

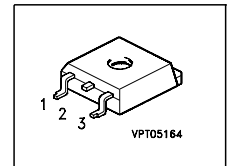
Cool MOS™ Power Transistor

Feature

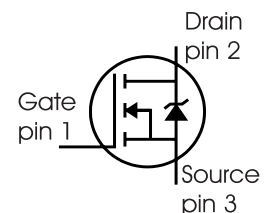
- New revolutionary high voltage technology
- Ultra low gate charge
- Periodic avalanche rated
- Extreme dv/dt rated
- Ultra low effective capacitances
- Improved transconductance
- Qualified according to JEDEC⁰⁾ for target applications

| | | |
|---------------------|------|----------|
| $V_{DS} @ T_{jmax}$ | 560 | V |
| $R_{DS(on)}$ | 0.95 | Ω |
| I_D | 4.5 | A |

PG-TO263



| Type | Package | Ordering Code | Marking |
|------------|----------|---------------|---------|
| SPB04N50C3 | PG-TO263 | Q67040-S4573 | 04N50C3 |



Maximum Ratings

| Parameter | Symbol | Value | | Unit |
|---|--------------------|------------|--|-------------|
| | | SPB | | |
| Continuous drain current $T_C = 25\text{ °C}$ $T_C = 100\text{ °C}$ | I_D | 4.5 2.8 | | A |
| Pulsed drain current, t_p limited by T_{jmax} | $I_D \text{ puls}$ | 13.5 | | A |
| Avalanche energy, single pulse $I_D=3.4A, V_{DD}=50V$ | E_{AS} | 130 | | mJ |
| Avalanche energy, repetitive t_{AR} limited by T_{jmax} ²⁾ $I_D=4.5A, V_{DD}=50V$ | E_{AR} | 0.4 | | |
| Avalanche current, repetitive t_{AR} limited by T_{jmax} | I_{AR} | 4.5 | | A |
| Gate source voltage | V_{GS} | ± 20 | | V |
| Gate source voltage AC ($f > 1\text{Hz}$) | V_{GS} | ± 30 | | |
| Power dissipation, $T_C = 25\text{ °C}$ | P_{tot} | 50 | | W |
| Operating and storage temperature | T_j, T_{stg} | -55...+150 | | °C |
| Reverse diode dv/dt ⁷⁾ | dv/dt | 15 | | V/ns |

Maximum Ratings

| Parameter | Symbol | Value | Unit |
|---|---------|-------|------|
| Drain Source voltage slope $V_{DS} = 400 \text{ V}$, $I_D = 4.5 \text{ A}$, $T_j = 125 \text{ }^\circ\text{C}$ | dv/dt | 50 | V/ns |

Thermal Characteristics

| Parameter | Symbol | Values | | | Unit |
|--|-----------------------|--------|------|------|------------------|
| | | min. | typ. | max. | |
| Thermal resistance, junction - case | R_{thJC} | - | - | 2.5 | K/W |
| Thermal resistance, junction - case, FullPAK | $R_{thJC \text{ FP}}$ | - | - | 4 | |
| Thermal resistance, junction - ambient, leaded | R_{thJA} | - | - | 62 | |
| Thermal resistance, junction - ambient, FullPAK | $R_{thJA \text{ FP}}$ | - | - | 80 | |
| SMD version, device on PCB: @ min. footprint @ 6 cm ² cooling area ³⁾ | R_{thJA} | - | - | 62 | |
| | | - | 35 | - | |
| Soldering temperature, reflow soldering, MSL 1 1.6 mm (0.063 in.) from case for 10s ⁴⁾ | 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 | $V_{(BR)DSS}$ | $V_{GS}=0\text{V}$, $I_D=0.25\text{mA}$ | 500 | - | - | V |
| Drain-Source avalanche breakdown voltage | $V_{(BR)DS}$ | $V_{GS}=0\text{V}$, $I_D=4.5\text{A}$ | - | 600 | - | |
| Gate threshold voltage | $V_{GS(th)}$ | $I_D=200\mu\text{A}$, $V_{GS}=V_{DS}$ | 2.1 | 3 | 3.9 | |
| Zero gate voltage drain current | I_{DSS} | $V_{DS}=500\text{V}$, $V_{GS}=0\text{V}$, $T_j=25^\circ\text{C}$ $T_j=150^\circ\text{C}$ | - | 0.1 | 1 | μA |
| | | | - | - | 100 | |
| Gate-source leakage current | I_{GSS} | $V_{GS}=20\text{V}$, $V_{DS}=0\text{V}$ | - | - | 100 | nA |
| Drain-source on-state resistance | $R_{DS(on)}$ | $V_{GS}=10\text{V}$, $I_D=2.8\text{A}$, $T_j=25^\circ\text{C}$ $T_j=150^\circ\text{C}$ | - | 0.85 | 0.95 | Ω |
| | | | - | 2.3 | - | |
| Gate input resistance | R_G | $f=1\text{MHz}$, open drain | - | 1.4 | - | |

Electrical Characteristics

| Parameter | Symbol | Conditions | Values | | | Unit |
|---|--------------|---|--------|------|------|------|
| | | | min. | typ. | max. | |
| Transconductance | g_{fs} | $V_{DS} \geq 2 \cdot I_D \cdot R_{DS(on)max}$, $I_D = 2.8A$ | - | 4.4 | - | S |
| Input capacitance | C_{iss} | $V_{GS} = 0V$, $V_{DS} = 25V$, | - | 470 | - | pF |
| Output capacitance | C_{oss} | $f = 1MHz$ | - | 160 | - | |
| Reverse transfer capacitance | C_{rss} | | - | 15 | - | |
| Effective output capacitance, ⁵⁾ energy related | $C_{o(er)}$ | $V_{GS} = 0V$, $V_{DS} = 0V$ to 400V | - | 27 | - | |
| Effective output capacitance, ⁶⁾ time related | $C_{o(tr)}$ | | - | 44 | - | |
| Turn-on delay time | $t_{d(on)}$ | $V_{DD} = 350V$, $V_{GS} = 0/10V$, | - | 10 | - | ns |
| Rise time | t_r | $I_D = 4.5A$, | - | 5 | - | |
| Turn-off delay time | $t_{d(off)}$ | $R_G = 18\Omega$ | - | 70 | - | |
| Fall time | t_f | | - | 10 | - | |

Gate Charge Characteristics

| | | | | | | |
|-----------------------|-----------------|---|---|-----|---|----|
| Gate to source charge | Q_{gs} | $V_{DD} = 400V$, $I_D = 4.5A$ | - | 2.2 | - | nC |
| Gate to drain charge | Q_{gd} | | - | 10 | - | |
| Gate charge total | Q_g | $V_{DD} = 400V$, $I_D = 4.5A$, $V_{GS} = 0$ to 10V | - | 22 | - | |
| Gate plateau voltage | $V_{(plateau)}$ | $V_{DD} = 400V$, $I_D = 4.5A$ | - | 5 | - | V |

⁰J-STD20 and JESD22

¹Limited only by maximum temperature

²Repetitive avalanche causes additional power losses that can be calculated as $P_{AV} = E_{AR} \cdot f$.

³Device on 40mm*40mm*1.5mm epoxy PCB FR4 with 6cm² (one layer, 70 μm thick) copper area for drain connection. PCB is vertical without blown air.

⁴Soldering temperature for TO-263: 220°C, reflow

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

⁶ $C_{o(tr)}$ is a fixed capacitance that gives the same charging time as C_{oss} while V_{DS} is rising from 0 to 80% V_{DSS} .

⁷ $I_{SD} \leq I_D$, $di/dt \leq 400A/\mu s$, $V_{DClink} = 400V$, $V_{peak} < V_{BR, DSS}$, $T_j < T_{j,max}$.

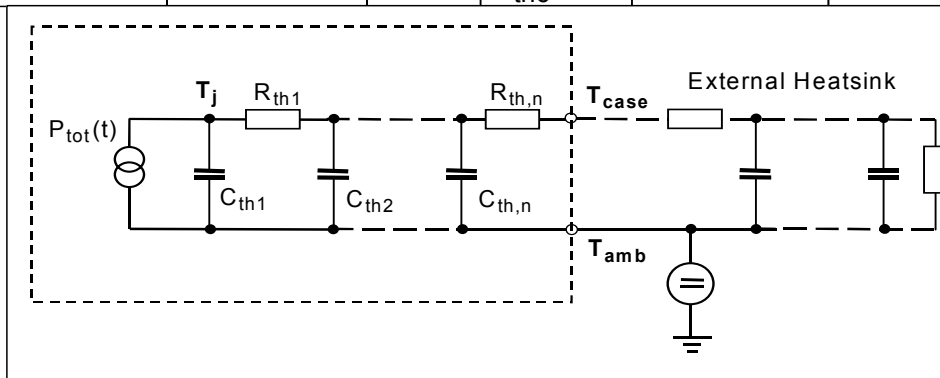
Identical low-side and high-side switch.

Electrical Characteristics

| Parameter | Symbol | Conditions | Values | | | Unit |
|---|--------------|-----------------------------------|--------|------|------|------------------------|
| | | | min. | typ. | max. | |
| Inverse diode continuous forward current | I_S | $T_C=25^\circ\text{C}$ | - | - | 4.5 | A |
| Inverse diode direct current, pulsed | I_{SM} | | - | - | 13.5 | |
| Inverse diode forward voltage | V_{SD} | $V_{GS}=0\text{V}, I_F=I_S$ | - | 1 | 1.2 | V |
| Reverse recovery time | t_{rr} | $V_R=400\text{V}, I_F=I_S,$ | - | 280 | - | ns |
| Reverse recovery charge | Q_{rr} | $di_F/dt=100\text{A}/\mu\text{s}$ | - | 2.3 | - | μC |
| Peak reverse recovery current | I_{rrm} | | - | 16 | - | A |
| Peak rate of fall of reverse recovery current | di_{rr}/dt | $T_j=25^\circ\text{C}$ | - | 860 | - | $\text{A}/\mu\text{s}$ |

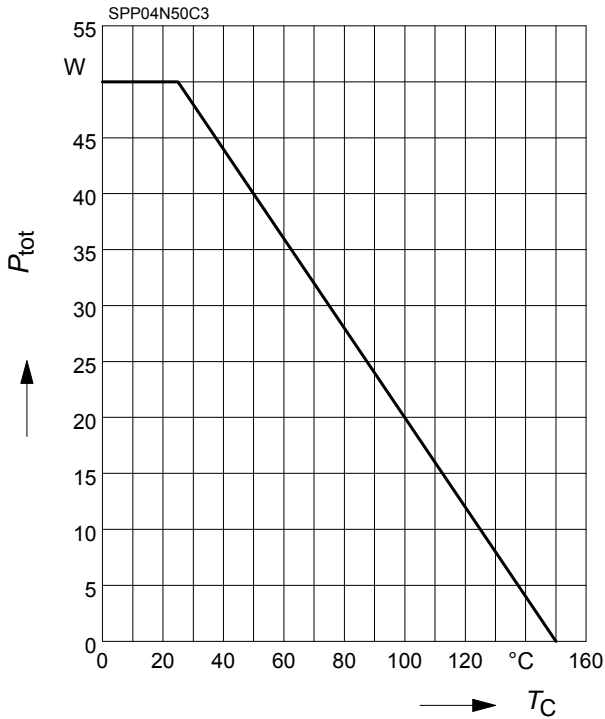
Typical Transient Thermal Characteristics

| Symbol | Value | | Unit | Symbol | Value | | Unit |
|-----------|-------|--|------|-----------|------------|--|------|
| | SPB | | | | SPB | | |
| R_{th1} | 0.039 | | K/W | C_{th1} | 0.00007347 | | Ws/K |
| R_{th2} | 0.074 | | | C_{th2} | 0.0002831 | | |
| R_{th3} | 0.132 | | | C_{th3} | 0.0004062 | | |
| R_{th4} | 0.555 | | | C_{th4} | 0.001215 | | |
| R_{th5} | 0.529 | | | C_{th5} | 0.00276 | | |
| R_{th6} | 0.169 | | | C_{th6} | 0.029 | | |



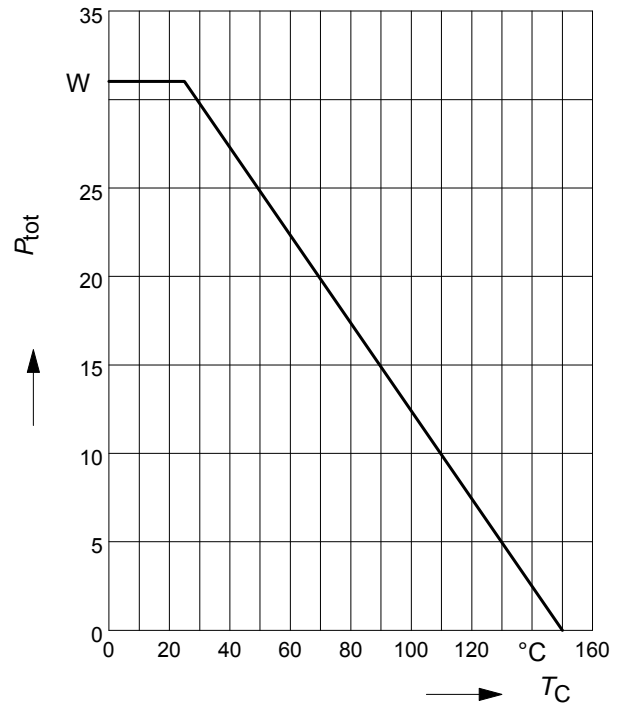
1 Power dissipation

$P_{tot} = f(T_C)$



2 Power dissipation FullPAK

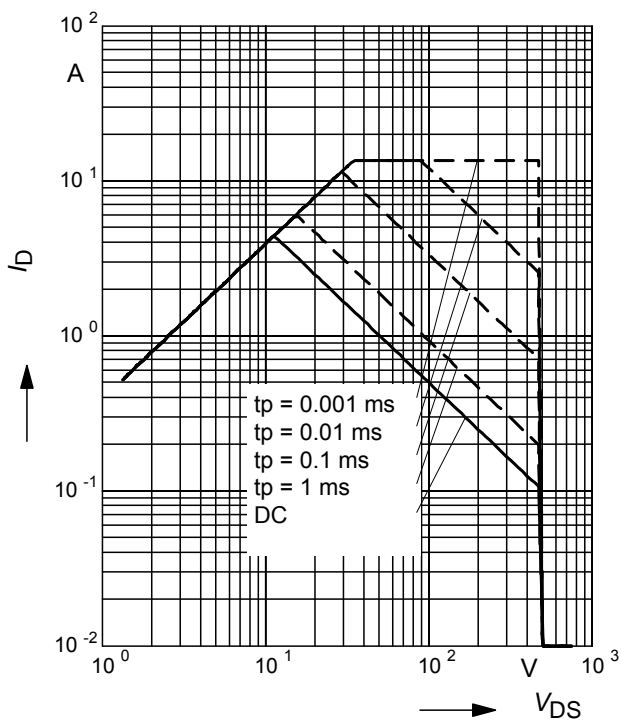
$P_{tot} = f(T_C)$



3 Safe operating area

$I_D = f(V_{DS})$

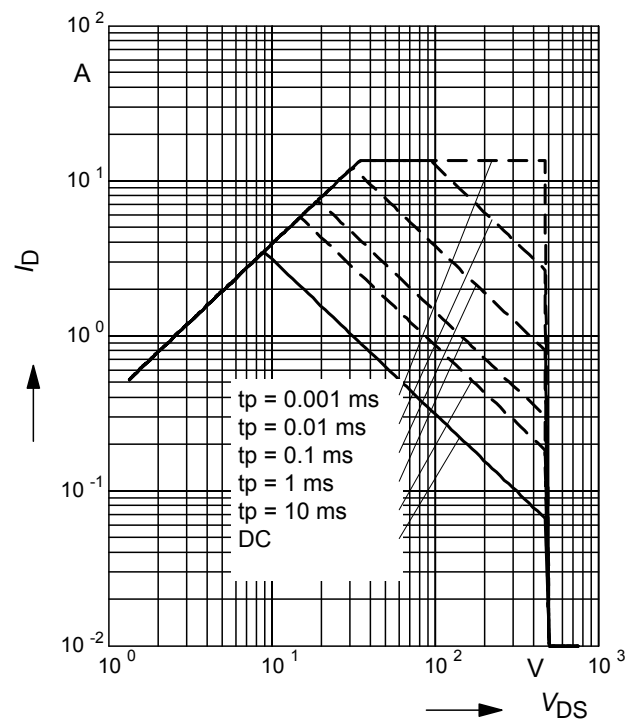
parameter : $D = 0$, $T_C = 25^\circ\text{C}$



4 Safe operating area FullPAK

$I_D = f(V_{DS})$

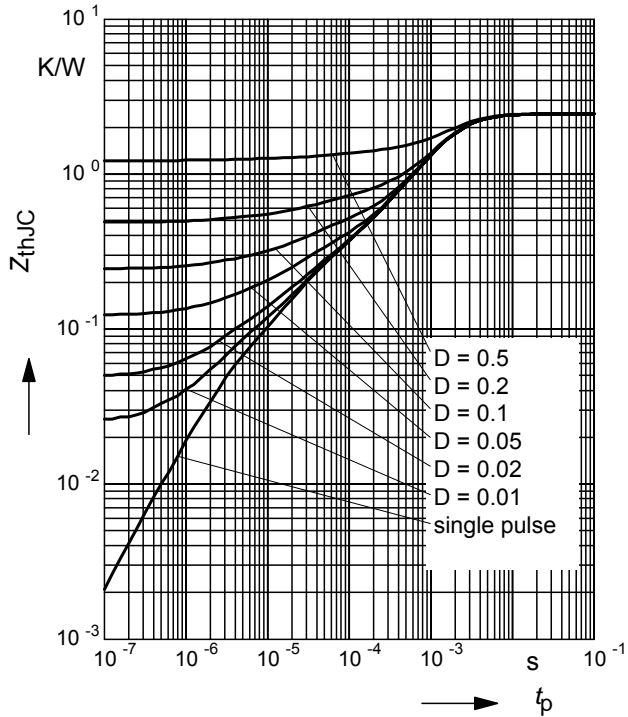
parameter: $D = 0$, $T_C = 25^\circ\text{C}$



5 Transient thermal impedance

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

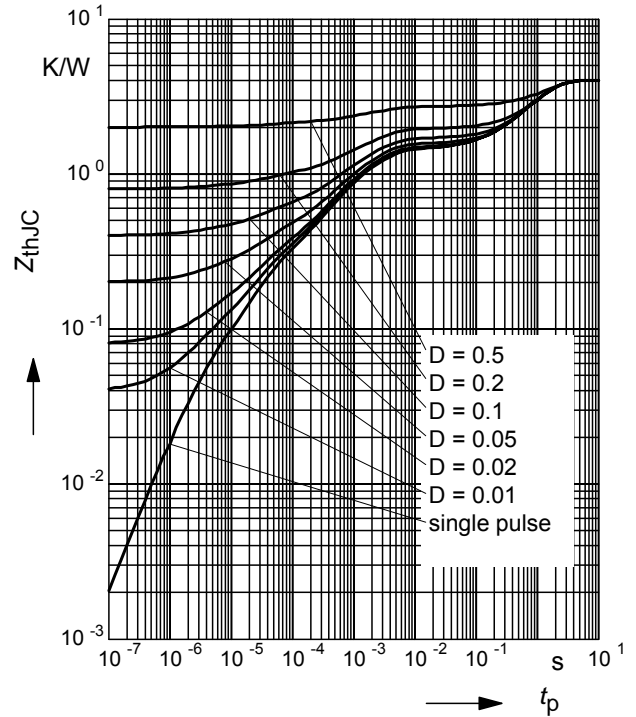
parameter: $D = t_p/T$



6 Transient thermal impedance FullPAK

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

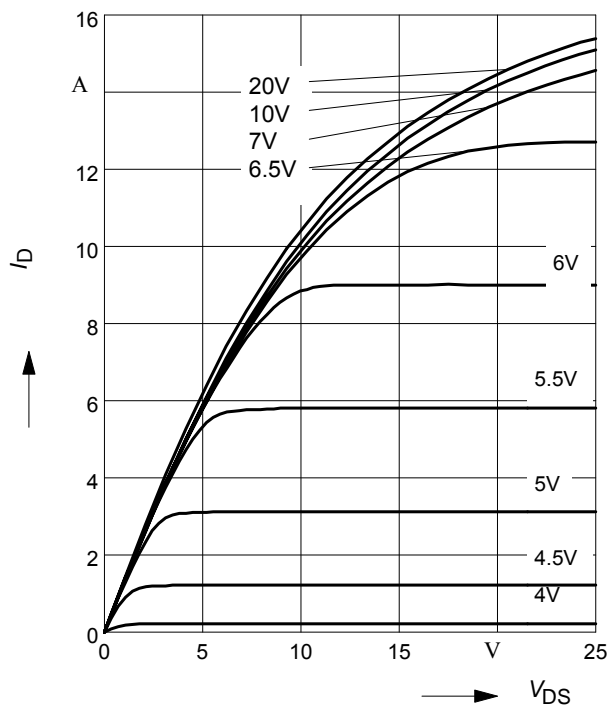
parameter: $D = t_p/t$



7 Typ. output characteristic

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

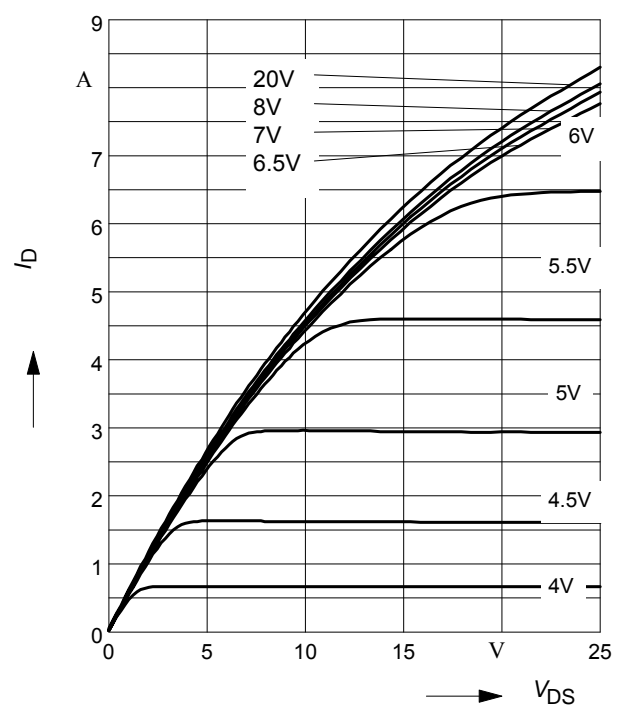
parameter: $t_p = 10 \mu\text{s}, V_{GS}$



8 Typ. output characteristic

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

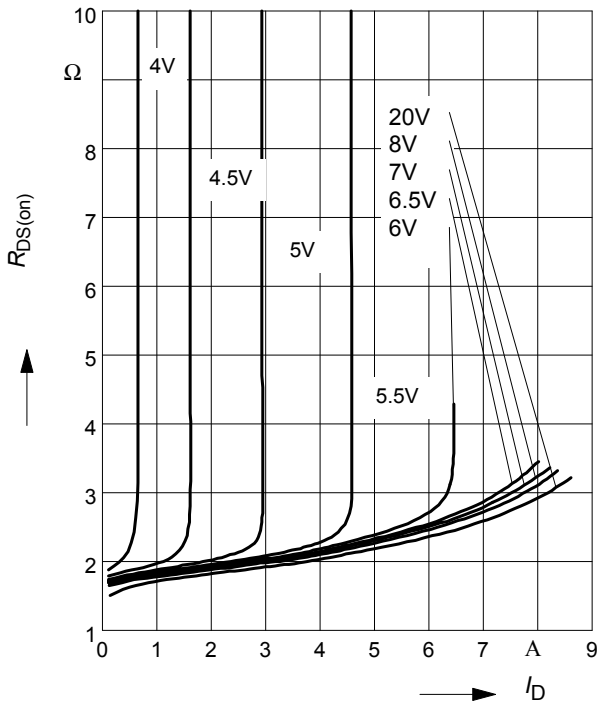
parameter: $t_p = 10 \mu\text{s}, V_{GS}$



9 Typ. drain-source on resistance

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

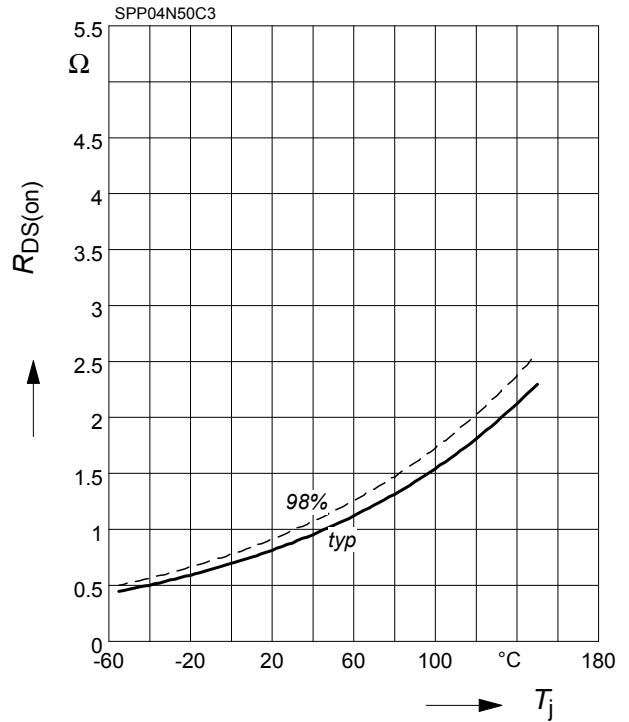
parameter: $T_j = 150^\circ\text{C}$, V_{GS}



10 Drain-source on-state resistance

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

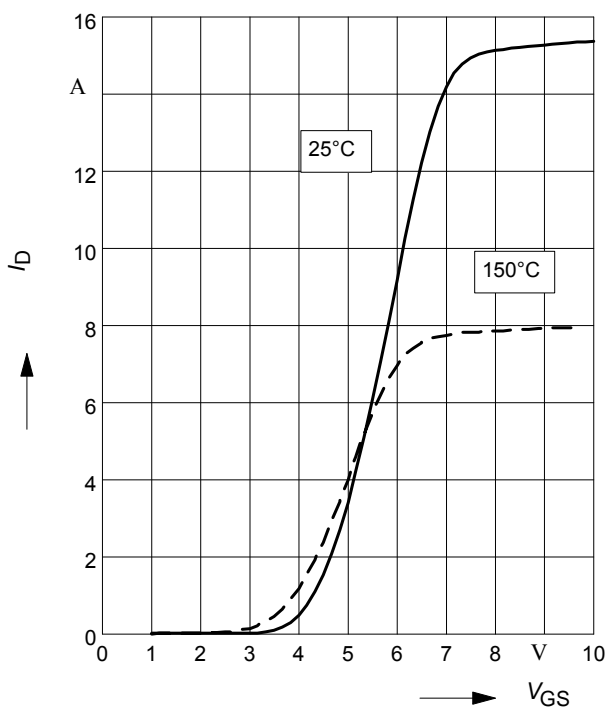
parameter: $I_D = 2.8\text{ A}$, $V_{GS} = 10\text{ V}$



11 Typ. transfer characteristics

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

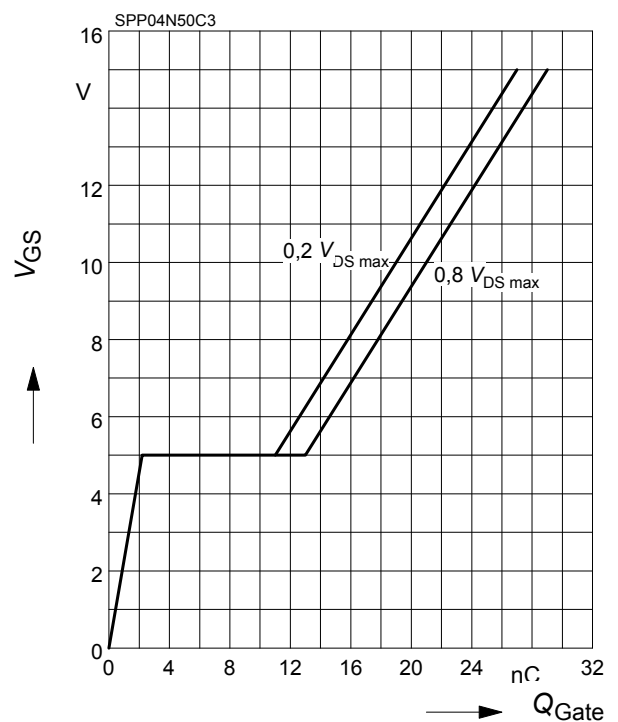
parameter: $t_p = 10\ \mu\text{s}$



12 Typ. gate charge

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

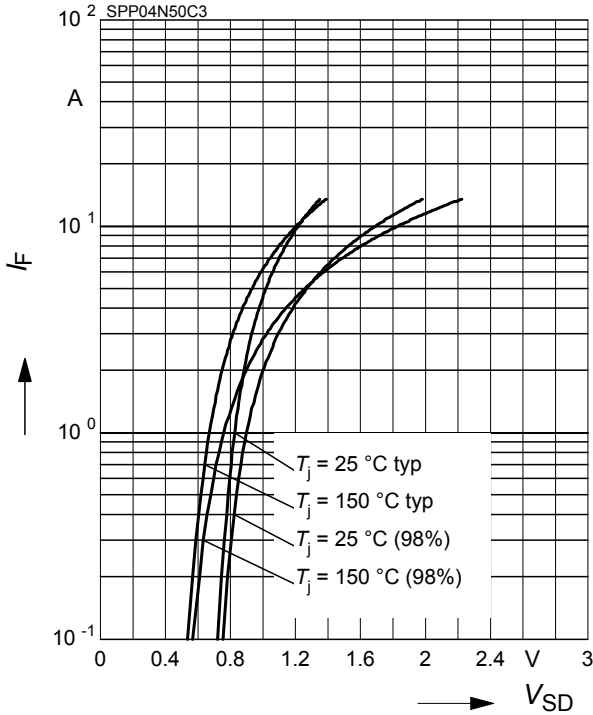
parameter: $I_D = 4.5\text{ A pulsed}$



13 Forward characteristics of body diode

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

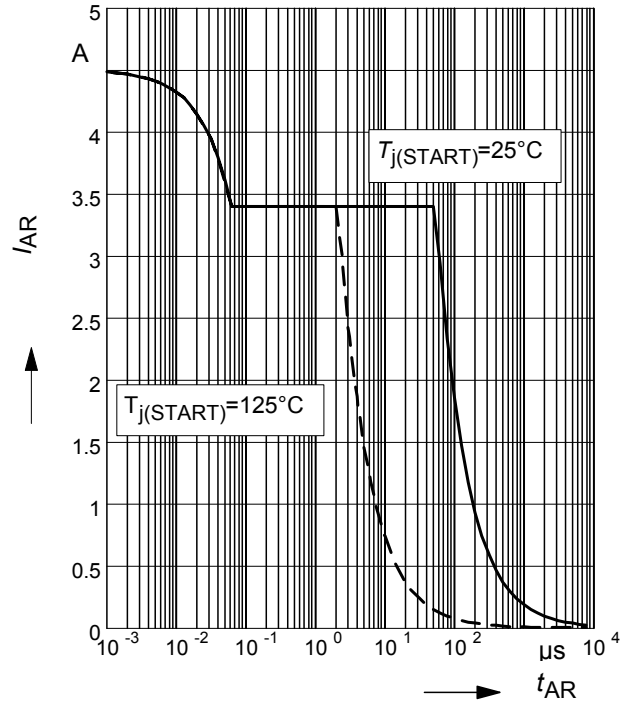
parameter: T_j , $t_p = 10 \mu s$



14 Avalanche SOA

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

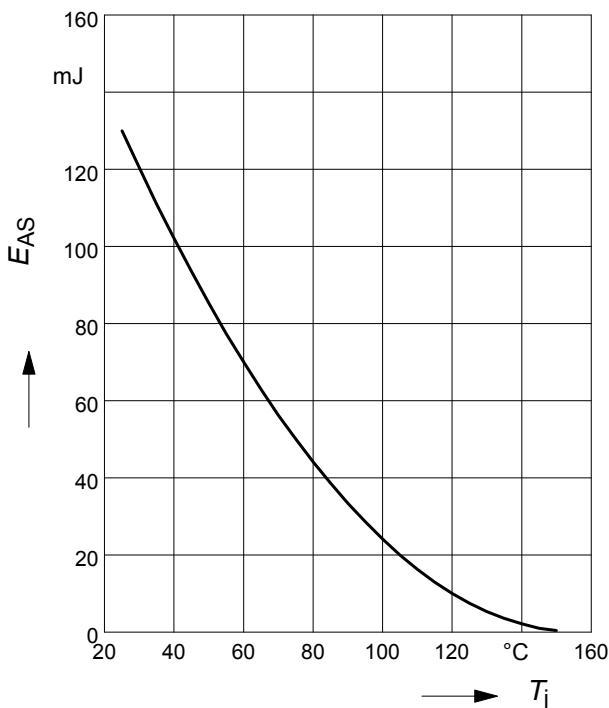
par.: $T_j \leq 150 \text{ °C}$



15 Avalanche energy

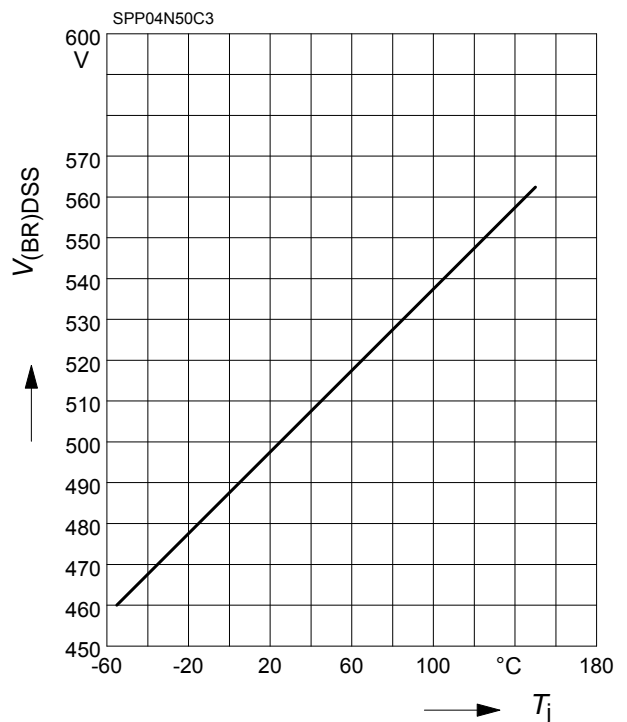
$$E_{AS} = f(T_j)$$

par.: $I_D = 3.4 \text{ A}$, $V_{DD} = 50 \text{ V}$



16 Drain-source breakdown voltage

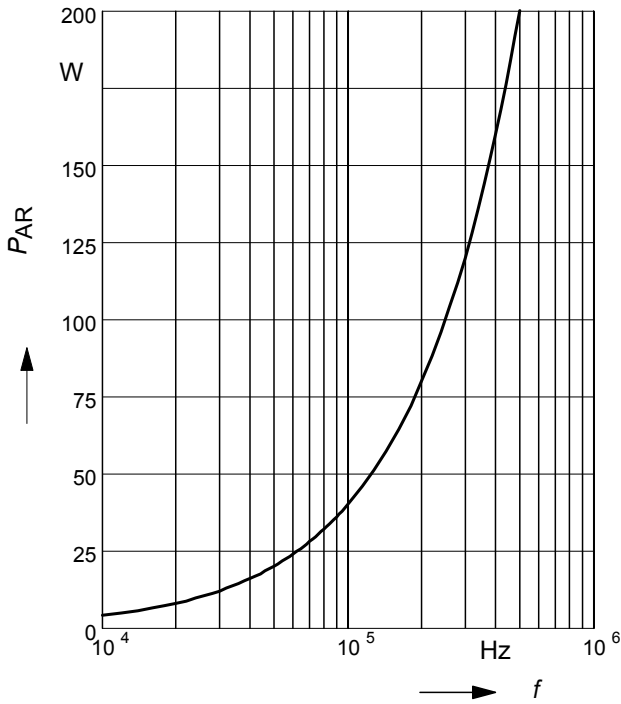
$$V_{(BR)DSS} = f(T_j)$$



17 Avalanche power losses

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

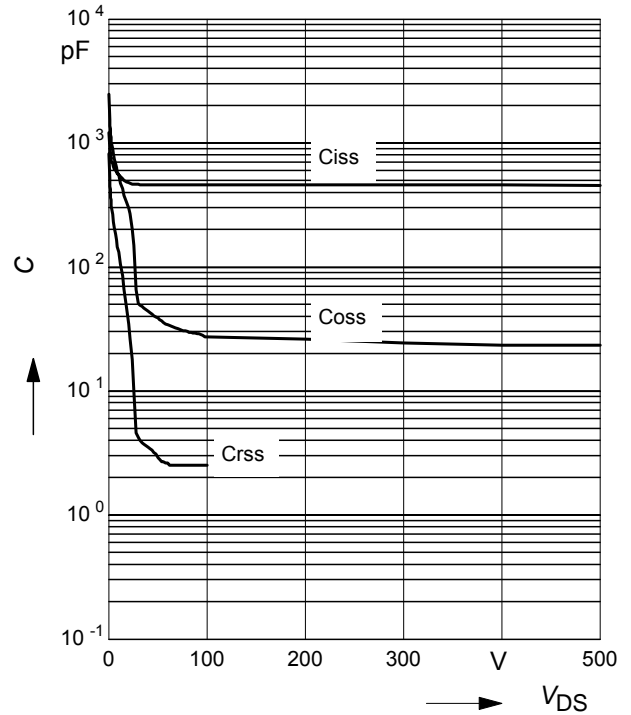
parameter: $E_{AR}=0.4\text{mJ}$



18 Typ. capacitances

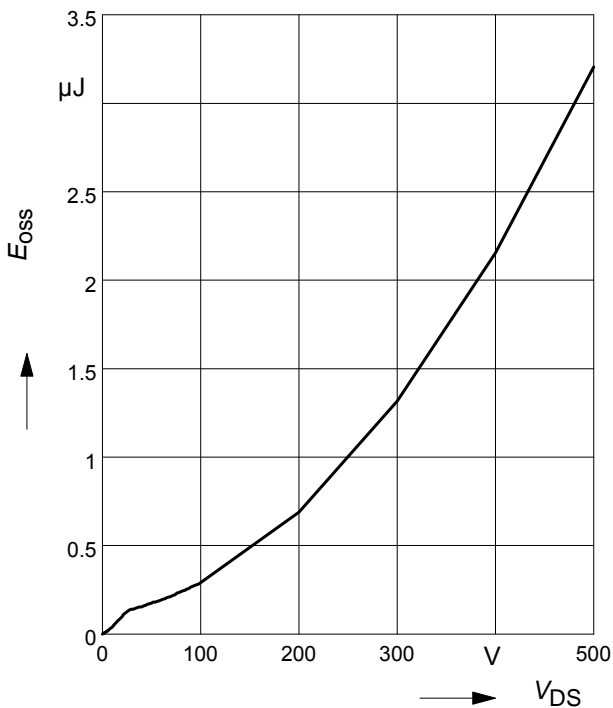
$$C = f(V_{DS})$$

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

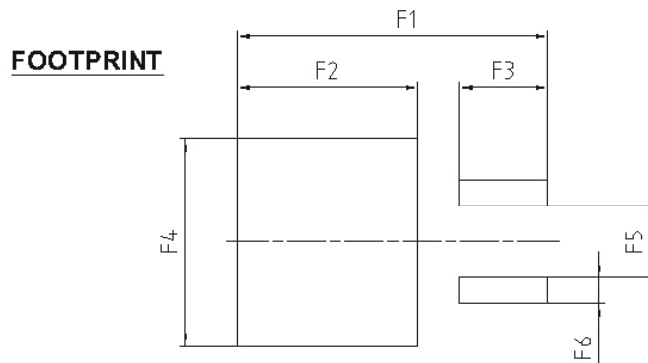
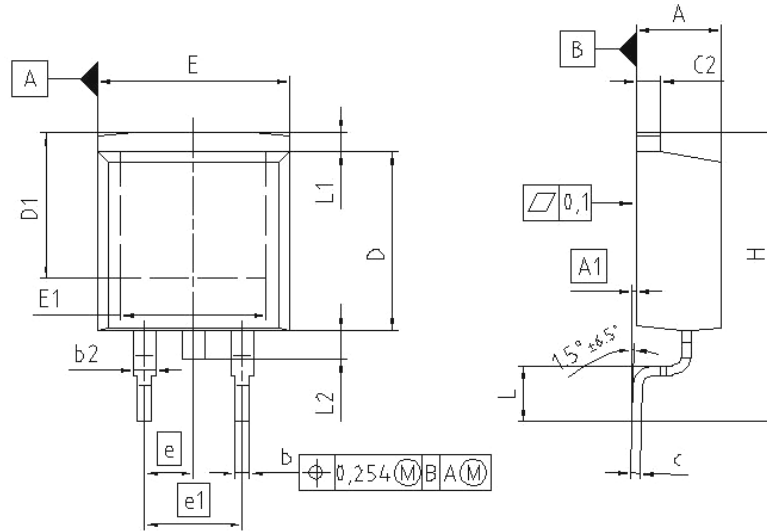


19 Typ. C_{oss} stored energy

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



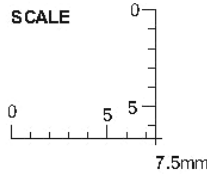
PG-TO263-3-2, PG-TO263-3-5, PG-TO263-3-22



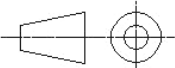
| DIM | MILLIMETERS | | INCHES | |
|-----|-------------|--------|--------|-------|
| | MIN | MAX | MIN | MAX |
| A | 4.300 | 4.572 | 0.169 | 0.180 |
| A1 | 0.000 | 0.254 | 0.000 | 0.010 |
| b | 0.650 | 0.850 | 0.026 | 0.033 |
| b2 | 0.950 | 1.321 | 0.037 | 0.052 |
| c | 0.330 | 0.650 | 0.013 | 0.026 |
| c2 | 0.170 | 1.400 | 0.046 | 0.055 |
| D | 8.509 | 9.450 | 0.335 | 0.372 |
| D1 | 7.100 | - | 0.280 | - |
| E | 9.800 | 10.312 | 0.386 | 0.406 |
| E1 | 6.500 | - | 0.256 | - |
| e | 2.540 | | 0.100 | |
| e1 | 5.080 | | 0.200 | |
| N | 2 | | 2 | |
| H | 14.605 | 15.875 | 0.575 | 0.625 |
| L | 2.200 | 3.000 | 0.087 | 0.118 |
| L1 | - | 1.600 | - | 0.063 |
| L2 | 1.000 | 1.778 | 0.039 | 0.070 |
| F1 | 16.050 | 16.250 | 0.632 | 0.640 |
| F2 | 9.300 | 9.500 | 0.366 | 0.374 |
| F3 | 4.500 | 4.700 | 0.177 | 0.185 |
| F4 | 10.700 | 10.900 | 0.421 | 0.429 |
| F5 | 3.630 | 3.830 | 0.143 | 0.151 |
| F6 | 1.100 | 1.300 | 0.043 | 0.051 |

REFERENCE
JEDEC TO263

SCALE



EUROPEAN PROJECTION



ISSUE DATE
12-02-2006

FILE
TO263_2

Published by
Infineon Technologies AG,
Bereichs Kommunikation
St.-Martin-Strasse 53,
D-81541 München
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