

# TC74HCU04AFT

## 1. Functional Description

- Hex Inverter

## 2. General

The TC74HCU04AFT is a high speed CMOS INVERTER fabricated with silicon gate C<sup>2</sup>MOS technology.

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

Since the internal circuit is composed of a single stage inverter, it can be used in analog applications such as crystal oscillators.

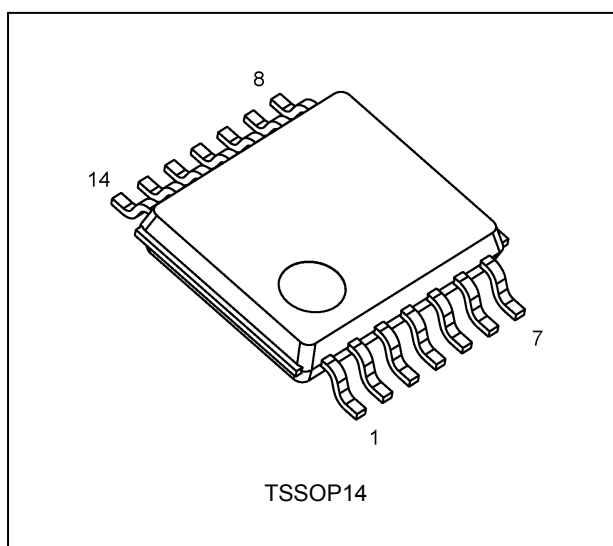
All inputs are equipped with protection circuits against static discharge or transient excess voltage.

## 3. Features

- (1) Wide operating temperature range:  $T_{opr} = -40$  to  $125$  °C (Note 1)
- (2) High speed:  $t_{pd} = 4$  ns (typ.) at  $V_{CC} = 5$  V
- (3) Low power dissipation:  $I_{CC} = 1.0$   $\mu$ A (max)  $T_a = 25$  °C
- (4) High noise immunity:  $V_{NIH} = V_{NIL} = 10$  %  $V_{CC}$  (min)
- (5) Output drive capability: 10 LSTTL loads
- (6) Symmetrical output impedance:  $|I_{OH}| = I_{OL} = 4$  mA (min)
- (7) Balanced propagation delays:  $t_{PLH} \approx t_{PHL}$
- (8) Wide operating voltage range:  $V_{CC(opr)} = 2.0$  to  $6.0$  V
- (9) Pin and function compatible with 74LS04

Note 1: Operating Range spec of  $T_{opr} = -40$  °C to  $125$  °C is applicable only for the products which manufactured after July 2020.

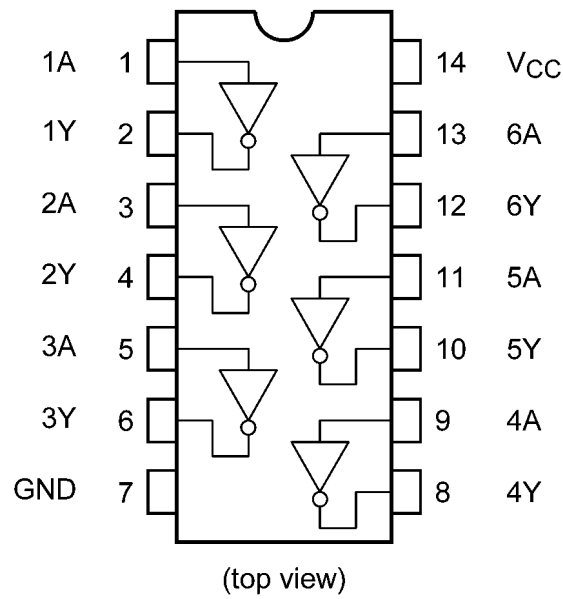
## 4. Packaging



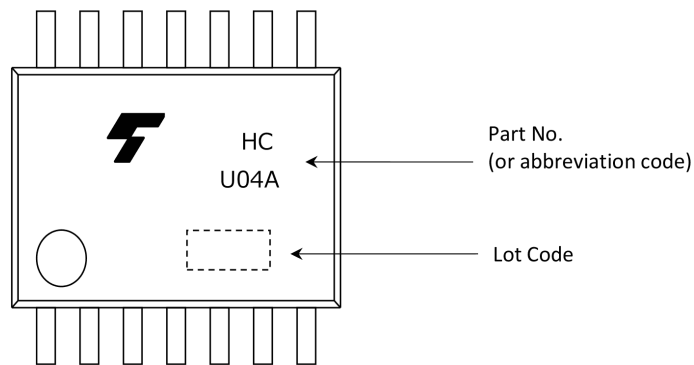
Start of commercial production

2020-07

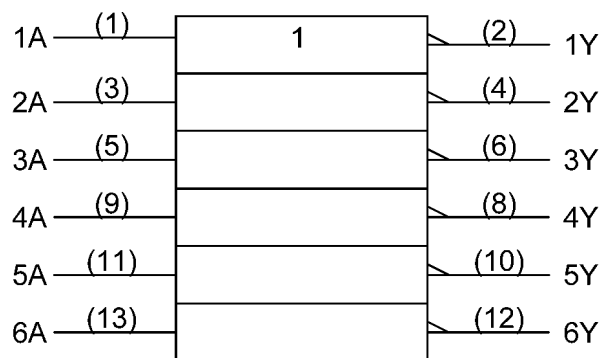
### 5. Pin Assignment



### 6. Marking



### 7. IEC Logic Symbol



### 8. Truth Table

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

### 9. Absolute Maximum Ratings (Note)

| Characteristics          | Symbol    | Note     | Rating                 | Unit |
|--------------------------|-----------|----------|------------------------|------|
| Supply voltage           | $V_{CC}$  |          | -0.5 to 7.0            | V    |
| Input voltage            | $V_{IN}$  |          | -0.5 to $V_{CC} + 0.5$ | V    |
| Output voltage           | $V_{OUT}$ |          | -0.5 to $V_{CC} + 0.5$ | V    |
| Input diode current      | $I_{IK}$  |          | $\pm 20$               | mA   |
| Output diode current     | $I_{OK}$  |          | $\pm 20$               | mA   |
| Output current           | $I_{OUT}$ |          | $\pm 25$               | mA   |
| $V_{CC}$ /ground current | $I_{CC}$  |          | $\pm 50$               | mA   |
| Power dissipation        | $P_D$     | (Note 1) | 180                    | mW   |
| Storage temperature      | $T_{stg}$ |          | -65 to 150             | °C   |

Note: 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 1: 180 mW in the range of  $T_a = -40$  to  $85$  °C. From  $T_a = 85$  to  $125$  °C a derating factor of  $-3.25$  mW/°C shall be applied until 50 mW.

### 10. Operating Ranges (Note)

| Characteristics       | Symbol    | Note     | Rating        | Unit |
|-----------------------|-----------|----------|---------------|------|
| Supply voltage        | $V_{CC}$  |          | 2.0 to 6.0    | V    |
| Input voltage         | $V_{IN}$  |          | 0 to $V_{CC}$ | V    |
| Output voltage        | $V_{OUT}$ |          | 0 to $V_{CC}$ | V    |
| Operating temperature | $T_{opr}$ | (Note 1) | -40 to 125    | °C   |

Note: The operating ranges must be maintained to ensure the normal operation of the device.

Unused inputs must be tied to either  $V_{CC}$  or GND.

Note 1: Operating Range spec of  $T_{opr} = -40$  °C to  $125$  °C is applicable only for the products which manufactured after July 2020.

### 11. Electrical Characteristics

#### 11.1. DC Characteristics (Unless otherwise specified, $T_a = 25\text{ }^\circ\text{C}$ )

| Characteristics           | Symbol   | Test Condition           |                                   | $V_{CC}$ (V) | Min  | Typ. | Max       | Unit          |
|---------------------------|----------|--------------------------|-----------------------------------|--------------|------|------|-----------|---------------|
| High-level input voltage  | $V_{IH}$ | —                        |                                   | 2.0          | 1.7  | —    | —         | V             |
|                           |          |                          |                                   | 4.5          | 3.6  | —    | —         |               |
|                           |          |                          |                                   | 6.0          | 4.8  | —    | —         |               |
| Low-level input voltage   | $V_{IL}$ | —                        |                                   | 2.0          | —    | —    | 0.3       | V             |
|                           |          |                          |                                   | 4.5          | —    | —    | 0.9       |               |
|                           |          |                          |                                   | 6.0          | —    | —    | 1.2       |               |
| High-level output voltage | $V_{OH}$ | $V_{IN} = V_{IL}$        | $I_{OH} = -20\text{ }\mu\text{A}$ | 2.0          | 1.8  | 2.0  | —         | V             |
|                           |          |                          |                                   | 4.5          | 4.0  | 4.5  | —         |               |
|                           |          | $V_{IN} = \text{GND}$    | $I_{OH} = -4\text{ mA}$           | 4.5          | 4.18 | 4.31 | —         |               |
|                           |          |                          |                                   | 6.0          | 5.68 | 5.80 | —         |               |
| Low-level output voltage  | $V_{OL}$ | $V_{IN} = V_{IH}$        | $I_{OL} = 20\text{ }\mu\text{A}$  | 2.0          | —    | 0.0  | 0.2       | V             |
|                           |          |                          |                                   | 4.5          | —    | 0.0  | 0.5       |               |
|                           |          |                          |                                   | 6.0          | —    | 0.1  | 0.5       |               |
|                           |          | $V_{IN} = V_{CC}$        | $I_{OL} = 4\text{ mA}$            | 4.5          | —    | 0.17 | 0.26      |               |
| 6.0                       | —        |                          |                                   | 0.18         | 0.26 |      |           |               |
| Input leakage current     | $I_{IN}$ | $V_{IN} = V_{CC}$ or GND |                                   | 6.0          | —    | —    | $\pm 0.1$ | $\mu\text{A}$ |
| Quiescent supply current  | $I_{CC}$ | $V_{IN} = V_{CC}$ or GND |                                   | 6.0          | —    | —    | 1.0       | $\mu\text{A}$ |

#### 11.2. DC Characteristics (Unless otherwise specified, $T_a = -40\text{ to }85\text{ }^\circ\text{C}$ )

| Characteristics           | Symbol   | Test Condition           |                                   | $V_{CC}$ (V) | Min  | Max       | Unit          |
|---------------------------|----------|--------------------------|-----------------------------------|--------------|------|-----------|---------------|
| High-level input voltage  | $V_{IH}$ | —                        |                                   | 2.0          | 1.7  | —         | V             |
|                           |          |                          |                                   | 4.5          | 3.6  | —         |               |
|                           |          |                          |                                   | 6.0          | 4.8  | —         |               |
| Low-level input voltage   | $V_{IL}$ | —                        |                                   | 2.0          | —    | 0.3       | V             |
|                           |          |                          |                                   | 4.5          | —    | 0.9       |               |
|                           |          |                          |                                   | 6.0          | —    | 1.2       |               |
| High-level output voltage | $V_{OH}$ | $V_{IN} = V_{IL}$        | $I_{OH} = -20\text{ }\mu\text{A}$ | 2.0          | 1.8  | —         | V             |
|                           |          |                          |                                   | 4.5          | 4.0  | —         |               |
|                           |          | $V_{IN} = \text{GND}$    | $I_{OH} = -4\text{ mA}$           | 4.5          | 4.13 | —         |               |
|                           |          |                          |                                   | 6.0          | 5.63 | —         |               |
| Low-level output voltage  | $V_{OL}$ | $V_{IN} = V_{IH}$        | $I_{OL} = 20\text{ }\mu\text{A}$  | 2.0          | —    | 0.2       | V             |
|                           |          |                          |                                   | 4.5          | —    | 0.5       |               |
|                           |          |                          |                                   | 6.0          | —    | 0.5       |               |
|                           |          | $V_{IN} = V_{CC}$        | $I_{OL} = 4\text{ mA}$            | 4.5          | —    | 0.33      |               |
| 6.0                       | —        |                          |                                   | 0.33         |      |           |               |
| Input leakage current     | $I_{IN}$ | $V_{IN} = V_{CC}$ or GND |                                   | 6.0          | —    | $\pm 1.0$ | $\mu\text{A}$ |
| Quiescent supply current  | $I_{CC}$ | $V_{IN} = V_{CC}$ or GND |                                   | 6.0          | —    | 10.0      | $\mu\text{A}$ |

### 11.3. DC Characteristics (Note) (Unless otherwise specified, $T_a = -40$ to $125$ °C)

| Characteristics           | Symbol   | Test Condition                |                        | $V_{CC}$ (V) | Min | Max       | Unit    |
|---------------------------|----------|-------------------------------|------------------------|--------------|-----|-----------|---------|
| High-level input voltage  | $V_{IH}$ | —                             |                        | 2.0          | 1.7 | —         | V       |
|                           |          |                               |                        | 4.5          | 3.6 | —         |         |
|                           |          |                               |                        | 6.0          | 4.8 | —         |         |
| Low-level input voltage   | $V_{IL}$ | —                             |                        | 2.0          | —   | 0.3       | V       |
|                           |          |                               |                        | 4.5          | —   | 0.9       |         |
|                           |          |                               |                        | 6.0          | —   | 1.2       |         |
| High-level output voltage | $V_{OH}$ | $V_{IN} = V_{IH}$ or $V_{IL}$ | $I_{OH} = -20$ $\mu$ A | 2.0          | 1.8 | —         | V       |
|                           |          |                               |                        | 4.5          | 4.0 | —         |         |
|                           |          |                               |                        | 6.0          | 5.5 | —         |         |
|                           |          |                               | $I_{OH} = -4$ mA       | 4.5          | 3.7 | —         |         |
| Low-level output voltage  | $V_{OL}$ | $V_{IN} = V_{IH}$ or $V_{IL}$ | $I_{OL} = 20$ $\mu$ A  | 2.0          | —   | 0.2       | V       |
|                           |          |                               |                        | 4.5          | —   | 0.5       |         |
|                           |          |                               |                        | 6.0          | —   | 0.5       |         |
|                           |          |                               | $I_{OL} = 4$ mA        | 4.5          | —   | 0.4       |         |
|                           |          |                               | $I_{OL} = 5.2$ mA      | 6.0          | —   | 0.4       |         |
| Input leakage current     | $I_{IN}$ | $V_{IN} = V_{CC}$ or GND      |                        | 6.0          | —   | $\pm 1.0$ | $\mu$ A |
| Quiescent supply current  | $I_{CC}$ | $V_{IN} = V_{CC}$ or GND      |                        | 6.0          | —   | 20.0      | $\mu$ A |

Note: Operating Range spec of  $T_{opr} = -40$  °C to  $125$  °C is applicable only for the products which manufactured after July 2020.

### 11.4. AC Characteristics

(Unless otherwise specified,  $C_L = 15 \text{ pF}$ ,  $V_{CC} = 5 \text{ V}$ ,  $T_a = 25 \text{ }^\circ\text{C}$ , Input:  $t_r = t_f = 6 \text{ ns}$ )

| Characteristics        | Symbol             | Test Condition | Min | Typ. | Max | Unit |
|------------------------|--------------------|----------------|-----|------|-----|------|
| Output transition time | $t_{TLH}, t_{THL}$ | —              | —   | 4    | 8   | ns   |
| Propagation delay time | $t_{PLH}, t_{PHL}$ | —              | —   | 4    | 8   | ns   |

### 11.5. AC Characteristics

(Unless otherwise specified,  $C_L = 50 \text{ pF}$ ,  $T_a = 25 \text{ }^\circ\text{C}$ , Input:  $t_r = t_f = 6 \text{ ns}$ )

| Characteristics               | Symbol             | Note     | $V_{CC}$ (V) | Min | Typ. | Max | Unit |
|-------------------------------|--------------------|----------|--------------|-----|------|-----|------|
| Output transition time        | $t_{TLH}, t_{THL}$ |          | 2.0          | —   | 30   | 75  | ns   |
|                               |                    |          | 4.5          | —   | 8    | 15  |      |
|                               |                    |          | 6.0          | —   | 7    | 13  |      |
| Propagation delay time        | $t_{PLH}, t_{PHL}$ |          | 2.0          | —   | 18   | 60  | ns   |
|                               |                    |          | 4.5          | —   | 6    | 12  |      |
|                               |                    |          | 6.0          | —   | 5    | 10  |      |
| Input capacitance             | $C_{IN}$           |          | —            | —   | 9    | 15  | pF   |
| Power dissipation capacitance | $C_{PD}$           | (Note 1) | —            | —   | 13   | —   | pF   |

Note 1:  $C_{PD}$  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.

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

### 11.6. AC Characteristics

(Unless otherwise specified,  $C_L = 50 \text{ pF}$ ,  $T_a = -40 \text{ to } 85 \text{ }^\circ\text{C}$ , Input:  $t_r = t_f = 6 \text{ ns}$ )

| Characteristics        | Symbol             | $V_{CC}$ (V) | Min | Max | Unit |
|------------------------|--------------------|--------------|-----|-----|------|
| Output transition time | $t_{TLH}, t_{THL}$ | 2.0          | —   | 95  | ns   |
|                        |                    | 4.5          | —   | 19  |      |
|                        |                    | 6.0          | —   | 16  |      |
| Propagation delay time | $t_{PLH}, t_{PHL}$ | 2.0          | —   | 75  | ns   |
|                        |                    | 4.5          | —   | 15  |      |
|                        |                    | 6.0          | —   | 13  |      |
| Input capacitance      | $C_{IN}$           | —            | —   | 15  | pF   |

### 11.7. AC Characteristics (Note)

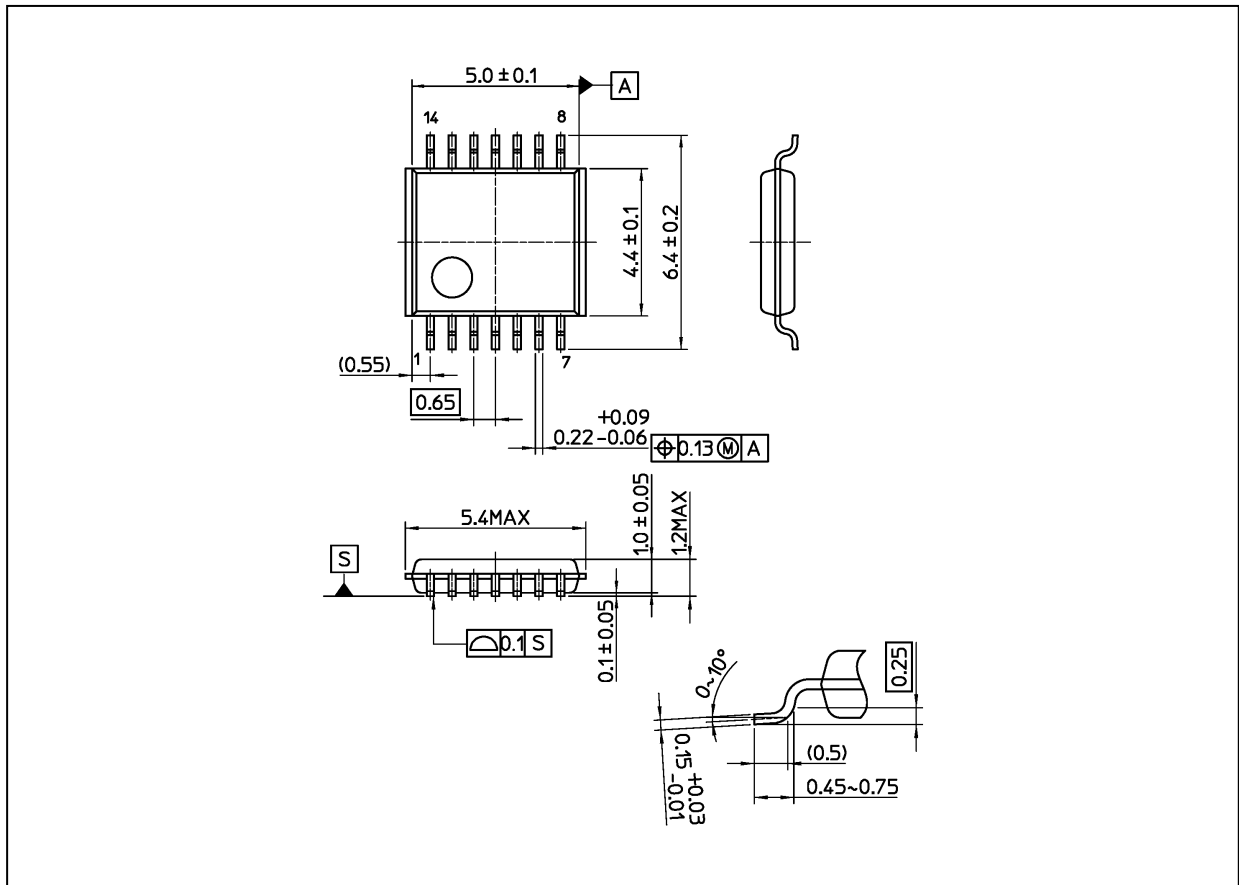
(Unless otherwise specified,  $C_L = 50 \text{ pF}$ ,  $T_a = -40 \text{ to } 125 \text{ }^\circ\text{C}$ , Input:  $t_r = t_f = 6 \text{ ns}$ )

| Characteristics        | Symbol             | $V_{CC}$ (V) | Min | Max | Unit |
|------------------------|--------------------|--------------|-----|-----|------|
| Output transition time | $t_{TLH}, t_{THL}$ | 2.0          | —   | 110 | ns   |
|                        |                    | 4.5          | —   | 22  |      |
|                        |                    | 6.0          | —   | 18  |      |
| Propagation delay time | $t_{PLH}, t_{PHL}$ | 2.0          | —   | 85  | ns   |
|                        |                    | 4.5          | —   | 17  |      |
|                        |                    | 6.0          | —   | 15  |      |
| Input capacitance      | $C_{IN}$           | —            | —   | 15  | pF   |

Note: Operating Range spec of  $T_{opr} = -40 \text{ }^\circ\text{C}$  to  $125 \text{ }^\circ\text{C}$  is applicable only for the products which manufactured after July 2020.

### Package Dimensions

Unit: mm



Weight: 0.06 g (typ.)

|                   |
|-------------------|
| Package Name(s)   |
| Nickname: TSSOP14 |

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