

TOSHIBA CMOS Digital Integrated Circuit Silicon Monolithic

# TC74LCX16244FT

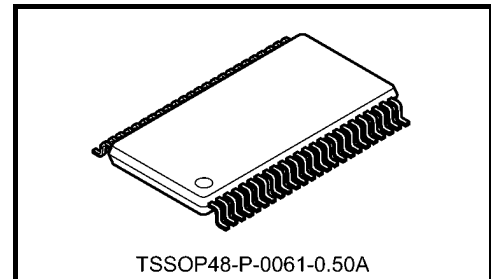
## Low-Voltage 16-Bit Bus Buffer with 5-V Tolerant Inputs and Outputs

The TC74LCX16244FT is a high-performance CMOS 16-bit bus buffer. Designed for use in 2.5-V or 3.3-V systems, it achieves high-speed operation while maintaining the CMOS low power dissipation.

The device is designed for low-voltage (2.5-V or 3.3-V) VCC applications, but it could be used to interface to 5 V supply environment for both inputs and outputs.

This device is non-inverting 3-state buffer having four active-low output enables. It can be used as four 4-bit buffers two 8-bit buffers or one 16-bit buffer. When the  $\overline{OE}$  input is high, the outputs are in a high-impedance state. This device is designed to be used with 3-state memory address drivers, etc.

All inputs are equipped with protection circuits against static discharge.



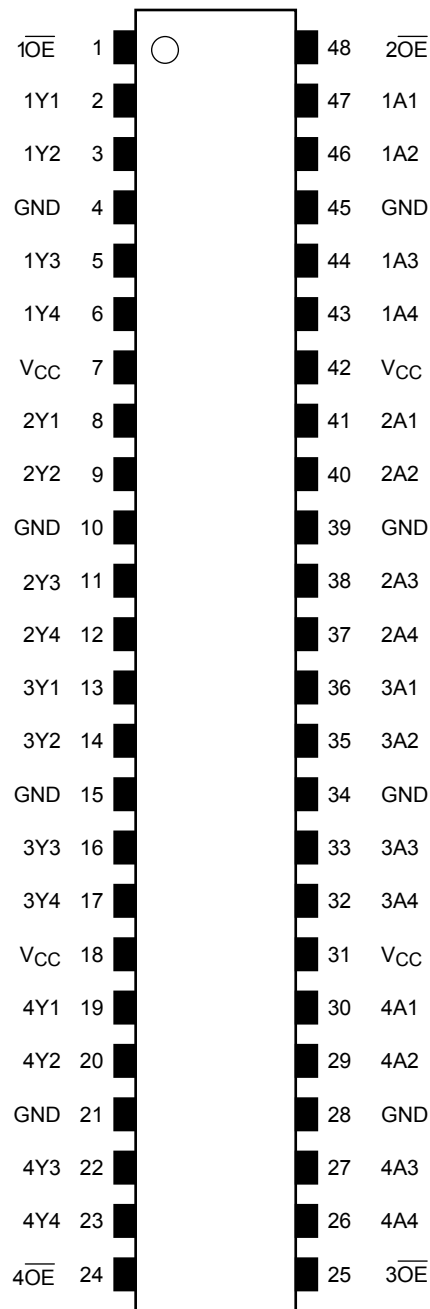
Weight: 0.25 g (typ.)

### Features

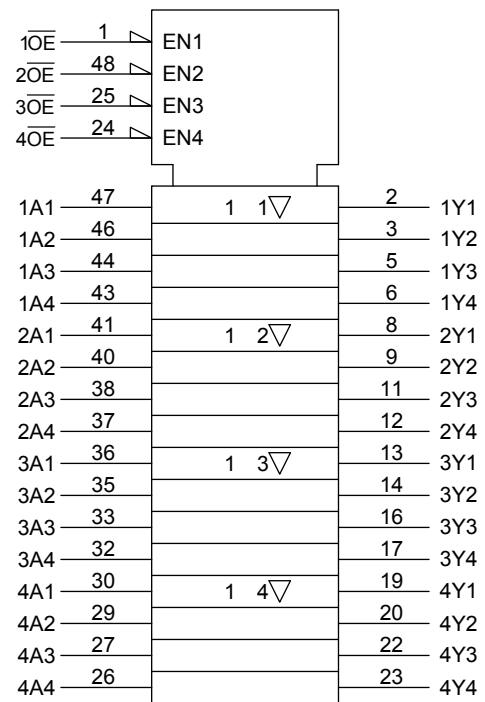
- Low-voltage operation:  $V_{CC} = 2.0$  to  $3.6$  V
- High-speed operation:  $t_{pd} = 4.5$  ns (max) ( $V_{CC} = 3.0$  to  $3.6$  V)
- Output current:  $|I_{OH}|/I_{OL} = 24$  mA (min) ( $V_{CC} = 3.0$  V)
- Latch-up performance:  $-500$  mA
- Package: TSSOP
- Power-down protection provided on all inputs and outputs

Start of commercial production  
2002-03

## Pin Assignment (top view)



## IEC Logic Symbol



## Truth Table

| Inputs           |         | Outputs |
|------------------|---------|---------|
| $\overline{1OE}$ | 1A1-1A4 | 1Y1-1Y4 |
| L                | L       | L       |
| L                | H       | H       |
| H                | X       | Z       |

| Inputs           |         | Outputs |
|------------------|---------|---------|
| $\overline{2OE}$ | 2A1-2A4 | 2Y1-2Y4 |
| L                | L       | L       |
| L                | H       | H       |
| H                | X       | Z       |

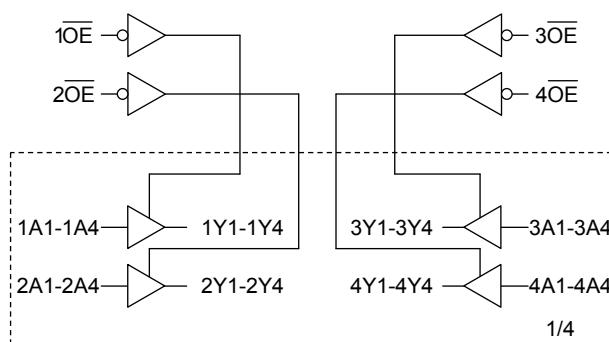
| Inputs           |         | Outputs |
|------------------|---------|---------|
| $\overline{3OE}$ | 3A1-3A4 | 3Y1-3Y4 |
| L                | L       | L       |
| L                | H       | H       |
| H                | X       | Z       |

| Inputs           |         | Outputs |
|------------------|---------|---------|
| $\overline{4OE}$ | 4A1-4A4 | 4Y1-4Y4 |
| L                | L       | L       |
| L                | H       | H       |
| H                | X       | Z       |

X: Don't care

Z: High impedance

## System Diagram



## Absolute Maximum Ratings (Note 1)

| Characteristics                            | Symbol           | Rating                             | Unit |
|--|------------------|------------------------------------|------|
| Power supply voltage                       | $V_{CC}$         | -0.5 to 6.0                        | V    |
| Input voltage                              | $V_{IN}$         | -0.5 to 7.0                        | V    |
| Output voltage                             | $V_{OUT}$        | -0.5 to 7.0 (Note 2)               | V    |
|  |                  | -0.5 to $V_{CC} + 0.5$<br>(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: Output in 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     | $V_{CC}$        | 2.0 to 3.6             | V    |
|                          |                 | 1.5 to 3.6 (Note 2)    |      |
| Input voltage            | $V_{IN}$        | 0 to 5.5               | V    |
| Output voltage           | $V_{OUT}$       | 0 to 5.5 (Note 3)      | V    |
|                          |                 | 0 to $V_{CC}$ (Note 4) |      |
| Output current           | $I_{OH}/I_{OL}$ | ±24 (Note 5)           | mA   |
|                          |                 | ±12 (Note 6)           |      |
|                          |                 | ±8 (Note 7)            |      |
| Operating temperature    | $T_{opr}$       | -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: Output in OFF state

Note 4: High or low state

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

Note 6:  $V_{CC} = 2.7$  to 3.0 V

Note 7:  $V_{CC} = 2.3$  to 2.7 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)

| Characteristics                       |         | Symbol           | Test Condition  |  | V <sub>CC</sub> (V)       | Min        | Max                     | Unit |   |
|---------------------------------------|---------|------------------|---|--|---------------------------|------------|-------------------------|------|---|
|                                       |         |                  |   |  |                           |            |                         |      |   |
| Input voltage                         | H-level | V <sub>IH</sub>  | —   |  | 2.3 to 2.7                | 1.7        | —                       | V    |   |
|                                       |         |                  |   |  | 2.7 to 3.6                | 2.0        | —                       |      |   |
|                                       | L-level | V <sub>IL</sub>  |   |  | 2.3 to 2.7                | —          | 0.7                     |      |   |
|                                       |         |                  |   |  | 2.7 to 3.6                | —          | 0.8                     |      |   |
| Output voltage                        | H-level | V <sub>OH</sub>  | V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub>                                  |  | I <sub>OH</sub> = -100 μA | 2.3 to 3.6 | V <sub>CC</sub><br>-0.2 | —    | V |
|                                       |         |                  |   |  | I <sub>OH</sub> = -8 mA   | 2.3        | 1.8                     | —    |   |
|                                       |         |                  |   |  | I <sub>OH</sub> = -12 mA  | 2.7        | 2.2                     | —    |   |
|                                       |         |                  |   |  | I <sub>OH</sub> = -18 mA  | 3.0        | 2.4                     | —    |   |
|                                       |         |                  |   |  | I <sub>OH</sub> = -24 mA  | 3.0        | 2.2                     | —    |   |
|                                       | L-level | V <sub>OL</sub>  | V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub>                                  |  | I <sub>OL</sub> = 100 μA  | 2.3 to 3.6 | —                       | 0.2  |   |
|                                       |         |                  |   |  | I <sub>OL</sub> = 8 mA    | 2.3        | —                       | 0.6  |   |
|                                       |         |                  |   |  | I <sub>OL</sub> = 12 mA   | 2.7        | —                       | 0.4  |   |
|                                       |         |                  |   |  | I <sub>OL</sub> = 16 mA   | 3.0        | —                       | 0.4  |   |
|                                       |         |                  |   |  | I <sub>OL</sub> = 24 mA   | 3.0        | —                       | 0.55 |   |
| Input leakage current                 |         | I <sub>IN</sub>  | V <sub>IN</sub> = 0 to 5.5 V  |  | 2.3 to 3.6                | —          | ±5.0                    | μA   |   |
| 3-state output off-state current      |         | I <sub>OZ</sub>  | V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub><br>V <sub>OUT</sub> = 0 to 5.5 V |  | 2.3 to 3.6                | —          | ±5.0                    | μA   |   |
| Power off leakage current             |         | I <sub>OFF</sub> | V <sub>IN</sub> /V <sub>OUT</sub> = 5.5 V   |  | 0                         | —          | 10.0                    | μA   |   |
| Quiescent supply current              |         | I <sub>CC</sub>  | V <sub>IN</sub> = V <sub>CC</sub> or GND  |  | 2.3 to 3.6                | —          | 20.0                    | μA   |   |
|                                       |         |                  | V <sub>IN</sub> /V <sub>OUT</sub> = 3.6 to 5.5 V                                      |  | 2.3 to 3.6                | —          | ±20.0                   |      |   |
| Increase in I <sub>CC</sub> per input |         | ΔI <sub>CC</sub> | V <sub>IH</sub> = V <sub>CC</sub> - 0.6 V   |  | 2.3 to 3.6                | —          | 500                     |      |   |

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

| Characteristics             |  | Symbol             | Test Condition |           | V <sub>CC</sub> (V) | C <sub>L</sub> (pF) | Min | Max | Unit |
|-----------------------------|--|--------------------|----------------|-----------|---------------------|---------------------|-----|-----|------|
|                             |  |                    |                |           |                     |                     |     |     |      |
| Propagation delay time      | t <sub>pLH</sub><br>t <sub>pHL</sub>   | Figure 1, Figure 2 |                | 2.5 ± 0.2 | 30                  | 1.5                 | 5.4 | ns  |      |
|                             |  |                    |                | 2.7       | 50                  | 1.5                 | 5.2 |     |      |
|                             |  |                    |                | 3.3 ± 0.3 | 50                  | 1.5                 | 4.5 |     |      |
| 3-state output enable time  | t <sub>pZL</sub><br>t <sub>pZH</sub>   | Figure 1, Figure 3 |                | 2.5 ± 0.2 | 30                  | 1.5                 | 7.2 | ns  |      |
|                             |  |                    |                | 2.7       | 50                  | 1.5                 | 6.3 |     |      |
|                             |  |                    |                | 3.3 ± 0.3 | 50                  | 1.5                 | 5.5 |     |      |
| 3-state output disable time | t <sub>pLZ</sub><br>t <sub>pHZ</sub>   | Figure 1, Figure 3 |                | 2.5 ± 0.2 | 30                  | 1.5                 | 6.5 | ns  |      |
|                             |  |                    |                | 2.7       | 50                  | 1.5                 | 5.7 |     |      |
|                             |  |                    |                | 3.3 ± 0.3 | 50                  | 1.5                 | 5.4 |     |      |
| Output to output skew       | t <sub>osLH</sub><br>t <sub>osHL</sub> | (Note)             |                | 2.5 ± 0.2 | 30                  | —                   | —   | ns  |      |
|                             |  |                    |                | 2.7       | 50                  | —                   | —   |     |      |
|                             |  |                    |                | 3.3 ± 0.3 | 50                  | —                   | 1.0 |     |      |

Note: Parameter guaranteed by design.  
 (t<sub>osLH</sub> = |t<sub>pLHm</sub> - t<sub>pLHn</sub>|; t<sub>osHL</sub> = |t<sub>pHLm</sub> - t<sub>pHLn</sub>|)

## Dynamic Switching Characteristics

(Ta = 25°C, input: tr = tf = 2.5 ns, RL = 500 Ω)

| Characteristics              | Symbol | Test Condition | VCC (V)                           | Typ. | Unit |   |
|------------------------------|--------|----------------|-----------------------------------|------|------|---|
|                              |        |                |                                   |      |      |   |
| Quiet output maximum dynamic | VOL    | VOLP           | VIH = 2.5 V, VIL = 0 V, CL = 30pF | 2.5  | 0.6  | V |
|                              |        |                | VIH = 3.3 V, VIL = 0 V, CL = 50pF | 3.3  | 0.8  |   |
| Quiet output minimum dynamic | VOL    | VOLV           | VIH = 2.5 V, VIL = 0 V, CL = 30pF | 2.5  | 0.6  | V |
|                              |        |                | VIH = 3.3 V, VIL = 0 V, CL = 50pF | 3.3  | 0.8  |   |

## Capacitive Characteristics (Ta = 25°C)

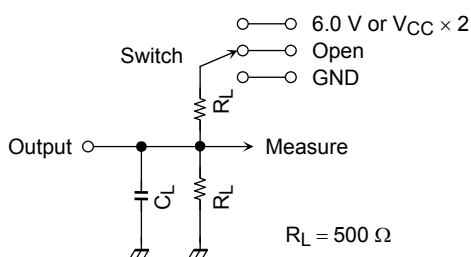
| Characteristics               | Symbol | Test Condition | VCC (V) | Typ. | Unit |    |
|-------------------------------|--------|----------------|---------|------|------|----|
|                               |        |                |         |      |      |    |
| Input capacitance             | CIN    | —              | 3.3     | 7    | pF   |    |
| Output capacitance            | COUT   | —              | 3.3     | 8    | pF   |    |
| Power dissipation capacitance | CPD    | fIN = 10 MHz   | (Note)  | 3.3  | 25   | 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 <sub>pLH</sub> , t <sub>pHL</sub> | Open   |
| t <sub>pLZ</sub> , t <sub>pZL</sub> | 6.0 V @VCC = 3.3 ± 0.3 V<br>VCC × 2 @VCC = 2.5 ± 0.2 V |
| t <sub>pHZ</sub> , t <sub>pZH</sub> | GND  |

Figure 1

## AC Waveform

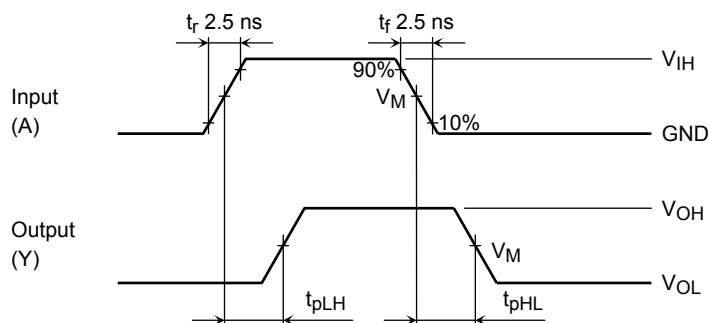
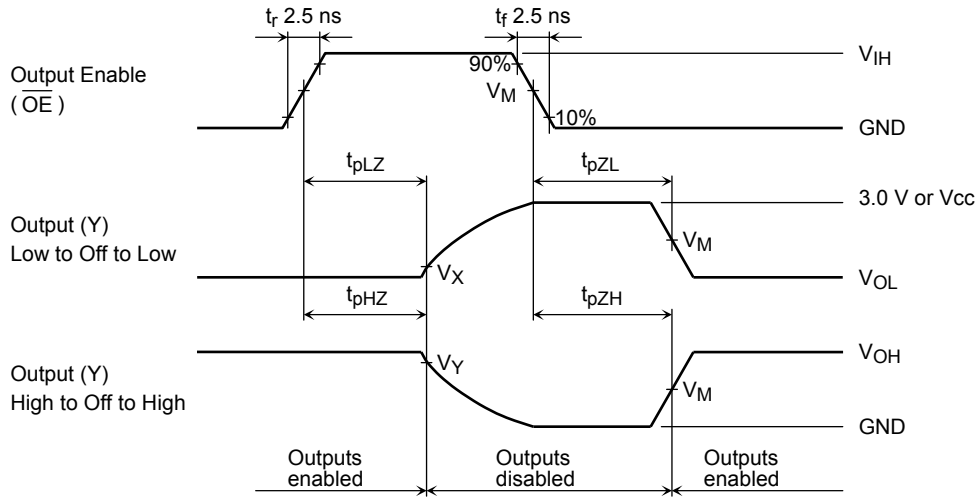


Figure 2 t<sub>pLH</sub>, t<sub>pHL</sub>



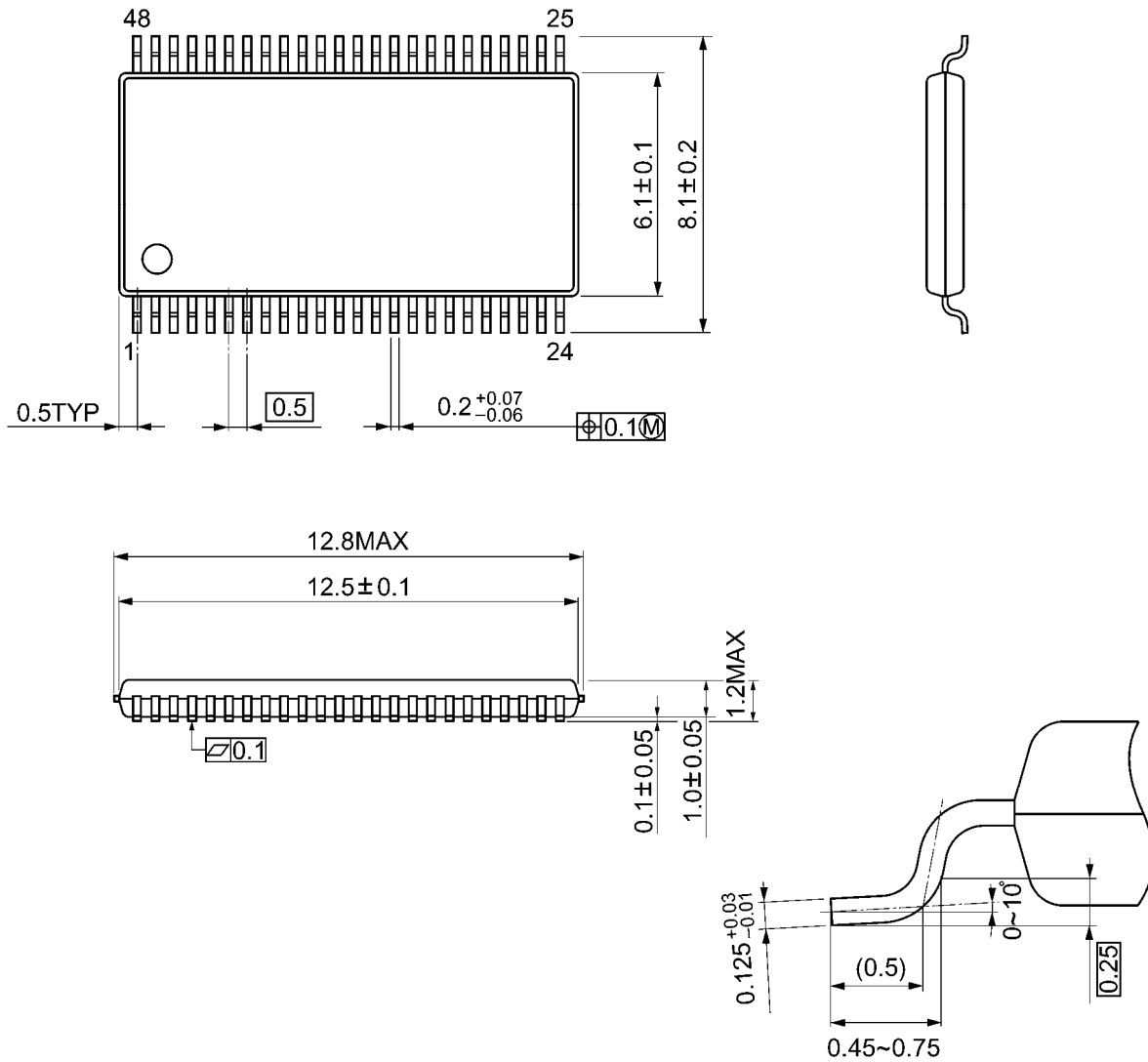
**Figure 3**  $t_{pLZ}$ ,  $t_{pHZ}$ ,  $t_{pZL}$ ,  $t_{pZH}$

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

**Package Dimensions**

TSSOP48-P-0061-0.50A

Unit: mm



Weight: 0.25 g (typ.)



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