

# MOSFET

## OptiMOS™ 3 Power-Transistor, 150 V

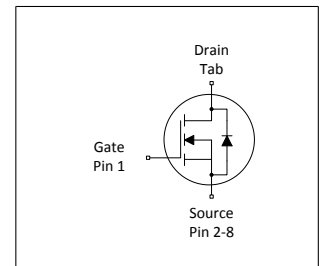
### Features

- N-channel, normal level
- Excellent gate charge x  $R_{DS(on)}$  product (FOM)
- Very low on-resistance  $R_{DS(on)}$
- 175 °C operating temperature
- Pb-free lead plating; RoHS compliant
- Qualified according to JEDEC<sup>1)</sup> for target application
- Ideal for high-frequency switching and synchronous rectification
- Halogen-free according to IEC61249-2-21



**Table 1 Key Performance Parameters**

| Parameter        | Value | Unit |
|------------------|-------|------|
| $V_{DS}$         | 150   | V    |
| $R_{DS(on),max}$ | 5.9   | mΩ   |
| $I_D$            | 155   | A    |



| Type / Ordering Code | Package   | Marking  | Related Links |
|----------------------|-----------|----------|---------------|
| IPT059N15N3          | PG-HSOF-8 | 059N15N3 | -             |

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

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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           | $I_D$             | -      | -    | 155<br>110 | A    | $T_C=25\text{ °C}$<br>$T_C=100\text{ °C}$         |
| Pulsed drain current <sup>1)</sup> | $I_{D,pulse}$     | -      | -    | 620        | A    | $T_C=25\text{ °C}$                                |
| Avalanche energy, single pulse     | $E_{AS}$          | -      | -    | 520        | mJ   | $I_D=150\text{ A}$ , $R_{GS}=25\text{ }\Omega$    |
| Gate source voltage                | $V_{GS}$          | -20    | -    | 20         | V    | -                                                 |
| Power dissipation                  | $P_{tot}$         | -      | -    | 375        | W    | $T_C=25\text{ °C}$                                |
| Operating and storage temperature  | $T_j$ , $T_{stg}$ | -55    | -    | 175        | °C   | IEC climatic category;<br>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                                                  | $R_{thJC}$ | -      | 0.2  | 0.4  | K/W  | -                     |
| Thermal resistance, junction - ambient, minimal footprint                            | $R_{thJA}$ | -      | -    | 62   | K/W  | -                     |
| Thermal resistance, junction - ambient, 6 cm <sup>2</sup> cooling area <sup>2)</sup> | $R_{thJA}$ | -      | -    | 40   | K/W  | -                     |

## 3 Electrical characteristics

**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           | $V_{GS(th)}$  | 2      | 3         | 4          | V             | $V_{DS}=V_{GS}$ , $I_D=270\text{ }\mu\text{A}$                                                                                        |
| 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      | $I_{GSS}$     | -      | 1         | 100        | nA            | $V_{GS}=20\text{ V}$ , $V_{DS}=0\text{ V}$                                                                                            |
| Drain-source on-state resistance | $R_{DS(on)}$  | -      | 5<br>5.2  | 5.9<br>6.2 | m $\Omega$    | $V_{GS}=10\text{ V}$ , $I_D=150\text{ A}$<br>$V_{GS}=8\text{ V}$ , $I_D=75\text{ A}$                                                  |
| Gate resistance                  | $R_G$         | -      | 2.1       | 3.2        | $\Omega$      | -                                                                                                                                     |
| Transconductance                 | $g_{fs}$      | 86     | 172       | -          | S             | $ V_{DS} >2 I_D /R_{DS(on)max}$ , $I_D=150\text{ A}$                                                                                  |

<sup>1)</sup> See figure 3

<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  $\mu\text{m}$  thick) copper area for drain connection. PCB is vertical in still air.

**Table 5 Dynamic characteristics**

| Parameter                    | Symbol       | Values |      |      | Unit | Note / Test Condition                                                                      |
|------------------------------|--------------|--------|------|------|------|--------------------------------------------------------------------------------------------|
|                              |              | Min.   | Typ. | Max. |      |                                                                                            |
| Input capacitance            | $C_{iss}$    | -      | 5400 | 7182 | pF   | $V_{GS}=0\text{ V}$ , $V_{DS}=75\text{ V}$ , $f=1\text{ MHz}$                              |
| Output capacitance           | $C_{oss}$    | -      | 630  | 838  | pF   | $V_{GS}=0\text{ V}$ , $V_{DS}=75\text{ V}$ , $f=1\text{ MHz}$                              |
| Reverse transfer capacitance | $C_{rss}$    | -      | 10   | 19   | pF   | $V_{GS}=0\text{ V}$ , $V_{DS}=75\text{ V}$ , $f=1\text{ MHz}$                              |
| Turn-on delay time           | $t_{d(on)}$  | -      | 25   | -    | ns   | $V_{DD}=75\text{ V}$ , $V_{GS}=10\text{ V}$ , $I_D=100\text{ A}$ , $R_{G,ext}=1.6\ \Omega$ |
| Rise time                    | $t_r$        | -      | 35   | -    | ns   | $V_{DD}=75\text{ V}$ , $V_{GS}=10\text{ V}$ , $I_D=100\text{ A}$ , $R_{G,ext}=1.6\ \Omega$ |
| Turn-off delay time          | $t_{d(off)}$ | -      | 46   | -    | ns   | $V_{DD}=75\text{ V}$ , $V_{GS}=10\text{ V}$ , $I_D=100\text{ A}$ , $R_{G,ext}=1.6\ \Omega$ |
| Fall time                    | $t_f$        | -      | 14   | -    | ns   | $V_{DD}=75\text{ V}$ , $V_{GS}=10\text{ V}$ , $I_D=100\text{ A}$ , $R_{G,ext}=1.6\ \Omega$ |

**Table 6 Gate charge characteristics<sup>1)</sup>**

| Parameter             | Symbol        | Values |      |      | Unit | Note / Test Condition                                                        |
|-----------------------|---------------|--------|------|------|------|------------------------------------------------------------------------------|
|                       |               | Min.   | Typ. | Max. |      |                                                                              |
| Gate to source charge | $Q_{gs}$      | -      | 29   | -    | nC   | $V_{DD}=75\text{ V}$ , $I_D=100\text{ A}$ , $V_{GS}=0\text{ to }10\text{ V}$ |
| Gate to drain charge  | $Q_{gd}$      | -      | 11   | -    | nC   | $V_{DD}=75\text{ V}$ , $I_D=100\text{ A}$ , $V_{GS}=0\text{ to }10\text{ V}$ |
| Switching charge      | $Q_{sw}$      | -      | 24   | -    | nC   | $V_{DD}=75\text{ V}$ , $I_D=100\text{ A}$ , $V_{GS}=0\text{ to }10\text{ V}$ |
| Gate charge total     | $Q_g$         | -      | 69   | 92   | nC   | $V_{DD}=75\text{ V}$ , $I_D=100\text{ A}$ , $V_{GS}=0\text{ to }10\text{ V}$ |
| Gate plateau voltage  | $V_{plateau}$ | -      | 5.4  | -    | V    | $V_{DD}=75\text{ V}$ , $I_D=100\text{ A}$ , $V_{GS}=0\text{ to }10\text{ V}$ |
| Output charge         | $Q_{oss}$     | -      | 178  | -    | nC   | $V_{DD}=75\text{ V}$ , $V_{GS}=0\text{ V}$                                   |

**Table 7 Reverse diode**

| Parameter                        | Symbol        | Values |      |      | Unit | Note / Test Condition                                              |
|----------------------------------|---------------|--------|------|------|------|--------------------------------------------------------------------|
|                                  |               | Min.   | Typ. | Max. |      |                                                                    |
| Diode continuous forward current | $I_S$         | -      | -    | 155  | A    | $T_C=25\text{ °C}$                                                 |
| Diode pulse current              | $I_{S,pulse}$ | -      | -    | 620  | A    | $T_C=25\text{ °C}$                                                 |
| Diode forward voltage            | $V_{SD}$      | -      | 0.94 | 1.2  | V    | $V_{GS}=0\text{ V}$ , $I_F=150\text{ A}$ , $T_J=25\text{ °C}$      |
| Reverse recovery time            | $t_{rr}$      | -      | 146  | 292  | ns   | $V_R=75\text{ V}$ , $I_F=I_S$ , $di_F/dt=100\text{ A}/\mu\text{s}$ |
| Reverse recovery charge          | $Q_{rr}$      | -      | 478  | -    | nC   | $V_R=75\text{ V}$ , $I_F=I_S$ , $di_F/dt=100\text{ A}/\mu\text{s}$ |

<sup>1)</sup> See "Gate charge waveforms" for parameter definition

## 4 Electrical characteristics diagrams

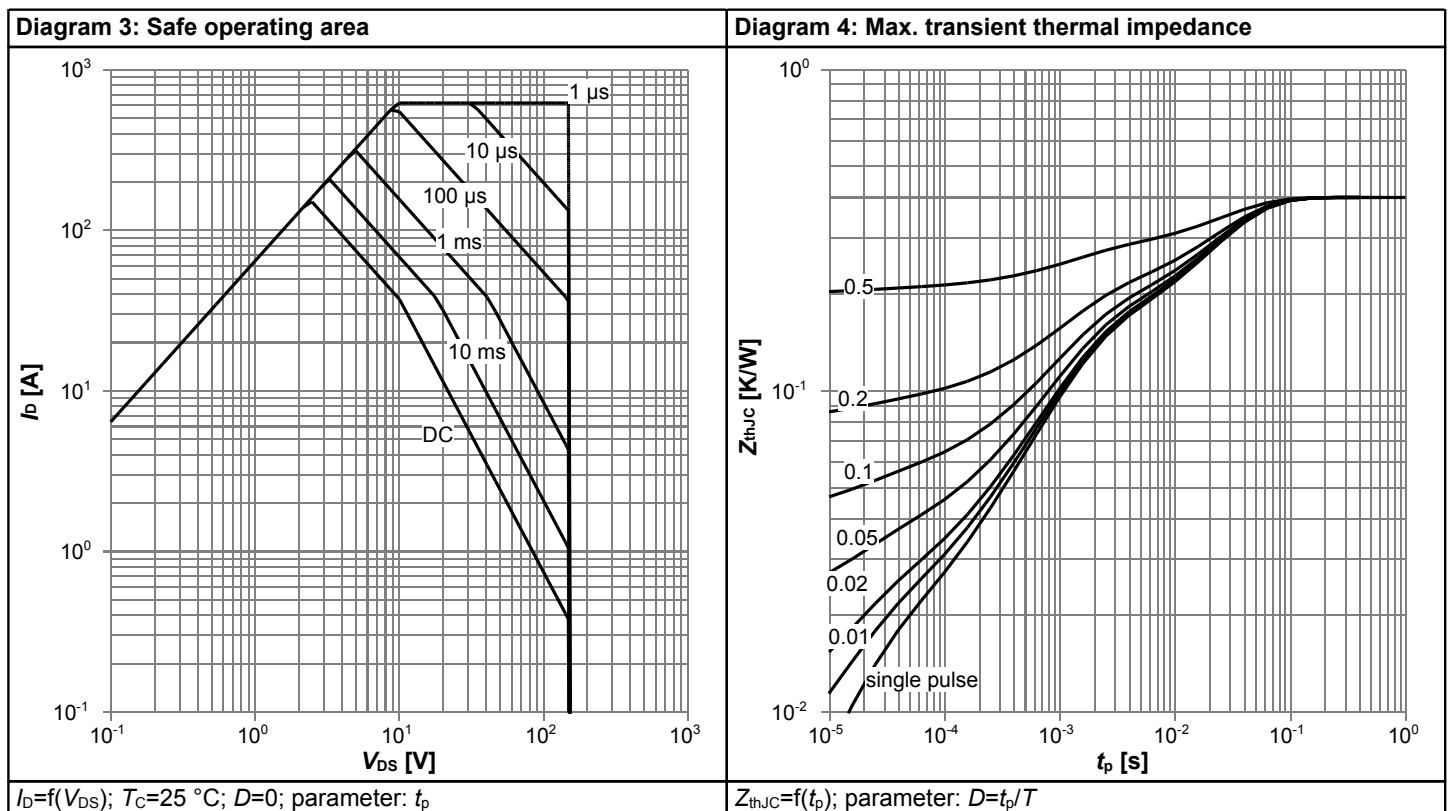
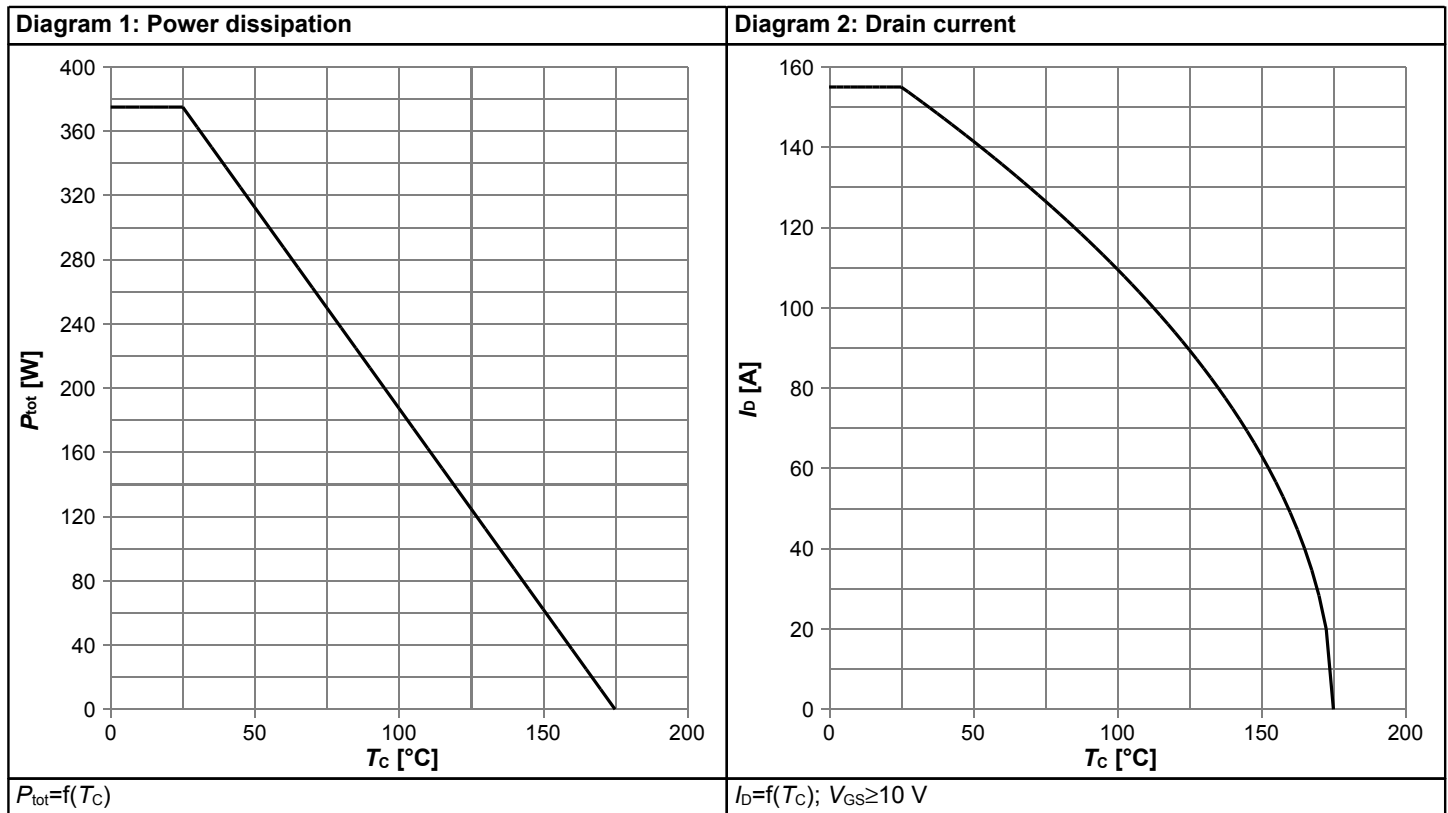
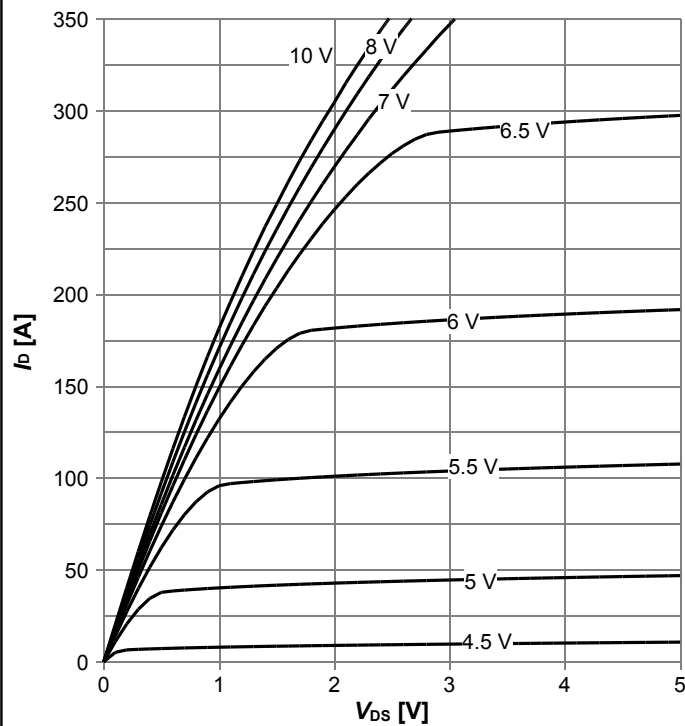
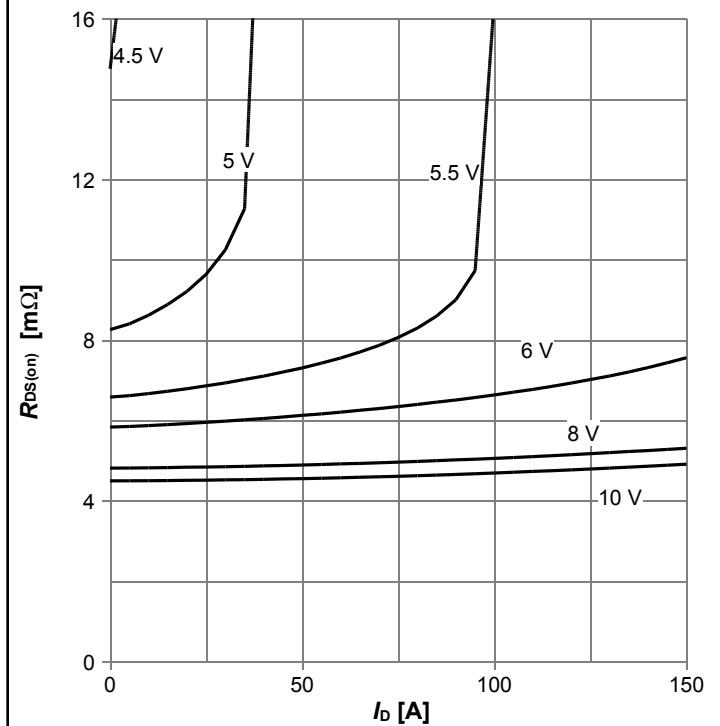


Diagram 5: Typ. output characteristics



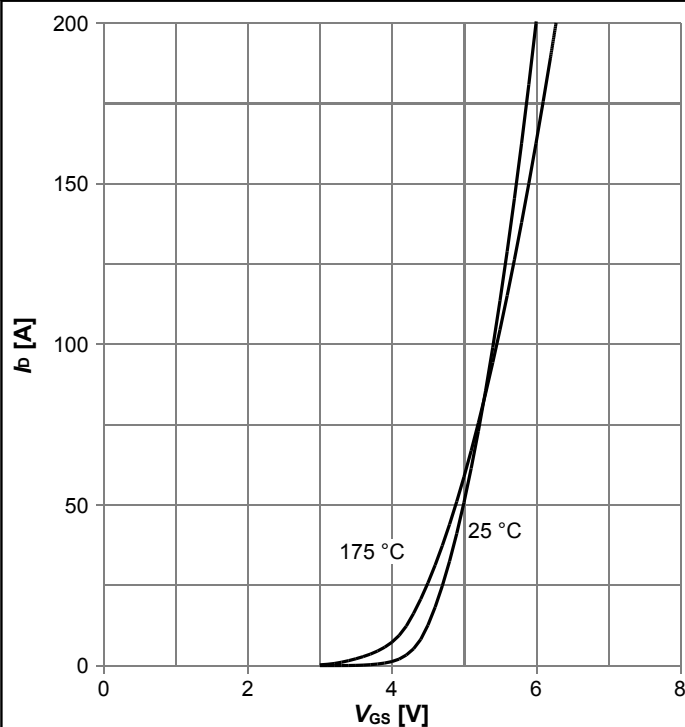
$I_D = f(V_{DS})$ ;  $T_j = 25^\circ\text{C}$ ; parameter:  $V_{GS}$

Diagram 6: Typ. drain-source on resistance



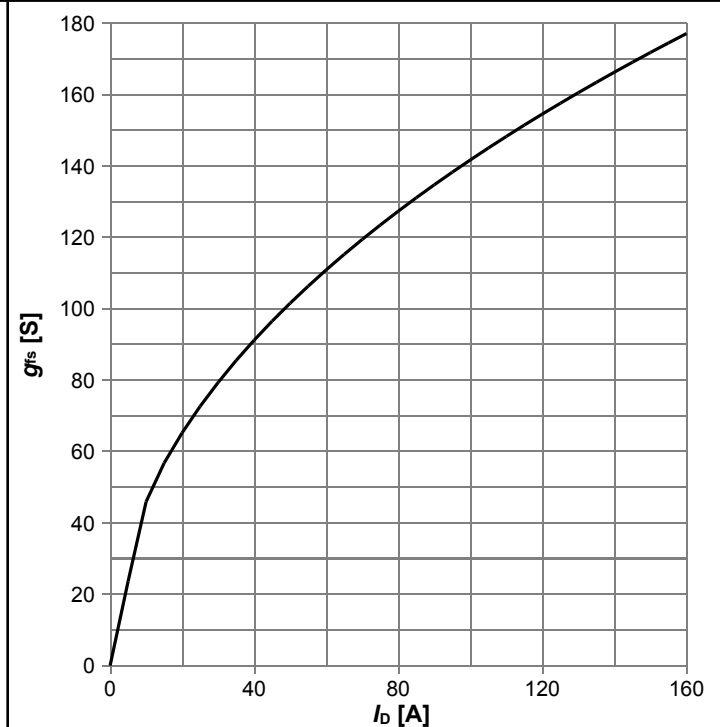
$R_{DS(on)} = f(I_D)$ ;  $T_j = 25^\circ\text{C}$ ; parameter:  $V_{GS}$

Diagram 7: Typ. transfer characteristics



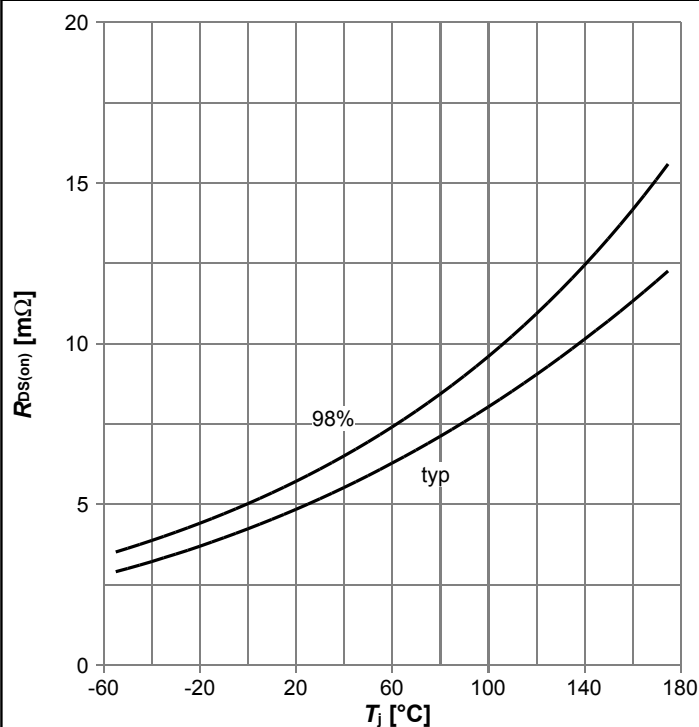
$I_D = f(V_{GS})$ ;  $|V_{DS}| > 2|I_D|R_{DS(on)max}$ ; parameter:  $T_j$

Diagram 8: Typ. forward transconductance



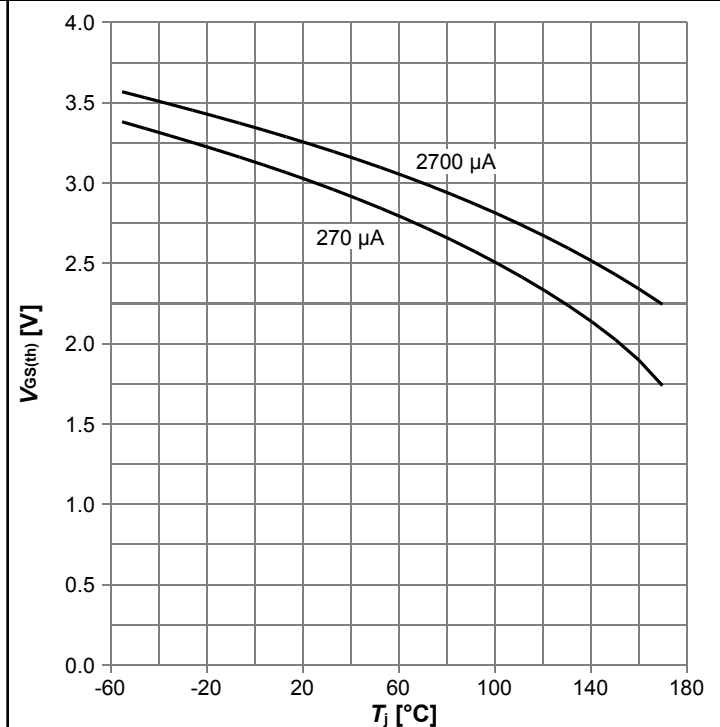
$g_{fs} = f(I_D)$ ;  $T_j = 25^\circ\text{C}$

Diagram 9: Drain-source on-state resistance



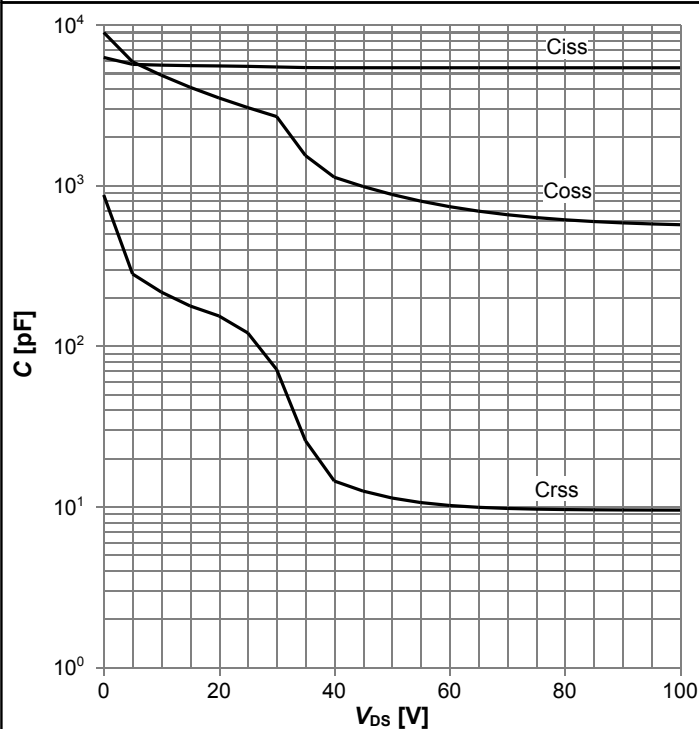
$R_{DS(on)} = f(T_j)$ ;  $I_D = 150$  A;  $V_{GS} = 10$  V

Diagram 10: Typ. gate threshold voltage



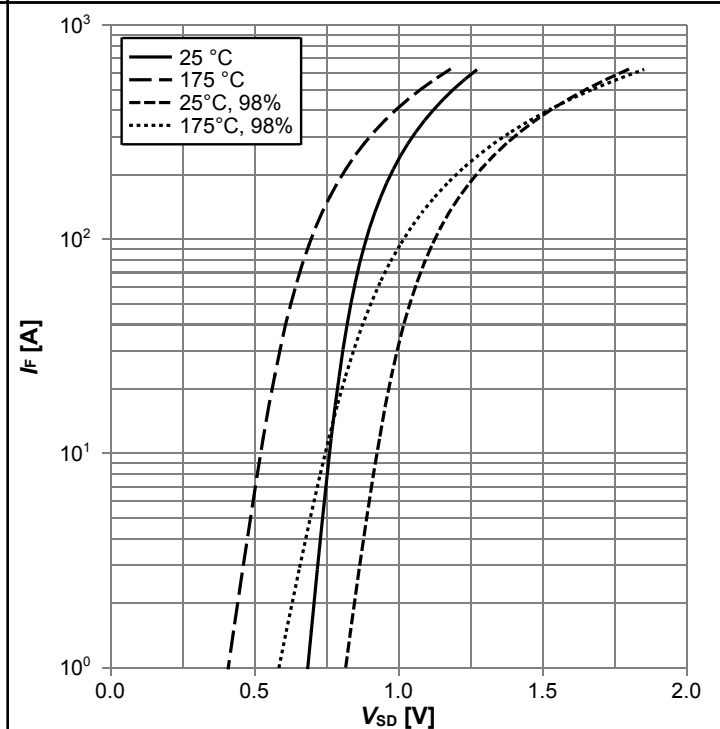
$V_{GS(th)} = f(T_j)$ ;  $V_{GS} = V_{DS}$ ; parameter:  $I_D$

Diagram 11: Typ. capacitances



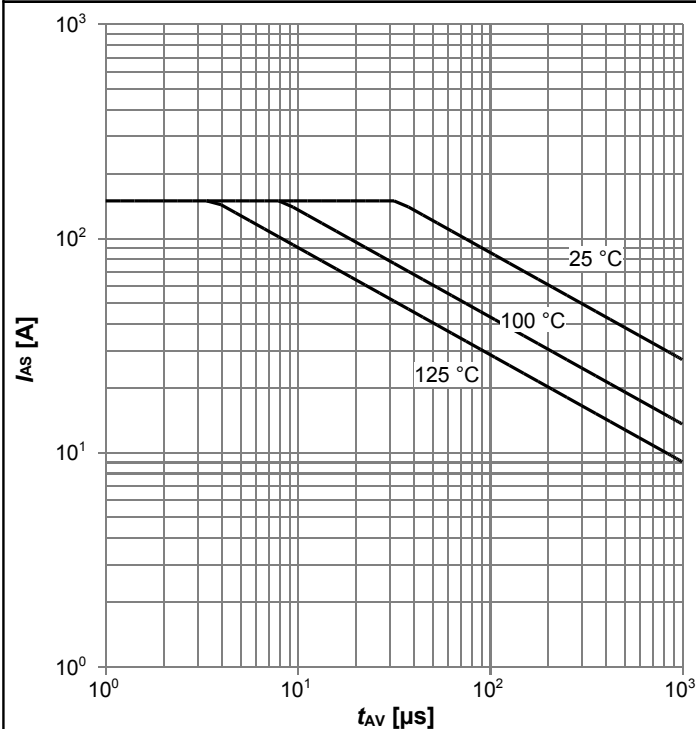
$C = f(V_{DS})$ ;  $V_{GS} = 0$  V;  $f = 1$  MHz

Diagram 12: Forward characteristics of reverse diode



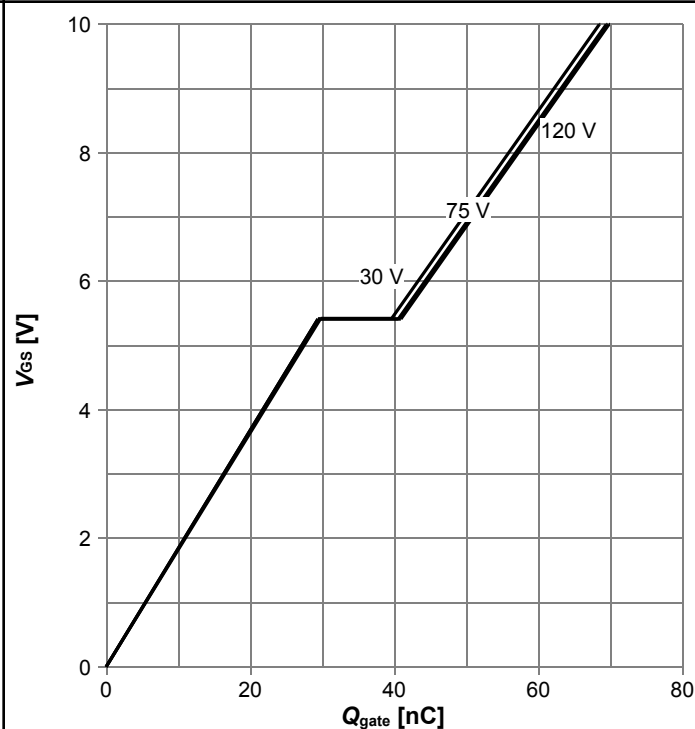
$I_F = f(V_{SD})$ ; parameter:  $T_j$

Diagram 13: Avalanche characteristics



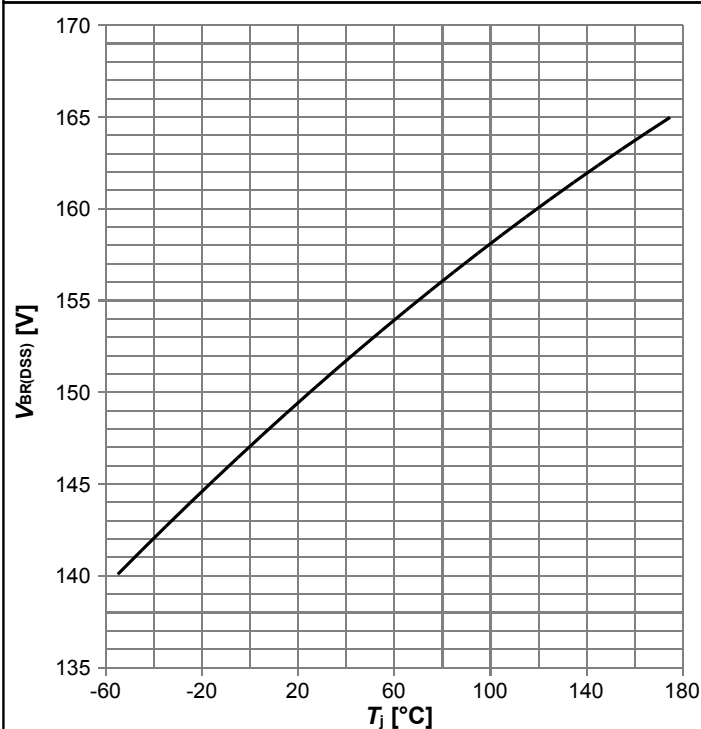
$I_{AS}=f(t_{AV})$ ;  $R_{GS}=25\ \Omega$ ; parameter:  $T_{j(start)}$

Diagram 14: Typ. gate charge



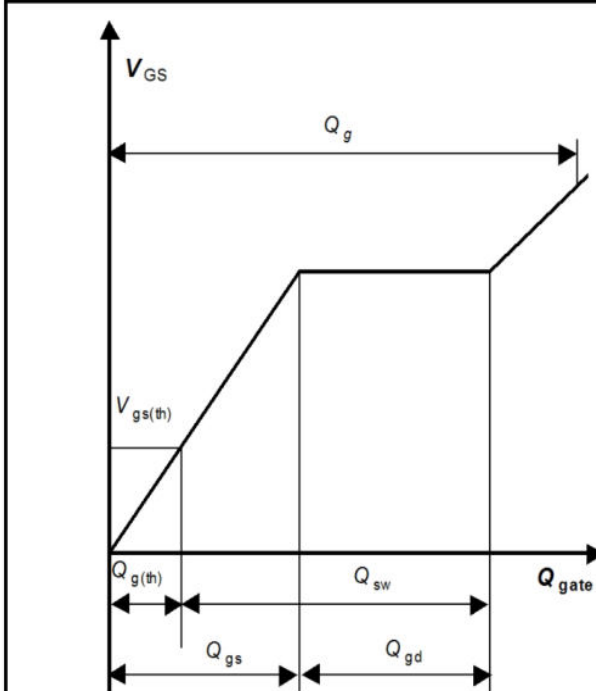
$V_{GS}=f(Q_{gate})$ ;  $I_D=100\text{ A}$  pulsed; parameter:  $V_{DD}$

Diagram 15: Drain-source breakdown voltage



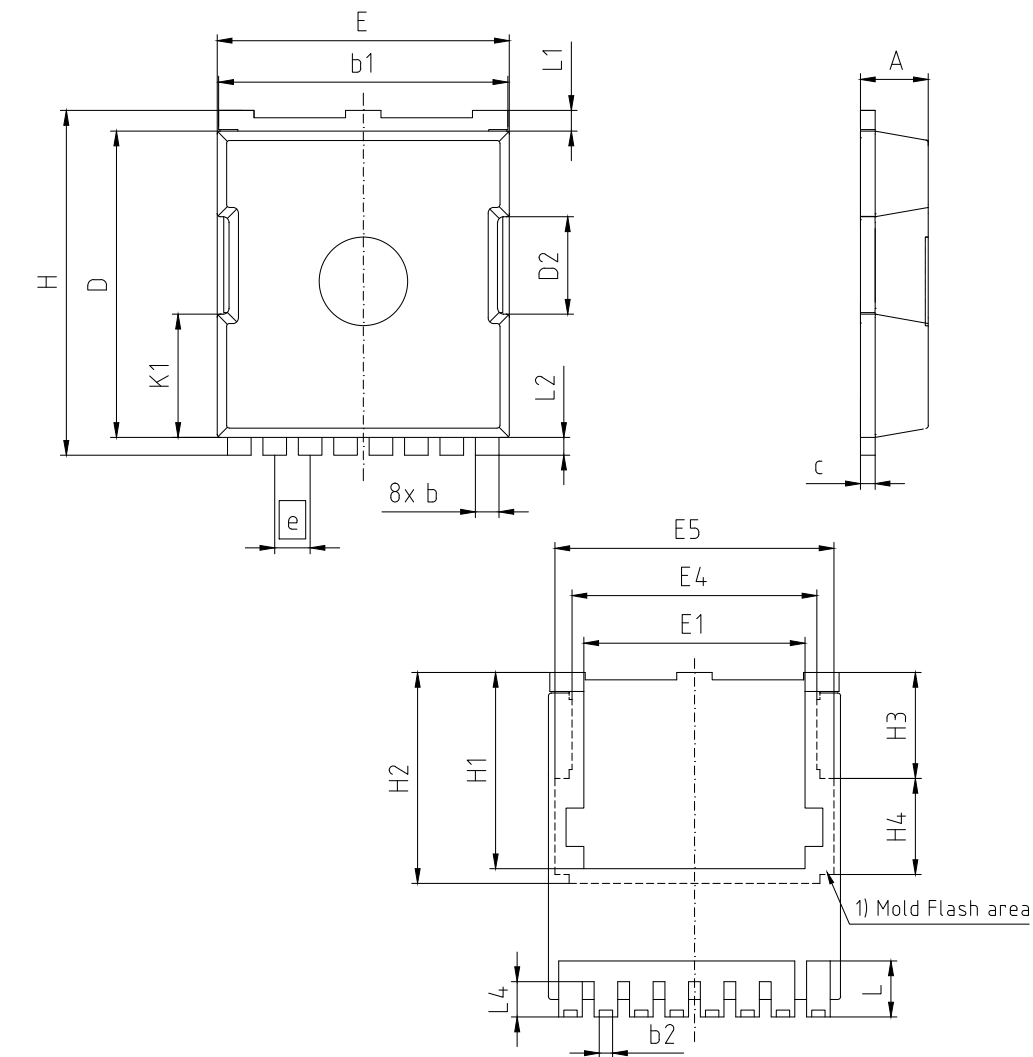
$V_{BR(DSS)}=f(T_j)$ ;  $I_D=1\text{ mA}$

Gate charge waveforms





## 5 Package Outlines



1) partially covered with Mold Flash

| DIM | MILLIMETERS |       | INCHES      |       |
|-----|-------------|-------|-------------|-------|
|     | MIN         | MAX   | MIN         | MAX   |
| A   | 2.20        | 2.40  | 0.087       | 0.094 |
| b   | 0.70        | 0.90  | 0.028       | 0.035 |
| b1  | 9.70        | 9.90  | 0.382       | 0.390 |
| b2  | 0.42        | 0.50  | 0.017       | 0.020 |
| c   | 0.40        | 0.60  | 0.016       | 0.024 |
| D   | 10.28       | 10.58 | 0.405       | 0.416 |
| D2  | 3.30        |       | 0.130       |       |
| E   | 9.70        | 10.10 | 0.382       | 0.398 |
| E1  | 7.50        |       | 0.295       |       |
| E4  | 8.50        |       | 0.335       |       |
| E5  | 9.46        |       | 0.372       |       |
| e   | 1.20 (BSC)  |       | 0.047 (BSC) |       |
| H   | 11.48       | 11.88 | 0.452       | 0.468 |
| H1  | 6.55        | 6.75  | 0.258       | 0.266 |
| H2  | 7.15        |       | 0.281       |       |
| H3  | 3.59        |       | 0.141       |       |
| H4  | 3.26        |       | 0.128       |       |
| N   | 8           |       | 8           |       |
| K1  | 4.18        |       | 0.165       |       |
| L   | 1.60        | 2.10  | 0.063       | 0.083 |
| L1  | 0.70        |       | 0.028       |       |
| L2  | 0.60        |       | 0.024       |       |
| L4  | 1.00        | 1.30  | 0.039       | 0.051 |

|                                    |
|------------------------------------|
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| <b>REVISION</b><br>02              |

Figure 1 Outline PG-HSOF-8

## Revision History

IPT059N15N3

**Revision: 2017-05-16, Rev. 2.2**

Previous Revision

| Revision | Date       | Subjects (major changes since last revision)                                     |
|----------|------------|----------------------------------------------------------------------------------|
| 2.0      | 2014-01-27 | Release of final version                                                         |
| 2.1      | 2014-02-07 | Insert additional typ value (Rthjc) and max values (Crss,trr, Rg,Qg, Coss, Ciss) |
| 2.2      | 2017-05-16 | Update Zth Diagram and "T" condition in "Maximum ratings"                        |

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