

# 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.

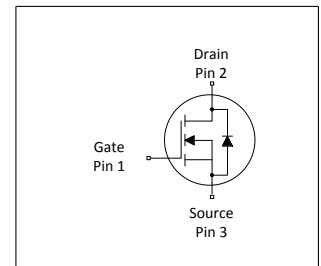
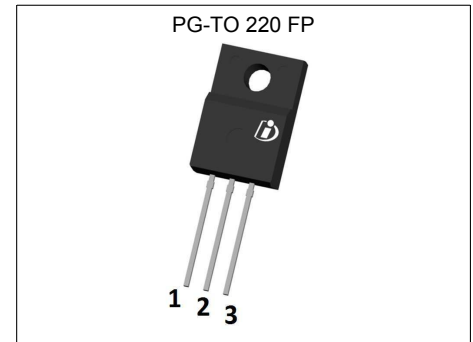
### Features

- 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        |
| $R_{DS(on),max}$     | 0.5   | $\Omega$ |
| $I_D$                | 11.1  | A        |
| $Q_{g,typ}$          | 18.7  | nC       |
| $I_{D,pulse}$        | 24    | A        |
| $E_{oss} @ 400V$     | 2.02  | $\mu J$  |

| Type / Ordering Code | Package                         | Marking  | Related Links  |
|----------------------|---------------------------------|----------|----------------|
| IPAN50R500CE         | PG-TO 220 FullPAK - Narrow Lead | 50S500CE | 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>          | $I_D$          | -          | -    | 11.1<br>7.0 | A                | $T_C = 25^\circ\text{C}$<br>$T_C = 100^\circ\text{C}$                         |
| Pulsed drain current <sup>2)</sup>              | $I_{D,pulse}$  | -          | -    | 24          | A                | $T_C = 25^\circ\text{C}$                                                      |
| Avalanche energy, single pulse                  | $E_{AS}$       | -          | -    | 129         | mJ               | $I_D = 2.9\text{A}$ ; $V_{DD} = 50\text{V}$                                   |
| Avalanche energy, repetitive                    | $E_{AR}$       | -          | -    | 0.20        | mJ               | $I_D = 2.9\text{A}$ ; $V_{DD} = 50\text{V}$                                   |
| Avalanche current, repetitive                   | $I_{AR}$       | -          | -    | 2.9         | 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 (Full PAK)                    | $P_{tot}$      | -          | -    | 28.0        | 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                | $I_S$          | -          | -    | 4.6         | A                | $T_C = 25^\circ\text{C}$                                                      |
| Diode pulse current <sup>2)</sup>               | $I_{S,pulse}$  | -          | -    | 24.0        | 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                        | $R_{thJC}$ | -      | -    | 4.46 | $^\circ\text{C/W}$ | -                                   |
| Thermal resistance, junction - ambient                     | $R_{thJA}$ | -      | -    | 80   | $^\circ\text{C/W}$ | lead                                |
| Soldering temperature, wavesoldering only allowed at leads | $T_{sld}$  | -      | -    | 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>  $V_{DClk} = 400\text{V}$ ;  $V_{DS,peak} < V_{(BR)DSS}$ ; 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        | $V_{DS}=V_{GS}$ , $I_D=0.2mA$                                                                     |
| 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 | $R_{DS(on)}$  | -      | 0.45 | 0.50 | $\Omega$ | $V_{GS}=13V$ , $I_D=2.3A$ , $T_j=25^\circ C$<br>$V_{GS}=13V$ , $I_D=2.3A$ , $T_j=150^\circ C$     |
| 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                                          | $C_{iss}$    | -      | 433  | -    | pF   | $V_{GS}=0V$ , $V_{DS}=100V$ , $f=1\text{ MHz}$                 |
| Output capacitance                                         | $C_{oss}$    | -      | 31   | -    | pF   | $V_{GS}=0V$ , $V_{DS}=100V$ , $f=1\text{ MHz}$                 |
| Effective output capacitance, energy related <sup>1)</sup> | $C_{o(er)}$  | -      | 25   | -    | pF   | $V_{GS}=0V$ , $V_{DS}=0...400V$                                |
| Effective output capacitance, time related <sup>2)</sup>   | $C_{o(tr)}$  | -      | 100  | -    | pF   | $I_D=\text{constant}$ , $V_{GS}=0V$ , $V_{DS}=0...400V$        |
| Turn-on delay time                                         | $t_{d(on)}$  | -      | 6    | -    | ns   | $V_{DD}=400V$ , $V_{GS}=13V$ , $I_D=2.9A$ ,<br>$R_G=3.4\Omega$ |
| Rise time                                                  | $t_r$        | -      | 5    | -    | ns   | $V_{DD}=400V$ , $V_{GS}=13V$ , $I_D=2.9A$ ,<br>$R_G=3.4\Omega$ |
| Turn-off delay time                                        | $t_{d(off)}$ | -      | 30   | -    | ns   | $V_{DD}=400V$ , $V_{GS}=13V$ , $I_D=2.9A$ ,<br>$R_G=3.4\Omega$ |
| Fall time                                                  | $t_f$        | -      | 12   | -    | ns   | $V_{DD}=400V$ , $V_{GS}=13V$ , $I_D=2.9A$ ,<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 | $Q_{gs}$      | -      | 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 $10V$ |

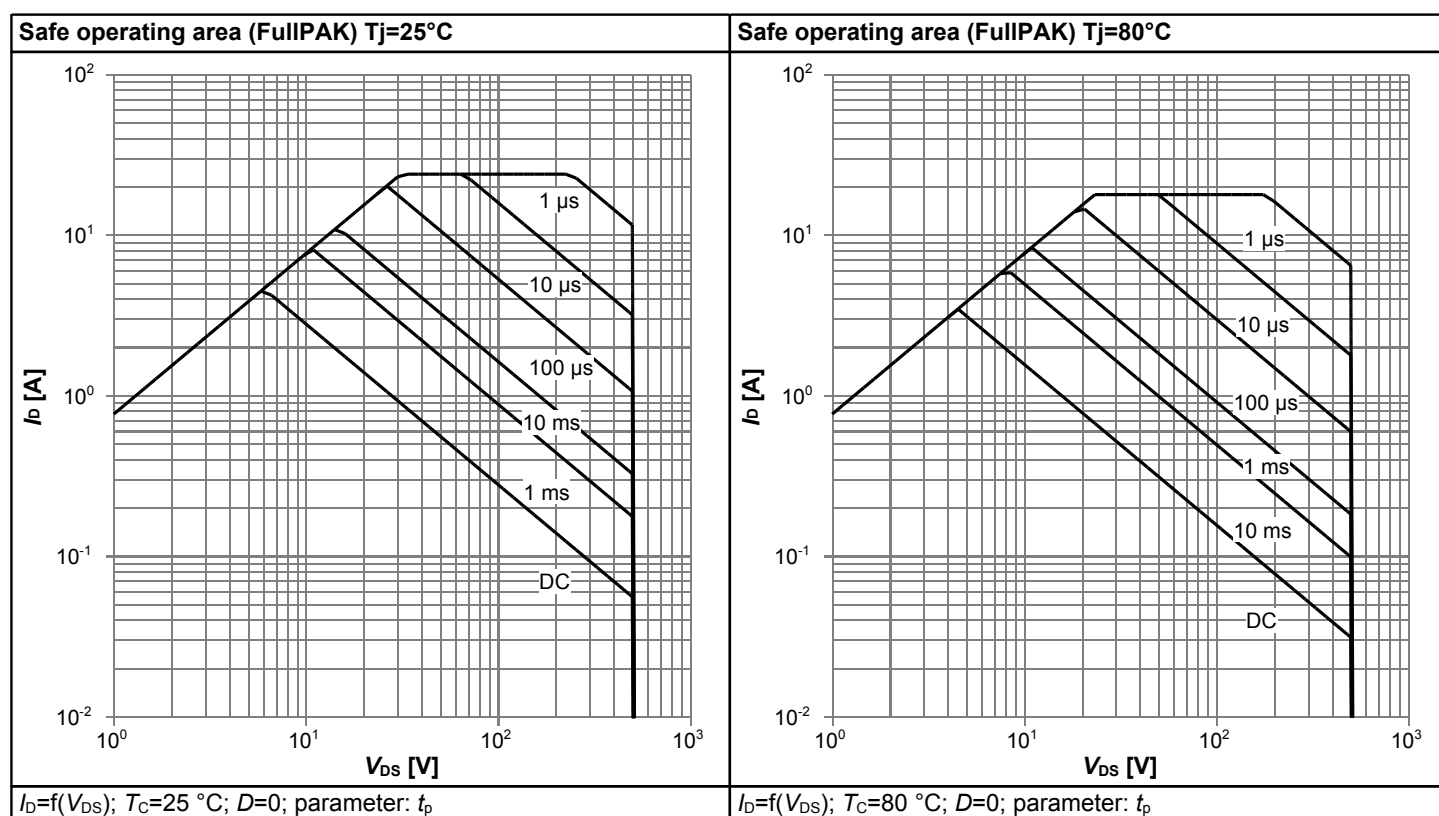
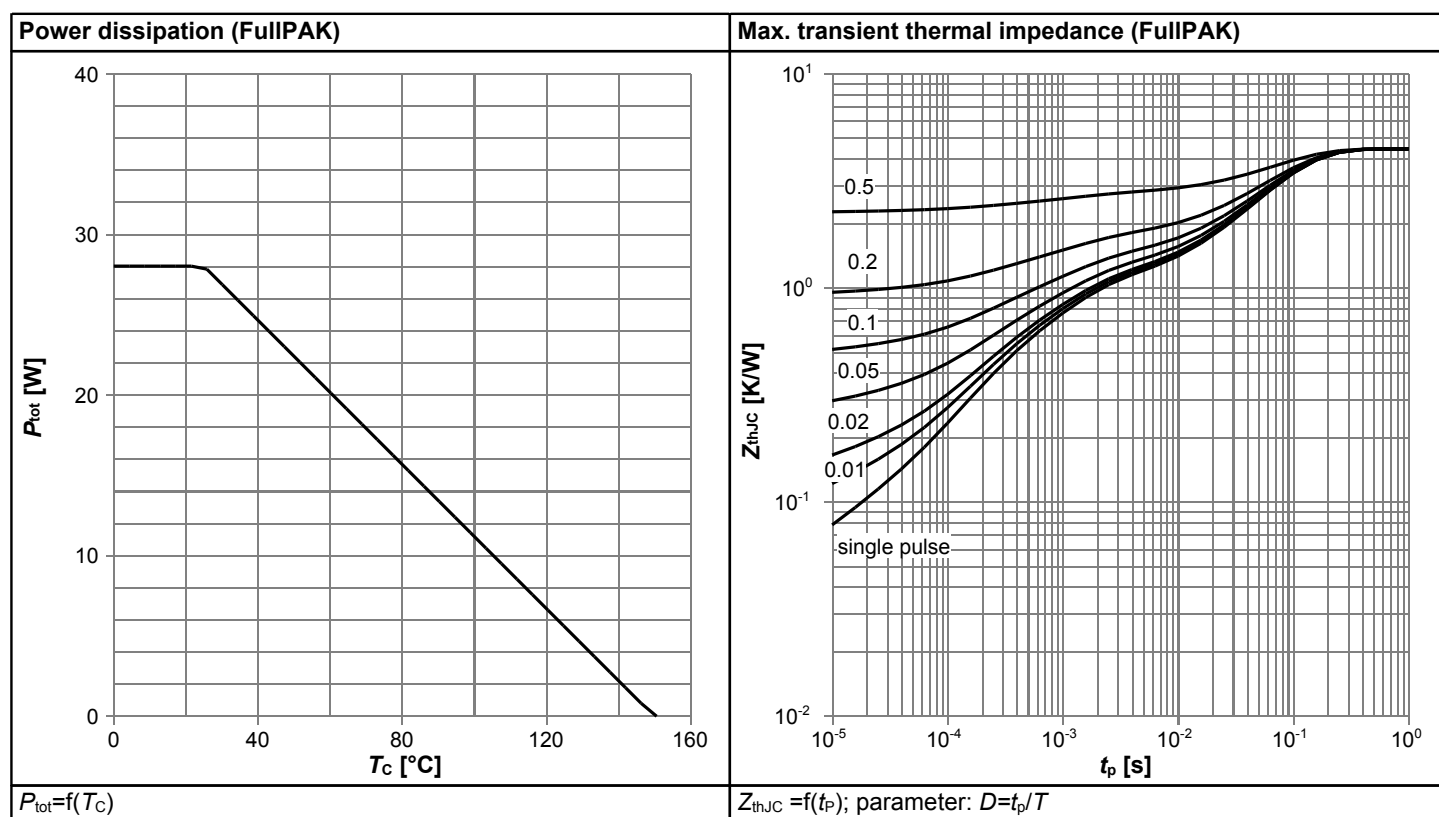
<sup>1)</sup>  $C_{o(er)}$  is a fixed capacitance that gives the same stored energy as  $C_{oss}$  while  $V_{DS}$  is rising from 0 to 400V

<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

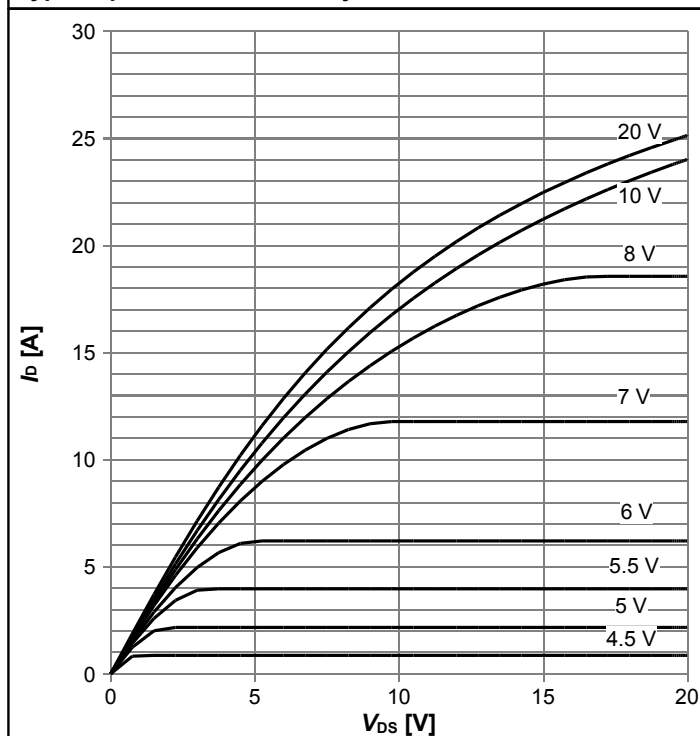
**Table 7 Reverse diode characteristics**

| Parameter                     | Symbol    | Values |      |      | Unit    | Note / Test Condition                    |
|-------------------------------|-----------|--------|------|------|---------|------------------------------------------|
|                               |           | Min.   | Typ. | Max. |         |                                          |
| Diode forward voltage         | $V_{SD}$  | -      | 0.85 | -    | V       | $V_{GS}=0V, I_F=2.9A, T_J=25^{\circ}C$   |
| Reverse recovery time         | $t_{rr}$  | -      | 180  | -    | ns      | $V_R=400V, I_F=2.9A, di_F/dt=100A/\mu s$ |
| Reverse recovery charge       | $Q_{rr}$  | -      | 1.2  | -    | $\mu C$ | $V_R=400V, I_F=2.9A, di_F/dt=100A/\mu s$ |
| Peak reverse recovery current | $I_{rrm}$ | -      | 12   | -    | A       | $V_R=400V, I_F=2.9A, di_F/dt=100A/\mu s$ |

## 4 Electrical characteristics diagrams

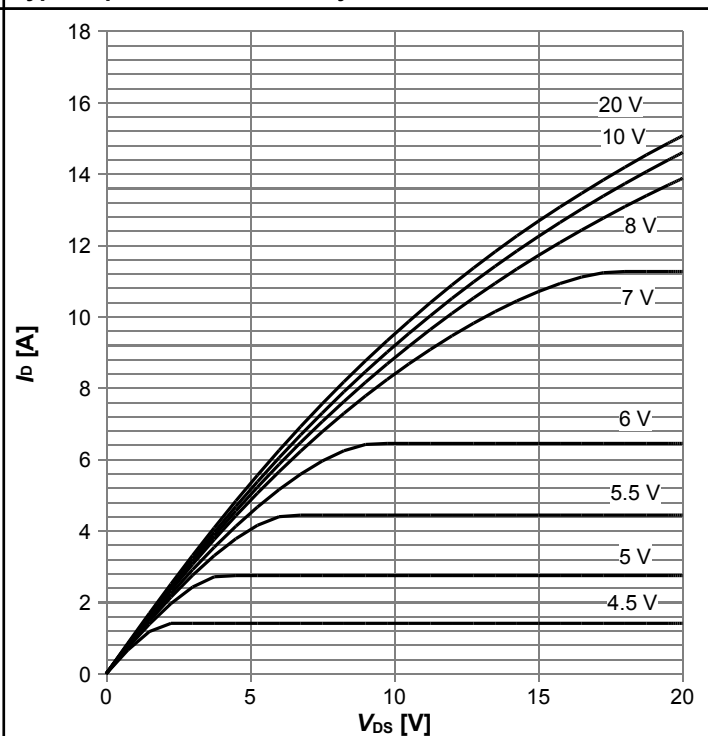


**Typ. output characteristics  $T_J=25^\circ\text{C}$**



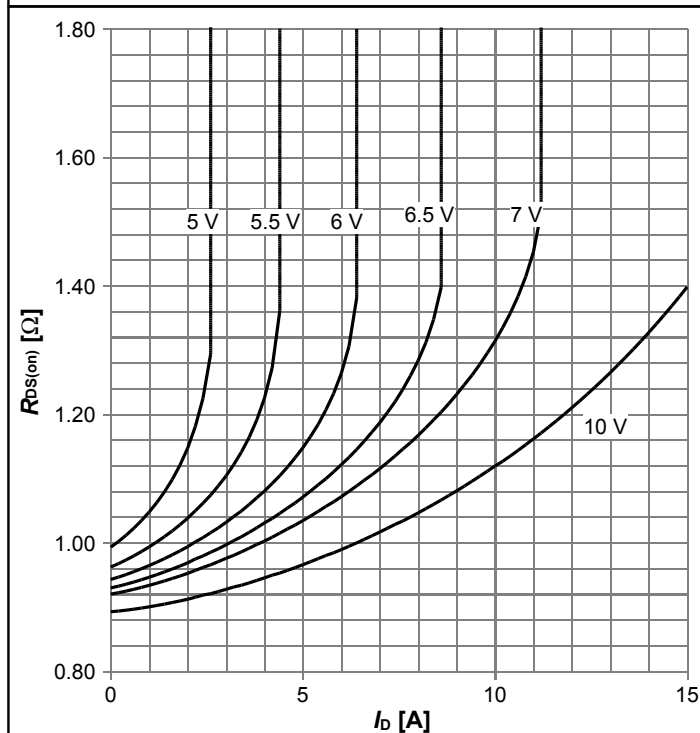
$I_D=f(V_{DS}); T_J=25^\circ\text{C}; \text{parameter: } V_{GS}$

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



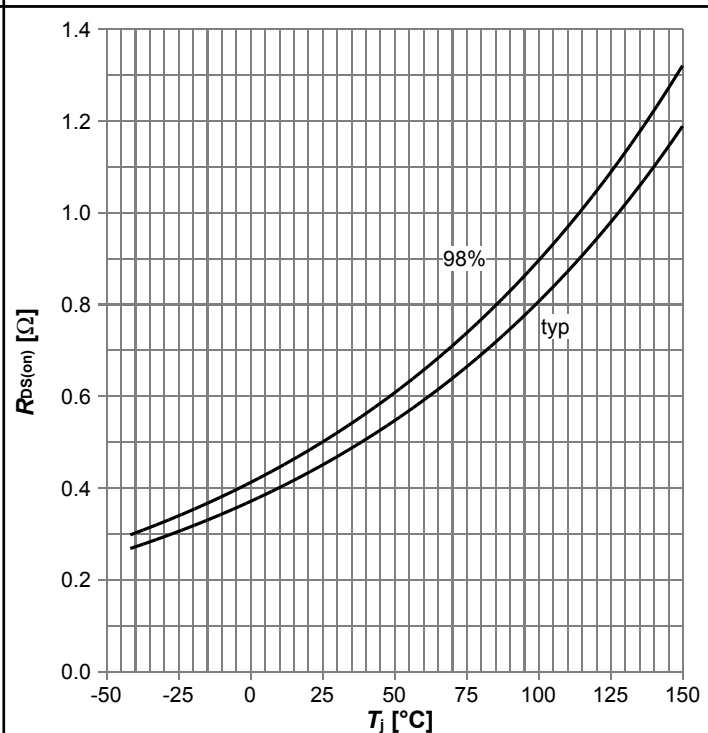
$I_D=f(V_{DS}); T_J=125^\circ\text{C}; \text{parameter: } V_{GS}$

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

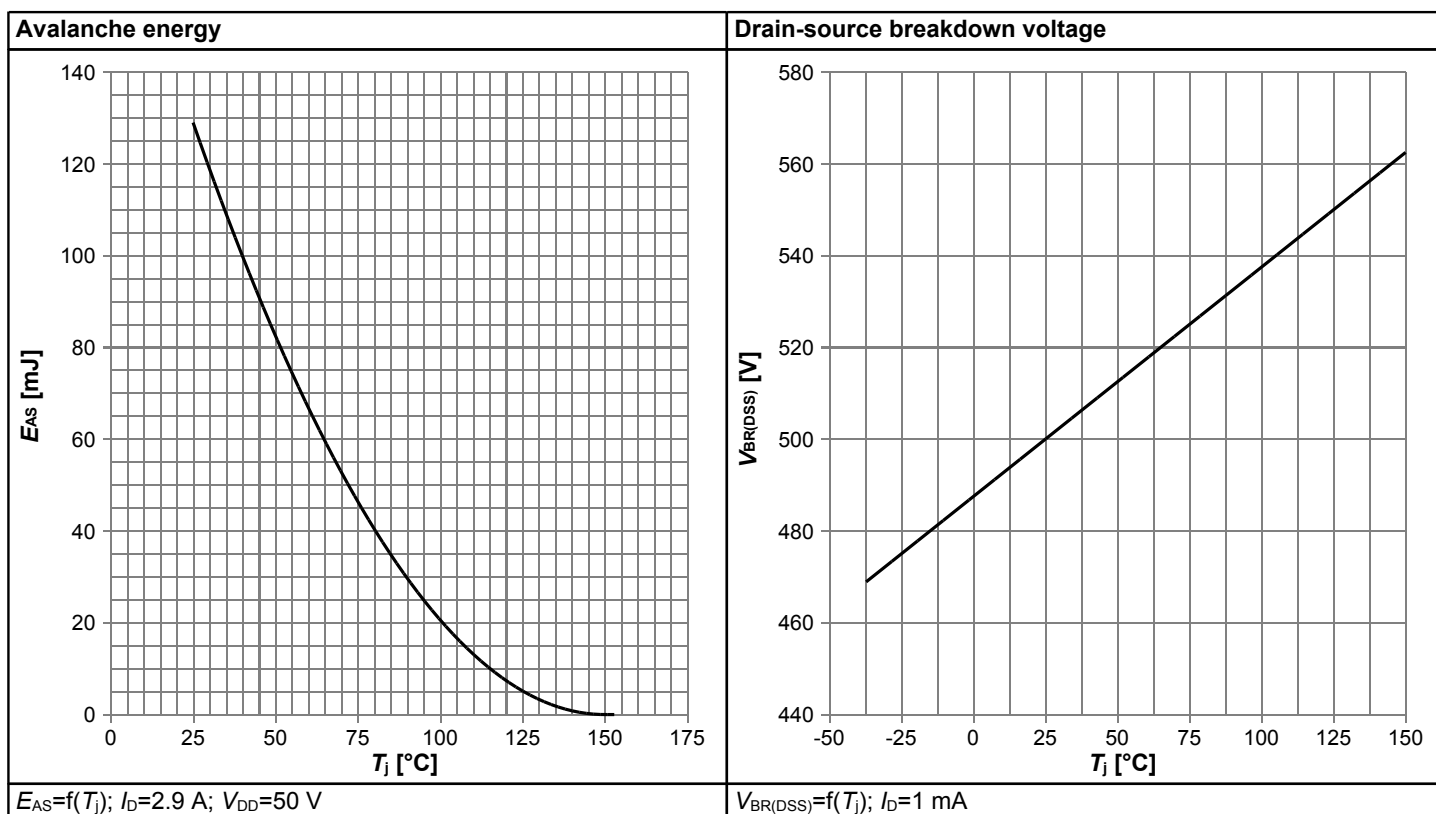
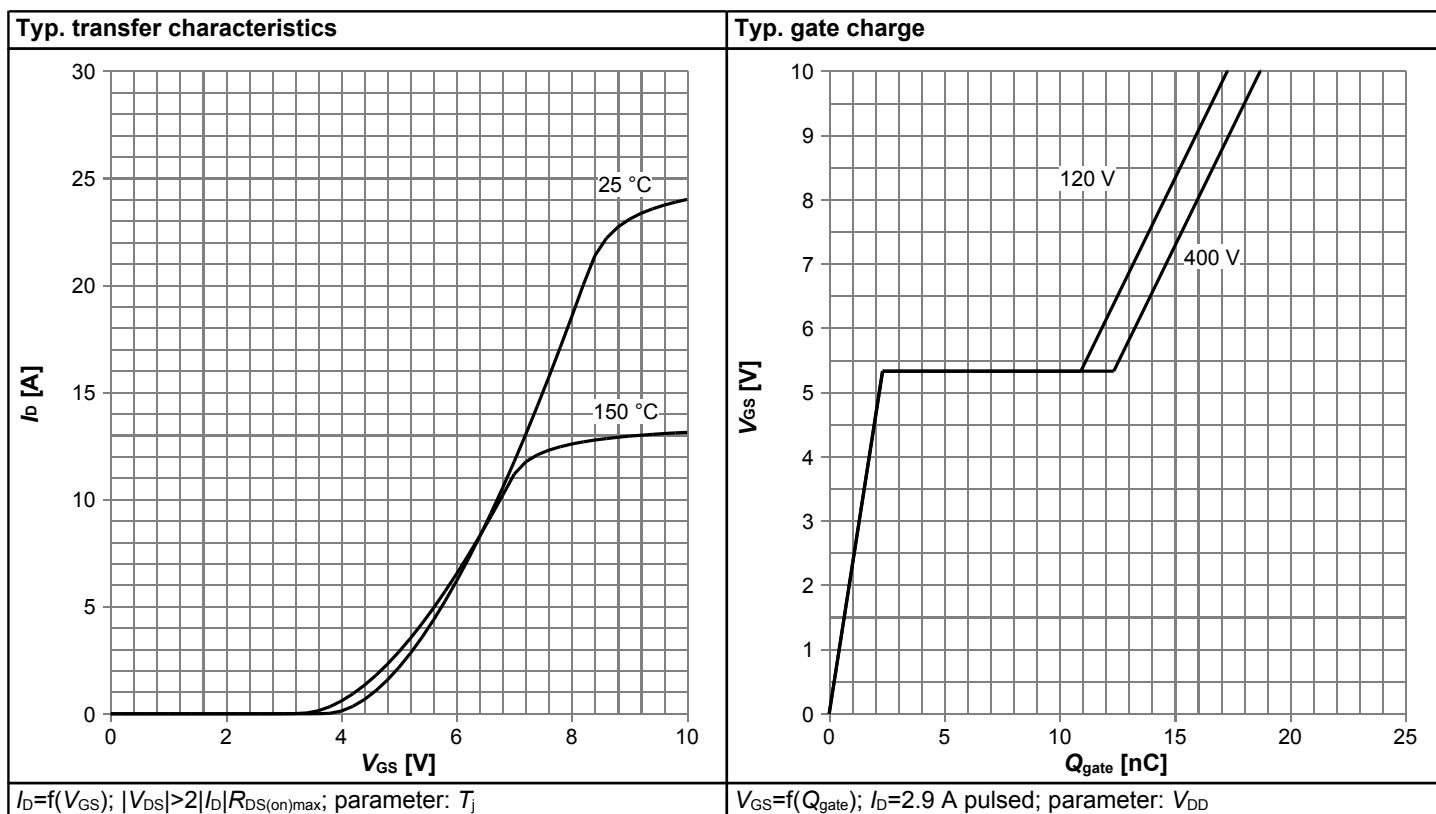


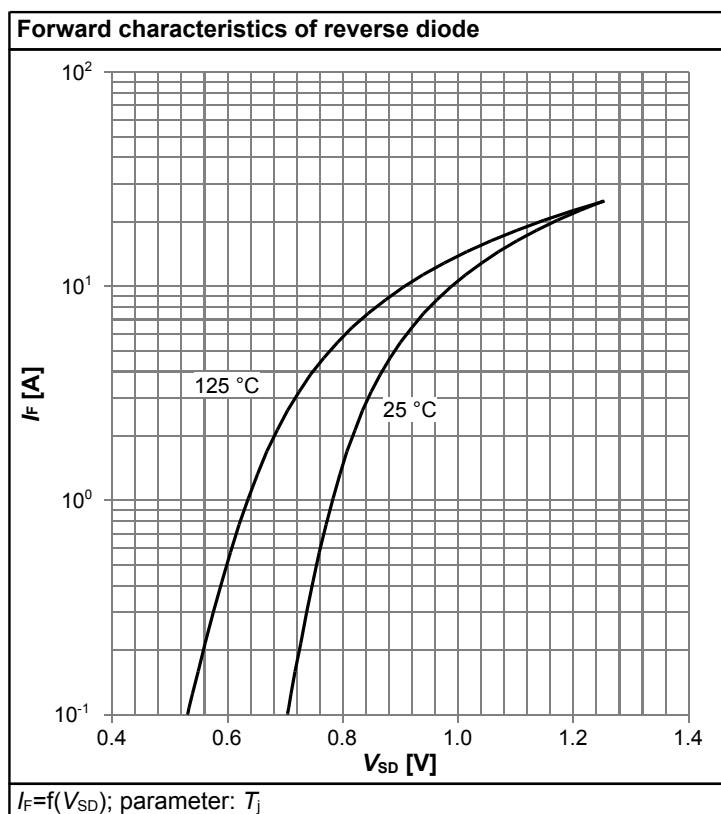
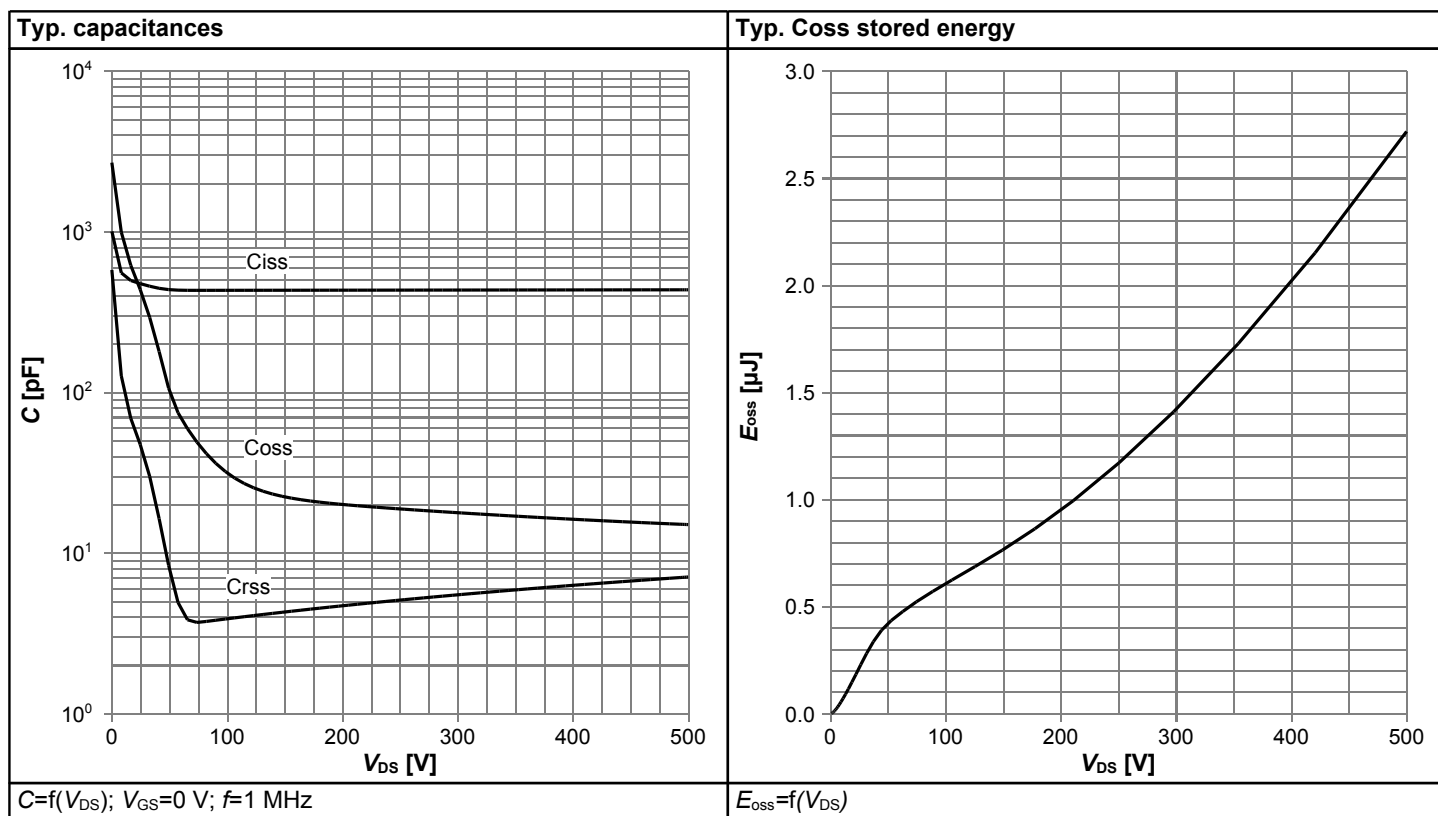
$R_{DS(on)}=f(I_D); T_J=125^\circ\text{C}; \text{parameter: } V_{GS}$

**Drain-source on-state resistance**



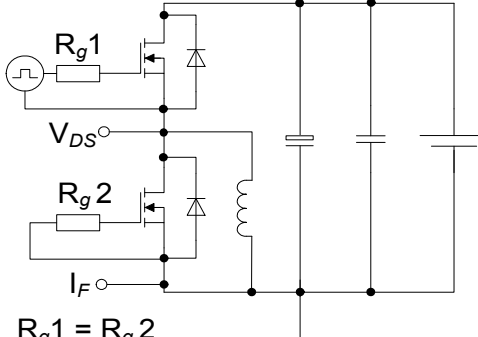
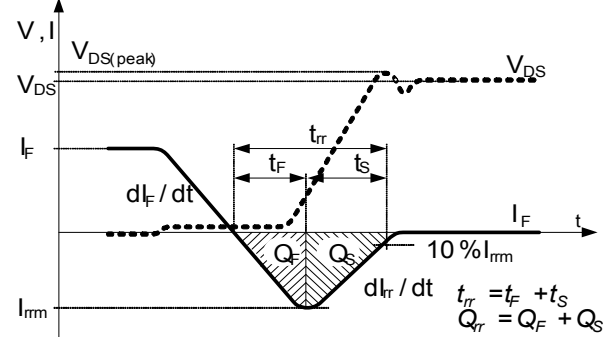
$R_{DS(on)}=f(T_J); I_D=2.3\text{ A}; V_{GS}=13\text{ V}$



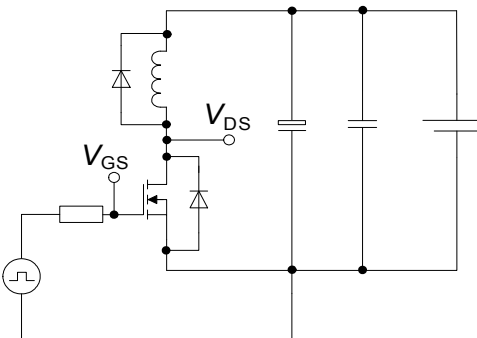
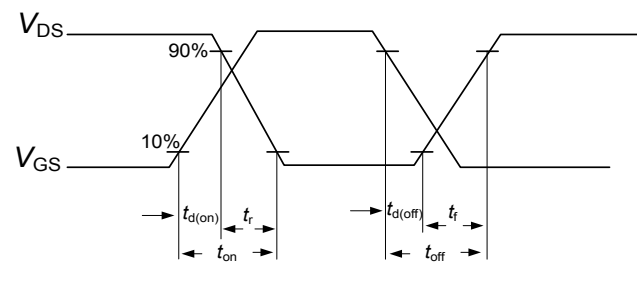


## 5 Test Circuits

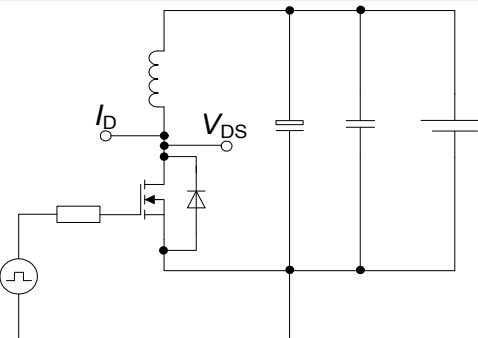
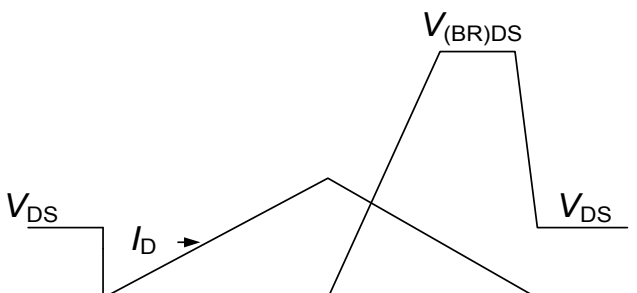
**Table 8 Diode characteristics**

| Test circuit for diode characteristics                                                                                | Diode recovery waveform                                                                                                                                       |
|-----------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------|
|  <p><math>R_{g1} = R_{g2}</math></p> |  <p><math>t_{rr} = t_F + 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

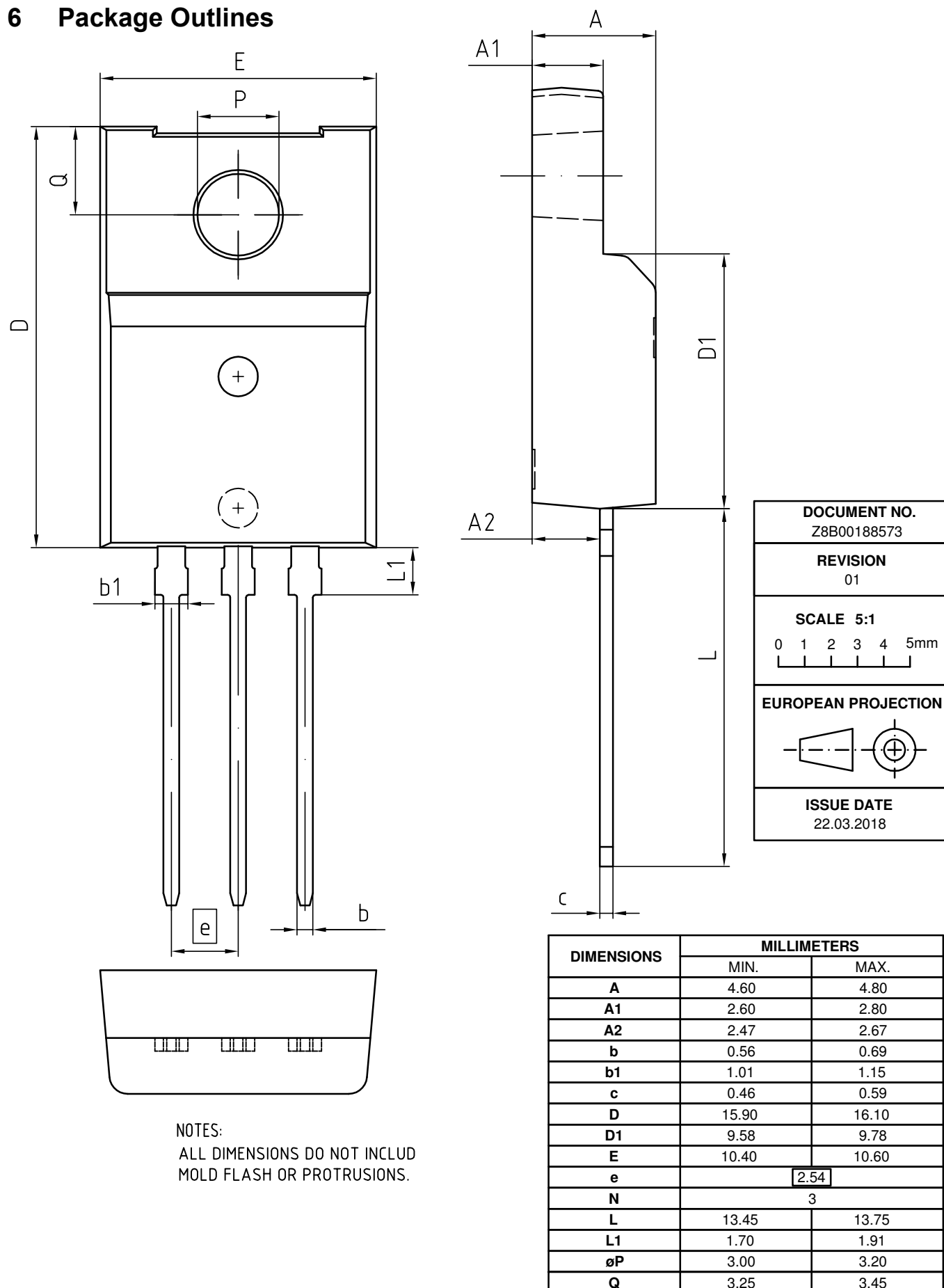


Figure 1 Outline PG-TO 220 FullPAK - Narrow Lead, dimensions in mm

## 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

IPAN50R500CE

**Revision: 2018-05-14, Rev. 2.4**

Previous Revision

| Revision | Date       | Subjects (major changes since last revision) |
|----------|------------|----------------------------------------------|
| 2.1      | 2016-06-13 | Updated ID ratings                           |
| 2.2      | 2016-11-28 | Revised package drawing on page 11           |
| 2.3      | 2018-04-26 | Revised package drawing                      |
| 2.4      | 2018-05-14 | Part Marking update                          |

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