

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

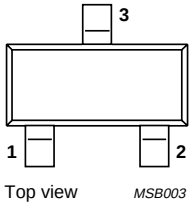
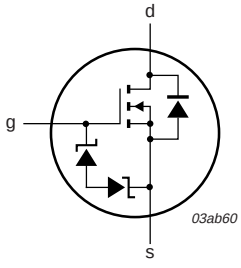
- Relay driver
- High speed line driver.

1.4 Quick reference data

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

2. Pinning information

Table 1: Pinning - SOT23, simplified outline and symbol

Pin	Description	Simplified outline	Symbol
1	gate (g)		
2	source (s)		
3	drain (d)		

SOT23

3. Ordering information

Table 2: Ordering information

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

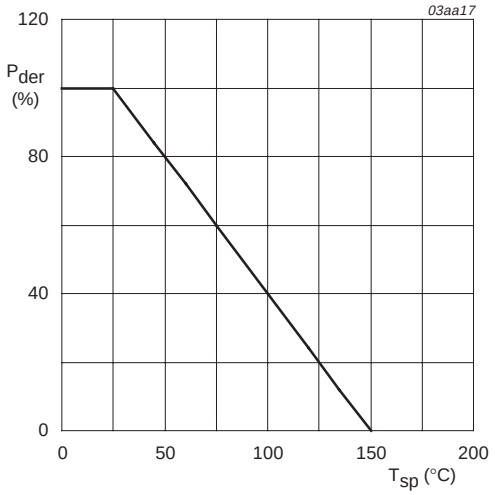
4. Limiting values

Table 3: Limiting values

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

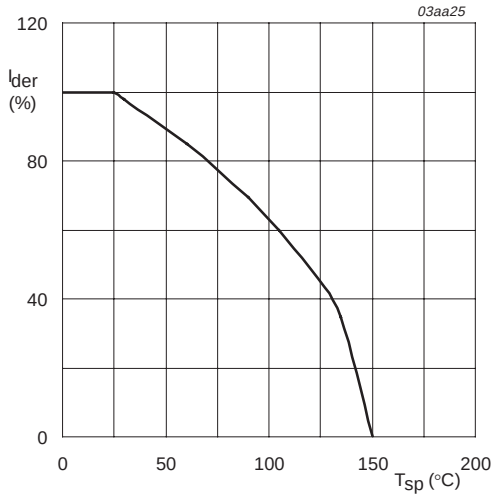
Symbol	Parameter	Conditions	Min	Max	Unit
V_{DS}	drain-source voltage (DC)	25 °C ≤ T_j ≤ 150 °C	-	60	V
V_{DGR}	drain-gate voltage (DC)	25 °C ≤ T_j ≤ 150 °C; R_{GS} = 20 kΩ	-	60	V
V_{GS}	gate-source voltage (DC)		-	±15	V
I_D	drain current (DC)	T_{sp} = 25 °C; V_{GS} = 10 V; Figure 2 and 3	-	340	mA
		T_{sp} = 100 °C; V_{GS} = 10 V; Figure 2	-	215	mA
I_{DM}	peak drain current	T_{sp} = 25 °C; pulsed; t_p ≤ 10 µs; Figure 3	-	680	mA
P_{tot}	total power dissipation	T_{sp} = 25 °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 °C	-	340	mA
I_{SM}	peak source (diode forward) current	T_{sp} = 25 °C; pulsed; t_p ≤ 10 µs	-	680	mA
Electrostatic discharge voltage					
V_{esd}	electrostatic discharge voltage	Human Body Model 1; C = 100 pF; R = 1.5 kΩ	-	1	kV

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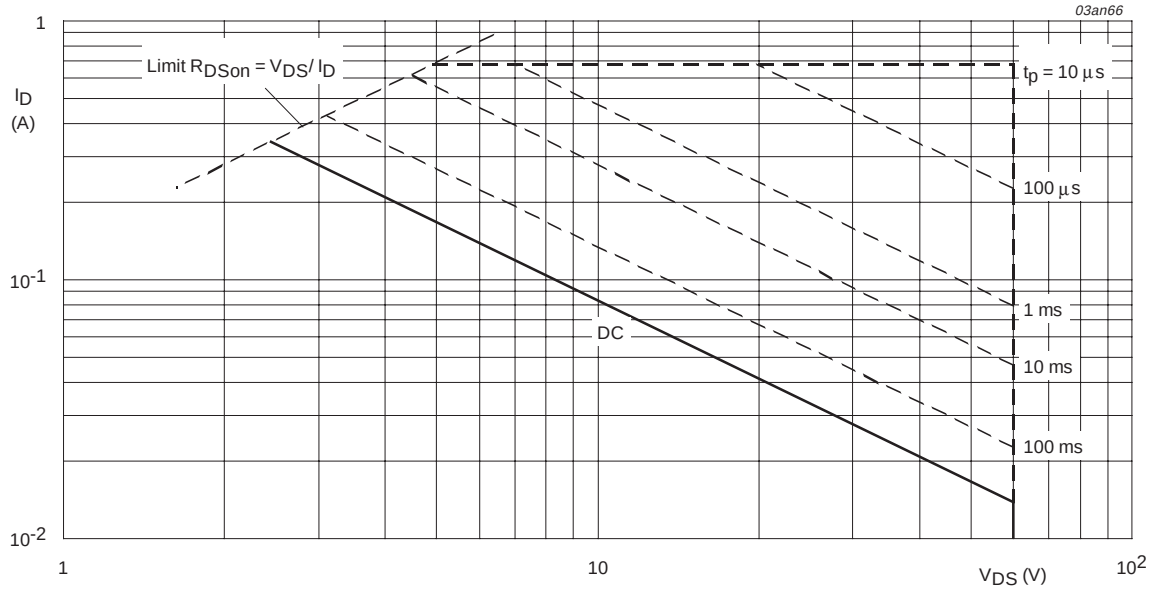
$$P_{der} = \frac{P_{tot}}{P_{tot(25^{\circ}C)}} \times 100\%$$

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.

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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

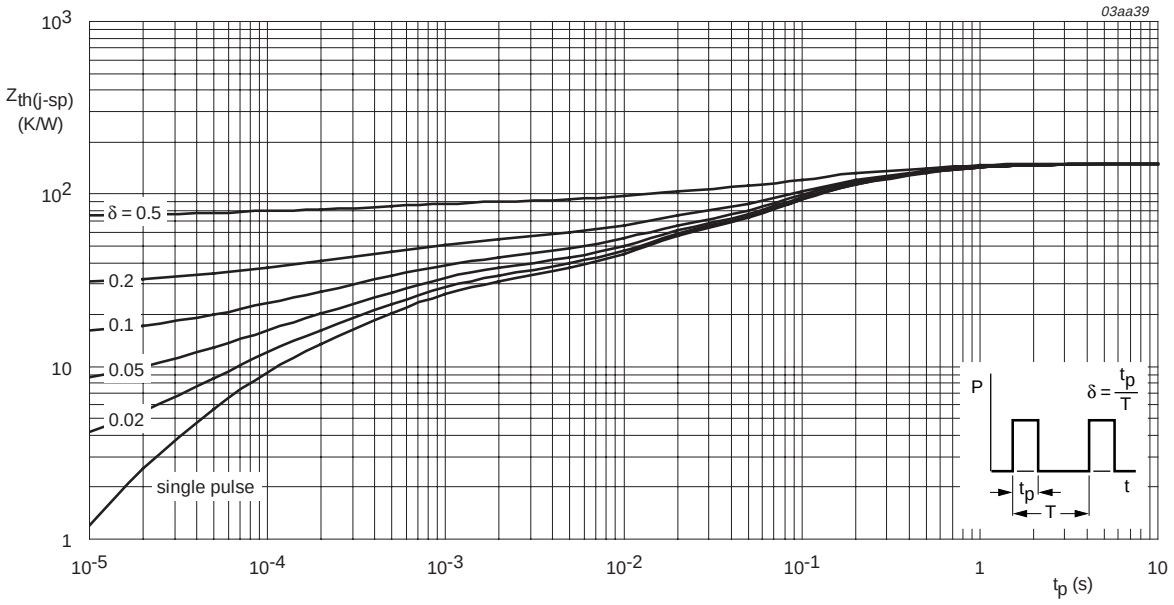


Fig 4. Transient thermal impedance from junction to solder point as a function of pulse duration.

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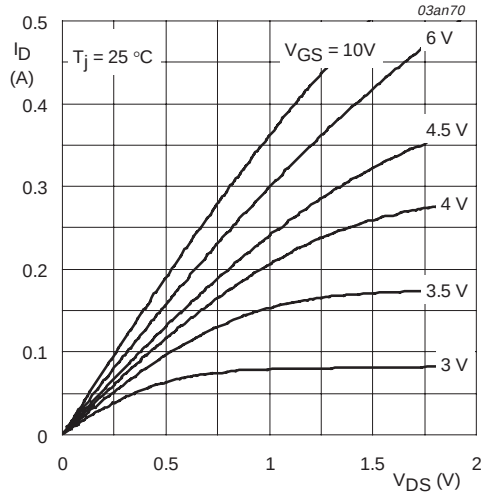
6. Characteristics

Table 5: Characteristics

T_j = 25 °C unless otherwise specified.

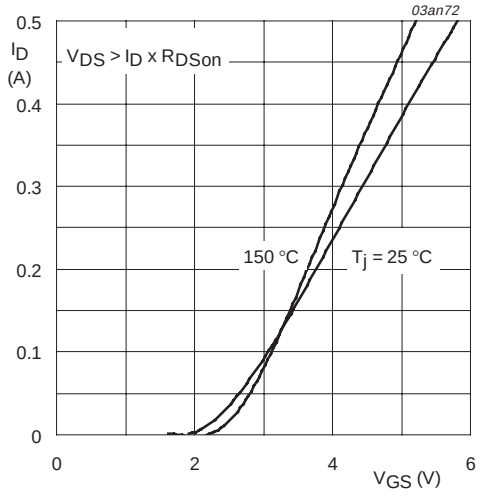
Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Static characteristics						
$V_{(BR)DSS}$	drain-source breakdown voltage	I_D = 10 µA; V_{GS} = 0 V				
		T_j = 25 °C	60	75	-	V
		T_j = –55 °C	55	-	-	V
$V_{(BR)GSS}$	drain-source breakdown voltage	I_G = ±1 mA; V_{DS} = 0 V	16	22	-	V
$V_{GS(th)}$	gate-source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

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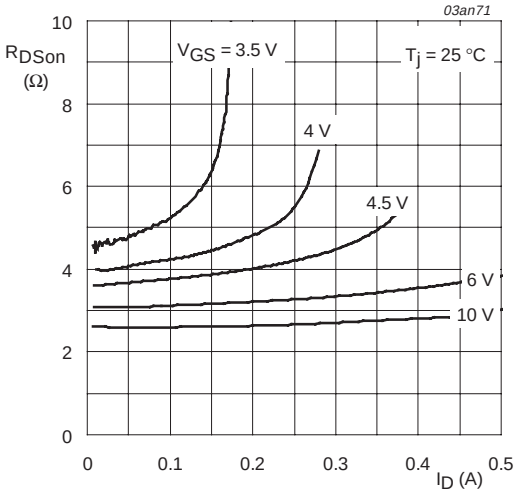
T_j = 25 °C

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



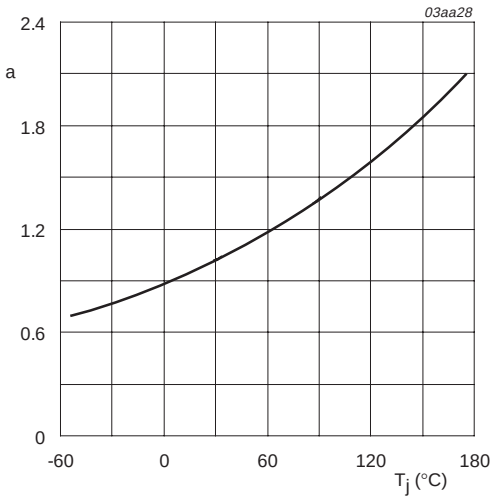
T_j = 25 °C and 150 °C; $V_{DS} > I_D \times R_{DSon}$

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



T_j = 25 °C

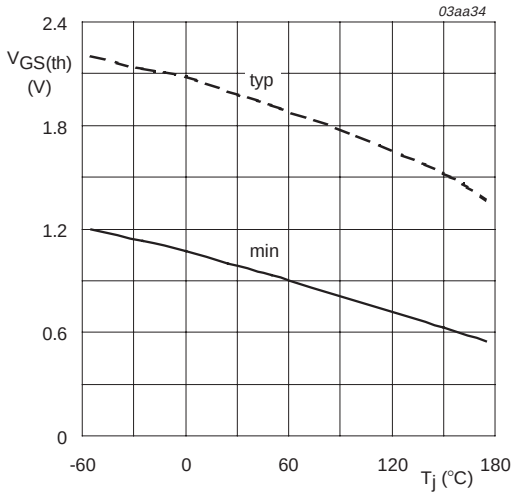
Fig 7. Drain-source on-state resistance as a function of drain current; typical values.



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

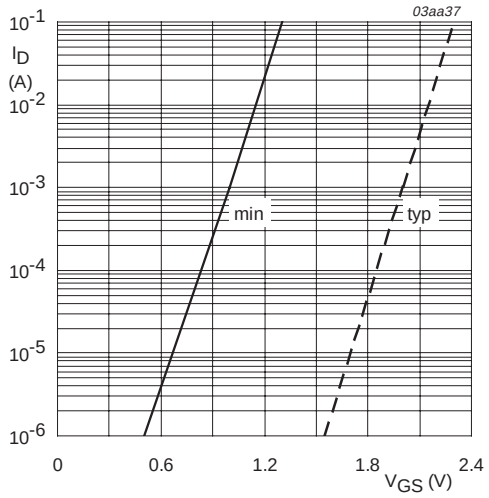
Fig 8. Normalized drain-source on-state resistance factor as a function of junction temperature.

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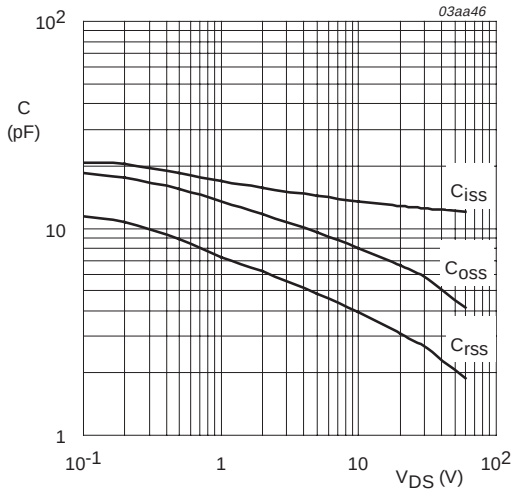
I_D = 1 mA; V_{DS} = V_{GS}

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



T_j = 25 °C; V_{DS} = 5 V

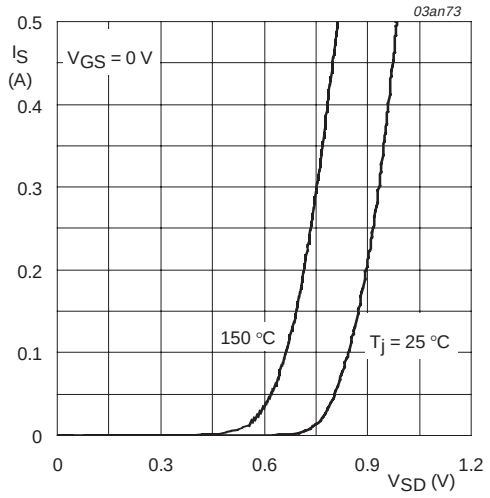
Fig 10. Sub-threshold drain current as a function of gate-source voltage.



V_{GS} = 0 V; f = 1 MHz

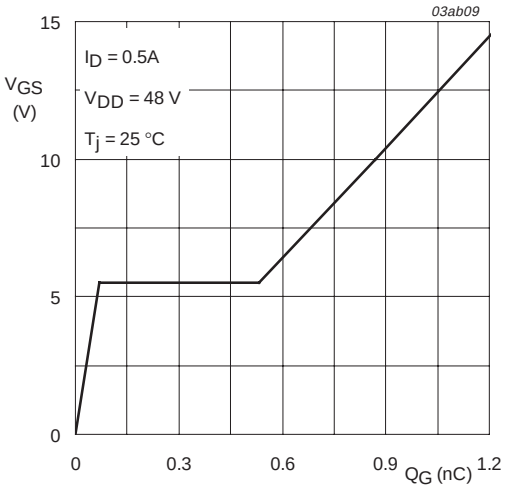
Fig 11. Input, output and reverse transfer capacitances as a function of drain-source voltage; typical values.

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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.



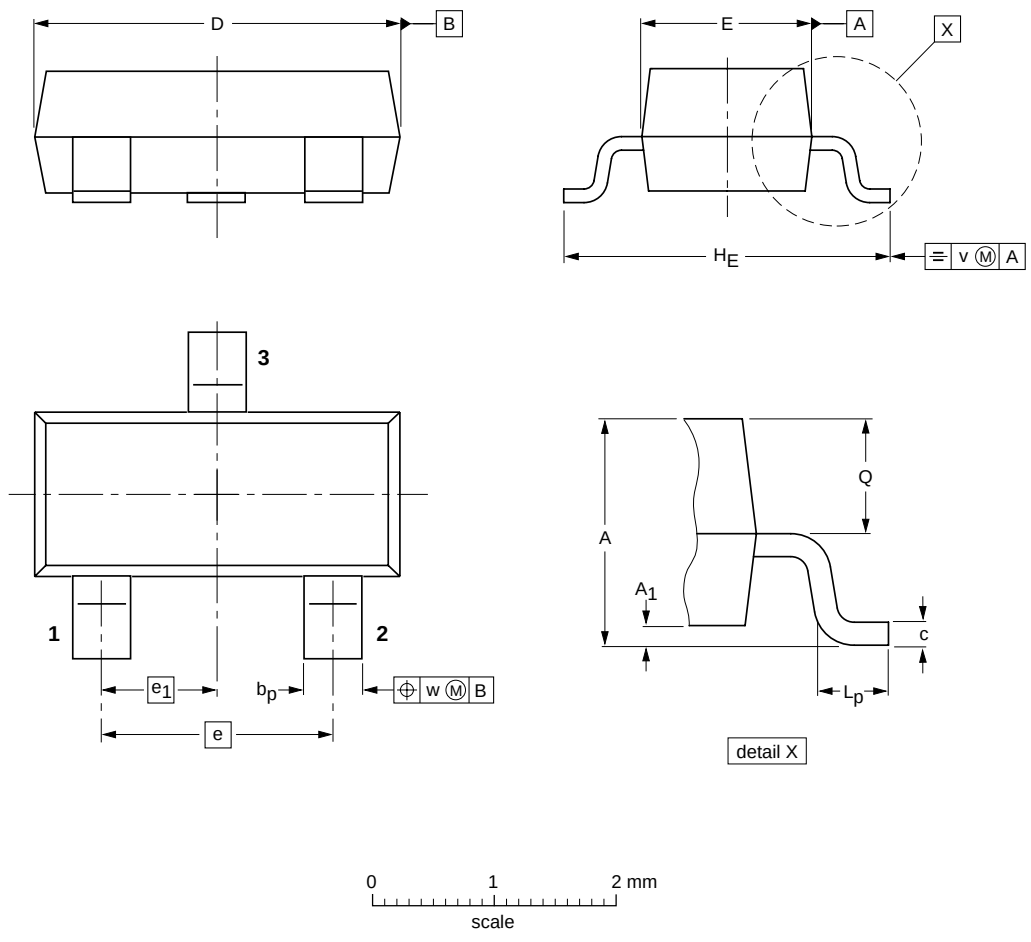
I_D = 0.5 A; V_{DD} = 48 V

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

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7. Package outline

Plastic surface mounted package; 3 leads **SOT23**



DIMENSIONS (mm are the original dimensions)

UNIT	A	A_1 max.	b_p	c	D	E	e	e_1	H_E	L_p	Q	v	w
mm	1.1 0.9	0.1	0.48 0.38	0.15 0.09	3.0 2.8	1.4 1.2	1.9	0.95	2.5 2.1	0.45 0.15	0.55 0.45	0.2	0.1

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	EIAJ			
SOT23		TO-236AB				~~97-02-28~~ 99-09-13

Fig 14. SOT23.

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8. Revision history

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[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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[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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