

MOSFET

600V CoolMOS™ C7 Power Transistor

CoolMOS™ C7 is a revolutionary technology for high voltage power MOSFETs, designed according to the superjunction (SJ) principle and pioneered by Infineon Technologies.

600V CoolMOS™ C7 series combines the experience of the leading SJ MOSFET supplier with high class innovation.

The 600V C7 is the first technology ever with $R_{DS(on)} \cdot A$ below $10\text{Ohm} \cdot \text{mm}^2$.

Features

- Suitable for hard and soft switching (PFC and high performance LLC)
- Increased MOSFET dv/dt ruggedness to 120V/ns
- Increased efficiency due to best in class FOM $R_{DS(on)} \cdot E_{oss}$ and $R_{DS(on)} \cdot Q_g$
- Best in class $R_{DS(on)}$ /package
- SMD package with very low parasitic inductance for easy device control
- Qualified for industrial grade applications according to JEDEC (J-STD20 and JESD22)
- 4pin kelvin source concept

Benefits

- Increased economies of scale by use in PFC and PWM topologies in the application
- Higher dv/dt limit enables faster switching leading to higher efficiency
- Enabling higher system efficiency by lower switching losses
- Increased power density solutions due to smaller packages
- Optimized PCB assembly and layout solutions
- Suitable for applications such as server, telecom and solar
- Up to 0.5% better full load efficiency @100kHz compared to conventional 3pin package

Potential applications

PFC stages and PWM stages (TTF, LLC) for high power/performance SMPS e.g. Computing, Server, Telecom, UPS and Solar.

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 |
| $R_{DS(on),max}$ | 104 | mΩ |
| $Q_{g,typ}$ | 42 | nC |
| $I_{D,pulse}$ | 83 | A |
| $I_{D,continuous}$ @ $T_j < 150^\circ\text{C}$ | 35 | A |
| E_{oss} @4 00V | 4.95 | μJ |
| Body diode di_f/dt | 375 | A/μs |

| Type / Ordering Code | Package | Marking | Related Links |
|----------------------|-----------|---------|----------------|
| IPL60R104C7 | PG-VSON-4 | 60C7104 | see Appendix A |

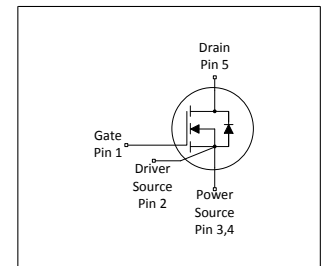
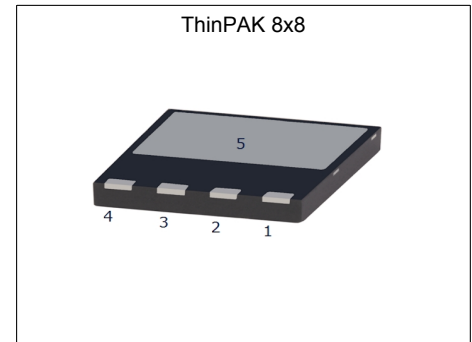


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1 Maximum ratings

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 | - | - | 20 15 | A | $T_C=25^\circ\text{C}$ $T_C=100^\circ\text{C}$ |
| Pulsed drain current ²⁾ | $I_{D,pulse}$ | - | - | 83 | A | $T_C=25^\circ\text{C}$ |
| Avalanche energy, single pulse | E_{AS} | - | - | 97 | mJ | $I_D=5.0\text{A}$; $V_{DD}=50\text{V}$; see table 10 |
| Avalanche energy, repetitive | E_{AR} | - | - | 0.49 | mJ | $I_D=5.0\text{A}$; $V_{DD}=50\text{V}$; see table 10 |
| Avalanche current, single pulse | I_{AS} | - | - | 5.0 | 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} | - | - | 122 | 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 | - | - | - | n.a. | Ncm | - |
| Continuous diode forward current | I_S | - | - | 20 | A | $T_C=25^\circ\text{C}$ |
| Diode pulse current ²⁾ | $I_{S,pulse}$ | - | - | 83 | A | $T_C=25^\circ\text{C}$ |
| Reverse diode dv/dt ³⁾ | dv/dt | - | - | 20 | V/ns | $V_{DS}=0\dots400\text{V}$, $I_{SD}\leq 7.7\text{A}$, $T_j=25^\circ\text{C}$ see table 8 |
| Maximum diode commutation speed | di _F /dt | - | - | 375 | A/ μs | $V_{DS}=0\dots400\text{V}$, $I_{SD}\leq 7.7\text{A}$, $T_j=25^\circ\text{C}$ 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

2 Thermal characteristics

Table 3 Thermal characteristics

| Parameter | Symbol | Values | | | Unit | Note / Test Condition |
|--------------------------------------------------------|------------|--------|------|-------|------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| | | Min. | Typ. | Max. | | |
| Thermal resistance, junction - case | R_{thJC} | - | - | 1.026 | °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. |
| Reflow soldering temperature | T_{sold} | - | - | 260 | °C | reflow MSL2a |

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 | 3.5 | 4 | V | $V_{DS}=V_{GS}$, $I_D=0.49\text{mA}$ |
| Zero gate voltage drain current | I_{DSS} | - | - | 1 | μA | $V_{DS}=600$, $V_{GS}=0\text{V}$, $T_j=25^\circ\text{C}$ $V_{DS}=600$, $V_{GS}=0\text{V}$, $T_j=150^\circ\text{C}$ |
| Gate-source leakage current | I_{GSS} | - | - | 100 | nA | $V_{GS}=20\text{V}$, $V_{DS}=0\text{V}$ |
| Drain-source on-state resistance | $R_{DS(on)}$ | - | 0.090 0.200 | 0.104 - | Ω | $V_{GS}=10\text{V}$, $I_D=9.7\text{A}$, $T_j=25^\circ\text{C}$ $V_{GS}=10\text{V}$, $I_D=9.7\text{A}$, $T_j=150^\circ\text{C}$ |
| Gate resistance | R_G | - | 0.82 | - | 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} | - | 1819 | - | pF | $V_{GS}=0\text{V}$, $V_{DS}=400\text{V}$, $f=250\text{kHz}$ |
| Output capacitance | C_{oss} | - | 33 | - | pF | $V_{GS}=0\text{V}$, $V_{DS}=400\text{V}$, $f=250\text{kHz}$ |
| Effective output capacitance, energy related ¹⁾ | $C_{o(er)}$ | - | 62 | - | pF | $V_{GS}=0\text{V}$, $V_{DS}=0\dots400\text{V}$ |
| Effective output capacitance, time related ²⁾ | $C_{o(tr)}$ | - | 641 | - | pF | $I_D=\text{constant}$, $V_{GS}=0\text{V}$, $V_{DS}=0\dots400\text{V}$ |
| Turn-on delay time | $t_{d(on)}$ | - | 11.8 | - | ns | $V_{DD}=400\text{V}$, $V_{GS}=13\text{V}$, $I_D=9.7\text{A}$, $R_G=5.3\Omega$; see table 9 |
| Rise time | t_r | - | 8 | - | ns | $V_{DD}=400\text{V}$, $V_{GS}=13\text{V}$, $I_D=9.7\text{A}$, $R_G=5.3\Omega$; see table 9 |
| Turn-off delay time | $t_{d(off)}$ | - | 48 | - | ns | $V_{DD}=400\text{V}$, $V_{GS}=13\text{V}$, $I_D=9.7\text{A}$, $R_G=5.3\Omega$; see table 9 |
| Fall time | t_f | - | 8 | - | ns | $V_{DD}=400\text{V}$, $V_{GS}=13\text{V}$, $I_D=9.7\text{A}$, $R_G=5.3\Omega$; see table 9 |

Table 6 Gate charge characteristics

| Parameter | Symbol | Values | | | Unit | Note / Test Condition |
|-----------------------|---------------|--------|------|------|------|-----------------------------------------------------------------------|
| | | Min. | Typ. | Max. | | |
| Gate to source charge | Q_{GS} | - | 9 | - | nC | $V_{DD}=400\text{V}$, $I_D=9.7\text{A}$, $V_{GS}=0$ to 10V |
| Gate to drain charge | Q_{gd} | - | 14 | - | nC | $V_{DD}=400\text{V}$, $I_D=9.7\text{A}$, $V_{GS}=0$ to 10V |
| Gate charge total | Q_g | - | 42 | - | nC | $V_{DD}=400\text{V}$, $I_D=9.7\text{A}$, $V_{GS}=0$ to 10V |
| Gate plateau voltage | $V_{plateau}$ | - | 5.0 | - | V | $V_{DD}=400\text{V}$, $I_D=9.7\text{A}$, $V_{GS}=0$ 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 | $V_{GS}=0V, I_F=9.7A, T_j=25^\circ C$ |
| Reverse recovery time | t_{rr} | - | 350 | - | ns | $V_R=400V, I_F=9.7A, di_F/dt=100A/\mu s$; see table 8 |
| Reverse recovery charge | Q_{rr} | - | 4.4 | - | μC | $V_R=400V, I_F=9.7A, di_F/dt=100A/\mu s$; see table 8 |
| Peak reverse recovery current | I_{rrm} | - | 27 | - | A | $V_R=400V, I_F=9.7A, di_F/dt=100A/\mu s$; see table 8 |

4 Electrical characteristics diagrams

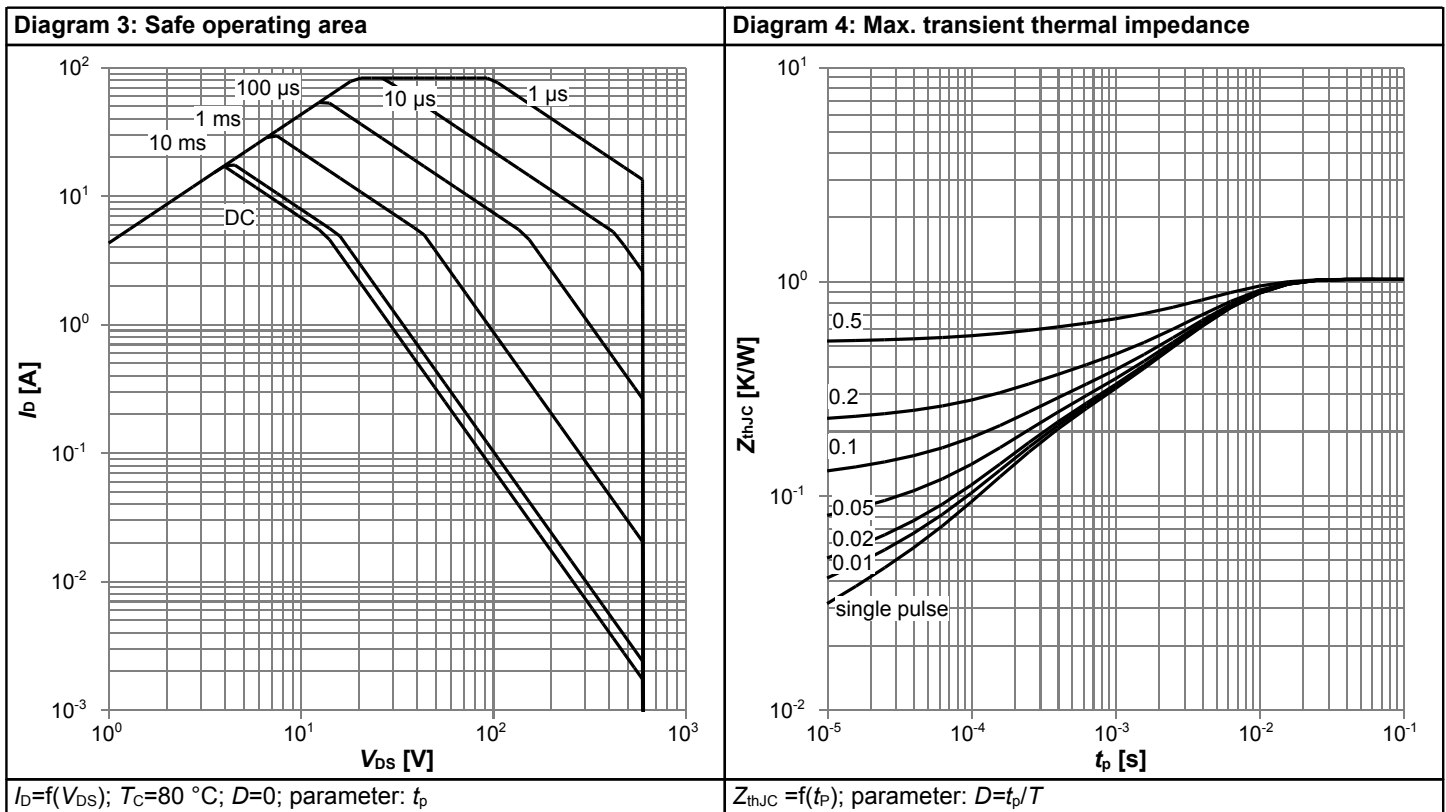
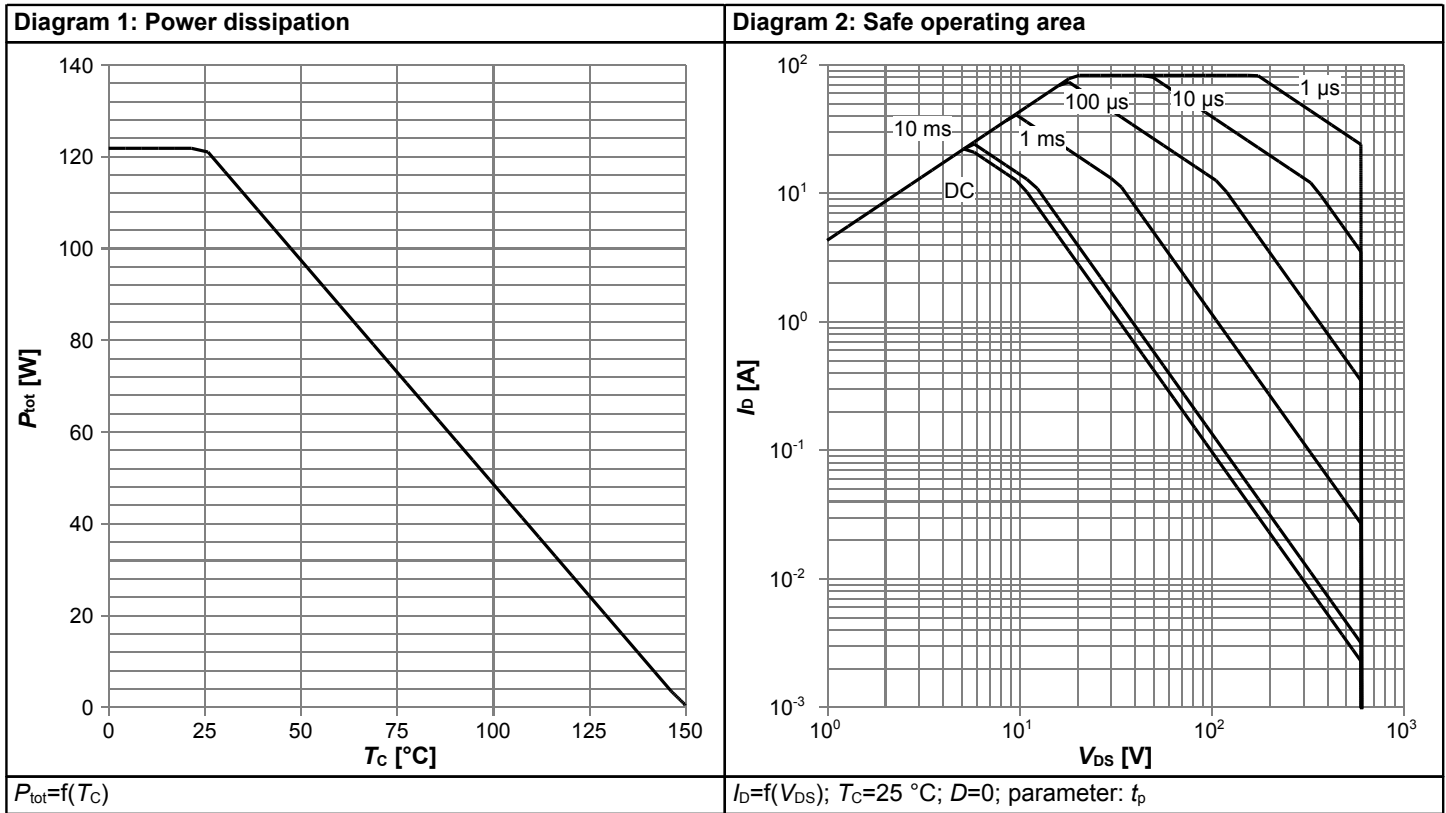
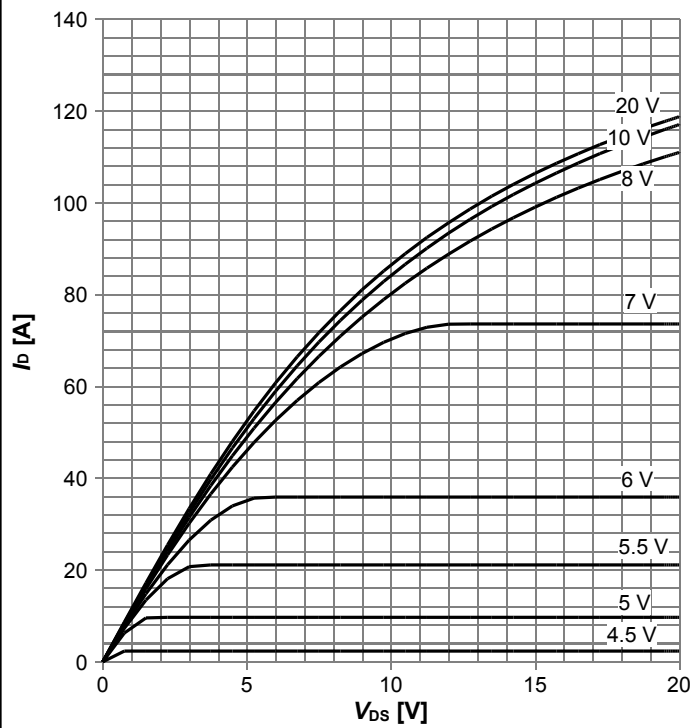
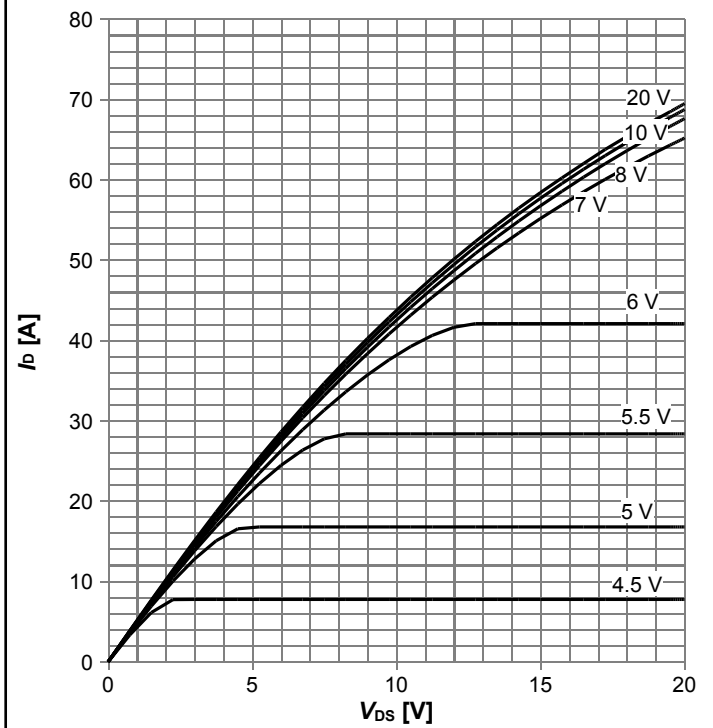


Diagram 5: Typ. output characteristics



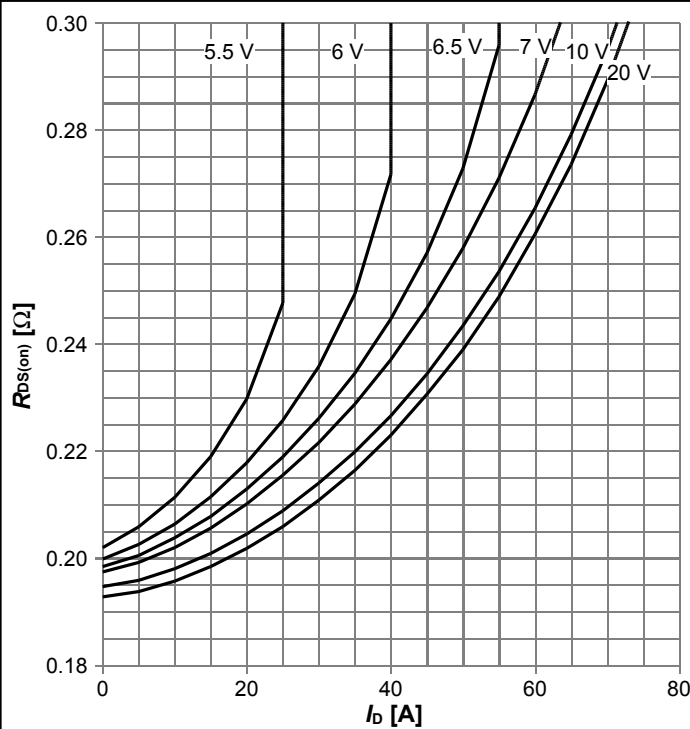
$I_D=f(V_{DS}); T_j=25\text{ }^\circ\text{C}; \text{parameter: } V_{GS}$

Diagram 6: Typ. output characteristics



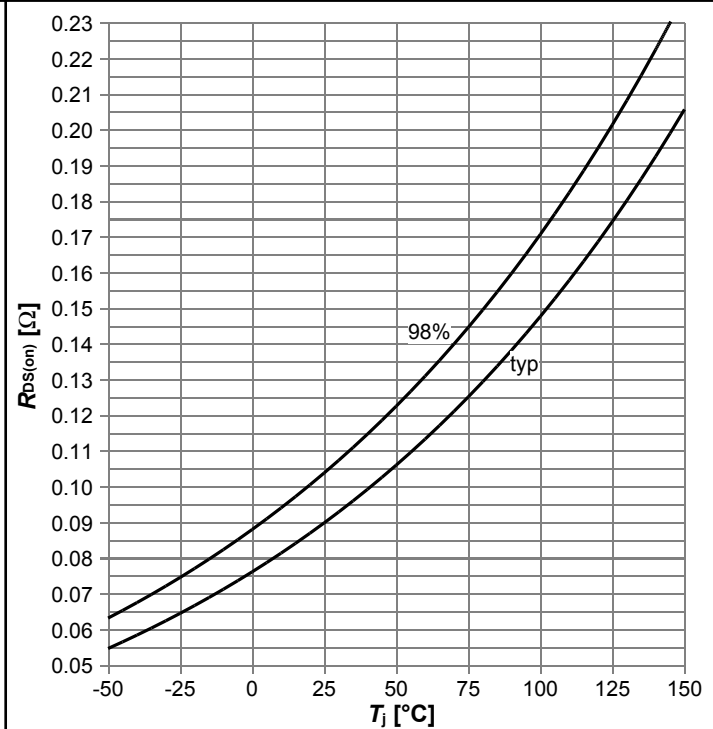
$I_D=f(V_{DS}); T_j=125\text{ }^\circ\text{C}; \text{parameter: } V_{GS}$

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



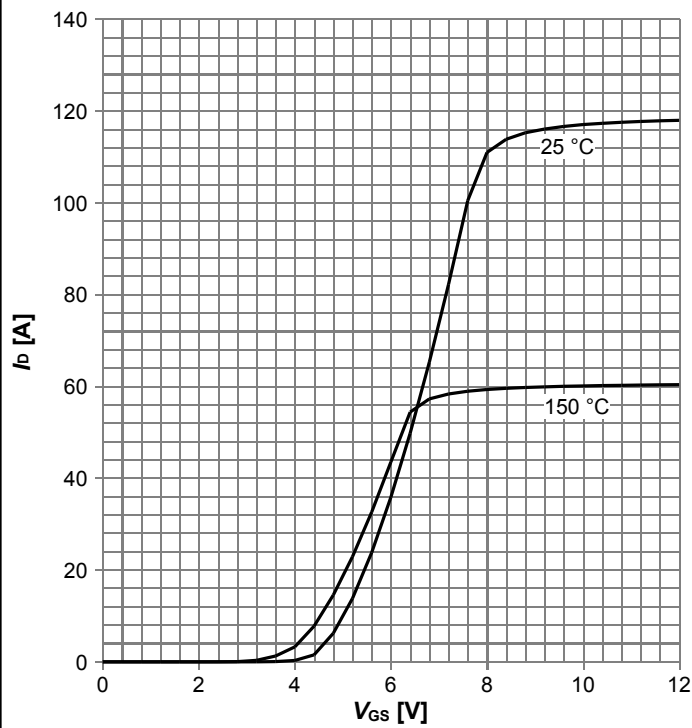
$R_{DS(on)}=f(I_D); T_j=125\text{ }^\circ\text{C}; \text{parameter: } V_{GS}$

Diagram 8: Drain-source on-state resistance



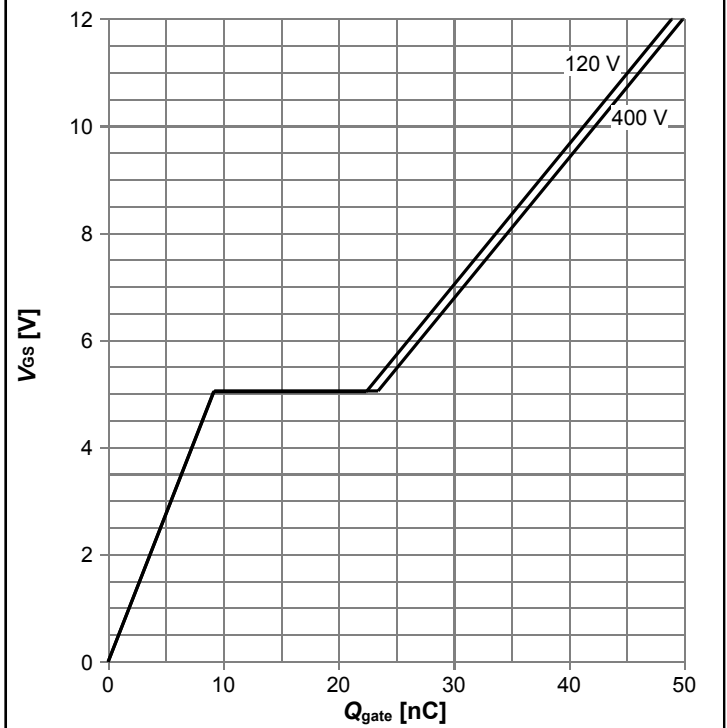
$R_{DS(on)}=f(T_j); I_D=9.7\text{ A}; V_{GS}=10\text{ V}$

Diagram 9: Typ. transfer characteristics



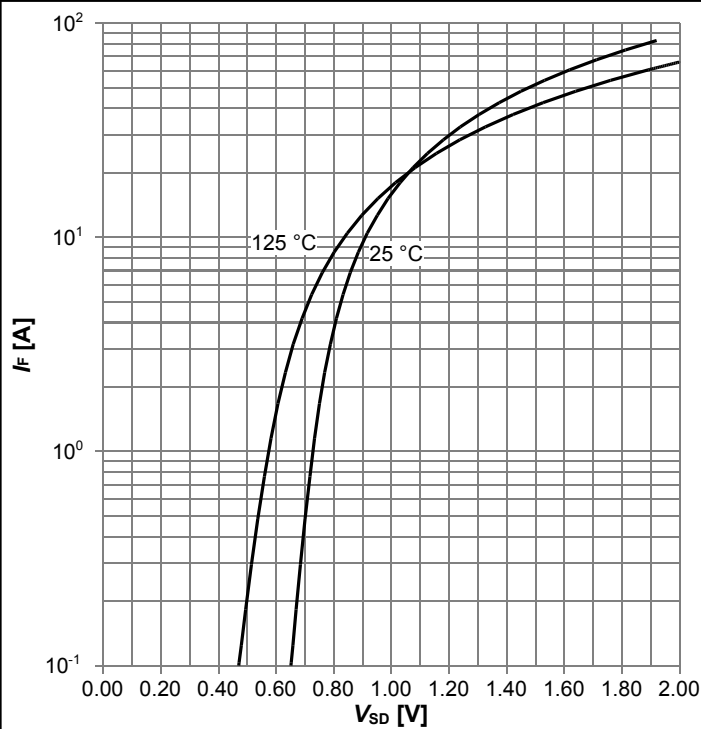
$I_D=f(V_{GS}); V_{DS}=20V; \text{parameter: } T_j$

Diagram 10: Typ. gate charge



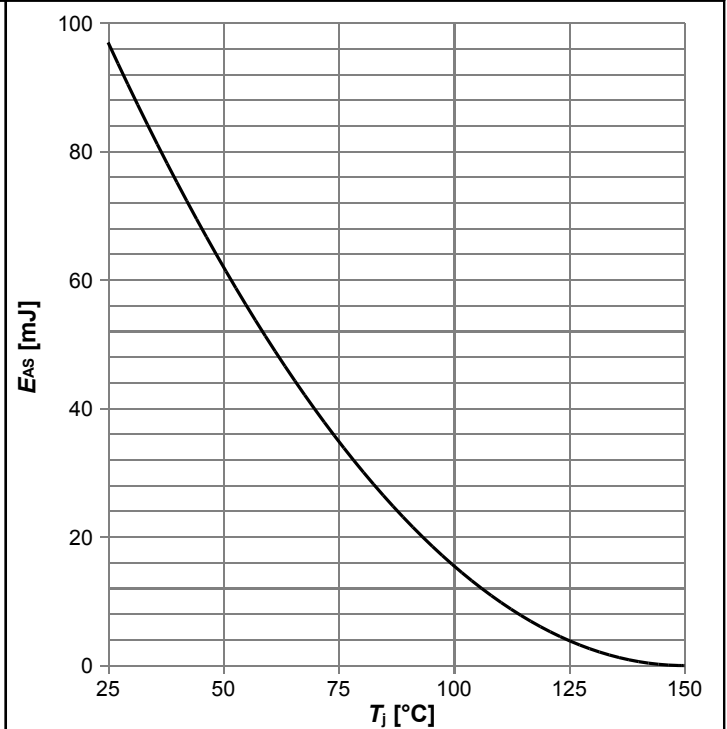
$V_{GS}=f(Q_{gate}); I_D=9.7 \text{ A pulsed}; \text{parameter: } V_{DD}$

Diagram 11: Forward characteristics of reverse diode



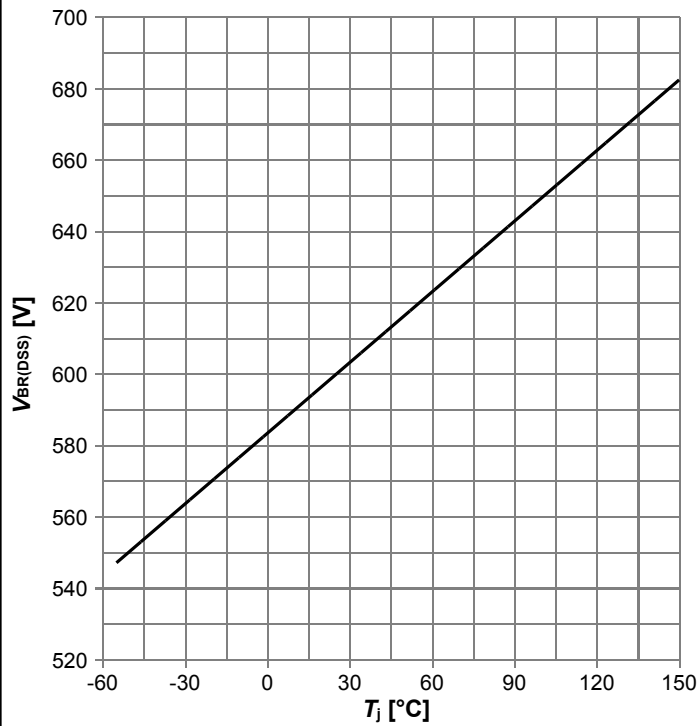
$I_F=f(V_{SD}); \text{parameter: } T_j$

Diagram 12: Avalanche energy



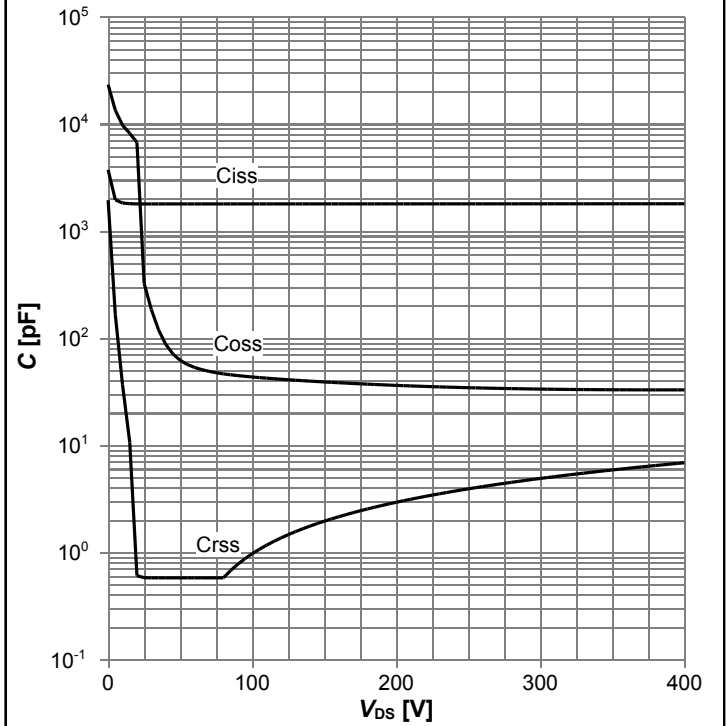
$E_{AS}=f(T_j); I_D=5.0 \text{ A}; V_{DD}=50 \text{ V}$

Diagram 13: Drain-source breakdown voltage



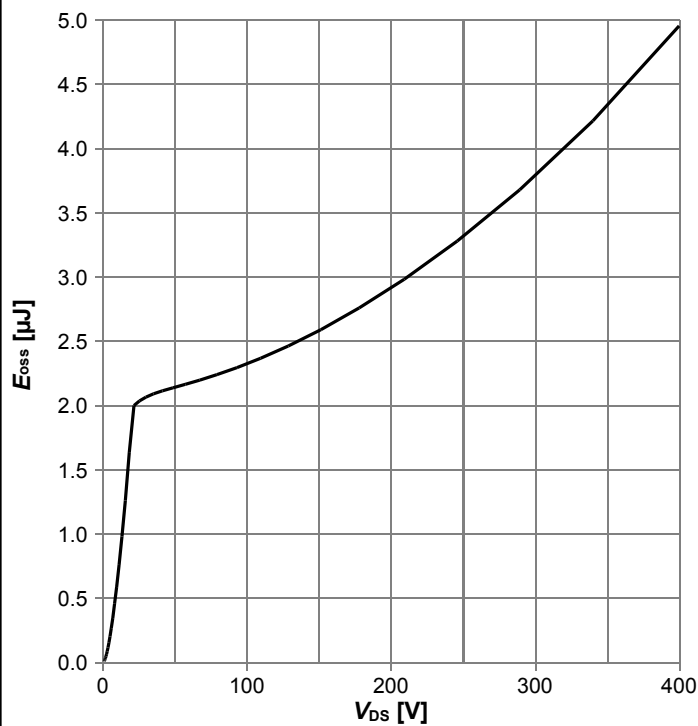
$V_{BR(DSS)}=f(T_j); I_D=1 \text{ mA}$

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

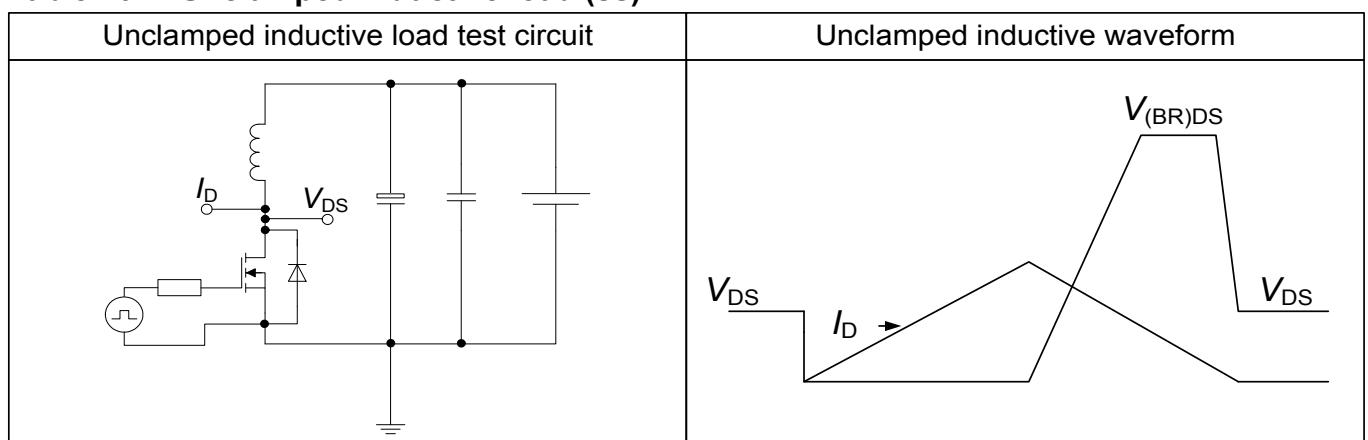
Table 8 Diode characteristics



Table 9 switching times (ss)



Table 10 Unclamped inductive load (ss)



6 Package Outlines



Figure 1 Outline PG-VSON-4, dimensions in mm/inches

7 Appendix A

Table 11 Related Links

- IFX CoolMOS™ C7 Webpage: www.infineon.com
- IFX CoolMOS™ C7 application note: www.infineon.com
- IFX CoolMOS™ C7 simulation model: www.infineon.com
- IFX Design tools: www.infineon.com

Revision History

IPL60R104C7

Revision: 2017-08-30, Rev. 2.1

Previous Revision

| Revision | Date | Subjects (major changes since last revision) |
|----------|------------|----------------------------------------------|
| 2.0 | 2015-12-11 | Release of final version |
| 2.1 | 2017-08-30 | Updated MSL |

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