

MOSFET

Metal Oxide Semiconductor Field Effect Transistor

CoolMOS™ CE

650V CoolMOS™ CE Power Transistor
IPS65R1K5CE

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™ CE is a price-performance optimized platform enabling to target cost sensitive applications in Consumer and Lighting markets by still meeting highest efficiency standards. The new series provides all benefits of a fast switching Superjunction MOSFET while not sacrificing ease of use and offering the best cost down performance ratio available on the market.

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 consumer grade applications

Applications

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

Please note: For MOSFET paralleling the use of ferrite beads on the gate or separate totem poles is generally recommended.

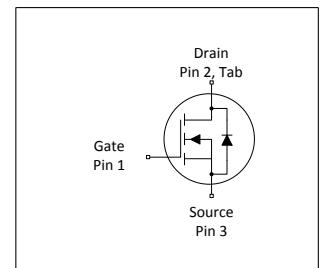


Table 1 Key Performance Parameters

| Parameter | Value | Unit |
|----------------------|-------|-----------|
| $V_{DS} @ T_{j,max}$ | 700 | V |
| $R_{DS(on),max}$ | 1500 | $m\Omega$ |
| $Q_{g,typ}$ | 10.5 | nC |
| $I_{D,pulse}$ | 8.3 | A |
| $E_{oss@400V}$ | 1.15 | μJ |
| Body diode di/dt | 500 | $A/\mu s$ |

| Type / Ordering Code | Package | Marking | Related Links |
|----------------------|-----------|---------|----------------|
| IPS65R1K5CE | PG-TO 251 | 65CE1K5 | 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 | - | - | 3.1 2.0 | A | $T_C=25^\circ\text{C}$ $T_C=100^\circ\text{C}$ |
| Pulsed drain current ²⁾ | $I_{D,pulse}$ | - | - | 8.3 | A | $T_C=25^\circ\text{C}$ |
| Avalanche energy, single pulse | E_{AS} | - | - | 26 | mJ | $I_D=0.6\text{A}$; $V_{DD}=50\text{V}$; see table 10 |
| Avalanche energy, repetitive | E_{AR} | - | - | 0.10 | mJ | $I_D=0.6\text{A}$; $V_{DD}=50\text{V}$; see table 10 |
| Avalanche current, repetitive | I_{AR} | - | - | 0.6 | A | - |
| MOSFET dv/dt ruggedness | dv/dt | - | - | 50 | V/ns | $V_{DS}=0\dots480\text{V}$ |
| 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} | - | - | 28 | W | $T_C=25^\circ\text{C}$ |
| Storage temperature | T_{stg} | -40 | - | 150 | $^\circ\text{C}$ | - |
| Operating junction temperature | T_j | -40 | - | 150 | $^\circ\text{C}$ | - |
| Continuous diode forward current | I_S | - | - | 2.7 | A | $T_C=25^\circ\text{C}$ |
| Diode pulse current ²⁾ | $I_{S,pulse}$ | - | - | 8.3 | A | $T_C=25^\circ\text{C}$ |
| Reverse diode dv/dt ³⁾ | dv/dt | - | - | 15 | 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 | - | - | 500 | A/ μs | $V_{DS}=0\dots400\text{V}$, $I_{SD}\leq I_S$, $T_j=25^\circ\text{C}$ see table 8 |

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

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} | - | - | 4.4 | °C/W | - |
| Thermal resistance, junction - ambient | R_{thJA} | - | - | 62 | °C/W | leaded |
| Soldering temperature, wavesoldering only allowed at leads | T_{sold} | - | - | 260 | °C | 1.6mm (0.063 in.) from case for 10s |

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 | $V_{(GS)th}$ | 2.5 | 3.0 | 3.5 | V | $V_{DS}=V_{GS}$, $I_D=0.1\text{mA}$ |
| 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 | $R_{DS(on)}$ | - | 1.26 3.28 | 1.50 - | Ω | $V_{GS}=10\text{V}$, $I_D=1\text{A}$, $T_j=25^\circ\text{C}$ $V_{GS}=10\text{V}$, $I_D=1\text{A}$, $T_j=150^\circ\text{C}$ |
| Gate resistance | R_G | - | 6.5 | - | 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} | - | 225 | - | pF | $V_{GS}=0\text{V}$, $V_{DS}=100\text{V}$, $f=1\text{MHz}$ |
| Output capacitance | C_{oss} | - | 18 | - | pF | $V_{GS}=0\text{V}$, $V_{DS}=100\text{V}$, $f=1\text{MHz}$ |
| Effective output capacitance, energy related ¹⁾ | $C_{o(er)}$ | - | 10 | - | pF | $V_{GS}=0\text{V}$, $V_{DS}=0\dots480\text{V}$ |
| Effective output capacitance, time related ²⁾ | $C_{o(tr)}$ | - | 42 | - | pF | $I_D=\text{constant}$, $V_{GS}=0\text{V}$, $V_{DS}=0\dots480\text{V}$ |
| Turn-on delay time | $t_{d(on)}$ | - | 7.7 | - | ns | $V_{DD}=400\text{V}$, $V_{GS}=13\text{V}$, $I_D=1.5\text{A}$, $R_G=10.2\Omega$; see table 9 |
| Rise time | t_r | - | 5.9 | - | ns | $V_{DD}=400\text{V}$, $V_{GS}=13\text{V}$, $I_D=1.5\text{A}$, $R_G=10.2\Omega$; see table 9 |
| Turn-off delay time | $t_{d(off)}$ | - | 33 | - | ns | $V_{DD}=400\text{V}$, $V_{GS}=13\text{V}$, $I_D=1.5\text{A}$, $R_G=10.2\Omega$; see table 9 |
| Fall time | t_f | - | 18.2 | - | ns | $V_{DD}=400\text{V}$, $V_{GS}=13\text{V}$, $I_D=1.5\text{A}$, $R_G=10.2\Omega$; see table 9 |

Table 6 Gate charge characteristics

| Parameter | Symbol | Values | | | Unit | Note / Test Condition |
|-----------------------|----------------------|--------|------|------|------|---|
| | | Min. | Typ. | Max. | | |
| Gate to source charge | Q_{gs} | - | 1.3 | - | nC | $V_{DD}=480\text{V}$, $I_D=1.5\text{A}$, $V_{GS}=0$ to 10V |
| Gate to drain charge | Q_{gd} | - | 5.8 | - | nC | $V_{DD}=480\text{V}$, $I_D=1.5\text{A}$, $V_{GS}=0$ to 10V |
| Gate charge total | Q_g | - | 10.5 | - | nC | $V_{DD}=480\text{V}$, $I_D=1.5\text{A}$, $V_{GS}=0$ to 10V |
| Gate plateau voltage | V_{plateau} | - | 5.4 | - | V | $V_{DD}=480\text{V}$, $I_D=1.5\text{A}$, $V_{GS}=0$ 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 480V

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 480V

Table 7 Reverse diode characteristics

| Parameter | Symbol | Values | | | Unit | Note / Test Condition |
|-------------------------------|-----------|--------|------|------|---------|--|
| | | Min. | Typ. | Max. | | |
| Diode forward voltage | V_{SD} | - | 0.9 | - | V | $V_{GS}=0V, I_F=1.5A, T_j=25^\circ C$ |
| Reverse recovery time | t_{rr} | - | 200 | - | ns | $V_R=400V, I_F=1.5A, di_F/dt=100A/\mu s$; see table 8 |
| Reverse recovery charge | Q_{rr} | - | 0.9 | - | μC | $V_R=400V, I_F=1.5A, di_F/dt=100A/\mu s$; see table 8 |
| Peak reverse recovery current | I_{rrm} | - | 8 | - | A | $V_R=400V, I_F=1.5A, di_F/dt=100A/\mu s$; see table 8 |

5 Electrical characteristics diagrams

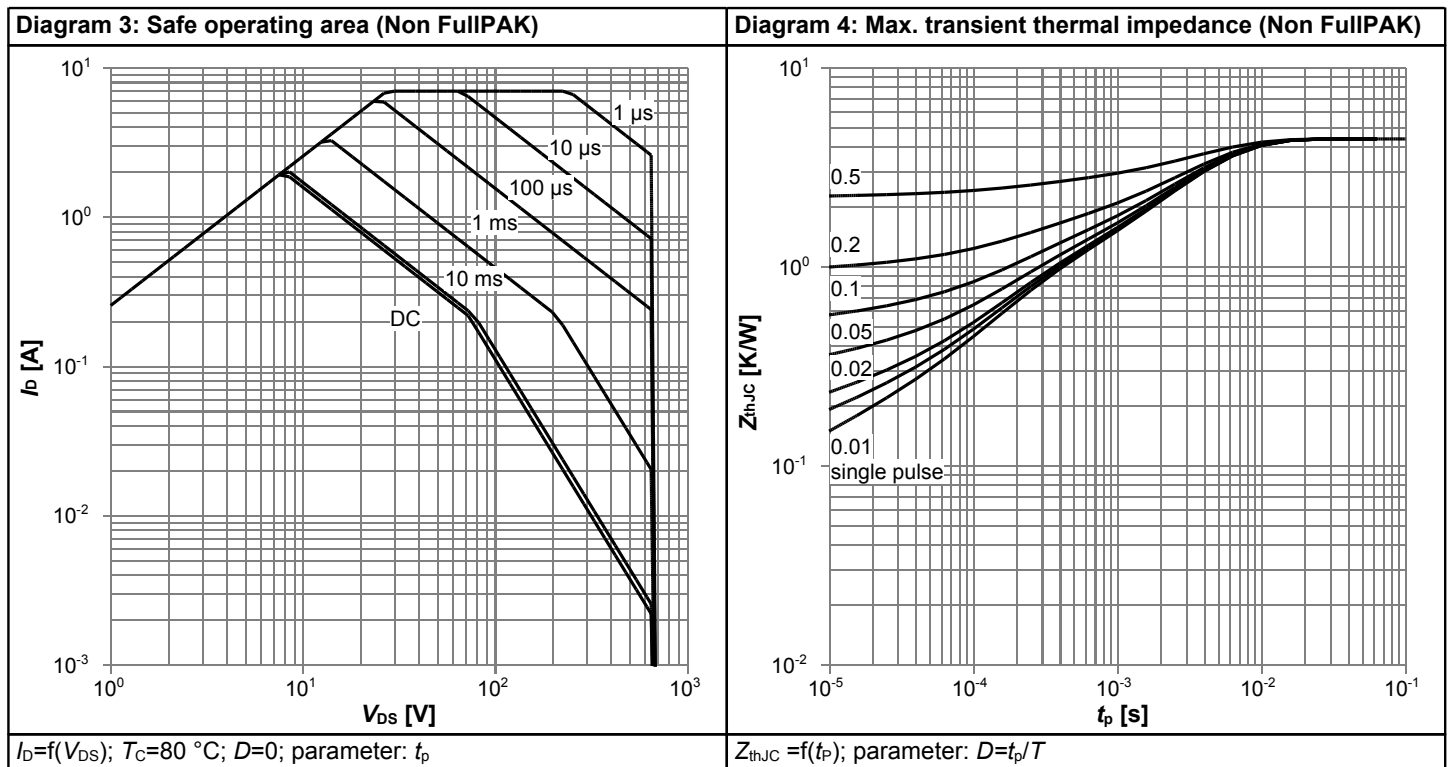
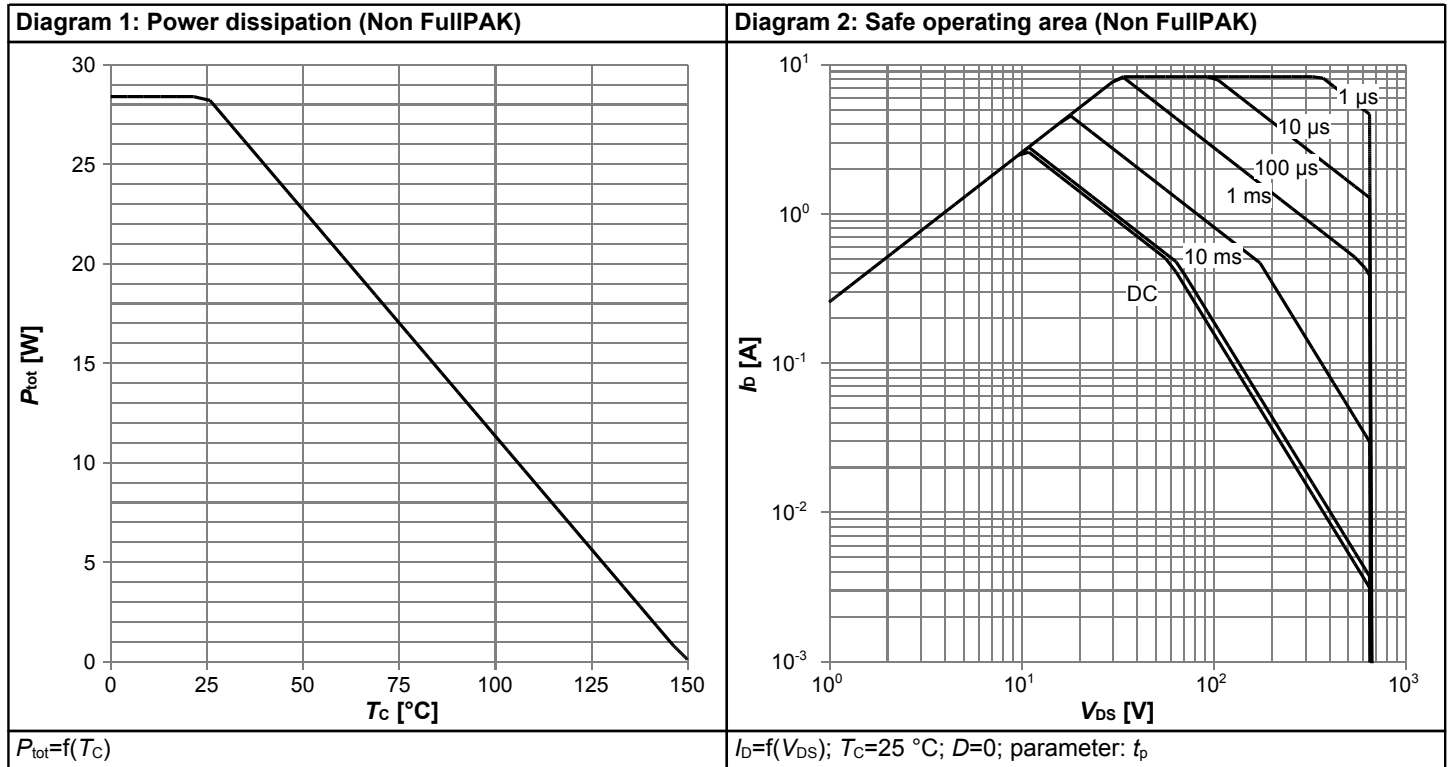
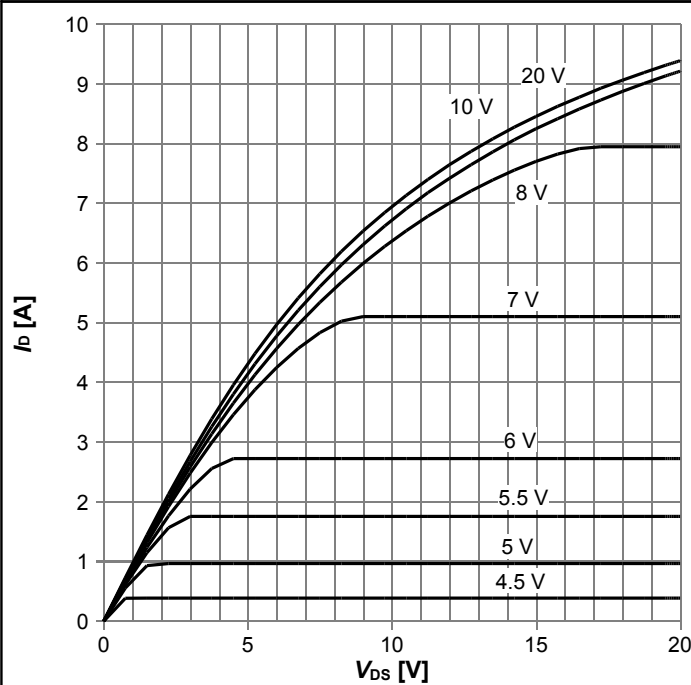
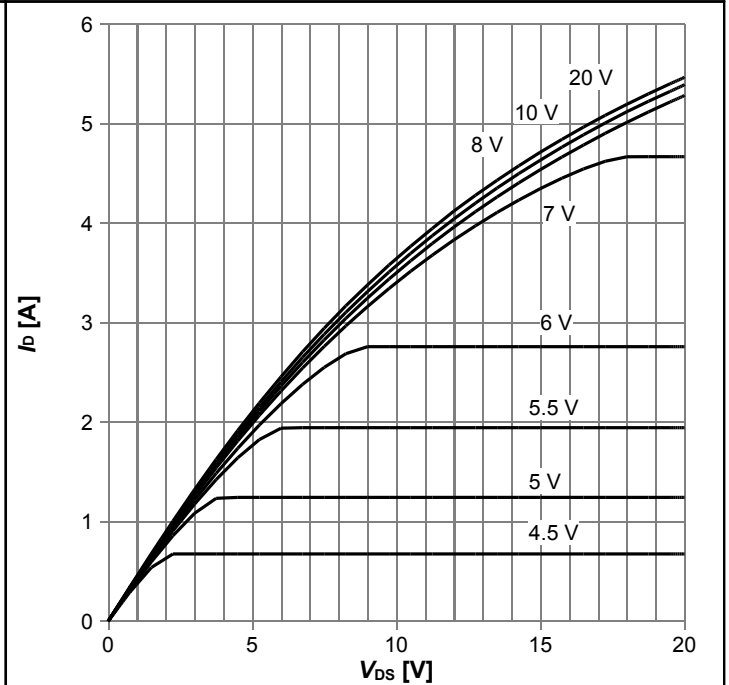


Diagram 5: Typ. output characteristics



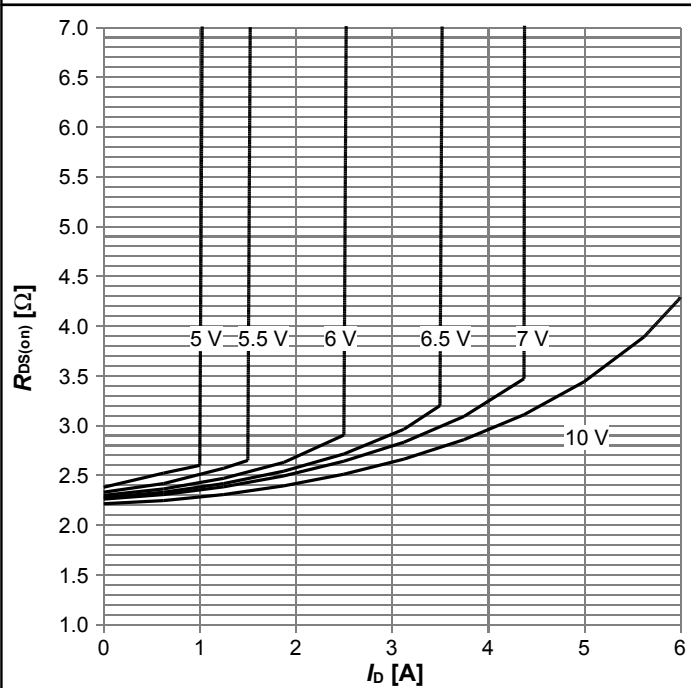
$I_D = f(V_{DS})$; $T_j = 25^\circ\text{C}$; parameter: V_{GS}

Diagram 6: Typ. output characteristics



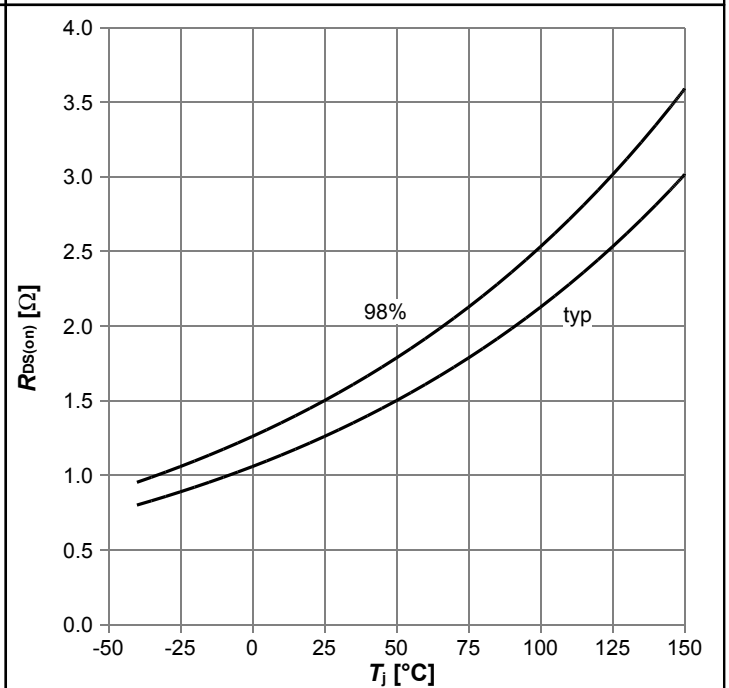
$I_D = f(V_{DS})$; $T_j = 125^\circ\text{C}$; parameter: V_{GS}

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



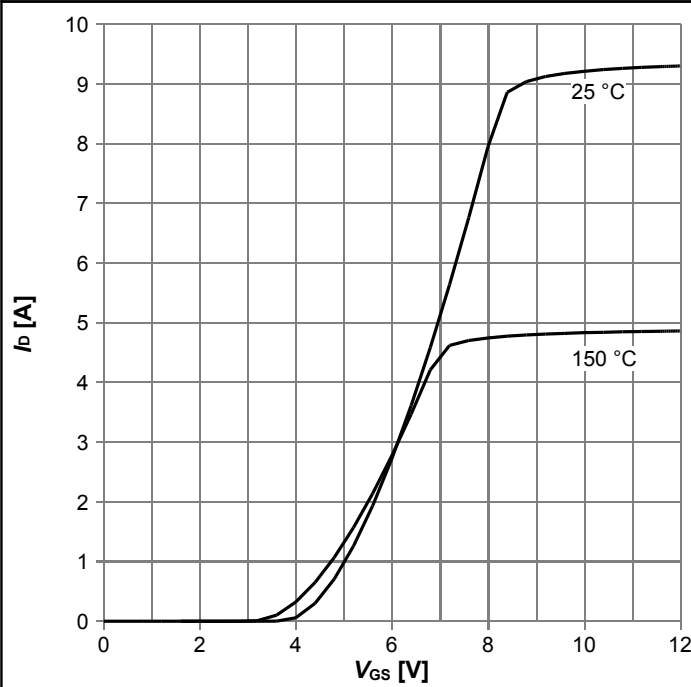
$R_{DS(on)} = f(I_D)$; $T_j = 125^\circ\text{C}$; parameter: V_{GS}

Diagram 8: Drain-source on-state resistance



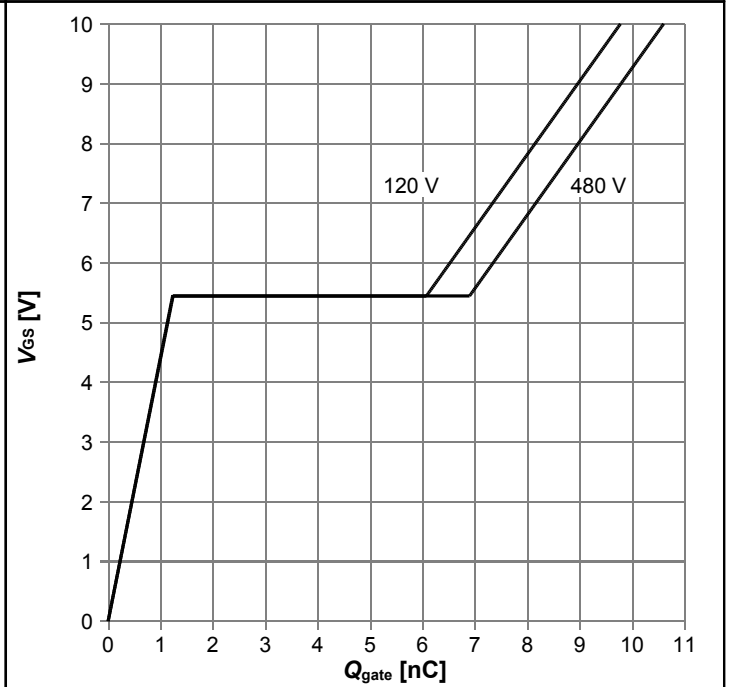
$R_{DS(on)} = f(T_j)$; $I_D = 1.0\text{ A}$; $V_{GS} = 10\text{ V}$

Diagram 9: Typ. transfer characteristics



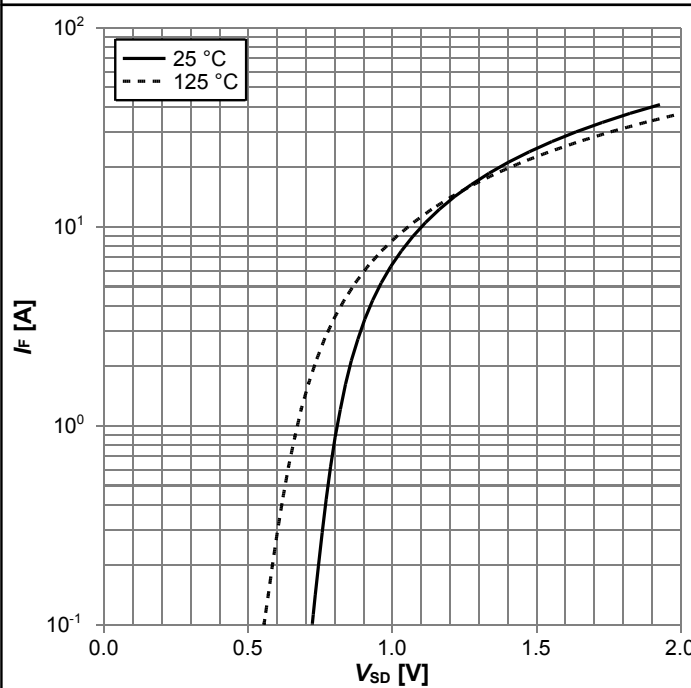
$I_D=f(V_{GS}); V_{DS}=20V$; parameter: T_j

Diagram 10: Typ. gate charge



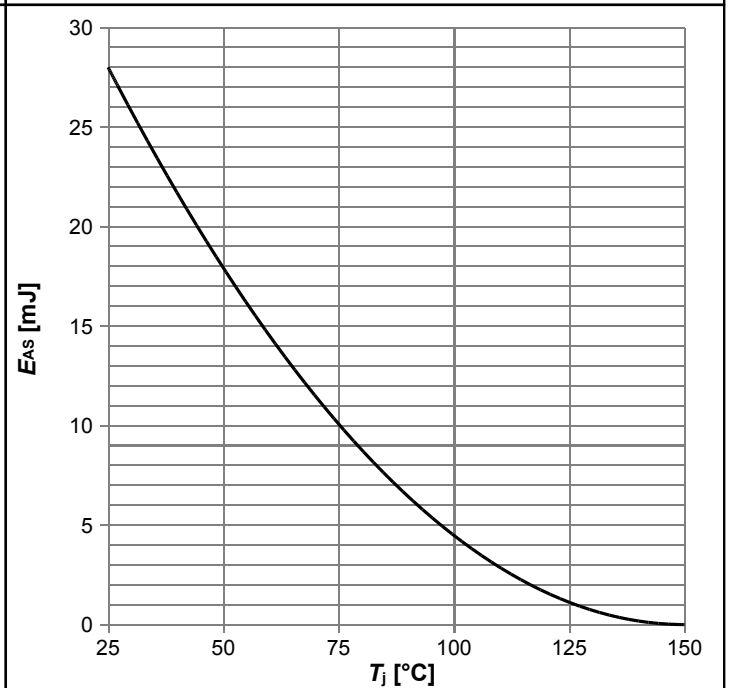
$V_{GS}=f(Q_{gate}); I_D=1.5 A$ pulsed; parameter: V_{DD}

Diagram 11: Forward characteristics of reverse diode



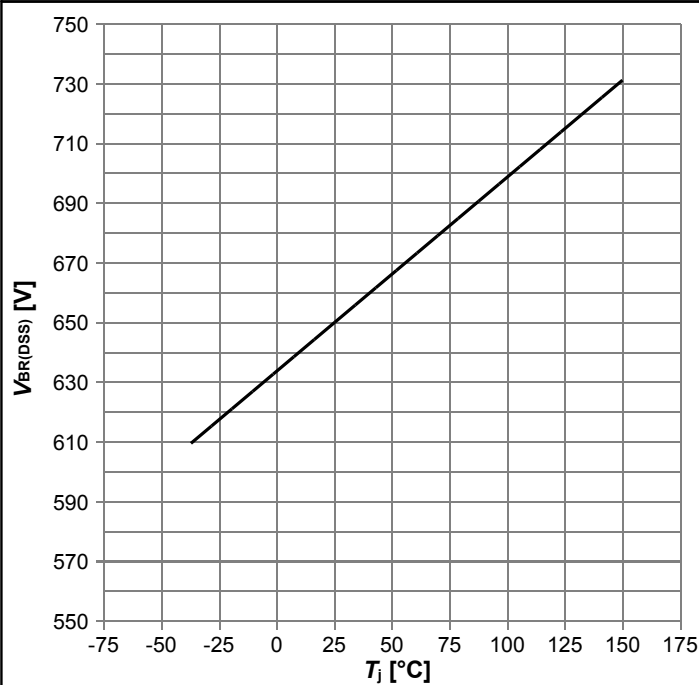
$I_F=f(V_{SD})$; parameter: T_j

Diagram 12: Avalanche energy



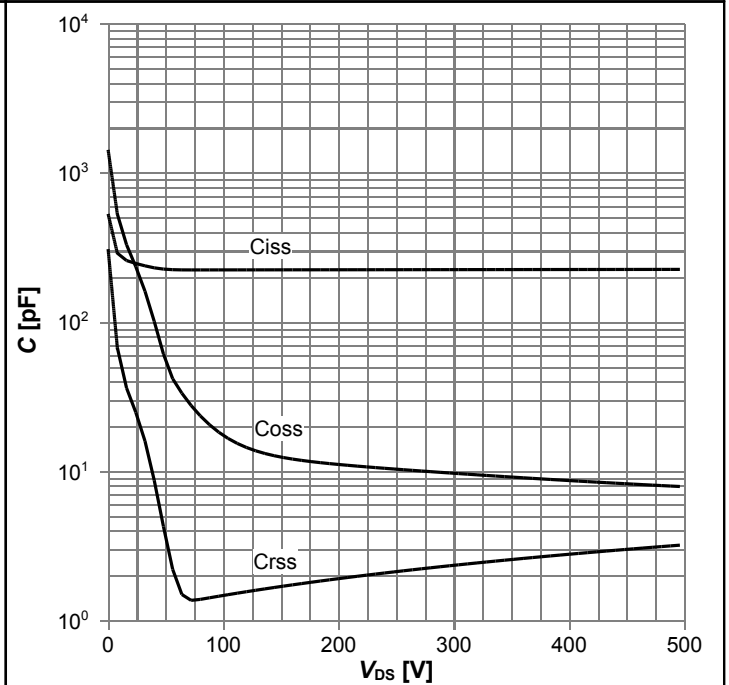
$E_{AS}=f(T_j); I_D=0.6 A; V_{DD}=50 V$

Diagram 13: Drain-source breakdown voltage



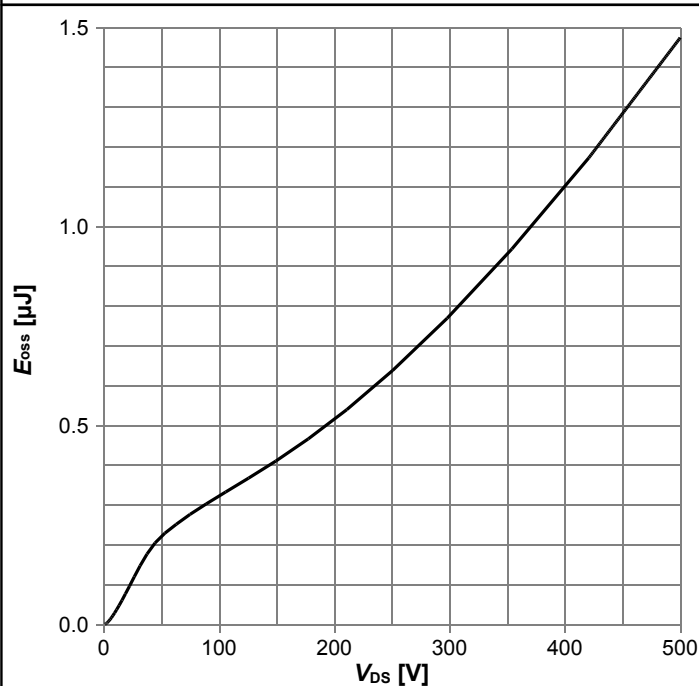
$V_{BR(DSS)}=f(T_j); I_D=1.0 \text{ mA}$

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

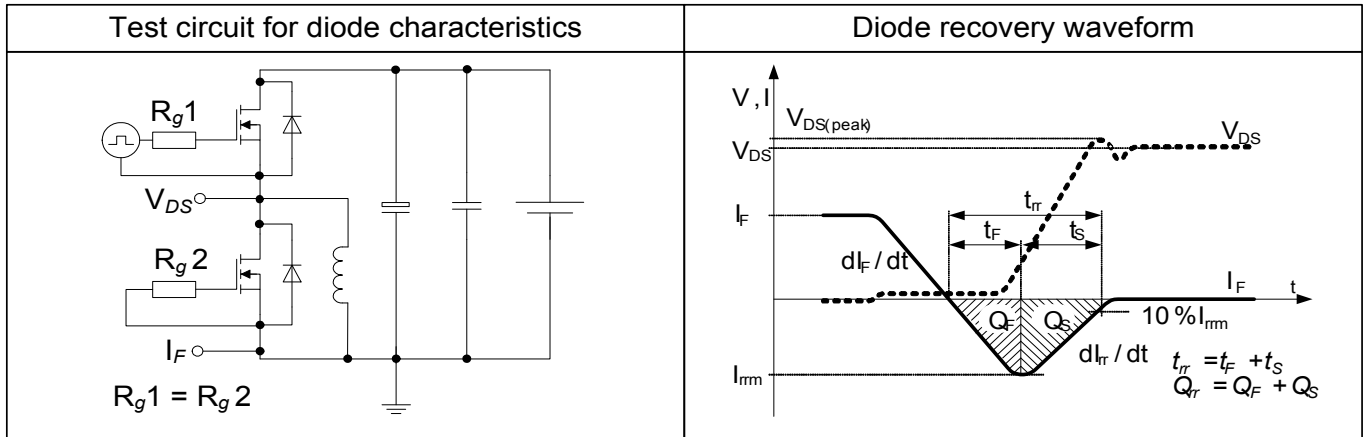


Table 9 Switching times

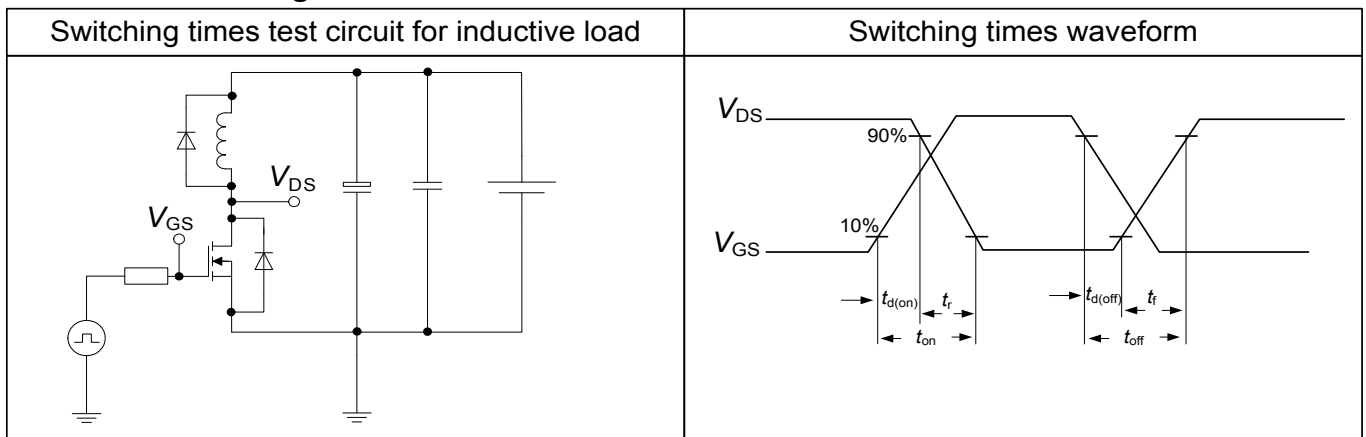
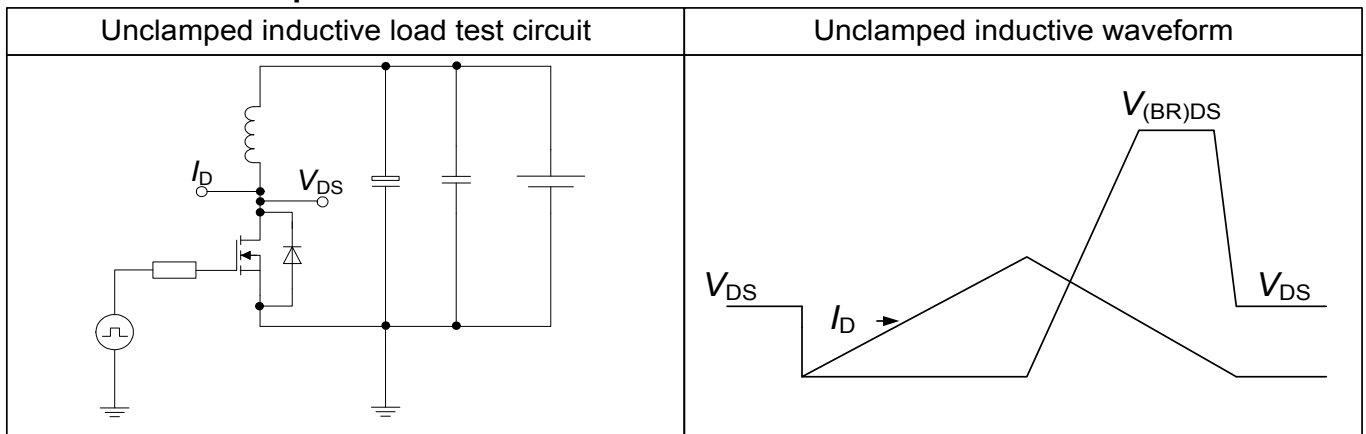
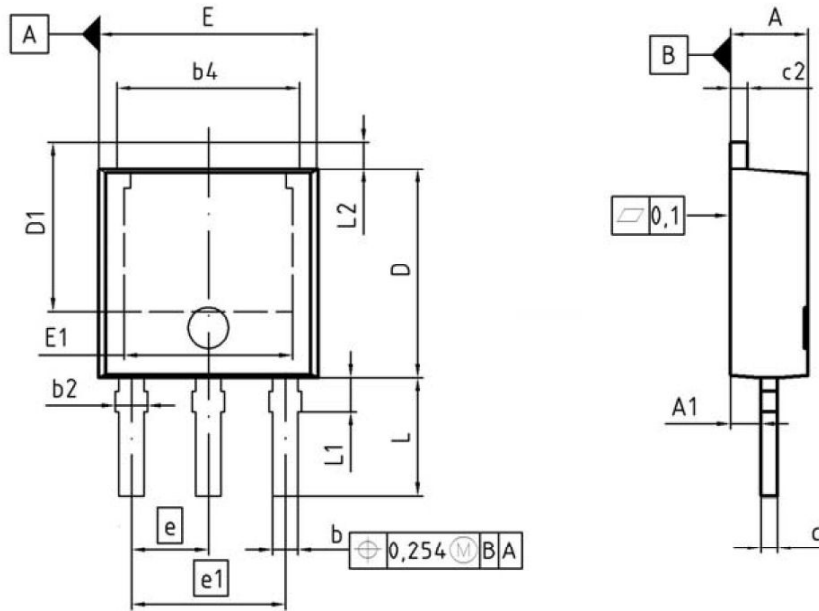


Table 10 Unclamped inductive load



7 Package Outlines



| DIM | MILLIMETERS | | INCHES | |
|-----|-------------|------|--------|-------|
| | MIN | MAX | MIN | MAX |
| A | 2.18 | 2.39 | 0.086 | 0.094 |
| A1 | 0.80 | 1.14 | 0.031 | 0.045 |
| b | 0.64 | 0.89 | 0.025 | 0.035 |
| b2 | 0.65 | 1.15 | 0.026 | 0.045 |
| b4 | 4.95 | 5.50 | 0.195 | 0.217 |
| c | 0.46 | 0.58 | 0.018 | 0.023 |
| c2 | 0.46 | 0.89 | 0.018 | 0.035 |
| D | 5.97 | 6.22 | 0.235 | 0.245 |
| D1 | 5.04 | 5.44 | 0.198 | 0.214 |
| E | 6.35 | 6.73 | 0.250 | 0.265 |
| E1 | 4.90 | 5.10 | 0.193 | 0.201 |
| e | 2.29 | | 0.090 | |
| e1 | 4.57 | | 0.180 | |
| N | 3 | | 3 | |
| L | 3.30 | 3.50 | 0.130 | 0.138 |
| L1 | 0.90 | 1.10 | 0.035 | 0.043 |
| L2 | 0.90 | 1.10 | 0.035 | 0.043 |

DOCUMENT NO.
Z8B00003329

SCALE

EUROPEAN PROJECTION

ISSUE DATE
05-07-2012

REVISION
04

Figure 1 Outline PG-TO 251, dimensions in mm/inches

8 Appendix A

Table 11 Related Links

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

Revision History

IPS65R1K5CE

Revision: 2014-09-25, Rev. 2.0

Previous Revision

| Revision | Date | Subjects (major changes since last revision) |
|----------|------------|--|
| 2.0 | 2014-09-25 | Release of final version |

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Published by

Infineon Technologies AG

81726 München, Germany

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