

# MOSFET

## OptiMOS™ Power Transistor, -60 V

### Features

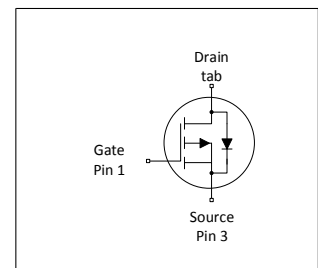
- P-Channel
- Very low on-resistance  $R_{DS(on)}$
- 100% avalanche tested
- Normal Level
- Enhancement mode
- Pb-free lead plating; RoHS compliant
- Halogen-free according to IEC61249-2-21

### Product validation

Fully qualified according to JEDEC for Industrial Applications

**Table 1 Key Performance Parameters**

| Parameter        | Value | Unit |
|------------------|-------|------|
| $V_{DS}$         | -60   | V    |
| $R_{DS(on),max}$ | 38    | mΩ   |
| $I_D$            | -35   | A    |



| Type / Ordering Code | Package     | Marking  | Related Links |
|----------------------|-------------|----------|---------------|
| IPD380P06NM          | PG-TO 252-3 | 380P06NM | -             |

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## 1 Maximum ratings

at  $T_C=25\text{ °C}$ , unless otherwise specified

**Table 2 Maximum ratings**

| Parameter                                    | Symbol            | Values |      |            | Unit | Note / Test Condition                                                                     |
|----------------------------------------------|-------------------|--------|------|------------|------|-------------------------------------------------------------------------------------------|
|                                              |                   | Min.   | Typ. | Max.       |      |                                                                                           |
| Continuous drain current                     | $I_D$             | -      | -    | -35<br>-28 | A    | $V_{GS}=-10\text{ V}$ , $T_C=25\text{ °C}$<br>$V_{GS}=-10\text{ V}$ , $T_C=100\text{ °C}$ |
| Pulsed drain current <sup>1)</sup>           | $I_{D,pulse}$     | -      | -    | -140       | A    | $T_C=25\text{ °C}$                                                                        |
| Avalanche energy, single pulse <sup>2)</sup> | $E_{AS}$          | -      | -    | 559        | mJ   | $I_D=-35\text{ A}$ , $R_{GS}=25\text{ }\Omega$                                            |
| Gate source voltage                          | $V_{GS}$          | -20    | -    | 20         | V    | -                                                                                         |
| Power dissipation                            | $P_{tot}$         | -      | -    | 125        | W    | $T_C=25\text{ °C}$                                                                        |
| 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                 | $R_{thJC}$ | -      | -    | 1.2  | °C/W | -                     |
| Device on PCB, 6 cm <sup>2</sup> cooling area <sup>3)</sup> | $R_{thJA}$ | -      | -    | 75   | °C/W | -                     |

## 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   | $V_{(BR)DSS}$ | -60    | -           | -          | V             | $V_{GS}=0\text{ V}$ , $I_D=-1\text{ mA}$                                                                                              |
| Gate threshold voltage           | $V_{GS(th)}$  | -2.1   | -3          | -4         | V             | $V_{DS}=V_{GS}$ , $I_D=-1700\text{ }\mu\text{A}$                                                                                      |
| Zero gate voltage drain current  | $I_{DSS}$     | -      | -0.1<br>-10 | -1<br>-100 | $\mu\text{A}$ | $V_{DS}=-60\text{ V}$ , $V_{GS}=0\text{ V}$ , $T_j=25\text{ °C}$<br>$V_{DS}=-60\text{ V}$ , $V_{GS}=0\text{ V}$ , $T_j=125\text{ °C}$ |
| Gate-source leakage current      | $I_{GSS}$     | -      | -10         | -100       | nA            | $V_{GS}=-20\text{ V}$ , $V_{DS}=0\text{ V}$                                                                                           |
| Drain-source on-state resistance | $R_{DS(on)}$  | -      | 32          | 38         | m $\Omega$    | $V_{GS}=-10\text{ V}$ , $I_D=-35\text{ A}$                                                                                            |
| Gate resistance                  | $R_G$         | -      | 5           | -          | $\Omega$      | -                                                                                                                                     |
| Transconductance                 | $g_{fs}$      | -      | 33          | -          | S             | $ V_{DS} \geq 2 I_D /R_{DS(on)max}$ , $I_D=-35\text{ A}$                                                                              |

<sup>1)</sup> See Diagram 3 for more detailed information

<sup>2)</sup> See Diagram 13 for more detailed information

<sup>3)</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            | $C_{iss}$    | -      | 2500 | -    | pF   | $V_{GS}=0\text{ V}$ , $V_{DS}=-30\text{ V}$ , $f=1\text{ MHz}$                                 |
| Output capacitance           | $C_{oss}$    | -      | 360  | -    | pF   | $V_{GS}=0\text{ V}$ , $V_{DS}=-30\text{ V}$ , $f=1\text{ MHz}$                                 |
| Reverse transfer capacitance | $C_{rss}$    | -      | 83   | -    | pF   | $V_{GS}=0\text{ V}$ , $V_{DS}=-30\text{ V}$ , $f=1\text{ MHz}$                                 |
| Turn-on delay time           | $t_{d(on)}$  | -      | 16   | -    | ns   | $V_{DD}=-30\text{ V}$ , $V_{GS}=-10\text{ V}$ , $I_D=-17.5\text{ A}$ , $R_{G,ext}=1.6\ \Omega$ |
| Rise time                    | $t_r$        | -      | 19   | -    | ns   | $V_{DD}=-30\text{ V}$ , $V_{GS}=-10\text{ V}$ , $I_D=-17.5\text{ A}$ , $R_{G,ext}=1.6\ \Omega$ |
| Turn-off delay time          | $t_{d(off)}$ | -      | 47   | -    | ns   | $V_{DD}=-30\text{ V}$ , $V_{GS}=-10\text{ V}$ , $I_D=-17.5\text{ A}$ , $R_{G,ext}=1.6\ \Omega$ |
| Fall time                    | $t_f$        | -      | 19   | -    | ns   | $V_{DD}=-30\text{ V}$ , $V_{GS}=-10\text{ V}$ , $I_D=-17.5\text{ A}$ , $R_{G,ext}=1.6\ \Omega$ |

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

| Parameter                | Symbol        | Values |      |      | Unit | Note / Test Condition                                                          |
|--------------------------|---------------|--------|------|------|------|--------------------------------------------------------------------------------|
|                          |               | Min.   | Typ. | Max. |      |                                                                                |
| Gate to source charge    | $Q_{gs}$      | -      | -14  | -    | nC   | $V_{DD}=-30\text{ V}$ , $I_D=-35\text{ A}$ , $V_{GS}=0\text{ to }-10\text{ V}$ |
| Gate charge at threshold | $Q_{g(th)}$   | -      | -8   | -    | nC   | $V_{DD}=-30\text{ V}$ , $I_D=-35\text{ A}$ , $V_{GS}=0\text{ to }-10\text{ V}$ |
| Gate to drain charge     | $Q_{gd}$      | -      | -24  | -    | nC   | $V_{DD}=-30\text{ V}$ , $I_D=-35\text{ A}$ , $V_{GS}=0\text{ to }-10\text{ V}$ |
| Switching charge         | $Q_{sw}$      | -      | -30  | -    | nC   | $V_{DD}=-30\text{ V}$ , $I_D=-35\text{ A}$ , $V_{GS}=0\text{ to }-10\text{ V}$ |
| Gate charge total        | $Q_g$         | -      | -63  | -    | nC   | $V_{DD}=-30\text{ V}$ , $I_D=-35\text{ A}$ , $V_{GS}=0\text{ to }-10\text{ V}$ |
| Gate plateau voltage     | $V_{plateau}$ | -      | -5.5 | -    | V    | $V_{DD}=-30\text{ V}$ , $I_D=-35\text{ A}$ , $V_{GS}=0\text{ to }-10\text{ V}$ |
| Output charge            | $Q_{oss}$     | -      | -28  | -    | nC   | $V_{DD}=-30\text{ V}$ , $V_{GS}=0\text{ V}$                                    |

**Table 7 Reverse diode**

| Parameter                        | Symbol        | Values |      |      | Unit | Note / Test Condition                                                         |
|----------------------------------|---------------|--------|------|------|------|-------------------------------------------------------------------------------|
|                                  |               | Min.   | Typ. | Max. |      |                                                                               |
| Diode continuous forward current | $I_S$         | -      | -    | -35  | A    | $T_C=25\text{ °C}$                                                            |
| Diode pulse current              | $I_{S,pulse}$ | -      | -    | -140 | A    | $T_C=25\text{ °C}$                                                            |
| Diode forward voltage            | $V_{SD}$      | -      | -0.9 | -1.2 | V    | $V_{GS}=0\text{ V}$ , $I_F=-35\text{ A}$ , $T_J=25\text{ °C}$                 |
| Reverse recovery time            | $t_{rr}$      | -      | 63   | -    | ns   | $V_R=-30\text{ V}$ , $I_F=-37\text{ A}$ , $di_F/dt=-100\text{ A}/\mu\text{s}$ |
| Reverse recovery charge          | $Q_{rr}$      | -      | 192  | -    | nC   | $V_R=-30\text{ V}$ , $I_F=-37\text{ A}$ , $di_F/dt=-100\text{ A}/\mu\text{s}$ |

<sup>1)</sup> See diagram „Gate charge waveform, for gate charge parameter definition

## 4 Electrical characteristics diagrams

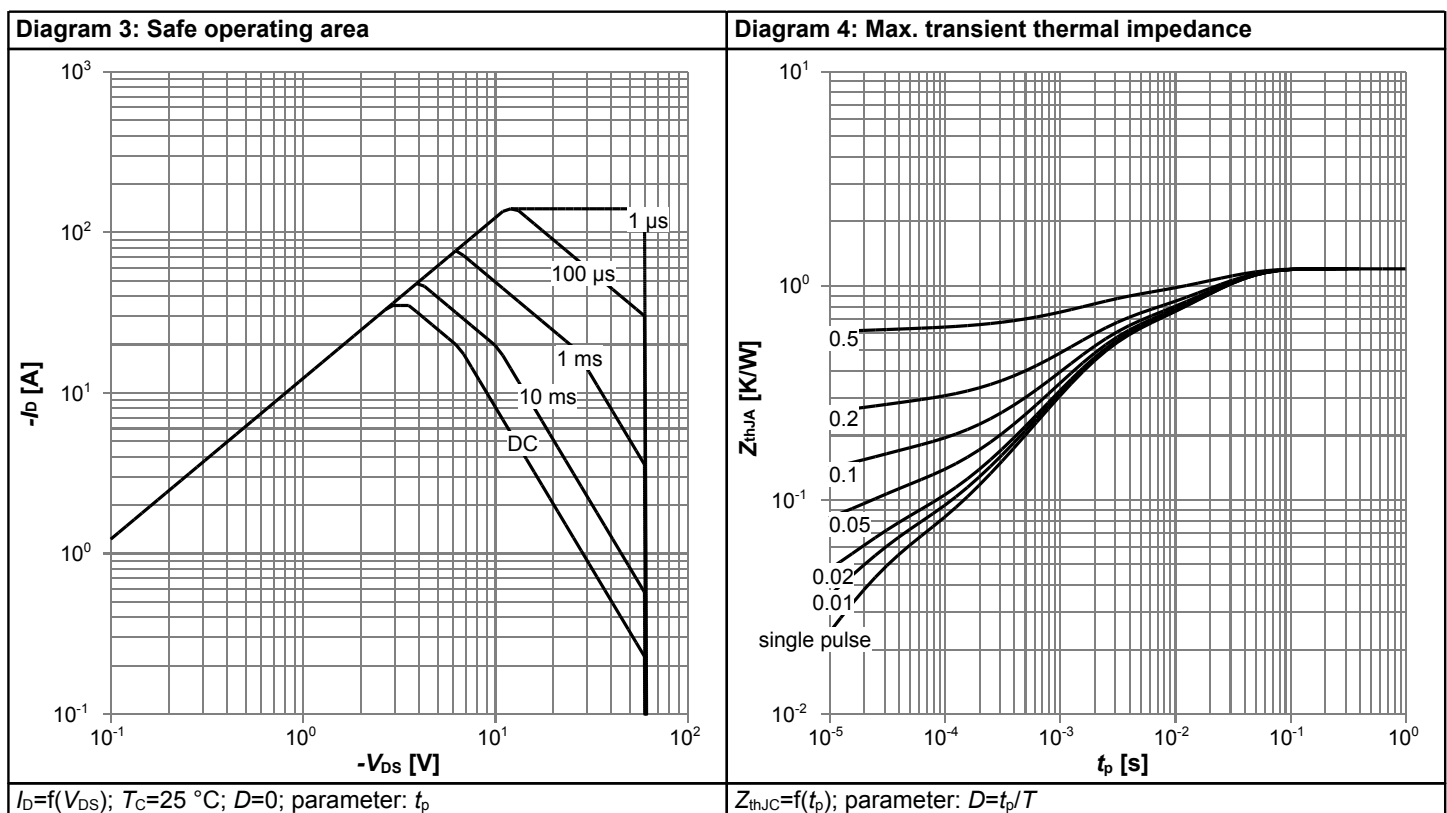
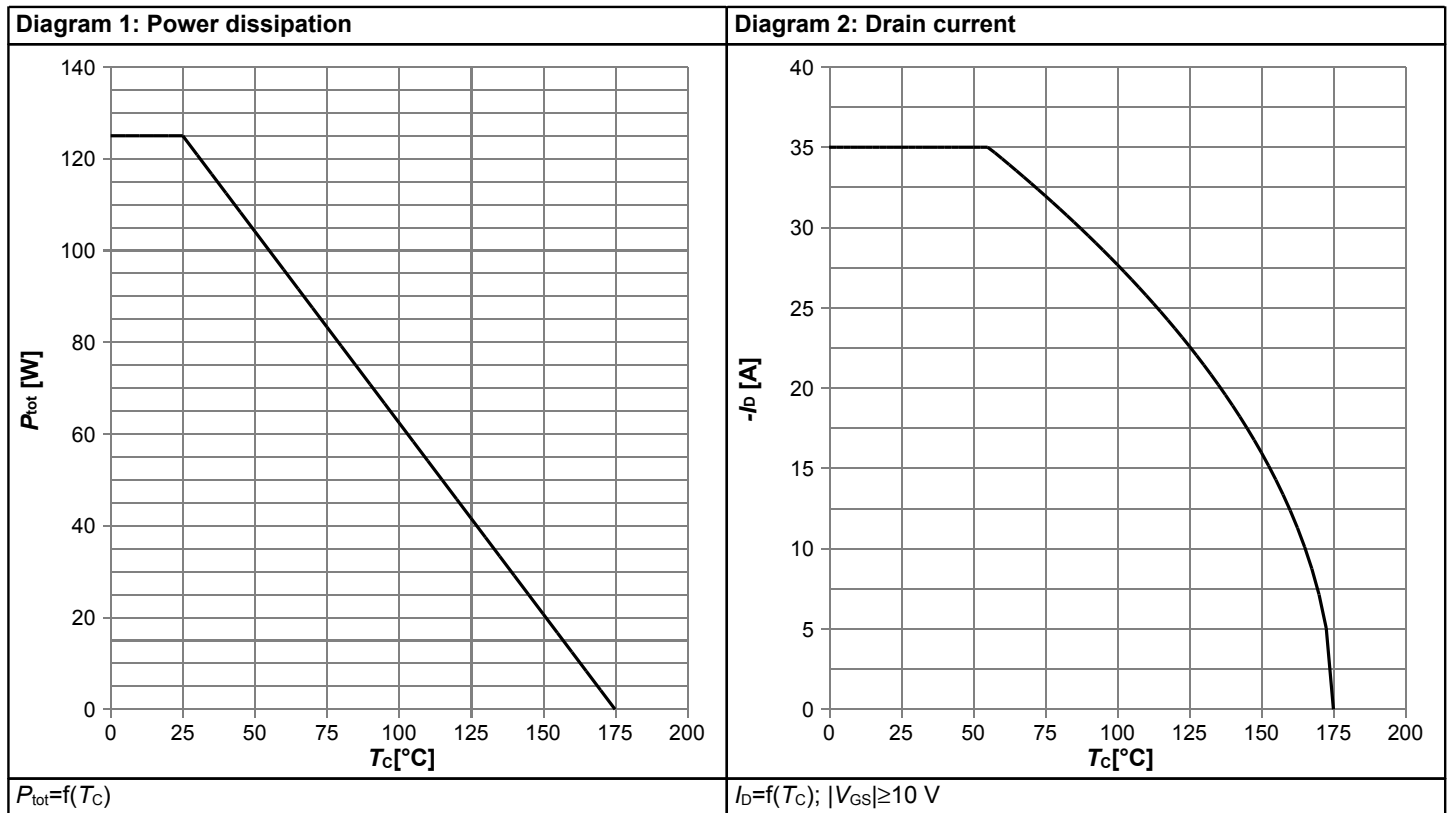
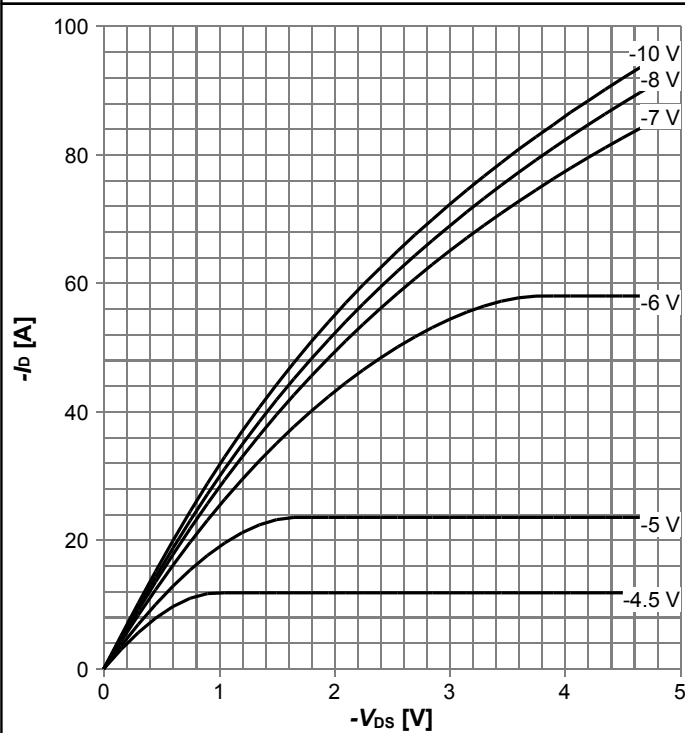
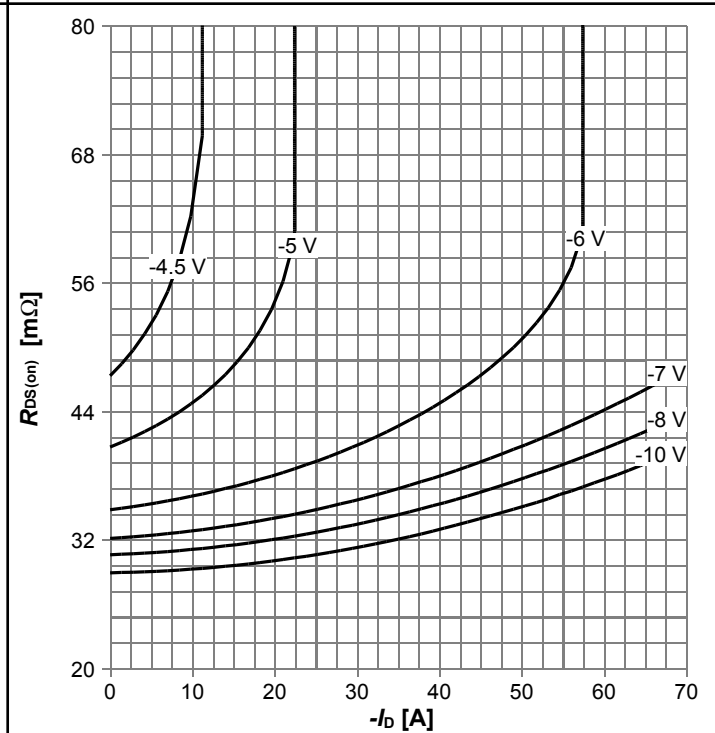


Diagram 5: Typ. output characteristics



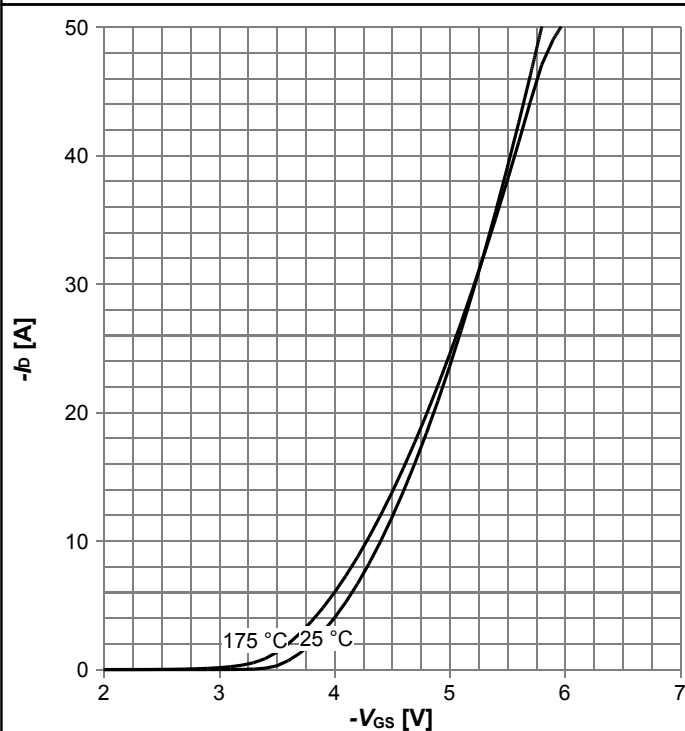
$I_D = f(V_{DS})$ ,  $T_j = 25^\circ\text{C}$ ; parameter:  $V_{GS}$

Diagram 6: Typ. drain-source on resistance



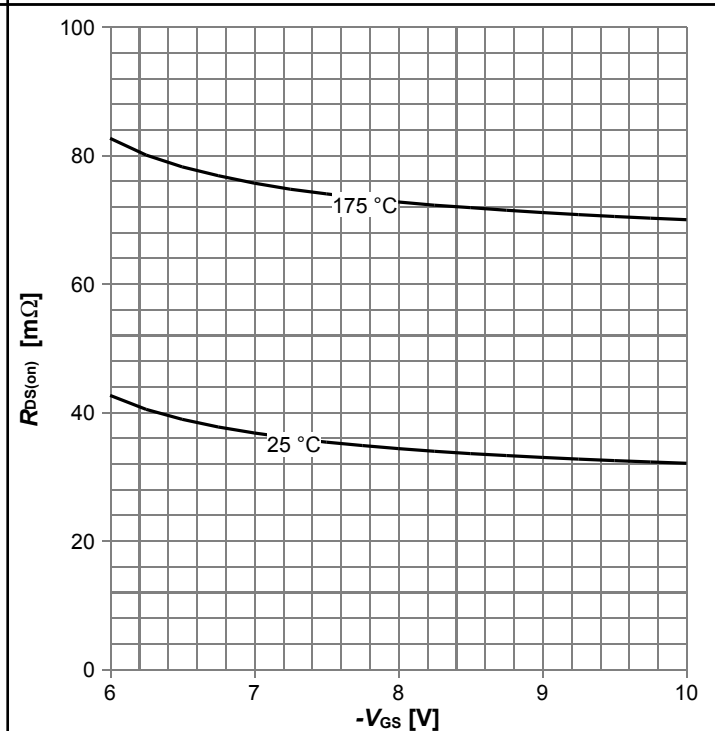
$R_{DS(on)} = f(I_D)$ ,  $T_j = 25^\circ\text{C}$ ; parameter:  $V_{GS}$

Diagram 7: Typ. transfer characteristics



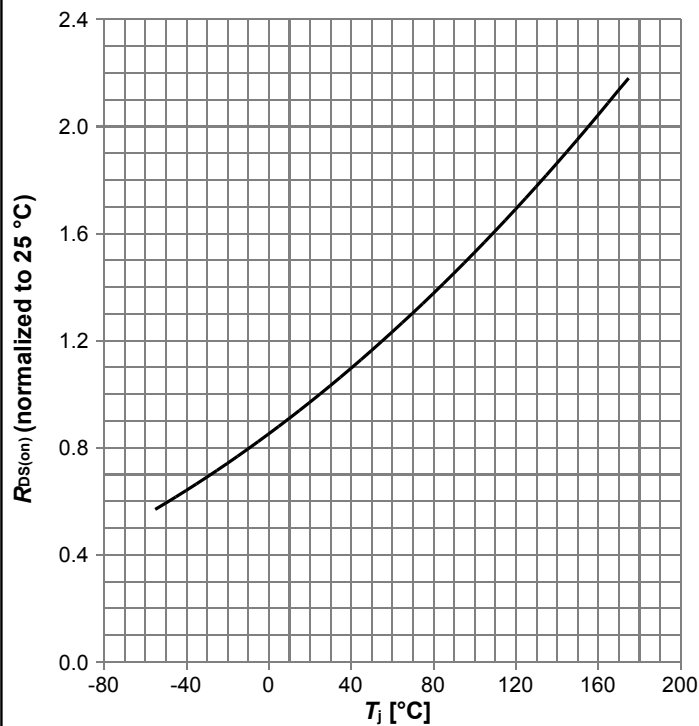
$I_D = f(V_{GS})$ ,  $|V_{DS}| > 2|I_D|R_{DS(on)\text{max}}$ ; parameter:  $T_j$

Diagram 8: Typ. drain-source on resistance



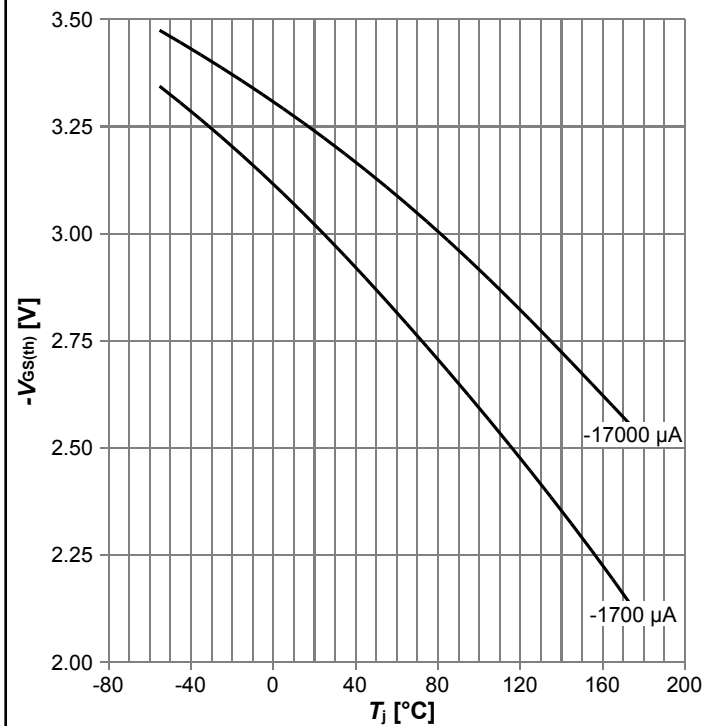
$R_{DS(on)} = f(V_{GS})$ ,  $I_D = -35\text{ A}$ ; parameter:  $T_j$

Diagram 9: Normalized drain-source on resistance



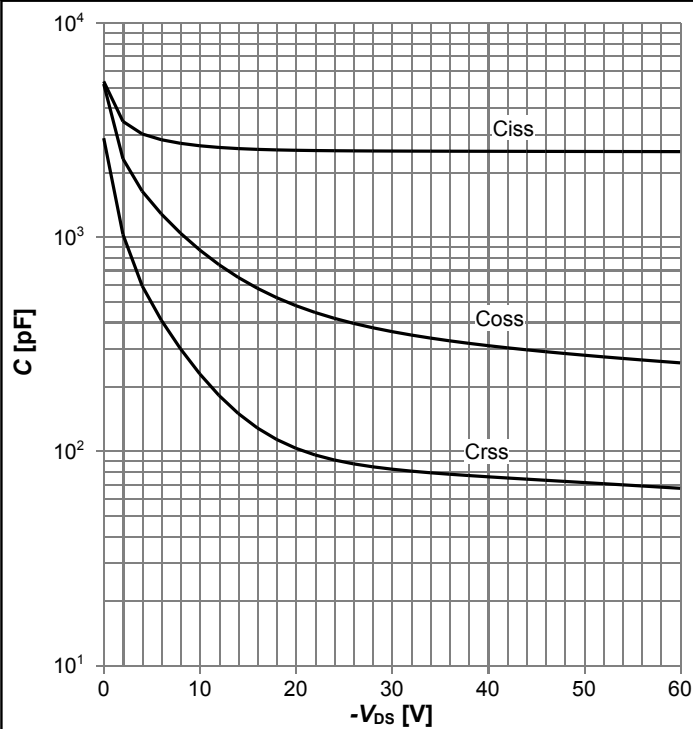
$$R_{DS(on)} = f(T_j), I_D = -35 \text{ A}, V_{GS} = -10 \text{ V}$$

Diagram 10: Typ. gate threshold voltage



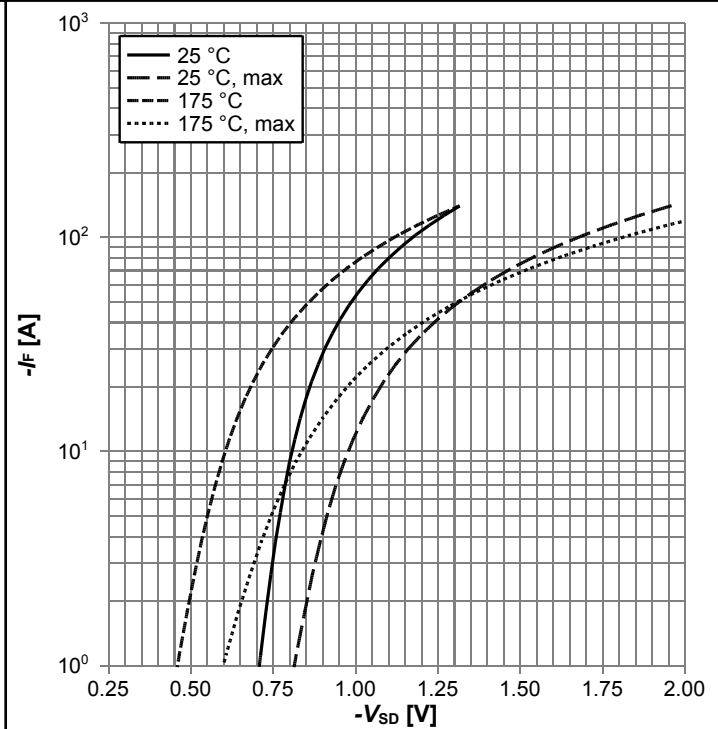
$$V_{GS(th)} = f(T_j), V_{GS} = V_{DS}; \text{ parameter: } I_D$$

Diagram 11: Typ. capacitances



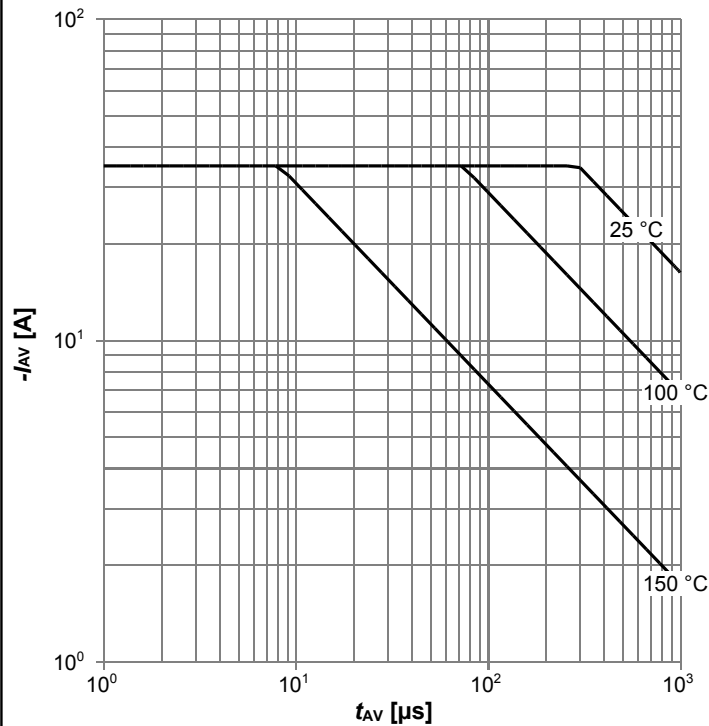
$$C = f(V_{DS}); V_{GS} = 0 \text{ V}; f = 1 \text{ MHz}$$

Diagram 12: Forward characteristics of reverse diode



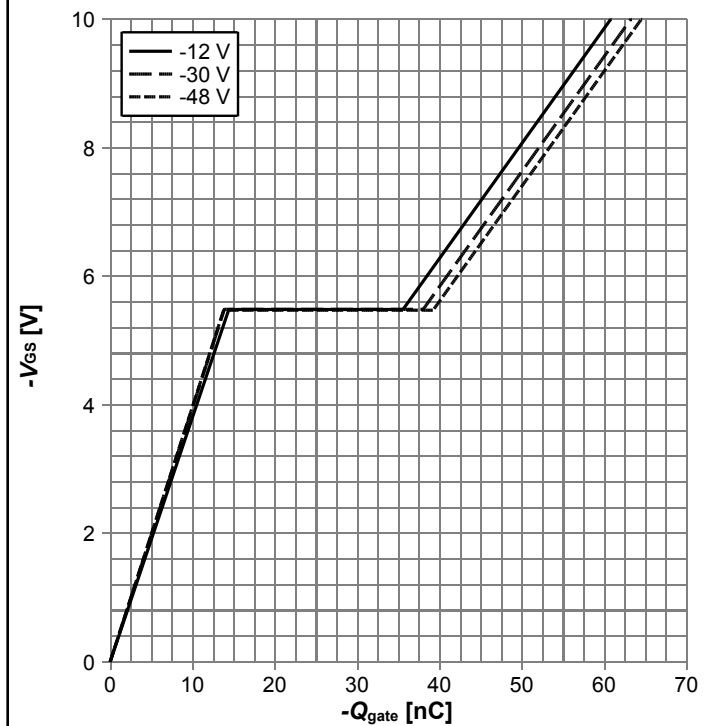
$$I_F = f(V_{SD}); \text{ parameter: } T_j$$

Diagram 13: Avalanche characteristics



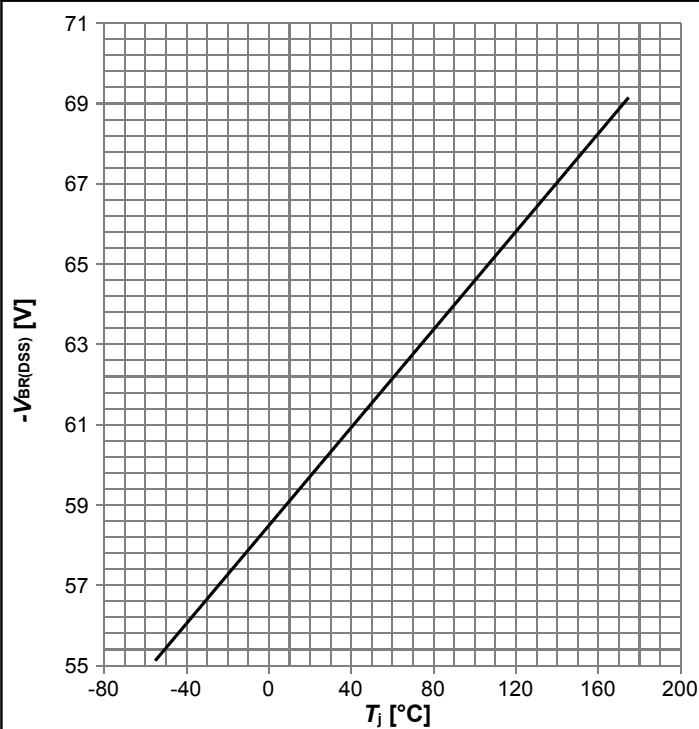
$I_{AS}=f(t_{AV})$ ;  $R_{GS}=25\ \Omega$ ; parameter:  $T_{j,start}$

Diagram 14: Typ. gate charge



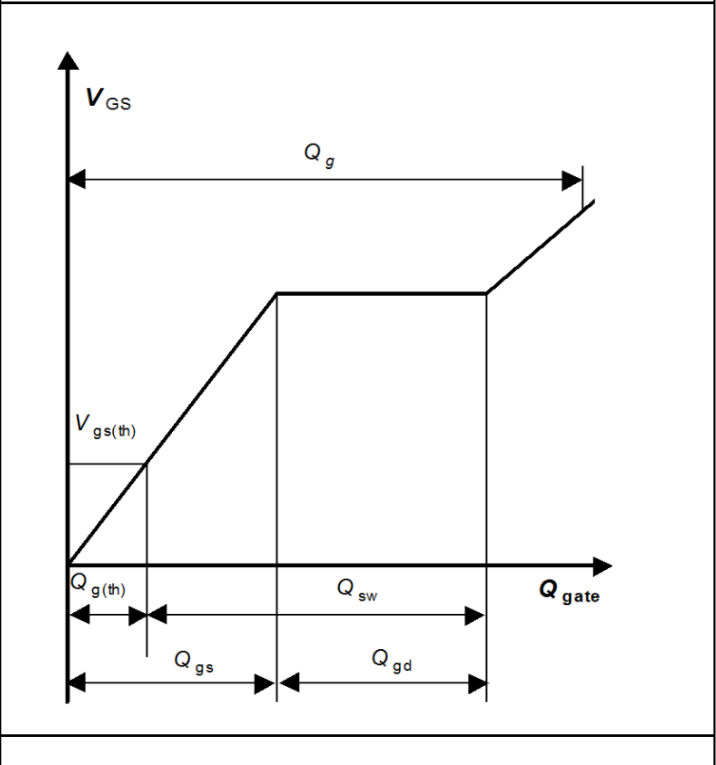
$V_{GS}=f(Q_{gate})$ ,  $I_D=-35\text{ A}$  pulsed,  $T_j=25\text{ °C}$ ; parameter:  $V_{DD}$

Diagram 15: Drain-source breakdown voltage



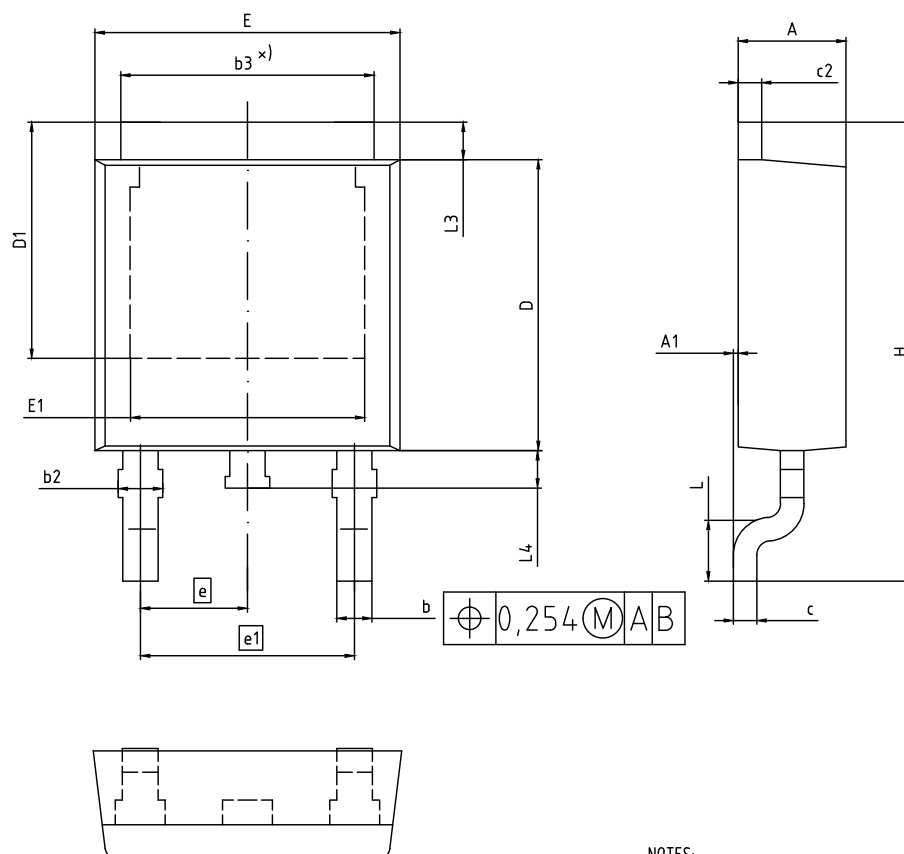
$V_{BR(DSS)}=f(T_j)$ ;  $I_D=-250\ \mu\text{A}$

Diagram Gate charge waveforms





## 5 Package Outlines



### NOTES:

1. INDUSTRIAL QUALITY GRADE
2. ALL DIMENSIONS REFER TO JEDEC STANDARD TO-252 DO NOT INCLUDE MOLD FLASH OR PROTRUSIONS.

| DIM | MILLIMETERS |       | INCHES      |       |
|-----|-------------|-------|-------------|-------|
|     | MIN         | MAX   | MIN         | MAX   |
| A   | 2.16        | 2.41  | 0.085       | 0.095 |
| A1  | 0.00        | 0.15  | 0.000       | 0.006 |
| b   | 0.64        | 0.89  | 0.025       | 0.035 |
| b2  | 0.65        | 1.15  | 0.026       | 0.045 |
| b3  | 4.95        | 5.50  | 0.195       | 0.217 |
| c   | 0.46        | 0.61  | 0.018       | 0.024 |
| c2  | 0.40        | 0.98  | 0.016       | 0.039 |
| D   | 5.97        | 6.22  | 0.235       | 0.245 |
| D1  | 5.02        | 5.84  | 0.198       | 0.230 |
| E   | 6.35        | 6.73  | 0.250       | 0.265 |
| E1  | 4.32        | 5.21  | 0.185       | 0.205 |
| e   | 2.29 (BSC)  |       | 0.090 (BSC) |       |
| e1  | 4.57 (BSC)  |       | 0.180 (BSC) |       |
| N   | 3           |       | 3           |       |
| H   | 9.40        | 10.48 | 0.370       | 0.413 |
| L   | 1.18        | 1.78  | 0.046       | 0.070 |
| L3  | 0.89        | 1.27  | 0.035       | 0.050 |
| L4  | 0.51        | 1.02  | 0.020       | 0.040 |

|                             |
|-----------------------------|
| DOCUMENT NO.<br>Z8B00003328 |
| SCALE<br>0 2.5 5mm          |
| EUROPEAN PROJECTION<br>     |
| ISSUE DATE<br>05-02-2016    |
| REVISION<br>06              |

Figure 1 Outline PG-TO 252-3, dimensions in mm/inches

## Revision History

IPD380P06NM

**Revision: 2019-03-28, Rev. 2.0**

Previous Revision

| Revision | Date       | Subjects (major changes since last revision) |
|----------|------------|----------------------------------------------|
| 2.0      | 2019-03-28 | Release of final version                     |

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