

**TC74LCX541F, TC74LCX541FT, TC74LCX541FK**

Low-Voltage Octal Bus Buffer with 5-V Tolerant Inputs and Outputs

The TC74LCX541 is a high-performance CMOS octal bus buffer. Designed for use in 3.3-V systems, it achieves high-speed operation while maintaining the CMOS low power dissipation.

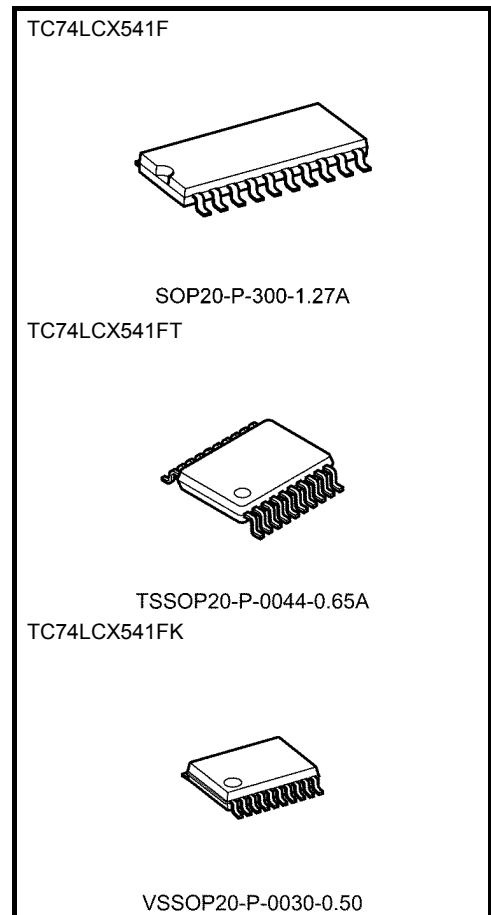
The device is designed for low-voltage (3.3 V) VCC applications, but it could be used to interface to 5 V supply environment for both inputs and outputs.

The TC74LCX541 is a non-inverting 3-state buffer having two active-low output enables. When either OE1 or OE2 are high, the terminal outputs are in the 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.

**Features**

- Low-voltage operation: VCC = 1.65 to 3.6 V
- High-speed operation: tpd = 6.5 ns (max) (VCC = 3.0 to 3.6 V)
- Output current: |IOH|/IOL = 24 mA (min) (VCC = 3.0 V)
- Latch-up performance: ≥ ±500 mA
- Available in JEITA SOP, TSSOP and VSSOP (US)
- Power-down protection provided on all inputs and outputs
- Pin and function compatible with the 74 series (74AC/VHC/HC/F/ALS/LS etc.) 541 type



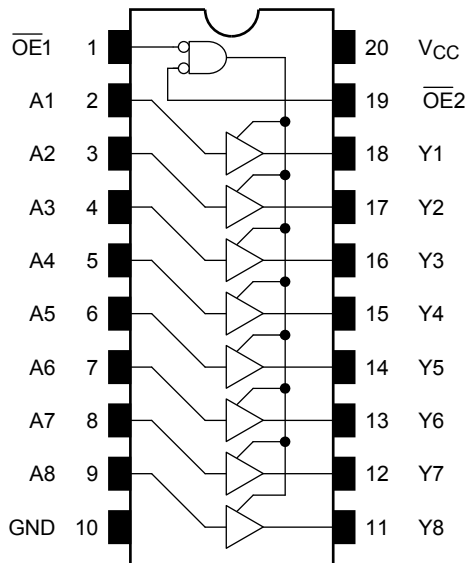
Weight:

|                      |                 |
|----------------------|-----------------|
| SOP20-P-300-1.27A    | : 0.22 g (typ.) |
| TSSOP20-P-0044-0.65A | : 0.08 g (typ.) |
| VSSOP20-P-0030-0.50  | : 0.03 g (typ.) |

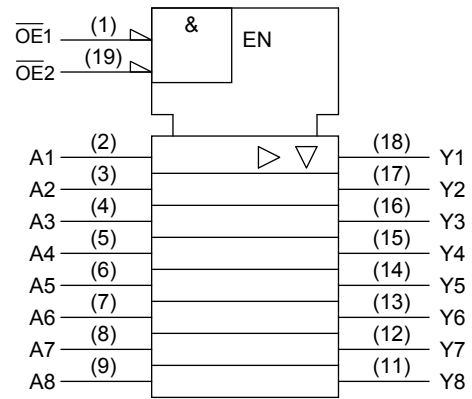
Note: The Electrical Characteristics of VCC=1.8±0.15V is only applicable for products which manufactured from January 2009 onward.

Start of commercial production  
1995-02

## Pin Assignment (top view)



## IEC Logic Symbol



## Truth Table

| Inputs           |                  |       | Outputs |
|------------------|------------------|-------|---------|
| $\overline{OE1}$ | $\overline{OE2}$ | $A_n$ |         |
| H                | X                | X     | Z       |
| X                | H                | X     | Z       |
| L                | L                | H     | H       |
| L                | L                | L     | L       |

X: Don't care

Z: High impedance

## Absolute Maximum Ratings (Note 1)

| Characteristics             | Symbol           | Rating                          | Unit |
|-----------------------------|------------------|---------------------------------|------|
| Power supply voltage        | $V_{CC}$         | -0.5 to 7.0                     | V    |
| DC input voltage            | $V_{IN}$         | -0.5 to 7.0                     | V    |
| DC 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           | $P_D$            | 180                             | mW   |
| DC $V_{CC}$ /ground current | $I_{CC}/I_{GND}$ | ±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     | $V_{CC}$        | 1.65 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)           |      |
| Operating temperature    | $T_{opr}$       | -40 to 85              | °C   |
| Input rise and fall time | $dt/dv$         | 0 to 10 (Note 7)       | 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:  $V_{IN} = 0.8$  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>  | —   | 1.65 to 2.3               | V <sub>CC</sub> ×0.9 | —                    | V    |   |
|                                       |         |                  |   | 2.3 to 2.7                | 1.7                  | —                    |      |   |
|                                       |         |                  |   | 2.7 to 3.6                | 2.0                  | —                    |      |   |
|                                       | L-level | V <sub>IL</sub>  | —   | 1.65 to 2.3               | —                    | V <sub>CC</sub> ×0.1 |      |   |
|                                       |         |                  |   | 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 | 1.65 to 3.6          | V <sub>CC</sub> -0.2 | V    |   |
|                                       |         |                  |   | I <sub>OH</sub> = -4 mA   | 1.65                 | 1.05                 |      | — |
|                                       |         |                  |   | I <sub>OH</sub> = -8 mA   | 2.3                  | 1.7                  |      | — |
|                                       |         |                  |   | 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  | 1.65 to 3.6          | —                    | 0.2  |   |
|                                       |         |                  |   | I <sub>OL</sub> = 4 mA    | 1.65                 | —                    | 0.45 |   |
|                                       |         |                  |   | I <sub>OL</sub> = 8 mA    | 2.3                  | —                    | 0.7  |   |
|                                       |         |                  |   | 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  | 1.65 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 | 1.65 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  | 1.65 to 3.6               | —                    | 10.0                 | μA   |   |
|                                       |         |                  | V <sub>IN</sub> /V <sub>OUT</sub> = 3.6 to 5.5 V                                      | 1.65 to 3.6               | —                    | ±10.0                |      |   |
| Increase in I <sub>CC</sub> per input |         | ΔI <sub>CC</sub> | V <sub>IH</sub> = V <sub>CC</sub> - 0.6 V   | 2.7 to 3.6                | —                    | 500                  |      |   |

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

| Characteristics        | Symbol                                 | Test Condition     | V <sub>CC</sub> (V) | Min | Max  | Unit |
|------------------------|--|--------------------|---------------------|-----|------|------|
|                        |  |                    |                     |     |      |      |
| Propagation delay time | t <sub>pLH</sub><br>t <sub>pHL</sub>   | Figure 1, Figure 2 | 1.8 ± 0.15          | —   | 25.0 | ns   |
|                        |  |                    | 2.5 ± 0.2           | —   | 8.5  |      |
|                        |  |                    | 2.7                 | —   | 7.5  |      |
|                        |  |                    | 3.3 ± 0.3           | 1.5 | 6.5  |      |
| Output enable time     | t <sub>pZL</sub><br>t <sub>pZH</sub>   | Figure 1, Figure 3 | 1.8 ± 0.15          | —   | 34.0 | ns   |
|                        |  |                    | 2.5 ± 0.2           | —   | 17.0 |      |
|                        |  |                    | 2.7                 | —   | 9.5  |      |
|                        |  |                    | 3.3 ± 0.3           | 1.5 | 8.5  |      |
| Output disable time    | t <sub>pLZ</sub><br>t <sub>pHZ</sub>   | Figure 1, Figure 3 | 1.8 ± 0.15          | —   | 32.0 | ns   |
|                        |  |                    | 2.5 ± 0.2           | —   | 16.0 |      |
|                        |  |                    | 2.7                 | —   | 8.5  |      |
|                        |  |                    | 3.3 ± 0.3           | 1.5 | 7.5  |      |
| Output to output skew  | t <sub>osLH</sub><br>t <sub>osHL</sub> | (Note)             | 2.7                 | —   | —    | ns   |
|                        |  |                    | 3.3 ± 0.3           | —   | 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: t<sub>r</sub> = t<sub>f</sub> = 2.5 ns, C<sub>L</sub> = 50 pF, R<sub>L</sub> = 500 Ω)

| Characteristics              | Symbol          | Test Condition   | V <sub>CC</sub> (V)                            | Typ. | Unit |   |
|------------------------------|-----------------|------------------|--|------|------|---|
|                              |                 |                  |  |      |      |   |
| Quiet output maximum dynamic | V <sub>OL</sub> | V <sub>OLP</sub> | V <sub>IH</sub> = 3.3 V, V <sub>IL</sub> = 0 V | 3.3  | 0.8  | V |
| Quiet output minimum dynamic | V <sub>OL</sub> | V <sub>OLV</sub> | V <sub>IH</sub> = 3.3 V, V <sub>IL</sub> = 0 V | 3.3  | 0.8  | V |

## Capacitive Characteristics (Ta = 25°C)

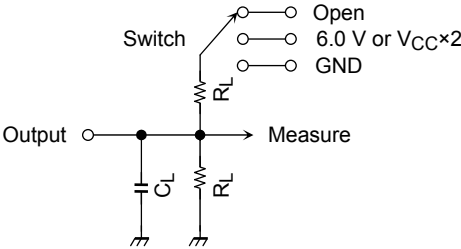
| Characteristics               | Symbol           | Test Condition           | V <sub>CC</sub> (V) | Typ. | Unit |    |
|-------------------------------|------------------|--------------------------|---------------------|------|------|----|
|                               |                  |                          |                     |      |      |    |
| Input capacitance             | C <sub>IN</sub>  | —                        | 3.3                 | 7    | pF   |    |
| Output capacitance            | C <sub>OUT</sub> | —                        | 3.3                 | 8    | pF   |    |
| Power dissipation capacitance | C <sub>PD</sub>  | f <sub>IN</sub> = 10 MHz | (Note)              | 3.3  | 40   | pF |

Note: C<sub>PD</sub> is defined as the value of the internal equivalent capacitance which is calculated from the operating current consumption.

Average operating current can be obtained by the equation:

$$I_{CC(opr)} = C_{PD} \cdot V_{CC} \cdot f_{IN} + I_{CC}/8 \text{ (per bit)}$$

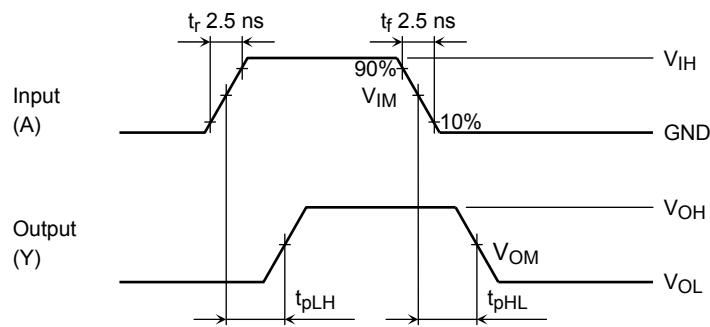
AC Test Circuit



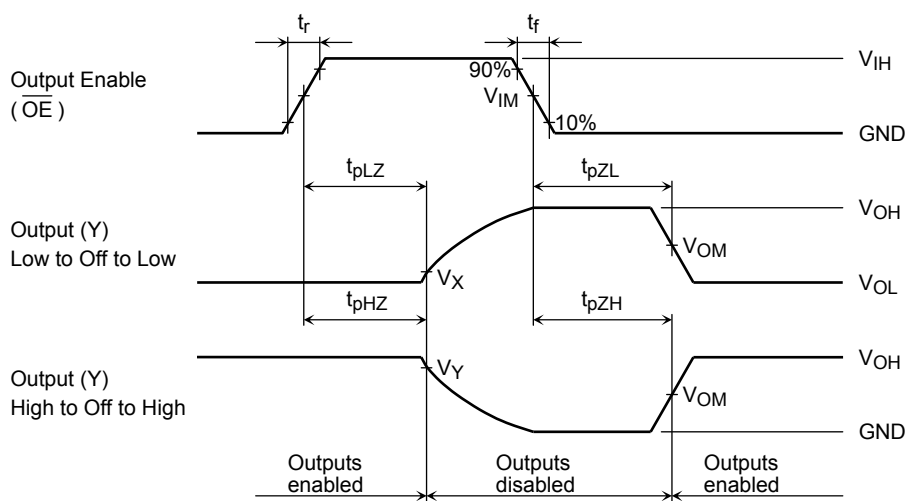
| Parameter          | Switch  |
|--------------------|---|
| $t_{pLH}, t_{pHL}$ | Open  |
| $t_{pLZ}, t_{pZL}$ | 6.0 V @ $V_{CC} = 3.3 \pm 0.3V$<br>@ $V_{CC} = 2.7V$                      |
|                    | $V_{CC} \times 2$ @ $V_{CC} = 2.5 \pm 0.2V$<br>@ $V_{CC} = 1.8 \pm 0.15V$ |
| $t_{pHZ}, t_{pZH}$ | GND   |

Figure 1

## AC Waveform



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



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

|        | Symbol     | $V_{CC}$                        |                         |                          |
|--------|------------|---------------------------------|-------------------------|--------------------------|
|        |            | $3.3 \pm 0.3 \text{ V}$<br>2.7V | $2.5 \pm 0.2 \text{ V}$ | $1.8 \pm 0.15 \text{ V}$ |
| Input  | $V_{IH}$   | 2.7V                            | $V_{CC}$                | $V_{CC}$                 |
|        | $V_{IM}$   | 1.5V                            | $V_{CC}/2$              | $V_{CC}/2$               |
|        | $t_r, t_f$ | 2.5ns                           | 2.0ns                   | 2.0ns                    |
| Output | $V_{OM}$   | 1.5V                            | $V_{OH}/2$              | $V_{OH}/2$               |
|        | $V_X$      | $V_{OL} + 0.3\text{V}$          | $V_{OL} + 0.15\text{V}$ | $V_{OL} + 0.15\text{V}$  |
|        | $V_Y$      | $V_{OH} - 0.3\text{V}$          | $V_{OH} - 0.15\text{V}$ | $V_{OH} - 0.15\text{V}$  |
| Load   | $C_L$      | 50pF                            | 30pF                    | 30pF                     |
|        | $R_L$      | 500 $\Omega$                    | 500 $\Omega$            | 1k $\Omega$              |

## Package Dimensions

SOP20-P-300-1.27A

Unit: mm



Weight: 0.22 g (typ.)



## Package Dimensions

TSSOP20-P-0044-0.65A

Unit: mm

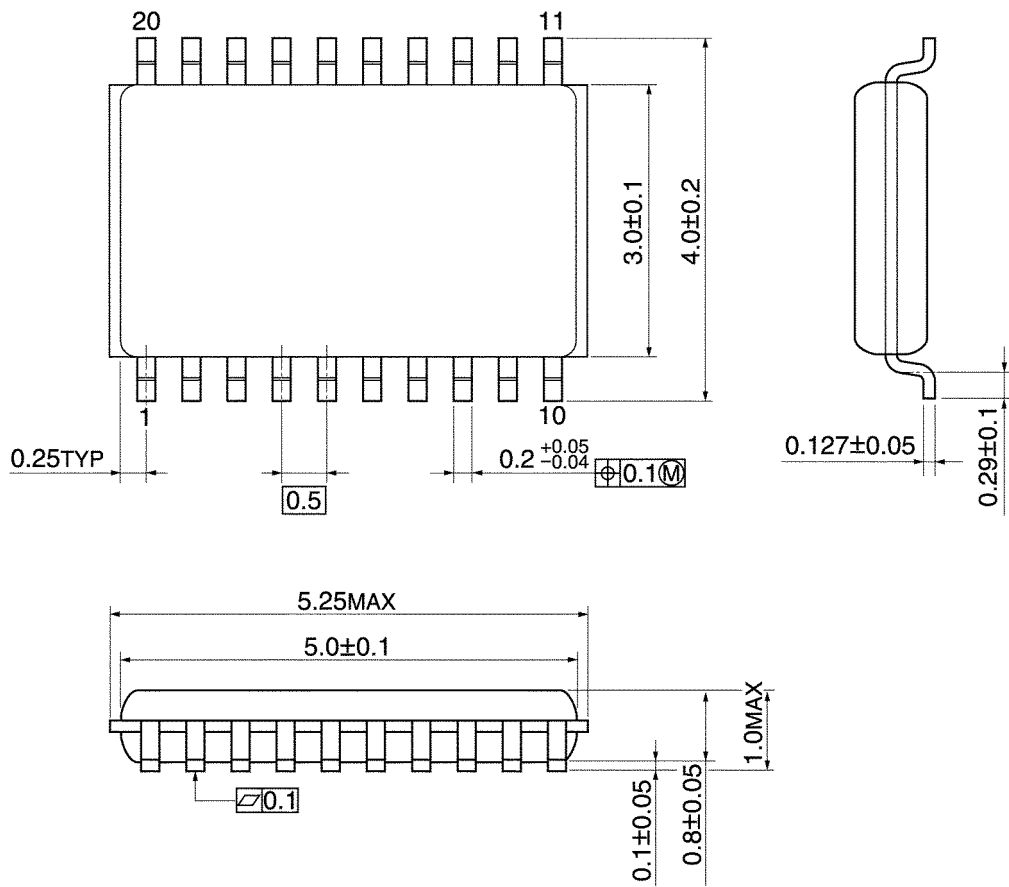


Weight: 0.08 g (typ.)

## Package Dimensions

VSSOP20-P-0030-0.50

Unit: mm



Weight: 0.03 g (typ.)

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