

# HEF4014B-Q100

## 8-bit static shift register

Rev. 1 — 27 February 2013

Product data sheet

## 1. General description

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The HEF4014B-Q100 is a fully synchronous edge-triggered 8-bit static shift register with eight synchronous parallel inputs (D0 to D7). It has a synchronous serial data input (DS), a synchronous parallel enable input (PE) and a LOW-to-HIGH edge-triggered clock input (CP). It also has buffered parallel outputs from the last three stages (Q5 to Q7).

Operation is synchronous and the device is edge-triggered on the LOW-to-HIGH transition of CP. Each register stage is of a D-type master-slave flip-flop type. When PE is HIGH, data is loaded into the register from D0 to D7 on the LOW-to-HIGH transition of CP. When PE is LOW, data is shifted to the first position from DS. All the data in the register is shifted one position to the right on the LOW-to-HIGH transition of CP. The Schmitt trigger action of the clock input makes the HEF4014B-Q100 highly tolerant of slower clock rise and fall times.

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

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- 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 times
- Fully static operation
- 5 V, 10 V, and 15 V parametric ratings
- Standardized symmetrical output characteristics
- ESD protection:
  - ◆ MIL-STD-883C, 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

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- Parallel-to-serial converter
- Serial data queueing
- General-purpose register

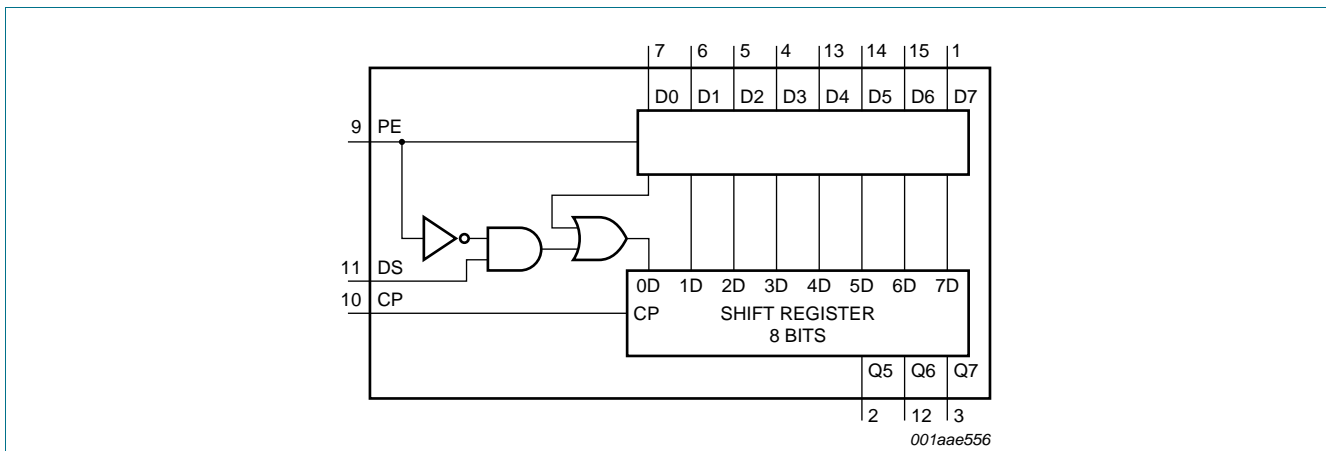


### 4. Ordering information

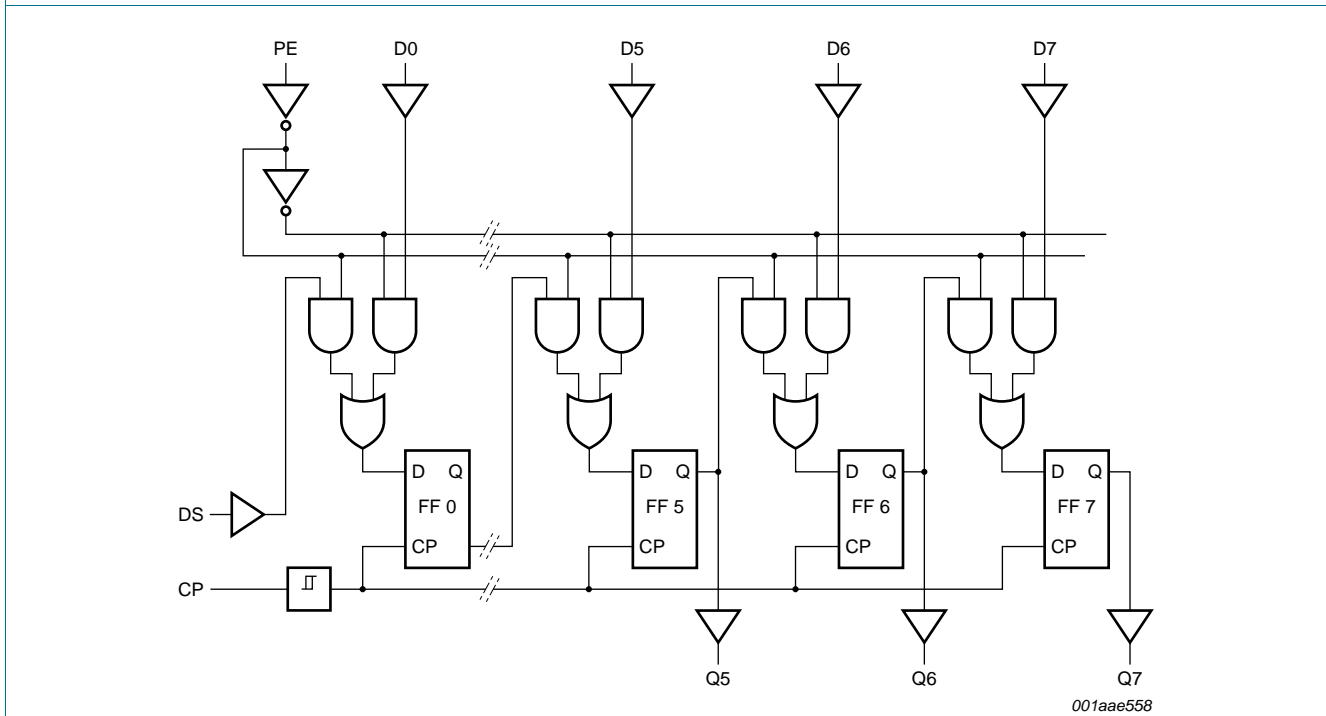
**Table 1. Ordering information**  
All types operate from -40 °C to +85 °C

Type number	Package		Version
	Name	Description	
HEF4014BT-Q100	SO16	plastic small outline package; 16 leads; body width 3.9 mm	SOT109-1

### 5. Functional diagram



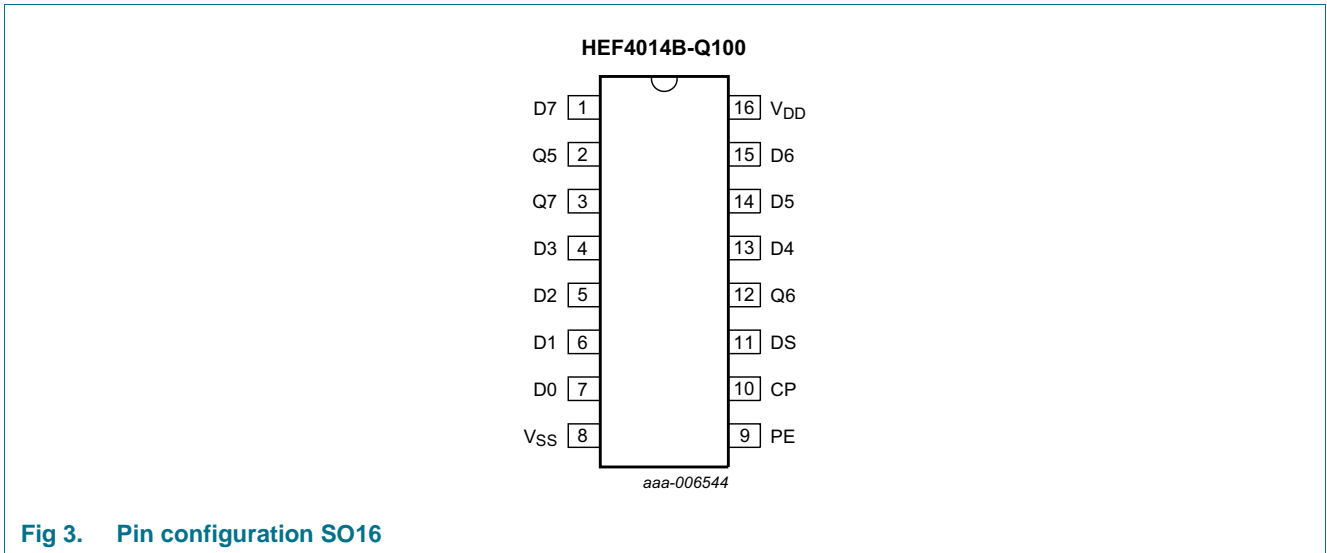
**Fig 1. Functional diagram**



**Fig 2. Logic diagram**

## 6. Pinning information

### 6.1 Pinning



### 6.2 Pin description

**Table 2. Pin description**

Symbol	Pin	Description
Q5 to Q7	2, 12, 3	output
D0 to D7	7, 6, 5, 4, 13, 14, 15, 1	parallel data input
V <sub>SS</sub>	8	ground supply voltage
PE	9	parallel enable input
CP	10	clock input (LOW-to-HIGH edge-triggered)
DS	11	serial data input
V <sub>DD</sub>	16	supply voltage

## 7. Functional description

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

Number of clock transitions	Inputs			Outputs		
	CP	DS	PE	Q5	Q6	Q7
<b>Serial operation</b>						
1	↑	1D	L	X	X	X
2	↑	2D	L	X	X	X
3	↑	3D	L	X	X	X
6	↑	X	L	1D	X	X
7	↑	X	L	2D	1D	X
8	↑	X	L	3D	2D	1D
	↓	X	X	no change	no change	no change
<b>Parallel operation</b>						
1	↑	X	H	D5	D6	D7
	↓	X	X	no change	no change	no change

[1] H = HIGH voltage level; L = LOW voltage level; X = don't care; nD = HIGH or LOW;  
 ↑ = LOW-to-HIGH clock transition; ↓ = HIGH-to-LOW clock transition;

## 8. 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
$I_{IO}$	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 $+85\text{ °C}$	[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.

## 9. 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	$V_{DD} = 5\text{ V}$	-	-	3.75	$\mu\text{s/V}$
		$V_{DD} = 10\text{ V}$	-	-	0.5	$\mu\text{s/V}$
		$V_{DD} = 15\text{ V}$	-	-	0.08	$\mu\text{s/V}$

## 10. Static characteristics

**Table 6. 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\ \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\ \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\ \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\ \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	$I_O = 0\text{ A}$	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

## 11. Dynamic characteristics

**Table 7. Dynamic characteristics**

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

Symbol	Parameter	Conditions	V <sub>DD</sub>	Extrapolation formula <sup>[1]</sup>	Min	Typ	Max	Unit		
t <sub>PHL</sub>	HIGH to LOW propagation delay	CP to Qn; see <a href="#">Figure 4</a>	5 V	103 ns + (0.55 ns/pF)C <sub>L</sub>	-	130	260	ns		
			10 V	44 ns + (0.23 ns/pF)C <sub>L</sub>	-	55	110	ns		
			15 V	32 ns + (0.16 ns/pF)C <sub>L</sub>	-	40	80	ns		
t <sub>PLH</sub>	LOW to HIGH propagation delay	CP to Qn; see <a href="#">Figure 4</a>	5 V	88 ns + (0.55 ns/pF)C <sub>L</sub>	-	115	230	ns		
			10 V	39 ns + (0.23 ns/pF)C <sub>L</sub>	-	50	100	ns		
			15 V	32 ns + (0.16 ns/pF)C <sub>L</sub>	-	40	80	ns		
t <sub>t</sub>	transition time	Qn output; see <a href="#">Figure 4</a>	5 V	<sup>[2]</sup> 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; minimum width; see <a href="#">Figure 5</a>	5 V		70	35	-	ns		
			10 V		30	15	-	ns		
			15 V		24	12	-	ns		
t <sub>su</sub>	set-up time	PE → CP; see <a href="#">Figure 5</a>	5 V		40	10	-	ns		
			10 V		25	5	-	ns		
			15 V		15	0	-	ns		
		DS → CP; see <a href="#">Figure 5</a>	5 V		+35	-5	-	ns		
			10 V		+25	-5	-	ns		
			15 V		25	0	-	ns		
		Dn → CP; see <a href="#">Figure 5</a>	5 V		+35	-5	-	ns		
			10 V		+25	-5	-	ns		
			15 V		25	0	-	ns		
		t <sub>h</sub>	hold time	PE → CP; see <a href="#">Figure 5</a>	5 V		+25	-5	-	ns
					10 V		20	0	-	ns
					15 V		15	0	-	ns
DS → CP; see <a href="#">Figure 5</a>	5 V				30	15	-	ns		
	10 V				20	10	-	ns		
	15 V				15	7	-	ns		
Dn → CP; see <a href="#">Figure 5</a>	5 V				30	15	-	ns		
	10 V				20	10	-	ns		
	15 V				15	7	-	ns		
f <sub>clk(max)</sub>	maximum clock frequency			see <a href="#">Figure 5</a>	5 V		6	13	-	MHz
					10 V		15	30	-	MHz
					15 V		20	40	-	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).

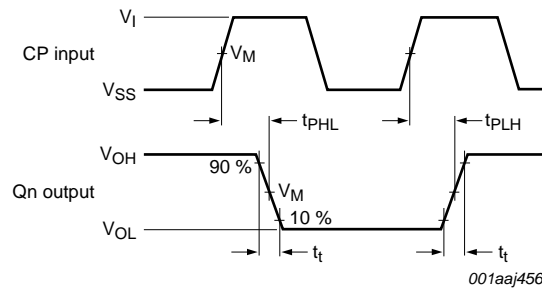
[2] t<sub>t</sub> is the same as t<sub>THL</sub> and t<sub>TLH</sub>.

**Table 8. Dynamic power dissipation  $P_D$**

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

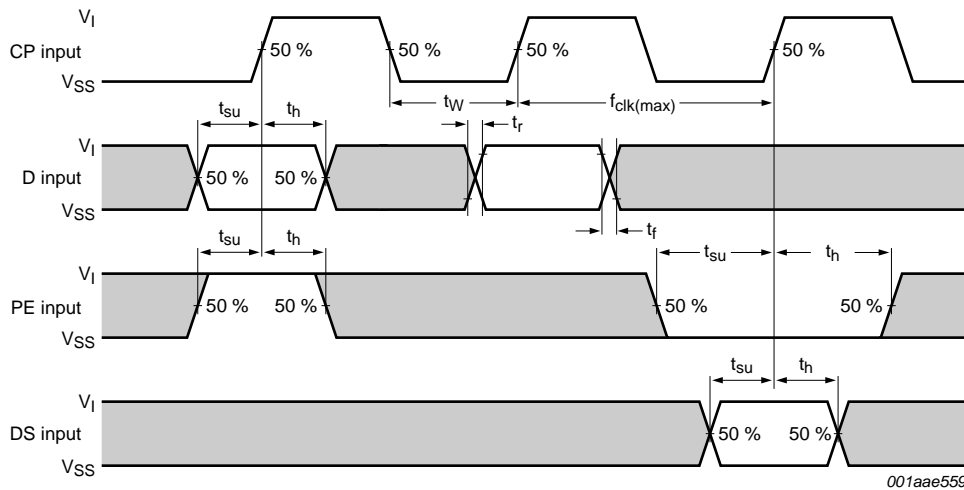
Symbol	Parameter	$V_{DD}$	Typical formula for $P_D$ ( $\mu\text{W}$ )	Where:
$P_D$	dynamic power dissipation	5 V	$P_D = 900 \times f_i + \Sigma(f_o \times C_L) \times V_{DD}^2$	$f_i$ = input frequency in MHz;
		10 V	$P_D = 4300 \times f_i + \Sigma(f_o \times C_L) \times V_{DD}^2$	$f_o$ = output frequency in MHz;
		15 V	$P_D = 12000 \times f_i + \Sigma(f_o \times C_L) \times V_{DD}^2$	$C_L$ = output load capacitance in pF;
				$V_{DD}$ = supply voltage in V;
				$\Sigma(C_L \times f_o)$ = sum of the outputs.

## 12. Waveforms



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

**Fig 4. CP to Qn propagation delays and output transition times**



The shaded areas indicate where change is permitted for predictable output performance.

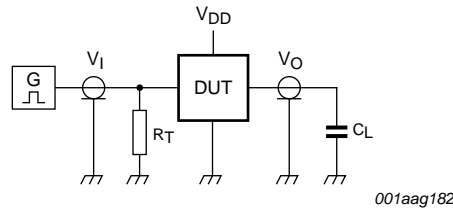
Set-up and hold times are shown as positive values but may be specified as negative values.

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

**Fig 5. Minimum clock pulse width, and set-up and hold times for PE to CP, DS to CP, and D to CP**

**Table 9. Measurement points**

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



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 6. Test circuit**

**Table 10. Test data**

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



13. Package outline

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

SOT109-1

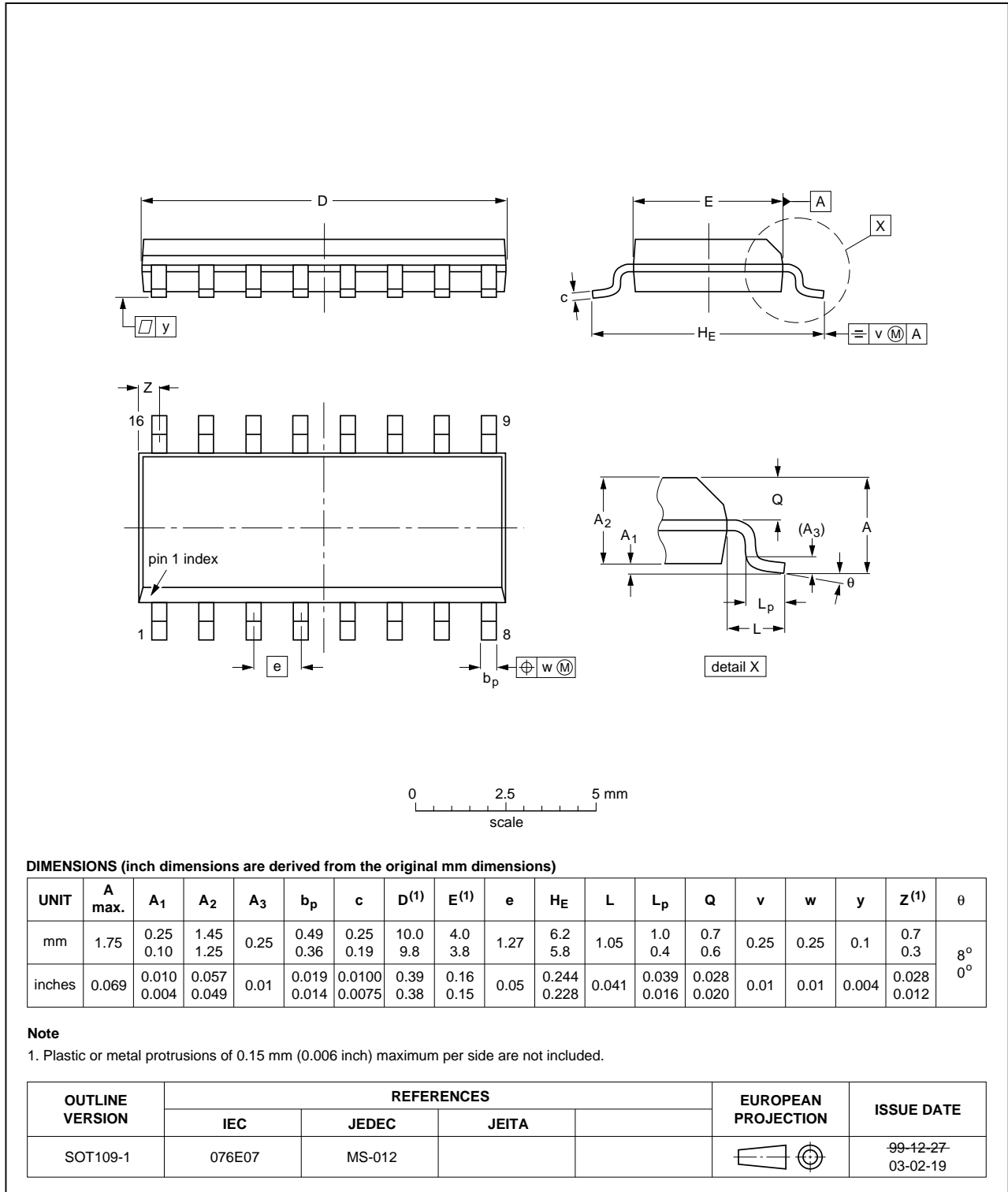


Fig 7. Package outline SOT109-1 (SO16)

## 14. Abbreviations

Table 11. Abbreviations

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

## 15. Revision history

Table 12. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
HEF4014B_Q100 v.1	20130227	Product data sheet	-	-

## 16. Legal information

### 16.1 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.
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