

# HEF4104B-Q100

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

Rev. 1 — 24 March 2014

Product data sheet

## 1. General description

The HEF4104B-Q100 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 (LOC MOS) and Transistor-Transistor Logic (TTL) to high-voltage LOC MOS. It has four data inputs (A0 to A3) and an active HIGH output enable input (OE). It also has four data outputs (B0 to B3) with 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. The inputs A0 to A3 determine whether it is HIGH or LOW. 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  $V_{SS}$ . It 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.

This product has been qualified to the Automotive Electronics Council (AEC) standard Q100 (Grade 3) and is suitable for use in automotive applications.

## 2. Features and benefits

- Automotive product qualification in accordance with AEC-Q100 (Grade 3)
  - ◆ Specified from  $-40\text{ }^{\circ}\text{C}$  to  $+85\text{ }^{\circ}\text{C}$
- Fully static operation
- 5 V, 10 V, and 15 V parametric ratings
- Standardized symmetrical output characteristics
- Inputs and outputs are protected against electrostatic effects
- ESD protection:
  - ◆ MIL-STD-883, method 3015 exceeds 2000 V
  - ◆ HBM JESD22-A114F exceeds 2000 V
  - ◆ MM JESD22-A115-A exceeds 200 V ( $C = 200\text{ pF}$ ,  $R = 0\text{ }\Omega$ )
- Complies with JEDEC standard JESD 13-B

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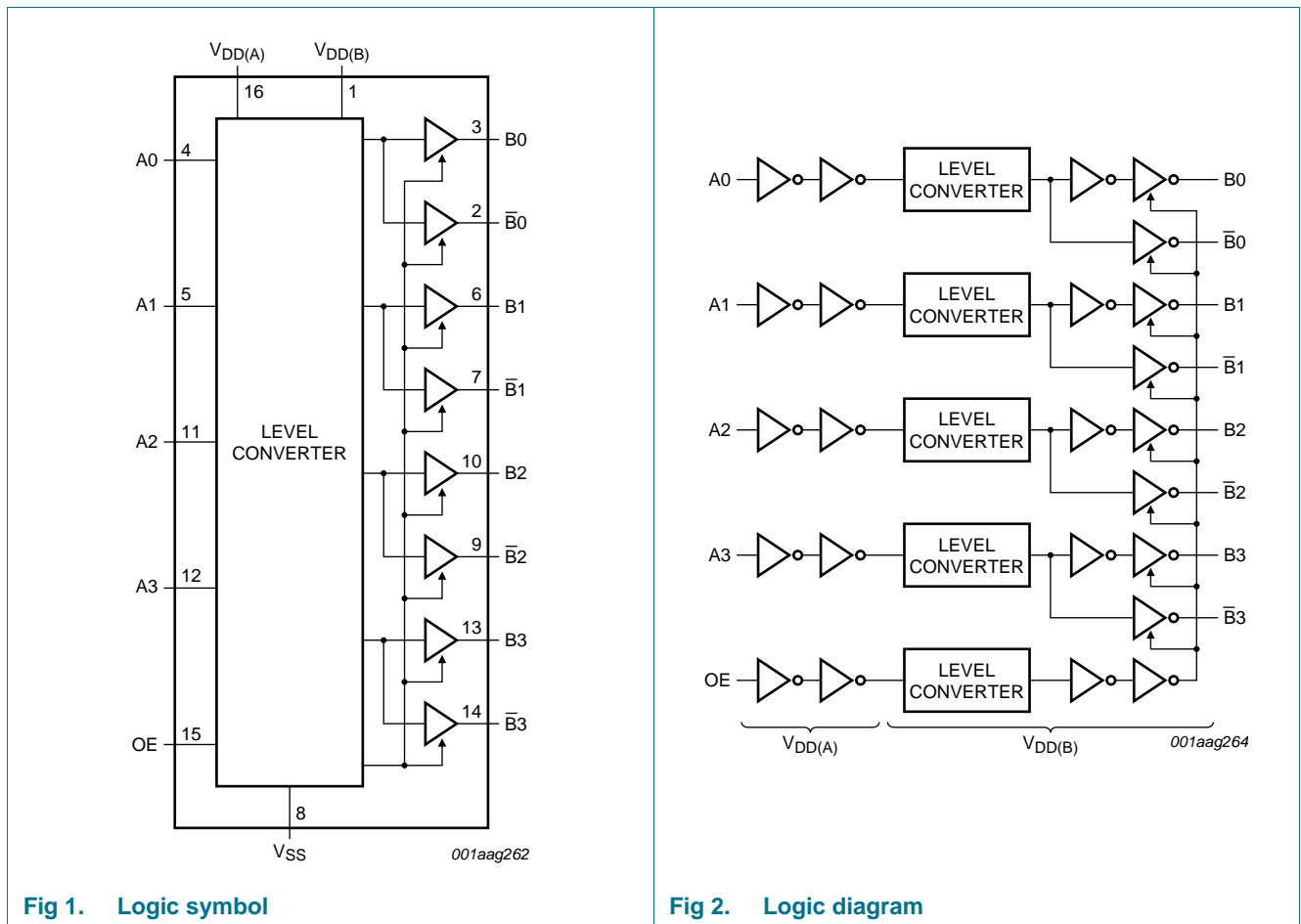
## 3. Ordering information

**Table 1. Ordering information**

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

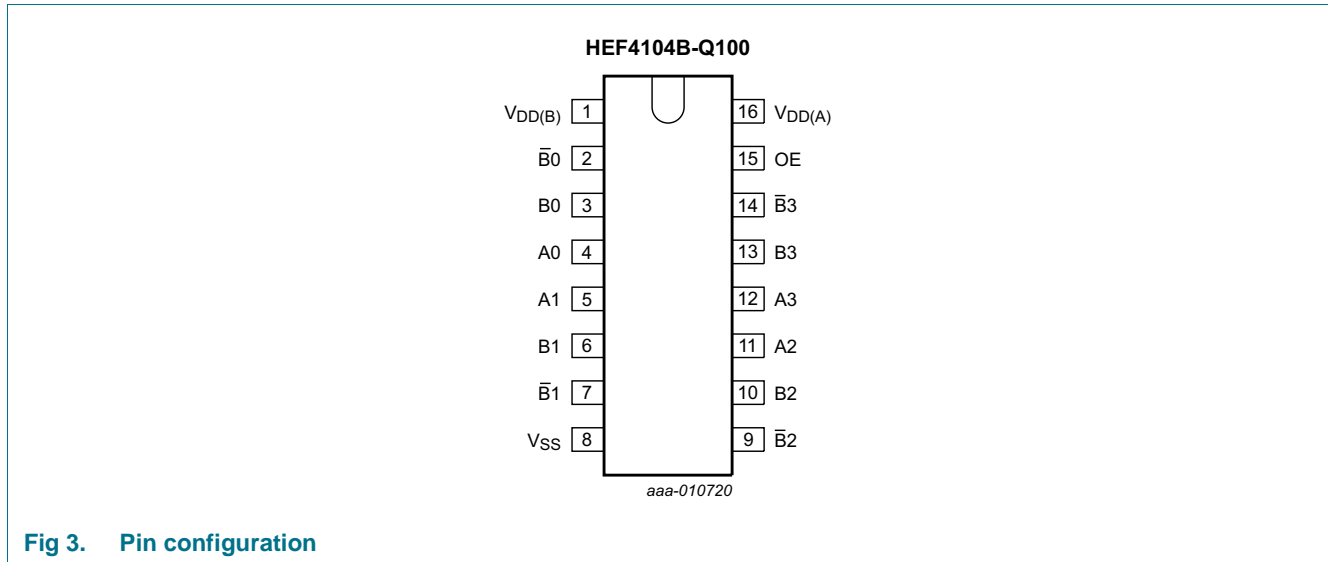
Type number	Package		Version
	Name	Description	
HEF4104BT-Q100	SO16	plastic small outline package; 16 leads; body width 3.9 mm	SOT109-1

## 4. Functional diagram



## 5. Pinning information

### 5.1 Pinning



### 5.2 Pin description

**Table 2. Pin description**

Symbol	Pin	Description
V <sub>DD(B)</sub>	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 <sub>SS</sub>	8	common negative supply voltage (0 V)
OE	15	output enable input
V <sub>DD(A)</sub>	16	supply voltage port A

## 6. Functional description

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

Control	Output	
OE	B <sub>n</sub>	$\bar{B}_n$
H	A <sub>n</sub>	$\bar{A}_n$
L	Z	Z

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

## 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
$V_{DD(A)}$	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	[2] -	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 SO16 packages: above  $T_{amb} = 70$  °C,  $P_{tot}$  derates linearly at 8 mW/K.

## 8. 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	$\mu\text{s/V}$
		$V_{DD(A)} = 10$ V	-	-	0.5	$\mu\text{s/V}$
		$V_{DD(A)} = 15$ V	-	-	0.08	$\mu\text{s/V}$

## 9. Static characteristics

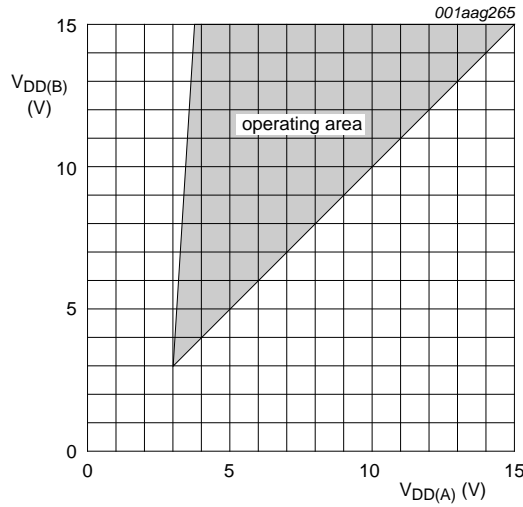
**Table 6. Static characteristics**

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

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

## 10. Dynamic characteristics

Table 7. Dynamic characteristics

$T_{amb} = 25\text{ }^{\circ}\text{C}$ , unless otherwise specified. For test circuit, see Figure 7.

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 Figure 5					
		$V_{DD(A)} = V_{DD(B)} = 5\text{ V}$	$143\text{ ns} + (0.55\text{ ns/pF})C_L$	-	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 Figure 5					
		$V_{DD(A)} = V_{DD(B)} = 5\text{ V}$	$143\text{ ns} + (0.55\text{ ns/pF})C_L$	-	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 Figure 6					
		$V_{DD(A)} = V_{DD(B)} = 5\text{ V}$	$10\text{ ns} + (1.00\text{ ns/pF})C_L$	-	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 Figure 6					
		$V_{DD(A)} = V_{DD(B)} = 5\text{ V}$	$10\text{ ns} + (1.00\text{ ns/pF})C_L$	-	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 Figure 6					
		$V_{DD(A)} = V_{DD(B)} = 5\text{ V}$		-	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** $T_{amb} = 25\text{ }^{\circ}\text{C}$ , unless otherwise specified. For test circuit, see [Figure 7](#).

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
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
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

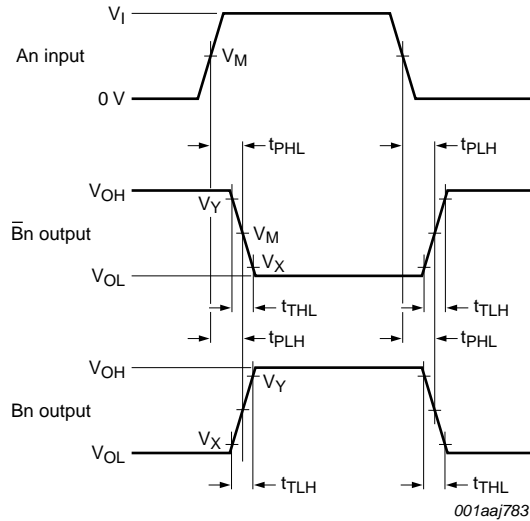
[1] Typical value of the propagation delay and output transition time can be calculated with the extrapolation formula ( $C_L$  in pF).

**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 <sub>DD</sub> <sup>[1]</sup>	Typical formula (μW)	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.

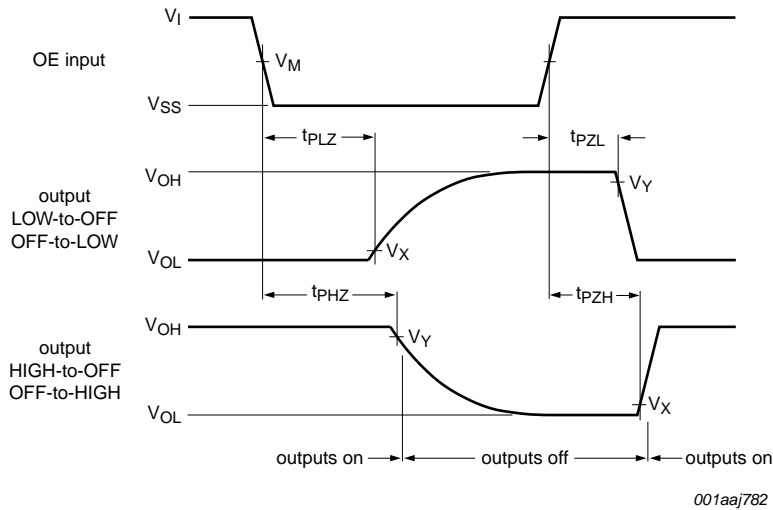
[1]  $V_{DD}$  is the same as  $V_{DD(A)}$  and  $V_{DD(B)}$ .

11. 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**



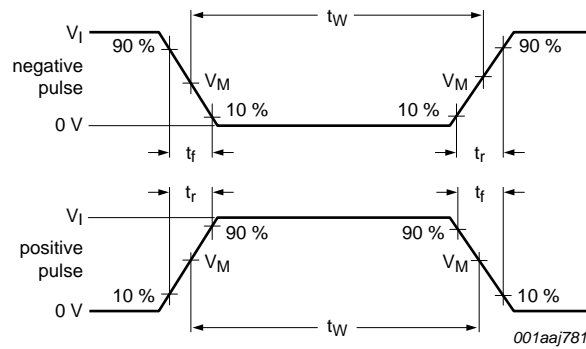
Measurement points are given in [Table 9](#).  
 Logic levels:  $V_{OL}$  and  $V_{OH}$  are typical output voltage levels that occur with the output load.

**Fig 6. Enable and disable times**

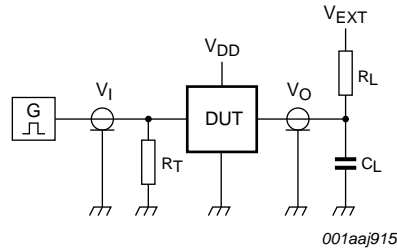
**Table 9. Measurement points**

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	$V_{DD(B)}$	$V_{SS}$

## 12. Package outline

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

SOT109-1

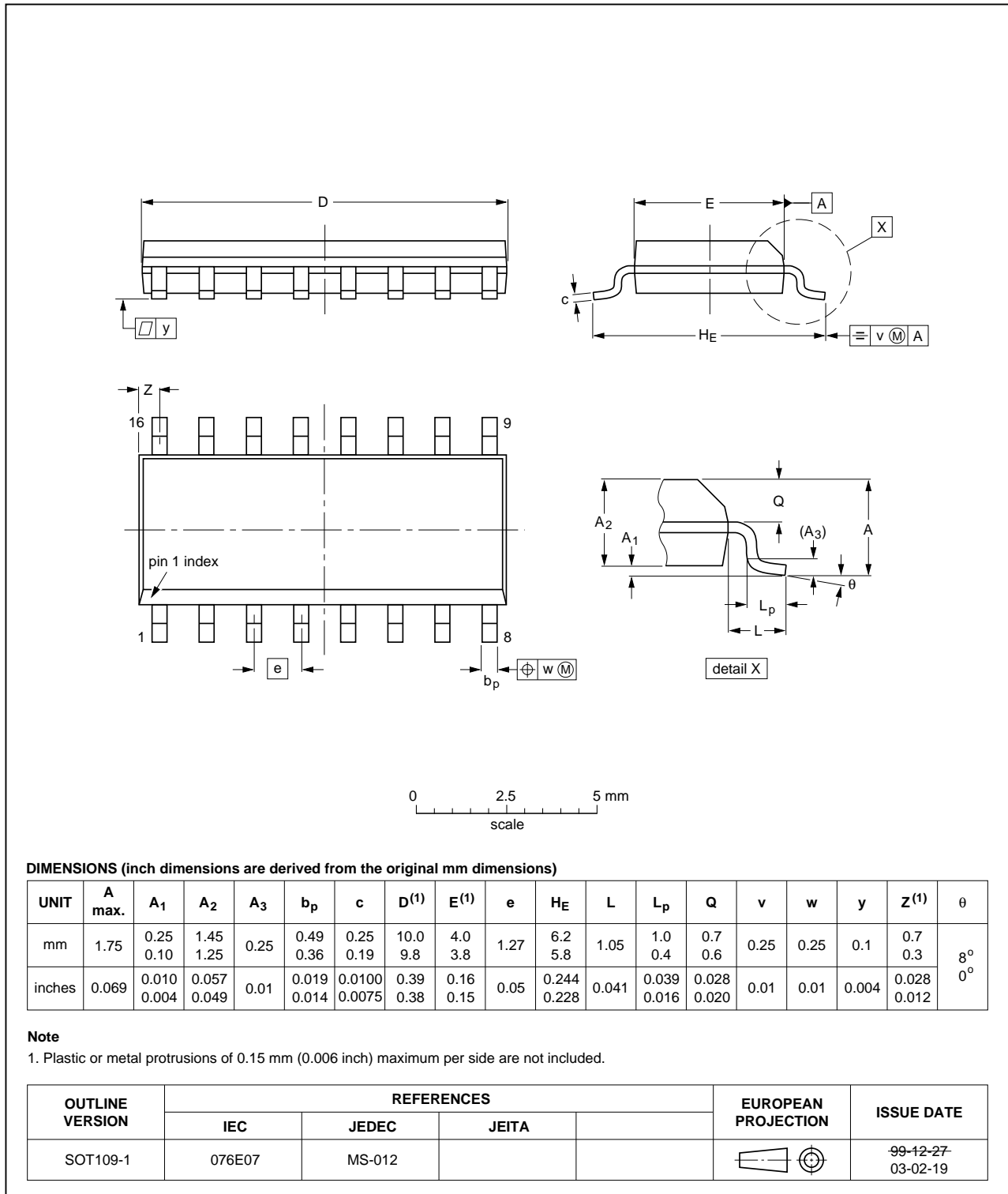


Fig 8. Package outline SOT109-1 (SO16)

## 13. Abbreviations

Table 11. Abbreviations

Acronym	Description
HBM	Human Body Model
ESD	ElectroStatic Discharge
MM	Machine Model
MIL	Military

## 14. Revision history

Table 12. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
HEF4104B_Q100 v.1	20140324	Product data sheet	-	-

## 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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