

HEF4518B

Dual BCD counter

Rev. 8 — 19 April 2016

Product data sheet

1. General description

The HEF4518B is a dual 4-bit internally synchronous BCD counter. The counter has an active HIGH clock input (nCP0) and an active LOW clock input (nCP1), buffered outputs from all four bit positions (nQ0 to nQ3) and an active HIGH overriding asynchronous master reset input (nMR). The counter advances on either the LOW-to-HIGH transition of the nCP0 input if nCP1 is HIGH or the HIGH-to-LOW transition of the nCP1 input if nCP0 is LOW. Either nCP0 or nCP1 may be used as the clock input to the counter and the other clock input may be used as a clock enable input. A HIGH on nMR resets the counter (nQ0 to nQ3 = LOW) independent of nCP0, nCP1. Schmitt trigger action in the clock input makes the circuit highly tolerant of slower clock 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

- 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 $-40\text{ }^{\circ}\text{C}$ to $+85\text{ }^{\circ}\text{C}$
- Complies with JEDEC standard JESD 13-B

3. Applications

- Multistage synchronous counting
- Multistage asynchronous counting
- Frequency dividers

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
HEF4518BT	SO16	plastic small outline package; 16 leads; body width 3.9 mm	SOT109-1

5. Functional diagram

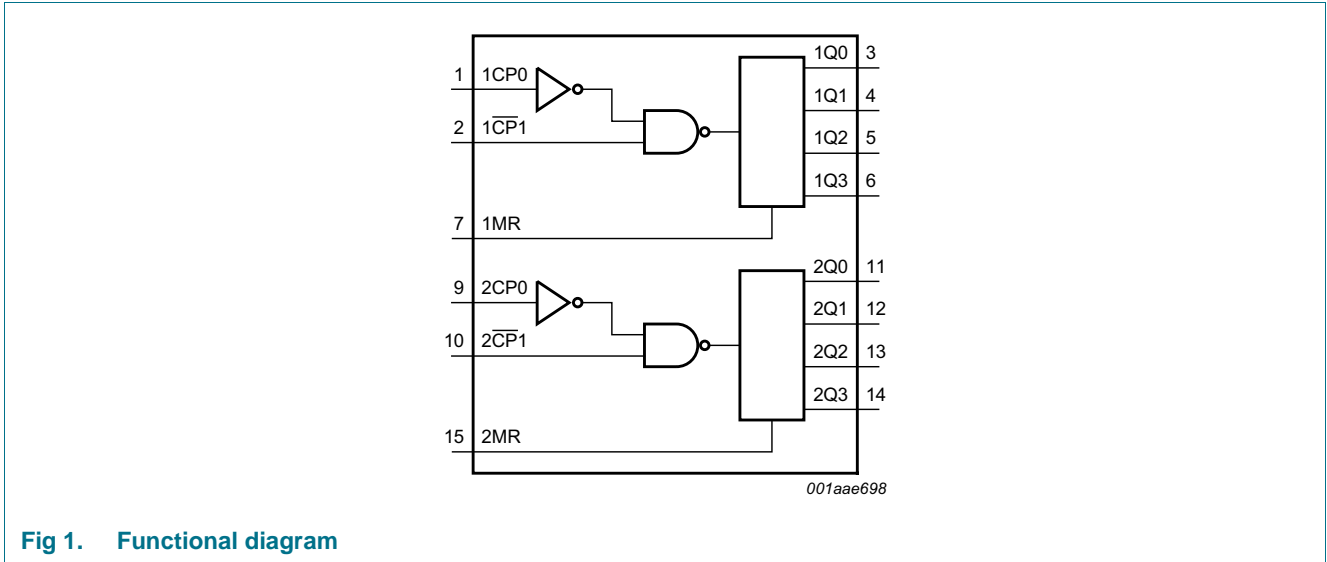


Fig 1. Functional diagram

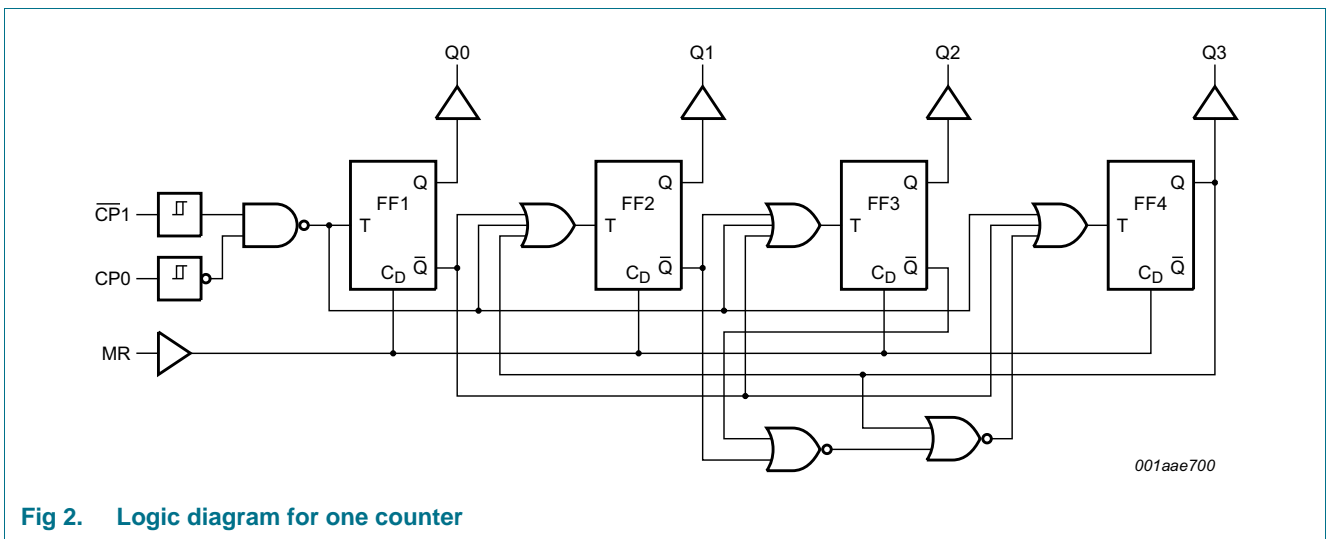
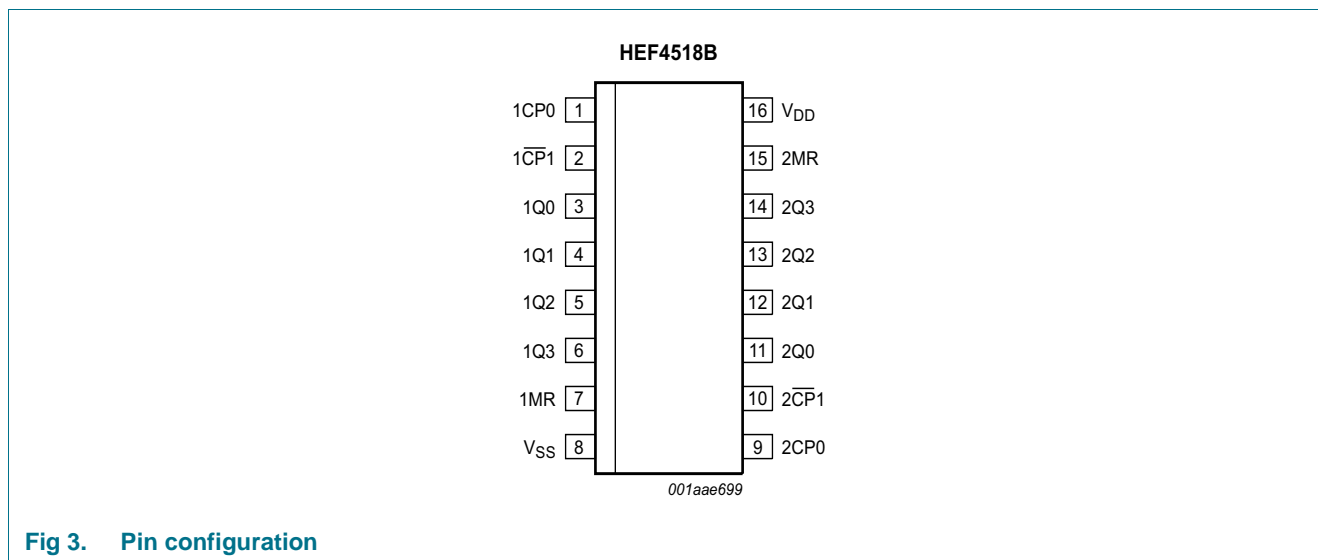


Fig 2. Logic diagram for one counter

6. Pinning information

6.1 Pinning



6.2 Pin description

Table 2. Pin description

Symbol	Pin	Description
1CP0, 2CP0	1, 9	clock input (LOW-to-HIGH triggered)
1CP1, 2CP1	2, 10	clock input (HIGH-to-LOW triggered)
1Q0, 2Q0	3, 11	output
1Q1, 2Q1	4, 12	output
1Q2, 2Q2	5, 13	output
1Q3, 2Q3	6, 14	output
1MR, 2MR	7, 15	master reset input
V _{DD}	16	supply voltage
V _{SS}	8	ground supply voltage

7. Functional description

Table 3. Function table^[1]

nCP0	nCP1	nMR	Mode
↑	H	L	counter advances
L	↓	L	counter advances
↓	X	L	no change
X	↑	L	no change
↑	L	L	no change
H	↓	L	no change
X	X	H	nQ0 to nQ3 = LOW

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

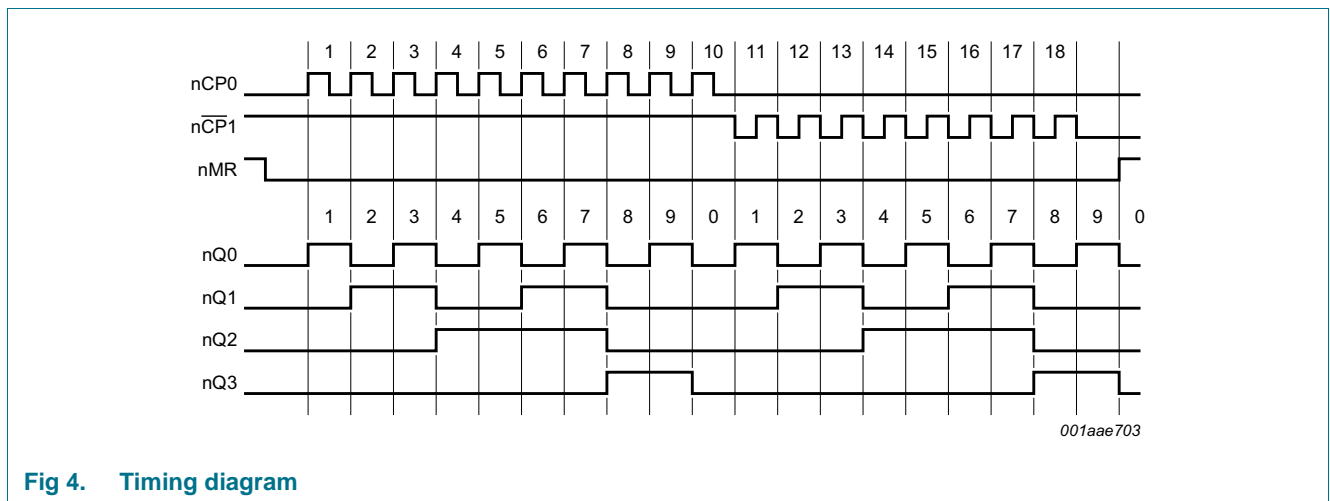


Fig 4. Timing diagram

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	$V_I < -0.5\text{ V}$ 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.

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	$V_{DD} = 5\text{ V}$	-	-	3.75	$\mu\text{s/V}$
		$V_{DD} = 10\text{ V}$	-	-	0.5	$\mu\text{s/V}$
		$V_{DD} = 15\text{ V}$	-	-	0.08	$\mu\text{s/V}$

10. 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}	$T_{amb} = -40\text{ °C}$		$T_{amb} = 25\text{ °C}$		$T_{amb} = 85\text{ °C}$		Unit
				Min	Max	Min	Max	Min	Max	
V_{IH}	HIGH-level input voltage	$ I_O < 1\ \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\ \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\ \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 6. Static characteristics ...continued $V_{SS} = 0\text{ V}$; $V_I = V_{SS}$ or V_{DD} unless otherwise specified.

Symbol	Parameter	Conditions	V_{DD}	$T_{amb} = -40\text{ °C}$		$T_{amb} = 25\text{ °C}$		$T_{amb} = 85\text{ °C}$		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	-	0.5	-	0.36	-	mA
			10 V	1.3	-	1.1	-	0.9	-	mA
			15 V	3.6	-	3.0	-	2.4	-	mA
I_I	input leakage current	$V_{DD} = 15\text{ V}$	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

11. Dynamic characteristics

Table 7. Dynamic characteristics $V_{SS} = 0\text{ V}$; $T_{amb} = 25\text{ °C}$; for test circuit see [Figure 6](#); unless otherwise specified.

Symbol	Parameter	Conditions	V_{DD}	Extrapolation formula	Min	Typ	Max	Unit
t_{PHL}	HIGH to LOW propagation delay	nCP0, nCP1 to nQn; see Figure 5	5 V [1]	$93\text{ ns} + (0.55\text{ ns/pF})C_L$	-	120	240	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
		nMR to nQn; see Figure 5	5 V	$48\text{ ns} + (0.55\text{ ns/pF})C_L$	-	75	150	ns
			10 V	$24\text{ ns} + (0.23\text{ ns/pF})C_L$	-	35	70	ns
			15 V	$17\text{ ns} + (0.16\text{ ns/pF})C_L$	-	25	50	ns
t_{PLH}	LOW to HIGH propagation delay	nCP0, nCP1 to nQn; see Figure 5	5 V [1]	$93\text{ ns} + (0.55\text{ ns/pF})C_L$	-	120	240	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
t_t	transition time	nQn; see Figure 5	5 V [1]	$10\text{ ns} + (1.00\text{ ns/pF})C_L$	-	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 7. Dynamic characteristics ...continued

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

Symbol	Parameter	Conditions	V_{DD}	Extrapolation formula	Min	Typ	Max	Unit
t_w	pulse width	nCP0 input LOW; minimum width; see Figure 5	5 V		60	30	-	ns
			10 V		30	15	-	ns
			15 V		20	10	-	ns
		nCP1 input HIGH; minimum width; see Figure 5	5 V		60	30	-	ns
			10 V		30	15	-	ns
			15 V		20	10	-	ns
		nMR input HIGH; minimum width; see Figure 5	5 V		30	15	-	ns
			10 V		20	10	-	ns
			15 V		16	8	-	ns
t_{rec}	recovery time	nMR input; see Figure 5	5 V		50	25	-	ns
			10 V		30	15	-	ns
			15 V		20	10	-	ns
t_{su}	set-up time	nCP0 to nCP1; see Figure 5	5 V		50	25	-	ns
			10 V		30	15	-	ns
			15 V		20	10	-	ns
		nCP1 to nCP0; see Figure 5	5 V		50	25	-	ns
			10 V		30	15	-	ns
			15 V		20	10	-	ns
f_{max}	maximum frequency	nCP0, nCP1; see Figure 5	5 V		8	16	-	MHz
			10 V		15	30	-	MHz
			15 V		20	40	-	MHz

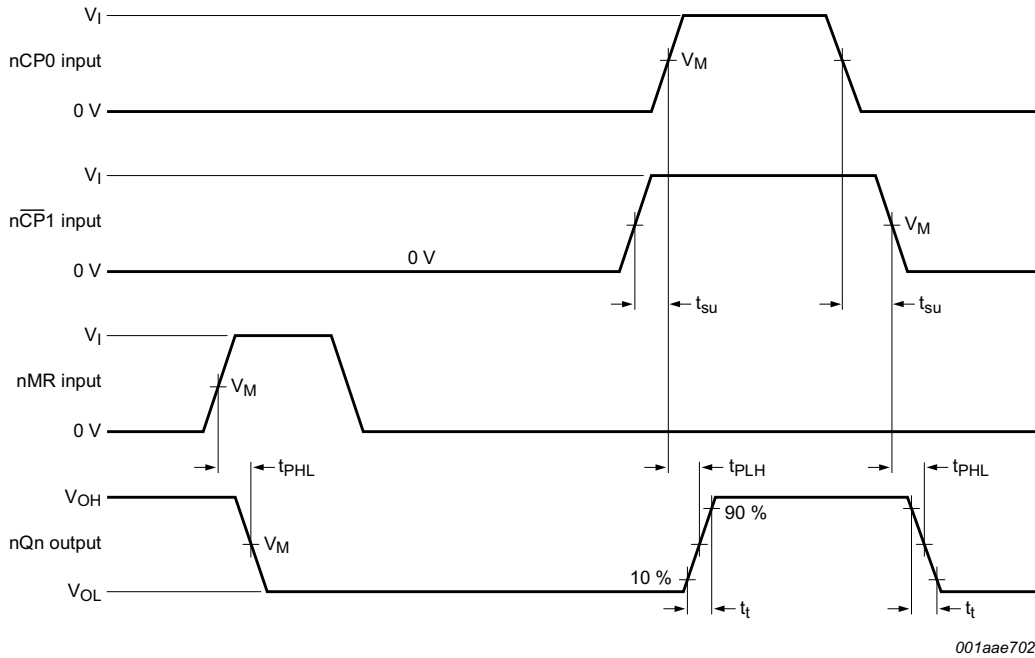
[1] The typical values of the propagation delay and transition times are calculated from the extrapolation formulas shown (C_L in pF).

Table 8. Dynamic power dissipation P_D

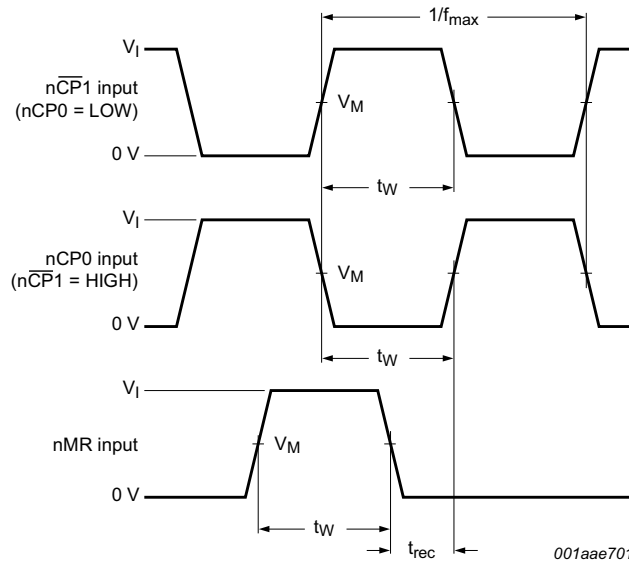
P_D can be calculated from the formulas shown. $V_{SS} = 0\text{ V}$; $t_r = t_f \leq 20\text{ ns}$; $T_{amb} = 25\text{ °C}$.

Symbol	Parameter	V_{DD}	Typical formula for P_D (μW)	Where:
P_D	dynamic power dissipation	5 V	$P_D = 750 \times f_i + \Sigma(f_o \times C_L) \times V_{DD}^2$	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	$P_D = 3300 \times f_i + \Sigma(f_o \times C_L) \times V_{DD}^2$	
		15 V	$P_D = 8000 \times f_i + \Sigma(f_o \times C_L) \times V_{DD}^2$	

12. Waveforms



a. nCP0 and nCP1 set-up times, propagation delays and output transition times

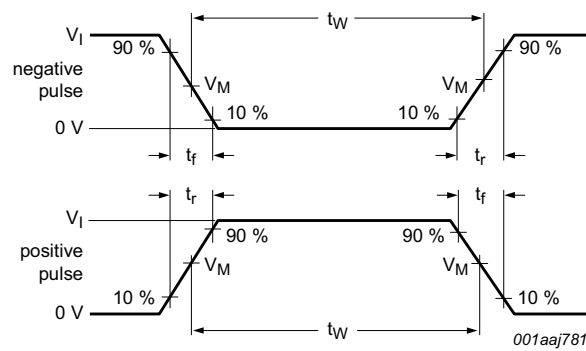


b. nMR recovery time, minimum nCP0, nCP1, and nMR pulse widths and maximum frequency

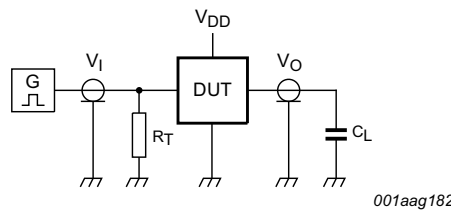
Measurement points are given in table [Table 9](#).

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

Fig 5. Waveforms showing measurements for switching times



a. Input waveforms



b. Test circuit

Test data is given in [Table 9](#).

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 output impedance Z_o of the pulse generator.

Fig 6. Test circuit for switching times

Table 9. Measurement points and test data

Supply voltage	Input			Load
V_{DD}	V_I	V_M	t_r, t_f	C_L
5 V to 15 V	V_{DD}	$0.5V_I$	≤ 20 ns	50 pF

13. Package outline

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

SOT109-1

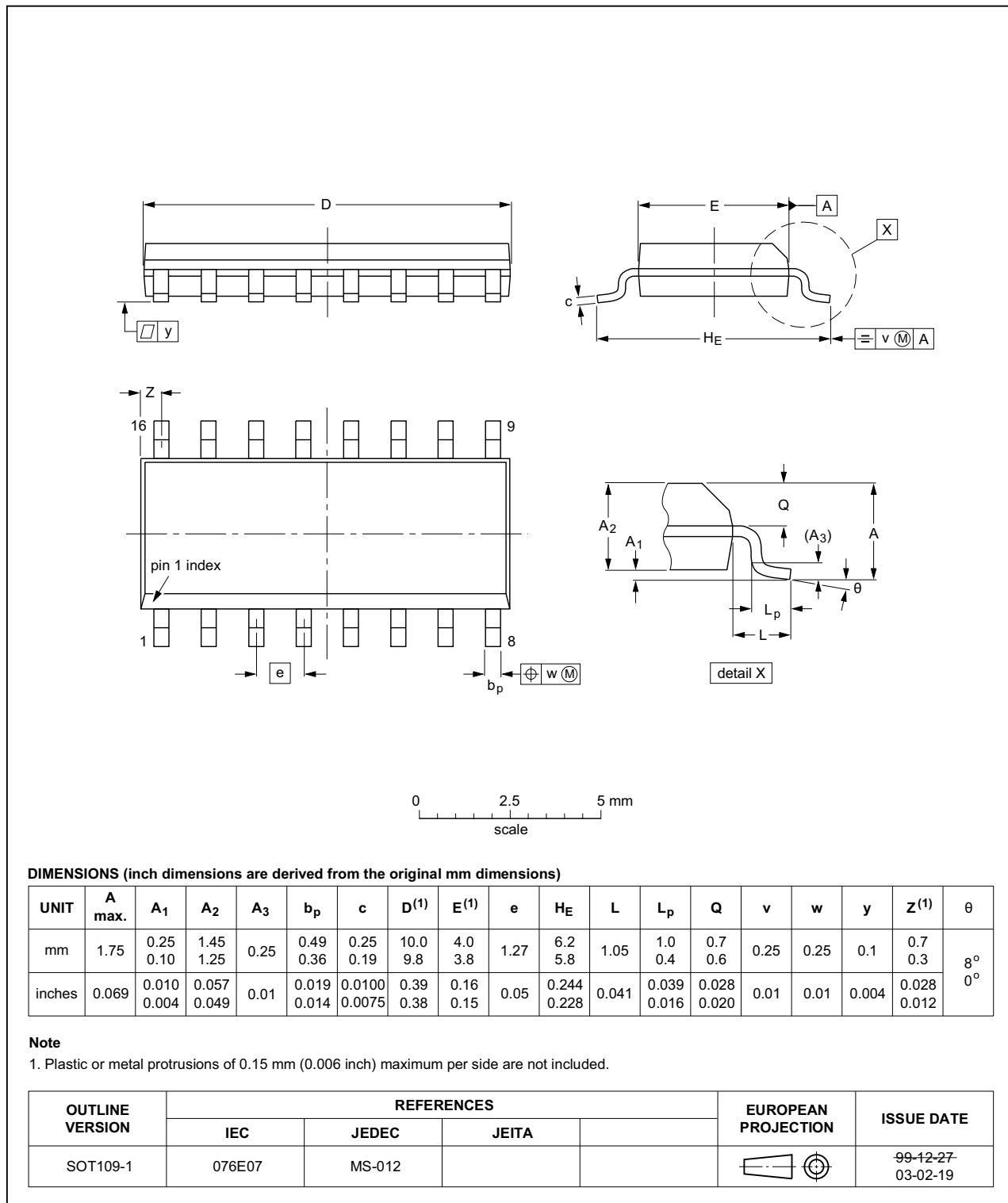


Fig 7. Package outline SOT109-1 (SO16)

14. Revision history

Table 10. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
HEF4518B v.8	20160419	Product data sheet	-	HEF4518B v.7
Modifications:	<ul style="list-style-type: none"> Type number HEF4518BP (SOT38-4) removed. 			
HEF4518B v.7	20111121	Product data sheet	-	HEF4518B v.6
Modifications:	<ul style="list-style-type: none"> Table 6: I_{OH} minimum values changed to maximum Figure 6: added "DUT = Device Under Test" 			
HEF4518B v.6	20091210	Product data sheet	-	HEF4518B v.5
HEF4518B v.5	20090727	Product data sheet	-	HEF4518B v.4
HEF4518B v.4	20090703	Product data sheet	-	HEF4518B_CNV v.3
HEF4518B_CNV v.3	19950101	Product specification	-	HEF4518B_CNV v.2
HEF4518B_CNV v.2	19950101	Product specification	-	-

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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".

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