

# MOSFET

## OptiMOS™6 Power-Transistor, 40 V

### Features

- Optimized for low voltage motor drives application
- Optimized for battery power applications
- Very low on-resistance  $R_{DS(on)}$
- 100% avalanche tested
- Superior thermal performance
- N-channel
- Pb-free lead plating : RoHS compliant
- Halogen-free according to IEC61249-2-21
- 175°C rated

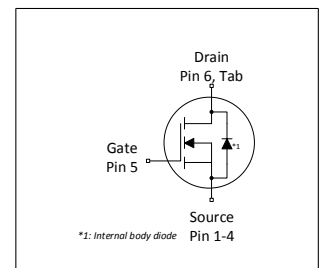


### Product validation

Fully qualified according to JEDEC for Industrial Applications

**Table 1 Key Performance Parameters**

| Parameter        | Value | Unit |
|------------------|-------|------|
| $V_{DS}$         | 40    | V    |
| $R_{DS(on),max}$ | 0.7   | mΩ   |
| $I_D$            | 440   | A    |
| $Q_{oss}$        | 122   | nC   |
| $Q_G(0V..10V)$   | 114   | nC   |



RoHS

| Type / Ordering Code | Package | Marking | Related Links |
|----------------------|---------|---------|---------------|
| IST007N04NM6         | sTOLL   | 7N04N6  | -             |

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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>       | $I_D$          | -      | -    | 440<br>311<br>54 | 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>           | $I_{D,pulse}$  | -      | -    | 1760             | A    | $T_C=25\text{ °C}$                                                                                                                                                       |
| Avalanche energy, single pulse <sup>4)</sup> | $E_{AS}$       | -      | -    | 400              | mJ   | $I_D=125\text{ A}$ , $R_{GS}=25\text{ }\Omega$                                                                                                                           |
| Gate source voltage                          | $V_{GS}$       | -20    | -    | 20               | V    | -                                                                                                                                                                        |
| Power dissipation                            | $P_{tot}$      | -      | -    | 250<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   | IEC climatic category; DIN IEC 68-1:<br>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                                          | $R_{thJC}$ | -      | -    | 0.6  | °C/W | -                     |
| Thermal resistance, junction - ambient, 6 cm <sup>2</sup> cooling area <sup>2)</sup> | $R_{thJA}$ | -      | -    | 40   | °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 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    | -          | 3.3      | V             | $V_{DS}=V_{GS}$ , $I_D=250\text{ }\mu\text{A}$                                                                                      |
| Zero gate voltage drain current  | $I_{DSS}$     | -      | -          | 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      | $I_{GSS}$     | -      | -          | 100      | nA            | $V_{GS}=20\text{ V}$ , $V_{DS}=0\text{ V}$                                                                                          |
| Drain-source on-state resistance | $R_{DS(on)}$  | -      | 0.5<br>0.7 | 0.7<br>- | 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                  | $R_G$         | -      | 0.9        | -        | $\Omega$      | -                                                                                                                                   |
| Transconductance                 | $g_{fs}$      | -      | 320        | -        | 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            | $C_{iss}$    | -      | 7900 | -    | pF   | $V_{GS}=0\text{ V}$ , $V_{DS}=20\text{ V}$ , $f=1\text{ MHz}$                                       |
| Output capacitance           | $C_{oss}$    | -      | 3200 | -    | pF   | $V_{GS}=0\text{ V}$ , $V_{DS}=20\text{ V}$ , $f=1\text{ MHz}$                                       |
| Reverse transfer capacitance | $C_{rss}$    | -      | 150  | -    | pF   | $V_{GS}=0\text{ V}$ , $V_{DS}=20\text{ V}$ , $f=1\text{ MHz}$                                       |
| Turn-on delay time           | $t_{d(on)}$  | -      | 23   | -    | ns   | $V_{DD}=20\text{ V}$ , $V_{GS}=10\text{ V}$ , $I_D=100\text{ A}$ ,<br>$R_{G,ext}=2.7\text{ }\Omega$ |
| Rise time                    | $t_r$        | -      | 23   | -    | ns   | $V_{DD}=20\text{ V}$ , $V_{GS}=10\text{ V}$ , $I_D=100\text{ A}$ ,<br>$R_{G,ext}=2.7\text{ }\Omega$ |
| Turn-off delay time          | $t_{d(off)}$ | -      | 48   | -    | ns   | $V_{DD}=20\text{ V}$ , $V_{GS}=10\text{ V}$ , $I_D=100\text{ A}$ ,<br>$R_{G,ext}=2.7\text{ }\Omega$ |
| Fall time                    | $t_f$        | -      | 14   | -    | ns   | $V_{DD}=20\text{ V}$ , $V_{GS}=10\text{ V}$ , $I_D=100\text{ A}$ ,<br>$R_{G,ext}=2.7\text{ }\Omega$ |

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

| Parameter                    | Symbol        | Values |      |      | Unit | Note / Test Condition                                                        |
|------------------------------|---------------|--------|------|------|------|------------------------------------------------------------------------------|
|                              |               | Min.   | Typ. | Max. |      |                                                                              |
| Gate to source charge        | $Q_{gs}$      | -      | 32   | -    | nC   | $V_{DD}=20\text{ V}$ , $I_D=100\text{ A}$ , $V_{GS}=0\text{ to }10\text{ V}$ |
| Gate charge at threshold     | $Q_{g(th)}$   | -      | 18   | -    | 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             | $Q_{sw}$      | -      | 33   | -    | nC   | $V_{DD}=20\text{ V}$ , $I_D=100\text{ A}$ , $V_{GS}=0\text{ to }10\text{ V}$ |
| Gate charge total            | $Q_g$         | -      | 114  | 152  | 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    | -    | 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   | -    | -    | $V_{DS}=0.1\text{ V}$ , $V_{GS}=0\text{ to }10\text{ V}$                     |
| Output charge                | $Q_{oss}$     | -      | 122  | -    | -    | $V_{DS}=20\text{ V}$ , $V_{GS}=0\text{ V}$                                   |

<sup>1)</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 | $I_S$         | -      | -    | 250  | A    | $T_C=25\text{ °C}$                                                          |
| Diode pulse current              | $I_{S,pulse}$ | -      | -    | 1760 | A    | $T_C=25\text{ °C}$                                                          |
| Diode forward voltage            | $V_{SD}$      | -      | 0.83 | 1    | V    | $V_{GS}=0\text{ V}$ , $I_F=100\text{ A}$ , $T_J=25\text{ °C}$               |
| Reverse recovery time            | $t_{rr}$      | -      | 61   | -    | ns   | $V_R=20\text{ V}$ , $I_F=100\text{ A}$ , $di_F/dt=100\text{ A}/\mu\text{s}$ |
| Reverse recovery charge          | $Q_{rr}$      | -      | 90   | -    | nC   | $V_R=20\text{ V}$ , $I_F=100\text{ A}$ , $di_F/dt=100\text{ A}/\mu\text{s}$ |

## 4 Electrical characteristics diagrams

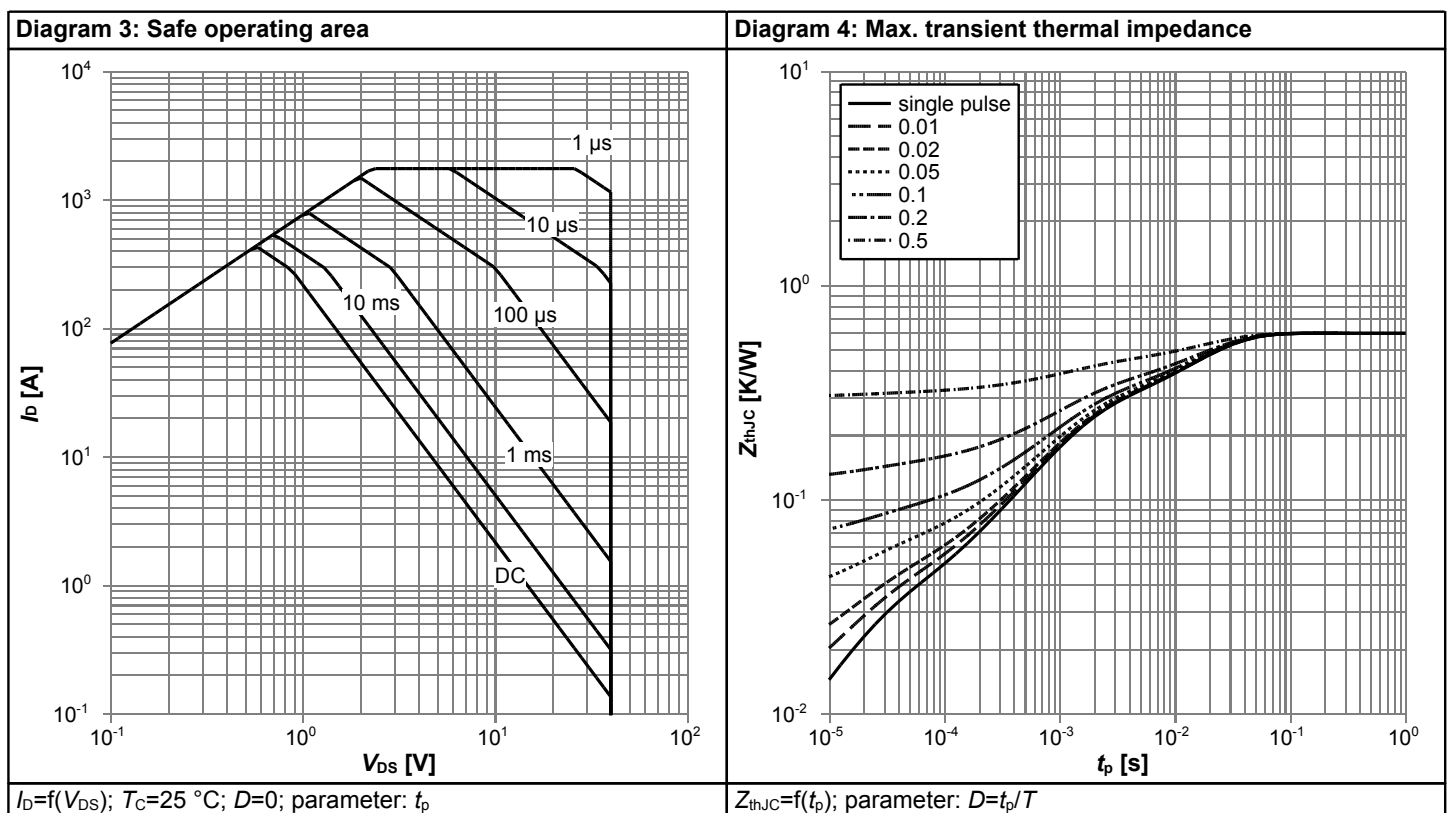
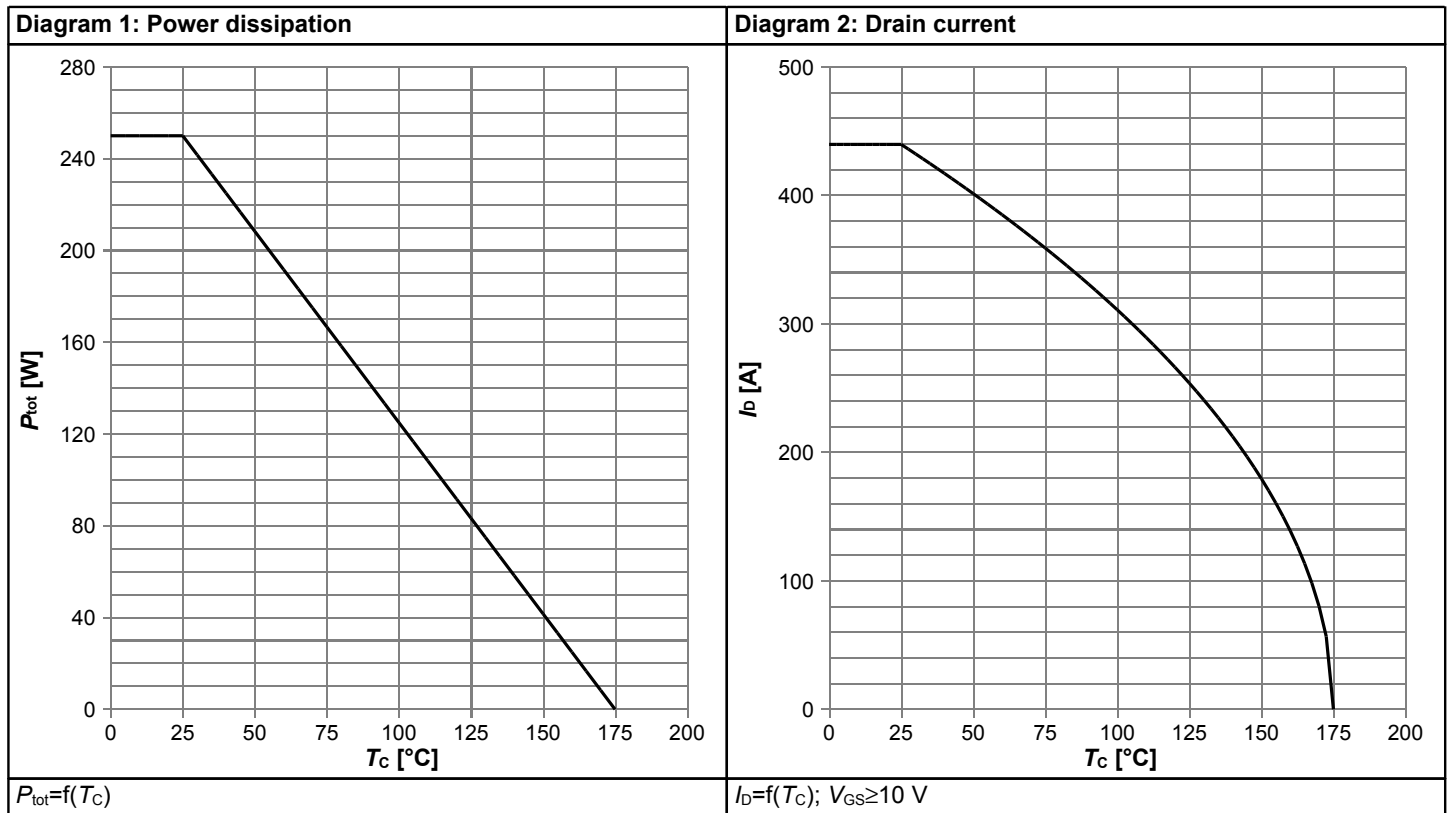
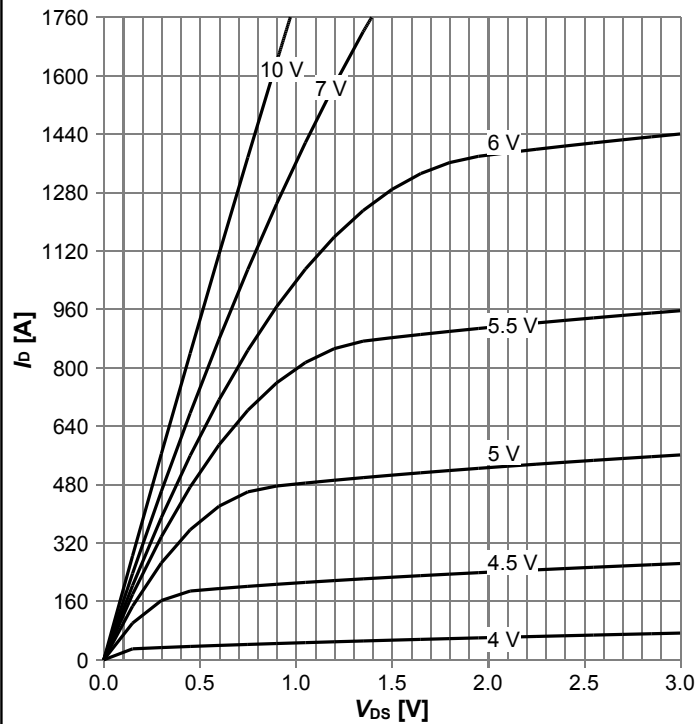
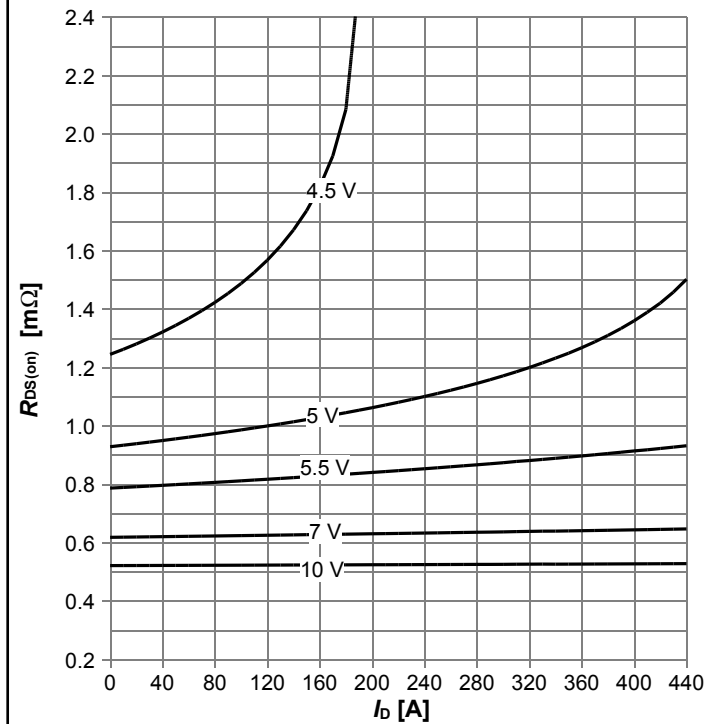


Diagram 5: Typ. output characteristics



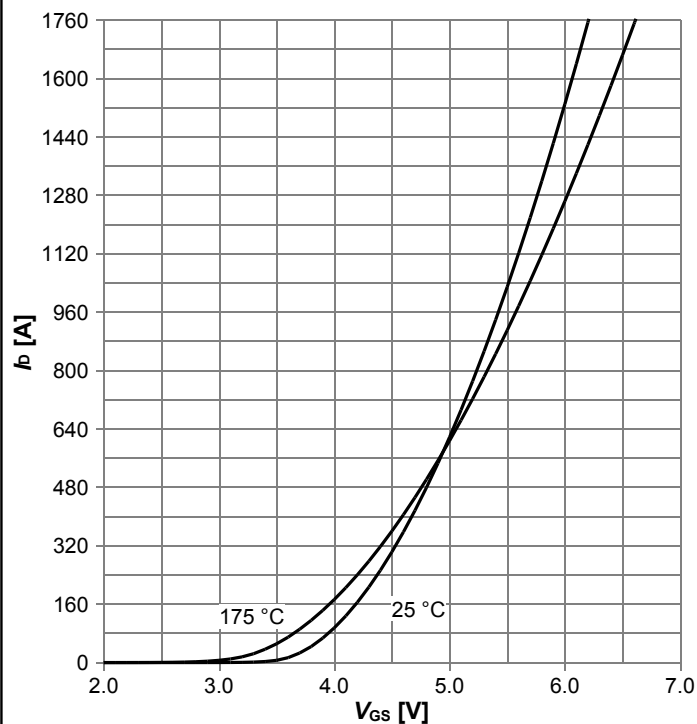
$I_D = f(V_{DS})$ ,  $T_j = 25^\circ\text{C}$ ; parameter:  $V_{GS}$

Diagram 6: Typ. drain-source on resistance



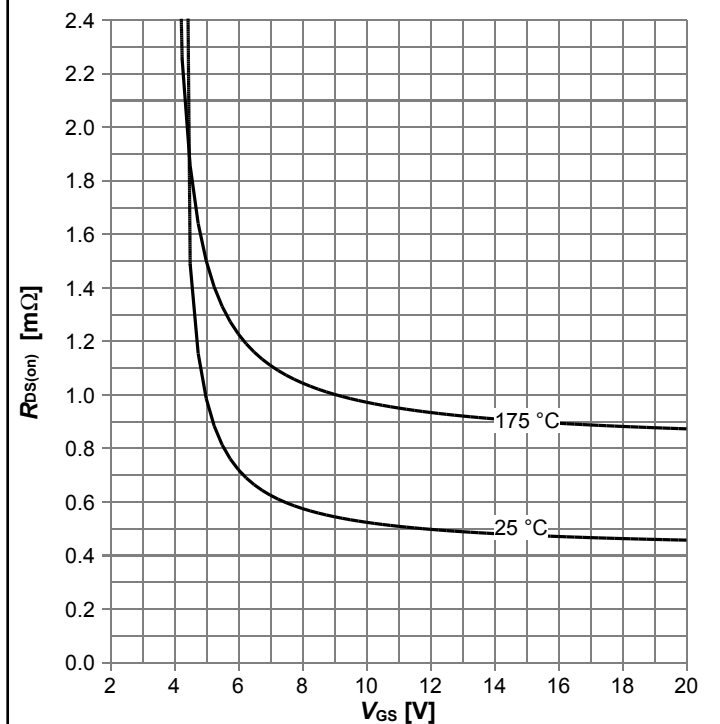
$R_{DS(on)} = f(I_D)$ ,  $T_j = 25^\circ\text{C}$ ; parameter:  $V_{GS}$

Diagram 7: Typ. transfer characteristics



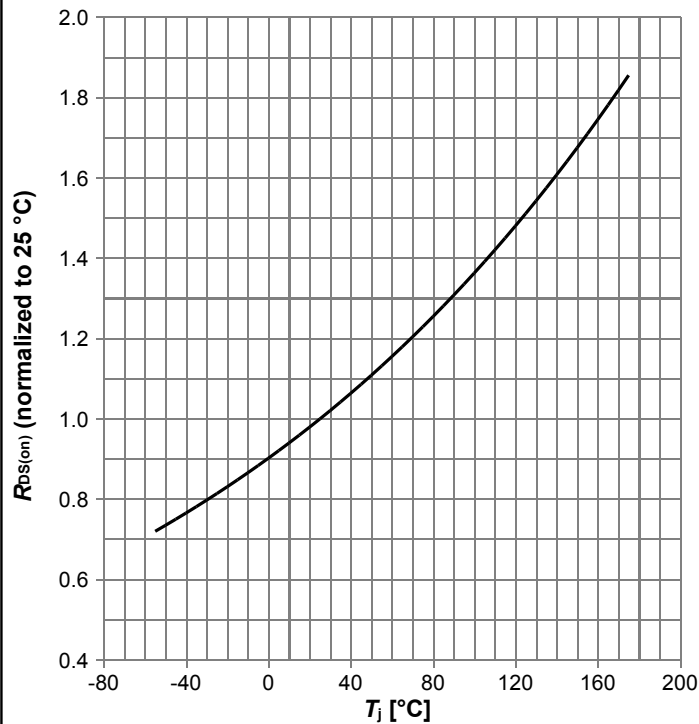
$I_D = f(V_{GS})$ ,  $|V_{DS}| > 2|I_D|R_{DS(on)\max}$ ; parameter:  $T_j$

Diagram 8: Typ. drain-source on resistance



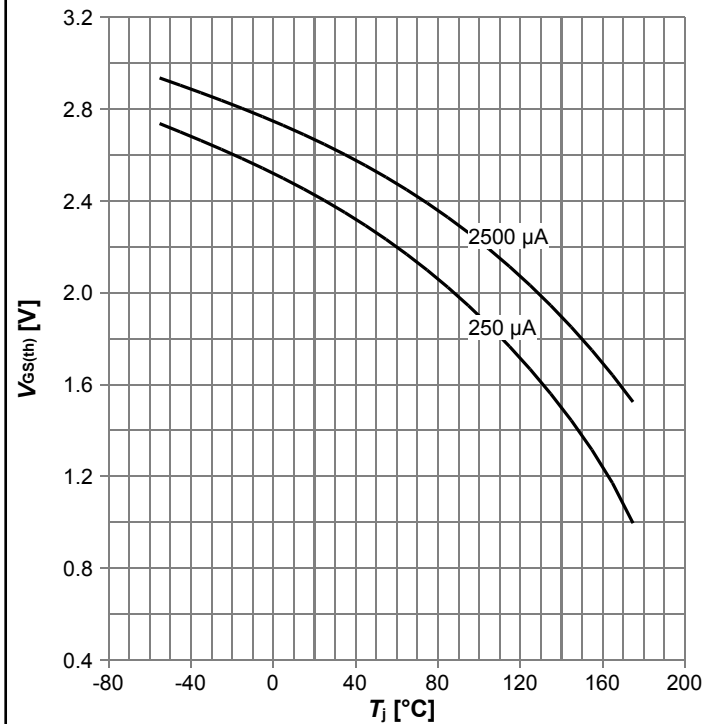
$R_{DS(on)} = f(V_{GS})$ ,  $I_D = 100\text{ A}$ ; parameter:  $T_j$

Diagram 9: Normalized drain-source on resistance



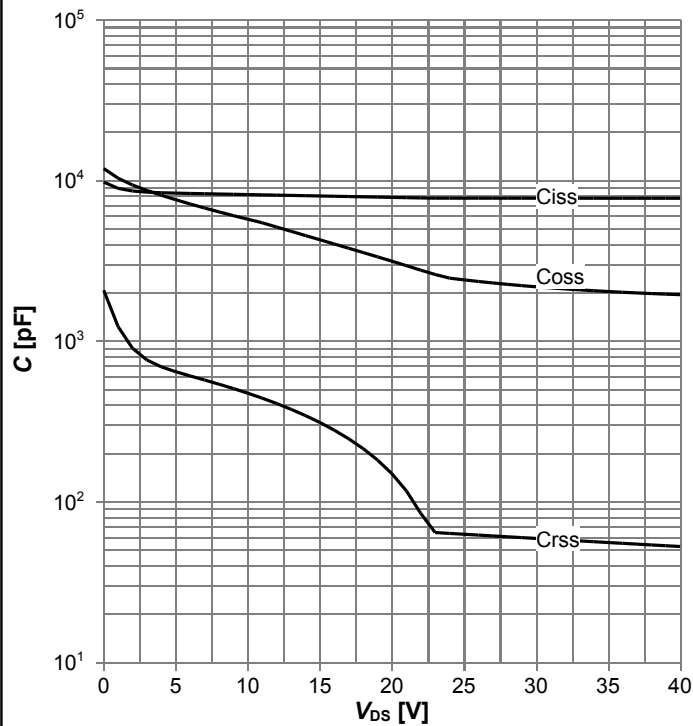
$R_{DS(on)} = f(T_j)$ ,  $I_D = 100$  A,  $V_{GS} = 10$  V

Diagram 10: Typ. gate threshold voltage



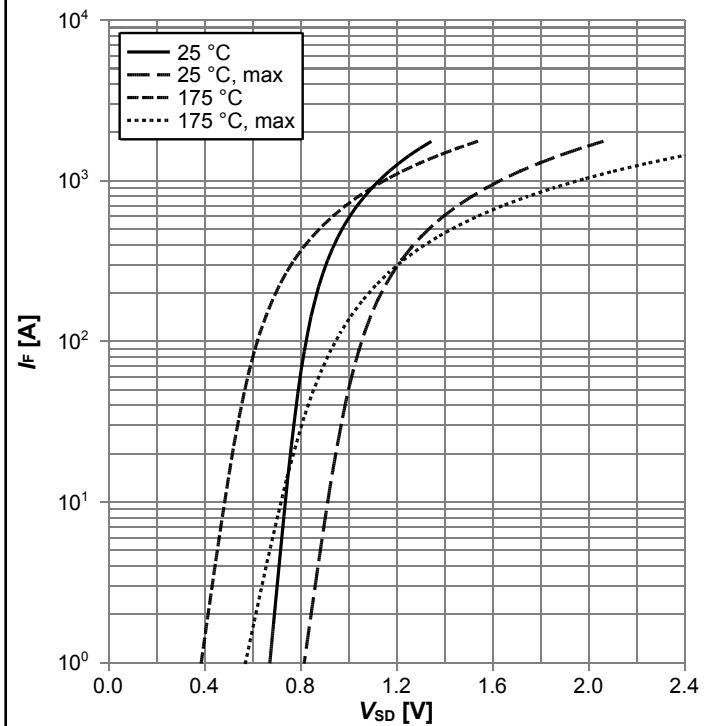
$V_{GS(th)} = f(T_j)$ ,  $V_{GS} = V_{DS}$ ; parameter:  $I_D$

Diagram 11: Typ. capacitances



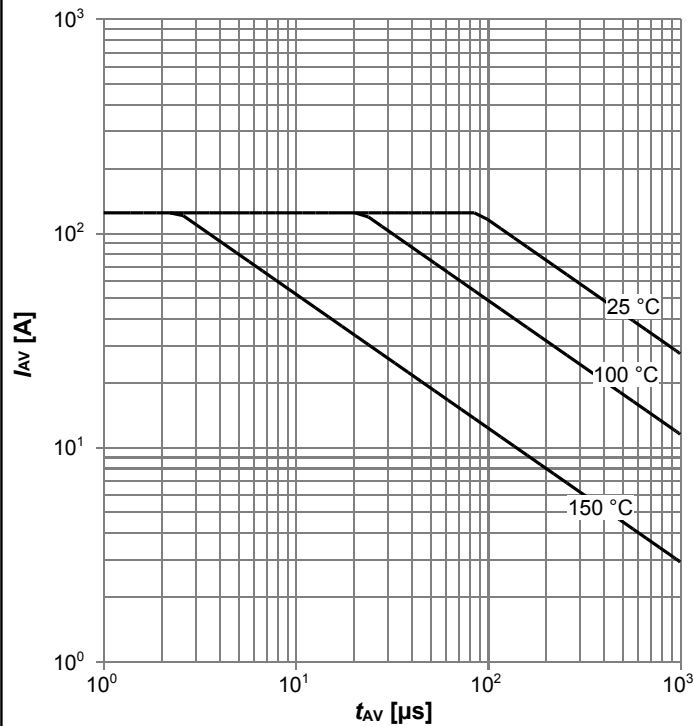
$C = f(V_{DS})$ ;  $V_{GS} = 0$  V;  $f = 1$  MHz

Diagram 12: Forward characteristics of reverse diode



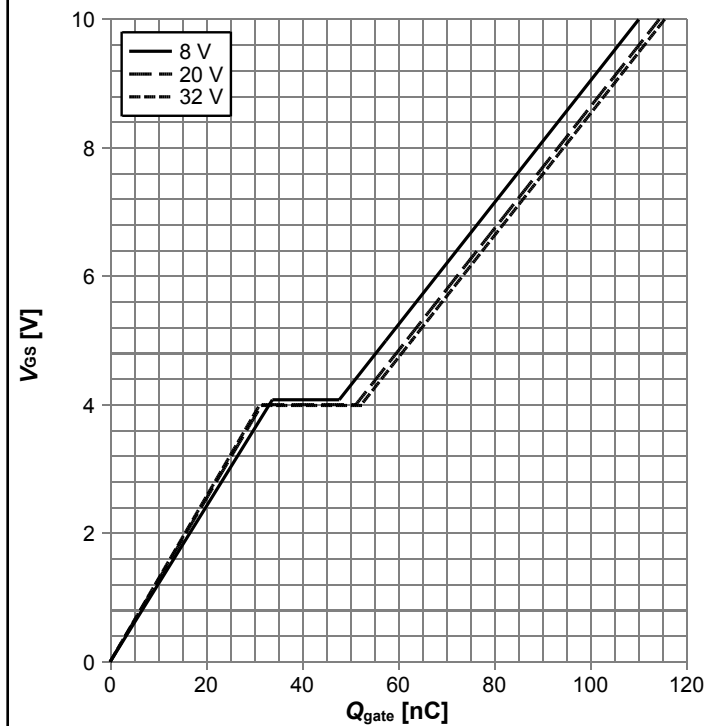
$I_F = f(V_{SD})$ ; parameter:  $T_j$

Diagram 13: Avalanche characteristics



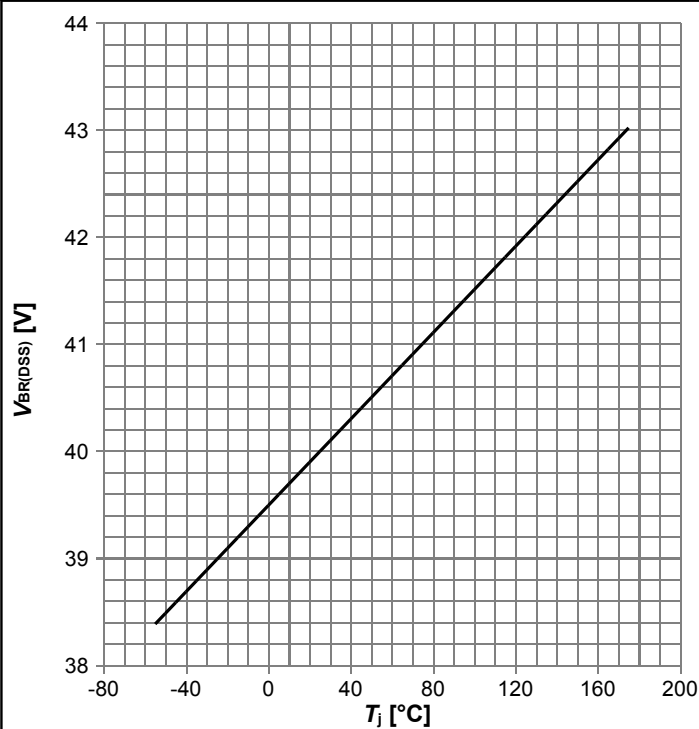
$I_{AS}=f(t_{AV})$ ;  $R_{GS}=25\ \Omega$ ; parameter:  $T_{j,start}$

Diagram 14: Typ. gate charge



$V_{GS}=f(Q_{gate})$ ,  $I_D=100\text{ A}$  pulsed,  $T_j=25\text{ °C}$ ; parameter:  $V_{DD}$

Diagram 15: Drain-source breakdown voltage

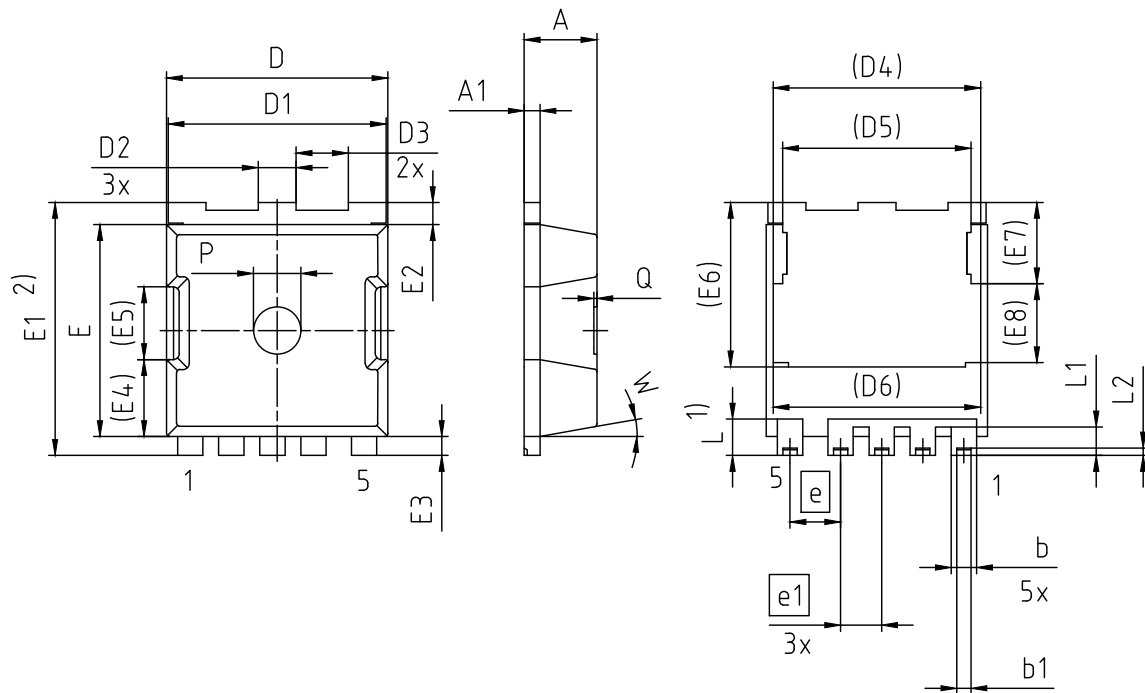


$V_{BR(DSS)}=f(T_j)$ ;  $I_D=1\text{ mA}$

Diagram Gate charge waveforms



## 5 Package Outlines



- 1) LEAD LENGTH UP TO ANTI FLASH PROFILE, MOLD FLASHES EXCLUDED.  
2) EXCLUDING BURR

| DIMENSION | MILLIMETERS |        |
|-----------|-------------|--------|
|           | MIN.        | MAX.   |
| A         | 2.20        | 2.40   |
| A1        | 0.40        | 0.60   |
| b         | 0.70        | 0.90   |
| b1        | 0.42        | 0.50   |
| D         | 6.80        | 7.20   |
| D1        | 6.80        | 7.00   |
| D2        | 1.10        | 1.30   |
| D3        | 1.55        | 1.75   |
| D4        | 6.56        |        |
| D5        | 5.96        |        |
| D6        | 5.60        |        |
| E         | 6.50        | 6.90   |
| E1        | 7.80        | 8.20   |
| E2        | 0.60        | 0.80   |
| E3        | 0.50        | 0.70   |
| E4        | 2.43        |        |
| E5        | 2.30        |        |
| E6        | 5.20        |        |
| E7        | 2.57        |        |
| E8        | 2.50        |        |
| e         | 1.60        |        |
| e1        | 1.30        |        |
| L         | 1.05        | 1.25   |
| L1        | 0.80        | 1.00   |
| L2        | 0.13        | 0.33   |
| P         | 1.40        | 1.60   |
| Q         | 0.00        | 0.10   |
| W         | 8.50°       | 11.50° |

|                                     |
|-------------------------------------|
| <b>DOCUMENT NO.</b><br>Z8B000195632 |
| <b>REVISION</b><br>01               |
| <b>SCALE</b> 5:1<br>0 1 2 3 4 5mm   |
| <b>EUROPEAN PROJECTION</b><br>      |
| <b>ISSUE DATE</b><br>11.06.2019     |

Figure 1 Outline sTOLL, dimensions in mm

## Revision History

IST007N04NM6

**Revision: 2020-06-18, Rev. 2.0**

Previous Revision

| Revision | Date       | Subjects (major changes since last revision) |
|----------|------------|----------------------------------------------|
| 1.0      | 2020-04-27 | Release of preliminary version               |
| 2.0      | 2020-06-18 | Release of final version                     |

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