

HEF4017B

5-stage Johnson decade counter

Rev. 9 — 8 April 2016

Product data sheet

1. General description

The HEF4017B is a 5-stage Johnson decade counter with ten spike-free decoded active HIGH outputs (Q0 to Q9), an active LOW carry output from the most significant flip-flop ($\overline{Q5-9}$), active HIGH and active LOW clock inputs (CP0, $\overline{CP1}$) and an overriding asynchronous master reset input (MR).

The counter is advanced by either a LOW-to-HIGH transition at CP0 while $\overline{CP1}$ is LOW or a HIGH-to-LOW transition at $\overline{CP1}$ while CP0 is HIGH (see [Table 3](#)).

When cascading counters, the $\overline{Q5-9}$ output, which is LOW while the counter is in states 5, 6, 7, 8, and 9, can be used to drive the CP0 input of the next counter. A HIGH on MR resets the counter to zero (Q0 = $\overline{Q5-9}$ = HIGH; Q1 to Q9 = LOW) independent of the clock inputs (CP0, $\overline{CP1}$).

Automatic counter code correction is provided by an internal circuit: following any illegal code the counter returns to a proper counting mode within 11 clock pulses.

Schmitt trigger action makes the clock inputs 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.

2. Features and benefits

- Automatic counter correction
- Tolerant of slow clock rise and fall times
- Fully static operation
- 5 V, 10 V, and 15 V parametric ratings
- Standardized symmetrical output characteristics
- Specified from -40 °C to $+125\text{ °C}$
- Complies with JEDEC standard JESD 13-B

3. Ordering information

Table 1. Ordering information

All types operate from -40 °C to $+125\text{ °C}$

Type number	Package		Version
	Name	Description	
HEF4017BT	SO16	plastic small outline package; 16 leads; body width 3.9 mm	SOT109-1

4. Functional diagram

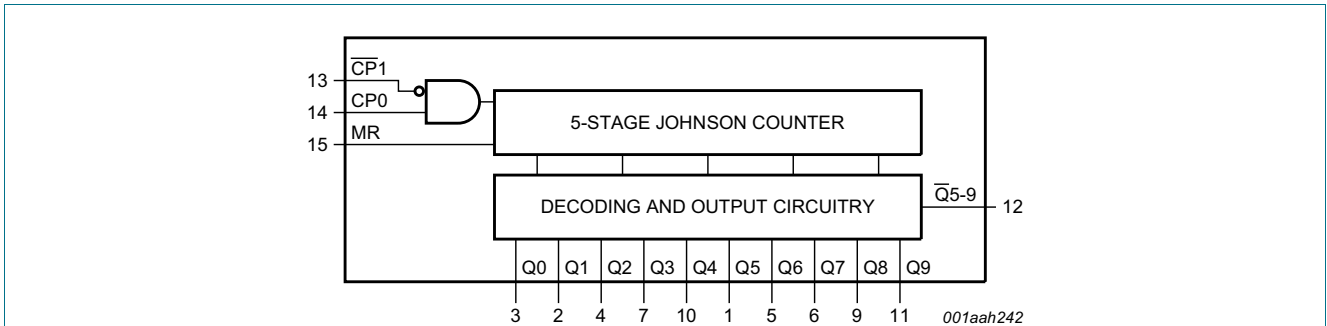


Fig 1. Functional diagram

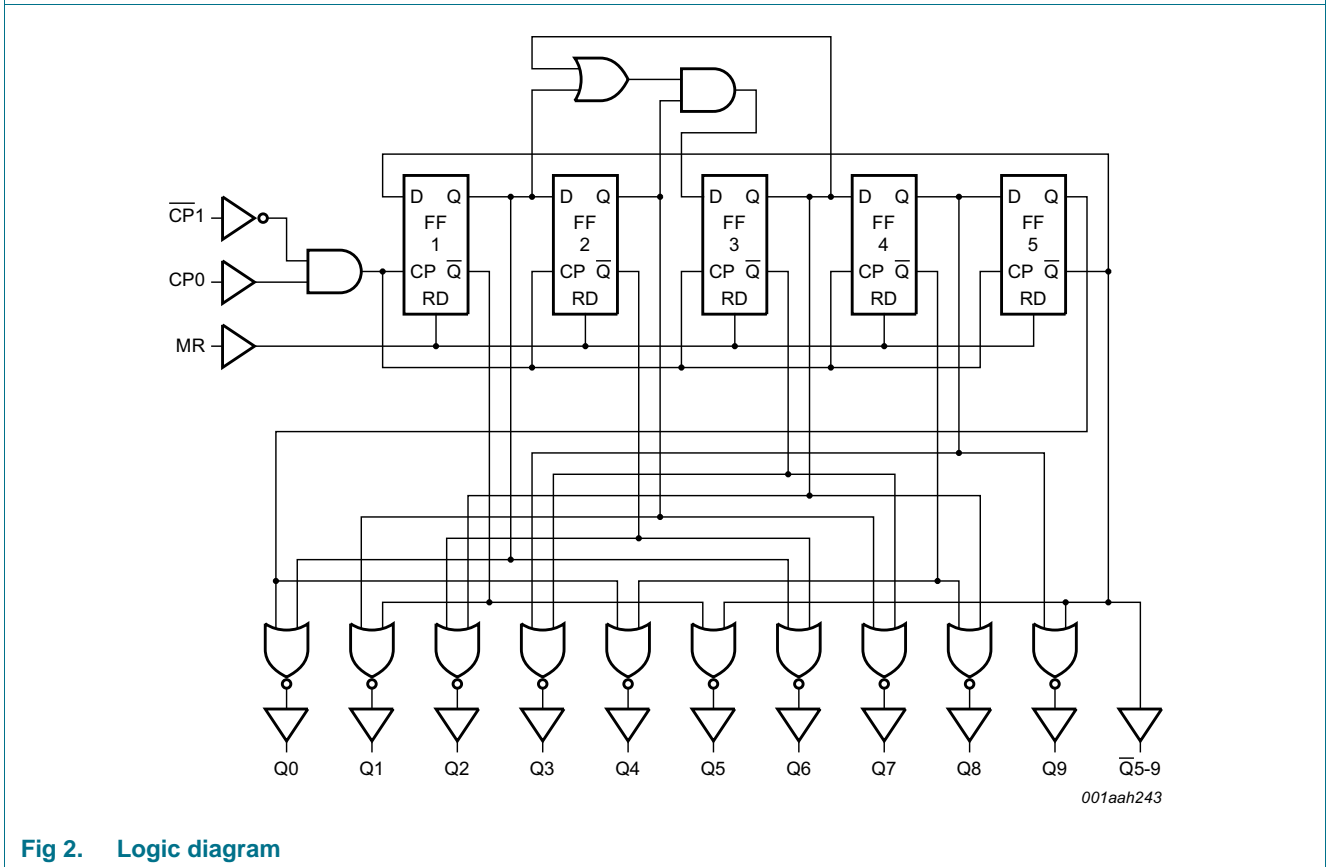


Fig 2. Logic diagram

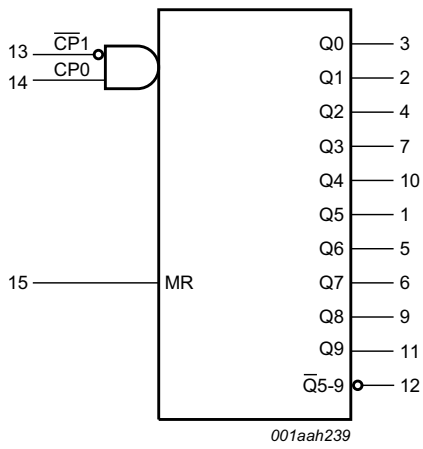


Fig 3. Logic symbol

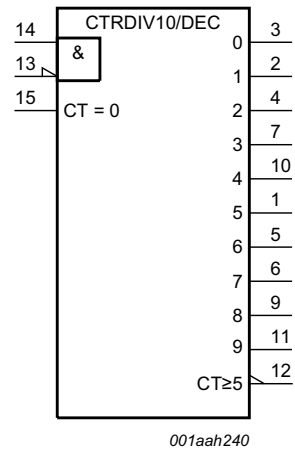


Fig 4. IEE logic symbol

5. Pinning information

5.1 Pinning

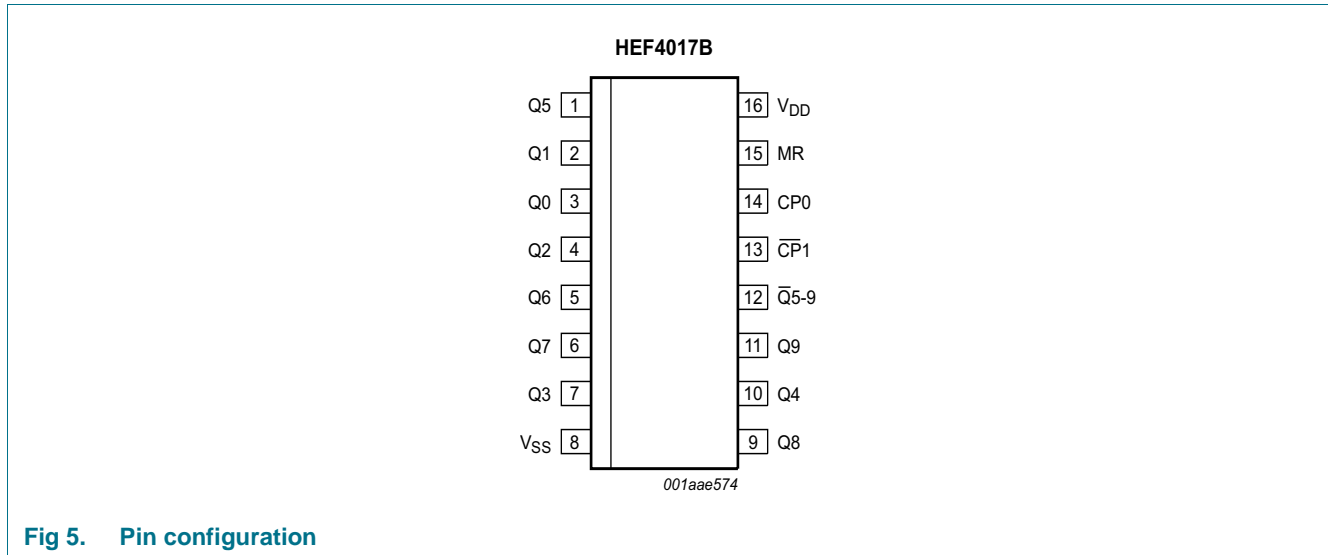


Fig 5. Pin configuration

5.2 Pin description

Table 2. Pin description

Symbol	Pin	Description
Q0 to Q9	3, 2, 4, 7, 10, 1, 5, 6, 9, 11	decoded output
V _{SS}	8	ground supply voltage
$\overline{Q5-9}$	12	carry output (active LOW)
$\overline{CP1}$	13	clock input (HIGH-to-LOW edge-triggered)
CP0	14	clock input (LOW-to-HIGH edge-triggered)
MR	15	master reset input
V _{DD}	16	supply voltage

6. Functional description

Table 3. Function table [1]

MR	CP0	$\overline{CP1}$	Operation
H	X	X	Q0 = $\overline{Q5-9}$ = H; Q1 to Q9 = L
L	H	↓	counter advances
L	↑	L	counter advances
L	L	X	no change
L	X	H	no change
L	H	↑	no change
L	↓	L	no change

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

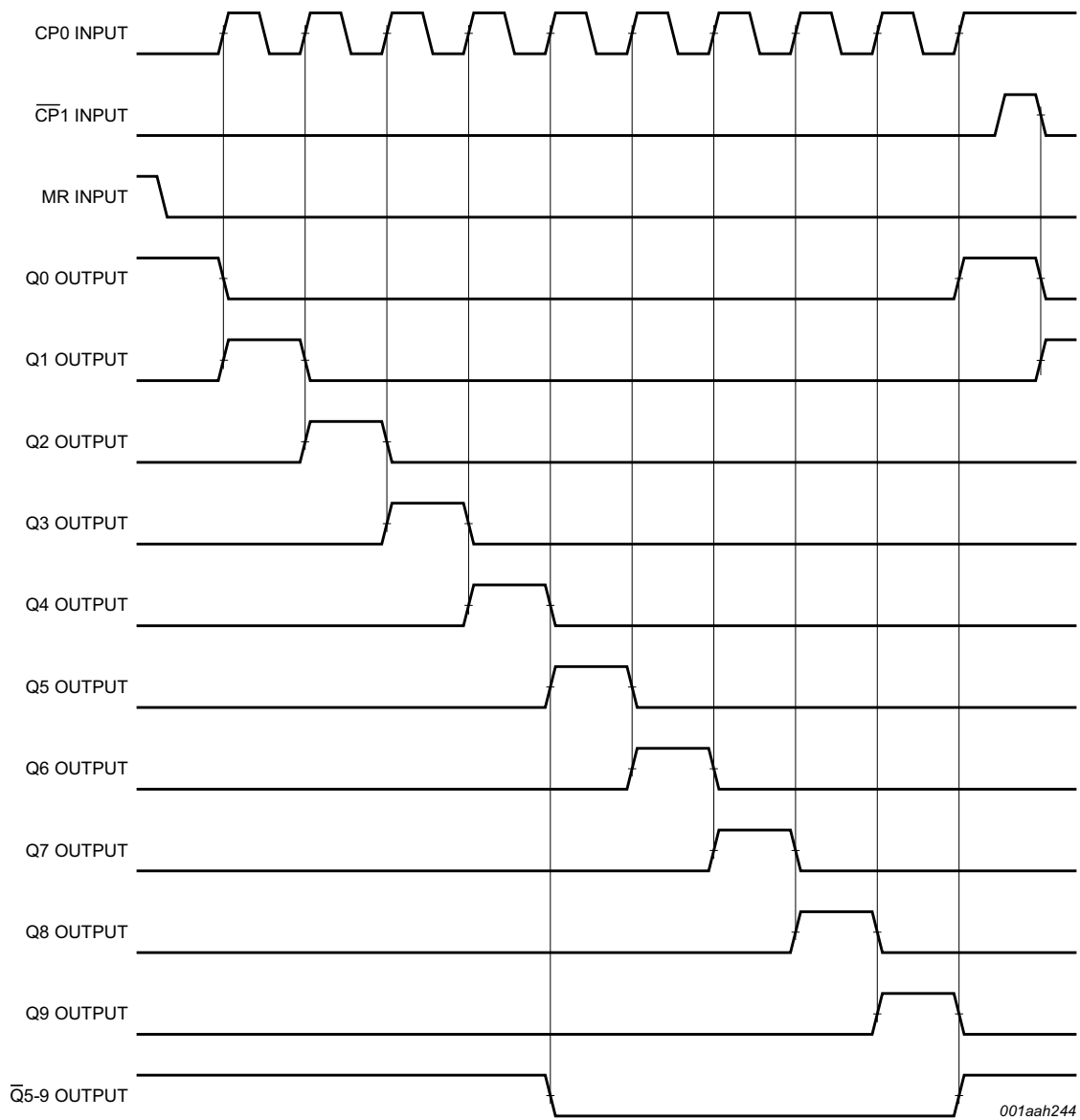


Fig 6. Timing diagram

7. 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
$I_{I/O}$	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	$T_{amb} = -40\text{ °C}$ to $+125\text{ °C}$			
		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 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	$V_{DD} = 5\text{ V}$	-	-	3.75	$\mu\text{s/V}$
		$V_{DD} = 10\text{ V}$	-	-	0.5	$\mu\text{s/V}$
		$V_{DD} = 15\text{ V}$	-	-	0.08	$\mu\text{s/V}$

9. 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}	$T_{amb} = -40\text{ °C}$		$T_{amb} = 25\text{ °C}$		$T_{amb} = 85\text{ °C}$		$T_{amb} = 125\text{ °C}$		Unit
				Min	Max	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	-	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\text{ }\mu\text{A}$	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\text{ }\mu\text{A}$; $V_I = V_{SS}$ or V_{DD}	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\text{ }\mu\text{A}$; $V_I = V_{SS}$ or V_{DD}	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	$V_O = 2.5\text{ V}$	5 V	-	-1.7	-	-1.4	-	-1.1	-	-1.1	mA
		$V_O = 4.6\text{ V}$	5 V	-	-0.64	-	-0.5	-	-0.36	-	-0.36	mA
		$V_O = 9.5\text{ V}$	10 V	-	-1.6	-	-1.3	-	-0.9	-	-0.9	mA
		$V_O = 13.5\text{ V}$	15 V	-	-4.2	-	-3.4	-	-2.4	-	-2.4	mA
I_{OL}	LOW-level output current	$V_O = 0.4\text{ V}$	5 V	0.64	-	0.5	-	0.36	-	0.36	-	mA
		$V_O = 0.5\text{ V}$	10 V	1.6	-	1.3	-	0.9	-	0.9	-	mA
		$V_O = 1.5\text{ V}$	15 V	4.2	-	3.4	-	2.4	-	2.4	-	mA
I_I	input leakage current		15 V	-	± 0.1	-	± 0.1	-	± 1.0	-	± 1.0	μA
I_{DD}	supply current	$I_O = 0\text{ A}$; $V_I = V_{SS}$ or V_{DD}	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	

10. Dynamic characteristics

Table 7. Dynamic characteristics
 $T_{amb} = 25\text{ }^{\circ}\text{C}$; $V_{SS} = 0\text{ V}$; for test circuit see [Figure 10](#)

Symbol	Parameter	Conditions	V _{DD}	Extrapolation formula ^[1]	Min	Typ	Max	Unit
t _{PHL}	HIGH to LOW propagation delay	CP0, $\overline{\text{CP1}} \rightarrow \text{Q0 to Q9}$; see Figure 7	5 V	$113\text{ ns} + (0.55\text{ ns/pF})C_L$	-	140	280	ns
			10 V	$44\text{ ns} + (0.23\text{ ns/pF})C_L$	-	55	110	ns
			15 V	$32\text{ ns} + (0.16\text{ ns/pF})C_L$	-	40	80	ns
		CP0, $\overline{\text{CP1}} \rightarrow \overline{\text{Q5-9}}$; see Figure 7	5 V	$118\text{ ns} + (0.55\text{ ns/pF})C_L$	-	145	290	ns
			10 V	$44\text{ ns} + (0.23\text{ ns/pF})C_L$	-	55	110	ns
			15 V	$32\text{ ns} + (0.16\text{ ns/pF})C_L$	-	40	80	ns
		MR $\rightarrow \text{Q1 to Q9}$; see Figure 8	5 V	$88\text{ ns} + (0.55\text{ ns/pF})C_L$	-	115	230	ns
			10 V	$39\text{ ns} + (0.23\text{ ns/pF})C_L$	-	50	100	ns
			15 V	$27\text{ ns} + (0.16\text{ ns/pF})C_L$	-	35	70	ns
t _{PLH}	LOW to HIGH propagation delay	CP0, $\overline{\text{CP1}} \rightarrow \text{Q0 to Q9}$; see Figure 7	5 V	$98\text{ ns} + (0.55\text{ ns/pF})C_L$	-	125	250	ns
			10 V	$39\text{ ns} + (0.23\text{ ns/pF})C_L$	-	50	100	ns
			15 V	$32\text{ ns} + (0.16\text{ ns/pF})C_L$	-	40	80	ns
		CP0, $\overline{\text{CP1}} \rightarrow \overline{\text{Q5-9}}$; see Figure 7	5 V	$98\text{ ns} + (0.55\text{ ns/pF})C_L$	-	125	250	ns
			10 V	$39\text{ ns} + (0.23\text{ ns/pF})C_L$	-	50	100	ns
			15 V	$32\text{ ns} + (0.16\text{ ns/pF})C_L$	-	40	80	ns
		MR $\rightarrow \overline{\text{Q5-9}}$; see Figure 8	5 V	$83\text{ ns} + (0.55\text{ ns/pF})C_L$	-	110	220	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
		MR $\rightarrow \text{Q0}$; see Figure 8	5 V	$103\text{ ns} + (0.55\text{ ns/pF})C_L$	-	130	260	ns
			10 V	$44\text{ ns} + (0.23\text{ ns/pF})C_L$	-	55	105	ns
			15 V	$32\text{ ns} + (0.16\text{ ns/pF})C_L$	-	40	75	ns
t _t	transition time	see Figure 7	5 V	^[2] $10\text{ ns} + (1.00\text{ ns/pF})C_L$	-	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
t _h	hold time	CP0 $\rightarrow \overline{\text{CP1}}$; see Figure 9	5 V		90	45	-	ns
			10 V		40	20	-	ns
			15 V		20	10	-	ns
		$\overline{\text{CP1}} \rightarrow \text{CP0}$; see Figure 9	5 V		80	40	-	ns
			10 V		40	20	-	ns
			15 V		30	10	-	ns

Table 7. Dynamic characteristics ...continued $T_{amb} = 25\text{ }^{\circ}\text{C}$; $V_{SS} = 0\text{ V}$; for test circuit see [Figure 10](#)

Symbol	Parameter	Conditions	V _{DD}	Extrapolation formula ^[1]	Min	Typ	Max	Unit
t _w	pulse width	CP0 input LOW; minimum width; see Figure 8	5 V		80	40	-	ns
			10 V		40	20	-	ns
			15 V		30	15	-	ns
		CP1 input HIGH; minimum width; see Figure 8	5 V		80	40	-	ns
			10 V		40	20	-	ns
			15 V		30	15	-	ns
		MR input HIGH; minimum width; see Figure 8	5 V		50	25	-	ns
			10 V		30	15	-	ns
			15 V		20	10	-	ns
t _{rec}	recovery time	MR input; see Figure 8	5 V		60	30	-	ns
			10 V		30	15	-	ns
			15 V		20	10	-	ns
f _{max}	maximum frequency	see Figure 8	5 V		6	12	-	MHz
			10 V		12	30	-	MHz
			15 V		15	30	-	MHz

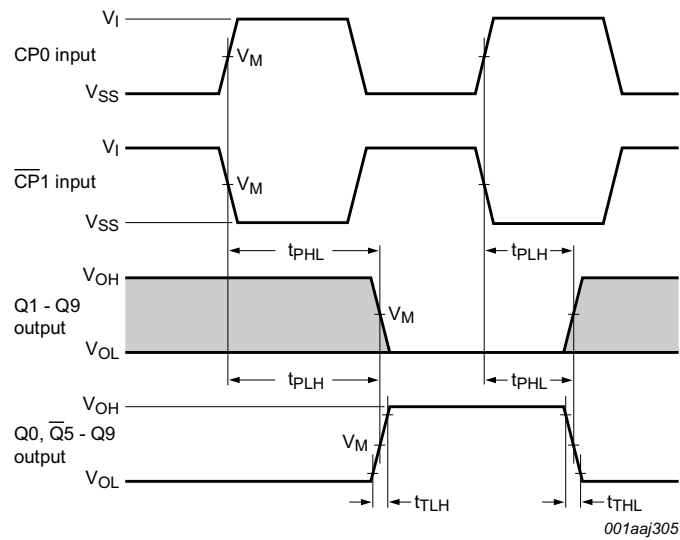
[1] The typical values of the propagation delay and transition times are calculated from the extrapolation formulas shown (C_L in pF).

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

Table 8. Dynamic power dissipation P_D P_D can be calculated from the formulas shown. $V_{SS} = 0\text{ V}$; $t_r = t_f \leq 20\text{ ns}$; $T_{amb} = 25\text{ }^{\circ}\text{C}$.

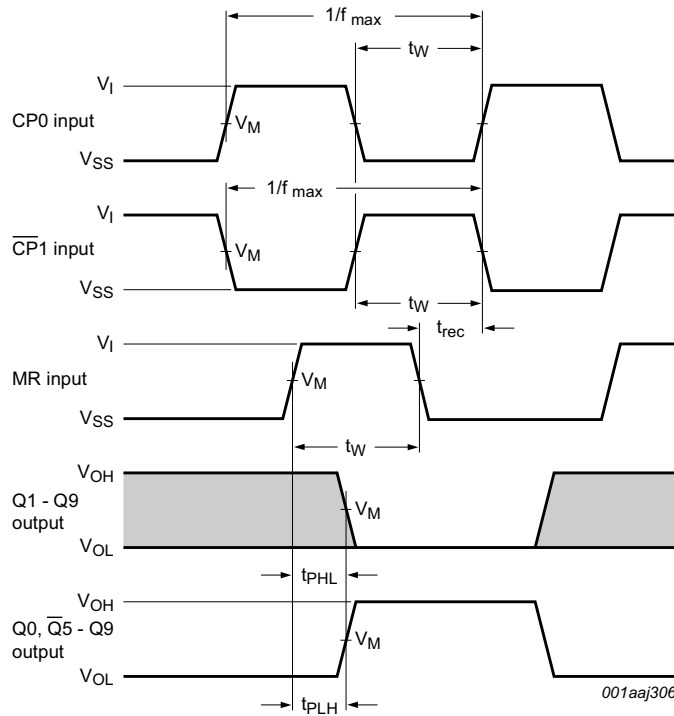
Symbol	Parameter	V _{DD}	Typical formula for P _D (μW)	where:
P _D	dynamic power dissipation	5 V	$P_D = 500 \times f_i + \Sigma(f_o \times C_L) \times V_{DD}^2$	f _i = input frequency in MHz; f _o = output frequency in MHz; C _L = output load capacitance in pF; V _{DD} = supply voltage in V; Σ(C _L × f _o) = sum of the outputs.
		10 V	$P_D = 2200 \times f_i + \Sigma(f_o \times C_L) \times V_{DD}^2$	
		15 V	$P_D = 6000 \times f_i + \Sigma(f_o \times C_L) \times V_{DD}^2$	

11. Waveforms



Conditions: $\overline{CP1} = \text{LOW}$, while CP0 triggers on a LOW-to-HIGH transition. $\overline{CP1}$ triggers on a HIGH-to-LOW transition;
 The shaded areas indicate where the output state is set by the input count.
 Measurement points given in [Table 9](#).

Fig 7. Waveforms showing the propagation delays for CP0, $\overline{CP1}$ to Qn, Q5-9 outputs and the output transition times

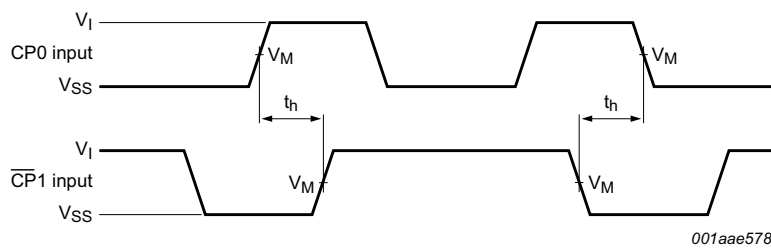


Conditions: $\overline{CP1} = \text{LOW}$, while CP0 triggers on a LOW-to-HIGH transition, t_W and t_{rec} are measured when CP0 = HIGH and $\overline{CP1}$ triggers on a HIGH-to-LOW transition.

The shaded areas indicate where the output state is set by the input count.

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

Fig 8. Waveforms showing the minimum pulse width for CP0, $\overline{CP1}$ and MR input; the maximum frequency for CP0 and CP1 input; the recovery time for MR and the MR input to Qn and Q5-9 output propagation delays



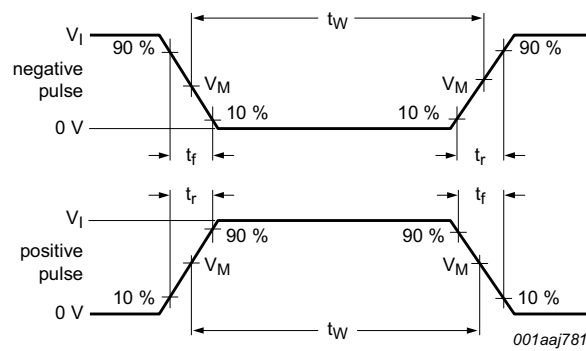
Hold times are shown as positive values, but may be specified as negative values;

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

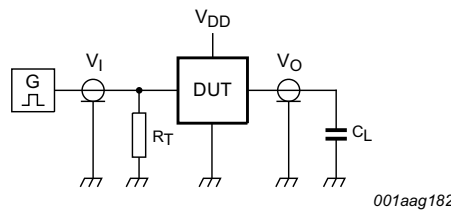
Fig 9. Waveforms showing hold times for CP0 to $\overline{CP1}$ and $\overline{CP1}$ to CP0

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 10. Test circuit for measuring switching times

Table 10. Test data

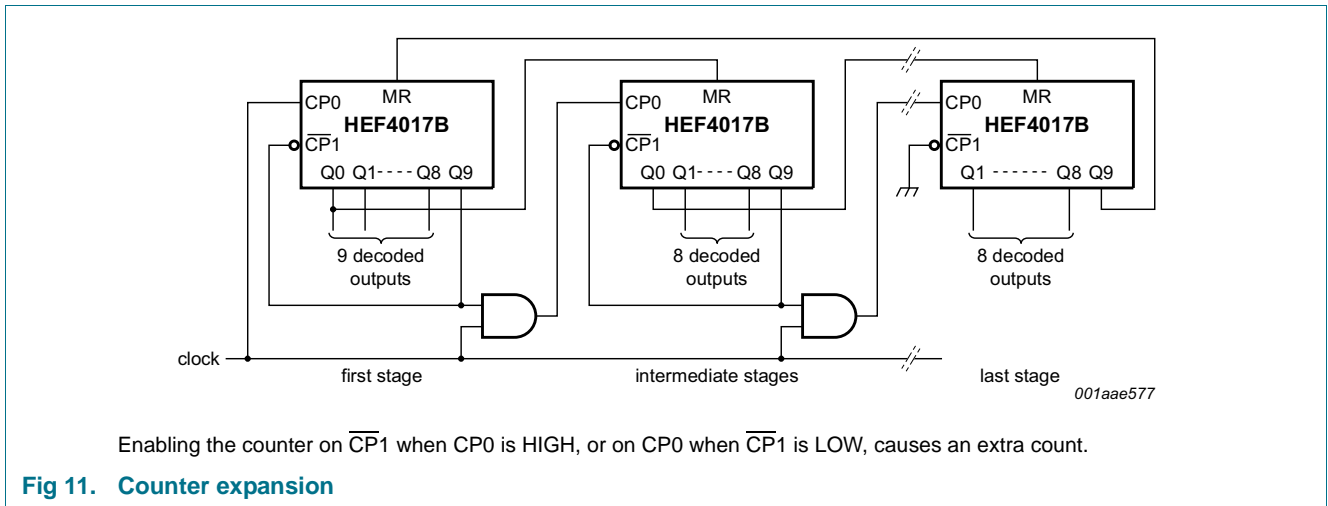
Supply voltage	Input	Load
V_{DD}	V_I	C_L
5 V to 15 V	V_{SS} or V_{DD}	50 pF

12. Application information

Some examples of applications for the HEF4017B are:

- Decade counter with decimal decoding
- 1 out of n decoding counter (when cascaded)
- Sequential controller
- Timer

Figure 11 shows a technique for extending the number of decoded output states for the HEF4017B. Decoded outputs are sequential within each stage and from stage to stage, with no dead time (except propagation delay).



13. Package outline

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

SOT109-1

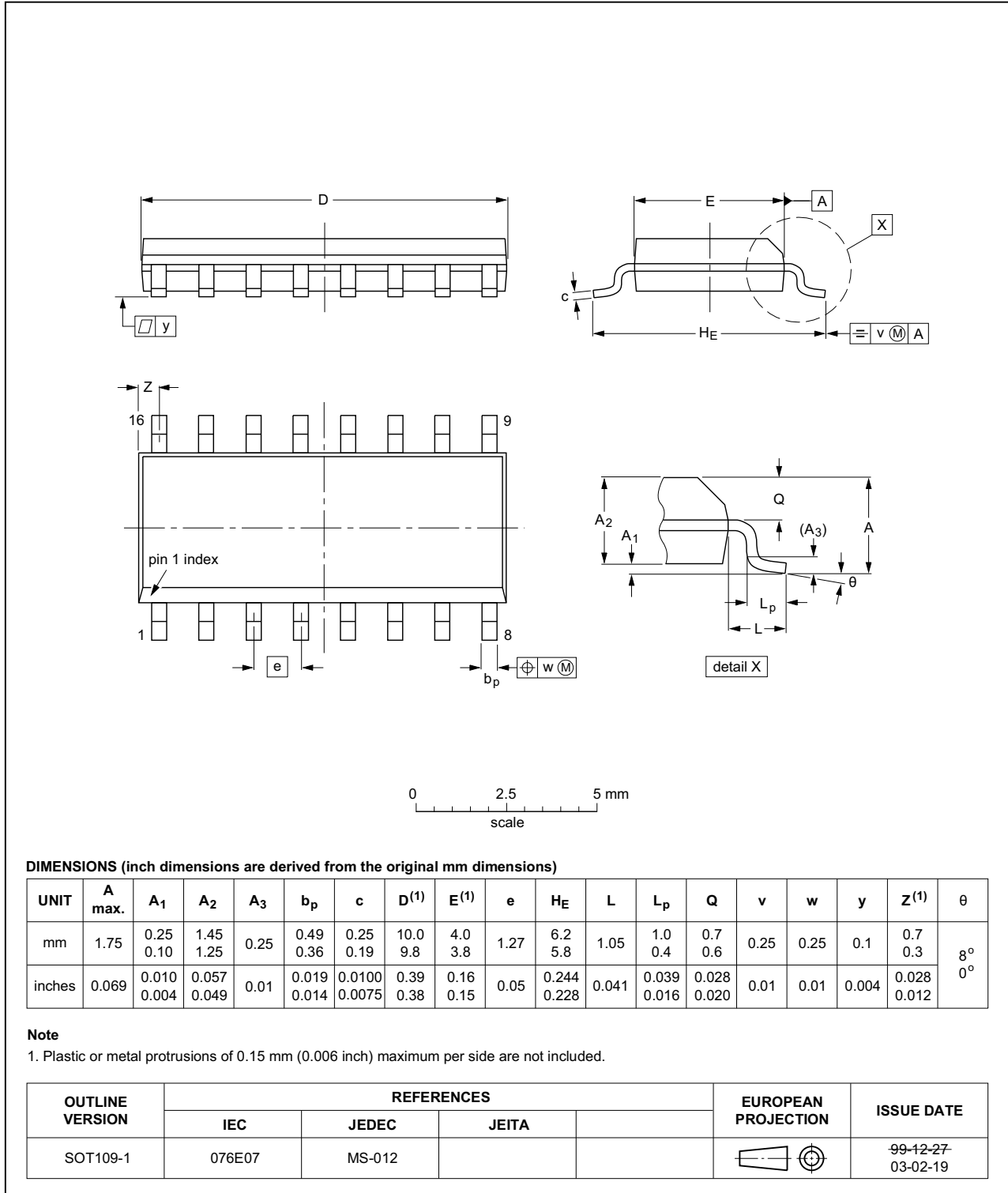


Fig 12. Package outline SOT109-1 (SO16)

14. Revision history

Table 11. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
HEF4017B v.9	20160408	Product data sheet	-	HEF4017B v.8
Modifications:	<ul style="list-style-type: none"> Type number HEF4017BP (SOT38-4) removed. 			
HEF4017B v.8	20111118	Product data sheet	-	HEF4017B v.7
Modifications:	<ul style="list-style-type: none"> Legal pages updated. Changes in “General description” and “Features and benefits”. Section “Applications” removed. 			
HEF4017B v.7	20110914	Product data sheet	-	HEF4017B v.6
HEF4017B v.6	20091105	Product data sheet	-	HEF4017B v.5
HEF4017B v.5	20090709	Product data sheet	-	HEF4017B v.4
HEF4017B v.4	20081209	Product data sheet	-	HEF4017B_CNV v.3
HEF4017B_CNV v.3	19950101	Product specification	-	HEF4017B_CNV v.2
HEF4017B_CNV v.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.nexperia.com>.

15.2 Definitions

Draft — The document is a draft version only. The content is still under internal review and subject to formal approval, which may result in modifications or additions. Nexperia does not give any representations or warranties as to the accuracy or completeness of information included herein and shall have no liability for the consequences of use of such information.

Short data sheet — A short data sheet is an extract from a full data sheet with the same product type number(s) and title. A short data sheet is intended for quick reference only and should not be relied upon to contain detailed and full information. For detailed and full information see the relevant full data sheet, which is available on request via the local Nexperia sales office. In case of any inconsistency or conflict with the short data sheet, the full data sheet shall prevail.

Product specification — The information and data provided in a Product data sheet shall define the specification of the product as agreed between Nexperia and its customer, unless Nexperia and customer have explicitly agreed otherwise in writing. In no event however, shall an agreement be valid in which the Nexperia product is deemed to offer functions and qualities beyond those described in the Product data sheet.

15.3 Disclaimers

Limited warranty and liability — Information in this document is believed to be accurate and reliable. However, Nexperia does not give any representations or warranties, expressed or implied, as to the accuracy or completeness of such information and shall have no liability for the consequences of use of such information. Nexperia takes no responsibility for the content in this document if provided by an information source outside of Nexperia.

In no event shall Nexperia be liable for any indirect, incidental, punitive, special or consequential damages (including - without limitation - lost profits, lost savings, business interruption, costs related to the removal or replacement of any products or rework charges) whether or not such damages are based on tort (including negligence), warranty, breach of contract or any other legal theory.

Notwithstanding any damages that customer might incur for any reason whatsoever, Nexperia's aggregate and cumulative liability towards customer for the products described herein shall be limited in accordance with the *Terms and conditions of commercial sale* of Nexperia.

Right to make changes — Nexperia reserves the right to make changes to information published in this document, including without limitation specifications and product descriptions, at any time and without notice. This document supersedes and replaces all information supplied prior to the publication hereof.

Suitability for use — Nexperia products are not designed, authorized or warranted to be suitable for use in life support, life-critical or safety-critical systems or equipment, nor in applications where failure or malfunction of a Nexperia product can reasonably be expected to result in personal injury, death or severe property or environmental damage. Nexperia and its suppliers accept no liability for inclusion and/or use of Nexperia products in such equipment or applications and therefore such inclusion and/or use is at the customer's own risk.

Applications — Applications that are described herein for any of these products are for illustrative purposes only. Nexperia makes no representation or warranty that such applications will be suitable for the specified use without further testing or modification.

Customers are responsible for the design and operation of their applications and products using Nexperia products, and Nexperia accepts no liability for any assistance with applications or customer product design. It is customer's sole responsibility to determine whether the Nexperia product is suitable and fit for the customer's applications and products planned, as well as for the planned application and use of customer's third party customer(s). Customers should provide appropriate design and operating safeguards to minimize the risks associated with their applications and products.

Nexperia does not accept any liability related to any default, damage, costs or problem which is based on any weakness or default in the customer's applications or products, or the application or use by customer's third party customer(s). Customer is responsible for doing all necessary testing for the customer's applications and products using Nexperia products in order to avoid a default of the applications and the products or of the application or use by customer's third party customer(s). Nexperia does not accept any liability in this respect.

Limiting values — Stress above one or more limiting values (as defined in the Absolute Maximum Ratings System of IEC 60134) will cause permanent damage to the device. Limiting values are stress ratings only and (proper) operation of the device at these or any other conditions above those given in the Recommended operating conditions section (if present) or the Characteristics sections of this document is not warranted. Constant or repeated exposure to limiting values will permanently and irreversibly affect the quality and reliability of the device.

Terms and conditions of commercial sale — Nexperia products are sold subject to the general terms and conditions of commercial sale, as published at <http://www.nexperia.com/profile/terms>, unless otherwise agreed in a valid written individual agreement. In case an individual agreement is concluded only the terms and conditions of the respective agreement shall apply. Nexperia hereby expressly objects to applying the customer's general terms and conditions with regard to the purchase of Nexperia products by customer.

No offer to sell or license — Nothing in this document may be interpreted or construed as an offer to sell products that is open for acceptance or the grant, conveyance or implication of any license under any copyrights, patents or other industrial or intellectual property rights.

Export control — This document as well as the item(s) described herein may be subject to export control regulations. Export might require a prior authorization from competent authorities.

Non-automotive qualified products — Unless this data sheet expressly states that this specific Nexperia product is automotive qualified, the product is not suitable for automotive use. It is neither qualified nor tested in accordance with automotive testing or application requirements. Nexperia accepts no liability for inclusion and/or use of non-automotive qualified products in automotive equipment or applications.

In the event that customer uses the product for design-in and use in automotive applications to automotive specifications and standards, customer (a) shall use the product without Nexperia's warranty of the product for such automotive applications, use and specifications, and (b) whenever customer uses the product for automotive applications beyond

Nexperia's specifications such use shall be solely at customer's own risk, and (c) customer fully indemnifies Nexperia for any liability, damages or failed product claims resulting from customer design and use of the product for automotive applications beyond Nexperia's standard warranty and Nexperia's product specifications.

Translations — A non-English (translated) version of a document is for reference only. The English version shall prevail in case of any discrepancy between the translated and English versions.

15.4 Trademarks

Notice: All referenced brands, product names, service names and trademarks are the property of their respective owners.

16. Contact information

For more information, please visit: <http://www.nexperia.com>

For sales office addresses, please send an email to: salesaddresses@nexperia.com

17. Contents

1	General description	1
2	Features and benefits	1
3	Ordering information	1
4	Functional diagram	2
5	Pinning information	4
5.1	Pinning	4
5.2	Pin description	4
6	Functional description	4
7	Limiting values	6
8	Recommended operating conditions	6
9	Static characteristics	7
10	Dynamic characteristics	8
11	Waveforms	10
12	Application information	13
13	Package outline	14
14	Revision history	15
15	Legal information	16
15.1	Data sheet status	16
15.2	Definitions	16
15.3	Disclaimers	16
15.4	Trademarks	17
16	Contact information	17
17	Contents	18