HEF4021B

8-bit static shift register

Rev. 04 — 10 November 2008 Product data sheet

1. General description

The HEF4021B is an 8-bit static shift register (parallel-to-serial converter) with a synchronous serial data input (DS), a clock input (CP), an asynchronous active HIGH parallel load input (PL), eight asynchronous parallel data inputs (D0 to D7) and buffered parallel outputs from the last three stages (Q5 to Q7).

Each register stage is a D-type master-slave flip-flop with a set direct (SD) and clear direct (CD) input. Information on D0 to D7 is asynchronously loaded into the register while PL is HIGH, independent of CP and DS. When PL is LOW, data on DS is shifted into the first register position and all the data in the register is shifted one position to the right on the LOW-to-HIGH transition of CP. Schmitt trigger action makes the clock input highly tolerant of slower 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. It is also suitable for use over both the industrial (–40 °C to +85 °C) and automotive (–40 °C to +125 °C) temperature ranges.

2. Features

- Tolerant of slower rise and fall times
- Fully static operation
- 5 V, 10 V, and 15 V parametric ratings
- Standardized symmetrical output characteristics
- Operates across the automotive temperature range –40 °C to +125 °C
- Complies with JEDEC standard JESD 13-B
- ESD protection:
  - HBM JESD22-A114E exceeds 2000 V
  - MM JESD22-A115-A exceeds 200 V

3. Applications

- Industrial and automotive

4. Ordering information

Table 1. Ordering information

All types operate from −40 °C to +125 °C.

Type number	Package		Version
	Name	Description	
HEF4021BP	DIP16	plastic dual in-line package; 16-leads (300 mil)	SOT38-4
HEF4021BT	SO16	plastic small outline package; 16 leads; body width 3.9 mm	SOT109-1

5. Functional diagram

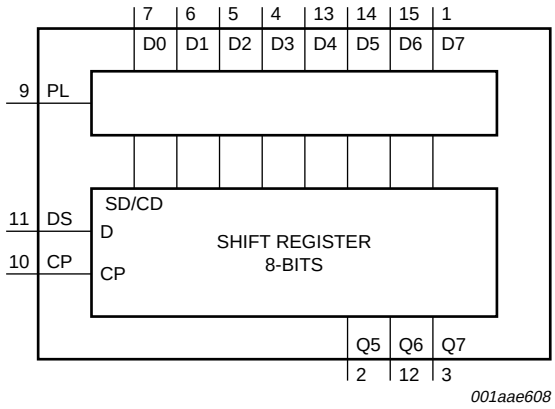


Fig 1. Functional diagram

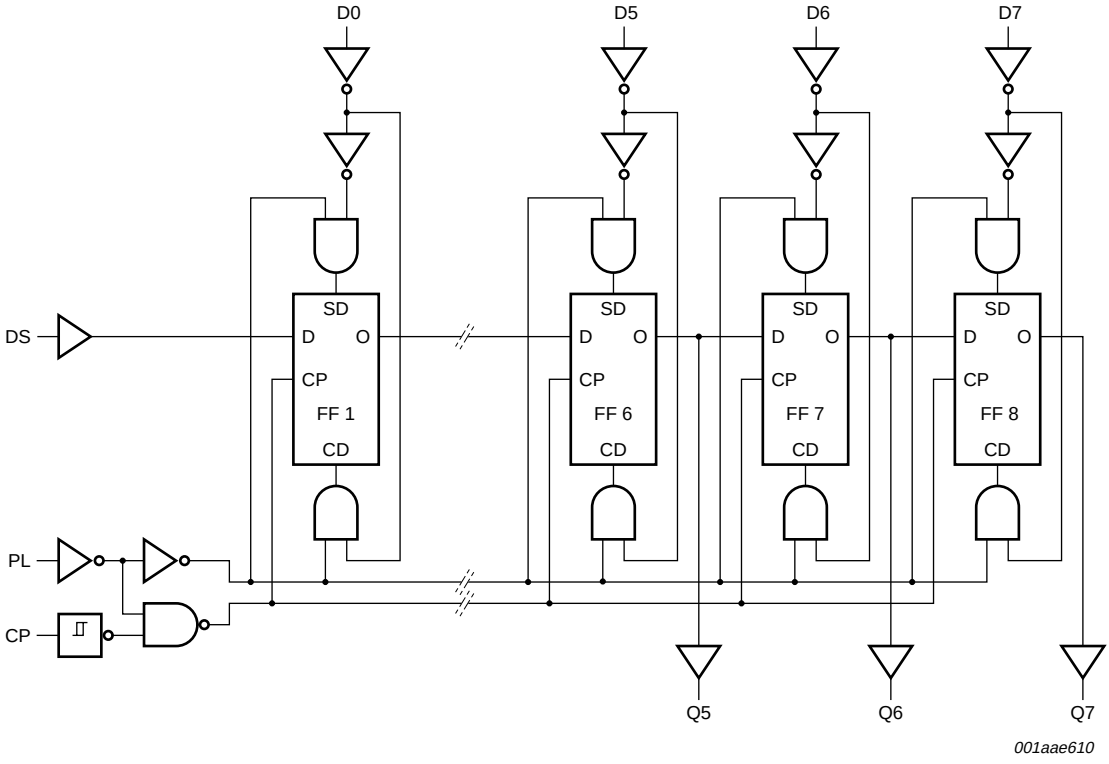


Fig 2. Logic diagram

6. Pinning information

6.1 Pinning

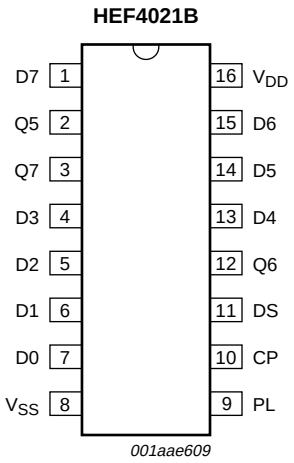


Fig 3. Pin configuration

6.2 Pin description

Table 2. Pin description

Symbol	Pin	Description
Q5 to Q7	2, 12, 3	buffered parallel output from the last three stages
D0 to D7	7, 6, 5, 4, 13, 14,15, 1	parallel data input
V_{SS}	8	ground supply voltage
PL	9	parallel load input
CP	10	clock input (LOW-to-HIGH edge-triggered)
DS	11	serial data input
V_{DD}	16	supply voltage

7. Functional description

Table 3. Function table[1]

Number of clock transitions	Inputs			Outputs		
	CP	DS	PL	Q5	Q6	Q7
Serial operation						
1	↑	data 1	L	X	X	X
2	↑	data 2	L	X	X	X
3	↑	data 3	L	X	X	X
6	↑	X	L	data 1	X	X
7	↑	X	L	data 2	data 1	X

Table 3. Function table[1] *…continued*

Number of clock transitions	Inputs			Outputs		
	CP	DS	PL	Q5	Q6	Q7
8	↑	X	L	data 3	data 2	data 1
	↓	X	L	no change	no change	no change
Parallel operation						
	X	X	H	D5	D6	D7

[1] H = HIGH voltage level; L = LOW voltage level; X = don't care;
↑ = LOW to HIGH clock transition; ↓ = HIGH to LOW clock transition;
data n = data (HIGH or LOW) on the DS input at the n^{th} ↑ CP 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	$V_I < 0.5$ V or $V_I > V_{DD} + 0.5$ V		-	±10	mA
V_I	input voltage			–0.5	$V_{DD} + 0.5$	V
I_{OK}	output clamping current	$V_O < 0.5$ V or $V_O > V_{DD} + 0.5$ 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	+125	°C
P_{tot}	total power dissipation	T_{amb} –40 °C to +125 °C				
		DIP16 package	[1]	-	750	mW
		SO16 package	[2]	-	500	mW
P	power dissipation	per output		-	100	mW

[1] For DIP16 package: P_{tot} derates linearly with 12 mW/K above 70 °C.

[2] 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	-	+125	°C
$\Delta t/\Delta V$	input transition rise and fall rate	V_{DD} = 5 V	-	-	3.75	ns/V
		V_{DD} = 10 V	-	-	0.5	ns/V
		V_{DD} = 15 V	-	-	0.08	ns/V

10. Static characteristics

Table 6. Static characteristics

V_{SS} = 0 V; V_I = V_{SS} or V_{DD} unless otherwise specified.

Symbol	Parameter	Conditions	V_{DD}	T_{amb} = −40 °C		T_{amb} = 25 °C		T_{amb} = 85 °C		T_{amb} = 125 °C		Unit
				Min	Max	Min	Max	Min	Max	Min	Max	
V_{IH}	HIGH-level input voltage	$\|I_O\|$ < 1 µA	5 V	3.5	-	3.5	-	3.5	-	3.5	-	V
			10 V	7.0	-	7.0	-	7.0	-	7.0	-	V
			15 V	11.0	-	11.0	-	11.0	-	11.0	-	V
V_{IL}	LOW-level input voltage	$\|I_O\|$ < 1 µA	5 V	-	1.5	-	1.5	-	1.5	-	1.5	V
			10 V	-	3.0	-	3.0	-	3.0	-	3.0	V
			15 V	-	4.0	-	4.0	-	4.0	-	4.0	V
V_{OH}	HIGH-level output voltage	$\|I_O\|$ < 1 µA	5 V	4.95	-	4.95	-	4.95	-	4.95	-	V
			10 V	9.95	-	9.95	-	9.95	-	9.95	-	V
			15 V	14.95	-	14.95	-	14.95	-	14.95	-	V
V_{OL}	LOW-level output voltage	$\|I_O\|$ < 1 µA	5 V	-	0.05	-	0.05	-	0.05	-	0.05	V
			10 V	-	0.05	-	0.05	-	0.05	-	0.05	V
			15 V	-	0.05	-	0.05	-	0.05	-	0.05	V
I_{OH}	HIGH-level output current	V_O = 2.5 V	5 V	−1.7	-	−1.4	-	−1.1	-	−1.1	-	mA
		V_O = 4.6 V	5 V	−0.64	-	−0.5	-	−0.36	-	−0.36	-	mA
		V_O = 9.5 V	10 V	−1.6	-	−1.3	-	−0.9	-	−0.9	-	mA
		V_O = 13.5 V	15 V	−4.2	-	−3.4	-	−2.4	-	−2.4	-	mA
I_{OL}	LOW-level output current	V_O = 0.4 V	5 V	0.64	-	0.5	-	0.36	-	0.36	-	mA
		V_O = 0.5 V	10 V	1.6	-	1.3	-	0.9	-	0.9	-	mA
		V_O = 1.5 V	15 V	4.2	-	3.4	-	2.4	-	2.4	-	mA
I_I	input leakage current	V_{DD} = 15 V	15 V	-	±0.1	-	±0.1	-	±1.0	-	±1.0	µA
I_{DD}	supply current	I_O = 0 A	5 V	-	5	-	5	-	150	-	150	µA
			10 V	-	10	-	10	-	300	-	300	µA
			15 V	-	20	-	20	-	600	-	600	µA
C_I	input capacitance		-	-	-	-	7.5	-	-	-	-	pF

11. Dynamic characteristics

Table 7. Dynamic characteristics

V_{SS} = 0 V; T_{amb} = 25 °C; for test circuit see Figure 7; unless otherwise specified.

Symbol	Parameter	Conditions	V_{DD}		Extrapolation formula	Min	Typ	Max	Unit
t_{PHL}	HIGH to LOW propagation delay	CP to Qn see Figure 4	5 V	[1]	98 ns + (0.55 ns/pF) C_L	-	125	250	ns
			10 V		44 ns + (0.23 ns/pF) C_L	-	55	110	ns
			15 V		32 ns + (0.16 ns/pF) C_L	-	40	80	ns
		PL to Qn see Figure 4	5 V		93 ns + (0.55 ns/pF) C_L	-	120	240	ns
			10 V		44 ns + (0.23 ns/pF) C_L	-	55	110	ns
			15 V		32 ns + (0.16 ns/pF) C_L	-	40	80	ns

Table 7. Dynamic characteristics *…continued*

V_{SS} = 0 V; T_{amb} = 25 °C; for test circuit see Figure 7; unless otherwise specified.

Symbol	Parameter	Conditions	V_{DD}		Extrapolation formula	Min	Typ	Max	Unit
t_{PLH}	LOW to HIGH propagation delay	CP to Qn see Figure 4	5 V	[1]	88 ns + (0.55 ns/pF) C_L	-	115	230	ns
			10 V		39 ns + (0.23 ns/pF) C_L	-	50	100	ns
			15 V		32 ns + (0.16 ns/pF) C_L	-	40	80	ns
		PL to Qn see Figure 4	5 V		78 ns + (0.55 ns/pF) C_L	-	105	210	ns
			10 V		39 ns + (0.23 ns/pF) C_L	-	50	100	ns
			15 V		32 ns + (0.16 ns/pF) C_L	-	40	80	ns
t_t	transition time	Qn; see Figure 4	5 V	[1]	10 ns + (1.00 ns/pF) C_L	-	60	120	ns
			10 V		9 ns + (0.42 ns/pF) C_L	-	30	60	ns
			15 V		6 ns + (0.28 ns/pF) C_L	-	20	40	ns
t_{su}	set-up time	DS to CP; see Figure 5	5 V			+25	–15	-	ns
			10 V			+25	–10	-	ns
			15 V			+15	–5	-	ns
		Dn to PL; see Figure 6	5 V			50	25	-	ns
			10 V			30	10	-	ns
			15 V			20	5	-	ns
t_h	hold time	DS to CP; see Figure 5	5 V			40	20	-	ns
			10 V			20	10	-	ns
			15 V			15	8	-	ns
		Dn to PL; see Figure 6	5 V			+15	–10	-	ns
			10 V			15	0	-	ns
			15 V			15	0	-	ns
t_W	pulse width	CP = LOW; minimum width; see Figure 5	5 V			70	35	-	ns
			10 V			30	15	-	ns
			15 V			24	12	-	ns
		PL = HIGH; minimum width; see Figure 6	5 V			70	35	-	ns
			10 V			30	15	-	ns
			15 V			24	12	-	ns
t_{rec}	recovery time	PL input; see Figure 6	5 V			50	10	-	ns
			10 V			40	5	-	ns
			15 V			35	5	-	ns
$f_{clk(max)}$	maximum clock frequency	CP input; see Figure 5	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_L in pF).

Table 8. Dynamic power dissipation P_D

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

Symbol	Parameter	V_{DD}	Typical formula for P_D (μW)	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

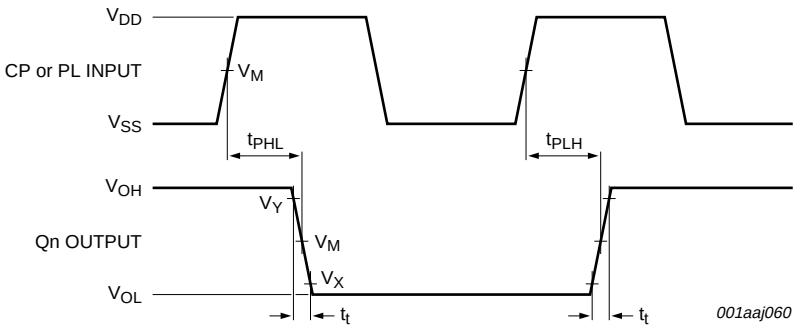


Fig 4. Waveforms showing propagation delays for CP and PL inputs to Qn output and Qn transition times

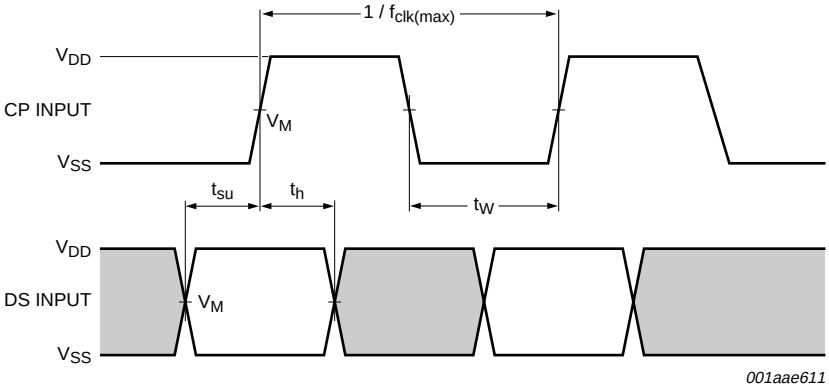
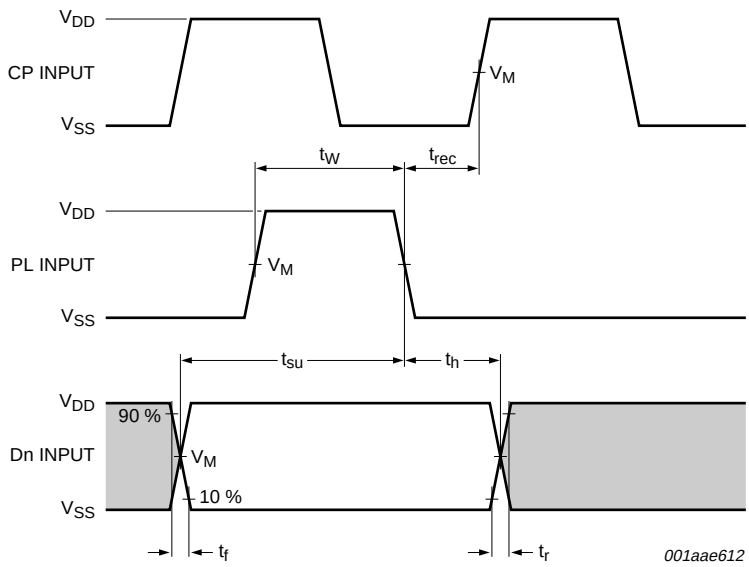


Fig 5. Waveforms showing minimum clock pulse width, set-up time, and hold time for CP and DS.

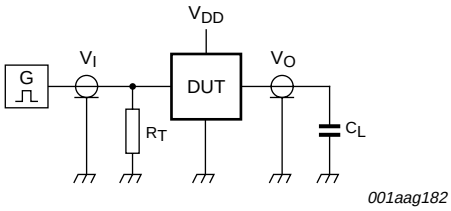


Set-up times and hold times are shown as positive values but may be specified as negative values;
Measurement points are given in Table 9.

Fig 6. Waveforms showing minimum pulse width and recovery time for PL; set-up and hold times for Dn to PL.

Table 9. Measurement points

Supply voltage	Input	Output		
V_{DD}	V_M	V_M	V_X	V_Y
5 V to 15 V	$0.5V_{DD}$	$0.5V_{DD}$	$0.1V_{DD}$	$0.9V_{DD}$



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.

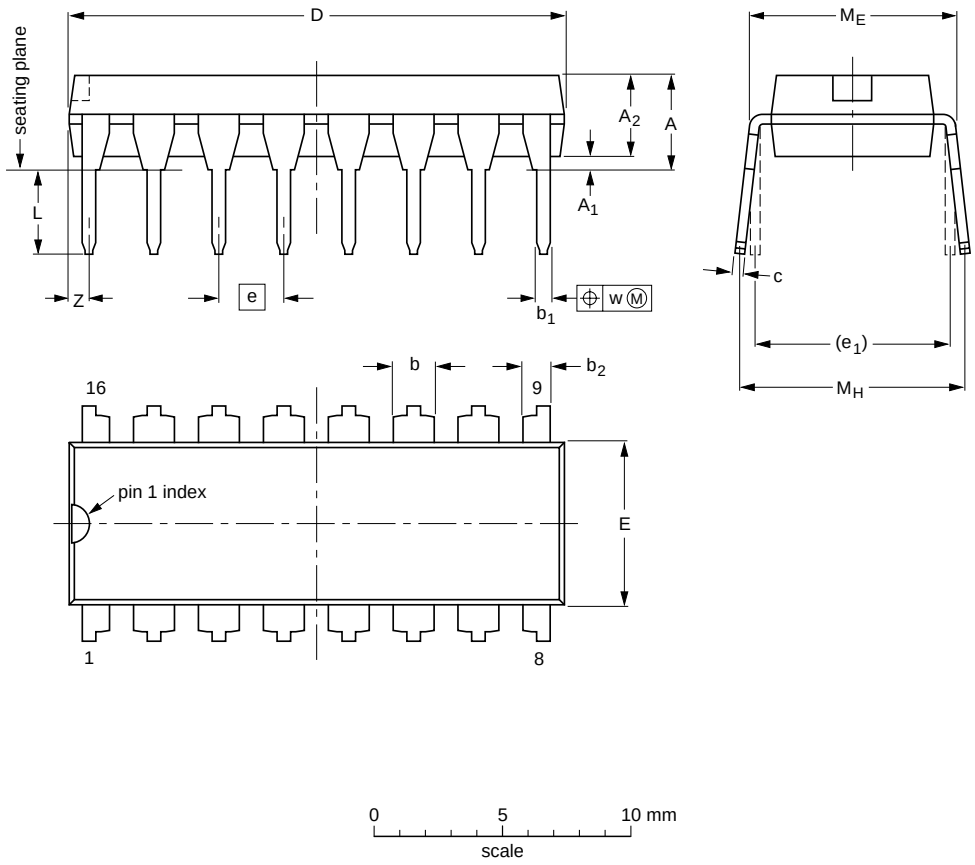
Fig 7. Test circuit

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

13. Package outline

DIP16: plastic dual in-line package; 16 leads (300 mil) **SOT38-4**



DIMENSIONS (inch dimensions are derived from the original mm dimensions)

UNIT	A max.	A_1 min.	A_2 max.	b	b_1	b_2	c	D (1)	E (1)	e	e_1	L	M_E	M_H	w	Z (1) max.
mm	4.2	0.51	3.2	1.73 1.30	0.53 0.38	1.25 0.85	0.36 0.23	19.50 18.55	6.48 6.20	2.54	7.62	3.60 3.05	8.25 7.80	10.0 8.3	0.254	0.76
inches	0.17	0.02	0.13	0.068 0.051	0.021 0.015	0.049 0.033	0.014 0.009	0.77 0.73	0.26 0.24	0.1	0.3	0.14 0.12	0.32 0.31	0.39 0.33	0.01	0.03

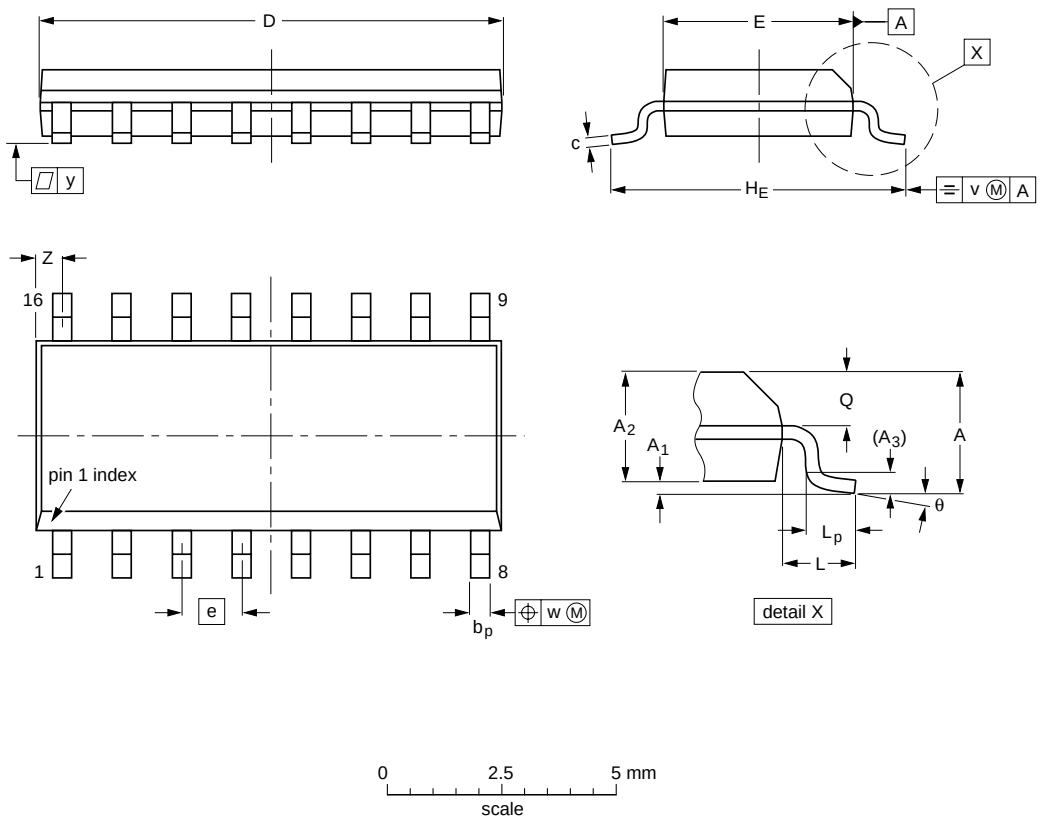
Note

1. Plastic or metal protrusions of 0.25 mm (0.01 inch) maximum per side are not included.

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	JEITA			
SOT38-4						~~95-01-14~~ 03-02-13

Fig 8. Package outline SOT38-4 (DIP16)

SO16: plastic small outline package; 16 leads; body width 3.9 mm **SOT109-1**



DIMENSIONS (inch dimensions are derived from the original mm dimensions)

UNIT	A max.	A_1	A_2	A_3	b_p	c	$D^{(1)}$	$E^{(1)}$	e	H_E	L	L_p	Q	v	w	y	$Z^{(1)}$	θ
mm	1.75	0.25 0.10	1.45 1.25	0.25	0.49 0.36	0.25 0.19	10.0 9.8	4.0 3.8	1.27	6.2 5.8	1.05	1.0 0.4	0.7 0.6	0.25	0.25	0.1	0.7 0.3	8^o 0^o
inches	0.069	0.010 0.004	0.057 0.049	0.01	0.019 0.014	0.0100 0.0075	0.39 0.38	0.16 0.15	0.05	0.244 0.228	0.041	0.039 0.016	0.028 0.020	0.01	0.01	0.004	0.028 0.012	

Note

1. Plastic or metal protrusions of 0.15 mm (0.006 inch) maximum per side are not included.

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	JEITA			
SOT109-1	076E07	MS-012				~~99-12-27~~ 03-02-19

Fig 9. Package outline SOT109-1 (SO16)

14. Abbreviations

Table 11. Abbreviations

Acronym	Description
DUT	Device Under Test
ESD	ElectroStatic Discharge
HBM	Human Body Model
MM	Machine Model

15. Revision history

Table 12. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
HEF4021B_4	20081110	Product data sheet	-	HEF4021B_CNV_3
Modifications:	• The format of this data sheet has been redesigned to comply with the new identity guidelines of NXP Semiconductors. • Legal texts have been adapted to the new company name where appropriate. • Pins renamed throughout, see Figure 3 “Pin configuration” and Table 2 “Pin description”. • Maximum temperature increased throughout and 125 °C data added to Table 6 “Static characteristics”. • Section 2 “Features” added. • Package version SOT38-1 changed to SOT38-4 in Section 4, and Figure 8. Package SOT74 removed from Section 4. • Table 1 “Ordering information” restructured. • Section 8 “Limiting values” and Section 10 “Static characteristics” added, taken from the HE4000B Family Specifications data sheet. • I_{DD}, I_{OL}, I_{OH} and I_I values updated in Section 10 “Static characteristics”. • Section 9 “Recommended operating conditions” added. • Figure references added to table Table 7 “Dynamic characteristics”. • t_{hold}, t_{WCPL}, t_{WPLH} and t_{RPL} changed to t_h, t_W and t_{rec} for Table 7, Figure 5 and Figure 6. • 50 % changed to V_M for Figure 5 and 6. • Table 9 “Measurement points”, Figure 7 “Test circuit” and Table 10 “Test data” added.			
HEF4021B_CNV_3	19950101	Product specification	-	HEF4021B_CNV_2
HEF4021B_CNV_2	19950101	Product specification	-	-

16. Legal information

16.1 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.

[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".

[3] The product status of device(s) described in this document may have changed since this document was published and may differ in case of multiple devices. The latest product status information is available on the Internet at URL http://www.nxp.com.

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18. Contents

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