

# MOSFET

Metal Oxide Semiconductor Field Effect Transistor

## CoolMOS™ C6 600V

600V CoolMOS™ C6 Power Transistor  
IPU60R950C6

## Data Sheet

Rev. 2.1  
Final

Industrial & Multimarket

## 1 Description

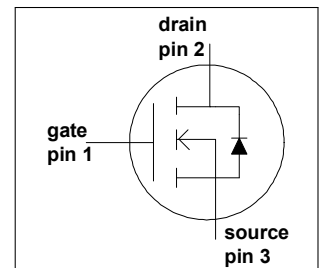
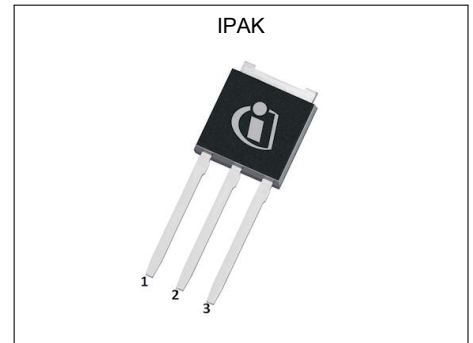
CoolMOS™ is a revolutionary technology for high voltage power MOSFETs, designed according to the superjunction (SJ) principle and pioneered by Infineon Technologies. CoolMOS™ C6 series combines the experience of the leading SJ MOSFET supplier with high class innovation. The resulting devices provide 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
- 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, UPS.



**Table 1 Key Performance Parameters**

| Parameter             | Value | Unit       |
|-----------------------|-------|------------|
| $V_{DS} @ T_{j \max}$ | 650   | V          |
| $R_{DS(on),max}$      | 0.95  | $\Omega$   |
| $Q_g, typ$            | 13    | nC         |
| $I_D, pulse$          | 12    | A          |
| $E_{oss} @ 400V$      | 1.3   | $\mu J$    |
| Body diode $di/dt$    | 500   | A/ $\mu s$ |

| Type / Ordering Code | Package   | Marking | Related Links  |
|----------------------|-----------|---------|----------------|
| IPU60R950C6          | PG-TO 251 | 6R950C6 | see Appendix A |

## Table of Contents

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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> | $I_D$               |        |      | 4.4  | A                | $T_C = 25^\circ\text{C}$                                                                           |
|                                        |                     |        |      | 2.8  |                  | $T_C = 100^\circ\text{C}$                                                                          |
| Pulsed drain current <sup>2)</sup>     | $I_{D,pulse}$       |        |      | 12   | A                | $T_C = 25^\circ\text{C}$                                                                           |
| Avalanche energy, single pulse         | $E_{AS}$            |        |      | 46   | mJ               | $I_D = 0.8\text{A}$ , $V_{DD} = 50\text{V}$<br>(see table 18)                                      |
| Avalanche energy, repetitive           | $E_{AR}$            |        |      | 0.13 | mJ               | $I_D = 0.8\text{A}$ , $V_{DD} = 50\text{V}$                                                        |
| Avalanche current, repetitive          | $I_{AR}$            |        |      | 0.8  | A                |                                                                                                    |
| MOSFET dv/dt ruggedness                | dv/dt               |        |      | 50   | V/ns             | $V_{DS} = 0 \dots 480\text{V}$                                                                     |
| Gate source voltage                    | $V_{GS}$            | -20    |      | 20   | V                | static                                                                                             |
|                                        |                     | -30    |      | 30   |                  | AC ( $f > 1\text{ Hz}$ )                                                                           |
| Operating and storage temperature      | $T_j, T_{stg}$      | -55    |      | 150  | $^\circ\text{C}$ |                                                                                                    |
| Continuous diode forward current       | $I_S$               |        |      | 3.9  | A                | $T_C = 25^\circ\text{C}$                                                                           |
| Diode pulse current                    | $I_{S,pulse}$       |        |      | 12   | A                | $T_C = 25^\circ\text{C}$                                                                           |
| Reverse diode dv/dt <sup>3)</sup>      | dv/dt               |        |      | 15   | V/ns             | $V_{DS} = 0 \dots 480\text{V}$ , $I_{SD} \leq I_D$ ,<br>$T_j = 25^\circ\text{C}$<br>(see table 16) |
| Maximum diode commutation speed        | di <sub>f</sub> /dt |        |      | 500  | A/ $\mu\text{s}$ |                                                                                                    |
| Power dissipation                      | $P_{tot}$           |        |      | 37   | W                | $T_C = 25^\circ\text{C}$                                                                           |

<sup>1)</sup> Limited by  $T_{j\text{ max}}$ . Maximum duty cycle  $D=0.75$

<sup>2)</sup> Pulse width  $t_p$  limited by  $T_{j\text{ max}}$

<sup>3)</sup> Identical low side and high side switch with identical  $R_G$

### 3 Thermal characteristics

**Table 3 Thermal characteristics IPAK**

| Parameter                                              | Symbol     | Values |      |      | Unit | Note / Test Condition                                     |
|--------------------------------------------------------|------------|--------|------|------|------|-----------------------------------------------------------|
|                                                        |            | Min.   | Typ. | Max. |      |                                                           |
| Thermal resistance, junction - case                    | $R_{thJC}$ |        |      | 3.41 | °C/W |                                                           |
| Thermal resistance, junction - ambient <sup>1)</sup>   | $R_{thJA}$ |        |      | 62   | °C/W | SMD version, device on PCB, minimal footprint             |
|                                                        |            |        | 35   |      |      | SMD version, device on PCB, 6cm <sup>2</sup> cooling area |
| Soldering temperature, wave- & reflowsoldering allowed | $T_{sld}$  |        |      | 260  | °C   | reflow MSL                                                |

<sup>1)</sup> Device on 40mm\*40mm\*1.5mm one layer epoxy PCB FR4 with 6cm<sup>2</sup> copper area (thickness 70µm) for drain connection. PCB is vertical without air stream cooling.

## 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   | $V_{(BR)DSS}$ | 600    |       |      | V        | $V_{GS} = 0V$ , $I_D = 0.25mA$                              |
| Gate threshold voltage           | $V_{GS(th)}$  | 2.5    | 3     | 3.5  | V        | $V_{DS} = V_{GS}$ , $I_D = 0.13mA$                          |
| Zero gate voltage drain current  | $I_{DSS}$     |        |       | 1    | $\mu A$  | $V_{DS} = 600V$ , $V_{GS} = 0V$ , $T_j = 25^\circ\text{C}$  |
|                                  |               |        | 10    |      |          | $V_{DS} = 600V$ , $V_{GS} = 0V$ , $T_j = 150^\circ\text{C}$ |
| Gate-source leakage current      | $I_{GSS}$     |        |       | 100  | nA       | $V_{GS} = 20V$ , $V_{DS} = 0V$                              |
| Drain-source on-state resistance | $R_{DS(on)}$  |        | 0.860 | 0.95 | $\Omega$ | $V_{GS} = 10V$ , $I_D = 1.5A$ , $T_j = 25^\circ\text{C}$    |
|                                  |               |        | 2.220 |      |          | $V_{GS} = 10V$ , $I_D = 1.5A$ , $T_j = 150^\circ\text{C}$   |
| Gate resistance                  | $R_G$         |        | 16    |      | $\Omega$ | $f = 1MHz$ , open drain                                     |

**Table 5 Dynamic characteristics**

| Parameter                                                  | Symbol       | Values |      |      | Unit | Note / Test Condition                                                               |
|------------------------------------------------------------|--------------|--------|------|------|------|-------------------------------------------------------------------------------------|
|                                                            |              | Min.   | Typ. | Max. |      |                                                                                     |
| Input capacitance                                          | $C_{iss}$    |        | 280  |      | pF   | $V_{GS} = 0V$ , $V_{DS} = 100V$ , $f = 1MHz$                                        |
| Output capacitance                                         | $C_{oss}$    |        | 21   |      | pF   |                                                                                     |
| Effective output capacitance, energy related <sup>1)</sup> | $C_{o(er)}$  |        | 14   |      | pF   | $V_{GS} = 0V$ , $V_{DS} = 0 \dots 480V$                                             |
| Effective output capacitance, time related <sup>2)</sup>   | $C_{o(tr)}$  |        | 57   |      | pF   | $I_D = \text{constant}$ , $V_{GS} = 0V$ , $V_{DS} = 0 \dots 480V$                   |
| Turn-on delay time                                         | $t_{d(on)}$  |        | 10   |      | ns   | $V_{DD} = 480V$ , $V_{GS} = 10V$ , $I_D = 1.9A$ , $R_G = 12.2\Omega$ (see table 17) |
| Rise time                                                  | $t_r$        |        | 8    |      | ns   |                                                                                     |
| Turn-off delay time                                        | $t_{d(off)}$ |        | 60   |      | ns   |                                                                                     |
| Fall time                                                  | $t_f$        |        | 13   |      | ns   |                                                                                     |

**Table 6 Gate charge characteristics**

| Parameter             | Symbol        | Values |      |      | Unit | Note / Test Condition                                         |
|-----------------------|---------------|--------|------|------|------|---------------------------------------------------------------|
|                       |               | Min.   | Typ. | Max. |      |                                                               |
| Gate to source charge | $Q_{gs}$      |        | 1.5  |      | nC   | $V_{DD} = 480V$ , $I_D = 1.9A$ , $V_{GS} = 0 \text{ to } 10V$ |
| Gate to drain charge  | $Q_{gd}$      |        | 6.5  |      | nC   |                                                               |
| Gate charge total     | $Q_g$         |        | 13   |      | nC   |                                                               |
| Gate plateau voltage  | $V_{plateau}$ |        | 5.4  |      | V    |                                                               |

<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       | $V_{GS} = 0V, I_F = 1.9A, T_j = 25^\circ C$                           |
| Reverse recovery time         | $t_{rr}$  |        | 220  |      | ns      | $V_R = 400V, I_F = 1.9A,$<br>$di_F/dt = 100A/\mu s$<br>(see table 16) |
| Reverse recovery charge       | $Q_{rr}$  |        | 1.5  |      | $\mu C$ |                                                                       |
| Peak reverse recovery current | $I_{rrm}$ |        | 12   |      | A       |                                                                       |

## 5 Electrical characteristics diagrams

Table 8

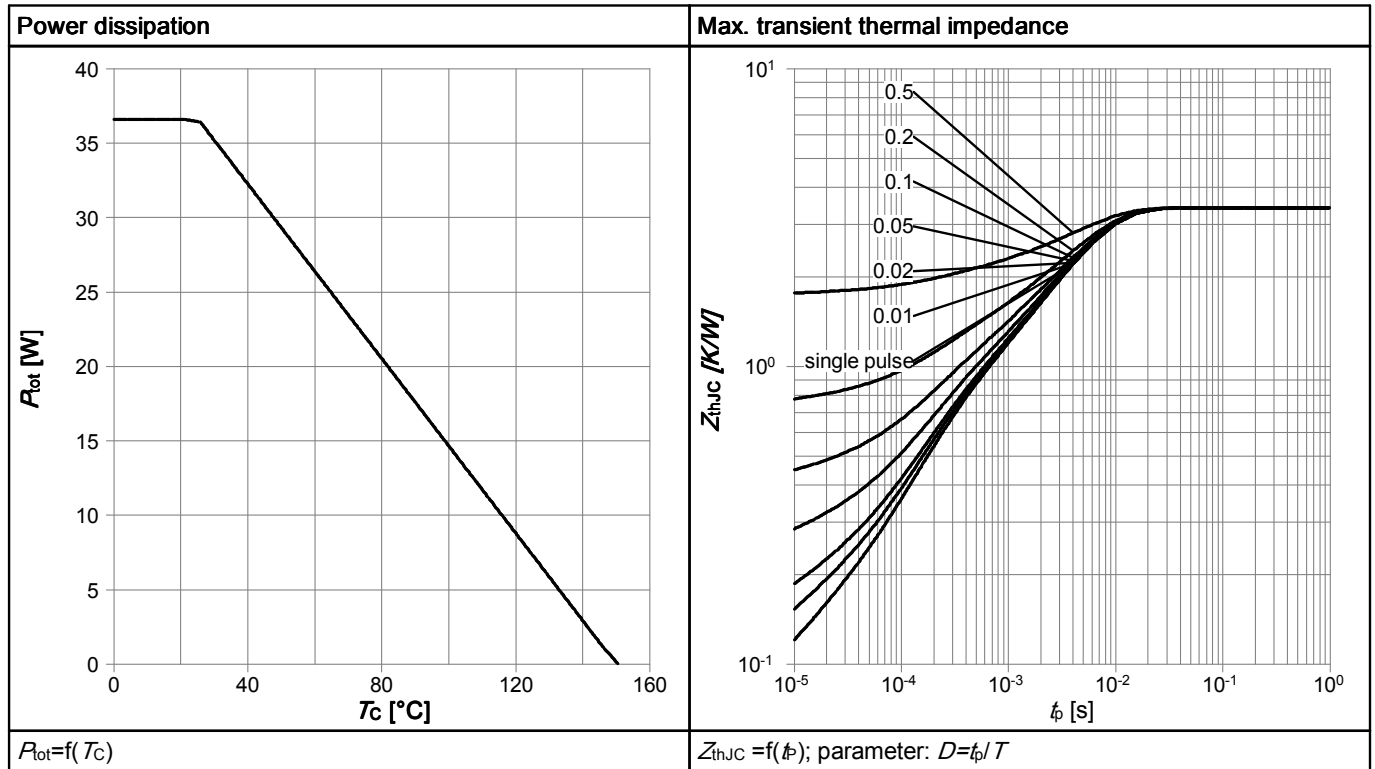


Table 9

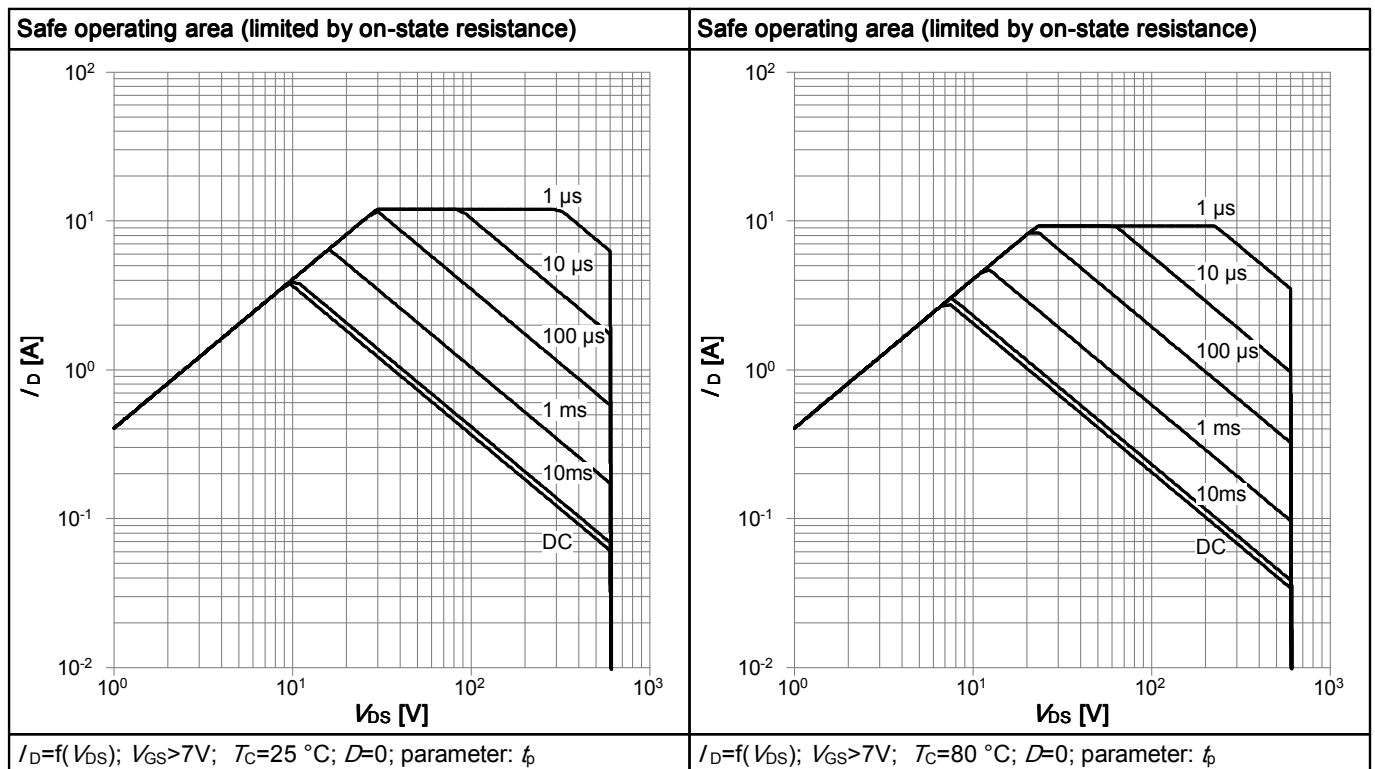


Table 10

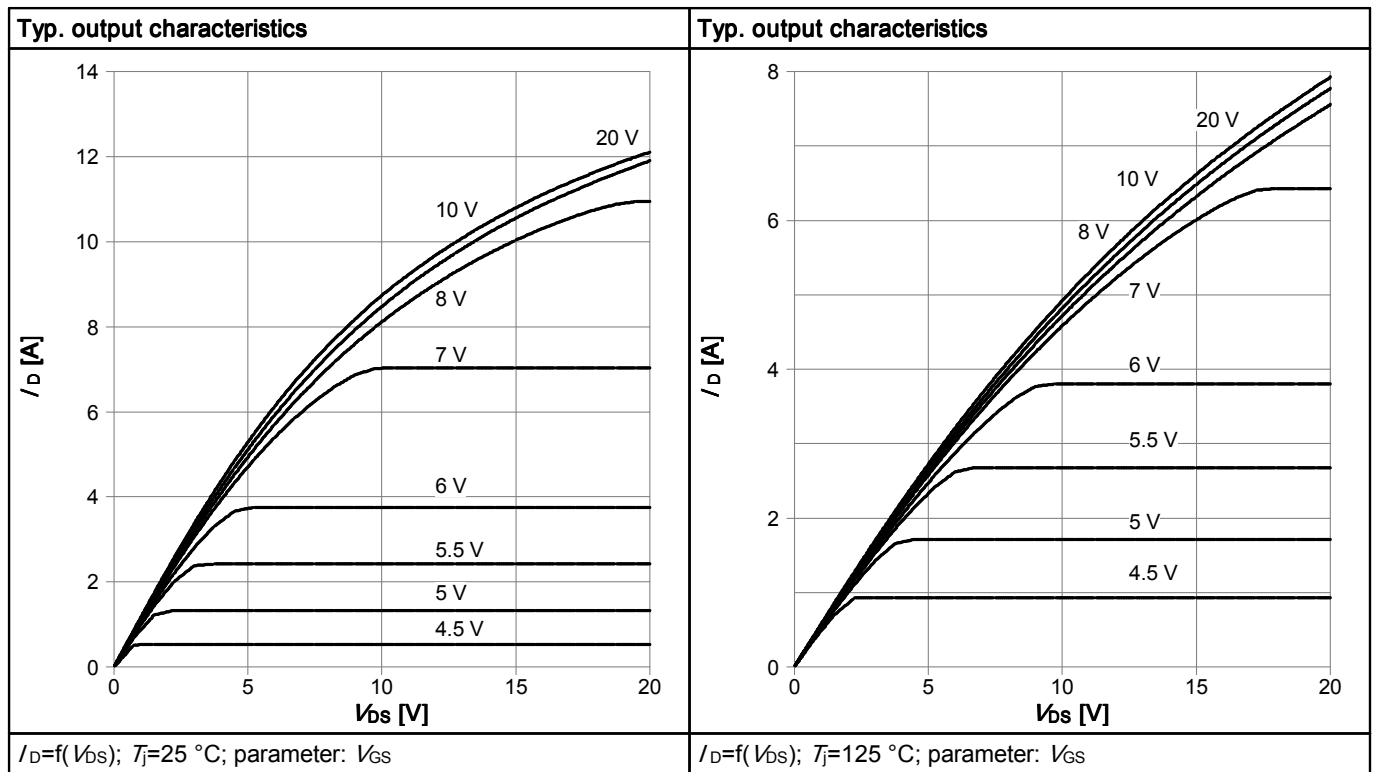


Table 11

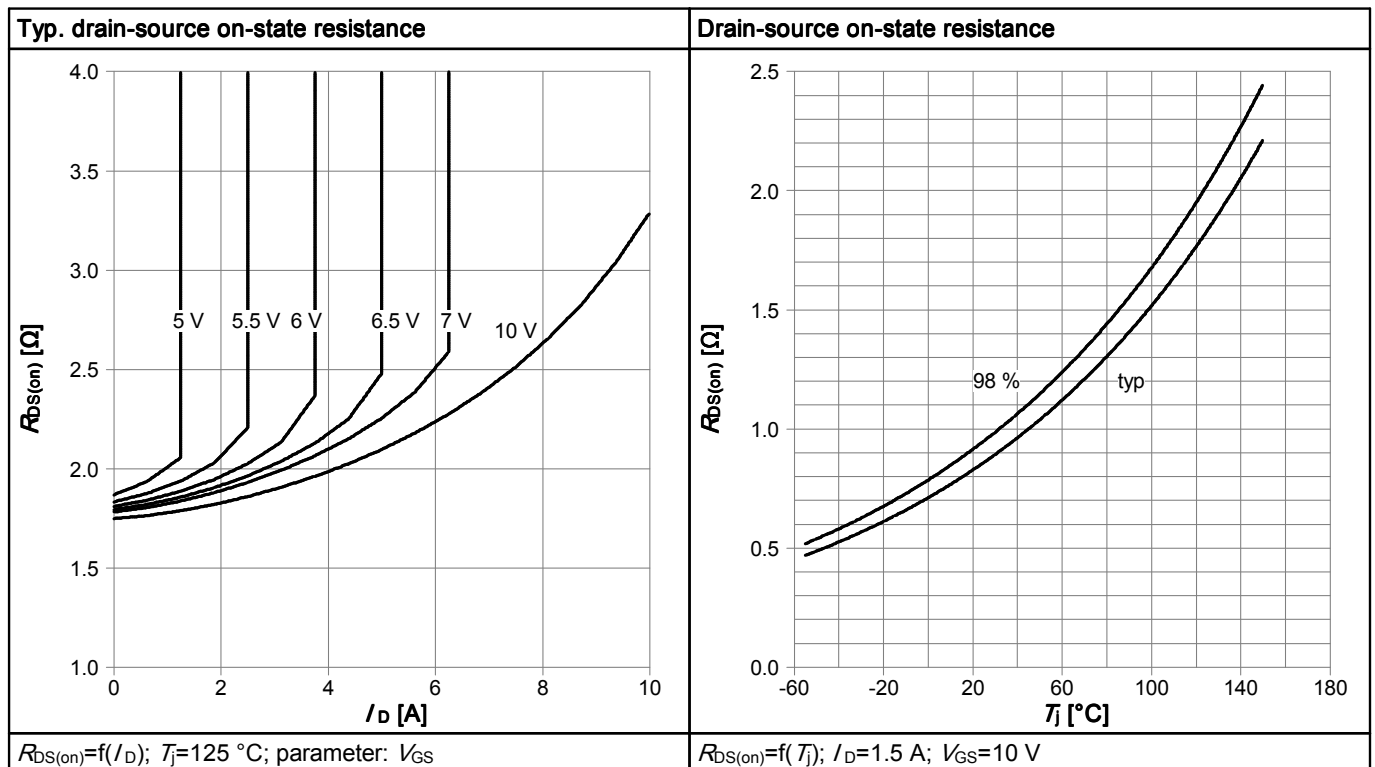


Table 12

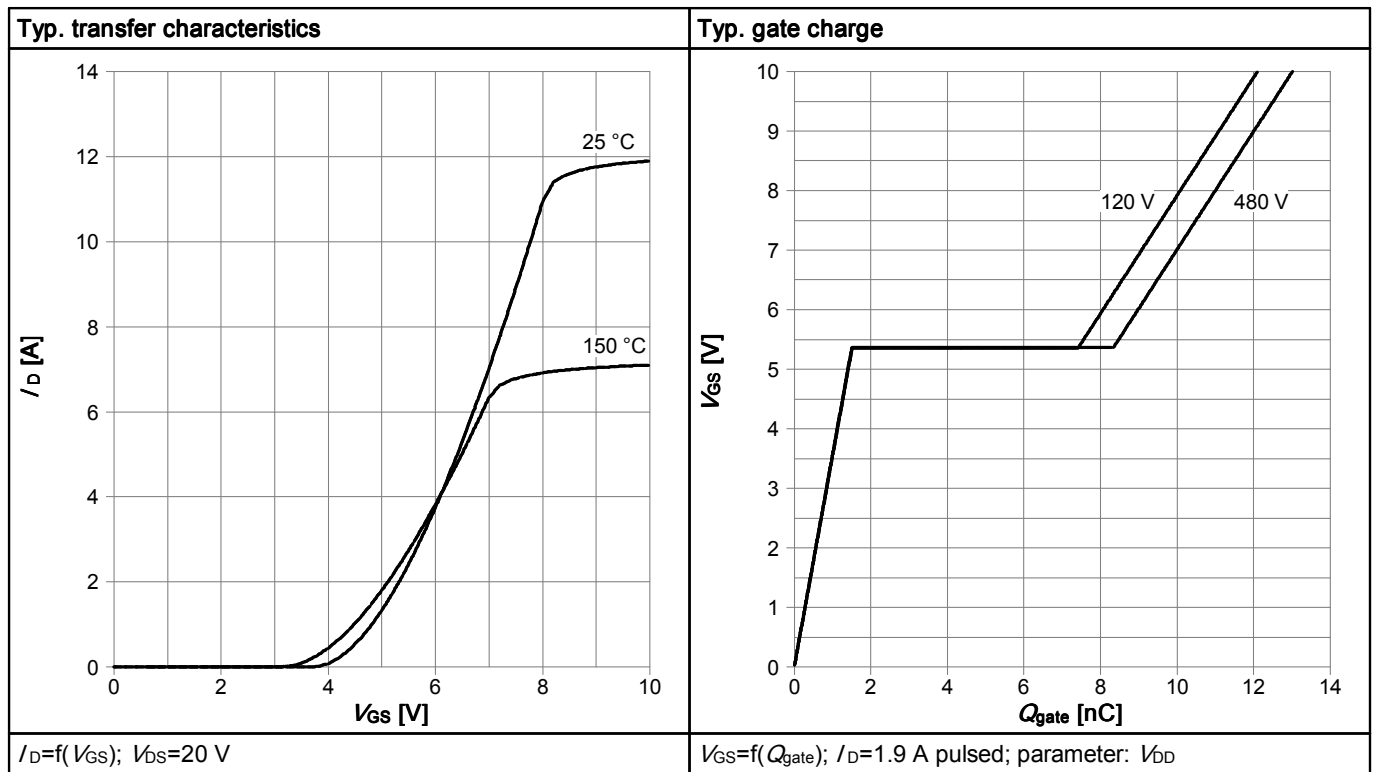


Table 13

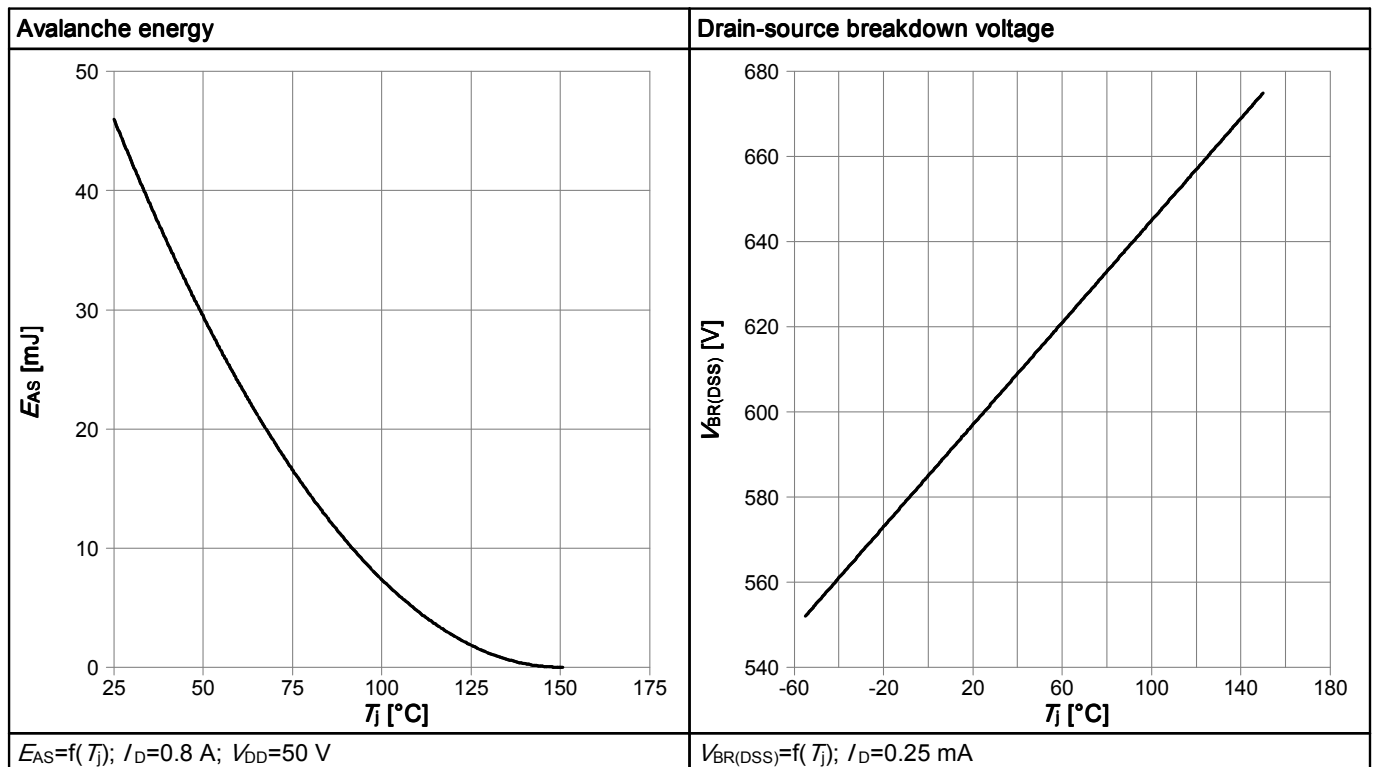


Table 14

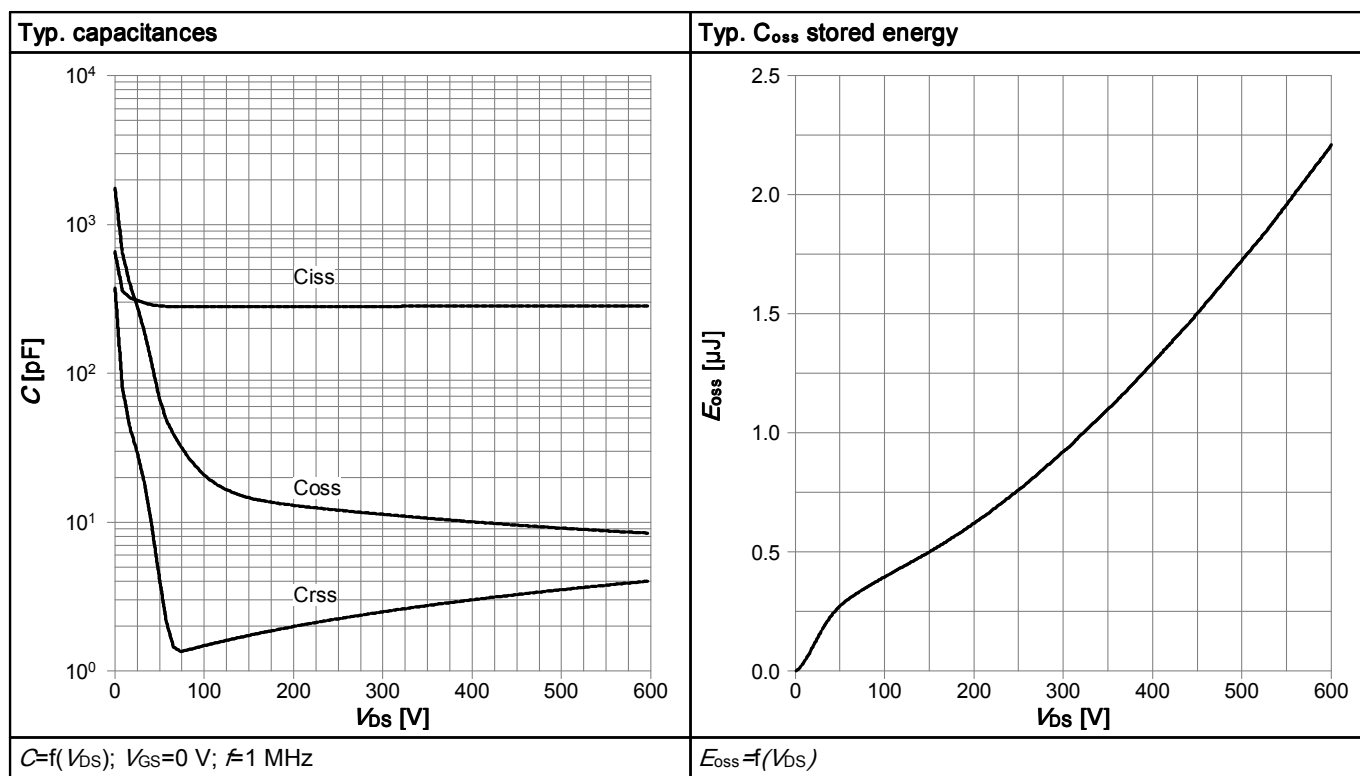
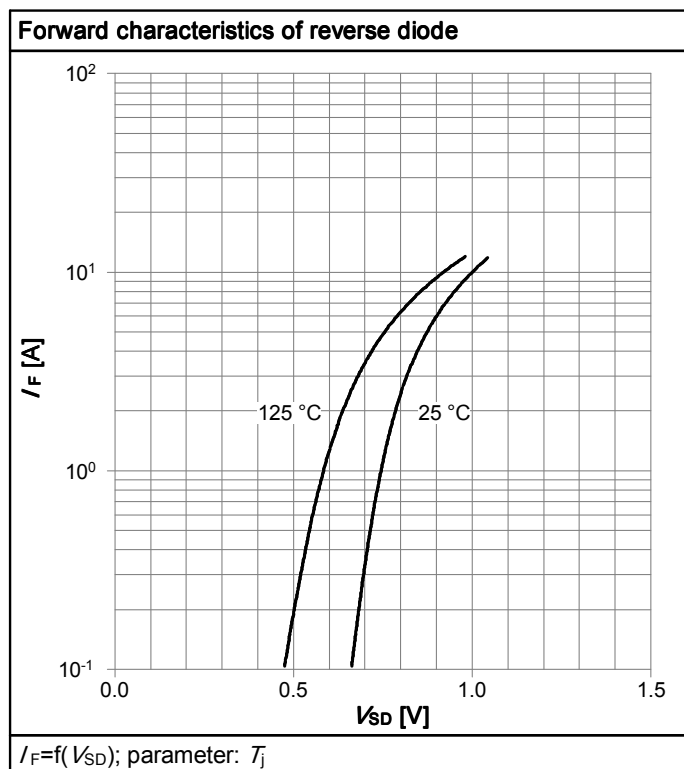
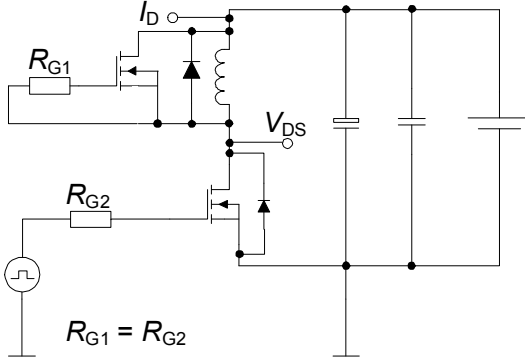
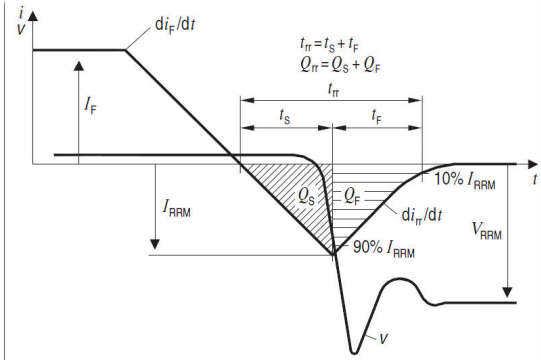


Table 15

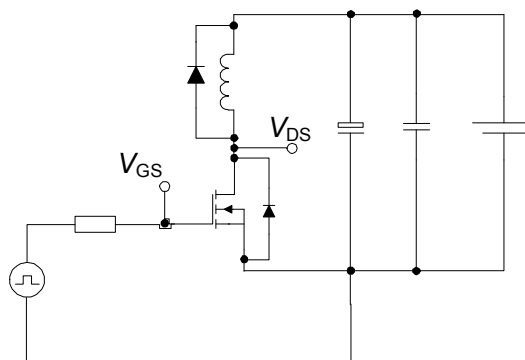
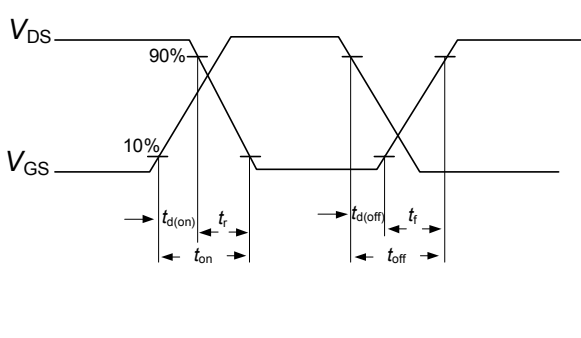


## 6 Test Circuits

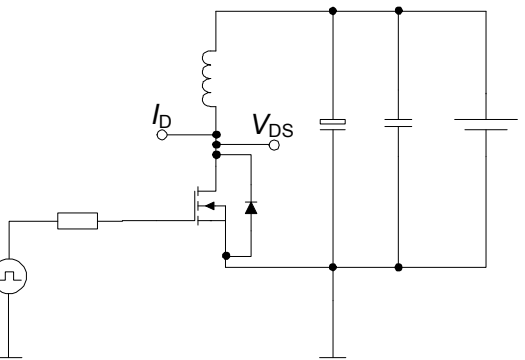
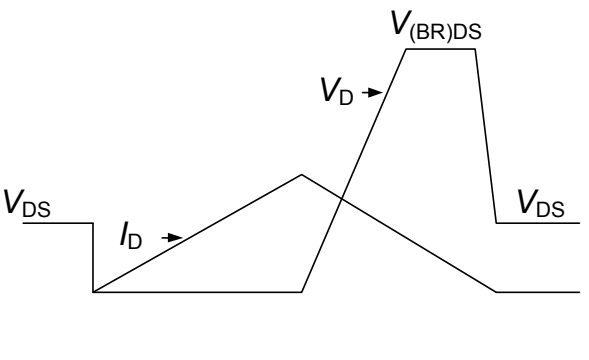
**Table 16 Diode characteristics**

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

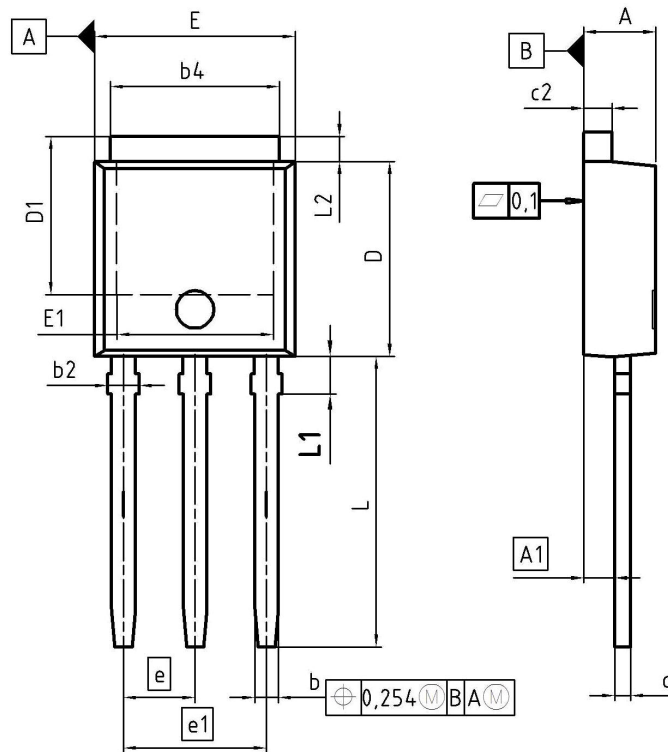
**Table 17 Switching times**

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

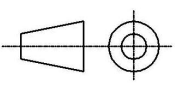
**Table 18 Unclamped inductive**

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

## 7 Package Outlines



| DIM | MILLIMETERS |      | INCHES |       |
|-----|-------------|------|--------|-------|
|     | MIN         | MAX  | MIN    | MAX   |
| A   | 2.16        | 2.41 | 0.085  | 0.095 |
| A1  | 0.90        | 1.14 | 0.035  | 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        | 0.60 | 0.018  | 0.024 |
| c2  | 0.46        | 0.89 | 0.018  | 0.035 |
| D   | 5.97        | 6.22 | 0.235  | 0.245 |
| D1  | 5.04        | 5.77 | 0.198  | 0.227 |
| E   | 6.35        | 6.73 | 0.250  | 0.265 |
| E1  | 4.70        | 5.21 | 0.185  | 0.205 |
| e   | 2.29        |      | 0.090  |       |
| e1  | 4.57        |      | 0.180  |       |
| N   | 3           |      | 3      |       |
| L   | 8.89        | 9.65 | 0.350  | 0.380 |
| L1  | 1.90        | 2.29 | 0.075  | 0.090 |
| L2  | 0.89        | 1.37 | 0.035  | 0.054 |

|                                                                                                              |
|--------------------------------------------------------------------------------------------------------------|
| DOCUMENT NO.<br>Z8B00003330                                                                                  |
| SCALE<br>0 2.0 4mm                                                                                           |
| EUROPEAN PROJECTION<br> |
| ISSUE DATE<br>19-03-2008                                                                                     |
| REVISION<br>03                                                                                               |

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

## 8 Appendix A

### Table 19 Related Links

- **IFX C6 Product Brief:**

<http://www.infineon.com/dgdl/Product+Brief+600V+CoolMOS+C6+.pdf?folderId=db3a3043156fd5730115939eb6b506db>

- **IFX C6 Portfolio:**

[http://www.infineon.com/cms/en/product/findProductTypeByName.html?q=ip\\*c6](http://www.infineon.com/cms/en/product/findProductTypeByName.html?q=ip*c6)

- **IFX CoolMOS Webpage:**

<http://www.infineon.com/cms/en/product/channel.html?channel=ff80808112ab681d0112ab6a628704d8>

- **IFX Design Tools:**

<http://www.infineon.com/cms/en/product/promopages/designtools/index.html>

## Revision History

IPU60R950C6

Revision: 2012-02-02, Rev. 2.1

Previous Revision

| Revision | Date       | Subjects (major changes since last revision) |
|----------|------------|----------------------------------------------|
| 2.1      | 2012-02-02 | Final datasheet release                      |

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