

TOSHIBA CMOS Digital Integrated Circuit Silicon Monolithic

# TC74VHCT14AF, TC74VHCT14AFK

## Hex Schmitt Inverter

The TC74VHCT14A is an advanced high speed CMOS SCHMITT INVERTER fabricated with silicon gate C<sup>2</sup>MOS technology.

It achieves the high speed operation similar to equivalent Bipolar Schottky TTL while maintaining the CMOS low power dissipation.

Pin configuration and function are the same as the TC74VHC04 but the inputs have hysteresis and with its schmitt trigger function, the TC74VHC14 can be used as a line receivers which will receive slow input signals.

The input voltage are compatible with TTL output voltage.

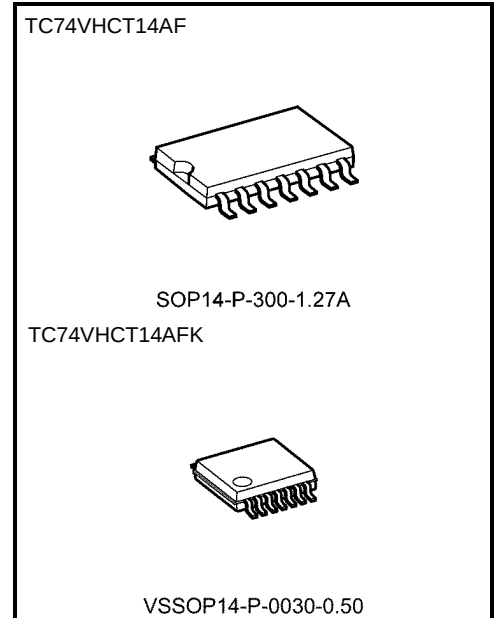
This device may be used as a level converter for interfacing 3.3 V to 5 V system.

Input protection and output circuit ensure that 0 to 5.5 V can be applied to the input and output <sup>(Note)</sup> pins without regard to the supply voltage. These structure prevents device destruction due to mismatched supply and input/output voltages such as battery back up, hot board insertion, etc.

Note: VCC = 0 V

## Features

- High speed: t<sub>pd</sub> = 5.0 ns (typ.) at VCC = 5 V
- Low power dissipation: I<sub>CC</sub> = 2 μA (max) at Ta = 25°C
- Compatible with TTL inputs
  - : V<sub>IL</sub> = 0.5 V (max)
  - V<sub>IH</sub> = 2.1 V (min)
- Power down protection is provided on all inputs and outputs.
- Balanced propagation delays: t<sub>pLH</sub> ≈ t<sub>pHL</sub>
- Low noise: VOLP = 0.8 V (max)
- Pin and function compatible with the 74 series (74AC/HC/F/ALS/LS etc.) 14 type.

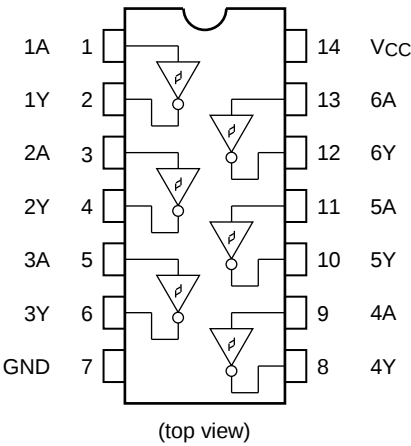


Weight

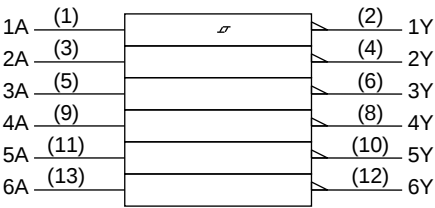
|                     |                 |
|---------------------|-----------------|
| SOP14-P-300-1.27A   | : 0.18 g (typ.) |
| VSSOP14-P-0030-0.50 | : 0.02 g (typ.) |

Start of commercial production  
1998-02

Pin Assignment



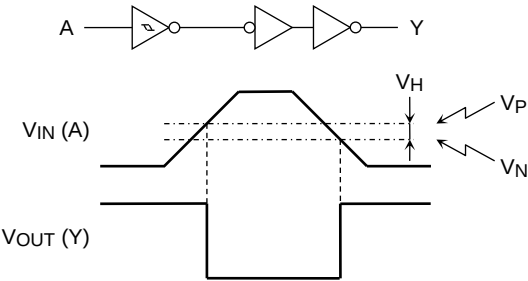
IEC Logic Symbol



Truth Table

| A | Y |
|---|---|
| L | H |
| H | L |

System Diagram, Waveform



### Absolute Maximum Ratings (Note 1)

| Characteristics                    | Symbol           | Rating                                 | Unit |
|------------------------------------|------------------|----------------------------------------|------|
| Supply voltage range               | V <sub>CC</sub>  | −0.5 to 7.0                            | V    |
| DC input voltage                   | V <sub>IN</sub>  | −0.5 to 7.0                            | V    |
| DC output voltage                  | V <sub>OUT</sub> | −0.5 to 7.0 (Note 2)                   | V    |
|                                    |                  | −0.5 to V <sub>CC</sub> + 0.5 (Note 3) |      |
| Input diode current                | I <sub>IK</sub>  | −20                                    | mA   |
| Output diode current               | I <sub>OK</sub>  | ±20 (Note 4)                           | mA   |
| DC output current                  | I <sub>OUT</sub> | ±25                                    | mA   |
| DC V <sub>CC</sub> /ground current | I <sub>CC</sub>  | ±50                                    | mA   |
| Power dissipation                  | P <sub>D</sub>   | 180                                    | mW   |
| Storage temperature                | T <sub>stg</sub> | −65 to 150                             | °C   |

Note 1: Exceeding any of the absolute maximum ratings, even briefly, lead to deterioration in IC performance or even destruction.

Using continuously under heavy loads (e.g. the application of high temperature/current/voltage and the significant change in temperature, etc.) may cause this product to decrease in the reliability significantly even if the operating conditions (i.e. operating temperature/current/voltage, etc.) are within the absolute maximum ratings and the operating ranges.

Please design the appropriate reliability upon reviewing the Toshiba Semiconductor Reliability Handbook (“Handling Precautions”/“Derating Concept and Methods”) and individual reliability data (i.e. reliability test report and estimated failure rate, etc).

Note 2: V<sub>CC</sub> = 0 V

Note 3: High or low state. I<sub>OUT</sub> absolute maximum rating must be observed.

Note 4: V<sub>OUT</sub> < GND, V<sub>OUT</sub> > V<sub>CC</sub>

### Operating Ranges (Note 1)

| Characteristics       | Symbol           | Rating                        | Unit |
|-----------------------|------------------|-------------------------------|------|
| Supply voltage        | V <sub>CC</sub>  | 4.5 to 5.5                    | V    |
| Input voltage         | V <sub>IN</sub>  | 0 to 5.5                      | V    |
| Output voltage        | V <sub>OUT</sub> | 0 to 5.5 (Note 2)             | V    |
|                       |                  | 0 to V <sub>CC</sub> (Note 3) |      |
| Operating temperature | T <sub>opr</sub> | −40 to 85                     | °C   |

Note 1: The operating ranges must be maintained to ensure the normal operation of the device.  
Unused inputs must be tied to either V<sub>CC</sub> or GND.

Note 2: V<sub>CC</sub> = 0 V

Note 3: High or low state

## Electrical Characteristics

## DC Characteristics

| Characteristics                    | Symbol | Test Condition                                    |              | Ta = 25°C    |        |              | Ta =<br>−40 to 85°C |              | Unit |     |
|------------------------------------|--------|---------------------------------------------------|--------------|--------------|--------|--------------|---------------------|--------------|------|-----|
|                                    |        |                                                   |              | VCC (V)      | Min    | Typ.         | Max                 | Min          |      | Max |
| Positive threshold voltage         | VP     | —                                                 | 4.5<br>5.5   | —<br>—       | —<br>— | 1.90<br>2.10 | —<br>—              | 1.90<br>2.10 | V    |     |
| Negative threshold voltage         | VN     | —                                                 | 4.5<br>5.5   | 0.50<br>0.60 | —<br>— | —<br>—       | 0.50<br>0.60        | —<br>—       | V    |     |
| Hysteresis voltage                 | VH     | —                                                 | 4.5<br>5.5   | 0.40<br>0.40 | —<br>— | 1.40<br>1.50 | 0.40<br>0.40        | 1.40<br>1.50 | V    |     |
| High-level output voltage          | VOH    | VIN = VIL                                         | IOH = −50 μA | 4.5          | 4.4    | 4.5          | —                   | 4.4          | —    | V   |
|                                    |        |                                                   | IOH = −8 mA  | 4.5          | 3.94   | —            | —                   | 3.80         | —    |     |
| Low-level output voltage           | VOL    | VIN = VIH                                         | IOL = 50 μA  | 4.5          | —      | 0.0          | 0.1                 | —            | 0.1  | V   |
|                                    |        |                                                   | IOL = 8 mA   | 4.5          | —      | —            | 0.36                | —            | 0.44 |     |
| Input leakage current              | IIN    | VIN = 5.5 V or GND                                | 0 to 5.5     | —            | —      | ±0.1         | —                   | ±1.0         | μA   |     |
| Quiescent supply current           | ICC    | VIN = VCC or GND                                  | 5.5          | —            | —      | 2.0          | —                   | 20.0         | μA   |     |
|                                    | ICCT   | Per input: VIN = 3.4 V<br>Other input: VCC or GND | 5.5          | —            | —      | 1.35         | —                   | 1.50         | mA   |     |
| Output leakage current (Power-OFF) | IOPD   | VOUT = 5.5 V                                      | 0            | —            | —      | 0.5          | —                   | 5.0          | μA   |     |

## AC Characteristics (input: tr = tf = 3 ns)

| Characteristics               | Symbol           | Test Condition |                     |                     | Ta = 25°C |      |     | Ta =<br>-40 to 85°C |      | Unit |
|-------------------------------|------------------|----------------|---------------------|---------------------|-----------|------|-----|---------------------|------|------|
|                               |                  |                | V <sub>CC</sub> (V) | C <sub>L</sub> (pF) | Min       | Typ. | Max | Min                 | Max  |      |
| Propagation delay time        | t <sub>pLH</sub> | —              | 5.0 ± 0.5           | 15                  | —         | 5.0  | 7.6 | 1.0                 | 9.0  | ns   |
|                               | t <sub>pHL</sub> |                |                     | 50                  | —         | 6.5  | 9.6 | 1.0                 | 11.0 |      |
| Input capacitance             | C <sub>IN</sub>  | —              |                     |                     | —         | 4    | 10  | —                   | 10   | pF   |
| Power dissipation capacitance | C <sub>PD</sub>  | (Note)         |                     |                     | —         | 18   | —   | —                   | —    | pF   |

Note: CPD is defined as the value of the internal equivalent capacitance which is calculated from the operating current consumption without load.

Average operating current can be obtained by the equation:

$$I_{CC}(\text{opr}) = C_{PD} \cdot V_{CC} \cdot f_{IN} + I_{CC} / 6 \text{ (per gate)}$$

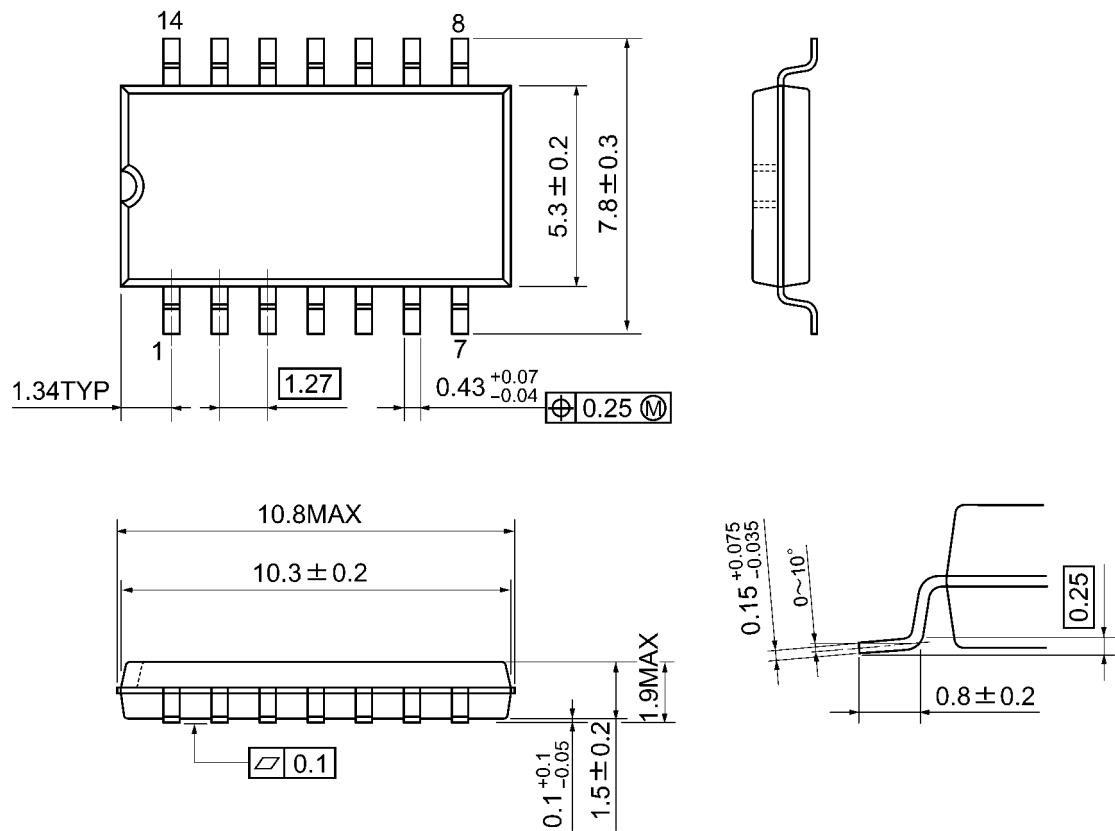
## Noise Characteristics (input: tr = tf = 3 ns)

| Characteristics                              | Symbol           | Test Condition         |   | Ta = 25°C           |            | Unit |
|----------------------------------------------|------------------|------------------------|---|---------------------|------------|------|
|                                              |                  |                        |   | V <sub>CC</sub> (V) | Typ. Limit |      |
| Quiet output maximum dynamic V <sub>OL</sub> | V <sub>OLP</sub> | C <sub>L</sub> = 50 pF | — | 5.0                 | 0.5 0.8    | V    |
| Quiet output minimum dynamic V <sub>OL</sub> | V <sub>OLV</sub> | C <sub>L</sub> = 50 pF | — | 5.0                 | -0.5 -0.8  | V    |
| Minimum high level dynamic input voltage     | V <sub>IHD</sub> | C <sub>L</sub> = 50 pF | — | 5.0                 | — 2.1      | V    |
| Maximum low level dynamic input voltage      | V <sub>ILD</sub> | C <sub>L</sub> = 50 pF | — | 5.0                 | — 0.5      | V    |

### Package Dimensions

SOP14-P-300-1.27A

Unit: mm

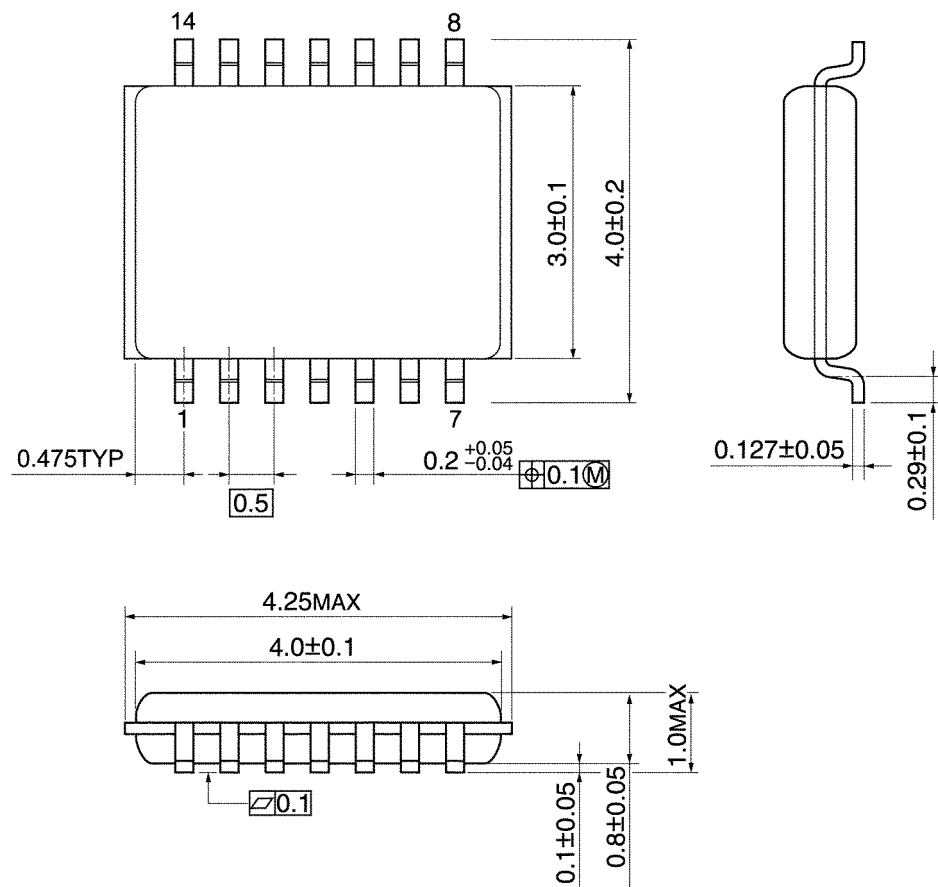


Weight: 0.18 g (typ.)

### Package Dimensions

VSSOP14-P-0030-0.50

Unit: mm



Weight: 0.02 g (typ.)

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