$ |
| Diode pulse current ²⁾ | $I_{S,pulse}$ | - | - | 24 | A | $T_C=25^\circ\text{C}$ |
| Reverse diode dv/dt ³⁾ | dv/dt | - | - | 70 | V/ns | $V_{DS}=0\dots400\text{V}$, $I_{SD}\leq 7.2\text{A}$, $T_j=25^\circ\text{C}$ see table 8 |
| Maximum diode commutation speed | di _F /dt | - | - | 1300 | A/ μs | $V_{DS}=0\dots400\text{V}$, $I_{SD}\leq 7.2\text{A}$, $T_j=25^\circ\text{C}$ 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 $D = 0.50$

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

³⁾ Identical low side and high side switch with identical R_θ

2 Thermal characteristics

Table 3 Thermal characteristics

| Parameter | Symbol | Values | | | Unit | Note / Test Condition |
|--|------------|--------|------|------|------|-------------------------------------|
| | | Min. | Typ. | Max. | | |
| Thermal resistance, junction - case | R_{thJC} | - | - | 2.89 | °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 $T_j=25^\circ\text{C}$, unless otherwise specified

Table 4 Static characteristics

| Parameter | Symbol | Values | | | Unit | Note / Test Condition |
|---|---------------|--------|----------------|-------|---------------|---|
| | | Min. | Typ. | Max. | | |
| Drain-source breakdown voltage | $V_{(BR)DSS}$ | 600 | - | - | V | $V_{GS}=0\text{V}$, $I_D=1\text{mA}$ |
| Gate threshold voltage | $V_{(GS)th}$ | 3.5 | 4 | 4.5 | V | $V_{DS}=V_{GS}$, $I_D=0.14\text{mA}$ |
| Zero gate voltage drain current ¹⁾ | I_{DSS} | - | - | 1 | μA | $V_{DS}=600\text{V}$, $V_{GS}=0\text{V}$, $T_j=25^\circ\text{C}$ $V_{DS}=600\text{V}$, $V_{GS}=0\text{V}$, $T_j=125^\circ\text{C}$ |
| Gate-source leakage current | I_{GSS} | - | - | 1000 | nA | $V_{GS}=20\text{V}$, $V_{DS}=0\text{V}$ |
| Drain-source on-state resistance | $R_{DS(on)}$ | - | 0.303 0.714 | 0.360 | Ω | $V_{GS}=10\text{V}$, $I_D=2.9\text{A}$, $T_j=25^\circ\text{C}$ $V_{GS}=10\text{V}$, $I_D=2.9\text{A}$, $T_j=150^\circ\text{C}$ |
| Gate resistance | R_G | - | 11.0 | - | Ω | $f=1\text{MHz}$, open drain |

Table 5 Dynamic characteristics

| Parameter | Symbol | Values | | | Unit | Note / Test Condition |
|--|--------------|--------|------|------|------|--|
| | | Min. | Typ. | Max. | | |
| Input capacitance | C_{iss} | - | 534 | - | pF | $V_{GS}=0\text{V}$, $V_{DS}=400\text{V}$, $f=250\text{kHz}$ |
| Output capacitance | C_{oss} | - | 12 | - | pF | $V_{GS}=0\text{V}$, $V_{DS}=400\text{V}$, $f=250\text{kHz}$ |
| Effective output capacitance, energy related ²⁾ | $C_{o(er)}$ | - | 20 | - | pF | $V_{GS}=0\text{V}$, $V_{DS}=0\dots400\text{V}$ |
| Effective output capacitance, time related ³⁾ | $C_{o(tr)}$ | - | 187 | - | pF | $I_D=\text{constant}$, $V_{GS}=0\text{V}$, $V_{DS}=0\dots400\text{V}$ |
| Turn-on delay time | $t_{d(on)}$ | - | 13.5 | - | ns | $V_{DD}=400\text{V}$, $V_{GS}=10\text{V}$, $I_D=2.9\text{A}$, $R_G=10.2\Omega$; see table 9 |
| Rise time | t_r | - | 11 | - | ns | $V_{DD}=400\text{V}$, $V_{GS}=10\text{V}$, $I_D=2.9\text{A}$, $R_G=10.2\Omega$; see table 9 |
| Turn-off delay time | $t_{d(off)}$ | - | 46 | - | ns | $V_{DD}=400\text{V}$, $V_{GS}=10\text{V}$, $I_D=2.9\text{A}$, $R_G=10.2\Omega$; see table 9 |
| Fall time | t_f | - | 13 | - | ns | $V_{DD}=400\text{V}$, $V_{GS}=10\text{V}$, $I_D=2.9\text{A}$, $R_G=10.2\Omega$; see table 9 |

Table 6 Gate charge characteristics

| Parameter | Symbol | Values | | | Unit | Note / Test Condition |
|-----------------------|---------------|--------|------|------|------|---|
| | | Min. | Typ. | Max. | | |
| Gate to source charge | Q_{GS} | - | 3.0 | - | nC | $V_{DD}=400\text{V}$, $I_D=2.9\text{A}$, $V_{GS}=0$ to 10V |
| Gate to drain charge | Q_{gd} | - | 4.4 | - | nC | $V_{DD}=400\text{V}$, $I_D=2.9\text{A}$, $V_{GS}=0$ to 10V |
| Gate charge total | Q_g | - | 12.7 | - | nC | $V_{DD}=400\text{V}$, $I_D=2.9\text{A}$, $V_{GS}=0$ to 10V |
| Gate plateau voltage | $V_{plateau}$ | - | 5.6 | - | V | $V_{DD}=400\text{V}$, $I_D=2.9\text{A}$, $V_{GS}=0$ 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 | $V_{GS}=0V, I_F=2.9A, T_j=25^\circ C$ |
| Reverse recovery time | t_{rr} | - | 60 | 90 | ns | $V_R=400V, I_F=2.9A, di_F/dt=100A/\mu s$; see table 8 |
| Reverse recovery charge | Q_{rr} | - | 0.14 | 0.28 | μC | $V_R=400V, I_F=2.9A, di_F/dt=100A/\mu s$; see table 8 |
| Peak reverse recovery current | I_{rrm} | - | 4.1 | - | A | $V_R=400V, I_F=2.9A, di_F/dt=100A/\mu s$; see table 8 |

4 Electrical characteristics diagrams

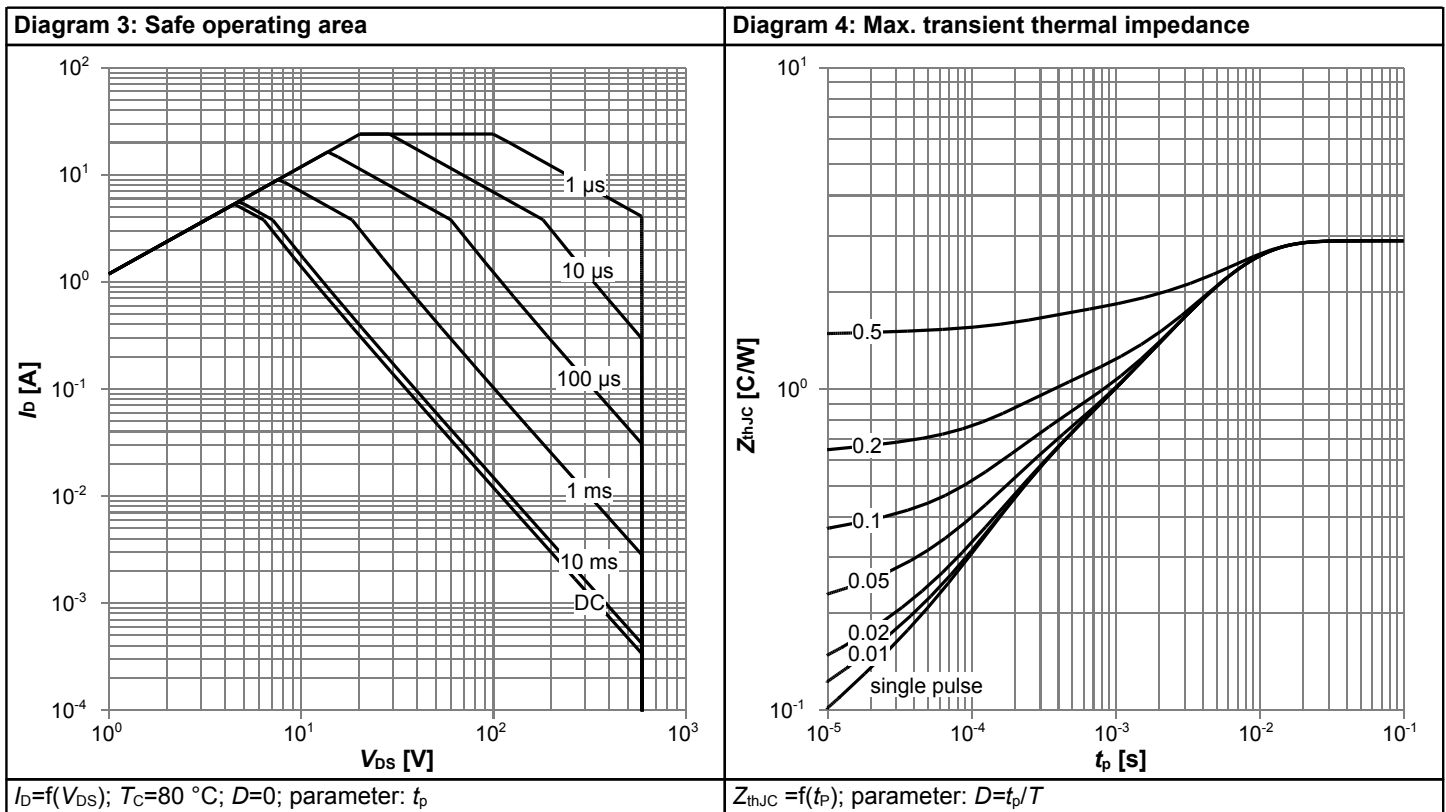
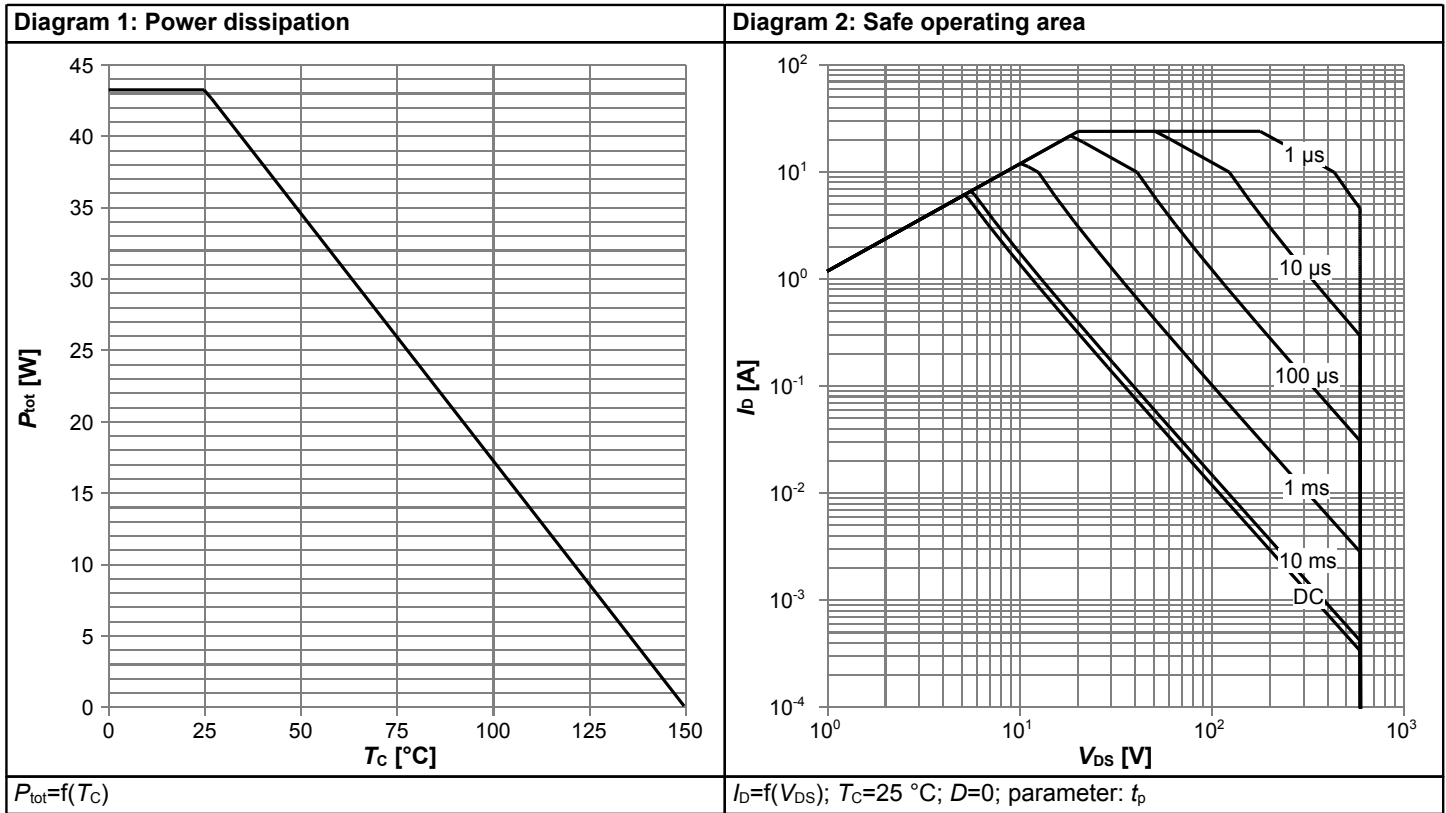
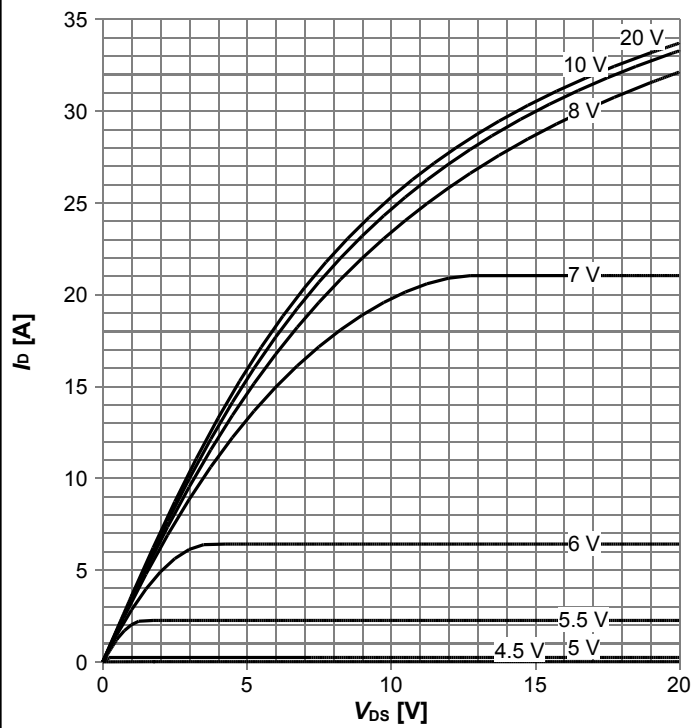
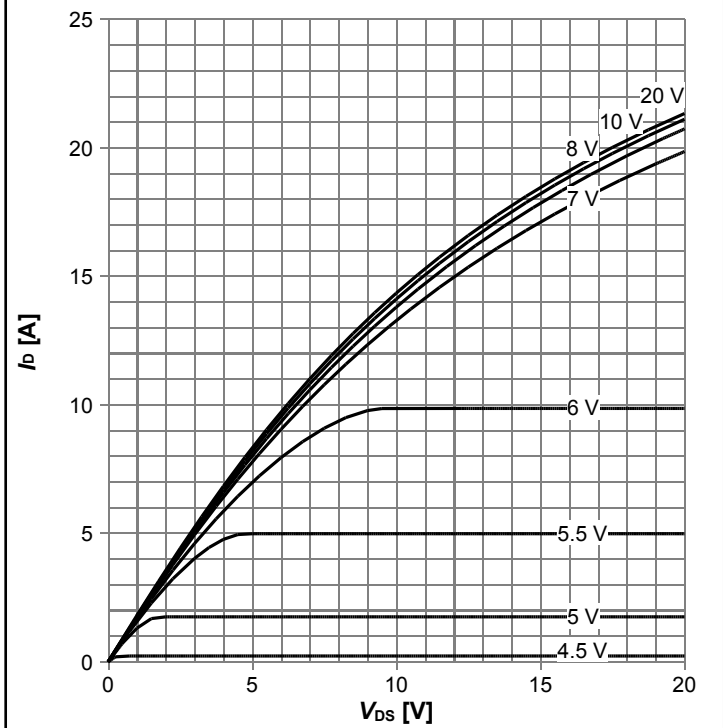


Diagram 5: Typ. output characteristics



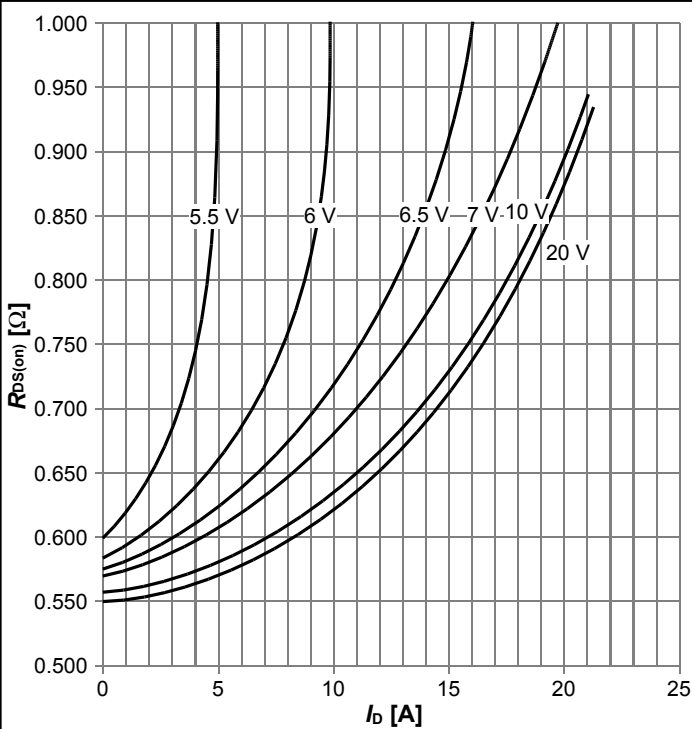
$I_D=f(V_{DS})$; $T_j=25\text{ °C}$; parameter: V_{GS}

Diagram 6: Typ. output characteristics



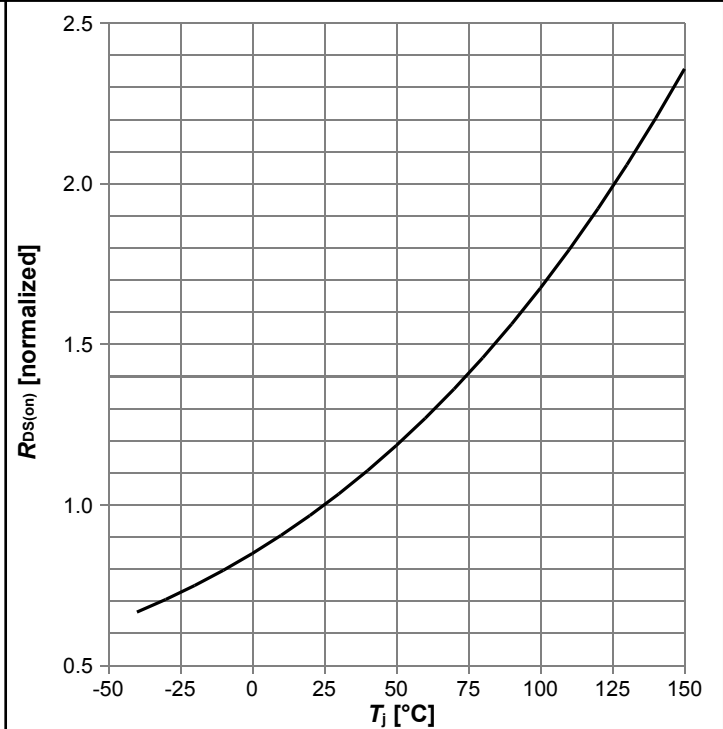
$I_D=f(V_{DS})$; $T_j=125\text{ °C}$; parameter: V_{GS}

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



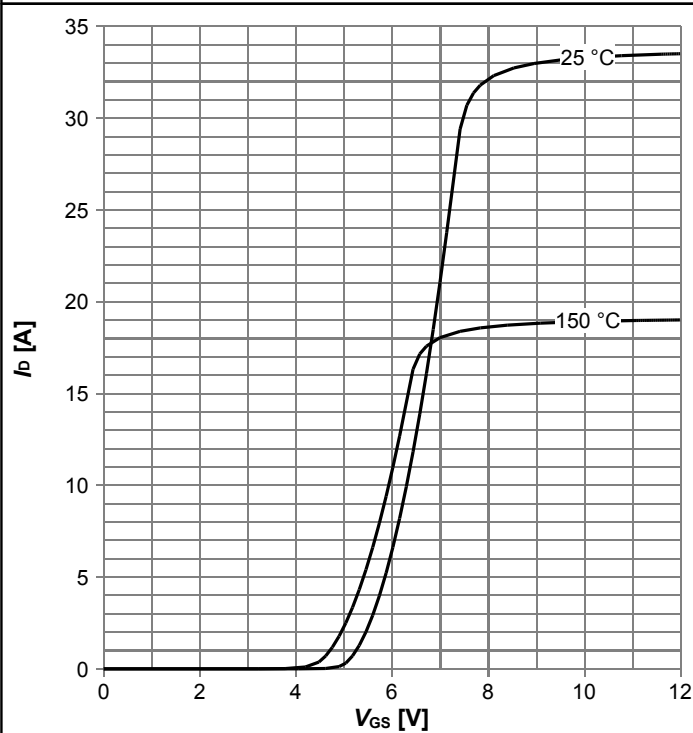
$R_{DS(on)}=f(I_D)$; $T_j=125\text{ °C}$; parameter: V_{GS}

Diagram 8: Drain-source on-state resistance



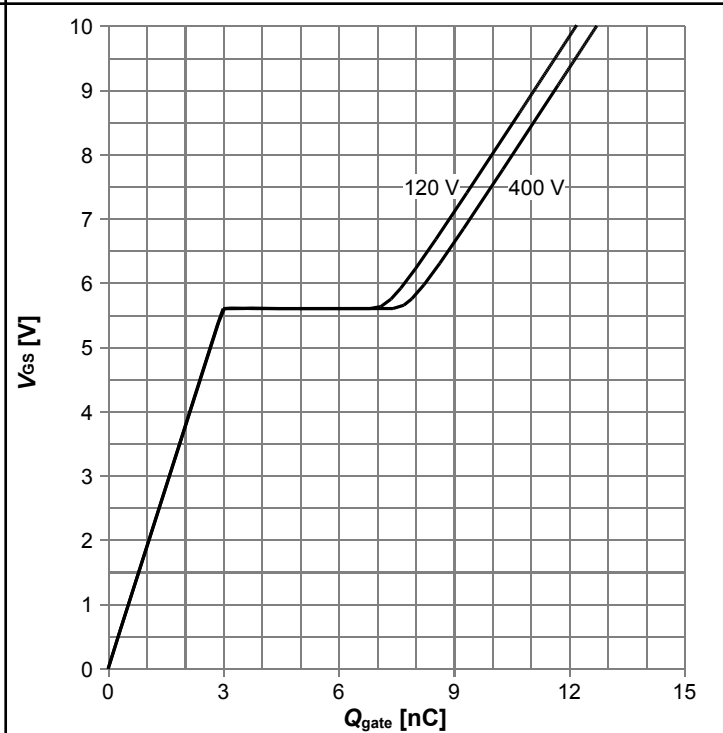
$R_{DS(on)}=f(T_j)$; $I_D=2.9\text{ A}$; $V_{GS}=10\text{ V}$

Diagram 9: Typ. transfer characteristics



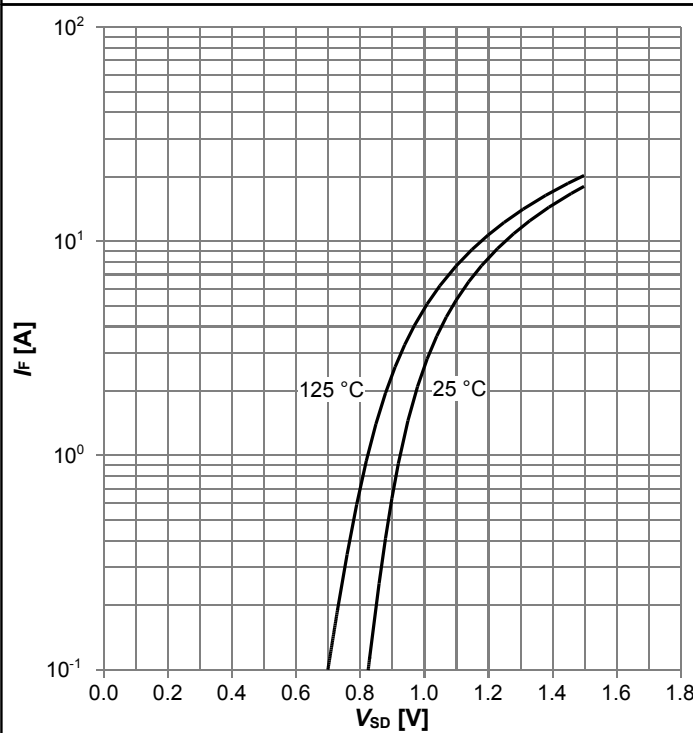
$I_D = f(V_{GS}); V_{DS} = 20V; \text{parameter: } T_j$

Diagram 10: Typ. gate charge



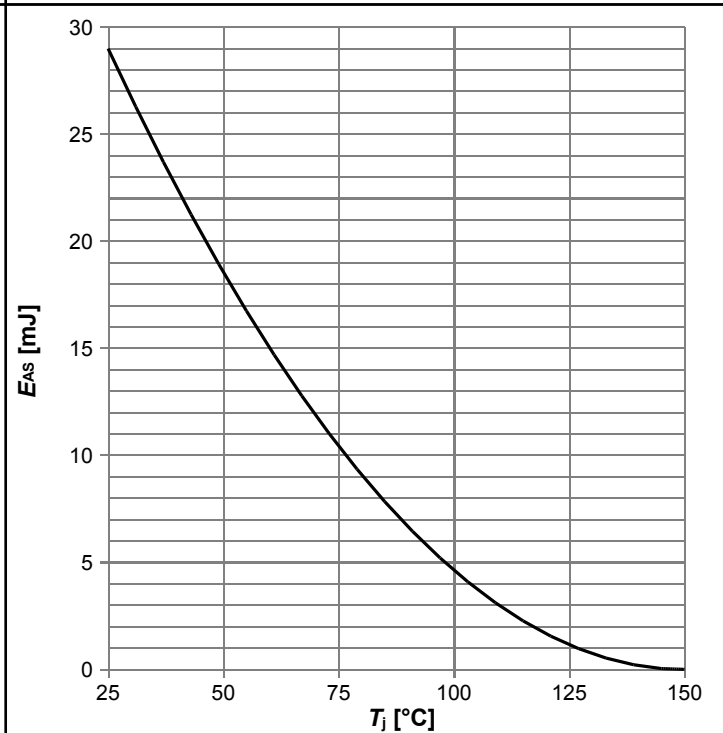
$V_{GS} = f(Q_{gate}); I_D = 2.9 \text{ A pulsed}; \text{parameter: } V_{DD}$

Diagram 11: Forward characteristics of reverse diode



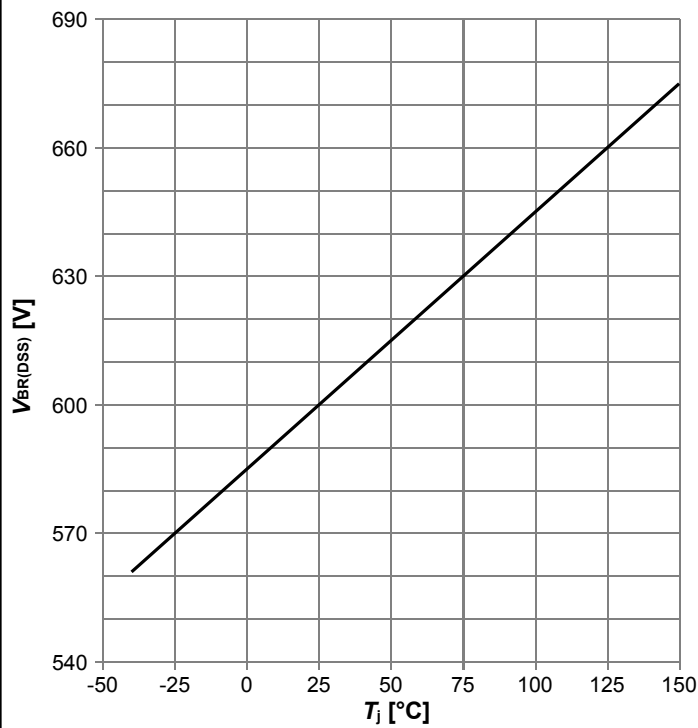
$I_F = f(V_{SD}); \text{parameter: } T_j$

Diagram 12: Avalanche energy



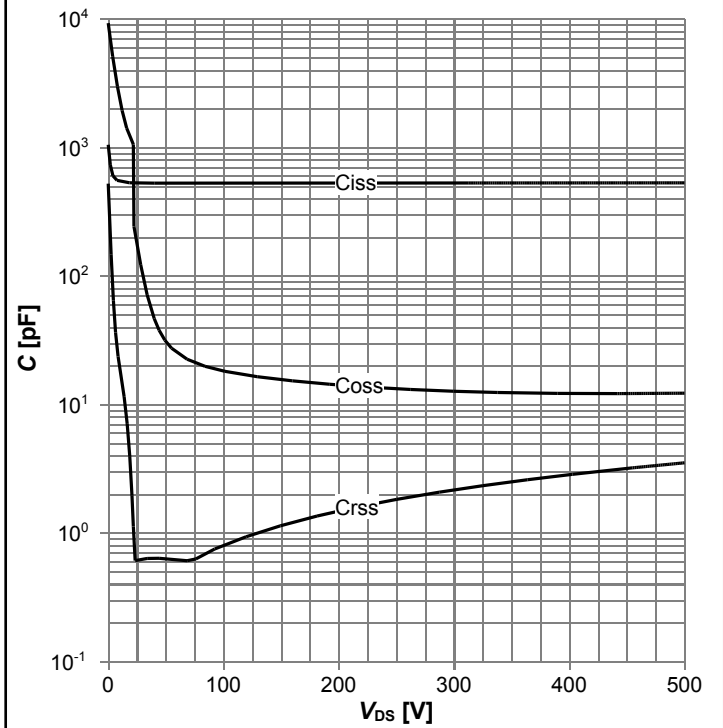
$E_{AS} = f(T_j); I_D = 2.1 \text{ A}; V_{DD} = 50 \text{ V}$

Diagram 13: Drain-source breakdown voltage



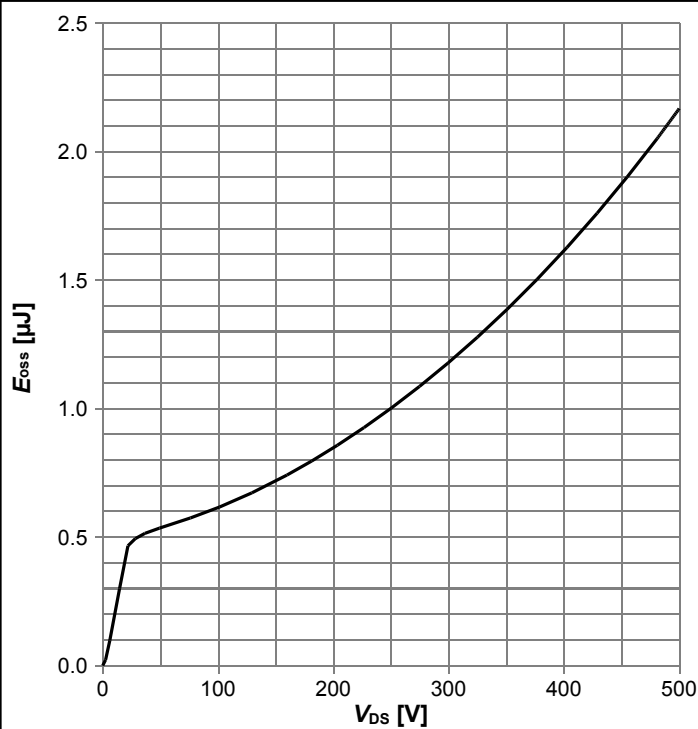
$V_{BR(DSS)}=f(T_j); I_D=1\text{ mA}$

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

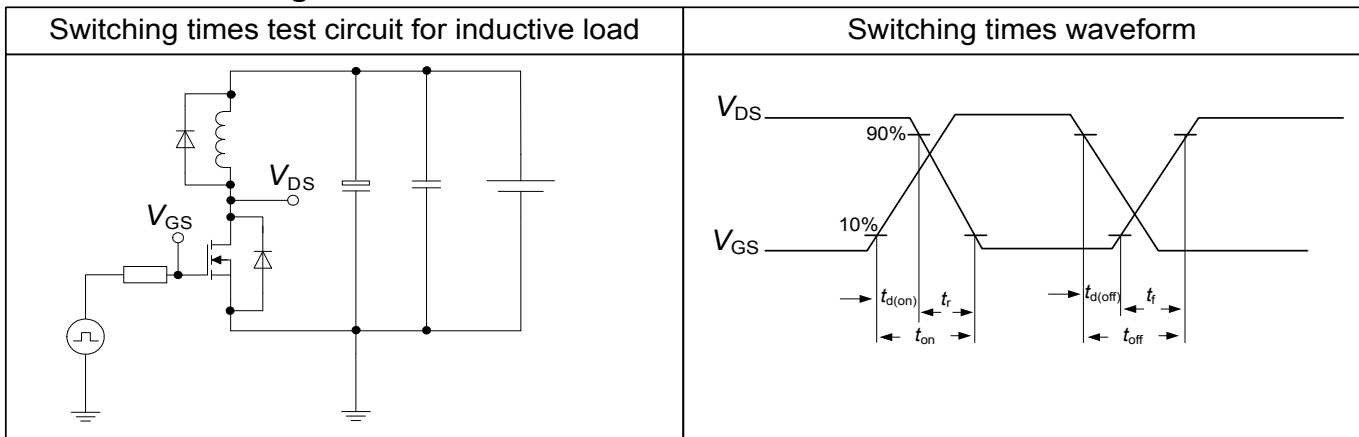
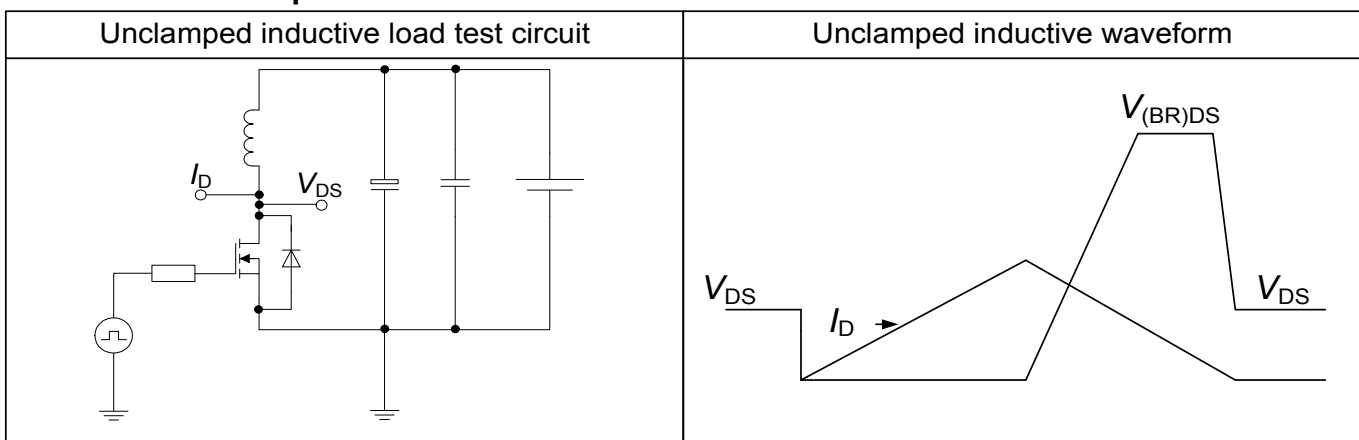
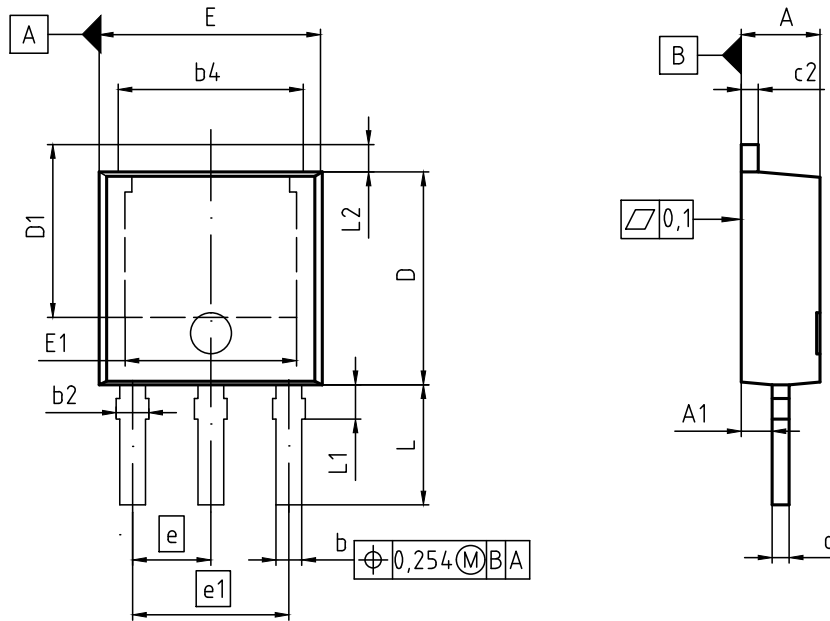


Table 10 Unclamped inductive load



6 Package Outlines



NOTES:

1. STANDARD QUALITY GRADE
2. ALL DIMENSIONS REFER TO JEDEC STANDARD TO-251 DO NOT INCLUDE MOLD FLASH OR PROTRUSIONS.

| DIM | MILLIMETERS | | INCHES | |
|-----|-------------|------|--------|-------|
| | MIN | MAX | MIN | MAX |
| A | 2.20 | 2.40 | 0.087 | 0.094 |
| A1 | 0.90 | 1.14 | 0.035 | 0.045 |
| b | 0.64 | 0.89 | 0.025 | 0.035 |
| b2 | 0.65 | 1.15 | 0.026 | 0.045 |
| b4 | 5.20 | 5.50 | 0.205 | 0.217 |
| c | 0.46 | 0.60 | 0.018 | 0.024 |
| c2 | 0.46 | 0.60 | 0.018 | 0.024 |
| D | 5.98 | 6.22 | 0.235 | 0.245 |
| D1 | 5.00 | 5.60 | 0.197 | 0.220 |
| E | 6.35 | 6.73 | 0.250 | 0.265 |
| E1 | 4.63 | 5.21 | 0.182 | 0.205 |
| e | 2.29 | | 0.090 | |
| e1 | 4.57 | | 0.180 | |
| N | 3 | | 3 | |
| L | 3.30 | 3.60 | 0.130 | 0.142 |
| L1 | 0.85 | 1.25 | 0.033 | 0.049 |
| L2 | 0.88 | 1.28 | 0.035 | 0.050 |

| |
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Figure 1 Outline PG-TO 251-3, 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

IPS60R360PFD7S

Revision: 2019-09-27, Rev. 2.0

Previous Revision

| Revision | Date | Subjects (major changes since last revision) |
|----------|------------|--|
| 2.0 | 2019-09-27 | Release of final version |

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