

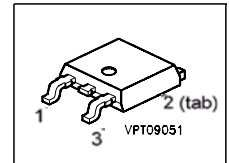
**Cool MOS™ Power Transistor**
**Feature**

- New revolutionary high voltage technology
- Ultra low gate charge
- Periodic avalanche rated
- Extreme dv/dt rated
- Ultra low effective capacitances
- Improved transconductance
- Pb-free lead plating; RoHS compliant; available in Halogen free mold compound<sup>a)</sup>
- Qualified according to JEDEC<sup>0)</sup> for target applications

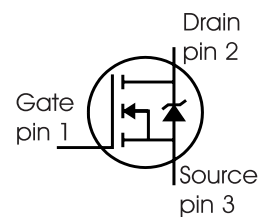
|                     |     |          |
|---------------------|-----|----------|
| $V_{DS} @ T_{jmax}$ | 560 | V        |
| $R_{DS(on)}$        | 1.4 | $\Omega$ |
| $I_D$               | 3.2 | A        |



PG-TO252



| Type       | Package  | Ordering Code | Marking |
|------------|----------|---------------|---------|
| SPD03N50C3 | PG-TO252 | Q67040-S4571  | 03N50C3 |


**Maximum Ratings**

| Parameter  | Symbol             | Value       | Unit               |
|--|--------------------|-------------|--------------------|
| Continuous drain current<br>$T_C = 25\text{ °C}$<br>$T_C = 100\text{ °C}$  | $I_D$              | 3.2<br>2    | A                  |
| Pulsed drain current, $t_p$ limited by $T_{jmax}$  | $I_D \text{ puls}$ | 9.6         |                    |
| Avalanche energy, single pulse<br>$I_D = 2.4\text{ A}$ , $V_{DD} = 50\text{ V}$  | $E_{AS}$           | 100         | mJ                 |
| Avalanche energy, repetitive $t_{AR}$ limited by $T_{jmax}$ <sup>1)</sup><br>$I_D = 3.2\text{ A}$ , $V_{DD} = 50\text{ V}$ | $E_{AR}$           | 0.2         |                    |
| Avalanche current, repetitive $t_{AR}$ limited by $T_{jmax}$   | $I_{AR}$           | 3.2         | A                  |
| Gate source voltage  | $V_{GS}$           | $\pm 20$    | V                  |
| Gate source voltage AC ( $f > 1\text{ Hz}$ )   | $V_{GS}$           | $\pm 30$    |                    |
| Power dissipation, $T_C = 25\text{ °C}$  | $P_{tot}$          | 38          | W                  |
| Operating and storage temperature  | $T_j, T_{stg}$     | -55... +150 | $^{\circ}\text{C}$ |
| Reverse diode dv/dt <sup>5)</sup>  | dv/dt              | 15          | V/ns               |

<sup>a)</sup> non-Halogen free (OPN: SPD03N50C3BT); Halogen free (OPN: SPD03N50C3AT)

**Maximum Ratings**

| Parameter   | Symbol  | Value | Unit |
|---|---------|-------|------|
| Drain Source voltage slope<br>$V_{DS} = 400 \text{ V}, I_D = 3.2 \text{ A}, T_j = 125 \text{ }^\circ\text{C}$ | $dv/dt$ | 50    | V/ns |

**Thermal Characteristics**

| Parameter   | Symbol     | Values |      |          | Unit |
|---|------------|--------|------|----------|------|
|   |            | min.   | typ. | max.     |      |
| Thermal resistance, junction - case   | $R_{thJC}$ | -      | -    | 3.3      | K/W  |
| Thermal resistance, junction - ambient, leaded  | $R_{thJA}$ | -      | -    | 75       |      |
| SMD version, device on PCB:<br>@ min. footprint<br>@ 6 cm <sup>2</sup> cooling area <sup>2)</sup> | $R_{thJA}$ | -      | -    | 75<br>50 |      |
| Soldering temperature, reflow soldering, MSL3<br>1.6 mm (0.063 in.) from case for 10s             | $T_{sold}$ | -      | -    | 260      | °C   |

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

| Parameter                                   | Symbol        | Conditions  | Values |             |          | Unit          |
|---|---------------|---|--------|-------------|----------|---------------|
|   |               |   | min.   | typ.        | max.     |               |
| Drain-source breakdown voltage              | $V_{(BR)DSS}$ | $V_{GS}=0\text{V}, I_D=0.25\text{mA}$   | 500    | -           | -        | V             |
| Drain-Source avalanche<br>breakdown voltage | $V_{(BR)DS}$  | $V_{GS}=0\text{V}, I_D=3.2\text{A}$   | -      | 600         | -        |               |
| Gate threshold voltage                      | $V_{GS(th)}$  | $I_D=135\mu\text{A}, V_{GS}=V_{DS}$   | 2.1    | 3           | 3.9      |               |
| Zero gate voltage drain current             | $I_{DSS}$     | $V_{DS}=500\text{V}, V_{GS}=0\text{V},$<br>$T_j=25^\circ\text{C},$<br>$T_j=150^\circ\text{C}$ | -<br>- | 0.1<br>-    | 1<br>100 | $\mu\text{A}$ |
| Gate-source leakage current                 | $I_{GSS}$     | $V_{GS}=20\text{V}, V_{DS}=0\text{V}$   | -      | -           | 100      |               |
| Drain-source on-state resistance            | $R_{DS(on)}$  | $V_{GS}=10\text{V}, I_D=2\text{A},$<br>$T_j=25^\circ\text{C}$<br>$T_j=150^\circ\text{C}$      | -<br>- | 1.25<br>3.4 | 1.4<br>- | $\Omega$      |
| Gate input resistance                       | $R_G$         | $f=1\text{MHz}, \text{open Drain}$  | -      | 15          | -        |               |

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

| Parameter   | Symbol       | Conditions   | Values |      |      | Unit |
|---|--------------|--|--------|------|------|------|
|   |              |  | min.   | typ. | max. |      |
| Transconductance  | $g_{fs}$     | $V_{DS} \geq 2 \cdot I_D \cdot R_{DS(on)max}$ ,<br>$I_D = 2\text{A}$                         | -      | 3.5  | -    | S    |
| Input capacitance   | $C_{iss}$    | $V_{GS} = 0\text{V}$ , $V_{DS} = 25\text{V}$ ,<br>$f = 1\text{MHz}$                          | -      | 350  | -    | pF   |
| Output capacitance  | $C_{oss}$    |  | -      | 150  | -    |      |
| Reverse transfer capacitance                                  | $C_{rss}$    |  | -      | 5    | -    |      |
| Effective output capacitance, <sup>3)</sup><br>energy related | $C_{o(er)}$  | $V_{GS} = 0\text{V}$ ,<br>$V_{DS} = 0\text{V to } 400\text{V}$                               | -      | 18   | -    | pF   |
| Effective output capacitance, <sup>4)</sup><br>time related   | $C_{o(tr)}$  |  | -      | 31   | -    |      |
| Turn-on delay time  | $t_{d(on)}$  | $V_{DD} = 350\text{V}$ , $V_{GS} = 0/10\text{V}$ ,<br>$I_D = 3.2\text{A}$ , $R_G = 20\Omega$ | -      | 10   | -    | ns   |
| Rise time   | $t_r$        |  | -      | 5    | -    |      |
| Turn-off delay time   | $t_{d(off)}$ |  | -      | 70   | -    |      |
| Fall time   | $t_f$        |  | -      | 15   | -    |      |

**Gate Charge Characteristics**

|                       |                 |  |   |    |   |    |
|-----------------------|-----------------|--|---|----|---|----|
| Gate to source charge | $Q_{gs}$        | $V_{DD} = 400\text{V}$ , $I_D = 3.2\text{A}$   | - | 2  | - | nC |
| Gate to drain charge  | $Q_{gd}$        |  | - | 8  | - |    |
| Gate charge total     | $Q_g$           | $V_{DD} = 400\text{V}$ , $I_D = 3.2\text{A}$ ,<br>$V_{GS} = 0\text{ to } 10\text{V}$ | - | 15 | - |    |
| Gate plateau voltage  | $V_{(plateau)}$ | $V_{DD} = 400\text{V}$ , $I_D = 3.2\text{A}$   | - | 5  | - | V  |

<sup>0</sup>J-STD20 and JESD22

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

<sup>2</sup>Device on 40mm\*40mm\*1.5mm epoxy PCB FR4 with 6cm<sup>2</sup> (one layer, 70 μm thick) copper area for drain connection. PCB is vertical without blown air.

<sup>3</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>4</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%  $V_{DSS}$ .

<sup>5</sup> $I_{SD} \leq I_D$ ,  $di/dt \leq 400\text{A/us}$ ,  $V_{DClink} = 400\text{V}$ ,  $V_{peak} < V_{BR, DSS}$ ,  $T_j < T_{j,max}$ .

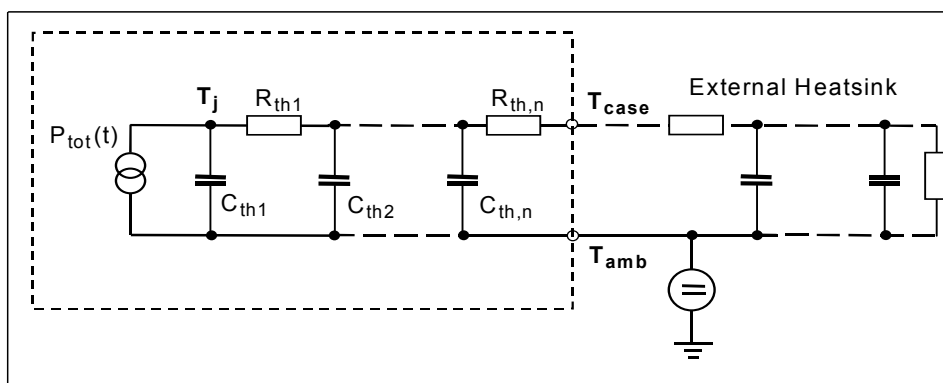
Identical low-side and high-side switch.

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

| Parameter                                     | Symbol       | Conditions                        | Values |      |      | Unit                   |
|---|--------------|-----------------------------------|--------|------|------|------------------------|
|   |              |                                   | min.   | typ. | max. |                        |
| Inverse diode continuous forward current      | $I_S$        | $T_C=25^\circ\text{C}$            | -      | -    | 3.2  | A                      |
| Inverse diode direct current, pulsed          | $I_{SM}$     |                                   | -      | -    | 9.6  |                        |
| Inverse diode forward voltage                 | $V_{SD}$     | $V_{GS}=0\text{V}, I_F=I_S$       | -      | 1    | 1.2  | V                      |
| Reverse recovery time                         | $t_{rr}$     | $V_R=400\text{V}, I_F=I_S,$       | -      | 240  | -    | ns                     |
| Reverse recovery charge                       | $Q_{rr}$     | $di_F/dt=100\text{A}/\mu\text{s}$ | -      | 1.6  | -    | $\mu\text{C}$          |
| Peak reverse recovery current                 | $I_{rrm}$    |                                   | -      | 12   | -    | A                      |
| Peak rate of fall of reverse recovery current | $di_{rr}/dt$ |                                   | -      | 550  | -    | $\text{A}/\mu\text{s}$ |

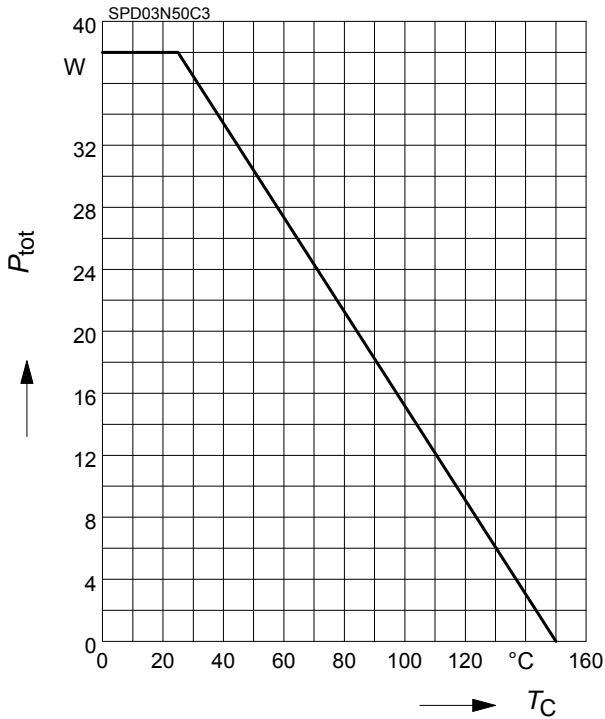
**Typical Transient Thermal Characteristics**

| Symbol             | Value | Unit | Symbol              | Value      | Unit |
|--------------------|-------|------|---------------------|------------|------|
|                    | typ.  |      |                     | typ.       |      |
| Thermal resistance |       |      | Thermal capacitance |            |      |
| $R_{th1}$          | 0.054 | K/W  | $C_{th1}$           | 0.00005232 | Ws/K |
| $R_{th2}$          | 0.103 |      | $C_{th2}$           | 0.0002034  |      |
| $R_{th3}$          | 0.178 |      | $C_{th3}$           | 0.0002963  |      |
| $R_{th4}$          | 0.757 |      | $C_{th4}$           | 0.0009103  |      |
| $R_{th5}$          | 0.682 |      | $C_{th5}$           | 0.002084   |      |
| $R_{th6}$          | 0.202 |      | $C_{th6}$           | 0.024      |      |



**1 Power dissipation**

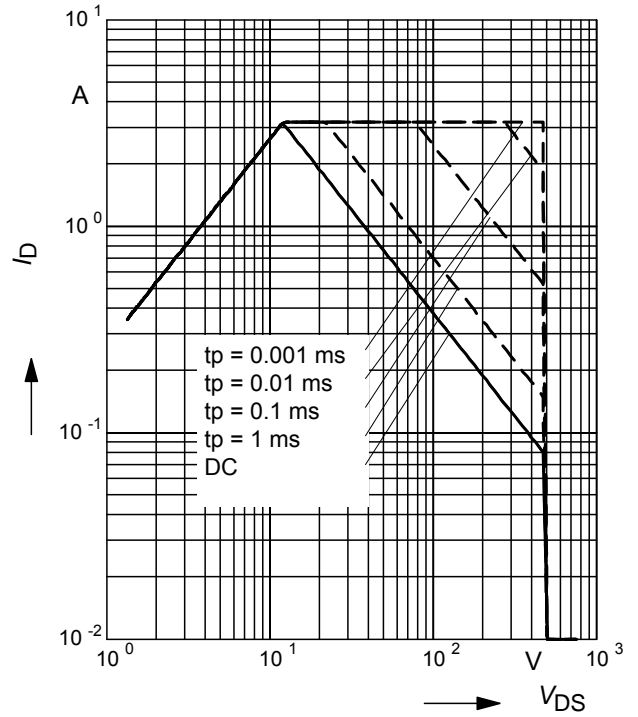
$P_{tot} = f(T_C)$



**2 Safe operating area**

$I_D = f(V_{DS})$

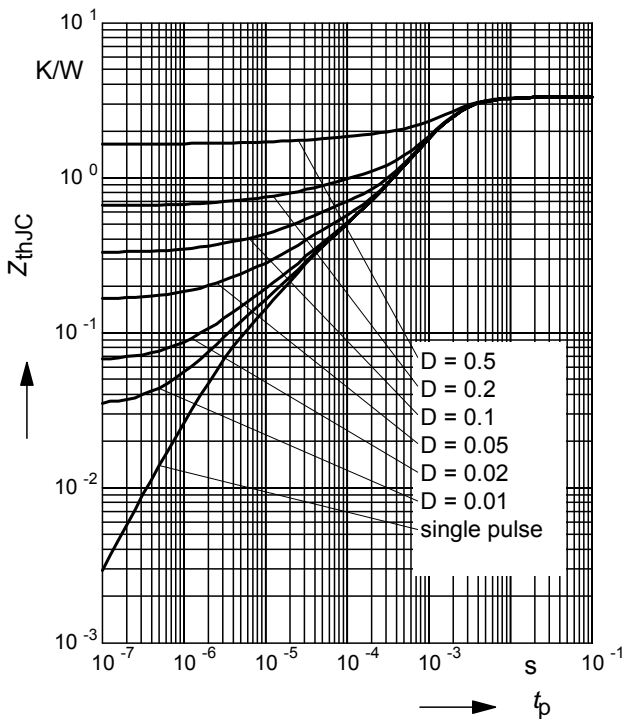
parameter :  $D = 0$  ,  $T_C = 25^\circ C$



**3 Transient thermal impedance**

$Z_{thJC} = f(t_p)$

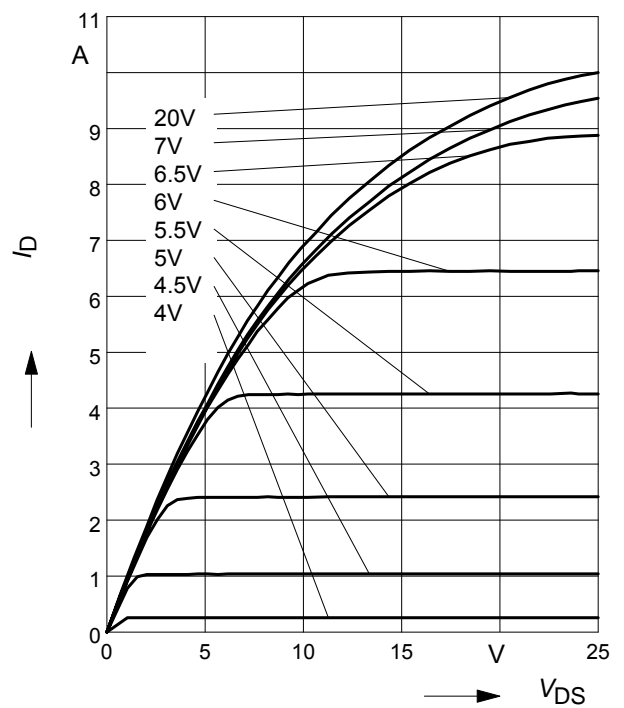
parameter:  $D = t_p/T$



**4 Typ. output characteristic**

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

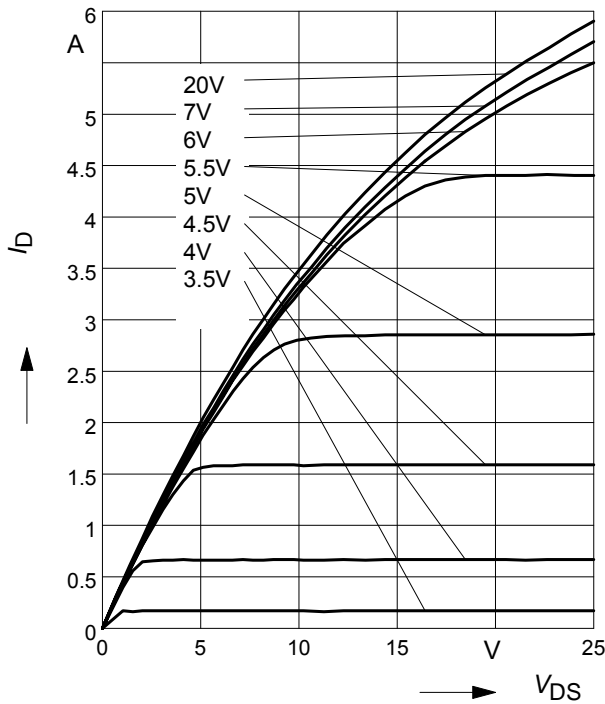
parameter:  $t_p = 10 \mu s$ ,  $V_{GS}$



**5 Typ. output characteristic**

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

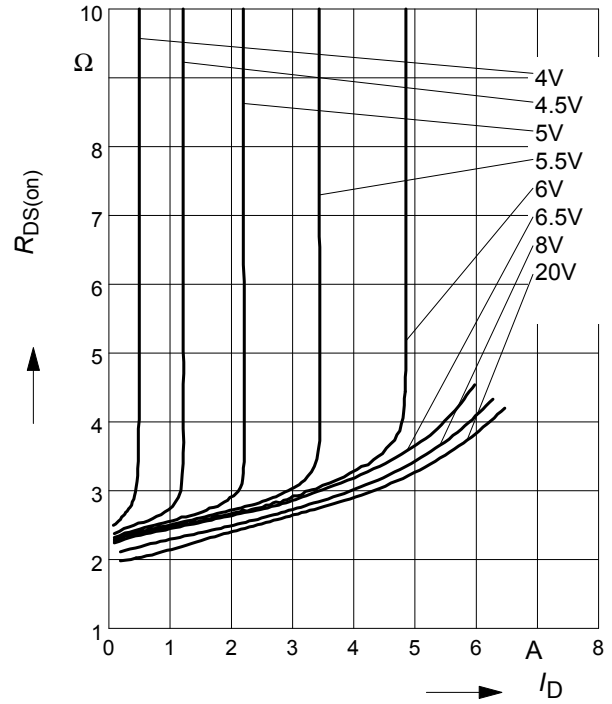
parameter:  $t_p = 10 \mu\text{s}, V_{GS}$



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

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

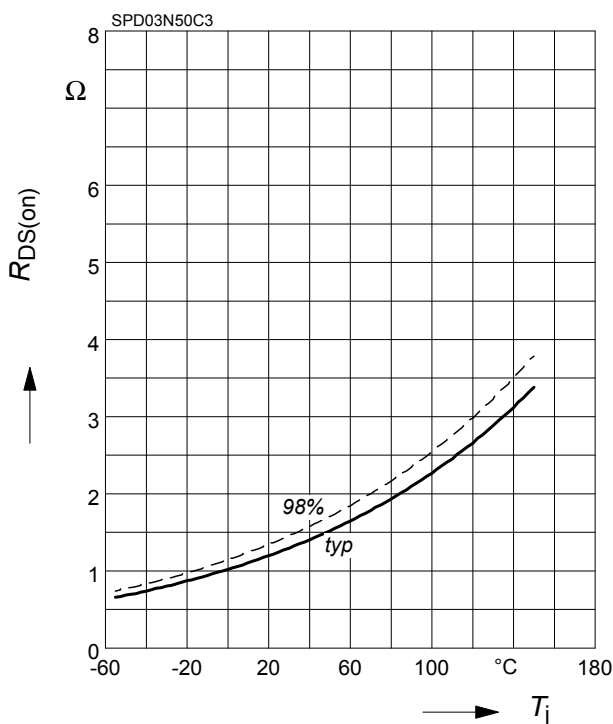
parameter:  $T_j = 150^\circ\text{C}, V_{GS}$



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

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

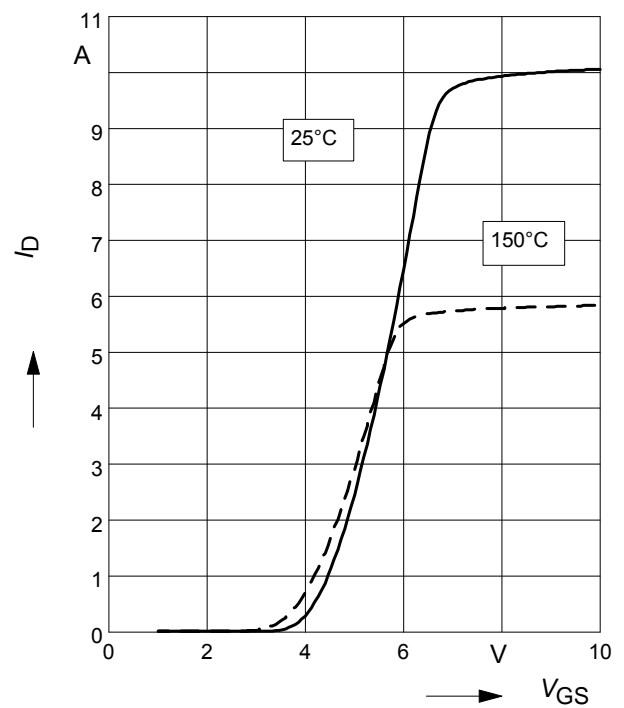
parameter:  $I_D = 2 \text{ A}, V_{GS} = 10 \text{ V}$



**8 Typ. transfer characteristics**

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

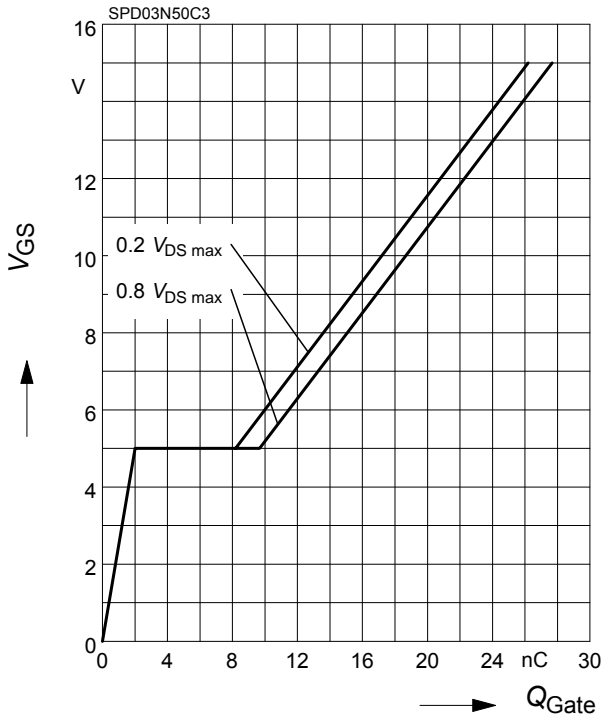
parameter:  $t_p = 10 \mu\text{s}$



**9 Typ. gate charge**

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

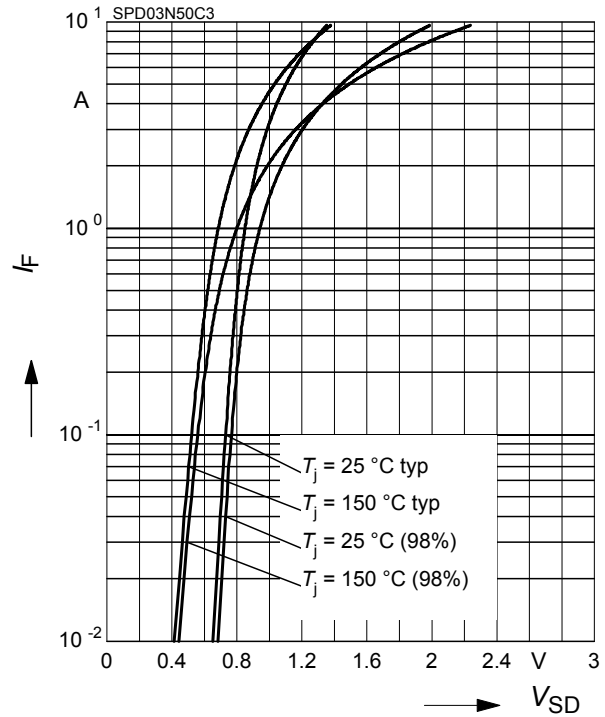
parameter:  $I_D = 3.2$  A pulsed



**10 Forward characteristics of body diode**

$I_F = f(V_{SD})$

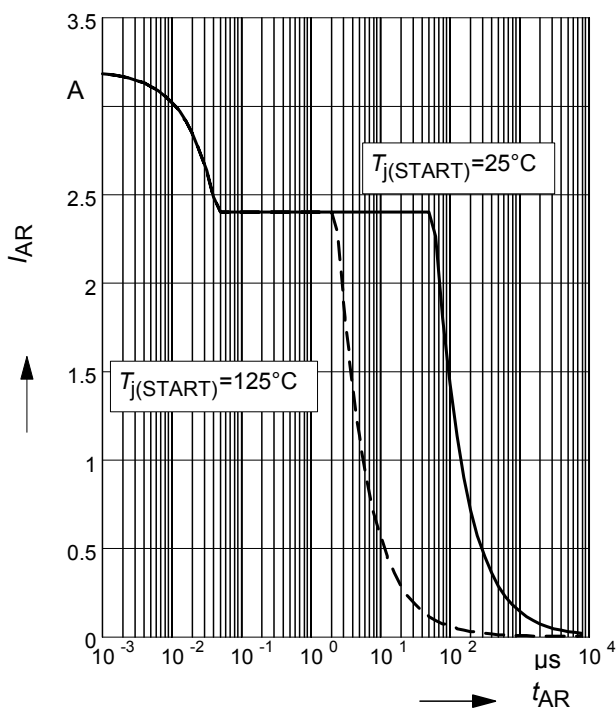
parameter:  $T_j, t_p = 10 \mu s$



**11 Avalanche SOA**

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

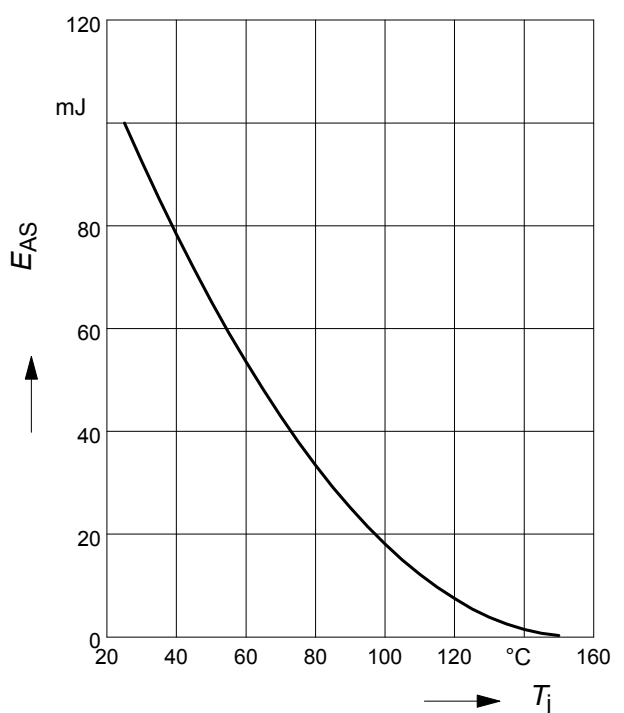
par.:  $T_j \leq 150 \text{ °C}$



**12 Avalanche energy**

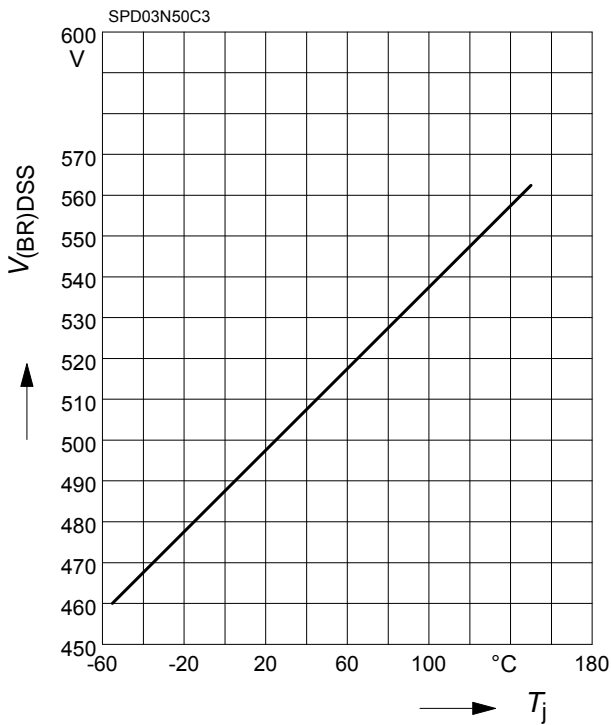
$E_{AS} = f(T_j)$

par.:  $I_D = 2.4$  A,  $V_{DD} = 50$  V



**13 Drain-source breakdown voltage**

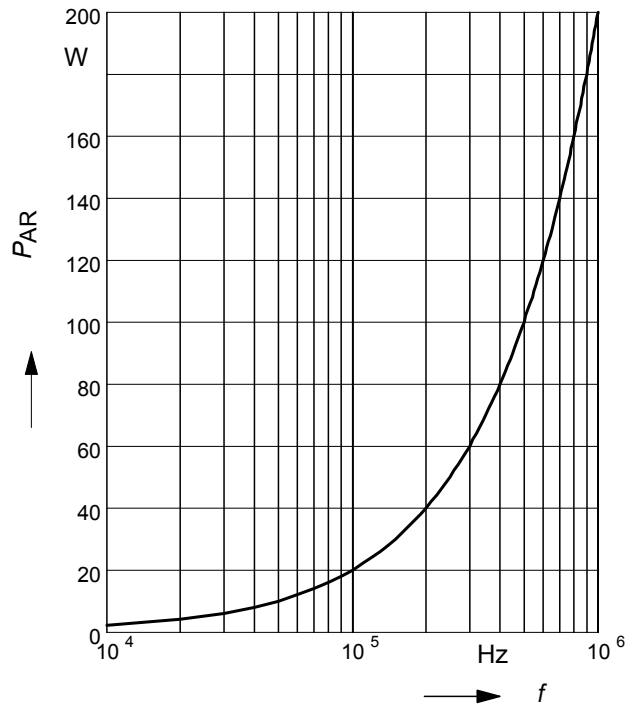
$$V_{(BR)DSS} = f(T_j)$$



**14 Avalanche power losses**

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

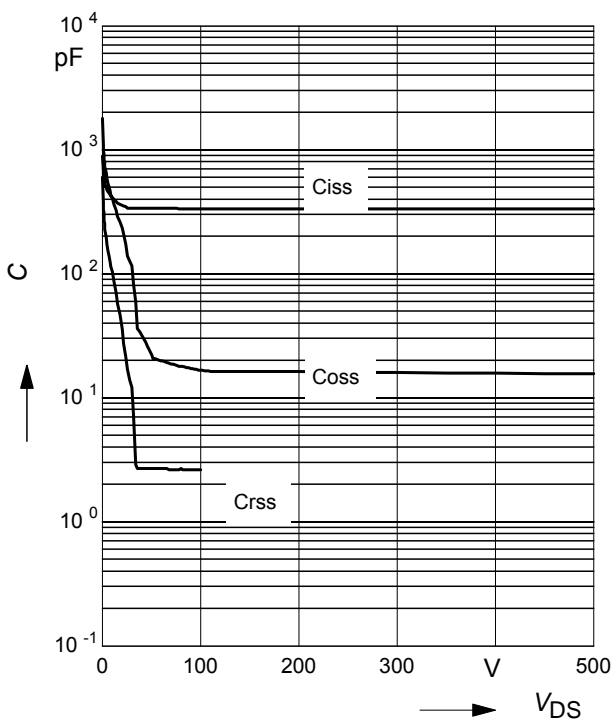
parameter:  $E_{AR}=0.2mJ$



**15 Typ. capacitances**

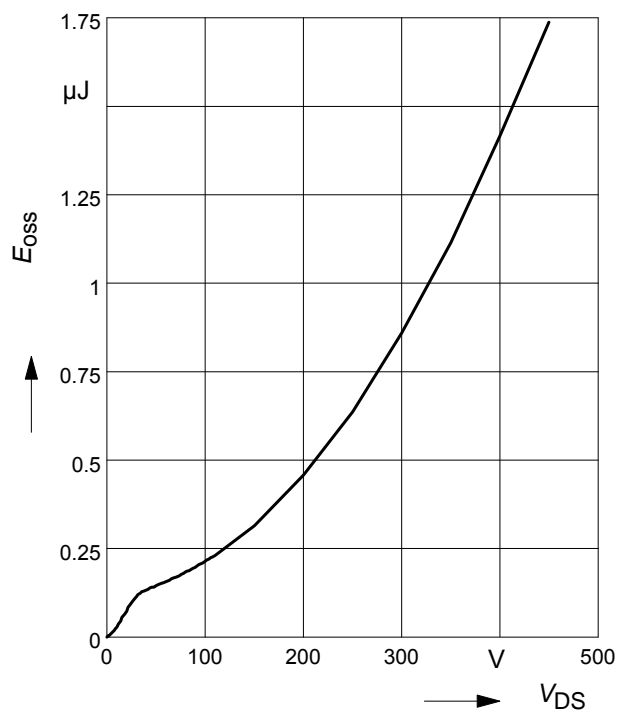
$$C = f(V_{DS})$$

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



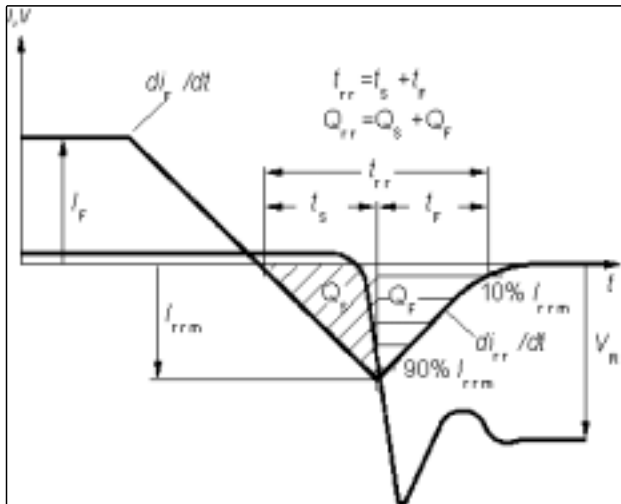
**16 Typ.  $C_{OSS}$  stored energy**

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

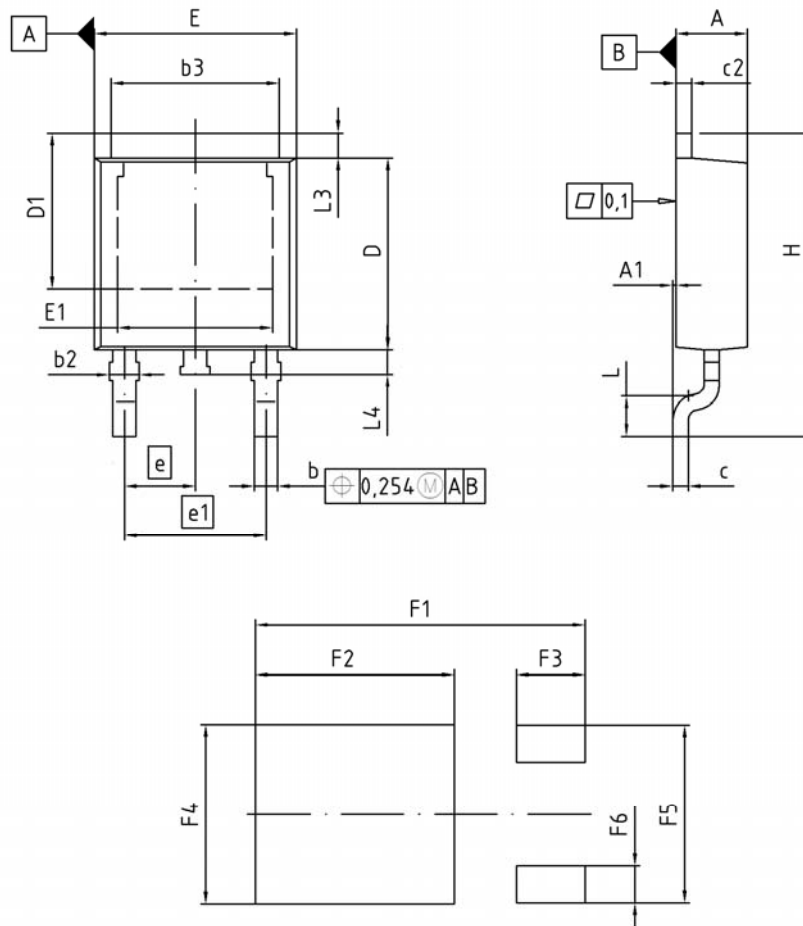




Definition of diodes switching characteristics



PG-TO252-3-1, PG-TO252-3-11, PG-TO252-3-21 (D-PAK)



| 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        | 5.21  | 0.185  | 0.205 |
| e   | 2.29        |       | 0.090  |       |
| e1  | 4.57        |       | 0.180  |       |
| 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  | 10.50       | 10.70 | 0.413  | 0.421 |
| F2  | 6.30        | 6.50  | 0.248  | 0.256 |
| F3  | 2.10        | 2.30  | 0.083  | 0.091 |
| F4  | 5.70        | 5.90  | 0.224  | 0.232 |
| F5  | 5.66        | 5.86  | 0.223  | 0.231 |
| F6  | 1.10        | 1.30  | 0.043  | 0.051 |

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