

# TC74VHCV05FK

## 1. Functional Description

- Hex Schmitt Inverter (Open Drain)

## 2. General

The TC74VHCV05FK is an advanced high speed CMOS INVERTER fabricated with silicon gate CMOS technology. It achieves the high speed operation similar to equivalent Bipolar Schottky TTL while maintaining the CMOS low power dissipation.

Output have high performance MOS N-channel transistor. (Open Drain outputs)

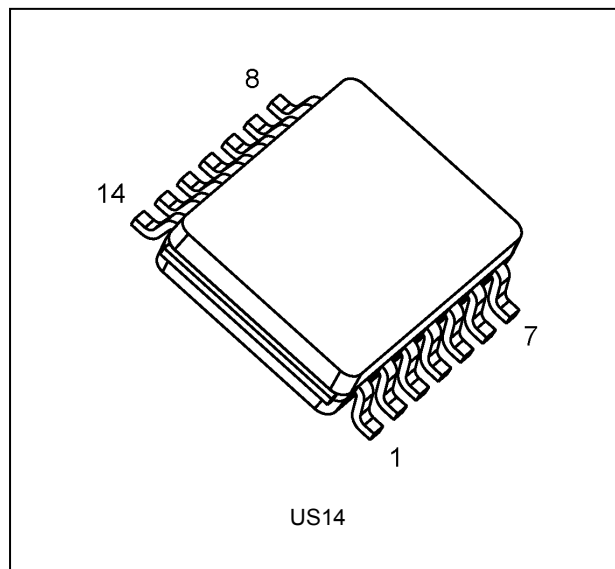
Input pin have hysteresis between the positive-going and negative-going thresholds. Thus the TC74VHCV05FK is capable of squaring up transitions of slowly changing input signals such as line receivers.

Input protection and output circuit ensure that 0 to 5.5 V can be applied to the input and output pin without regard to the supply voltage. These structure prevents device destruction due to mismatched supply and input/output voltages such as battery back up, etc.

## 3. Features

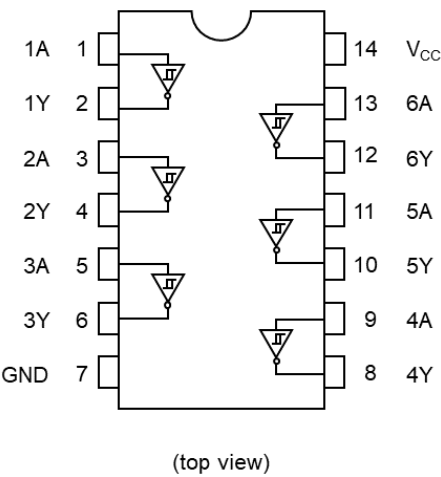
- (1) High speed:  $t_{pd} = 4.2 \text{ ns}$  (typ.) at  $V_{CC} = 5.0 \text{ V}$
- (2) Low power dissipation:  $I_{CC} = 2.0 \mu\text{A}$  (max) at  $T_a = 25^\circ\text{C}$
- (3) Wide operating voltage range:  $V_{CC(opr)} = 1.8 \text{ V}$  to  $5.5 \text{ V}$
- (4) Output current:  $I_{OL} = 16 \text{ mA}$  (min) ( $V_{CC} = 4.5 \text{ V}$ )
- (5) Power-down protection is provided on all inputs and outputs.
- (6) Pin and function compatible with the 74 series (74AC/HC/AHC/LV etc.) 05 type.

## 4. Packaging

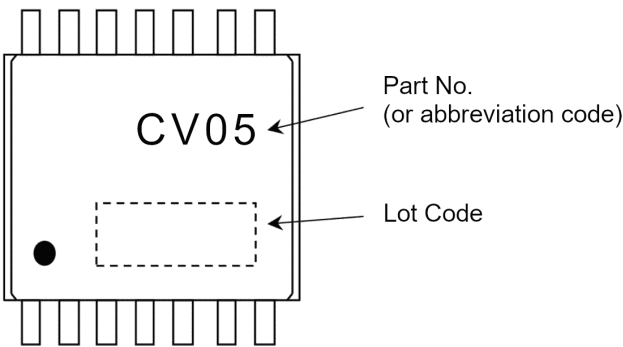


Start of commercial production  
2010-01

5. Pin Assignment



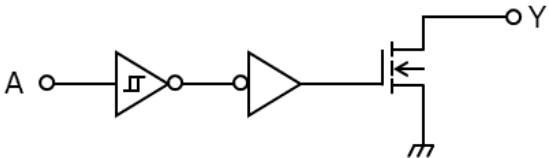
6. Marking



7. Truth Table

| Input A | Output Y |
|---------|----------|
| L       | Z        |
| H       | L        |

8. System Diagram (per gate)



### 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           | $V_{OUT}$        | (Note 1) | -0.5 to 7.0 | V    |
| Input diode current      | $I_{IK}$         |          | -50         | mA   |
| Output diode current     | $I_{OK}$         | (Note 2) | -50         | mA   |
| Output current           | $I_{OUT}$        |          | 50          | mA   |
| Power dissipation        | $P_D$            |          | 180         | mW   |
| $V_{CC}$ /ground current | $I_{CC}/I_{GND}$ |          | $\pm 100$   | mA   |
| 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: Output in off state.  $I_{OUT}$  absolute maximum rating must be observed.(Output in low state)

Note 2:  $V_{OUT} < GND$

### 10. Operating Ranges (Note)

| Characteristics           | Symbol    | Test Condition                   | Rating     | Unit |
|---------------------------|-----------|----------------------------------|------------|------|
| Supply voltage            | $V_{CC}$  | —                                | 1.8 to 5.5 | V    |
| Input voltage             | $V_{IN}$  | —                                | 0 to 5.5   | V    |
| Output voltage            | $V_{OUT}$ | —                                | 0 to 5.5   | V    |
| Operating temperature     | $T_{opr}$ | —                                | -40 to 85  | °C   |
| Input rise and fall times | $dt/dv$   | $V_{CC} = 3.3 \pm 0.3 \text{ V}$ | 0 to 20    | ms/V |
|                           |           | $V_{CC} = 5.0 \pm 0.5 \text{ V}$ | 0 to 1     |      |

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.

### 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          |
|--|-----------|---|----------------------------------|--------------|------|------|------------|---------------|
| Positive threshold voltage               | $V_P$     | —   |                                  | 1.8          | —    | —    | 1.65       | V             |
|  |           |   |                                  | 2.3          | —    | —    | 1.85       |               |
|  |           |   |                                  | 3.0          | —    | —    | 2.20       |               |
|  |           |   |                                  | 4.5          | —    | —    | 3.15       |               |
|  |           |   |                                  | 5.5          | —    | —    | 3.85       |               |
| Negative threshold voltage               | $V_N$     | —   |                                  | 1.8          | 0.15 | —    | —          | V             |
|  |           |   |                                  | 2.3          | 0.45 | —    | —          |               |
|  |           |   |                                  | 3.0          | 0.90 | —    | —          |               |
|  |           |   |                                  | 4.5          | 1.35 | —    | —          |               |
|  |           |   |                                  | 5.5          | 1.65 | —    | —          |               |
| Hysteresis voltage                       | $V_H$     | —   |                                  | 1.8          | 0.15 | —    | 1.05       | V             |
|  |           |   |                                  | 2.3          | 0.20 | —    | 1.10       |               |
|  |           |   |                                  | 3.0          | 0.30 | —    | 1.20       |               |
|  |           |   |                                  | 4.5          | 0.40 | —    | 1.40       |               |
|  |           |   |                                  | 5.5          | 0.50 | —    | 1.60       |               |
| Low-level output voltage                 | $V_{OL}$  | $V_{IN} = V_{IH}$   | $I_{OL} = 50\text{ }\mu\text{A}$ | 1.8          | —    | 0.0  | 0.1        | V             |
|  |           |   |                                  | 3.0          | —    | 0.0  | 0.1        |               |
|  |           |   |                                  | 4.5          | —    | 0.0  | 0.1        |               |
|  |           |   | $I_{OL} = 8\text{ mA}$           | 3.0          | —    | —    | 0.36       |               |
|  |           |   | $I_{OL} = 16\text{ mA}$          | 4.5          | —    | —    | 0.44       |               |
| 3-state output OFF-state leakage current | $I_{OZ}$  | $V_{IN} = V_{IL}$<br>$V_{OUT} = 0\text{ to }5.5\text{ V}$ |                                  | 1.8 to 5.5   | —    | —    | $\pm 0.25$ | $\mu\text{A}$ |
| Power-OFF leakage current                | $I_{OFF}$ | $V_{IN}/V_{OUT} = 5.5\text{ V}$                           |                                  | 0            | —    | —    | 0.5        | $\mu\text{A}$ |
| Input leakage current                    | $I_{IN}$  | $V_{IN} = 5.5\text{ V or GND}$                            |                                  | 0 to 5.5     | —    | —    | $\pm 0.1$  | $\mu\text{A}$ |
| Quiescent supply current                 | $I_{CC}$  | $V_{IN} = V_{CC}\text{ or GND}$                           |                                  | 5.5          | —    | —    | 2.0        | $\mu\text{A}$ |

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

| Characteristics                          | Symbol    | Test Condition                                       |                                  | $V_{CC}$ (V) | Min  | Max       | Unit          |
|--|-----------|--|----------------------------------|--------------|------|-----------|---------------|
| Positive threshold voltage               | $V_P$     | —  |                                  | 1.8          | —    | 1.65      | V             |
|  |           |  |                                  | 2.3          | —    | 1.85      |               |
|  |           |  |                                  | 3.0          | —    | 2.20      |               |
|  |           |  |                                  | 4.5          | —    | 3.15      |               |
|  |           |  |                                  | 5.5          | —    | 3.85      |               |
| Negative threshold voltage               | $V_N$     | —  |                                  | 1.8          | 0.15 | —         | V             |
|  |           |  |                                  | 2.3          | 0.45 | —         |               |
|  |           |  |                                  | 3.0          | 0.90 | —         |               |
|  |           |  |                                  | 4.5          | 1.35 | —         |               |
|  |           |  |                                  | 5.5          | 1.65 | —         |               |
| Hysteresis voltage                       | $V_H$     | —  |                                  | 1.8          | 0.15 | 1.05      | V             |
|  |           |  |                                  | 2.3          | 0.20 | 1.10      |               |
|  |           |  |                                  | 3.0          | 0.30 | 1.20      |               |
|  |           |  |                                  | 4.5          | 0.40 | 1.40      |               |
|  |           |  |                                  | 5.5          | 0.50 | 1.60      |               |
| Low-level output voltage                 | $V_{OL}$  | $V_{IN} = V_{IH}$                                    | $I_{OL} = 50\text{ }\mu\text{A}$ | 1.8          | —    | 0.1       | V             |
|  |           |  |                                  | 3.0          | —    | 0.1       |               |
|  |           |  |                                  | 4.5          | —    | 0.1       |               |
|  |           |  | $I_{OL} = 8\text{ mA}$           | 3.0          | —    | 0.44      |               |
|  |           |  | $I_{OL} = 16\text{ mA}$          | 4.5          | —    | 0.55      |               |
| 3-state output OFF-state leakage current | $I_{OZ}$  | $V_{IN} = V_{IL}$<br>$V_{OUT} = 0$ to $5.5\text{ V}$ |                                  | 1.8 to 5.5   | —    | $\pm 2.5$ | $\mu\text{A}$ |
| Power-OFF leakage current                | $I_{OFF}$ | $V_{IN}/V_{OUT} = 5.5\text{ V}$                      |                                  | 0            | —    | 5.0       | $\mu\text{A}$ |
| Input leakage current                    | $I_{IN}$  | $V_{IN} = 5.5\text{ V}$ or GND                       |                                  | 0 to 5.5     | —    | $\pm 1.0$ | $\mu\text{A}$ |
| Quiescent supply current                 | $I_{CC}$  | $V_{IN} = V_{CC}$ or GND                             |                                  | 5.5          | —    | 20.0      | $\mu\text{A}$ |

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

| Characteristics               | Symbol    | Note     | Test Condition           | $V_{CC}$ (V)  | $C_L$ (pF) | Min | Typ. | Max  | Unit |
|-------------------------------|-----------|----------|--------------------------|---------------|------------|-----|------|------|------|
| Propagation delay time        | $t_{pZL}$ |          | $R_L = 1\text{ k}\Omega$ | $2.5 \pm 0.2$ | 15         | —   | 7.3  | 12.2 | ns   |
|                               |           |          |                          |               | 50         | —   | 10.1 | 16.6 |      |
|                               |           |          |                          | $3.3 \pm 0.3$ | 15         | —   | 5.6  | 7.1  |      |
|                               |           |          |                          |               | 50         | —   | 7.6  | 10.6 |      |
|                               |           |          |                          | $5.0 \pm 0.5$ | 15         | —   | 4.2  | 5.5  |      |
|                               |           |          |                          |               | 50         | —   | 5.7  | 7.5  |      |
|                               |           |          |                          | $2.5 \pm 0.2$ | 50         | —   | 11.6 | 15.2 |      |
|                               |           |          |                          |               | 50         | —   | 9.2  | 10.6 |      |
| Propagation delay time        | $t_{PLZ}$ |          | $R_L = 1\text{ k}\Omega$ | $3.3 \pm 0.3$ | 50         | —   | 6.9  | 7.5  | ns   |
| Input capacitance             | $C_{IN}$  |          | —                        | —             | —          | —   | 4    | 10   | pF   |
| Output capacitance            | $C_{OUT}$ |          | —                        | —             | —          | —   | 5    | —    | pF   |
| Power dissipation capacitance | $C_{PD}$  | (Note 1) | —                        | —             | —          | —   | 4    | —    | 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.

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

### 11.4. AC Characteristics

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

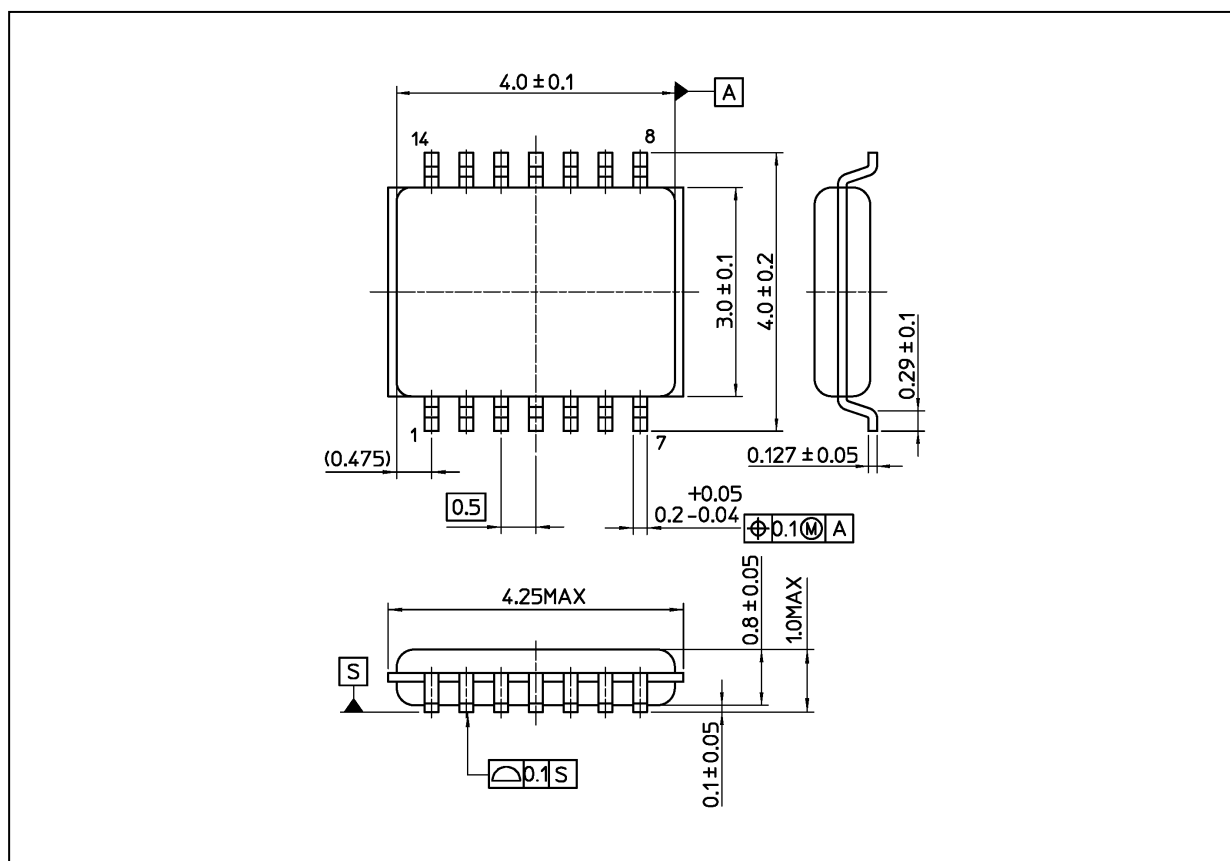
| Characteristics        | Symbol    | Test Condition           | $V_{CC}$ (V)  | $C_L$ (pF) | Min | Max  | Unit |
|------------------------|-----------|--------------------------|---------------|------------|-----|------|------|
| Propagation delay time | $t_{PZL}$ | $R_L = 1\text{ k}\Omega$ | $2.5 \pm 0.2$ | 15         | 1.0 | 15.0 | ns   |
|                        |           |                          |               | 50         | 1.0 | 19.5 |      |
|                        |           |                          | $3.3 \pm 0.3$ | 15         | 1.0 | 8.5  |      |
|                        |           |                          |               | 50         | 1.0 | 12.0 |      |
|                        |           |                          | $5.0 \pm 0.5$ | 15         | 1.0 | 6.5  |      |
|                        |           |                          |               | 50         | 1.0 | 8.5  |      |
| Propagation delay time | $t_{PLZ}$ | $R_L = 1\text{ k}\Omega$ | $2.5 \pm 0.2$ | 50         | 1.0 | 18.0 | ns   |
|                        |           |                          | $3.3 \pm 0.3$ | 50         | 1.0 | 12.0 |      |
|                        |           |                          | $5.0 \pm 0.5$ | 50         | 1.0 | 8.5  |      |
| Input capacitance      | $C_{IN}$  | —                        |               |            | —   | 10   | pF   |

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

| Characteristics                          | Symbol    | Test Condition       | $V_{CC}$ (V) | Typ. | Max | Unit |
|--|-----------|----------------------|--------------|------|-----|------|
| Quiet output maximum dynamic $V_{OL}$    | $V_{OLP}$ | $C_L = 50\text{ pF}$ | 3.3          | 0.3  | —   | V    |
|  |           |                      | 5.0          | 0.6  | —   |      |
| Quiet output minimum dynamic $V_{OL}$    | $V_{OLV}$ | $C_L = 50\text{ pF}$ | 3.3          | -0.1 | —   | V    |
|  |           |                      | 5.0          | -0.2 | —   |      |
| 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    |

## Package Dimensions

Unit: mm



Weight: 0.02 g (typ.)

| Package Name(s) |
|-----------------|
| Nickname: US14  |

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