

# R1RW0404D Series

4M High Speed SRAM (1-Mword  $\times$  4-bit)

REJ03C0115-0100Z

Rev. 1.00

Mar.12.2004

## Description

The R1RW0404D is a 4-Mbit high speed static RAM organized 1-Mword  $\times$  4-bit. It has realized high speed access time by employing CMOS process (6-transistor memory cell) and high speed circuit designing technology. It is most appropriate for the application which requires high speed and high density memory, such as cache and buffer memory in system. The R1RW0404D is packaged in 400-mil 32-pin SOJ for high density surface mounting.

## Features

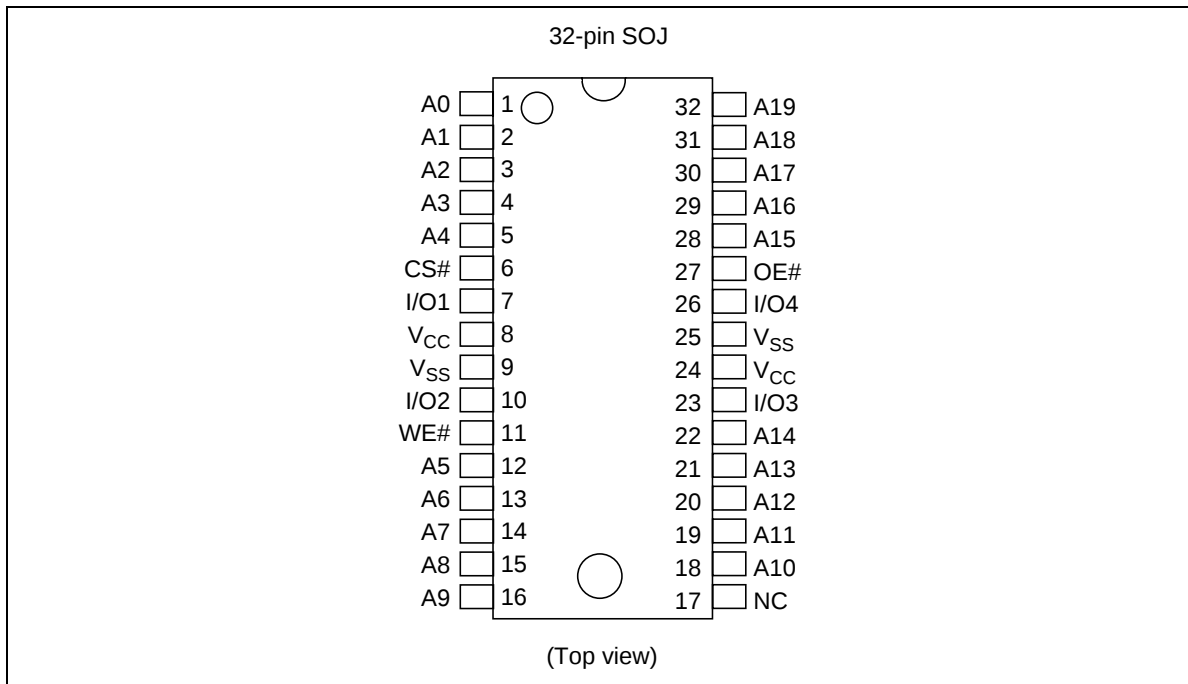
- Single supply: 3.3 V  $\pm$  0.3 V
- Access time: 12 ns (max)
- Completely static memory
  - No clock or timing strobe required
- Equal access and cycle times
- Directly TTL compatible
  - All inputs and outputs
- Operating current: 100 mA (max)
- TTL standby current: 40 mA (max)
- CMOS standby current: 5 mA (max)
  - : 0.8 mA (max) (L-version)
- Data retention current: 0.4 mA (max) (L-version)
- Data retention voltage: 2 V (min) (L-version)
- Center  $V_{CC}$  and  $V_{SS}$  type pin out

## R1RW0404D Series

### Ordering Information

| Type No.        | Access time | Package                            |
|-----------------|-------------|------------------------------------|
| R1RW0404DGE-2PR | 12 ns       | 400-mil 32-pin plastic SOJ (32P0K) |
| R1RW0404DGE-2LR | 12 ns       |                                    |

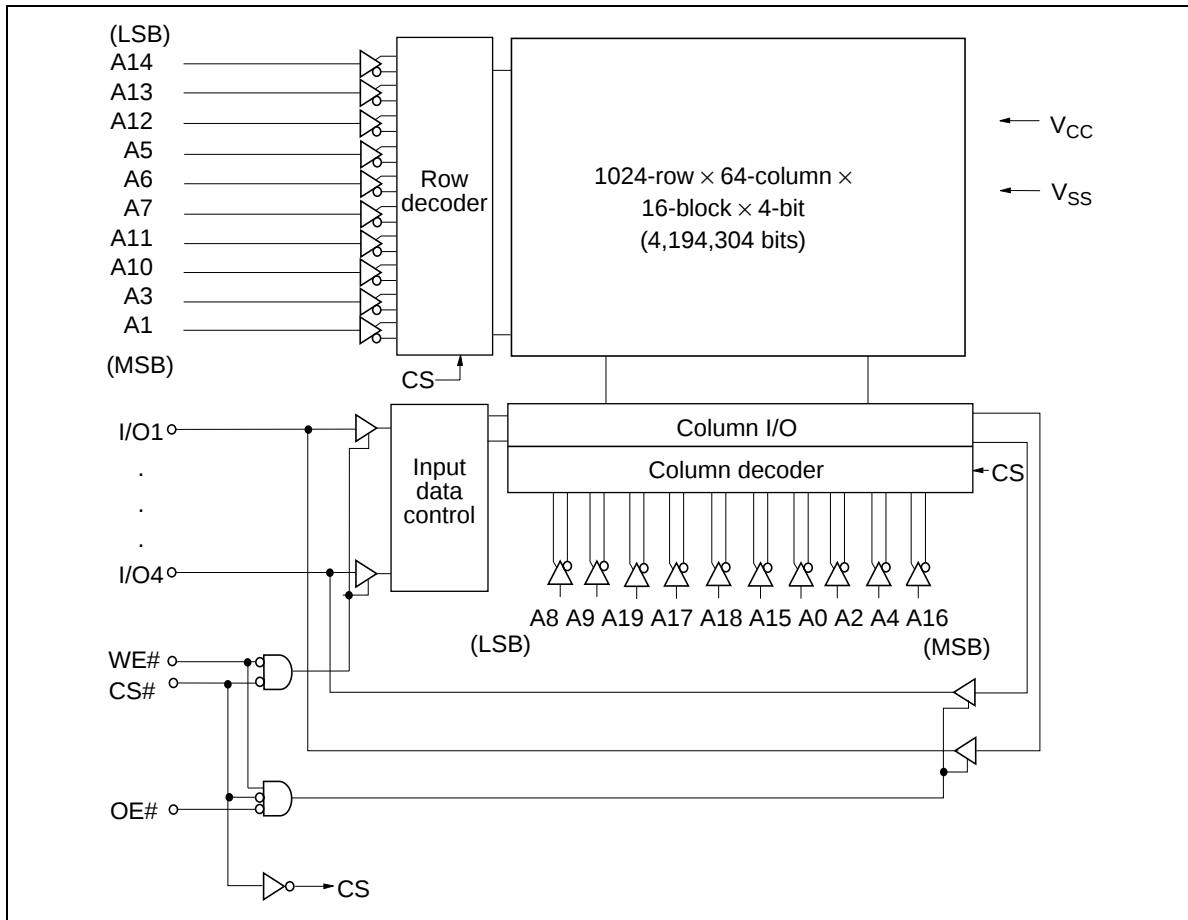
### Pin Arrangement



### Pin Description

| Pin name        | Function          |
|-----------------|-------------------|
| A0 to A19       | Address input     |
| I/O1 to I/O4    | Data input/output |
| CS#             | Chip select       |
| OE#             | Output enable     |
| WE#             | Write enable      |
| V <sub>CC</sub> | Power supply      |
| V <sub>SS</sub> | Ground            |
| NC              | No connection     |

## Block Diagram



## Operation Table

| CS# | OE# | WE# | Mode           | V <sub>CC</sub> current            | I/O              | Ref. cycle            |
|-----|-----|-----|----------------|------------------------------------|------------------|-----------------------|
| H   | ×   | ×   | Standby        | I <sub>SB</sub> , I <sub>SB1</sub> | High-Z           | —                     |
| L   | H   | H   | Output disable | I <sub>CC</sub>                    | High-Z           | —                     |
| L   | L   | H   | Read           | I <sub>CC</sub>                    | D <sub>OUT</sub> | Read cycle (1) to (3) |
| L   | H   | L   | Write          | I <sub>CC</sub>                    | D <sub>IN</sub>  | Write cycle (1)       |
| L   | L   | L   | Write          | I <sub>CC</sub>                    | D <sub>IN</sub>  | Write cycle (2)       |

Note: H: V<sub>IH</sub>, L: V<sub>IL</sub>, ×: V<sub>IH</sub> or V<sub>IL</sub>

## Absolute Maximum Ratings

| Parameter                                      | Symbol            | Value                                                     | Unit |
|------------------------------------------------|-------------------|-----------------------------------------------------------|------|
| Supply voltage relative to V <sub>SS</sub>     | V <sub>CC</sub>   | −0.5 to +4.6                                              | V    |
| Voltage on any pin relative to V <sub>SS</sub> | V <sub>T</sub>    | −0.5* <sup>1</sup> to V <sub>CC</sub> + 0.5* <sup>2</sup> | V    |
| Power dissipation                              | P <sub>T</sub>    | 1.0                                                       | W    |
| Operating temperature                          | T <sub>opr</sub>  | 0 to +70                                                  | °C   |
| Storage temperature                            | T <sub>stg</sub>  | −55 to +125                                               | °C   |
| Storage temperature under bias                 | T <sub>bias</sub> | −10 to +85                                                | °C   |

Notes: 1. V<sub>T</sub> (min) = −2.0 V for pulse width (under shoot) ≤ 6 ns.

2. V<sub>T</sub> (max) = V<sub>CC</sub> + 2.0 V for pulse width (over shoot) ≤ 6 ns.

## Recommended DC Operating Conditions

(T<sub>a</sub> = 0 to +70°C)

| Parameter      | Symbol                         | Min                | Typ | Max                                 | Unit |
|----------------|--------------------------------|--------------------|-----|-------------------------------------|------|
| Supply voltage | V <sub>CC</sub> * <sup>3</sup> | 3.0                | 3.3 | 3.6                                 | V    |
|                | V <sub>SS</sub> * <sup>4</sup> | 0                  | 0   | 0                                   | V    |
| Input voltage  | V <sub>IH</sub>                | 2.0                | —   | V <sub>CC</sub> + 0.5* <sup>2</sup> | V    |
|                | V <sub>IL</sub>                | −0.5* <sup>1</sup> | —   | 0.8                                 | V    |

Notes: 1. V<sub>IL</sub> (min) = −2.0 V for pulse width (under shoot) ≤ 6 ns.

2. V<sub>IH</sub> (max) = V<sub>CC</sub> + 2.0 V for pulse width (over shoot) ≤ 6 ns.

3. The supply voltage with all V<sub>CC</sub> pins must be on the same level.

4. The supply voltage with all V<sub>SS</sub> pins must be on the same level.

## DC Characteristics

(Ta = 0 to +70°C, V<sub>CC</sub> = 3.3 V ± 0.3 V, V<sub>SS</sub> = 0 V)

| Parameter                      | Symbol           | Min             | Max               | Unit | Test conditions                                                                                                                                                          |
|--------------------------------|------------------|-----------------|-------------------|------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Input leakage current          | I <sub>LI</sub>  | —               | 2                 | μA   | V <sub>IN</sub> = V <sub>SS</sub> to V <sub>CC</sub>                                                                                                                     |
| Output leakage current         | I <sub>LO</sub>  | —               | 2                 | μA   | V <sub>IN</sub> = V <sub>SS</sub> to V <sub>CC</sub>                                                                                                                     |
| Operation power supply current | I <sub>CC</sub>  | —               | 100               | mA   | Min cycle<br>CS# = V <sub>IL</sub> , I <sub>OUT</sub> = 0 mA<br>Other inputs = V <sub>IH</sub> /V <sub>IL</sub>                                                          |
| Standby power supply current   | I <sub>SB</sub>  | —               | 40                | mA   | Min cycle, CS# = V <sub>IH</sub> ,<br>Other inputs = V <sub>IH</sub> /V <sub>IL</sub>                                                                                    |
|                                | I <sub>SB1</sub> | —               | 5                 | mA   | f = 0 MHz<br>V <sub>CC</sub> ≥ CS# ≥ V <sub>CC</sub> – 0.2 V,<br>(1) 0 V ≤ V <sub>IN</sub> ≤ 0.2 V or<br>(2) V <sub>CC</sub> ≥ V <sub>IN</sub> ≥ V <sub>CC</sub> – 0.2 V |
|                                |                  | —* <sup>1</sup> | 0.8* <sup>1</sup> |      |                                                                                                                                                                          |
| Output voltage                 | V <sub>OL</sub>  | —               | 0.4               | V    | I <sub>OL</sub> = 8 mA                                                                                                                                                   |
|                                | V <sub>OH</sub>  | 2.4             | —                 | V    | I <sub>OH</sub> = –4 mA                                                                                                                                                  |

Note: 1. This characteristics is guaranteed only for L-version.

## Capacitance

(Ta = +25°C, f = 1.0 MHz)

| Parameter                              | Symbol           | Min | Max | Unit | Test conditions        |
|----------------------------------------|------------------|-----|-----|------|------------------------|
| Input capacitance* <sup>1</sup>        | C <sub>IN</sub>  | —   | 6   | pF   | V <sub>IN</sub> = 0 V  |
| Input/output capacitance* <sup>1</sup> | C <sub>I/O</sub> | —   | 8   | pF   | V <sub>I/O</sub> = 0 V |

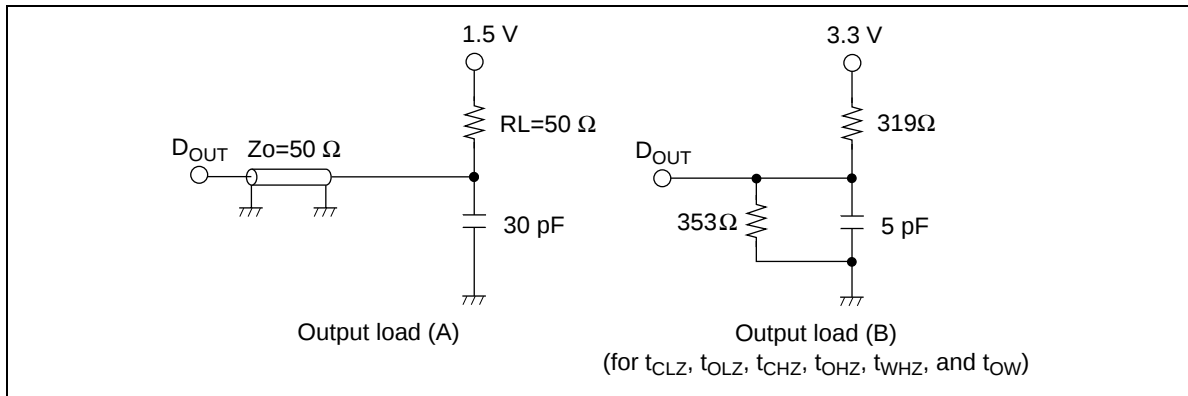
Note: 1. This parameter is sampled and not 100% tested.

## AC Characteristics

( $T_a = 0$  to  $+70^\circ\text{C}$ ,  $V_{CC} = 3.3\text{ V} \pm 0.3\text{ V}$ , unless otherwise noted.)

### Test Conditions

- Input pulse levels: 3.0 V/0.0 V
- Input rise and fall time: 3 ns
- Input and output timing reference levels: 1.5 V
- Output load: See figures (Including scope and jig)



### Read Cycle

|                                    |                  | R1RW0404D |     |      |       |
|------------------------------------|------------------|-----------|-----|------|-------|
|                                    |                  | -2        |     |      |       |
| Parameter                          | Symbol           | Min       | Max | Unit | Notes |
| Read cycle time                    | t <sub>RC</sub>  | 12        | —   | ns   |       |
| Address access time                | t <sub>AA</sub>  | —         | 12  | ns   |       |
| Chip select access time            | t <sub>ACS</sub> | —         | 12  | ns   |       |
| Output enable to output valid      | t <sub>OE</sub>  | —         | 6   | ns   |       |
| Output hold from address change    | t <sub>OH</sub>  | 3         | —   | ns   |       |
| Chip select to output in low-Z     | t <sub>CLZ</sub> | 3         | —   | ns   | 1     |
| Output enable to output in low-Z   | t <sub>OLZ</sub> | 0         | —   | ns   | 1     |
| Chip deselect to output in high-Z  | t <sub>CHZ</sub> | —         | 6   | ns   | 1     |
| Output disable to output in high-Z | t <sub>OHZ</sub> | —         | 6   | ns   | 1     |

## R1RW0404D Series

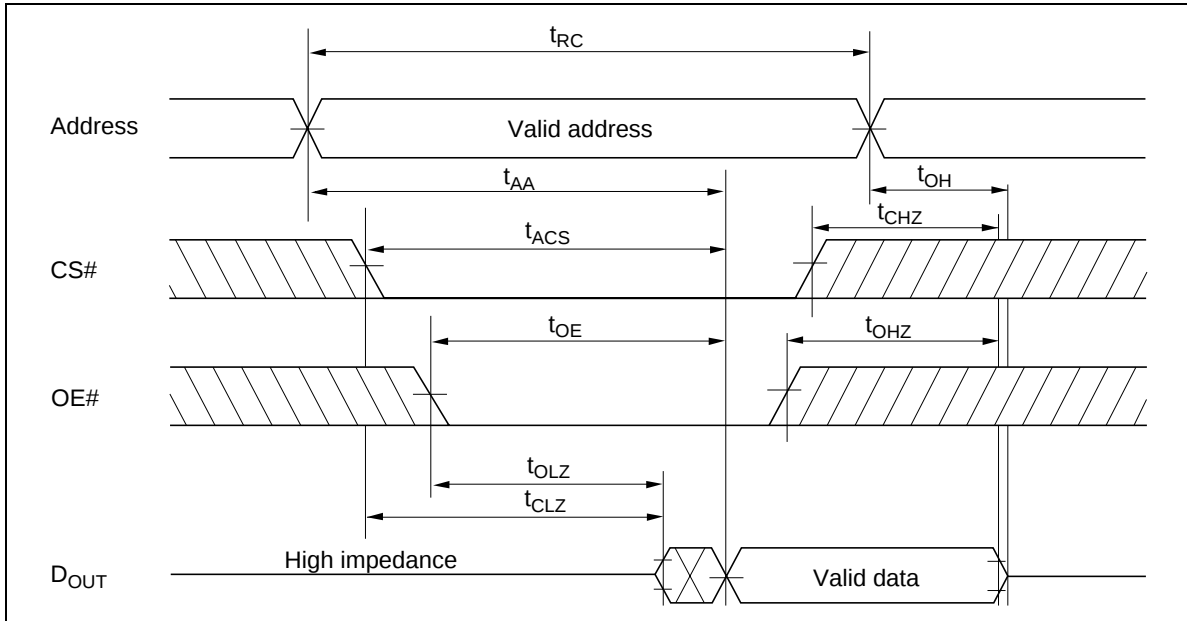
### Write Cycle

|                                    |                  | R1RW0404D |     |      |       |
|------------------------------------|------------------|-----------|-----|------|-------|
|                                    |                  | -2        |     |      |       |
| Parameter                          | Symbol           | Min       | Max | Unit | Notes |
| Write cycle time                   | t <sub>WC</sub>  | 12        | —   | ns   |       |
| Address valid to end of write      | t <sub>AW</sub>  | 8         | —   | ns   |       |
| Chip select to end of write        | t <sub>CW</sub>  | 8         | —   | ns   | 9     |
| Write pulse width                  | t <sub>WP</sub>  | 8         | —   | ns   | 8     |
| Address setup time                 | t <sub>AS</sub>  | 0         | —   | ns   | 6     |
| Write recovery time                | t <sub>WR</sub>  | 0         | —   | ns   | 7     |
| Data to write time overlap         | t <sub>DW</sub>  | 6         | —   | ns   |       |
| Data hold from write time          | t <sub>DH</sub>  | 0         | —   | ns   |       |
| Write disable to output in low-Z   | t <sub>OW</sub>  | 3         | —   | ns   | 1     |
| Output disable to output in high-Z | t <sub>OHZ</sub> | —         | 6   | ns   | 1     |
| Write enable to output in high-Z   | t <sub>WHZ</sub> | —         | 6   | ns   | 1     |

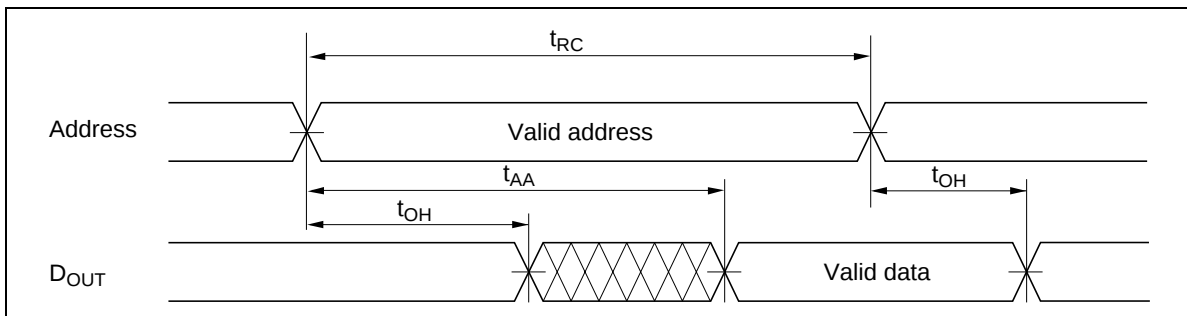
- Notes:
1. Transition is measured  $\pm 200$  mV from steady voltage with output load (B). This parameter is sampled and not 100% tested.
  2. Address should be valid prior to or coincident with CS# transition low.
  3. WE# and/or CS# must be high during address transition time.
  4. If CS# and OE# are low during this period, I/O pins are in the output state. Then, the data input signals of opposite phase to the outputs must not be applied to them.
  5. If the CS# low transition occurs simultaneously with the WE# low transition or after the WE# transition, output remains a high impedance state.
  6.  $t_{AS}$  is measured from the latest address transition to the later of CS# or WE# going low.
  7.  $t_{WR}$  is measured from the earlier of CS# or WE# going high to the first address transition.
  8. A write occurs during the overlap of a low CS# and a low WE#. A write begins at the latest transition among CS# going low and WE# going low. A write ends at the earliest transition among CS# going high and WE# going high.  $t_{WP}$  is measured from the beginning of write to the end of write.
  9.  $t_{CW}$  is measured from the later of CS# going low to the end of write.

## Timing Waveforms

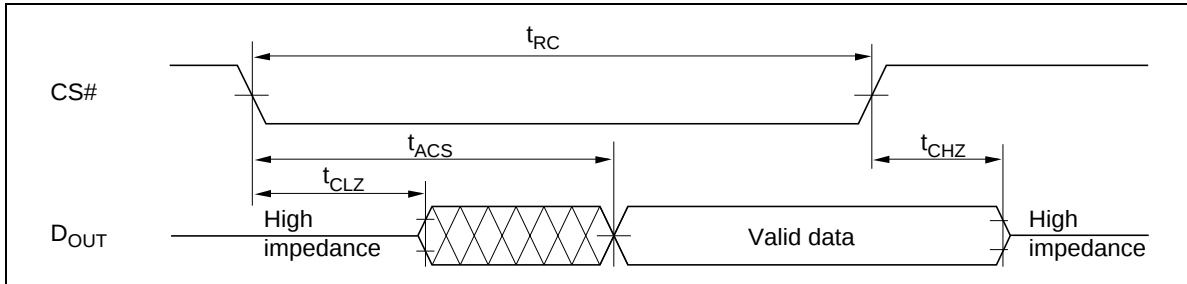
Read Timing Waveform (1) ( $WE\# = V_{IH}$ )



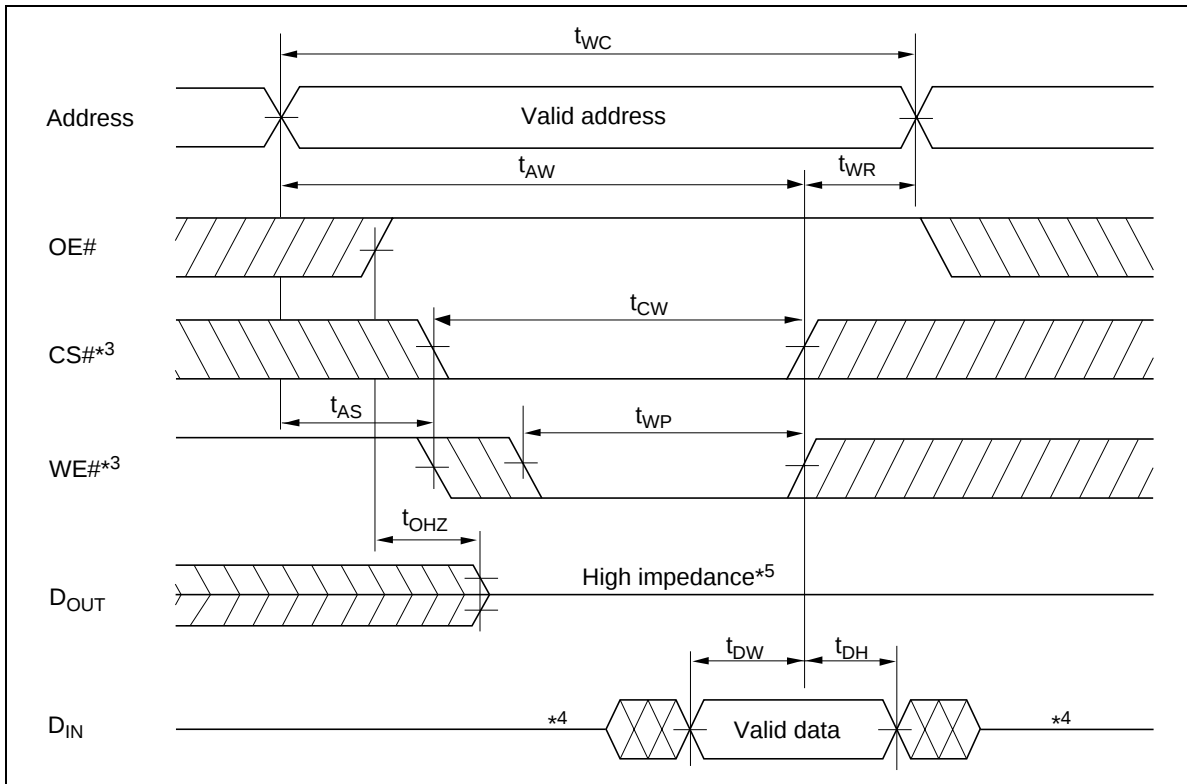
Read Timing Waveform (2) ( $WE\# = V_{IH}$ ,  $CS\# = V_{IL}$ ,  $OE\# = V_{IL}$ )



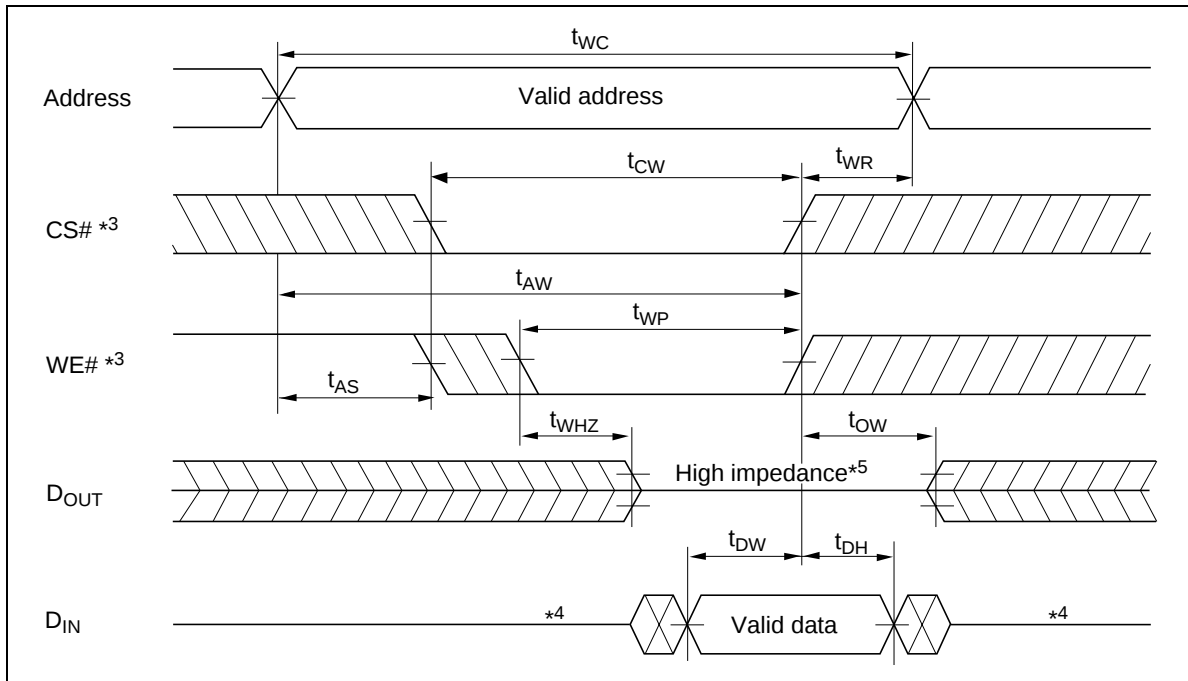
**Read Timing Waveform (3)** ( $WE\# = V_{IH}$ ,  $CS\# = V_{IL}$ ,  $OE\# = V_{IL}$ )\*<sup>2</sup>



**Write Timing Waveform (1)** ( $WE\#$  Controlled)



Write Timing Waveform (2) (CS# Controlled)



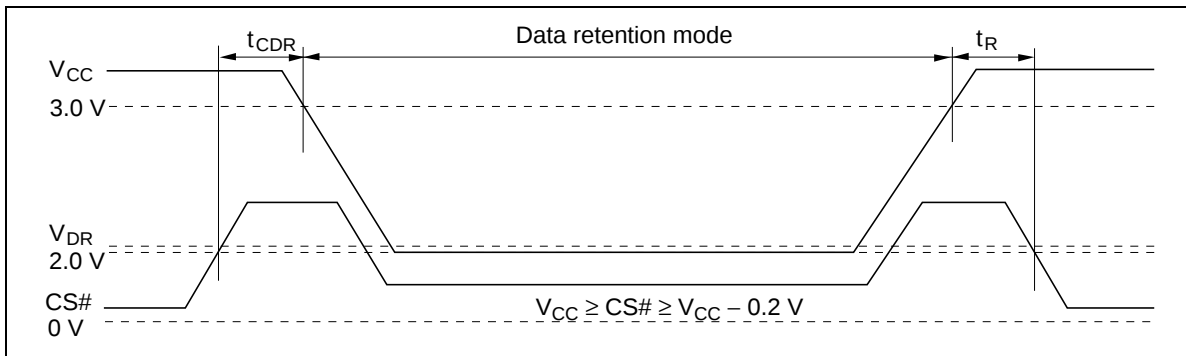
## Low $V_{CC}$ Data Retention Characteristics

( $T_a = 0$  to  $+70^\circ\text{C}$ )

This characteristics is guaranteed only for L-version.

| Parameter                            | Symbol     | Min | Max | Unit          | Test conditions                                                                                                                                                                   |
|--------------------------------------|------------|-----|-----|---------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| $V_{CC}$ for data retention          | $V_{DR}$   | 2.0 | —   | V             | $V_{CC} \geq CS\# \geq V_{CC} - 0.2\text{ V}$<br>(1) $0\text{ V} \leq V_{IN} \leq 0.2\text{ V}$ or<br>(2) $V_{CC} \geq V_{IN} \geq V_{CC} - 0.2\text{ V}$                         |
| Data retention current               | $I_{CCDR}$ | —   | 400 | $\mu\text{A}$ | $V_{CC} = 3\text{ V}$ , $V_{CC} \geq CS\# \geq V_{CC} - 0.2\text{ V}$<br>(1) $0\text{ V} \leq V_{IN} \leq 0.2\text{ V}$ or<br>(2) $V_{CC} \geq V_{IN} \geq V_{CC} - 0.2\text{ V}$ |
| Chip deselect to data retention time | $t_{CDR}$  | 0   | —   | ns            | See retention waveform                                                                                                                                                            |
| Operation recovery time              | $t_R$      | 5   | —   | ms            |                                                                                                                                                                                   |

## Low $V_{CC}$ Data Retention Timing Waveform



## Revision History

## R1RW0404D Series Data Sheet

| Rev. | Date          | Contents of Modification |                         |
|------|---------------|--------------------------|-------------------------|
|      |               | Page                     | Description             |
| 0.01 | Oct. 01, 2003 | —                        | Initial issue           |
| 1.00 | Mar.12.2004   | —                        | Deletion of Preliminary |

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