HEF4024B

7-stage binary counter

Rev. 05 — 9 November 2009 Product data sheet

1. General description

The HEF4024B is a 7-stage binary ripple counter with a clock input ($\overline{CP}$), and overriding asynchronous master reset input (MR) and seven fully buffered parallel outputs (Q0 to Q6). 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.

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

- Tolerant of slow clock rise and fall time
- 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

3. Applications

- Frequency dividers
- Time delay circuits

4. Ordering information

Table 1. Ordering information

All types operate from –40 °C to +125 °C

Type number	Package		
	Name	Description	Version
HEF4024BP	DIP14	plastic dual in-line package; 14 leads (300 mil)	SOT27-1
HEF4024BT	SO14	plastic small outline package; 14 leads; body width 3.9 mm	SOT108-1

5. Functional diagram

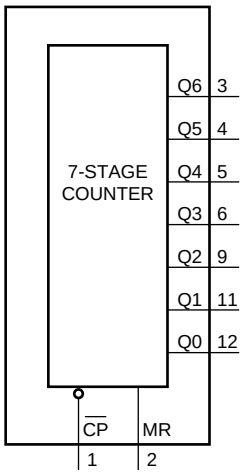


Fig 1. Functional diagram

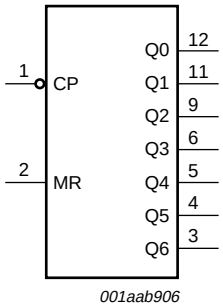


Fig 2. Logic symbol

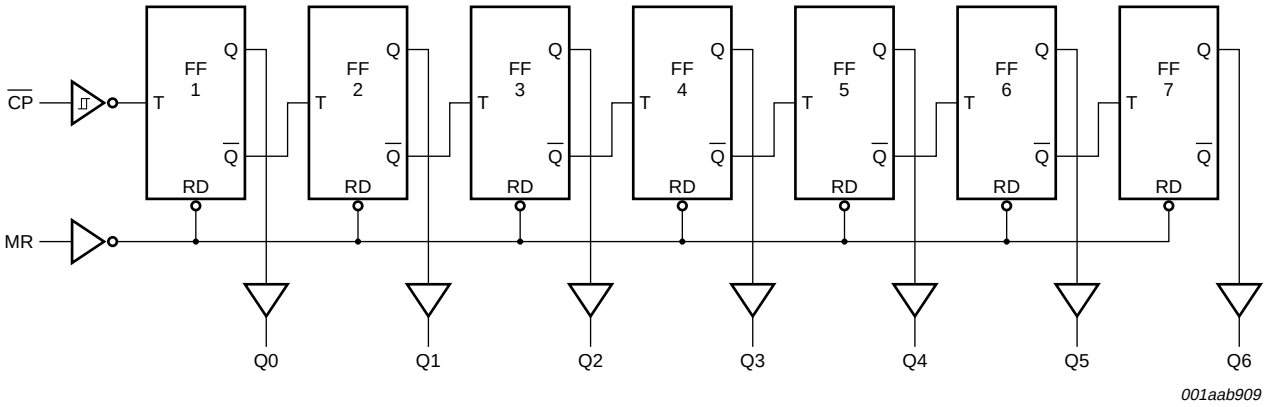


Fig 3. Logic diagram

6. Pinning information

6.1 Pinning

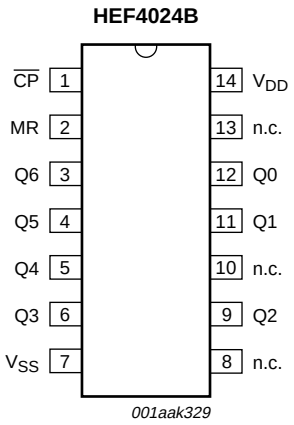


Fig 4. Pin configuration

6.2 Pin description

Table 2. Pin description

Symbol	Pin	Description
$\overline{CP}$	1	clock input (HIGH to LOW edge-triggered)
MR	2	master reset input
V_{SS}	7	ground (0 V)
n.c.	8, 10, 13	not connected
Q0 to Q6	12, 11, 9, 6, 5, 4, 3,	buffered parallel outputs
V_{DD}	14	supply voltage

7. Functional description

Table 3. Functional table[1]

Input		Output
$\overline{CP}$	MR	Q0 to Q6
↑	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.

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	in free air		–40	+85	°C
P_{tot}	total power dissipation	T_{amb} –40 °C to +85 °C				
		DIP14 package	[1]	-	750	mW
		SO14 package	[2]	-	500	mW
P	power dissipation	per output		-	100	mW

[1] For DIP14 package: P_{tot} derates linearly with 12 mW/K above 70 °C.

[2] For SO14 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	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	µs/V
		V_{DD} = 10 V	-	0.5	µs/V
		V_{DD} = 15 V	-	0.08	µs/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

Table 6. Static characteristics *...continued*

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_{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	-	30	µA
			10 V	-	40	-	40	-	60	µA
			15 V	-	80	-	80	-	120	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 6; unless otherwise specified.

Symbol	Parameter	Conditions	V_{DD}	Extrapolation formula[1]	Min	Typ	Max	Unit
t_{PHL}	HIGH to LOW propagation delay	$\overline{CP}$ → Q0; see Figure 5	5 V	73 ns + (0.55 ns/pF)C_L	-	100	200	ns
			10 V	29 ns + (0.23 ns/pF)C_L	-	40	75	ns
			15 V	17 ns + (0.16 ns/pF)C_L	-	25	50	ns
		Qn → Qn + 1; see Figure 5	5 V	33 ns + (0.55 ns/pF)C_L	-	60	120	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
		MR → Qn; see Figure 5	5 V	93 ns + (0.55 ns/pF)C_L	-	120	240	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	60	ns
t_{PLH}	LOW to HIGH propagation delay	$\overline{CP}$ → Q0; see Figure 5	5 V	78 ns + (0.55 ns/pF)C_L	-	105	210	ns
			10 V	34 ns + (0.23 ns/pF)C_L	-	45	85	ns
			15 V	22 ns + (0.16 ns/pF)C_L	-	30	60	ns
		Qn → Qn + 1 see Figure 5	5 V	23 ns + (0.55 ns/pF)C_L	-	50	100	ns
			10 V	9 ns + (0.23 ns/pF)C_L	-	20	40	ns
			15 V	7 ns + (0.16 ns/pF)C_L	-	15	30	ns

Table 7. Dynamic characteristics *…continued*

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

Symbol	Parameter	Conditions	V_{DD}	Extrapolation formula[1]	Min	Typ	Max	Unit
t_t	transition time	see Figure 5	5 V [2]	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	$\overline{CP}$ HIGH; minimum width see Figure 5	5 V		60	30	-	ns
			10 V		30	15	-	ns
			15 V		20	10	-	ns
		MR HIGH; minimum width see Figure 5	5 V		80	40	-	ns
			10 V		35	20	-	ns
			15 V		25	15	-	ns
t_{rec}	recovery time	MR; see Figure 5	5 V		20	10	-	ns
			10 V		15	5	-	ns
			15 V		15	5	-	ns
f_{max}	maximum frequency	$\overline{CP}$ input; J = K = HIGH; see Figure 5	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).

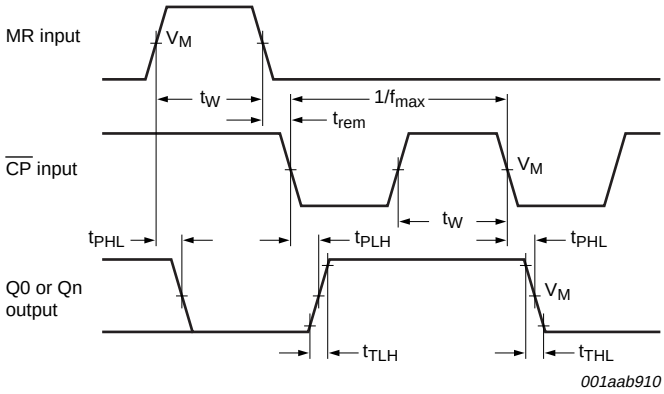
[2] t_t is the same as t_{TLH} and t_{THL}.

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	$P_D = 500 \times f_i + \Sigma(f_o \times C_L) \times V_{DD}^2$	f_i = input frequency in MHz;
		10 V	$P_D = 2100 \times f_i + \Sigma(f_o \times C_L) \times V_{DD}^2$	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.

12. Waveforms



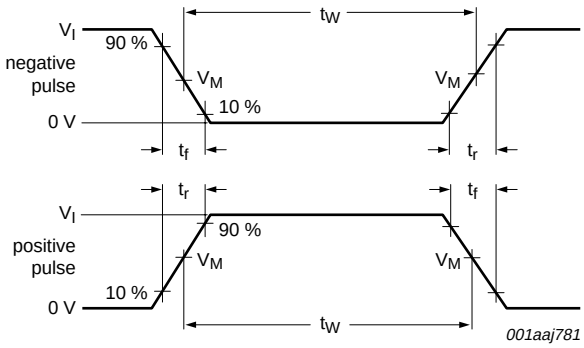
V_{OH} and V_{OL} are typical output voltages levels that occur with the output load.

Measurement points are given in Table 9.

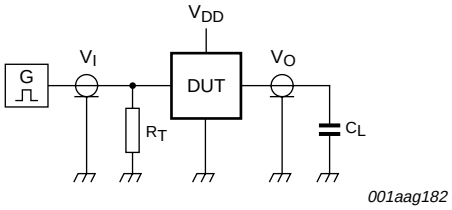
Fig 5. Waveforms showing propagation delays for MR to Qn and $\overline{CP}$ to Q0, minimum MR and $\overline{CP}$ pulse widths and recovery time for MR.

Table 9. Measurement points

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



a. Input waveforms



b. Test circuit

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.

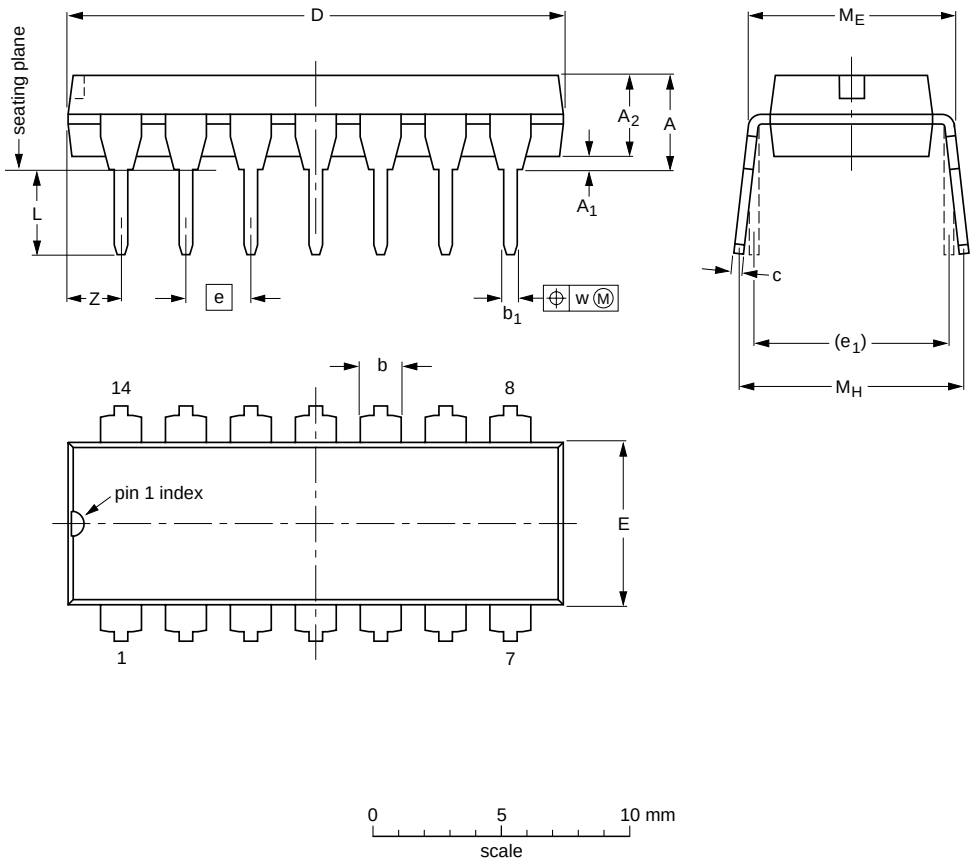
Fig 6. Test circuit for measuring switching times

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

DIP14: plastic dual in-line package; 14 leads (300 mil) **SOT27-1**



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

UNIT	A max.	A_1 min.	A_2 max.	b	b_1	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 1.13	0.53 0.38	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	2.2
inches	0.17	0.02	0.13	0.068 0.044	0.021 0.015	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	0.087

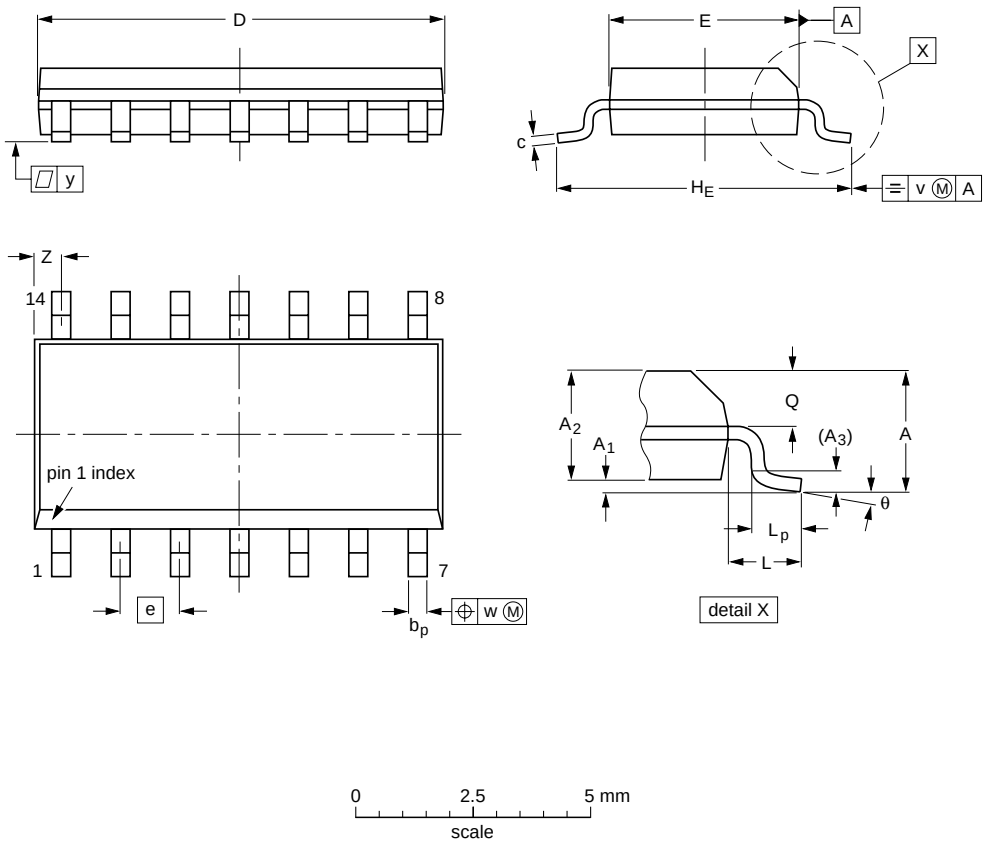
Note

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			
SOT27-1	050G04	MO-001	SC-501-14			~~99-12-27~~ 03-02-13

Fig 7. Package outline SOT27-1 (DIP14)

SO14: plastic small outline package; 14 leads; body width 3.9 mm **SOT108-1**



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	8.75 8.55	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	0.35 0.34	0.16 0.15	0.05	0.244 0.228	0.041	0.039 0.016	0.028 0.024	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			
SOT108-1	076E06	MS-012				~~99-12-27~~ 03-02-19

Fig 8. Package outline SOT108-1 (SO14)

14. Revision history

Table 11. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
HEF4024B_5	20091109	Product data sheet	-	HEF4024B_4
Modifications:	• Section 9 “Recommended operating conditions” Δt/ΔV values updated.			
HEF4024B_4	20090902	Product data sheet	-	HEF4024B_CNV_3
HEF4024B_CNV_3	19950101	Product specification	-	HEF4024B_CNV_2
HEF4024B_CNV_2	19950101	Product specification	-	-

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.

[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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17. Contents

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