

TC74VCX164245

1. Functional Description

- 16-Bit Dual Supply Bus Transceiver

2. General

The TC74VCX164245 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 ($\overline{\text{OE}}$) 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.

3. Features (Note)

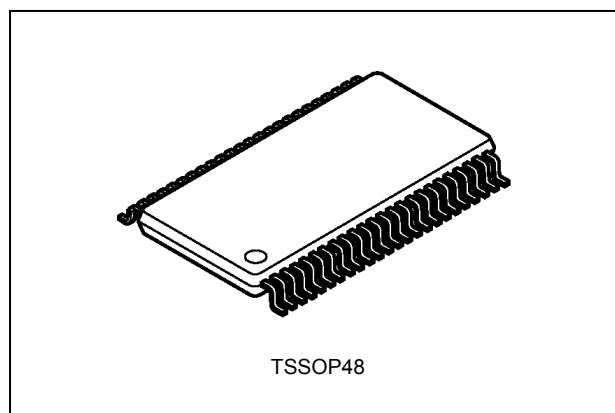
- (1) Wide operating temperature range: $T_{\text{opr}} = -40$ to 125 °C (Note 1)
- (2) Operating voltage: 3.3 V-2.5 V / 3.3 V-1.8 V / 2.5 V-1.8 V bidirectional interface
- (3) High-speed operation: $t_{\text{pd}} = 4.6$ ns (max) ($V_{\text{CCB}} = 3.3 \pm 0.3$ V, $V_{\text{CCA}} = 2.5 \pm 0.2$ V)
 $t_{\text{pd}} = 7.1$ ns (max) ($V_{\text{CCB}} = 3.3 \pm 0.3$ V, $V_{\text{CCA}} = 1.8 \pm 0.15$ V)
 $t_{\text{pd}} = 7.0$ ns (max) ($V_{\text{CCB}} = 2.5 \pm 0.2$ V, $V_{\text{CCA}} = 1.8 \pm 0.15$ V)
- (4) Output current: $I_{\text{OH}}/I_{\text{OL}} = \pm 24$ mA (min) ($V_{\text{CC}} = 3.0$ V)
 $I_{\text{OH}}/I_{\text{OL}} = \pm 18$ mA (min) ($V_{\text{CC}} = 2.3$ V)
 $I_{\text{OH}}/I_{\text{OL}} = \pm 6$ mA (min) ($V_{\text{CC}} = 1.65$ V)
- (5) 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 levels fixed by means of pull-up or pull-down resistors.

Note 1: Operating Range spec of $T_{\text{opr}} = -40$ °C to 125 °C is applicable only for the products which manufactured after April 2020.

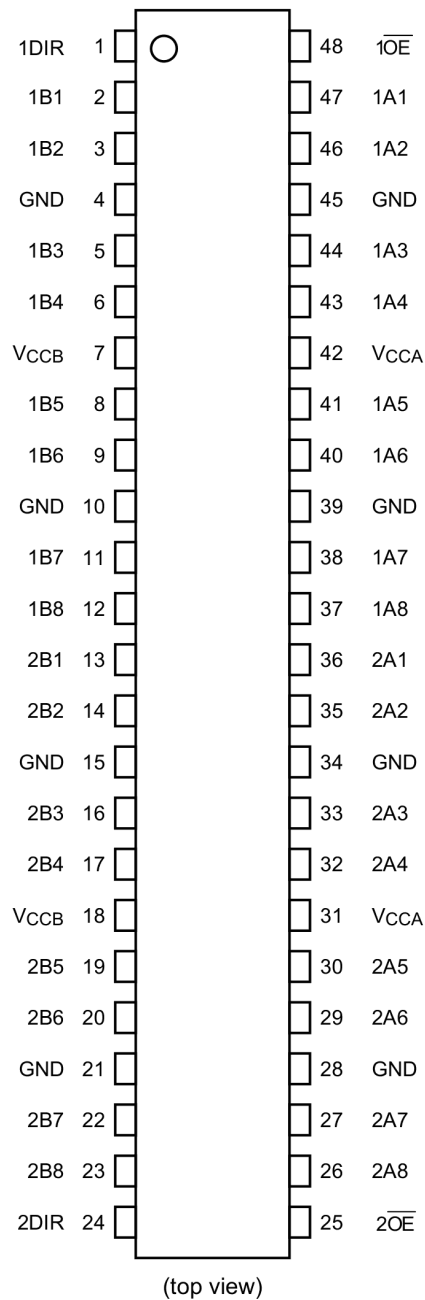
4. Packaging



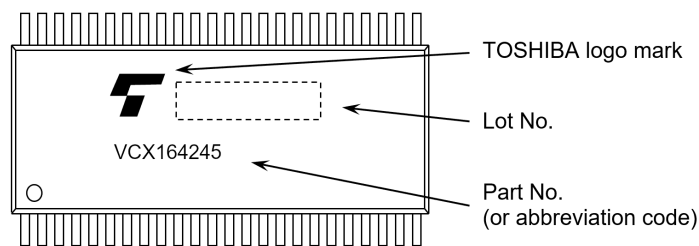
Start of commercial production

2020-04

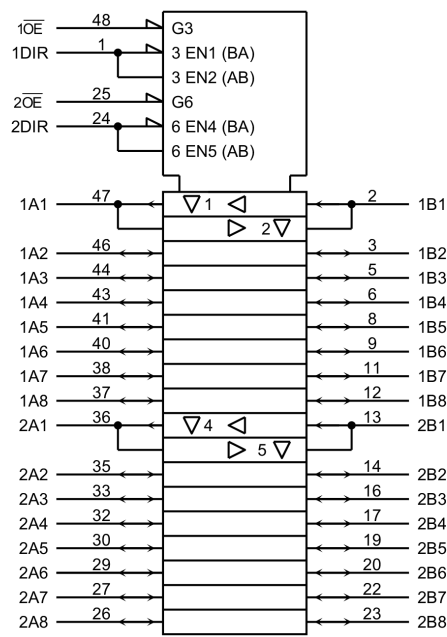
5. Pin Assignment



6. Marking



7. IEC Logic Symbol

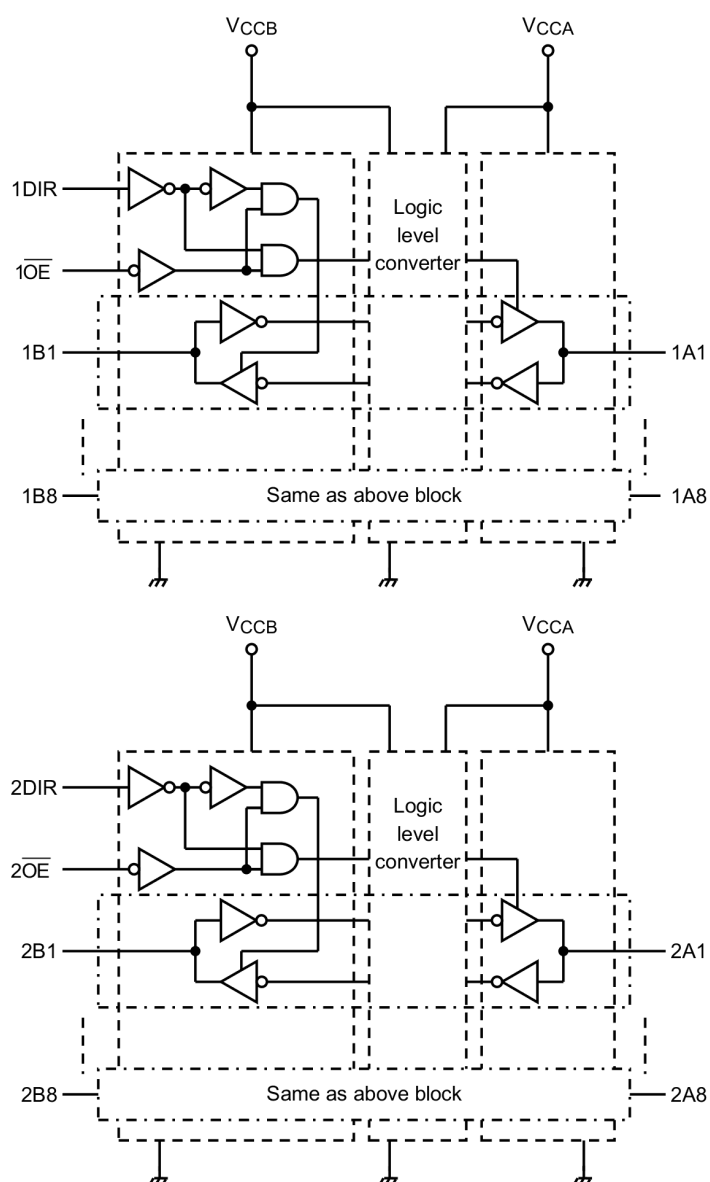


8. Truth Table

| Inputs 1OE 2OE | Inputs 1DIR 2DIR | Outputs | Function Bus 1A1-1A8 Bus 2A1-2A8 | Function Bus 1B1-1B8 Bus 2B1-2B8 |
|----------------------|------------------------|---------|--|--|
| L | L | A = B | Output | Input |
| L | H | B = A | Input | Output |
| H | X | Z | Z | Z |

X: Don't care
Z: High impedance

9. System Diagram



10. Absolute Maximum Ratings (Note)

| Characteristics | Symbol | Note | Rating | Unit |
|---|------------|----------|-------------------------|--------------------|
| Supply voltage | V_{CCB} | (Note 1) | -0.5 to 4.6 | V |
| | V_{CCA} | | -0.5 to V_{CCB} | |
| Input voltage (DIR/ \overline{OE}) | V_{IN} | | -0.5 to 4.6 | V |
| Bus I/O voltage | $V_{I/OB}$ | (Note 2) | -0.5 to 4.6 | V |
| | | (Note 3) | -0.5 to $V_{CCB} + 0.5$ | |
| | $V_{I/OA}$ | (Note 2) | -0.5 to 4.6 | |
| | | (Note 3) | -0.5 to $V_{CCA} + 0.5$ | |
| Input diode current | I_{IK} | | -50 | mA |
| I/O diode current | $I_{I/OK}$ | (Note 4) | ± 50 | mA |
| Output current | I_{OUTB} | | ± 50 | mA |
| | I_{OUTA} | | ± 50 | |
| Power dissipation | P_D | (Note 5) | 400 | mW |
| V_{CC} /ground current per supply pin | I_{CCB} | | ± 100 | mA |
| | I_{CCA} | | ± 100 | |
| Storage temperature | T_{stg} | | -65 to 150 | $^{\circ}\text{C}$ |

Note: 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 1: Don't supply a voltage to V_{CCA} terminal when V_{CCB} is in the off-state.

Note 2: Output in OFF state.

Note 3: High (H) or Low (L) state. I_{OUT} absolute maximum rating must be observed.

Note 4: $V_{OUT} < \text{GND}$, $V_{OUT} > V_{CC}$

Note 5: 400 mW in the range of $T_a = -40$ to 85°C . From $T_a = 85$ to 125°C a derating factor of $-6.25 \text{ mW}/^{\circ}\text{C}$ shall be applied until 150 mW.

11. Operating Ranges (Note)

| Characteristics | Symbol | Note | Rating | Unit |
|---------------------------------------|------------|----------|----------------|------|
| Supply voltage | V_{CCB} | (Note 1) | 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 | $V_{I/OB}$ | (Note 2) | 0 to 3.6 | V |
| | | (Note 3) | 0 to V_{CCB} | |
| | $V_{I/OA}$ | (Note 2) | 0 to 3.6 | |
| | | (Note 3) | 0 to V_{CCA} | |
| Output current | I_{OUTB} | (Note 4) | ± 24 | mA |
| | | (Note 5) | ± 18 | |
| | I_{OUTA} | (Note 6) | ± 18 | |
| | | (Note 7) | ± 6 | |
| Operating temperature | T_{opr} | (Note 8) | -40 to 125 | °C |
| Input rise and fall times | dt/dv | (Note 9) | 0 to 10 | ns/V |

Note: 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 1: Don't use in $V_{CCB} < V_{CCA}$

Note 2: Output in OFF state.

Note 3: High (H) or Low (L) state.

Note 4: $V_{CCB} = 3.0$ to 3.6 V

Note 5: $V_{CCB} = 2.3$ to 2.7 V

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

Note 7: $V_{CCA} = 1.65$ to 1.95 V

Note 8: Operating Range spec of $T_{opr} = -40$ °C to 125 °C is applicable only for the products which manufactured after April 2020.

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

12. Electrical Characteristics

12.1. DC Characteristics (Unless otherwise specified, $T_a = -40$ to 85°C)

| Characteristics | Symbol | Test Condition | V_{CCB} (V) | V_{CCA} (V) | Min | Max | Unit |
|--|------------|---|-----------------------------|---------------|-----------------------|-----------------------|---------------|
| High-level input voltage | V_{IHB} | DIR, \overline{OE} , Bn | 2.3 to 2.7 | 1.65 to 1.95 | 1.6 | — | V |
| | | | 3.0 to 3.6 | 1.65 to 2.7 | 2.0 | — | |
| | V_{IHA} | An | 2.3 to 3.6 | 1.65 to 1.95 | $V_{CCB} \times 0.65$ | — | V |
| | | | 3.0 to 3.6 | 2.3 to 2.7 | 1.6 | — | |
| Low-level input voltage | V_{ILB} | DIR, \overline{OE} , Bn | 2.3 to 2.7 | 1.65 to 1.95 | — | 0.7 | V |
| | | | 3.0 to 3.6 | 1.65 to 2.7 | — | 0.8 | |
| | V_{ILA} | An | 2.3 to 3.6 | 1.65 to 1.95 | — | $V_{CCB} \times 0.35$ | V |
| | | | 3.0 to 3.6 | 2.3 to 2.7 | — | 0.7 | |
| High-level output voltage | V_{OHB} | $V_{IN} = V_{IH}$ or V_{IL} | $I_{OH} = -100 \mu\text{A}$ | 2.3 to 3.6 | 1.65 to 1.95 | $V_{CCB} - 0.2$ | V |
| | | | $I_{OH} = -100 \mu\text{A}$ | 3.0 to 3.6 | 2.3 to 2.7 | $V_{CCB} - 0.2$ | |
| | | | $I_{OH} = -18 \text{ mA}$ | 2.3 | 1.65 to 1.95 | 1.7 | |
| | | | $I_{OH} = -24 \text{ mA}$ | 3.0 | 1.65 to 2.7 | 2.2 | |
| | V_{OHA} | $V_{IN} = V_{IH}$ or V_{IL} | $I_{OH} = -100 \mu\text{A}$ | 2.3 to 3.6 | 1.65 to 1.95 | $V_{CCA} - 0.2$ | |
| | | | | 3.0 to 3.6 | 2.3 to 2.7 | $V_{CCA} - 0.2$ | |
| | | | $I_{OH} = -6 \text{ mA}$ | 2.3 to 3.6 | 1.65 | 1.25 | |
| | | | $I_{OH} = -18 \text{ mA}$ | 3.0 to 3.6 | 2.3 | 1.7 | |
| Low-level output voltage | V_{OLB} | $V_{IN} = V_{IH}$ or V_{IL} | $I_{OL} = 100 \mu\text{A}$ | 2.3 to 3.6 | 1.65 to 1.95 | — | V |
| | | | $I_{OL} = 100 \mu\text{A}$ | 3.0 to 3.6 | 2.3 to 2.7 | — | |
| | | | $I_{OL} = 18 \text{ mA}$ | 2.3 | 1.65 to 1.95 | — | |
| | | | $I_{OL} = 24 \text{ mA}$ | 3.0 | 1.65 to 2.7 | — | |
| | V_{OLA} | $V_{IN} = V_{IH}$ or V_{IL} | $I_{OL} = 100 \mu\text{A}$ | 2.3 to 3.6 | 1.65 to 1.95 | — | |
| | | | $I_{OL} = 100 \mu\text{A}$ | 3.0 to 3.6 | 2.3 to 2.7 | — | |
| | | | $I_{OL} = 6 \text{ mA}$ | 2.3 to 3.6 | 1.65 | — | |
| | | | $I_{OL} = 18 \text{ mA}$ | 3.0 to 3.6 | 2.3 | — | |
| Input leakage current | I_{IN} | $V_{IN} = 0$ to 3.6 V | | 2.3 to 3.6 | 1.65 to 1.95 | — | μA |
| | | | | 3.0 to 3.6 | 2.3 to 2.7 | — | |
| 3-state output OFF-state leakage current | I_{OZB} | $V_{IN} = V_{IH}$ or V_{IL} $V_{OUT} = 0$ to 3.6 V | | 2.3 to 3.6 | 1.65 to 1.95 | — | μA |
| | | | | 3.0 to 3.6 | 2.3 to 2.7 | — | |
| | I_{OZA} | $V_{IN} = V_{IH}$ or V_{IL} $V_{OUT} = 0$ to 3.6 V | | 2.3 to 3.6 | 1.65 to 1.95 | — | μA |
| | | | | 3.0 to 3.6 | 2.3 to 2.7 | — | |
| Power-OFF leakage current | I_{OFF} | $V_{IN}/V_{OUT} = 0$ to 3.6 V | 0 | 0 | — | 10.0 | μA |
| Quiescent supply current | I_{CCB} | $V_{INA} = V_{CCA}$ or GND $V_{INB} = V_{CCB}$ or GND | | 2.3 to 3.6 | 1.65 to 1.95 | — | μA |
| | | | | 3.0 to 3.6 | 2.3 to 2.7 | — | |
| | | $V_{CCB} \leq (V_{IN}/V_{OUT}) \leq 3.6 \text{ V}$ | | 2.3 to 3.6 | 1.65 to 1.95 | — | |
| | | | | 3.0 to 3.6 | 2.3 to 2.7 | — | |
| | I_{CCA} | $V_{INA} = V_{CCA}$ or GND $V_{INB} = V_{CCB}$ or GND | | 2.3 to 3.6 | 1.65 to 1.95 | — | μA |
| | | | | 3.0 to 3.6 | 2.3 to 2.7 | — | |
| | | $V_{CCA} \leq (V_{IN}/V_{OUT}) \leq 3.6 \text{ V}$ | | 2.3 to 3.6 | 1.65 to 1.95 | — | |
| | | | | 3.0 to 3.6 | 2.3 to 2.7 | — | |
| | I_{CCTB} | $V_{IHB} = V_{CCB} - 0.6 \text{ V}$ (per input) | | 2.3 to 3.6 | 1.65 to 1.95 | — | μA |
| | | | | 3.0 to 3.6 | 2.3 to 2.7 | — | |
| | I_{CCTA} | $V_{IHA} = V_{CCA} - 0.6 \text{ V}$ (per input) | | 2.3 to 3.6 | 1.65 to 1.95 | — | μA |
| | | | | 3.0 to 3.6 | 2.3 to 2.7 | — | |

12.2. DC Characteristics (Note) (Unless otherwise specified, $T_a = -40$ to $125\text{ }^{\circ}\text{C}$)

| Characteristics | Symbol | Test Condition | | V_{CCB} (V) | V_{CCA} (V) | Min | Max | Unit |
|--|------------|--|------------------------------------|---------------|---------------|-----------------------|-----------------------|---------------|
| High-level input voltage | V_{IHB} | DIR, \overline{OE} , Bn | | 2.3 to 2.7 | 1.65 to 1.95 | 1.6 | — | V |
| | | | | 3.0 to 3.6 | 1.65 to 2.7 | 2.0 | — | |
| | V_{IHA} | An | | 2.3 to 3.6 | 1.65 to 1.95 | $V_{CCB} \times 0.65$ | — | V |
| | | | | 3.0 to 3.6 | 2.3 to 2.7 | 1.6 | — | |
| Low-level input voltage | V_{ILB} | DIR, \overline{OE} , Bn | | 2.3 to 2.7 | 1.65 to 1.95 | — | 0.7 | V |
| | | | | 3.0 to 3.6 | 1.65 to 2.7 | — | 0.8 | |
| | V_{ILA} | An | | 2.3 to 3.6 | 1.65 to 1.95 | — | $V_{CCB} \times 0.35$ | V |
| | | | | 3.0 to 3.6 | 2.3 to 2.7 | — | 0.7 | |
| High-level output voltage | V_{OHB} | $V_{IN} = V_{IH}$ or V_{IL} | $I_{OH} = -100\text{ }\mu\text{A}$ | 2.3 to 3.6 | 1.65 to 1.95 | $V_{CCB} - 0.2$ | — | V |
| | | | | 3.0 to 3.6 | 2.3 to 2.7 | $V_{CCB} - 0.2$ | — | |
| | | | $I_{OH} = -18\text{ mA}$ | 2.3 | 1.65 to 1.95 | 1.6 | — | |
| | | | $I_{OH} = -24\text{ mA}$ | 3.0 | 1.65 to 2.7 | 2.2 | — | |
| | V_{OHA} | $V_{IN} = V_{IH}$ or V_{IL} | $I_{OH} = -100\text{ }\mu\text{A}$ | 2.3 to 3.6 | 1.65 to 1.95 | $V_{CCA} - 0.2$ | — | |
| | | | | 3.0 to 3.6 | 2.3 to 2.7 | $V_{CCA} - 0.2$ | — | |
| | | | $I_{OH} = -6\text{ mA}$ | 2.3 to 3.6 | 1.65 | 1.25 | — | |
| | | | $I_{OH} = -18\text{ mA}$ | 3.0 to 3.6 | 2.3 | 1.6 | — | |
| Low-level output voltage | V_{OLB} | $V_{IN} = V_{IH}$ or V_{IL} | $I_{OL} = 100\text{ }\mu\text{A}$ | 2.3 to 3.6 | 1.65 to 1.95 | — | 0.2 | V |
| | | | | 3.0 to 3.6 | 2.3 to 2.7 | — | 0.2 | |
| | | | $I_{OL} = 18\text{ mA}$ | 2.3 | 1.65 to 1.95 | — | 0.8 | |
| | | | $I_{OL} = 24\text{ mA}$ | 3.0 | 1.65 to 2.7 | — | 0.55 | |
| | V_{OLA} | $V_{IN} = V_{IH}$ or V_{IL} | $I_{OL} = 100\text{ }\mu\text{A}$ | 2.3 to 3.6 | 1.65 to 1.95 | — | 0.2 | |
| | | | | 3.0 to 3.6 | 2.3 to 2.7 | — | 0.2 | |
| | | | $I_{OL} = 6\text{ mA}$ | 2.3 to 3.6 | 1.65 | — | 0.3 | |
| | | | $I_{OL} = 18\text{ mA}$ | 3.0 to 3.6 | 2.3 | — | 0.8 | |
| Input leakage current | I_{IN} | $V_{IN} = 0$ to 3.6 V | | 2.3 to 3.6 | 1.65 to 1.95 | — | ± 20.0 | μA |
| | | | | 3.0 to 3.6 | 2.3 to 2.7 | — | ± 20.0 | |
| 3-state output OFF-state leakage current | I_{OZB} | $V_{IN} = V_{IH}$ or V_{IL} $V_{OUT} = 0$ to 3.6 V | | 2.3 to 3.6 | 1.65 to 1.95 | — | ± 40.0 | μA |
| | | | | 3.0 to 3.6 | 2.3 to 2.7 | — | ± 40.0 | |
| | I_{OZA} | $V_{IN} = V_{IH}$ or V_{IL} $V_{OUT} = 0$ to 3.6 V | | 2.3 to 3.6 | 1.65 to 1.95 | — | ± 40.0 | μA |
| | | | | 3.0 to 3.6 | 2.3 to 2.7 | — | ± 40.0 | |
| Power-OFF leakage current | I_{OFF} | $V_{IN}/V_{OUT} = 0$ to 3.6 V | | 0 | 0 | — | 40.0 | μA |
| Quiescent supply current | I_{CCB} | $V_{INA} = V_{CCA}$ or GND $V_{INB} = V_{CCB}$ or GND | | 2.3 to 3.6 | 1.65 to 1.95 | — | 80.0 | μA |
| | | | | 3.0 to 3.6 | 2.3 to 2.7 | — | 80.0 | |
| | | $V_{CCB} \leq (V_{IN}/V_{OUT}) \leq 3.6\text{ V}$ | | 2.3 to 3.6 | 1.65 to 1.95 | — | ± 80.0 | |
| | | | | 3.0 to 3.6 | 2.3 to 2.7 | — | ± 80.0 | |
| | I_{CCA} | $V_{INA} = V_{CCA}$ or GND $V_{INB} = V_{CCB}$ or GND | | 2.3 to 3.6 | 1.65 to 1.95 | — | 80.0 | |
| | | | | 3.0 to 3.6 | 2.3 to 2.7 | — | 80.0 | |
| | | $V_{CCA} \leq (V_{IN}/V_{OUT}) \leq 3.6\text{ V}$ | | 2.3 to 3.6 | 1.65 to 1.95 | — | ± 80.0 | |
| | | | | 3.0 to 3.6 | 2.3 to 2.7 | — | ± 80.0 | |
| | I_{CCTB} | $V_{IHB} = V_{CCB} - 0.6\text{ V}$ (per input) | | 2.3 to 3.6 | 1.65 to 1.95 | — | 1.5 | mA |
| | | | | 3.0 to 3.6 | 2.3 to 2.7 | — | 1.5 | |
| | I_{CCTA} | $V_{IHA} = V_{CCA} - 0.6\text{ V}$ (per input) | | 2.3 to 3.6 | 1.65 to 1.95 | — | 1.5 | |
| | | | | 3.0 to 3.6 | 2.3 to 2.7 | — | 1.5 | |

Note: Operating Range spec of $T_{opr} = -40\text{ }^{\circ}\text{C}$ to $125\text{ }^{\circ}\text{C}$ is applicable only for the products which manufactured after April 2020.

12.3. AC Characteristics (Unless otherwise specified, $T_a = -40$ to 85°C)

| Characteristics | Symbol | Note | Test Condition | V_{CCB} (V) | V_{CCA} (V) | Min | Max | Unit |
|--|----------------------|----------|---|---------------|----------------|-----|-----|------|
| Propagation delay time ($B_n \rightarrow A_n$) | t_{PLH}, t_{PHL} | | See 12.7 AC Test Circuit, Table 12.7.1, Fig. 12.8.1, Table 12.8.1 | 2.5 ± 0.2 | 1.8 ± 0.15 | 1.5 | 7.0 | ns |
| | | | | 3.3 ± 0.3 | 1.8 ± 0.15 | 1.5 | 7.1 | |
| | | | | 3.3 ± 0.3 | 2.5 ± 0.2 | 0.8 | 4.6 | |
| Propagation delay time ($A_n \rightarrow B_n$) | t_{PLH}, t_{PHL} | | See 12.7 AC Test Circuit, Table 12.7.1, Fig. 12.8.1, Table 12.8.1 | 2.5 ± 0.2 | 1.8 ± 0.15 | 0.8 | 5.8 | ns |
| | | | | 3.3 ± 0.3 | 1.8 ± 0.15 | 0.6 | 5.5 | |
| | | | | 3.3 ± 0.3 | 2.5 ± 0.2 | 0.6 | 4.4 | |
| 3-state output enable time ($\overline{OE} \rightarrow A_n$) | t_{PZL}, t_{PZH} | | See 12.7 AC Test Circuit, Table 12.7.1, Fig. 12.8.2, Table 12.8.1 | 2.5 ± 0.2 | 1.8 ± 0.15 | 1.5 | 8.3 | ns |
| | | | | 3.3 ± 0.3 | 1.8 ± 0.15 | 1.5 | 8.2 | |
| | | | | 3.3 ± 0.3 | 2.5 ± 0.2 | 0.8 | 4.6 | |
| 3-state output enable time ($\overline{OE} \rightarrow B_n$) | t_{PZL}, t_{PZH} | | See 12.7 AC Test Circuit, Table 12.7.1, Fig. 12.8.2, Table 12.8.1 | 2.5 ± 0.2 | 1.8 ± 0.15 | 0.8 | 5.8 | ns |
| | | | | 3.3 ± 0.3 | 1.8 ± 0.15 | 0.6 | 5.3 | |
| | | | | 3.3 ± 0.3 | 2.5 ± 0.2 | 0.6 | 4.8 | |
| 3-state output disable time ($\overline{OE} \rightarrow A_n$) | t_{PLZ}, t_{PHZ} | | See 12.7 AC Test Circuit, Table 12.7.1, Fig. 12.8.2, Table 12.8.1 | 2.5 ± 0.2 | 1.8 ± 0.15 | 0.8 | 4.6 | ns |
| | | | | 3.3 ± 0.3 | 1.8 ± 0.15 | 0.8 | 4.5 | |
| | | | | 3.3 ± 0.3 | 2.5 ± 0.2 | 0.8 | 4.4 | |
| 3-state output disable time ($\overline{OE} \rightarrow B_n$) | t_{PLZ}, t_{PHZ} | | See 12.7 AC Test Circuit, Table 12.7.1, Fig. 12.8.2, Table 12.8.1 | 2.5 ± 0.2 | 1.8 ± 0.15 | 0.8 | 5.2 | ns |
| | | | | 3.3 ± 0.3 | 1.8 ± 0.15 | 0.8 | 5.6 | |
| | | | | 3.3 ± 0.3 | 2.5 ± 0.2 | 0.8 | 4.8 | |
| Output skew | t_{osLH}, t_{osHL} | (Note 1) | — | 2.5 ± 0.2 | 1.8 ± 0.15 | — | 0.5 | ns |
| | | | | 3.3 ± 0.3 | 1.8 ± 0.15 | — | 0.5 | |
| | | | | 3.3 ± 0.3 | 2.5 ± 0.2 | — | 0.5 | |

Note 1: Parameter guaranteed by design. ($t_{osLH} = |t_{PLHM} - t_{PLHN}|$, $t_{osHL} = |t_{PHLM} - t_{PHLN}|$)

12.4. AC Characteristics (Note) (Unless otherwise specified, $T_a = -40$ to 125 °C)

| Characteristics | Symbol | Note | Test Condition | V_{CCB} (V) | V_{CCA} (V) | Min | Max | Unit |
|--|----------------------|----------|---|---------------|----------------|-----|------|------|
| Propagation delay time (Bn→An) | t_{PLH}, t_{PHL} | | See 12.7 AC Test Circuit, Table 12.7.1, Fig. 12.8.1, Table 12.8.1 | 2.5 ± 0.2 | 1.8 ± 0.15 | 1.5 | 8.8 | ns |
| | | | | 3.3 ± 0.3 | 1.8 ± 0.15 | 1.5 | 8.9 | |
| | | | | 3.3 ± 0.3 | 2.5 ± 0.2 | 0.8 | 5.8 | |
| Propagation delay time (An→Bn) | t_{PLH}, t_{PHL} | | See 12.7 AC Test Circuit, Table 12.7.1, Fig. 12.8.1, Table 12.8.1 | 2.5 ± 0.2 | 1.8 ± 0.15 | 0.8 | 7.3 | ns |
| | | | | 3.3 ± 0.3 | 1.8 ± 0.15 | 0.6 | 6.9 | |
| | | | | 3.3 ± 0.3 | 2.5 ± 0.2 | 0.6 | 5.5 | |
| 3-state output enable time ($\overline{OE} \rightarrow An$) | t_{PZL}, t_{PZH} | | See 12.7 AC Test Circuit, Table 12.7.1, Fig. 12.8.2, Table 12.8.1 | 2.5 ± 0.2 | 1.8 ± 0.15 | 1.5 | 10.4 | ns |
| | | | | 3.3 ± 0.3 | 1.8 ± 0.15 | 1.5 | 10.3 | |
| | | | | 3.3 ± 0.3 | 2.5 ± 0.2 | 0.8 | 5.8 | |
| 3-state output enable time ($\overline{OE} \rightarrow Bn$) | t_{PZL}, t_{PZH} | | See 12.7 AC Test Circuit, Table 12.7.1, Fig. 12.8.2, Table 12.8.1 | 2.5 ± 0.2 | 1.8 ± 0.15 | 0.8 | 7.3 | ns |
| | | | | 3.3 ± 0.3 | 1.8 ± 0.15 | 0.6 | 6.7 | |
| | | | | 3.3 ± 0.3 | 2.5 ± 0.2 | 0.6 | 6.0 | |
| 3-state output disable time ($\overline{OE} \rightarrow An$) | t_{PLZ}, t_{PHZ} | | See 12.7 AC Test Circuit, Table 12.7.1, Fig. 12.8.2, Table 12.8.1 | 2.5 ± 0.2 | 1.8 ± 0.15 | 0.8 | 5.8 | ns |
| | | | | 3.3 ± 0.3 | 1.8 ± 0.15 | 0.8 | 5.7 | |
| | | | | 3.3 ± 0.3 | 2.5 ± 0.2 | 0.8 | 5.5 | |
| 3-state output disable time ($\overline{OE} \rightarrow Bn$) | t_{PLZ}, t_{PHZ} | | See 12.7 AC Test Circuit, Table 12.7.1, Fig. 12.8.2, Table 12.8.1 | 2.5 ± 0.2 | 1.8 ± 0.15 | 0.8 | 6.5 | ns |
| | | | | 3.3 ± 0.3 | 1.8 ± 0.15 | 0.8 | 7.1 | |
| | | | | 3.3 ± 0.3 | 2.5 ± 0.2 | 0.8 | 6.0 | |
| Output skew | t_{osLH}, t_{osHL} | (Note 1) | — | 2.5 ± 0.2 | 1.8 ± 0.15 | — | 1.0 | ns |
| | | | | 3.3 ± 0.3 | 1.8 ± 0.15 | — | 1.0 | |
| | | | | 3.3 ± 0.3 | 2.5 ± 0.2 | — | 1.0 | |

Note: Operating Range spec of $T_{opr} = -40$ °C to 125 °C is applicable only for the products which manufactured after April 2020.

Note 1: Parameter guaranteed by design. ($t_{osLH} = |t_{PLHM} - t_{PLHN}|$, $t_{osHL} = |t_{PHLM} - t_{PHLN}|$)

12.5. Dynamic Switching Characteristics (Note) (Unless otherwise specified, $T_a = 25$ °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 | |
| Quiet output maximum dynamic V_{OL} (A→B) | | | 2.5 | 1.8 | 0.6 | V |
| | | | 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 | |
| Quiet output minimum dynamic V_{OL} (A→B) | | | 2.5 | 1.8 | -0.6 | V |
| | | | 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 | |
| Quiet output minimum dynamic V_{OH} (A→B) | | | 2.5 | 1.8 | 1.7 | V |
| | | | 3.3 | 1.8 | 2.0 | |
| | | | 3.3 | 2.5 | 2.0 | |

Note: Parameter guaranteed by design.

12.6. Capacitive Characteristics (Unless otherwise specified, $T_a = 25^\circ\text{C}$)

| Characteristics | Symbol | Note | Test Condition | V _{CCB} (V) | V _{CCA} (V) | Typ. | Unit |
|-------------------------------|------------------|----------|----------------------|----------------------|----------------------|------|------|
| Input capacitance | C _{IN} | | DIR, \overline{OE} | 3.3 | 2.5 | 7 | pF |
| Bus I/O capacitance | C _{I/O} | | An, Bn | 3.3 | 2.5 | 8 | pF |
| Power dissipation capacitance | C _{PDA} | (Note 1) | 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 1: 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.

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

12.7. AC Test Circuit

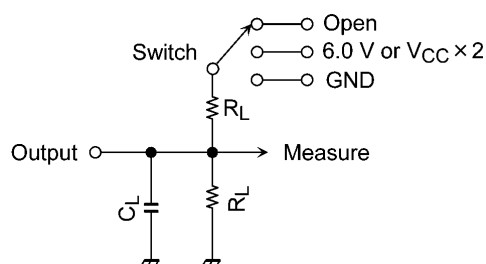


Table 12.7.1 Parameter for AC Test Circuit

| Parameter | Switch | Test Condition |
|-----------------------|-------------------|-----------------------------------|
| t_{PLH} , t_{PHL} | OPEN | — |
| t_{PLZ} , t_{PZL} | 6.0 V | $V_{CC} = 3.3 \pm 0.3 \text{ V}$ |
| | $V_{CC} \times 2$ | $V_{CC} = 2.5 \pm 0.2 \text{ V}$ |
| | | $V_{CC} = 1.8 \pm 0.15 \text{ V}$ |
| t_{PHZ} , t_{PZH} | GND | — |

12.8. AC Waveform

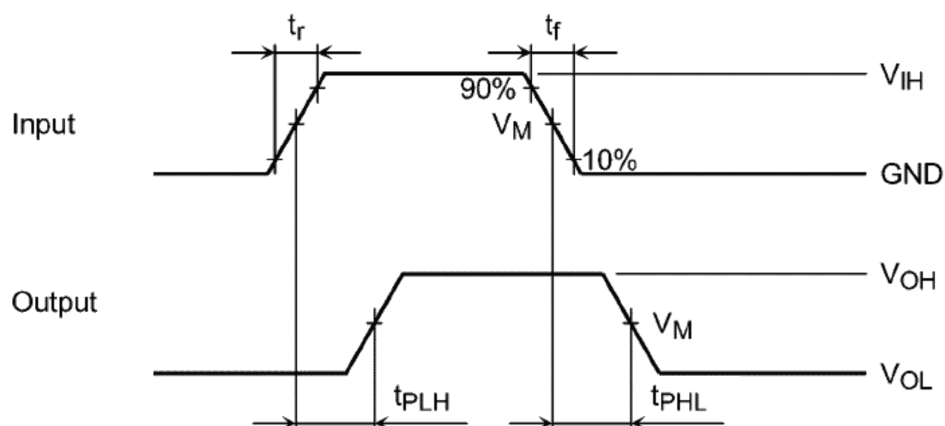


Fig. 12.8.1 t_{PLH} , t_{PHL}

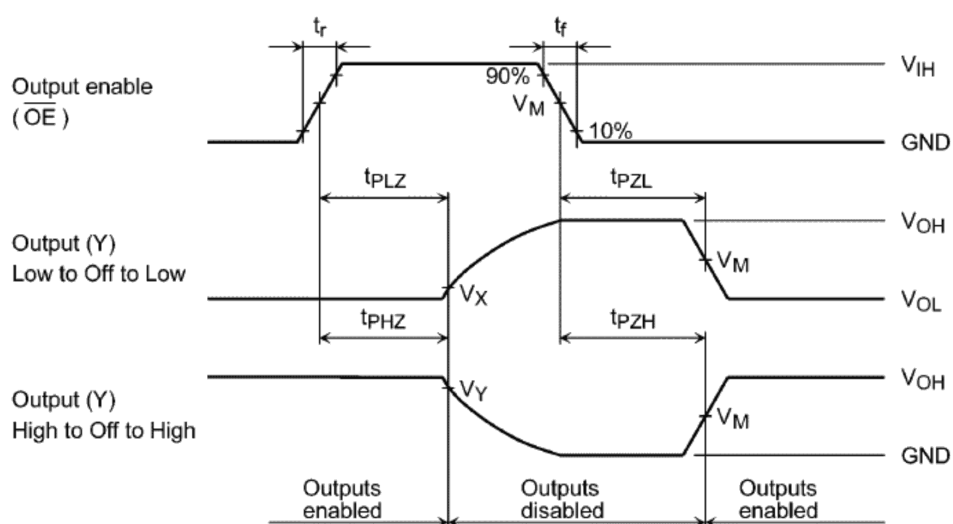


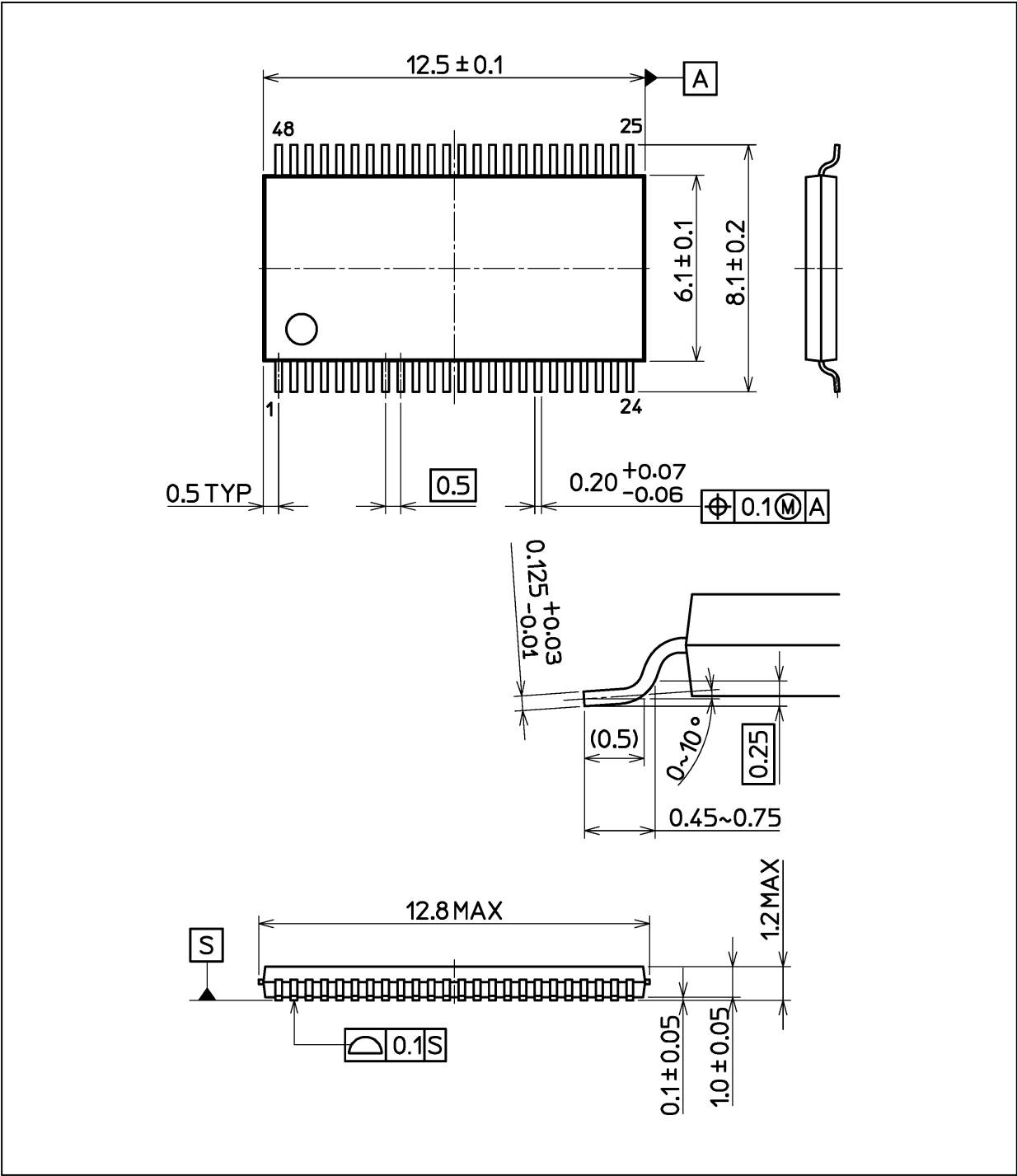
Fig. 12.8.2 t_{PLZ} , t_{PHZ} , t_{PZL} , t_{PZH}

Table 12.8.1 AC Waveform Symbols

| | Symbol | $V_{CC} = 3.3 \pm 0.3 \text{ V}$ | $V_{CC} = 2.5 \pm 0.2 \text{ V}$ | $V_{CC} = 1.8 \pm 0.15 \text{ V}$ |
|--------|------------|----------------------------------|----------------------------------|-----------------------------------|
| Input | V_{IH} | 2.7 V | V_{CC} | V_{CC} |
| | V_M | 1.5 V | $V_{CC}/2$ | $V_{CC}/2$ |
| | t_r, t_f | 2.0 ns | 2.0 ns | 2.0 ns |
| Output | V_M | 1.5 V | $V_{CC}/2$ | $V_{CC}/2$ |
| | 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 | 30 pF | 30 pF | 30 pF |
| | R_L | 500 Ω | 500 Ω | 500 Ω |

Package Dimensions

Unit: mm



Weight: 0.25 g (typ.)

| Package Name(s) |
|-------------------|
| Nickname: TSSOP48 |

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