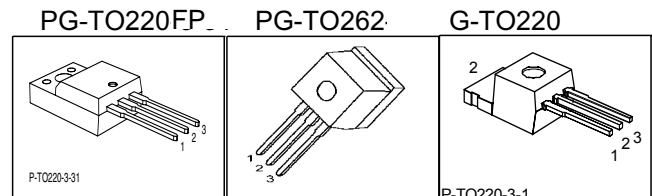


## Cool MOS™ Power Transistor

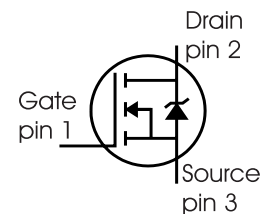
### Feature

- New revolutionary high voltage technology
- Ultra low gate charge
- Periodic avalanche rated
- Extreme dv/dt rated
- Ultra low effective capacitances
- Improved transconductance
- PG-TO-220-3-31;-3-111: Fully isolated package (2500 VAC; 1 minute)
- Pb-free lead plating; RoHS compliant
- Qualified according to JEDEC<sup>0)</sup> for target applications

|                     |      |          |
|---------------------|------|----------|
| $V_{DS} @ T_{jmax}$ | 560  | V        |
| $R_{DS(on)}$        | 0.38 | $\Omega$ |
| $I_D$               | 11.6 | A        |



| Type       | Package    | Ordering Code | Marking |
|------------|------------|---------------|---------|
| SPP12N50C3 | PG-TO220   | Q67040-S4579  | 12N50C3 |
| SPI12N50C3 | PG-TO262   | Q67040-S4578  | 12N50C3 |
| SPA12N50C3 | PG-TO220FP | SP000216322   | 12N50C3 |



### Maximum Ratings

| Parameter  | Symbol             | Value      |                                       | Unit             |
|--|--------------------|------------|---------------------------------------|------------------|
|  |                    | SPP_I      | SPA                                   |                  |
| Continuous drain current<br>$T_C = 25\text{ }^\circ\text{C}$<br>$T_C = 100\text{ }^\circ\text{C}$                  | $I_D$              | 11.6<br>7  | 11.6 <sup>1)</sup><br>7 <sup>1)</sup> | A                |
| Pulsed drain current, $t_p$ limited by $T_{jmax}$  | $I_D \text{ puls}$ | 34.8       | 34.8                                  | A                |
| Avalanche energy, single pulse<br>$I_D=5.5\text{A}, V_{DD}=50\text{V}$   | $E_{AS}$           | 340        | 340                                   | mJ               |
| Avalanche energy, repetitive $t_{AR}$ limited by $T_{jmax}$ <sup>2)</sup><br>$I_D=11.6\text{A}, V_{DD}=50\text{V}$ | $E_{AR}$           | 0.6        | 0.6                                   |                  |
| Avalanche current, repetitive $t_{AR}$ limited by $T_{jmax}$   | $I_{AR}$           | 11.6       | 11.6                                  | A                |
| Gate source voltage  | $V_{GS}$           | $\pm 20$   | $\pm 20$                              | V                |
| Gate source voltage AC ( $f > 1\text{Hz}$ )  | $V_{GS}$           | $\pm 30$   | $\pm 30$                              |                  |
| Power dissipation, $T_C = 25\text{ }^\circ\text{C}$  | $P_{tot}$          | 125        | 33                                    | W                |
| Operating and storage temperature  | $T_j, T_{stg}$     | -55...+150 |                                       | $^\circ\text{C}$ |
| Reverse diode dv/dt <sup>7)</sup>  | dv/dt              | 15         |                                       | V/ns             |

### Maximum Ratings

| Parameter   | Symbol  | Value | Unit |
|---|---------|-------|------|
| Drain Source voltage slope<br>$V_{DS} = 400\text{ V}$ , $I_D = 11.6\text{ A}$ , $T_j = 125\text{ °C}$ | $dv/dt$ | 50    | V/ns |

### Thermal Characteristics

| Parameter   | Symbol               | Values |      |      | Unit |
|---|----------------------|--------|------|------|------|
|   |                      | min.   | typ. | max. |      |
| Thermal resistance, junction - case   | $R_{thJC}$           | -      | -    | 1    | K/W  |
| Thermal resistance, junction - case, FullPAK  | $R_{thJC\text{ FP}}$ | -      | -    | 3.8  |      |
| Thermal resistance, junction - ambient, leaded  | $R_{thJA}$           | -      | -    | 62   |      |
| Thermal resistance, junction - ambient, FullPAK   | $R_{thJA\text{ FP}}$ | -      | -    | 80   |      |
| SMD version, device on PCB:<br>@ min. footprint<br>@ 6 cm <sup>2</sup> cooling area <sup>3)</sup> | $R_{thJA}$           | -      | -    | 62   |      |
| Soldering temperature, wavesoldering<br>1.6 mm (0.063 in.) from case for 10s <sup>4)</sup>        | $T_{sold}$           | -      | -    | 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              | $V_{(BR)DSS}$ | $V_{GS}=0\text{V}$ , $I_D=0.25\text{mA}$   | 500    | -    | -    | V             |
| Drain-Source avalanche<br>breakdown voltage | $V_{(BR)DS}$  | $V_{GS}=0\text{V}$ , $I_D=11.6\text{A}$  | -      | 600  | -    |               |
| Gate threshold voltage                      | $V_{GS(th)}$  | $I_D=500\mu\text{A}$ , $V_{GS}=V_{DS}$   | 2.1    | 3    | 3.9  |               |
| Zero gate voltage drain current             | $I_{DSS}$     | $V_{DS}=500\text{V}$ , $V_{GS}=0\text{V}$ ,<br>$T_j=25\text{ °C}$<br>$T_j=150\text{ °C}$ | -      | 0.1  | 1    | $\mu\text{A}$ |
| Gate-source leakage current                 | $I_{GSS}$     | $V_{GS}=20\text{V}$ , $V_{DS}=0\text{V}$   | -      | -    | 100  |               |
| Drain-source on-state resistance            | $R_{DS(on)}$  | $V_{GS}=10\text{V}$ , $I_D=7\text{A}$<br>$T_j=25\text{ °C}$<br>$T_j=150\text{ °C}$       | -      | 0.34 | 0.38 | $\Omega$      |
| Gate input resistance                       | $R_G$         | $f=1\text{MHz}$ , open drain   | -      | 1.4  | -    |               |

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

| Parameter   | Symbol       | Conditions   | Values |      |      | Unit |
|---|--------------|--|--------|------|------|------|
|   |              |  | min.   | typ. | max. |      |
| <b>Characteristics</b>  |              |  |        |      |      |      |
| Transconductance  | $g_{fs}$     | $V_{DS} \geq 2 \cdot I_D \cdot R_{DS(on)max}$ ,<br>$I_D = 7\text{A}$                           | -      | 8    | -    | S    |
| Input capacitance   | $C_{iss}$    | $V_{GS} = 0\text{V}$ , $V_{DS} = 25\text{V}$ ,<br>$f = 1\text{MHz}$                            | -      | 1200 | -    | pF   |
| Output capacitance  | $C_{oss}$    |  | -      | 400  | -    |      |
| Reverse transfer capacitance                                  | $C_{rss}$    |  | -      | 30   | -    |      |
| Effective output capacitance, <sup>5)</sup><br>energy related | $C_{o(er)}$  | $V_{GS} = 0\text{V}$ ,<br>$V_{DS} = 0\text{V to } 400\text{V}$                                 | -      | 45   | -    |      |
| Effective output capacitance, <sup>6)</sup><br>time related   | $C_{o(tr)}$  |  | -      | 92   | -    |      |
| Turn-on delay time  | $t_{d(on)}$  | $V_{DD} = 380\text{V}$ , $V_{GS} = 0/10\text{V}$ ,<br>$I_D = 11.6\text{A}$ , $R_G = 6.8\Omega$ | -      | 10   | -    | ns   |
| Rise time   | $t_r$        |  | -      | 8    | -    |      |
| Turn-off delay time   | $t_{d(off)}$ |  | -      | 45   | -    |      |
| Fall time   | $t_f$        |  | -      | 8    | -    |      |

**Gate Charge Characteristics**

|                       |                 |   |   |    |   |    |
|-----------------------|-----------------|---|---|----|---|----|
| Gate to source charge | $Q_{gs}$        | $V_{DD} = 400\text{V}$ , $I_D = 11.6\text{A}$   | - | 5  | - | nC |
| Gate to drain charge  | $Q_{gd}$        |   | - | 26 | - |    |
| Gate charge total     | $Q_g$           | $V_{DD} = 400\text{V}$ , $I_D = 11.6\text{A}$ ,<br>$V_{GS} = 0\text{ to } 10\text{V}$ | - | 49 | - |    |
| Gate plateau voltage  | $V_{(plateau)}$ | $V_{DD} = 400\text{V}$ , $I_D = 11.6\text{A}$   | - | 5  | - | V  |

<sup>0</sup>J-STD20 and JESD22

<sup>1</sup>Limited only by maximum temperature

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

<sup>3</sup>Device on 40mm\*40mm\*1.5mm epoxy PCB FR4 with 6cm<sup>2</sup> (one layer, 70 μm thick) copper area for drain connection. PCB is vertical without blown air.

<sup>4</sup>Soldering temperature for TO-263: 220°C, reflow

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

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

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

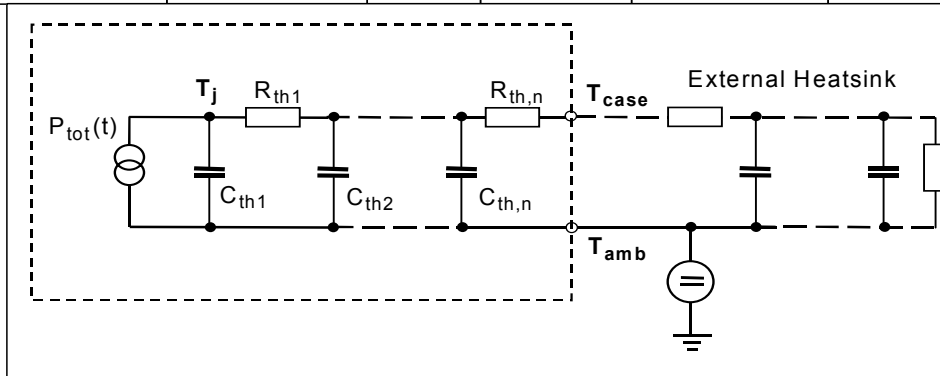
Identical low-side and high-side switch.

**Electrical Characteristics**

| Parameter                                     | Symbol       | Conditions                        | Values |      |      | Unit                   |
|---|--------------|-----------------------------------|--------|------|------|------------------------|
|   |              |                                   | min.   | typ. | max. |                        |
| Inverse diode continuous forward current      | $I_S$        | $T_C=25^\circ\text{C}$            | -      | -    | 11.6 | A                      |
| Inverse diode direct current, pulsed          | $I_{SM}$     |                                   | -      | -    | 34.8 |                        |
| Inverse diode forward voltage                 | $V_{SD}$     | $V_{GS}=0\text{V}, I_F=I_S$       | -      | 1    | 1.2  | V                      |
| Reverse recovery time                         | $t_{rr}$     | $V_R=400\text{V}, I_F=I_S,$       | -      | 380  | -    | ns                     |
| Reverse recovery charge                       | $Q_{rr}$     | $di_F/dt=100\text{A}/\mu\text{s}$ | -      | 5.5  | -    | $\mu\text{C}$          |
| Peak reverse recovery current                 | $I_{rrm}$    |                                   | -      | 38   | -    | A                      |
| Peak rate of fall of reverse recovery current | $di_{rr}/dt$ | $T_j=25^\circ\text{C}$            | -      | 1100 | -    | $\text{A}/\mu\text{s}$ |

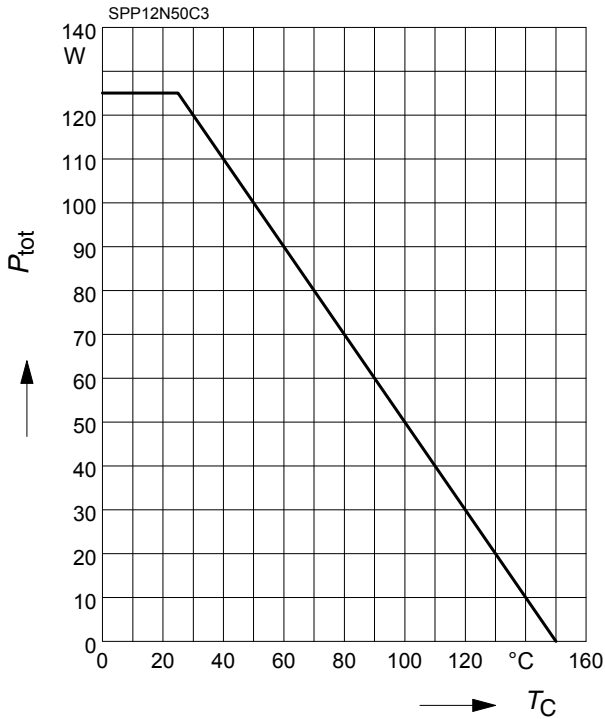
**Typical Transient Thermal Characteristics**

| Symbol    | Value |       | Unit | Symbol    | Value     |           | Unit |
|-----------|-------|-------|------|-----------|-----------|-----------|------|
|           | SPP_I | SPA   |      |           | SPP_I     | SPA       |      |
| $R_{th1}$ | 0.015 | 0.15  | K/W  | $C_{th1}$ | 0.0001878 | 0.0001878 | Ws/K |
| $R_{th2}$ | 0.03  | 0.03  |      | $C_{th2}$ | 0.0007106 | 0.0007106 |      |
| $R_{th3}$ | 0.056 | 0.056 |      | $C_{th3}$ | 0.000988  | 0.000988  |      |
| $R_{th4}$ | 0.197 | 0.194 |      | $C_{th4}$ | 0.002791  | 0.002791  |      |
| $R_{th5}$ | 0.216 | 0.413 |      | $C_{th5}$ | 0.007285  | 0.007401  |      |
| $R_{th6}$ | 0.083 | 2.522 |      | $C_{th6}$ | 0.063     | 0.412     |      |



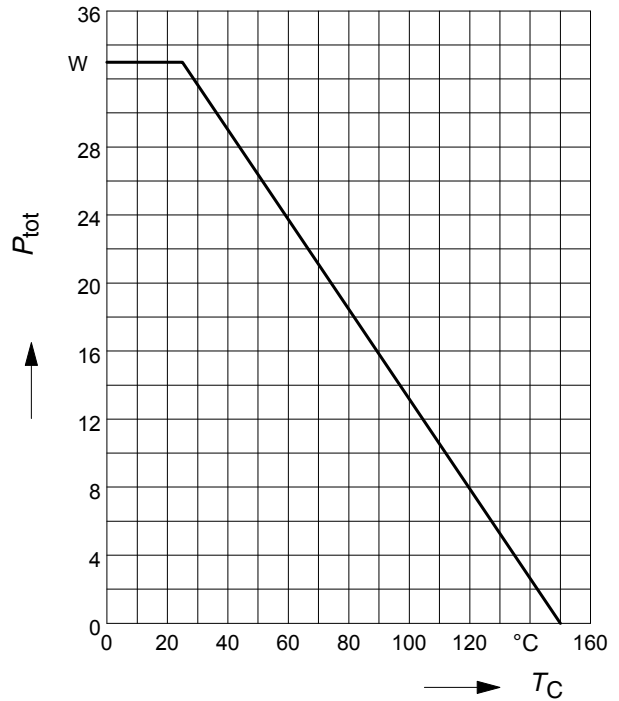
**1 Power dissipation**

$P_{tot} = f(T_C)$



**2 Power dissipation FullPAK**

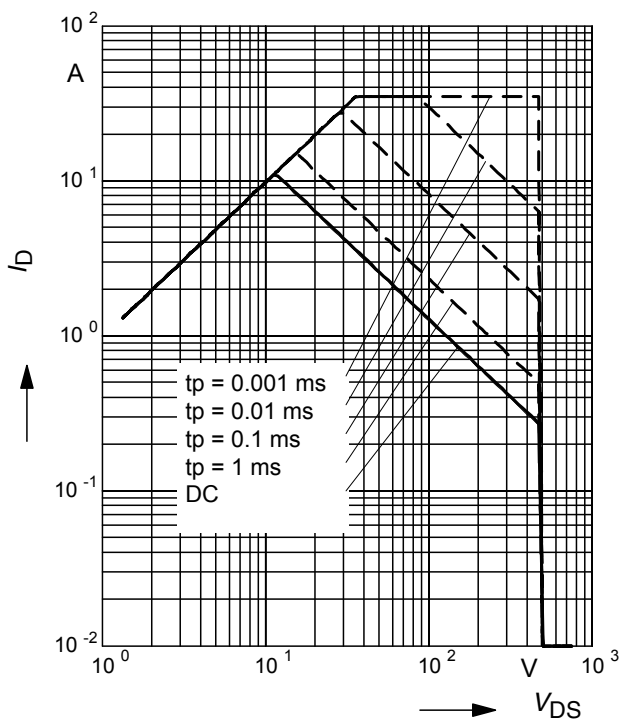
$P_{tot} = f(T_C)$



**3 Safe operating area**

$I_D = f(V_{DS})$

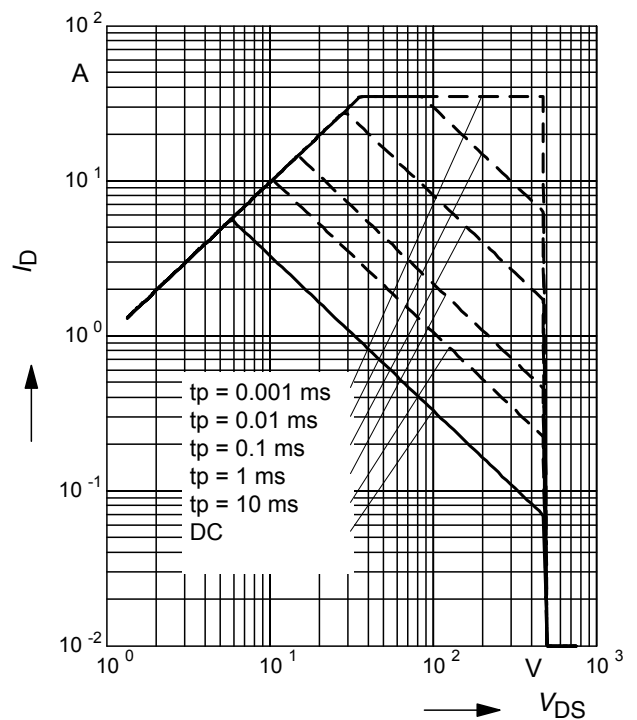
parameter :  $D = 0$  ,  $T_C = 25^\circ\text{C}$



**4 Safe operating area FullPAK**

$I_D = f(V_{DS})$

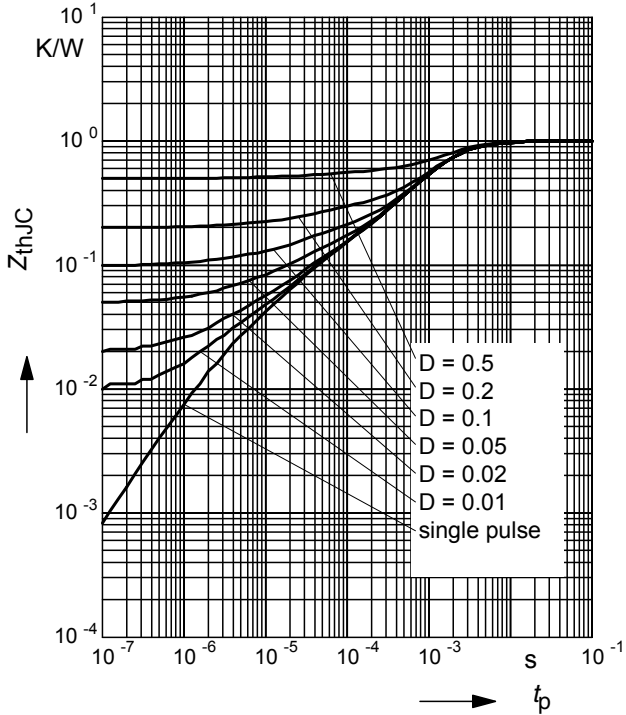
parameter:  $D = 0$  ,  $T_C = 25^\circ\text{C}$



### 5 Transient thermal impedance

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

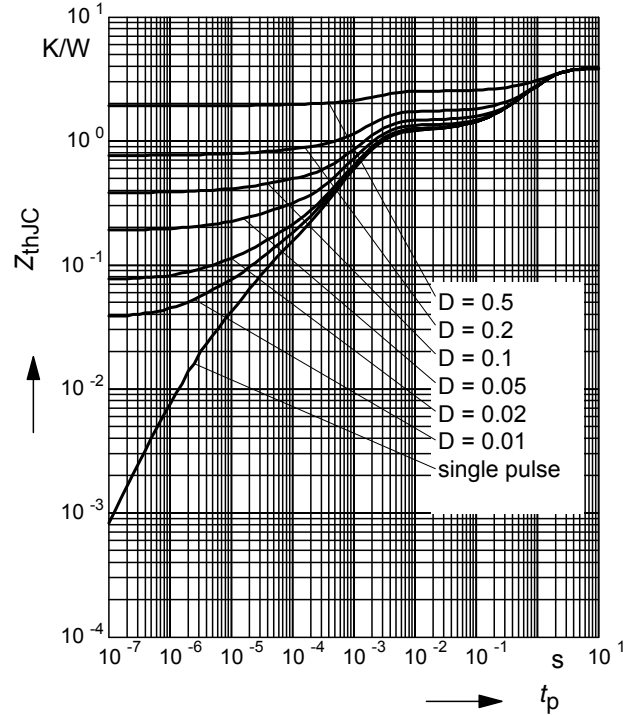
parameter:  $D = t_p/T$



### 6 Transient thermal impedance FullPAK

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

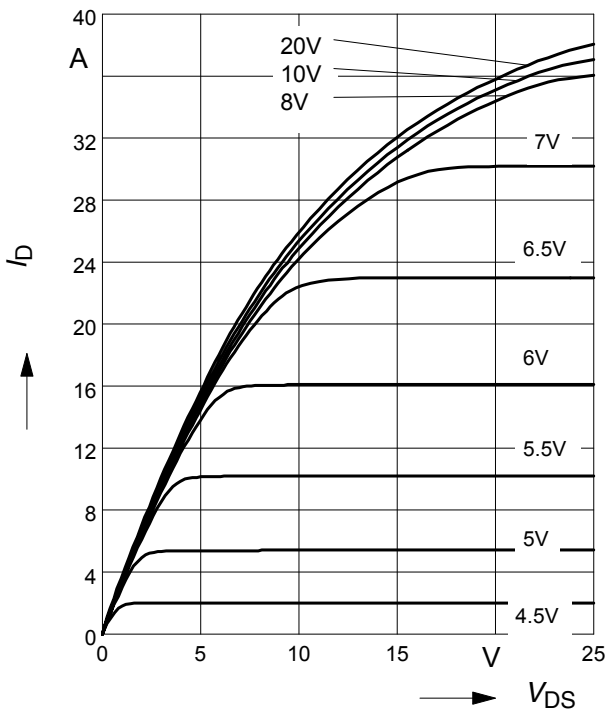
parameter:  $D = t_p/t$



### 7 Typ. output characteristic

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

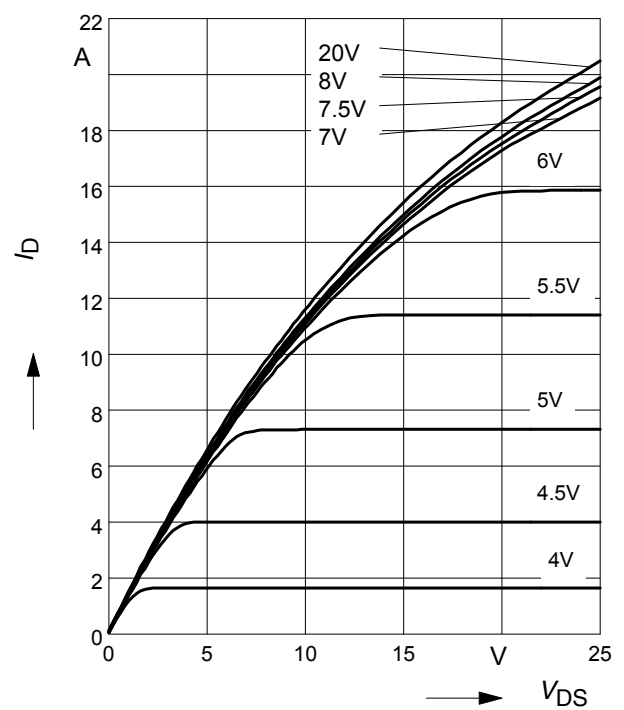
parameter:  $t_p = 10 \mu\text{s}, V_{GS}$



### 8 Typ. output characteristic

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

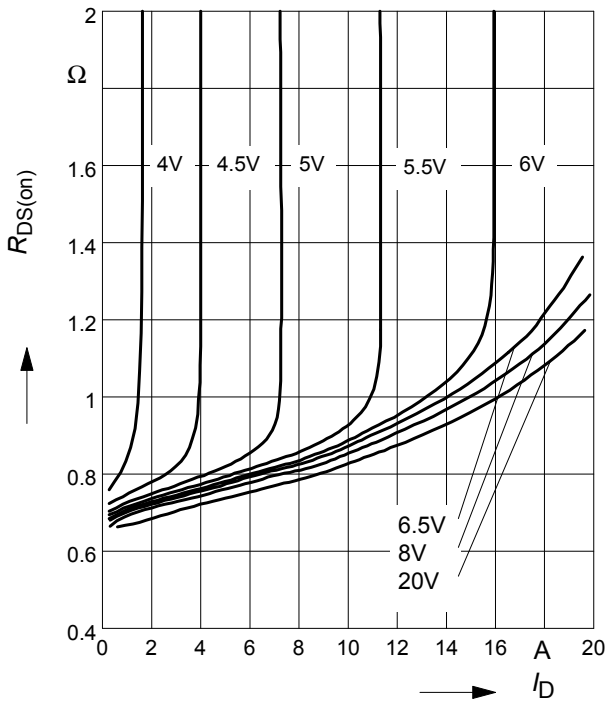
parameter:  $t_p = 10 \mu\text{s}, V_{GS}$



**9 Typ. drain-source on resistance**

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

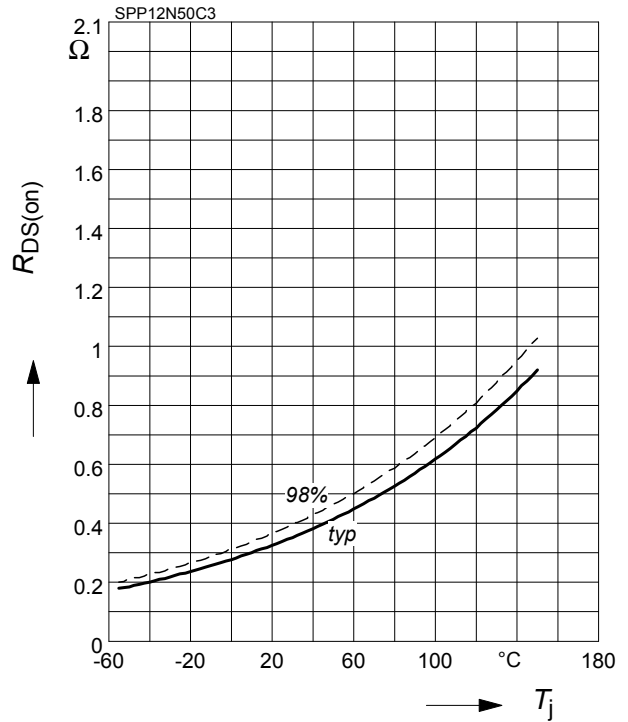
parameter:  $T_j = 150^\circ\text{C}$ ,  $V_{GS}$



**10 Drain-source on-state resistance**

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

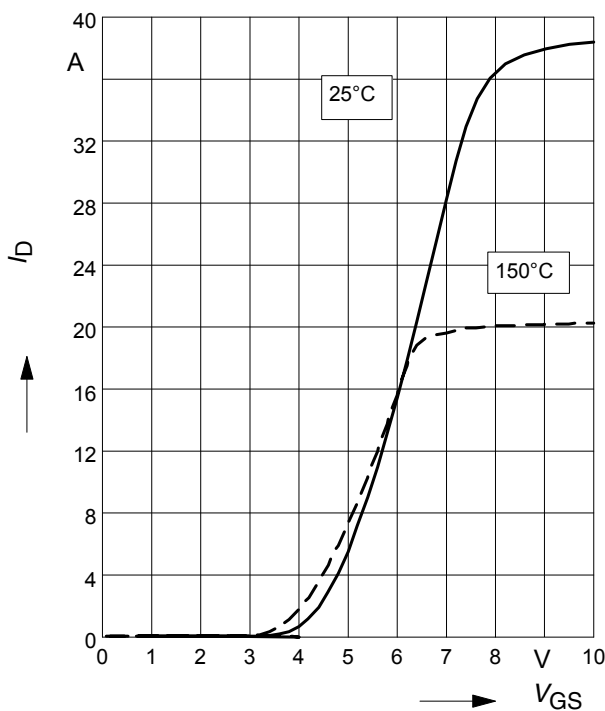
parameter:  $I_D = 7\text{ A}$ ,  $V_{GS} = 10\text{ V}$



**11 Typ. transfer characteristics**

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

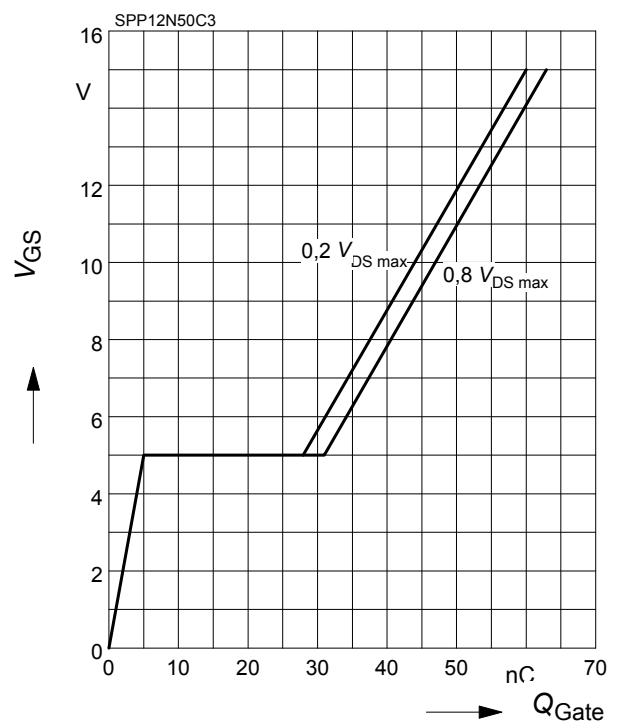
parameter:  $t_p = 10\ \mu\text{s}$



**12 Typ. gate charge**

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

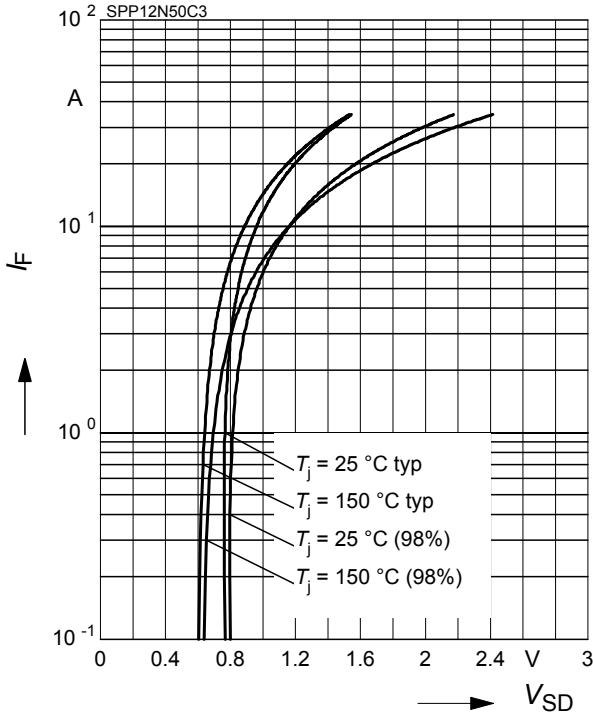
parameter:  $I_D = 11.6\text{ A pulsed}$



**13 Forward characteristics of body diode**

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

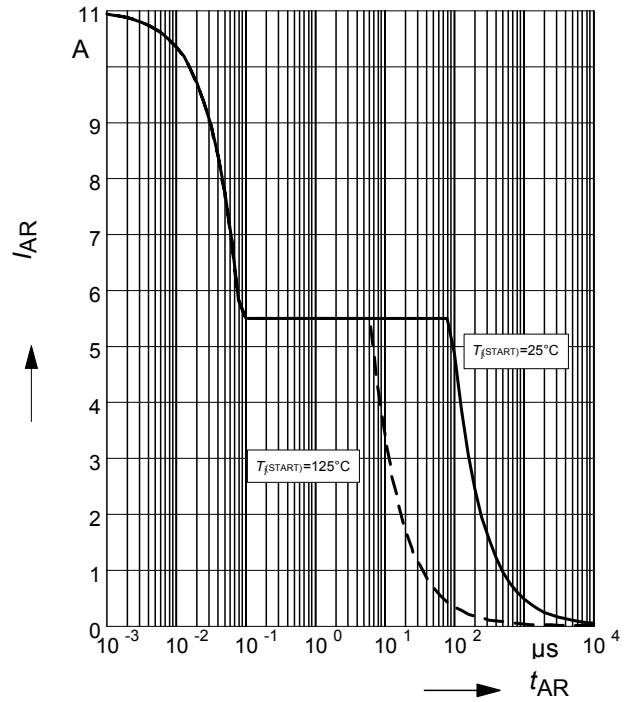
parameter:  $T_j$ ,  $t_p = 10 \mu s$



**14 Avalanche SOA**

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

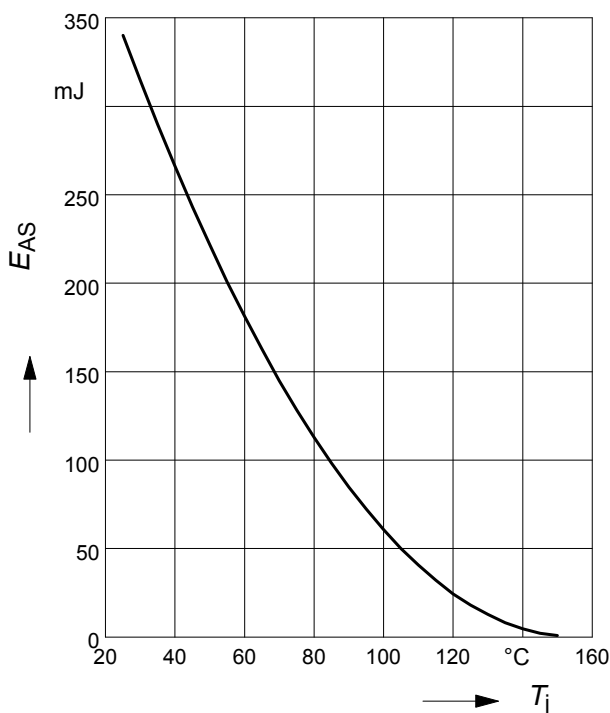
par.:  $T_j \leq 150 \text{ °C}$



**15 Avalanche energy**

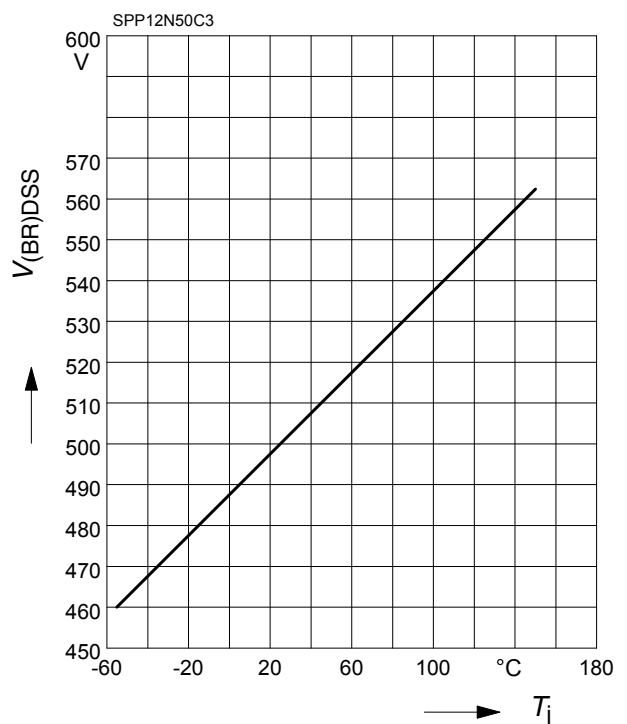
$$E_{AS} = f(T_j)$$

par.:  $I_D = 5.5 \text{ A}$ ,  $V_{DD} = 50 \text{ V}$



**16 Drain-source breakdown voltage**

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

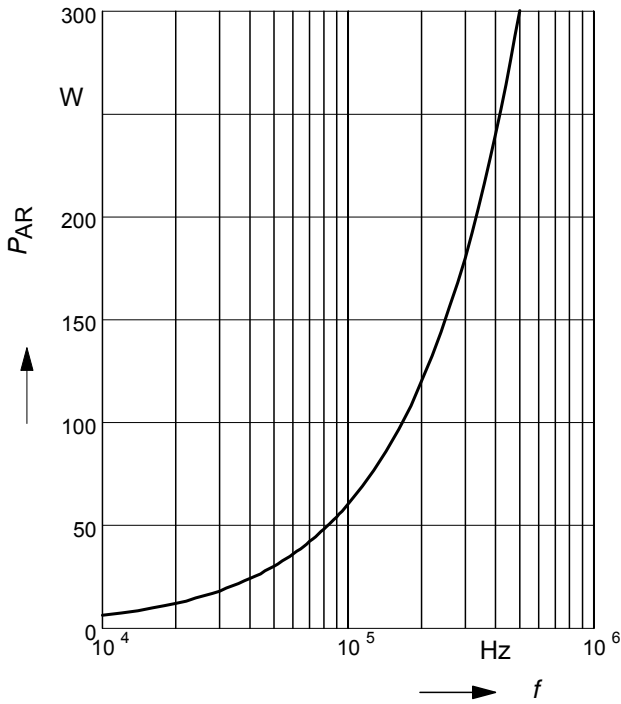




**17 Avalanche power losses**

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

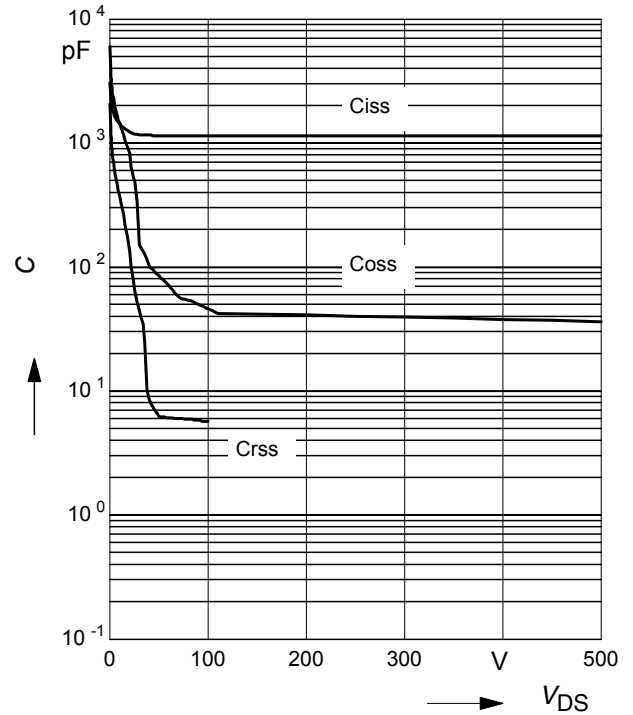
parameter:  $E_{AR}=0.6\text{mJ}$



**18 Typ. capacitances**

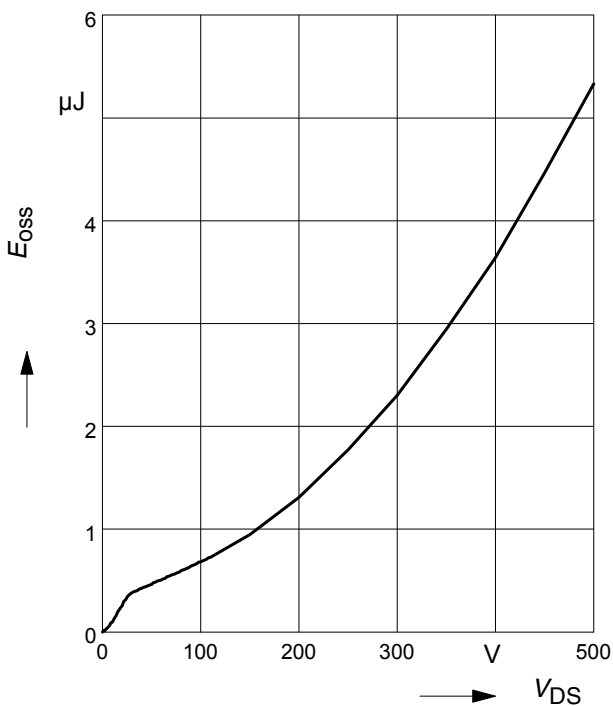
$$C = f(V_{DS})$$

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



**19 Typ. C<sub>OSS</sub> stored energy**

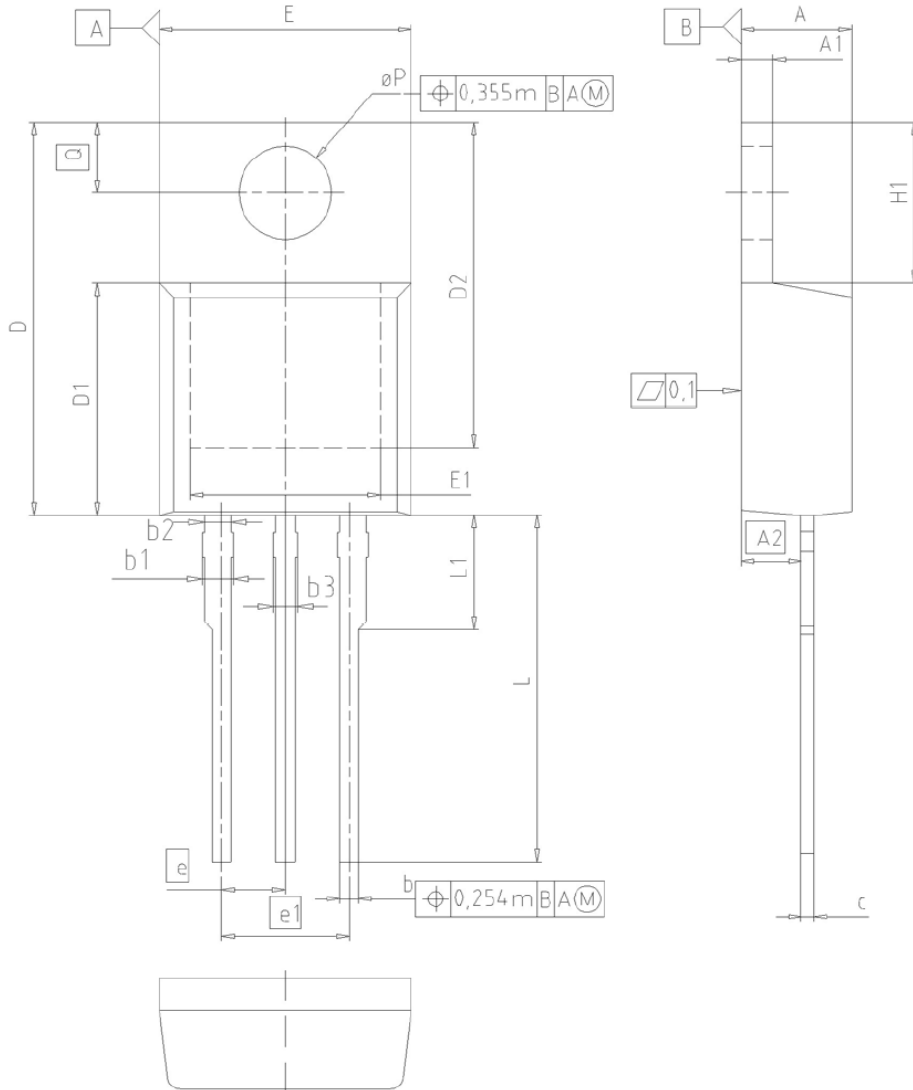
$$E_{Oss}=f(V_{DS})$$



Definition of diodes switching characteristics



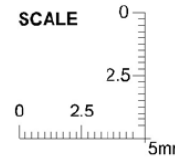
PG-TO-220-3-1, PG-TO220-3-21




| 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 |
| $\phi P$ | 3.60        | 3.89  | 0.142  | 0.153 |
| Q        | 2.60        | 3.00  | 0.102  | 0.118 |

**DOCUMENT NO.**  
Z8B00003318

**SCALE**



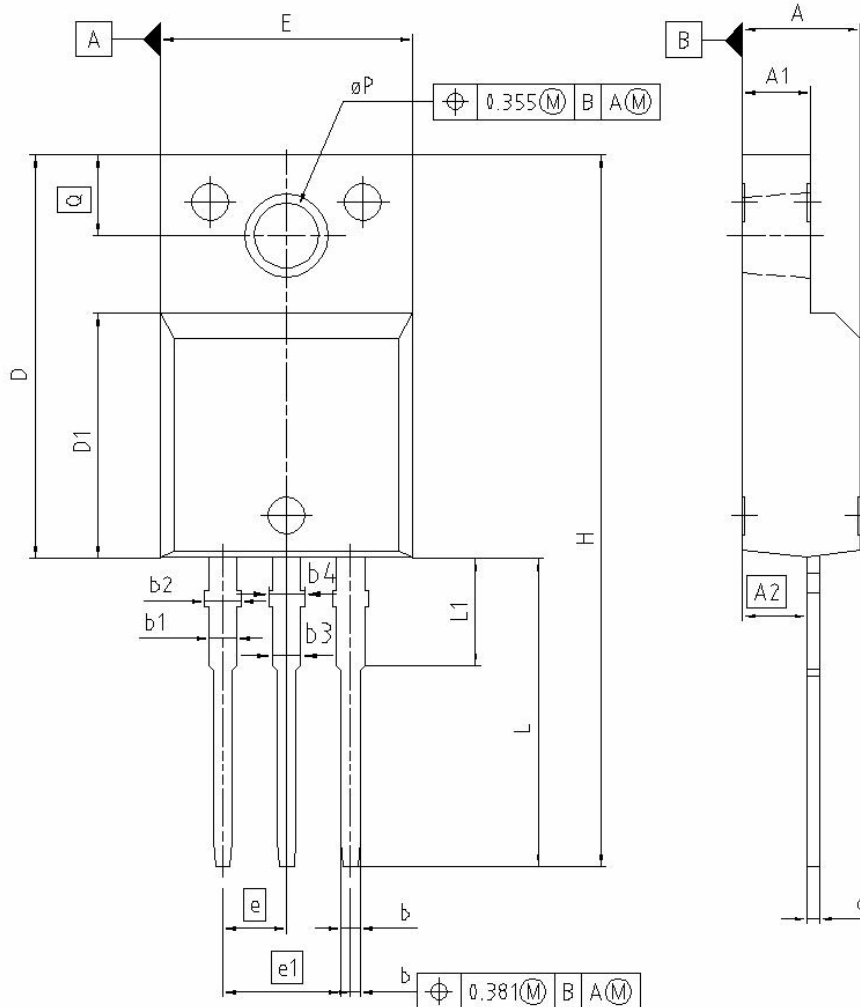
**EUROPEAN PROJECTION**



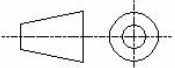
**ISSUE DATE**  
23-08-2007

**REVISION**  
05

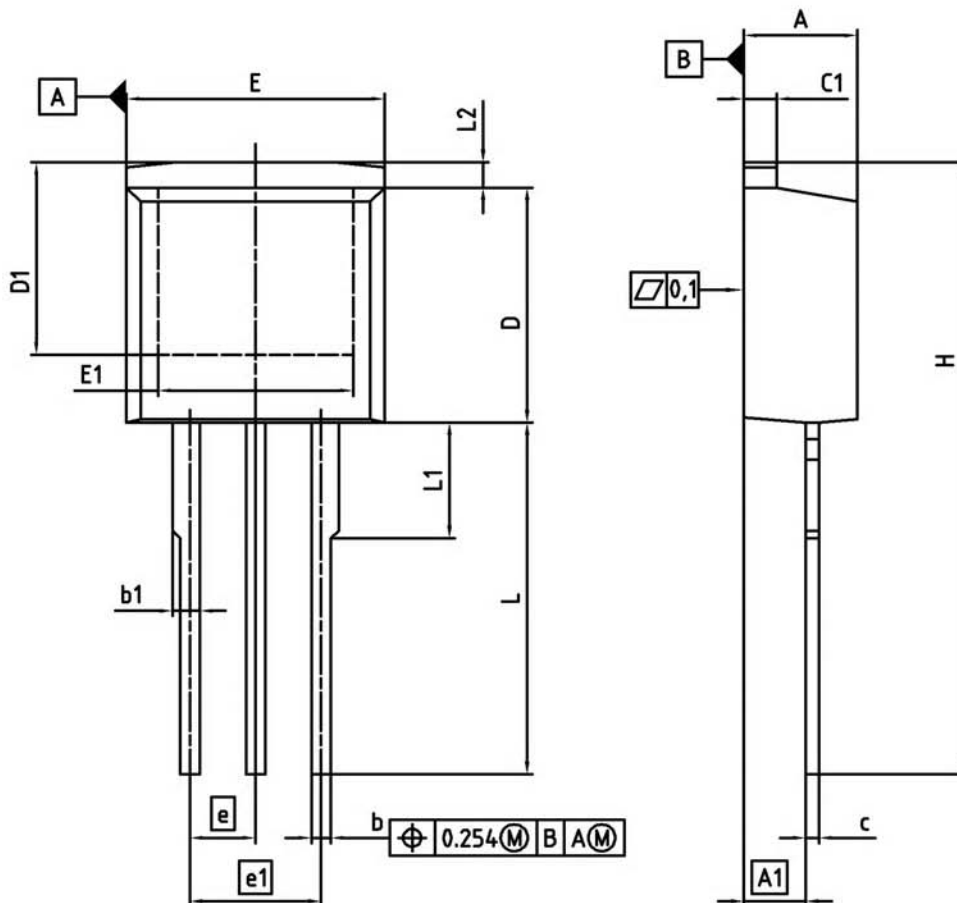
PG-TO220-3-31/3-111 Fully isolated package (2500VAC; 1 minute)



| 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 |
| pP  | 2.95        | 3.20  | 0.116  | 0.126 |
| Q   | 3.15        | 3.50  | 0.124  | 0.138 |

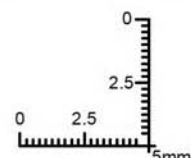
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|---|
| <b>REFERENCE</b><br>..  |
| <b>SCALE</b><br>0<br>2.5<br>5mm   |
| <b>EUROPEAN PROJECTION</b><br> |
| <b>ISSUE DATE</b><br>08-01-2007   |
| <b>FILE</b><br>TO220_2  |

PG-TO262-3-1, PG-TO262-3-21 (I<sup>2</sup>-PAK)

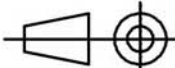


| DIM | MILLIMETERS |        | INCHES |       |
|-----|-------------|--------|--------|-------|
|     | MIN         | MAX    | MIN    | MAX   |
| A   | 4.300       | 4.572  | 0.169  | 0.180 |
| A1  | 2.150       | 2.718  | 0.085  | 0.107 |
| b   | 0.650       | 0.864  | 0.026  | 0.034 |
| b1  | 0.635       | 1.400  | 0.025  | 0.055 |
| c   | 0.330       | 0.600  | 0.013  | 0.024 |
| c1  | 1.170       | 1.400  | 0.046  | 0.055 |
| D   | 8.509       | 9.450  | 0.335  | 0.372 |
| D1  | 6.900       | -      | 0.272  | -     |
| E   | 9.700       | 10.363 | 0.382  | 0.408 |
| E1  | 6.500       | 8.600  | 0.256  | 0.339 |
| e   | 2.540       |        | 0.100  |       |
| e1  | 5.080       |        | 0.200  |       |
| N   | 3           |        | 3      |       |
| L   | 13.000      | 14.000 | 0.512  | 0.551 |
| L1  | -           | 4.800  | -      | 0.189 |
| L2  | -           | 1.727  | -      | 0.068 |

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JEDEC TO262



EUROPEAN PROJECTION



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TO262\_1

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