

TOSHIBA CMOS Digital Integrated Circuit Silicon Monolithic

TC74VCX162373FT

Low-Voltage 16-Bit D-Type Latch with 3.6-V Tolerant Inputs and Outputs

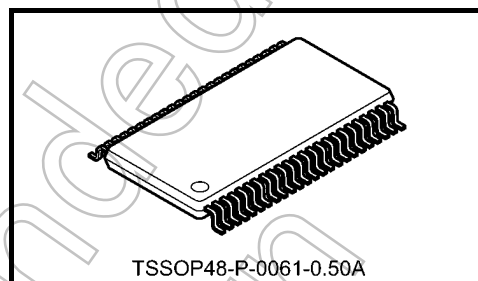
The TC74VCX162373FT is a high-performance CMOS 16-bit D-type latch. Designed for use in 1.8-V, 2.5-V or 3.3-V systems, it achieves high-speed operation while maintaining the CMOS low power dissipation.

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

This 16-bit D-type latch is controlled by a latch enable input (LE) and an output enable input (\overline{OE}) which are common to each byte. It can be used as two 8-bit latches or one 16-bit latch. When the \overline{OE} input is high, the outputs are in a high-impedance state.

The 26- Ω series resistor helps reducing output overshoot and undershoot without external resistor.

All inputs are equipped with protection circuits against static discharge.



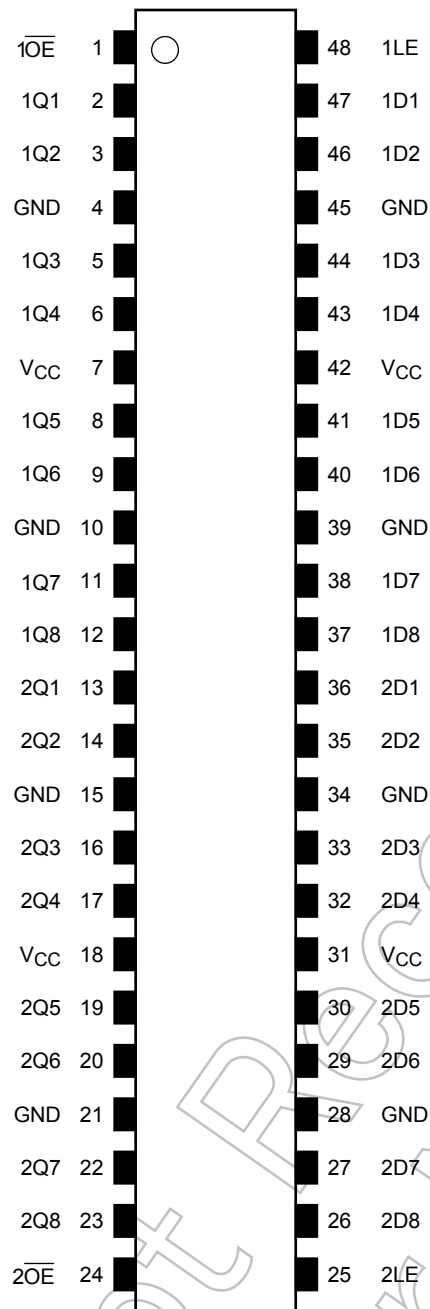
Weight: 0.25 g (typ.)

Features

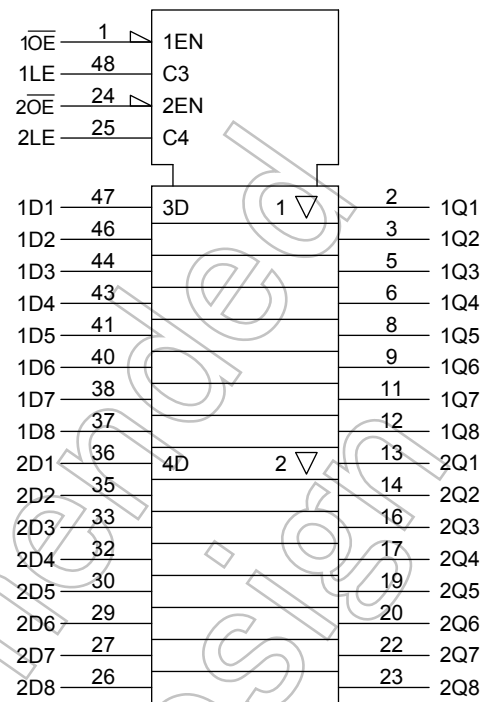
- 26- Ω series resistors on outputs
- Low-voltage operation: $V_{CC} = 1.8$ to 3.6 V
- High-speed operation: $t_{pd} = 3.3$ ns (max) ($V_{CC} = 3.0$ to 3.6 V)
 : $t_{pd} = 4.5$ ns (max) ($V_{CC} = 2.3$ to 2.7 V)
 : $t_{pd} = 5.8$ ns (max) ($V_{CC} = 1.8$ V)
- Output current: $I_{OH}/I_{OL} = \pm 12$ mA (min) ($V_{CC} = 3.0$ V)
 : $I_{OH}/I_{OL} = \pm 8$ mA (min) ($V_{CC} = 2.3$ V)
 : $I_{OH}/I_{OL} = \pm 4$ mA (min) ($V_{CC} = 1.8$ V)
- Latch-up performance: -300 mA
- ESD performance: Machine model $\geq \pm 200$ V
 Human body model $\geq \pm 2000$ V
- Package: TSSOP
- 3.6-V tolerant function and power-down protection provided on all inputs and outputs

Start of commercial production
1997-03

Pin Assignment (top view)



IEC Logic Symbol



Not Recommended for New Design

Truth Table

| Inputs | | | Outputs |
|------------------|-----|---------|---------|
| $\overline{1OE}$ | 1LE | 1D1-1D8 | 1Q1-1Q8 |
| H | X | X | Z |
| L | L | X | Qn |
| L | H | L | L |
| L | H | H | H |

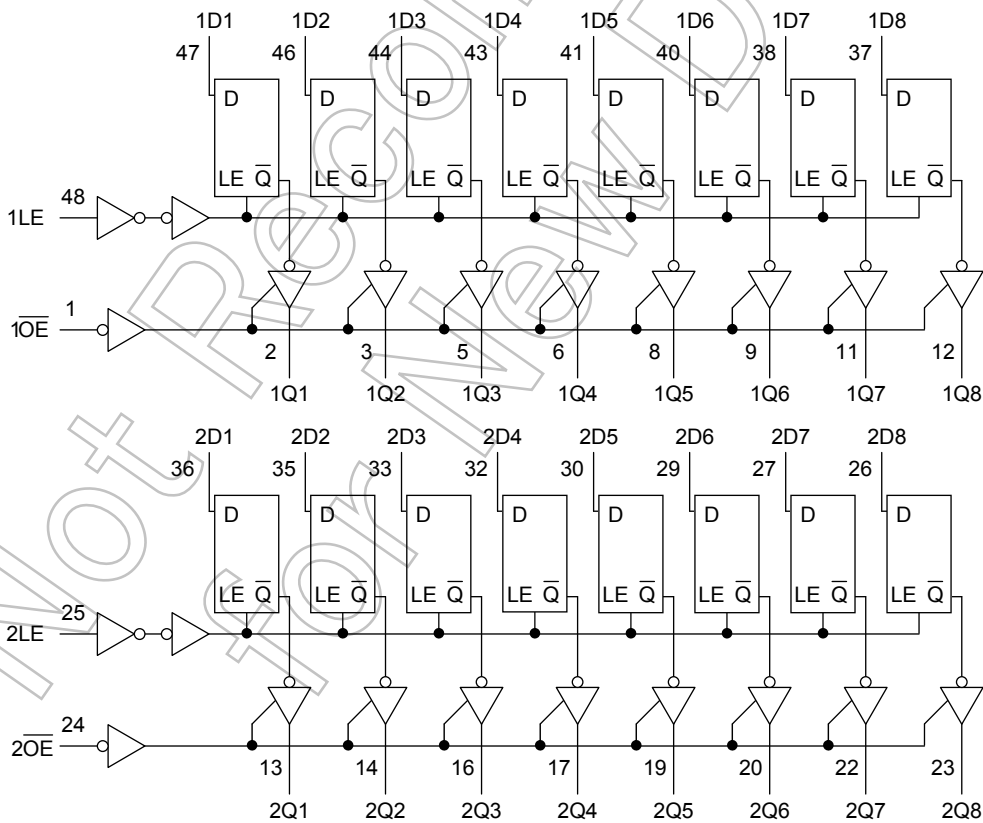
| Inputs | | | Outputs |
|------------------|-----|---------|---------|
| $\overline{2OE}$ | 2LE | 2D1-2D8 | 2Q1-2Q8 |
| H | X | X | Z |
| L | L | X | Qn |
| L | H | L | L |
| L | H | H | H |

X: Don't care

Z: High impedance

Qn: Q outputs are latched at the time when the LE input is taken to a low logic level.

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 | 400 | mW |
| DC V_{CC} /ground current per supply pin | I_{CC}/I_{GND} | ±100 | mA |
| Storage temperature | T_{stg} | -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: OFF state

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 |
|--------------------------|-----------------|------------------------|------|
| Power supply voltage | V_{CC} | 1.8 to 3.6 | V |
| | | 1.2 to 3.6 (Note 2) | |
| Input voltage | V_{IN} | -0.3 to 3.6 | V |
| Output voltage | V_{OUT} | 0 to 3.6 (Note 3) | V |
| | | 0 to V_{CC} (Note 4) | |
| Output current | I_{OH}/I_{OL} | ±12 (Note 5) | mA |
| | | ±8 (Note 6) | |
| | | ±4 (Note 7) | |
| Operating temperature | T_{opt} | -40 to 85 | °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: Data retention only

Note 3: OFF state

Note 4: High or low state

Note 5: $V_{CC} = 3.0$ to 3.6 V

Note 6: $V_{CC} = 2.3$ to 2.7 V

Note 7: $V_{CC} = 1.8$ V

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

Electrical Characteristics

DC Characteristics (Ta = -40 to 85°C, 2.7 V < VCC ≤ 3.6 V)

| Characteristics | | Symbol | Test Condition | | VCC (V) | Min | Max | Unit |
|---------------------------------------|---------|------------------|---|---------------------------|------------|-----------------------|-------|------|
| | | | | | | | | |
| Input voltage | H-level | V _{IH} | — | | 2.7 to 3.6 | 2.0 | — | V |
| | L-level | V _{IL} | — | | 2.7 to 3.6 | — | 0.8 | |
| Output voltage | H-level | V _{OH} | V _{IN} = V _{IH} or V _{IL} | I _{OH} = -100 μA | 2.7 to 3.6 | V _{CC} - 0.2 | — | V |
| | | | | I _{OH} = -6 mA | 2.7 | 2.2 | — | |
| | | | | I _{OH} = -8 mA | 3.0 | 2.4 | — | |
| | | | | I _{OH} = -12 mA | 3.0 | 2.2 | — | |
| | L-level | V _{OL} | V _{IN} = V _{IH} or V _{IL} | I _{OL} = 100 μA | 2.7 to 3.6 | — | 0.2 | |
| | | | | I _{OL} = 6 mA | 2.7 | — | 0.4 | |
| | | | | I _{OL} = 8 mA | 3.0 | — | 0.55 | |
| | | | | I _{OL} = 12 mA | 3.0 | — | 0.8 | |
| Input leakage current | | I _{IN} | V _{IN} = 0 to 3.6 V | | 2.7 to 3.6 | — | ±5.0 | μA |
| 3-state output OFF state current | | I _{OZ} | V _{IN} = V _{IH} or V _{IL} V _{OUT} = 0 to 3.6 V | | 2.7 to 3.6 | — | ±10.0 | 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} ≤ (V _{IN} , V _{OUT}) ≤ 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 | H-level | V _{IH} | — | | 2.3 to 2.7 | 1.6 | — | V |
| | L-level | V _{IL} | — | | 2.3 to 2.7 | — | 0.7 | |
| Output voltage | H-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} = -4 mA | 2.3 | 2.0 | — | |
| | | | | I _{OH} = -6 mA | 2.3 | 1.8 | — | |
| | | | | I _{OH} = -8 mA | 2.3 | 1.7 | — | |
| | L-level | V _{OL} | V _{IN} = V _{IH} or V _{IL} | I _{OL} = 100 μA | 2.3 to 2.7 | — | 0.2 | |
| | | | | I _{OL} = 6 mA | 2.3 | — | 0.4 | |
| | | | | I _{OL} = 8 mA | 2.3 | — | 0.6 | |
| | | | | I _{OL} = 8 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 |
| 3-state output OFF state current | | I _{OZ} | V _{IN} = V _{IH} or V _{IL} V _{OUT} = 0 to 3.6 V | | 2.3 to 2.7 | — | ±10.0 | 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} , V _{OUT}) ≤ 3.6 V | | 2.3 to 2.7 | — | ±20.0 | |

DC Characteristics (Ta = -40 to 85°C, 1.8 V ≤ VCC < 2.3 V)

| Characteristics | | Symbol | Test Condition | | VCC (V) | Min | Max | Unit |
|----------------------------------|---------|------------------|---|---------------------------|------------|-----------------------|-----------------------|------|
| | | | | | | | | |
| Input voltage | H-level | V _{IH} | — | | 1.8 to 2.3 | 0.7 × V _{CC} | — | V |
| | L-level | V _{IL} | — | | 1.8 to 2.3 | — | 0.2 × V _{CC} | |
| Output voltage | H-level | V _{OH} | V _{IN} = V _{IH} or V _{IL} | I _{OH} = -100 μA | 1.8 | V _{CC} - 0.2 | — | V |
| | | | | I _{OH} = -4 mA | 1.8 | 1.4 | — | |
| | L-level | V _{OL} | V _{IN} = V _{IH} or V _{IL} | I _{OL} = 100 μA | 1.8 | — | 0.2 | |
| | | | | I _{OL} = 4 mA | 1.8 | — | 0.3 | |
| Input leakage current | | I _{IN} | V _{IN} = 0 to 3.6 V | | 1.8 | — | ±5.0 | μA |
| 3-state output OFF state current | | I _{OZ} | V _{IN} = V _{IH} or V _{IL} V _{OUT} = 0 to 3.6 V | | 1.8 | — | ±10.0 | 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 | | 1.8 | — | 20.0 | μA |
| | | | V _{CC} ≤ (V _{IN} , V _{OUT}) ≤ 3.6 V | | 1.8 | — | ±20.0 | |

Not Recommended for New Designs

AC Characteristics (Ta = -40 to 85°C, input: tr = tf = 2.0 ns, CL = 30 pF, RL = 500 Ω) (Note 1)

| Characteristics | Symbol | Test Condition | VCC (V) | Min | Max | Unit |
|----------------------------------|--|--------------------|-----------|-----|-----|------|
| | | | | | | |
| Propagation delay time (D-Q) | t _{pLH} t _{pHL} | Figure 1, Figure 2 | 1.8 | 1.5 | 5.8 | ns |
| | | | 2.5 ± 0.2 | 1.0 | 4.5 | |
| | | | 3.3 ± 0.3 | 0.8 | 3.3 | |
| Propagation delay time (LE-Q) | t _{pLH} t _{pHL} | Figure 1, Figure 2 | 1.8 | 1.5 | 6.2 | ns |
| | | | 2.5 ± 0.2 | 1.0 | 4.9 | |
| | | | 3.3 ± 0.3 | 0.8 | 3.6 | |
| 3-state output enable time | t _{pZL} t _{pZH} | Figure 1, Figure 3 | 1.8 | 1.5 | 7.6 | ns |
| | | | 2.5 ± 0.2 | 1.0 | 5.4 | |
| | | | 3.3 ± 0.3 | 0.8 | 3.9 | |
| 3-state output disable time | t _{pLZ} t _{pHZ} | Figure 1, Figure 3 | 1.8 | 1.5 | 5.3 | ns |
| | | | 2.5 ± 0.2 | 1.0 | 4.4 | |
| | | | 3.3 ± 0.3 | 0.8 | 4.0 | |
| Minimum pulse width (LE) | t _w (H) | Figure 1, Figure 2 | 1.8 | 3.0 | — | ns |
| | | | 2.5 ± 0.2 | 1.5 | — | |
| | | | 3.3 ± 0.3 | 1.5 | — | |
| Minimum setup time | t _s | Figure 1, Figure 2 | 1.8 | 2.5 | — | ns |
| | | | 2.5 ± 0.2 | 1.5 | — | |
| | | | 3.3 ± 0.3 | 1.5 | — | |
| Minimum hold time | t _h | Figure 1, Figure 2 | 1.8 | 1.0 | — | ns |
| | | | 2.5 ± 0.2 | 1.0 | — | |
| | | | 3.3 ± 0.3 | 1.0 | — | |
| Output to output skew | t _{osLH} t _{osHL} | (Note 2) | 1.8 | — | 0.5 | ns |
| | | | 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: Parameter 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 | | Typ. | Unit | |
|----------------------------------|--------|------------------------|---------|------|-------|---|
| | | | VCC (V) | | | |
| Quiet output maximum dynamic VOL | VOLP | VIH = 1.8 V, VIL = 0 V | (Note) | 1.8 | 0.15 | V |
| | | VIH = 2.5 V, VIL = 0 V | (Note) | 2.5 | 0.25 | |
| | | VIH = 3.3 V, VIL = 0 V | (Note) | 3.3 | 0.35 | |
| Quiet output minimum dynamic VOL | VOLV | VIH = 1.8 V, VIL = 0 V | (Note) | 1.8 | -0.15 | V |
| | | VIH = 2.5 V, VIL = 0 V | (Note) | 2.5 | -0.25 | |
| | | VIH = 3.3 V, VIL = 0 V | (Note) | 3.3 | -0.35 | |
| Quiet output minimum dynamic VOH | VOHV | VIH = 1.8 V, VIL = 0 V | (Note) | 1.8 | 1.55 | V |
| | | VIH = 2.5 V, VIL = 0 V | (Note) | 2.5 | 2.05 | |
| | | VIH = 3.3 V, VIL = 0 V | (Note) | 3.3 | 2.65 | |

Note: Parameter guaranteed by design.

Capacitive Characteristics (Ta = 25°C)

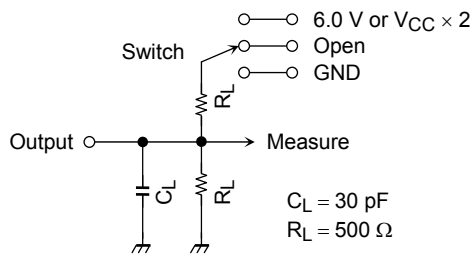
| Characteristics | Symbol | Test Condition | | Typ. | Unit | |
|-------------------------------|--------|----------------|---------|---------------|------|----|
| | | | VCC (V) | | | |
| Input capacitance | CIN | — | | 1.8, 2.5, 3.3 | 6 | pF |
| Output capacitance | CO | — | | 1.8, 2.5, 3.3 | 7 | pF |
| 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:

$$I_{CC(opr)} = C_{PD} \cdot V_{CC} \cdot f_{IN} + I_{CC}/16 \text{ (per bit)}$$

AC Test Circuit



| Parameter | Switch |
|-----------------------|--|
| t_{pLH} , t_{pHL} | Open |
| t_{pLZ} , t_{pZL} | 6.0 V $V_{CC} \times 2$ |
| | @ $V_{CC} = 3.3 \pm 0.3 \text{ V}$ @ $V_{CC} = 2.5 \pm 0.2 \text{ V}$ @ $V_{CC} = 1.8 \text{ V}$ |
| t_{pHZ} , t_{pZH} | GND |

Figure 1

AC Waveform

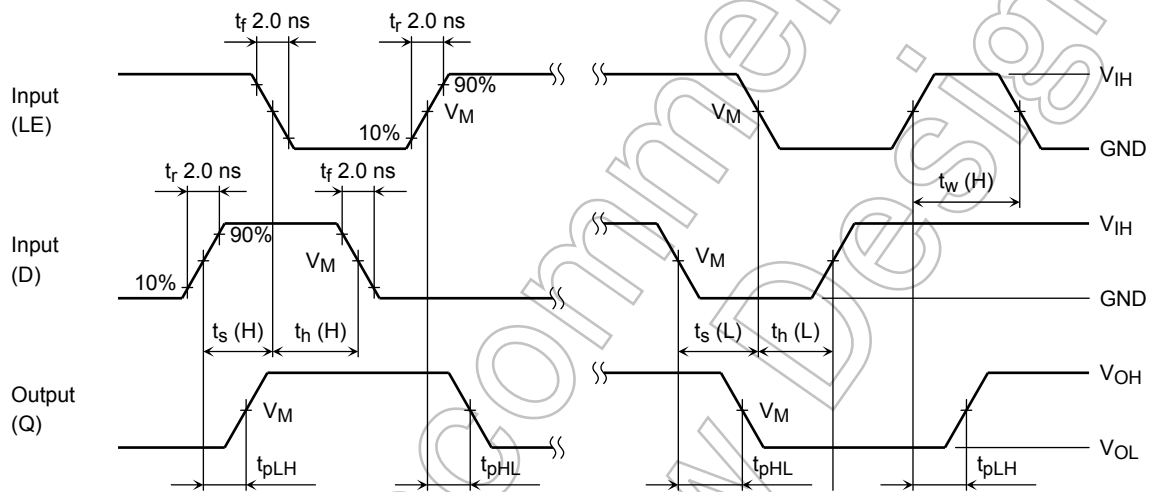


Figure 2 t_{pLH} , t_{pHL} , t_w , t_s , t_h

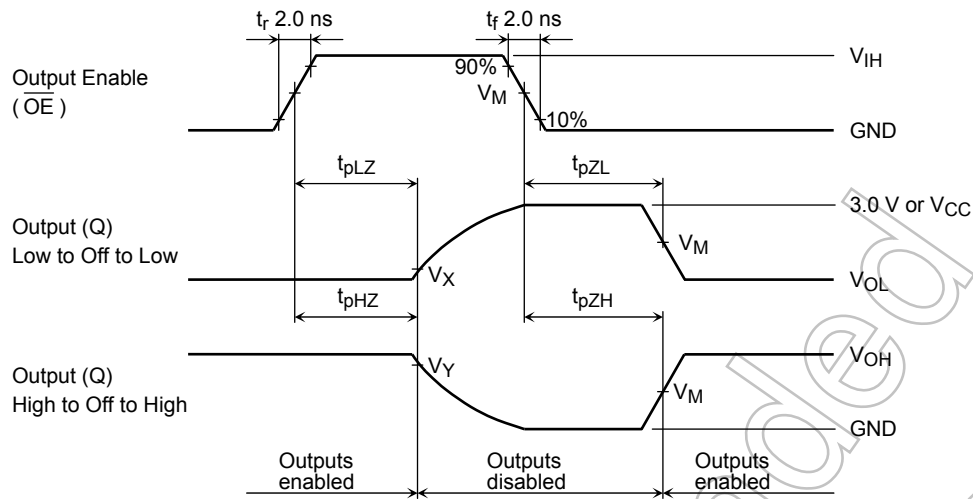


Figure 3 t_{pLZ} , t_{pHZ} , t_{pZL} , t_{pZH}

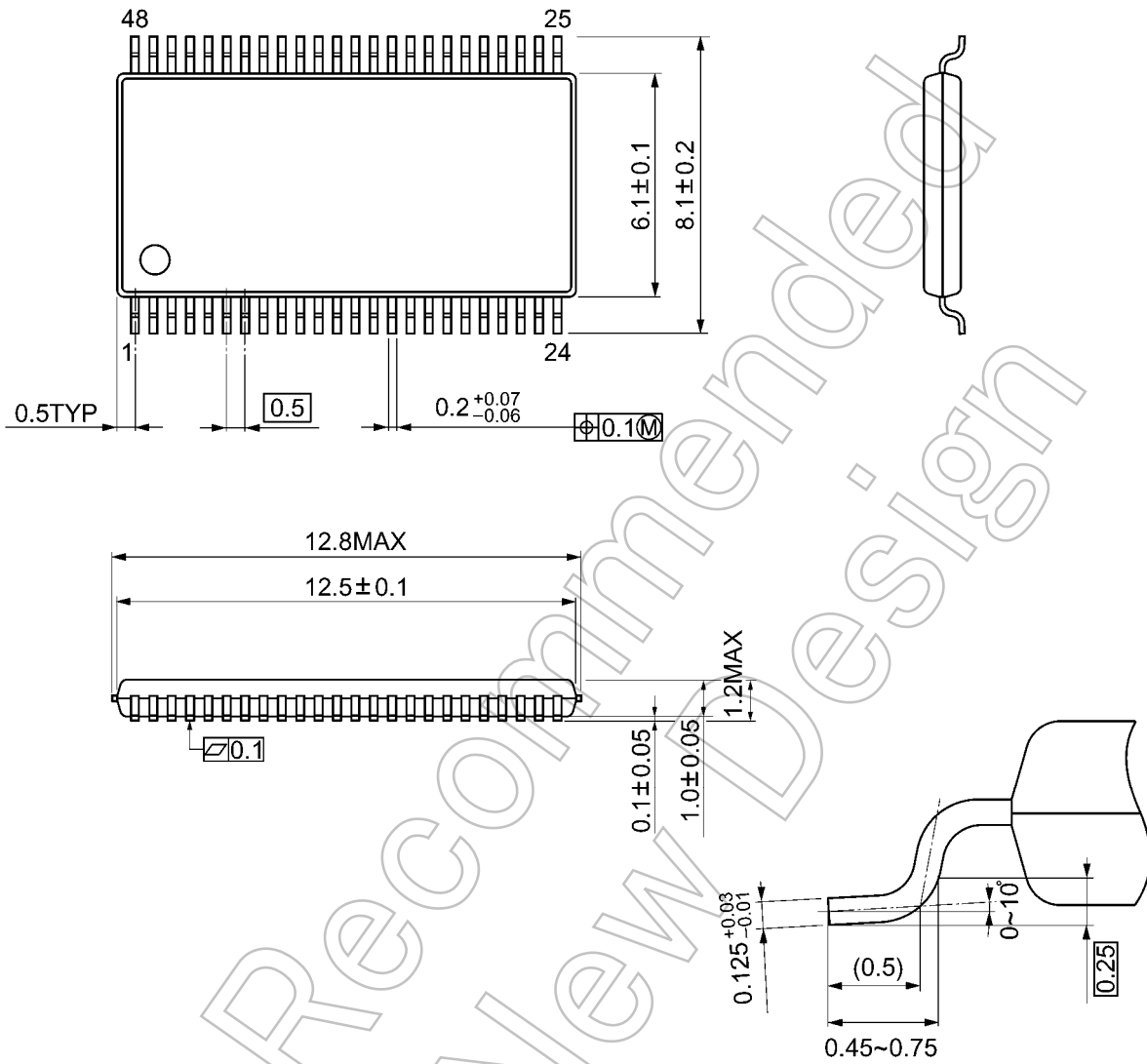
| Symbol | V_{CC} | | |
|----------|--------------------------|---------------------------|---------------------------|
| | $3.3 \pm 0.3 \text{ V}$ | $2.5 \pm 0.2 \text{ V}$ | 1.8 V |
| V_{IH} | 2.7 V | V_{CC} | V_{CC} |
| V_M | 1.5 V | $V_{CC}/2$ | $V_{CC}/2$ |
| V_X | $V_{OL} + 0.3 \text{ V}$ | $V_{OL} + 0.15 \text{ V}$ | $V_{OL} + 0.15 \text{ V}$ |
| V_Y | $V_{OH} - 0.3 \text{ V}$ | $V_{OH} - 0.15 \text{ V}$ | $V_{OH} - 0.15 \text{ V}$ |

Not Recommended for New Design

Package Dimensions

TSSOP48-P-0061-0.50A

Unit: mm



Weight: 0.25 g (typ.)

Not Recommended for New Design

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