

# HEF4040B-Q100

## 12-stage binary ripple counter

Rev. 2 — 7 December 2021

Product data sheet

## 1. General description

The HEF4040B is a 12-stage binary ripple counter with a clock input ( $\overline{CP}$ ), an overriding asynchronous master reset input (MR) and twelve fully buffered outputs (Q0 to Q11). The counter advances on the HIGH-to-LOW transition of  $\overline{CP}$ . A HIGH on MR clears all counter stages and forces all outputs LOW, independent of  $\overline{CP}$ . Each counter stage is a static toggle flip-flop. Inputs are overvoltage tolerant to 15 V. This enables the device to be used in HIGH-to-LOW level shifting applications.

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 °C to +85 °C
- Wide supply voltage range from 3.0 V to 15.0 V
- CMOS low power dissipation
- High noise immunity
- Tolerant of slow clock rise and fall time
- Fully static operation
- 5 V, 10 V, and 15 V parametric ratings
- Standardized symmetrical output characteristics
- 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 pF, R = 0 Ω)
- Complies with JEDEC standard JESD 13-B

## 3. Applications

- Frequency dividing circuits
- Time delay circuits
- Control counters

## 4. Ordering information

Table 1. Ordering information

Type number	Package			
	Temperature range	Name	Description	Version
HEF4040BT-Q100	-40 °C to +85 °C	SO16	plastic small outline package; 16 leads; body width 3.9 mm	SOT109-1

### 5. Functional diagram

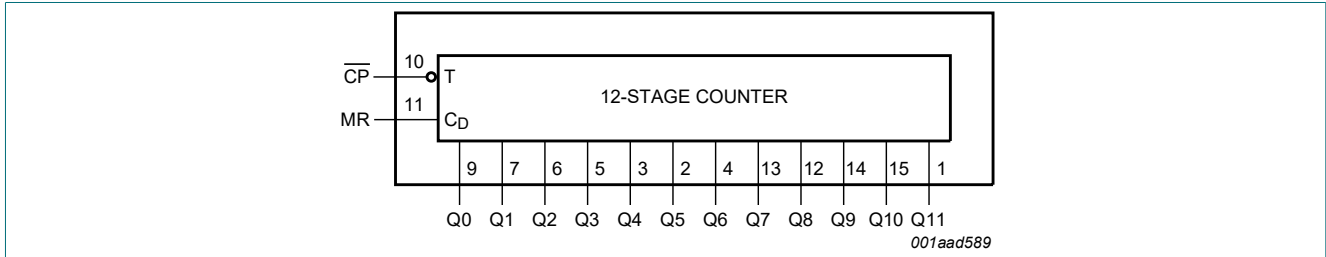


Fig. 1. Functional diagram

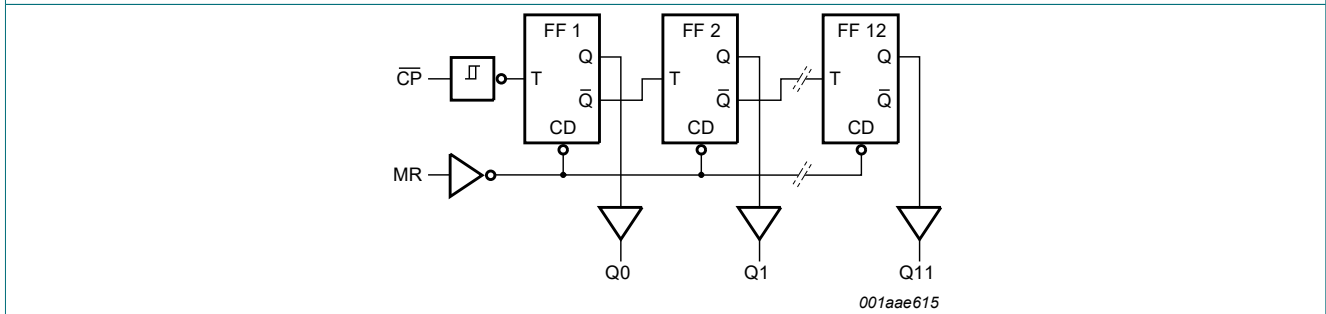


Fig. 2. Logic diagram

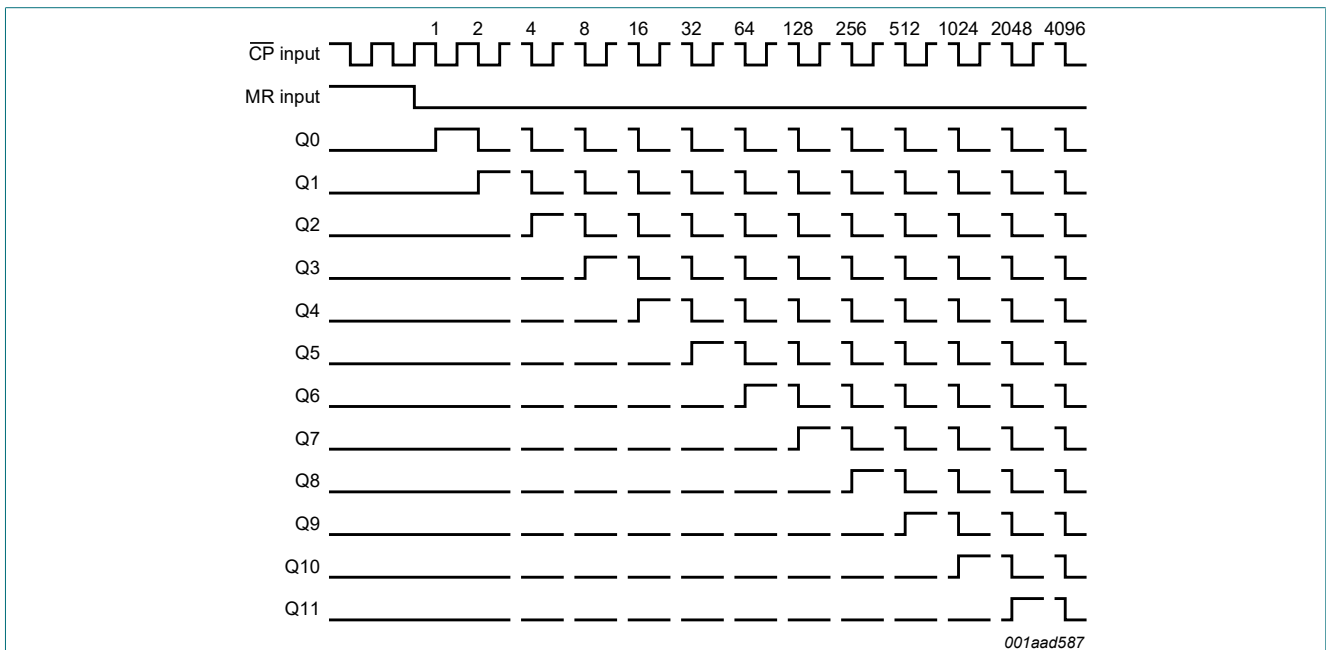


Fig. 3. Timing diagram

## 6. Pinning information

### 6.1. Pinning

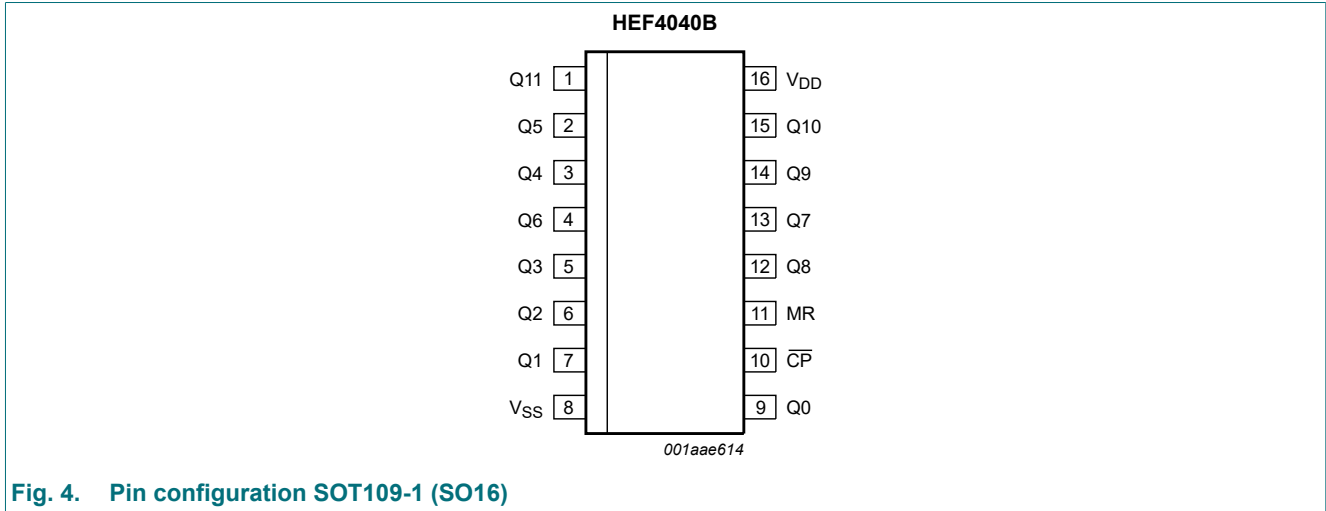


Fig. 4. Pin configuration SOT109-1 (SO16)

### 6.2. Pin description

Table 2. Pin description

Symbol	Pin	Description
V <sub>SS</sub>	8	ground supply voltage
Q0, Q1, Q2, Q3, Q4, Q5, Q6, Q7, Q8, Q9, Q10, Q11	9, 7, 6, 5, 3, 2, 4, 13, 12, 14, 15, 1	parallel output
CP	10	clock input (HIGH-to-LOW edge-triggered)
MR	11	master reset input (active HIGH)
V <sub>DD</sub>	16	supply voltage

## 7. Limiting values

Table 3. Limiting values

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

Symbol	Parameter	Conditions	Min	Max	Unit
V <sub>DD</sub>	supply voltage		-0.5	+18	V
I <sub>IK</sub>	input clamping current	V <sub>I</sub> < -0.5 V or V <sub>I</sub> > V <sub>DD</sub> + 0.5 V	-	±10	mA
V <sub>I</sub>	input voltage		-0.5	V <sub>DD</sub> + 0.5	V
I <sub>OK</sub>	output clamping current	V <sub>O</sub> < -0.5 V or V <sub>O</sub> > V <sub>DD</sub> + 0.5 V	-	±10	mA
I <sub>I/O</sub>	input/output current		-	±10	mA
I <sub>DD</sub>	supply current		-	50	mA
T <sub>stg</sub>	storage temperature		-65	+150	°C
T <sub>amb</sub>	ambient temperature		-40	+85	°C
P <sub>tot</sub>	total power dissipation		-	500	mW
P	power dissipation	per output	-	100	mW

## 8. Recommended operating conditions

Table 4. 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	ms/V
		$V_{DD} = 10\text{ V}$	-	-	0.5	ms/V
		$V_{DD} = 15\text{ V}$	-	-	0.08	ms/V

## 9. Static characteristics

Table 5. 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	-	-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
$I_{LI}$	input leakage current		15 V	-	$\pm 0.3$	-	$\pm 0.3$	-	$\pm 1.0$	$\mu\text{A}$
$I_{DD}$	supply current	$I_O = 0\text{ A}$	5 V	-	20	-	20	-	150	$\mu\text{A}$
			10 V	-	40	-	40	-	300	$\mu\text{A}$
			15 V	-	80	-	80	-	600	$\mu\text{A}$
$C_I$	input capacitance		-	-	-	-	7.5	-	-	pF

## 10. Dynamic characteristics

**Table 6. Dynamic characteristics**

$V_{SS} = 0\text{ V}$ ;  $T_{amb} = 25\text{ °C}$ ; unless otherwise specified; for test circuit see Fig. 6.

Symbol	Parameter	Conditions	V <sub>DD</sub>	Extrapolation formula [1]	Min	Typ	Max	Unit		
t <sub>PHL</sub>	HIGH to LOW propagation delay	CP → Q0; see Fig. 5	5 V	78 ns + (0.55 ns/pF)C <sub>L</sub>	-	105	210	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		
		Q <sub>n</sub> → Q <sub>n</sub> + 1	5 V	[2] (0.55 ns/pF)C <sub>L</sub>	-	35	70	ns		
			10 V	[2] (0.23 ns/pF)C <sub>L</sub>	-	15	30	ns		
			15 V	[2] (0.16 ns/pF)C <sub>L</sub>	-	10	20	ns		
		MR → Q <sub>n</sub> ; see Fig. 5	5 V	63 ns + (0.55 ns/pF)C <sub>L</sub>	-	90	180	ns		
			10 V	29 ns + (0.23 ns/pF)C <sub>L</sub>	-	40	80	ns		
			15 V	22 ns + (0.16 ns/pF)C <sub>L</sub>	-	30	60	ns		
t <sub>PLH</sub>	LOW to HIGH propagation delay	CP → Q0; see Fig. 5	5 V	58 ns + (0.55 ns/pF)C <sub>L</sub>	-	85	170	ns		
			10 V	29 ns + (0.23 ns/pF)C <sub>L</sub>	-	40	80	ns		
			15 V	22 ns + (0.16 ns/pF)C <sub>L</sub>	-	30	60	ns		
		Q <sub>n</sub> → Q <sub>n</sub> + 1	5 V	[2] (0.55 ns/pF)C <sub>L</sub>	-	35	70	ns		
			10 V	[2] (0.23 ns/pF)C <sub>L</sub>	-	15	30	ns		
			15 V	[2] (0.16 ns/pF)C <sub>L</sub>	-	10	20	ns		
		t <sub>t</sub>	transition time	see Fig. 5	5 V	[3] 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
t <sub>w</sub>	pulse width	CP input HIGH; minimum width; see Fig. 5	5 V		50	25	-	ns		
			10 V		30	15	-	ns		
			15 V		20	10	-	ns		
		MR input HIGH; minimum width; see Fig. 5	5 V		40	20	-	ns		
			10 V		30	15	-	ns		
			15 V		20	10	-	ns		
t <sub>rec</sub>	recovery time	MR input; see Fig. 5	5 V		40	20	-	ns		
			10 V		30	15	-	ns		
			15 V		20	10	-	ns		
f <sub>max</sub>	maximum frequency	CP input; see Fig. 5	5 V		10	20	-	MHz		
			10 V		15	30	-	MHz		
			15 V		25	50	-	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).

[2] For loads other than 50 pF at the n<sup>th</sup> output, use the slope given.

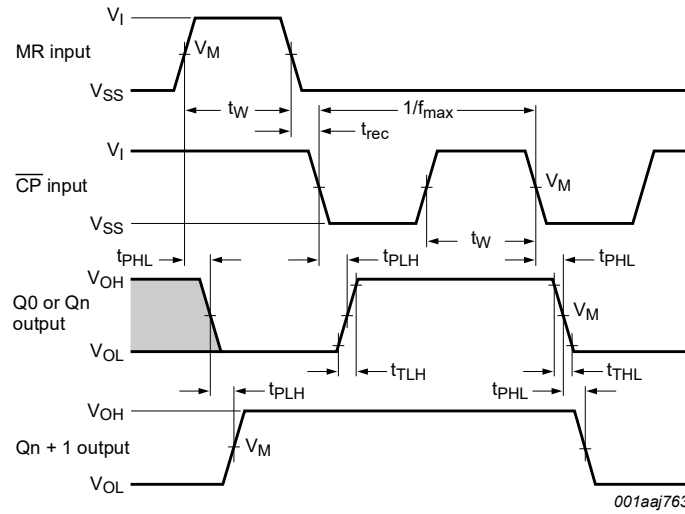
[3] t<sub>t</sub> is the same as t<sub>THL</sub> and t<sub>TLH</sub>.

**Table 7. Dynamic power dissipation P<sub>D</sub>**

P<sub>D</sub> can be calculated from the formulas shown. V<sub>SS</sub> = 0 V; t<sub>r</sub> = t<sub>f</sub> ≤ 20 ns; T<sub>amb</sub> = 25 °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	$P_D = 400 \times f_i + \Sigma(f_o \times C_L) \times V_{DD}^2$	f <sub>i</sub> = input frequency in MHz, f <sub>o</sub> = output frequency in MHz, C <sub>L</sub> = output load capacitance in pF, V <sub>DD</sub> = supply voltage in V, Σ(f <sub>o</sub> × C <sub>L</sub> ) = sum of the outputs.
		10 V	$P_D = 2000 \times f_i + \Sigma(f_o \times C_L) \times V_{DD}^2$	
		15 V	$P_D = 5200 \times f_i + \Sigma(f_o \times C_L) \times V_{DD}^2$	

10.1. Waveforms and test circuit

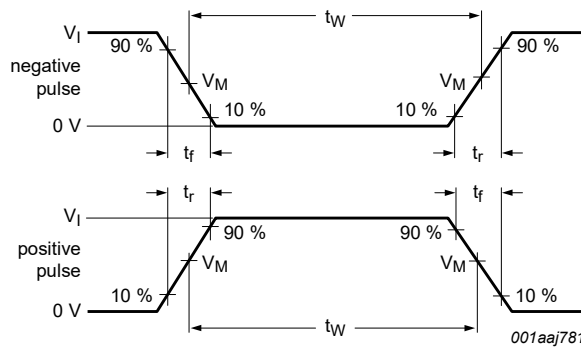


Logic levels:  $V_{OL}$  and  $V_{OH}$  are typical output voltage levels that occur with the output load. Measurement points are given in Table 8.

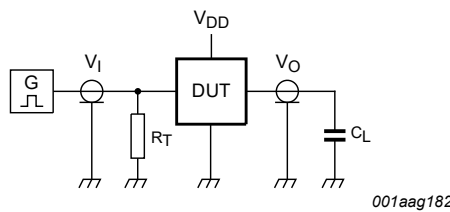
Fig. 5. Waveforms showing the propagation delays, pulse widths, recovery times, maximum clock frequency, and output transition times

Table 8. Measurement points

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



a. Input waveforms



b. Test circuit

Test data is given in Table 9.

Definitions test circuit:

$C_L$  = load capacitance, including the jig and probe capacitance;

$R_L$  = load resistance, which should be equal to the output impedance of the pulse generator.

Fig. 6. Test circuit for measuring switching times

Table 9. Test data

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

### 11. Package outline

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

SOT109-1

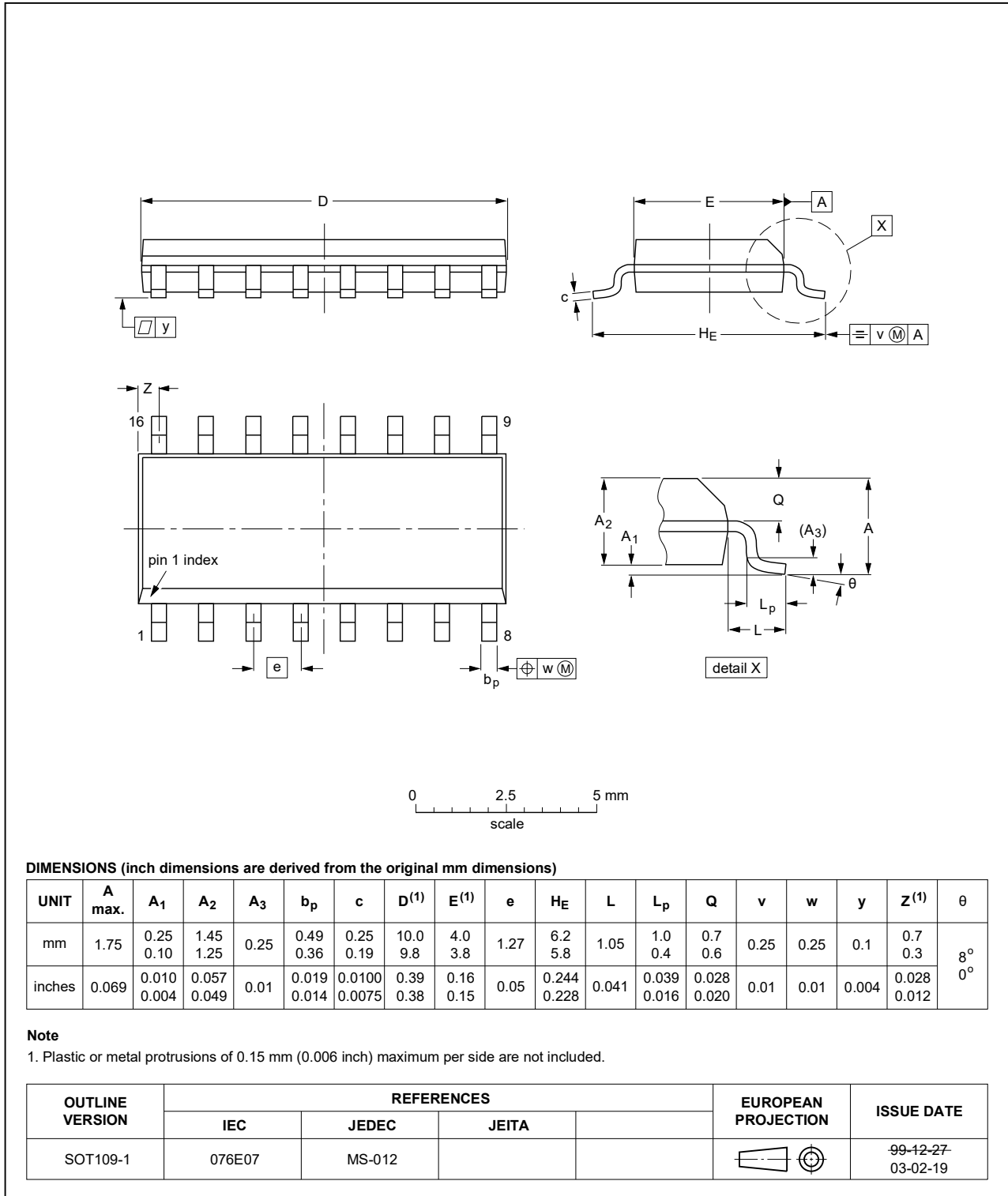


Fig. 7. Package outline SOT109-1 (SO16)



## 12. Abbreviations

Table 10. Abbreviations

Acronym	Description
CMOS	Complementary Metal-Oxide Semiconductor
DUT	Device Under Test
ESD	ElectroStatic Discharge
HBM	Human Body Model
MIL	Military
MM	Machine Model

## 13. Revision history

Table 11. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
HEF4040B_Q100 v.2	20211207	Product data sheet	-	HEF4040B_Q100 v.1
Modifications:	<ul style="list-style-type: none"> <li>The format of this data sheet has been redesigned to comply with the identity guidelines of Nexperia.</li> <li>Legal texts have been adapted to the new company name where appropriate.</li> <li><a href="#">Section 1</a> and <a href="#">Section 2</a> updated.</li> <li><a href="#">Section 12</a> added.</li> </ul>			
HEF4040B_Q100 v.1	20130404	Product data sheet	-	-

## 14. Legal information

### Data sheet status

Document status [1][2]	Product status [3]	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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