# MOSFET

Metal Oxide Semiconductor Field Effect Transistor

# CoolMOS™ CE

500V CoolMOS™ CE Power Transistor
IPD50R500CE

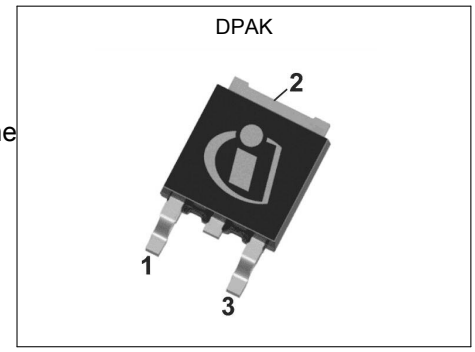
## Data Sheet

Rev. 2.0
Final

## Industrial & Multimarket

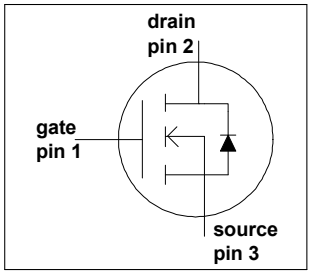
## 1 Description

CoolMOS™ is a revolutionary technology for high voltage power MOSFETs, designed according to the superjunction (SJ) principle and pioneered by Infineon Technologies. CoolMOS™ CE series combines the experience of the leading SJ MOSFET supplier with high class innovation while representing a cost appealing alternative compared to standard MOSFETs in target applications. 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 Rdson*Qg and Eoss
- 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, LCD & PDP TV and Lighting.

RoHS

### Table 1 Key Performance Parameters

| Parameter | Value | Unit |
|---|---|---|
| $V_{DS}$ @ $T_{j,max}$ | 550 | V |
| $R_{DS(on),max}$ | 0.5 | Ω |
| $Q_{g.typ}$ | 18.7 | nC |
| $I_{D,pulse}$ | 24 | A |
| $E_{oss}$@400V | 2.02 | µJ |
| Body diode di/dt | 500 | A/µs |

| Type / Ordering Code | Package | Marking | Related Links |
|---|---|---|---|
| IPD50R500CE | PG-TO 252 | 5R500CE | 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>- | 7.6<br>4.8 | A | $T_C$ = 25°C<br>$T_C$ = 100°C |
| Pulsed drain current[2] | $I_{D,pulse}$ | - | - | 24 | A | $T_C$=25°C |
| Avalanche energy, single pulse | $E_{AS}$ | - | - | 129 | mJ | $I_D$ =2.9A; $V_{DD}$ = 50V |
| Avalanche energy, repetitive | $E_{AR}$ | - | - | 0.20 | mJ | $I_D$ =2.9A; $V_{DD}$ = 50V |
| Avalanche current, repetitive | $I_{AR}$ | - | - | 2.9 | A | - |
| MOSFET dv/dt ruggedness | dv/dt | - | - | 50 | V/ns | $V_{DS}$ =0...400V |
| Gate source voltage | $V_{GS}$ | -20<br>-30 | -<br>- | 20<br>30 | V | static;<br>AC (f>1 Hz) |
| Power dissipation (non FullPAK) TO-252 | $P_{tot}$ | - | - | 57 | W | $T_C$=25°C |
| Operating and storage temperature | $T_j$, $T_{stg}$ | -55 | - | 150 | °C | - |
| Continuous diode forward current | $I_S$ | - | - | 6.6 | A | $T_C$=25°C |
| Diode pulse current[2] | $I_{S,pulse}$ | - | - | 24.0 | 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, $t_{cond}$<2µs |
| Maximum diode commutation speed[3] | $di_f/dt$ | - | - | 500 | A/µs | $V_{DS}$ =0...400V, $I_{SD}$<=$I_S$, $T_j$=25°C, $t_{cond}$<2µs |

## 3 Thermal characteristics

### Table 3 Thermal characteristics DPAK

| Parameter | Symbol | Values | | | Unit | Note / Test Condition |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| Thermal resistance, junction - case | $R_{thJC}$ | - | - | 2.19 | °C/W | - |
| Thermal resistance, junction - ambient[4] | $R_{thJA}$ | -<br>- | -<br>35 | 62<br>- | °C/W | SMD version, device on PCB, minimal footprint<br>SMD version, device on PCB, 6cm² cooling area[4] |
| Soldering temperature, wave- & reflowsoldering allowed | $T_{sold}$ | - | - | 260 | °C | reflow MSL 1 |

[1] Limited by $T_{j\,max}$. Maximum duty cycle D=0.75
[2] Pulse width $t_p$ limited by $T_{j,max}$
[3] $V_{DClink}$=400V; $V_{DS,peak}$< $V_{(BR)DSS}$; identical low side and high side switch with identical $R_G$
[4] Device on 40mm*40mm*1.5mm one layer epoxy PCB FR4 with 6cm² copper area (thickness 70µm) for drain connection. PCB is vertical without air stream cooling.

# 4 Electrical characteristics

## Table 4 Static characteristics

| Parameter | Symbol | Values | | | Unit | Note / Test Condition |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| Drain-source breakdown voltage | $V_{(BR)DSS}$ | 500 | - | - | V | $V_{GS}$=0V, $I_D$=1mA |
| Gate threshold voltage | $V_{(GS)th}$ | 2.50 | 3 | 3.50 | V | $V_{DS}$= $V_{GS}$, $I_D$=0.2mA |
| Zero gate voltage drain current | $I_{DSS}$ | -<br>- | -<br>10 | 1<br>- | µA | $V_{DS}$=500V, $V_{GS}$=0V, $T_j$=25°C<br>$V_{DS}$=500V, $V_{GS}$=0V, $T_j$=150°C |
| Gate-source leakage curent | $I_{GSS}$ | - | - | 100 | nA | $V_{GS}$=20V, $V_{DS}$=0V |
| Drain-source on-state resistance | $R_{DS(on)}$ | -<br>- | 0.45<br>1.18 | 0.50<br>- | Ω | $V_{GS}$=13V, $I_D$=2.3A, $T_j$=25°C<br>$V_{GS}$=13V, $I_D$=2.3A, $T_j$=150°C |
| Gate resistance | $R_G$ | - | 3 | - | Ω | $f$=1 MHz, open drain |

## Table 5 Dynamic characteristics

| Parameter | Symbol | Values | | | Unit | Note / Test Condition |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| Input capacitance | $C_{iss}$ | - | 433 | - | pF | $V_{GS}$=0V, $V_{DS}$=100V, $f$=1MHz |
| Output capacitance | $C_{oss}$ | - | 31 | - | pF | $V_{GS}$=0V, $V_{DS}$=100V, $f$=1MHz |
| Effective output capacitance, energy related[1)] | $C_{o(er)}$ | - | 25 | - | pF | $V_{GS}$=0V, $V_{DS}$=0...400V |
| Effective output capacitance, time related[2)] | $C_{o(tr)}$ | - | 100 | - | pF | $I_D$=constant, $V_{GS}$=0V, $V_{DS}$=0...400V |
| Turn-on delay time | $t_{d(on)}$ | - | 6 | - | ns | $V_{DD}$=400V, $V_{GS}$=13V, $I_D$=2.9A, $R_G$=3.4Ω |
| Rise time | $t_r$ | - | 5 | - | ns | $V_{DD}$=400V, $V_{GS}$=13V, $I_D$=2.9A, $R_G$=3.4Ω |
| Turn-off delay time | $t_{d(off)}$ | - | 30 | - | ns | $V_{DD}$=400V, $V_{GS}$=13V, $I_D$=2.9A, $R_G$=3.4Ω |
| Fall time | $t_f$ | - | 12 | - | ns | $V_{DD}$=400V, $V_{GS}$=13 V, $I_D$=2.9A, $R_G$=3.4Ω |

## Table 6 Gate charge characteristics

| Parameter | Symbol | Values | | | Unit | Note / Test Condition |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| Gate to source charge | $Q_{gs}$ | - | 2.3 | - | nC | $V_{DD}$=400V, $I_D$=2.9A, $V_{GS}$=0 to 10V |
| Gate to drain charge | $Q_{gd}$ | - | 10 | - | nC | $V_{DD}$=400V, $I_D$=2.9A, $V_{GS}$=0 to 10V |
| Gate charge total | $Q_g$ | - | 18.7 | - | nC | $V_{DD}$=400V, $I_D$=2.9A, $V_{GS}$=0 to 10V |
| Gate plateau voltage | $V_{plateau}$ | - | 5.3 | - | V | $V_{DD}$=400V, $I_D$=2.9A, $V_{GS}$=0 to 10V |

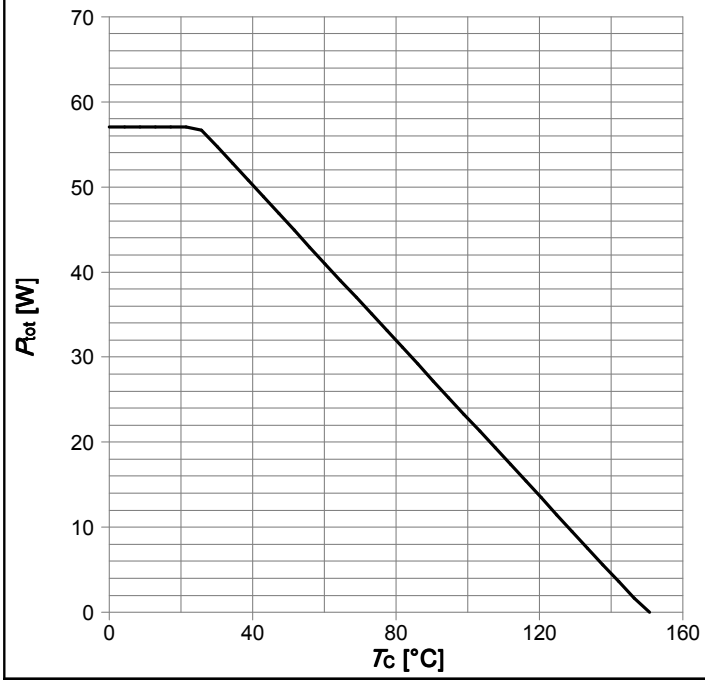
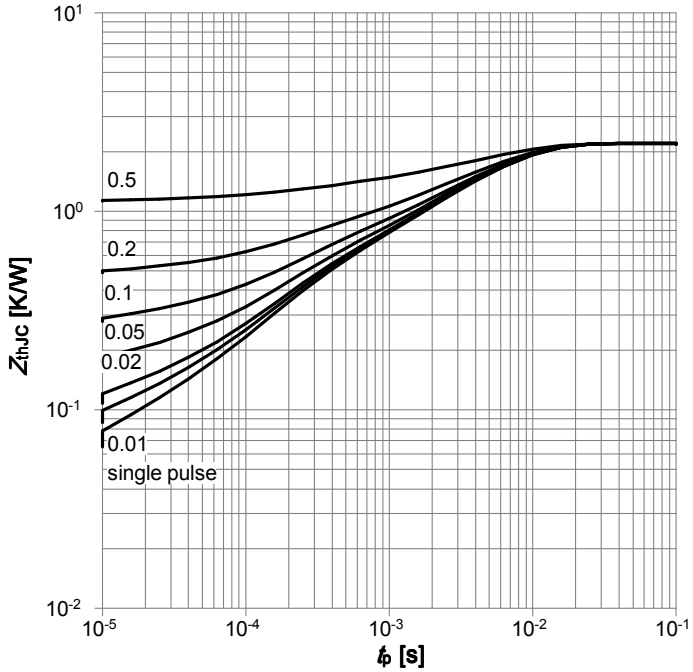
[1)] $C_{o(er)}$ is a fixed capacitance that gives the same stored energy as $C_{oss}$ while $V_{DS}$ is rising from 0 to 80% $V_{(BR)DSS}$
[2)] $C_{o(tr)}$ is a fixed capacitance that gives the same charging time as $C_{oss}$ while $V_{DS}$ is rising from 0 to 80% $V_{(BR)DSS}$

**Table 7 Reverse diode characteristics**

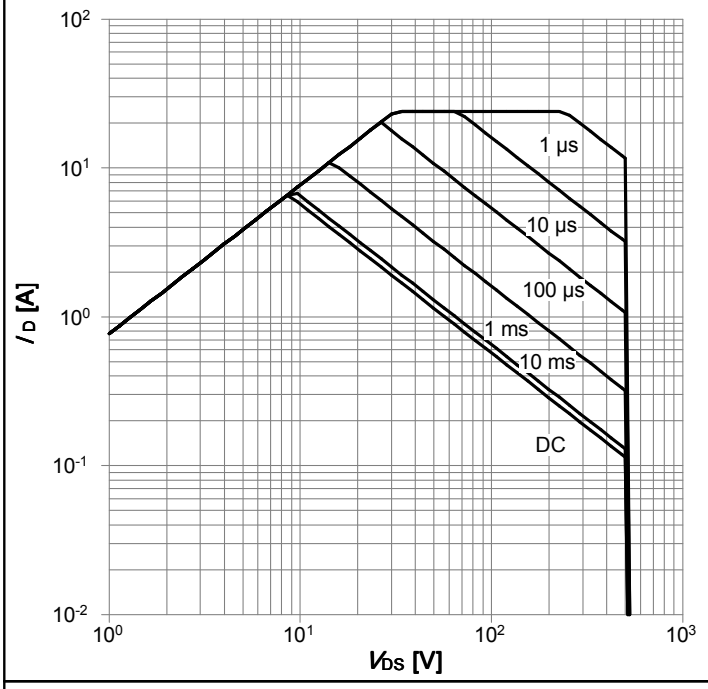
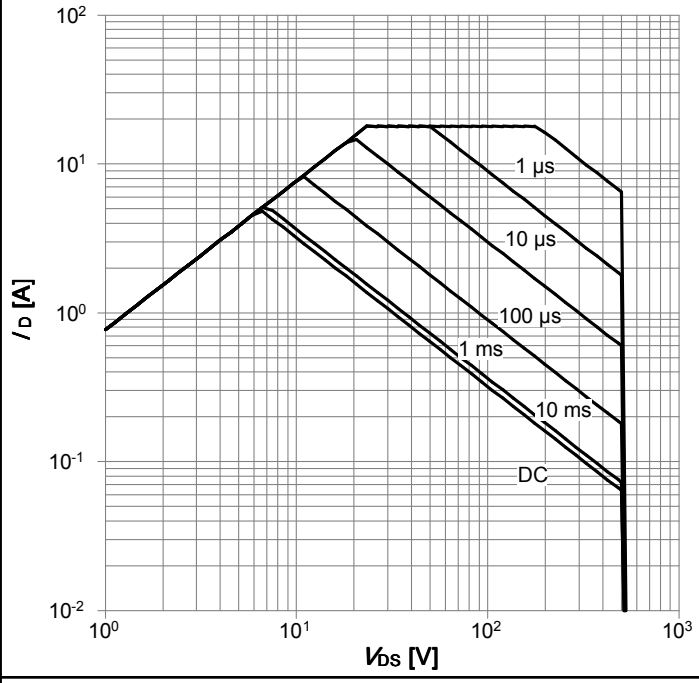
| Parameter | Symbol | Values | | | Unit | Note / Test Condition |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| Diode forward voltage | $V_{SD}$ | - | 0.85 | - | V | $V_{GS}$=0V, $I_F$=2.9A, $T_j$=25°C |
| Reverse recovery time | $t_{rr}$ | - | 180 | - | ns | $V_R$=400V, $I_F$=2.9A, d$i_F$/d$t$=100A/µs |
| Reverse recovery charge | $Q_{rr}$ | - | 1.2 | - | µC | $V_R$=400V, $I_F$=2.9A, d$i_F$/d$t$=100A/µs |
| Peak reverse recovery current | $I_{rrm}$ | - | 12 | - | A | $V_R$=400V, $I_F$=2.9A, d$i_F$/d$t$=100A/µs |

# 5 Electrical characteristics diagrams

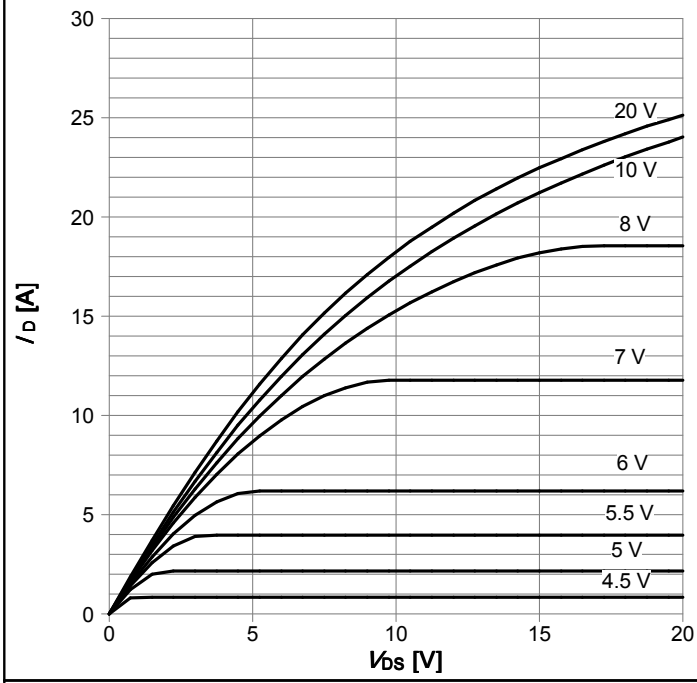
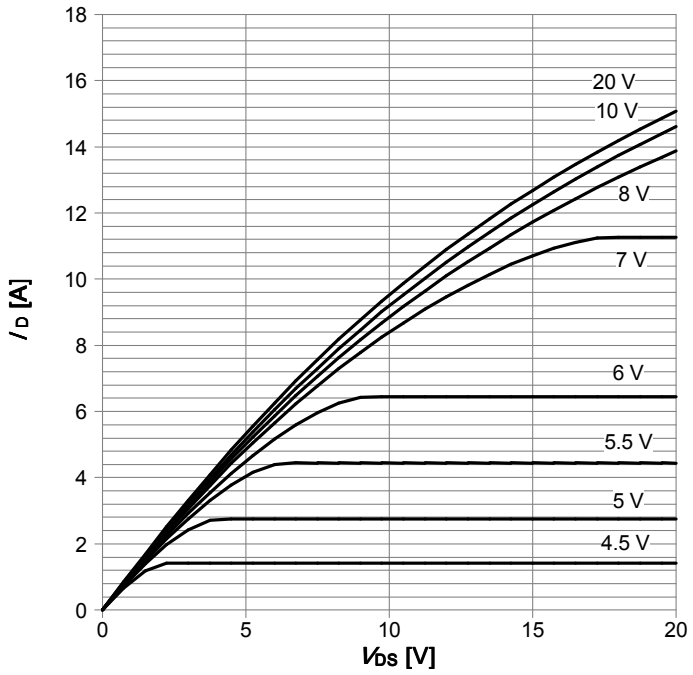
## Table 8

| Power dissipation (Non FullPAK) | Max. transient thermal impedance (Non FullPAK) |
|---|---|
|  |  |
| $P_{tot}=f(T_C)$ | $Z_{thJC}=f(t_P)$; parameter: $D=t_p/T$ |

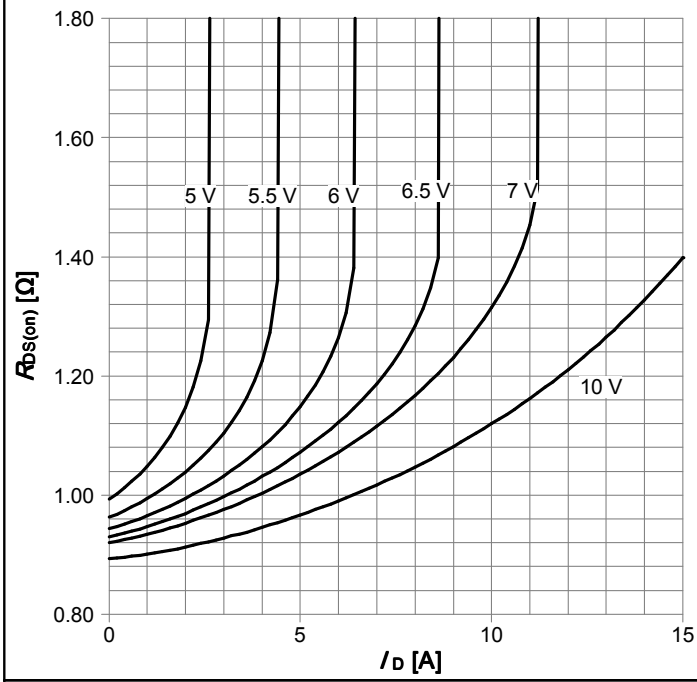
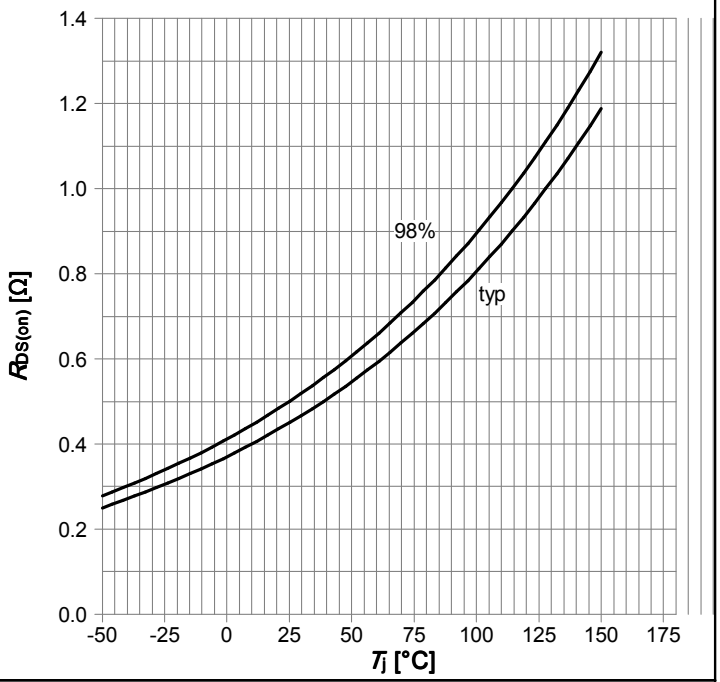
## Table 9

| Safe operating area (Non FullPAK) Tj=25°C | Safe operating area (Non FullPAK) Tj=80°C |
|---|---|
|  |  |
| $I_D=f(V_{DS})$; $T_C=25$ °C; $D=0$; parameter: $t_p$ | $I_D=f(V_{DS})$; $T_C=80$ °C; $D=0$; parameter: $t_p$ |

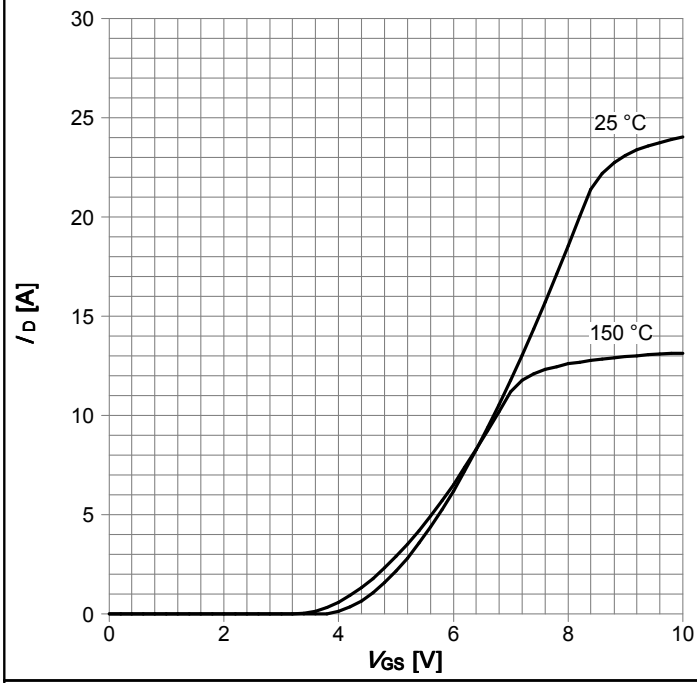
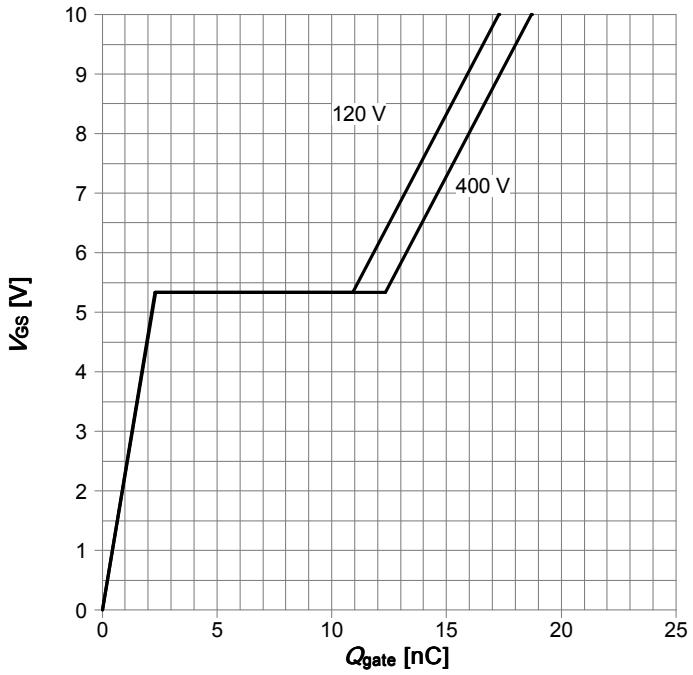
## Table 10

| Typ. output characteristics Tj=25°C | Typ. output characteristics Tj=125°C |
|---|---|
|  |  |
| $I_D=f(V_{DS})$; $T_j=25$ °C; parameter: $V_{GS}$ | $I_D=f(V_{DS})$; $T_j=125$ °C; parameter: $V_{GS}$ |

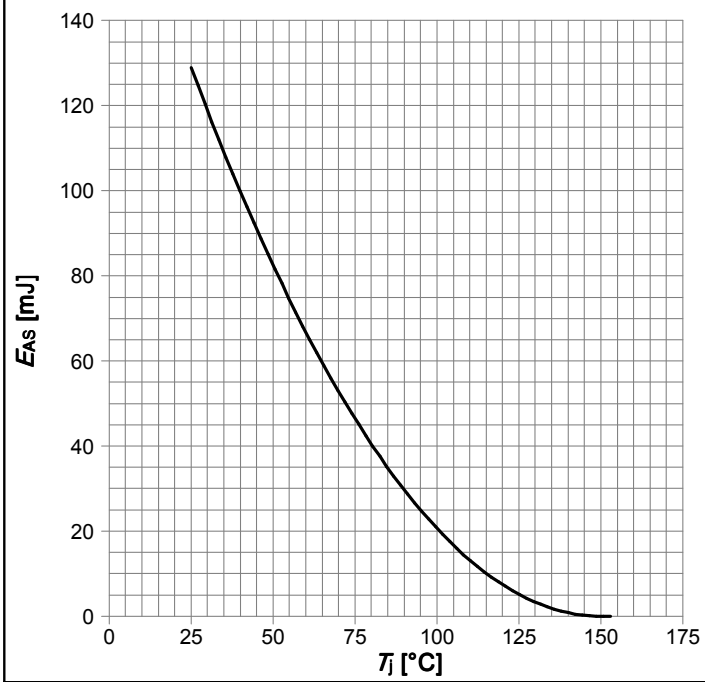
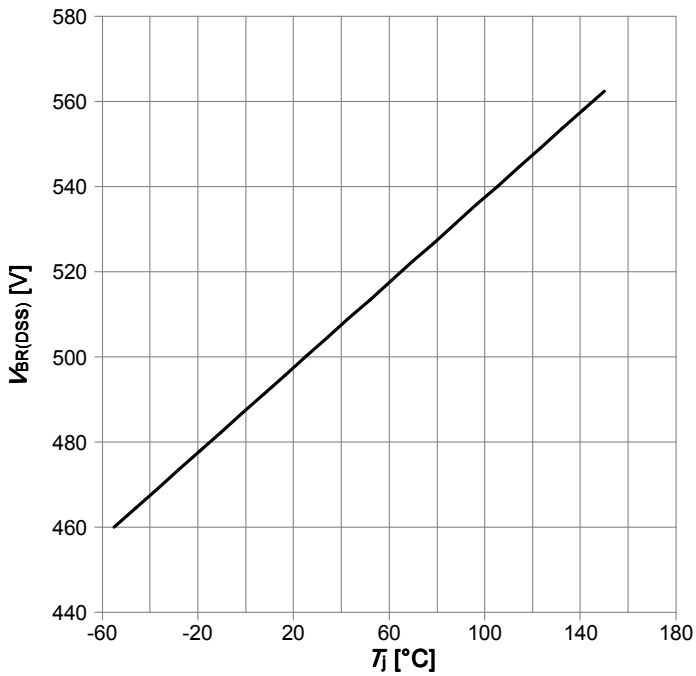
## Table 11

| Typ. drain-source on-state resistance | Drain-source on-state resistance |
|---|---|
|  |  |
| $R_{DS(on)}=f(I_D)$; $T_j=125$ °C; parameter: $V_{GS}$ | $R_{DS(on)}=f(T_j)$; $I_D=2.3$ A; $V_{GS}=13$ V |

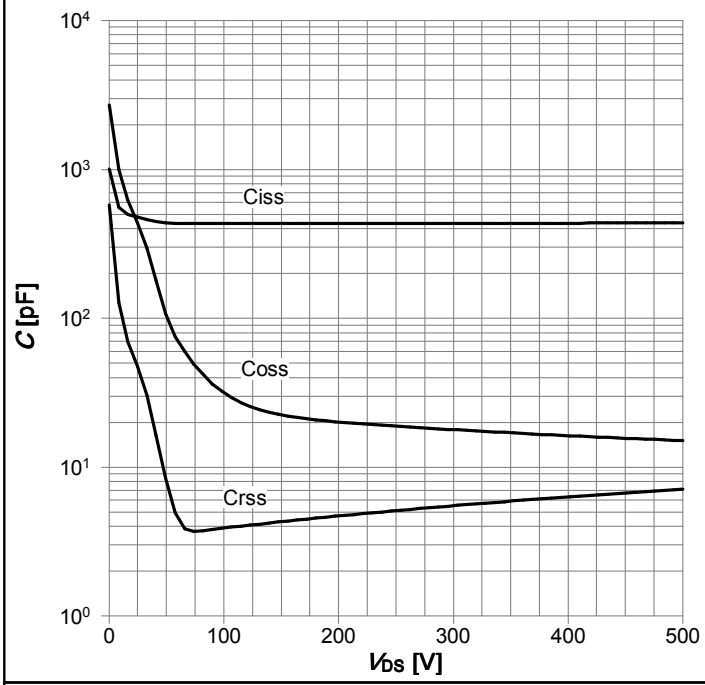
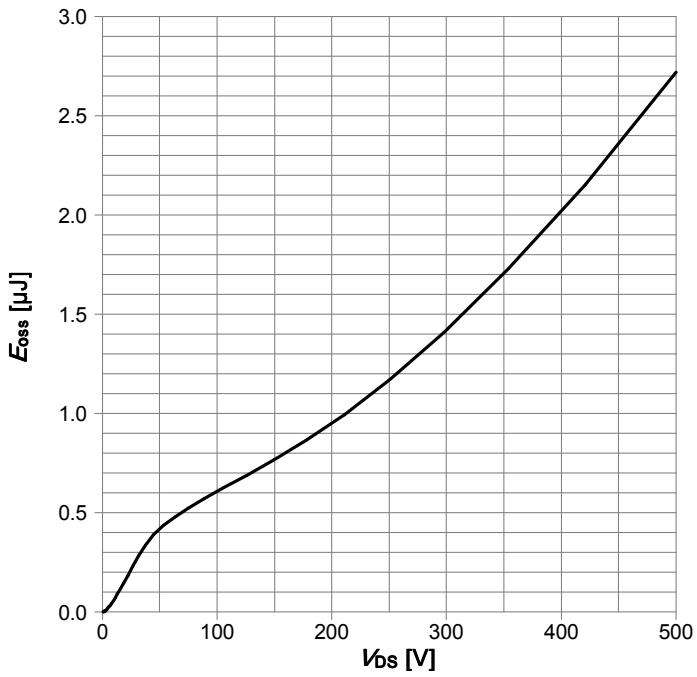
## Table 12

| Typ. transfer characteristics | Typ. gate charge |
|---|---|
|  |  |
| $I_D=f(V_{GS})$; $V_{DS}$=20V; parameter: $T_j$ | $V_{GS}=f(Q_{gate})$; $I_D$=2.9 A pulsed; parameter: $V_{DD}$ |

## Table 13

| Avalanche energy | Drain-source breakdown voltage |
|---|---|
|  |  |
| $E_{AS}=f(T_j)$; $I_D$=2.9 A; $V_{DD}$=50 V | $V_{BR(DSS)}=f(T_j)$; $I_D$=1 mA |

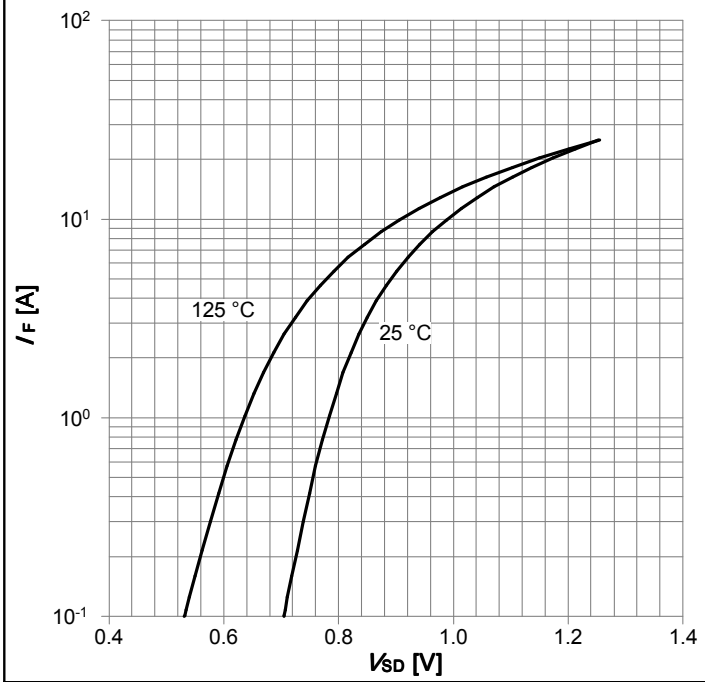
## Table 14

| Typ. capacitances | Typ. Coss stored energy |
|---|---|
|  |  |
| $C$=f($V_{DS}$); $V_{GS}$=0 V; $f$=1 MHz | $E_{oss}$=f($V_{DS}$) |





## Table 15

| Forward characteristics of reverse diode |
|---|
|  |
| $I_F$=f($V_{SD}$); parameter: $T_j$ |

# 6 Test Circuits

**Table 16 Diode characteristics**

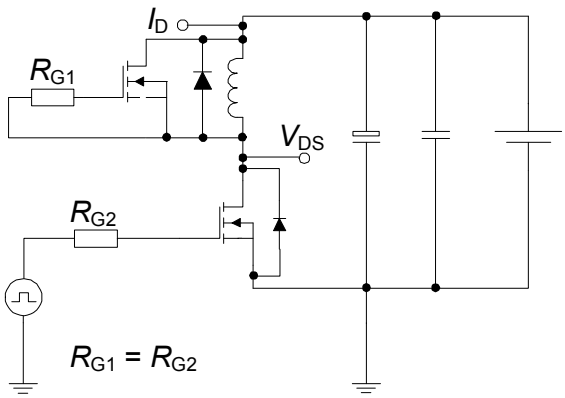
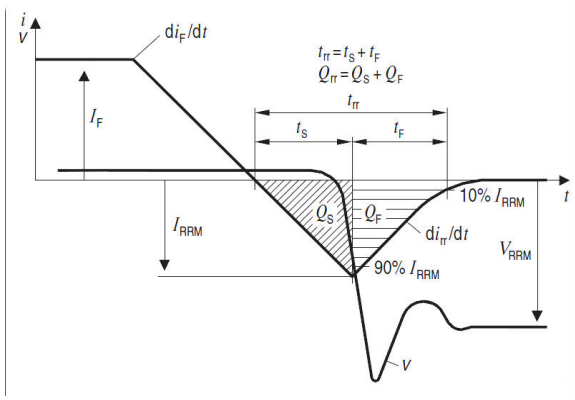
| Test circuit for diode characteristics | Diode recovery waveform |
|---|---|
|  |  |



**Table 17 Switching times**

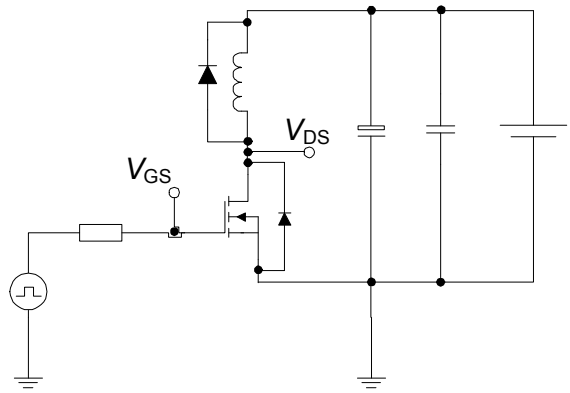
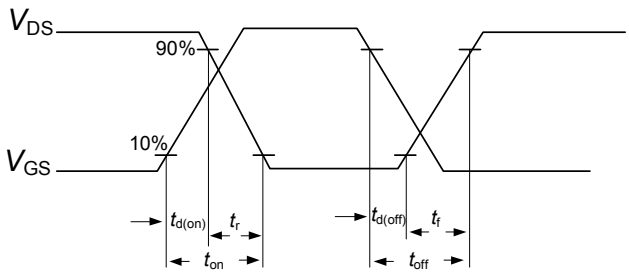
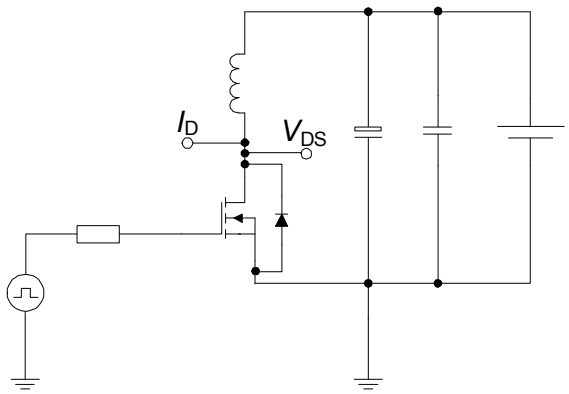
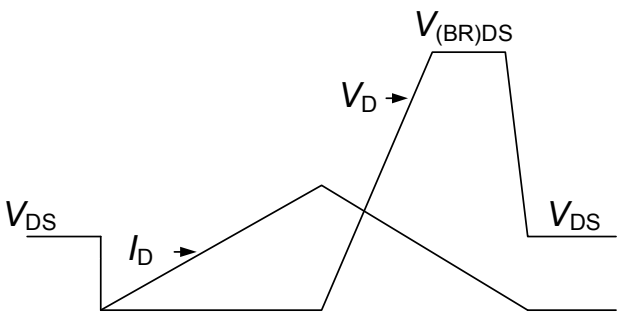
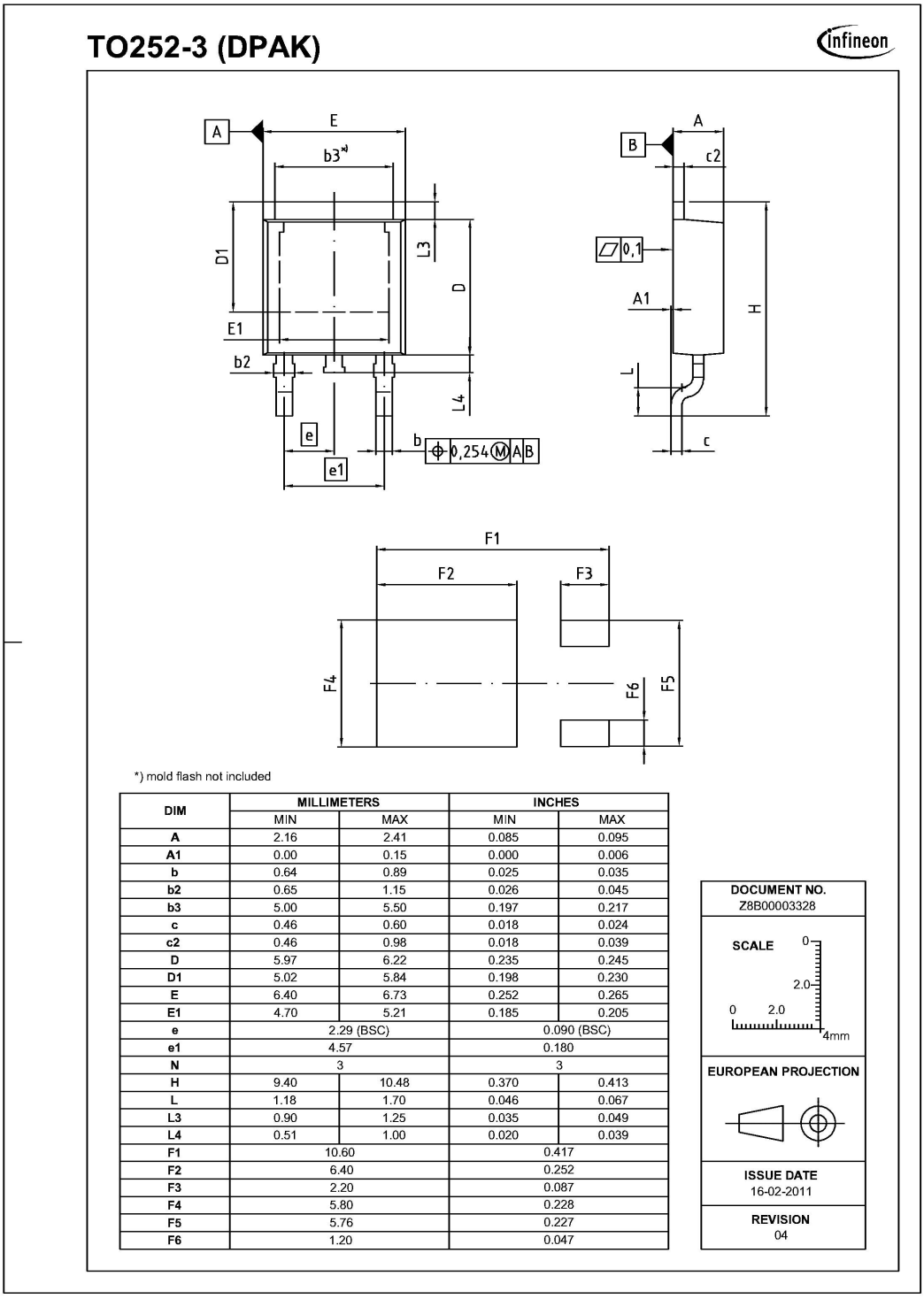
| Switching times test circuit for inductive load | Switching times waveform |
|---|---|
|  |  |



**Table 18 Unclamped inductive**

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

# 7 Package Outlines




*) mold flash not included

| DIM | MILLIMETERS | | INCHES | |
|---|---|---|---|---|
| | MIN | MAX | MIN | MAX |
| A | 2.16 | 2.41 | 0.085 | 0.095 |
| A1 | 0.00 | 0.15 | 0.000 | 0.006 |
| b | 0.64 | 0.89 | 0.025 | 0.035 |
| b2 | 0.65 | 1.15 | 0.026 | 0.045 |
| b3 | 5.00 | 5.50 | 0.197 | 0.217 |
| c | 0.46 | 0.60 | 0.018 | 0.024 |
| c2 | 0.46 | 0.98 | 0.018 | 0.039 |
| D | 5.97 | 6.22 | 0.235 | 0.245 |
| D1 | 5.02 | 5.84 | 0.198 | 0.230 |
| E | 6.40 | 6.73 | 0.252 | 0.265 |
| E1 | 4.70 | 5.21 | 0.185 | 0.205 |
| e | 2.29 (BSC) | | 0.090 (BSC) | |
| e1 | 4.57 | | 0.180 | |
| N | 3 | | 3 | |
| H | 9.40 | 10.48 | 0.370 | 0.413 |
| L | 1.18 | 1.70 | 0.046 | 0.067 |
| L3 | 0.90 | 1.25 | 0.035 | 0.049 |
| L4 | 0.51 | 1.00 | 0.020 | 0.039 |
| F1 | 10.60 | | 0.417 | |
| F2 | 6.40 | | 0.252 | |
| F3 | 2.20 | | 0.087 | |
| F4 | 5.80 | | 0.228 | |
| F5 | 5.76 | | 0.227 | |
| F6 | 1.20 | | 0.047 | |

DOCUMENT NO.
Z8B00003328

SCALE 0 2.0 0 2.0 4mm

EUROPEAN PROJECTION

ISSUE DATE
16-02-2011

REVISION
04

**Figure 1 Outline PG-TO 252, dimensions in mm/inches**

# 8 Appendix A

## Table 19 Related Links

- **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

IPD50R500CE

**Revision: 2012-06-28, Rev. 2.0**

| Previous Revision | | |
|---|---|---|
| Revision | Date | Subjects (major changes since last revision) |
| 2.0 | 2012-06-28 | Release of final version |

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