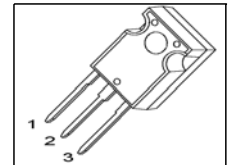


Cool MOS™ Power Transistor
Feature

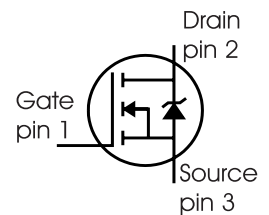
- New revolutionary high voltage technology
- Ultra low gate charge
- Periodic avalanche rated
- Extreme dv/dt rated
- Ultra low effective capacitances
- Improved transconductance
- Pb-free lead plating; RoHS compliant
- Qualified according to JEDEC⁰⁾ for target applications

| | | |
|---------------------|------|----------|
| $V_{DS} @ T_{jmax}$ | 650 | V |
| $R_{DS(on)}$ | 0.16 | Ω |
| I_D | 24.3 | A |

PG-TO247



| Type | Package | Ordering Code | Marking |
|------------|----------|---------------|---------|
| SPW24N60C3 | PG-TO247 | Q67040-S4640 | 24N60C3 |


Maximum Ratings

| Parameter | Symbol | Value | Unit |
|---|---------------------|--------------|------|
| Continuous drain current $T_C = 25\text{ °C}$ $T_C = 100\text{ °C}$ | I_D | 24.3 15.4 | A |
| Pulsed drain current, t_p limited by T_{jmax} | $I_{D\text{ puls}}$ | 72.9 | |
| Avalanche energy, single pulse $I_D = 10\text{ A}$, $V_{DD} = 50\text{ V}$ | E_{AS} | 780 | mJ |
| Avalanche energy, repetitive t_{AR} limited by T_{jmax} ¹⁾ $I_D = 24.3\text{ A}$, $V_{DD} = 50\text{ V}$ | E_{AR} | 1 | |
| Avalanche current, repetitive t_{AR} limited by T_{jmax} | I_{AR} | 24.3 | A |
| Gate source voltage static | V_{GS} | ± 20 | V |
| Gate source voltage AC ($f > 1\text{ Hz}$) | V_{GS} | ± 30 | |
| Power dissipation, $T_C = 25\text{ °C}$ | P_{tot} | 240 | W |
| Operating and storage temperature | T_j, T_{stg} | -55... +150 | °C |
| Reverse diode dv/dt ⁴⁾ | dv/dt | 15 | V/ns |

Maximum Ratings

| Parameter | Symbol | Value | Unit |
|--|---------|-------|------|
| Drain Source voltage slope $V_{DS} = 480$, $I_D = 24.3$, $T_j = 125$ °C | dv/dt | 50 | V/ns |

Thermal Characteristics

| Parameter | Symbol | Values | | | Unit |
|--|------------|--------|------|------|------|
| | | min. | typ. | max. | |
| Thermal resistance, junction - case | R_{thJC} | - | - | 0.52 | K/W |
| Thermal resistance, junction - ambient, leaded | R_{thJA} | - | - | 62 | |
| Soldering temperature, wavesoldering 1.6 mm (0.063 in.) from case for 10s | T_{sold} | - | - | 260 | °C |

Electrical Characteristics, at $T_j=25$ °C unless otherwise specified

| Parameter | Symbol | Conditions | Values | | | Unit |
|---|---------------|---|--------|--------------|-----------|----------|
| | | | min. | typ. | max. | |
| Drain-source breakdown voltage | $V_{(BR)DSS}$ | $V_{GS}=0V$, $I_D=0.25mA$ | 600 | - | - | V |
| Drain-Source avalanche breakdown voltage | $V_{(BR)DS}$ | $V_{GS}=0V$, $I_D=24.3A$ | - | 700 | - | |
| Gate threshold voltage | $V_{GS(th)}$ | $I_D=1200\mu A$, $V_{GS}=V_{DS}$ | 2.1 | 3 | 3.9 | |
| Zero gate voltage drain current | I_{DSS} | $V_{DS}=600V$, $V_{GS}=0V$, $T_j=25$ °C, $T_j=150$ °C | - - | 0.1 - | 1 100 | μA |
| Gate-source leakage current | I_{GSS} | $V_{GS}=20$, $V_{DS}=0V$ | - | - | 100 | nA |
| Drain-source on-state resistance | $R_{DS(on)}$ | $V_{GS}=10V$, $I_D=15.4A$, $T_j=25$ °C $T_j=150$ °C | - - | 0.14 0.34 | 0.16 - | Ω |
| Gate input resistance | R_G | $f=1MHz$, open Drain | - | 0.66 | - | |

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

| Parameter | Symbol | Conditions | Values | | | Unit |
|---|--------------|--|--------|------|------|------|
| | | | min. | typ. | max. | |
| Transconductance | g_{fs} | $V_{DS} \geq 2 \cdot I_D \cdot R_{DS(on)max}$, $I_D = 15.4\text{A}$ | - | 21.5 | - | S |
| Input capacitance | C_{iss} | $V_{GS} = 0\text{V}$, $V_{DS} = 25\text{V}$, | - | 3000 | - | pF |
| Output capacitance | C_{oss} | $f = 1\text{MHz}$ | - | 1000 | - | |
| Reverse transfer capacitance | C_{rss} | | - | 60 | - | |
| Effective output capacitance, ²⁾ energy related | $C_{o(er)}$ | $V_{GS} = 0\text{V}$, $V_{DS} = 0\text{V to } 480\text{V}$ | - | 141 | - | pF |
| Effective output capacitance, ³⁾ time related | $C_{o(tr)}$ | | - | 224 | - | |
| Turn-on delay time | $t_{d(on)}$ | $V_{DD} = 380\text{V}$, $V_{GS} = 0/10\text{V}$, $I_D = 24.3\text{A}$, $R_G = 3.3$ | - | 13 | - | ns |
| Rise time | t_r | $V_{DD} = 380\text{V}$, $V_{GS} = 0/10\text{V}$, | - | 21 | - | |
| Turn-off delay time | $t_{d(off)}$ | $I_D = 24.3\text{A}$, $R_G = 3.3\Omega$ | - | 140 | - | |
| Fall time | t_f | | - | 14 | - | |

Gate Charge Characteristics

| | | | | | | |
|-----------------------|-----------------|---|---|-------|-----|----|
| Gate to source charge | Q_{gs} | $V_{DD} = 480$, $I_D = 24.3\text{A}$ | - | 12.7 | - | nC |
| Gate to drain charge | Q_{gd} | | - | 45.8 | - | |
| Gate charge total | Q_g | $V_{DD} = 480\text{V}$, $I_D = 24.3\text{A}$, $V_{GS} = 0\text{ to } 10\text{V}$ | - | 104.9 | 135 | |
| Gate plateau voltage | $V_{(plateau)}$ | $V_{DD} = 480\text{V}$, $I_D = 24.3\text{A}$ | - | 5 | - | 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} .

⁴ $I_{SD} \leq I_D$, $di/dt \leq 200\text{A/us}$, $V_{DClink} = 400\text{V}$, $V_{peak} < V_{BR, DSS}$, $T_j < T_{j,max}$.

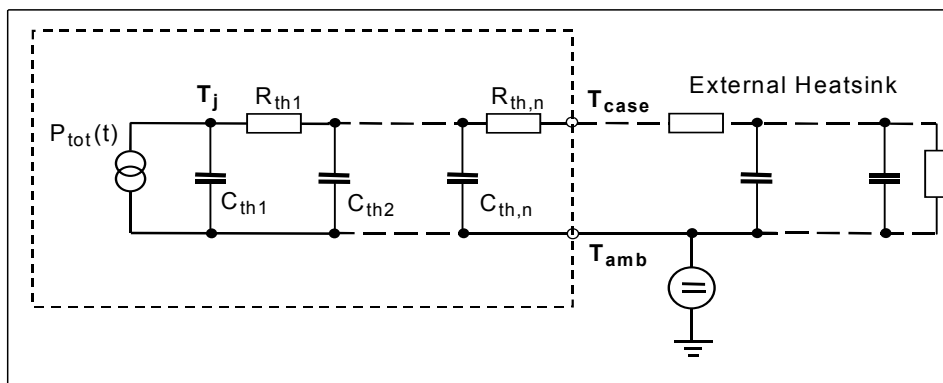
Identical low-side and high-side switch.

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 | $T_C=25^\circ\text{C}$ | - | - | 24.3 | A |
| Inverse diode direct current, pulsed | I_{SM} | | - | - | 72.9 | |
| Inverse diode forward voltage | V_{SD} | $V_{GS}=0\text{V}, I_F=I_S$ | - | 1 | 1.2 | V |
| Reverse recovery time | t_{rr} | $V_R=480\text{V}, I_F=I_S,$ | - | 600 | - | ns |
| Reverse recovery charge | Q_{rr} | $di_F/dt=100\text{A}/\mu\text{s}$ | - | 13 | - | μC |
| Peak reverse recovery current | I_{rrm} | | - | 70 | - | A |
| Peak rate of fall of reverse recovery current | di_{rr}/dt | | - | 1400 | - | $\text{A}/\mu\text{s}$ |

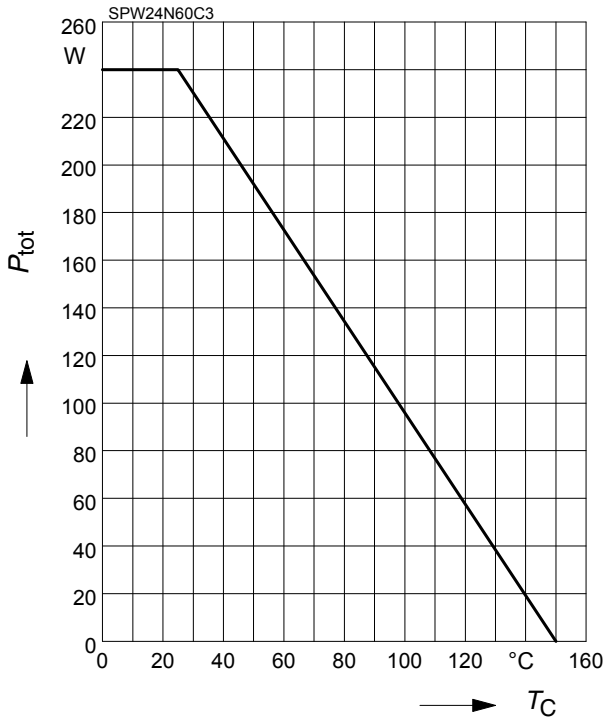
Typical Transient Thermal Characteristics

| Symbol | Value | Unit | Symbol | Value | Unit |
|--------------------|----------|------|---------------------|-----------|------|
| | typ. | | | typ. | |
| Thermal resistance | | | Thermal capacitance | | |
| R_{th1} | 0.006524 | K/W | C_{th1} | 0.0004439 | Ws/K |
| R_{th2} | 0.013 | | C_{th2} | 0.001662 | |
| R_{th3} | 0.025 | | C_{th3} | 0.002268 | |
| R_{th4} | 0.096 | | C_{th4} | 0.006183 | |
| R_{th5} | 0.117 | | C_{th5} | 0.014 | |
| R_{th6} | 0.053 | | C_{th6} | 0.104 | |



1 Power dissipation

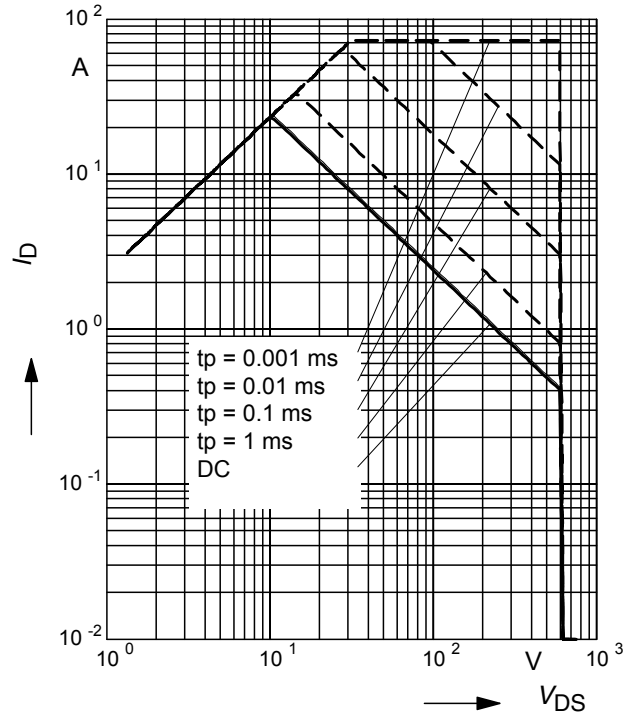
$P_{tot} = f(T_C)$



2 Safe operating area

$I_D = f(V_{DS})$

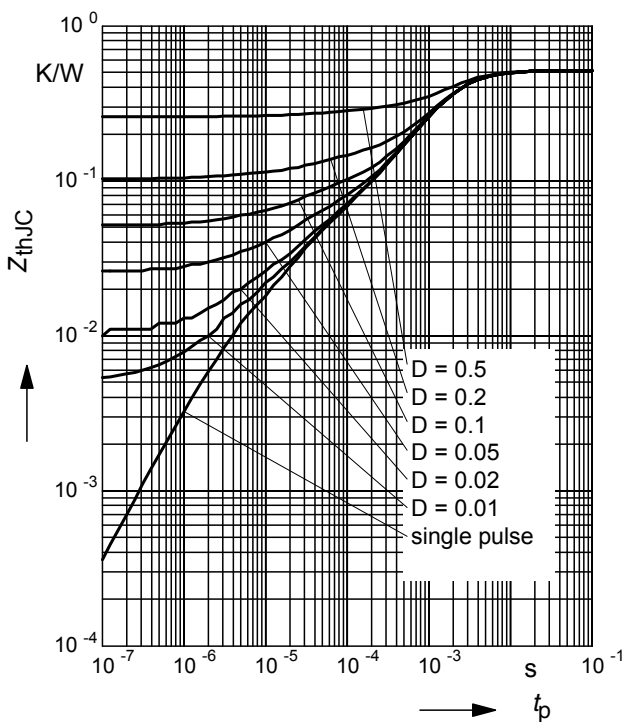
parameter : $D = 0$, $T_C = 25^\circ C$



3 Transient thermal impedance

$Z_{thJC} = f(t_p)$

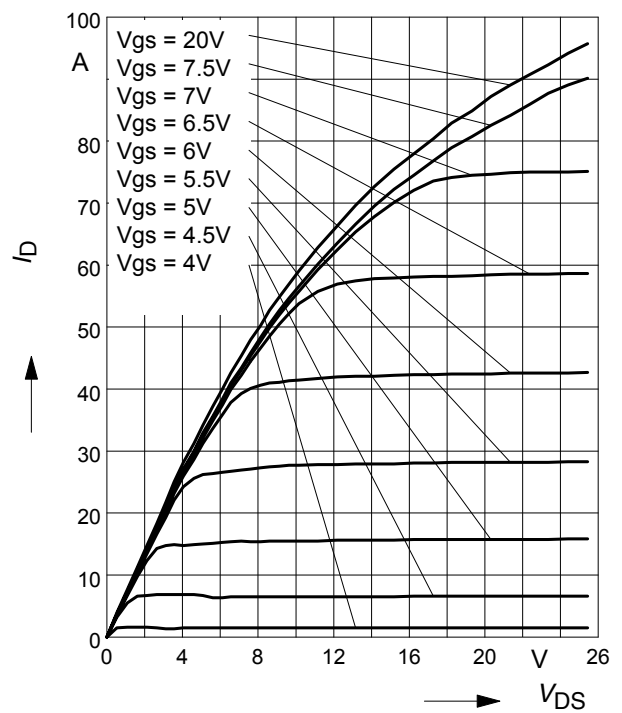
parameter: $D = t_p/T$



4 Typ. output characteristic

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

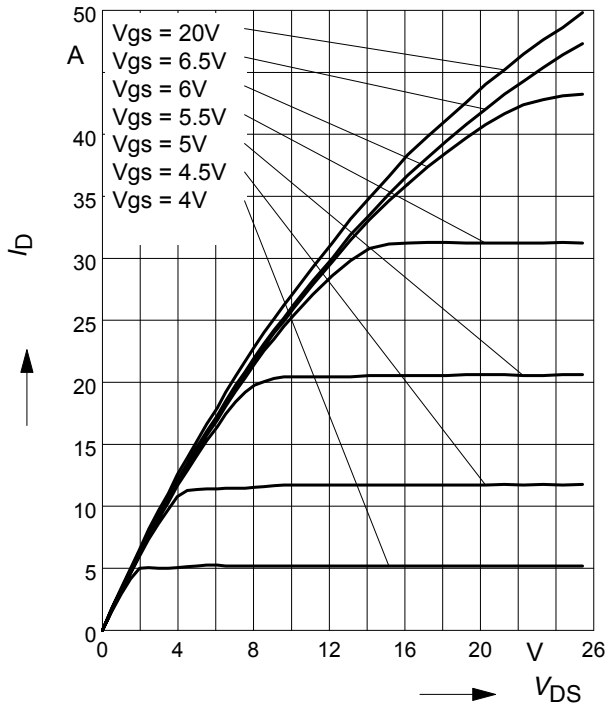
parameter: $t_p = 10 \mu s$, V_{GS}



5 Typ. output characteristic

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

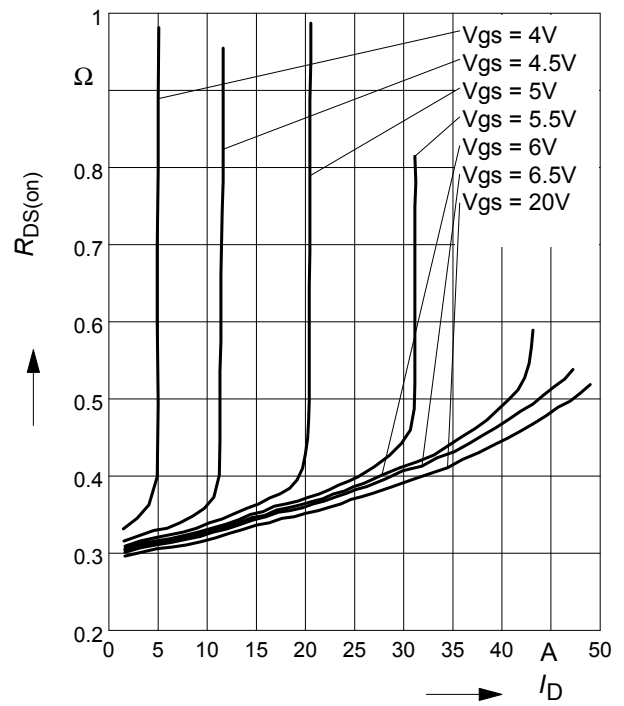
parameter: $t_p = 10 \mu\text{s}, V_{GS}$



6 Typ. drain-source on resistance

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

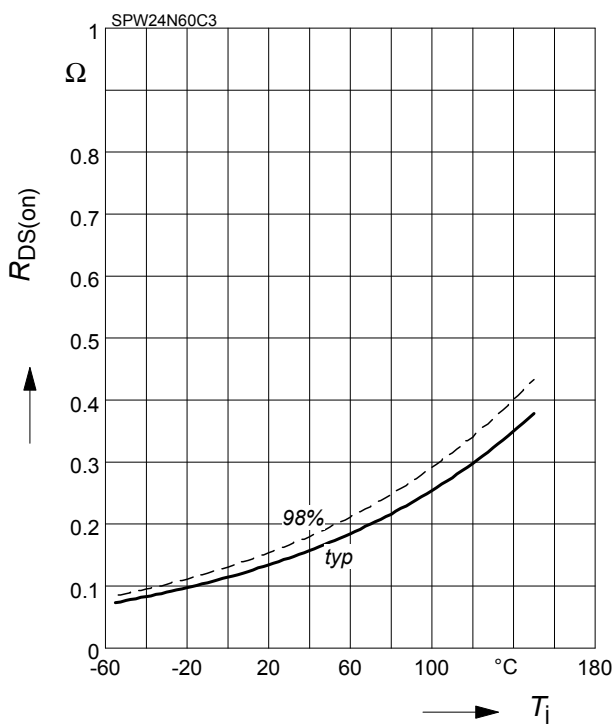
parameter: $T_j = 150^\circ\text{C}, V_{GS}$



7 Drain-source on-state resistance

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

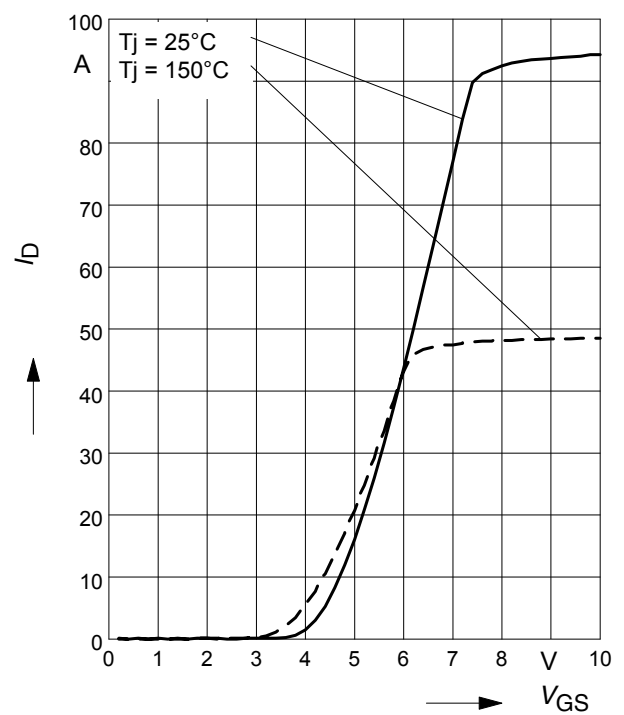
parameter: $I_D = 15.4 \text{ A}, V_{GS} = 10 \text{ V}$



8 Typ. transfer characteristics

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

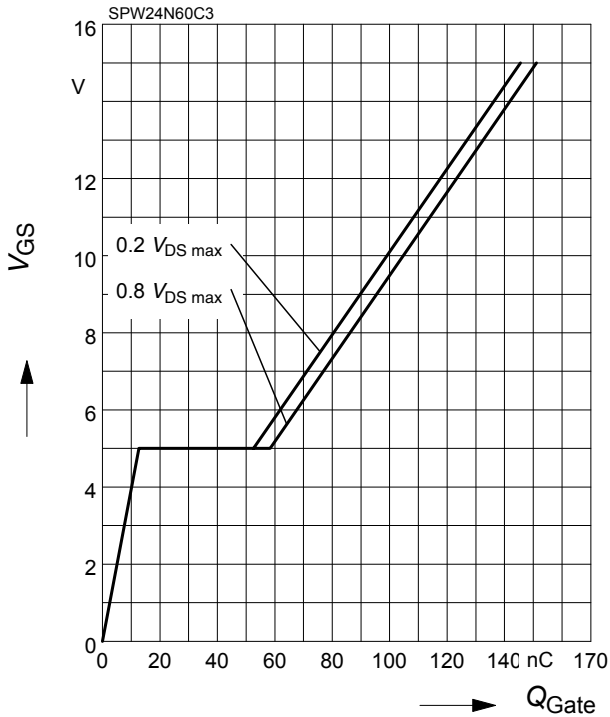
parameter: $t_p = 10 \mu\text{s}$



9 Typ. gate charge

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

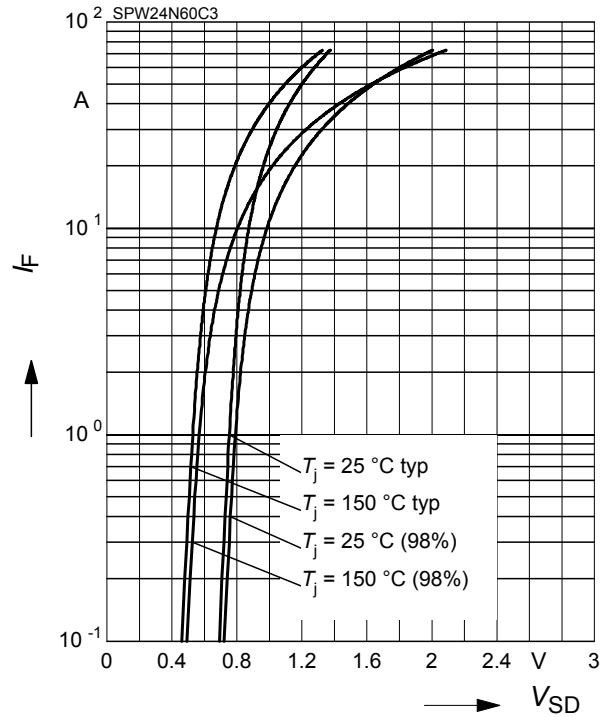
parameter: $I_D = 24.3 \text{ A}$ pulsed



10 Forward characteristics of body diode

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

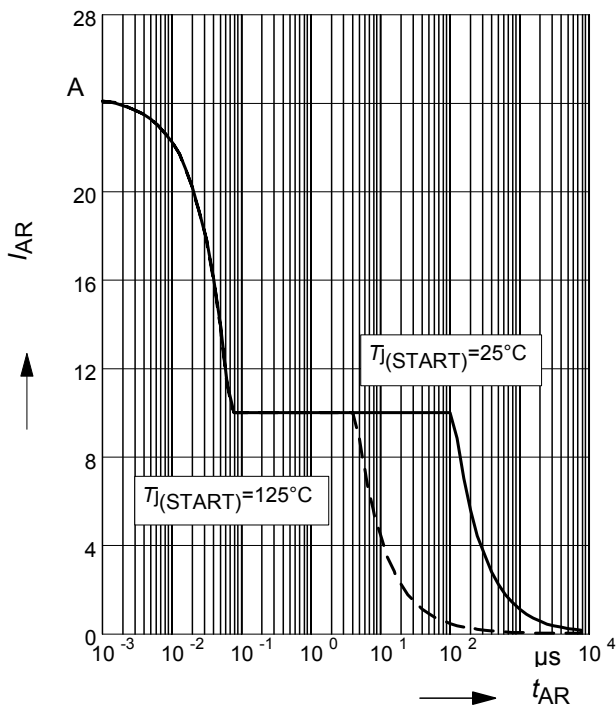
parameter: $T_j, t_p = 10 \mu\text{s}$



11 Avalanche SOA

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

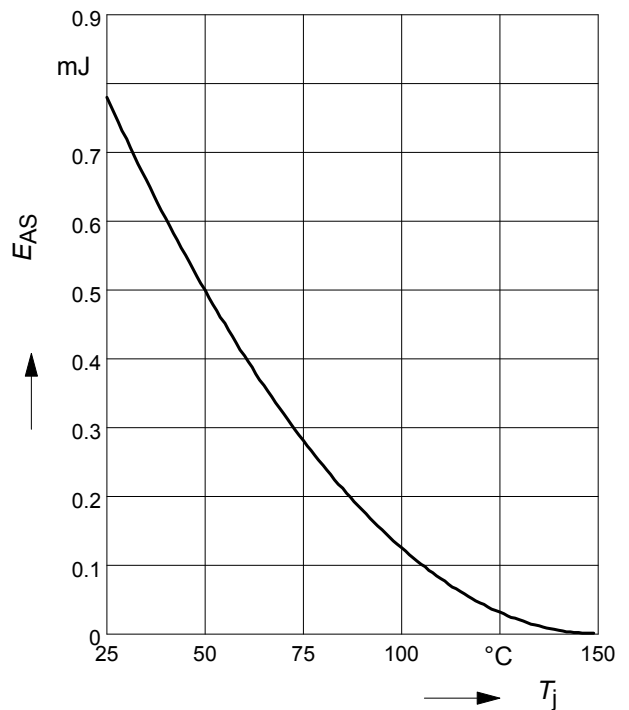
par.: $T_j \leq 150 \text{ °C}$



12 Avalanche energy

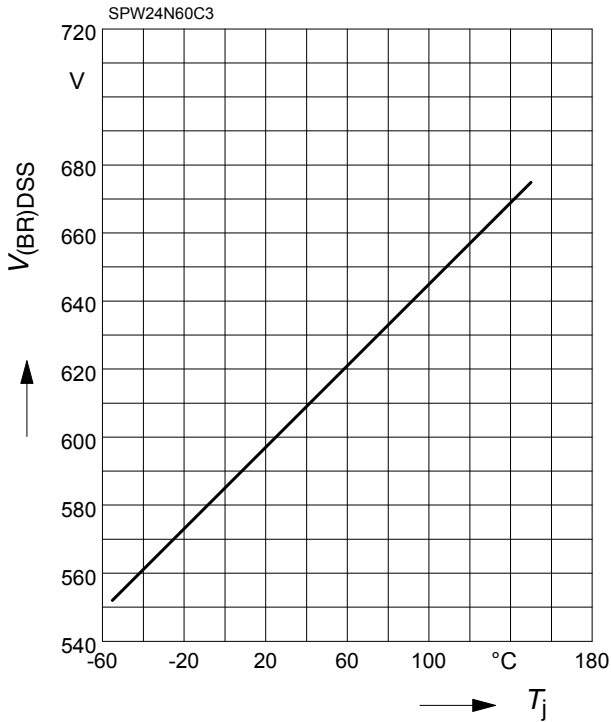
$$E_{AS} = f(T_j)$$

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



13 Drain-source breakdown voltage

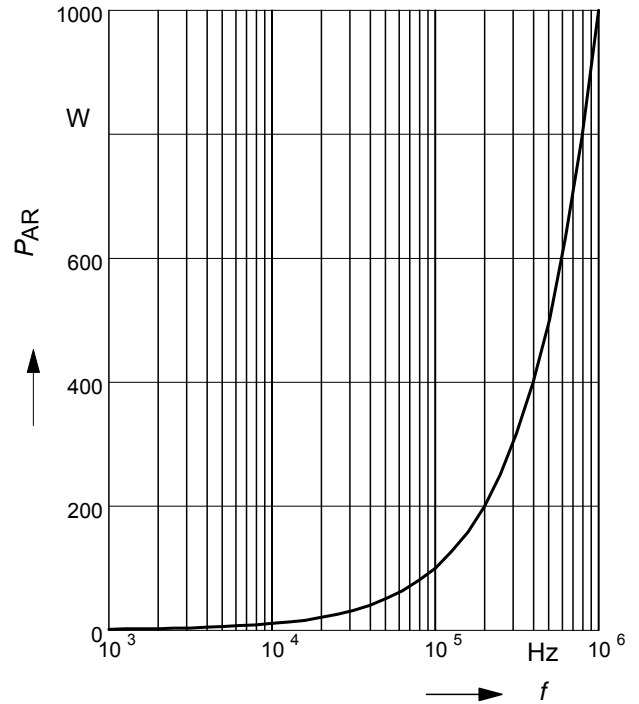
$$V_{(BR)DSS} = f(T_j)$$



14 Avalanche power losses

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

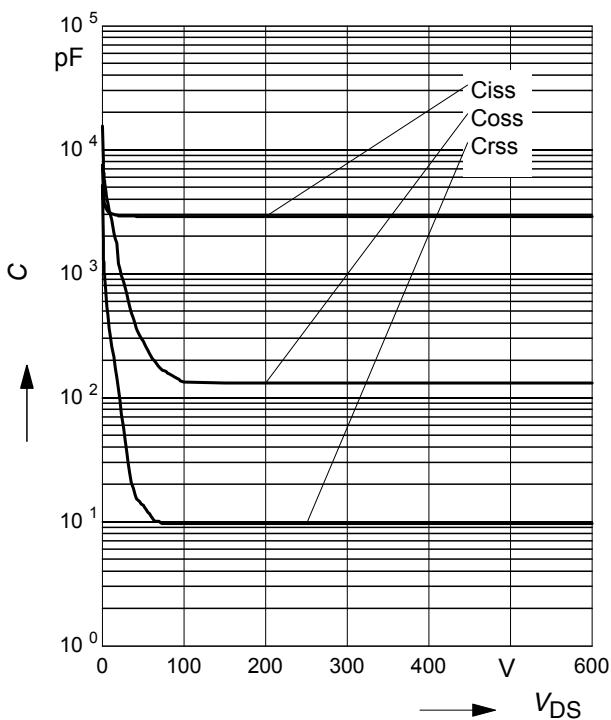
parameter: $E_{AR}=1mJ$



15 Typ. capacitances

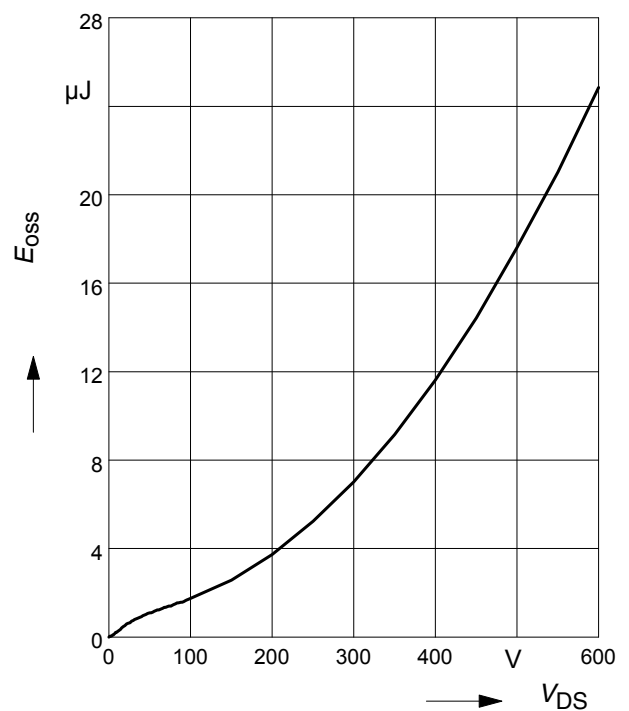
$$C = f(V_{DS})$$

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

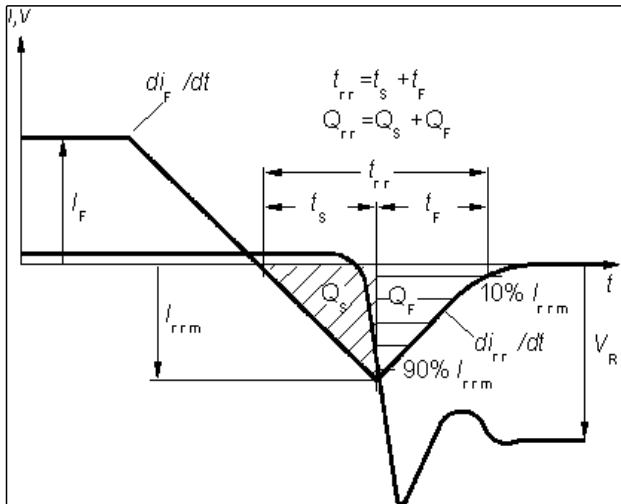


16 Typ. C_{OSS} stored energy

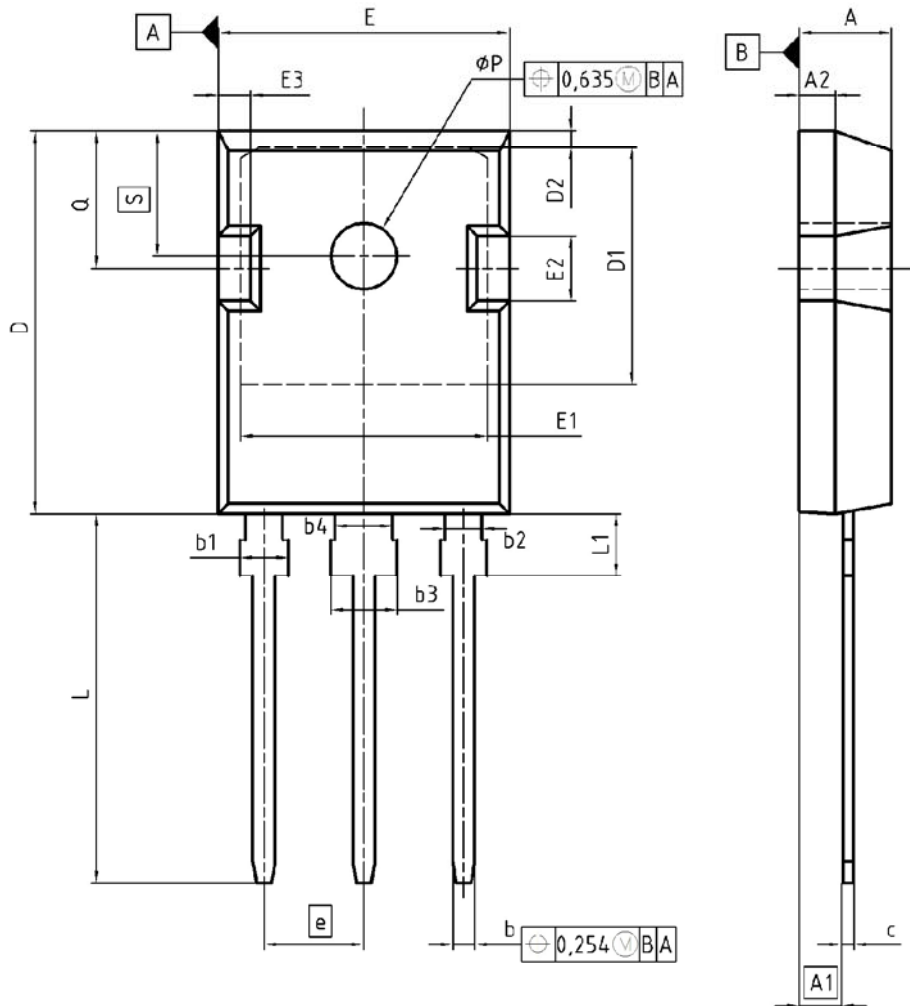
$$E_{OSS} = f(V_{DS})$$



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 | 1.88 | 2.80 | 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 |
| øP | 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

EUROPEAN PROJECTION

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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.)

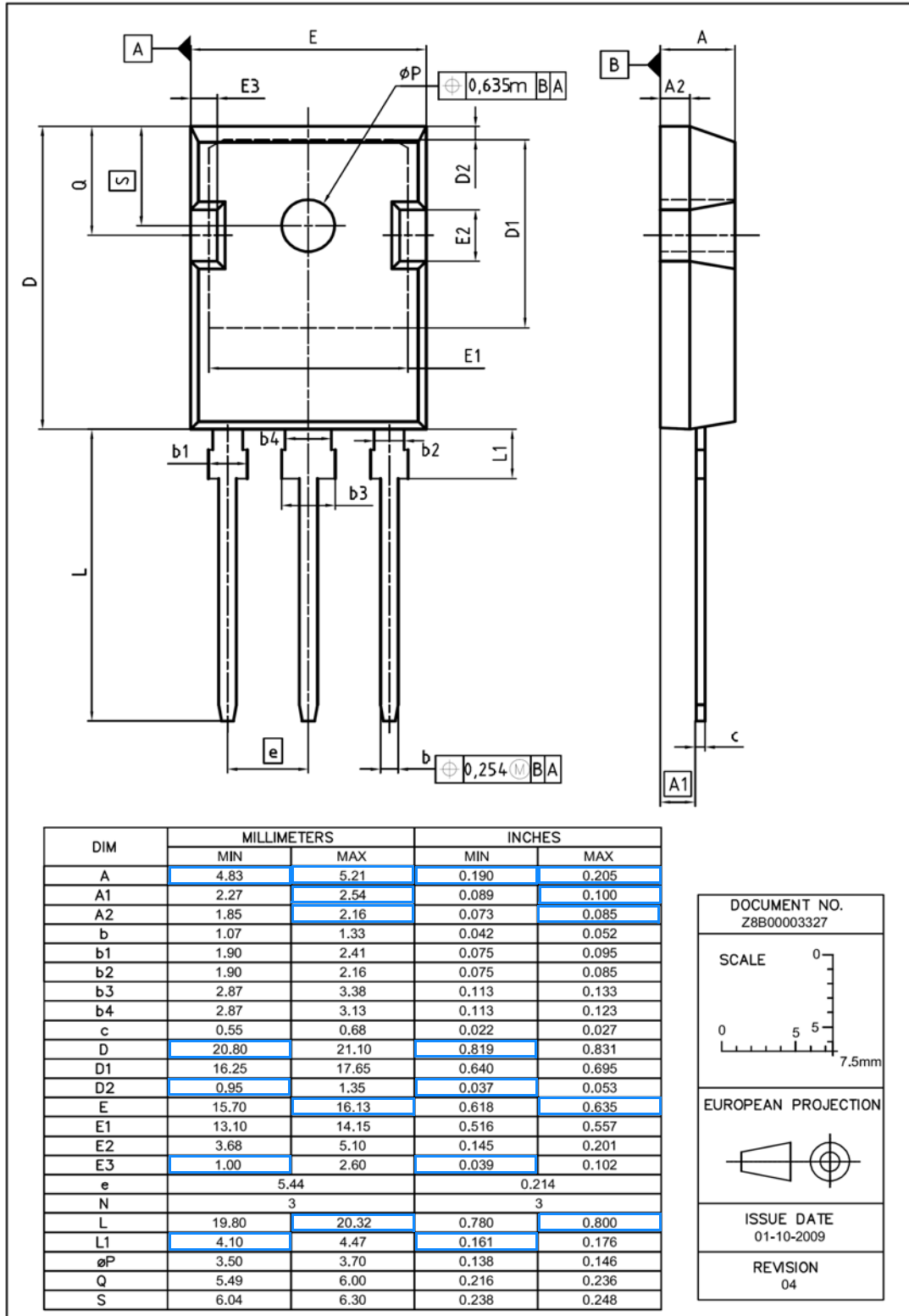


Figure 1 Outlines TO-247, dimensions in mm/inches