CMOS Digital Integrated Circuits Silicon Monolithic

# TC7MP3125FK

## 1. Functional Description

- Low-Voltage, Low-Power 2-Bit × 2 Dual-Supply Bus Transceiver

## 2. General

The TC7MP3215FK is an advanced high-speed CMOS 4-bit dual supply voltage interface bus transceiver fabricated with silicon gate CMOS technology.
All inputs and outputs have tolerant function, and can be applied up to 3.6 V at power down mode.
The input consists of two same 2-bit configuration and it can be used as dual 2-bit configurations or single 4-bit configuration.
When the DIR input that changes transmission direction is H level, A-bus works as input and B-bus works as output, and when the DIR is L level, A-bus works as output and B-bus works as input.
When the Enable input $\overline{OE}$ is H level, both A-bus and B-bus become to floating state (high-impedance).
All inputs are equipped with protection circuits against static discharge or transient excess voltage.

## 3. Features (Note)

(1) Operating voltage: 1.2 V and 1.8 V / 1.2 V and 2.5 V / 1.2 V and 3.3 V / 1.5 V and 2.5 V
1.5 V and 3.3 V / 1.8 V and 2.5 V / 1.8 V and 3.3 V / 2.5 V and 3.3 V
bidirectional interface

(2) High-speed operation: $t_{pd}$ = 6.8 ns (max) ($V_{CCA}$ = 2.5 ± 0.2 V, $V_{CCB}$ = 3.3 ± 0.3 V)
$t_{pd}$ = 8.9 ns (max) ($V_{CCA}$ = 1.8 ± 0.15 V, $V_{CCB}$ = 3.3 ± 0.3 V)
$t_{pd}$ = 10.3 ns (max) ($V_{CCA}$ = 1.5 ± 0.1 V, $V_{CCB}$ = 3.3 ± 0.3 V)
$t_{pd}$ = 61 ns (max) ($V_{CCA}$ = 1.2 ± 0.1 V, $V_{CCB}$ = 3.3 ± 0.3 V)
$t_{pd}$ = 9.5 ns (max) ($V_{CCA}$ = 1.8 ± 0.15 V, $V_{CCB}$ = 2.5 ± 0.2 V)
$t_{pd}$ = 10.8 ns (max) ($V_{CCA}$ = 1.5 ± 0.1 V, $V_{CCB}$ = 2.5 ± 0.2 V)
$t_{pd}$ = 60 ns (max) ($V_{CCA}$ = 1.2 ± 0.1 V, $V_{CCB}$ = 2.5 ± 0.2 V)
$t_{pd}$ = 58 ns (max) ($V_{CCA}$ = 1.2 ± 0.1 V, $V_{CCB}$ = 1.8 ± 0.15 V)

(3) Output current: $|I_{OH}|/I_{OL}$ = 12 mA (min) ($V_{CC}$ = 3.0 V)
$|I_{OH}|/I_{OL}$ = 9 mA (min) ($V_{CC}$ = 2.3 V)
$|I_{OH}|/I_{OL}$ = 3 mA (min) ($V_{CC}$ = 1.65 V)
$|I_{OH}|/I_{OL}$ = 1 mA (min) ($V_{CC}$ = 1.4 V)

(4) Latch-up performance: ≥ ±300 mA

(5) ESD performance: MM ≥ ±200 V, HBM ≥ ±2000 V

(6) Ultra-small package: VSSOP (US16)

(7) Low power dissipation: By using the new circuit, the power consumption is reduced significantly when $\overline{OE}$ = "H".
Suitable for battery-driven applications such as PDAs and cellular phones.

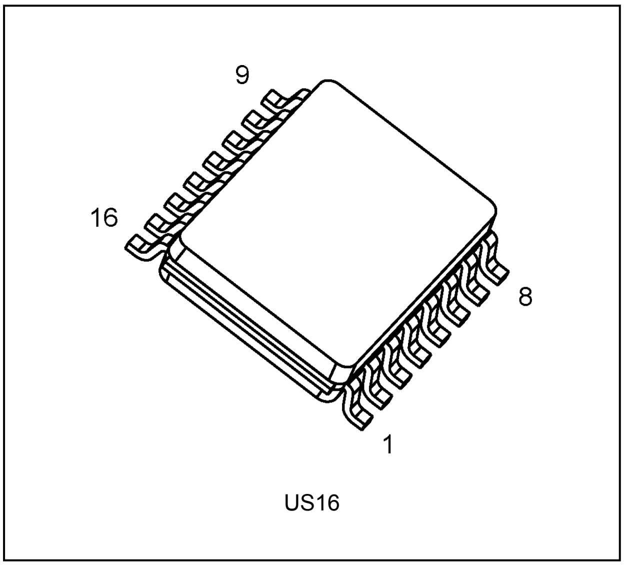
(8) Floating of A-bus and B-bus is permitted (when $\overline{OE}$ = "H").

(9) 3.6 V tolerance and power-down protection are provided to all inputs and outputs.

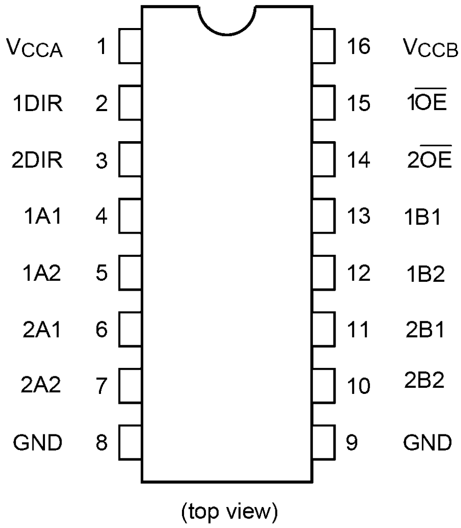
Note: Do not apply a signal to any bus pins when it is in the output mode. Damage may result.

Start of commercial production
2019-03

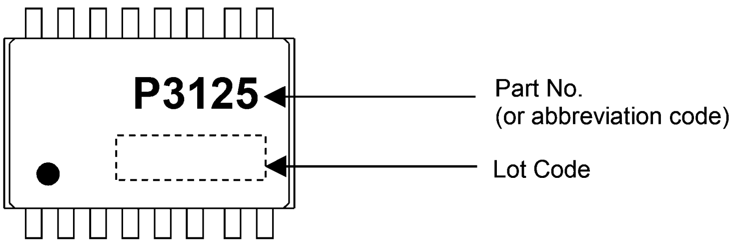
## 4. Packaging



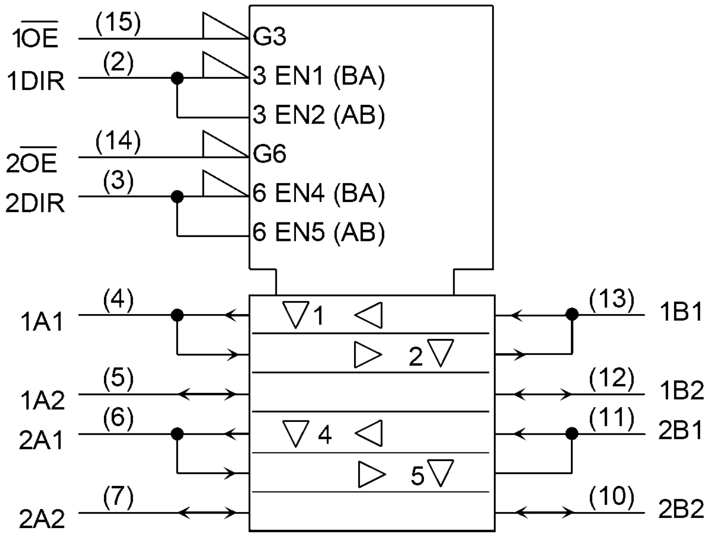

## 5. Pin Assignment



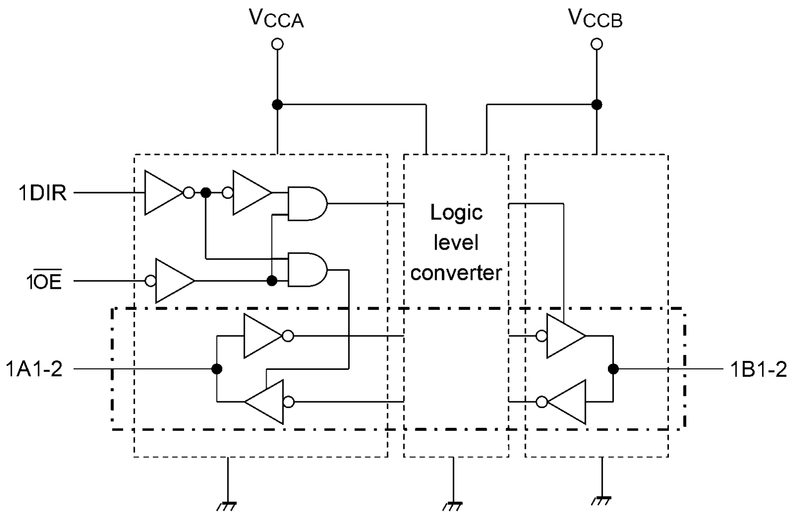

## 6. Marking

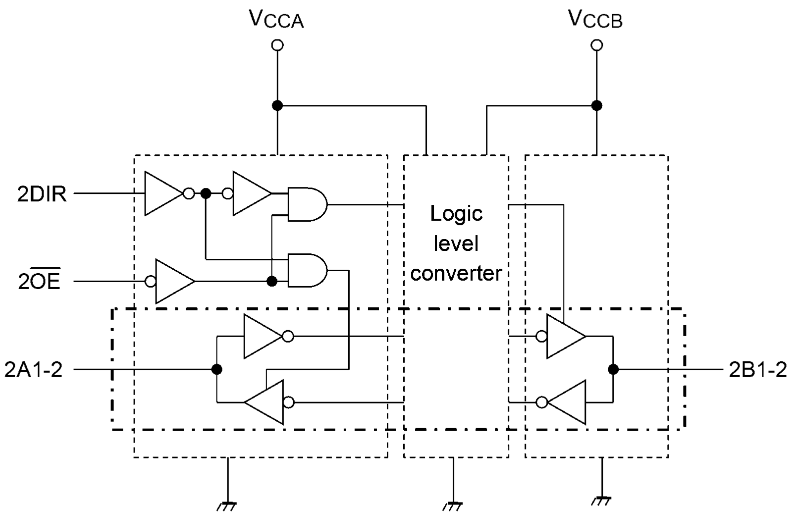


## 7. IEC Logic Symbol




## 8. Block Diagram



## 9. Truth Table

| Input $\overline{1OE}$ | Input 1DIR | Function Bus 1A1-1A2 | Function Bus 1B1-1B2 | Outputs |
|---|---|---|---|---|
| L | L | Output | Input | A = B |
| L | H | Input | Output | B = A |
| H | X | Z | Z | Z |

| Input $\overline{2OE}$ | Input 2DIR | Function Bus 2A1-2A2 | Function Bus 2B1-2B2 | Outputs |
|---|---|---|---|---|
| L | L | Output | Input | A = B |
| L | H | Input | Output | B = A |
| H | X | Z | Z | Z |

X: Don't care
Z: High impedance

## 10. Absolute Maximum Ratings (Note)

| Characteristics | Symbol | Note | Rating | Unit |
|---|---|---|---|---|
| Supply voltage | $V_{CCA}$ | (Note 1) | -0.5 to 4.6 | V |
| | $V_{CCB}$ | | -0.5 to 4.6 | |
| Input voltage (DIR, $\overline{OE}$) | $V_{IN}$ | | -0.5 to 4.6 | V |
| Bus I/O voltage | $V_{I/OA}$ | (Note 2) | -0.5 to 4.6 | V |
| | | (Note 3) | -0.5 to $V_{CCA}$ + 0.5 | |
| | $V_{I/OB}$ | (Note 2) | -0.5 to 4.6 | |
| | | (Note 3) | -0.5 to $V_{CCB}$ + 0.5 | |
| Input diode current | $I_{IK}$ | | -50 | mA |
| I/O diode current | $I_{I/OK}$ | (Note 4) | ±50 | mA |
| Output current | $I_{OUTA}$ | | ±25 | mA |
| | $I_{OUTB}$ | | ±25 | |
| $V_{CC}$/ground current per supply pin | $I_{CCA}$ | | ±50 | mA |
| | $I_{CCB}$ | | ±50 | |
| Power dissipation | $P_D$ | | 180 | mW |
| Storage temperature | $T_{stg}$ | | -65 to 150 | °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 $V_{CCB}$ pin when $V_{CCA}$ 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: $V_{OUT}$ < GND, $V_{OUT}$ > $V_{CC}$

## 11. Operating Ranges (Note)

| Characteristics | Symbol | Note | Test Condition | Rating | Unit |
|---|---|---|---|---|---|
| Supply voltage | $V_{CCA}$ | (Note 1) | — | 1.1 to 2.7 | V |
| | $V_{CCB}$ | | | 1.65 to 3.6 | |
| Input voltage(DIR, $\overline{OE}$) | $V_{IN}$ | | — | 0 to 3.6 | V |
| Bus I/O voltage | $V_{I/OA}$ | (Note 2) | — | 0 to 3.6 | V |
| | | (Note 3) | | 0 to $V_{CCA}$ | |
| | $V_{I/OB}$ | (Note 2) | | 0 to 3.6 | |
| | | (Note 3) | | 0 to $V_{CCB}$ | |
| Output current | $I_{OUTA}$ | | $V_{CCA}$ = 2.3 to 2.7 V | ±9 | mA |
| | | | $V_{CCA}$ = 1.65 to 1.95 V | ±3 | |
| | | | $V_{CCA}$ = 1.4 to 1.6 V | ±1 | |
| | $I_{OUTB}$ | | $V_{CCB}$ = 3.0 to 3.6 V | ±12 | |
| | | | $V_{CCB}$ = 2.3 to 2.7 V | ±9 | |
| | | | $V_{CCB}$ = 1.65 to 1.95 V | ±3 | |
| Operating temperature | $T_{opr}$ | | — | -40 to 85 | ℃ |
| Input rise and fall times | dt/dv | | $V_{IN}$ = 0.8 to 2.0 V, $V_{CCA}$ = 2.5 V, $V_{CCB}$ = 3.0 V | 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.

Note 1: Don't use at $V_{CCA} > V_{CCB}$.

Note 2: Output in OFF state.

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

# 12. Electrical Characteristics

## 12.1. DC Characteristics

### 12.1.1. 2.3 V ≤ $V_{CCA}$ ≤ 2.7 V, 2.7 V < $V_{CCB}$ ≤ 3.6 V (Unless otherwise specified, $T_a$ = -40 to 85 °C)

| Characteristics | Symbol | Test Condition | | $V_{CCA}$ (V) | $V_{CCB}$ (V) | Min | Max | Unit |
|---|---|---|---|---|---|---|---|---|
| High-level input voltage | $V_{IHA}$ | DIR, $\overline{OE}$, An | | 2.3 to 2.7 | 2.7 to 3.6 | 1.6 | — | V |
| | $V_{IHB}$ | Bn | | 2.3 to 2.7 | 2.7 to 3.6 | 2.0 | — | |
| Low-level input voltage | $V_{ILA}$ | DIR, $\overline{OE}$, An | | 2.3 to 2.7 | 2.7 to 3.6 | — | 0.7 | V |
| | $V_{ILB}$ | Bn | | 2.3 to 2.7 | 2.7 to 3.6 | — | 0.8 | |
| High-level output voltage | $V_{OHA}$ | $V_{IN}$ = $V_{IH}$ or $V_{IL}$ | $I_{OHA}$ = -100 μA | 2.3 to 2.7 | 2.7 to 3.6 | $V_{CCA}$ -0.2 | — | V |
| | | | $I_{OHA}$ = -9 mA | 2.3 | 2.7 to 3.6 | 1.7 | — | |
| | $V_{OHB}$ | | $I_{OHB}$ = -100 μA | 2.3 to 2.7 | 2.7 to 3.6 | $V_{CCB}$ -0.2 | — | |
| | | | $I_{OHB}$ = -12 mA | 2.3 to 2.7 | 3.0 | 2.2 | — | |
| Low-level output voltage | $V_{OLA}$ | $V_{IN}$ = $V_{IH}$ or $V_{IL}$ | $I_{OLA}$ = 100 μA | 2.3 to 2.7 | 2.7 to 3.6 | — | 0.2 | V |
| | | | $I_{OLA}$ = 9 mA | 2.3 | 2.7 to 3.6 | — | 0.6 | |
| | $V_{OLB}$ | | $I_{OLB}$ = 100 μA | 2.3 to 2.7 | 2.7 to 3.6 | — | 0.2 | |
| | | | $I_{OLB}$ = 12 mA | 2.3 to 2.7 | 3.0 | — | 0.55 | |
| 3-state output OFF-state leakage current | $I_{OZA}$ | $V_{IN}$ = $V_{IH}$ or $V_{IL}$<br>$V_{OUT}$ = 0 to 3.6 V | | 2.3 to 2.7 | 2.7 to 3.6 | — | ±2.0 | μA |
| | $I_{OZB}$ | $V_{IN}$ = $V_{IH}$ or $V_{IL}$<br>$V_{OUT}$ = 0 to 3.6 V | | 2.3 to 2.7 | 2.7 to 3.6 | — | ±2.0 | |
| Input leakage current | $I_{IN}$ | $V_{IN}$ (DIR, $\overline{OE}$) = 0 to 3.6 V | | 2.3 to 2.7 | 2.7 to 3.6 | — | ±1.0 | μA |
| Power-off leakage current | $I_{OFF1}$ | $V_{IN}$, $V_{OUT}$ = 0 to 3.6 V | | 0 | 0 | — | 2.0 | μA |
| | $I_{OFF2}$ | $\overline{OE}$ = $V_{CCA}$<br>$V_{IN}$, $V_{OUT}$ = 0 to 3.6 V | | 2.3 to 2.7 | 0 | — | 2.0 | |
| | $I_{OFF3}$ | | | 2.3 to 2.7 | Open | — | 2.0 | |
| Quiescent supply current | $I_{CCA}$ | $V_{INA}$ = $V_{CCA}$ or GND<br>$V_{INB}$ = $V_{CCB}$ or GND | | 2.3 to 2.7 | 2.7 to 3.6 | — | 2.0 | μA |
| | $I_{CCB}$ | $V_{INA}$ = $V_{CCA}$ or GND<br>$V_{INB}$ = $V_{CCB}$ or GND | | 2.3 to 2.7 | 2.7 to 3.6 | — | 2.0 | |
| | $I_{CCA}$ | $V_{CCA}$ ≤ ($V_{IN}$, $V_{OUT}$) ≤ 3.6 V | | 2.3 to 2.7 | 2.7 to 3.6 | — | ±2.0 | |
| | $I_{CCB}$ | $V_{CCB}$ ≤ ($V_{IN}$, $V_{OUT}$) ≤ 3.6 V | | 2.3 to 2.7 | 2.7 to 3.6 | — | ±2.0 | |
| | $I_{CCTB}$ | $V_{INB}$ = $V_{CCB}$ - 0.6 V<br>per input | | 2.3 to 2.7 | 2.7 to 3.6 | — | 750.0 | |

### 12.1.2. 1.65 V ≤ $V_{CCA}$ < 2.3 V, 2.7 V < $V_{CCB}$ ≤ 3.6 V (Unless otherwise specified, $T_a$ = -40 to 85 °C)

| Characteristics | Symbol | Test Condition | | $V_{CCA}$ (V) | $V_{CCB}$ (V) | Min | Max | Unit |
|---|---|---|---|---|---|---|---|---|
| High-level input voltage | $V_{IHA}$ | DIR, $\overline{OE}$, An | | 1.65 to 2.3 | 2.7 to 3.6 | 0.65× $V_{CCA}$ | — | V |
| | $V_{IHB}$ | Bn | | 1.65 to 2.3 | 2.7 to 3.6 | 2.0 | — | |
| Low-level input voltage | $V_{ILA}$ | DIR, $\overline{OE}$, An | | 1.65 to 2.3 | 2.7 to 3.6 | — | 0.35× $V_{CCA}$ | V |
| | $V_{ILB}$ | Bn | | 1.65 to 2.3 | 2.7 to 3.6 | — | 0.8 | |
| High-level output voltage | $V_{OHA}$ | $V_{IN}$ = $V_{IH}$ or $V_{IL}$ | $I_{OHA}$ = -100 μA | 1.65 to 2.3 | 2.7 to 3.6 | $V_{CCA}$ -0.2 | — | V |
| | | | $I_{OHA}$ = -3 mA | 1.65 | 2.7 to 3.6 | 1.25 | — | |
| | $V_{OHB}$ | | $I_{OHB}$ = -100 μA | 1.65 to 2.3 | 2.7 to 3.6 | $V_{CCB}$ -0.2 | — | |
| | | | $I_{OHB}$ = -12 mA | 1.65 to 2.3 | 3.0 | 2.2 | — | |
| Low-level output voltage | $V_{OLA}$ | $V_{IN}$ = $V_{IH}$ or $V_{IL}$ | $I_{OLA}$ = 100 μA | 1.65 to 2.3 | 2.7 to 3.6 | — | 0.2 | V |
| | | | $I_{OLA}$ = 3 mA | 1.65 | 2.7 to 3.6 | — | 0.3 | |
| | $V_{OLB}$ | | $I_{OLB}$ = 100 μA | 1.65 to 2.3 | 2.7 to 3.6 | — | 0.2 | |
| | | | $I_{OLB}$ = 12 mA | 1.65 to 2.3 | 3.0 | — | 0.55 | |
| 3-state output OFF-state leakage current | $I_{OZA}$ | $V_{IN}$ = $V_{IH}$ or $V_{IL}$<br>$V_{OUT}$ = 0 to 3.6 V | | 1.65 to 2.3 | 2.7 to 3.6 | — | ±2.0 | μA |
| | $I_{OZB}$ | $V_{IN}$ = $V_{IH}$ or $V_{IL}$<br>$V_{OUT}$ = 0 to 3.6 V | | 1.65 to 2.3 | 2.7 to 3.6 | — | ±2.0 | |
| Input leakage current | $I_{IN}$ | $V_{IN}$ (DIR, $\overline{OE}$) = 0 to 3.6 V | | 1.65 to 2.3 | 2.7 to 3.6 | — | ±1.0 | μA |
| Power-off leakage current | $I_{OFF1}$ | $V_{IN}$, $V_{OUT}$ = 0 to 3.6 V | | 0 | 0 | — | 2.0 | μA |
| | $I_{OFF2}$ | $\overline{OE}$ = $V_{CCA}$<br>$V_{IN}$, $V_{OUT}$ = 0 to 3.6 V | | 1.65 to 2.3 | 0 | — | 2.0 | |
| | $I_{OFF3}$ | | | 1.65 to 2.3 | Open | — | 2.0 | |
| Quiescent supply current | $I_{CCA}$ | $V_{INA}$ = $V_{CCA}$ or GND<br>$V_{INB}$ = $V_{CCB}$ or GND | | 1.65 to 2.3 | 2.7 to 3.6 | — | 2.0 | μA |
| | $I_{CCB}$ | $V_{INA}$ = $V_{CCA}$ or GND<br>$V_{INB}$ = $V_{CCB}$ or GND | | 1.65 to 2.3 | 2.7 to 3.6 | — | 2.0 | |
| | $I_{CCA}$ | $V_{CCA}$ ≤ ($V_{IN}$, $V_{OUT}$) ≤ 3.6 V | | 1.65 to 2.3 | 2.7 to 3.6 | — | ±2.0 | |
| | $I_{CCB}$ | $V_{CCB}$ ≤ ($V_{IN}$, $V_{OUT}$) ≤ 3.6 V | | 1.65 to 2.3 | 2.7 to 3.6 | — | ±2.0 | |
| | $I_{CCTB}$ | $V_{INB}$ = $V_{CCB}$ - 0.6 V<br>per input | | 1.65 to 2.3 | 2.7 to 3.6 | — | 750.0 | |

### 12.1.3. 1.4 V ≤ $V_{CCA}$ < 1.65 V, 2.7 V < $V_{CCB}$ ≤ 3.6 V (Unless otherwise specified, $T_a$ = -40 to 85 °C)

| Characteristics | Symbol | Test Condition | | $V_{CCA}$ (V) | $V_{CCB}$ (V) | Min | Max | Unit |
|---|---|---|---|---|---|---|---|---|
| High-level input voltage | $V_{IHA}$ | DIR, $\overline{OE}$, An | | 1.4 to 1.65 | 2.7 to 3.6 | 0.65× $V_{CCA}$ | — | V |
| | $V_{IHB}$ | Bn | | 1.4 to 1.65 | 2.7 to 3.6 | 2.0 | — | |
| Low-level input voltage | $V_{ILA}$ | DIR, $\overline{OE}$, An | | 1.4 to 1.65 | 2.7 to 3.6 | — | 0.30× $V_{CCA}$ | V |
| | $V_{ILB}$ | Bn | | 1.4 to 1.65 | 2.7 to 3.6 | — | 0.8 | |
| High-level output voltage | $V_{OHA}$ | $V_{IN}$ = $V_{IH}$ or $V_{IL}$ | $I_{OHA}$ = -100 μA | 1.4 to 1.65 | 2.7 to 3.6 | $V_{CCA}$ -0.2 | — | V |
| | | | $I_{OHA}$ = -1 mA | 1.4 | 2.7 to 3.6 | 1.05 | — | |
| | $V_{OHB}$ | | $I_{OHB}$ = -100 μA | 1.4 to 1.65 | 2.7 to 3.6 | $V_{CCB}$ -0.2 | — | |
| | | | $I_{OHB}$ = -12 mA | 1.4 to 1.65 | 3.0 | 2.2 | — | |
| Low-level output voltage | $V_{OLA}$ | $V_{IN}$ = $V_{IH}$ or $V_{IL}$ | $I_{OLA}$ = 100 μA | 1.4 to 1.65 | 2.7 to 3.6 | — | 0.2 | V |
| | | | $I_{OLA}$ = 1 mA | 1.4 | 2.7 to 3.6 | — | 0.35 | |
| | $V_{OLB}$ | | $I_{OLB}$ = 100 μA | 1.4 to 1.65 | 2.7 to 3.6 | — | 0.2 | |
| | | | $I_{OLB}$ = 12 mA | 1.4 to 1.65 | 3.0 | — | 0.55 | |
| 3-state output OFF-state leakage current | $I_{OZA}$ | $V_{IN}$ = $V_{IH}$ or $V_{IL}$ $V_{OUT}$ = 0 to 3.6 V | | 1.4 to 1.65 | 2.7 to 3.6 | — | ±2.0 | μA |
| | $I_{OZB}$ | $V_{IN}$ = $V_{IH}$ or $V_{IL}$ $V_{OUT}$ = 0 to 3.6 V | | 1.4 to 1.65 | 2.7 to 3.6 | — | ±2.0 | |
| Input leakage current | $I_{IN}$ | $V_{IN}$ (DIR, $\overline{OE}$) = 0 to 3.6 V | | 1.4 to 1.65 | 2.7 to 3.6 | — | ±1.0 | μA |
| Power-off leakage current | $I_{OFF1}$ | $V_{IN}$, $V_{OUT}$ = 0 to 3.6 V | | 0 | 0 | — | 2.0 | μA |
| | $I_{OFF2}$ | $\overline{OE}$ = $V_{CCA}$ $V_{IN}$, $V_{OUT}$ = 0 to 3.6 V | | 1.4 to 1.65 | 0 | — | 2.0 | |
| | $I_{OFF3}$ | | | 1.4 to 1.65 | Open | — | 2.0 | |
| Quiescent supply current | $I_{CCA}$ | $V_{INA}$ = $V_{CCA}$ or GND $V_{INB}$ = $V_{CCB}$ or GND | | 1.4 to 1.65 | 2.7 to 3.6 | — | 2.0 | μA |
| | $I_{CCB}$ | $V_{INA}$ = $V_{CCA}$ or GND $V_{INB}$ = $V_{CCB}$ or GND | | 1.4 to 1.65 | 2.7 to 3.6 | — | 2.0 | |
| | $I_{CCA}$ | $V_{CCA}$ ≤ ($V_{IN}$, $V_{OUT}$) ≤ 3.6 V | | 1.4 to 1.65 | 2.7 to 3.6 | — | ±2.0 | |
| | $I_{CCB}$ | $V_{CCB}$ ≤ ($V_{IN}$, $V_{OUT}$) ≤ 3.6 V | | 1.4 to 1.65 | 2.7 to 3.6 | — | ±2.0 | |
| | $I_{CCTB}$ | $V_{INB}$ = $V_{CCB}$ - 0.6 V per input | | 1.4 to 1.65 | 2.7 to 3.6 | — | 750.0 | |

### 12.1.4. 1.1 V ≤ $V_{CCA}$ < 1.4 V, 2.7 V < $V_{CCB}$ ≤ 3.6 V (Unless otherwise specified, $T_a$ = -40 to 85 °C)

| Characteristics | Symbol | Test Condition | | $V_{CCA}$ (V) | $V_{CCB}$ (V) | Min | Max | Unit |
|---|---|---|---|---|---|---|---|---|
| High-level input voltage | $V_{IHA}$ | DIR, $\overline{OE}$, An | | 1.1 to 1.4 | 2.7 to 3.6 | 0.65× $V_{CCA}$ | — | V |
| | $V_{IHB}$ | Bn | | 1.1 to 1.4 | 2.7 to 3.6 | 2.0 | — | |
| Low-level input voltage | $V_{ILA}$ | DIR, $\overline{OE}$, An | | 1.1 to 1.4 | 2.7 to 3.6 | — | 0.30× $V_{CCA}$ | V |
| | $V_{ILB}$ | Bn | | 1.1 to 1.4 | 2.7 to 3.6 | — | 0.8 | |
| High-level output voltage | $V_{OHA}$ | $V_{IN}$ = $V_{IH}$ or $V_{IL}$ | $I_{OHA}$ = -100 μA | 1.1 to 1.4 | 2.7 to 3.6 | $V_{CCA}$ -0.2 | — | V |
| | $V_{OHB}$ | | $I_{OHB}$ = -100 μA | 1.1 to 1.4 | 2.7 to 3.6 | $V_{CCB}$ -0.2 | — | |
| | | | $I_{OHB}$ = -12 mA | 1.1 to 1.4 | 3.0 | 2.2 | — | |
| Low-level output voltage | $V_{OLA}$ | $V_{IN}$ = $V_{IH}$ or $V_{IL}$ | $I_{OLA}$ = 100 μA | 1.1 to 1.4 | 2.7 to 3.6 | — | 0.2 | V |
| | $V_{OLB}$ | | $I_{OLB}$ = 100 μA | 1.1 to 1.4 | 2.7 to 3.6 | — | 0.2 | |
| | | | $I_{OLB}$ = 12 mA | 1.1 to 1.4 | 3.0 | — | 0.55 | |
| 3-state output OFF-state leakage current | $I_{OZA}$ | $V_{IN}$ = $V_{IH}$ or $V_{IL}$<br>$V_{OUT}$ = 0 to 3.6 V | | 1.1 to 1.4 | 2.7 to 3.6 | — | ±2.0 | μA |
| | $I_{OZB}$ | $V_{IN}$ = $V_{IH}$ or $V_{IL}$<br>$V_{OUT}$ = 0 to 3.6 V | | 1.1 to 1.4 | 2.7 to 3.6 | — | ±2.0 | |
| Input leakage current | $I_{IN}$ | $V_{IN}$ (DIR, $\overline{OE}$) = 0 to 3.6 V | | 1.1 to 1.4 | 2.7 to 3.6 | — | ±1.0 | μA |
| Power-off leakage current | $I_{OFF1}$ | $V_{IN}$, $V_{OUT}$ = 0 to 3.6 V | | 0 | 0 | — | 2.0 | μA |
| | $I_{OFF2}$ | $\overline{OE}$ = $V_{CCA}$<br>$V_{IN}$, $V_{OUT}$ = 0 to 3.6 V | | 1.1 to 1.4 | 0 | — | 2.0 | |
| | $I_{OFF3}$ | | | 1.1 to 1.4 | Open | — | 2.0 | |
| Quiescent supply current | $I_{CCA}$ | $V_{INA}$ = $V_{CCA}$ or GND<br>$V_{INB}$ = $V_{CCB}$ or GND | | 1.1 to 1.4 | 2.7 to 3.6 | — | 2.0 | μA |
| | $I_{CCB}$ | $V_{INA}$ = $V_{CCA}$ or GND<br>$V_{INB}$ = $V_{CCB}$ or GND | | 1.1 to 1.4 | 2.7 to 3.6 | — | 2.0 | |
| | $I_{CCA}$ | $V_{CCA}$ ≤ ($V_{IN}$, $V_{OUT}$) ≤ 3.6 V | | 1.1 to 1.4 | 2.7 to 3.6 | — | ±2.0 | |
| | $I_{CCB}$ | $V_{CCB}$ ≤ ($V_{IN}$, $V_{OUT}$) ≤ 3.6 V | | 1.1 to 1.4 | 2.7 to 3.6 | — | ±2.0 | |
| | $I_{CCTB}$ | $V_{INB}$ = $V_{CCB}$ - 0.6 V<br>per input | | 1.1 to 1.4 | 2.7 to 3.6 | — | 750.0 | |

### 12.1.5. 1.65 V ≤ $V_{CCA}$ < 2.3 V, 2.3 V ≤ $V_{CCB}$ ≤ 2.7 V (Unless otherwise specified, $T_a$ = -40 to 85 °C)

| Characteristics | Symbol | Test Condition | | $V_{CCA}$ (V) | $V_{CCB}$ (V) | Min | Max | Unit |
|---|---|---|---|---|---|---|---|---|
| High-level input voltage | $V_{IHA}$ | DIR, $\overline{OE}$, An | | 1.65 to 2.3 | 2.3 to 2.7 | 0.65× $V_{CCA}$ | — | V |
| | $V_{IHB}$ | Bn | | 1.65 to 2.3 | 2.3 to 2.7 | 1.6 | — | |
| Low-level input voltage | $V_{ILA}$ | DIR, $\overline{OE}$, An | | 1.65 to 2.3 | 2.3 to 2.7 | — | 0.35× $V_{CCA}$ | V |
| | $V_{ILB}$ | Bn | | 1.65 to 2.3 | 2.3 to 2.7 | — | 0.7 | |
| High-level output voltage | $V_{OHA}$ | $V_{IN}$ = $V_{IH}$ or $V_{IL}$ | $I_{OHA}$ = -100 μA | 1.65 to 2.3 | 2.3 to 2.7 | $V_{CCA}$ -0.2 | — | V |
| | | | $I_{OHA}$ = -3 mA | 1.65 | 2.3 to 2.7 | 1.25 | — | |
| | $V_{OHB}$ | | $I_{OHB}$ = -100 μA | 1.65 to 2.3 | 2.3 to 2.7 | $V_{CCB}$ -0.2 | — | |
| | | | $I_{OHB}$ = -9 mA | 1.65 to 2.3 | 2.3 | 1.7 | — | |
| Low-level output voltage | $V_{OLA}$ | $V_{IN}$ = $V_{IH}$ or $V_{IL}$ | $I_{OLA}$ = 100 μA | 1.65 to 2.3 | 2.3 to 2.7 | — | 0.2 | V |
| | | | $I_{OLA}$ = 3 mA | 1.65 | 2.3 to 2.7 | — | 0.3 | |
| | $V_{OLB}$ | | $I_{OLB}$ = 100 μA | 1.65 to 2.3 | 2.3 to 2.7 | — | 0.2 | |
| | | | $I_{OLB}$ = 9 mA | 1.65 to 2.3 | 2.3 | — | 0.6 | |
| 3-state output OFF-state leakage current | $I_{OZA}$ | $V_{IN}$ = $V_{IH}$ or $V_{IL}$<br>$V_{OUT}$ = 0 to 3.6 V | | 1.65 to 2.3 | 2.3 to 2.7 | — | ±2.0 | μA |
| | $I_{OZB}$ | $V_{IN}$ = $V_{IH}$ or $V_{IL}$<br>$V_{OUT}$ = 0 to 3.6 V | | 1.65 to 2.3 | 2.3 to 2.7 | — | ±2.0 | |
| Input leakage current | $I_{IN}$ | $V_{IN}$ (DIR, $\overline{OE}$) = 0 to 3.6 V | | 1.65 to 2.3 | 2.3 to 2.7 | — | ±1.0 | μA |
| Power-off leakage current | $I_{OFF1}$ | $V_{IN}$, $V_{OUT}$ = 0 to 3.6 V | | 0 | 0 | — | 2.0 | μA |
| | $I_{OFF2}$ | $\overline{OE}$ = $V_{CCA}$<br>$V_{IN}$, $V_{OUT}$ = 0 to 3.6 V | | 1.65 to 2.3 | 0 | — | 2.0 | |
| | $I_{OFF3}$ | | | 1.65 to 2.3 | Open | — | 2.0 | |
| Quiescent supply current | $I_{CCA}$ | $V_{INA}$ = $V_{CCA}$ or GND<br>$V_{INB}$ = $V_{CCB}$ or GND | | 1.65 to 2.3 | 2.3 to 2.7 | — | 2.0 | μA |
| | $I_{CCB}$ | $V_{INA}$ = $V_{CCA}$ or GND<br>$V_{INB}$ = $V_{CCB}$ or GND | | 1.65 to 2.3 | 2.3 to 2.7 | — | 2.0 | |
| | $I_{CCA}$ | $V_{CCA}$ ≤ ($V_{IN}$, $V_{OUT}$) ≤ 3.6 V | | 1.65 to 2.3 | 2.3 to 2.7 | — | ±2.0 | |
| | $I_{CCB}$ | $V_{CCB}$ ≤ ($V_{IN}$, $V_{OUT}$) ≤ 3.6 V | | 1.65 to 2.3 | 2.3 to 2.7 | — | ±2.0 | |

### 12.1.6. 1.4 V ≤ $V_{CCA}$ < 1.65 V, 2.3 V ≤ $V_{CCB}$ ≤ 2.7 V (Unless otherwise specified, $T_a$ = -40 to 85 °C)

| Characteristics | Symbol | Test Condition | | $V_{CCA}$ (V) | $V_{CCB}$ (V) | Min | Max | Unit |
|---|---|---|---|---|---|---|---|---|
| High-level input voltage | $V_{IHA}$ | DIR, $\overline{OE}$, An | | 1.4 to 1.65 | 2.3 to 2.7 | 0.65× $V_{CCA}$ | — | V |
| | $V_{IHB}$ | Bn | | 1.4 to 1.65 | 2.3 to 2.7 | 1.6 | — | |
| Low-level input voltage | $V_{ILA}$ | DIR, $\overline{OE}$, An | | 1.4 to 1.65 | 2.3 to 2.7 | — | 0.30× $V_{CCA}$ | V |
| | $V_{ILB}$ | Bn | | 1.4 to 1.65 | 2.3 to 2.7 | — | 0.7 | |
| High-level output voltage | $V_{OHA}$ | $V_{IN}$ = $V_{IH}$ or $V_{IL}$ | $I_{OHA}$ = -100 μA | 1.4 to 1.65 | 2.3 to 2.7 | $V_{CCA}$ -0.2 | — | V |
| | | | $I_{OHA}$ = -1 mA | 1.4 | 2.3 to 2.7 | 1.05 | — | |
| | $V_{OHB}$ | | $I_{OHB}$ = -100 μA | 1.4 to 1.65 | 2.3 to 2.7 | $V_{CCB}$ -0.2 | — | |
| | | | $I_{OHB}$ = -9 mA | 1.4 to 1.65 | 2.3 | 1.7 | — | |
| Low-level output voltage | $V_{OLA}$ | $V_{IN}$ = $V_{IH}$ or $V_{IL}$ | $I_{OLA}$ = 100 μA | 1.4 to 1.65 | 2.3 to 2.7 | — | 0.2 | V |
| | | | $I_{OLA}$ = 1 mA | 1.4 | 2.3 to 2.7 | — | 0.35 | |
| | $V_{OLB}$ | | $I_{OLB}$ = 100 μA | 1.4 to 1.65 | 2.3 to 2.7 | — | 0.2 | |
| | | | $I_{OLB}$ = 9 mA | 1.4 to 1.65 | 2.3 | — | 0.6 | |
| 3-state output OFF-state leakage current | $I_{OZA}$ | $V_{IN}$ = $V_{IH}$ or $V_{IL}$<br>$V_{OUT}$ = 0 to 3.6 V | | 1.4 to 1.65 | 2.3 to 2.7 | — | ±2.0 | μA |
| | $I_{OZB}$ | $V_{IN}$ = $V_{IH}$ or $V_{IL}$<br>$V_{OUT}$ = 0 to 3.6 V | | 1.4 to 1.65 | 2.3 to 2.7 | — | ±2.0 | |
| Input leakage current | $I_{IN}$ | $V_{IN}$ (DIR, $\overline{OE}$) = 0 to 3.6 V | | 1.4 to 1.65 | 2.3 to 2.7 | — | ±1.0 | μA |
| Power-off leakage current | $I_{OFF1}$ | $V_{IN}$, $V_{OUT}$ = 0 to 3.6 V | | 0 | 0 | — | 2.0 | μA |
| | $I_{OFF2}$ | $\overline{OE}$ = $V_{CCA}$<br>$V_{IN}$, $V_{OUT}$ = 0 to 3.6 V | | 1.4 to 1.65 | 0 | — | 2.0 | |
| | $I_{OFF3}$ | | | 1.4 to 1.65 | Open | — | 2.0 | |
| Quiescent supply current | $I_{CCA}$ | $V_{INA}$ = $V_{CCA}$ or GND<br>$V_{INB}$ = $V_{CCB}$ or GND | | 1.4 to 1.65 | 2.3 to 2.7 | — | 2.0 | μA |
| | $I_{CCB}$ | $V_{INA}$ = $V_{CCA}$ or GND<br>$V_{INB}$ = $V_{CCB}$ or GND | | 1.4 to 1.65 | 2.3 to 2.7 | — | 2.0 | |
| | $I_{CCA}$ | $V_{CCA}$ ≤ ($V_{IN}$, $V_{OUT}$) ≤ 3.6 V | | 1.4 to 1.65 | 2.3 to 2.7 | — | ±2.0 | |
| | $I_{CCB}$ | $V_{CCB}$ ≤ ($V_{IN}$, $V_{OUT}$) ≤ 3.6 V | | 1.4 to 1.65 | 2.3 to 2.7 | — | ±2.0 | |

### 12.1.7. 1.1 V ≤ $V_{CCA}$ < 1.4 V, 2.3 V ≤ $V_{CCB}$ ≤ 2.7 V (Unless otherwise specified, $T_a$ = -40 to 85 °C)

| Characteristics | Symbol | Test Condition | | $V_{CCA}$ (V) | $V_{CCB}$ (V) | Min | Max | Unit |
|---|---|---|---|---|---|---|---|---|
| High-level input voltage | $V_{IHA}$ | DIR, $\overline{OE}$, An | | 1.1 to 1.4 | 2.3 to 2.7 | 0.65× $V_{CCA}$ | — | V |
| | $V_{IHB}$ | Bn | | 1.1 to 1.4 | 2.3 to 2.7 | 1.6 | — | |
| Low-level input voltage | $V_{ILA}$ | DIR, $\overline{OE}$, An | | 1.1 to 1.4 | 2.3 to 2.7 | — | 0.30× $V_{CCA}$ | V |
| | $V_{ILB}$ | Bn | | 1.1 to 1.4 | 2.3 to 2.7 | — | 0.7 | |
| High-level output voltage | $V_{OHA}$ | $V_{IN}$ = $V_{IH}$ or $V_{IL}$ | $I_{OHA}$ = -100 μA | 1.1 to 1.4 | 2.3 to 2.7 | $V_{CCA}$ -0.2 | — | V |
| | $V_{OHB}$ | | $I_{OHB}$ = -100 μA | 1.1 to 1.4 | 2.3 to 2.7 | $V_{CCB}$ -0.2 | — | |
| | | | $I_{OHB}$ = -9 mA | 1.1 to 1.4 | 2.3 | 1.7 | — | |
| Low-level output voltage | $V_{OLA}$ | $V_{IN}$ = $V_{IH}$ or $V_{IL}$ | $I_{OLA}$ = 100 μA | 1.1 to 1.4 | 2.3 to 2.7 | — | 0.2 | V |
| | $V_{OLB}$ | | $I_{OLB}$ = 100 μA | 1.1 to 1.4 | 2.3 to 2.7 | — | 0.2 | |
| | | | $I_{OLB}$ = 9 mA | 1.1 to 1.4 | 2.3 | — | 0.6 | |
| 3-state output OFF-state leakage current | $I_{OZA}$ | $V_{IN}$ = $V_{IH}$ or $V_{IL}$<br>$V_{OUT}$ = 0 to 3.6 V | | 1.1 to 1.4 | 2.3 to 2.7 | — | ±2.0 | μA |
| | $I_{OZB}$ | $V_{IN}$ = $V_{IH}$ or $V_{IL}$<br>$V_{OUT}$ = 0 to 3.6 V | | 1.1 to 1.4 | 2.3 to 2.7 | — | ±2.0 | |
| Input leakage current | $I_{IN}$ | $V_{IN}$ (DIR, $\overline{OE}$) = 0 to 3.6 V | | 1.1 to 1.4 | 2.3 to 2.7 | — | ±1.0 | μA |
| Power-off leakage current | $I_{OFF1}$ | $V_{IN}$, $V_{OUT}$ = 0 to 3.6 V | | 0 | 0 | — | 2.0 | μA |
| | $I_{OFF2}$ | $\overline{OE}$ = $V_{CCA}$<br>$V_{IN}$, $V_{OUT}$ = 0 to 3.6 V | | 1.1 to 1.4 | 0 | — | 2.0 | |
| | $I_{OFF3}$ | | | 1.1 to 1.4 | Open | — | 2.0 | |
| Quiescent supply current | $I_{CCA}$ | $V_{INA}$ = $V_{CCA}$ or GND<br>$V_{INB}$ = $V_{CCB}$ or GND | | 1.1 to 1.4 | 2.3 to 2.7 | — | 2.0 | μA |
| | $I_{CCB}$ | $V_{INA}$ = $V_{CCA}$ or GND<br>$V_{INB}$ = $V_{CCB}$ or GND | | 1.1 to 1.4 | 2.3 to 2.7 | — | 2.0 | |
| | $I_{CCA}$ | $V_{CCA}$ ≤ ($V_{IN}$, $V_{OUT}$) ≤ 3.6 V | | 1.1 to 1.4 | 2.3 to 2.7 | — | ±2.0 | |
| | $I_{CCB}$ | $V_{CCB}$ ≤ ($V_{IN}$, $V_{OUT}$) ≤ 3.6 V | | 1.1 to 1.4 | 2.3 to 2.7 | — | ±2.0 | |

### 12.1.8. 1.1 V ≤ $V_{CCA}$ < 1.4 V, 1.65 V ≤ $V_{CCB}$ < 2.3 V (Unless otherwise specified, $T_a$ = -40 to 85 °C)

| Characteristics | Symbol | Test Condition | | $V_{CCA}$ (V) | $V_{CCB}$ (V) | Min | Max | Unit |
|---|---|---|---|---|---|---|---|---|
| High-level input voltage | $V_{IHA}$ | DIR, $\overline{OE}$, An | | 1.1 to 1.4 | 1.65 to 2.3 | 0.65× $V_{CCA}$ | — | V |
| | $V_{IHB}$ | Bn | | 1.1 to 1.4 | 1.65 to 2.3 | 0.65× $V_{CCB}$ | — | |
| Low-level input voltage | $V_{ILA}$ | DIR, $\overline{OE}$, An | | 1.1 to 1.4 | 1.65 to 2.3 | — | 0.30× $V_{CCA}$ | V |
| | $V_{ILB}$ | Bn | | 1.1 to 1.4 | 1.65 to 2.3 | — | 0.35× $V_{CCB}$ | |
| High-level output voltage | $V_{OHA}$ | $V_{IN}$ = $V_{IH}$ or $V_{IL}$ | $I_{OHA}$ = -100 μA | 1.1 to 1.4 | 1.65 to 2.3 | $V_{CCA}$ -0.2 | — | V |
| | $V_{OHB}$ | | $I_{OHB}$ = -100 μA | 1.1 to 1.4 | 1.65 to 2.3 | $V_{CCB}$ -0.2 | — | |
| | | | $I_{OHB}$ = -3 mA | 1.1 to 1.4 | 1.65 | 1.25 | — | |
| Low-level output voltage | $V_{OLA}$ | $V_{IN}$ = $V_{IH}$ or $V_{IL}$ | $I_{OLA}$ = 100 μA | 1.1 to 1.4 | 1.65 to 2.3 | — | 0.2 | V |
| | $V_{OLB}$ | | $I_{OLB}$ = 100 μA | 1.1 to 1.4 | 1.65 to 2.3 | — | 0.2 | |
| | | | $I_{OLB}$ = 3 mA | 1.1 to 1.4 | 1.65 | — | 0.3 | |
| 3-state output OFF-state leakage current | $I_{OZA}$ | $V_{IN}$ = $V_{IH}$ or $V_{IL}$<br>$V_{OUT}$ = 0 to 3.6 V | | 1.1 to 1.4 | 1.65 to 2.3 | — | ±2.0 | μA |
| | $I_{OZB}$ | $V_{IN}$ = $V_{IH}$ or $V_{IL}$<br>$V_{OUT}$ = 0 to 3.6 V | | 1.1 to 1.4 | 1.65 to 2.3 | — | ±2.0 | |
| Input leakage current | $I_{IN}$ | $V_{IN}$ (DIR, $\overline{OE}$) = 0 to 3.6 V | | 1.1 to 1.4 | 1.65 to 2.3 | — | ±1.0 | μA |
| Power-off leakage current | $I_{OFF1}$ | $V_{IN}$, $V_{OUT}$ = 0 to 3.6 V | | 0 | 0 | — | 2.0 | μA |
| | $I_{OFF2}$ | $\overline{OE}$ = $V_{CCA}$<br>$V_{IN}$, $V_{OUT}$ = 0 to 3.6 V | | 1.1 to 1.4 | 0 | — | 2.0 | |
| | $I_{OFF3}$ | | | 1.1 to 1.4 | Open | — | 2.0 | |
| Quiescent supply current | $I_{CCA}$ | $V_{INA}$ = $V_{CCA}$ or GND<br>$V_{INB}$ = $V_{CCB}$ or GND | | 1.1 to 1.4 | 1.65 to 2.3 | — | 2.0 | μA |
| | $I_{CCB}$ | $V_{INA}$ = $V_{CCA}$ or GND<br>$V_{INB}$ = $V_{CCB}$ or GND | | 1.1 to 1.4 | 1.65 to 2.3 | — | 2.0 | |
| | $I_{CCA}$ | $V_{CCA}$ ≤ ($V_{IN}$, $V_{OUT}$) ≤ 3.6 V | | 1.1 to 1.4 | 1.65 to 2.3 | — | ±2.0 | |
| | $I_{CCB}$ | $V_{CCB}$ ≤ ($V_{IN}$, $V_{OUT}$) ≤ 3.6 V | | 1.1 to 1.4 | 1.65 to 2.3 | — | ±2.0 | |

## 12.2. AC Characteristics

### 12.2.1. $V_{CCA}$ = 2.5 ± 0.2 V, $V_{CCB}$ = 3.3 ± 0.3 V (Unless otherwise specified, $T_a$ = -40 to 85 °C, Input: $t_r$ = $t_f$ = 2.0 ns)

| Characteristics | Symbol | Note | Test Condition | Min | Max | Unit |
|---|---|---|---|---|---|---|
| Propagation delay time (Bn → An) | $t_{PLH}/t_{PHL}$ | | See Fig. 13.1, 14.1<br>Table 13.1.1, 13.1.2, 14.1.1 | 1.0 | 5.4 | ns |
| 3-state output enable time ($\overline{OE}$ → An) | $t_{PZL}/t_{PZH}$ | | See Fig. 13.1, 14.2<br>Table 13.1.1, 13.1.2, 14.1.1 | 1.0 | 8.4 | |
| 3-state output disable time ($\overline{OE}$ → An) | $t_{PLZ}/t_{PHZ}$ | | See Fig. 13.1, 14.2<br>Table 13.1.1, 13.1.2, 14.1.1 | 1.0 | 6.7 | |
| Propagation delay time (An → Bn) | $t_{PLH}/t_{PHL}$ | | See Fig. 13.1, 14.1<br>Table 13.1.1, 13.1.2, 14.1.1 | 1.0 | 6.8 | ns |
| 3-state output enable time ($\overline{OE}$ → Bn) | $t_{PZL}/t_{PZH}$ | | See Fig. 13.1, 14.2<br>Table 13.1.1, 13.1.2, 14.1.1 | 1.0 | 8.7 | |
| 3-state output disable time ($\overline{OE}$ → Bn) | $t_{PLZ}/t_{PHZ}$ | | See Fig. 13.1, 14.2<br>Table 13.1.1, 13.1.2, 14.1.1 | 1.0 | 3.9 | |
| Output skew | $t_{osLH}/t_{osHL}$ | (Note 1) | | — | 0.5 | ns |

Note 1: Parameter guaranteed by design. ($t_{osLH}$ = |$t_{PLH}$m-$t_{PLH}$n|, $t_{osHL}$ = |$t_{PHL}$m-$t_{PHL}$n|)

### 12.2.2. $V_{CCA}$ = 1.8 ± 0.15 V, $V_{CCB}$ = 3.3 ± 0.3 V (Unless otherwise specified, $T_a$ = -40 to 85 °C, Input: $t_r$ = $t_f$ = 2.0 ns)

| Characteristics | Symbol | Note | Test Condition | Min | Max | Unit |
|---|---|---|---|---|---|---|
| Propagation delay time (Bn → An) | $t_{PLH}/t_{PHL}$ | | See Fig. 13.1, 14.1<br>Table 13.1.1, 13.1.2, 14.1.1 | 1.0 | 8.9 | ns |
| 3-state output enable time ($\overline{OE}$ → An) | $t_{PZL}/t_{PZH}$ | | See Fig. 13.1, 14.2<br>Table 13.1.1, 13.1.2, 14.1.1 | 1.0 | 13.4 | |
| 3-state output disable time ($\overline{OE}$ → An) | $t_{PLZ}/t_{PHZ}$ | | See Fig. 13.1, 14.2<br>Table 13.1.1, 13.1.2, 14.1.1 | 1.0 | 10.9 | |
| Propagation delay time (An → Bn) | $t_{PLH}/t_{PHL}$ | | See Fig. 13.1, 14.1<br>Table 13.1.1, 13.1.2, 14.1.1 | 1.0 | 7.8 | ns |
| 3-state output enable time ($\overline{OE}$ → Bn) | $t_{PZL}/t_{PZH}$ | | See Fig. 13.1, 14.2<br>Table 13.1.1, 13.1.2, 14.1.1 | 1.0 | 10.7 | |
| 3-state output disable time ($\overline{OE}$ → Bn) | $t_{PLZ}/t_{PHZ}$ | | See Fig. 13.1, 14.2<br>Table 13.1.1, 13.1.2, 14.1.1 | 1.0 | 5.2 | |
| Output skew | $t_{osLH}/t_{osHL}$ | (Note 1) | | — | 0.5 | ns |

Note 1: Parameter guaranteed by design. ($t_{osLH}$ = |$t_{PLH}$m-$t_{PLH}$n|, $t_{osHL}$ = |$t_{PHL}$m-$t_{PHL}$n|)

### 12.2.3. $V_{CCA}$ = 1.5 ± 0.1 V, $V_{CCB}$ = 3.3 ± 0.3 V (Unless otherwise specified, $T_a$ = -40 to 85 °C, Input: $t_r$ = $t_f$ = 2.0 ns)

| Characteristics | Symbol | Note | Test Condition | Min | Max | Unit |
|---|---|---|---|---|---|---|
| Propagation delay time (Bn → An) | $t_{PLH}/t_{PHL}$ | | See Fig. 13.1, 14.1<br>Table 13.1.1, 13.1.2, 14.1.1 | 1.0 | 10.3 | ns |
| 3-state output enable time ($\overline{OE}$ → An) | $t_{PZL}/t_{PZH}$ | | See Fig. 13.1, 14.2<br>Table 13.1.1, 13.1.2, 14.1.1 | 1.0 | 18.5 | |
| 3-state output disable time ($\overline{OE}$ → An) | $t_{PLZ}/t_{PHZ}$ | | See Fig. 13.1, 14.2<br>Table 13.1.1, 13.1.2, 14.1.1 | 1.0 | 13.0 | |
| Propagation delay time (An → Bn) | $t_{PLH}/t_{PHL}$ | | See Fig. 13.1, 14.1<br>Table 13.1.1, 13.1.2, 14.1.1 | 1.0 | 8.6 | ns |
| 3-state output enable time ($\overline{OE}$ → Bn) | $t_{PZL}/t_{PZH}$ | | See Fig. 13.1, 14.2<br>Table 13.1.1, 13.1.2, 14.1.1 | 1.0 | 14.3 | |
| 3-state output disable time ($\overline{OE}$ → Bn) | $t_{PLZ}/t_{PHZ}$ | | See Fig. 13.1, 14.2<br>Table 13.1.1, 13.1.2, 14.1.1 | 1.0 | 6.6 | |
| Output skew | $t_{osLH}/t_{osHL}$ | (Note 1) | | — | 1.5 | ns |

Note 1: Parameter guaranteed by design. ($t_{osLH}$ = |$t_{PLH}$m-$t_{PLH}$n|, $t_{osHL}$ = |$t_{PHL}$m-$t_{PHL}$n|)

### 12.2.4. $V_{CCA}$ = 1.2 ± 0.1 V, $V_{CCB}$ = 3.3 ± 0.3 V (Unless otherwise specified, $T_a$ = -40 to 85 °C, Input: $t_r$ = $t_f$ = 2.0 ns)

| Characteristics | Symbol | Note | Test Condition | Min | Max | Unit |
|---|---|---|---|---|---|---|
| Propagation delay time (Bn → An) | $t_{PLH}/t_{PHL}$ | | See Fig. 13.1, 14.1<br>Table 13.1.1, 13.1.2, 14.1.1 | 1.0 | 61 | ns |
| 3-state output enable time ($\overline{OE}$ → An) | $t_{PZL}/t_{PZH}$ | | See Fig. 13.1, 14.2<br>Table 13.1.1, 13.1.2, 14.1.1 | 1.0 | 95 | |
| 3-state output disable time ($\overline{OE}$ → An) | $t_{PLZ}/t_{PHZ}$ | | See Fig. 13.1, 14.2<br>Table 13.1.1, 13.1.2, 14.1.1 | 1.0 | 44 | |
| Propagation delay time (An → Bn) | $t_{PLH}/t_{PHL}$ | | See Fig. 13.1, 14.1<br>Table 13.1.1, 13.1.2, 14.1.1 | 1.0 | 22 | ns |
| 3-state output enable time ($\overline{OE}$ → Bn) | $t_{PZL}/t_{PZH}$ | | See Fig. 13.1, 14.2<br>Table 13.1.1, 13.1.2, 14.1.1 | 1.0 | 52 | |
| 3-state output disable time ($\overline{OE}$ → Bn) | $t_{PLZ}/t_{PHZ}$ | | See Fig. 13.1, 14.2<br>Table 13.1.1, 13.1.2, 14.1.1 | 1.0 | 18 | |
| Output skew | $t_{osLH}/t_{osHL}$ | (Note 1) | | — | 1.5 | ns |

Note 1: Parameter guaranteed by design. ($t_{osLH}$ = $|t_{PLH}m-t_{PLH}n|$, $t_{osHL}$ = $|t_{PHL}m-t_{PHL}n|$)

### 12.2.5. $V_{CCA}$ = 1.8 ± 0.15 V, $V_{CCB}$ = 2.5 ± 0.2 V (Unless otherwise specified, $T_a$ = -40 to 85 °C, Input: $t_r$ = $t_f$ = 2.0 ns)

| Characteristics | Symbol | Note | Test Condition | Min | Max | Unit |
|---|---|---|---|---|---|---|
| Propagation delay time (Bn → An) | $t_{PLH}/t_{PHL}$ | | See Fig. 13.1, 14.1<br>Table 13.1.1, 13.1.2, 14.1.1 | 1.0 | 9.1 | ns |
| 3-state output enable time ($\overline{OE}$ → An) | $t_{PZL}/t_{PZH}$ | | See Fig. 13.1, 14.2<br>Table 13.1.1, 13.1.2, 14.1.1 | 1.0 | 13.5 | |
| 3-state output disable time ($\overline{OE}$ → An) | $t_{PLZ}/t_{PHZ}$ | | See Fig. 13.1, 14.2<br>Table 13.1.1, 13.1.2, 14.1.1 | 1.0 | 11.8 | |
| Propagation delay time (An → Bn) | $t_{PLH}/t_{PHL}$ | | See Fig. 13.1, 14.1<br>Table 13.1.1, 13.1.2, 14.1.1 | 1.0 | 9.5 | ns |
| 3-state output enable time ($\overline{OE}$ → Bn) | $t_{PZL}/t_{PZH}$ | | See Fig. 13.1, 14.2<br>Table 13.1.1, 13.1.2, 14.1.1 | 1.0 | 12.6 | |
| 3-state output disable time ($\overline{OE}$ → Bn) | $t_{PLZ}/t_{PHZ}$ | | See Fig. 13.1, 14.2<br>Table 13.1.1, 13.1.2, 14.1.1 | 1.0 | 5.1 | |
| Output skew | $t_{osLH}/t_{osHL}$ | (Note 1) | | — | 0.5 | ns |

Note 1: Parameter guaranteed by design. ($t_{osLH}$ = $|t_{PLH}m-t_{PLH}n|$, $t_{osHL}$ = $|t_{PHL}m-t_{PHL}n|$)

### 12.2.6. $V_{CCA}$ = 1.5 ± 0.1 V, $V_{CCB}$ = 2.5 ± 0.2 V (Unless otherwise specified, $T_a$ = -40 to 85 °C, Input: $t_r$ = $t_f$ = 2.0 ns)

| Characteristics | Symbol | Note | Test Condition | Min | Max | Unit |
|---|---|---|---|---|---|---|
| Propagation delay time (Bn → An) | $t_{PLH}/t_{PHL}$ | | See Fig. 13.1, 14.1<br>Table 13.1.1, 13.1.2, 14.1.1 | 1.0 | 10.8 | ns |
| 3-state output enable time ($\overline{OE}$ → An) | $t_{PZL}/t_{PZH}$ | | See Fig. 13.1, 14.2<br>Table 13.1.1, 13.1.2, 14.1.1 | 1.0 | 18.3 | |
| 3-state output disable time ($\overline{OE}$ → An) | $t_{PLZ}/t_{PHZ}$ | | See Fig. 13.1, 14.2<br>Table 13.1.1, 13.1.2, 14.1.1 | 1.0 | 14.2 | |
| Propagation delay time (An → Bn) | $t_{PLH}/t_{PHL}$ | | See Fig. 13.1, 14.1<br>Table 13.1.1, 13.1.2, 14.1.1 | 1.0 | 10.5 | ns |
| 3-state output enable time ($\overline{OE}$ → Bn) | $t_{PZL}/t_{PZH}$ | | See Fig. 13.1, 14.2<br>Table 13.1.1, 13.1.2, 14.1.1 | 1.0 | 15.4 | |
| 3-state output disable time ($\overline{OE}$ → Bn) | $t_{PLZ}/t_{PHZ}$ | | See Fig. 13.1, 14.2<br>Table 13.1.1, 13.1.2, 14.1.1 | 1.0 | 6.4 | |
| Output skew | $t_{osLH}/t_{osHL}$ | (Note 1) | | — | 1.5 | ns |

Note 1: Parameter guaranteed by design. ($t_{osLH}$ = $|t_{PLH}m-t_{PLH}n|$, $t_{osHL}$ = $|t_{PHL}m-t_{PHL}n|$)

### 12.2.7. $V_{CCA}$ = 1.2 ± 0.1 V, $V_{CCB}$ = 2.5 ± 0.2 V (Unless otherwise specified, $T_a$ = -40 to 85 °C, Input: $t_r$ = $t_f$ = 2.0 ns)

| Characteristics | Symbol | Note | Test Condition | Min | Max | Unit |
|---|---|---|---|---|---|---|
| Propagation delay time (Bn → An) | $t_{PLH}/t_{PHL}$ | | See Fig. 13.1, 14.1<br>Table 13.1.1, 13.1.2, 14.1.1 | 1.0 | 60 | ns |
| 3-state output enable time ($\overline{OE}$ → An) | $t_{PZL}/t_{PZH}$ | | See Fig. 13.1, 14.2<br>Table 13.1.1, 13.1.2, 14.1.1 | 1.0 | 95 | |
| 3-state output disable time ($\overline{OE}$ → An) | $t_{PLZ}/t_{PHZ}$ | | See Fig. 13.1, 14.2<br>Table 13.1.1, 13.1.2, 14.1.1 | 1.0 | 45 | |
| Propagation delay time (An → Bn) | $t_{PLH}/t_{PHL}$ | | See Fig. 13.1, 14.1<br>Table 13.1.1, 13.1.2, 14.1.1 | 1.0 | 23 | ns |
| 3-state output enable time ($\overline{OE}$ → Bn) | $t_{PZL}/t_{PZH}$ | | See Fig. 13.1, 14.2<br>Table 13.1.1, 13.1.2, 14.1.1 | 1.0 | 54 | |
| 3-state output disable time ($\overline{OE}$ → Bn) | $t_{PLZ}/t_{PHZ}$ | | See Fig. 13.1, 14.2<br>Table 13.1.1, 13.1.2, 14.1.1 | 1.0 | 17 | |
| Output skew | $t_{osLH}/t_{osHL}$ | (Note 1) | | — | 1.5 | ns |

Note 1: Parameter guaranteed by design. ($t_{osLH}$ = $|t_{PLH}m - t_{PLH}n|$, $t_{osHL}$ = $|t_{PHL}m - t_{PHL}n|$)

### 12.2.8. $V_{CCA}$ = 1.2 ± 0.1 V, $V_{CCB}$ = 1.8 ± 0.15 V (Unless otherwise specified, $T_a$ = -40 to 85 °C, Input: $t_r$ = $t_f$ = 2.0 ns)

| Characteristics | Symbol | Note | Test Condition | Min | Max | Unit |
|---|---|---|---|---|---|---|
| Propagation delay time (Bn → An) | $t_{PLH}/t_{PHL}$ | | See Fig. 13.1, 14.1<br>Table 13.1.1, 13.1.2, 14.1.1 | 1.0 | 58 | ns |
| 3-state output enable time ($\overline{OE}$ → An) | $t_{PZL}/t_{PZH}$ | | See Fig. 13.1, 14.2<br>Table 13.1.1, 13.1.2, 14.1.1 | 1.0 | 92 | |
| 3-state output disable time ($\overline{OE}$ → An) | $t_{PLZ}/t_{PHZ}$ | | See Fig. 13.1, 14.2<br>Table 13.1.1, 13.1.2, 14.1.1 | 1.0 | 47 | |
| Propagation delay time (An → Bn) | $t_{PLH}/t_{PHL}$ | | See Fig. 13.1, 14.1<br>Table 13.1.1, 13.1.2, 14.1.1 | 1.0 | 30 | ns |
| 3-state output enable time ($\overline{OE}$ → Bn) | $t_{PZL}/t_{PZH}$ | | See Fig. 13.1, 14.2<br>Table 13.1.1, 13.1.2, 14.1.1 | 1.0 | 55 | |
| 3-state output disable time ($\overline{OE}$ → Bn) | $t_{PLZ}/t_{PHZ}$ | | See Fig. 13.1, 14.2<br>Table 13.1.1, 13.1.2, 14.1.1 | 1.0 | 17 | |
| Output skew | $t_{osLH}/t_{osHL}$ | (Note 1) | | — | 1.5 | ns |

Note 1: Parameter guaranteed by design. ($t_{osLH}$ = $|t_{PLH}m - t_{PLH}n|$, $t_{osHL}$ = $|t_{PHL}m - t_{PHL}n|$)

### 12.3. Dynamic Switching Characteristics (Unless otherwise specified, $T_a$ = 25 °C, Input: $t_r$ = $t_f$ = 2.0 ns, $C_L$ = 30 pF)

| Characteristics | | Symbol | Note | Test Condition | $V_{CCA}$ (V) | $V_{CCB}$ (V) | Typ. | Unit |
|---|---|---|---|---|---|---|---|---|
| Quiet output maximum dynamic $V_{OL}$ | A → B | $V_{OLP}$ | (Note 1) | $V_{IH}$ = $V_{CC}$, $V_{IL}$ = 0 V | 2.5 | 3.3 | 0.8 | V |
| | | | | | 1.8 | 3.3 | 0.8 | |
| | | | | | 1.8 | 2.5 | 0.6 | |
| | B → A | | | | 2.5 | 3.3 | 0.6 | |
| | | | | | 1.8 | 3.3 | 0.25 | |
| | | | | | 1.8 | 2.5 | 0.25 | |
| Quiet output minimum dynamic $V_{OL}$ | A → B | $V_{OLV}$ | (Note 1) | $V_{IH}$ = $V_{CC}$, $V_{IL}$ = 0 V | 2.5 | 3.3 | -0.8 | V |
| | | | | | 1.8 | 3.3 | -0.8 | |
| | | | | | 1.8 | 2.5 | -0.6 | |
| | B → A | | | | 2.5 | 3.3 | -0.6 | |
| | | | | | 1.8 | 3.3 | -0.25 | |
| | | | | | 1.8 | 2.5 | -0.25 | |
| Quiet output maximum dynamic $V_{OH}$ | A → B | $V_{OHP}$ | (Note 1) | $V_{IH}$ = $V_{CC}$, $V_{IL}$ = 0 V | 2.5 | 3.3 | 4.6 | V |
| | | | | | 1.8 | 3.3 | 4.6 | |
| | | | | | 1.8 | 2.5 | 3.3 | |
| | B → A | | | | 2.5 | 3.3 | 3.3 | |
| | | | | | 1.8 | 3.3 | 2.3 | |
| | | | | | 1.8 | 2.5 | 2.3 | |
| Quiet output minimum dynamic $V_{OH}$ | A → B | $V_{OHV}$ | (Note 1) | $V_{IH}$ = $V_{CC}$, $V_{IL}$ = 0 V | 2.5 | 3.3 | 2.0 | V |
| | | | | | 1.8 | 3.3 | 2.0 | |
| | | | | | 1.8 | 2.5 | 1.7 | |
| | B → A | | | | 2.5 | 3.3 | 1.7 | |
| | | | | | 1.8 | 3.3 | 1.3 | |
| | | | | | 1.8 | 2.5 | 1.3 | |

Note 1: Parameter guaranteed by design.

### 12.4. Capacitive Characteristics (Unless otherwise specified, $T_a$ = 25 °C)

| Characteristics | Symbol | Note | Test Condition | | $V_{CCA}$ (V) | $V_{CCB}$ (V) | Typ. | Unit |
|---|---|---|---|---|---|---|---|---|
| Input capacitance | $C_{IN}$ | | DIR, $\overline{OE}$ | | 2.5 | 3.3 | 7 | pF |
| Bus I/O capacitance | $C_{I/O}$ | | An, Bn | | 2.5 | 3.3 | 8 | pF |
| Power dissipation capacitance | $C_{PDA}$ | (Note 1) | $\overline{OE}$ = L | A → B (DIR = H) | 2.5 | 3.3 | 3 | pF |
| | | | | B → A (DIR = L) | 2.5 | 3.3 | 16 | |
| | | | $\overline{OE}$ = H | A → B (DIR = H) | 2.5 | 3.3 | 0 | |
| | | | | B → A (DIR = L) | 2.5 | 3.3 | 0 | |
| | $C_{PDB}$ | (Note 1) | $\overline{OE}$ = L | A → B (DIR = H) | 2.5 | 3.3 | 16 | |
| | | | | B → A (DIR = L) | 2.5 | 3.3 | 5 | |
| | | | $\overline{OE}$ = H | A → B (DIR = H) | 2.5 | 3.3 | 0 | |
| | | | | B → A (DIR = L) | 2.5 | 3.3 | 0 | |

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.

$I_{CC(opr)} = C_{PD} \times V_{CC} \times f_{IN} + I_{CC}/4$ (per bit)

## 13. AC Test Circuit

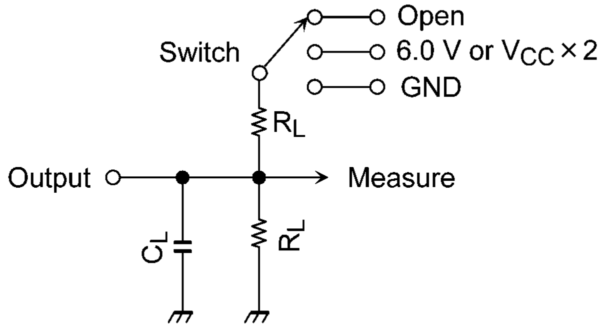



**Fig. 13.1 AC Test Circuit**

**Table 13.1.1 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 ± 0.3 V |
| | $V_{CC}$ × 2 | $V_{CC}$ = 2.5 ± 0.2 V |
| | | $V_{CC}$ = 1.8 ± 0.15 V |
| | | $V_{CC}$ = 1.5 ± 0.1 V |
| | | $V_{CC}$ = 1.2 ± 0.1 V |
| $t_{PHZ}$, $t_{PZH}$ | GND | — |

**Table 13.1.2 Parameter for AC Test Circuit**

| Symbol | $V_{CC}$ = 3.3 ± 0.3 V<br>$V_{CC}$ = 2.5 ± 0.2 V | $V_{CC}$ = 1.8 ± 0.15 V | $V_{CC}$ = 1.5 ± 0.1 V | $V_{CC}$ = 1.2 ± 0.1 V |
|---|---|---|---|---|
| $R_L$ | 500 Ω | 1 kΩ | 2 kΩ | 10 kΩ |
| $C_L$ | 30 pF | 30 pF | 15 pF | 15 pF |

## 14. AC Waveform

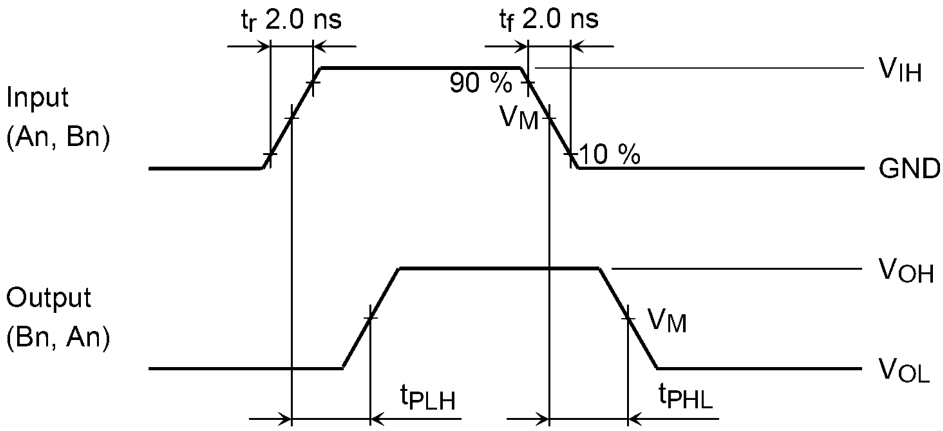



**Fig. 14.1 $t_{PLH}$, $t_{PHL}$**

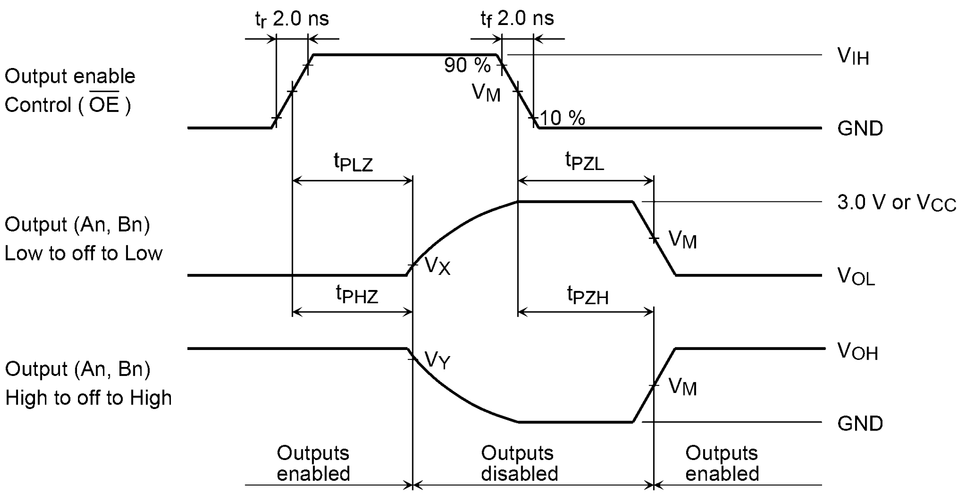


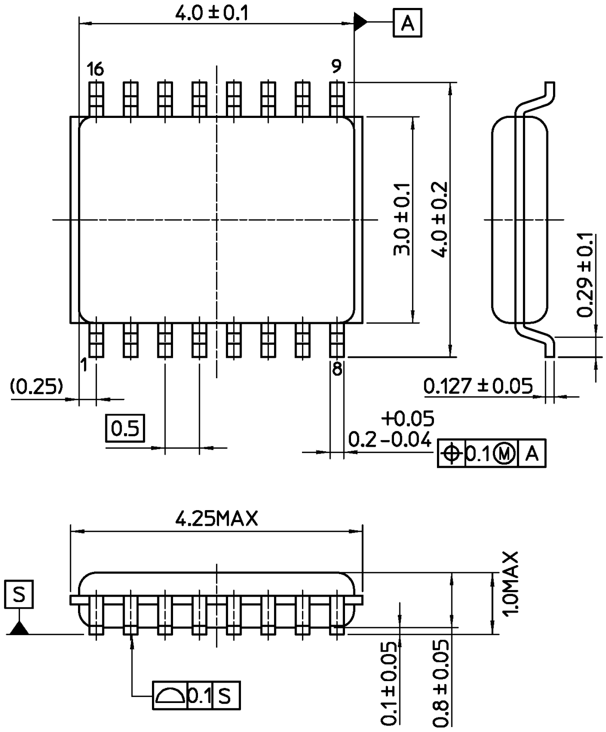

**Fig. 14.2 $t_{PLZ}$, $t_{PHZ}$, $t_{PZL}$, $t_{PZH}$**

**Table 14.1.1 AC Waveform Symbols**

| Symbol | $V_{CC}$ = 3.3 ± 0.3 V | $V_{CC}$ = 2.5 ± 0.2 V<br>$V_{CC}$ = 1.8 ± 0.15 V | $V_{CC}$ = 1.5 ± 0.1 V<br>$V_{CC}$ = 1.2 ± 0.1 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 | $V_{OL}$ + 0.1 V |
| $V_Y$ | $V_{OH}$ - 0.3 V | $V_{OH}$ - 0.15 V | $V_{OH}$ - 0.1 V |

## Package Dimensions

Unit: mm




Weight: 0.02 g (typ.)

| Package Name(s) |
|---|
| Nickname: US16 |

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