

MOSFET

Metal Oxide Semiconductor Field Effect Transistor

CoolMOS™ C7

650V CoolMOS™ C7 Power Transistor
IPL65R099C7

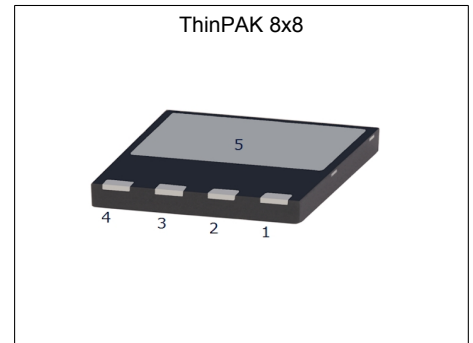
Data Sheet

Rev. 2.0
Final

1 Description

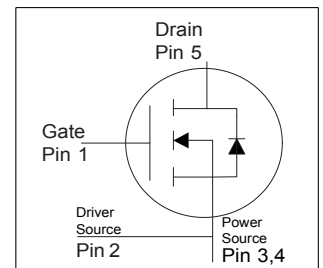
CoolMOS™ is a revolutionary technology for high voltage power MOSFETs, designed according to the superjunction (SJ) principle and pioneered by Infineon Technologies.

CoolMOS™ C7 series combines the experience of the leading SJ MOSFET supplier with high class innovation. The product portfolio provides all benefits of fast switching superjunction MOSFETs offering better efficiency, reduced gate charge, easy implementation and outstanding reliability.



Features

- Increased MOSFET dv/dt ruggedness
- Better efficiency due to best in class FOM $R_{DS(on)} \cdot E_{oss}$ and $R_{DS(on)} \cdot Q_g$
- **ThinPAK** SMD Package with very low parasitic inductance to enable fast and reliable switching with minimum of size to increase power-density
- Easy to use/drive due to **driver source pin** for better control of the gate.
- Pb-free plating, halogen free mold compound
- Qualified for industrial grade applications according to JEDEC (J-STD20 and JESD22)



Benefits

- Enabling higher system efficiency by lower switching losses
- Enabling higher frequency / increased power density solutions
- System cost / size savings due to reduced cooling requirements
- Higher system reliability due to lower operating temperatures



Applications

PFC stages and hard switching PWM stages for 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 |
|----------------------|-------|------|
| $V_{DS} @ T_{j,max}$ | 700 | V |
| $R_{DS(on),max}$ | 99 | mΩ |
| $Q_{g,typ}$ | 45 | nC |
| $I_{D,pulse}$ | 100 | A |
| $E_{oss@400V}$ | 5.5 | μJ |
| Body diode di/dt | 60 | A/μs |

| Type / Ordering Code | Package | Marking | Related Links |
|----------------------|-----------|---------|----------------|
| IPL65R099C7 | PG-VSON-4 | 65C7099 | see Appendix A |

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2 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 | - | - | 21 15 | A | $T_C=25^\circ\text{C}$ $T_C=100^\circ\text{C}$ |
| Pulsed drain current ²⁾ | $I_{D,pulse}$ | - | - | 100 | A | $T_C=25^\circ\text{C}$ |
| Avalanche energy, single pulse | E_{AS} | - | - | 118 | mJ | $I_D=8.4\text{A}$; $V_{DD}=50\text{V}$; see table 10 |
| Avalanche energy, repetitive | E_{AR} | - | - | 0.59 | mJ | $I_D=8.4\text{A}$; $V_{DD}=50\text{V}$; see table 10 |
| Avalanche current, single pulse | I_{AS} | - | - | 8.4 | A | - |
| 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} | - | - | 128 | 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 | - | - | 21 | A | $T_C=25^\circ\text{C}$ |
| Diode pulse current ²⁾ | $I_{S,pulse}$ | - | - | 100 | A | $T_C=25^\circ\text{C}$ |
| Reverse diode dv/dt ³⁾ | dv/dt | - | - | 1.5 | V/ns | $V_{DS}=0\dots400\text{V}$, $I_{SD}\leq I_S$, $T_j=25^\circ\text{C}$ see table 8 |
| Maximum diode commutation speed | di/dt | - | - | 60 | A/ μs | $V_{DS}=0\dots400\text{V}$, $I_{SD}\leq I_S$, $T_j=25^\circ\text{C}$ 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_G

3 Thermal characteristics

Table 3 Thermal characteristics

| Parameter | Symbol | Values | | | Unit | Note / Test Condition |
|--|------------|--------|------|------|------|---|
| | | Min. | Typ. | Max. | | |
| Thermal resistance, junction - case | R_{thJC} | - | - | 0.98 | °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 MSL3 |

4 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 | $V_{(BR)DSS}$ | 650 | - | - | V | $V_{GS}=0\text{V}$, $I_D=1\text{mA}$ |
| Gate threshold voltage | $V_{(GS)th}$ | 3 | 3.5 | 4 | V | $V_{DS}=V_{GS}$, $I_D=0.59\text{mA}$ |
| Zero gate voltage drain current | I_{DSS} | - | - | 1 | μA | $V_{DS}=650$, $V_{GS}=0\text{V}$, $T_j=25^\circ\text{C}$ $V_{DS}=650$, $V_{GS}=0\text{V}$, $T_j=150^\circ\text{C}$ |
| Gate-source leakage current | I_{GSS} | - | - | 100 | nA | $V_{GS}=20\text{V}$, $V_{DS}=0\text{V}$ |
| Drain-source on-state resistance | $R_{DS(on)}$ | - | 0.088 0.210 | 0.099 - | Ω | $V_{GS}=10\text{V}$, $I_D=5.9\text{A}$, $T_j=25^\circ\text{C}$ $V_{GS}=10\text{V}$, $I_D=5.9\text{A}$, $T_j=150^\circ\text{C}$ |
| Gate resistance | R_G | - | 0.9 | - | 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} | - | 2140 | - | 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⁾ | $C_{o(er)}$ | - | 69 | - | pF | $V_{GS}=0\text{V}$, $V_{DS}=0\dots400\text{V}$ |
| Effective output capacitance, time related ²⁾ | $C_{o(tr)}$ | - | 763 | - | pF | $I_D=\text{constant}$, $V_{GS}=0\text{V}$, $V_{DS}=0\dots400\text{V}$ |
| Turn-on delay time | $t_{d(on)}$ | - | 11 | - | ns | $V_{DD}=400\text{V}$, $V_{GS}=13\text{V}$, $I_D=5.9\text{A}$, $R_G=5.3\Omega$; see table 9 |
| Rise time | t_r | - | 5 | - | ns | $V_{DD}=400\text{V}$, $V_{GS}=13\text{V}$, $I_D=5.9\text{A}$, $R_G=5.3\Omega$; see table 9 |
| Turn-off delay time | $t_{d(off)}$ | - | 89 | - | ns | $V_{DD}=400\text{V}$, $V_{GS}=13\text{V}$, $I_D=5.9\text{A}$, $R_G=5.3\Omega$; see table 9 |
| Fall time | t_f | - | 12 | - | ns | $V_{DD}=400\text{V}$, $V_{GS}=13\text{V}$, $I_D=5.9\text{A}$, $R_G=5.3\Omega$; see table 9 |

Table 6 Gate charge characteristics

| Parameter | Symbol | Values | | | Unit | Note / Test Condition |
|-----------------------|----------------------|--------|------|------|------|---|
| | | Min. | Typ. | Max. | | |
| Gate to source charge | Q_{gs} | - | 11 | - | nC | $V_{DD}=400\text{V}$, $I_D=5.9\text{A}$, $V_{GS}=0$ to 10V |
| Gate to drain charge | Q_{gd} | - | 15 | - | nC | $V_{DD}=400\text{V}$, $I_D=5.9\text{A}$, $V_{GS}=0$ to 10V |
| Gate charge total | Q_g | - | 45 | - | nC | $V_{DD}=400\text{V}$, $I_D=5.9\text{A}$, $V_{GS}=0$ to 10V |
| Gate plateau voltage | V_{plateau} | - | 5.0 | - | V | $V_{DD}=400\text{V}$, $I_D=5.9\text{A}$, $V_{GS}=0$ 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} | - | 0.8 | - | V | $V_{GS}=0V, I_F=5.9A, T_j=25^{\circ}C$ |
| Reverse recovery time | t_{rr} | - | 700 | - | ns | $V_R=400V, I_F=21A, di_F/dt=60A/\mu s$; see table 8 |
| Reverse recovery charge | Q_{rr} | - | 8 | - | μC | $V_R=400V, I_F=21A, di_F/dt=60A/\mu s$; see table 8 |
| Peak reverse recovery current | I_{rrm} | - | 25 | - | A | $V_R=400V, I_F=21A, di_F/dt=60A/\mu s$; see table 8 |

5 Electrical characteristics diagrams

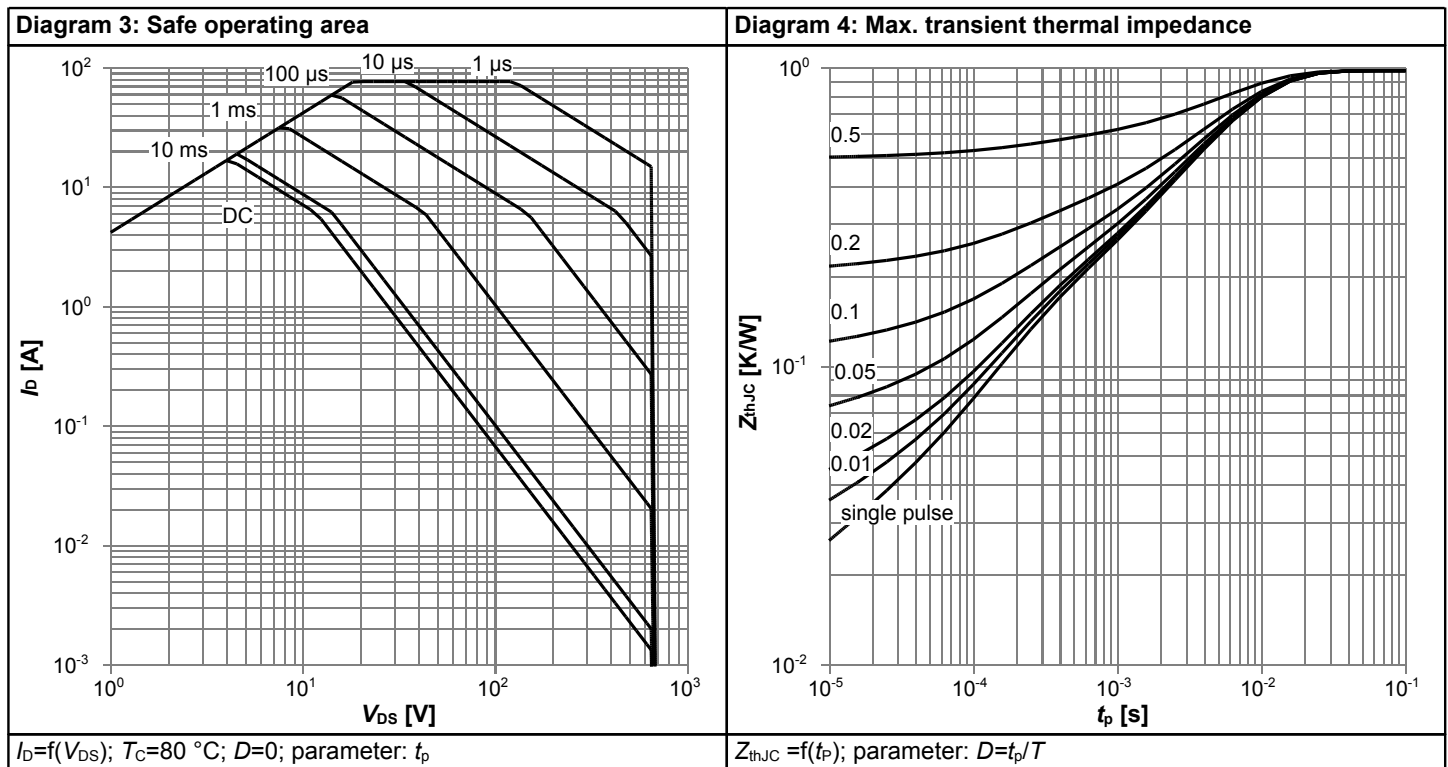
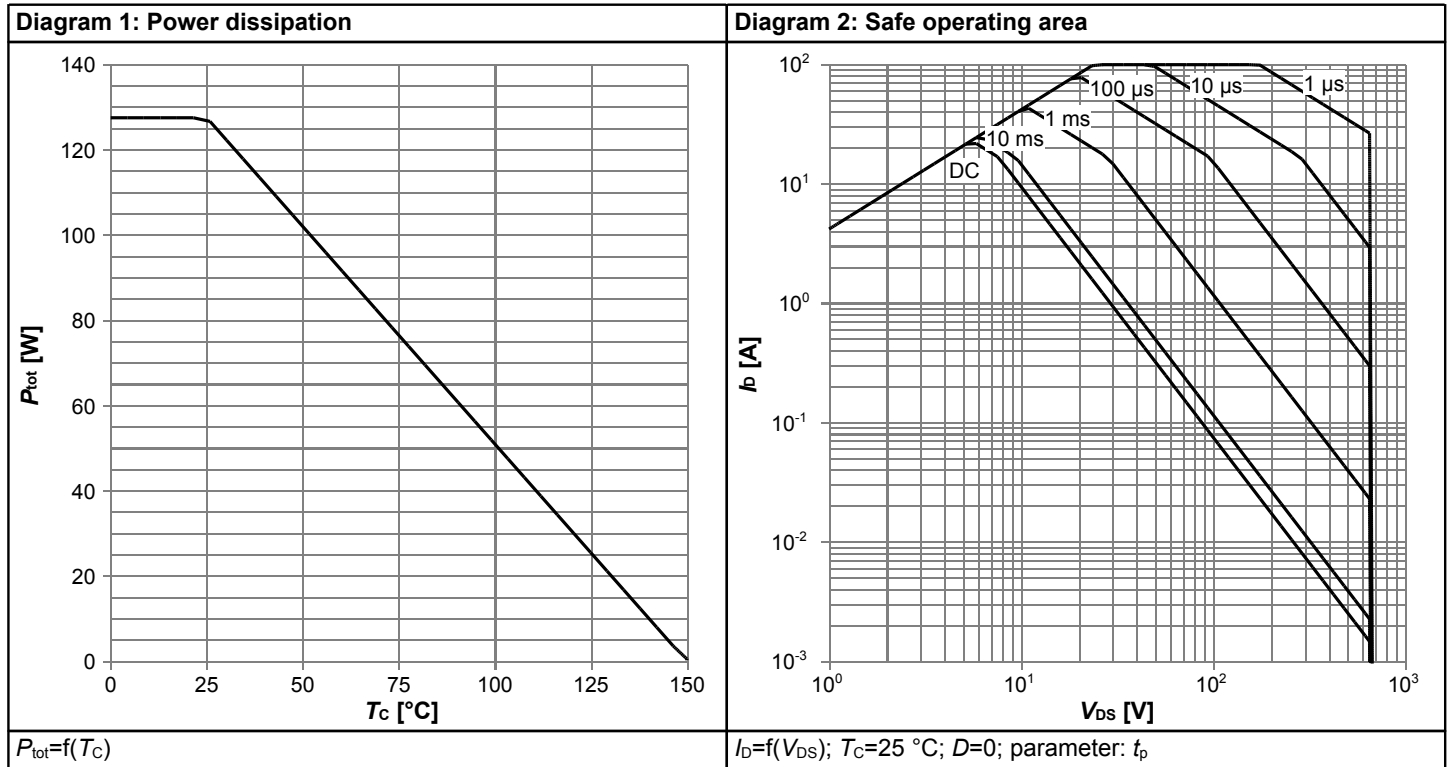
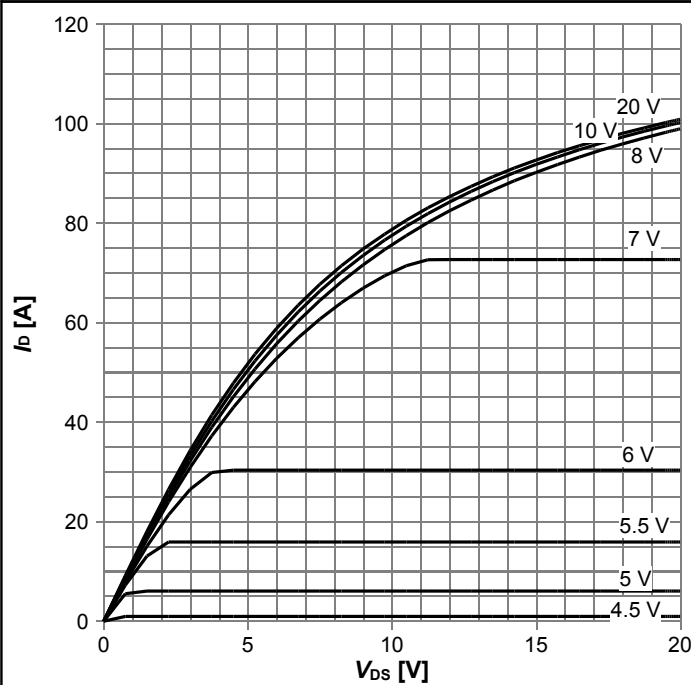
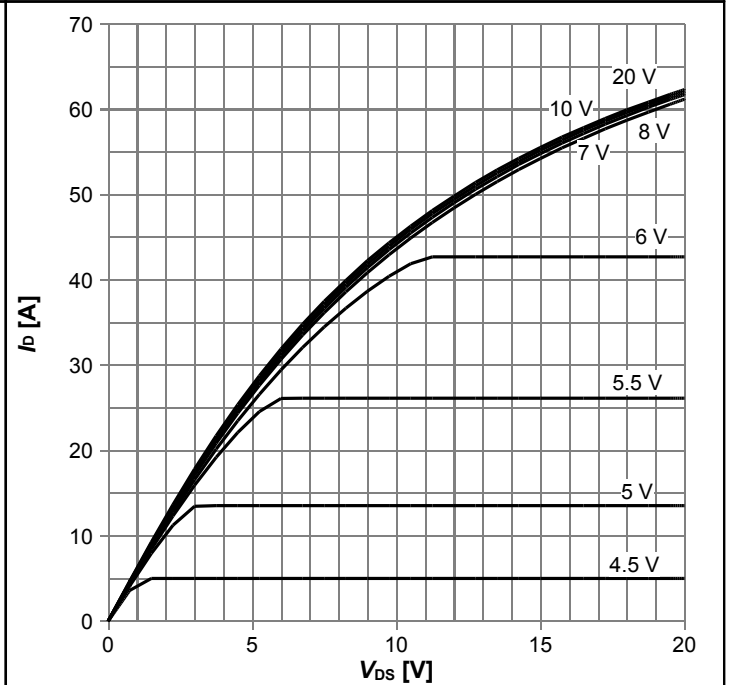


Diagram 5: Typ. output characteristics



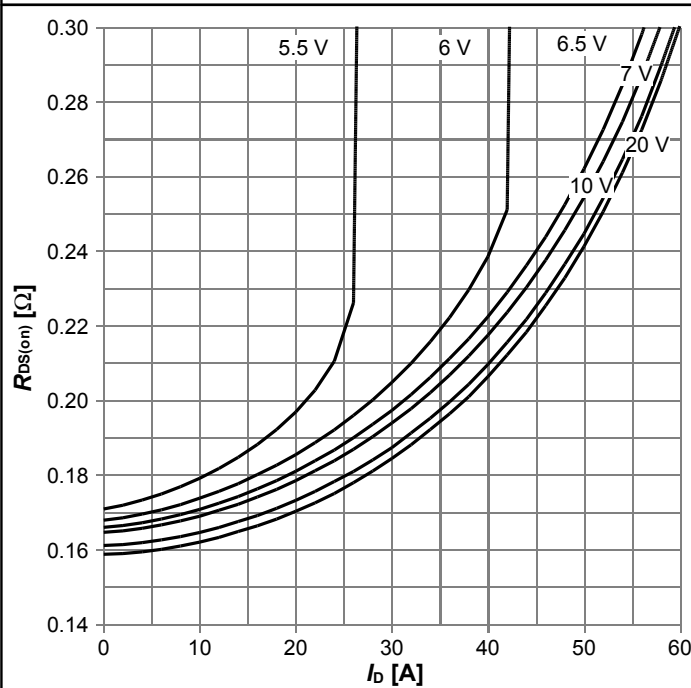
$I_D=f(V_{DS}); T_j=25\text{ }^\circ\text{C}; \text{parameter: } V_{GS}$

Diagram 6: Typ. output characteristics



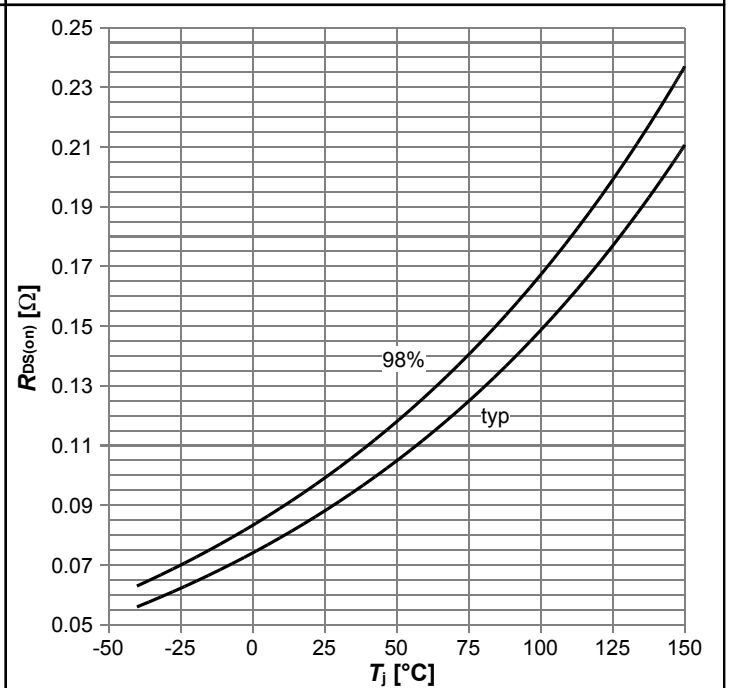
$I_D=f(V_{DS}); T_j=125\text{ }^\circ\text{C}; \text{parameter: } V_{GS}$

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



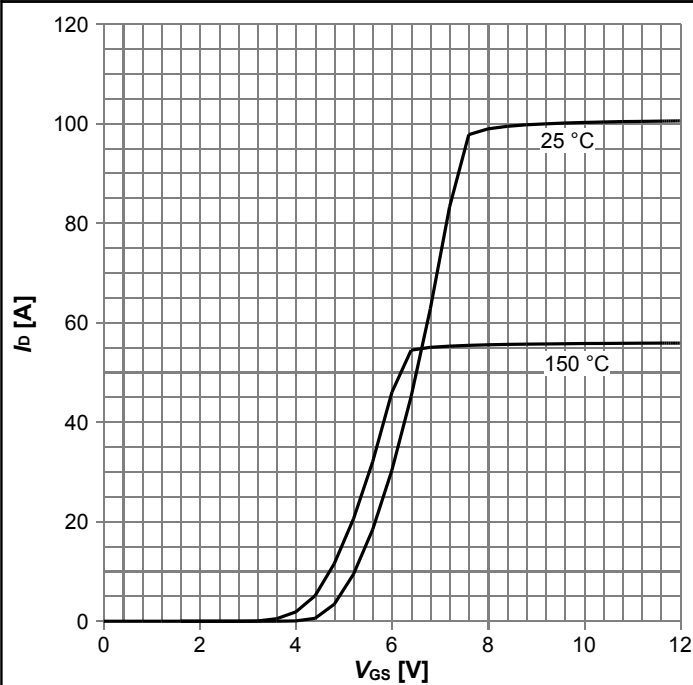
$R_{DS(on)}=f(I_D); T_j=125\text{ }^\circ\text{C}; \text{parameter: } V_{GS}$

Diagram 8: Drain-source on-state resistance



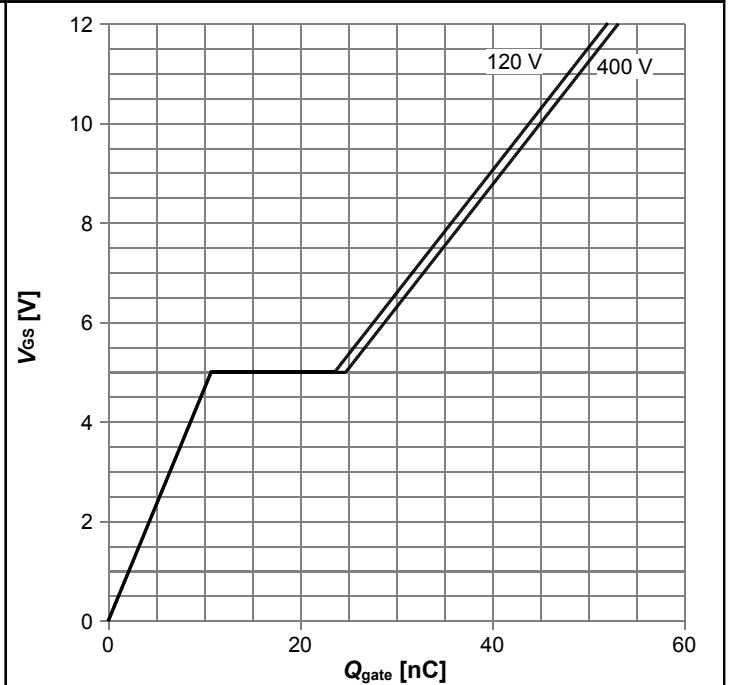
$R_{DS(on)}=f(T_j); I_D=5,9\text{ A}; V_{GS}=10\text{ V}$

Diagram 9: Typ. transfer characteristics



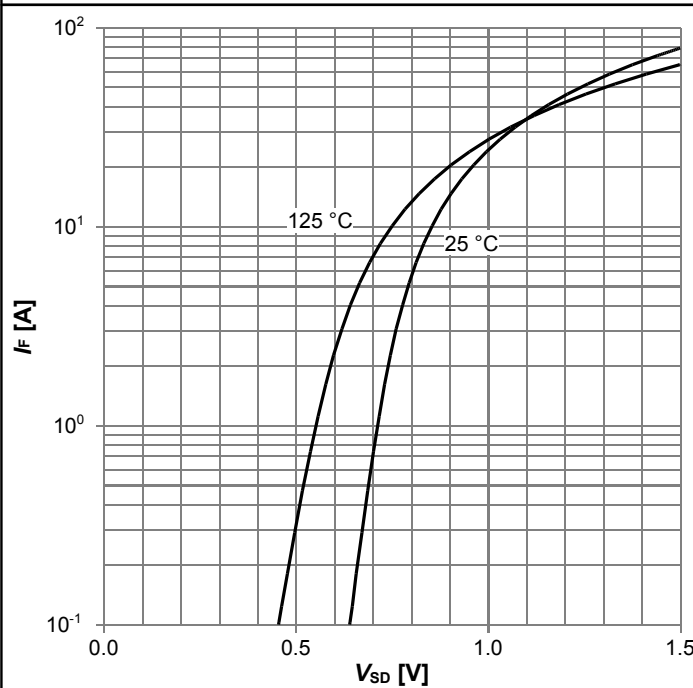
$I_D=f(V_{GS}); V_{DS}=20V; \text{parameter: } T_j$

Diagram 10: Typ. gate charge



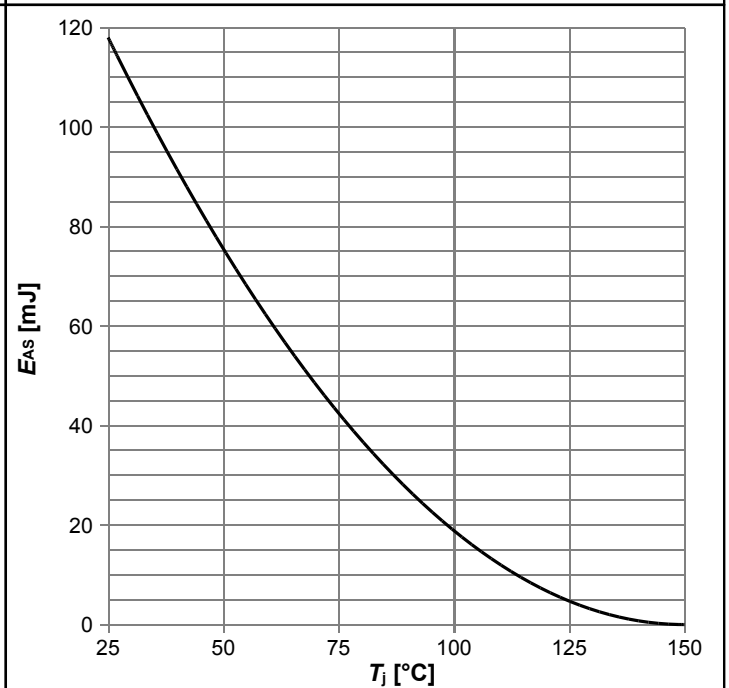
$V_{GS}=f(Q_{gate}); I_D=5.9 \text{ A pulsed}; \text{parameter: } V_{DD}$

Diagram 11: Forward characteristics of reverse diode



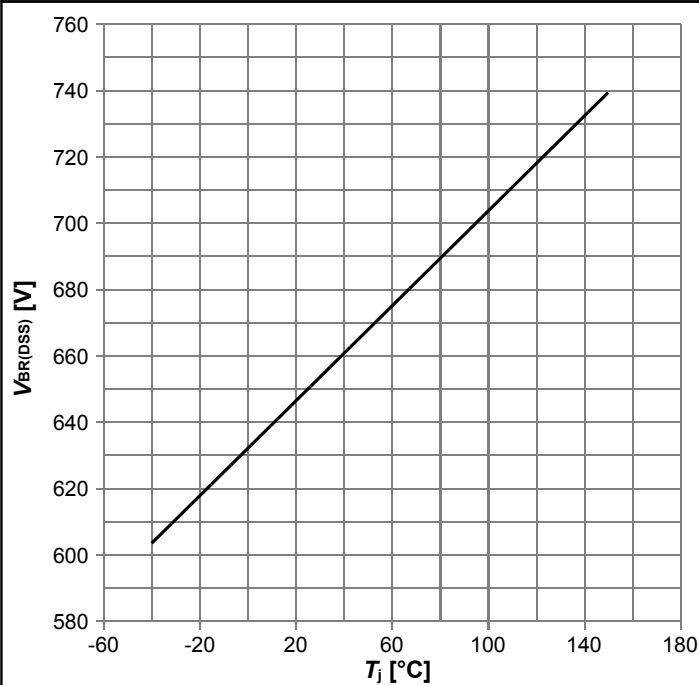
$I_F=f(V_{SD}); \text{parameter: } T_j$

Diagram 12: Avalanche energy



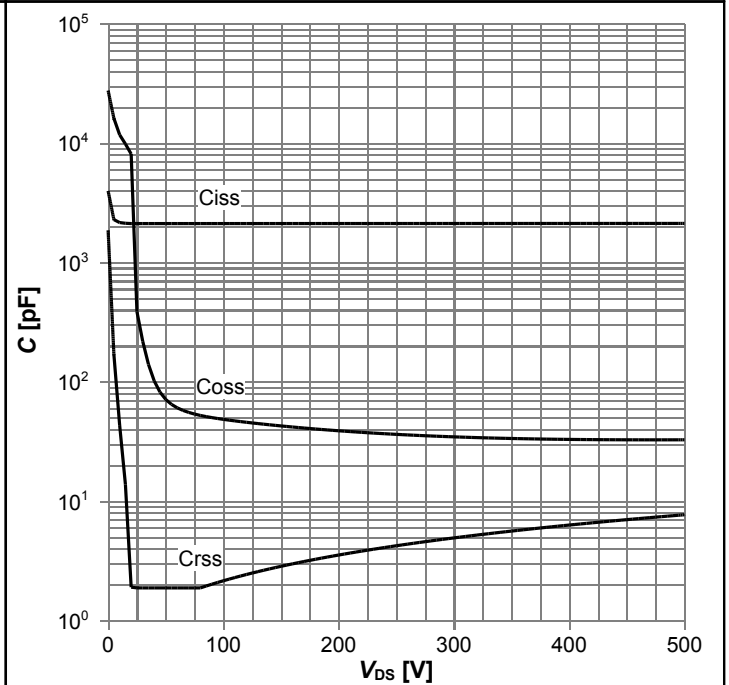
$E_{AS}=f(T_j); I_D=8.4 \text{ A}; V_{DD}=50 \text{ V}$

Diagram 13: Drain-source breakdown voltage



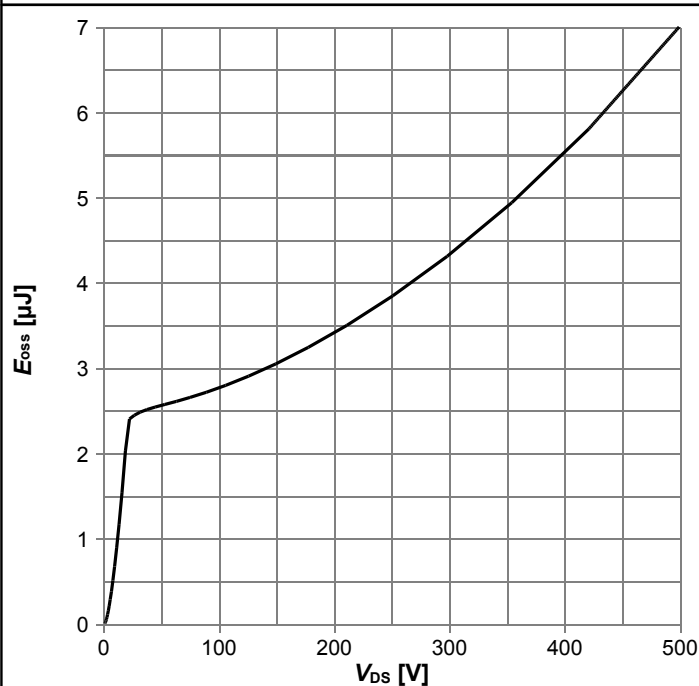
$V_{BR(DSS)}=f(T_j); I_D=1 \text{ mA}$

Diagram 14: Typ. capacitances



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

Diagram 15: Typ. Coss stored energy



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

6 Test Circuits

Table 8 Diode characteristics

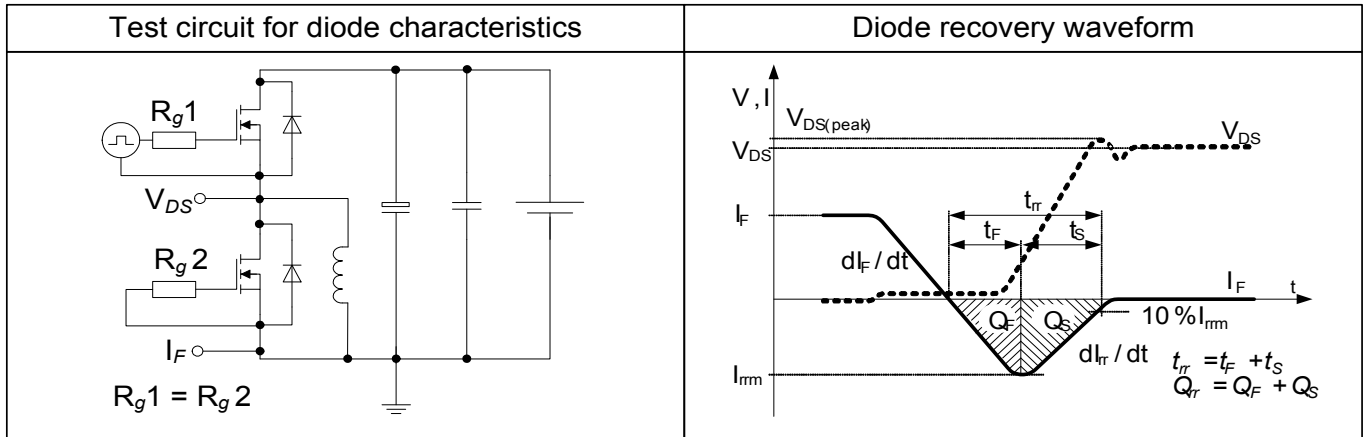


Table 9 switching times (ss)

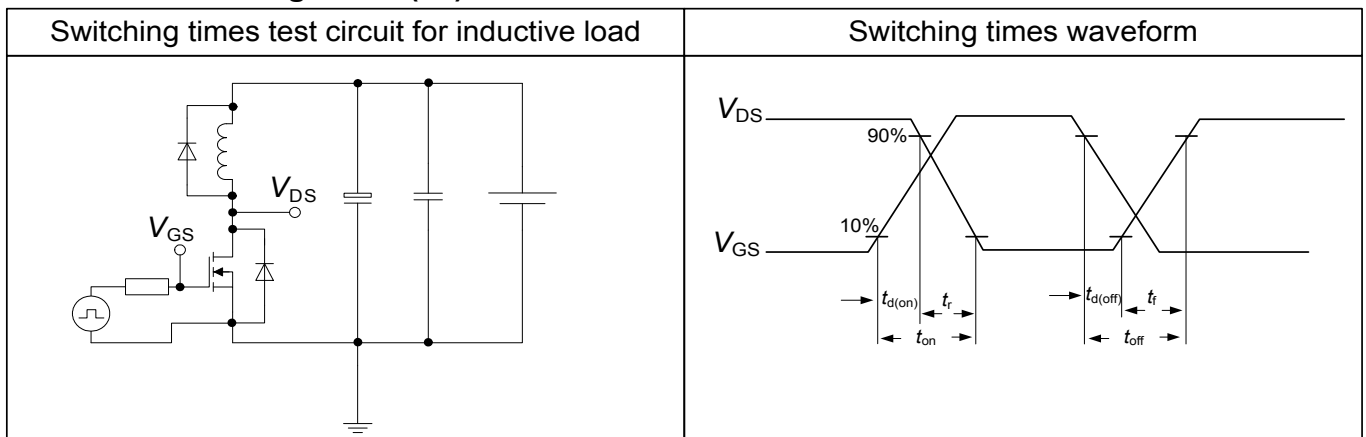
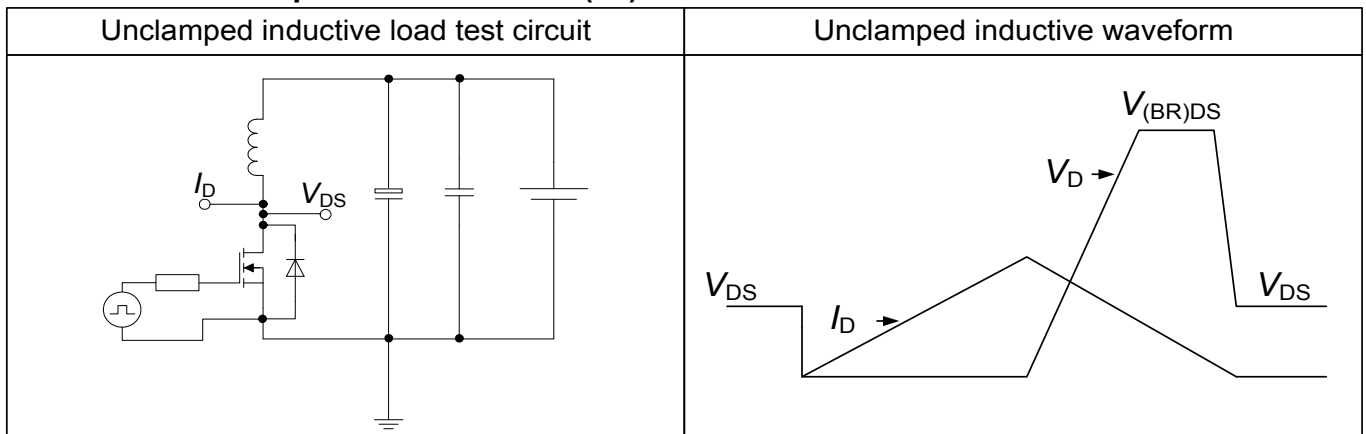
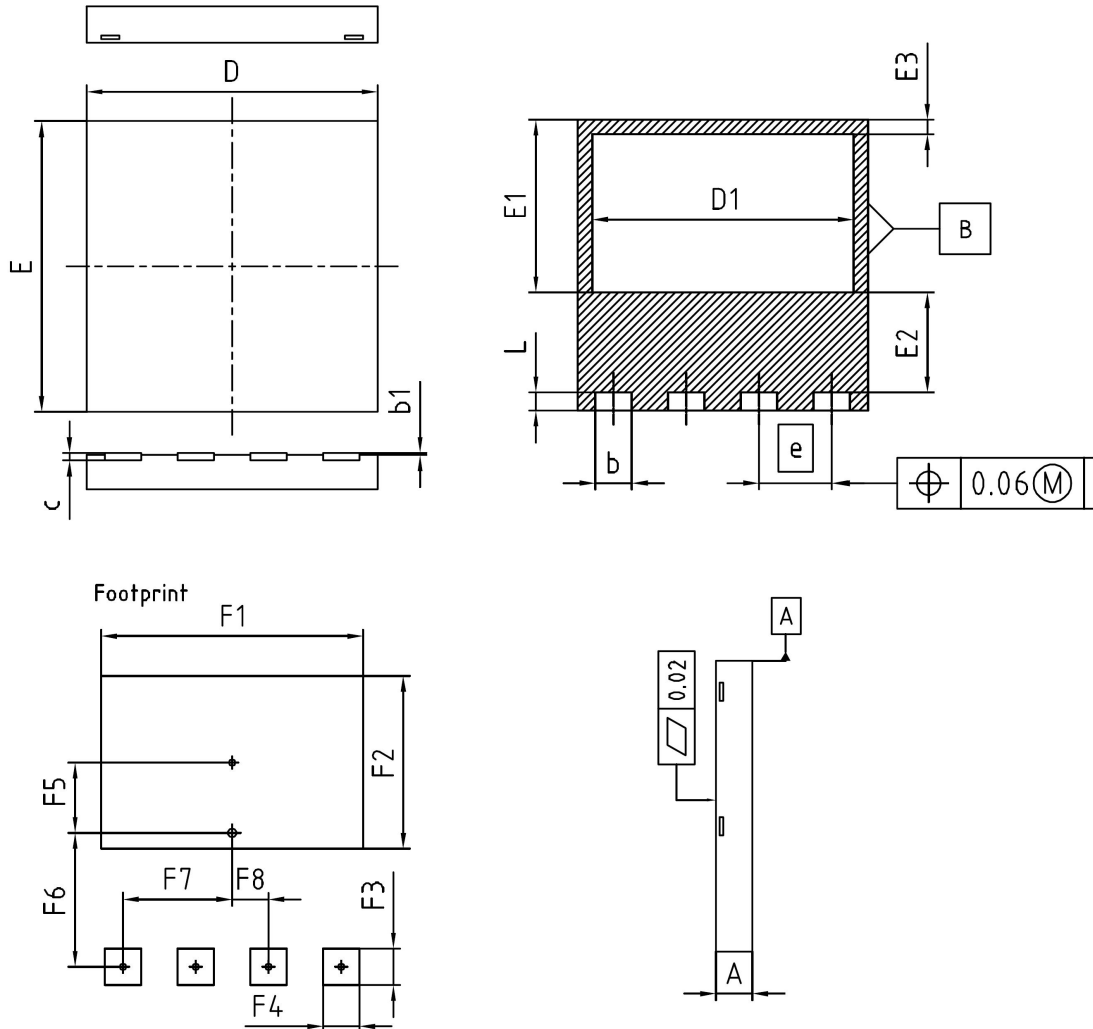


Table 10 Unclamped inductive load (ss)



7 Package Outlines



| DIM | MILLIMETERS | | INCHES | |
|-----|-------------|------|-------------|-------|
| | MIN | MAX | MIN | MAX |
| A | 0.90 | 1.10 | 0.035 | 0.043 |
| b | 0.90 | 1.10 | 0.035 | 0.043 |
| b1 | 0.00 | 0.05 | 0.000 | 0.002 |
| c | 0.10 | 0.30 | 0.004 | 0.012 |
| D | 7.90 | 8.10 | 0.311 | 0.319 |
| D1 | 7.10 | 7.30 | 0.280 | 0.287 |
| E | 7.90 | 8.10 | 0.311 | 0.319 |
| E1 | 4.65 | 4.85 | 0.183 | 0.191 |
| E2 | 2.65 | 2.85 | 0.104 | 0.112 |
| E3 | 0.30 | 0.50 | 0.012 | 0.020 |
| e | 2.00 (BSC) | | 0.079 (BSC) | |
| L | 0.40 | 0.60 | 0.016 | 0.024 |
| N | 4 | | 4 | |
| F1 | 7.20 | | 0.283 | |
| F2 | 4.75 | | 0.187 | |
| F3 | 1.00 | | 0.039 | |
| F4 | 1.00 | | 0.039 | |
| F5 | 1.43 | | 0.056 | |
| F6 | 4.20 | | 0.165 | |
| F7 | 3.00 | | 0.118 | |
| F8 | 1.00 | | 0.039 | |

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SCALE

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REVISION
01

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

8 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

IPL65R099C7

Revision: 2013-11-05, Rev. 2.0

Previous Revision

| Revision | Date | Subjects (major changes since last revision) |
|----------|------------|--|
| 2.0 | 2013-11-05 | Release of final version |

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Any information within this document that you feel is wrong, unclear or missing at all? Your feedback will help us to continuously improve the quality of this document. Please send your proposal (including a reference to this document) to:

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