

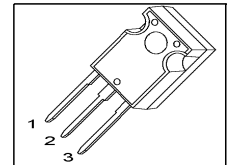
## Cool MOS™ Power Transistor

### Feature

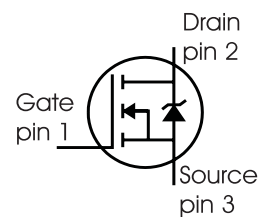
- New revolutionary high voltage technology
- Ultra low gate charge
- Periodic avalanche rated
- Extreme  $dv/dt$  rated
- Ultra low effective capacitances
- Improved transconductance

|              |      |          |
|--------------|------|----------|
| $V_{DS}$     | 600  | V        |
| $R_{DS(on)}$ | 0.19 | $\Omega$ |
| $I_D$        | 20   | A        |

P-TO247



| Type       | Package | Ordering Code | Marking |
|------------|---------|---------------|---------|
| SPW20N60S5 | P-TO247 | Q67040-S4238  | 20N60S5 |



### Maximum Ratings

| Parameter                                                                                                                | Symbol              | Value       | Unit             |
|--------------------------------------------------------------------------------------------------------------------------|---------------------|-------------|------------------|
| Continuous drain current<br>$T_C = 25\text{ }^\circ\text{C}$<br>$T_C = 100\text{ }^\circ\text{C}$                        | $I_D$               | 20<br>13    | A                |
| Pulsed drain current, $t_p$ limited by $T_{jmax}$                                                                        | $I_{D\text{ puls}}$ | 40          |                  |
| Avalanche energy, single pulse<br>$I_D = 10\text{ A}$ , $V_{DD} = 50\text{ V}$                                           | $E_{AS}$            | 690         | mJ               |
| Avalanche energy, repetitive $t_{AR}$ limited by $T_{jmax}$ <sup>1</sup><br>$I_D = 20\text{ A}$ , $V_{DD} = 50\text{ V}$ | $E_{AR}$            | 1           |                  |
| Avalanche current, repetitive $t_{AR}$ limited by $T_{jmax}$                                                             | $I_{AR}$            | 20          | A                |
| Gate source voltage                                                                                                      | $V_{GS}$            | $\pm 20$    | V                |
| Gate source voltage AC ( $f > 1\text{ Hz}$ )                                                                             | $V_{GS}$            | $\pm 30$    |                  |
| Power dissipation, $T_C = 25\text{ }^\circ\text{C}$                                                                      | $P_{tot}$           | 208         | W                |
| Operating and storage temperature                                                                                        | $T_j, T_{stg}$      | -55... +150 | $^\circ\text{C}$ |

**Maximum Ratings**

| Parameter                                                                                           | Symbol  | Value | Unit |
|-----------------------------------------------------------------------------------------------------|---------|-------|------|
| Drain Source voltage slope<br>$V_{DS} = 480\text{ V}$ , $I_D = 20\text{ A}$ , $T_j = 125\text{ °C}$ | $dv/dt$ | 20    | V/ns |

**Thermal Characteristics**

| Parameter                                                      | Symbol     | Values |      |      | Unit |
|----------------------------------------------------------------|------------|--------|------|------|------|
|                                                                |            | min.   | typ. | max. |      |
| Thermal resistance, junction - case                            | $R_{thJC}$ | -      | -    | 0.6  | K/W  |
| Thermal resistance, junction - ambient, leaded                 | $R_{thJA}$ | -      | -    | 50   |      |
| Soldering temperature,<br>1.6 mm (0.063 in.) from case for 10s | $T_{sold}$ | -      | -    | 260  | °C   |

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

| Parameter                                   | Symbol        | Conditions                                                                                   | Values |      |      | Unit          |
|---------------------------------------------|---------------|----------------------------------------------------------------------------------------------|--------|------|------|---------------|
|                                             |               |                                                                                              | min.   | typ. | max. |               |
| Drain-source breakdown voltage              | $V_{(BR)DSS}$ | $V_{GS}=0\text{ V}$ , $I_D=0.25\text{ mA}$                                                   | 600    | -    | -    | V             |
| Drain-Source avalanche<br>breakdown voltage | $V_{(BR)DS}$  | $V_{GS}=0\text{ V}$ , $I_D=20\text{ A}$                                                      | -      | 700  | -    |               |
| Gate threshold voltage                      | $V_{GS(th)}$  | $I_D=1000\text{ }\mu\text{A}$ , $V_{GS}=V_{DS}$                                              | 3.5    | 4.5  | 5.5  |               |
| Zero gate voltage drain current             | $I_{DSS}$     | $V_{DS}=600\text{ V}$ , $V_{GS}=0\text{ V}$ ,<br>$T_j=25\text{ °C}$ ,<br>$T_j=150\text{ °C}$ | -      | 0.5  | 5    | $\mu\text{A}$ |
|                                             |               |                                                                                              | -      | -    | 250  |               |
| Gate-source leakage current                 | $I_{GSS}$     | $V_{GS}=20\text{ V}$ , $V_{DS}=0\text{ V}$                                                   | -      | -    | 100  | nA            |
| Drain-source on-state resistance            | $R_{DS(on)}$  | $V_{GS}=10\text{ V}$ , $I_D=13\text{ A}$ ,<br>$T_j=25\text{ °C}$<br>$T_j=150\text{ °C}$      | -      | 0.16 | 0.19 | $\Omega$      |
|                                             |               |                                                                                              | -      | 0.43 | -    |               |
| Gate input resistance                       | $R_G$         | $f=1\text{ MHz}$ , open Drain                                                                | -      | 12   | -    |               |

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

| Parameter                                                     | Symbol       | Conditions                                                              | Values |      |      | Unit |
|---------------------------------------------------------------|--------------|-------------------------------------------------------------------------|--------|------|------|------|
|                                                               |              |                                                                         | min.   | typ. | max. |      |
| Characteristics                                               |              |                                                                         |        |      |      |      |
| Transconductance                                              | $g_{fs}$     | $V_{DS} \geq 2 \cdot I_D \cdot R_{DS(on)max}$ ,<br>$I_D = 13A$          | -      | 12   | -    | S    |
| Input capacitance                                             | $C_{iss}$    | $V_{GS} = 0V$ , $V_{DS} = 25V$ ,<br>$f = 1MHz$                          | -      | 3000 | -    | pF   |
| Output capacitance                                            | $C_{oss}$    |                                                                         | -      | 1170 | -    |      |
| Reverse transfer capacitance                                  | $C_{rss}$    |                                                                         | -      | 28   | -    |      |
| Effective output capacitance, <sup>2)</sup><br>energy related | $C_{o(er)}$  | $V_{GS} = 0V$ ,<br>$V_{DS} = 0V$ to 480V                                | -      | 83   | -    | pF   |
| Effective output capacitance, <sup>3)</sup><br>time related   | $C_{o(tr)}$  |                                                                         | -      | 160  | -    |      |
| Turn-on delay time                                            | $t_{d(on)}$  | $V_{DD} = 350V$ , $V_{GS} = 0/10V$ ,<br>$I_D = 20A$ , $R_G = 3.6\Omega$ | -      | 120  | -    | ns   |
| Rise time                                                     | $t_r$        |                                                                         | -      | 25   | -    |      |
| Turn-off delay time                                           | $t_{d(off)}$ |                                                                         | -      | 130  | 195  |      |
| Fall time                                                     | $t_f$        |                                                                         | -      | 30   | 45   |      |

**Gate Charge Characteristics**

|                       |                 |                                                                                     |   |    |     |    |
|-----------------------|-----------------|-------------------------------------------------------------------------------------|---|----|-----|----|
| Gate to source charge | $Q_{gs}$        | $V_{DD} = 350\text{V}$ , $I_D = 20\text{A}$                                         | - | 21 | -   | nC |
| Gate to drain charge  | $Q_{gd}$        |                                                                                     | - | 47 | -   |    |
| Gate charge total     | $Q_g$           | $V_{DD} = 350\text{V}$ , $I_D = 20\text{A}$ ,<br>$V_{GS} = 0\text{ to } 10\text{V}$ | - | 79 | 103 |    |
| Gate plateau voltage  | $V_{(plateau)}$ | $V_{DD} = 350\text{V}$ , $I_D = 20\text{A}$                                         | - | 8  | -   | V  |

<sup>1</sup> Repetitive avalanche causes additional power losses that can be calculated as  $P_{AV} = E_{AR} \cdot f$ .

<sup>2</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%  $V_{DSS}$ .

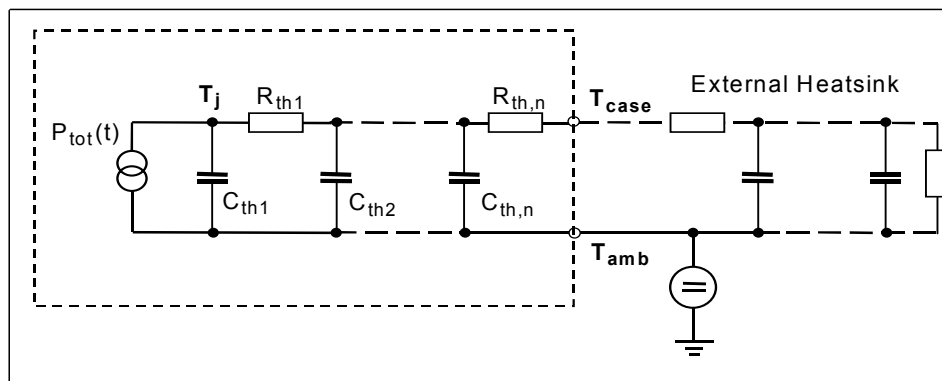
<sup>3</sup>  $C_{o(tr)}$  is a fixed capacitance that gives the same charging time as  $C_{oss}$  while  $V_{DS}$  is rising from 0 to 80%  $V_{DSS}$ .

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

| Parameter                                | Symbol   | Conditions                          | Values |      |      | Unit          |
|------------------------------------------|----------|-------------------------------------|--------|------|------|---------------|
|                                          |          |                                     | min.   | typ. | max. |               |
| Inverse diode continuous forward current | $I_S$    | $T_C = 25^\circ\text{C}$            | -      | -    | 20   | A             |
| Inverse diode direct current, pulsed     | $I_{SM}$ |                                     | -      | -    | 40   |               |
| Inverse diode forward voltage            | $V_{SD}$ | $V_{GS} = 0\text{V}, I_F = I_S$     | -      | 1    | 1.2  | V             |
| Reverse recovery time                    | $t_{rr}$ | $V_R = 350\text{V}, I_F = I_S$      | -      | 610  | -    | ns            |
| Reverse recovery charge                  | $Q_{rr}$ | $di_F/dt = 100\text{A}/\mu\text{s}$ | -      | 12   | -    | $\mu\text{C}$ |

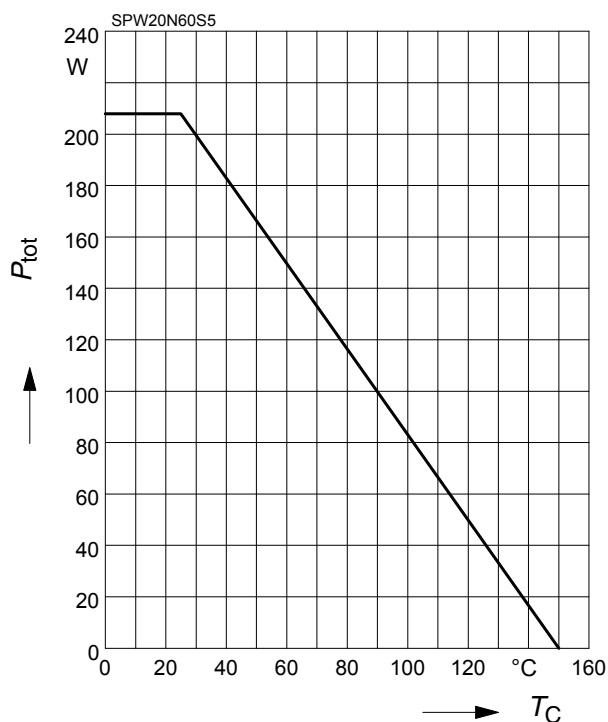
### Typical Transient Thermal Characteristics

| Symbol             | Value   | Unit | Symbol              | Value     | Unit |
|--------------------|---------|------|---------------------|-----------|------|
|                    | typ.    |      |                     | typ.      |      |
| Thermal resistance |         |      | Thermal capacitance |           |      |
| $R_{th1}$          | 0.00769 | K/W  | $C_{th1}$           | 0.0003763 | Ws/K |
| $R_{th2}$          | 0.015   |      | $C_{th2}$           | 0.001411  |      |
| $R_{th3}$          | 0.029   |      | $C_{th3}$           | 0.001931  |      |
| $R_{th4}$          | 0.114   |      | $C_{th4}$           | 0.005297  |      |
| $R_{th5}$          | 0.136   |      | $C_{th5}$           | 0.012     |      |
| $R_{th6}$          | 0.059   |      | $C_{th6}$           | 0.091     |      |



### 1 Power dissipation

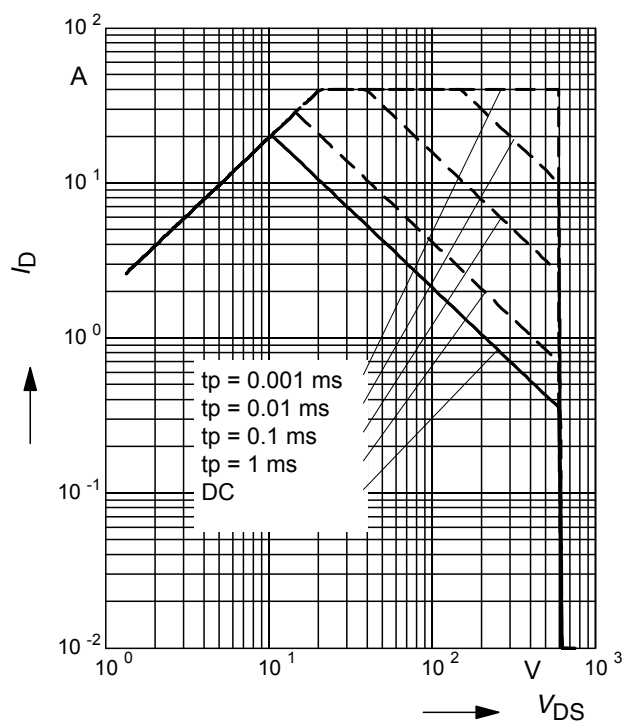
$$P_{\text{tot}} = f(T_C)$$



### 2 Safe operating area

$$I_D = f(V_{DS})$$

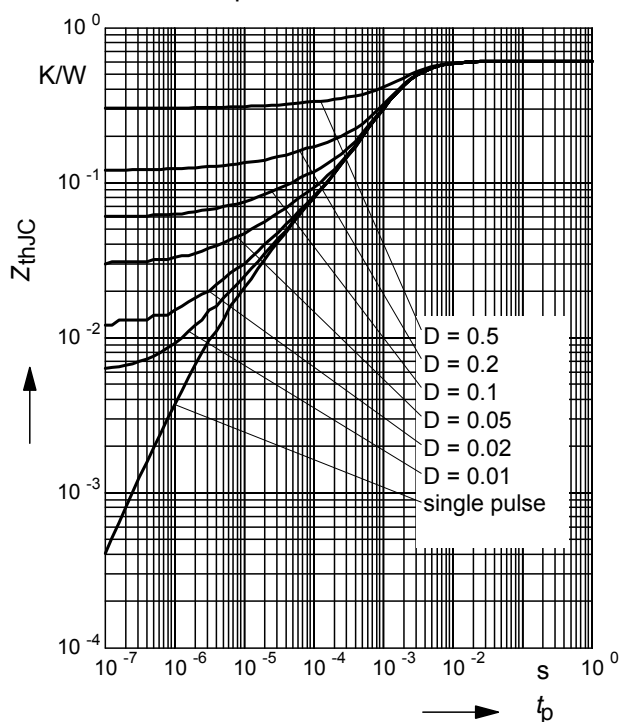
parameter :  $D = 0$  ,  $T_C = 25^\circ\text{C}$



### 3 Transient thermal impedance

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

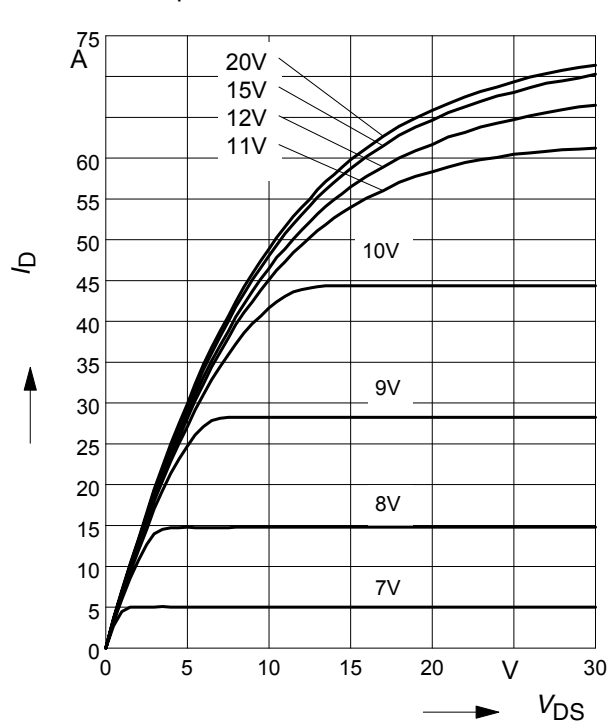
parameter:  $D = t_p/T$



### 4 Typ. output characteristic

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

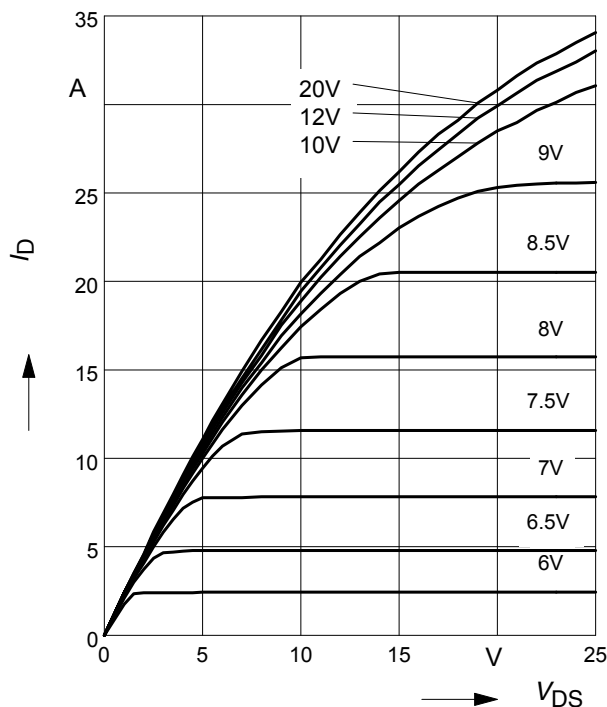
parameter:  $t_p = 10 \mu\text{s}$ ,  $V_{GS}$



### 5 Typ. output characteristic

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

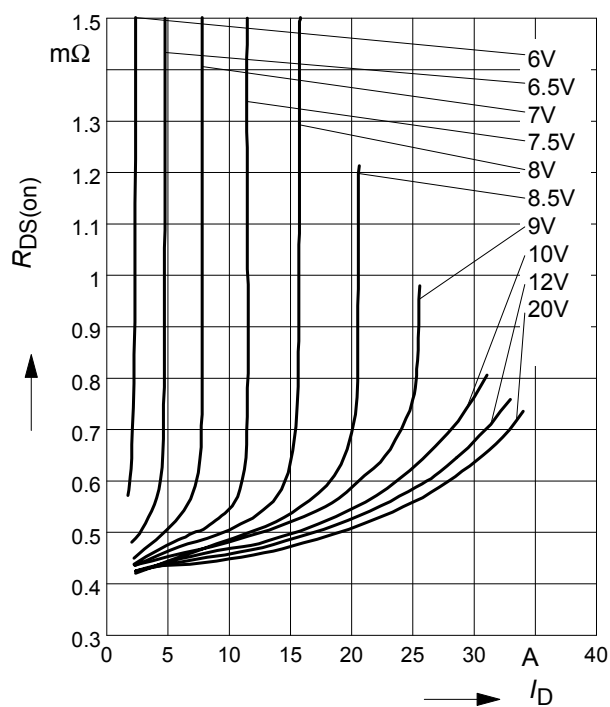
parameter:  $t_p = 10 \mu\text{s}$ ,  $V_{GS}$



### 6 Typ. drain-source on resistance

$$R_{DS(on)} = f(I_D)$$

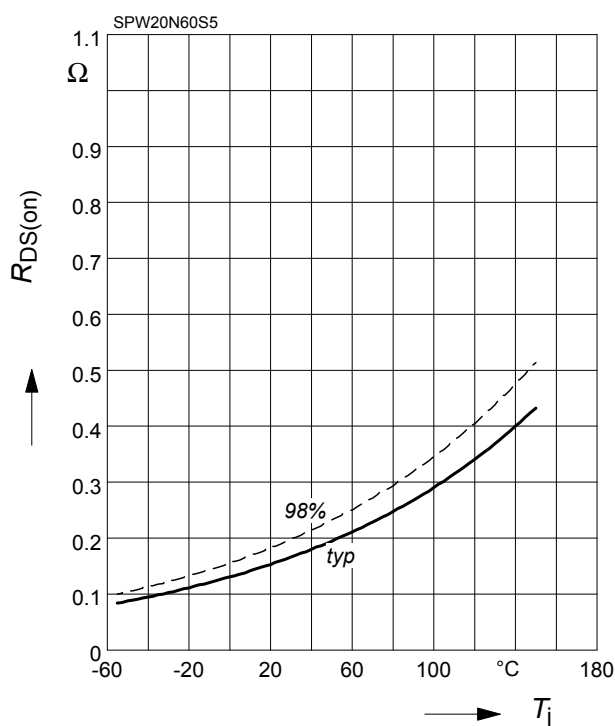
parameter:  $T_j = 150^\circ\text{C}$ ,  $V_{GS}$



### 7 Drain-source on-state resistance

$$R_{DS(on)} = f(T_j)$$

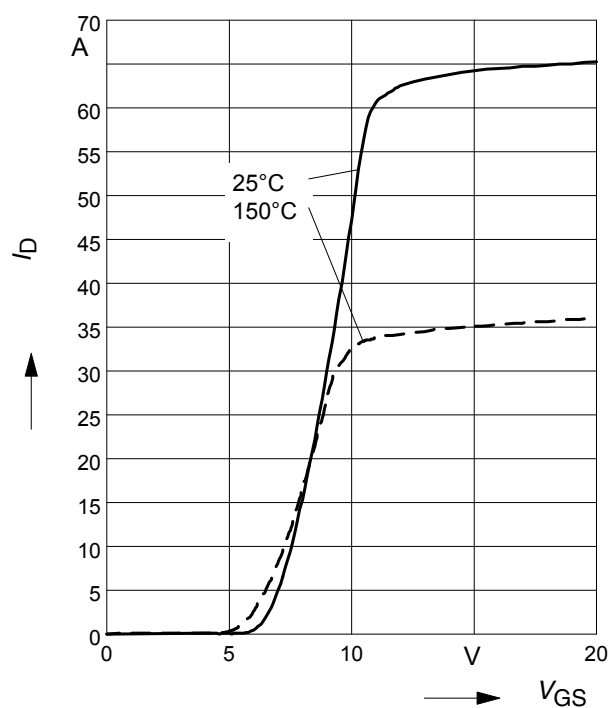
parameter:  $I_D = 13 \text{ A}$ ,  $V_{GS} = 10 \text{ V}$



### 8 Typ. transfer characteristics

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

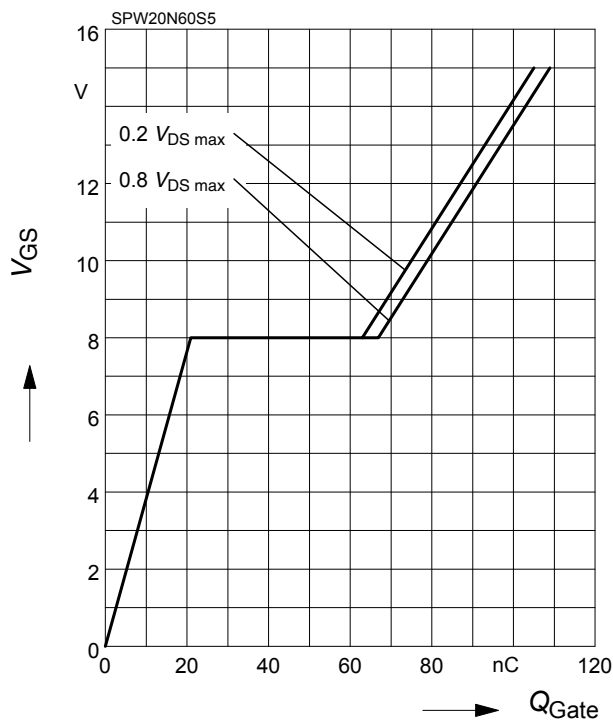
parameter:  $t_p = 10 \mu\text{s}$



## 9 Typ. gate charge

$$V_{GS} = f(Q_{Gate})$$

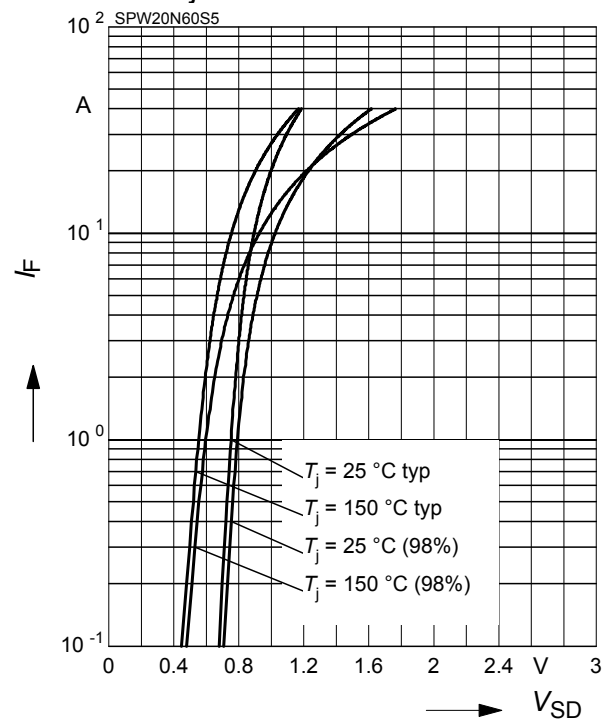
parameter:  $I_D = 20$  A pulsed



## 10 Forward characteristics of body diode

$$I_F = f(V_{SD})$$

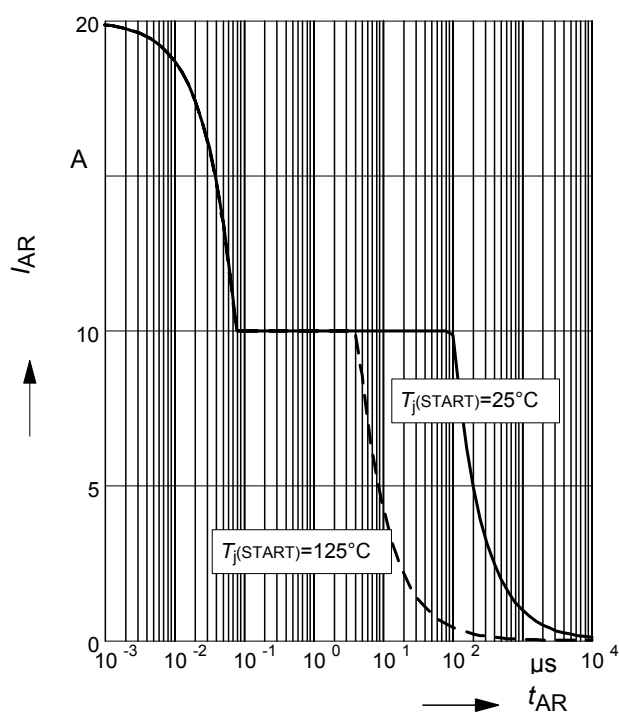
parameter:  $T_j$ ,  $t_p = 10$   $\mu$ s



## 11 Avalanche SOA

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

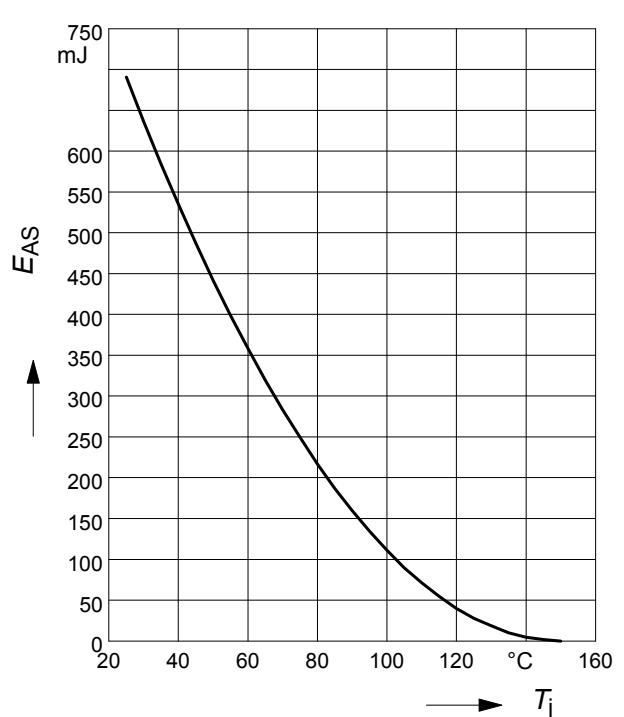
par.:  $T_j \leq 150$  °C



## 12 Avalanche energy

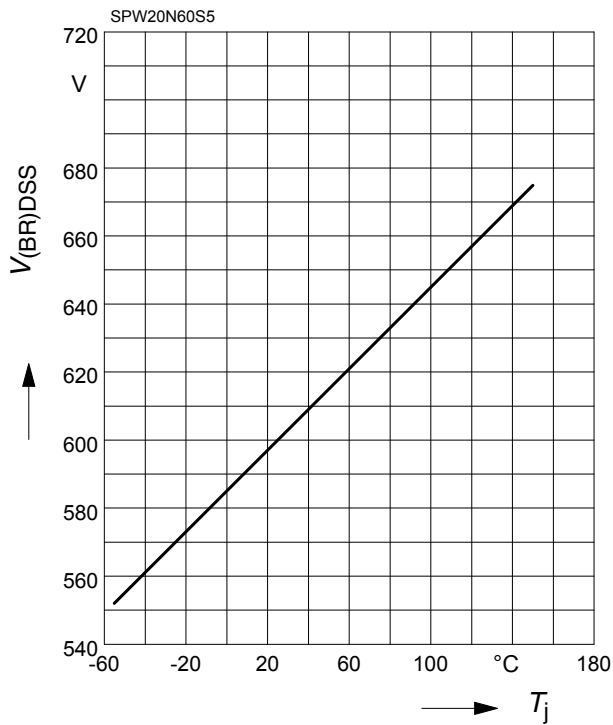
$$E_{AS} = f(T_j)$$

par.:  $I_D = 10$  A,  $V_{DD} = 50$  V



### 13 Drain-source breakdown voltage

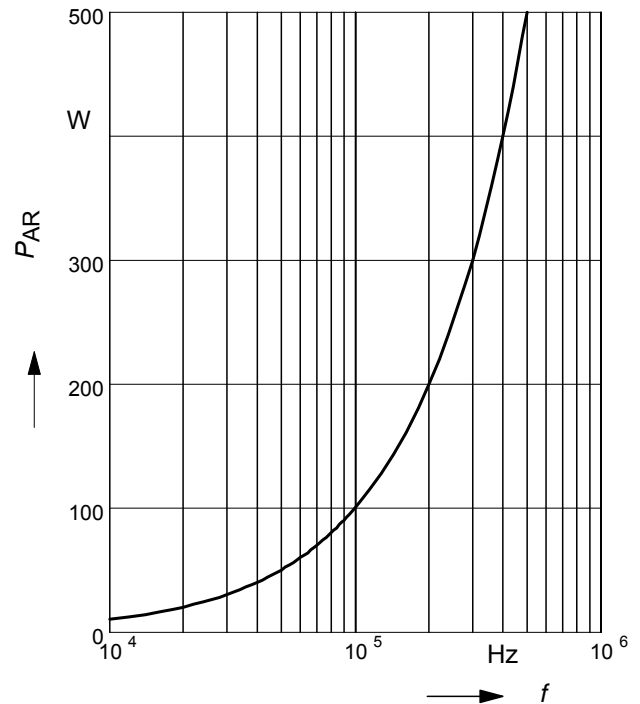
$$V_{(BR)DSS} = f(T_j)$$



### 14 Avalanche power losses

$$P_{AR} = f(f)$$

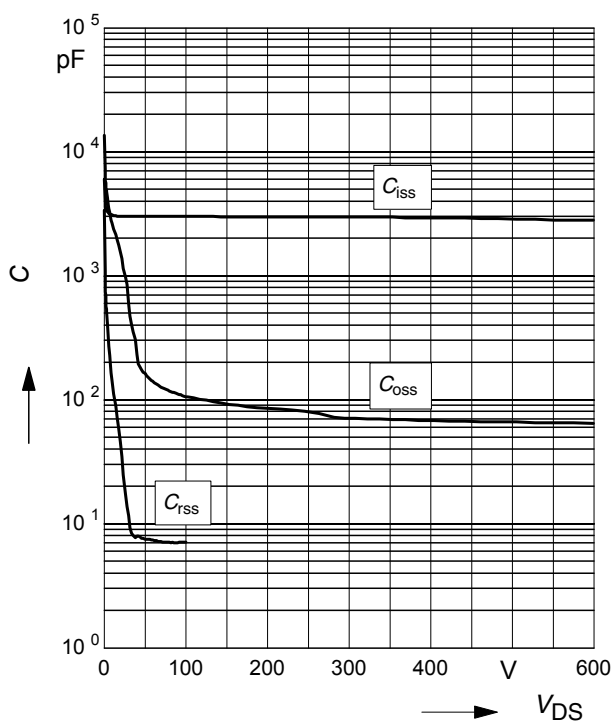
parameter:  $E_{AR}=1\text{mJ}$



### 15 Typ. capacitances

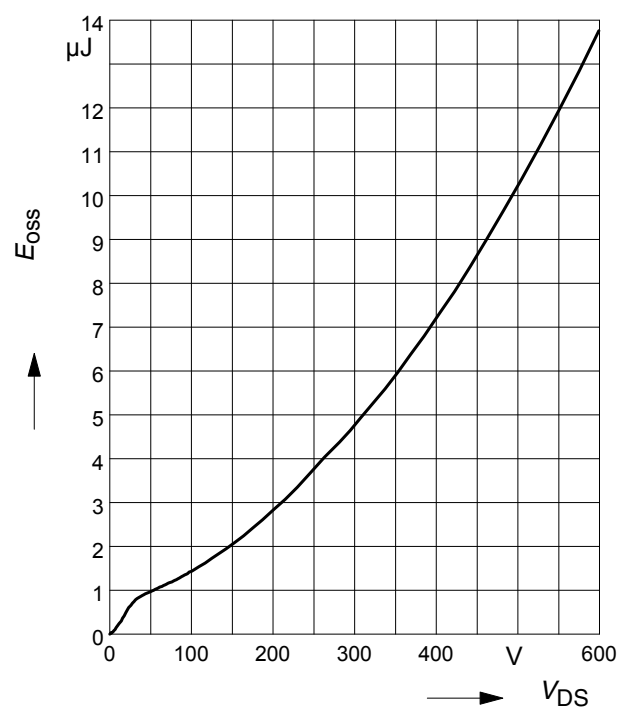
$$C = f(V_{DS})$$

parameter:  $V_{GS}=0\text{V}$ ,  $f=1\text{ MHz}$



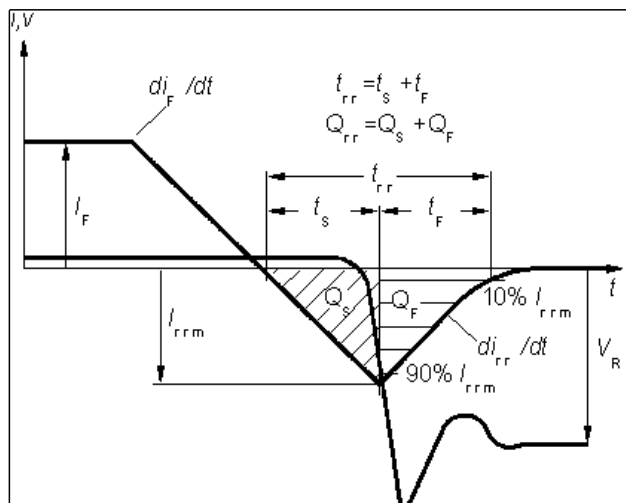
### 16 Typ. $C_{oss}$ stored energy

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

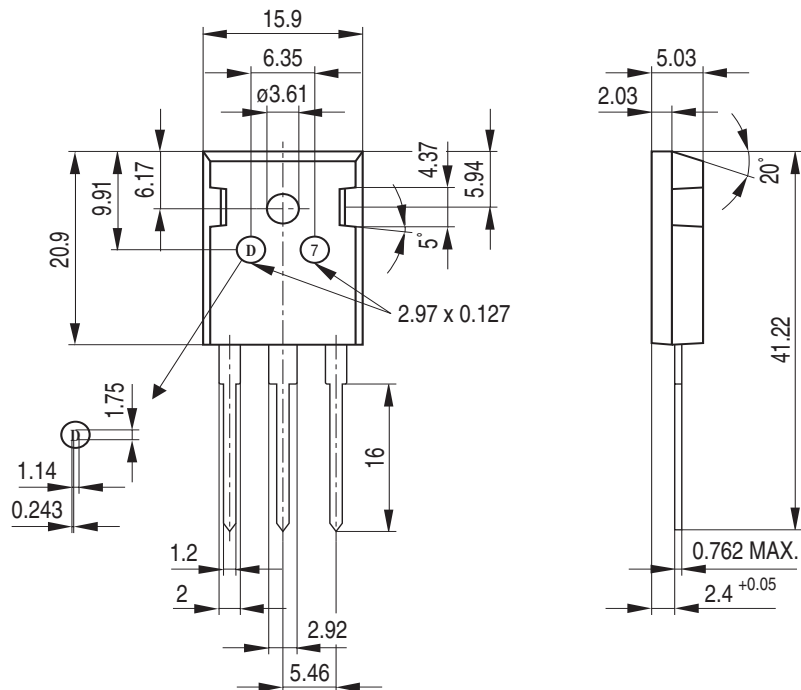




## Definition of diodes switching characteristics



P-TO-247-3-1



General tolerance unless otherwise specified: Leadframe parts:  $\pm 0.05$   
 Package parts:  $\pm 0.12$

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