HEF4020B

14-stage binary counter

Rev. 04 — 4 December 2008 Product data sheet

1. General description

The HEF4020B is a 14-stage binary counter with a clock input ($\overline{CP}$), an overriding asynchronous master reset input (MR) and twelve fully buffered outputs (Q0, and Q3 to Q13). 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 the state of $\overline{CP}$. Each counter stage is a static toggle flip-flop. A feature of the device is its high speed (typ. 35 MHz at V_{DD} = 15 V).

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 the full industrial (–40 °C to +85 °C) temperature range.

2. Features

- High speed operation
- Fully static operation
- 5 V, 10 V, and 15 V parametric ratings
- Standardized symmetrical output characteristics
- Operates across the full industrial temperature range –40 °C to +85 °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

4. Ordering information

Table 1. Ordering information

All types operate from –40 °C to +85 °C.

Type number	Package		
	Name	Description	Version
HEF4020BP	DIP16	plastic dual in-line package; 16-leads (300 mil)	SOT38-4
HEF4020BT	SO16	plastic small outline package; 16 leads; body width 3.9 mm	SOT109-1

5. Functional diagram

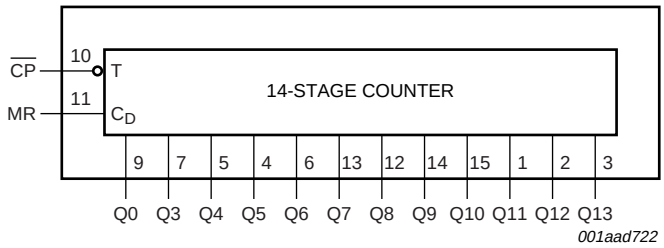


Fig 1. Functional diagram

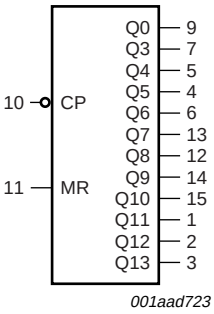


Fig 2. Logic symbol

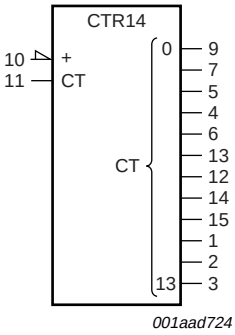


Fig 3. IEC Logic symbol

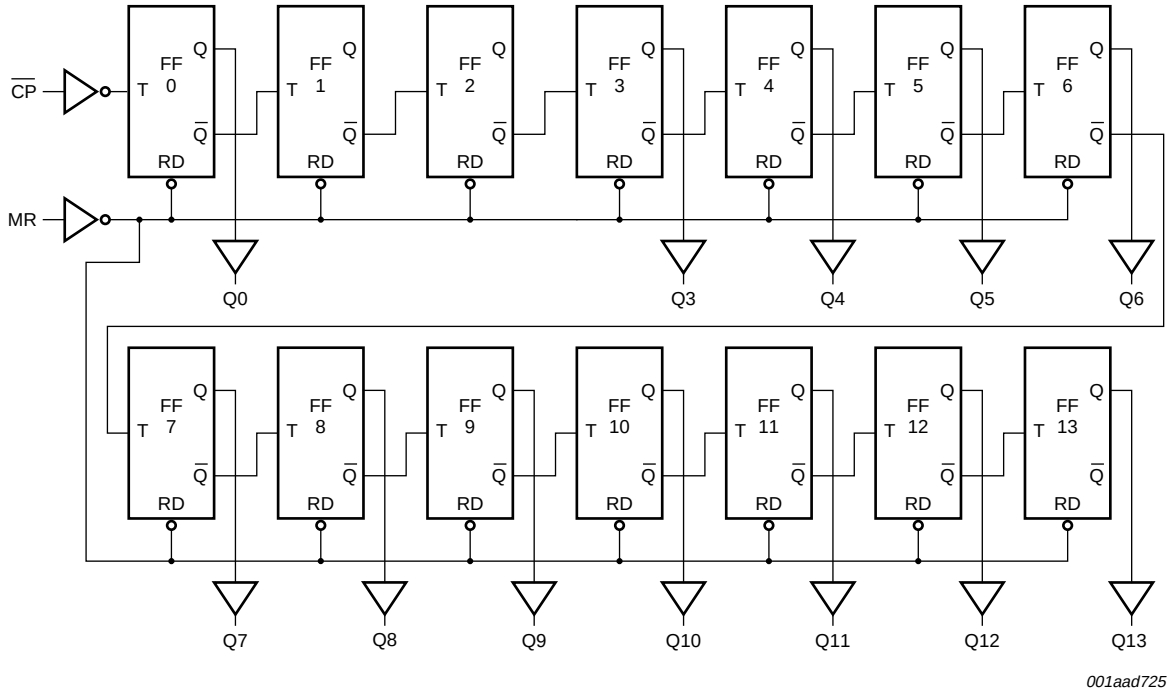


Fig 4. Logic diagram

6. Pinning information

6.1 Pinning

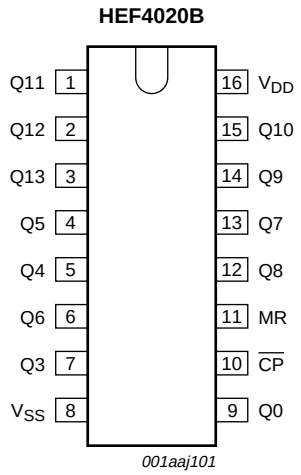


Fig 5. Pin configuration

6.2 Pin description

Table 2. Pin description

Symbol	Pin	Description
Q3 to Q13	7, 5, 4, 6, 13, 12, 14, 15, 1, 2, 3	parallel output (Q3 to Q13)
V_{SS}	8	ground supply voltage
Q0	9	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. Functional description

Table 3. Functional table[1]

Input		Output
CP	**MR**	**Q0, Q3 to Q13**
↑	L	no change
↓	L	count
X	H	L

[1] H = HIGH voltage level; L = LOW voltage level; X = don't care; ↑ = positive-going transition; ↓ = negative-going transition.

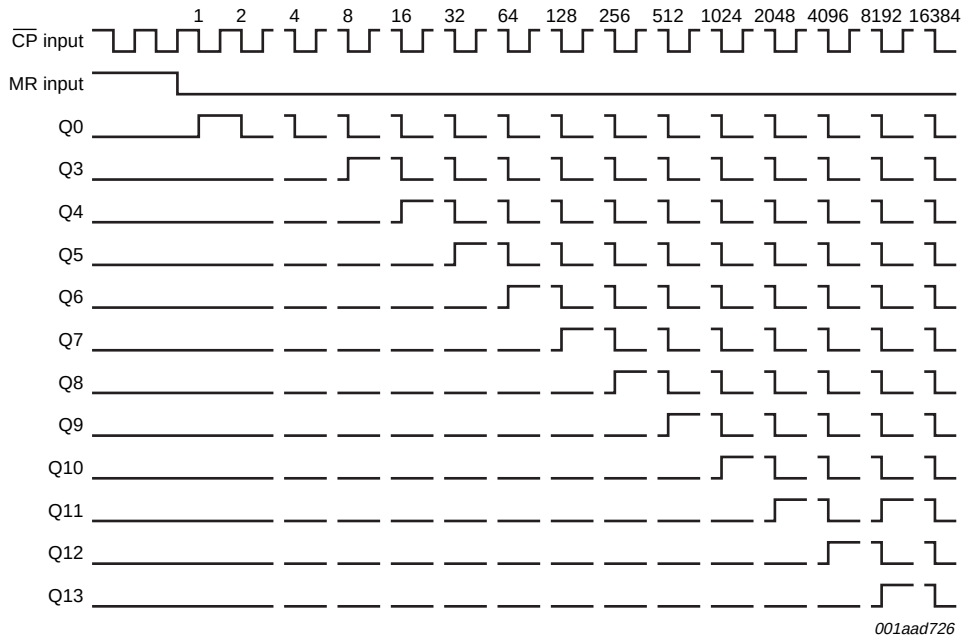


Fig 6. Timing diagram

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	+85	°C
P_{tot}	total power dissipation	T_{amb} –40 °C to +85 °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	-	+85	°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		Unit
				Min	Max	Min	Max	Min	Max	
V_{IH}	HIGH-level input voltage	$\|I_O\|$ < 1 µA	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 µA	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 µA	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 µA	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 V	5 V	–1.7	-	–1.4	-	–1.1	-	mA
		V_O = 4.6 V	5 V	–0.52	-	–0.44	-	–0.36	-	mA
		V_O = 9.5 V	10 V	–1.3	-	–1.1	-	–0.9	-	mA
		V_O = 13.5 V	15 V	–3.6	-	–3.0	-	–2.4	-	mA
I_{OL}	LOW-level output current	V_O = 0.4 V	5 V	0.52	-	0.44	-	0.36	-	mA
		V_O = 0.5 V	10 V	1.3	-	1.1	-	0.9	-	mA
		V_O = 1.5 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 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

11. Dynamic characteristics

Table 7. Dynamic characteristics

V_{SS} = 0 V; T_{amb} = 25 °C; for test circuit see Figure 8.

Symbol	Parameter	Conditions	V_{DD}	Extrapolation formula[1]	Min	Typ	Max	Unit
t_{PHL}	HIGH to LOW propagation delay	CP to Q0; see Figure 7	5 V	78 ns + (0.55 ns/pF) C_L	-	105	210	ns
			10 V	34 ns + (0.23 ns/pF) C_L	-	45	90	ns
			15 V	22 ns + (0.16 ns/pF) C_L	-	30	65	ns
		Qn to Qn + 1	5 V	53 ns + (0.55 ns/pF) C_L	-	80	160	ns
			10 V	19 ns + (0.23 ns/pF) C_L	-	30	60	ns
			15 V	12 ns + (0.16 ns/pF) C_L	-	20	40	ns
		MR to Qn; see Figure 7	5 V	153 ns + (0.55 ns/pF) C_L	-	180	360	ns
			10 V	79 ns + (0.23 ns/pF) C_L	-	90	180	ns
			15 V	62 ns + (0.16 ns/pF) C_L	-	70	140	ns
t_{PLH}	LOW to HIGH propagation delay	CP to Q0; see Figure 7	5 V	78 ns + (0.55 ns/pF) C_L	-	105	210	ns
			10 V	39 ns + (0.23 ns/pF) C_L	-	50	95	ns
			15 V	27 ns + (0.16 ns/pF) C_L	-	35	70	ns
		Qn to Qn + 1	5 V	43 ns + (0.55 ns/pF) C_L	-	70	140	ns
			10 V	14 ns + (0.23 ns/pF) C_L	-	25	50	ns
			15 V	12 ns + (0.16 ns/pF) C_L	-	20	40	ns
t_t	transition time	see Figure 7	5 V	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_W	pulse width	CP = HIGH; minimum width; see Figure 7	5 V		50	25	-	ns
			10 V		25	15	-	ns
			15 V		20	10	-	ns
		MR = HIGH; minimum width; see Figure 7	5 V		130	65	-	ns
			10 V		95	50	-	ns
			15 V		90	45	-	ns
t_{rec}	recovery time	MR input; see Figure 7	5 V		115	60	-	ns
			10 V		65	35	-	ns
			15 V		55	25	-	ns
f_{max}	maximum frequency	see Figure 7	5 V		5	10	-	MHz
			10 V		13	25	-	MHz
			15 V		18	35	-	MHz

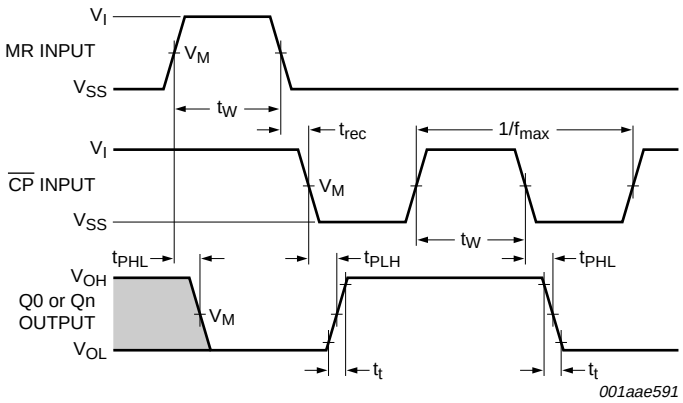
[1] The typical values of the propagation delay and transition times are calculated from the extrapolation formulas shown (C_L in pF).

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	$P_D = 600 \times f_i + \Sigma(f_o \times C_L) \times V_{DD}^2$	f_i = input frequency in MHz,
		10 V	$P_D = 2800 \times f_i + \Sigma(f_o \times C_L) \times V_{DD}^2$	f_o = output frequency in MHz,
		15 V	$P_D = 8200 \times f_i + \Sigma(f_o \times C_L) \times V_{DD}^2$	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

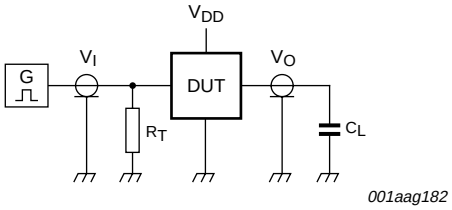


Measurement points are given in Table 9.

Fig 7. Propagation delays, minimum pulse widths, transition and recovery times and maximum clock frequency

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.

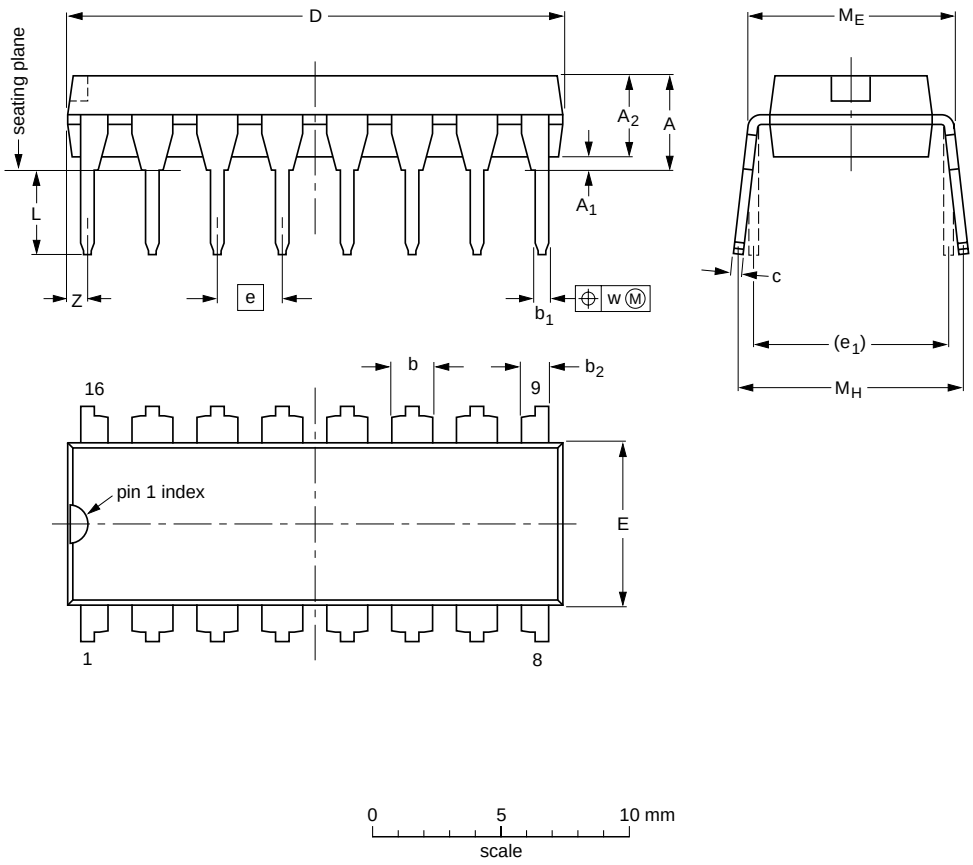
Fig 8. Test circuit

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

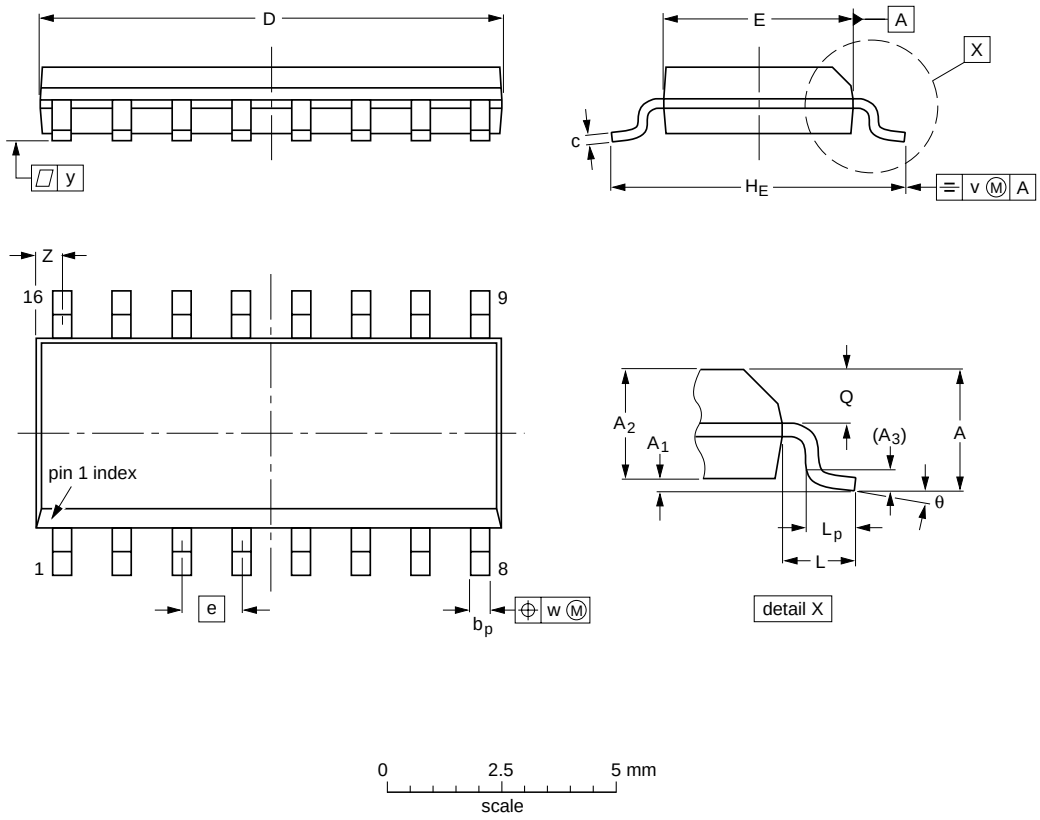
Note

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 9. 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 10. 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
HEF4020B_4	20081204	Product data sheet	-	HEF4020B_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. • Parallel output pins renamed Q0 to Q13 throughout. • Temperature statement added to Section 1 “General description”. • Section 2 “Features” added. • Table 1 “Ordering information” restructured. • Package version SOT38-1 changed to SOT38-4 in Section 4, and Figure 9. Package SOT74 removed from Section 4. • Figure 1 “Functional diagram”, Figure 4 “Logic diagram”, Figure 5 “Pin configuration”, Figure 7 “Propagation delays, minimum pulse widths, transition and recovery times and maximum clock frequency” and Figure 6 “Timing diagram” changed for pin name changes. • Figure 2 “Logic symbol” and Figure 3 “IEC Logic symbol” added. • Table 2 “Pin description” edited for pin name changes. • Section 7 “Functional description” added. • Section 8 “Limiting values” and Section 10 “Static characteristics” added, taken from the HE4000B Family Specifications data sheet. • t_{RMR}, t_{WCPH} and t_{WMRH} changed to t_{rec} and t_W for Table 7 “Dynamic characteristics” and Figure 7 “Propagation delays, minimum pulse widths, transition and recovery times and maximum clock frequency”. • 50 % replaced by V_M for Figure 7 “Propagation delays, minimum pulse widths, transition and recovery times and maximum clock frequency”. • Table 9 “Measurement points”, Figure 8 “Test circuit” and Table 10 “Test data” added.			
HEF4020B_CNV_3	19950101	Product specification	-	HEF4020B_CNV_2
HEF4020B_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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