



**THE DATASHEET OF
2N7002E,215**



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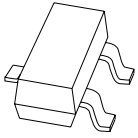
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Kind regards,

Team Nexperia



2N7002E

N-channel TrenchMOS FET

Rev. 03 — 28 April 2006

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

- $V_{DS} \leq 60 \text{ V}$
- $R_{DSon} \leq 3 \Omega$
- $I_D \leq 385 \text{ mA}$
- $P_{tot} \leq 0.83 \text{ W}$

2. Pinning information

Table 1: Pinning

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

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3. Ordering information

Table 2: Ordering information

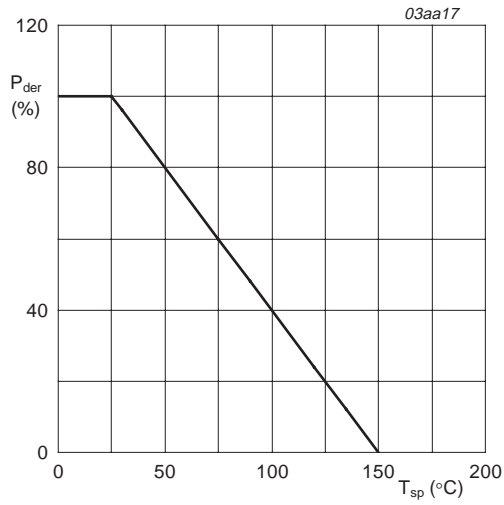
Type number	Package		
	Name	Description	Version
2N7002E	TO-236AB	plastic surface-mounted package; 3 leads	SOT23

4. Limiting values

Table 3: Limiting values

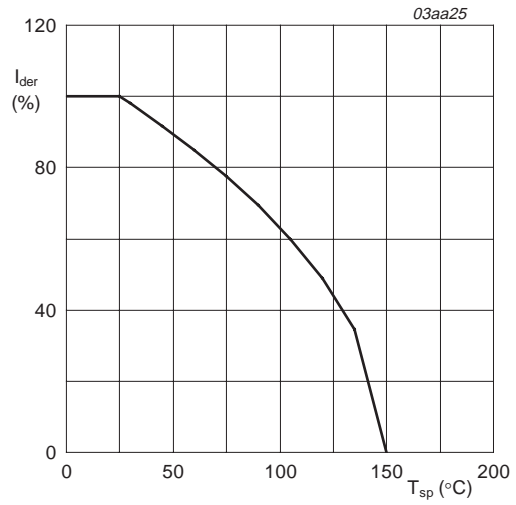
In accordance with the Absolute Maximum Rating System (IEC 60134).

Symbol	Parameter	Conditions	Min	Max	Unit
V_{DS}	drain-source voltage	$25\text{ °C} \leq T_j \leq 150\text{ °C}$	-	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		-	± 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	$T_{sp} = 25\text{ °C}$; $V_{GS} = 10\text{ V}$; see Figure 2 and 3	-	385	mA
		$T_{sp} = 100\text{ °C}$; $V_{GS} = 10\text{ V}$; see Figure 2	-	245	mA
I_{DM}	peak drain current	$T_{sp} = 25\text{ °C}$; pulsed; $t_p \leq 10\text{ }\mu\text{s}$; see Figure 3	-	1.5	A
P_{tot}	total power dissipation	$T_{sp} = 25\text{ °C}$; see 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 current	$T_{sp} = 25\text{ °C}$	-	385	mA
I_{SM}	peak source current	$T_{sp} = 25\text{ °C}$; pulsed; $t_p \leq 10\text{ }\mu\text{s}$	-	1.5	mA



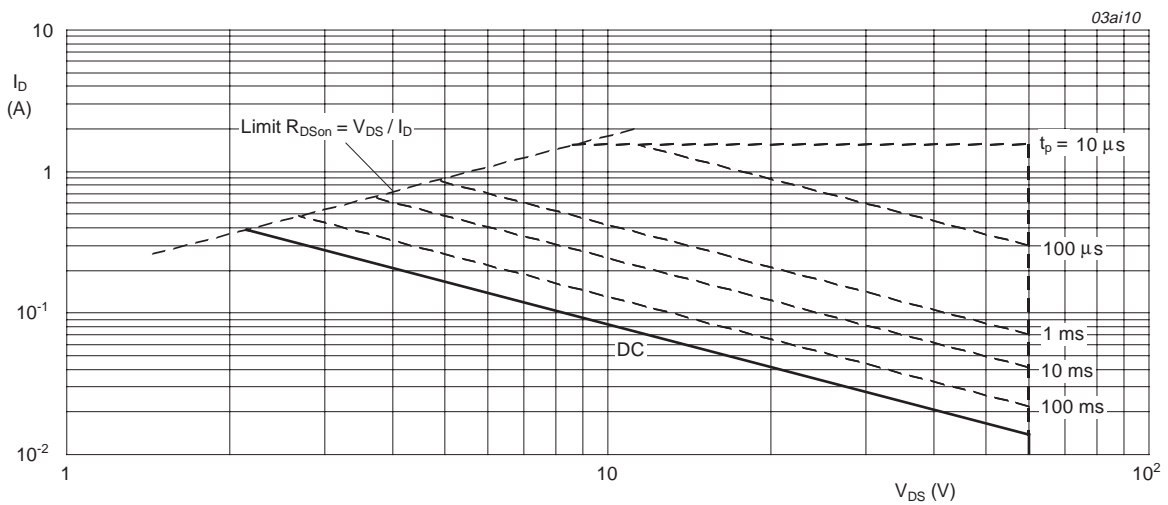
$$P_{der} = \frac{P_{tot}}{P_{tot(25^\circ C)}} \times 100\%$$

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	see Figure 4	-	-	150	K/W
$R_{th(j-a)}$	thermal resistance from junction to ambient		[1]	-	350	K/W

[1] Mounted on a printed-circuit board; minimum footprint; vertical in still air

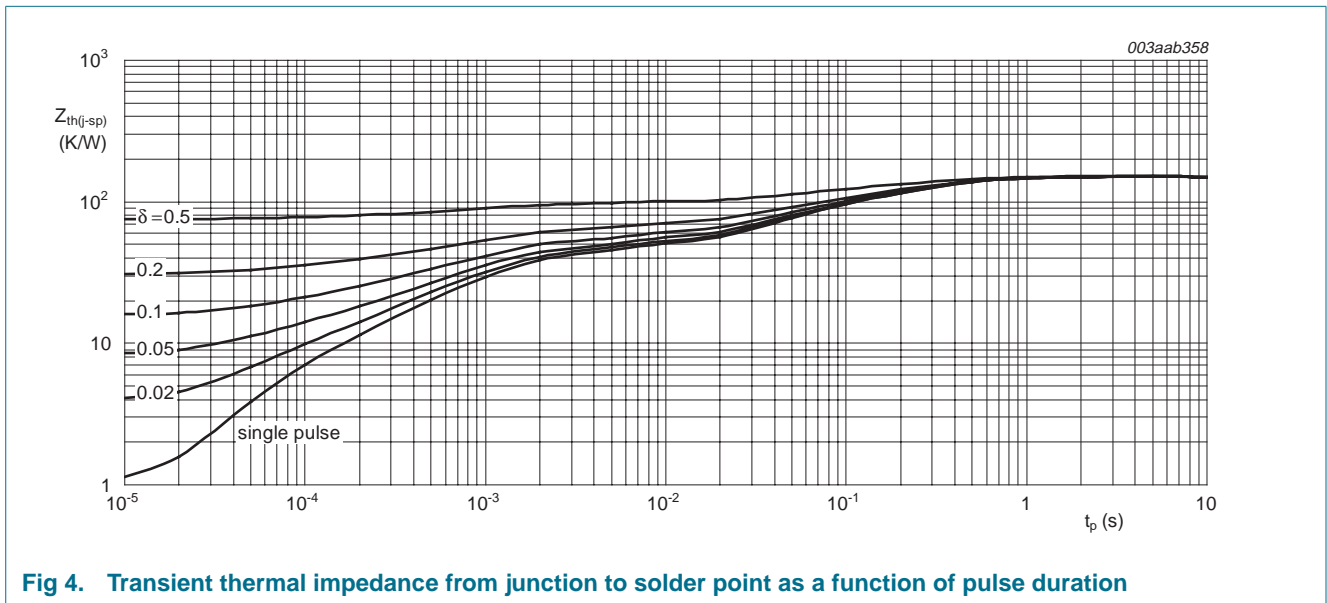
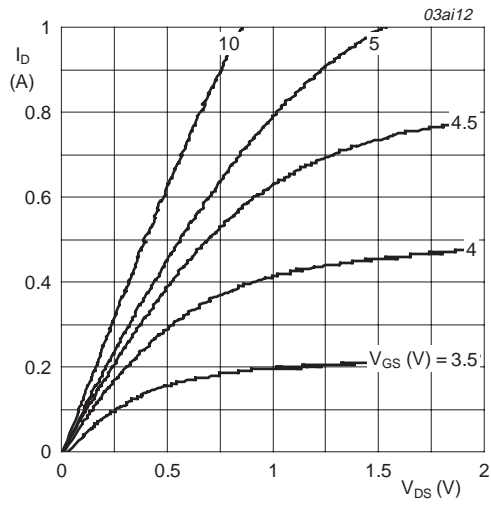


Fig 4. Transient thermal impedance from junction to solder point as a function of pulse duration

6. Characteristics

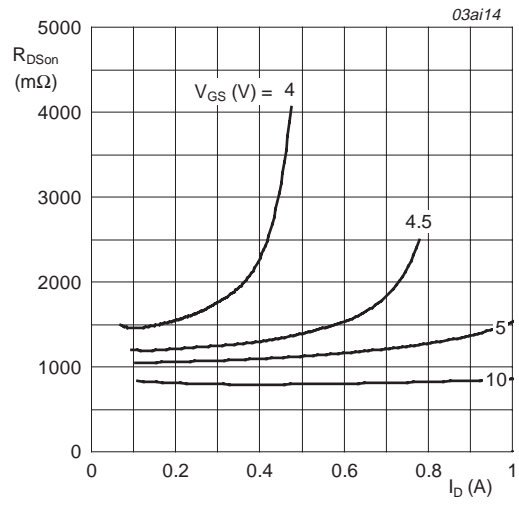
Table 5: Characteristics
T_j = 25 °C unless otherwise specified.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Static characteristics						
V _{(BR)DSS}	drain-source breakdown voltage	I _D = 10 μA; V _{GS} = 0 V T _j = 25 °C	60	-	-	V
		T _j = -55 °C	55	-	-	V
V _{GS(th)}	gate-source threshold voltage	I _D = 0.25 mA; V _{DS} = V _{GS} ; see Figure 9 and 10 T _j = 25 °C	1	2	2.5	V
		T _j = 150 °C	0.6	-	-	V
		T _j = -55 °C	-	-	2.75	V
I _{DSS}	drain leakage current	V _{DS} = 48 V; V _{GS} = 0 V T _j = 25 °C	-	-	1	μA
		T _j = 150 °C	-	-	10	μA
I _{GSS}	gate leakage current	V _{GS} = ±15 V; V _{DS} = 0 V	-	10	100	nA
R _{DS(on)}	drain-source on-state resistance	V _{GS} = 10 V; I _D = 500 mA; see Figure 6 and 8 T _j = 25 °C	-	0.78	3	Ω
		T _j = 150 °C	-	1.45	5.5	Ω
		V _{GS} = 4.5 V; I _D = 75 mA; see Figure 6 and 8	-	1.2	4	Ω
Dynamic characteristics						
Q _{G(tot)}	total gate charge	I _D = 300 mA; V _{DS} = 30 V; V _{GS} = 10 V; see Figure 11 and 12	-	0.69	-	nC
Q _{GS}	gate-source charge		-	0.1	-	nC
Q _{GD}	gate-drain charge		-	0.27	-	nC
C _{iss}	input capacitance	V _{GS} = 0 V; V _{DS} = 10 V; f = 1 MHz; see Figure 14	-	31	50	pF
C _{oss}	output capacitance		-	6.8	30	pF
C _{rss}	reverse transfer capacitance		-	3.5	10	pF
t _{on}	turn-on time	V _{DS} = 50 V; R _L = 250 Ω; V _{GS} = 10 V; R _G = 50 Ω; R _{GS} = 50 Ω	-	2.5	10	ns
t _{off}	turn-off time		-	11	15	ns
Source-drain diode						
V _{SD}	source-drain voltage	I _S = 300 mA; V _{GS} = 0 V; see Figure 13	-	0.85	1.5	V
t _{rr}	reverse recovery time	I _S = 300 mA; dI _S /dt = -100 A/μs; V _{GS} = 0 V	-	30	-	ns
Q _r	recovered charge		-	30	-	nC



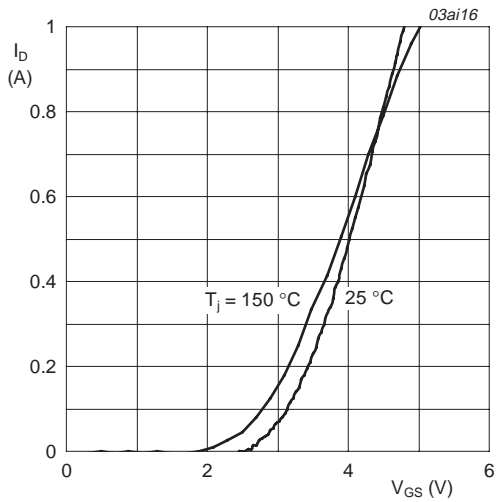
$T_j = 25\text{ }^\circ\text{C}$

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



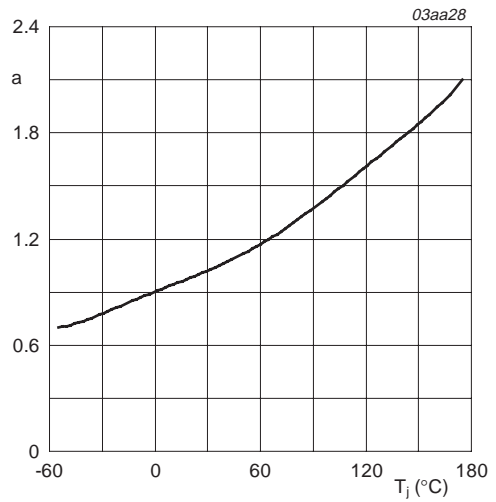
$T_j = 25\text{ }^\circ\text{C}$

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



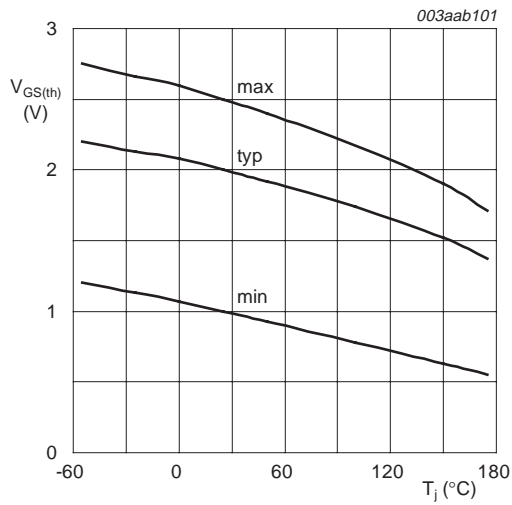
$T_j = 25\text{ }^\circ\text{C}$ and $150\text{ }^\circ\text{C}$; $V_{DS} > I_D \times R_{DS(on)}$

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



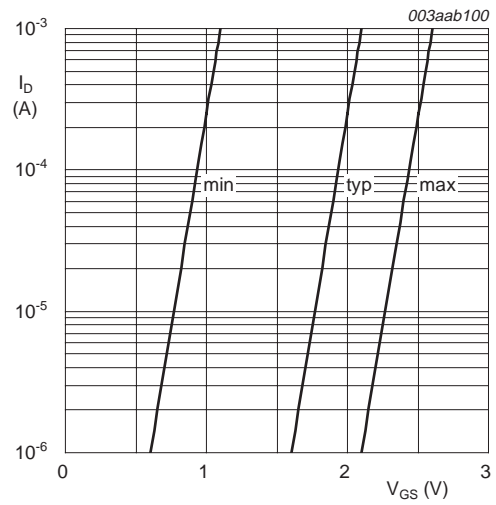
$$a = \frac{R_{DS(on)}}{R_{DS(on)(25\text{ }^\circ\text{C})}}$$

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



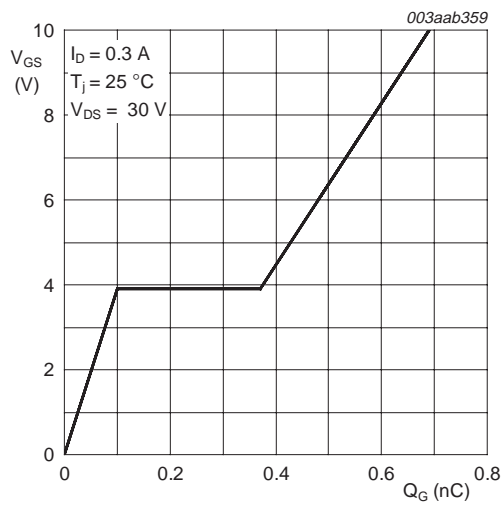
$I_D = 0.25 \text{ mA}; V_{DS} = V_{GS}$

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



$I_D = 0.3 \text{ A}; V_{DS} = 30 \text{ V}$

Fig 11. Gate-source voltage as a function of gate charge; typical values

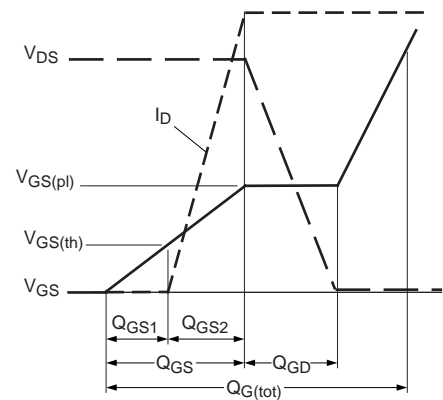
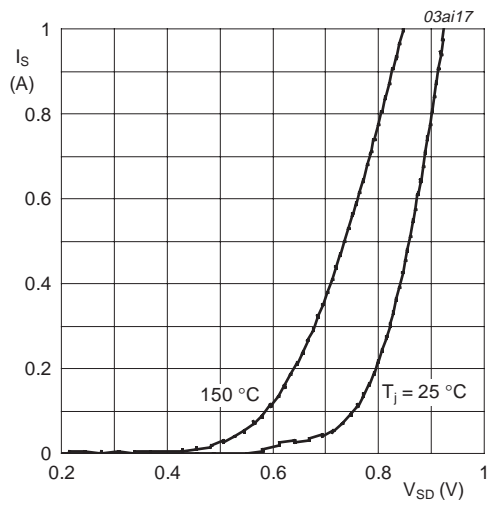
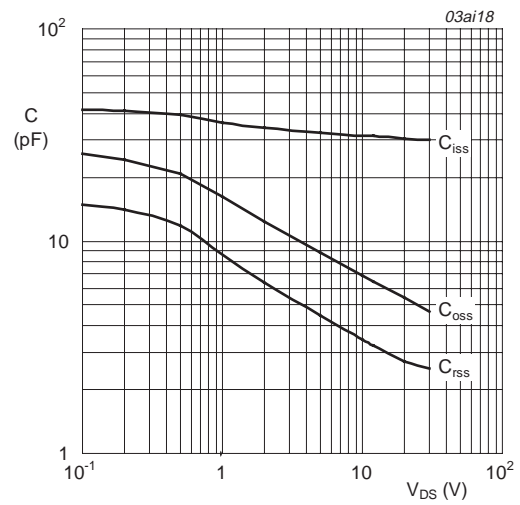


Fig 12. Gate charge waveform definitions



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

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



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

Fig 14. Input, output and reverse transfer capacitances as a function of drain-source voltage; typical values

7. Package outline

Plastic surface-mounted package; 3 leads

SOT23

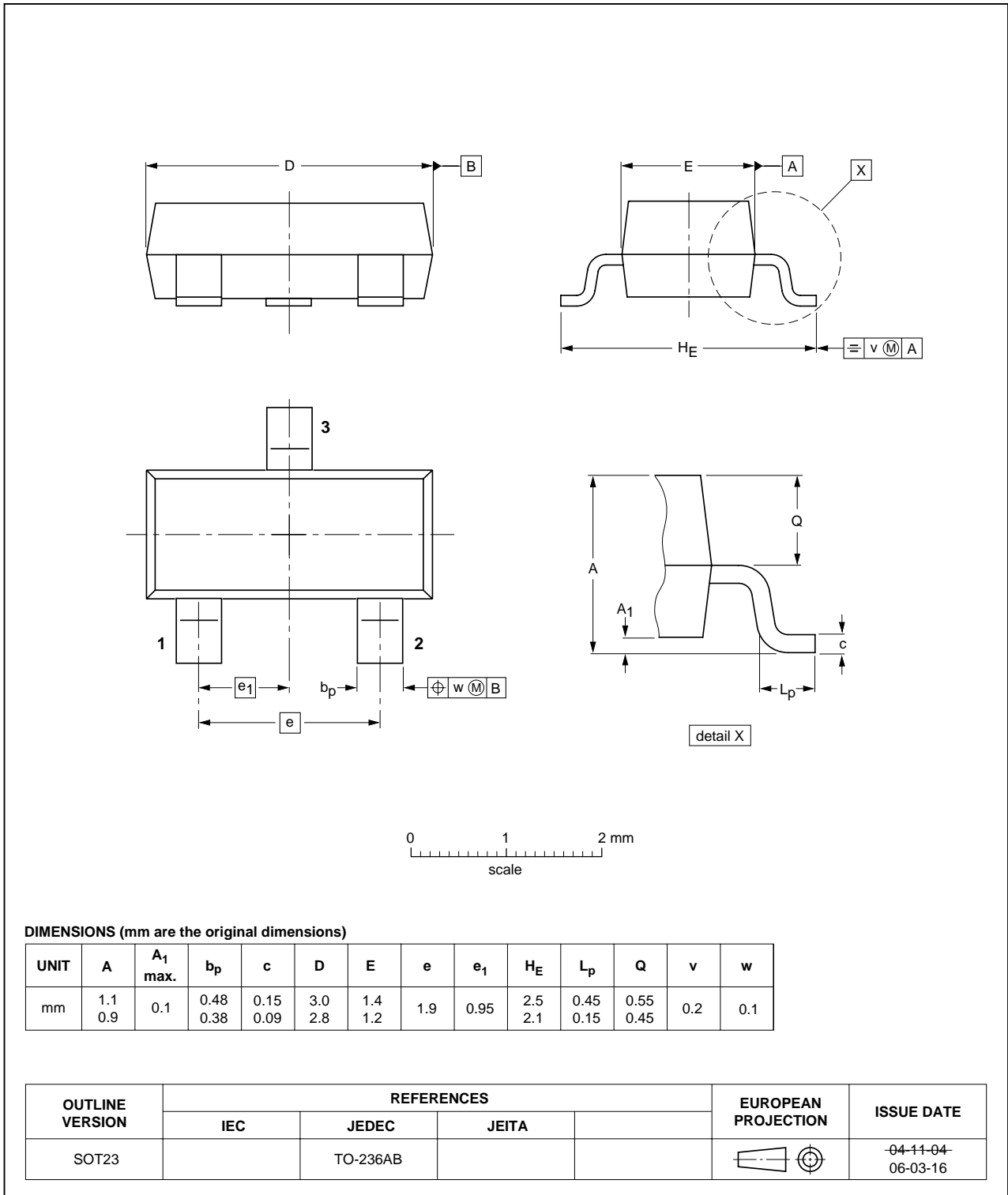


Fig 15. Package outline SOT23

8. Revision history

Table 6: Revision history

Document ID	Release date	Data sheet status	Change notice	Doc. number	Supersedes
2N7002E_3	20060428	Product data sheet	-	-	2N7002E_2
Modifications:	<ul style="list-style-type: none"> • Table 5 “Characteristics”: $V_{GS(th)}$ I_D condition modified • Table 5 “Characteristics”: $V_{GS(th)}$ maximum limits modified • Table 5 “Characteristics”: $R_{DS(on)}$ typical values modified • Table 5 “Characteristics”: g_{fs} removed • Table 5 “Characteristics”: Addition of $Q_{G(tot)}$, Q_{GS} and Q_{GD} • Table 5 “Characteristics”: C_{iss}, C_{oss} and C_{rss} values modified • Table 5 “Characteristics”: t_{on} and t_{off} typical values modified • Figure 3, 4, 5, 6, 7, 9, 10, 13 and 14: modified • Figure 11: added 				
2N7002E_2	20050426	Product data sheet	-	9397 750 14944	2N7002E-01
2N7002E-01	20020211	Product data	-	9397 750 09095	-

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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.
II	Preliminary data	Qualification	This data sheet contains data from the preliminary specification. Supplementary data will be published at a later date. Philips Semiconductors reserves the right to change the specification without notice, in order to improve the design and supply the best possible product.
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[2] The product status of the device(s) described in this data sheet may have changed since this data sheet was published. The latest information is available on the Internet at URL <http://www.semiconductors.philips.com>.

[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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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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