

## MOSFET

Metal Oxide Semiconductor Field Effect Transistor

## CoolMOS™ P6

600V CoolMOS™ P6 Power Transistor  
IPW60R070P6

## 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™ P6 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.

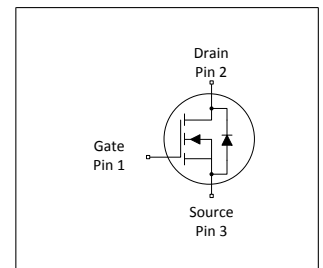
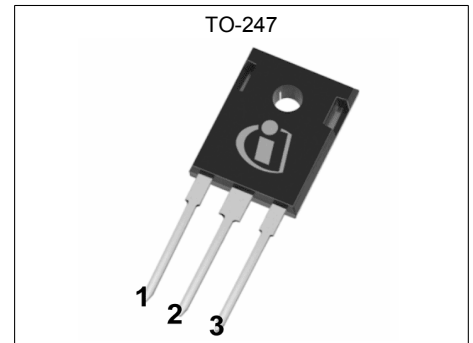
### Features

- Increased MOSFET dv/dt ruggedness
- 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 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 |
|----------------------|-------|------|
| $V_{DS} @ T_{j,max}$ | 650   | V    |
| $R_{DS(on),max}$     | 70    | mΩ   |
| $Q_{g,typ}$          | 100   | nC   |
| $I_{D,pulse}$        | 156   | A    |
| $E_{oss@400V}$       | 12.3  | μJ   |
| Body diode di/dt     | 300   | A/μs |

| Type / Ordering Code | Package   | Marking | Related Links  |
|----------------------|-----------|---------|----------------|
| IPW60R070P6          | PG-TO 247 | 6R070P6 | see Appendix A |

**Table of Contents**

|   |    |
|---|----|
| Description .....                         | 2  |
| Maximum ratings .....                     | 4  |
| Thermal characteristics .....             | 5  |
| Electrical characteristics .....          | 6  |
| Electrical characteristics diagrams ..... | 8  |
| Test Circuits .....                       | 12 |
| Package Outlines .....                    | 13 |
| Appendix A .....                          | 14 |
| Revision History .....                    | 15 |
| Disclaimer .....                          | 15 |

## 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>    | $I_D$         | -      | -    | 53.5<br>33.8 | A                | $T_C=25^\circ\text{C}$<br>$T_C=100^\circ\text{C}$                                     |
| Pulsed drain current <sup>2)</sup>        | $I_{D,pulse}$ | -      | -    | 156          | A                | $T_C=25^\circ\text{C}$  |
| Avalanche energy, single pulse            | $E_{AS}$      | -      | -    | 1136         | mJ               | $I_D=9.3\text{A}$ ; $V_{DD}=50\text{V}$ ; see table 10                                |
| Avalanche energy, repetitive              | $E_{AR}$      | -      | -    | 1.72         | mJ               | $I_D=9.3\text{A}$ ; $V_{DD}=50\text{V}$ ; see table 10                                |
| Avalanche current, repetitive             | $I_{AR}$      | -      | -    | 9.3          | A                | -   |
| MOSFET dv/dt ruggedness                   | dv/dt         | -      | -    | 100          | 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 (Non FullPAK)<br>TO-247 | $P_{tot}$     | -      | -    | 391          | W                | $T_C=25^\circ\text{C}$  |
| Storage temperature                       | $T_{stg}$     | -55    | -    | 150          | $^\circ\text{C}$ | -   |
| Operating junction temperature            | $T_j$         | -55    | -    | 150          | $^\circ\text{C}$ | -   |
| Mounting torque (Non FullPAK)<br>TO-247   | -             | -      | -    | 60           | Ncm              | M3 and M3.5 screws  |
| Continuous diode forward current          | $I_S$         | -      | -    | 46.3         | A                | $T_C=25^\circ\text{C}$  |
| Diode pulse current <sup>2)</sup>         | $I_{S,pulse}$ | -      | -    | 156          | A                | $T_C=25^\circ\text{C}$  |
| Reverse diode dv/dt <sup>3)</sup>         | dv/dt         | -      | -    | 15           | V/ns             | $V_{DS}=0\dots400\text{V}$ , $I_{SD}\leq I_S$ , $T_j=25^\circ\text{C}$<br>see table 8 |
| Maximum diode commutation speed           | $di_i/dt$     | -      | -    | 300          | A/ $\mu\text{s}$ | $V_{DS}=0\dots400\text{V}$ , $I_{SD}\leq I_S$ , $T_j=25^\circ\text{C}$<br>see table 8 |

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

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

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

### 3 Thermal characteristics

**Table 3 Thermal characteristics (Non FullPAK) TO-247**

| Parameter  | Symbol     | Values |      |      | Unit | Note / Test Condition               |
|--|------------|--------|------|------|------|-------------------------------------|
|  |            | Min.   | Typ. | Max. |      |                                     |
| Thermal resistance, junction - case                        | $R_{thJC}$ | -      | -    | 0.32 | °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   | $V_{(BR)DSS}$ | 600    | -              | -          | V             | $V_{GS}=0\text{V}$ , $I_D=1\text{mA}$   |
| Gate threshold voltage           | $V_{(GS)th}$  | 3.5    | 4.0            | 4.5        | V             | $V_{DS}=V_{GS}$ , $I_D=1.72\text{mA}$   |
| Zero gate voltage drain current  | $I_{DSS}$     | -      | -              | 5          | $\mu\text{A}$ | $V_{DS}=600$ , $V_{GS}=0\text{V}$ , $T_j=25^\circ\text{C}$<br>$V_{DS}=600$ , $V_{GS}=0\text{V}$ , $T_j=150^\circ\text{C}$               |
| Gate-source leakage current      | $I_{GSS}$     | -      | -              | 100        | nA            | $V_{GS}=20\text{V}$ , $V_{DS}=0\text{V}$  |
| Drain-source on-state resistance | $R_{DS(on)}$  | -      | 0.063<br>0.164 | 0.070<br>- | $\Omega$      | $V_{GS}=10\text{V}$ , $I_D=20.6\text{A}$ , $T_j=25^\circ\text{C}$<br>$V_{GS}=10\text{V}$ , $I_D=20.6\text{A}$ , $T_j=150^\circ\text{C}$ |
| Gate resistance                  | $R_G$         | -      | 1              | -          | $\Omega$      | $f=1\text{MHz}$ , open drain  |

**Table 5 Dynamic characteristics**

| Parameter  | Symbol       | Values |      |      | Unit | Note / Test Condition  |
|--|--------------|--------|------|------|------|--|
|  |              | Min.   | Typ. | Max. |      |  |
| Input capacitance  | $C_{iss}$    | -      | 4750 | -    | pF   | $V_{GS}=0\text{V}$ , $V_{DS}=100\text{V}$ , $f=1\text{MHz}$  |
| Output capacitance   | $C_{oss}$    | -      | 190  | -    | pF   | $V_{GS}=0\text{V}$ , $V_{DS}=100\text{V}$ , $f=1\text{MHz}$  |
| Effective output capacitance, energy related <sup>1)</sup> | $C_{o(er)}$  | -      | 150  | -    | pF   | $V_{GS}=0\text{V}$ , $V_{DS}=0\dots400\text{V}$  |
| Effective output capacitance, time related <sup>2)</sup>   | $C_{o(tr)}$  | -      | 703  | -    | pF   | $I_D=\text{constant}$ , $V_{GS}=0\text{V}$ , $V_{DS}=0\dots400\text{V}$                            |
| Turn-on delay time   | $t_{d(on)}$  | -      | 23   | -    | ns   | $V_{DD}=400\text{V}$ , $V_{GS}=13\text{V}$ , $I_D=25.8\text{A}$ ,<br>$R_G=1.7\Omega$ ; see table 9 |
| Rise time  | $t_r$        | -      | 15   | -    | ns   | $V_{DD}=400\text{V}$ , $V_{GS}=13\text{V}$ , $I_D=25.8\text{A}$ ,<br>$R_G=1.7\Omega$ ; see table 9 |
| Turn-off delay time  | $t_{d(off)}$ | -      | 64   | -    | ns   | $V_{DD}=400\text{V}$ , $V_{GS}=13\text{V}$ , $I_D=25.8\text{A}$ ,<br>$R_G=1.7\Omega$ ; see table 9 |
| Fall time  | $t_f$        | -      | 4    | -    | ns   | $V_{DD}=400\text{V}$ , $V_{GS}=13\text{V}$ , $I_D=25.8\text{A}$ ,<br>$R_G=1.7\Omega$ ; see table 9 |

**Table 6 Gate charge characteristics**

| Parameter             | Symbol        | Values |      |      | Unit | Note / Test Condition  |
|-----------------------|---------------|--------|------|------|------|--|
|                       |               | Min.   | Typ. | Max. |      |  |
| Gate to source charge | $Q_{gs}$      | -      | 30   | -    | nC   | $V_{DD}=400\text{V}$ , $I_D=25.8\text{A}$ , $V_{GS}=0$ to $10\text{V}$ |
| Gate to drain charge  | $Q_{gd}$      | -      | 35   | -    | nC   | $V_{DD}=400\text{V}$ , $I_D=25.8\text{A}$ , $V_{GS}=0$ to $10\text{V}$ |
| Gate charge total     | $Q_g$         | -      | 100  | -    | nC   | $V_{DD}=400\text{V}$ , $I_D=25.8\text{A}$ , $V_{GS}=0$ to $10\text{V}$ |
| Gate plateau voltage  | $V_{plateau}$ | -      | 6.1  | -    | V    | $V_{DD}=400\text{V}$ , $I_D=25.8\text{A}$ , $V_{GS}=0$ to $10\text{V}$ |

<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 400V

<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 400V

**Table 7 Reverse diode characteristics**

| Parameter                     | Symbol    | Values |      |      | Unit    | Note / Test Condition                                      |
|-------------------------------|-----------|--------|------|------|---------|--|
|                               |           | Min.   | Typ. | Max. |         |  |
| Diode forward voltage         | $V_{SD}$  | -      | 0.9  | -    | V       | $V_{GS}=0V, I_F=25.8A, T_j=25^{\circ}C$                    |
| Reverse recovery time         | $t_{rr}$  | -      | 520  | -    | ns      | $V_R=400V, I_F=25.8A, di_F/dt=100A/\mu s$ ;<br>see table 8 |
| Reverse recovery charge       | $Q_{rr}$  | -      | 12   | -    | $\mu C$ | $V_R=400V, I_F=25.8A, di_F/dt=100A/\mu s$ ;<br>see table 8 |
| Peak reverse recovery current | $I_{rrm}$ | -      | 44   | -    | A       | $V_R=400V, I_F=25.8A, di_F/dt=100A/\mu s$ ;<br>see table 8 |

### 5 Electrical characteristics diagrams

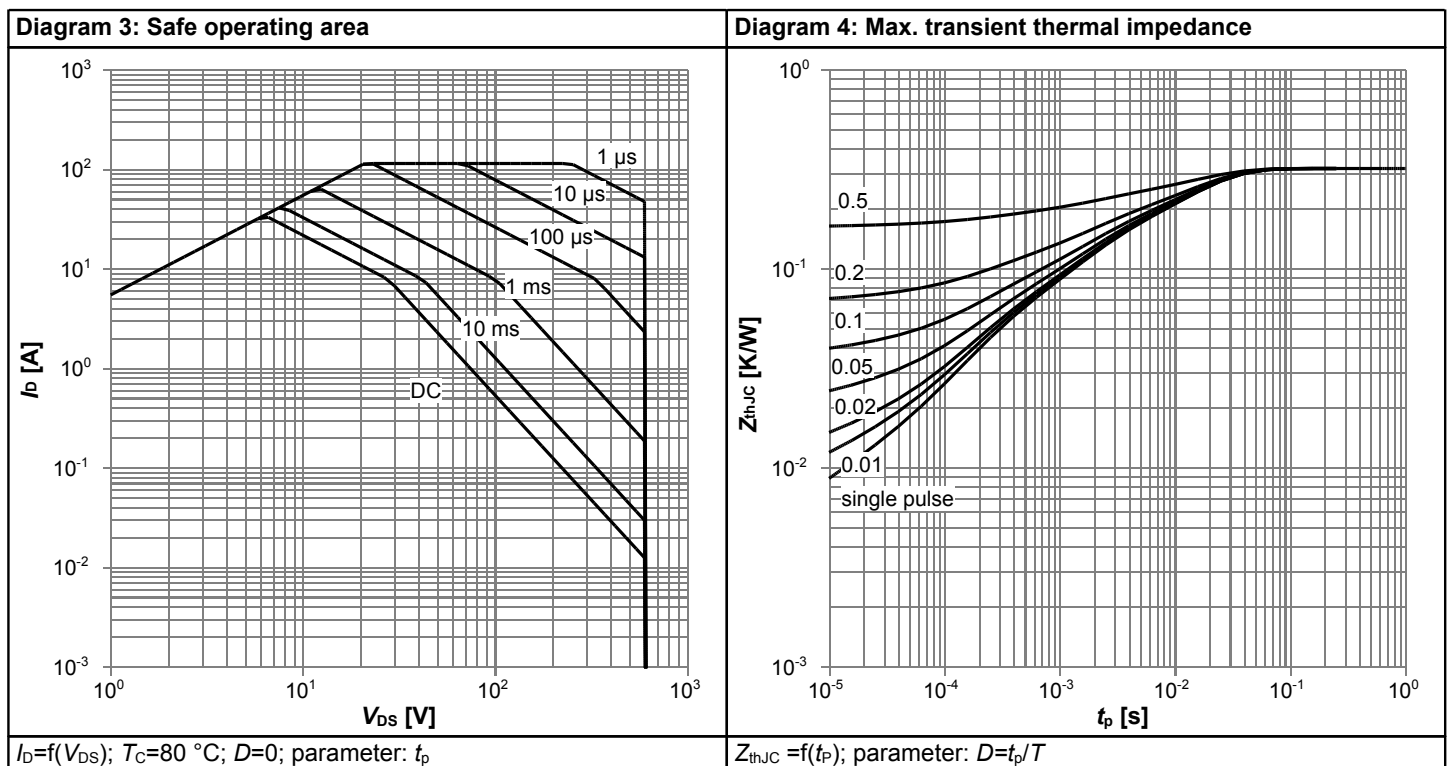
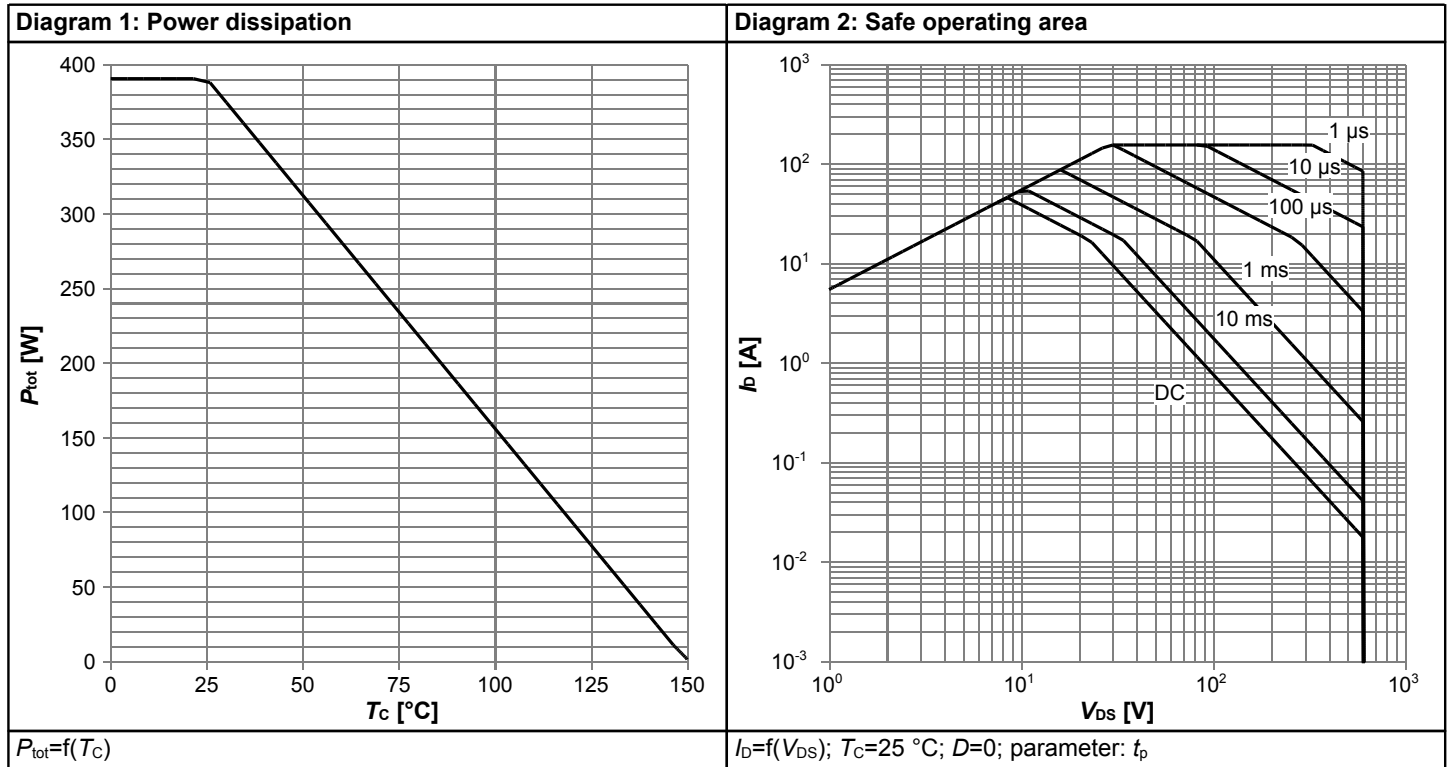
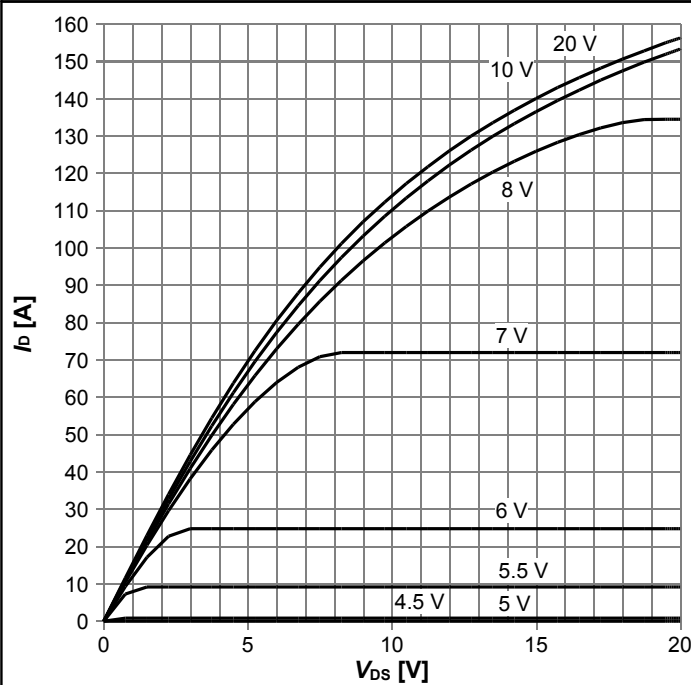


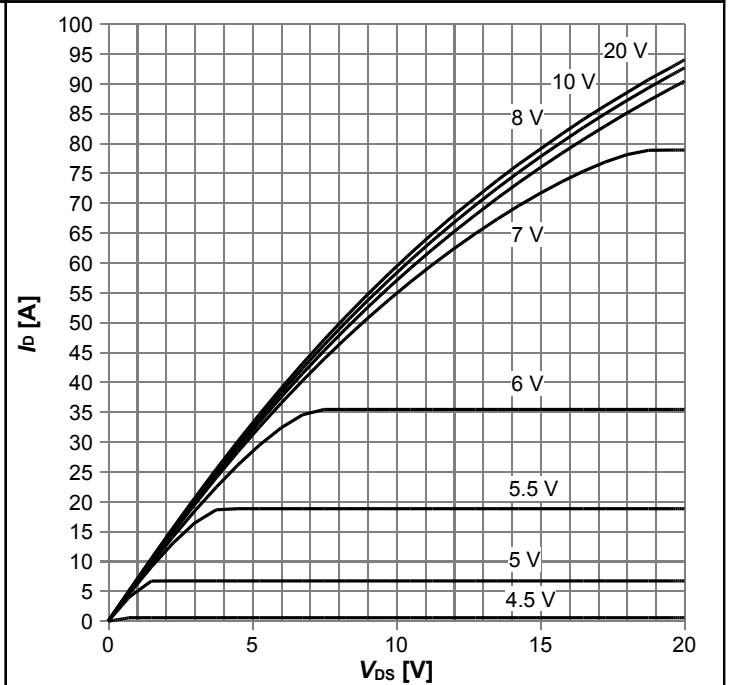


Diagram 5: Typ. output characteristics



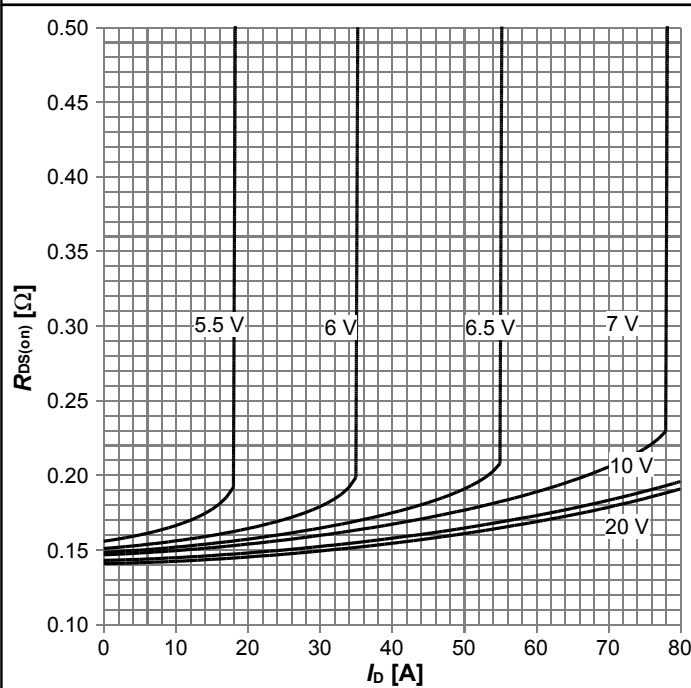
$I_D=f(V_{DS})$ ;  $T_j=25\text{ °C}$ ; parameter:  $V_{GS}$

Diagram 6: Typ. output characteristics



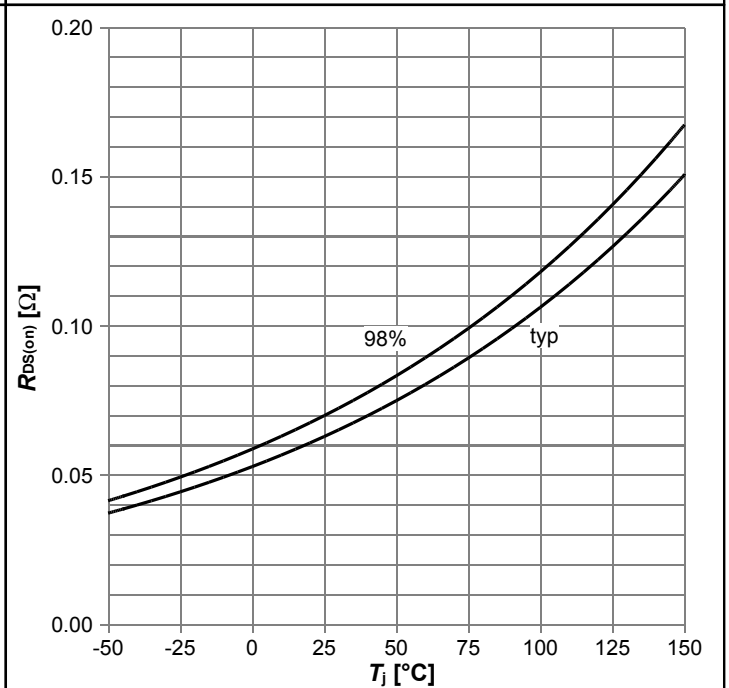
$I_D=f(V_{DS})$ ;  $T_j=125\text{ °C}$ ; parameter:  $V_{GS}$

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



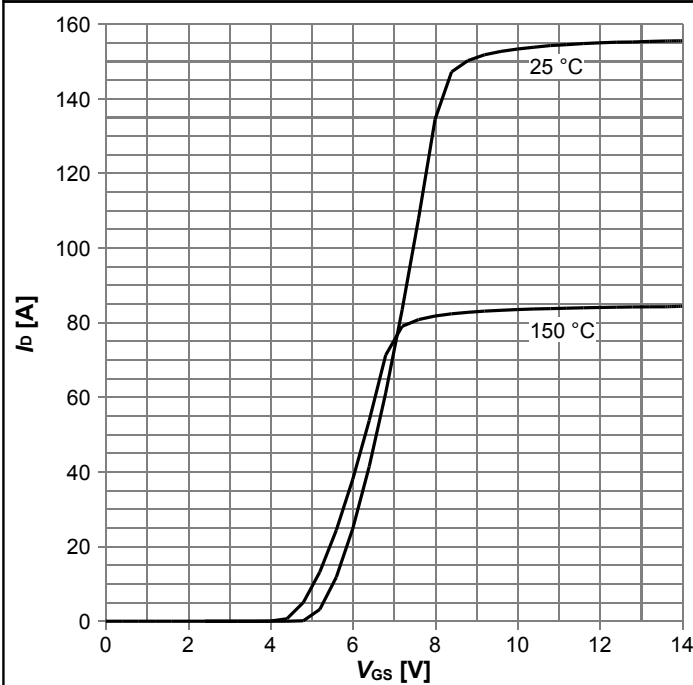
$R_{DS(on)}=f(I_D)$ ;  $T_j=125\text{ °C}$ ; parameter:  $V_{GS}$

Diagram 8: Drain-source on-state resistance



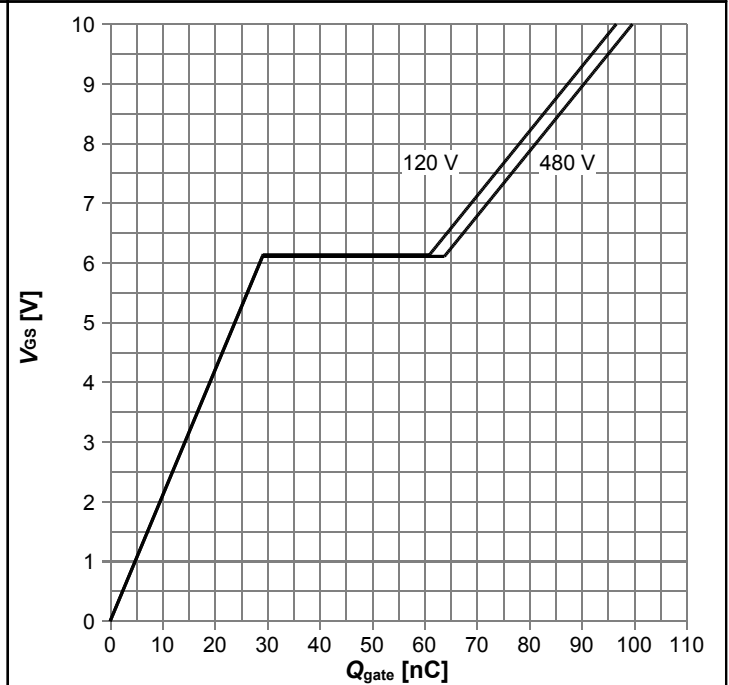
$R_{DS(on)}=f(T_j)$ ;  $I_D=20.6\text{ A}$ ;  $V_{GS}=10\text{ V}$

Diagram 9: Typ. transfer characteristics



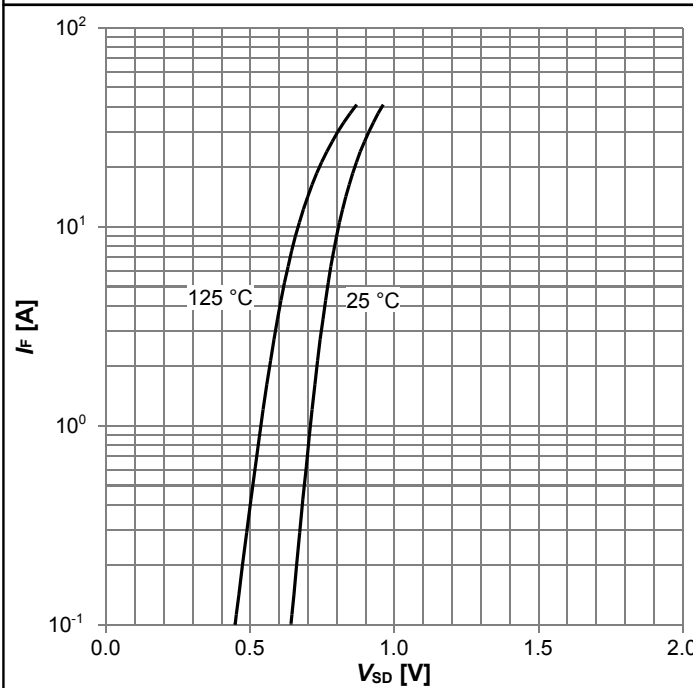
$I_D=f(V_{GS}); V_{DS}=20V; \text{parameter: } T_j$

Diagram 10: Typ. gate charge



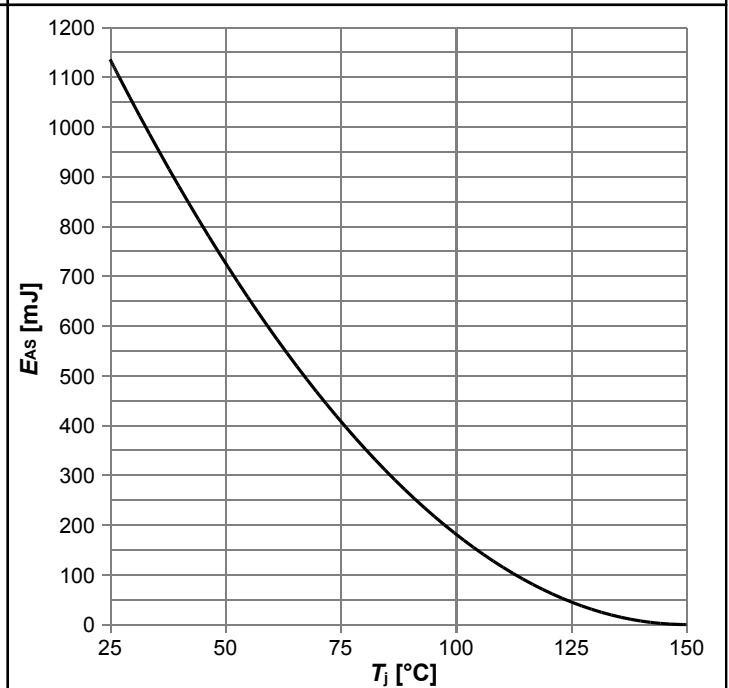
$V_{GS}=f(Q_{gate}); I_D=25.8 \text{ A pulsed}; \text{parameter: } V_{DD}$

Diagram 11: Forward characteristics of reverse diode



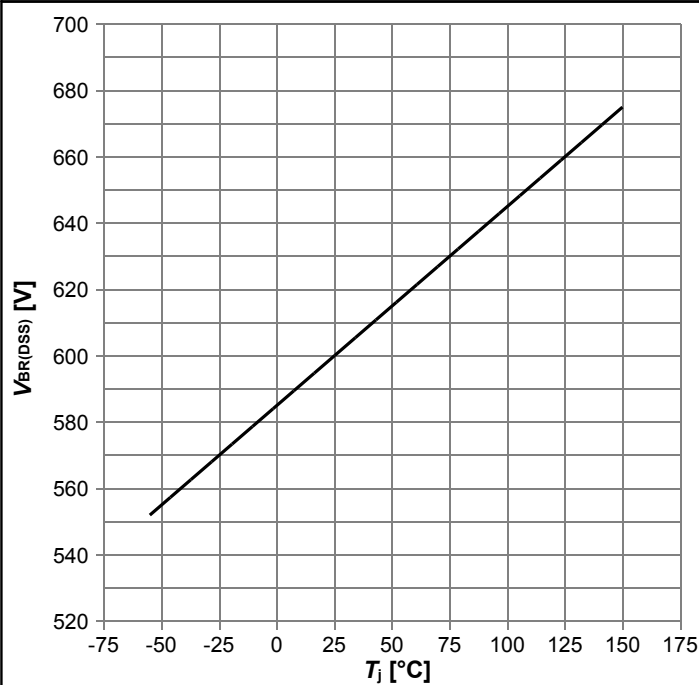
$I_F=f(V_{SD}); \text{parameter: } T_j$

Diagram 12: Avalanche energy



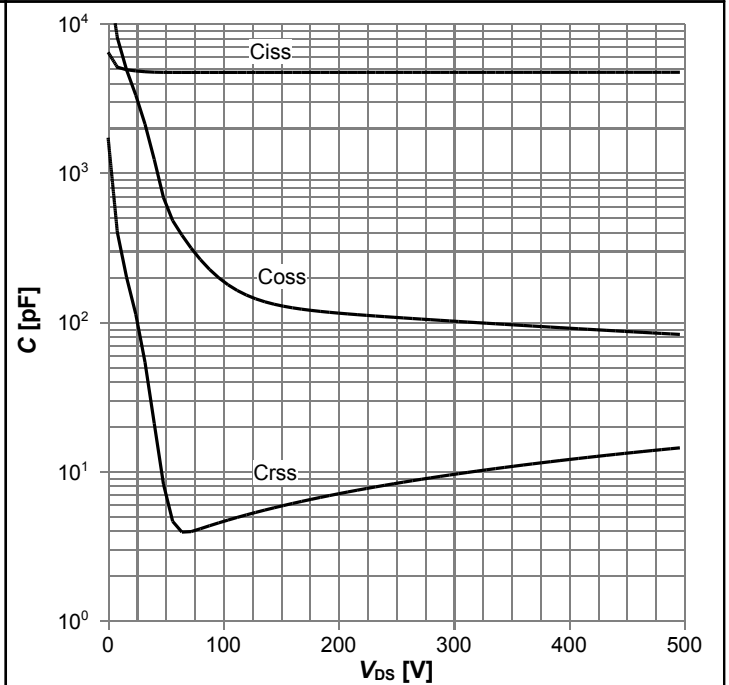
$E_{AS}=f(T_j); I_D=9.3 \text{ A}; V_{DD}=50 \text{ V}$

Diagram 13: Drain-source breakdown voltage



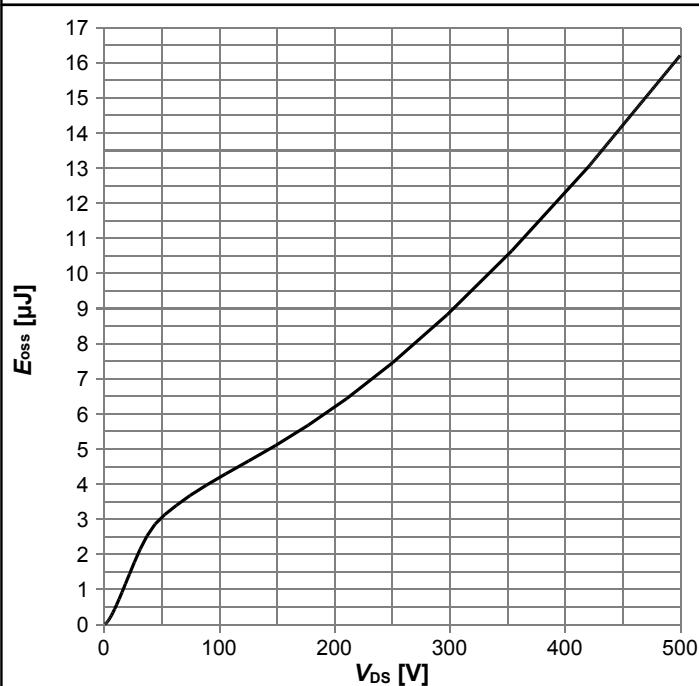
$V_{BR(DSS)}=f(T_j); I_D=1 \text{ mA}$

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

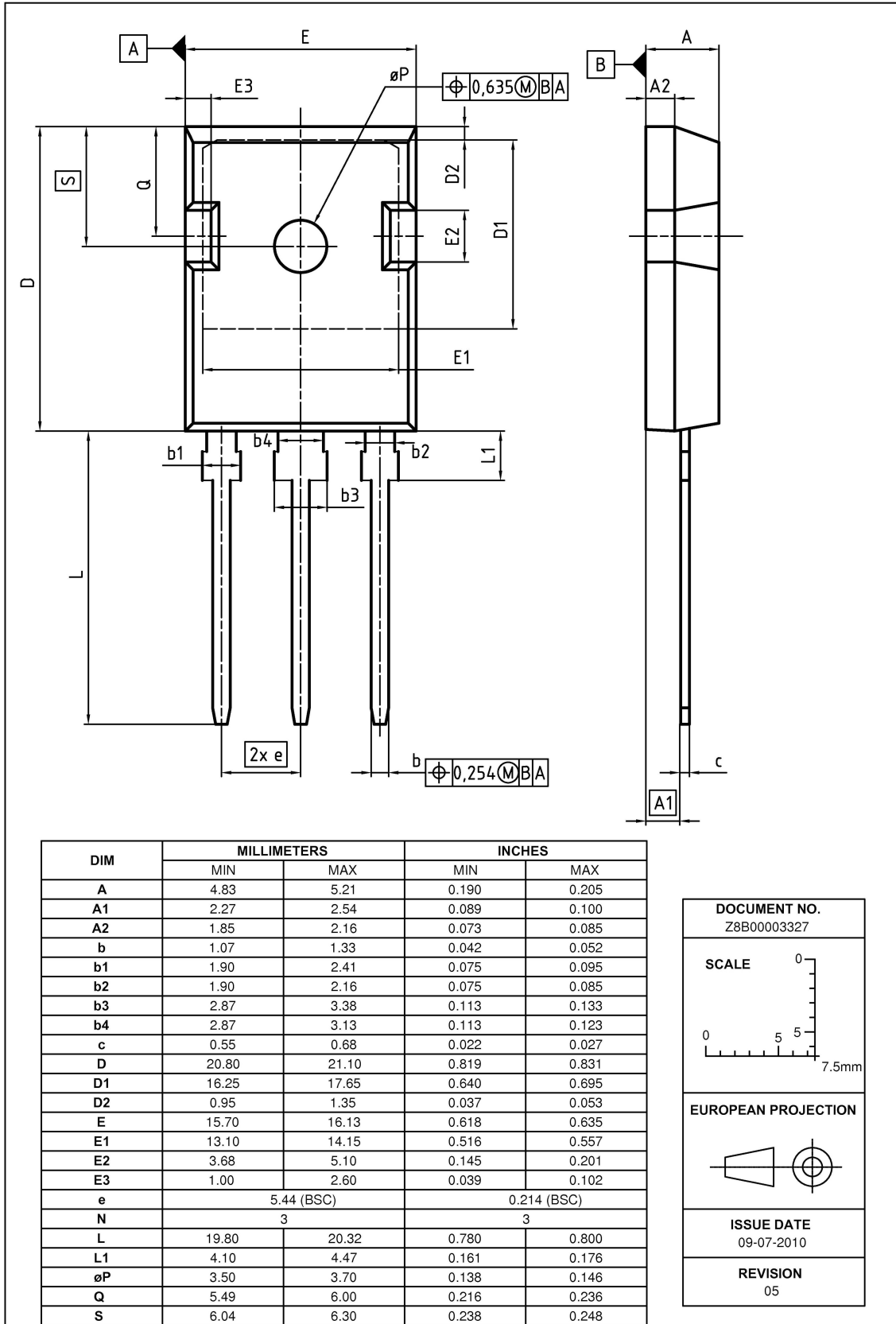


Figure 1 Outline PG-TO 247, dimensions in mm/inches

## 8 Appendix A

### Table 11 Related Links

- IFX CoolMOS™ P6 Webpage: [www.infineon.com](http://www.infineon.com)
- IFX CoolMOS™ P6 application note: [www.infineon.com](http://www.infineon.com)
- IFX CoolMOS™ P6 simulation model: [www.infineon.com](http://www.infineon.com)
- IFX Design tools: [www.infineon.com](http://www.infineon.com)

## Revision History

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IPW60R070P6

**Revision: 2014-03-07, Rev. 2.0**

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Previous Revision

| Revision | Date       | Subjects (major changes since last revision) |
|----------|------------|--|
| 2.0      | 2014-03-07 | Release of final version                     |

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### Published by

**Infineon Technologies AG**

**81726 München, Germany**

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