

## 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

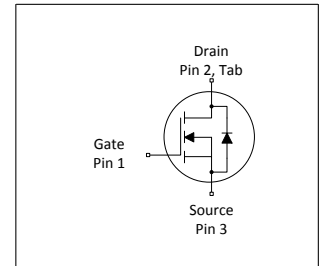
- Extremely low losses due to very low FOM  $R_{DS(on)} \cdot Q_g$  and  $E_{oss}$
- Very high commutation ruggedness
- Easy to use/drive
- Pb-free plating, Halogen free mold compound
- Qualified for standard grade applications

### 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: Note1: For MOSFET paralleling the use of ferrite beads on the gate or separate totem poles is generally recommended.*

*Note2: \*6R800CE is Full PAK marking only*



**Table 1 Key Performance Parameters**

| Parameter            | Value | Unit |
|----------------------|-------|------|
| $V_{DS} @ T_{j,max}$ | 650   | V    |
| $R_{DS(on),max}$     | 800   | mΩ   |
| $I_D$                | 8.4   | A    |
| $Q_{g,typ}$          | 17.2  | nC   |
| $I_{D,pulse}$        | 15.7  | A    |
| $E_{oss}@400V$       | 1.6   | μJ   |

| Type / Ordering Code | Package           | Marking             | Related Links  |
|----------------------|-------------------|---------------------|----------------|
| IPD60R800CE          | PG-TO 252         | 60S800CE / 6R800CE* | see Appendix A |
| IPA60R800CE          | PG-TO 220 FullPAK |                     |                |

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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>       | $I_D$         | -      | -    | 8.4<br>5.3 | A                | $T_C=25^\circ\text{C}$<br>$T_C=100^\circ\text{C}$                                     |
| Pulsed drain current <sup>2)</sup>           | $I_{D,pulse}$ | -      | -    | 15.7       | A                | $T_C=25^\circ\text{C}$                                                                |
| Avalanche energy, single pulse               | $E_{AS}$      | -      | -    | 72         | mJ               | $I_D=1\text{A}$ ; $V_{DD}=50\text{V}$ ; see table 11                                  |
| Avalanche energy, repetitive                 | $E_{AR}$      | -      | -    | 0.17       | mJ               | $I_D=1\text{A}$ ; $V_{DD}=50\text{V}$ ; see table 11                                  |
| Avalanche current, repetitive                | $I_{AR}$      | -      | -    | 1.0        | 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 (Non FullPAK)<br>TO-252    | $P_{tot}$     | -      | -    | 74         | 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             | $I_S$         | -      | -    | 5.9        | A                | $T_C=25^\circ\text{C}$                                                                |
| Diode pulse current <sup>2)</sup>            | $I_{S,pulse}$ | -      | -    | 15.7       | 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 |
| Power dissipation (FullPAK)<br>TO-220FP      | $P_{tot}$     | -      | -    | 27         | W                | $T_C=25^\circ\text{C}$                                                                |
| Mounting torque (FullPAK)<br>TO-220FP        | -             | -      | -    | 50         | Ncm              | M2.5 screws                                                                           |
| Insulation withstand voltage for<br>TO-220FP | $V_{ISO}$     | -      | -    | 2500       | V                | $V_{rms}$ , $T_C=25^\circ\text{C}$ , $t=1\text{min}$                                  |

## 2 Thermal characteristics

**Table 3 Thermal characteristics (FullPAK) TO-220FP**

| Parameter                                                     | Symbol     | Values |      |      | Unit               | Note / Test Condition               |
|---------------------------------------------------------------|------------|--------|------|------|--------------------|-------------------------------------|
|                                                               |            | Min.   | Typ. | Max. |                    |                                     |
| Thermal resistance, junction - case                           | $R_{thJC}$ | -      | -    | 4.6  | $^\circ\text{C/W}$ | -                                   |
| Thermal resistance, junction - ambient                        | $R_{thJA}$ | -      | -    | 80   | $^\circ\text{C/W}$ | lead                                |
| Soldering temperature, wavesoldering<br>only allowed at leads | $T_{sld}$  | -      | -    | 260  | $^\circ\text{C}$   | 1.6mm (0.063 in.) from case for 10s |

<sup>1)</sup> Limited by  $T_{j,max}$ . TO252 equivalent, 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  $R_\theta$

**Table 4 Thermal characteristics TO-252**

| Parameter                                              | Symbol       | Values |      |      | Unit | Note / Test Condition                                                                                                                                                   |
|--------------------------------------------------------|--------------|--------|------|------|------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                        |              | Min.   | Typ. | Max. |      |                                                                                                                                                                         |
| Thermal resistance, junction - case                    | $R_{thJC}$   | -      | -    | 1.70 | °C/W | -                                                                                                                                                                       |
| Thermal resistance, junction - ambient                 | $R_{thJA}$   | -      | -    | 62   | °C/W | device on PCB, minimal footprint                                                                                                                                        |
| Thermal resistance, junction - ambient for SMD version | $R_{thJA}$   | -      | 35   | 45   | °C/W | Device on 40mm*40mm*1.5mm epoxy PCB FR4 with 6cm² (one layer, 70µm thickness) copper area for drain connection and cooling. PCB is vertical without air stream cooling. |
| Soldering temperature, wave & reflow soldering allowed | $T_{solder}$ | -      | -    | 260  | °C   | reflow MSL3                                                                                                                                                             |

### 3 Electrical characteristics

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

**Table 5 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        | $V_{DS}=V_{GS}$ , $I_D=0.17mA$                                                                              |
| 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 | $R_{DS(on)}$  | -      | 0.68<br>1.76 | 0.80 | $\Omega$ | $V_{GS}=10V$ , $I_D=2A$ , $T_j=25^\circ\text{C}$<br>$V_{GS}=10V$ , $I_D=2A$ , $T_j=150^\circ\text{C}$       |
| Gate resistance                  | $R_G$         | -      | 11           | -    | $\Omega$ | $f=1MHz$ , open drain                                                                                       |

**Table 6 Dynamic characteristics**

| Parameter                                                  | Symbol       | Values |      |      | Unit | Note / Test Condition                                                         |
|------------------------------------------------------------|--------------|--------|------|------|------|-------------------------------------------------------------------------------|
|                                                            |              | Min.   | Typ. | Max. |      |                                                                               |
| Input capacitance                                          | $C_{iss}$    | -      | 373  | -    | pF   | $V_{GS}=0V$ , $V_{DS}=100V$ , $f=1MHz$                                        |
| Output capacitance                                         | $C_{oss}$    | -      | 27   | -    | pF   | $V_{GS}=0V$ , $V_{DS}=100V$ , $f=1MHz$                                        |
| Effective output capacitance, energy related <sup>1)</sup> | $C_{o(er)}$  | -      | 18   | -    | pF   | $V_{GS}=0V$ , $V_{DS}=0...480V$                                               |
| Effective output capacitance, time related <sup>2)</sup>   | $C_{o(tr)}$  | -      | 74   | -    | pF   | $I_D=\text{constant}$ , $V_{GS}=0V$ , $V_{DS}=0...480V$                       |
| Turn-on delay time                                         | $t_{d(on)}$  | -      | 9    | -    | ns   | $V_{DD}=400V$ , $V_{GS}=13V$ , $I_D=2.5A$ ,<br>$R_G=6.8\Omega$ ; see table 10 |
| Rise time                                                  | $t_r$        | -      | 7    | -    | ns   | $V_{DD}=400V$ , $V_{GS}=13V$ , $I_D=2.5A$ ,<br>$R_G=6.8\Omega$ ; see table 10 |
| Turn-off delay time                                        | $t_{d(off)}$ | -      | 50   | -    | ns   | $V_{DD}=400V$ , $V_{GS}=13V$ , $I_D=2.5A$ ,<br>$R_G=6.8\Omega$ ; see table 10 |
| Fall time                                                  | $t_f$        | -      | 12   | -    | ns   | $V_{DD}=400V$ , $V_{GS}=13V$ , $I_D=2.5A$ ,<br>$R_G=6.8\Omega$ ; see table 10 |

**Table 7 Gate charge characteristics**

| Parameter             | Symbol        | Values |      |      | Unit | Note / Test Condition                            |
|-----------------------|---------------|--------|------|------|------|--------------------------------------------------|
|                       |               | Min.   | Typ. | Max. |      |                                                  |
| Gate to source charge | $Q_{gs}$      | -      | 2    | -    | nC   | $V_{DD}=480V$ , $I_D=2.5A$ , $V_{GS}=0$ to $10V$ |
| Gate to drain charge  | $Q_{gd}$      | -      | 8.9  | -    | nC   | $V_{DD}=480V$ , $I_D=2.5A$ , $V_{GS}=0$ to $10V$ |
| Gate charge total     | $Q_g$         | -      | 17.2 | -    | nC   | $V_{DD}=480V$ , $I_D=2.5A$ , $V_{GS}=0$ to $10V$ |
| Gate plateau voltage  | $V_{plateau}$ | -      | 5.4  | -    | V    | $V_{DD}=480V$ , $I_D=2.5A$ , $V_{GS}=0$ to $10V$ |

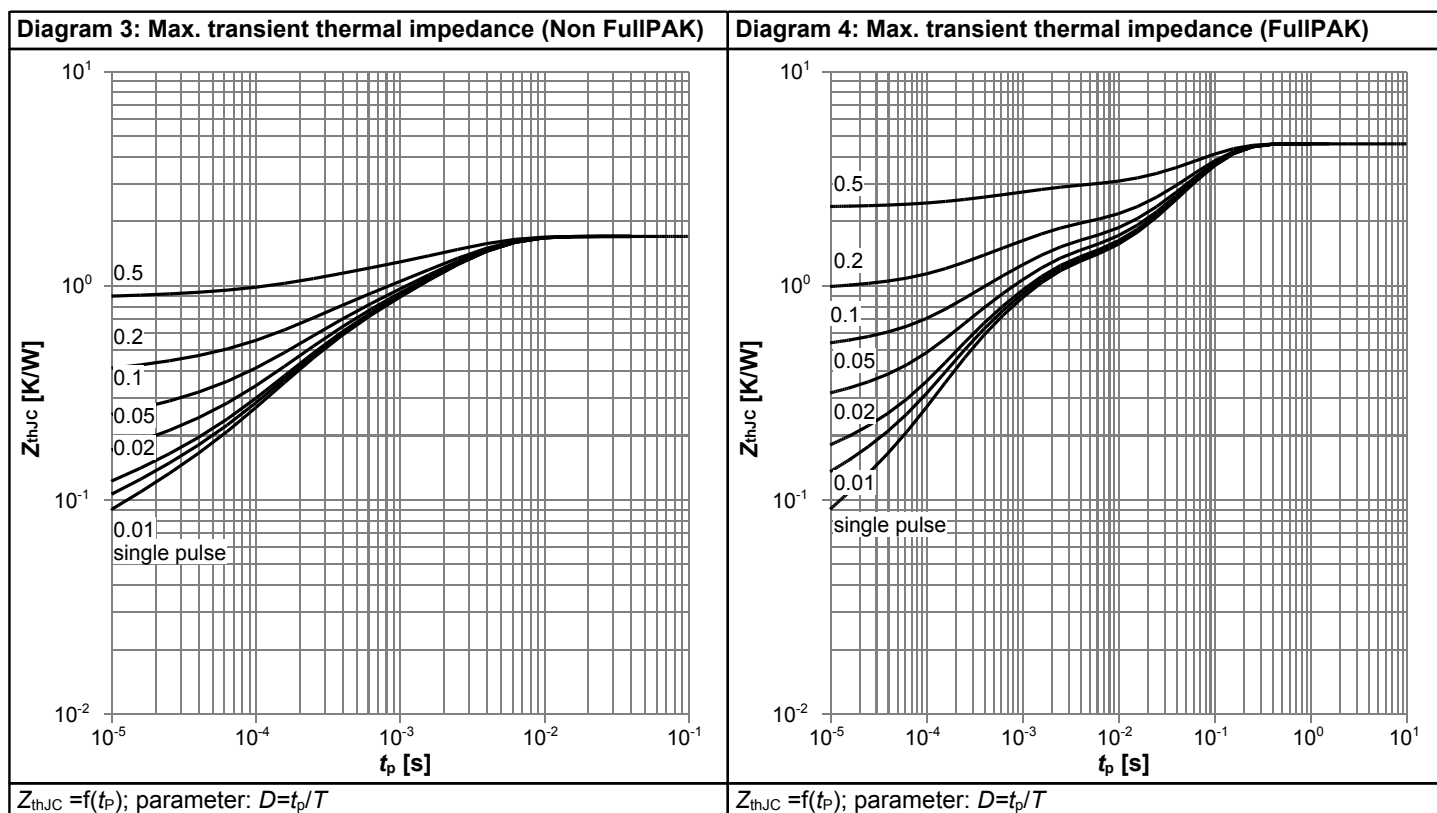
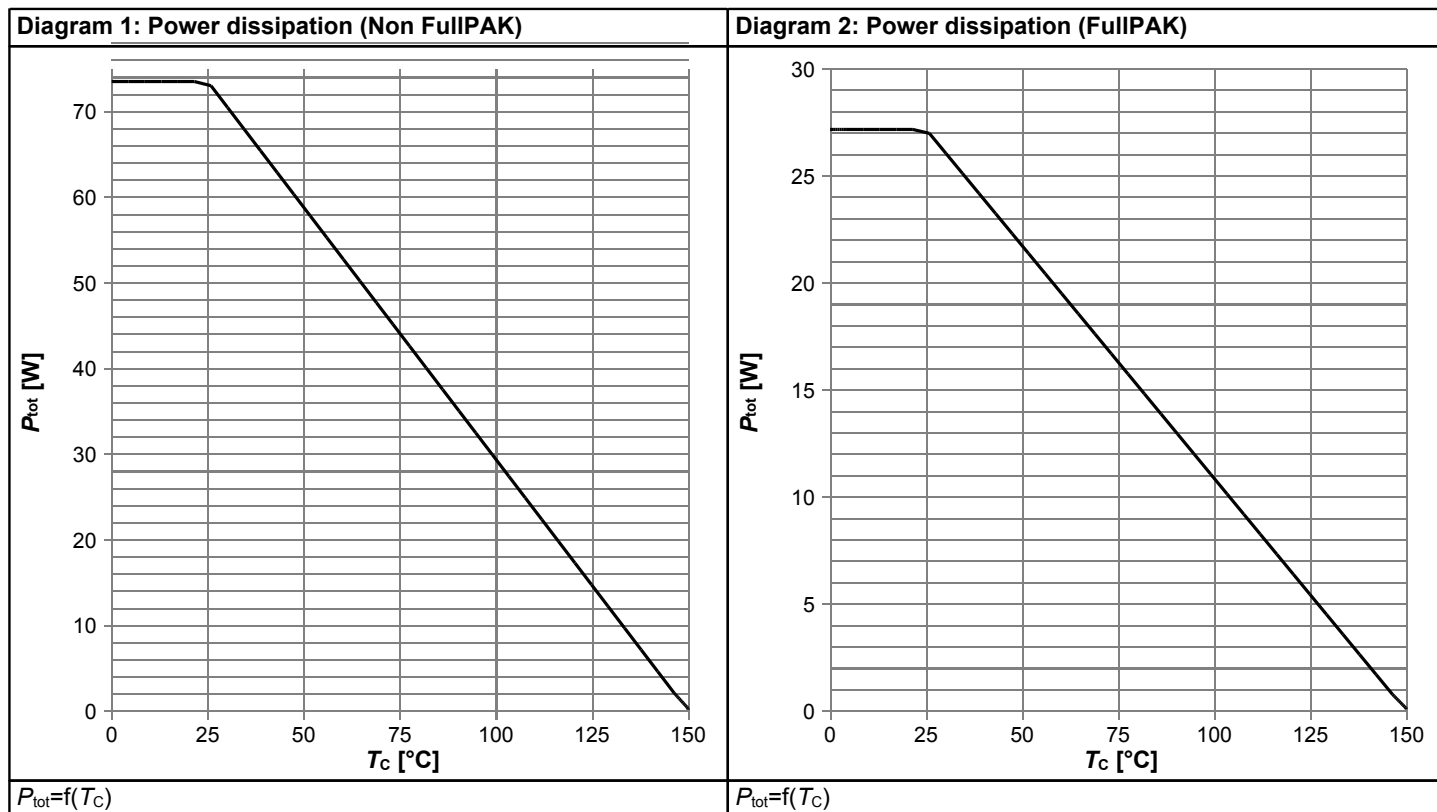
<sup>1)</sup>  $C_{o(er)}$  is a fixed capacitance that gives the same stored energy as  $C_{oss}$  while  $V_{DS}$  is rising from 0 to 80%  $V_{(BR)DSS}$

<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%  $V_{(BR)DSS}$

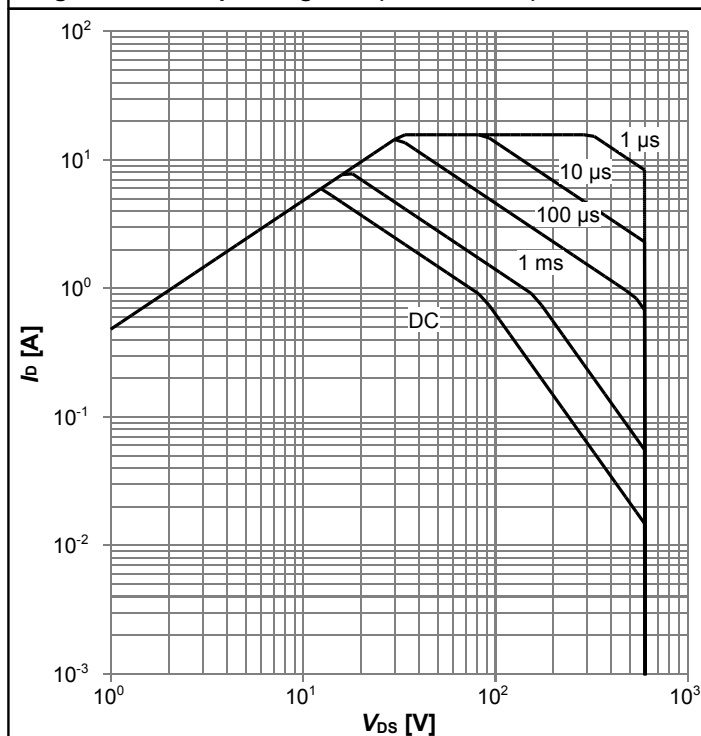
**Table 8 Reverse diode characteristics**

| Parameter                     | Symbol    | Values |      |      | Unit    | Note / Test Condition                                        |
|-------------------------------|-----------|--------|------|------|---------|--------------------------------------------------------------|
|                               |           | Min.   | Typ. | Max. |         |                                                              |
| Diode forward voltage         | $V_{SD}$  | -      | 0.9  | -    | V       | $V_{GS}=0V$ , $I_F=2.5A$ , $T_J=25^{\circ}C$                 |
| Reverse recovery time         | $t_{rr}$  | -      | 250  | -    | ns      | $V_R=400V$ , $I_F=2.5A$ , $di_F/dt=100A/\mu s$ ; see table 9 |
| Reverse recovery charge       | $Q_{rr}$  | -      | 1.8  | -    | $\mu C$ | $V_R=400V$ , $I_F=2.5A$ , $di_F/dt=100A/\mu s$ ; see table 9 |
| Peak reverse recovery current | $I_{rrm}$ | -      | 16   | -    | A       | $V_R=400V$ , $I_F=2.5A$ , $di_F/dt=100A/\mu s$ ; see table 9 |

## 4 Electrical characteristics diagrams

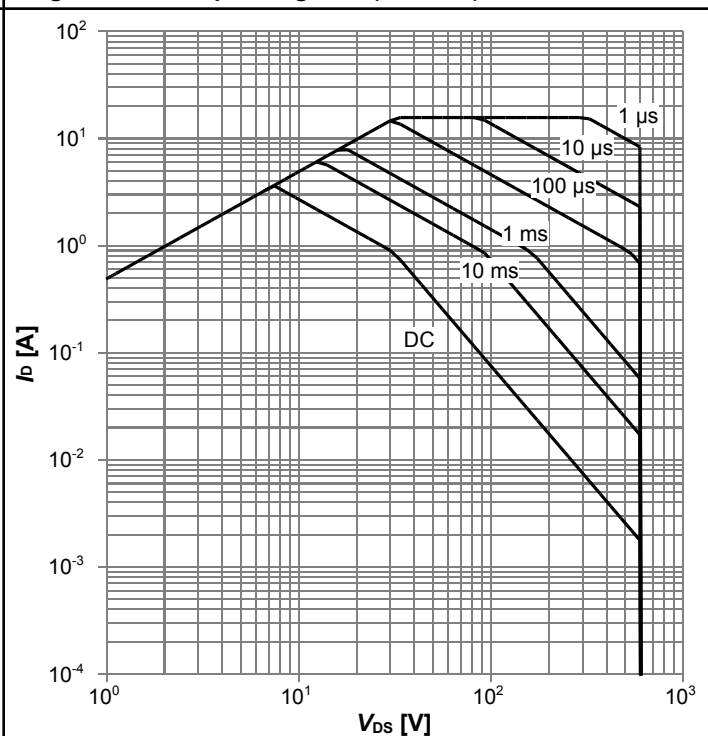


**Diagram 5: Safe operating area (Non FullPAK)**



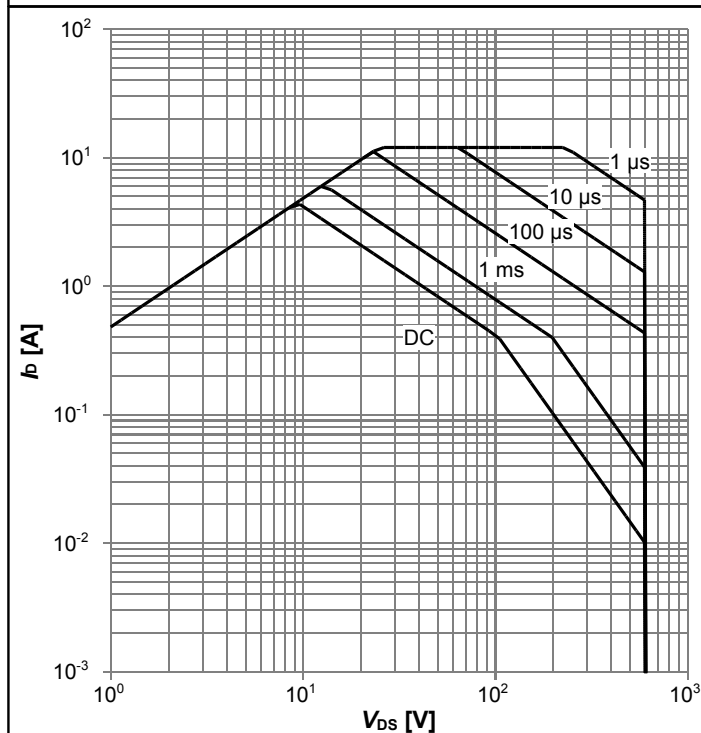
$I_D=f(V_{DS})$ ;  $T_C=25\text{ °C}$ ;  $D=0$ ; parameter:  $t_p$

**Diagram 6: Safe operating area (FullPAK)**



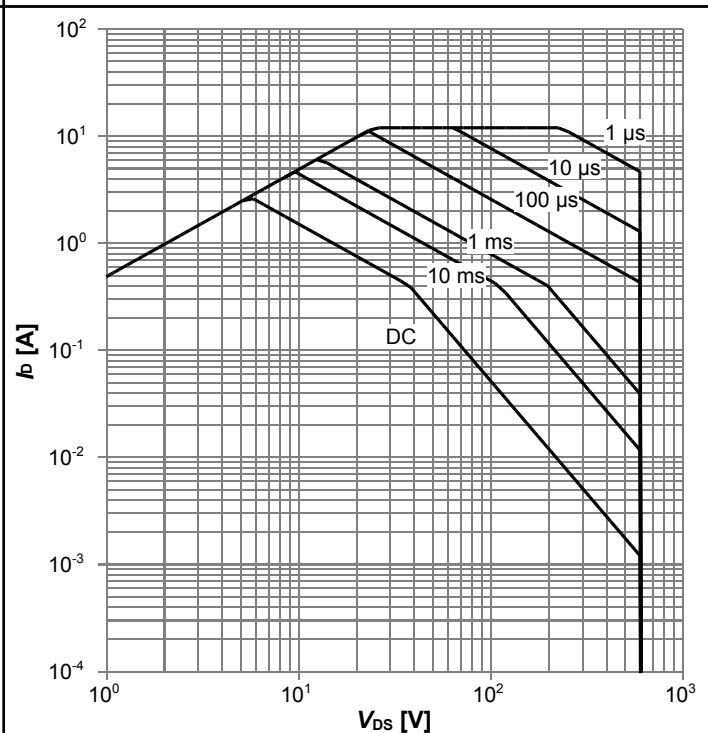
$I_D=f(V_{DS})$ ;  $T_C=25\text{ °C}$ ;  $D=0$ ; parameter:  $t_p$

**Diagram 7: Safe operating area (Non FullPAK)**



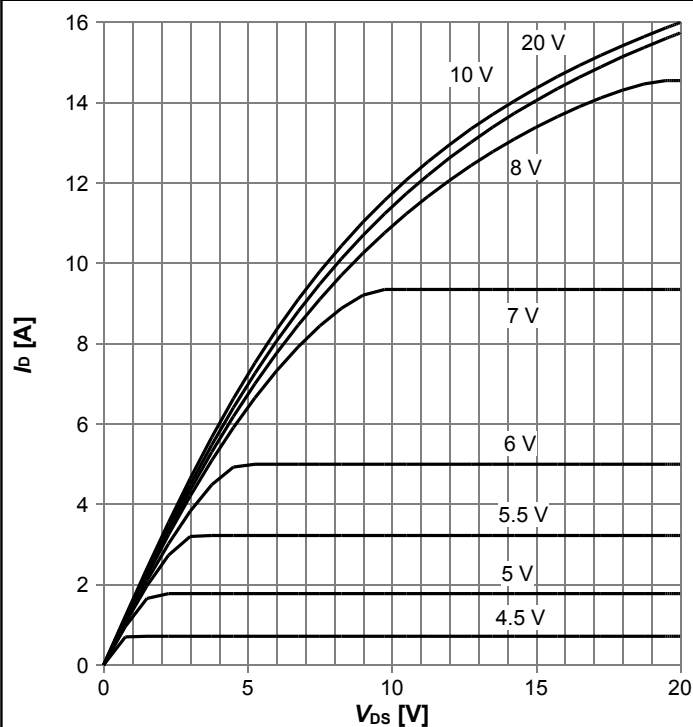
$I_D=f(V_{DS})$ ;  $T_C=80\text{ °C}$ ;  $D=0$ ; parameter:  $t_p$

**Diagram 8: Safe operating area (FullPAK)**



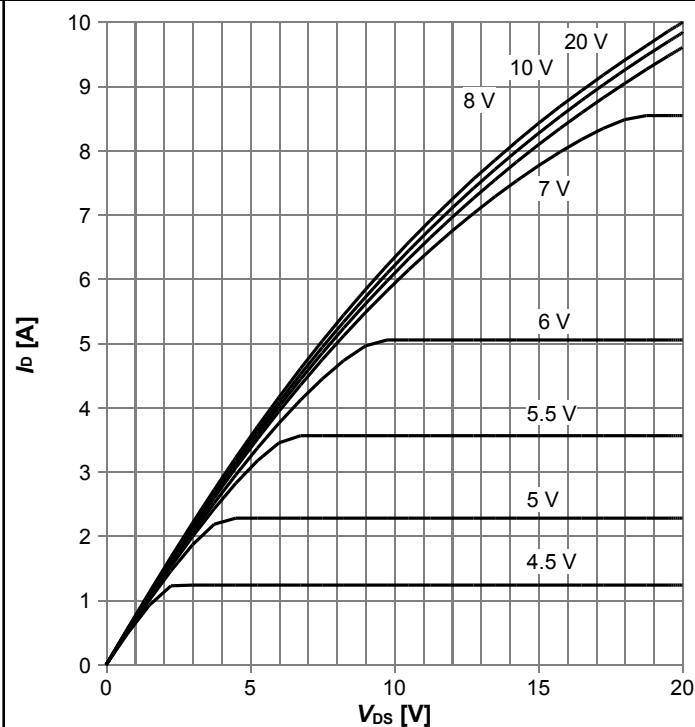
$I_D=f(V_{DS})$ ;  $T_C=80\text{ °C}$ ;  $D=0$ ; parameter:  $t_p$

**Diagram 9: Typ. output characteristics**



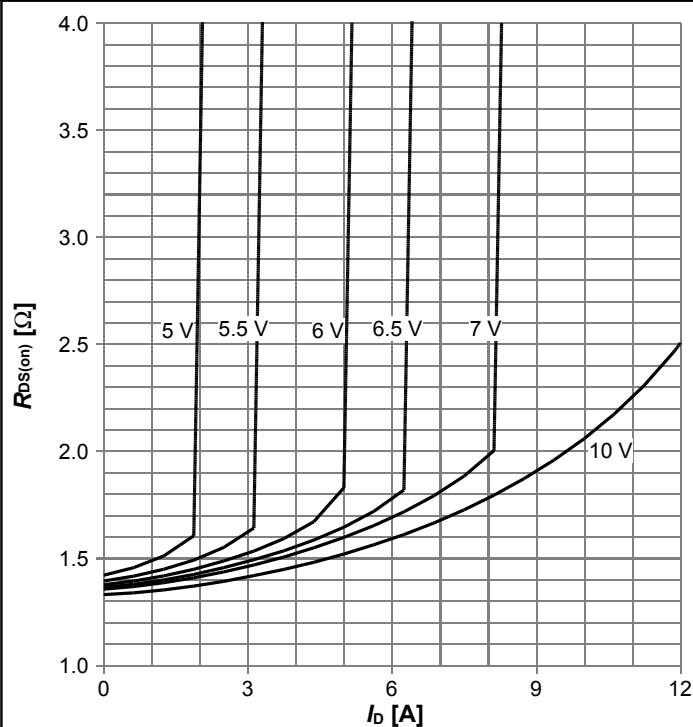
$I_D = f(V_{DS})$ ;  $T_j = 25\text{ °C}$ ; parameter:  $V_{GS}$

**Diagram 10: Typ. output characteristics**



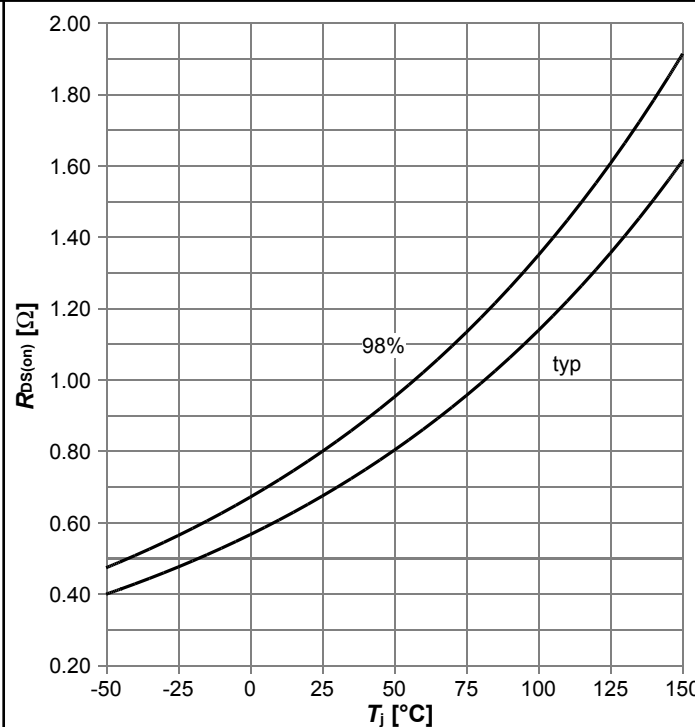
$I_D = f(V_{DS})$ ;  $T_j = 125\text{ °C}$ ; parameter:  $V_{GS}$

**Diagram 11: Typ. drain-source on-state resistance**



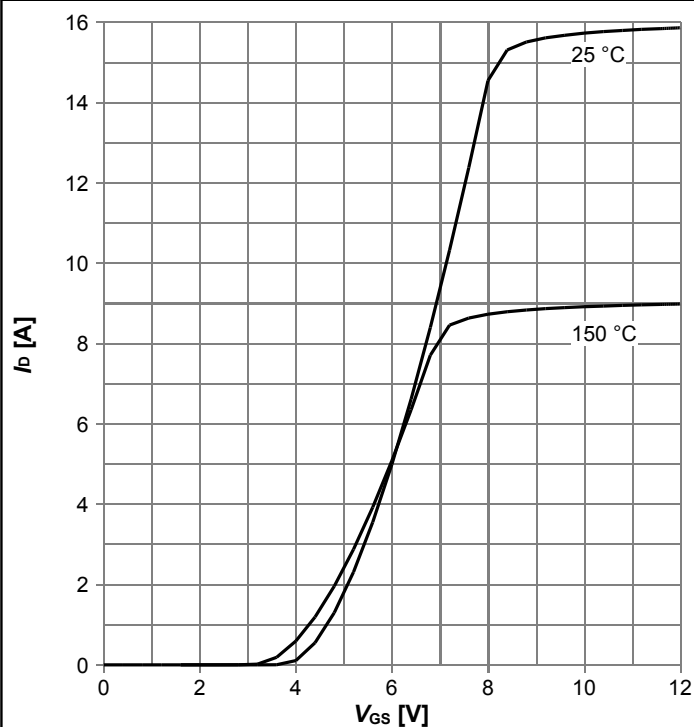
$R_{DS(on)} = f(I_D)$ ;  $T_j = 125\text{ °C}$ ; parameter:  $V_{GS}$

**Diagram 12: Drain-source on-state resistance**



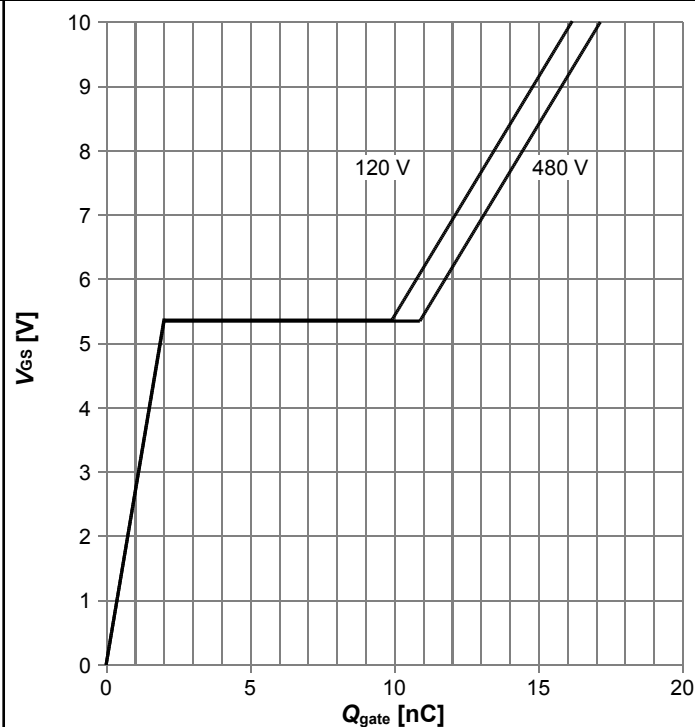
$R_{DS(on)} = f(T_j)$ ;  $I_D = 2.0\text{ A}$ ;  $V_{GS} = 10\text{ V}$

**Diagram 13: Typ. transfer characteristics**



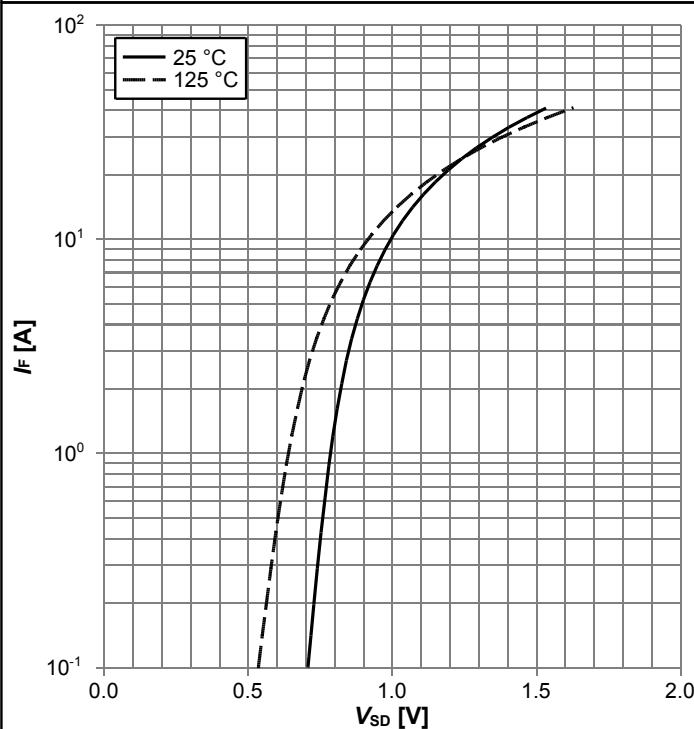
$I_D = f(V_{GS})$ ;  $V_{DS} = 20V$ ; parameter:  $T_j$

**Diagram 14: Typ. gate charge**



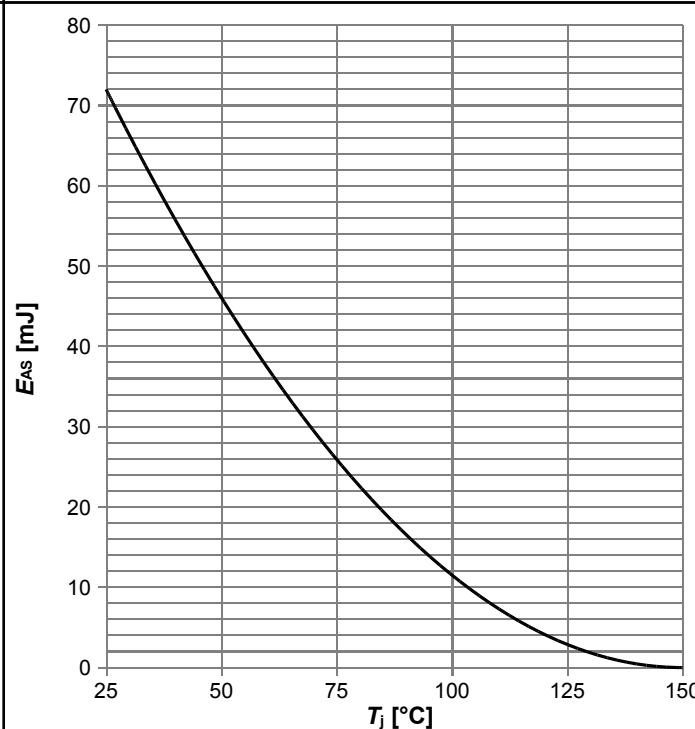
$V_{GS} = f(Q_{gate})$ ;  $I_D = 2.5$  A pulsed; parameter:  $V_{DD}$

**Diagram 15: Forward characteristics of reverse diode**



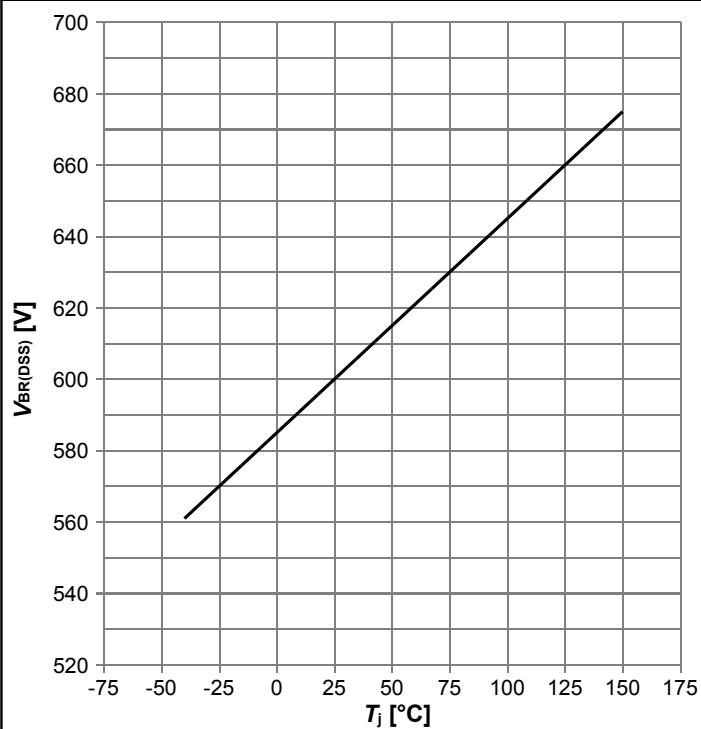
$I_F = f(V_{SD})$ ; parameter:  $T_j$

**Diagram 16: Avalanche energy**



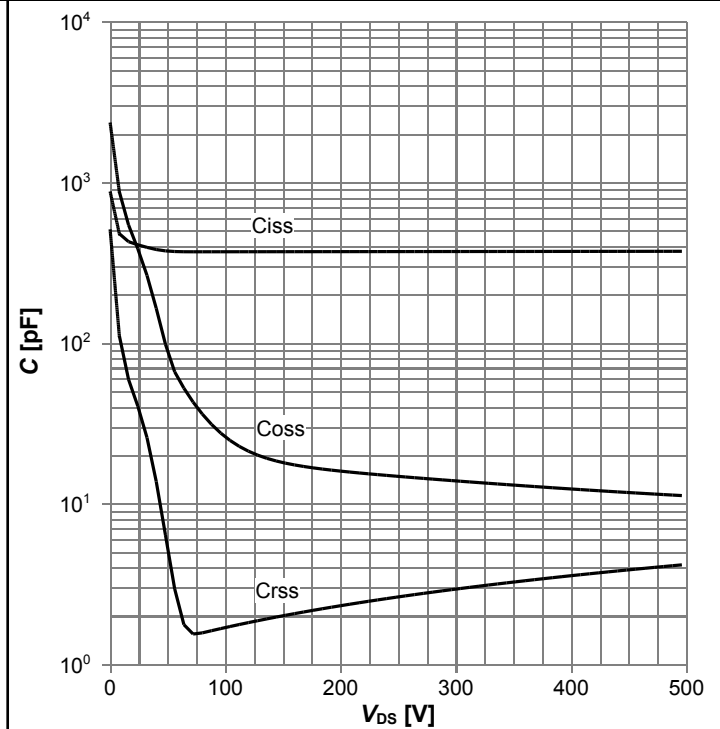
$E_{AS} = f(T_j)$ ;  $I_D = 1.0$  A;  $V_{DD} = 50$  V

**Diagram 17: Drain-source breakdown voltage**



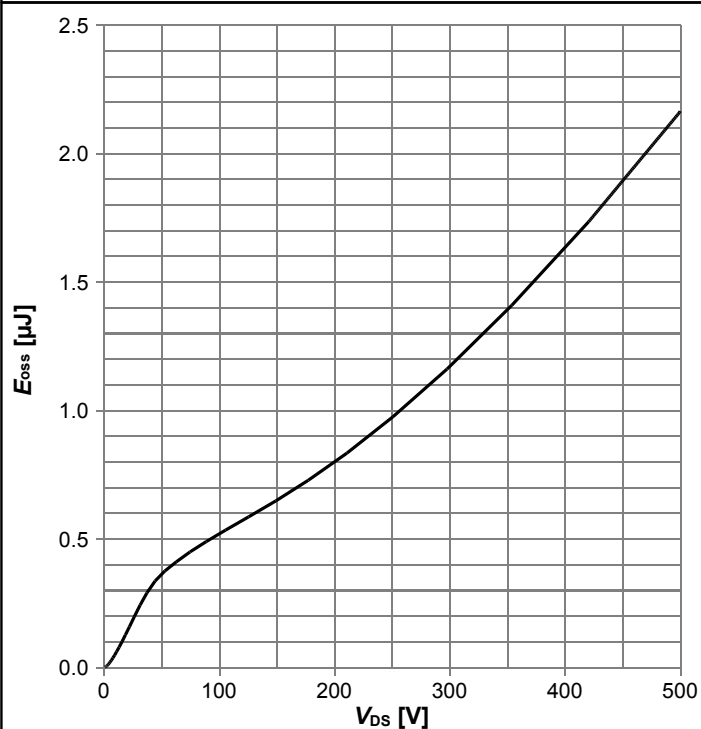
$V_{BR(DSS)} = f(T_j); I_D = 0.25 \text{ mA}$

**Diagram 18: Typ. capacitances**



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

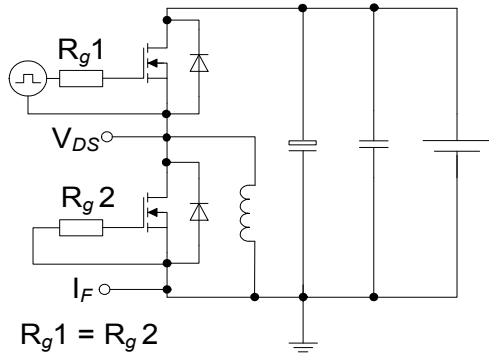
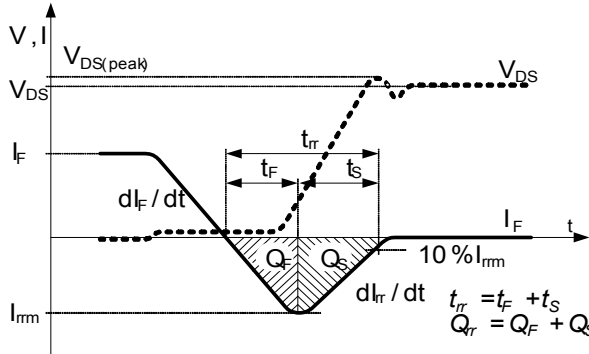
**Diagram 19: Typ. Coss stored energy**



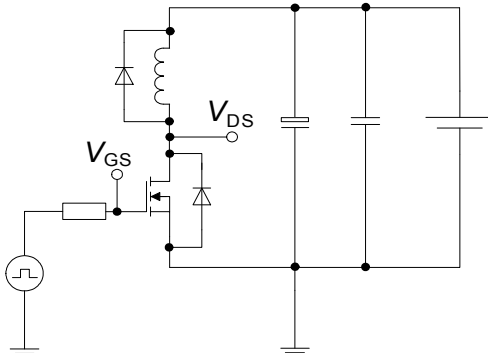
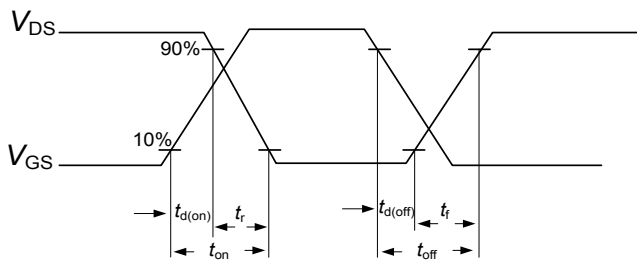
$E_{oss} = f(V_{DS})$

## 5 Test Circuits

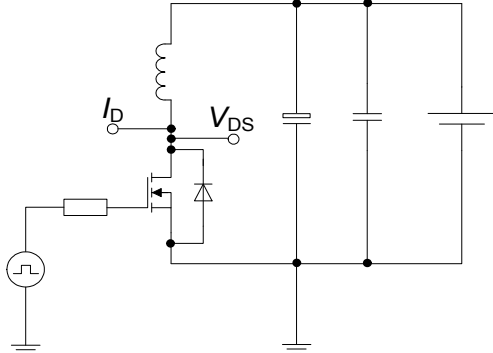
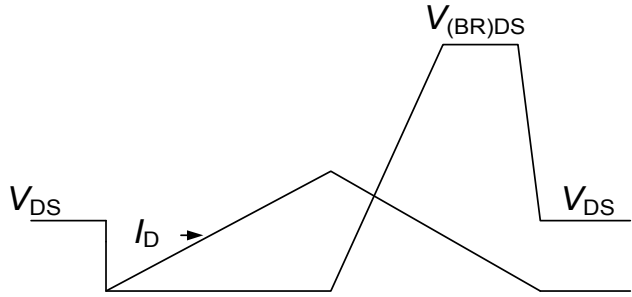
**Table 9 Diode characteristics**

| 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> |

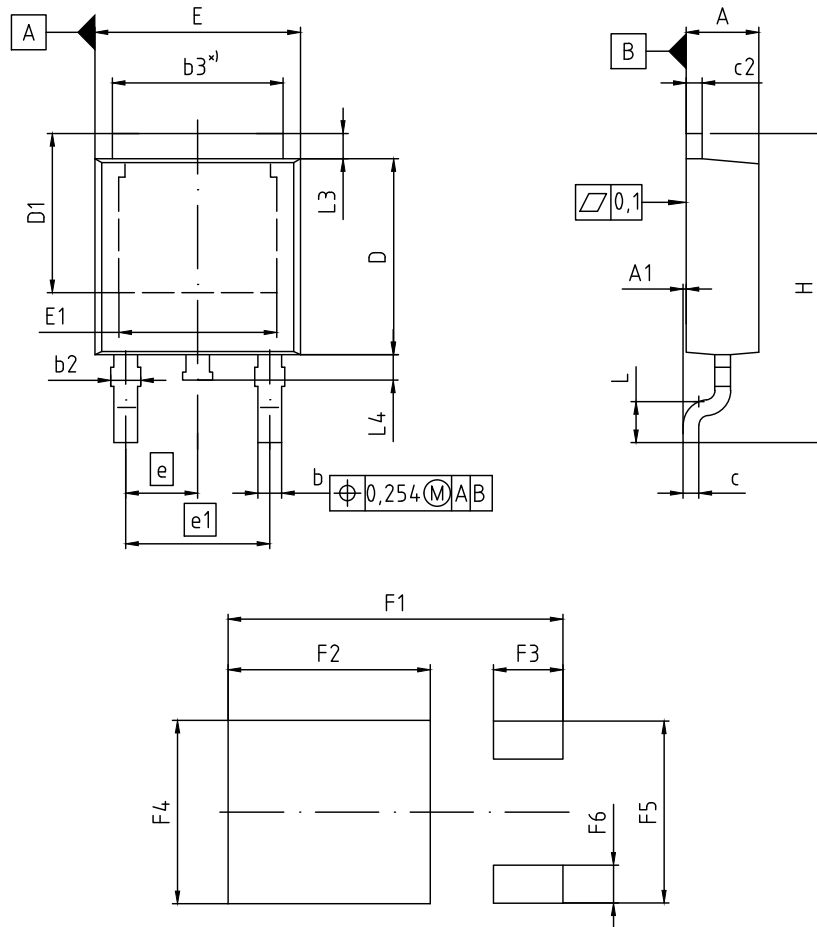
**Table 10 Switching times**

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

**Table 11 Unclamped inductive load**

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

## 6 Package Outlines

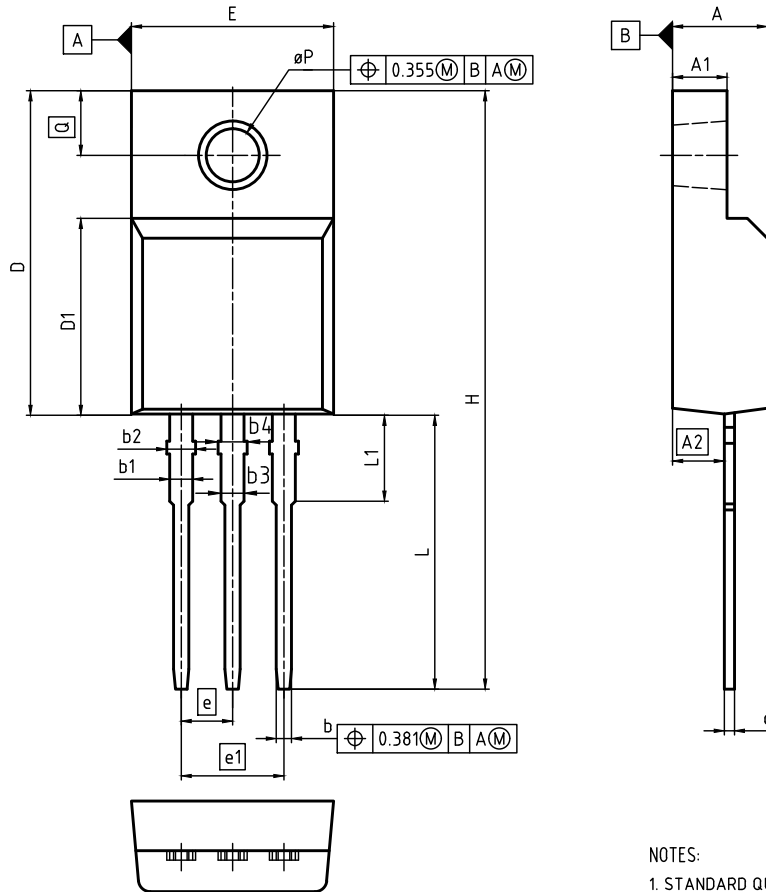


\*) mold flash not included

| 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**



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 |
| øP  | 3.00        | 3.38  | 0.118       | 0.133 |
| Q   | 3.15        | 3.50  | 0.124       | 0.138 |

NOTES:

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

|                                    |
|------------------------------------|
| <b>DOCUMENT NO.</b><br>Z8B00181328 |
| <b>SCALE</b><br>0 2.5 5mm          |
| <b>EUROPEAN PROJECTION</b><br>     |
| <b>ISSUE DATE</b><br>29-04-2016    |
| <b>REVISION</b><br>01              |

**Figure 2 Outline PG-TO 220 FullPAK, dimensions in mm/inches**

## **7 Appendix A**

### **Table 12 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

IPD60R800CE, IPA60R800CE

**Revision: 2016-08-08, Rev. 2.3**

Previous Revision

| Revision | Date       | Subjects (major changes since last revision)                                                                                                   |
|----------|------------|------------------------------------------------------------------------------------------------------------------------------------------------|
| 2.0      | 2014-09-25 | Release of final version                                                                                                                       |
| 2.1      | 2016-03-31 | Modified Id, Rthjc. Modified SOA and Zthjc curves                                                                                              |
| 2.2      | 2016-05-03 | Changed TO220 Full PAK package drawing                                                                                                         |
| 2.3      | 2016-08-08 | Added Full PAK marking on page 1, revised Full PAK package drawing on page 14 and changed TO252 package solder reflow rating to MSL3 on page 4 |

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