



# 2N7002

60 V, 300 mA N-channel Trench MOSFET

Rev. 7 — 8 September 2011

Product data sheet

## 1. Product profile

### 1.1 General description

N-channel enhancement mode Field-Effect Transistor (FET) in a plastic package using Trench MOSFET technology.

### 1.2 Features and benefits

- Suitable for logic level gate drive sources
- Surface-mounted package
- Very fast switching
- Trench MOSFET technology

### 1.3 Applications

- Logic level translators
- High-speed line drivers

### 1.4 Quick reference data

Table 1. Quick reference data

| Symbol                        | Parameter                        | Conditions  | Min | Typ | Max  | Unit     |
|-------------------------------|----------------------------------|---|-----|-----|------|----------|
| $V_{DS}$                      | drain-source voltage             | $25\text{ °C} \leq T_j \leq 150\text{ °C}$  | -   | -   | 60   | V        |
| $I_D$                         | drain current                    | $V_{GS} = 10\text{ V}$ ; $T_{sp} = 25\text{ °C}$ ; see <a href="#">Figure 1</a> ; see <a href="#">Figure 3</a>                      | -   | -   | 300  | mA       |
| $P_{tot}$                     | total power dissipation          | $T_{sp} = 25\text{ °C}$ ; see <a href="#">Figure 2</a>  | -   | -   | 0.83 | W        |
| <b>Static characteristics</b> |                                  |   |     |     |      |          |
| $R_{DS(on)}$                  | drain-source on-state resistance | $V_{GS} = 10\text{ V}$ ; $I_D = 500\text{ mA}$ ; $T_j = 25\text{ °C}$ ; see <a href="#">Figure 6</a> ; see <a href="#">Figure 8</a> | -   | 2.8 | 5    | $\Omega$ |

## 2. Pinning information

Table 2. Pinning information

| Pin | Symbol | Description | Simplified outline      | Graphic symbol |
|-----|--------|-------------|-------------------------|----------------|
| 1   | G      | gate        | <p>SOT23 (TO-236AB)</p> | <p>mbb076</p>  |
| 2   | S      | source      |                         |                |
| 3   | D      | drain       |                         |                |

### 3. Ordering information

Table 3. Ordering information

| Type number | Package  |  | Version |
|-------------|----------|--|---------|
|             | Name     | Description                              |         |
| 2N7002      | TO-236AB | plastic surface-mounted package; 3 leads | SOT23   |

### 4. Marking

Table 4. Marking codes

| Type number | Marking code <sup>[1]</sup> |
|-------------|-----------------------------|
| 2N7002      | 12%                         |

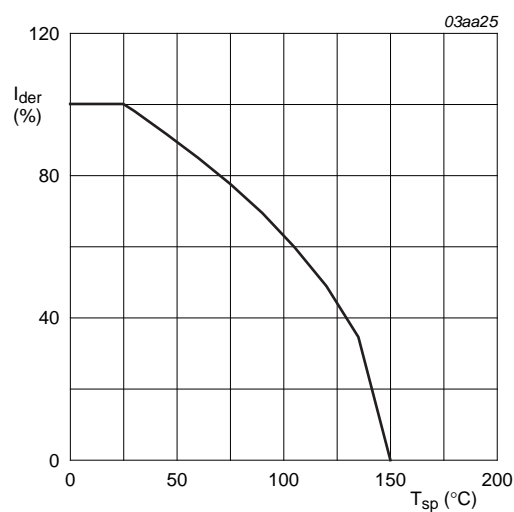
[1] % = placeholder for manufacturing site code

### 5. Limiting values

Table 5. Limiting values

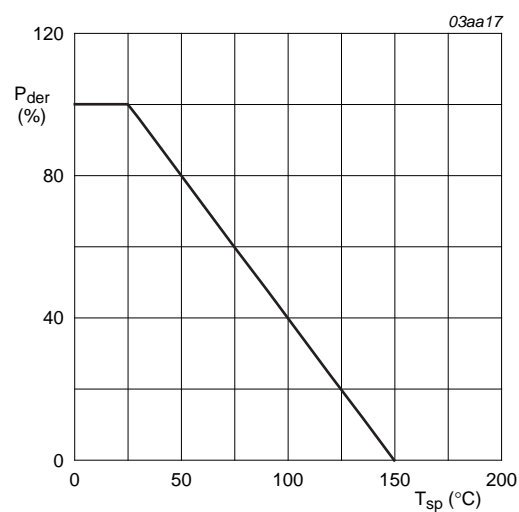
In accordance with the Absolute Maximum Rating System (IEC 60134).

| Symbol                    | Parameter                | Conditions   | Min | Max  | Unit |
|---------------------------|--------------------------|--|-----|------|------|
| $V_{DS}$                  | drain-source voltage     | $25\text{ °C} \leq T_j \leq 150\text{ °C}$   | -   | 60   | V    |
| $V_{DGR}$                 | drain-gate voltage       | $25\text{ °C} \leq T_j \leq 150\text{ °C}$ ; $R_{GS} = 20\text{ k}\Omega$                                      | -   | 60   | V    |
| $V_{GS}$                  | gate-source voltage      |  | -30 | 30   | V    |
| $V_{GSM}$                 | peak gate-source voltage | pulsed; $t_p \leq 50\text{ }\mu\text{s}$ ; $\delta = 0.25$   | -40 | 40   | V    |
| $I_D$                     | drain current            | $V_{GS} = 10\text{ V}$ ; $T_{sp} = 25\text{ °C}$ ; see <a href="#">Figure 1</a> ; see <a href="#">Figure 3</a> | -   | 300  | mA   |
|                           |                          | $V_{GS} = 10\text{ V}$ ; $T_{sp} = 100\text{ °C}$ ; see <a href="#">Figure 1</a>                               | -   | 190  | mA   |
| $I_{DM}$                  | peak drain current       | pulsed; $t_p \leq 10\text{ }\mu\text{s}$ ; $T_{sp} = 25\text{ °C}$ ; see <a href="#">Figure 3</a>              | -   | 1.2  | A    |
| $P_{tot}$                 | total power dissipation  | $T_{sp} = 25\text{ °C}$ ; see <a href="#">Figure 2</a>   | -   | 0.83 | W    |
| $T_j$                     | junction temperature     |  | -65 | 150  | °C   |
| $T_{stg}$                 | storage temperature      |  | -65 | 150  | °C   |
| <b>Source-drain diode</b> |                          |  |     |      |      |
| $I_S$                     | source current           | $T_{sp} = 25\text{ °C}$  | -   | 300  | mA   |
| $I_{SM}$                  | peak source current      | pulsed; $t_p \leq 10\text{ }\mu\text{s}$ ; $T_{sp} = 25\text{ °C}$   | -   | 1.2  | A    |



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

Fig 1. Normalized continuous drain current as a function of solder point temperature



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

Fig 2. Normalized total power dissipation as a function of solder point temperature

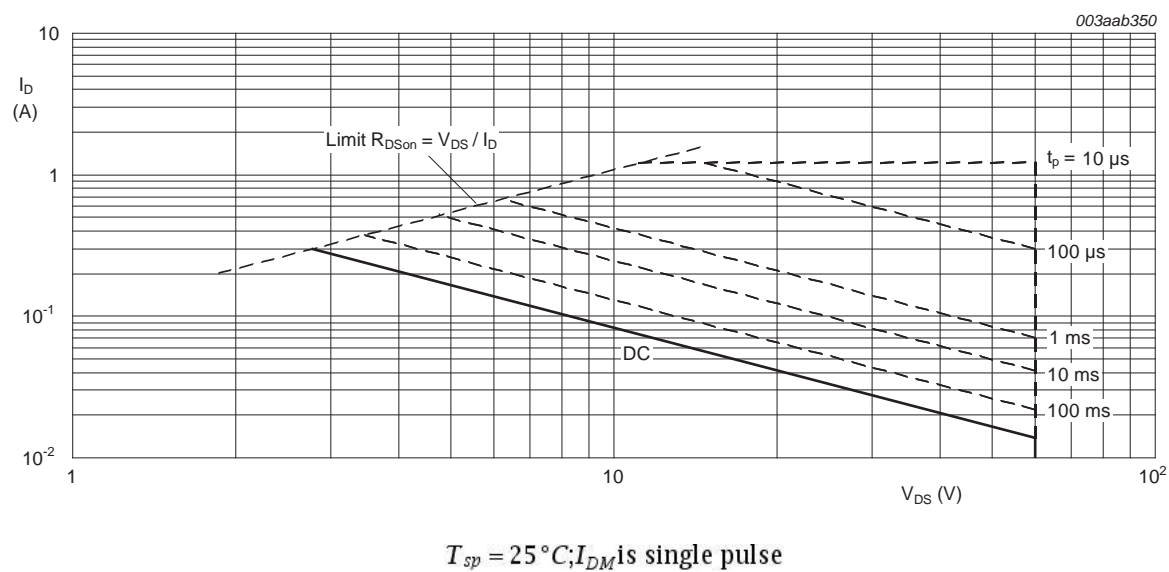


Fig 3. Safe operating area; continous and peak drain currents as a function of drain-source voltage

6. Thermal characteristics

Table 6. Thermal characteristics

| Symbol         | Parameter  | Conditions  | Min | Typ | Max | Unit |
|----------------|--|---|-----|-----|-----|------|
| $R_{th(j-a)}$  | thermal resistance from junction to ambient      | Mounted on a printed-circuit board; minimum footprint ; vertical in still air | -   | -   | 350 | K/W  |
| $R_{th(j-sp)}$ | thermal resistance from junction to solder point | see <a href="#">Figure 4</a>  | -   | -   | 150 | K/W  |

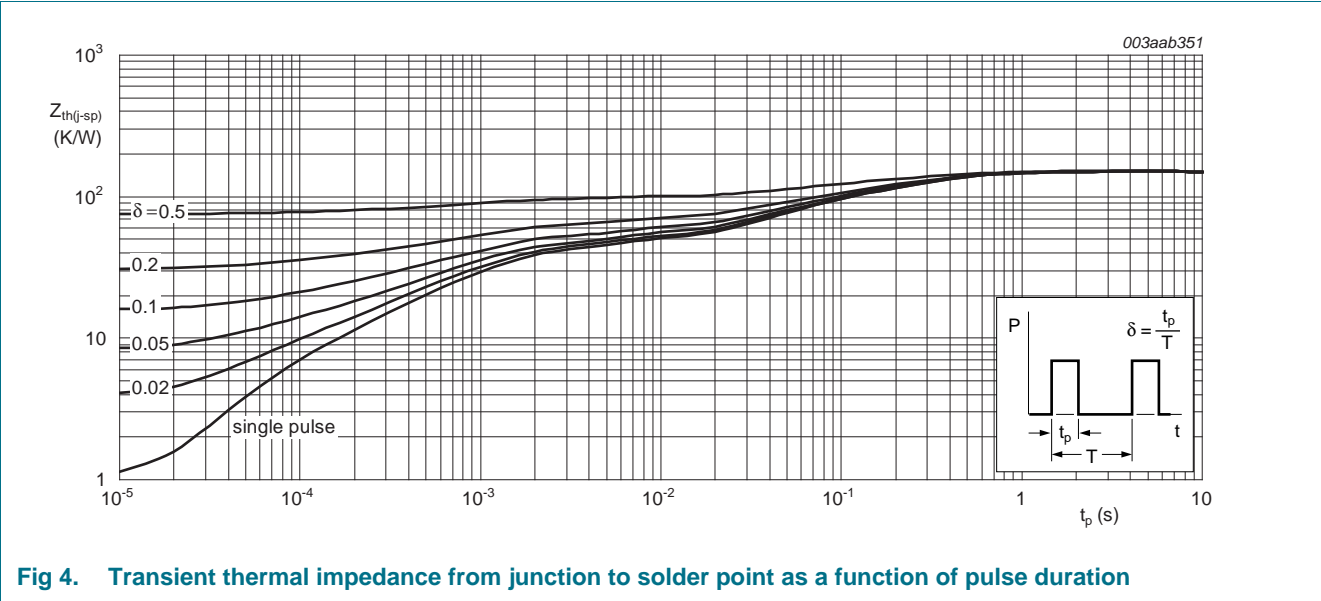


Fig 4. Transient thermal impedance from junction to solder point as a function of pulse duration

## 7. Characteristics

**Table 7. Characteristics**

| Symbol                  | Parameter                        | Conditions  | Min | Typ  | Max  | Unit |
|-------------------------|----------------------------------|---|-----|------|------|------|
| Static characteristics  |                                  |   |     |      |      |      |
| V <sub>(BR)DSS</sub>    | drain-source breakdown voltage   | I <sub>D</sub> = 10 μA; V <sub>GS</sub> = 0 V; T <sub>j</sub> = 25 °C   | 60  | -    | -    | V    |
|                         |                                  | I <sub>D</sub> = 10 μA; V <sub>GS</sub> = 0 V; T <sub>j</sub> = -55 °C  | 55  | -    | -    | V    |
| V <sub>GSth</sub>       | gate-source threshold voltage    | I <sub>D</sub> = 0.25 mA; V <sub>DS</sub> = V <sub>GS</sub> ; T <sub>j</sub> = 25 °C; see <a href="#">Figure 9</a> ; see <a href="#">Figure 10</a>  | 1   | 2    | 2.5  | V    |
|                         |                                  | I <sub>D</sub> = 0.25 mA; V <sub>DS</sub> = V <sub>GS</sub> ; T <sub>j</sub> = 150 °C; see <a href="#">Figure 9</a> ; see <a href="#">Figure 10</a> | 0.6 | -    | -    | V    |
|                         |                                  | I <sub>D</sub> = 0.25 mA; V <sub>DS</sub> = V <sub>GS</sub> ; T <sub>j</sub> = -55 °C; see <a href="#">Figure 9</a> ; see <a href="#">Figure 10</a> | -   | -    | 2.75 | V    |
| I <sub>DSS</sub>        | drain leakage current            | V <sub>DS</sub> = 48 V; V <sub>GS</sub> = 0 V; T <sub>j</sub> = 25 °C   | -   | 0.01 | 1    | μA   |
|                         |                                  | V <sub>DS</sub> = 48 V; V <sub>GS</sub> = 0 V; T <sub>j</sub> = 150 °C  | -   | -    | 10   | μA   |
| I <sub>GSS</sub>        | gate leakage current             | V <sub>GS</sub> = 15 V; V <sub>DS</sub> = 0 V; T <sub>j</sub> = 25 °C   | -   | 10   | 100  | nA   |
|                         |                                  | V <sub>GS</sub> = -15 V; V <sub>DS</sub> = 0 V; T <sub>j</sub> = 25 °C  | -   | 10   | 100  | nA   |
| R <sub>DSon</sub>       | drain-source on-state resistance | V <sub>GS</sub> = 10 V; I <sub>D</sub> = 500 mA; T <sub>j</sub> = 25 °C; see <a href="#">Figure 6</a> ; see <a href="#">Figure 8</a>                | -   | 2.8  | 5    | Ω    |
|                         |                                  | V <sub>GS</sub> = 10 V; I <sub>D</sub> = 500 mA; T <sub>j</sub> = 150 °C; see <a href="#">Figure 6</a> ; see <a href="#">Figure 8</a>               | -   | -    | 9.25 | Ω    |
|                         |                                  | V <sub>GS</sub> = 4.5 V; I <sub>D</sub> = 75 mA; T <sub>j</sub> = 25 °C; see <a href="#">Figure 6</a> ; see <a href="#">Figure 8</a>                | -   | 3.8  | 5.3  | Ω    |
| Dynamic characteristics |                                  |   |     |      |      |      |
| C <sub>iss</sub>        | input capacitance                | V <sub>DS</sub> = 10 V; f = 1 MHz; V <sub>GS</sub> = 0 V; T <sub>j</sub> = 25 °C  | -   | 31   | 50   | pF   |
| C <sub>oss</sub>        | output capacitance               |   | -   | 6.8  | 30   | pF   |
| C <sub>rss</sub>        | reverse transfer capacitance     |   | -   | 3.5  | 10   | pF   |
| t <sub>on</sub>         | turn-on time                     | V <sub>GS</sub> = 10 V; V <sub>DS</sub> = 50 V; R <sub>L</sub> = 250 Ω;   | -   | 2.5  | 10   | ns   |
| t <sub>off</sub>        | turn-off time                    | R <sub>G(ext)</sub> = 50 Ω; R <sub>GS</sub> = 50 Ω  | -   | 11   | 15   | ns   |
| Source-drain diode      |                                  |   |     |      |      |      |
| V <sub>SD</sub>         | source-drain voltage             | I <sub>S</sub> = 300 mA; V <sub>GS</sub> = 0 V; T <sub>j</sub> = 25 °C; see <a href="#">Figure 11</a>   | -   | 0.85 | 1.5  | V    |
| Q <sub>r</sub>          | recovered charge                 | V <sub>GS</sub> = 0 V; I <sub>S</sub> = 300 mA;   | -   | 30   | -    | nC   |
| t <sub>rr</sub>         | reverse recovery time            | dI <sub>S</sub> /dt = -100 A/μs   | -   | 30   | -    | ns   |

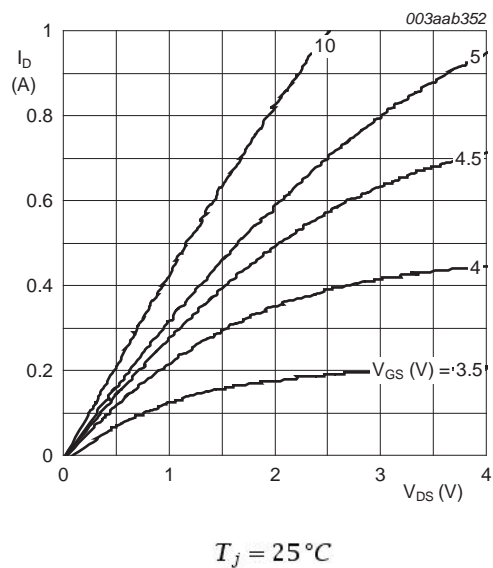


Fig 5. Output characteristics: drain current as a function of drain-source voltage; typical values

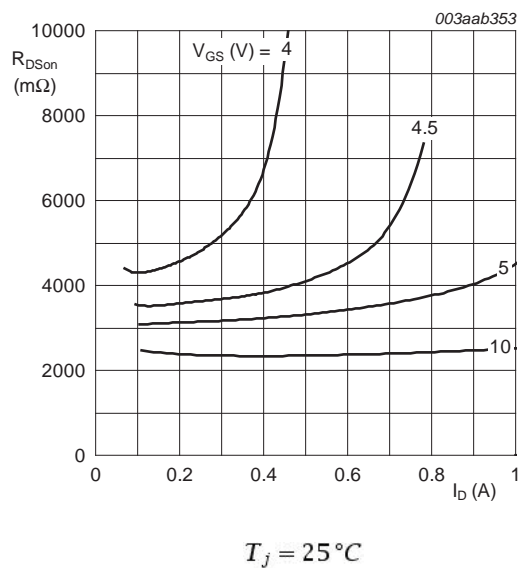


Fig 6. Drain-source on-state resistance as a function of drain current; typical values

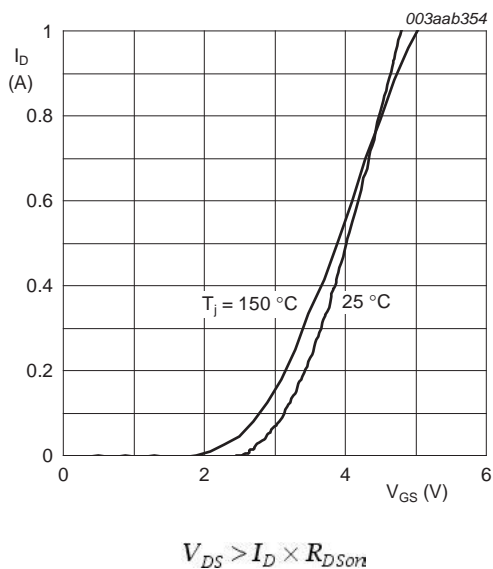


Fig 7. Transfer characteristics: drain current as a function of gate-source voltage; typical values

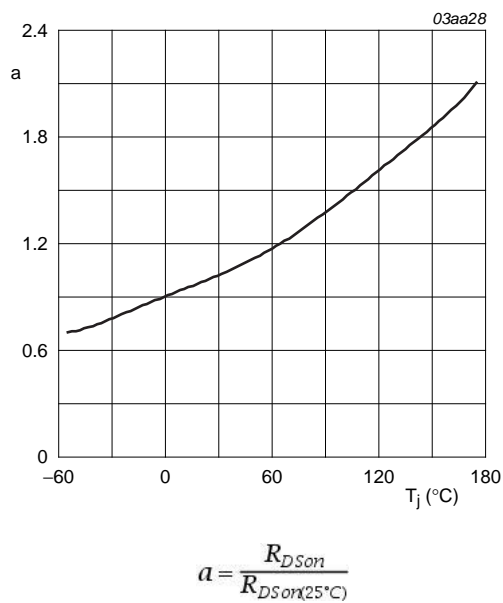


Fig 8. Normalized drain-source on-state resistance factor as a function of junction temperature

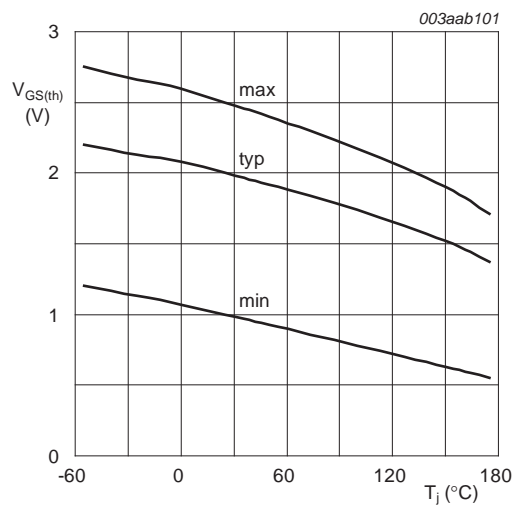


Fig 9. Gate-source threshold voltage as a function of junction temperature

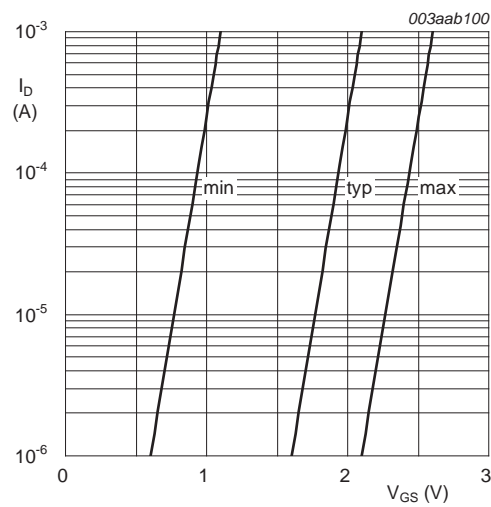


Fig 10. Sub-threshold drain current as a function of gate-source voltage

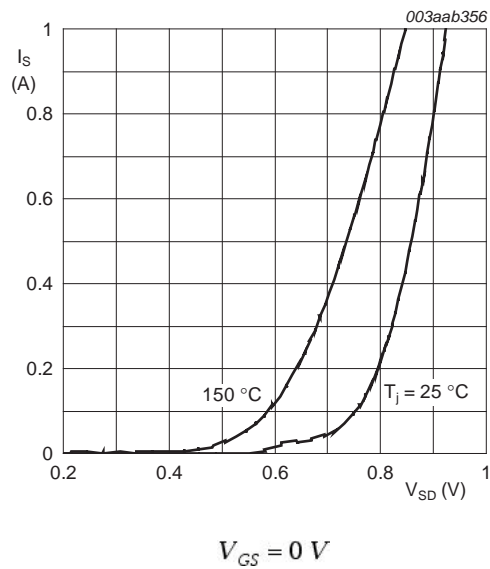


Fig 11. Source current as a function of source-drain voltage; typical values

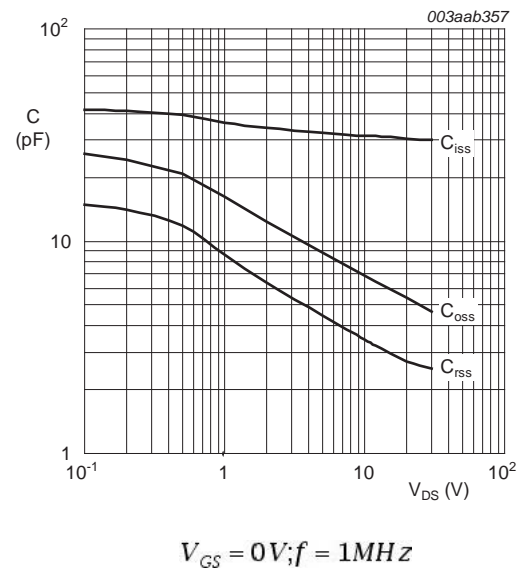


Fig 12. Input, output and reverse transfer capacitances as a function of drain-source voltage; typical values

8. Package outline

Plastic surface-mounted package; 3 leads

SOT23

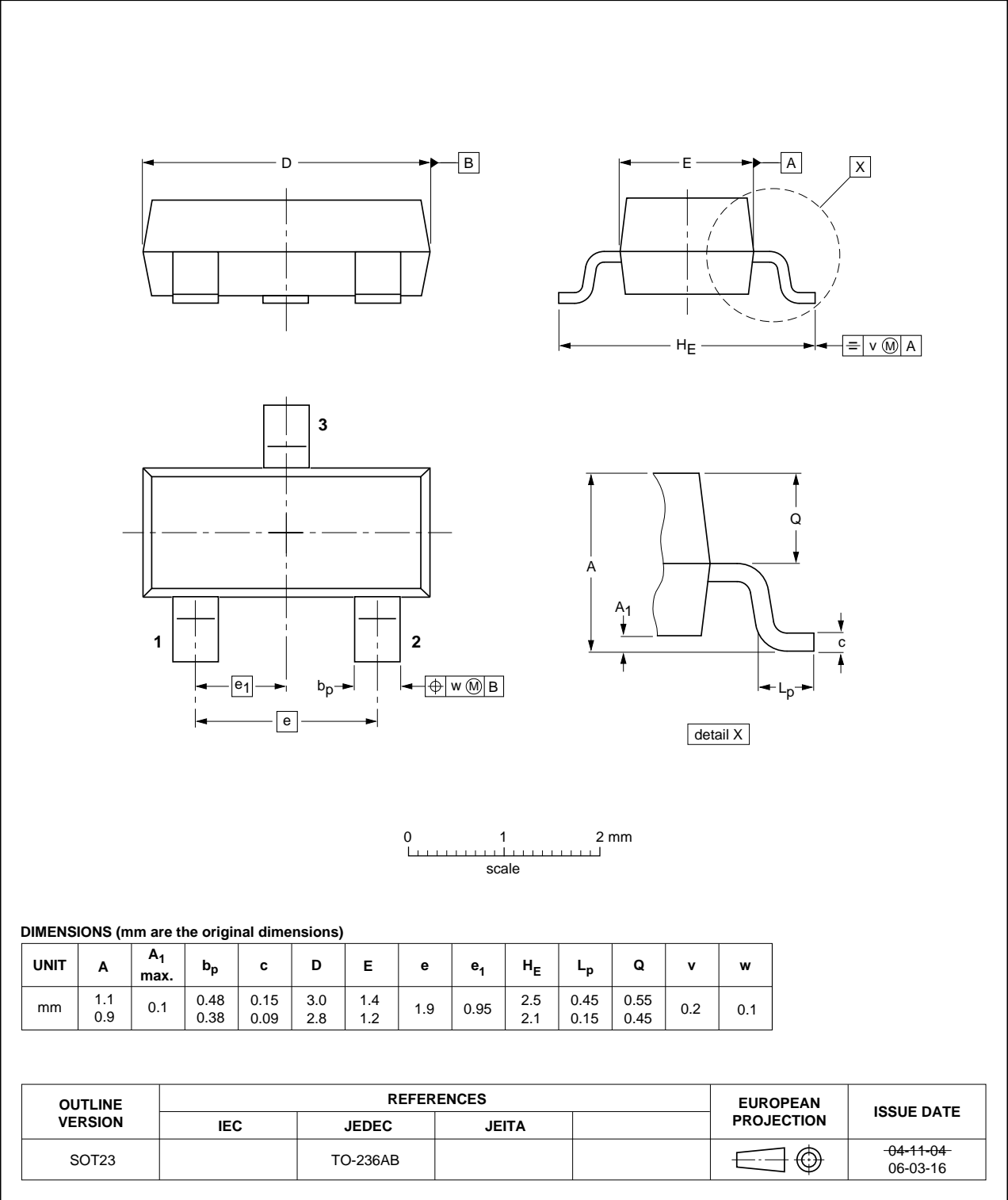


Fig 13. Package outline SOT23 (TO-236AB)



9. Soldering

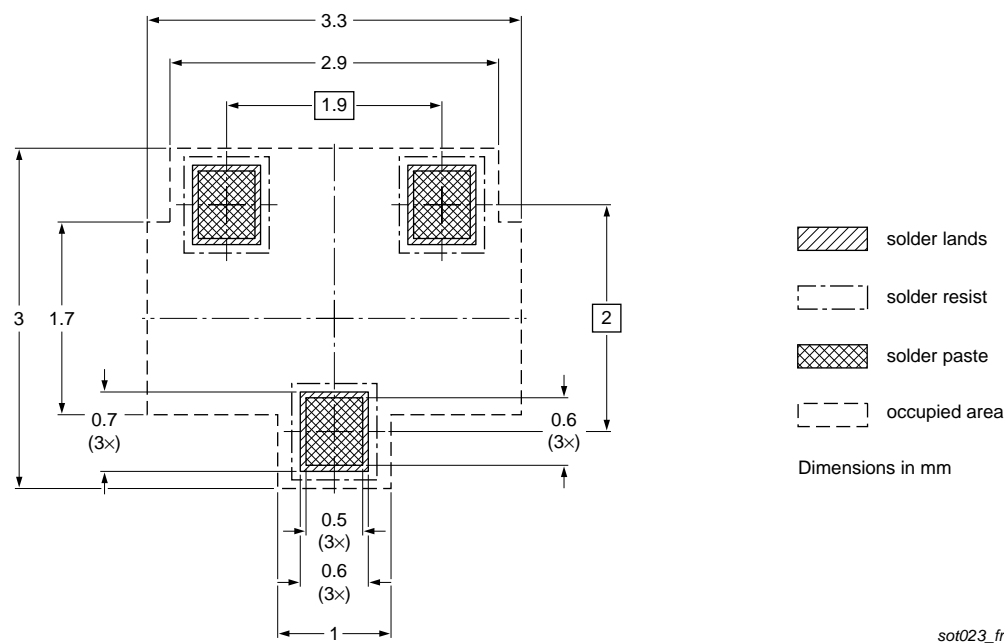


Fig 14. Reflow soldering footprint for SOT23 (TO-236AB)

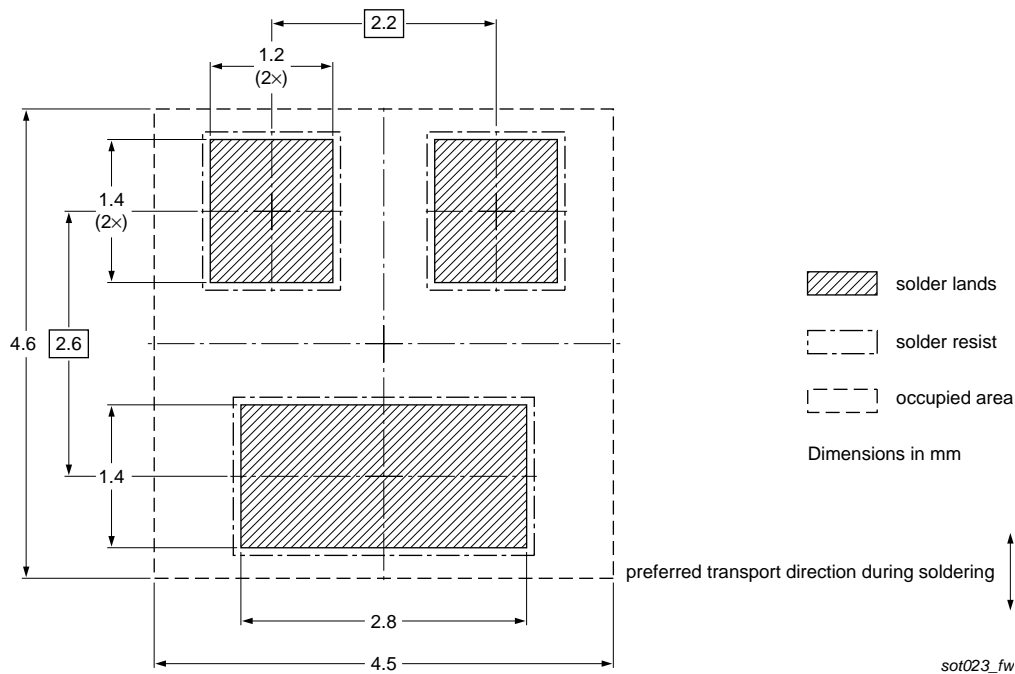


Fig 15. Wave soldering footprint for SOT23 (TO-236AB)

## 10. Revision history

**Table 8.** Revision history

| Document ID    | Release date   | Data sheet status     | Change notice | Supersedes |
|----------------|--|-----------------------|---------------|------------|
| 2N7002 v.7     | 20110908   | Product data sheet    | -             | 2N7002 v.6 |
| 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></ul> |                       |               |            |
| 2N7002 v.6     | 20060428   | Product data sheet    |               | 2N7002 v.5 |
| 2N7002 v.5     | 20051115   | Product data sheet    |               | 2N7002 v.4 |
| 2N7002 v.4     | 20050426   | Product data sheet    |               | 2N7002 v.3 |
| 2N7002 v.3     | 20000727   | Product specification | HZG336        | 2N7002 v.2 |
| 2N7002 v.2     | 19970617   | Product specification |               | 2N7002 v.1 |
| 2N7002 v.1     | 19901031   | Product specification | -             | -          |

## 11. Legal information

### 11.1 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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