

# MOSFET

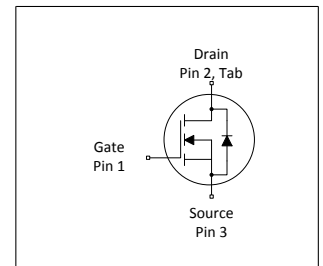
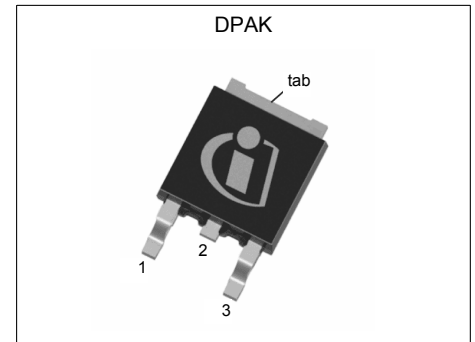
## StrongIRFET™2 Power-Transistor

### 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    |
| $R_{DS(on),max}$ | 2.3   | mΩ   |
| $I_D$            | 143   | A    |
| $Q_{oss}$        | 76    | nC   |
| $Q_G (0V..10V)$  | 68    | nC   |



RoHS

| Type / Ordering Code | Package    | Marking  | Related Links |
|----------------------|------------|----------|---------------|
| IPD023N04NF2S        | PG-TO252-3 | 023N04NS | -             |

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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>       | $I_D$             | -      | -    | 143<br>110<br>27 | A    | $V_{GS}=10\text{ V}$ , $T_C=25\text{ °C}$<br>$V_{GS}=10\text{ V}$ , $T_C=100\text{ °C}$<br>$V_{GS}=10\text{ V}$ , $T_A=25\text{ °C}$ ,<br>$R_{THJA}=50\text{ °C/W}^{2)}$ |
| Pulsed drain current <sup>3)</sup>           | $I_{D,pulse}$     | -      | -    | 572              | 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                            | $P_{tot}$         | -      | -    | 150<br>3.0       | W    | $T_C=25\text{ °C}$<br>$T_A=25\text{ °C}$ , $R_{THJA}=50\text{ °C/W}^{2)}$                                                                                                |
| Operating and storage temperature            | $T_j$ , $T_{stg}$ | -55    | -    | 175              | °C   | -                                                                                                                                                                        |

## 2 Thermal characteristics

**Table 3 Thermal characteristics**

| Parameter                                                                            | Symbol     | Values |      |      | Unit | Note / Test Condition |
|--------------------------------------------------------------------------------------|------------|--------|------|------|------|-----------------------|
|                                                                                      |            | Min.   | Typ. | Max. |      |                       |
| Thermal resistance, junction - case                                                  | $R_{thJC}$ | -      | -    | 1.0  | °C/W | -                     |
| Thermal resistance, junction - ambient, 6 cm <sup>2</sup> cooling area <sup>2)</sup> | $R_{thJA}$ | -      | -    | 50   | °C/W | -                     |
| Thermal resistance, junction - ambient, minimal footprint                            | $R_{thJA}$ | -      | -    | 75   | °C/W | -                     |

<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

### 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   | $V_{(BR)DSS}$ | 40     | -          | -          | V             | $V_{GS}=0\text{ V}$ , $I_D=1\text{ mA}$                                                                                             |
| Gate threshold voltage           | $V_{GS(th)}$  | 2.2    | 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   | $\mu\text{A}$ | $V_{DS}=40\text{ V}$ , $V_{GS}=0\text{ V}$ , $T_j=25\text{ °C}$<br>$V_{DS}=40\text{ V}$ , $V_{GS}=0\text{ V}$ , $T_j=125\text{ °C}$ |
| Gate-source leakage current      | $I_{GSS}$     | -      | 10         | 100        | nA            | $V_{GS}=20\text{ V}$ , $V_{DS}=0\text{ V}$                                                                                          |
| Drain-source on-state resistance | $R_{DS(on)}$  | -      | 1.9<br>2.2 | 2.3<br>3.1 | 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>1)</sup>   | $g_{fs}$      | 125    | -          | -          | S             | $ V_{DS} \geq 2 I_D /R_{DS(on)max}$ , $I_D=70\text{ A}$                                                                             |

**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           | $C_{oss}$    | -      | 1800 | -    | 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>2)</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        | $Q_{g(th)}$   | -      | 13.5 | -    | 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   | $V_{DD}=20\text{ V}$ , $I_D=70\text{ A}$ , $V_{GS}=0\text{ to }10\text{ V}$ |
| 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>1)</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   | $V_{DS}=20\text{ V}$ , $V_{GS}=0\text{ V}$                                  |

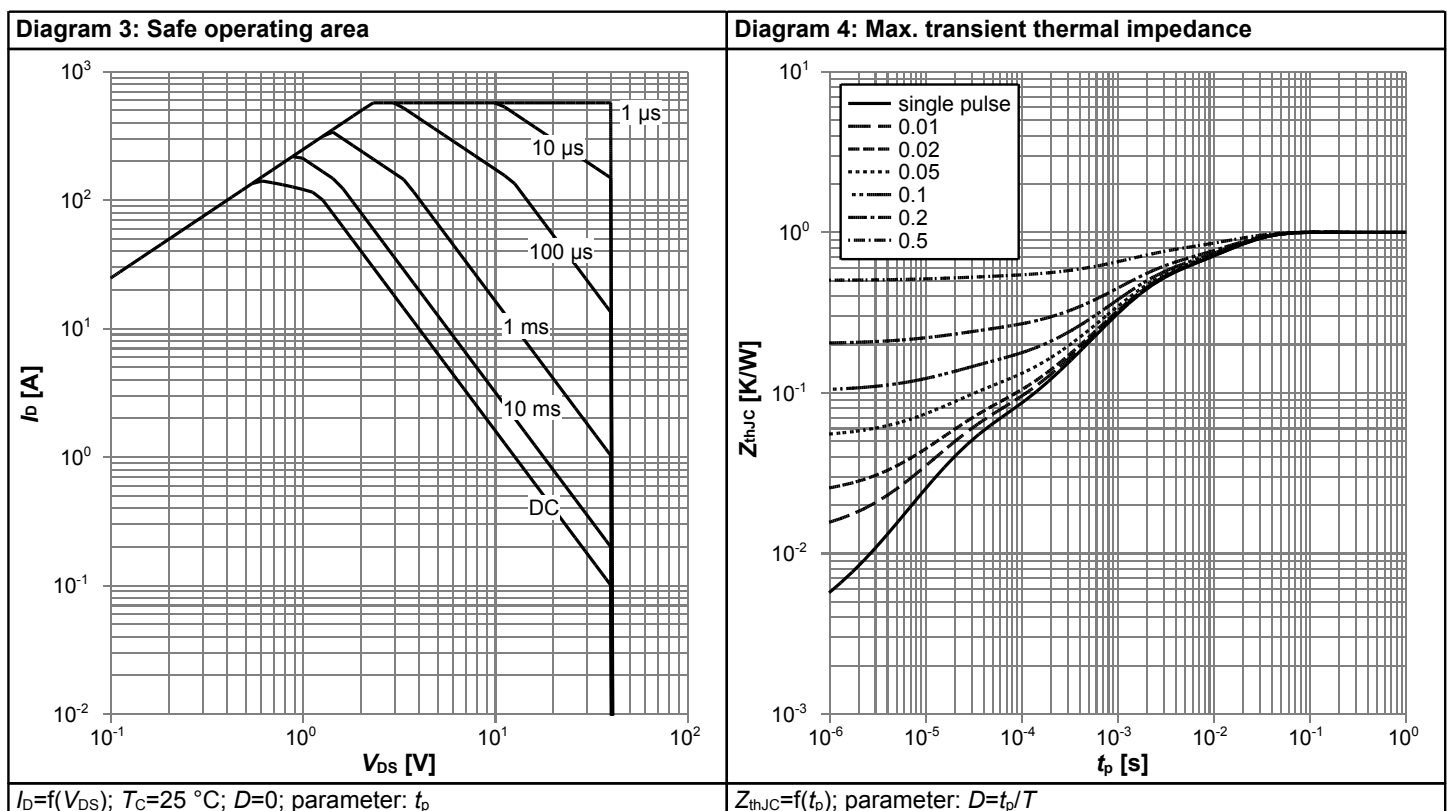
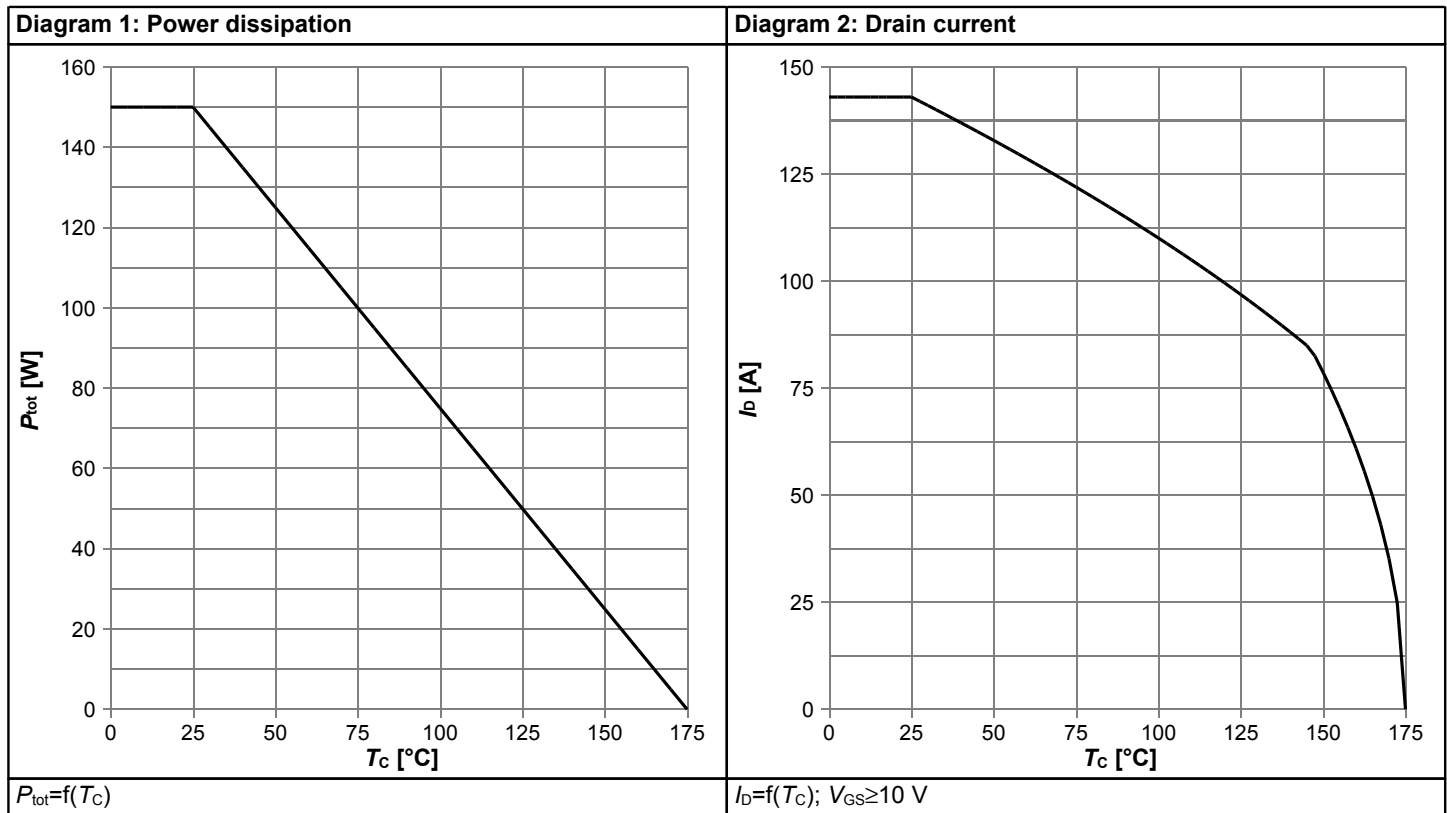
<sup>1)</sup> Defined by design. Not subject to production test.

<sup>2)</sup> See "Gate charge waveforms" for parameter definition

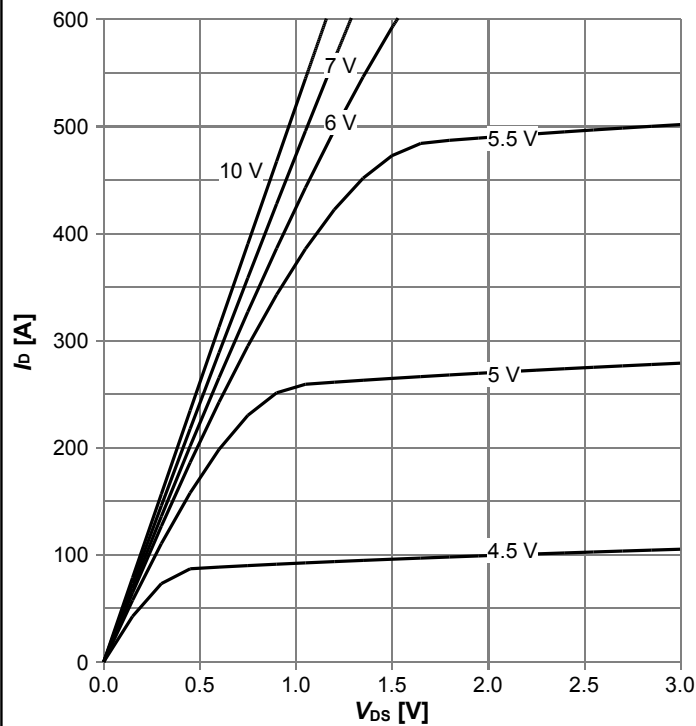
**Table 7 Reverse diode**

| Parameter                        | Symbol        | Values |      |      | Unit | Note / Test Condition                                                      |
|----------------------------------|---------------|--------|------|------|------|----------------------------------------------------------------------------|
|                                  |               | Min.   | Typ. | Max. |      |                                                                            |
| Diode continuous forward current | $I_S$         | -      | -    | 106  | A    | $T_C=25\text{ °C}$                                                         |
| Diode pulse current              | $I_{S,pulse}$ | -      | -    | 572  | A    | $T_C=25\text{ °C}$                                                         |
| Diode forward voltage            | $V_{SD}$      | -      | 0.87 | 1.1  | V    | $V_{GS}=0\text{ V}$ , $I_F=70\text{ A}$ , $T_j=25\text{ °C}$               |
| Reverse recovery time            | $t_{rr}$      | -      | 32   | -    | ns   | $V_R=20\text{ V}$ , $I_F=70\text{ A}$ , $di_F/dt=500\text{ A}/\mu\text{s}$ |
| Reverse recovery charge          | $Q_{rr}$      | -      | 125  | -    | nC   | $V_R=20\text{ V}$ , $I_F=70\text{ A}$ , $di_F/dt=500\text{ A}/\mu\text{s}$ |

## 4 Electrical characteristics diagrams

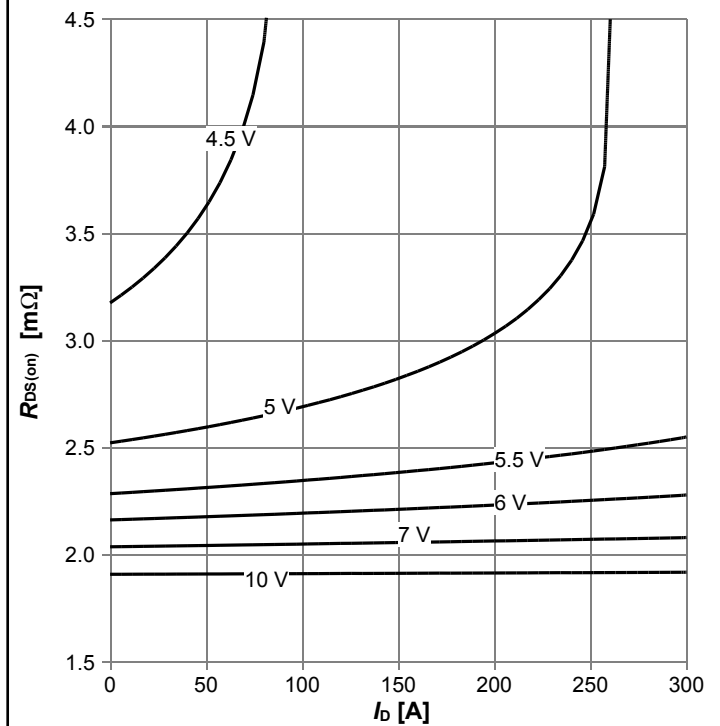


**Diagram 5: Typ. output characteristics**



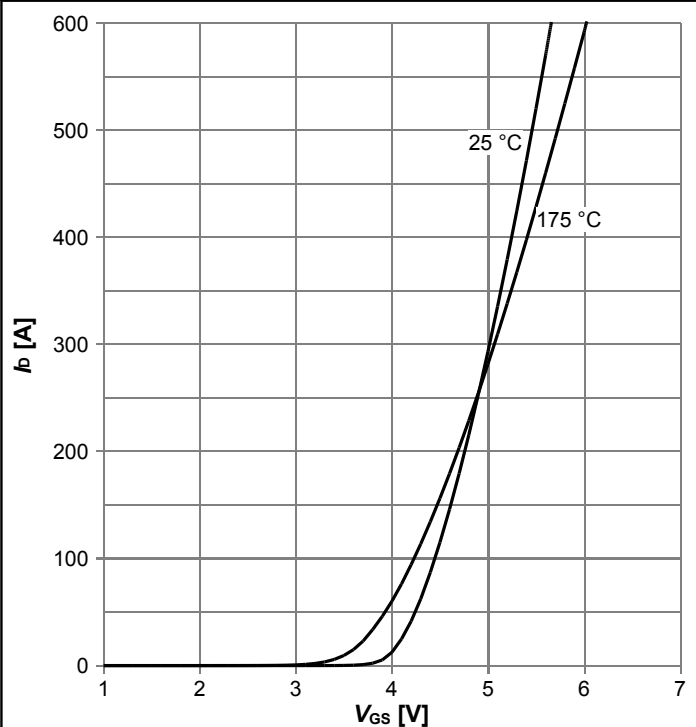
$I_D = f(V_{DS})$ ,  $T_j = 25^\circ\text{C}$ ; parameter:  $V_{GS}$

**Diagram 6: Typ. drain-source on resistance**



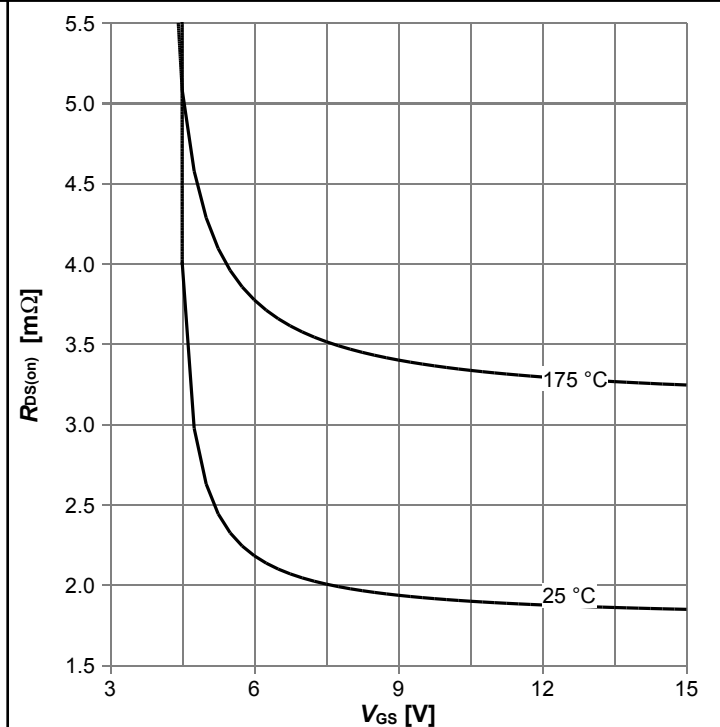
$R_{DS(on)} = f(I_D)$ ,  $T_j = 25^\circ\text{C}$ ; parameter:  $V_{GS}$

**Diagram 7: Typ. transfer characteristics**



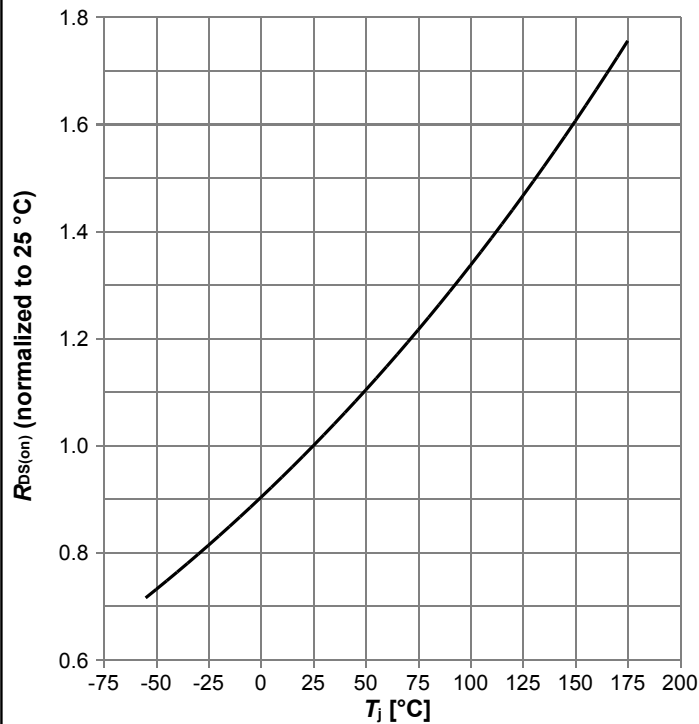
$I_D = f(V_{GS})$ ,  $|V_{DS}| > 2|I_D|R_{DS(on)max}$ ; parameter:  $T_j$

**Diagram 8: Typ. drain-source on resistance**



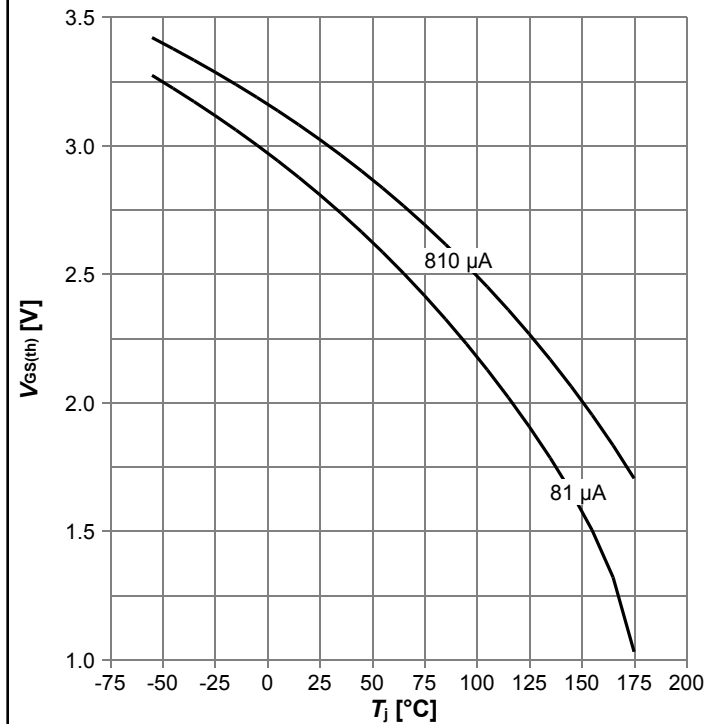
$R_{DS(on)} = f(V_{GS})$ ,  $I_D = 70\text{ A}$ ; parameter:  $T_j$

**Diagram 9: Normalized drain-source on resistance**



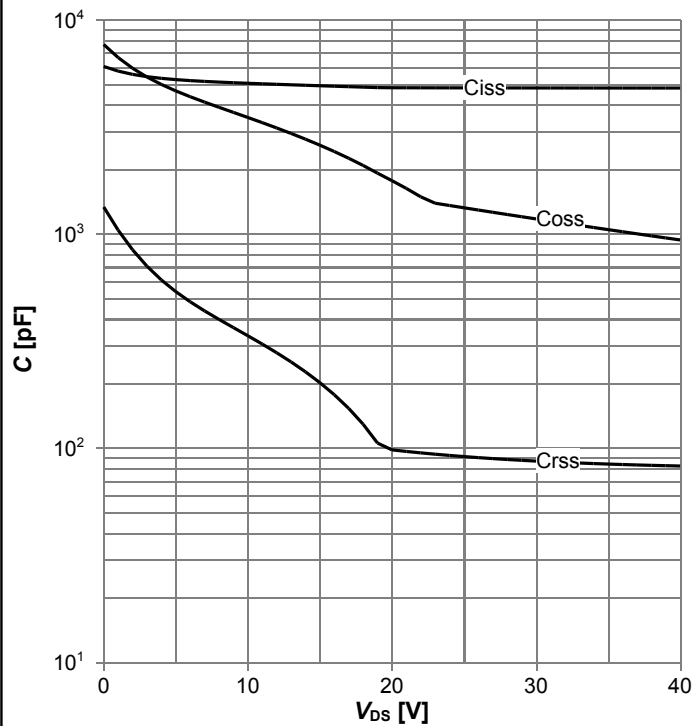
$R_{DS(on)}=f(T_j)$ ,  $I_D=70$  A,  $V_{GS}=10$  V

**Diagram 10: Typ. gate threshold voltage**



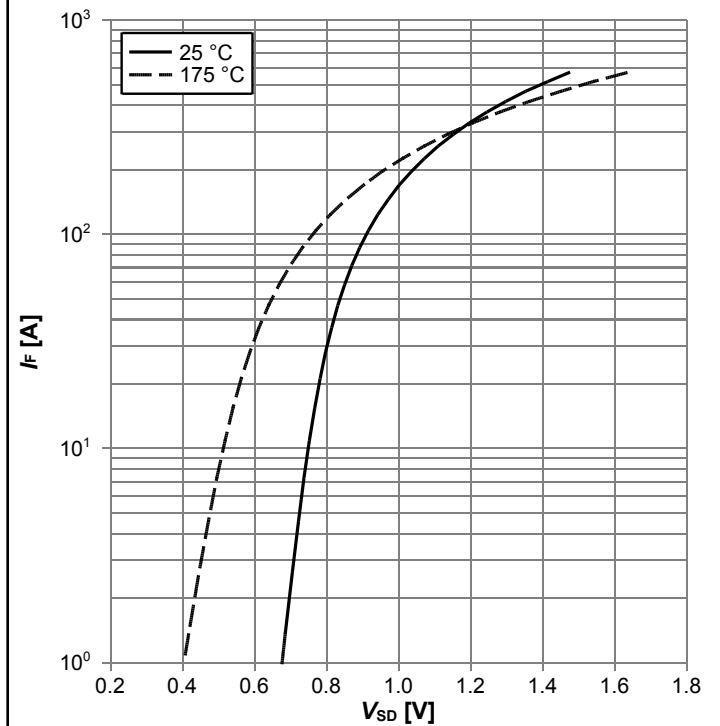
$V_{GS(th)}=f(T_j)$ ,  $V_{GS}=V_{DS}$ ; parameter:  $I_D$

**Diagram 11: Typ. capacitances**



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

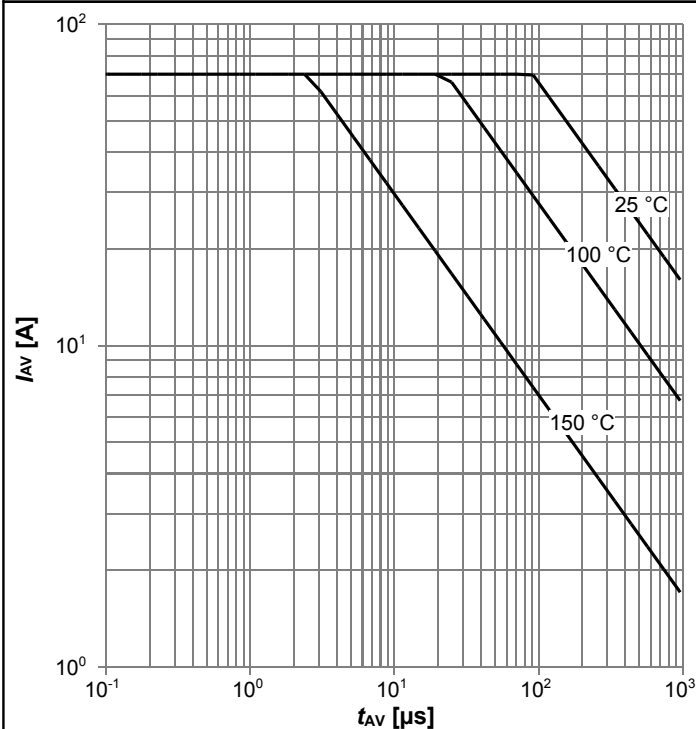
**Diagram 12: Typ. forward characteristics of reverse diode**



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

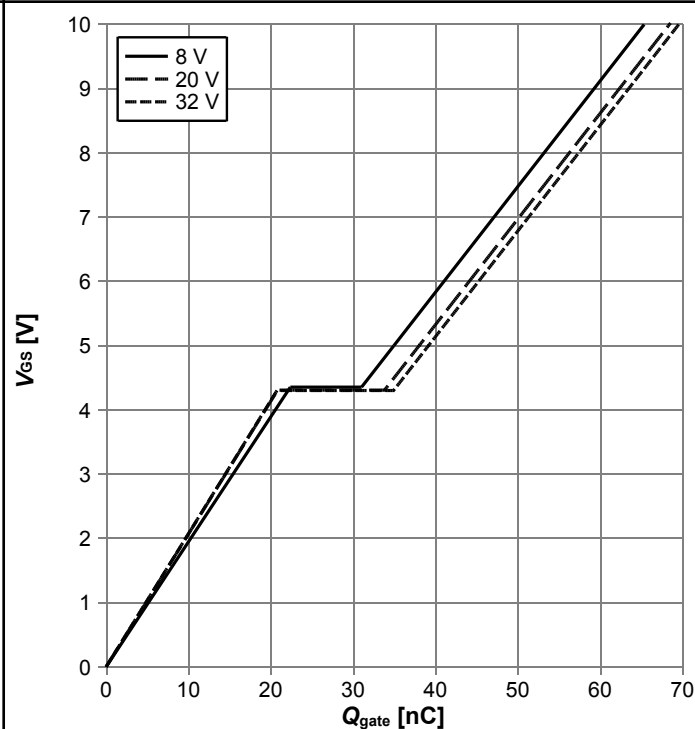


**Diagram 13: Avalanche characteristics**



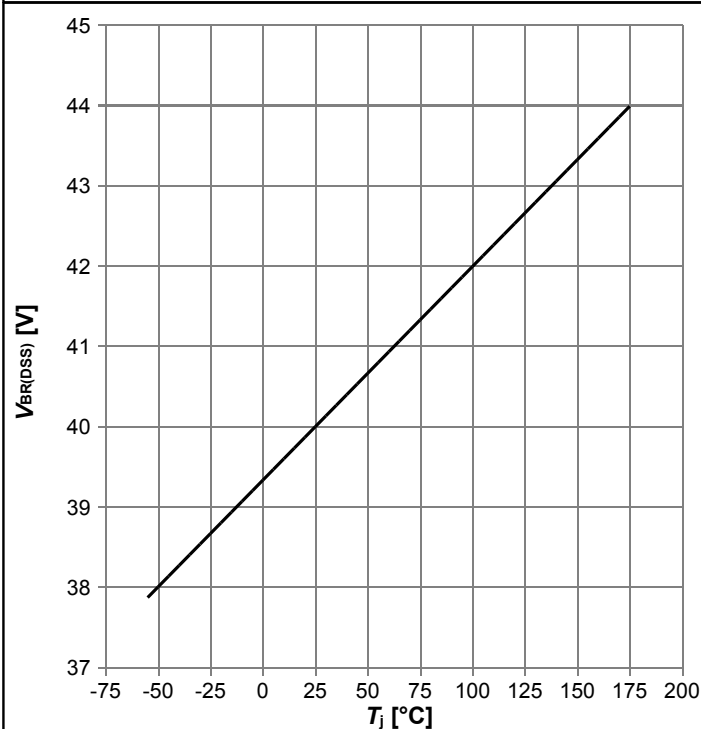
$I_{AS}=f(t_{AV})$ ;  $R_{GS}=25\ \Omega$ ; parameter:  $T_{j,start}$

**Diagram 14: Typ. gate charge**



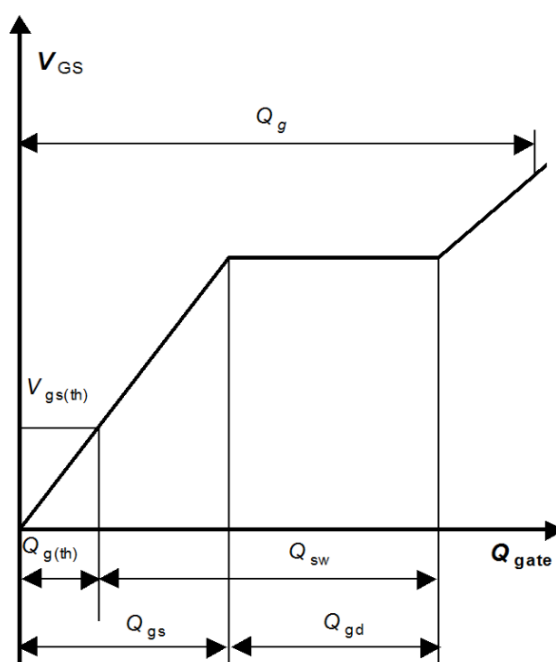
$V_{GS}=f(Q_{gate})$ ,  $I_D=70\ A$  pulsed,  $T_j=25\ ^\circ C$ ; parameter:  $V_{DD}$

**Diagram 15: Drain-source breakdown voltage**

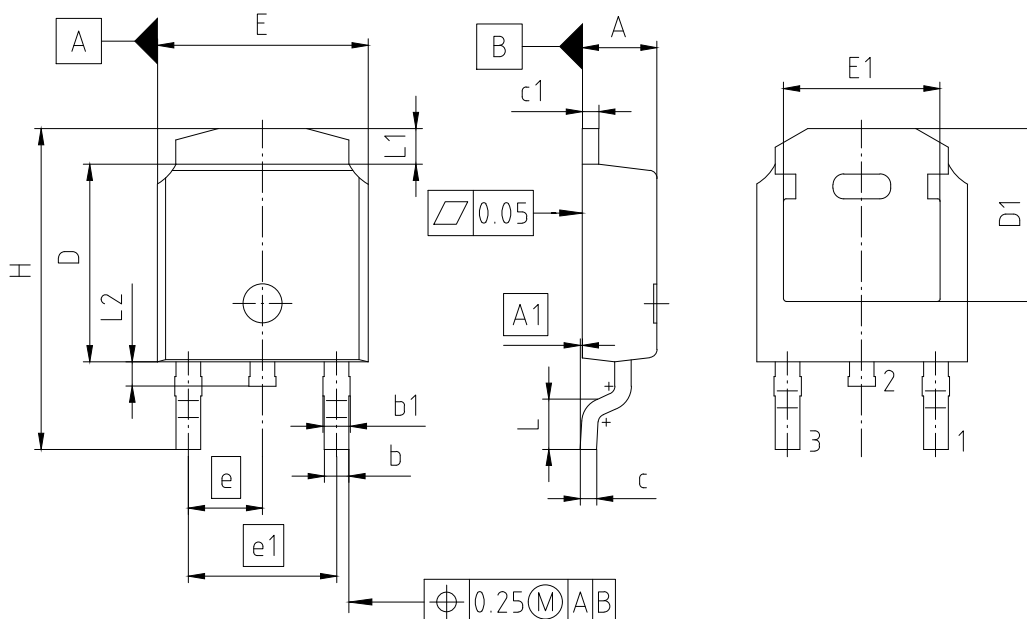


$V_{BR(DSS)}=f(T_j)$ ;  $I_D=1\ mA$

**Diagram Gate charge waveforms**



## 5 Package Outlines



| PACKAGE - GROUP<br>NUMBER: <b>PG-TO252-3-U01</b> |             |       |
|--------------------------------------------------|-------------|-------|
| DIMENSIONS                                       | MILLIMETERS |       |
|                                                  | MIN.        | MAX.  |
| <b>A</b>                                         | 2.18        | 2.39  |
| <b>A1</b>                                        | 0.00        | 0.13  |
| <b>b</b>                                         | 0.64        | 0.89  |
| <b>b1</b>                                        | 0.76        | 1.14  |
| <b>c</b>                                         | 0.46        | 0.61  |
| <b>c1</b>                                        | 0.40        | 0.89  |
| <b>D</b>                                         | 5.97        | 6.22  |
| <b>D1</b>                                        | 5.21        | ---   |
| <b>E</b>                                         | 6.35        | 6.73  |
| <b>E1</b>                                        | 4.32        | ---   |
| <b>e</b>                                         | 2.29        |       |
| <b>e1</b>                                        | 4.58        |       |
| <b>N</b>                                         | 3           |       |
| <b>H</b>                                         | 9.40        | 10.41 |
| <b>L</b>                                         | 1.40        | 1.78  |
| <b>L1</b>                                        | 0.89        | 1.27  |
| <b>L2</b>                                        | 0.50        | 1.02  |

**Figure 1 Outline PG-TO252-3, dimensions in mm**

## Revision History

IPD023N04NF2S

**Revision: 2022-09-20, Rev. 2.1**

Previous Revision

| Revision | Date       | Subjects (major changes since last revision) |
|----------|------------|----------------------------------------------|
| 2.0      | 2022-07-13 | Release of final version                     |
| 2.1      | 2022-09-20 | updated Package outline drawing              |

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