TOSHIBA CMOS Digital Integrated Circuit Silicon Monolithic

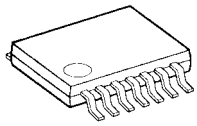
# TC74VCX32FT

## Low-Voltage Quad 2-Input OR Gate with 3.6-V Tolerant Inputs and Outputs

The TC74VCX32FT is a high-performance CMOS 2-input OR gate. 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.

All inputs are equipped with protection circuits against static discharge.



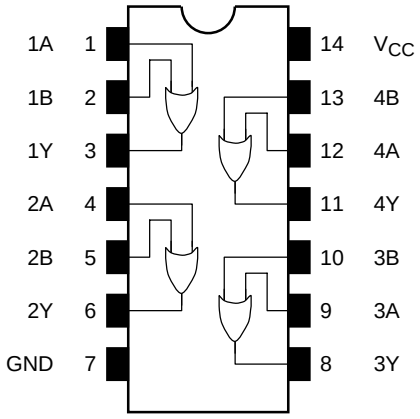
TSSOP14-P-0044-0.65

Weight: 0.06 g (typ.)

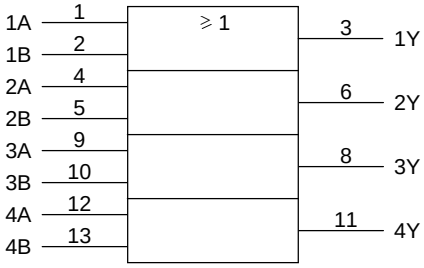
### Features

- Low-voltage operation: $V_{CC}$ = 1.8 to 3.6 V
- High-speed operation: $t_{pd}$ = 2.8 ns (max) ($V_{CC}$ = 3.0 to 3.6 V)
  : $t_{pd}$ = 3.7 ns (max) ($V_{CC}$ = 2.3 to 2.7 V)
  : $t_{pd}$ = 7.4 ns (max) ($V_{CC}$ = 1.8 V)
- Output current: $I_{OH}/I_{OL}$ = ±24 mA (min) ($V_{CC}$ = 3.0 V)
  : $I_{OH}/I_{OL}$ = ±18 mA (min) ($V_{CC}$ = 2.3 V)
  : $I_{OH}/I_{OL}$ = ±6 mA (min) ($V_{CC}$ = 1.8 V)
- Latch-up performance: ±300 mA
- ESD performance: Machine model > ±200 V
  : Human body model > ±2000 V
- Package: TSSOP (thin shrink small outline package)
- 3.6-V tolerant function and power-down protection provided on all inputs and outputs

## Pin Assignment (top view)




## IEC Logic Level




## Truth Table

| Inputs | | Outputs |
|---|---|---|
| A | B | Y |
| L | L | L |
| L | H | H |
| H | L | H |
| H | H | H |

## Maximum Ratings

| 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 1) | V |
| | | −0.5 to $V_{CC}$ + 0.5 (Note 2) | |
| Input diode current | $I_{IK}$ | −50 | mA |
| Output diode current | $I_{OK}$ | ±50 (Note 3) | 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: $V_{CC}$ = 0 V

Note 2: High or low state. $I_{OUT}$ absolute maximum rating must be observed.

Note 3: $V_{OUT} < GND$, $V_{OUT} > V_{CC}$

## Recommended Operating Range

| Characteristics | Symbol | Rating | Unit |
|---|---|---|---|
| Power supply voltage | $V_{CC}$ | 1.8 to 3.6 | V |
| | | 1.2 to 3.6 (Note 4) | |
| Input voltage | $V_{IN}$ | −0.3 to 3.6 | V |
| Output voltage | $V_{OUT}$ | 0 to 3.6 (Note 5) | V |
| | | 0 to $V_{CC}$ (Note 6) | |
| Output current | $I_{OH}/I_{OL}$ | ±24 (Note 7) | mA |
| | | ±18 (Note 8) | |
| | | ±6 (Note 9) | |
| Operating temperature | $T_{opr}$ | −40 to 85 | °C |
| Input rise and fall time | dt/dv | 0 to 10 (Note 10) | ns/V |

Note 4: Data retention only

Note 5: $V_{CC}$ = 0 V

Note 6: High or low state

Note 7: $V_{CC}$ = 3.0 to 3.6 V

Note 8: $V_{CC}$ = 2.3 to 2.7 V

Note 9: $V_{CC}$ = 1.8 V

Note 10: $V_{IN}$ = 0.8 to 2.0 V, $V_{CC}$ = 3.0 V

## Electrical Characteristics

## DC Characteristics (Ta = –40 to 85°C, 2.7 V < $V_{CC}$ ≦ 3.6 V)

| Characteristics | | Symbol | Test Condition | | $V_{CC}$ (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 |
| | | | | $I_{OH}$ = −12 mA | 2.7 | 2.2 | — | |
| | | | | $I_{OH}$ = −18 mA | 3.0 | 2.4 | — | |
| | | | | $I_{OH}$ = −24 mA | 3.0 | 2.2 | — | |
| | L-level | $V_{OL}$ | $V_{IN}$ = $V_{IL}$ | $I_{OL}$ = 100 μA | 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 |
| | | | $V_{CC}$ ≦ $V_{IN}$ ≦ 3.6 V | | 2.7 to 3.6 | — | ±20.0 | |
| Increase in $I_{CC}$ per input | | $\Delta I_{CC}$ | $V_{IH}$ = $V_{CC}$ − 0.6 V | | 2.7 to 3.6 | — | 750 | |

## DC Characteristics (Ta = –40 to 85°C, 2.3 V ≦ $V_{CC}$ ≦ 2.7 V)

| Characteristics | | Symbol | Test Condition | | $V_{CC}$ (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 |
| | | | | $I_{OH}$ = –6 mA | 2.3 | 2.0 | — | |
| | | | | $I_{OH}$ = –12 mA | 2.3 | 1.8 | — | |
| | | | | $I_{OH}$ = –18 mA | 2.3 | 1.7 | — | |
| | L-level | $V_{OL}$ | $V_{IN}$ = $V_{IL}$ | $I_{OL}$ = 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, 1.8 V ≦ $V_{CC}$ < 2.3 V)

| Characteristics | | Symbol | Test Condition | | $V_{CC}$ (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 |
| | | | | $I_{OH}$ = –6 mA | 1.8 | 1.4 | — | |
| | L-level | $V_{OL}$ | $V_{IN}$ = $V_{IL}$ | $I_{OL}$ = 100 μA | 1.8 | — | 0.2 | |
| | | | | $I_{OL}$ = 6 mA | 1.8 | — | 0.3 | |
| Input leakage current | | $I_{IN}$ | $V_{IN}$ = 0 to 3.6 V | | 1.8 | — | ±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 | | 1.8 | — | 20.0 | μA |
| | | | $V_{CC}$ ≦ $V_{IN}$ ≦ 3.6 V | | 1.8 | — | ±20.0 | |

## AC Characteristics (Ta = –40 to 85°C, input: $t_r = t_f = 2.0$ ns, $C_L = 30$ pF, $R_L = 500\ \Omega$)

| Characteristics | Symbol | Test Condition | $V_{CC}$ (V) | Min | Max | Unit |
|---|---|---|---|---|---|---|
| Propagation delay time | $t_{pLH}$ $t_{pHL}$ | Figure 1, Figure 2 | 1.8 | 1.0 | 7.4 | ns |
| | | | 2.5 ± 0.2 | 0.8 | 3.7 | |
| | | | 3.3 ± 0.3 | 0.6 | 2.8 | |
| Output to output skew | $t_{osLH}$ $t_{osHL}$ | (Note 11) | 1.8 | — | 0.5 | ns |
| | | | 2.5 ± 0.2 | — | 0.5 | |
| | | | 3.3 ± 0.3 | — | 0.5 | |

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

Note 11: Parameter guaranteed by design.
($t_{osLH} = |t_{pLHm} - t_{pLHn}|$, $t_{osHL} = |t_{pHLm} - t_{pHLn}|$)

## Dynamic Switching Characteristics (Ta = 25°C, input: $t_r = t_f = 2.0$ ns, $C_L = 30$ pF)

| Characteristics | Symbol | Test Condition | $V_{CC}$ (V) | Typ. | Unit |
|---|---|---|---|---|---|
| Quiet output maximum dynamic $V_{OL}$ | $V_{OLP}$ | $V_{IH}$ = 1.8 V, $V_{IL}$ = 0 V (Note 12) | 1.8 | 0.25 | V |
| | | $V_{IH}$ = 2.5 V, $V_{IL}$ = 0 V (Note 12) | 2.5 | 0.6 | |
| | | $V_{IH}$ = 3.3 V, $V_{IL}$ = 0 V (Note 12) | 3.3 | 0.8 | |
| Quiet output minimum dynamic $V_{OL}$ | $V_{OLV}$ | $V_{IH}$ = 1.8 V, $V_{IL}$ = 0 V (Note 12) | 1.8 | –0.25 | V |
| | | $V_{IH}$ = 2.5 V, $V_{IL}$ = 0 V (Note 12) | 2.5 | –0.6 | |
| | | $V_{IH}$ = 3.3 V, $V_{IL}$ = 0 V (Note 12) | 3.3 | –0.8 | |
| Quiet output minimum dynamic $V_{OH}$ | $V_{OHV}$ | $V_{IH}$ = 1.8 V, $V_{IL}$ = 0 V (Note 12) | 1.8 | 1.5 | V |
| | | $V_{IH}$ = 2.5 V, $V_{IL}$ = 0 V (Note 12) | 2.5 | 1.9 | |
| | | $V_{IH}$ = 3.3 V, $V_{IL}$ = 0 V (Note 12) | 3.3 | 2.2 | |

Note 12: Parameter guaranteed by design.

## Capacitive Characteristics (Ta = 25°C)

| Characteristics | Symbol | Test Condition | $V_{CC}$ (V) | Typ. | Unit |
|---|---|---|---|---|---|
| Input capacitance | $C_{IN}$ | — | 1.8, 2.5, 3.3 | 6 | pF |
| Power dissipation capacitance | $C_{PD}$ | $f_{IN}$ = 10 MHz (Note 13) | 1.8, 2.5, 3.3 | 20 | pF |

Note 13: $C_{PD}$ 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:
$I_{CC\ (opr)} = C_{PD} \cdot V_{CC} \cdot f_{IN} + I_{CC}/4$ (per gate)

## AC Test Circuit

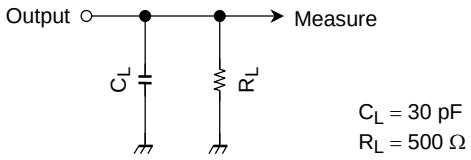
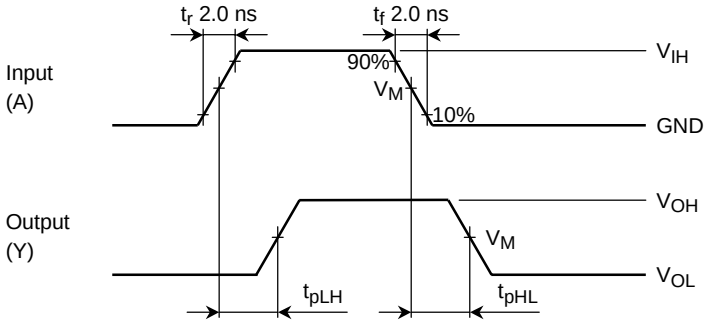



**Figure 1**

## AC Waveform

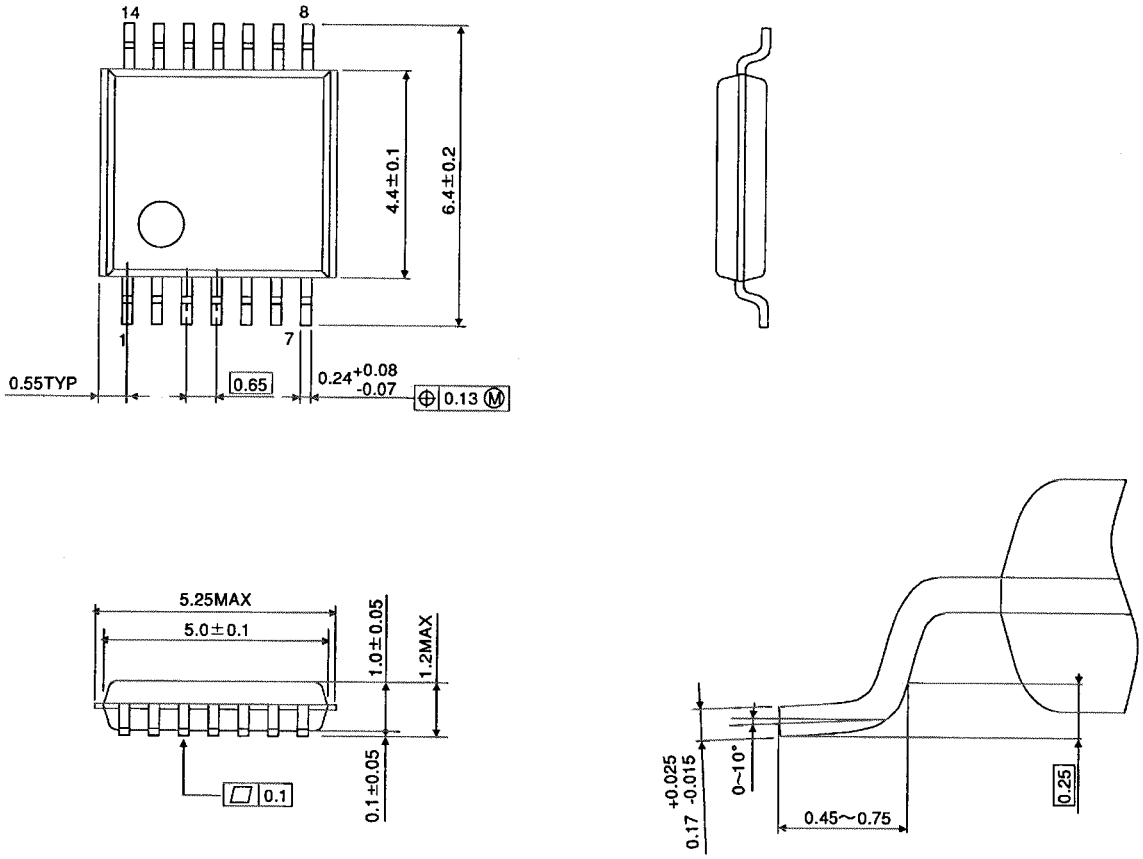



| Symbol | $V_{CC}$ | | |
|---|---|---|---|
| | 3.3 ± 0.3 V | 2.5 ± 0.2 V | 1.8 V |
| $V_{IH}$ | 2.7 V | $V_{CC}$ | $V_{CC}$ |
| $V_M$ | 1.5 V | $V_{CC}/2$ | $V_{CC}/2$ |

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

## Package Dimensions

TSSOP14-P-0044-0.65 Unit : mm




Weight: 0.06 g (typ.)

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000707EBA

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