

## 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 is a price-performance optimized platform enabling to target cost sensitive applications in Consumer and Lighting markets by still meeting highest efficiency standards. The new series provides all benefits of a fast switching Superjunction MOSFET while not sacrificing ease of use and offering the best cost down performance ratio available on the market.

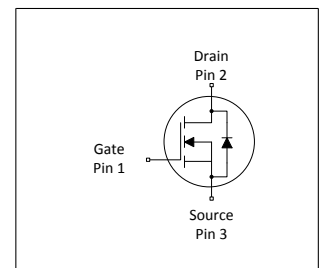
### Features

- 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, Halogen free mold compound
- Qualified for standard grade applications

### Applications

PFC stages, hard switching PWM stages and resonant switching stages for e.g. PC Silverbox, Adapter, LCD & PDP TV and indoor lighting.

*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     |
|----------------------|-------|----------|
| $V_{DS} @ T_{j,max}$ | 550   | V        |
| $R_{DS(on),max}$     | 0.38  | $\Omega$ |
| $I_D$                | 14.1  | A        |
| $Q_{g,typ}$          | 24.8  | nC       |
| $I_{D,pulse}$        | 32.4  | A        |
| $E_{oss} @ 400V$     | 2.54  | $\mu J$  |

| Type / Ordering Code | Package           | Marking | Related Links  |
|----------------------|-------------------|---------|----------------|
| IPA50R380CE          | PG-TO 220 FullPAK | 5R380CE | see Appendix A |

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## 1 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>          | $I_D$          | -          | -    | 14.1<br>8.9 | A                | $T_C = 25^\circ\text{C}$<br>$T_C = 100^\circ\text{C}$                |
| Pulsed drain current <sup>2)</sup>              | $I_{D,pulse}$  | -          | -    | 32.4        | A                | $T_C=25^\circ\text{C}$   |
| Avalanche energy, single pulse                  | $E_{AS}$       | -          | -    | 173         | mJ               | $I_D=4\text{A}; V_{DD} = 50\text{V}$                                 |
| Avalanche energy, repetitive                    | $E_{AR}$       | -          | -    | 0.26        | mJ               | $I_D=4\text{A}; V_{DD} = 50\text{V}$                                 |
| Avalanche current, repetitive                   | $I_{AR}$       | -          | -    | 4.0         | A                | -  |
| MOSFET dv/dt ruggedness                         | dv/dt          | -          | -    | 50          | V/ns             | $V_{DS} = 0\dots 400\text{V}$  |
| Gate source voltage                             | $V_{GS}$       | -20<br>-30 | -    | 20<br>30    | V                | static;<br>AC ( $f > 1\text{ Hz}$ )                                  |
| Power dissipation (FullPAK)                     | $P_{tot}$      | -          | -    | 29.2        | W                | $T_C=25^\circ\text{C}$   |
| Operating and storage temperature               | $T_j, T_{stg}$ | -40        | -    | 150         | $^\circ\text{C}$ | -  |
| Mounting torque                                 | -              | -          | -    | 50          | Ncm              | M2.5 screws  |
| Continuous diode forward current                | $I_S$          | -          | -    | 5.4         | A                | $T_C=25^\circ\text{C}$   |
| Diode pulse current <sup>2)</sup>               | $I_{S,pulse}$  | -          | -    | 32.4        | A                | $T_C = 25^\circ\text{C}$   |
| Reverse diode dv/dt <sup>3)</sup>               | dv/dt          | -          | -    | 15          | V/ns             | $V_{DS} = 0\dots 400\text{V}, I_{SD} \leq I_S, T_j=25^\circ\text{C}$ |
| Maximum diode commutation speed <sup>3)</sup>   | di/dt          | -          | -    | 500         | A/ $\mu\text{s}$ | $V_{DS} = 0\dots 400\text{V}, I_{SD} \leq I_S, T_j=25^\circ\text{C}$ |
| Insulation withstand voltage for TO-220 FullPAK | $V_{ISO}$      | -          | -    | 2500        | V                | $V_{rms}, T_C=25^\circ\text{C}, t=1\text{min}$                       |

## 2 Thermal characteristics

**Table 3 Thermal characteristics TO220 Full PAK**

| Parameter  | Symbol     | Values |      |      | Unit               | Note / Test Condition               |
|--|------------|--------|------|------|--------------------|-------------------------------------|
|  |            | Min.   | Typ. | Max. |                    |                                     |
| Thermal resistance, junction - case                        | $R_{thJC}$ | -      | -    | 4.28 | $^\circ\text{C/W}$ | -                                   |
| Thermal resistance, junction - ambient                     | $R_{thJA}$ | -      | -    | 80   | $^\circ\text{C/W}$ | leaded                              |
| Soldering temperature, wavesoldering only allowed at leads | $T_{sold}$ | -      | -    | 260  | $^\circ\text{C}$   | 1.6mm (0.063 in.) from case for 10s |

<sup>1)</sup> Limited by  $T_{j,max} < 150^\circ\text{C}$ , Maximum Duty Cycle  $D = 0.5$ , TO220 equivalent

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

<sup>3)</sup>  $V_{DClink}=400\text{V}; V_{DS,peak} < V_{(BR)DSS}$ ; 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  | $I_{DSS}$     | -      | -    | 1    | $\mu A$  | $V_{DS}=500V, V_{GS}=0V, T_j=25^\circ C$<br>$V_{DS}=500V, V_{GS}=0V, T_j=150^\circ C$ |
| Gate-source leakage current      | $I_{GSS}$     | -      | -    | 100  | nA       | $V_{GS}=20V, V_{DS}=0V$   |
| Drain-source on-state resistance | $R_{DS(on)}$  | -      | 0.34 | 0.38 | $\Omega$ | $V_{GS}=13V, I_D=3.2A, T_j=25^\circ C$<br>$V_{GS}=13V, I_D=3.2A, T_j=150^\circ C$     |
| Gate resistance                  | $R_G$         | -      | 3    | -    | $\Omega$ | $f=1\text{ MHz, open drain}$  |

**Table 5 Dynamic characteristics**

| Parameter  | Symbol       | Values |      |      | Unit | Note / Test Condition                                   |
|--|--------------|--------|------|------|------|---|
|  |              | Min.   | Typ. | Max. |      |   |
| Input capacitance  | $C_{iss}$    | -      | 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 <sup>1)</sup> | $C_{o(er)}$  | -      | 32   | -    | pF   | $V_{GS}=0V, V_{DS}=0...400V$                            |
| Effective output capacitance, time related <sup>2)</sup>   | $C_{o(tr)}$  | -      | 133  | -    | pF   | $I_D=constant, V_{GS}=0V, V_{DS}=0...400V$              |
| Turn-on delay time   | $t_{d(on)}$  | -      | 7.2  | -    | ns   | $V_{DD}=400V, V_{GS}=13V, I_D=3.9A,$<br>$R_G=3.4\Omega$ |
| Rise time  | $t_r$        | -      | 5.6  | -    | ns   | $V_{DD}=400V, V_{GS}=13V, I_D=3.9A,$<br>$R_G=3.4\Omega$ |
| Turn-off delay time  | $t_{d(off)}$ | -      | 35   | -    | ns   | $V_{DD}=400V, V_{GS}=13V, I_D=3.9A,$<br>$R_G=3.4\Omega$ |
| Fall time  | $t_f$        | -      | 8.6  | -    | ns   | $V_{DD}=400V, V_{GS}=13V, I_D=3.9A,$<br>$R_G=3.4\Omega$ |

**Table 6 Gate charge characteristics**

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

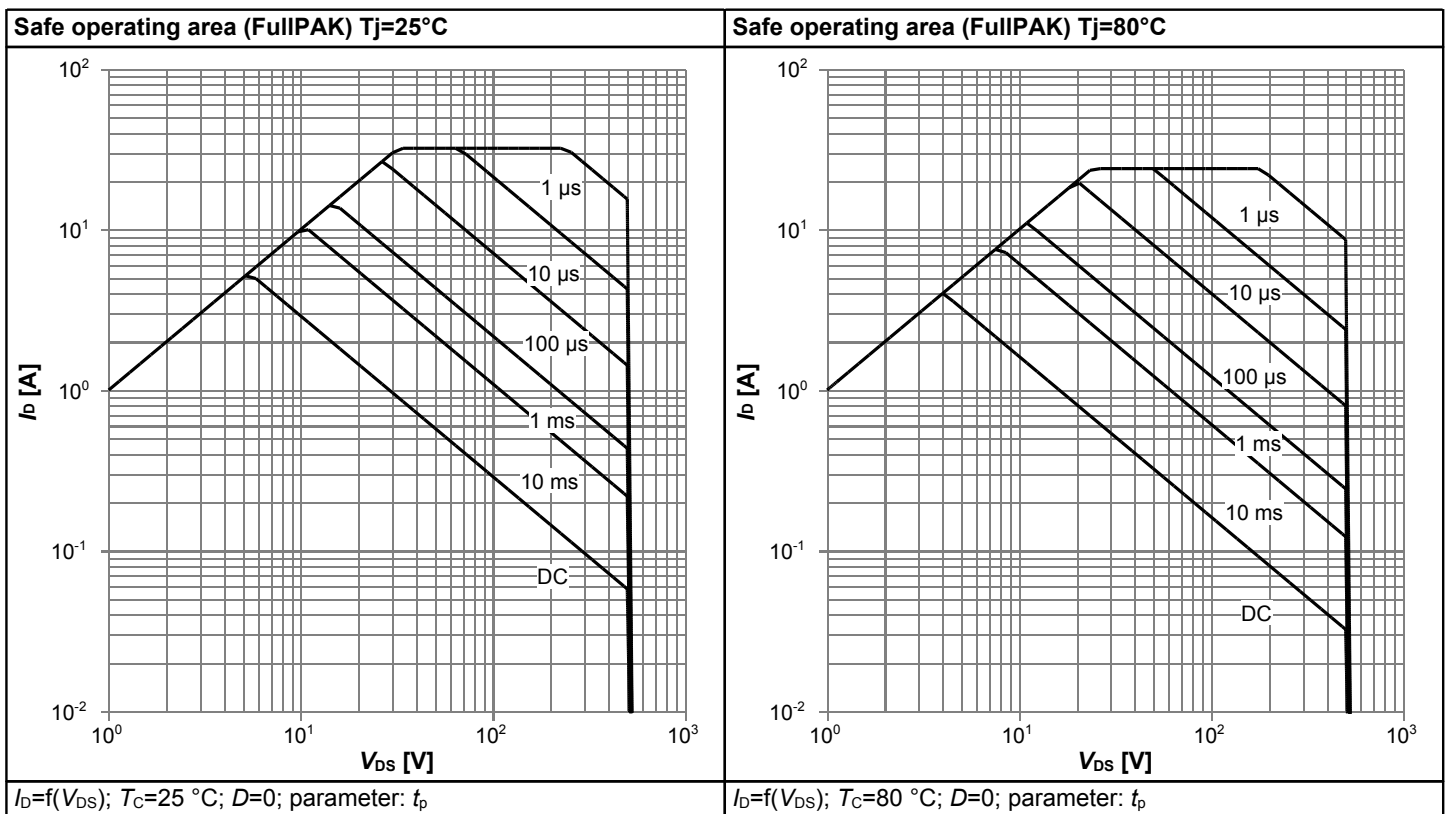
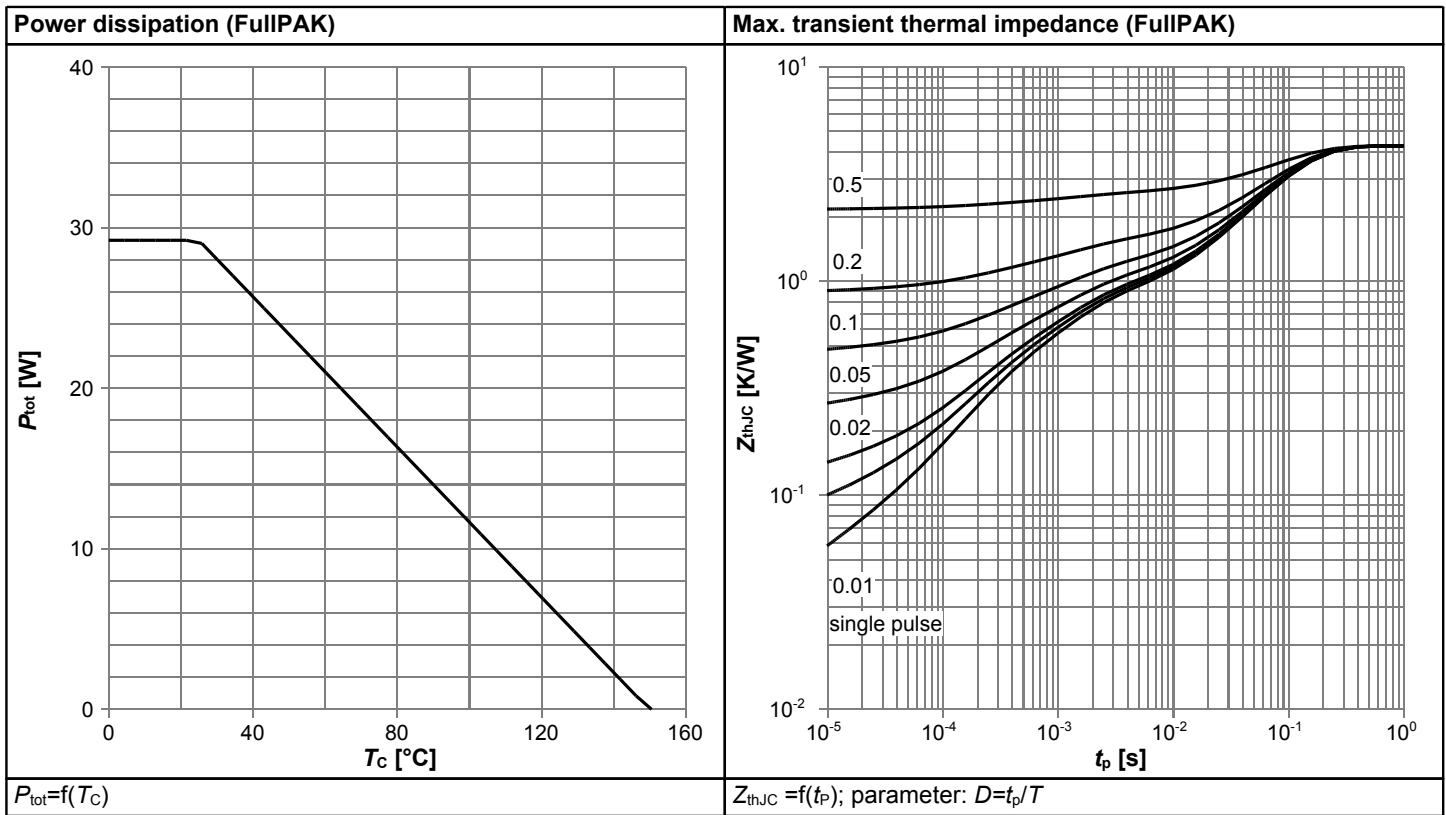
<sup>1)</sup>  $C_{o(er)}$  is a fixed capacitance that gives the same stored energy as  $C_{oss}$  while  $V_{DS}$  is rising from 0 to 400V

<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

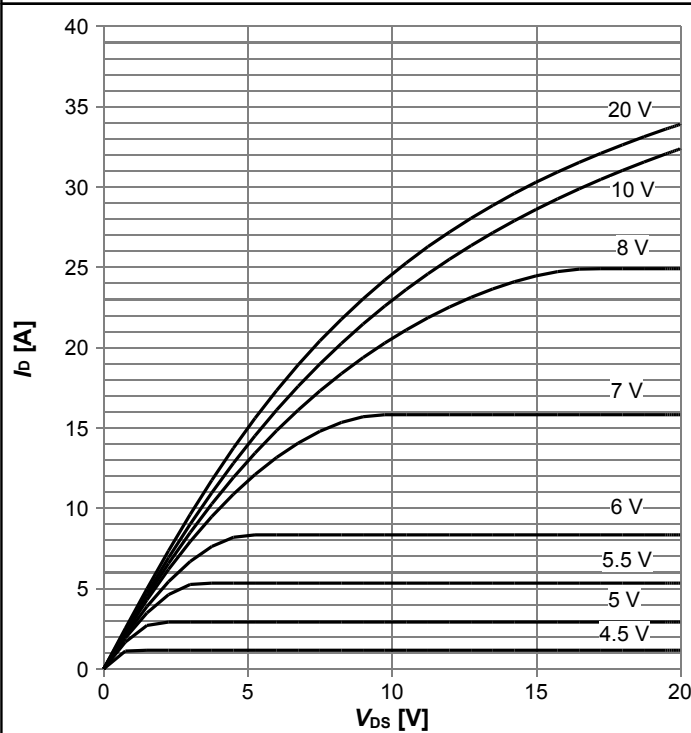
**Table 7 Reverse diode characteristics**

| Parameter                     | Symbol    | Values |      |      | Unit    | Note / Test Condition                    |
|-------------------------------|-----------|--------|------|------|---------|--|
|                               |           | Min.   | Typ. | Max. |         |  |
| Diode forward voltage         | $V_{SD}$  | -      | 0.85 | -    | V       | $V_{GS}=0V, I_F=3.9A, T_j=25^{\circ}C$   |
| Reverse recovery time         | $t_{rr}$  | -      | 207  | -    | ns      | $V_R=400V, I_F=3.9A, di_F/dt=100A/\mu s$ |
| Reverse recovery charge       | $Q_{rr}$  | -      | 1.7  | -    | $\mu C$ | $V_R=400V, I_F=3.9A, di_F/dt=100A/\mu s$ |
| Peak reverse recovery current | $I_{rrm}$ | -      | 15.5 | -    | A       | $V_R=400V, I_F=3.9A, di_F/dt=100A/\mu s$ |

### 4 Electrical characteristics diagrams

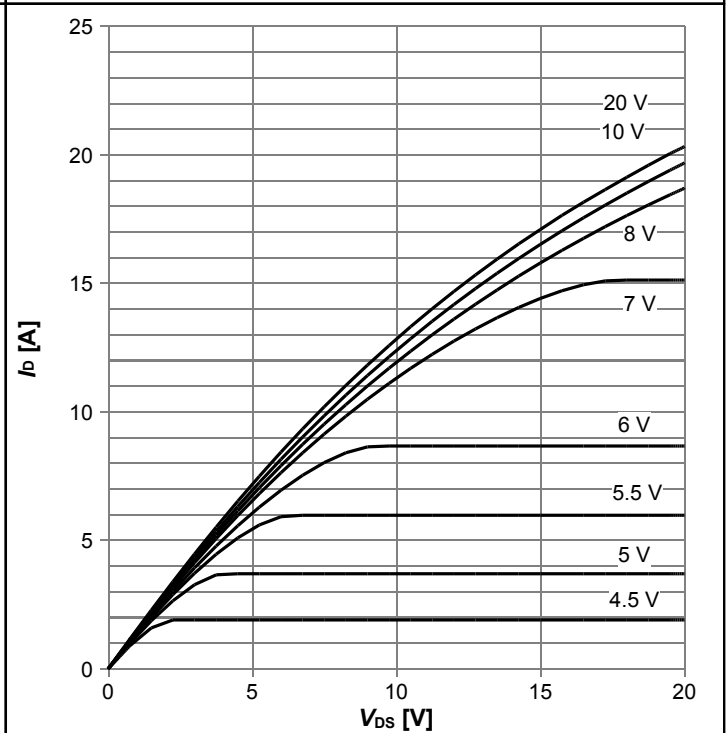


Typ. output characteristics  $T_j=25^\circ\text{C}$



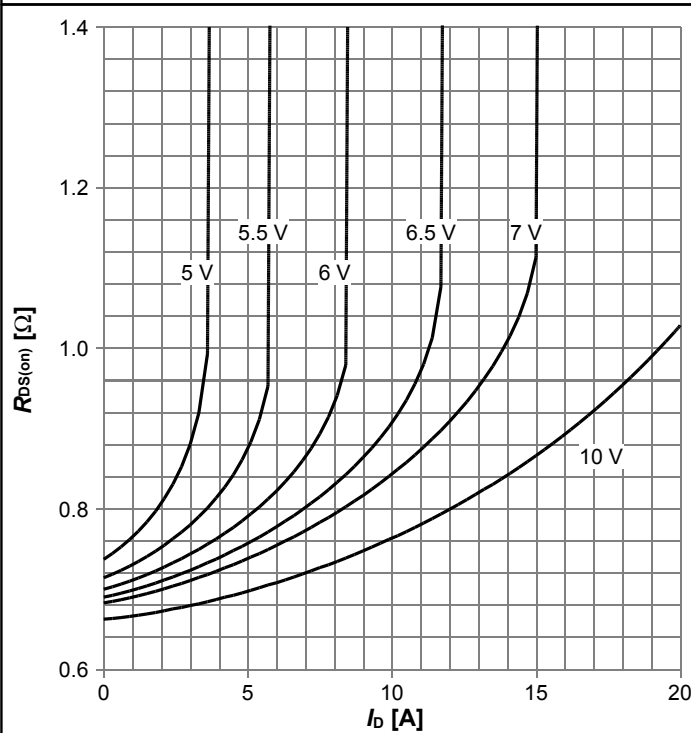
$I_D=f(V_{DS}); T_j=25^\circ\text{C};$  parameter:  $V_{GS}$

Typ. output characteristics  $T_j=125^\circ\text{C}$



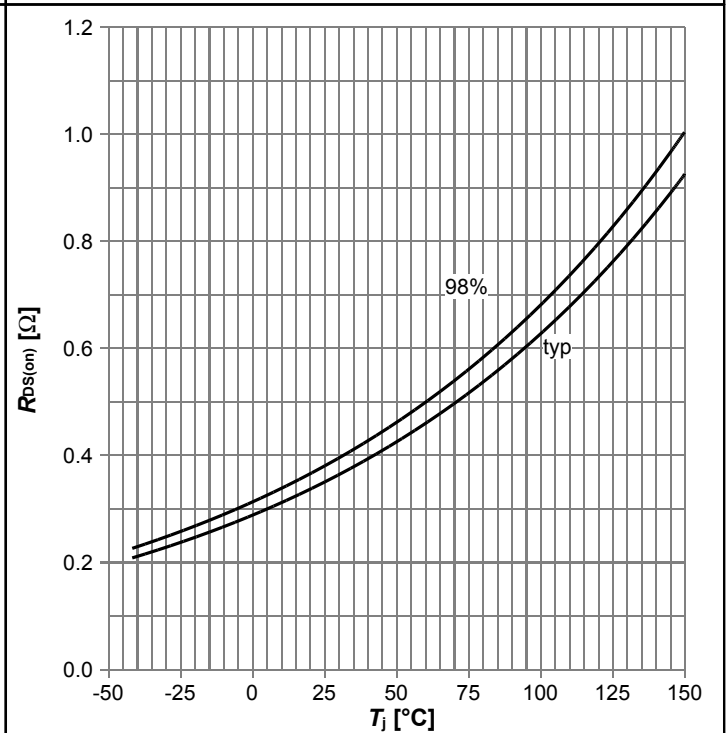
$I_D=f(V_{DS}); T_j=125^\circ\text{C};$  parameter:  $V_{GS}$

Typ. drain-source on-state resistance



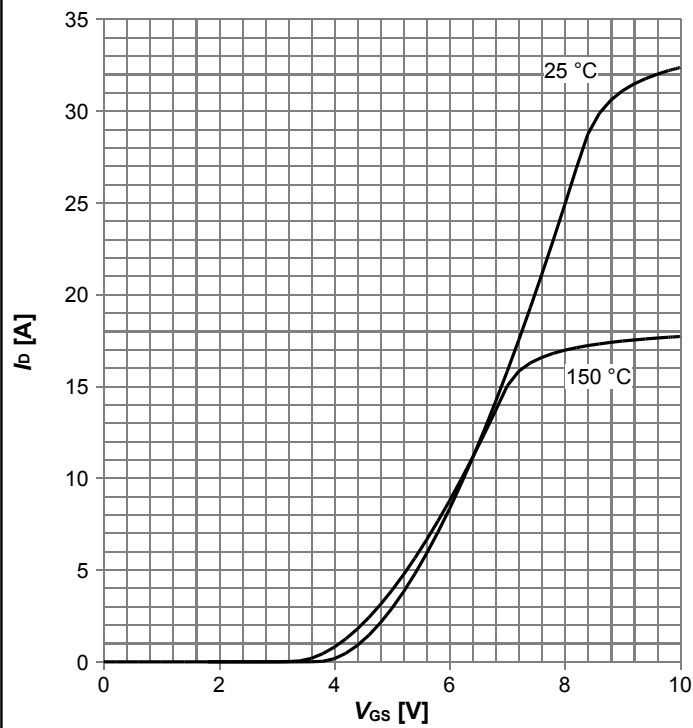
$R_{DS(on)}=f(I_D); T_j=125^\circ\text{C};$  parameter:  $V_{GS}$

Drain-source on-state resistance



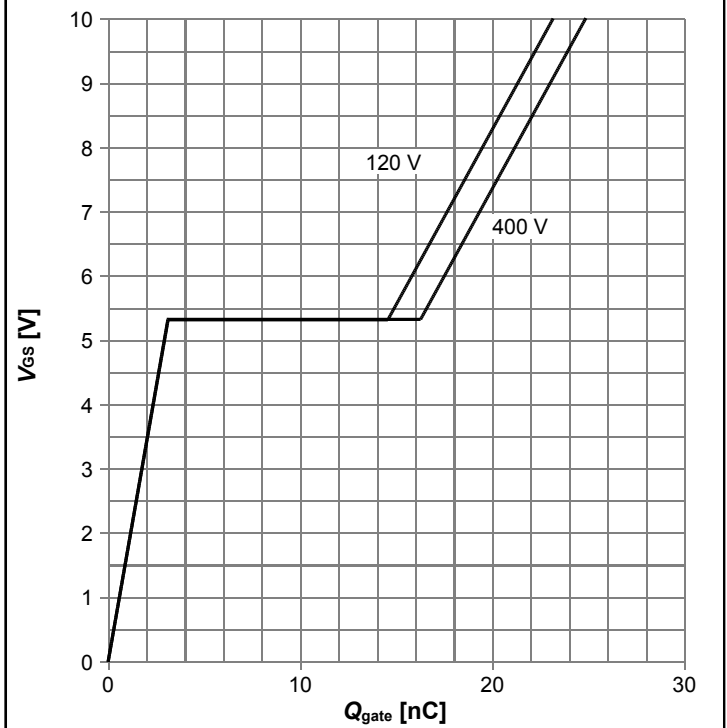
$R_{DS(on)}=f(T_j); I_D=3.2\text{ A}; V_{GS}=13\text{ V}$

Typ. transfer characteristics



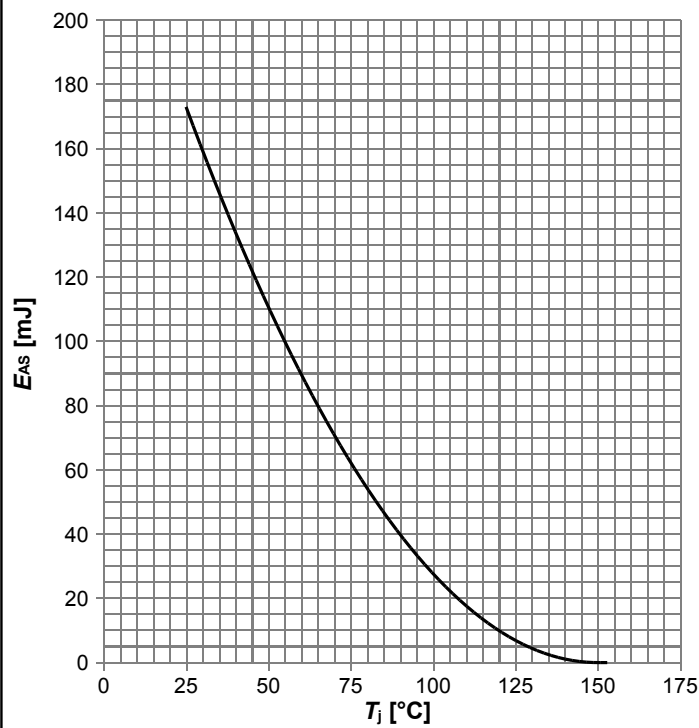
$I_D=f(V_{GS})$ ;  $V_{DS}=20V$ ; parameter:  $T_j$

Typ. gate charge



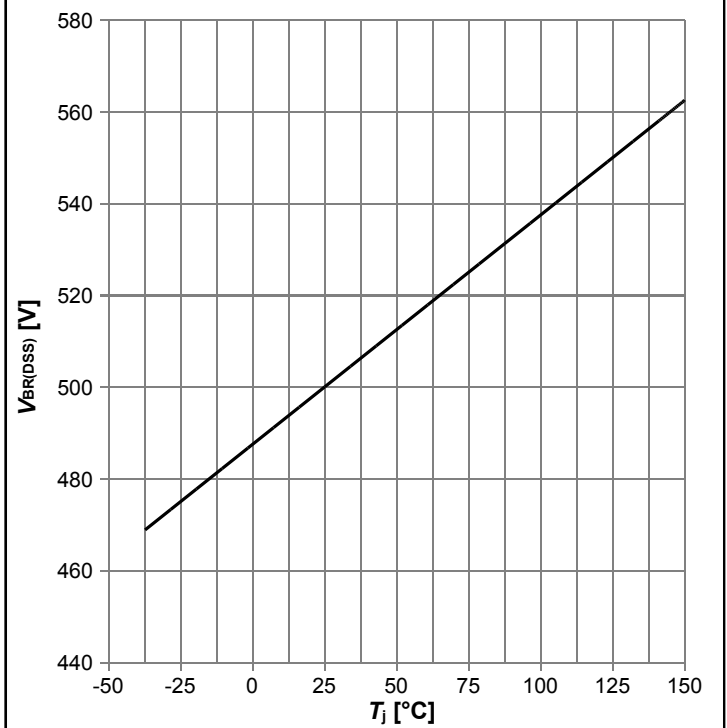
$V_{GS}=f(Q_{gate})$ ;  $I_D=3.9$  A pulsed; parameter:  $V_{DD}$

Avalanche energy



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

Drain-source breakdown voltage

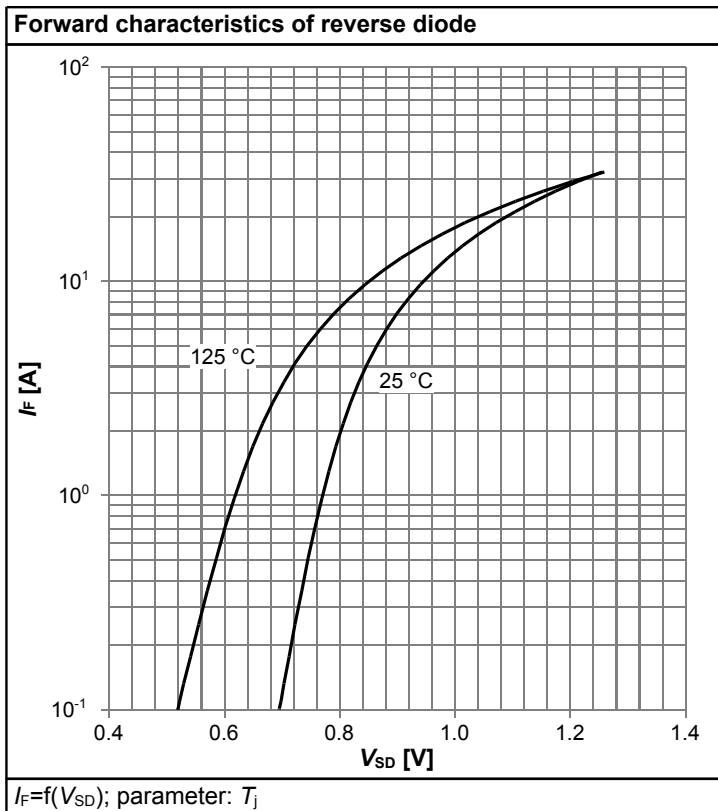
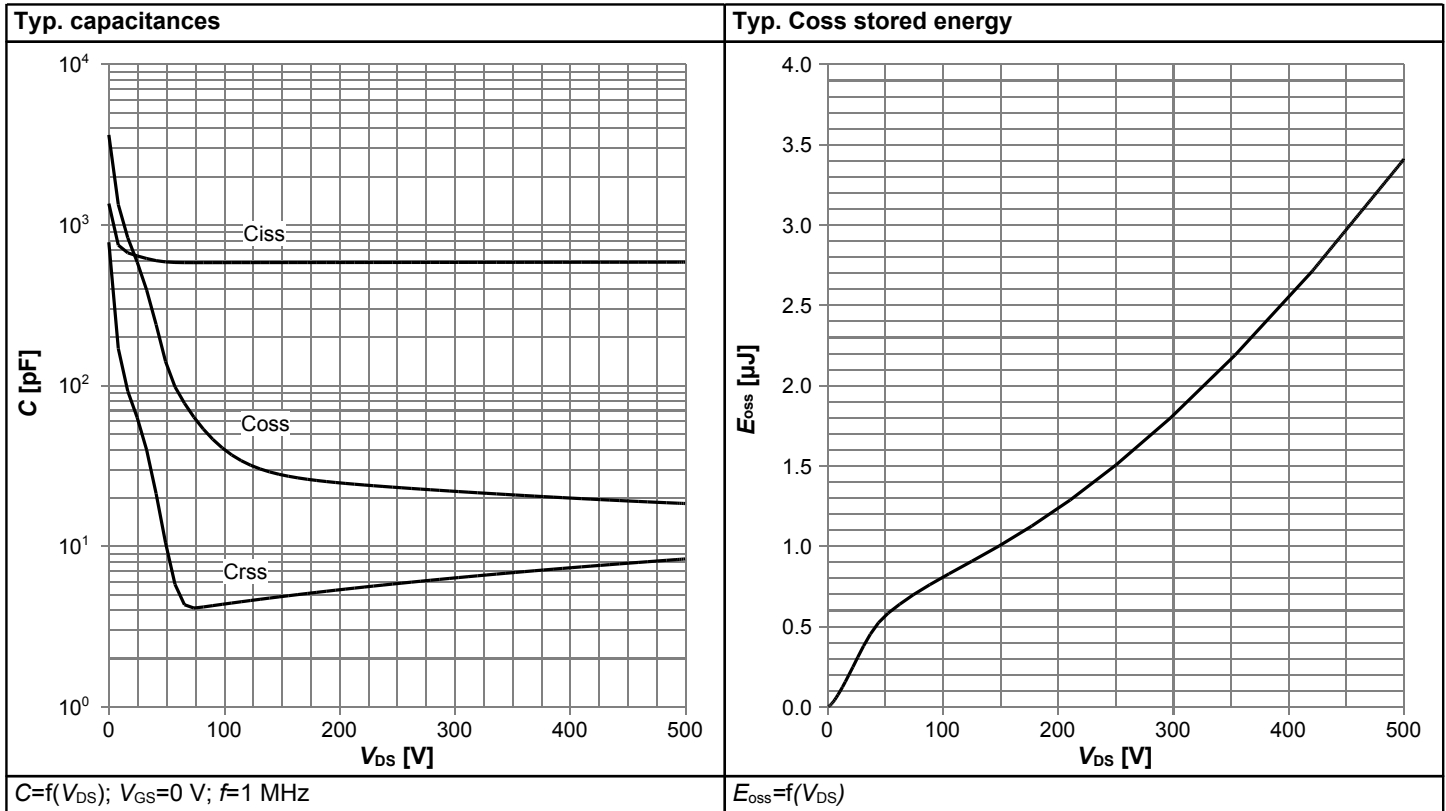


$V_{BR(DSS)}=f(T_j)$ ;  $I_D=1$  mA



# 500V CoolMOS™ CE Power Transistor

## IPA50R380CE



## 5 Test Circuits

**Table 8 Diode characteristics**

| Test circuit for diode characteristics | Diode recovery waveform   |
|--|---|
| <p><math>R_{g1} = R_{g2}</math></p>    | <p><math>t_{rr} = t_r + t_s</math><br/> <math>Q_{rr} = Q_F + Q_S</math></p> |

**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



**NOTES:**

1. STANDARD QUALITY GRADE
2. ALL DIMENSIONS REFER TO JEDEC STANDARD TO-281 NOT INCLUDE MOLD FLASH, PROTRUSIONS OR GATE BURRS

DIMENSIONS DO NOT INCLUDE MOLD FLASH, PROTRUSIONS OR GATE BURRS.

| DIM      | MILLIMETERS |       | INCHES      |       |
|----------|-------------|-------|-------------|-------|
|          | MIN         | MAX   | MIN         | MAX   |
| A        | 4.50        | 4.90  | 0.177       | 0.193 |
| A1       | 2.34        | 2.80  | 0.092       | 0.110 |
| A2       | 2.42        | 2.86  | 0.095       | 0.113 |
| b        | 0.65        | 0.90  | 0.026       | 0.035 |
| b1       | 0.95        | 1.38  | 0.037       | 0.054 |
| b2       | 1.20        | 1.50  | 0.047       | 0.059 |
| b3       | 0.65        | 1.38  | 0.026       | 0.054 |
| b4       | 1.20        | 1.50  | 0.047       | 0.059 |
| c        | 0.40        | 0.63  | 0.016       | 0.025 |
| D        | 15.67       | 16.15 | 0.617       | 0.636 |
| D1       | 8.97        | 9.83  | 0.353       | 0.387 |
| E        | 10.00       | 10.65 | 0.394       | 0.419 |
| e        | 2.54 (BSC)  |       | 0.100 (BSC) |       |
| e1       | 5.08        |       | 0.200       |       |
| N        | 3           |       | 3           |       |
| H        | 28.70       | 29.75 | 1.130       | 1.171 |
| L        | 12.78       | 13.75 | 0.503       | 0.541 |
| L1       | 2.83        | 3.45  | 0.111       | 0.136 |
| $\phi P$ | 3.00        | 3.38  | 0.118       | 0.133 |
| Q        | 3.15        | 3.50  | 0.124       | 0.138 |

|                                    |
|------------------------------------|
| <b>DOCUMENT NO.</b><br>Z8B00181328 |
| <b>SCALE</b><br>                   |
| <b>EUROPEAN PROJECTION</b><br>     |
| <b>ISSUE DATE</b><br>29-04-2016    |
| <b>REVISION</b><br>01              |

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

## **7 Appendix A**

### **Table 11 Related Links**

- **IFX CoolMOS Webpage:** [www.infineon.com](http://www.infineon.com)
- **IFX Design tools:** [www.infineon.com](http://www.infineon.com)

## Revision History

IPA50R380CE

**Revision: 2016-07-12, Rev. 2.4**

Previous Revision

| Revision | Date       | Subjects (major changes since last revision)               |
|----------|------------|--|
| 2.0      | 2011-06-08 | Release of final data sheet                                |
| 2.1      | 2011-06-16 | -  |
| 2.2      | 2014-06-12 | Release of final datasheet                                 |
| 2.3      | 2016-06-13 | Updated ID ratings, package marking code & package drawing |
| 2.4      | 2016-07-12 | Changed marking information in page 1                      |

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**Published by**  
**Infineon Technologies AG**  
**81726 München, Germany**  
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