

74HC4024

7-stage binary ripple counter

Rev. 10 — 23 November 2018

Product data sheet

1. General description

The 74HC4024 is a 7-stage binary ripple counter with a clock input (\overline{CP}), an 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 the state of \overline{CP} . Each counter stage is a static toggle flip-flop. Schmitt-trigger action in the clock input makes the circuit highly tolerant to slower clock rise and fall times. Inputs include clamp diodes. This enables the use of current limiting resistors to interface inputs to voltages in excess of V_{CC} .

2. Features and benefits

- Low-power dissipation
- Complies with JEDEC standard no. 7A
- CMOS input levels
- ESD protection:
 - HBM JESD22-A114F exceeds 2 000 V
 - MM JESD22-A115-A exceeds 200 V.
- Specified from -40 °C to +80 °C and from -40 °C to +125 °C.

3. Applications

- Frequency dividing circuits
- Time delay circuits.

4. Ordering information

Table 1. Ordering information

| Type number | Package | | | |
|-------------|-------------------|------|---|----------|
| | Temperature range | Name | Description | Version |
| 74HC4024D | -40 °C to +125 °C | SO14 | plastic small outline package; 14 leads; body width 3.9 mm | SOT108-1 |

5. Functional diagram

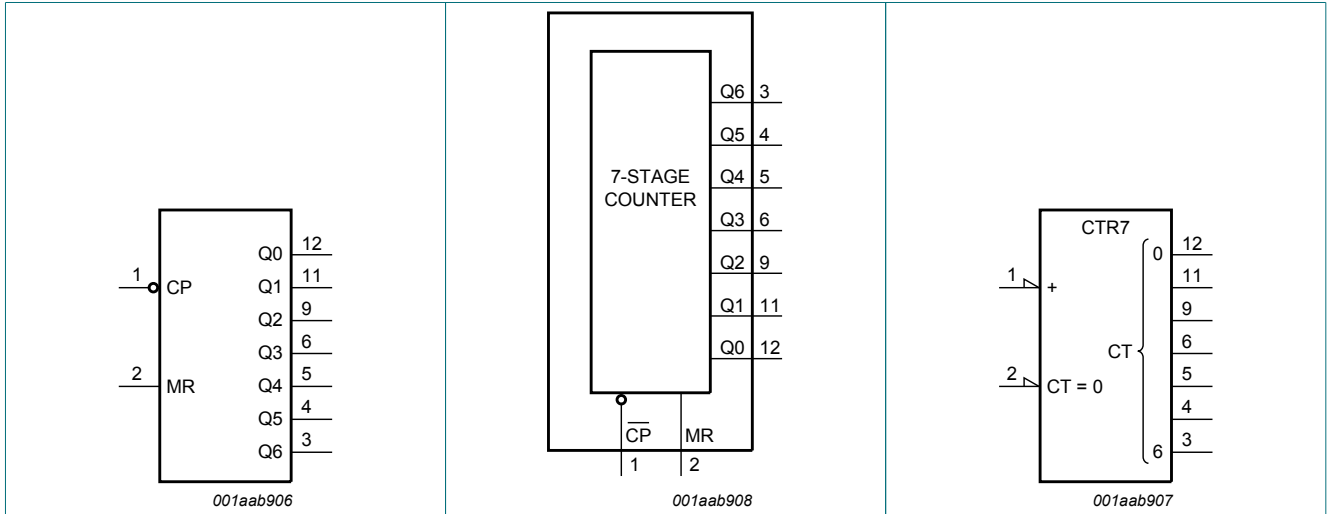


Fig. 1. Logic symbol

Fig. 2. Functional diagram

Fig. 3. IEC logic symbol

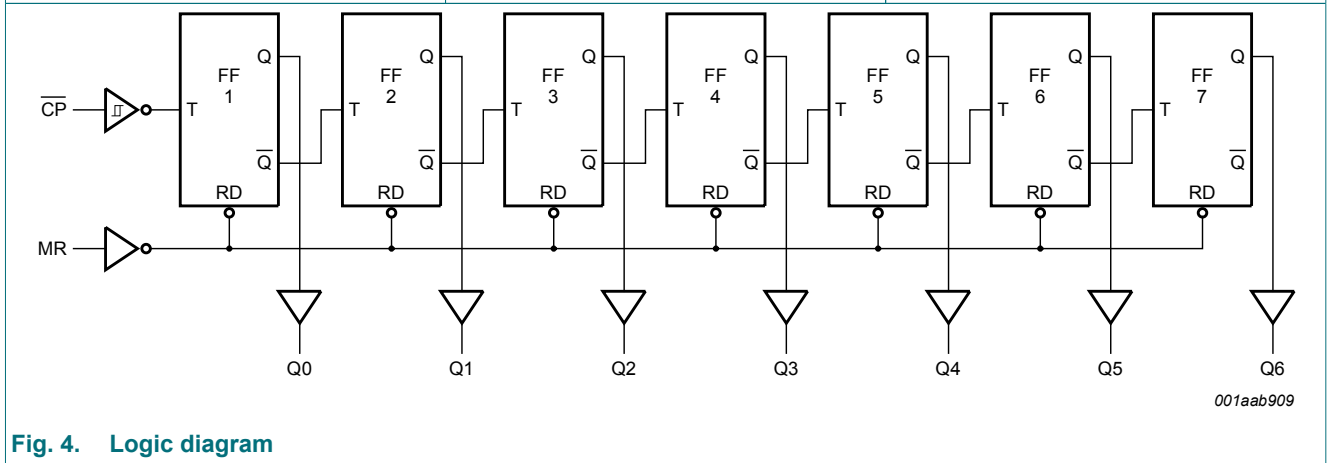


Fig. 4. Logic diagram

6. Pinning information

6.1. Pinning

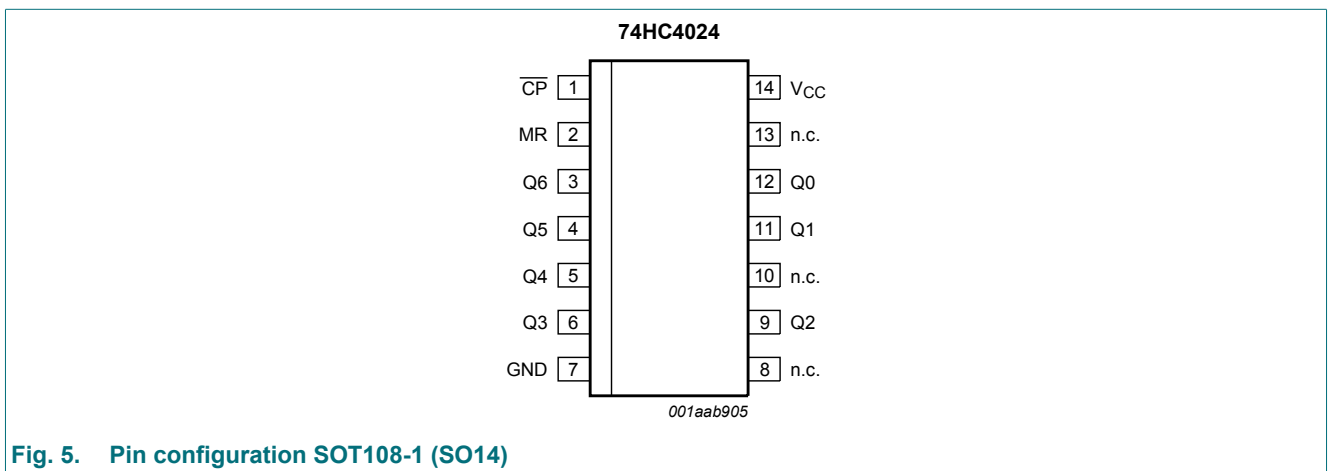


Fig. 5. Pin configuration SOT108-1 (SO14)

6.2. Pin description

Table 2. Pin description

| Symbol | Pin | Description |
|----------------------------|-----------------------|---|
| CP | 1 | clock input (HIGH-to-LOW, edge-triggered) |
| MR | 2 | master reset input (active HIGH) |
| Q6, Q5, Q4, Q3, Q2, Q1, Q0 | 3, 4, 5, 6, 9, 11, 12 | parallel output |
| GND | 7 | ground (0 V) |
| n.c. | 8, 10, 13 | not connected |
| V _{CC} | 14 | positive supply voltage |

7. Functional description

Table 3. Function table

H = HIGH voltage level; L = LOW voltage level; X = don't care; ↑ = LOW-to-HIGH clock transition;
↓ = HIGH-to-LOW clock transition.

| Input | | Output |
|-------|----|-----------|
| MR | CP | Qn |
| H | X | L |
| L | ↑ | no change |
| | ↓ | count |

8. Limiting values

Table 4. Limiting values

In accordance with the Absolute Maximum Rating System (IEC 60134). Voltages are referenced to GND (ground = 0 V).

| Symbol | Parameter | Conditions | Min | Max | Unit |
|------------------|-------------------------|---|------|------|------|
| V _{CC} | supply voltage | | -0.5 | +7 | V |
| I _{IK} | input clamping current | V _I < -0.5 V or V _I > V _{CC} + 0.5 V | - | ±20 | mA |
| I _{OK} | output clamping current | V _O < -0.5 V or V _O > V _{CC} + 0.5 V | - | ±20 | mA |
| I _O | output current | V _O = -0.5 V to V _{CC} + 0.5 V | - | ±25 | mA |
| I _{CC} | supply current | | - | 50 | mA |
| I _{GND} | ground current | | -50 | - | mA |
| T _{stg} | storage temperature | | -65 | +150 | °C |
| P _{tot} | total power dissipation | [1] | - | 500 | 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_{CC} | supply voltage | | 2.0 | 5.0 | 6.0 | V |
| V_I | input voltage | | 0 | - | V_{CC} | V |
| V_O | output voltage | | 0 | - | V_{CC} | V |
| $\Delta t/\Delta V$ | input transition rise and fall rate | $V_{CC} = 2.0\text{ V}$ | - | - | 625 | ns/V |
| | | $V_{CC} = 4.5\text{ V}$ | - | 1.67 | 139 | ns/V |
| | | $V_{CC} = 6.0\text{ V}$ | - | - | 83 | ns/V |
| T_{amb} | ambient temperature | | -40 | - | +125 | °C |

10. Static characteristics

Table 6. Static characteristics

At recommended operating conditions; voltages are referenced to GND (ground = 0 V).

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|--|---------------------------|---|------|------|-----------|---------------|
| $T_{amb} = 25\text{ °C}$ | | | | | | |
| V_{IH} | HIGH-level input voltage | $V_{CC} = 2.0\text{ V}$ | 1.5 | 1.2 | - | V |
| | | $V_{CC} = 4.5\text{ V}$ | 3.15 | 2.4 | - | V |
| | | $V_{CC} = 6.0\text{ V}$ | 4.2 | 3.2 | - | V |
| V_{IL} | LOW-level input voltage | $V_{CC} = 2.0\text{ V}$ | - | 0.8 | 0.5 | V |
| | | $V_{CC} = 4.5\text{ V}$ | - | 2.1 | 1.35 | V |
| | | $V_{CC} = 6.0\text{ V}$ | - | 2.8 | 1.8 | V |
| V_{OH} | HIGH-level output voltage | $V_I = V_{IH}$ or V_{IL} | | | | |
| | | $I_O = -20\text{ }\mu\text{A}$; $V_{CC} = 2.0\text{ V}$ | 1.9 | 2.0 | - | V |
| | | $I_O = -20\text{ }\mu\text{A}$; $V_{CC} = 4.5\text{ V}$ | 4.4 | 4.5 | - | V |
| | | $I_O = -20\text{ }\mu\text{A}$; $V_{CC} = 6.0\text{ V}$ | 5.9 | 6.0 | - | V |
| | | $I_O = -4\text{ mA}$; $V_{CC} = 4.5\text{ V}$ | 3.98 | 4.32 | - | V |
| V_{OL} | LOW-level output voltage | $V_I = V_{IH}$ or V_{IL} | | | | |
| | | $I_O = 20\text{ }\mu\text{A}$; $V_{CC} = 2.0\text{ V}$ | - | 0 | 0.1 | V |
| | | $I_O = 20\text{ }\mu\text{A}$; $V_{CC} = 4.5\text{ V}$ | - | 0 | 0.1 | V |
| | | $I_O = 20\text{ }\mu\text{A}$; $V_{CC} = 6.0\text{ V}$ | - | 0 | 0.1 | V |
| | | $I_O = 4\text{ mA}$; $V_{CC} = 4.5\text{ V}$ | - | 0.15 | 0.26 | V |
| | | $I_O = 5.2\text{ mA}$; $V_{CC} = 6.0\text{ V}$ | - | 0.16 | 0.26 | V |
| I_I | input leakage current | $V_I = V_{CC}$ or GND; $V_{CC} = 6.0\text{ V}$ | - | - | ± 0.1 | μA |
| I_{CC} | supply current | $V_I = V_{CC}$ or GND; $I_O = 0\text{ A}$; $V_{CC} = 6.0\text{ V}$ | - | - | 8.0 | μA |
| C_I | input capacitance | | - | 3.5 | - | pF |

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|--|---------------------------|--|------|-----|------|------|
| T_{amb} = -40 °C to +85 °C | | | | | | |
| V _{IH} | HIGH-level input voltage | V _{CC} = 2.0 V | 1.5 | - | - | V |
| | | V _{CC} = 4.5 V | 3.15 | - | - | V |
| | | V _{CC} = 6.0 V | 4.2 | - | - | V |
| V _{IL} | LOW-level input voltage | V _{CC} = 2.0 V | - | - | 0.5 | V |
| | | V _{CC} = 4.5 V | - | - | 1.35 | V |
| | | V _{CC} = 6.0 V | - | - | 1.8 | V |
| V _{OH} | HIGH-level output voltage | V _I = V _{IH} or V _{IL} | | | | |
| | | I _O = -20 µA; V _{CC} = 2.0 V | 1.9 | - | - | V |
| | | I _O = -20 µA; V _{CC} = 4.5 V | 4.4 | - | - | V |
| | | I _O = -20 µA; V _{CC} = 6.0 V | 5.9 | - | - | V |
| | | I _O = -4 mA; V _{CC} = 4.5 V | 3.84 | - | - | V |
| V _{OL} | LOW-level output voltage | V _I = V _{IH} or V _{IL} | | | | |
| | | I _O = 20 µA; V _{CC} = 2.0 V | - | - | 0.1 | V |
| | | I _O = 20 µA; V _{CC} = 4.5 V | - | - | 0.1 | V |
| | | I _O = 20 µA; V _{CC} = 6.0 V | - | - | 0.1 | V |
| | | I _O = 4 mA; V _{CC} = 4.5 V | - | - | 0.33 | V |
| I _I | input leakage current | V _I = V _{CC} or GND; V _{CC} = 6.0 V | - | - | ±1.0 | µA |
| | | | | | | |
| I _{CC} | supply current | V _I = V _{CC} or GND; I _O = 0 A; V _{CC} = 6.0 V | - | - | 80 | µA |
| T_{amb} = -40 °C to +125 °C | | | | | | |
| V _{IH} | HIGH-level input voltage | V _{CC} = 2.0 V | 1.5 | - | - | V |
| | | V _{CC} = 4.5 V | 3.15 | - | - | V |
| | | V _{CC} = 6.0 V | 4.2 | - | - | V |
| V _{IL} | LOW-level input voltage | V _{CC} = 2.0 V | - | - | 0.5 | V |
| | | V _{CC} = 4.5 V | - | - | 1.35 | V |
| | | V _{CC} = 6.0 V | - | - | 1.8 | V |
| V _{OH} | HIGH-level output voltage | V _I = V _{IH} or V _{IL} | | | | |
| | | I _O = -20 µA; V _{CC} = 2.0 V | 1.9 | - | - | V |
| | | I _O = -20 µA; V _{CC} = 4.5 V | 4.4 | - | - | V |
| | | I _O = -20 µA; V _{CC} = 6.0 V | 5.9 | - | - | V |
| | | I _O = -4 mA; V _{CC} = 4.5 V | 3.7 | - | - | V |
| V _{OL} | LOW-level output voltage | V _I = V _{IH} or V _{IL} | | | | |
| | | I _O = 20 µA; V _{CC} = 2.0 V | - | - | 0.1 | V |
| | | I _O = 20 µA; V _{CC} = 4.5 V | - | - | 0.1 | V |
| | | I _O = 20 µA; V _{CC} = 6.0 V | - | - | 0.1 | V |
| | | I _O = 4 mA; V _{CC} = 4.5 V | - | - | 0.4 | V |
| I _I | input leakage current | V _I = V _{CC} or GND; V _{CC} = 6.0 V | - | - | ±1.0 | µA |
| | | | | | | |
| I _{CC} | supply current | V _I = V _{CC} or GND; I _O = 0 A; V _{CC} = 6.0 V | - | - | 160 | µA |

11. Dynamic characteristics

Table 7. Dynamic characteristics

$GND = 0\text{ V}$; $t_r = t_f = 6\text{ ns}$; $C_L = 50\text{ pF}$; for test circuit see [Fig. 7](#).

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|--------------------------------|-------------------------------|---|-----|-----|-----|------|
| T_{amb} = 25 °C | | | | | | |
| t _{pd} | propagation delay | \overline{CP} to Q0; see Fig. 6 [1] | | | | |
| | | V _{CC} = 2.0 V | - | 47 | 175 | ns |
| | | V _{CC} = 4.5 V | - | 17 | 35 | ns |
| | | V _{CC} = 6.0 V | - | 14 | 30 | ns |
| | | V _{CC} = 5.0 V; C _L = 15 pF | - | 14 | - | ns |
| | | Qn to Qn+1; see Fig. 6 [1] | | | | |
| | | V _{CC} = 2.0 V | - | 25 | 80 | ns |
| | | V _{CC} = 4.5 V | - | 9 | 16 | ns |
| t _{PHL} | HIGH to LOW propagation delay | MR to Q0; see Fig. 6 | | | | |
| | | V _{CC} = 2.0 V | - | 63 | 200 | ns |
| | | V _{CC} = 4.5 V | - | 23 | 40 | ns |
| t _t | transition time | see Fig. 6 [2] | | | | |
| | | V _{CC} = 2.0 V | - | 19 | 75 | ns |
| | | V _{CC} = 4.5 V | - | 7 | 15 | ns |
| t _w | pulse width | \overline{CP} HIGH or LOW; see Fig. 6 | | | | |
| | | V _{CC} = 2.0 V | 80 | 17 | - | ns |
| | | V _{CC} = 4.5 V | 16 | 6 | - | ns |
| | | V _{CC} = 6.0 V | 14 | 5 | - | ns |
| | | MR HIGH; see Fig. 6 | | | | |
| | | V _{CC} = 2.0 V | 80 | 22 | - | ns |
| | | V _{CC} = 4.5 V | 16 | 8 | - | ns |
| t _{rec} | recovery time | MR to \overline{CP} ; see Fig. 6 | | | | |
| | | V _{CC} = 2.0 V | 50 | 6 | - | ns |
| | | V _{CC} = 4.5 V | 10 | 2 | - | ns |
| f _{max} | maximum frequency | CP; see Fig. 6 | | | | |
| | | V _{CC} = 2.0 V | 6.0 | 27 | - | MHz |
| | | V _{CC} = 4.5 V | 30 | 82 | - | MHz |
| | | V _{CC} = 6.0 V | 35 | 98 | - | MHz |
| C _{PD} | power dissipation capacitance | V _I = GND to V _{CC} [3] | - | 25 | - | pF |

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|---|-------------------------------|----------------------------|-----|-----|-----|------|
| T_{amb} = -40 °C to +85 °C | | | | | | |
| t _{pd} | propagation delay | CP̄ to Q0; see Fig. 6 [1] | | | | |
| | | V _{CC} = 2.0 V | - | - | 220 | ns |
| | | V _{CC} = 4.5 V | - | - | 44 | ns |
| | | V _{CC} = 6.0 V | - | - | 37 | ns |
| | | Qn to Qn+1; see Fig. 6 [1] | | | | |
| | | V _{CC} = 2.0 V | - | - | 100 | ns |
| | | V _{CC} = 4.5 V | - | - | 20 | ns |
| t _{PHL} | HIGH to LOW propagation delay | MR to Q0; see Fig. 6 | | | | |
| | | V _{CC} = 2.0 V | - | - | 250 | ns |
| | | V _{CC} = 4.5 V | - | - | 50 | ns |
| t _t | transition time | see Fig. 6 [2] | | | | |
| | | V _{CC} = 2.0 V | - | - | 95 | ns |
| | | V _{CC} = 4.5 V | - | - | 19 | ns |
| t _w | pulse width | CP HIGH or LOW; see Fig. 6 | | | | |
| | | V _{CC} = 2.0 V | 100 | - | - | ns |
| | | V _{CC} = 4.5 V | 20 | - | - | ns |
| | | V _{CC} = 6.0 V | 17 | - | - | ns |
| | | MR HIGH; see Fig. 6 | | | | |
| | | V _{CC} = 2.0 V | 100 | - | - | ns |
| | | V _{CC} = 4.5 V | 20 | - | - | ns |
| t _{rec} | recovery time | MR to CP̄; see Fig. 6 | | | | |
| | | V _{CC} = 2.0 V | 65 | - | - | ns |
| | | V _{CC} = 4.5 V | 13 | - | - | ns |
| f _{max} | maximum frequency | CP; see Fig. 6 | | | | |
| | | V _{CC} = 2.0 V | 4.8 | - | - | MHz |
| | | V _{CC} = 4.5 V | 24 | - | - | MHz |
| | | V _{CC} = 6.0 V | 28 | - | - | MHz |

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|--|-------------------------------|----------------------------|-----|-----|-----|------|
| T_{amb} = -40 °C to +125 °C | | | | | | |
| t _{pd} | propagation delay | CP̄ to Q0; see Fig. 6 [1] | | | | |
| | | V _{CC} = 2.0 V | - | - | 265 | ns |
| | | V _{CC} = 4.5 V | - | - | 53 | ns |
| | | V _{CC} = 6.0 V | - | - | 45 | ns |
| | | Qn to Qn+1; see Fig. 6 [1] | | | | |
| | | V _{CC} = 2.0 V | - | - | 120 | ns |
| | | V _{CC} = 4.5 V | - | - | 24 | ns |
| t _{PHL} | HIGH to LOW propagation delay | MR to Q0; see Fig. 6 | | | | |
| | | V _{CC} = 2.0 V | - | - | 300 | ns |
| | | V _{CC} = 4.5 V | - | - | 60 | ns |
| t _t | transition time | see Fig. 6 [2] | | | | |
| | | V _{CC} = 2.0 V | - | - | 110 | ns |
| | | V _{CC} = 4.5 V | - | - | 22 | ns |
| t _w | pulse width | CP HIGH or LOW; see Fig. 6 | | | | |
| | | V _{CC} = 2.0 V | 120 | - | - | ns |
| | | V _{CC} = 4.5 V | 24 | - | - | ns |
| | | V _{CC} = 6.0 V | 20 | - | - | ns |
| | | MR HIGH; see Fig. 6 | | | | |
| | | V _{CC} = 2.0 V | 120 | - | - | ns |
| | | V _{CC} = 4.5 V | 24 | - | - | ns |
| t _{rec} | recovery time | MR to CP̄; see Fig. 6 | | | | |
| | | V _{CC} = 2.0 V | 75 | - | - | ns |
| | | V _{CC} = 4.5 V | 15 | - | - | ns |
| f _{max} | maximum frequency | CP; see Fig. 6 | | | | |
| | | V _{CC} = 2.0 V | 4.0 | - | - | MHz |
| | | V _{CC} = 4.5 V | 20 | - | - | MHz |
| | | V _{CC} = 6.0 V | 24 | - | - | MHz |

[1] t_{pd} is the same as t_{PLH} and t_{PHL}.

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

[3] C_{PD} is used to determine the dynamic power dissipation (P_D in μW).

$$P_D = C_{PD} \times V_{CC}^2 \times f_i \times N + \sum(C_L \times V_{CC}^2 \times f_o) \text{ where:}$$

f_i = input frequency in MHz;

f_o = output frequency in MHz;

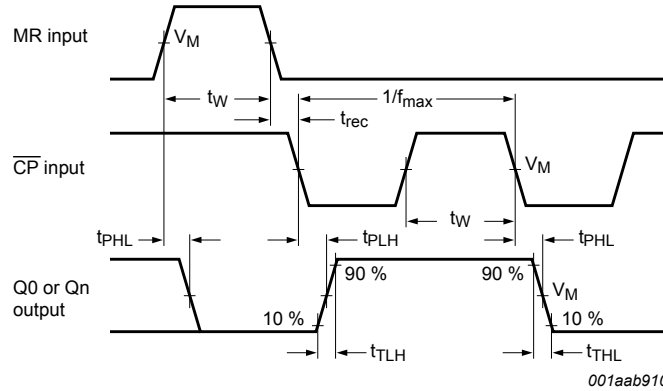
C_L = output load capacitance in pF;

V_{CC} = supply voltage in V;

N = number of inputs switching;

$\sum(C_L \times V_{CC}^2 \times f_o)$ = sum of outputs.

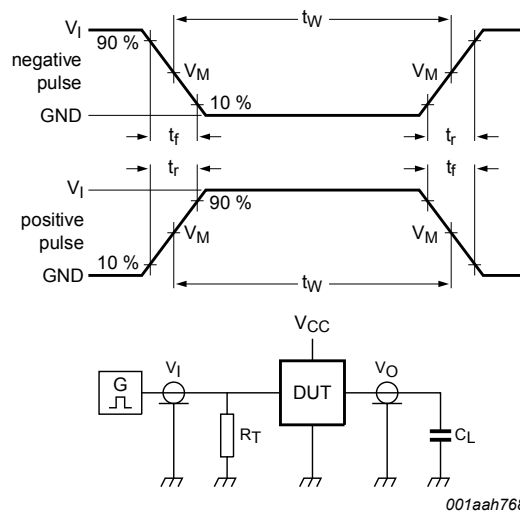
11.1. Waveforms and test circuit



Also showing the master reset (MR) pulse width, the master reset to output (Qn) propagation delays and the master reset to clock (CP) recovery time.

$$V_M = 0.5 \times V_{CC}$$

Fig. 6. Waveforms showing the clock (CP) to output (Qn) propagation delays, the clock pulse width, the output transition times and the maximum clock frequency



Test data is given in Table 8.

Definitions for test circuit:

R_T = Termination resistance should be equal to output impedance Z_o of the pulse generator.

C_L = Load capacitance including jig and probe capacitance.

Fig. 7. Test circuit for measuring switching times

Table 8. Test data

| Supply | Input | Load |
|----------|----------|-------|
| V_{CC} | V_I | C_L |
| 2.0 V | V_{CC} | 50 pF |
| 4.5 V | V_{CC} | 50 pF |
| 6.0 V | V_{CC} | 50 pF |
| 5.0 V | V_{CC} | 15 pF |

12. Package outline

SO14: plastic small outline package; 14 leads; body width 3.9 mm

SOT108-1

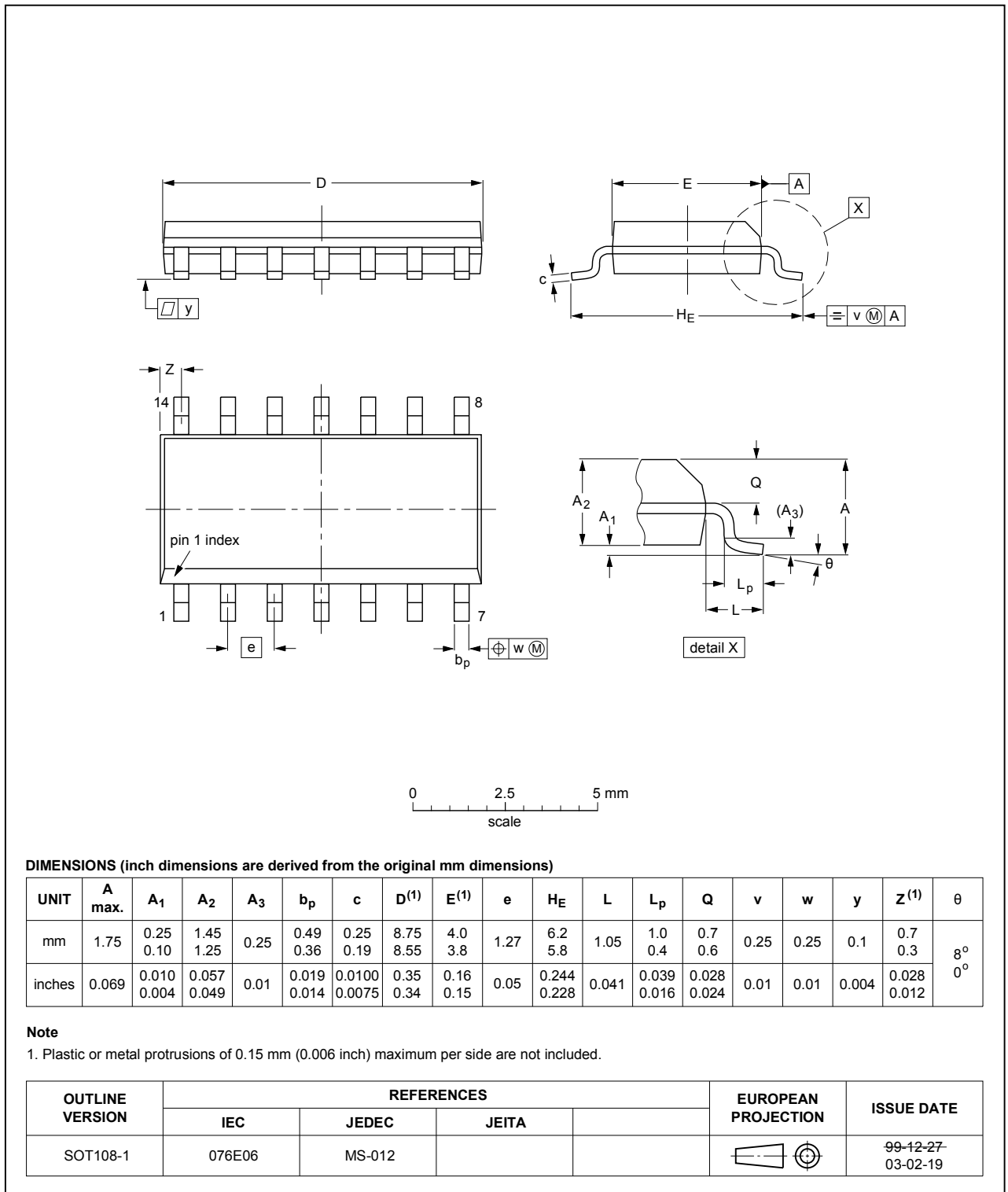


Fig. 8. Package outline SOT108-1 (SO14)

13. Abbreviations

Table 9. Abbreviations

| Acronym | Description |
|---------|---|
| CMOS | Complementary Metal-Oxide Semiconductor |
| DUT | Device Under Test |
| ESD | ElectroStatic Discharge |
| HBM | Human Body Model |
| MM | Machine Model |

14. Revision history

Table 10. Revision history

| Document ID | Release date | Data sheet status | Change notice | Supersedes |
|----------------------|---|-----------------------|---------------|----------------------|
| 74HC4024 v.10 | 20181123 | Product data sheet | - | 74HC4024 v.9 |
| Modifications: | <ul style="list-style-type: none"> The format of this data sheet has been redesigned to comply with the identity guidelines of Nexperia. Legal texts have been adapted to the new company name where appropriate. Type number 74HC4024PW (SOT402-1/TSSOP14) removed. | | | |
| 74HC4024 v.9 | 20160428 | Product data sheet | - | 74HC4024 v.8 |
| Modifications: | <ul style="list-style-type: none"> Type number 74HC4024DB (SOT337-1) removed. | | | |
| 74HC4024 v.8 | 20151202 | Product data sheet | - | 74HC4024 v.7 |
| Modifications: | <ul style="list-style-type: none"> Type number 74HC4024N (SOT27-1) removed. | | | |
| 74HC4024 v.7 | 20131031 | Product data sheet | - | 74HC4024 v.6 |
| Modifications: | <ul style="list-style-type: none"> General description updated. | | | |
| 74HC4024 v.6 | 20120823 | Product data sheet | - | 74HC4024 v.5 |
| 74HC4024 v.4 | 20100929 | Product data sheet | - | 74HC4024 v.3 |
| 74HC4024 v.3 | 20041112 | Product data sheet | - | 74HC_HCT4024_CNV v.2 |
| 74HC_HCT4024_CNV v.2 | 19970901 | Product specification | - | 74HC_HCT4024 v.1 |
| 74HC_HCT4024 v.1 | 19901201 | Product specification | - | - |

15. Legal information

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. |

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Date of release: 23 November 2018