# MOSFET

Metal Oxide Semiconductor Field Effect Transistor

# CoolMOS™ P6

600V CoolMOS™ P6 Power Transistor
IPZ60R070P6

## Data Sheet

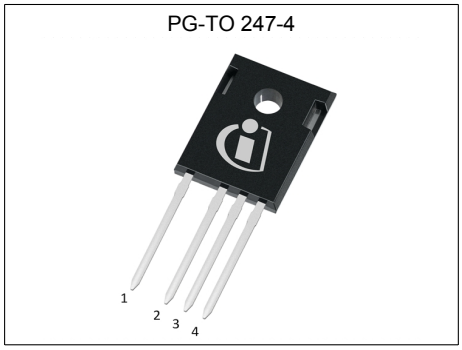
Rev. 2.0
Final

## Power Management & Multimarket

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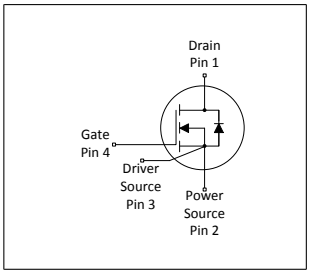
# 1 Description

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 Rdson*Qg and Eoss
- Very high commutation ruggedness
- Best in class $R_{DS(on)}$ /package
- Easy to use/drive due to driver source pin for better control of the gate
- Pb-free plating, Halogen free mold compound
- Qualified for industrial grade applications according to JEDEC (J-STD20 and JESD22)
- 4-pin kelvin source concept




## Applications

PFC stages, hard switching PWM stages and resonant switching stages for e.g. Computing, Server, Telecom and UPS.

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

RoHS

**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 | 250 | A/µs |

| Type / Ordering Code | Package | Marking | Related Links |
|---|---|---|---|
| IPZ60R070P6 | PG-TO 247-4 | 6R070P6 | see Appendix A |



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## 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>- | 53.5<br>33.8 | A | $T_C$=25°C<br>$T_C$=100°C |
| Pulsed drain current[2] | $I_{D,pulse}$ | - | - | 156 | A | $T_C$=25°C |
| Avalanche energy, single pulse | $E_{AS}$ | - | - | 1136 | mJ | $I_D$=9.3A; $V_{DD}$=50V; see table 10 |
| Avalanche energy, repetitive | $E_{AR}$ | - | - | 1.72 | mJ | $I_D$=9.3A; $V_{DD}$=50V; see table 10 |
| Avalanche current, repetitive | $I_{AR}$ | - | - | 9.3 | 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 | $P_{tot}$ | - | - | 391 | W | $T_C$=25°C |
| Storage temperature | $T_{stg}$ | -55 | - | 150 | °C | - |
| Operating junction temperature | $T_j$ | -55 | - | 150 | °C | - |
| Mounting torque | - | - | - | 60 | Ncm | M3 and M3.5 screws |
| Continuous diode forward current | $I_S$ | - | - | 46.3 | A | $T_C$=25°C |
| Diode pulse current[2] | $I_{S,pulse}$ | - | - | 156 | A | $T_C$=25°C |
| Reverse diode dv/dt[3] | dv/dt | - | - | 15 | V/ns | $V_{DS}$=0...400V, $I_{SD}$<=$I_S$, $T_j$=25°C see table 8 |
| Maximum diode commutation speed | $di_f/dt$ | - | - | 250 | A/µs | $V_{DS}$=0...400V, $I_{SD}$<=$I_S$, $T_j$=25°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 $R_G$



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## 3 Thermal characteristics

**Table 3 Thermal characteristics**

| 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 |



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# 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 | $V_{(BR)DSS}$ | 600 | - | - | V | $V_{GS}$=0V, $I_D$=1mA |
| Gate threshold voltage | $V_{(GS)th}$ | 3.5 | 4.0 | 4.5 | V | $V_{DS}$=$V_{GS}$, $I_D$=1.72mA |
| Zero gate voltage drain current | $I_{DSS}$ | -<br>- | -<br>10 | 5<br>- | µA | $V_{DS}$=600, $V_{GS}$=0V, $T_j$=25°C<br>$V_{DS}$=600, $V_{GS}$=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>- | 0.063<br>0.164 | 0.070<br>- | Ω | $V_{GS}$=10V, $I_D$=20.6A, $T_j$=25°C<br>$V_{GS}$=10V, $I_D$=20.6A, $T_j$=150°C |
| Gate resistance | $R_G$ | - | 1 | - | Ω | $f$=1MHz, open drain |

## Table 5 Dynamic characteristics

| Parameter | Symbol | Values | | | Unit | Note / Test Condition |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| Input capacitance | $C_{iss}$ | - | 4750 | - | pF | $V_{GS}$=0V, $V_{DS}$=100V, $f$=1MHz |
| Output capacitance | $C_{oss}$ | - | 190 | - | pF | $V_{GS}$=0V, $V_{DS}$=100V, $f$=1MHz |
| Effective output capacitance, energy related[1)] | $C_{o(er)}$ | - | 150 | - | pF | $V_{GS}$=0V, $V_{DS}$=0...400V |
| Effective output capacitance, time related[2)] | $C_{o(tr)}$ | - | 703 | - | pF | $I_D$=constant, $V_{GS}$=0V, $V_{DS}$=0...400V |
| Turn-on delay time | $t_{d(on)}$ | - | 21 | - | ns | $V_{DD}$=400V, $V_{GS}$=13V, $I_D$=25.8A, $R_G$=1.7Ω; see table 9 |
| Rise time | $t_r$ | - | 14 | - | ns | $V_{DD}$=400V, $V_{GS}$=13V, $I_D$=25.8A, $R_G$=1.7Ω; see table 9 |
| Turn-off delay time | $t_{d(off)}$ | - | 62 | - | ns | $V_{DD}$=400V, $V_{GS}$=13V, $I_D$=25.8A, $R_G$=1.7Ω; see table 9 |
| Fall time | $t_f$ | - | 4 | - | ns | $V_{DD}$=400V, $V_{GS}$=13 V, $I_D$=25.8A, $R_G$=1.7Ω; 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 | $V_{DD}$=400V, $I_D$=25.8A, $V_{GS}$=0 to 10V |
| Gate to drain charge | $Q_{gd}$ | - | 35 | - | nC | $V_{DD}$=400V, $I_D$=25.8A, $V_{GS}$=0 to 10V |
| Gate charge total | $Q_g$ | - | 100 | - | nC | $V_{DD}$=400V, $I_D$=25.8A, $V_{GS}$=0 to 10V |
| Gate plateau voltage | $V_{plateau}$ | - | 6.1 | - | V | $V_{DD}$=400V, $I_D$=25.8A, $V_{GS}$=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



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**Table 7 Reverse diode characteristics**

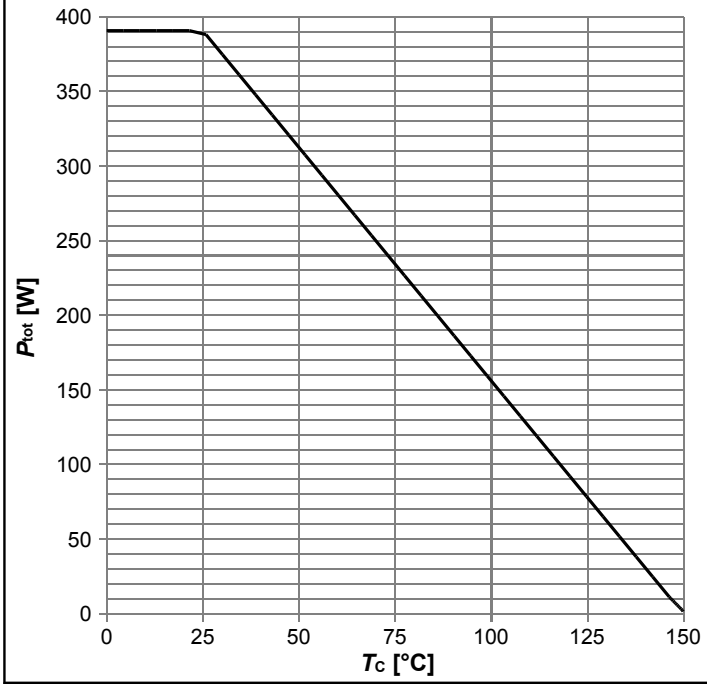
| Parameter | Symbol | Values | | | Unit | Note / Test Condition |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| Diode forward voltage | $V_{SD}$ | - | 0.9 | - | V | $V_{GS}$=0V, $I_F$=25.8A, $T_j$=25°C |
| Reverse recovery time | $t_{rr}$ | - | 520 | - | ns | $V_R$=400V, $I_F$=25.8A, d$i_F$/d$t$=100A/µs; see table 8 |
| Reverse recovery charge | $Q_{rr}$ | - | 12 | - | µC | $V_R$=400V, $I_F$=25.8A, d$i_F$/d$t$=100A/µs; see table 8 |
| Peak reverse recovery current | $I_{rrm}$ | - | 44 | - | A | $V_R$=400V, $I_F$=25.8A, d$i_F$/d$t$=100A/µs; see table 8 |



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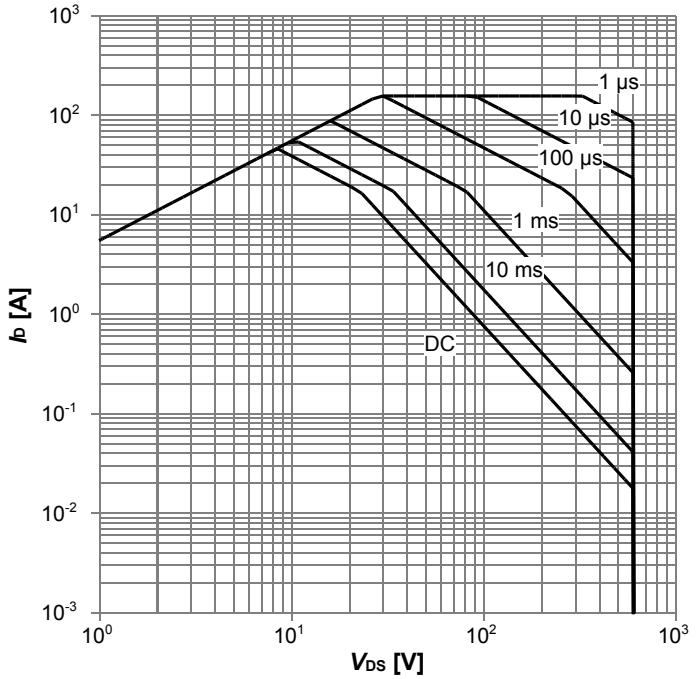
## 5 Electrical characteristics diagrams

**Diagram 1: Power dissipation**



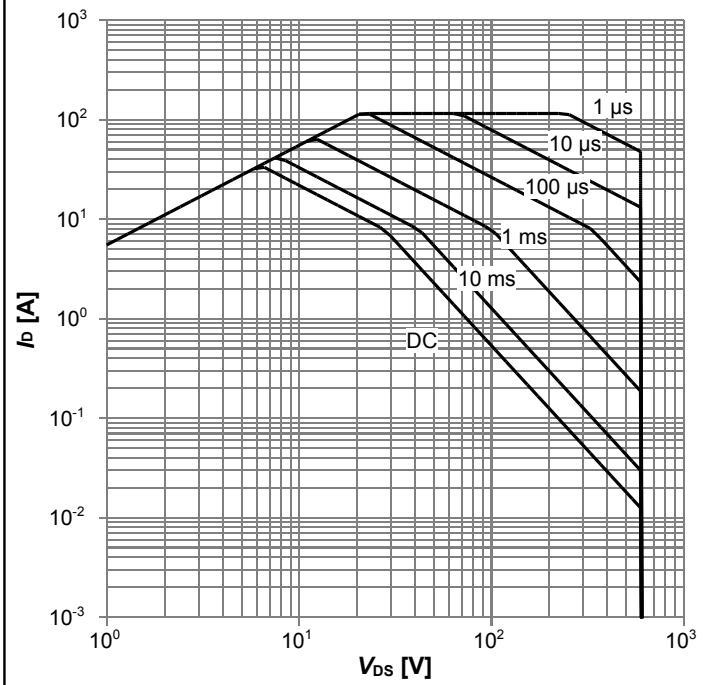

$P_{tot}=f(T_C)$

**Diagram 2: Safe operating area**



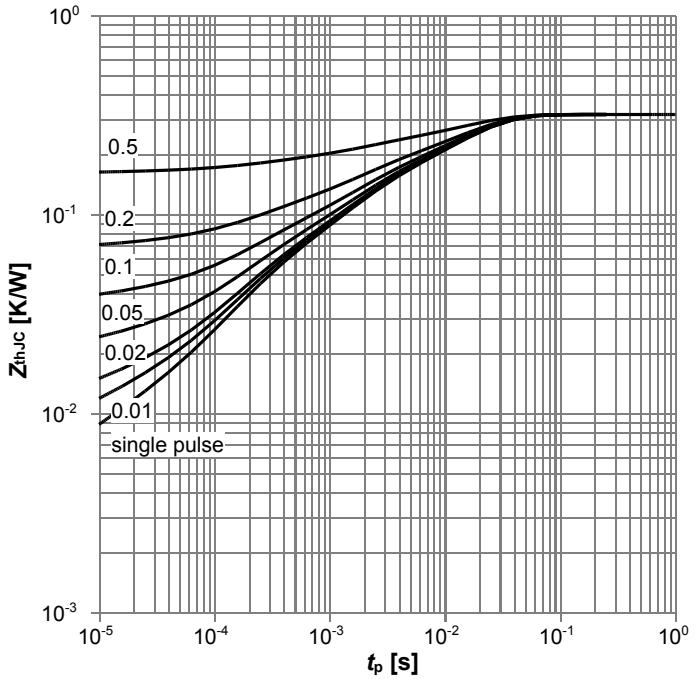

$I_D=f(V_{DS})$; $T_C$=25 °C; $D$=0; parameter: $t_p$

**Diagram 3: Safe operating area**




$I_D=f(V_{DS})$; $T_C$=80 °C; $D$=0; parameter: $t_p$

**Diagram 4: Max. transient thermal impedance**

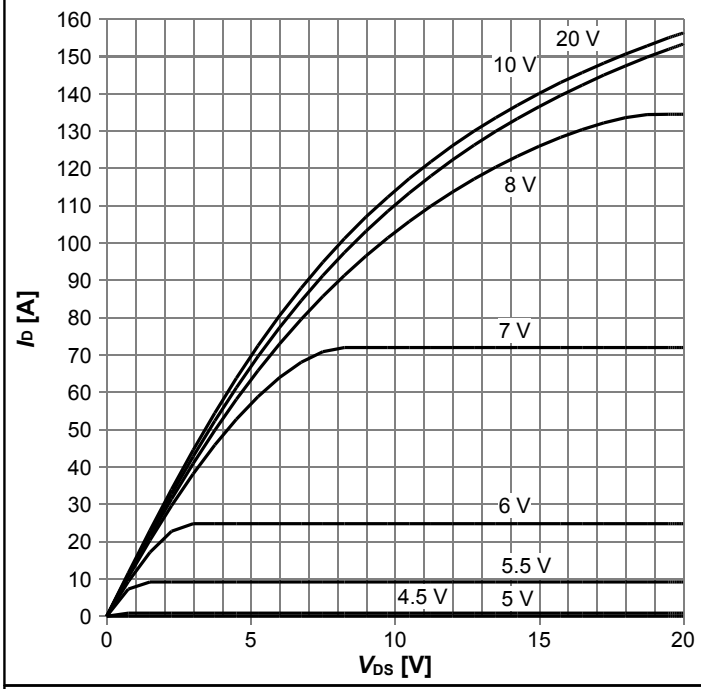



$Z_{thJC}=f(t_P)$; parameter: $D=t_p/T$



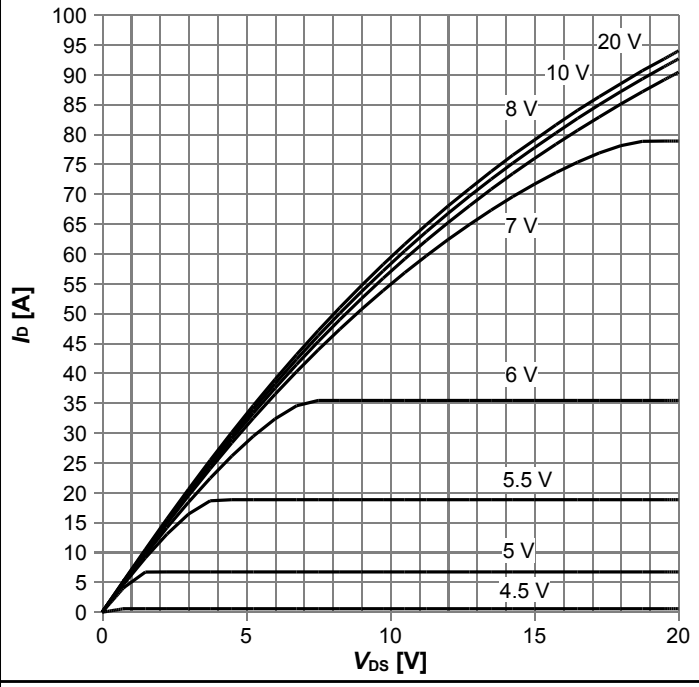
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**Diagram 5: Typ. output characteristics**



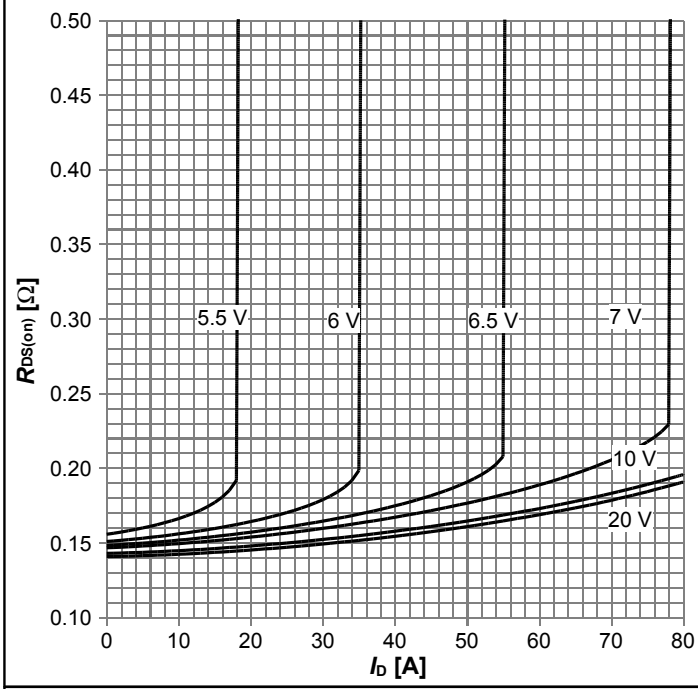

$I_D$=f($V_{DS}$); $T_j$=25 °C; parameter: $V_{GS}$

**Diagram 6: Typ. output characteristics**



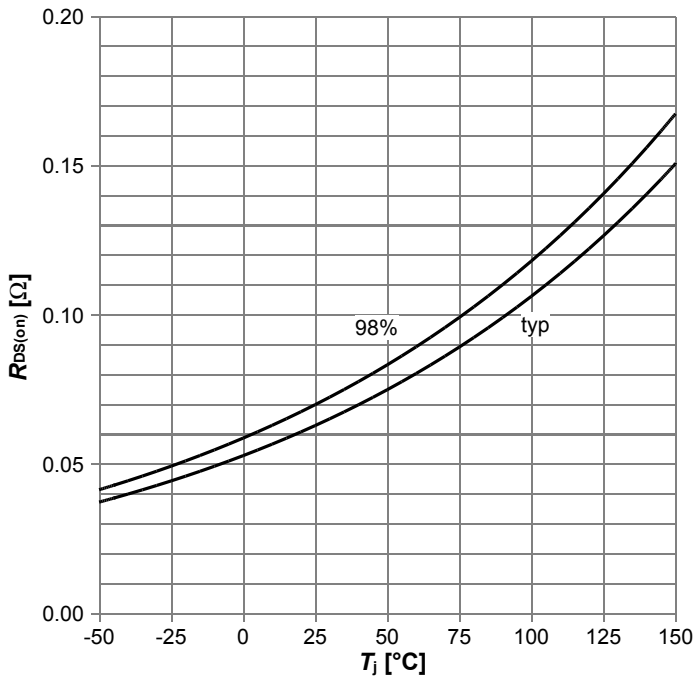

$I_D$=f($V_{DS}$); $T_j$=125 °C; parameter: $V_{GS}$

**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**

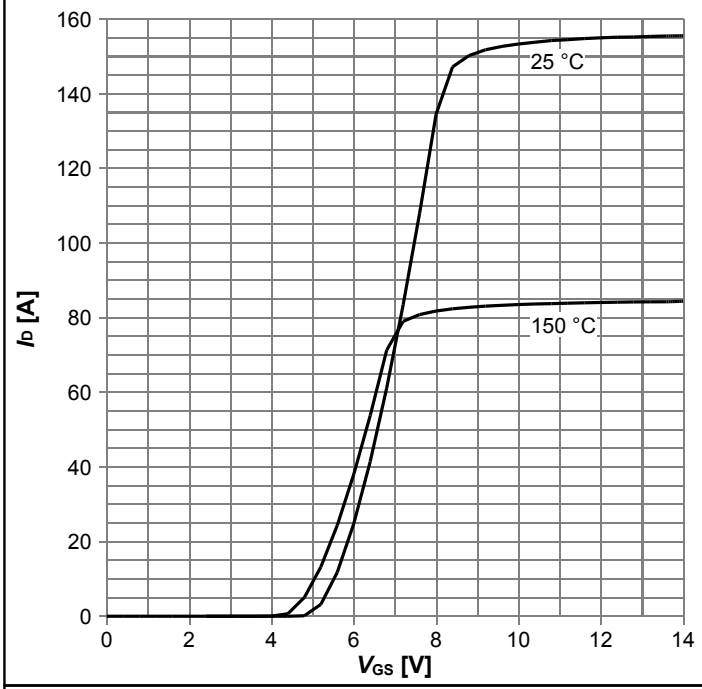



$R_{DS(on)}$=f($T_j$); $I_D$=20.6 A; $V_{GS}$=10 V



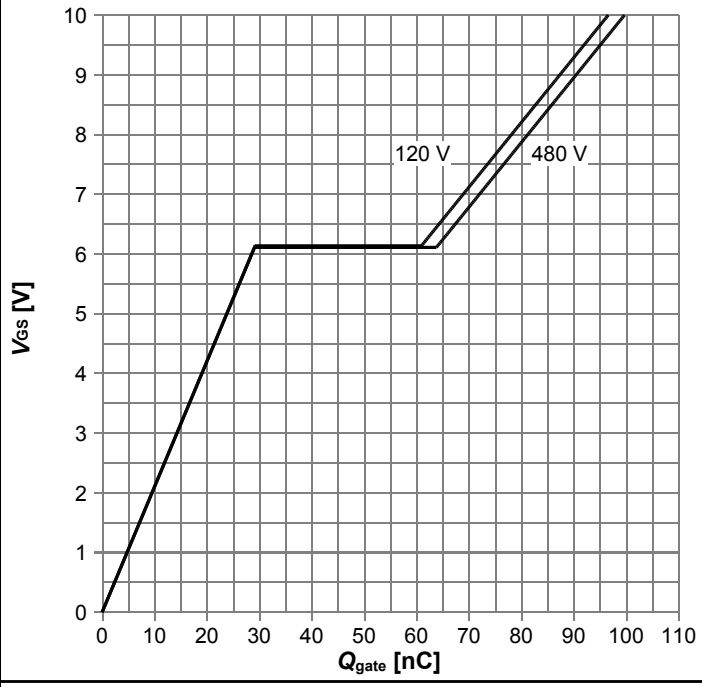
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**Diagram 9: Typ. transfer characteristics**



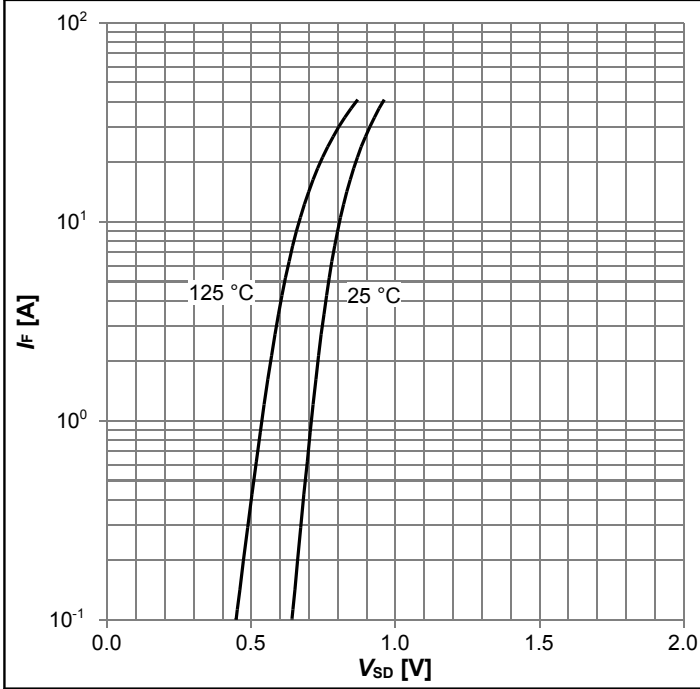

$I_D$=f($V_{GS}$); $V_{DS}$=20V; parameter: $T_j$

**Diagram 10: Typ. gate charge**



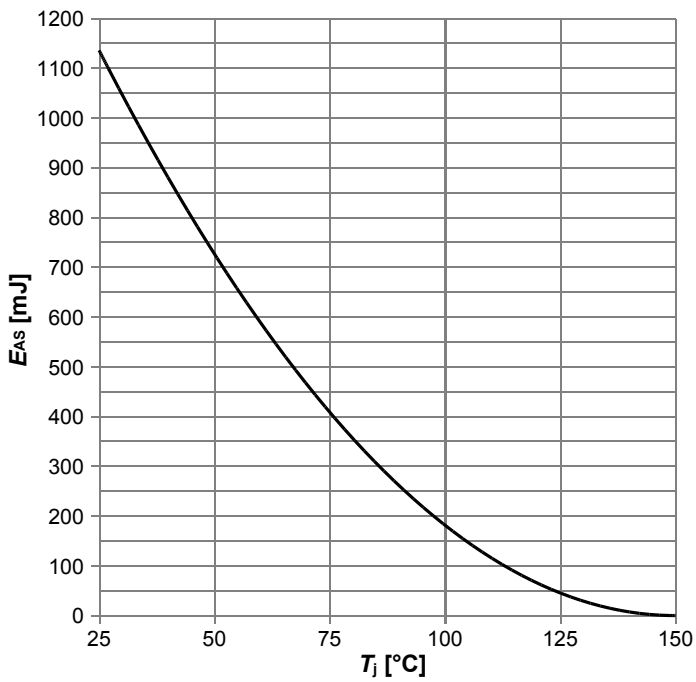

$V_{GS}$=f($Q_{gate}$); $I_D$=25.8 A pulsed; parameter: $V_{DD}$

**Diagram 11: Forward characteristics of reverse diode**




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

**Diagram 12: Avalanche energy**

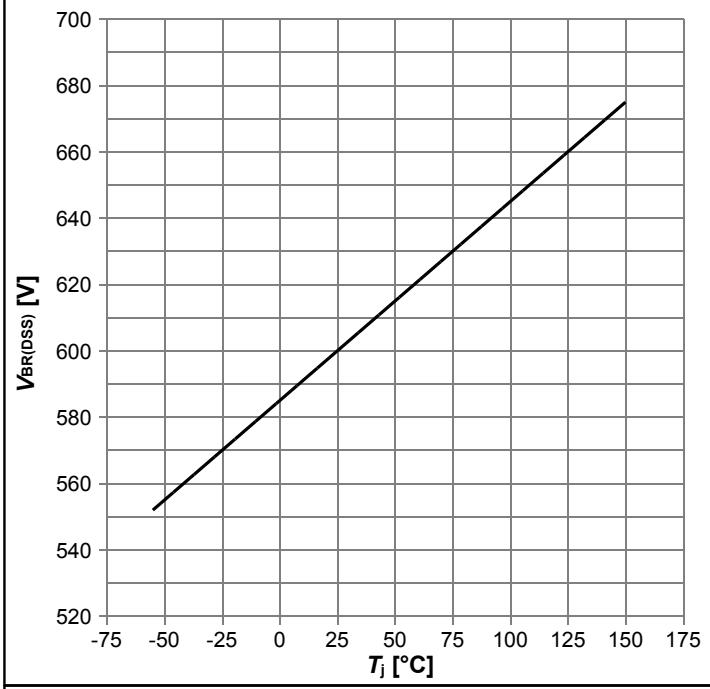



$E_{AS}$=f($T_j$); $I_D$=9.3 A; $V_{DD}$=50 V



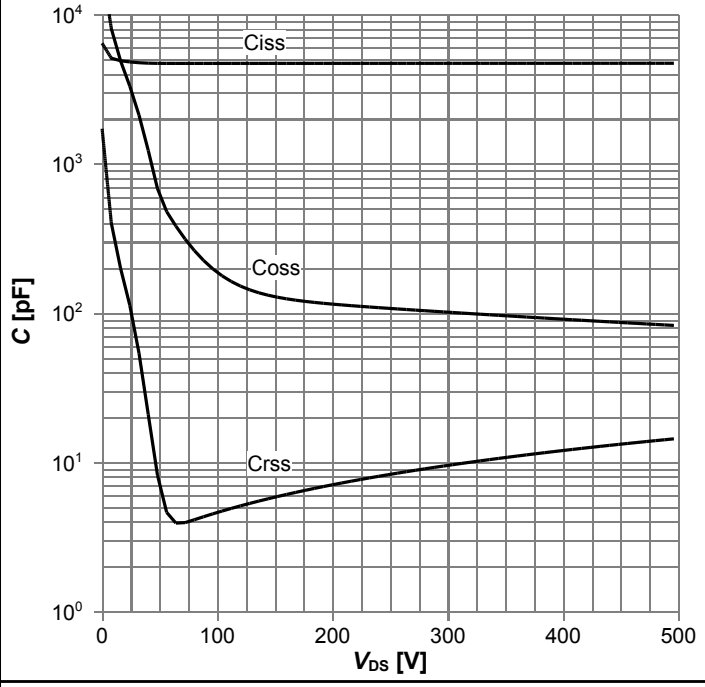
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**Diagram 13: Drain-source breakdown voltage**



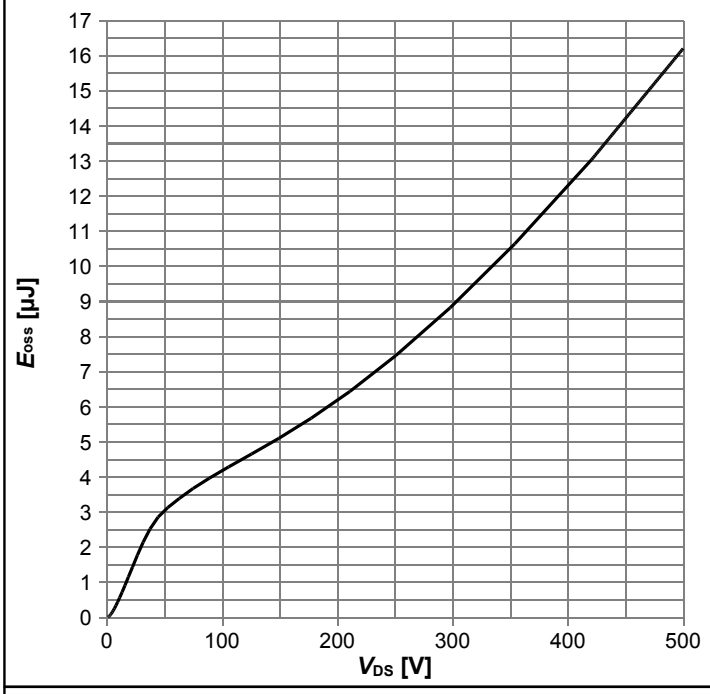

$V_{BR(DSS)}$=f($T_j$); $I_D$=1 mA

**Diagram 14: Typ. capacitances**




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

**Diagram 15: Typ. Coss stored energy**




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



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# 6 Test Circuits

**Table 8 Diode characteristics**

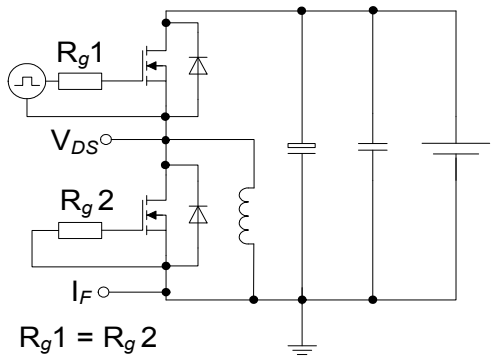
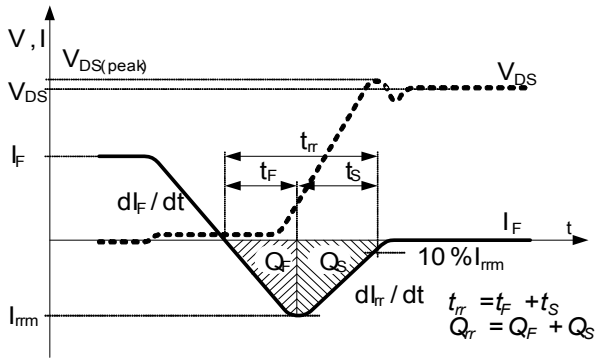
| Test circuit for diode characteristics | Diode recovery waveform |
|---|---|
|  |  |



**Table 9 switching times (ss)**

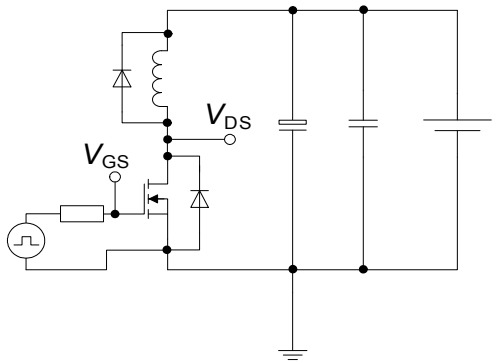
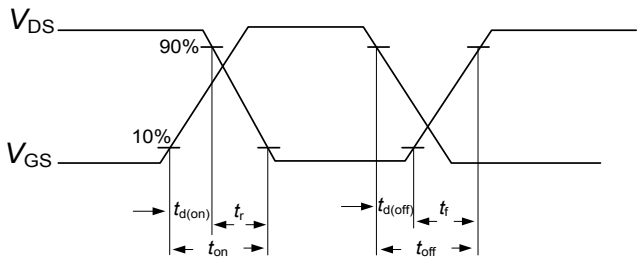
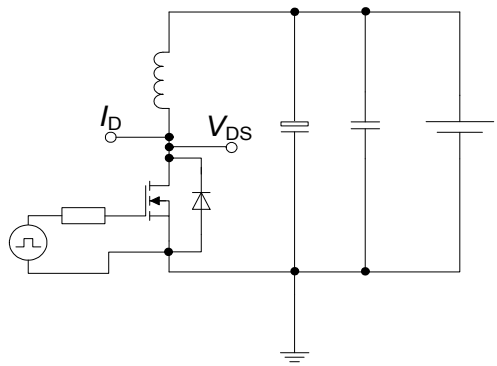
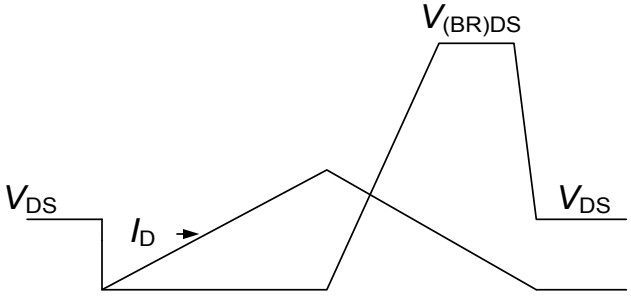
| Switching times test circuit for inductive load | Switching times waveform |
|---|---|
|  |  |



**Table 10 Unclamped inductive load (ss)**

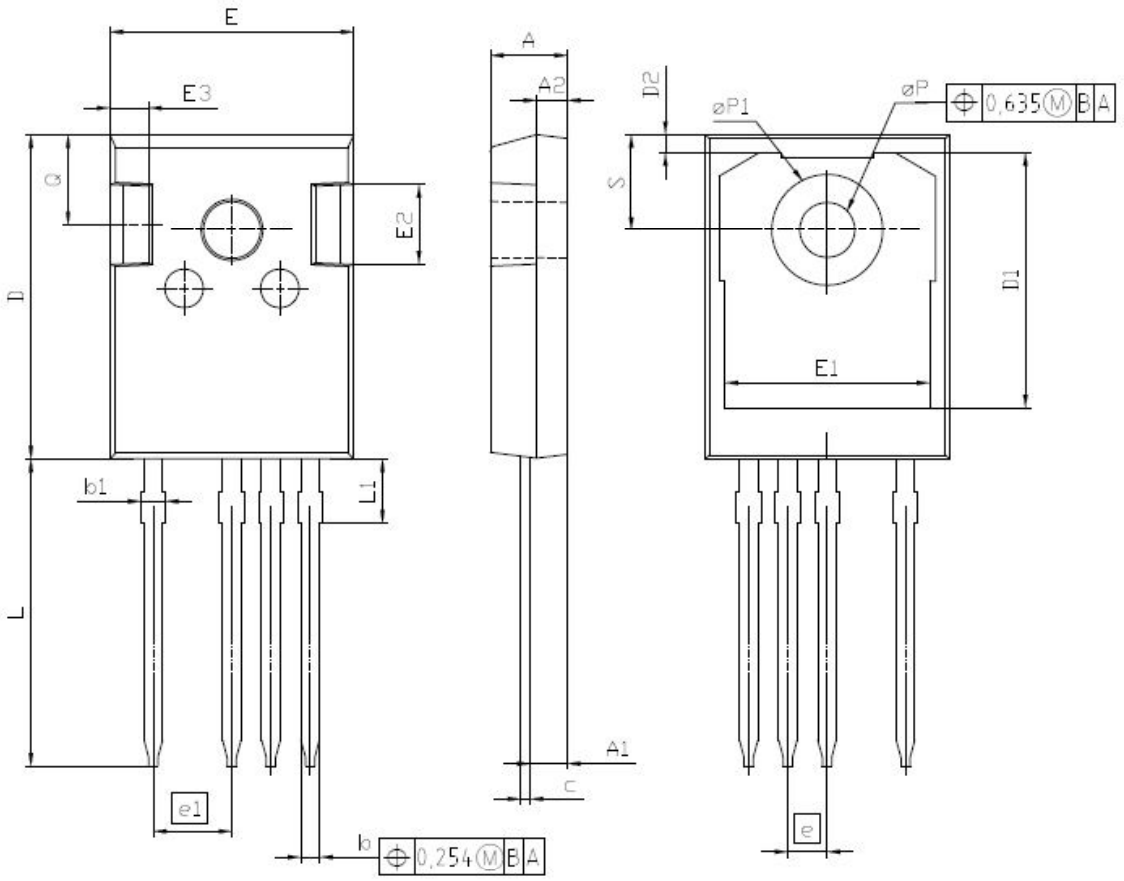
| Unclamped inductive load test circuit | Unclamped inductive waveform |
|---|---|
|  |  |





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## 7 Package Outlines




| DIM | MILLIMETERS | | INCHES | |
|---|---|---|---|---|
| | MIN | MAX | MIN | MAX |
| A | 4.83 | 5.21 | 0.190 | 0.205 |
| A1 | 2.29 | 2.54 | 0.090 | 0.100 |
| A2 | 1.90 | 2.16 | 0.075 | 0.085 |
| b | 1.07 | 1.33 | 0.042 | 0.052 |
| b1 | 1.10 | 1.70 | 0.043 | 0.067 |
| c | 0.50 | 0.70 | 0.020 | 0.028 |
| D | 20.80 | 21.10 | 0.819 | 0.831 |
| D1 | 16.25 | 17.65 | 0.640 | 0.695 |
| D2 | 0.95 | 1.35 | 0.037 | 0.053 |
| E | 15.70 | 16.13 | 0.618 | 0.635 |
| E1 | 13.10 | 14.15 | 0.516 | 0.557 |
| E2 | 3.68 | 5.10 | 0.145 | 0.201 |
| E3 | 1.00 | 2.60 | 0.039 | 0.102 |
| e | 2.54 (BSC) | | 0.100 (BSC) | |
| e1 | 5.08 | | 0.200 | |
| N | 4 | | 4 | |
| L | 19.72 | 20.32 | 0.776 | 0.800 |
| L1 | 4.02 | 4.40 | 0.158 | 0.173 |
| øP | 3.50 | 3.70 | 0.138 | 0.146 |
| øP1 | 7.00 | 7.40 | 0.276 | 0.291 |
| Q | 5.49 | 6.00 | 0.216 | 0.236 |
| S | 6.04 | 6.30 | 0.238 | 0.248 |

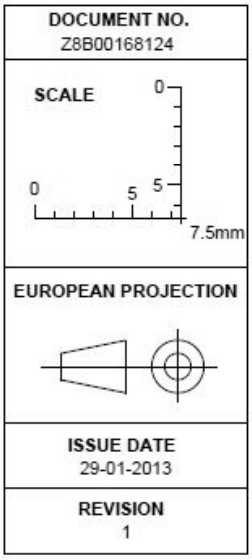



**Figure 1 Outline PG-TO 247-4**



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# 8 Appendix A

## Table 11 Related Links

- **IFX CoolMOS™ P6 Webpage:** www.infineon.com
- **IFX CoolMOS™ P6 application note:** www.infineon.com
- **IFX CoolMOS™ P6 simulation model:** www.infineon.com
- **IFX Design tools:** www.infineon.com



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## Revision History

IPZ60R070P6

**Revision: 2015-07-13, Rev. 2.0**

| Previous Revision | | |
|---|---|---|
| Revision | Date | Subjects (major changes since last revision) |
| 2.0 | 2015-07-13 | Release of final version |

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