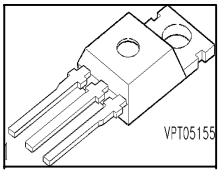
## Cool MOS™ Power Transistor

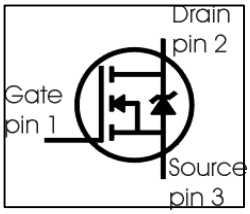
| | | |
|---|---|---|
| $V_{DS}$ @ $T_{jmax}$ | 650 | V |
| $R_{DS(on)}$ | 0.22 | Ω |
| $I_D$ | 20.7 | A |

### Feature

- New revolutionary high voltage technology
- Worldwide best $R_{DS(on)}$ in TO 220
- Ultra low gate charge
- Periodic avalanche rated
- Extreme d*v*/d*t* 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 JEDEC[0)]**

PG-TO220




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

### Maximum Ratings

| Parameter | Symbol | Value | Unit |
|---|---|---|---|
| Continuous drain current<br>$T_C$ = 25 °C<br>$T_C$ = 100 °C | $I_D$ | <br>20.7<br>13.1 | A |
| Pulsed drain current, $t_p$ limited by $T_{jmax}$ | $I_{D\ puls}$ | 52 | |
| Avalanche energy, single pulse<br>$I_D$ = 10 A, $V_{DD}$ = 50 V | $E_{AS}$ | 690 | mJ |
| Avalanche energy, repetitive $t_{AR}$ limited by $T_{jmax}$ [1)]<br>$I_D$ = 20 A, $V_{DD}$ = 50 V | $E_{AR}$ | 1 | |
| Avalanche current, repetitive $t_{AR}$ limited by $T_{jmax}$ | $I_{AR}$ | 20 | A |
| Reverse diode d*v*/d*t*<br>$I_S$=20.7A, $V_{DS}$=480V, $T_j$=125°C | d*v*/d*t* | 40 | V/ns |
| Gate source voltage | $V_{GS}$ | ±20 | V |
| Gate source voltage AC (f >1Hz) | $V_{GS}$ | ±30 | |
| Power dissipation, $T_C$ = 25°C | $P_{tot}$ | 208 | W |
| Operating and storage temperature | $T_j$ , $T_{stg}$ | -55... +150 | °C |

## Maximum Ratings

| Parameter | Symbol | Value | Unit |
|---|---|---|---|
| Drain Source voltage slope<br>$V_{DS}$ = 480 V, $I_D$ = 20.7 A, $T_j$ = 125 °C | d$v$/d$t$ | 80 | V/ns |
| Maximum diode commutation speed<br>$V_{DS}$ = 480 V, $I_D$ = 20.7 A, $T_j$ = 125 °C | d$i_F$/d$t$ | 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<br>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, $I_D$=20A | - | 700 | - | |
| Gate threshold voltage | $V_{GS(th)}$ | $I_D$=1000µA, $V_{GS}$=$V_{DS}$ | 3 | 4 | 5 | |
| Zero gate voltage drain current | $I_{DSS}$ | $V_{DS}$=600V, $V_{GS}$=0V,<br>$T_j$=25°C,<br>$T_j$=150°C | <br>-<br>- | <br>2.1<br>1700 | <br>-<br>- | µA |
| Gate-source leakage current | $I_{GSS}$ | $V_{GS}$=20V, $V_{DS}$=0V | - | - | 100 | nA |
| Drain-source on-state resistance | $R_{DS(on)}$ | $V_{GS}$=10V, $I_D$=13.1A,<br>$T_j$=25°C<br>$T_j$=150°C | <br>-<br>- | <br>0.19<br>0.51 | <br>0.22<br>- | Ω |
| Gate input resistance | $R_G$ | $f$=1MHz, open Drain | - | 0.54 | - | |

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

| Parameter | Symbol | Conditions | Values | | | Unit |
|---|---|---|---|---|---|---|
| | | | min. | typ. | max. | |
| Transconductance | $g_{fs}$ | $V_{DS}\geq 2*I_D*R_{DS(on)max}$, $I_D$=13.1A | - | 17.5 | - | S |
| Input capacitance | $C_{iss}$ | $V_{GS}$=0V, $V_{DS}$=25V, $f$=1MHz | - | 2400 | - | pF |
| Output capacitance | $C_{oss}$ | | - | 780 | - | |
| Reverse transfer capacitance | $C_{rss}$ | | - | 50 | - | |
| Effective output capacitance,[2] energy related | $C_{o(er)}$ | $V_{GS}$=0V, $V_{DS}$=0V to 480V | - | 83 | - | pF |
| Effective output capacitance,[3] time related | $C_{o(tr)}$ | | - | 160 | - | |
| Turn-on delay time | $t_{d(on)}$ | $V_{DD}$=380V, $V_{GS}$=0/10V, $I_D$=20.7A, $R_G$=3.6Ω | - | 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 | $Q_{gs}$ | $V_{DD}$=480V, $I_D$=20.7A | - | 15 | - | nC |
| Gate to drain charge | $Q_{gd}$ | | - | 54 | - | |
| Gate charge total | $Q_g$ | $V_{DD}$=480V, $I_D$=20.7A, $V_{GS}$=0 to 10V | - | 95 | 124 | |
| Gate plateau voltage | $V_{(plateau)}$ | $V_{DD}$=480V, $I_D$=20.7A | - | 7 | - | V |

[0] J-STD20 and JESD22

[1] Repetitve avalanche causes additional power losses that can be calculated as $P_{AV}=E_{AR}*f$.

[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% $V_{DSS}$.

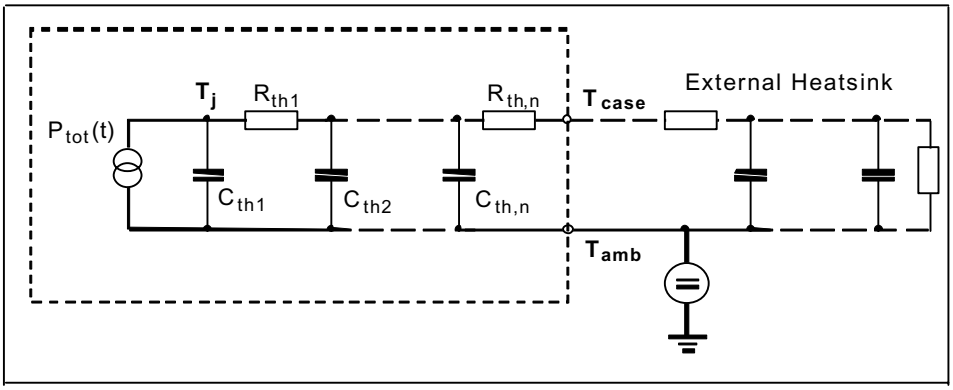
[3] $C_{o(tr)}$ is a fixed capacitance that gives the same charging time as $C_{oss}$ while $V_{DS}$ is rising from 0 to 80% $V_{DSS}$.

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

| Parameter | Symbol | Conditions | Values | | | Unit |
|---|---|---|---|---|---|---|
| | | | min. | typ. | max. | |
| Inverse diode continuous forward current | $I_S$ | $T_C$=25°C | - | - | 20.7 | A |
| Inverse diode direct current, pulsed | $I_{SM}$ | | - | - | 52 | |
| Inverse diode forward voltage | $V_{SD}$ | $V_{GS}$=0V, $I_F$=$I_S$ | - | 1 | 1.2 | V |
| Reverse recovery time | $t_{rr}$ | $V_R$=480V, $I_F$=$I_S$ , d$i_F$/d$t$=100A/µs | - | 150 | - | ns |
| Reverse recovery charge | $Q_{rr}$ | | - | 1 | - | µC |
| Peak reverse recovery current | $I_{rrm}$ | | - | 13 | - | A |
| Peak rate of fall of reverse recovery current | $di_{rr}/dt$ | | - | 1400 | - | A/µs |

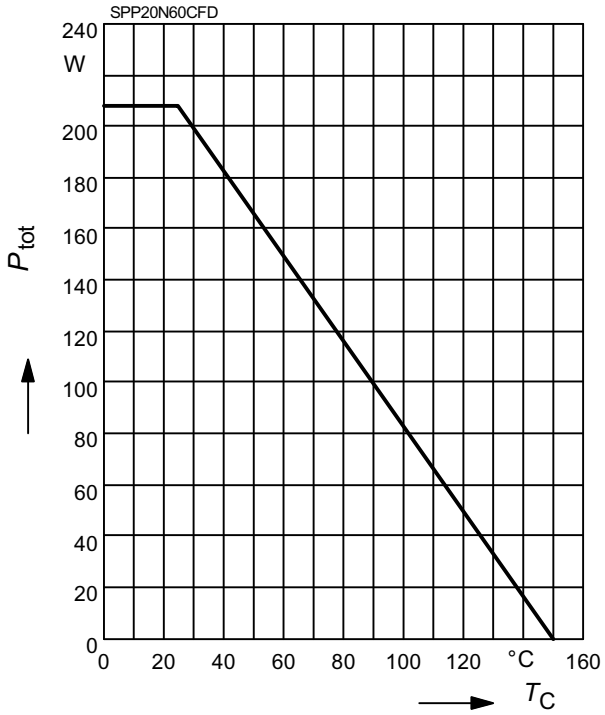
**Typical Transient Thermal Characteristics**

| 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

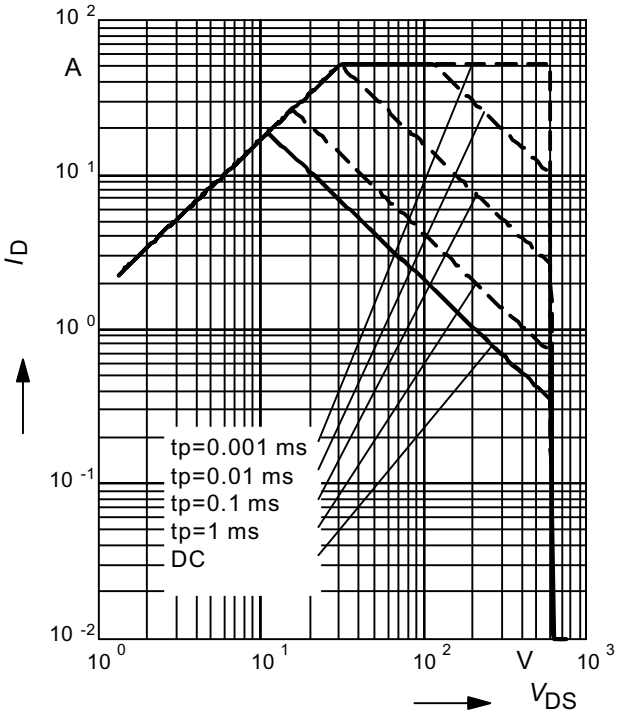
$P_{tot} = f(T_C)$




## 2 Safe operating area

$I_D = f(V_{DS})$

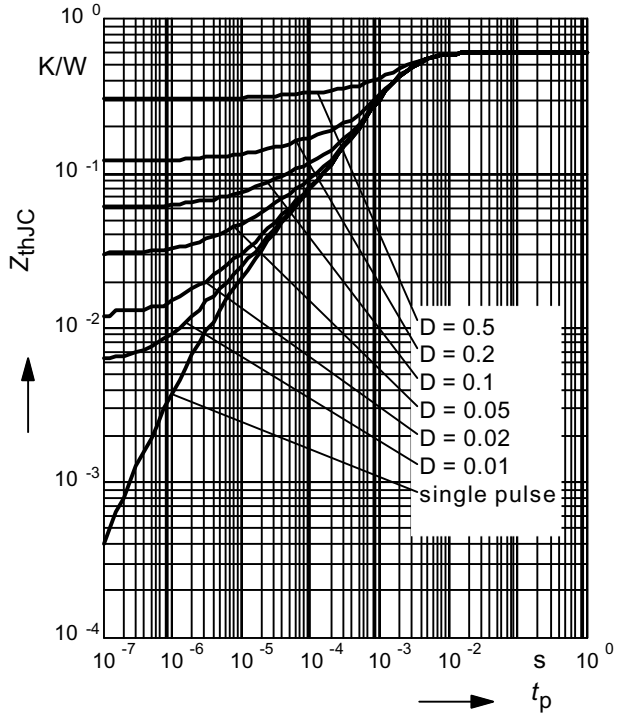
parameter : $D = 0$ , $T_C$=25°C




## 3 Transient thermal impedance

$Z_{thJC} = f(t_p)$

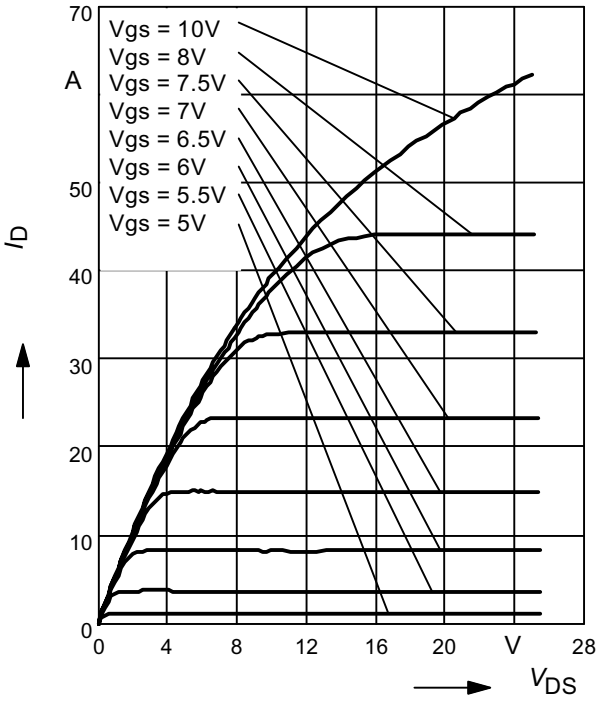
parameter: $D = t_p/T$




## 4 Typ. output characteristic

$I_D = f(V_{DS})$; $T_j$=25°C

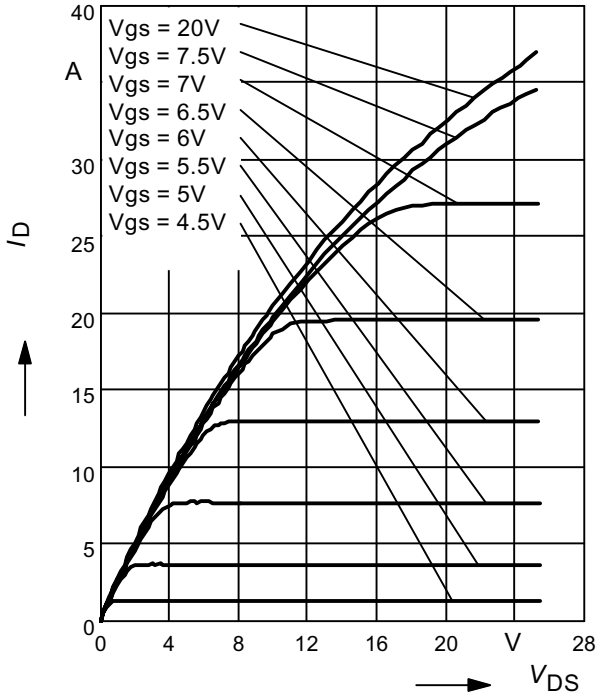
parameter: $t_p$ = 10 µs, $V_{GS}$



## 5 Typ. output characteristic

$I_D = f(V_{DS})$; $T_j$=150°C

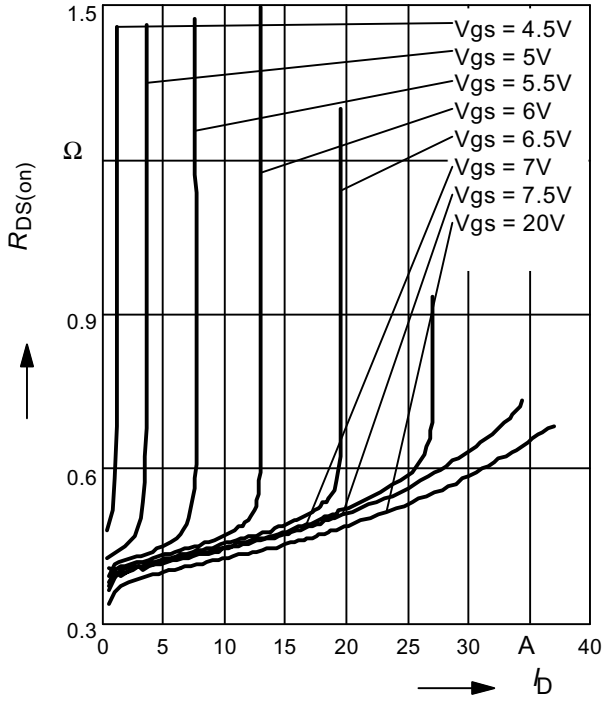
parameter: $t_p$ = 10 µs, $V_{GS}$




## 6 Typ. drain-source on resistance

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

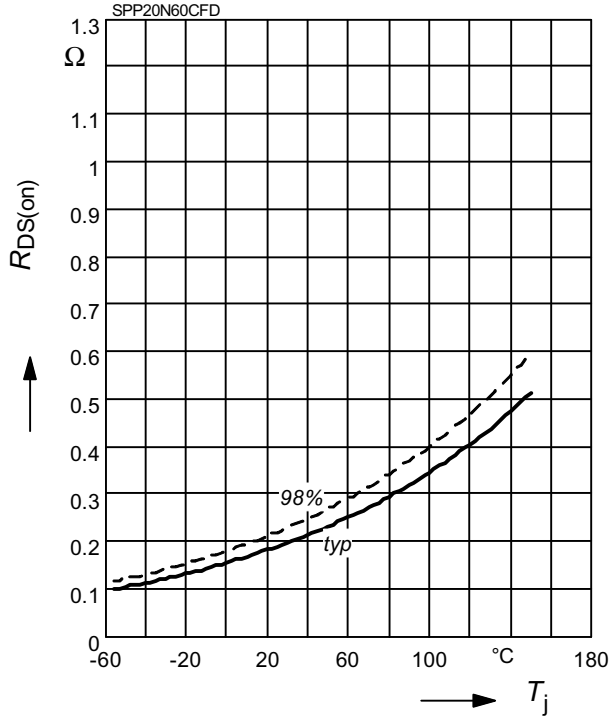
parameter: $T_j$=150°C, $V_{GS}$




## 7 Drain-source on-state resistance

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

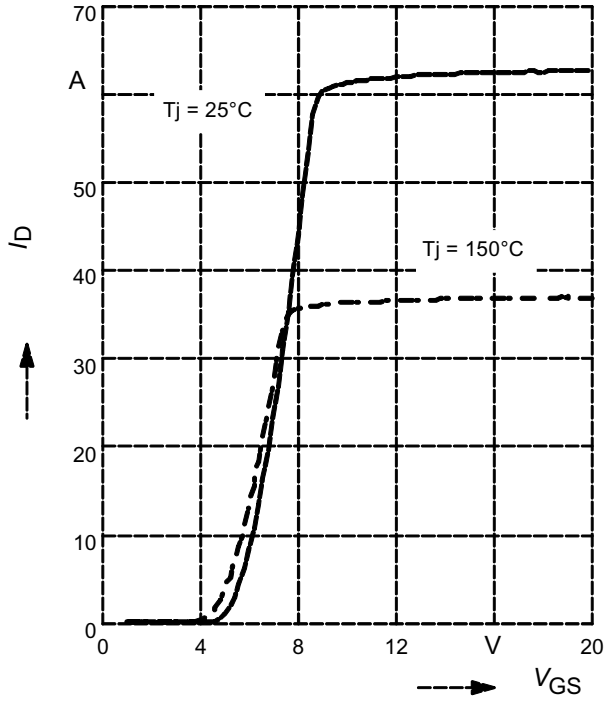
parameter : $I_D$ = 13.1 A, $V_{GS}$ = 10 V




## 8 Typ. transfer characteristics

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

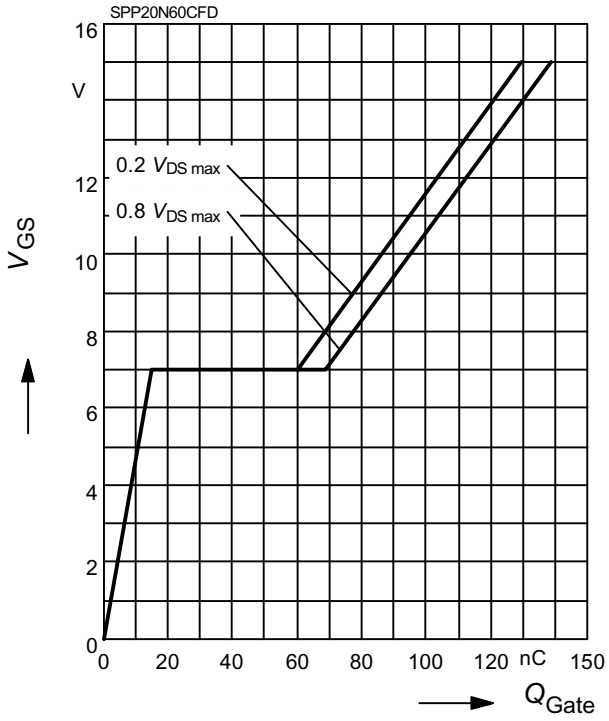
parameter: $t_p$ = 10 µs



## 9 Typ. gate charge

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

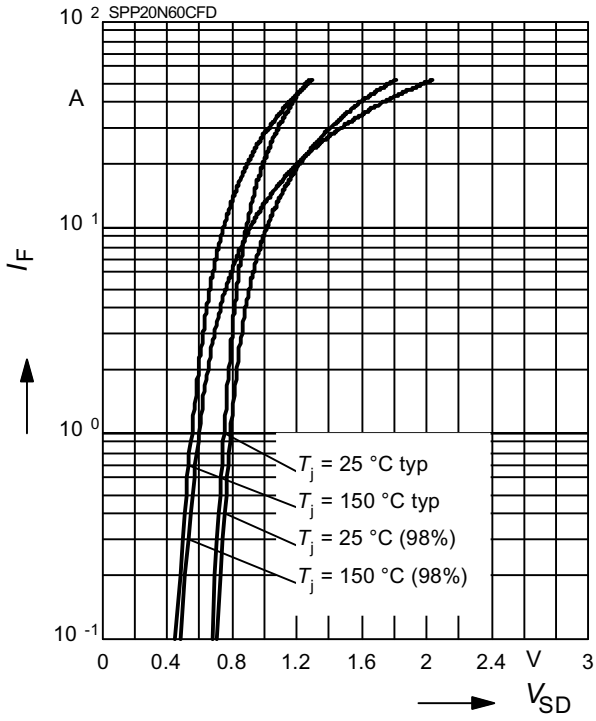
parameter: $I_D$ = 20.7 A pulsed




## 10 Forward characteristics of body diode

$I_F = f(V_{SD})$

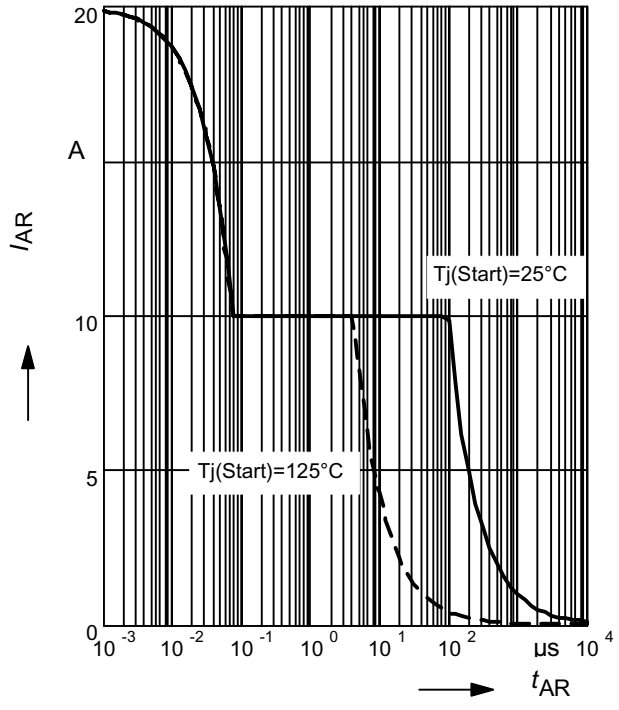
parameter: $T_j$ , tp = 10 µs




## 11 Avalanche SOA

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

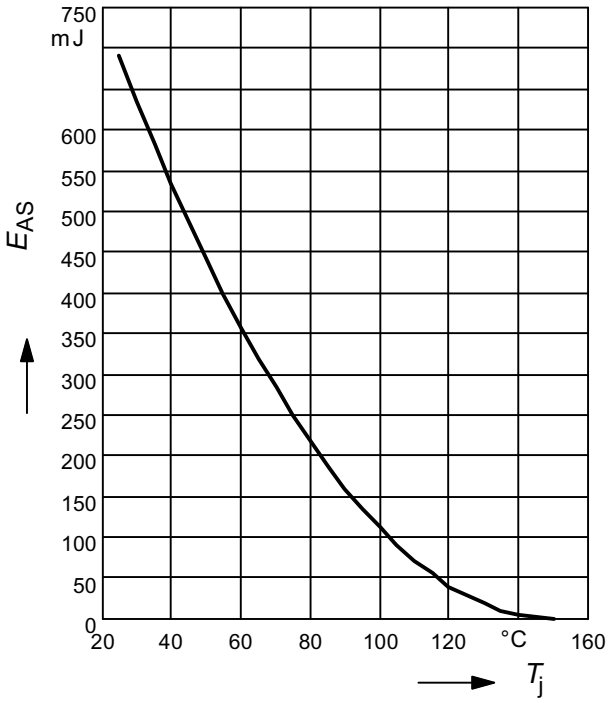
par.: $T_j \leq 150$ °C




## 12 Avalanche energy

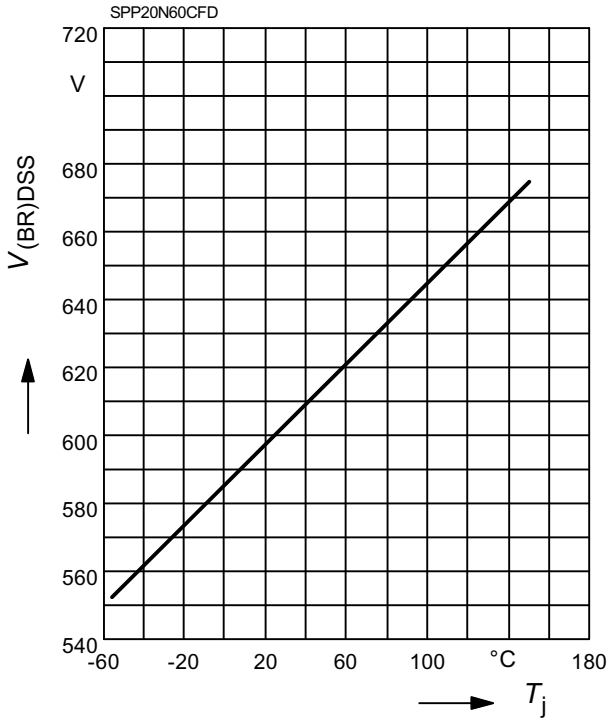
$E_{AS} = f(T_j)$

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



## 13 Drain-source breakdown voltage

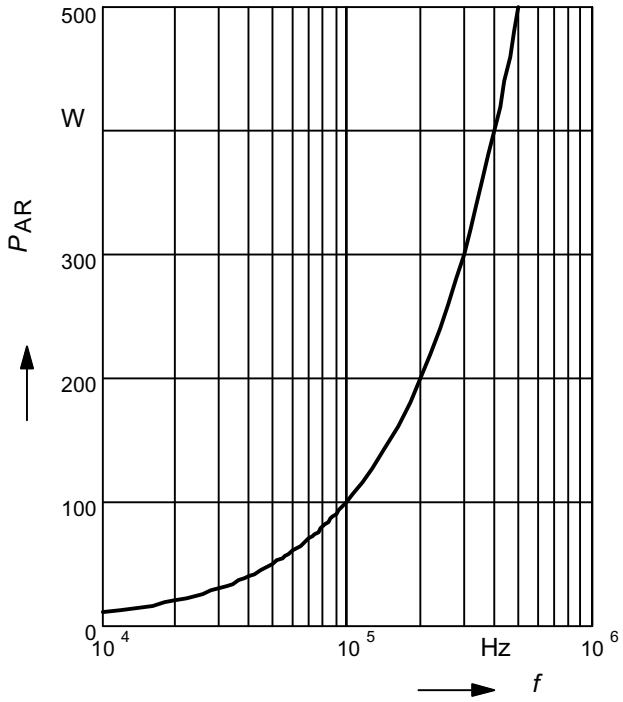
$V_{(BR)DSS} = f(T_j)$




## 14 Avalanche power losses

$P_{AR} = f(f)$

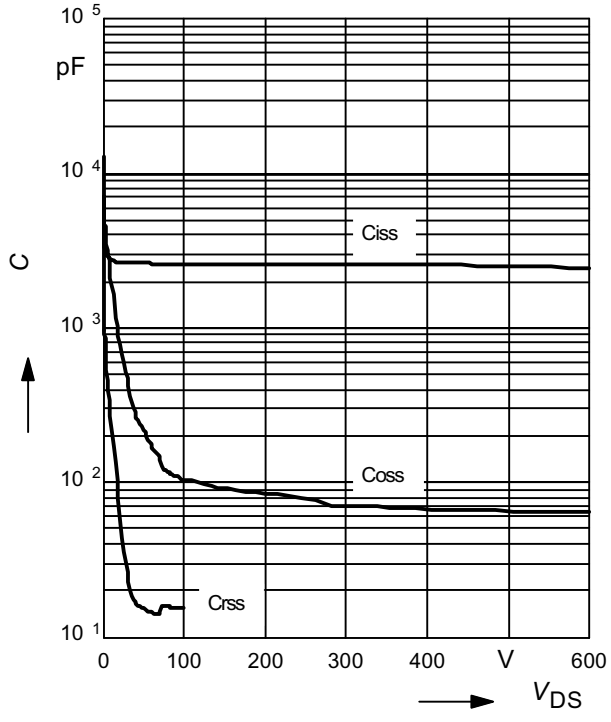
parameter: $E_{AR}$=1mJ




## 15 Typ. capacitances

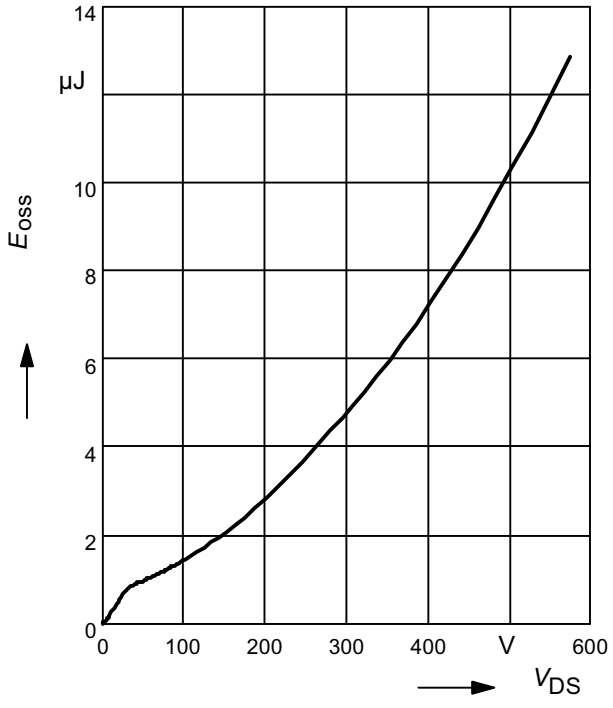
$C = f(V_{DS})$

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




## 16 Typ. $C_{oss}$ stored energy

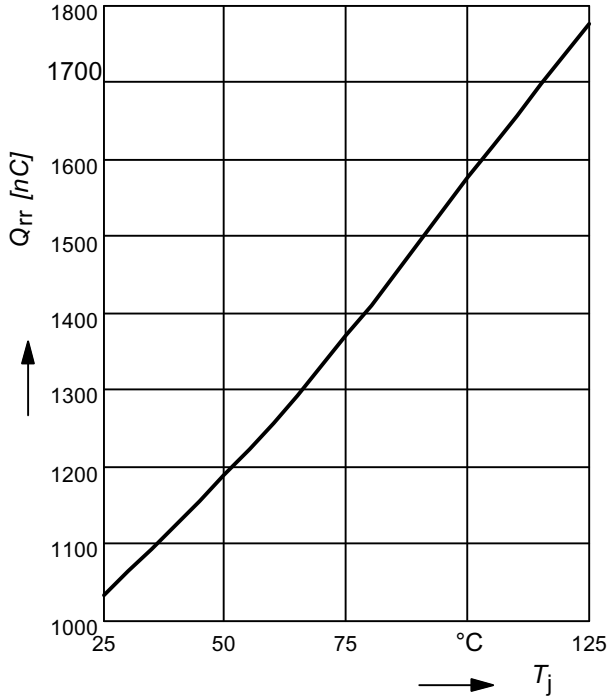
$E_{oss}$=$f$($V_{DS}$)



## 17 Typ. reverse recovery charge

$Q_{rr} = f(T_J)$

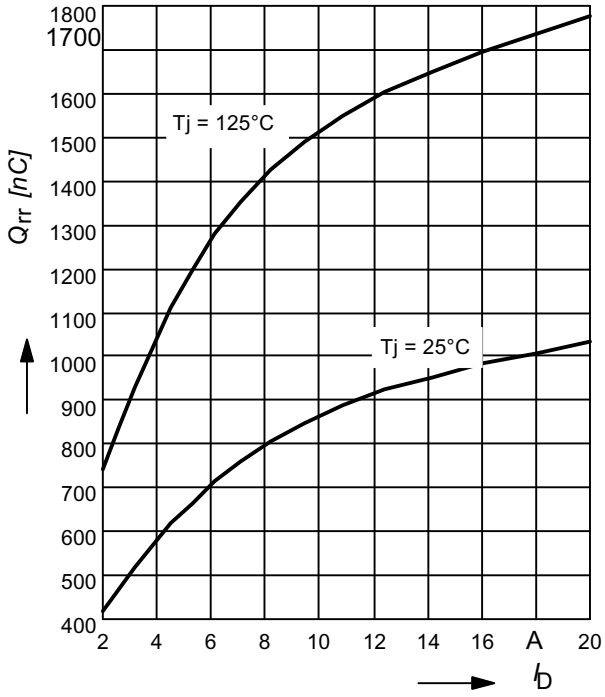
parameter: $I_D$ = 20.7A




## 18 Typ. reverse recovery charge

$Q_{rr} = f(I_D)$

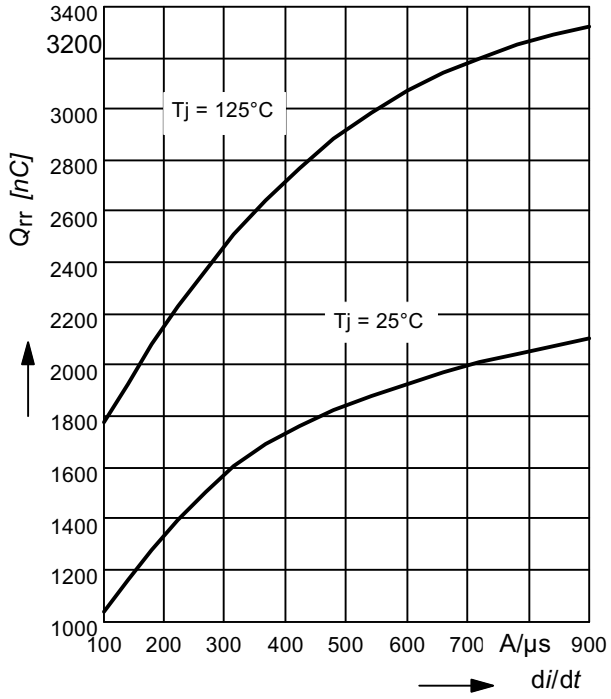
parameter: $di/dt$ = 100 A/µs



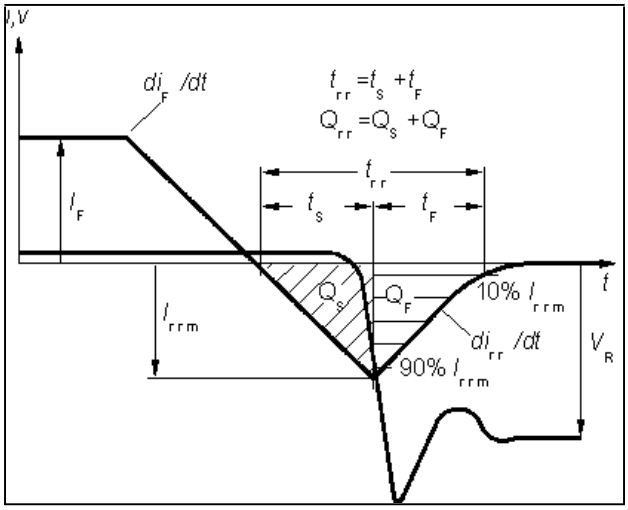

## 19 Typ. reverse recovery charge

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

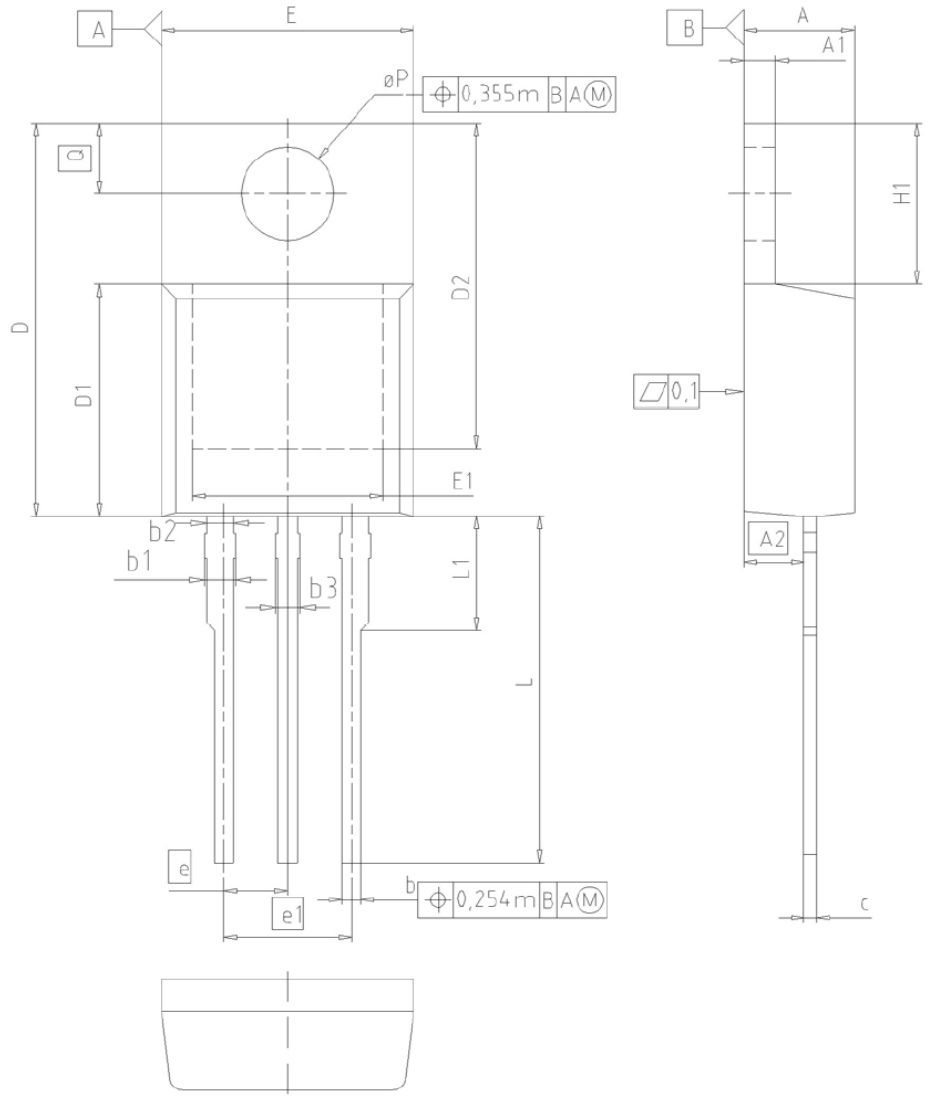
parameter: $I_D$ = 20.7 A



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 |
| øP | 3.60 | 3.89 | 0.142 | 0.153 |
| Q | 2.60 | 3.00 | 0.102 | 0.118 |

| | |
|---|---|
| DOCUMENT NO. | Z8B00003318 |
| SCALE | 0 2.5 0 2.5 5mm |
| EUROPEAN PROJECTION | |
| ISSUE DATE | 23-08-2007 |
| REVISION | 05 |

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