

74HC14; 74HCT14

Hex inverting Schmitt trigger

Rev. 8 — 22 May 2020

Product data sheet

1. General description

The 74HC14; 74HCT14 is a hex inverter with Schmitt-trigger inputs. This device features reduced input threshold levels to allow interfacing to TTL logic levels. Inputs also include clamp diodes, this enables the use of current limiting resistors to interface inputs to voltages in excess of V_{CC} . Schmitt trigger inputs transform slowly changing input signals into sharply defined jitter-free output signals.

2. Features and benefits

- Complies with JEDEC standard no. 7A
- Low-power dissipation
- ESD protection:
 - HBM JESD22-A114F exceeds 2000 V
 - MM JESD22-A115-A exceeds 200 V
- Multiple package options
- Specified from -40 °C to +85 °C and from -40 °C to +125 °C

3. Applications

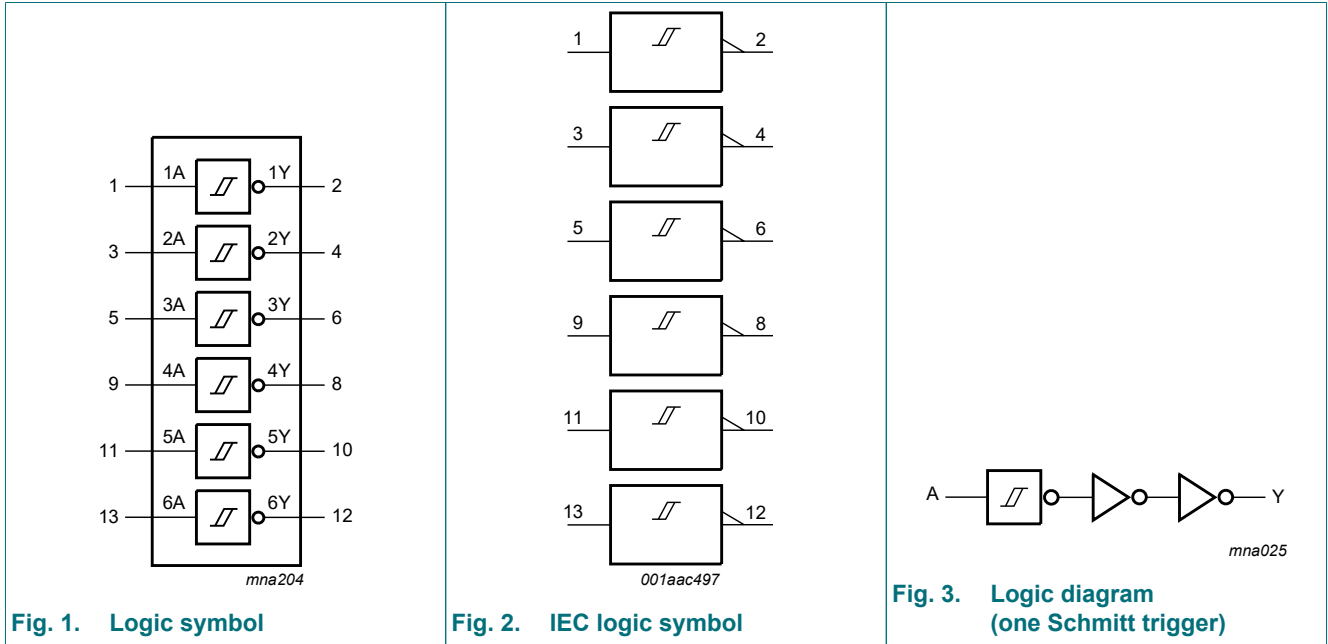
- Wave and pulse shapers
- Astable multivibrators
- Monostable multivibrators

4. Ordering information

Table 1. Ordering information

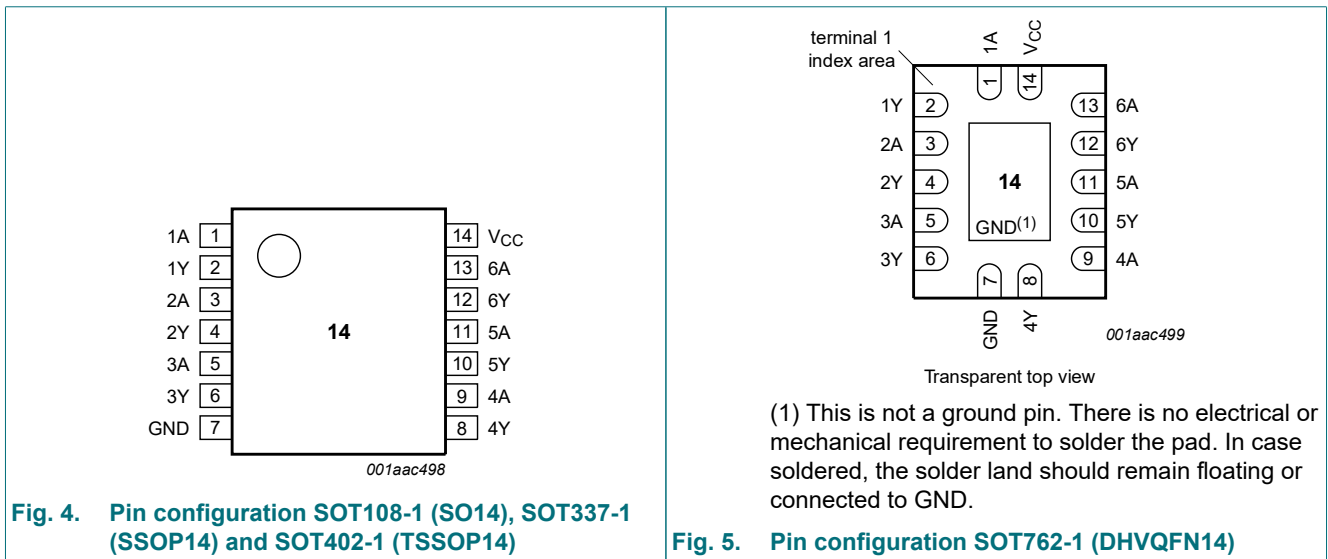
| Type number | Package | | | Version |
|-----------------------|-------------------|----------|--|----------|
| | Temperature range | Name | Description | |
| 74HC14D 74HCT14D | -40 °C to +125 °C | SO14 | plastic small outline package; 14 leads; body width 3.9 mm | SOT108-1 |
| 74HC14DB 74HCT14DB | -40 °C to +125 °C | SSOP14 | plastic shrink small outline package; 14 leads; body width 5.3 mm | SOT337-1 |
| 74HC14PW 74HCT14PW | -40 °C to +125 °C | TSSOP14 | plastic thin shrink small outline package; 14 leads; body width 4.4 mm | SOT402-1 |
| 74HC14BQ 74HCT14BQ | -40 °C to +125 °C | DHVQFN14 | plastic dual in-line compatible thermal enhanced very thin quad flat package; no leads; 14 terminals; body 2.5 × 3 × 0.85 mm | SOT762-1 |

5. Functional diagram



6. Pinning information

6.1. Pinning



6.2. Pin description

Table 2. Pin description

| Symbol | Pin | Description |
|------------------------|--------------------|----------------|
| 1A, 2A, 3A, 4A, 5A, 6A | 1, 3, 5, 9, 11, 13 | data input |
| 1Y, 2Y, 3Y, 4Y, 5Y, 6Y | 2, 4, 6, 8, 10, 12 | data output |
| GND | 7 | ground (0 V) |
| V _{CC} | 14 | supply voltage |

7. Functional description

Table 3. Function table

H = HIGH voltage level; L = LOW voltage level.

| Input | Output |
|-------|--------|
| nA | nY |
| L | H |
| H | L |

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 [1] | - | ±20 | mA |
| I _{OK} | output clamping current | V _O < -0.5 V or V _O > V _{CC} + 0.5 V [1] | - | ±20 | mA |
| I _O | output current | -0.5 V < V _O < 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 | [2] | - | 500 | mW |

[1] The input and output voltage ratings may be exceeded if the input and output current ratings are observed.

[2] For SOT108-1 (SO14) package: P_{tot} derates linearly with 10.1 mW/K above 100 °C.
 For SOT337-1 (SSOP14) package: P_{tot} derates linearly with 7.3 mW/K above 81 °C.
 For SOT402-1 (TSSOP14) package: P_{tot} derates linearly with 7.3 mW/K above 81 °C.
 For SOT762-1 (DHVQFN14) package: P_{tot} derates linearly with 9.6 mW/K above 98 °C.

9. Recommended operating conditions

Table 5. Recommended operating conditions

Voltages are referenced to GND (ground = 0 V)

| Symbol | Parameter | Conditions | 74HC14 | | | 74HCT14 | | | Unit |
|------------------|---------------------|------------|--------|-----|-----------------|---------|-----|-----------------|------|
| | | | Min | Typ | Max | Min | Typ | Max | |
| V _{CC} | supply voltage | | 2.0 | 5.0 | 6.0 | 4.5 | 5.0 | 5.5 | V |
| V _I | input voltage | | 0 | - | V _{CC} | 0 | - | V _{CC} | V |
| V _O | output voltage | | 0 | - | V _{CC} | 0 | - | V _{CC} | V |
| T _{amb} | ambient temperature | | -40 | +25 | +125 | -40 | +25 | +125 | °C |

10. Static characteristics

Table 6. Static characteristics

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

| Symbol | Parameter | Conditions | T _{amb} = 25 °C | | | T _{amb} = -40 °C to +85 °C | | T _{amb} = -40 °C to +125 °C | | Unit |
|-----------------|---------------------------|--|--------------------------|------|------|-------------------------------------|------|--------------------------------------|------|------|
| | | | Min | Typ | Max | Min | Max | Min | Max | |
| 74HC14 | | | | | | | | | | |
| V _{OH} | HIGH-level output voltage | V _I = V _{T+} or V _{T-} | | | | | | | | |
| | | I _O = -20 μA; V _{CC} = 2.0 V | 1.9 | 2.0 | - | 1.9 | - | 1.9 | - | V |
| | | I _O = -20 μA; V _{CC} = 4.5 V | 4.4 | 4.5 | - | 4.4 | - | 4.4 | - | V |
| | | I _O = -20 μA; V _{CC} = 6.0 V | 5.9 | 6.0 | - | 5.9 | - | 5.9 | - | V |
| | | I _O = -4.0 mA; V _{CC} = 4.5 V | 3.98 | 4.32 | - | 3.84 | - | 3.7 | - | V |
| | | I _O = -5.2 mA; V _{CC} = 6.0 V | 5.48 | 5.81 | - | 5.34 | - | 5.2 | - | V |
| V _{OL} | LOW-level output voltage | V _I = V _{T+} or V _{T-} | | | | | | | | |
| | | I _O = 20 μA; V _{CC} = 2.0 V | - | 0 | 0.1 | - | 0.1 | - | 0.1 | V |
| | | I _O = 20 μA; V _{CC} = 4.5 V | - | 0 | 0.1 | - | 0.1 | - | 0.1 | V |
| | | I _O = 20 μA; V _{CC} = 6.0 V | - | 0 | 0.1 | - | 0.1 | - | 0.1 | V |
| | | I _O = 4.0 mA; V _{CC} = 4.5 V | - | 0.15 | 0.26 | - | 0.33 | - | 0.4 | V |
| | | I _O = 5.2 mA; V _{CC} = 6.0 V | - | 0.16 | 0.26 | - | 0.33 | - | 0.4 | V |
| I _I | input leakage current | V _I = V _{CC} or GND; V _{CC} = 6.0 V | - | - | ±0.1 | - | ±1.0 | - | ±1.0 | μA |
| I _{CC} | supply current | V _I = V _{CC} or GND; I _O = 0 A; V _{CC} = 6.0 V | - | - | 2.0 | - | 20 | - | 40 | μA |
| C _I | input capacitance | | - | 3.5 | - | - | - | - | - | pF |

| Symbol | Parameter | Conditions | T _{amb} = 25 °C | | | T _{amb} = -40 °C to +85 °C | | T _{amb} = -40 °C to +125 °C | | Unit |
|------------------|---------------------------|---|--------------------------|------|------|-------------------------------------|------|--------------------------------------|------|------|
| | | | Min | Typ | Max | Min | Max | Min | Max | |
| 74HCT14 | | | | | | | | | | |
| V _{OH} | HIGH-level output voltage | V _I = V _{T+} or V _{T-} ; V _{CC} = 4.5 V | | | | | | | | |
| | | I _O = -20 µA | 4.4 | 4.5 | - | 4.4 | - | 4.4 | - | V |
| | | I _O = -4.0 mA | 3.98 | 4.32 | - | 3.84 | - | 3.7 | - | V |
| V _{OL} | LOW-level output voltage | V _I = V _{T+} or V _{T-} ; V _{CC} = 4.5 V | | | | | | | | |
| | | I _O = 20 µA; | - | 0 | 0.1 | - | 0.1 | - | 0.1 | V |
| | | I _O = 4.0 mA; | - | 0.15 | 0.26 | - | 0.33 | - | 0.4 | V |
| I _I | input leakage current | V _I = V _{CC} or GND; V _{CC} = 5.5 V | - | - | ±0.1 | - | ±1.0 | - | ±1.0 | µA |
| I _{CC} | supply current | V _I = V _{CC} or GND; I _O = 0 A; V _{CC} = 5.5 V | - | - | 2.0 | - | 20 | - | 40 | µA |
| ΔI _{CC} | additional supply current | per input pin; V _I = V _{CC} - 2.1 V; other pins at V _{CC} or GND; I _O = 0 A; V _{CC} = 4.5 V to 5.5 V | - | 30 | 108 | - | 135 | - | 147 | µA |
| C _I | input capacitance | | - | 3.5 | - | - | - | - | - | pF |

11. Dynamic characteristics

Table 7. Dynamic characteristics

GND = 0 V; C_L = 50 pF; for test circuit see Fig. 7.

| Symbol | Parameter | Conditions | T _{amb} = 25 °C | | | T _{amb} = -40 °C to +85 °C | | T _{amb} = -40 °C to +125 °C | | Unit |
|-----------------|-------------------------------|--|--------------------------|-----|-----|-------------------------------------|-----|--------------------------------------|-----|------|
| | | | Min | Typ | Max | Min | Max | Min | Max | |
| 74HC14 | | | | | | | | | | |
| t _{pd} | propagation delay | nA to nY; see Fig. 6 [1] | | | | | | | | |
| | | V _{CC} = 2.0 V | - | 41 | 125 | - | 155 | - | 190 | ns |
| | | V _{CC} = 4.5 V | - | 15 | 25 | - | 31 | - | 38 | ns |
| | | V _{CC} = 5.0 V; C _L = 15 pF | - | 12 | - | - | - | - | - | ns |
| | | V _{CC} = 6.0 V | - | 12 | 21 | - | 26 | - | 32 | ns |
| t _t | transition time | see Fig. 6 [2] | | | | | | | | |
| | | V _{CC} = 2.0 V | - | 19 | 75 | - | 95 | - | 110 | ns |
| | | V _{CC} = 4.5 V | - | 7 | 15 | - | 19 | - | 22 | ns |
| | | V _{CC} = 6.0 V | - | 6 | 13 | - | 15 | - | 19 | ns |
| C _{PD} | power dissipation capacitance | per package; V _I = GND to V _{CC} [3] | - | 7 | - | - | - | - | - | pF |

| Symbol | Parameter | Conditions | T _{amb} = 25 °C | | | T _{amb} = -40 °C to +85 °C | | T _{amb} = -40 °C to +125 °C | | Unit |
|-----------------|-------------------------------|--|--------------------------|-----|-----|-------------------------------------|-----|--------------------------------------|-----|------|
| | | | Min | Typ | Max | Min | Max | Min | Max | |
| 74HCT14 | | | | | | | | | | |
| t _{pd} | propagation delay | nA to nY; see Fig. 6 [1] | | | | | | | | |
| | | V _{CC} = 4.5 V | - | 20 | 34 | - | 43 | - | 51 | ns |
| | | V _{CC} = 5.0 V; C _L = 15 pF | - | 17 | - | - | - | - | - | ns |
| t _t | transition time | V _{CC} = 4.5 V; see Fig. 6 [2] | - | 7 | 15 | - | 19 | - | 22 | ns |
| C _{PD} | power dissipation capacitance | per package; V _I = GND to V _{CC} - 1.5 V [3] | - | 8 | - | - | - | - | - | pF |

- [1] t_{pd} is the same as t_{PHL} and t_{PLH}.
- [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):
 $P_D = C_{PD} \times V_{CC}^2 \times f_i \times N + \sum (C_L \times V_{CC}^2 \times f_o)$ 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

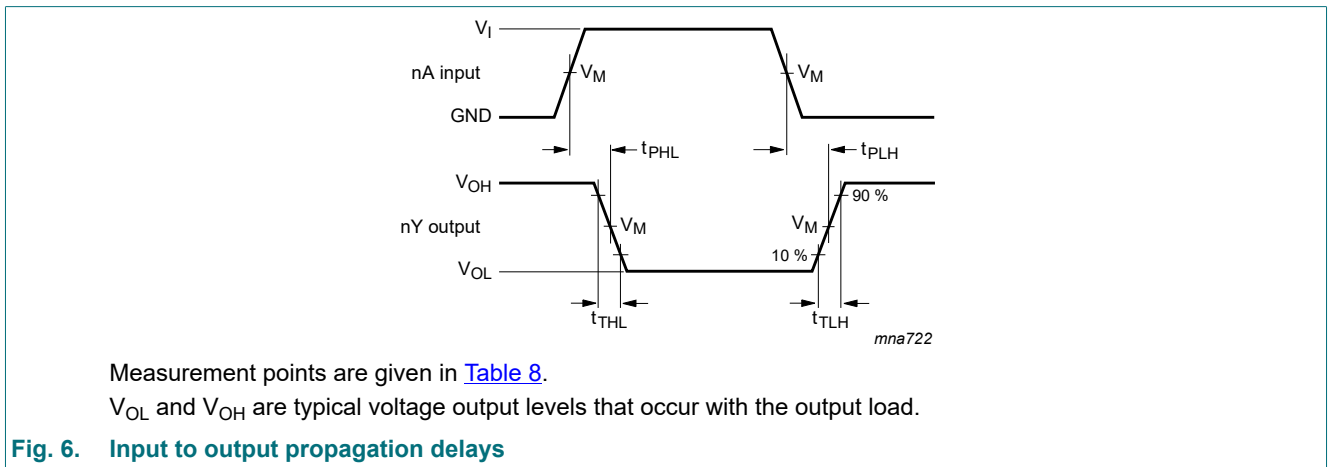


Table 8. Measurement points

| Type | Input | Output | | |
|---------|--------------------|--------------------|--------------------|--------------------|
| | V _M | V _M | V _X | V _Y |
| 74HC14 | 0.5V _{CC} | 0.5V _{CC} | 0.1V _{CC} | 0.9V _{CC} |
| 74HCT14 | 1.3 V | 1.3 V | 0.1V _{CC} | 0.9V _{CC} |

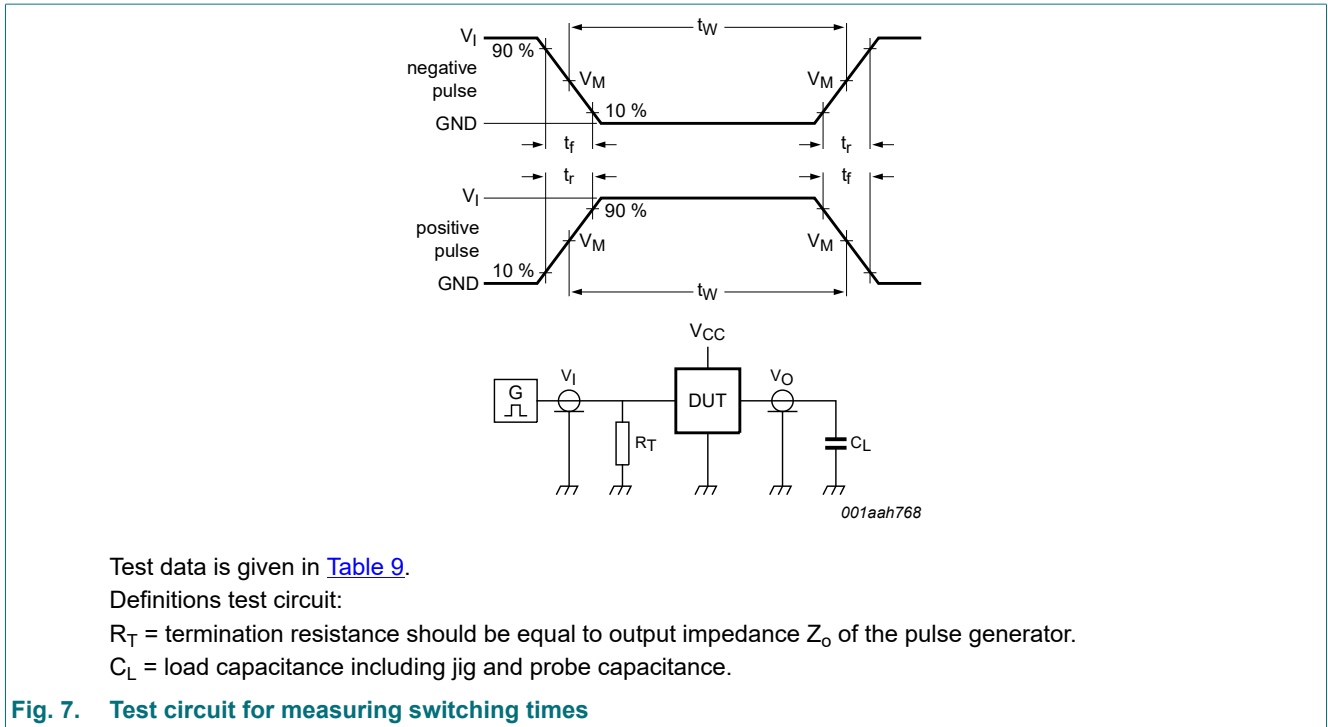


Fig. 7. Test circuit for measuring switching times

Table 9. Test data

| Type | Input | | Load | Test |
|---------|----------|------------|--------------|--------------------|
| | V_I | t_r, t_f | C_L | |
| 74HC14 | V_{CC} | 6.0 ns | 15 pF, 50 pF | t_{PLH}, t_{PHL} |
| 74HCT14 | 3.0 V | 6.0 ns | 15 pF, 50 pF | t_{PLH}, t_{PHL} |

12. Transfer characteristics

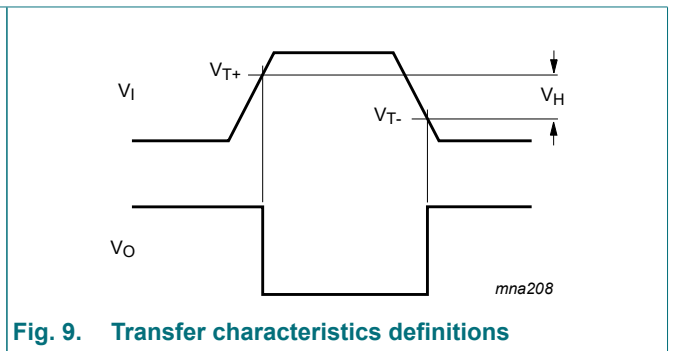
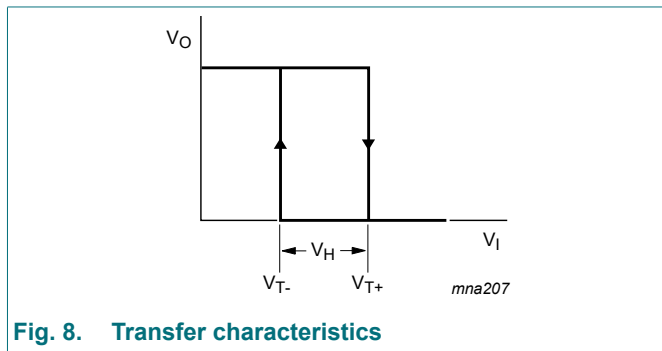
Table 10. Transfer characteristics

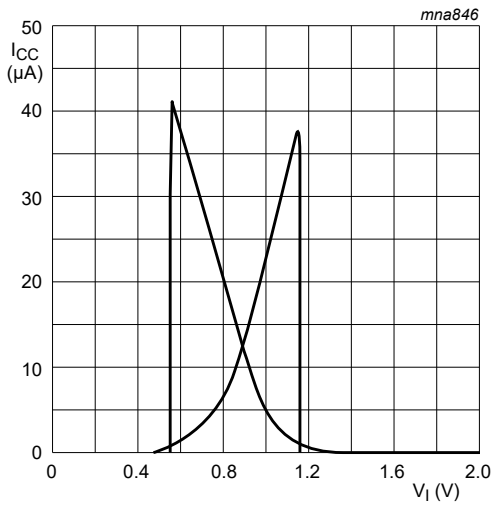
At recommended operating conditions; voltages are referenced to GND (ground = 0 V); see [Fig. 8](#) and [Fig. 9](#).

| Symbol | Parameter | Conditions | $T_{amb} = 25\text{ }^\circ\text{C}$ | | | $T_{amb} = -40\text{ }^\circ\text{C}$ to $+85\text{ }^\circ\text{C}$ | | $T_{amb} = -40\text{ }^\circ\text{C}$ to $+125\text{ }^\circ\text{C}$ | | Unit |
|---------------|----------------------------------|-------------------------|--------------------------------------|------|------|---|------|--|------|------|
| | | | Min | Typ | Max | Min | Max | Min | Max | |
| 74HC14 | | | | | | | | | | |
| V_{T+} | positive-going threshold voltage | $V_{CC} = 2.0\text{ V}$ | 0.7 | 1.18 | 1.5 | 0.7 | 1.5 | 0.7 | 1.5 | V |
| | | $V_{CC} = 4.5\text{ V}$ | 1.7 | 2.38 | 3.15 | 1.7 | 3.15 | 1.7 | 3.15 | V |
| | | $V_{CC} = 6.0\text{ V}$ | 2.1 | 3.14 | 4.2 | 2.1 | 4.2 | 2.1 | 4.2 | V |
| V_{T-} | negative-going threshold voltage | $V_{CC} = 2.0\text{ V}$ | 0.3 | 0.52 | 0.9 | 0.3 | 0.9 | 0.3 | 0.9 | V |
| | | $V_{CC} = 4.5\text{ V}$ | 0.9 | 1.4 | 2.0 | 0.9 | 2.0 | 0.9 | 2.0 | V |
| | | $V_{CC} = 6.0\text{ V}$ | 1.2 | 1.89 | 2.6 | 1.2 | 2.6 | 1.2 | 2.6 | V |
| V_H | hysteresis voltage | $V_{CC} = 2.0\text{ V}$ | 0.2 | 0.66 | 1.0 | 0.2 | 1.0 | 0.2 | 1.0 | V |
| | | $V_{CC} = 4.5\text{ V}$ | 0.4 | 0.98 | 1.4 | 0.4 | 1.4 | 0.4 | 1.4 | V |
| | | $V_{CC} = 6.0\text{ V}$ | 0.6 | 1.25 | 1.6 | 0.6 | 1.6 | 0.6 | 1.6 | V |

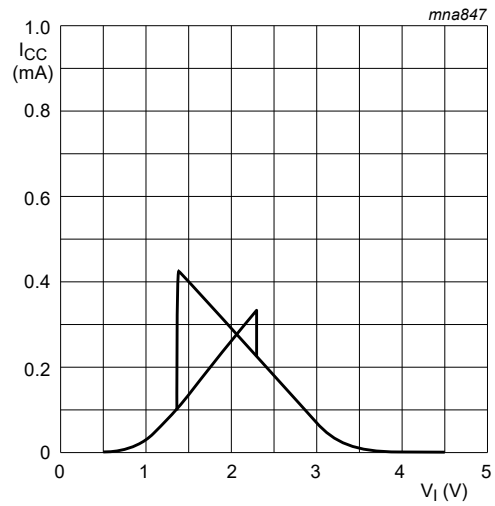
| Symbol | Parameter | Conditions | T _{amb} = 25 °C | | | T _{amb} = -40 °C to +85 °C | | T _{amb} = -40 °C to +125 °C | | Unit |
|-----------------|----------------------------------|-------------------------|--------------------------|------|-----|-------------------------------------|-----|--------------------------------------|-----|------|
| | | | Min | Typ | Max | Min | Max | Min | Max | |
| 74HCT14 | | | | | | | | | | |
| V _{T+} | positive-going threshold voltage | V _{CC} = 4.5 V | 1.2 | 1.41 | 1.9 | 1.2 | 1.9 | 1.2 | 1.9 | V |
| | | V _{CC} = 5.5 V | 1.4 | 1.59 | 2.1 | 1.4 | 2.1 | 1.4 | 2.1 | V |
| V _{T-} | negative-going threshold voltage | V _{CC} = 4.5 V | 0.5 | 0.85 | 1.2 | 0.5 | 1.2 | 0.5 | 1.2 | V |
| | | V _{CC} = 5.5 V | 0.6 | 0.99 | 1.4 | 0.6 | 1.4 | 0.6 | 1.4 | V |
| V _H | hysteresis voltage | V _{CC} = 4.5 V | 0.4 | 0.56 | - | 0.4 | - | 0.4 | - | V |
| | | V _{CC} = 5.5 V | 0.4 | 0.6 | - | 0.4 | - | 0.4 | - | V |

12.1. Transfer characteristics waveforms

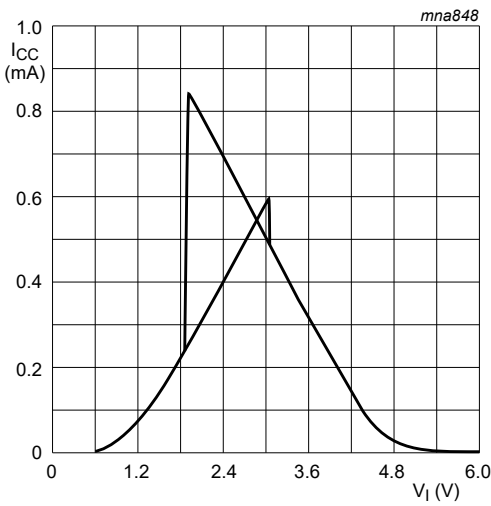




a. $V_{CC} = 2.0\text{ V}$

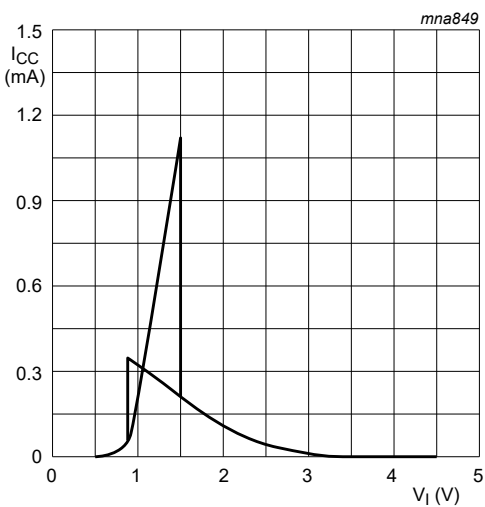


b. $V_{CC} = 4.5\text{ V}$

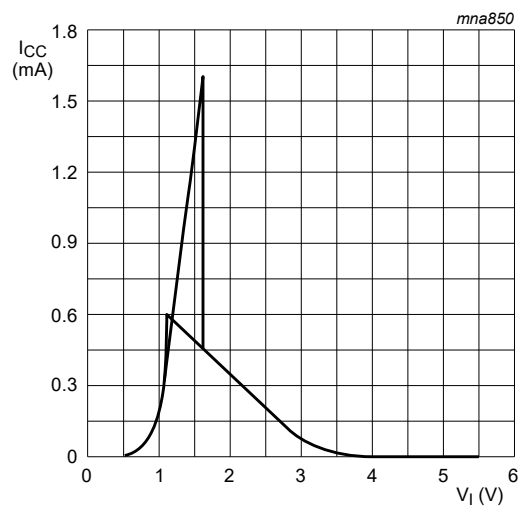


c. $V_{CC} = 6.0\text{ V}$

Fig. 10. Typical 74HC transfer characteristics



a. $V_{CC} = 4.5\text{ V}$



b. $V_{CC} = 5.5\text{ V}$

Fig. 11. Typical 74HCT transfer characteristics

13. Application information

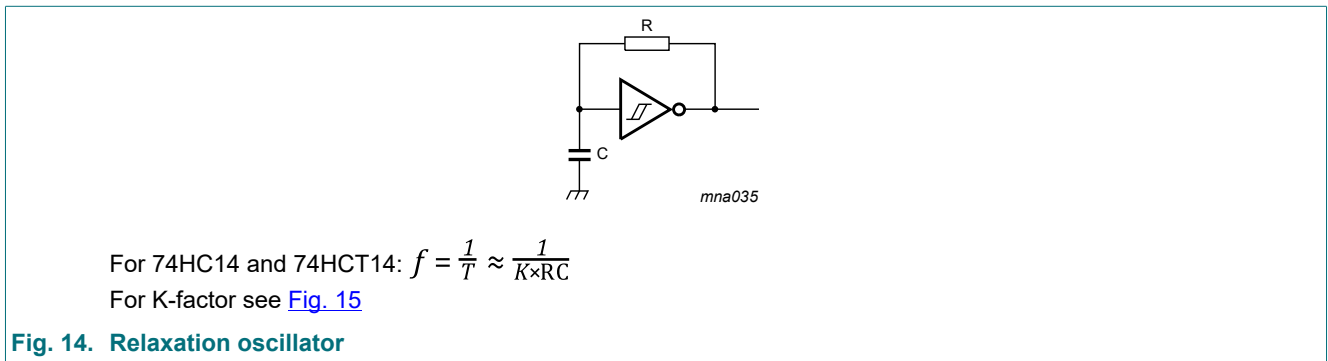
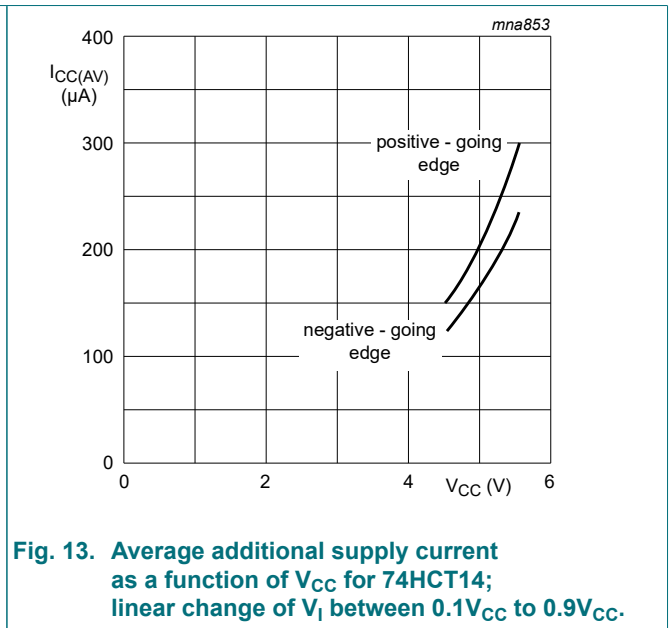
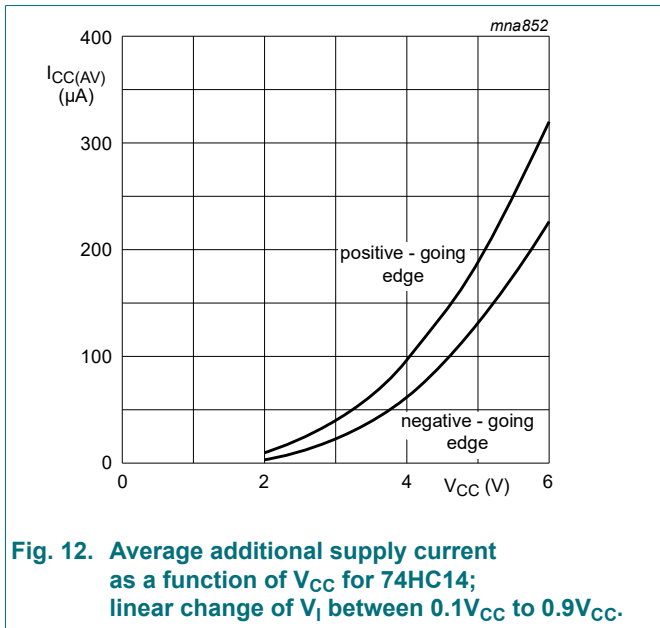
The slow input rise and fall times cause additional power dissipation, this can be calculated using the following formula:

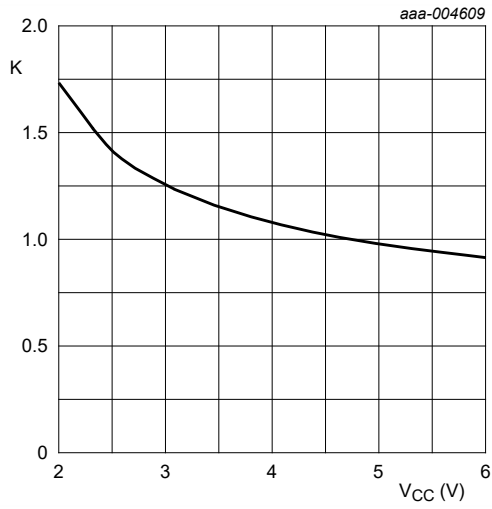
$$P_{add} = f_i \times (t_r \times \Delta I_{CC(AV)} + t_f \times \Delta I_{CC(AV)}) \times V_{CC} \text{ where:}$$

- P_{add} = additional power dissipation (μW);
- f_i = input frequency (MHz);
- t_r = rise time (ns); 10 % to 90 %;
- t_f = fall time (ns); 90 % to 10 %;
- $\Delta I_{CC(AV)}$ = average additional supply current (μA).

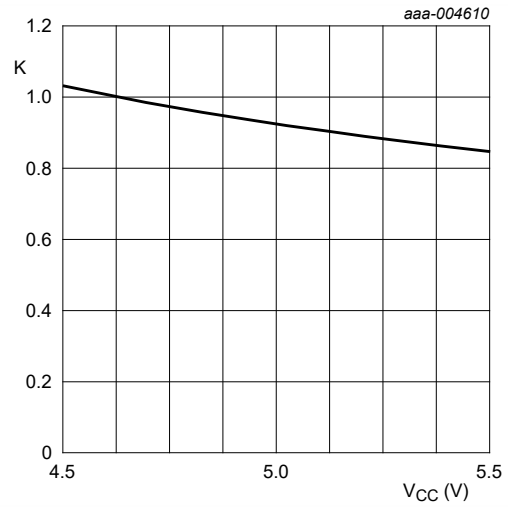
Average $\Delta I_{CC(AV)}$ differs with positive or negative input transitions, as shown in Fig. 12 and Fig. 13.

An example of a relaxation circuit using the 74HC14; 74HCT14 is shown in Fig. 14.





K-factor for 74HC14



K-factor for 74HCT14

Fig. 15. Typical K-factor for relaxation oscillator

14. Package outline

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

SOT108-1

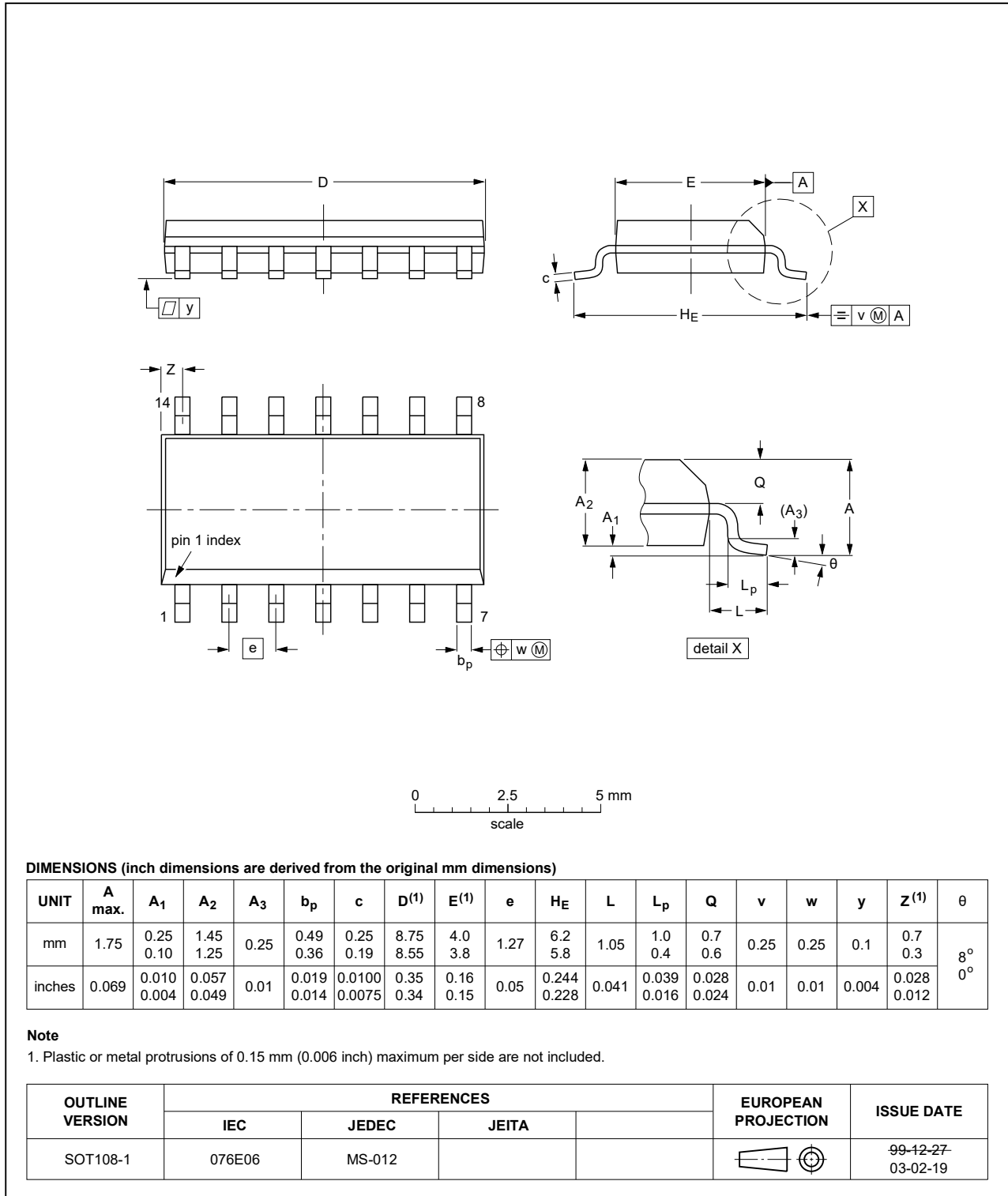


Fig. 16. Package outline SOT108-1 (SO14)

SSOP14: plastic shrink small outline package; 14 leads; body width 5.3 mm

SOT337-1

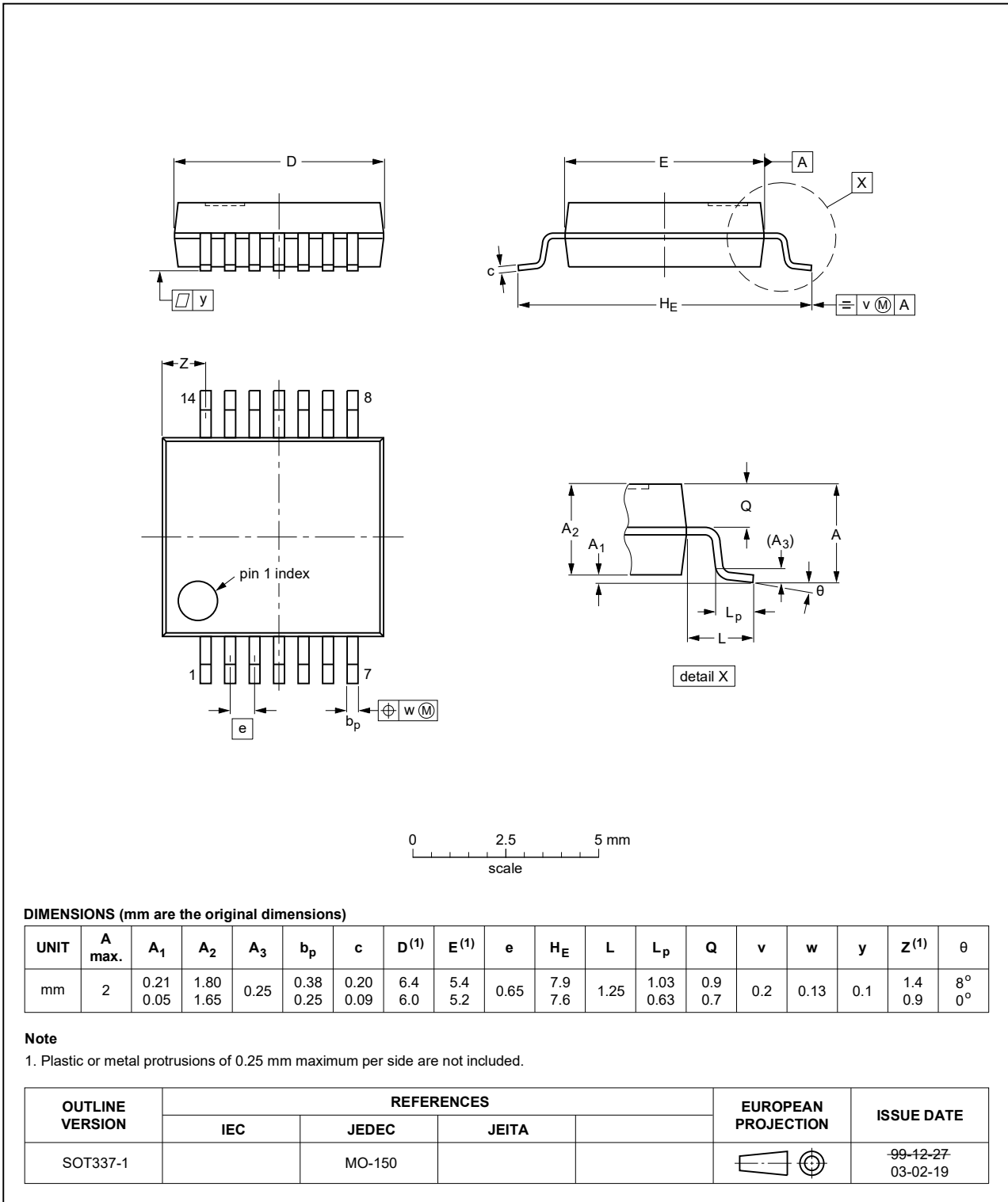


Fig. 17. Package outline SOT337-1 (SSOP14)

TSSOP14: plastic thin shrink small outline package; 14 leads; body width 4.4 mm

SOT402-1

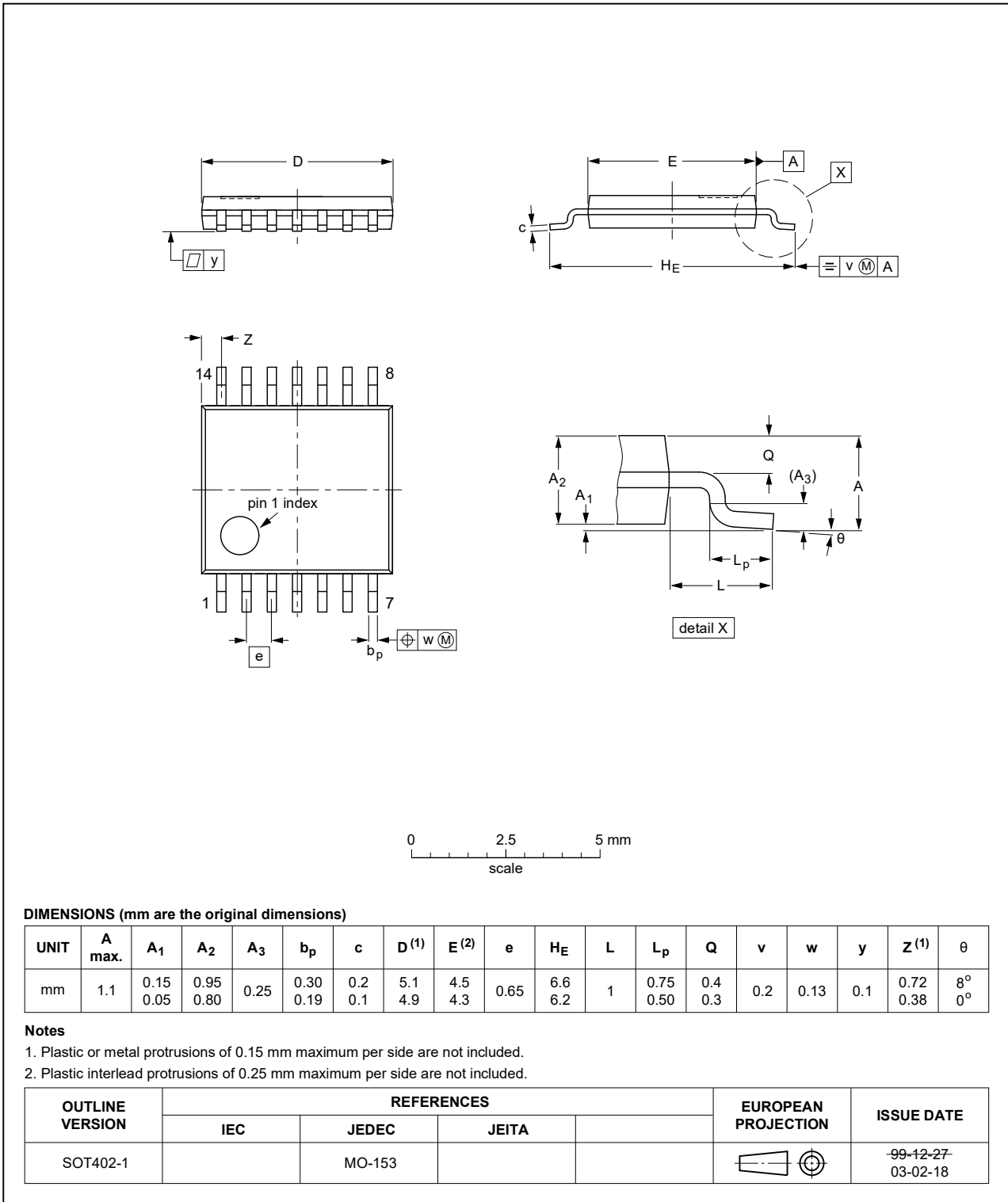


Fig. 18. Package outline SOT402-1 (TSSOP14)

15. Abbreviations

Table 11. Abbreviations

| Acronym | Description |
|---------|-----------------------------|
| DUT | Device Under Test |
| ESD | ElectroStatic Discharge |
| HBM | Human Body Model |
| MM | Machine Model |
| TTL | Transistor-Transistor Logic |

16. Revision history

Table 12. Revision history

| Document ID | Release date | Data sheet status | Change notice | Supersedes |
|--------------------|---|-----------------------|---------------|--------------------|
| 74HC_HCT14 v.8 | 20200522 | Product data sheet | - | 74HC_HCT14 v.7 |
| 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. Table 4: Derating values for P_{tot} total power dissipation updated. | | | |
| 74HC_HCT14 v.7 | 20151119 | Product data sheet | - | 74HC_HCT14 v.6 |
| Modifications: | <ul style="list-style-type: none"> Type numbers 74HC14N and 74HCT14N (SOT27-1) removed. | | | |
| 74HC_HCT14 v.6 | 20120919 | Product data sheet | - | 74HC_HCT14 v.5 |
| Modifications: | <ul style="list-style-type: none"> Fig. 15 added (typical K-factor for relaxation oscillator). | | | |
| 74HC_HCT14 v.5 | 20111219 | Product data sheet | - | 74HC_HCT14 v.4 |
| Modifications: | <ul style="list-style-type: none"> Legal pages updated. | | | |
| 74HC_HCT14 v.4 | 20110117 | Product data sheet | - | 74HC_HCT14 v.3 |
| 74HC_HCT14 v.3 | 20031030 | Product specification | - | 74HC_HCT14_CNV v.2 |
| 74HC_HCT14_CNV v.2 | 19970826 | Product specification | - | - |

17. 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. |

- [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 <https://www.nexperia.com>.

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