

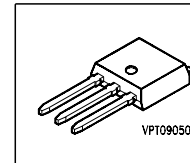
Cool MOS™ Power Transistor

Feature

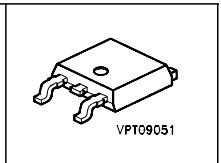
- New revolutionary high voltage technology
- Ultra low gate charge
- Periodic avalanche rated
- Extreme dv/dt rated
- Ultra low effective capacitances

| | | |
|---------------------|-----|----------|
| $V_{DS} @ T_{jmax}$ | 650 | V |
| $R_{DS(on)}$ | 3 | Ω |
| I_D | 1.8 | A |

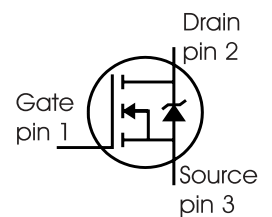
P-TO251



P-TO252



| Type | Package | Ordering Code | Marking |
|------------|---------|---------------|---------|
| SPD02N60C3 | P-TO252 | Q67040-S4420 | 02N60C3 |
| SPU02N60C3 | P-TO251 | - | 02N60C3 |



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 | 1.8 1.1 | A |
| Pulsed drain current, t_p limited by T_{jmax} | $I_{D\text{ puls}}$ | 5.4 | |
| Avalanche energy, single pulse $I_D = 1.35\text{ A}$, $V_{DD} = 50\text{ V}$ | E_{AS} | 50 | mJ |
| Avalanche energy, repetitive t_{AR} limited by T_{jmax} ¹ $I_D = 1.8\text{ A}$, $V_{DD} = 50\text{ V}$ | E_{AR} | 0.07 | |
| Avalanche current, repetitive t_{AR} limited by T_{jmax} | I_{AR} | 1.8 | A |
| Gate source voltage static | V_{GS} | ± 20 | V |
| Gate source voltage AC ($f > 1\text{ Hz}$) | V_{GS} | ± 30 | |
| Power dissipation, $T_C = 25\text{ }^\circ\text{C}$ | P_{tot} | 25 | W |
| Operating and storage temperature | T_j, T_{stg} | -55... +150 | $^\circ\text{C}$ |

Maximum Ratings

| Parameter | Symbol | Value | Unit |
|---|---------|-------|------|
| Drain Source voltage slope $V_{DS} = 480 \text{ V}$, $I_D = 1.8 \text{ A}$, $T_j = 125 \text{ }^\circ\text{C}$ | dv/dt | 50 | V/ns |

Thermal Characteristics

| Parameter | Symbol | Values | | | Unit |
|---|------------|--------|------|----------|------------------|
| | | min. | typ. | max. | |
| Thermal resistance, junction - case | R_{thJC} | - | - | 5 | K/W |
| Thermal resistance, junction - ambient, leaded | R_{thJA} | - | - | 75 | |
| SMD version, device on PCB: @ min. footprint @ 6 cm ² cooling area ²⁾ | R_{thJA} | - | - | 75 50 | |
| Soldering temperature, 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 | $V_{(BR)DS}$ | $V_{GS}=0\text{V}$, $I_D=0.25\text{A}$ | - | 700 | - | |
| Gate threshold voltage | $V_{GS(th)}$ | $I_D=80\mu\text{A}$, $V_{GS}=V_{DS}$ | 2.1 | 3 | 3.9 | |
| Zero gate voltage drain current | I_{DSS} | $V_{DS}=600\text{V}$, $V_{GS}=0\text{V}$, $T_j=25^\circ\text{C}$, $T_j=150^\circ\text{C}$ | - - | 0.5 - | 1 50 | μA |
| Gate-source leakage current | I_{GSS} | $V_{GS}=30\text{V}$, $V_{DS}=0\text{V}$ | - | - | 100 | |
| Drain-source on-state resistance | $R_{DS(on)}$ | $V_{GS}=10\text{V}$, $I_D=1.1\text{A}$, $T_j=25^\circ\text{C}$ $T_j=150^\circ\text{C}$ | - - | 2.7 7.3 | 3 - | Ω |
| Gate input resistance | R_G | $f=1\text{MHz}$, open Drain | - | 9 | - | |

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

| Parameter | Symbol | Conditions | Values | | | Unit |
|---|--------------|--|--------|------|------|------|
| | | | min. | typ. | max. | |
| Transconductance | g_{fs} | $V_{DS} \geq 2 \cdot I_D \cdot R_{DS(on)max}$, $I_D = 1.1\text{A}$ | - | 1.75 | - | S |
| Input capacitance | C_{iss} | $V_{GS} = 0\text{V}$, $V_{DS} = 25\text{V}$, $f = 1\text{MHz}$ | - | 200 | - | pF |
| Output capacitance | C_{oss} | | - | 90 | - | |
| Reverse transfer capacitance | C_{rss} | | - | 4 | - | |
| Effective output capacitance, ³⁾ energy related | $C_{o(er)}$ | $V_{GS} = 0\text{V}$, $V_{DS} = 0\text{V to } 480\text{V}$ | - | 8.1 | - | pF |
| Effective output capacitance, ⁴⁾ time related | $C_{o(tr)}$ | | - | 15.7 | - | |
| Turn-on delay time | $t_{d(on)}$ | $V_{DD} = 350\text{V}$, $V_{GS} = 0/10\text{V}$, $I_D = 1.8\text{A}$, $R_G = 25\Omega$ | - | 6 | - | ns |
| Rise time | t_r | | - | 3 | - | |
| Turn-off delay time | $t_{d(off)}$ | | - | 68 | 70 | |
| Fall time | t_f | | - | 12 | 30 | |

Gate Charge Characteristics

| | | | | | | |
|-----------------------|-----------------|--|---|-----|------|----|
| Gate to source charge | Q_{gs} | $V_{DD} = 420\text{V}$, $I_D = 1.8\text{A}$ | - | 1.6 | - | nC |
| Gate to drain charge | Q_{gd} | | - | 3.8 | - | |
| Gate charge total | Q_g | $V_{DD} = 420\text{V}$, $I_D = 1.8\text{A}$, $V_{GS} = 0\text{ to } 10\text{V}$ | - | 9.5 | 12.5 | |
| Gate plateau voltage | $V_{(plateau)}$ | $V_{DD} = 420\text{V}$, $I_D = 1.8\text{A}$ | - | 5.5 | - | V |

¹ Repetitive avalanche causes additional power losses that can be calculated as $P_{AV} = E_{AR} \cdot f$.

² Device 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.

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

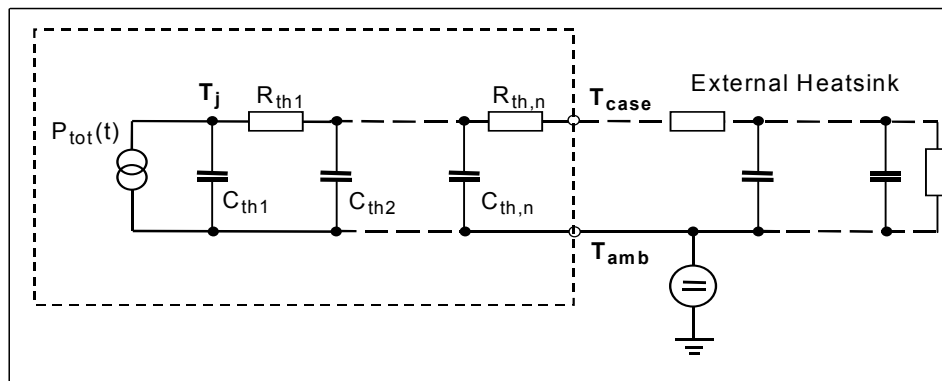
⁴ $C_{o(tr)}$ is a fixed capacitance that gives the same charging time as C_{oss} while V_{DS} is rising from 0 to 80% V_{DSS} .

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

| Parameter | Symbol | Conditions | Values | | | Unit |
|---|--------------|--|--------|------|------|------------------------|
| | | | min. | typ. | max. | |
| Inverse diode continuous forward current | I_S | $T_C = 25^\circ\text{C}$ | - | - | 1.8 | A |
| Inverse diode direct current, pulsed | I_{SM} | | - | - | 5.4 | |
| Inverse diode forward voltage | V_{SD} | $V_{GS} = 0\text{V}$, $I_F = I_S$ | - | 1 | 1.2 | V |
| Reverse recovery time | t_{rr} | $V_R = 420\text{V}$, $I_F = I_S$, $di_F/dt = 100\text{A}/\mu\text{s}$ | - | 200 | 350 | ns |
| Reverse recovery charge | Q_{rr} | | - | 1.3 | - | μC |
| Peak reverse recovery current | I_{rrm} | | - | 9 | - | A |
| Peak rate of fall of reverse recovery current | di_{rr}/dt | | - | - | 200 | $\text{A}/\mu\text{s}$ |

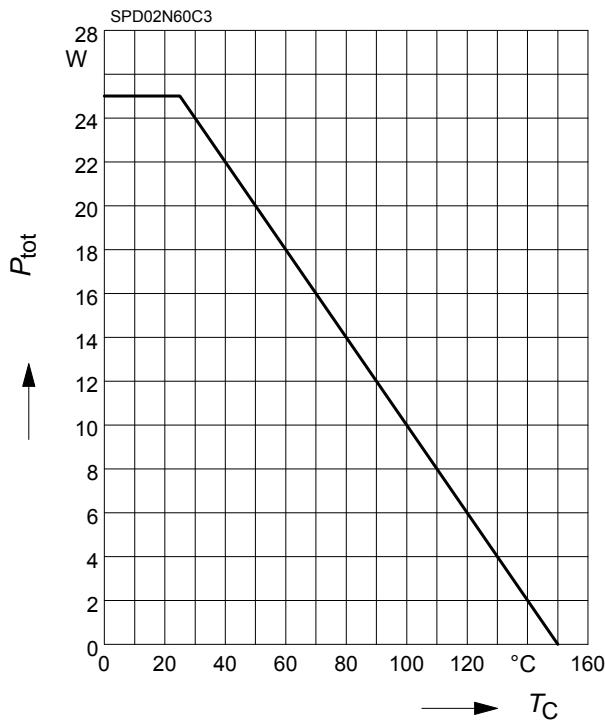
Typical Transient Thermal Characteristics

| Symbol | Value | Unit | Symbol | Value | Unit |
|--------------------|-------|------|---------------------|------------|------|
| | typ. | | | typ. | |
| Thermal resistance | | | Thermal capacitance | | |
| R_{th1} | 0.1 | K/W | C_{th1} | 0.00002806 | Ws/K |
| R_{th2} | 0.184 | | C_{th2} | 0.0001113 | |
| R_{th3} | 0.306 | | C_{th3} | 0.0001679 | |
| R_{th4} | 1.207 | | C_{th4} | 0.000547 | |
| R_{th5} | 0.974 | | C_{th5} | 0.001388 | |
| R_{th6} | 0.251 | | C_{th6} | 0.019 | |



1 Power dissipation

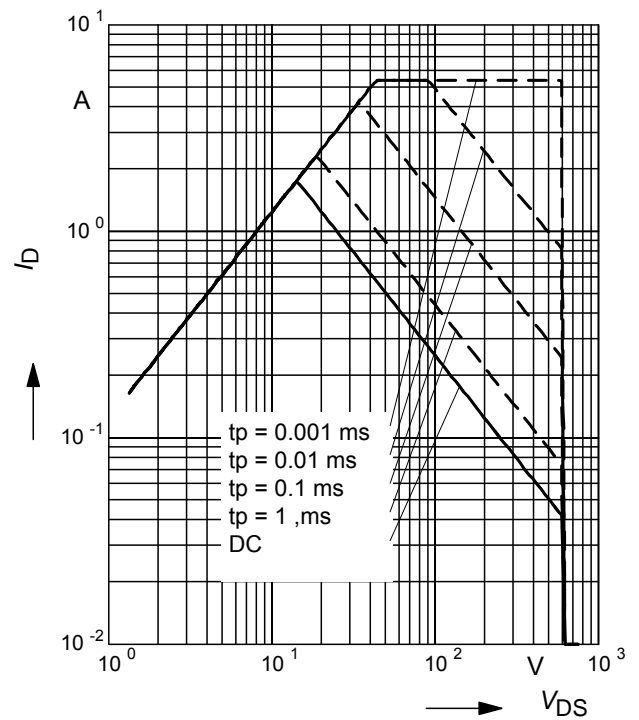
$$P_{\text{tot}} = f(T_C)$$



2 Safe operating area

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

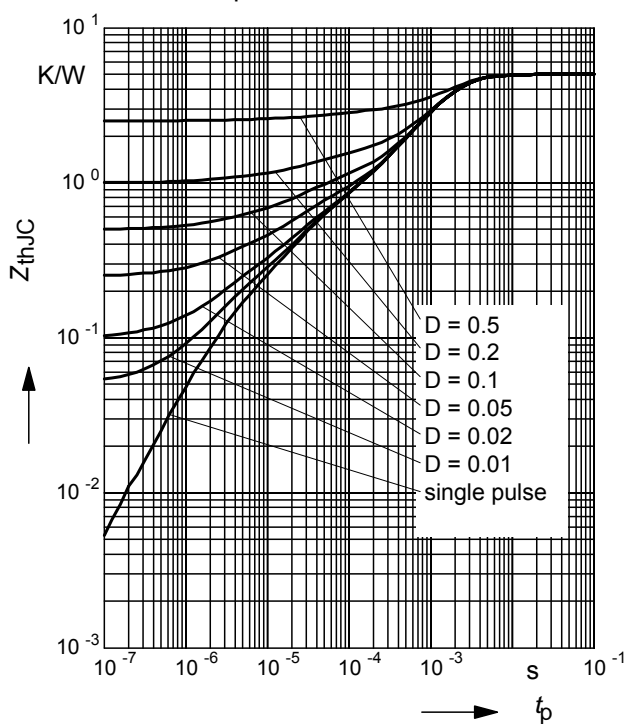
parameter : $D = 0$, $T_C = 25^\circ\text{C}$



3 Transient thermal impedance

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

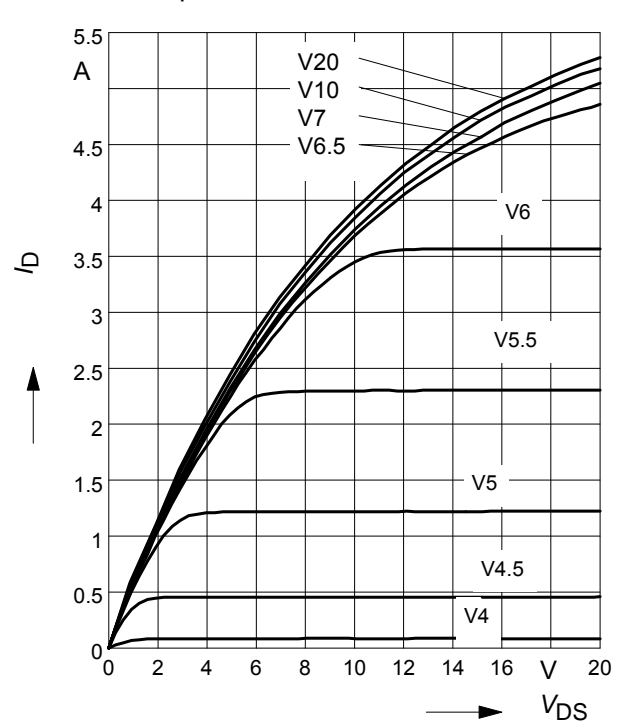
parameter: $D = t_p/T$



4 Typ. output characteristic

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

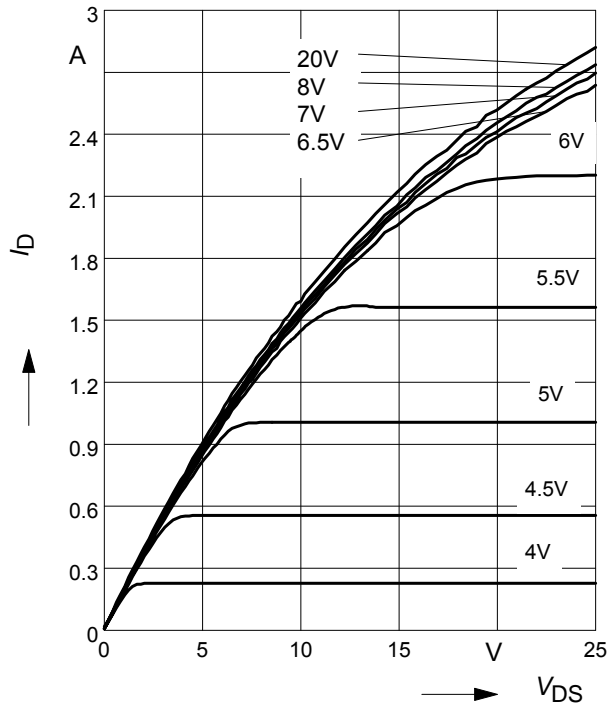
parameter: $t_p = 10 \mu\text{s}$, V_{GS}



5 Typ. output characteristic

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

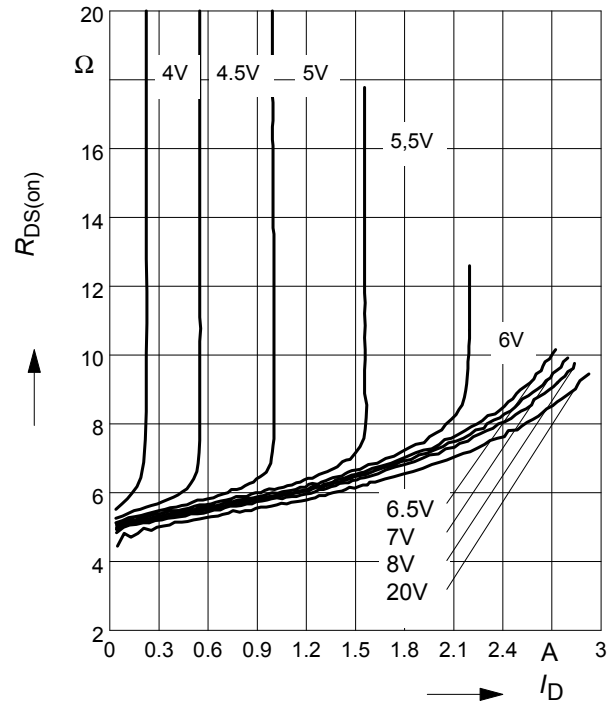
parameter: $t_p = 10 \mu\text{s}$, V_{GS}



6 Typ. drain-source on resistance

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

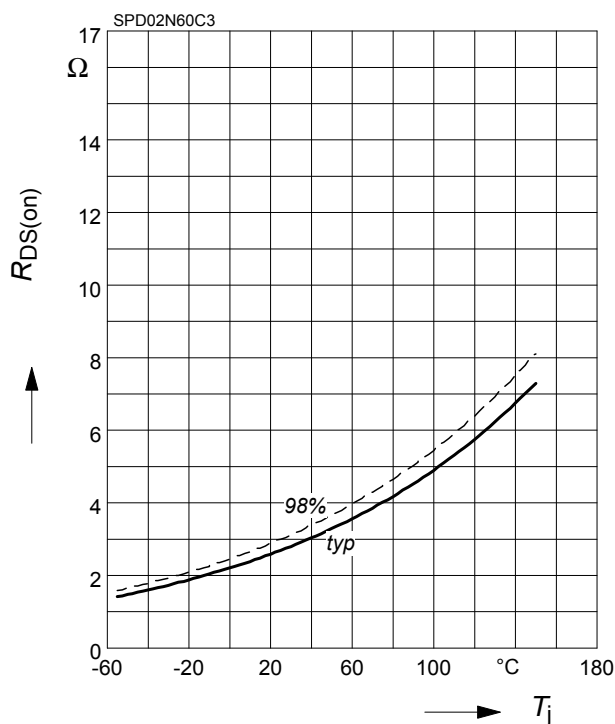
parameter: $T_j = 150^\circ\text{C}$, V_{GS}



7 Drain-source on-state resistance

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

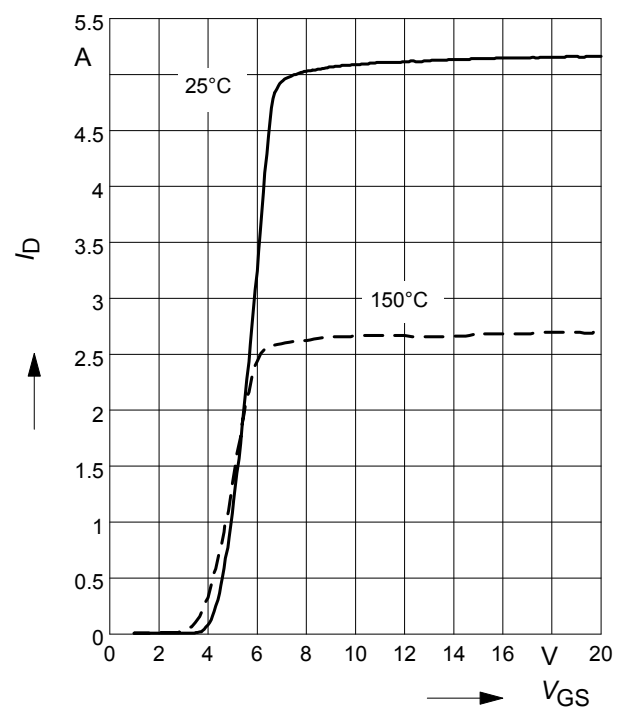
parameter: $I_D = 1.1 \text{ A}$, $V_{GS} = 10 \text{ V}$



8 Typ. transfer characteristics

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

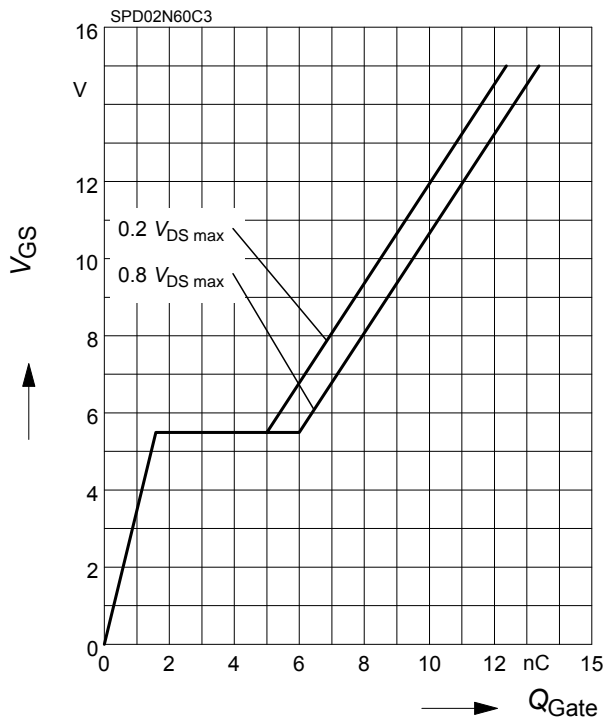
parameter: $t_p = 10 \mu\text{s}$



9 Typ. gate charge

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

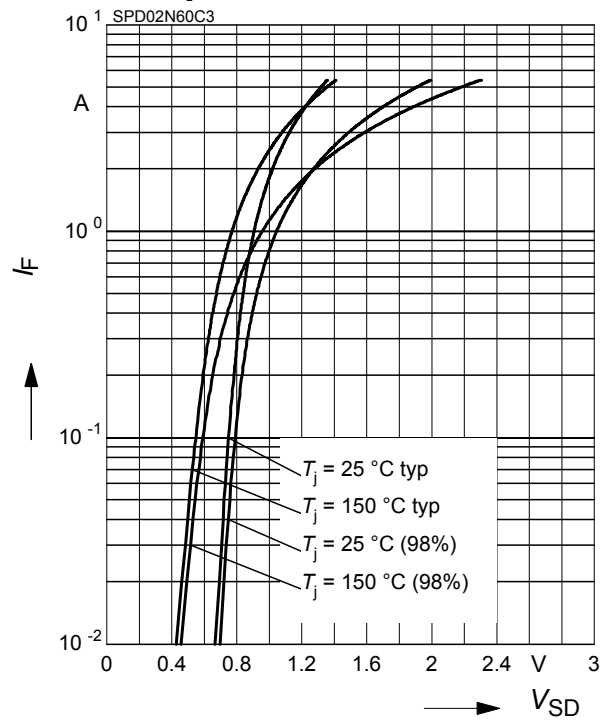
parameter: $I_D = 1.8 \text{ A}$ pulsed



10 Forward characteristics of body diode

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

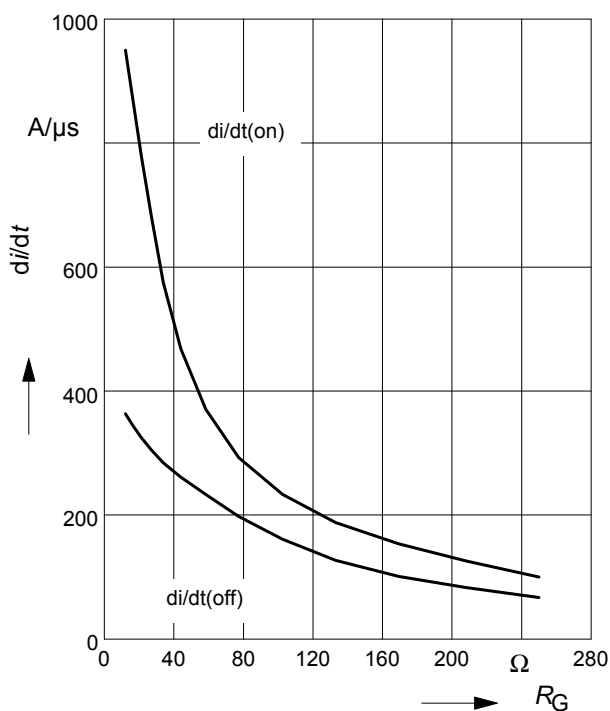
parameter: T_j , $t_p = 10 \mu\text{s}$



11 Typ. drain current slope

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

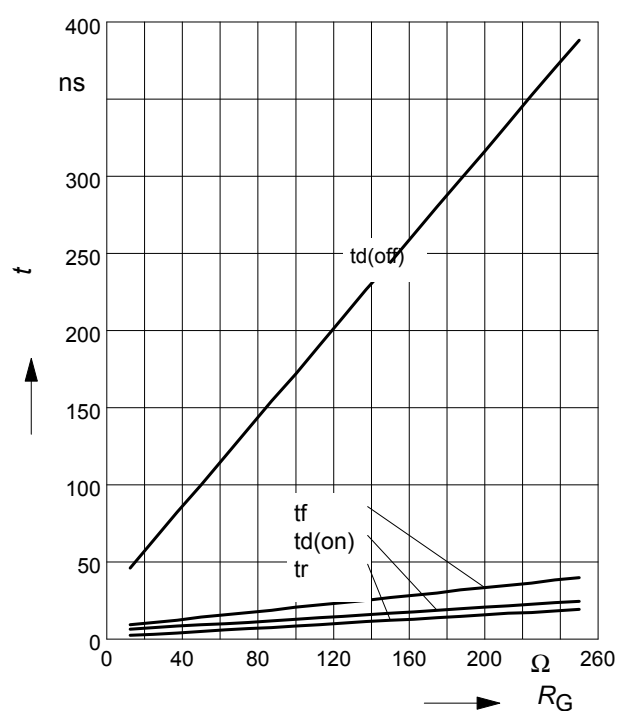
par.: $V_{DS} = 380\text{V}$, $V_{GS} = 0/+13\text{V}$, $I_D = 1.8\text{A}$



12 Typ. switching time

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

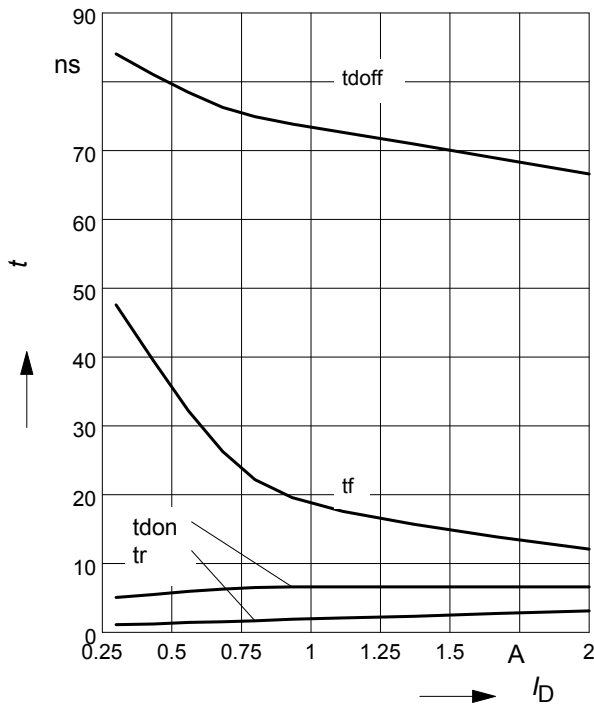
par.: $V_{DS} = 380\text{V}$, $V_{GS} = 0/+13\text{V}$, $I_D = 1.8\text{A}$



13 Typ. switching time

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

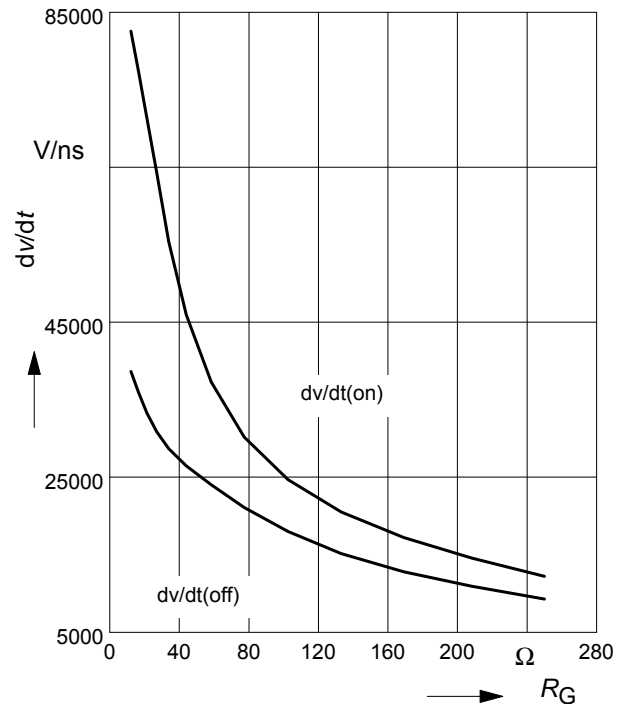
par.: $V_{DS} = 380\text{V}$, $V_{GS} = 0/+13\text{V}$, $R_G = 25\Omega$



14 Typ. drain source voltage slope

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

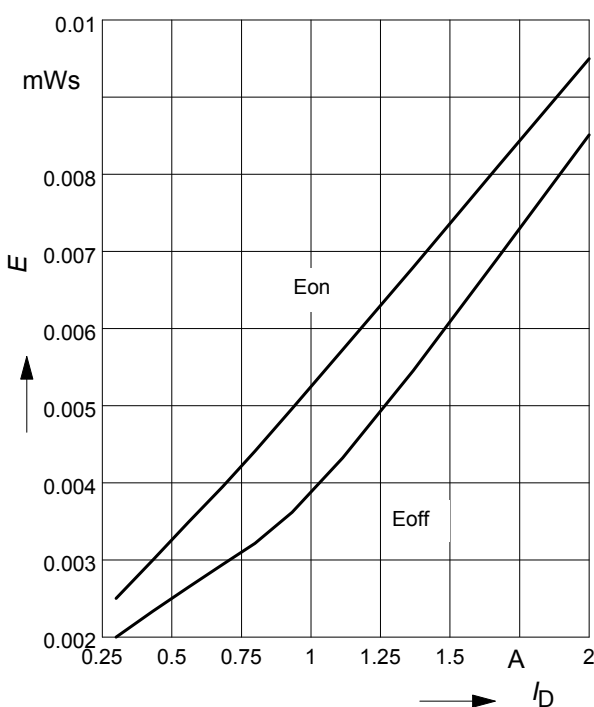
par.: $V_{DS} = 380\text{V}$, $V_{GS} = 0/+13\text{V}$, $I_D = 1.8\text{A}$



15 Typ. switching losses

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

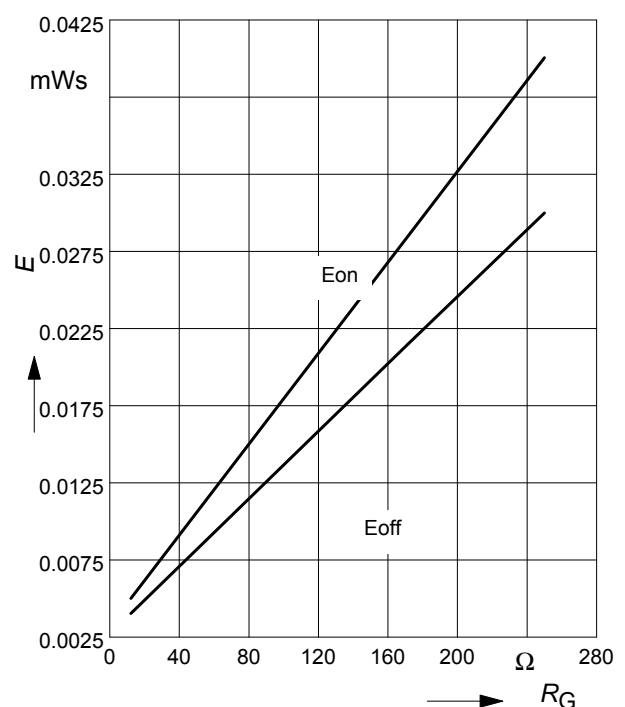
par.: $V_{DS} = 380\text{V}$, $V_{GS} = 0/+13\text{V}$, $R_G = 25\Omega$



16 Typ. switching losses

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

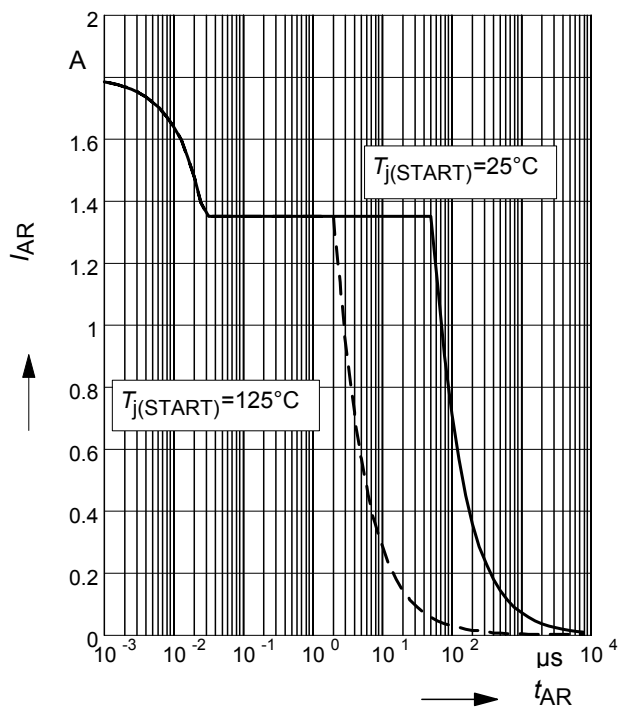
par.: $V_{DS} = 380\text{V}$, $V_{GS} = 0/+13\text{V}$, $I_D = 1.8\text{A}$



17 Avalanche SOA

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

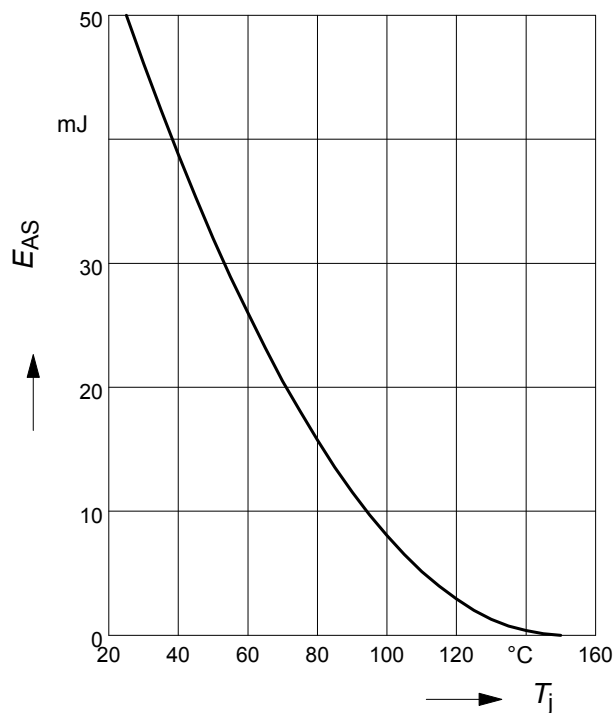
par.: $T_j \leq 150^\circ\text{C}$



18 Avalanche energy

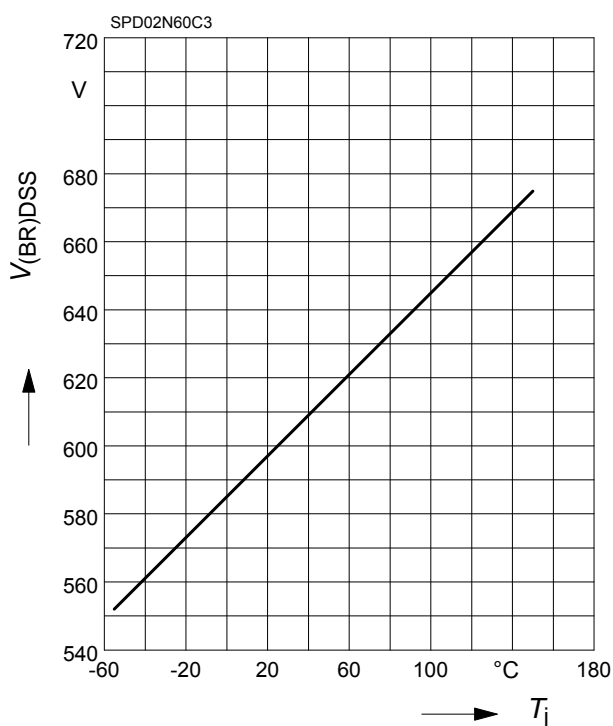
$$E_{AS} = f(T_j)$$

par.: $I_D = 1.35\text{ A}$, $V_{DD} = 50\text{ V}$



19 Drain-source breakdown voltage

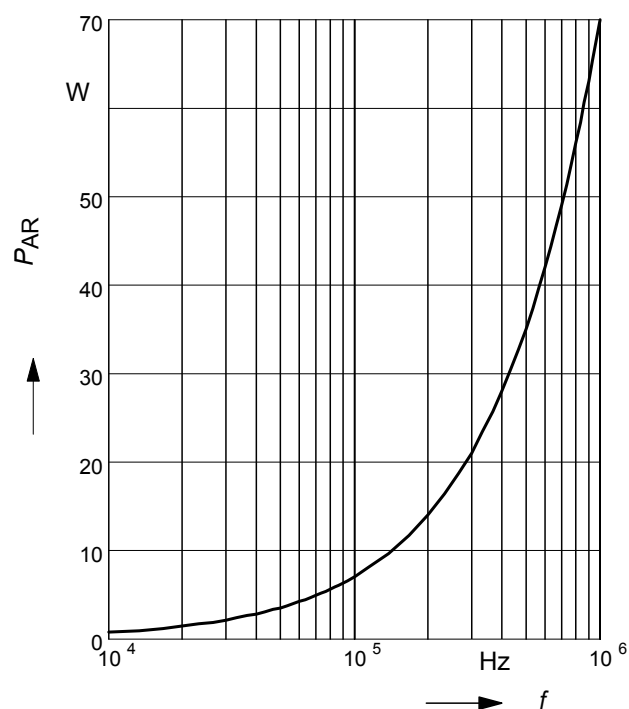
$$V_{(BR)DSS} = f(T_j)$$



20 Avalanche power losses

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

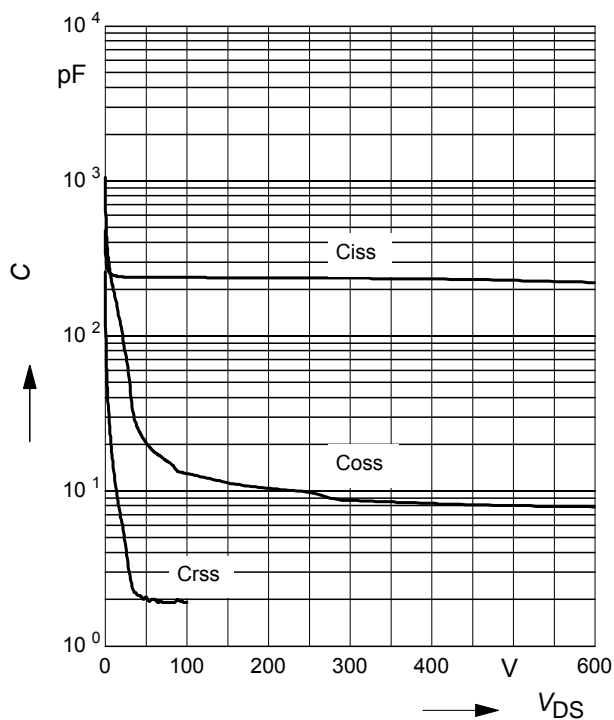
parameter: $E_{AR} = 0.07\text{ mJ}$



21 Typ. capacitances

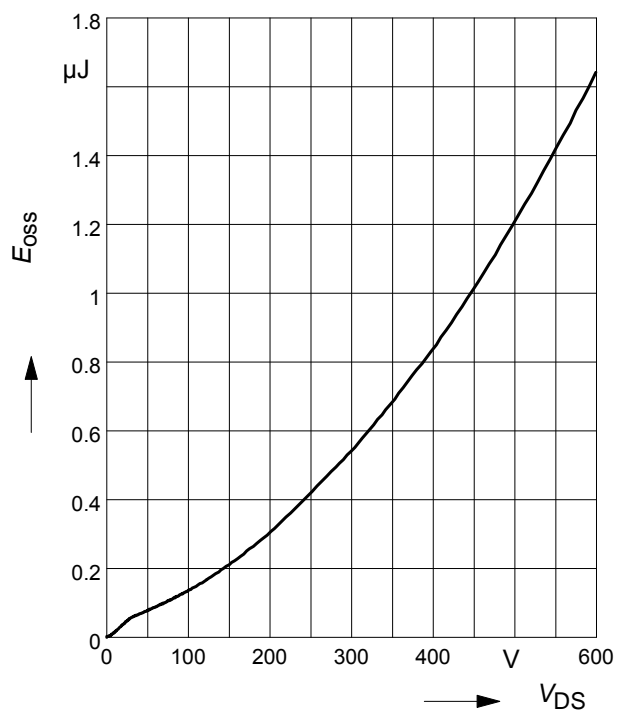
$$C = f(V_{DS})$$

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

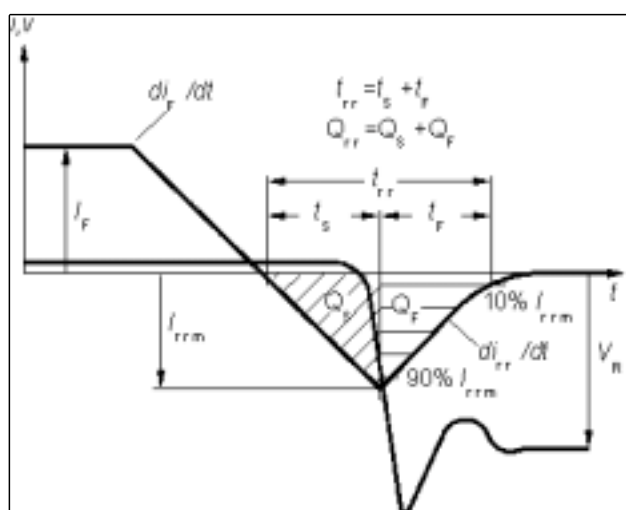


22 Typ. C_{oss} stored energy

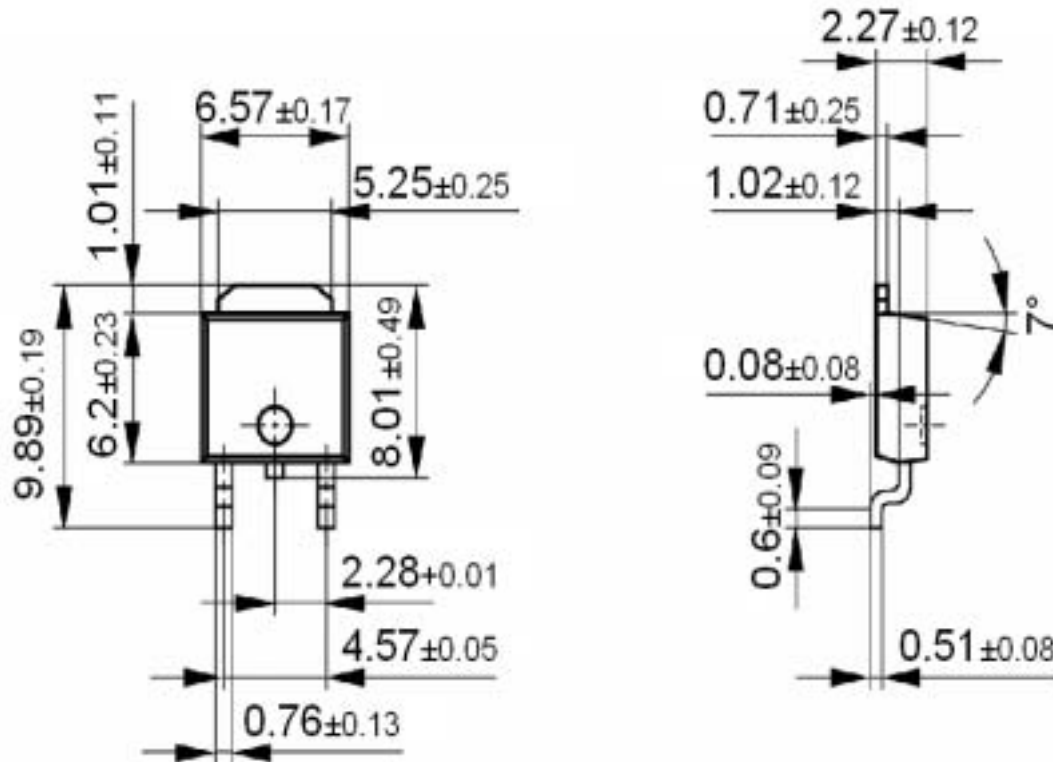
$$E_{oss} = f(V_{DS})$$



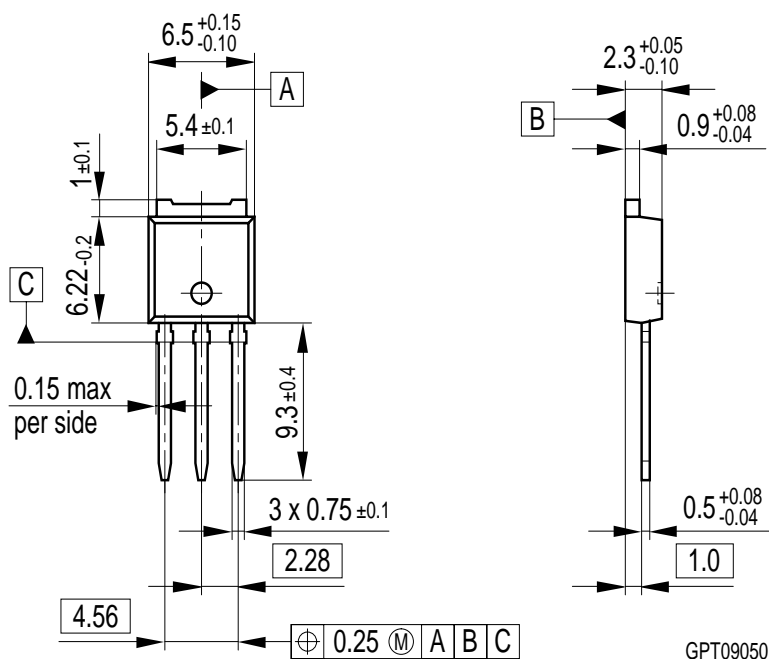
Definition of diodes switching characteristics



P-TO-252-3-1 (D-PAK)



P-TO-251-3-1 (I-PAK)



All metal surfaces tin plated, except area of cut.

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