

PG-TO220-3

MOSFET

OptiMOS™ 6 Power-Transistor, 150 V

Features

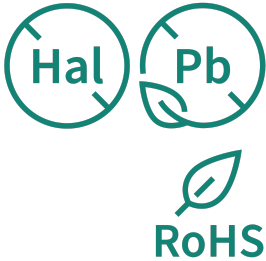
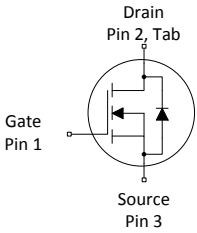
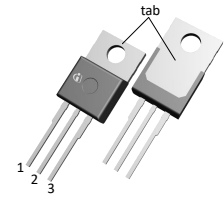
- N-channel, normal level
- Very low on-resistance  $R_{DS(on)}$
- Superior thermal resistance
- 100% avalanche tested
- Pb-free lead plating; RoHS compliant
- Halogen-free according to IEC61249-2-21

Product validation

Fully qualified according to JEDEC for Industrial Applications

Table 1 Key performance parameters

| Parameter          | Value | Unit |
|--------------------|-------|------|
| $V_{DS}$           | 150   | V    |
| $R_{DS(on),max}$   | 5.7   | mΩ   |
| $I_D$              | 128   | A    |
| $Q_{oss}$          | 132   | nC   |
| $Q_G$              | 44    | nC   |
| $Q_{rr}$ (500A/μs) | 131   | nC   |



| Type / Ordering code | Package    | Marking  | Related links |
|----------------------|------------|----------|---------------|
| IPP057N15NM6         | PG-TO220-3 | 057N15N6 | -             |



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## 1 Maximum ratings

at  $T_A=25\text{ °C}$ , unless otherwise specified

**Table 2 Maximum ratings**

| Parameter                                     | Symbol            | Values |      |                       | Unit | Note / Test condition                                                                                                                                                                                                       |
|-----------------------------------------------|-------------------|--------|------|-----------------------|------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                               |                   | Min.   | Typ. | Max.                  |      |                                                                                                                                                                                                                             |
| Continuous drain current <sup>1)</sup>        | $I_D$             | -      | -    | 128<br>90<br>83<br>17 | A    | $V_{GS}=10\text{ V}$ , $T_C=25\text{ °C}$<br>$V_{GS}=10\text{ V}$ , $T_C=100\text{ °C}$<br>$V_{GS}=8\text{ V}$ , $T_C=100\text{ °C}$<br>$V_{GS}=10\text{ V}$ , $T_A=25\text{ °C}$ , $R_{thJA}=40\text{ °C/W}$ <sup>2)</sup> |
| Pulsed drain current <sup>3)</sup>            | $I_{D,pulse}$     | -      | -    | 512                   | A    | $T_A=25\text{ °C}$                                                                                                                                                                                                          |
| Avalanche current, single pulse <sup>4)</sup> | $I_{AS}$          | -      | -    | 52                    | A    | $T_C=25\text{ °C}$                                                                                                                                                                                                          |
| Avalanche energy, single pulse                | $E_{AS}$          | -      | -    | 241                   | mJ   | $I_D=42\text{ A}$ , $R_{GS}=25\text{ }\Omega$                                                                                                                                                                               |
| Gate source voltage                           | $V_{GS}$          | -20    | -    | 20                    | V    | -                                                                                                                                                                                                                           |
| Power dissipation                             | $P_{tot}$         | -      | -    | 211<br>3.8            | W    | $T_C=25\text{ °C}$<br>$T_A=25\text{ °C}$ , $R_{thJA}=40\text{ °C/W}$ <sup>2)</sup>                                                                                                                                          |
| Operating and storage temperature             | $T_j$ , $T_{stg}$ | -55    | -    | 175                   | °C   | -                                                                                                                                                                                                                           |

<sup>1)</sup> Rating refers to the product only with datasheet specified absolute maximum values, maintaining case temperature as specified. For other case temperatures please refer to Diagram 2. De-rating will be required based on the actual environmental conditions.

<sup>2)</sup> Device on 40 mm x 40 mm x 1.5 mm epoxy PCB FR4 with 6 cm<sup>2</sup> (one layer, 70 µm thick) copper area for drain connection. PCB is vertical in still air.

<sup>3)</sup> See Diagram 3 for more detailed information

<sup>4)</sup> See Diagram 13 for more detailed information

## 2 Thermal characteristics

**Table 3 Thermal characteristics**

| Parameter                                                                               | Symbol     | Values |      |      | Unit | Note / Test condition |
|-----------------------------------------------------------------------------------------|------------|--------|------|------|------|-----------------------|
|                                                                                         |            | Min.   | Typ. | Max. |      |                       |
| Thermal resistance, junction - case                                                     | $R_{thJC}$ | -      | -    | 0.71 | °C/W | -                     |
| Thermal resistance, junction - ambient,<br>6 cm <sup>2</sup> cooling area <sup>5)</sup> | $R_{thJA}$ | -      | -    | 40   | °C/W |                       |
| Thermal resistance, junction - ambient,<br>minimal footprint                            | $R_{thJA}$ | -      | -    | 62   | °C/W |                       |

<sup>5)</sup> Device on 40 mm x 40 mm x 1.5 mm epoxy PCB FR4 with 6 cm<sup>2</sup> (one layer, 70 µm thick) copper area for drain connection. PCB is vertical in still air.

### 3 Electrical characteristics

at  $T_j=25\text{ °C}$ , unless otherwise specified

**Table 4 Static characteristics**

| Parameter                        | Symbol        | Values |           |          | Unit          | Note / Test condition                                                                                                                 |
|----------------------------------|---------------|--------|-----------|----------|---------------|---------------------------------------------------------------------------------------------------------------------------------------|
|                                  |               | Min.   | Typ.      | Max.     |               |                                                                                                                                       |
| Drain-source breakdown voltage   | $V_{(BR)DSS}$ | 150    | -         | -        | V             | $V_{GS}=0\text{ V}$ , $I_D=1\text{ mA}$                                                                                               |
| Gate threshold voltage           | $V_{GS(th)}$  | 3.0    | 3.5       | 4.0      | V             | $V_{DS}=V_{GS}$ , $I_D=112\text{ }\mu\text{A}$                                                                                        |
| Zero gate voltage drain current  | $I_{DSS}$     | -      | 0.1<br>10 | 1<br>100 | $\mu\text{A}$ | $V_{DS}=120\text{ V}$ , $V_{GS}=0\text{ V}$ , $T_j=25\text{ °C}$<br>$V_{DS}=120\text{ V}$ , $V_{GS}=0\text{ V}$ , $T_j=125\text{ °C}$ |
| Gate-source leakage current      | $I_{GSS}$     | -      | 10        | 100      | nA            | $V_{GS}=20\text{ V}$ , $V_{DS}=0\text{ V}$                                                                                            |
| Drain-source on-state resistance | $R_{DS(on)}$  | -      | 4.8       | 5.4      | m $\Omega$    | $V_{GS}=15\text{ V}$ , $I_D=52\text{ A}$                                                                                              |
|                                  |               |        | 5.2       | 5.7      |               | $V_{GS}=10\text{ V}$ , $I_D=52\text{ A}$                                                                                              |
|                                  |               |        | 5.8       | 6.8      |               | $V_{GS}=8\text{ V}$ , $I_D=26\text{ A}$                                                                                               |
| Gate resistance                  | $R_G$         | -      | 0.9       | 1.4      | $\Omega$      | -                                                                                                                                     |
| Transconductance                 | $g_{fs}$      | 43     | 86        | -        | S             | $ V_{DS} \geq 2 I_D $ , $R_{DS(on)max}$ , $I_D=52\text{ A}$                                                                           |

**Table 5 Dynamic characteristics**

| Parameter                                  | Symbol       | Values |      |      | Unit | Note / Test condition                                                                              |
|--------------------------------------------|--------------|--------|------|------|------|----------------------------------------------------------------------------------------------------|
|                                            |              | Min.   | Typ. | Max. |      |                                                                                                    |
| Input capacitance <sup>6)</sup>            | $C_{iss}$    | -      | 3100 | 4000 | pF   | $V_{GS}=0\text{ V}$ , $V_{DS}=75\text{ V}$ , $f=1\text{ MHz}$                                      |
| Output capacitance <sup>6)</sup>           | $C_{oss}$    | -      | 990  | 1300 | pF   |                                                                                                    |
| Reverse transfer capacitance <sup>6)</sup> | $C_{rss}$    | -      | 15   | 26   | pF   |                                                                                                    |
| Turn-on delay time                         | $t_{d(on)}$  | -      | 15   | -    | ns   | $V_{DD}=75\text{ V}$ , $V_{GS}=10\text{ V}$ , $I_D=26\text{ A}$ ,<br>$R_{G,ext}=1.6\text{ }\Omega$ |
| Rise time                                  | $t_r$        | -      | 10   | -    | ns   |                                                                                                    |
| Turn-off delay time                        | $t_{d(off)}$ | -      | 21   | -    | ns   |                                                                                                    |
| Fall time                                  | $t_f$        | -      | 10   | -    | ns   |                                                                                                    |

<sup>6)</sup> Defined by design. Not subject to production test.

**Table 6 Gate charge characteristics** <sup>7)</sup>

| Parameter                           | Symbol        | Values |      |      | Unit | Note / Test condition                                                       |
|-------------------------------------|---------------|--------|------|------|------|-----------------------------------------------------------------------------|
|                                     |               | Min.   | Typ. | Max. |      |                                                                             |
| Gate to source charge <sup>8)</sup> | $Q_{gs}$      | -      | 17   | 23   | nC   | $V_{DD}=75\text{ V}$ , $I_D=26\text{ A}$ , $V_{GS}=0\text{ to }10\text{ V}$ |
| Gate charge at threshold            | $Q_{g(th)}$   | -      | 11   | -    | nC   |                                                                             |
| Gate to drain charge <sup>8)</sup>  | $Q_{gd}$      | -      | 10.3 | 15.5 | nC   |                                                                             |
| Switching charge                    | $Q_{sw}$      | -      | 16.2 | -    | nC   |                                                                             |
| Gate charge total <sup>8)</sup>     | $Q_g$         | -      | 44   | 55   | nC   |                                                                             |
| Gate plateau voltage                | $V_{plateau}$ | -      | 5.4  | -    | V    | $V_{DS}=0.1\text{ V}$ , $V_{GS}=0\text{ to }10\text{ V}$                    |
| Gate charge total, sync. FET        | $Q_{g(sync)}$ | -      | 37   | -    | nC   |                                                                             |
| Output charge <sup>8)</sup>         | $Q_{oss}$     | -      | 132  | 176  | nC   |                                                                             |

<sup>7)</sup> See "Gate charge waveforms" for parameter definition

<sup>8)</sup> Defined by design. Not subject to production test.

**Table 7 Reverse diode**

| Parameter                             | Symbol        | Values |      |      | Unit | Note / Test condition                                                       |
|---------------------------------------|---------------|--------|------|------|------|-----------------------------------------------------------------------------|
|                                       |               | Min.   | Typ. | Max. |      |                                                                             |
| Diode continuous forward current      | $I_S$         | -      | -    | 128  | A    | $T_C=25\text{ °C}$                                                          |
| Diode pulse current                   | $I_{S,pulse}$ | -      | -    | 512  | A    |                                                                             |
| Diode forward voltage                 | $V_{SD}$      | -      | 0.87 | 1.0  | V    | $V_{GS}=0\text{ V}$ , $I_F=52\text{ A}$ , $T_J=25\text{ °C}$                |
| Reverse recovery time <sup>9)</sup>   | $t_{rr}$      | -      | 34   | 68   | ns   | $V_R=75\text{ V}$ , $I_F=26\text{ A}$ , $di_F/dt=500\text{ A}/\mu\text{s}$  |
| Reverse recovery charge <sup>9)</sup> | $Q_{rr}$      | -      | 131  | 262  | nC   |                                                                             |
| Reverse recovery time <sup>9)</sup>   | $t_{rr}$      | -      | 29   | 58   | ns   | $V_R=75\text{ V}$ , $I_F=26\text{ A}$ , $di_F/dt=1000\text{ A}/\mu\text{s}$ |
| Reverse recovery charge <sup>9)</sup> | $Q_{rr}$      | -      | 218  | 436  | nC   |                                                                             |

<sup>9)</sup> Defined by design. Not subject to production test.

## 4 Electrical characteristics diagrams

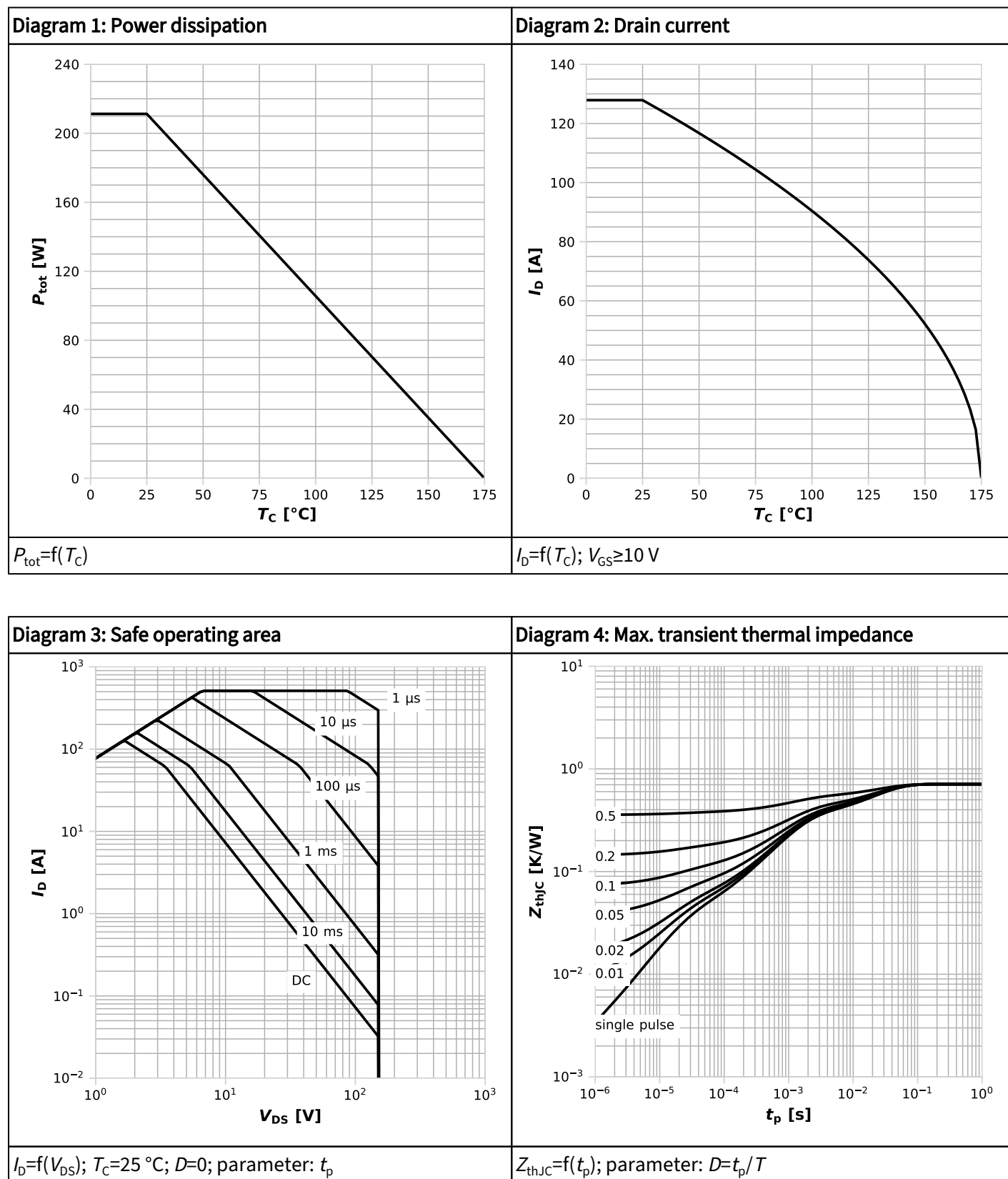
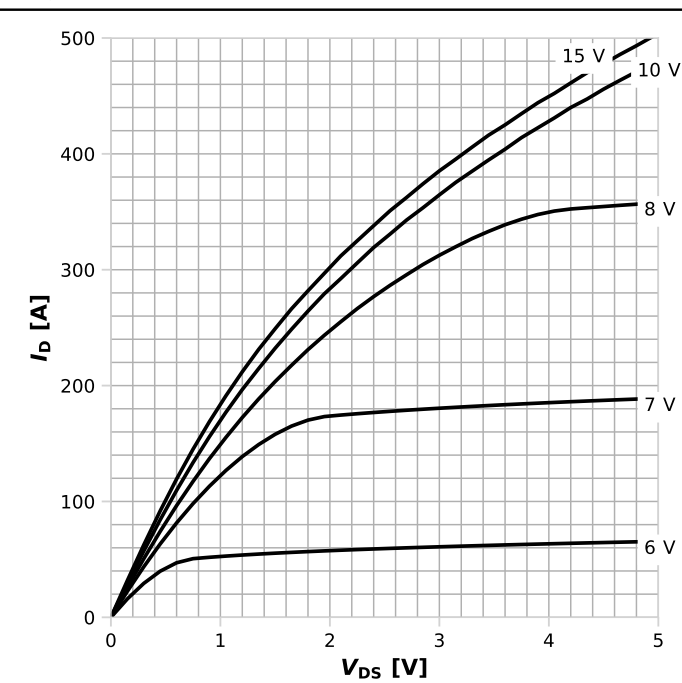
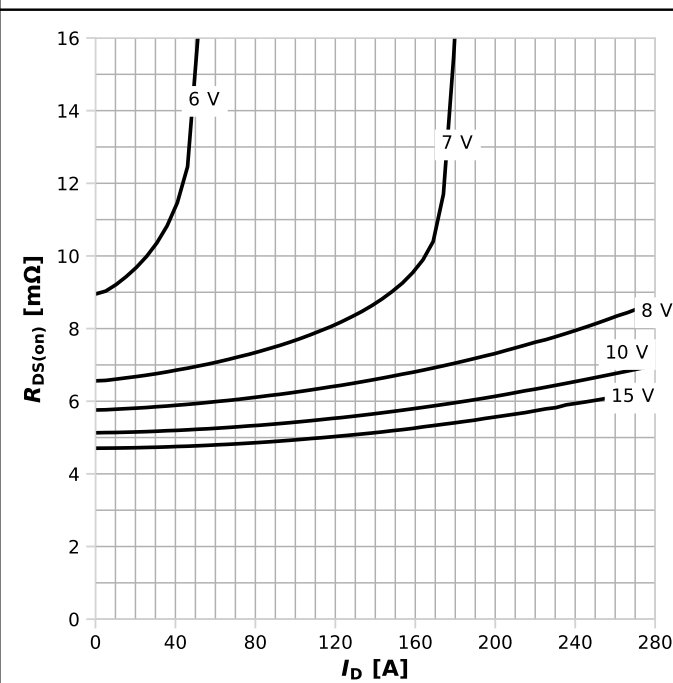


Diagram 5: Typ. output characteristics



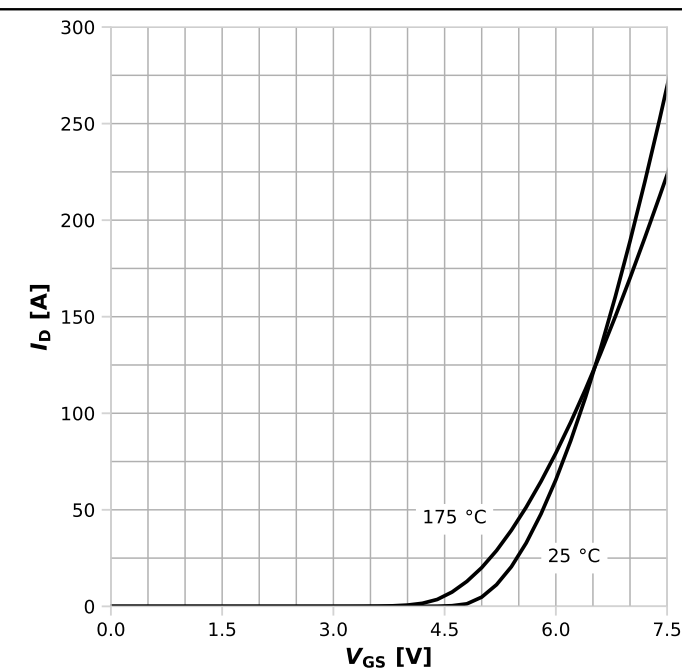
$I_D = f(V_{DS})$ ,  $T_j = 25^\circ\text{C}$ ; parameter:  $V_{GS}$

Diagram 6: Typ. drain-source on resistance



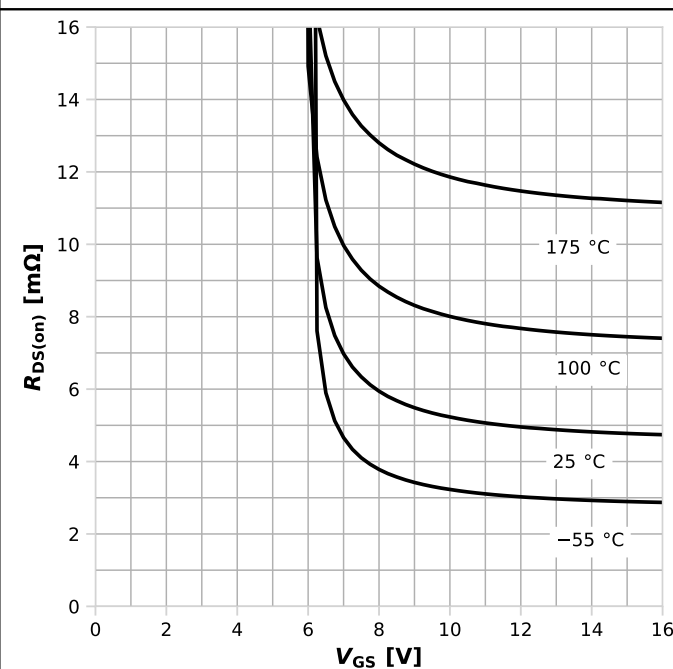
$R_{DS(on)} = f(I_D)$ ,  $T_j = 25^\circ\text{C}$ ; parameter:  $V_{GS}$

Diagram 7: Typ. transfer characteristics



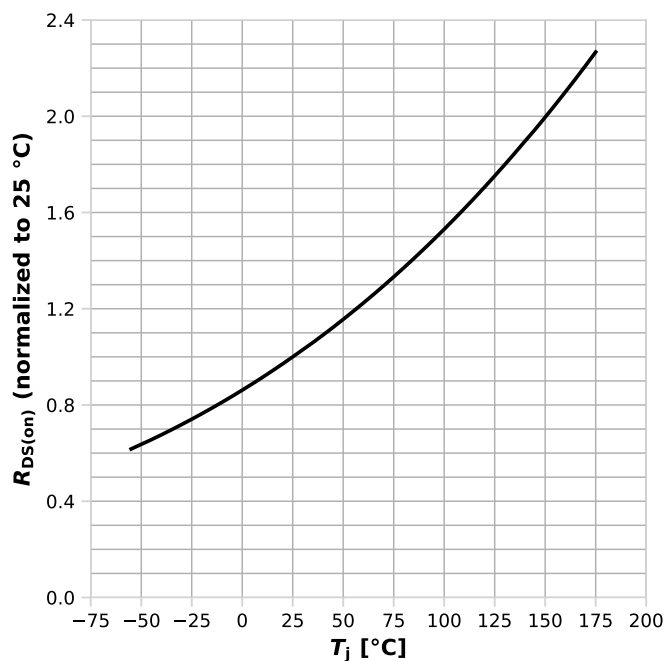
$I_D = f(V_{GS})$ ,  $|V_{DS}| > 2|I_D|R_{DS(on)\max}$ ; parameter:  $T_j$

Diagram 8: Typ. drain-source on resistance



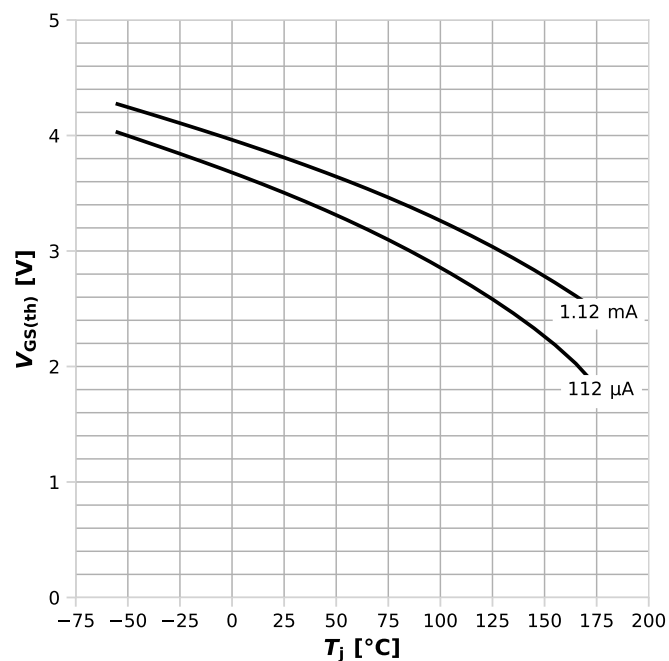
$R_{DS(on)} = f(V_{GS})$ ,  $I_D = 52\text{ A}$ ; parameter:  $T_j$

Diagram 9: Normalized drain-source on resistance



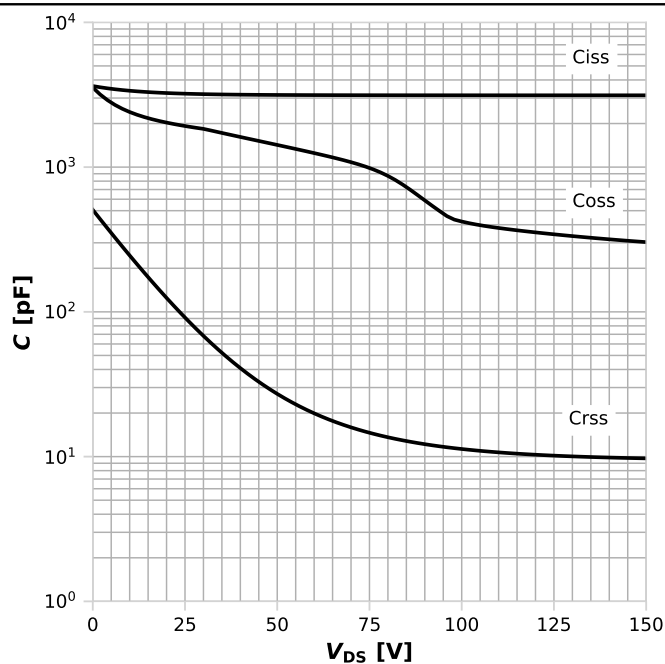
$$R_{DS(on)} = f(T_j), I_D = 52 \text{ A}, V_{GS} = 10 \text{ V}$$

Diagram 10: Typ. gate threshold voltage



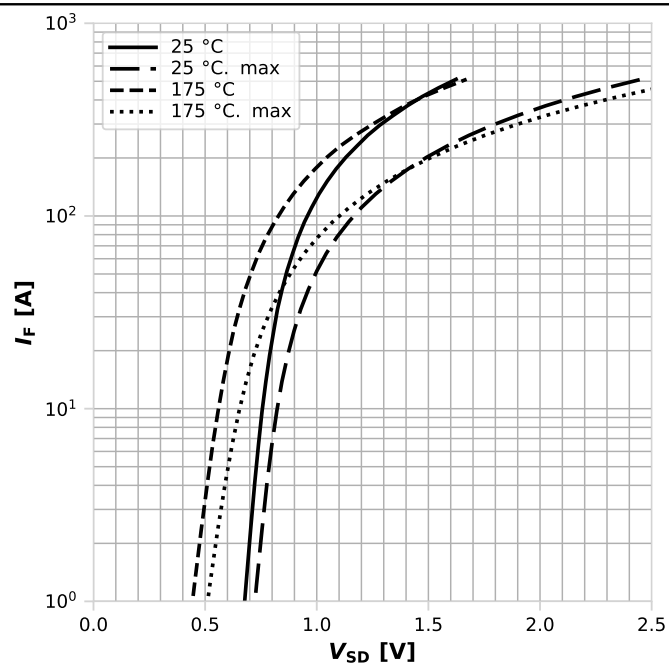
$$V_{GS(th)} = f(T_j), V_{GS} = V_{DS}; \text{ parameter: } I_D$$

Diagram 11: Typ. capacitances



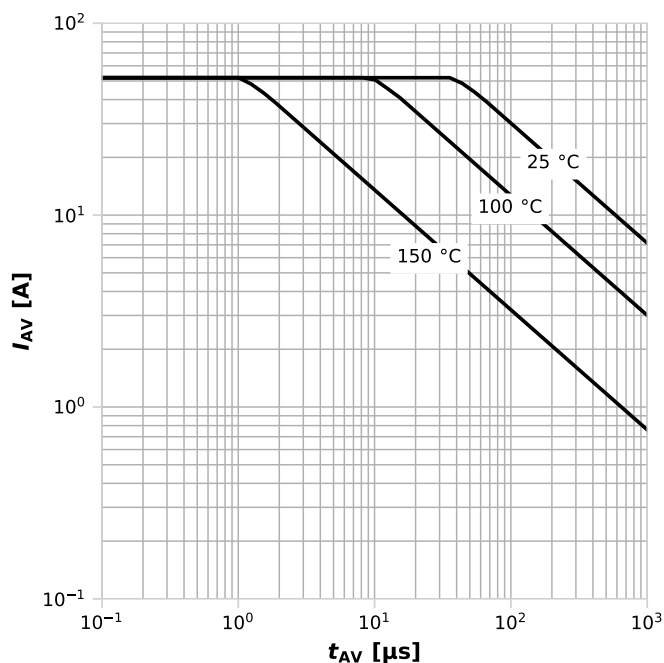
$$C = f(V_{DS}); V_{GS} = 0 \text{ V}; f = 1 \text{ MHz}$$

Diagram 12: Forward characteristics of reverse diode



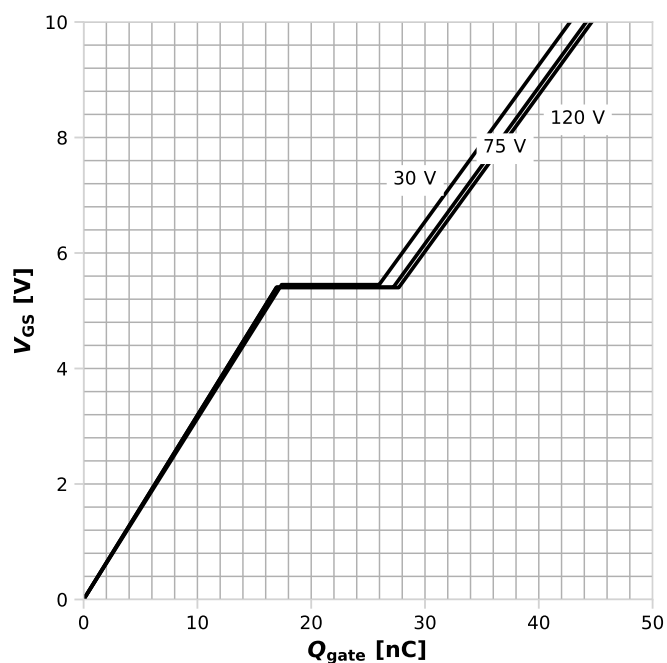
$$I_F = f(V_{SD}); \text{ parameter: } T_j$$

**Diagram 13: Avalanche characteristics**



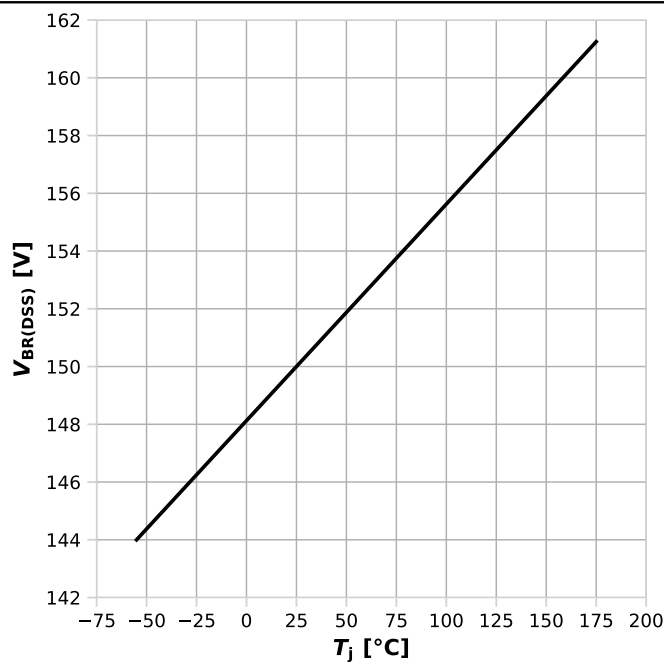
$I_{AS}=f(t_{AV})$ ;  $R_{GS}=25\ \Omega$ ; parameter:  $T_{j,start}$

**Diagram 14: Typ. gate charge**



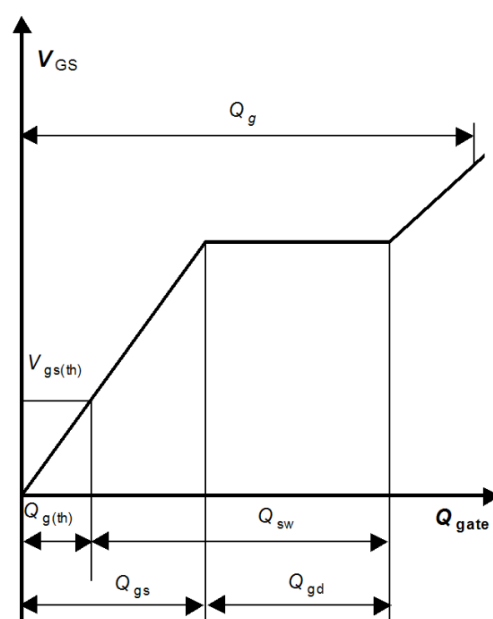
$V_{GS}=f(Q_{gate})$ ,  $I_D=26\text{ A}$  pulsed,  $T_j=25\text{ °C}$ ; parameter:  $V_{DD}$

**Diagram 15: Min. drain-source breakdown voltage**



$V_{BR(DSS)}=f(T_j)$ ;  $I_D=1\text{ mA}$

**Gate charge waveforms**



-

5 Package outlines

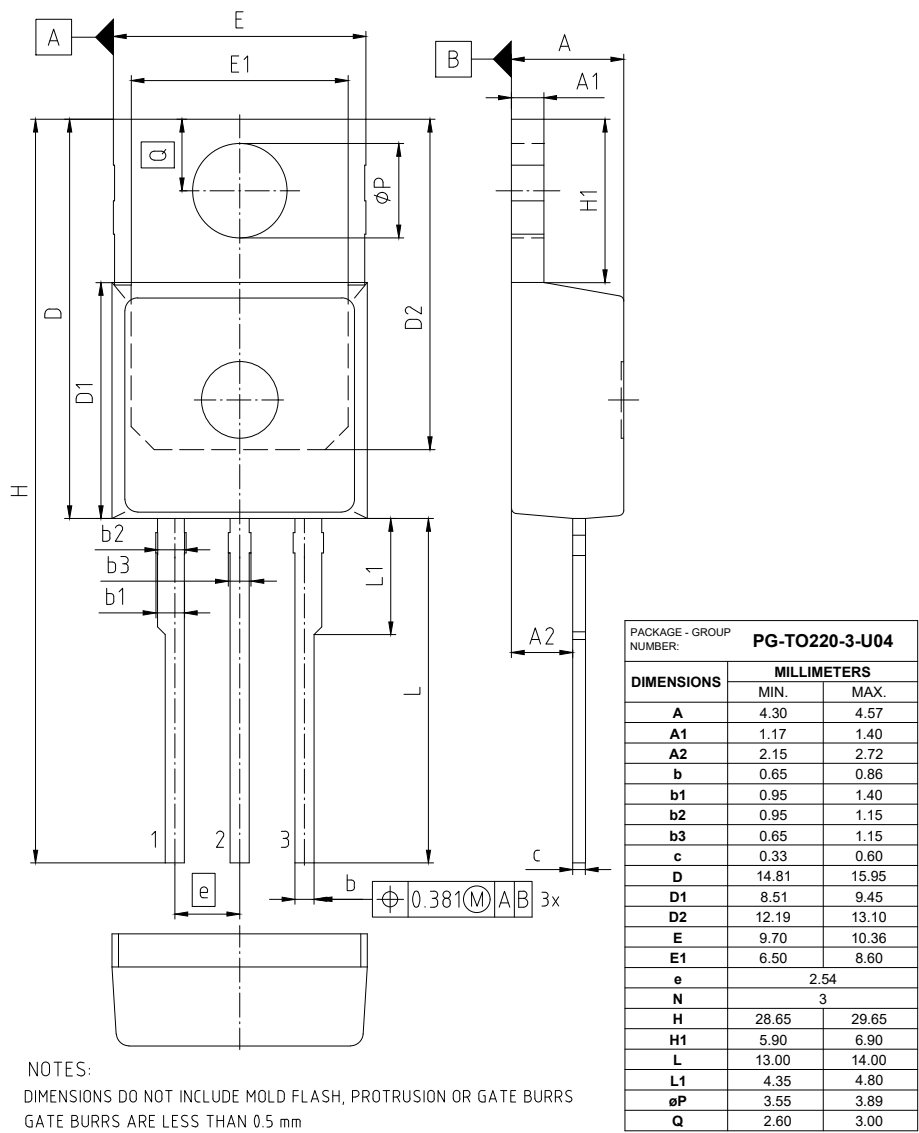


Figure 1 Outline PG-TO220-3, dimensions in mm

## Revision history

IPP057N15NM6

### Revision 2024-11-22, Rev. 1.0

Previous revisions

| Revision | Date       | Subjects (major changes since last revision) |
|----------|------------|----------------------------------------------|
| 1.0      | 2024-11-22 | Release of final datasheet                   |

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