



# 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	$25\text{ °C} \leq T_j \leq 150\text{ °C}$	-	-	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%

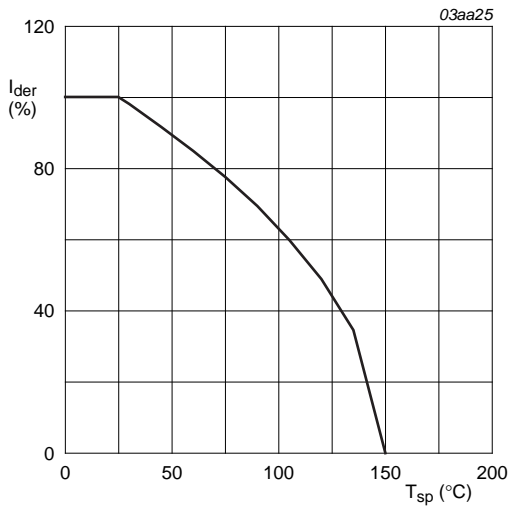
[1] % = placeholder for manufacturing site code

### 5. Limiting values

Table 5. Limiting values

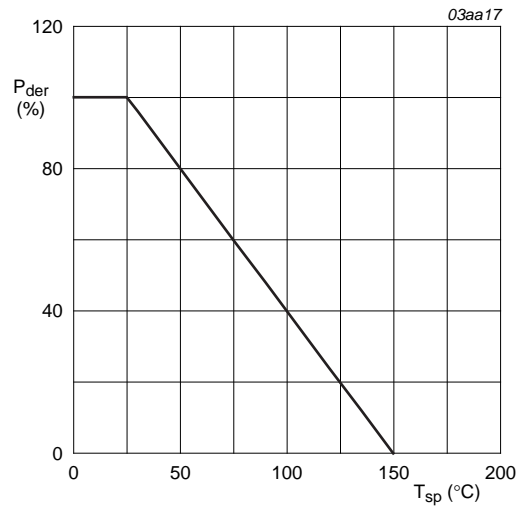
In accordance with the Absolute Maximum Rating System (IEC 60134).

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



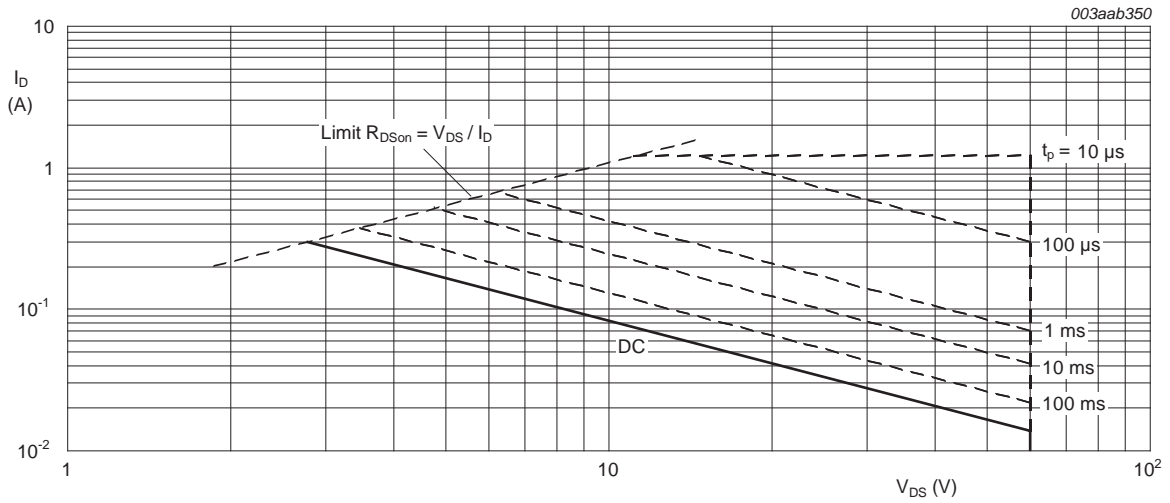
$$I_{der} = \frac{I_D}{I_{D(25^\circ\text{C})}} \times 100\%$$

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



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

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



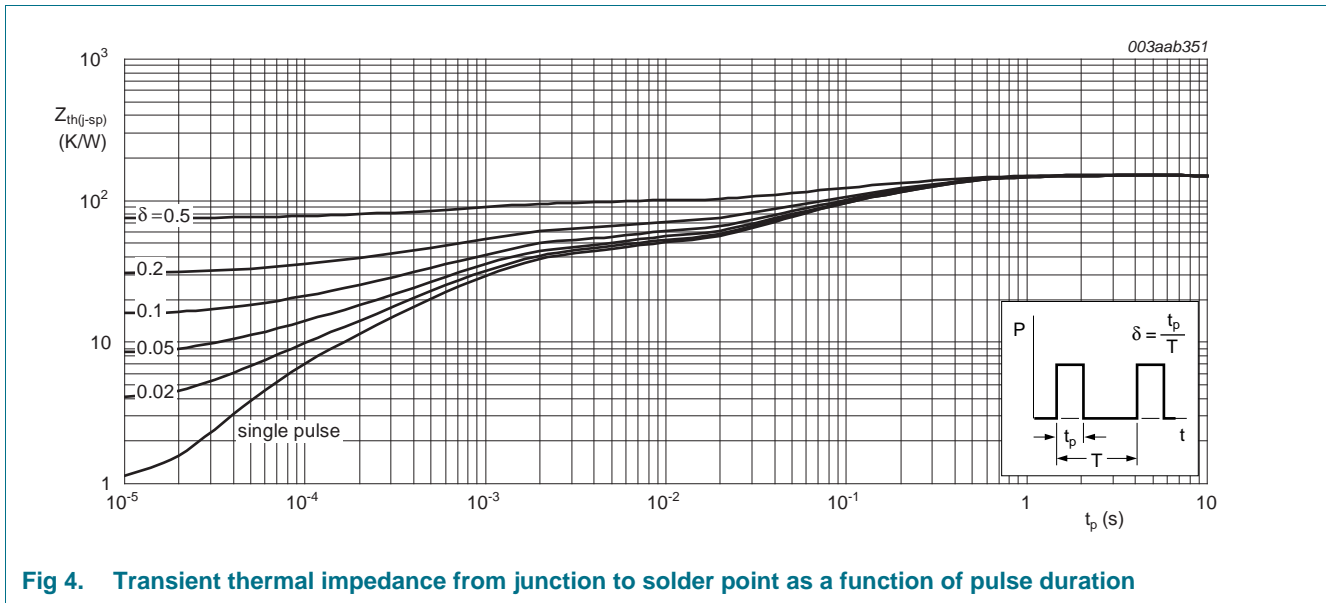
$T_{sp} = 25^\circ\text{C}; I_{DM}$  is single pulse

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 <a href="#">Figure 4</a>	-	-	150	K/W

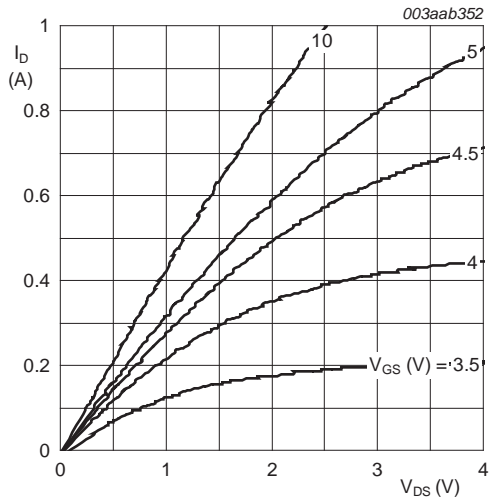


**Fig 4. Transient thermal impedance from junction to solder point as a function of pulse duration**

## 7. Characteristics

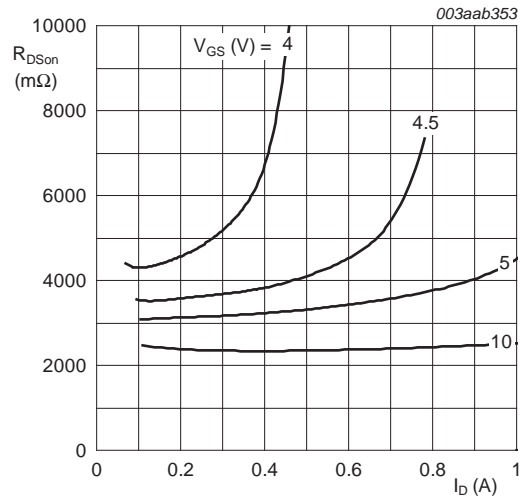
Table 7. Characteristics

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
<b>Static characteristics</b>						
$V_{(BR)DSS}$	drain-source breakdown voltage	$I_D = 10 \mu\text{A}; V_{GS} = 0 \text{ V}; T_j = 25 \text{ }^\circ\text{C}$	60	-	-	V
		$I_D = 10 \mu\text{A}; V_{GS} = 0 \text{ V}; T_j = -55 \text{ }^\circ\text{C}$	55	-	-	V
$V_{GSth}$	gate-source threshold voltage	$I_D = 0.25 \text{ mA}; V_{DS} = V_{GS}; T_j = 25 \text{ }^\circ\text{C};$ see <a href="#">Figure 9</a> ; see <a href="#">Figure 10</a>	1	2	2.5	V
		$I_D = 0.25 \text{ mA}; V_{DS} = V_{GS}; T_j = 150 \text{ }^\circ\text{C};$ see <a href="#">Figure 9</a> ; see <a href="#">Figure 10</a>	0.6	-	-	V
		$I_D = 0.25 \text{ mA}; V_{DS} = V_{GS}; T_j = -55 \text{ }^\circ\text{C};$ see <a href="#">Figure 9</a> ; see <a href="#">Figure 10</a>	-	-	2.75	V
$I_{DSS}$	drain leakage current	$V_{DS} = 48 \text{ V}; V_{GS} = 0 \text{ V}; T_j = 25 \text{ }^\circ\text{C}$	-	0.01	1	$\mu\text{A}$
		$V_{DS} = 48 \text{ V}; V_{GS} = 0 \text{ V}; T_j = 150 \text{ }^\circ\text{C}$	-	-	10	$\mu\text{A}$
$I_{GSS}$	gate leakage current	$V_{GS} = 15 \text{ V}; V_{DS} = 0 \text{ V}; T_j = 25 \text{ }^\circ\text{C}$	-	10	100	nA
		$V_{GS} = -15 \text{ V}; V_{DS} = 0 \text{ V}; T_j = 25 \text{ }^\circ\text{C}$	-	10	100	nA
$R_{DSon}$	drain-source on-state resistance	$V_{GS} = 10 \text{ V}; I_D = 500 \text{ mA}; T_j = 25 \text{ }^\circ\text{C};$ see <a href="#">Figure 6</a> ; see <a href="#">Figure 8</a>	-	2.8	5	$\Omega$
		$V_{GS} = 10 \text{ V}; I_D = 500 \text{ mA}; T_j = 150 \text{ }^\circ\text{C};$ see <a href="#">Figure 6</a> ; see <a href="#">Figure 8</a>	-	-	9.25	$\Omega$
		$V_{GS} = 4.5 \text{ V}; I_D = 75 \text{ mA}; T_j = 25 \text{ }^\circ\text{C};$ see <a href="#">Figure 6</a> ; see <a href="#">Figure 8</a>	-	3.8	5.3	$\Omega$
<b>Dynamic characteristics</b>						
$C_{iss}$	input capacitance	$V_{DS} = 10 \text{ V}; f = 1 \text{ MHz}; V_{GS} = 0 \text{ V};$ $T_j = 25 \text{ }^\circ\text{C}$	-	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	$V_{GS} = 10 \text{ V}; V_{DS} = 50 \text{ V}; R_L = 250 \text{ } \Omega;$ $R_{G(ext)} = 50 \text{ } \Omega; R_{GS} = 50 \text{ } \Omega$	-	2.5	10	ns
$t_{off}$	turn-off time		-	11	15	ns
<b>Source-drain diode</b>						
$V_{SD}$	source-drain voltage	$I_S = 300 \text{ mA}; V_{GS} = 0 \text{ V}; T_j = 25 \text{ }^\circ\text{C};$ see <a href="#">Figure 11</a>	-	0.85	1.5	V
$Q_r$	recovered charge	$V_{GS} = 0 \text{ V}; I_S = 300 \text{ mA};$ $di_S/dt = -100 \text{ A}/\mu\text{s}$	-	30	-	nC
$t_{rr}$	reverse recovery time		-	30	-	ns



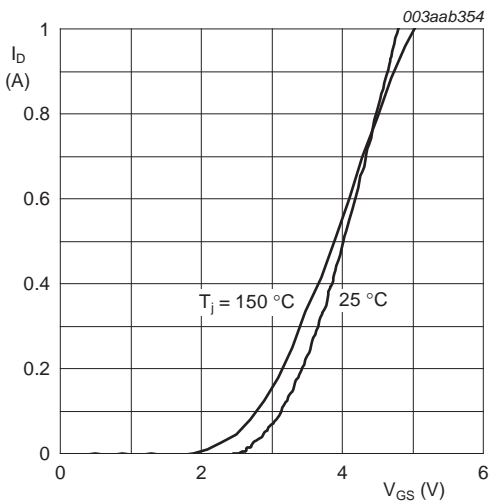
$T_j = 25^\circ\text{C}$

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



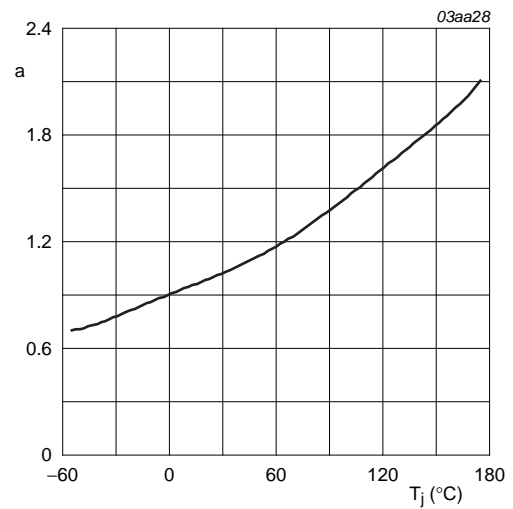
$T_j = 25^\circ\text{C}$

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



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

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

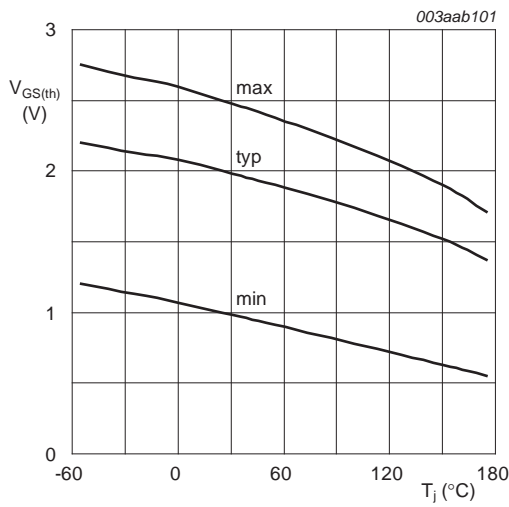


Fig 9. Gate-source threshold voltage as a function of junction temperature

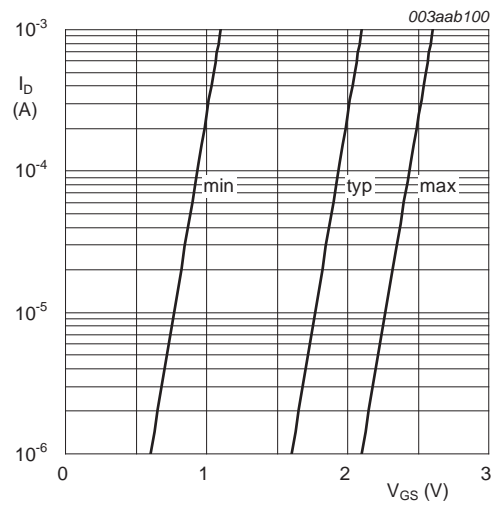


Fig 10. Sub-threshold drain current as a function of gate-source voltage

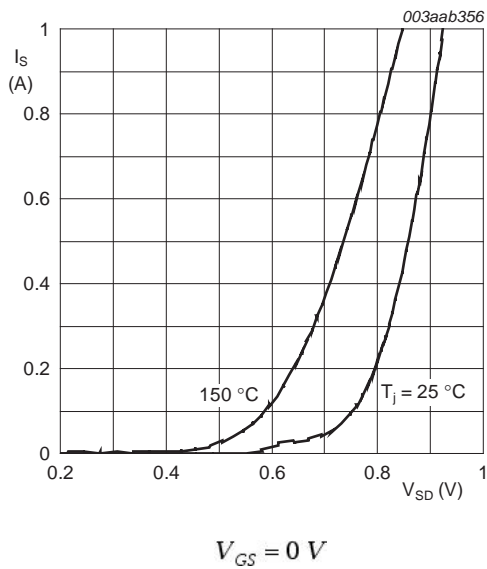


Fig 11. Source current as a function of source-drain voltage; typical values

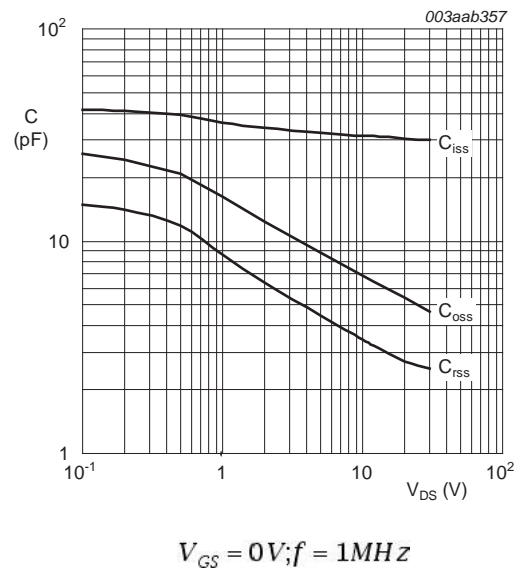


Fig 12. Input, output and reverse transfer capacitances as a function of drain-source voltage; typical values

8. Package outline

Plastic surface-mounted package; 3 leads

SOT23

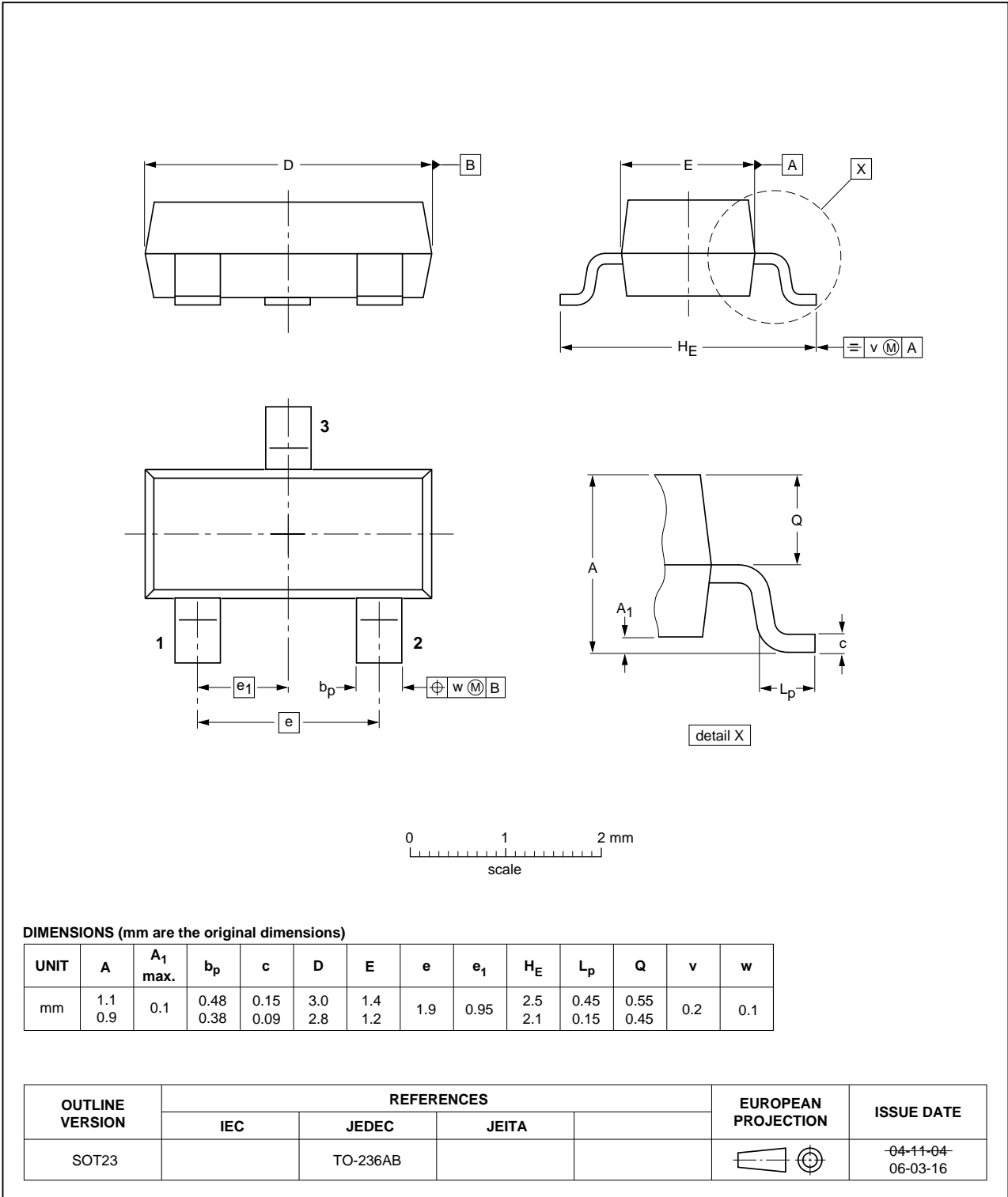


Fig 13. Package outline SOT23 (TO-236AB)



9. Soldering

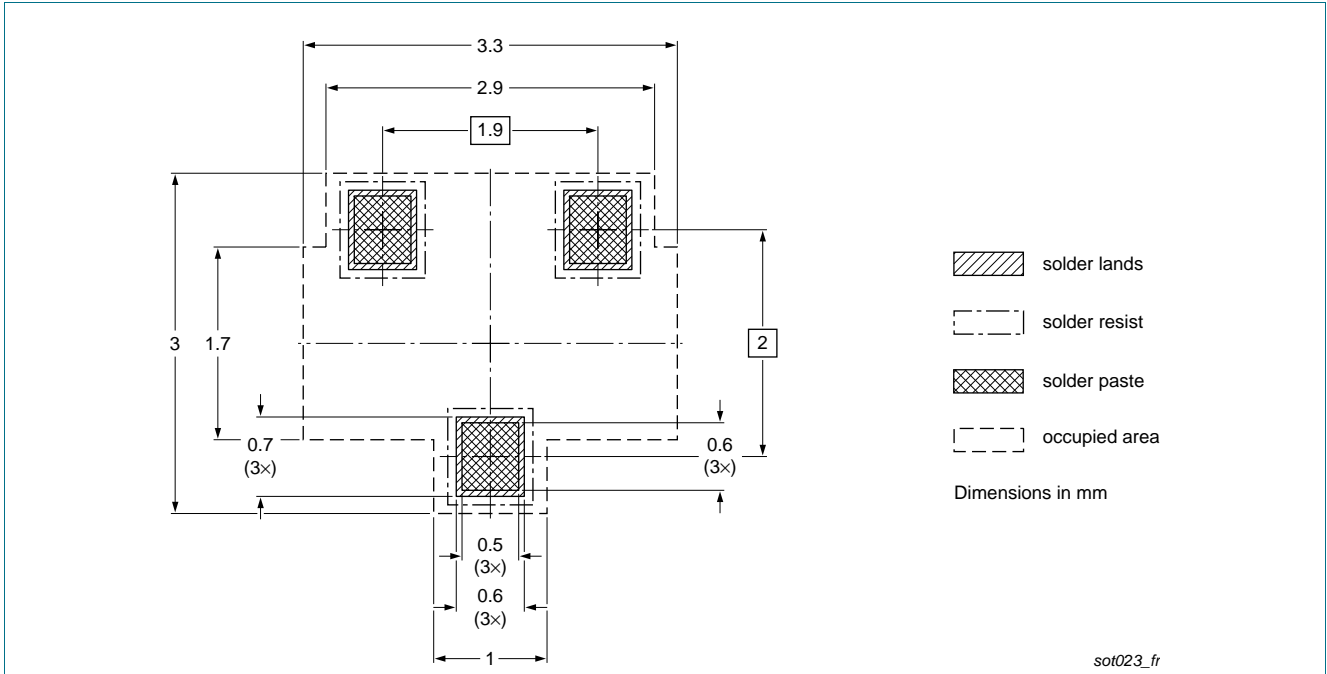


Fig 14. Reflow soldering footprint for SOT23 (TO-236AB)

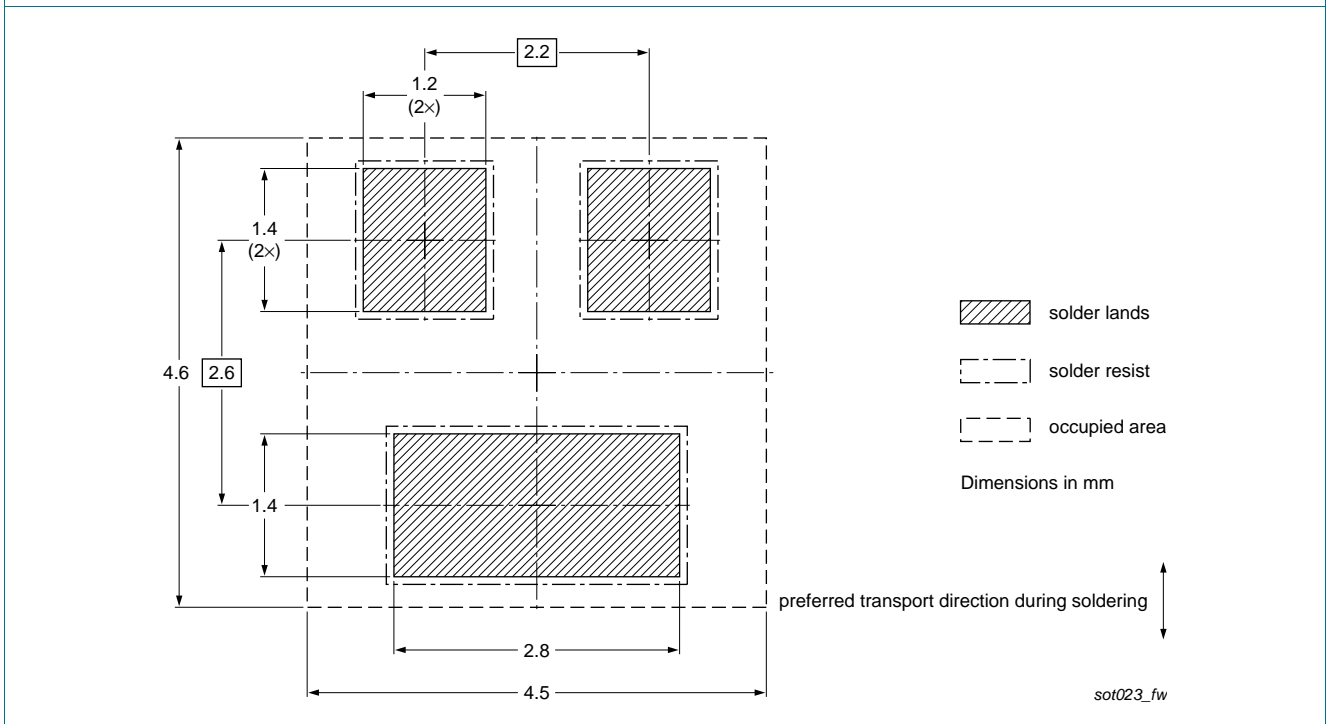


Fig 15. Wave soldering footprint for SOT23 (TO-236AB)

## 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 <a href="#">[1]</a> <a href="#">[2]</a>	Product status <a href="#">[3]</a>	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.

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

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