

TC74VCX157FT, TC74VCX157FK

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

The TC74VCX157 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.

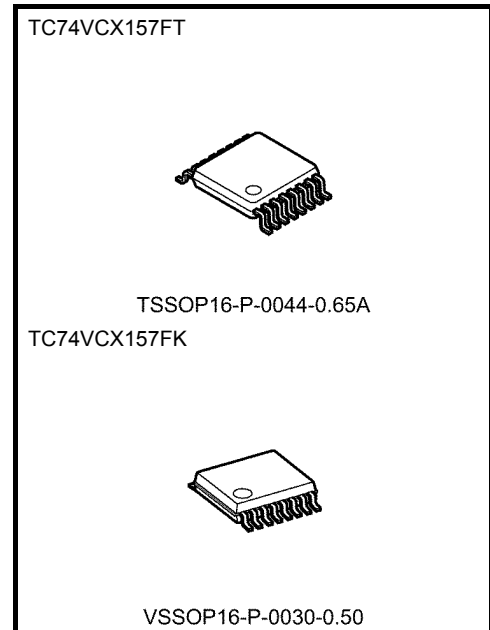
It consists of four 2-input digital multiplexers with common select and strobe inputs.

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.

Features

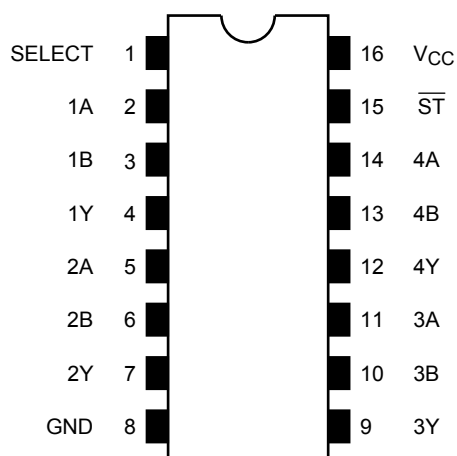
- Low voltage operation: $V_{CC} = 1.2$ to 3.6 V
- High speed operation: $t_{pd} = 3.0$ ns (max) ($V_{CC} = 3.0$ to 3.6 V)
 $t_{pd} = 3.5$ ns (max) ($V_{CC} = 2.3$ to 2.7 V)
 $t_{pd} = 7.0$ ns (max) ($V_{CC} = 1.65$ to 1.95 V)
 $t_{pd} = 14.0$ ns (max) ($V_{CC} = 1.4$ to 1.6 V)
 $t_{pd} = 35.0$ ns (max) ($V_{CC} = 1.2$ V)
- 3.6 V tolerant inputs and outputs.
- 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)
- Latch-up performance: -300 mA
- ESD performance: Machine model $\geq \pm 200$ V
Human body model $\geq \pm 2000$ V
- Package: TSSOP and VSSOP (US)
- Power down protection is provided on all inputs and outputs.



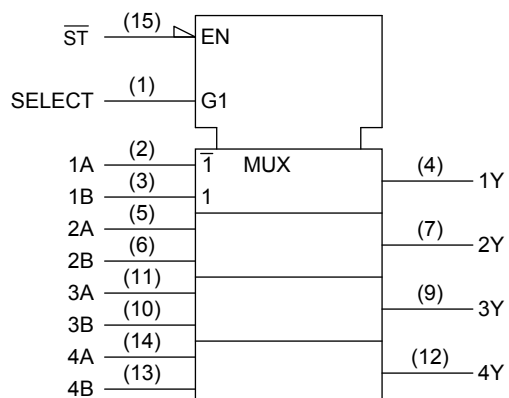
| | |
|----------------------|-----------------|
| Weight | |
| TSSOP16-P-0044-0.65A | : 0.06 g (typ.) |
| VSSOP16-P-0030-0.50 | : 0.02 g (typ.) |

Start of commercial production
1999-07

Pin Assignment (top view)



IEC Logic Symbol

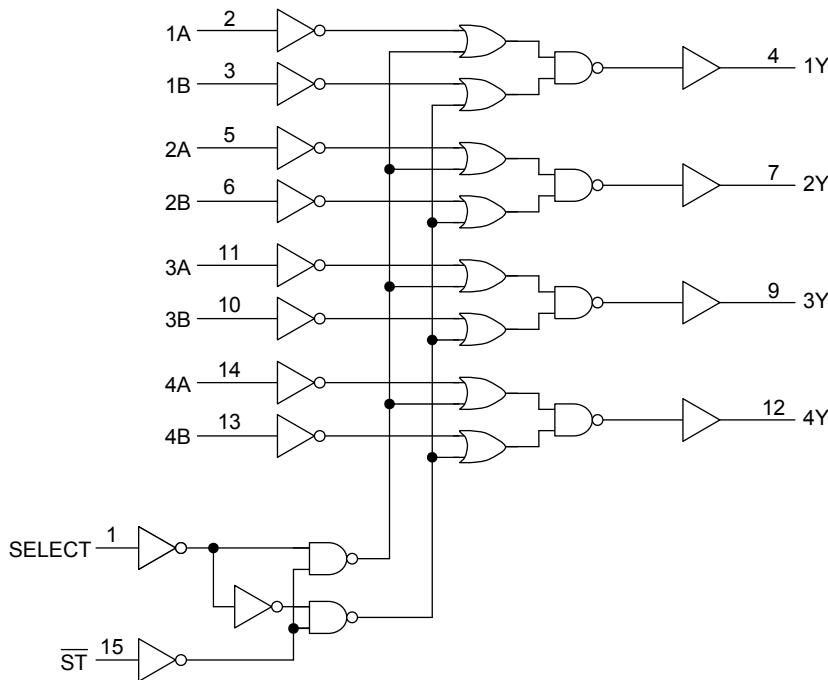


Truth Table

| Inputs | | | | Outputs |
|--------|--------|---|---|---------|
| ST-bar | SELECT | A | B | 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

System Diagram



Absolute Maximum Ratings (Note 1)

| Characteristics | Symbol | Rating | Unit |
|-----------------------------|------------------|---------------------------------|-------------|
| Power supply voltage | V_{CC} | -0.5 to 4.6 | V |
| DC input voltage | V_{IN} | -0.5 to 4.6 | V |
| DC output voltage | V_{OUT} | -0.5 to 4.6 (Note 2) | V |
| | | -0.5 to $V_{CC} + 0.5$ (Note 3) | |
| Input diode current | I_{IK} | -50 | mA |
| Output diode current | I_{OK} | ± 50 (Note 4) | mA |
| DC output current | I_{OUT} | ± 50 | mA |
| Power dissipation | P_D | 180 | mW |
| DC V_{CC} /ground current | I_{CC}/I_{GND} | ± 100 | mA |
| Storage temperature | T_{stg} | -65 to 150 | $^{\circ}C$ |

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: $V_{CC} = 0$ V

Note 3: High or low state. I_{OUT} absolute maximum rating must be observed.

Note 4: $V_{OUT} < GND$, $V_{OUT} > V_{CC}$

Operating Ranges (Note 1)

| Characteristics | Symbol | 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} | 0 to 3.6 (Note 2) | V |
| | | 0 to V_{CC} (Note 3) | |
| Output current | I_{OH}/I_{OL} | ± 24 (Note 4) | mA |
| | | ± 18 (Note 5) | |
| | | ± 6 (Note 6) | |
| | | ± 2 (Note 7) | |
| Operating temperature | T_{opr} | -40 to 85 | $^{\circ}C$ |
| Input rise and fall time | dt/dv | 0 to 10 (Note 8) | 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 V_{CC} or GND.

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

Note 3: High or low state

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

Note 5: $V_{CC} = 2.3$ to 2.7 V

Note 6: $V_{CC} = 1.65$ to 1.95 V

Note 7: $V_{CC} = 1.4$ to 1.6 V

Note 8: $V_{IN} = 0.8$ to 2.0 V, $V_{CC} = 3.0$ V

Electrical Characteristics

DC Characteristics ($T_a = -40$ to $85^{\circ}C$, 2.7 V < $V_{CC} \leq 3.6$ V)

| Characteristics | | Symbol | Test Condition | V_{CC} (V) | Min | Max | Unit |
|--------------------------------|------------|-----------------|---------------------------------|-----------------------|------------|----------------|---------|
| | | | | | | | |
| Input voltage | High level | V_{IH} | — | 2.7 to 3.6 | 2.0 | — | V |
| | Low level | V_{IL} | — | 2.7 to 3.6 | — | 0.8 | |
| Output voltage | High level | V_{OH} | $V_{IN} = V_{IH}$ or V_{IL} | $I_{OH} = -100 \mu A$ | 2.7 to 3.6 | $V_{CC} - 0.2$ | V |
| | | | | $I_{OH} = -12$ mA | 2.7 | 2.2 | |
| | | | | $I_{OH} = -18$ mA | 3.0 | 2.4 | |
| | | | | $I_{OH} = -24$ mA | 3.0 | 2.2 | |
| | Low level | V_{OL} | $V_{IN} = V_{IH}$ or V_{IL} | $I_{OL} = 100 \mu A$ | 2.7 to 3.6 | — | 0.2 |
| | | | | $I_{OL} = 12$ mA | 2.7 | — | 0.4 |
| | | | | $I_{OL} = 18$ mA | 3.0 | — | 0.4 |
| | | | | $I_{OL} = 24$ mA | 3.0 | — | 0.55 |
| Input leakage current | | I_{IN} | $V_{IN} = 0$ to 3.6 V | 2.7 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 | 2.7 to 3.6 | — | 20.0 | μA |
| | | | $V_{CC} \leq V_{IN} \leq 3.6$ V | 2.7 to 3.6 | — | ± 20.0 | |
| Increase in I_{CC} per input | | ΔI_{CC} | $V_{IH} = V_{CC} - 0.6$ V | 2.7 to 3.6 | — | 750 | |

DC Characteristics (Ta = -40 to 85°C, 2.3 V ≤ VCC ≤ 2.7 V)

| Characteristics | | Symbol | Test Condition | | VCC (V) | Min | Max | Unit |
|---------------------------|------------|------------------|--|---------------------------|------------|-----------------------|-------|------|
| | | | | | | | | |
| Input voltage | High level | V _{IH} | — | | 2.3 to 2.7 | 1.6 | — | V |
| | Low level | V _{IL} | — | | 2.3 to 2.7 | — | 0.7 | |
| Output voltage | High level | V _{OH} | V _{IN} = V _{IH} or V _{IL} | I _{OH} = -100 μA | 2.3 to 2.7 | V _{CC} - 0.2 | — | V |
| | | | | I _{OH} = -6 mA | 2.3 | 2.0 | — | |
| | | | | I _{OH} = -12 mA | 2.3 | 1.8 | — | |
| | Low level | V _{OL} | V _{IN} = V _{IH} or V _{IL} | I _{OL} = 100 μA | 2.3 to 2.7 | — | 0.2 | |
| | | | | I _{OL} = 12 mA | 2.3 | — | 0.4 | |
| | | | | I _{OL} = 18 mA | 2.3 | — | 0.6 | |
| Input leakage current | | I _{IN} | V _{IN} = 0 to 3.6 V | | 2.3 to 2.7 | — | ±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 | | 2.3 to 2.7 | — | 20.0 | μA |
| | | | V _{CC} ≤ V _{IN} ≤ 3.6 V | | 2.3 to 2.7 | — | ±20.0 | |

DC Characteristics (Ta = -40 to 85°C, 1.65 V ≤ VCC < 2.3 V)

| Characteristics | | Symbol | Test Condition | | VCC (V) | Min | Max | Unit |
|---------------------------|------------|------------------|--|---------------------------|-------------|------------------------|-----------------------|------|
| | | | | | | | | |
| Input voltage | High level | V _{IH} | — | | 1.65 to 2.3 | 0.65 × V _{CC} | — | V |
| | Low level | V _{IL} | — | | 1.65 to 2.3 | — | 0.2 × V _{CC} | |
| Output voltage | High level | V _{OH} | V _{IN} = V _{IH} or V _{IL} | I _{OH} = -100 μA | 1.65 to 2.3 | V _{CC} - 0.2 | — | V |
| | | | | I _{OH} = -6 mA | 1.65 | 1.25 | — | |
| | Low level | V _{OL} | V _{IN} = V _{IH} or V _{IL} | I _{OL} = 100 μA | 1.65 to 2.3 | — | 0.2 | |
| | | | | I _{OL} = 6 mA | 1.65 | — | 0.3 | |
| Input leakage current | | I _{IN} | V _{IN} = 0 to 3.6 V | | 1.65 to 2.3 | — | ±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 | | 1.65 to 2.3 | — | 20.0 | μA |
| | | | V _{CC} ≤ V _{IN} ≤ 3.6 V | | 1.65 to 2.3 | — | ±20.0 | |

DC Characteristics (Ta = -40 to 85°C, 1.4 V ≤ VCC ≤ 1.65 V)

| Characteristics | | Symbol | Test Condition | | VCC (V) | Min | Max | Unit |
|---------------------------|------------|------------------|--|---------------------------|-------------|------------------------|------------------------|------|
| | | | | | | | | |
| Input voltage | High level | V _{IH} | — | | 1.4 to 1.65 | 0.65 × V _{CC} | — | V |
| | Low level | V _{IL} | — | | 1.4 to 1.65 | — | 0.05 × V _{CC} | |
| Output voltage | High level | V _{OH} | V _{IN} = V _{IH} or V _{IL} | I _{OH} = -100 μA | 1.4 to 1.65 | V _{CC} - 0.2 | — | V |
| | | | | I _{OH} = -2 mA | 1.4 | 1.05 | — | |
| | Low level | V _{OL} | V _{IN} = V _{IH} or V _{IL} | I _{OL} = 100 μA | 1.4 to 1.65 | — | 0.05 | |
| | | | | I _{OL} = 2 mA | 1.4 | — | 0.35 | |
| Input leakage current | | I _{IN} | V _{IN} = 0 to 3.6 V | | 1.4 to 1.65 | — | ±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 | | 1.4 to 1.65 | — | 20.0 | μA |
| | | | V _{CC} ≤ V _{IN} ≤ 3.6 V | | 1.4 to 1.65 | — | ±20.0 | |

DC Characteristics (Ta = -40 to 85°C, 1.2 V ≤ VCC < 1.4 V)

| Characteristics | | Symbol | Test Condition | | VCC (V) | Min | Max | Unit |
|---------------------------|------------|------------------|--|---------------------------|------------|-----------------------|------------------------|------|
| | | | | | | | | |
| Input voltage | High level | V _{IH} | — | | 1.2 to 1.4 | 0.8 × V _{CC} | — | V |
| | Low level | V _{IL} | — | | 1.2 to 1.4 | — | 0.05 × V _{CC} | |
| Output voltage | High level | V _{OH} | V _{IN} = V _{IH} or V _{IL} | I _{OH} = -100 μA | 1.2 | V _{CC} - 0.1 | — | V |
| | Low level | V _{OL} | V _{IN} = V _{IH} or V _{IL} | I _{OL} = 100 μA | 1.2 | — | 0.05 | |
| Input leakage current | | I _{IN} | V _{IN} = 0 to 3.6 V | | 1.2 | — | ±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 | — | 20.0 | μA |
| | | | V _{CC} ≤ V _{IN} ≤ 3.6 V | | 1.2 | — | ±20.0 | |

AC Characteristics (Ta = -40 to 85°C, Input: tr = tf = 2.0 ns) (Note 1)

| Characteristics | Symbol | Test Condition | | VCC (V) | Min | Max | Unit |
|---|--|--------------------|--|------------|-----|------|------|
| | | | | | | | |
| Propagation delay time (A, B-Y) | t _{pLH} t _{pHL} | Figure 1, Figure 2 | C _L = 15 pF, R _L = 2 kΩ | 1.2 | 3.0 | 35.0 | ns |
| | | | | 1.5 ± 0.1 | 2.0 | 14.0 | |
| | | | C _L = 30 pF, R _L = 500 Ω | 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} | Figure 1, Figure 2 | C _L = 15 pF, R _L = 2 kΩ | 1.2 | 3.0 | 45.0 | ns |
| | | | | 1.5 ± 0.1 | 2.0 | 18.0 | |
| | | | C _L = 30 pF, R _L = 500 Ω | 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} | Figure 1, Figure 2 | C _L = 15 pF, R _L = 2 kΩ | 1.2 | 3.0 | 45.0 | ns |
| | | | | 1.5 ± 0.1 | 2.0 | 18.0 | |
| | | | C _L = 30 pF, R _L = 500 Ω | 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 to output skew | t _{osLH} t _{osHL} | (Note 2) | C _L = 15 pF, R _L = 2 kΩ | 1.2 | — | 1.5 | ns |
| | | | | 1.5 ± 0.1 | — | 1.5 | |
| | | | C _L = 30 pF, R _L = 500 Ω | 1.8 ± 0.15 | — | 0.5 | |
| | | | | 2.5 ± 0.2 | — | 0.5 | |
| | | | | 3.3 ± 0.3 | — | 0.5 | |

Note 1: For C_L = 50 pF, add approximately 300 ps to the AC maximum specification.

Note 2: This parameter is guaranteed by design.

$$(t_{osLH} = |t_{pLHm} - t_{pLHn}|, t_{osHL} = |t_{pHLm} - t_{pHLn}|)$$

Dynamic Switching Characteristics (Ta = 25°C, Input: tr = tf = 2.0 ns, CL = 30 pF)

| Characteristics | Symbol | Test Condition | VCC (V) | Typ. | Unit |
|----------------------------------|--------|-------------------------------|---------|-------|------|
| | | | | | |
| Quiet output maximum dynamic VOL | VOLP | VIH = 1.8 V, VIL = 0 V (Note) | 1.8 | 0.25 | V |
| | | VIH = 2.5 V, VIL = 0 V (Note) | 2.5 | 0.6 | |
| | | VIH = 3.3 V, VIL = 0 V (Note) | 3.3 | 0.8 | |
| Quiet output minimum dynamic VOL | VOLV | VIH = 1.8 V, VIL = 0 V (Note) | 1.8 | -0.25 | V |
| | | VIH = 2.5 V, VIL = 0 V (Note) | 2.5 | -0.6 | |
| | | VIH = 3.3 V, VIL = 0 V (Note) | 3.3 | -0.8 | |
| Quiet output minimum dynamic VOH | VOHV | VIH = 1.8 V, VIL = 0 V (Note) | 1.8 | 1.5 | V |
| | | VIH = 2.5 V, VIL = 0 V (Note) | 2.5 | 1.9 | |
| | | VIH = 3.3 V, VIL = 0 V (Note) | 3.3 | 2.2 | |

Note: This parameter is guaranteed by design.

Capacitive Characteristics (Ta = 25°C)

| Characteristics | Symbol | Test Condition | VCC (V) | Typ. | Unit |
|-------------------------------|--------|---------------------|---------------|------|------|
| | | | | | |
| Input capacitance | CIN | — | 1.8, 2.5, 3.3 | 6 | pF |
| Power dissipation capacitance | CPD | fIN = 10 MHz (Note) | 1.8, 2.5, 3.3 | 20 | 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:

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

AC Test Circuit

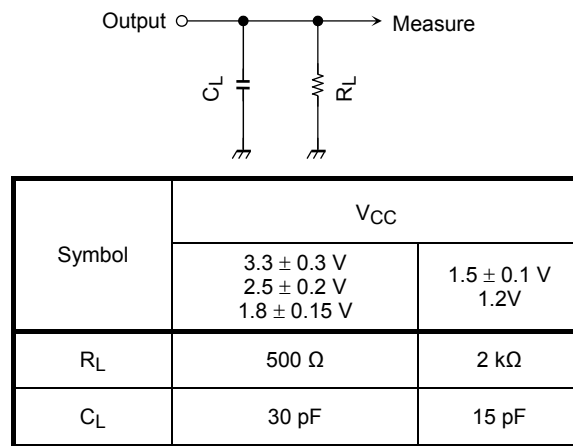
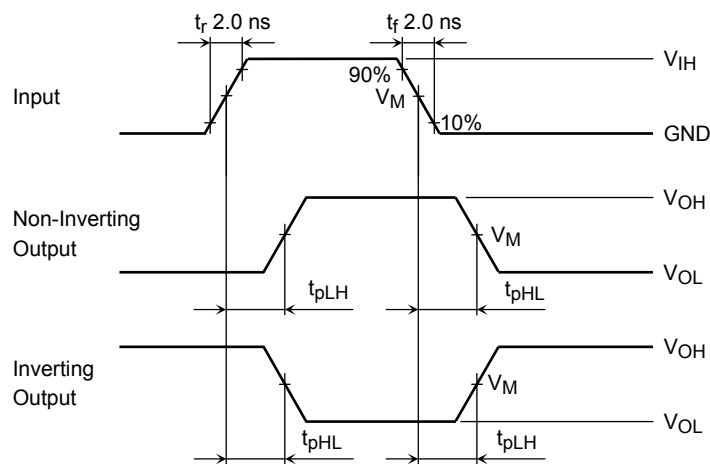


Figure 1

AC Waveform



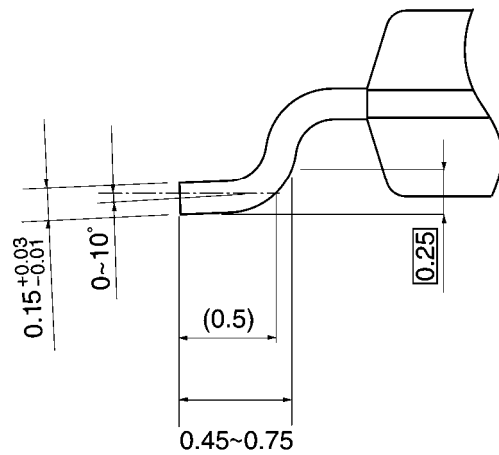
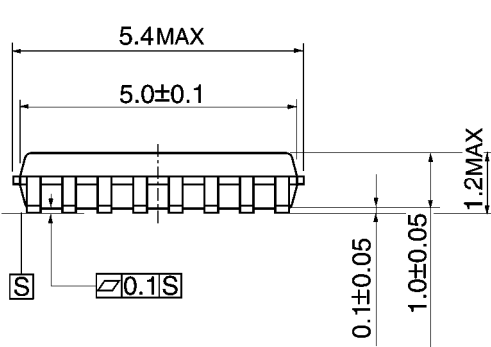
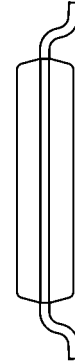
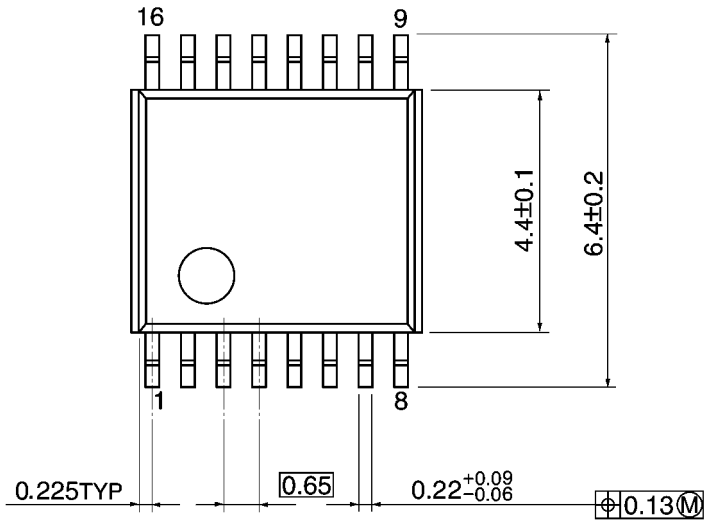
| | | | | | |
|-----------------|-----------------|--------------------|--------------------|--------------------|--------------------|
| Symbol | V _{CC} | | | | |
| | 3.3 ± 0.3 V | 2.5 ± 0.2 V | 1.8 ± 0.15 V | 1.5 ± 0.1 V | 1.2 V |
| V _{IH} | 2.7 V | V _{CC} | V _{CC} | V _{CC} | V _{CC} |
| V _M | 1.5 V | V _{CC} /2 | V _{CC} /2 | V _{CC} /2 | V _{CC} /2 |

Figure 2 t_{pLH}, t_{pHL}

Package Dimensions

TSSOP16-P-0044-0.65A

Unit: mm

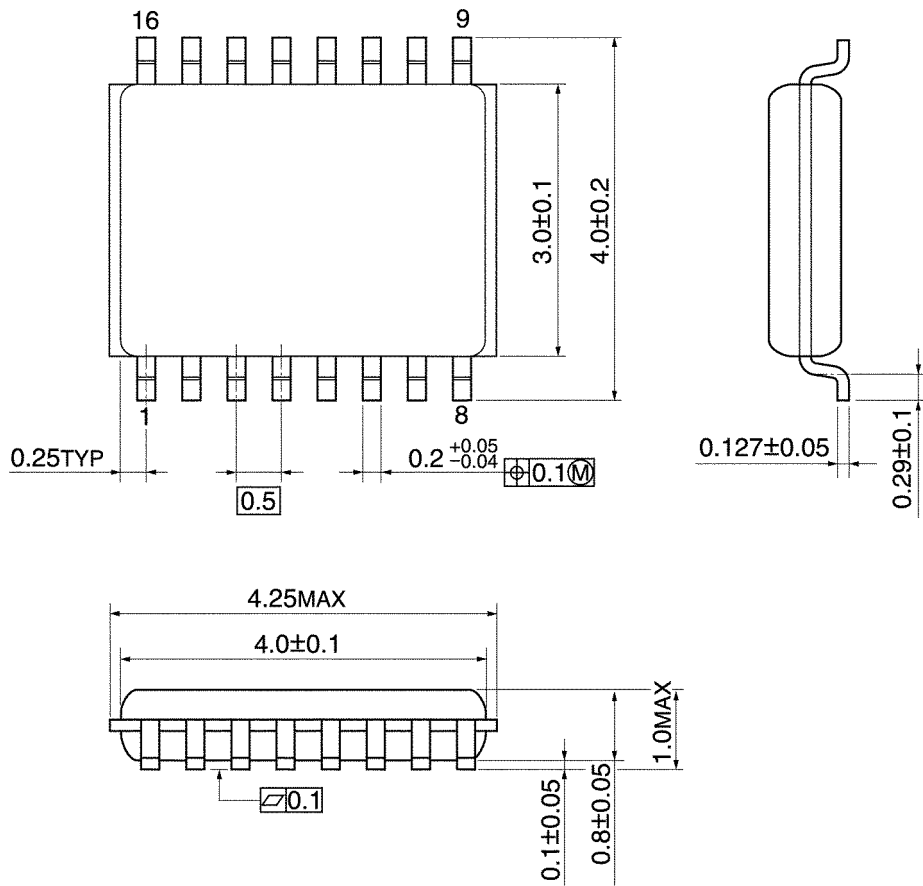


Weight: 0.06 g (typ.)

Package Dimensions

VSSOP16-P-0030-0.50

Unit: mm



Weight: 0.02 g (typ.)

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