

MOSFET

StrongIRFET™2 Power-Transistor, 40 V

Features

- Optimized for wide range of applications
- N-channel, normal level
- 100% avalanche tested
- Pb-free lead plating; RoHS compliant
- Halogen-free according to IEC61249-2-21

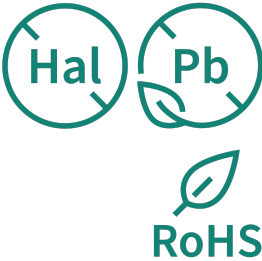
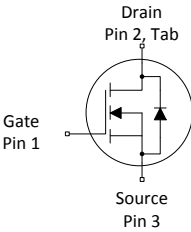
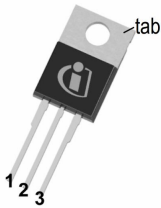
Product validation

Qualified according to JEDEC Standard

Table 1 Key Performance Parameters

| Parameter        | Value | Unit |
|------------------|-------|------|
| $V_{DS}$         | 40    | V    |
| $R_{DS(on),max}$ | 2.6   | mΩ   |
| $I_D$            | 122   | A    |
| $Q_{oss}$        | 76    | nC   |
| $Q_G(0V..10V)$   | 68    | nC   |

PG-TO220-3



| Type/Ordering Code | Package    | Marking  | Related Links |
|--------------------|------------|----------|---------------|
| IPP026N04NF2S      | PG-TO220-3 | 026N04NS | -             |



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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>       | $I_D$             | -      | -    | 122<br>94<br>29 | A    | $V_{GS}=10\text{ V}$ , $T_C=25\text{ °C}$<br>$V_{GS}=10\text{ V}$ , $T_C=100\text{ °C}$<br>$V_{GS}=10\text{ V}$ , $T_A=25\text{ °C}$ , $R_{THJA}=40\text{ °C/W}$ <sup>2)</sup> |
| Pulsed drain current <sup>3)</sup>           | $I_{D,pulse}$     | -      | -    | 488             | A    | $T_A=25\text{ °C}$                                                                                                                                                             |
| Avalanche energy, single pulse <sup>4)</sup> | $E_{AS}$          | -      | -    | 167             | mJ   | $I_D=70\text{ A}$ , $R_{GS}=25\text{ }\Omega$                                                                                                                                  |
| Gate source voltage                          | $V_{GS}$          | -20    | -    | 20              | V    | -                                                                                                                                                                              |
| Power dissipation                            | $P_{tot}$         | -      | -    | 158<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                                                     | $R_{thJC}$ | -      | -    | 0.95 | °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  $T_j=25\text{ }^{\circ}\text{C}$ , unless otherwise specified

**Table 4 Static characteristics**

| Parameter                                      | Symbol        | Values |            |            | Unit          | Note/ Test Condition                                                                                                                                            |
|------------------------------------------------|---------------|--------|------------|------------|---------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                |               | Min.   | Typ.       | Max.       |               |                                                                                                                                                                 |
| Drain-source breakdown voltage                 | $V_{(BR)DSS}$ | 40     | -          | -          | V             | $V_{GS}=0\text{ V}$ , $I_D=1\text{ mA}$                                                                                                                         |
| Gate threshold voltage                         | $V_{GS(th)}$  | 2.1    | 2.8        | 3.4        | V             | $V_{DS}=V_{GS}$ , $I_D=81\text{ }\mu\text{A}$                                                                                                                   |
| Zero gate voltage drain current                | $I_{DSS}$     | -      | 0.1<br>10  | 1<br>100   | $\mu\text{A}$ | $V_{DS}=40\text{ V}$ , $V_{GS}=0\text{ V}$ , $T_j=25\text{ }^{\circ}\text{C}$<br>$V_{DS}=40\text{ V}$ , $V_{GS}=0\text{ V}$ , $T_j=125\text{ }^{\circ}\text{C}$ |
| Gate-source leakage current                    | $I_{GSS}$     | -      | 10         | 100        | nA            | $V_{GS}=20\text{ V}$ , $V_{DS}=0\text{ V}$                                                                                                                      |
| Drain-source on-state resistance <sup>6)</sup> | $R_{DS(on)}$  | -      | 2.1<br>2.3 | 2.6<br>3.2 | m $\Omega$    | $V_{GS}=10\text{ V}$ , $I_D=70\text{ A}$<br>$V_{GS}=6\text{ V}$ , $I_D=35\text{ A}$                                                                             |
| Gate resistance                                | $R_G$         | -      | 3.0        | -          | $\Omega$      | -                                                                                                                                                               |
| Transconductance <sup>7)</sup>                 | $g_{fs}$      | 120    | -          | -          | S             | $ V_{DS} \geq 2 I_D R_{DS(on)max}$ , $I_D=70\text{ A}$                                                                                                          |

<sup>6)</sup>  $R_{DS(on)}$  is specified at a distance of 1.8 mm distance to the package body; mounting at a larger distance increases the overall package resistance of approximately 0.04 mOhm/mm per leg.

<sup>7)</sup> Defined by design. Not subject to production test.

**Table 5 Dynamic characteristics**

| Parameter                    | Symbol       | Values |      |      | Unit | Note/ Test Condition                                                                               |
|------------------------------|--------------|--------|------|------|------|----------------------------------------------------------------------------------------------------|
|                              |              | Min.   | Typ. | Max. |      |                                                                                                    |
| Input capacitance            | $C_{iss}$    | -      | 4800 | -    | pF   | $V_{GS}=0\text{ V}$ , $V_{DS}=20\text{ V}$ , $f=1\text{ MHz}$                                      |
| Output capacitance           | $C_{oss}$    | -      | 1780 | -    | pF   | $V_{GS}=0\text{ V}$ , $V_{DS}=20\text{ V}$ , $f=1\text{ MHz}$                                      |
| Reverse transfer capacitance | $C_{rss}$    | -      | 98   | -    | pF   | $V_{GS}=0\text{ V}$ , $V_{DS}=20\text{ V}$ , $f=1\text{ MHz}$                                      |
| Turn-on delay time           | $t_{d(on)}$  | -      | 16   | -    | ns   | $V_{DD}=20\text{ V}$ , $V_{GS}=10\text{ V}$ , $I_D=70\text{ A}$ ,<br>$R_{G,ext}=1.6\text{ }\Omega$ |
| Rise time                    | $t_r$        | -      | 15   | -    | ns   | $V_{DD}=20\text{ V}$ , $V_{GS}=10\text{ V}$ , $I_D=70\text{ A}$ ,<br>$R_{G,ext}=1.6\text{ }\Omega$ |
| Turn-off delay time          | $t_{d(off)}$ | -      | 35   | -    | ns   | $V_{DD}=20\text{ V}$ , $V_{GS}=10\text{ V}$ , $I_D=70\text{ A}$ ,<br>$R_{G,ext}=1.6\text{ }\Omega$ |
| Fall time                    | $t_f$        | -      | 15   | -    | ns   | $V_{DD}=20\text{ V}$ , $V_{GS}=10\text{ V}$ , $I_D=70\text{ A}$ ,<br>$R_{G,ext}=1.6\text{ }\Omega$ |

**Table 6 Gate charge characteristics <sup>8)</sup>**

| Parameter                | Symbol      | Values |      |      | Unit | Note/ Test Condition                                                        |
|--------------------------|-------------|--------|------|------|------|-----------------------------------------------------------------------------|
|                          |             | Min.   | Typ. | Max. |      |                                                                             |
| Gate to source charge    | $Q_{gs}$    | -      | 21   | -    | nC   | $V_{DD}=20\text{ V}$ , $I_D=70\text{ A}$ , $V_{GS}=0\text{ to }10\text{ V}$ |
| Gate charge at threshold | $Q_{g(th)}$ | -      | 14   | -    | nC   | $V_{DD}=20\text{ V}$ , $I_D=70\text{ A}$ , $V_{GS}=0\text{ to }10\text{ V}$ |
| Gate to drain charge     | $Q_{gd}$    | -      | 13   | -    | nC   | $V_{DD}=20\text{ V}$ , $I_D=70\text{ A}$ , $V_{GS}=0\text{ to }10\text{ V}$ |

**Table 6 Gate charge characteristics** <sup>8)</sup>

| Parameter                       | Symbol        | Values |      |      | Unit | Note/ Test Condition                                                        |
|---------------------------------|---------------|--------|------|------|------|-----------------------------------------------------------------------------|
|                                 |               | Min.   | Typ. | Max. |      |                                                                             |
| Switching charge                | $Q_{sw}$      | -      | 20   | -    | nC   | $V_{DD}=20\text{ V}$ , $I_D=70\text{ A}$ , $V_{GS}=0\text{ to }10\text{ V}$ |
| Gate charge total <sup>9)</sup> | $Q_g$         | -      | 68   | 102  | nC   | $V_{DD}=20\text{ V}$ , $I_D=70\text{ A}$ , $V_{GS}=0\text{ to }10\text{ V}$ |
| Gate plateau voltage            | $V_{plateau}$ | -      | 4.3  | -    | V    | $V_{DD}=20\text{ V}$ , $I_D=70\text{ A}$ , $V_{GS}=0\text{ to }10\text{ V}$ |
| Gate charge total, sync. FET    | $Q_{g(sync)}$ | -      | 61   | -    | nC   | $V_{DS}=0.1\text{ V}$ , $V_{GS}=0\text{ to }10\text{ V}$                    |
| Output charge                   | $Q_{oss}$     | -      | 76   | -    | nC   | $V_{DS}=20\text{ V}$ , $V_{GS}=0\text{ V}$                                  |

<sup>8)</sup> See "Gate charge waveforms" for parameter definition

<sup>9)</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 | $I_S$         | -      | -    | 95   | A    | $T_C=25\text{ °C}$                                                         |
| Diode pulse current              | $I_{S,pulse}$ | -      | -    | 488  | A    | $T_C=25\text{ °C}$                                                         |
| Diode forward voltage            | $V_{SD}$      | -      | 0.88 | 1.1  | V    | $V_{GS}=0\text{ V}$ , $I_F=70\text{ A}$ , $T_j=25\text{ °C}$               |
| Reverse recovery time            | $t_{rr}$      | -      | 44   | -    | ns   | $V_R=20\text{ V}$ , $I_F=70\text{ A}$ , $di_F/dt=100\text{ A}/\mu\text{s}$ |
| Reverse recovery charge          | $Q_{rr}$      | -      | 45   | -    | nC   | $V_R=20\text{ V}$ , $I_F=70\text{ A}$ , $di_F/dt=100\text{ A}/\mu\text{s}$ |
| Reverse recovery time            | $t_{rr}$      | -      | 31   | -    | ns   | $V_R=20\text{ V}$ , $I_F=70\text{ A}$ , $di_F/dt=500\text{ A}/\mu\text{s}$ |
| Reverse recovery charge          | $Q_{rr}$      | -      | 122  | -    | nC   | $V_R=20\text{ V}$ , $I_F=70\text{ A}$ , $di_F/dt=500\text{ A}/\mu\text{s}$ |

4 Electrical characteristics diagrams

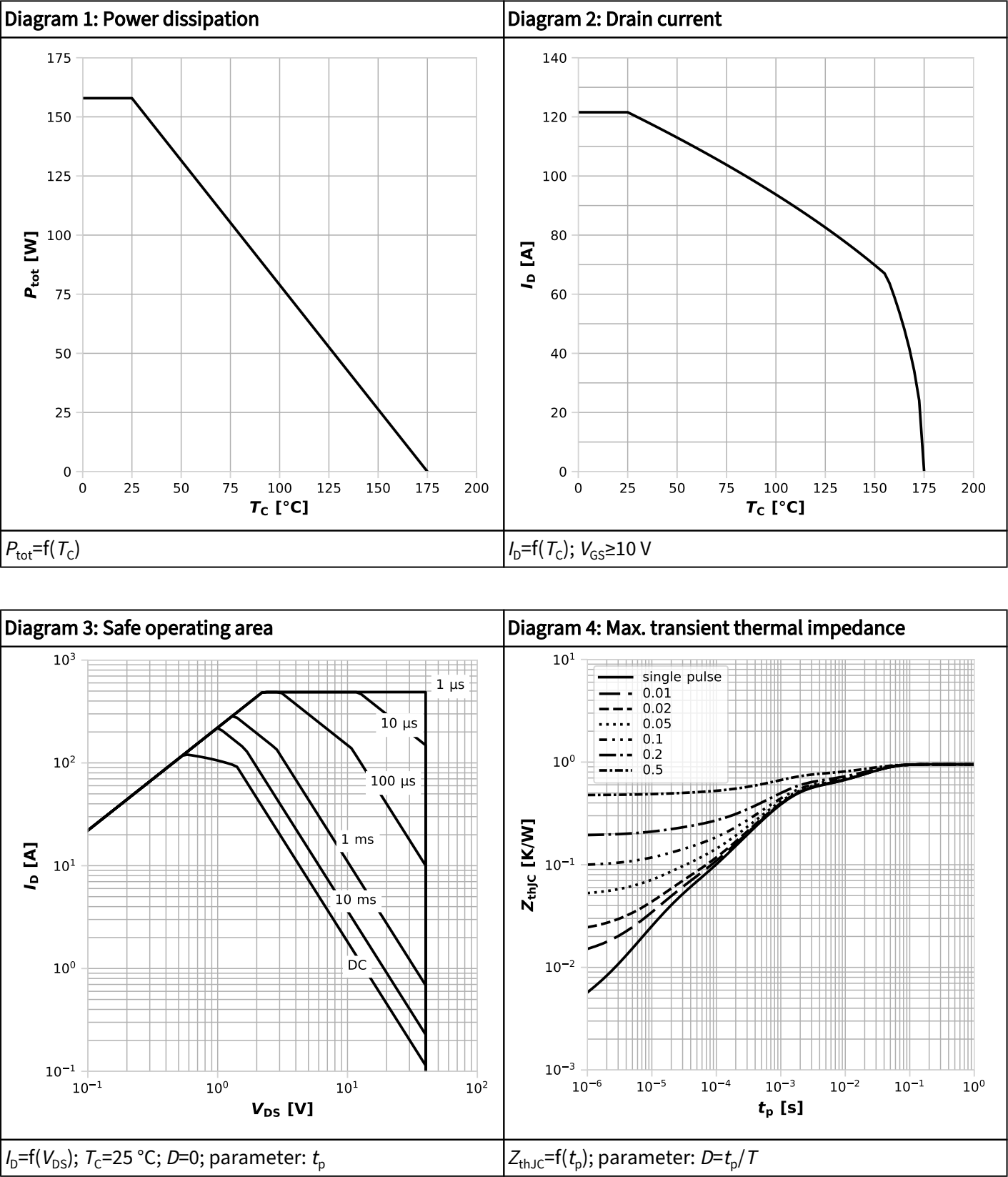
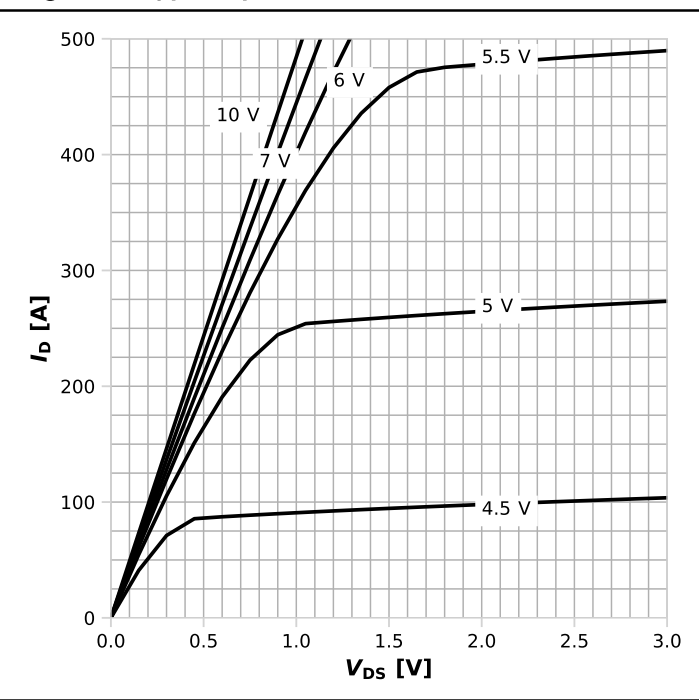
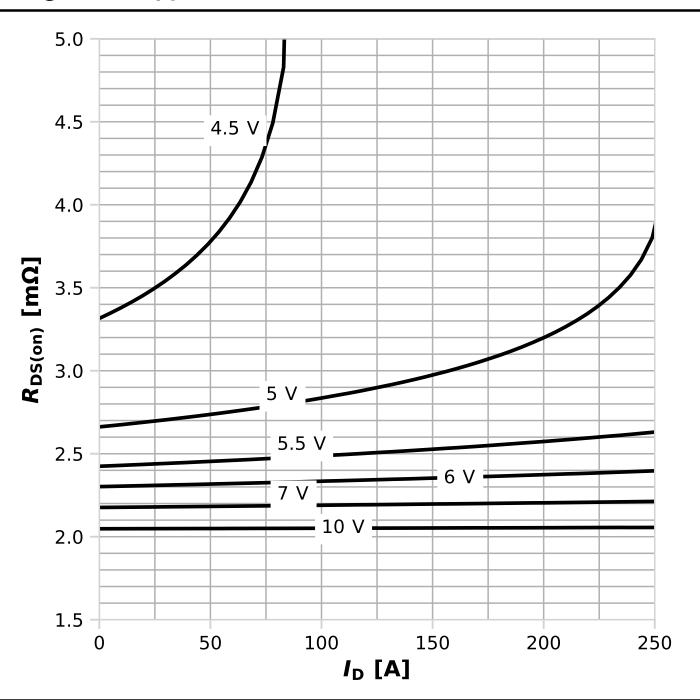


Diagram 5: Typ. output characteristics



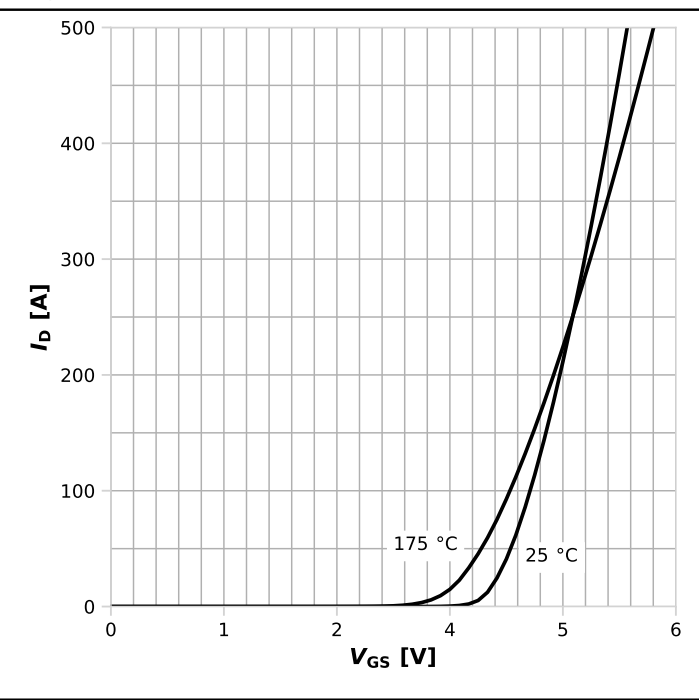
$I_D = f(V_{DS}), T_j = 25\text{ °C}; \text{parameter: } V_{GS}$

Diagram 6: Typ. drain-source on resistance



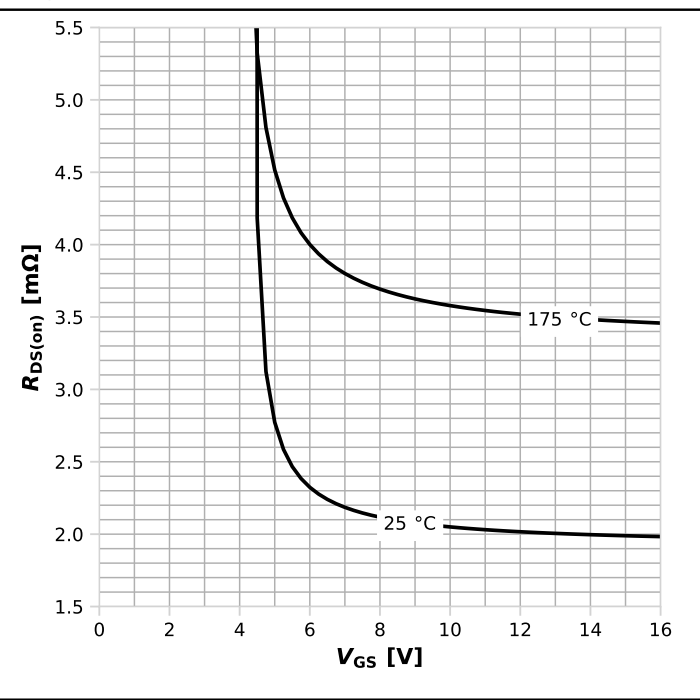
$R_{DS(on)} = f(I_D), T_j = 25\text{ °C}; \text{parameter: } V_{GS}$

Diagram 7: Typ. transfer characteristics



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

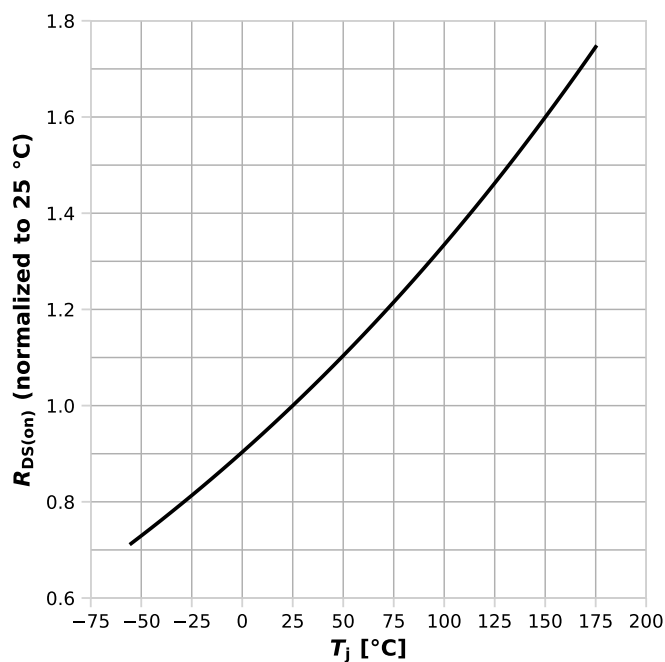
Diagram 8: Typ. drain-source on resistance



$R_{DS(on)} = f(V_{GS}), I_D = 70\text{ A}; \text{parameter: } T_j$

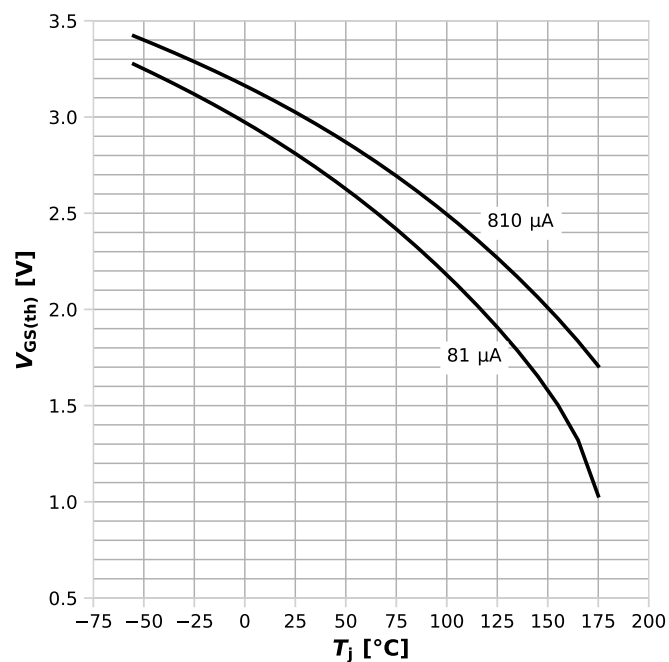


Diagram 9: Normalized drain-source on resistance



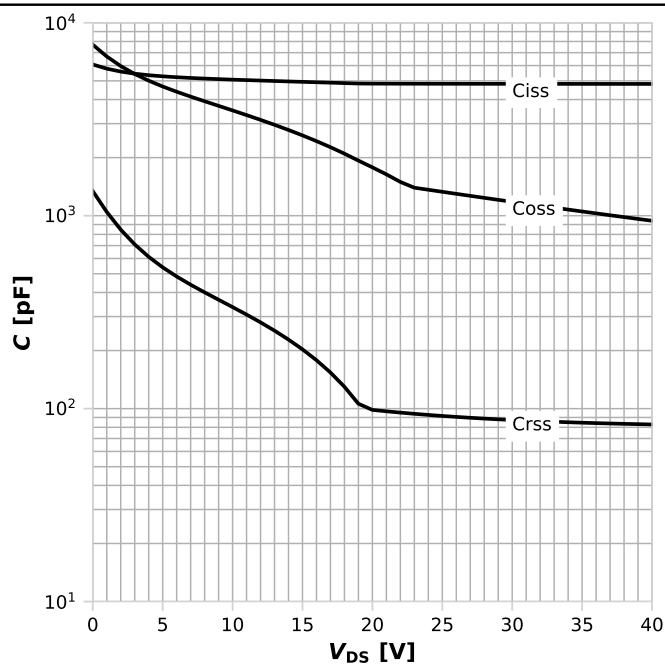
$$R_{DS(on)} = f(T_j), I_D = 70 \text{ A}, V_{GS} = 10 \text{ V}$$

Diagram 10: Typ. gate threshold voltage



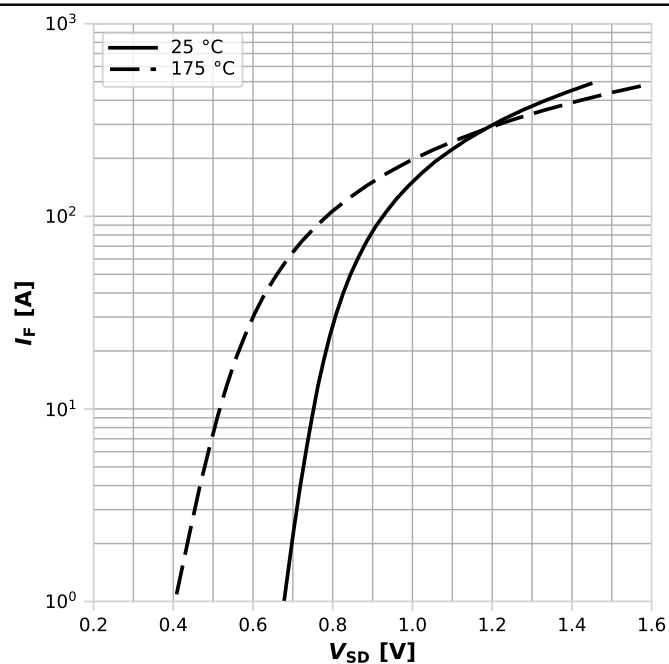
$$V_{GS(th)} = f(T_j), V_{GS} = V_{DS}; \text{ parameter: } I_D$$

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

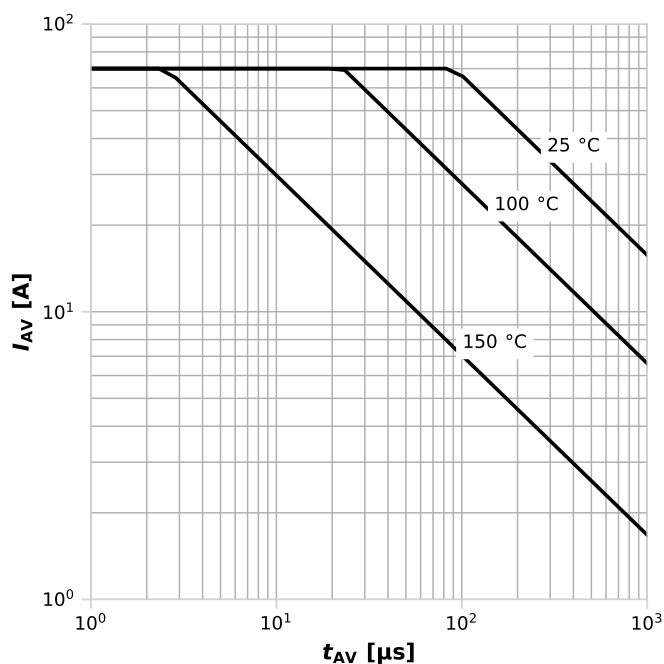

 $I_{AS}=f(t_{AV}); R_{GS}=25\ \Omega; \text{parameter: } T_{j,\text{start}}$ 

Diagram 14: Typ. gate charge

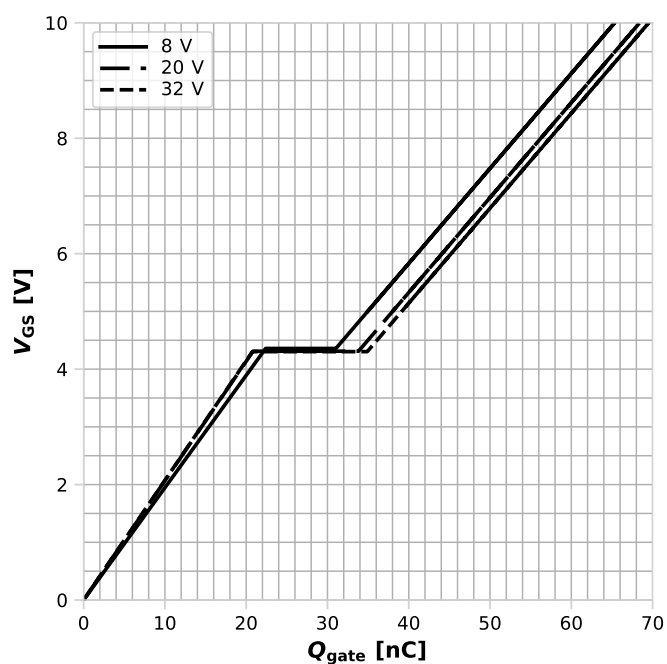
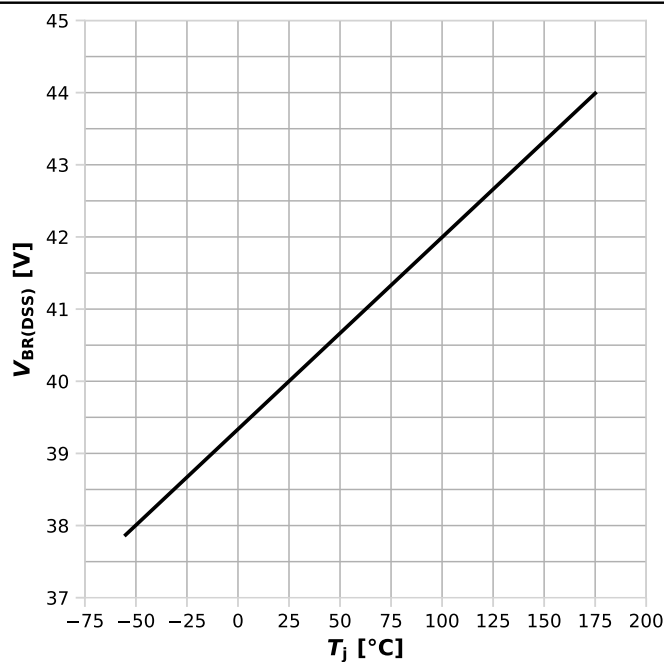
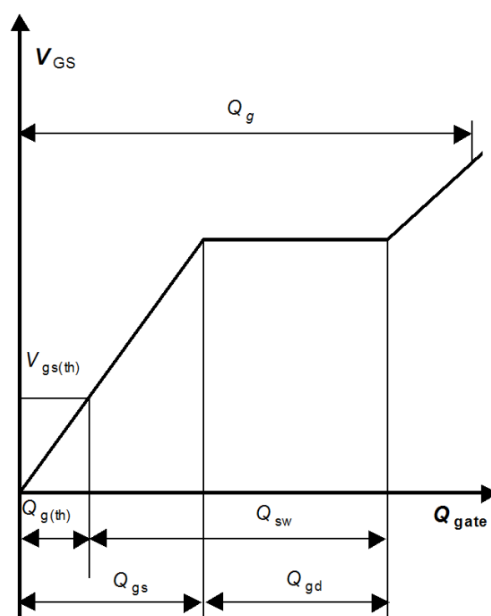

 $V_{GS}=f(Q_{\text{gate}}), I_D=70\ \text{A pulsed}, T_j=25\ ^\circ\text{C}; \text{parameter: } V_{DD}$ 

Diagram 15: Drain-source breakdown voltage


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

Gate charge waveforms



5 Package Outlines

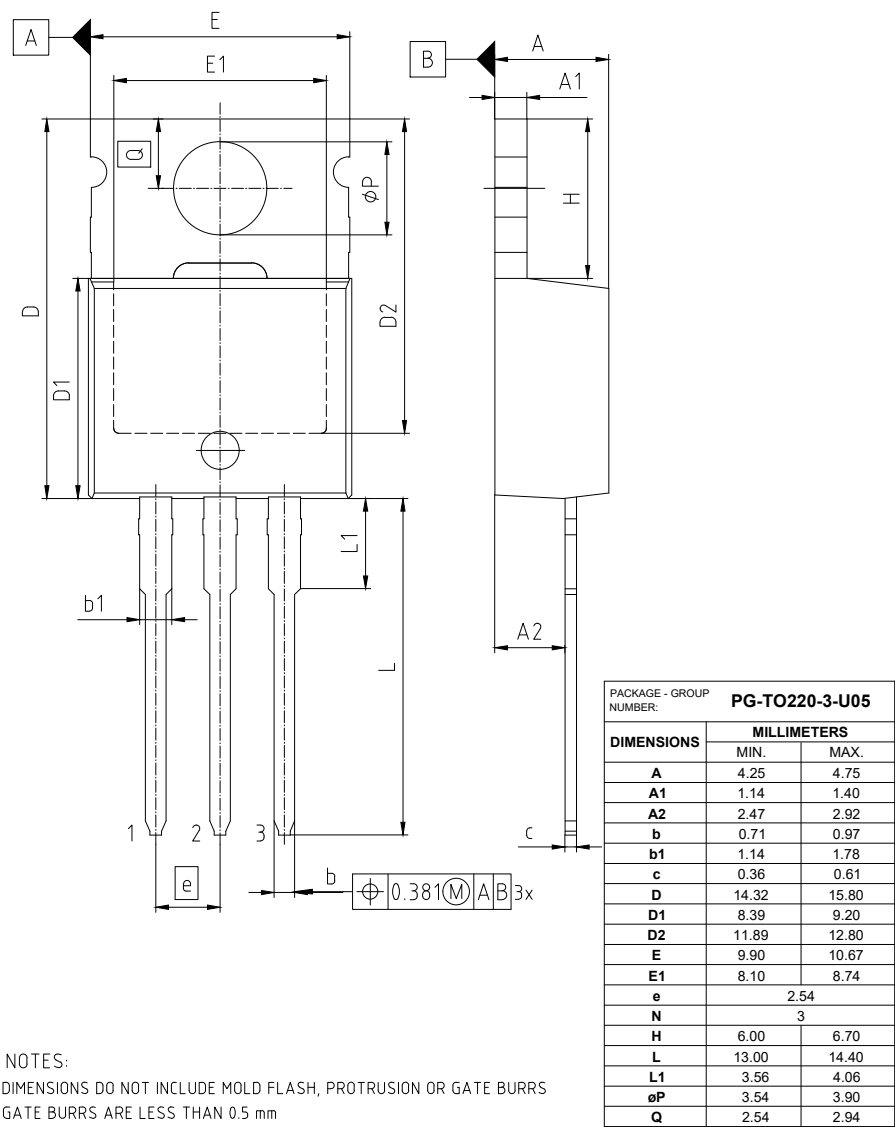


Figure 1 Outline PG-TO220-3, dimensions in mm

## Revision History

IPP026N04NF2S

### Revision 2024-10-07, Rev. 2.1

Previous Revision

| Revision | Date       | Subjects (major changes since last revision) |
|----------|------------|----------------------------------------------|
| 2.0      | 2022-06-07 | Release of final version                     |
| 2.1      | 2024-10-07 | Added trr and Qrr at diF/dt=100 A/μs         |

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