

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>SOT23</p>	<p>03ab60</p>
2	source (s)		
3	drain (d)		



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3. Ordering information

Table 2: Ordering information

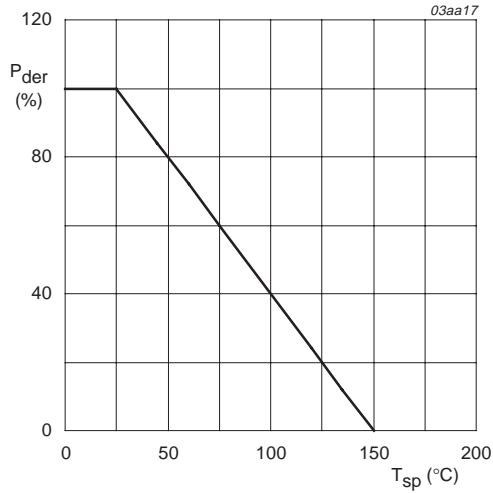
Type number	Package		Version
	Name	Description	
2N7002K	SOT23	Plastic surface mounted package; 3 leads.	SOT23

4. Limiting values

Table 3: Limiting values

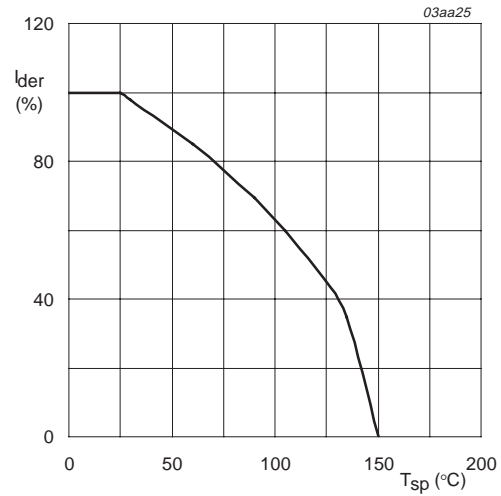
In accordance with the Absolute Maximum Rating System (IEC 60134).

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)		-	± 15	V
I_D	drain current (DC)	$T_{sp} = 25\text{ °C}$; $V_{GS} = 10\text{ V}$; Figure 2 and 3	-	340	mA
		$T_{sp} = 100\text{ °C}$; $V_{GS} = 10\text{ V}$; Figure 2	-	215	mA
I_{DM}	peak drain current	$T_{sp} = 25\text{ °C}$; pulsed; $t_p \leq 10\text{ }\mu\text{s}$; Figure 3	-	680	mA
P_{tot}	total power dissipation	$T_{sp} = 25\text{ °C}$; Figure 1	-	0.83	W
T_{stg}	storage temperature		-65	+150	°C
T_j	junction temperature		-65	+150	°C
Source-drain diode					
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
Electrostatic discharge voltage					
V_{esd}	electrostatic discharge voltage	Human Body Model 1; $C = 100\text{ pF}$; $R = 1.5\text{ k}\Omega$	-	1	kV



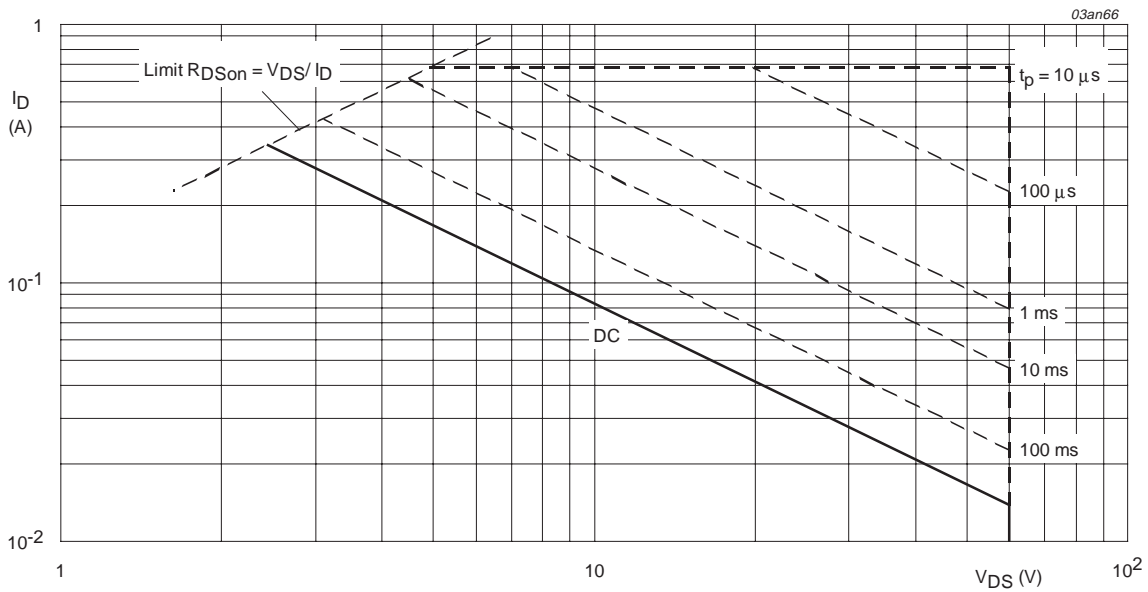
$$P_{der} = \frac{P_{tot}}{P_{tot(25^{\circ}C)}} \times 100\%$$

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 °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

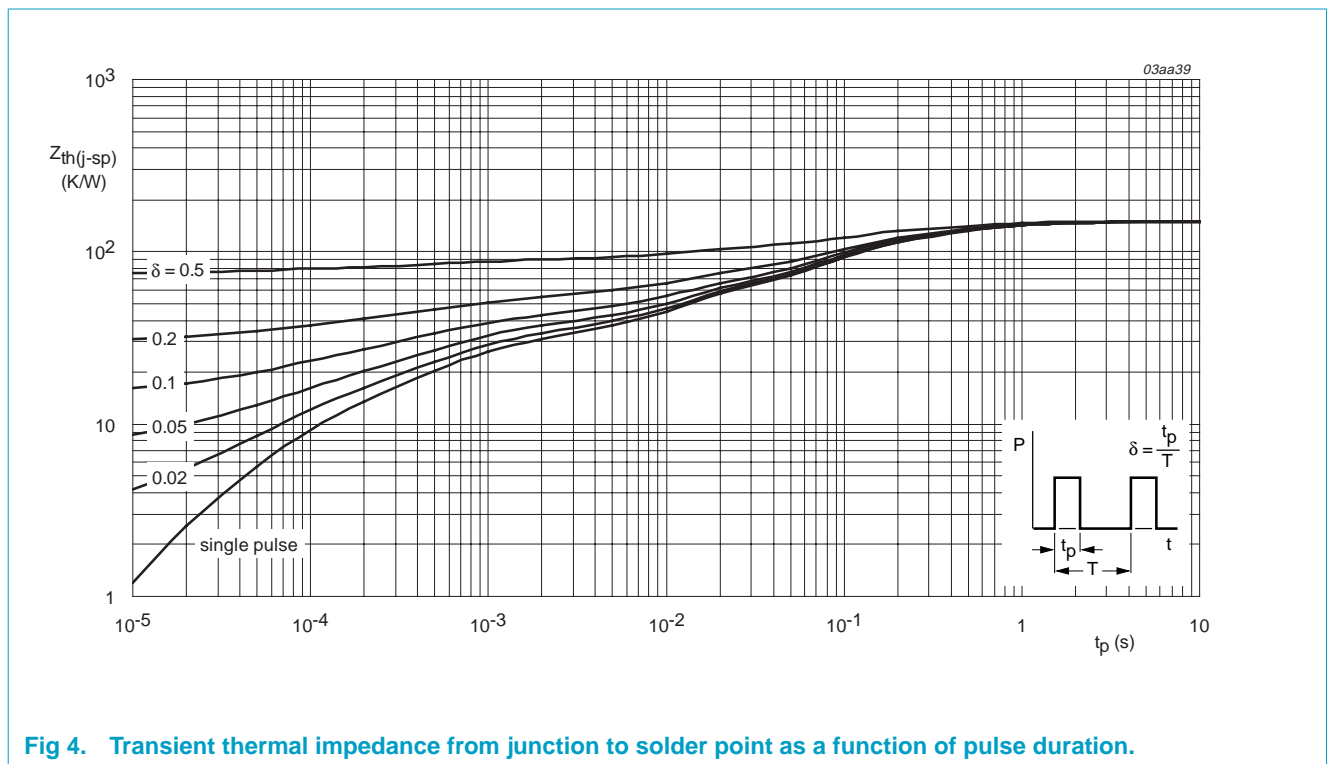


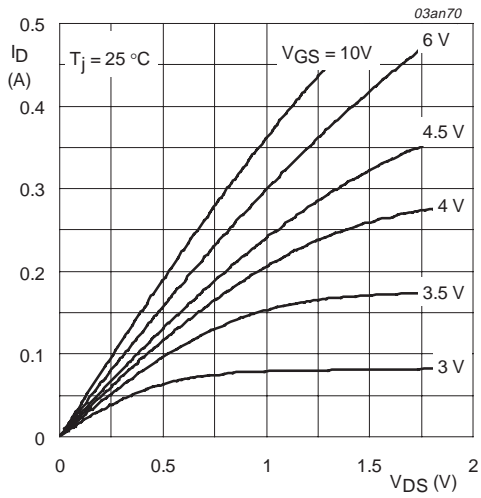
Fig 4. Transient thermal impedance from junction to solder point as a function of pulse duration.

6. Characteristics

Table 5: Characteristics

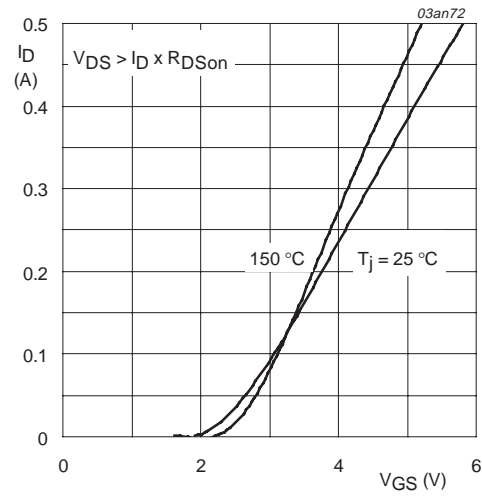
$T_j = 25\text{ °C}$ unless otherwise specified.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
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	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	$I_D = 1\ \text{mA}; V_{DS} = V_{GS};$ Figure 9				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	μA
		$T_j = 150\text{ °C}$	-	-	10	μA
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	$V_{GS} = 10\ \text{V}; I_D = 500\ \text{mA};$ Figure 7 and 8				
		$T_j = 25\text{ °C}$	-	2.8	3.9	Ω
		$T_j = 150\text{ °C}$	-	5.2	7.2	Ω
		$V_{GS} = 4.5\ \text{V}; I_D = 200\ \text{mA};$ Figure 7 and 8	-	3.8	5.3	Ω
Dynamic characteristics						
C_{iss}	input capacitance	$V_{GS} = 0\ \text{V}; V_{DS} = 10\ \text{V}; f = 1\ \text{MHz};$ Figure 11	-	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
Source-drain diode						
V_{SD}	source-drain (diode forward) voltage	$I_S = 300\ \text{mA}; V_{GS} = 0\ \text{V};$ Figure 12	-	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



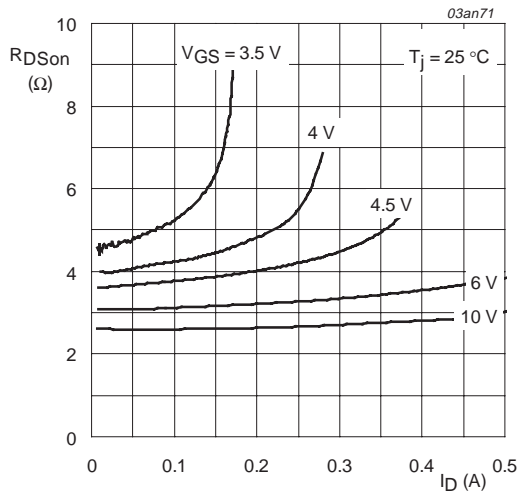
$T_j = 25\text{ °C}$

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



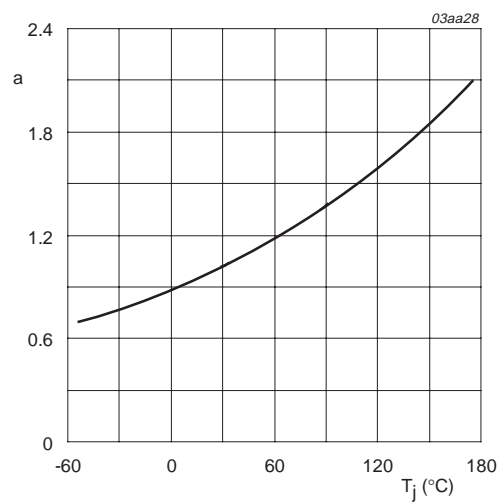
$T_j = 25\text{ °C}$ and 150 °C ; $V_{DS} > I_D \times R_{DSon}$

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



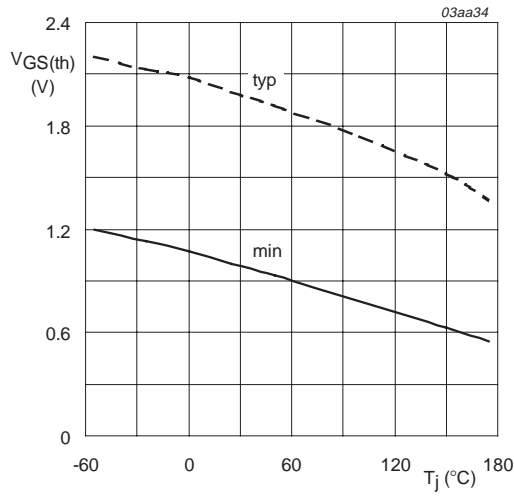
$T_j = 25\text{ °C}$

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



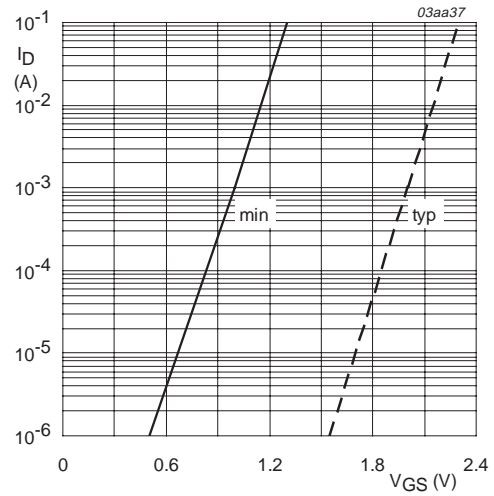
$$a = \frac{R_{DSon}}{R_{DSon}(25^{\circ}\text{C})}$$

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



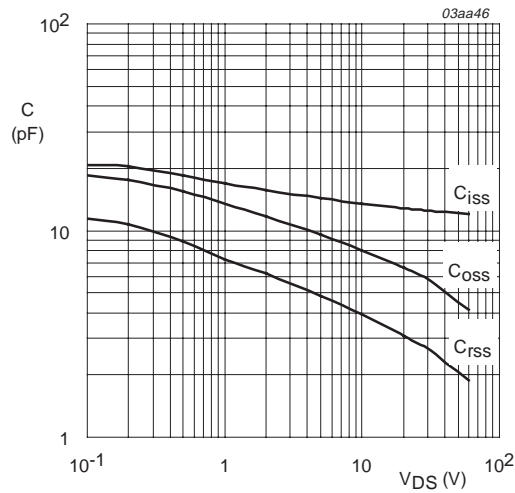
$I_D = 1 \text{ mA}; V_{DS} = V_{GS}$

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



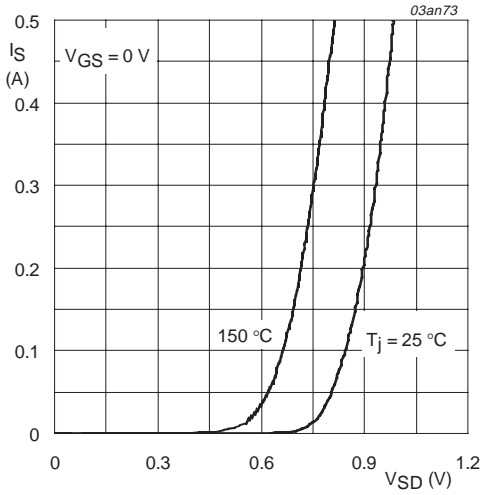
$T_j = 25 \text{ }^{\circ}C; V_{DS} = 5 \text{ V}$

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



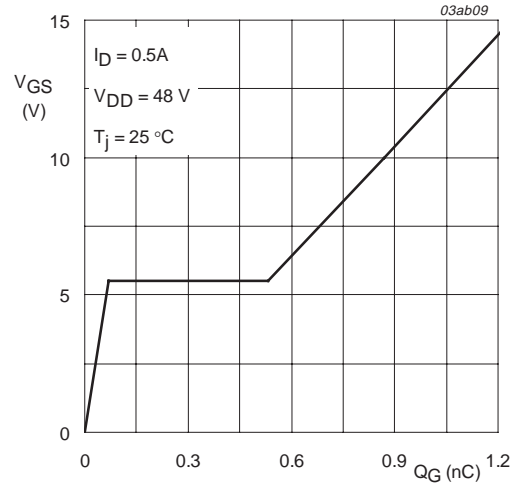
$V_{GS} = 0 \text{ V}; f = 1 \text{ MHz}$

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



$T_j = 25\text{ }^\circ\text{C}$ and $150\text{ }^\circ\text{C}$; $V_{GS} = 0\text{ V}$

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



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

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

7. Package outline

Plastic surface mounted package; 3 leads

SOT23

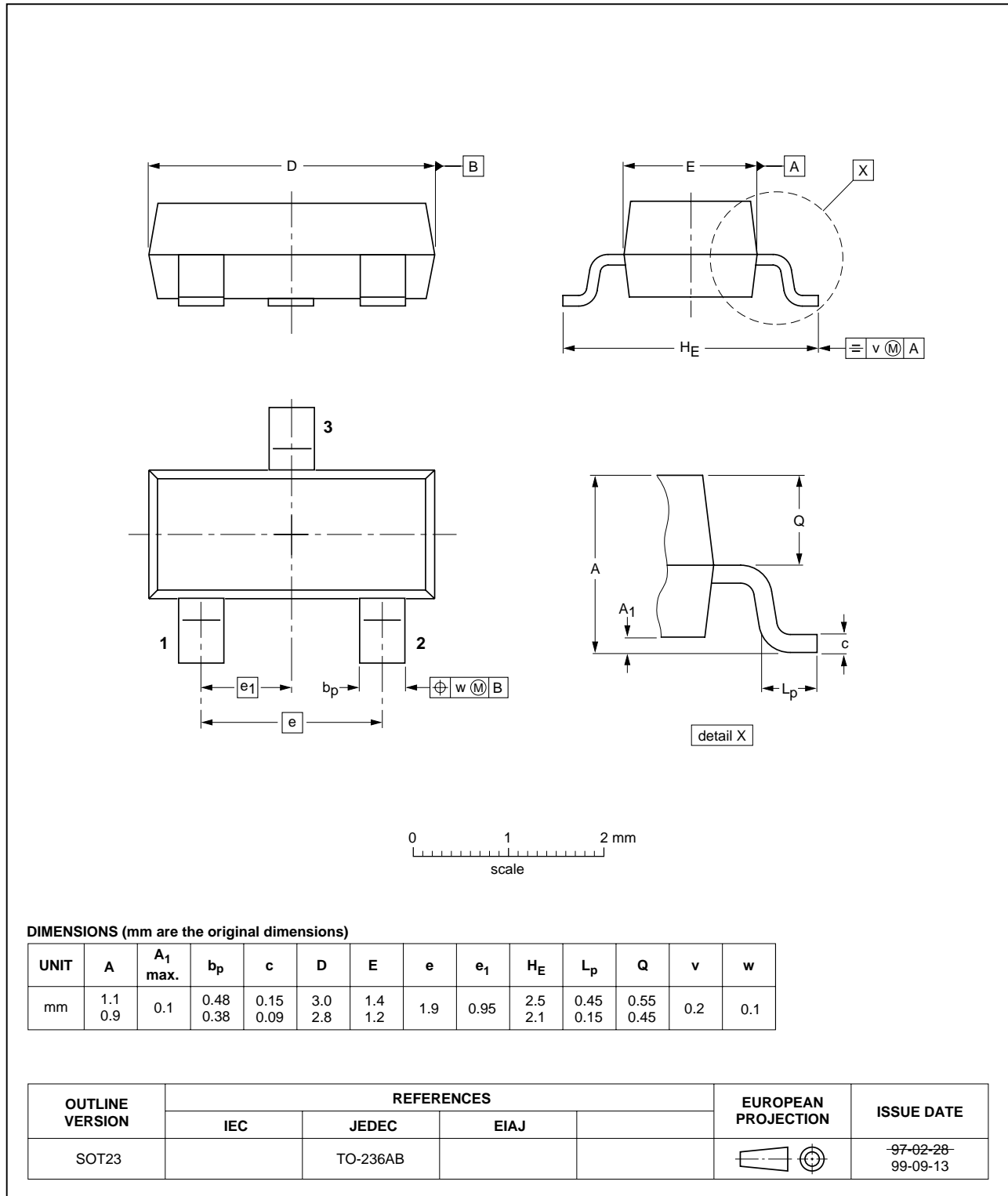


Fig 14. SOT23.

8. Revision history

Table 6: Revision history

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

9. Data sheet status

Level	Data sheet status ^[1]	Product status ^{[2][3]}	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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