

# PHU78NQ03LT

## N-channel TrenchMOS logic level FET

Rev. 06 — 15 June 2009

Product data sheet

## 1. Product profile

### 1.1 General description

Logic level N-channel enhancement mode Field-Effect Transistor (FET) in a plastic package using TrenchMOS technology. This product is designed and qualified for use in computing, communications, consumer and industrial applications only.

### 1.2 Features and benefits

- Suitable for high frequency applications due to fast switching characteristics
- Suitable for logic level gate drive sources

### 1.3 Applications

- Computer motherboards
- DC-to-DC convertors

### 1.4 Quick reference data

Table 1. Quick reference

| Symbol                         | Parameter                        | Conditions                                                                                                                                                   | Min | Typ  | Max | Unit |
|--------------------------------|----------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|------|-----|------|
| $V_{DS}$                       | drain-source voltage             | $T_j \geq 25\text{ °C}$ ; $T_j \leq 175\text{ °C}$                                                                                                           | -   | -    | 25  | V    |
| $I_D$                          | drain current                    | $T_{mb} = 25\text{ °C}$ ; $V_{GS} = 10\text{ V}$ ; see <a href="#">Figure 1</a> ; see <a href="#">Figure 3</a>                                               | -   | -    | 75  | A    |
| $P_{tot}$                      | total power dissipation          | $T_{mb} = 25\text{ °C}$ ; see <a href="#">Figure 2</a>                                                                                                       | -   | -    | 107 | W    |
| <b>Dynamic characteristics</b> |                                  |                                                                                                                                                              |     |      |     |      |
| $Q_{GD}$                       | gate-drain charge                | $V_{GS} = 4.5\text{ V}$ ; $I_D = 25\text{ A}$ ; $V_{DS} = 12\text{ V}$ ; $T_j = 25\text{ °C}$ ; see <a href="#">Figure 9</a> ; see <a href="#">Figure 10</a> | -   | 4    | -   | nC   |
| <b>Static characteristics</b>  |                                  |                                                                                                                                                              |     |      |     |      |
| $R_{DS(on)}$                   | drain-source on-state resistance | $V_{GS} = 10\text{ V}$ ; $I_D = 25\text{ A}$ ; $T_j = 25\text{ °C}$ ; see <a href="#">Figure 7</a> ; see <a href="#">Figure 8</a>                            | -   | 7.65 | 9   | mΩ   |

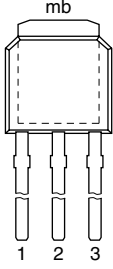
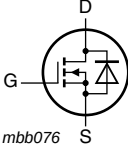
2. Ordering information

Table 2. Ordering information

| Type number | Package |                                                        | Version |
|-------------|---------|--------------------------------------------------------|---------|
|             | Name    | Description                                            |         |
| PHU78NQ03LT | IPAK    | plastic single-ended package (IPAK); 3 leads (in-line) | SOT533  |

3. Pinning information

Table 3. Pinning information

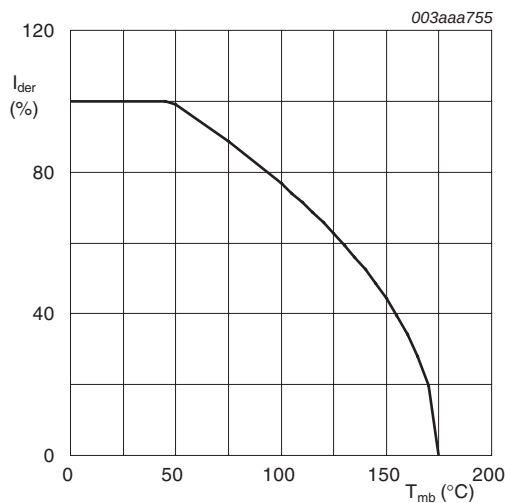
| Pin | Symbol | Description                       | Simplified outline                                                                 | Graphic symbol                                                                      |
|-----|--------|-----------------------------------|------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
| 1   | G      | gate                              |  |  |
| 2   | D      | drain                             |                                                                                    |                                                                                     |
| 3   | S      | source                            |                                                                                    |                                                                                     |
| mb  | D      | mounting base; connected to drain |                                                                                    |                                                                                     |
|     |        |                                   | <b>SOT533<br/>(IPAK)</b>                                                           |                                                                                     |

## 4. Limiting values

**Table 4. Limiting values**

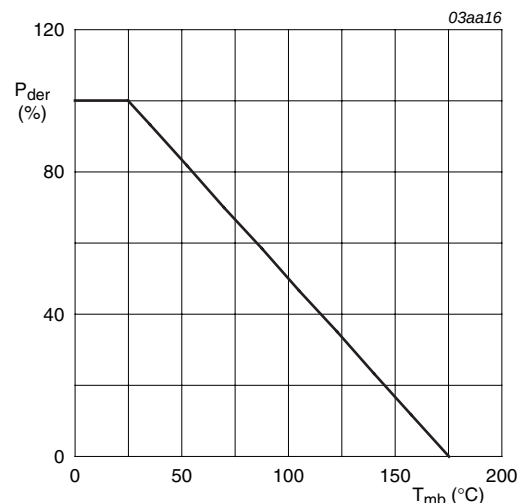
In accordance with the Absolute Maximum Rating System (IEC 60134).

| Symbol                      | Parameter                                    | Conditions                                                                                                                                                        | Min | Max  | Unit |
|-----------------------------|----------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|------|------|
| V <sub>DS</sub>             | drain-source voltage                         | T <sub>j</sub> ≥ 25 °C; T <sub>j</sub> ≤ 175 °C                                                                                                                   | -   | 25   | V    |
| V <sub>DGR</sub>            | drain-gate voltage                           | R <sub>GS</sub> = 20 kΩ; T <sub>mb</sub> ≥ 25 °C; T <sub>mb</sub> ≤ 175 °C                                                                                        | -   | 25   | V    |
| V <sub>GS</sub>             | gate-source voltage                          |                                                                                                                                                                   | -20 | 20   | V    |
| I <sub>D</sub>              | drain current                                | V <sub>GS</sub> = 5 V; T <sub>mb</sub> = 100 °C                                                                                                                   | -   | 46.9 | A    |
|                             |                                              | V <sub>GS</sub> = 10 V; T <sub>mb</sub> = 100 °C; see <a href="#">Figure 1</a>                                                                                    | -   | 57.5 | A    |
|                             |                                              | V <sub>GS</sub> = 10 V; T <sub>mb</sub> = 25 °C; see <a href="#">Figure 1</a> ; see <a href="#">Figure 3</a>                                                      | -   | 75   | A    |
|                             |                                              | V <sub>GS</sub> = 5 V; T <sub>mb</sub> = 25 °C                                                                                                                    | -   | 66.4 | A    |
| I <sub>DM</sub>             | peak drain current                           | t <sub>p</sub> ≤ 10 μs; pulsed; T <sub>mb</sub> = 25 °C; see <a href="#">Figure 3</a>                                                                             | -   | 240  | A    |
| P <sub>tot</sub>            | total power dissipation                      | T <sub>mb</sub> = 25 °C; see <a href="#">Figure 2</a>                                                                                                             | -   | 107  | W    |
| T <sub>stg</sub>            | storage temperature                          |                                                                                                                                                                   | -55 | 175  | °C   |
| T <sub>j</sub>              | junction temperature                         |                                                                                                                                                                   | -55 | 175  | °C   |
| <b>Source-drain diode</b>   |                                              |                                                                                                                                                                   |     |      |      |
| I <sub>S</sub>              | source current                               | T <sub>mb</sub> = 25 °C                                                                                                                                           | -   | 75   | A    |
| I <sub>SM</sub>             | peak source current                          | t <sub>p</sub> ≤ 10 μs; pulsed; T <sub>mb</sub> = 25 °C                                                                                                           | -   | 240  | A    |
| <b>Avalanche ruggedness</b> |                                              |                                                                                                                                                                   |     |      |      |
| E <sub>DS(AL)S</sub>        | non-repetitive drain-source avalanche energy | V <sub>GS</sub> = 10 V; T <sub>j(init)</sub> = 25 °C; I <sub>D</sub> = 32 A; V <sub>sup</sub> ≤ 25 V; unclamped; t <sub>p</sub> = 0.17 ms; R <sub>GS</sub> = 50 Ω | -   | 100  | mJ   |



$$I_{der} = \frac{I_D}{I_{D(25^\circ\text{C})}} \times 100\%$$

**Fig 1. Normalized continuous drain current as a function of mounting base temperature**



$$P_{der} = \frac{P_{tot}}{P_{tot(25^\circ\text{C})}} \times 100\%$$

**Fig 2. Normalized total power dissipation as a function of mounting base temperature**

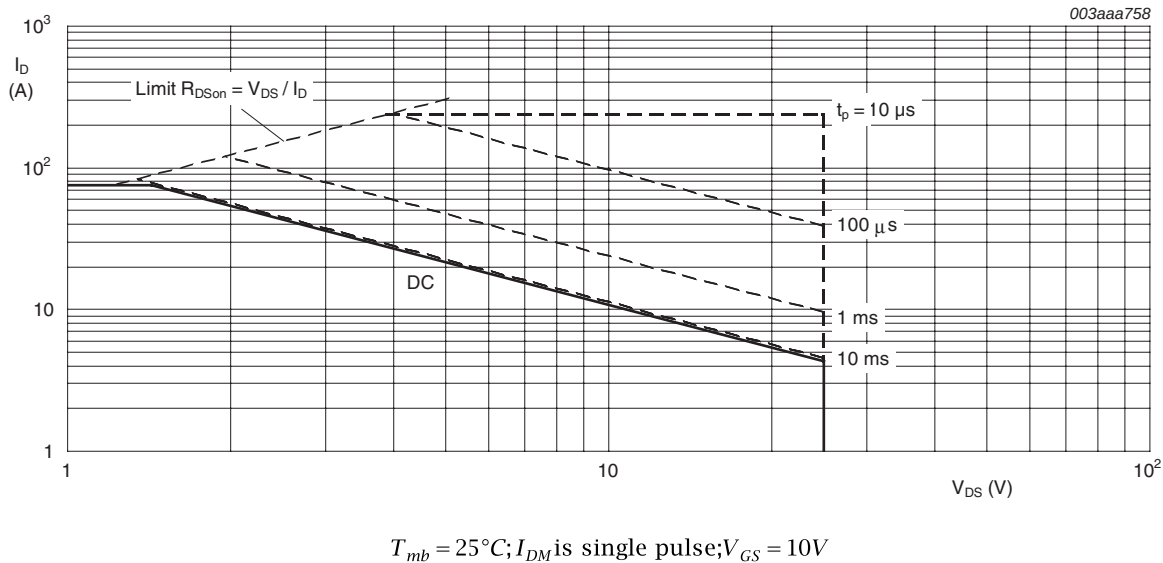


Fig 3. Safe operating area; continuous and peak drain currents as a function of drain-source voltage

5. Thermal characteristics

Table 5. Thermal characteristics

| Symbol         | Parameter                                         | Conditions                   | Min | Typ | Max | Unit |
|----------------|---------------------------------------------------|------------------------------|-----|-----|-----|------|
| $R_{th(j-mb)}$ | thermal resistance from junction to mounting base | see <a href="#">Figure 4</a> | -   | -   | 1.4 | K/W  |
| $R_{th(j-a)}$  | thermal resistance from junction to ambient       | vertical in free air         | -   | 70  | -   | K/W  |

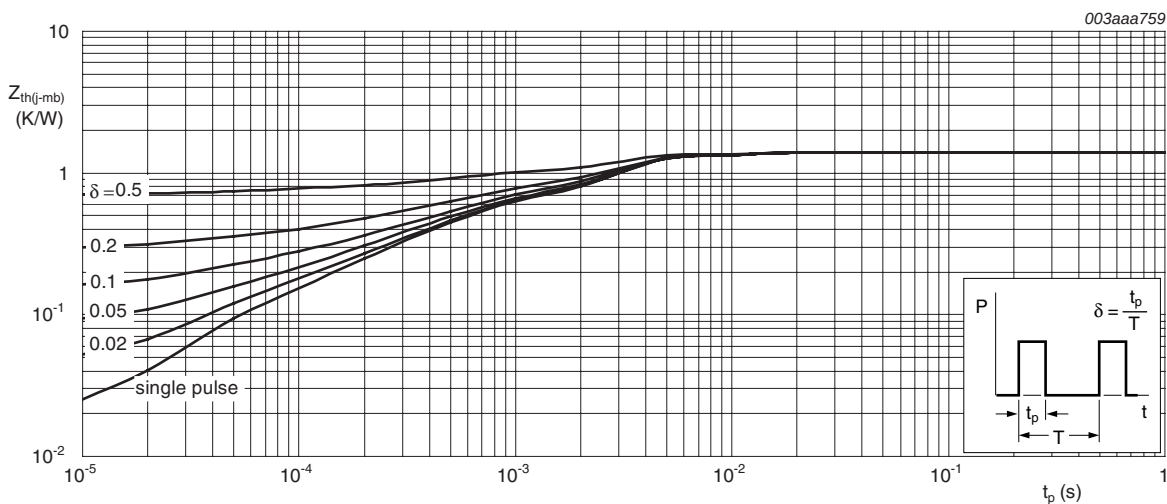


Fig 4. Transient thermal impedance from junction to mounting base as a function of pulse duration

## 6. Characteristics

**Table 6. Characteristics**

| Symbol                         | Parameter                         | Conditions                                                                                                                                  | Min | Typ  | Max  | Unit       |
|--------------------------------|-----------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------|-----|------|------|------------|
| <b>Static characteristics</b>  |                                   |                                                                                                                                             |     |      |      |            |
| $V_{(BR)DSS}$                  | drain-source breakdown voltage    | $I_D = 250\ \mu A$ ; $V_{GS} = 0\ V$ ; $T_j = -55\ ^\circ C$                                                                                | 22  | -    | -    | V          |
|                                |                                   | $I_D = 250\ \mu A$ ; $V_{GS} = 0\ V$ ; $T_j = 25\ ^\circ C$                                                                                 | 25  | -    | -    | V          |
| $V_{GS(th)}$                   | gate-source threshold voltage     | $I_D = 1\ mA$ ; $V_{DS} = V_{GS}$ ; $T_j = -55\ ^\circ C$ ; see <a href="#">Figure 5</a> ; see <a href="#">Figure 6</a>                     | -   | -    | 2.2  | V          |
|                                |                                   | $I_D = 1\ mA$ ; $V_{DS} = V_{GS}$ ; $T_j = 175\ ^\circ C$ ; see <a href="#">Figure 5</a> ; see <a href="#">Figure 6</a>                     | 0.5 | -    | -    | V          |
|                                |                                   | $I_D = 1\ mA$ ; $V_{DS} = V_{GS}$ ; $T_j = 25\ ^\circ C$ ; see <a href="#">Figure 5</a> ; see <a href="#">Figure 6</a>                      | 1   | 1.5  | 2    | V          |
| $I_{DSS}$                      | drain leakage current             | $V_{DS} = 25\ V$ ; $V_{GS} = 0\ V$ ; $T_j = 25\ ^\circ C$                                                                                   | -   | -    | 1    | $\mu A$    |
|                                |                                   | $V_{DS} = 25\ V$ ; $V_{GS} = 0\ V$ ; $T_j = 175\ ^\circ C$                                                                                  | -   | -    | 500  | $\mu A$    |
| $I_{GSS}$                      | gate leakage current              | $V_{GS} = 15\ V$ ; $V_{DS} = 0\ V$ ; $T_j = 25\ ^\circ C$                                                                                   | -   | 10   | 100  | nA         |
|                                |                                   | $V_{GS} = -15\ V$ ; $V_{DS} = 0\ V$ ; $T_j = 25\ ^\circ C$                                                                                  | -   | 10   | 100  | nA         |
| $R_{DS(on)}$                   | drain-source on-state resistance  | $V_{GS} = 10\ V$ ; $I_D = 25\ A$ ; $T_j = 25\ ^\circ C$ ; see <a href="#">Figure 7</a> ; see <a href="#">Figure 8</a>                       | -   | 7.65 | 9    | m $\Omega$ |
|                                |                                   | $V_{GS} = 5\ V$ ; $I_D = 25\ A$ ; $T_j = 175\ ^\circ C$ ; see <a href="#">Figure 7</a> ; see <a href="#">Figure 8</a>                       | -   | 18.9 | 24.3 | m $\Omega$ |
|                                |                                   | $V_{GS} = 5\ V$ ; $I_D = 25\ A$ ; $T_j = 25\ ^\circ C$ ; see <a href="#">Figure 7</a> ; see <a href="#">Figure 8</a>                        | -   | 10.5 | 13.5 | m $\Omega$ |
| $R_G$                          | internal gate resistance (AC)     | $f = 1\ MHz$ ; $T_j = 25\ ^\circ C$                                                                                                         | -   | 1    | -    | $\Omega$   |
| <b>Dynamic characteristics</b> |                                   |                                                                                                                                             |     |      |      |            |
| $Q_{G(tot)}$                   | total gate charge                 | $I_D = 0\ A$ ; $V_{DS} = 0\ V$ ; $V_{GS} = 4.5\ V$ ; $T_j = 25\ ^\circ C$                                                                   | -   | 8.6  | -    | nC         |
|                                |                                   | $I_D = 25\ A$ ; $V_{DS} = 12\ V$ ; $V_{GS} = 4.5\ V$ ; $T_j = 25\ ^\circ C$ ; see <a href="#">Figure 9</a> ; see <a href="#">Figure 10</a>  | -   | 11   | -    | nC         |
| $Q_{GS}$                       | gate-source charge                | $I_D = 25\ A$ ; $V_{DS} = 12\ V$ ; $V_{GS} = 4.5\ V$ ; $T_j = 25\ ^\circ C$ ; see <a href="#">Figure 10</a> ; see <a href="#">Figure 10</a> | -   | 3.6  | -    | nC         |
| $Q_{GS1}$                      | pre-threshold gate-source charge  |                                                                                                                                             | -   | 1.8  | -    | nC         |
| $Q_{GS2}$                      | post-threshold gate-source charge |                                                                                                                                             | -   | 1.8  | -    | nC         |
| $Q_{GD}$                       | gate-drain charge                 |                                                                                                                                             | -   | 4    | -    | nC         |
| $V_{GS(pl)}$                   | gate-source plateau voltage       | $I_D = 25\ A$ ; $V_{DS} = 12\ V$ ; $T_j = 25\ ^\circ C$ ; see <a href="#">Figure 9</a> ; see <a href="#">Figure 10</a>                      | -   | 3    | -    | V          |
| $C_{iss}$                      | input capacitance                 | $V_{DS} = 12\ V$ ; $V_{GS} = 0\ V$ ; $f = 1\ MHz$ ; $T_j = 25\ ^\circ C$ ; see <a href="#">Figure 11</a>                                    | -   | 970  | -    | pF         |
|                                |                                   |                                                                                                                                             | -   | 1460 | -    | pF         |
| $C_{oss}$                      | output capacitance                |                                                                                                                                             | -   | 415  | -    | pF         |
| $C_{rss}$                      | reverse transfer capacitance      |                                                                                                                                             | -   | 170  | -    | pF         |

Table 6. Characteristics ...continued

| Symbol              | Parameter             | Conditions                                                                                                                    | Min | Typ  | Max | Unit |
|---------------------|-----------------------|-------------------------------------------------------------------------------------------------------------------------------|-----|------|-----|------|
| t <sub>d(on)</sub>  | turn-on delay time    | V <sub>DS</sub> = 12 V; R <sub>L</sub> = 0.5 Ω; V <sub>GS</sub> = 5 V;<br>R <sub>G(ext)</sub> = 5.6 Ω; T <sub>j</sub> = 25 °C | -   | 13   | -   | ns   |
| t <sub>r</sub>      | rise time             |                                                                                                                               | -   | 46   | -   | ns   |
| t <sub>d(off)</sub> | turn-off delay time   |                                                                                                                               | -   | 20   | -   | ns   |
| t <sub>f</sub>      | fall time             |                                                                                                                               | -   | 15   | -   | ns   |
| Source-drain diode  |                       |                                                                                                                               |     |      |     |      |
| V <sub>SD</sub>     | source-drain voltage  | I <sub>S</sub> = 25 A; V <sub>GS</sub> = 0 V; T <sub>j</sub> = 25 °C;<br>see <a href="#">Figure 12</a>                        | -   | 0.78 | 1.2 | V    |
| t <sub>rr</sub>     | reverse recovery time | I <sub>S</sub> = 20 A; dI <sub>S</sub> /dt = -100 A/μs; V <sub>GS</sub> = 0 V;                                                | -   | 35   | -   | ns   |
| Q <sub>r</sub>      | recovered charge      | V <sub>DS</sub> = 25 V; T <sub>j</sub> = 25 °C                                                                                | -   | 20   | -   | nC   |

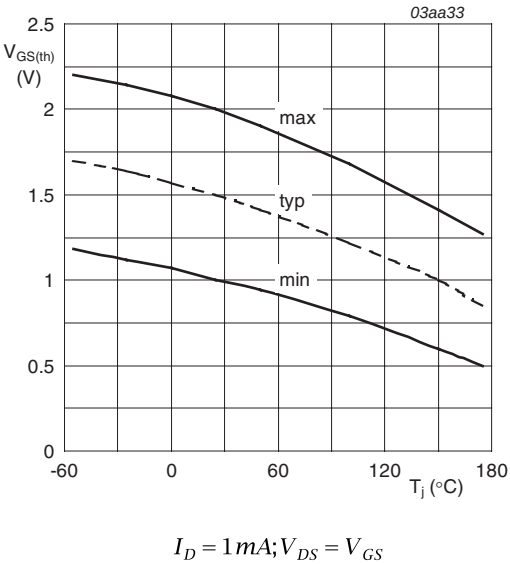


Fig 5. Gate-source threshold voltage as a function of junction temperature

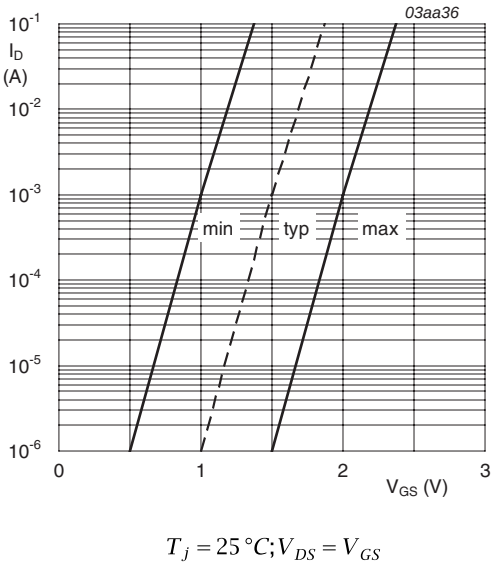


Fig 6. Sub-threshold drain current as a function of gate-source voltage

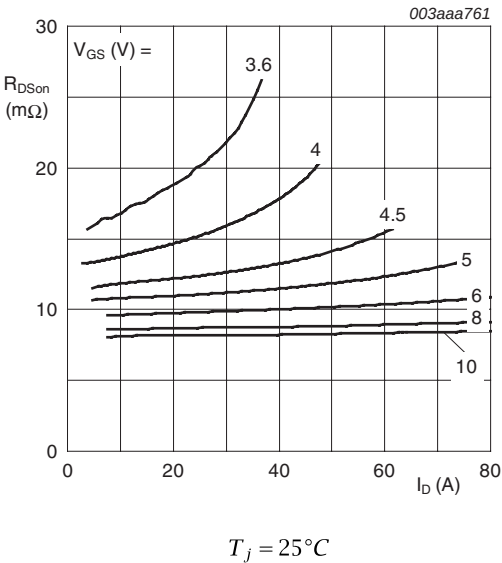
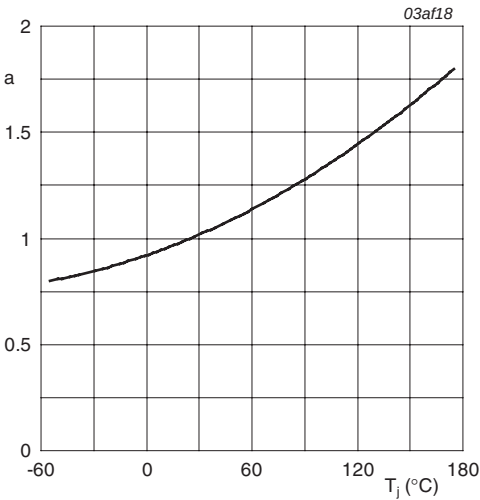


Fig 7. Drain-source on-state resistance as a function of drain current; typical values



$$a = \frac{R_{DS(on)}}{R_{DS(on)(25^\circ\text{C})}}$$

Fig 8. Normalized drain-source on-state resistance factor as a function of junction temperature

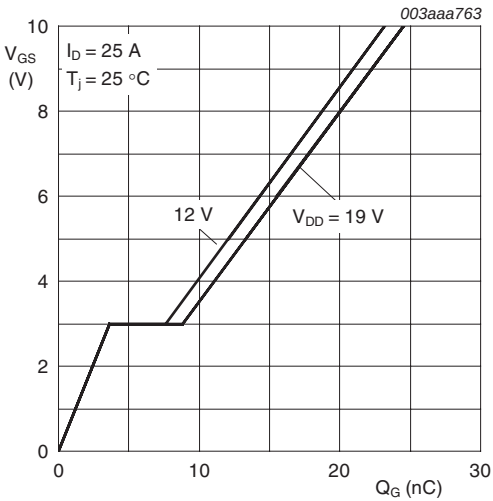


Fig 9. Gate-source voltage as a function of gate charge; typical values

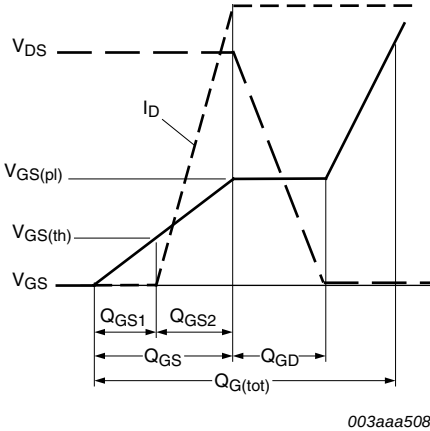
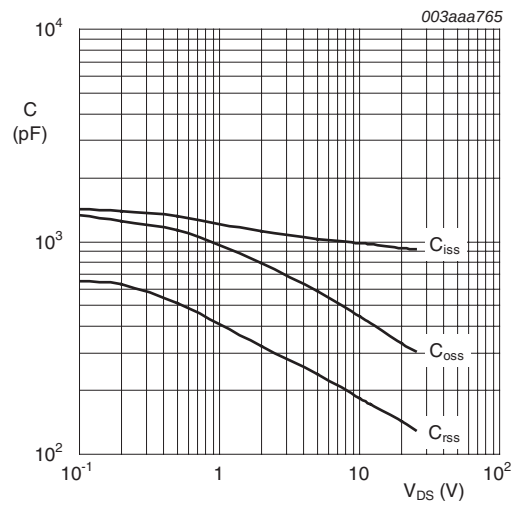
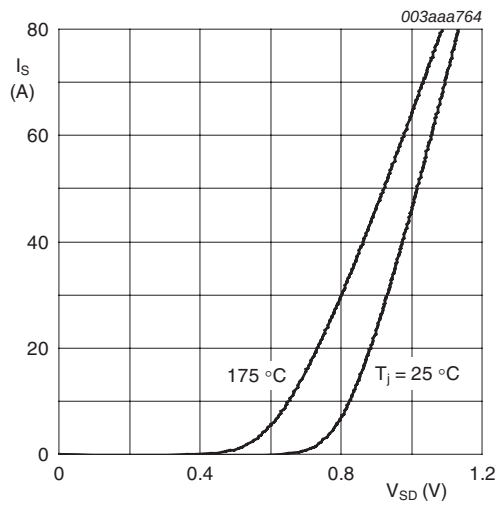


Fig 10. Gate charge waveform definitions



$V_{GS} = 0V; f = 1MHz$

Fig 11. Input, output and reverse transfer capacitances as a function of drain-source voltage; typical values



$T_j = 25^{\circ}C \text{ and } 175^{\circ}C; V_{GS} = 0V$

Fig 12. Source current as a function of source-drain voltage; typical values



7. Package outline

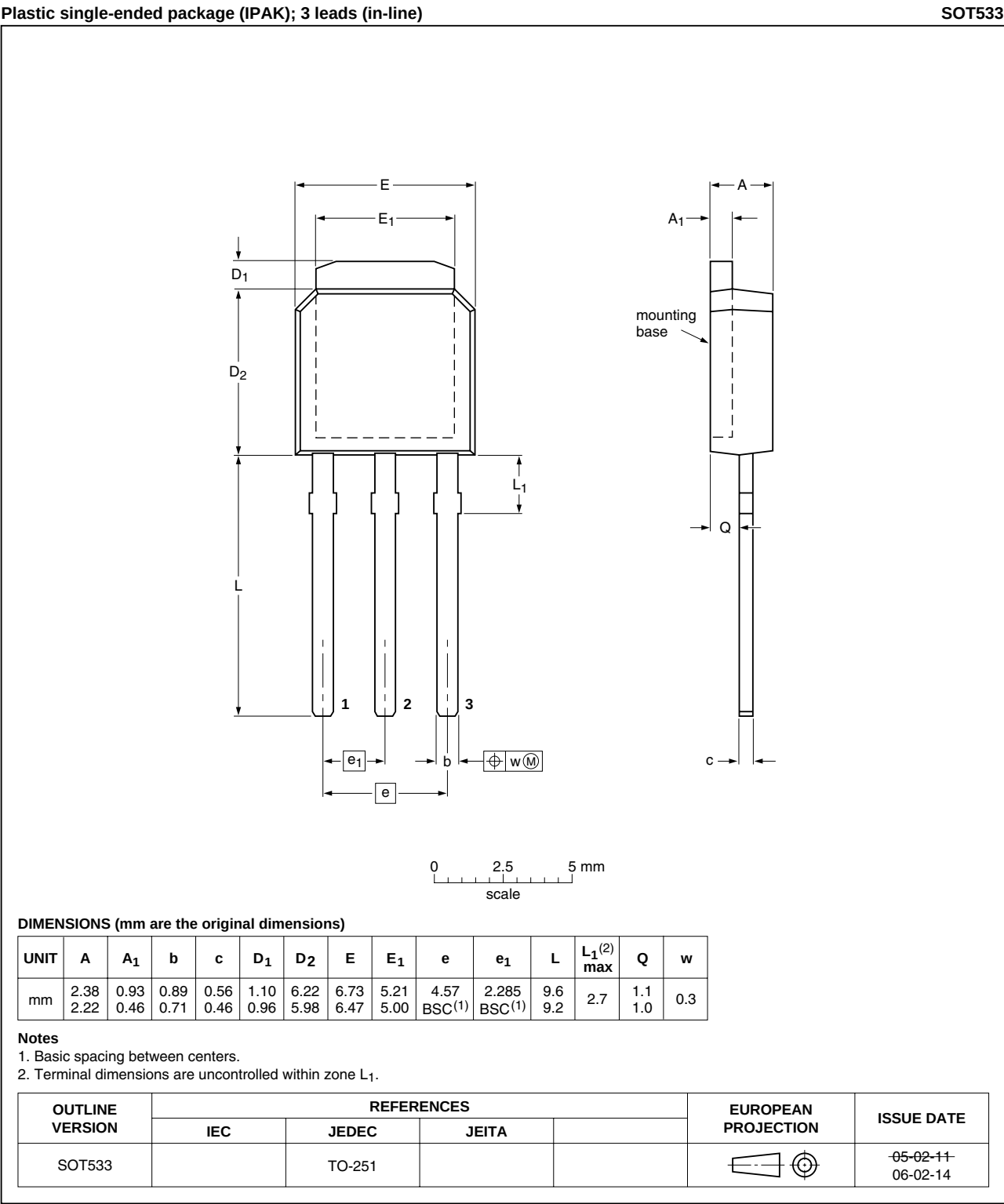


Fig 13. Package outline SOT533 (IPAK)

## 8. Revision history

**Table 7.** Revision history

| Document ID                                                                                                                                                                                                                                                                                                                                                | Release date | Data sheet status  | Change notice | Supersedes                 |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|--------------------|---------------|----------------------------|
| PHU78NQ03LT_6                                                                                                                                                                                                                                                                                                                                              | 20090615     | Product data sheet | -             | PHU_PHD78NQ03LT_5          |
| Modifications: <ul style="list-style-type: none"> <li>• The format of this data sheet has been redesigned to comply with the new identity guidelines of NXP Semiconductors.</li> <li>• Legal texts have been adapted to the new company name where appropriate.</li> <li>• Type number PHU78NQ03LT separated from data sheet PHU_PHD78NQ03LT_5.</li> </ul> |              |                    |               |                            |
| PHU_PHD78NQ03LT_5<br>(9397 750 15084)                                                                                                                                                                                                                                                                                                                      | 20050727     | Product data sheet | -             | PHP_PHU78NQ03LT_4          |
| PHP_PHU78NQ03LT_4<br>(9397 750 13431)                                                                                                                                                                                                                                                                                                                      | 20040726     | Product data sheet | -             | PHP_PHB_PHD78NQ03<br>LT-03 |
| PHP_PHB_PHD78NQ03<br>LT-03 (9397 750 09667)                                                                                                                                                                                                                                                                                                                | 20020626     | Product data       | -             | PHP_PHB_PHD78NQ03<br>LT-02 |
| PHP_PHB_PHD78NQ03<br>LT-02 (9397 750 09418)                                                                                                                                                                                                                                                                                                                | 20020322     | Product data       | -             | PHP_PHB_PHD78NQ03<br>LT-01 |
| PHP_PHB_PHD78NQ03<br>LT-01 (9397 750 08916)                                                                                                                                                                                                                                                                                                                | 20011114     | Product data       | -             | -                          |

## 9. Legal information

### 9.1 Data sheet status

| Document status <sup>[1][2]</sup> | Product status <sup>[3]</sup> | Definition                                                                            |
|-----------------------------------|-------------------------------|---------------------------------------------------------------------------------------|
| Objective [short] data sheet      | Development                   | This document contains data from the objective specification for product development. |
| Preliminary [short] data sheet    | Qualification                 | This document contains data from the preliminary specification.                       |
| Product [short] data sheet        | Production                    | This document contains the product specification.                                     |

[1] Please consult the most recently issued document before initiating or completing a design.

[2] The term 'short data sheet' is explained in section "Definitions".

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