

MOSFET

OptiMOS™ 5 Power-Transistor, 40 V

Features

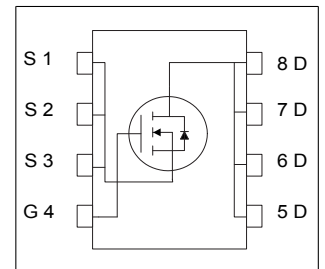
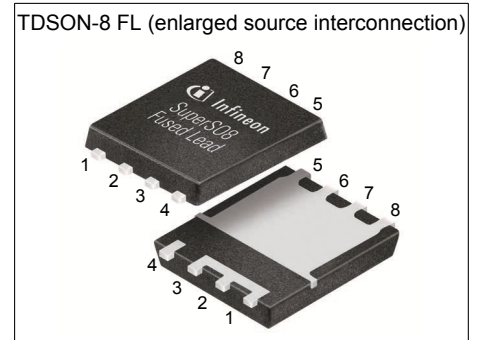
- Battery powered application
- LV motor drives
- Very low on-resistance $R_{DS(on)}$
- 100% avalanche tested
- Superior thermal resistance
- N-channel
- Pb-free lead plating; RoHS compliant
- Halogen-free according to IEC61249-2-21
- 175 °C rated

Product validation

Fully qualified according to JEDEC for Industrial Applications

Table 1 Key Performance Parameters

| Parameter | Value | Unit |
|------------------|-------|------|
| V_{DS} | 40 | V |
| $R_{DS(on),max}$ | 4.6 | mΩ |
| I_D | 77 | A |
| Q_{oss} | 17 | nC |
| $Q_G(0V..10V)$ | 16 | nC |



| Type / Ordering Code | Package | Marking | Related Links |
|----------------------|------------|----------|---------------|
| ISC046N04NM5 | TDSON-8 FL | 46N04NM5 | - |

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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 ¹⁾ | I_D | - | - | 77 55 69 49 19 | A | $V_{GS}=10\text{ V}$, $T_C=25\text{ °C}$ $V_{GS}=10\text{ V}$, $T_C=100\text{ °C}$ $V_{GS}=7\text{ V}$, $T_C=25\text{ °C}$ $V_{GS}=7\text{ V}$, $T_C=100\text{ °C}$ $V_{GS}=10\text{ V}$, $T_A=25\text{ °C}$, $R_{THJA}=50\text{ °C/W}^2)$ |
| Pulsed drain current ³⁾ | $I_{D,pulse}$ | - | - | 308 | A | $T_C=25\text{ °C}$ |
| Avalanche energy, single pulse ⁴⁾ | E_{AS} | - | - | 32 | mJ | $I_D=35\text{ A}$, $R_{GS}=25\text{ }\Omega$ |
| Gate source voltage | V_{GS} | -20 | - | 20 | V | - |
| Power dissipation | P_{tot} | - | - | 50 3.0 | W | $T_C=25\text{ °C}$ $T_A=25\text{ °C}$, $R_{THJA}=50\text{ °C/W}^2)$ |
| 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} | - | - | 3 | °C/W | - |
| Thermal resistance, junction - case, top | R_{thJC} | - | - | 20 | °C/W | - |
| Device on PCB, 6 cm ² cooling area | R_{thJA} | - | - | 50 | °C/W | - |

¹⁾ Rating refers to the product only with datasheet specified absolute maximum values, maintaining case temperature at 25°C. For higher Tcase please refer to Diagram 2. De-rating will be required based on the actual environmental conditions.

²⁾ 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.

³⁾ See Diagram 3 for more detailed information

⁴⁾ 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 | $V_{GS(th)}$ | 2.2 | - | 3.4 | V | $V_{DS}=V_{GS}$, $I_D=17\text{ }\mu\text{A}$ |
| Zero gate voltage drain current | I_{DSS} | - | 0.1 10 | 1 100 | μA | $V_{DS}=40\text{ V}$, $V_{GS}=0\text{ V}$, $T_j=25\text{ °C}$ $V_{DS}=40\text{ V}$, $V_{GS}=0\text{ V}$, $T_j=125\text{ °C}$ |
| Gate-source leakage current | I_{GSS} | - | 10 | 100 | nA | $V_{GS}=20\text{ V}$, $V_{DS}=0\text{ V}$ |
| Drain-source on-state resistance | $R_{DS(on)}$ | - | 3.5 4.0 | 4.6 5.7 | m Ω | $V_{GS}=10\text{ V}$, $I_D=35\text{ A}$ $V_{GS}=7\text{ V}$, $I_D=35\text{ A}$ |
| Gate resistance | R_G | - | 2.1 | 3 | Ω | - |
| Transconductance | g_{fs} | - | 100 | - | S | $ V_{DS} \geq 2 I_D /R_{DS(on)max}$, $I_D=35\text{ A}$ |

Table 5 Dynamic characteristics

| Parameter | Symbol | Values | | | Unit | Note / Test Condition |
|--|--------------|--------|------|------|------|--|
| | | Min. | Typ. | Max. | | |
| Input capacitance | C_{iss} | - | 1100 | 1400 | pF | $V_{GS}=0\text{ V}$, $V_{DS}=20\text{ V}$, $f=1\text{ MHz}$ |
| Output capacitance ¹⁾ | C_{oss} | - | 410 | 530 | pF | $V_{GS}=0\text{ V}$, $V_{DS}=20\text{ V}$, $f=1\text{ MHz}$ |
| Reverse transfer capacitance ¹⁾ | C_{rss} | - | 39 | 68 | pF | $V_{GS}=0\text{ V}$, $V_{DS}=20\text{ V}$, $f=1\text{ MHz}$ |
| Turn-on delay time | $t_{d(on)}$ | - | 4 | - | ns | $V_{DD}=20\text{ V}$, $V_{GS}=10\text{ V}$, $I_D=50\text{ A}$, $R_{G,ext}=1.6\text{ }\Omega$ |
| Rise time | t_r | - | 2 | - | ns | $V_{DD}=20\text{ V}$, $V_{GS}=10\text{ V}$, $I_D=50\text{ A}$, $R_{G,ext}=1.6\text{ }\Omega$ |
| Turn-off delay time | $t_{d(off)}$ | - | 7 | - | ns | $V_{DD}=20\text{ V}$, $V_{GS}=10\text{ V}$, $I_D=50\text{ A}$, $R_{G,ext}=1.6\text{ }\Omega$ |
| Fall time | t_f | - | 3 | - | ns | $V_{DD}=20\text{ V}$, $V_{GS}=10\text{ V}$, $I_D=50\text{ A}$, $R_{G,ext}=1.6\text{ }\Omega$ |

Table 6 Gate charge characteristics²⁾

| Parameter | Symbol | Values | | | Unit | Note / Test Condition |
|------------------------------------|---------------|--------|------|------|------|---|
| | | Min. | Typ. | Max. | | |
| Gate to source charge | Q_{gs} | - | 5 | - | nC | $V_{DD}=20\text{ V}$, $I_D=35\text{ A}$, $V_{GS}=0\text{ to }10\text{ V}$ |
| Gate charge at threshold | $Q_{g(th)}$ | - | 3 | - | nC | $V_{DD}=20\text{ V}$, $I_D=35\text{ A}$, $V_{GS}=0\text{ to }10\text{ V}$ |
| Gate to drain charge ¹⁾ | Q_{gd} | - | 3 | 4.6 | nC | $V_{DD}=20\text{ V}$, $I_D=35\text{ A}$, $V_{GS}=0\text{ to }10\text{ V}$ |
| Switching charge | Q_{sw} | - | 5 | - | nC | $V_{DD}=20\text{ V}$, $I_D=35\text{ A}$, $V_{GS}=0\text{ to }10\text{ V}$ |
| Gate charge total ¹⁾ | Q_g | - | 16 | 21 | nC | $V_{DD}=20\text{ V}$, $I_D=35\text{ A}$, $V_{GS}=0\text{ to }10\text{ V}$ |
| Gate plateau voltage | $V_{plateau}$ | - | 4.5 | - | V | $V_{DD}=20\text{ V}$, $I_D=35\text{ A}$, $V_{GS}=0\text{ to }10\text{ V}$ |
| Gate charge total, sync. FET | $Q_{g(sync)}$ | - | 14 | - | nC | $V_{DS}=0.1\text{ V}$, $V_{GS}=0\text{ to }10\text{ V}$ |
| Output charge | Q_{oss} | - | 17 | - | nC | $V_{DD}=20\text{ V}$, $V_{GS}=0\text{ V}$ |

¹⁾ Defined by design. Not subject to production test.

²⁾ 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 | - | - | 50 | A | $T_C=25\text{ °C}$ |
| Diode pulse current | $I_{S,pulse}$ | - | - | 308 | A | $T_C=25\text{ °C}$ |
| Diode forward voltage | V_{SD} | - | 0.88 | 1 | V | $V_{GS}=0\text{ V}, I_F=35\text{ A}, T_j=25\text{ °C}$ |
| Reverse recovery time | t_{rr} | - | 30 | - | ns | $V_R=20\text{ V}, I_F=50\text{ A}, di_F/dt=100\text{ A}/\mu\text{s}$ |
| Reverse recovery charge | Q_{rr} | - | 19 | - | nC | $V_R=20\text{ V}, I_F=50\text{ A}, di_F/dt=100\text{ A}/\mu\text{s}$ |

4 Electrical characteristics diagrams

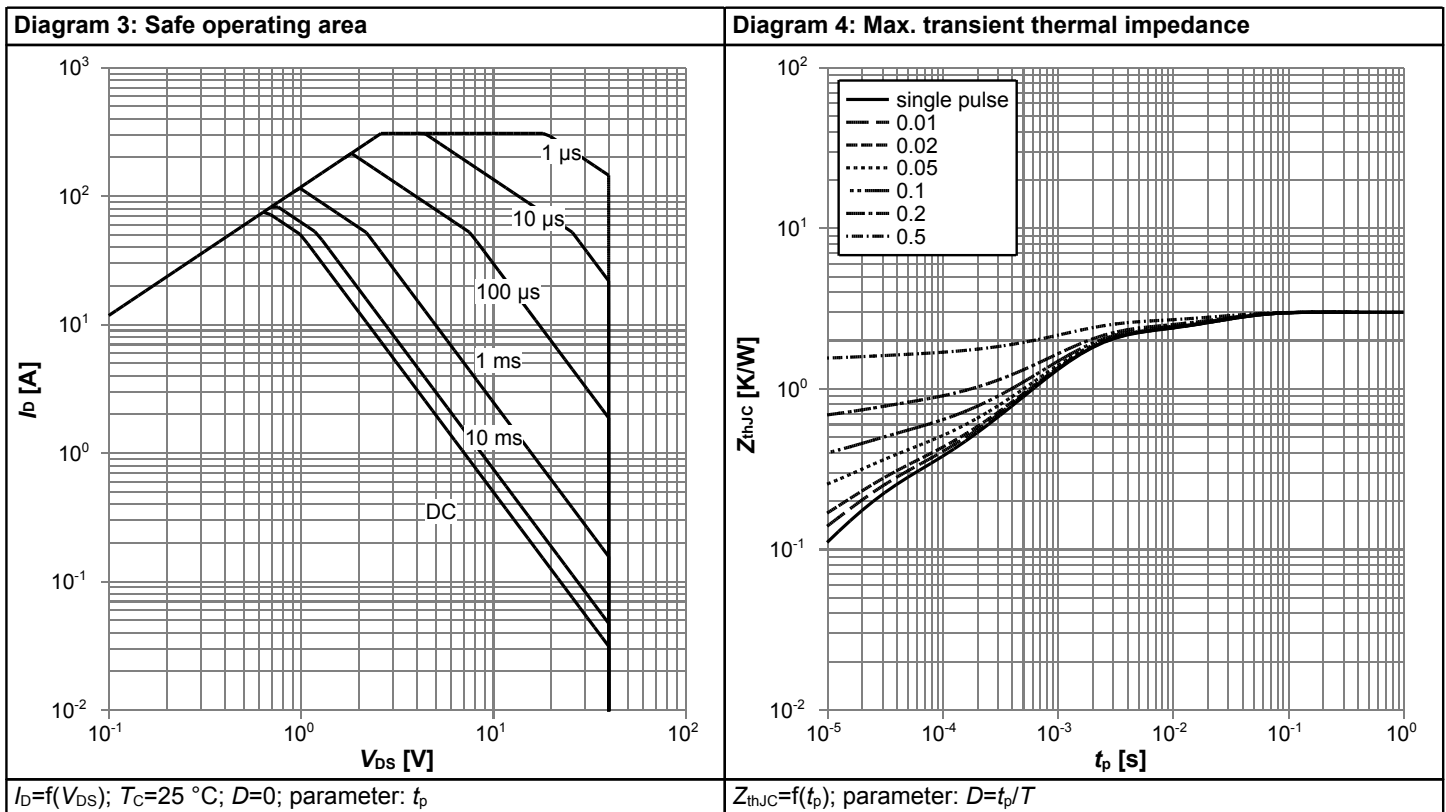
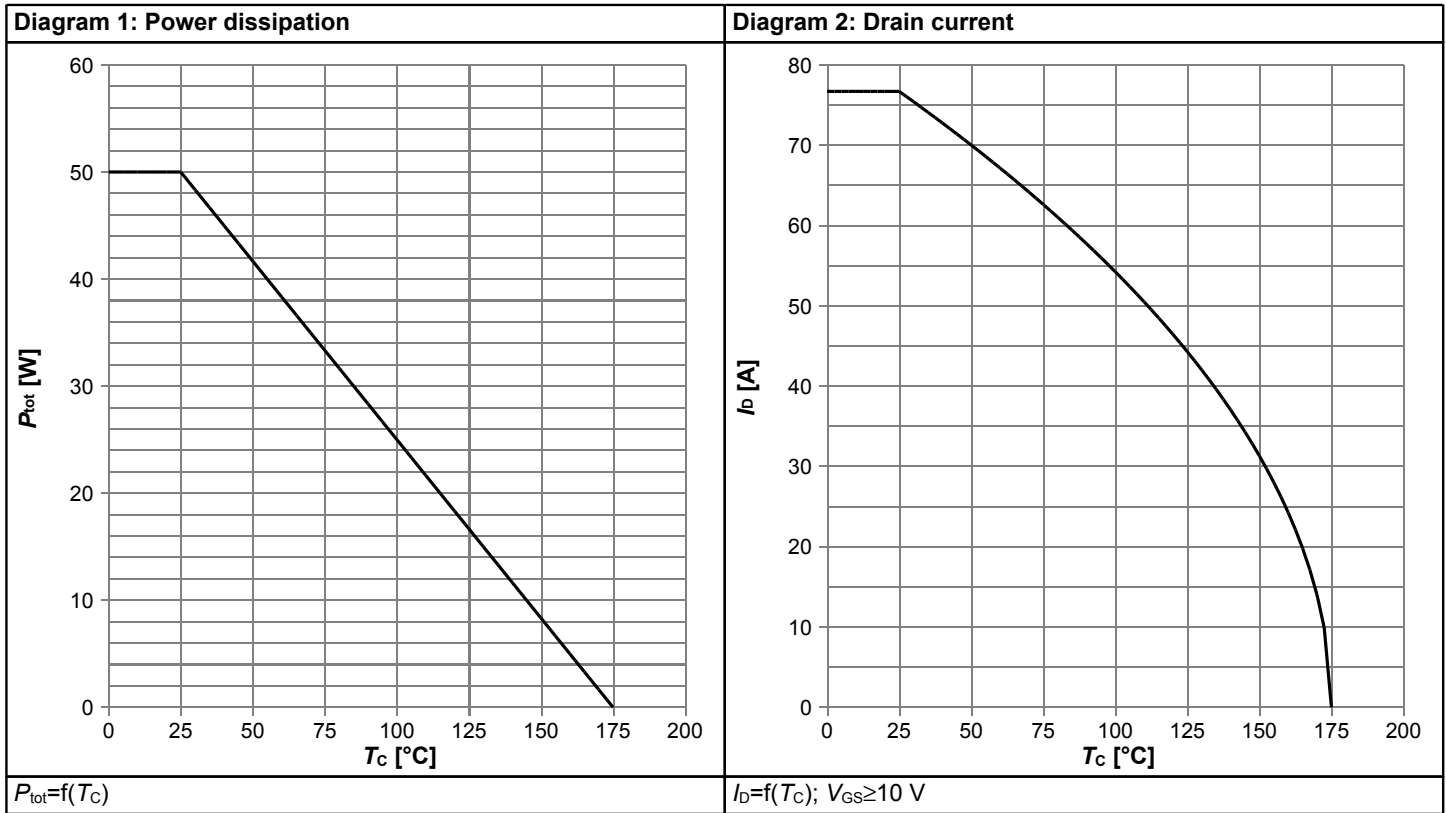
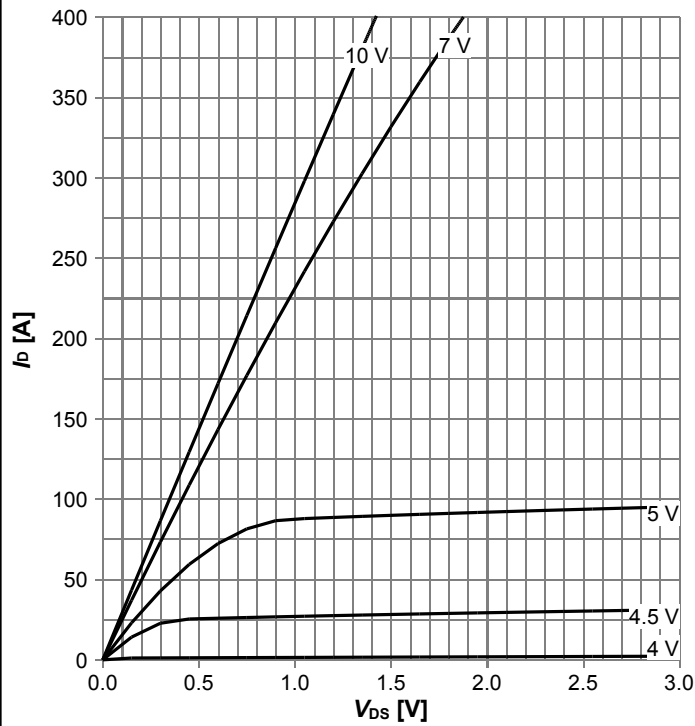
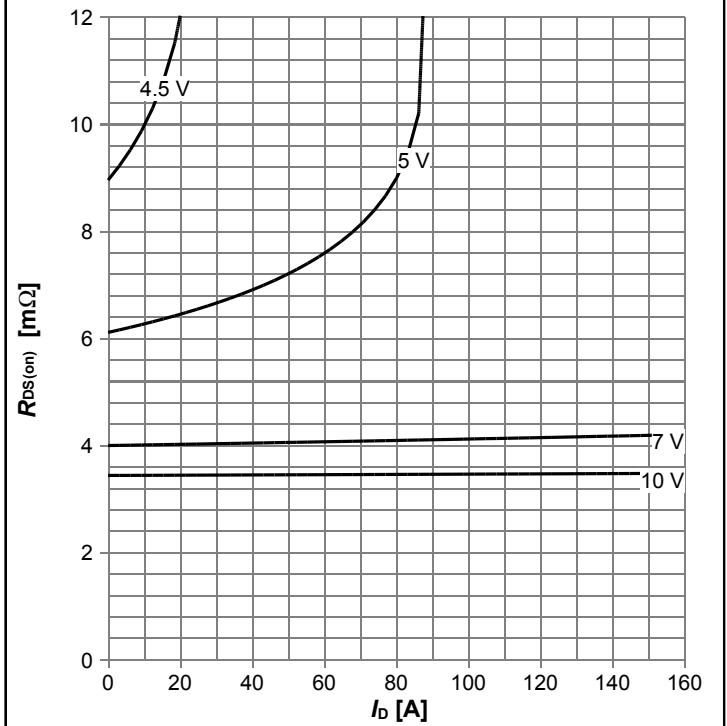


Diagram 5: Typ. output characteristics



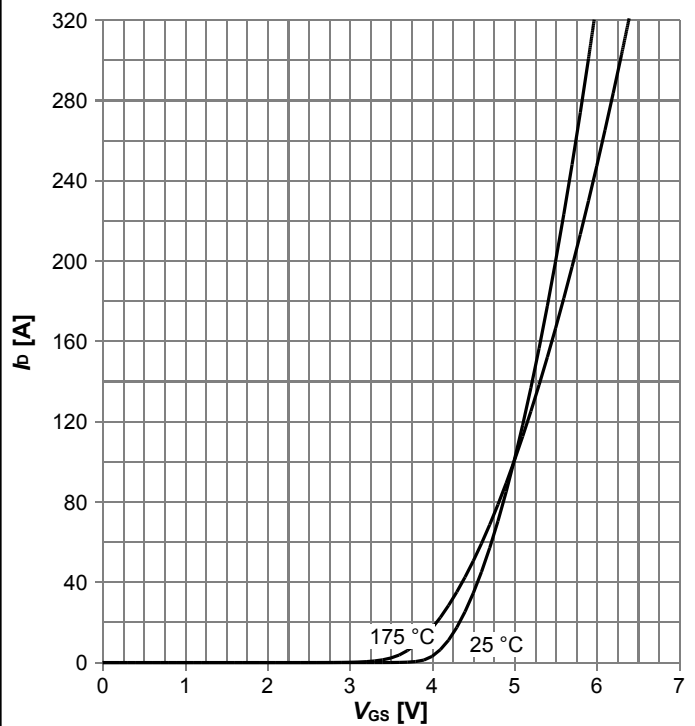
$I_D = f(V_{DS})$, $T_j = 25^\circ\text{C}$; parameter: V_{GS}

Diagram 6: Typ. drain-source on resistance



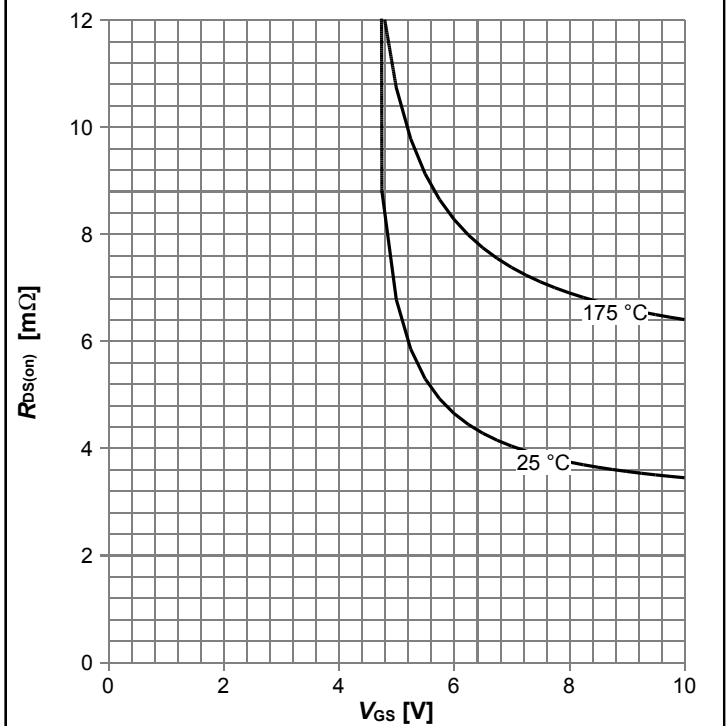
$R_{DS(on)} = f(I_D)$, $T_j = 25^\circ\text{C}$; parameter: V_{GS}

Diagram 7: Typ. transfer characteristics



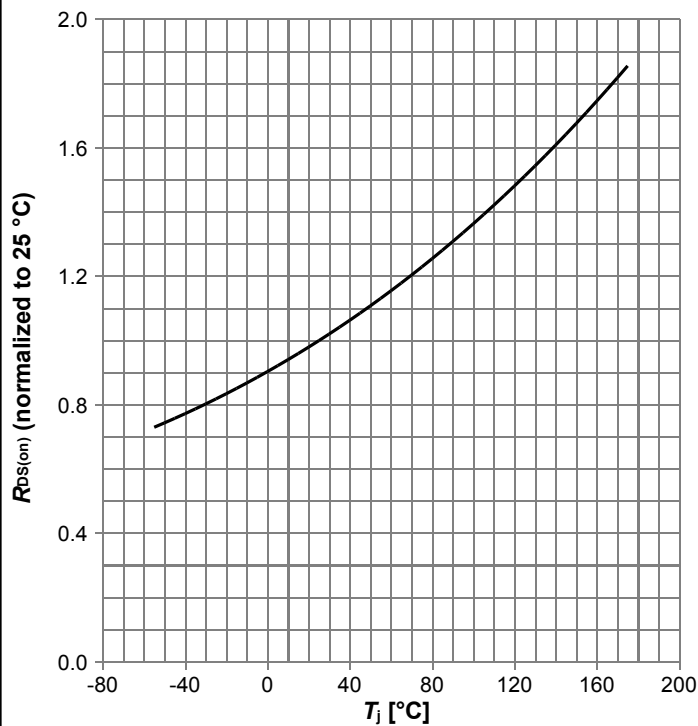
$I_D = f(V_{GS})$, $|V_{DS}| > 2|I_D|R_{DS(on)max}$; parameter: T_j

Diagram 8: Typ. drain-source on resistance



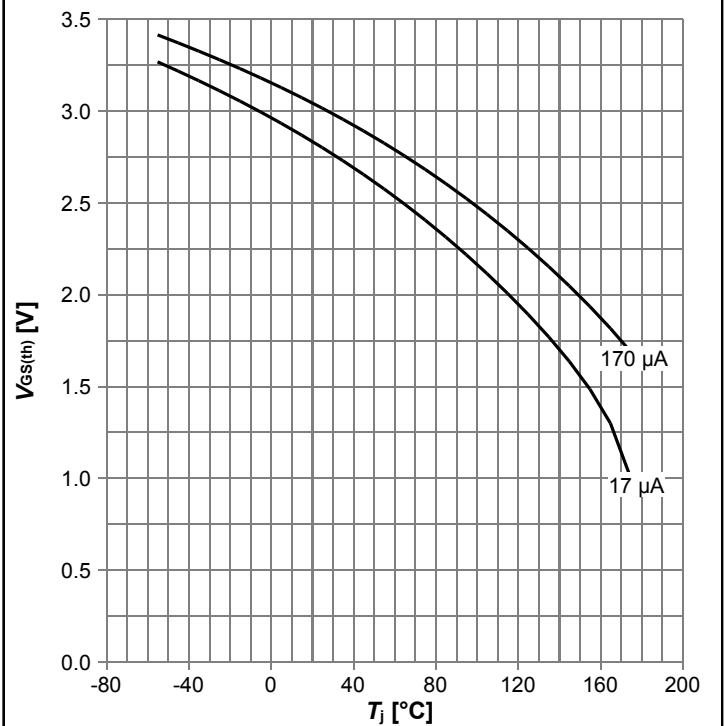
$R_{DS(on)} = f(V_{GS})$, $I_D = 35\text{ A}$; parameter: T_j

Diagram 9: Normalized drain-source on resistance



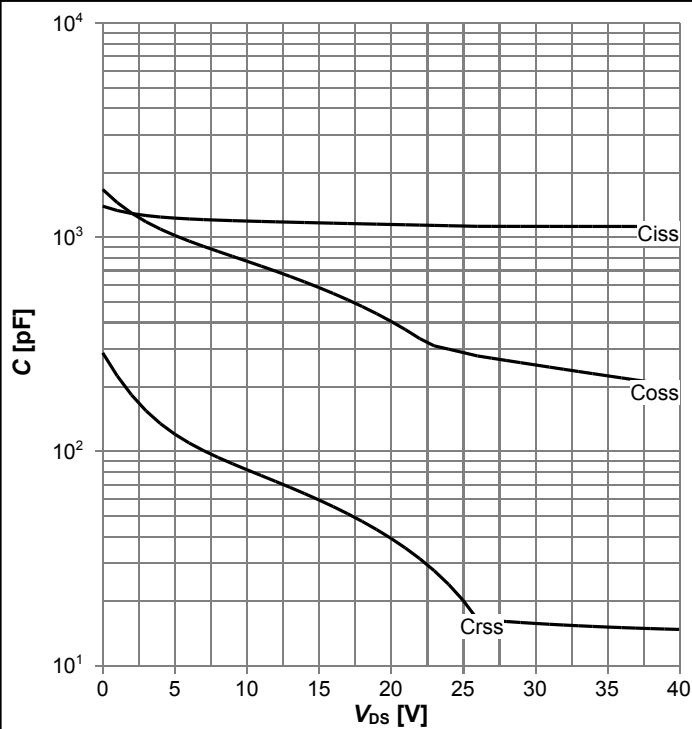
$R_{DS(on)}=f(T_j)$, $I_D=35$ A, $V_{GS}=10$ V

Diagram 10: Typ. gate threshold voltage



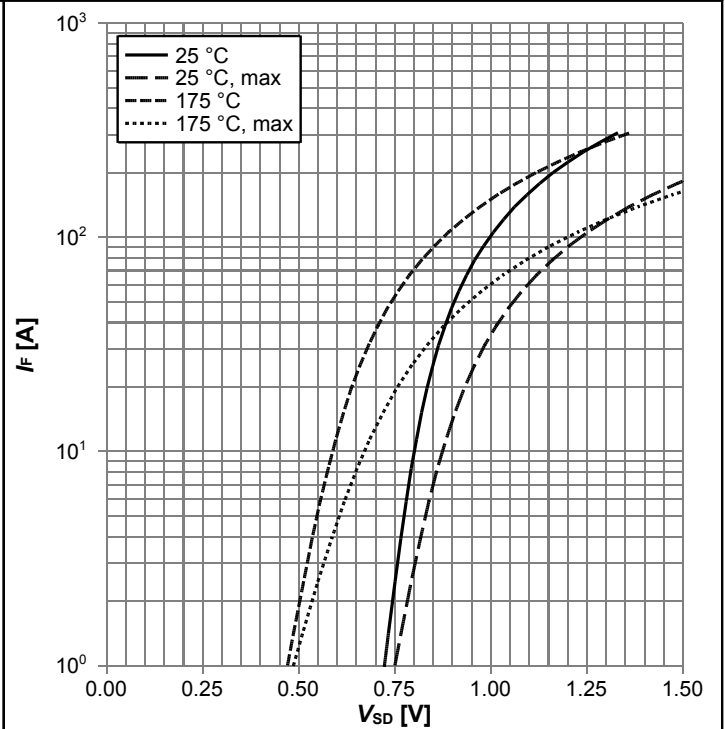
$V_{GS(th)}=f(T_j)$, $V_{GS}=V_{DS}$; parameter: I_D

Diagram 11: Typ. capacitances



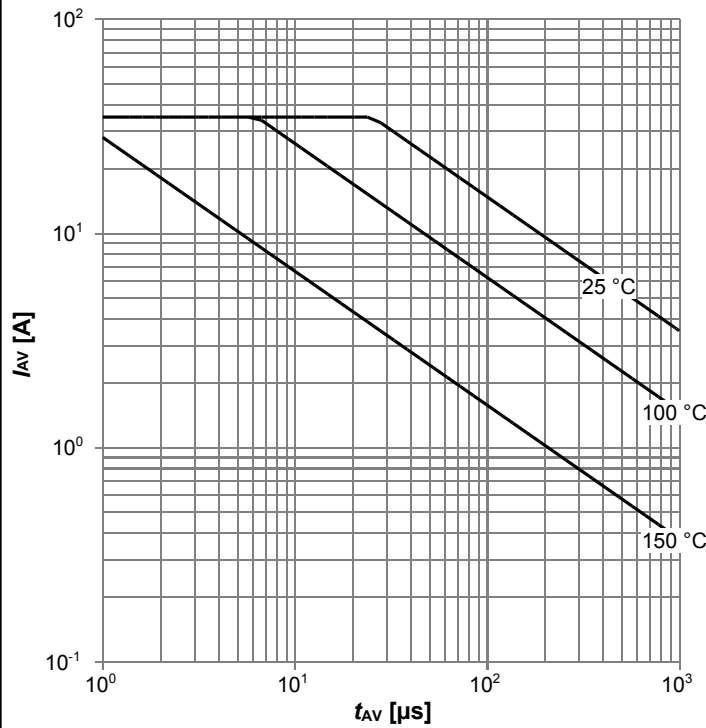
$C=f(V_{DS})$; $V_{GS}=0$ V; $f=1$ MHz

Diagram 12: Forward characteristics of reverse diode



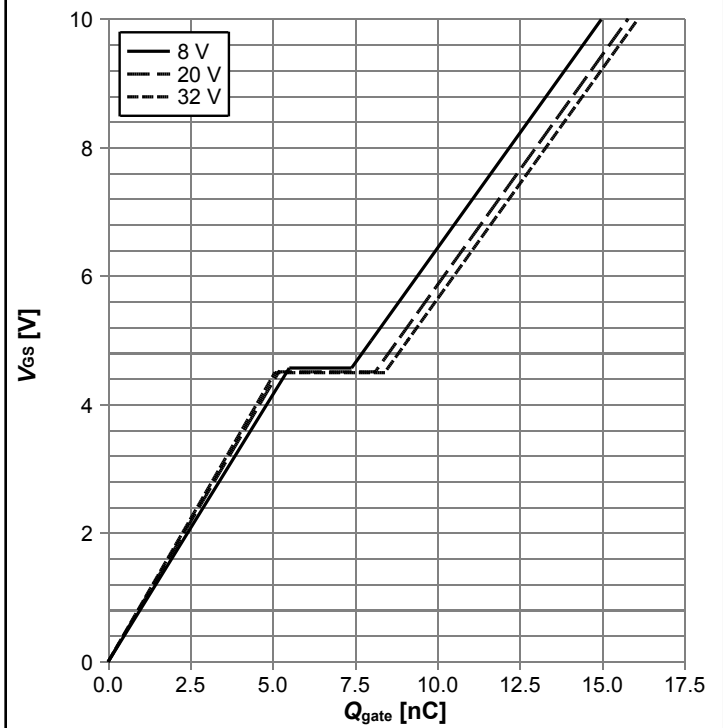
$I_F=f(V_{SD})$; parameter: T_j

Diagram 13: Avalanche characteristics



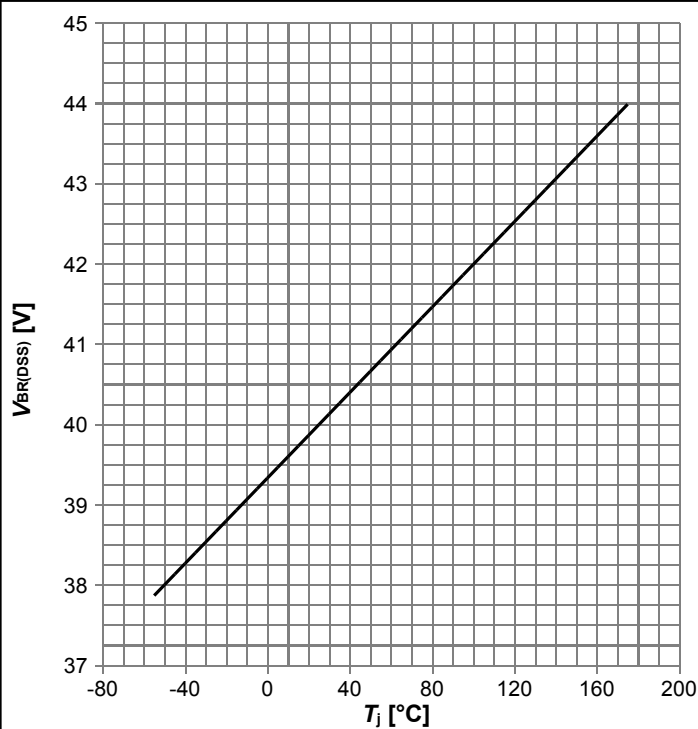
$I_{AS}=f(t_{AV}); R_{GS}=25 \Omega$; parameter: $T_{j,start}$

Diagram 14: Typ. gate charge



$V_{GS}=f(Q_{gate}), I_D=39 \text{ A pulsed}, T_j=25 \text{ °C}$; parameter: V_{DD}

Diagram 15: Drain-source breakdown voltage

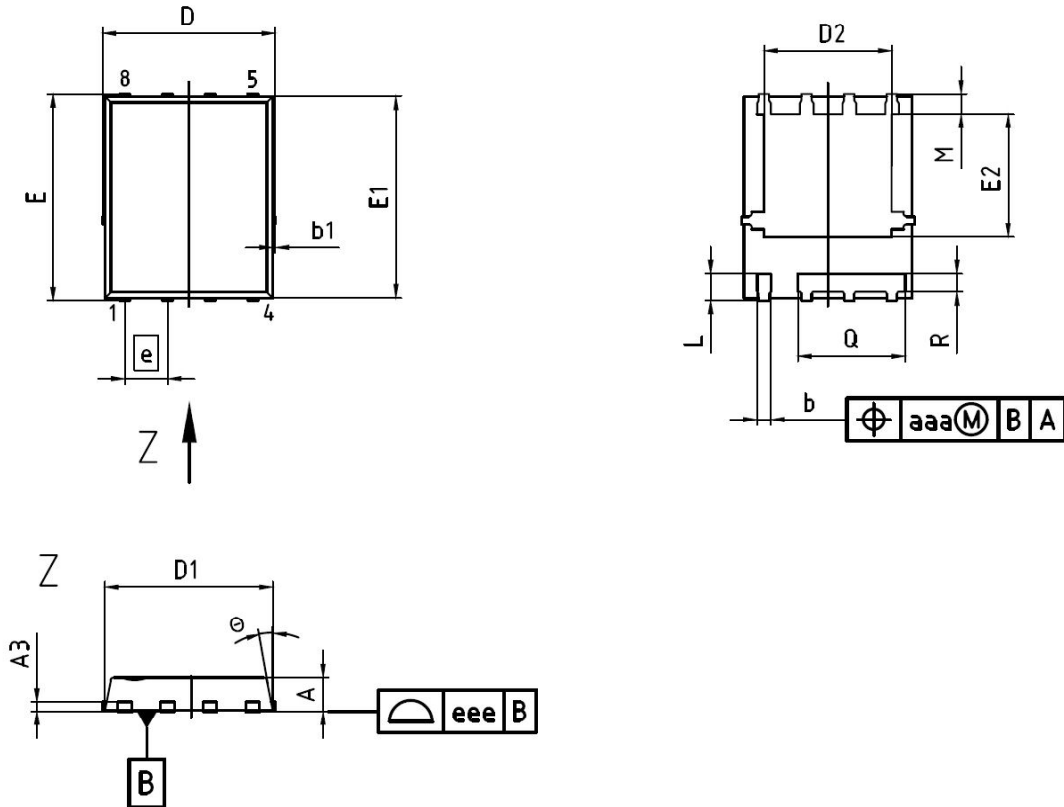


$V_{BR(DSS)}=f(T_j); I_D=1 \text{ mA}$

Diagram Gate charge waveforms



5 Package Outlines



| DIM | MILLIMETERS | | INCHES | |
|-------|-------------|------|-------------|-------|
| | MIN | MAX | MIN | MAX |
| A | 0.90 | 1.10 | 0.035 | 0.043 |
| A3 | 0.25 (REF) | | 0.011 (REF) | |
| b | 0.34 | 0.54 | 0.013 | 0.021 |
| b1 | 0.02 | 0.22 | 0.001 | 0.009 |
| D | 5.15 (BSC) | | 0.203 (BSC) | |
| D1 | 5.00 (BSC) | | 0.197 (BSC) | |
| D2 | 3.70 | 4.40 | 0.146 | 0.173 |
| E | 6.15 (BSC) | | 0.242 (BSC) | |
| E1 | 6.00 (BSC) | | 0.236 (BSC) | |
| E2 | 3.40 | 3.80 | 0.134 | 0.150 |
| e | 1.27 (BSC) | | 0.050 (BSC) | |
| N | 8 | | 8 | |
| L | 0.74 | 0.84 | 0.029 | 0.033 |
| M | 0.45 | 0.66 | 0.018 | 0.026 |
| theta | 8.5° | 12° | 8.5° | 12° |
| Q | 3.15 | 3.25 | 0.124 | 0.128 |
| R | 0.48 | 0.58 | 0.019 | 0.023 |
| aaa | 0.25 | | 0.010 | |
| eee | 0.08 | | 0.003 | |

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SCALE

EUROPEAN PROJECTION

ISSUE DATE
02-08-2011

REVISION
01

Figure 1 Outline TDSON-8 FL, dimensions in mm/inches

Revision History

ISC046N04NM5

Revision: 2020-03-23, Rev. 2.1

Previous Revision

| Revision | Date | Subjects (major changes since last revision) |
|----------|------------|---|
| 2.0 | 2020-02-04 | Release of final version |
| 2.1 | 2020-03-23 | Update condition Id pulse, Features and footnotes |

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