

MOSFET

StrongIRFET™2 Power-Transistor

Features

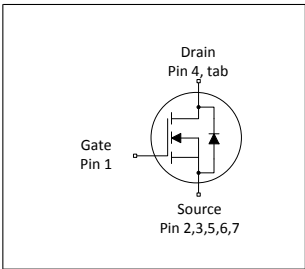
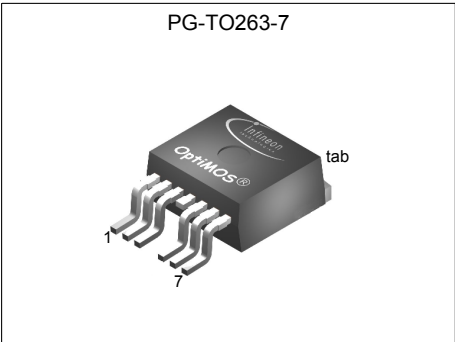
- Optimized for wide range of applications
- N-channel, normal level
- 100% avalanche tested
- Pb-free lead plating; RoHS compliant
- Halogen-free according to IEC61249-2-21

Product validation

Fully qualified according to JEDEC for Industrial Applications

Table 1 Key Performance Parameters

| Parameter        | Value | Unit |
|------------------|-------|------|
| $V_{DS}$         | 40    | V    |
| $R_{DS(on),max}$ | 1.35  | mΩ   |
| $I_D$            | 232   | A    |
| $Q_{oss}$        | 117   | nC   |
| $Q_G(0V..10V)$   | 106   | nC   |



RoHS

| Type / Ordering Code | Package    | Marking  | Related Links |
|----------------------|------------|----------|---------------|
| IPF013N04NF2S        | PG-TO263-7 | 013N04NS | -             |

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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>       | $I_D$             | -      | -    | 232<br>178<br>40 | 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>$R_{THJA}=40\text{ °C/W}^{2)}$ |
| Pulsed drain current <sup>3)</sup>           | $I_{D,pulse}$     | -      | -    | 928              | A    | $T_A=25\text{ °C}$                                                                                                                                                       |
| Avalanche energy, single pulse <sup>4)</sup> | $E_{AS}$          | -      | -    | 283              | mJ   | $I_D=100\text{ A}$ , $R_{GS}=25\text{ }\Omega$                                                                                                                           |
| Gate source voltage                          | $V_{GS}$          | -20    | -    | 20               | V    | -                                                                                                                                                                        |
| Power dissipation                            | $P_{tot}$         | -      | -    | 188<br>3.8       | W    | $T_C=25\text{ °C}$<br>$T_A=25\text{ °C}$ , $R_{THJA}=40\text{ °C/W}^{2)}$                                                                                                |
| 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                                                  | $R_{thJC}$ | -      | -    | 0.8  | °C/W | -                     |
| Thermal resistance, junction - ambient, 6 cm <sup>2</sup> cooling area <sup>2)</sup> | $R_{thJA}$ | -      | -    | 40   | °C/W | -                     |
| Thermal resistance, junction - ambient, minimal footprint                            | $R_{thJA}$ | -      | -    | 62   | °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           | $V_{GS(th)}$  | 2.1    | 2.8          | 3.4         | V             | $V_{DS}=V_{GS}$ , $I_D=126\text{ }\mu\text{A}$                                                                                      |
| 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 | $R_{DS(on)}$  | -      | 1.08<br>1.24 | 1.35<br>1.8 | m $\Omega$    | $V_{GS}=10\text{ V}$ , $I_D=100\text{ A}$<br>$V_{GS}=6\text{ V}$ , $I_D=50\text{ A}$                                                |
| Gate resistance                  | $R_G$         | -      | 2.0          | -           | $\Omega$      | -                                                                                                                                   |
| Transconductance <sup>1)</sup>   | $g_{fs}$      | 195    | -            | -           | S             | $ V_{DS} \geq 2 I_D /R_{DS(on)max}$ , $I_D=100\text{ A}$                                                                            |

**Table 5 Dynamic characteristics**

| Parameter                    | Symbol       | Values |      |      | Unit | Note / Test Condition                                                                               |
|------------------------------|--------------|--------|------|------|------|-----------------------------------------------------------------------------------------------------|
|                              |              | Min.   | Typ. | Max. |      |                                                                                                     |
| Input capacitance            | $C_{iss}$    | -      | 7500 | -    | pF   | $V_{GS}=0\text{ V}$ , $V_{DS}=20\text{ V}$ , $f=1\text{ MHz}$                                       |
| Output capacitance           | $C_{oss}$    | -      | 2760 | -    | pF   | $V_{GS}=0\text{ V}$ , $V_{DS}=20\text{ V}$ , $f=1\text{ MHz}$                                       |
| Reverse transfer capacitance | $C_{rss}$    | -      | 145  | -    | pF   | $V_{GS}=0\text{ V}$ , $V_{DS}=20\text{ V}$ , $f=1\text{ MHz}$                                       |
| Turn-on delay time           | $t_{d(on)}$  | -      | 20   | -    | ns   | $V_{DD}=20\text{ V}$ , $V_{GS}=10\text{ V}$ , $I_D=100\text{ A}$ ,<br>$R_{G,ext}=1.6\text{ }\Omega$ |
| Rise time                    | $t_r$        | -      | 42   | -    | ns   | $V_{DD}=20\text{ V}$ , $V_{GS}=10\text{ V}$ , $I_D=100\text{ A}$ ,<br>$R_{G,ext}=1.6\text{ }\Omega$ |
| Turn-off delay time          | $t_{d(off)}$ | -      | 47   | -    | ns   | $V_{DD}=20\text{ V}$ , $V_{GS}=10\text{ V}$ , $I_D=100\text{ A}$ ,<br>$R_{G,ext}=1.6\text{ }\Omega$ |
| Fall time                    | $t_f$        | -      | 20   | -    | ns   | $V_{DD}=20\text{ V}$ , $V_{GS}=10\text{ V}$ , $I_D=100\text{ A}$ ,<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           | $Q_{gs}$      | -      | 32   | -    | nC   | $V_{DD}=20\text{ V}$ , $I_D=100\text{ A}$ , $V_{GS}=0\text{ to }10\text{ V}$ |
| Gate charge at threshold        | $Q_{g(th)}$   | -      | 21   | -    | nC   | $V_{DD}=20\text{ V}$ , $I_D=100\text{ A}$ , $V_{GS}=0\text{ to }10\text{ V}$ |
| Gate to drain charge            | $Q_{gd}$      | -      | 20   | -    | nC   | $V_{DD}=20\text{ V}$ , $I_D=100\text{ A}$ , $V_{GS}=0\text{ to }10\text{ V}$ |
| Switching charge                | $Q_{sw}$      | -      | 31   | -    | nC   | $V_{DD}=20\text{ V}$ , $I_D=100\text{ A}$ , $V_{GS}=0\text{ to }10\text{ V}$ |
| Gate charge total <sup>1)</sup> | $Q_g$         | -      | 106  | 159  | nC   | $V_{DD}=20\text{ V}$ , $I_D=100\text{ A}$ , $V_{GS}=0\text{ to }10\text{ V}$ |
| Gate plateau voltage            | $V_{plateau}$ | -      | 4.3  | -    | V    | $V_{DD}=20\text{ V}$ , $I_D=100\text{ A}$ , $V_{GS}=0\text{ to }10\text{ V}$ |
| Gate charge total, sync. FET    | $Q_{g(sync)}$ | -      | 94   | -    | nC   | $V_{DS}=0.1\text{ V}$ , $V_{GS}=0\text{ to }10\text{ V}$                     |
| Output charge                   | $Q_{oss}$     | -      | 117  | -    | nC   | $V_{DS}=20\text{ V}$ , $V_{GS}=0\text{ V}$                                   |

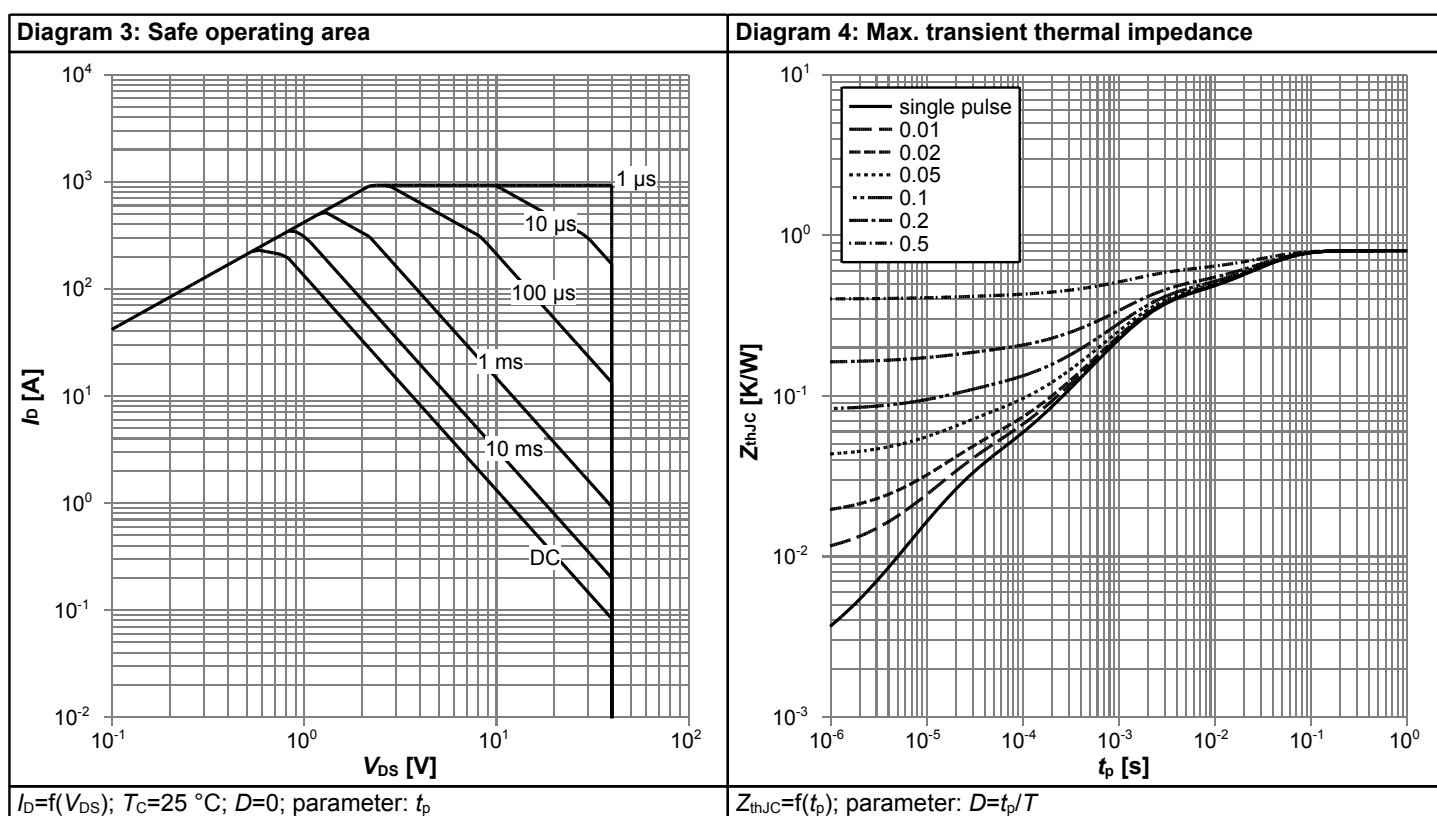
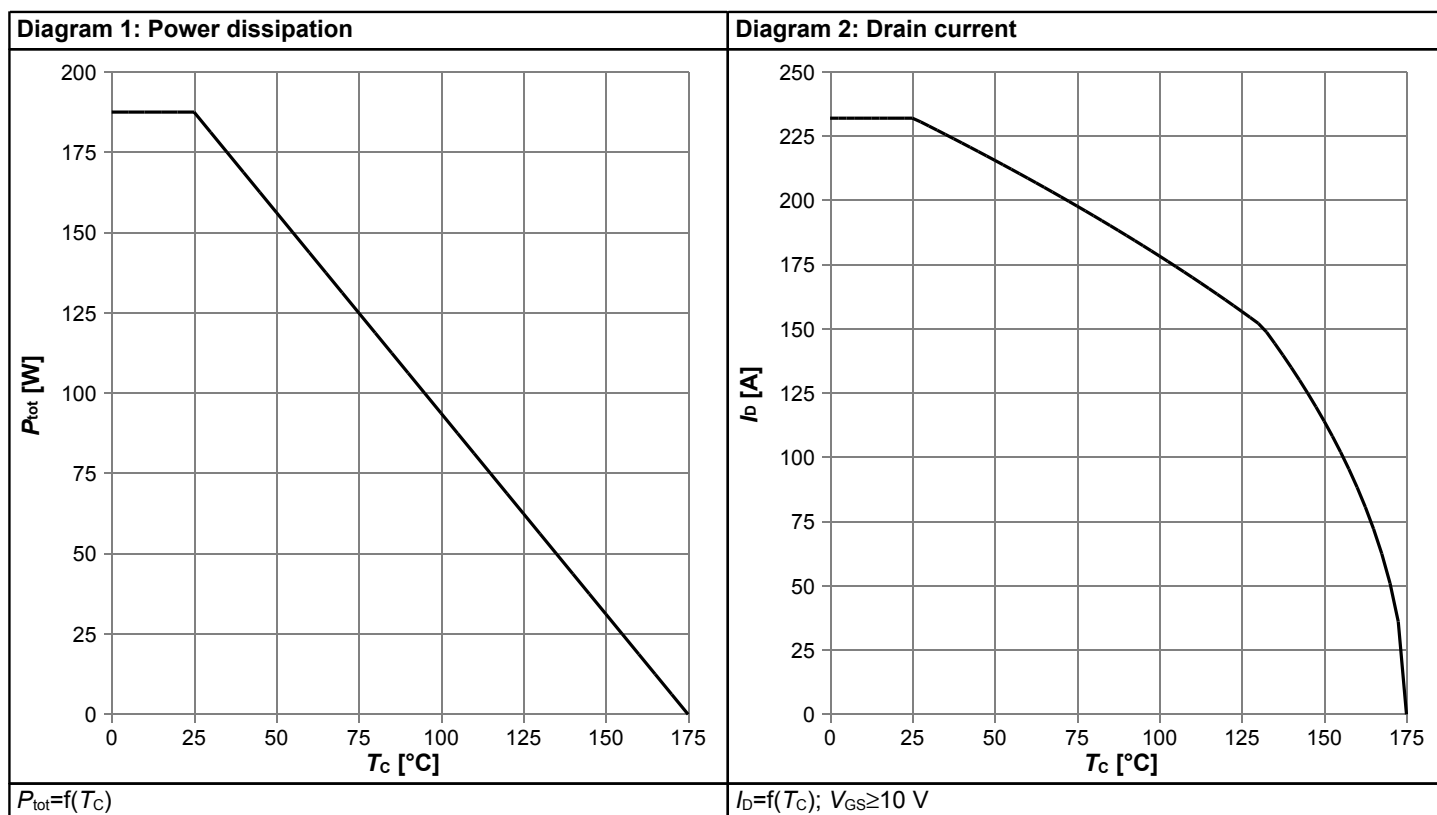
<sup>1)</sup> Defined by design. Not subject to production test.

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

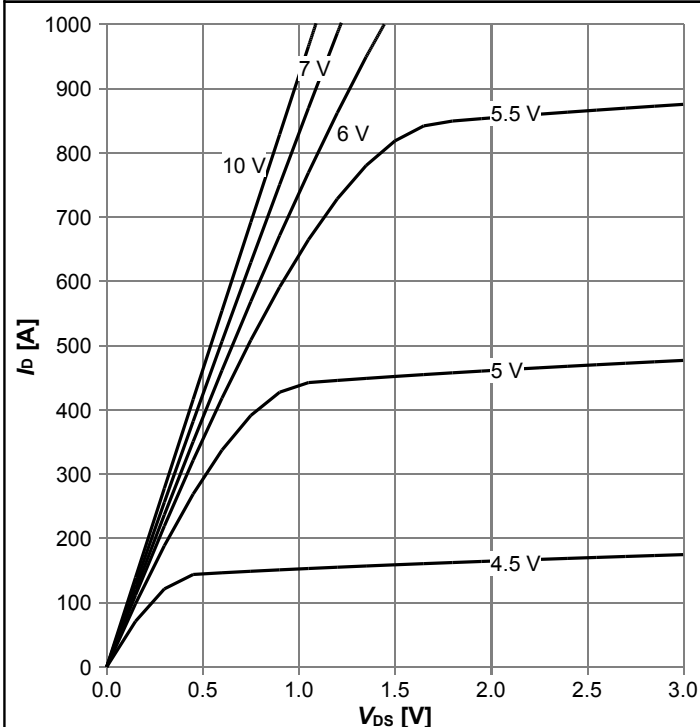
**Table 7 Reverse diode**

| Parameter                        | Symbol        | Values |      |      | Unit | Note / Test Condition                                                       |
|----------------------------------|---------------|--------|------|------|------|-----------------------------------------------------------------------------|
|                                  |               | Min.   | Typ. | Max. |      |                                                                             |
| Diode continuous forward current | $I_S$         | -      | -    | 169  | A    | $T_C=25\text{ °C}$                                                          |
| Diode pulse current              | $I_{S,pulse}$ | -      | -    | 928  | A    | $T_C=25\text{ °C}$                                                          |
| Diode forward voltage            | $V_{SD}$      | -      | 0.85 | 1    | V    | $V_{GS}=0\text{ V}$ , $I_F=100\text{ A}$ , $T_J=25\text{ °C}$               |
| Reverse recovery time            | $t_{rr}$      | -      | 37   | -    | ns   | $V_R=20\text{ V}$ , $I_F=100\text{ A}$ , $di_F/dt=500\text{ A}/\mu\text{s}$ |
| Reverse recovery charge          | $Q_{rr}$      | -      | 174  | -    | nC   | $V_R=20\text{ V}$ , $I_F=100\text{ A}$ , $di_F/dt=500\text{ A}/\mu\text{s}$ |

## 4 Electrical characteristics diagrams

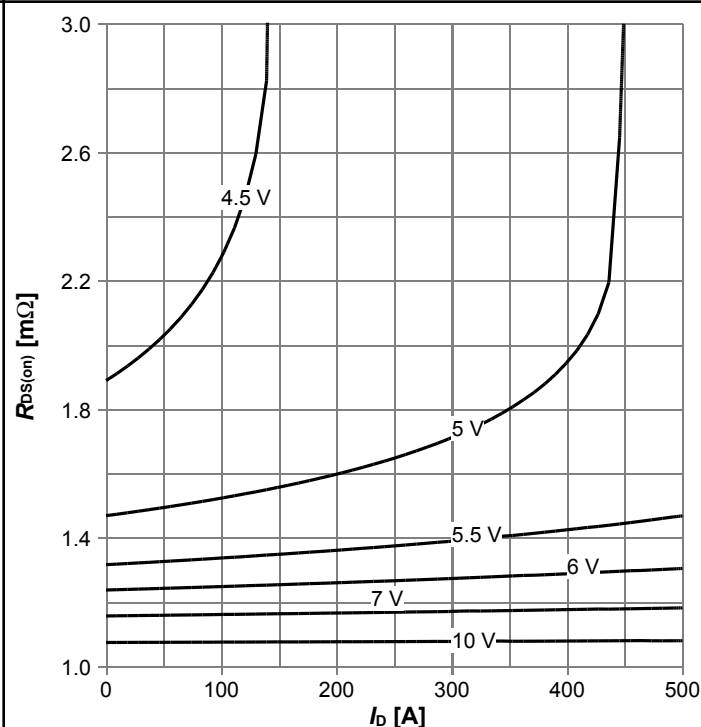


**Diagram 5: Typ. output characteristics**



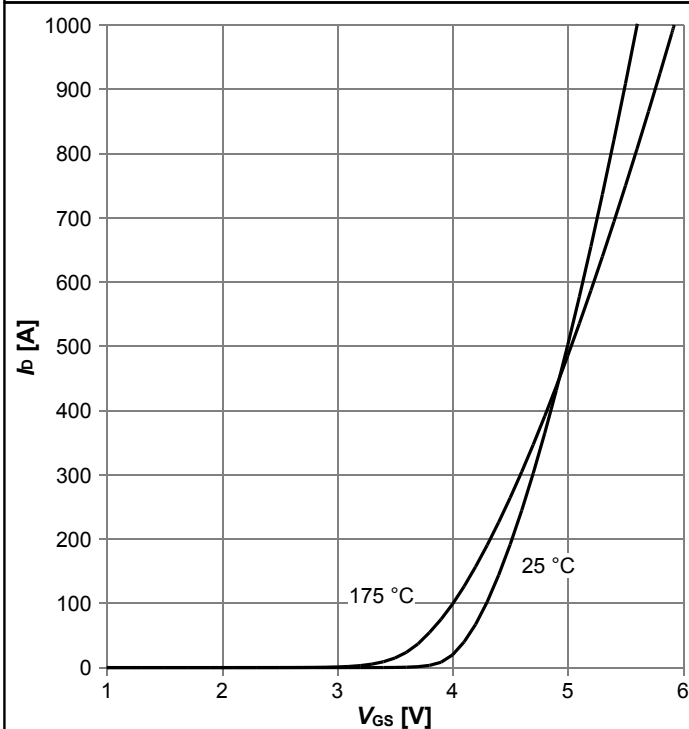
$I_D = f(V_{DS})$ ,  $T_j = 25^\circ\text{C}$ ; parameter:  $V_{GS}$

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



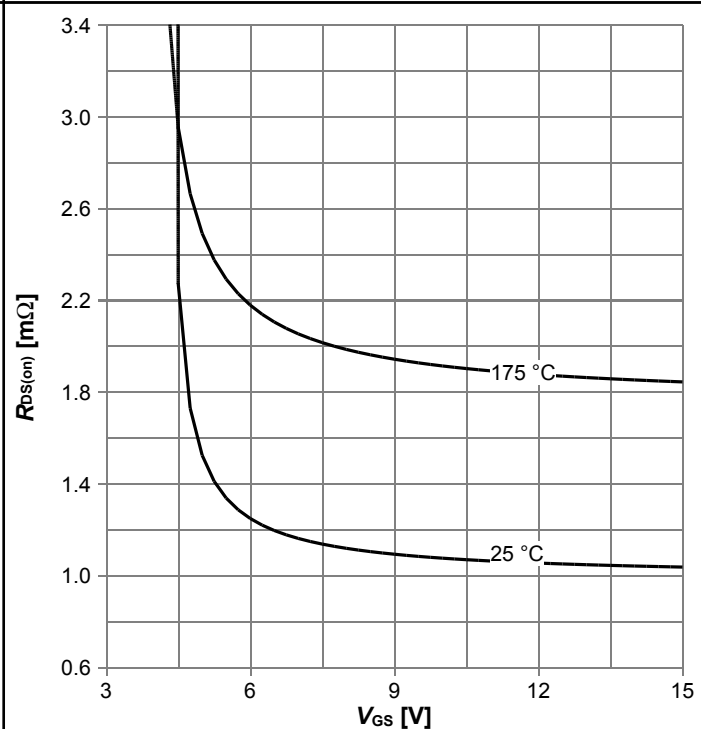
$R_{DS(on)} = f(I_D)$ ,  $T_j = 25^\circ\text{C}$ ; parameter:  $V_{GS}$

**Diagram 7: Typ. transfer characteristics**



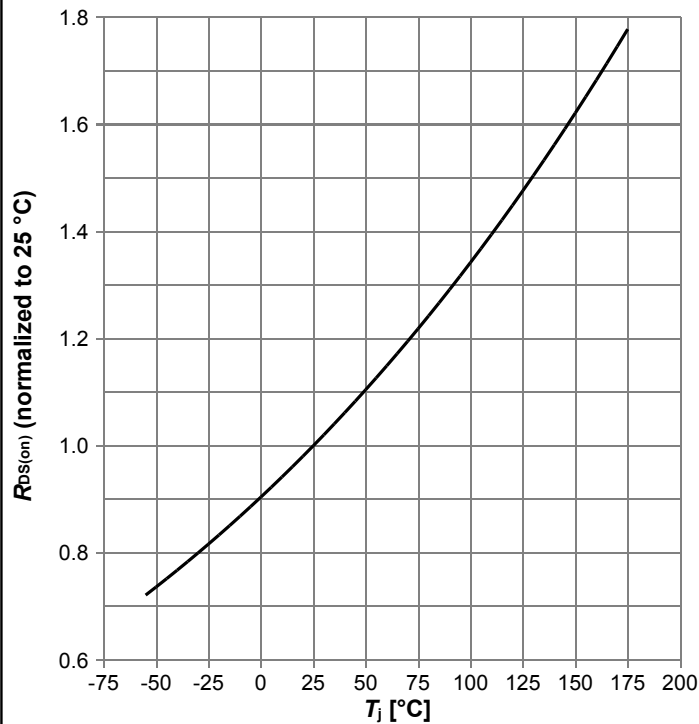
$I_D = f(V_{GS})$ ,  $|V_{DS}| > 2|I_D|R_{DS(on)\max}$ ; parameter:  $T_j$

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



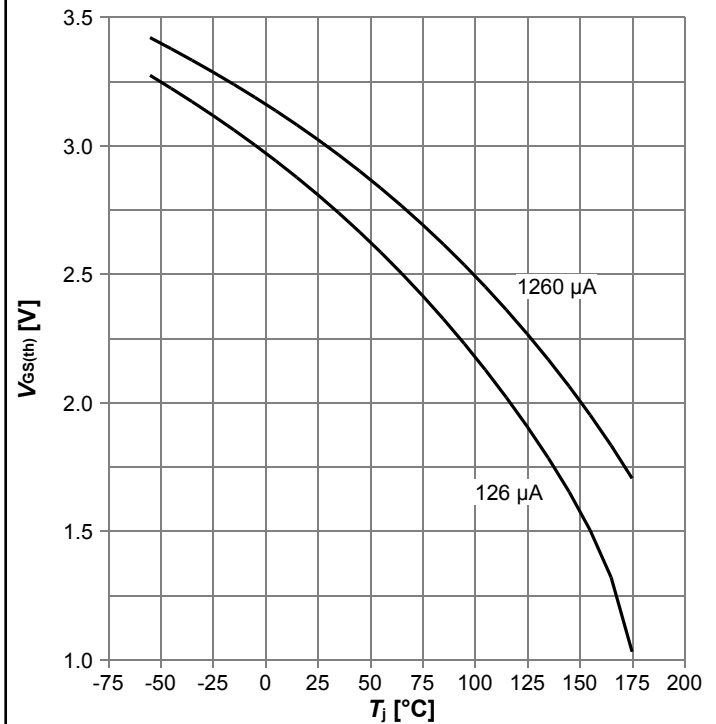
$R_{DS(on)} = f(V_{GS})$ ,  $I_D = 100\text{ A}$ ; parameter:  $T_j$

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



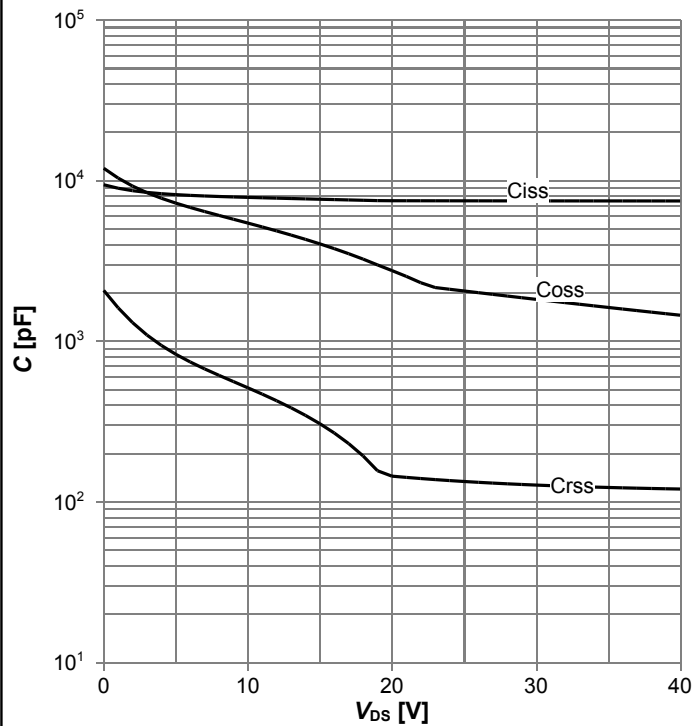
$R_{DS(on)}=f(T_j)$ ,  $I_D=100$  A,  $V_{GS}=10$  V

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



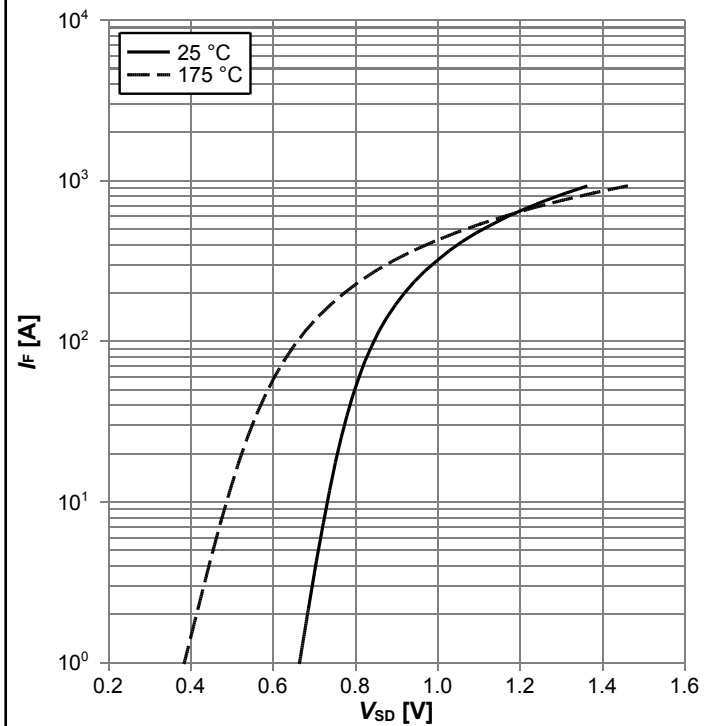
$V_{GS(th)}=f(T_j)$ ,  $V_{GS}=V_{DS}$ ; parameter:  $I_D$

**Diagram 11: Typ. capacitances**



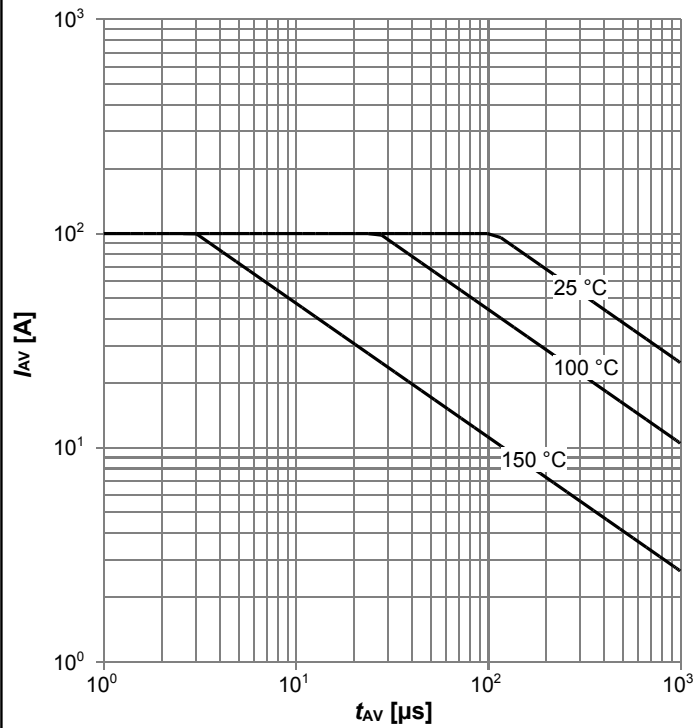
$C=f(V_{DS})$ ;  $V_{GS}=0$  V;  $f=1$  MHz

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

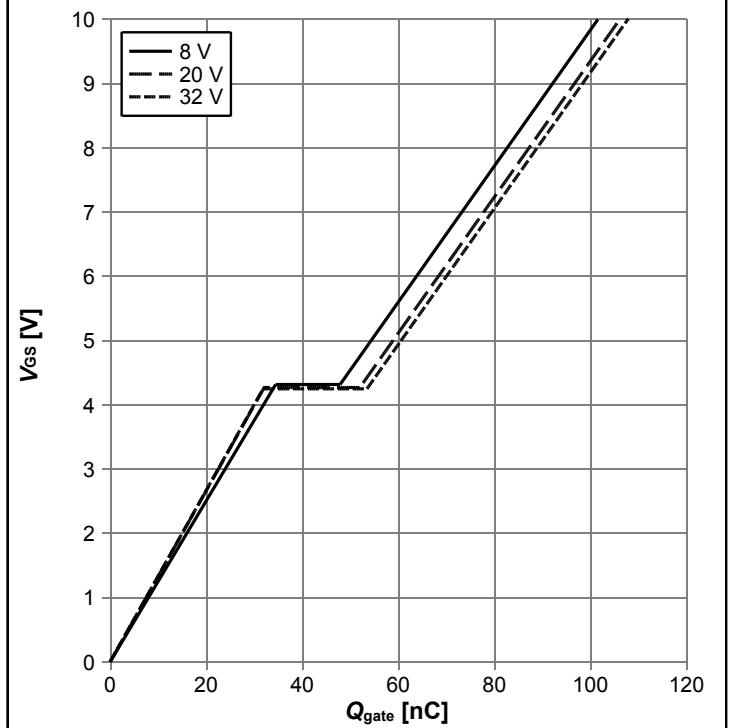


$I_F=f(V_{SD})$ ; parameter:  $T_j$

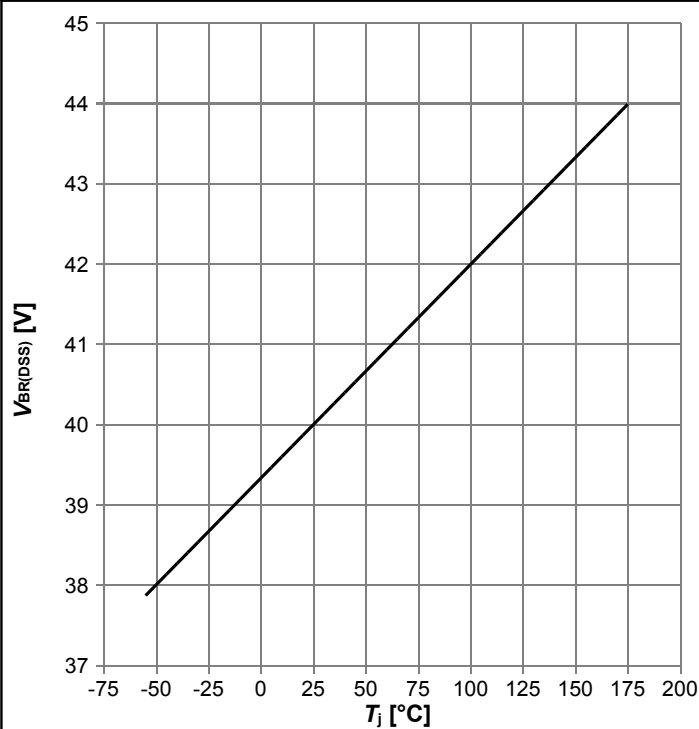
**Diagram 13: Avalanche characteristics**



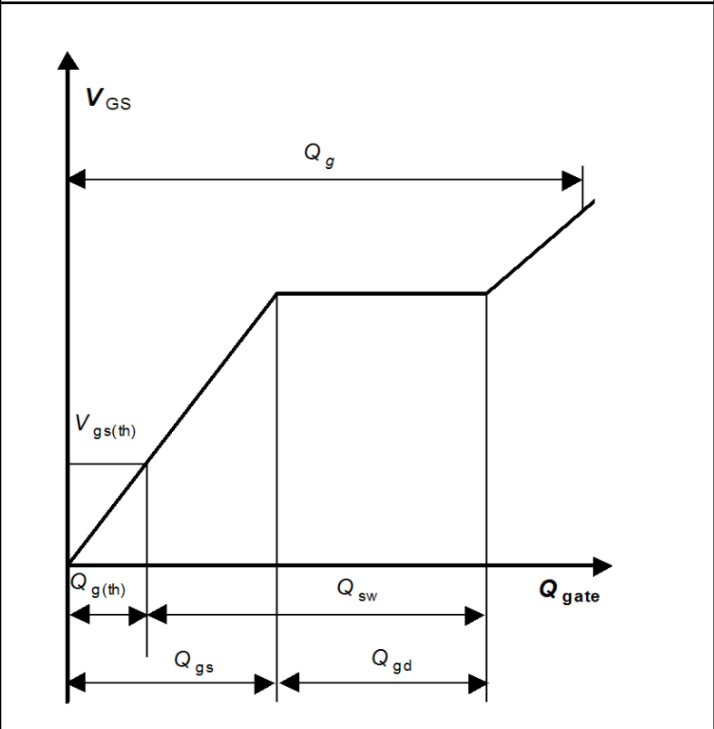
**Diagram 14: Typ. gate charge**



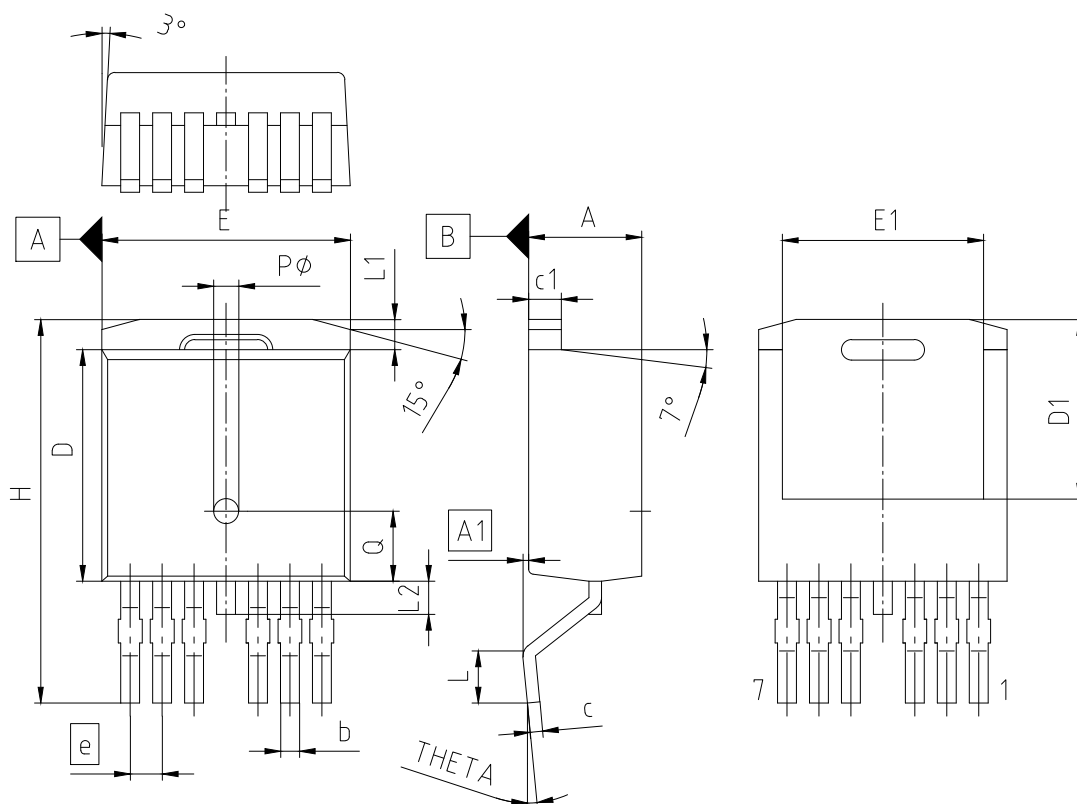
**Diagram 15: Drain-source breakdown voltage**



**Diagram Gate charge waveforms**



## 5 Package Outlines



| PACKAGE - GROUP<br>NUMBER: <b>PG-TO263-7-U02</b> |             |       |
|--------------------------------------------------|-------------|-------|
| DIMENSIONS                                       | MILLIMETERS |       |
|                                                  | MIN.        | MAX.  |
| <b>A</b>                                         | 4.30        | 4.70  |
| <b>A1</b>                                        | 0.00        | 0.25  |
| <b>b</b>                                         | 0.65        | 0.85  |
| <b>c</b>                                         | 0.45        | 0.60  |
| <b>c1</b>                                        | 1.25        | 1.40  |
| <b>D</b>                                         | 9.00        | 9.40  |
| <b>D1</b>                                        | 6.86        | 7.42  |
| <b>E</b>                                         | 9.68        | 10.08 |
| <b>E1</b>                                        | 7.70        | 8.30  |
| <b>e</b>                                         | 1.27        |       |
| <b>N</b>                                         | 7           |       |
| <b>H</b>                                         | 14.61       | 15.88 |
| <b>L</b>                                         | 1.78        | 2.79  |
| <b>L1</b>                                        | 0.00        | 1.60  |
| <b>L2</b>                                        | 0.00        | 1.78  |
| <b>THETA</b>                                     | 0° - 8°     |       |
| <b>PØ</b>                                        | 0.90        | 1.10  |
| <b>Q</b>                                         | 2.78        |       |

**Figure 1 Outline PG-TO263-7, dimensions in mm**

## Revision History

IPF013N04NF2S

**Revision: 2022-10-11, Rev. 2.0**

Previous Revision

| Revision | Date       | Subjects (major changes since last revision) |
|----------|------------|----------------------------------------------|
| 2.0      | 2022-10-11 | Release of final version                     |

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