TOSHIBA CMOS Digital Integrated Circuit Silicon Monolithic

# TC74LCX16244FT

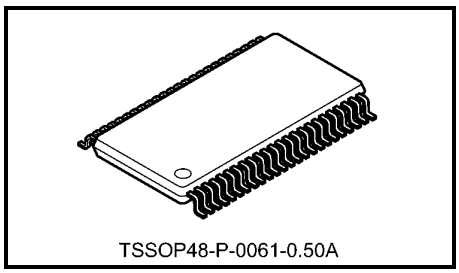
## Low-Voltage 16-Bit Bus Buffer with 5-V Tolerant Inputs and Outputs

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) $V_{CC}$ 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.



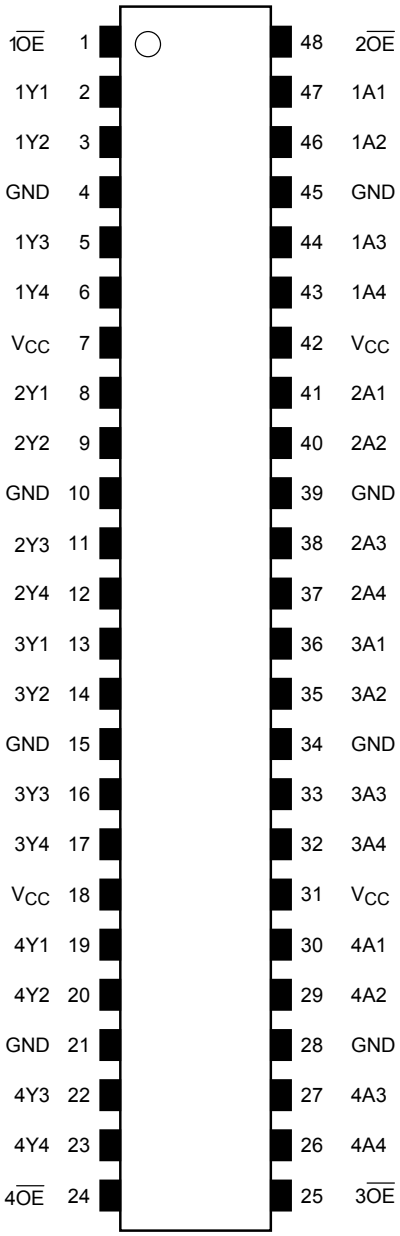
TSSOP48-P-0061-0.50A

Weight: 0.25 g (typ.)

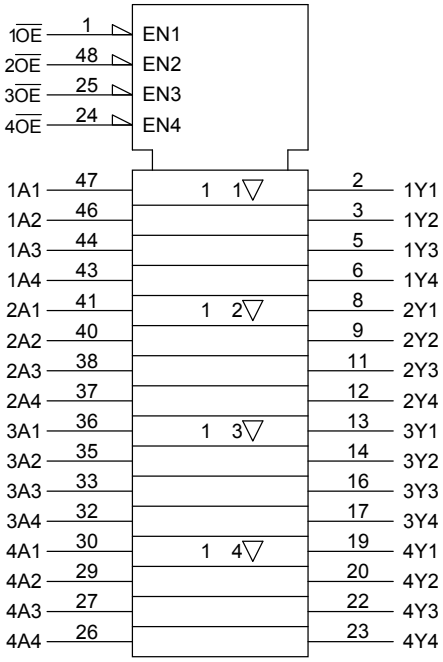
### Features

- 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

## Pin Assignment (top view)




## IEC Logic Symbol



## Truth Table

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

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

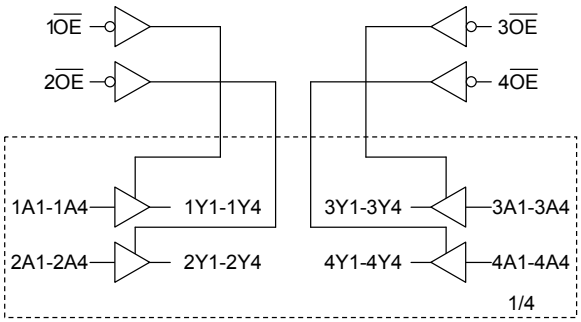
| Inputs | | Outputs |
|---|---|---|
| $3\overline{OE}$ | 3A1-3A4 | 3Y1-3Y4 |
| L | L | L |
| L | H | H |
| H | X | Z |

| Inputs | | Outputs |
|---|---|---|
| $4\overline{OE}$ | 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 (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 VCC 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 | | $V_{CC}$ (V) | Min | Max | Unit |
|---|---|---|---|---|---|---|---|---|
| Input voltage | H-level | $V_{IH}$ | — | | 2.3 to 2.7 | 1.7 | — | V |
| | | | | | 2.7 to 3.6 | 2.0 | — | |
| | L-level | $V_{IL}$ | — | | 2.3 to 2.7 | — | 0.7 | |
| | | | | | 2.7 to 3.6 | — | 0.8 | |
| Output voltage | H-level | $V_{OH}$ | $V_{IN}$ = $V_{IH}$ or $V_{IL}$ | $I_{OH}$ = –100 μA | 2.3 to 3.6 | $V_{CC}$ –0.2 | — | V |
| | | | | $I_{OH}$ = –8 mA | 2.3 | 1.8 | — | |
| | | | | $I_{OH}$ = –12 mA | 2.7 | 2.2 | — | |
| | | | | $I_{OH}$ = –18 mA | 3.0 | 2.4 | — | |
| | | | | $I_{OH}$ = –24 mA | 3.0 | 2.2 | — | |
| | L-level | $V_{OL}$ | $V_{IN}$ = $V_{IH}$ or $V_{IL}$ | $I_{OL}$ = 100 μA | 2.3 to 3.6 | — | 0.2 | |
| | | | | $I_{OL}$ = 8 mA | 2.3 | — | 0.6 | |
| | | | | $I_{OL}$ = 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 | | 2.3 to 3.6 | — | ±5.0 | μA |
| 3-state output off-state current | | $I_{OZ}$ | $V_{IN}$ = $V_{IH}$ or $V_{IL}$<br>$V_{OUT}$ = 0 to 5.5 V | | 2.3 to 3.6 | — | ±5.0 | μA |
| Power off leakage current | | $I_{OFF}$ | $V_{IN}$/$V_{OUT}$ = 5.5 V | | 0 | — | 10.0 | μA |
| Quiescent supply current | | $I_{CC}$ | $V_{IN}$ = $V_{CC}$ or GND | | 2.3 to 3.6 | — | 20.0 | μA |
| | | | $V_{IN}$/$V_{OUT}$ = 3.6 to 5.5 V | | 2.3 to 3.6 | — | ±20.0 | |
| Increase in Icc per input | | $\Delta I_{CC}$ | $V_{IH}$ = $V_{CC}$ – 0.6 V | | 2.3 to 3.6 | — | 500 | |

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

| Characteristics | Symbol | Test Condition | $V_{CC}$ (V) | $C_L$(pF) | Min | Max | Unit |
|---|---|---|---|---|---|---|---|
| Propagation delay time | $t_{pLH}$<br>$t_{pHL}$ | 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 | $t_{pZL}$<br>$t_{pZH}$ | 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 | $t_{pLZ}$<br>$t_{pHZ}$ | 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 | $t_{osLH}$<br>$t_{osHL}$ | (Note) | 2.5 ± 0.2 | 30 | — | — | ns |
| | | | 2.7 | 50 | — | — | |
| | | | 3.3 ± 0.3 | 50 | — | 1.0 | |

Note: Parameter guaranteed by design.
($t_{osLH}$ = $|t_{pLHm} - t_{pLHn}|$, $t_{osHL}$ = $|t_{pHLm} - t_{pHLn}|$)

## Dynamic Switching Characteristics
**(Ta = 25°C, input: $t_r = t_f = 2.5$ ns, $R_L = 500\ \Omega$)**

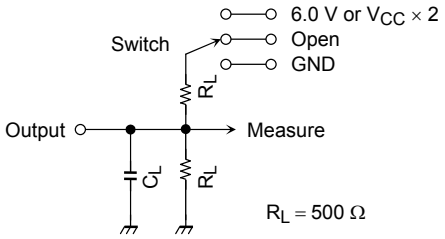
| Characteristics | | Symbol | Test Condition | $V_{CC}$ (V) | Typ. | Unit |
|---|---|---|---|---|---|---|
| Quiet output maximum dynamic | $V_{OL}$ | $V_{OLP}$ | $V_{IH}$ = 2.5 V, $V_{IL}$ = 0 V, $C_L$ =30pF | 2.5 | 0.6 | V |
| | | | $V_{IH}$ = 3.3 V, $V_{IL}$ = 0 V, $C_L$ =50pF | 3.3 | 0.8 | |
| Quiet output minimum dynamic | $V_{OL}$ | $\|V_{OLV}\|$ | $V_{IH}$ = 2.5 V, $V_{IL}$ = 0 V, $C_L$ =30pF | 2.5 | 0.6 | V |
| | | | $V_{IH}$ = 3.3 V, $V_{IL}$ = 0 V, $C_L$ =50pF | 3.3 | 0.8 | |

## Capacitive Characteristics (Ta = 25°C)

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

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

## AC Test Circuit




| Parameter | Switch | |
|---|---|---|
| $t_{pLH}$, $t_{pHL}$ | Open | |
| $t_{pLZ}$, $t_{pZL}$ | 6.0 V<br>$V_{CC}$ × 2 | @$V_{CC}$ = 3.3 ± 0.3 V<br>@$V_{CC}$ = 2.5 ± 0.2 V |
| $t_{pHZ}$, $t_{pZH}$ | GND | |

**Figure 1**

## AC Waveform

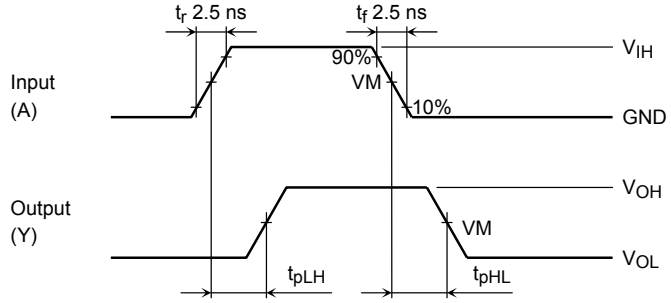



**Figure 2 $t_{pLH}$, $t_{pHL}$**

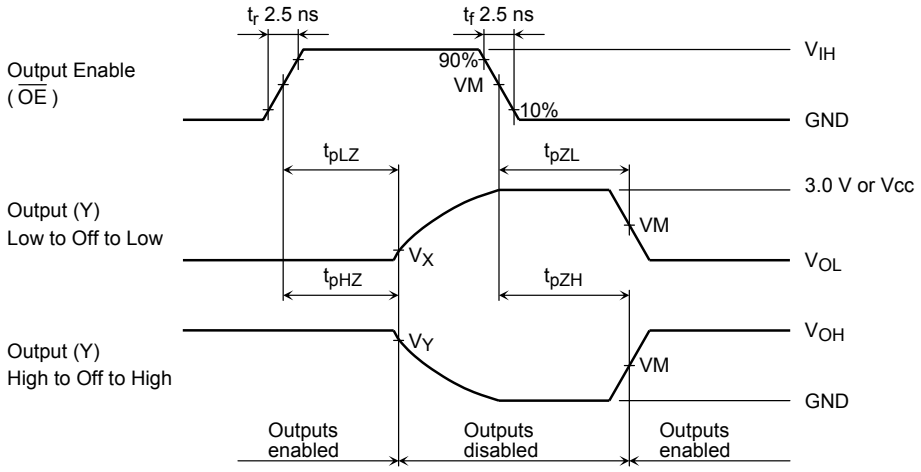
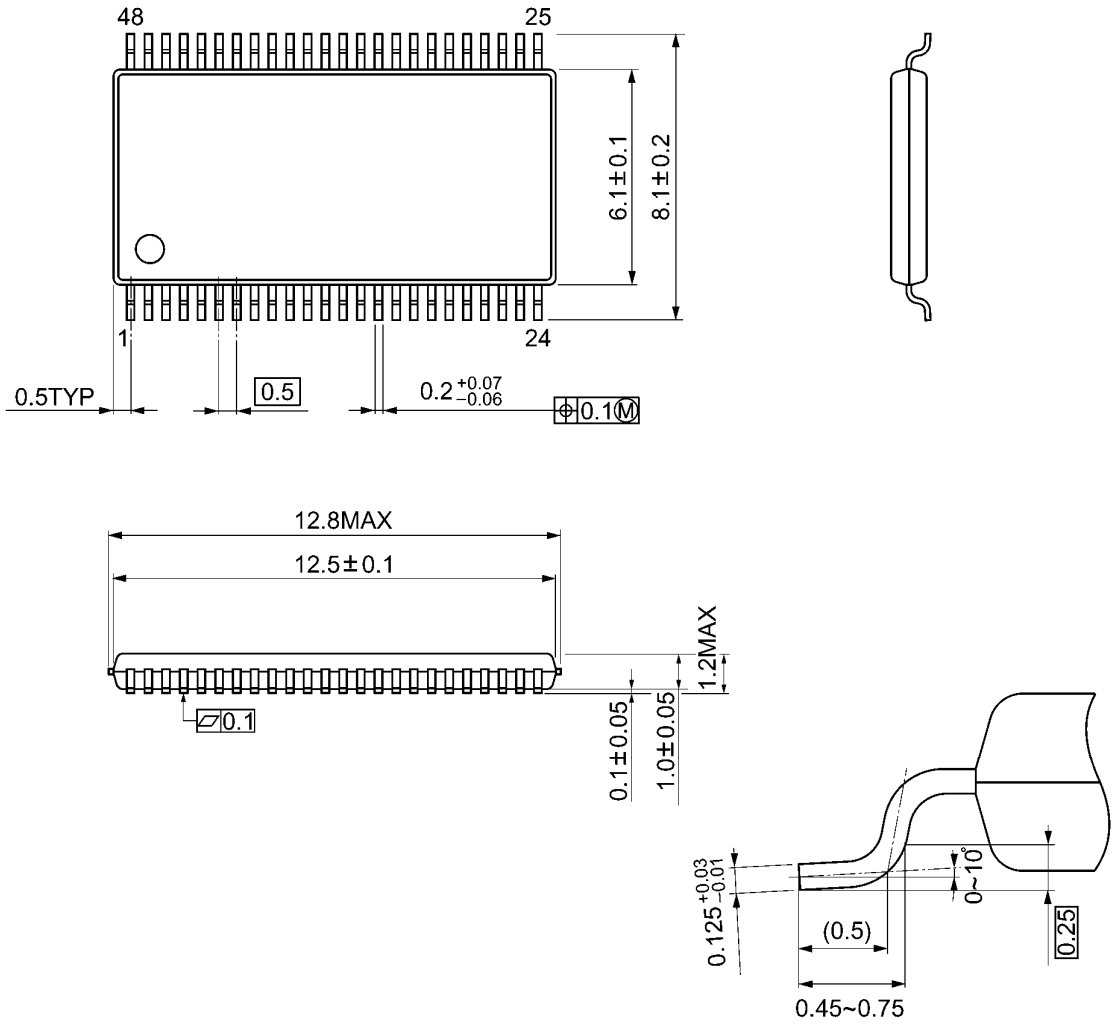



**Figure 3 $t_{pLZ}$, $t_{pHZ}$, $t_{pZL}$, $t_{pZH}$**

| Symbol | $V_{CC}$ | | |
|---|---|---|---|
| | 3.3 ± 0.3 V | 2.7 V | 2.5 ± 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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20070701-EN GENERAL

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