# 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
- Very fast switching
- Surface-mounted package
- Trench MOSFET technology

### 1.3 Applications

- Logic level translators
- High-speed line drivers

### 1.4 Quick reference data

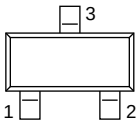
**Table 1. Quick reference data**

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| $V_{DS}$ | drain-source voltage | 25 °C ≤ $T_j$ ≤ 150 °C | - | - | 60 | V |
| $I_D$ | drain current | $V_{GS}$ = 10 V; $T_{sp}$ = 25 °C; see Figure 1; see Figure 3 | - | - | 300 | mA |
| $P_{tot}$ | total power dissipation | $T_{sp}$ = 25 °C; see Figure 2 | - | - | 0.83 | W |
| **Static characteristics** | | | | | | |
| $R_{DSon}$ | drain-source on-state resistance | $V_{GS}$ = 10 V; $I_D$ = 500 mA; $T_j$ = 25 °C; see Figure 6; see Figure 8 | - | 2.8 | 5 | Ω |

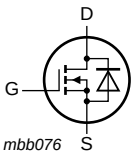
## 2. Pinning information

**Table 2. Pinning information**

| Pin | Symbol | Description | Simplified outline | Graphic symbol |
|---|---|---|---|---|
| 1 | G | gate | | |
| 2 | S | source | | |
| 3 | D | drain | | |




**SOT23 (TO-236AB)**



## 3. Ordering information

**Table 3. Ordering information**

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

## 4. Marking

**Table 4. Marking codes**

| Type number | Marking code[1] |
|---|---|
| 2N7002 | 12% |

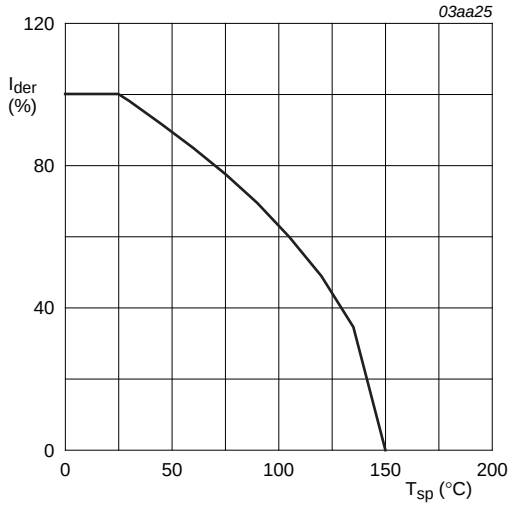
[1] % = placeholder for manufacturing site code

## 5. Limiting values

**Table 5. Limiting values**

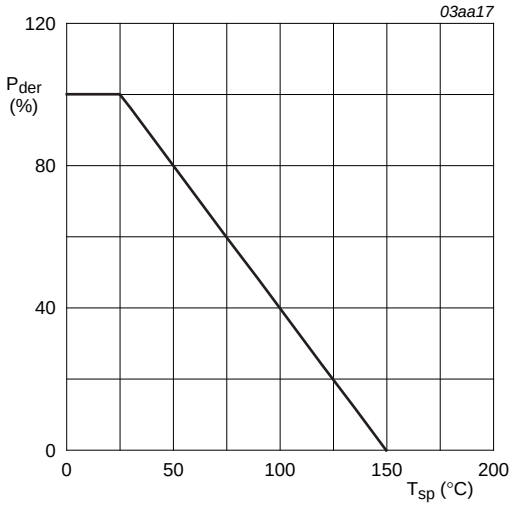
*In accordance with the Absolute Maximum Rating System (IEC 60134).*

| Symbol | Parameter | Conditions | Min | Max | Unit |
|---|---|---|---|---|---|
| $V_{DS}$ | drain-source voltage | 25 °C ≤ $T_j$ ≤ 150 °C | - | 60 | V |
| $V_{DGR}$ | drain-gate voltage | 25 °C ≤ $T_j$ ≤ 150 °C; $R_{GS}$ = 20 kΩ | - | 60 | V |
| $V_{GS}$ | gate-source voltage | | -30 | 30 | V |
| $V_{GSM}$ | peak gate-source voltage | pulsed; $t_p$ ≤ 50 µs; δ = 0.25 | -40 | 40 | V |
| $I_D$ | drain current | $V_{GS}$ = 10 V; $T_{sp}$ = 25 °C; see Figure 1; see Figure 3 | - | 300 | mA |
| | | $V_{GS}$ = 10 V; $T_{sp}$ = 100 °C; see Figure 1 | - | 190 | mA |
| $I_{DM}$ | peak drain current | pulsed; $t_p$ ≤ 10 µs; $T_{sp}$ = 25 °C; see Figure 3 | - | 1.2 | A |
| $P_{tot}$ | total power dissipation | $T_{sp}$ = 25 °C; see Figure 2 | - | 0.83 | W |
| $T_j$ | junction temperature | | -65 | 150 | °C |
| $T_{stg}$ | storage temperature | | -65 | 150 | °C |
| **Source-drain diode** | | | | | |
| $I_S$ | source current | $T_{sp}$ = 25 °C | - | 300 | mA |
| $I_{SM}$ | peak source current | pulsed; $t_p$ ≤ 10 µs; $T_{sp}$ = 25 °C | - | 1.2 | A |



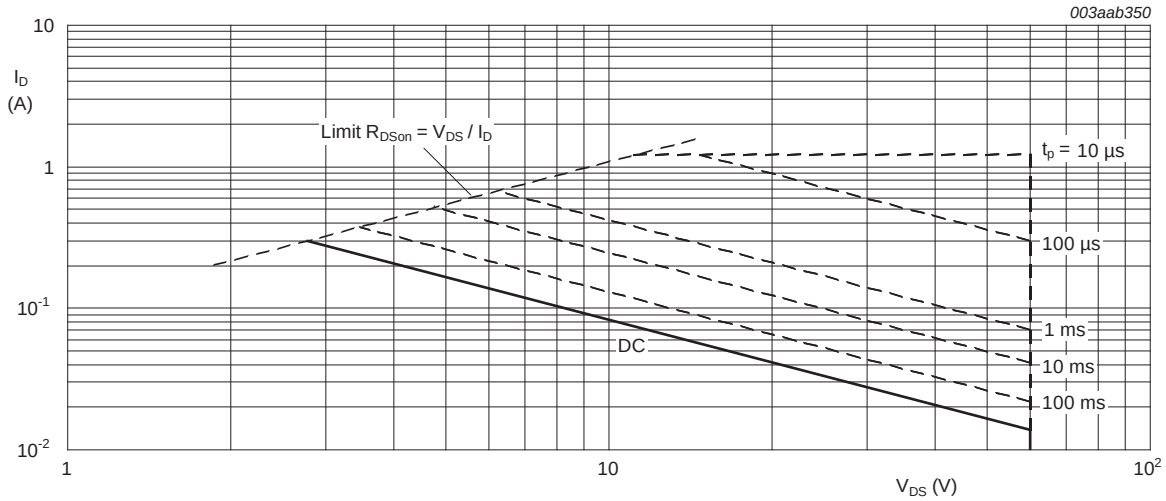

$$I_{der} = \frac{I_D}{I_{D(25°C)}} \times 100\,\%$$

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




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

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




$T_{sp} = 25\,°C; I_{DM}$ is single pulse

**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 Figure 4 | - | - | 150 | K/W |

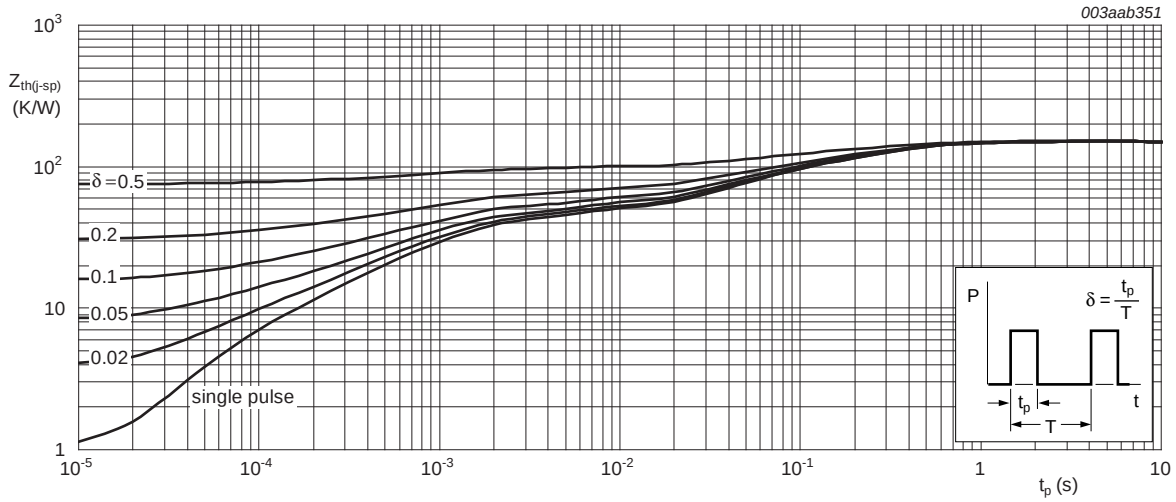
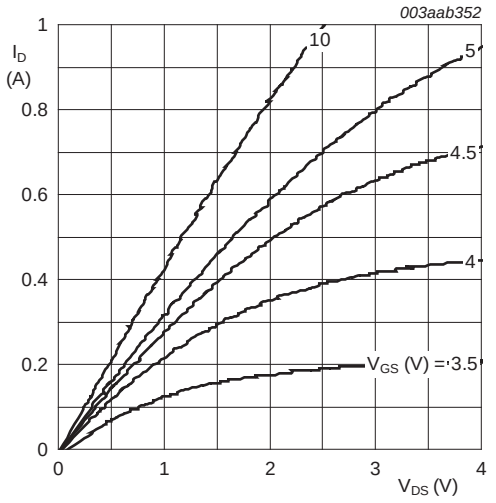



**Fig 4. Transient thermal impedance from junction to solder point as a function of pulse duration**

# 7. Characteristics

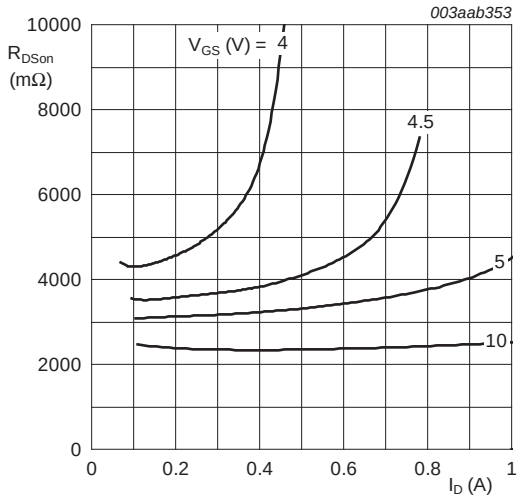
**Table 7. Characteristics**

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| **Static characteristics** | | | | | | |
| $V_{(BR)DSS}$ | drain-source breakdown voltage | $I_D$ = 10 µA; $V_{GS}$ = 0 V; $T_j$ = 25 °C | 60 | - | - | V |
| | | $I_D$ = 10 µA; $V_{GS}$ = 0 V; $T_j$ = -55 °C | 55 | - | - | V |
| $V_{GSth}$ | gate-source threshold voltage | $I_D$ = 0.25 mA; $V_{DS}$ = $V_{GS}$; $T_j$ = 25 °C; see Figure 9; see Figure 10 | 1 | 2 | 2.5 | V |
| | | $I_D$ = 0.25 mA; $V_{DS}$ = $V_{GS}$; $T_j$ = 150 °C; see Figure 9; see Figure 10 | 0.6 | - | - | V |
| | | $I_D$ = 0.25 mA; $V_{DS}$ = $V_{GS}$; $T_j$ = -55 °C; see Figure 9; see Figure 10 | - | - | 2.75 | V |
| $I_{DSS}$ | drain leakage current | $V_{DS}$ = 48 V; $V_{GS}$ = 0 V; $T_j$ = 25 °C | - | 0.01 | 1 | µA |
| | | $V_{DS}$ = 48 V; $V_{GS}$ = 0 V; $T_j$ = 150 °C | - | - | 10 | µA |
| $I_{GSS}$ | gate leakage current | $V_{GS}$ = 15 V; $V_{DS}$ = 0 V; $T_j$ = 25 °C | - | 10 | 100 | nA |
| | | $V_{GS}$ = -15 V; $V_{DS}$ = 0 V; $T_j$ = 25 °C | - | 10 | 100 | nA |
| $R_{DSon}$ | drain-source on-state resistance | $V_{GS}$ = 10 V; $I_D$ = 500 mA; $T_j$ = 25 °C; see Figure 6; see Figure 8 | - | 2.8 | 5 | Ω |
| | | $V_{GS}$ = 10 V; $I_D$ = 500 mA; $T_j$ = 150 °C; see Figure 6; see Figure 8 | - | - | 9.25 | Ω |
| | | $V_{GS}$ = 4.5 V; $I_D$ = 75 mA; $T_j$ = 25 °C; see Figure 6; see Figure 8 | - | 3.8 | 5.3 | Ω |
| **Dynamic characteristics** | | | | | | |
| $C_{iss}$ | input capacitance | $V_{DS}$ = 10 V; f = 1 MHz; $V_{GS}$ = 0 V; $T_j$ = 25 °C | - | 31 | 50 | pF |
| $C_{oss}$ | output capacitance | | - | 6.8 | 30 | pF |
| $C_{rss}$ | reverse transfer capacitance | | - | 3.5 | 10 | pF |
| $t_{on}$ | turn-on time | $V_{GS}$ = 10 V; $V_{DS}$ = 50 V; $R_L$ = 250 Ω; $R_{G(ext)}$ = 50 Ω; $R_{GS}$ = 50 Ω | - | 2.5 | 10 | ns |
| $t_{off}$ | turn-off time | | - | 11 | 15 | ns |
| **Source-drain diode** | | | | | | |
| $V_{SD}$ | source-drain voltage | $I_S$ = 300 mA; $V_{GS}$ = 0 V; $T_j$ = 25 °C; see Figure 11 | - | 0.85 | 1.5 | V |
| $Q_r$ | recovered charge | $V_{GS}$ = 0 V; $I_S$ = 300 mA; $dI_S/dt$ = -100 A/µs | - | 30 | - | nC |
| $t_{rr}$ | reverse recovery time | | - | 30 | - | ns |



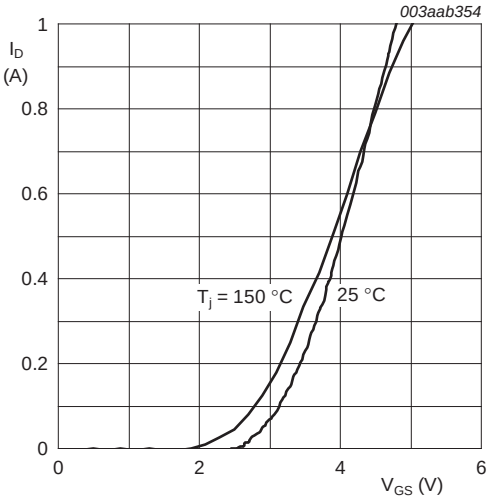

$T_j = 25\,°C$

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



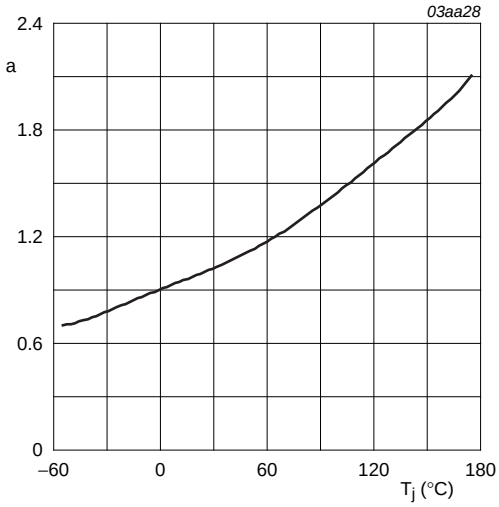

$T_j = 25\,°C$

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




$V_{DS} > I_D \times R_{DSon}$

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




$$a = \frac{R_{DSon}}{R_{DSon(25°C)}}$$

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

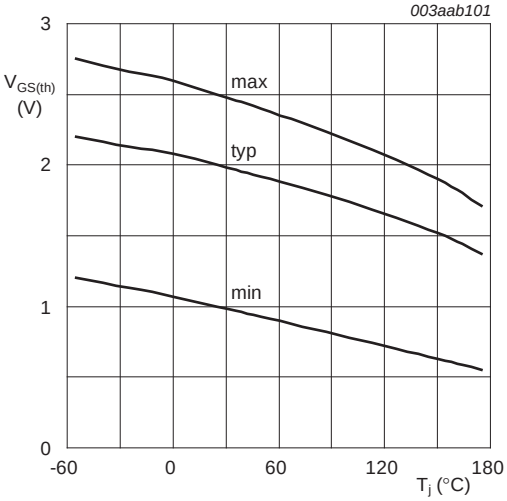



**Fig 9. Gate-source threshold voltage as a function of junction temperature**

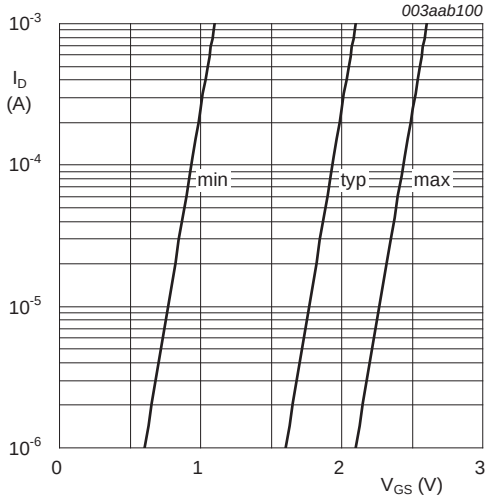
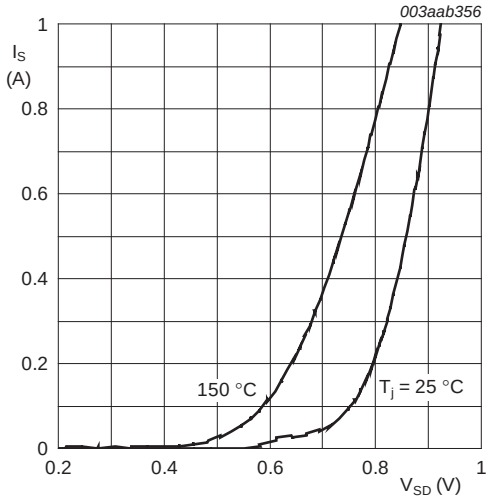
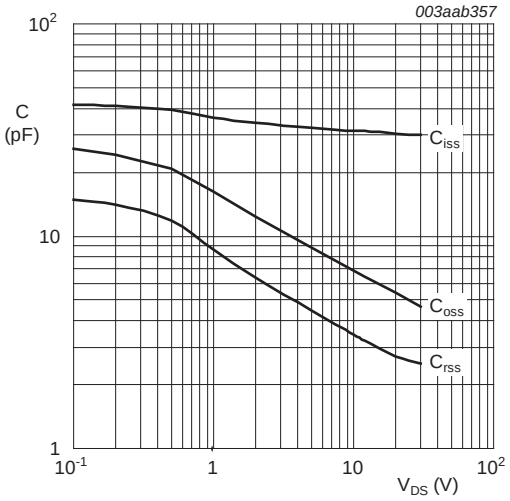



**Fig 10. Sub-threshold drain current as a function of gate-source voltage**




$V_{GS} = 0\ V$

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

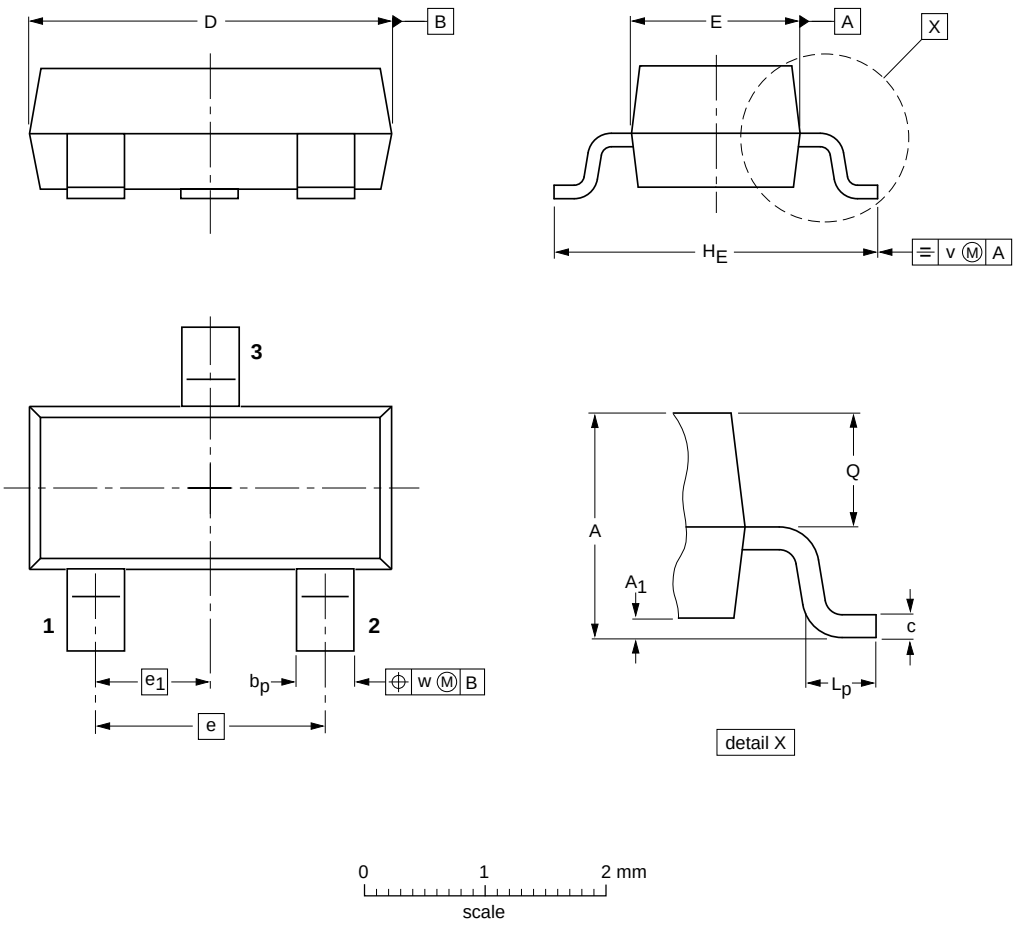



$V_{GS} = 0V; f = 1MHz$

**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**




**DIMENSIONS (mm are the original dimensions)**

| UNIT | A | $A_1$ max. | $b_p$ | c | D | E | e | $e_1$ | $H_E$ | $L_p$ | Q | v | w |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| mm | 1.1<br>0.9 | 0.1 | 0.48<br>0.38 | 0.15<br>0.09 | 3.0<br>2.8 | 1.4<br>1.2 | 1.9 | 0.95 | 2.5<br>2.1 | 0.45<br>0.15 | 0.55<br>0.45 | 0.2 | 0.1 |

| OUTLINE VERSION | REFERENCES | | | | EUROPEAN PROJECTION | ISSUE DATE |
|---|---|---|---|---|---|---|
| | IEC | JEDEC | JEITA | | | |
| SOT23 | | TO-236AB | | | | ~~04-11-04~~<br>06-03-16 |

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

# 9. Soldering

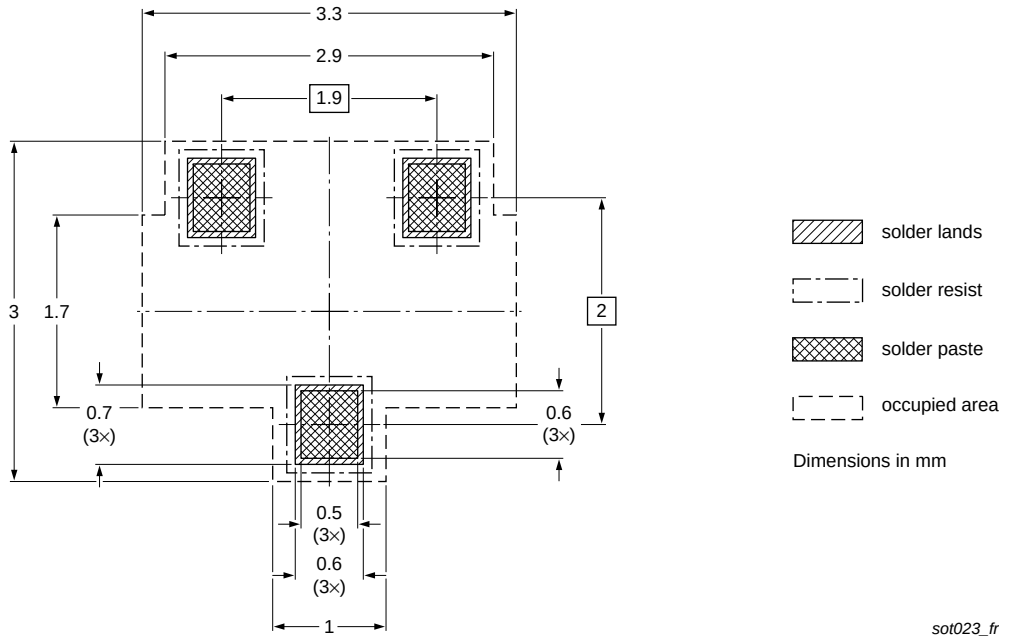



**Fig 14. Reflow soldering footprint for SOT23 (TO-236AB)**

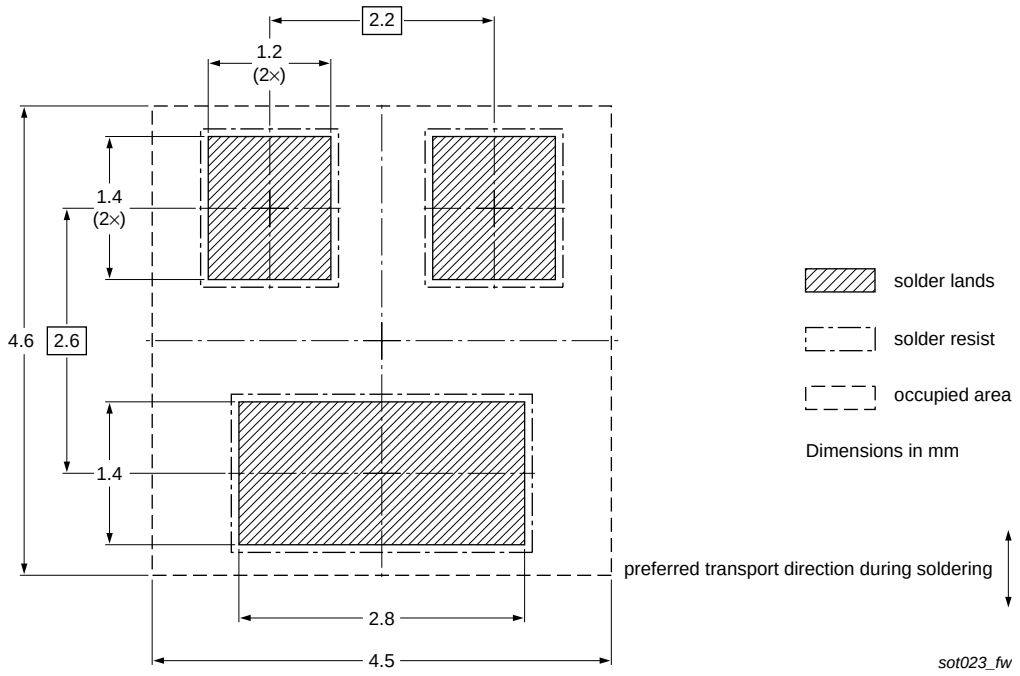



**Fig 15. Wave soldering footprint for SOT23 (TO-236AB)**

## 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: | • The format of this data sheet has been redesigned to comply with the new identity guidelines of NXP Semiconductors.<br>• Legal texts have been adapted to the new company name where appropriate. | | | |
| 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 | - | - |

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| Document status [1] [2] | Product status [3] | Definition |
|---|---|---|
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| Preliminary [short] data sheet | Qualification | This document contains data from the preliminary specification. |
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[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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**Date of release: 08 September 2011**