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# HN58S65A Series

8192-word  $\times$  8-bit Electrically Erasable and Programmable  
CMOS ROM

# HITACHI

ADE-203-691 (Z)

Preliminary

Rev. 0.1

Mar. 13, 1997

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## Description

The Hitachi HN58S65A series is electrically erasable and programmable ROM organized as 8192-word  $\times$  8-bit. It has realized high speed, low power consumption and high reliability by employing advanced MNOS memory technology and CMOS process and circuitry technology. They also have a 64-byte page programming function to make their write operations faster.

## Features

- Single supply: 2.2 to 3.6 V
- Access time: 150 ns (max)
- Power dissipation
  - Active: 10 mW/MHz (typ)
  - Standby: 36  $\mu$ W (max)
- On-chip latches: address, data,  $\overline{\text{CE}}$ ,  $\overline{\text{OE}}$ ,  $\overline{\text{WE}}$
- Automatic byte write: 15 ms (max)
- Automatic page write (64 bytes): 15 ms (max)
- Ready/ $\overline{\text{Busy}}$
- $\overline{\text{Data}}$  polling and Toggle bit
- Data protection circuit on power on/off
- Conforms to JEDEC byte-wide standard
- Reliable CMOS with MNOS cell technology
- $10^5$  erase/write cycles (in page mode)
- 10 years data retention
- Software data protection
- Industrial versions (Temperature range:  $-40$  to  $+85^\circ\text{C}$ ) are also available.

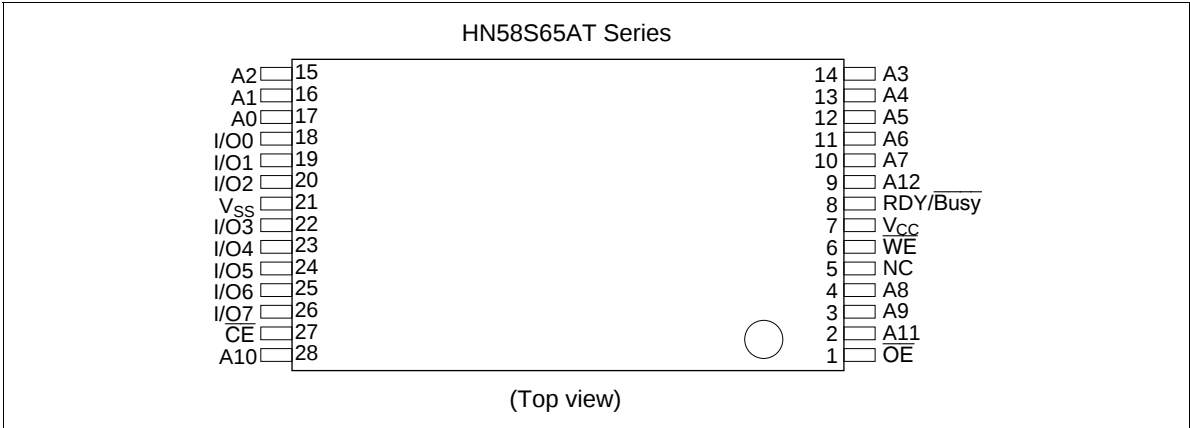
Preliminary: This document contains information on a new product. Specifications and information contained herein are subject to change without notice.

# HN58S65A Series

## Ordering Information

| Type No.     | Access time | Package                       |
|--------------|-------------|-------------------------------|
| HN58S65AT-15 | 150 ns      | 28-pin plastic TSOP(TFP-28DB) |

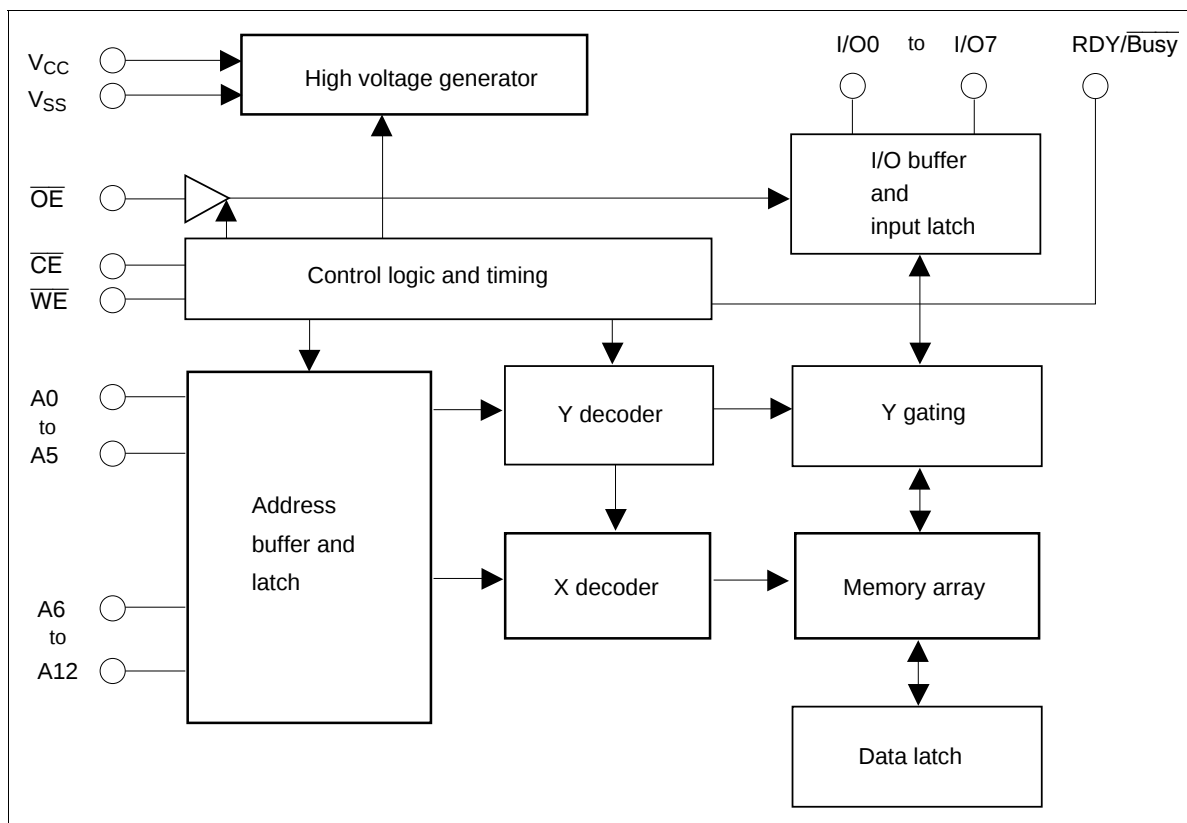
## Pin Arrangement



## Pin Description

| Pin name        | Function          |
|-----------------|-------------------|
| A0 to A12       | Address input     |
| I/O0 to I/O7    | Data input/output |
| $\overline{OE}$ | Output enable     |
| $\overline{CE}$ | Chip enable       |
| $\overline{WE}$ | Write enable      |
| V <sub>CC</sub> | Power supply      |
| V <sub>SS</sub> | Ground            |
| RDY/Busy        | Ready busy        |
| NC              | No connection     |

## Block Diagram



## Operation Table

| Operation     | $\overline{CE}$ | $\overline{OE}$ | $\overline{WE}$ | $\overline{RDY/Busy}$ | I/O         |
|---------------|-----------------|-----------------|-----------------|-----------------------|-------------|
| Read          | $V_{IL}$        | $V_{IL}$        | $V_{IH}$        | High-Z                | Dout        |
| Standby       | $V_{IH}$        | $\times^{*1}$   | $\times$        | High-Z                | High-Z      |
| Write         | $V_{IL}$        | $V_{IH}$        | $V_{IL}$        | High-Z to $V_{OL}$    | Din         |
| Deselect      | $V_{IL}$        | $V_{IH}$        | $V_{IH}$        | High-Z                | High-Z      |
| Write Inhibit | $\times$        | $\times$        | $V_{IH}$        | —                     | —           |
|               | $\times$        | $V_{IL}$        | $\times$        | —                     | —           |
| Data Polling  | $V_{IL}$        | $V_{IL}$        | $V_{IH}$        | $V_{OL}$              | Dout (I/O7) |

Notes: 1.  $\times$ : Don't care

## Absolute Maximum Ratings

| Parameter                                  | Symbol    | Value                                    | Unit |
|--------------------------------------------|-----------|------------------------------------------|------|
| Power supply voltage relative to $V_{SS}$  | $V_{CC}$  | −0.6 to +7.0                             | V    |
| Input voltage relative to $V_{SS}$         | $V_{in}$  | −0.5* <sup>1</sup> to +7.0* <sup>3</sup> | V    |
| Operating temperature range * <sup>2</sup> | $T_{opr}$ | 0 to +70                                 | °C   |
| Storage temperature range                  | $T_{stg}$ | −55 to +125                              | °C   |

Notes: 1.  $V_{in}$  min : −3.0 V for pulse width ≤ 50 ns.  
2. Including electrical characteristics and data retention.  
3. Should not exceed  $V_{CC} + 1.0$  V.

## Recommended DC Operating Conditions

| Parameter             | Symbol    | Min                 | Typ | Max                           | Unit |
|-----------------------|-----------|---------------------|-----|-------------------------------|------|
| Supply voltage        | $V_{CC}$  | 2.2                 | 3.0 | 3.6                           | V    |
|                       | $V_{SS}$  | 0                   | 0   | 0                             | V    |
| Input voltage         | $V_{IL}$  | −0.3* <sup>1</sup>  | —   | 0.4                           | V    |
|                       | $V_{IH}$  | $V_{CC} \times 0.7$ | —   | $V_{CC} + 0.3$ * <sup>2</sup> | V    |
| Operating temperature | $T_{opr}$ | 0                   | —   | 70                            | °C   |

Notes: 1.  $V_{IL}$  min: −1.0 V for pulse width ≤ 50 ns.  
2.  $V_{IH}$  max:  $V_{CC} + 1.0$  V for pulse width ≤ 50 ns.

## DC Characteristics ( $T_a = 0$ to + 70°C, $V_{CC} = 2.2$ to 3.6 V)

| Parameter                  | Symbol    | Min                 | Typ    | Max | Unit | Test conditions                                                      |
|----------------------------|-----------|---------------------|--------|-----|------|----------------------------------------------------------------------|
| Input leakage current      | $I_{LI}$  | —                   | —      | 2   | μA   | $V_{CC} = 5.5$ V, $V_{in} = 5.5$ V                                   |
| Output leakage current     | $I_{LO}$  | —                   | —      | 2   | μA   | $V_{CC} = 5.5$ V, $V_{out} = 5.5/0.4$ V                              |
| Standby $V_{CC}$ current   | $I_{CC1}$ | —                   | 1 to 2 | 3.5 | μA   | $\overline{CE} = V_{CC}$                                             |
|                            | $I_{CC2}$ | —                   | —      | 500 | μA   | $\overline{CE} = V_{IH}$                                             |
| Operating $V_{CC}$ current | $I_{CC3}$ | —                   | —      | 6   | mA   | $I_{out} = 0$ mA, Duty = 100%,<br>Cycle = 1 μs at $V_{CC} = 3.6$ V   |
|                            | —         | —                   | —      | 12  | mA   | $I_{out} = 0$ mA, Duty = 100%,<br>Cycle = 150 ns at $V_{CC} = 3.6$ V |
| Output low voltage         | $V_{OL}$  | —                   | —      | 0.4 | V    | $I_{OL} = 1.0$ mA                                                    |
| Output high voltage        | $V_{OH}$  | $V_{CC} \times 0.8$ | —      | —   | V    | $I_{OH} = -100$ μA                                                   |

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

| Parameter          | Symbol         | Min | Typ | Max | Unit | Test conditions        |
|--------------------|----------------|-----|-----|-----|------|------------------------|
| Input capacitance  | $C_{in}^{*1}$  | —   | —   | 6   | pF   | $V_{in} = 0\text{ V}$  |
| Output capacitance | $C_{out}^{*1}$ | —   | —   | 12  | pF   | $V_{out} = 0\text{ V}$ |

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

**AC Characteristics** ( $T_a = 0\text{ to }+70^\circ\text{C}$ ,  $V_{CC} = 2.2\text{ to }3.6\text{ V}$ )

**Test Conditions**

- Input pulse levels :  $0.4\text{ V to }2.4\text{ V}$  ( $V_{CC} = 2.7\text{ to }3.6\text{ V}$ ),  $0.4\text{ V to }1.9\text{ V}$  ( $V_{CC} = 2.2\text{ to }2.7\text{ V}$ )
- Input rise and fall time :  $\leq 5\text{ ns}$
- Input timing reference levels :  $0.8, 1.8\text{ V}$
- Output load :  $1\text{ TTL Gate} + 100\text{ pF}$
- Output reference levels :  $1.5\text{ V}, 1.5\text{ V}$  ( $V_{CC} = 2.7\text{ to }3.6\text{ V}$ )  
 $1.1\text{ V}, 1.1\text{ V}$  ( $V_{CC} = 2.2\text{ to }2.7\text{ V}$ )

**Read Cycle**

| HN58S65A                                                               |           |     |     |      |                                                                  |
|------------------------------------------------------------------------|-----------|-----|-----|------|------------------------------------------------------------------|
| -15                                                                    |           |     |     |      |                                                                  |
| Parameter                                                              | Symbol    | Min | Max | Unit | Test conditions                                                  |
| Address to output delay                                                | $t_{ACC}$ | —   | 150 | ns   | $\overline{CE} = \overline{OE} = V_{IL}, \overline{WE} = V_{IH}$ |
| $\overline{CE}$ to output delay                                        | $t_{CE}$  | —   | 150 | ns   | $\overline{OE} = V_{IL}, \overline{WE} = V_{IH}$                 |
| $\overline{OE}$ to output delay                                        | $t_{OE}$  | 10  | 80  | ns   | $\overline{CE} = V_{IL}, \overline{WE} = V_{IH}$                 |
| Address to output hold                                                 | $t_{OH}$  | 0   | —   | ns   | $\overline{CE} = \overline{OE} = V_{IL}, \overline{WE} = V_{IH}$ |
| $\overline{OE}$ ( $\overline{CE}$ ) high to output float <sup>*1</sup> | $t_{DF}$  | 0   | 80  | ns   | $\overline{CE} = V_{IL}, \overline{WE} = V_{IH}$                 |

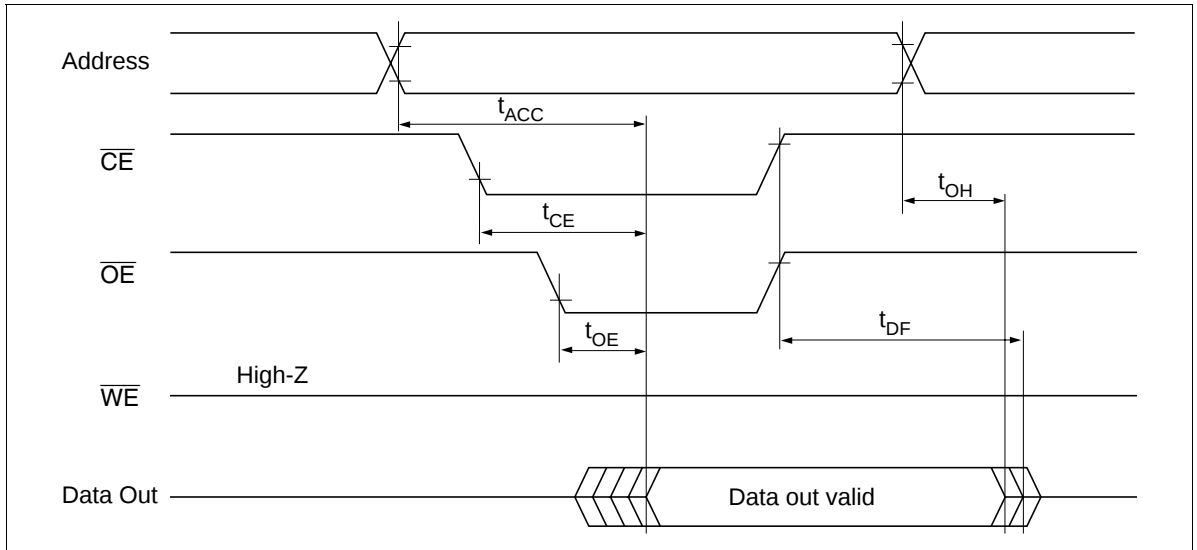
## Write Cycle

| Parameter                                                         | Symbol    | Min*2 | Typ | Max  | Unit    | Test conditions |
|-------------------------------------------------------------------|-----------|-------|-----|------|---------|-----------------|
| Address setup time                                                | $t_{AS}$  | 0     | —   | —    | ns      |                 |
| Address hold time                                                 | $t_{AH}$  | 150   | —   | —    | ns      |                 |
| $\overline{CE}$ to write setup time ( $\overline{WE}$ controlled) | $t_{CS}$  | 0     | —   | —    | ns      |                 |
| $\overline{CE}$ hold time ( $\overline{WE}$ controlled)           | $t_{CH}$  | 0     | —   | —    | ns      |                 |
| $\overline{WE}$ to write setup time ( $\overline{CE}$ controlled) | $t_{WS}$  | 0     | —   | —    | ns      |                 |
| $\overline{WE}$ hold time ( $\overline{CE}$ controlled)           | $t_{WH}$  | 0     | —   | —    | ns      |                 |
| $\overline{OE}$ to write setup time                               | $t_{OES}$ | 0     | —   | —    | ns      |                 |
| $\overline{OE}$ hold time                                         | $t_{OEH}$ | 0     | —   | —    | ns      |                 |
| Data setup time                                                   | $t_{DS}$  | 150   | —   | —    | ns      |                 |
| Data hold time                                                    | $t_{DH}$  | 0     | —   | —    | ns      |                 |
| $\overline{WE}$ pulse width ( $\overline{WE}$ controlled)         | $t_{WP}$  | 200   | —   | —    | ns      |                 |
| $\overline{CE}$ pulse width ( $\overline{CE}$ controlled)         | $t_{CW}$  | 200   | —   | —    | ns      |                 |
| Data latch time                                                   | $t_{DL}$  | 200   | —   | —    | ns      |                 |
| Byte load cycle                                                   | $t_{BLC}$ | 0.4   | —   | 30   | $\mu s$ |                 |
| Byte load window                                                  | $t_{BL}$  | 100   | —   | —    | $\mu s$ |                 |
| Write cycle time                                                  | $t_{WC}$  | —     | —   | 15*3 | ms      |                 |
| Time to device busy                                               | $t_{DB}$  | 120   | —   | —    | ns      |                 |
| Write start time                                                  | $t_{DW}$  | 0*4   | —   | —    | ns      |                 |

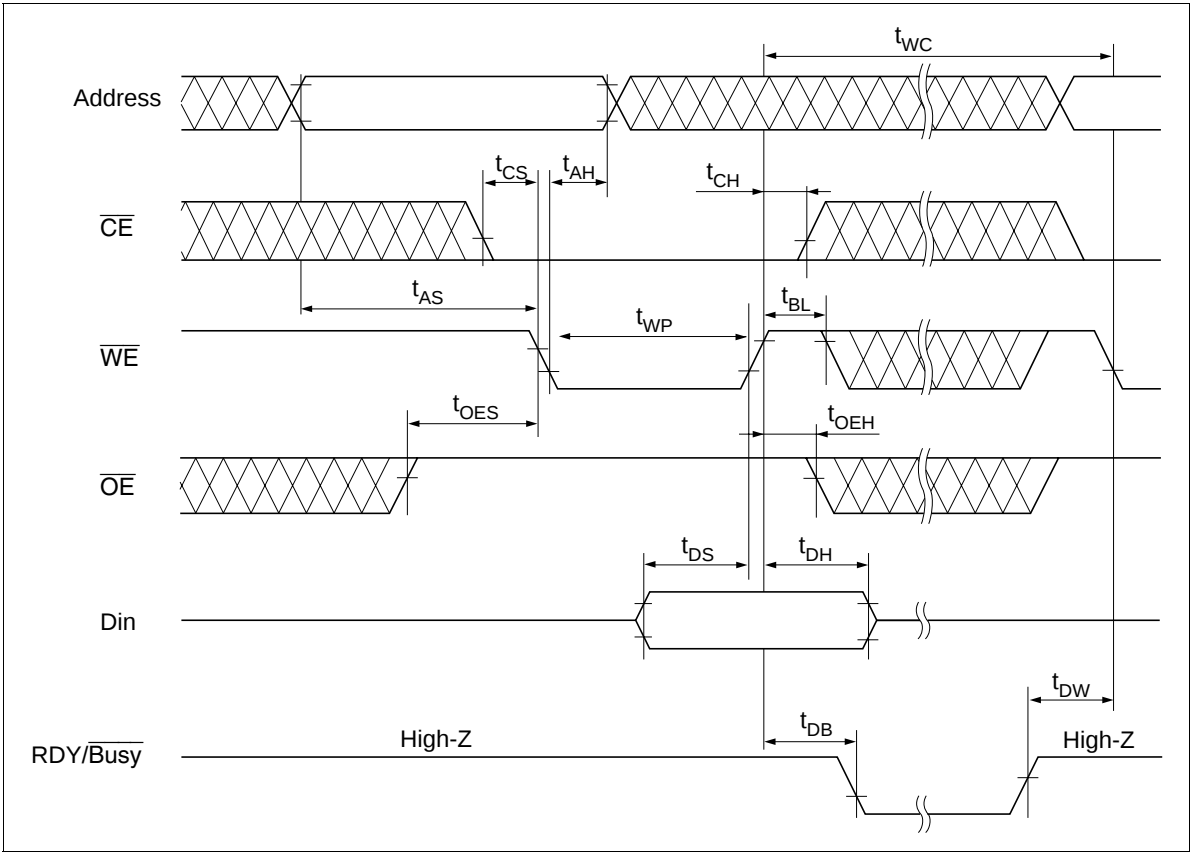
- Notes: 1.  $t_{DF}$  is defined as the time at which the outputs achieve the open circuit conditions and are no longer driven.
2. Use this device in longer cycle than this value.
3.  $t_{WC}$  must be longer than this value unless polling techniques or  $RDY/\overline{Busy}$  are used. This device automatically completes the internal write operation within this value.
4. Next read or write operation can be initiated after  $t_{DW}$  if polling techniques or  $RDY/\overline{Busy}$  are used.
5. A6 through A12 are page addresses and these addresses are latched at the first falling edge of  $\overline{WE}$ .
6. A6 through A12 are page addresses and these addresses are latched at the first falling edge of  $\overline{CE}$ .
7. See AC read characteristics.

## Timing Waveforms

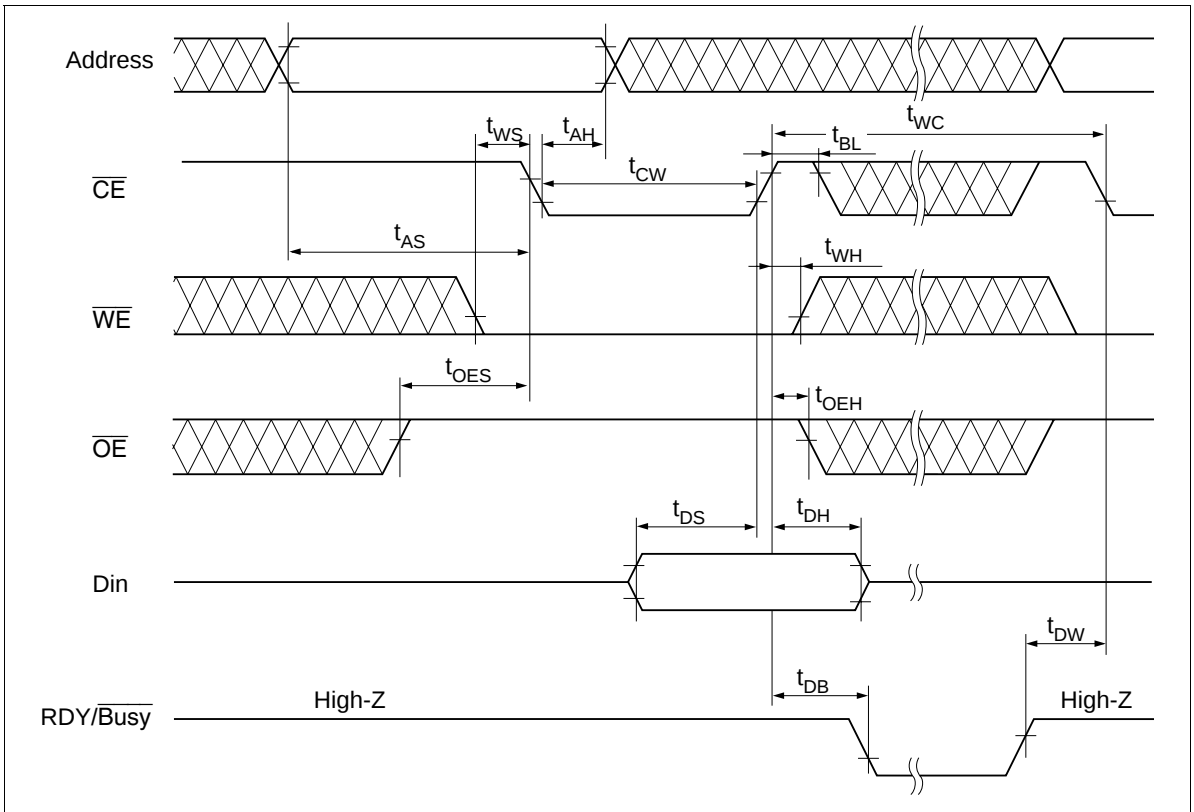
### Read Timing Waveform



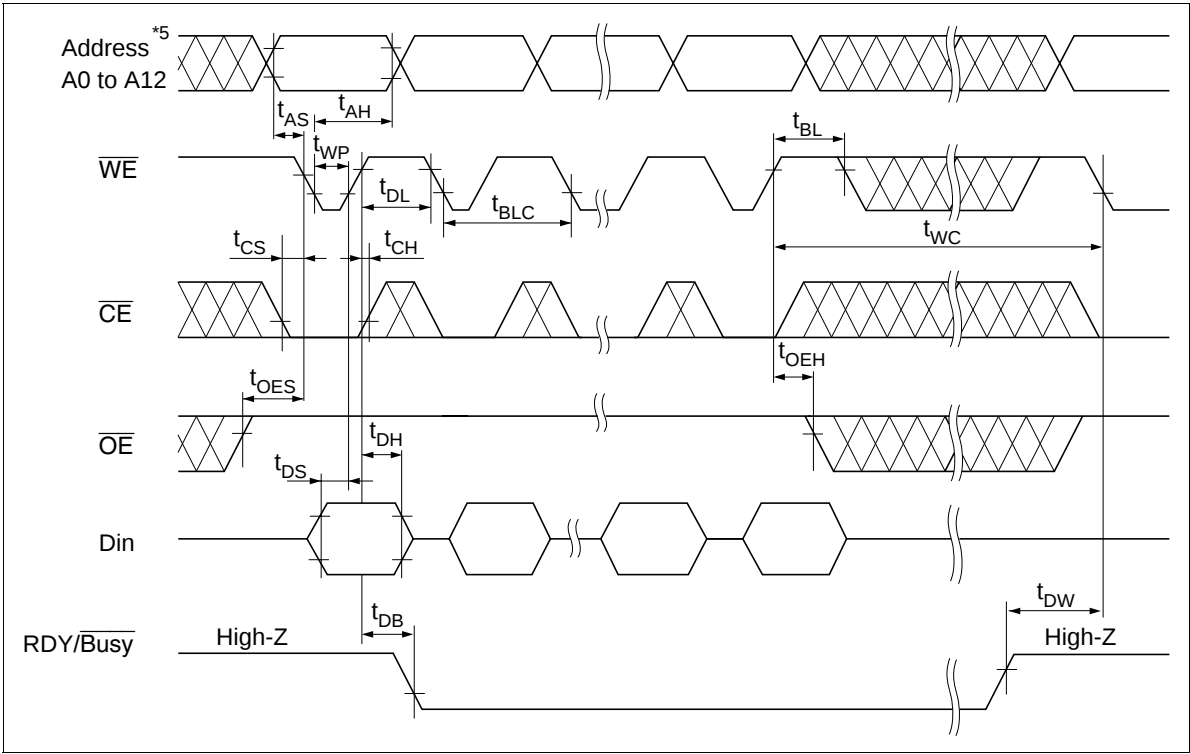
Byte Write Timing Waveform(1) ( $\overline{\text{WE}}$  Controlled)



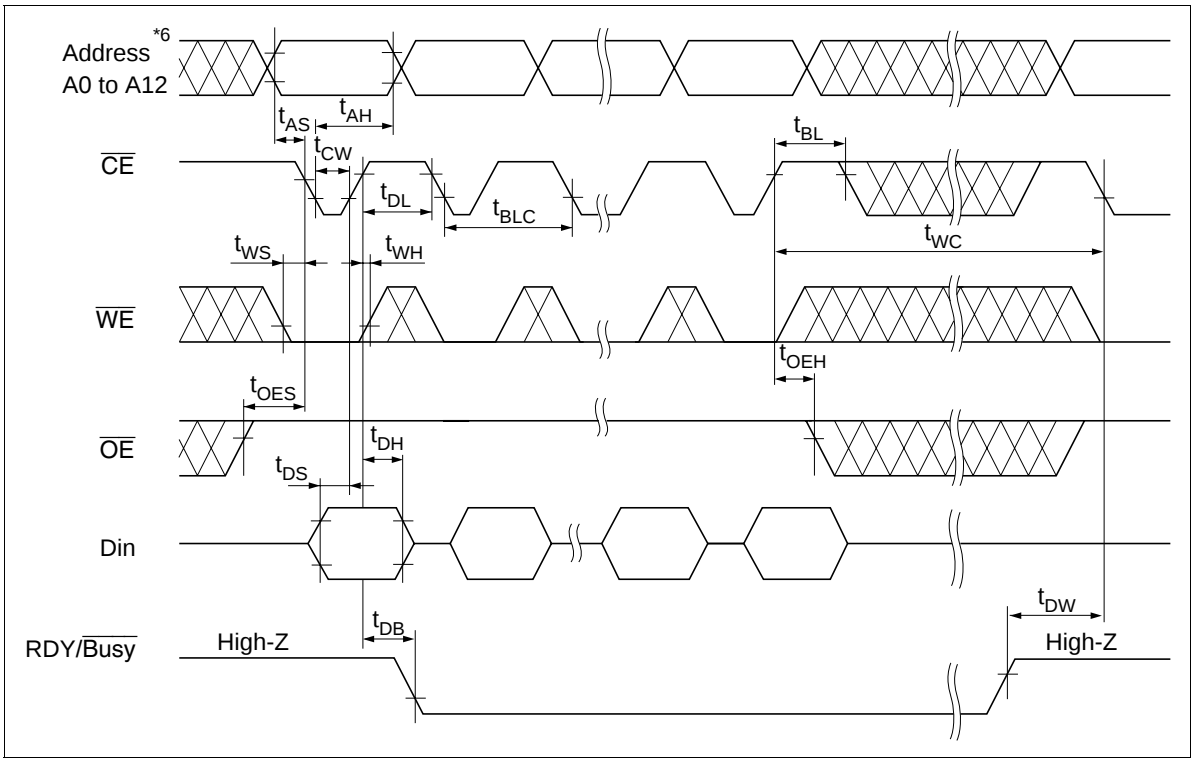
Byte Write Timing Waveform(2) ( $\overline{\text{CE}}$  Controlled)



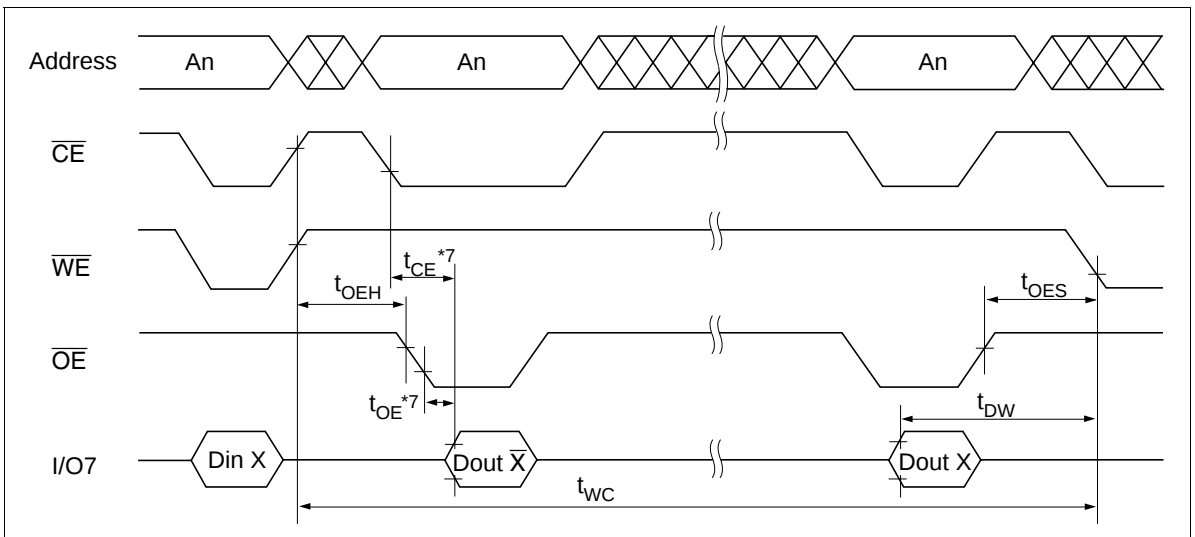
Page Write Timing Waveform(1) ( $\overline{\text{WE}}$  Controlled)



Page Write Timing Waveform(2) ( $\overline{\text{CE}}$  Controlled)



Data Polling Timing Waveform

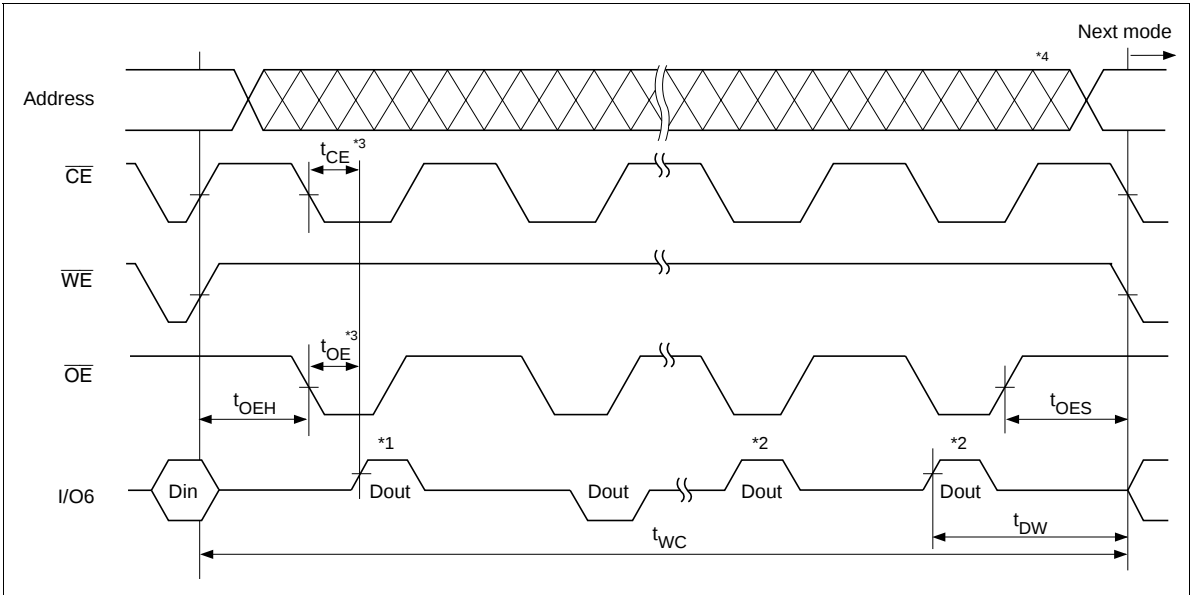


Toggle Bit

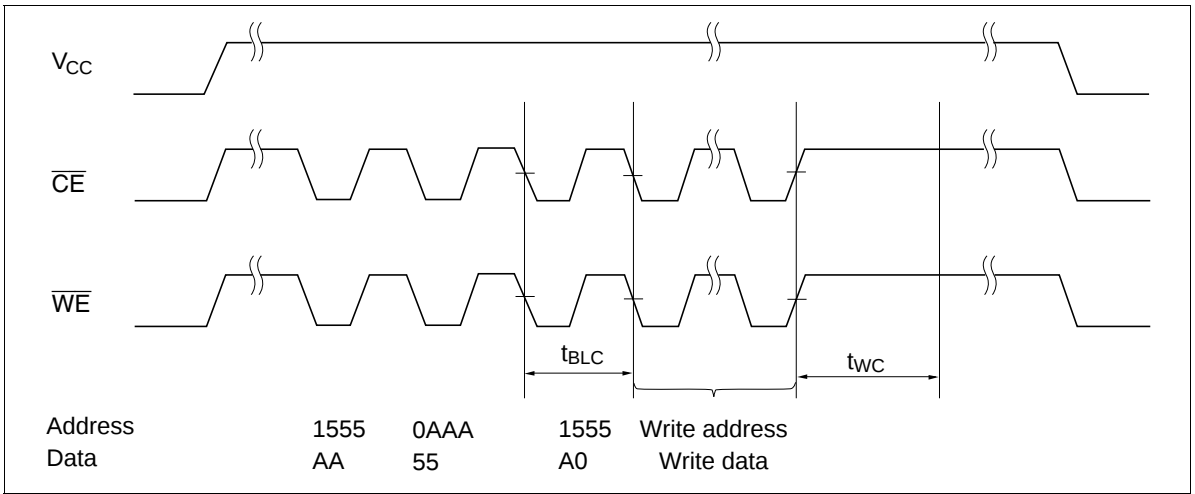
This device provide another function to determine the internal programming cycle. If the EEPROM is set to read mode during the internal programming cycle, I/O6 will charge from “1” to “0” (toggling) for each read. When the internal programming cycle is finished, toggling of I/O6 will stop and the device can be accessible for next read or program.

Toggle Bit Waveform

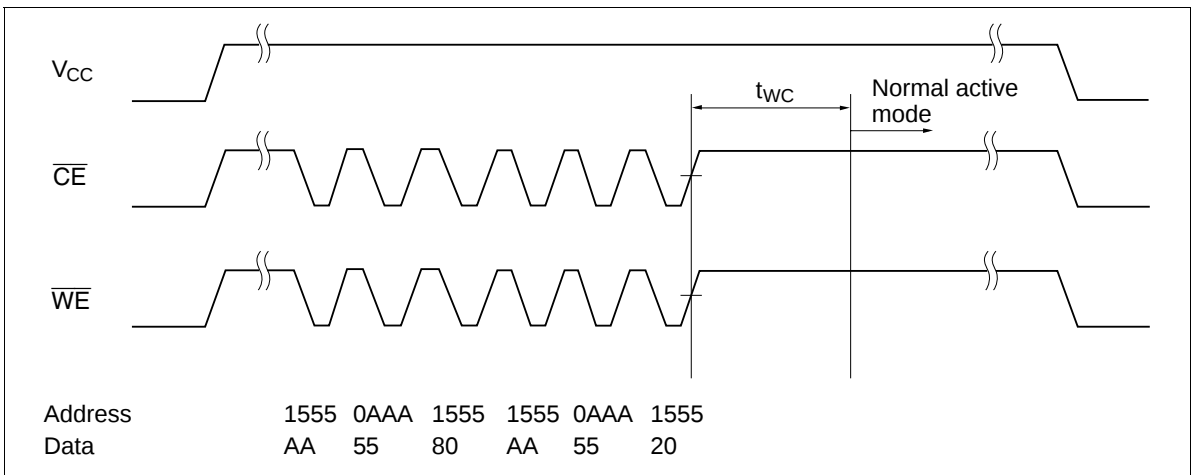
- Notes:
- 1. I/O6 beginning state is “1”.
  - 2. I/O6 ending state will vary.
  - 3. See AC read characteristics.
  - 4. Any address location can be used, but the address must be fixed.



**Software Data Protection Timing Waveform(1) (in protection mode)**



**Software Data Protection Timing Waveform(2) (in non-protection mode)**



### Functional Description

#### Automatic Page Write

Page-mode write feature allows 1 to 64 bytes of data to be written into the EEPROM in a single write cycle. Following the initial byte cycle, an additional 1 to 63 bytes can be written in the same manner. Each additional byte load cycle must be started within 30  $\mu$ s from the preceding falling edge of  $\overline{\text{WE}}$  or  $\overline{\text{CE}}$ . When  $\overline{\text{CE}}$  or  $\overline{\text{WE}}$  is kept high for 100  $\mu$ s after data input, the EEPROM enters write mode automatically and the input data are written into the EEPROM.

#### Data Polling

Data polling indicates the status that the EEPROM is in a write cycle or not. If EEPROM is set to read mode during a write cycle, an inversion of the last byte of data outputs from I/O7 to indicate that the EEPROM is performing a write operation.

#### RDY/ $\overline{\text{Busy}}$ Signal

RDY/ $\overline{\text{Busy}}$  signal also allows status of the EEPROM to be determined. The RDY/ $\overline{\text{Busy}}$  signal has high impedance except in write cycle and is lowered to  $V_{\text{OL}}$  after the first write signal. At the end of a write cycle, the RDY/ $\overline{\text{Busy}}$  signal changes state to high impedance.

#### $\overline{\text{WE}}$ , $\overline{\text{CE}}$ Pin Operation

During a write cycle, addresses are latched by the falling edge of  $\overline{\text{WE}}$  or  $\overline{\text{CE}}$ , and data is latched by the rising edge of  $\overline{\text{WE}}$  or  $\overline{\text{CE}}$ .

#### Write/Erase Endurance and Data Retention Time

The endurance is  $10^5$  cycles in case of the page programming and  $10^4$  cycles in case of the byte programming (1% cumulative failure rate). The data retention time is more than 10 years when a device is page-programmed less than  $10^4$  cycles.

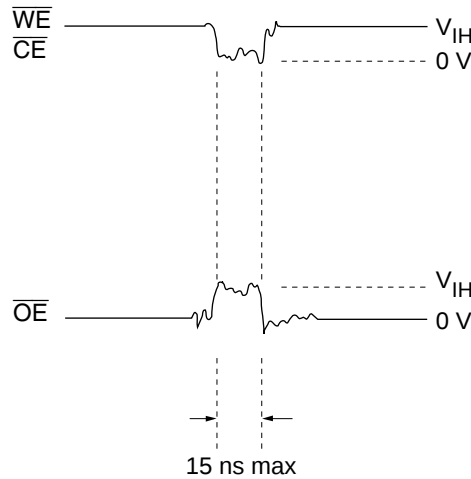
## Data Protection

### 1. Data Protection against Noise on Control Pins ( $\overline{\text{CE}}$ , $\overline{\text{OE}}$ , $\overline{\text{WE}}$ ) during Operation

During readout or standby, noise on the control pins may act as a trigger and turn the EEPROM to programming mode by mistake.

To prevent this phenomenon, this device has a noise cancellation function that cuts noise if its width is 15 ns or less.

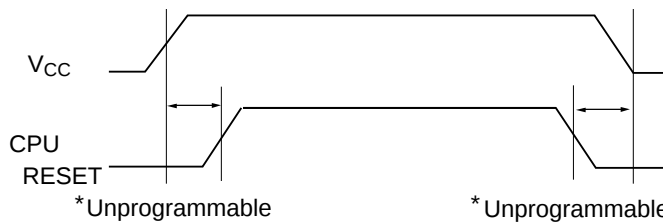
Be careful not to allow noise of a width of more than 15 ns on the control pins.



### 2. Data protection at $V_{CC}$ on/off

When  $V_{CC}$  is turned on or off, noise on the control pins generated by external circuits (CPU, etc) may act as a trigger and turn the EEPROM to program mode by mistake. To prevent this unintentional programming, the EEPROM must be kept in an unprogrammable state while the CPU is in an unstable state.

Note: The EEPROM should be kept in unprogrammable state during  $V_{CC}$  on/off by using CPU RESET signal.



# HN58S65A Series

## (1) Protection by $\overline{CE}$ , $\overline{OE}$ , $\overline{WE}$

To realize the unprogrammable state, the input level of control pins must be held as shown in the table below.

|                 |          |          |          |
|-----------------|----------|----------|----------|
| $\overline{CE}$ | $V_{CC}$ | ×        | ×        |
| $\overline{OE}$ | ×        | $V_{SS}$ | ×        |
| $\overline{WE}$ | ×        | ×        | $V_{CC}$ |

×: Don't care.  
 $V_{CC}$ : Pull-up to  $V_{CC}$  level.  
 $V_{SS}$ : Pull-down to  $V_{SS}$  level.

## 3. Software data protection

To prevent unintentional programming caused by noise generated by external circuits, this device has the software data protection function. In software data protection mode, 3 bytes of data must be input before write data as follows. And these bytes can switch the non-protection mode to the protection mode.

| Address                                        | Data |
|------------------------------------------------|------|
| 1555                                           | AA   |
| ↓                                              | ↓    |
| 0AAA                                           | 55   |
| ↓                                              | ↓    |
| 1555                                           | A0   |
| ↓                                              | ↓    |
| Write address   Write data } Normal data input |      |

Software data protection mode can be canceled by inputting the following 6 bytes. After that, this device turns to the non-protection mode and can write data normally. But when the data is input in the canceling cycle, the data cannot be written.

| Address | Data |
|---------|------|
| 1555    | AA   |
| ↓       | ↓    |
| 0AAA    | 55   |
| ↓       | ↓    |
| 1555    | 80   |
| ↓       | ↓    |
| 1555    | AA   |
| ↓       | ↓    |
| 0AAA    | 55   |
| ↓       | ↓    |
| 1555    | 20   |

The software data protection is not enabled at the shipment.

Note: There are some differences between Hitachi's and other company's for enable/disable sequence of software data protection. If there are any questions , please contact with Hitachi sales offices.



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**Revision Record**

| Rev. | Date          | Contents of Modification                | Drawn by | Approved by |
|------|---------------|-----------------------------------------|----------|-------------|
| 0.0  | Dec. 5, 1996  | Initial issue                           | Y. Nagai | T. Wada     |
| 0.1  | Mar. 13, 1997 | Change of page size: 32 byte to 64 byte |          |             |