



**THE DATASHEET OF
IPA040N06NXKSA1**



MOSFET

Metal Oxide Semiconductor Field Effect Transistor

OptiMOS™

OptiMOS™ Power-Transistor, 60 V
IPA040N06N

Data Sheet

Rev. 2.1
Final

1 Description

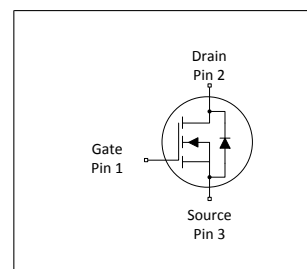
Features

- Optimized for high performance SMPS, e.g. sync. rec.
- 100% avalanche tested
- Superior thermal resistance
- N-channel
- Qualified according to JEDEC¹⁾ for target applications
- Pb-free lead plating; RoHS compliant
- Halogen-free according to IEC61249-2-21



Table 1 Key Performance Parameters

| Parameter | Value | Unit |
|------------------|-------|------|
| V_{DS} | 60 | V |
| $R_{DS(on),max}$ | 4.0 | mΩ |
| I_D | 69 | A |
| Q_{OSS} | 44 | nC |
| $Q_G(0V..10V)$ | 38 | nC |



| Type / Ordering Code | Package | Marking | Related Links |
|----------------------|-------------|---------|---------------|
| IPA040N06N | PG-TO220-FP | 040N06N | - |

¹⁾ J-STD20 and JESD22

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2 Maximum ratings

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

Table 2 Maximum ratings

| Parameter | Symbol | Values | | | Unit | Note / Test Condition |
|--|----------------|--------|------|----------|------|---|
| | | Min. | Typ. | Max. | | |
| Continuous drain current | I_D | - | - | 69 48 | A | $V_{GS}=10\text{ V}$, $T_C=25\text{ °C}$ $V_{GS}=10\text{ V}$, $T_C=100\text{ °C}$ |
| Pulsed drain current ¹⁾ | $I_{D,pulse}$ | - | - | 276 | A | $T_C=25\text{ °C}$ |
| Avalanche energy, single pulse ²⁾ | E_{AS} | - | - | 77 | mJ | $I_D=69\text{ A}$, $R_{GS}=25\text{ }\Omega$ |
| Gate source voltage | V_{GS} | -20 | - | 20 | V | - |
| Power dissipation | P_{tot} | - | - | 36 | 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 |

3 Thermal characteristics

Table 3 Thermal characteristics

| Parameter | Symbol | Values | | | Unit | Note / Test Condition |
|-------------------------------------|------------|--------|------|------|------|-----------------------|
| | | Min. | Typ. | Max. | | |
| Thermal resistance, junction - case | R_{thJC} | - | 3.1 | 4.2 | K/W | - |

4 Electrical characteristics

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 | 2.8 | 3.3 | V | $V_{DS}=V_{GS}$, $I_D=50\text{ }\mu\text{A}$ |
| Zero gate voltage drain current | I_{DSS} | - | 0.1 10 | 1 100 | μA | $V_{DS}=60\text{ V}$, $V_{GS}=0\text{ V}$, $T_j=25\text{ °C}$ $V_{DS}=60\text{ V}$, $V_{GS}=0\text{ V}$, $T_j=125\text{ °C}$ |
| Gate-source leakage current | I_{GSS} | - | 10 | 100 | nA | $V_{GS}=20\text{ V}$, $V_{DS}=0\text{ V}$ |
| Drain-source on-state resistance | $R_{DS(on)}$ | - | 3.6 4.7 | 4.0 5.0 | m Ω | $V_{GS}=10\text{ V}$, $I_D=69\text{ A}$ $V_{GS}=6\text{ V}$, $I_D=18\text{ A}$ |
| Gate resistance ³⁾ | R_G | - | 1.3 | 1.95 | Ω | - |
| Transconductance | g_{fs} | 55 | 110 | - | S | $ V_{DS} >2 I_D /R_{DS(on)max}$, $I_D=69\text{ A}$ |

¹⁾ See figure 3 for more detailed information

²⁾ See figure 13 for more detailed information

³⁾ Defined by design. Not subject to production test

Table 5 Dynamic characteristics¹⁾

| Parameter | Symbol | Values | | | Unit | Note / Test Condition |
|------------------------------|--------------|--------|------|------|------|---|
| | | Min. | Typ. | Max. | | |
| Input capacitance | C_{iss} | - | 2700 | 3375 | pF | $V_{GS}=0\text{ V}$, $V_{DS}=30\text{ V}$, $f=1\text{ MHz}$ |
| Output capacitance | C_{oss} | - | 670 | 838 | pF | $V_{GS}=0\text{ V}$, $V_{DS}=30\text{ V}$, $f=1\text{ MHz}$ |
| Reverse transfer capacitance | C_{rss} | - | 28 | 56 | pF | $V_{GS}=0\text{ V}$, $V_{DS}=30\text{ V}$, $f=1\text{ MHz}$ |
| Turn-on delay time | $t_{d(on)}$ | - | 14 | - | ns | $V_{DD}=30\text{ V}$, $V_{GS}=10\text{ V}$, $I_D=69\text{ A}$, $R_{G,ext}=3\ \Omega$ |
| Rise time | t_r | - | 16 | - | ns | $V_{DD}=30\text{ V}$, $V_{GS}=10\text{ V}$, $I_D=69\text{ A}$, $R_{G,ext}=3\ \Omega$ |
| Turn-off delay time | $t_{d(off)}$ | - | 33 | - | ns | $V_{DD}=30\text{ V}$, $V_{GS}=10\text{ V}$, $I_D=69\text{ A}$, $R_{G,ext}=3\ \Omega$ |
| Fall time | t_f | - | 8 | - | ns | $V_{DD}=30\text{ V}$, $V_{GS}=10\text{ V}$, $I_D=69\text{ A}$, $R_{G,ext}=3\ \Omega$ |

Table 6 Gate charge characteristics²⁾

| Parameter | Symbol | Values | | | Unit | Note / Test Condition |
|------------------------------------|---------------|--------|------|------|------|---|
| | | Min. | Typ. | Max. | | |
| Gate to source charge | Q_{gs} | - | 13 | - | nC | $V_{DD}=30\text{ V}$, $I_D=69\text{ A}$, $V_{GS}=0\text{ to }10\text{ V}$ |
| Gate charge at threshold | $Q_{g(th)}$ | - | 8 | - | nC | $V_{DD}=30\text{ V}$, $I_D=69\text{ A}$, $V_{GS}=0\text{ to }10\text{ V}$ |
| Gate to drain charge ¹⁾ | Q_{gd} | - | 7 | 9 | nC | $V_{DD}=30\text{ V}$, $I_D=69\text{ A}$, $V_{GS}=0\text{ to }10\text{ V}$ |
| Switching charge | Q_{sw} | - | 13 | - | nC | $V_{DD}=30\text{ V}$, $I_D=69\text{ A}$, $V_{GS}=0\text{ to }10\text{ V}$ |
| Gate charge total | Q_g | - | 38 | 44 | nC | $V_{DD}=30\text{ V}$, $I_D=69\text{ A}$, $V_{GS}=0\text{ to }10\text{ V}$ |
| Gate plateau voltage | $V_{plateau}$ | - | 4.8 | - | V | $V_{DD}=30\text{ V}$, $I_D=69\text{ A}$, $V_{GS}=0\text{ to }10\text{ V}$ |
| Gate charge total, sync. FET | $Q_{g(sync)}$ | - | 33 | - | nC | $V_{DS}=0.1\text{ V}$, $V_{GS}=0\text{ to }10\text{ V}$ |
| Output charge ¹⁾ | Q_{oss} | - | 44 | 55 | 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 | - | - | 30 | A | $T_C=25\text{ }^\circ\text{C}$ |
| Diode pulse current | $I_{S,pulse}$ | - | - | 276 | A | $T_C=25\text{ }^\circ\text{C}$ |
| Diode forward voltage | V_{SD} | - | 0.88 | 1.2 | V | $V_{GS}=0\text{ V}$, $I_F=30\text{ A}$, $T_J=25\text{ }^\circ\text{C}$ |
| Reverse recovery time ¹⁾ | t_{rr} | - | 33 | 53 | ns | $V_R=30\text{ V}$, $I_F=30\text{ A}$, $di_F/dt=100\text{ A}/\mu\text{s}$ |
| Reverse recovery charge ¹⁾ | Q_{rr} | - | 28 | - | nC | $V_R=30\text{ V}$, $I_F=30\text{ A}$, $di_F/dt=100\text{ A}/\mu\text{s}$ |

¹⁾ Defined by design. Not subject to production test

²⁾ See "Gate charge waveforms" for parameter definition

5 Electrical characteristics diagrams

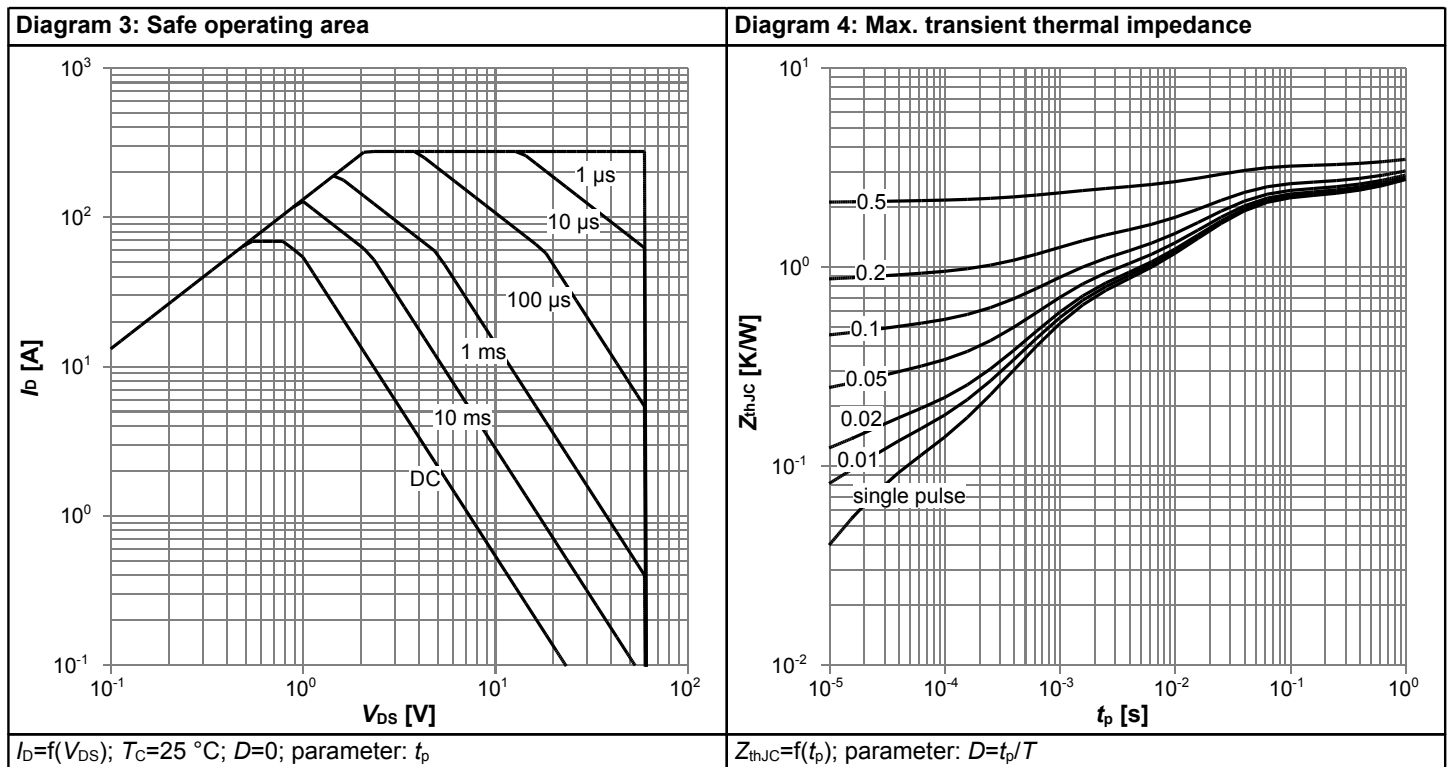
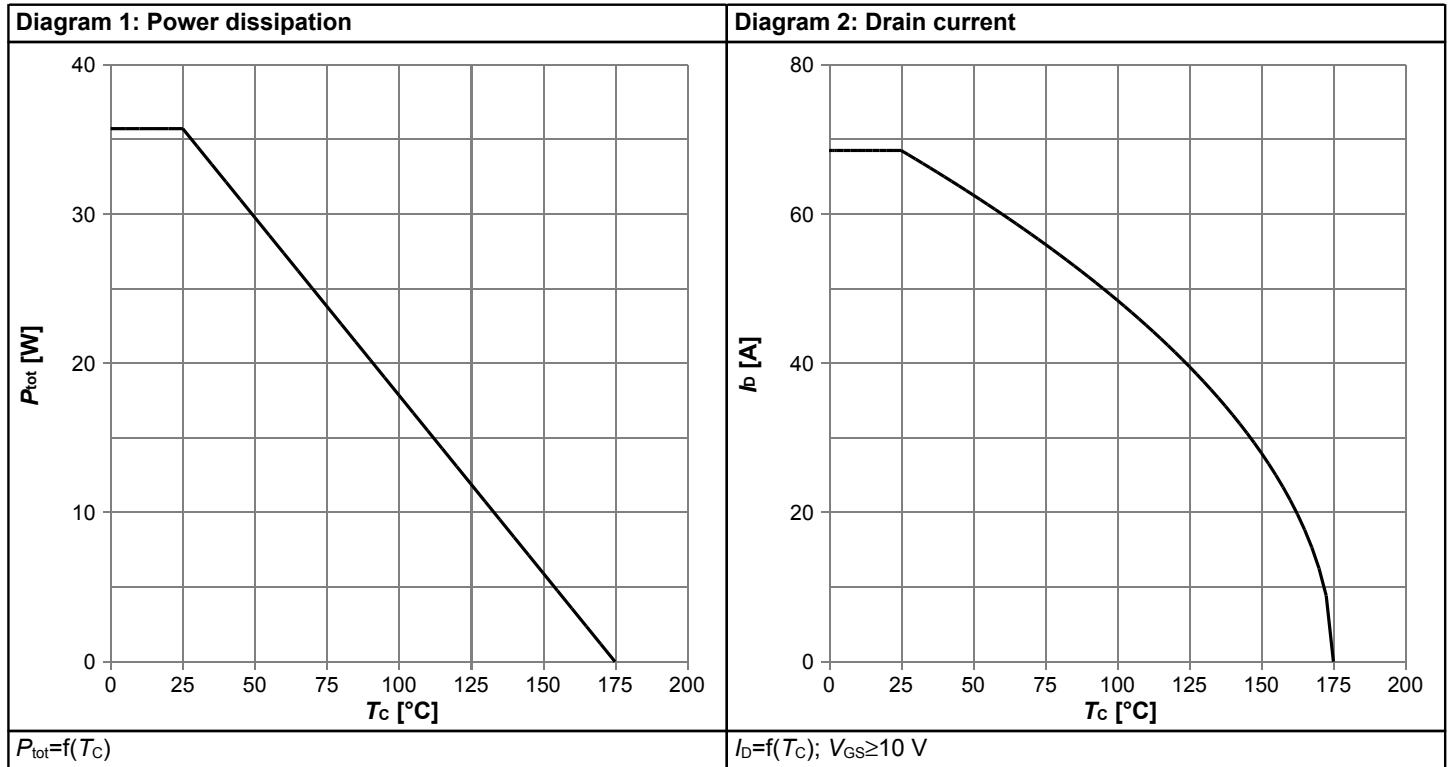
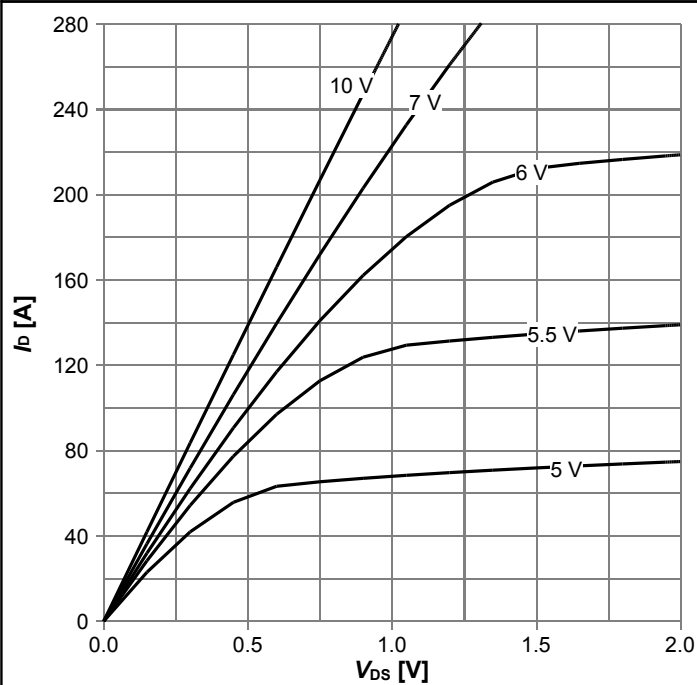
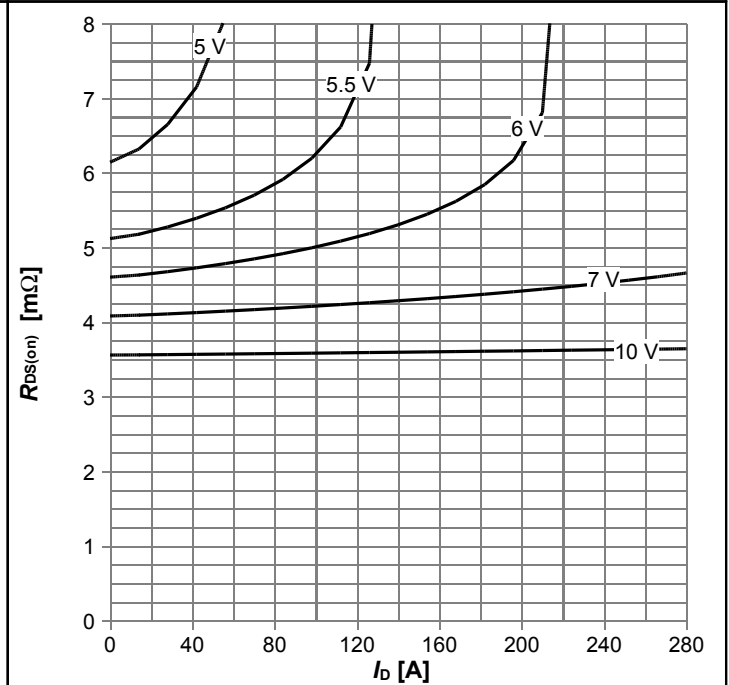


Diagram 5: Typ. output characteristics



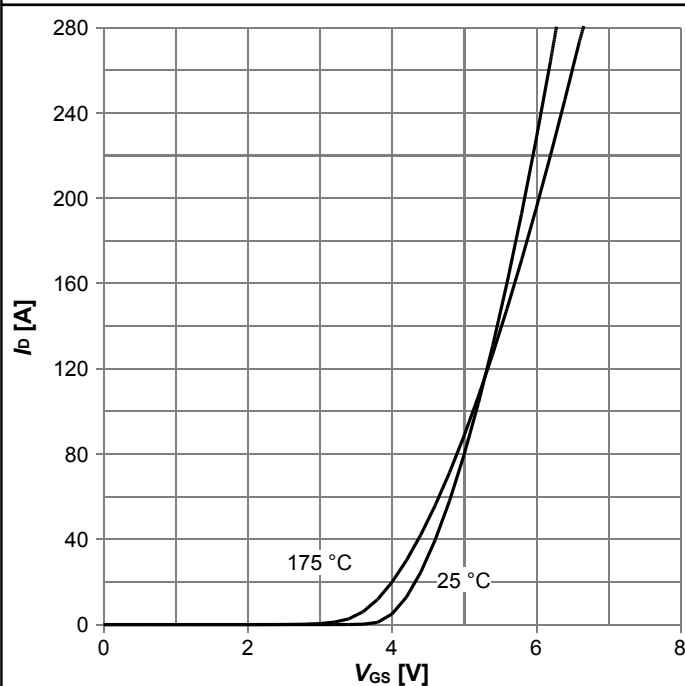
$I_D=f(V_{DS}); T_j=25\text{ }^\circ\text{C};$ parameter: V_{GS}

Diagram 6: Typ. drain-source on resistance



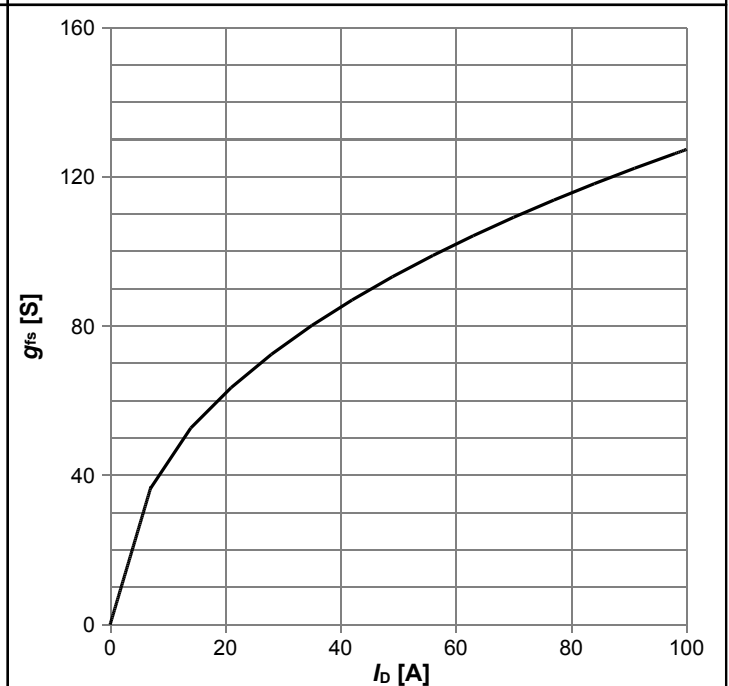
$R_{DS(on)}=f(I_D); T_j=25\text{ }^\circ\text{C};$ parameter: V_{GS}

Diagram 7: Typ. transfer characteristics



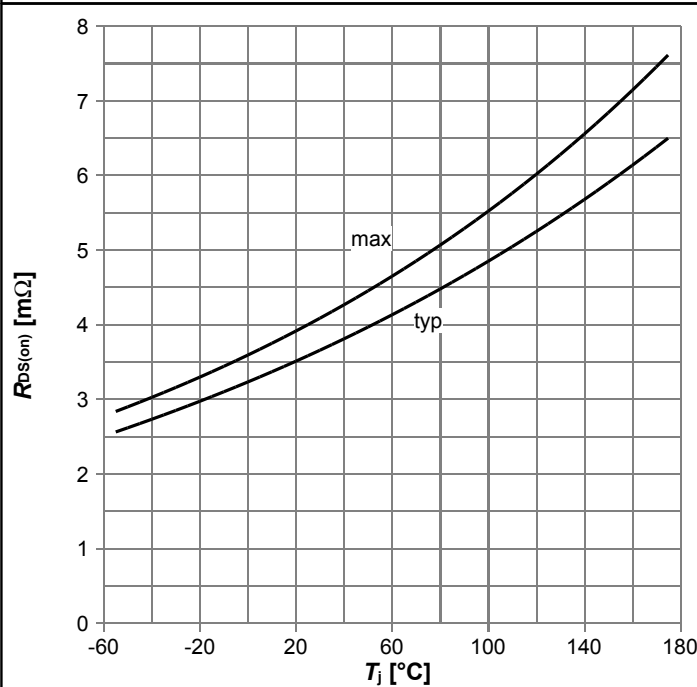
$I_D=f(V_{GS}); |V_{DS}|>2|I_D|R_{DS(on)max};$ parameter: T_j

Diagram 8: Typ. forward transconductance



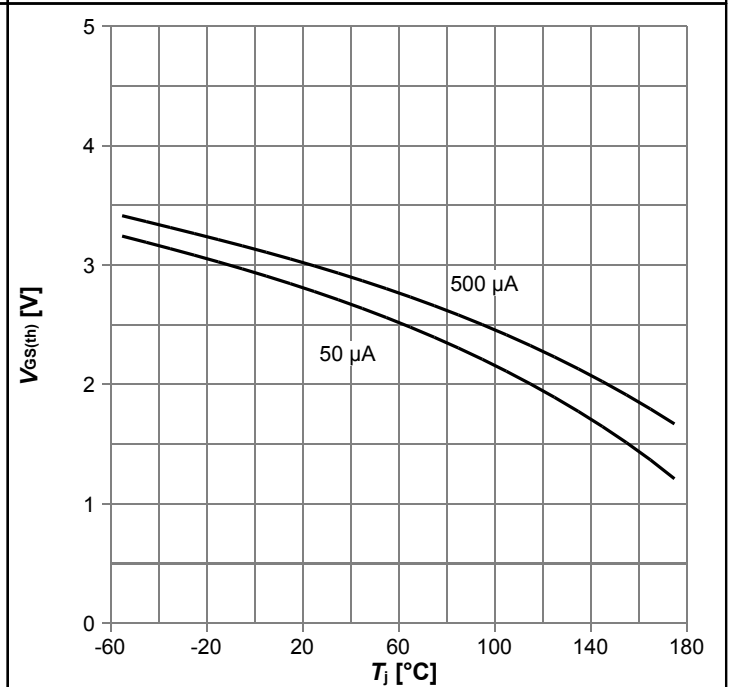
$g_{fs}=f(I_D); T_j=25\text{ }^\circ\text{C}$

Diagram 9: Drain-source on-state resistance



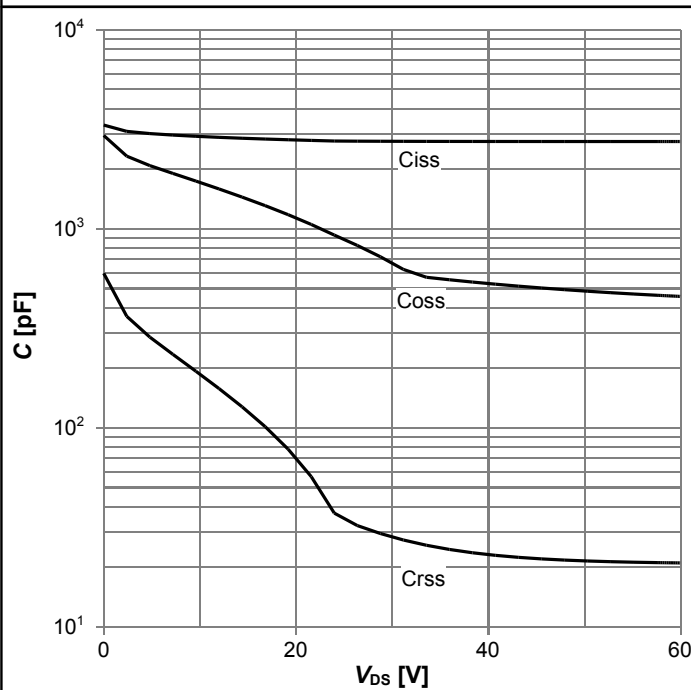
$R_{DS(on)}=f(T_j); I_D=69\text{ A}; V_{GS}=10\text{ V}$

Diagram 10: Typ. gate threshold voltage



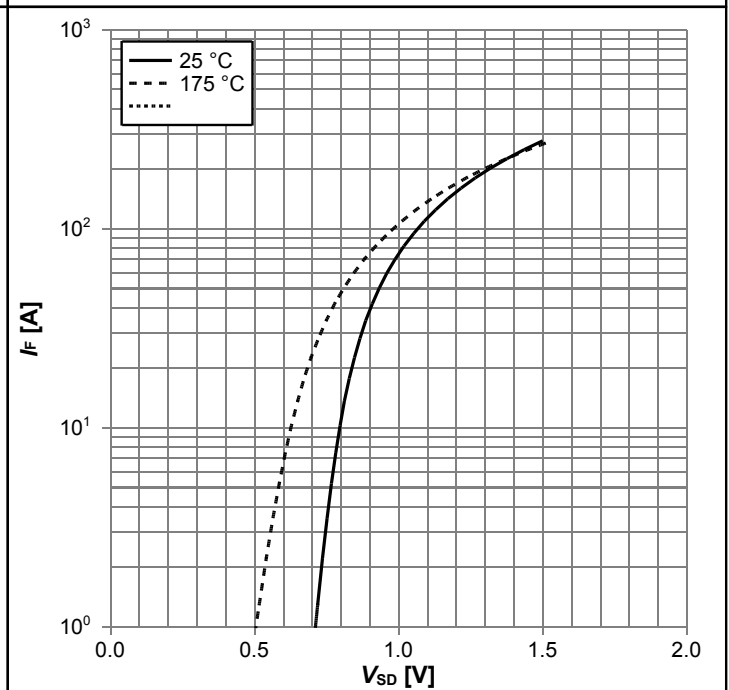
$V_{GS(th)}=f(T_j); V_{GS}=V_{DS}$

Diagram 11: Typ. capacitances



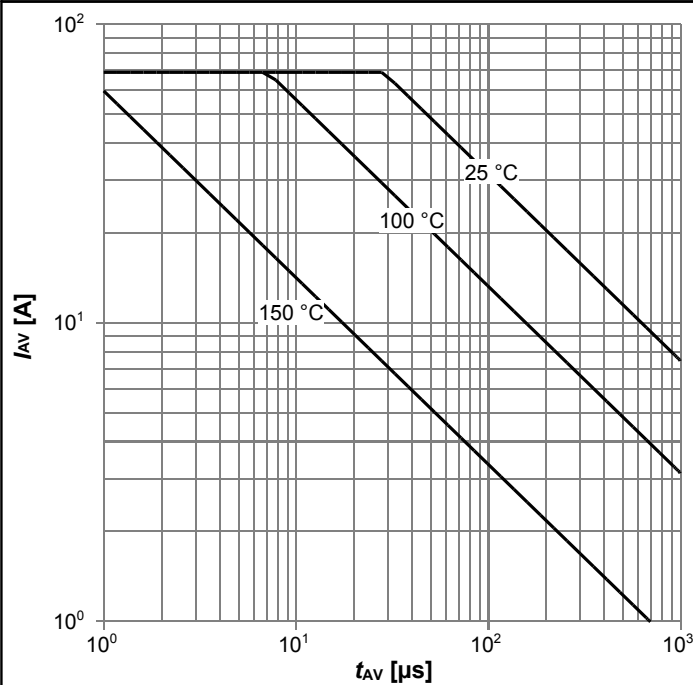
$C=f(V_{DS}); V_{GS}=0\text{ V}; f=1\text{ MHz}$

Diagram 12: Forward characteristics of reverse diode



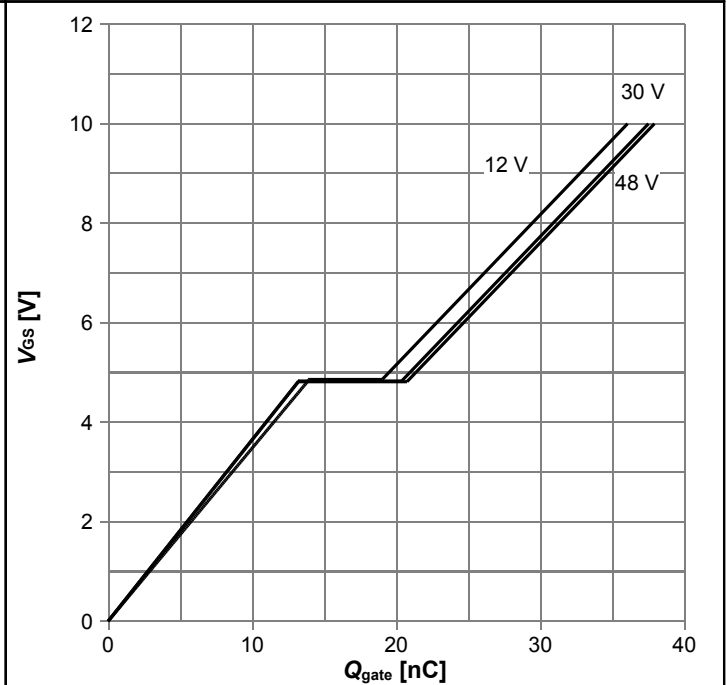
$I_F=f(V_{SD}); \text{parameter: } T_j$

Diagram 13: Avalanche characteristics



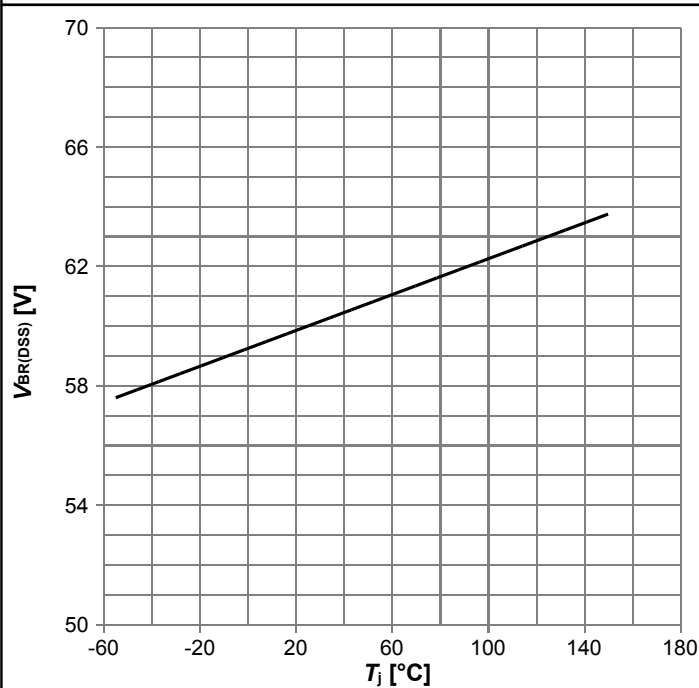
$I_{AS}=f(t_{AV})$; $R_{GS}=25 \Omega$; parameter: $T_{j(start)}$

Diagram 14: Typ. gate charge



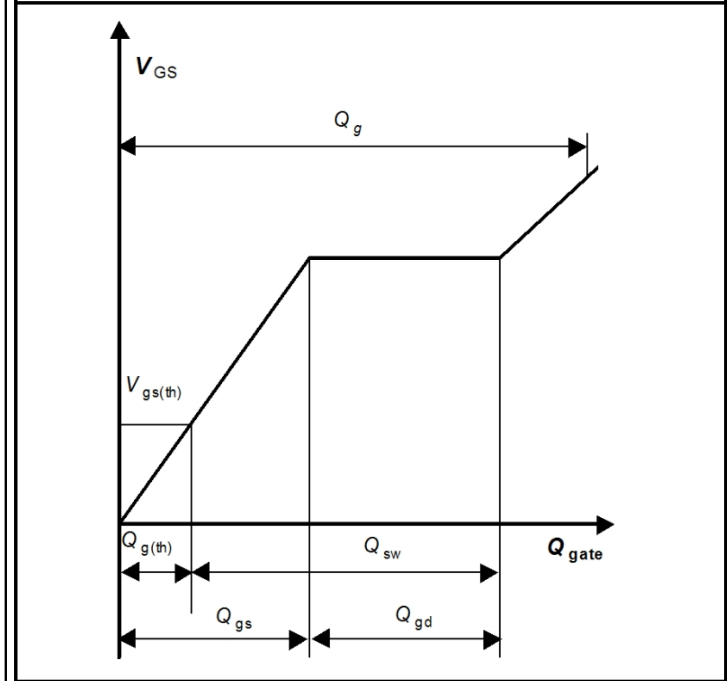
$V_{GS}=f(Q_{gate})$; $I_D=69$ A pulsed; parameter: V_{DD}

Diagram 15: Drain-source breakdown voltage

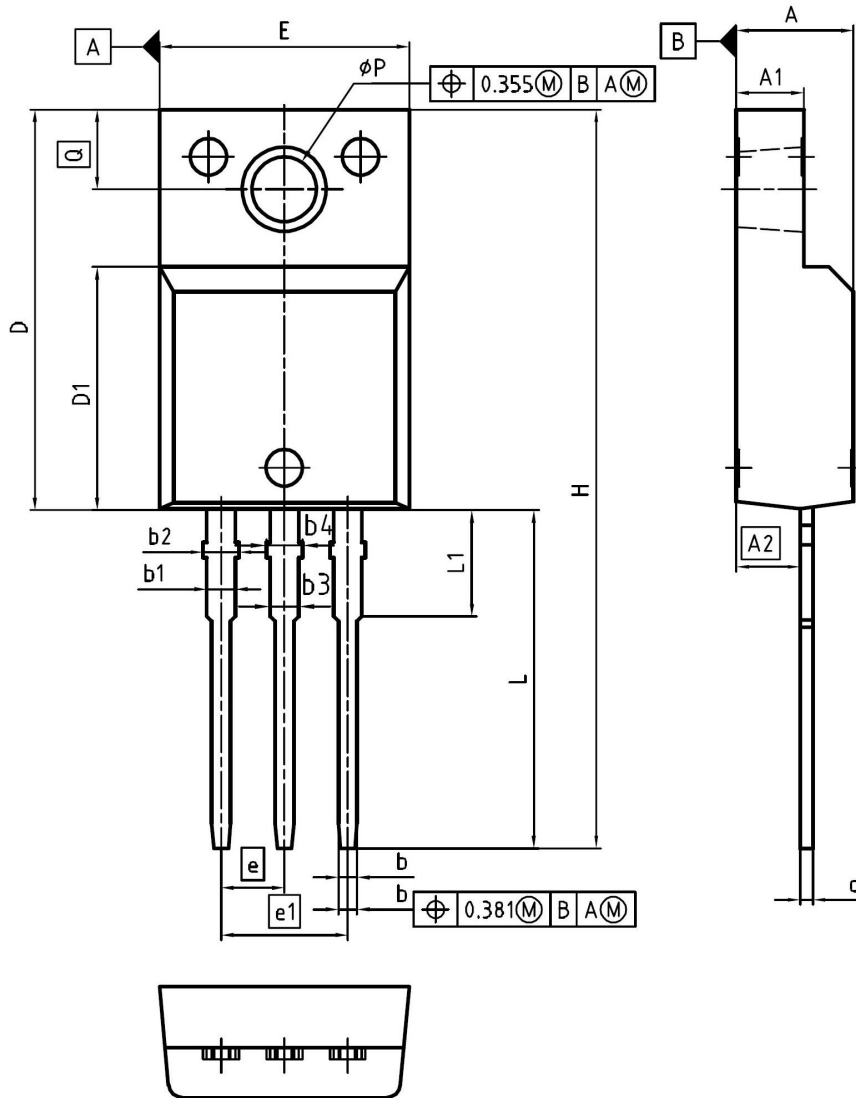


$V_{BR(DSS)}=f(T_j)$; $I_D=1$ mA

Gate charge waveforms



6 Package Outlines



| DIM | MILLIMETERS | | INCHES | |
|-----|-------------|-------|--------|-------|
| | MIN | MAX | MIN | MAX |
| A | 4.55 | 4.85 | 0.179 | 0.191 |
| A1 | 2.55 | 2.85 | 0.100 | 0.112 |
| A2 | 2.42 | 2.72 | 0.095 | 0.107 |
| b | 0.65 | 0.85 | 0.026 | 0.033 |
| b1 | 0.95 | 1.33 | 0.037 | 0.052 |
| b2 | 0.95 | 1.51 | 0.037 | 0.059 |
| b3 | 0.65 | 1.33 | 0.026 | 0.052 |
| b4 | 0.65 | 1.51 | 0.026 | 0.059 |
| c | 0.40 | 0.63 | 0.016 | 0.025 |
| D | 15.85 | 16.15 | 0.624 | 0.636 |
| D1 | 9.53 | 9.83 | 0.375 | 0.387 |
| E | 10.35 | 10.65 | 0.407 | 0.419 |
| e | 2.54 | | 0.100 | |
| e1 | 5.08 | | 0.200 | |
| N | 3 | | 3 | |
| H | 29.45 | 29.75 | 1.159 | 1.171 |
| L | 13.45 | 13.75 | 0.530 | 0.541 |
| L1 | 3.15 | 3.45 | 0.124 | 0.136 |
| φP | 2.95 | 3.20 | 0.116 | 0.126 |
| Q | 3.15 | 3.50 | 0.124 | 0.138 |

DOCUMENT NO.
Z8B00003319

SCALE

EUROPEAN PROJECTION

ISSUE DATE
08-03-2007

REVISION
03

Figure 1 Outline PG-TO220-FP, dimensions in mm/inches

Revision History

IPA040N06N

Revision: 2014-06-19, Rev. 2.1

Previous Revision

| Revision | Date | Subjects (major changes since last revision) |
|----------|------------|--|
| 2.1 | 2014-06-19 | Rev.2.1 |

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Infineon Technologies AG

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