

HEF4040B

12-stage binary ripple counter

Rev. 9 — 23 March 2016

Product data sheet

1. General description

The HEF4040B 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.

2. Features and benefits

- Tolerant of slow clock rise and fall time
- Fully static operation
- 5 V, 10 V, and 15 V parametric ratings
- Standardized symmetrical output characteristics
- Specified from $-40\text{ }^{\circ}\text{C}$ to $+85\text{ }^{\circ}\text{C}$
- 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		
	Name	Description	Version
HEF4040BT	SO16	plastic small outline package; 16 leads; body width 3.9 mm	SOT109-1

5. Functional diagram

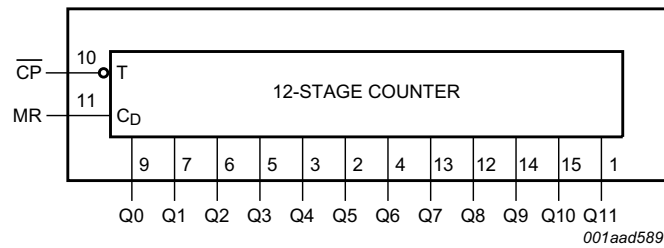


Fig 1. Functional diagram

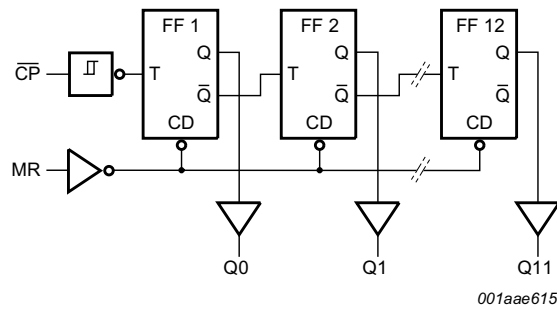


Fig 2. Logic diagram

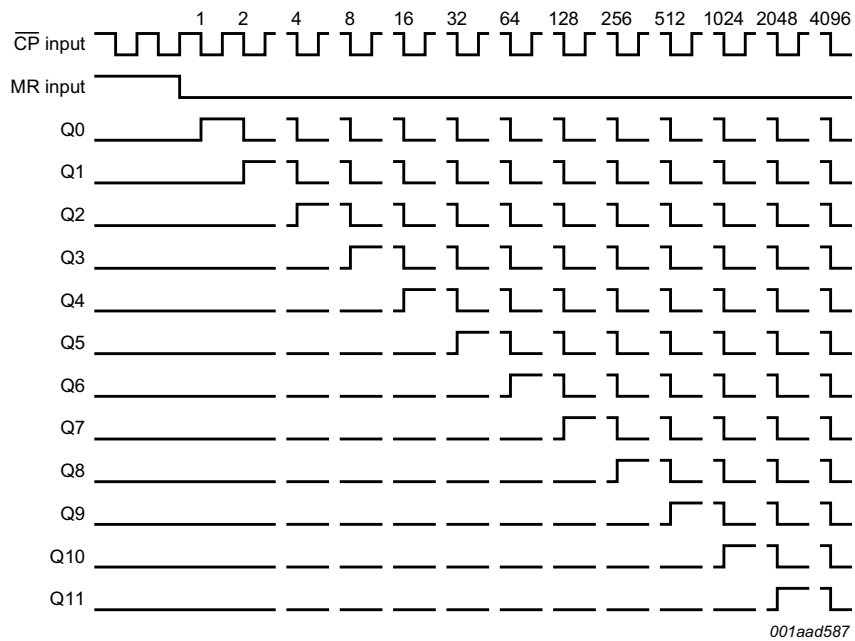
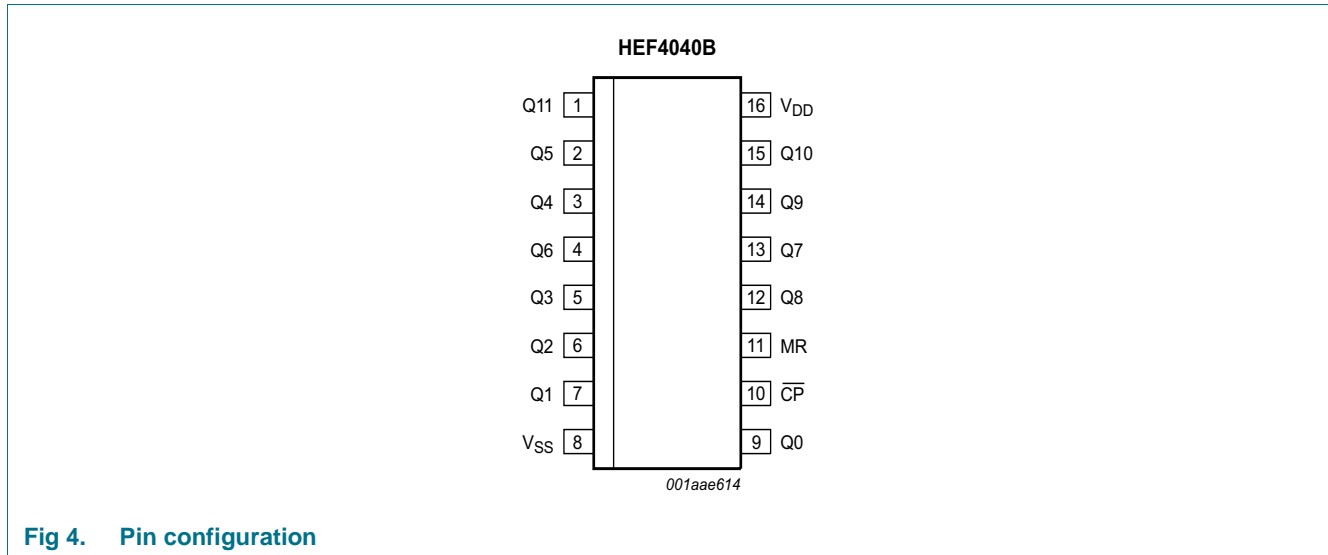


Fig 3. Timing diagram

6. Pinning information

6.1 Pinning



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	SO16 package [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}	$T_{amb} = -40\text{ °C}$		$T_{amb} = 25\text{ °C}$		$T_{amb} = 85\text{ °C}$		Unit
				Min	Max	Min	Max	Min	Max	
V_{IH}	HIGH-level input voltage	$ I_O < 1\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

Table 5. Static characteristics ...continued
 $V_{SS} = 0\text{ V}$; $V_I = V_{SS}$ 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_{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
			5 V	-	-0.52	-	-0.44	-	-0.36	mA
			10 V	-	-1.3	-	-1.1	-	-0.9	mA
			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
			10 V	1.3	-	1.1	-	0.9	-	mA
			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
 $V_{SS} = 0\text{ V}$; $T_{amb} = 25\text{ }^{\circ}\text{C}$; 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	$\overline{CP} \rightarrow Q_0$ 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	$\overline{CP} \rightarrow Q_0$ 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

Table 6. Dynamic characteristics ...continued

$V_{SS} = 0\text{ V}$; $T_{amb} = 25\text{ °C}$; unless otherwise specified; for test circuit see [Figure 6](#).

Symbol	Parameter	Conditions	V_{DD}	Extrapolation formula ^[1]	Min	Typ	Max	Unit
t_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.

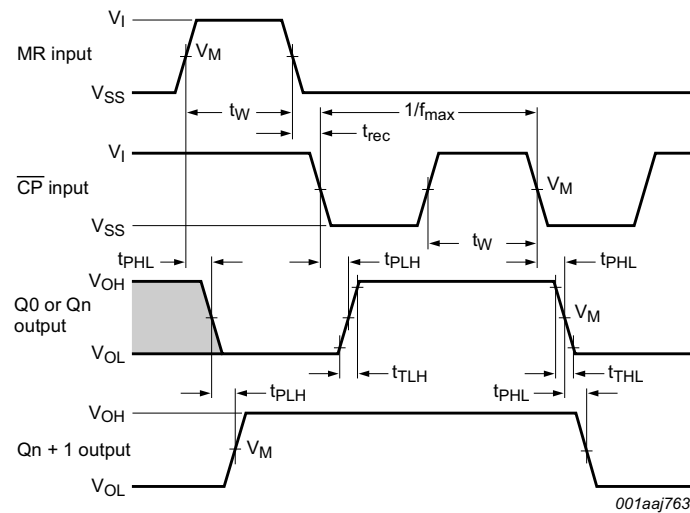
[3] t_t is the same as t_{THL} and t_{TLH} .

Table 7. Dynamic power dissipation P_D

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

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

11. Waveforms



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

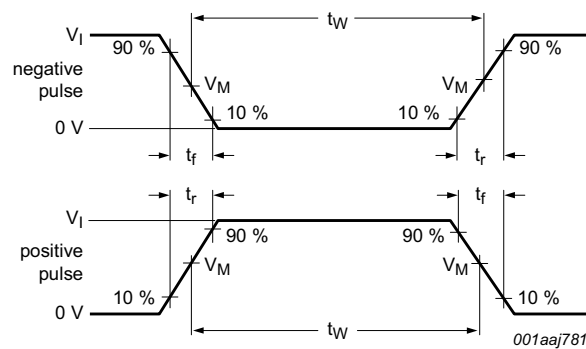
Transition times: transition time (t_t) = HIGH LOW (t_{THL}) or LOW HIGH (t_{TLH}) transition times.

Measurement points are given in [Table 8](#), test circuit in [Figure 6](#) and test data in [Table 9](#)

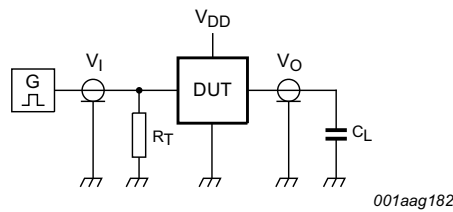
Fig 5. Waveforms showing propagation delays for MR to Qn and CP to Q0, minimum MR and CP pulse widths

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

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. Revision history

Table 10. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
HEF4040B v.9	20160323	Product data sheet	-	HEF4040B v.8
Modifications:	<ul style="list-style-type: none"> Type number HEF4040BP (SOT38-4) removed. 			
HEF4040B v.8	20111117	Product data sheet	-	HEF4040B v.7
Modifications:	<ul style="list-style-type: none"> Legal pages updated. Changes in “General description” and “Features and benefits”. 			
HEF4040B v.7	20111010	Product data sheet	-	HEF4040B v.6
HEF4040B v.6	20091125	Product data sheet	-	HEF4040B v.5
HEF4040B v.5	20090709	Product data sheet	-	HEF4040B v.4
HEF4040B v.4	20090304	Product data sheet	-	HEF4040B_CNV v.3
HEF4040B_CNV v.3	19950101	Product specification	-	HEF4040B_CNV v.2
HEF4040B_CNV v.2	19950101	Product specification	-	-

14. Legal information

14.1 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.
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[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".

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16. Contents

1	General description	1
2	Features and benefits	1
3	Applications	1
4	Ordering information	1
5	Functional diagram	2
6	Pinning information	3
6.1	Pinning	3
6.2	Pin description	3
7	Limiting values	4
8	Recommended operating conditions	4
9	Static characteristics	4
10	Dynamic characteristics	5
11	Waveforms	7
12	Package outline	9
13	Revision history	10
14	Legal information	11
14.1	Data sheet status	11
14.2	Definitions	11
14.3	Disclaimers	11
14.4	Trademarks	12
15	Contact information	12
16	Contents	13