

16M-BIT CMOS MOBILE SPECIFIED RAM

1M-WORD BY 16-BIT

Description

The μ PD4616112 is a high speed, low power, 16,777,216 bits (1,048,576 words by 16 bits) CMOS mobile specified RAM featuring low power static RAM compatible function and pin configuration.

The μ PD4616112 is fabricated with advanced CMOS technology using one-transistor memory cell.

The μ PD4616112 is packed in 48-pin TAPE FBGA.

Features

- 1,048,576 words by 16 bits organization
- Fast access time: 80, 90, 100 ns (MAX.)
- Byte data control: /LB (I/O1 - I/O8), /UB (I/O9 - I/O16)
- Low voltage operation: $V_{CC} = 2.6$ to 3.0 V
- Operating ambient temperature: $T_A = -20$ to $+70$ °C
- Output Enable input for easy application
- Chip Enable input: /CS pin
- Standby Mode input: MODE pin
- Standby Mode1: Normal standby (Memory cell data hold valid)
- Standby Mode2: Memory cell data hold invalid

| Product name | Access time ns (MAX.) | Operating supply Voltage | Operating ambient temperature °C | Supply current | |
|----------------------|--------------------------|-----------------------------|--|---------------------------|------------------------------|
| | | | | At operating mA (MAX.) | At standby μ A (MAX.) |
| μ PD4616112-BCxx | 80, 90, 100 | 2.6 to 3.0 | -20 to +70 | 35 | 100 / 10 |

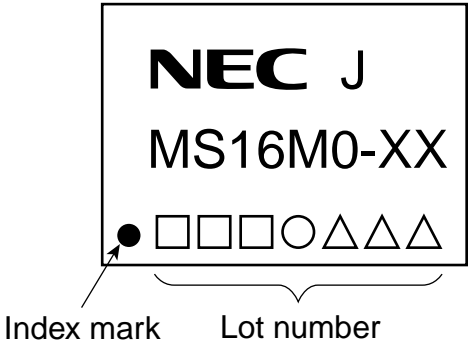
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Not all devices/types available in every country. Please check with local NEC representative for availability and additional information.

★ Ordering Information

| Part number | Package | Access time ns (MAX.) | Operating supply voltage V | Operating temperature °C | Remark |
|-----------------------|--------------------------|--------------------------|----------------------------------|--------------------------------|------------|
| μPD4616112F9-BC80-BC2 | 48-pin TAPE FBGA (6 x 8) | 80 | 2.6 to 3.0 | -20 to +70 | BC version |
| μPD4616112F9-BC90-BC2 | | 90 | | | |
| μPD4616112F9-BC10-BC2 | | 100 | | | |

★ Marking Image

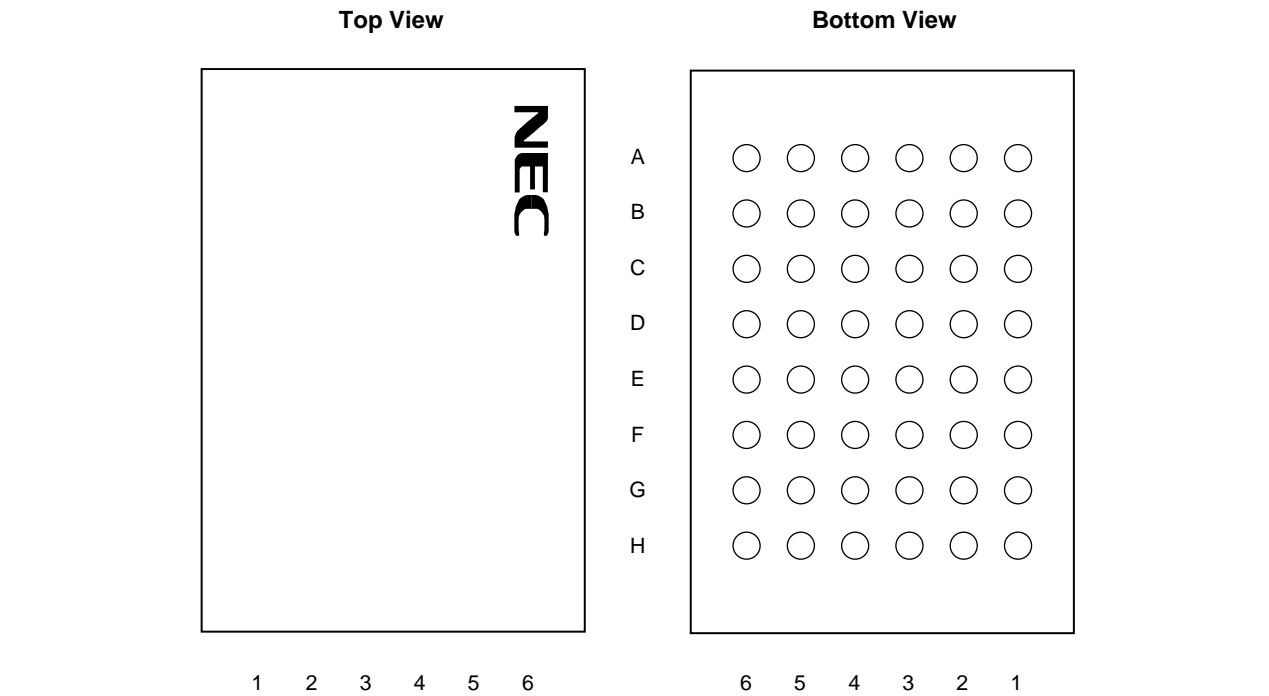
| Part number | Marking (XX) |
|-----------------------|--------------|
| μPD4616112F9-BC80-BC2 | B1 |
| μPD4616112F9-BC90-BC2 | B2 |
| μPD4616112F9-BC10-BC2 | B3 |



Pin Configuration

/xxx indicates active low signal.

48-pin TAPE FBGA (6 x 8)



| | 1 | 2 | 3 | 4 | 5 | 6 |
|---|-------|-------|-----|-----|------|------|
| A | /LB | /OE | A0 | A1 | A2 | MODE |
| B | I/O9 | /UB | A3 | A4 | /CS | I/O1 |
| C | I/O10 | I/O11 | A5 | A6 | I/O2 | I/O3 |
| D | GND | I/O12 | A17 | A7 | I/O4 | Vcc |
| E | Vcc | I/O13 | GND | A16 | I/O5 | GND |
| F | I/O15 | I/O14 | A14 | A15 | I/O6 | I/O7 |
| G | I/O16 | A19 | A12 | A13 | /WE | I/O8 |
| H | A18 | A8 | A9 | A10 | A11 | GND |

| | 6 | 5 | 4 | 3 | 2 | 1 |
|---|------|------|-----|-----|-------|-------|
| A | MODE | A2 | A1 | A0 | /OE | /LB |
| B | I/O1 | /CS | A4 | A3 | /UB | I/O9 |
| C | I/O3 | I/O2 | A6 | A5 | I/O11 | I/O10 |
| D | Vcc | I/O4 | A7 | A17 | I/O12 | GND |
| E | GND | I/O5 | A16 | GND | I/O13 | Vcc |
| F | I/O7 | I/O6 | A15 | A14 | I/O14 | I/O15 |
| G | I/O8 | /WE | A13 | A12 | A19 | I/O16 |
| H | GND | A11 | A10 | A9 | A8 | A18 |

- A0 - A19

: Address inputs
- I/O1 - I/O16

: Data inputs / outputs
- /CS

: Chip Select
- MODE

: Standby mode
- /WE

: Write enable
- /OE

: Output enable
- /LB, /UB

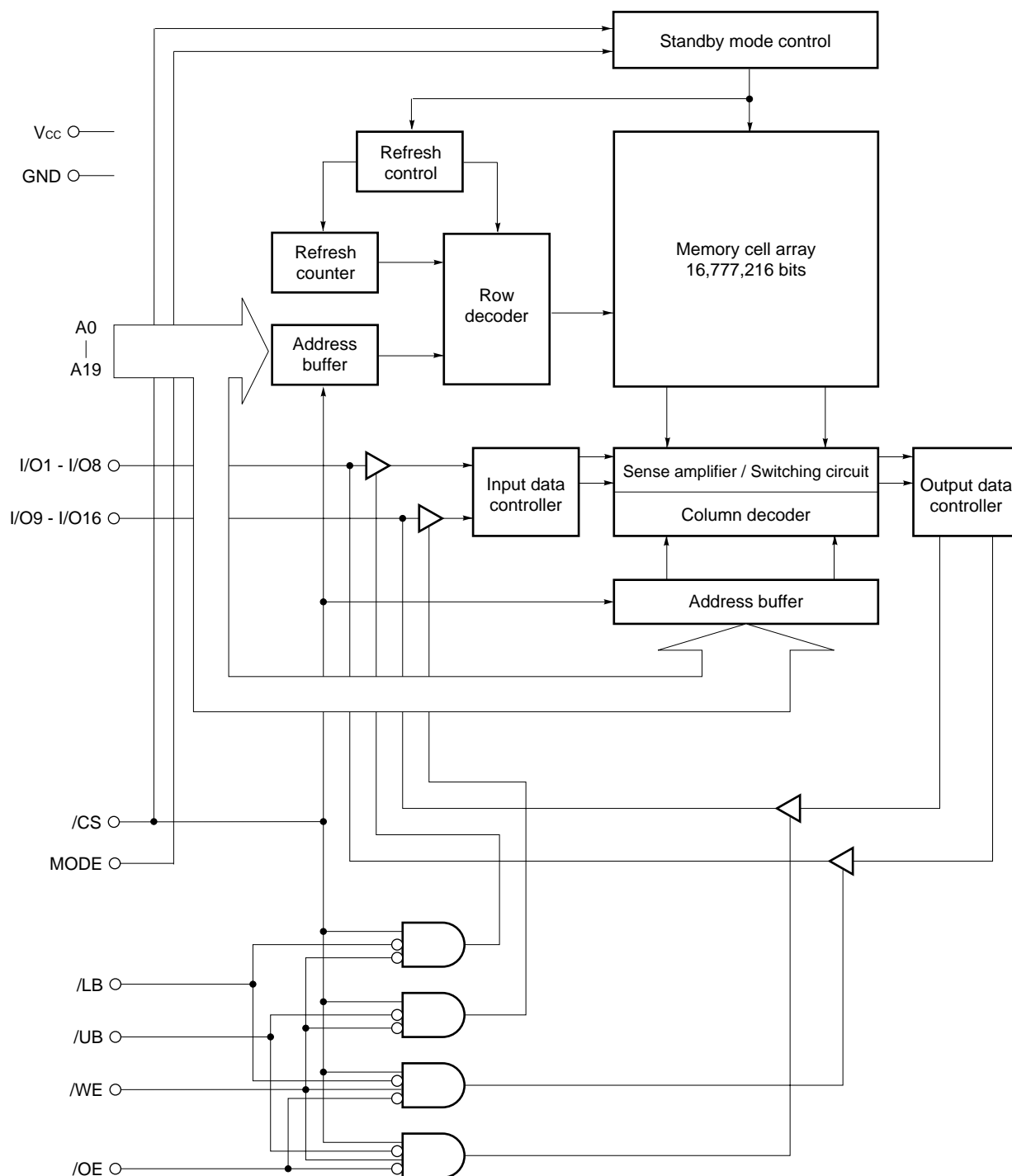
: Byte data select
- Vcc

: Power supply
- GND

: Ground

Remark Refer to **Package Drawing** for the index mark.

Block Diagram



Truth Table

| /CS | MODE | /OE | /WE | /LB | /UB | Mode | I/O | | Supply current |
|-----|------|-----|-----|-----|-----|-------------------------------|------------------|------------------|------------------|
| | | | | | | | I/O1 - I/O8 | I/O9 - I/O16 | |
| H | H | x | x | x | x | Not selected (Standby Mode 1) | High impedance | High impedance | I _{SB1} |
| H | L | x | x | x | x | Not selected (Standby Mode 2) | High impedance | High impedance | I _{SB2} |
| L | H | H | H | x | x | Output disable | High impedance | High impedance | I _{CCA} |
| | | L | H | L | L | Word read | D _{OUT} | D _{OUT} | |
| | | | | L | H | Lower byte read | D _{OUT} | High impedance | |
| | | | | H | L | Upper byte read | High impedance | D _{OUT} | |
| | | | | H | H | Output disable | High impedance | High impedance | |
| | | x | L | L | L | Word write | D _{IN} | D _{IN} | |
| | | | | L | H | Lower byte write | D _{IN} | High impedance | |
| | | | | H | L | Upper byte write | High impedance | D _{IN} | |
| | | | | H | H | Write abort | High impedance | High impedance | |

Caution MODE pin must be fixed to High except Standby Mode 2.

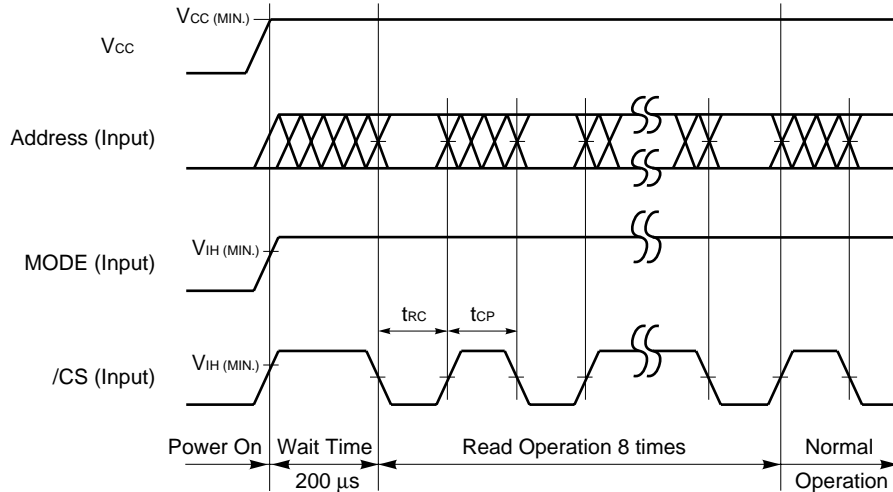
Remark x: V_{IH} or V_{IL}

Initialization

The μPD4616112 is initialized in the power-on sequence according to the following.

- ★ (1) To stabilize internal circuits, before turning on the power, a 200 μs or longer wait time must precede any signal toggling.
- (2) After the wait time, read operation must be performed at least 8 times. After that, it can be normal operation.

Initialization Timing Chart



- Cautions**
- Following power application, make MODE and /CS high level during the wait time interval.
 - Following power application, make MODE high level during the wait time and eight read operations.
 - The read operation must satisfy the specs described on page 10 (Read Cycle (BC Version)).
 - The address is don't care (V_{IH} or V_{IL}) during read operation.
 - Read operation must be executed with toggled the /CS pin.
 - To prevent bus contention, it is recommended to set /OE to high level. However, do not input data to the I/O pins if /OE is low level during a read operation.

Electrical Specifications

Absolute Maximum Ratings

| Parameter | Symbol | Condition | Rating | Unit |
|-------------------------------|-----------|-----------|---|------|
| Supply voltage | V_{CC} | | -0.5^{Note} to +3.3 | V |
| Input / Output voltage | V_T | | -0.5^{Note} to $V_{CC} + 0.4$ (3.3 V MAX). | V |
| Operating ambient temperature | T_A | | -20 to +70 | °C |
| Storage temperature | T_{stg} | | -55 to +125 | °C |

Note -1.0 V (MIN.) (Pulse width: 30 ns)

Caution Exposing the device to stress above those listed in Absolute Maximum Rating could cause permanent damage. The device is not meant to be operated under conditions outside the limits described in the operational section of this specification. Exposure to Absolute Maximum Rating conditions for extended periods may affect device reliability.

Recommended Operating Conditions

| Parameter | Symbol | Condition | μPD4616112-BCxx | | Unit |
|-------------------------------|----------|-----------|----------------------|---------------------|------|
| | | | MIN. | MAX. | |
| Supply voltage | V_{CC} | | 2.6 | 3.0 | V |
| High level input voltage | V_{IH} | | $V_{CC} \times 0.8$ | $V_{CC} + 0.3$ | V |
| Low level input voltage | V_{IL} | | -0.3^{Note} | $V_{CC} \times 0.2$ | V |
| Operating ambient temperature | T_A | | -20 | +70 | °C |

Note -0.5 V (MIN.) (Pulse width: 30 ns)

Capacitance ($T_A = 25^\circ\text{C}$, $f = 1\text{ MHz}$)

| Parameter | Symbol | Test condition | MIN. | TYP. | MAX. | Unit |
|----------------------------|-----------|------------------------|------|------|------|------|
| Input capacitance | C_{IN} | $V_{IN} = 0\text{ V}$ | | | 8 | pF |
| Input / Output capacitance | $C_{I/O}$ | $V_{I/O} = 0\text{ V}$ | | | 10 | pF |

Remarks 1. V_{IN} : Input voltage

$V_{I/O}$: Input / Output voltage

2. These parameters are not 100% tested.

DC Characteristics (Recommended Operating Conditions Unless Otherwise Noted)

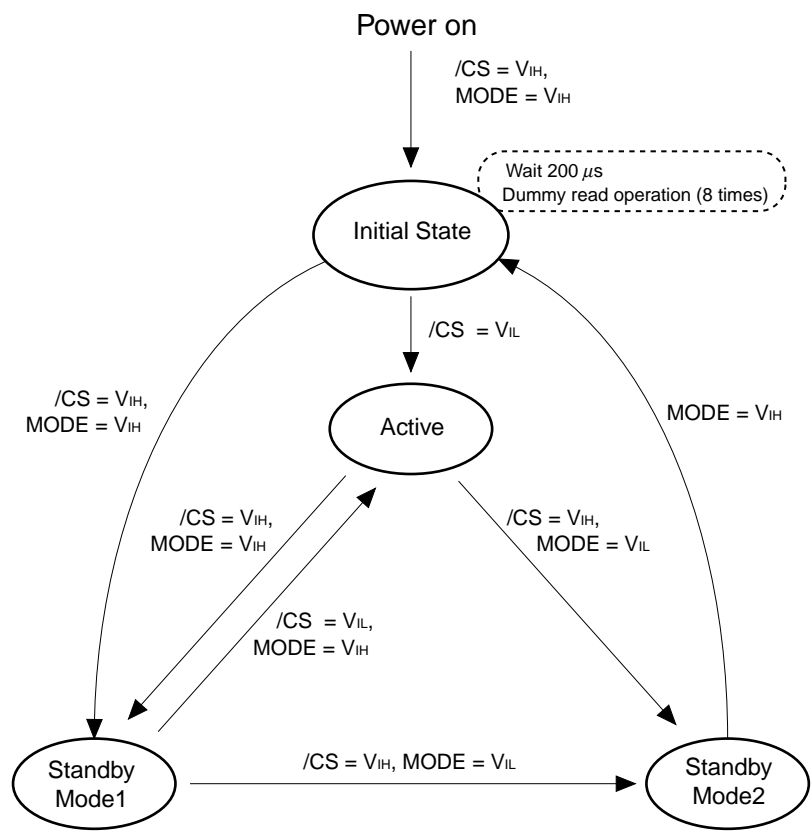
| Parameter | Symbol | Test condition | μPD4616112-BCxx | | | Unit |
|---------------------------|------------------|--|----------------------|------|----------------------|------|
| | | | MIN. | TYP. | MAX. | |
| Input leakage current | I _{LI} | V _{IN} = 0 V to V _{CC} | -1.0 | | +1.0 | μA |
| I/O leakage current | I _{LO} | V _{I/O} = 0 V to V _{CC} , /CS = V _{IH} or /WE = V _{IL} or /OE = V _{IH} | -1.0 | | +1.0 | μA |
| Operating supply current | I _{CCA} | /CS = V _{IL} , Minimum cycle time, I _{I/O} = 0 mA | | | 35 | mA |
| Standby supply current | I _{SB1} | /CS ≥ V _{CC} - 0.2 V, MODE ≥ V _{CC} - 0.2 V | | | 100 | μA |
| | I _{SB2} | /CS ≥ V _{CC} - 0.2 V, MODE ≤ 0.2 V | | | 10 | |
| High level output voltage | V _{OH} | I _{OH} = -0.5 mA | V _{CC} ×0.8 | | | V |
| Low level output voltage | V _{OL} | I _{OL} = 1 mA | | | V _{CC} ×0.2 | V |

Remarks 1. V_{IN}: Input voltage

V_{I/O}: Input / Output voltage

2. These DC characteristics are in common regardless of product classifications.

Standby Mode State Machine



Standby Mode Characteristics

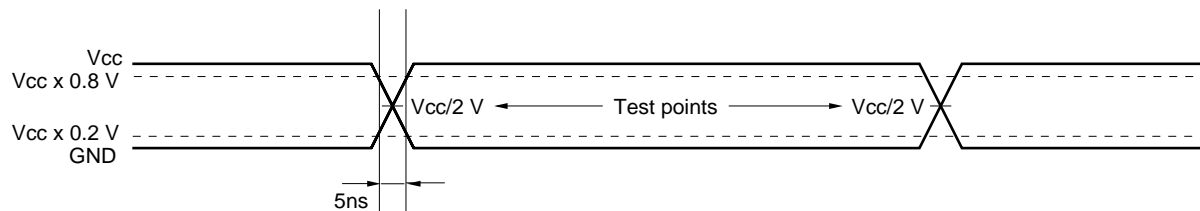
| Standby Mode | Memory Cell Data Hold | Standby Supply Current (μA) |
|--------------|-----------------------|------------------------------------|
| Mode 1 | Valid | 100 (I_{SB1}) |
| Mode 2 | Invalid | 10 (I_{SB2}) |

AC Characteristics (Recommended Operating Conditions Unless Otherwise Noted)

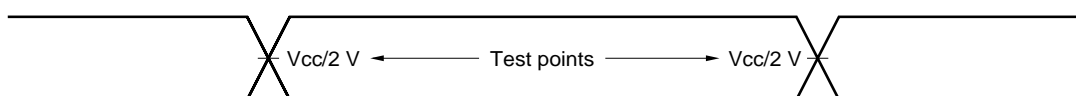
AC Test Conditions

[μ PD4616112-BC80, μ PD4616112-BC90, μ PD4616112-BC10]

Input Waveform (Rise and Fall Time ≤ 5 ns)



Output Waveform



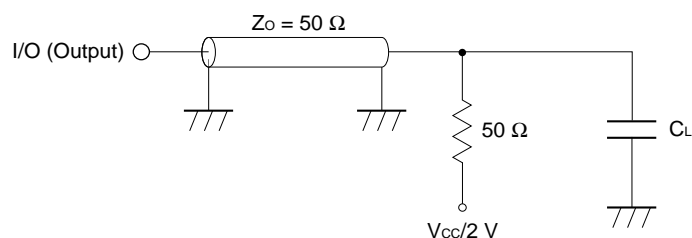
Output Load

AC characteristics directed with the note should be measured with the output load shown in **Figure 1**.

Figure 1

C_L : 50 pF

5 pF (tCLZ, tOLZ, tBLZ, tCHZ, tOHZ, tBHZ, tWHZ, tOW)



Read Cycle (BC version)

| Parameter | Symbol | μ PD4616112-BC80 | | μ PD4616112-BC90 | | μ PD4616112-BC10 | | Unit | Notes |
|--------------------------------------|------------|----------------------|--------|----------------------|--------|----------------------|--------|------|-------|
| | | MIN. | MAX. | MIN. | MAX. | MIN. | MAX. | | |
| Read cycle time | t_{RC} | 80 | 10,000 | 90 | 10,000 | 110 | 10,000 | ns | 1 |
| Identical address read cycle time | t_{RC1} | 80 | 10,000 | 90 | 10,000 | 110 | 10,000 | ns | 2 |
| Address skew time | t_{SKEW} | | 10 | | 15 | | 20 | ns | 3 |
| /CS pulse width | t_{CP} | 10 | | 10 | | 10 | | ns | |
| Address access time | t_{AA} | | 80 | | 90 | | 100 | ns | 4 |
| /CS access time | t_{ACS} | | 80 | | 90 | | 100 | ns | |
| /OE to output valid | t_{OE} | | 35 | | 40 | | 50 | ns | 5 |
| /LB, /UB to output valid | t_{BA} | | 35 | | 40 | | 50 | ns | |
| Output hold from address change | t_{OH} | 10 | | 10 | | 10 | | ns | |
| /CS to output in low impedance | t_{CLZ} | 10 | | 10 | | 10 | | ns | |
| /OE to output in low impedance | t_{OLZ} | 5 | | 5 | | 5 | | ns | |
| /LB, /UB to output in low impedance | t_{BLZ} | 5 | | 5 | | 5 | | ns | |
| /CS to output in high impedance | t_{CHZ} | | 25 | | 25 | | 25 | ns | |
| /OE to output in high impedance | t_{OHZ} | | 25 | | 25 | | 25 | ns | |
| /LB, /UB to output in high impedance | t_{BHZ} | | 25 | | 25 | | 25 | ns | |

Notes 1. One read cycle (t_{RC}) must satisfy the minimum value ($t_{RC(MIN.)}$) and maximum value ($t_{RC(MAX.)} = 10 \mu s$). t_{RC} indicates the time from the /CS low level input point or address determination point, whichever is later, to the /CS high level input point or the next address change start point, whichever is earlier. As a result, there are the following four conditions for t_{RC} .

- 1) Time from address determination point to /CS high level input point (address access)
- 2) Time from address determination point to next address change start point (address access)
- 3) Time from /CS low level input point to next address change start point (/CS access)
- 4) Time from /CS low level input point to /CS high level input point (/CS access)

★ **2.** The identical address read cycle time (t_{RC1}) is the cycle time of one read operation when performing continuous read operations toggling /OE, /LB, and /UB with the address fixed and /CS low level. Perform settings so that the sum (t_{RC}) of the identical address read cycle times (t_{RC1}) is 10 μs or less.

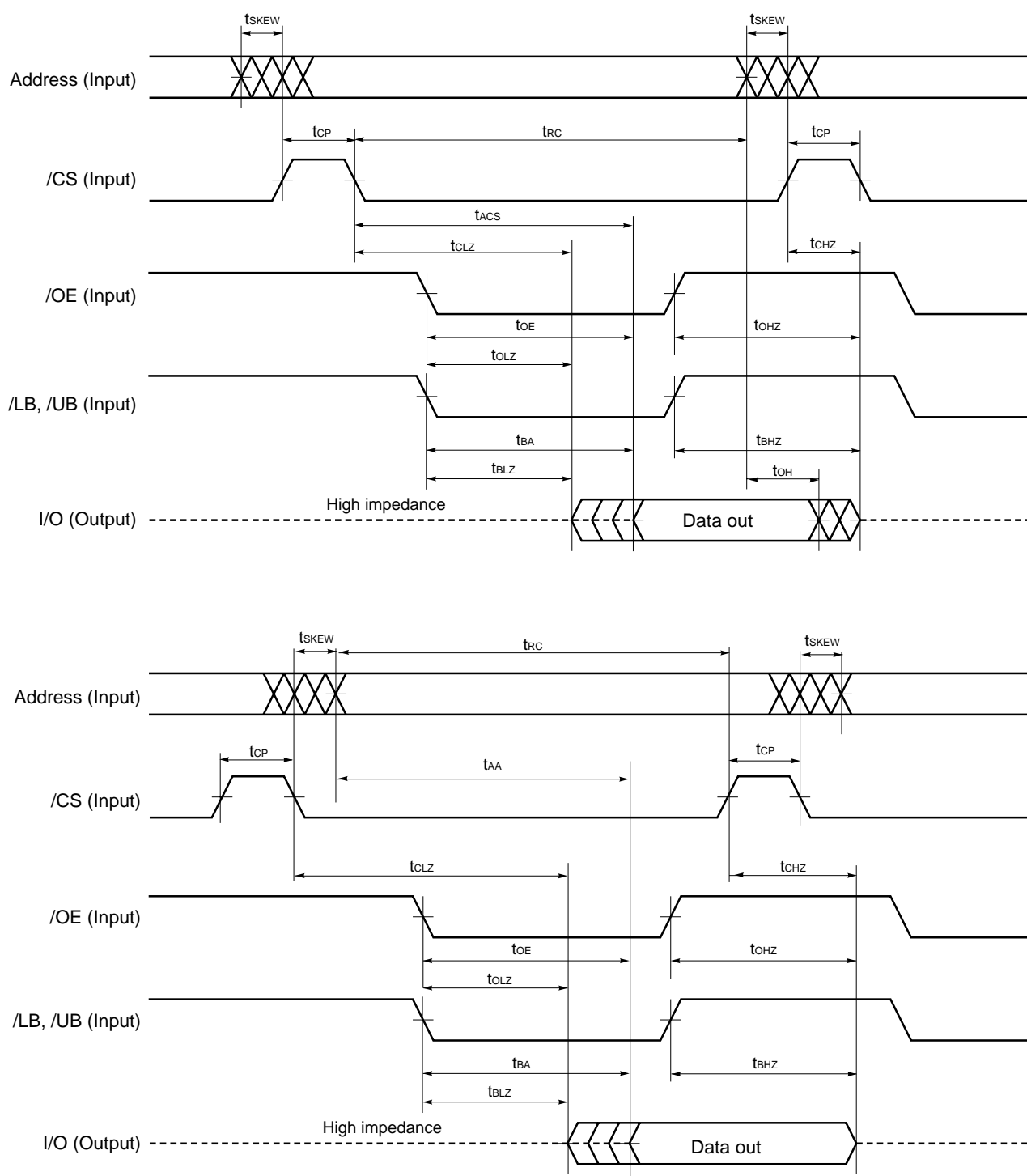
3. t_{SKEW} indicates the following three types of time depending on the condition.

- 1) When switching /CS from high level to low level, t_{SKEW} is the time from the /CS low level input point until the next address is determined.
- 2) When switching /CS from low level to high level, t_{SKEW} is the time from the address change start point to the /CS high level input point.
- 3) When /CS is fixed to low level, t_{SKEW} is the time from the address change start point until the next address is determined.

Since specs are defined for t_{SKEW} only when /CS is active, t_{SKEW} is not subject to limitations when /CS is switched from high level to low level following address determination, or when the address is changed after /CS is switched from low level to high level.

- 4.** Regarding t_{AA} and t_{ACS} , only t_{AA} is satisfied during address access (refer to 1) and 2) of **Note 1**), and only t_{ACS} is satisfied during /CS access (refer to 3) of **Note 1**).
- 5.** Regarding t_{BA} and t_{OE} , only t_{BA} is satisfied if /OE becomes active later than /UB and /LB, and only t_{OE} is satisfied if /UB and /LB become active before /OE.

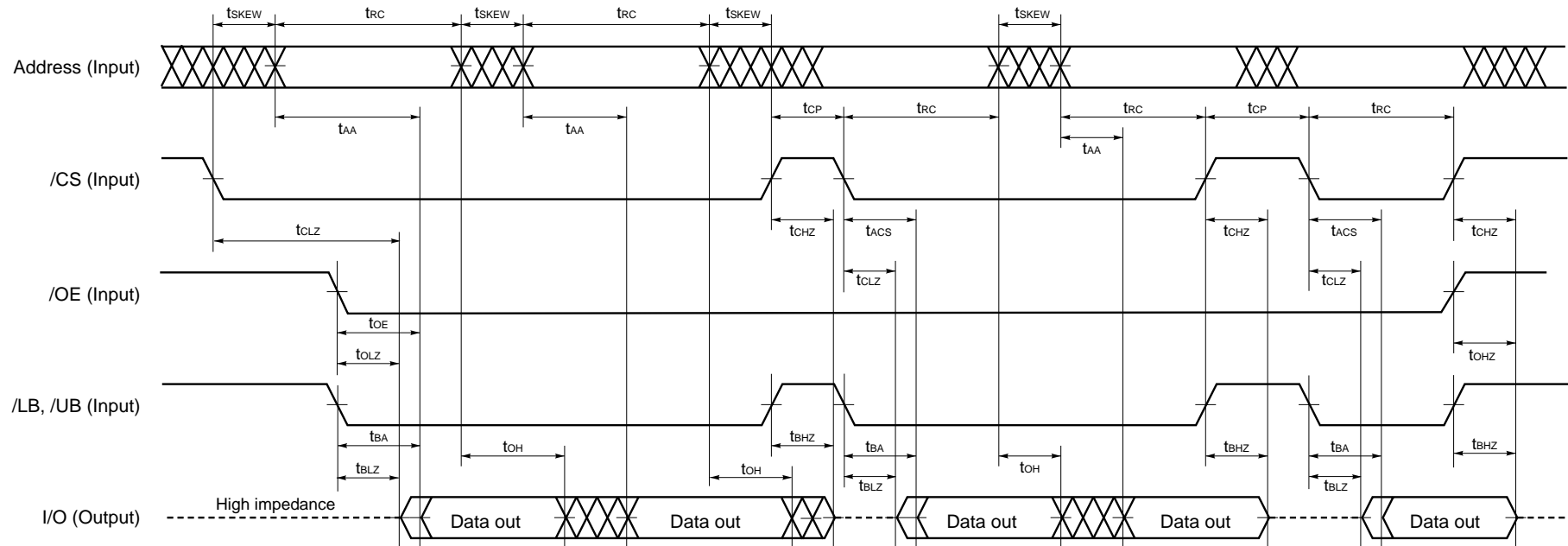
Read Cycle Timing Chart 1



Caution If the address is changed using a value that is either lower than the minimum value or higher than the maximum value for the read cycle time (t_{RC}), none of the data can be guaranteed.

Remark In read cycle, $\overline{\text{WE}}$ should be fixed to High.

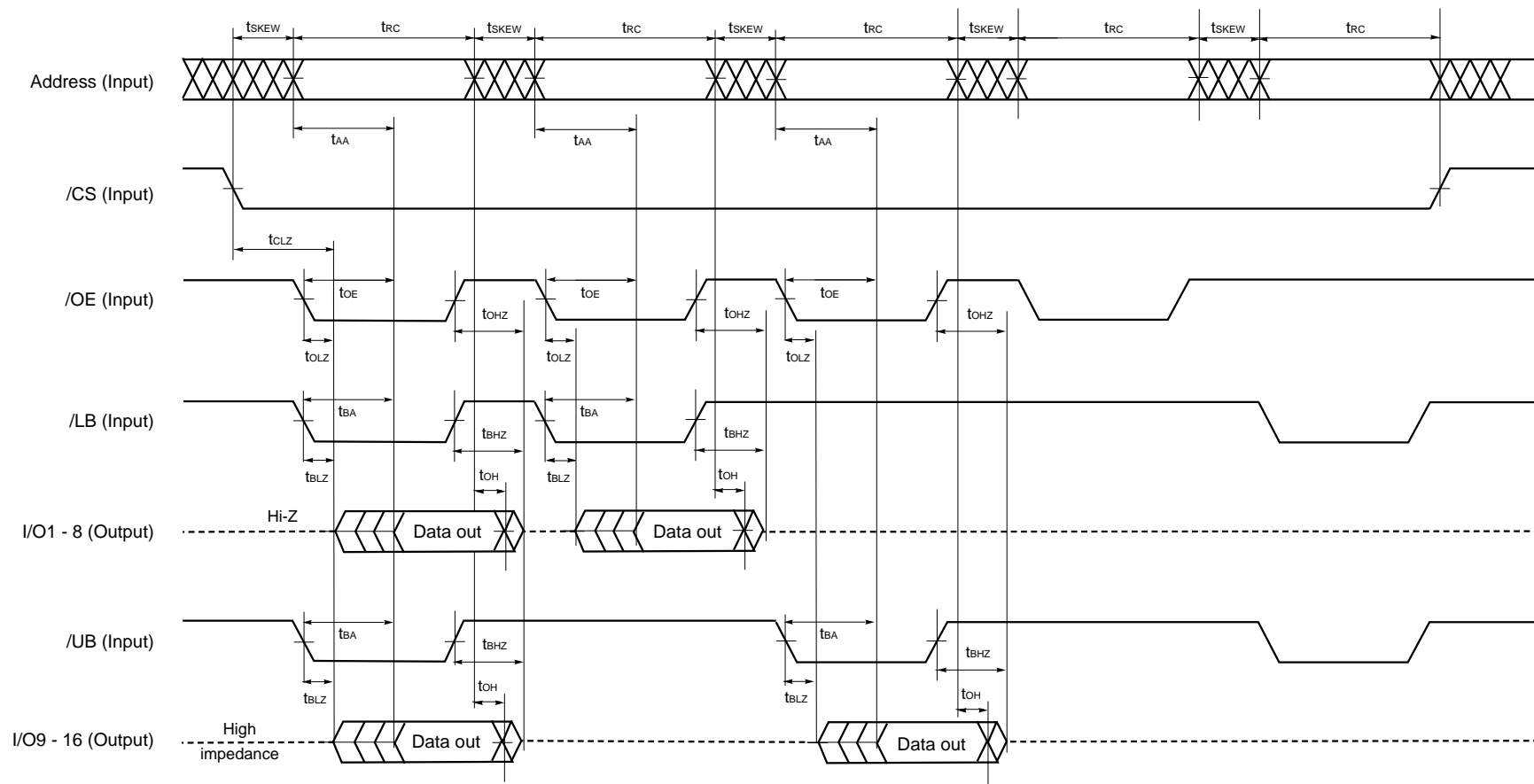
Read Cycle Timing Chart 2



Caution If the address is changed using a value that is either lower than the minimum value or higher than the maximum value for the read cycle time (t_{RC}), none of the data can be guaranteed.

Remark In read cycle, /WE should be fixed to High.

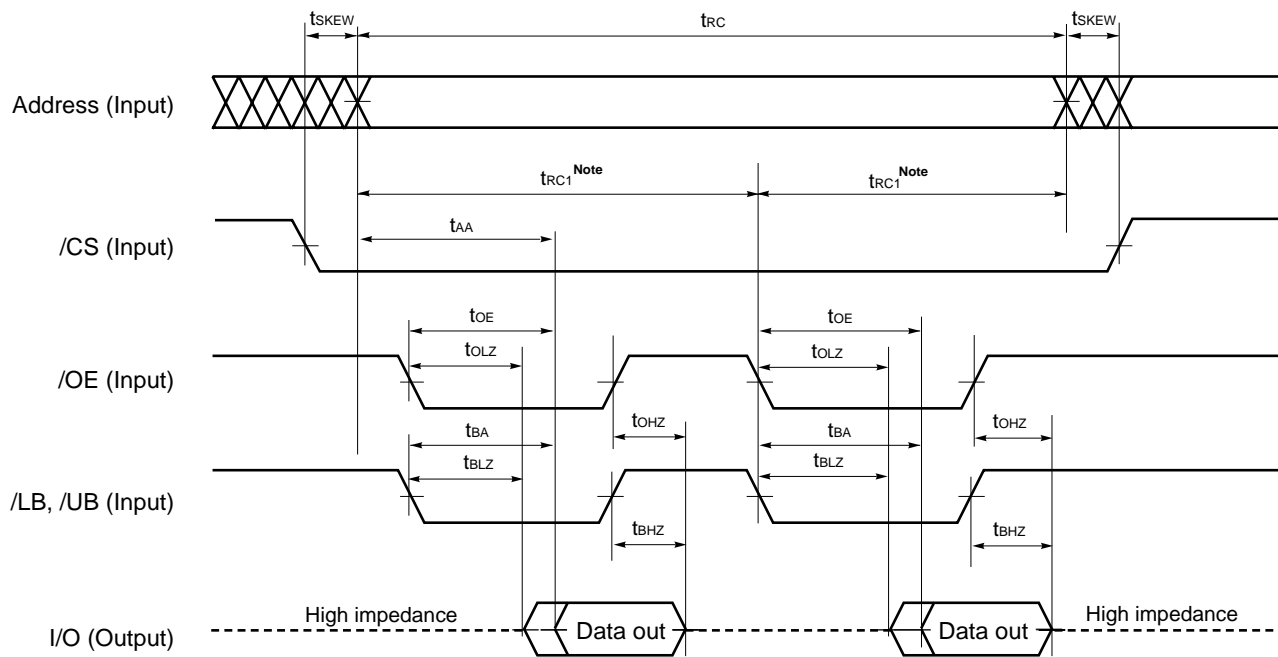
Read Cycle Timing Chart 3



Caution If the address is changed using a value that is either lower than the minimum value or higher than the maximum value for the read cycle time (t_{RC}), none of the data can be guaranteed.

Remark In read cycle, /WE should be fixed to High.

Read Cycle Timing Chart 4



Caution If the address is changed using a value that is either lower than the minimum value or higher than the maximum value for the read cycle time (t_{RC}), none of the data can be guaranteed.

Note To perform a continuous read toggling /OE, /UB, and /LB with /CS low level at an identical address, make settings so that the sum (t_{RC}) of the identical address read cycle times (t_{RC1}) is 10 μs or less.

Remark In read cycle, /WE should be fixed to High.

Write Cycle (BC version)

| Parameter | Symbol | μ PD4616112-BC80 | | μ PD4616112-BC90 | | μ PD4616112-BC10 | | Unit | Notes |
|------------------------------------|------------|----------------------|--------|----------------------|--------|----------------------|--------|------|-------|
| | | MIN. | MAX. | MIN. | MAX. | MIN. | MAX. | | |
| Write cycle time | t_{WC} | 80 | 10,000 | 90 | 10,000 | 110 | 10,000 | ns | 1 |
| Identical address write cycle time | t_{WC1} | 80 | 10,000 | 90 | 10,000 | 110 | 10,000 | ns | 2 |
| Address skew time | t_{SKEW} | | 10 | | 15 | | 20 | ns | 3 |
| /CS to end of write | t_{CW} | 40 | | 50 | | 60 | | ns | 4 |
| /LB, /UB to end of write | t_{BW} | 30 | | 35 | | 40 | | ns | |
| Address valid to end of write | t_{AW} | 35 | | 45 | | 55 | | ns | |
| Write pulse width | t_{WP} | 30 | | 35 | | 40 | | ns | |
| Write recovery time | t_{WR} | 20 | | 20 | | 20 | | ns | 5 |
| /CS pulse width | t_{CP} | 10 | | 10 | | 10 | | ns | |
| Address setup time | t_{AS} | 0 | | 0 | | 0 | | ns | |
| Byte write hold time | t_{BWH} | 20 | | 20 | | 20 | | ns | |
| Data valid to end of write | t_{DW} | 20 | | 25 | | 30 | | ns | |
| Data hold time | t_{DH} | 0 | | 0 | | 0 | | ns | |
| /OE to output in low impedance | t_{OLZ} | 5 | | 5 | | 5 | | ns | |
| /WE to output in high impedance | t_{WHZ} | | 25 | | 25 | | 25 | ns | |
| /OE to output in high impedance | t_{OHZ} | | 25 | | 25 | | 25 | ns | |
| Output active from end of write | t_{OW} | 5 | | 5 | | 5 | | ns | |

Notes 1. One write cycle (t_{WC}) must satisfy the minimum value ($t_{WC(MIN.)}$) and the maximum value ($t_{WC(MAX.)} = 10 \mu s$).

t_{WC} indicates the time from the /CS low level input point or address determination point, whichever is after, to the /CS high level input point or the next address change start point, whichever is earlier. As a result, there are the following four conditions for t_{WC} .

- 1) Time from address determination point to /CS high level input point
 - 2) Time from address determination point to next address change start point
 - 3) Time from /CS low level input point to next address change start point
 - 4) Time from /CS low level input point to /CS high level input point
- 2.** The identical address read cycle time (t_{WC1}) is the cycle time of one write cycle when performing continuous write operations with the address fixed and /CS low level, changing /LB and /UB at the same time, and toggling /WE, as well as when performing a continuous write toggling /LB and /UB. Make settings so that the sum (t_{WC}) of the identical address write cycle times (t_{WC1}) is $10 \mu s$ or less.
- 3.** t_{SKEW} indicates the following three types of time depending on the condition.
- 1) When switching /CS from high level to low level, t_{SKEW} is the time from the /CS low level input point until the next address is determined.
 - 2) When switching /CS from low level to high level, t_{SKEW} is the time from the address change start point to the /CS high level input point.
 - 3) When /CS is fixed to low level, t_{SKEW} is the time from the address change start point until the next address is determined.

Since specs are defined for t_{SKEW} only when /CS is active, t_{SKEW} is not subject to limitations when /CS is switched from high level to low level following address determination, or when the address is changed after /CS is switched from low level to high level.

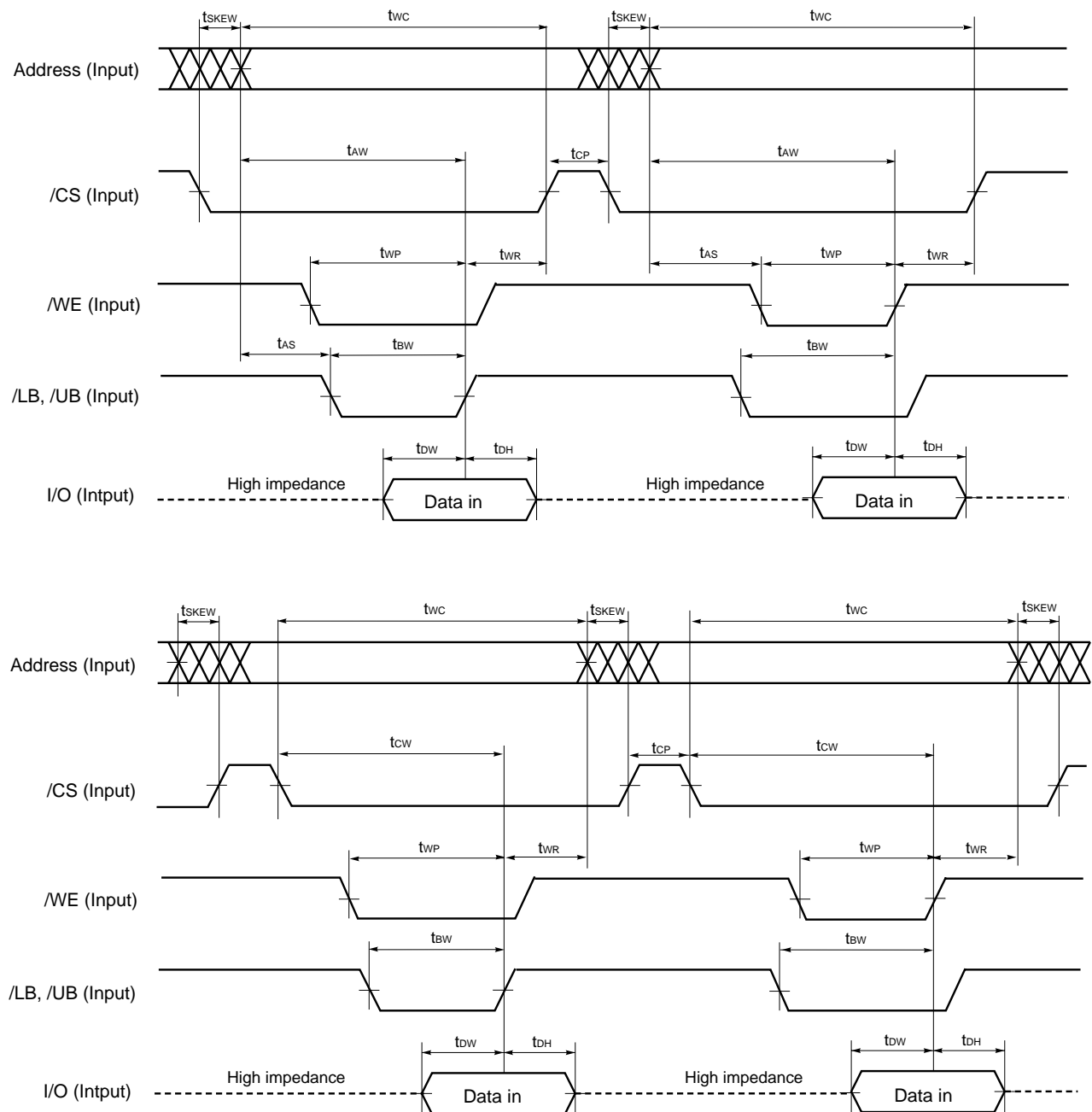
4. Definition of write start and write end

| | /CS | /WE | /LB, /UB | Status |
|-----------------------|--------|--------|----------|--|
| Write start pattern 1 | H to L | L | L | If /WE, /LB, /UB are low level, time when /CS changes from high level to low level |
| Write start pattern 2 | L | H to L | L | If /CS, /LB, /UB are low level, time when /WE changes from high level to low level |
| Write start pattern 3 | L | L | H to L | If /CS, /WE are low level, time when /LB or /UB changes from high level to low level |
| Write end pattern 1 | L | L to H | L | If /CS, /WE, /LB, /UB are low level, time when /WE changes from low level to high level |
| Write end pattern 2 | L | L | L to H | When /CS, /WE, /LB, /UB are low level, time when /LB or /UB changes from low level to high level |

5. Definition of write end recovery time (t_{WR})

- 1) Time from write end to address change start point, or from write end to /CS high level input point
- 2) When /CS, /LB, /UB are low level and continuously written to the identical address, time from /WE high level input point to /WE low level input point
- 3) When /CS, /WE are low level and continuously written to the identical address, time from /LB or /UB high level input point, whichever is later, to /LB or /UB low level input point, whichever is earlier.
- 4) When /CS is low level and continuously written to the identical address, time from write end to point at which /WE, /LB, or /UB starts to change from high level to low level, whichever is earliest.

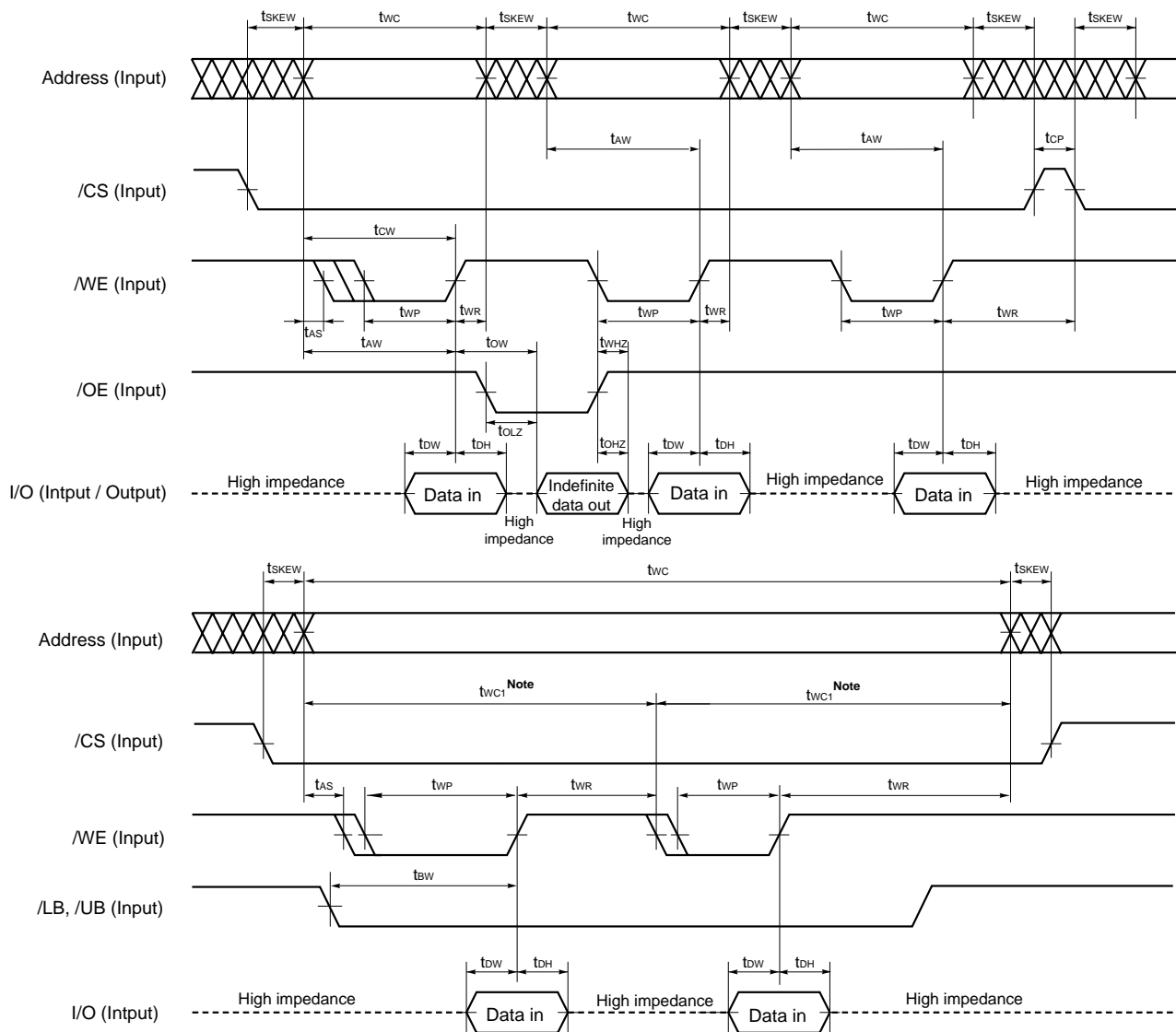
Write Cycle Timing Chart 1



- Cautions**
1. During address transition, at least one of pins /CS, /WE should be inactivated.
 2. Do not input data to the I/O pins while they are in the output state.
 3. If the address is changed using a value that is either lower than the minimum value or higher than the maximum value for the write cycle time (t_{wc}), none of the data can be guaranteed.

Remark Write operation is done during the overlap time of a Low /CS, /WE, /LB and/or /UB.

Write Cycle Timing Chart 2



Cautions 1. During address transition, at least one of pins /CS, /WE should be inactivated.

2. Do not input data to the I/O pins while they are in the output state.

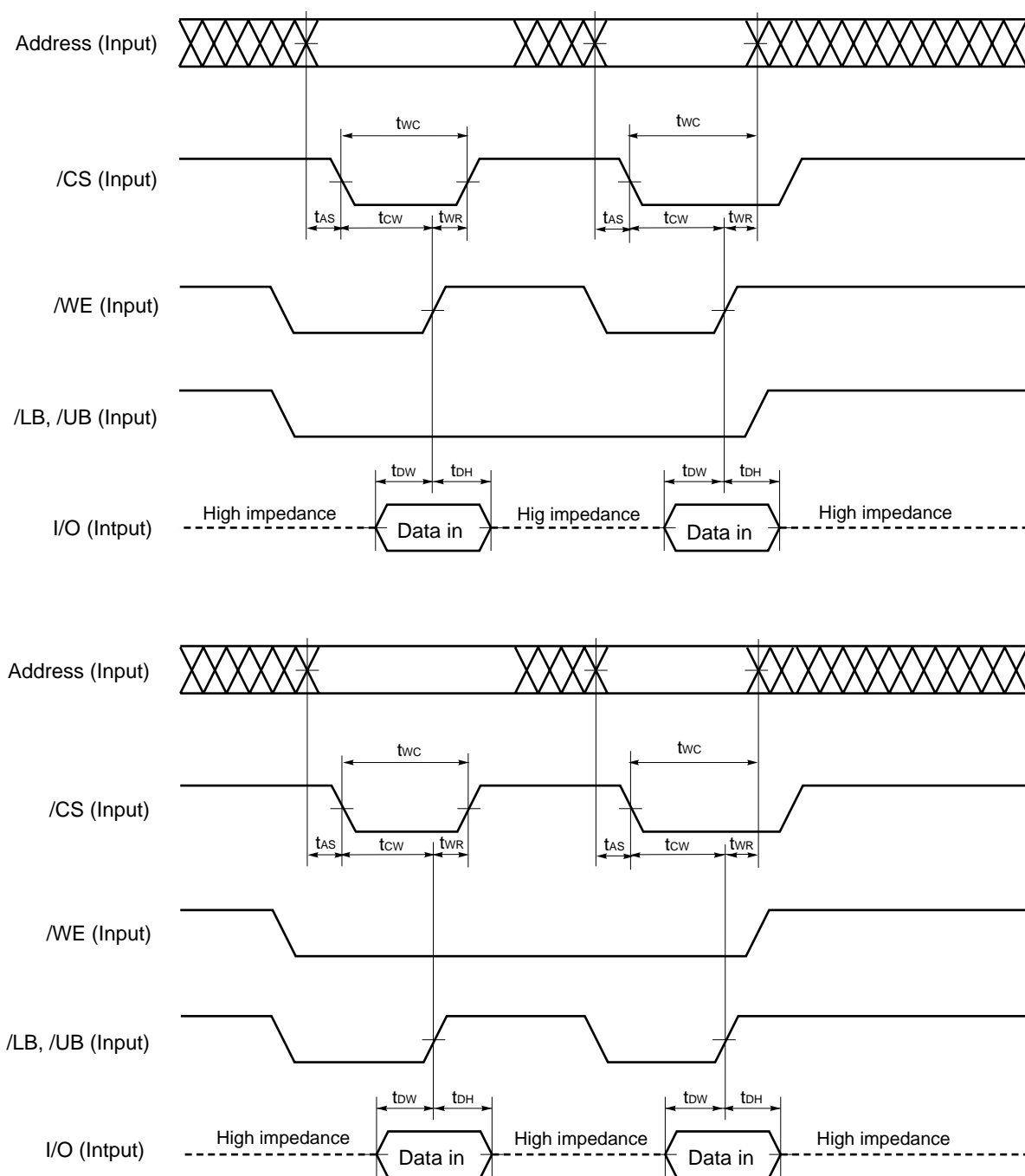
3. If the address is changed using a value that is either lower than the minimum value or higher than the maximum value for the write cycle time (twc), none of the data can be guaranteed.

Note If /LB and /UB are changed at the same time with /CS low level and a continuous write operation toggling /WE is performed, make settings so that the sum (twc) of the identical address write cycle time (twc1) is 10 μs or less.

Remarks 1. Write operation is done during the overlap time of a Low /CS, /WE, /LB and/or /UB.

2. When /WE is at Low, the I/O pins are always high impedance. When /WE is at High, read operation is executed. Therefore /OE should be at High to make the I/O pins high impedance.

Write Cycle Timing Chart 3 (/CS Controlled)



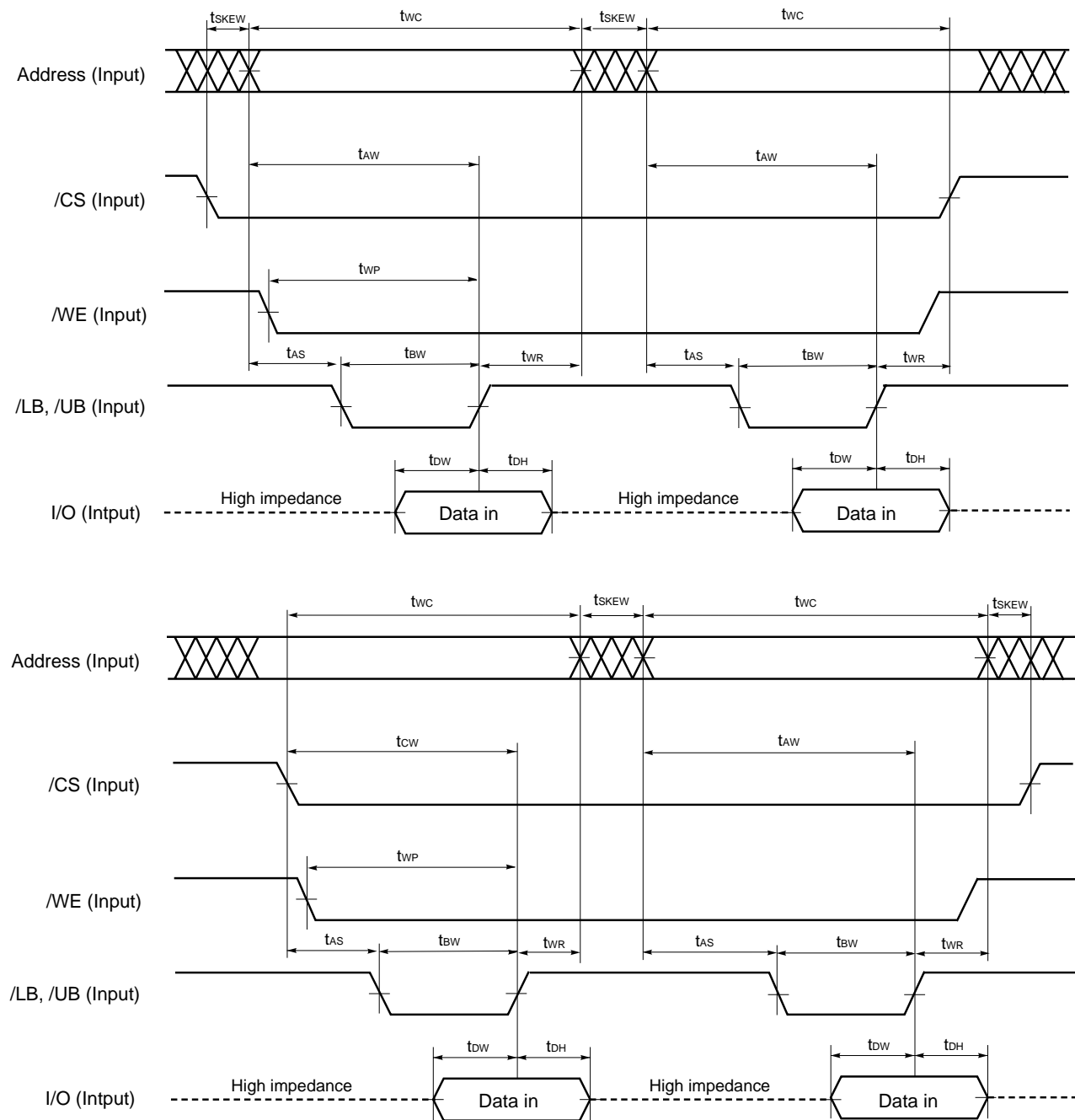
Cautions 1. During address transition, at least one of pins /CS, /WE should be inactivated.

2. Do not input data to the I/O pins while they are in the output state.

3. If the address is changed using a value that is either lower than the minimum value or higher than the maximum value for the write cycle time (t_{WC}), none of the data can be guaranteed.

Remark Write operation is done during the overlap time of a Low /CS, /WE, /LB and/or /UB.

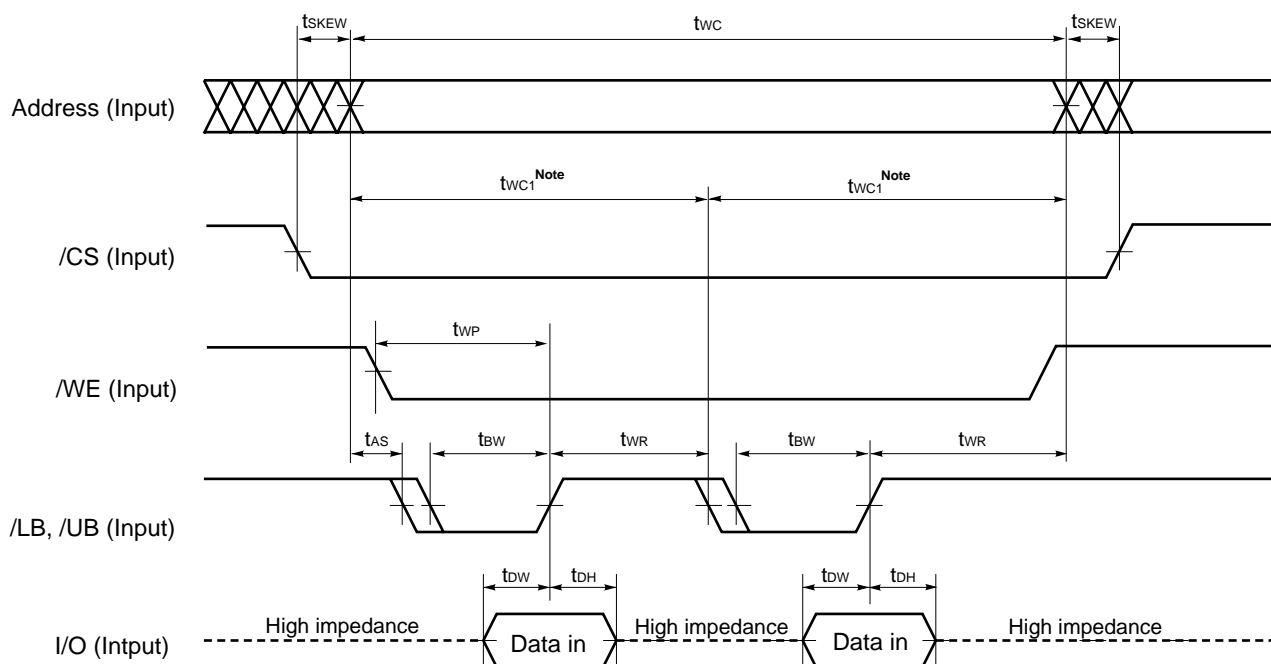
Write Cycle Timing Chart 4 (/LB, /UB Controlled 1)



- Cautions**
1. During address transition, at least one of pins /CS, /WE should be inactivated.
 2. Do not input data to the I/O pins while they are in the output state.
 3. If the address is changed using a value that is either lower than the minimum value or higher than the maximum value for the write cycle time (t_{WC}), none of the data can be guaranteed.

Remark Write operation is done during the overlap time of a Low /CS, /WE, /LB and/or /UB.

Write Cycle Timing Chart 5 (/LB, /UB Controlled 2)

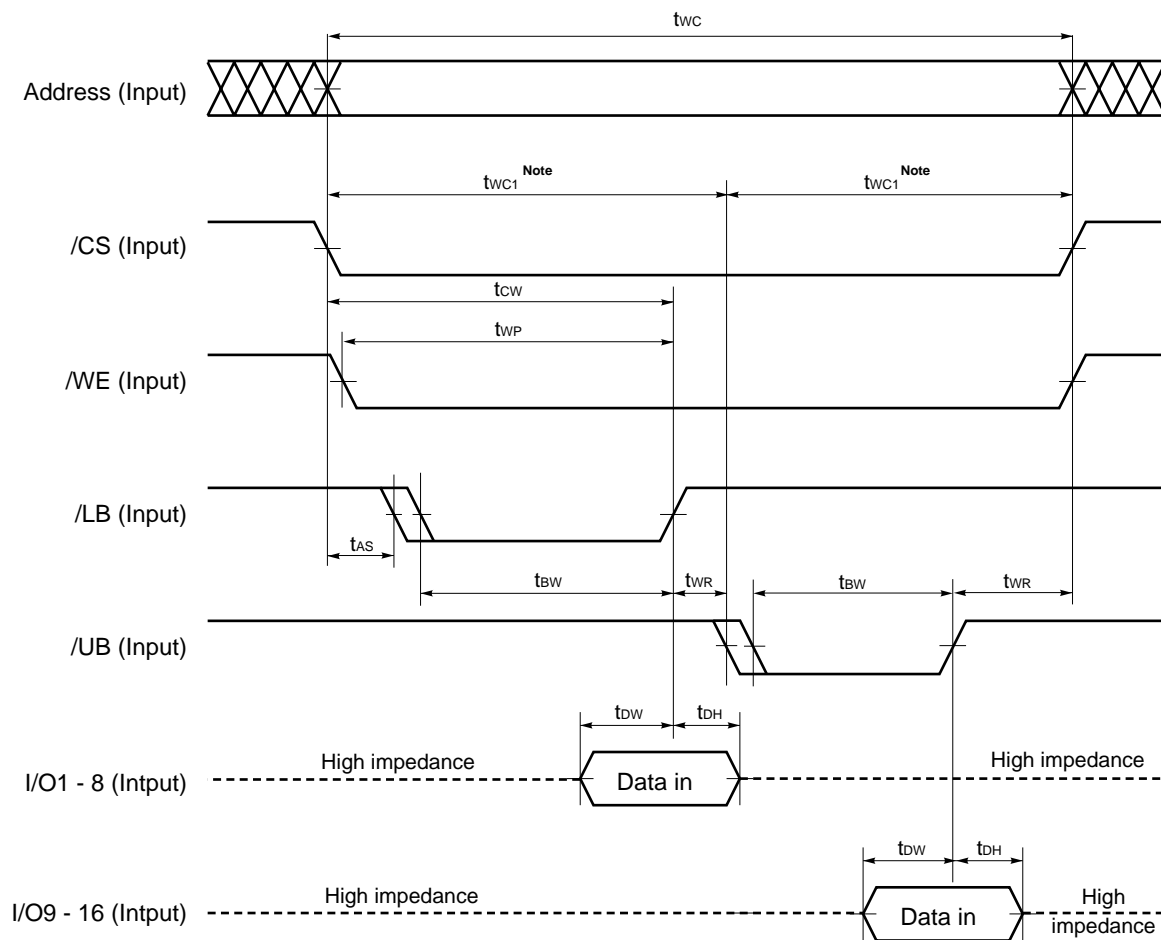


- Cautions**
1. During address transition, at least one of pins /CS, /WE should be inactivated.
 2. Do not input data to the I/O pins while they are in the output state.
 3. If the address is changed using a value that is either lower than the minimum value or higher than the maximum value for the write cycle time (t_{wc}), none of the data can be guaranteed.

Note If /LB and /UB are changed at the same time with /CS low level and a continuous write operation toggling /WE is performed, make settings so that the sum (t_{wc}) of the identical address write cycle time (t_{wc1}) is 10 μs or less.

Remark Write operation is done during the overlap time of a Low /CS, /WE, /LB and/or /UB.

Write Cycle Timing Chart 6 (/LB, /UB Independent Controlled 1)



Cautions 1. During address transition, at least one of pins /CS, /WE should be inactivated.

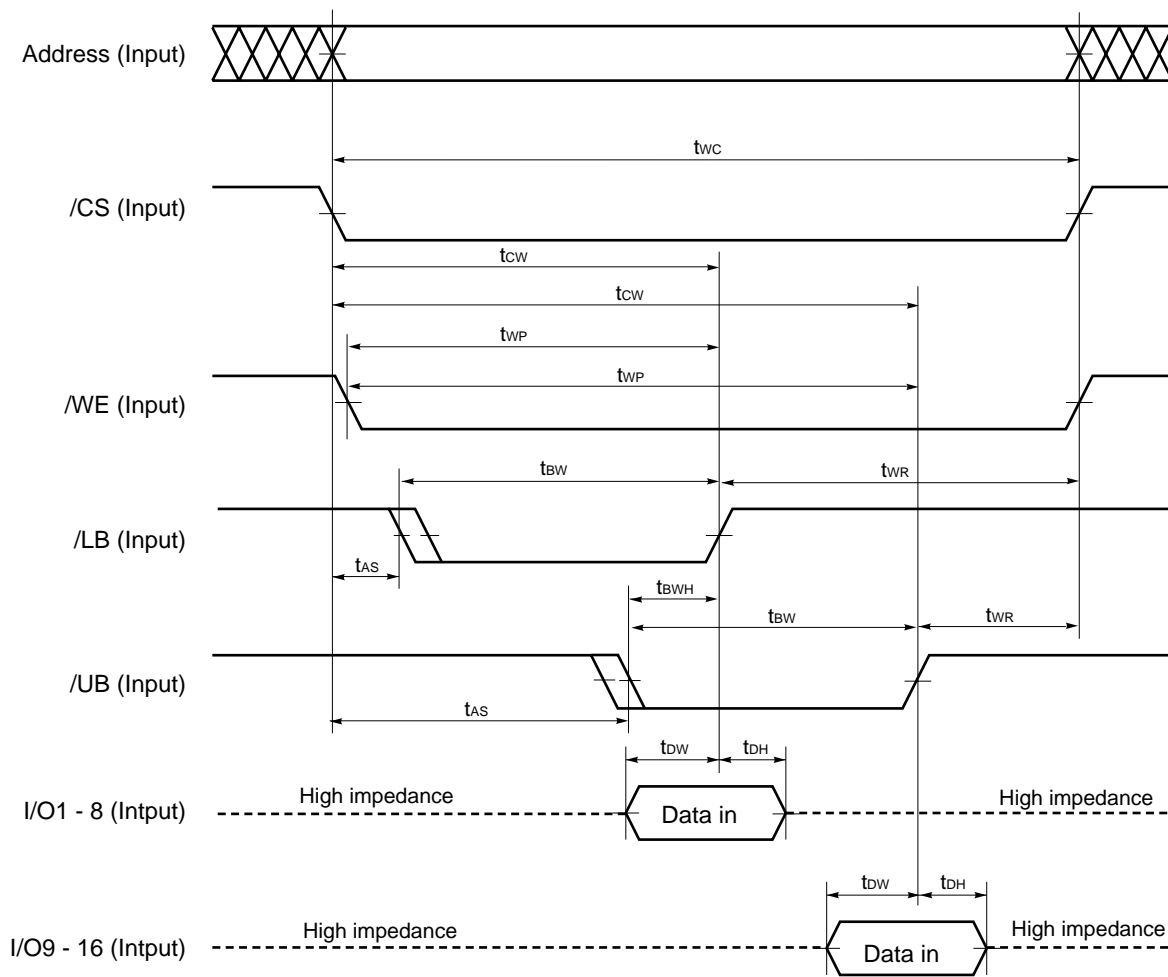
2. Do not input data to the I/O pins while they are in the output state.

3. If the address is changed using a value that is either lower than the minimum value or higher than the maximum value for the write cycle time (t_{WC}), none of the data can be guaranteed.

Note If /LB and /UB are changed at the same time with /CS low level and a continuous write operation toggling /WE is performed, make settings so that the sum (t_{WC}) of the identical address write cycle time (t_{WC1}) is 10 μ s or less.

Remark Write operation is done during the overlap time of a Low /CS, /WE, /LB and/or /UB.

Write Cycle Timing Chart 7 (/LB, /UB Independent Controlled 2)



- Cautions**
1. During address transition, at least one of pins /CS, /WE should be inactivated.
 2. Do not input data to the I/O pins while they are in the output state.
 3. If the address is changed using a value that is either lower than the minimum value or higher than the maximum value for the write cycle time (t_{WC}), none of the data can be guaranteed.

Remark Write operation is done during the overlap time of a Low /CS, /WE, /LB and/or /UB.

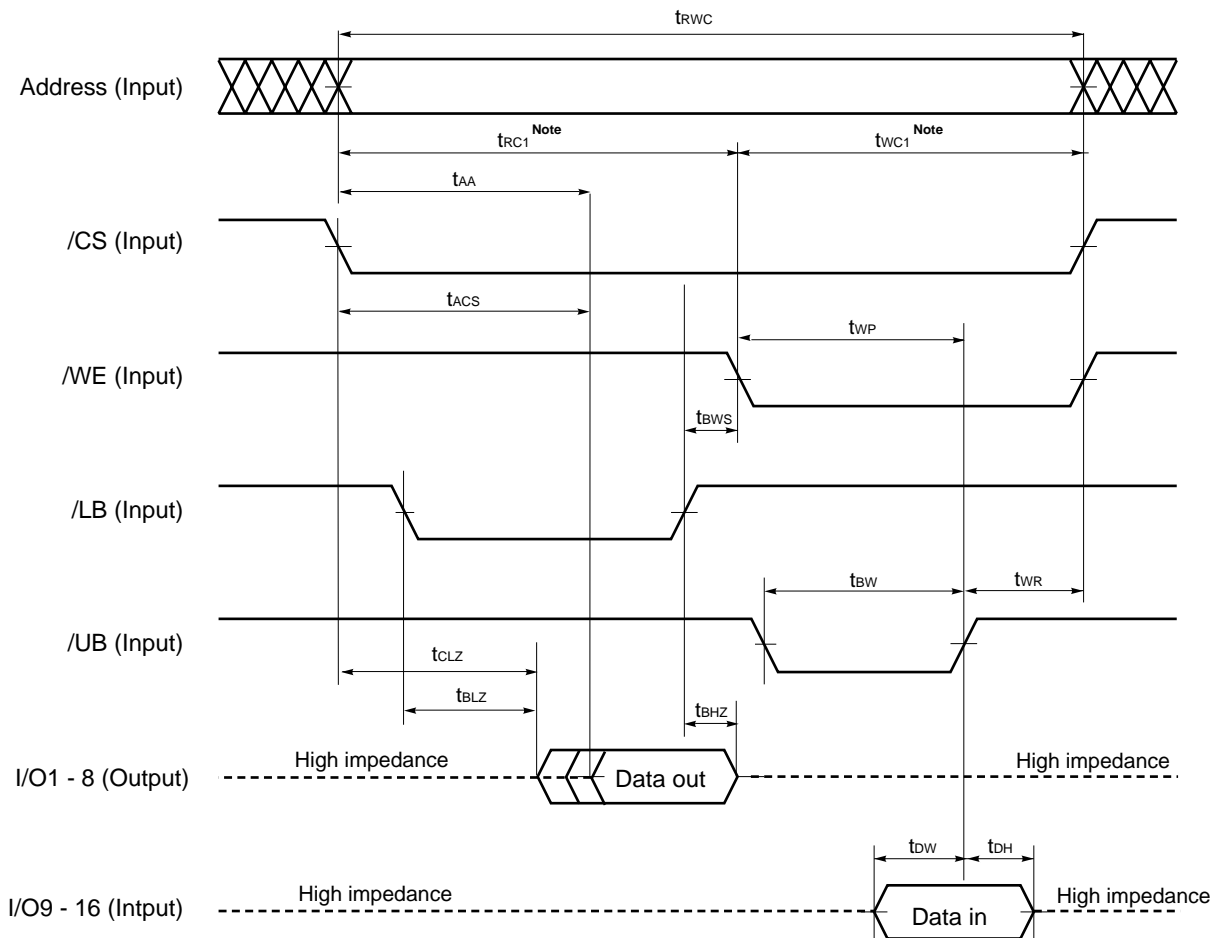
Read Write Cycle (BC version)

| Parameter | Symbol | μ PD4616112-BC80 | | μ PD4616112-BC90 | | μ PD4616112-BC10 | | Unit | Notes |
|-----------------------|-----------|----------------------|--------|----------------------|--------|----------------------|--------|------|-------|
| | | MIN. | MAX. | MIN. | MAX. | MIN. | MAX. | | |
| Read write cycle time | t_{RWC} | | 10,000 | | 10,000 | | 10,000 | ns | 1, 2 |
| Byte write setup time | t_{BWS} | 20 | | 20 | | 20 | | ns | |
| Byte read setup time | t_{BRS} | 20 | | 20 | | 20 | | ns | |

Notes 1. Make settings so that the sum (t_{RWC}) of the identical address read cycle time (t_{RC1}) and the identical address write cycle time (t_{WC1}) is 10 μ s or less when a write is performed at the identical address using /UB following a read using /LB with /CS low level, or when a write is performed using /LB following a read using /UB.

- ★ **2.** Make settings so that the sum (t_{RWC}) of the identical address read cycle time (t_{RC1}) and the identical address write cycle time (t_{WC1}) is 10 μ s or less when a read is performed at the identical address using /UB following a write using /LB with /CS low level, or when a read is performed using /LB following a write using /UB.

Read Write Cycle Timing Chart 1 (/LB, /UB Independent Controlled 1)



Cautions 1. During address transition, at least one of pins $/CS$, $/WE$ should be inactivated.

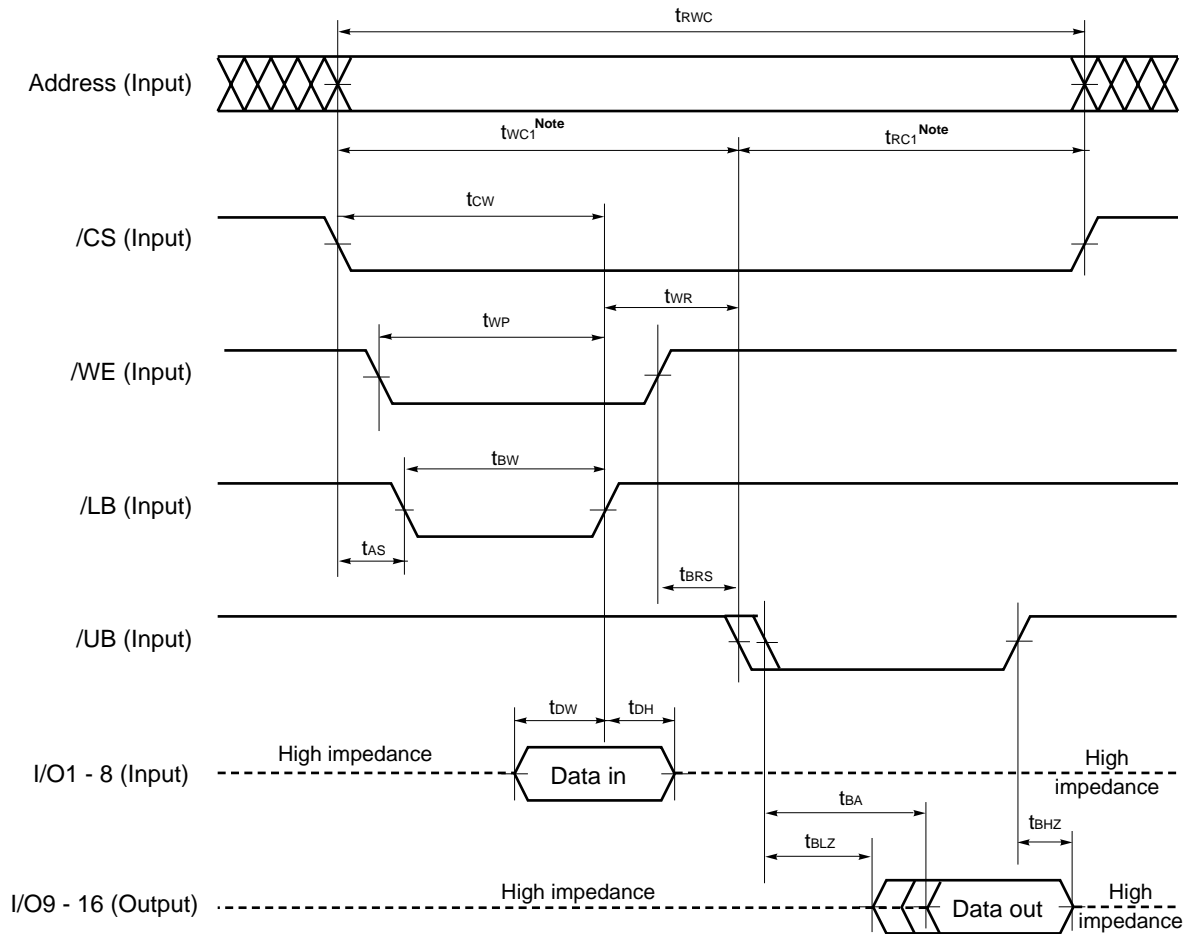
2. Do not input data to the I/O pins while they are in the output state.

3. If the address is changed using a value that is either lower than the minimum value or higher than the maximum value for the identical address read cycle time (t_{RC1}) and the identical address write cycle time (t_{WC1}), none of the data can be guaranteed.

Note Make settings so that the sum (t_{RWC}) of the identical address read cycle time (t_{RC1}) and the identical address write cycle time (t_{WC1}) is 10 μs or less when a write is performed at the identical address using $/UB$ following a read using $/LB$ with $/CS$ low level, or when a write is performed using $/LB$ following a read using $/UB$.

Remark Write operation is done during the overlap time of a Low $/CS$, $/WE$, $/LB$ and/or $/UB$.

Read Write Cycle Timing Chart 2 (/LB, /UB Independent Controlled 2)

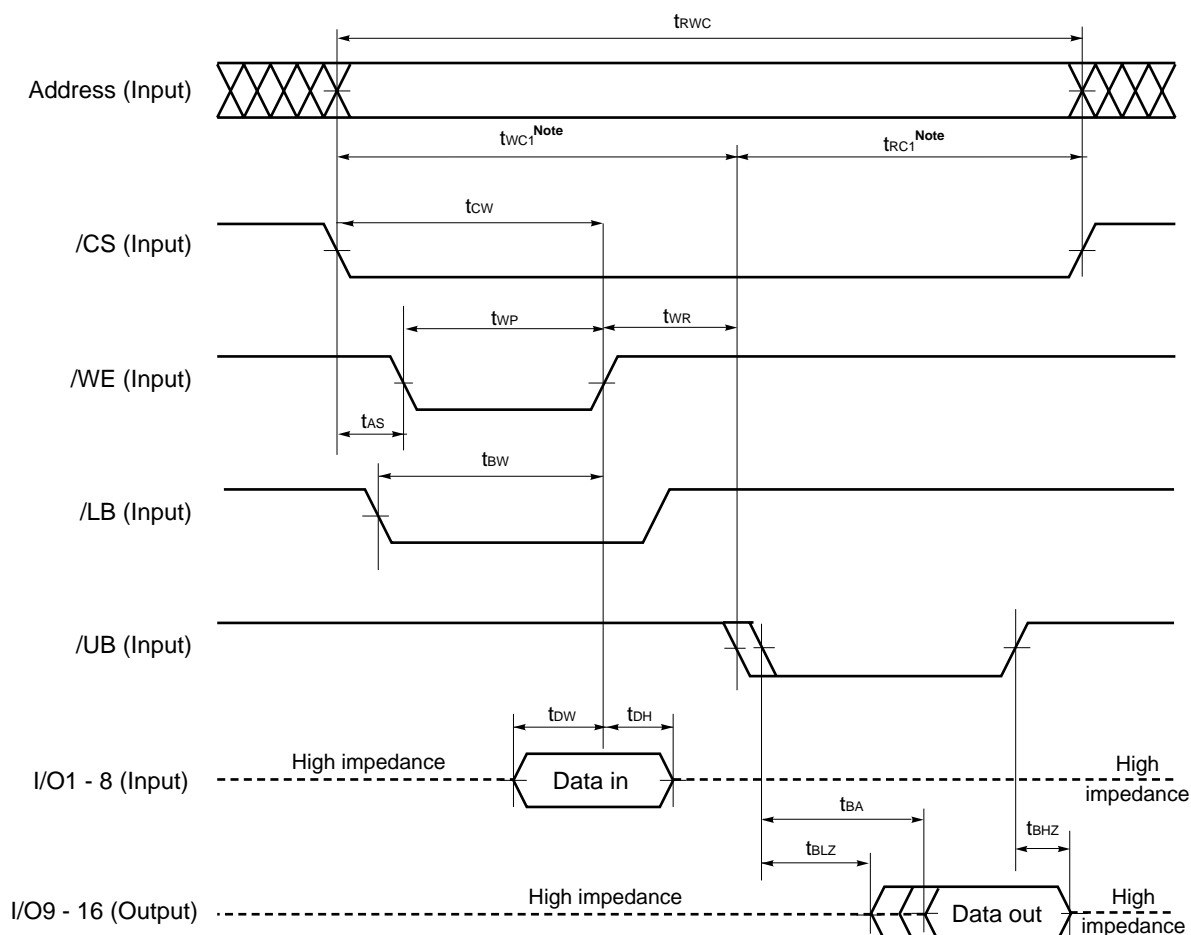


- Cautions**
1. During address transition, at least one of pins /CS, /WE should be inactivated.
 2. Do not input data to the I/O pins while they are in the output state.
 3. If the address is changed using a value that is either lower than the minimum value or higher than the maximum value for the identical address read cycle time (t_{RC1}) and the identical address write cycle time (t_{WC1}), none of the data can be guaranteed.

Note Make settings so that the sum (t_{RWC}) of the identical address read cycle time (t_{RC1}) and the identical address write cycle time (t_{WC1}) is 10 μ s or less when a write is performed at the identical address using /UB following a read using /LB with /CS low level, or when a write is performed using /LB following a read using /UB.

Remark Write operation is done during the overlap time of a Low /CS, /WE, /LB and/or /UB.

Read Write Cycle Timing Chart 3 (/LB, /UB Independent Controlled 3)

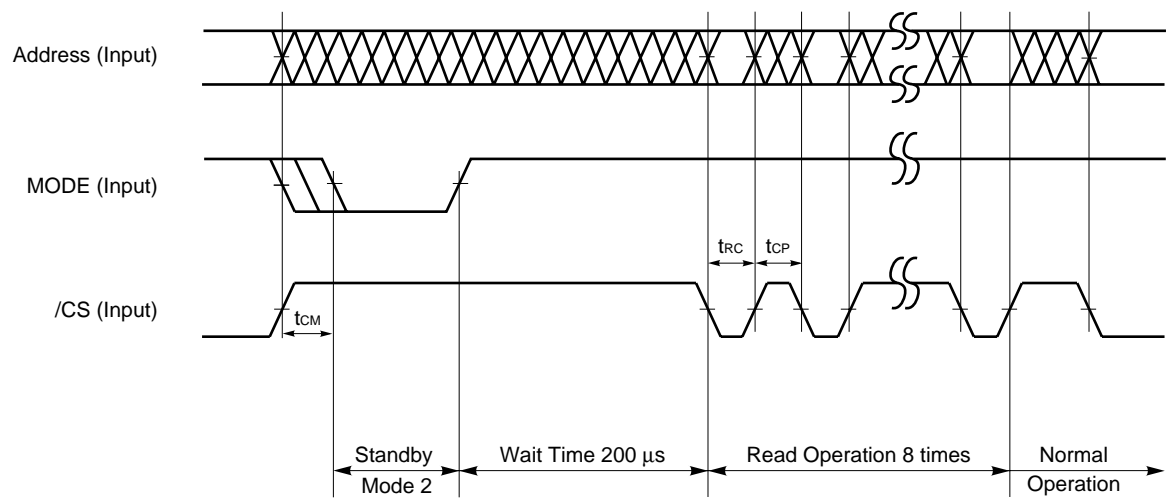


- Cautions**
1. During address transition, at least one of pins /CS, /WE should be inactivated.
 2. Do not input data to the I/O pins while they are in the output state.
 3. If the address is changed using a value that is either lower than the minimum value or higher than the maximum value for the identical address read cycle time (t_{RC1}) and the identical address write cycle time (t_{WC1}), none of the data can be guaranteed.

Note Make settings so that the sum (t_{RWC}) of the identical address read cycle time (t_{RC1}) and the identical address write cycle time (t_{WC1}) is 10 μ s or less when a write is performed at the identical address using /UB following a read using /LB with /CS low level, or when a write is performed using /LB following a read using /UB.

Remark Write operation is done during the overlap time of a Low /CS, /WE, /LB and/or /UB.

Standby Mode 2 entry and recovery Timing Chart

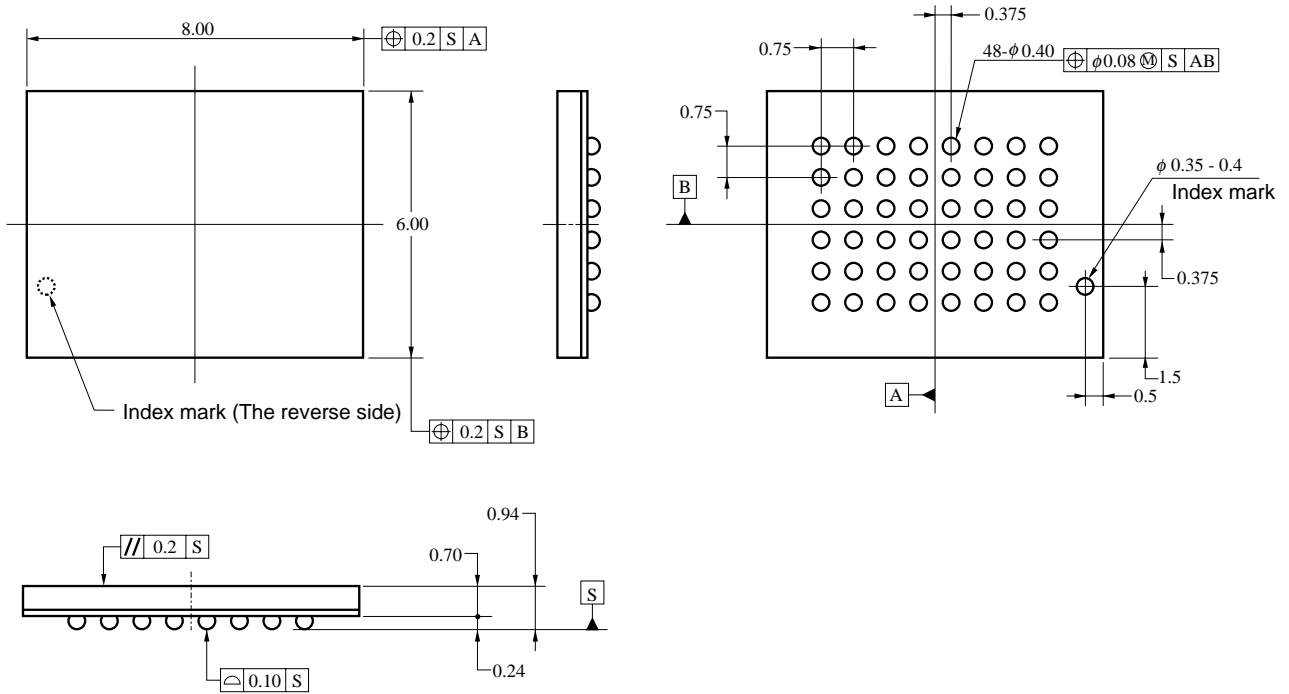


| Parameter | Symbol | MIN. | MAX. | Unit | Note |
|----------------------|----------|------|------|------|------|
| /CS High to MODE Low | t_{CM} | 0 | | ns | |

- Cautions**
1. Make MODE and /CS high level during the wait time.
 2. Make MODE high level during the wait time and eight read operations.
 3. The read operation must satisfy the specs described on page 10 (Read Cycle (BC Version)).
 4. The read operation address can be either V_{IH} or V_{IL} .
 5. Perform reading by toggling /CS.
 6. To prevent bus contention, it is recommended to set /OE to high level. However, do not input data to the I/O pins if /OE is low level during a read operation.

★ Package Drawing

48-PIN TAPE FBGA (6x8) (Unit : mm)



This package drawing is a preliminary version. It may be changed in the future.

Recommended Soldering Conditions

Please consult with our sales offices for soldering conditions of the μ PD4616112.

Type of Surface Mount Device

μ PD4616112F9-BCxx-BC2: 48-pin TAPE FBGA (6 x 8)

NOTES FOR CMOS DEVICES

① PRECAUTION AGAINST ESD FOR SEMICONDUCTORS

Note:

Strong electric field, when exposed to a MOS device, can cause destruction of the gate oxide and ultimately degrade the device operation. Steps must be taken to stop generation of static electricity as much as possible, and quickly dissipate it once, when it has occurred. Environmental control must be adequate. When it is dry, humidifier should be used. It is recommended to avoid using insulators that easily build static electricity. Semiconductor devices must be stored and transported in an anti-static container, static shielding bag or conductive material. All test and measurement tools including work bench and floor should be grounded. The operator should be grounded using wrist strap. Semiconductor devices must not be touched with bare hands. Similar precautions need to be taken for PW boards with semiconductor devices on it.

② HANDLING OF UNUSED INPUT PINS FOR CMOS

Note:

No connection for CMOS device inputs can be cause of malfunction. If no connection is provided to the input pins, it is possible that an internal input level may be generated due to noise, etc., hence causing malfunction. CMOS devices behave differently than Bipolar or NMOS devices. Input levels of CMOS devices must be fixed high or low by using a pull-up or pull-down circuitry. Each unused pin should be connected to V_{DD} or GND with a resistor, if it is considered to have a possibility of being an output pin. All handling related to the unused pins must be judged device by device and related specifications governing the devices.

③ STATUS BEFORE INITIALIZATION OF MOS DEVICES

Note:

Power-on does not necessarily define initial status of MOS device. Production process of MOS does not define the initial operation status of the device. Immediately after the power source is turned ON, the devices with reset function have not yet been initialized. Hence, power-on does not guarantee out-pin levels, I/O settings or contents of registers. Device is not initialized until the reset signal is received. Reset operation must be executed immediately after power-on for devices having reset function.

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