

## MOSFET

### 600V 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.

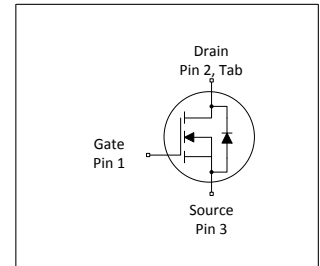
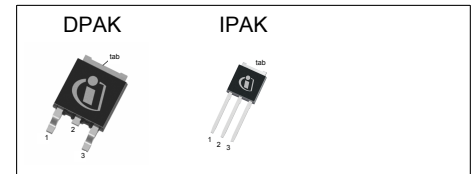
### Features

- 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 |
|----------------------|-------|------|
| $V_{DS} @ T_{j,max}$ | 650   | V    |
| $R_{DS(on),max}$     | 1000  | mΩ   |
| $I_d$                | 6.8   | A    |
| $Q_{g,typ}$          | 13    | nC   |
| $I_{D,pulse}$        | 12    | A    |
| $E_{oss}@400V$       | 1.3   | μJ   |

| Type / Ordering Code | Package   | Marking  | Related Links  |
|----------------------|-----------|----------|----------------|
| IPD60R1K0CE          | PG-TO 252 | 60S1K0CE | see Appendix A |
| IPU60R1K0CE          | PG-TO 251 |          |                |

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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> | $I_D$         | -      | -    | 6.8<br>4.3 | A                | $T_C=25^\circ\text{C}$<br>$T_C=100^\circ\text{C}$                                     |
| Pulsed drain current <sup>2)</sup>     | $I_{D,pulse}$ | -      | -    | 12         | A                | $T_C=25^\circ\text{C}$                                                                |
| Avalanche energy, single pulse         | $E_{AS}$      | -      | -    | 46         | mJ               | $I_D=0.8\text{A}$ ; $V_{DD}=50\text{V}$ ; see table 11                                |
| Avalanche energy, repetitive           | $E_{AR}$      | -      | -    | 0.13       | mJ               | $I_D=0.8\text{A}$ ; $V_{DD}=50\text{V}$ ; see table 11                                |
| Avalanche current, repetitive          | $I_{AR}$      | -      | -    | 0.8        | A                | -                                                                                     |
| MOSFET dv/dt ruggedness                | dv/dt         | -      | -    | 50         | V/ns             | $V_{DS}=0\dots480\text{V}$                                                            |
| Gate source voltage (static)           | $V_{GS}$      | -20    | -    | 20         | V                | static;                                                                               |
| Gate source voltage (dynamic)          | $V_{GS}$      | -30    | -    | 30         | V                | AC ( $f>1\text{ Hz}$ )                                                                |
| Power dissipation<br>TO-251, TO-252    | $P_{tot}$     | -      | -    | 61         | W                | $T_C=25^\circ\text{C}$                                                                |
| Storage temperature                    | $T_{stg}$     | -40    | -    | 150        | $^\circ\text{C}$ | -                                                                                     |
| Operating junction temperature         | $T_j$         | -40    | -    | 150        | $^\circ\text{C}$ | -                                                                                     |
| Continuous diode forward current       | $I_S$         | -      | -    | 4.8        | A                | $T_C=25^\circ\text{C}$                                                                |
| Diode pulse current <sup>2)</sup>      | $I_{S,pulse}$ | -      | -    | 12         | A                | $T_C=25^\circ\text{C}$                                                                |
| Reverse diode dv/dt <sup>3)</sup>      | dv/dt         | -      | -    | 15         | V/ns             | $V_{DS}=0\dots400\text{V}$ , $I_{SD}\leq I_S$ , $T_j=25^\circ\text{C}$<br>see table 9 |
| Maximum diode commutation speed        | di/dt         | -      | -    | 500        | A/ $\mu\text{s}$ | $V_{DS}=0\dots400\text{V}$ , $I_{SD}\leq I_S$ , $T_j=25^\circ\text{C}$<br>see table 9 |

## 2 Thermal characteristics

**Table 3 Thermal characteristics TO-251, TO252**

| Parameter                                                     | Symbol     | Values |      |      | Unit               | Note / Test Condition               |
|---------------------------------------------------------------|------------|--------|------|------|--------------------|-------------------------------------|
|                                                               |            | Min.   | Typ. | Max. |                    |                                     |
| Thermal resistance, junction - case                           | $R_{thJC}$ | -      | -    | 2.06 | $^\circ\text{C/W}$ | -                                   |
| Thermal resistance, junction - ambient                        | $R_{thJA}$ | -      | -    | 62   | $^\circ\text{C/W}$ | lead                                |
| 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  $T_{j,max}$ . Maximum duty cycle  $D=0.50$

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

<sup>3)</sup> Identical low side and high side switch with identical  $R_G$

### 3 Electrical characteristics

at  $T_j=25^\circ\text{C}$ , unless otherwise specified

**Table 4 Static characteristics**

| Parameter                        | Symbol        | Values |              |      | Unit     | Note / Test Condition                                                                                       |
|----------------------------------|---------------|--------|--------------|------|----------|-------------------------------------------------------------------------------------------------------------|
|                                  |               | Min.   | Typ.         | Max. |          |                                                                                                             |
| Drain-source breakdown voltage   | $V_{(BR)DSS}$ | 600    | -            | -    | V        | $V_{GS}=0V$ , $I_D=0.25mA$                                                                                  |
| Gate threshold voltage           | $V_{(GS)th}$  | 2.5    | 3.0          | 3.5  | V        | $V_{DS}=V_{GS}$ , $I_D=0.13mA$                                                                              |
| Zero gate voltage drain current  | $I_{DSS}$     | -      | -            | 1    | $\mu A$  | $V_{DS}=600$ , $V_{GS}=0V$ , $T_j=25^\circ\text{C}$<br>$V_{DS}=600$ , $V_{GS}=0V$ , $T_j=150^\circ\text{C}$ |
| Gate-source leakage current      | $I_{GSS}$     | -      | -            | 100  | nA       | $V_{GS}=20V$ , $V_{DS}=0V$                                                                                  |
| Drain-source on-state resistance | $R_{DS(on)}$  | -      | 0.86<br>2.22 | 1.00 | $\Omega$ | $V_{GS}=10V$ , $I_D=1.5A$ , $T_j=25^\circ\text{C}$<br>$V_{GS}=10V$ , $I_D=1.5A$ , $T_j=150^\circ\text{C}$   |
| Gate resistance                  | $R_G$         | -      | 16           | -    | $\Omega$ | $f=1MHz$ , open drain                                                                                       |

**Table 5 Dynamic characteristics**

| Parameter                                                  | Symbol       | Values |      |      | Unit | Note / Test Condition                                                          |
|------------------------------------------------------------|--------------|--------|------|------|------|--------------------------------------------------------------------------------|
|                                                            |              | Min.   | Typ. | Max. |      |                                                                                |
| Input capacitance                                          | $C_{iss}$    | -      | 280  | -    | pF   | $V_{GS}=0V$ , $V_{DS}=100V$ , $f=1MHz$                                         |
| Output capacitance                                         | $C_{oss}$    | -      | 21   | -    | pF   | $V_{GS}=0V$ , $V_{DS}=100V$ , $f=1MHz$                                         |
| Effective output capacitance, energy related <sup>1)</sup> | $C_{o(er)}$  | -      | 14   | -    | pF   | $V_{GS}=0V$ , $V_{DS}=0...480V$                                                |
| Effective output capacitance, time related <sup>2)</sup>   | $C_{o(tr)}$  | -      | 57   | -    | pF   | $I_D=\text{constant}$ , $V_{GS}=0V$ , $V_{DS}=0...480V$                        |
| Turn-on delay time                                         | $t_{d(on)}$  | -      | 10   | -    | ns   | $V_{DD}=400V$ , $V_{GS}=10V$ , $I_D=1.9A$ ,<br>$R_G=12.2\Omega$ ; see table 10 |
| Rise time                                                  | $t_r$        | -      | 8    | -    | ns   | $V_{DD}=400V$ , $V_{GS}=10V$ , $I_D=1.9A$ ,<br>$R_G=12.2\Omega$ ; see table 10 |
| Turn-off delay time                                        | $t_{d(off)}$ | -      | 60   | -    | ns   | $V_{DD}=400V$ , $V_{GS}=10V$ , $I_D=1.9A$ ,<br>$R_G=12.2\Omega$ ; see table 10 |
| Fall time                                                  | $t_f$        | -      | 13   | -    | ns   | $V_{DD}=400V$ , $V_{GS}=10V$ , $I_D=1.9A$ ,<br>$R_G=12.2\Omega$ ; see table 10 |

**Table 6 Gate charge characteristics**

| Parameter             | Symbol        | Values |      |      | Unit | Note / Test Condition                            |
|-----------------------|---------------|--------|------|------|------|--------------------------------------------------|
|                       |               | Min.   | Typ. | Max. |      |                                                  |
| Gate to source charge | $Q_{gs}$      | -      | 1.5  | -    | nC   | $V_{DD}=480V$ , $I_D=1.9A$ , $V_{GS}=0$ to $10V$ |
| Gate to drain charge  | $Q_{gd}$      | -      | 6.5  | -    | nC   | $V_{DD}=480V$ , $I_D=1.9A$ , $V_{GS}=0$ to $10V$ |
| Gate charge total     | $Q_g$         | -      | 13   | -    | nC   | $V_{DD}=480V$ , $I_D=1.9A$ , $V_{GS}=0$ to $10V$ |
| Gate plateau voltage  | $V_{plateau}$ | -      | 5.4  | -    | V    | $V_{DD}=480V$ , $I_D=1.9A$ , $V_{GS}=0$ to $10V$ |

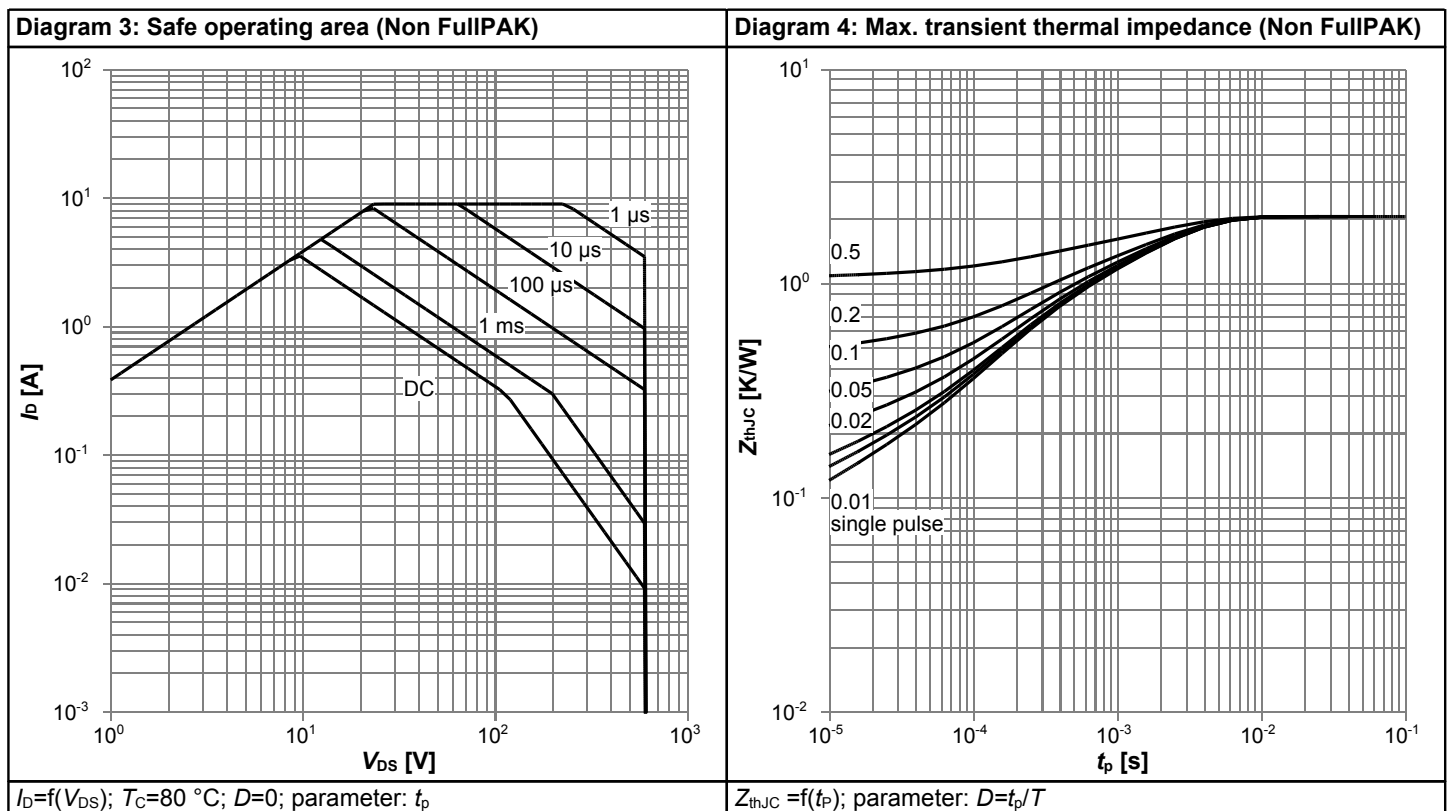
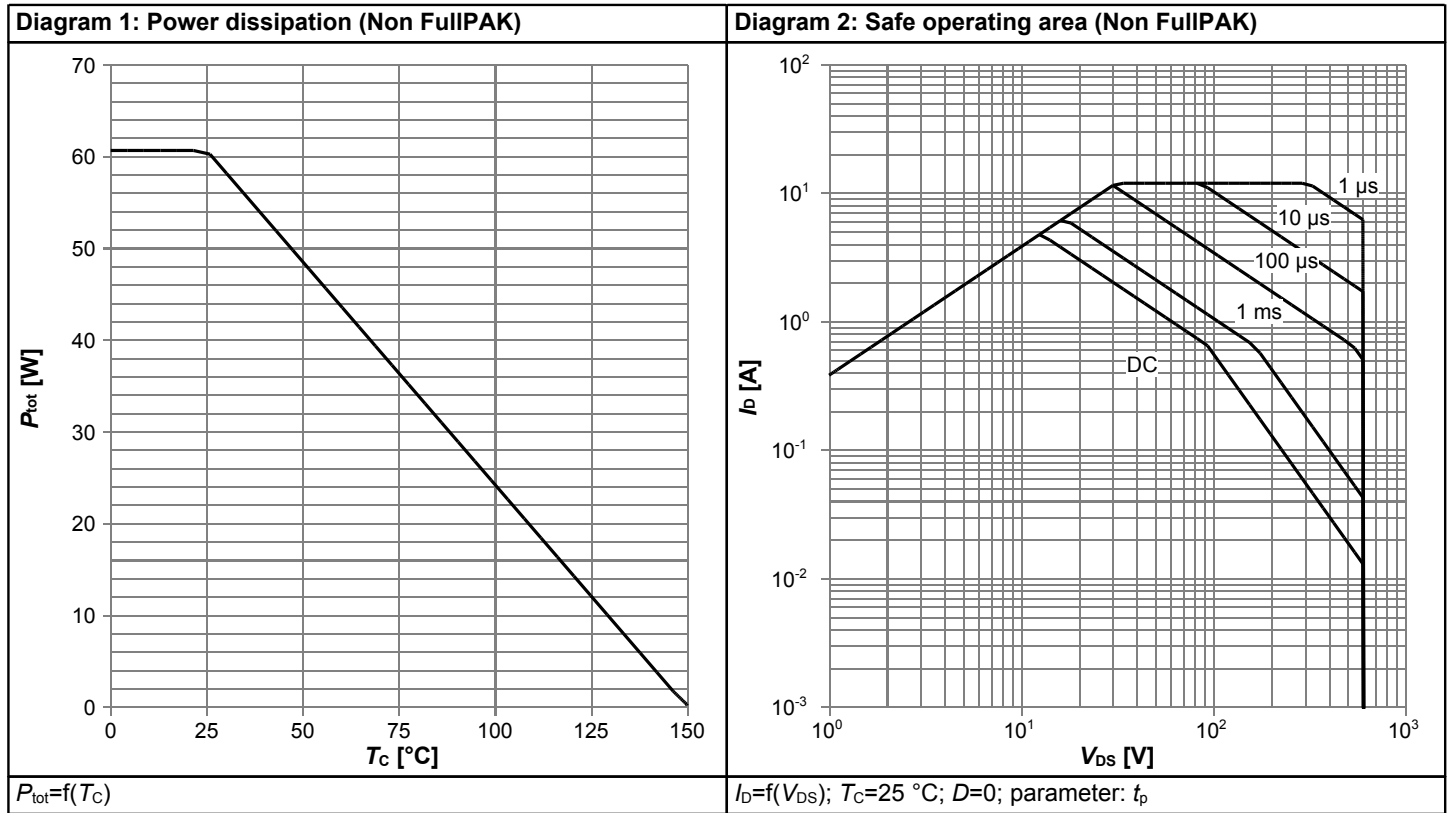
<sup>1)</sup>  $C_{o(er)}$  is a fixed capacitance that gives the same stored energy as  $C_{oss}$  while  $V_{DS}$  is rising from 0 to 80%  $V_{(BR)DSS}$

<sup>2)</sup>  $C_{o(tr)}$  is a fixed capacitance that gives the same stored energy as  $C_{oss}$  while  $V_{DS}$  is rising from 0 to 80%  $V_{(BR)DSS}$

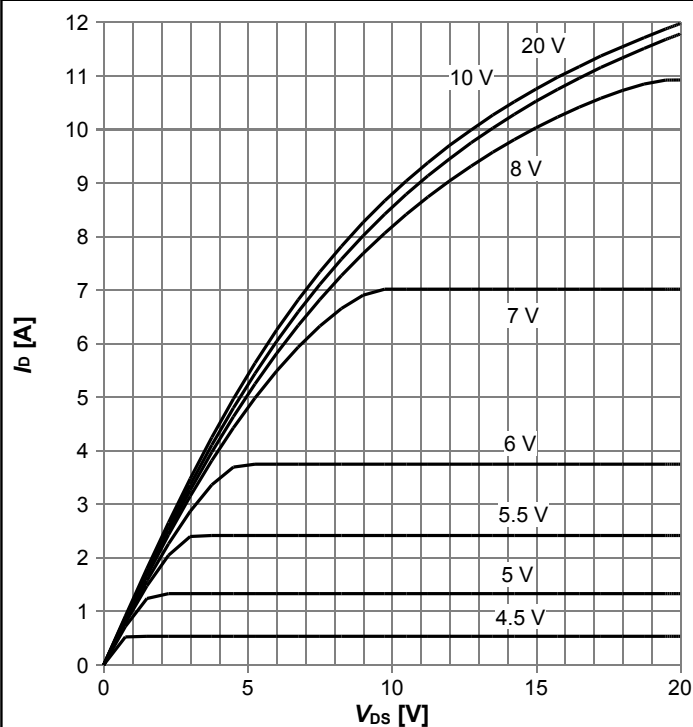
**Table 7 Reverse diode characteristics**

| Parameter                     | Symbol    | Values |      |      | Unit    | Note / Test Condition                                        |
|-------------------------------|-----------|--------|------|------|---------|--------------------------------------------------------------|
|                               |           | Min.   | Typ. | Max. |         |                                                              |
| Diode forward voltage         | $V_{SD}$  | -      | 0.9  | -    | V       | $V_{GS}=0V$ , $I_F=1.9A$ , $T_J=25^{\circ}C$                 |
| Reverse recovery time         | $t_{rr}$  | -      | 220  | -    | ns      | $V_R=400V$ , $I_F=1.9A$ , $di_F/dt=100A/\mu s$ ; see table 9 |
| Reverse recovery charge       | $Q_{rr}$  | -      | 1.5  | -    | $\mu C$ | $V_R=400V$ , $I_F=1.9A$ , $di_F/dt=100A/\mu s$ ; see table 9 |
| Peak reverse recovery current | $I_{rrm}$ | -      | 12   | -    | A       | $V_R=400V$ , $I_F=1.9A$ , $di_F/dt=100A/\mu s$ ; see table 9 |

## 4 Electrical characteristics diagrams

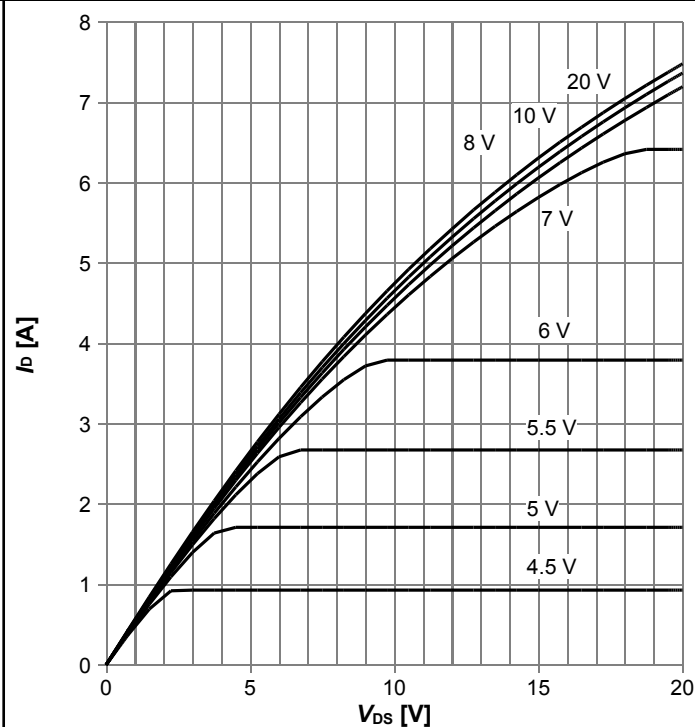


**Diagram 5: Typ. output characteristics**



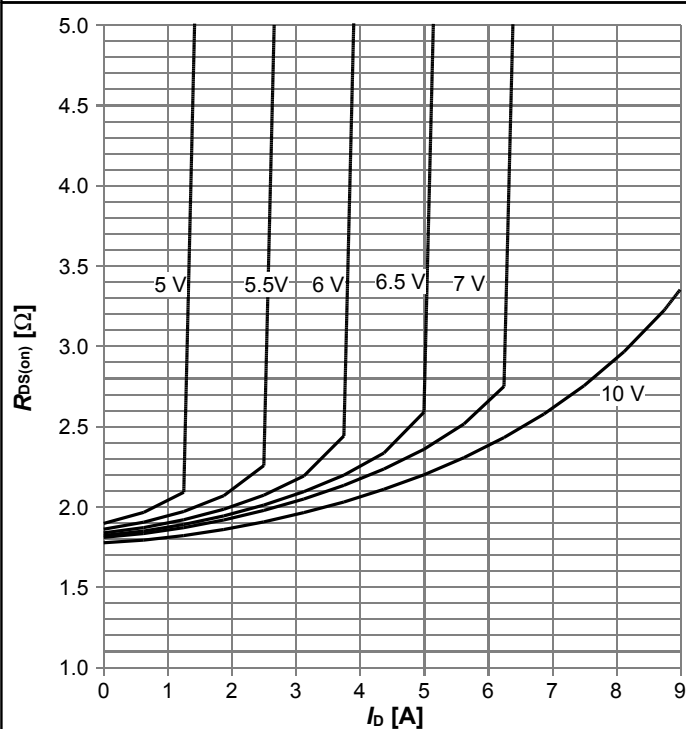
$I_D = f(V_{DS})$ ;  $T_J = 25\text{ °C}$ ; parameter:  $V_{GS}$

**Diagram 6: Typ. output characteristics**



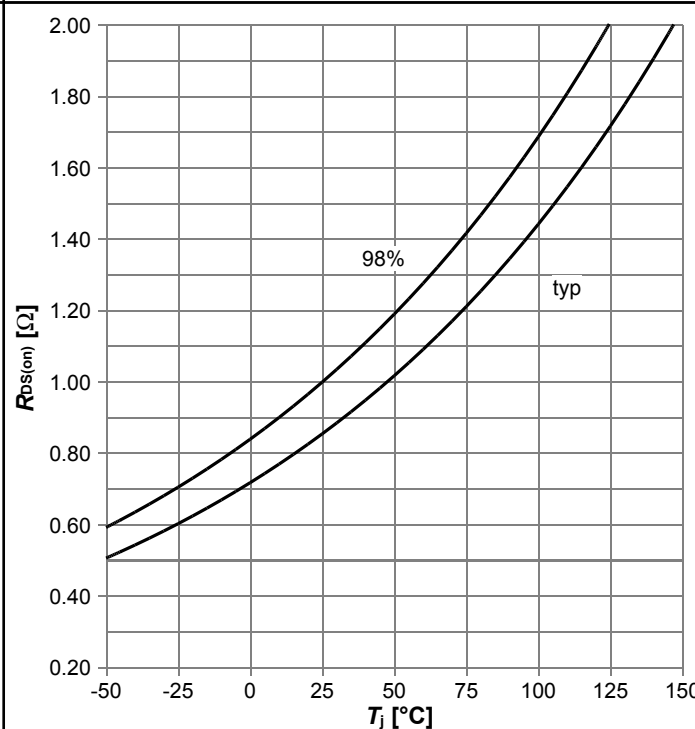
$I_D = f(V_{DS})$ ;  $T_J = 125\text{ °C}$ ; parameter:  $V_{GS}$

**Diagram 7: Typ. drain-source on-state resistance**



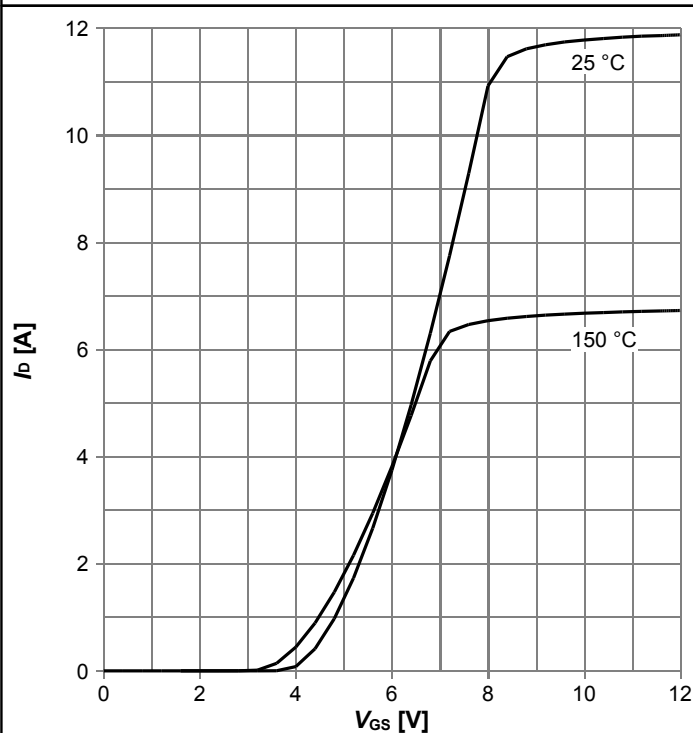
$R_{DS(on)} = f(I_D)$ ;  $T_J = 125\text{ °C}$ ; parameter:  $V_{GS}$

**Diagram 8: Drain-source on-state resistance**



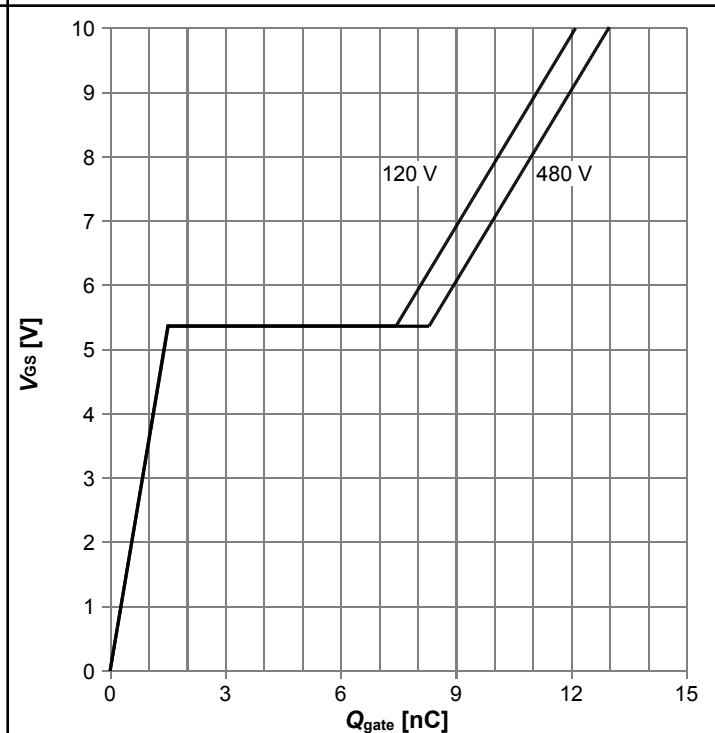
$R_{DS(on)} = f(T_J)$ ;  $I_D = 1.5\text{ A}$ ;  $V_{GS} = 10\text{ V}$

**Diagram 9: Typ. transfer characteristics**



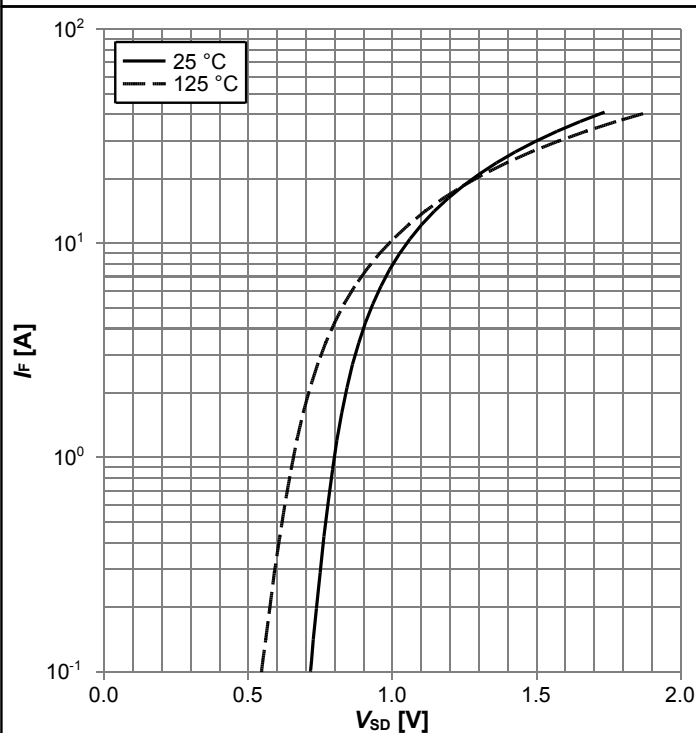
$I_D = f(V_{GS})$ ;  $V_{DS} = 20V$ ; parameter:  $T_j$

**Diagram 10: Typ. gate charge**



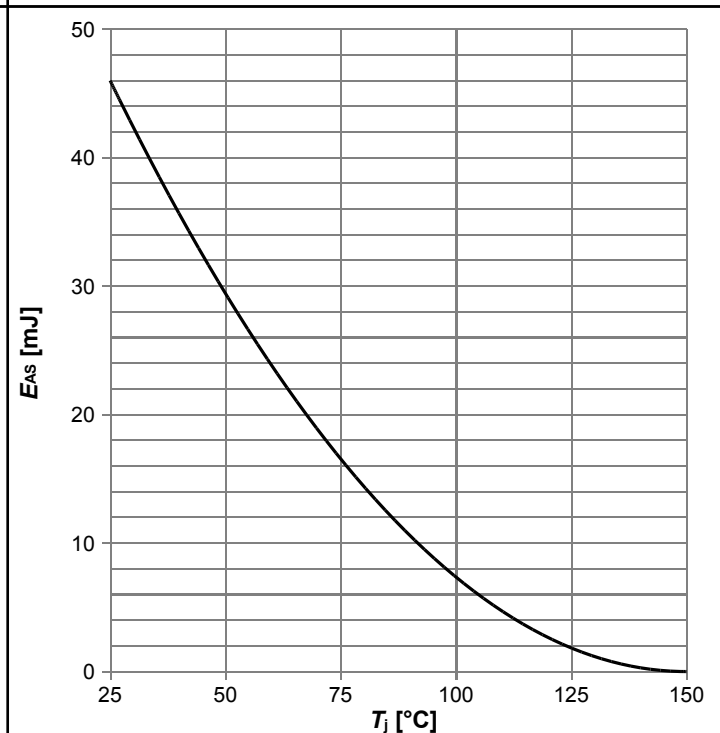
$V_{GS} = f(Q_{gate})$ ;  $I_D = 1.9 A$  pulsed; parameter:  $V_{DD}$

**Diagram 11: Forward characteristics of reverse diode**



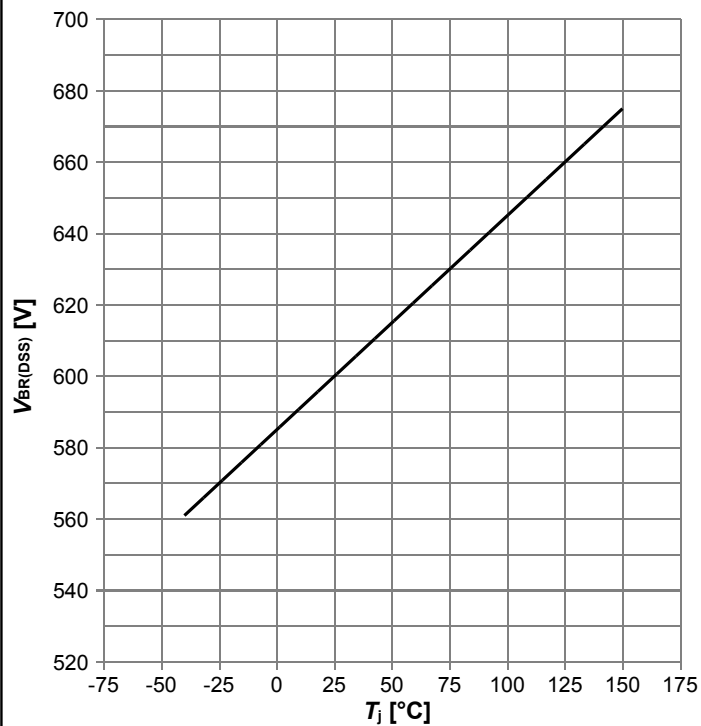
$I_F = f(V_{SD})$ ; parameter:  $T_j$

**Diagram 12: Avalanche energy**



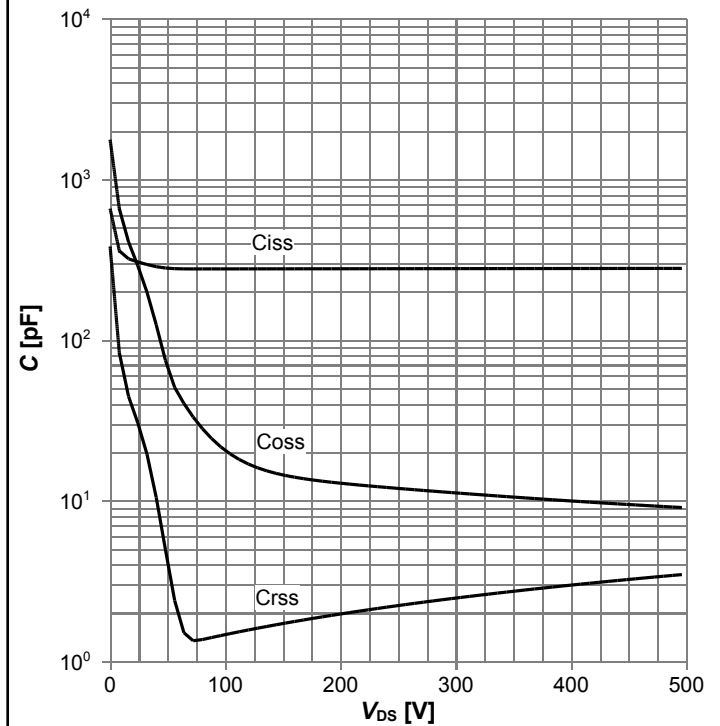
$E_{AS} = f(T_j)$ ;  $I_D = 0.8 A$ ;  $V_{DD} = 50 V$

**Diagram 13: Drain-source breakdown voltage**



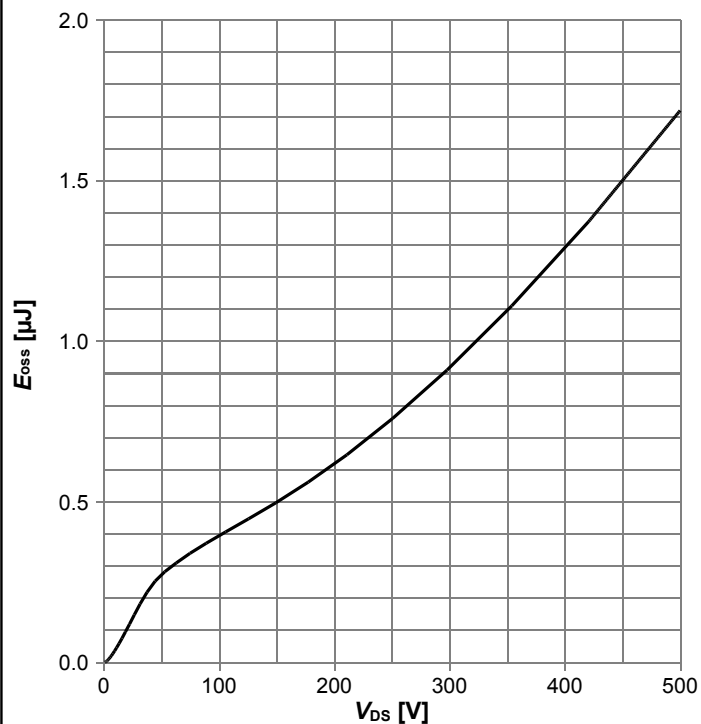
$V_{BR(DSS)} = f(T_j); I_D = 0.25 \text{ mA}$

**Diagram 14: Typ. capacitances**



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

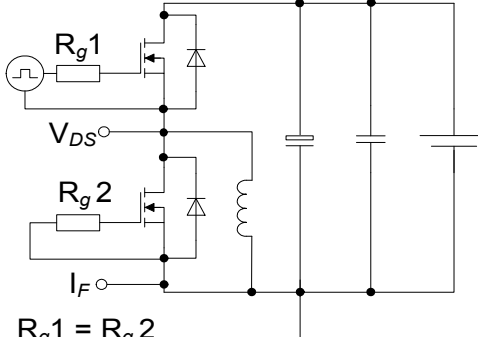
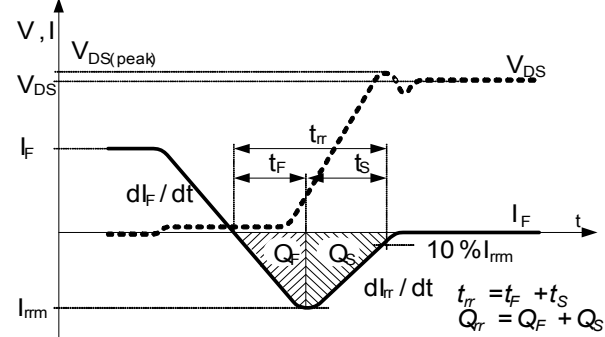
**Diagram 15: Typ. Coss stored energy**



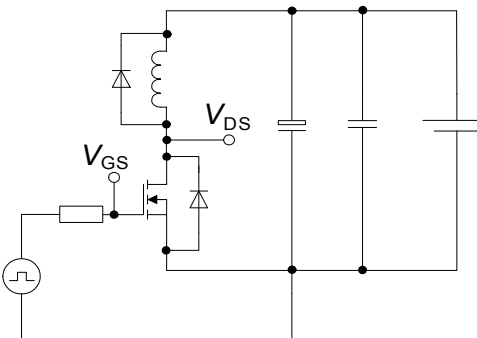
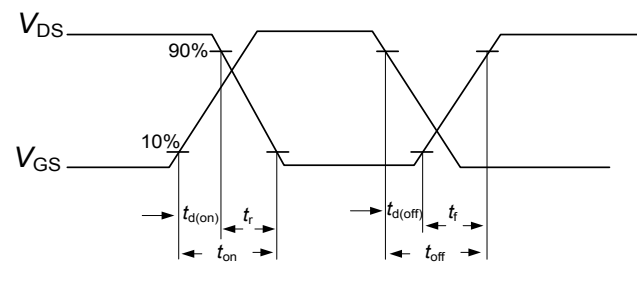
$E_{oss} = f(V_{DS})$

## 5 Test Circuits

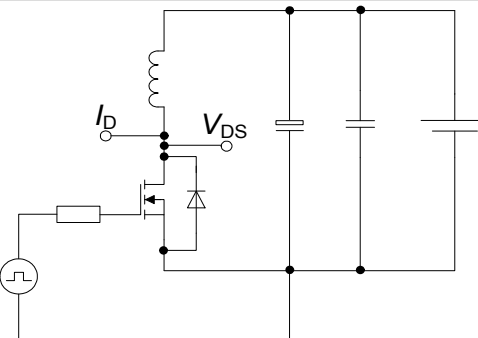
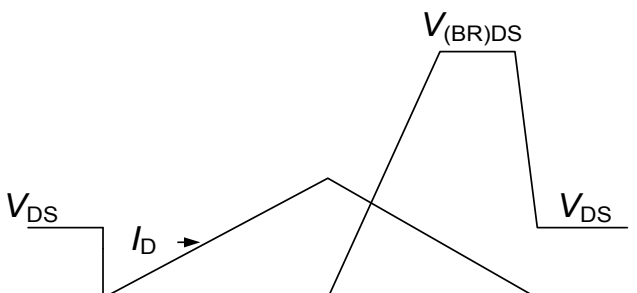
**Table 8 Diode characteristics**

| 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> |

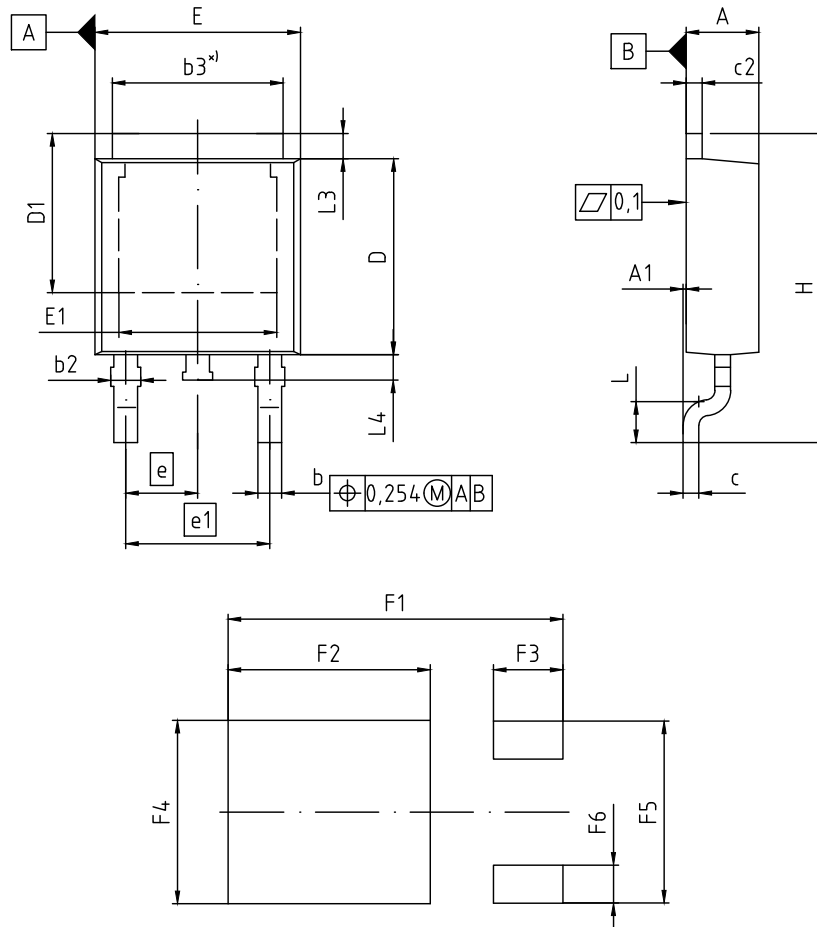
**Table 9 Switching times**

| 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

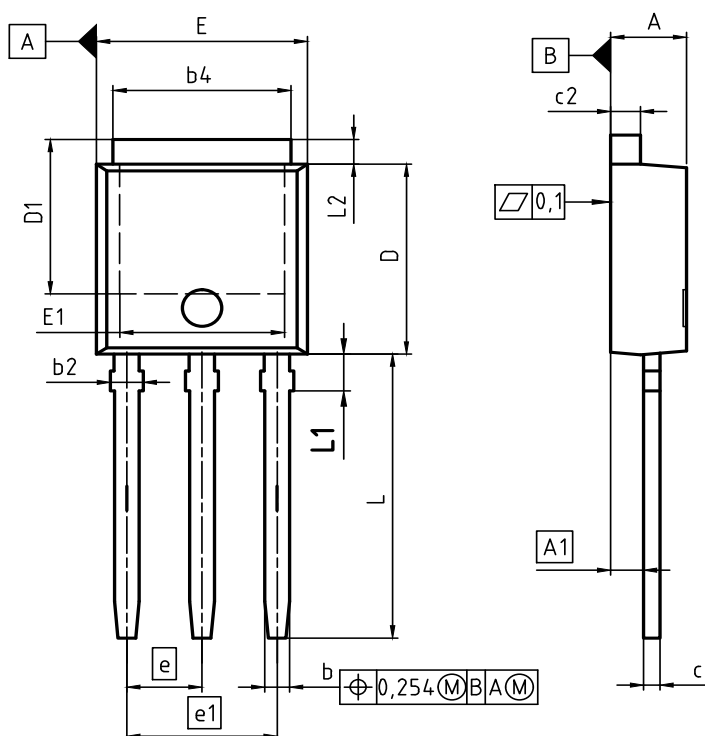


\*) mold flash not included

| 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**



| DIM | MILLIMETERS |      | INCHES |       |
|-----|-------------|------|--------|-------|
|     | MIN         | MAX  | MIN    | MAX   |
| A   | 2.16        | 2.41 | 0.085  | 0.095 |
| A1  | 0.90        | 1.14 | 0.035  | 0.045 |
| b   | 0.64        | 0.89 | 0.025  | 0.035 |
| b2  | 0.65        | 1.15 | 0.026  | 0.045 |
| b4  | 4.95        | 5.50 | 0.195  | 0.217 |
| c   | 0.46        | 0.60 | 0.018  | 0.024 |
| c2  | 0.46        | 0.89 | 0.018  | 0.035 |
| D   | 5.97        | 6.22 | 0.235  | 0.245 |
| D1  | 5.04        | 5.77 | 0.198  | 0.227 |
| E   | 6.35        | 6.73 | 0.250  | 0.265 |
| E1  | 4.70        | 5.21 | 0.185  | 0.205 |
| e   | 2.29        |      | 0.090  |       |
| e1  | 4.57        |      | 0.180  |       |
| N   | 3           |      | 3      |       |
| L   | 8.89        | 9.65 | 0.350  | 0.380 |
| L1  | 0.85        | 2.29 | 0.033  | 0.090 |
| L2  | 0.89        | 1.37 | 0.035  | 0.054 |

|                                    |
|------------------------------------|
| <b>DOCUMENT NO.</b><br>Z8B00003330 |
| <b>SCALE</b><br>                   |
| <b>EUROPEAN PROJECTION</b><br>     |
| <b>ISSUE DATE</b><br>31-08-2015    |
| <b>REVISION</b><br>04              |

**Figure 2 Outline PG-TO 251, dimensions in mm/inches**

## **7 Appendix A**

### **Table 11 Related Links**

- IFX CoolMOS™ CE Webpage: [www.infineon.com](http://www.infineon.com)
- IFX CoolMOS™ CE application note: [www.infineon.com](http://www.infineon.com)
- IFX CoolMOS™ CE simulation model: [www.infineon.com](http://www.infineon.com)
- IFX Design tools: [www.infineon.com](http://www.infineon.com)

## Revision History

IPD60R1K0CE, IPU60R1K0CE

**Revision: 2016-03-31**

Previous Revision

| Date       | Subjects (major changes since last revision)                      |
|------------|-------------------------------------------------------------------|
| 2014-09-25 | Release of final version                                          |
| 2015-11-17 | Updated to qualified for standard grade & updated package drawing |
| 2016-03-31 | Modified Id, Rthjc. Modified SOA, Zthjc curves                    |

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- Поставка образцов и прототипов;
- Техническая поддержка проекта;
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#### Как с нами связаться

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