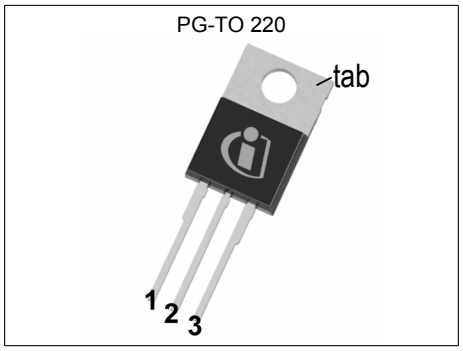
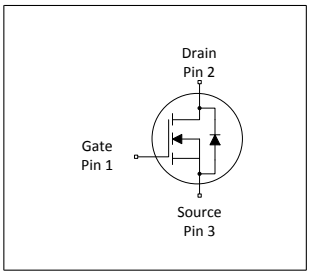
# MOSFET

## 500V CoolMOS™ CE Power Transistor




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, 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 PWM stages for e.g. PC Silverbox, LCD & PDP TV and Lighting.

### Table 1 Key Performance Parameters

| Parameter | Value | Unit |
|---|---|---|
| $V_{DS}$ @ $T_{j,max}$ | 550 | V |
| $R_{DS(on),max}$ | 0.38 | Ω |
| $I_D$ | 14.1 | A |
| $Q_{g,typ}$ | 24.8 | nC |
| $I_{D,pulse}$ | 32.4 | A |
| $E_{oss}$ @ 400V | 2.54 | µJ |

| Type / Ordering Code | Package | Marking | Related Links |
|---|---|---|---|
| IPP50R380CE | PG-TO 220 | 5R380CE | see Appendix A |

## Table of Contents

# 1 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>- | 14.1<br>8.9 | A | $T_C$ = 25°C<br>$T_C$ = 100°C |
| Pulsed drain current[2] | $I_{D,pulse}$ | - | - | 32.4 | A | $T_C$=25°C |
| Avalanche energy, single pulse | $E_{AS}$ | - | - | 173 | mJ | $I_D$ =4A; $V_{DD}$ = 50V |
| Avalanche energy, repetitive | $E_{AR}$ | - | - | 0.26 | mJ | $I_D$ =4A; $V_{DD}$ = 50V |
| Avalanche current, repetitive | $I_{AR}$ | - | - | 4.0 | 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)<br>TO-220 | $P_{tot}$ | - | - | 98 | W | $T_C$=25°C |
| Operating and storage temperature | $T_j$, $T_{stg}$ | -55 | - | 150 | °C | - |
| Mounting torque (non FullPAK) TO-220 | - | - | - | 60 | Ncm | M3 and M3.5 screws |
| Continuous diode forward current | $I_S$ | - | - | 10 | A | $T_C$=25°C |
| Diode pulse current[2] | $I_{S,pulse}$ | - | - | 32.4 | 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 |

# 2 Thermal characteristics

## Table 3 Thermal characteristics (non FullPAK) TO-220

| Parameter | Symbol | Values | | | Unit | Note / Test Condition |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| Thermal resistance, junction - case | $R_{thJC}$ | - | - | 1.27 | °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 |

[1] Limited by $T_{j\,max}$ <150°C, Maximum Duty Cycle D = 0.5
[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 $R_G$

# 3 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 | $V_{DS}$=$V_{GS}$, $I_D$=0.26mA |
| 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>- | 0.35<br>0.90 | 0.38<br>- | Ω | $V_{GS}$=13V, $I_D$=3.2A, $T_j$=25°C<br>$V_{GS}$=13V, $I_D$=3.2A, $T_j$=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 | $C_{iss}$ | - | 584 | - | pF | $V_{GS}$=0V, $V_{DS}$=100V, $f$=1MHz |
| Output capacitance | $C_{oss}$ | - | 40 | - | pF | $V_{GS}$=0V, $V_{DS}$=100V, $f$=1MHz |
| Effective output capacitance, energy related[1)] | $C_{o(er)}$ | - | 32 | - | pF | $V_{GS}$=0V, $V_{DS}$=0...400V |
| Effective output capacitance, time related[2)] | $C_{o(tr)}$ | - | 133 | - | pF | $I_D$=constant, $V_{GS}$=0V, $V_{DS}$=0...400V |
| Turn-on delay time | $t_{d(on)}$ | - | 7.2 | - | ns | $V_{DD}$=400V, $V_{GS}$=13V, $I_D$=3.9A, $R_G$=3.4Ω |
| Rise time | $t_r$ | - | 5.6 | - | ns | $V_{DD}$=400V, $V_{GS}$=13V, $I_D$=3.9A, $R_G$=3.4Ω |
| Turn-off delay time | $t_{d(off)}$ | - | 35 | - | ns | $V_{DD}$=400V, $V_{GS}$=13V, $I_D$=3.9A, $R_G$=3.4Ω |
| Fall time | $t_f$ | - | 8.6 | - | ns | $V_{DD}$=400V, $V_{GS}$=13 V, $I_D$=3.9A, $R_G$=3.4Ω |

## Table 6 Gate charge characteristics

| Parameter | Symbol | Values | | | Unit | Note / Test Condition |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| Gate to source charge | $Q_{gs}$ | - | 3.1 | - | nC | $V_{DD}$=400V, $I_D$=3.9A, $V_{GS}$=0 to 10V |
| Gate to drain charge | $Q_{gd}$ | - | 13.1 | - | nC | $V_{DD}$=400V, $I_D$=3.9A, $V_{GS}$=0 to 10V |
| Gate charge total | $Q_g$ | - | 24.8 | - | nC | $V_{DD}$=400V, $I_D$=3.9A, $V_{GS}$=0 to 10V |
| Gate plateau voltage | $V_{plateau}$ | - | 5.3 | - | V | $V_{DD}$=400V, $I_D$=3.9A, $V_{GS}$=0 to 10V |

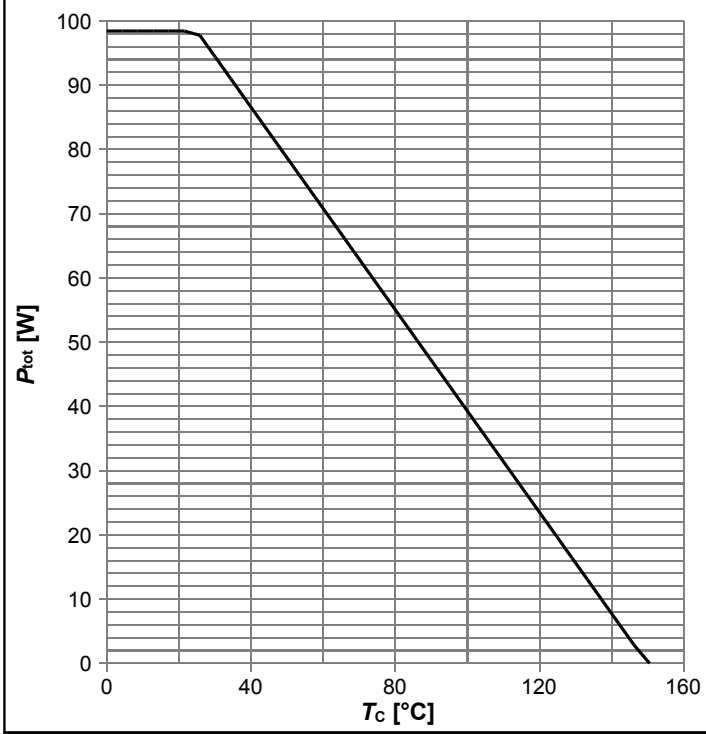
[1)] $C_{o(er)}$ is a fixed capacitance that gives the same stored energy as $C_{oss}$ while $V_{DS}$ is rising from 0 to 80% $V_{(BR)DSS}$
[2)] $C_{o(tr)}$ is a fixed capacitance that gives the same charging time as $C_{oss}$ while $V_{DS}$ is rising from 0 to 80% $V_{(BR)DSS}$

## 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, $I_F$=3.9A, $T_f$=25°C |
| Reverse recovery time | $t_{rr}$ | - | 207 | - | ns | $V_R$=400V, $I_F$=3.9A, d$i_F$/d$t$=100A/µs |
| Reverse recovery charge | $Q_{rr}$ | - | 1.7 | - | µC | $V_R$=400V, $I_F$=3.9A, d$i_F$/d$t$=100A/µs |
| Peak reverse recovery current | $I_{rrm}$ | - | 15.5 | - | A | $V_R$=400V, $I_F$=3.9A, d$i_F$/d$t$=100A/µs |

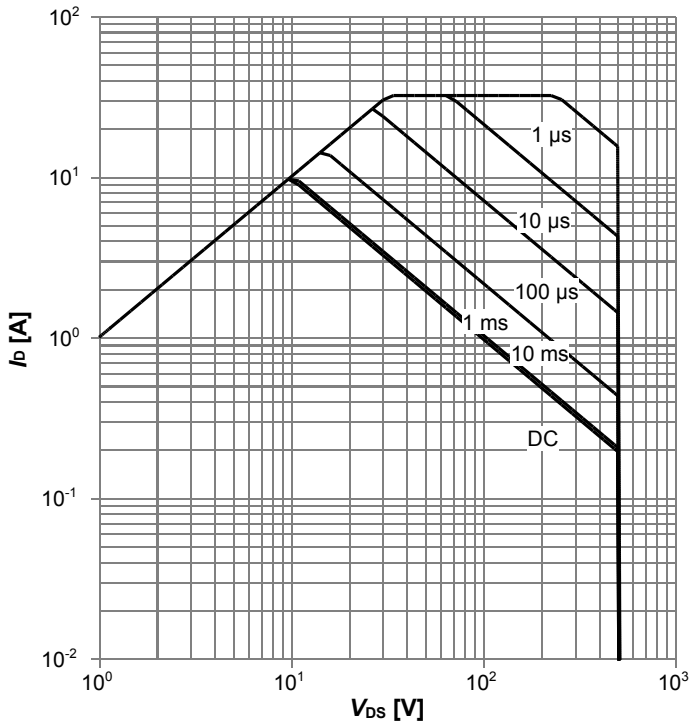
# 4 Electrical characteristics diagrams

**Diagram 1: Power dissipation**



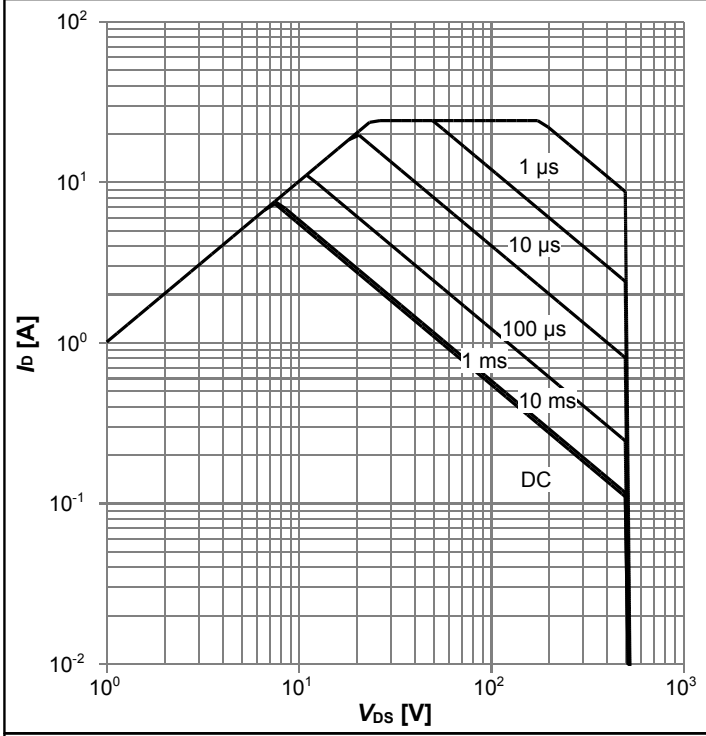

$P_{tot}=f(T_C)$

**Diagram 2: Safe operating area**



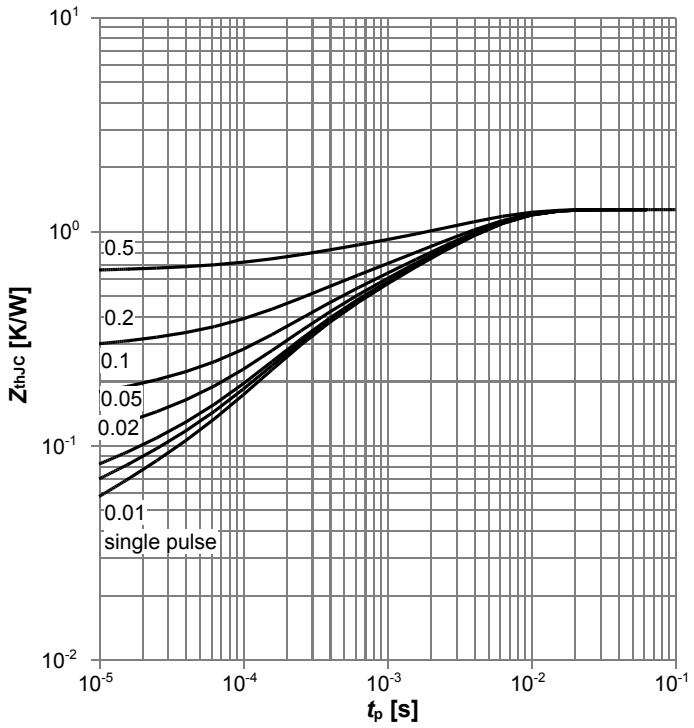

$I_D=f(V_{DS})$; $T_C=25$ °C; $D=0$; parameter: $t_p$

**Diagram 3: Safe operating area**



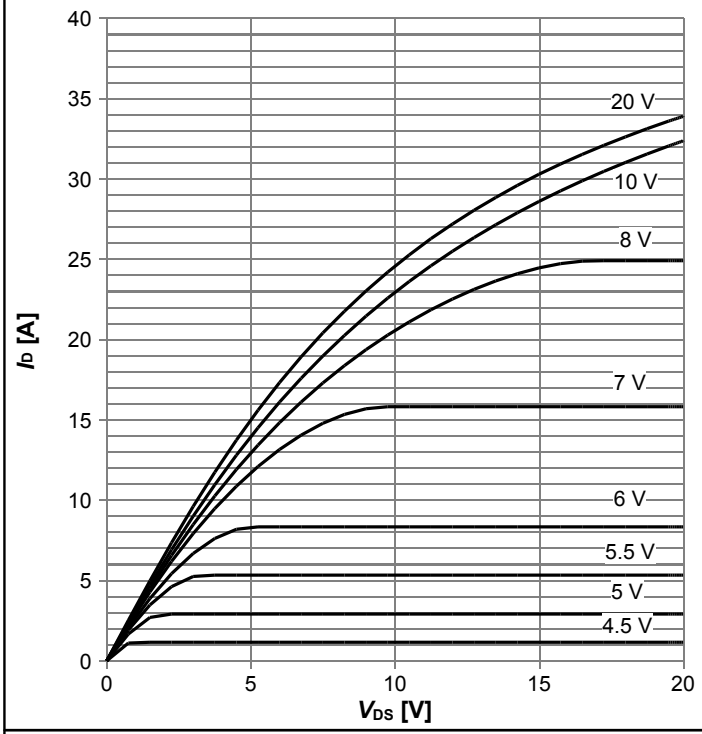

$I_D=f(V_{DS})$; $T_C=80$ °C; $D=0$; parameter: $t_p$

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



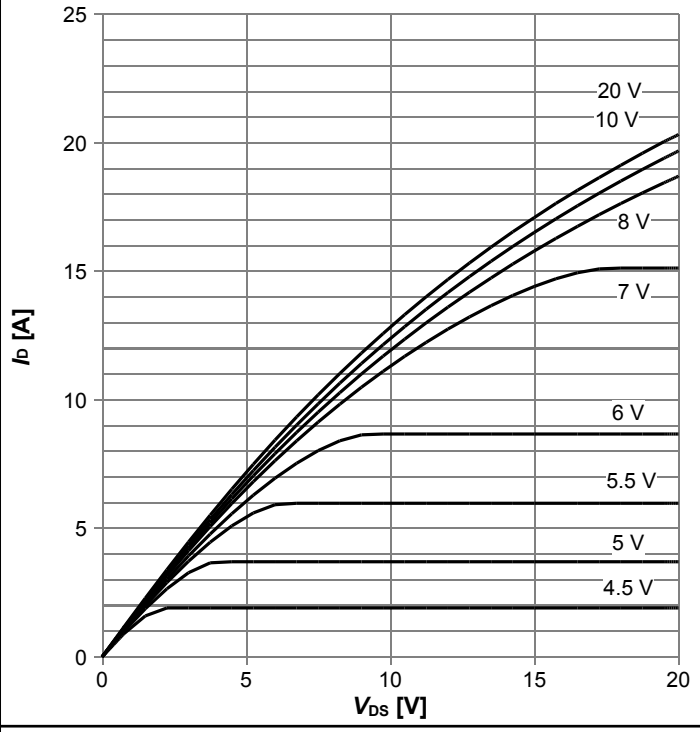

$Z_{thJC}=f(t_P)$; parameter: $D=t_p/T$

**Typ. output characteristics Tj=25°C**



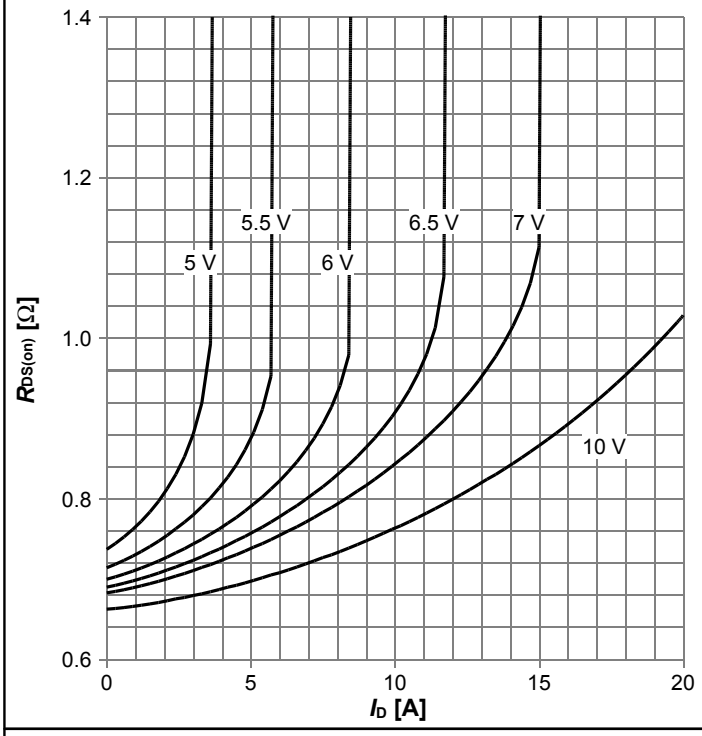

$I_D=f(V_{DS})$; $T_j=25$ °C; parameter: $V_{GS}$

**Typ. output characteristics Tj=125°C**



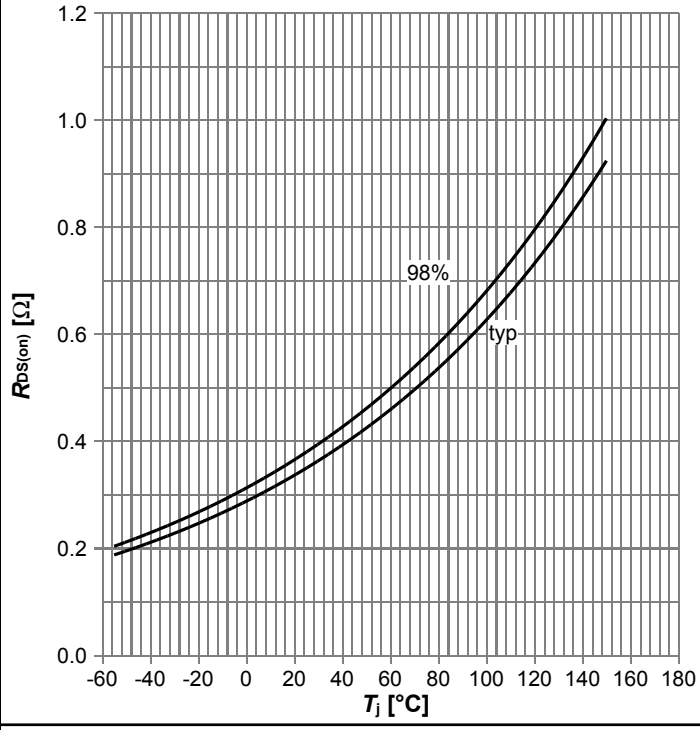

$I_D=f(V_{DS})$; $T_j=125$ °C; parameter: $V_{GS}$

**Typ. drain-source on-state resistance**



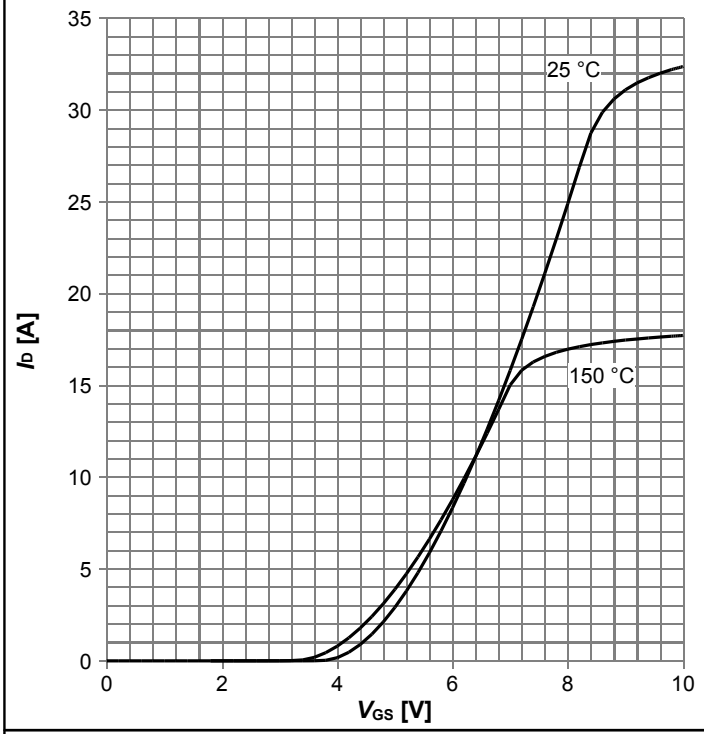

$R_{DS(on)}=f(I_D)$; $T_j=125$ °C; parameter: $V_{GS}$

**Drain-source on-state resistance**



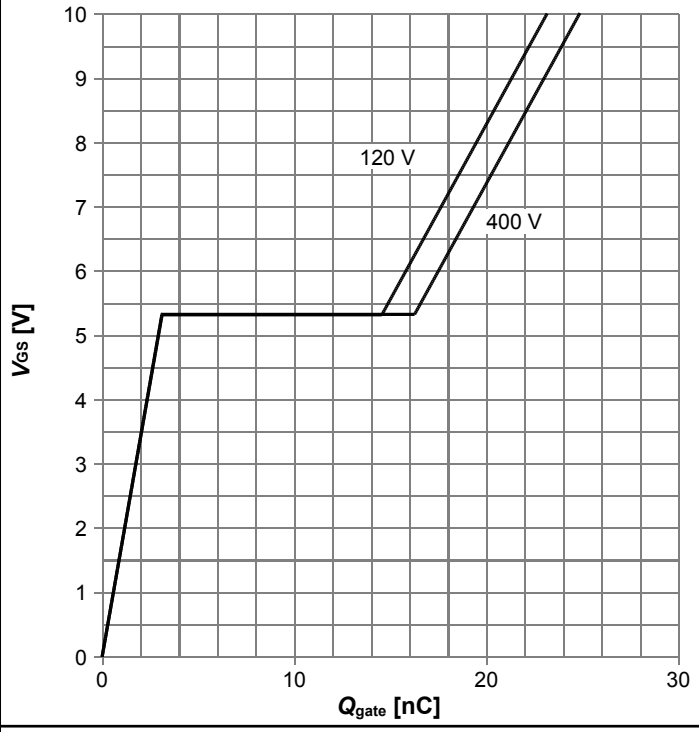

$R_{DS(on)}=f(T_j)$; $I_D=3.2$ A; $V_{GS}=13$ V

**Typ. transfer characteristics**



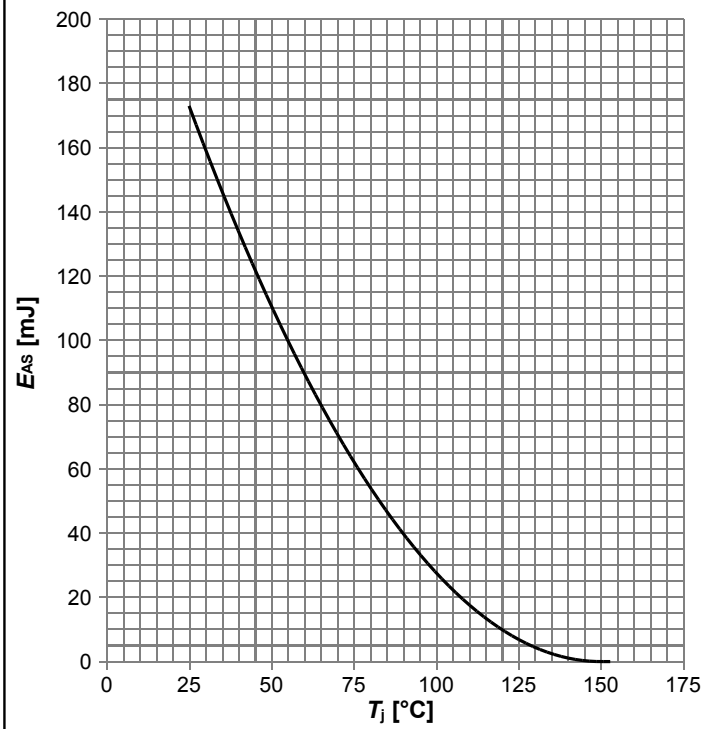

$I_D$=f($V_{GS}$); $V_{DS}$=20V; parameter: $T_j$

**Typ. gate charge**



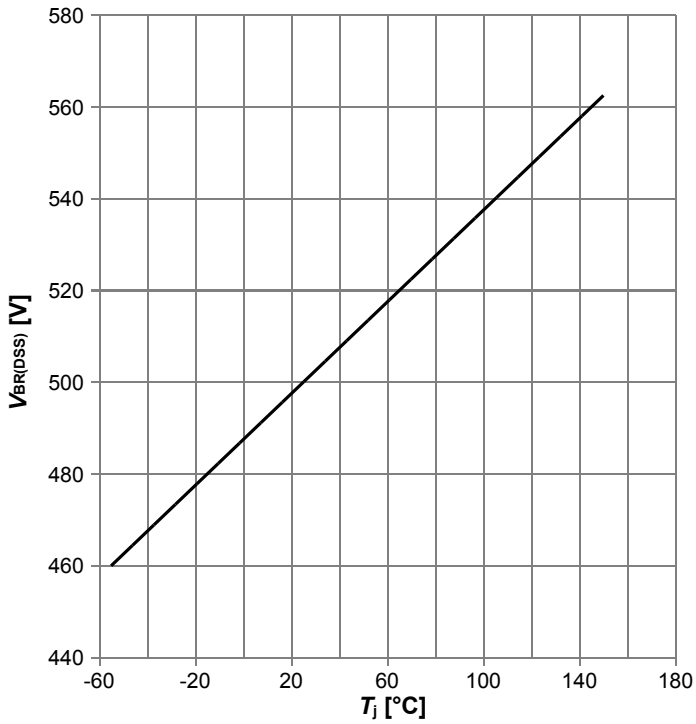

$V_{GS}$=f($Q_{gate}$); $I_D$=3.9 A pulsed; parameter: $V_{DD}$

**Avalanche energy**



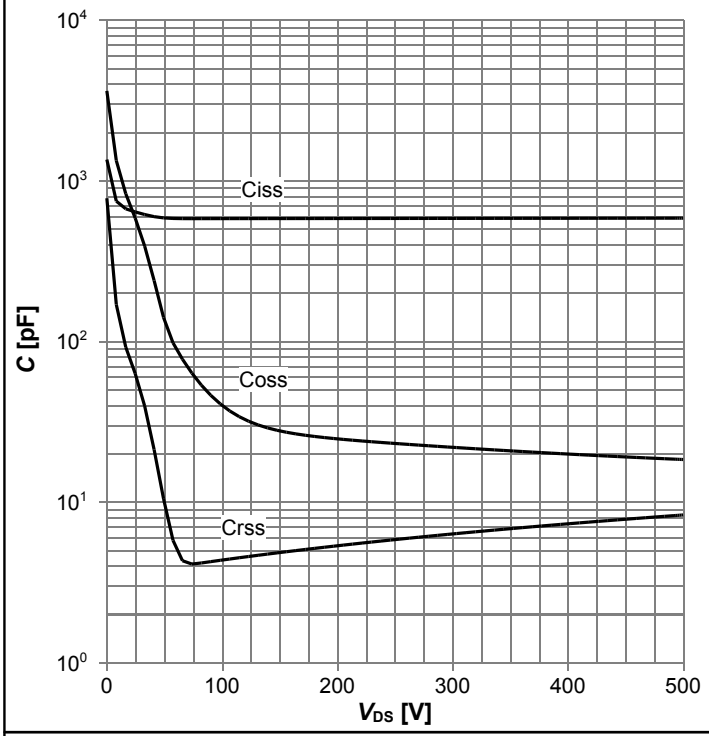

$E_{AS}$=f($T_j$); $I_D$=4 A; $V_{DD}$=50 V

**Drain-source breakdown voltage**



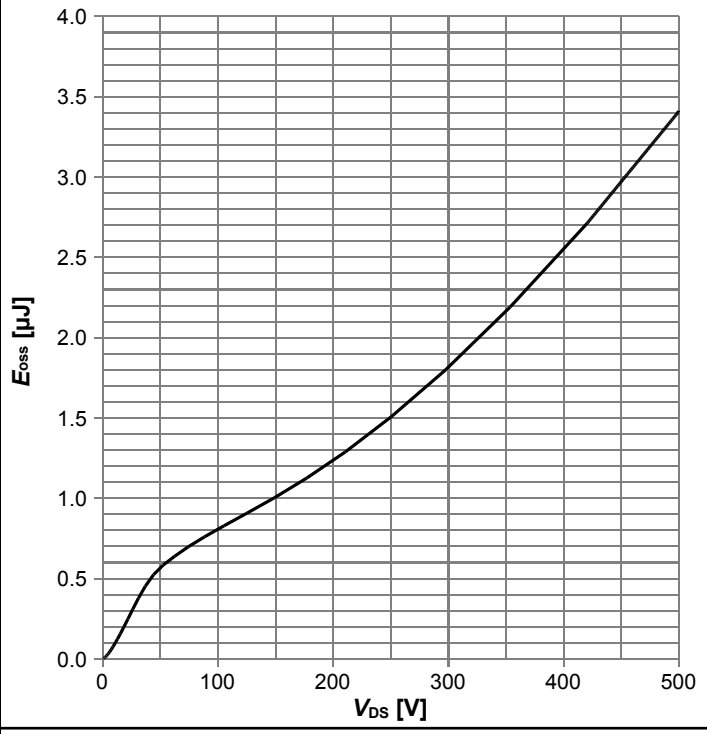

$V_{BR(DSS)}$=f($T_j$); $I_D$=1 mA

**Typ. capacitances**



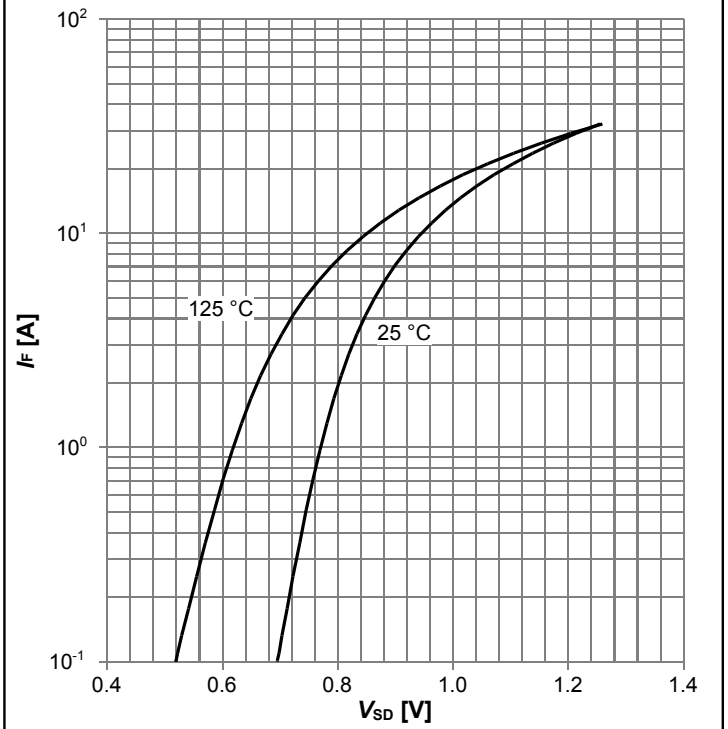

$C$=f($V_{DS}$); $V_{GS}$=0 V; $f$=1 MHz

**Typ. Coss stored energy**




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

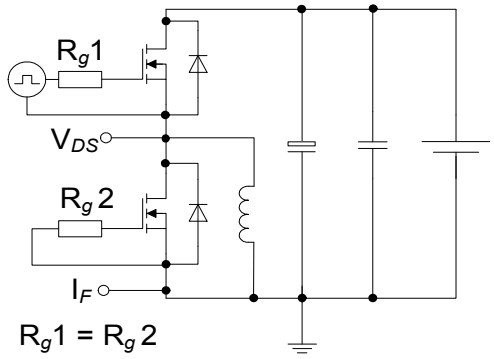
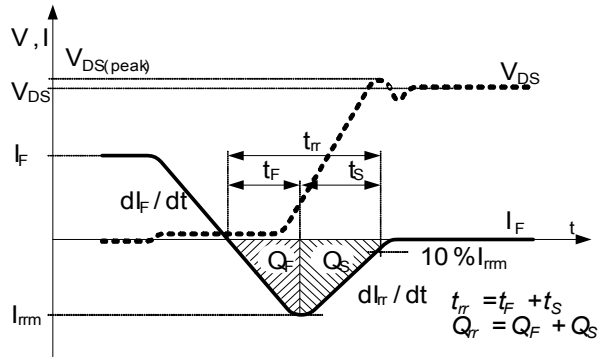
**Forward characteristics of reverse diode**




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

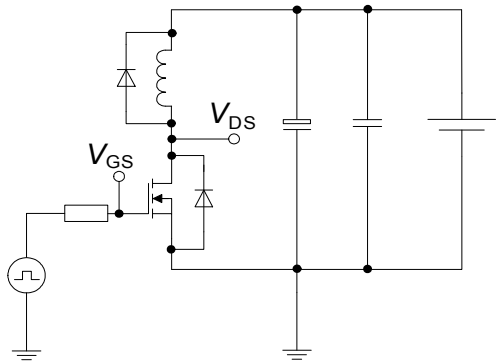
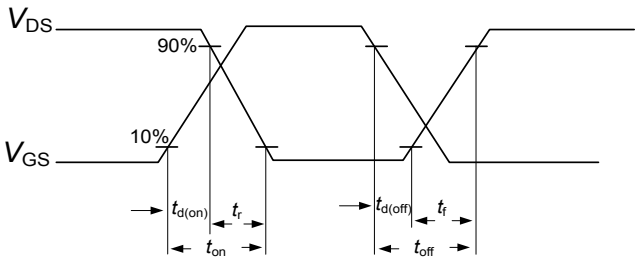
# 5 Test Circuits

## Table 8 Diode characteristics

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

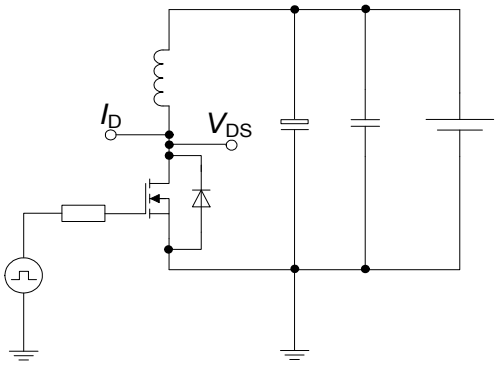
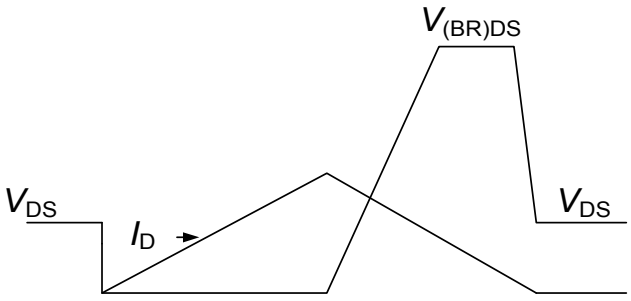


## Table 9 Switching times

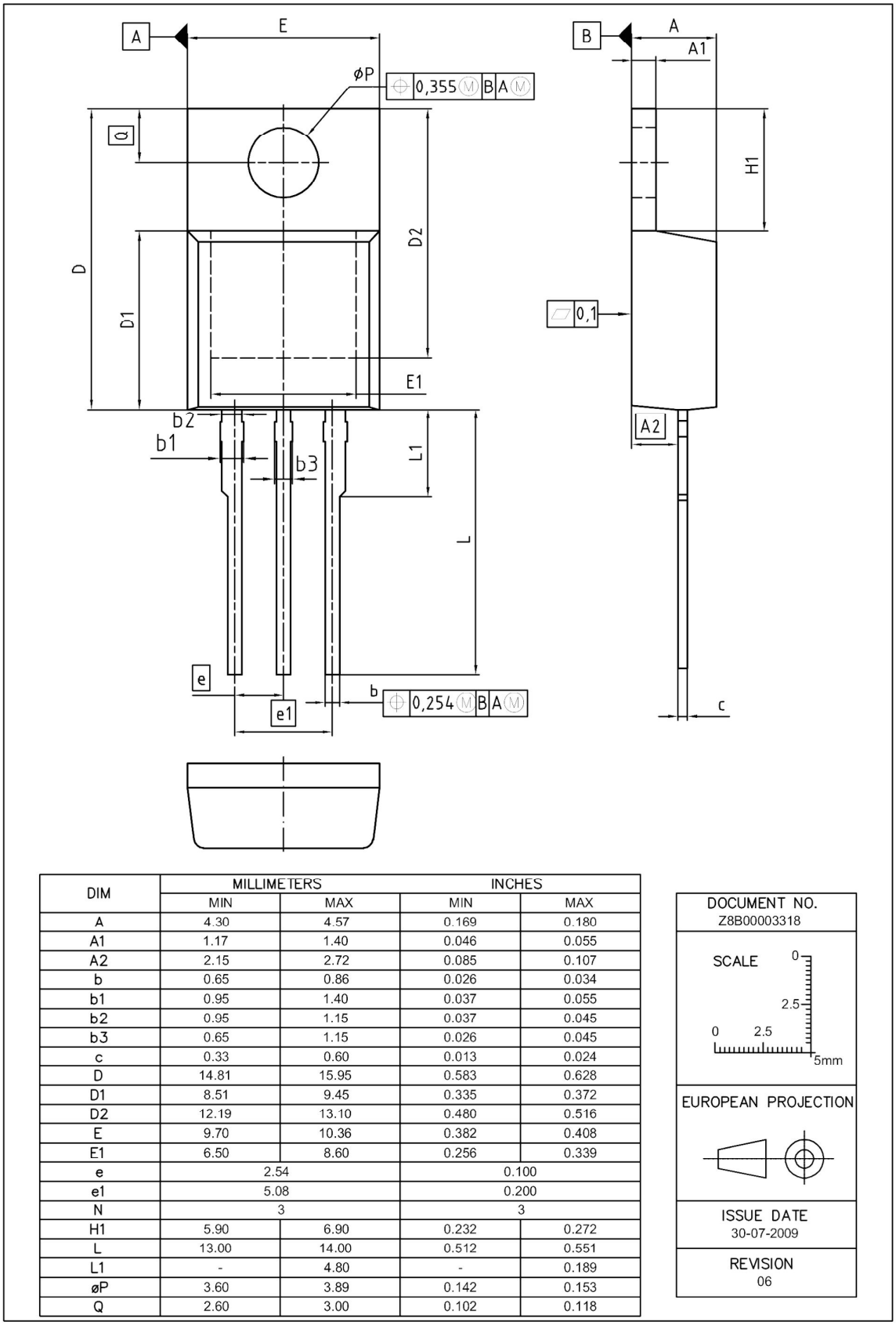
| Switching times test circuit for inductive load | Switching times waveform |
|---|---|
|  |  |



## Table 10 Unclamped inductive load

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

# 6 Package Outlines




| DIM | MILLIMETERS | | INCHES | |
|---|---|---|---|---|
| | MIN | MAX | MIN | MAX |
| A | 4.30 | 4.57 | 0.169 | 0.180 |
| A1 | 1.17 | 1.40 | 0.046 | 0.055 |
| A2 | 2.15 | 2.72 | 0.085 | 0.107 |
| b | 0.65 | 0.86 | 0.026 | 0.034 |
| b1 | 0.95 | 1.40 | 0.037 | 0.055 |
| b2 | 0.95 | 1.15 | 0.037 | 0.045 |
| b3 | 0.65 | 1.15 | 0.026 | 0.045 |
| c | 0.33 | 0.60 | 0.013 | 0.024 |
| D | 14.81 | 15.95 | 0.583 | 0.628 |
| D1 | 8.51 | 9.45 | 0.335 | 0.372 |
| D2 | 12.19 | 13.10 | 0.480 | 0.516 |
| E | 9.70 | 10.36 | 0.382 | 0.408 |
| E1 | 6.50 | 8.60 | 0.256 | 0.339 |
| e | 2.54 | | 0.100 | |
| e1 | 5.08 | | 0.200 | |
| N | 3 | | 3 | |
| H1 | 5.90 | 6.90 | 0.232 | 0.272 |
| L | 13.00 | 14.00 | 0.512 | 0.551 |
| L1 | - | 4.80 | - | 0.189 |
| øP | 3.60 | 3.89 | 0.142 | 0.153 |
| Q | 2.60 | 3.00 | 0.102 | 0.118 |

DOCUMENT NO.
Z8B00003318

SCALE 0 2.5 0 2.5 5mm

EUROPEAN PROJECTION

ISSUE DATE
30-07-2009

REVISION
06

**Figure 1 Outline PG-TO 220, dimensions in mm/inches**

# 7 Appendix A

## Table 11 Related Links

- **IFX CoolMOS Webpage:** www.infineon.com
- **IFX Design tools:** www.infineon.com

## Revision History

IPP50R380CE

**Revision: 2016-06-13, Rev. 2.2**

Previous Revision

| Revision | Date | Subjects (major changes since last revision) |
|---|---|---|
| 2.0 | 2012-08-24 | Release of final version |
| 2.1 | 2014-06-06 | Removal of TO-220FP |
| 2.2 | 2016-06-13 | Updated ID rating, Zth, SOA and Pd curves |



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