

# 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.

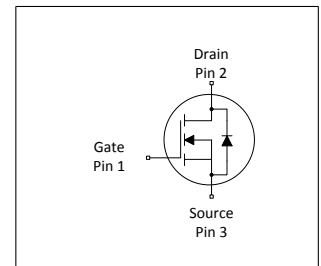
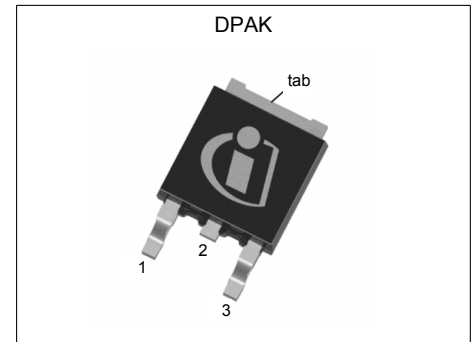
### Features

- 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  |
|----------------------|-----------|----------|----------------|
| IPD50R380CE          | PG-TO 252 | 50S380CE | 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 (non FullPAK)<br>TO-252     | $P_{tot}$      | -          | -    | 98          | W                | $T_C = 25^\circ\text{C}$                                                                                     |
| Operating and storage temperature             | $T_j, T_{stg}$ | -55        | -    | 150         | $^\circ\text{C}$ | -                                                                                                            |
| Continuous diode forward current              | $I_S$          | -          | -    | 10          | 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             | $V_{DS} = 0 \dots 400\text{V}$ , $I_{SD} \leq I_S$ , $T_j = 25^\circ\text{C}$ ,<br>$t_{cond} < 2\mu\text{s}$ |
| Maximum diode commutation speed <sup>3)</sup> | di/dt          | -          | -    | 500         | A/ $\mu\text{s}$ | $V_{DS} = 0 \dots 400\text{V}$ , $I_{SD} \leq I_S$ , $T_j = 25^\circ\text{C}$ ,<br>$t_{cond} < 2\mu\text{s}$ |

## 2 Thermal characteristics

**Table 3 Thermal characteristics (non FullPAK) TO-252**

| Parameter                                                     | Symbol     | Values |      |      | Unit               | Note / Test Condition               |
|---------------------------------------------------------------|------------|--------|------|------|--------------------|-------------------------------------|
|                                                               |            | Min.   | Typ. | Max. |                    |                                     |
| Thermal resistance, junction - case                           | $R_{thJC}$ | -      | -    | 1.27 | $^\circ\text{C/W}$ | -                                   |
| Thermal resistance, junction - ambient                        | $R_{thJA}$ | -      | -    | 62   | $^\circ\text{C/W}$ | leaded                              |
| Soldering temperature, wavesoldering<br>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  $D = 0.5$

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

<sup>3)</sup>  $V_{DClamp} = 400\text{V}$ ;  $V_{DS,peak} < V_{(BR)DSS}$ ; 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 | $R_{DS(on)}$  | -      | 0.35 | 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   | $I_D=\text{constant}$ , $V_{GS}=0V$ , $V_{DS}=0...400V$        |
| 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   | $V_{DD}=400V$ , $I_D=3.9A$ , $V_{GS}=0$ 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 $10V$ |

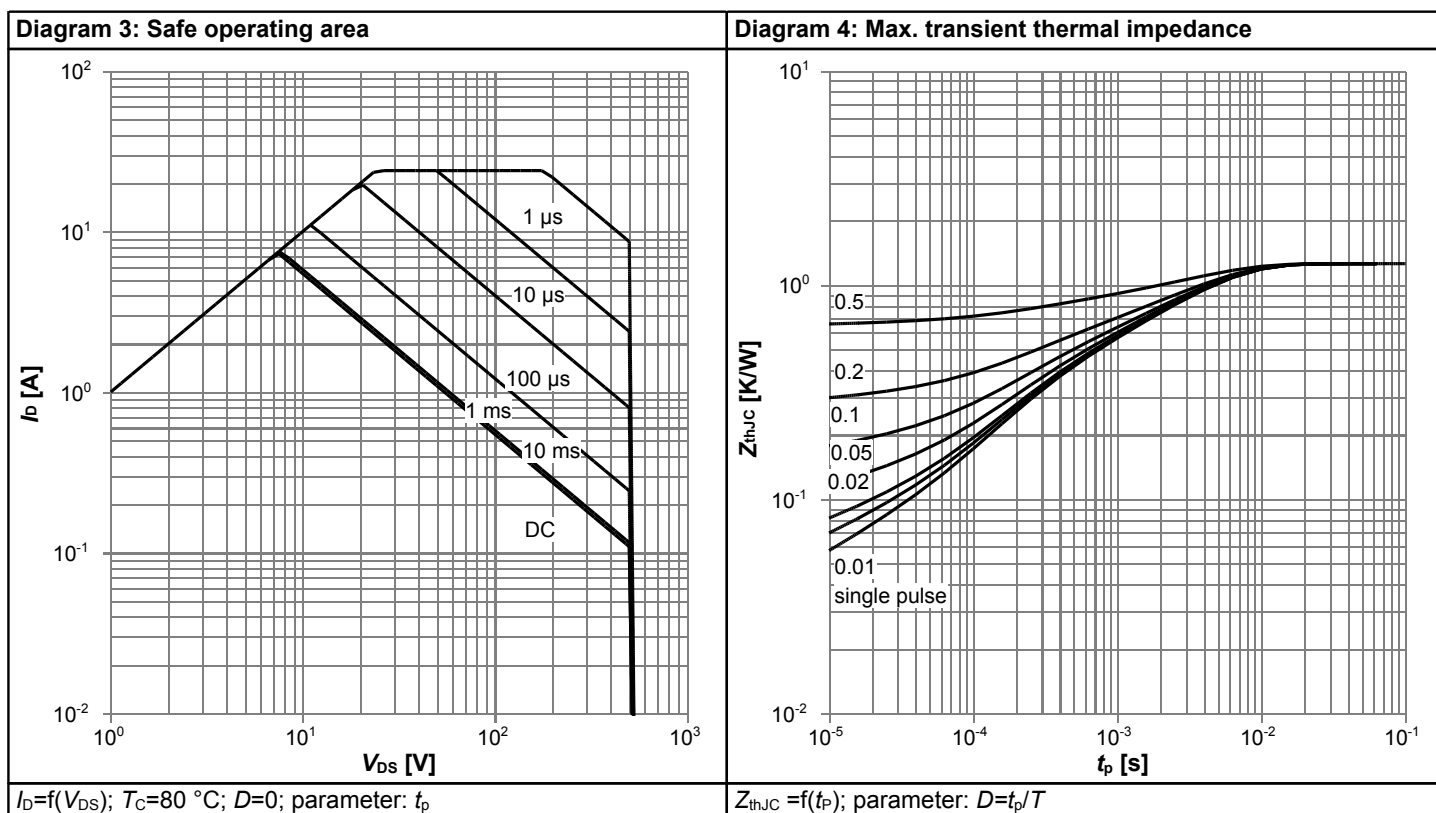
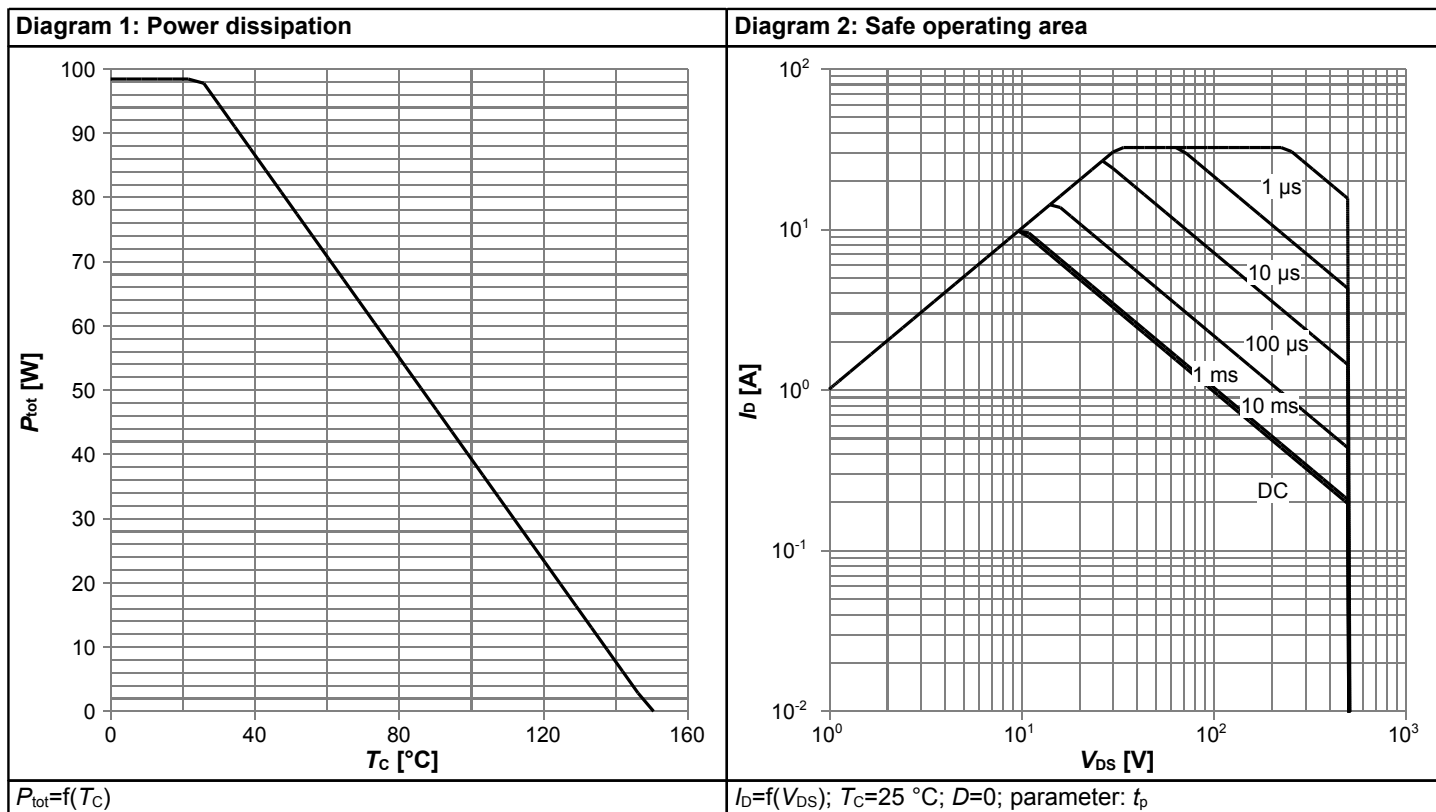
<sup>1)</sup>  $C_{o(er)}$  is a fixed capacitance that gives the same stored energy as  $C_{oss}$  while  $V_{DS}$  is rising from 0 to 80%  $V_{(BR)DSS}$

<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 80%  $V_{(BR)DSS}$

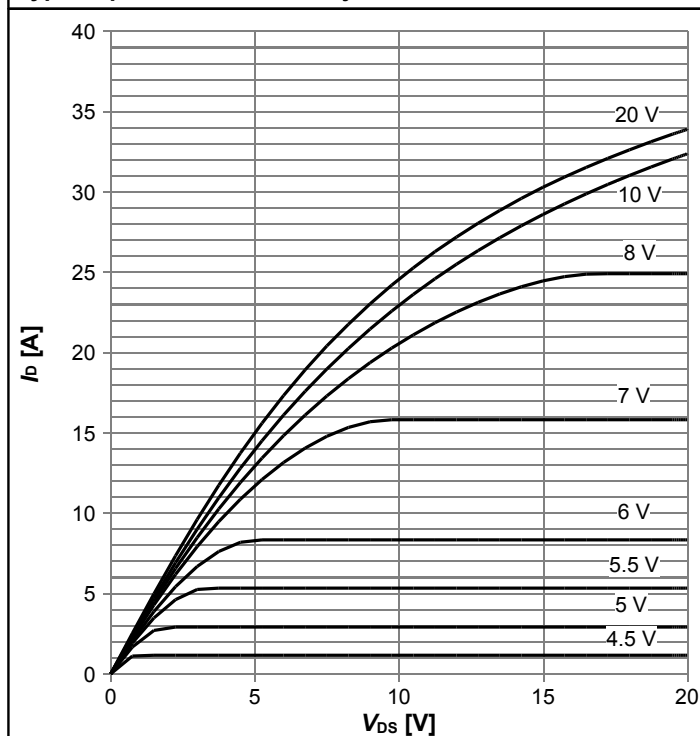
**Table 7 Reverse diode characteristics**

| Parameter                     | Symbol    | Values |      |      | Unit    | Note / Test Condition                    |
|-------------------------------|-----------|--------|------|------|---------|------------------------------------------|
|                               |           | Min.   | Typ. | Max. |         |                                          |
| Diode forward voltage         | $V_{SD}$  | -      | 0.85 | -    | V       | $V_{GS}=0V, I_F=3.9A, T_f=25^{\circ}C$   |
| 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

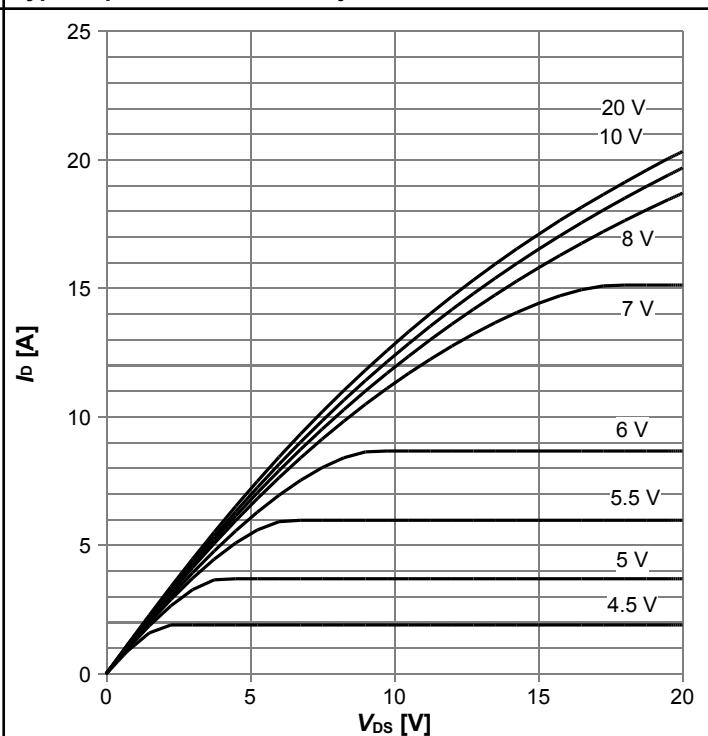


Typ. output characteristics  $T_j=25^\circ\text{C}$



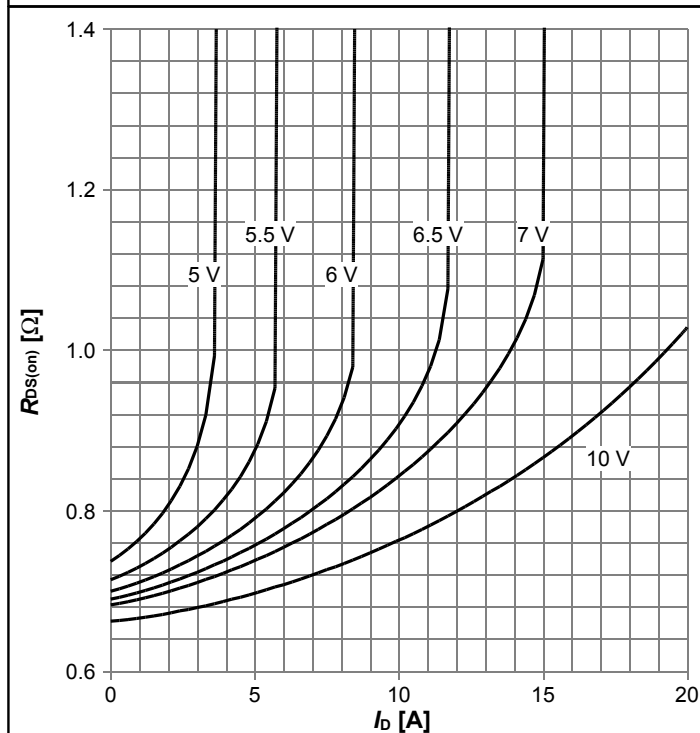
$I_D=f(V_{DS})$ ;  $T_j=25^\circ\text{C}$ ; parameter:  $V_{GS}$

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



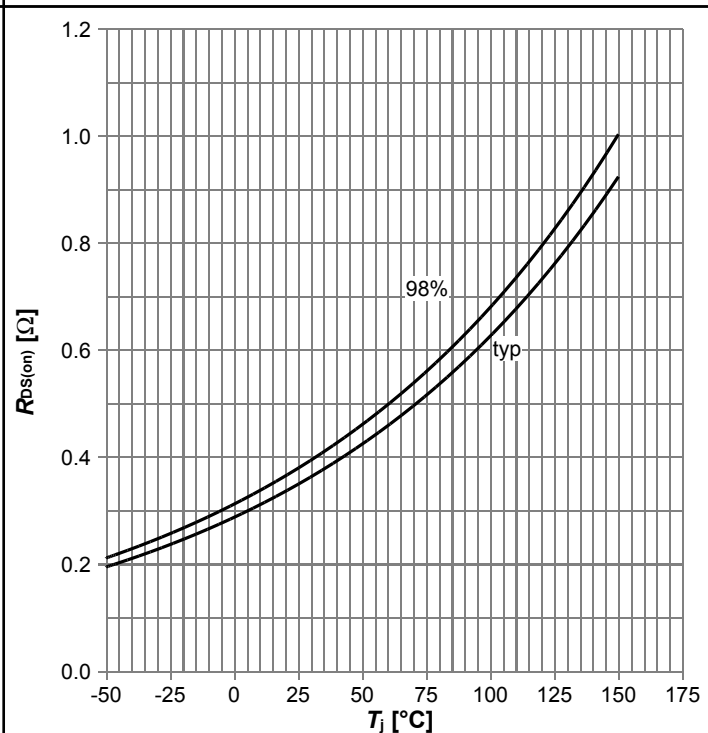
$I_D=f(V_{DS})$ ;  $T_j=125^\circ\text{C}$ ; parameter:  $V_{GS}$

Typ. drain-source on-state resistance

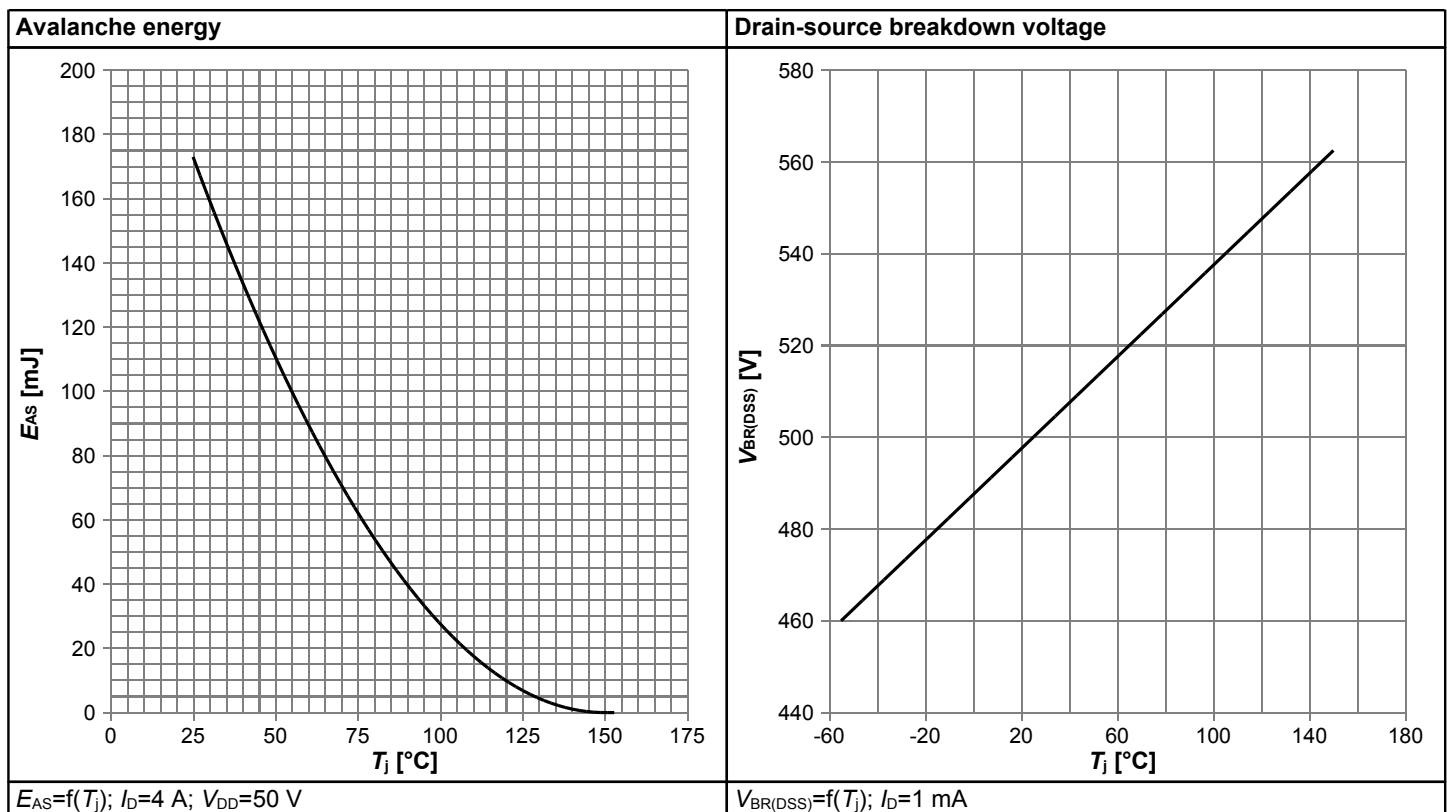
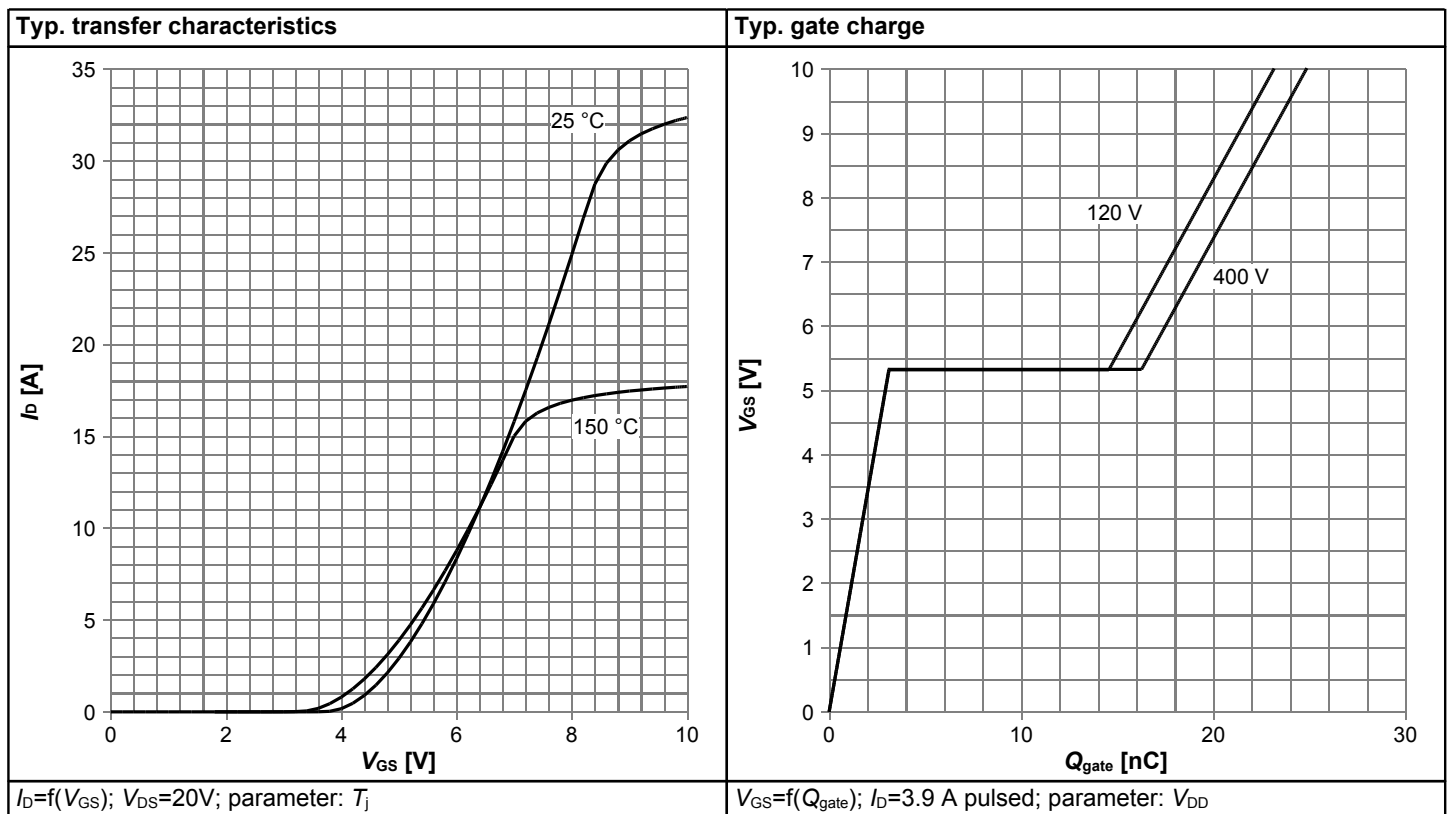


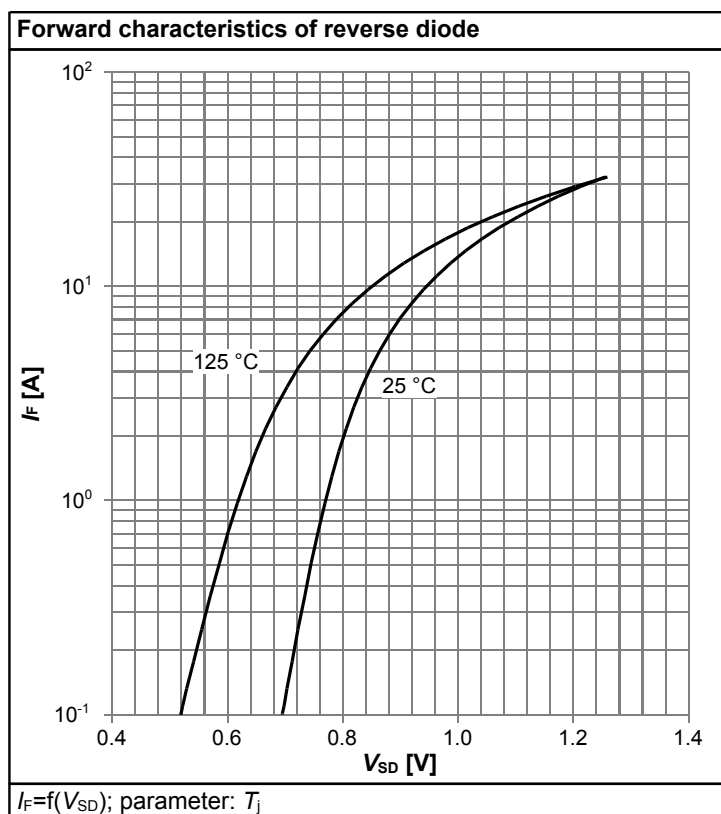
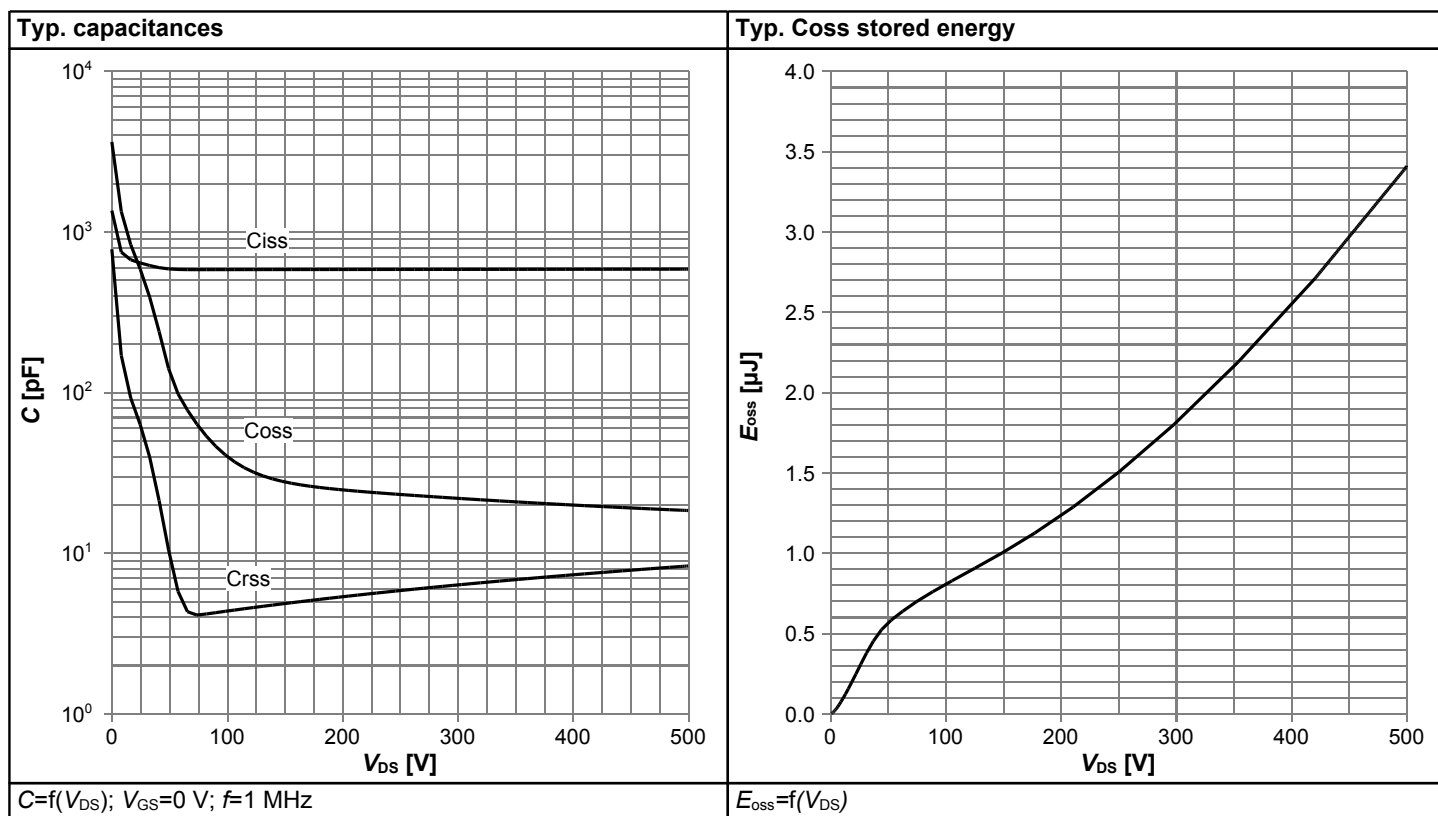
$R_{DS(on)}=f(I_D)$ ;  $T_j=125^\circ\text{C}$ ; parameter:  $V_{GS}$

Drain-source on-state resistance



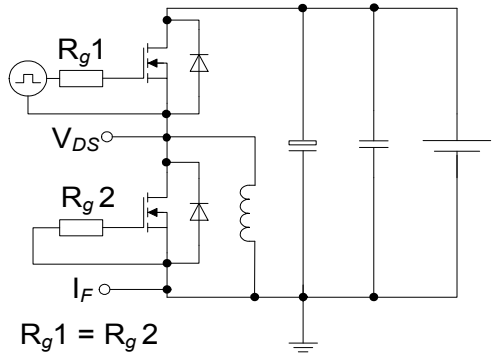
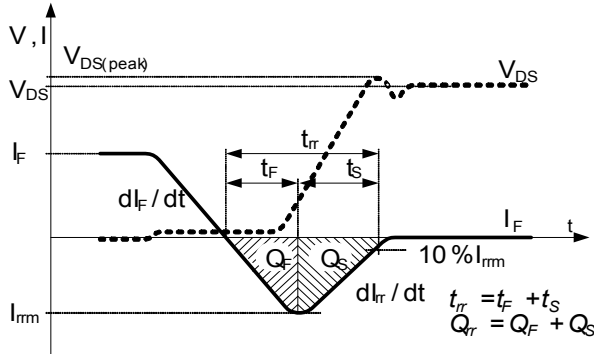
$R_{DS(on)}=f(T_j)$ ;  $I_D=3.2\text{ A}$ ;  $V_{GS}=13\text{ V}$



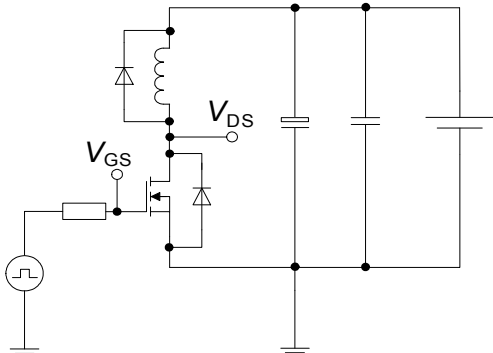
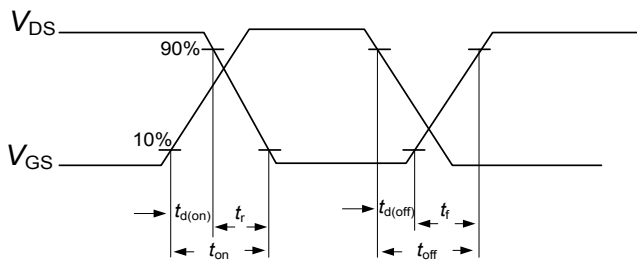


## 5 Test Circuits

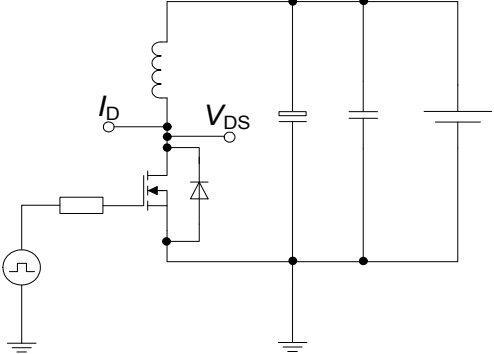
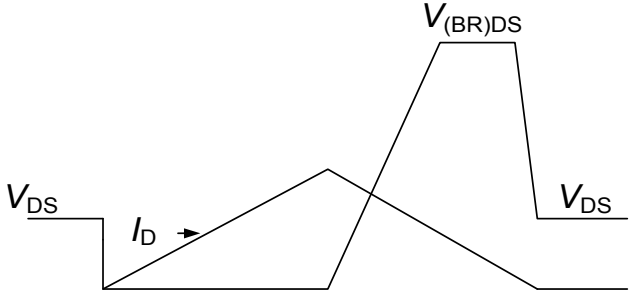
**Table 8 Diode characteristics**

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

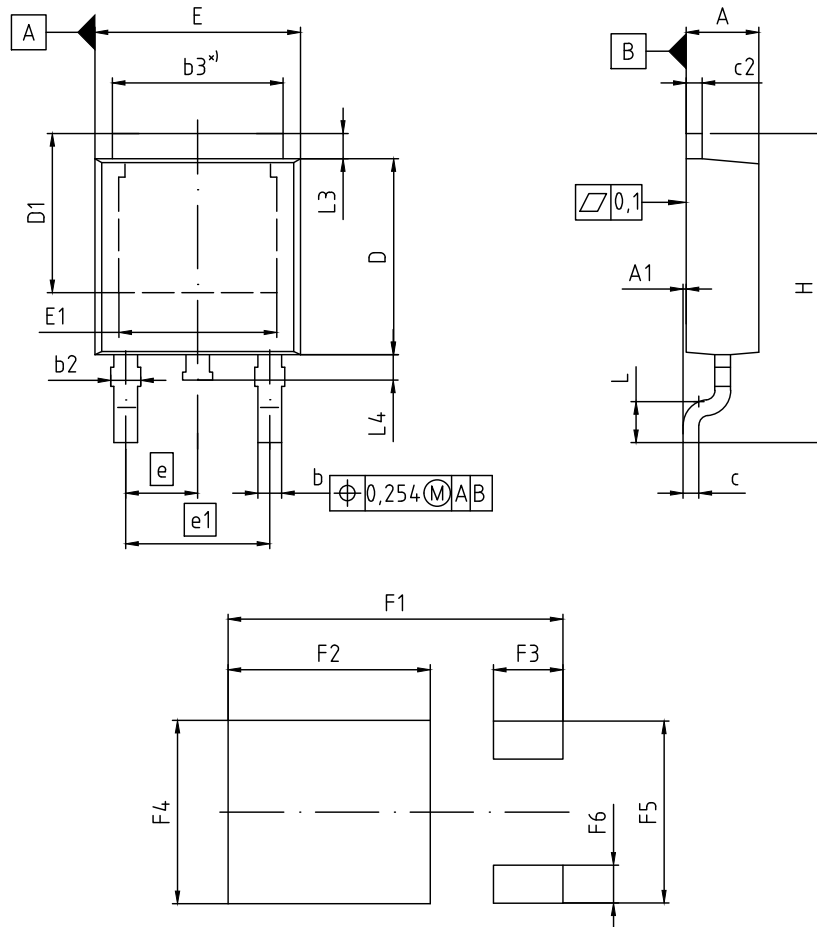
**Table 9 Switching times**

| Switching times test circuit for inductive load                                    | Switching times waveform                                                                                                                                                                                                  |
|------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|  |  <p><math>t_{d(on)}</math>, <math>t_r</math>, <math>t_{d(off)}</math>, <math>t_f</math>, <math>t_{on}</math>, <math>t_{off}</math></p> |

**Table 10 Unclamped inductive load**

| Unclamped inductive load test circuit                                               | Unclamped inductive waveform                                                                                        |
|-------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------|
|  |  <p><math>V_{(BR)DS}</math></p> |

## 6 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        | 5.60  | 0.185       | 0.220 |
| e   | 2.29 (BSC)  |       | 0.090 (BSC) |       |
| e1  | 4.57 (BSC)  |       | 0.180 (BSC) |       |
| 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       |       |

|                                    |
|------------------------------------|
| <b>DOCUMENT NO.</b><br>Z8B00003328 |
| <b>SCALE</b><br>0 2.0 4mm          |
| <b>EUROPEAN PROJECTION</b><br>     |
| <b>ISSUE DATE</b><br>01-09-2015    |
| <b>REVISION</b><br>05              |

Figure 1 Outline PG-TO 252, 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

IPD50R380CE

**Revision: 2016-06-13, Rev. 2.3**

Previous Revision

| Revision | Date       | Subjects (major changes since last revision)                       |
|----------|------------|--------------------------------------------------------------------|
| 2.0      | 2012-08-24 | Release of final version                                           |
| 2.1      | 2013-07-16 | update to Halogen free mold compound                               |
| 2.2      | 2015-11-17 | Update to qualified for standard grade and updated package drawing |
| 2.3      | 2016-06-13 | Updated ID ratings, Zth, SOA and Pd curves                         |

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