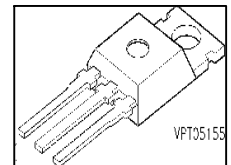


Cool MOS™ Power Transistor
Feature

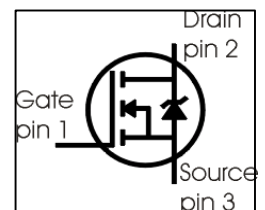
- New revolutionary high voltage technology
- Worldwide best $R_{DS(on)}$ in TO 220
- Ultra low gate charge
- Periodic avalanche rated
- Extreme dv/dt rated
- High peak current capability
- Intrinsic fast-recovery body diode
- Extreme low reverse recovery charge
- **Pb-free lead plating; RoHS compliant; Halogen free mold compound**
- **Qualified for industrial grade applications according to JEDEC⁰⁾**

| | | |
|---------------------|------|----------|
| $V_{DS} @ T_{jmax}$ | 650 | V |
| $R_{DS(on)}$ | 0.22 | Ω |
| I_D | 20.7 | A |

PG-TO220



| Type | Package | Ordering Code | Marking |
|-------------|----------|---------------|----------|
| SPP20N60CFD | PG-TO220 | Q67040-S4616 | 20N60CFD |


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 | 20.7 13.1 | A |
| Pulsed drain current, t_D limited by T_{jmax} | $I_{D\text{ puls}}$ | 52 | |
| 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 |
| Reverse diode dv/dt $I_S = 20.7\text{ A}, V_{DS} = 480\text{ V}, T_j = 125\text{ }^\circ\text{C}$ | dv/dt | 40 | V/ns |
| 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_{sta} | -55... +150 | $^\circ\text{C}$ |

Maximum Ratings

| Parameter | Symbol | Value | Unit |
|---|-----------|-------|------------------|
| Drain Source voltage slope $V_{DS} = 480 \text{ V}$, $I_D = 20.7 \text{ A}$, $T_j = 125 \text{ }^\circ\text{C}$ | dv/dt | 80 | V/ns |
| Maximum diode commutation speed $V_{DS} = 480 \text{ V}$, $I_D = 20.7 \text{ A}$, $T_j = 125 \text{ }^\circ\text{C}$ | di_F/dt | 900 | A/ μs |

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} | - | - | 62 | |
| 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 | 4 | 5 | |
| Zero gate voltage drain current | I_{DSS} | $V_{DS}=600\text{V}$, $V_{GS}=0\text{V}$, $T_j=25^\circ\text{C}$, $T_j=150^\circ\text{C}$ | - | 2.1 | - | μA |
| | | | - | 1700 | - | |
| Gate-source leakage current | I_{GSS} | $V_{GS}=20\text{V}$, $V_{DS}=0\text{V}$ | - | - | 100 | nA |
| Drain-source on-state resistance | $R_{DS(on)}$ | $V_{GS}=10\text{V}$, $I_D=13.1\text{A}$, $T_j=25^\circ\text{C}$ $T_j=150^\circ\text{C}$ | - | 0.19 | 0.22 | Ω |
| | | | - | 0.51 | - | |
| Gate input resistance | R_G | $f=1\text{MHz}$, open Drain | - | 0.54 | - | |

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

| Parameter | Symbol | Conditions | Values | | | Unit |
|---|--------------|--|--------|------|------|------|
| | | | min. | typ. | max. | |
| Transconductance | g_{fs} | $V_{DS} \geq 2 \cdot I_D \cdot R_{DS(on)max}$, $I_D = 13.1\text{A}$ | - | 17.5 | - | S |
| Input capacitance | C_{iss} | $V_{GS} = 0\text{V}$, $V_{DS} = 25\text{V}$, $f = 1\text{MHz}$ | - | 2400 | - | pF |
| Output capacitance | C_{oss} | | - | 780 | - | |
| Reverse transfer capacitance | C_{rss} | | - | 50 | - | |
| 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 | $t_{d(on)}$ | $V_{DD} = 380\text{V}$, $V_{GS} = 0/10\text{V}$, $I_D = 20.7\text{A}$, $R_G = 3.6\Omega$ | - | 12 | - | ns |
| Rise time | t_r | | - | 15 | - | |
| Turn-off delay time | $t_{d(off)}$ | | - | 59 | - | |
| Fall time | t_f | | - | 6.4 | - | |

Gate Charge Characteristics

| | | | | | | |
|-----------------------|-----------------|---|---|----|-----|----|
| Gate to source charge | Q_{gs} | $V_{DD} = 480\text{V}$, $I_D = 20.7\text{A}$ | - | 15 | - | nC |
| Gate to drain charge | Q_{gd} | | - | 54 | - | |
| Gate charge total | Q_g | $V_{DD} = 480\text{V}$, $I_D = 20.7\text{A}$, $V_{GS} = 0\text{ to } 10\text{V}$ | - | 95 | 124 | |
| Gate plateau voltage | $V_{(plateau)}$ | $V_{DD} = 480\text{V}$, $I_D = 20.7\text{A}$ | - | 7 | - | 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} .

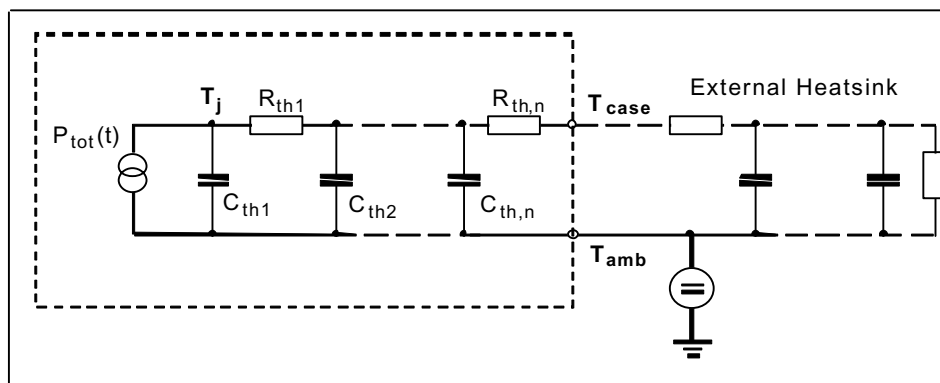
³ $C_{o(tr)}$ is a fixed capacitance that gives the same charging time as C_{oss} while V_{DS} is rising from 0 to 80% V_{DSS} .

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 | $T_C=25^\circ\text{C}$ | - | - | 20.7 | A |
| Inverse diode direct current, pulsed | I_{SM} | | - | - | 52 | |
| Inverse diode forward voltage | V_{SD} | $V_{GS}=0\text{V}, I_F=I_S$ | - | 1 | 1.2 | V |
| Reverse recovery time | t_{rr} | $V_R=480\text{V}, I_F=I_S,$ | - | 150 | - | ns |
| Reverse recovery charge | Q_{rr} | $di_F/dt=100\text{A}/\mu\text{s}$ | - | 1 | - | μC |
| Peak reverse recovery current | I_{rrm} | | - | 13 | - | A |
| Peak rate of fall of reverse recovery current | di_{rr}/dt | | - | 1400 | - | $\text{A}/\mu\text{s}$ |

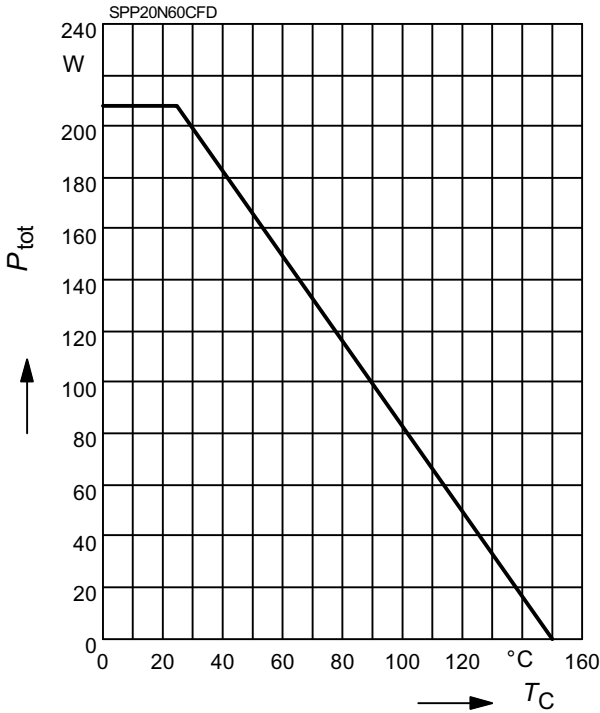
Typical Transient Thermal Characteristics

| Symbol | Value | Unit | Symbol | Value | Unit |
|--------------------|----------|------|---------------------|-----------|------|
| | typ. | | | typ. | |
| Thermal resistance | | | Thermal capacitance | | |
| R_{th1} | 0.007686 | K/W | C_{th1} | 0.0003764 | Ws/K |
| R_{th2} | 0.015 | | C_{th2} | 0.001412 | |
| R_{th3} | 0.029 | | C_{th3} | 0.001932 | |
| R_{th4} | 0.114 | | C_{th4} | 0.005299 | |
| R_{th5} | 0.136 | | C_{th5} | 0.012 | |
| R_{th6} | 0.059 | | C_{th6} | 0.091 | |



1 Power dissipation

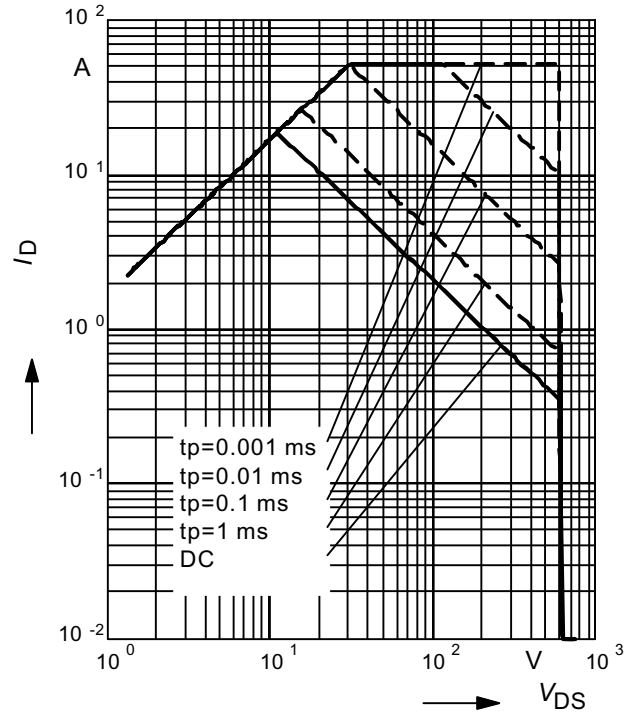
$$P_{tot} = f(T_C)$$



2 Safe operating area

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

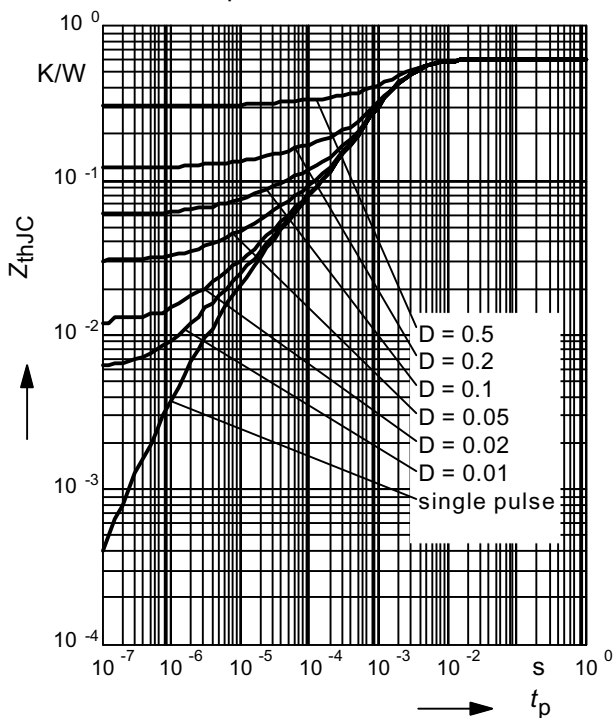
parameter : $D = 0, T_C = 25^\circ\text{C}$



3 Transient thermal impedance

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

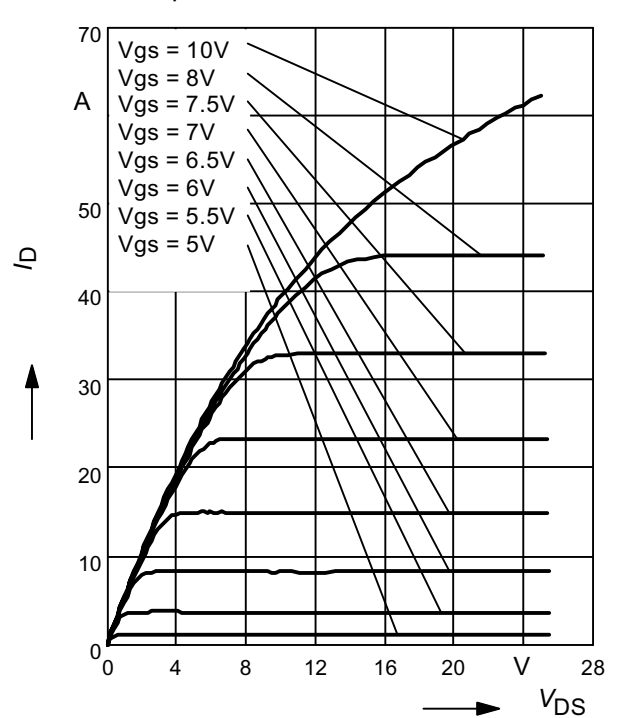
parameter: $D = t_p/T$



4 Typ. output characteristic

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

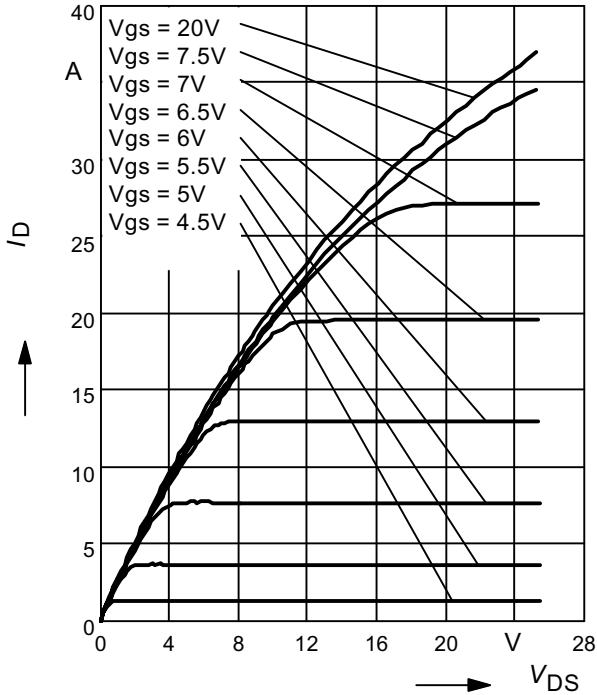
parameter: $t_p = 10 \mu\text{s}, V_{GS}$



5 Typ. output characteristic

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

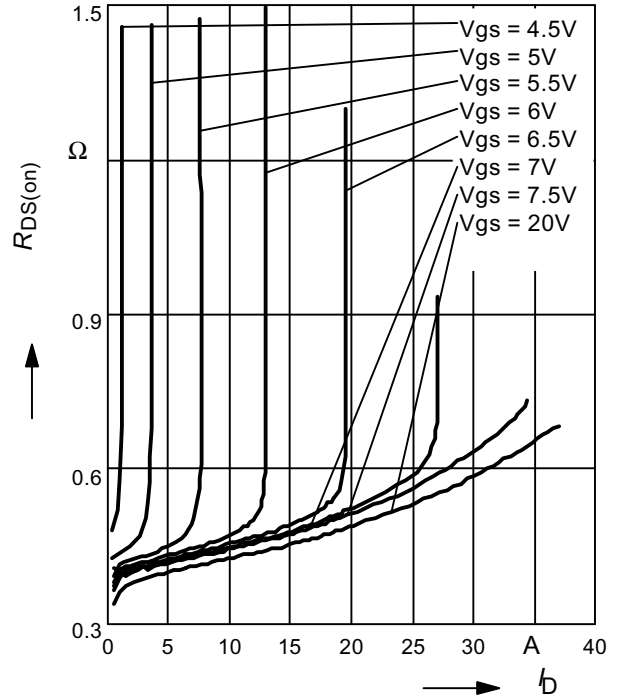
parameter: $t_p = 10 \mu\text{s}, V_{GS}$



6 Typ. drain-source on resistance

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

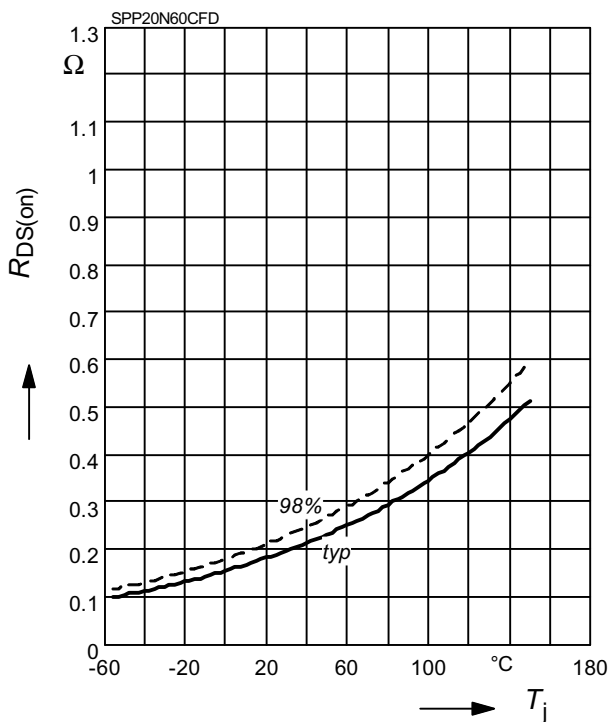
parameter: $T_j = 150^\circ\text{C}, V_{GS}$



7 Drain-source on-state resistance

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

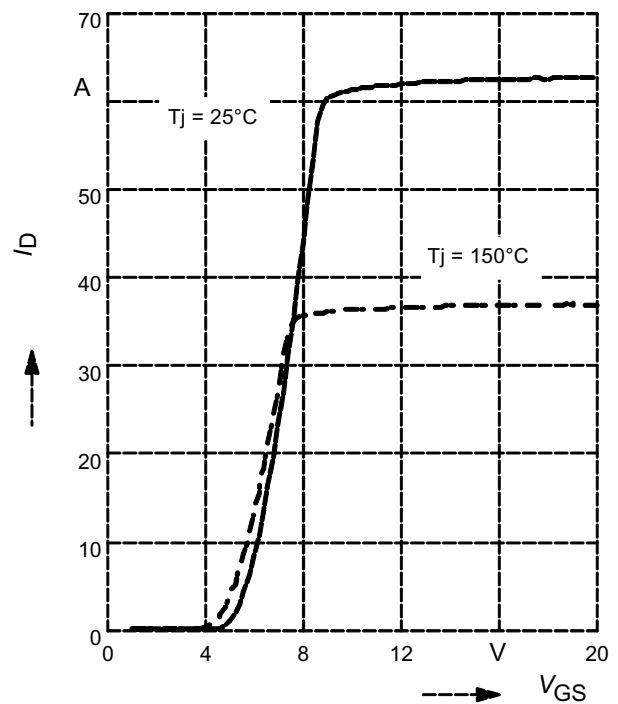
parameter: $I_D = 13.1 \text{ A}, V_{GS} = 10 \text{ V}$



8 Typ. transfer characteristics

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

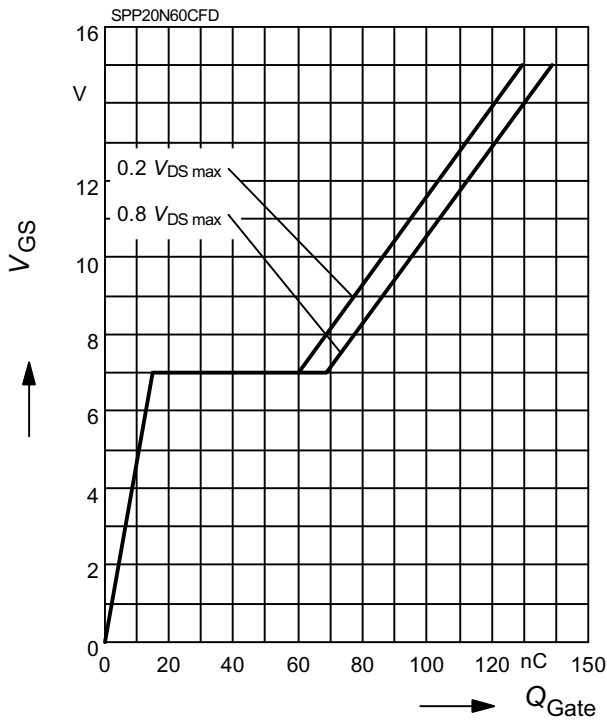
parameter: $t_p = 10 \mu\text{s}$



9 Typ. gate charge

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

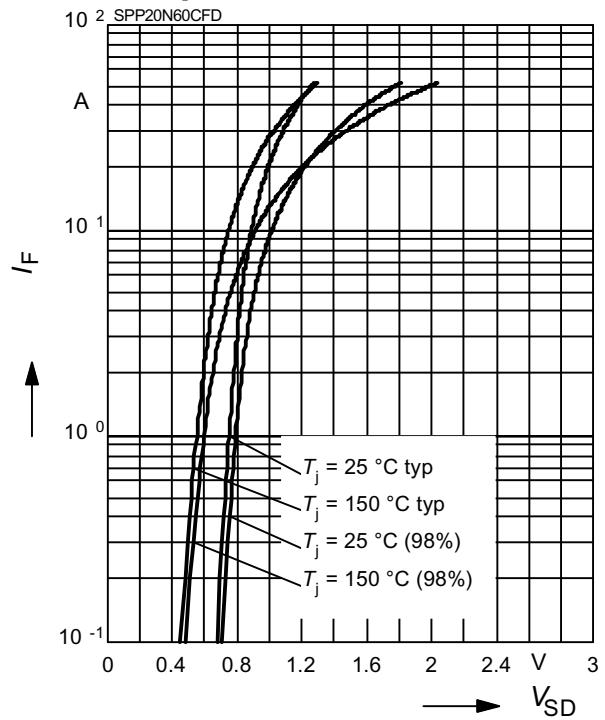
parameter: $I_D = 20.7 \text{ A}$ pulsed



10 Forward characteristics of body diode

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

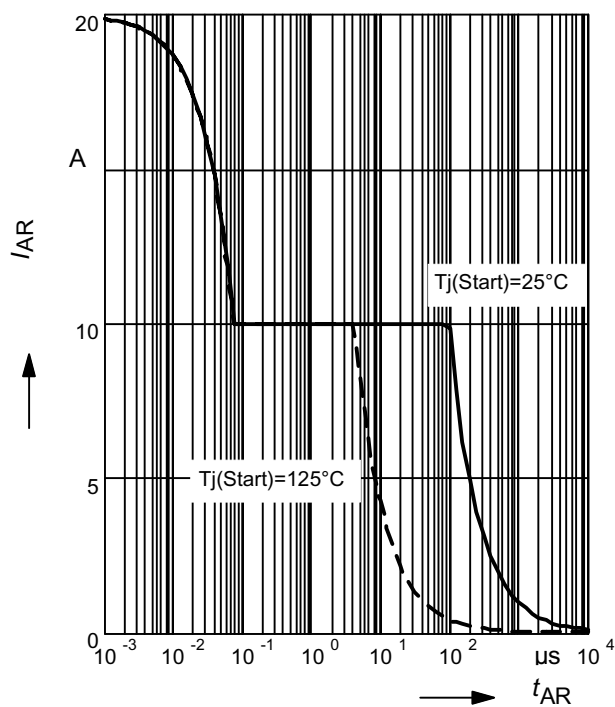
parameter: $T_j, t_p = 10 \mu\text{s}$



11 Avalanche SOA

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

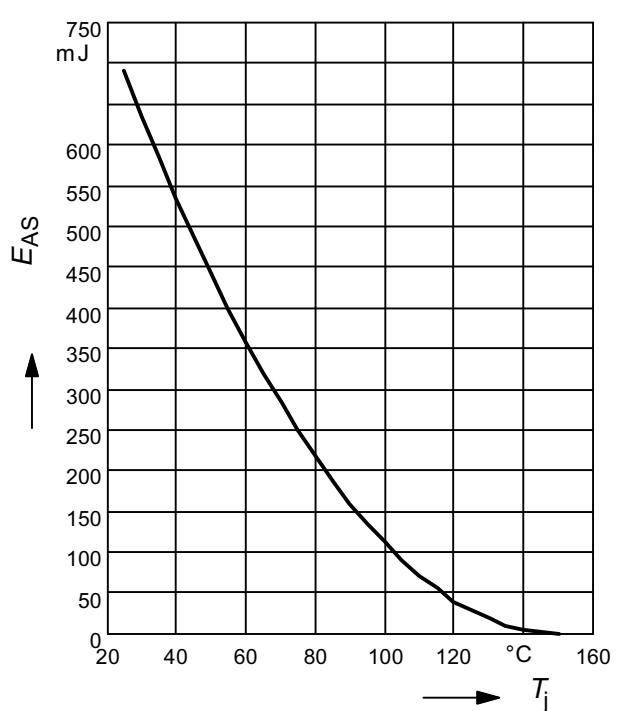
par.: $T_j \leq 150 \text{ °C}$



12 Avalanche energy

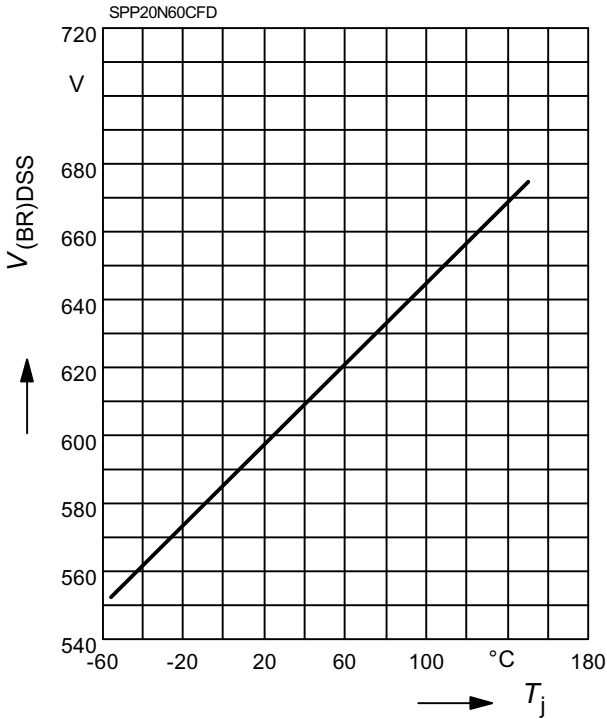
$$E_{AS} = f(T_j)$$

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



13 Drain-source breakdown voltage

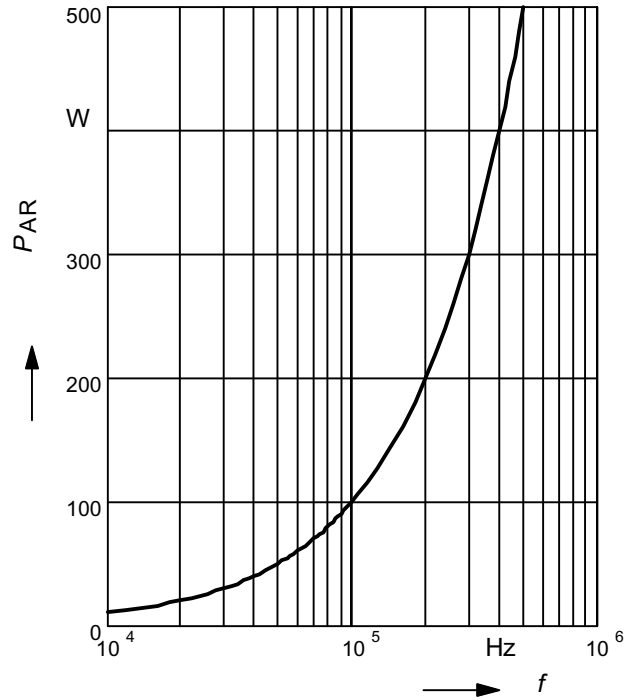
$$V_{(BR)DSS} = f(T_j)$$



14 Avalanche power losses

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

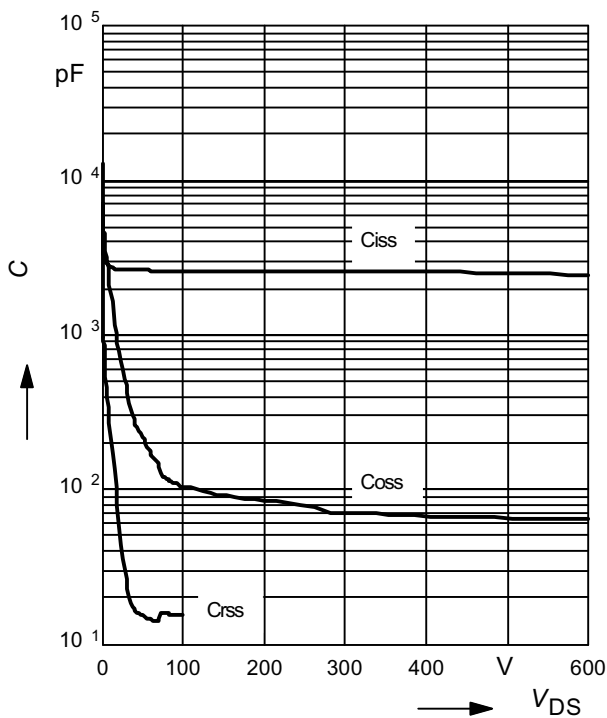
parameter: $E_{AR}=1mJ$



15 Typ. capacitances

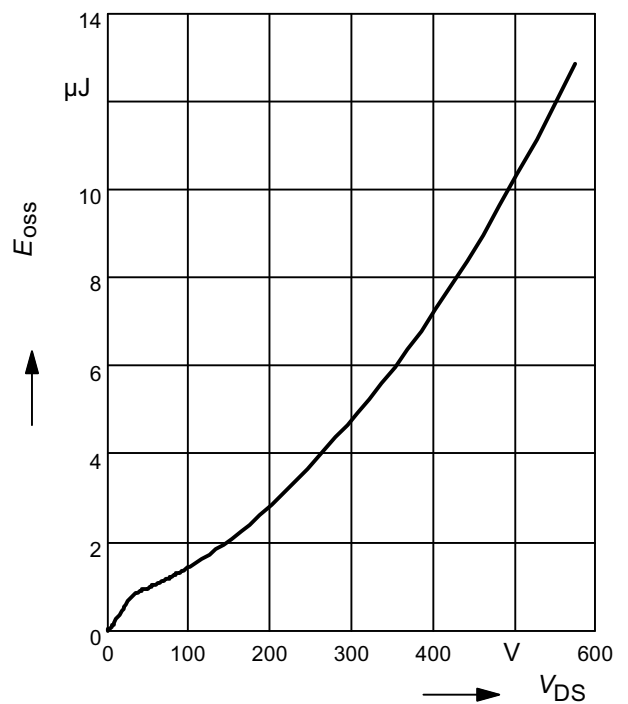
$$C = f(V_{DS})$$

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



16 Typ. C_{OSS} stored energy

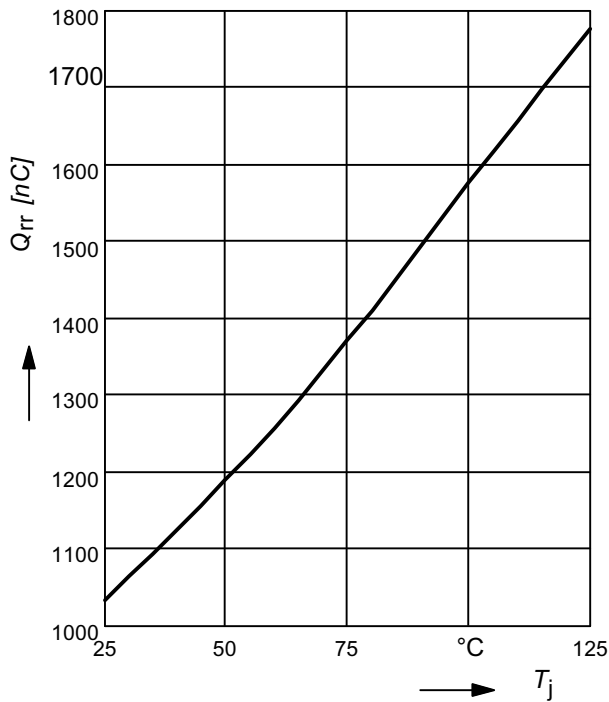
$$E_{OSS} = f(V_{DS})$$



17 Typ. reverse recovery charge

$$Q_{rr} = f(T_j)$$

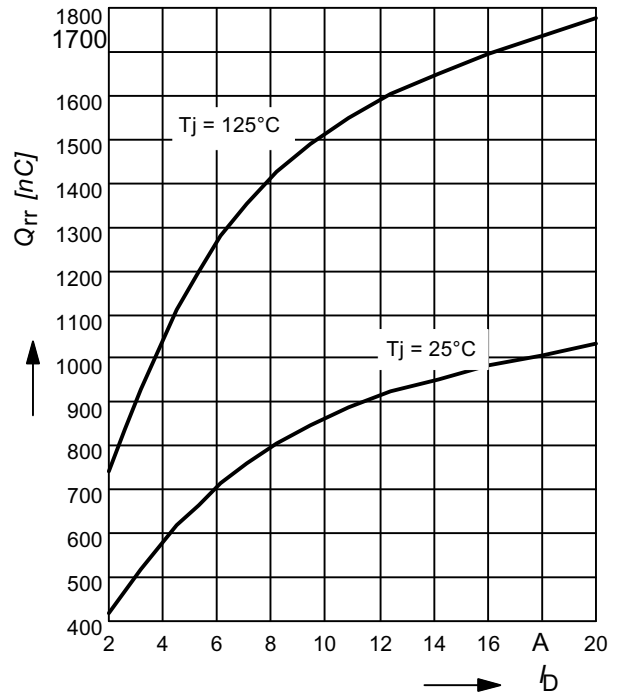
parameter: $I_D = 20.7A$



18 Typ. reverse recovery charge

$$Q_{rr} = f(I_D)$$

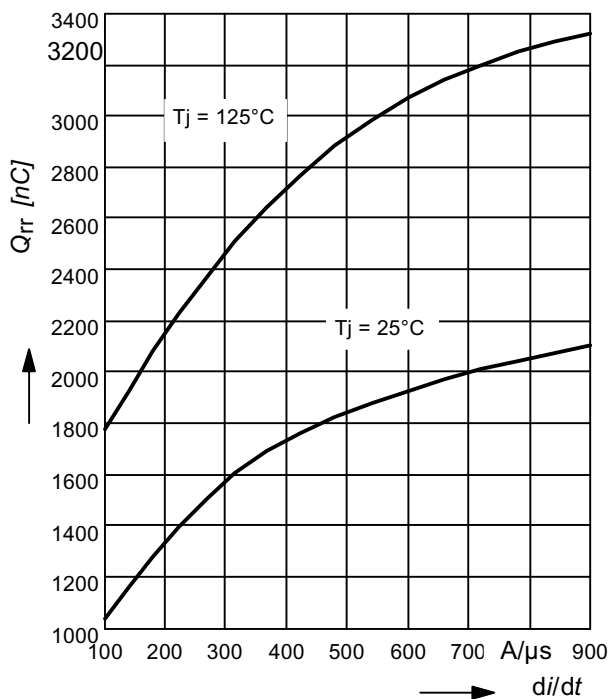
parameter: $di/dt = 100 A/\mu s$



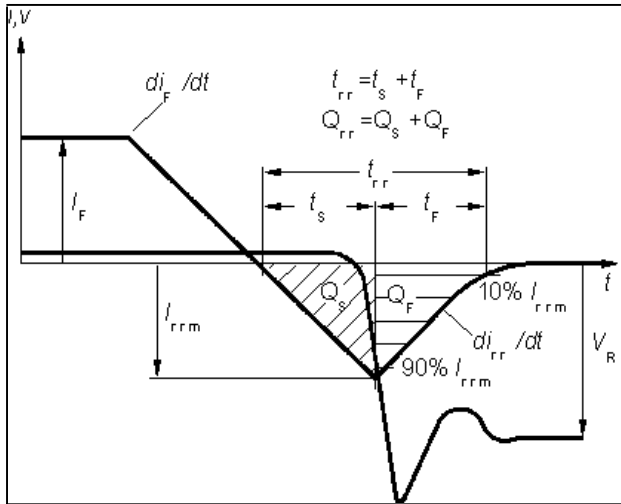
19 Typ. reverse recovery charge

$$Q_{rr} = f(di/dt)$$

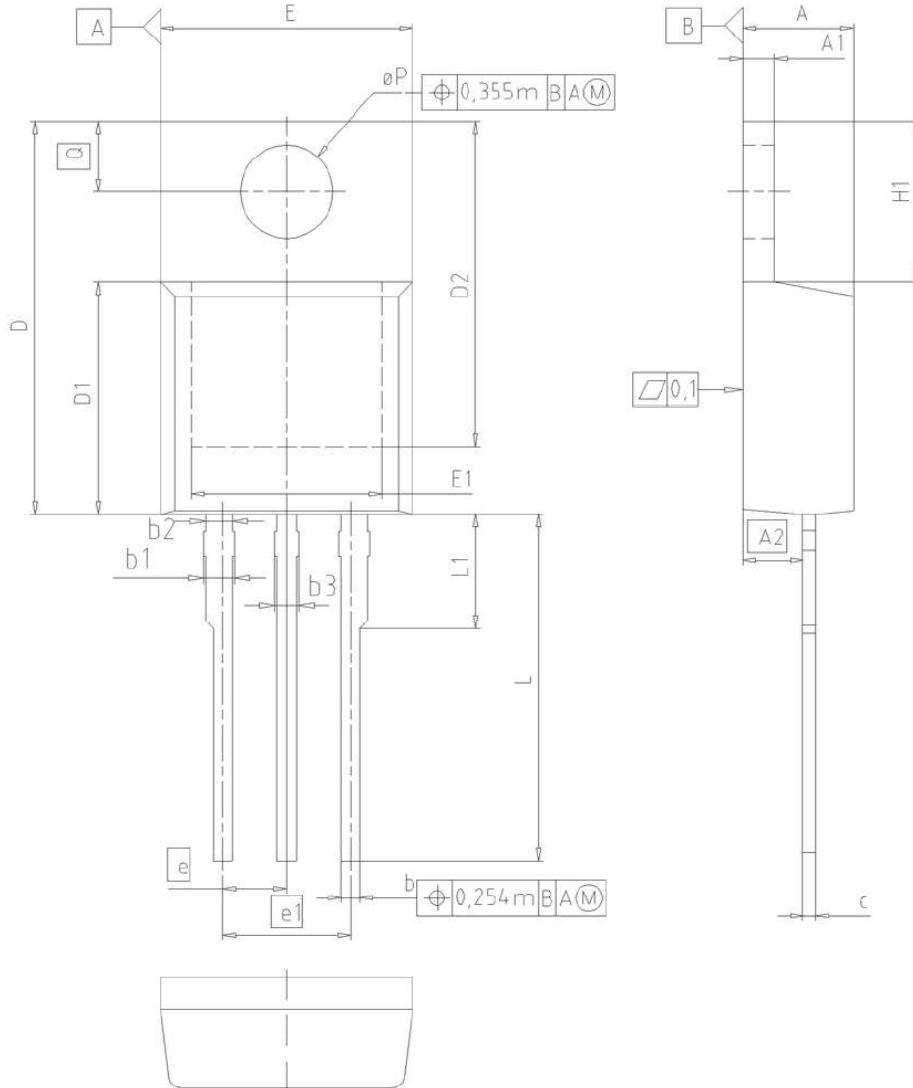
parameter: $I_D = 20.7 A$



Definition of diodes switching characteristics



PG-TO-220-3-1, PG-TO220-3-21



| DIM | MILLIMETERS | | INCHES | |
|----------|-------------|-------|--------|-------|
| | MIN | MAX | MIN | MAX |
| A | 4.30 | 4.57 | 0.169 | 0.180 |
| A1 | 1.17 | 1.40 | 0.046 | 0.055 |
| A2 | 2.15 | 2.72 | 0.085 | 0.107 |
| b | 0.65 | 0.86 | 0.026 | 0.034 |
| b1 | 0.95 | 1.40 | 0.037 | 0.055 |
| b2 | 0.95 | 1.15 | 0.037 | 0.045 |
| b3 | 0.65 | 1.15 | 0.026 | 0.045 |
| c | 0.33 | 0.60 | 0.013 | 0.024 |
| D | 14.81 | 15.95 | 0.583 | 0.628 |
| D1 | 8.51 | 9.45 | 0.335 | 0.372 |
| D2 | 12.19 | 13.10 | 0.480 | 0.516 |
| E | 9.70 | 10.36 | 0.382 | 0.408 |
| E1 | 6.50 | 8.60 | 0.256 | 0.339 |
| e | 2.54 | | 0.100 | |
| e1 | 5.08 | | 0.200 | |
| N | 3 | | 3 | |
| H1 | 5.90 | 6.90 | 0.232 | 0.272 |
| L | 13.00 | 14.00 | 0.512 | 0.551 |
| L1 | - | 4.80 | - | 0.189 |
| ϕP | 3.60 | 3.89 | 0.142 | 0.153 |
| Q | 2.60 | 3.00 | 0.102 | 0.118 |

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SCALE
0 2.5 5mm

EUROPEAN PROJECTION

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