# MOSFET

Metal Oxide Semiconductor Field Effect Transistor

# CoolMOS™ C7

650V CoolMOS™ C7 Power Transistor
IPB65R045C7

## Data Sheet

Rev. 2.1
Final

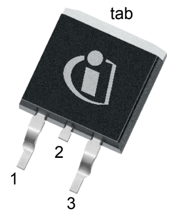
Power Management & Multimarket

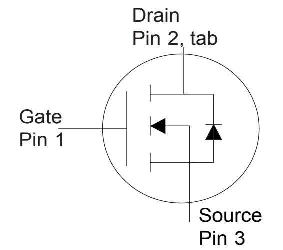
# 1 Description

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.

D²PAK




## Features

- Increased MOSFET dv/dt ruggedness
- Better efficiency due to best in class FOM $R_{DS(on)}*E_{oss}$ and $R_{DS(on)}*Q_g$
- Best in class $R_{DS(on)}$ /package
- Easy to use/drive
- Pb-free plating, halogen free mold compound
- Qualified for industrial grade applications according to JEDEC (J-STD20 and JESD22)

## Benefits

- Enabling higher system efficiency
- 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 |
| $R_{DS(on),max}$ | 45 | mΩ |
| $Q_{g.typ}$ | 93 | nC |
| $I_{D,pulse}$ | 212 | A |
| $E_{oss}$@400V | 11.7 | µJ |
| Body diode di/dt | 60 | A/µs |

| Type / Ordering Code | Package | Marking | Related Links |
|---|---|---|---|
| IPB65R045C7 | PG-TO 263 | 65C7045 | see Appendix A |

## Table of Contents

## 2 Maximum ratings

at $T_j$ = 25°C, unless otherwise specified

### Table 2 Maximum ratings

| Parameter | Symbol | Values | | | Unit | Note / Test Condition |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| Continuous drain current [1] | $I_D$ | -<br>- | -<br>- | 46<br>29 | A | $T_C$=25°C<br>$T_C$=100°C |
| Pulsed drain current [2] | $I_{D,pulse}$ | - | - | 212 | A | $T_C$=25°C |
| Avalanche energy, single pulse | $E_{AS}$ | - | - | 249 | mJ | $I_D$=12A; $V_{DD}$=50V |
| Avalanche energy, repetitive | $E_{AR}$ | - | - | 1.25 | mJ | $I_D$=12A; $V_{DD}$=50V |
| Avalanche current, single pulse | $I_{AS}$ | - | - | 12.0 | A | - |
| MOSFET dv/dt ruggedness | dv/dt | - | - | 100 | V/ns | $V_{DS}$=0...400V |
| Gate source voltage (static) | $V_{GS}$ | -20 | - | 20 | V | static; |
| Gate source voltage (dynamic) | $V_{GS}$ | -30 | - | 30 | V | AC (f>1 Hz) |
| Power dissipation | $P_{tot}$ | - | - | 227 | W | $T_C$=25°C |
| Storage temperature | $T_{stg}$ | -55 | - | 150 | °C | - |
| Operating junction temperature | $T_j$ | -55 | - | 150 | °C | - |
| Mounting torque | - | - | - | - | Ncm | - |
| Continuous diode forward current | $I_S$ | - | - | 46 | A | $T_C$=25°C |
| Diode pulse current [2] | $I_{S,pulse}$ | - | - | 212 | A | $T_C$=25°C |
| Reverse diode dv/dt [3] | dv/dt | - | - | 1.5 | V/ns | $V_{DS}$=0...400V, $I_{SD}$<=$I_S$, $T_j$=25°C |
| Maximum diode commutation speed | $di_f/dt$ | - | - | 60 | A/µs | $V_{DS}$=0...400V, $I_{SD}$<=$I_S$, $T_j$=25°C |
| Insulation withstand voltage | $V_{ISO}$ | - | - | n.a. | V | $V_{rms}$, $T_C$=25°C, $t$=1min |

[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 | $R_{thJC}$ | - | - | 0.55 | °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 6cm² (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 MSL1 |

# 4 Electrical characteristics

at $T_j$=25°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 | 3.5 | 4 | V | $V_{DS}$=$V_{GS}$, $I_D$=1.25mA |
| Zero gate voltage drain current | $I_{DSS}$ | -<br>- | -<br>20 | 2<br>- | µA | $V_{DS}$=650, $V_{GS}$=0V, $T_j$=25°C<br>$V_{DS}$=650, $V_{GS}$=0V, $T_j$=150°C |
| Gate-source leakage current | $I_{GSS}$ | - | - | 100 | nA | $V_{GS}$=20V, $V_{DS}$=0V |
| Drain-source on-state resistance | $R_{DS(on)}$ | -<br>- | 0.040<br>0.096 | 0.045<br>- | Ω | $V_{GS}$=10V, $I_D$=24.9A, $T_j$=25°C<br>$V_{GS}$=10V, $I_D$=24.9A, $T_j$=150°C |
| Gate resistance | $R_G$ | - | 0.85 | - | Ω | $f$=1MHz, open drain |

## Table 5 Dynamic characteristics

| Parameter | Symbol | Values | | | Unit | Note / Test Condition |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| Input capacitance | $C_{iss}$ | - | 4340 | - | pF | $V_{GS}$=0V, $V_{DS}$=400V, $f$=250kHz |
| Output capacitance | $C_{oss}$ | - | 70 | - | pF | $V_{GS}$=0V, $V_{DS}$=400V, $f$=250kHz |
| Effective output capacitance, energy related [1] | $C_{o(er)}$ | - | 146 | - | pF | $V_{GS}$=0V, $V_{DS}$=0...400V |
| Effective output capacitance, time related [2] | $C_{o(tr)}$ | - | 1630 | - | pF | $I_D$=constant, $V_{GS}$=0V, $V_{DS}$=0...400V |
| Turn-on delay time | $t_{d(on)}$ | - | 20 | - | ns | $V_{DD}$=400V, $V_{GS}$=13V, $I_D$=24.9A, $R_G$=3.3Ω |
| Rise time | $t_r$ | - | 14 | - | ns | $V_{DD}$=400V, $V_{GS}$=13V, $I_D$=24.9A, $R_G$=3.3Ω |
| Turn-off delay time | $t_{d(off)}$ | - | 82 | - | ns | $V_{DD}$=400V, $V_{GS}$=13V, $I_D$=24.9A, $R_G$=3.3Ω |
| Fall time | $t_f$ | - | 7 | - | ns | $V_{DD}$=400V, $V_{GS}$=13 V, $I_D$=24.9A, $R_G$=3.3Ω |

## Table 6 Gate charge characteristics

| Parameter | Symbol | Values | | | Unit | Note / Test Condition |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| Gate to source charge | $Q_{gs}$ | - | 23 | - | nC | $V_{DD}$=400V, $I_D$=24.9A, $V_{GS}$=0 to 10V |
| Gate to drain charge | $Q_{gd}$ | - | 30 | - | nC | $V_{DD}$=400V, $I_D$=24.9A, $V_{GS}$=0 to 10V |
| Gate charge total | $Q_g$ | - | 93 | - | nC | $V_{DD}$=400V, $I_D$=24.9A, $V_{GS}$=0 to 10V |
| Gate plateau voltage | $V_{plateau}$ | - | 5.4 | - | V | $V_{DD}$=400V, $I_D$=24.9A, $V_{GS}$=0 to 10V |

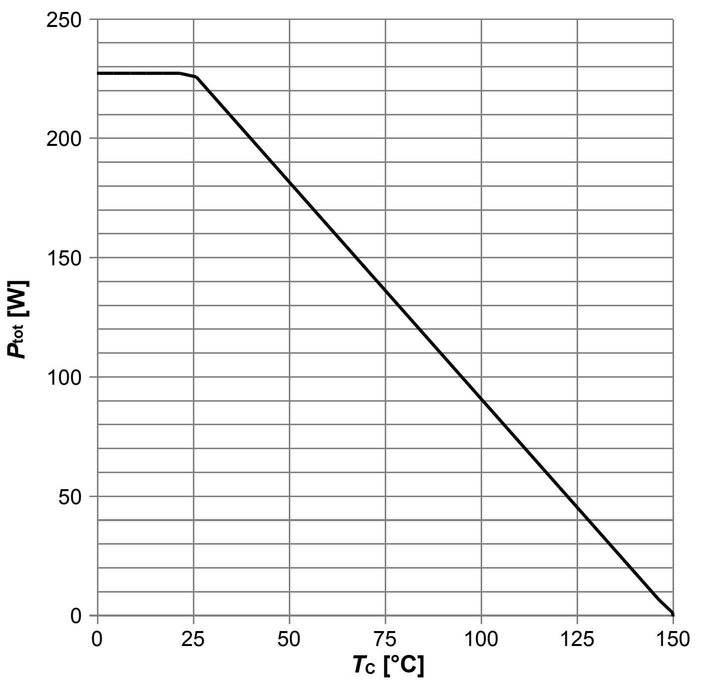
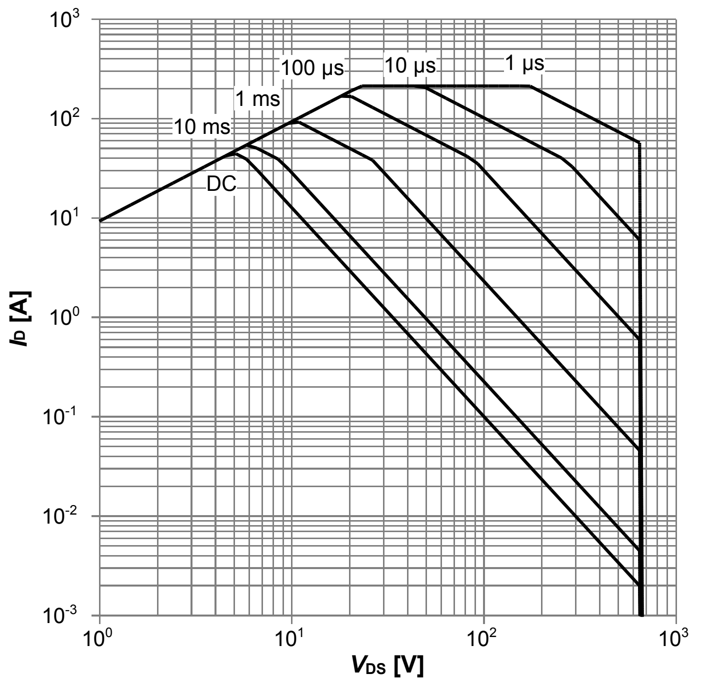
[1] $C_{o(er)}$ is a fixed capacitance that gives the same stored energy as $C_{oss}$ while $V_{DS}$ is rising from 0 to 400V
[2] $C_{o(tr)}$ is a fixed capacitance that gives the same charging time as $C_{oss}$ while $V_{DS}$ is rising from 0 to 400V

### Table 7 Reverse diode characteristics

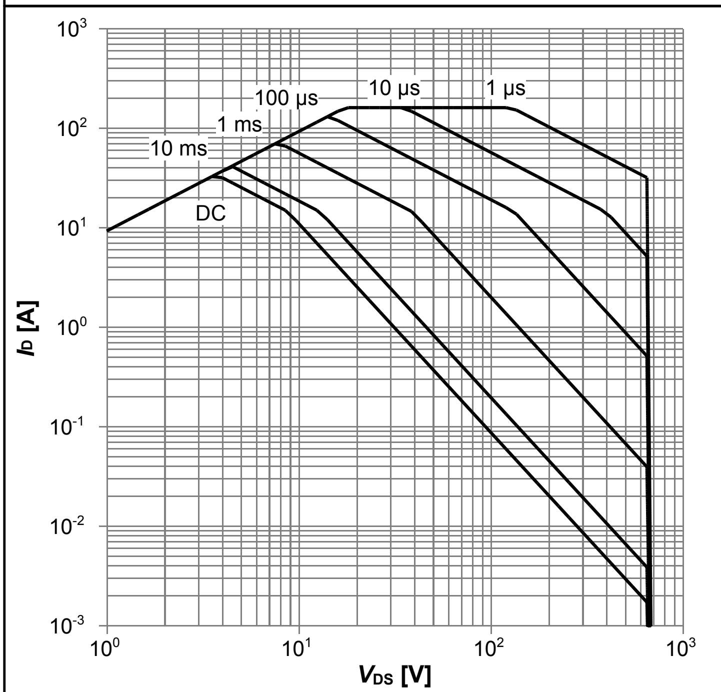
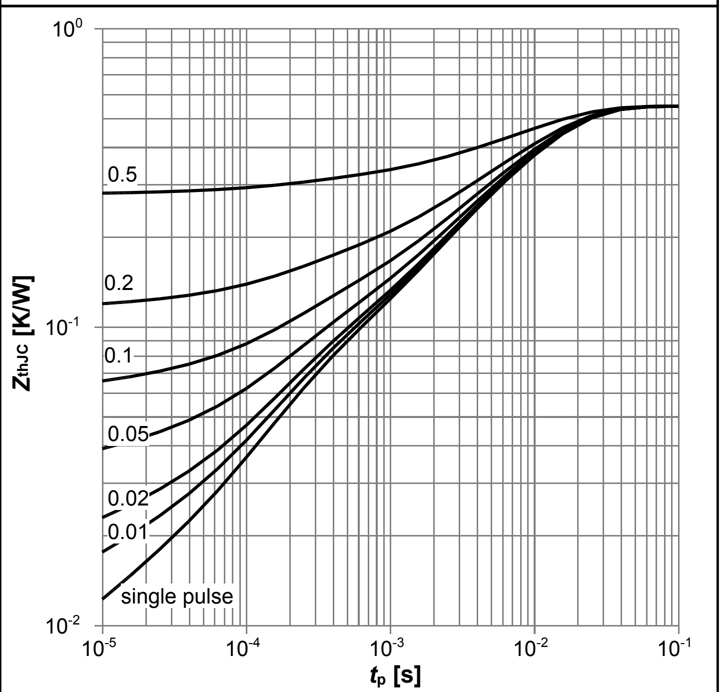
| Parameter | Symbol | Values | | | Unit | Note / Test Condition |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| Diode forward voltage | $V_{SD}$ | - | 0.9 | - | V | $V_{GS}$=0V, $I_F$=24.9A, $T_j$=25°C |
| Reverse recovery time | $t_{rr}$ | - | 725 | - | ns | $V_R$=400V, $I_F$=46A, $di_F/dt$=60A/µs |
| Reverse recovery charge | $Q_{rr}$ | - | 13 | - | µC | $V_R$=400V, $I_F$=46A, $di_F/dt$=60A/µs |
| Peak reverse recovery current | $I_{rrm}$ | - | 36 | - | A | $V_R$=400V, $I_F$=46A, $di_F/dt$=60A/µs |

# 5 Electrical characteristics diagrams

## Table 8

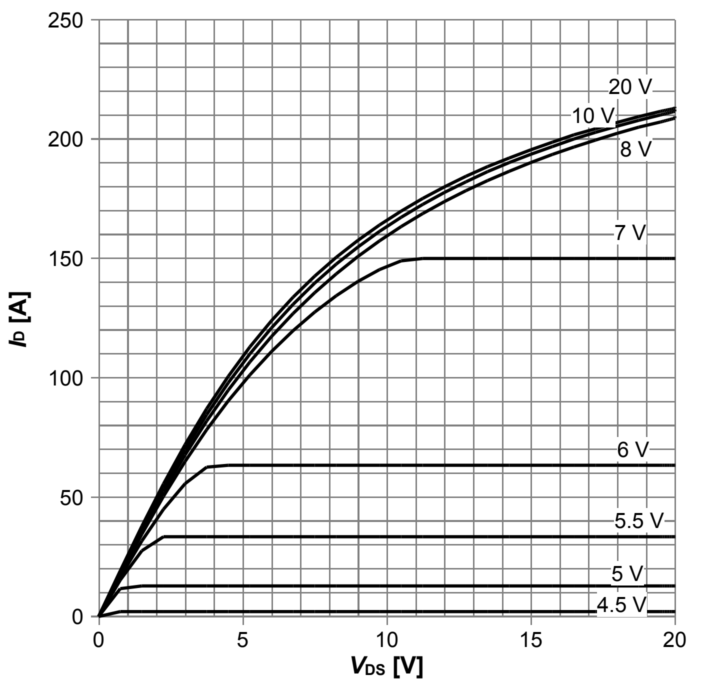
<table>
<tr><th>Diagram 1: Power dissipation</th><th>Diagram 2: Safe operating area</th></tr>
<tr><td>
</td><td>
</td></tr>
<tr><td>$P_{tot}$=f($T_C$)</td><td>$I_D$=f($V_{DS}$); $T_C$=25 °C; $D$=0; parameter: $t_p$</td></tr>
</table>

## Table 9

<table>
<tr><th>Diagram 3: Safe operating area</th><th>Diagram 4: Max. transient thermal impedance</th></tr>
<tr><td>
</td><td>
</td></tr>
<tr><td>$I_D$=f($V_{DS}$); $T_C$=80 °C; $D$=0; parameter: $t_p$</td><td>$Z_{thJC}$ =f($t_P$); parameter: $D$=$t_p$/$T$</td></tr>
</table>

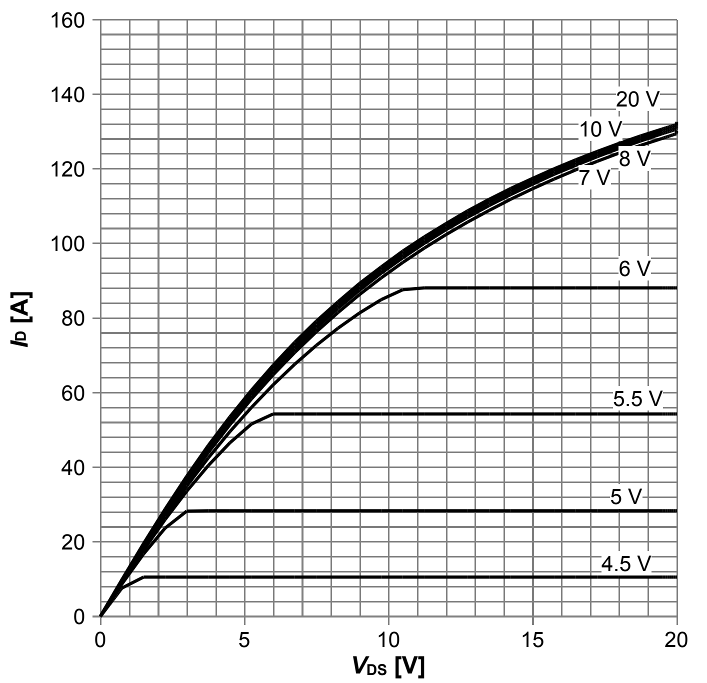
## Table 10

**Diagram 5: Typ. output characteristics**




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

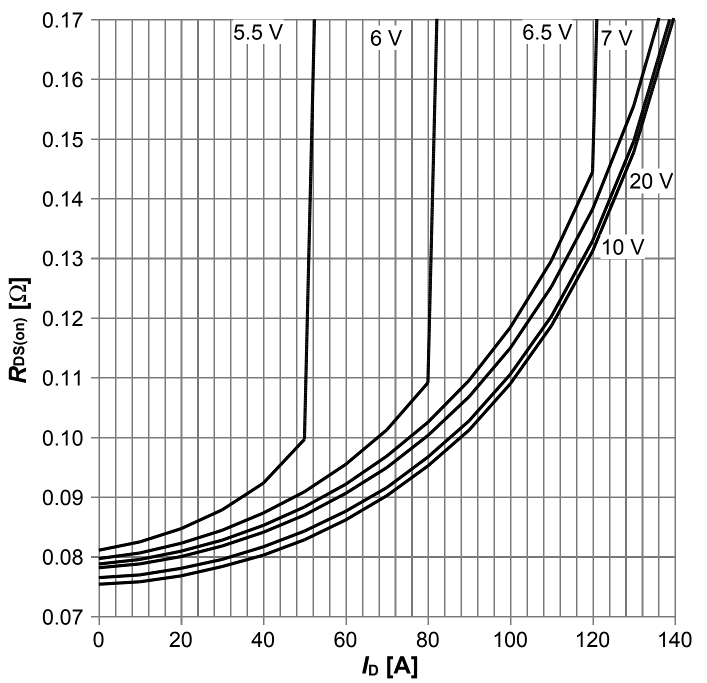
**Diagram 6: Typ. output characteristics**




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

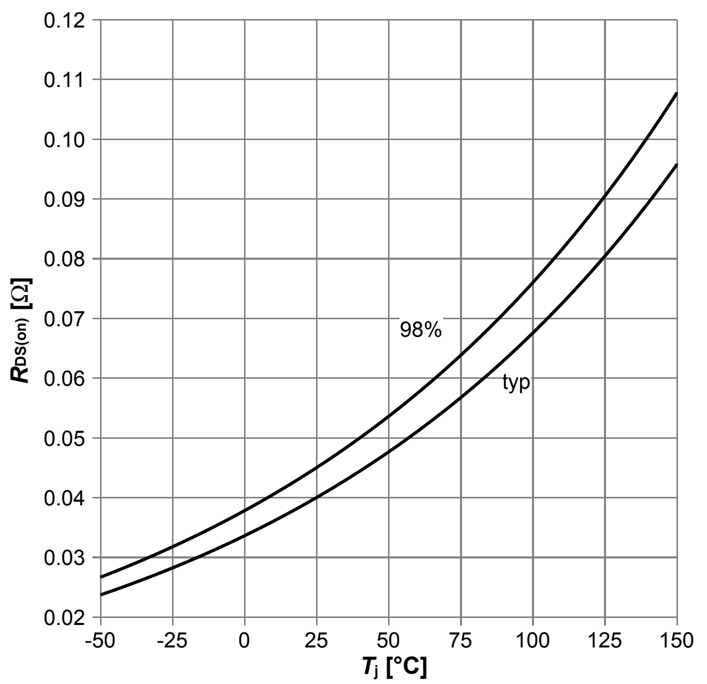
## Table 11

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



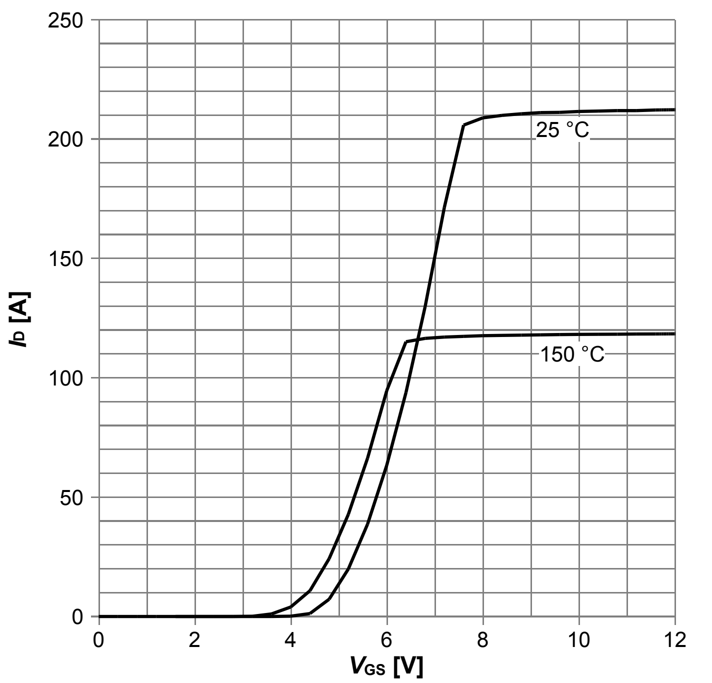
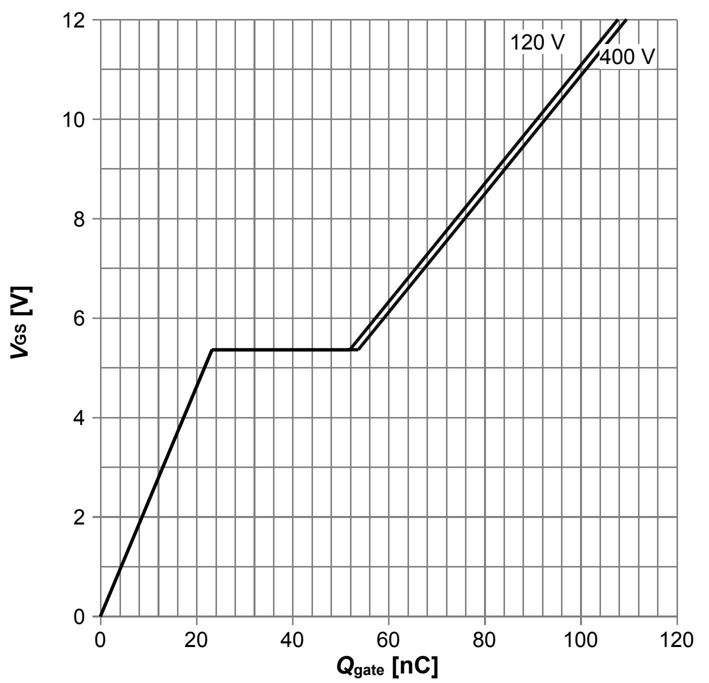

$R_{DS(on)}$=f($I_D$); $T_j$=125 °C; parameter: $V_{GS}$

**Diagram 8: Drain-source on-state resistance**




$R_{DS(on)}$=f($T_j$); $I_D$=24.9 A; $V_{GS}$=10 V

## Table 12

| Diagram 9: Typ. transfer characteristics | Diagram 10: Typ. gate charge |
|---|---|
|  |  |
| $I_D$=f($V_{GS}$); $V_{DS}$=20V; parameter: $T_j$ | $V_{GS}$=f($Q_{gate}$); $I_D$=24.9 A pulsed; parameter: $V_{DD}$ |

## Table 13

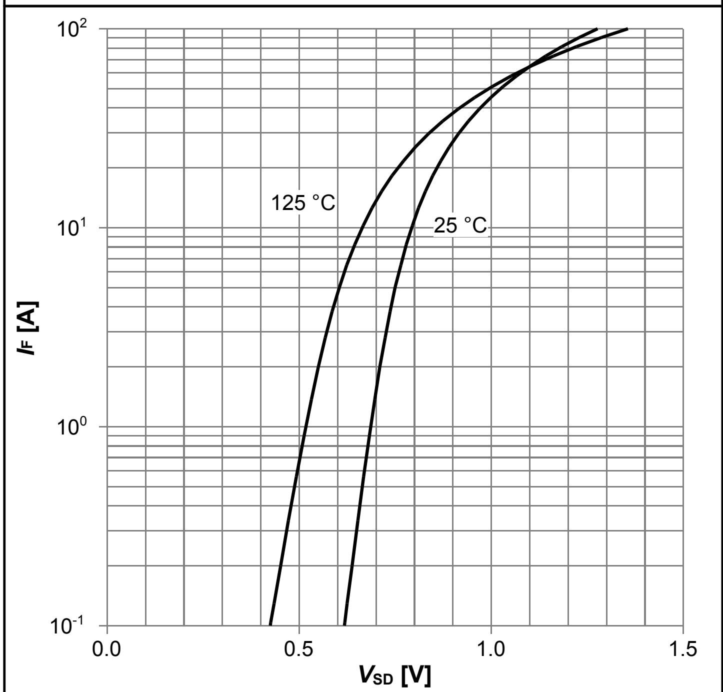
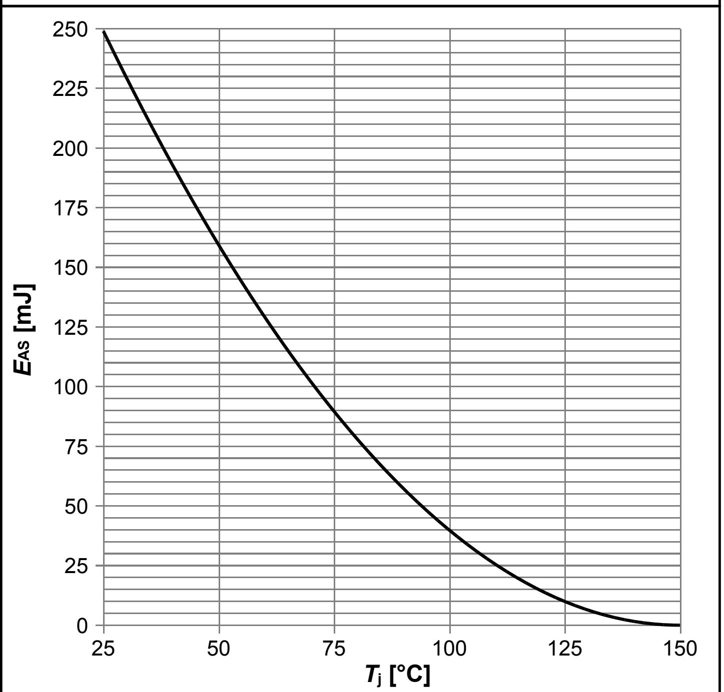
| Diagram 11: Forward characteristics of reverse diode | Diagram 12: Avalanche energy |
|---|---|
|  |  |
| $I_F$=f($V_{SD}$); parameter: $T_j$ | $E_{AS}$=f($T_j$); $I_D$=12 A; $V_{DD}$=50 V |

**Table 14**

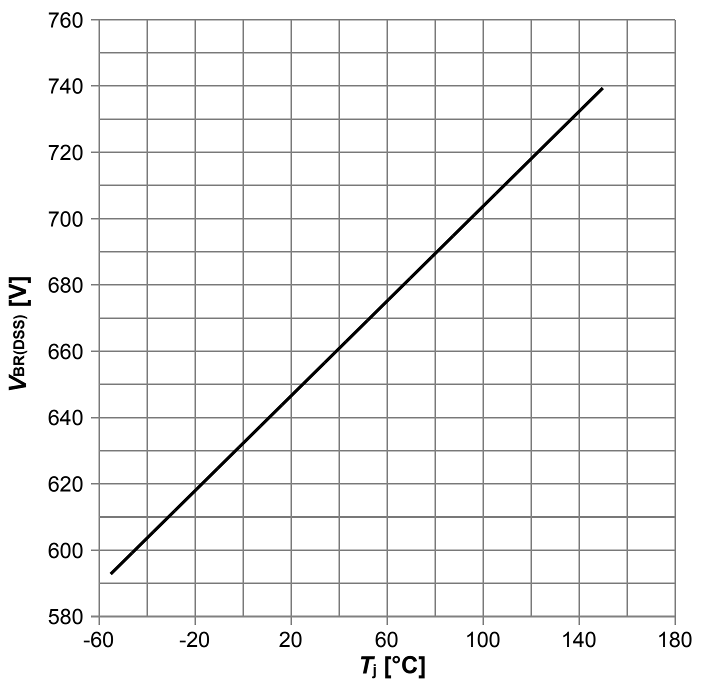
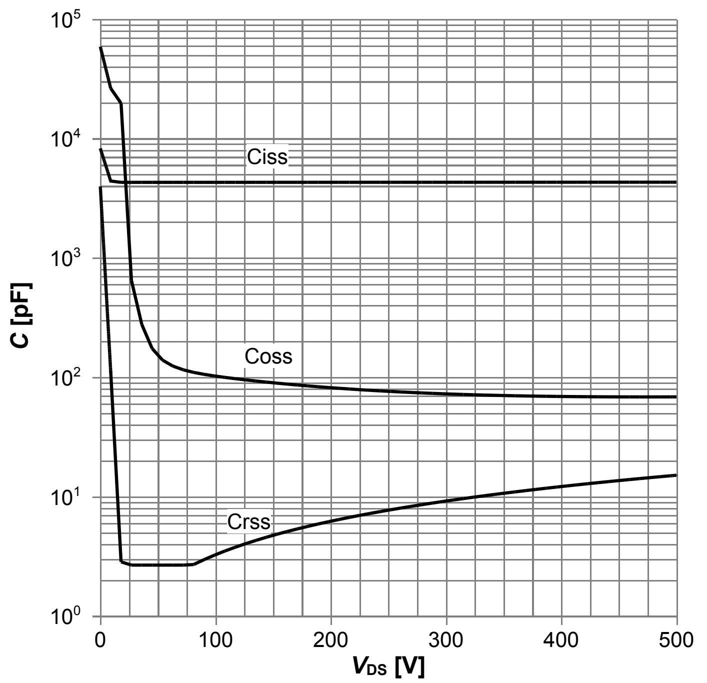
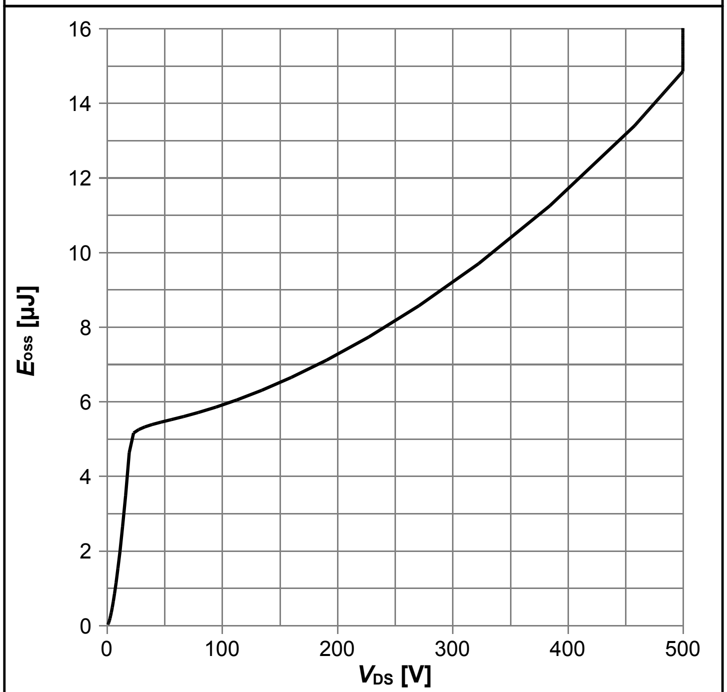
| Diagram 13: Drain-source breakdown voltage | Diagram 14: Typ. capacitances |
|---|---|
|  |  |
| $V_{BR(DSS)}$=f($T_j$); $I_D$=1 mA | $C$=f($V_{DS}$); $V_{GS}$=0 V; $f$=250 kHz |

**Table 15**

| Diagram 15: Typ. Coss stored energy |
|---|
|  |
| $E_{oss}$=f($V_{DS}$) |

# 6 Test Circuits

**Table 16 Diode characteristics**

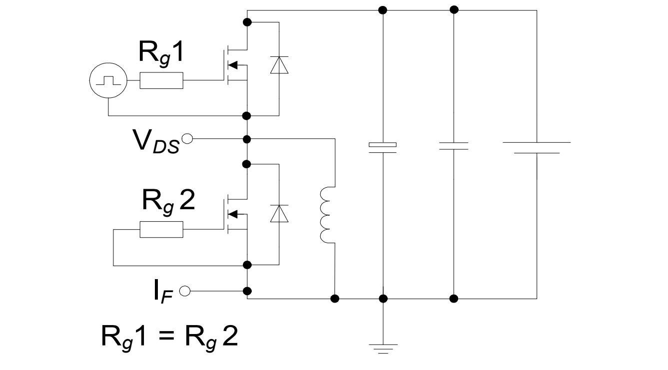
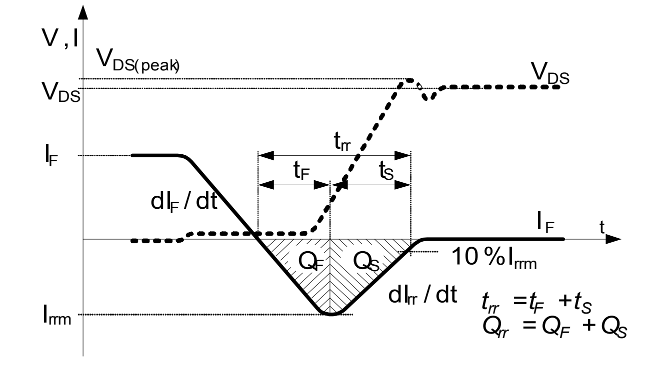
| Test circuit for diode characteristics | Diode recovery waveform |
|---|---|
|  |  |

**Table 17 Switching times**

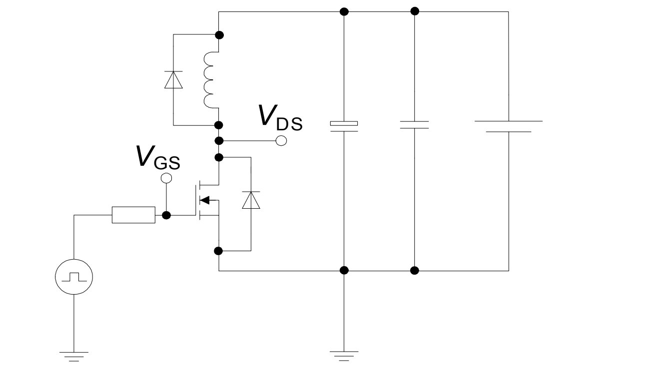
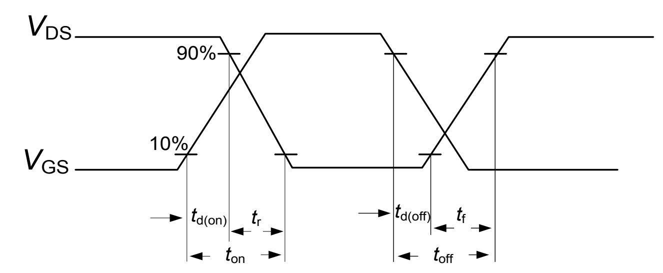
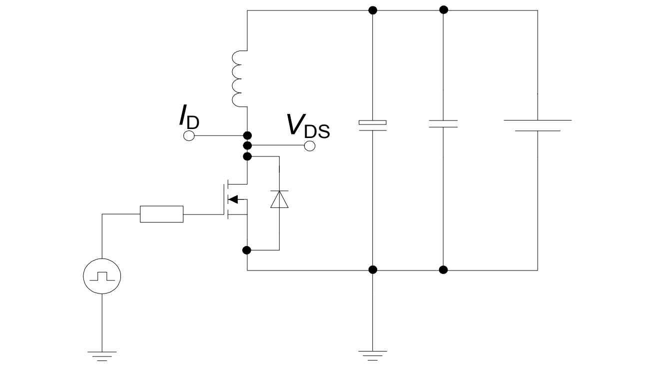
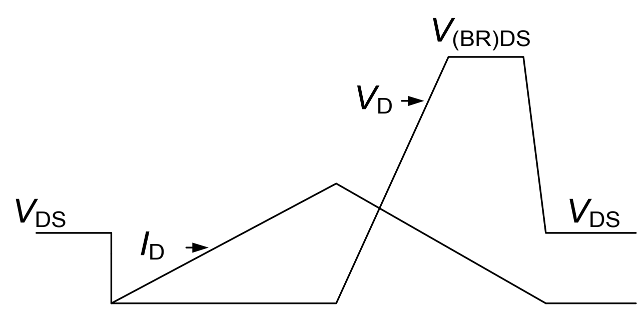
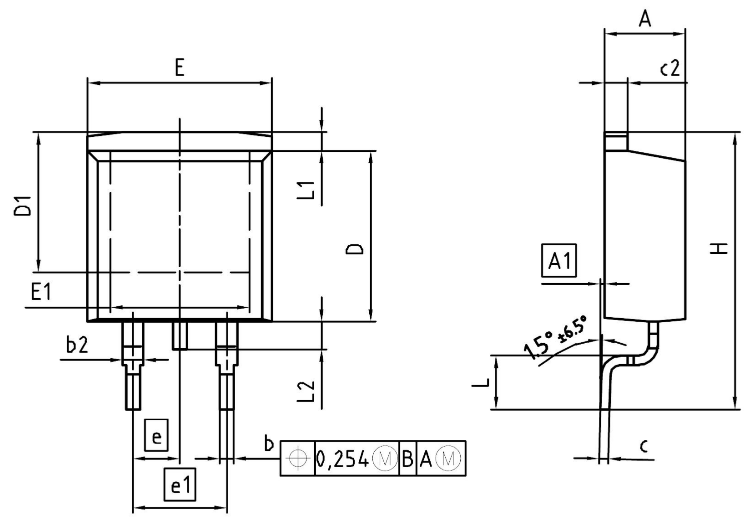
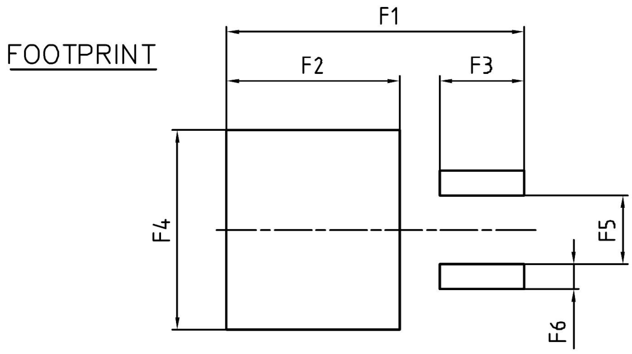
| Switching times test circuit for inductive load | Switching times waveform |
|---|---|
|  |  |

**Table 18 Unclamped inductive load**

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

# 7 Package Outlines




| DIM | MILLIMETERS | | INCHES | |
|---|---|---|---|---|
| | MIN | MAX | MIN | MAX |
| A | 4.30 | 4.57 | 0.169 | 0.180 |
| A1 | 0.00 | 0.25 | 0.000 | 0.010 |
| b | 0.65 | 0.85 | 0.026 | 0.033 |
| b2 | 0.95 | 1.15 | 0.037 | 0.045 |
| c | 0.33 | 0.65 | 0.013 | 0.026 |
| c2 | 1.17 | 1.40 | 0.046 | 0.055 |
| D | 8.51 | 9.45 | 0.335 | 0.372 |
| D1 | 7.10 | 7.90 | 0.280 | 0.311 |
| E | 9.80 | 10.31 | 0.386 | 0.406 |
| E1 | 6.50 | 8.60 | 0.256 | 0.339 |
| e | 2.54 | | 0.100 | |
| e1 | 5.08 | | 0.200 | |
| N | 2 | | 2 | |
| H | 14.61 | 15.88 | 0.575 | 0.625 |
| L | 2.29 | 3.00 | 0.090 | 0.118 |
| L1 | 0.70 | 1.60 | 0.028 | 0.063 |
| L2 | 1.00 | 1.78 | 0.039 | 0.070 |
| F1 | 16.05 | 16.25 | 0.632 | 0.640 |
| F2 | 9.30 | 9.50 | 0.366 | 0.374 |
| F3 | 4.50 | 4.70 | 0.177 | 0.185 |
| F4 | 10.70 | 10.90 | 0.421 | 0.429 |
| F5 | 3.65 | 3.85 | 0.144 | 0.152 |
| F6 | 1.25 | 1.45 | 0.049 | 0.057 |

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Z8B00003324

SCALE 0 5 7.5mm

EUROPEAN PROJECTION

ISSUE DATE
30-08-2007

REVISION
01

**Figure 1 Outline PG-TO 263, dimensions in mm/inches**

# 8 Appendix A

**Table 19 Related Links**

- **IFX CoolMOS$^{TM}$ C7 Webpage:** www.infineon.com
- **IFX CoolMOS$^{TM}$ C7 application note:** www.infineon.com
- **IFX CoolMOS$^{TM}$ C7 simulation model:** www.infineon.com
- **IFX Design tools:** www.infineon.com

## Revision History

IPB65R045C7

**Revision: 2013-04-30, Rev. 2.1**

Previous Revision

| Revision | Date | Subjects (major changes since last revision) |
|---|---|---|
| 2.0 | 2013-04-18 | Release of final version |
| 2.1 | 2013-04-30 | Body diode di/dt update |

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