

# HEF40098B

## 3-state hex inverting buffer

Rev. 05 — 31 October 2008

Product data sheet

## 1. General description

The HEF40098B is a hex inverting buffer with 3-state outputs. The 3-state outputs are controlled by two active LOW enable inputs ( $1\overline{OE}$  and  $2\overline{OE}$ ). A HIGH on  $1\overline{OE}$  causes four of the six active LOW buffer elements ( $1\overline{Y}0$  to  $1\overline{Y}3$ ) to assume a high-impedance or OFF-state regardless of the other input conditions and a HIGH on  $2\overline{OE}$  causes the outputs of the remaining two buffer elements ( $2\overline{Y}0$  and  $2\overline{Y}1$ ) to assume a high-impedance or OFF-state regardless of the other input conditions.

It operates over a recommended  $V_{DD}$  power supply range of 3 V to 15 V referenced to  $V_{SS}$  (usually ground). Unused inputs must be connected to  $V_{DD}$ ,  $V_{SS}$ , or another input. It is also suitable for use over the full industrial ( $-40\text{ }^{\circ}\text{C}$  to  $+85\text{ }^{\circ}\text{C}$ ) temperature range.

## 2. Features

- Fully static operation
- 5 V, 10 V, and 15 V parametric ratings
- Standardized symmetrical output characteristics
- Operates across the full industrial temperature range  $-40\text{ }^{\circ}\text{C}$  to  $+85\text{ }^{\circ}\text{C}$
- Complies with JEDEC standard JESD 13-B
- ESD protection:
  - ◆ HBM JESD22-A114E exceeds 2000 V
  - ◆ MM JESD22-A115-A exceeds 200 V

## 3. Applications

- Industrial

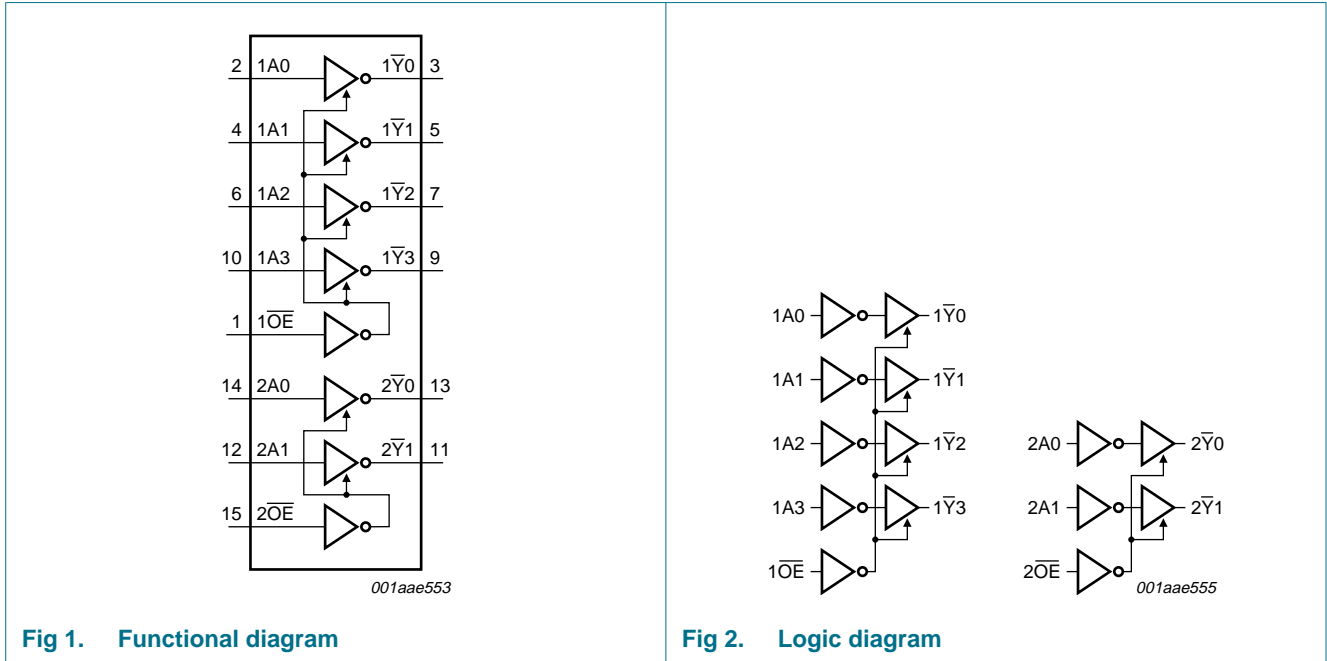
## 4. Ordering information

**Table 1. Ordering information**

All types operate from  $-40\text{ }^{\circ}\text{C}$  to  $+85\text{ }^{\circ}\text{C}$

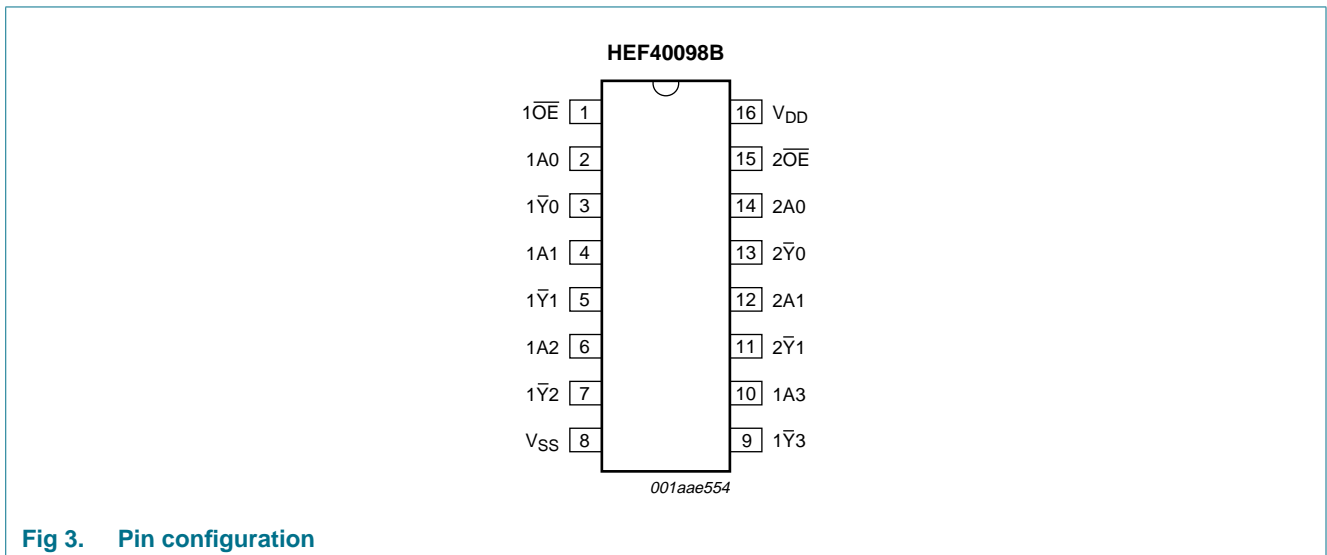
Type number	Package		Version
	Name	Description	
HEF40098BP	DIP16	plastic dual in-line package; 16-leads (300 mil)	SOT38-4
HEF40098BT	SO16	plastic small outline package; 16 leads; body width 3.9 mm	SOT109-1

**5. Functional diagram**



**6. Pinning information**

**6.1 Pinning**



## 6.2 Pin description

Table 2. Pin description

Symbol	Pin	Description
$1\overline{OE}$	1	output enable input (active LOW)
1A0, 1A1, 1A2, 1A3	2, 4, 6, 10	buffer input
$1\overline{Y}0, 1\overline{Y}1, 1\overline{Y}2, 1\overline{Y}3$	3, 5, 7, 9	buffer output (active LOW)
$V_{SS}$	8	supply voltage
$2\overline{Y}0, 2\overline{Y}1$	13, 11	buffer output (active LOW)
2A0, 2A1	14, 12	buffer input
$2\overline{OE}$	15	output enable input (active LOW)
$V_{DD}$	16	supply voltage

## 7. Functional description

Table 3. Function table<sup>[1]</sup>

Inputs		Output
nAn	n $\overline{OE}$	n $\overline{Y}$ n
H	L	L
L	L	H
X	H	Z

[1] H = HIGH voltage level; L = LOW voltage level; X = don't care; Z = high-impedance OFF state.

## 8. Limiting values

Table 4. Limiting values

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

Symbol	Parameter	Conditions	Min	Max	Unit
$V_{DD}$	supply voltage		-0.5	+18	V
$I_{IK}$	input clamping current	$V_I < 0.5\text{ V}$ or $V_I > V_{DD} + 0.5\text{ V}$	-	$\pm 10$	mA
$V_I$	input voltage		-0.5	$V_{DD} + 0.5$	V
$I_{OK}$	output clamping current	$V_O < 0.5\text{ V}$ or $V_O > V_{DD} + 0.5\text{ V}$	-	$\pm 10$	mA
$I_{I/O}$	input/output current		-	$\pm 10$	mA
$I_{DD}$	supply current		-	50	mA
$T_{stg}$	storage temperature		-65	+150	°C
$T_{amb}$	ambient temperature		-40	+85	°C
$P_{tot}$	total power dissipation	$T_{amb} = -40\text{ to }+85\text{ °C}$			
		DIP16 package	[1] -	750	mW
		SO16 package	[2] -	500	mW
P	power dissipation		-	100	mW

[1] For DIP16 package:  $P_{tot}$  derates linearly with 12 mW/K above 70 °C.

[2] For SO16 package:  $P_{tot}$  derates linearly with 8 mW/K above 70 °C.

## 9. Recommended operating conditions

**Table 5. Recommended operating conditions**

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$V_{DD}$	supply voltage		3	-	15	V
$V_I$	input voltage		0	-	$V_{DD}$	V
$T_{amb}$	ambient temperature	in free air	-40	-	+85	°C
$\Delta t/\Delta V$	input transition rise and fall rate	$V_{DD} = 5\text{ V}$	-	-	3.75	ns/V
		$V_{DD} = 10\text{ V}$	-	-	0.5	ns/V
		$V_{DD} = 15\text{ V}$	-	-	0.08	ns/V

## 10. Static characteristics

**Table 6. Static characteristics**

$V_{SS} = 0\text{ V}$ ;  $V_I = V_{SS}$  or  $V_{DD}$ ; unless otherwise specified.

Symbol	Parameter	Conditions	$V_{DD}$	$T_{amb} = -40\text{ °C}$		$T_{amb} = 25\text{ °C}$		$T_{amb} = 85\text{ °C}$		Unit
				Min	Max	Min	Max	Min	Max	
$V_{IH}$	HIGH-level input voltage	$ I_O  < 1\text{ }\mu\text{A}$	5 V	3.5	-	3.5	-	3.5	-	V
			10 V	7.0	-	7.0	-	7.0	-	V
			15 V	11.0	-	11.0	-	11.0	-	V
$V_{IL}$	LOW-level input voltage	$ I_O  < 1\text{ }\mu\text{A}$	5 V	-	1.5	-	1.5	-	1.5	V
			10 V	-	3.0	-	3.0	-	3.0	V
			15 V	-	4.0	-	4.0	-	4.0	V
$V_{OH}$	HIGH-level output voltage	$ I_O  < 1\text{ }\mu\text{A}$	5 V	4.95	-	4.95	-	4.95	-	V
			10 V	9.95	-	9.95	-	9.95	-	V
			15 V	14.95	-	14.95	-	14.95	-	V
$V_{OL}$	LOW-level output voltage	$ I_O  < 1\text{ }\mu\text{A}$	5 V	-	0.05	-	0.05	-	0.05	V
			10 V	-	0.05	-	0.05	-	0.05	V
			15 V	-	0.05	-	0.05	-	0.05	V
$I_{OH}$	HIGH-level output current	$V_O = 2.5\text{ V}$	5 V	-3.8	-	-3.2	-	-2.5	-	mA
		$V_O = 4.6\text{ V}$	5 V	-1.2	-	-1.0	-	-0.8	-	mA
		$V_O = 9.5\text{ V}$	10 V	-3.8	-	-3.2	-	-2.5	-	mA
		$V_O = 13.5\text{ V}$	15 V	-12.0	-	-10.0	-	-8.0	-	mA
$I_{OL}$	LOW-level output current	$V_O = 0.4\text{ V}$ ;	4.75 V	3.5	-	2.9	-	2.3	-	mA
		$V_O = 0.5\text{ V}$ ;	10 V	12.0	-	10.0	-	8.0	-	mA
		$V_O = 1.5\text{ V}$ ;	15 V	24.0	-	20.0	-	16.0	-	mA
$I_I$	input leakage current	$V_I = 0\text{ V}$ or $15\text{ V}$	15 V	-	0.3	-	0.3	-	1.0	$\mu\text{A}$
$I_{DD}$	supply current	$I_O = 0\text{ A}$	5 V	-	4	-	4	-	30	$\mu\text{A}$
			10 V	-	8	-	8	-	60	$\mu\text{A}$
			15 V	-	16	-	16	-	120	$\mu\text{A}$
$I_{OZ}$	OFF-state output current		15 V	-	1.6	-	1.6	-	12.0	$\mu\text{A}$
$C_I$	input capacitance			-	-	-	7.5	-	-	pF

## 11. Dynamic characteristics

**Table 7. Dynamic characteristics**

$V_{SS} = 0\text{ V}$ ;  $T_{amb} = 25\text{ °C}$ ; for test circuit see [Figure 6](#); unless otherwise specified.

Symbol	Parameter	Conditions	$V_{DD}$	Extrapolation formula <sup>[1]</sup>	Min	Typ	Max	Unit
t <sub>PHL</sub>	HIGH to LOW propagation delay	nAn to nYn; see <a href="#">Figure 4</a>	5 V	70 ns + (0.20 ns/pF) C <sub>L</sub>	-	80	160	ns
			10 V	31 ns + (0.08 ns/pF) C <sub>L</sub>	-	35	70	ns
			15 V	22 ns + (0.06 ns/pF) C <sub>L</sub>	-	25	50	ns
t <sub>PLH</sub>	LOW to HIGH propagation delay	nAn to nYn; see <a href="#">Figure 4</a>	5 V	50 ns + (0.30 ns/pF) C <sub>L</sub>	-	65	130	ns
			10 V	24 ns + (0.13 ns/pF) C <sub>L</sub>	-	30	60	ns
			15 V	23 ns + (0.05 ns/pF) C <sub>L</sub>	-	25	50	ns
t <sub>THL</sub>	HIGH to LOW output transition time	see <a href="#">Figure 4</a>	5 V	15 ns + (0.30 ns/pF) C <sub>L</sub>	-	30	60	ns
			10 V	10 ns + (0.11 ns/pF) C <sub>L</sub>	-	15	30	ns
			15 V	7 ns + (0.07 ns/pF) C <sub>L</sub>	-	10	20	ns
t <sub>TLH</sub>	LOW to HIGH output transition time	see <a href="#">Figure 4</a>	5 V	10 ns + (0.50 ns/pF) C <sub>L</sub>	-	35	70	ns
			10 V	8 ns + (0.24 ns/pF) C <sub>L</sub>	-	20	40	ns
			15 V	6 ns + (0.18 ns/pF) C <sub>L</sub>	-	15	30	ns
t <sub>PHZ</sub>	HIGH to OFF-state propagation delay	n $\overline{OE}$ , to nYn; see <a href="#">Figure 5</a>	5 V	-	-	45	85	ns
			10 V	-	-	35	65	ns
			15 V	-	-	30	60	ns
t <sub>PLZ</sub>	LOW to OFF-state propagation delay	n $\overline{OE}$ , to nYn; see <a href="#">Figure 5</a>	5 V	-	-	65	135	ns
			10 V	-	-	40	80	ns
			15 V	-	-	35	70	ns
t <sub>PZH</sub>	OFF-state to HIGH propagation delay	n $\overline{OE}$ , to nYn; see <a href="#">Figure 5</a>	5 V	-	-	70	140	ns
			10 V	-	-	35	75	ns
			15 V	-	-	30	65	ns
t <sub>PZL</sub>	OFF-state to LOW propagation delay	n $\overline{OE}$ , to nYn; see <a href="#">Figure 5</a>	5 V	-	-	90	185	ns
			10 V	-	-	40	85	ns
			15 V	-	-	35	70	ns

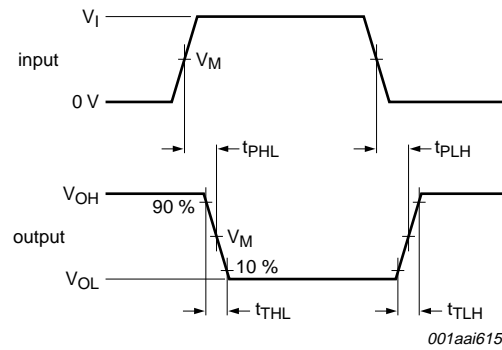
[1] The typical value of the propagation delay and transition times are calculated from the extrapolation formula as shown (C<sub>L</sub> in pF).

**Table 8. Dynamic power dissipation P<sub>D</sub>**

P<sub>D</sub> can be calculated (in  $\mu\text{W}$ ) from the formulas shown.  $V_{SS} = 0\text{ V}$ ;  $t_r = t_f \leq 20\text{ ns}$ ;  $T_{amb} = 25\text{ °C}$ .

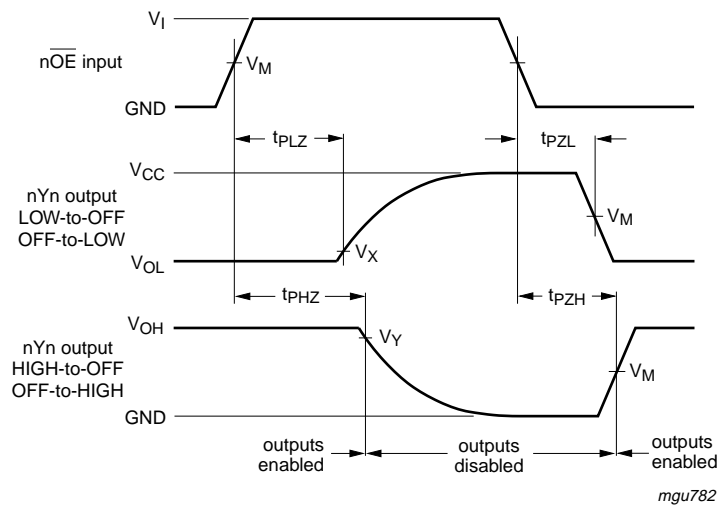
Symbol	Parameter	$V_{DD}$	Typical formula for P <sub>D</sub> ( $\mu\text{W}$ )	where:
P <sub>D</sub>	dynamic power dissipation	5 V	$P_D = 5000 \times f_i + \Sigma(f_o \times C_L) \times V_{DD}^2$	f <sub>i</sub> = input frequency in MHz,
		10 V	$P_D = 22800 \times f_i + \Sigma(f_o \times C_L) \times V_{DD}^2$	f <sub>o</sub> = output frequency in MHz,
		15 V	$P_D = 81000 \times f_i + \Sigma(f_o \times C_L) \times V_{DD}^2$	C <sub>L</sub> = output load capacitance in pF, V <sub>DD</sub> = supply voltage in V, $\Sigma(C_L \times f_o)$ = sum of the outputs.

12. AC waveforms



Measurement points are given in Table 9,  $V_{OL}$  and  $V_{OH}$  are typical output voltage levels that occur with the output load.

Fig 4. Input (nAn) to output (nYn) propagation delays

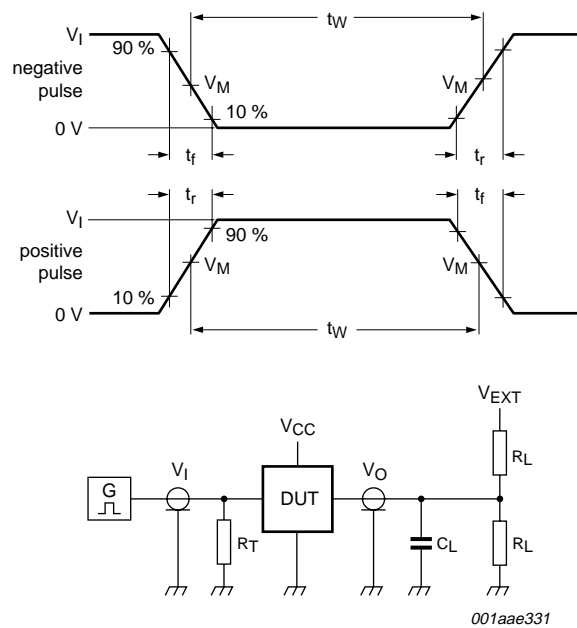


Measurement points are given in Table 9,  $V_{OL}$  and  $V_{OH}$  are typical output voltage levels that occur with the output load.

Fig 5. 3-state enable and disable times

Table 9. Measurement points

Supply voltage	Input	Output		
$V_{DD}$	$V_M$	$V_M$	$V_X$	$V_Y$
5 V to 15 V	$0.5V_{DD}$	$0.5V_{DD}$	$0.1V_{DD}$	$0.9V_{DD}$



Test data is given in [Table 10](#).

Definitions for test circuit:

$R_L$  = Load resistance;

$C_L$  = Load capacitance including jig and probe capacitance;

$R_T$  = Termination resistance should be equal to output impedance  $Z_o$  of the pulse generator;

$V_{EXT}$  = External voltage for measuring switching times.

**Fig 6. Test circuitry for switching times**

**Table 10. Test data**

Supply voltage	Input		Load		$V_{EXT}$		
	$V_I$	$t_r, t_f$	$C_L$	$R_L$	$t_{PLH}, t_{PHL}$	$t_{PLZ}, t_{PZL}$	$t_{PHZ}, t_{PZH}$
5 V to 15 V	$V_{DD}$	$\leq 20$ ns	50 pF	1 k $\Omega$	open	$2V_{DD}$	GND

13. Package outline

DIP16: plastic dual in-line package; 16 leads (300 mil)

SOT38-4

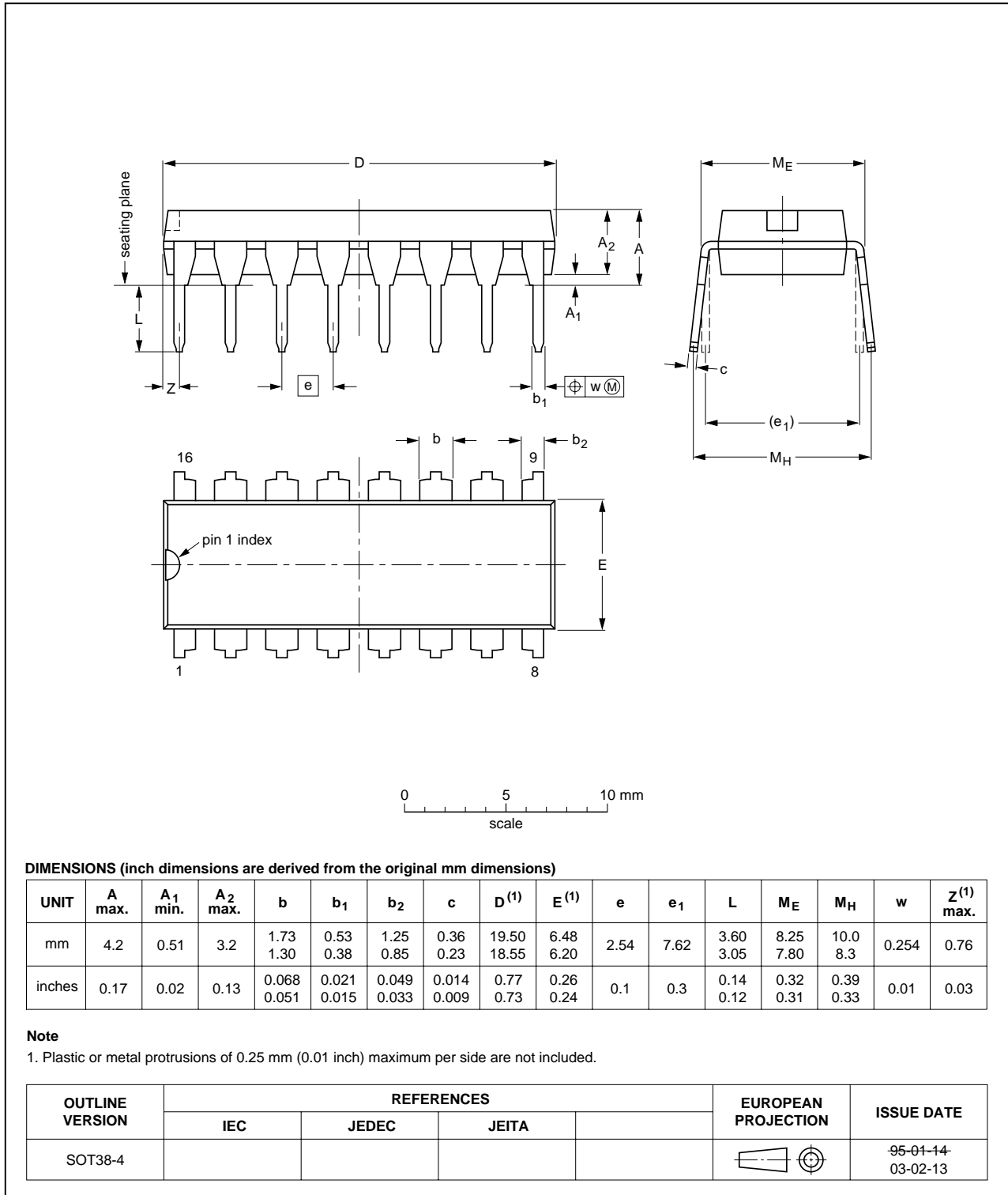


Fig 7. Package outline SOT38-4 (DIP16)



SO16: plastic small outline package; 16 leads; body width 3.9 mm

SOT109-1

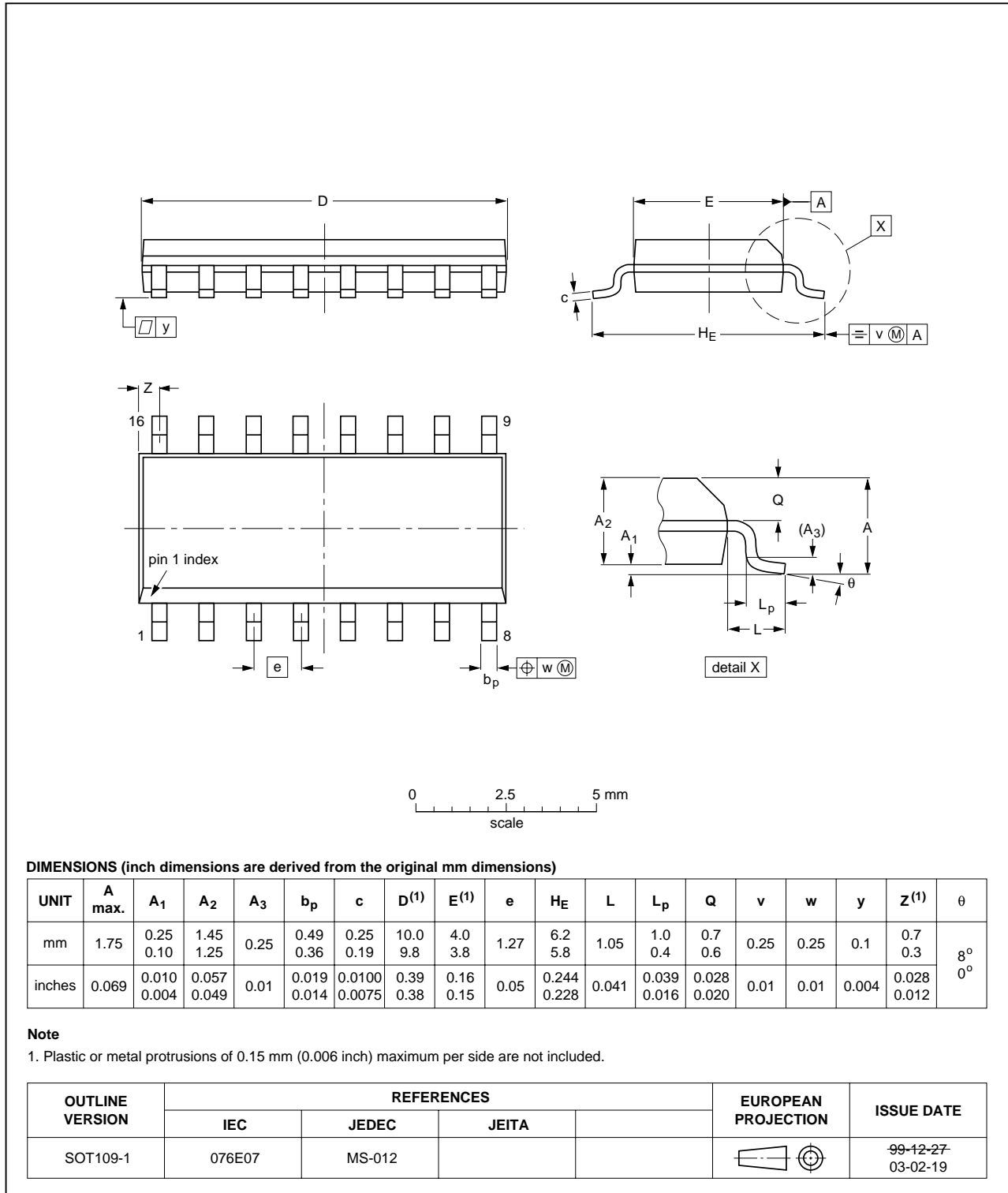


Fig 8. Package outline SOT109-1 (SO16)

## 14. Abbreviations

Table 11. Abbreviations

Acronym	Description
DUT	Device Under Test
ESD	ElectroStatic Discharge
HBM	Human Body Model
MM	Machine Model

## 15. Revision history

Table 12. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
HEF40098B_5	20081031	Product data sheet	-	HEF40098B_4
Modifications:	<ul style="list-style-type: none"> <li>• Maximum <math>T_{amb}</math> changed to 85 °C and <math>T_{amb} = 125</math> °C parameter data removed throughout the data sheet.</li> <li>• <a href="#">Section 1 "General description"</a> temperature range statement modified.</li> <li>• <a href="#">Section 10 "Static characteristics"</a> <math>I_i</math>, <math>I_{DD}</math> and <math>I_{OZ}</math> values updated.</li> </ul>			
HEF40098B_4	20080731	Product data sheet	-	HEF40098B_CNV_3
HEF40098B_CNV_3	19950101	Product specification	-	HEF40098B_CNV_2
HEF40098B_CNV_2	19950101	Product specification	-	-

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Document status <sup>[1][2]</sup>	Product status <sup>[3]</sup>	Definition
Objective [short] data sheet	Development	This document contains data from the objective specification for product development.
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Product [short] data sheet	Production	This document contains the product specification.

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[2] The term 'short data sheet' is explained in section "Definitions".

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