TOSHIBA CMOS Digital Integrated Circuit Silicon Monolithic

# TC74VCX164245FT

16-Bit Dual Supply Bus Transceiver

The TC74VCX164245FT is a dual supply, advanced high-speed CMOS 16-bit bus transceiver fabricated with silicon gate CMOS technology.

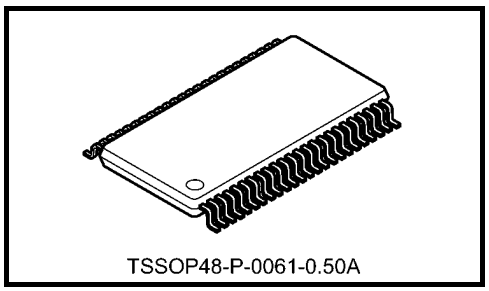
It is also designed with over voltage tolerant inputs and outputs up to 3.6 V.

Designed for use as an interface between a 3.3-V or 2.5-V bus and a 2.5-V or 1.8-V bus in mixed 3.3-V or 2.5-V/2.5-V or 1.8-V supply systems.

The B-port interfaces with the 3.3-V or 2.5-V bus, the A-port with the 2.5-V or 1.8-V bus.

The direction of data transmission is determined by the level of the DIR input. The enable input ( $\overline{OE}$ ) can be used to disable the device so that the buses are effectively isolated.

All inputs are equipped with protection circuits against static discharge or transient excess voltage.



TSSOP48-P-0061-0.50A

Weight: 0.25 g (typ.)

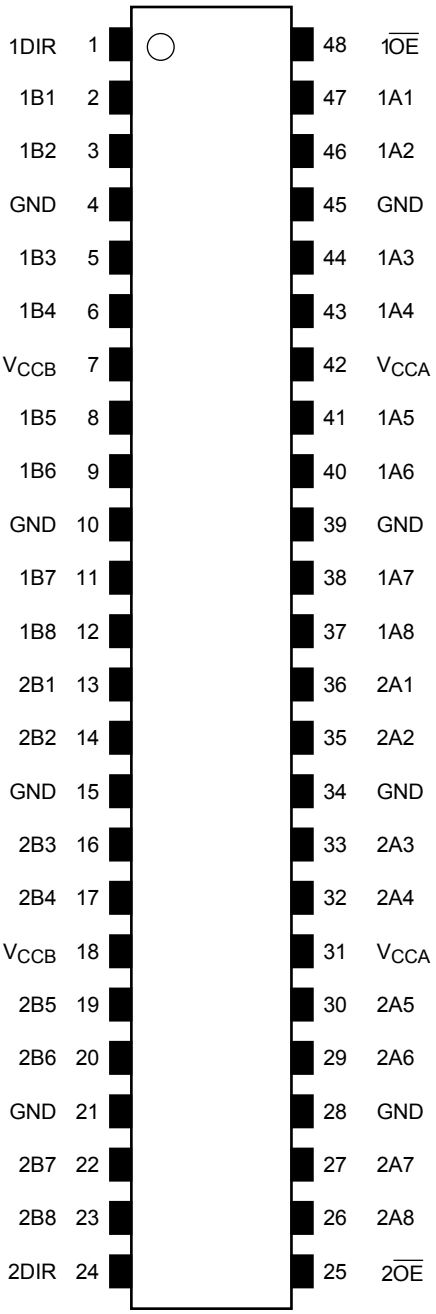
## Features (Note)

- Bidirectional interface between 3.3 V and 2.5 V, 3.3 V and 1.8 V, 2.5 V and 1.8 V
- High-speed: $t_{pd}$ = 4.6 ns (max) ($V_{CCB}$ = 3.3 ± 0.3 V, $V_{CCA}$ = 2.5 ± 0.2 V)
- $t_{pd}$ = 7.1 ns (max) ($V_{CCB}$ = 3.3 ± 0.3 V, $V_{CCA}$ = 1.8 ± 0.15 V)
- $t_{pd}$ = 7.0 ns (max) ($V_{CCB}$ = 2.5 ± 0.2 V, $V_{CCA}$ = 1.8 ± 0.15 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) ($V_{CC}$ = 1.65 V)
- Latch-up performance: −300 mA
- ESD performance: Machine model ≥ ±200 V
  Human body model ≥ ±2000 V
- Package: TSSOP
- 3.6-V tolerant function and power-down protection provided on all inputs and outputs

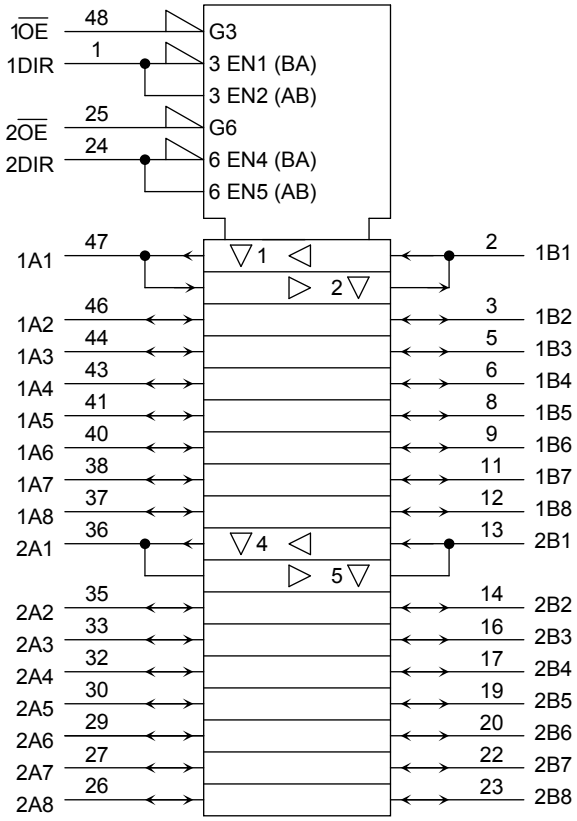
Note: Do not apply a signal to any bus pins when it is in the output mode. Damage may result.
All floating (high impedance) bus pins must have their input level fixed by means of pull-up or pull-down resistors.

Start of commercial production
2001-06

## Pin Assignment (top view)




## IEC Logic Symbol



## Truth Table

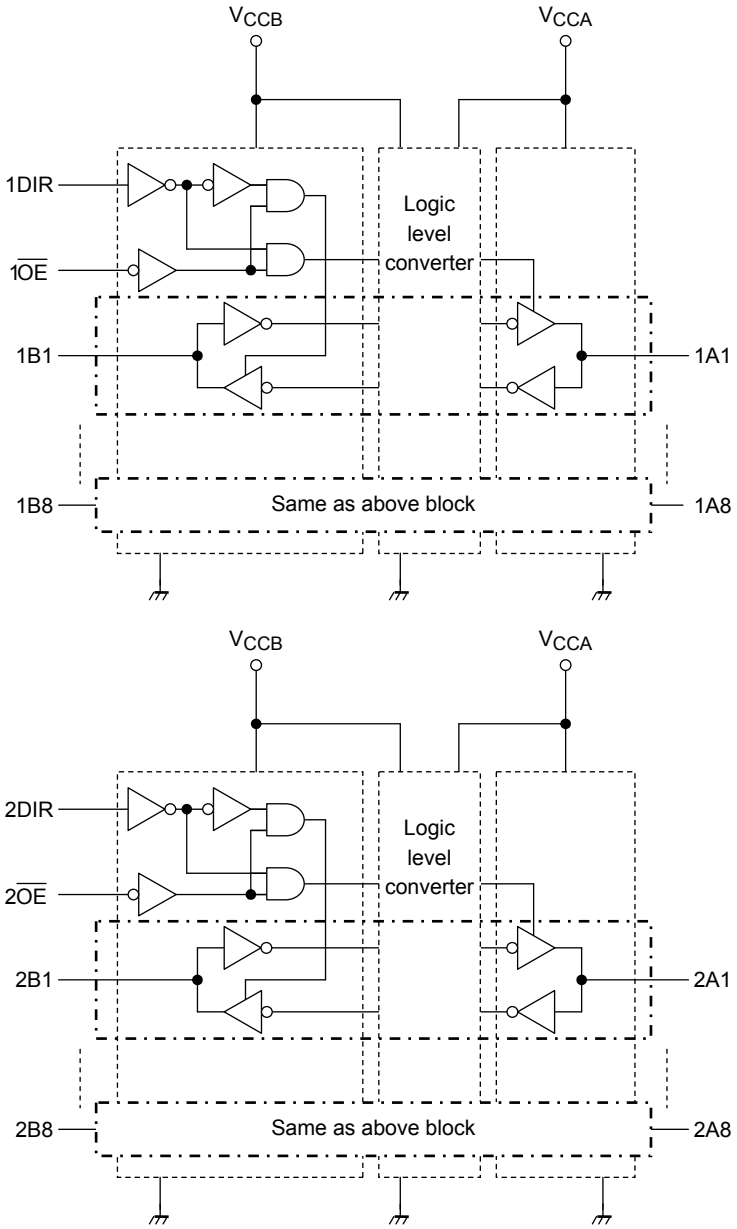
| Inputs | | Function | | Outputs |
|---|---|---|---|---|
| $1\overline{OE}$ | 1DIR | Bus 1A1-1A8 | Bus 1B1-1B8 | |
| L | L | Output | Input | A = B |
| L | H | Input | Output | B = A |
| H | X | Z | | Z |

| Inputs | | Function | | Outputs |
|---|---|---|---|---|
| $2\overline{OE}$ | 2DIR | Bus 2A1-2A8 | Bus 2B1-2B8 | |
| L | L | Output | Input | A = B |
| L | H | Input | Output | B = A |
| H | X | Z | | Z |

X: Don’t care

Z: High impedance

## Block Diagram



## Absolute Maximum Ratings (Note 1)

| Characteristics | Symbol | Rating | Unit |
|---|---|---|---|
| Power supply voltage (Note 2) | $V_{CCB}$ | −0.5 to 4.6 | V |
| | $V_{CCA}$ | −0.5 to $V_{CCB}$ | |
| DC input voltage (DIR, $\overline{OE}$) | $V_{IN}$ | −0.5 to 4.6 | V |
| DC bus I/O voltage | $V_{I/OB}$ | −0.5 to 4.6 (Note 3) | V |
| | | −0.5 to $V_{CCB}$ + 0.5 (Note 4) | |
| | $V_{I/OA}$ | −0.5 to 4.6 (Note 3) | |
| | | −0.5 to $V_{CCA}$ + 0.5 (Note 4) | |
| Input diode current | $I_{IK}$ | −50 | mA |
| Output diode current | $I_{I/OK}$ | ±50 (Note 5) | mA |
| DC output current | $I_{OUTB}$ | ±50 | mA |
| | $I_{OUTA}$ | ±50 | |
| DC $V_{CC}$/ground current per supply pin | $I_{CCB}$ | ±100 | mA |
| | $I_{CCA}$ | ±100 | |
| Power dissipation | $P_D$ | 400 | mW |
| 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: Don’t supply a voltage to $V_{CCA}$ terminal when $V_{CCB}$ is in the off-state.

Note 3: OFF state

Note 4: High or low state. $I_{OUT}$ absolute maximum rating must be observed.

Note 5: $V_{OUT} < GND$, $V_{OUT} > V_{CC}$

## Operating Ranges (Note 1)

| Characteristics | Symbol | Rating | Unit |
|---|---|---|---|
| Power supply voltage (Note 2) | $V_{CCB}$ | 2.3 to 3.6 | V |
| | $V_{CCA}$ | 1.65 to 2.7 | |
| Input voltage (DIR, $\overline{OE}$) | $V_{IN}$ | 0 to 3.6 | V |
| Bus I/O voltage | $V_{I/OB}$ | 0 to 3.6 (Note 3) | V |
| | | 0 to $V_{CCB}$ (Note 4) | |
| | $V_{I/OA}$ | 0 to 3.6 (Note 3) | |
| | | 0 to $V_{CCA}$ (Note 4) | |
| Output current | $I_{OUTB}$ | ±24 (Note 5) | mA |
| | | ±18 (Note 6) | |
| | $I_{OUTA}$ | ±18 (Note 7) | |
| | | ±6 (Note 8) | |
| Operating temperature | $T_{opr}$ | −40 to 85 | °C |
| Input rise and fall time | dt/dv | 0 to 10 (Note 9) | ns/V |

Note 1: The operating ranges must be maintained to ensure the normal operation of the device. Unused inputs and bus inputs must be tied to either $V_{CC}$ or GND. Please connect both bus inputs and the bus outputs with $V_{CC}$ or GND when the I/O of the bus terminal changes by the function. In this case, please note that the output is not short-circuited.

Note 2: Don't use in $V_{CCA} > V_{CCB}$.

Note 3: Output in OFF state

Note 4: High or low state

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

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

Note 7: $V_{CCA} = 2.3$ to 2.7 V

Note 8: $V_{CCA} = 1.65$ to 1.95 V

Note 9: $V_{INB} = 0.8$ to 2.0 V, $V_{CCB} = 3.0$ V
$V_{INA} = 0.7$ to 1.6 V, $V_{CCA} = 2.5$ V

## Electrical Characteristics

### DC Characteristics ($V_{CCB}$ = 3.3 ± 0.3 V, $V_{CCA}$ = 2.5 ± 0.2 V)

| Characteristics | Symbol | Test Condition | | $V_{CCB}$ (V) | $V_{CCA}$ (V) | Ta = −40 to 85°C | | Unit |
|---|---|---|---|---|---|---|---|---|
| | | | | | | Min | Max | |
| H-level input voltage | $V_{IHB}$ | DIR, $\overline{OE}$, Bn | | 3.3 ± 0.3 | 2.5 ± 0.2 | 2.0 | — | V |
| | $V_{IHA}$ | An | | 3.3 ± 0.3 | 2.5 ± 0.2 | 1.6 | — | |
| L-level input voltage | $V_{ILB}$ | DIR, $\overline{OE}$, Bn | | 3.3 ± 0.3 | 2.5 ± 0.2 | — | 0.8 | V |
| | $V_{ILA}$ | An | | 3.3 ± 0.3 | 2.5 ± 0.2 | — | 0.7 | |
| H-level output voltage | $V_{OHB}$ | $V_{IN}$ = $V_{IH}$ or $V_{IL}$ | $I_{OHB}$ = −100 μA | 3.3 ± 0.3 | 2.5 ± 0.2 | $V_{CCB}$ − 0.2 | — | V |
| | | | $I_{OHB}$ = −24 mA | 3.0 | 2.5 ± 0.2 | 2.2 | — | |
| | $V_{OHA}$ | | $I_{OHA}$ = −100 μA | 3.3 ± 0.3 | 2.5 ± 0.2 | $V_{CCA}$ − 0.2 | — | |
| | | | $I_{OHA}$ = −18 mA | 3.3 ± 0.3 | 2.3 | 1.7 | — | |
| L-level output voltage | $V_{OLB}$ | $V_{IN}$ = $V_{IH}$ or $V_{IL}$ | $I_{OLB}$ = 100 μA | 3.3 ± 0.3 | 2.5 ± 0.2 | — | 0.2 | V |
| | | | $I_{OLB}$ = 24 mA | 3.0 | 2.5 ± 0.2 | — | 0.55 | |
| | $V_{OLA}$ | | $I_{OLA}$ = 100 μA | 3.3 ± 0.3 | 2.5 ± 0.2 | — | 0.2 | |
| | | | $I_{OLA}$ = 18 mA | 3.3 ± 0.3 | 2.3 | — | 0.6 | |
| 3-state output OFF state current | $I_{OZB}$ | $V_{IN}$ = $V_{IH}$ or $V_{IL}$<br>$V_{OUT}$ = 0 to 3.6 V | | 3.3 ± 0.3 | 2.5 ± 0.2 | — | ±10 | μA |
| | $I_{OZA}$ | $V_{IN}$ = $V_{IH}$ or $V_{IL}$<br>$V_{OUT}$ = 0 to 3.6 V | | 3.3 ± 0.3 | 2.5 ± 0.2 | — | ±10 | |
| Input leakage current | $I_{IN}$ | $V_{IN}$ (DIR, $\overline{OE}$) = 0 to 3.6 V | | 3.3 ± 0.3 | 2.5 ± 0.2 | — | ±5.0 | μA |
| Power-off leakage current | $I_{OFF}$ | $V_{IN}$, $V_{OUT}$ = 0 to 3.6 V | | 0 | 0 | — | 10 | μA |
| Quiescent supply current | $I_{CCB}$ | $V_{INA}$ = $V_{CCA}$ or GND<br>$V_{INB}$ = $V_{CCB}$ or GND | | 3.3 ± 0.3 | 2.5 ± 0.2 | — | 20 | μA |
| | $I_{CCA}$ | $V_{INA}$ = $V_{CCA}$ or GND<br>$V_{INB}$ = $V_{CCB}$ or GND | | 3.3 ± 0.3 | 2.5 ± 0.2 | — | 20 | |
| | $I_{CCB}$ | $V_{CCB}$ < ($V_{IN}$, $V_{OUT}$) ≤ 3.6 V | | 3.3 ± 0.3 | 2.5 ± 0.2 | — | ±20 | μA |
| | $I_{CCA}$ | $V_{CCA}$ ≤ ($V_{IN}$, $V_{OUT}$) ≤ 3.6 V | | 3.3 ± 0.3 | 2.5 ± 0.2 | — | ±20 | |
| | $I_{CCTB}$ | $V_{INB}$ = $V_{CCB}$ − 0.6 V per input | | 3.3 ± 0.3 | 2.5 ± 0.2 | — | 750 | μA |
| | $I_{CCTA}$ | $V_{INA}$ = $V_{CCA}$ − 0.6 V per input | | 3.3 ± 0.3 | 2.5 ± 0.2 | — | 750 | μA |

## DC Characteristics ($V_{CCB}$ = 3.3 ± 0.3 V, $V_{CCA}$ = 1.8 ± 0.15 V)

| Characteristics | Symbol | Test Condition | | $V_{CCB}$ (V) | $V_{CCA}$ (V) | Ta = −40 to 85°C | | Unit |
|---|---|---|---|---|---|---|---|---|
| | | | | | | Min | Max | |
| H-level input voltage | $V_{IHB}$ | DIR, $\overline{OE}$, Bn | | 3.3 ± 0.3 | 1.8 ± 0.15 | 2.0 | — | V |
| | $V_{IHA}$ | An | | 3.3 ± 0.3 | 1.8 ± 0.15 | 0.65 × $V_{CCA}$ | — | |
| L-level input voltage | $V_{ILB}$ | DIR, $\overline{OE}$, Bn | | 3.3 ± 0.3 | 1.8 ± 0.15 | — | 0.8 | V |
| | $V_{ILA}$ | An | | 3.3 ± 0.3 | 1.8 ± 0.15 | — | 0.35 × $V_{CCA}$ | |
| H-level output voltage | $V_{OHB}$ | $V_{IN}$ = $V_{IH}$ or $V_{IL}$ | $I_{OHB}$ = −100 μA | 3.3 ± 0.3 | 1.8 ± 0.15 | $V_{CCB}$ − 0.2 | — | V |
| | | | $I_{OHB}$ = −24 mA | 3.0 | 1.8 ± 0.15 | 2.2 | — | |
| | $V_{OHA}$ | | $I_{OHA}$ = −100 μA | 3.3 ± 0.3 | 1.8 ± 0.15 | $V_{CCA}$ − 0.2 | — | |
| | | | $I_{OHA}$ = −6 mA | 3.3 ± 0.3 | 1.65 | 1.25 | — | |
| L-level output voltage | $V_{OLB}$ | $V_{IN}$ = $V_{IH}$ or $V_{IL}$ | $I_{OLB}$ = 100 μA | 3.3 ± 0.3 | 1.8 ± 0.15 | — | 0.2 | V |
| | | | $I_{OLB}$ = 24 mA | 3.0 | 1.8 ± 0.15 | — | 0.55 | |
| | $V_{OLA}$ | | $I_{OLA}$ = 100 μA | 3.3 ± 0.3 | 1.8 ± 0.15 | — | 0.2 | |
| | | | $I_{OLA}$ = 6 mA | 3.3 ± 0.3 | 1.65 | — | 0.3 | |
| 3-state output OFF state current | $I_{OZB}$ | $V_{IN}$ = $V_{IH}$ or $V_{IL}$<br>$V_{OUT}$ = 0 to 3.6 V | | 3.3 ± 0.3 | 1.8 ± 0.15 | — | ±10 | μA |
| | $I_{OZA}$ | $V_{IN}$ = $V_{IH}$ or $V_{IL}$<br>$V_{OUT}$ = 0 to 3.6 V | | 3.3 ± 0.3 | 1.8 ± 0.15 | — | ±10 | |
| Input leakage current | $I_{IN}$ | $V_{IN}$ (DIR, $\overline{OE}$) = 0 to 3.6 V | | 3.3 ± 0.3 | 1.8 ± 0.15 | — | ±5.0 | μA |
| Power-off leakage current | $I_{OFF}$ | $V_{IN}$, $V_{OUT}$ = 0 to 3.6 V | | 0 | 0 | — | 10 | μA |
| Quiescent supply current | $I_{CCB}$ | $V_{INA}$ = $V_{CCA}$ or GND<br>$V_{INB}$ = $V_{CCB}$ or GND | | 3.3 ± 0.3 | 1.8 ± 0.15 | — | 20 | μA |
| | $I_{CCA}$ | $V_{INA}$ = $V_{CCA}$ or GND<br>$V_{INB}$ = $V_{CCB}$ or GND | | 3.3 ± 0.3 | 1.8 ± 0.15 | — | 20 | |
| | $I_{CCB}$ | $V_{CCB}$ < ($V_{IN}$, $V_{OUT}$) ≤ 3.6 V | | 3.3 ± 0.3 | 1.8 ± 0.15 | — | ±20 | μA |
| | $I_{CCA}$ | $V_{CCA}$ ≤ ($V_{IN}$, $V_{OUT}$) ≤ 3.6 V | | 3.3 ± 0.3 | 1.8 ± 0.15 | — | ±20 | |
| | $I_{CCTB}$ | $V_{INB}$ = $V_{CCB}$ − 0.6 V per input | | 3.3 ± 0.3 | 1.8 ± 0.15 | — | 750 | μA |
| | $I_{CCTA}$ | $V_{INA}$ = $V_{CCA}$ − 0.6 V per input | | 3.3 ± 0.3 | 1.8 ± 0.15 | — | 750 | μA |

## DC Characteristics ($V_{CCB}$ = 2.5 ± 0.2 V, $V_{CCA}$ = 1.8 ± 0.15 V)

| Characteristics | Symbol | Test Condition | | $V_{CCB}$ (V) | $V_{CCA}$ (V) | Ta = −40 to 85°C | | Unit |
|---|---|---|---|---|---|---|---|---|
| | | | | | | Min | Max | |
| H-level input voltage | $V_{IHB}$ | DIR, $\overline{OE}$, Bn | | 2.5 ± 0.2 | 1.8 ± 0.15 | 1.6 | — | V |
| | $V_{IHA}$ | An | | 2.5 ± 0.2 | 1.8 ± 0.15 | 0.65 × $V_{CCA}$ | — | |
| L-level input voltage | $V_{ILB}$ | DIR, $\overline{OE}$, Bn | | 2.5 ± 0.2 | 1.8 ± 0.15 | — | 0.7 | V |
| | $V_{ILA}$ | An | | 2.5 ± 0.2 | 1.8 ± 0.15 | — | 0.35 × $V_{CCA}$ | |
| H-level output voltage | $V_{OHB}$ | $V_{IN}$ = $V_{IH}$ or $V_{IL}$ | $I_{OHB}$ = −100 μA | 2.5 ± 0.2 | 1.8 ± 0.15 | $V_{CCB}$ − 0.2 | — | V |
| | | | $I_{OHB}$ = −18 mA | 2.3 | 1.8 ± 0.15 | 1.7 | — | |
| | $V_{OHA}$ | | $I_{OHA}$ = −100 μA | 2.5 ± 0.2 | 1.8 ± 0.15 | $V_{CCA}$ − 0.2 | — | |
| | | | $I_{OHA}$ = −6 mA | 2.5 ± 0.2 | 1.65 | 1.25 | — | |
| L-level output voltage | $V_{OLB}$ | $V_{IN}$ = $V_{IH}$ or $V_{IL}$ | $I_{OLB}$ = 100 μA | 2.5 ± 0.2 | 1.8 ± 0.15 | — | 0.2 | V |
| | | | $I_{OLB}$ = 18 mA | 2.3 | 1.8 ± 0.15 | — | 0.6 | |
| | $V_{OLA}$ | | $I_{OLA}$ = 100 μA | 2.5 ± 0.2 | 1.8 ± 0.15 | — | 0.2 | |
| | | | $I_{OLA}$ = 6 mA | 2.5 ± 0.2 | 1.65 | — | 0.3 | |
| 3-state output OFF state current | $I_{OZB}$ | $V_{IN}$ = $V_{IH}$ or $V_{IL}$<br>$V_{OUT}$ = 0 to 3.6 V | | 2.5 ± 0.2 | 1.8 ± 0.15 | — | ±10 | μA |
| | $I_{OZA}$ | $V_{IN}$ = $V_{IH}$ or $V_{IL}$<br>$V_{OUT}$ = 0 to 3.6 V | | 2.5 ± 0.2 | 1.8 ± 0.15 | — | ±10 | |
| Input leakage current | $I_{IN}$ | $V_{IN}$ (DIR, $\overline{OE}$) = 0 to 3.6 V | | 2.5 ± 0.2 | 1.8 ± 0.15 | — | ±5.0 | μA |
| Power-off leakage current | $I_{OFF}$ | $V_{IN}$, $V_{OUT}$ = 0 to 3.6 V | | 0 | 0 | — | 10 | μA |
| Quiescent supply current | $I_{CCB}$ | $V_{INA}$ = $V_{CCA}$ or GND<br>$V_{INB}$ = $V_{CCB}$ or GND | | 2.5 ± 0.2 | 1.8 ± 0.15 | — | 20 | μA |
| | $I_{CCA}$ | $V_{INA}$ = $V_{CCA}$ or GND<br>$V_{INB}$ = $V_{CCB}$ or GND | | 2.5 ± 0.2 | 1.8 ± 0.15 | — | 20 | |
| | $I_{CCB}$ | $V_{CCB}$ < ($V_{IN}$, $V_{OUT}$) ≤ 3.6 V | | 2.5 ± 0.2 | 1.8 ± 0.15 | — | ±20 | μA |
| | $I_{CCA}$ | $V_{CCA}$ ≤ ($V_{IN}$, $V_{OUT}$) ≤ 3.6 V | | 2.5 ± 0.2 | 1.8 ± 0.15 | — | ±20 | |
| | $I_{CCTB}$ | $V_{INB}$ = $V_{CCB}$ − 0.6 V per input | | 2.5 ± 0.2 | 1.8 ± 0.15 | — | 750 | μA |
| | $I_{CCTA}$ | $V_{INA}$ = $V_{CCA}$ − 0.6 V per input | | 2.5 ± 0.2 | 1.8 ± 0.15 | — | 750 | μA |

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

### $V_{CCB} = 3.3 \pm 0.3$ V, $V_{CCA} = 2.5 \pm 0.2$ V

| Characteristics | Symbol | Test Condition | Min | Max | Unit |
|---|---|---|---|---|---|
| Propagation delay time (Bn → An) | $t_{pLH}$ $t_{pHL}$ | Figure 1, Figure 2 | 0.8 | 4.6 | ns |
| 3-state output enable time ($\overline{OE}$ → An) | $t_{pZL}$ $t_{pZH}$ | Figure 1, Figure 3 | 0.8 | 4.6 | |
| 3-state output disable time ($\overline{OE}$ → An) | $t_{pLZ}$ $t_{pHZ}$ | Figure 1, Figure 3 | 0.8 | 4.4 | |
| Propagation delay time (An → Bn) | $t_{pLH}$ $t_{pHL}$ | Figure 1, Figure 2 | 0.6 | 4.4 | ns |
| 3-state output enable time ($\overline{OE}$ → Bn) | $t_{pZL}$ $t_{pZH}$ | Figure 1, Figure 3 | 0.6 | 4.8 | |
| 3-state output disable time ($\overline{OE}$ → Bn) | $t_{pLZ}$ $t_{pHZ}$ | Figure 1, Figure 3 | 0.8 | 4.8 | |
| Output to output skew | $t_{osLH}$ $t_{osHL}$ | (Note) | — | 0.5 | ns |

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

### $V_{CCB} = 3.3 \pm 0.3$ V, $V_{CCA} = 1.8 \pm 0.15$ V

| Characteristics | Symbol | Test Condition | Min | Max | Unit |
|---|---|---|---|---|---|
| Propagation delay time (Bn → An) | $t_{pLH}$ $t_{pHL}$ | Figure 1, Figure 2 | 1.5 | 7.1 | ns |
| 3-state output enable time ($\overline{OE}$ → An) | $t_{pZL}$ $t_{pZH}$ | Figure 1, Figure 3 | 1.5 | 8.2 | |
| 3-state output disable time ($\overline{OE}$ → An) | $t_{pLZ}$ $t_{pHZ}$ | Figure 1, Figure 3 | 0.8 | 4.5 | |
| Propagation delay time (An → Bn) | $t_{pLH}$ $t_{pHL}$ | Figure 1, Figure 2 | 0.6 | 5.5 | ns |
| 3-state output enable time ($\overline{OE}$ → Bn) | $t_{pZL}$ $t_{pZH}$ | Figure 1, Figure 3 | 0.6 | 5.3 | |
| 3-state output disable time ($\overline{OE}$ → Bn) | $t_{pLZ}$ $t_{pHZ}$ | Figure 1, Figure 3 | 0.8 | 5.6 | |
| Output to output skew | $t_{osLH}$ $t_{osHL}$ | (Note) | — | 0.5 | ns |

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

### $V_{CCB}$ = 2.5 ± 0.2 V, $V_{CCA}$ = 1.8 ± 0.15 V

| Characteristics | Symbol | Test Condition | Min | Max | Unit |
|---|---|---|---|---|---|
| Propagation delay time (Bn → An) | $t_{pLH}$ $t_{pHL}$ | Figure 1, Figure 2 | 1.5 | 7.0 | ns |
| 3-state output enable time ($\overline{OE}$ → An) | $t_{pZL}$ $t_{pZH}$ | Figure 1, Figure 3 | 1.5 | 8.3 | |
| 3-state output disable time ($\overline{OE}$ → An) | $t_{pLZ}$ $t_{pHZ}$ | Figure 1, Figure 3 | 0.8 | 4.6 | |
| Propagation delay time (An → Bn) | $t_{pLH}$ $t_{pHL}$ | Figure 1, Figure 2 | 0.8 | 5.8 | ns |
| 3-state output enable time ($\overline{OE}$ → Bn) | $t_{pZL}$ $t_{pZH}$ | Figure 1, Figure 3 | 0.8 | 5.8 | |
| 3-state output disable time ($\overline{OE}$ → Bn) | $t_{pLZ}$ $t_{pHZ}$ | Figure 1, Figure 3 | 0.8 | 5.2 | |
| Output to output skew | $t_{osLH}$ $t_{osHL}$ | (Note) | — | 0.5 | ns |

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

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

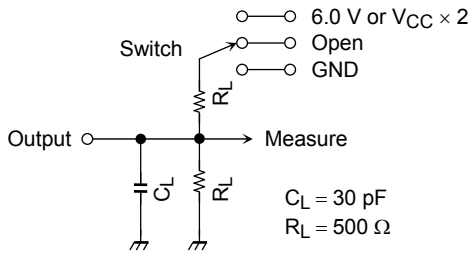
| Characteristics | | Symbol | Test Condition | $V_{CCB}$ (V) | $V_{CCA}$ (V) | Typ. | Unit |
|---|---|---|---|---|---|---|---|
| Quiet output maximum dynamic $V_{OL}$ | B → A | $V_{OLP}$ | $V_{IH} = V_{CC}$, $V_{IL}$ = 0 V | 2.5 | 1.8 | 0.25 | V |
| | | | | 3.3 | 1.8 | 0.25 | |
| | | | | 3.3 | 2.5 | 0.6 | |
| | A → B | | | 2.5 | 1.8 | 0.6 | |
| | | | | 3.3 | 1.8 | 0.8 | |
| | | | | 3.3 | 2.5 | 0.8 | |
| Quiet output minimum dynamic $V_{OL}$ | B → A | $V_{OLV}$ | $V_{IH} = V_{CC}$, $V_{IL}$ = 0 V | 2.5 | 1.8 | −0.25 | V |
| | | | | 3.3 | 1.8 | −0.25 | |
| | | | | 3.3 | 2.5 | −0.6 | |
| | A → B | | | 2.5 | 1.8 | −0.6 | |
| | | | | 3.3 | 1.8 | −0.8 | |
| | | | | 3.3 | 2.5 | −0.8 | |
| Quiet output minimum dynamic $V_{OH}$ | B → A | $V_{OHV}$ | $V_{IH} = V_{CC}$, $V_{IL}$ = 0 V | 2.5 | 1.8 | 1.3 | V |
| | | | | 3.3 | 1.8 | 1.3 | |
| | | | | 3.3 | 2.5 | 1.7 | |
| | A → B | | | 2.5 | 1.8 | 1.7 | |
| | | | | 3.3 | 1.8 | 2.0 | |
| | | | | 3.3 | 2.5 | 2.0 | |

## Capacitive Characteristics (Ta = 25°C)

| Characteristics | Symbol | Test Circuit | Test Condition | $V_{CCB}$ (V) | $V_{CCA}$ (V) | Typ. | Unit |
|---|---|---|---|---|---|---|---|
| Input capacitance | $C_{IN}$ | — | DIR, $\overline{OE}$ | 3.3 | 2.5 | 7 | pF |
| Output capacitance | $C_{I/O}$ | — | An, Bn | 3.3 | 2.5 | 8 | pF |
| Power dissipation capacitance (Note) | $C_{PDA}$ | — | A ⇒ B (DIR = "H") | 3.3 | 2.5 | 2 | pF |
| | | | B ⇒ A (DIR = "L") | 3.3 | 2.5 | 33 | |
| | $C_{PDB}$ | — | A ⇒ B (DIR = "H") | 3.3 | 2.5 | 24 | |
| | | | B ⇒ A (DIR = "L") | 3.3 | 2.5 | 3 | |

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>$V_{CC} \times 2$ | @$V_{CC}$ = 3.3 ± 0.3 V<br>@$V_{CC}$ = 2.5 ± 0.2 V<br>@$V_{CC}$ = 1.8 ± 0.15 V |
| $t_{pHZ}$, $t_{pZH}$ | GND | |

**Figure 1**

## AC Waveform

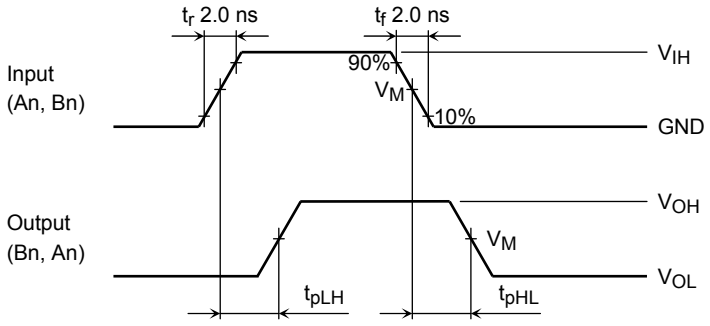



**Figure 2 $t_{pLH}$, $t_{pHL}$**

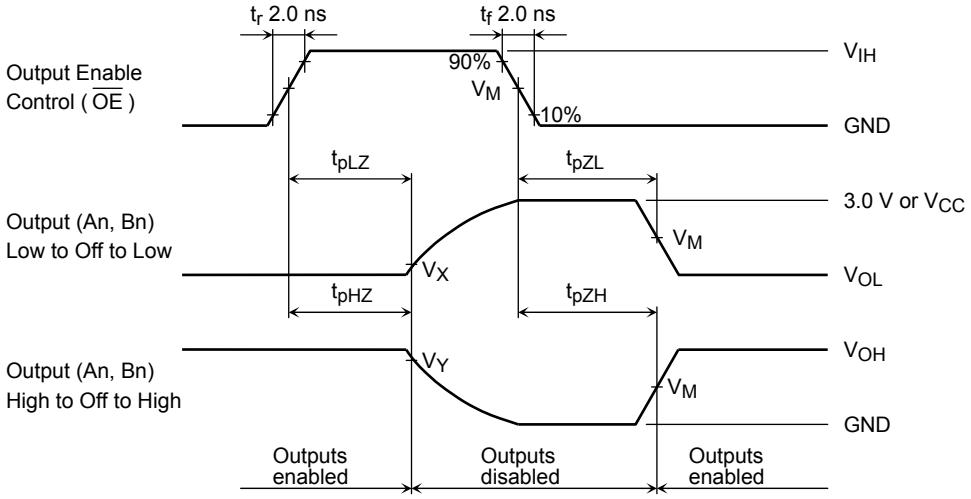
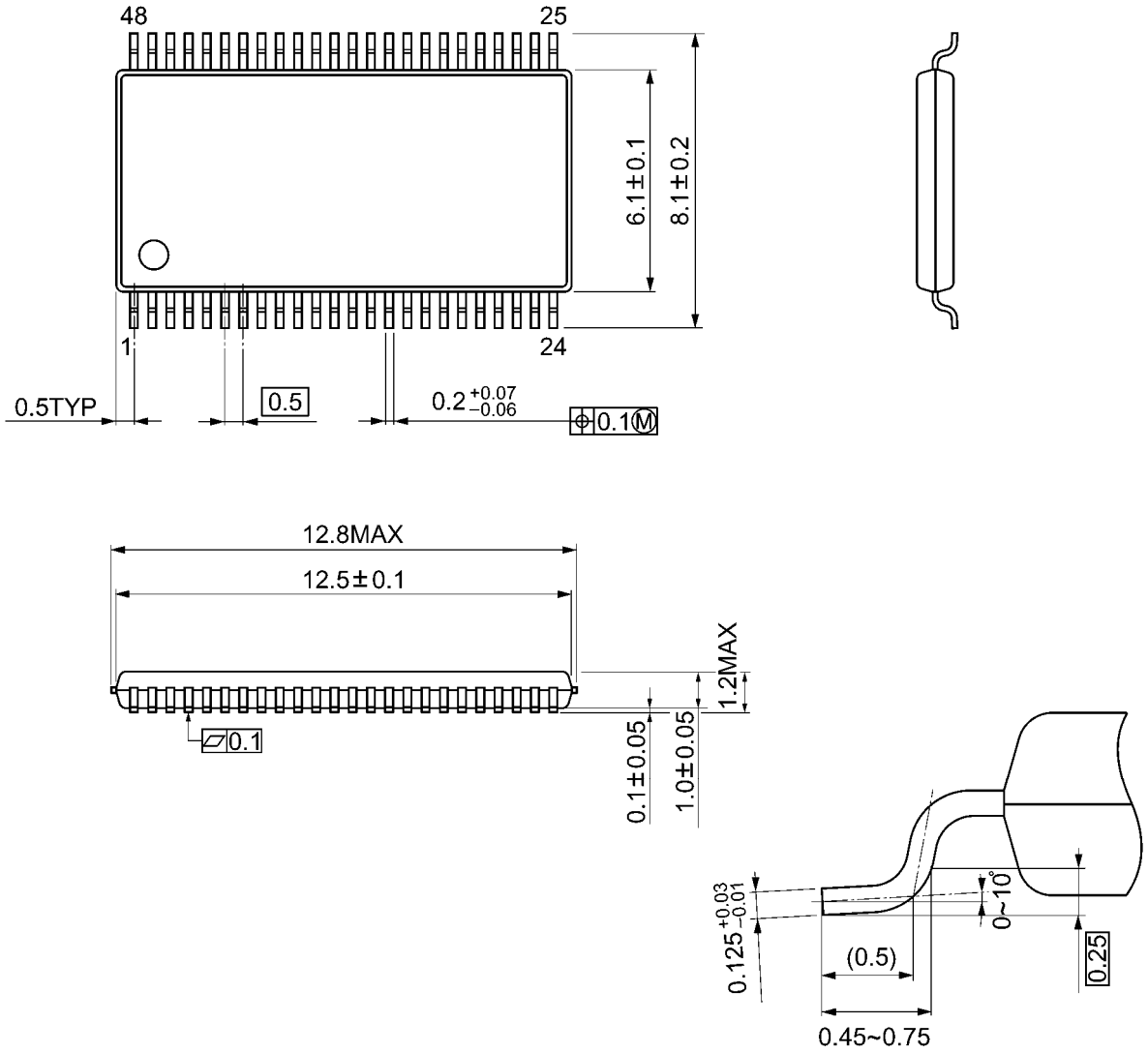



**Figure 3 $t_{pLZ}$, $t_{pHZ}$, $t_{pZL}$, $t_{pZH}$**

| Symbol | $V_{CC}$ | | |
|---|---|---|---|
| | 3.3 ± 0.3 V | 2.5 ± 0.2 V | 1.8 ± 0.15 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 V | $V_{OL}$ + 0.15 V | $V_{OL}$ + 0.15 V |
| $V_Y$ | $V_{OH}$ − 0.3 V | $V_{OH}$ − 0.15 V | $V_{OH}$ − 0.15 V |

## Package Dimensions

TSSOP48-P-0061-0.50A Unit: mm




Weight: 0.25 g (typ.)

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