

74HC14; 74HCT14

Hex inverting Schmitt trigger

Rev. 6 — 19 September 2012

Product data sheet

1. General description

The 74HC14; 74HCT14 is a high-speed Si-gate CMOS device and is pin compatible with Low-power Schottky TTL (LSTTL). It is specified in compliance with JEDEC standard No. 7A.

The 74HC14; 74HCT14 provides six inverting buffers with Schmitt-trigger action. It is capable of transforming slowly changing input signals into sharply defined, jitter-free output signals.

2. Features and benefits

- Low-power dissipation
- ESD protection:
 - ◆ HBM JESD22-A114F exceeds 2000 V
 - ◆ MM JESD22-A115-A exceeds 200 V
- Multiple package options
- Specified from $-40\text{ }^{\circ}\text{C}$ to $+85\text{ }^{\circ}\text{C}$ and from $-40\text{ }^{\circ}\text{C}$ to $+125\text{ }^{\circ}\text{C}$

3. Applications

- Wave and pulse shapers
- Astable multivibrators
- Monostable multivibrators

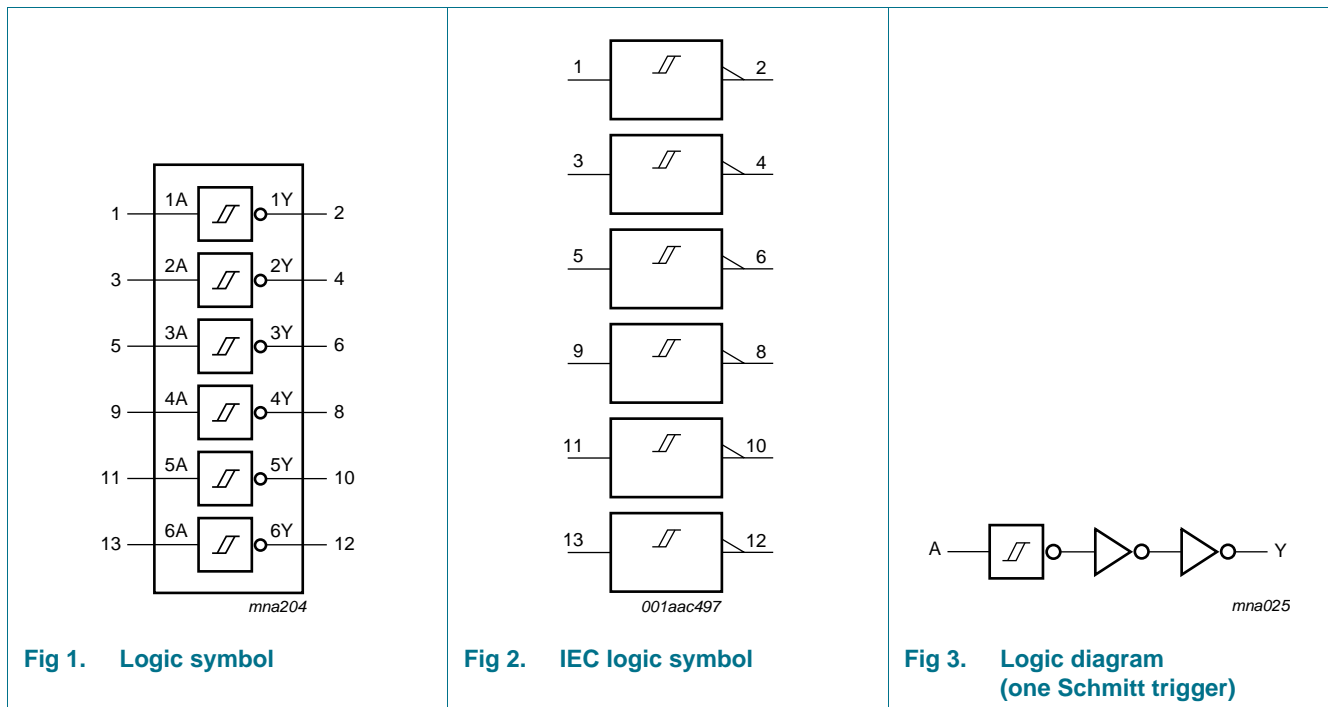


4. Ordering information

Table 1. Ordering information

| Type number | Package | | | Version |
|-----------------------|-------------------|----------|--|----------|
| | Temperature range | Name | Description | |
| 74HC14N 74HCT14N | -40 °C to +125 °C | DIP14 | plastic dual in-line package; 14 leads (300 mil) | SOT27-1 |
| 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

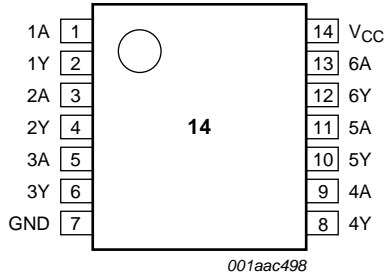
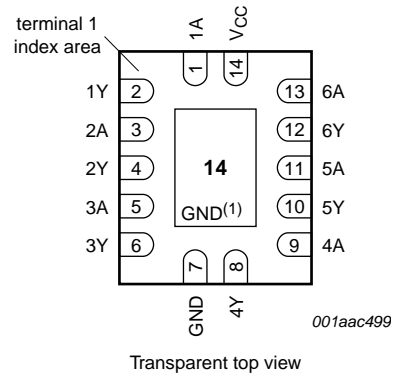


Fig 4. Pin configuration DIP14, SO14 and (T)SSOP14



- (1) The die substrate is attached to this pad using conductive die attach material. It cannot be used as a supply pin or input.

Fig 5. Pin configuration DHVQFN14

6.2 Pin description

Table 2. Pin description

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

7. Functional description

Table 3. Function table^[1]

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

[1] H = HIGH voltage level;
L = LOW voltage level.

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 | $V_I < -0.5\text{ V}$ or $V_I > V_{CC} + 0.5\text{ V}$ | [1] - | ±20 | mA |
| I_{OK} | output clamping current | $V_O < -0.5\text{ V}$ or $V_O > V_{CC} + 0.5\text{ V}$ | [1] - | ±20 | mA |
| I_O | output current | $-0.5\text{ V} < V_O < V_{CC} + 0.5\text{ V}$ | - | ±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] | | |
| | DIP14 package | | - | 750 | mW |
| | SO14, (T)SSOP14 and DHVQFN14 packages | | - | 500 | mW |

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

[2] For DIP14 package: P_{tot} derates linearly with 12 mW/K above 70 °C.
 For SO14 package: P_{tot} derates linearly with 8 mW/K above 70 °C.
 For (T)SSOP14 packages: P_{tot} derates linearly with 5.5 mW/K above 60 °C.
 For DHVQFN14 packages: P_{tot} derates linearly with 4.5 mW/K above 60 °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 |
| 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

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

| Symbol | Parameter | Conditions | $T_{amb} = 25\text{ °C}$ | | | $T_{amb} = -40\text{ °C to }+125\text{ °C}$ | | Unit |
|----------------|-------------------------------|--|--------------------------|-----|-----|---|--------------|------|
| | | | Min | Typ | Max | Max (85 °C) | Max (125 °C) | |
| 74HC14 | | | | | | | | |
| t_{pd} | propagation delay | nA to nY; see Figure 6 [1] | | | | | | |
| | | $V_{CC} = 2.0\text{ V}$ | - | 41 | 125 | 155 | 190 | ns |
| | | $V_{CC} = 4.5\text{ V}$ | - | 15 | 25 | 31 | 38 | ns |
| | | $V_{CC} = 5.0\text{ V}$; $C_L = 15\text{ pF}$ | - | 12 | - | - | - | ns |
| | | $V_{CC} = 6.0\text{ V}$ | - | 12 | 21 | 26 | 32 | ns |
| t_t | transition time | see Figure 6 [2] | | | | | | |
| | | $V_{CC} = 2.0\text{ V}$ | - | 19 | 75 | 95 | 110 | ns |
| | | $V_{CC} = 4.5\text{ V}$ | - | 7 | 15 | 19 | 22 | ns |
| | | $V_{CC} = 6.0\text{ V}$ | - | 6 | 13 | 15 | 19 | ns |
| C_{PD} | power dissipation capacitance | per package; $V_I = GND\text{ to }V_{CC}$ [3] | - | 7 | - | - | - | pF |
| 74HCT14 | | | | | | | | |
| t_{pd} | propagation delay | nA to nY; see Figure 6 [1] | | | | | | |
| | | $V_{CC} = 4.5\text{ V}$ | - | 20 | 34 | 43 | 51 | ns |
| | | $V_{CC} = 5.0\text{ V}$; $C_L = 15\text{ pF}$ | - | 17 | - | - | - | ns |
| t_t | transition time | $V_{CC} = 4.5\text{ V}$; see Figure 6 [2] | - | 7 | 15 | 19 | 22 | ns |
| C_{PD} | power dissipation capacitance | per package; $V_I = GND\text{ to }V_{CC} - 1.5\text{ V}$ [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):

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

f_i = input frequency in MHz;

f_o = output frequency in MHz;

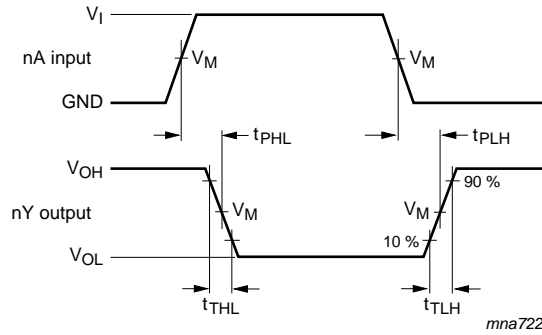
C_L = output load capacitance in pF;

V_{CC} = supply voltage in V;

N = number of inputs switching;

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

12. Waveforms

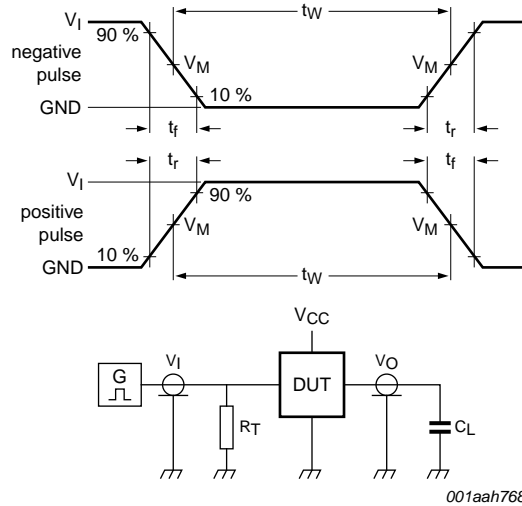


Measurement points are given in [Table 8](#).
 V_{OL} and V_{OH} are typical voltage output levels that occur with the output load.

Fig 6. Input to output propagation delays

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 | $0.1V_{CC}$ | $0.9V_{CC}$ |



Test data is given in [Table 9](#).
 Definitions 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. Load circuitry 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} |

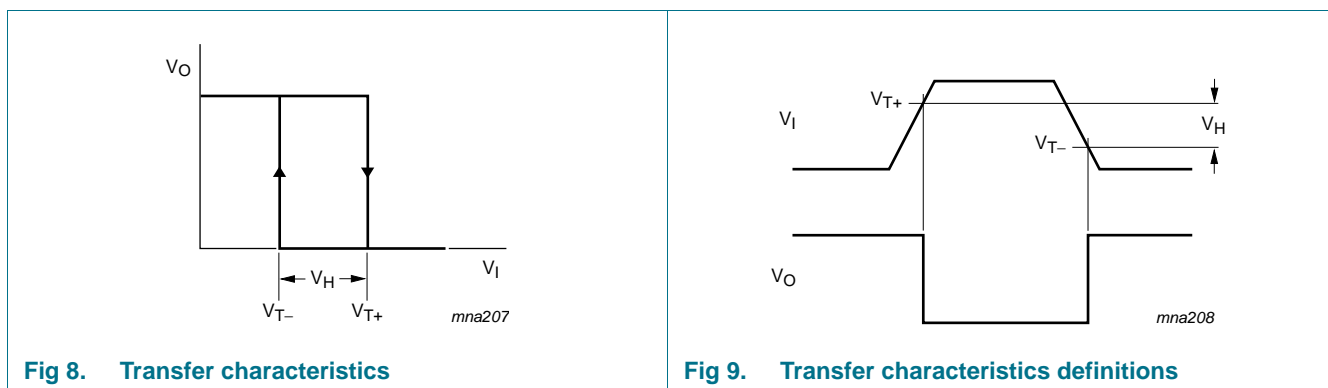
13. Transfer characteristics

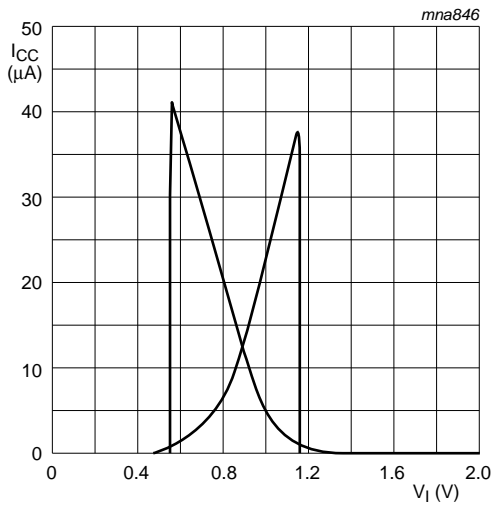
Table 10. Transfer characteristics

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

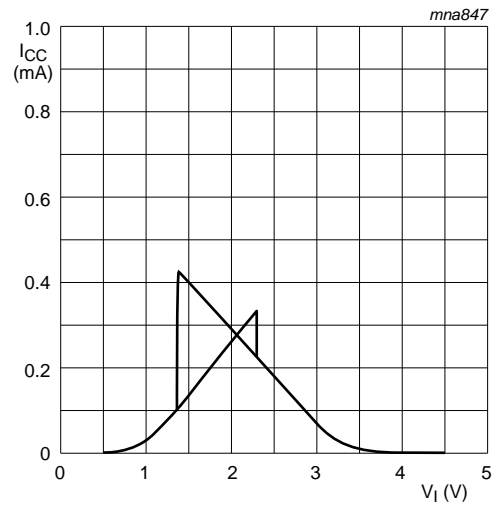
| Symbol | Parameter | Conditions | $T_{amb} = 25\text{ }^\circ\text{C}$ | | | $T_{amb} = -40\text{ }^\circ\text{C}$ to $+85\text{ }^\circ\text{C}$ | | $T_{amb} = -40\text{ }^\circ\text{C}$ to $+125\text{ }^\circ\text{C}$ | | Unit |
|----------------|----------------------------------|-------------------------|--------------------------------------|------|------|---|------|--|------|------|
| | | | 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 |
| 74HCT14 | | | | | | | | | | |
| V_{T+} | positive-going threshold voltage | $V_{CC} = 4.5\text{ V}$ | 1.2 | 1.41 | 1.9 | 1.2 | 1.9 | 1.2 | 1.9 | V |
| | | $V_{CC} = 5.5\text{ V}$ | 1.4 | 1.59 | 2.1 | 1.4 | 2.1 | 1.4 | 2.1 | V |
| V_{T-} | negative-going threshold voltage | $V_{CC} = 4.5\text{ V}$ | 0.5 | 0.85 | 1.2 | 0.5 | 1.2 | 0.5 | 1.2 | V |
| | | $V_{CC} = 5.5\text{ V}$ | 0.6 | 0.99 | 1.4 | 0.6 | 1.4 | 0.6 | 1.4 | V |
| V_H | hysteresis voltage | $V_{CC} = 4.5\text{ V}$ | 0.4 | 0.56 | - | 0.4 | - | 0.4 | - | V |
| | | $V_{CC} = 5.5\text{ V}$ | 0.4 | 0.6 | - | 0.4 | - | 0.4 | - | V |

14. Transfer characteristics waveforms

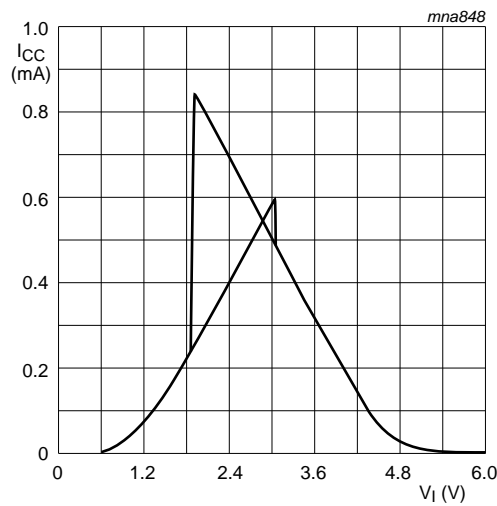




a. $V_{CC} = 2.0\text{ V}$

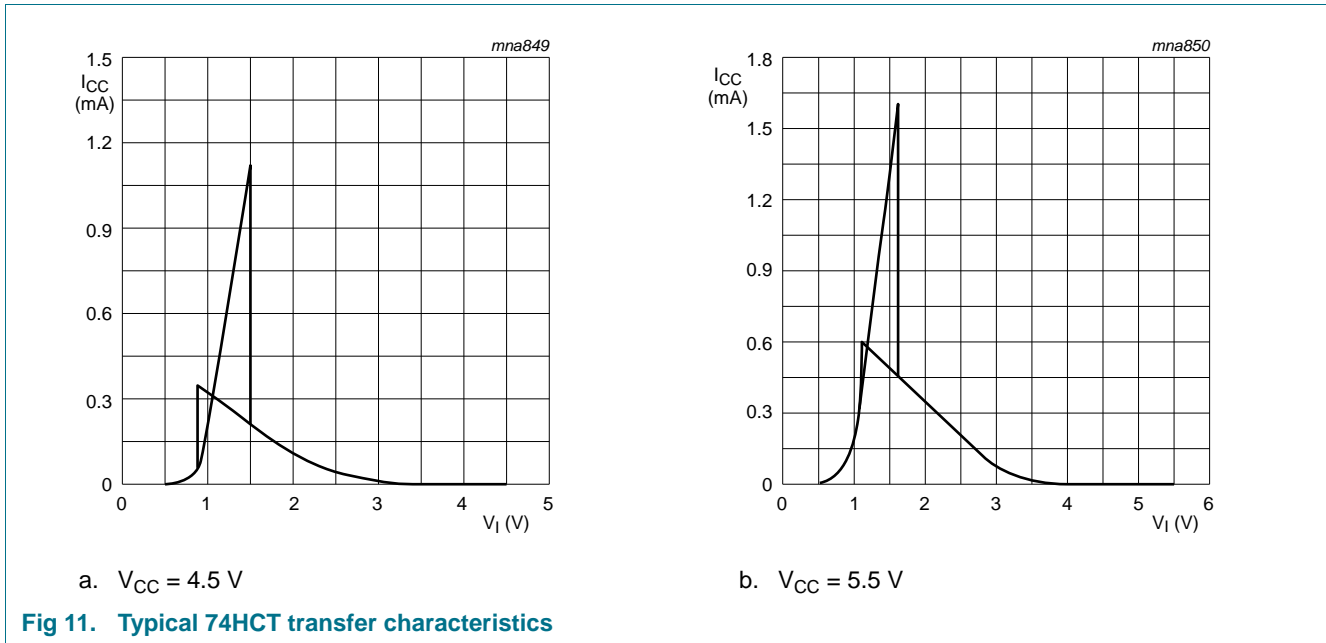


b. $V_{CC} = 4.5\text{ V}$



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

Fig 10. Typical 74HC transfer characteristics



15. Application information

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

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

P_{add} = additional power dissipation (μW);

f_i = input frequency (MHz);

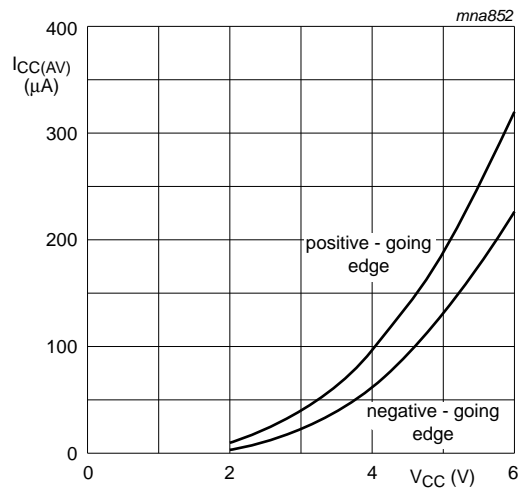
t_r = rise time (ns); 10 % to 90 %;

t_f = fall time (ns); 90 % to 10 %;

$\Delta I_{CC(\text{AV})}$ = average additional supply current (μA).

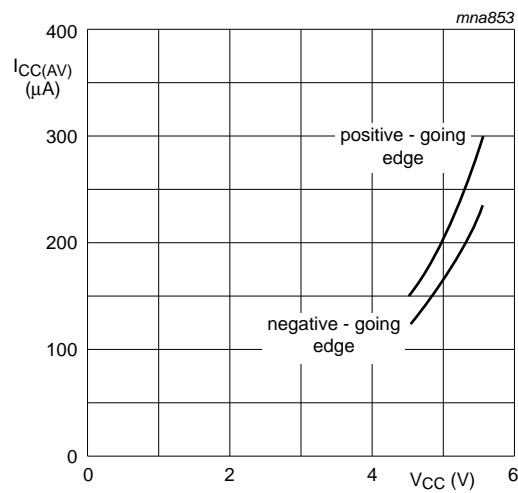
Average $\Delta I_{CC(\text{AV})}$ differs with positive or negative input transitions, as shown in [Figure 12](#) and [Figure 13](#).

An example of a relaxation circuit using the 74HC14; 74HCT14 is shown in [Figure 14](#).



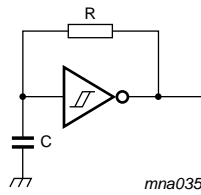
- (1) Positive-going edge.
- (2) Negative-going edge.

Fig 12. Average additional supply current as a function of V_{CC} for 74HC14; linear change of V_I between 0.1V_{CC} to 0.9V_{CC}.



- (1) Positive-going edge.
- (2) Negative-going edge.

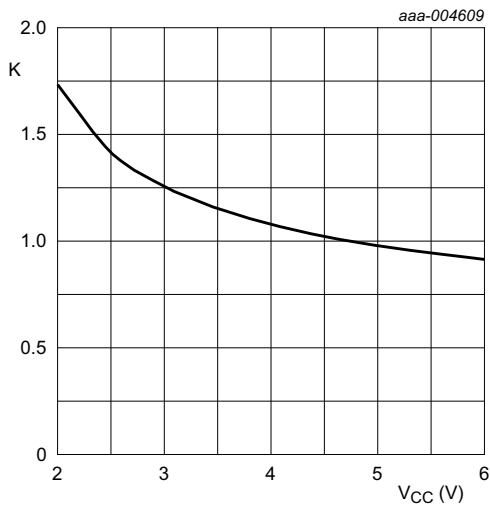
Fig 13. Average additional supply current as a function of V_{CC} for 74HCT14; linear change of V_I between 0.1V_{CC} to 0.9V_{CC}.



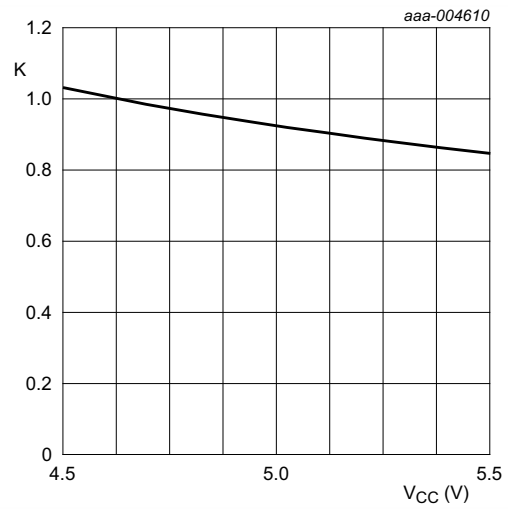
For 74HC14 and 74HCT14: $f = \frac{1}{T} \approx \frac{1}{K \times RC}$

For K-factor see [Figure 15](#)

Fig 14. Relaxation oscillator



K-factor for 74HC14



K-factor for 74HCT14

Fig 15. Typical K-factor for relaxation oscillator

16. Package outline

DIP14: plastic dual in-line package; 14 leads (300 mil)

SOT27-1

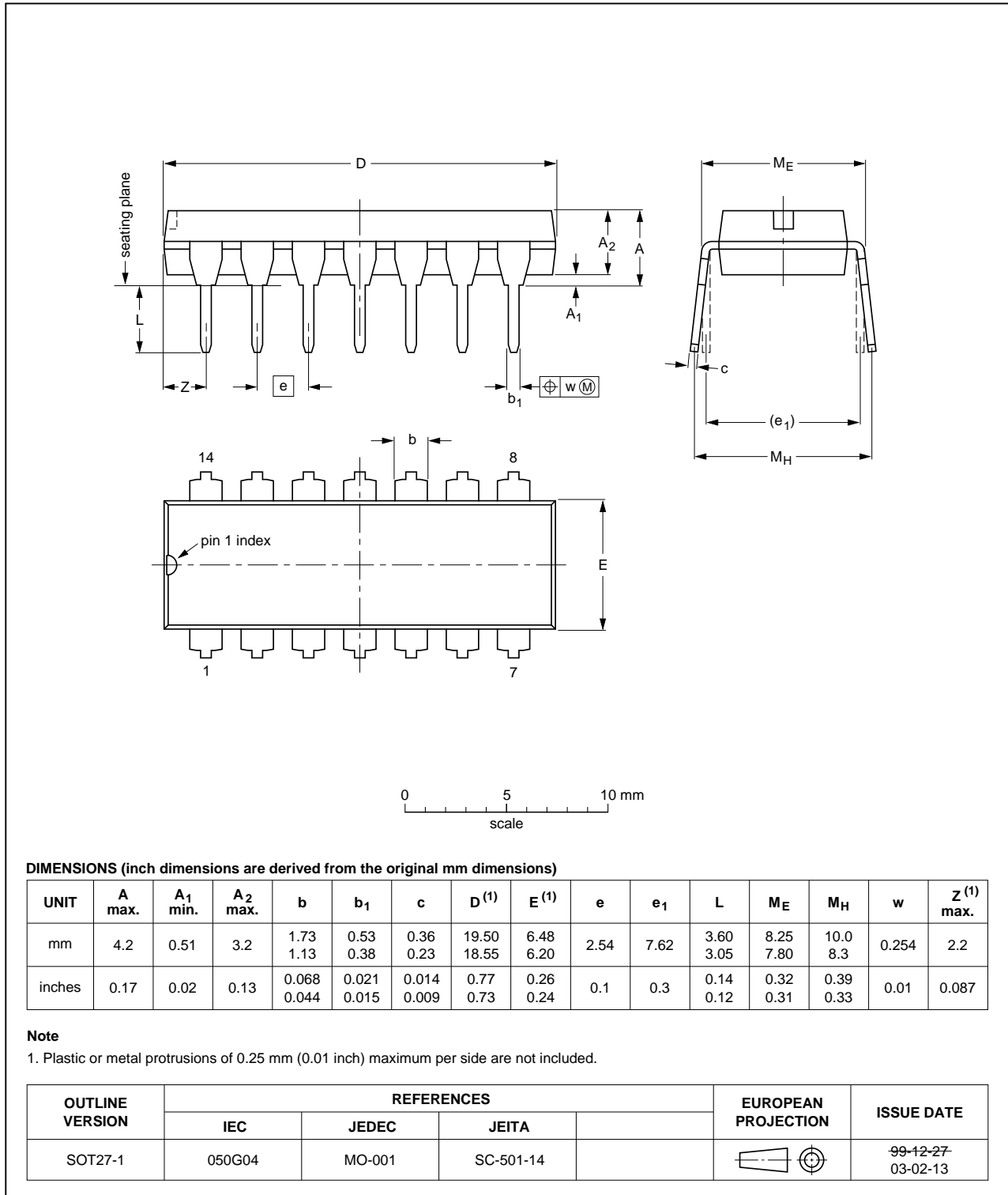


Fig 16. Package outline SOT27-1 (DIP14)

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

SOT108-1

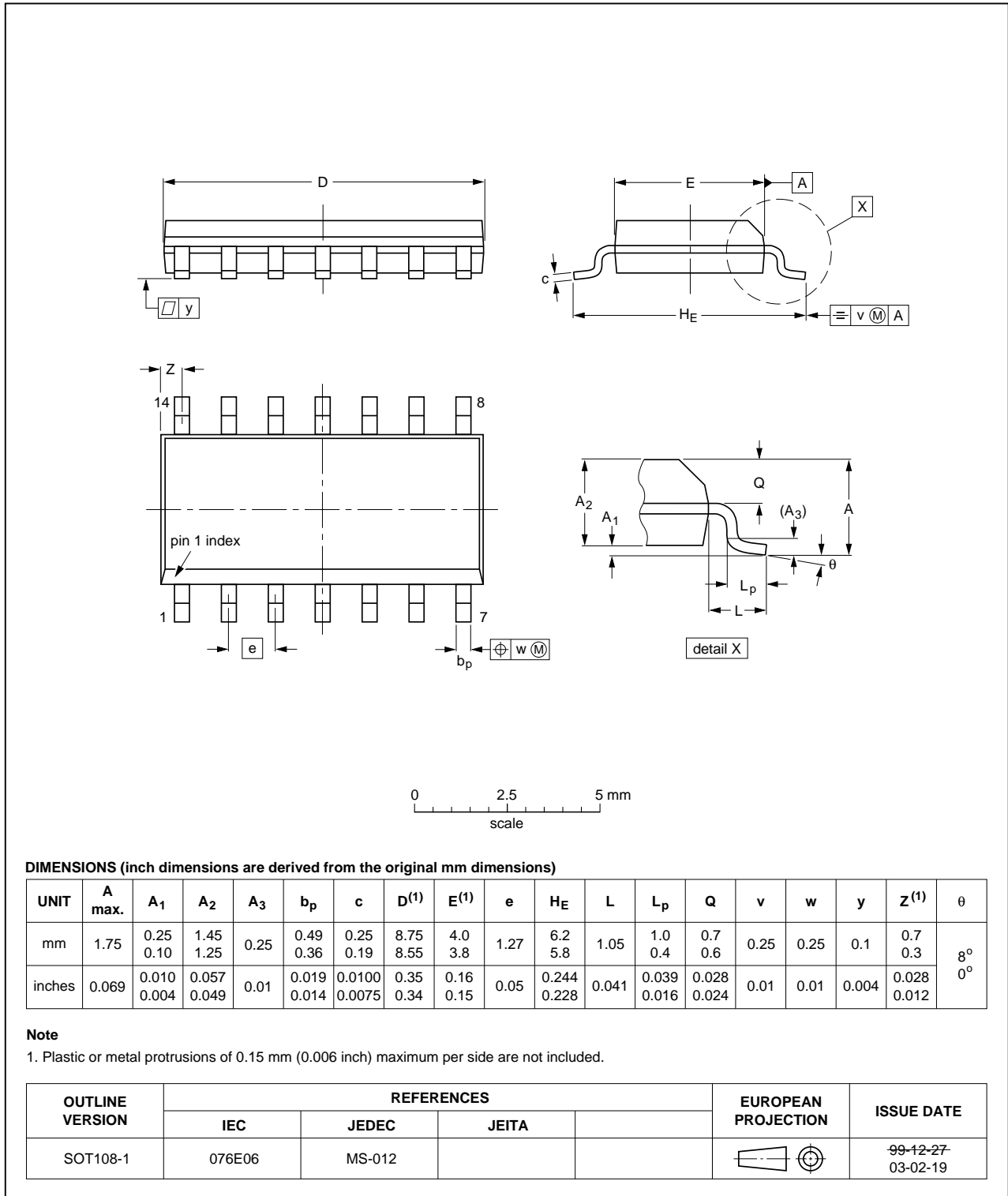


Fig 17. Package outline SOT108-1 (SO14)

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

SOT337-1

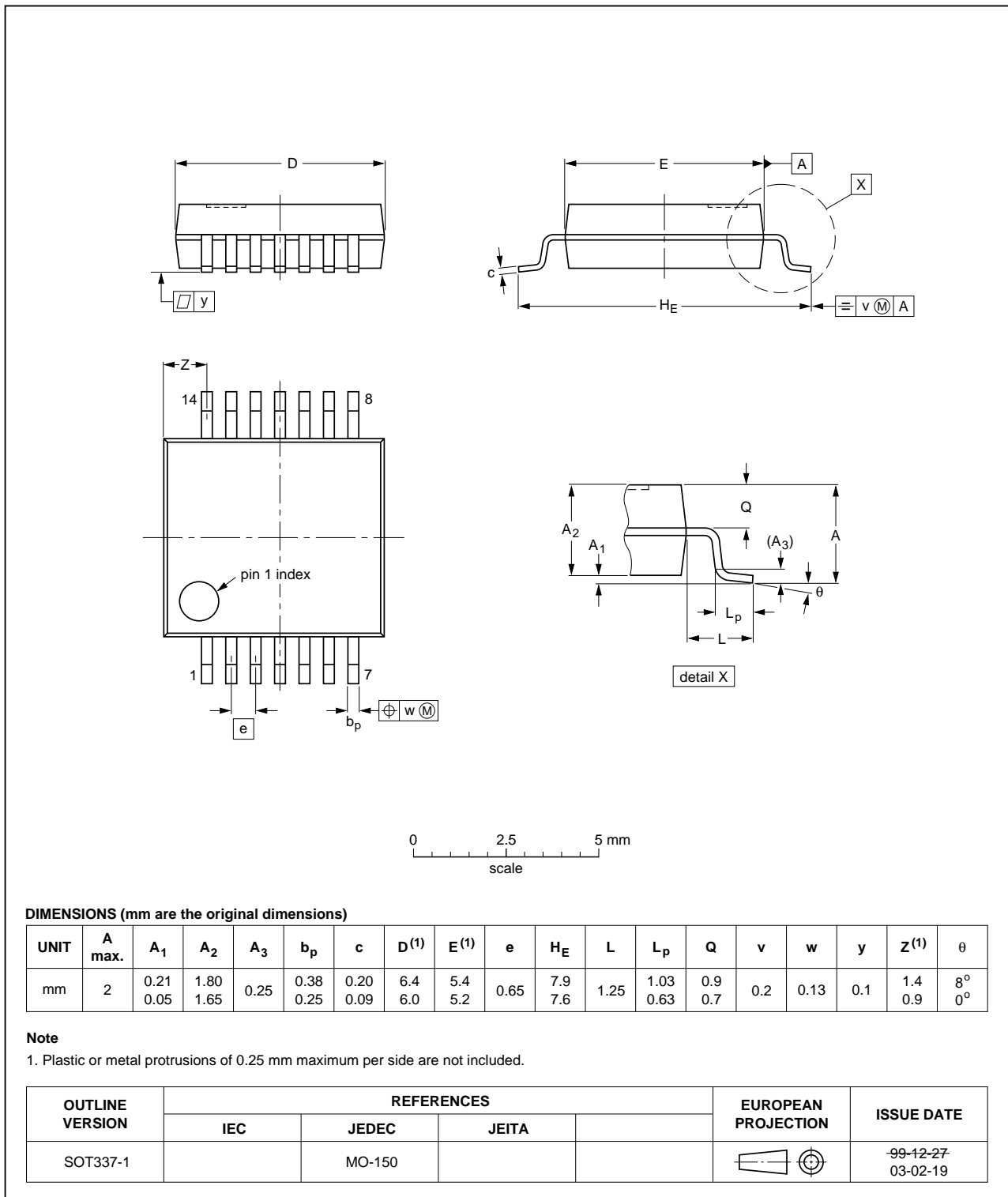


Fig 18. Package outline SOT337-1 (SSOP14)

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

SOT402-1

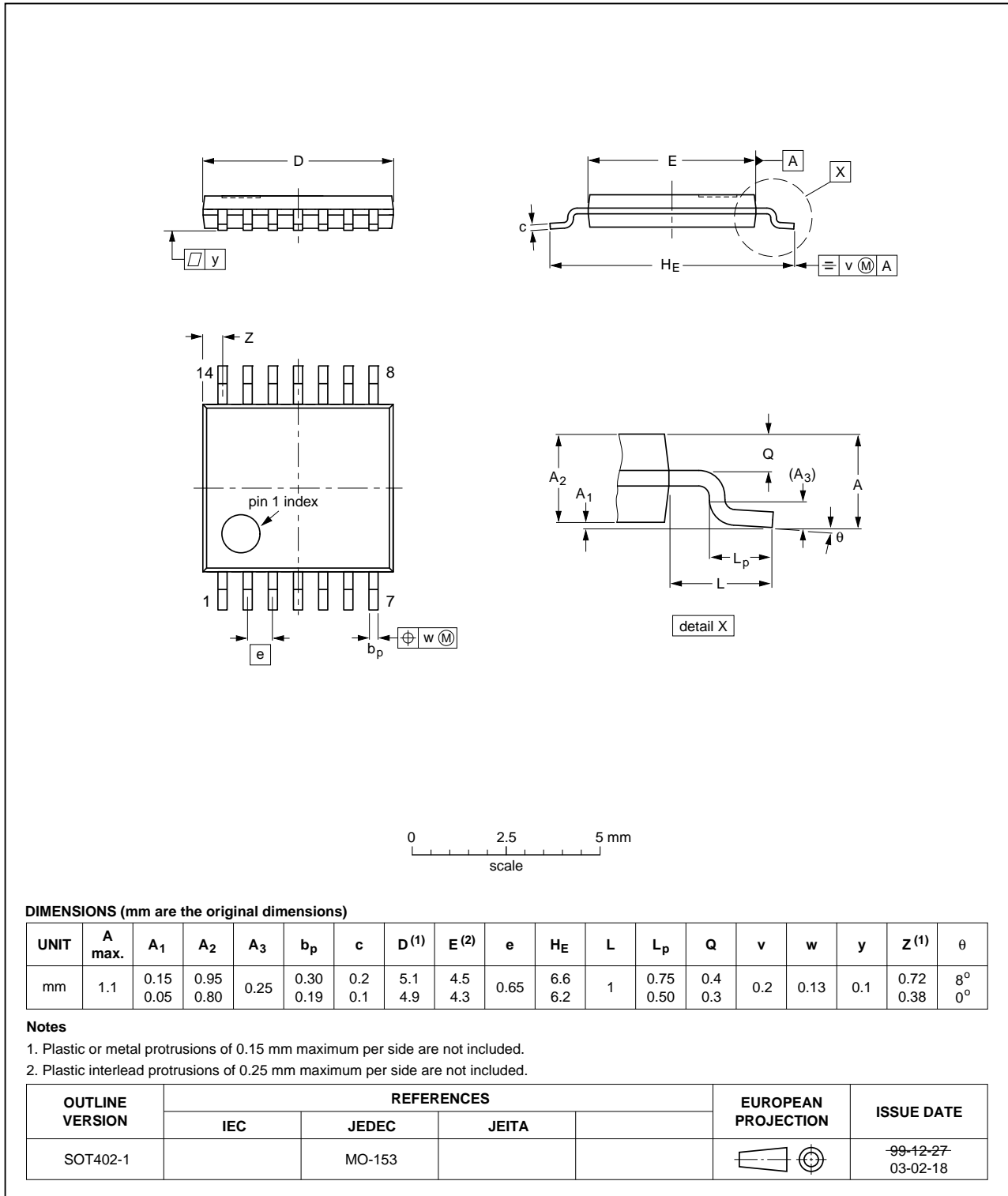


Fig 19. Package outline SOT402-1 (TSSOP14)

DHVQFN14: plastic dual in-line compatible thermal enhanced very thin quad flat package; no leads; 14 terminals; body 2.5 x 3 x 0.85 mm

SOT762-1

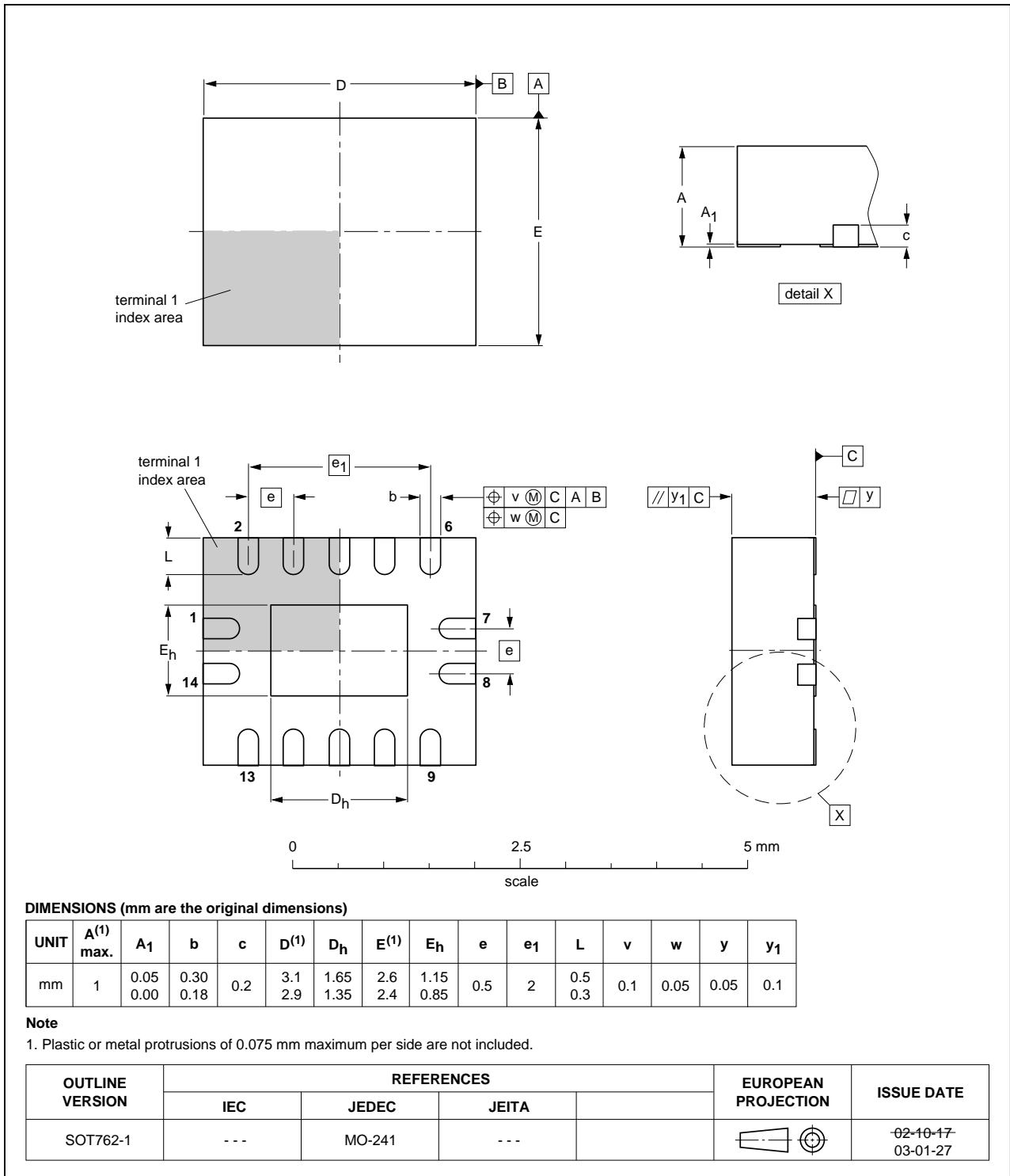


Fig 20. Package outline SOT762-1 (DHVQFN14)

17. Abbreviations

Table 11. Abbreviations

| Acronym | Description |
|---------|--|
| CMOS | Complementary Metal-Oxide Semiconductor |
| DUT | Device Under Test |
| ESD | ElectroStatic Discharge |
| HBM | Human Body Model |
| LSTTL | Low-power Schottky Transistor-Transistor Logic |
| MM | Machine Model |

18. Revision history

Table 12. Revision history

| Document ID | Release date | Data sheet status | Change notice | Supersedes |
|--------------------|---|-----------------------|---------------|--------------------|
| 74HC_HCT14 v.6 | 20120919 | Product data sheet | - | 74HC_HCT14 v.5 |
| Modifications: | <ul style="list-style-type: none"> • Figure 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 | - | - |

19. Legal information

19.1 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.

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