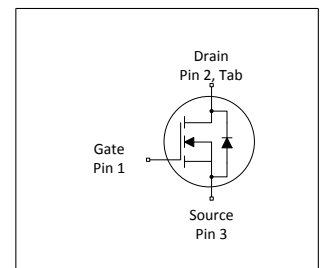
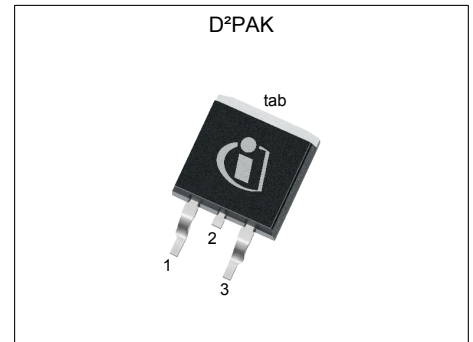


MOSFET

600V CoolMOS™ CFD7 Power Transistor

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™ CFD7 is the successor to the CoolMOS™ CFD2 series and is an optimized platform tailored to target soft switching applications such as phase-shift full-bridge (ZVS) and LLC. Resulting from reduced gate charge (Q_g), best-in-class reverse recovery charge (Q_{rr}) and improved turn off behavior CoolMOS™ CFD7 offers highest efficiency in resonant topologies. As part of Infineon's fast body diode portfolio, this new product series blends all advantages of a fast switching technology together with superior hard commutation robustness, without sacrificing easy implementation in the design-in process. The CoolMOS™ CFD7 technology meets highest efficiency and reliability standards and furthermore supports high power density solutions. Altogether, CoolMOS™ CFD7 makes resonant switching topologies more efficient, more reliable, lighter and cooler.



Features

- Ultra-fast body diode
- Low gate charge
- Best-in-class reverse recovery charge (Q_{rr})
- Improved MOSFET reverse diode dv/dt and di_f/dt ruggedness
- Lowest FOM $R_{DS(on)} * Q_g$ and $R_{DS(on)} * E_{oss}$
- Best-in-class $R_{DS(on)}$ in SMD and THD packages

Benefits

- Excellent hard commutation ruggedness
- Highest reliability for resonant topologies
- Highest efficiency with outstanding ease-of-use / performance tradeoff
- Enabling increased power density solutions

Potential applications

Suitable for Soft Switching topologies
 Optimized for phase-shift full-bridge (ZVS), LLC Applications – Server, Telecom, EV Charging

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 |
|----------------------|-------|------|
| $V_{DS} @ T_{j,max}$ | 650 | V |
| $R_{DS(on),max}$ | 360 | mΩ |
| $Q_{g,typ}$ | 14 | nC |
| $I_{D,pulse}$ | 24 | A |
| $E_{oss} @ 400V$ | 1.6 | μJ |
| Body diode di_f/dt | 1300 | A/μs |

| Type / Ordering Code | Package | Marking | Related Links |
|----------------------|-------------|----------|----------------|
| IPB60R360CFD7 | PG-TO 263-3 | 60R360F7 | see Appendix A |

Table of Contents

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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 | - | - | 7 5 | 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 | $I_D=2.0\text{A}$; $V_{DD}=50\text{V}$; see table 10 |
| Avalanche energy, repetitive | E_{AR} | - | - | 0.14 | mJ | $I_D=2.0\text{A}$; $V_{DD}=50\text{V}$; see table 10 |
| Avalanche current, single pulse | I_{AS} | - | - | 2.0 | 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} | -55 | - | 150 | $^\circ\text{C}$ | - |
| Operating junction temperature | T_j | -55 | - | 150 | $^\circ\text{C}$ | - |
| Mounting torque | - | - | - | - | Ncm | - |
| Continuous diode forward current | I_S | - | - | 7 | 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 | $V_{DS}=0\dots400\text{V}$, $I_{SD}\leq 7\text{A}$, $T_j=25^\circ\text{C}$ see table 8 |
| Maximum diode commutation speed | di _F /dt | - | - | 1300 | A/ μs | $V_{DS}=0\dots400\text{V}$, $I_{SD}\leq 7\text{A}$, $T_j=25^\circ\text{C}$ 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 $T_{j,max}$.

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 | device on PCB, minimal footprint |
| Thermal resistance, junction - ambient for SMD version | R_{thJA} | - | 35 | 45 | °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, wavesoldering only allowed at leads | 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 | $V_{(BR)DSS}$ | 600 | - | - | V | $V_{GS}=0V, I_D=1mA$ |
| Gate threshold voltage | $V_{(GS)th}$ | 3.5 | 4 | 4.5 | V | $V_{DS}=V_{GS}, I_D=0.14mA$ |
| Zero gate voltage drain current ¹⁾ | I_{DSS} | - | - | 1 | μA | $V_{DS}=600V, V_{GS}=0V, T_j=25^\circ C$ $V_{DS}=600V, V_{GS}=0V, T_j=125^\circ C$ |
| Gate-source leakage current | I_{GSS} | - | - | 100 | nA | $V_{GS}=20V, V_{DS}=0V$ |
| Drain-source on-state resistance | $R_{DS(on)}$ | - | 0.295 | 0.36 | Ω | $V_{GS}=10V, I_D=2.9A, T_j=25^\circ C$ $V_{GS}=10V, I_D=2.9A, T_j=150^\circ C$ |
| Gate resistance | R_G | - | 11.6 | - | Ω | $f=1MHz, \text{open drain}$ |

Table 5 Dynamic characteristics

| Parameter | Symbol | Values | | | Unit | Note / Test Condition |
|--|--------------|--------|------|------|------|--|
| | | Min. | Typ. | Max. | | |
| Input capacitance | C_{iss} | - | 679 | - | pF | $V_{GS}=0V, V_{DS}=400V, f=250kHz$ |
| Output capacitance | C_{oss} | - | 11 | - | pF | $V_{GS}=0V, V_{DS}=400V, f=250kHz$ |
| Effective output capacitance, energy related ²⁾ | $C_{o(er)}$ | - | 20 | - | pF | $V_{GS}=0V, V_{DS}=0...400V$ |
| Effective output capacitance, time related ³⁾ | $C_{o(tr)}$ | - | 198 | - | pF | $I_D=\text{constant}, V_{GS}=0V, V_{DS}=0...400V$ |
| Turn-on delay time | $t_{d(on)}$ | - | 15.5 | - | ns | $V_{DD}=400V, V_{GS}=10V, I_D=4.0A,$ $R_G=10.2\Omega; \text{see table 9}$ |
| Rise time | t_r | - | 12 | - | ns | $V_{DD}=400V, V_{GS}=10V, I_D=4.0A,$ $R_G=10.2\Omega; \text{see table 9}$ |
| Turn-off delay time | $t_{d(off)}$ | - | 41.5 | - | ns | $V_{DD}=400V, V_{GS}=10V, I_D=4.0A,$ $R_G=10.2\Omega; \text{see table 9}$ |
| Fall time | t_f | - | 8.5 | - | ns | $V_{DD}=400V, V_{GS}=10V, I_D=4.0A,$ $R_G=10.2\Omega; \text{see table 9}$ |

Table 6 Gate charge characteristics

| Parameter | Symbol | Values | | | Unit | Note / Test Condition |
|-----------------------|---------------|--------|------|------|------|---|
| | | Min. | Typ. | Max. | | |
| Gate to source charge | Q_{GS} | - | 4 | - | nC | $V_{DD}=400V, I_D=4.0A, V_{GS}=0 \text{ to } 10V$ |
| Gate to drain charge | Q_{gd} | - | 4 | - | nC | $V_{DD}=400V, I_D=4.0A, V_{GS}=0 \text{ to } 10V$ |
| Gate charge total | Q_g | - | 14 | - | nC | $V_{DD}=400V, I_D=4.0A, V_{GS}=0 \text{ to } 10V$ |
| Gate plateau voltage | $V_{plateau}$ | - | 5.8 | - | V | $V_{DD}=400V, I_D=4.0A, V_{GS}=0 \text{ to } 10V$ |

¹⁾ Maximum specification is defined by calculated six sigma upper confidence bound

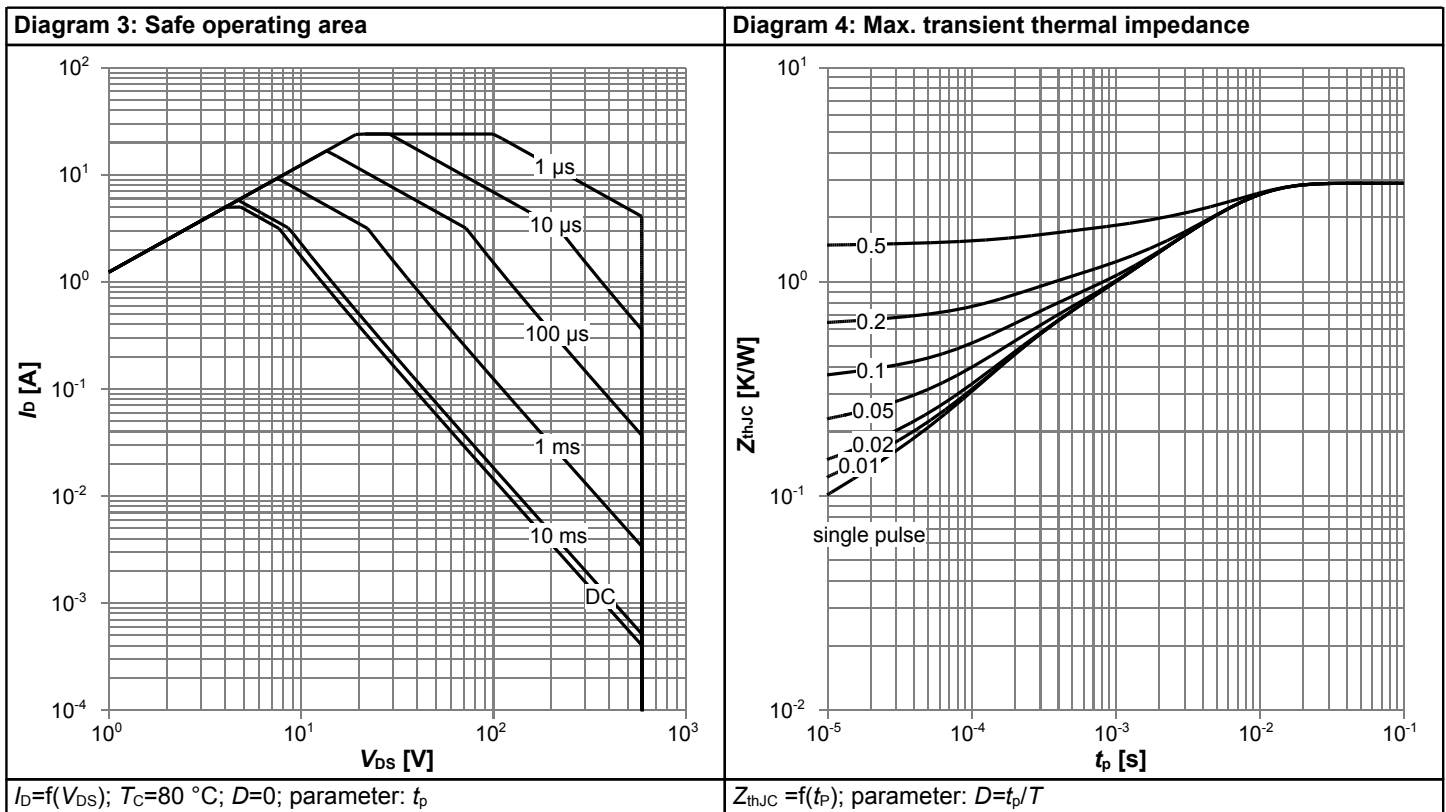
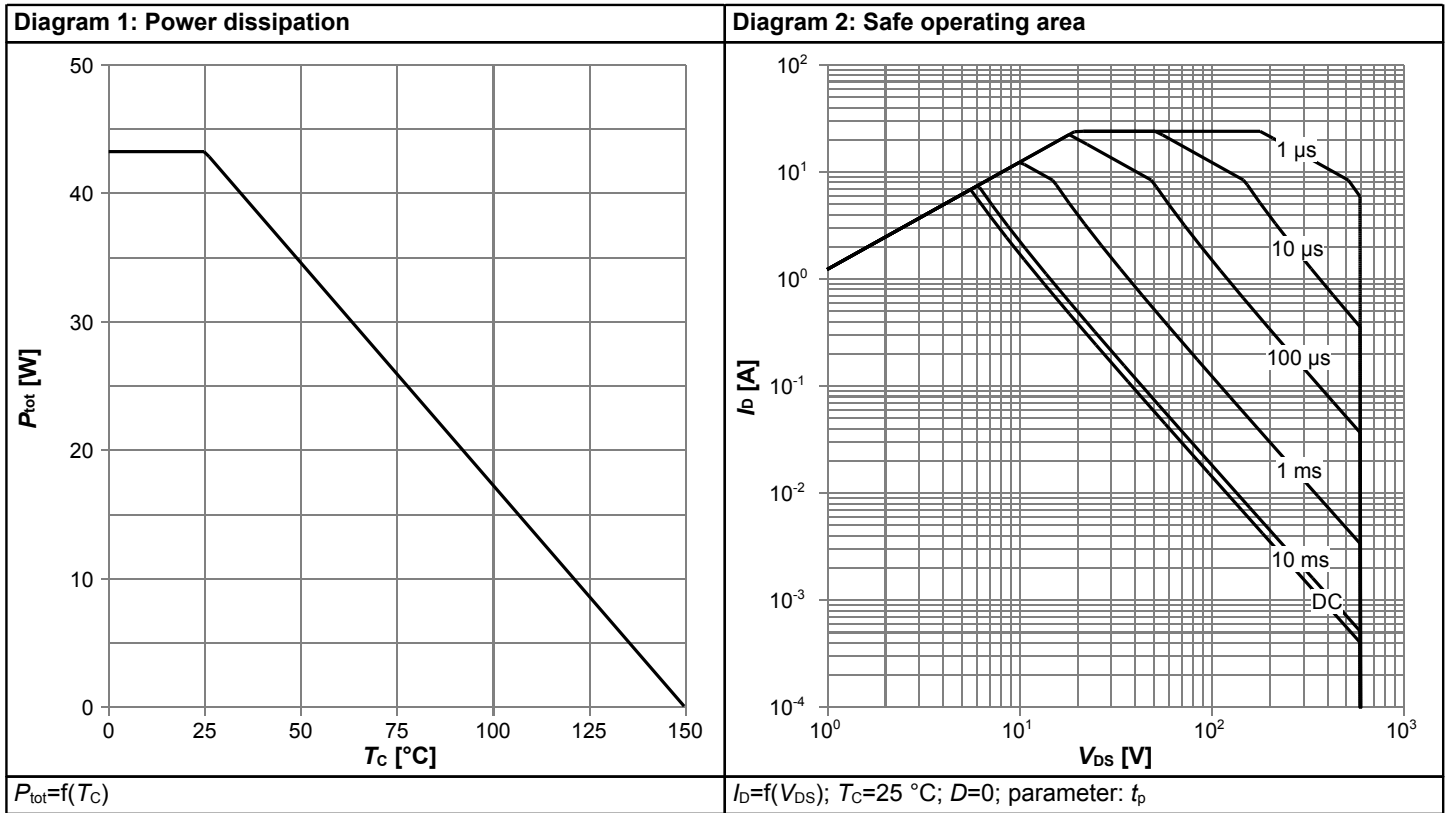
²⁾ $C_{o(er)}$ is a fixed capacitance that gives the same stored energy as C_{oss} while V_{DS} is rising from 0 to 400V

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} | - | 81 | 122 | ns | $V_R=400V, I_F=4.0A, di_F/dt=100A/\mu s$; see table 8 |
| Reverse recovery charge | Q_{rr} | - | 0.28 | 0.56 | μC | $V_R=400V, I_F=4.0A, di_F/dt=100A/\mu s$; see table 8 |
| Peak reverse recovery current | I_{rrm} | - | 6.4 | - | A | $V_R=400V, I_F=4.0A, di_F/dt=100A/\mu s$; see table 8 |

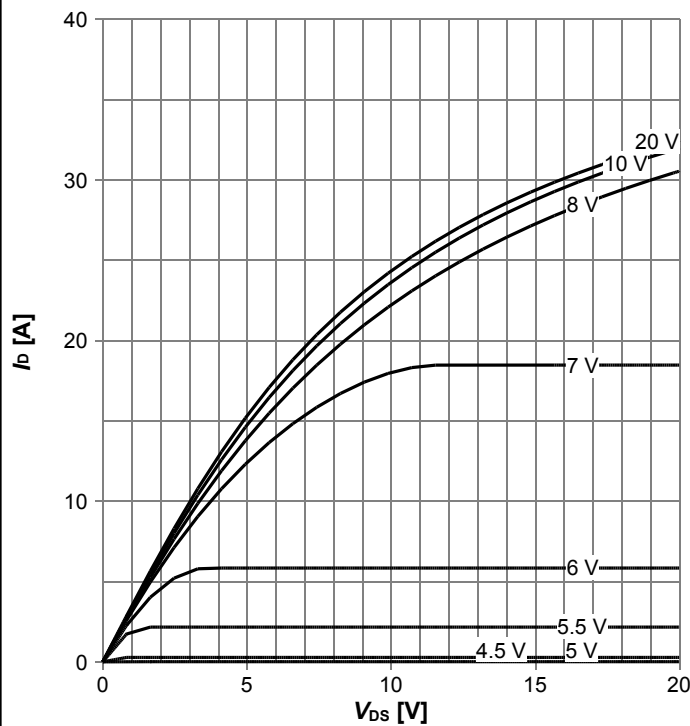
4 Electrical characteristics diagrams



600V CoolMOS™ CFD7 Power Transistor

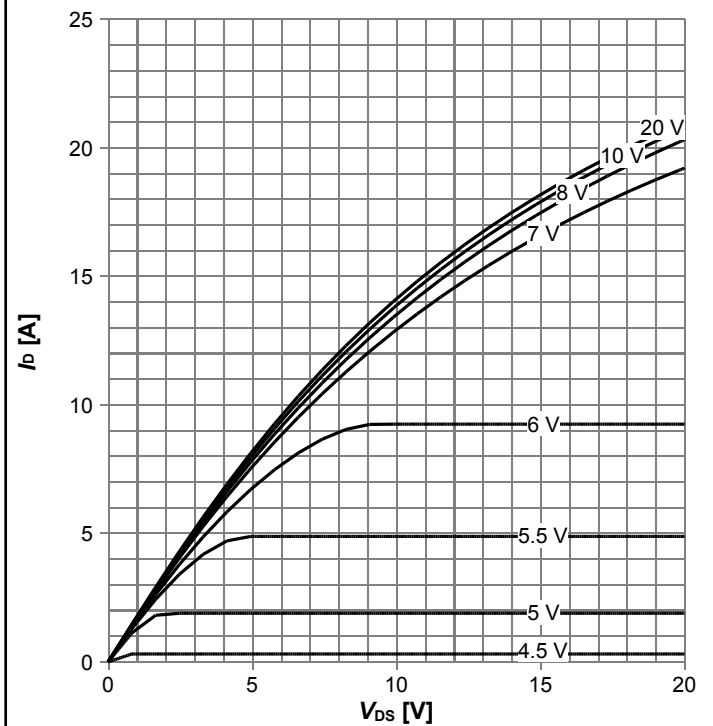
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Diagram 5: Typ. output characteristics



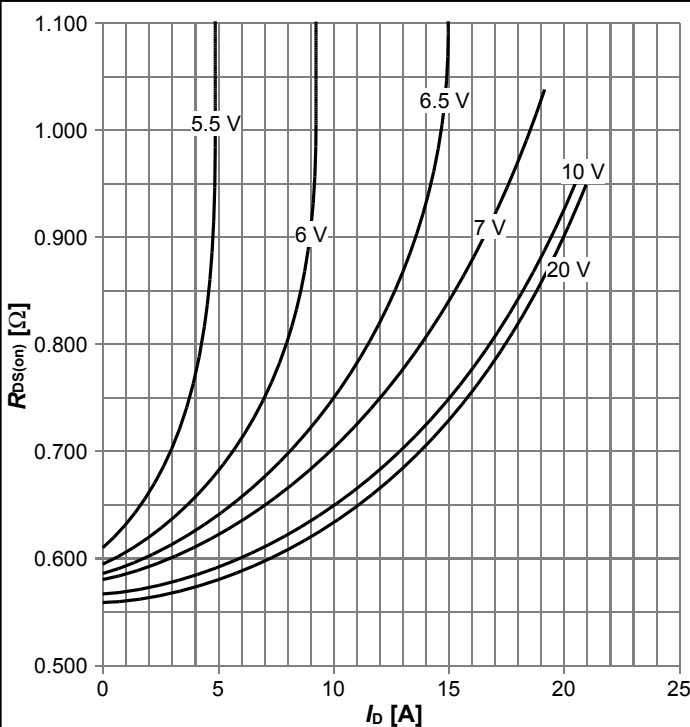
$I_D=f(V_{DS})$; $T_j=25\text{ °C}$; parameter: V_{GS}

Diagram 6: Typ. output characteristics



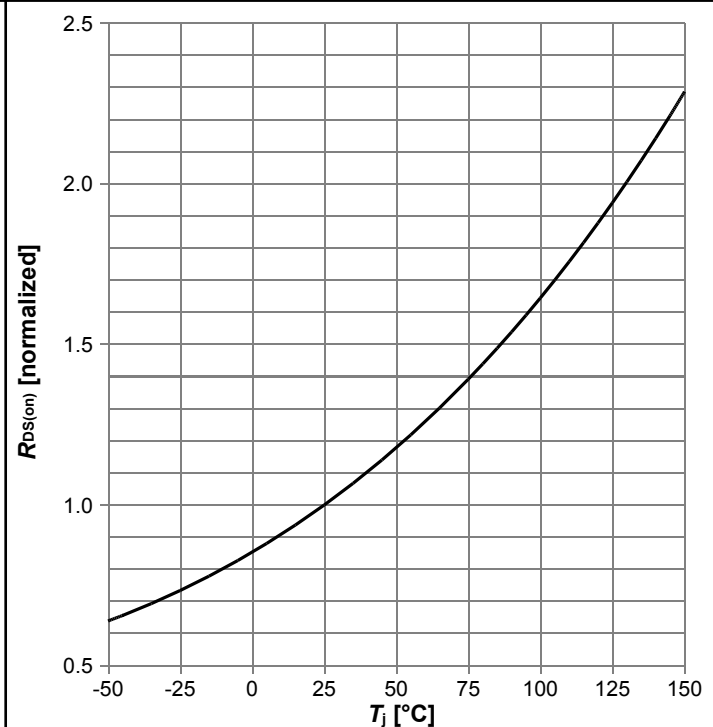
$I_D=f(V_{DS})$; $T_j=125\text{ °C}$; parameter: V_{GS}

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

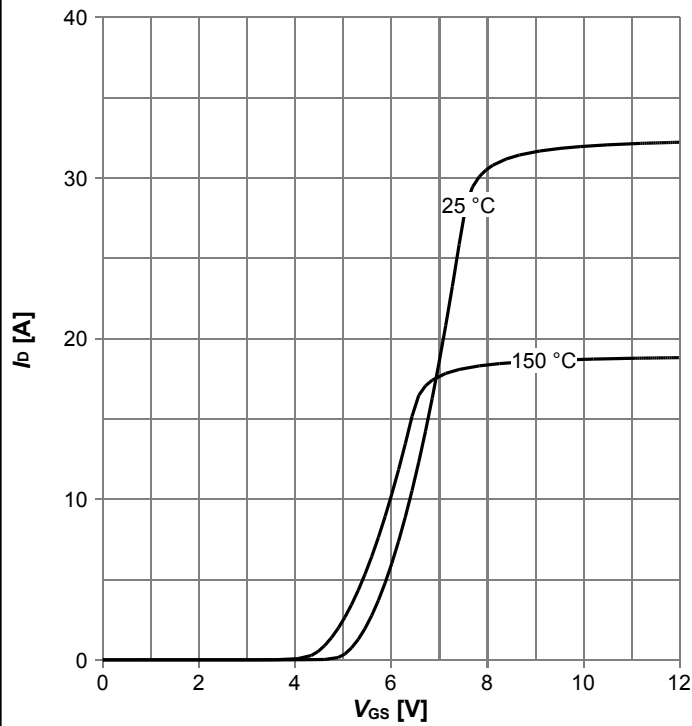


$R_{DS(on)}=f(T_j)$; $I_D=2.9\text{ A}$; $V_{GS}=10\text{ V}$

600V CoolMOS™ CFD7 Power Transistor

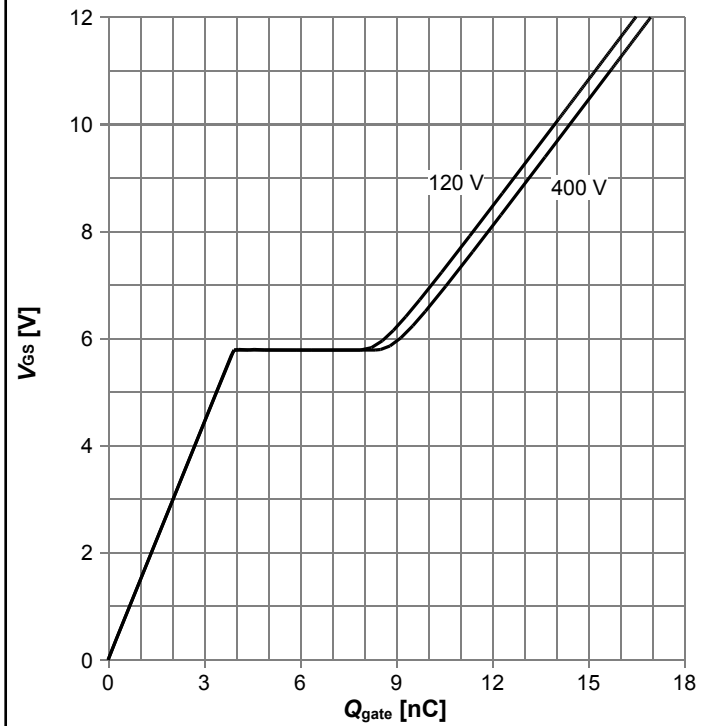
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Diagram 9: Typ. transfer characteristics



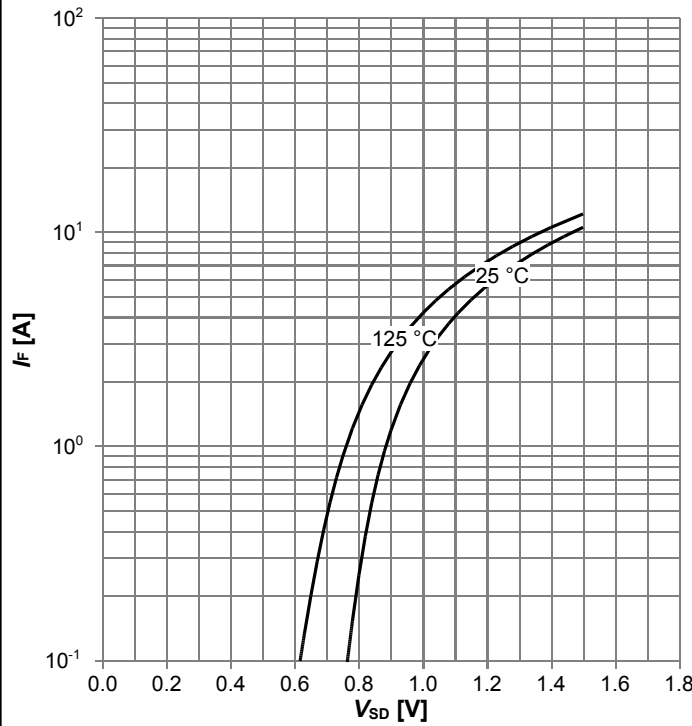
$I_D = f(V_{GS})$; $V_{DS} = 20V$; parameter: T_j

Diagram 10: Typ. gate charge



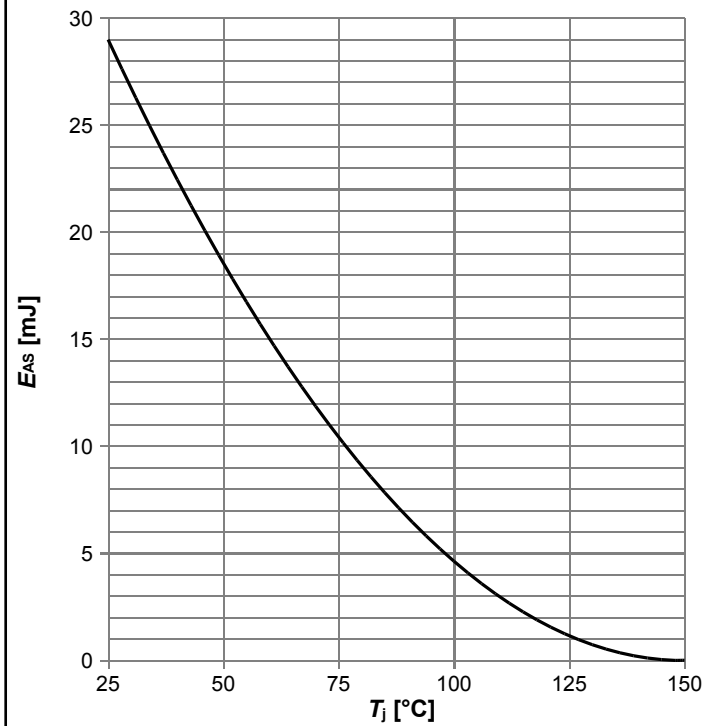
$V_{GS} = f(Q_{gate})$; $I_D = 4.0$ A pulsed; parameter: V_{DD}

Diagram 11: Forward characteristics of reverse diode



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

Diagram 12: Avalanche energy



$E_{AS} = f(T_j)$; $I_D = 2.0$ A; $V_{DD} = 50$ V

600V CoolMOS™ CFD7 Power Transistor

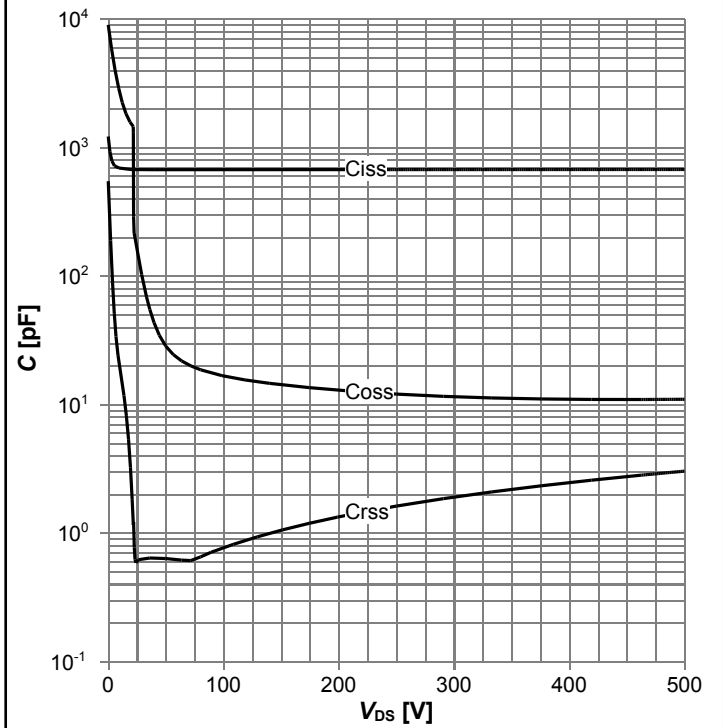
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Diagram 13: Drain-source breakdown voltage



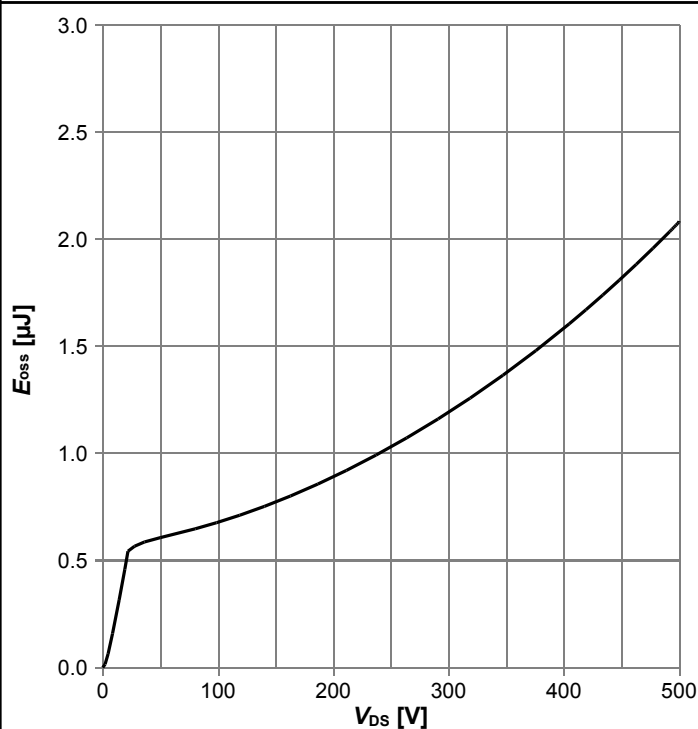
$V_{BR(DSS)}=f(T_j); I_D=1\text{ mA}$

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



Figure 1 Outline PG-TO 263-3, dimensions in mm/inches

7 Appendix A

Table 11 Related Links

- IFX CoolMOS CFD7 Webpage: www.infineon.com
- IFX CoolMOS CFD7 application note: www.infineon.com
- IFX CoolMOS CFD7 simulation model: www.infineon.com
- IFX Design tools: www.infineon.com

Revision History

IPB60R360CFD7

Revision: 2019-05-15, Rev. 2.0

Previous Revision

| Revision | Date | Subjects (major changes since last revision) |
|----------|------------|--|
| 2.0 | 2019-05-15 | Release of final version |

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