

MOSFET

650V CoolMOS™ CFD7 SJ Power Device

The latest 650 V CoolMOS™ CFD7 extends the voltage class offering of the CFD7 family and is a successor to the 650 V CoolMOS™ CFD2. Resulting from improved switching performance and excellent thermal behavior, 650 V CoolMOS™ CFD7 offers highest efficiency in resonant switching topologies, such as LLC and phase-shift-full-bridge (ZVS). 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. The CoolMOS™ CFD7 technology meets highest efficiency and reliability standards and furthermore supports high power density solutions.



Features

- Ultra-fast body diode
- 650V break down voltage
- Best-in-class $R_{DS(on)}$
- Reduced switching losses
- Low $R_{DS(on)}$ dependency over temperature

Benefits

- Excellent hard commutation ruggedness
- Extra safety margin for designs with increased bus voltage
- Enabling increased power density solutions
- Outstanding light load efficiency in industrial SMPS applications
- Improved full load efficiency in industrial SMPS applications
- Price competitiveness over previous CoolMOS™ families

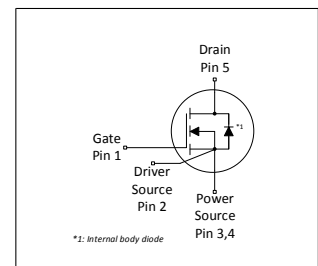
Potential applications

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

Product validation

Fully qualified according to JEDEC for Industrial Applications

Please note: The source and sense source pins are not exchangeable. Their exchange might lead to malfunction. For paralleling 4pin MOSFET devices the placement of the gate resistor is generally recommended to be on the Driver Source instead of the Gate.



RoHS

Table 1 Key Performance Parameters

| Parameter | Value | Unit |
|----------------------|-------|------------|
| $V_{DS} @ T_{j,max}$ | 700 | V |
| $R_{DS(on),max}$ | 65 | m Ω |
| $Q_{g,typ}$ | 68 | nC |
| $I_{D,pulse}$ | 139 | A |
| $E_{oss} @ 400V$ | 9.5 | μ J |
| Body diode di_F/dt | 1300 | A/ μ s |

| Type / Ordering Code | Package | Marking | Related Links |
|----------------------|-----------|----------|----------------|
| IPL65R065CFD7 | PG-VSON-4 | 65R065F7 | 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 | - | - | 33 23 | A | $T_C=25^\circ\text{C}$ $T_C=100^\circ\text{C}$ |
| Pulsed drain current ²⁾ | $I_{D,pulse}$ | - | - | 139 | A | $T_C=25^\circ\text{C}$ |
| Avalanche energy, single pulse | E_{AS} | - | - | 171 | mJ | $I_D=5.1\text{A}$; $V_{DD}=50\text{V}$; see table 10 |
| Avalanche energy, repetitive | E_{AR} | - | - | 0.86 | mJ | $I_D=5.1\text{A}$; $V_{DD}=50\text{V}$; see table 10 |
| Avalanche current, single pulse | I_{AS} | - | - | 5.1 | 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} | - | - | 195 | 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 | - | - | 33 | A | $T_C=25^\circ\text{C}$ |
| Diode pulse current ²⁾ | $I_{S,pulse}$ | - | - | 139 | A | $T_C=25^\circ\text{C}$ |
| Reverse diode dv/dt ³⁾ | dv/dt | - | - | 70 | V/ns | $V_{DS}=0\dots400\text{V}$, $I_{SD}\leq 16.4\text{A}$, $T_j=25^\circ\text{C}$ see table 8 |
| Maximum diode commutation speed | di _F /dt | - | - | 1300 | A/ μs | $V_{DS}=0\dots400\text{V}$, $I_{SD}\leq 16.4\text{A}$, $T_j=25^\circ\text{C}$ 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} | - | - | 0.64 | °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, wave- & reflow soldering allowed | 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 | $V_{(BR)DSS}$ | 650 | - | - | V | $V_{GS}=0V, I_D=1mA$ |
| Gate threshold voltage | $V_{(GS)th}$ | 3.5 | 4 | 4.5 | V | $V_{DS}=V_{GS}, I_D=0.86mA$ |
| Zero gate voltage drain current ¹⁾ | I_{DSS} | - | - | 1 | μA | $V_{DS}=650V, V_{GS}=0V, T_j=25^\circ C$ $V_{DS}=650V, V_{GS}=0V, T_j=125^\circ C$ |
| Gate-source leakage current | I_{GSS} | - | - | 100 | nA | $V_{GS}=20V, V_{DS}=0V$ |
| Drain-source on-state resistance | $R_{DS(on)}$ | - | 0.053 0.116 | 0.065 | Ω | $V_{GS}=10V, I_D=16.4A, T_j=25^\circ C$ $V_{GS}=10V, I_D=16.4A, T_j=150^\circ C$ |
| Gate resistance | R_G | - | 5.8 | - | Ω | $f=1MHz, \text{open drain}$ |

Table 5 Dynamic characteristics

| Parameter | Symbol | Values | | | Unit | Note / Test Condition |
|--|--------------|--------|------|------|------|--|
| | | Min. | Typ. | Max. | | |
| Input capacitance | C_{iss} | - | 3288 | - | pF | $V_{GS}=0V, V_{DS}=400V, f=250kHz$ |
| Output capacitance | C_{oss} | - | 51 | - | pF | $V_{GS}=0V, V_{DS}=400V, f=250kHz$ |
| Effective output capacitance, energy related ²⁾ | $C_{o(er)}$ | - | 119 | - | pF | $V_{GS}=0V, V_{DS}=0...400V$ |
| Effective output capacitance, time related ³⁾ | $C_{o(tr)}$ | - | 1231 | - | pF | $I_D=\text{constant}, V_{GS}=0V, V_{DS}=0...400V$ |
| Turn-on delay time | $t_{d(on)}$ | - | 27 | - | ns | $V_{DD}=400V, V_{GS}=13V, I_D=16.4A,$ $R_G=5.3\Omega; \text{see table 9}$ |
| Rise time | t_r | - | 8 | - | ns | $V_{DD}=400V, V_{GS}=13V, I_D=16.4A,$ $R_G=5.3\Omega; \text{see table 9}$ |
| Turn-off delay time | $t_{d(off)}$ | - | 121 | - | ns | $V_{DD}=400V, V_{GS}=13V, I_D=16.4A,$ $R_G=5.3\Omega; \text{see table 9}$ |
| Fall time | t_f | - | 3 | - | ns | $V_{DD}=400V, V_{GS}=13V, I_D=16.4A,$ $R_G=5.3\Omega; \text{see table 9}$ |

Table 6 Gate charge characteristics

| Parameter | Symbol | Values | | | Unit | Note / Test Condition |
|-----------------------|---------------|--------|------|------|------|--|
| | | Min. | Typ. | Max. | | |
| Gate to source charge | Q_{GS} | - | 19 | - | nC | $V_{DD}=400V, I_D=16.4A, V_{GS}=0 \text{ to } 10V$ |
| Gate to drain charge | Q_{GD} | - | 21 | - | nC | $V_{DD}=400V, I_D=16.4A, V_{GS}=0 \text{ to } 10V$ |
| Gate charge total | Q_g | - | 68 | - | nC | $V_{DD}=400V, I_D=16.4A, V_{GS}=0 \text{ to } 10V$ |
| Gate plateau voltage | $V_{plateau}$ | - | 5.7 | - | V | $V_{DD}=400V, I_D=16.4A, V_{GS}=0 \text{ to } 10V$ |

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 | $V_{GS}=0V, I_F=16.4A, T_j=25^{\circ}C$ |
| Reverse recovery time | t_{rr} | - | 156 | 234 | ns | $V_R=400V, I_F=16.4A, di_F/dt=100A/\mu s$; see table 8 |
| Reverse recovery charge | Q_{rr} | - | 0.86 | 1.72 | μC | $V_R=400V, I_F=16.4A, di_F/dt=100A/\mu s$; see table 8 |
| Peak reverse recovery current | I_{rrm} | - | 10.1 | - | A | $V_R=400V, I_F=16.4A, di_F/dt=100A/\mu s$; see table 8 |

4 Electrical characteristics diagrams

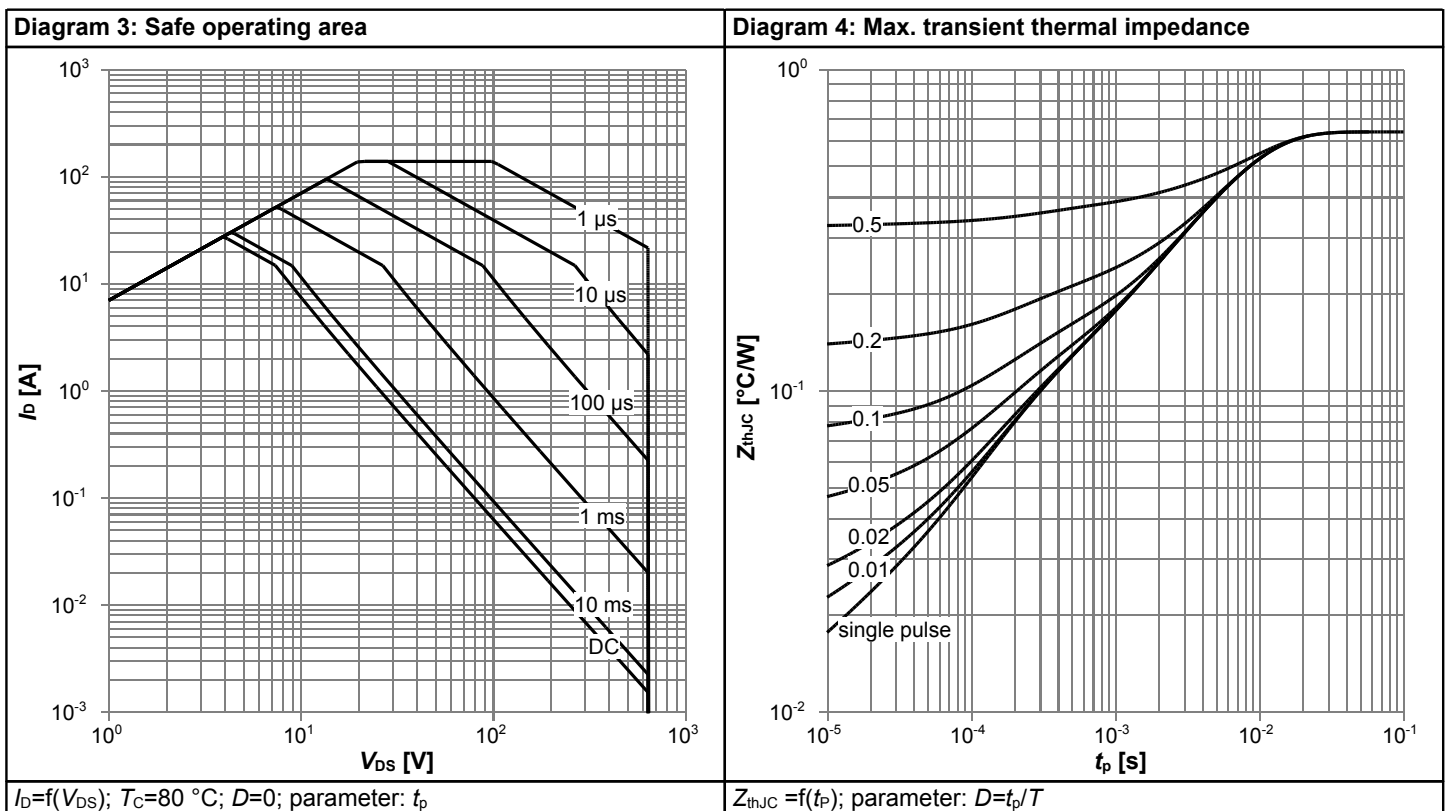
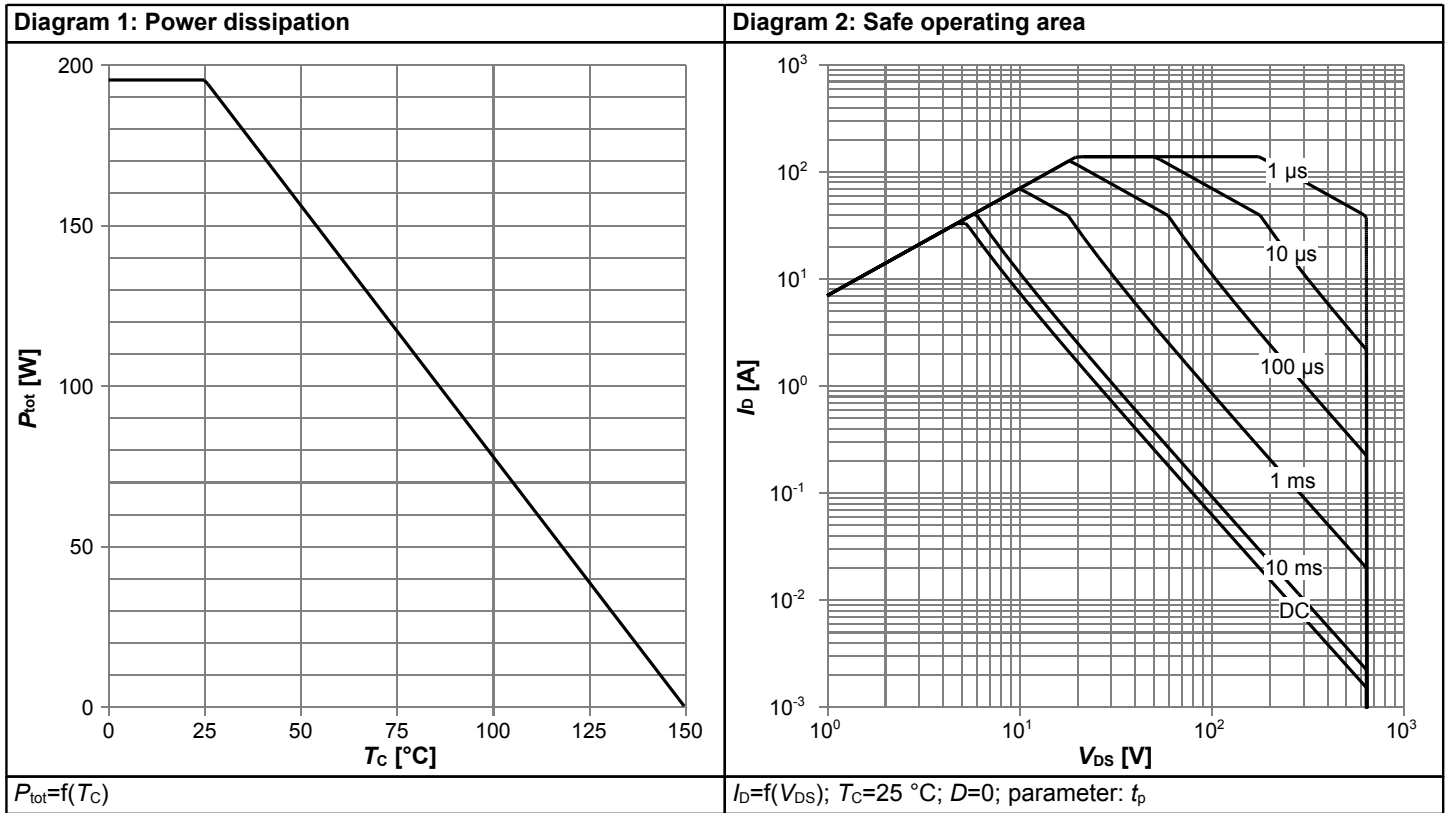
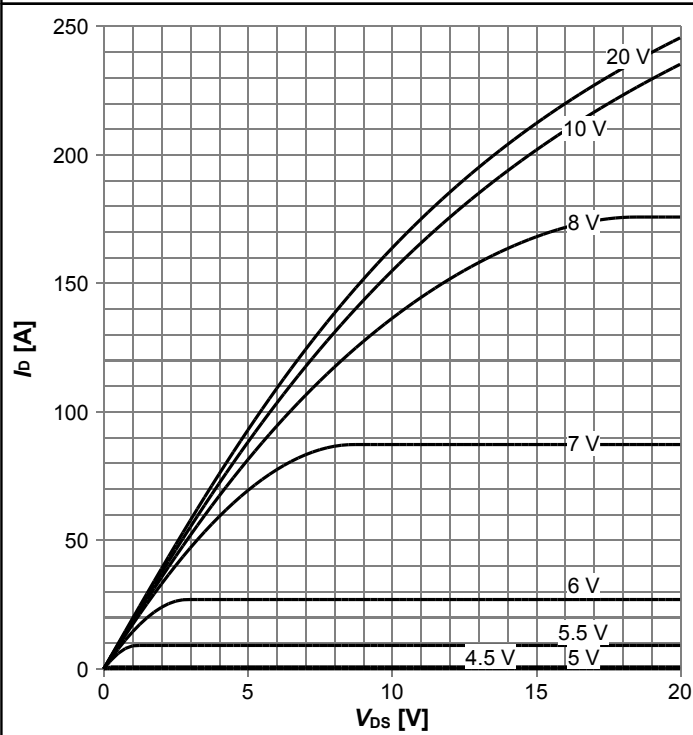
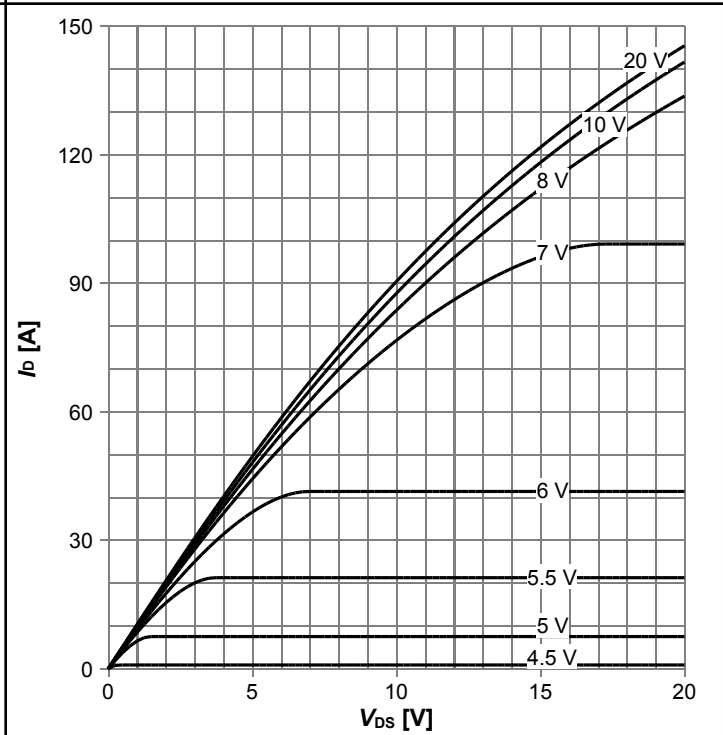


Diagram 5: Typ. output characteristics



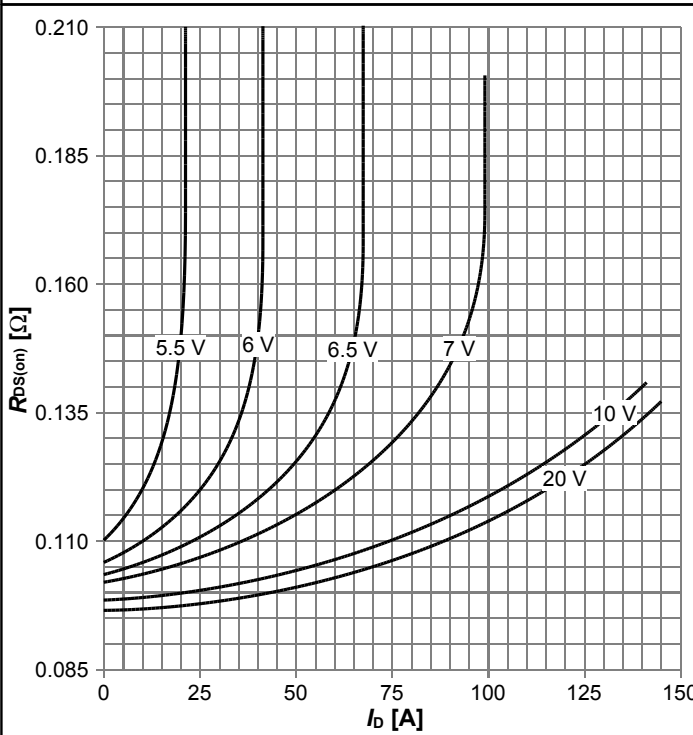
$I_D=f(V_{DS}); T_j=25\text{ °C};$ parameter: V_{GS}

Diagram 6: Typ. output characteristics



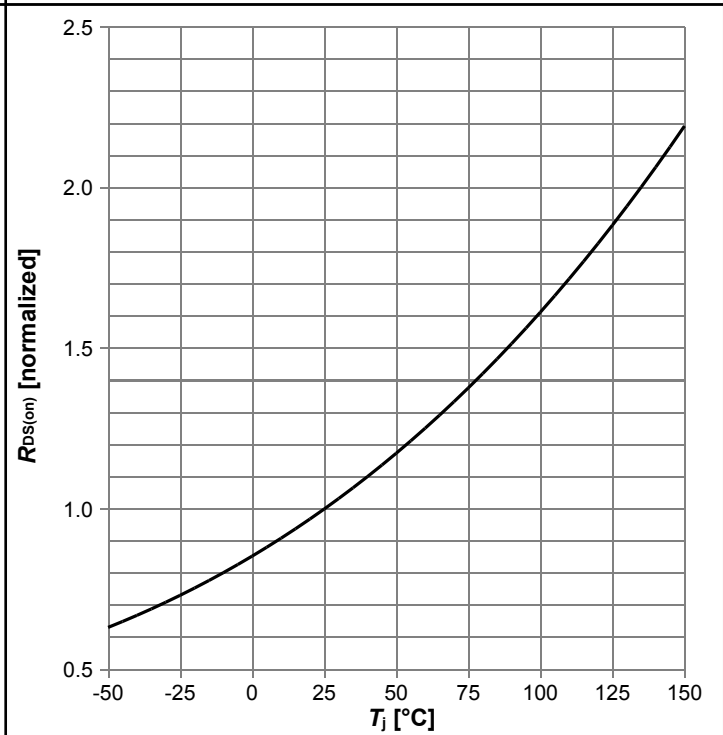
$I_D=f(V_{DS}); T_j=125\text{ °C};$ parameter: V_{GS}

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



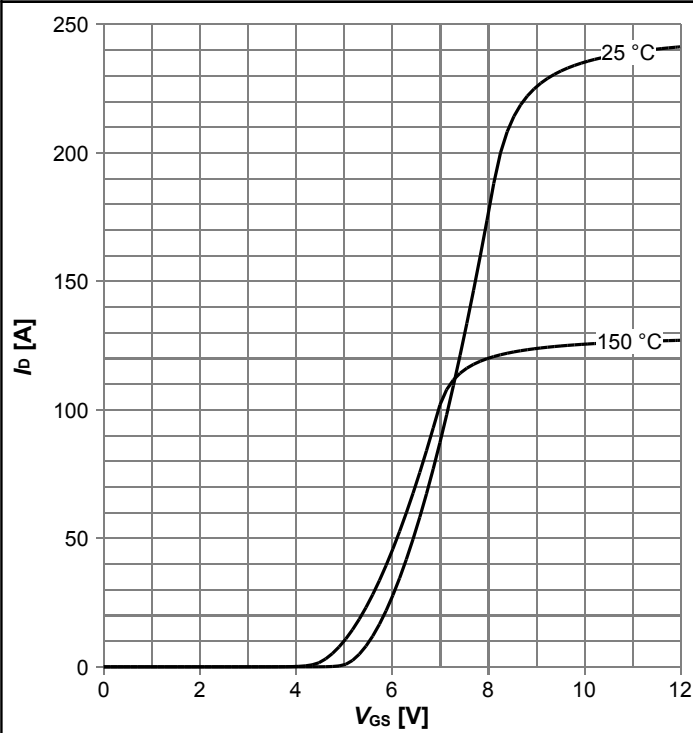
$R_{DS(on)}=f(I_D); T_j=125\text{ °C};$ parameter: V_{GS}

Diagram 8: Drain-source on-state resistance



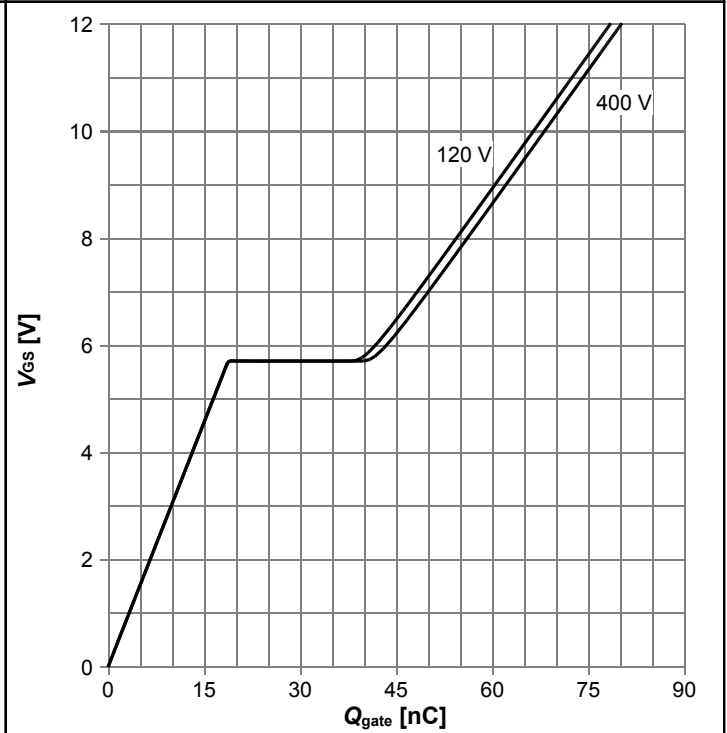
$R_{DS(on)}=f(T_j); I_D=16.4\text{ A}; V_{GS}=10\text{ V}$

Diagram 9: Typ. transfer characteristics



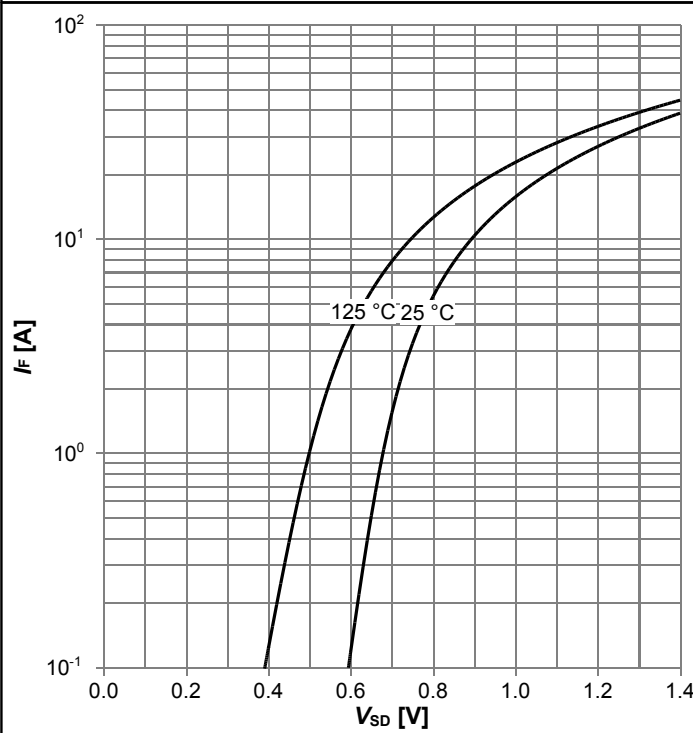
$I_D=f(V_{GS})$; $V_{DS}=20V$; parameter: T_j

Diagram 10: Typ. gate charge



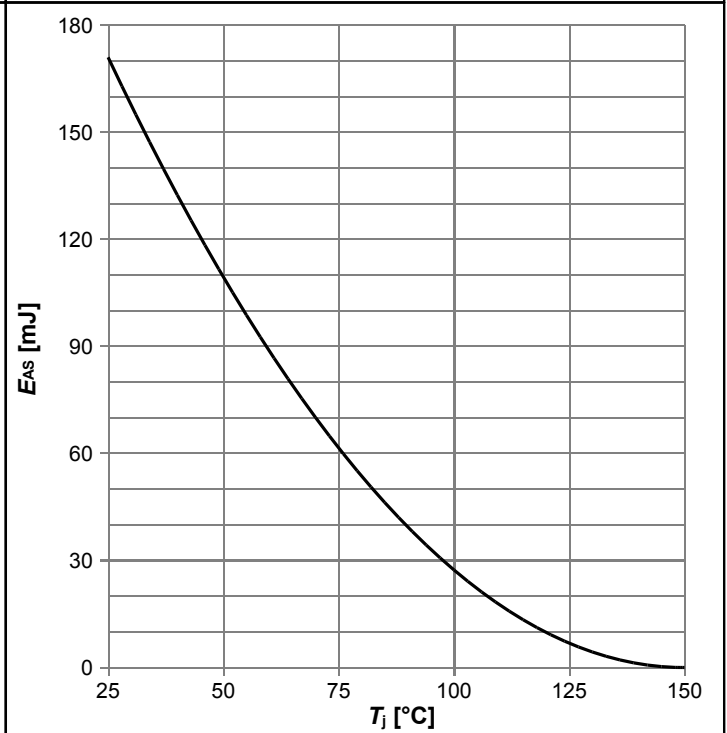
$V_{GS}=f(Q_{gate})$; $I_D=16.4 A$ pulsed; parameter: V_{DD}

Diagram 11: Forward characteristics of reverse diode



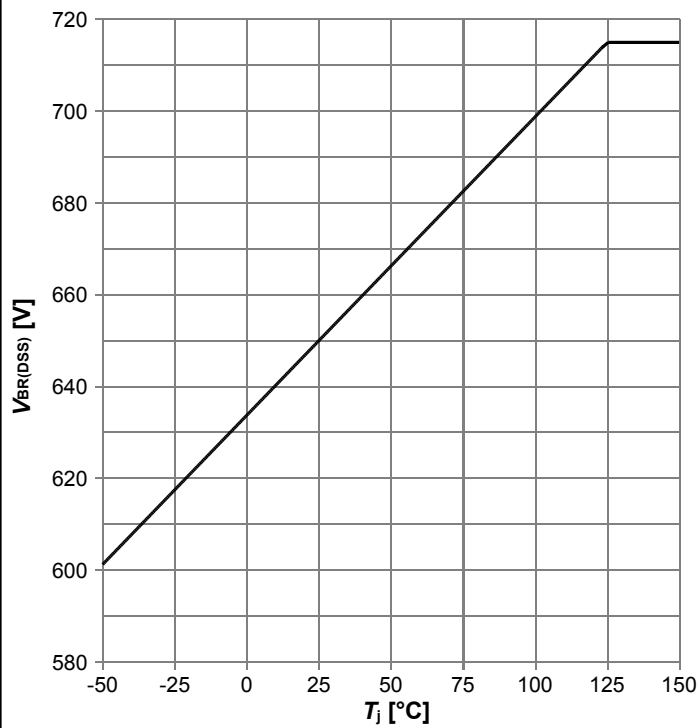
$I_F=f(V_{SD})$; parameter: T_j

Diagram 12: Avalanche energy



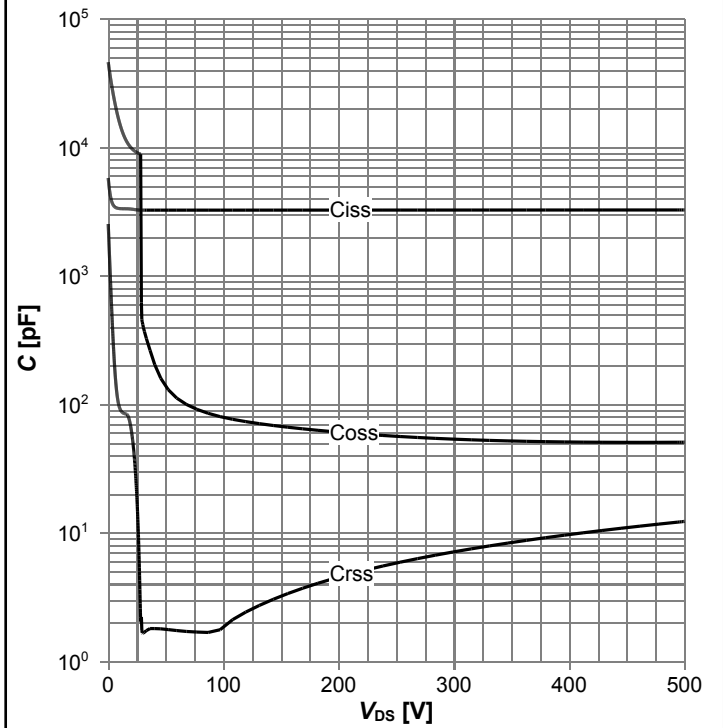
$E_{AS}=f(T_j)$; $I_D=5.1 A$; $V_{DD}=50 V$

Diagram 13: Drain-source breakdown voltage



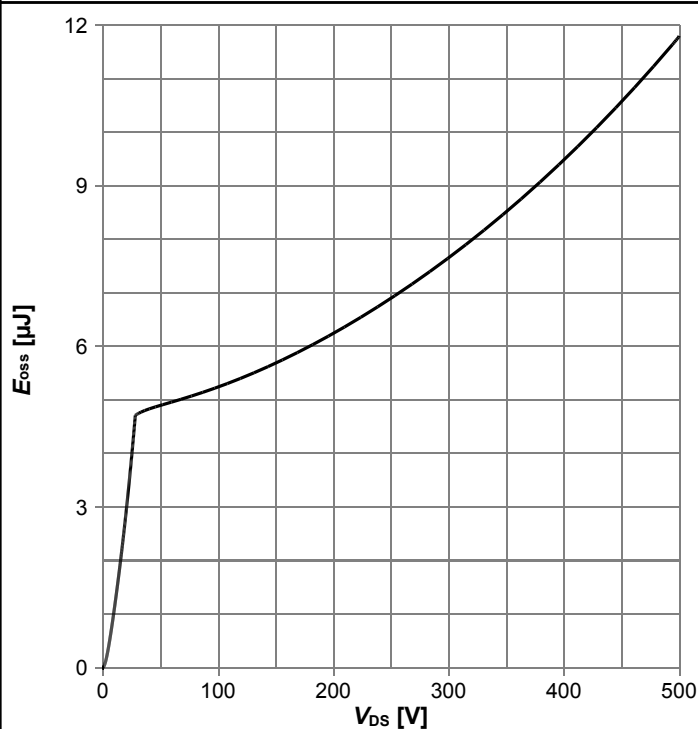
$V_{BR(DSS)}=f(T_j); I_D=1\text{ mA}$

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

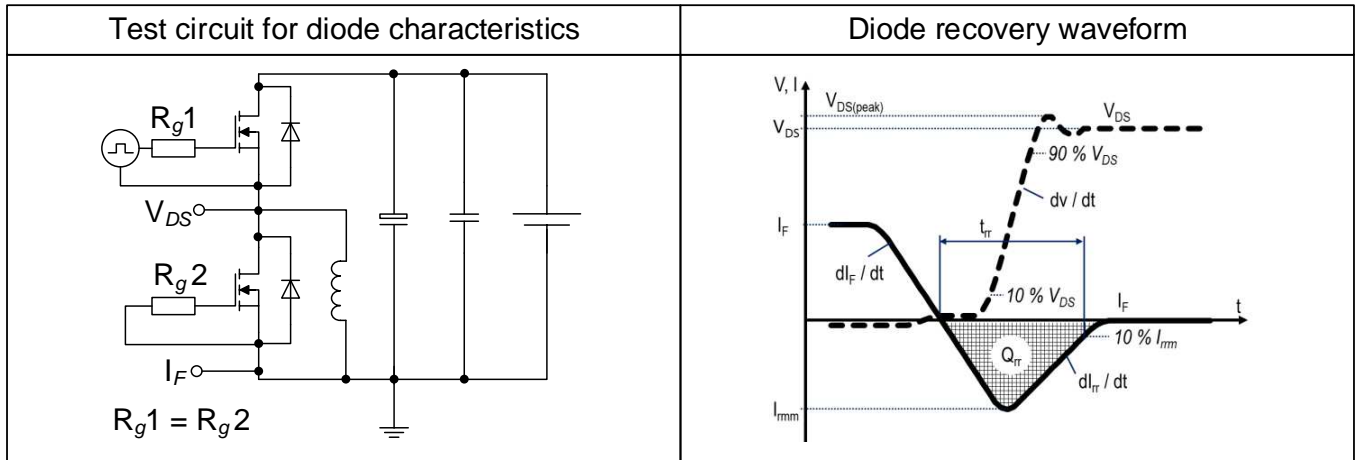


Table 9 Switching times (ss)

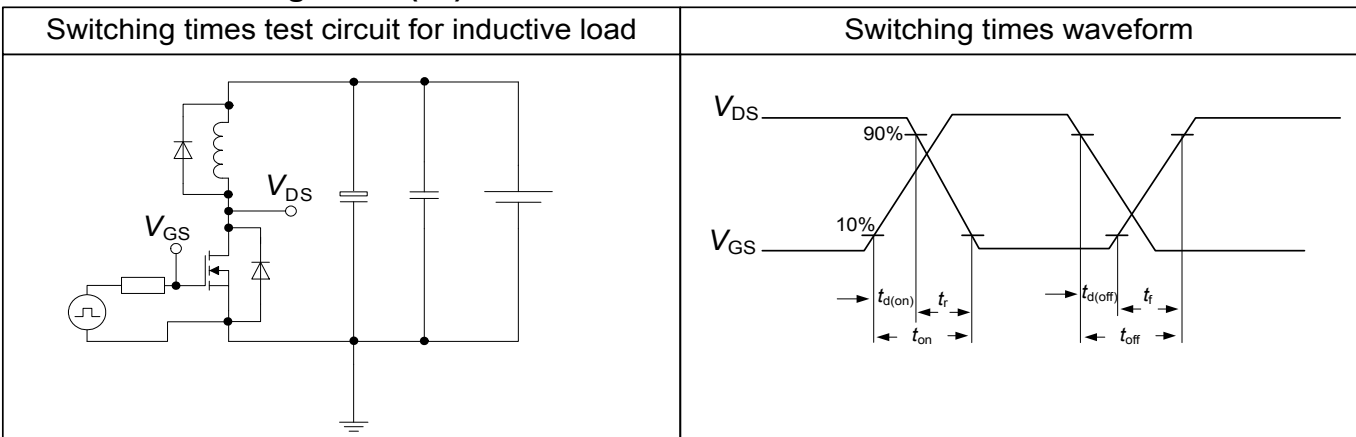
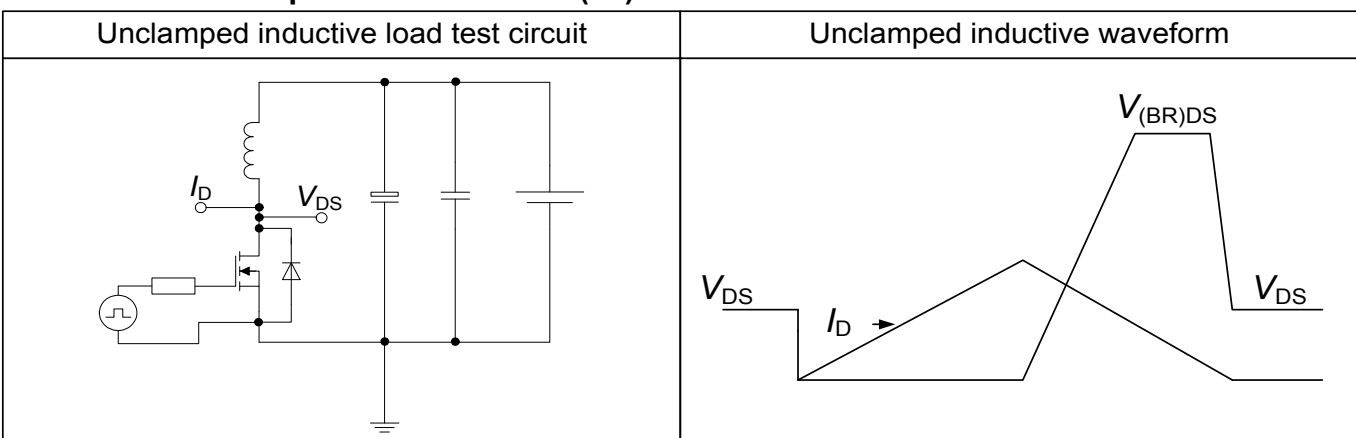


Table 10 Unclamped inductive load (ss)



6 Package Outlines

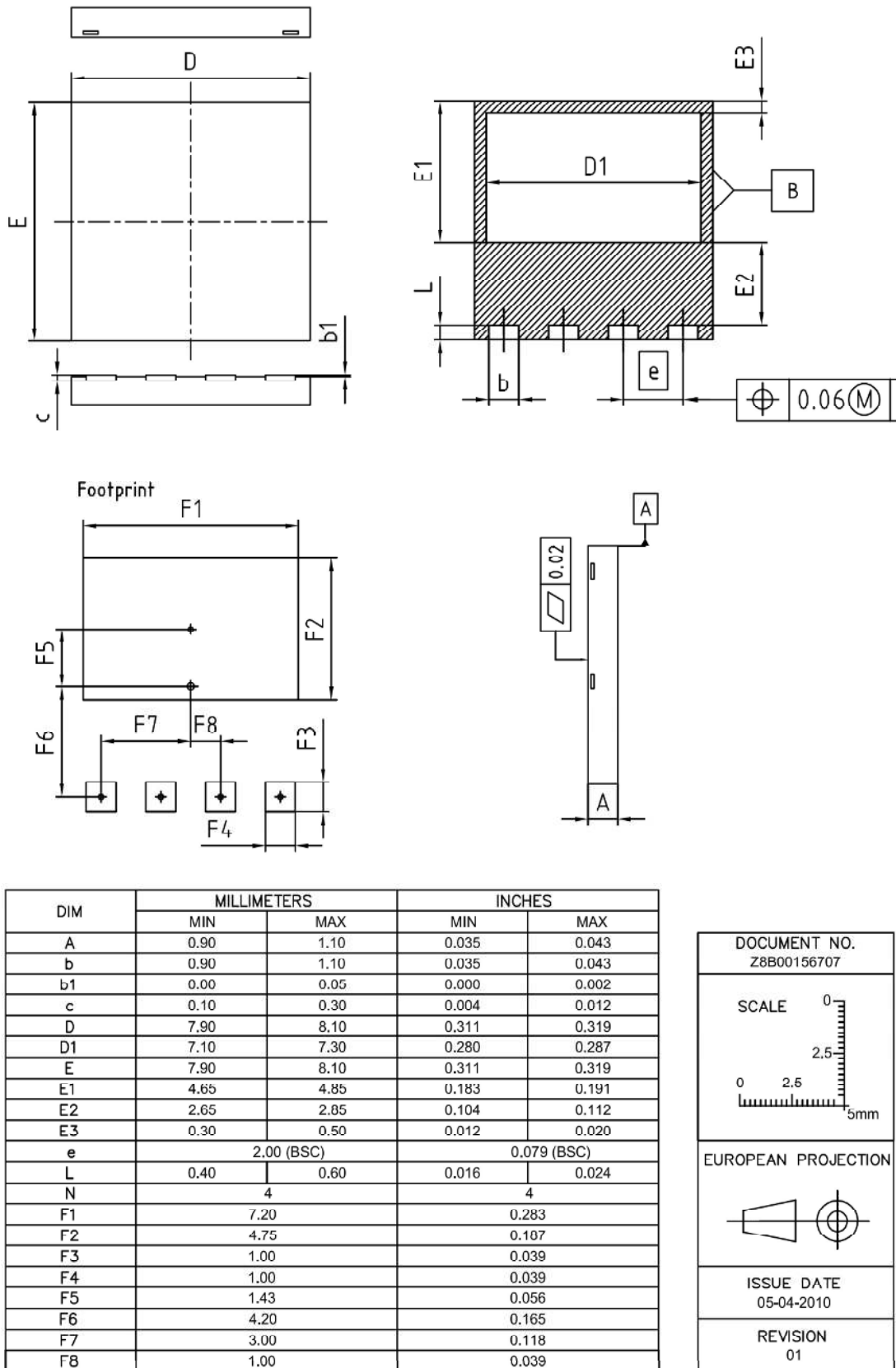


Figure 1 Outline PG-VSON-4, dimensions in mm/inches

7 Appendix A

Table 11 Related Links

- IFX CoolMOS CFD7 650V Webpage: www.infineon.com
- IFX CoolMOS CFD7 650V application note: www.infineon.com
- IFX CoolMOS CFD7 650V simulation model: www.infineon.com
- IFX Design tools: www.infineon.com

Revision History

IPL65R065CFD7

Revision: 2021-07-28, Rev. 2.0

Previous Revision

| Revision | Date | Subjects (major changes since last revision) |
|----------|------------|--|
| 2.0 | 2021-07-28 | Release of final version |

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