

HEF4028B

BCD to decimal decoder

Rev. 9 — 23 March 2016

Product data sheet

1. General description

The HEF4028B is a 4-bit BCD to decimal decoder, a 4-bit BCO to octal decoder with active LOW enable or an 8-output (Y0 to Y7) inverting demultiplexer. The outputs are fully buffered for best performance.

When used as a BCD to decimal decoder a 1-2-4-8 BCD code applied to inputs A0 to A3 causes the selected output to be HIGH. The other nine outputs will be LOW.

To use the HEF4028B as a BCO to octal decoder, input A3 is an active LOW enable pin and outputs Y8 and Y9 are not used. A 1-2-4 BCO code applied to inputs A0 to A2 causes the selected output (Y0 to Y7) to be HIGH. The other seven outputs will be LOW. When A3 is HIGH outputs (Y0 to Y7) will be forced LOW.

When used as an 8-output (Y0 to Y7) inverting demultiplexer A0 to A2 are used as address inputs and A3 is the data input. Outputs Y8 and Y9 are not used.

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.

2. Features and benefits

- Fully static operation
- 5 V, 10 V, and 15 V parametric ratings
- Standardized symmetrical output characteristics
- Specified from $-40\text{ }^{\circ}\text{C}$ to $+85\text{ }^{\circ}\text{C}$
- Complies with JEDEC standard JESD 13-B

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		
	Name	Description	Version
HEF4028BT	SO16	plastic small outline package; 16 leads; body width 3.9 mm	SOT109-1

4. Functional diagram

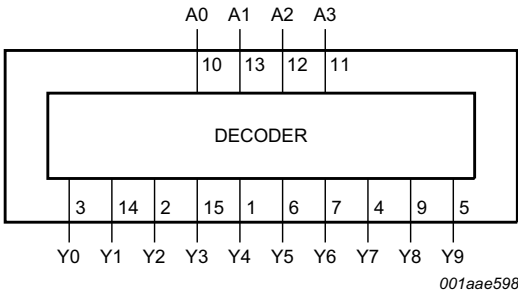


Fig 1. Functional diagram

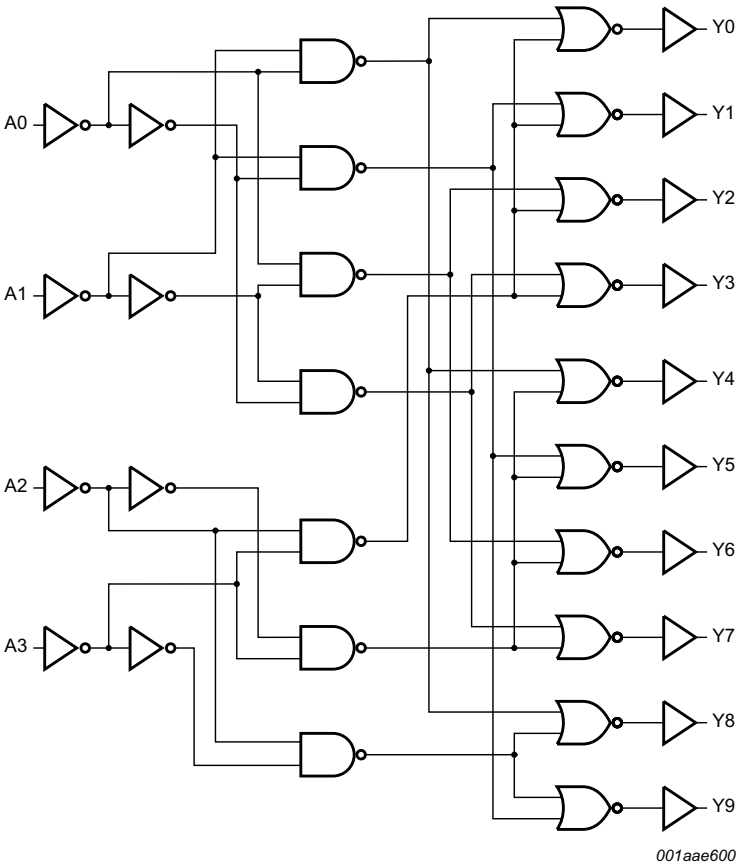
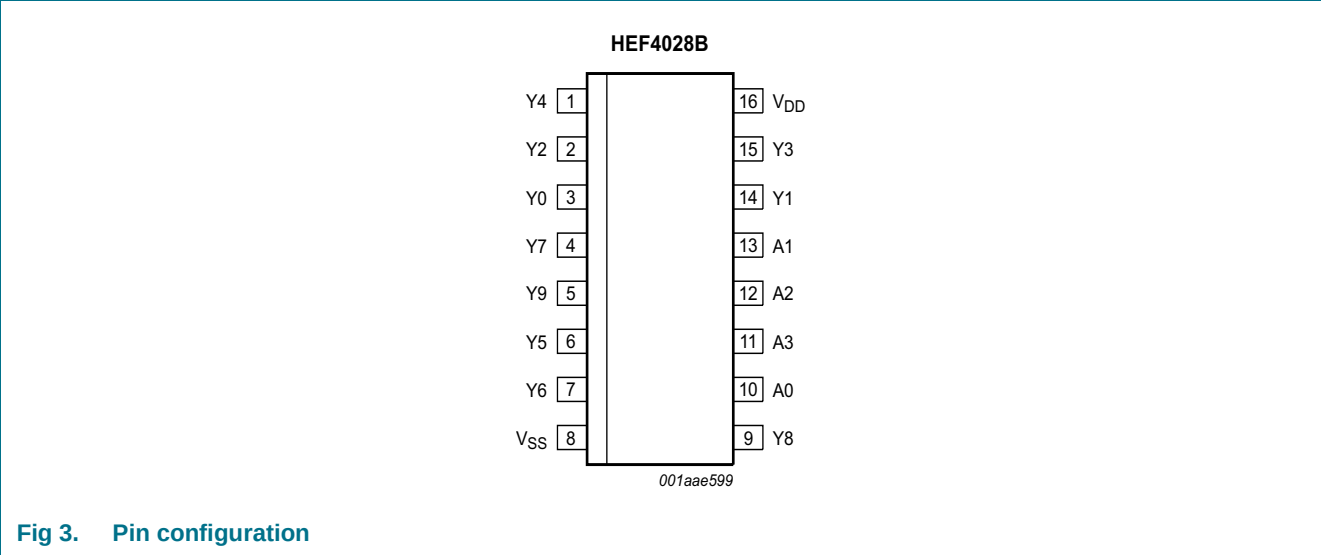


Fig 2. Logic diagram

5. Pinning information

5.1 Pinning



5.2 Pin description

Table 2. Pin description

Symbol	Pin	Description
Y0 to Y9	3, 14, 2, 15, 1, 6, 7, 4, 9, 5	output (active HIGH)
VSS	8	ground supply voltage
A0 to A3	10, 13, 12, 11	address input
VDD	16	supply voltage

6. Functional description

Table 3. Function table [\[1\]](#)

Inputs				Outputs										
A3	A2	A1	A0	Y0	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	
L	L	L	L	H	L	L	L	L	L	L	L	L	L	
L	L	L	H	L	H	L	L	L	L	L	L	L	L	
L	L	H	L	L	L	H	L	L	L	L	L	L	L	
L	L	H	H	L	L	L	H	L	L	L	L	L	L	
L	H	L	L	L	L	L	L	H	L	L	L	L	L	
L	H	L	H	L	L	L	L	L	H	L	L	L	L	
L	H	H	L	L	L	L	L	L	L	H	L	L	L	
L	H	H	H	L	L	L	L	L	L	L	H	L	L	
H	L	L	L	L	L	L	L	L	L	L	L	H	L	

Table 3. Function table [\[1\]](#) ...continued

Inputs				Outputs										
A3	A2	A1	A0	Y0	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	
H	L	L	H	L	L	L	L	L	L	L	L	L	H	
H	L	H	X	L	L	L	L	L	L	L	L	L	L	[2]
H	H	X	X	L	L	L	L	L	L	L	L	L	L	[2]

[1] H = HIGH voltage level; L = LOW voltage level; X = don't care.

[2] Extraordinary states.

7. 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 $V_I > V_{DD} + 0.5\text{ V}$	-	± 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 $V_O > V_{DD} + 0.5\text{ V}$	-	± 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	+85	°C
P_{tot}	total power dissipation	$T_{amb} = -40\text{ °C}$ to $+85\text{ °C}$			
		SO16 package [1]	-	500	mW
P	power dissipation	per output	-	100	mW

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

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	-	+85	°C
$\Delta t/\Delta V$	input transition rise and fall rate	$V_{DD} = 5\text{ V}$	-	-	6.25	ms/V
		$V_{DD} = 10\text{ V}$	-	-	0.5	ms/V
		$V_{DD} = 15\text{ V}$	-	-	0.08	ms/V

9. Static characteristics

Table 6. Static characteristics

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

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	-	-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	-	± 0.3	-	± 0.3	-	± 1.0	μA
I_{DD}	supply current	$I_O = 0\text{ A}$	5 V	-	20	-	20	-	150	μA
			10 V	-	40	-	40	-	300	μA
			15 V	-	80	-	80	-	600	μA
C_I	input capacitance		-	-	-	-	7.5	-	-	pF

10. Dynamic characteristics

Table 7. Dynamic characteristics

$V_{SS} = 0\text{ V}$; $T_{amb} = 25\text{ °C}$.

Symbol	Parameter	Conditions	V_{DD}	Extrapolation formula	Min	Typ	Max	Unit
t_{PHL}	HIGH to LOW propagation delay	An to Yn; see Figure 4	5 V [1]	$73\text{ ns} + (0.55\text{ ns/pF})C_L$	-	100	200	ns
			10 V	$29\text{ ns} + (0.23\text{ ns/pF})C_L$	-	40	80	ns
			15 V	$22\text{ ns} + (0.16\text{ ns/pF})C_L$	-	30	60	ns
t_{PLH}	LOW to HIGH propagation delay	An to Yn; see Figure 4	5 V [1]	$63\text{ ns} + (0.55\text{ ns/pF})C_L$	-	90	180	ns
			10 V	$29\text{ ns} + (0.23\text{ ns/pF})C_L$	-	40	80	ns
			15 V	$22\text{ ns} + (0.16\text{ ns/pF})C_L$	-	30	60	ns

Table 7. Dynamic characteristics ...continued

$V_{SS} = 0\text{ V}$; $T_{amb} = 25\text{ }^{\circ}\text{C}$.

Symbol	Parameter	Conditions	V_{DD}	Extrapolation formula	Min	Typ	Max	Unit
t_t	transition time	see Figure 4	5 V	[1] $10\text{ ns} + (1.00\text{ ns/pF})C_L$	-	60	120	ns
			10 V	$9\text{ ns} + (0.42\text{ ns/pF})C_L$	-	30	60	ns
			15 V	$6\text{ ns} + (0.28\text{ ns/pF})C_L$	-	20	40	ns

[1] The typical values of the propagation delay and transition times are calculated from the extrapolation formulas shown (C_L in pF).

Table 8. Dynamic power dissipation P_D

P_D can be calculated from the formulas shown. $V_{SS} = 0\text{ V}$; $t_r = t_f \leq 20\text{ ns}$; $T_{amb} = 25\text{ }^{\circ}\text{C}$.

Symbol	Parameter	V_{DD}	Typical formula for P_D (μW)	where:
P_D	dynamic power dissipation	5 V	$P_D = 350 \times f_i + \Sigma(f_o \times C_L) \times V_{DD}^2$	f_i = input frequency in MHz; f_o = output frequency in MHz; C_L = output load capacitance in pF; V_{DD} = supply voltage in V; $\Sigma(f_o \times C_L)$ = sum of the outputs.
		10 V	$P_D = 2200 \times f_i + \Sigma(f_o \times C_L) \times V_{DD}^2$	
		15 V	$P_D = 7350 \times f_i + \Sigma(f_o \times C_L) \times V_{DD}^2$	

11. Waveforms

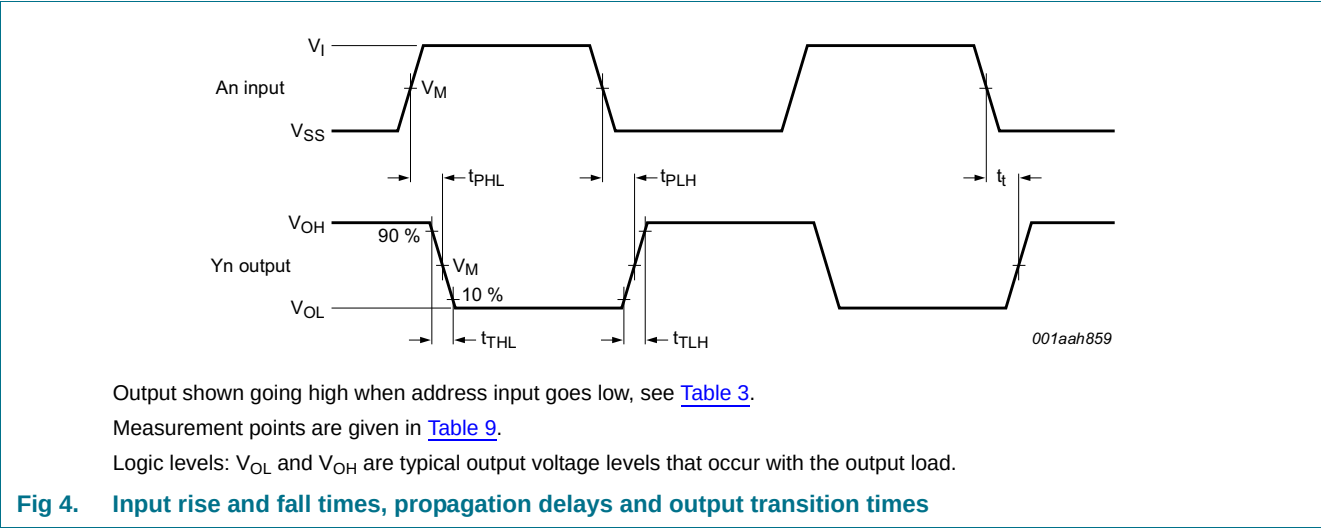
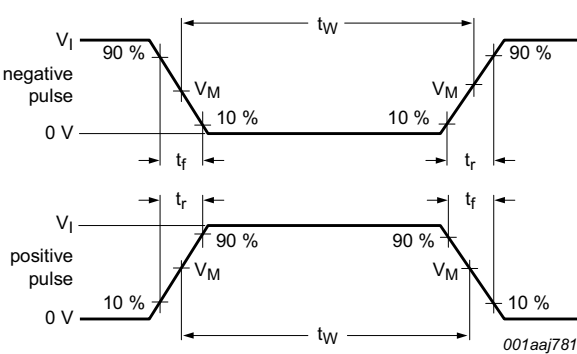
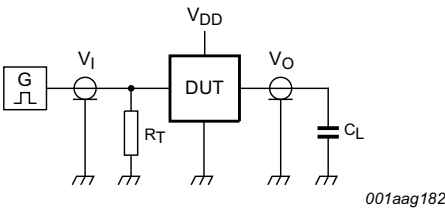


Table 9. Measurement points

Supply voltage	Input	Output
V_{DD}	V_M	V_M
5 V to 15 V	$0.5V_{DD}$	$0.5V_{DD}$



a. Input waveforms



b. Test circuit

Test data is given in [Table 10](#).
Definitions for test circuit:
DUT = Device Under Test;
 C_L = load capacitance including jig and probe capacitance;
 R_T = termination resistance should be equal to the output impedance Z_o of the pulse generator.

Fig 5. Test circuit for measuring switching times

Table 10. Test data

Supply voltage	Input		Load
V_{DD}	V_I	t_r, t_f	C_L
5 V to 15 V	V_{SS} or V_{DD}	≤ 20 ns	50 pF

12. Package outline

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

SOT109-1

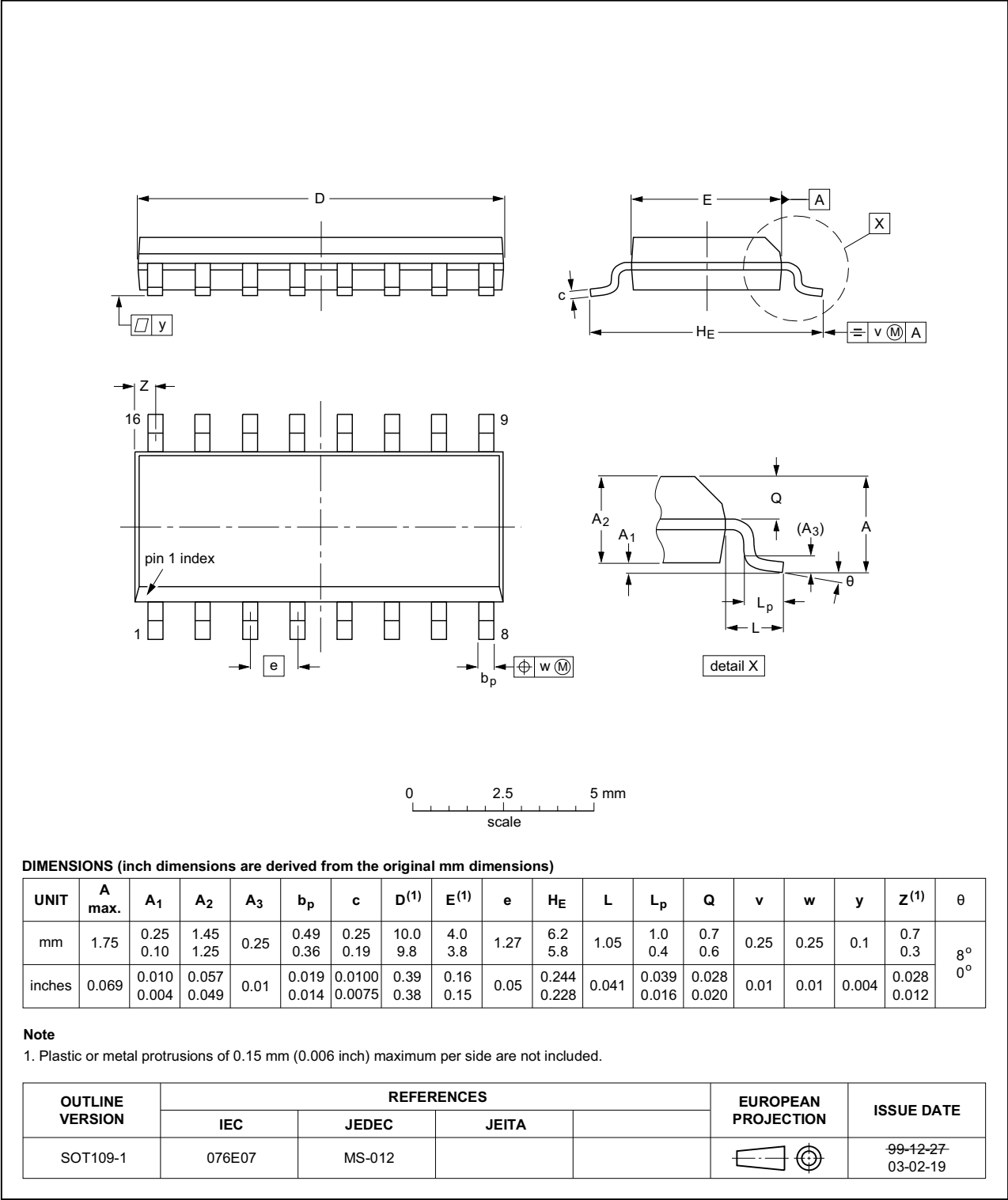


Fig 6. Package outline SOT109-1 (SO16)

13. Abbreviations

Table 11. Abbreviations

Acronym	Description
BCD	Binary Coded Decimal
BCO	Binary Coded Octal

14. Revision history

Table 12. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
HEF4028B v.9	20160323	Product data sheet	-	HEF4028B v.8
Modifications:	• Type number HEF4028BP (SOT38-4) removed.			
HEF4028B v.8	20111117	Product data sheet	-	HEF4028B v.7
Modifications:	• Legal pages updated. • Changes in “General description” and “Features and benefits”. • Section “Applications” removed.			
HEF4028B v.7	20111010	Product data sheet	-	HEF4028B v.6
HEF4028B v.6	20091125	Product data sheet	-	HEF4028B v.5
HEF4028B v.5	20090707	Product data sheet	-	HEF4028B v.4
HEF4028B v.4	20090304	Product data sheet	-	HEF4028B_CNV v.3
HEF4028B_CNV v.3	19950101	Product specification	-	HEF4028B_CNV v.2
HEF4028B_CNV v.2	19950101	Product specification	-	-

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

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17. Contents

1	General description	1
2	Features and benefits	1
3	Ordering information	1
4	Functional diagram	2
5	Pinning information	3
5.1	Pinning	3
5.2	Pin description	3
6	Functional description	3
7	Limiting values	4
8	Recommended operating conditions	4
9	Static characteristics	5
10	Dynamic characteristics	5
11	Waveforms	6
12	Package outline	8
13	Abbreviations	9
14	Revision history	9
15	Legal information	10
15.1	Data sheet status	10
15.2	Definitions	10
15.3	Disclaimers	10
15.4	Trademarks	11
16	Contact information	11
17	Contents	12

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