

74VHC04FT

1. Functional Description

- Hex Inverter

2. General

The 74VHC04FT is an advanced high speed CMOS INVERTER fabricated with silicon gate C²MOS technology. It achieves the high speed operation similar to equivalent Bipolar Schottky TTL while maintaining the CMOS low power dissipation.

The internal circuit is composed of 3 stages including buffer output, which provide high noise immunity and stable output.

An input protection circuit ensures that 0 to 5.5 V can be applied to the input pins without regard to the supply voltage. This device can be used to interface 5 V to 3 V systems and two supply systems such as battery back up.

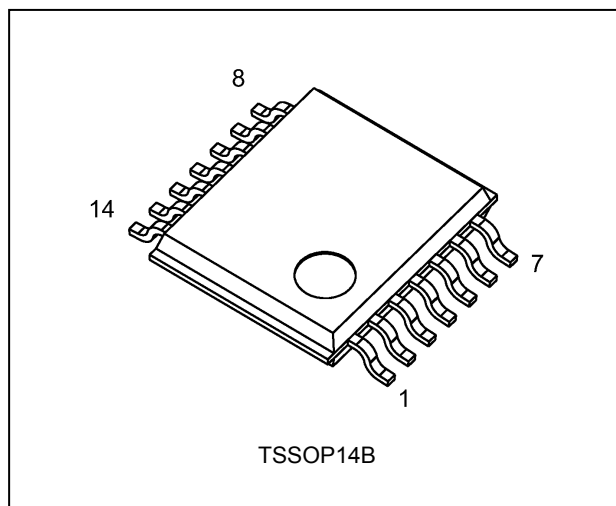
This circuit prevents device destruction due to mismatched supply and input voltages.

3. Features

- (1) AEC-Q100 (Rev. H) (Note 1)
- (2) Wide operating temperature: $T_{opr} = -40$ to 125 °C
- (3) High speed: Propagation delay time = 3.8 ns (typ.) at $V_{CC} = 5.0$ V
- (4) Low power dissipation: $I_{CC} = 2.0$ μ A (max) at $T_a = 25$ °C
- (5) High noise immunity: $V_{NIH} = V_{NIL} = 28\%$ V_{CC} (min)
- (6) Power-down protection is provided on all inputs.
- (7) Balanced propagation delays: $t_{PLH} \approx t_{PHL}$
- (8) Wide operating voltage range: $V_{CC(opr)} = 2.0$ to 5.5 V
- (9) Low noise: $V_{OLP} = 0.8$ V (max)
- (10) Pin and function compatible with the 74 series (AC/HC/AHC/LV etc.) 04 type.

Note 1: This device is compliant with the reliability requirements of AEC-Q100. For details, contact your Toshiba sales representative.

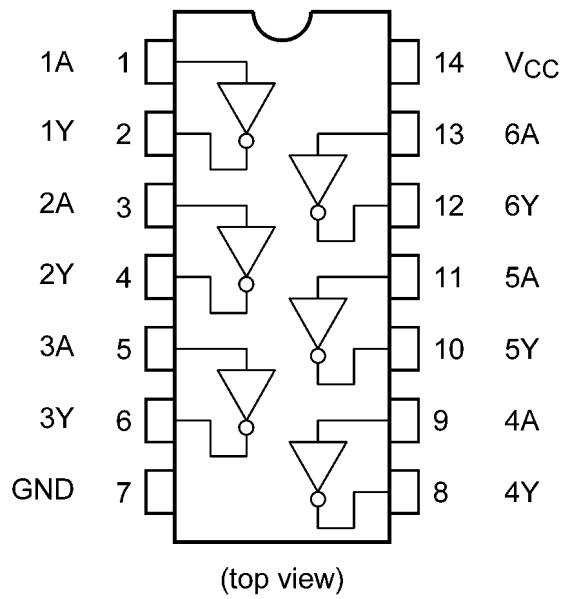
4. Packaging



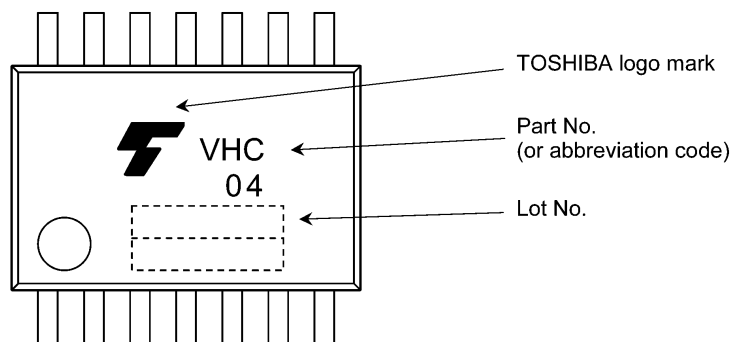
Start of commercial production

2013-05

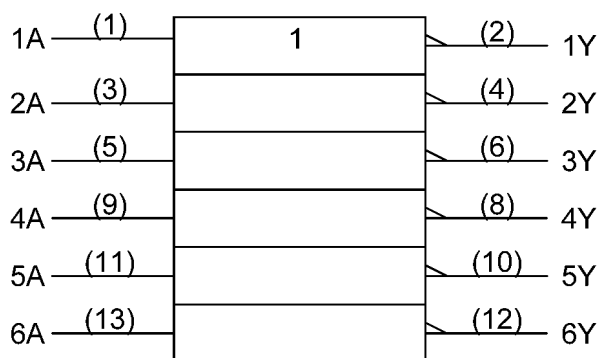
5. Pin Assignment



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

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 $85^{\circ}C$. From $T_a = 85$ to $125^{\circ}C$ a derating factor of -3.25 mW/ $^{\circ}C$ shall be applied until 50 mW.

10. Operating Ranges (Note)

| Characteristics | Symbol | Test Condition | Rating | Unit |
|---------------------------|-----------|--------------------------|---------------|-------------|
| Supply voltage | V_{CC} | | 2.0 to 5.5 | V |
| Input voltage | V_{IN} | | 0 to 5.5 | V |
| Output voltage | V_{OUT} | | 0 to V_{CC} | V |
| Operating temperature | T_{opr} | | -40 to 125 | $^{\circ}C$ |
| Input rise and fall times | dt/dv | $V_{CC} = 3.3 \pm 0.3$ V | 0 to 100 | ns/V |
| | | $V_{CC} = 5.0 \pm 0.5$ V | 0 to 20 | |

Note: The operating ranges are required to ensure the normal operation of the device. Unused inputs must be tied to either V_{CC} or GND.

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 | 1.50 | — | — | V | |
| | | | 3.0 to 5.5 | $V_{CC} \times 0.7$ | — | — | | |
| Low-level input voltage | V_{IL} | — | 2.0 | — | — | 0.50 | V | |
| | | | 3.0 to 5.5 | — | — | $V_{CC} \times 0.3$ | | |
| High-level output voltage | V_{OH} | $V_{IN} = V_{IL}$ | $I_{OH} = -50\text{ }\mu\text{A}$ | 2.0 | 1.9 | 2.0 | — | V |
| | | | | 3.0 | 2.9 | 3.0 | | |
| | | | | 4.5 | 4.4 | 4.5 | | |
| | | | $I_{OH} = -4\text{ mA}$ | 3.0 | 2.58 | — | — | |
| | | | | 4.5 | 3.94 | — | — | |
| Low-level output voltage | V_{OL} | $V_{IN} = V_{IH}$ | $I_{OL} = 50\text{ }\mu\text{A}$ | 2.0 | — | 0.0 | 0.1 | V |
| | | | | 3.0 | — | 0.0 | 0.1 | |
| | | | | 4.5 | — | 0.0 | 0.1 | |
| | | | $I_{OL} = 4\text{ mA}$ | 3.0 | — | — | 0.36 | |
| | | | | 4.5 | — | — | 0.36 | |
| Input leakage current | I_{IN} | $V_{IN} = 5.5\text{ V or GND}$ | 0 to 5.5 | — | — | ± 0.1 | μA | |
| Quiescent supply current | I_{CC} | $V_{IN} = V_{CC}\text{ or GND}$ | 5.5 | — | — | 2.0 | μA | |

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 | 1.50 | — | V | |
| | | | 3.0 to 5.5 | $V_{CC} \times 0.7$ | — | | |
| Low-level input voltage | V_{IL} | — | 2.0 | — | 0.50 | V | |
| | | | 3.0 to 5.5 | — | $V_{CC} \times 0.3$ | | |
| High-level output voltage | V_{OH} | $V_{IN} = V_{IL}$ | $I_{OH} = -50\text{ }\mu\text{A}$ | 2.0 | 1.9 | — | V |
| | | | | 3.0 | 2.9 | — | |
| | | | | 4.5 | 4.4 | — | |
| | | | $I_{OH} = -4\text{ mA}$ | 3.0 | 2.48 | — | |
| | | | | 4.5 | 3.80 | — | |
| Low-level output voltage | V_{OL} | $V_{IN} = V_{IH}$ | $I_{OL} = 50\text{ }\mu\text{A}$ | 2.0 | — | 0.1 | V |
| | | | | 3.0 | — | 0.1 | |
| | | | | 4.5 | — | 0.1 | |
| | | | $I_{OL} = 4\text{ mA}$ | 3.0 | — | 0.44 | |
| | | | | 4.5 | — | 0.44 | |
| Input leakage current | I_{IN} | $V_{IN} = 5.5\text{ V or GND}$ | 0 to 5.5 | — | ± 1.0 | μA | |
| Quiescent supply current | I_{CC} | $V_{IN} = V_{CC}\text{ or GND}$ | 5.5 | — | 20.0 | μA | |

11.3. DC Characteristics (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 | 1.50 | — | V |
| | | | | 3.0 to 5.5 | $V_{CC} \times 0.7$ | — | |
| Low-level input voltage | V_{IL} | — | | 2.0 | — | 0.50 | V |
| | | | | 3.0 to 5.5 | — | $V_{CC} \times 0.3$ | |
| High-level output voltage | V_{OH} | $V_{IN} = V_{IL}$ | $I_{OH} = -50 \mu A$ | 2.0 | 1.9 | — | V |
| | | | | 3.0 | 2.9 | — | |
| | | | | 4.5 | 4.4 | — | |
| | | | | $I_{OH} = -4$ mA | 3.0 | 2.40 | |
| Low-level output voltage | V_{OL} | $V_{IN} = V_{IH}$ | $I_{OL} = 50 \mu A$ | 2.0 | — | 0.1 | V |
| | | | | 3.0 | — | 0.1 | |
| | | | | 4.5 | — | 0.1 | |
| | | | | $I_{OL} = 4$ mA | 3.0 | — | |
| Input leakage current | I_{IN} | $V_{IN} = 5.5$ V or GND | | 0 to 5.5 | — | ± 2.0 | μA |
| | | | | 5.5 | — | 40.0 | |
| Quiescent supply current | I_{CC} | $V_{IN} = V_{CC}$ or GND | | 5.5 | — | 40.0 | μA |

11.4. AC Characteristics (Unless otherwise specified, $T_a = 25$ °C, Input: $t_r = t_f = 3$ ns)

| Characteristics | Symbol | Note | V_{CC} (V) | C_L (pF) | Min | Typ. | Max | Unit |
|-------------------------------|--------------------|----------|---------------|------------|-----|------|------|------|
| Propagation delay time | t_{PLH}, t_{PHL} | | 3.3 ± 0.3 | 15 | — | 5.0 | 7.1 | ns |
| | | | | 50 | — | 7.5 | 10.6 | |
| | | | 5.0 ± 0.5 | 15 | — | 3.8 | 5.5 | |
| | | | | 50 | — | 5.3 | 7.5 | |
| Input capacitance | C_{IN} | | | — | 4 | 10 | pF | |
| Power dissipation capacitance | C_{PD} | (Note 1) | | — | 18 | — | 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.

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

11.5. AC Characteristics (Unless otherwise specified, $T_a = -40$ to 85 °C, Input: $t_r = t_f = 3$ ns)

| Characteristics | Symbol | V_{CC} (V) | C_L (pF) | Min | Max | Unit |
|------------------------|--------------------|---------------|------------|-----|------|------|
| Propagation delay time | t_{PLH}, t_{PHL} | 3.3 ± 0.3 | 15 | 1.0 | 8.5 | ns |
| | | | 50 | 1.0 | 12.0 | |
| | | 5.0 ± 0.5 | 15 | 1.0 | 6.5 | |
| | | | 50 | 1.0 | 8.5 | |
| Input capacitance | C_{IN} | | — | 10 | pF | |

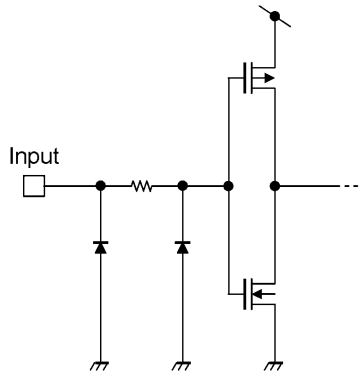
11.6. AC Characteristics (Unless otherwise specified, $T_a = -40$ to 125 °C, Input: $t_r = t_f = 3$ ns)

| Characteristics | Symbol | Note | Test Condition | V_{CC} (V) | C_L (pF) | Min | Max | Unit |
|------------------------|--------------------|------|----------------|---------------|------------|-----|------|------|
| Propagation delay time | t_{PLH}, t_{PHL} | | — | 3.3 ± 0.3 | 15 | 1.0 | 10.0 | ns |
| | | | | | 50 | 1.0 | 13.5 | |
| | | | | 5.0 ± 0.5 | 15 | 1.0 | 7.5 | |
| | | | | | 50 | 1.0 | 9.5 | |
| Input capacitance | C_{IN} | | — | — | 10 | pF | | |

11.7. Noise Characteristics (Unless otherwise specified, $T_a = 25\text{ }^\circ\text{C}$, Input: $t_r = t_f = 3\text{ ns}$)

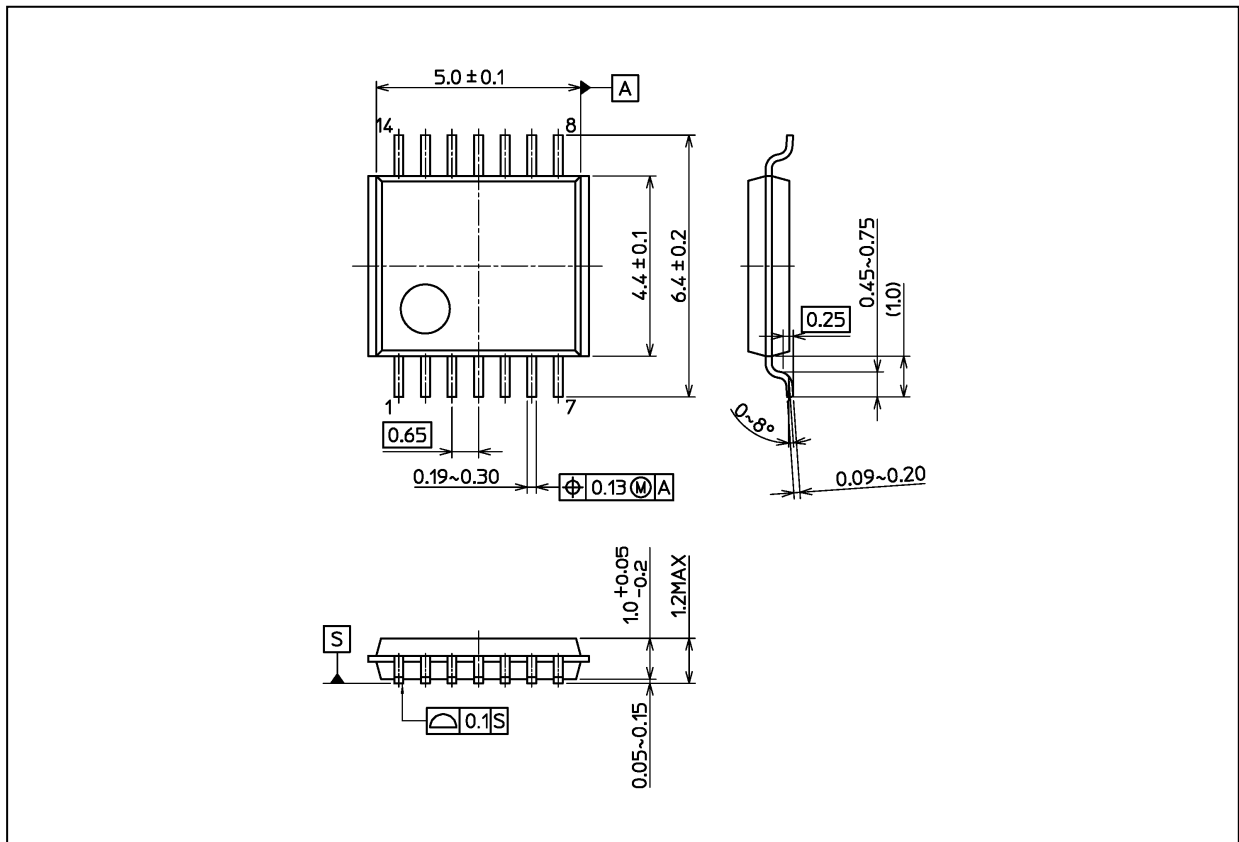
| Characteristics | Symbol | Test Condition | V_{CC} (V) | Typ. | Limit | Unit |
|--|-----------|----------------------|--------------|------|-------|------|
| Quiet output maximum dynamic V_{OL} | V_{OLP} | $C_L = 50\text{ pF}$ | 5.0 | 0.4 | 0.8 | V |
| Quiet output minimum dynamic V_{OL} | V_{OLV} | $C_L = 50\text{ pF}$ | 5.0 | -0.4 | -0.8 | V |
| Minimum high-level dynamic input voltage | V_{IHD} | $C_L = 50\text{ pF}$ | 5.0 | — | 3.5 | V |
| Maximum low-level dynamic input voltage | V_{ILD} | $C_L = 50\text{ pF}$ | 5.0 | — | 1.5 | V |

11.8. Input Equivalent Circuit



Package Dimensions

Unit: mm



Weight: 0.054 g (typ.)

| |
|--------------------|
| Package Name(s) |
| Nickname: TSSOP14B |

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