

## CoolMOS™ Power Transistor

### Features

- Intrinsic fast-recovery body diode
- Extremely low reverse recovery charge
- Ultra low gate charge
- Extreme  $dv/dt$  rated
- High peak current capability
- Qualified for industrial grade applications according to JEDEC<sup>1)</sup>
- **Halogen free mold compound**

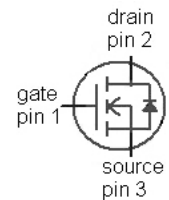
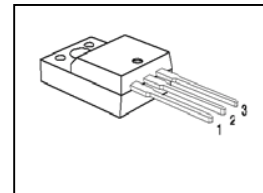
### CoolMOS CFD designed for:

- Softswitching PWM Stages
- LCD & CRT TV

### Product Summary

|                     |       |          |
|---------------------|-------|----------|
| $V_{DS} @ T_{jmax}$ | 650   | V        |
| $R_{DS(on),max}$    | 0.330 | $\Omega$ |
| $I_D$               | 13.4  | A        |

### PG-TO220FP



| Type        | Package    | Marking  |
|-------------|------------|----------|
| SPA15N60CFD | PG-TO220FP | 15N60CFD |

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

| Parameter                                      | Symbol            | Conditions                                                               | Value       | Unit             |
|------------------------------------------------|-------------------|--------------------------------------------------------------------------|-------------|------------------|
| Continuous drain current <sup>2)</sup>         | $I_D$             | $T_C=25^\circ\text{C}$                                                   | 13.4        | A                |
|                                                |                   | $T_C=100^\circ\text{C}$                                                  | 8.4         |                  |
| Pulsed drain current <sup>3)</sup>             | $I_{D,pulse}$     | $T_C=25^\circ\text{C}$                                                   | 33          |                  |
| Avalanche energy, single pulse                 | $E_{AS}$          | $I_D=6.7\text{ A}$ , $V_{DD}=50\text{ V}$                                | 460         | mJ               |
| Avalanche energy, repetitive <sup>3),4)</sup>  | $E_{AR}$          | $I_D=13.4\text{ A}$ , $V_{DD}=50\text{ V}$                               | 0.8         |                  |
| Avalanche current, repetitive <sup>3),4)</sup> | $I_{AR}$          |                                                                          | 13.4        | A                |
| Drain source voltage slope                     | $dv/dt$           | $I_D=13.4\text{ A}$ ,<br>$V_{DS}=480\text{ V}$ , $T_j=125^\circ\text{C}$ | 80          | V/ns             |
| Reverse diode $dv/dt$                          | $dv/dt$           | $I_S=13.4\text{ A}$ , $V_{DS}=480\text{ V}$ ,<br>$T_j=125^\circ\text{C}$ | 40          | V/ns             |
| Maximum diode commutation speed                | $di/dt$           |                                                                          | 600         | A/ $\mu\text{s}$ |
| Gate source voltage                            | $V_{GS}$          | static                                                                   | $\pm 20$    | V                |
|                                                |                   | AC ( $f>1\text{ Hz}$ )                                                   | $\pm 30$    |                  |
| Power dissipation                              | $P_{tot}$         | $T_C=25^\circ\text{C}$                                                   | 34          | W                |
| Operating and storage temperature              | $T_j$ , $T_{stg}$ |                                                                          | -55 ... 150 | $^\circ\text{C}$ |
| Mounting torque                                |                   | M2.5 screws                                                              | 50          | Ncm              |

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

**Thermal characteristics**

|                                                             |            |                                       |   |   |     |     |
|-------------------------------------------------------------|------------|---------------------------------------|---|---|-----|-----|
| Thermal resistance, junction - case                         | $R_{thJC}$ |                                       | - | - | 3.7 | K/W |
| Thermal resistance, junction - ambient                      | $R_{thJA}$ | leaded                                | - | - | 62  |     |
| Soldering temperature, wave soldering only allowed at leads | $T_{sold}$ | 1.6 mm (0.063 in.) from case for 10 s | - | - | 260 | °C  |

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

|                                  |               |                                                                   |     |      |      |               |
|----------------------------------|---------------|-------------------------------------------------------------------|-----|------|------|---------------|
| Drain-source breakdown voltage   | $V_{(BR)DSS}$ | $V_{GS}=0\text{ V}$ , $I_D=250\text{ }\mu\text{A}$                | 600 | -    | -    | V             |
| Avalanche breakdown voltage      | $V_{(BR)DS}$  | $V_{GS}=0\text{ V}$ , $I_D=13.4\text{ A}$                         | -   | 700  | -    |               |
| Gate threshold voltage           | $V_{GS(th)}$  | $V_{DS}=V_{GS}$ , $I_D=750\text{ }\mu\text{A}$                    | 3   | 4    | 5    |               |
| Zero gate voltage drain current  | $I_{DSS}$     | $V_{DS}=600\text{ V}$ , $V_{GS}=0\text{ V}$ , $T_j=25\text{ °C}$  | -   | 1.4  | -    | $\mu\text{A}$ |
|                                  |               | $V_{DS}=600\text{ V}$ , $V_{GS}=0\text{ V}$ , $T_j=150\text{ °C}$ | -   | 1200 | -    |               |
| Gate-source leakage current      | $I_{GSS}$     | $V_{GS}=20\text{ V}$ , $V_{DS}=0\text{ V}$                        | -   | -    | 100  | nA            |
| Drain-source on-state resistance | $R_{DS(on)}$  | $V_{GS}=10\text{ V}$ , $I_D=9.4\text{ A}$ , $T_j=25\text{ °C}$    | -   | 0.28 | 0.33 | $\Omega$      |
|                                  |               | $V_{GS}=10\text{ V}$ , $I_D=9.4\text{ A}$ , $T_j=150\text{ °C}$   | -   | 0.78 | -    |               |
| Gate resistance                  | $R_G$         | $f=1\text{ MHz}$ , open drain                                     | -   | 1.3  | -    |               |
| Transconductance                 | $g_{fs}$      | $ V_{DS} >2 I_D R_{DS(on)max}$ , $I_D=9.4\text{ A}$               | -   | 8    | -    | S             |

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

**Dynamic characteristics**

|                                                            |              |                                                                                         |   |      |   |    |
|------------------------------------------------------------|--------------|-----------------------------------------------------------------------------------------|---|------|---|----|
| Input capacitance                                          | $C_{iss}$    | $V_{GS}=0\text{ V}, V_{DS}=25\text{ V},$<br>$f=1\text{ MHz}$                            | - | 1820 | - | pF |
| Output capacitance                                         | $C_{oss}$    |                                                                                         | - | 520  | - |    |
| Reverse transfer capacitance                               | $C_{rss}$    |                                                                                         | - | 21   | - |    |
| Effective output capacitance, energy related <sup>5)</sup> | $C_{o(er)}$  | $V_{GS}=0\text{ V}, V_{DS}=0\text{ V}$<br>to 480 V                                      | - | 61   | - |    |
| Effective output capacitance, time related <sup>6)</sup>   | $C_{o(tr)}$  |                                                                                         | - | 110  | - |    |
| Turn-on delay time                                         | $t_{d(on)}$  | $V_{DD}=400\text{ V},$<br>$V_{GS}=10\text{ V}, I_D=13.4\text{ A},$<br>$R_G=3.6\ \Omega$ | - | 43   | - | ns |
| Rise time                                                  | $t_r$        |                                                                                         | - | 24   | - |    |
| Turn-off delay time                                        | $t_{d(off)}$ |                                                                                         | - | 47   | - |    |
| Fall time                                                  | $t_f$        |                                                                                         | - | 5    | - |    |

**Gate Charge Characteristics**

|                       |               |                                                                                    |   |     |    |    |
|-----------------------|---------------|------------------------------------------------------------------------------------|---|-----|----|----|
| Gate to source charge | $Q_{gs}$      | $V_{DD}=480\text{ V},$<br>$I_D=13.4\text{ A},$<br>$V_{GS}=0\text{ to }10\text{ V}$ | - | 11  | -  | nC |
| Gate to drain charge  | $Q_{gd}$      |                                                                                    | - | 38  | -  |    |
| Gate charge total     | $Q_g$         |                                                                                    | - | 63  | 84 |    |
| Gate plateau voltage  | $V_{plateau}$ |                                                                                    | - | 7.3 | -  | V  |

<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  $P_{AV}=E_{AR} \cdot f$ .

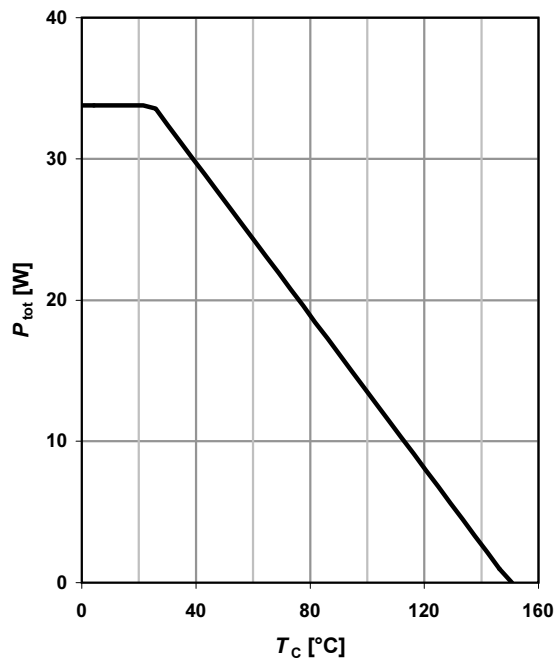
<sup>5)</sup>  $C_{o(er)}$  is a fixed capacitance that gives the same stored energy as  $C_{oss}$  while  $V_{DS}$  is rising from 0 to 80%  $V_{DSS}$ .

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

| Parameter                                      | Symbol        | Conditions                                                         | Values |      |      | Unit             |
|------------------------------------------------|---------------|--------------------------------------------------------------------|--------|------|------|------------------|
|                                                |               |                                                                    | min.   | typ. | max. |                  |
| Reverse Diode                                  |               |                                                                    |        |      |      |                  |
| Diode continuous forward current <sup>2)</sup> | $I_S$         | $T_C=25\text{ }^{\circ}\text{C}$                                   | -      | -    | 13.4 | A                |
| Diode pulse current <sup>3)</sup>              | $I_{S,pulse}$ |                                                                    | -      | -    | 33   |                  |
| Diode forward voltage                          | $V_{SD}$      | $V_{GS}=0\text{ V}, I_F=I_S,$<br>$T_j=25\text{ }^{\circ}\text{C}$  | -      | 1.0  | 1.2  | V                |
| Reverse recovery time                          | $t_{rr}$      | $V_R=480\text{ V}, I_F=I_S,$<br>$di_F/dt=100\text{ A}/\mu\text{s}$ | -      | 147  | -    | ns               |
| Reverse recovery charge                        | $Q_{rr}$      |                                                                    | -      | 1    | -    | $\mu\text{C}$    |
| Peak reverse recovery current                  | $I_{rrm}$     |                                                                    | -      | 12   | -    | A                |
| Peak rate of fall of reverse recovery current  | $di_{rr}/dt$  | $T_j=25\text{ }^{\circ}\text{C}$                                   | -      | 1200 | -    | A/ $\mu\text{s}$ |

### 1 Power dissipation

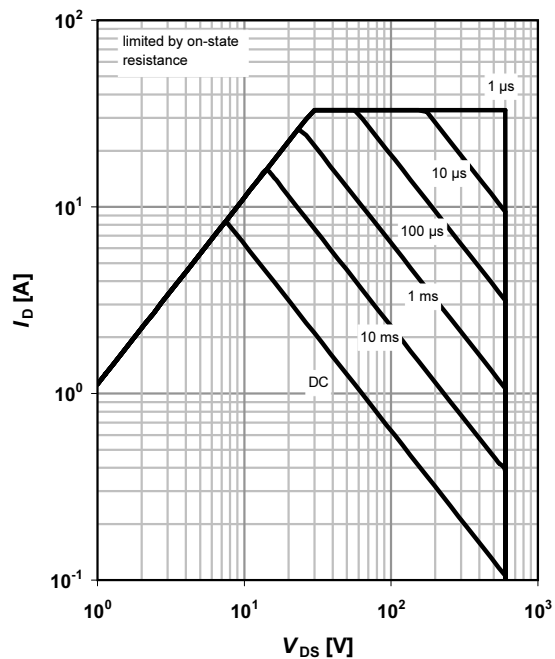
$$P_{\text{tot}} = f(T_C)$$



### 2 Safe operating area

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

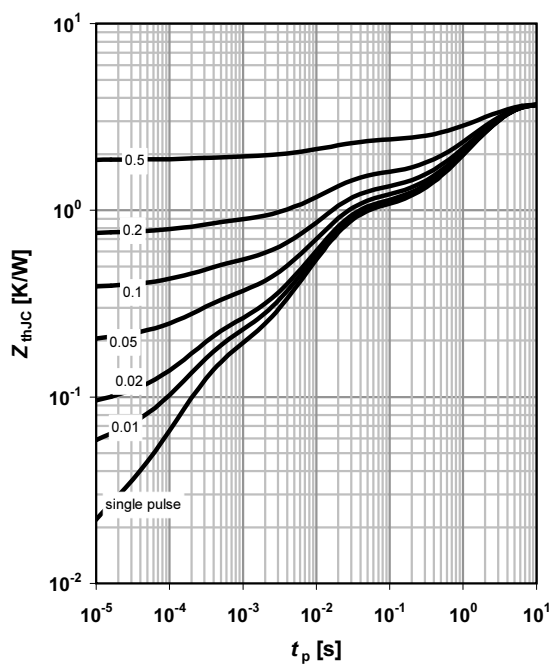
parameter:  $t_p$



### 3 Max. transient thermal impedance

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

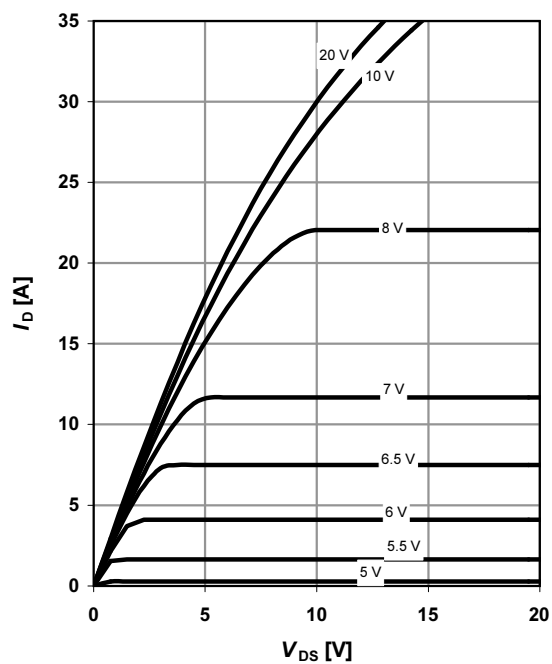
parameter:  $D = t_p / T$



### 4 Typ. output characteristics

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

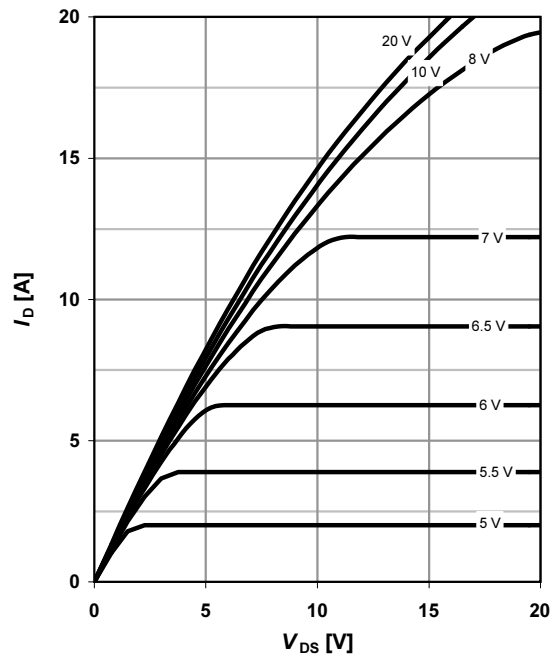
parameter:  $V_{GS}$



**5 Typ. output characteristics**

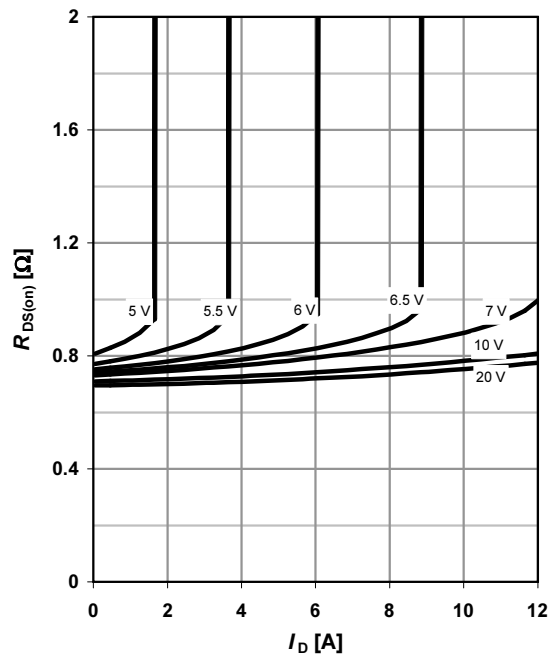
$$I_D = f(V_{DS}); T_J = 150^\circ\text{C}$$

parameter:  $V_{GS}$

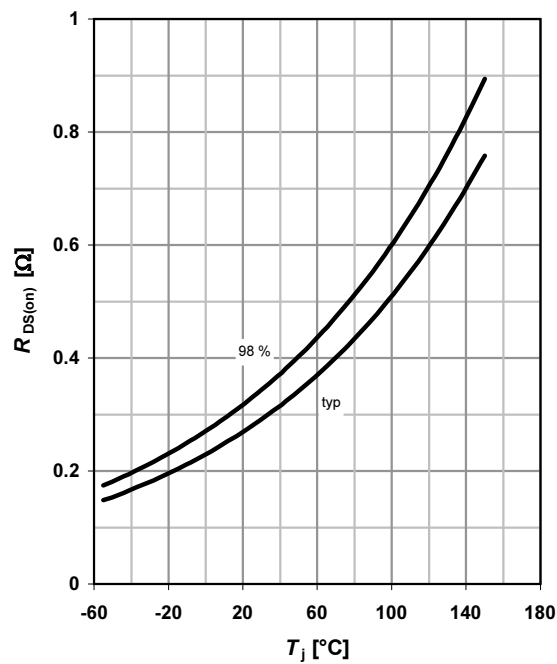

**6 Typ. drain-source on-state resistance**

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

parameter:  $V_{GS}$

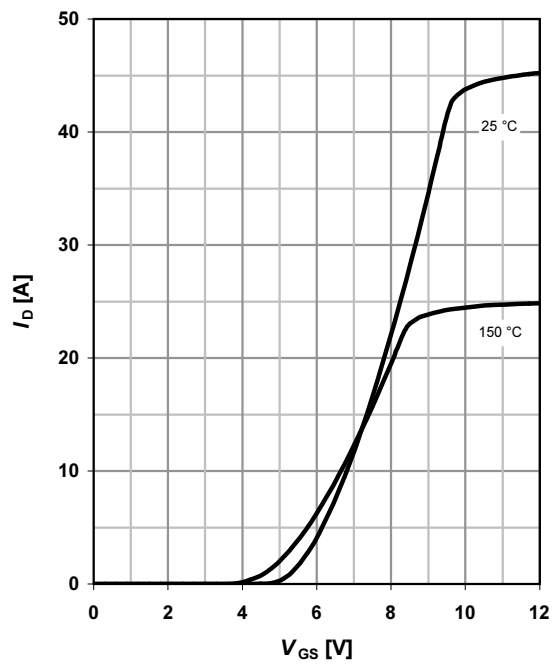

**7 Drain-source on-state resistance**

$$R_{DS(on)} = f(T_J); I_D = 9.4\text{ A}; V_{GS} = 10\text{ V}$$


**8 Typ. transfer characteristics**

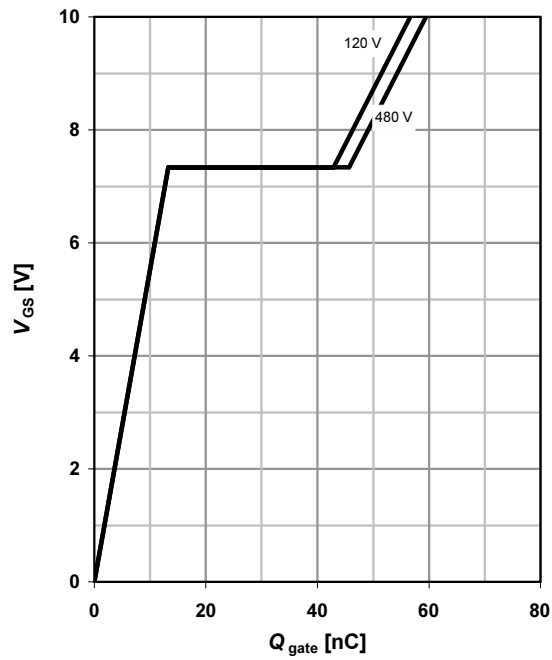
$$I_D = f(V_{GS}); |V_{DS}| > 2|I_D|R_{DS(on)\text{max}}$$

parameter:  $T_J$



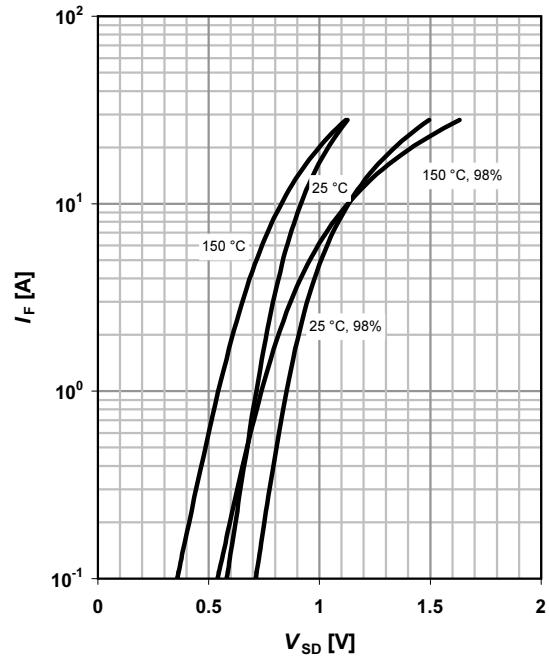
### 9 Typ. gate charge

 $V_{GS}=f(Q_{gate}); I_D=13.4 \text{ A pulsed}$ 

parameter:  $V_{DD}$ 


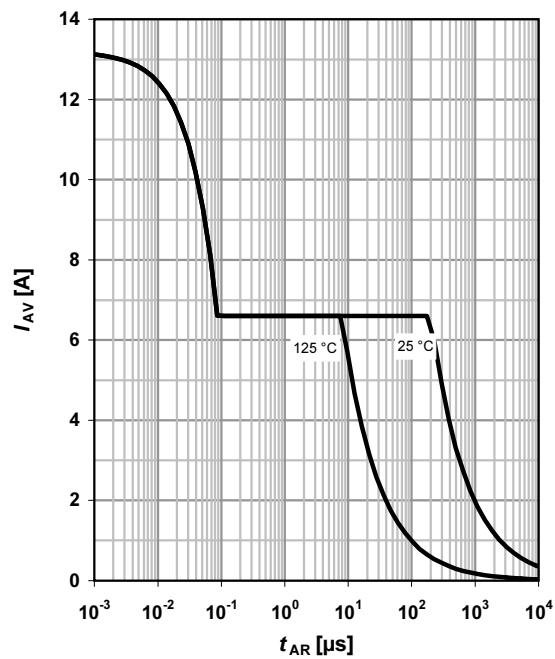
### 10 Forward characteristics of reverse diode

 $I_F=f(V_{SD})$ 

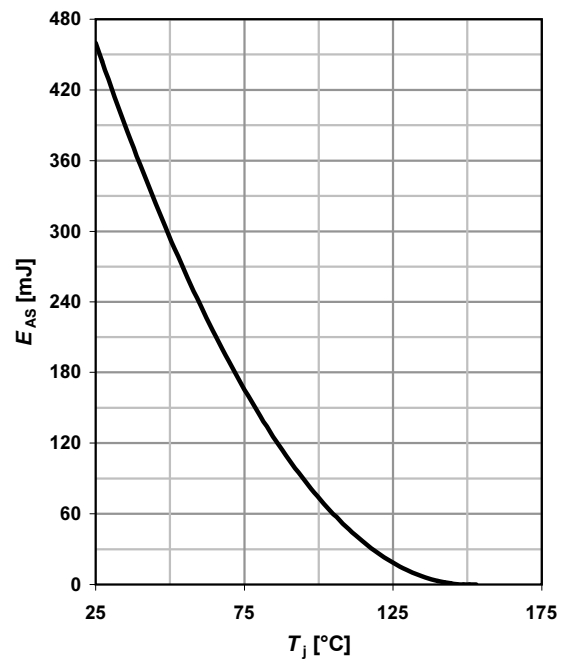
parameter:  $T_j$ 


### 11 Avalanche SOA

 $I_{AR}=f(t_{AR})$ 

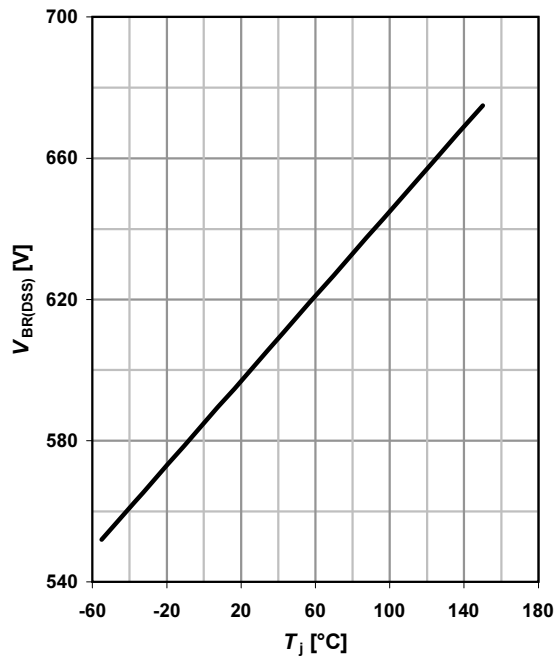
parameter:  $T_{j(start)}$ 


### 12 Avalanche energy

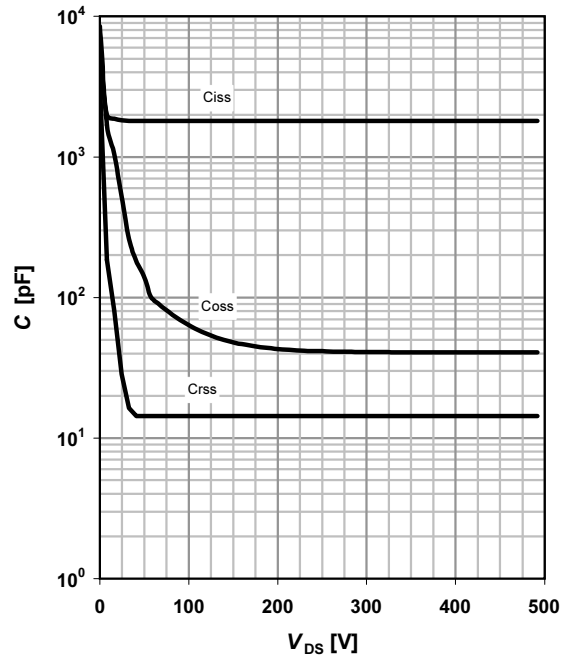
 $E_{AS}=f(T_j); I_D=6.7 \text{ A}; V_{DD}=50 \text{ V}$ 


**13 Drain-source breakdown voltage**

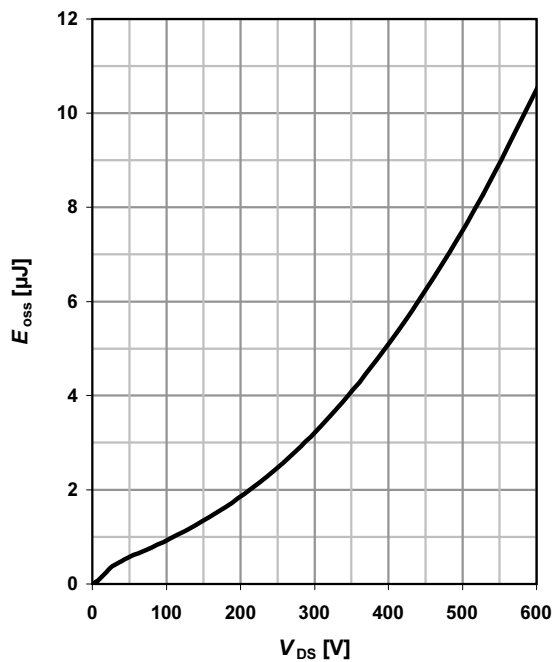
$$V_{BR(DSS)} = f(T_j)$$


**14 Typ. capacitances**

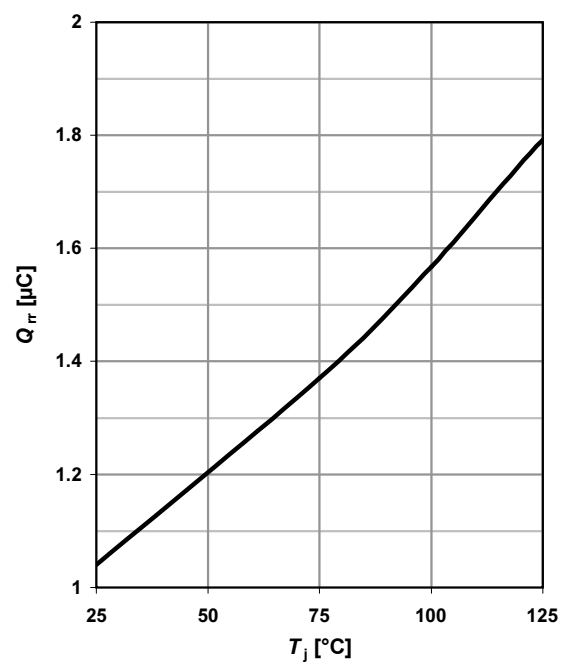
$$C = f(V_{DS}); V_{GS} = 0 \text{ V}; f = 1 \text{ MHz}$$

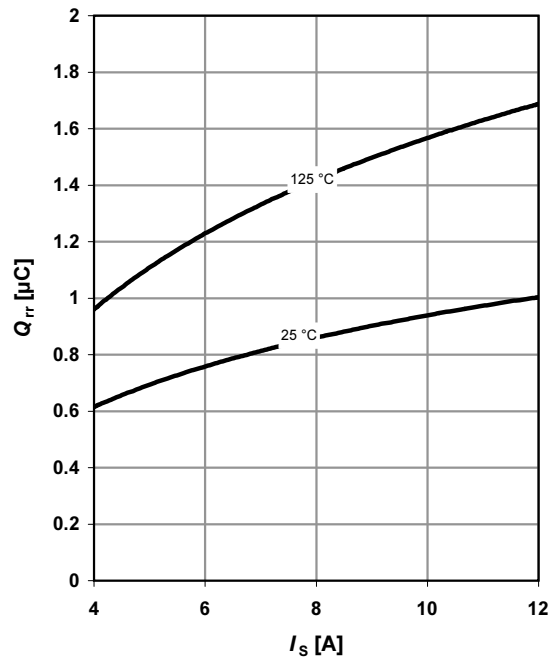
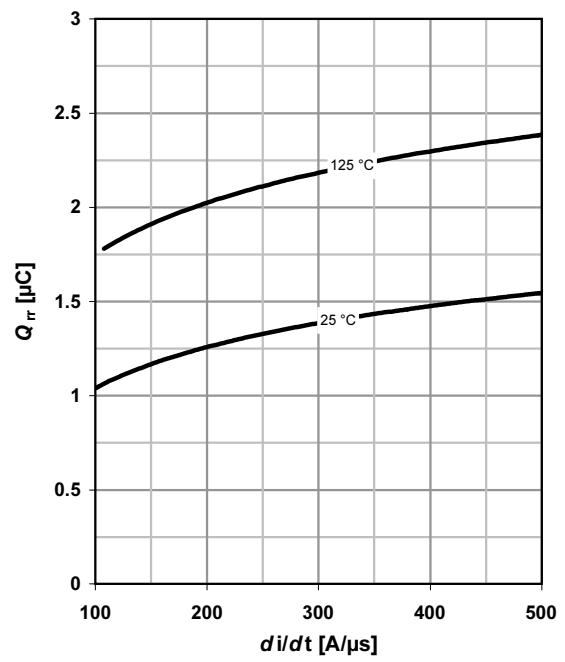

**15 Typ.  $C_{oss}$  stored energy**

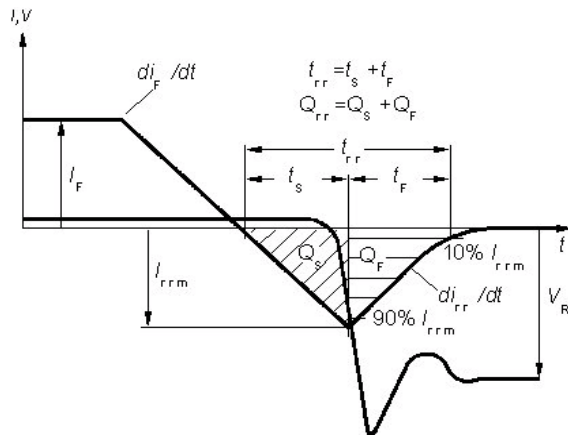
$$E_{oss} = f(V_{DS})$$


**16 Typ. reverse recovery charge**

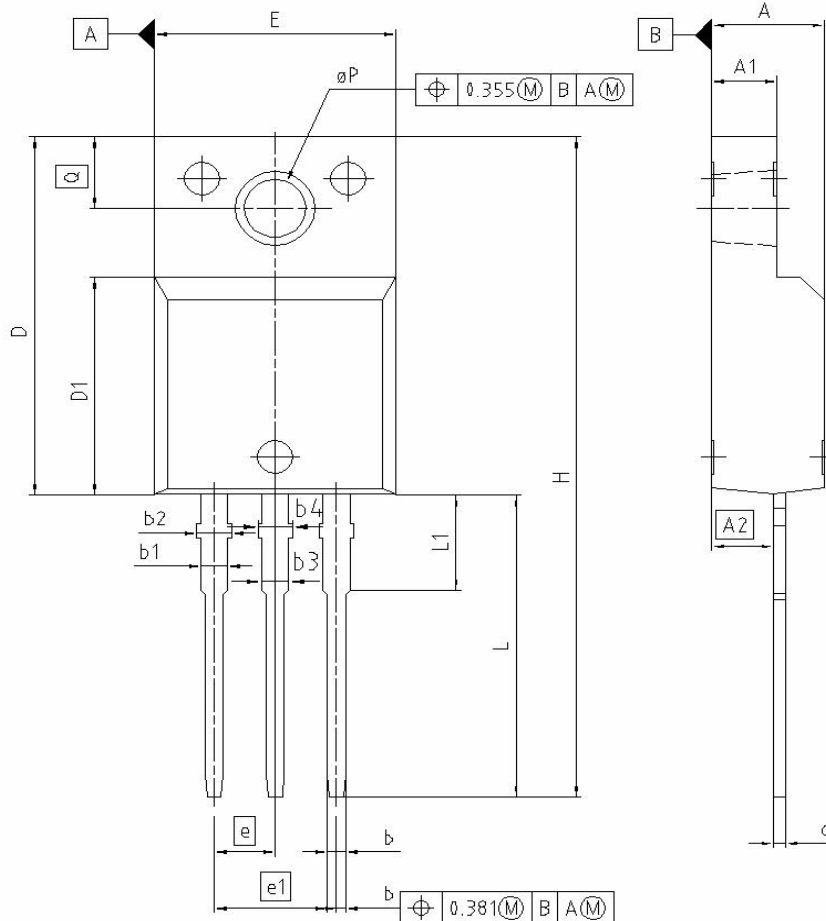
$$Q_{rr} = f(T_j); \text{parameter: } I_D = 13.4 \text{ A}$$



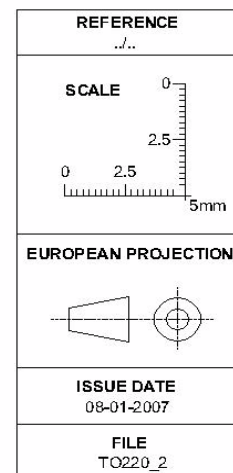
**17 Typ. reverse recovery charge**
 $Q_{rr}=f(I_S)$ ; parameter:  $di/dt=100\text{ A}/\mu\text{s}$ 

**18 Typ. reverse recovery charge**
 $Q_{rr}=f(di/dt)$ ; parameter:  $I_D=13.4\text{ A}$ 


**Definition of diode switching characteristics**


PG-TO-220-3--31; -3-111: Outlines/Fully isolated package (2500VAC; 1minute)



| DIM | MILLIMETERS |       | INCHES |       |
|-----|-------------|-------|--------|-------|
|     | MIN         | MAX   | MIN    | MAX   |
| A   | 4.55        | 4.85  | 0.179  | 0.191 |
| A1  | 2.55        | 2.85  | 0.100  | 0.112 |
| A2  | 2.42        | 2.72  | 0.095  | 0.107 |
| b   | 0.65        | 0.85  | 0.026  | 0.033 |
| b1  | 0.95        | 1.33  | 0.037  | 0.052 |
| b2  | 0.95        | 1.51  | 0.037  | 0.059 |
| b3  | 0.65        | 1.33  | 0.026  | 0.052 |
| b4  | 0.65        | 1.51  | 0.026  | 0.059 |
| c   | 0.40        | 0.63  | 0.016  | 0.025 |
| D   | 15.85       | 16.15 | 0.624  | 0.636 |
| D1  | 9.53        | 9.83  | 0.375  | 0.387 |
| E   | 10.35       | 10.65 | 0.407  | 0.419 |
| e   | 2.54        |       | 0.100  |       |
| e1  | 5.08        |       | 0.200  |       |
| N   | 3           |       | 3      |       |
| H   | 29.45       | 29.75 | 1.159  | 1.171 |
| L   | 13.45       | 13.75 | 0.530  | 0.541 |
| L1  | 3.15        | 3.45  | 0.124  | 0.136 |
| øP  | 2.95        | 3.20  | 0.116  | 0.126 |
| Q   | 3.15        | 3.50  | 0.124  | 0.138 |



Dimensions in mm/ inches

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«FORSTAR» (основан в 1998 г.)

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(Применяются в телекоммуникациях гражданского и специального назначения, в средствах связи, РЛС, а так же военной, авиационной и аэрокосмической отраслях промышленности).



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