



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

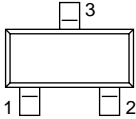
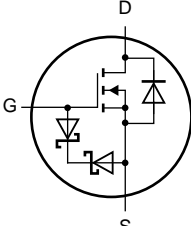
1.4 Quick reference data

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	Ω

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 ^[1]
2N7002CK	LP*

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

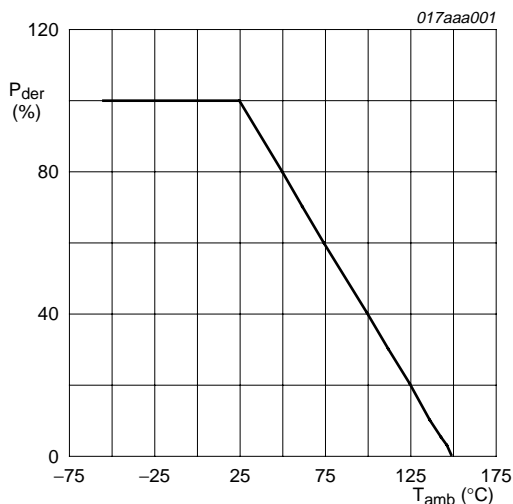
5. Limiting values

Table 5. Limiting values

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

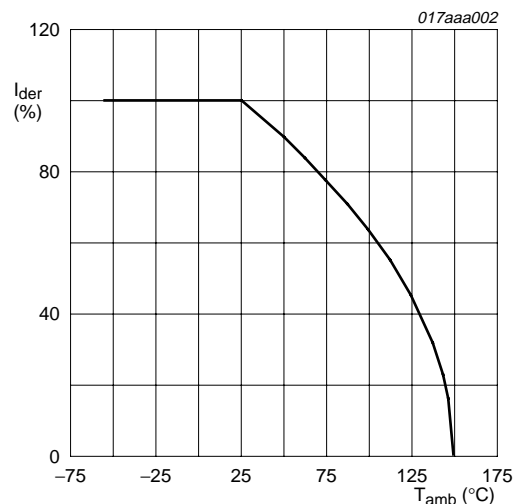
Symbol	Parameter	Conditions	Min	Max	Unit
V _{DS}	drain-source voltage	25 °C ≤ T _j ≤ 150 °C	-	60	V
V _{GS}	gate-source voltage		-	±20	V
I _D	drain current	V _{GS} = 10 V			
		T _{amb} = 25 °C	-	300	mA
		T _{amb} = 100 °C	-	190	mA
I _{DM}	peak drain current	T _{amb} = 25 °C; t _p ≤ 10 μs	-	1.2	A
P _{tot}	total power dissipation	T _{amb} = 25 °C	[1]	350	mW
T _j	junction temperature			150	°C
T _{amb}	ambient temperature		-55	+150	°C
T _{stg}	storage temperature		-65	+150	°C
Source-drain diode					
I _S	source current	T _{amb} = 25 °C	-	200	mA
I _{SM}	peak source current	T _{amb} = 25 °C; t _p ≤ 10 μs	-	1.2	A
ElectroStatic Discharge (ESD)					
V _{ESD}	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 cm².



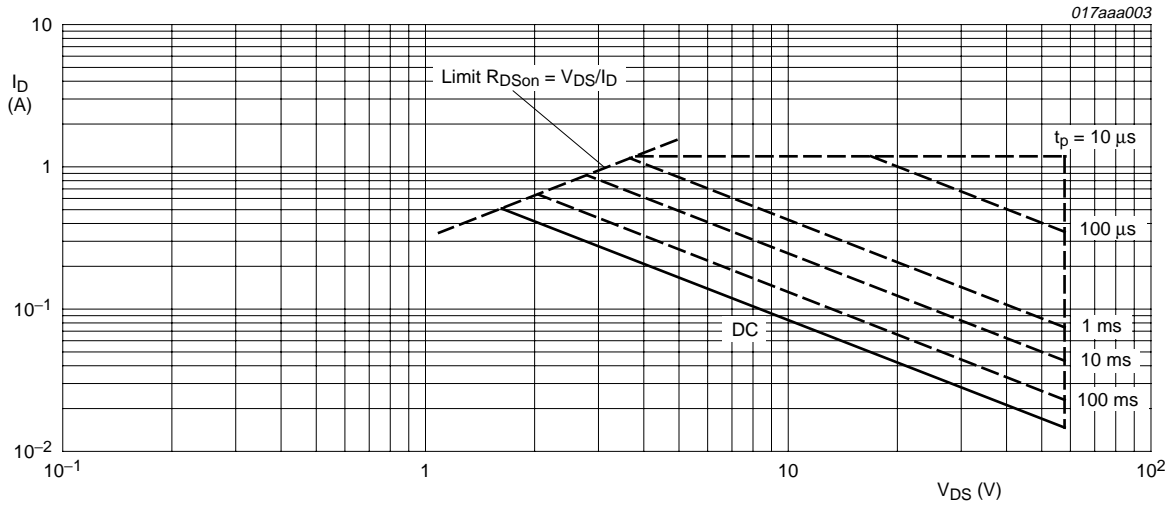
$$P_{der} = \frac{P_{tot}}{P_{tot(25^{\circ}C)}} \times 100\%$$

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



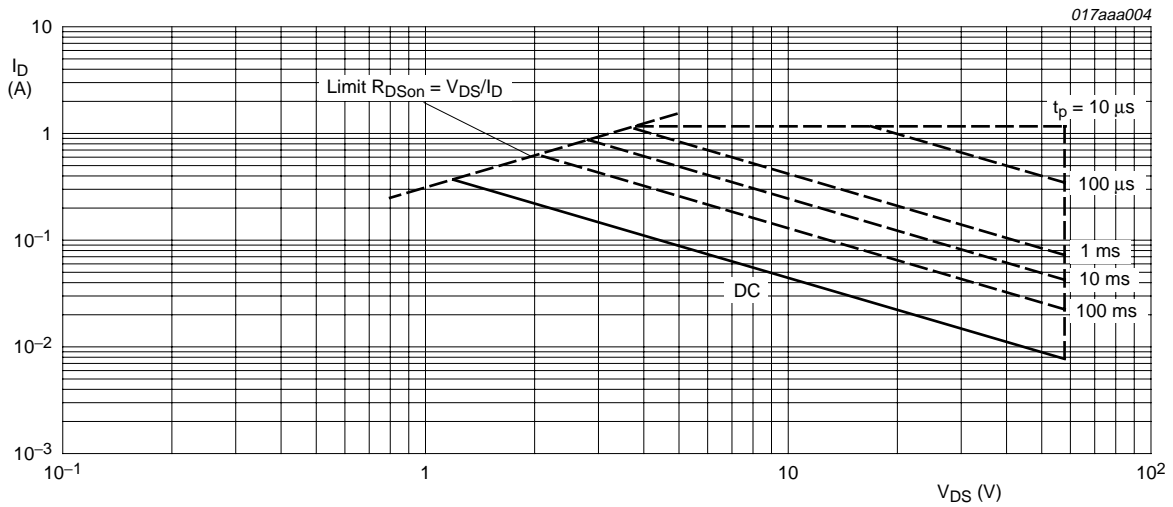
$$I_{der} = \frac{I_D}{I_{D(25^{\circ}C)}} \times 100\%$$

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

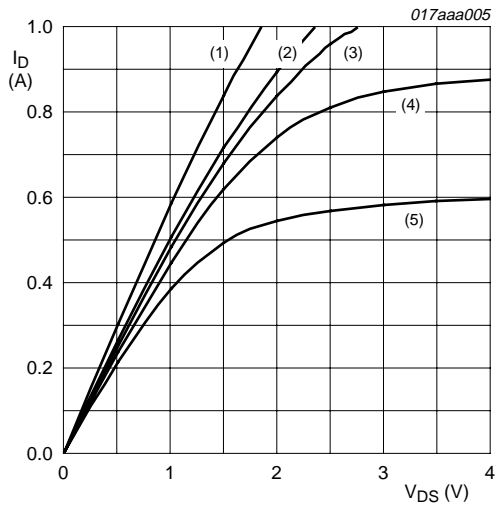
[1] Device mounted on an FR4 PCB, single-sided copper, tin-plated and standard footprint.

7. Characteristics

Table 7. Characteristics

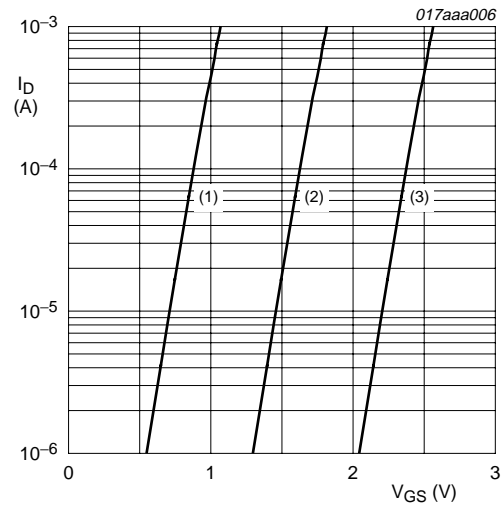
$T_{amb} = 25\text{ °C}$ unless otherwise specified.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Static characteristics						
$V_{(BR)DSS}$	drain-source breakdown voltage	$I_D = 10\ \mu\text{A}; V_{GS} = 0\ \text{V}$				
		$T_j = 25\text{ °C}$	60	-	-	V
		$T_j = -55\text{ °C}$	55	-	-	V
$V_{GS(th)}$	gate-source threshold voltage	$I_D = 250\ \mu\text{A}; V_{DS} = V_{GS}; T_j = 25\text{ °C}$	1	1.75	2.5	V
I_{DSS}	drain leakage current	$V_{DS} = 60\ \text{V}; V_{GS} = 0\ \text{V}$				
		$T_j = 25\text{ °C}$	-	-	100	nA
		$T_j = 150\text{ °C}$	-	-	1	μA
I_{GSS}	gate leakage current	$V_{GS} = \pm 20\ \text{V}; V_{DS} = 0\ \text{V}$	-	-	5	μA
		$V_{GS} = \pm 10\ \text{V}; V_{DS} = 0\ \text{V}$	-	50	450	nA
		$V_{GS} = \pm 5\ \text{V}; V_{DS} = 0\ \text{V}$	-	-	100	nA
$R_{DS(on)}$	drain-source on-state resistance	$V_{GS} = 4.5\ \text{V}; I_D = 200\ \text{mA}$				
		$T_j = 25\text{ °C}$	-	1.3	3	Ω
		$T_j = 150\text{ °C}$	-	2.8	4.4	Ω
		$V_{GS} = 10\ \text{V}; I_D = 500\ \text{mA}$	-	1.1	1.6	Ω
Dynamic characteristics						
$Q_{G(tot)}$	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	$V_{DS} = 15\ \text{V}; R_L = 15\ \Omega;$	-	8	15	ns
t_r	rise time	$V_{GS} = 10\ \text{V}; R_G = 6\ \Omega$	-	8	15	ns
$t_{d(off)}$	turn-off delay time		-	38	50	ns
t_f	fall time		-	22	35	ns
Source-drain diode						
V_{SD}	source-drain voltage	$I_S = 200\ \text{mA}; V_{GS} = 0\ \text{V}$	0.47	0.79	1.1	V



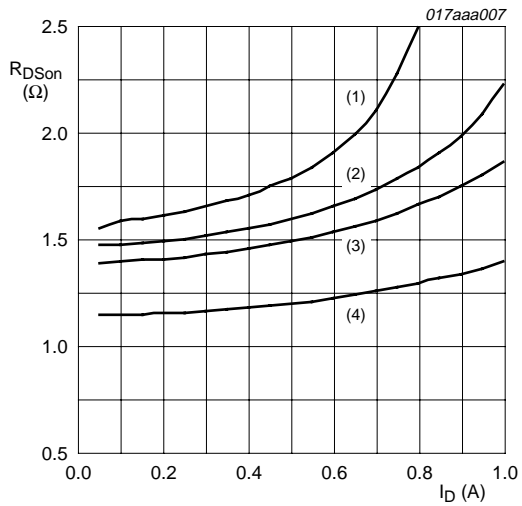
- $T_j = 25\text{ °C}$
- (1) $V_{GS} = 10\text{ V}$
 - (2) $V_{GS} = 5\text{ V}$
 - (3) $V_{GS} = 4.5\text{ V}$
 - (4) $V_{GS} = 4\text{ V}$
 - (5) $V_{GS} = 3.5\text{ V}$

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



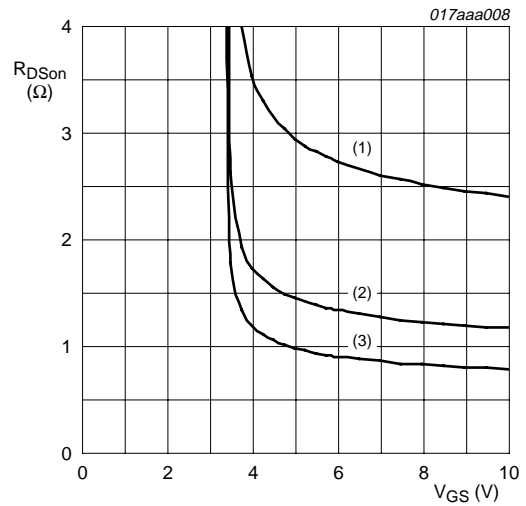
- $T_j = 25\text{ °C}; V_{DS} = 5\text{ V}$
- (1) minimum values
 - (2) typical values
 - (3) maximum values

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



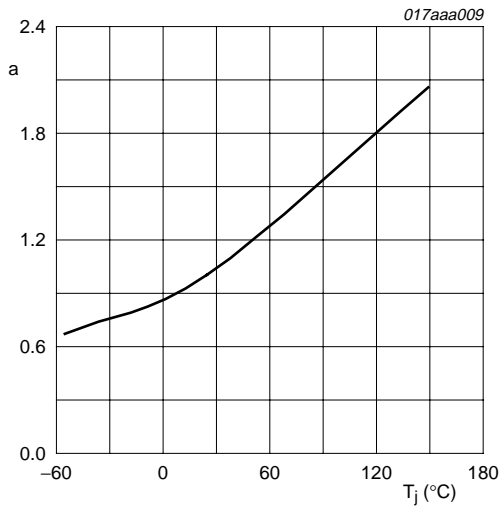
- $T_j = 25\text{ °C}$
- (1) $V_{GS} = 4\text{ V}$
 - (2) $V_{GS} = 4.5\text{ V}$
 - (3) $V_{GS} = 5\text{ V}$
 - (4) $V_{GS} = 10\text{ V}$

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



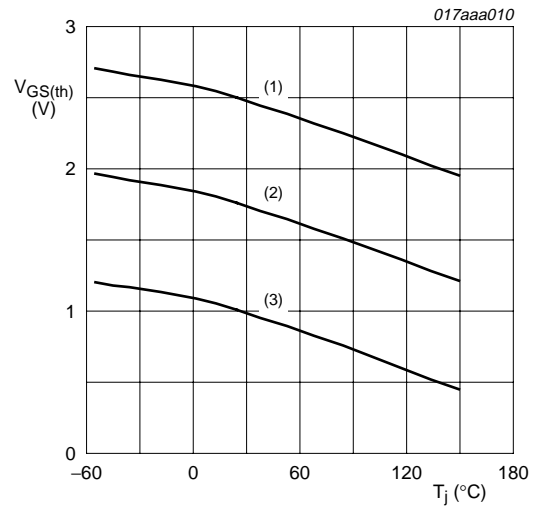
- $I_D = 500\text{ mA}$
- (1) $T_j = 150\text{ °C}$
 - (2) $T_j = 25\text{ °C}$
 - (3) $T_j = -55\text{ °C}$

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



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

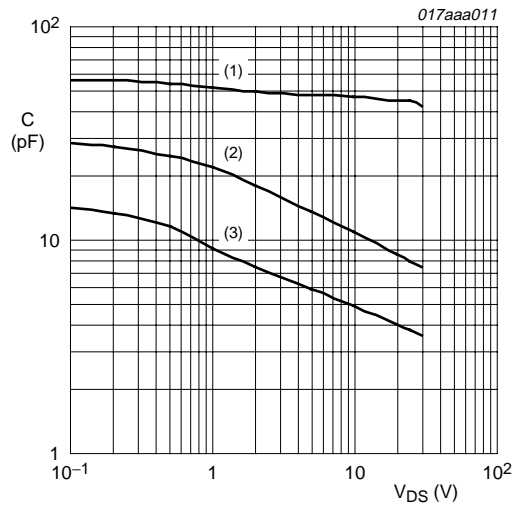
Fig 9. Normalized drain-source on-state resistance factor as a function of junction temperature



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

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

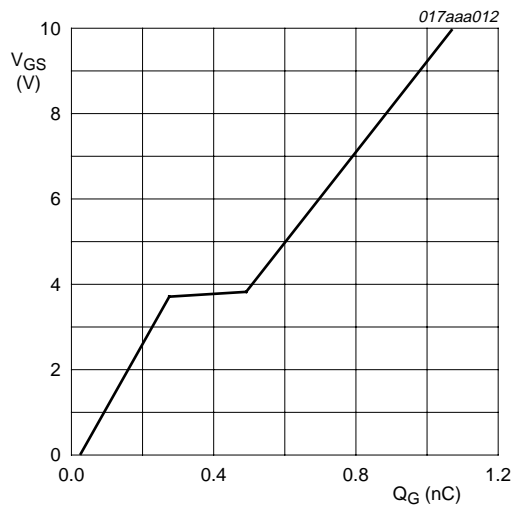
Fig 10. Gate-source threshold voltage as a function of junction temperature



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

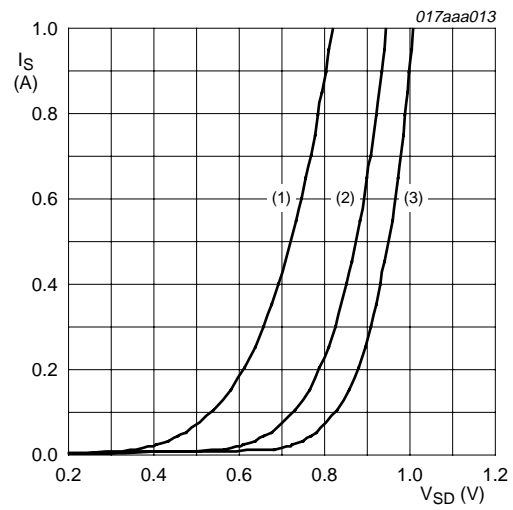
- (1) C_{iss}
- (2) C_{oss}
- (3) C_{rss}

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

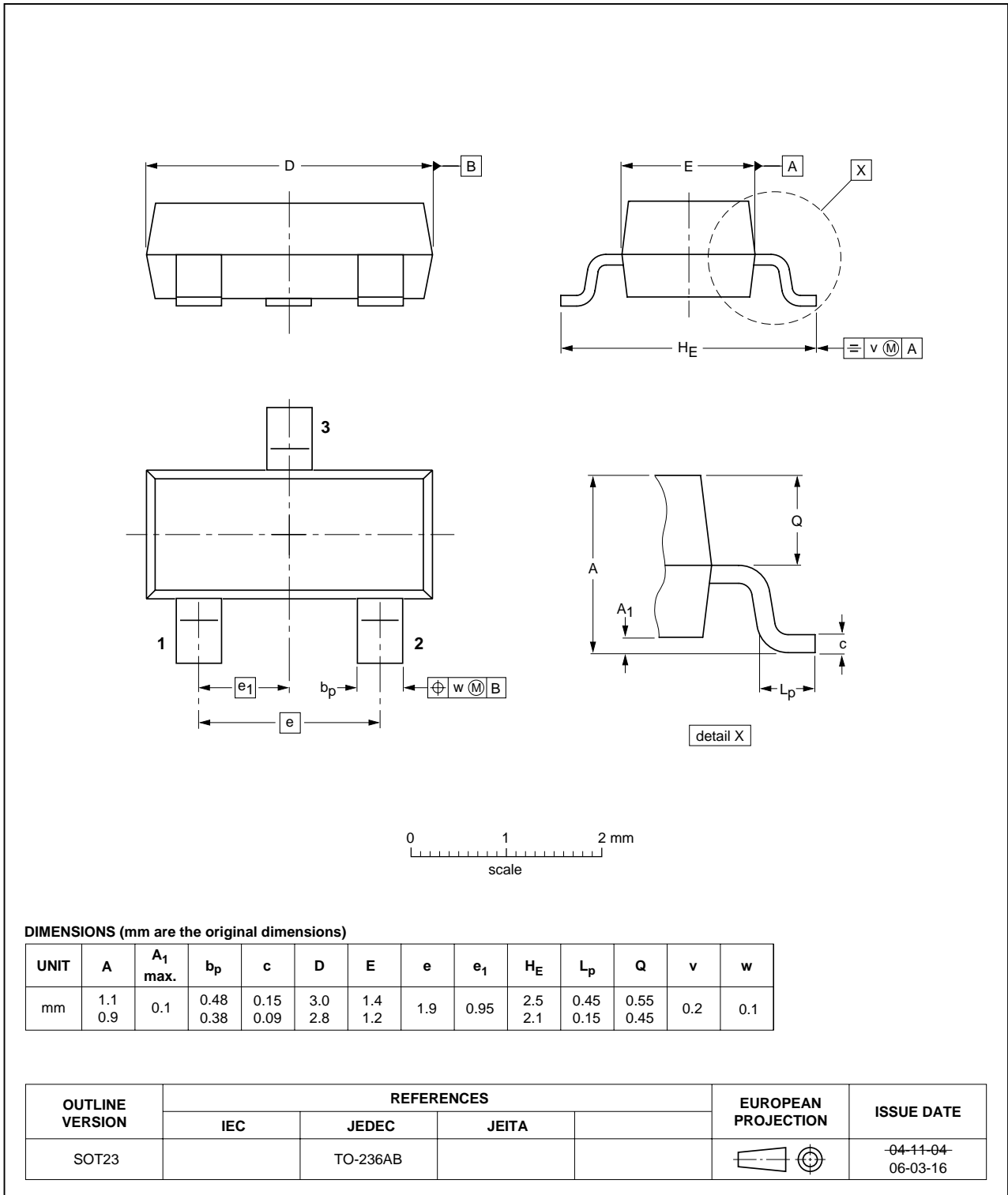


Fig 14. Package outline SOT23 (TO-236AB)

9. Soldering

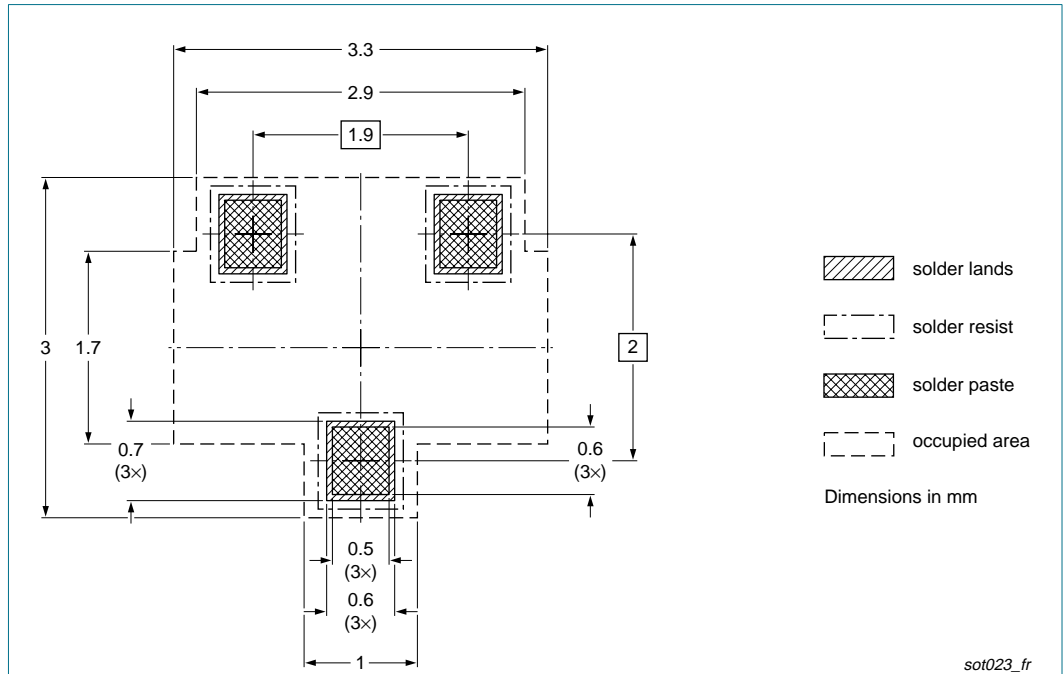


Fig 15. Reflow soldering footprint SOT23 (TO-236AB)

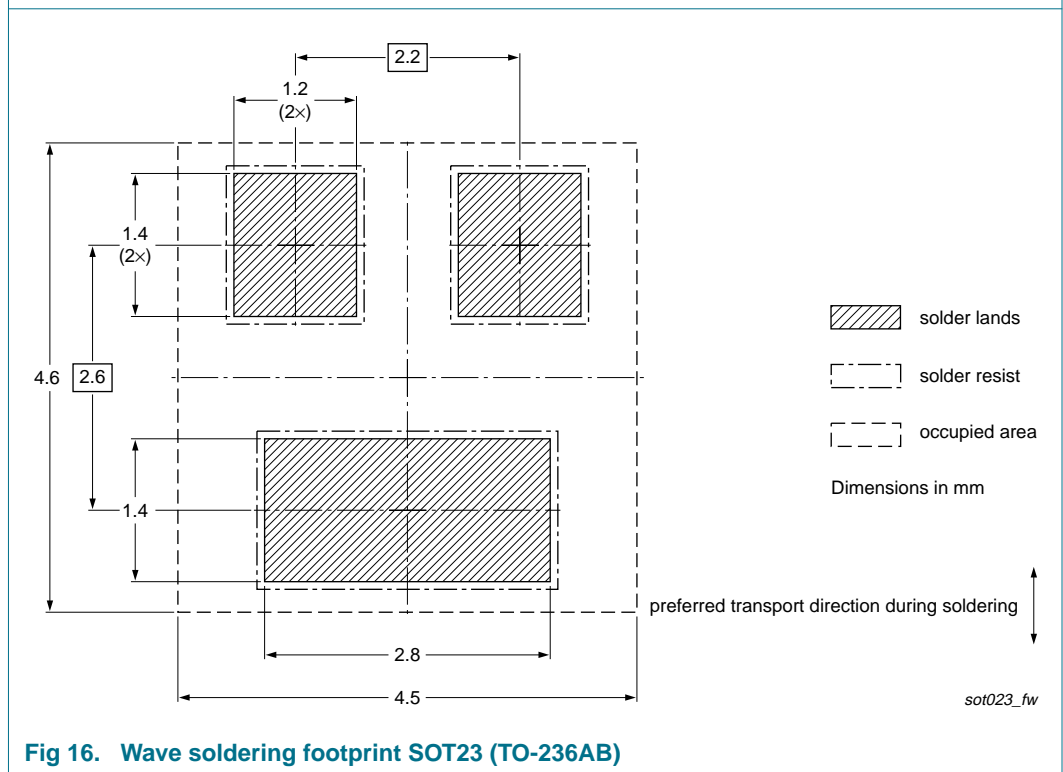


Fig 16. Wave soldering footprint SOT23 (TO-236AB)

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 ^{[1][2]}	Product status ^[3]	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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