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Team Nexperia

HEF4040B-Q100

12-stage binary ripple counter

Rev. 1 — 4 April 2013

Product data sheet

1. General description

The HEF4040B-Q100 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. The clock input is highly tolerant of slow rise and fall times due to its Schmitt trigger action.

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 $+85\text{ }^{\circ}\text{C}$
- 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 ($C = 200\text{ pF}$, $R = 0\text{ }\Omega$)
- Complies with JEDEC standard JESD 13-B

3. Applications

- Frequency dividing circuits
- Time delay circuits
- Control counters



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	
HEF4040BT-Q100	SO16	plastic small outline package; 16 leads; body width 3.9 mm	SOT109-1

5. Functional diagram

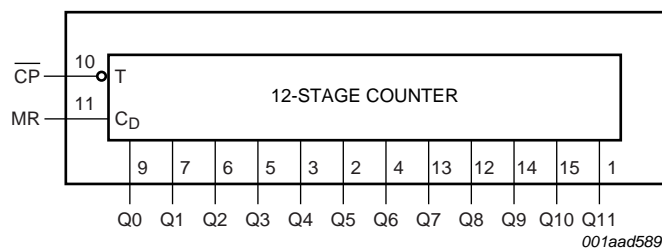


Fig 1. Functional diagram

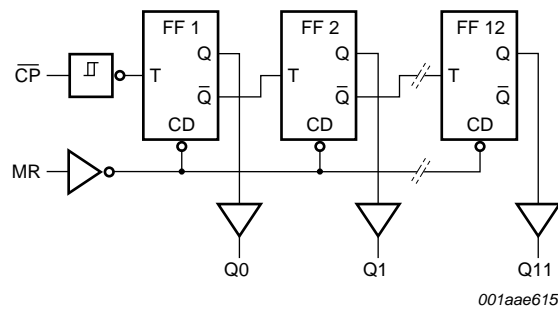


Fig 2. Logic diagram

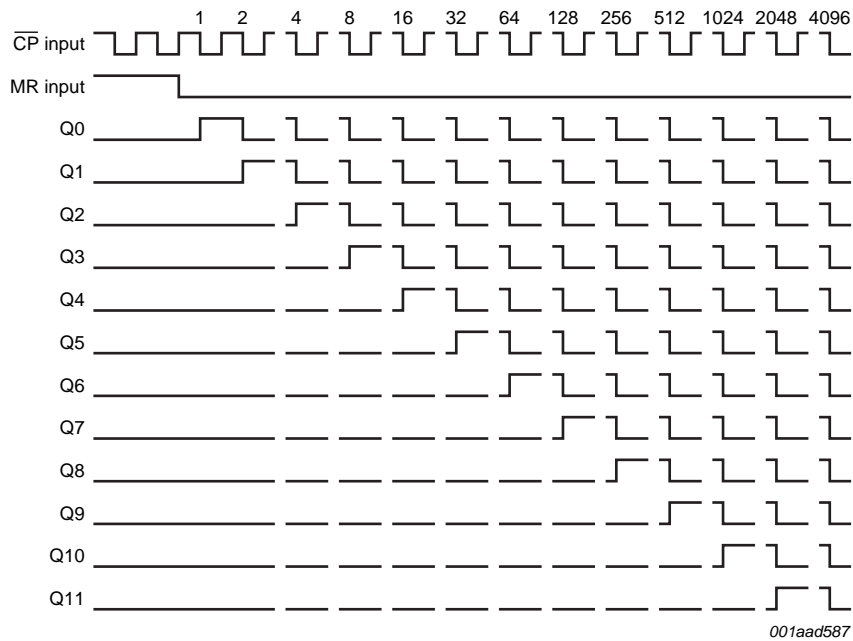


Fig 3. Timing diagram

6. Pinning information

6.1 Pinning

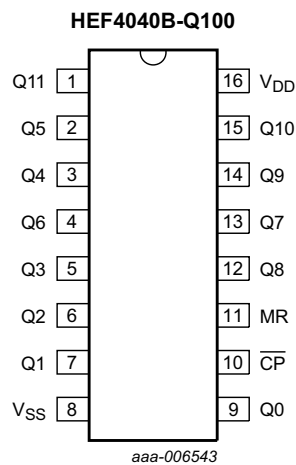


Fig 4. Pin configuration

6.2 Pin description

Table 2. Pin description

Symbol	Pin	Description
V_{SS}	8	ground supply voltage
Q0 to Q11	9, 7, 6, 5, 3, 2, 4, 13, 12, 14, 15, 1	parallel output
\overline{CP}	10	clock input (HIGH-to-LOW edge-triggered)
MR	11	master reset input (active HIGH)
V_{DD}	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_{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		[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 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}	$T_{amb} = -40\text{ }^{\circ}\text{C}$		$T_{amb} = 25\text{ }^{\circ}\text{C}$		$T_{amb} = 85\text{ }^{\circ}\text{C}$		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	-	± 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 6. Dynamic characteristics
 $V_{SS} = 0\text{ V}$; $T_{amb} = 25\text{ °C}$; unless otherwise specified; for test circuit see [Figure 6](#).

Symbol	Parameter	Conditions	V_{DD}	Extrapolation formula ^[1]	Min	Typ	Max	Unit	
t_{PHL}	HIGH to LOW propagation delay	$\overline{CP} \rightarrow Q0$ see Figure 5	5 V	$78\text{ ns} + (0.55\text{ ns/pF})C_L$	-	105	210	ns	
			10 V	$34\text{ ns} + (0.23\text{ ns/pF})C_L$	-	45	90	ns	
			15 V	$27\text{ ns} + (0.16\text{ ns/pF})C_L$	-	35	70	ns	
		$Q_n \rightarrow Q_n + 1$	5 V	^[2] $(0.55\text{ ns/pF})C_L$	-	35	70	ns	
			10 V	^[2] $(0.23\text{ ns/pF})C_L$	-	15	30	ns	
			15 V	^[2] $(0.16\text{ ns/pF})C_L$	-	10	20	ns	
	MR \rightarrow Q_n see Figure 5	5 V	$63\text{ ns} + (0.55\text{ ns/pF})C_L$	-	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		
t_{PLH}	LOW to HIGH propagation delay	$\overline{CP} \rightarrow Q0$ see Figure 5	5 V	$58\text{ ns} + (0.55\text{ ns/pF})C_L$	-	85	170	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	
		$Q_n \rightarrow Q_n + 1$	5 V	^[2] $(0.55\text{ ns/pF})C_L$	-	35	70	ns	
			10 V	^[2] $(0.23\text{ ns/pF})C_L$	-	15	30	ns	
			15 V	^[2] $(0.16\text{ ns/pF})C_L$	-	10	20	ns	
	t_t	transition time	see Figure 5	5 V	^[3] $10\text{ ns} + (1.00\text{ ns/pF})C_L$	-	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
t_W	pulse width	\overline{CP} input HIGH; minimum width; see Figure 5	5 V		50	25	-	ns	
			10 V		30	15	-	ns	
			15 V		20	10	-	ns	
		MR input HIGH; minimum width; see Figure 5	5 V		40	20	-	ns	
			10 V		30	15	-	ns	
			15 V		20	10	-	ns	
t_{rec}	recovery time	MR input; see Figure 5	5 V		40	20	-	ns	
			10 V		30	15	-	ns	
			15 V		20	10	-	ns	
f_{max}	maximum frequency	\overline{CP} input; see Figure 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_L in pF).

[2] For loads other than 50 pF at the n^{th} output, use the slope given.

[3] t_t is the same as t_{THL} and t_{TLH} .

Table 7. 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	$P_D = 400 \times f_i + \Sigma(f_o \times C_L) \times V_{DD}^2$	f_i = input frequency in MHz,
		10 V	$P_D = 2000 \times f_i + \Sigma(f_o \times C_L) \times V_{DD}^2$	f_o = output frequency in MHz,
		15 V	$P_D = 5200 \times f_i + \Sigma(f_o \times C_L) \times V_{DD}^2$	C_L = output load capacitance in pF, V_{DD} = supply voltage in V, $\Sigma(f_o \times C_L)$ = sum of the outputs.

11. Waveforms

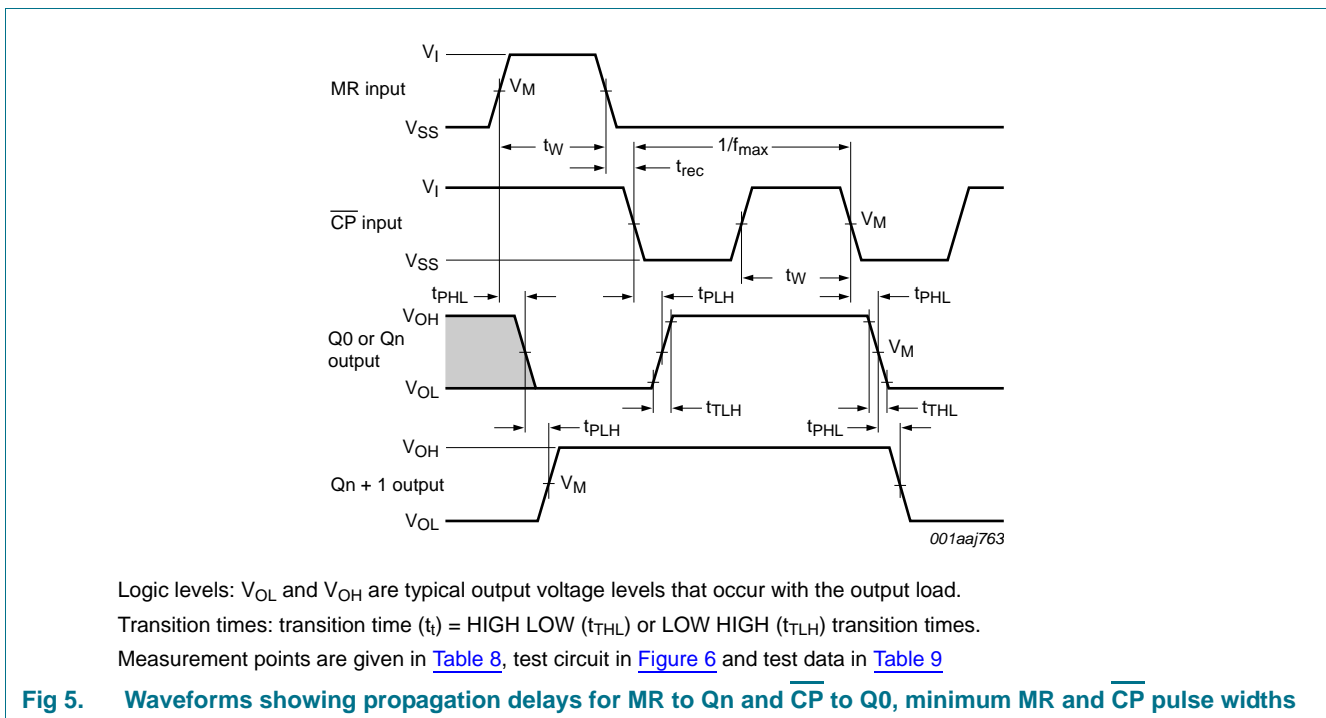
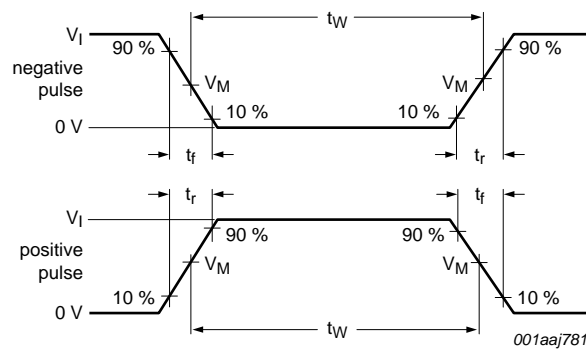
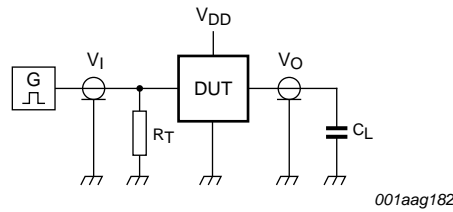


Table 8. Measurement points

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



a. Input waveforms



b. Test circuit

Test data is given in [Table 9](#).

Definitions test circuit:

DUT = Device Under Test;

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	C_L
5 V to 15 V	V_{SS} or V_{DD}	50 pF
	t_r, t_f	≤ 20 ns

12. Package outline

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

SOT109-1

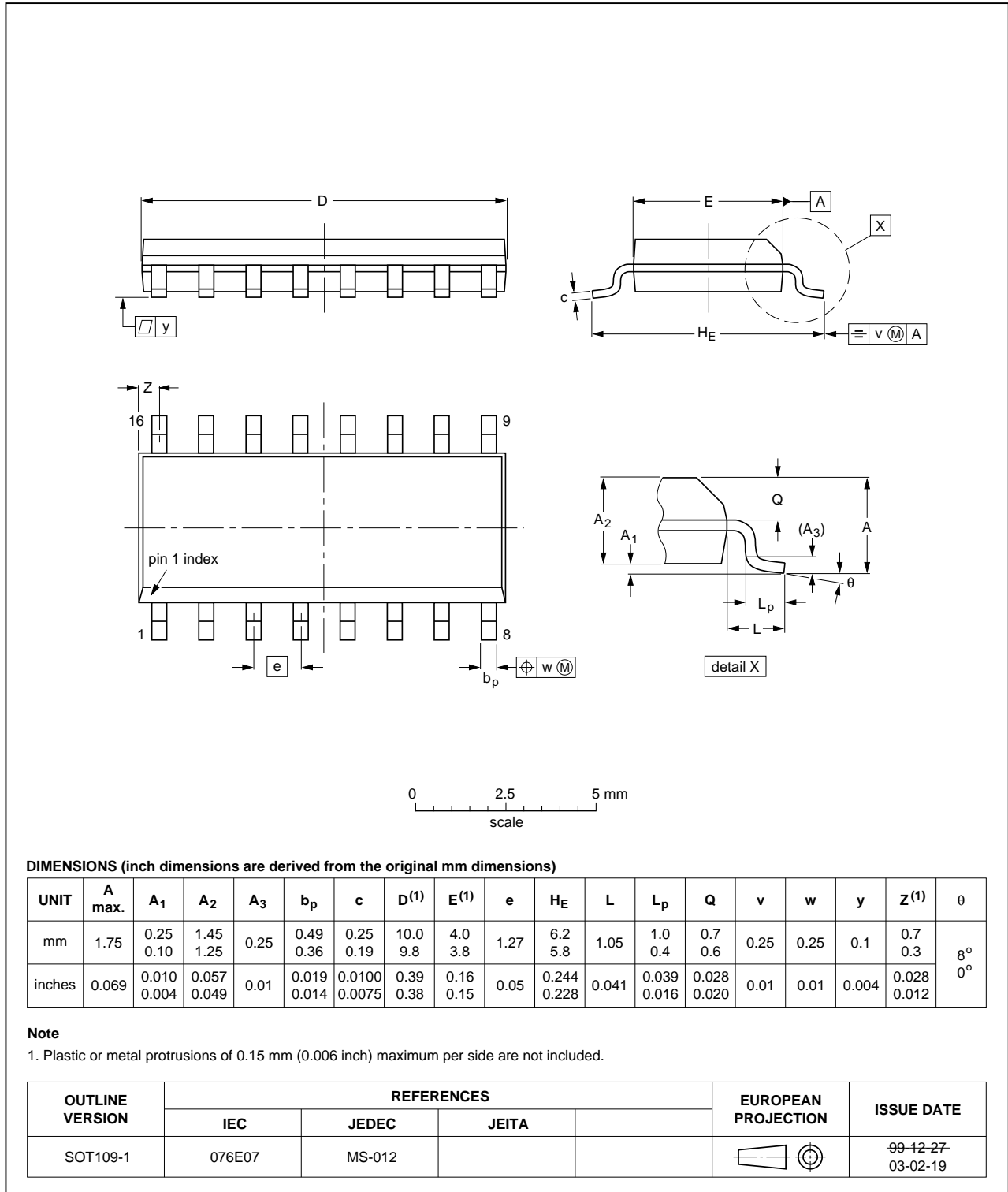


Fig 7. Package outline SOT109-1 (SO16)

13. Abbreviations

Table 10. Abbreviations

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

14. Revision history

Table 11. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
HEF4040B_Q100 v.1	20130404	Product data sheet	-	-

15. Legal information

15.1 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.

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