



**THE DATASHEET OF
SPW20N60S5**

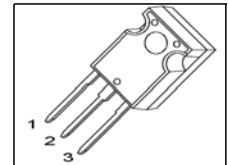


Cool MOS™ Power Transistor
Feature

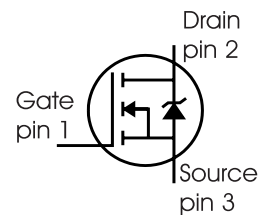
- New revolutionary high voltage technology
- Ultra low gate charge
- Periodic avalanche rated
- Extreme dv/dt rated
- Ultra low effective capacitances
- Improved transconductance
- Pb-free lead plating; RoHS compliant
- Qualified according to JEDEC⁰⁾ for target applications

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

PG-TO247



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


Maximum Ratings

| Parameter | Symbol | Value | Unit |
|--------------------------------------------------------------------------------------------------------------------------|---------------------|-------------|------------------|
| Continuous drain current $T_C = 25\text{ }^\circ\text{C}$ $T_C = 100\text{ }^\circ\text{C}$ | I_D | 20 13 | A |
| Pulsed drain current, t_p limited by T_{jmax} | $I_{D\text{ puls}}$ | 40 | |
| Avalanche energy, single pulse $I_D = 10\text{ A}$, $V_{DD} = 50\text{ V}$ | E_{AS} | 690 | mJ |
| Avalanche energy, repetitive t_{AR} limited by T_{jmax} ¹ $I_D = 20\text{ A}$, $V_{DD} = 50\text{ V}$ | E_{AR} | 1 | |
| Avalanche current, repetitive t_{AR} limited by T_{jmax} | I_{AR} | 20 | A |
| Gate source voltage | V_{GS} | ± 20 | V |
| Gate source voltage AC ($f > 1\text{ Hz}$) | V_{GS} | ± 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 $V_{DS} = 480 \text{ V}$, $I_D = 20 \text{ A}$, $T_j = 125 \text{ }^\circ\text{C}$ | 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, wavesoldering 1.6 mm (0.063 in.) from case for 10s | T_{sold} | - | - | 260 | $^\circ\text{C}$ |

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

| Parameter | Symbol | Conditions | Values | | | Unit |
|---------------------------------------------|---------------|----------------------------------------------------------------------------------------------------|--------|--------------|-----------|---------------|
| | | | min. | typ. | max. | |
| Drain-source breakdown voltage | $V_{(BR)DSS}$ | $V_{GS}=0\text{V}$, $I_D=0.25\text{mA}$ | 600 | - | - | V |
| Drain-Source avalanche breakdown voltage | $V_{(BR)DS}$ | $V_{GS}=0\text{V}$, $I_D=20\text{A}$ | - | 700 | - | |
| Gate threshold voltage | $V_{GS(th)}$ | $I_D=1000\mu\text{A}$, $V_{GS}=V_{DS}$ | 3.5 | 4.5 | 5.5 | |
| Zero gate voltage drain current | I_{DSS} | $V_{DS}=600\text{V}$, $V_{GS}=0\text{V}$, $T_j=25^\circ\text{C}$, $T_j=150^\circ\text{C}$ | - - | 0.5 - | 5 250 | μA |
| Gate-source leakage current | I_{GSS} | $V_{GS}=20\text{V}$, $V_{DS}=0\text{V}$ | - | - | 100 | nA |
| Drain-source on-state resistance | $R_{DS(on)}$ | $V_{GS}=10\text{V}$, $I_D=13\text{A}$, $T_j=25^\circ\text{C}$ $T_j=150^\circ\text{C}$ | - - | 0.16 0.43 | 0.19 - | Ω |
| 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} | $V_{DS} \geq 2 \cdot I_D \cdot R_{DS(on)max}$, $I_D = 13\text{A}$ | - | 12 | - | S |
| Input capacitance | C_{iss} | $V_{GS} = 0\text{V}$, $V_{DS} = 25\text{V}$, $f = 1\text{MHz}$ | - | 3000 | - | pF |
| Output capacitance | C_{oss} | | - | 1170 | - | |
| Reverse transfer capacitance | C_{rss} | | - | 28 | - | |
| Effective output capacitance, ²⁾ energy related | $C_{o(er)}$ | $V_{GS} = 0\text{V}$, $V_{DS} = 0\text{V to } 480\text{V}$ | - | 83 | - | pF |
| Effective output capacitance, ³⁾ time related | $C_{o(tr)}$ | | - | 160 | - | |
| Turn-on delay time | $t_{d(on)}$ | $V_{DD} = 350\text{V}$, $V_{GS} = 0/10\text{V}$, $I_D = 20\text{A}$, $R_G = 3.6\Omega$ | - | 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 | $V_{DD} = 350\text{V}$, $I_D = 20\text{A}$, $V_{GS} = 0\text{ to } 10\text{V}$ | - | 79 | 103 | |
| Gate plateau voltage | $V_{(plateau)}$ | $V_{DD} = 350\text{V}$, $I_D = 20\text{A}$ | - | 8 | - | V |

⁰J-STD20 and JESD22

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

² $C_{o(er)}$ is a fixed capacitance that gives the same stored energy as C_{oss} while V_{DS} is rising from 0 to 80% V_{DSS} .

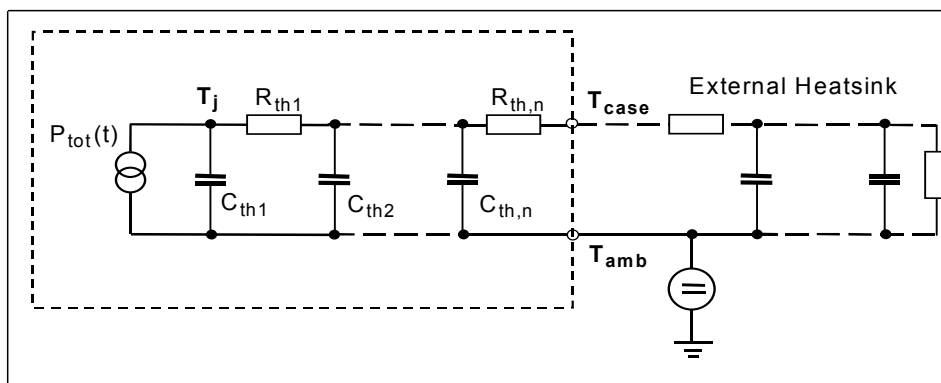
³ $C_{o(tr)}$ is a fixed capacitance that gives the same charging time as C_{oss} while V_{DS} is rising from 0 to 80% V_{DSS} .

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

| Parameter | Symbol | Conditions | Values | | | Unit |
|------------------------------------------|----------|-----------------------------------|--------|------|------|---------------|
| | | | min. | typ. | max. | |
| Inverse diode continuous forward current | I_S | $T_C=25^\circ\text{C}$ | - | - | 20 | A |
| | | | - | - | 40 | |
| 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 | - | μC |

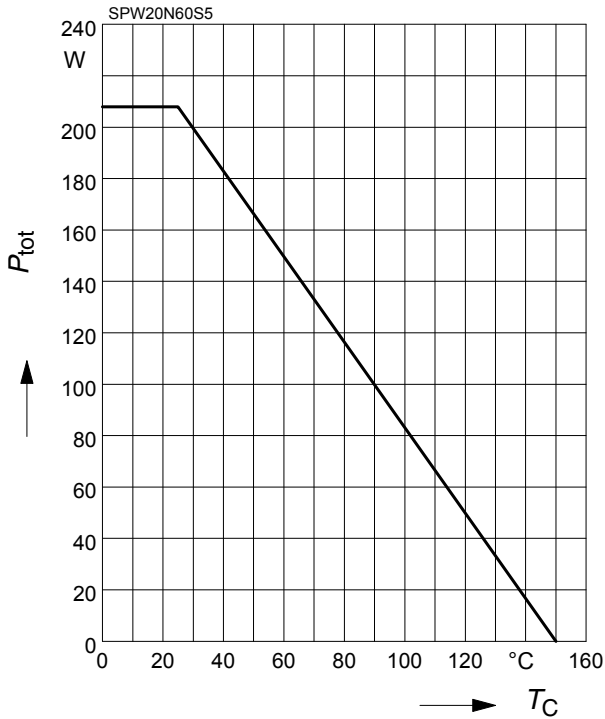
Typical Transient Thermal Characteristics

| 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

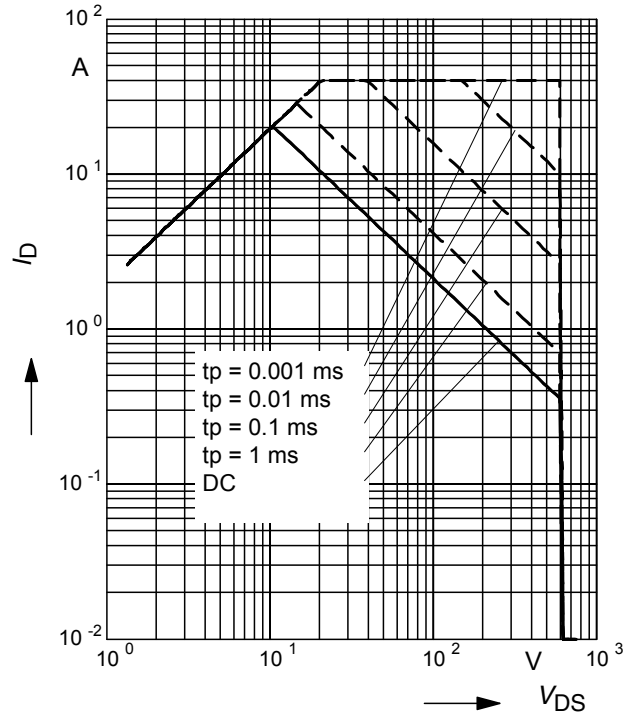
$$P_{tot} = f(T_C)$$



2 Safe operating area

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

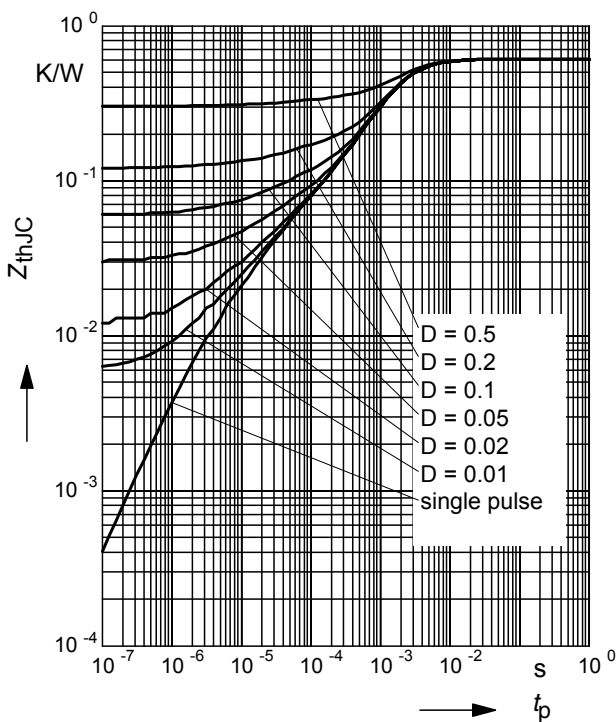
parameter : $D = 0$, $T_C = 25^\circ C$



3 Transient thermal impedance

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

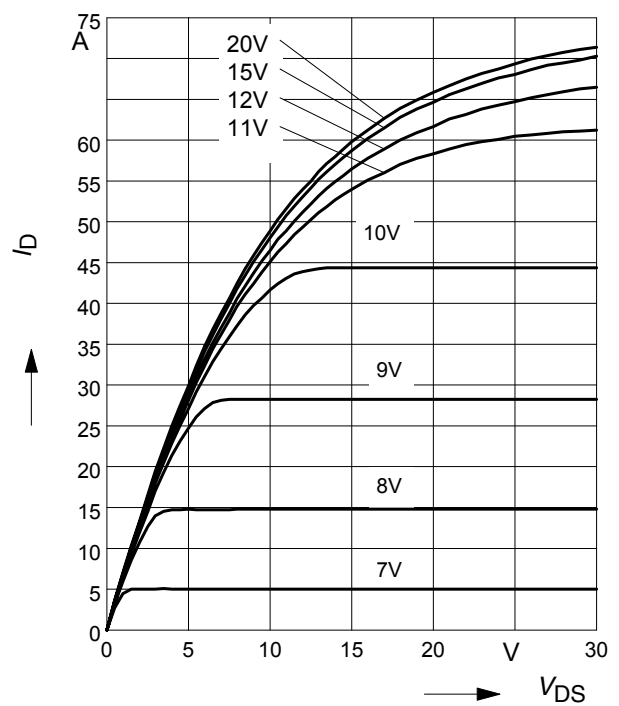
parameter: $D = t_p/T$



4 Typ. output characteristic

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

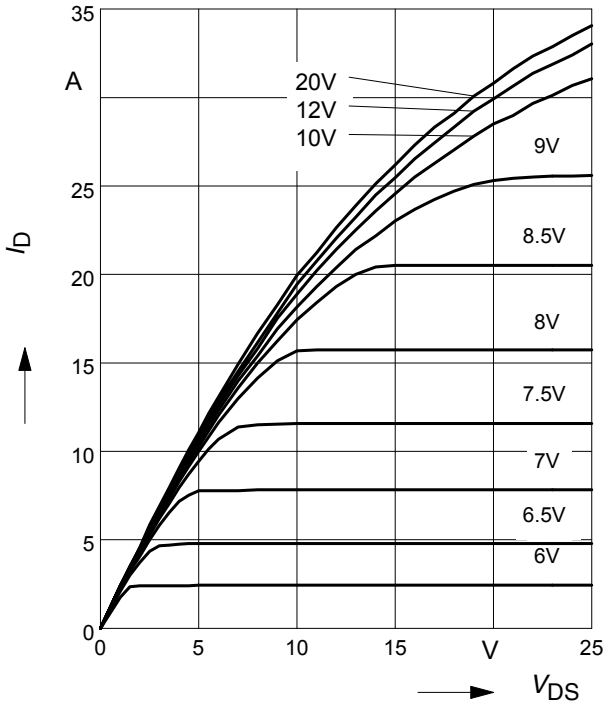
parameter: $t_p = 10 \mu s$, V_{GS}



5 Typ. output characteristic

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

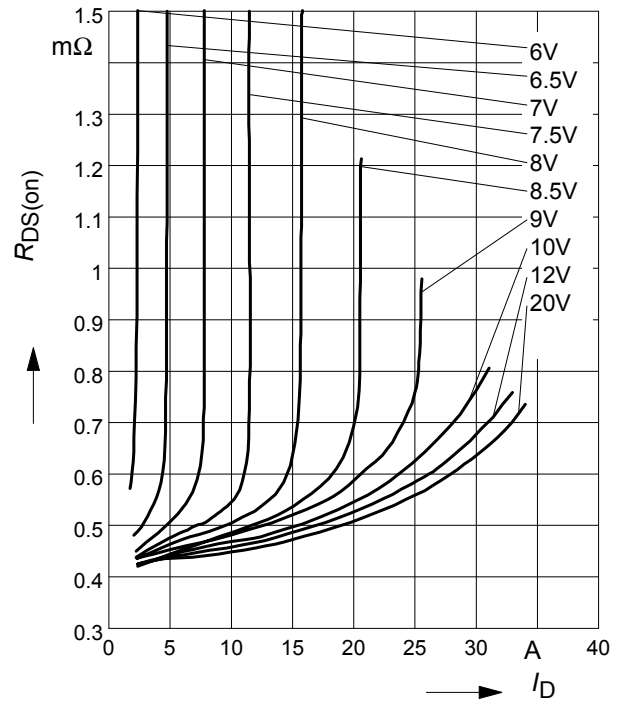
parameter: $t_p = 10 \mu\text{s}, V_{GS}$



6 Typ. drain-source on resistance

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

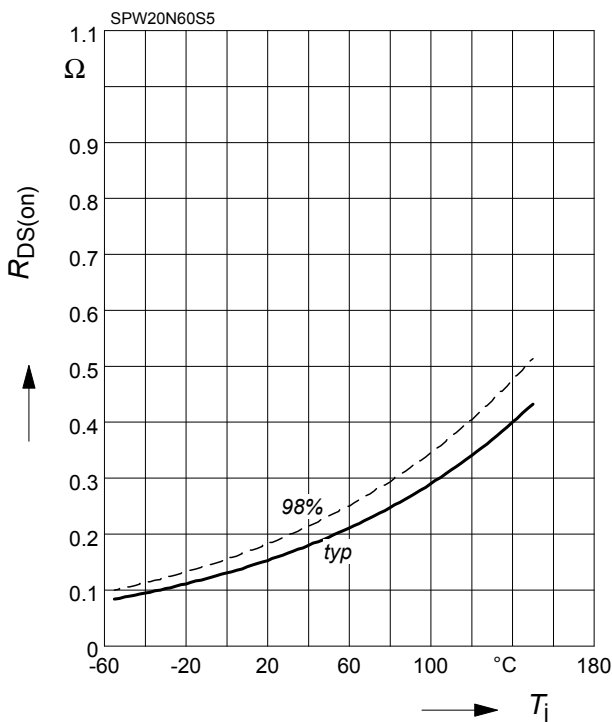
parameter: $T_j = 150^\circ\text{C}, V_{GS}$



7 Drain-source on-state resistance

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

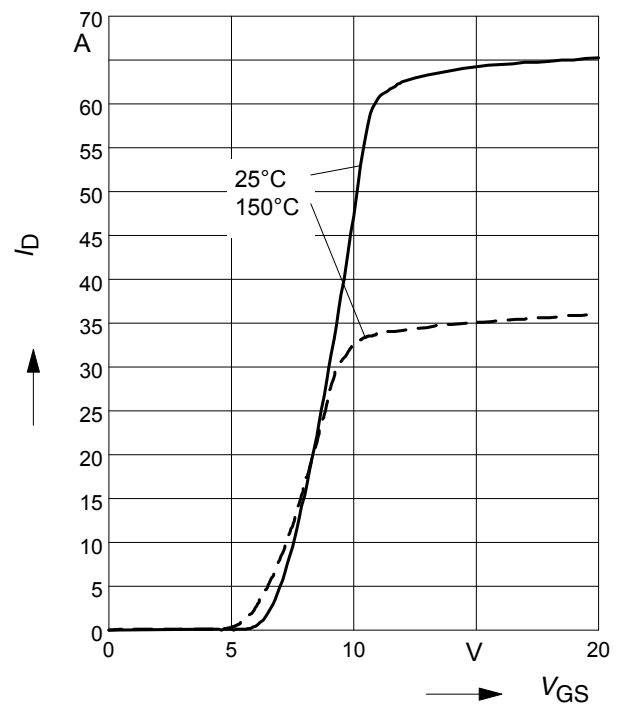
parameter: $I_D = 13 \text{ A}, V_{GS} = 10 \text{ V}$



8 Typ. transfer characteristics

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

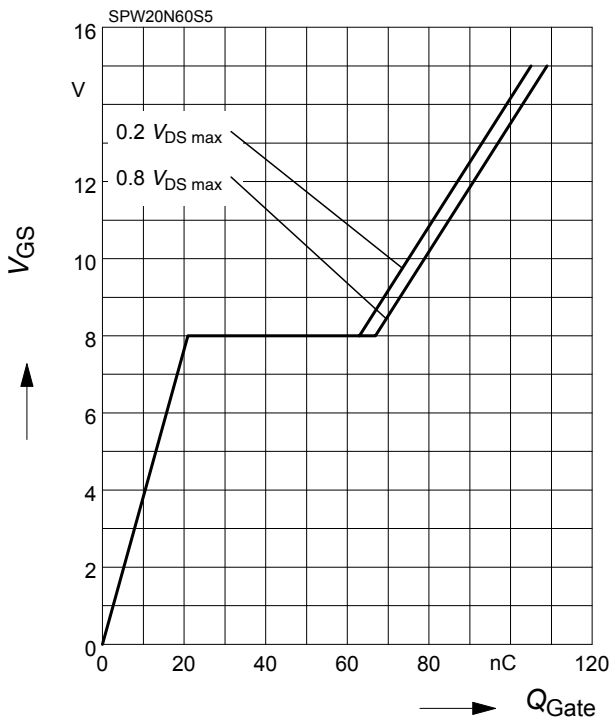
parameter: $t_p = 10 \mu\text{s}$



9 Typ. gate charge

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

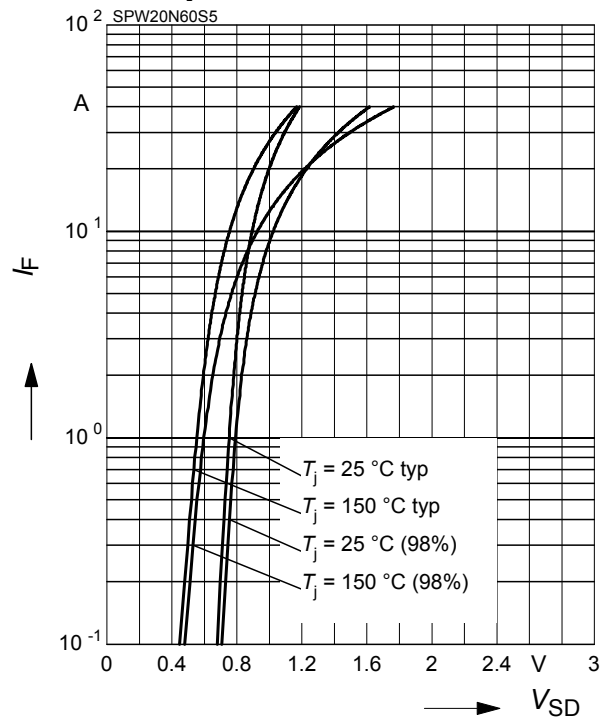
parameter: $I_D = 20$ A pulsed



10 Forward characteristics of body diode

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

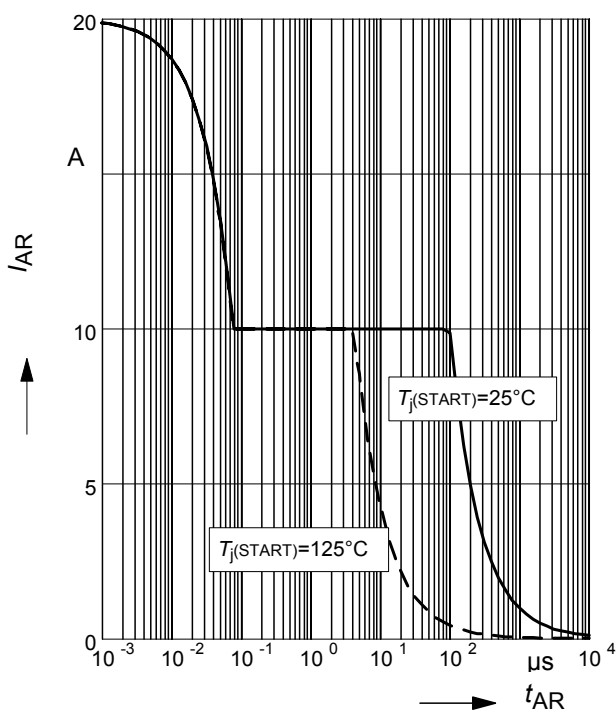
parameter: T_j , $t_p = 10$ μ s



11 Avalanche SOA

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

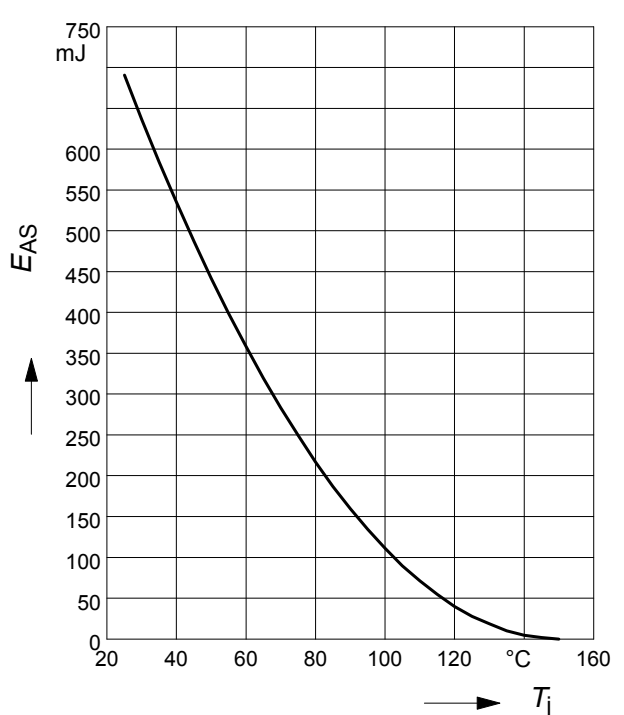
par.: $T_j \leq 150$ °C



12 Avalanche energy

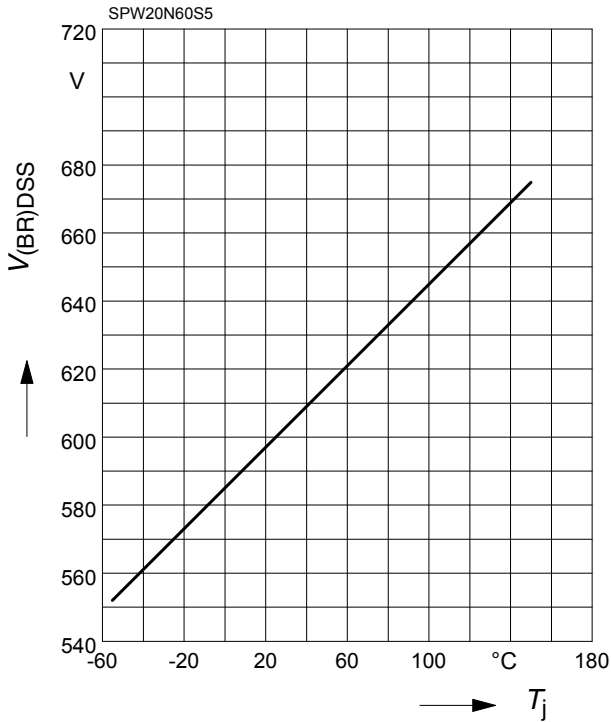
$$E_{AS} = f(T_j)$$

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



13 Drain-source breakdown voltage

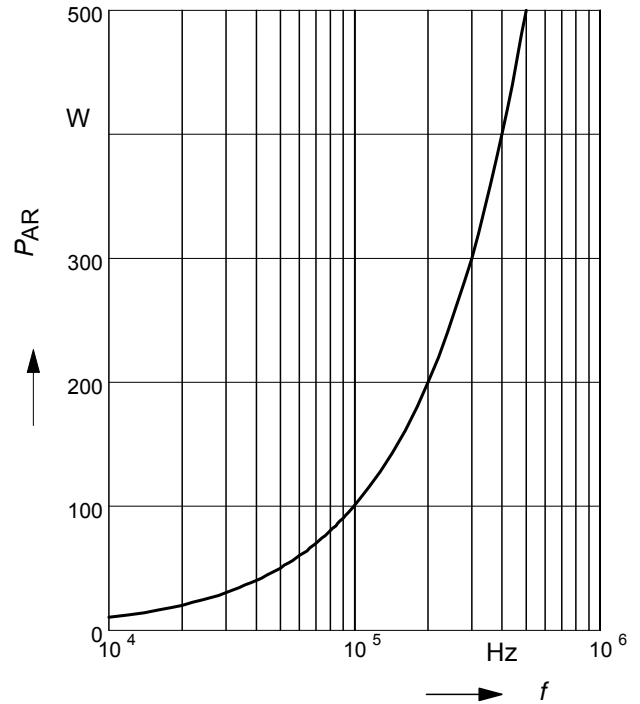
$$V_{(BR)DSS} = f(T_j)$$



14 Avalanche power losses

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

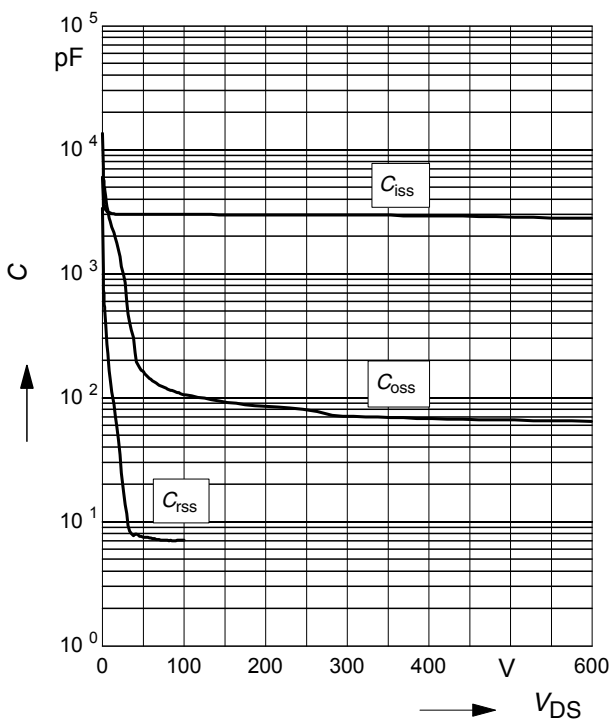
parameter: $E_{AR}=1mJ$



15 Typ. capacitances

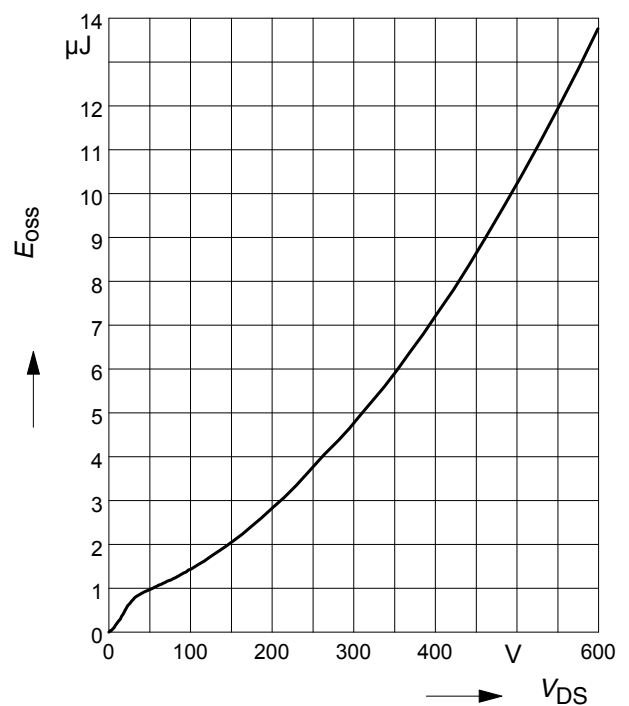
$$C = f(V_{DS})$$

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

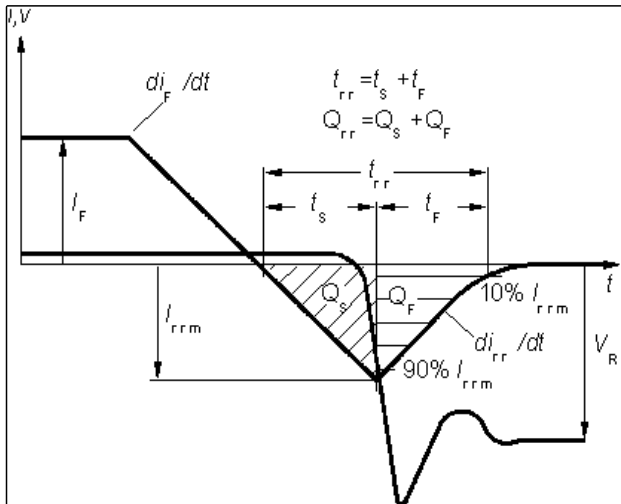


16 Typ. C_{OSS} stored energy

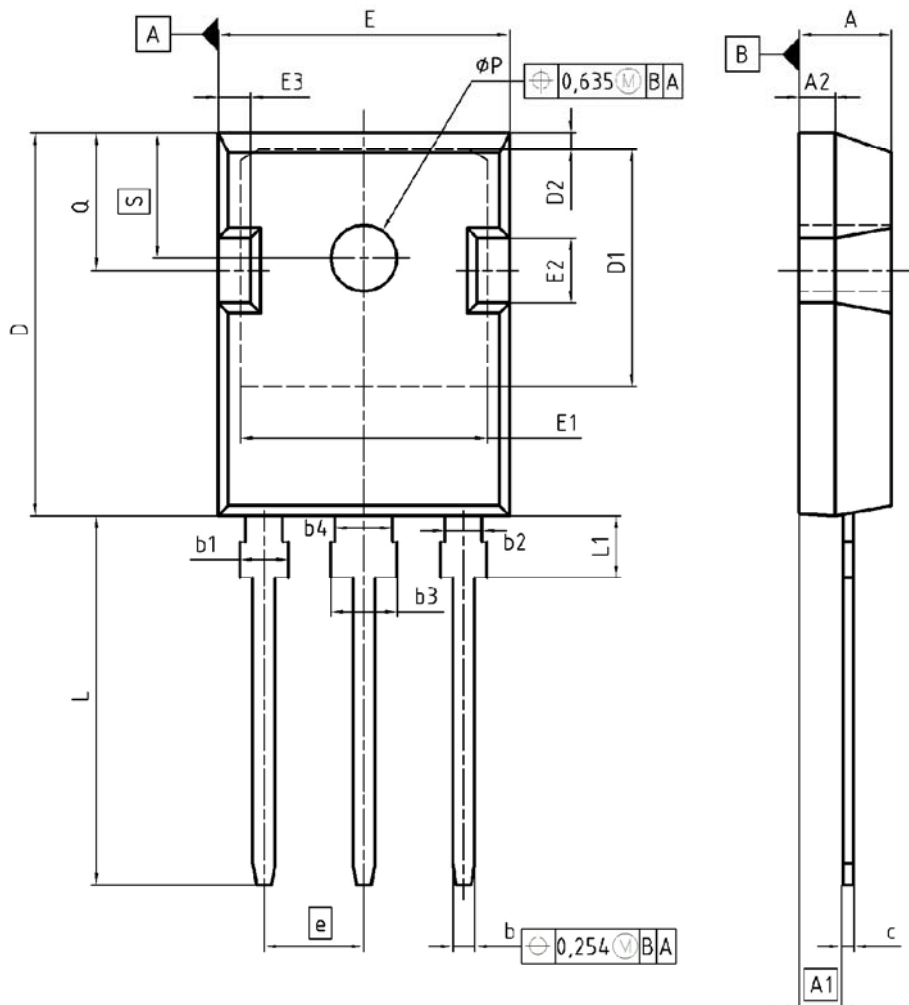
$$E_{OSS} = f(V_{DS})$$



Definition of diodes switching characteristics



PG-TO-247-3-1



| DIM | MILLIMETERS | | INCHES | |
|-----|-------------|-------|--------|-------|
| | MIN | MAX | MIN | MAX |
| A | 4.90 | 5.16 | 0.193 | 0.203 |
| A1 | 2.27 | 2.53 | 0.089 | 0.099 |
| A2 | 1.85 | 2.11 | 0.073 | 0.083 |
| b | 1.07 | 1.33 | 0.042 | 0.052 |
| b1 | 1.90 | 2.41 | 0.075 | 0.095 |
| b2 | 1.90 | 2.16 | 0.075 | 0.085 |
| b3 | 2.87 | 3.38 | 0.113 | 0.133 |
| b4 | 2.87 | 3.13 | 0.113 | 0.123 |
| c | 0.55 | 0.68 | 0.022 | 0.027 |
| D | 20.82 | 21.10 | 0.820 | 0.831 |
| D1 | 16.25 | 17.65 | 0.640 | 0.695 |
| D2 | 1.05 | 1.35 | 0.041 | 0.053 |
| E | 15.70 | 16.03 | 0.618 | 0.631 |
| E1 | 13.10 | 14.15 | 0.516 | 0.557 |
| E2 | 3.68 | 5.10 | 0.145 | 0.201 |
| E3 | 1.68 | 2.60 | 0.066 | 0.102 |
| e | 5.44 | | 0.214 | |
| N | 3 | | 3 | |
| L | 19.80 | 20.31 | 0.780 | 0.799 |
| L1 | 4.17 | 4.47 | 0.164 | 0.176 |
| φP | 3.50 | 3.70 | 0.138 | 0.146 |
| Q | 5.49 | 6.00 | 0.216 | 0.236 |
| S | 6.04 | 6.30 | 0.238 | 0.248 |

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SCALE

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1 New package outlines TO-247

Assembly capacity extension for CoolMOSTM technology products assembled in lead-free package PG-TO247-3 at subcontractor ASE (Weihai) Inc., China (Changes are marked in blue.)

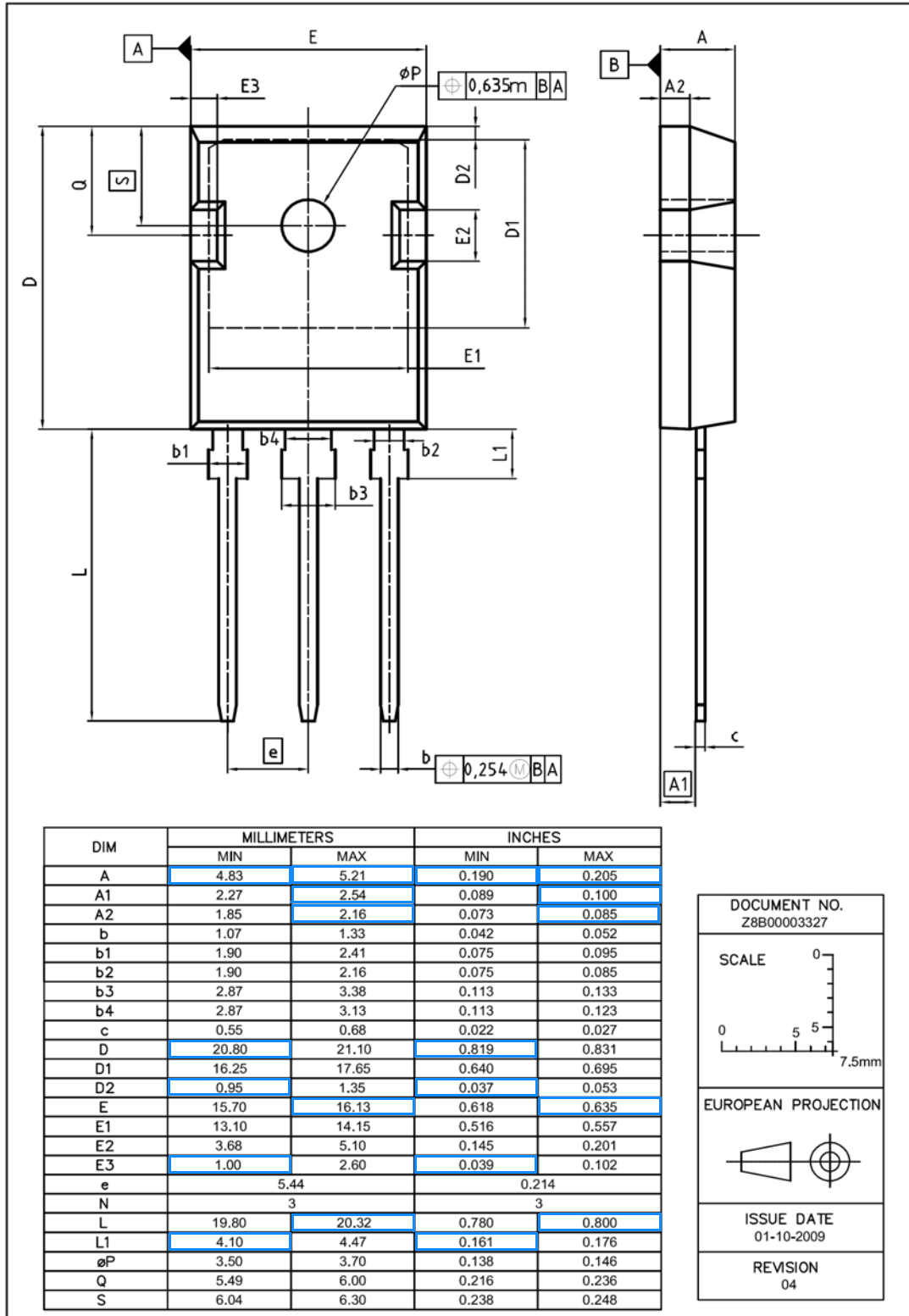


Figure 1 Outlines TO-247, dimensions in mm/inches

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