

2N7000

N-channel enhancement mode field-effect transistor

Rev. 03 — 19 May 2000

Product specification

1. Description

N-channel enhancement mode field-effect transistor in a plastic package using TrenchMOS™¹ technology.

Product availability:

2N7000 in SOT54 (TO-92 variant).

2. Features

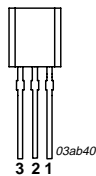
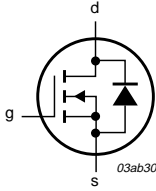
- TrenchMOS™ technology
- Very fast switching
- Logic level compatible.

3. Applications

- Relay driver
- High speed line driver
- Logic level translator.

4. Pinning information

Table 1: Pinning - SOT54, simplified outline and symbol

Pin	Description	Simplified outline	Symbol
1	drain (d)		
2	gate (g)		
3	source (s)		
		SOT54 (TO-92 variant)	N-channel MOSFET

1. TrenchMOS is a trademark of Royal Philips Electronics.

5. Quick reference data

Table 2: Quick reference data

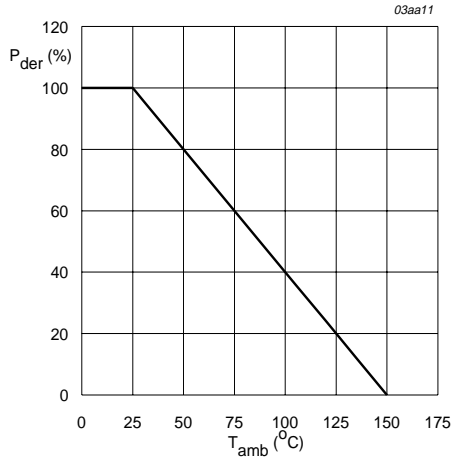
Symbol	Parameter	Conditions	Typ	Max	Unit
V_{DS}	drain-source voltage (DC)	$T_j = 25$ to 150 °C	–	60	V
I_D	drain current (DC)	$T_{amb} = 25$ °C; $V_{GS} = 10$ V	–	300	mA
P_{tot}	total power dissipation	$T_{amb} = 25$ °C	–	0.83	W
T_j	junction temperature		–	150	°C
$R_{DS(on)}$	drain-source on-state resistance	$V_{GS} = 10$ V; $I_D = 500$ mA	2.8	5	Ω
		$V_{GS} = 4.5$ V; $I_D = 75$ mA	3.8	5.3	Ω

6. Limiting values

Table 3: Limiting values

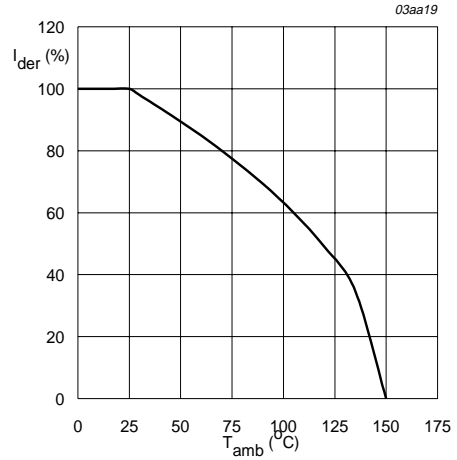
In accordance with the Absolute Maximum Rating System (IEC 60134).

Symbol	Parameter	Conditions	Min	Max	Unit
V_{DS}	drain-source voltage (DC)	$T_j = 25$ to 150 °C	–	60	V
V_{DGR}	drain-gate voltage (DC)	$T_j = 25$ to 150 °C; $R_{GS} = 20$ k Ω	–	60	V
V_{GS}	gate-source voltage (DC)		–	± 30	V
V_{GSM}	peak gate-source voltage	$t_p \leq 50$ μ s; pulsed; duty cycle = 25%	–	± 40	V
I_D	drain current (DC)	$T_{amb} = 25$ °C; $V_{GS} = 10$ V; Figure 2 and 3	–	300	mA
		$T_{amb} = 100$ °C; $V_{GS} = 10$ V; Figure 2	–	190	mA
I_{DM}	peak drain current	$T_{amb} = 25$ °C; pulsed; $t_p \leq 10$ μ s; Figure 3	–	1.3	A
P_{tot}	total power dissipation	$T_{amb} = 25$ °C; Figure 1	–	0.83	W
T_{stg}	storage temperature		–55	+150	°C
T_j	operating junction temperature		–55	+150	°C
Source-drain diode					
I_S	source (diode forward) current (DC)	$T_{amb} = 25$ °C	–	300	mA
I_{SM}	peak source (diode forward) current	$T_{amb} = 25$ °C; pulsed; $t_p \leq 10$ μ s	–	1.3	A



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

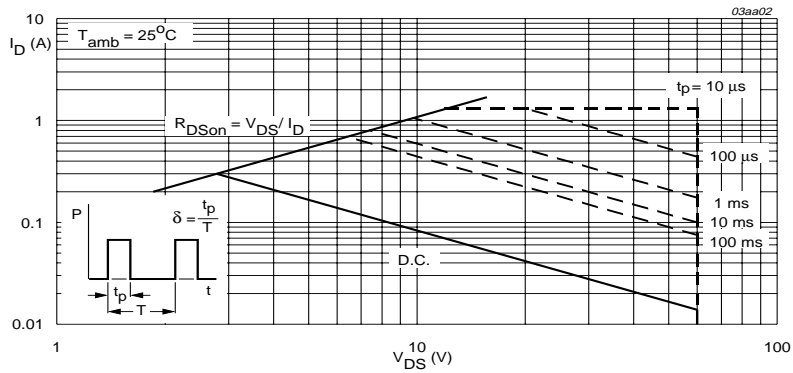
Fig 1. Normalized total power dissipation as a function of ambient temperature.



$$V_{GS} \geq 4.5 \text{ V}$$

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

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



T_{amb} = 25 °C; I_{DM} is single pulse.

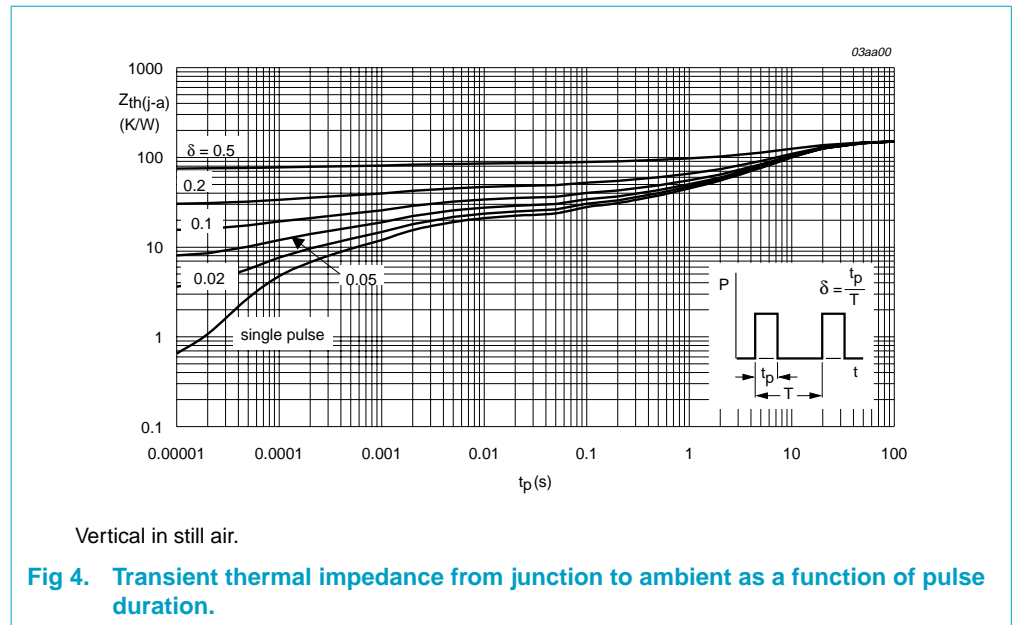
Fig 3. Safe operating area; continuous and peak drain currents as a function of drain-source voltage.

7. Thermal characteristics

Table 4: Thermal characteristics

Symbol	Parameter	Conditions	Value	Unit
$R_{th(j-a)}$	thermal resistance from junction to ambient	vertical in still air; lead length ≤ 5 mm; Figure 4	150	K/W

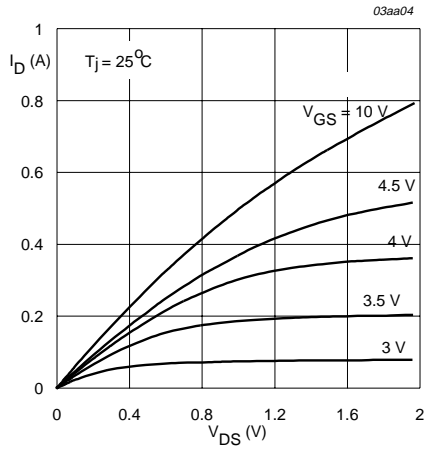
7.1 Transient thermal impedance



8. Characteristics

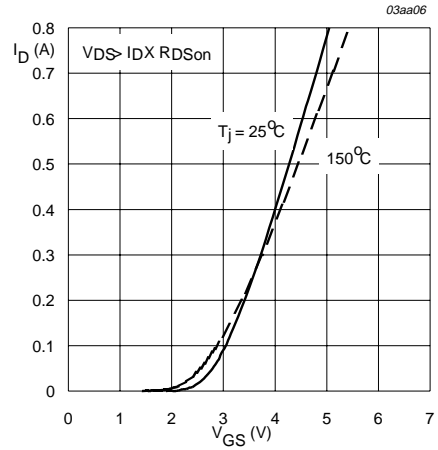
Table 5: Characteristics
 $T_j = 25\text{ }^\circ\text{C}$ unless otherwise specified

Symbol	Parameter	Conditions	Min	Typ	Max	Unit	
Static characteristics							
$V_{(BR)DSS}$	drain-source breakdown voltage	$I_D = 10\text{ }\mu\text{A}$; $V_{GS} = 0\text{ V}$					
		$T_j = 25\text{ }^\circ\text{C}$	60	75	–	V	
		$T_j = -55\text{ }^\circ\text{C}$	55	–	–	V	
$V_{GS(th)}$	gate-source threshold voltage	$I_D = 1\text{ mA}$; $V_{DS} = V_{GS}$; Figure 9					
		$T_j = 25\text{ }^\circ\text{C}$	1	2	–	V	
		$T_j = 150\text{ }^\circ\text{C}$	0.6	–	–	V	
		$T_j = -55\text{ }^\circ\text{C}$	–	–	3.5	V	
I_{DSS}	drain-source leakage current	$V_{DS} = 48\text{ V}$; $V_{GS} = 0\text{ V}$					
		$T_j = 25\text{ }^\circ\text{C}$	–	0.01	1.0	μA	
		$T_j = 150\text{ }^\circ\text{C}$	–	–	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 7 and 8					
		$T_j = 25\text{ }^\circ\text{C}$	–	2.8	5	Ω	
		$T_j = 150\text{ }^\circ\text{C}$	–	–	9.25	Ω	
		$V_{GS} = 4.5\text{ V}$; $I_D = 75\text{ mA}$; Figure 7 and 8					
		$T_j = 25\text{ }^\circ\text{C}$	–	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	$V_{GS} = 0\text{ V}$; $V_{DS} = 10\text{ V}$;	–	25	40	pF	
C_{oss}	output capacitance	$f = 1\text{ MHz}$; Figure 12	–	18	30	pF	
C_{rss}	reverse transfer capacitance		–	7.5	10	pF	
t_{on}	turn-on time	$V_{DD} = 50\text{ V}$; $R_D = 250\text{ }\Omega$;	–	3	10	ns	
t_{off}	turn-off time	$V_{GS} = 10\text{ V}$; $R_G = 50\text{ }\Omega$; $R_{GS} = 50\text{ }\Omega$	–	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	$I_S = 300\text{ mA}$;	–	30	–	ns	
Q_r	recovered charge	$di_S/dt = -100\text{ A}/\mu\text{s}$; $V_{GS} = 0\text{ V}$; $V_{DS} = 25\text{ V}$	–	30	–	nC	



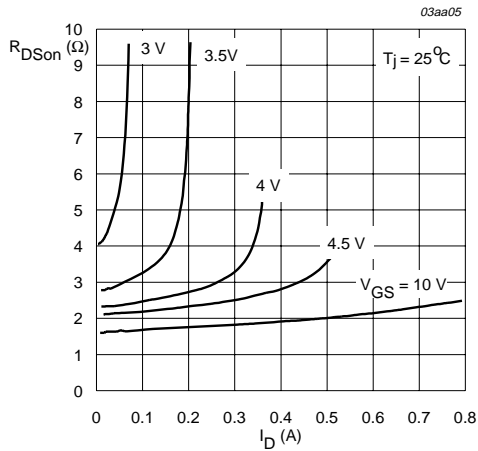
$T_J = 25^\circ\text{C}$

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



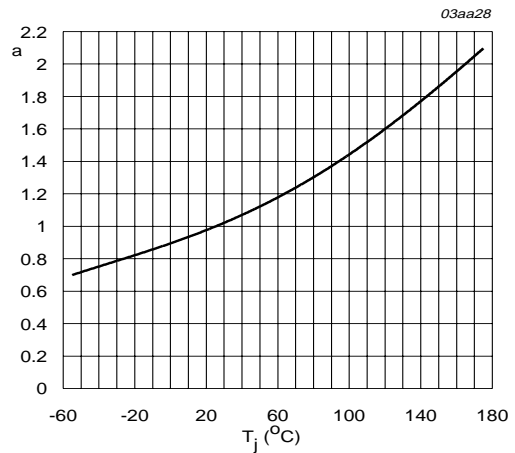
$T_J = 25^\circ\text{C}$ and 150°C ; $V_{DS} \geq I_D \times R_{DSon}$

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



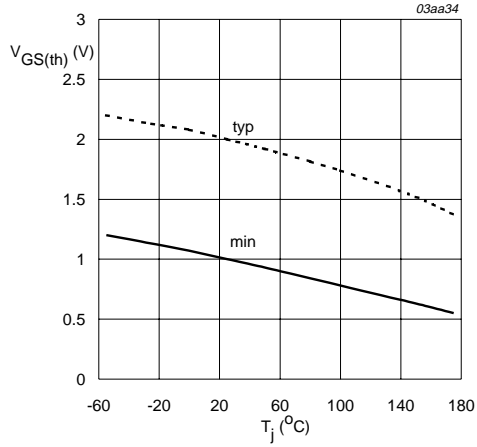
$T_J = 25^\circ\text{C}$

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



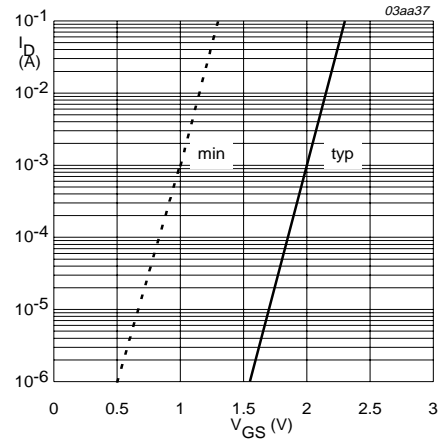
$$a = \frac{R_{DSon}}{R_{DSon}(25^\circ\text{C})}$$

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



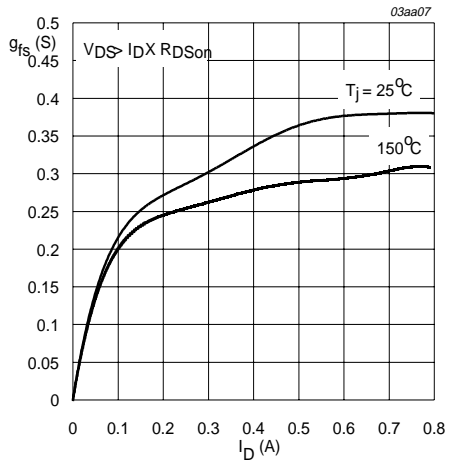
$I_D = 1 \text{ mA}; V_{DS} = V_{GS}$

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



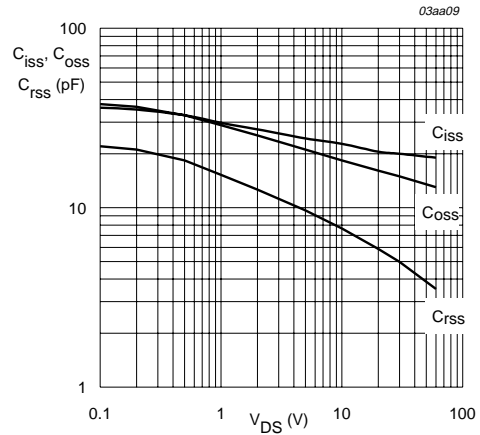
$T_j = 25 \text{ }^{\circ}C; V_{DS} = 5 \text{ V}$

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



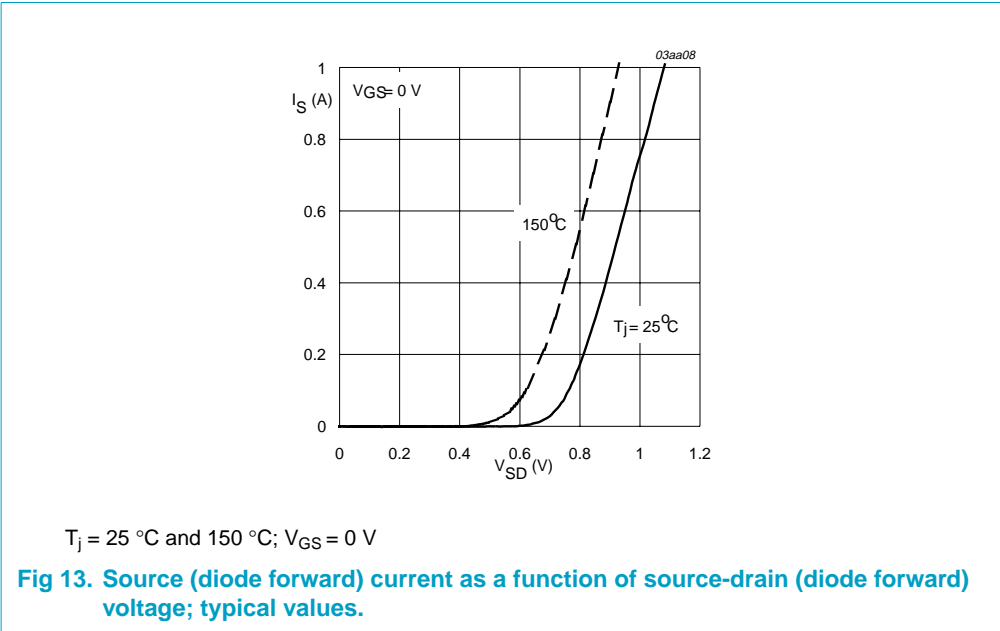
$T_j = 25 \text{ }^{\circ}C \text{ and } 150 \text{ }^{\circ}C; V_{DS} \geq I_D \times R_{DS(on)}$

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.



9. Package outline

Plastic single-ended leaded (through hole) package; 3 leads

SOT54

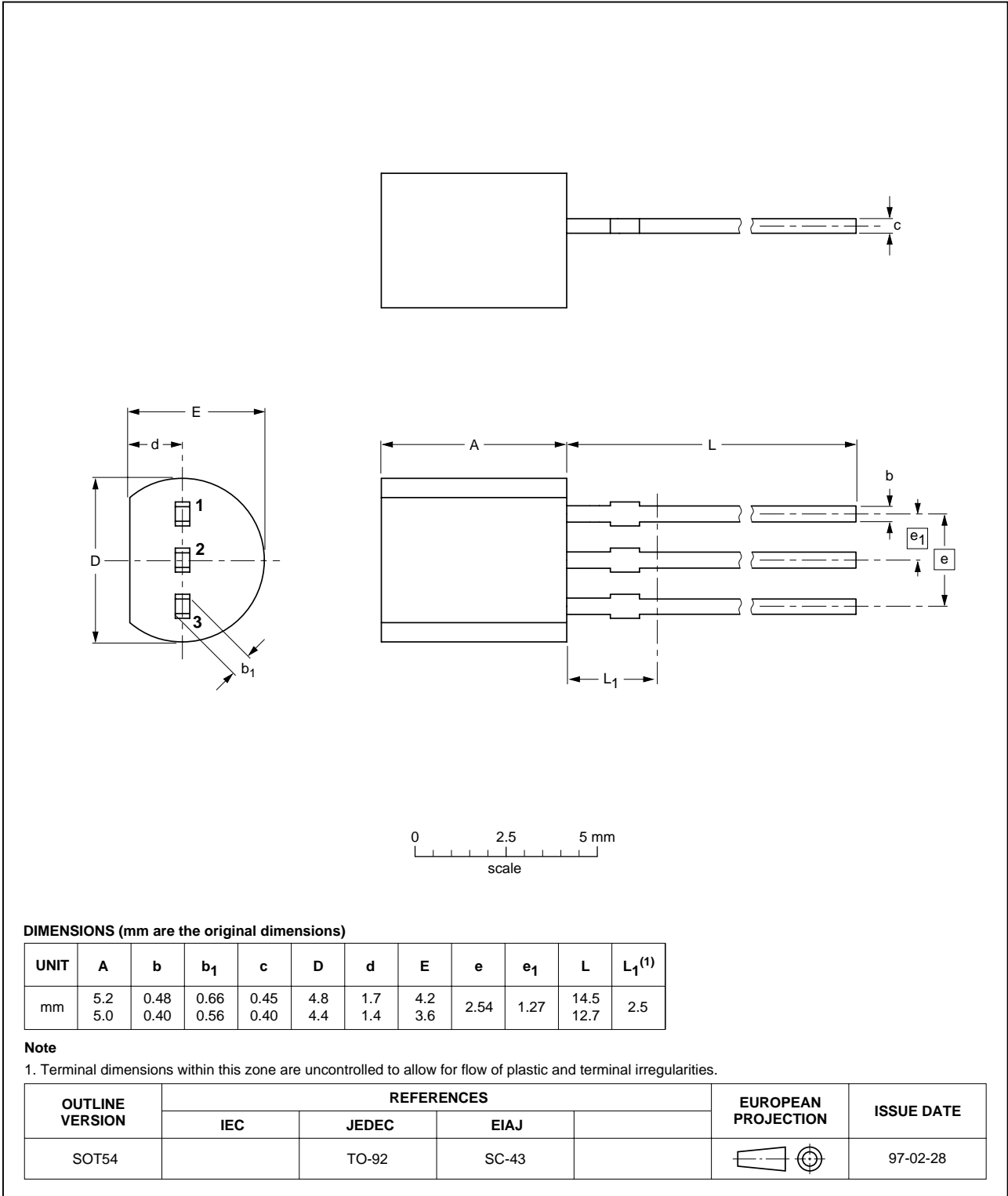


Fig 14. SOT54 (TO-92 variant).

10. Revision history

Table 6: Revision history

Rev	Date	CPCN	Description
03	20000519	HZG336	Product specification; third version. Converted to TrenchMOS™ technology.
02	19970617	-	Product specification; second version.
01	19901031	-	Product specification; initial version.

11. Data sheet status

Datasheet status	Product status	Definition ^[1]
Objective specification	Development	This data sheet contains the design target or goal specifications for product development. Specification may change in any manner without notice.
Preliminary specification	Qualification	This data sheet contains preliminary data, and supplementary data will be published at a later date. Philips Semiconductors reserves the right to make changes at any time without notice in order to improve design and supply the best possible product.
Product specification	Production	This data sheet contains final specifications. Philips Semiconductors reserves the right to make changes at any time without notice in order to improve design and supply the best possible product.

[1] Please consult the most recently issued data sheet before initiating or completing a design.

12. Definitions

Short-form specification — The data in a short-form specification is extracted from a full data sheet with the same type number and title. For detailed information see the relevant data sheet or data handbook.

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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