

# HEF4094B

## 8-stage shift-and-store bus register

Rev. 04 — 30 October 2008

Product data sheet

### 1. General description

The HEF4094B is an 8-stage serial shift register. It has a storage latch associated with each stage for strobing data from the serial input to parallel buffered 3-state outputs QP0 to QP7. The parallel outputs may be connected directly to common bus lines. Data is shifted on positive-going clock transitions. The data in each shift register stage is transferred to the storage register when the strobe (STR) input is HIGH. Data in the storage register appears at the outputs whenever the output enable (OE) signal is HIGH.

Two serial outputs (QS1 and QS2) are available for cascading a number of HEF4094B devices. Serial data is available at QS1 on positive-going clock edges to allow high-speed operation in cascaded systems with a fast clock rise time. The same serial data is available at QS2 on the next negative going clock edge. This is used for cascading HEF4094B devices when the clock has a slow rise time.

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 industrial ( $-40\text{ }^{\circ}\text{C}$  to  $+85\text{ }^{\circ}\text{C}$ ) and automotive ( $-40\text{ }^{\circ}\text{C}$  to  $+125\text{ }^{\circ}\text{C}$ ) temperature ranges.

### 2. Features

- Fully static operation
- 5 V, 10 V, and 15 V parametric ratings
- Standardized symmetrical output characteristics
- Operates across the automotive temperature range  $-40\text{ }^{\circ}\text{C}$  to  $+125\text{ }^{\circ}\text{C}$
- Complies with JEDEC standard JESD 13-B
- ESD protection:
  - ◆ HBM JESD22-A114E exceeds 2000 V
  - ◆ MM JESD22-A115-A exceeds 200 V

### 3. Ordering information

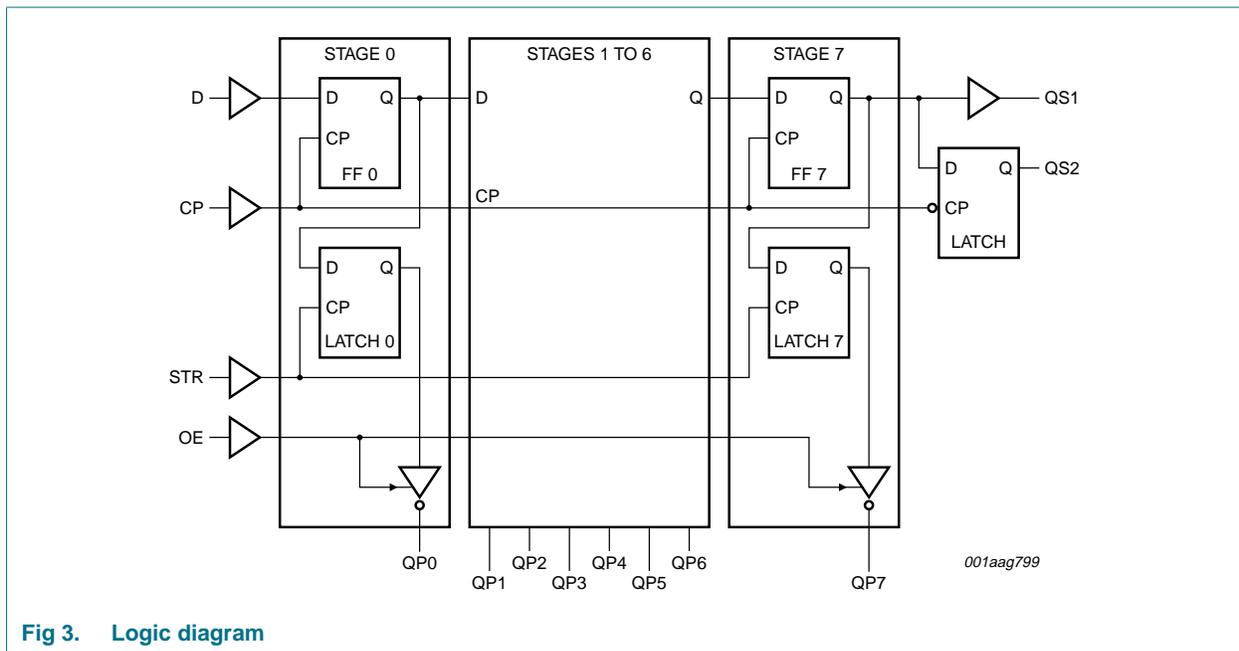
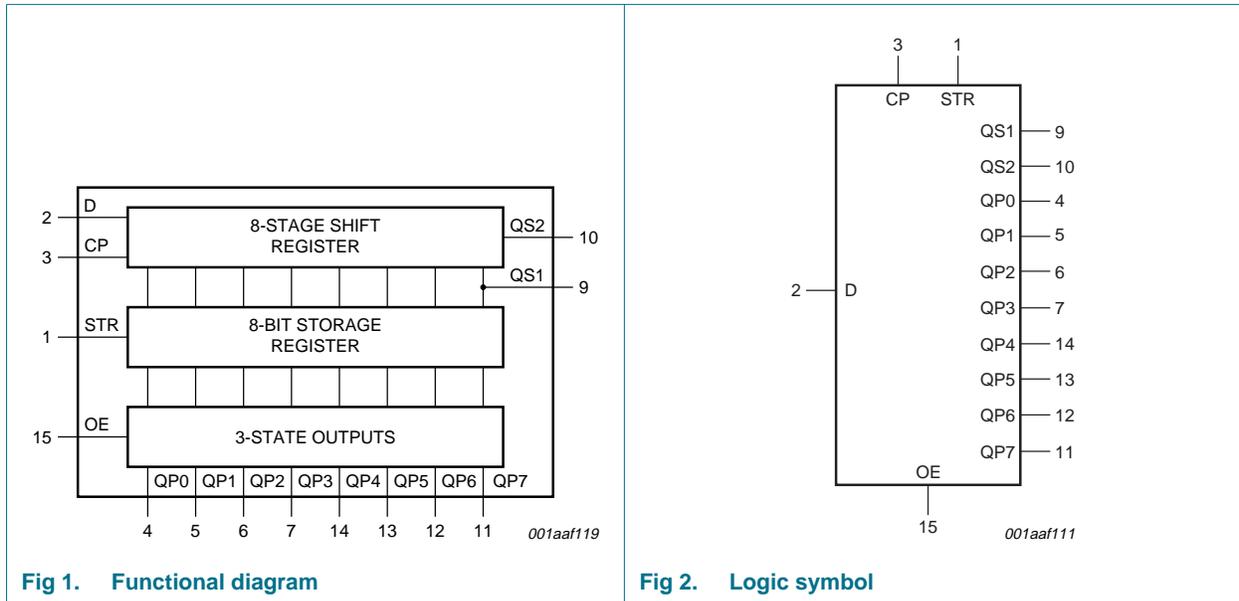
Table 1. Ordering information

All types operate from  $-40\text{ }^{\circ}\text{C}$  to  $+125\text{ }^{\circ}\text{C}$ .

Type number	Package		Version
	Name	Description	
HEF4094BP	DIP16	plastic dual in-line package; 16-leads (300 mil)	SOT38-4
HEF4094BT	SO16	plastic small outline package; 16 leads; body width 3.9 mm	SOT109-1
HEF4094BTS	SSOP16	plastic shrink small outline package; 16 leads; body width 5.3 mm	SOT338-1



4. Functional diagram



## 5. Pinning information

### 5.1 Pinning

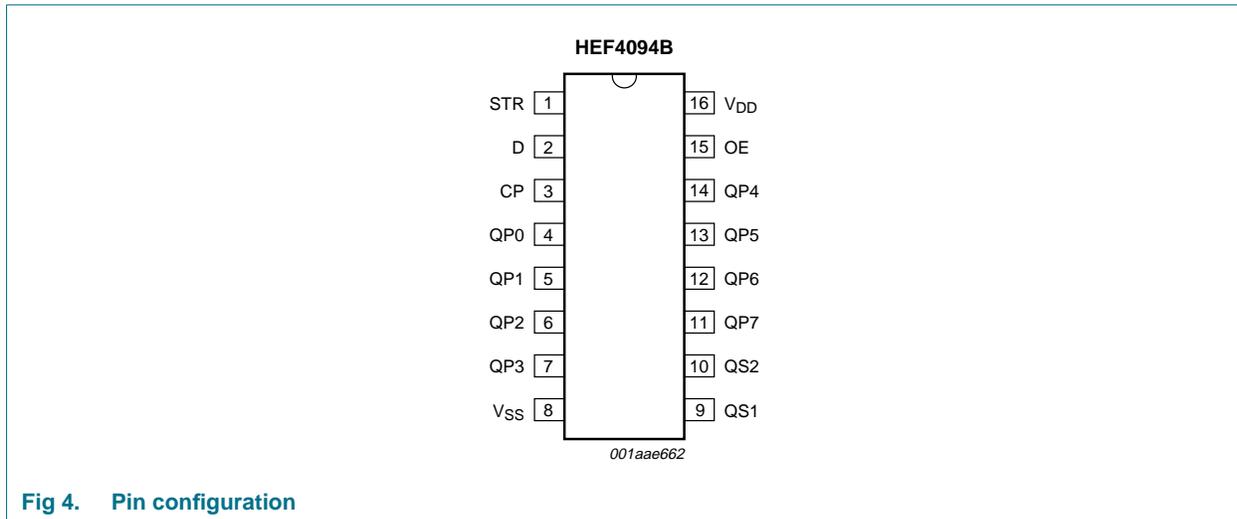


Fig 4. Pin configuration

### 5.2 Pin description

Table 2. Pin description

Symbol	Pin	Description
STR	1	strobe input
D	2	data input
CP	3	clock input
QP0 to QP7	4, 5, 6, 7, 14, 13, 12, 11	parallel output
V <sub>SS</sub>	8	ground supply voltage
QS1	9	serial output
QS2	10	serial output
OE	15	output enable input
V <sub>DD</sub>	16	supply voltage

## 6. Functional description

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

Inputs				Parallel outputs		Serial outputs	
CP	OE	STR	D	QP0	QPn	QS1	QS2
↑	L	X	X	Z	Z	Q6S	NC
↓	L	X	X	Z	Z	NC	Q7S
↑	H	L	X	NC	NC	QS6	NC
↑	H	H	L	L	QPn - 1	QS6	NC
↑	H	H	H	H	QPn - 1	QS6	NC

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

Inputs				Parallel outputs		Serial outputs	
CP	OE	STR	D	QP0	QPn	QS1	QS2
↓	H	H	H	NC	NC	NC	Q7S

- [1] At the positive clock edge, the information in the 7th register stage is transferred to the 8th register stage and the QSn outputs.  
 H = HIGH voltage level; L = LOW voltage level; X = don't care;  
 ↑ = positive-going transition; ↓ = negative-going transition;  
 Z = HIGH-impedance OFF-state; NC = no change;  
 Q6S = the data in register stage 6 before the LOW to HIGH clock transition;  
 Q7S = the data in register stage 7 before the HIGH to LOW clock transition.

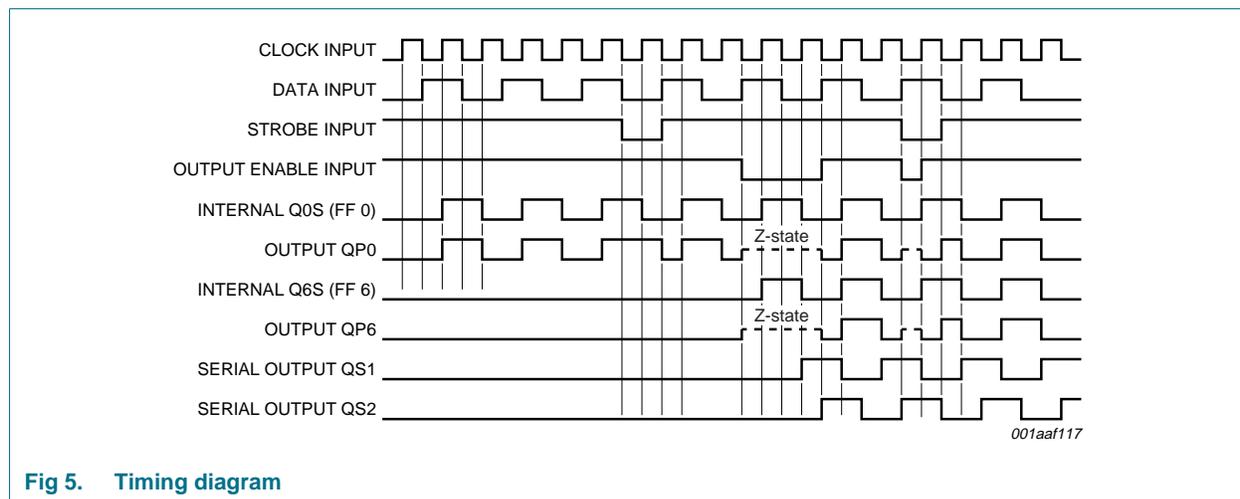


Fig 5. Timing diagram

## 7. Limiting values

Table 4. Limiting values

In accordance with the Absolute Maximum Rating System (IEC 60134). Voltages are referenced to  $V_{SS} = 0$  V (ground).

Symbol	Parameter	Conditions	Min	Max	Unit
$V_{DD}$	supply voltage		-0.5	+18	V
$I_{IK}$	input clamping current	$V_I < 0.5$ V or $V_I > V_{DD} + 0.5$ V	-	±10	mA
$V_I$	input voltage		-0.5	$V_{DD} + 0.5$	V
$I_{OK}$	output clamping current	$V_O < 0.5$ V or $V_O > V_{DD} + 0.5$ V	-	±10	mA
$I_{I/O}$	input/output current		-	±10	mA
$I_{DD}$	supply current		-	50	mA
$T_{stg}$	storage temperature		-65	+150	°C
$T_{amb}$	ambient temperature		-40	+125	°C
$P_{tot}$	total power dissipation	DIP16	[1]	750	mW
		SO16	[2]	500	mW
P	power dissipation	per output	-	100	mW

[1] For DIP16 packages: above  $T_{amb} = 70$  °C,  $P_{tot}$  derates linearly with 12 mW/K.

[2] For SO16 packages: above  $T_{amb} = 70$  °C,  $P_{tot}$  derates linearly with 8 mW/K.

## 8. 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	-	+125	°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

## 9. Static characteristics

**Table 6. Static characteristics**

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

Symbol	Parameter	Conditions	$V_{DD}$	$T_{amb} = -40\text{ °C}$		$T_{amb} = +25\text{ °C}$		$T_{amb} = +85\text{ °C}$		$T_{amb} = +125\text{ °C}$		Unit
				Min	Max	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	-	3.5	-	V
			10 V	7.0	-	7.0	-	7.0	-	7.0	-	V
			15 V	11.0	-	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	-	1.5	V
			10 V	-	3.0	-	3.0	-	3.0	-	3.0	V
			15 V	-	4.0	-	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	-	4.95	-	V
			10 V	9.95	-	9.95	-	9.95	-	9.95	-	V
			15 V	14.95	-	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	-	0.05	V
			10 V	-	0.05	-	0.05	-	0.05	-	0.05	V
			15 V	-	0.05	-	0.05	-	0.05	-	0.05	V
$I_{OH}$	HIGH-level output current	$V_O = 2.5\text{ V}$	5 V	-1.7	-	-1.4	-	-1.1	-	-1.1	-	mA
		$V_O = 4.6\text{ V}$	5 V	-0.64	-	-0.5	-	-0.36	-	-0.36	-	mA
		$V_O = 9.5\text{ V}$	10 V	-1.6	-	-1.3	-	-0.9	-	-0.9	-	mA
		$V_O = 13.5\text{ V}$	15 V	-4.2	-	-3.4	-	-2.4	-	-2.4	-	mA
$I_{OL}$	LOW-level output current	$V_O = 0.4\text{ V}$	5 V	0.64	-	0.5	-	0.36	-	0.36	-	mA
		$V_O = 0.5\text{ V}$	10 V	1.6	-	1.3	-	0.9	-	0.9	-	mA
		$V_O = 1.5\text{ V}$	15 V	4.2	-	3.4	-	2.4	-	2.4	-	mA
$I_{OZ}$	OFF-state output current	QPn output is HIGH; $V_O = 15\text{ V}$	15 V	-	0.4	-	0.4	-	12	-	12	$\mu\text{A}$
$I_I$	input leakage current		15 V	-	$\pm 0.1$	-	$\pm 0.1$	-	$\pm 1.0$	-	$\pm 1.0$	$\mu\text{A}$

**Table 6. Static characteristics ...continued**  
 $V_{SS} = 0\text{ V}$ ;  $V_I = V_{SS}$  or  $V_{DD}$ ; unless otherwise specified.

Symbol	Parameter	Conditions	V <sub>DD</sub>	T <sub>amb</sub> = -40 °C		T <sub>amb</sub> = +25 °C		T <sub>amb</sub> = +85 °C		T <sub>amb</sub> = +125 °C		Unit
				Min	Max	Min	Max	Min	Max	Min	Max	
I <sub>DD</sub>	supply current	all valid input combinations; I <sub>O</sub> = 0 A	5 V	-	5	-	5	-	150	-	150	μA
			10 V	-	10	-	10	-	300	-	300	μA
			15 V	-	20	-	20	-	600	-	600	μA
C <sub>I</sub>	input capacitance			-	-	-	7.5	-	-	-	-	pF

## 10. Dynamic characteristics

**Table 7. Dynamic characteristics**  
 $V_{SS} = 0\text{ V}$ ;  $T_{amb} = 25\text{ °C}$ ; for test circuit see [Figure 10](#); unless otherwise specified.

Symbol	Parameter	Conditions	V <sub>DD</sub>	Extrapolation formula	Min	Typ	Max	Unit		
t <sub>PHL</sub>	HIGH to LOW propagation delay	CP to QS1; see <a href="#">Figure 6</a>	5 V	<a href="#">[1]</a> 108 ns + (0.55 ns/pF) C <sub>L</sub>	-	135	270	ns		
			10 V	54 ns + (0.23 ns/pF) C <sub>L</sub>	-	65	130	ns		
			15 V	42 ns + (0.16 ns/pF) C <sub>L</sub>	-	50	100	ns		
		CP to QS2; see <a href="#">Figure 6</a>	5 V	78 ns + (0.55 ns/pF) C <sub>L</sub>	-	105	210	ns		
			10 V	39 ns + (0.23 ns/pF) C <sub>L</sub>	-	50	100	ns		
			15 V	32 ns + (0.16 ns/pF) C <sub>L</sub>	-	40	80	ns		
		CP to QPn; see <a href="#">Figure 6</a>	5 V	138 ns + (0.55 ns/pF) C <sub>L</sub>	-	165	330	ns		
			10 V	64 ns + (0.23 ns/pF) C <sub>L</sub>	-	75	150	ns		
			15 V	47 ns + (0.16 ns/pF) C <sub>L</sub>	-	55	110	ns		
		STR to QPn; see <a href="#">Figure 7</a>	5 V	83 ns + (0.55 ns/pF) C <sub>L</sub>	-	110	220	ns		
			10 V	39 ns + (0.23 ns/pF) C <sub>L</sub>	-	50	100	ns		
			15 V	27 ns + (0.16 ns/pF) C <sub>L</sub>	-	35	70	ns		
		t <sub>PLH</sub>	LOW to HIGH propagation delay,	CP to QS1; see <a href="#">Figure 6</a>	5 V	<a href="#">[1]</a> 78 ns + (0.55 ns/pF) C <sub>L</sub>	-	105	210	ns
					10 V	39 ns + (0.23 ns/pF) C <sub>L</sub>	-	50	100	ns
					15 V	32 ns + (0.16 ns/pF) C <sub>L</sub>	-	40	80	ns
CP to QS2; see <a href="#">Figure 6</a>	5 V			78 ns + (0.55 ns/pF) C <sub>L</sub>	-	105	210	ns		
	10 V			39 ns + (0.23 ns/pF) C <sub>L</sub>	-	50	100	ns		
	15 V			32 ns + (0.16 ns/pF) C <sub>L</sub>	-	40	80	ns		
CP to QPn; see <a href="#">Figure 6</a>	5 V			123 ns + (0.55 ns/pF) C <sub>L</sub>	-	150	300	ns		
	10 V			59 ns + (0.23 ns/pF) C <sub>L</sub>	-	70	140	ns		
	15 V			47 ns + (0.16 ns/pF) C <sub>L</sub>	-	55	110	ns		
STR to QPn; see <a href="#">Figure 7</a>	5 V			73 ns + (0.55 ns/pF) C <sub>L</sub>	-	100	200	ns		
	10 V			34 ns + (0.23 ns/pF) C <sub>L</sub>	-	45	90	ns		
	15 V			27 ns + (0.16 ns/pF) C <sub>L</sub>	-	35	70	ns		
t <sub>t</sub>	transition time			5 V	<a href="#">[1]</a> 10 ns + (1.00 ns/pF) C <sub>L</sub>	-	60	120	ns	
				10 V	9 ns + (0.42 ns/pF) C <sub>L</sub>	-	30	60	ns	
				15 V	6 ns + (0.28 ns/pF) C <sub>L</sub>	-	20	40	ns	

**Table 7. Dynamic characteristics ...continued**

$V_{SS} = 0\text{ V}$ ;  $T_{amb} = 25\text{ }^\circ\text{C}$ ; for test circuit see [Figure 10](#); unless otherwise specified.

Symbol	Parameter	Conditions	V <sub>DD</sub>	Extrapolation formula	Min	Typ	Max	Unit
t <sub>PZH</sub>	OFF-state to HIGH propagation delay	OE to QPn; see <a href="#">Figure 8</a>	5 V		-	40	80	MHz
			10 V		-	25	50	MHz
			15 V		-	20	40	MHz
t <sub>PZL</sub>	OFF-state to LOW propagation delay	OE to QPn; see <a href="#">Figure 8</a>	5 V		-	40	80	MHz
			10 V		-	25	50	MHz
			15 V		-	20	40	MHz
t <sub>PHZ</sub>	HIGH to OFF-state propagation delay	OE to QPn; see <a href="#">Figure 8</a>	5 V		-	75	150	MHz
			10 V		-	40	80	MHz
			15 V		-	30	60	MHz
t <sub>PLZ</sub>	LOW to OFF-state propagation delay	OE to QPn; see <a href="#">Figure 8</a>	5 V		-	80	160	MHz
			10 V		-	40	80	MHz
			15 V		-	30	60	MHz
t <sub>su</sub>	set-up time	D to CP; see <a href="#">Figure 9</a>	5 V		60	30	-	ns
			10 V		20	10	-	ns
			15 V		15	5	-	ns
t <sub>h</sub>	hold time	D to CP; see <a href="#">Figure 9</a>	5 V		+5	-15	-	ns
			10 V		20	5	-	ns
			15 V		20	5	-	ns
t <sub>w</sub>	pulse width	minimum LOW clock pulse; see <a href="#">Figure 6</a>	5 V		60	30	-	ns
			10 V		30	15	-	ns
			15 V		24	12	-	ns
		minimum HIGH strobe pulse; see <a href="#">Figure 7</a>	5 V		40	20	-	ns
			10 V		30	15	-	ns
			15 V		24	12	-	ns
f <sub>max</sub>	maximum frequency	see <a href="#">Figure 6</a>	5 V		5	10	-	MHz
			10 V		11	22	-	MHz
			15 V		14	28	-	MHz

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

**Table 8. Dynamic power dissipation**

$V_{SS} = 0\text{ V}$ ;  $t_r = t_f \leq 20\text{ ns}$ ;  $T_{amb} = 25\text{ }^\circ\text{C}$ .

Symbol	Parameter	V <sub>DD</sub>	Typical formula for P <sub>D</sub> (μW)	where:
P <sub>D</sub>	dynamic power dissipation	5 V	$P_D = 2100 \times f_i + \Sigma(f_o \times C_L) \times V_{DD}^2$	f <sub>i</sub> = input frequency in MHz,
		10 V	$P_D = 9700 \times f_i + \Sigma(f_o \times C_L) \times V_{DD}^2$	f <sub>o</sub> = output frequency in MHz,
		15 V	$P_D = 26000 \times f_i + \Sigma(f_o \times C_L) \times V_{DD}^2$	C <sub>L</sub> = output load capacitance in pF, V <sub>DD</sub> = supply voltage in V, Σ(C <sub>L</sub> × f <sub>o</sub> ) = sum of the outputs.

11. Waveforms

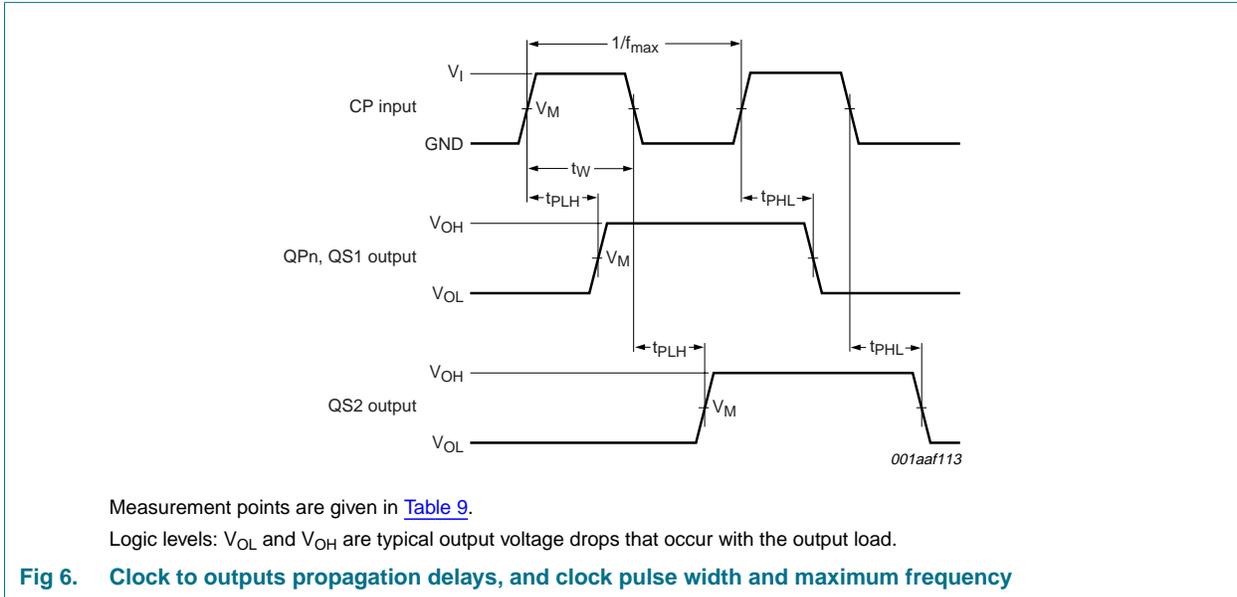
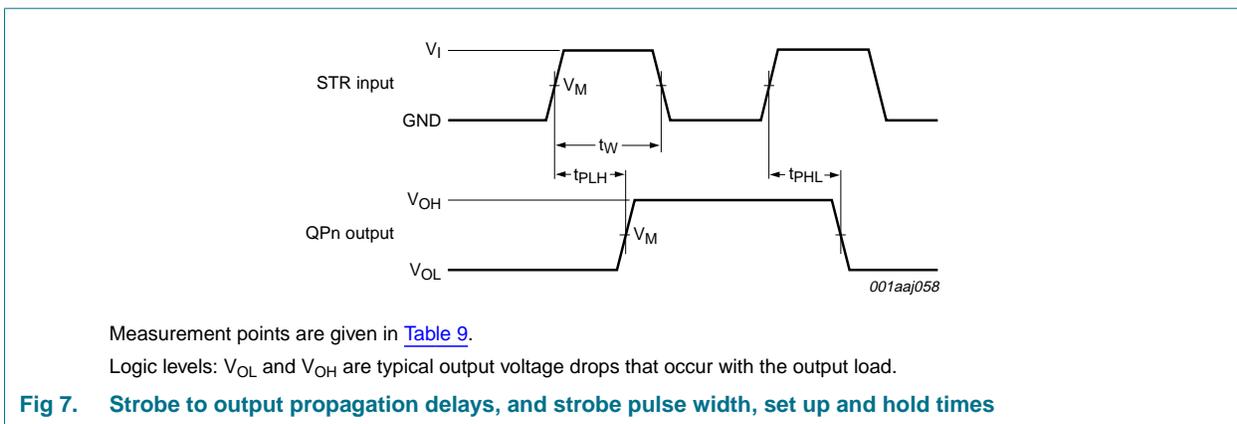


Table 9. Measurement points

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





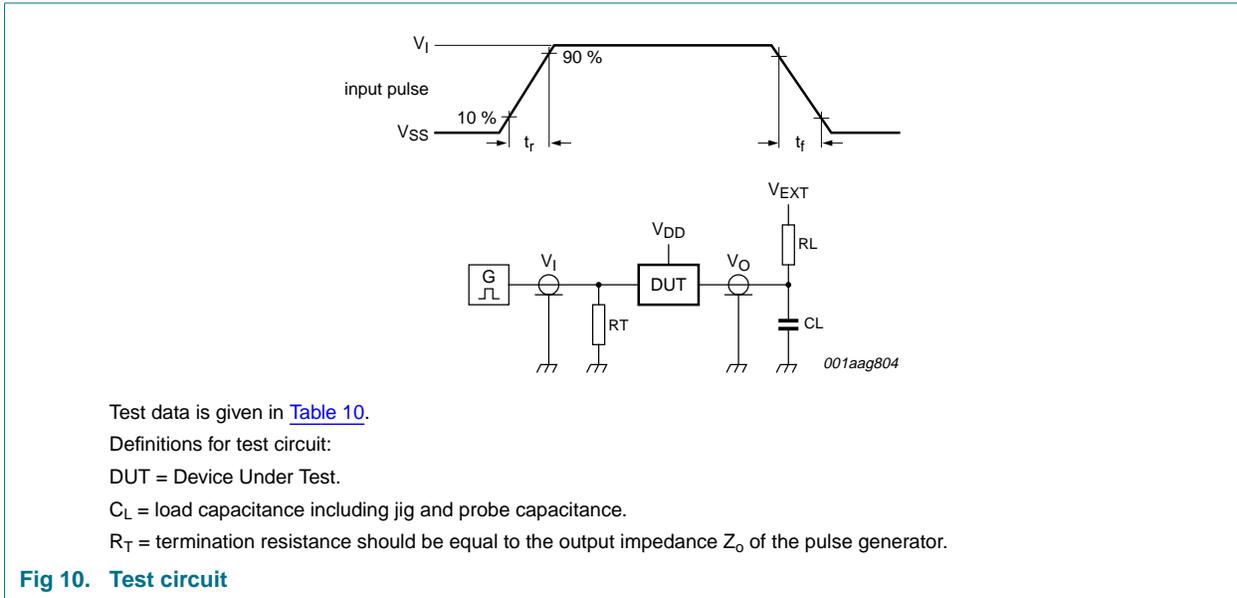


Table 10. Test data

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

## 12. Application information

Some examples of applications for the HEF4094B are:

- Serial-to-parallel data conversion
- Remote control holding register

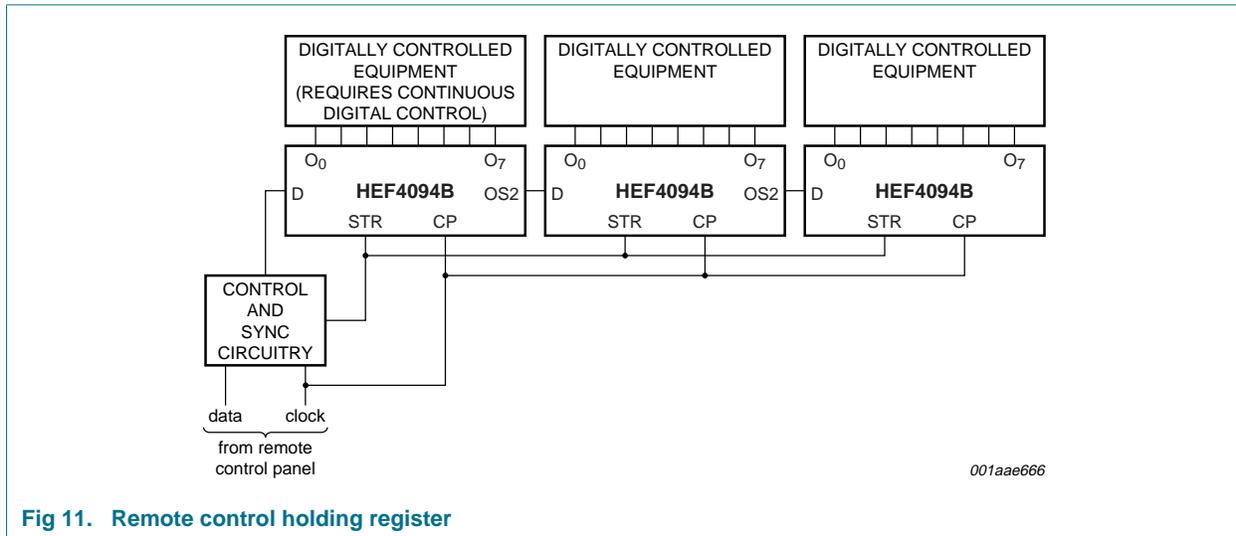


Fig 11. Remote control holding register

13. Package outline

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

SOT38-4

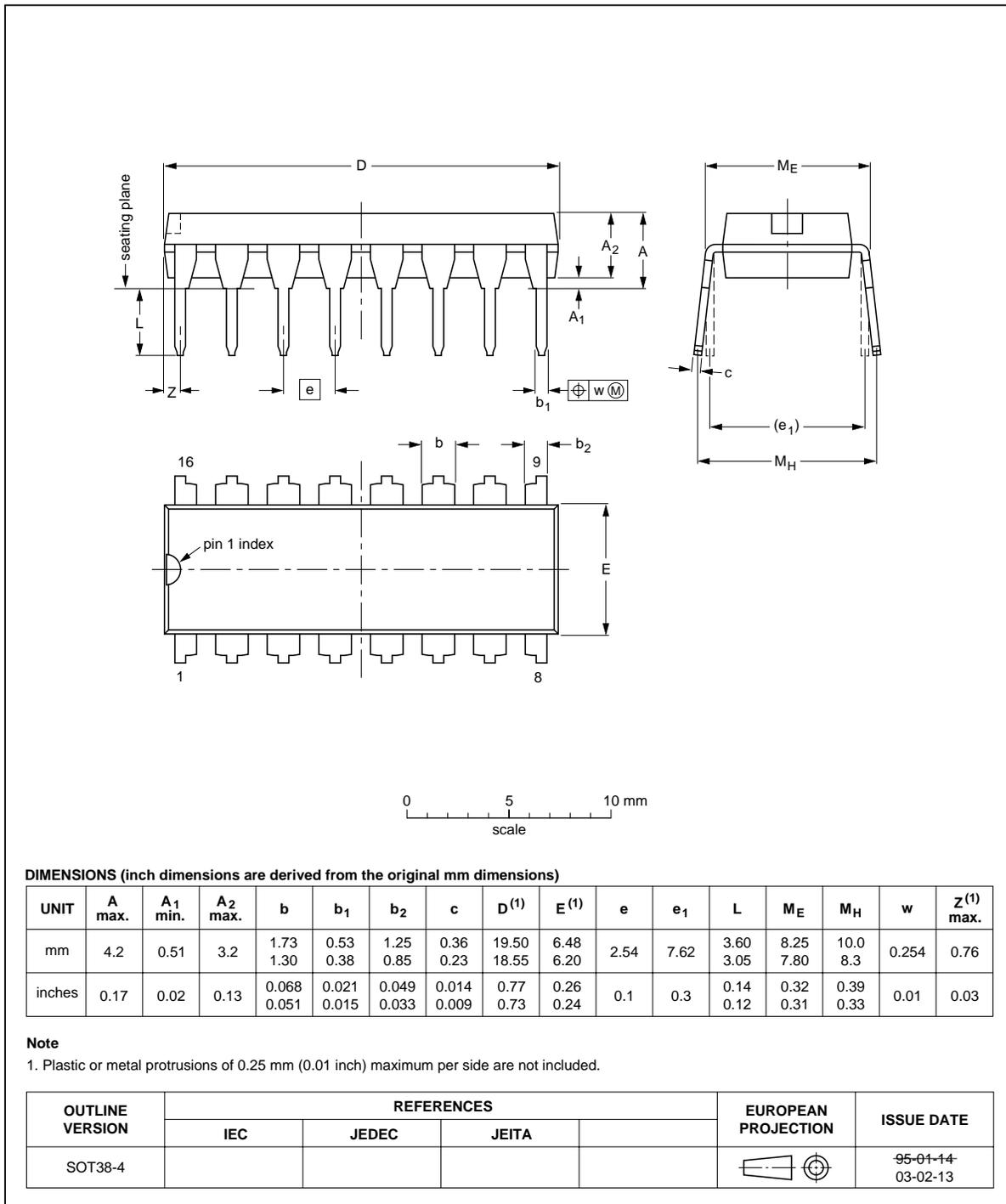


Fig 12. Package outline SOT38-4 (DIP16)

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

SOT109-1

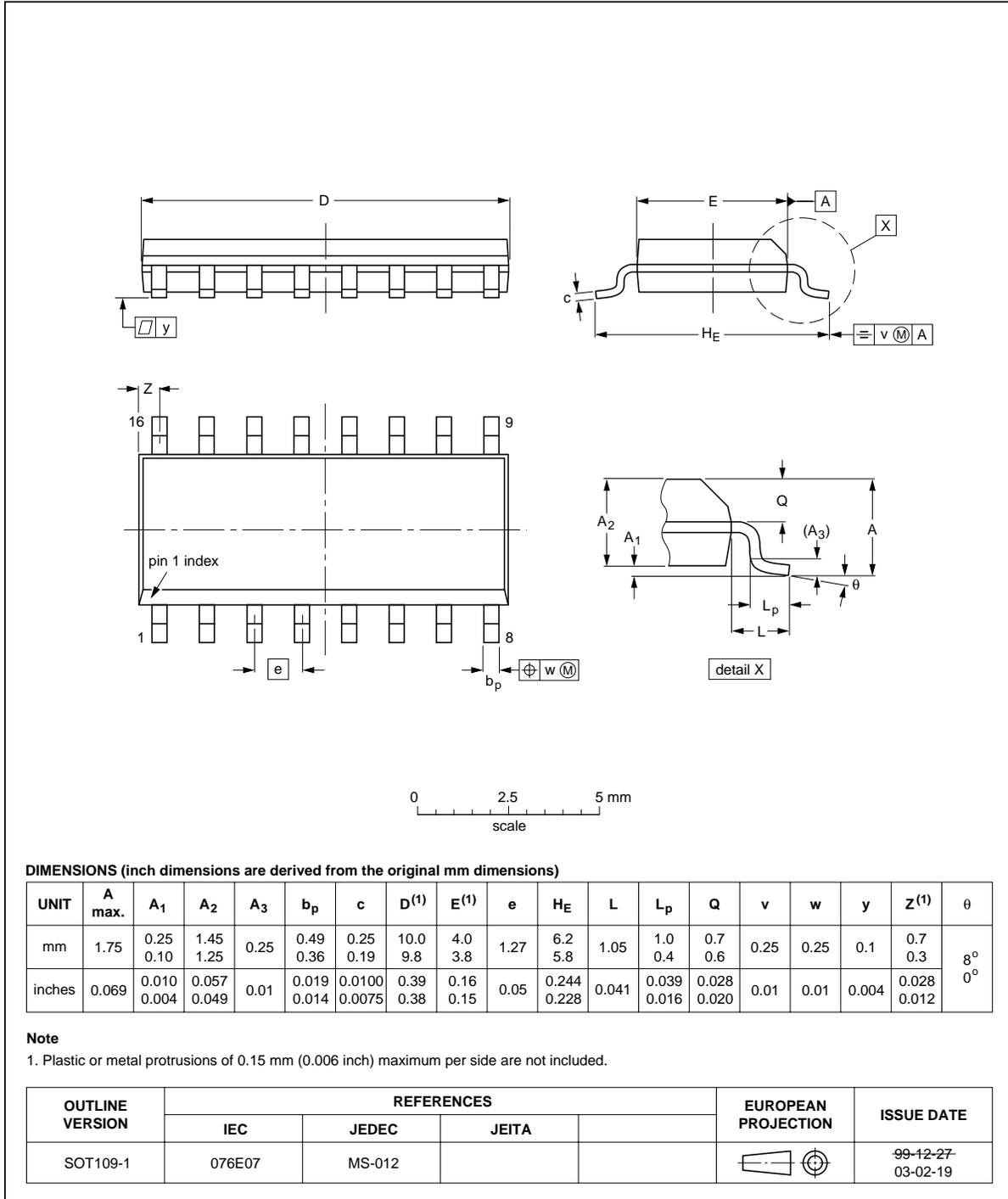


Fig 13. Package outline SOT109-1 (SO16)

SSOP16: plastic shrink small outline package; 16 leads; body width 5.3 mm

SOT338-1

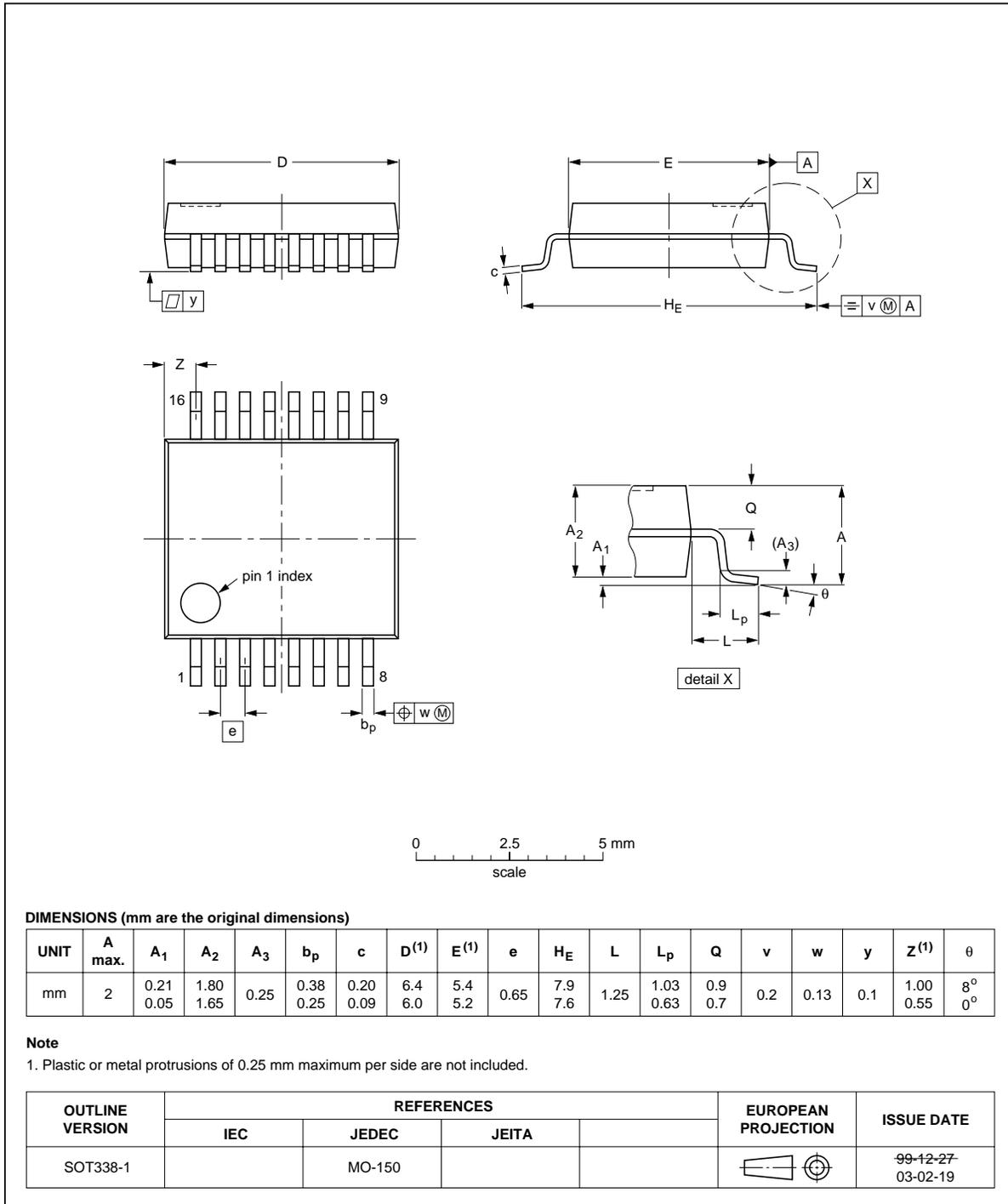


Fig 14. Package outline SOT338-1 (SSOP16)

## 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
HEF4094B_4	20081030	Product data sheet	-	HEF4094B_CNV_3
Modifications:	<ul style="list-style-type: none"> <li>The format of this data sheet has been redesigned to comply with the new identity guidelines of NXP Semiconductors.</li> <li>Legal texts have been adapted to the new company name where appropriate.</li> <li>Temperature range maximum value increased from 85 °C to 125 °C.</li> <li><a href="#">Section 2 "Features"</a> added.</li> <li>Package version SOT38-1 changed to SOT38-4 in <a href="#">Section 3</a>, and <a href="#">Figure 12</a>. Package SOT74 removed from <a href="#">Section 3</a>. Package SOT338-1 added to <a href="#">Section 3</a>, and <a href="#">Figure 14</a>.</li> <li><a href="#">Section 7 "Limiting values"</a> and <a href="#">Section 9 "Static characteristics"</a> added, taken from the HE4000B Family Specifications data sheet.</li> <li><a href="#">Section 9 "Static characteristics"</a> <math>I_{OH}</math>, <math>I_{OL}</math>, <math>I_I</math> and <math>I_{DD}</math> values updated.</li> <li><a href="#">Section 14 "Abbreviations"</a> added.</li> </ul>			
HEF4094B_CNV_3	19950101	Product specification	-	HEF4094B_CNV_2
HEF4094B_CNV_2	19950101	Product specification	-	-

## 16. Legal information

### 16.1 Data sheet status

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.
Preliminary [short] data sheet	Qualification	This document contains data from the preliminary specification.
Product [short] data sheet	Production	This document contains the product specification.

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

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

[3] The product status of device(s) described in this document may have changed since this document was published and may differ in case of multiple devices. The latest product status information is available on the Internet at URL <http://www.nxp.com>.

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