

TOSHIBA CMOS Digital Integrated Circuit Silicon Monolithic

# TC74LCX07F, TC74LCX07FK

Low-Voltage HEX Buffer with 5-V Tolerant Inputs and Outputs (open drain)

The TC74LCX07 is a high-performance CMOS buffer. Designed for use in 3.3-V systems, it achieves high-speed operation while maintaining the CMOS low power dissipation.

The TC74LCX07 has high performance MOS N-channel transistor. (open-drain outputs)

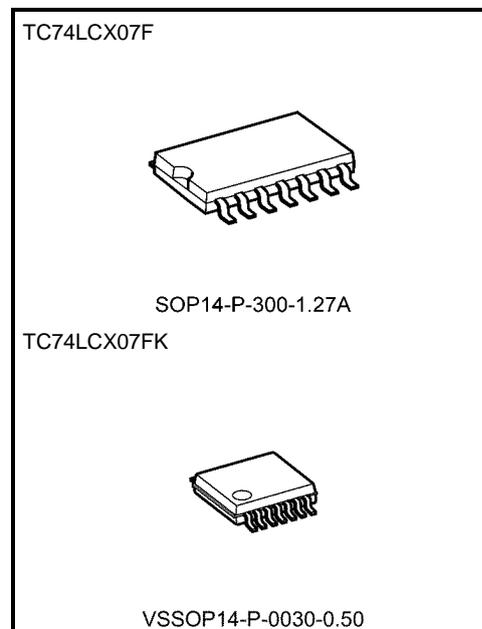
The device is designed for low-voltage (3.3 V)  $V_{CC}$  applications, but it could be used to interface to 5-V supply\* environment for inputs.

All inputs are equipped with protection circuits against static discharge.

\* $I_{OUT}$  absolute maximum rating must be observed.

## Features

- Low-voltage operation:  $V_{CC} = 1.65$  to  $5.5$  V
- High-speed operation:  $t_{pz} = 3.7$  ns (max) ( $V_{CC} = 3.0$  to  $3.6$  V)
- Output current:  $I_{OL} = 24$  mA (min) ( $V_{CC} = 3.0$  V)
- Available in JEITA SOP, VSSOP (US)
- Open-drain outputs
- Power-down protection provided on all inputs and outputs
- Pin and function compatible with the 74 series (74AC/VHC/HC/F/ALS/LS etc.) 07 type

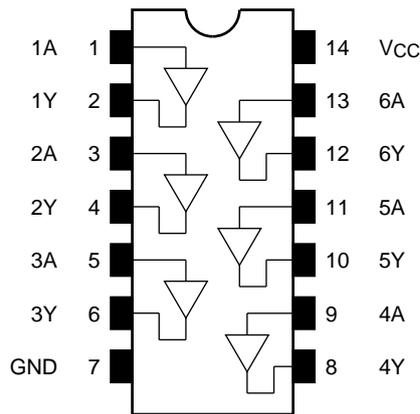


|                     |                  |
|---------------------|------------------|
| Weight              |                  |
| SOP14-P-300-1.27A   | : 0.18 g ( typ.) |
| VSSOP14-P-0030-0.50 | : 0.02 g ( typ.) |

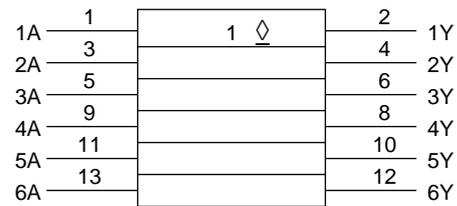
Note: The Electrical Characteristics of  $V_{CC} = 1.8 \pm 0.15$  V and that of  $V_{CC} = 5.0 \pm 0.5$  V are only applicable for products which manufactured from January 2009 onward.

Start of commercial production  
1999-10

### Pin Assignment (top view)



### IEC Logic Symbol

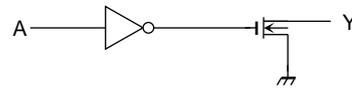


### Truth Table

| Inputs | Outputs |
|--------|---------|
| A      | Y       |
| L      | L       |
| H      | Z       |

Z: High impedance

### System Diagram (per gate)



### Absolute Maximum Ratings (Note 1)

| Characteristics                    | Symbol                            | Rating               | Unit |
|------------------------------------|-----------------------------------|----------------------|------|
| Power supply voltage               | 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    |
| Input diode current                | I <sub>IK</sub>                   | -50                  | mA   |
| Output diode current               | I <sub>OK</sub>                   | -50 (Note 3)         | mA   |
| DC output current                  | I <sub>OUT</sub>                  | 50                   | mA   |
| Power dissipation                  | P <sub>D</sub>                    | 180                  | mW   |
| DC V <sub>CC</sub> /ground current | I <sub>CC</sub> /I <sub>GND</sub> | ±100                 | mA   |
| 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: Output in OFF state. I<sub>OUT</sub> absolute maximum rating must be observed (Output in low state)

Note 3: V<sub>OUT</sub> < GND

### Operating Ranges (Note 1)

| Characteristics          | Symbol           | Rating              | Unit |
|--------------------------|------------------|---------------------|------|
| Power supply voltage     | VCC              | 1.65 to 5.5         | V    |
|                          |                  | 1.5 to 5.5 (Note 2) |      |
| Input voltage            | V <sub>IN</sub>  | 0 to 5.5            | V    |
| Output voltage           | V <sub>OUT</sub> | 0 to 5.5            | V    |
| Output current           | I <sub>OL</sub>  | 32 (Note 3)         | mA   |
|                          |                  | 24 (Note 4)         |      |
|                          |                  | 12 (Note 5)         |      |
| Operating temperature    | T <sub>opr</sub> | -40 to 85           | °C   |
| Input rise and fall time | dt/dv            | 0 to 10 (Note 6)    | ns/V |

Note 1: The operating ranges must be maintained to ensure the normal operation of the device.  
Unused inputs must be tied to either VCC or GND.

Note 2: Data retention only

Note 3: VCC = 4.5 to 5.5 V

Note 4: VCC = 3.0 to 3.6 V

Note 5: VCC = 2.7 to 3.0 V

Note 6: VCC = 1.65 to 5.5 V

### Electrical Characteristics

#### DC Characteristics (Ta = -40 to 85°C)

| Characteristics           |         | Symbol | Test Condition                  |              | VCC (V)     | Min       | Max       | Unit |
|---------------------------|---------|--------|---------------------------------|--------------|-------------|-----------|-----------|------|
|                           |         |        |                                 |              |             |           |           |      |
| Input voltage             | H-level | VIH    | —                               |              | 1.65 to 2.3 | VCC × 0.9 | —         | V    |
|                           |         |        |                                 |              | 2.3 to 2.7  | 1.7       | —         |      |
|                           |         |        |                                 |              | 2.7 to 3.6  | 2.0       | —         |      |
|                           |         |        |                                 |              | 4.5 to 5.5  | VCC × 0.7 | —         |      |
|                           | L-level | VIL    | —                               |              | 1.65 to 2.3 | —         | VCC × 0.1 |      |
|                           |         |        |                                 |              | 2.3 to 2.7  | —         | 0.7       |      |
|                           |         |        |                                 |              | 2.7 to 3.6  | —         | 0.8       |      |
|                           |         |        |                                 |              | 4.5 to 5.5  | —         | VCC × 0.3 |      |
| Output voltage            | L-level | VOL    | VIN = VIL                       | IOL = 100 μA | 1.65 to 5.5 | —         | 0.2       | V    |
|                           |         |        |                                 | IOL = 4 mA   | 1.65        | —         | 0.45      |      |
|                           |         |        |                                 | IOL = 8 mA   | 2.3         | —         | 0.7       |      |
|                           |         |        |                                 | IOL = 12 mA  | 2.7         | —         | 0.4       |      |
|                           |         |        |                                 | IOL = 16 mA  | 3.0         | —         | 0.4       |      |
|                           |         |        |                                 | IOL = 24 mA  | 3.0         | —         | 0.55      |      |
|                           |         |        |                                 | IOL = 32 mA  | 4.5         | —         | 0.55      |      |
| Input leakage current     |         | IIN    | VIN = 0 to 5.5 V                |              | 1.65 to 5.5 | —         | ±5.0      | μA   |
| Output OFF state current  |         | IOZ    | VIN = VIH, VOUT = 0 to 5.5 V    |              | 1.65 to 5.5 | —         | ±5.0      | μA   |
| Power-off leakage current |         | IOFF   | VIN/VOUT = 5.5 V                |              | 0           | —         | 10.0      | μA   |
| Quiescent supply current  |         | ICC    | VIN = VCC or GND                |              | 1.65 to 5.5 | —         | 10.0      | μA   |
| Increase in ICC per input |         | ΔICC   | VIH = VCC - 0.6 V (per 1 input) |              | 2.7 to 3.6  | —         | 500       |      |
|                           |         |        |                                 |              | 4.5 to 5.5  | —         | 1         | mA   |

### AC Characteristics (Ta = -40 to 85°C)

| Characteristics       | Symbol | Test Condition     | VCC (V)    | Min | Max  | Unit |
|-----------------------|--------|--------------------|------------|-----|------|------|
|                       |        |                    |            |     |      |      |
| Output enable time    | tpZL   | Figure 1, Figure 2 | 1.8 ± 0.15 | 1.5 | 22.0 | ns   |
|                       |        |                    | 2.5 ± 0.2  | 1.2 | 11.0 |      |
|                       |        |                    | 2.7        | 1.0 | 4.4  |      |
|                       |        |                    | 3.3 ± 0.3  | 0.8 | 3.7  |      |
|                       |        |                    | 5.0 ± 0.5  | 0.5 | 3.0  |      |
| Output disable time   | tpLZ   | Figure 1, Figure 2 | 1.8 ± 0.15 | 1.5 | 22.0 | ns   |
|                       |        |                    | 2.5 ± 0.2  | 1.2 | 11.0 |      |
|                       |        |                    | 2.7        | 1.0 | 4.4  |      |
|                       |        |                    | 3.3 ± 0.3  | 0.8 | 3.7  |      |
|                       |        |                    | 5.0 ± 0.5  | 0.5 | 3.0  |      |
| Output to output skew | tosZL  | (Note)             | 2.7        | —   | —    | ns   |
|                       |        |                    | 3.3 ± 0.3  | —   | 1.0  |      |

Note: Parameter guaranteed by design.  
(tosZL = |tpZLm - tpZLn|)

### Dynamic Switching Characteristics (Ta = 25°C, input: tr = tf = 2.5 ns, CL = 50 pF, RL = 500 Ω)

| Characteristics                  | Symbol | Test Condition                                 | VCC (V) | Typ. | Unit |
|----------------------------------|--------|--|---------|------|------|
|                                  |        |  |         |      |      |
| Quiet output maximum dynamic VOL | VOLP   | V <sub>IH</sub> = 3.3 V, V <sub>IL</sub> = 0 V | 3.3     | 0.8  | V    |
| Quiet output minimum dynamic VOL | VOLV   | V <sub>IH</sub> = 3.3 V, V <sub>IL</sub> = 0 V | 3.3     | 0.8  | V    |

### Capacitive Characteristics (Ta = 25°C)

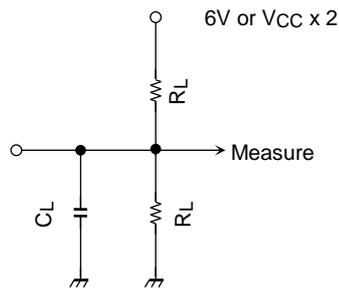
| Characteristics               | Symbol           | Test Condition           | VCC (V) | Typ. | Unit |    |
|-------------------------------|------------------|--------------------------|---------|------|------|----|
|                               |                  |                          |         |      |      |    |
| Input capacitance             | C <sub>IN</sub>  | —                        | 3.3     | 7    | pF   |    |
| Output capacitance            | C <sub>OUT</sub> |                          | 3.3     | 8    | pF   |    |
| Power dissipation capacitance | CPD              | f <sub>IN</sub> = 10 MHz | (Note)  | 3.3  | 5    | 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:

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

### AC Test Circuit



| Parameter             | Switch  |
|-----------------------|---|
| $t_{pLZ}$ , $t_{pZL}$ | 6.0 V @ $V_{CC} = 3.3 \pm 0.3$ V<br>@ $V_{CC} = 2.7$ V  |
|                       | $V_{CC} \times 2$ @ $V_{CC} = 5.0 \pm 0.5$ V<br>@ $V_{CC} = 2.5 \pm 0.2$ V<br>@ $V_{CC} = 1.8 \pm 0.15$ V |

Figure 1

### AC Waveform

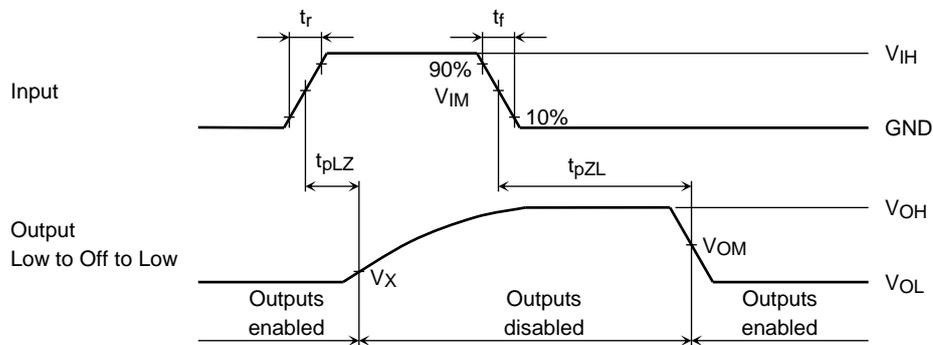


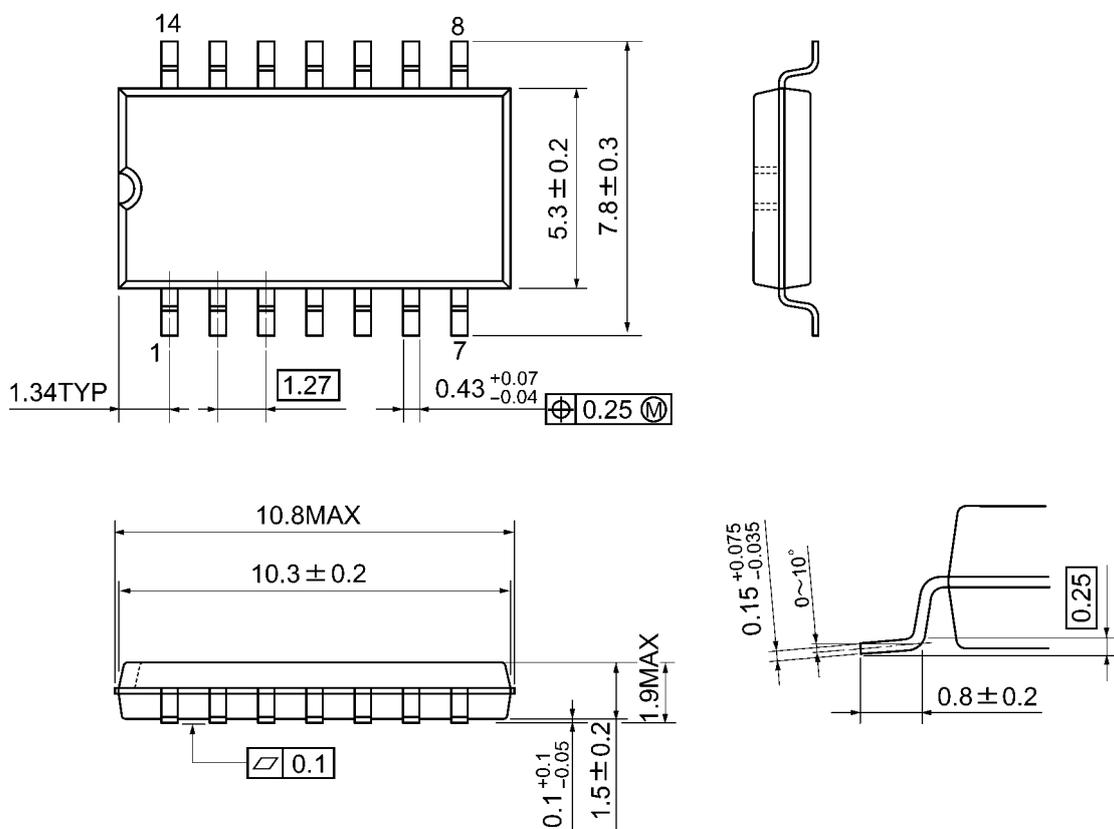
Figure 2  $t_{pLZ}$ ,  $t_{pZL}$

|        | Symbol     | $V_{CC}$         |                          |                   |                   |
|--------|------------|------------------|--------------------------|-------------------|-------------------|
|        |            | $5.0 \pm 0.5$ V  | $3.3 \pm 0.3$ V<br>2.7 V | $2.5 \pm 0.2$ V   | $1.8 \pm 0.15$ V  |
| Input  | $V_{IH}$   | $V_{CC}$         | 2.7 V                    | $V_{CC}$          | $V_{CC}$          |
|        | $V_{IM}$   | $V_{CC}/2$       | 1.5 V                    | $V_{CC}/2$        | $V_{CC}/2$        |
|        | $t_r, t_f$ | 2.5 ns           | 2.5 ns                   | 2.0 ns            | 2.0 ns            |
| Output | $V_{OM}$   | $V_{CC}/2$       | 1.5 V                    | $V_{OH}/2$        | $V_{OH}/2$        |
|        | $V_X$      | $V_{OL} + 0.3$ V | $V_{OL} + 0.3$ V         | $V_{OL} + 0.15$ V | $V_{OL} + 0.15$ V |
| Load   | $C_L$      | 50 pF            | 50 pF                    | 30 pF             | 30 pF             |
|        | $R_L$      | 500 $\Omega$     | 500 $\Omega$             | 500 $\Omega$      | 1 k $\Omega$      |

### Package Dimensions

SOP14-P-300-1.27A

Unit: mm

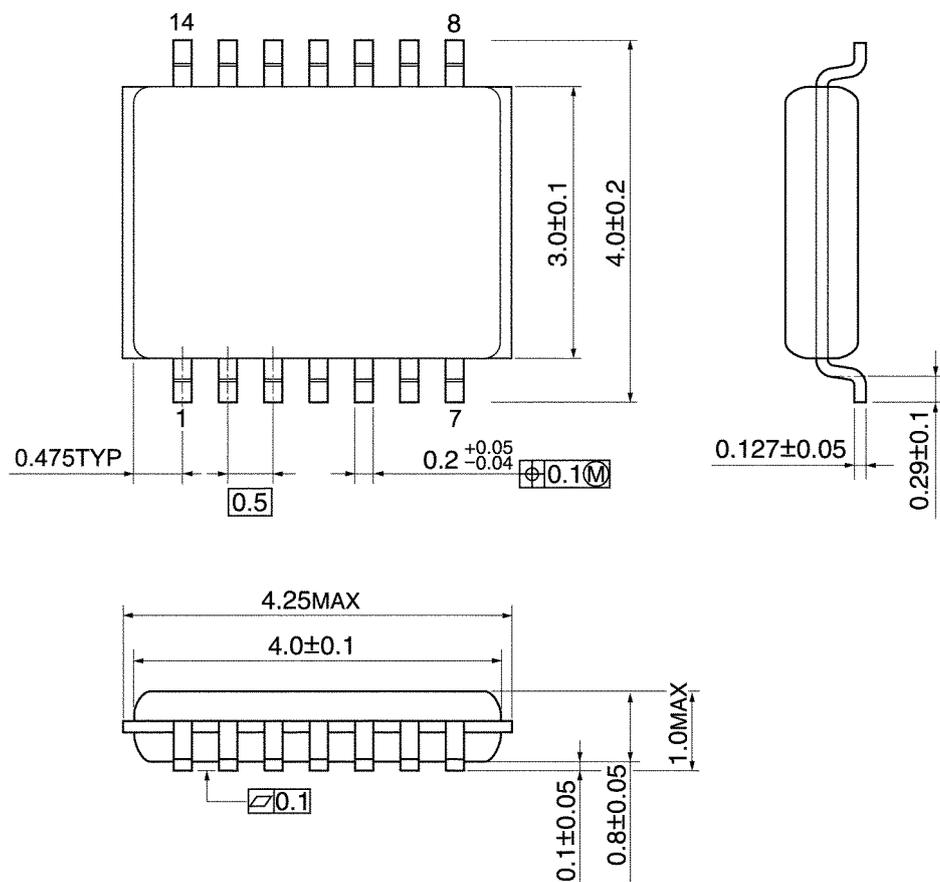


Weight: 0.18 g (typ.)

### Package Dimensions

VSSOP14-P-0030-0.50

Unit: mm



Weight: 0.02 g (typ.)

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