

CMOS Digital Integrated Circuits Silicon Monolithic

TC74VCX157FK

1. Functional Description

- Low-Voltage Quad 2-Channel Multiplexer with 3.6-V Tolerant Inputs and Outputs

2. General

The TC74VCX157FK is a high performance CMOS multiplexer which is guaranteed to operate from 1.2 V to 3.6 V. Designed for use in 1.5 V, 1.8 V, 2.5 V or 3.3 V systems, it achieves high. speed operation while maintaining the CMOS low power dissipation.

It is also designed with over voltage tolerant inputs and outputs up to 3.6 V.

It consists of four 2-input digital multiplexers with common select and strobe inputs.

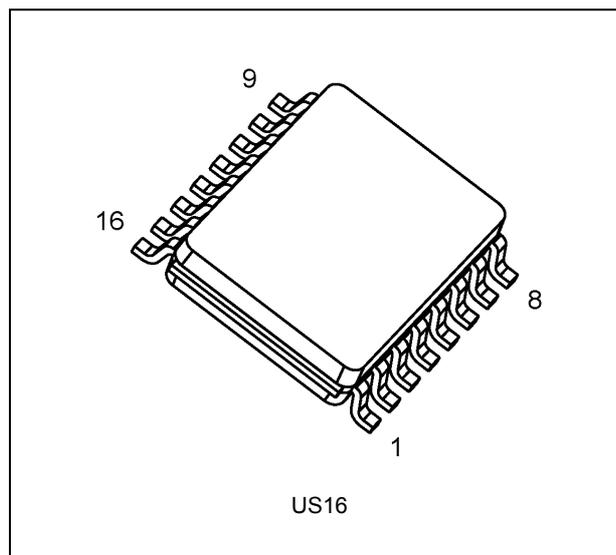
When the \overline{ST} input is held "H" level, selection of data is inhibited and all the outputs become "L" level. The SELECT decoding determines whether the A or B inputs get routed to their corresponding Y outputs.

All inputs are equipped with protection circuits against static discharge.

3. Features

- (1) Low-voltage operation: $V_{CC} = 1.2$ to 3.6 V
- (2) High-speed operation: $t_{pd} = 3.0$ ns (max) ($V_{CC} = 3.0$ to 3.6 V)
 $t_{pd} = 3.5$ ns (max) ($V_{CC} = 2.3$ to 2.7 V)
 $t_{pd} = 7.0$ ns (max) ($V_{CC} = 1.65$ to 1.95 V)
 $t_{pd} = 14.0$ ns (max) ($V_{CC} = 1.4$ to 1.6 V)
 $t_{pd} = 35.0$ ns (max) ($V_{CC} = 1.2$ V)
- (3) Output current: $I_{OH}/I_{OL} = \pm 24$ mA (min) ($V_{CC} = 3.0$ V)
 $I_{OH}/I_{OL} = \pm 18$ mA (min) ($V_{CC} = 2.3$ V)
 $I_{OH}/I_{OL} = \pm 6$ mA (min) ($V_{CC} = 1.65$ V)
 $I_{OH}/I_{OL} = \pm 2$ mA (min) ($V_{CC} = 1.4$ V)
- (4) 3.6 V tolerant function and power-down protection provided on all inputs and outputs.

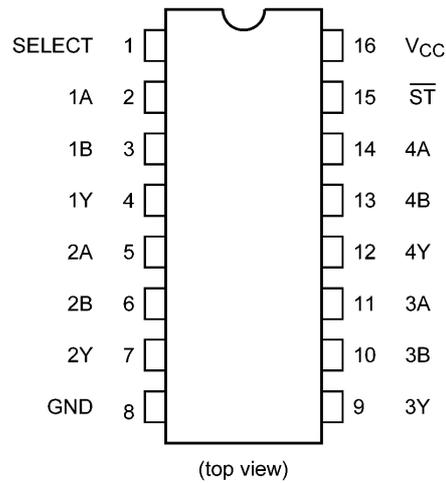
4. Packaging



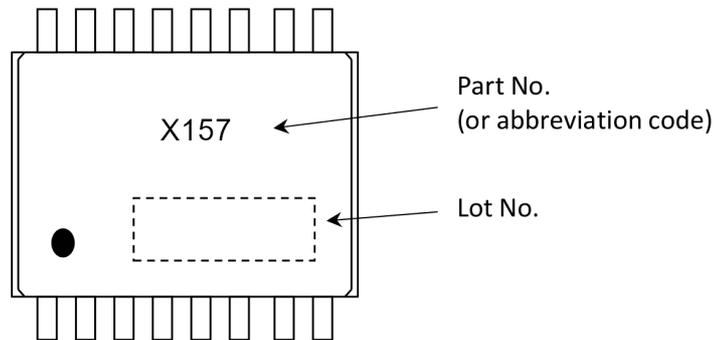
Start of commercial production

2006-04

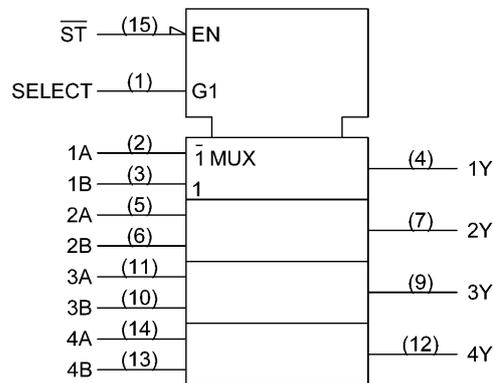
5. Pin Assignment



6. Marking



7. IEC Logic Symbol

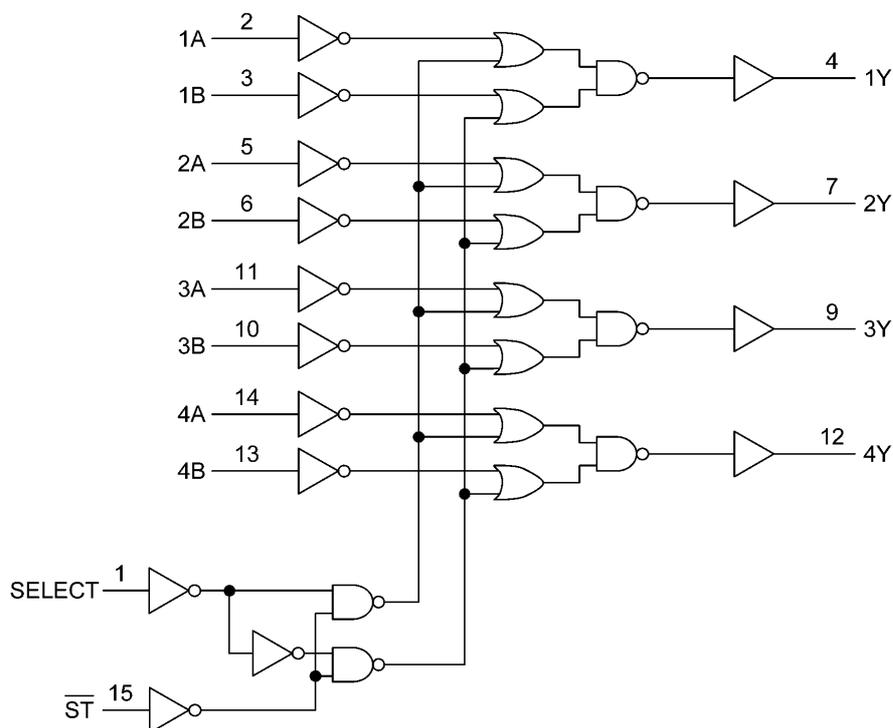


8. Truth Table

| Inputs \overline{ST} | Inputs SELECT | Inputs A | Inputs B | Outputs Y |
|---------------------------|------------------|-------------|-------------|--------------|
| H | X | X | X | L |
| L | L | L | X | L |
| L | L | H | X | H |
| L | H | X | L | L |
| L | H | X | H | H |

X: Don't care

9. System Diagram



10. Absolute Maximum Ratings (Note)

| Characteristics | Symbol | Note | Rating | Unit |
|--------------------------|------------------|----------|------------------------|-------------|
| Supply voltage | V_{CC} | | -0.5 to 4.6 | V |
| Input voltage | V_{IN} | | -0.5 to 4.6 | V |
| Output voltage | V_{OUT} | (Note 1) | -0.5 to 4.6 | V |
| | | (Note 2) | -0.5 to $V_{CC} + 0.5$ | |
| Input diode current | I_{IK} | | -50 | mA |
| Output diode current | I_{OK} | (Note 3) | ± 50 | mA |
| Output current | I_{OUT} | | ± 50 | mA |
| Power dissipation | P_D | | 180 | mW |
| V_{CC} /ground current | I_{CC}/I_{GND} | | ± 100 | mA |
| 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: $V_{CC} = 0$ V

Note 2: High (H) or Low (L) state. I_{OUT} absolute maximum rating must be observed.

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

11. Operating Ranges (Note)

| Characteristics | Symbol | Note | Rating | Unit |
|---------------------------|------------------|----------|---------------|-------------|
| Supply voltage | V_{CC} | | 1.2 to 3.6 | V |
| Input voltage | V_{IN} | | -0.3 to 3.6 | V |
| Output voltage | V_{OUT} | (Note 1) | 0 to 3.6 | V |
| | | (Note 2) | 0 to V_{CC} | |
| Output current | I_{OH}, I_{OL} | (Note 3) | ± 24 | mA |
| | | (Note 4) | ± 18 | |
| | | (Note 5) | ± 6 | |
| | | (Note 6) | ± 2 | |
| Operating temperature | T_{opr} | | -40 to 85 | $^{\circ}C$ |
| Input rise and fall times | dt/dv | (Note 7) | 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: Output in OFF state.

Note 2: High (H) or Low (L) state.

Note 3: $V_{CC} = 3.0$ to 3.6 V

Note 4: $V_{CC} = 2.3$ to 2.7 V

Note 5: $V_{CC} = 1.65$ to 1.95 V

Note 6: $V_{CC} = 1.4$ to 1.6 V

Note 7: $V_{IN} = 0.8$ to 2.0 V, $V_{CC} = 3.0$ V

12. Electrical Characteristics

12.1. 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} | — | 1.2 to 1.4 | $V_{CC} \times 0.8$ | — | V | |
| | | | 1.4 to 1.65 | $V_{CC} \times 0.65$ | — | | |
| | | | 1.65 to 2.3 | $V_{CC} \times 0.65$ | — | | |
| | | | 2.3 to 2.7 | 1.6 | — | | |
| | | | 2.7 to 3.6 | 2.0 | — | | |
| Low-level input voltage | V_{IL} | — | 1.2 to 1.4 | — | $V_{CC} \times 0.05$ | V | |
| | | | 1.4 to 1.65 | — | $V_{CC} \times 0.05$ | | |
| | | | 1.65 to 2.3 | — | $V_{CC} \times 0.2$ | | |
| | | | 2.3 to 2.7 | — | 0.7 | | |
| | | | 2.7 to 3.6 | — | 0.8 | | |
| High-level output voltage | V_{OH} | $V_{IN} = V_{IH}$ or V_{IL} | $I_{OH} = -100 \mu A$ | 1.2 | $V_{CC} - 0.1$ | — | V |
| | | | | 1.4 to 1.65 | $V_{CC} - 0.2$ | — | |
| | | | | 1.65 to 3.6 | $V_{CC} - 0.2$ | — | |
| | | | $I_{OH} = -2 \text{ mA}$ | 1.4 | 1.05 | — | |
| | | | | 1.65 | 1.25 | — | |
| | | | $I_{OH} = -6 \text{ mA}$ | 2.3 | 2.0 | — | |
| | | | | 2.7 | 2.2 | — | |
| | | | $I_{OH} = -12 \text{ mA}$ | 2.3 | 1.8 | — | |
| | | | | 2.7 | 2.2 | — | |
| | | | $I_{OH} = -18 \text{ mA}$ | 2.3 | 1.7 | — | |
| 3.0 | 2.4 | — | | | | | |
| $I_{OH} = -24 \text{ mA}$ | 2.3 | 1.7 | — | | | | |
| | 3.0 | 2.4 | — | | | | |
| Low-level output voltage | V_{OL} | $V_{IN} = V_{IH}$ or V_{IL} | $I_{OL} = 100 \mu A$ | 1.2 | — | 0.05 | V |
| | | | | 1.4 to 1.65 | — | 0.05 | |
| | | | | 1.65 to 3.6 | — | 0.2 | |
| | | | $I_{OL} = 2 \text{ mA}$ | 1.4 | — | 0.35 | |
| | | | | 1.65 | — | 0.3 | |
| | | | $I_{OL} = 6 \text{ mA}$ | 2.3 | — | 0.4 | |
| | | | | 2.7 | — | 0.4 | |
| | | | $I_{OL} = 12 \text{ mA}$ | 2.3 | — | 0.6 | |
| | | | | 3.0 | — | 0.4 | |
| | | | $I_{OL} = 18 \text{ mA}$ | 2.3 | — | 0.6 | |
| 3.0 | — | 0.4 | | | | | |
| $I_{OL} = 24 \text{ mA}$ | 2.3 | — | 0.6 | | | | |
| | 3.0 | — | 0.55 | | | | |
| Input leakage current | I_{IN} | $V_{IN} = 0$ to 3.6 V | 1.2 to 3.6 | — | ± 5.0 | μA | |
| Power-OFF leakage current | I_{OFF} | $V_{IN}/V_{OUT} = 0$ to 3.6 V | 0 | — | 10.0 | μA | |
| Quiescent supply current | I_{CC} | $V_{IN} = V_{CC}$ or GND | 1.2 to 3.6 | — | 20.0 | μA | |
| | | $V_{CC} \leq V_{IN} \leq 3.6 \text{ V}$ | 1.2 to 3.6 | — | ± 20.0 | | |
| | ΔI_{CC} | $V_{IH} = V_{CC} - 0.6 \text{ V}$ (per input) | 2.7 to 3.6 | — | 750 | μA | |

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

| Characteristics | Symbol | Note | Test Condition | V_{CC} (V) | Min | Max | Unit |
|---|----------------------|----------|---|----------------|-----|------|------|
| Propagation delay time (A,B - Y) | t_{PLH}, t_{PHL} | | See 12.5 AC Test Circuit, Fig. 12.6.1, Table 12.6.1 | 1.2 | 3.0 | 35.0 | ns |
| | | | | 1.5 ± 0.1 | 2.0 | 14.0 | |
| | | | | 1.8 ± 0.15 | 1.5 | 7.0 | |
| | | | | 2.5 ± 0.2 | 0.8 | 3.5 | |
| | | | | 3.3 ± 0.3 | 0.6 | 3.0 | |
| Propagation delay time (SELECT - Y) | t_{PLH}, t_{PHL} | | See 12.5 AC Test Circuit, Fig. 12.6.1, Table 12.6.1 | 1.2 | 3.0 | 45.0 | ns |
| | | | | 1.5 ± 0.1 | 2.0 | 18.0 | |
| | | | | 1.8 ± 0.15 | 1.5 | 9.0 | |
| | | | | 2.5 ± 0.2 | 0.8 | 4.5 | |
| | | | | 3.3 ± 0.3 | 0.6 | 3.5 | |
| Propagation delay time (\overline{ST} - Y) | t_{PLH}, t_{PHL} | | See 12.5 AC Test Circuit, Fig. 12.6.1, Table 12.6.1 | 1.2 | 3.0 | 45.0 | ns |
| | | | | 1.5 ± 0.1 | 2.0 | 18.0 | |
| | | | | 1.8 ± 0.15 | 1.5 | 9.0 | |
| | | | | 2.5 ± 0.2 | 0.8 | 4.5 | |
| | | | | 3.3 ± 0.3 | 0.6 | 3.5 | |
| Output skew | t_{osLH}, t_{osHL} | (Note 1) | — | 1.2 | — | 1.5 | ns |
| | | | | 1.5 ± 0.1 | — | 1.5 | |
| | | | | 1.8 ± 0.15 | — | 0.5 | |
| | | | | 2.5 ± 0.2 | — | 0.5 | |
| | | | | 3.3 ± 0.3 | — | 0.5 | |

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

12.3. Dynamic Switching Characteristics (Note)

(Unless otherwise specified, $T_a = 25$ °C, Input: $t_r = t_f = 2.0$ ns, $C_L = 30$ pF)

| Characteristics | Symbol | Test Condition | V_{CC} (V) | Typ. | Unit |
|---------------------------------------|-----------|----------------------------------|--------------|-------|------|
| Quiet output maximum dynamic V_{OL} | V_{OLP} | $V_{IH} = 1.8$ V, $V_{IL} = 0$ V | 1.8 | 0.25 | V |
| | | $V_{IH} = 2.5$ V, $V_{IL} = 0$ V | 2.5 | 0.6 | |
| | | $V_{IH} = 3.3$ V, $V_{IL} = 0$ V | 3.3 | 0.8 | |
| Quiet output minimum dynamic V_{OL} | V_{OLV} | $V_{IH} = 1.8$ V, $V_{IL} = 0$ V | 1.8 | -0.25 | V |
| | | $V_{IH} = 2.5$ V, $V_{IL} = 0$ V | 2.5 | -0.6 | |
| | | $V_{IH} = 3.3$ V, $V_{IL} = 0$ V | 3.3 | -0.8 | |
| Quiet output minimum dynamic V_{OH} | V_{OHV} | $V_{IH} = 1.8$ V, $V_{IL} = 0$ V | 1.8 | 1.5 | V |
| | | $V_{IH} = 2.5$ V, $V_{IL} = 0$ V | 2.5 | 1.9 | |
| | | $V_{IH} = 3.3$ V, $V_{IL} = 0$ V | 3.3 | 2.2 | |

Note: Parameter guaranteed by design.

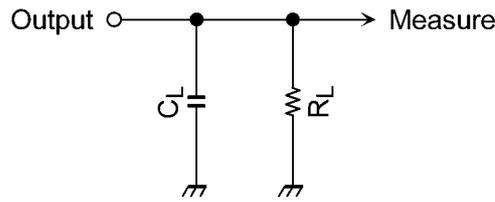
12.4. Capacitive Characteristics (Unless otherwise specified, $T_a = 25$ °C)

| Characteristics | Symbol | Note | Test Condition | V_{CC} (V) | Typ. | Unit |
|-------------------------------|----------|----------|-------------------|---------------|------|------|
| Input capacitance | C_{IN} | | — | 1.8, 2.5, 3.3 | 6 | pF |
| Power dissipation capacitance | C_{PD} | (Note 1) | $f_{IN} = 10$ MHz | 1.8, 2.5, 3.3 | 20 | 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.

$$I_{CC(opr)} = C_{PD} \times V_{CC} \times f_{IN} + I_{CC}$$

12.5. AC Test Circuit



12.6. AC Waveform

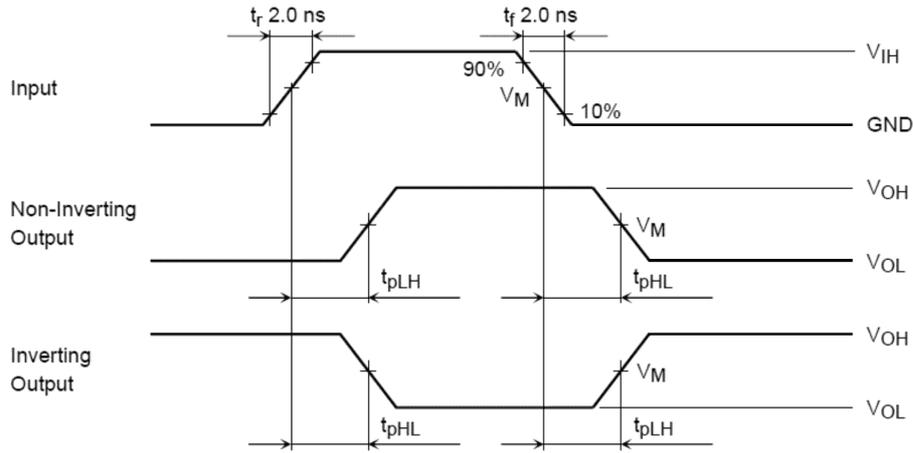


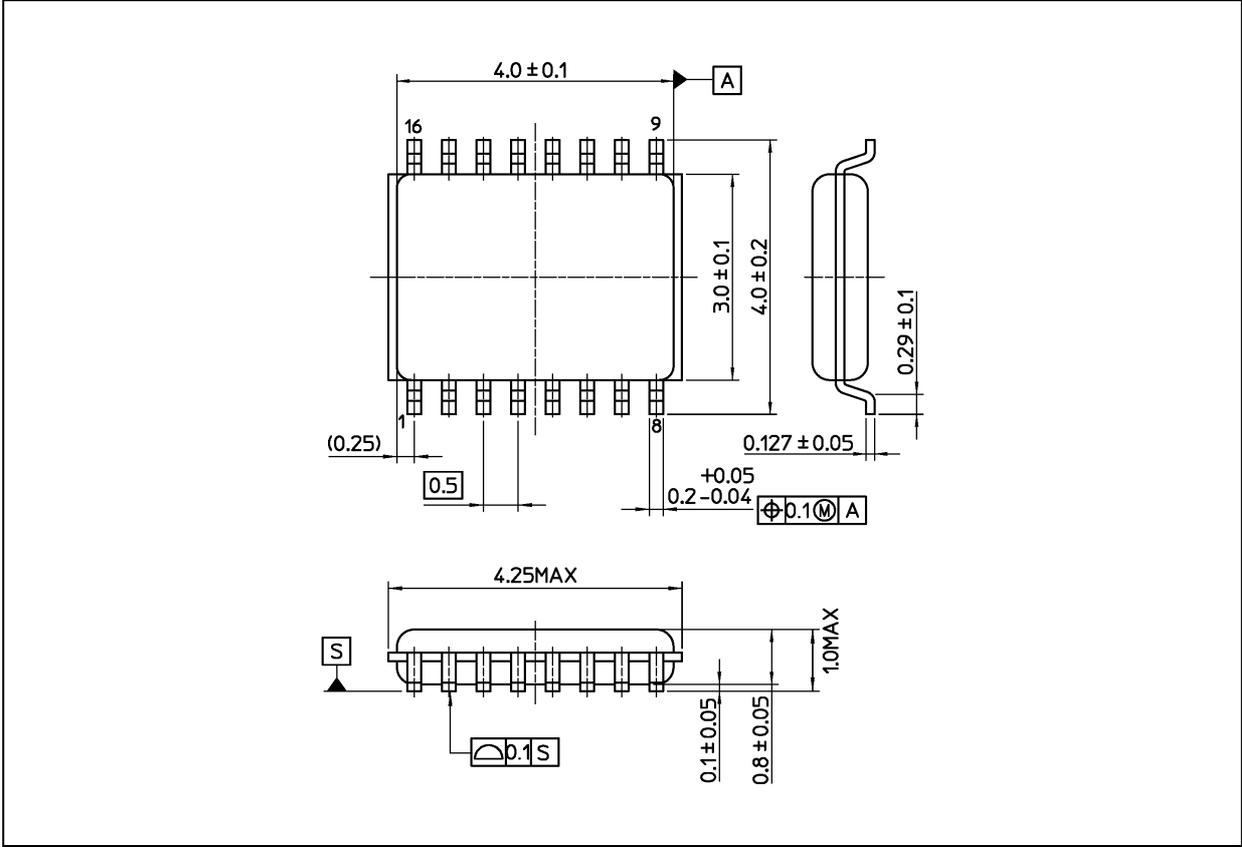
Fig. 12.6.1 t_{pLH} , t_{pHL}

Table 12.6.1 AC Waveform Symbols

| | Symbol | $V_{CC} = 3.3 \pm 0.3 \text{ V}$ | $V_{CC} = 2.5 \pm 0.2 \text{ V}$ $V_{CC} = 1.8 \pm 0.15 \text{ V}$ | $V_{CC} = 1.5 \pm 0.1 \text{ V}$ $V_{CC} = 1.2 \text{ V}$ |
|--------|------------|----------------------------------|---|--|
| Input | V_{IH} | 2.7 V | V_{CC} | V_{CC} |
| | V_M | 1.5 V | $V_{CC}/2$ | $V_{CC}/2$ |
| | t_r, t_f | 2.0 ns | 2.0 ns | 2.0 ns |
| Output | V_M | 1.5 V | $V_{CC}/2$ | $V_{CC}/2$ |
| Load | C_L | 30 pF | 30 pF | 15 pF |
| | R_L | 500 Ω | 500 Ω | 2 k Ω |

Package Dimensions

Unit: mm



Weight: 0.02 g (typ.)

| |
|-----------------|
| Package Name(s) |
| Nickname: US16 |

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