



2N7002

N-channel TrenchMOS™ FET

Rev. 04 — 26 April 2005

Product data sheet

1. Product profile

1.1 General description

N-channel enhancement mode Field-Effect Transistor (FET) in a plastic package using TrenchMOS™ technology.

1.2 Features

- Logic level threshold compatible
- Surface-mounted package
- Very fast switching
- TrenchMOS™ technology

1.3 Applications

- Logic level translator
- High speed line driver

1.4 Quick reference data

- $V_{DS} \leq 60 \text{ V}$
- $R_{DSon} \leq 5 \Omega$
- $I_D \leq 300 \text{ mA}$
- $P_{tot} = 0.83 \text{ W}$

2. Pinning information

Table 1: Pinning

Pin	Description	Simplified outline	Symbol
1	gate (G)	 SOT23	 mbb076
2	source (S)		
3	drain (D)		

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3. Ordering information

Table 2: Ordering information

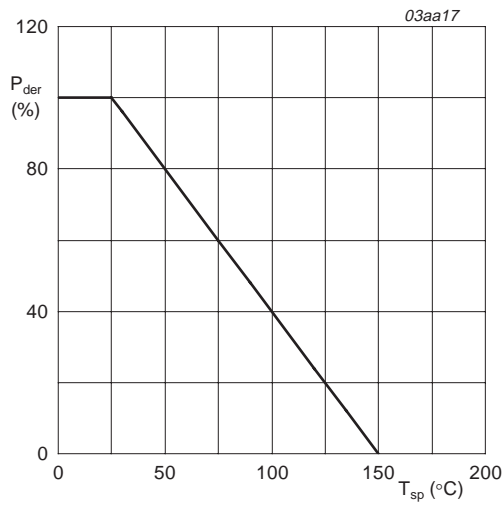
Type number	Package		
	Name	Description	Version
2N7002	TO-236AB	plastic surface mounted package; 3 leads	SOT23

4. Limiting values

Table 3: Limiting values

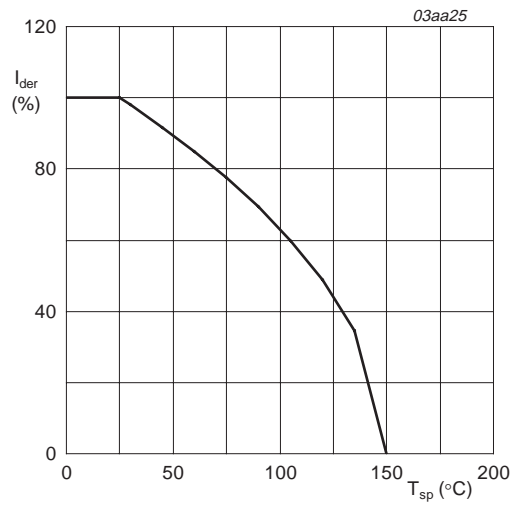
In accordance with the Absolute Maximum Rating System (IEC 60134).

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)		-	± 30	V
V_{GSM}	peak gate-source voltage	$t_p \leq 50\text{ }\mu\text{s}$; pulsed; duty cycle = 25 %	-	± 40	V
I_D	drain current (DC)	$T_{sp} = 25\text{ °C}$; $V_{GS} = 10\text{ V}$; Figure 2 and 3	-	300	mA
		$T_{sp} = 100\text{ °C}$; $V_{GS} = 10\text{ V}$; Figure 2	-	190	mA
I_{DM}	peak drain current	$T_{sp} = 25\text{ °C}$; pulsed; $t_p \leq 10\text{ }\mu\text{s}$; Figure 3	-	1.2	A
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)	$T_{sp} = 25\text{ °C}$	-	300	mA
I_{SM}	peak source (diode forward) current	$T_{sp} = 25\text{ °C}$; pulsed; $t_p \leq 10\text{ }\mu\text{s}$	-	1.2	A



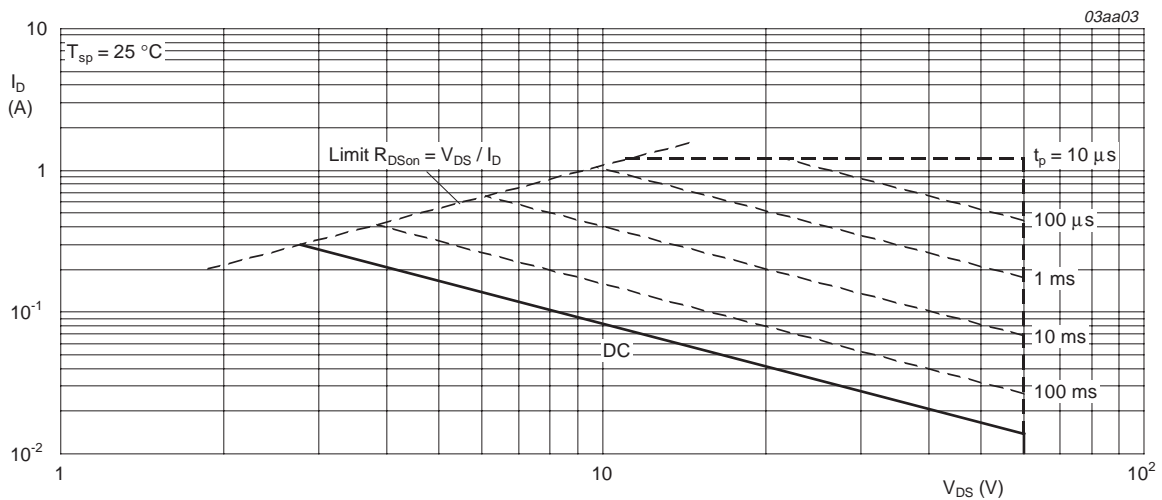
$$P_{der} = \frac{P_{tot}}{P_{tot(25^\circ C)}} \times 100\%$$

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

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	mounted on a printed-circuit board; minimum footprint; vertical in still air	-	-	350	K/W

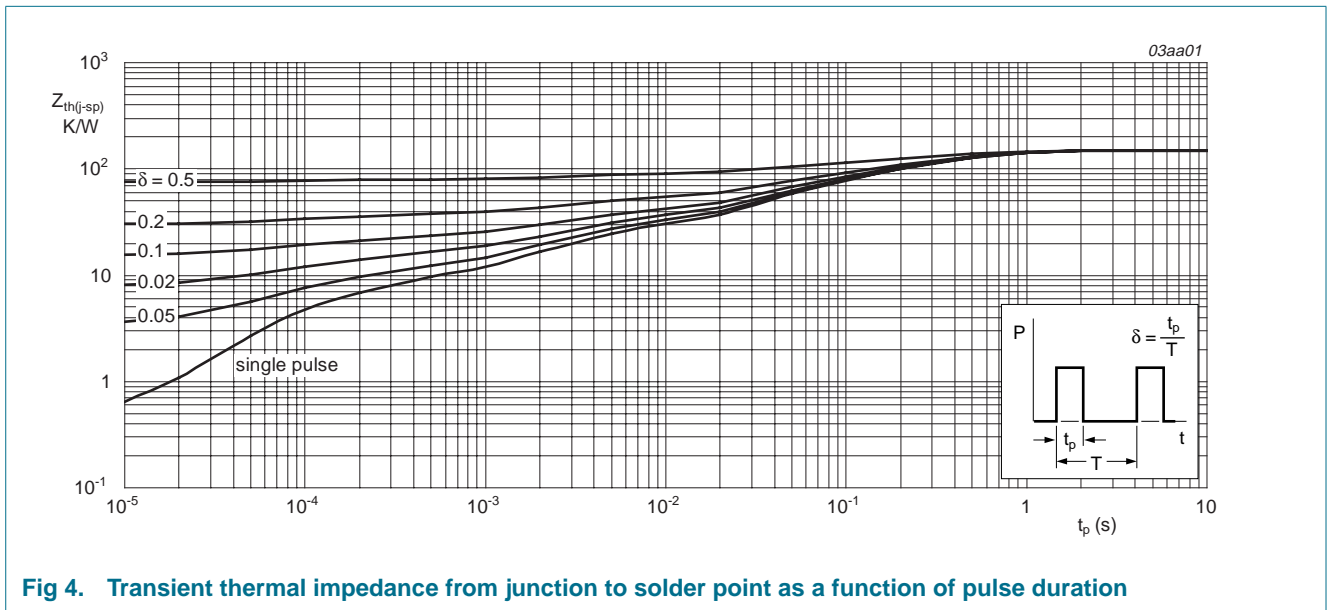


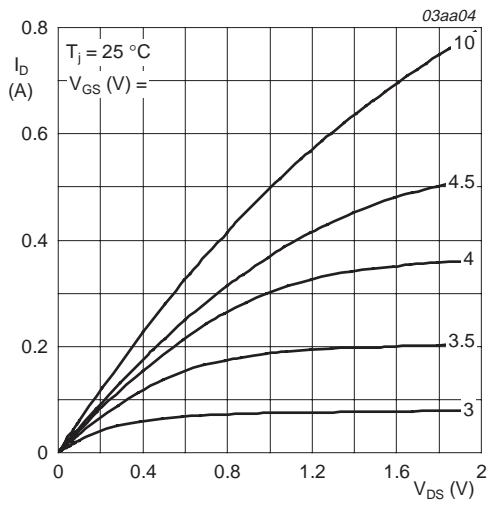
Fig 4. Transient thermal impedance from junction to solder point as a function of pulse duration

6. Characteristics

Table 5: Characteristics

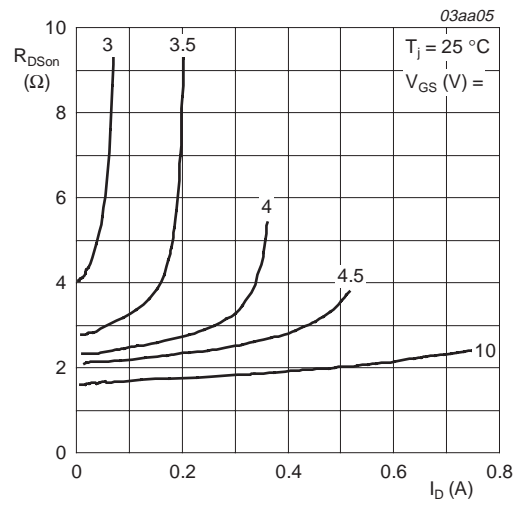
$T_j = 25\text{ °C}$ unless otherwise specified.

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	-	-	V
		$T_j = -55\text{ °C}$	55	-	-	V
$V_{GS(th)}$	gate-source threshold voltage	$I_D = 1\ \text{mA}; V_{DS} = V_{GS};$ Figure 9 and 10				
		$T_j = 25\text{ °C}$	1	2	3	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	$V_{GS} = \pm 15\ \text{V}; V_{DS} = 0\ \text{V}$	-	10	100	nA
$R_{DS(on)}$	drain-source on-state resistance	$V_{GS} = 10\ \text{V}; I_D = 500\ \text{mA};$ Figure 6 and 8				
		$T_j = 25\text{ °C}$	-	2.8	5	Ω
		$T_j = 150\text{ °C}$	-	-	9.25	Ω
		$V_{GS} = 4.5\ \text{V}; I_D = 75\ \text{mA};$ Figure 6 and 8	-	3.8	5.3	Ω
Dynamic characteristics						
g_{fs}	forward transconductance	$V_{DS} = 10\ \text{V}; I_D = 200\ \text{mA};$ Figure 11	100	300	-	mS
C_{iss}	input capacitance	$V_{GS} = 0\ \text{V}; V_{DS} = 10\ \text{V}; f = 1\ \text{MHz};$ Figure 12	-	25	40	pF
C_{oss}	output capacitance		-	18	30	pF
C_{rss}	reverse transfer capacitance		-	7.5	10	pF
t_{on}	turn-on delay time	$V_{DD} = 50\ \text{V}; R_L = 250\ \Omega; V_{GS} = 10\ \text{V};$ $R_G = 50\ \Omega; R_{GS} = 50\ \Omega$	-	3	10	ns
t_{off}	turn-off delay time		-	12	15	ns
Source-drain diode						
V_{SD}	source-drain (diode forward) voltage	$I_S = 300\ \text{mA}; V_{GS} = 0\ \text{V};$ Figure 13	-	0.85	1.5	V
t_{rr}	reverse recovery time	$I_S = 300\ \text{mA}; di_S/dt = -100\ \text{A}/\mu\text{s};$ $V_{GS} = 0\ \text{V}$	-	30	-	ns
Q_r	recovered charge		-	30	-	nC



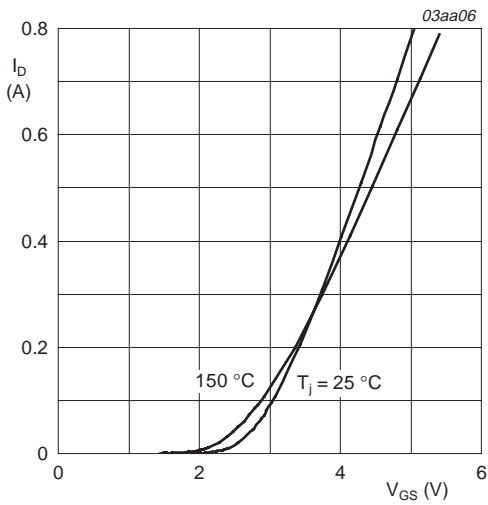
$T_j = 25\text{ °C}$

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



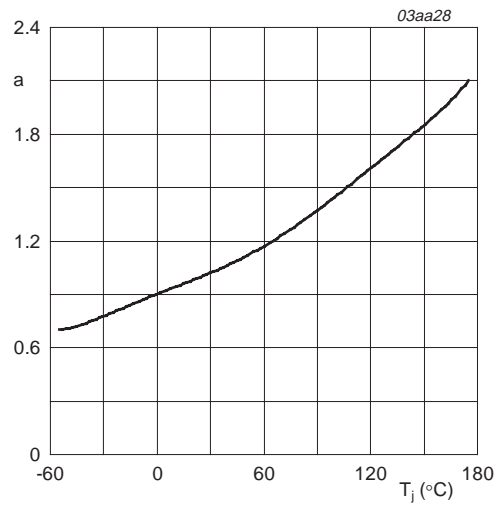
$T_j = 25\text{ °C}$

Fig 6. Drain-source on-state resistance as a function of drain current; typical values



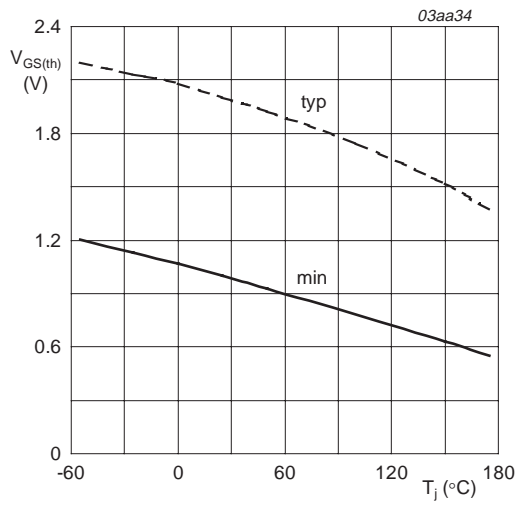
$T_j = 25\text{ °C and } 150\text{ °C}; V_{DS} > I_D \times R_{DS(on)}$

Fig 7. Transfer characteristics: drain current as a function of gate-source voltage; typical values



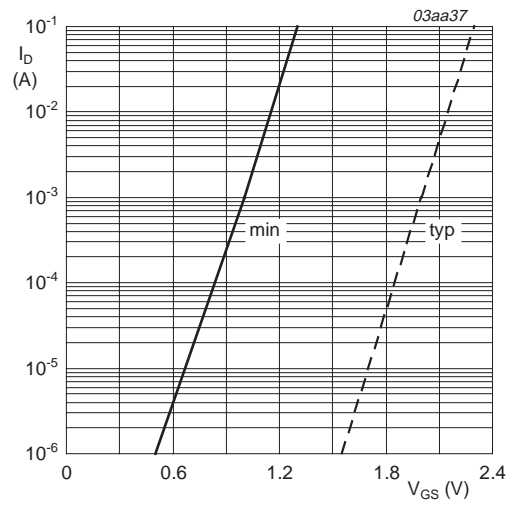
$$a = \frac{R_{DS(on)}}{R_{DS(on)(25\text{ °C})}}$$

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



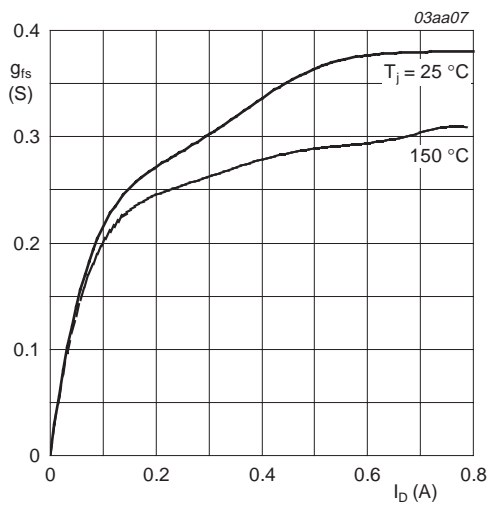
$I_D = 1 \text{ mA}; V_{DS} = V_{GS}$

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



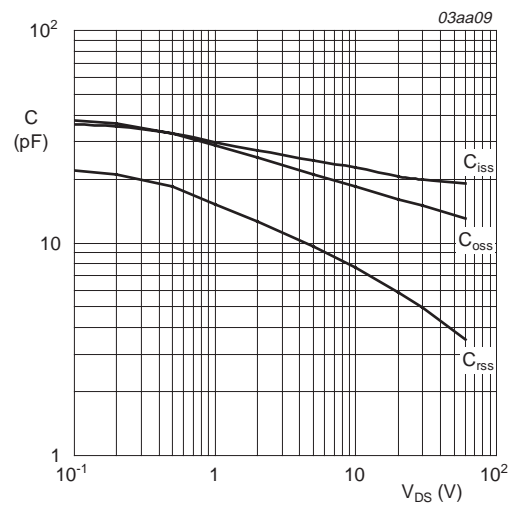
$T_j = 25 \text{ °C}; V_{DS} = 5 \text{ V}$

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



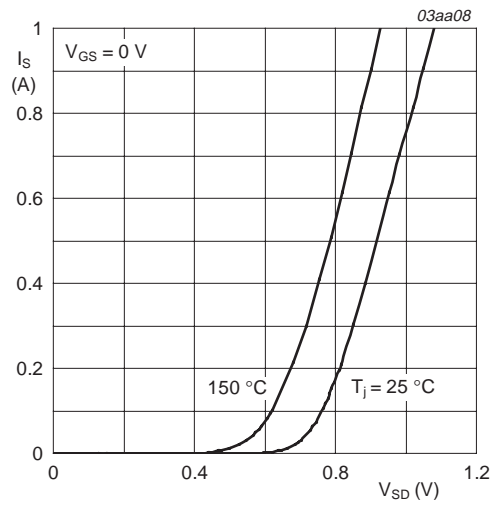
$T_j = 25 \text{ °C and } 150 \text{ °C}; V_{DS} > I_D \times R_{DS(on)}$

Fig. 11. Forward transconductance as a function of drain current; typical values



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

Fig. 12. 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 13. Source (diode forward) current as a function of source-drain (diode forward) voltage; typical values

7. Package outline

Plastic surface mounted package; 3 leads

SOT23

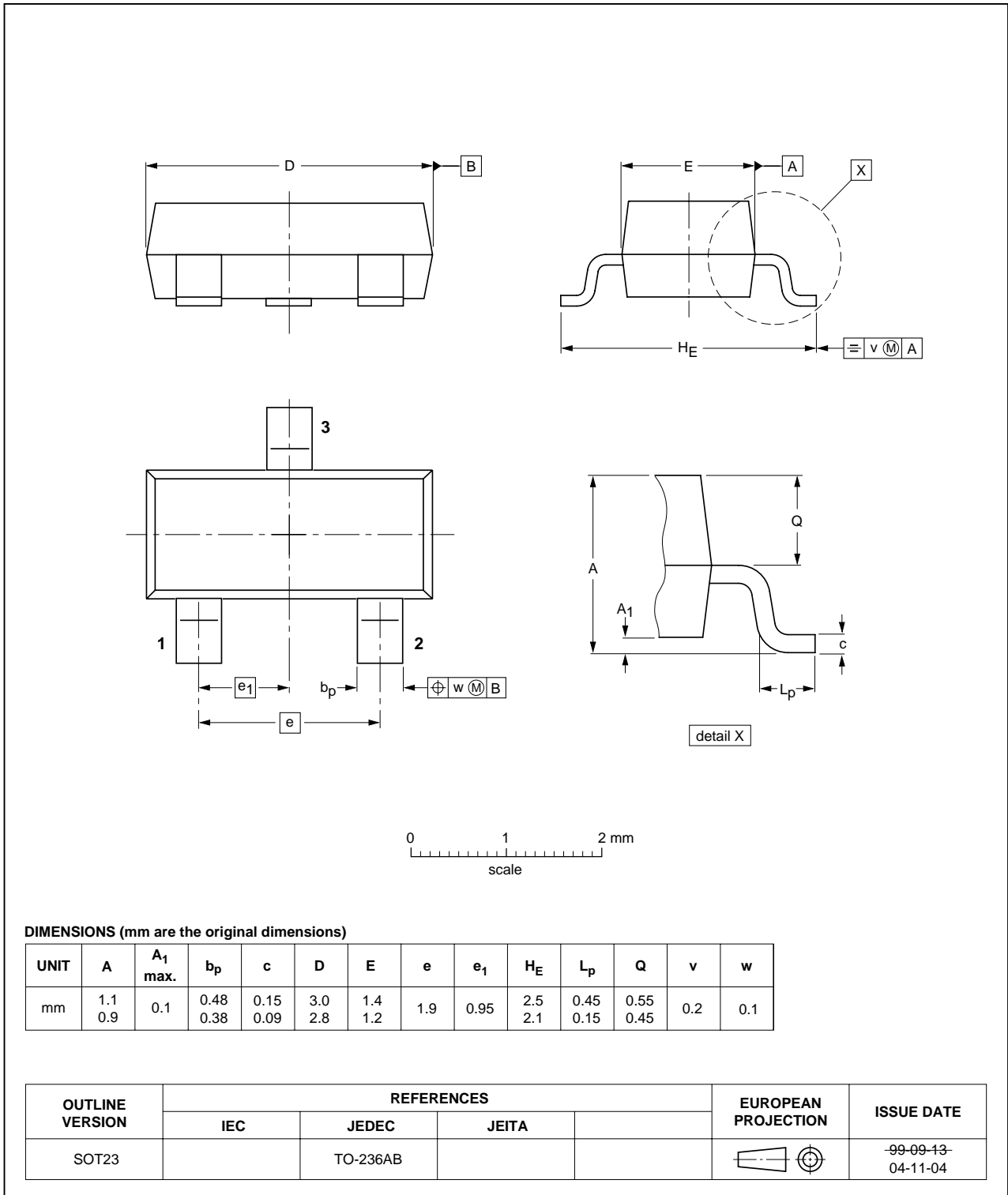


Fig 14. Package outline SOT23

8. Revision history

Table 6: Revision history

Document ID	Release date	Data sheet status	Change notice	Doc. number	Supersedes
2N7002_4	20050426	Product data sheet	-	9397 750 14915	2N7002-03
Modifications:	<ul style="list-style-type: none"> The format of this data sheet has been redesigned to comply with the new presentation and information standard of Philips Semiconductors. Table 5 “Characteristics” Addition of upper limit for $V_{GS(th)}$. 				
2N7002-03	20000727	Product specification	HZG336	9397 750 07319	2N7002_2
Modifications:	<ul style="list-style-type: none"> Converted from VDMOS to TrenchMOS™ technology. 				
2N7002_2	19970617	Product specification	-	-	2N7002_1
2N7002_1	19901031	Product specification	-	-	-

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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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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14. Contents

1	Product profile	1
1.1	General description.	1
1.2	Features	1
1.3	Applications	1
1.4	Quick reference data.	1
2	Pinning information	1
3	Ordering information	2
4	Limiting values	2
5	Thermal characteristics	4
6	Characteristics	5
7	Package outline	9
8	Revision history	10
9	Data sheet status	11
10	Definitions	11
11	Disclaimers	11
12	Trademarks	11
13	Contact information	11



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