

# HEF4104B

## Quad low-to-high voltage translator with 3-state outputs

Rev. 07 — 16 December 2009

Product data sheet

### 1. General description

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The HEF4104B is a quad low voltage-to-high voltage translator with 3-state outputs. It provides the capability of interfacing low voltage circuits to high voltage circuits. For example low voltage Local Oxidation Complementary MOS (LOCMOS) and Transistor Transistor Logic (TTL) to high voltage LOCMOS. It has four data inputs (A0 to A3), an active HIGH output enable input (OE), four data outputs (B0 to B3) and their complements ( $\bar{B}0$  to  $\bar{B}3$ ).

With OE = HIGH, the outputs B0 to B3 and  $\bar{B}0$  to  $\bar{B}3$  are in the low impedance ON-state, either HIGH or LOW as determined by the inputs A0 to A3. With OE = LOW, the outputs B0 to B3 and  $\bar{B}0$  to  $\bar{B}3$  are in the high-impedance OFF-state.

It uses a common negative supply ( $V_{SS}$ ) and separate positive supplies for the inputs ( $V_{DD(A)}$ ) and the outputs ( $V_{DD(B)}$ ).  $V_{DD(A)}$  must always be less than or equal to  $V_{DD(B)}$ , even during power turn-on and turn-off. For the permissible operating range of  $V_{DD(A)}$  and  $V_{DD(B)}$  see [Figure 4](#).

Each input protection circuit is terminated between  $V_{DD(B)}$  and  $V_{SS}$ . This allows the input signals to be driven from any potential between  $V_{DD(B)}$  and  $V_{SS}$ , without regard to current limiting. When driving from potentials greater than  $V_{DD(B)}$  or less than  $V_{SS}$ , the current at each input must be limited to 10 mA.

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

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- Fully static operation
- 5 V, 10 V, and 15 V parametric ratings
- Standardized symmetrical output characteristics
- Inputs and outputs are protected against electrostatic effects
- Operates across the full industrial temperature range from  $-40\text{ }^{\circ}\text{C}$  to  $+85\text{ }^{\circ}\text{C}$
- Complies with JEDEC standard JESD 13-B

### 3. Applications

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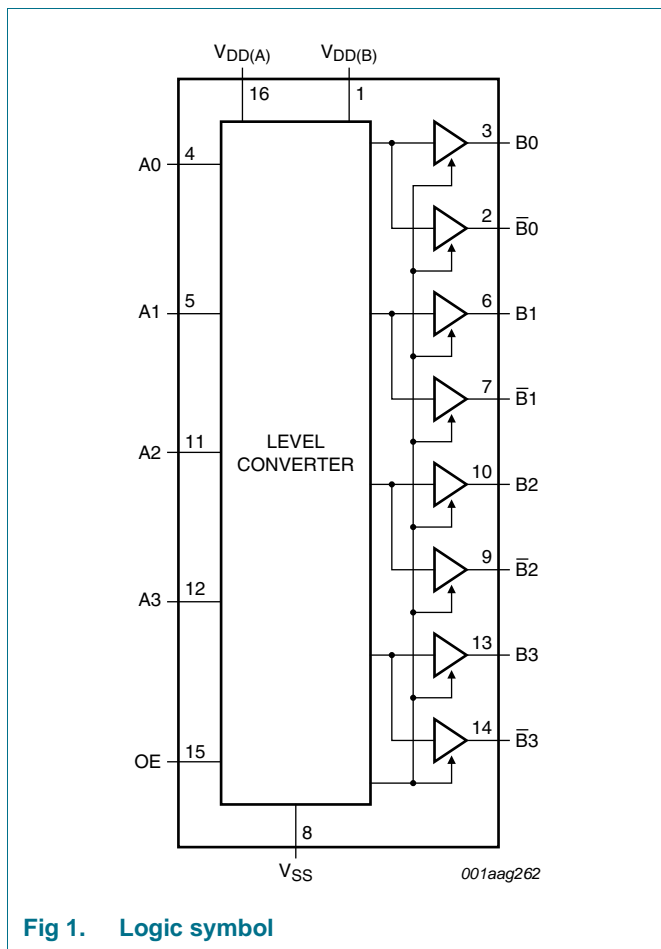
- Industrial

### 4. Ordering information

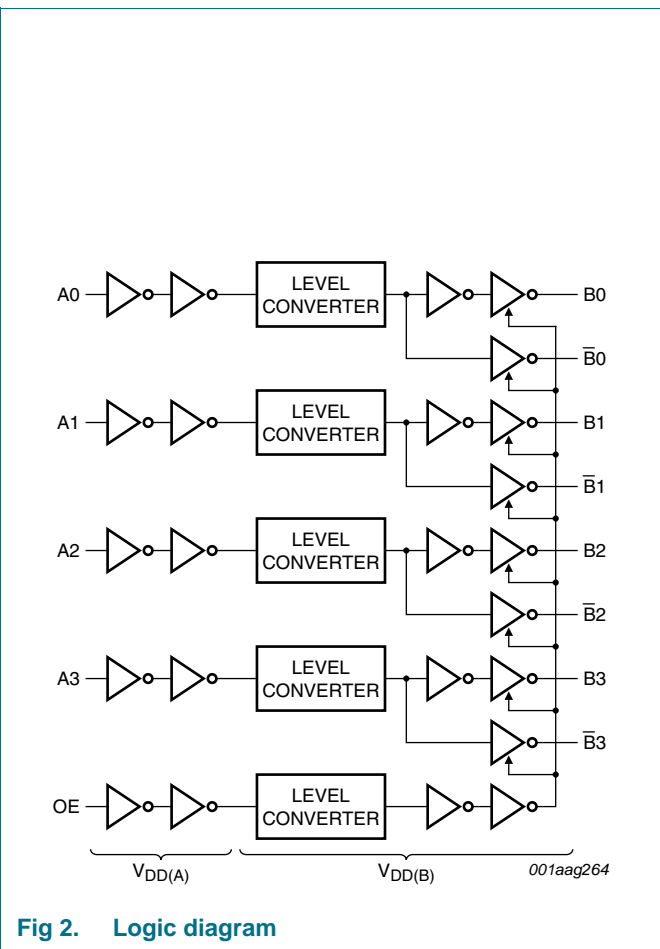
**Table 1. Ordering information**  
All types operate from  $-40\text{ }^{\circ}\text{C}$  to  $+85\text{ }^{\circ}\text{C}$ .

Type number	Package		Version
	Name	Description	
HEF4104BP	DIP16	plastic dual in-line package; 16 leads (300 mil)	SOT38-4
HEF4104BT	SO16	plastic small outline package; 16 leads; body width 3.9 mm	SOT109-1

### 5. Functional diagram



**Fig 1. Logic symbol**



**Fig 2. Logic diagram**

## 6. Pinning information

### 6.1 Pinning

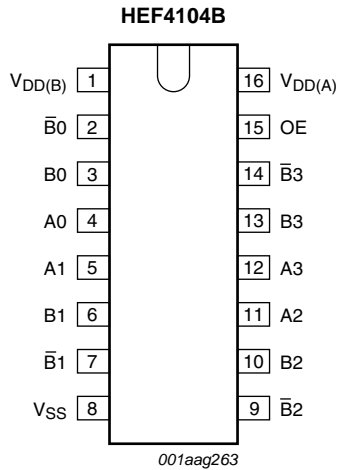


Fig 3. Pin configuration

### 6.2 Pin description

Table 2. Pin description

Symbol	Pin	Description
$V_{DD(B)}$	1	supply voltage port B
$\bar{B}0$ to $\bar{B}3$	2, 7, 9, 14	complementary data output
B0 to B3	3, 6, 10, 13	data output
A0 to A3	4, 5, 11, 12	data input
$V_{SS}$	8	common negative supply voltage (0 V)
OE	15	output enable input
$V_{DD(A)}$	16	supply voltage port A

## 7. Functional description

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

Control	Output	
OE	$B_n$	$\bar{B}_n$
H	$A_n$	$\bar{A}_n$
L	Z	Z

[1] H = HIGH voltage level; L = LOW voltage level; Z = high-impedance OFF-state.

## 8. 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
$V_{DD(A)}$	supply voltage A	port A; $V_{DD(A)} \leq V_{DD(B)}$	-0.5	+18	V
$V_{DD(B)}$	supply voltage B	port B; $V_{DD(B)} \geq V_{DD(A)}$	-0.5	+18	V
$I_{IK}$	input clamping current	$V_I < -0.5$ V or $V_I > V_{DD(A)} + 0.5$ V	-	$\pm 10$	mA
$V_I$	input voltage		-0.5	$V_{DD(A)} + 0.5$	V
$I_{OK}$	output clamping current	$V_O < -0.5$ V or $V_O > V_{DD(B)} + 0.5$ V	-	$\pm 10$	mA
$I_{I/O}$	input/output current		-	$\pm 10$	mA
$I_{DD}$	supply current		[1] -	50	mA
$T_{stg}$	storage temperature		-65	+150	°C
$T_{amb}$	ambient temperature		-40	+85	°C
$P_{tot}$	total power dissipation	$T_{amb} = -40$ °C to +85 °C			
		DIP16	[2] -	750	mW
		SO16	[3] -	500	mW
P	power dissipation	per output	-	100	mW

[1]  $I_{DD}$  is the combined current of  $I_{DD(A)}$  and  $I_{DD(B)}$ .

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

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

## 9. Recommended operating conditions

**Table 5. Recommended operating conditions**

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

## 10. Static characteristics

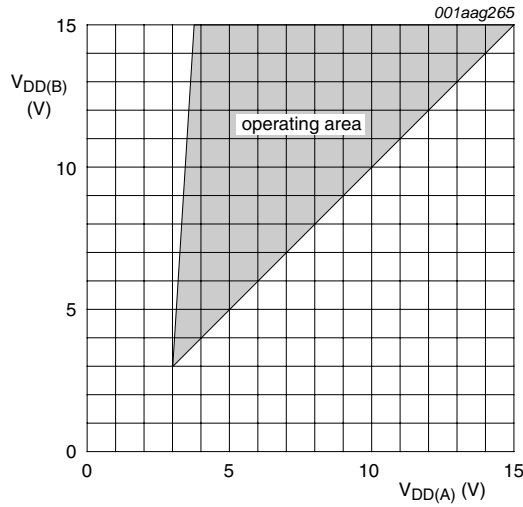
**Table 6. Static characteristics**

$V_{DD(A)} = V_{DD(B)}$ ;  $V_{SS} = 0$  V;  $V_I = V_{SS}$  or  $V_{DD(A)}$ ; unless otherwise specified.

Symbol	Parameter	Conditions	$V_{DD}$ <sup>[1]</sup>	$T_{amb} = -40$ °C		$T_{amb} = +25$ °C		$T_{amb} = +85$ °C		Unit	
				Min	Max	Min	Max	Min	Max		
$V_{IH}$	HIGH-level input voltage	$ I_O  < 1$ $\mu$ 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$ $\mu$ 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$ $\mu$ 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$ $\mu$ 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	$V_O = 2.5$ V	5 V	-1.7	-	-1.4	-	-1.1	-	mA	
		$V_O = 4.6$ V	5 V	-0.52	-	-0.44	-	-0.36	-	mA	
		$V_O = 9.5$ V	10 V	-1.3	-	-1.1	-	-0.9	-	mA	
		$V_O = 13.5$ V	15 V	-3.6	-	-3.0	-	-2.4	-	mA	
$I_{OL}$	LOW-level output current	$V_O = 0.4$ V	5 V	0.52	-	0.44	-	0.36	-	mA	
		$V_O = 0.5$ V	10 V	1.3	-	1.1	-	0.9	-	mA	
		$V_O = 1.5$ V	15 V	3.6	-	3.0	-	2.4	-	mA	
$I_I$	input leakage current		15 V	-	$\pm 0.3$	-	$\pm 0.3$	-	$\pm 1.0$	$\mu$ A	
$I_{DD}$	supply current	all valid input combinations; $I_O = 0$ A	5 V	<sup>[2]</sup>	-	20	-	20	-	150	$\mu$ A
			10 V	-	40	-	40	-	300	$\mu$ A	
			15 V	-	80	-	80	-	600	$\mu$ A	
$I_{OZ}$	OFF-state output current	HIGH level; $V_O = V_{DD(B)}$	15 V	-	1.6	-	1.6	-	12.0	$\mu$ A	
		LOW level; $V_O = V_{SS}$	15 V	-	-1.6	-	-1.6	-	-12.0	$\mu$ A	
$C_I$	input capacitance	digital inputs	-	-	-	-	7.5	-	-	pF	

[1]  $V_{DD}$  is the same as  $V_{DD(A)}$  and  $V_{DD(B)}$ .

[2]  $I_{DD}$  is the combined current of  $I_{DD(A)}$  and  $I_{DD(B)}$ .



The shaded area shows the permissible operating range.

Fig 4.  $V_{DD(B)}$  as a function of  $V_{DD(A)}$

## 11. Dynamic characteristics

Table 7. Dynamic characteristics

$T_{amb} = 25\text{ }^{\circ}\text{C}$ ; for test circuit see [Figure 7](#); unless otherwise specified.

Symbol	Parameter	Conditions	Extrapolation formula <sup>[1]</sup>	Min	Typ	Max	Unit
$t_{PHL}$	HIGH to LOW propagation delay	An to Bn, $\overline{Bn}$ ; see <a href="#">Figure 5</a>					
		$V_{DD(A)} = V_{DD(B)} = 5\text{ V}$	$143\text{ ns} + (0.55\text{ ns/pF})C_L$	-	170	340	ns
		$V_{DD(A)} = V_{DD(B)} = 10\text{ V}$	$69\text{ ns} + (0.23\text{ ns/pF})C_L$	-	80	160	ns
		$V_{DD(A)} = V_{DD(B)} = 15\text{ V}$	$57\text{ ns} + (0.16\text{ ns/pF})C_L$	-	65	135	ns
$t_{PLH}$	LOW to HIGH propagation delay	An to Bn, $\overline{Bn}$ ; see <a href="#">Figure 5</a>					
		$V_{DD(A)} = V_{DD(B)} = 5\text{ V}$	$143\text{ ns} + (0.55\text{ ns/pF})C_L$	-	170	340	ns
		$V_{DD(A)} = V_{DD(B)} = 10\text{ V}$	$69\text{ ns} + (0.23\text{ ns/pF})C_L$	-	80	160	ns
		$V_{DD(A)} = V_{DD(B)} = 15\text{ V}$	$62\text{ ns} + (0.16\text{ ns/pF})C_L$	-	70	140	ns
$t_{THL}$	HIGH to LOW output transition time	Bn or $\overline{Bn}$ ; see <a href="#">Figure 6</a>					
		$V_{DD(A)} = V_{DD(B)} = 5\text{ V}$	$10\text{ ns} + (1.00\text{ ns/pF})C_L$	-	60	120	ns
		$V_{DD(A)} = V_{DD(B)} = 10\text{ V}$	$9\text{ ns} + (0.42\text{ ns/pF})C_L$	-	30	60	ns
		$V_{DD(A)} = V_{DD(B)} = 15\text{ V}$	$6\text{ ns} + (0.28\text{ ns/pF})C_L$	-	20	40	ns
$t_{TLH}$	LOW to HIGH output transition time	Bn or $\overline{Bn}$ ; see <a href="#">Figure 6</a>					
		$V_{DD(A)} = V_{DD(B)} = 5\text{ V}$	$10\text{ ns} + (1.00\text{ ns/pF})C_L$	-	60	120	ns
		$V_{DD(A)} = V_{DD(B)} = 10\text{ V}$	$9\text{ ns} + (0.42\text{ ns/pF})C_L$	-	30	60	ns
		$V_{DD(A)} = V_{DD(B)} = 15\text{ V}$	$6\text{ ns} + (0.28\text{ ns/pF})C_L$	-	20	40	ns
$t_{PHZ}$	HIGH to OFF-state propagation delay	OE to Bn, $\overline{Bn}$ ; see <a href="#">Figure 6</a>					
		$V_{DD(A)} = V_{DD(B)} = 5\text{ V}$		-	70	135	ns
		$V_{DD(A)} = V_{DD(B)} = 10\text{ V}$		-	55	110	ns
		$V_{DD(A)} = V_{DD(B)} = 15\text{ V}$		-	60	120	ns

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

$T_{amb} = 25\text{ }^{\circ}\text{C}$ ; for test circuit see [Figure 7](#); unless otherwise specified.

Symbol	Parameter	Conditions	Extrapolation formula <sup>[1]</sup>	Min	Typ	Max	Unit
t <sub>PLZ</sub>	LOW to OFF-state propagation delay	OE to Bn, $\overline{\text{Bn}}$ ; see <a href="#">Figure 6</a>					
		$V_{DD(A)} = V_{DD(B)} = 5\text{ V}$		-	70	135	ns
		$V_{DD(A)} = V_{DD(B)} = 10\text{ V}$		-	55	105	ns
		$V_{DD(A)} = V_{DD(B)} = 15\text{ V}$		-	55	110	ns
t <sub>PZH</sub>	OFF-state to HIGH propagation delay	OE to Bn, $\overline{\text{Bn}}$ ; see <a href="#">Figure 6</a>					
		$V_{DD(A)} = V_{DD(B)} = 5\text{ V}$		-	195	395	ns
		$V_{DD(A)} = V_{DD(B)} = 10\text{ V}$		-	95	195	ns
		$V_{DD(A)} = V_{DD(B)} = 15\text{ V}$		-	80	165	ns
t <sub>PZL</sub>	OFF-state to LOW propagation delay	OE to Bn, $\overline{\text{Bn}}$ ; see <a href="#">Figure 6</a>					
		$V_{DD(A)} = V_{DD(B)} = 5\text{ V}$		-	195	395	ns
		$V_{DD(A)} = V_{DD(B)} = 10\text{ V}$		-	95	190	ns
		$V_{DD(A)} = V_{DD(B)} = 15\text{ V}$		-	80	160	ns

[1] Typical value of the propagation delay and output transition time can be calculated with the extrapolation formula ( $C_L$  in pF).

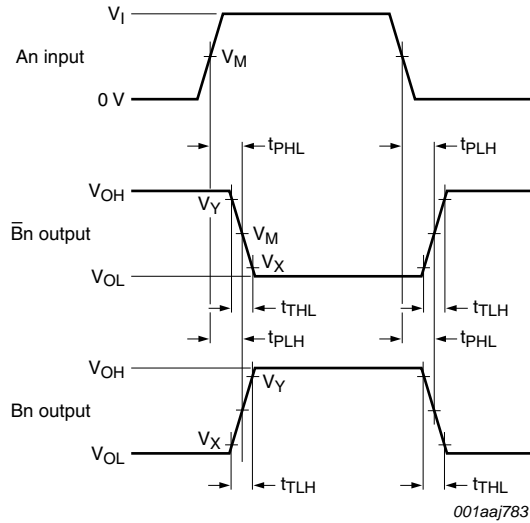
**Table 8. Dynamic power dissipation**

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

Symbol	Parameter	$V_{DD}$ <sup>[1]</sup>	Typical formula ( $\mu\text{W}$ )	where
P <sub>D</sub>	dynamic power dissipation	5 V	$P_D = 3000 \times f_i + \Sigma(f_o \times C_L) \times V_{DD}^2$	$f_i$ = input frequency in MHz;
		10 V	$P_D = 12200 \times f_i + \Sigma(f_o \times C_L) \times V_{DD}^2$	$f_o$ = output frequency in MHz;
		15 V	$P_D = 31000 \times f_i + \Sigma(f_o \times C_L) \times V_{DD}^2$	$C_L$ = output load capacitance in pF;
				$\Sigma(f_o \times C_L)$ = sum of the outputs;
				$V_{DD}$ = supply voltage in V.

[1]  $V_{DD}$  is the same as  $V_{DD(A)}$  and  $V_{DD(B)}$ .

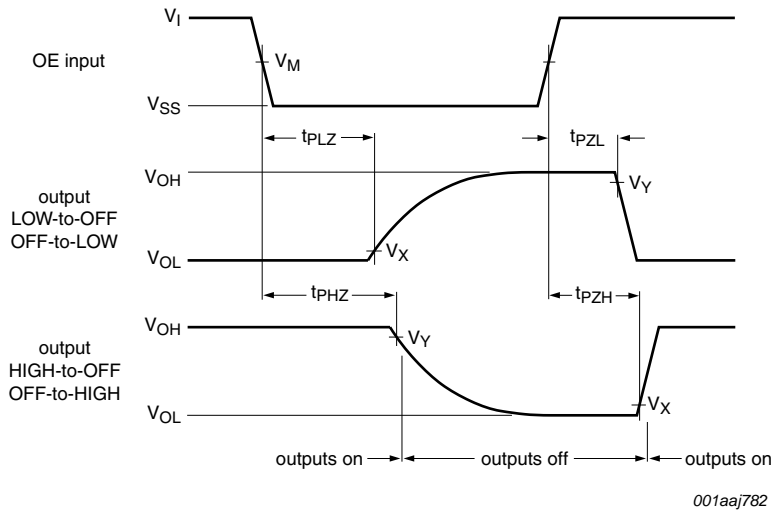
12. Waveforms



Measurement points are given in [Table 9](#).

Logic levels:  $V_{OL}$  and  $V_{OH}$  are typical output voltage levels that occur with the output load.

**Fig 5. Data input (An) to data output (Bn,  $\bar{B}n$ ) propagation delays and output transition times**



Measurement points are given in [Table 9](#).

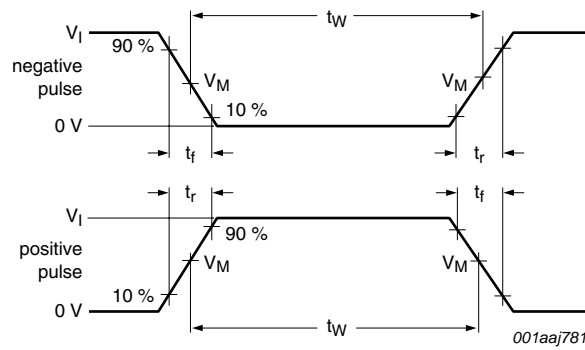
Logic levels:  $V_{OL}$  and  $V_{OH}$  are typical output voltage levels that occur with the output load.

**Fig 6. Enable and disable times**

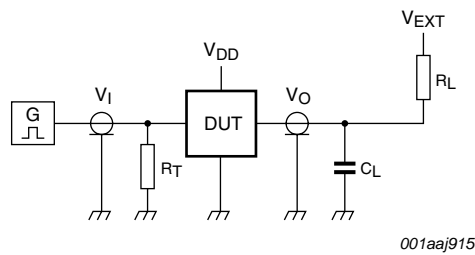
**Table 9. Measurement points**

Input		Output		
$V_I$	$V_M$	$V_M$	$V_X$	$V_Y$
$V_{SS}$ or $V_{DD(A)}$	$0.5V_{DD(A)}$	$0.5V_{DD(B)}$	$0.1V_{DD(B)}$	$0.9V_{DD(B)}$





a. Input waveforms



b. Test circuit

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

Definitions for test circuit:

DUT = Device Under Test.

$C_L$  = load capacitance including jig and probe capacitance.

$R_L$  = load resistance.

$R_T$  = termination resistance should be equal to the output impedance  $Z_o$  of the pulse generator.

Fig 7. Test circuit for measuring switching times

Table 10. Test data

Supplies	Input	Load		$V_{EXT}$		
$V_{DD(A)} = V_{DD(B)}$	$t_r, t_f$	$R_L$	$C_L$	$t_{PHL}, t_{PLH}$	$t_{PZL}, t_{PLZ}$	$t_{PZH}, t_{PHZ}$
5 V to 15 V	$\leq 20$ ns	1 k $\Omega$	50 pF	open	$V_{DD(B)}$	$V_{SS}$

13. Package outline

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

SOT38-4

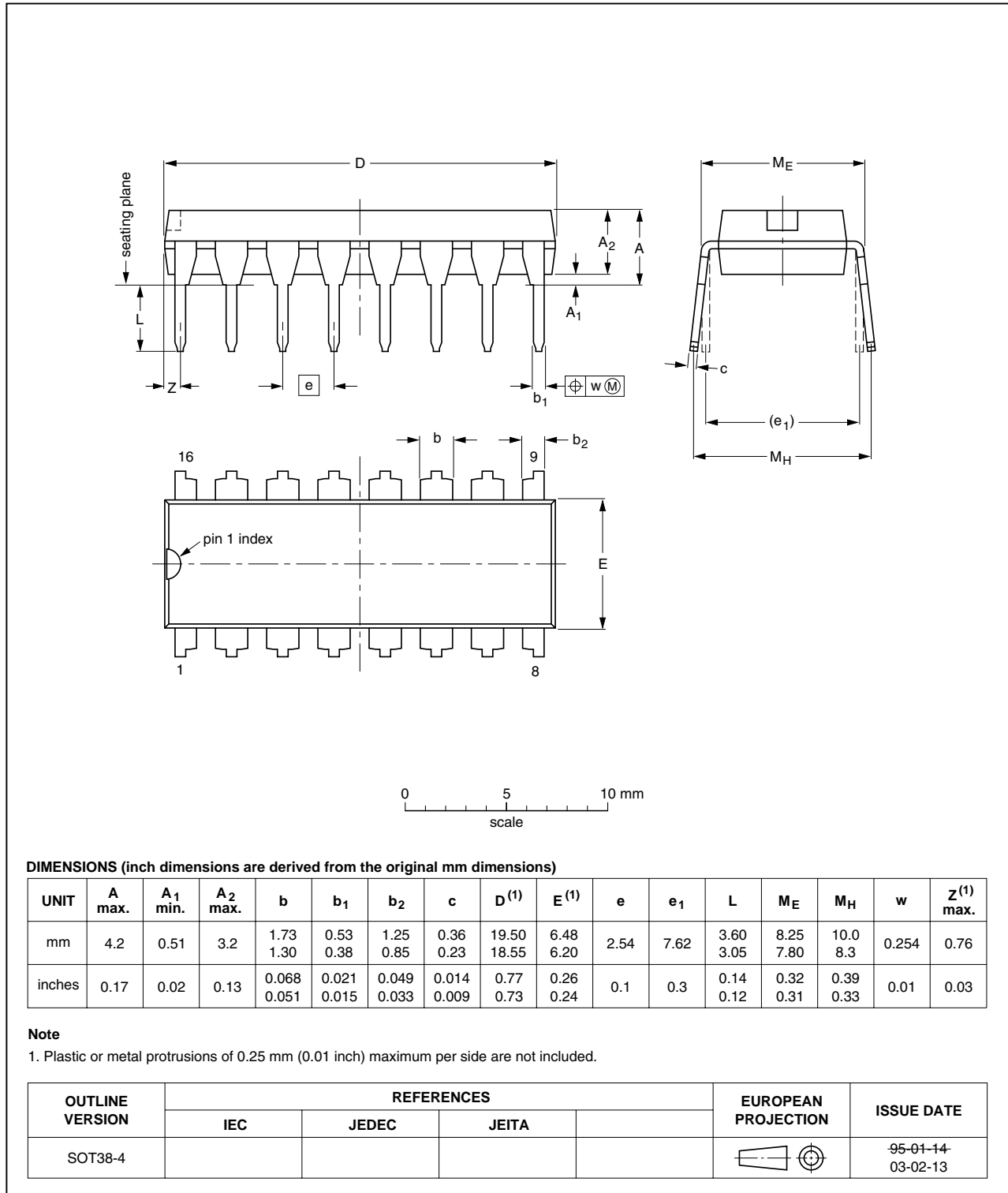


Fig 8. Package outline SOT38-4 (DIP16)

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

SOT109-1

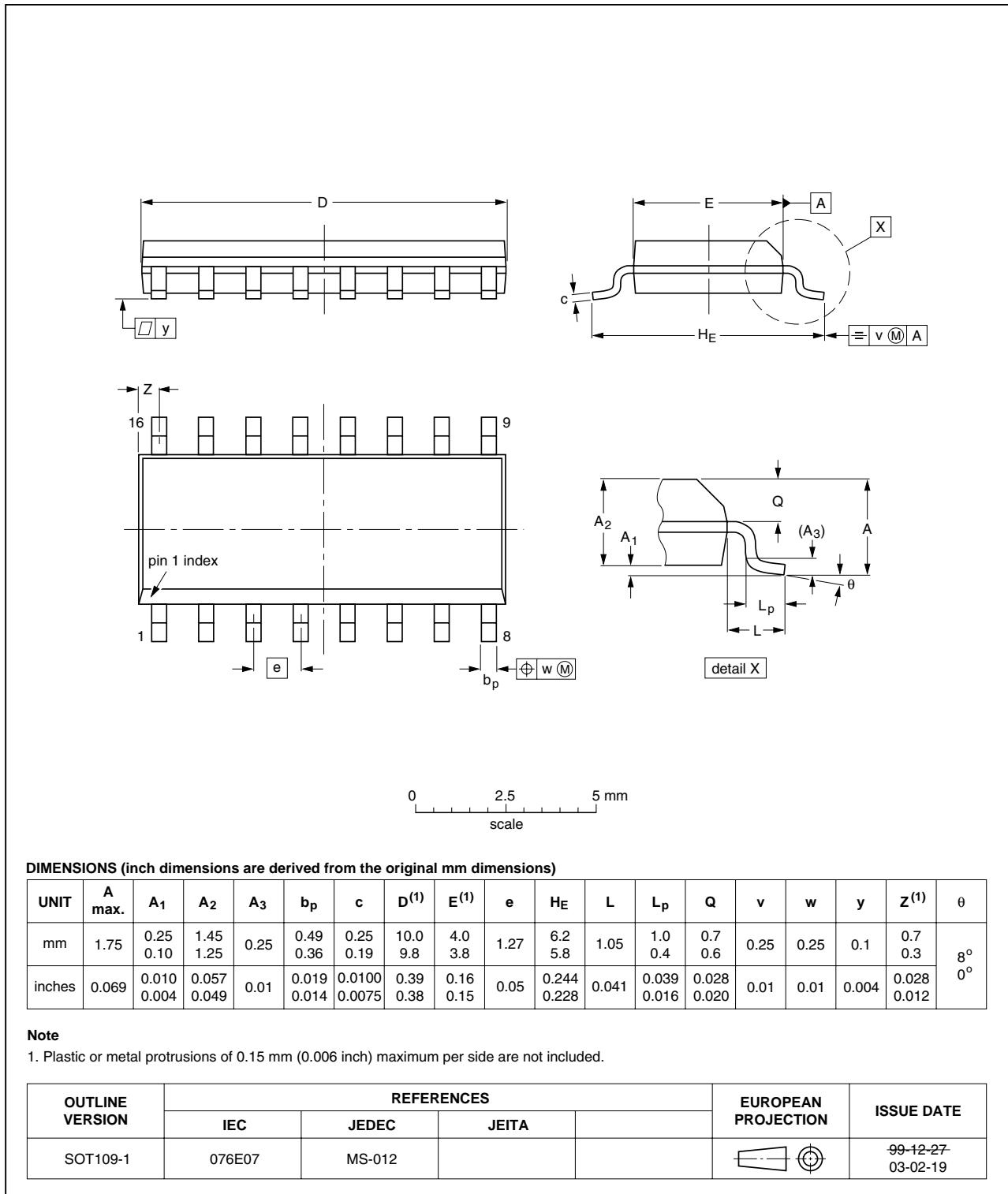


Fig 9. Package outline SOT109-1 (SO16)

## 14. Revision history

Table 11. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
HEF4104B_7	20091216	Product data sheet	-	HEF4104B_6
Modifications:	• <a href="#">Section 12 "Waveforms" Figure 7 "Test circuit for measuring switching times"</a> updated.			
HEF4104B_6	20091102	Product data sheet	-	HEF4104B_5
HEF4104B_5	20090728	Product data sheet	-	HEF4104B_4
HEF4104B_4	20090305	Product data sheet	-	HEF4104B_CNV_3
HEF4104B_CNV_3	19950101	Product specification	-	HEF4104B_CNV_2
HEF4104B_CNV_2	19950101	Product specification	-	-

## 15. Legal information

### 15.1 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".

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## 17. Contents

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