



# 2N7002CK

60 V, 0.3 A N-channel Trench MOSFET

Rev. 01 — 11 September 2009

Product data sheet

## 1. Product profile

### 1.1 General description

ESD protected N-channel enhancement mode Field-Effect Transistor (FET) in a small SOT23 (TO-236AB) Surface-Mounted Device (SMD) plastic package using Trench MOSFET technology.

### 1.2 Features

- Logic-level compatible
- Very fast switching
- Trench MOSFET technology
- ESD protection up to 3 kV

### 1.3 Applications

- Relay driver
- High-speed line driver
- Low-side loadswitch
- Switching circuits

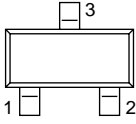
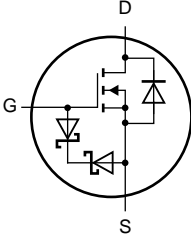
### 1.4 Quick reference data

Table 1. Quick reference data

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$V_{DS}$	drain-source voltage		-	-	60	V
$I_D$	drain current		-	-	300	mA
$I_{DM}$	peak drain current	single pulse; $t_p \leq 10 \mu s$	-	-	1.2	A
$R_{DS(on)}$	drain-source on-state resistance	$V_{GS} = 10 V$ ; $I_D = 500 mA$	-	1.1	1.6	$\Omega$

## 2. Pinning information

Table 2. Pinning

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

017aaa000

## 3. Ordering information

Table 3. Ordering information

Type number	Package		
	Name	Description	Version
2N7002CK	TO-236AB	plastic surface-mounted package; 3 leads	SOT23

## 4. Marking

Table 4. Marking codes

Type number	Marking code <sup>[1]</sup>
2N7002CK	LP*

- [1] \* = -: made in Hong Kong  
 \* = p: made in Hong Kong  
 \* = t: made in Malaysia  
 \* = W: made in China

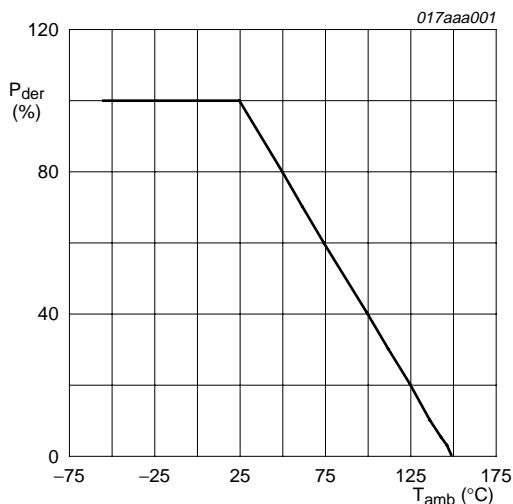
5. Limiting values

**Table 5. Limiting values**

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

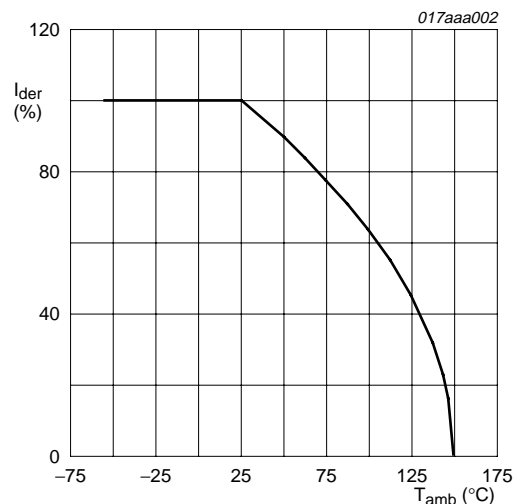
Symbol	Parameter	Conditions	Min	Max	Unit
V <sub>DS</sub>	drain-source voltage	25 °C ≤ T <sub>j</sub> ≤ 150 °C	-	60	V
V <sub>GS</sub>	gate-source voltage		-	±20	V
I <sub>D</sub>	drain current	V <sub>GS</sub> = 10 V			
		T <sub>amb</sub> = 25 °C	-	300	mA
		T <sub>amb</sub> = 100 °C	-	190	mA
I <sub>DM</sub>	peak drain current	T <sub>amb</sub> = 25 °C; t <sub>p</sub> ≤ 10 μs	-	1.2	A
P <sub>tot</sub>	total power dissipation	T <sub>amb</sub> = 25 °C	[1]	350	mW
T <sub>j</sub>	junction temperature			150	°C
T <sub>amb</sub>	ambient temperature		-55	+150	°C
T <sub>stg</sub>	storage temperature		-65	+150	°C
<b>Source-drain diode</b>					
I <sub>S</sub>	source current	T <sub>amb</sub> = 25 °C	-	200	mA
I <sub>SM</sub>	peak source current	T <sub>amb</sub> = 25 °C; t <sub>p</sub> ≤ 10 μs	-	1.2	A
<b>ElectroStatic Discharge (ESD)</b>					
V <sub>ESD</sub>	electrostatic discharge voltage	all pins; human body model; C = 100 pF; R = 1.5 kΩ	-	3	kV

[1] Device mounted on an FR4 Printed-Circuit Board (PCB), single-sided copper, tin-plated, mounting pad for drain 1 cm<sup>2</sup>.



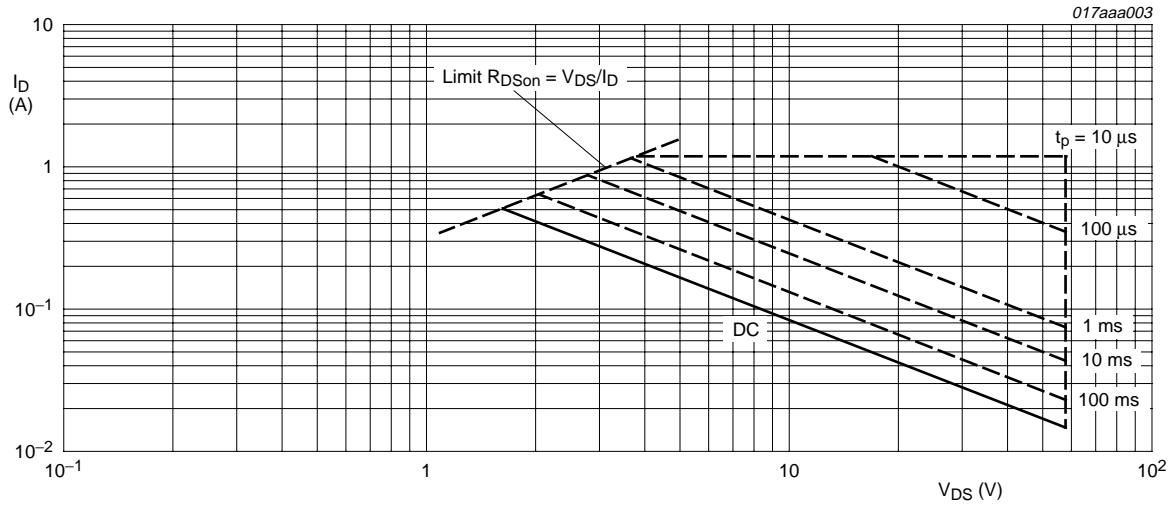
$$P_{der} = \frac{P_{tot}}{P_{tot(25^{\circ}C)}} \times 100\%$$

**Fig 1. Normalized total power dissipation as a function of ambient temperature**



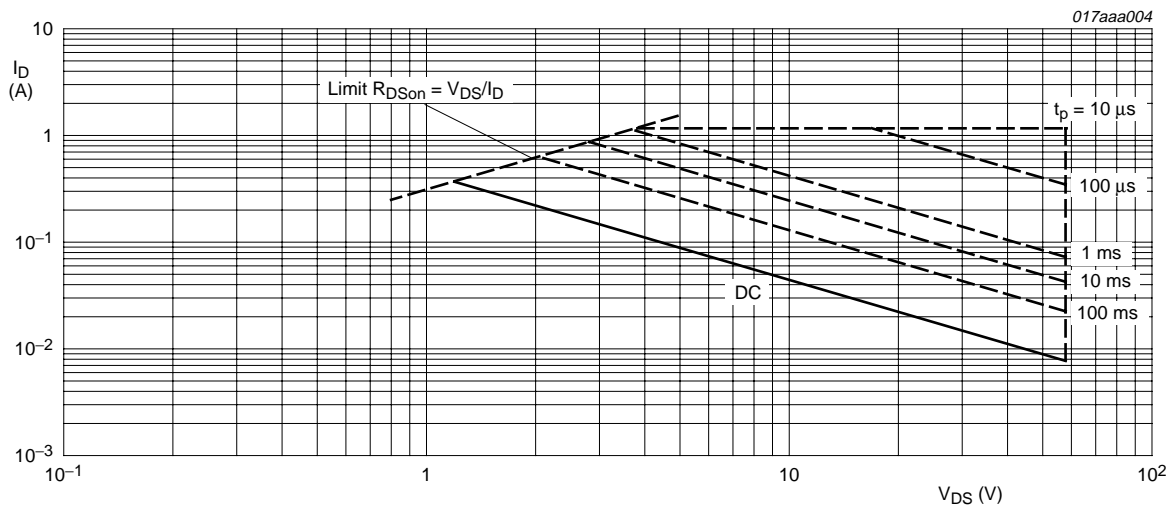
$$I_{der} = \frac{I_D}{I_{D(25^{\circ}C)}} \times 100\%$$

**Fig 2. Normalized continuous drain current as a function of ambient temperature**



$T_{sp} = 25 \text{ }^\circ\text{C}$ ;  $I_{DM} = \text{single pulse}$ ;  $V_{GS} = 10 \text{ V}$

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



$T_{amb} = 25 \text{ }^\circ\text{C}$ ;  $I_{DM} = \text{single pulse}$ ;  $V_{GS} = 10 \text{ V}$

Fig 4. Safe operating area; junction to ambient; continuous 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	in free air	[1] -	350	500	K/W

**Table 6. Thermal characteristics ...continued**

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$R_{th(j-sp)}$	thermal resistance from junction to solder point		-	-	150	K/W

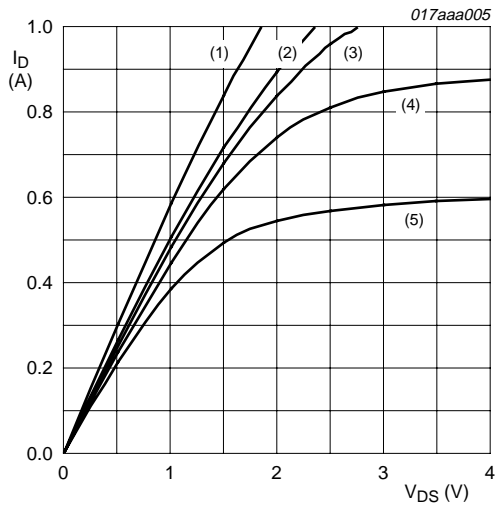
[1] Device mounted on an FR4 PCB, single-sided copper, tin-plated and standard footprint.

## 7. Characteristics

**Table 7. Characteristics**

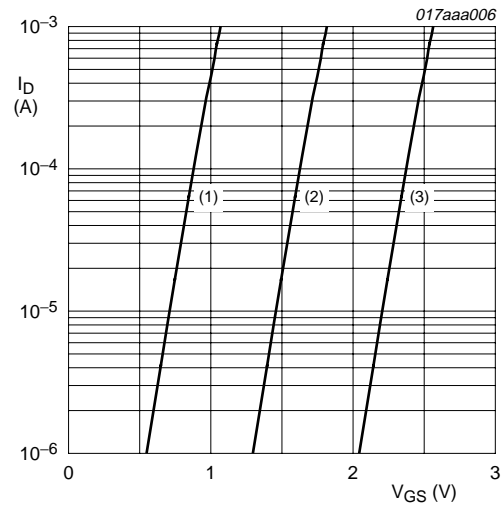
$T_{amb} = 25\text{ }^{\circ}\text{C}$  unless otherwise specified.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
<b>Static characteristics</b>						
$V_{(BR)DSS}$	drain-source breakdown voltage	$I_D = 10\text{ }\mu\text{A}; V_{GS} = 0\text{ V}$ $T_j = 25\text{ }^{\circ}\text{C}$	60	-	-	V
		$T_j = -55\text{ }^{\circ}\text{C}$	55	-	-	V
$V_{GS(th)}$	gate-source threshold voltage	$I_D = 250\text{ }\mu\text{A}; V_{DS} = V_{GS};$ $T_j = 25\text{ }^{\circ}\text{C}$	1	1.75	2.5	V
$I_{DSS}$	drain leakage current	$V_{DS} = 60\text{ V}; V_{GS} = 0\text{ V}$ $T_j = 25\text{ }^{\circ}\text{C}$	-	-	100	nA
		$T_j = 150\text{ }^{\circ}\text{C}$	-	-	1	$\mu\text{A}$
$I_{GSS}$	gate leakage current	$V_{GS} = \pm 20\text{ V}; V_{DS} = 0\text{ V}$	-	-	5	$\mu\text{A}$
		$V_{GS} = \pm 10\text{ V}; V_{DS} = 0\text{ V}$	-	50	450	nA
		$V_{GS} = \pm 5\text{ V}; V_{DS} = 0\text{ V}$	-	-	100	nA
$R_{DS(on)}$	drain-source on-state resistance	$V_{GS} = 4.5\text{ V};$ $I_D = 200\text{ mA}$ $T_j = 25\text{ }^{\circ}\text{C}$	-	1.3	3	$\Omega$
		$T_j = 150\text{ }^{\circ}\text{C}$	-	2.8	4.4	$\Omega$
		$V_{GS} = 10\text{ V}; I_D = 500\text{ mA}$	-	1.1	1.6	$\Omega$
<b>Dynamic characteristics</b>						
$Q_{G(tot)}$	total gate charge	$I_D = 200\text{ mA};$ $V_{DS} = 10\text{ V};$ $V_{GS} = 4.5\text{ V}$	-	1.09	1.3	nC
$Q_{GS}$	gate-source charge		-	0.22	-	nC
$Q_{GD}$	gate-drain charge		-	0.23	-	nC
$C_{iss}$	input capacitance	$V_{GS} = 0\text{ V}; V_{DS} = 25\text{ V};$ $f = 1\text{ MHz}$	-	47.2	55	pF
$C_{oss}$	output capacitance		-	11	20	pF
$C_{rss}$	reverse transfer capacitance		-	5	7.5	pF
$t_{d(on)}$	turn-on delay time	$V_{DS} = 15\text{ V};$ $R_L = 15\text{ }\Omega;$ $V_{GS} = 10\text{ V};$ $R_G = 6\text{ }\Omega$	-	8	15	ns
$t_r$	rise time		-	8	15	ns
$t_{d(off)}$	turn-off delay time		-	38	50	ns
$t_f$	fall time		-	22	35	ns
<b>Source-drain diode</b>						
$V_{SD}$	source-drain voltage	$I_S = 200\text{ mA}; V_{GS} = 0\text{ V}$	0.47	0.79	1.1	V



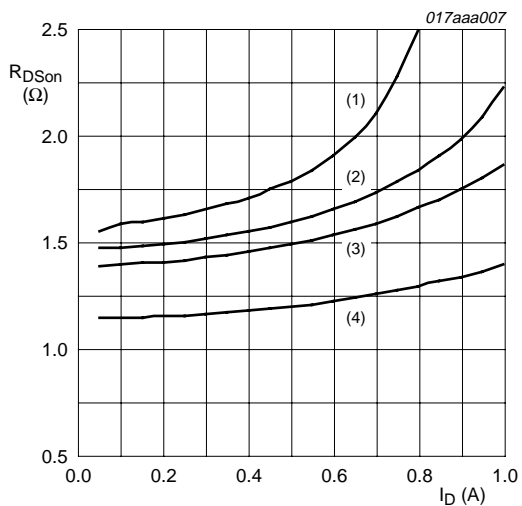
- $T_j = 25\text{ }^\circ\text{C}$
- (1)  $V_{GS} = 10\text{ V}$
  - (2)  $V_{GS} = 5\text{ V}$
  - (3)  $V_{GS} = 4.5\text{ V}$
  - (4)  $V_{GS} = 4\text{ V}$
  - (5)  $V_{GS} = 3.5\text{ V}$

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



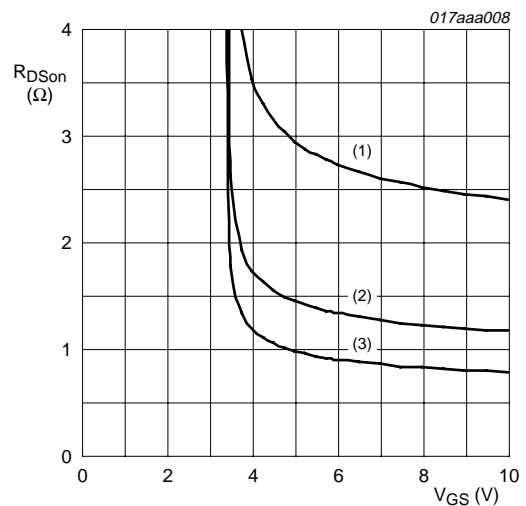
- $T_j = 25\text{ }^\circ\text{C}; V_{DS} = 5\text{ V}$
- (1) minimum values
  - (2) typical values
  - (3) maximum values

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



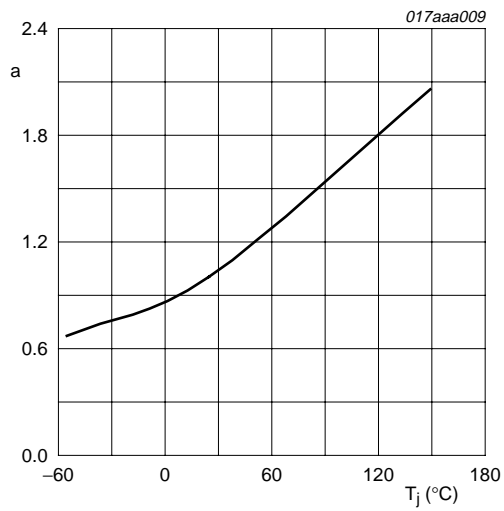
- $T_j = 25\text{ }^\circ\text{C}$
- (1)  $V_{GS} = 4\text{ V}$
  - (2)  $V_{GS} = 4.5\text{ V}$
  - (3)  $V_{GS} = 5\text{ V}$
  - (4)  $V_{GS} = 10\text{ V}$

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



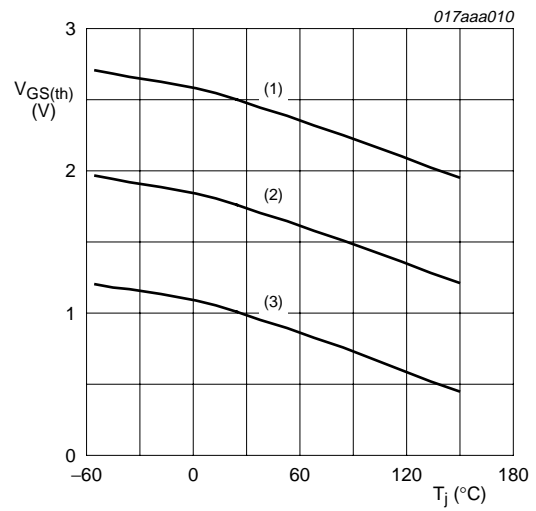
- $I_D = 500\text{ mA}$
- (1)  $T_j = 150\text{ }^\circ\text{C}$
  - (2)  $T_j = 25\text{ }^\circ\text{C}$
  - (3)  $T_j = -55\text{ }^\circ\text{C}$

**Fig 8. Drain-source on-resistance as a function of gate-source voltage; typical values**



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

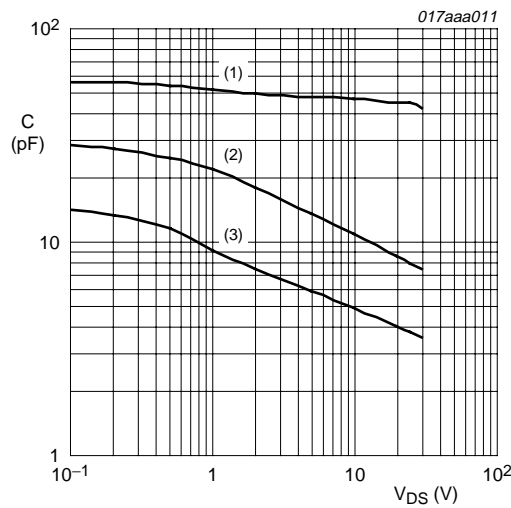
Fig 9. Normalized drain-source on-state resistance factor as a function of junction temperature



$I_D = 0.25 \text{ mA}; V_{DS} = V_{GS}$

- (1) maximum values
- (2) typical values
- (3) minimum values

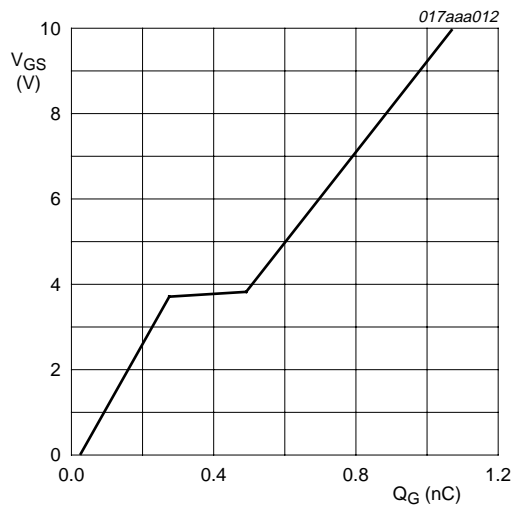
Fig 10. Gate-source threshold voltage as a function of junction temperature



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

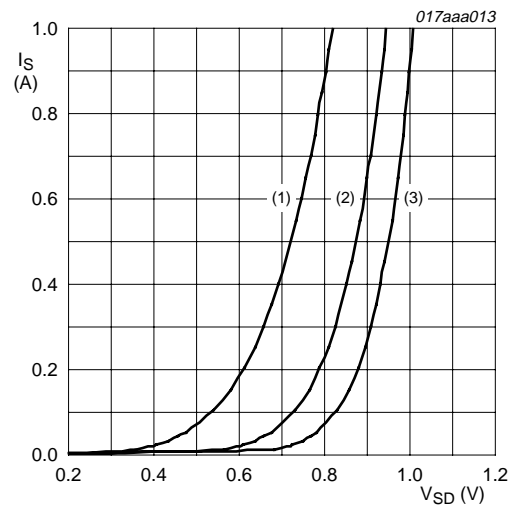
- (1)  $C_{iss}$
- (2)  $C_{oss}$
- (3)  $C_{rss}$

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



$I_D = 200 \text{ mA}$ ;  $V_{DD} = 30 \text{ V}$ ;  $T_j = 25 \text{ }^\circ\text{C}$

**Fig 12. Gate-source voltage as a function of gate charge; typical values**



$V_{GS} = 0 \text{ V}$

- (1)  $T_j = 150 \text{ }^\circ\text{C}$
- (2)  $T_j = 25 \text{ }^\circ\text{C}$
- (3)  $T_j = -55 \text{ }^\circ\text{C}$

**Fig 13. Source current as a function of source-drain voltage; typical values**



8. Package outline

Plastic surface-mounted package; 3 leads

SOT23

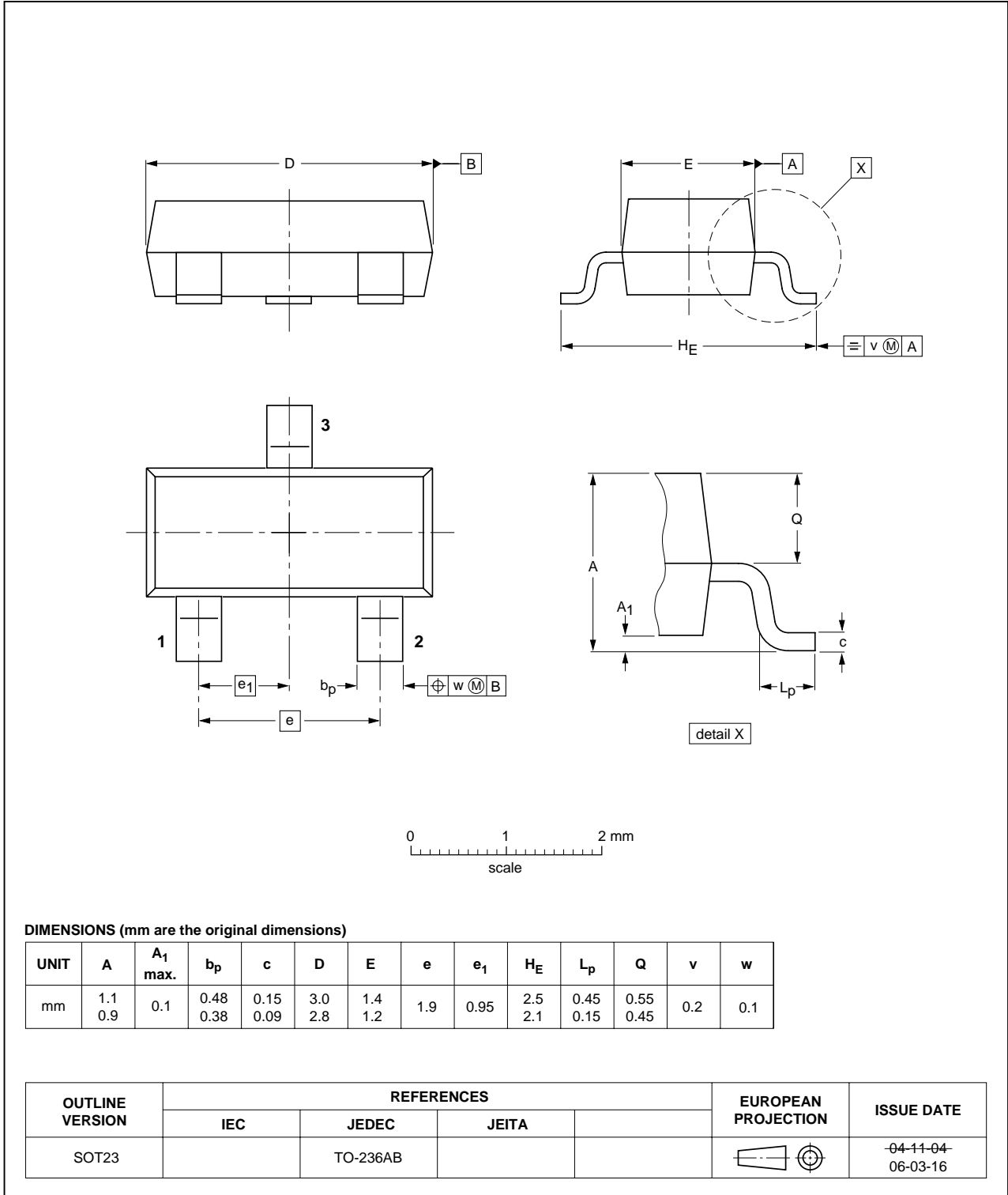


Fig 14. Package outline SOT23 (TO-236AB)

9. Soldering

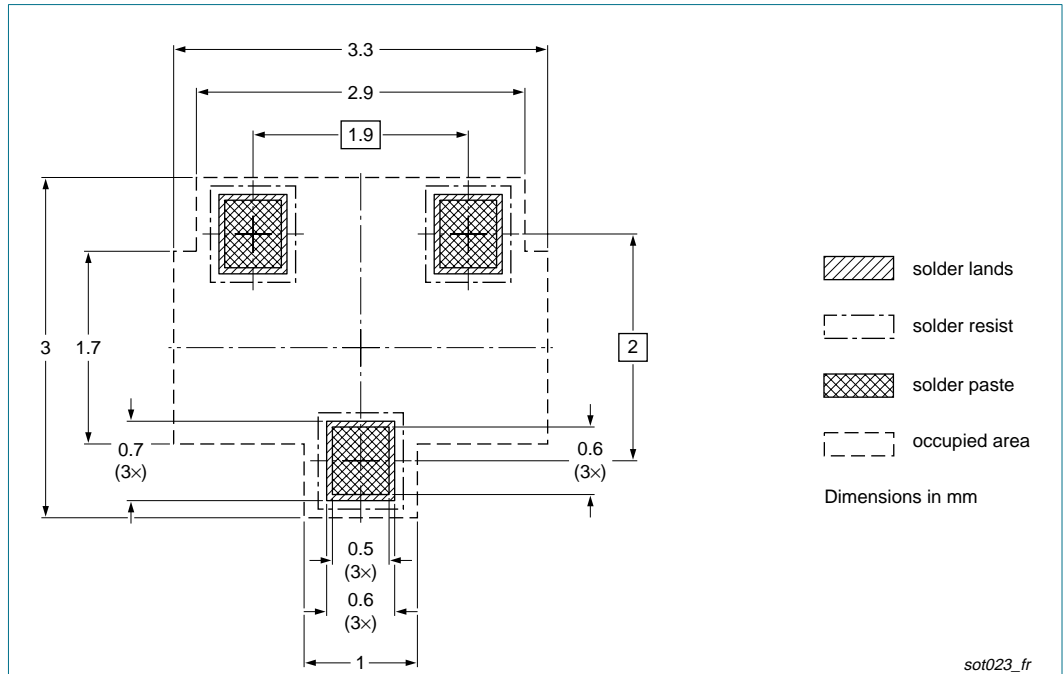


Fig 15. Reflow soldering footprint SOT23 (TO-236AB)

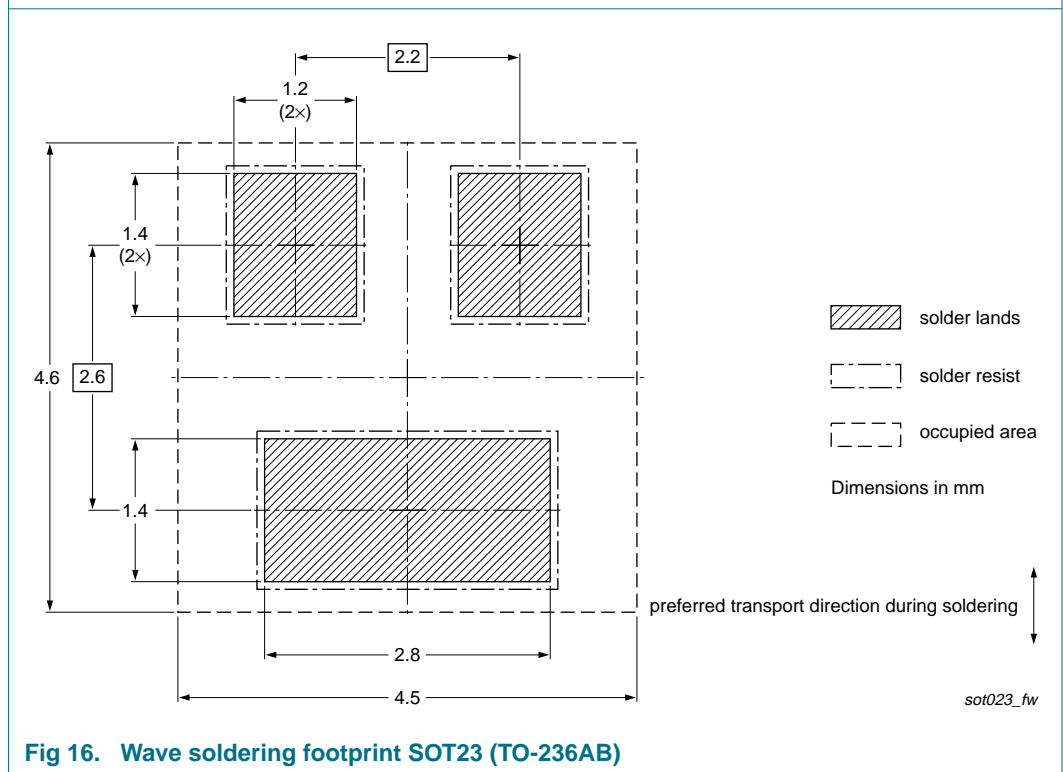


Fig 16. Wave soldering footprint SOT23 (TO-236AB)

## 10. Revision history

Table 8. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
2N7002CK_1	20090911	Product data sheet	-	-

## 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.

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

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