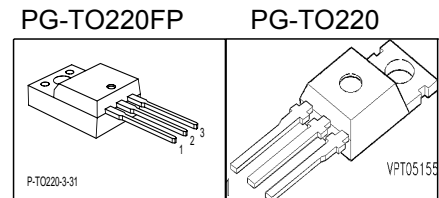


Cool MOS™ Power Transistor

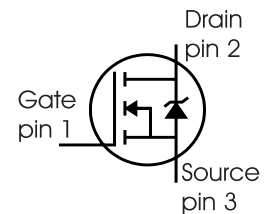
Feature

- New revolutionary high voltage technology
- Ultra low gate charge
- Periodic avalanche rated
- Extreme dv/dt rated
- High peak current capability
- Improved transconductance
- PG-TO-220-3-31;-3-111: Fully isolated package (2500 VAC; 1 minute)
- Pb-free lead plating; RoHS compliant
- Qualified according to JEDEC⁰⁾ for target applications

| | | |
|---------------------|-----|----------|
| $V_{DS} @ T_{jmax}$ | 650 | V |
| $R_{DS(on)}$ | 1.4 | Ω |
| I_D | 3.2 | A |



| Type | Package | Ordering Code | Marking |
|------------|------------|---------------|---------|
| SPP03N60C3 | PG-TO220 | Q67040-S4401 | 03N60C3 |
| SPA03N60C3 | PG-TO220FP | SP000216296 | 03N60C3 |



Maximum Ratings

| Parameter | Symbol | Value | | Unit |
|-------------------------------------------------------------------------------------------------------------------|---------------------|------------|--------------------------------------|------------------|
| | | SPP | SPA | |
| Continuous drain current $T_C = 25\text{ }^\circ\text{C}$ $T_C = 100\text{ }^\circ\text{C}$ | I_D | 3.2 2 | 3.2 ¹⁾ 2 ¹⁾ | A |
| Pulsed drain current, t_p limited by T_{jmax} | $I_{D\text{ puls}}$ | 9.6 | 9.6 | A |
| Avalanche energy, single pulse $I_D=2.4\text{A}, V_{DD}=50\text{V}$ | E_{AS} | 100 | 100 | mJ |
| Avalanche energy, repetitive t_{AR} limited by T_{jmax} ²⁾ $I_D=3.2\text{A}, V_{DD}=50\text{V}$ | E_{AR} | 0.2 | 0.2 | |
| Avalanche current, repetitive t_{AR} limited by T_{jmax} | I_{AR} | 3.2 | 3.2 | A |
| Gate source voltage static | V_{GS} | ± 20 | ± 20 | V |
| Gate source voltage AC ($f > 1\text{Hz}$) | V_{GS} | ± 30 | ± 30 | |
| Power dissipation, $T_C = 25\text{ }^\circ\text{C}$ | P_{tot} | 38 | 29.7 | W |
| Operating and storage temperature | T_j, T_{stg} | -55...+150 | | $^\circ\text{C}$ |
| Reverse diode dv/dt ⁷⁾ | dv/dt | 15 | | V/ns |

Maximum Ratings

| Parameter | Symbol | Value | Unit |
|------------------------------------------------------------------------------------------------------|---------|-------|------|
| Drain Source voltage slope $V_{DS} = 480\text{ V}$, $I_D = 3.2\text{ A}$, $T_j = 125\text{ °C}$ | dv/dt | 50 | V/ns |

Thermal Characteristics

| Parameter | Symbol | Values | | | Unit |
|---------------------------------------------------------------------------------------------------|----------------------|--------|------|------|------|
| | | min. | typ. | max. | |
| Thermal resistance, junction - case | R_{thJC} | - | - | 3.3 | K/W |
| Thermal resistance, junction - case, FullPAK | $R_{thJC\text{ FP}}$ | - | - | 4.1 | |
| 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 | |
| Soldering temperature, wavesoldering 1.6 mm (0.063 in.) from case for 10s ⁴⁾ | T_{sold} | - | - | 260 | °C |

Electrical Characteristics, at $T_j=25\text{ °C}$ 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 | $V_{(BR)DS}$ | $V_{GS}=0\text{V}$, $I_D=3.2\text{A}$ | - | 700 | - | |
| Gate threshold voltage | $V_{GS(th)}$ | $I_D=135\mu\text{A}$, $V_{GS}=V_{DS}$ | 2.1 | 3 | 3.9 | |
| Zero gate voltage drain current | I_{DSS} | $V_{DS}=600\text{V}$, $V_{GS}=0\text{V}$, $T_j=25\text{ °C}$ $T_j=150\text{ °C}$ | - | 0.5 | 1 | μA |
| Gate-source leakage current | I_{GSS} | $V_{GS}=30\text{V}$, $V_{DS}=0\text{V}$ | - | - | 100 | |
| Drain-source on-state resistance | $R_{DS(on)}$ | $V_{GS}=10\text{V}$, $I_D=2\text{A}$ $T_j=25\text{ °C}$ $T_j=150\text{ °C}$ | - | 1.26 | 1.4 | Ω |
| Gate input resistance | R_G | $f=1\text{MHz}$, open drain | - | 10 | - | |

Electrical Characteristics

| Parameter | Symbol | Conditions | Values | | | Unit |
|---------------------------------------------------------------|--------------|---------------------------------------------------------------|--------|------|------|------|
| | | | min. | typ. | max. | |
| Transconductance | g_{fs} | $V_{DS} \geq 2 \cdot I_D \cdot R_{DS(on)max}$, $I_D = 2A$ | - | 3.4 | - | S |
| Input capacitance | C_{iss} | $V_{GS} = 0V$, $V_{DS} = 25V$, | - | 400 | - | pF |
| Output capacitance | C_{oss} | $f = 1MHz$ | - | 150 | - | |
| Reverse transfer capacitance | C_{rss} | | - | 5 | - | |
| Effective output capacitance, ⁵⁾ energy related | $C_{o(er)}$ | $V_{GS} = 0V$, $V_{DS} = 0V$ to 480V | - | 12 | - | |
| Effective output capacitance, ⁶⁾ time related | $C_{o(tr)}$ | | - | 26 | - | |
| Turn-on delay time | $t_{d(on)}$ | $V_{DD} = 350V$, $V_{GS} = 0/10V$, | - | 7 | - | ns |
| Rise time | t_r | $I_D = 3.2A$, | - | 3 | - | |
| Turn-off delay time | $t_{d(off)}$ | $R_G = 20\Omega$ | - | 64 | 100 | |
| Fall time | t_f | | - | 12 | 20 | |

Gate Charge Characteristics

| | | | | | | |
|-----------------------|-----------------|---------------------------------------------------------|---|-----|----|----|
| Gate to source charge | Q_{gs} | $V_{DD} = 420V$, $I_D = 3.2A$ | - | 2 | - | nC |
| Gate to drain charge | Q_{gd} | | - | 6 | - | |
| Gate charge total | Q_g | $V_{DD} = 420V$, $I_D = 3.2A$, $V_{GS} = 0$ to 10V | - | 13 | 17 | |
| Gate plateau voltage | $V_{(plateau)}$ | $V_{DD} = 420V$, $I_D = 3.2A$ | - | 5.5 | - | 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 $I_{SD} \leq I_D$, $di/dt \leq 400A/us$, $V_{Dclink} = 400V$, $V_{peak} < V_{BR, DSS}$, $T_j < T_{j,max}$.

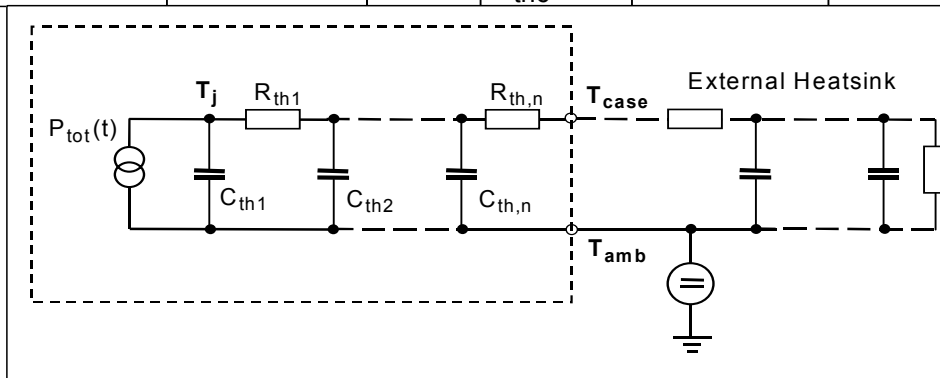
Identical low-side and high-side switch.

Electrical Characteristics

| Parameter | Symbol | Conditions | Values | | | Unit |
|-----------------------------------------------|--------------|-----------------------------------|--------|------|------|------------------------|
| | | | min. | typ. | max. | |
| Inverse diode continuous forward current | I_S | $T_C=25^\circ\text{C}$ | - | - | 3.2 | A |
| Inverse diode direct current, pulsed | I_{SM} | | - | - | 9.6 | |
| Inverse diode forward voltage | V_{SD} | $V_{GS}=0\text{V}, I_F=I_S$ | - | 1 | 1.2 | V |
| Reverse recovery time | t_{rr} | $V_R=420\text{V}, I_F=I_S,$ | - | 250 | 400 | ns |
| Reverse recovery charge | Q_{rr} | $di_F/dt=100\text{A}/\mu\text{s}$ | - | 1.8 | - | μC |
| Peak reverse recovery current | I_{rrm} | | - | 15 | - | A |
| Peak rate of fall of reverse recovery current | di_{rr}/dt | $T_j=25^\circ\text{C}$ | - | - | - | $\text{A}/\mu\text{s}$ |

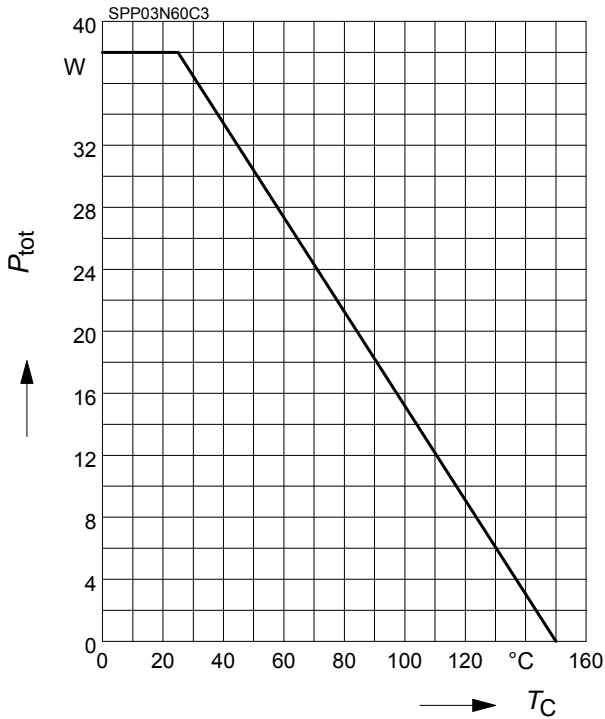
Typical Transient Thermal Characteristics

| Symbol | Value | | Unit | Symbol | Value | | Unit |
|-----------|-------|-------|------|-----------|------------|------------|------|
| | SPP | SPA | | | SPP | SPA | |
| R_{th1} | 0.054 | 0.054 | K/W | C_{th1} | 0.00005232 | 0.00005232 | Ws/K |
| R_{th2} | 0.103 | 0.103 | | C_{th2} | 0.0002034 | 0.0002034 | |
| R_{th3} | 0.178 | 0.178 | | C_{th3} | 0.0002963 | 0.0002963 | |
| R_{th4} | 0.757 | 0.356 | | C_{th4} | 0.0009103 | 0.0009103 | |
| R_{th5} | 0.682 | 0.655 | | C_{th5} | 0.002084 | 0.004434 | |
| R_{th6} | 0.202 | 2.535 | | C_{th6} | 0.024 | 0.412 | |



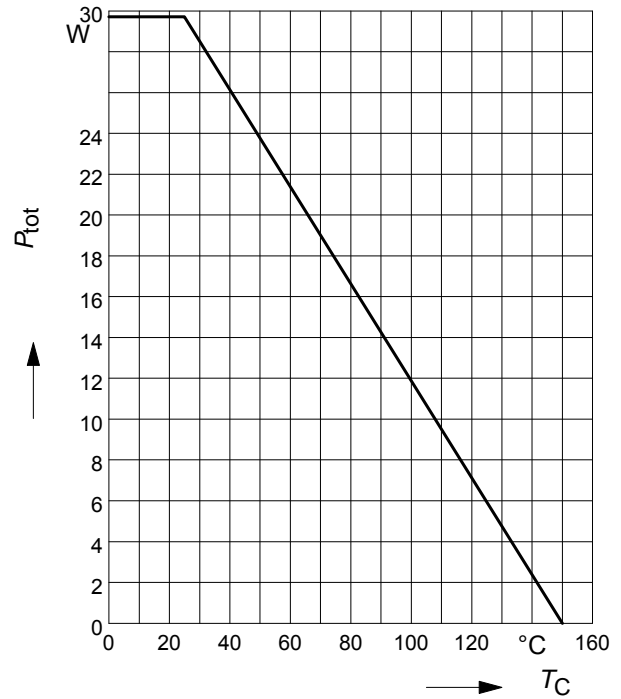
1 Power dissipation

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



2 Power dissipation FullPAK

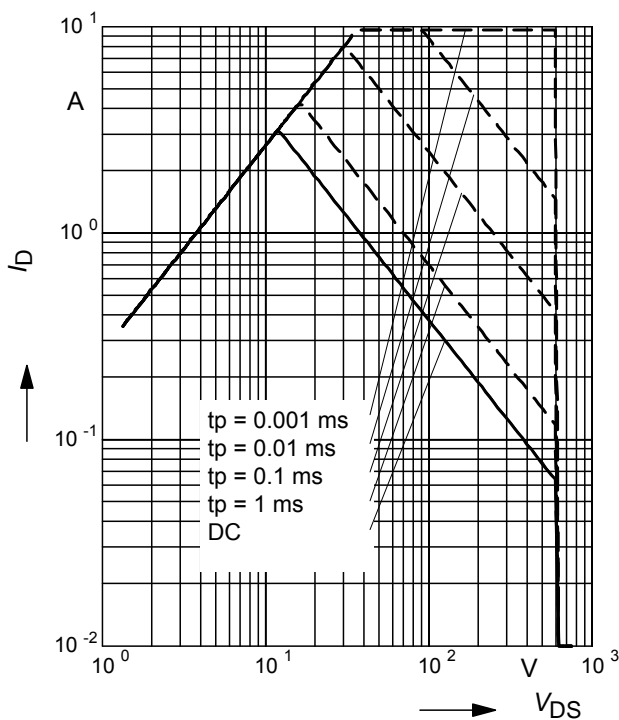
$$P_{tot} = f(T_C)$$



3 Safe operating area

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

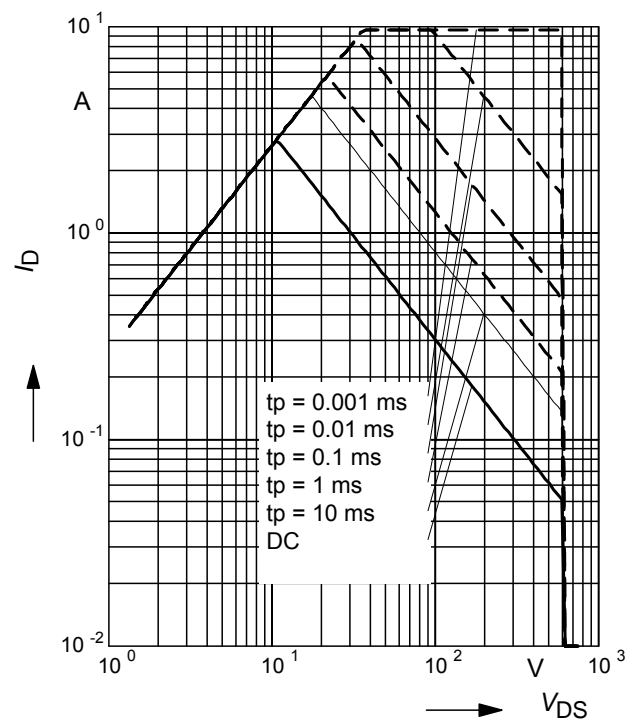
parameter : $D = 0$, $T_C = 25^\circ\text{C}$



4 Safe operating area FullPAK

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

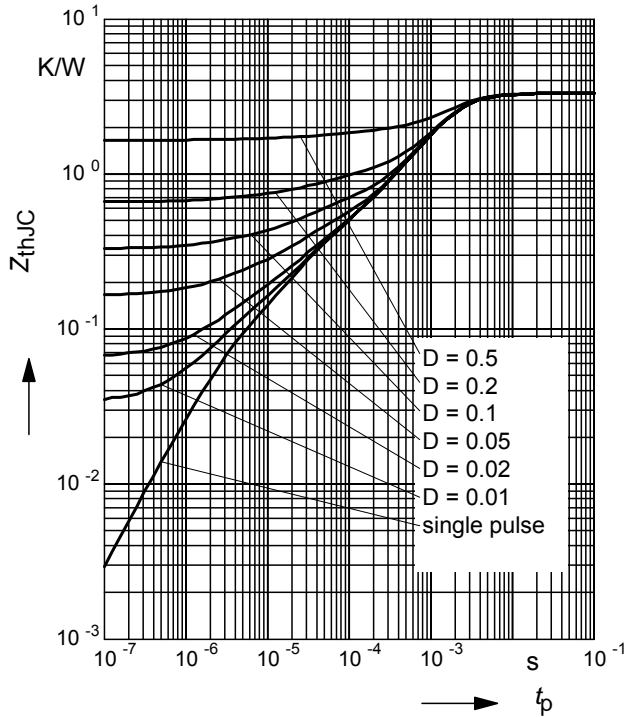
parameter: $D = 0$, $T_C = 25^\circ\text{C}$



5 Transient thermal impedance

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

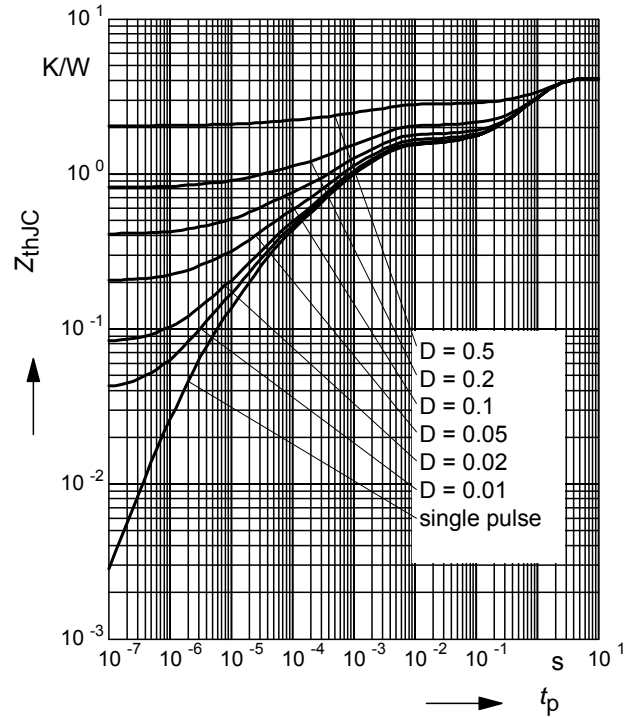
parameter: $D = t_p/T$



6 Transient thermal impedance FullPAK

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

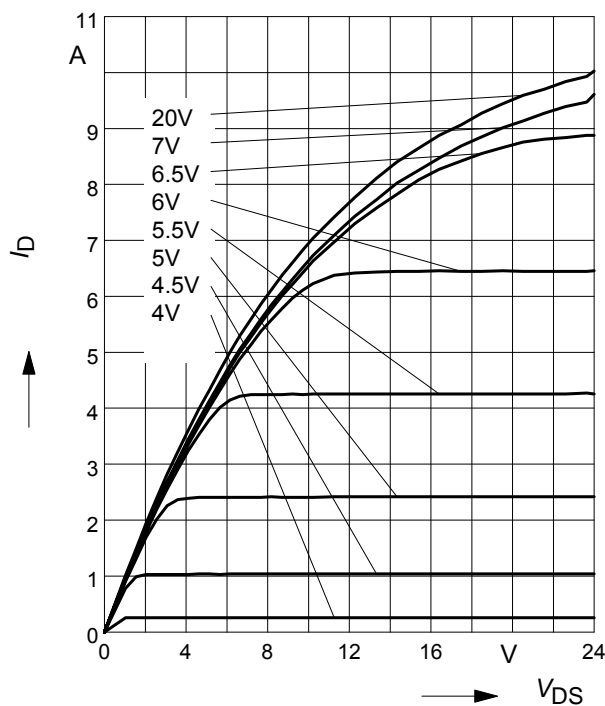
parameter: $D = t_p/t$



7 Typ. output characteristic

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

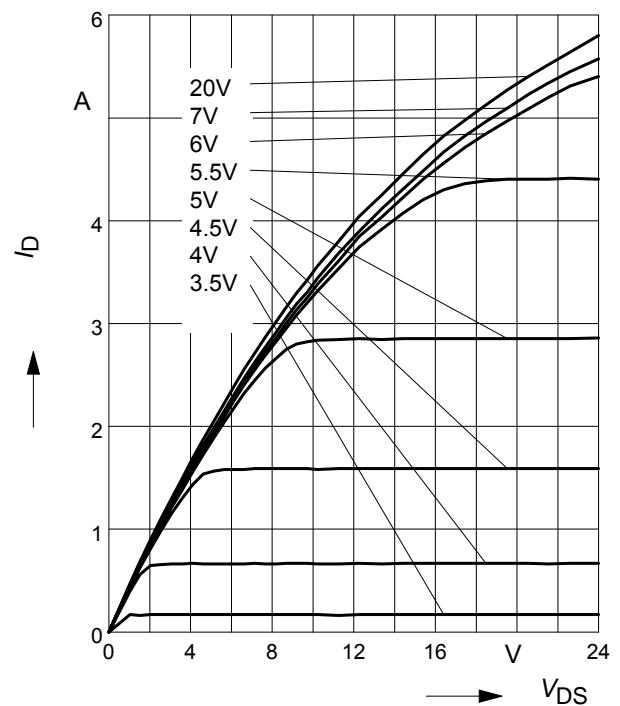
parameter: $t_p = 10 \mu\text{s}, V_{GS}$



8 Typ. output characteristic

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

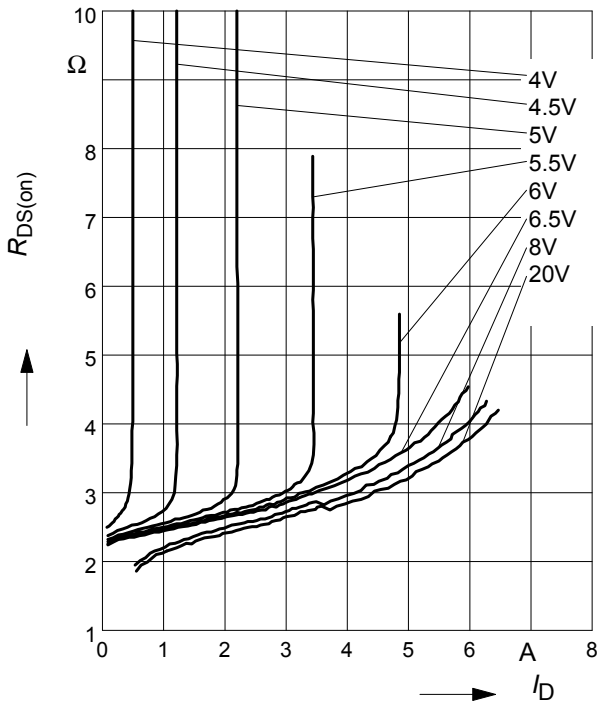
parameter: $t_p = 10 \mu\text{s}, V_{GS}$



9 Typ. drain-source on resistance

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

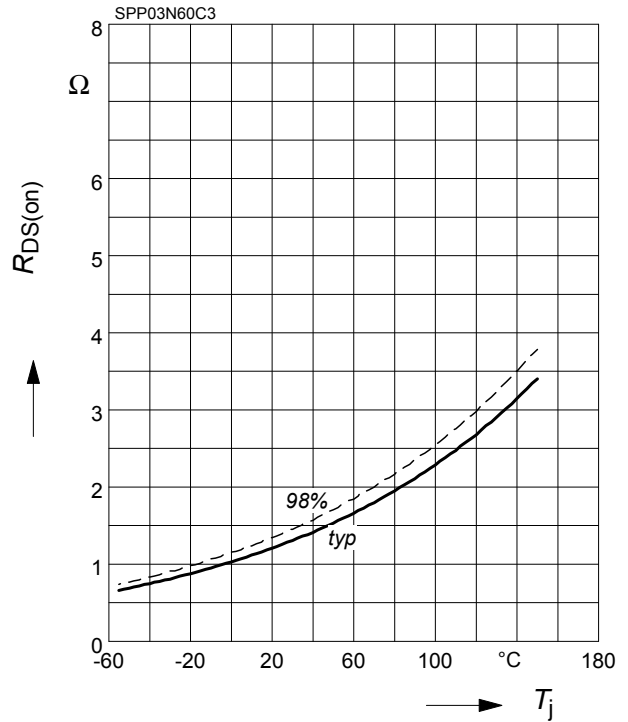
parameter: $T_j = 150^\circ\text{C}$, V_{GS}



10 Drain-source on-state resistance

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

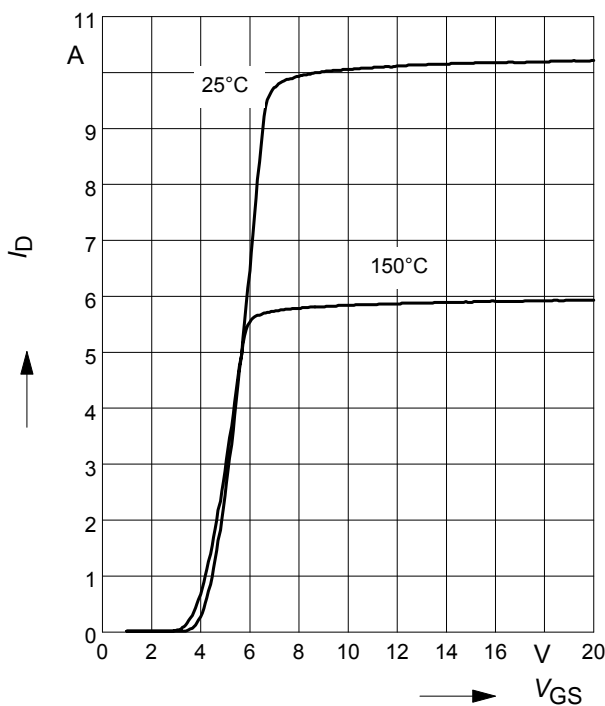
parameter: $I_D = 2\text{ A}$, $V_{GS} = 10\text{ V}$



11 Typ. transfer characteristics

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

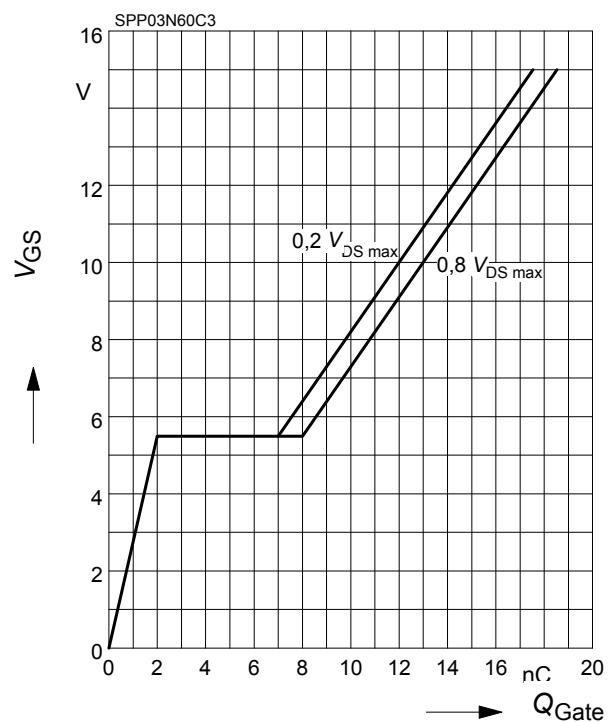
parameter: $t_p = 10\ \mu\text{s}$



12 Typ. gate charge

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

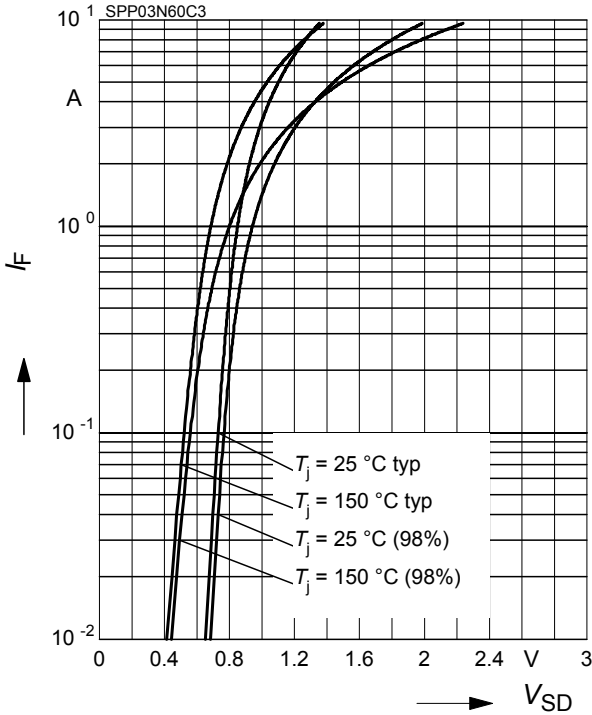
parameter: $I_D = 3.2\text{ A pulsed}$



13 Forward characteristics of body diode

$I_F = f(V_{SD})$

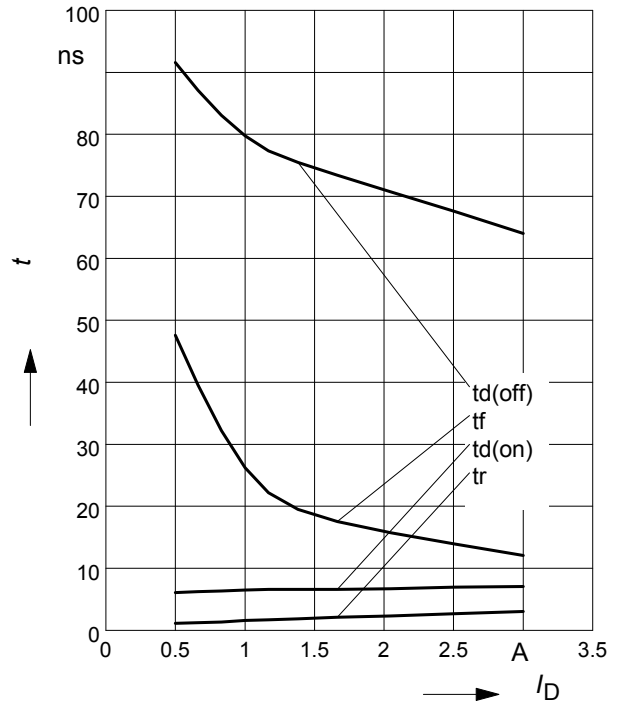
parameter: T_j , $t_p = 10 \mu s$



14 Typ. switching time

$t = f(I_D)$, inductive load, $T_j = 125^\circ C$

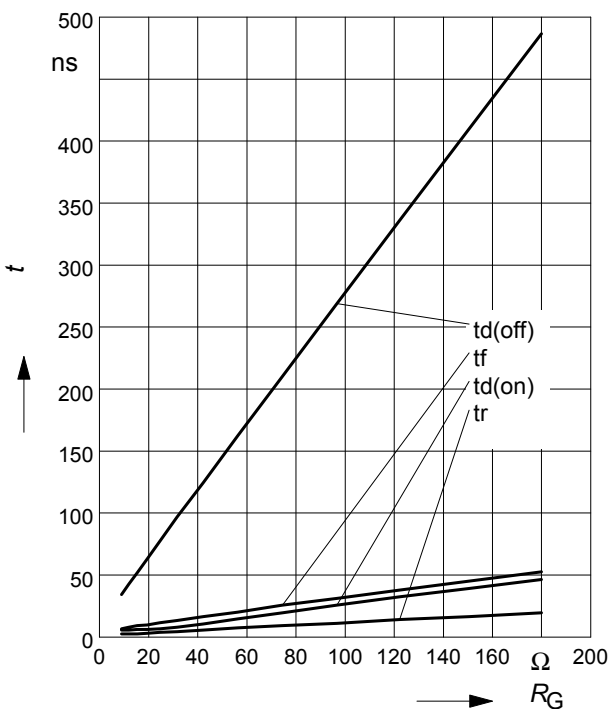
par.: $V_{DS} = 380V$, $V_{GS} = 0/+13V$, $R_G = 20\Omega$



15 Typ. switching time

$t = f(R_G)$, inductive load, $T_j = 125^\circ C$

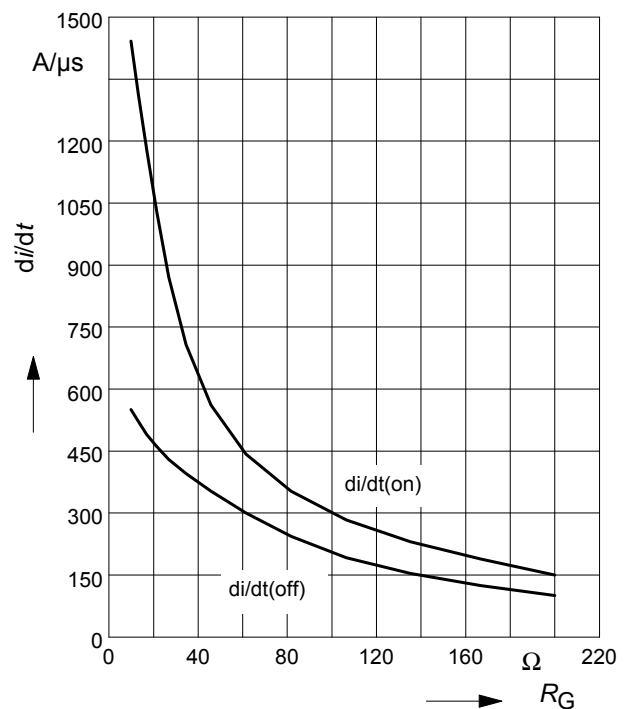
par.: $V_{DS} = 380V$, $V_{GS} = 0/+13V$, $I_D = 3.2 A$



16 Typ. drain current slope

$di/dt = f(R_G)$, inductive load, $T_j = 125^\circ C$

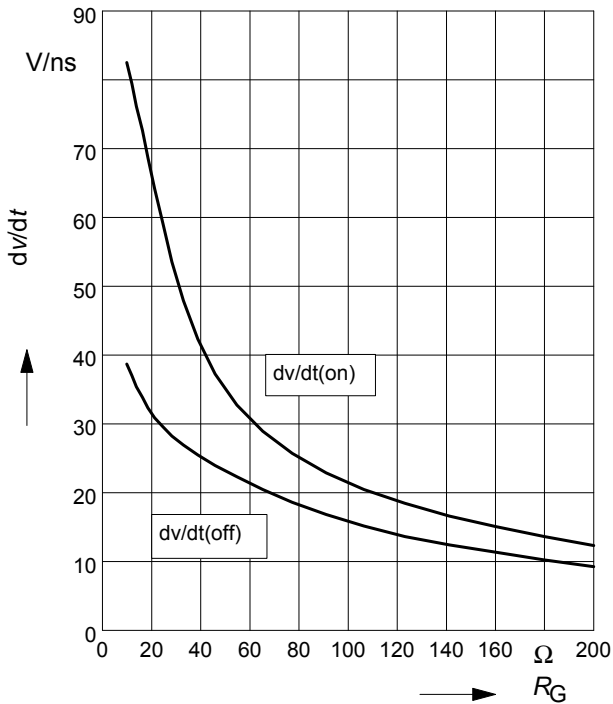
par.: $V_{DS} = 380V$, $V_{GS} = 0/+13V$, $I_D = 3.2A$



17 Typ. drain source voltage slope

$dv/dt = f(R_G)$, inductive load, $T_j = 125^\circ\text{C}$

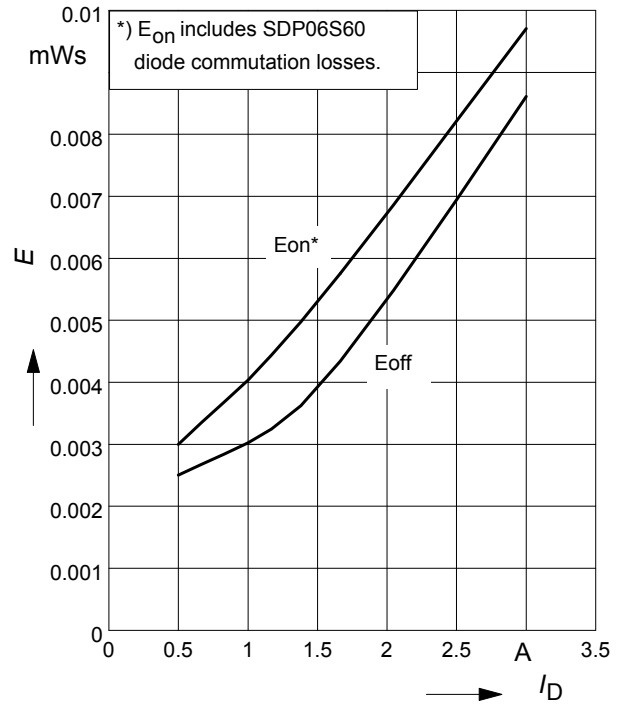
par.: $V_{DS}=380\text{V}$, $V_{GS}=0/+13\text{V}$, $I_D=3.2\text{A}$



18 Typ. switching losses

$E = f(I_D)$, inductive load, $T_j=125^\circ\text{C}$

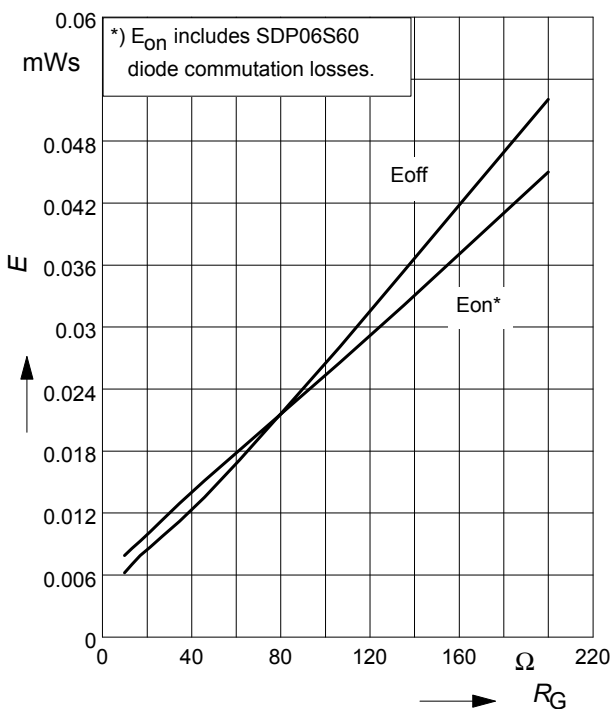
par.: $V_{DS}=380\text{V}$, $V_{GS}=0/+13\text{V}$, $R_G=20\Omega$



19 Typ. switching losses

$E = f(R_G)$, inductive load, $T_j=125^\circ\text{C}$

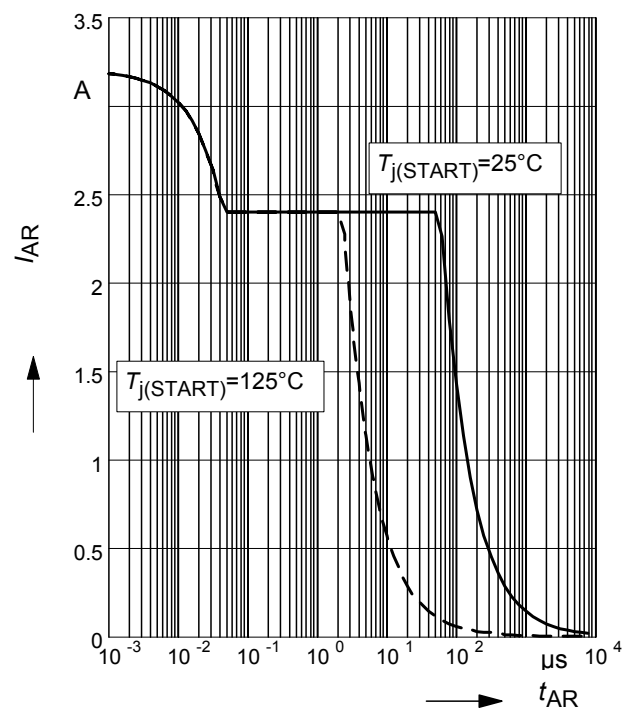
par.: $V_{DS}=380\text{V}$, $V_{GS}=0/+13\text{V}$, $I_D=3.2\text{A}$



20 Avalanche SOA

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

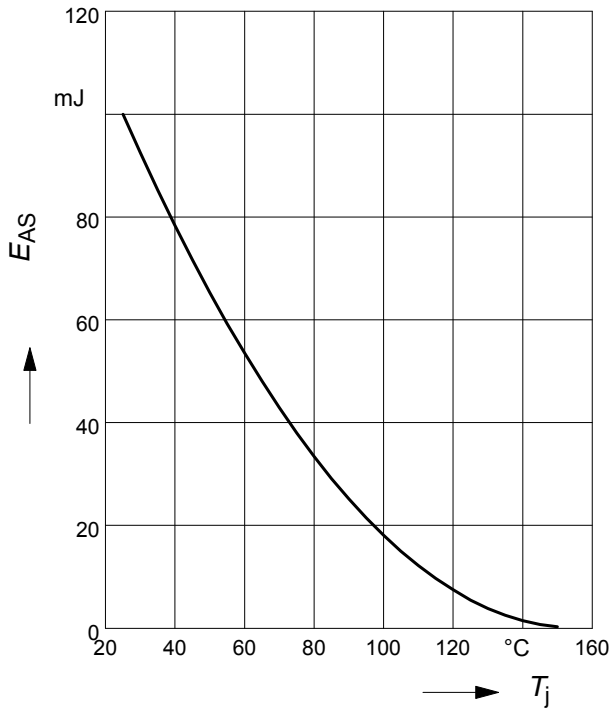
par.: $T_j \leq 150^\circ\text{C}$



21 Avalanche energy

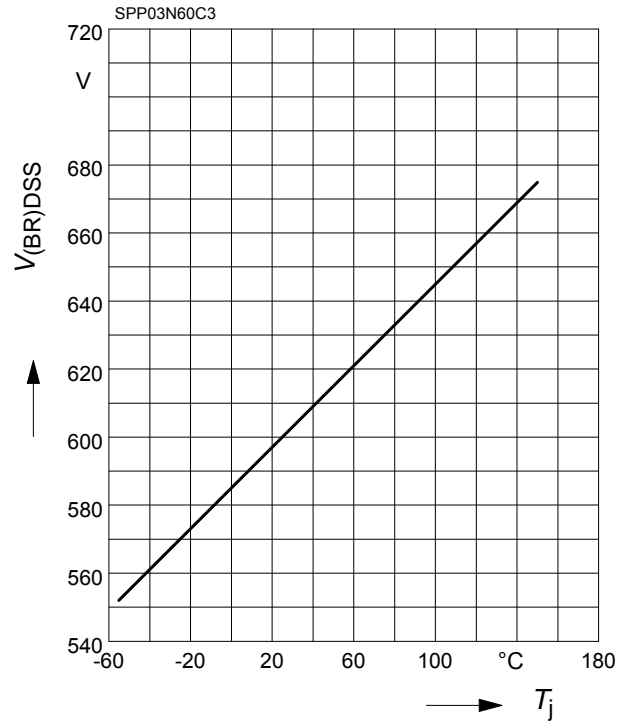
$$E_{AS} = f(T_j)$$

par.: $I_D = 2.4 \text{ A}$, $V_{DD} = 50 \text{ V}$



22 Drain-source breakdown voltage

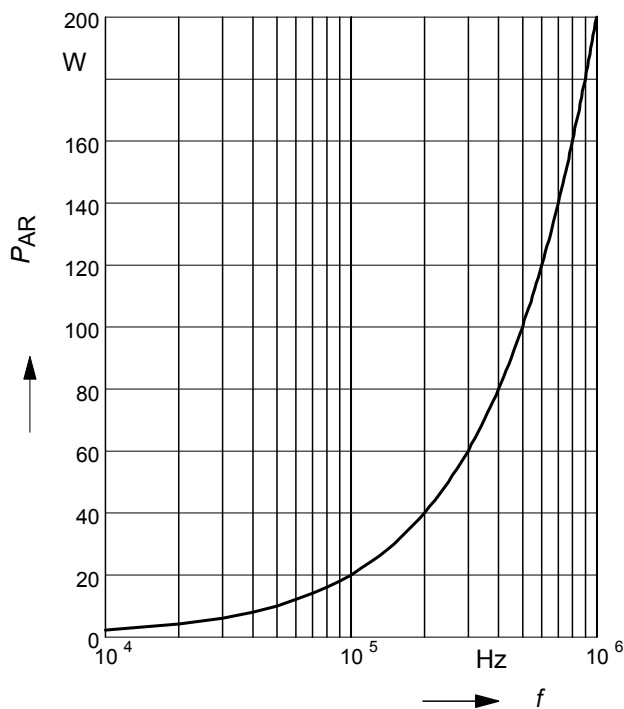
$$V_{(BR)DSS} = f(T_j)$$



23 Avalanche power losses

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

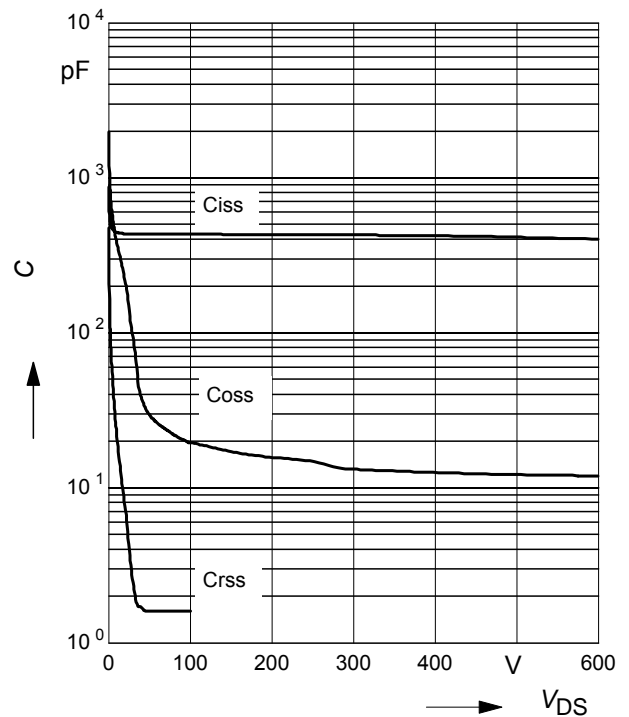
parameter: $E_{AR} = 0.2 \text{ mJ}$



24 Typ. capacitances

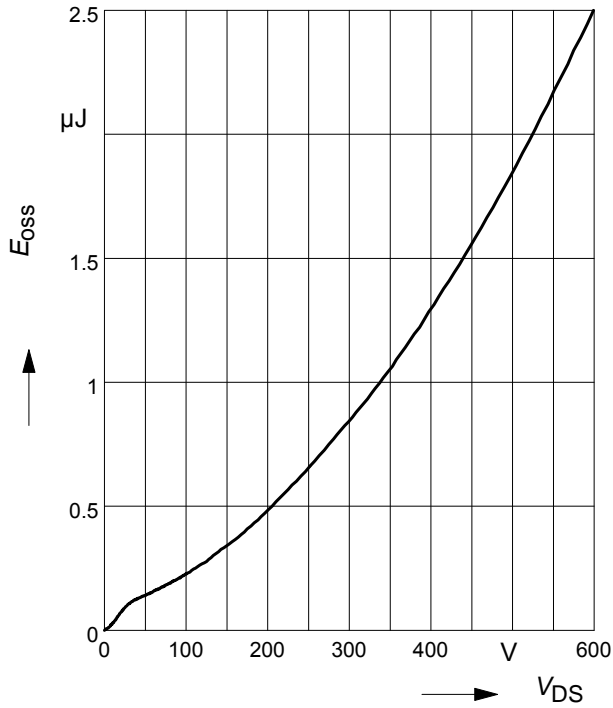
$$C = f(V_{DS})$$

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

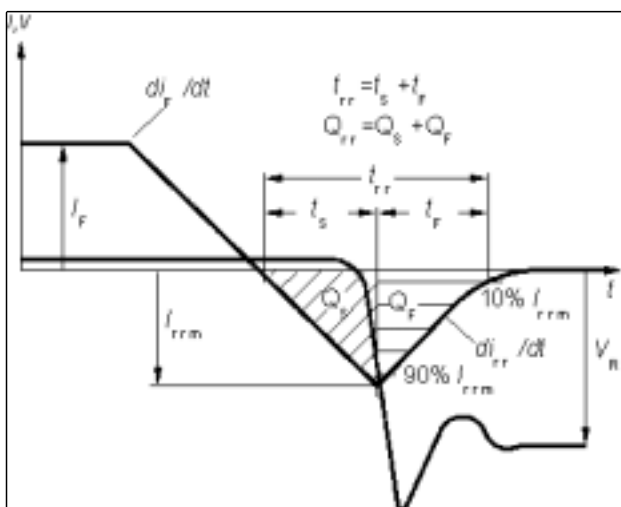


25 Typ. C_{oss} stored energy

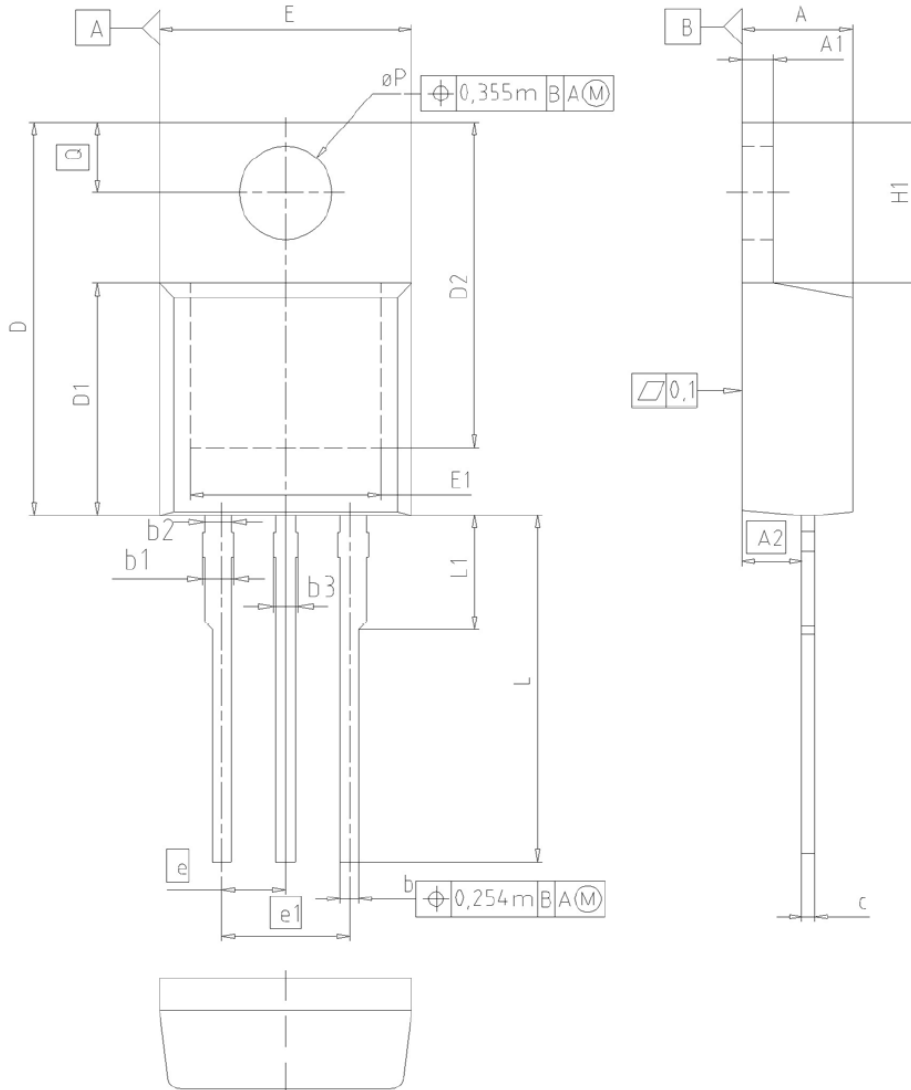
$$E_{oss} = f(V_{DS})$$



Definition of diodes switching characteristics



PG-TO220-3-1, PG-TO220-3-21 : Outline



| 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 |

DOCUMENT NO.
Z8B00003318

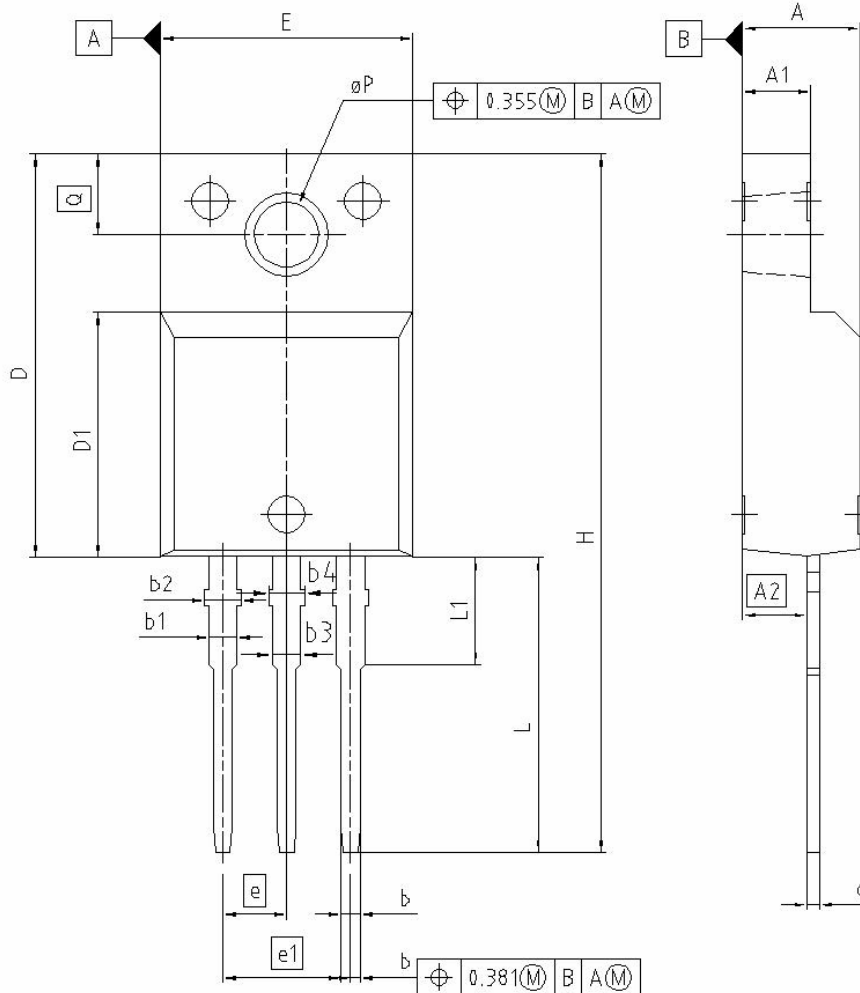
SCALE

EUROPEAN PROJECTION

ISSUE DATE
23-08-2007

REVISION
05

PG-TO220-3-31/3-111 Fully isolated package (2500VAC; 1 minute)



| DIM | MILLIMETERS | | INCHES | |
|-----|-------------|-------|--------|-------|
| | MIN | MAX | MIN | MAX |
| A | 4.55 | 4.85 | 0.179 | 0.191 |
| A1 | 2.55 | 2.85 | 0.100 | 0.112 |
| A2 | 2.42 | 2.72 | 0.095 | 0.107 |
| b | 0.65 | 0.85 | 0.026 | 0.033 |
| b1 | 0.95 | 1.33 | 0.037 | 0.052 |
| b2 | 0.95 | 1.51 | 0.037 | 0.059 |
| b3 | 0.65 | 1.33 | 0.026 | 0.052 |
| b4 | 0.65 | 1.51 | 0.026 | 0.059 |
| c | 0.40 | 0.63 | 0.016 | 0.025 |
| D | 15.85 | 16.15 | 0.624 | 0.636 |
| D1 | 9.53 | 9.83 | 0.375 | 0.387 |
| E | 10.35 | 10.65 | 0.407 | 0.419 |
| e | 2.54 | | 0.100 | |
| e1 | 5.08 | | 0.200 | |
| N | 3 | | 3 | |
| H | 29.45 | 29.75 | 1.159 | 1.171 |
| L | 13.45 | 13.75 | 0.530 | 0.541 |
| L1 | 3.15 | 3.45 | 0.124 | 0.136 |
| øP | 2.95 | 3.20 | 0.116 | 0.126 |
| Q | 3.15 | 3.50 | 0.124 | 0.138 |

REFERENCE
J..

SCALE
0 2.5 5mm

EUROPEAN PROJECTION

ISSUE DATE
08-01-2007

FILE
TO220_2

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