

## MOSFET

Metal Oxide Semiconductor Field Effect Transistor

## CoolMOS™ C6

650V CoolMOS™ C6 Power Transistor  
IPL65R650C6S

## 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™ C6 series combines the experience of the leading SJ MOSFET supplier with high class innovation. The offered devices provide all benefits of a fast switching SJ MOSFET while not sacrificing ease of use. Extremely low switching and conduction losses make switching applications even more efficient, more compact, lighter and cooler.

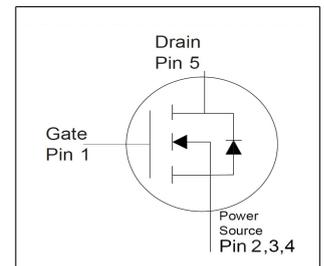
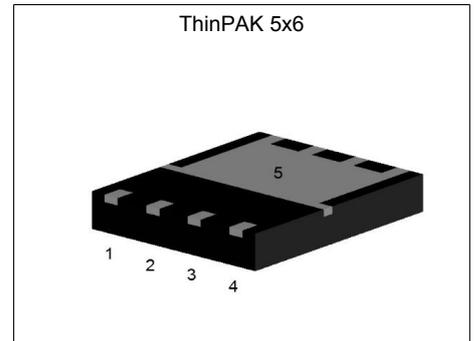
### Features

- Extremely low losses due to very low FOM  $R_{DS(on)} \cdot Q_g$  and  $E_{oss}$
- Very high commutation ruggedness
- Easy to use/drive
- Pb-free plating, Halogen free mold compound
- Qualified for industrial grade applications according to JEDEC (J-STD20 and JESD22)

### Applications

PFC stages, hard switching PWM stages and resonant switching PWM stages for e.g. PC Silverbox, Adapter, LCD & PDP TV, Lighting, Server, Telecom and UPS.

*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          |
| $R_{DS(on),max}$     | 0.65  | $\Omega$   |
| $Q_{g,typ}$          | 23    | nC         |
| $I_{D,pulse}$        | 16.6  | A          |
| $E_{oss@400V}$       | 2     | $\mu J$    |
| Body diode $di/dt$   | 500   | A/ $\mu s$ |

| Type / Ordering Code | Package         | Marking | Related Links  |
|----------------------|-----------------|---------|----------------|
| IPL65R650C6S         | ThinPAK 5x6 SMD | 65C6650 | 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 <sup>1)</sup>        | $I_D$          | -          | -    | 6.7<br>4.2 | A                | $T_C = 25^\circ\text{C}$<br>$T_C = 100^\circ\text{C}$                       |
| Pulsed drain current <sup>2)</sup>            | $I_{D,pulse}$  | -          | -    | 16.6       | A                | $T_C=25^\circ\text{C}$  |
| Avalanche energy, single pulse                | $E_{AS}$       | -          | -    | 142        | mJ               | $I_D = 1.3\text{A}$ ; $V_{DD} = 50\text{V}$                                 |
| Avalanche energy, repetitive                  | $E_{AR}$       | -          | -    | 0.21       | mJ               | $I_D = 1.3\text{A}$ ; $V_{DD} = 50\text{V}$                                 |
| Avalanche current, repetitive                 | $I_{AR}$       | -          | -    | 1.3        | A                | -   |
| MOSFET dv/dt ruggedness                       | dv/dt          | -          | -    | 50         | V/ns             | $V_{DS} = 0 \dots 520\text{V}$  |
| Gate source voltage                           | $V_{GS}$       | -20<br>-30 | -    | 20<br>30   | V                | static;<br>AC ( $f > 1\text{ Hz}$ )   |
| Power dissipation (non FullPAK)               | $P_{tot}$      | -          | -    | 56.8       | W                | $T_C=25^\circ\text{C}$  |
| Operating and storage temperature             | $T_j, T_{stg}$ | -40        | -    | 150        | $^\circ\text{C}$ | -   |
| Continuous diode forward current              | $I_S$          | -          | -    | 5.8        | A                | $T_C=25^\circ\text{C}$  |
| Diode pulse current <sup>2)</sup>             | $I_{S,pulse}$  | -          | -    | 16.2       | A                | $T_C = 25^\circ\text{C}$  |
| Reverse diode dv/dt <sup>3)</sup>             | dv/dt          | -          | -    | 15         | V/ns             | $V_{DS} = 0 \dots 400\text{V}$ , $I_{SD} \leq I_S$ , $T_j=25^\circ\text{C}$ |
| Maximum diode commutation speed <sup>3)</sup> | $di_f/dt$      | -          | -    | 500        | A/ $\mu\text{s}$ | $V_{DS} = 0 \dots 400\text{V}$ , $I_{SD} \leq I_S$ , $T_j=25^\circ\text{C}$ |

## 3 Thermal characteristics

**Table 3 Thermal characteristics (non FullPAK)**

| Parameter  | Symbol     | Values |      |      | Unit               | Note / Test Condition   |
|--|------------|--------|------|------|--------------------|---|
|  |            | Min.   | Typ. | Max. |                    |   |
| Thermal resistance, junction - case                        | $R_{thJC}$ | -      | -    | 2.2  | $^\circ\text{C/W}$ | -   |
| Thermal resistance, junction - ambient                     | $R_{thJA}$ | -      | 35   | 62   | $^\circ\text{C/W}$ | Device on 40mm*40mm*1.5 epoxy PCB FR4 with 6cm <sup>2</sup> (one layer 70 $\mu\text{m}$ thick) copper area for drain connection and cooling. PCB is vertical without blown air. |
| Soldering temperature, wavesoldering only allowed at leads | $T_{sold}$ | -      | -    | 260  | $^\circ\text{C}$   | reflow MSL1   |

 1) Limited by  $T_{j,max}$ . Maximum duty cycle  $D=0.75$ 

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

 3)  $V_{DClink}=400\text{V}$ ;  $V_{DS,peak} < V_{(BR)DSS}$ ; identical low side and high side switch with identical  $R_G$

## 4 Electrical characteristics

**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           | $V_{(GS)th}$  | 2.50   | 3    | 3.50 | V        | $V_{DS}=V_{GS}, I_D=0.21mA$   |
| Zero gate voltage drain current  | $I_{DSS}$     | -      | -    | 1    | $\mu A$  | $V_{DS}=650V, V_{GS}=0V, T_j=25^\circ C$<br>$V_{DS}=650V, V_{GS}=0V, T_j=150^\circ C$ |
| Gate-source leakage current      | $I_{GSS}$     | -      | -    | 100  | nA       | $V_{GS}=20V, V_{DS}=0V$   |
| Drain-source on-state resistance | $R_{DS(on)}$  | -      | 0.59 | 0.65 | $\Omega$ | $V_{GS}=10V, I_D=2.1A, T_j=25^\circ C$<br>$V_{GS}=10V, I_D=2.1A, T_j=150^\circ C$     |
| Gate resistance                  | $R_G$         | -      | 17.5 | -    | $\Omega$ | $f=1\text{ MHz}, \text{open drain}$   |

**Table 5 Dynamic characteristics**

| Parameter  | Symbol       | Values |      |      | Unit | Note / Test Condition                                   |
|--|--------------|--------|------|------|------|---|
|  |              | Min.   | Typ. | Max. |      |   |
| Input capacitance  | $C_{iss}$    | -      | 440  | -    | pF   | $V_{GS}=0V, V_{DS}=100V, f=1MHz$                        |
| Output capacitance   | $C_{oss}$    | -      | 30   | -    | pF   | $V_{GS}=0V, V_{DS}=100V, f=1MHz$                        |
| Effective output capacitance, energy related <sup>1)</sup> | $C_{o(er)}$  | -      | 21   | -    | pF   | $V_{GS}=0V, V_{DS}=0...520V$                            |
| Effective output capacitance, time related <sup>2)</sup>   | $C_{o(tr)}$  | -      | 88   | -    | pF   | $I_D=\text{constant}, V_{GS}=0V, V_{DS}=0...520V$       |
| Turn-on delay time   | $t_{d(on)}$  | -      | 12   | -    | ns   | $V_{DD}=400V, V_{GS}=10V, I_D=3.2A,$<br>$R_G=6.8\Omega$ |
| Rise time  | $t_r$        | -      | 9    | -    | ns   | $V_{DD}=400V, V_{GS}=10V, I_D=3.2A,$<br>$R_G=6.8\Omega$ |
| Turn-off delay time  | $t_{d(off)}$ | -      | 80   | -    | ns   | $V_{DD}=400V, V_{GS}=10V, I_D=3.2A,$<br>$R_G=6.8\Omega$ |
| Fall time  | $t_f$        | -      | 13   | -    | ns   | $V_{DD}=400V, V_{GS}=10V, I_D=3.2A,$<br>$R_G=6.8\Omega$ |

**Table 6 Gate charge characteristics**

| Parameter             | Symbol        | Values |      |      | Unit | Note / Test Condition                           |
|-----------------------|---------------|--------|------|------|------|---|
|                       |               | Min.   | Typ. | Max. |      |   |
| Gate to source charge | $Q_{gs}$      | -      | 2.5  | -    | nC   | $V_{DD}=520V, I_D=3.2A, V_{GS}=0\text{ to }10V$ |
| Gate to drain charge  | $Q_{gd}$      | -      | 11   | -    | nC   | $V_{DD}=520V, I_D=3.2A, V_{GS}=0\text{ to }10V$ |
| Gate charge total     | $Q_g$         | -      | 21   | -    | nC   | $V_{DD}=520V, I_D=3.2A, V_{GS}=0\text{ to }10V$ |
| Gate plateau voltage  | $V_{plateau}$ | -      | 5.5  | -    | V    | $V_{DD}=520V, I_D=3.2A, V_{GS}=0\text{ to }10V$ |

<sup>1)</sup>  $C_{o(er)}$  is a fixed capacitance that gives the same stored energy as  $C_{oss}$  while  $V_{DS}$  is rising from 0 to 80%  $V_{(BR)DSS}$ 
<sup>2)</sup>  $C_{o(tr)}$  is a fixed capacitance that gives the same charging time as  $C_{oss}$  while  $V_{DS}$  is rising from 0 to 80%  $V_{(BR)DSS}$

**Table 7 Reverse diode characteristics**

| Parameter                     | Symbol    | Values |      |      | Unit    | Note / Test Condition                    |
|-------------------------------|-----------|--------|------|------|---------|--|
|                               |           | Min.   | Typ. | Max. |         |  |
| Diode forward voltage         | $V_{SD}$  | -      | 0.9  | -    | V       | $V_{GS}=0V, I_F=3.2A, T_i=25^\circ C$    |
| Reverse recovery time         | $t_{rr}$  | -      | 270  | -    | ns      | $V_R=400V, I_F=3.2A, di_F/dt=100A/\mu s$ |
| Reverse recovery charge       | $Q_{rr}$  | -      | 2    | -    | $\mu C$ | $V_R=400V, I_F=3.2A, di_F/dt=100A/\mu s$ |
| Peak reverse recovery current | $I_{rrm}$ | -      | 13   | -    | A       | $V_R=400V, I_F=3.2A, di_F/dt=100A/\mu s$ |

### 5 Electrical characteristics diagrams

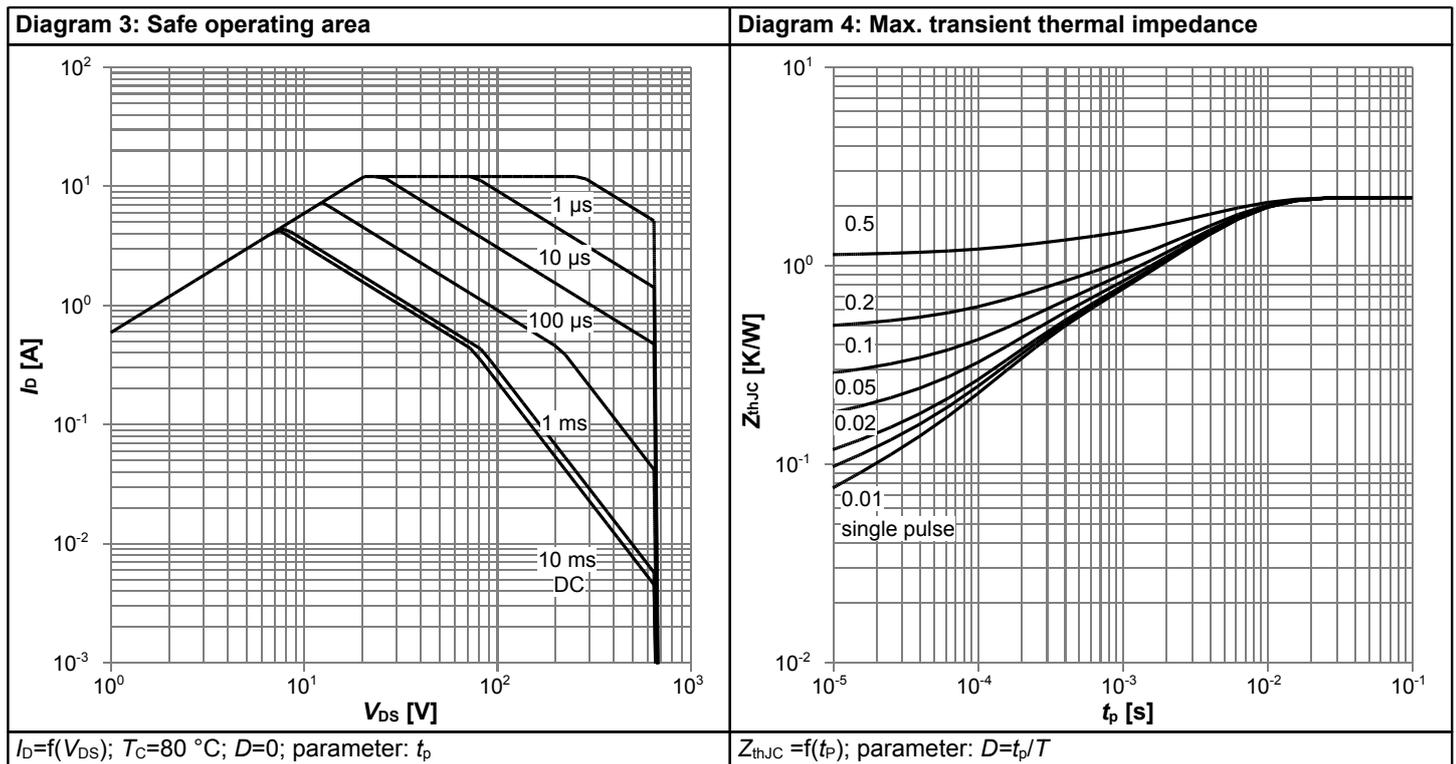
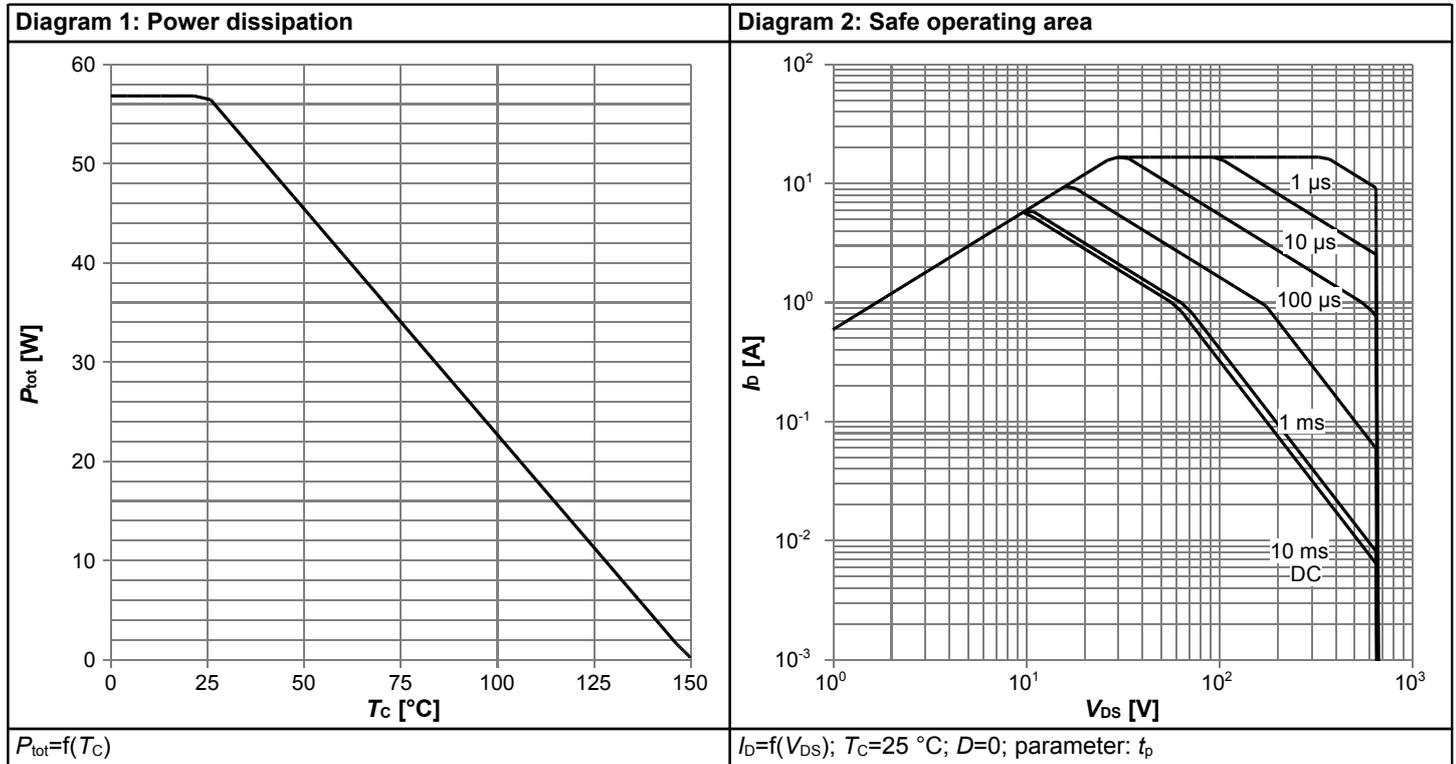
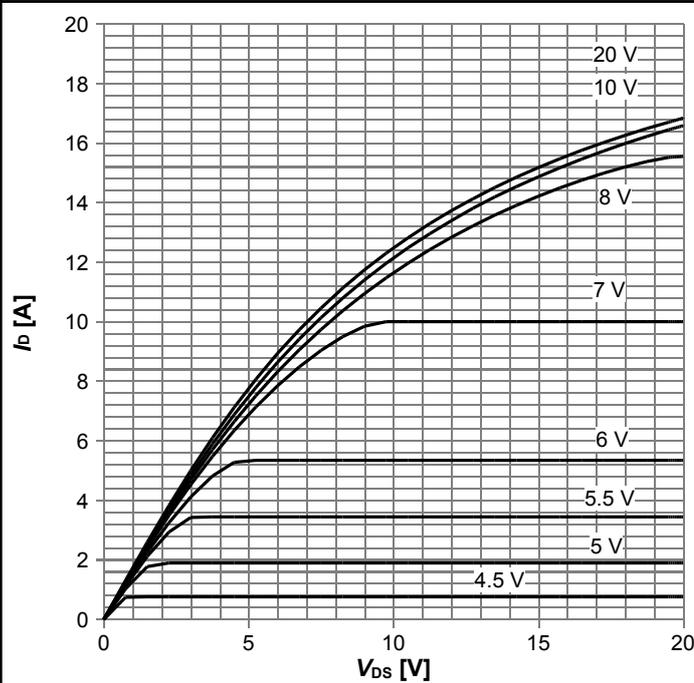
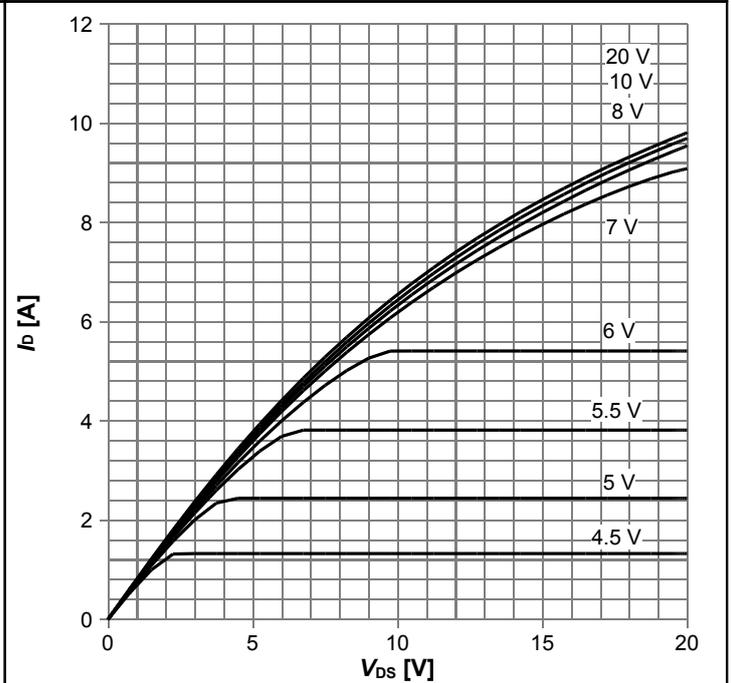


Diagram 5: Typ. output characteristics



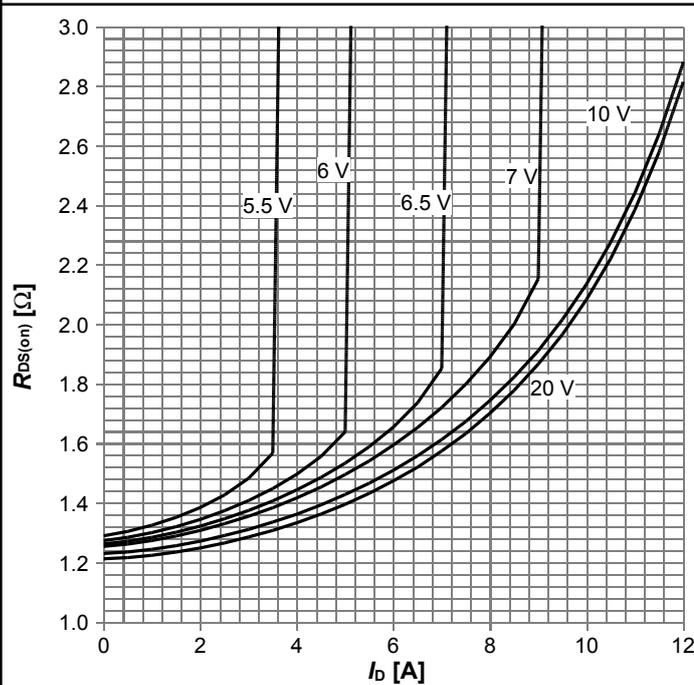
$I_D=f(V_{DS}); T_j=25\text{ }^\circ\text{C};$  parameter:  $V_{GS}$

Diagram 6: Typ. output characteristics



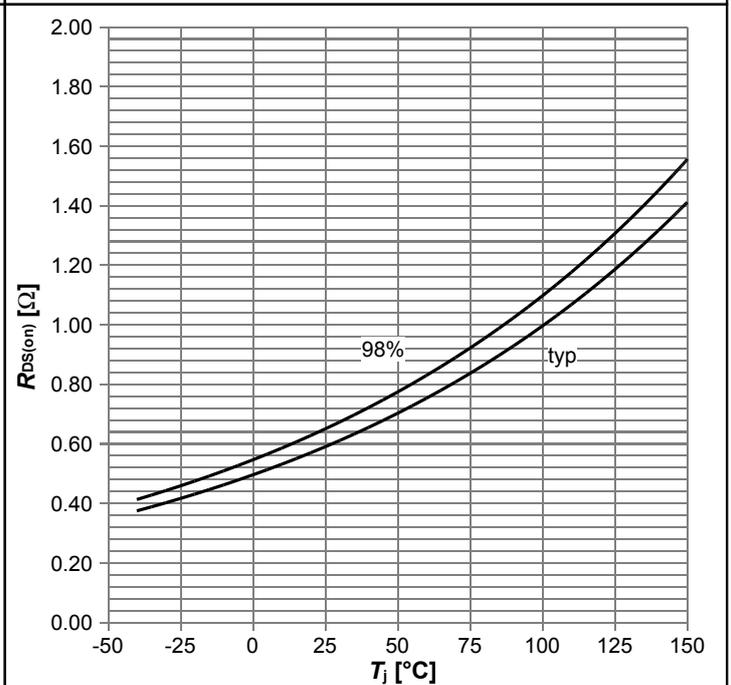
$I_D=f(V_{DS}); T_j=125\text{ }^\circ\text{C};$  parameter:  $V_{GS}$

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



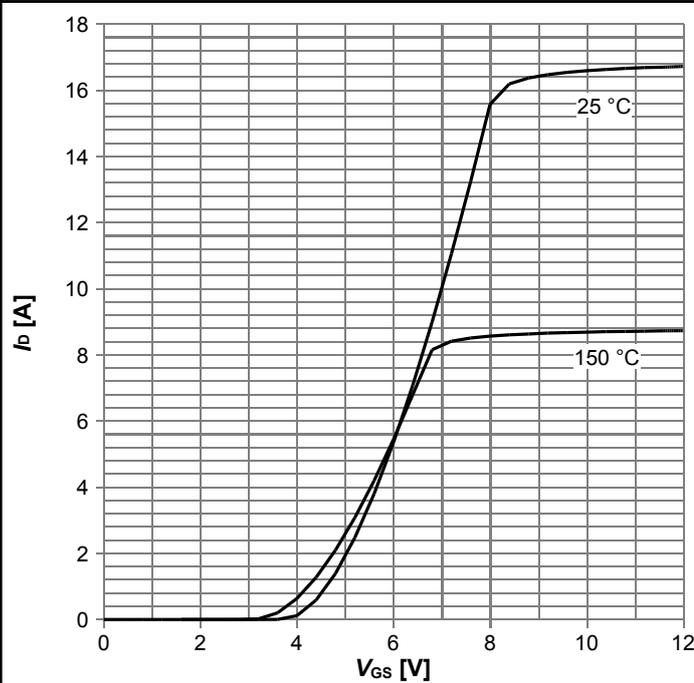
$R_{DS(on)}=f(I_D); T_j=125\text{ }^\circ\text{C};$  parameter:  $V_{GS}$

Diagram 8: Drain-source on-state resistance



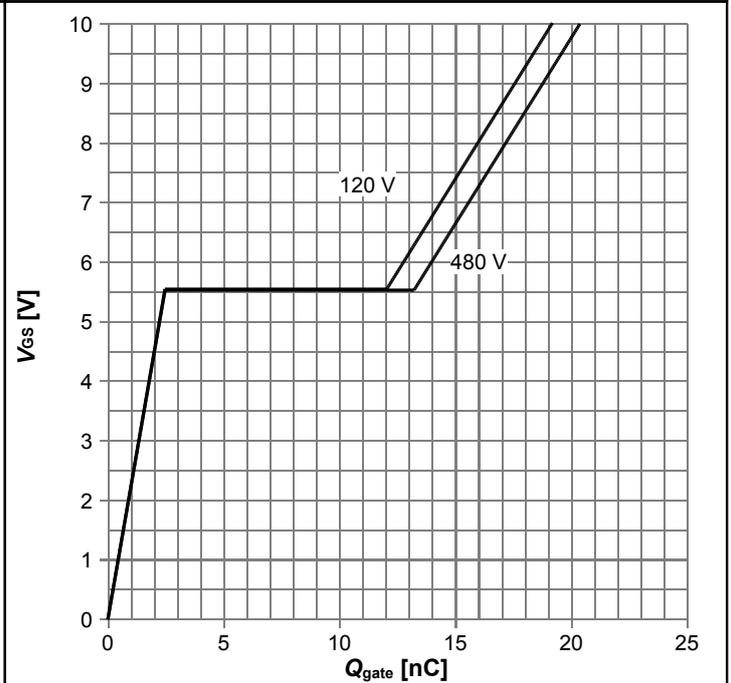
$R_{DS(on)}=f(T_j); I_D=2.1\text{ A}; V_{GS}=10\text{ V}$

Diagram 9: Typ. transfer characteristics



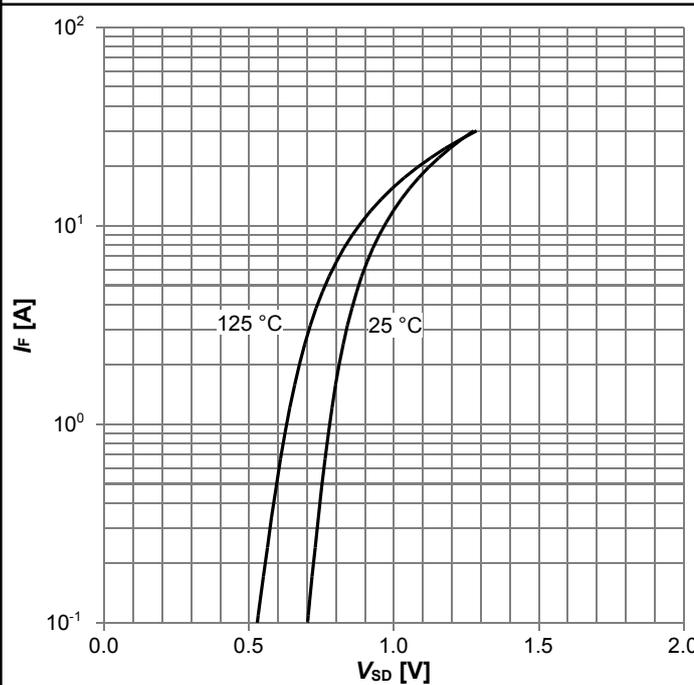
$I_D=f(V_{GS}); V_{DS}=20V; \text{parameter: } T_j$

Diagram 10: Typ. gate charge



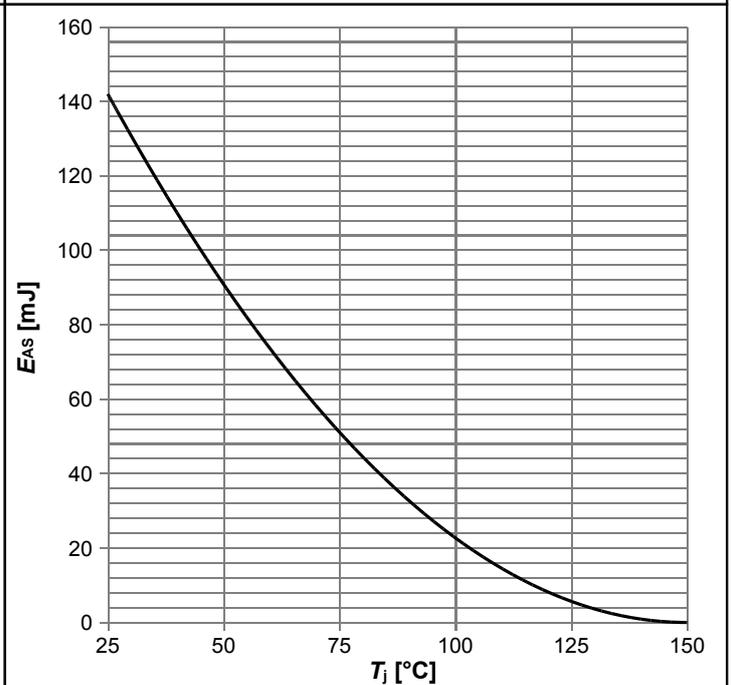
$V_{GS}=f(Q_{gate}); I_D=3.2 \text{ A pulsed}; \text{parameter: } V_{DD}$

Diagram 11: Forward characteristics of reverse diode



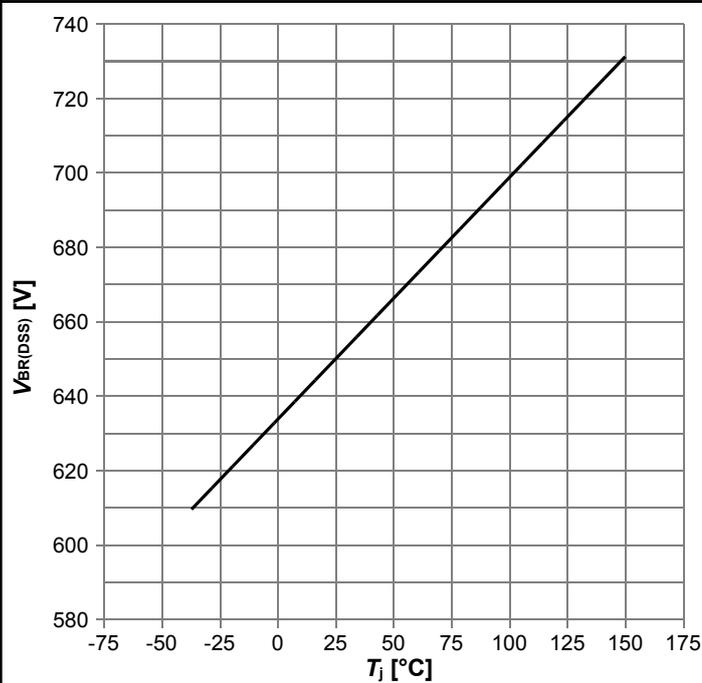
$I_F=f(V_{SD}); \text{parameter: } T_j$

Diagram 12: Avalanche energy



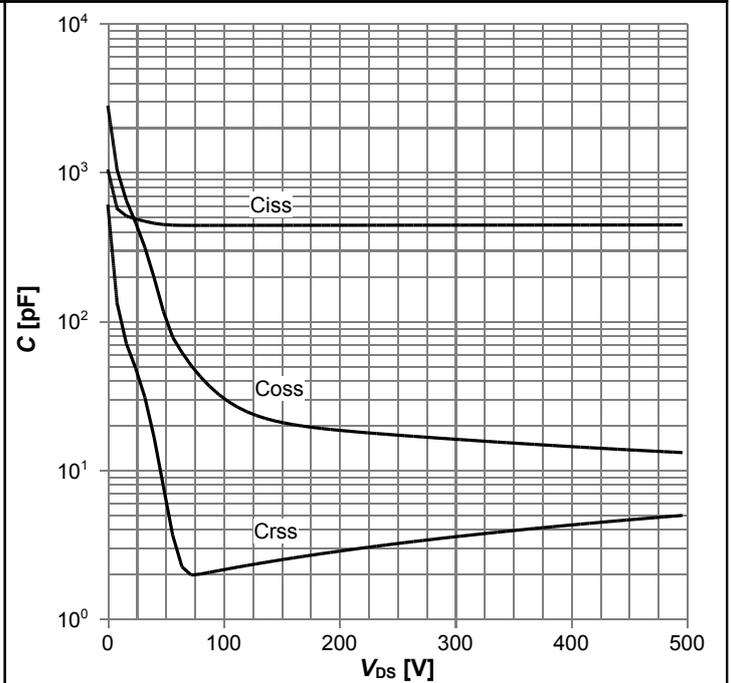
$E_{AS}=f(T_j); I_D=1.3 \text{ A}; V_{DD}=50 \text{ V}$

Diagram 13: Drain-source breakdown voltage



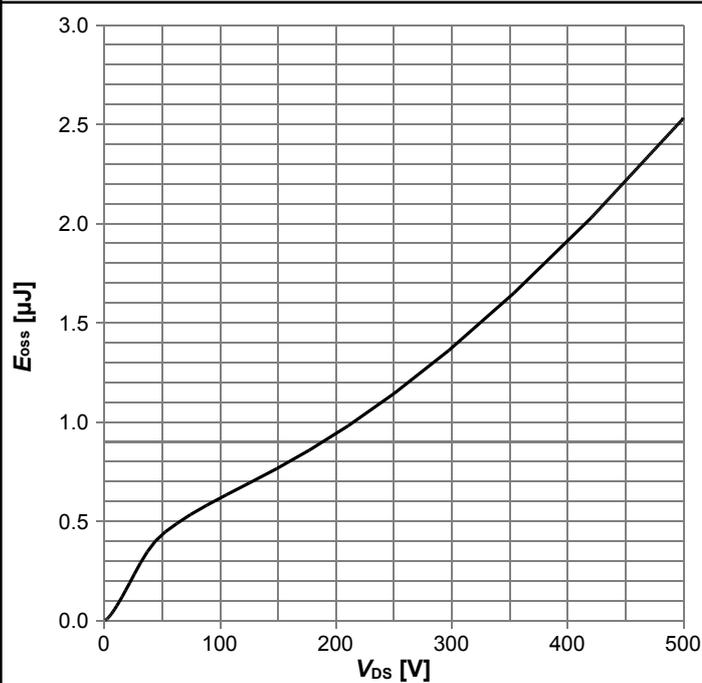
$V_{BR(DSS)}=f(T_j); I_D=1 \text{ mA}$

Diagram 14: Typ. capacitances



$C=f(V_{DS}); V_{GS}=0 \text{ V}; f=1 \text{ MHz}$

Diagram 15: Typ. Coss stored energy



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

## 6 Test Circuits

**Table 8 Diode characteristics**

| Test circuit for diode characteristics | Diode recovery waveform |
|--|-------------------------|
|  |                         |

**Table 9 Switching times**

| Switching times test circuit for inductive load | Switching times waveform |
|---|--------------------------|
|   |                          |

**Table 10 Unclamped inductive load**

| Unclamped inductive load test circuit | Unclamped inductive waveform |
|---------------------------------------|------------------------------|
|                                       |                              |

## 7 Package Outlines

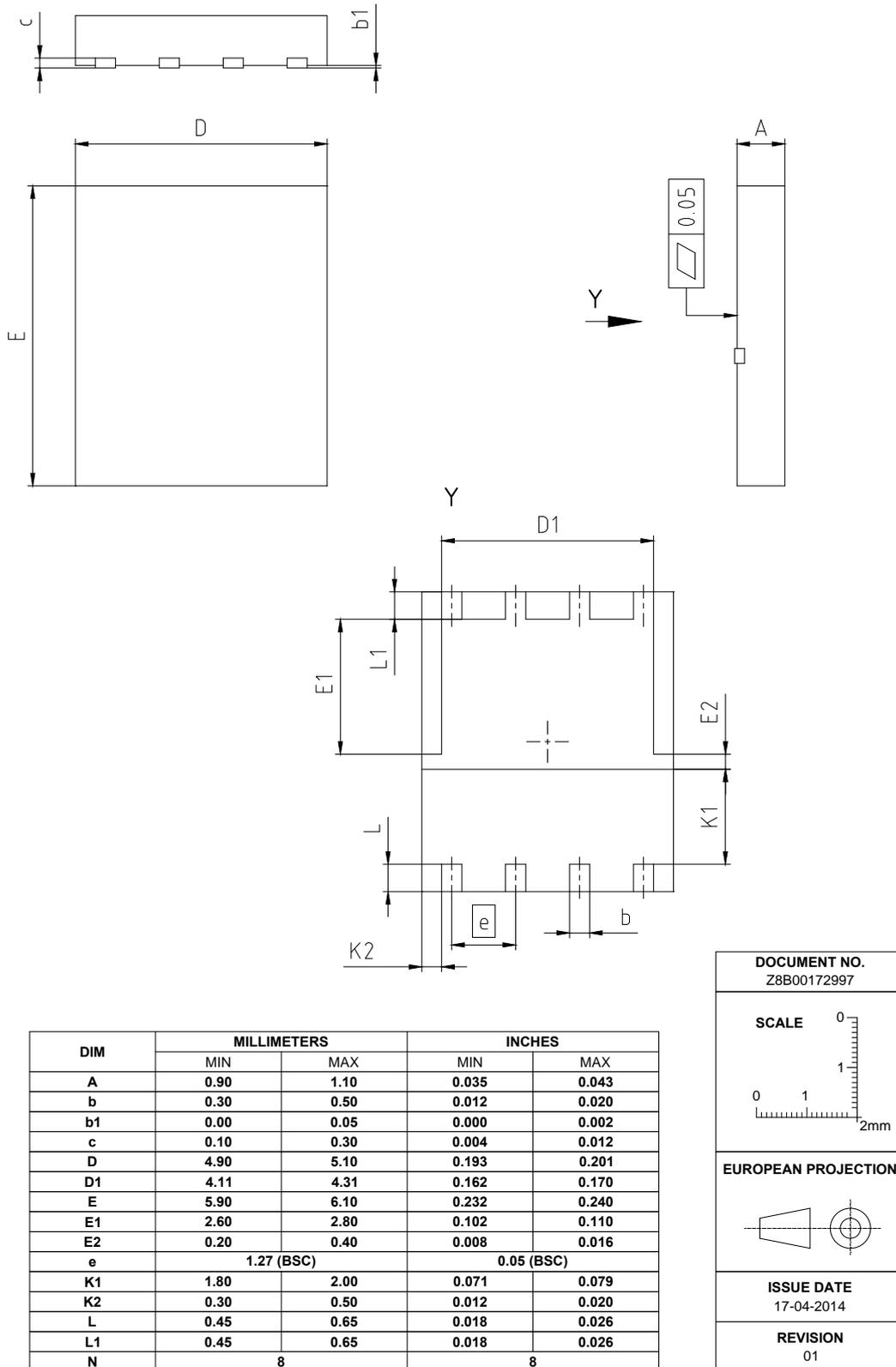


Figure 1 Outline ThinPAK 5x6 SMD, dimensions in mm/inches

## 8 Appendix A

### Table 11 Related Links

- IFX CoolMOS Webpage: [www.infineon.com](http://www.infineon.com)
- IFX Design tools: [www.infineon.com](http://www.infineon.com)

## Revision History

IPL65R650C6S

**Revision: 2014-07-08, Rev. 2.0**

Previous Revision

| Revision | Date       | Subjects (major changes since last revision) |
|----------|------------|--|
| 2.0      | 2014-07-08 | Release of final version                     |

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