

# 74LCX02FT

## 1. Functional Description

- Low-Voltage Quad 2-Input NOR Gate with 5-V Tolerant Inputs and Outputs

## 2. General

The 74LCX02FT is a high-performance CMOS 2-input NOR gate. Designed for use in 3.3 V systems, it achieves high-speed operation while maintaining the CMOS low power dissipation.

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.

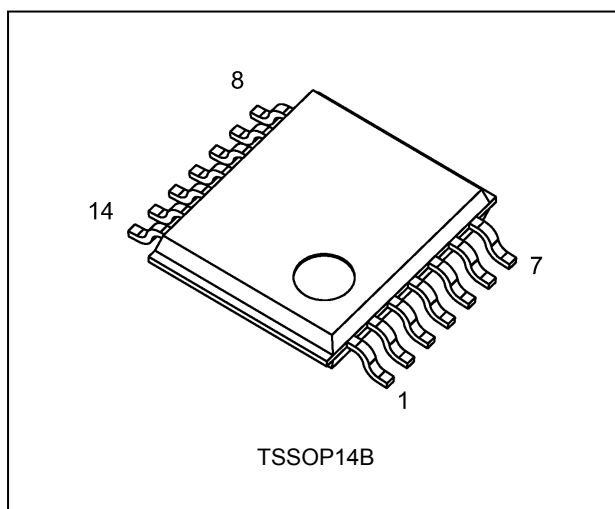
All inputs are equipped with protection circuits against static discharge.

## 3. Features

- (1) AEC-Q100 (Rev. H) (Note 1)
- (2) Wide operating temperature range:  $T_{opr} = -40$  to  $125\text{ }^{\circ}\text{C}$
- (3) Low-voltage operation:  $V_{CC} = 1.65$  to  $3.6\text{ V}$
- (4) High-speed operation:  $t_{pd} = 6.0\text{ ns (max)}$  ( $V_{CC} = 3.3 \pm 0.3\text{ V}$ )
- (5) Output current:  $|I_{OH}|/I_{OL} = 24\text{ mA (min)}$  ( $V_{CC} = 3.0\text{ V}$ )
- (6) Power-down protection provided on all inputs and outputs
- (7) Pin and function compatible with the 74 series  
(74LVC/ALVC etc.) 02 type

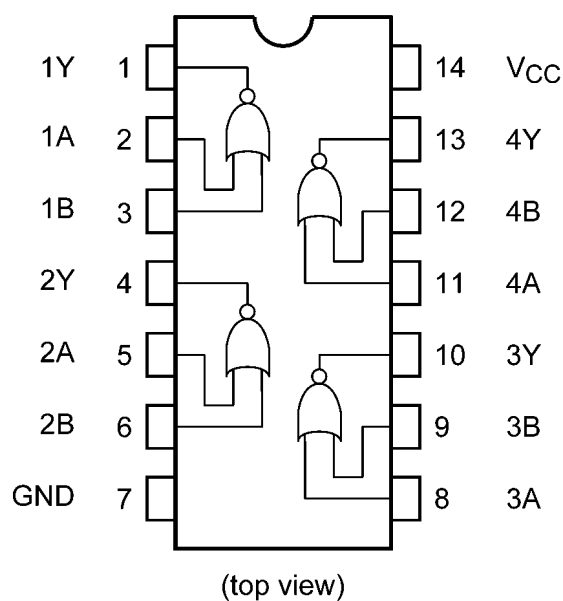
Note 1: This device is compliant with the reliability requirements of AEC-Q100. For details, contact your Toshiba sales representative.

## 4. Packaging

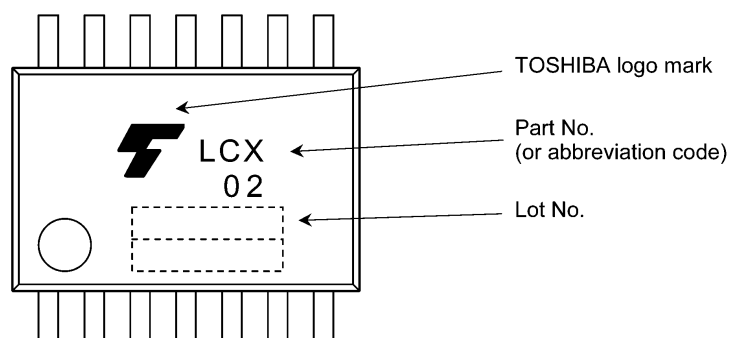


Start of commercial production  
2015-01

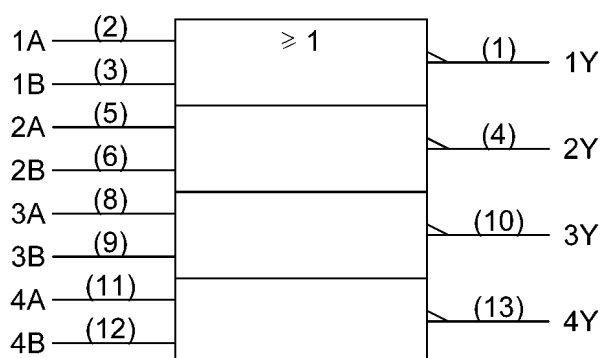
## 5. Pin Assignment



## 6. Marking



## 7. IEC Logic Symbol



## 8. Truth Table

| Inputs<br>A | Inputs<br>B | Outputs<br>Y |
|-------------|-------------|--------------|
| L           | L           | H            |
| L           | H           | L            |
| H           | L           | L            |
| H           | H           | L            |

## 9. Absolute Maximum Ratings (Note)

| Characteristics          | Symbol           | Note     | Rating                 | Unit |
|--------------------------|------------------|----------|------------------------|------|
| Supply voltage           | $V_{CC}$         |          | -0.5 to 6.5            | V    |
| Input voltage            | $V_{IN}$         |          | -0.5 to 6.5            | V    |
| Output voltage           | $V_{OUT}$        | (Note 1) | -0.5 to 6.5            | V    |
|                          |                  | (Note 2) | -0.5 to $V_{CC} + 0.5$ |      |
| Input diode current      | $I_{IK}$         |          | -50                    | mA   |
| Output diode current     | $I_{OK}$         | (Note 3) | $\pm 50$               | mA   |
| Output current           | $I_{OUT}$        |          | $\pm 50$               | mA   |
| Power dissipation        | $P_D$            | (Note 4) | 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:  $V_{CC} = 0$  V

Note 2: High or low state.  $I_{OUT}$  absolute maximum rating must be observed.

Note 3:  $V_{OUT} < GND$ ,  $V_{OUT} > V_{CC}$

Note 4: 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            | $V_{CC}$         |          | 1.65 to 3.6   | V    |
|                           |                  | (Note 1) | 1.5 to 3.6    |      |
| Input voltage             | $V_{IN}$         |          | 0 to 5.5      | V    |
| Output voltage            | $V_{OUT}$        | (Note 2) | 0 to 5.5      | V    |
|                           |                  | (Note 3) | 0 to $V_{CC}$ |      |
| Output current            | $I_{OH}, I_{OL}$ | (Note 4) | $\pm 24$      | mA   |
|                           |                  | (Note 5) | $\pm 12$      |      |
| Operating temperature     | $T_{opr}$        |          | -40 to 125    | °C   |
| Input rise and fall times | $dt/dv$          | (Note 6) | 0 to 10       | ns/V |

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: Data retention only

Note 2:  $V_{CC} = 0$  V

Note 3: High or low state ( However, it can not exceed  $I_{OUT}$  of absolute maximum ratings. )

Note 4:  $V_{CC} = 3.0$  to  $3.6$  V

Note 5:  $V_{CC} = 2.7$  to  $3.0$  V

Note 6:  $V_{IN} = 0.8$  to  $2.0$  V,  $V_{CC} = 3.0$  V

## 11. Electrical Characteristics

11.1. DC Characteristics (Unless otherwise specified,  $T_a = -40$  to  $85$  °C)

| Characteristics           | Symbol          | Test Condition                             |                       | $V_{CC}$ (V) | Min                 | Max                 | Unit    |
|---------------------------|-----------------|--------------------------------------------|-----------------------|--------------|---------------------|---------------------|---------|
| High-level input voltage  | $V_{IH}$        | —                                          |                       | 1.65 to 2.3  | $V_{CC} \times 0.8$ | —                   | V       |
|                           |                 |                                            |                       | 2.3 to 2.7   | 1.7                 | —                   |         |
|                           |                 |                                            |                       | 2.7 to 3.6   | 2.0                 | —                   |         |
| Low-level input voltage   | $V_{IL}$        | —                                          |                       | 1.65 to 2.3  | —                   | $V_{CC} \times 0.2$ | V       |
|                           |                 |                                            |                       | 2.3 to 2.7   | —                   | 0.7                 |         |
|                           |                 |                                            |                       | 2.7 to 3.6   | —                   | 0.8                 |         |
| High-level output voltage | $V_{OH}$        | $V_{IN} = V_{IL}$                          | $I_{OH} = -100 \mu A$ | 1.65 to 3.6  | $V_{CC} - 0.2$      | —                   | V       |
|                           |                 |                                            | $I_{OH} = -4$ mA      | 1.65         | 1.05                | —                   |         |
|                           |                 |                                            | $I_{OH} = -8$ mA      | 2.3          | 1.7                 | —                   |         |
|                           |                 |                                            | $I_{OH} = -12$ mA     | 2.7          | 2.2                 | —                   |         |
|                           |                 |                                            | $I_{OH} = -18$ mA     | 3.0          | 2.4                 | —                   |         |
|                           |                 |                                            | $I_{OH} = -24$ mA     | 3.0          | 2.2                 | —                   |         |
| Low-level output voltage  | $V_{OL}$        | $V_{IN} = V_{IH}$ or $V_{IL}$              | $I_{OL} = 100 \mu A$  | 1.65 to 3.6  | —                   | 0.2                 | V       |
|                           |                 |                                            | $I_{OL} = 4$ mA       | 1.65         | —                   | 0.45                |         |
|                           |                 |                                            | $I_{OL} = 8$ mA       | 2.3          | —                   | 0.7                 |         |
|                           |                 |                                            | $I_{OL} = 12$ mA      | 2.7          | —                   | 0.4                 |         |
|                           |                 |                                            | $I_{OL} = 16$ mA      | 3.0          | —                   | 0.4                 |         |
|                           |                 |                                            | $I_{OL} = 24$ mA      | 3.0          | —                   | 0.55                |         |
| Input leakage current     | $I_{IN}$        | $V_{IN} = 0$ to $5.5$ V                    |                       | 1.65 to 3.6  | —                   | $\pm 5.0$           | $\mu A$ |
| Power-OFF leakage current | $I_{OFF}$       | $V_{IN}/V_{OUT} = 5.5$ V                   |                       | 0            | —                   | 10.0                | $\mu A$ |
| Quiescent supply current  | $I_{CC}$        | $V_{IN} = V_{CC}$ or GND                   |                       | 1.65 to 3.6  | —                   | 10.0                | $\mu A$ |
|                           |                 | $V_{IN} = 3.6$ to $5.5$ V                  |                       | 1.65 to 3.6  | —                   | $\pm 10.0$          |         |
| Quiescent supply current  | $\Delta I_{CC}$ | $V_{IH} = V_{CC} - 0.6$ V<br>(per 1 input) |                       | 2.7 to 3.6   | —                   | 500                 | $\mu A$ |

11.2. DC Characteristics (Unless otherwise specified,  $T_a = -40$  to  $125\text{ }^{\circ}\text{C}$ )

| Characteristics           | Symbol          | Test Condition                                    | $V_{CC}$ (V)                       | Min                 | Max                 | Unit          |
|---------------------------|-----------------|---------------------------------------------------|------------------------------------|---------------------|---------------------|---------------|
| High-level input voltage  | $V_{IH}$        | —                                                 | 1.65 to 2.3                        | $V_{CC} \times 0.8$ | —                   | V             |
|                           |                 |                                                   | 2.3 to 2.7                         | 1.7                 | —                   |               |
|                           |                 |                                                   | 2.7 to 3.6                         | 2.0                 | —                   |               |
| Low-level input voltage   | $V_{IL}$        | —                                                 | 1.65 to 2.3                        | —                   | $V_{CC} \times 0.2$ | V             |
|                           |                 |                                                   | 2.3 to 2.7                         | —                   | 0.7                 |               |
|                           |                 |                                                   | 2.7 to 3.6                         | —                   | 0.8                 |               |
| High-level output voltage | $V_{OH}$        | $V_{IN} = V_{IL}$                                 | $I_{OH} = -100\text{ }\mu\text{A}$ | 1.65 to 3.6         | $V_{CC} - 0.2$      | V             |
|                           |                 |                                                   | $I_{OH} = -4\text{ mA}$            | 1.65                | 0.9                 |               |
|                           |                 |                                                   | $I_{OH} = -8\text{ mA}$            | 2.3                 | 1.55                |               |
|                           |                 |                                                   | $I_{OH} = -12\text{ mA}$           | 2.7                 | 2.0                 |               |
|                           |                 |                                                   | $I_{OH} = -18\text{ mA}$           | 3.0                 | 2.2                 |               |
|                           |                 |                                                   | $I_{OH} = -24\text{ mA}$           | 3.0                 | 2.0                 |               |
| Low-level output voltage  | $V_{OL}$        | $V_{IN} = V_{IH}$ or $V_{IL}$                     | $I_{OL} = 100\text{ }\mu\text{A}$  | 1.65 to 3.6         | —                   | V             |
|                           |                 |                                                   | $I_{OL} = 4\text{ mA}$             | 1.65                | —                   |               |
|                           |                 |                                                   | $I_{OL} = 8\text{ mA}$             | 2.3                 | —                   |               |
|                           |                 |                                                   | $I_{OL} = 12\text{ mA}$            | 2.7                 | —                   |               |
|                           |                 |                                                   | $I_{OL} = 16\text{ mA}$            | 3.0                 | —                   |               |
|                           |                 |                                                   | $I_{OL} = 24\text{ mA}$            | 3.0                 | —                   |               |
| Input leakage current     | $I_{IN}$        | $V_{IN} = 0$ to $5.5\text{ V}$                    | 1.65 to 3.6                        | —                   | $\pm 20.0$          | $\mu\text{A}$ |
| Power-OFF leakage current | $I_{OFF}$       | $V_{IN}/V_{OUT} = 5.5\text{ V}$                   | 0                                  | —                   | 40.0                | $\mu\text{A}$ |
| Quiescent supply current  | $I_{CC}$        | $V_{IN} = V_{CC}$ or GND                          | 1.65 to 3.6                        | —                   | 40.0                | $\mu\text{A}$ |
|                           |                 | $V_{IN} = 3.6$ to $5.5\text{ V}$                  | 1.65 to 3.6                        | —                   | $\pm 40.0$          |               |
| Quiescent supply current  | $\Delta I_{CC}$ | $V_{IH} = V_{CC} - 0.6\text{ V}$<br>(per 1 input) | 2.7 to 3.6                         | —                   | 5.0                 | mA            |

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

| Characteristics        | Symbol               | Note     | Test Condition                                      | $V_{CC}$ (V)   | Min | Max  | Unit |
|------------------------|----------------------|----------|-----------------------------------------------------|----------------|-----|------|------|
| Propagation delay time | $t_{PLH}, t_{PHL}$   |          | See 11.7 AC Test Circuit, Fig. 11.8.1, Table 11.8.1 | $1.8 \pm 0.15$ | —   | 20.0 | ns   |
|                        |                      |          |                                                     | $2.5 \pm 0.2$  | —   | 7.0  |      |
|                        |                      |          |                                                     | 2.7            | —   | 6.0  |      |
|                        |                      |          |                                                     | $3.3 \pm 0.3$  | 1.5 | 5.2  |      |
| Output skew            | $t_{osLH}, t_{osHL}$ | (Note 1) | —                                                   | 2.7            | —   | —    | ns   |
|                        |                      |          |                                                     | $3.3 \pm 0.3$  | —   | 1.0  |      |

Note 1: Parameter guaranteed by design. ( $t_{osLH} = |t_{PLHM} - t_{PLHN}|$ ,  $t_{osHL} = |t_{PHLM} - t_{PHLN}|$ )

11.4. AC Characteristics (Unless otherwise specified,  $T_a = -40$  to  $125\text{ }^{\circ}\text{C}$ )

| Characteristics        | Symbol               | Note     | Test Condition                                      | $V_{CC}$ (V)   | Min | Max  | Unit |
|------------------------|----------------------|----------|-----------------------------------------------------|----------------|-----|------|------|
| Propagation delay time | $t_{PLH}, t_{PHL}$   |          | See 11.7 AC Test Circuit, Fig. 11.8.1, Table 11.8.1 | $1.8 \pm 0.15$ | —   | 22.0 | ns   |
|                        |                      |          |                                                     | $2.5 \pm 0.2$  | —   | 8.0  |      |
|                        |                      |          |                                                     | 2.7            | —   | 7.0  |      |
|                        |                      |          |                                                     | $3.3 \pm 0.3$  | 1.5 | 6.0  |      |
| Output skew            | $t_{osLH}, t_{osHL}$ | (Note 1) | —                                                   | 2.7            | —   | —    | ns   |
|                        |                      |          |                                                     | $3.3 \pm 0.3$  | —   | 1.0  |      |

Note 1: Parameter guaranteed by design. ( $t_{osLH} = |t_{PLHM} - t_{PLHN}|$ ,  $t_{osHL} = |t_{PHLM} - t_{PHLN}|$ )

# 11.5. Dynamic Switching Characteristics

(Unless otherwise specified,  $T_a = 25\text{ }^{\circ}\text{C}$ , Input:  $t_r = t_f = 2.5\text{ ns}$ ,  $C_L = 50\text{ pF}$ ,  $R_L = 500\text{ }\Omega$ )

| Characteristics                       | Symbol      | Test Condition                                  | $V_{CC}$ (V) | Typ. | Unit |
|---------------------------------------|-------------|-------------------------------------------------|--------------|------|------|
| Quiet output maximum dynamic $V_{OL}$ | $V_{OLP}$   | $V_{IH} = 3.3\text{ V}$ , $V_{IL} = 0\text{ V}$ | 3.3          | 0.8  | V    |
| Quiet output minimum dynamic $V_{OL}$ | $ V_{OLV} $ | $V_{IH} = 3.3\text{ V}$ , $V_{IL} = 0\text{ V}$ | 3.3          | 0.8  | V    |

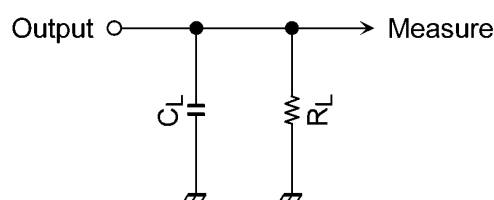
# 11.6. Capacitive Characteristics(Unless otherwise specified, $T_a = 25\text{ }^{\circ}\text{C}$ )

| Characteristics               | Symbol    | Note     | Test Condition           | $V_{CC}$ (V) | Typ. | Unit |
|-------------------------------|-----------|----------|--------------------------|--------------|------|------|
| Input capacitance             | $C_{IN}$  |          | —                        | 3.3          | 7    | pF   |
| Output capacitance            | $C_{OUT}$ |          | —                        | 0            | 8    | pF   |
| Power dissipation capacitance | $C_{PD}$  | (Note 1) | $f_{IN} = 10\text{ MHz}$ | 3.3          | 25   | 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.

$$I_{CC(opr)} = C_{PD} \times V_{CC} \times f_{IN} + I_{CC}/4 \text{ (per 1 gate)}$$

# 11.7. AC Test Circuit



# 11.8. AC Waveform

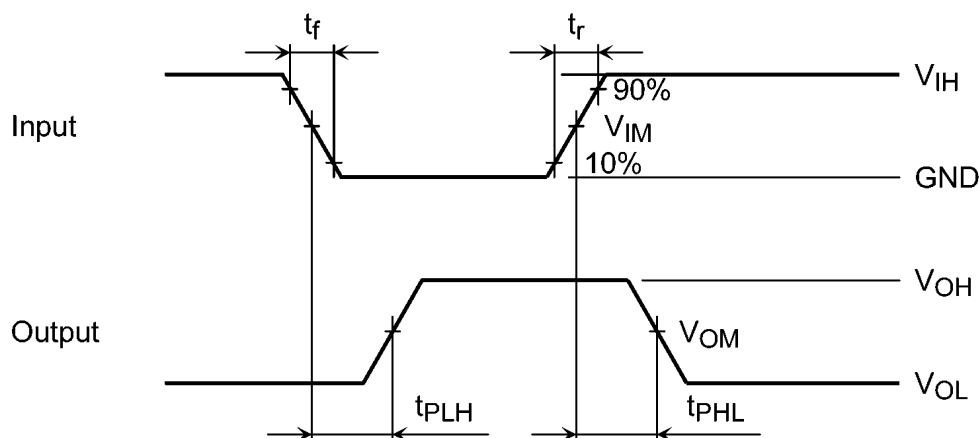


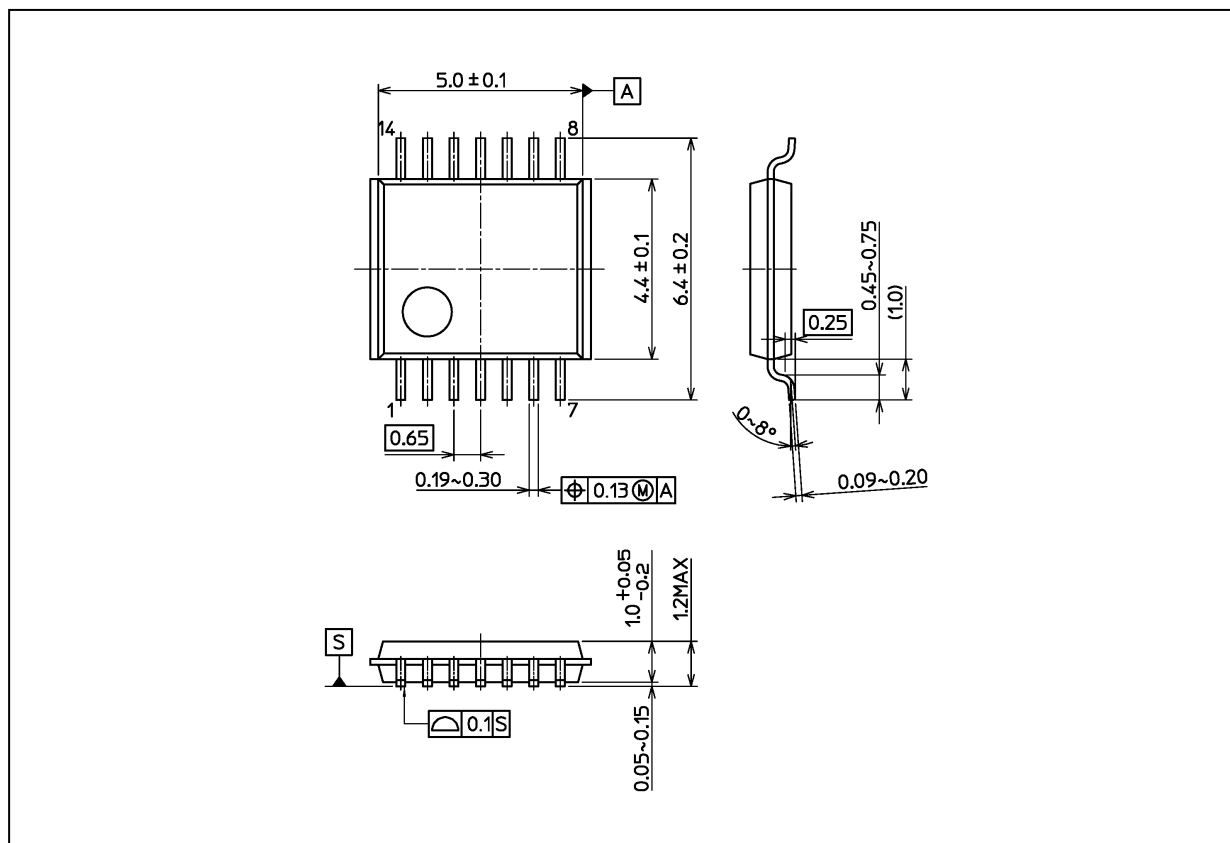
Fig. 11.8.1  $t_{PLH}, t_{PHL}$

Table 11.8.1 AC Waveform Symbols

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

## Package Dimensions

Unit: mm



Weight: 0.054 g (typ.)

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

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