

## CoolMOS™ Power Transistor

### Features

- New revolutionary high voltage technology
- Extreme dv/dt rated
- High peak current capability
- Qualified according to JEDEC<sup>1)</sup> for target applications
- Pb-free lead plating; RoHS compliant
- Ultra low gate charge
- Ultra low effective capacitances
- Fully isolated package (2500 VAC; 1 minute)

### CoolMOS™ 800V designed for:

- Industrial application with high DC bulk voltage
- Switching Application ( i.e. active clamp forward )

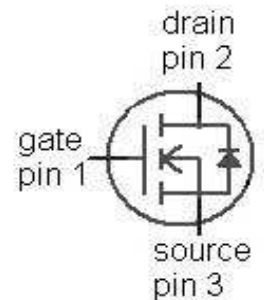
### Product Summary

|                                     |     |          |
|-------------------------------------|-----|----------|
| $V_{DS}$                            | 800 | V        |
| $R_{DS(on)max} @ T_j = 25^{\circ}C$ | 1.3 | $\Omega$ |
| $Q_{g,typ}$                         | 23  | nC       |

PG-TO220-3 (fully isolated)



| Type       | Package    | Marking |
|------------|------------|---------|
| SPA04N80C3 | PG-TO220-3 | 04N80C3 |



**Maximum ratings**, at  $T_j=25^{\circ}C$ , unless otherwise specified

| Parameter                                      | Symbol         | Conditions             | Value       | Unit        |
|------------------------------------------------|----------------|------------------------|-------------|-------------|
| Continuous drain current <sup>2)</sup>         | $I_D$          | $T_C=25^{\circ}C$      | 4           | A           |
|                                                |                | $T_C=100^{\circ}C$     | 2.5         |             |
| Pulsed drain current <sup>3)</sup>             | $I_{D,pulse}$  | $T_C=25^{\circ}C$      | 12          |             |
| Avalanche energy, single pulse                 | $E_{AS}$       | $I_D=0.8A, V_{DD}=50V$ | 170         | mJ          |
| Avalanche energy, repetitive $t_{AR}^{3),4)}$  | $E_{AR}$       | $I_D=4A, V_{DD}=50V$   | 0.1         |             |
| Avalanche current, repetitive $t_{AR}^{3),4)}$ | $I_{AR}$       |                        | 4           | A           |
| MOSFET dv/dt ruggedness                        | dv/dt          | $V_{DS}=0...640V$      | 50          | V/ns        |
| Gate source voltage                            | $V_{GS}$       | static                 | $\pm 20$    | V           |
|                                                |                | AC ( $f>1Hz$ )         | $\pm 30$    |             |
| Power dissipation                              | $P_{tot}$      | $T_C=25^{\circ}C$      | 38          | W           |
| Operating and storage temperature              | $T_j, T_{stg}$ |                        | -55 ... 150 | $^{\circ}C$ |
| Mounting torque                                |                | M2.5 screws            | 50          | Ncm         |

**Maximum ratings**, at  $T_j=25\text{ °C}$ , unless otherwise specified

| Parameter                           | Symbol        | Conditions         | Value | Unit |
|-------------------------------------|---------------|--------------------|-------|------|
| Continuous diode forward current    | $I_S$         | $T_C=25\text{ °C}$ | 4     | A    |
| Diode pulse current <sup>3)</sup>   | $I_{S,pulse}$ |                    | 12    |      |
| Reverse diode $dv/dt$ <sup>5)</sup> | $dv/dt$       |                    | 4     | V/ns |

| Parameter | Symbol | Conditions | Values |      |      | Unit |
|-----------|--------|------------|--------|------|------|------|
|           |        |            | min.   | typ. | max. |      |

### Thermal characteristics

|                                                             |              |                                      |   |   |     |     |
|-------------------------------------------------------------|--------------|--------------------------------------|---|---|-----|-----|
| Thermal resistance, junction - case                         | $R_{thJC}$   |                                      | - | - | 4   | K/W |
| Thermal resistance, junction - ambient                      | $R_{thJA}$   | leaded                               | - | - | 80  |     |
| Soldering temperature, wave soldering only allowed at leads | $T_{solder}$ | 1.6 mm (0.063 in.) from case for 10s | - | - | 260 | °C  |

**Electrical characteristics**, at  $T_j=25\text{ °C}$ , unless otherwise specified

### Static characteristics

|                                  |               |                                                                   |     |     |     |               |
|----------------------------------|---------------|-------------------------------------------------------------------|-----|-----|-----|---------------|
| Drain-source breakdown voltage   | $V_{(BR)DSS}$ | $V_{GS}=0\text{ V}$ , $I_D=250\text{ }\mu\text{A}$                | 800 | -   | -   | V             |
| Avalanche breakdown voltage      | $V_{(BR)DS}$  | $V_{GS}=0\text{ V}$ , $I_D=4\text{ A}$                            | -   | 870 | -   |               |
| Gate threshold voltage           | $V_{GS(th)}$  | $V_{DS}=V_{GS}$ , $I_D=0.24\text{ mA}$                            | 2.1 | 3   | 3.9 |               |
| Zero gate voltage drain current  | $I_{DSS}$     | $V_{DS}=800\text{ V}$ , $V_{GS}=0\text{ V}$ , $T_j=25\text{ °C}$  | -   | -   | 10  | $\mu\text{A}$ |
|                                  |               | $V_{DS}=800\text{ V}$ , $V_{GS}=0\text{ V}$ , $T_j=150\text{ °C}$ | -   | 50  | -   |               |
| Gate-source leakage current      | $I_{GSS}$     | $V_{GS}=20\text{ V}$ , $V_{DS}=0\text{ V}$                        | -   | -   | 100 | nA            |
| Drain-source on-state resistance | $R_{DS(on)}$  | $V_{GS}=10\text{ V}$ , $I_D=2.5\text{ A}$ , $T_j=25\text{ °C}$    | -   | 1.1 | 1.3 | $\Omega$      |
|                                  |               | $V_{GS}=10\text{ V}$ , $I_D=2.5\text{ A}$ , $T_j=150\text{ °C}$   | -   | 3   | -   |               |
| Gate resistance                  | $R_G$         | $f=1\text{ MHz}$ , open drain                                     | -   | 1.2 | -   | $\Omega$      |

| Parameter | Symbol | Conditions | Values |      |      | Unit |
|-----------|--------|------------|--------|------|------|------|
|           |        |            | min.   | typ. | max. |      |

**Dynamic characteristics**

|                                                            |              |                                                                                                                           |   |     |   |    |
|------------------------------------------------------------|--------------|---------------------------------------------------------------------------------------------------------------------------|---|-----|---|----|
| Input capacitance                                          | $C_{iss}$    | $V_{GS}=0\text{ V}, V_{DS}=100\text{ V},$<br>$f=1\text{ MHz}$                                                             | - | 570 | - | pF |
| Output capacitance                                         | $C_{oss}$    |                                                                                                                           | - | 25  | - |    |
| Effective output capacitance, energy related <sup>6)</sup> | $C_{o(er)}$  | $V_{GS}=0\text{ V}, V_{DS}=0\text{ V}$<br>to 480 V                                                                        | - | 19  | - |    |
| Effective output capacitance, time related <sup>7)</sup>   | $C_{o(tr)}$  |                                                                                                                           | - | 51  | - |    |
| Turn-on delay time                                         | $t_{d(on)}$  | $V_{DD}=400\text{ V},$<br>$V_{GS}=0/10\text{ V}, I_D=4\text{ A},$<br>$R_G=22\text{ }\Omega, T_j=25\text{ }^\circ\text{C}$ | - | 25  | - | ns |
| Rise time                                                  | $t_r$        |                                                                                                                           | - | 15  | - |    |
| Turn-off delay time                                        | $t_{d(off)}$ |                                                                                                                           | - | 72  | - |    |
| Fall time                                                  | $t_f$        |                                                                                                                           | - | 12  | - |    |

**Gate Charge Characteristics**

|                       |               |                                                                            |   |     |    |    |
|-----------------------|---------------|----------------------------------------------------------------------------|---|-----|----|----|
| Gate to source charge | $Q_{gs}$      | $V_{DD}=640\text{ V}, I_D=4\text{ A},$<br>$V_{GS}=0\text{ to }10\text{ V}$ | - | 3   | -  | nC |
| Gate to drain charge  | $Q_{gd}$      |                                                                            | - | 12  | -  |    |
| Gate charge total     | $Q_g$         |                                                                            | - | 23  | 31 |    |
| Gate plateau voltage  | $V_{plateau}$ |                                                                            | - | 5.5 | -  | V  |

**Reverse Diode**

|                               |           |                                                                               |   |     |     |               |
|-------------------------------|-----------|-------------------------------------------------------------------------------|---|-----|-----|---------------|
| Diode forward voltage         | $V_{SD}$  | $V_{GS}=0\text{ V}, I_F=I_S=4\text{ A},$<br>$T_j=25\text{ }^\circ\text{C}$    | - | 1   | 1.2 | V             |
| Reverse recovery time         | $t_{rr}$  | $V_R=400\text{ V}, I_F=I_S=4\text{ A},$<br>$di_F/dt=100\text{ A}/\mu\text{s}$ | - | 520 | -   | ns            |
| Reverse recovery charge       | $Q_{rr}$  |                                                                               | - | 4   | -   | $\mu\text{C}$ |
| Peak reverse recovery current | $I_{rrm}$ |                                                                               | - | 12  | -   | A             |

<sup>1)</sup> J-STD20 and JESD22

<sup>2)</sup> Limited only by maximum temperature

<sup>3)</sup> Pulse width  $t_p$  limited by  $T_{j,max}$ 
<sup>4)</sup> Repetitive avalanche causes additional power losses that can be calculated as  $P_{AV}=E_{AR} \cdot f$ .

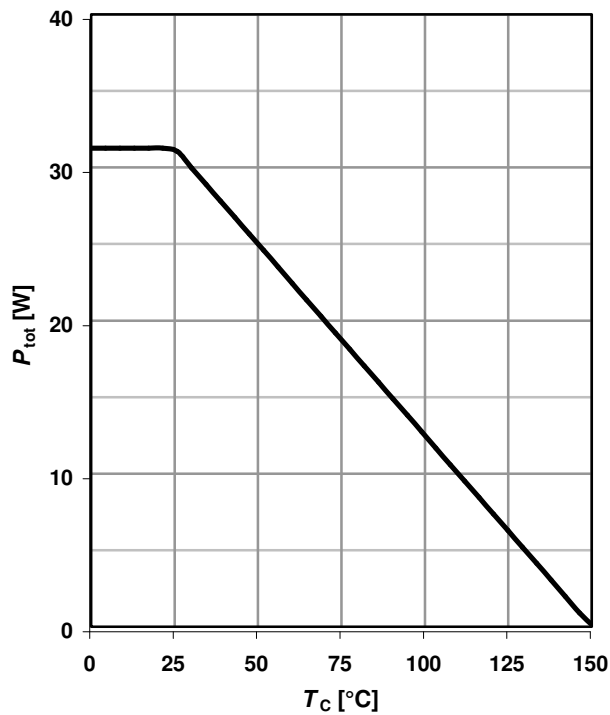
<sup>5)</sup>  $I_{SD}=I_D$ ,  $di/dt=400\text{ A}/\mu\text{s}$ ,  $V_{DClink}=400\text{ V}$ ,  $V_{peak}<V_{(BR)DSS}$ ,  $T_j<T_{j,max}$ , identical low side and high side switch

<sup>6)</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%  $V_{DSS}$ .

<sup>7)</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%  $V_{DSS}$ .

## 1 Power dissipation

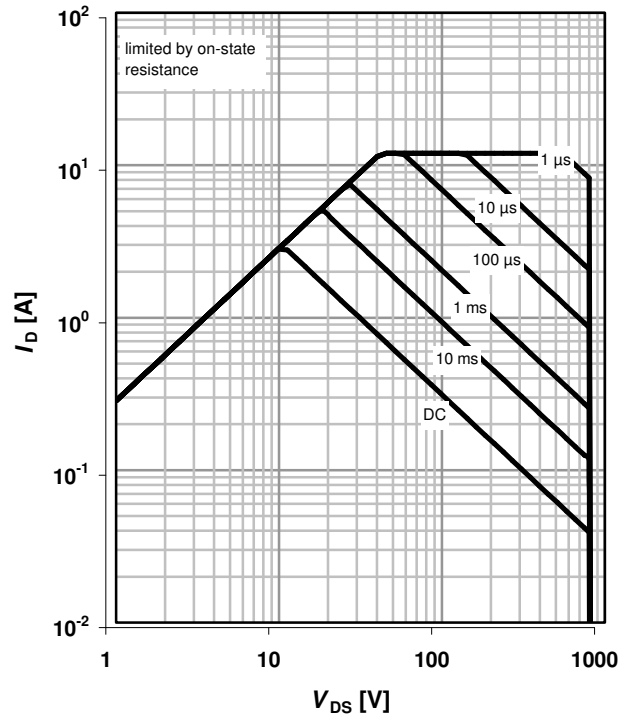
$$P_{\text{tot}} = f(T_C)$$



## 2 Safe operating area

$$I_D = f(V_{DS}); T_C = 25^\circ\text{C}; D = 0$$

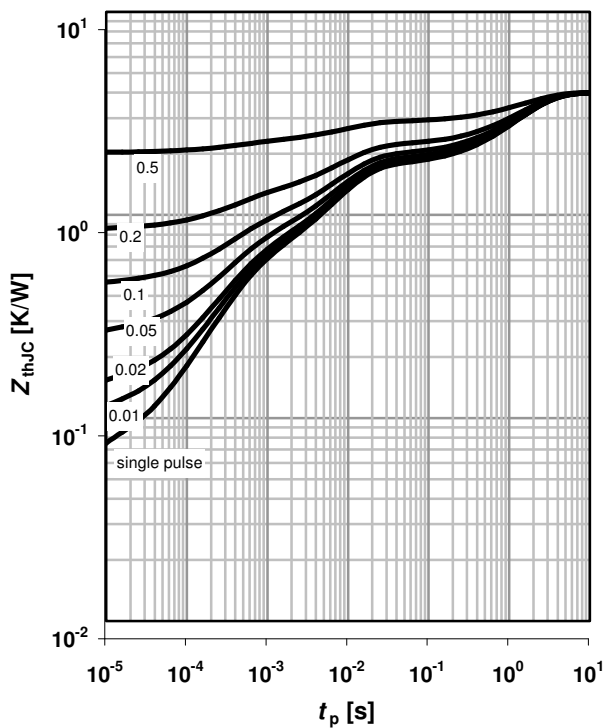
parameter:  $t_p$



## 3 Max. transient thermal impedance

$$Z_{\text{thJC}} = f(t_p)$$

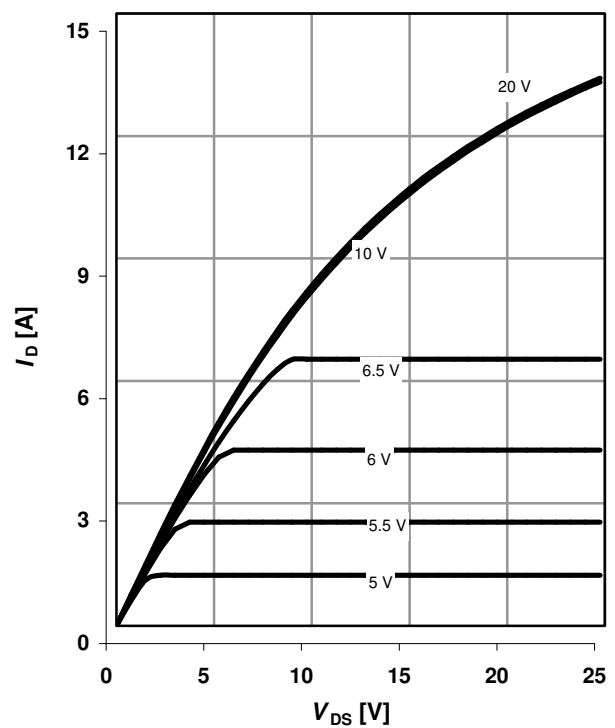
parameter:  $D = t_p / T$



## 4 Typ. output characteristics

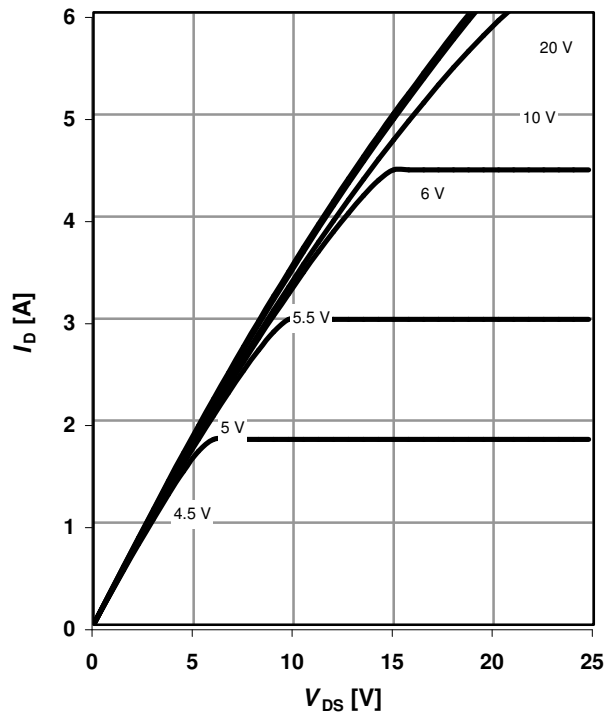
$$I_D = f(V_{DS}); T_J = 25^\circ\text{C}; t_p = 10 \mu\text{s}$$

parameter:  $V_{GS}$



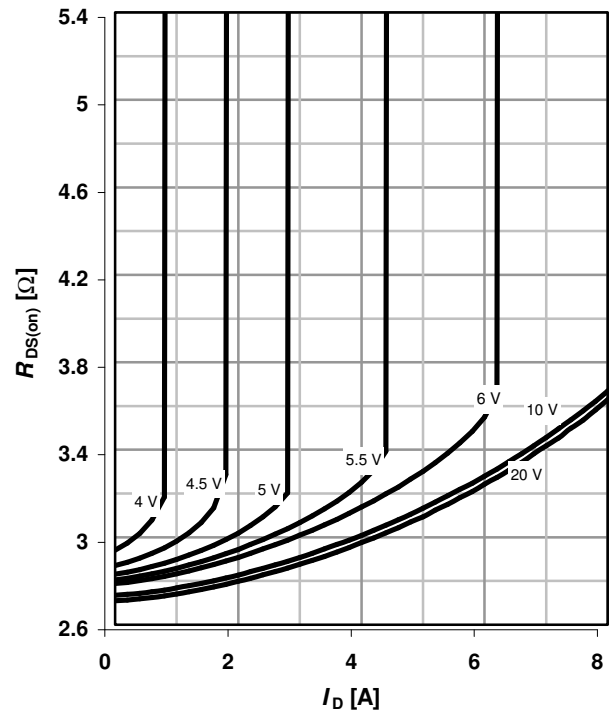
## 5 Typ. output characteristics

 $I_D = f(V_{DS}); T_j = 150^\circ\text{C}; t_p = 10\ \mu\text{s}$ 

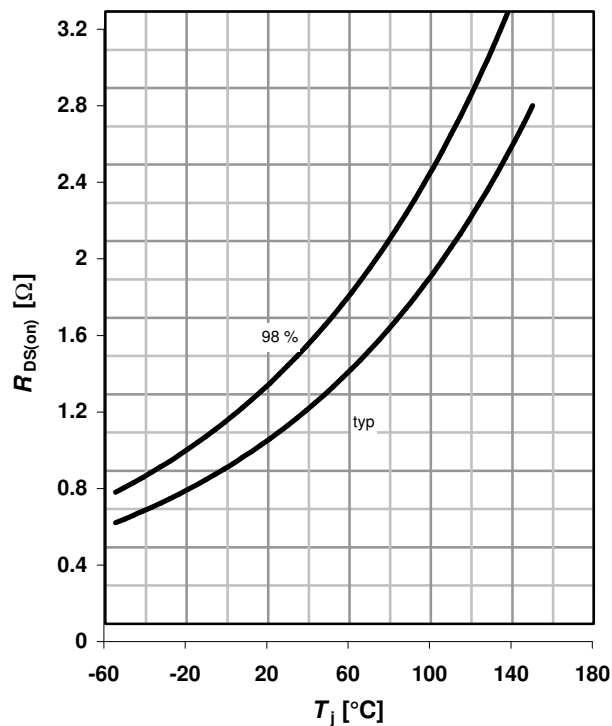
parameter:  $V_{GS}$ 


## 6 Typ. drain-source on-state resistance

 $R_{DS(on)} = f(I_D); T_j = 150^\circ\text{C}$ 

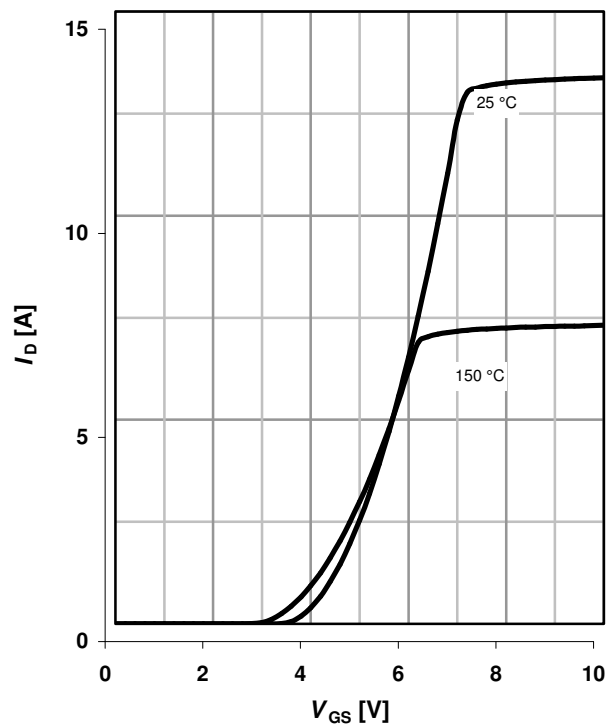
parameter:  $V_{GS}$ 


## 7 Drain-source on-state resistance

 $R_{DS(on)} = f(T_j); I_D = 2.5\ \text{A}; V_{GS} = 10\ \text{V}$ 


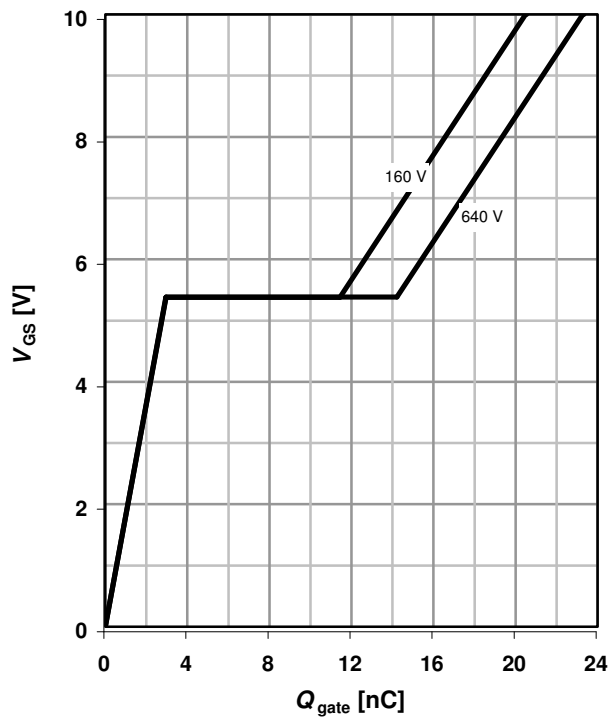
## 8 Typ. transfer characteristics

 $I_D = f(V_{GS}); |V_{DS}| > 2|I_D|R_{DS(on)\max}; t_p = 10\ \mu\text{s}$ 

parameter:  $T_j$ 


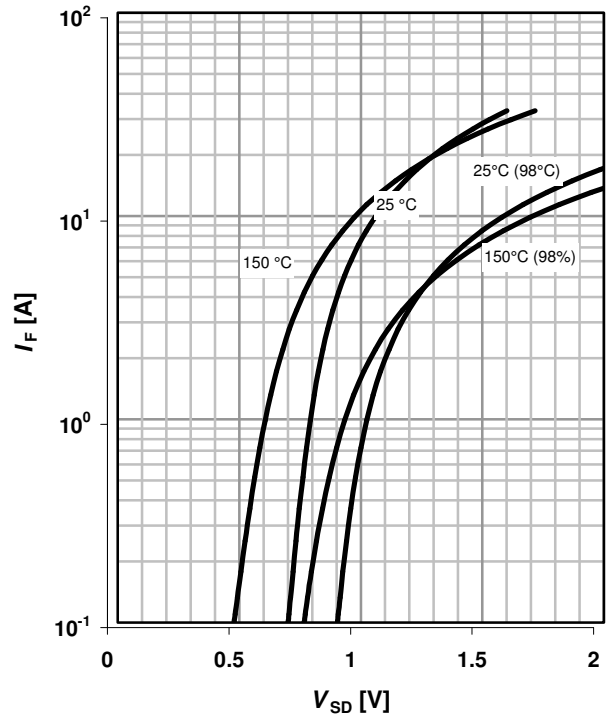
## 9 Typ. gate charge

 $V_{GS}=f(Q_{gate}); I_D=4\text{ A pulsed}$ 

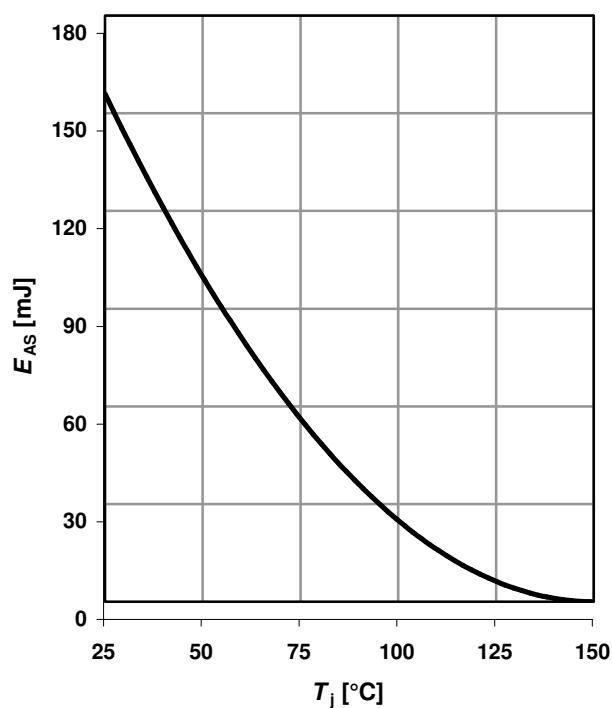
parameter:  $V_{DD}$ 


## 10 Forward characteristics of reverse diode

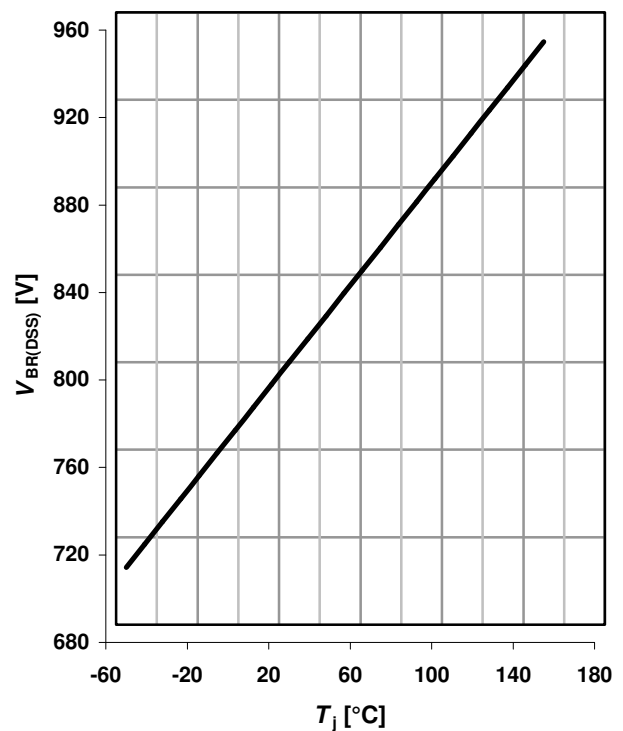
 $I_F=f(V_{SD}); t_p=10\text{ }\mu\text{s}$ 

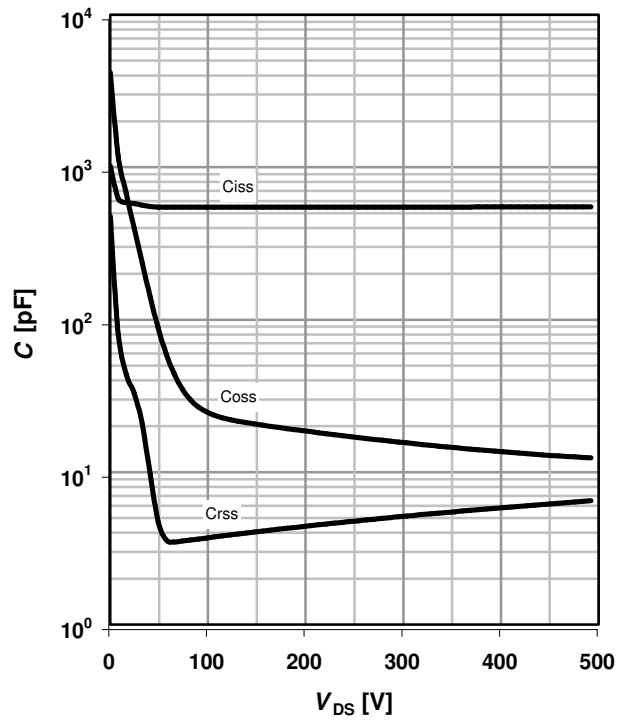
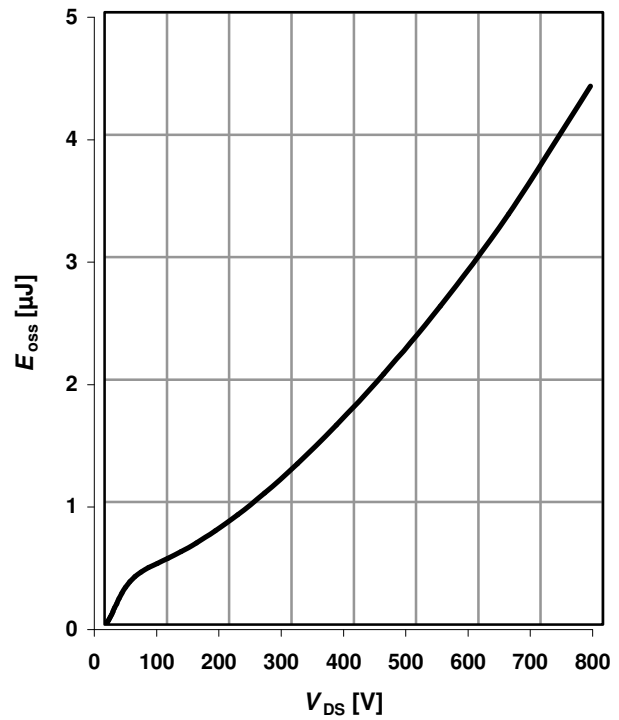
parameter:  $T_j$ 


## 11 Avalanche energy

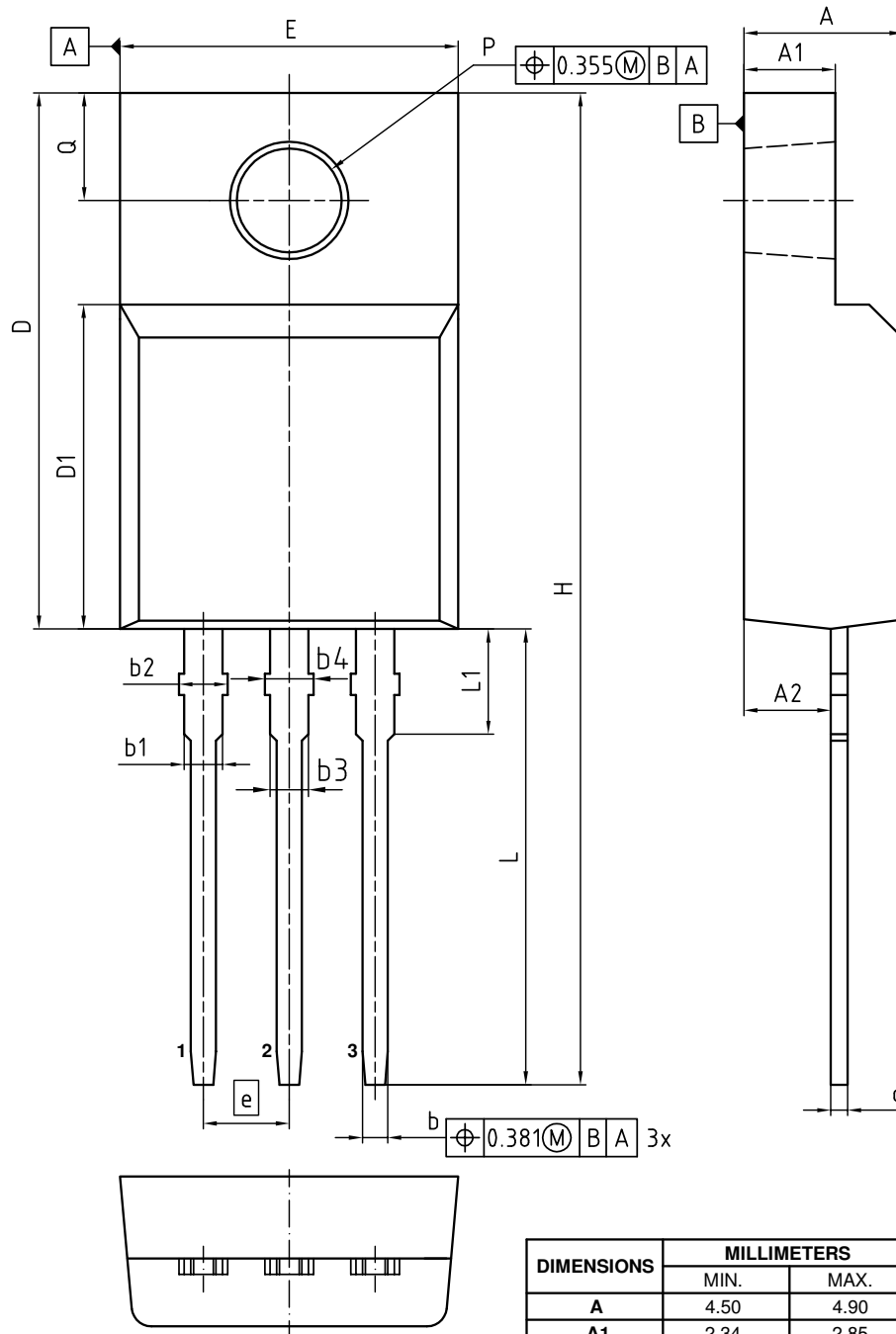
 $E_{AS}=f(T_j); I_D=0.8\text{ A}; V_{DD}=50\text{ V}$ 


## 12 Drain-source breakdown voltage

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


**13 Typ. capacitances**
 $C = f(V_{DS}); V_{GS} = 0 \text{ V}; f = 1 \text{ MHz}$ 

**14 Typ. Coss stored energy**
 $E_{oss} = f(V_{DS})$ 


**Definition of diode switching characteristics**


**Outline PG-TO220 FullPAK**

**NOTES:**

ALL DIMENSIONS REFER TO JEDEC STANDARD TO-281  
AND DOES NOT INCLUDE MOLD FLASH, PROTRUSIONS  
OR GATE BURRS  
GATE BURRS ARE LESS THAN 0.5 mm

| DIMENSIONS | MILLIMETERS |       |
|------------|-------------|-------|
|            | MIN.        | MAX.  |
| A          | 4.50        | 4.90  |
| A1         | 2.34        | 2.85  |
| A2         | 2.42        | 2.86  |
| b          | 0.65        | 0.90  |
| b1         | 0.95        | 1.38  |
| b2         | 0.95        | 1.51  |
| b3         | 0.65        | 1.38  |
| b4         | 0.65        | 1.51  |
| c          | 0.40        | 0.63  |
| D          | 15.67       | 16.15 |
| D1         | 8.97        | 9.83  |
| E          | 10.00       | 10.65 |
| e          | 2.54        |       |
| H          | 28.70       | 29.75 |
| L          | 12.78       | 13.75 |
| L1         | 2.83        | 3.45  |
| øP         | 3.00        | 3.30  |
| Q          | 3.15        | 3.50  |

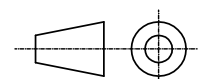
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**REVISION**  
07

**SCALE 5:1**

0 1 2 3 4 5mm

**EUROPEAN PROJECTION**



**ISSUE DATE**  
27.01.2017

## Revision History

SPA04N80C3

**Revision: 2018-02-27, Rev. 2.92**

Previous Revision

| Revision | Date       | Subjects (major changes since last revision) |
|----------|------------|----------------------------------------------|
| 2.92     | 2018-02-27 | Outline PG-TO-220 FullPAK update             |

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