

MOSFET

OptiMOS™ 5 Power-Transistor, 60 V

Features

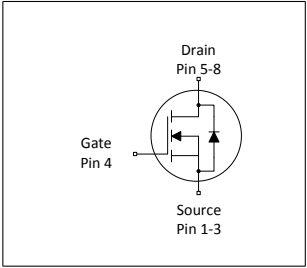
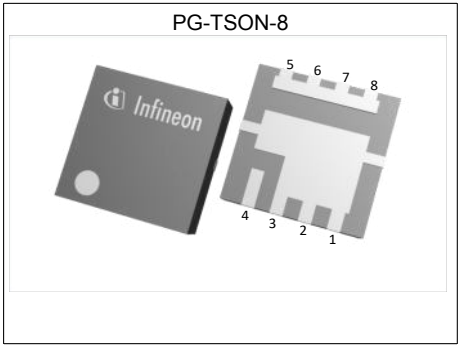
- Optimized for high performance SMPS, e.g. synchronous rectification
- N-channel, logic level
- Very low on-resistance  $R_{DS(on)}$
- Superior thermal resistance
- 100% avalanche tested
- Pb-free lead plating; RoHS compliant
- Halogen-free according to IEC61249-2-21

Product validation

Fully qualified according to JEDEC for Industrial Applications

Table 1 Key Performance Parameters

| Parameter             | Value | Unit      |
|-----------------------|-------|-----------|
| $V_{DS}$              | 60    | V         |
| $R_{DS(on),max} @10V$ | 2.2   | $m\Omega$ |
| $R_{DS(on),max}@4.5V$ | 2.9   | $m\Omega$ |
| $I_D$                 | 151   | A         |
| $Q_{oss}$             | 45    | nC        |
| $Q_G (0V...4.5V)$     | 26    | nC        |



RoHS

| Type / Ordering Code | Package   | Marking | Related Links |
|----------------------|-----------|---------|---------------|
| IQE022N06LM5         | PG-TSON-8 | 022N6L5 | -             |

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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>       | $I_D$             | -      | -    | 151<br>107<br>93<br>24 | A    | $V_{GS}=10\text{ V}$ , $T_C=25\text{ °C}$<br>$V_{GS}=10\text{ V}$ , $T_C=100\text{ °C}$<br>$V_{GS}=4.5\text{ V}$ , $T_C=100\text{ °C}$<br>$V_{GS}=10\text{ V}$ , $T_A=25\text{ °C}$ , $R_{thJA}=60\text{ °C/W}^{2)}$ |
| Pulsed drain current <sup>3)</sup>           | $I_{D,pulse}$     | -      | -    | 604                    | A    | $T_A=25\text{ °C}$                                                                                                                                                                                                   |
| Avalanche energy, single pulse <sup>4)</sup> | $E_{AS}$          | -      | -    | 241                    | mJ   | $I_D=20\text{ A}$ , $R_{GS}=25\text{ }\Omega$                                                                                                                                                                        |
| Gate source voltage                          | $V_{GS}$          | -20    | -    | 20                     | V    | -                                                                                                                                                                                                                    |
| Power dissipation                            | $P_{tot}$         | -      | -    | 100<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   | -                                                                                                                                                                                                                    |

## 2 Thermal characteristics

**Table 3 Thermal characteristics**

| Parameter                                                                            | Symbol     | Values |      |      | Unit | Note / Test Condition |
|--------------------------------------------------------------------------------------|------------|--------|------|------|------|-----------------------|
|                                                                                      |            | Min.   | Typ. | Max. |      |                       |
| Thermal resistance, junction - case                                                  | $R_{thJC}$ | -      | 0.9  | 1.5  | °C/W | -                     |
| Thermal resistance, junction - ambient, 6 cm <sup>2</sup> cooling area <sup>2)</sup> | $R_{thJA}$ | -      | -    | 60   | °C/W | -                     |

<sup>1)</sup> Rating refers to the product only with datasheet specified absolute maximum values, maintaining case temperature as specified. For other case temperatures 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   | $V_{(BR)DSS}$ | 60     | -          | -          | V             | $V_{GS}=0\text{ V}$ , $I_D=1\text{ mA}$                                                                                             |
| Gate threshold voltage           | $V_{GS(th)}$  | 1.1    | 1.7        | 2.3        | V             | $V_{DS}=V_{GS}$ , $I_D=48\text{ }\mu\text{A}$                                                                                       |
| Zero gate voltage drain current  | $I_{DSS}$     | -      | 0.1<br>10  | 1.0<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 | $R_{DS(on)}$  | -      | 1.9<br>2.5 | 2.2<br>2.9 | m $\Omega$    | $V_{GS}=10\text{ V}$ , $I_D=20\text{ A}$<br>$V_{GS}=4.5\text{ V}$ , $I_D=10\text{ A}$                                               |
| Gate resistance                  | $R_G$         | -      | 1.1        | 1.4        | $\Omega$      | -                                                                                                                                   |
| Transconductance <sup>1)</sup>   | $g_{fs}$      | -      | 93         | -          | 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>            | $C_{iss}$    | -      | 3400 | 4420 | pF   | $V_{GS}=0\text{ V}$ , $V_{DS}=30\text{ V}$ , $f=1\text{ MHz}$                                      |
| Output capacitance <sup>1)</sup>           | $C_{oss}$    | -      | 720  | 936  | pF   | $V_{GS}=0\text{ V}$ , $V_{DS}=30\text{ V}$ , $f=1\text{ MHz}$                                      |
| Reverse transfer capacitance <sup>1)</sup> | $C_{rss}$    | -      | 35   | 63   | pF   | $V_{GS}=0\text{ V}$ , $V_{DS}=30\text{ V}$ , $f=1\text{ MHz}$                                      |
| Turn-on delay time                         | $t_{d(on)}$  | -      | 6.1  | -    | ns   | $V_{DD}=30\text{ V}$ , $V_{GS}=10\text{ V}$ , $I_D=20\text{ A}$ ,<br>$R_{G,ext}=1.6\text{ }\Omega$ |
| Rise time                                  | $t_r$        | -      | 4.1  | -    | ns   | $V_{DD}=30\text{ V}$ , $V_{GS}=10\text{ V}$ , $I_D=20\text{ A}$ ,<br>$R_{G,ext}=1.6\text{ }\Omega$ |
| Turn-off delay time                        | $t_{d(off)}$ | -      | 26   | -    | ns   | $V_{DD}=30\text{ V}$ , $V_{GS}=10\text{ V}$ , $I_D=20\text{ A}$ ,<br>$R_{G,ext}=1.6\text{ }\Omega$ |
| Fall time                                  | $t_f$        | -      | 5.9  | -    | ns   | $V_{DD}=30\text{ V}$ , $V_{GS}=10\text{ V}$ , $I_D=20\text{ A}$ ,<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              | $Q_{gs}$      | -      | 8.5  | -    | nC   | $V_{DD}=30\text{ V}$ , $I_D=20\text{ A}$ , $V_{GS}=0\text{ to }4.5\text{ V}$ |
| Gate charge at threshold           | $Q_{g(th)}$   | -      | 5.9  | -    | nC   | $V_{DD}=30\text{ V}$ , $I_D=20\text{ A}$ , $V_{GS}=0\text{ to }4.5\text{ V}$ |
| Gate to drain charge <sup>1)</sup> | $Q_{gd}$      | -      | 8    | 12   | nC   | $V_{DD}=30\text{ V}$ , $I_D=20\text{ A}$ , $V_{GS}=0\text{ to }4.5\text{ V}$ |
| Switching charge                   | $Q_{sw}$      | -      | 10.7 | -    | nC   | $V_{DD}=30\text{ V}$ , $I_D=20\text{ A}$ , $V_{GS}=0\text{ to }4.5\text{ V}$ |
| Gate charge total <sup>1)</sup>    | $Q_g$         | -      | 26   | 33   | nC   | $V_{DD}=30\text{ V}$ , $I_D=20\text{ A}$ , $V_{GS}=0\text{ to }4.5\text{ V}$ |
| Gate plateau voltage               | $V_{plateau}$ | -      | 2.5  | -    | V    | $V_{DD}=30\text{ V}$ , $I_D=20\text{ A}$ , $V_{GS}=0\text{ to }4.5\text{ V}$ |
| Gate charge total                  | $Q_g$         | -      | 53   | -    | nC   | $V_{DD}=30\text{ V}$ , $I_D=20\text{ A}$ , $V_{GS}=0\text{ to }10\text{ V}$  |
| Output charge <sup>1)</sup>        | $Q_{oss}$     | -      | 45   | 59   | nC   | $V_{DS}=30\text{ V}$ , $V_{GS}=0\text{ V}$                                   |

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

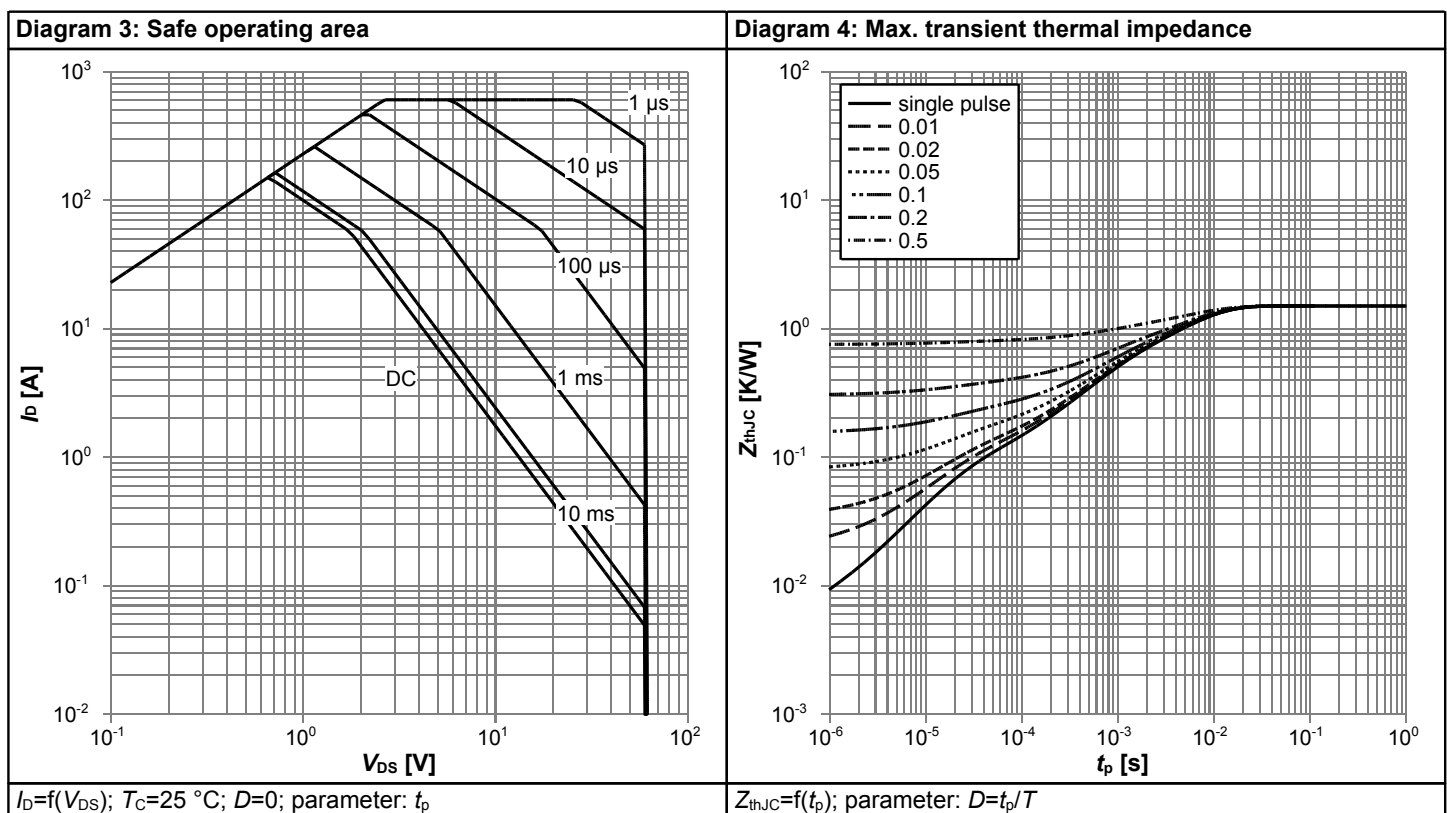
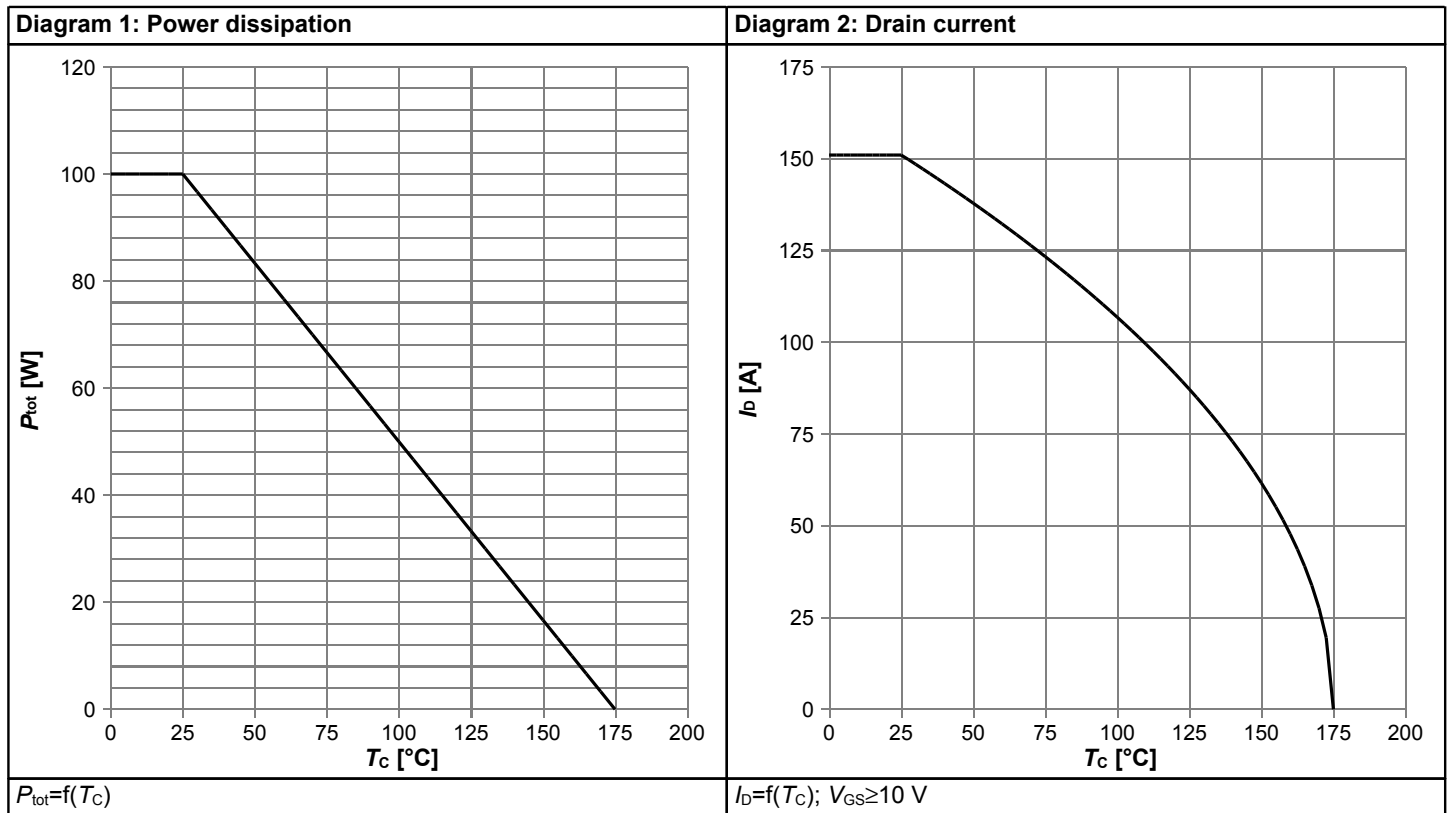
<sup>2)</sup> See "Gate charge waveforms" for parameter definition

**Table 7 Reverse diode**

| Parameter                             | Symbol        | Values |      |      | Unit | Note / Test Condition                                                       |
|---------------------------------------|---------------|--------|------|------|------|-----------------------------------------------------------------------------|
|                                       |               | Min.   | Typ. | Max. |      |                                                                             |
| Diode continuous forward current      | $I_S$         | -      | -    | 91   | A    | $T_C=25\text{ °C}$                                                          |
| Diode pulse current                   | $I_{S,pulse}$ | -      | -    | 604  | A    | $T_C=25\text{ °C}$                                                          |
| Diode forward voltage                 | $V_{SD}$      | -      | 0.79 | 1.0  | V    | $V_{GS}=0\text{ V}$ , $I_F=20\text{ A}$ , $T_J=25\text{ °C}$                |
| Reverse recovery time <sup>1)</sup>   | $t_{rr}$      | -      | 26   | 52   | ns   | $V_R=30\text{ V}$ , $I_F=20\text{ A}$ , $di_F/dt=100\text{ A/}\mu\text{s}$  |
| Reverse recovery charge <sup>1)</sup> | $Q_{rr}$      | -      | 19   | 38   | nC   | $V_R=30\text{ V}$ , $I_F=20\text{ A}$ , $di_F/dt=100\text{ A/}\mu\text{s}$  |
| Reverse recovery time <sup>1)</sup>   | $t_{rr}$      | -      | 17   | 34   | ns   | $V_R=30\text{ V}$ , $I_F=20\text{ A}$ , $di_F/dt=1000\text{ A/}\mu\text{s}$ |
| Reverse recovery charge <sup>1)</sup> | $Q_{rr}$      | -      | 98   | 196  | nC   | $V_R=30\text{ V}$ , $I_F=20\text{ A}$ , $di_F/dt=1000\text{ A/}\mu\text{s}$ |

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

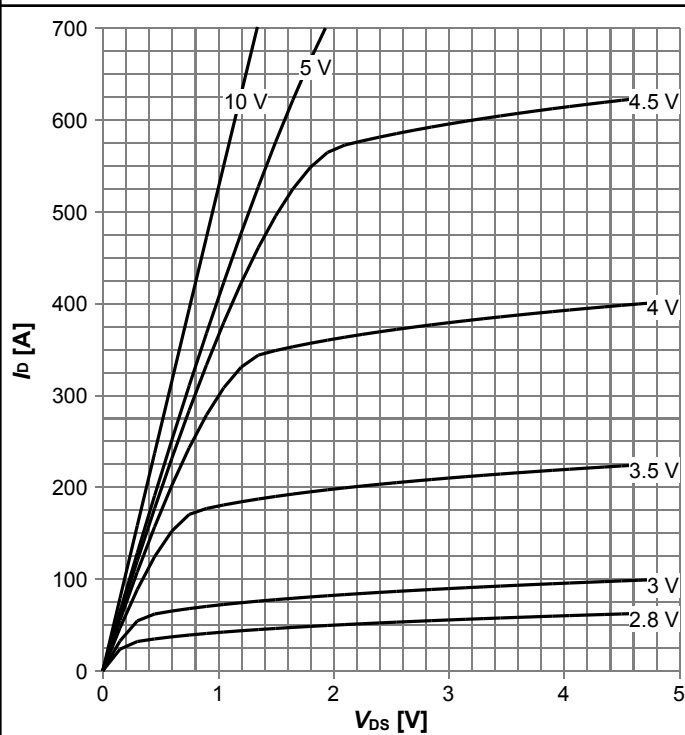
## 4 Electrical characteristics diagrams



# OptiMOS™ 5 Power-Transistor, 60 V

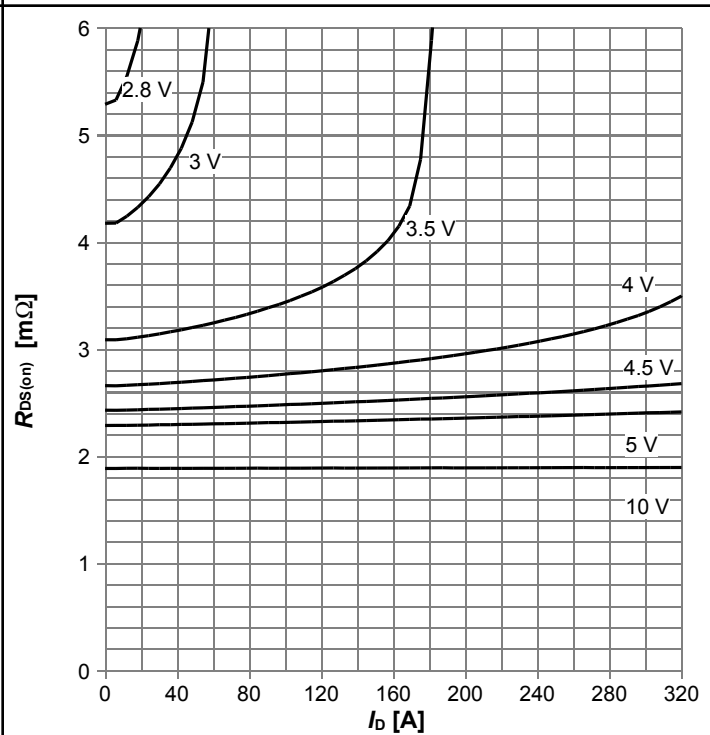
## IQE022N06LM5

Diagram 5: Typ. output characteristics



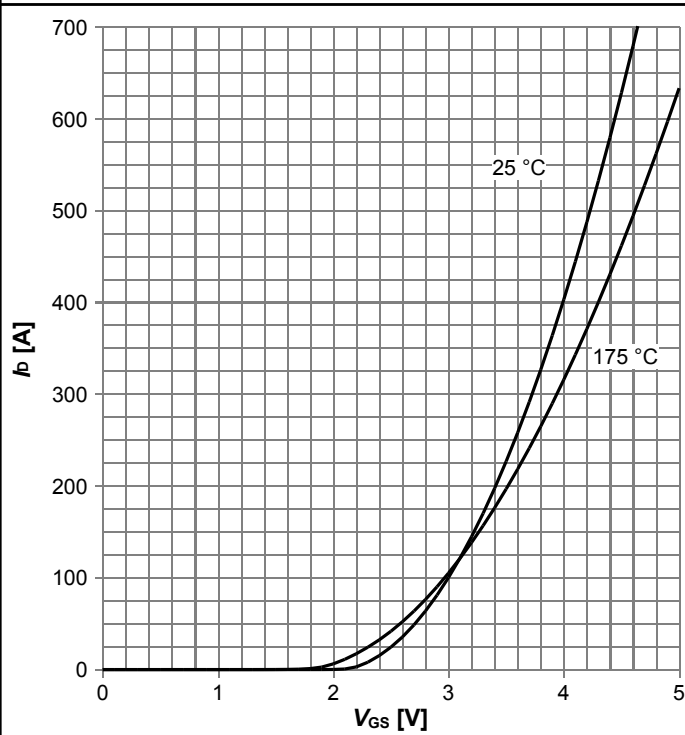
$I_D = f(V_{DS})$ ,  $T_j = 25^\circ\text{C}$ ; parameter:  $V_{GS}$

Diagram 6: Typ. drain-source on resistance



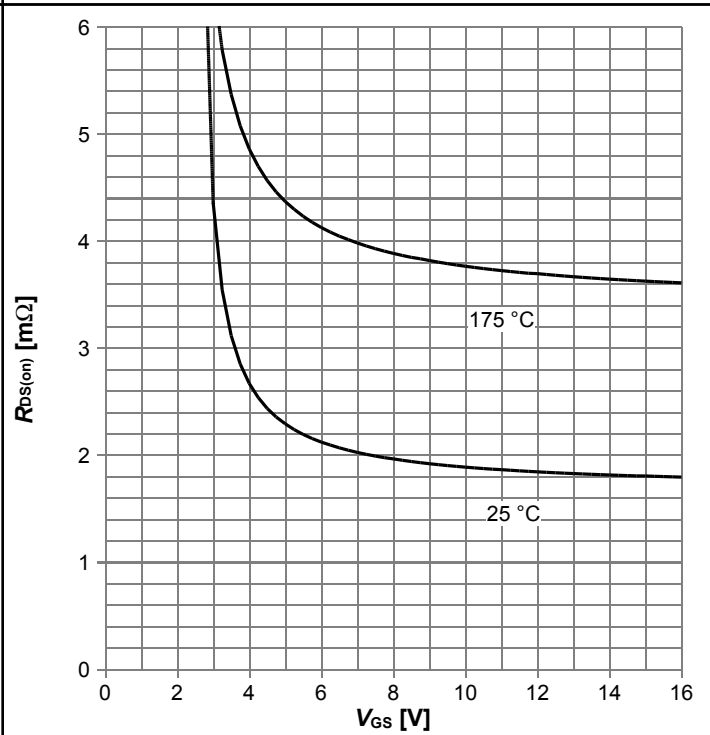
$R_{DS(on)} = f(I_D)$ ,  $T_j = 25^\circ\text{C}$ ; parameter:  $V_{GS}$

Diagram 7: Typ. transfer characteristics



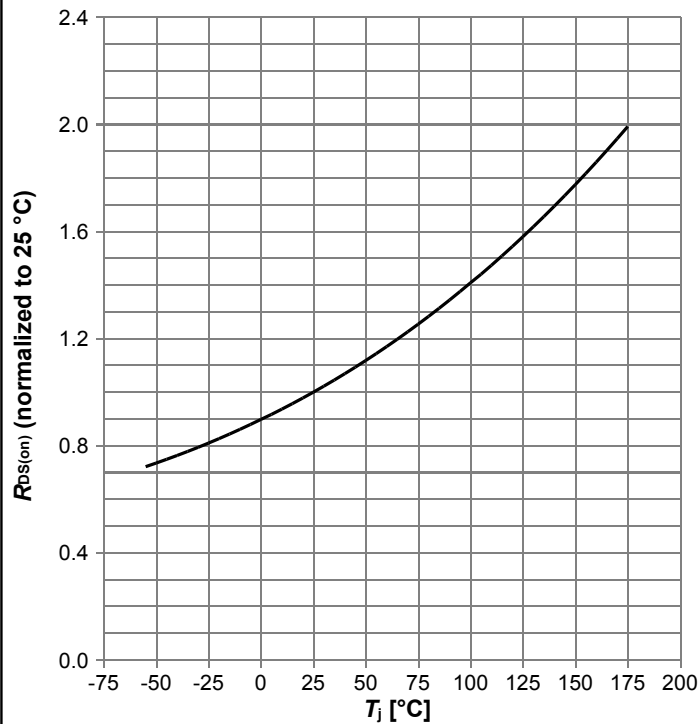
$I_D = f(V_{GS})$ ,  $|V_{DS}| > 2|I_D|R_{DS(on)max}$ ; parameter:  $T_j$

Diagram 8: Typ. drain-source on resistance



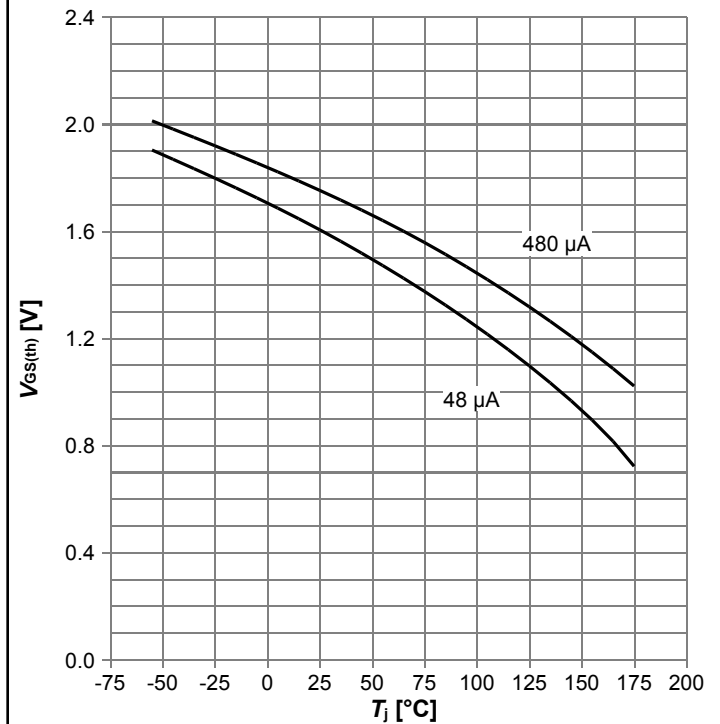
$R_{DS(on)} = f(V_{GS})$ ,  $I_D = 20\text{ A}$ ; parameter:  $T_j$

Diagram 9: Normalized drain-source on resistance



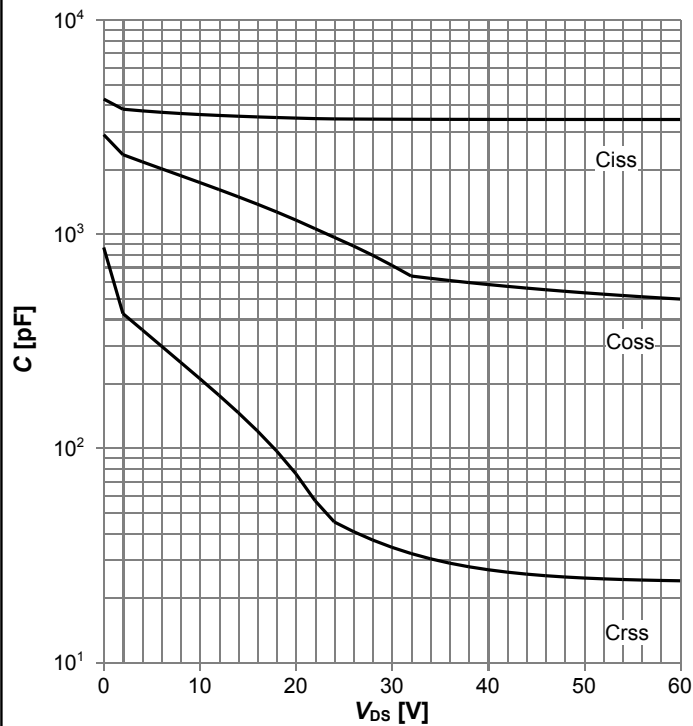
$R_{DS(on)} = f(T_j)$ ,  $I_D = 20$  A,  $V_{GS} = 10$  V

Diagram 10: Typ. gate threshold voltage



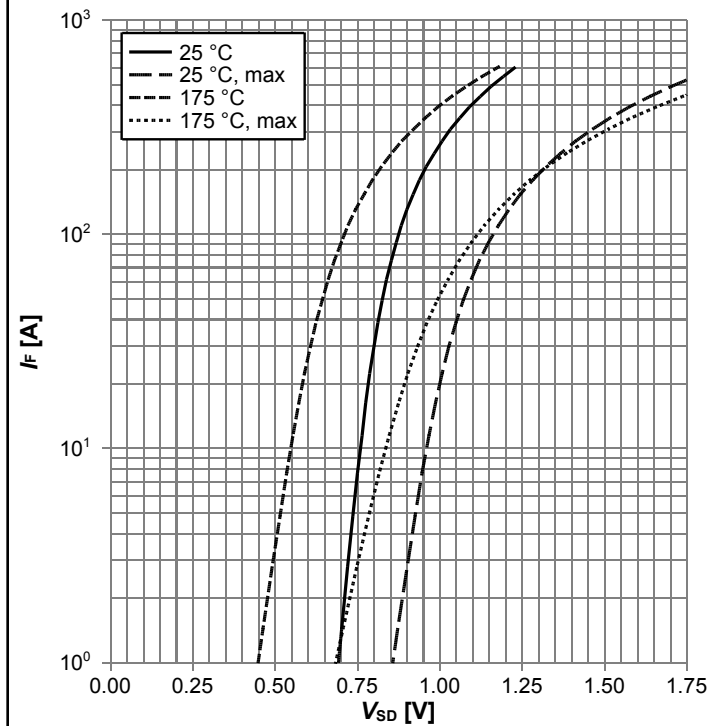
$V_{GS(th)} = f(T_j)$ ,  $V_{GS} = V_{DS}$ ; parameter:  $I_D$

Diagram 11: Typ. capacitances



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

Diagram 12: Forward characteristics of reverse diode



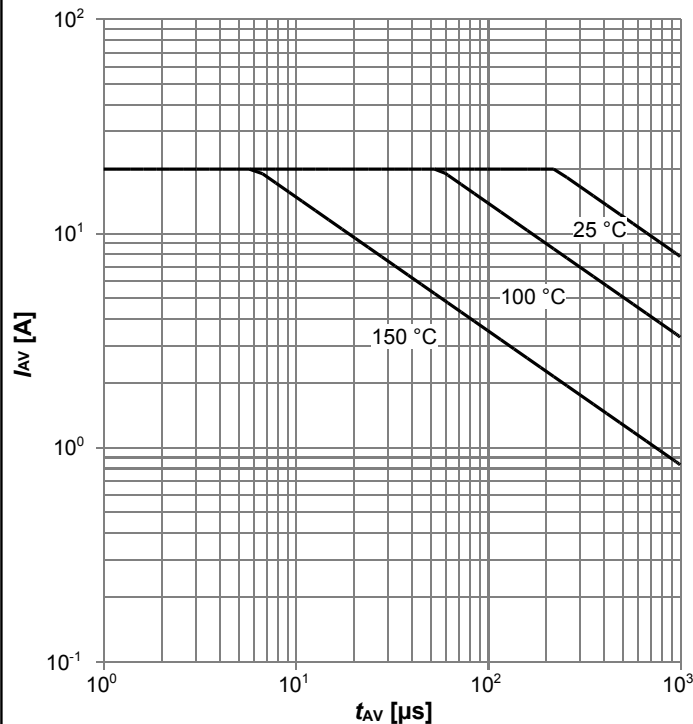
$I_F = f(V_{SD})$ ; parameter:  $T_j$



# OptiMOS™ 5 Power-Transistor, 60 V

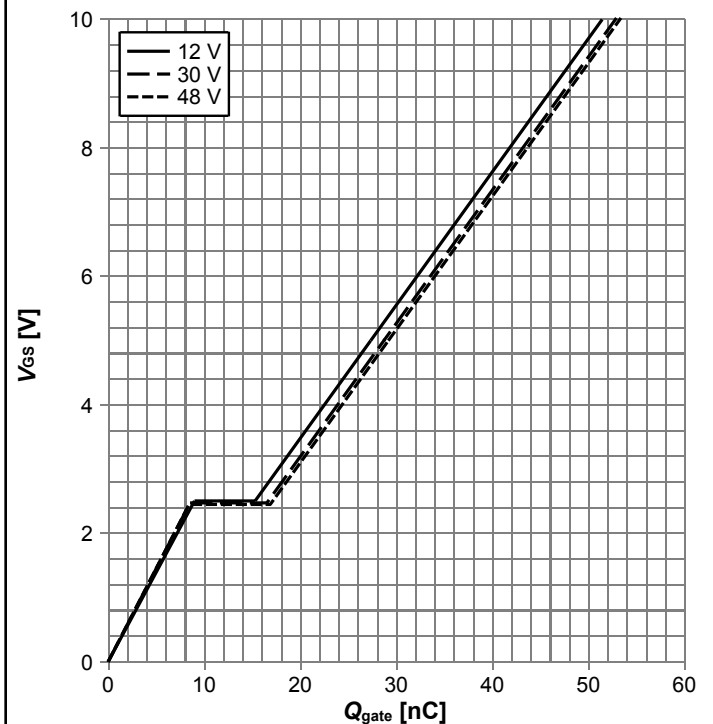
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Diagram 13: Avalanche characteristics



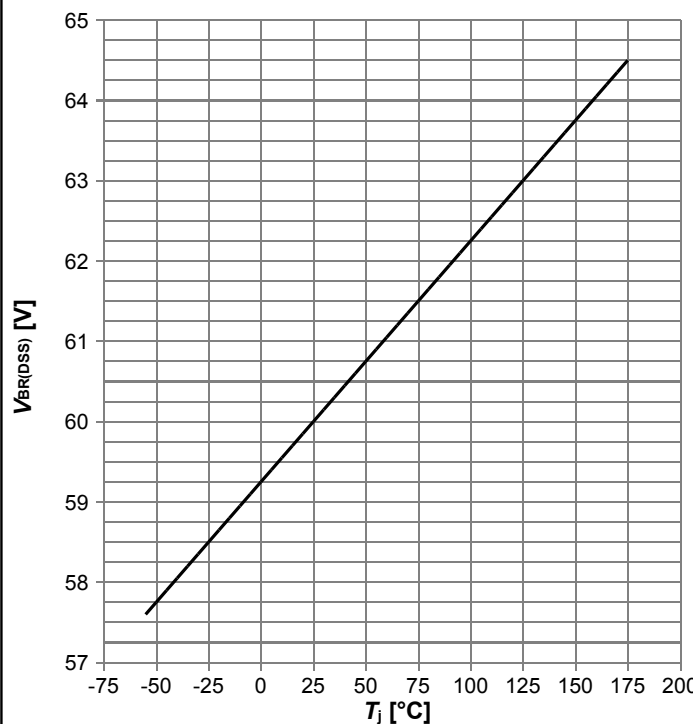
$I_{AS}=f(t_{AV})$ ;  $R_{GS}=25\ \Omega$ ; parameter:  $T_{j,start}$

Diagram 14: Typ. gate charge



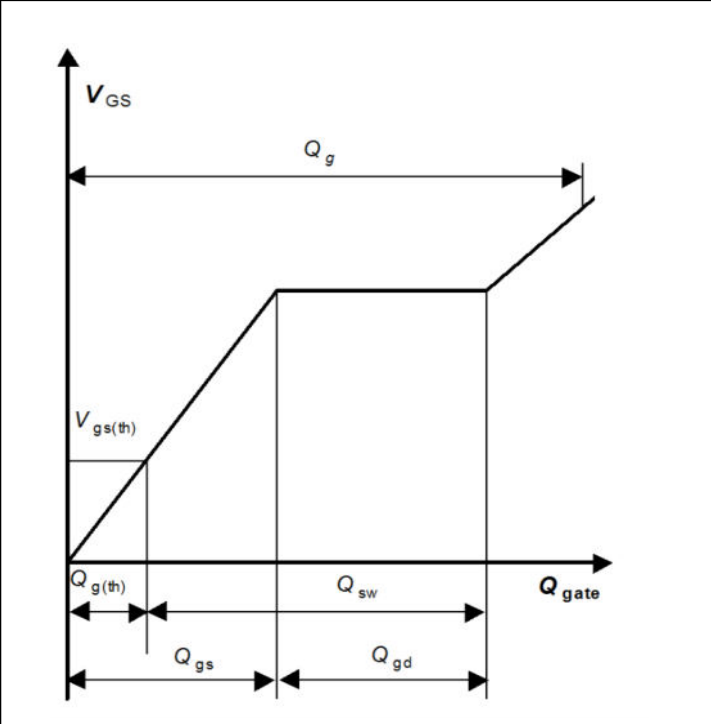
$V_{GS}=f(Q_{gate})$ ,  $I_D=20\text{ A}$  pulsed,  $T_j=25\text{ °C}$ ; parameter:  $V_{DD}$

Diagram 15: Drain-source breakdown voltage

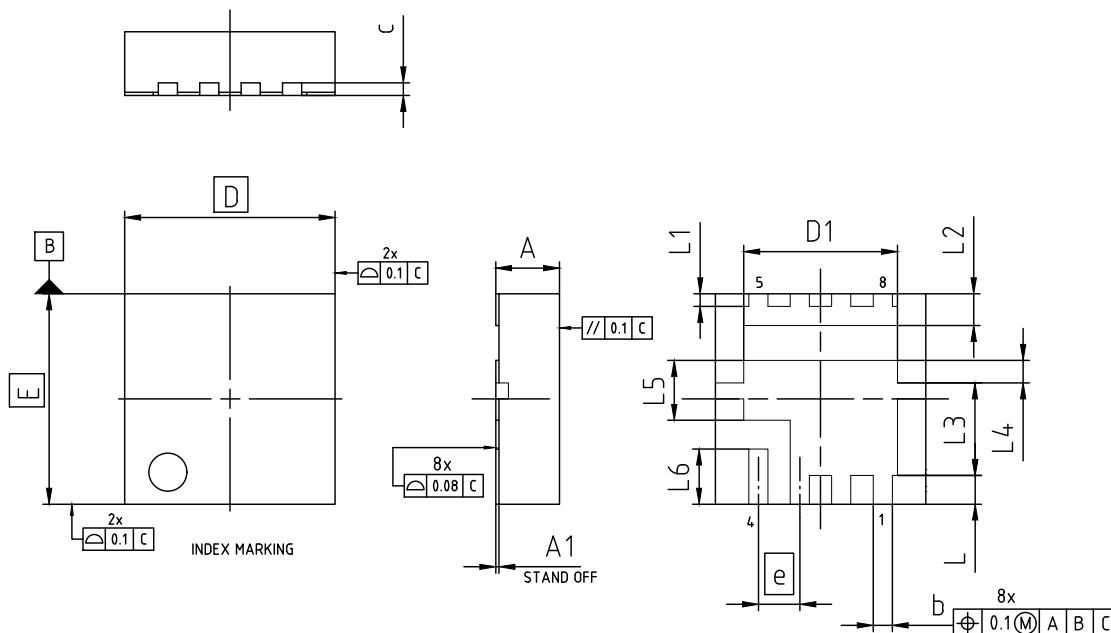


$V_{BR(DSS)}=f(T_j)$ ;  $I_D=1\text{ mA}$

Diagram Gate charge waveforms



## 5 Package Outlines



| DIMENSION | MILLIMETERS |      |
|-----------|-------------|------|
|           | MIN.        | MAX. |
| A         | -           | 1.10 |
| A1        | -           | 0.05 |
| b         | 0.20        | 0.40 |
| c         | 0.20        |      |
| D         | 3.30        |      |
| D1        | 2.31        | 2.51 |
| E         | 3.30        |      |
| e         | 0.65        |      |
| L         | 0.35        | 0.55 |
| L1        | 0.10        | 0.30 |
| L2        | 0.40        | 0.60 |
| L3        | 1.35        | 1.55 |
| L4        | 0.26        | 0.46 |
| L5        | 0.84        | 1.04 |
| L6        | 0.77        | 0.97 |

|                             |
|-----------------------------|
| DOCUMENT NO.<br>Z8B00198723 |
| REVISION<br>01              |
| SCALE 10:1<br>0 1 2mm       |
| EUROPEAN PROJECTION<br>     |
| ISSUE DATE<br>06.11.2019    |

Figure 1 Outline PG-TSON-8, dimensions in mm

## Revision History

IQE022N06LM5

**Revision: 2023-01-12, Rev. 2.0**

Previous Revision

| Revision | Date       | Subjects (major changes since last revision) |
|----------|------------|----------------------------------------------|
| 2.0      | 2023-01-12 | Release of final version                     |

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