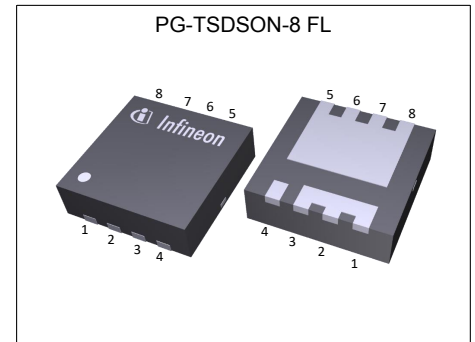


# MOSFET

## OptiMOS™6 Power-Transistor, 40 V

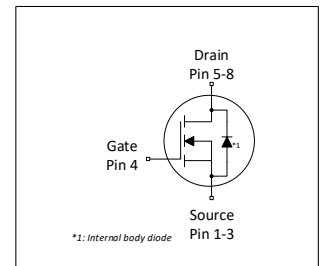
### Features

- Optimized for synchronous application
- Very low on-resistance  $R_{DS(on)}$
- 100% avalanche tested
- Superior thermal resistance
- N-channel
- Qualified according to JEDEC<sup>1)</sup> for target applications
- Pb-free lead plating; RoHS compliant
- Halogen-free according to IEC61249-2-21
- 175 °C rated



**Table 1 Key Performance Parameters**

| Parameter        | Value | Unit |
|------------------|-------|------|
| $V_{DS}$         | 40    | V    |
| $R_{DS(on),max}$ | 2.1   | mΩ   |
| $I_D$            | 147   | A    |
| $Q_{oss}$        | 34    | nC   |
| $Q_G(0V..10V)$   | 31    | nC   |
| $Q_G(0V..4.5V)$  | 15    | nC   |



RoHS

| Type / Ordering Code | Package        | Marking | Related Links |
|----------------------|----------------|---------|---------------|
| BSZ021N04LS6         | PG-TSDSON-8 FL | 21N04L6 | -             |

<sup>1)</sup> J-STD20 and JESD22

**Table of Contents**

Description ..... 1

Maximum ratings ..... 3

Thermal characteristics ..... 3

Electrical characteristics ..... 4

Electrical characteristics diagrams ..... 6

Package Outlines ..... 10

Revision History ..... 11

Trademarks ..... 11

Disclaimer ..... 11

## 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>       | $I_D$             | -      | -    | 147<br>104<br>123<br>87<br>25 | A    | $V_{GS}=10\text{ V}$ , $T_C=25\text{ °C}$<br>$V_{GS}=10\text{ V}$ , $T_C=100\text{ °C}$<br>$V_{GS}=4.5\text{ V}$ , $T_C=25\text{ °C}$<br>$V_{GS}=4.5\text{ V}$ , $T_C=100\text{ °C}$<br>$V_{GS}=10\text{ V}$ , $T_A=25\text{ °C}$ , $R_{THJA}=60\text{ °C/W}^{2)}$ |
| Pulsed drain current <sup>2)</sup>           | $I_{D,pulse}$     | -      | -    | 588                           | A    | $T_A=25\text{ °C}$                                                                                                                                                                                                                                                 |
| Avalanche energy, single pulse <sup>3)</sup> | $E_{AS}$          | -      | -    | 189                           | mJ   | $I_D=20\text{ A}$ , $R_{GS}=25\text{ }\Omega$                                                                                                                                                                                                                      |
| Gate source voltage                          | $V_{GS}$          | -20    | -    | 20                            | V    | -                                                                                                                                                                                                                                                                  |
| Power dissipation                            | $P_{tot}$         | -      | -    | 83<br>2.5                     | W    | $T_C=25\text{ °C}$<br>$T_A=25\text{ °C}$ , $R_{THJA}=60\text{ °C/W}^{2)}$                                                                                                                                                                                          |
| Operating and storage temperature            | $T_j$ , $T_{stg}$ | -55    | -    | 175                           | °C   | IEC climatic category; DIN IEC 68-1: 55/175/56                                                                                                                                                                                                                     |

## 2 Thermal characteristics

**Table 3 Thermal characteristics**

| Parameter                                   | Symbol     | Values |      |      | Unit | Note / Test Condition |
|---------------------------------------------|------------|--------|------|------|------|-----------------------|
|                                             |            | Min.   | Typ. | Max. |      |                       |
| Thermal resistance, junction - case, bottom | $R_{thJC}$ | -      | -    | 1.8  | °C/W | -                     |
| Thermal resistance, junction - case, top    | $R_{thJC}$ | -      | -    | 20   | °C/W | -                     |
| Device on PCB, 6 cm² cooling area           | $R_{thJA}$ | -      | -    | 60   | °C/W | -                     |

<sup>1)</sup> Rating refers to the product only with datasheet specified absolute maximum values, maintaining case temperature at 25°C. For higher case temperature 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 cm² (one layer, 70 µm thick) copper area for drain connection. PCB is vertical in still air.

<sup>3)</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           | $V_{GS(th)}$  | 1.3    | -          | 2.3        | V             | $V_{DS}=V_{GS}$ , $I_D=250\text{ }\mu\text{A}$                                                                                      |
| 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 | $R_{DS(on)}$  | -      | 1.8<br>2.4 | 2.1<br>3.0 | m $\Omega$    | $V_{GS}=10\text{ V}$ , $I_D=20\text{ A}$<br>$V_{GS}=4.5\text{ V}$ , $I_D=20\text{ A}$                                               |
| Gate resistance                  | $R_G$         | -      | 1.3        | -          | $\Omega$      | -                                                                                                                                   |
| Transconductance                 | $g_{fs}$      | -      | 110        | -          | S             | $ V_{DS} \geq 2 I_D /R_{DS(on)max}$ , $I_D=20\text{ A}$                                                                             |

**Table 5 Dynamic characteristics**

| Parameter                                  | Symbol       | Values |      |      | Unit | Note / Test Condition                                                                              |
|--------------------------------------------|--------------|--------|------|------|------|----------------------------------------------------------------------------------------------------|
|                                            |              | Min.   | Typ. | Max. |      |                                                                                                    |
| Input capacitance <sup>1)</sup>            | $C_{iss}$    | -      | 2100 | 2700 | pF   | $V_{GS}=0\text{ V}$ , $V_{DS}=20\text{ V}$ , $f=1\text{ MHz}$                                      |
| Output capacitance <sup>1)</sup>           | $C_{oss}$    | -      | 690  | 900  | pF   | $V_{GS}=0\text{ V}$ , $V_{DS}=20\text{ V}$ , $f=1\text{ MHz}$                                      |
| Reverse transfer capacitance <sup>1)</sup> | $C_{rss}$    | -      | 22   | 38   | pF   | $V_{GS}=0\text{ V}$ , $V_{DS}=20\text{ V}$ , $f=1\text{ MHz}$                                      |
| Turn-on delay time                         | $t_{d(on)}$  | -      | 5    | -    | ns   | $V_{DD}=20\text{ V}$ , $V_{GS}=10\text{ V}$ , $I_D=20\text{ A}$ ,<br>$R_{G,ext}=1.6\text{ }\Omega$ |
| Rise time                                  | $t_r$        | -      | 1.6  | -    | ns   | $V_{DD}=20\text{ V}$ , $V_{GS}=10\text{ V}$ , $I_D=20\text{ A}$ ,<br>$R_{G,ext}=1.6\text{ }\Omega$ |
| Turn-off delay time                        | $t_{d(off)}$ | -      | 18   | -    | ns   | $V_{DD}=20\text{ V}$ , $V_{GS}=10\text{ V}$ , $I_D=20\text{ A}$ ,<br>$R_{G,ext}=1.6\text{ }\Omega$ |
| Fall time                                  | $t_f$        | -      | 4    | -    | ns   | $V_{DD}=20\text{ V}$ , $V_{GS}=10\text{ V}$ , $I_D=20\text{ A}$ ,<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              | $Q_{gs}$      | -      | 5.6  | -    | nC   | $V_{DD}=20\text{ V}$ , $I_D=20\text{ A}$ , $V_{GS}=0\text{ to }10\text{ V}$  |
| Gate charge at threshold           | $Q_{g(th)}$   | -      | 3.3  | -    | nC   | $V_{DD}=20\text{ V}$ , $I_D=20\text{ A}$ , $V_{GS}=0\text{ to }10\text{ V}$  |
| Gate to drain charge <sup>1)</sup> | $Q_{gd}$      | -      | 3.8  | -    | nC   | $V_{DD}=20\text{ V}$ , $I_D=20\text{ A}$ , $V_{GS}=0\text{ to }10\text{ V}$  |
| Switching charge                   | $Q_{sw}$      | -      | 6.0  | -    | nC   | $V_{DD}=20\text{ V}$ , $I_D=20\text{ A}$ , $V_{GS}=0\text{ to }10\text{ V}$  |
| Gate charge total <sup>1)</sup>    | $Q_g$         | -      | 31   | -    | nC   | $V_{DD}=20\text{ V}$ , $I_D=20\text{ A}$ , $V_{GS}=0\text{ to }10\text{ V}$  |
| Gate plateau voltage               | $V_{plateau}$ | -      | 2.6  | -    | V    | $V_{DD}=20\text{ V}$ , $I_D=20\text{ A}$ , $V_{GS}=0\text{ to }10\text{ V}$  |
| Gate charge total                  | $Q_g$         | -      | 15   | -    | nC   | $V_{DD}=20\text{ V}$ , $I_D=20\text{ A}$ , $V_{GS}=0\text{ to }4.5\text{ V}$ |
| Gate charge total, sync. FET       | $Q_{g(sync)}$ | -      | 12.8 | -    | nC   | $V_{DS}=0.1\text{ V}$ , $V_{GS}=0\text{ to }4.5\text{ V}$                    |
| Output charge <sup>1)</sup>        | $Q_{oss}$     | -      | 34   | -    | nC   | $V_{DD}=20\text{ V}$ , $V_{GS}=0\text{ V}$                                   |

<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      | $I_S$         | -      | -    | 83   | A    | $T_C=25\text{ °C}$                                                         |
| Diode pulse current                   | $I_{S,pulse}$ | -      | -    | 588  | A    | $T_C=25\text{ °C}$                                                         |
| Diode forward voltage                 | $V_{SD}$      | -      | 0.79 | 1    | V    | $V_{GS}=0\text{ V}$ , $I_F=20\text{ A}$ , $T_j=25\text{ °C}$               |
| Reverse recovery time <sup>1)</sup>   | $t_{rr}$      | -      | 22   | -    | ns   | $V_R=20\text{ V}$ , $I_F=20\text{ A}$ , $di_F/dt=400\text{ A/}\mu\text{s}$ |
| Reverse recovery charge <sup>1)</sup> | $Q_{rr}$      | -      | 55   | -    | nC   | $V_R=20\text{ V}$ , $I_F=20\text{ A}$ , $di_F/dt=400\text{ A/}\mu\text{s}$ |

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

## 4 Electrical characteristics diagrams

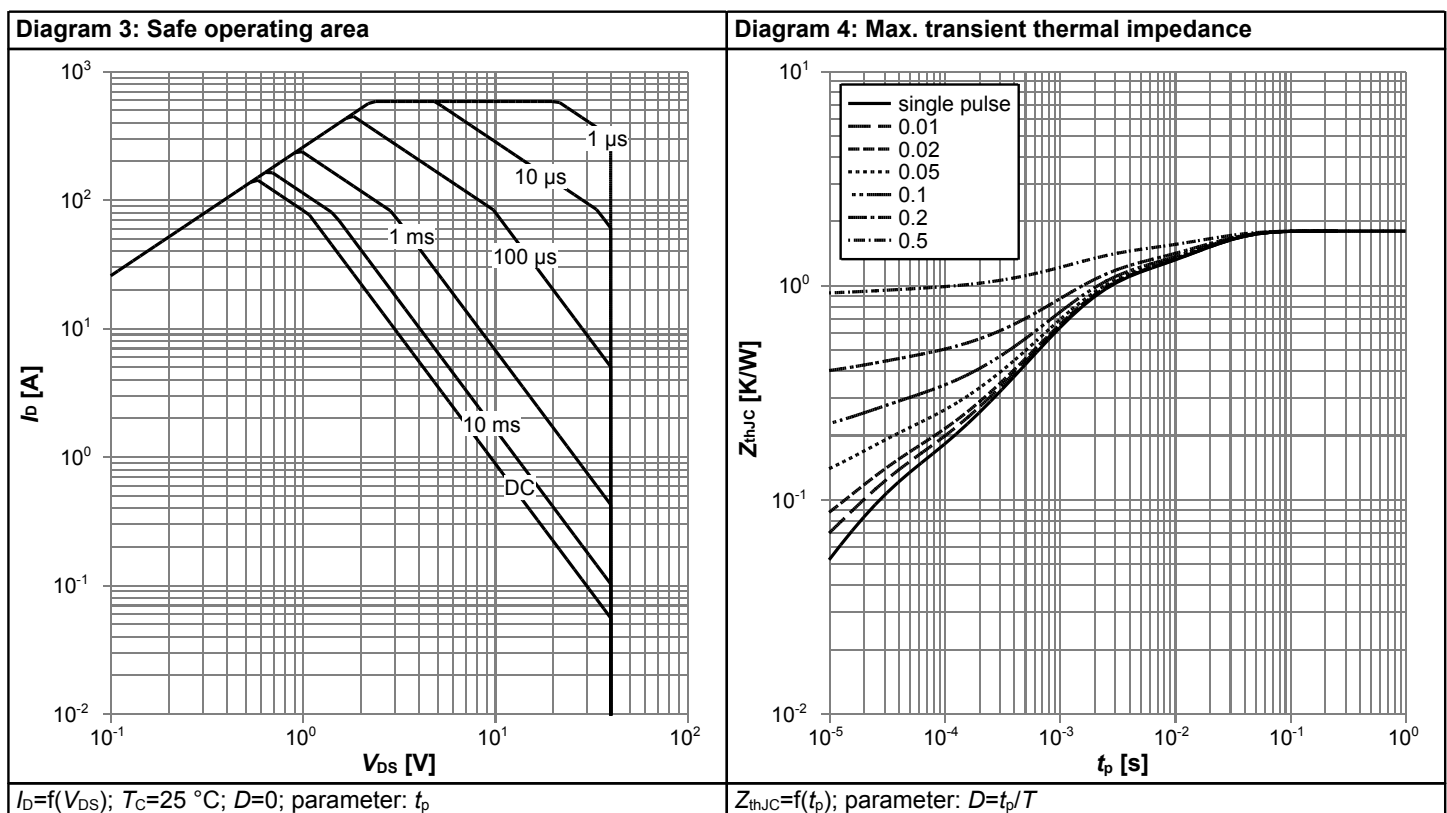
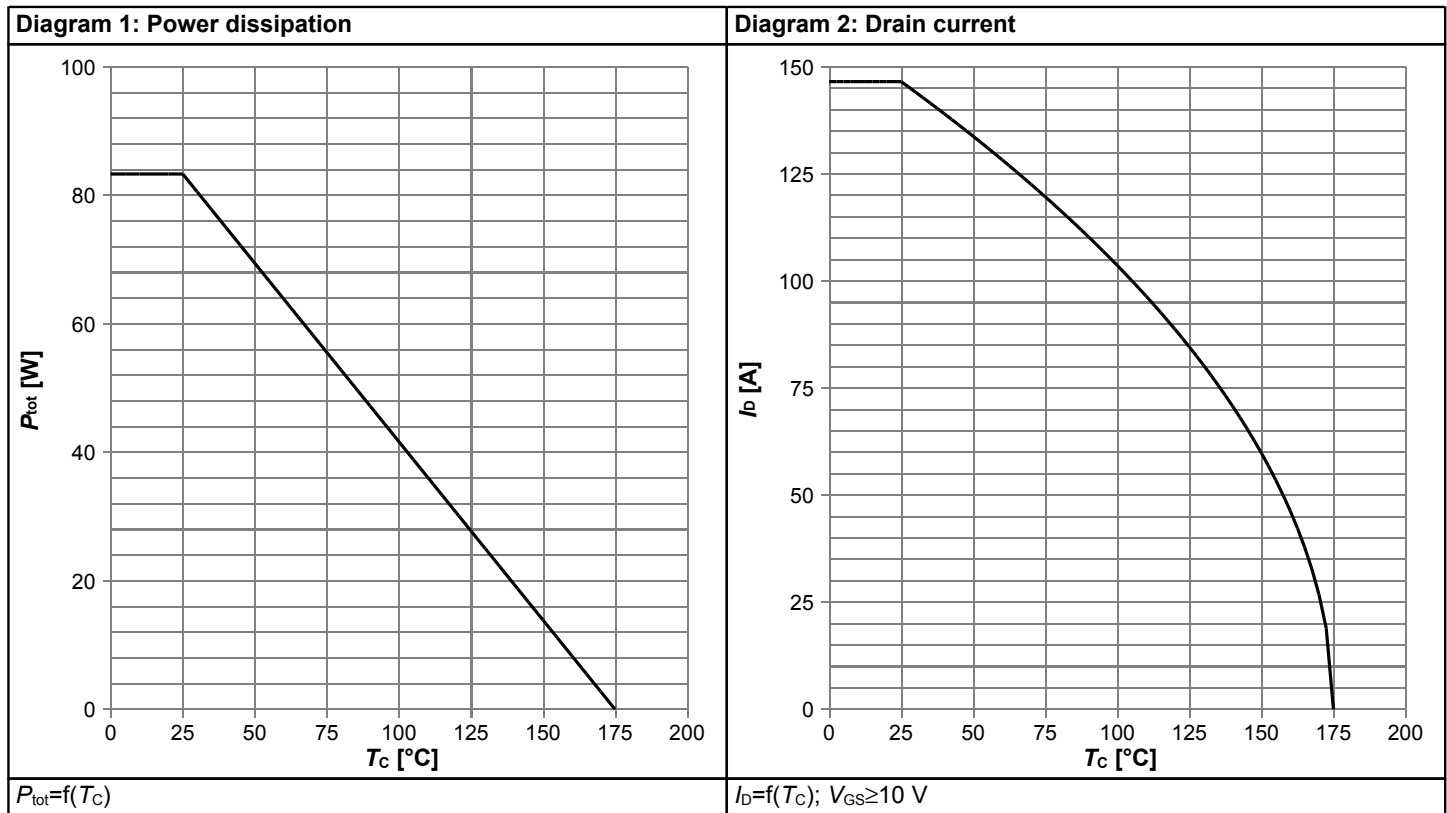
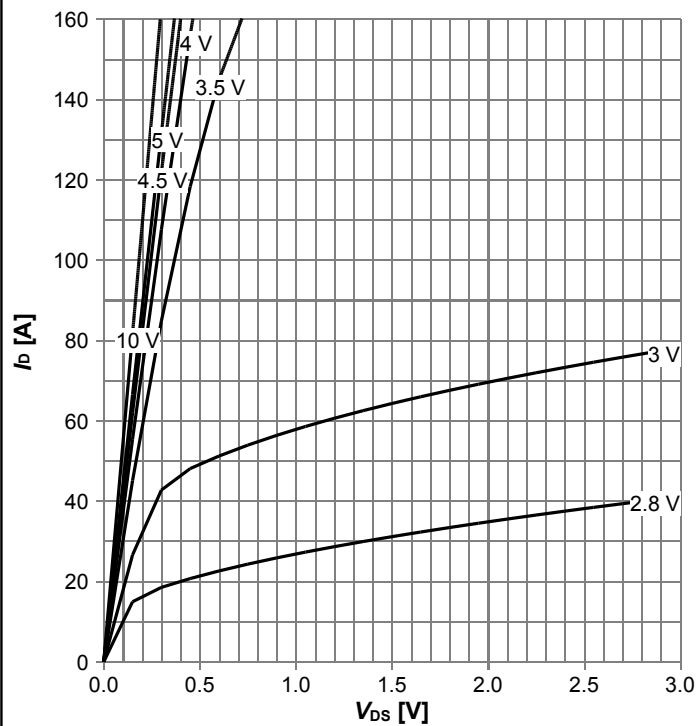
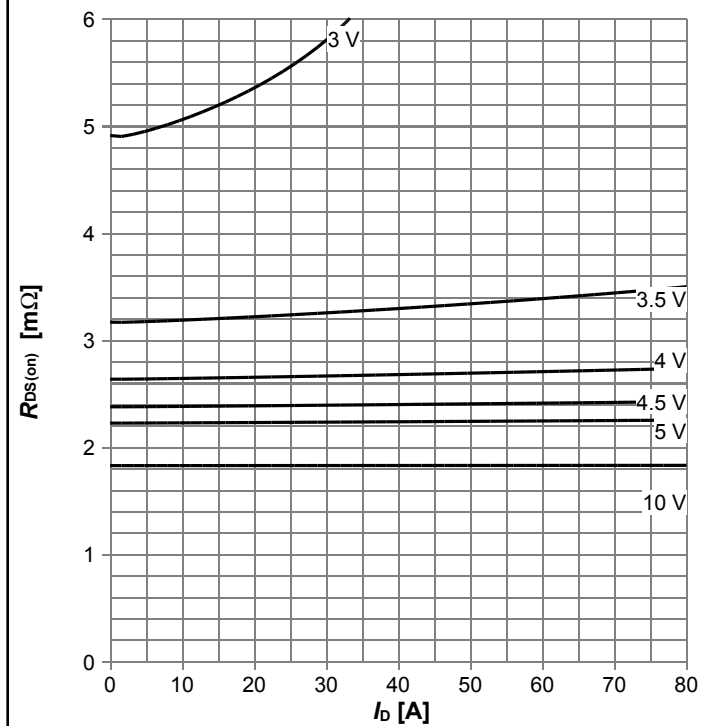


Diagram 5: Typ. output characteristics



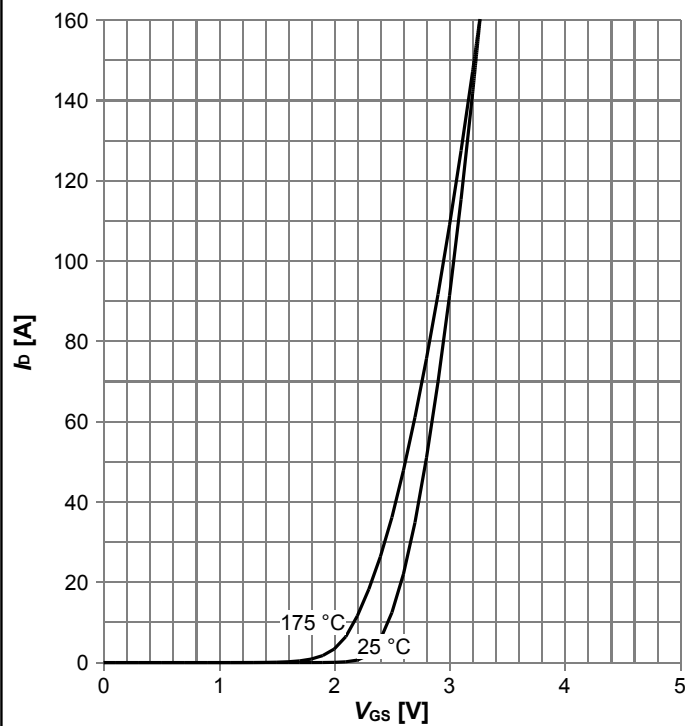
$I_D = f(V_{DS})$ ,  $T_j = 25^\circ\text{C}$ ; parameter:  $V_{GS}$

Diagram 6: Typ. drain-source on resistance



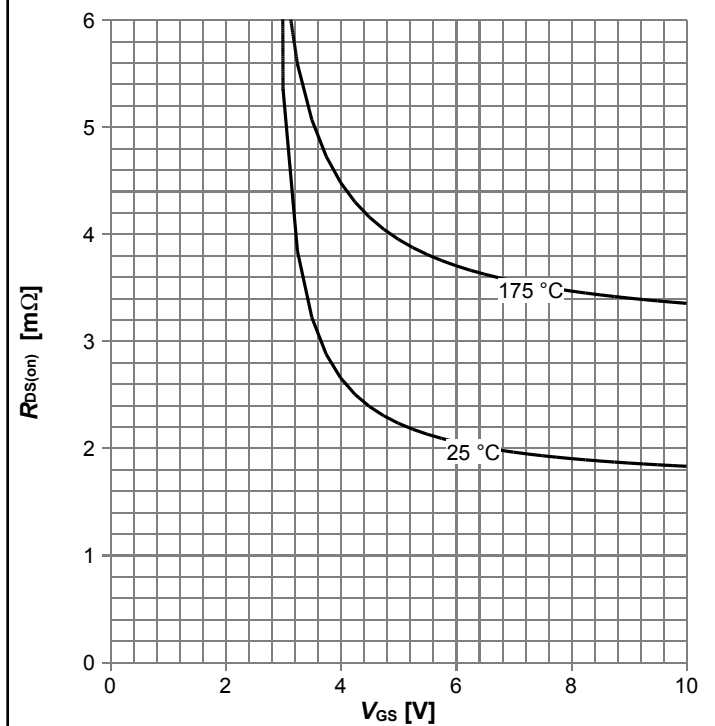
$R_{DS(on)} = f(I_D)$ ,  $T_j = 25^\circ\text{C}$ ; parameter:  $V_{GS}$

Diagram 7: Typ. transfer characteristics



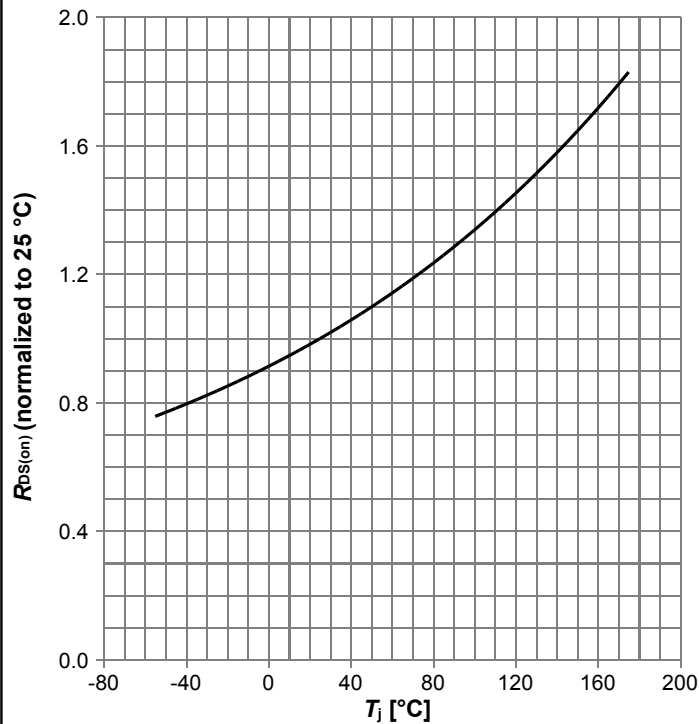
$I_D = f(V_{GS})$ ,  $|V_{DS}| > 2|I_D|R_{DS(on)\text{max}}$ ; parameter:  $T_j$

Diagram 8: Typ. drain-source on resistance



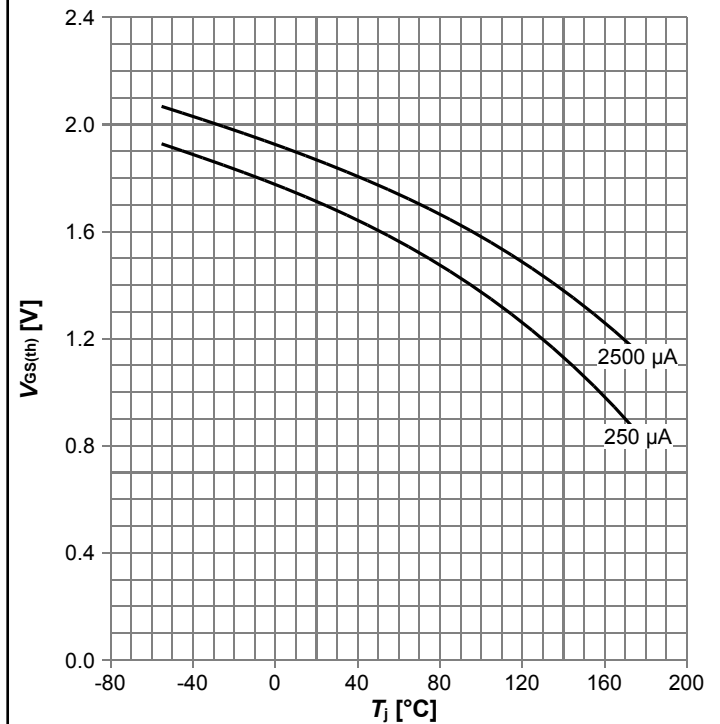
$R_{DS(on)} = f(V_{GS})$ ,  $I_D = 20\text{ A}$ ; parameter:  $T_j$

Diagram 9: Normalized drain-source on resistance



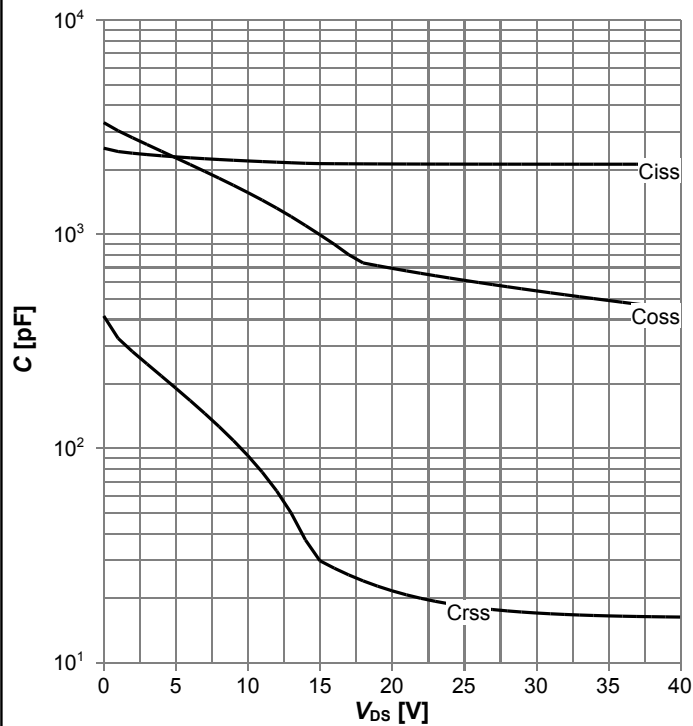
$R_{DS(on)} = f(T_j)$ ,  $I_D = 20$  A,  $V_{GS} = 10$  V

Diagram 10: Typ. gate threshold voltage



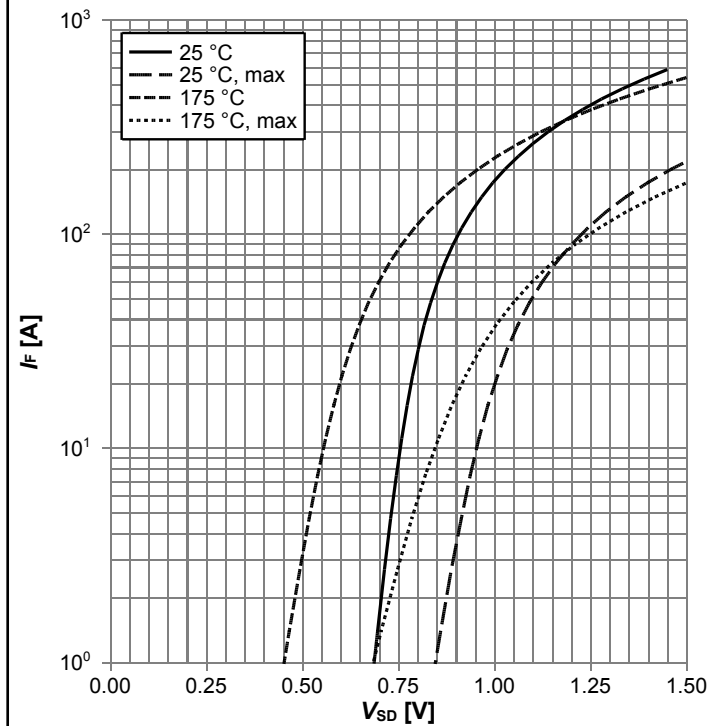
$V_{GS(th)} = f(T_j)$ ,  $V_{GS} = V_{DS}$ ; parameter:  $I_D$

Diagram 11: Typ. capacitances



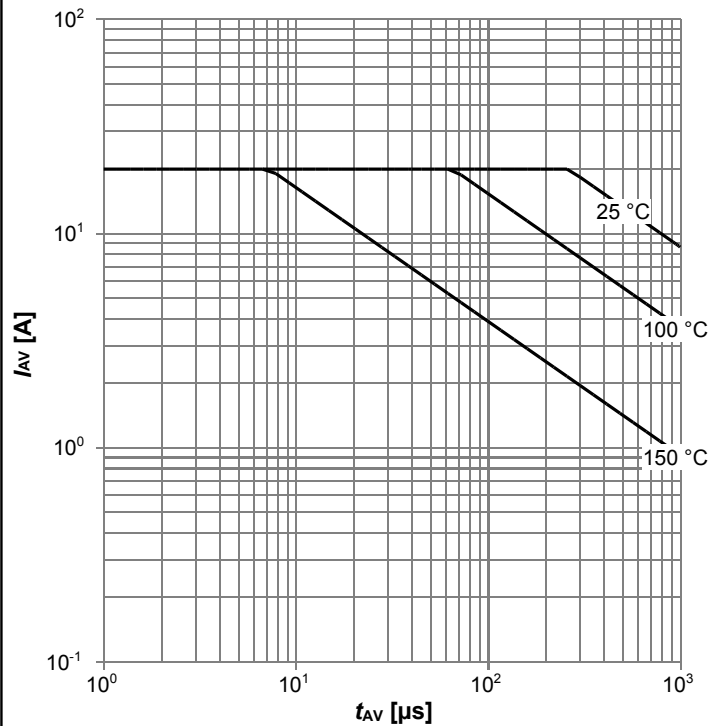
$C = f(V_{DS})$ ;  $V_{GS} = 0$  V;  $f = 1$  MHz

Diagram 12: Forward characteristics of reverse diode



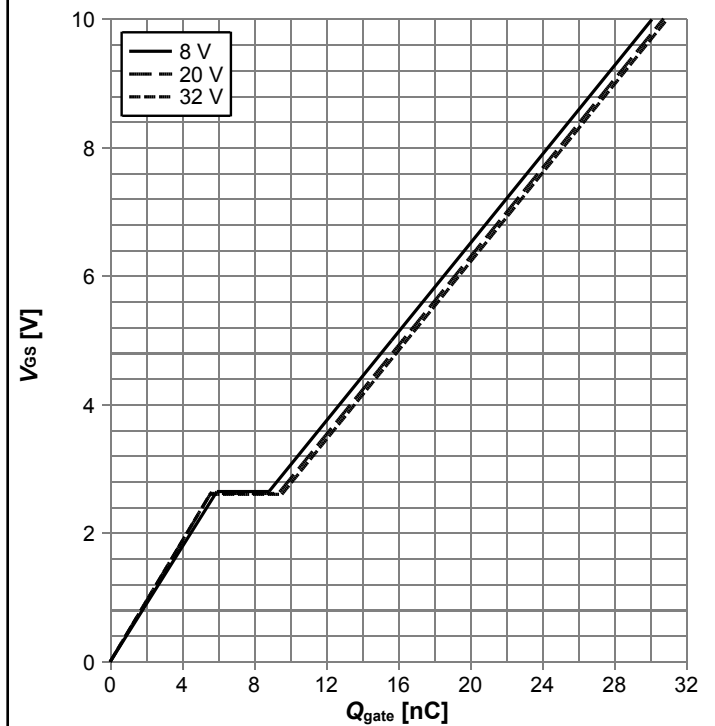
$I_F = f(V_{SD})$ ; parameter:  $T_j$

Diagram 13: Avalanche characteristics



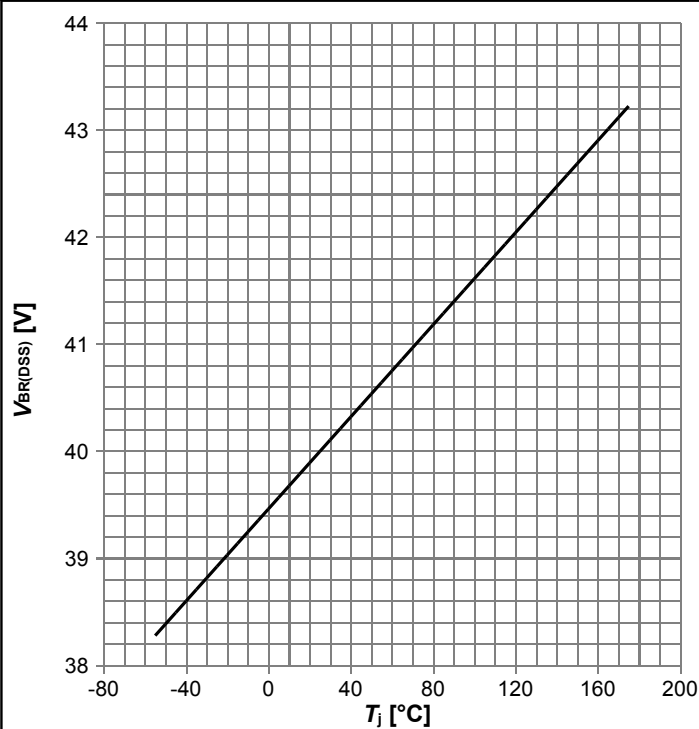
$I_{AS}=f(t_{AV})$ ;  $R_{GS}=25\ \Omega$ ; parameter:  $T_{j,start}$

Diagram 14: Typ. gate charge



$V_{GS}=f(Q_{gate})$ ,  $I_D=20\text{ A}$  pulsed,  $T_j=25\text{ °C}$ ; parameter:  $V_{DD}$

Diagram 15: Drain-source breakdown voltage



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

Diagram Gate charge waveforms



## 5 Package Outlines



| PACKAGE - GROUP<br>NUMBER: <b>PG-TSDSON-8-U03</b> |             |                  |
|---------------------------------------------------|-------------|------------------|
| REVISION: 03                                      |             | DATE: 20.10.2020 |
| DIMENSIONS                                        | MILLIMETERS |                  |
|                                                   | MIN.        | MAX.             |
| <b>A</b>                                          | 0.90        | 1.10             |
| <b>b</b>                                          | 0.24        | 0.44             |
| <b>c</b>                                          | (0.20)      |                  |
| <b>D</b>                                          | 3.20        | 3.40             |
| <b>D1</b>                                         | 2.19        | 2.39             |
| <b>D2</b>                                         | 1.54        | 1.74             |
| <b>E</b>                                          | 3.20        | 3.40             |
| <b>E1</b>                                         | 2.01        | 2.21             |
| <b>E2</b>                                         | 0.10        | 0.30             |
| <b>e</b>                                          | 0.65        |                  |
| <b>L</b>                                          | 0.30        | 0.50             |
| <b>L1</b>                                         | 0.40        | 0.60             |
| <b>L2</b>                                         | 0.50        | 0.70             |
| <b>aaa</b>                                        | 0.06        |                  |

Figure 1 Outline PG-TSDSON-8 FL, dimensions in mm

## Revision History

BSZ021N04LS6

**Revision: 2021-02-23, Rev. 2.3**

Previous Revision

| Revision | Date       | Subjects (major changes since last revision) |
|----------|------------|----------------------------------------------|
| 2.0      | 2018-05-18 | Release of final version                     |
| 2.1      | 2018-08-10 | Update continuous drain current              |
| 2.2      | 2020-05-12 | Update current rating                        |
| 2.3      | 2021-02-23 | Update package drawing                       |

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