

# 2N7002K

TrenchMOS™ logic level FET

Rev. 01 — 20 October 2003

Product data

## 1. Product profile

### 1.1 Description

N-channel enhancement mode field-effect transistor in a plastic package using TrenchMOS™ technology.

### 1.2 Features

- Logic level compatible
- Subminiature surface mount package
- Very fast switching
- Gate-source ESD protection diodes.

### 1.3 Applications

- Relay driver
- High speed line driver.

### 1.4 Quick reference data

- $V_{DS} \leq 60 \text{ V}$
- $I_D \leq 340 \text{ mA}$
- $P_{tot} \leq 0.83 \text{ W}$
- $R_{DSon} \leq 3.9 \Omega$ .

## 2. Pinning information

Table 1: Pinning - SOT23, simplified outline and symbol

Pin	Description	Simplified outline	Symbol
1	gate (g)	<p>Top view MSB003</p> <p><b>SOT23</b></p>	<p>03ab60</p>
2	source (s)		
3	drain (d)		



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### 3. Ordering information

Table 2: Ordering information

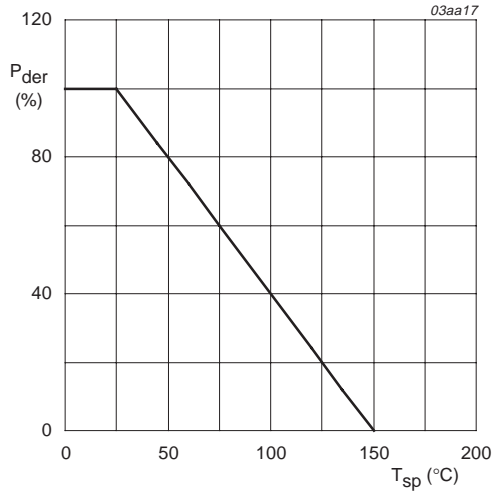
Type number	Package		Version
	Name	Description	
2N7002K	SOT23	Plastic surface mounted package; 3 leads.	SOT23

### 4. Limiting values

Table 3: Limiting values

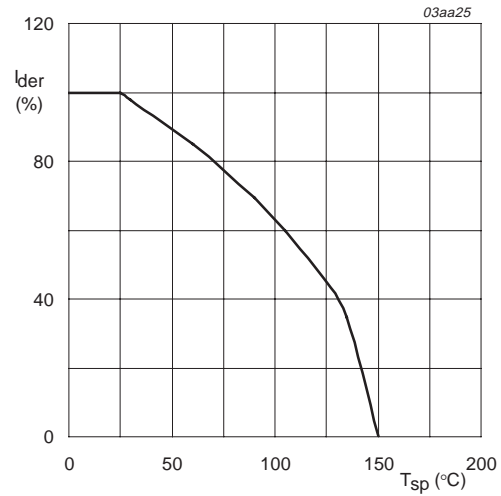
In accordance with the Absolute Maximum Rating System (IEC 60134).

Symbol	Parameter	Conditions	Min	Max	Unit
$V_{DS}$	drain-source voltage (DC)	$25\text{ °C} \leq T_j \leq 150\text{ °C}$	-	60	V
$V_{DGR}$	drain-gate voltage (DC)	$25\text{ °C} \leq T_j \leq 150\text{ °C}$ ; $R_{GS} = 20\text{ k}\Omega$	-	60	V
$V_{GS}$	gate-source voltage (DC)		-	$\pm 15$	V
$I_D$	drain current (DC)	$T_{sp} = 25\text{ °C}$ ; $V_{GS} = 10\text{ V}$ ; <b>Figure 2 and 3</b>	-	340	mA
		$T_{sp} = 100\text{ °C}$ ; $V_{GS} = 10\text{ V}$ ; <b>Figure 2</b>	-	215	mA
$I_{DM}$	peak drain current	$T_{sp} = 25\text{ °C}$ ; pulsed; $t_p \leq 10\text{ }\mu\text{s}$ ; <b>Figure 3</b>	-	680	mA
$P_{tot}$	total power dissipation	$T_{sp} = 25\text{ °C}$ ; <b>Figure 1</b>	-	0.83	W
$T_{stg}$	storage temperature		-65	+150	°C
$T_j$	junction temperature		-65	+150	°C
<b>Source-drain diode</b>					
$I_S$	source (diode forward) current (DC)	$T_{sp} = 25\text{ °C}$	-	340	mA
$I_{SM}$	peak source (diode forward) current	$T_{sp} = 25\text{ °C}$ ; pulsed; $t_p \leq 10\text{ }\mu\text{s}$	-	680	mA
<b>Electrostatic discharge voltage</b>					
$V_{esd}$	electrostatic discharge voltage	Human Body Model 1; $C = 100\text{ pF}$ ; $R = 1.5\text{ k}\Omega$	-	1	kV



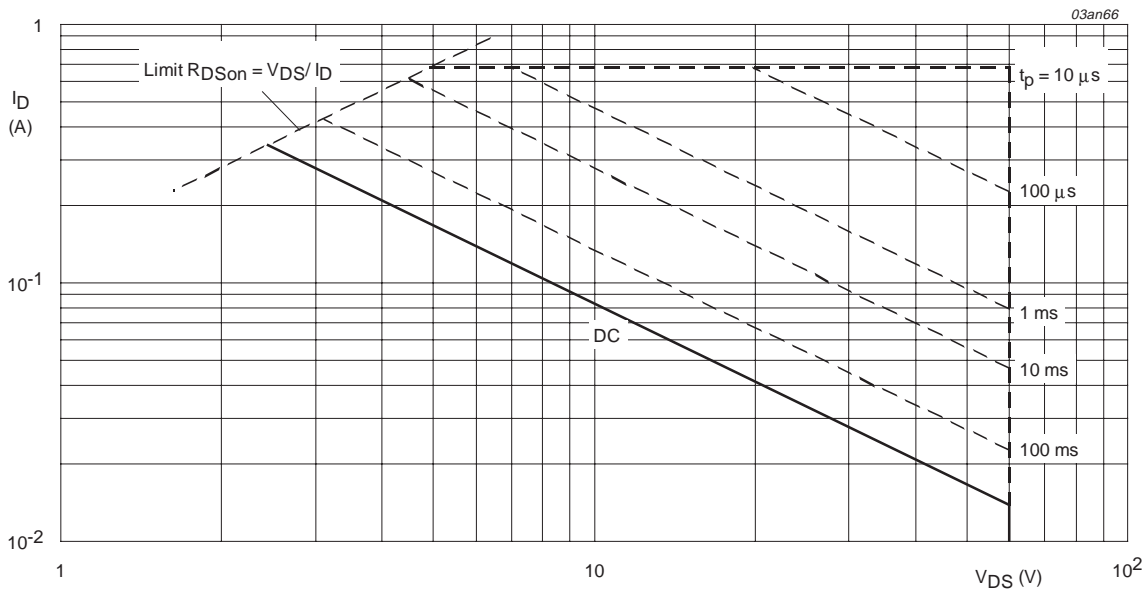
$$P_{der} = \frac{P_{tot}}{P_{tot(25^{\circ}C)}} \times 100\%$$

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



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

Fig 2. Normalized continuous drain current as a function of solder point temperature.



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

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

## 5. Thermal characteristics

Table 4: Thermal characteristics

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$R_{th(j-sp)}$	thermal resistance from junction to solder point	Figure 4	-	-	150	K/W
$R_{th(j-a)}$	thermal resistance from junction to ambient	minimum footprint; mounted on a printed-circuit board	-	350	-	K/W

### 5.1 Transient thermal impedance

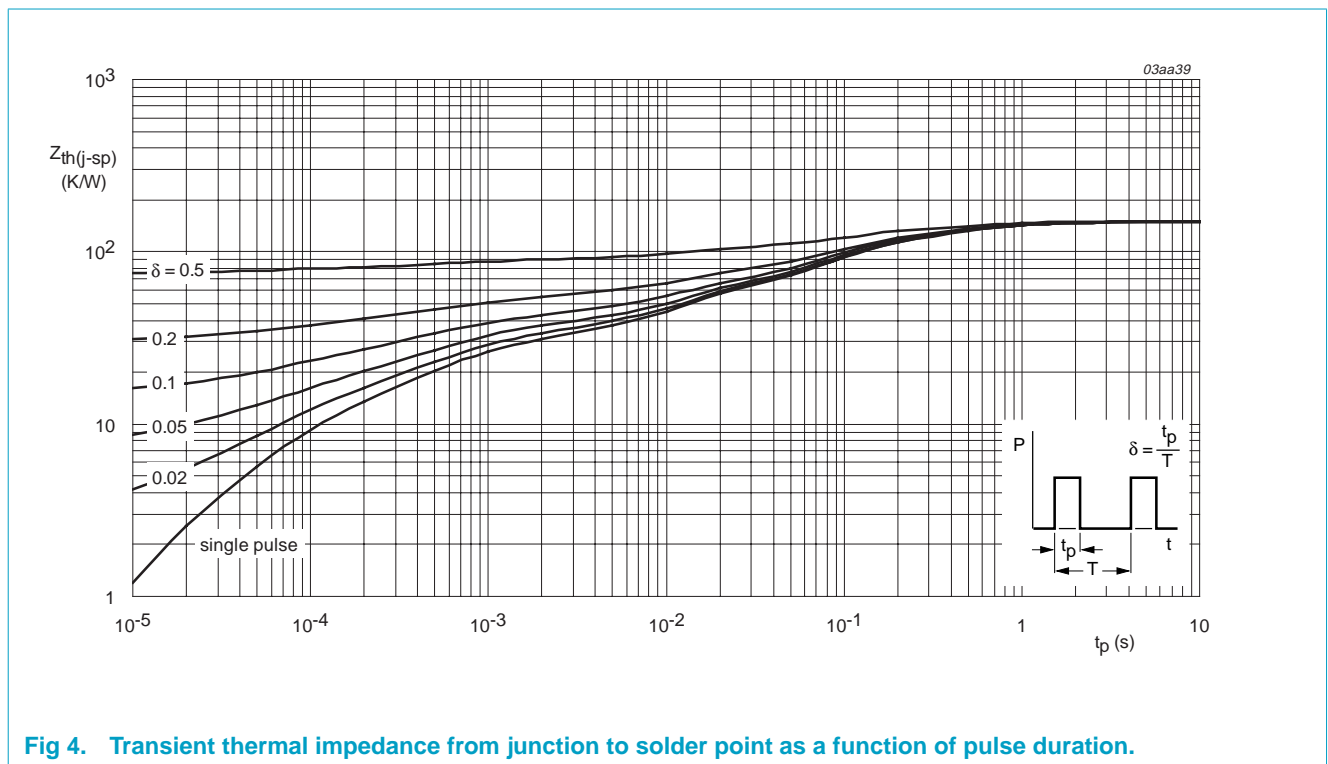


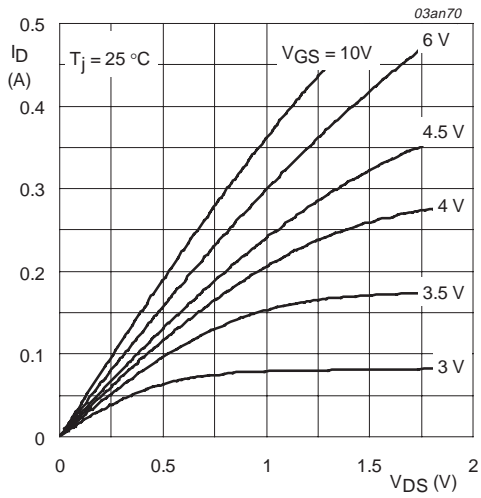
Fig 4. Transient thermal impedance from junction to solder point as a function of pulse duration.

## 6. Characteristics

**Table 5: Characteristics**

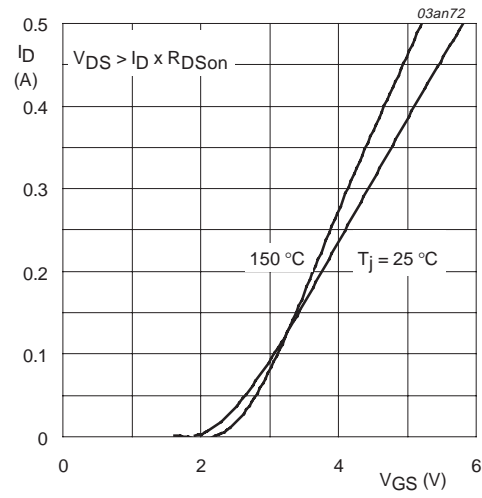
$T_j = 25\text{ °C}$  unless otherwise specified.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
<b>Static characteristics</b>						
$V_{(BR)DSS}$	drain-source breakdown voltage	$I_D = 10\ \mu\text{A}; V_{GS} = 0\ \text{V}$				
		$T_j = 25\text{ °C}$	60	75	-	V
		$T_j = -55\text{ °C}$	55	-	-	V
$V_{(BR)GSS}$	drain-source breakdown voltage	$I_G = \pm 1\ \text{mA}; V_{DS} = 0\ \text{V}$	16	22	-	V
$V_{GS(th)}$	gate-source threshold voltage	$I_D = 1\ \text{mA}; V_{DS} = V_{GS};$ <b>Figure 9</b>				V
		$T_j = 25\text{ °C}$	1	2	-	V
		$T_j = 150\text{ °C}$	0.6	-	-	V
		$T_j = -55\text{ °C}$	-	-	3.5	V
$I_{DSS}$	drain-source leakage current	$V_{DS} = 48\ \text{V}; V_{GS} = 0\ \text{V}$				
		$T_j = 25\text{ °C}$	-	0.01	1	$\mu\text{A}$
		$T_j = 150\text{ °C}$	-	-	10	$\mu\text{A}$
$I_{GSS}$	gate-source leakage current	$V_{GS} = \pm 10\ \text{V}; V_{DS} = 0\ \text{V}$	-	50	500	nA
$R_{DS(on)}$	drain-source on-state resistance	$V_{GS} = 10\ \text{V}; I_D = 500\ \text{mA};$ <b>Figure 7 and 8</b>				
		$T_j = 25\text{ °C}$	-	2.8	3.9	$\Omega$
		$T_j = 150\text{ °C}$	-	5.2	7.2	$\Omega$
		$V_{GS} = 4.5\ \text{V}; I_D = 200\ \text{mA};$ <b>Figure 7 and 8</b>	-	3.8	5.3	$\Omega$
<b>Dynamic characteristics</b>						
$C_{iss}$	input capacitance	$V_{GS} = 0\ \text{V}; V_{DS} = 10\ \text{V}; f = 1\ \text{MHz};$ <b>Figure 11</b>	-	13	40	pF
$C_{oss}$	output capacitance		-	8	30	pF
$C_{rss}$	reverse transfer capacitance		-	4	10	pF
$t_{on}$	turn-on time	$V_{DD} = 50\ \text{V}; R_L = 250\ \Omega;$	-	3	10	ns
$t_{off}$	turn-off time	$V_{GS} = 10\ \text{V}; R_G = 50\ \Omega; R_{GS} = 50\ \Omega$	-	9	15	ns
<b>Source-drain diode</b>						
$V_{SD}$	source-drain (diode forward) voltage	$I_S = 300\ \text{mA}; V_{GS} = 0\ \text{V};$ <b>Figure 12</b>	-	0.93	1.5	V
$t_{rr}$	reverse recovery time	$I_S = 300\ \text{mA}; dI_S/dt = -100\ \text{A}/\mu\text{s};$	-	30	-	ns
$Q_r$	recovered charge	$V_{GS} = 0\ \text{V}; V_R = 25\ \text{V}$	-	30	-	nC



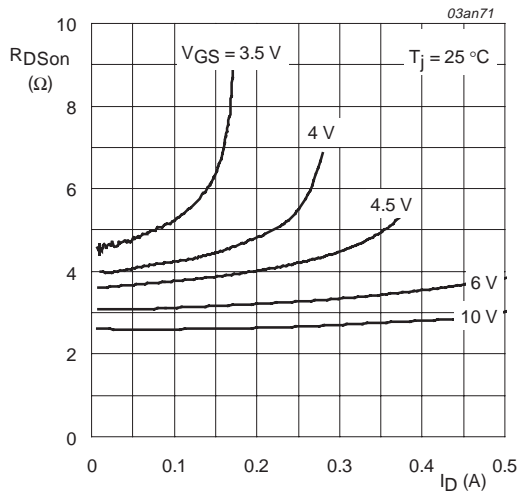
$T_j = 25\text{ }^\circ\text{C}$

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



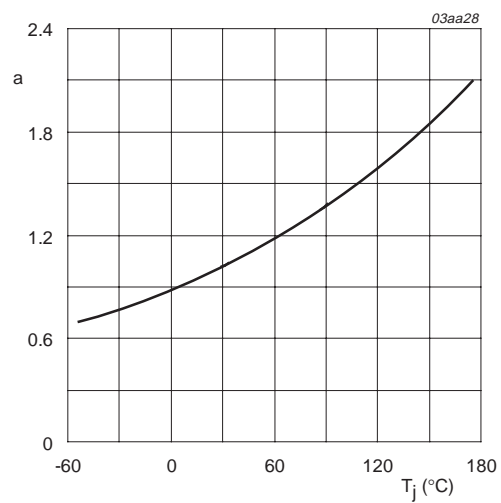
$T_j = 25\text{ }^\circ\text{C}$  and  $150\text{ }^\circ\text{C}$ ;  $V_{DS} > I_D \times R_{DSon}$

Fig 6. Transfer characteristics: drain current as a function of gate-source voltage; typical values.



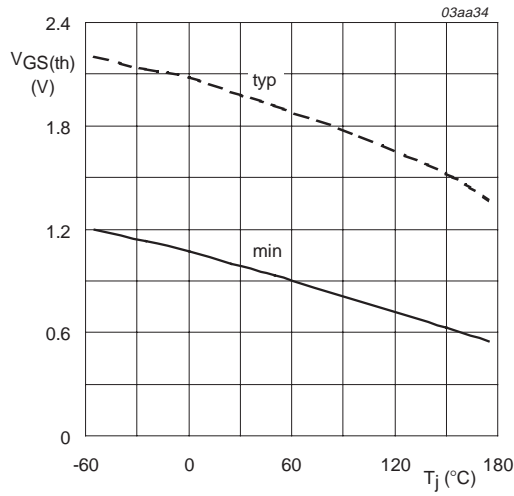
$T_j = 25\text{ }^\circ\text{C}$

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



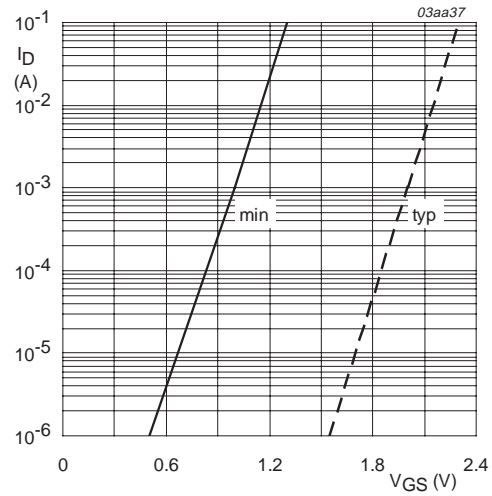
$$a = \frac{R_{DSon}}{R_{DSon}(25^\circ\text{C})}$$

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



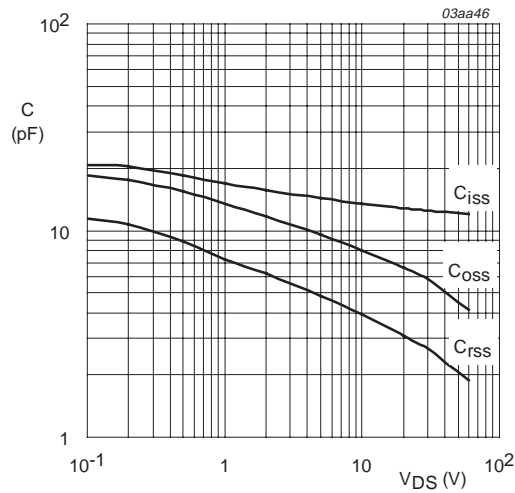
$I_D = 1 \text{ mA}; V_{DS} = V_{GS}$

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



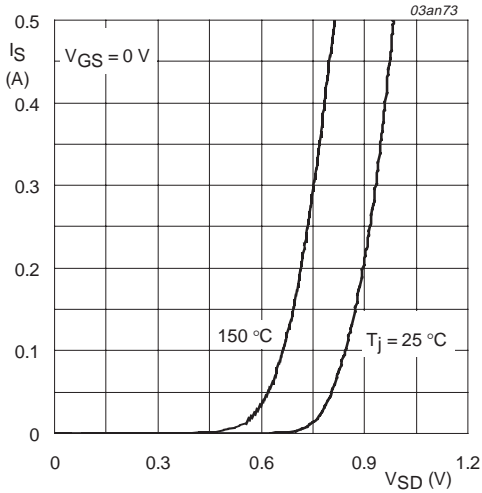
$T_j = 25 \text{ }^\circ\text{C}; V_{DS} = 5 \text{ V}$

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



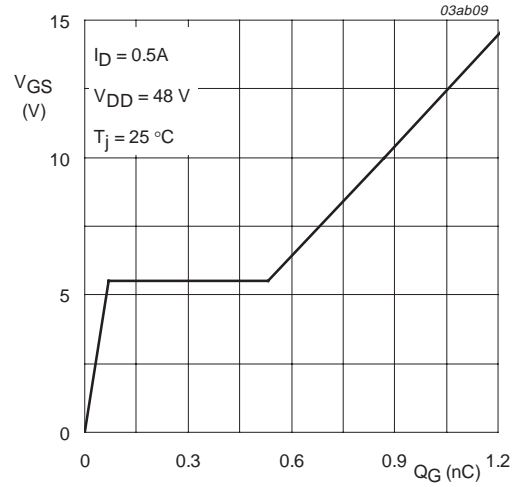
$V_{GS} = 0 \text{ V}; f = 1 \text{ MHz}$

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



$T_j = 25$  °C and  $150$  °C;  $V_{GS} = 0$  V

**Fig 12. Source (diode forward) current as a function of source-drain (diode forward) voltage; typical values.**



$I_D = 0.5$  A;  $V_{DD} = 48$  V

**Fig 13. Gate-source voltage as a function of gate charge; typical values.**



7. Package outline

Plastic surface mounted package; 3 leads

SOT23

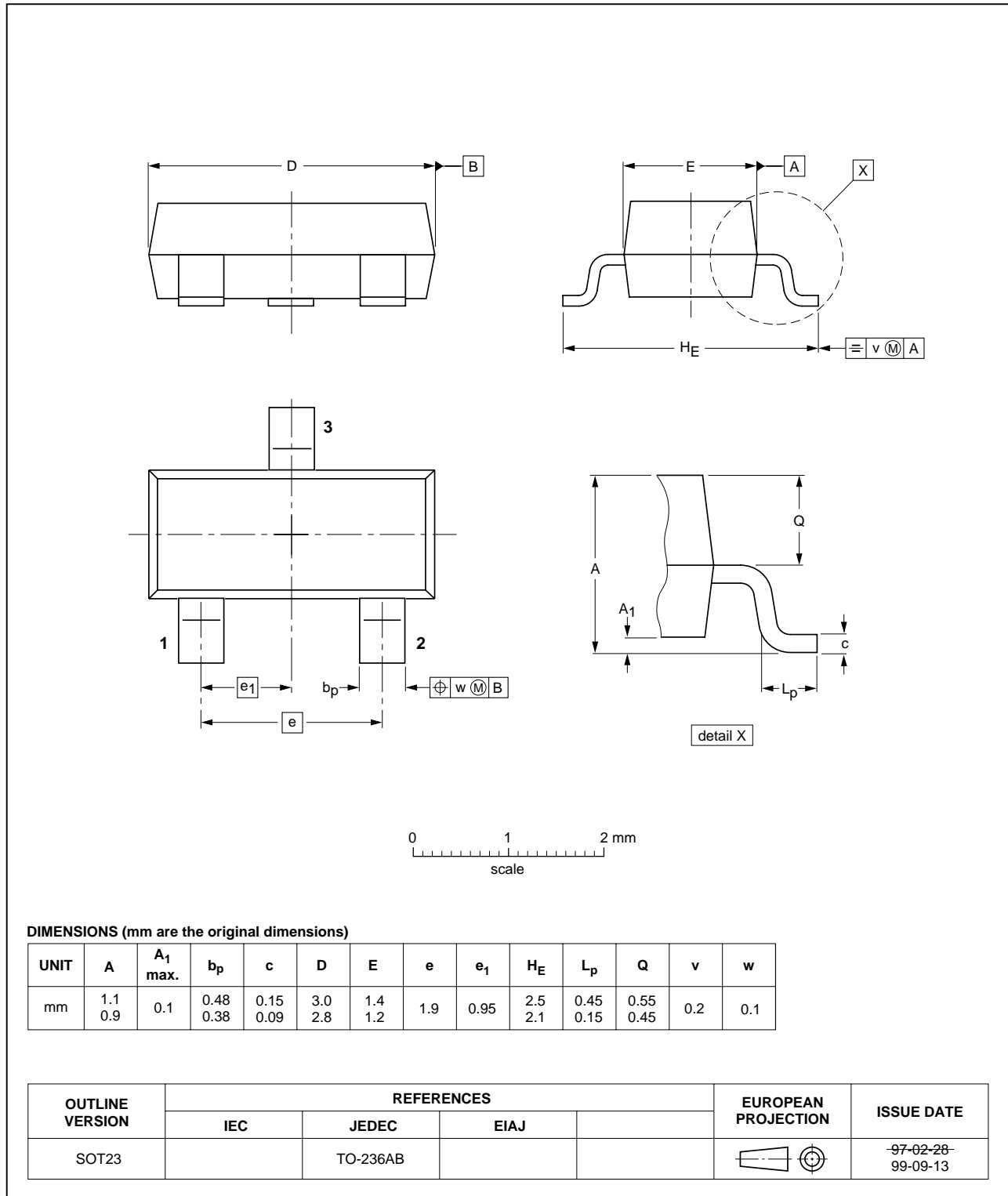


Fig 14. SOT23.

## 8. Revision history

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Table 6: Revision history

Rev	Date	CPCN	Description
01	20031020		Product data (9397 750 11703)

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## 9. Data sheet status

Level	Data sheet status <sup>[1]</sup>	Product status <sup>[2][3]</sup>	Definition
I	Objective data	Development	This data sheet contains data from the objective specification for product development. Philips Semiconductors reserves the right to change the specification in any manner without notice.
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[3] For data sheets describing multiple type numbers, the highest-level product status determines the data sheet status.

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**Limiting values definition** — Limiting values given are in accordance with the Absolute Maximum Rating System (IEC 60134). Stress above one or more of the limiting values may cause permanent damage to the device. These are stress ratings only and operation of the device at these or at any other conditions above those given in the Characteristics sections of the specification is not implied. Exposure to limiting values for extended periods may affect device reliability.

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