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# HN29W12811 Series

128M AND type Flash Memory  
More than 8,029-sector (135,657,984-bit)

# HITACHI

ADE-203-1183D (Z)

Rev. 3.0

Apr. 13, 2001

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## Description

The Hitachi HN29W12811 Series is a CMOS Flash Memory with AND type multi-level memory cells. It has fully automatic programming and erase capabilities with a single 3.3 V power supply. The functions are controlled by simple external commands. To fit the I/O card applications, the unit of programming and erase is as small as (2048 + 64) bytes. Initial available sectors of HN29W12811 are more than 8,029 (98% of all sector address).

## Features

- On-board single power supply ( $V_{CC}$ ):  $V_{CC} = 3.3\text{ V} \pm 0.3\text{ V}$
- Organization
  - AND Flash Memory: (2048 + 64) bytes  $\times$  (More than 8,029 sectors)
  - Data register: (2048 + 64) bytes
- Multi-level memory cell
  - 2 bit/per memory cell
- Automatic programming
  - Sector program time: 2.5 ms (typ)
  - System bus free
  - Address, data latch function
  - Internal automatic program verify function
  - Status data polling function
- Automatic erase
  - Single sector erase time: 1.0 ms (typ)
  - System bus free
  - Internal automatic erase verify function
  - Status data polling function

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# HN29W12811 Series

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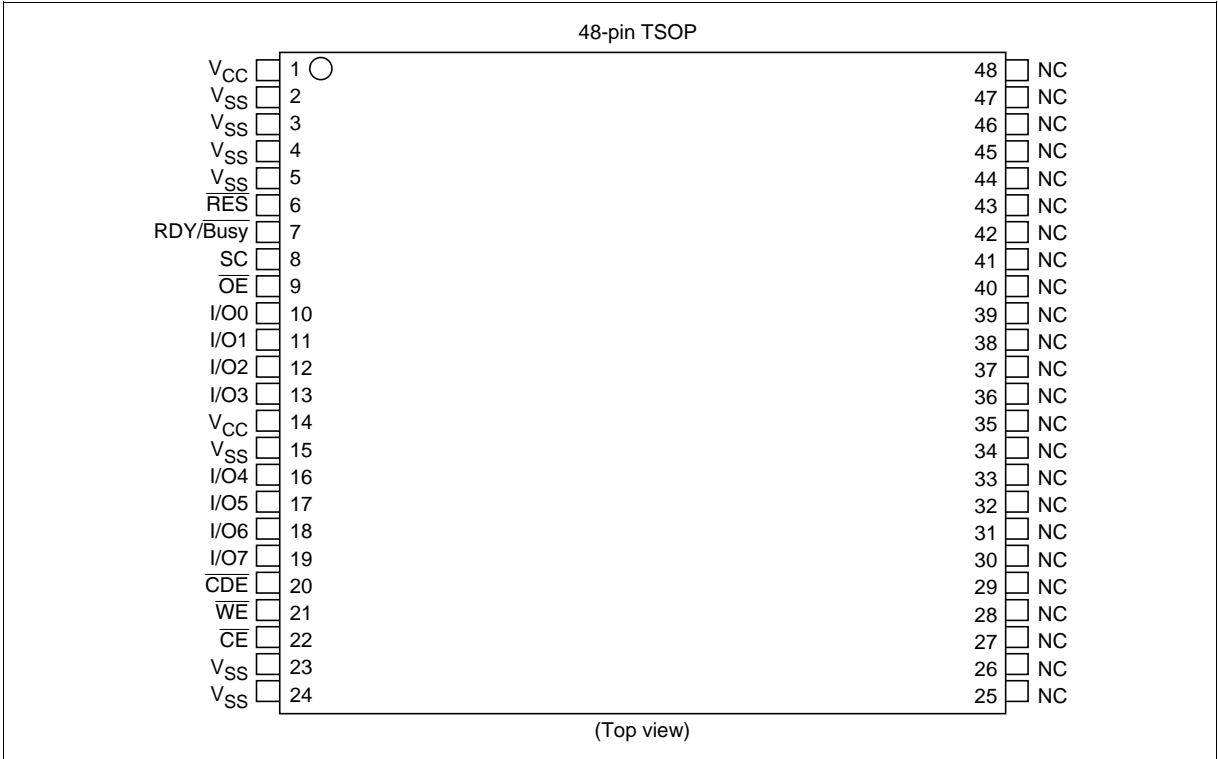
- Erase mode
  - Single sector erase ((2048 + 64) byte unit)
- Fast serial read access time:
  - First access time: 50  $\mu$ s (max)
  - Serial access time: 60 ns (max)
- Low power dissipation:
  - $I_{CC2}$  = 40 mA (max) (Read)
  - $I_{SB2}$  = 50  $\mu$ A (max) (Standby)
  - $I_{CC3}/I_{CC4}$  = 40 mA (max) (Erase/Program)
  - $I_{SB3}$  = 5  $\mu$ A (max) (Deep standby)
- The following architecture is required for data reliability.
  - Error correction: more than 1-bit error correction per each sector read
  - Spare sectors: 1.8% (145 sectors) within usable sectors

## Ordering Information

Type No.	Available sector	Package
HN29W12811T-60	More than 8,029 sectors	12.0 $\times$ 18.40 mm <sup>2</sup> 0.5 mm pitch 48-pin plastic TSOP I (TFP-48DA)

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Pin Arrangement

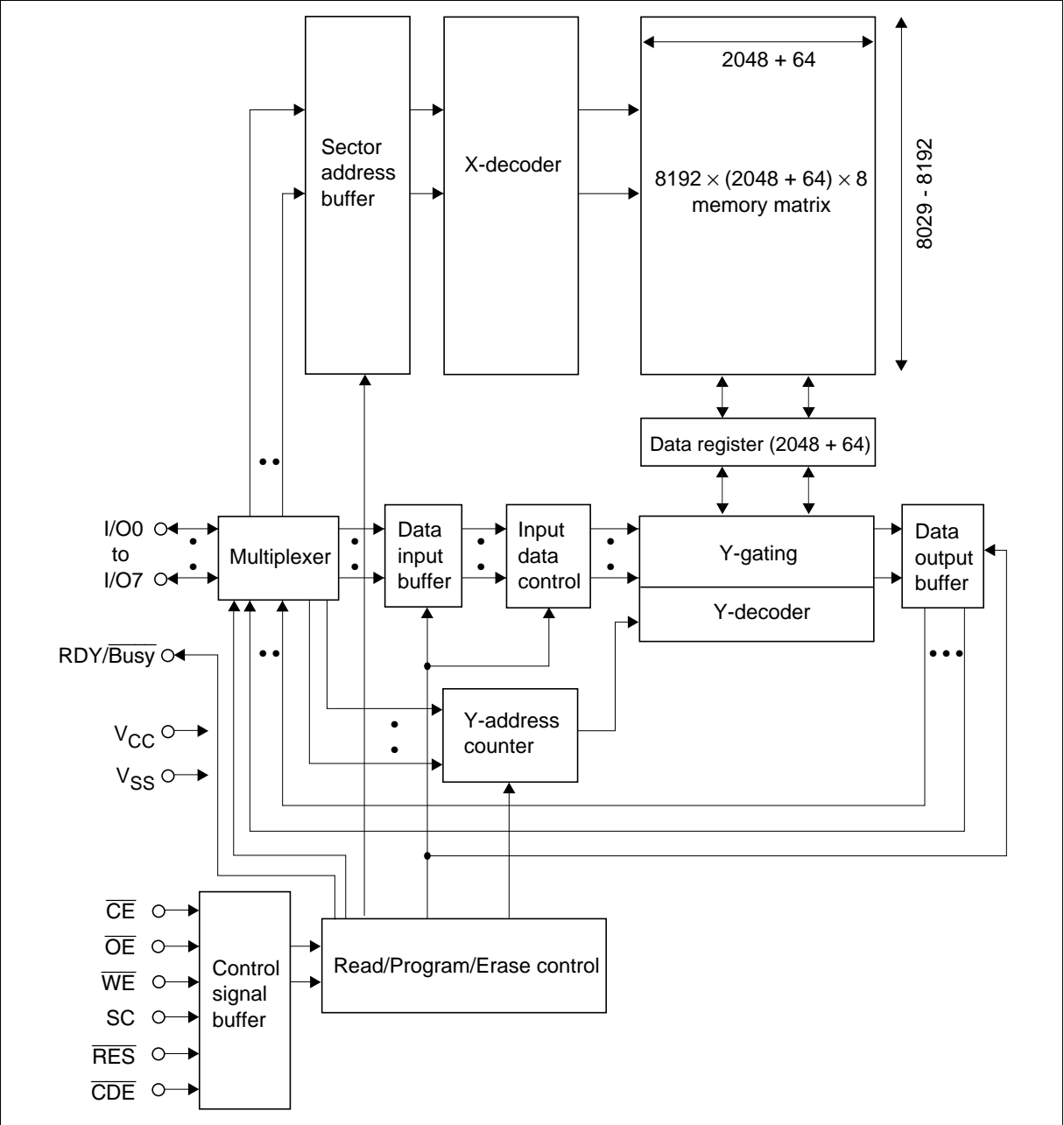


Pin Description

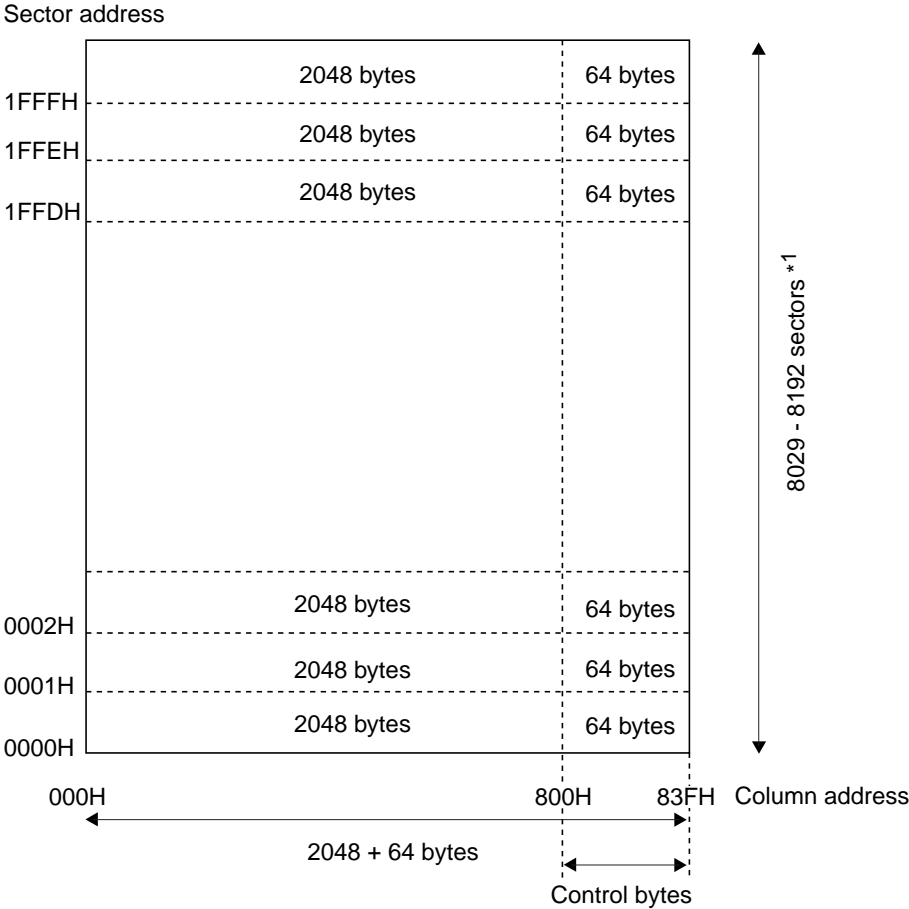
Pin name	Function
I/O0 to I/O7	Input/output
CE	Chip enable
OE	Output enable
WE	Write enable
CDE	Command data enable
V <sub>CC</sub> <sup>*1</sup>	Power supply
V <sub>SS</sub> <sup>*1</sup>	Ground
RDY/Busy	Ready/Busy
RES	Reset
SC	Serial clock

Note: 1. All V<sub>CC</sub> and V<sub>SS</sub> pins should be connected to a common power supply and a ground, respectively.

Block Diagram



Memory Map and Address



Address	Cycles	I/O0	I/O1	I/O2	I/O3	I/O4	I/O5	I/O6	I/O7
Sector address	SA (1): First cycle	A0	A1	A2	A3	A4	A5	A6	A7
	SA (2): Second cycle	A8	A9	A10	A11	A12	x*2	x	x
Column address	CA (1): First cycle	A0	A1	A2	A3	A4	A5	A6	A7
	CA (2): Second cycle	A8	A9	A10	A11	x	x	x	x

- Notes: 1. Some failed sectors may exist in the device. The failed sectors can be recognized by reading the sector valid data written in a part of the column address 800 to 83F (The specific address is TBD.). The sector valid data must be read and kept outside of the sector before the sector erase. When the sector is programmed, the sector valid data should be written back to the sector.
2. An x means "Don't care". The pin level can be set to either  $V_{IL}$  or  $V_{IH}$ , referred to DC characteristics.

## Pin Function

**$\overline{\text{CE}}$ :**  $\overline{\text{CE}}$  is used to select the device. The status returns to the standby at the rising edge of  $\overline{\text{CE}}$  in the reading operation. However, the status does not return to the standby at the rising edge of  $\overline{\text{CE}}$  in the busy state in programming and erase operation.

**$\overline{\text{OE}}$ :** Memory data and status register data can be read, when  $\overline{\text{OE}}$  is  $V_{\text{IL}}$ .

**$\overline{\text{WE}}$ :** Commands and address are latched at the rising edge of  $\overline{\text{WE}}$ .

**SC:** Programming and reading data is latched at the rising edge of SC.

**$\overline{\text{RES}}$ :**  $\overline{\text{RES}}$  pin must be kept at the  $V_{\text{ILR}}$  ( $V_{\text{SS}} \pm 0.2 \text{ V}$ ) level when  $V_{\text{CC}}$  is turned on and off. In this way, data in the memory is protected against unintentional erase and programming.  $\overline{\text{RES}}$  must be kept at the  $V_{\text{IHR}}$  ( $V_{\text{CC}} \pm 0.2 \text{ V}$ ) level during any operations such as programming, erase and read.

**$\overline{\text{CDE}}$ :** Commands and data are latched when  $\overline{\text{CDE}}$  is  $V_{\text{IL}}$  and address is latched when  $\overline{\text{CDE}}$  is  $V_{\text{IH}}$ .

**RDY/ $\overline{\text{Busy}}$ :** The RDY/ $\overline{\text{Busy}}$  indicates the program/erase status of the flash memory. The RDY/ $\overline{\text{Busy}}$  signal is initially at a high impedance state. It turns to a  $V_{\text{OL}}$  level after the (40H) command in programming operation or the (B0H) command in erase operation. After the erase or programming operation finishes, the RDY/ $\overline{\text{Busy}}$  signal turns back to the high impedance state.

**I/O0 to I/O7:** The I/O pins are used to input data, address and command, and are used to output memory data and status register data.

## Mode Selection

Mode	$\overline{\text{CE}}$	$\overline{\text{OE}}$	$\overline{\text{WE}}$	SC	$\overline{\text{RES}}$	$\overline{\text{CDE}}$	RDY/ $\overline{\text{Busy}}$ * <sup>3</sup>	I/O0 to I/O7
Deep standby	$\times$ * <sup>4</sup>	$\times$	$\times$	$\times$	$V_{\text{ILR}}$	$\times$	$V_{\text{OH}}$	High-Z
Standby	$V_{\text{IH}}$	$\times$	$\times$	$\times$	$V_{\text{IHR}}$	$\times$	$V_{\text{OH}}$	High-Z
Output disable	$V_{\text{IL}}$	$V_{\text{IH}}$	$V_{\text{IH}}$	$\times$	$V_{\text{IHR}}$	$\times$	$V_{\text{OH}}$	High-Z
Status register read* <sup>1</sup>	$V_{\text{IL}}$	$V_{\text{IL}}$	$V_{\text{IH}}$	$\times$	$V_{\text{IHR}}$	$\times$	$V_{\text{OH}}$	Status register outputs
Command write* <sup>2</sup>	$V_{\text{IL}}$	$V_{\text{IH}}$	$V_{\text{IL}}$	$V_{\text{IL}}$	$V_{\text{IHR}}$	$V_{\text{IL}}$	$V_{\text{OH}}$	Din

- Notes: 1. Default mode after the power on is the status register read mode (refer to status transition). From I/O0 to I/O7 pins output the status, when  $\overline{\text{CE}} = V_{\text{IL}}$  and  $\overline{\text{OE}} = V_{\text{IL}}$  (conventional read operation condition).
2. Refer to the command definition. Data can be read, programmed and erased after commands are written in this mode.
3. The RDY/ $\overline{\text{Busy}}$  bus should be pulled up to  $V_{\text{CC}}$  to maintain the  $V_{\text{OH}}$  level while the RDY/ $\overline{\text{Busy}}$  pin outputs a high impedance.
4. An  $\times$  means "Don't care". The pin level can be set to either  $V_{\text{IL}}$  or  $V_{\text{IH}}$  referred to DC characteristics.

# Command Definition\*1, 2

Command		Bus cycles	First bus cycle		Second bus cycle		
			Operation mode*3	Data in	Operation mode	Data in	Data out
Read	Serial read (1)	(Without CA)	3	Write	00H	Write	SA (1)*4
		(With CA)	3 + 2h*6	Write	00H	Write	SA (1)*4
	Serial read (2)		3	Write	F0H	Write	SA (1)*4
	Read identifier codes		1	Write	90H	Read	ID*8, 9
	Data recovery read		1	Write	01H	Read	Recovery data
Auto erase	Single sector		4	Write	20H	Write	SA (1)*4
Auto program	Program (1)	(Without CA*7)	4	Write	10H	Write	SA (1)*4
		(With CA*7)	4 + 2h*6	Write	10H	Write	SA (1)*4
	Program (2)*10		4	Write	1FH	Write	SA (1)*4
	Program (3) (Control bytes)*7		4	Write	0FH	Write	SA (1)*4
	Program (4)	(Without CA*7)	4	Write	11H	Write	SA (1)*4
		(With CA*7)	4 + 2h*6	Write	11H	Write	SA (1)*4
Reset			1	Write	FFH		
Clear status register		1	Write	50H			
Data recovery write		4	Write	12H	Write	SA (1)*4	

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Command			Bus cycles	Third bus cycle		Fourth bus cycle	
				Operation mode	Data in	Operation mode	Data in
Read	Serial read (1) (Without CA)	3	Write	SA (2) <sup>*4</sup>			
		(With CA)	3 + 2h <sup>*6</sup>	Write	SA (2) <sup>*4</sup>	Write	CA (1) <sup>*5</sup>
	Serial read (2)	3	Write	SA (2) <sup>*4</sup>			
	Read identifier codes	1					
	Data recovery read	1					
Auto erase	Single sector	4	Write	SA (2) <sup>*4</sup>	Write	B0H <sup>*11</sup>	
Auto program	Program (1)	(Without CA <sup>*7</sup> )	4	Write	SA (2) <sup>*4</sup>	Write	40H <sup>*11, 12</sup>
		(With CA <sup>*7</sup> )	4 + 2h <sup>*6</sup>	Write	SA (2) <sup>*4</sup>	Write	CA (1)
	Program (2) <sup>*10</sup>	4	Write	SA (2) <sup>*4</sup>	Write	40H <sup>*11, 12</sup>	
	Program (3) (Control bytes) <sup>*7</sup>	4	Write	SA (2) <sup>*4</sup>	Write	40H <sup>*11, 12</sup>	
	Program (4)	(WithoutCA <sup>*7</sup> )	4	Write	SA (2) <sup>*4</sup>	Write	40H <sup>*11, 12</sup>
		(With CA <sup>*7</sup> )	4 + 2h <sup>*6</sup>	Write	SA (2) <sup>*4</sup>	Write	CA (1)
Reset		1					
Clear status register		1					
Data recovery write		4	Write	SA (2) <sup>*4</sup>	Write	40H <sup>*11, 12</sup>	



Command		Bus cycles	Fifth bus cycle		Sixth bus cycle	
			Operation mode	Data in	Operation mode	Data in
Read	Serial read (1) (Without CA)	3				
	(With CA)	3 + 2h* <sup>6</sup>	Write	CA (2)* <sup>5</sup>		
	Serial read (2)	3				
	Read identifier codes	1				
	Data recovery read	1				
Auto erase	Single sector	4				
Auto program	Program (1) (Without CA* <sup>7</sup> )	4				
	(With CA* <sup>7</sup> )	4 + 2h* <sup>6</sup>	Write	CA (2)* <sup>5</sup>	Write	40H* <sup>11, 12</sup>
	Program (2)* <sup>10</sup>	4				
	Program (3) (Control bytes)* <sup>7</sup>	4				
	Program (4) (Without CA* <sup>7</sup> )	4				
	(With CA* <sup>7</sup> )	4 + 2h* <sup>6</sup>	Write	CA (2)	Write	40H* <sup>11, 12</sup>
Reset		1				
Clear status register		1				
Data recovery write		4				

- Notes: 1. Commands and sector address are latched at rising edge of  $\overline{WE}$  pulses. Program data is latched at rising edge of SC pulses.
2. The chip is in the read status register mode when  $\overline{RES}$  is set to  $V_{IHR}$  first time after the power up.
3. Refer to the command read and write mode in mode selection.
4. SA (1) = Sector address (A0 to A7), SA (2) = Sector address (A8 to A12).
5. CA (1) = Column address (A0 to A7), CA (2) = Column address (A8 to A11).  
(0 A11 to A0 83FH)
6. The variable h is the input number of times of set of CA (1) and CA (2) (1 h 2048 + 64).  
Set of CA (1) and CA (2) can be input without limitation.
7. By using program (1) and (3), data can additionally be programmed maximum 15 times for each sector before erase.
8. ID = Identifier code; Manufacturer code (07H), Device code (95H).
9. The manufacturer identifier code is output when  $\overline{CDE}$  is low and the device identifier code is output when  $\overline{CDE}$  is high.
10. Before program (2) operations, data in the programmed sector must be erased.
11. No commands can be written during auto program and erase (when the RDY/ $\overline{Busy}$  pin outputs a  $V_{OL}$ ).
12. The fourth or sixth cycle of the auto program comes after the program data input is complete.

### Mode Description

#### Read

**Serial Read (1):** Memory data D0 to D2111 in the sector of address SA is sequentially read. Output data is not valid after the number of the SC pulse exceeds 2112. When CA is input, memory data D (m) to D (m + j) in the sector of address SA is sequentially read. Then output data is not valid after the number of the SC pulse exceeds (2112 to m). The mode turns back to the standby mode at any time when  $\overline{CE}$  is  $V_{IH}$ .

**Serial Read (2):** Memory data D2048 to D2111 in the sector of address SA is sequentially read. Output data is not valid after the number of the SC pulse exceeds 64. The mode turns back to the standby mode at any time when  $\overline{CE}$  is  $V_{IH}$ .

#### Automatic Erase

**Single Sector Erase:** Memory data D0 to D2111 in the sector of address SA is erased automatically by internal control circuits. After the sector erase starts, the erasure completion can be checked through the  $RDY/\overline{Busy}$  signal and status data polling. All the bits in the sector are "1" after the erase. The sector valid data stored in a part of memory data D2048 to D2111 must be read and kept outside of the sector before the sector erase.

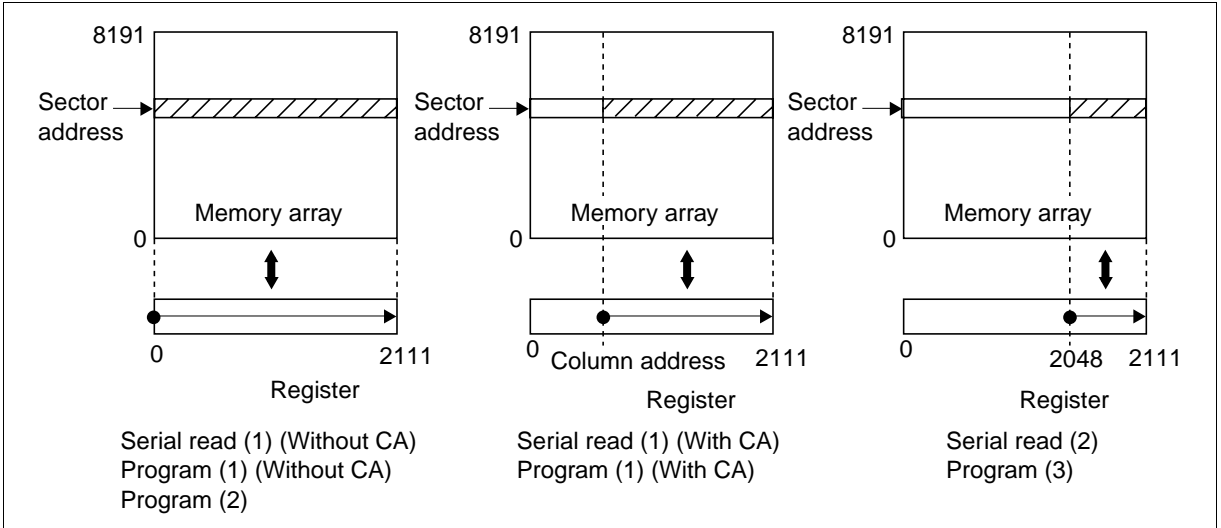
#### Automatic Program

**Program (1):** Program data PD0 to PD2111 is programmed into the sector of address SA automatically by internal control circuits. When CA is input, program data PD (m) to PD (m + j) is programmed from CA into the sector of address SA automatically by internal control circuits. By using program (1), data can additionally be programmed for each sector before the following erase. When the column is programmed, the data of the column must be [FF]. After the programming starts, the program completion can be checked through the  $RDY/\overline{Busy}$  signal and status data polling. Programmed bits in the sector turn from "1" to "0" when they are programmed. The sector valid data should be included in the program data PD2048 to PD2111.

**Program (2):** Program data PD0 to PD2111 is programmed into the sector of address SA automatically by internal control circuits. After the programming starts, the program completion can be checked through the  $RDY/\overline{Busy}$  signal and status data polling. Programmed bits in the sector turn from "1" to "0" when they are programmed. The sector must be erased before programming. The sector valid data should be included in the program data PD2048 to PD2111.

**Program (3):** Program data PD2048 to PD2111 is programmed into the sector of address SA automatically by internal control circuits. By using program (3), data can additionally be programmed for each sector before the following erase. When the column is programmed, the data of the column must be [FF]. After the programming starts, the program completion can be checked through the  $RDY/\overline{Busy}$  signal and status data polling. Programmed bits in the sector turn from "1" to "0" when they are programmed.

**Program (4):** Program data PD0 to PD2111 is programmed into the sector of address SA automatically by internal control circuits. When CA is input, program data PD (m) to PD (m + j) is programmed from CA into the sector of address SA automatically by internal control circuits. By using program (4), data can be rewritten for each sector before the following erase. So the column data before programming operation are either "1" or "0". In this mode, E/W number of times must be counted whenever program (4) execute. After the programming starts, the program completion can be checked through the RDY/Busy signal and status data polling. The sector valid data should be included in the program data PD2048 to PD2111.



### Status Register Read

The status returns to the status register read mode from standby mode, when  $\overline{CE}$  and  $\overline{OE}$  is  $V_{IL}$ . In the status register read mode, I/O pins output the same operation status as in the status data polling defined in the function description.

### Identifier Read

The manufacturer and device identifier code can be read in the identifier read mode. The manufacturer and device identifier code is selected with  $\overline{CDE} V_{IL}$  and  $V_{IH}$ , respectively.

### Data Recovery Read

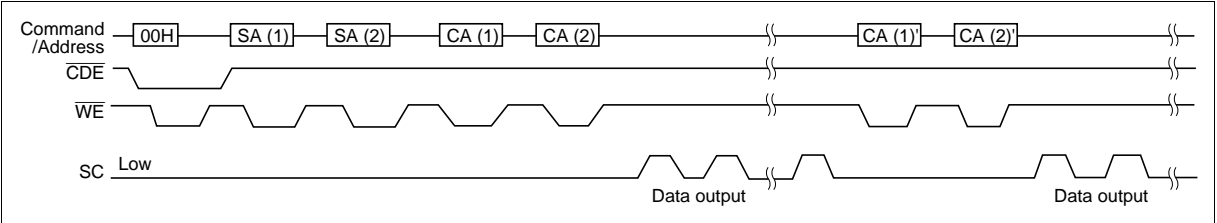
When the programming was an error, the program data can be read by using data recovery read. When an additional programming was an error, the data compounded of the program data and the origin data in the sector address SA can be read. Output data are not valid after the number of SA pulse exceeds 2112. The mode turns back to the standby mode at any time when  $\overline{CE}$  is  $V_{IH}$ . The read data are invalid when addresses are latched at a rising edge of  $\overline{WE}$  pulse after the data recovery read command is written.

### Data Recovery Write

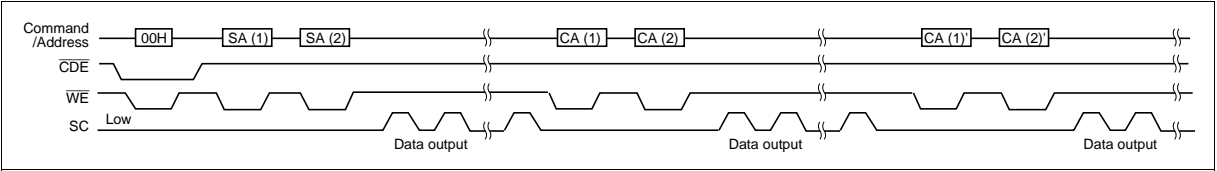
When the programming into a sector of address SA was an error, the program data can be rewritten automatically by internal control circuit into the other selected sector of address SA'. In this case, top address [SA12] of sector of address SA' must be the same as SA. Since the data recovery write mode is internally Program (4) mode, rewritten sector of address SA' needs no sector erase before rewrite. After the data recovery write mode starts, the program completion can be checked through the RDY/ $\overline{Busy}$  signal and the status data polling.

Command/Address/Data Input Sequence

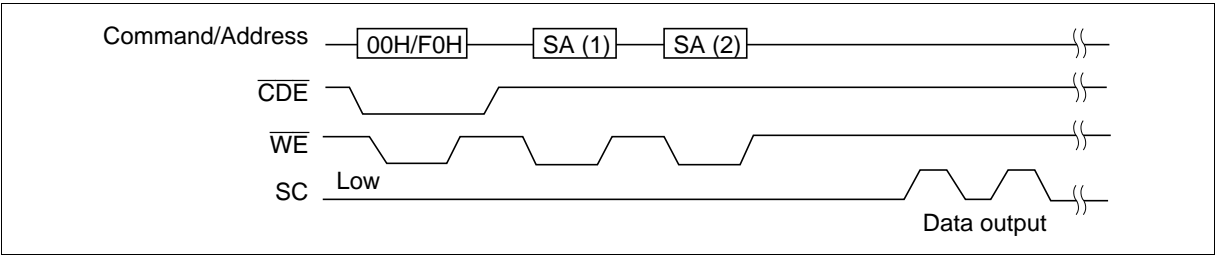
Serial Read (1) (With CA before SC)



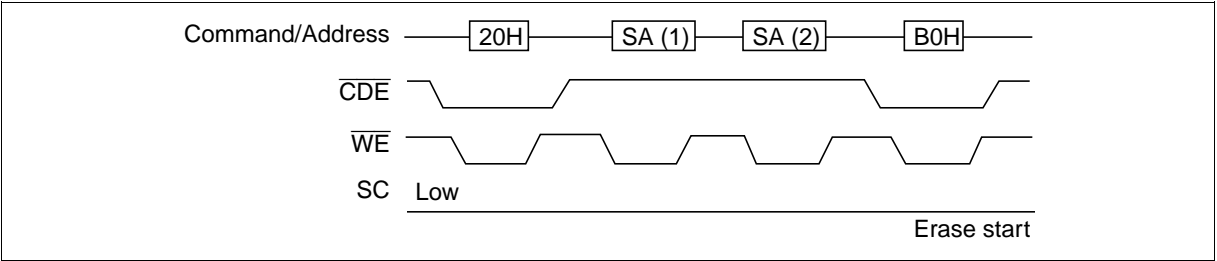
Serial Read (1) (With CA after SC)



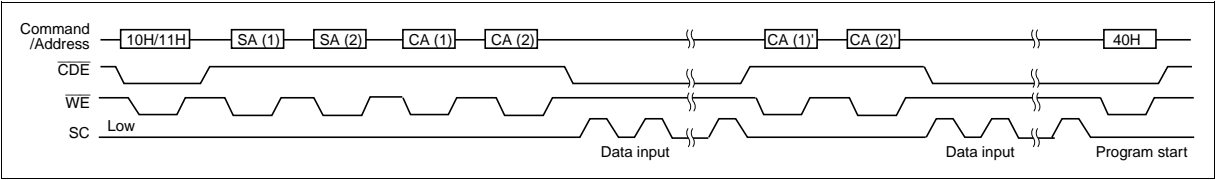
Serial Read (1) (Without CA), (2)



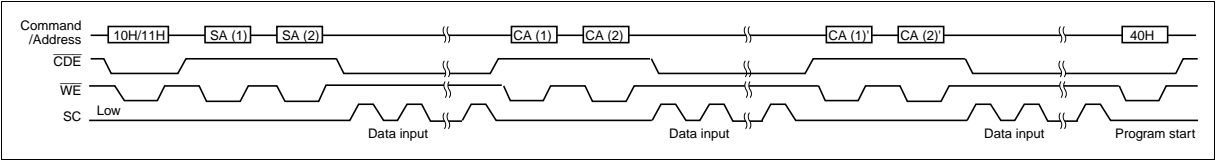
Single Sector Erase



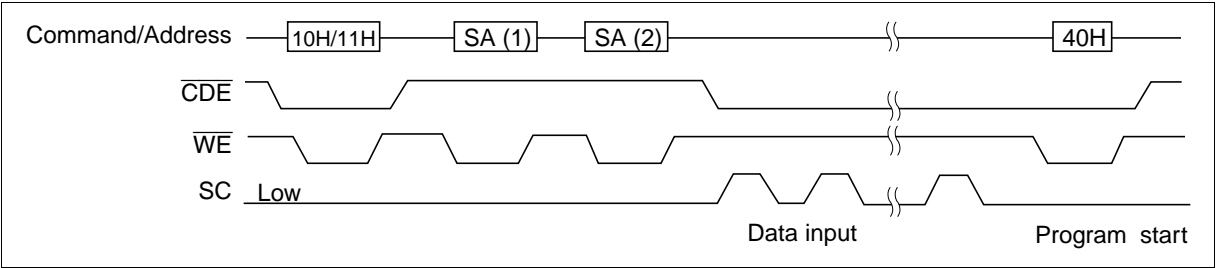
Program (1), (4) (With CA before SC)



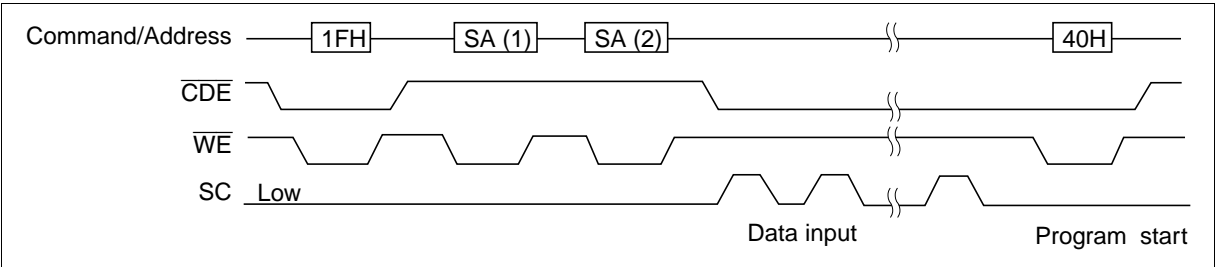
Program (1), (4) (With CA after SC)



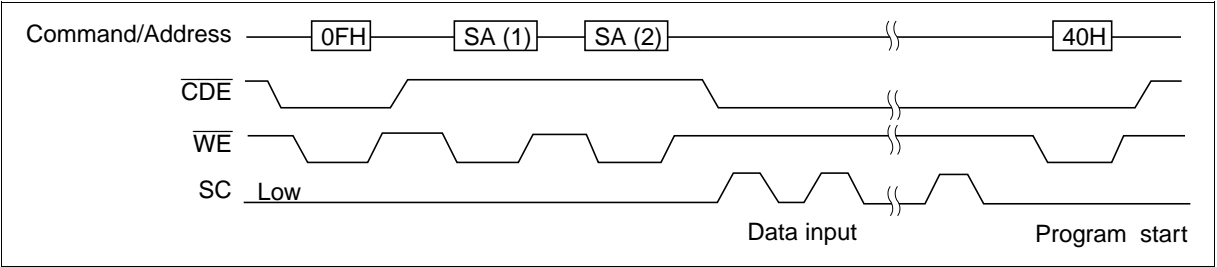
Program (1), (4) (Without CA)



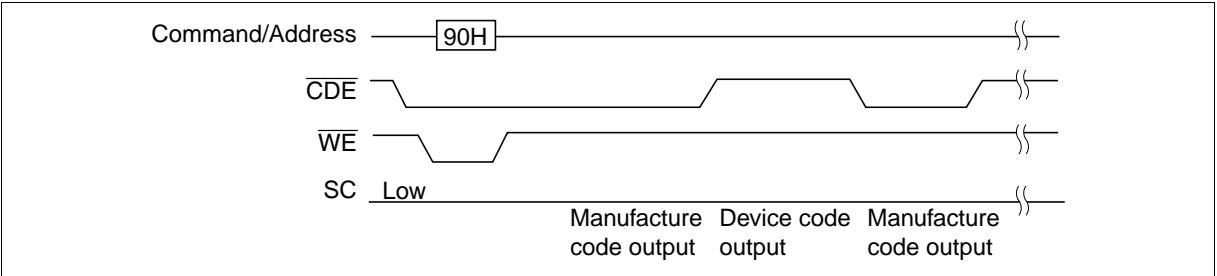
Program (2)



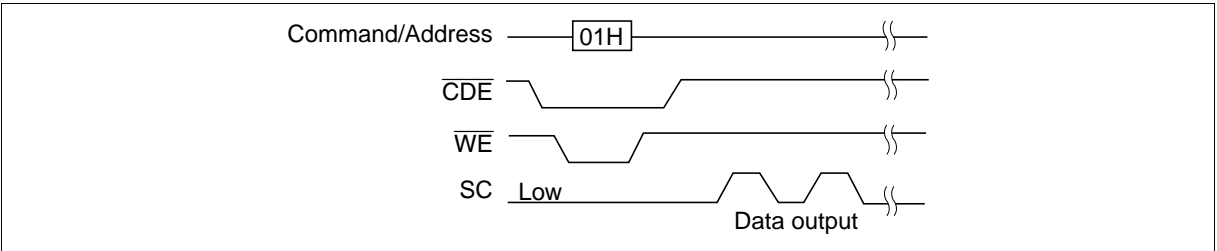
Program (3)



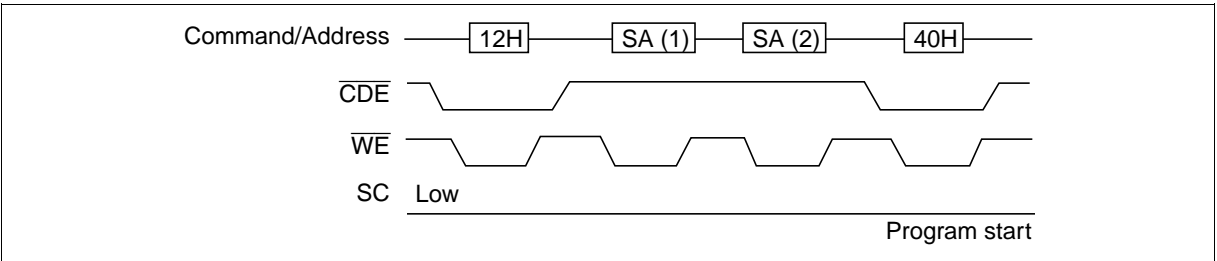
ID Read Mode



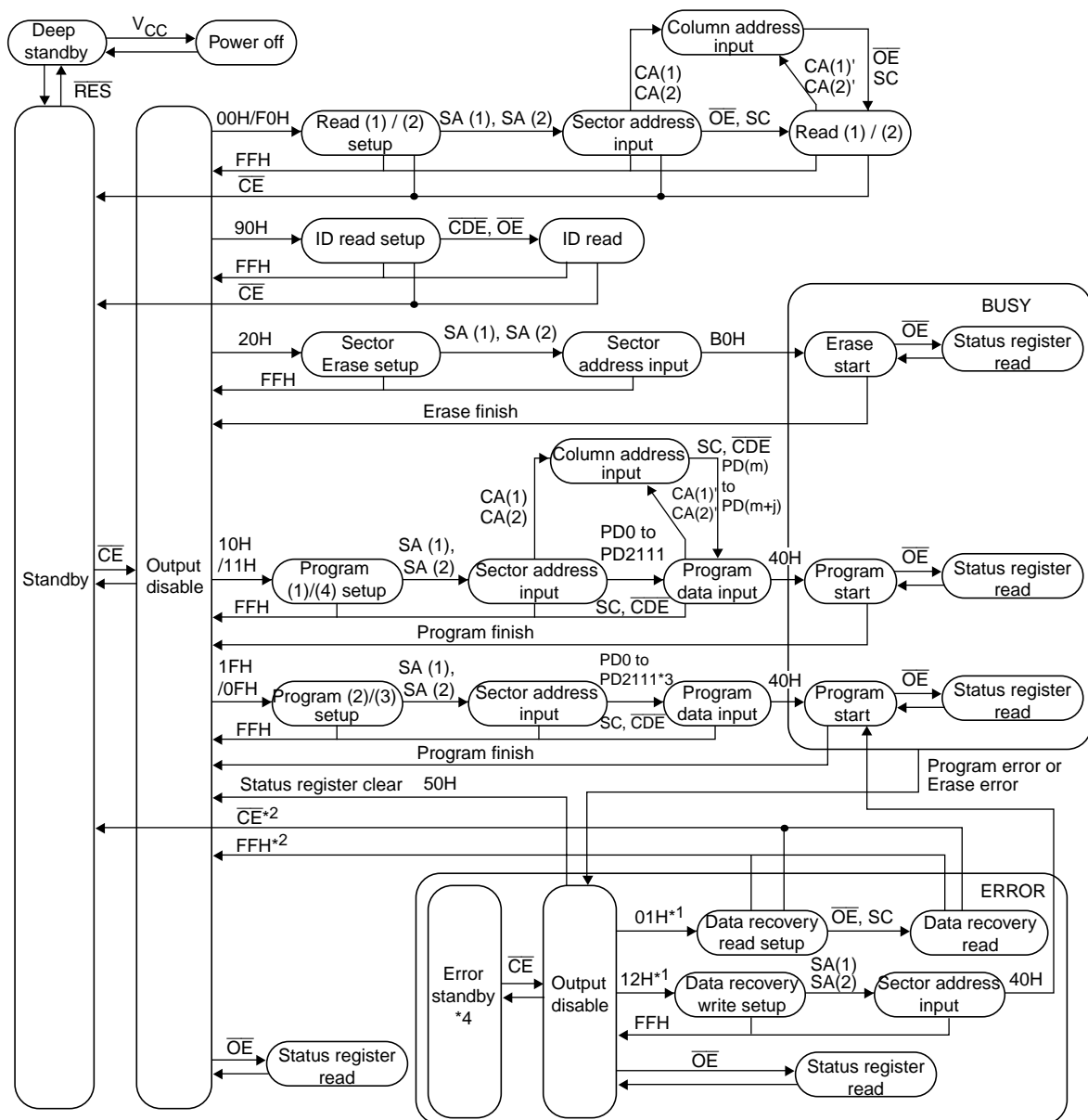
Data Recovery Read Mode



Data Recovery Write Mode



## Status Transition



- Notes:
1. (01H)/(12H) Data recovery read/write can be used only for Program (1), (2), (3), (4) errors.
  2. When reset is done by  $\overline{CE}$  or FFH, error status flag is cleared.
  3. When Program (3) mode, input data is PD2048 to PD2111.
  4. When Error standby,  $I_{CC3}$  level is current.



## Absolute Maximum Ratings

Parameter	Symbol	Value	Unit	Notes
$V_{CC}$ voltage	$V_{CC}$	−0.6 to +4.6	V	1
$V_{SS}$ voltage	$V_{SS}$	0	V	
All input and output voltages	$V_{in}$ , $V_{out}$	−0.6 to $V_{CC} + 0.3$	V	1, 2
Operating temperature range	$T_{opr}$	0 to +70	°C	
Storage temperature range	$T_{stg}$	−65 to +125	°C	3
Storage temperature under bias	$T_{bias}$	−10 to +80	°C	

Notes: 1. Relative to  $V_{SS}$ .

2.  $V_{in}$ ,  $V_{out}$  = −2.0 V for pulse width 20 ns.

3. Device storage temperature range before programming.

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

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

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### DC Characteristics ( $V_{CC} = 3.3 \text{ V} \pm 0.3 \text{ V}$ , $T_a = 0 \text{ to } +70^\circ\text{C}$ )

Parameter	Symbol	Min	Typ	Max	Unit	Test conditions
Input leakage current	$I_{LI}$	—	—	2	$\mu\text{A}$	$V_{in} = V_{SS} \text{ to } V_{CC}$
Output leakage current	$I_{LO}$	—	—	2	$\mu\text{A}$	$V_{out} = V_{SS} \text{ to } V_{CC}$
Standby $V_{CC}$ current	$I_{SB1}$	—	0.3	1	$\text{mA}$	$\overline{CE} = V_{IH}$
	$I_{SB2}$	—	30	50	$\mu\text{A}$	$\overline{CE} = V_{CC} \pm 0.2 \text{ V}$ , $\overline{RES} = V_{CC} \pm 0.2 \text{ V}$
Deep standby $V_{CC}$ current	$I_{SB3}$	—	1	5	$\mu\text{A}$	$\overline{RES} = V_{SS} \pm 0.2 \text{ V}$
Operating $V_{CC}$ current	$I_{CC1}$	—	5	20	$\text{mA}$	$I_{out} = 0 \text{ mA}$ , $f = 0.2 \text{ MHz}$
	$I_{CC2}$	—	20	40	$\text{mA}$	$I_{out} = 0 \text{ mA}$ , $f = 20 \text{ MHz}$
Operating $V_{CC}$ current (Program)	$I_{CC3}$	—	20	40	$\text{mA}$	In programming
Operating $V_{CC}$ current (Erase)	$I_{CC4}$	—	20	40	$\text{mA}$	In erase
Input voltage	$V_{IL}$	$-0.3^{*1, 2}$	—	0.8	$\text{V}$	
	$V_{IH}$	2.0	—	$V_{CC} + 0.3^{*3}$	$\text{V}$	
Input voltage ( $\overline{RES}$ pin)	$V_{ILR}$	-0.2	—	0.2	$\text{V}$	
	$V_{IHR}$	$V_{CC} - 0.2$	—	$V_{CC} + 0.2$	$\text{V}$	
Output voltage	$V_{OL}$	—	—	0.4	$\text{V}$	$I_{OL} = 2 \text{ mA}$
	$V_{OH}$	2.4	—	—	$\text{V}$	$I_{OH} = -2 \text{ mA}$

Notes: 1.  $V_{IL}$  min =  $-1.0 \text{ V}$  for pulse width 50 ns in the read operation.  $V_{IL}$  min =  $-2.0 \text{ V}$  for pulse width 20 ns in the read operation.

2.  $V_{IL}$  min =  $-0.6 \text{ V}$  for pulse width 20 ns in the erase/data programming operation.

3.  $V_{IH}$  max =  $V_{CC} + 1.5 \text{ V}$  for pulse width 20 ns. If  $V_{IH}$  is over the specified maximum value, the operations are not guaranteed.

### AC Characteristics ( $V_{CC} = 3.3 \text{ V} \pm 0.3 \text{ V}$ , $T_a = 0 \text{ to } +70^\circ\text{C}$ )

#### Test Conditions

- Input pulse levels: 0.4 V/2.4 V
- Input pulse levels for  $\overline{RES}$ : 0.2 V/ $V_{CC} - 0.2 \text{ V}$
- Input rise and fall time: 5 ns
- Output load: 1 TTL gate + 100 pF (Including scope and jig.)
- Reference levels for measuring timing: 0.8 V, 1.8 V

**Power on and off, Serial Read Mode**

		HN29W12811					
		-60					
Parameter	Symbol	Min	Typ	Max	Unit	Test conditions	Notes
Write cycle time	t <sub>CWC</sub>	120	—	—	ns		
Serial clock cycle time	t <sub>SCC</sub>	60	—	—	ns		
$\overline{CE}$ setup time	t <sub>CES</sub>	0	—	—	ns		
$\overline{CE}$ hold time	t <sub>CEH</sub>	0	—	—	ns		
Write pulse time	t <sub>WP</sub>	60	—	—	ns	$\overline{CE} = V_{IL}, \overline{OE} = V_{IH}$	
Write pulse high time	t <sub>WPH</sub>	40	—	—	ns		
Address setup time	t <sub>AS</sub>	50	—	—	ns		
Address hold time	t <sub>AH</sub>	10	—	—	ns		
Data setup time	t <sub>DS</sub>	50	—	—	ns		
Data hold time	t <sub>DH</sub>	10	—	—	ns		
SC to output delay	t <sub>SAC</sub>	—	—	60	ns	$\overline{CE} = \overline{OE} = V_{IL}, \overline{WE} = V_{IH}$	
$\overline{OE}$ setup time for SC	t <sub>OES</sub>	0	—	—	ns		
$\overline{OE}$ low to output low-Z	t <sub>OEL</sub>	0	—	40	ns		
$\overline{OE}$ setup time before read	t <sub>OER</sub>	250	—	—	ns		
$\overline{OE}$ setup time before command write	t <sub>OEWS</sub>	0	—	—	ns		
SC to output hold	t <sub>SH</sub>	15	—	—	ns	$\overline{CE} = \overline{OE} = V_{IL}, \overline{WE} = V_{IH}$	
$\overline{OE}$ high to output float	t <sub>DF</sub>	—	—	40	ns	$\overline{CE} = V_{IL}, \overline{WE} = V_{IH}$	1
$\overline{WE}$ to SC delay time	t <sub>WSD</sub>	50	—	—	μs		2
$\overline{RES}$ to $\overline{CE}$ setup time	t <sub>RP</sub>	1	—	—	ms		
SC to $\overline{OE}$ hold time	t <sub>SOH</sub>	50	—	—	ns		
SC pulse width	t <sub>SP</sub>	25	—	—	ns		
SC pulse low time	t <sub>SPL</sub>	25	—	—	ns		
SC setup time for $\overline{CE}$	t <sub>SCS</sub>	0	—	—	ns		
$\overline{CDE}$ setup time for $\overline{WE}$	t <sub>CDS</sub>	0	—	—	ns		
$\overline{CDE}$ hold time for $\overline{WE}$	t <sub>CDH</sub>	20	—	—	ns		
V <sub>CC</sub> setup time for $\overline{RES}$	t <sub>VRS</sub>	1	—	—	μs	$\overline{CE} = V_{IH}$	
$\overline{RES}$ to V <sub>CC</sub> hold time	t <sub>VRH</sub>	1	—	—	μs	$\overline{CE} = V_{IH}$	
$\overline{CE}$ setup time for $\overline{RES}$	t <sub>CESR</sub>	1	—	—	μs		
RDY/Busy undefined for V <sub>CC</sub> off	t <sub>DFP</sub>	0	—	—	ns		

# HN29W12811 Series

		HN29W12811				Test conditions	Notes
		-60					
Parameter	Symbol	Min	Typ	Max	Unit		
$\overline{\text{RES}}$ high to device ready	$t_{\text{BSY}}$	—	—	1	ms		
$\overline{\text{CE}}$ pulse high time	$t_{\text{CPH}}$	200	—	—	ns		
$\overline{\text{CE}}$ , $\overline{\text{WE}}$ setup time for RES	$t_{\text{CWRS}}$	0	—	—	ns		
RES to $\overline{\text{CE}}$ , $\overline{\text{WE}}$ hold time	$t_{\text{CWRH}}$	0	—	—	ns		
SC setup for $\overline{\text{WE}}$	$t_{\text{SW}}$	50	—	—	ns		
$\overline{\text{CE}}$ hold time for $\overline{\text{OE}}$	$t_{\text{COH}}$	0	—	—	ns		
SA (2) to CA (2) delay time	$t_{\text{SCD}}$	—	—	30	$\mu\text{s}$		
RDY/Busy setup for SC	$t_{\text{RS}}$	200	—	—	ns		
Time to device busy on read mode	$t_{\text{DBR}}$	—	—	1	$\mu\text{s}$		
Busy time on reset mode	$t_{\text{RBSY}}$	—	45	—	$\mu\text{s}$		

Notes: 1. t<sub>DF</sub> is a time after which the I/O pins become open.  
2. t<sub>WSD</sub> (min) is specified as a reference point only for SC, if t<sub>WSD</sub> is greater than the specified t<sub>WSD</sub> (min) limit, then access time is controlled exclusively by t<sub>SAC</sub>.

**Program, Erase and Erase Verify**

		HN29W12811					
		-60					
Parameter	Symbol	Min	Typ	Max	Unit	Test conditions	Note
Write cycle time	t <sub>CWC</sub>	120	—	—	ns		
Serial clock cycle time	t <sub>SCC</sub>	60	—	—	ns		
$\overline{CE}$ setup time	t <sub>CES</sub>	0	—	—	ns		
$\overline{CE}$ hold time	t <sub>CEH</sub>	0	—	—	ns		
Write pulse time	t <sub>WP</sub>	60	—	—	ns		
Write pulse high time	t <sub>WPH</sub>	40	—	—	ns		
Address setup time	t <sub>AS</sub>	50	—	—	ns		
Address hold time	t <sub>AH</sub>	10	—	—	ns		
Data setup time	t <sub>DS</sub>	50	—	—	ns		
Data hold time	t <sub>DH</sub>	10	—	—	ns		
$\overline{OE}$ setup time before command write	t <sub>OEWS</sub>	0	—	—	ns		
$\overline{OE}$ setup time before status polling	t <sub>OEPS</sub>	40	—	—	ns		
$\overline{OE}$ setup time before read	t <sub>OER</sub>	250	—	—	ns		
Time to device busy	t <sub>DB</sub>	—	—	150	ns		
Time to device busy on read mode	t <sub>DBR</sub>	—	—	1	μs		
Auto erase time	t <sub>ASE</sub>	—	1.0	14.0	ms		
Auto program time Program(1), (3)	t <sub>ASP</sub>	—	2.5	22.0	ms		
Program(2)	t <sub>ASP</sub>	—	2.0	22.0	ms		
Program(4), Data recovery write	t <sub>ASP</sub>	—	2.5	30.0	ms		
$\overline{WE}$ to SC delay time	t <sub>WSD</sub>	50	—	—	μs		
$\overline{WE}$ to SC delay time on recovery read mode	t <sub>WSDR</sub>	2	—	—	μs		
$\overline{CE}$ pulse high time	t <sub>CPH</sub>	200	—	—	ns		
SC pulse width	t <sub>SP</sub>	25	—	—	ns		
SC pulse low time	t <sub>SPL</sub>	25	—	—	ns		
Data setup time for SC	t <sub>SDS</sub>	0	—	—	ns		
Data hold time for SC	t <sub>SDH</sub>	35	—	—	ns	$\overline{CDE} = V_{IL}$	
SC setup for $\overline{WE}$	t <sub>SW</sub>	50	—	—	ns		

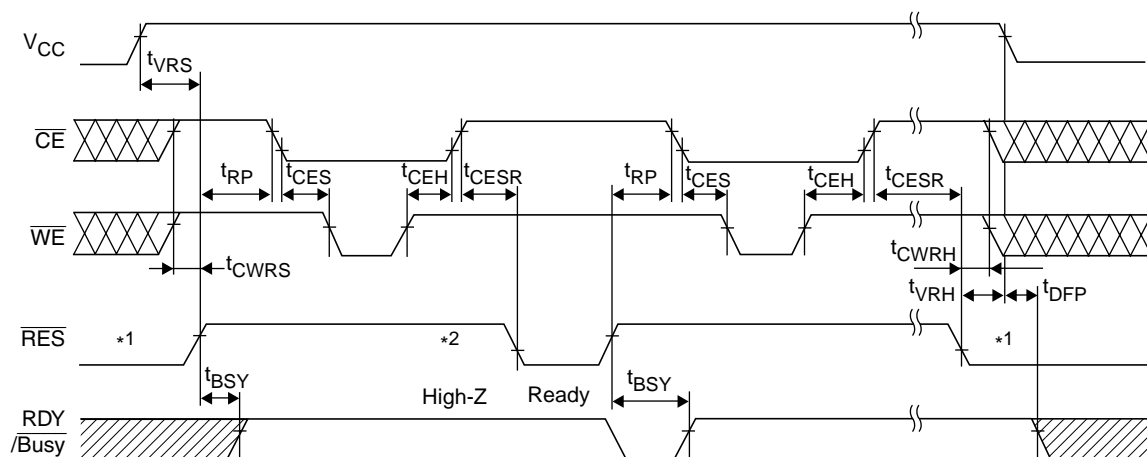
## HN29W12811 Series


		HN29W12811					
		-60					
Parameter	Symbol	Min	Typ	Max	Unit	Test conditions	Note
SC setup for $\overline{\text{CE}}$	$t_{\text{SCS}}$	0	—	—	ns		
SC hold time for $\overline{\text{WE}}$	$t_{\text{SCHW}}$	20	—	—	ns		
$\overline{\text{CE}}$ to output delay	$t_{\text{CE}}$	—	—	120	ns		
$\overline{\text{OE}}$ to output delay	$t_{\text{OE}}$	—	—	60	ns		
$\overline{\text{OE}}$ high to output float	$t_{\text{DF}}$	—	—	40	ns		1
$\overline{\text{RES}}$ to $\overline{\text{CE}}$ setup time	$t_{\text{RP}}$	1	—	—	ms		
$\overline{\text{CDE}}$ setup time for $\overline{\text{WE}}$	$t_{\text{CDS}}$	0	—	—	ns		
$\overline{\text{CDE}}$ hold time for $\overline{\text{WE}}$	$t_{\text{CDH}}$	20	—	—	ns		
$\overline{\text{CDE}}$ setup time for SC	$t_{\text{CDSS}}$	1.5	—	—	$\mu\text{s}$		
$\overline{\text{CDE}}$ hold time for SC	$t_{\text{CDSH}}$	30	—	—	ns		
Next cycle ready time	$t_{\text{RDY}}$	0	—	—	ns		
$\overline{\text{CDE}}$ to $\overline{\text{OE}}$ hold time	$t_{\text{CDOH}}$	50	—	—	ns		
$\overline{\text{CDE}}$ to output delay	$t_{\text{CDAC}}$	—	—	50	ns		
$\overline{\text{CDE}}$ to output invalid	$t_{\text{CDF}}$	—	—	100	ns		
$\overline{\text{CE}}$ setup time for $\overline{\text{OE}}$	$t_{\text{COS}}$	0	—	—	ns		
$\overline{\text{CE}}$ hold time for $\overline{\text{OE}}$	$t_{\text{COH}}$	0	—	—	ns		
$\overline{\text{CDE}}$ to $\overline{\text{OE}}$ setup time	$t_{\text{CDOS}}$	20	—	—	ns		
$\overline{\text{OE}}$ setup time for SC	$t_{\text{OES}}$	0	—	—	ns		
$\overline{\text{OE}}$ low to output low-Z	$t_{\text{OEL}}$	0	—	40	ns		
SC to output delay	$t_{\text{SAC}}$	—	—	60	ns		
SC to output hold	$t_{\text{SH}}$	15	—	—	ns		
RDY/Busy setup for SC	$t_{\text{RS}}$	200	—	—	ns		
$\overline{\text{CE}}$ hold time for $\overline{\text{WE}}$	$t_{\text{CWH}}$	1.0	—	—	$\mu\text{s}$		
$\overline{\text{CE}}$ hold time for $\overline{\text{WE}}$ on recovery read mode	$t_{\text{CWHR}}$	2	—	—	$\mu\text{s}$		
$\overline{\text{WE}}$ hold time for $\overline{\text{WE}}$	$t_{\text{WWH}}$	1	—	—	$\mu\text{s}$		
Busy time on read mode	$t_{\text{RBSY}}$	—	45	—	$\mu\text{s}$		

Note: 1.  $t_{\text{DF}}$  is a time after which the I/O pins become open.

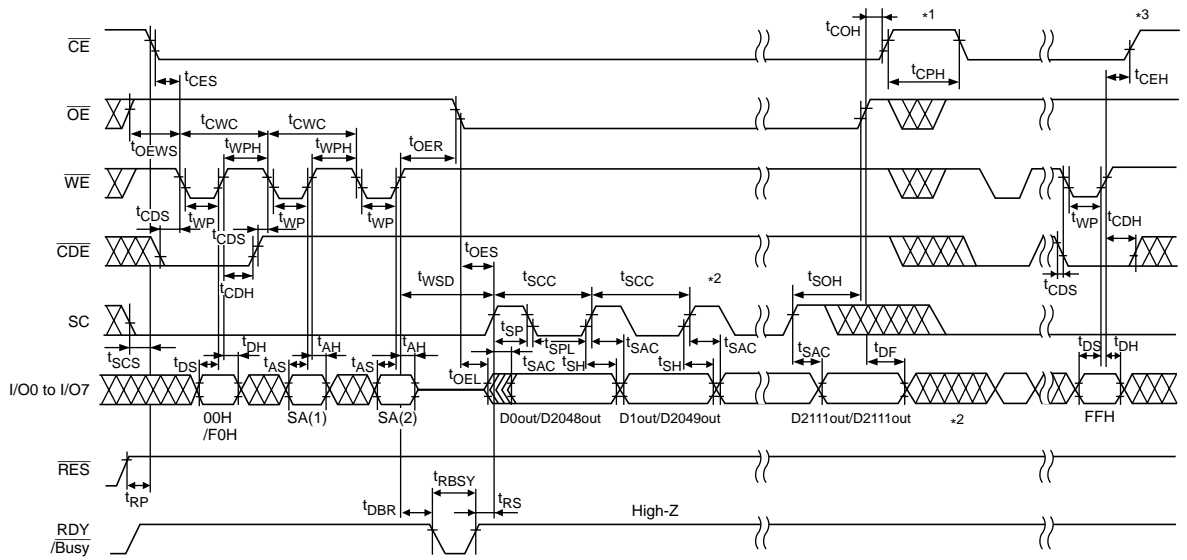
## Timing Waveforms

## Power on and off Sequence



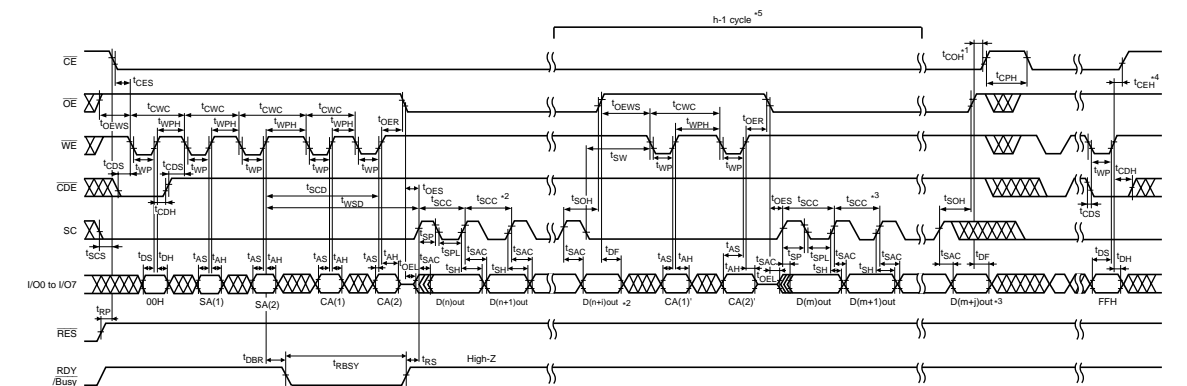
- Notes:
1.  $\overline{\text{RES}}$  must be kept at the  $V_{\text{ILR}}$  level referred to DC characteristics at the rising and falling edges of  $V_{\text{CC}}$  to guarantee data stored in the chip.
  2.  $\overline{\text{RES}}$  must be kept at the  $V_{\text{IHR}}$  level referred to DC characteristics while I/O outputs the  $V_{\text{OL}}$  level in the status data polling and RDY/Busy outputs the  $V_{\text{OL}}$  level.
  3.  : Undefined

## Serial Read (1) (2) Timing Waveform



- Notes: 1. The status returns to the standby at the rising edge of  $\overline{CE}$ .  
 2. Output data is not valid after the number of the SC pulse exceeds 2112 and 64 in the serial read mode (1) and (2), respectively.  
 3. After any commands are written, the status can return to the standby after the command FFH is input and  $\overline{CE}$  turns to the  $V_{IH}$  level.

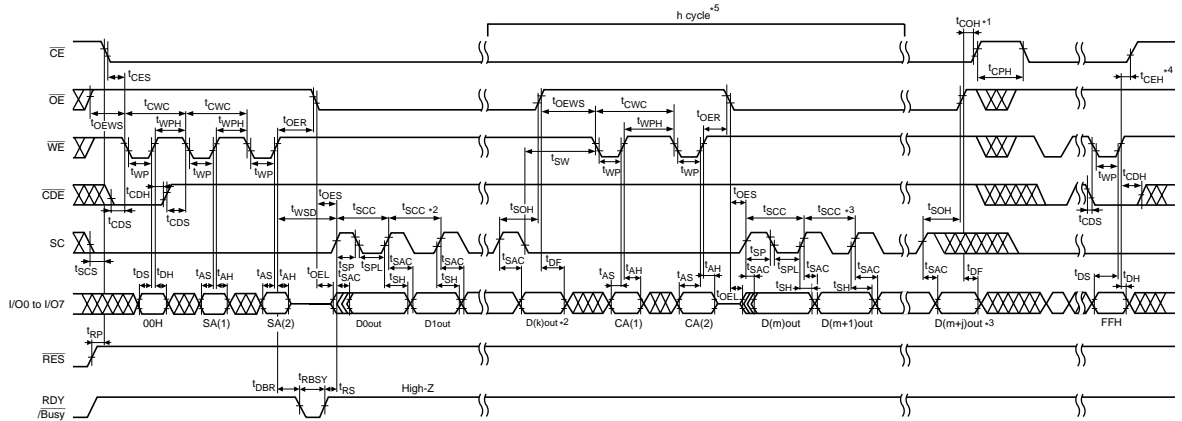
## Serial Read (1) with CA before SC Timing Waveform



- Notes: 1. The status returns to the Standby at the rising edge of  $\overline{CE}$ .  
 2. Output data is not valid after the number of the SC pulse exceeds  $(2112-n)$ . ( $i \leq 2111-n$ ,  $0 \leq n \leq 2111$ )  
 3. Output data is not valid after the number of the SC pulse exceeds  $(2112-m)$ . ( $j \leq 2111-m$ ,  $0 \leq m \leq 2111$ )  
 4. After any commands are written, the status can return to the standby after the command FFH is input and  $\overline{CE}$  turns to the  $V_{IH}$  level.  
 5. This interval can be repeated (h-1) cycle. ( $1 \leq h \leq 2048 + 64$ )

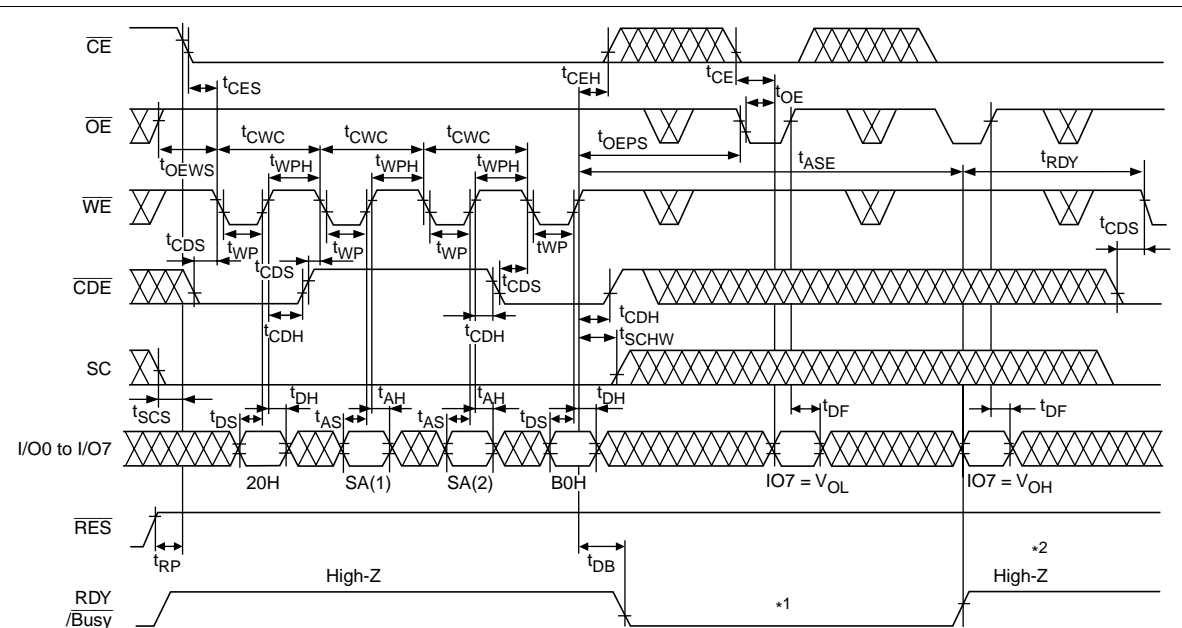


# Serial Read (1) with CA after SC Timing Waveform



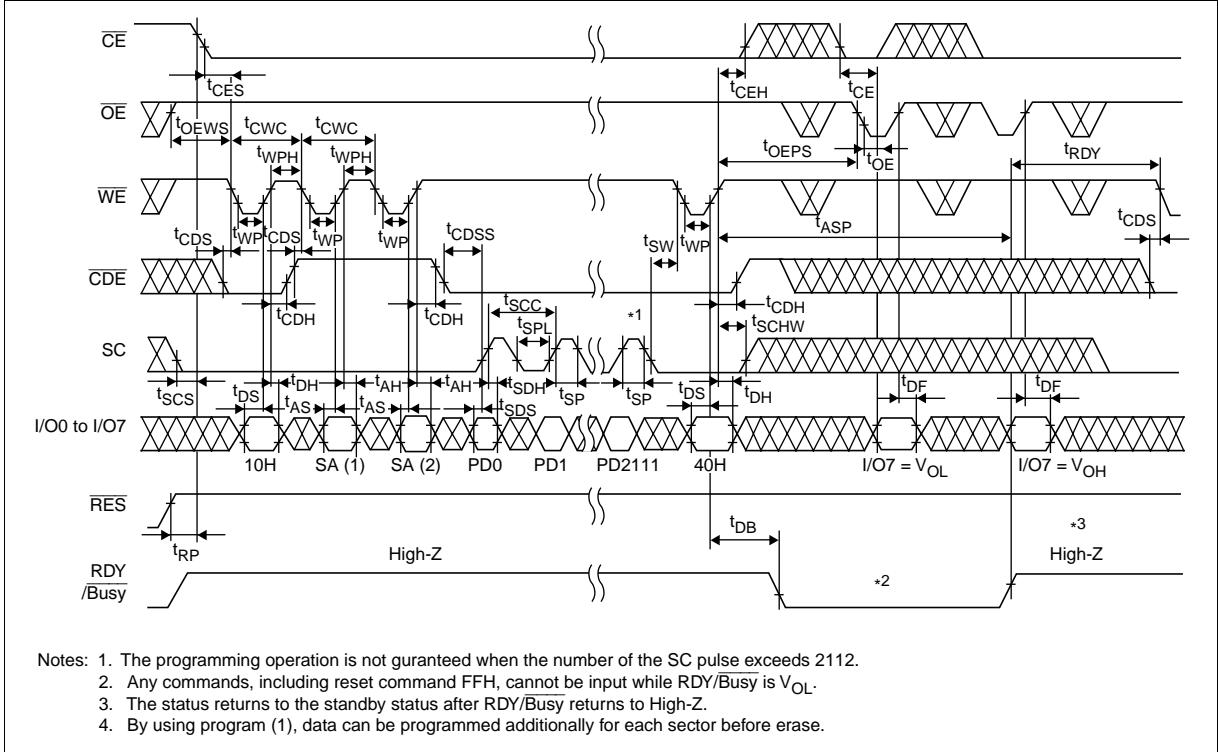
- Notes:
1. The status returns to the Standby at the rising edge of  $\overline{CE}$ .
  2. Output data is not valid after the number of the SC pulse exceeds 2112. ( $0 \leq k \leq 2111$ )
  3. Output data is not valid after the number of the SC pulse exceeds  $(2112-m)$ . ( $j \leq 2111-m, 0 \leq m \leq 2111$ )
  4. After any commands are written, the status can return to the standby after the command FFH is input and  $\overline{CE}$  turns to the  $V_{IH}$  level.
  5. This interval can be repeated h cycle. ( $1 \leq h \leq 2048 + 64$ )

# Erase and Status Data Polling Timing Waveform (Sector Erase)

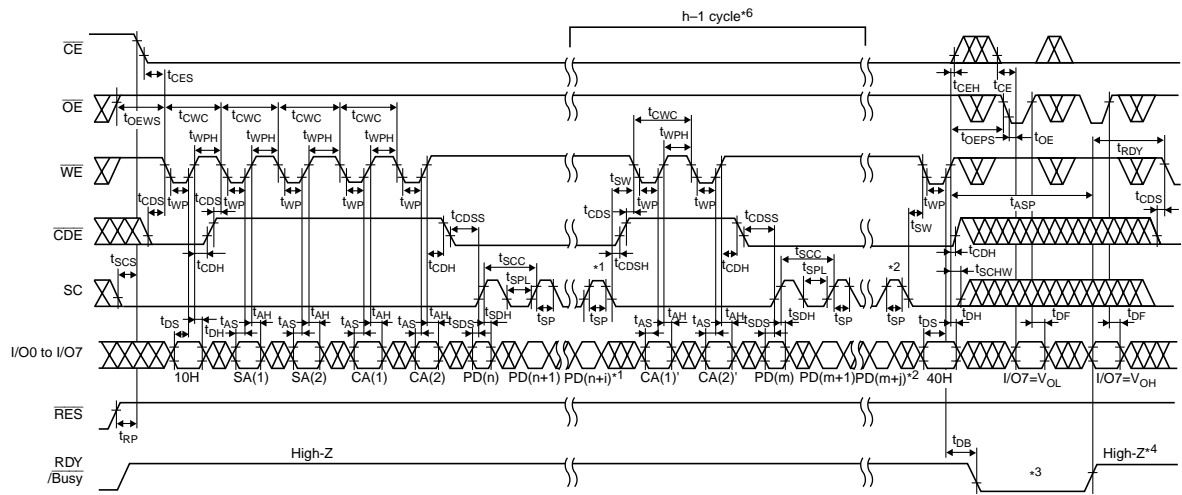


- Notes:
1. Any commands, including reset command FFH, cannot be input while RDY/Busy outputs a  $V_{OL}$ .
  2. The status returns to the standby status after RDY/Busy returns to High-Z.

Program (1) and Status Data Polling Timing Waveform

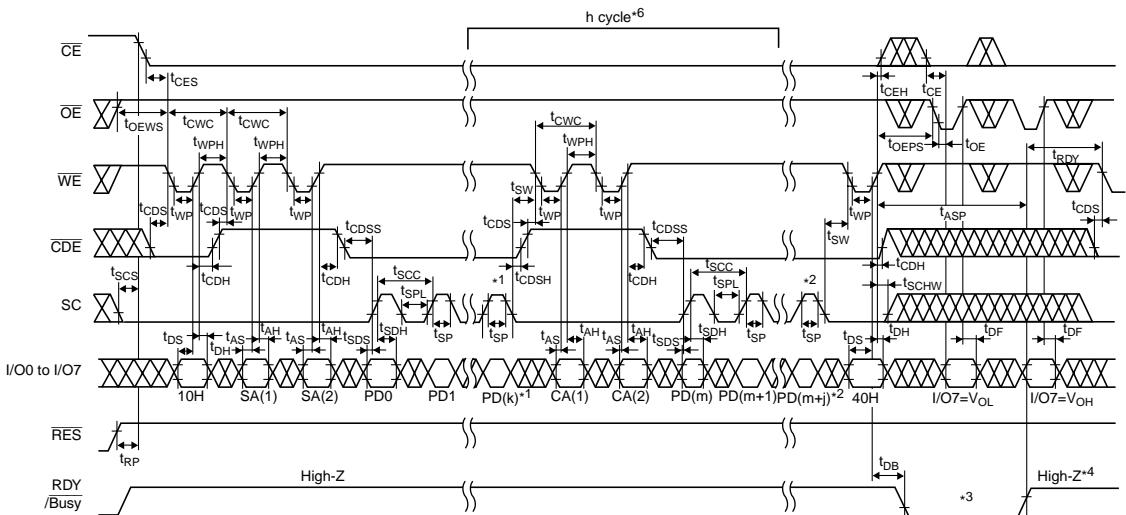


Program (1) with CA before SC and Status Data Polling Timing Waveform

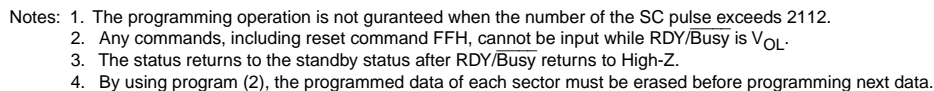


- Notes: 1. The programming operation is not guaranteed when the number of the SC pulse exceeds  $(2112 - n)$ , ( $i \leq 2111 - n$ ,  $0 \leq n \leq 2111$ )  
 2. The programming operation is not guaranteed when the number of the SC pulse exceeds  $(2112 - m)$ , ( $j \leq 2111 - m$ ,  $0 \leq m \leq 2111$ )  
 3. Any commands, including reset command FFH, cannot be input while RDY/Busy is  $V_{OL}$ .  
 4. The status returns to the standby status after RDY/Busy returns to High-Z.  
 5. By using program (1), data can be programmed additionally for each sector before erase.  
 6. This interval can be repeated  $(h - 1)$  cycle, ( $1 \leq h \leq 2048 + 64$ )

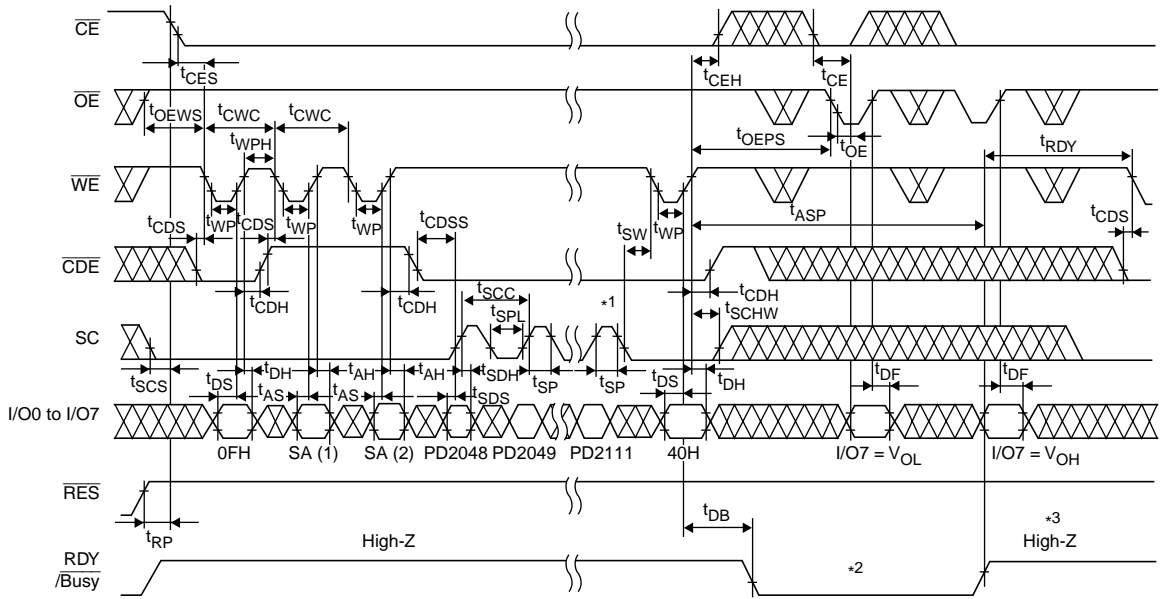
Program (1) with CA after SC and Status Data Polling Timing Waveform



- Notes: 1. The programming operation is not guaranteed when the number of the SC pulse exceeds 2112, ( $0 \leq k \leq 2111$ )  
 2. The programming operation is not guaranteed when the number of the SC pulse exceeds  $(2112 - m)$ , ( $j \leq 2111 - m$ ,  $0 \leq m \leq 2111$ )  
 3. Any commands, including reset command FFH, cannot be input while RDY/Busy is  $V_{OL}$ .  
 4. The status returns to the standby status after RDY/Busy returns to High-Z.  
 5. By using program (1), data can be programmed additionally for each sector before erase.  
 6. This interval can be repeated  $h$  cycle, ( $1 \leq h \leq 2048 + 64$ )

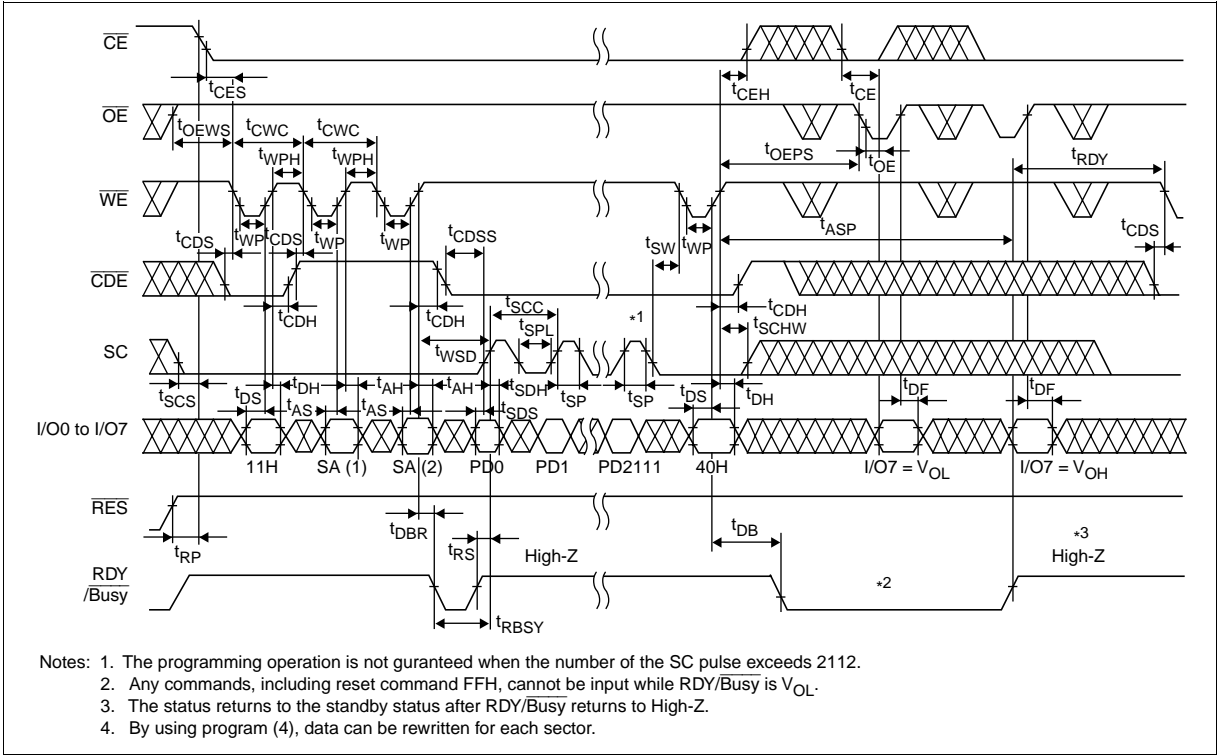


Program (3) and Status Data Polling Timing Waveform

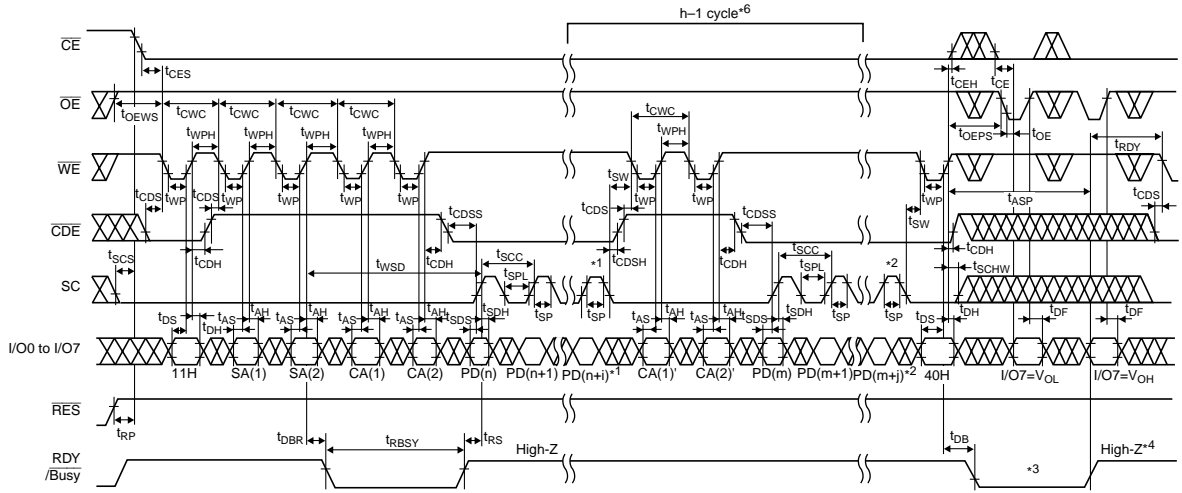


- Notes:
1. The programming operation is not guaranteed when the number of the SC pulse exceeds 64.
  2. Any commands, including reset command FFH, cannot be input while RDY/Busy is  $V_{OL}$ .
  3. The status returns to the standby status after RDY/Busy returns to High-Z.
  4. By using program (3), the data can be programmed additionally for each sector before erase.

Program (4) and Status Data Polling Timing Waveform

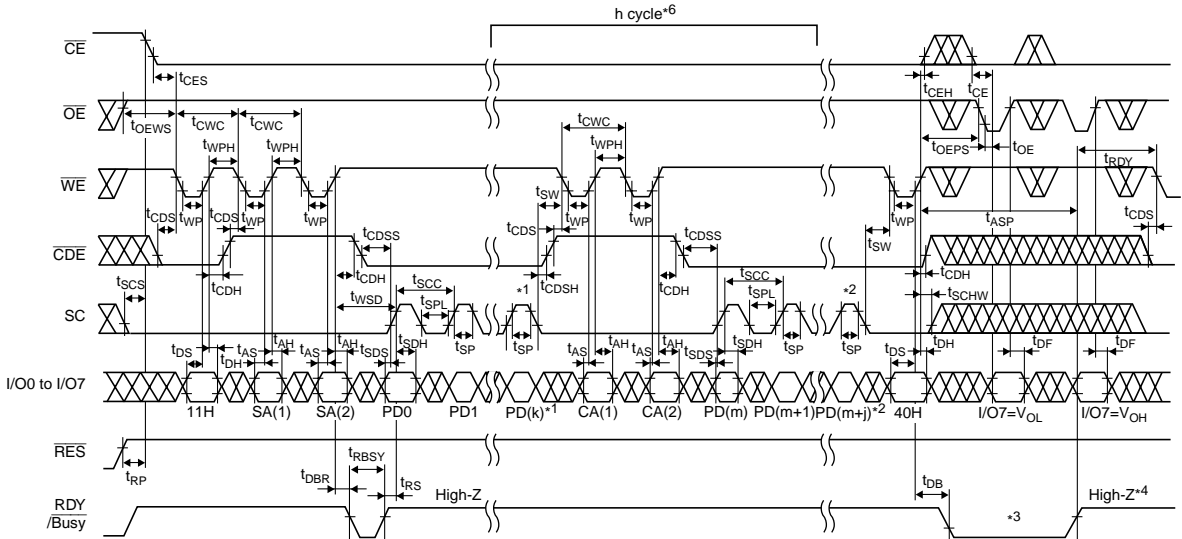


Program (4) with CA before SC and Status Data Polling Timing Waveform



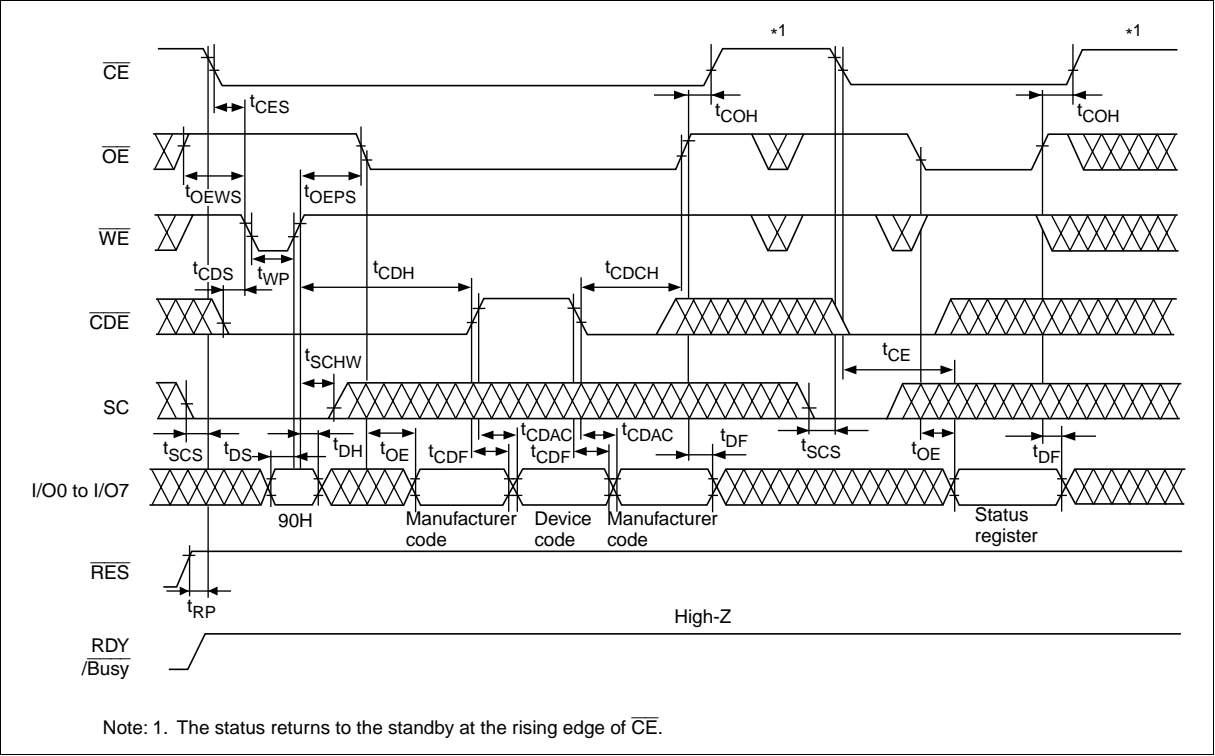
- Notes: 1. The programming operation is not guaranteed when the number of the SC pulse exceeds  $(2112 - n)$ ,  $(1 \leq n \leq 2111)$   
 2. The programming operation is not guaranteed when the number of the SC pulse exceeds  $(2112 - m)$ ,  $(1 \leq m \leq 2111)$   
 3. Any commands, including reset command FFH, cannot be input while RDY/Busy is  $V_{OL}$ .  
 4. The status returns to the standby status after RDY/Busy returns to High-Z.  
 5. By using program (4), data can be rewritten for each sector.  
 6. This interval can be repeated  $(h - 1)$  cycle,  $(1 \leq h \leq 2048 + 64)$

Program (4) with CA after SC and Status Data Polling Timing Waveform



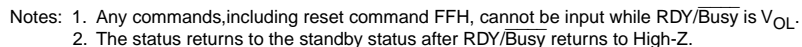
- Notes: 1. The programming operation is not guaranteed when the number of the SC pulse exceeds 2112,  $(0 \leq k \leq 2111)$   
 2. The programming operation is not guaranteed when the number of the SC pulse exceeds  $(2112 - m)$ ,  $(1 \leq m \leq 2111)$   
 3. Any commands, including reset command FFH, cannot be input while RDY/Busy is  $V_{OL}$ .  
 4. The status returns to the standby status after RDY/Busy returns to High-Z.  
 5. By using program (4), data can be rewritten for each sector.  
 6. This interval can be repeated  $h$  cycle,  $(1 \leq h \leq 2048 + 64)$

ID and Status Register Read Timing Waveform

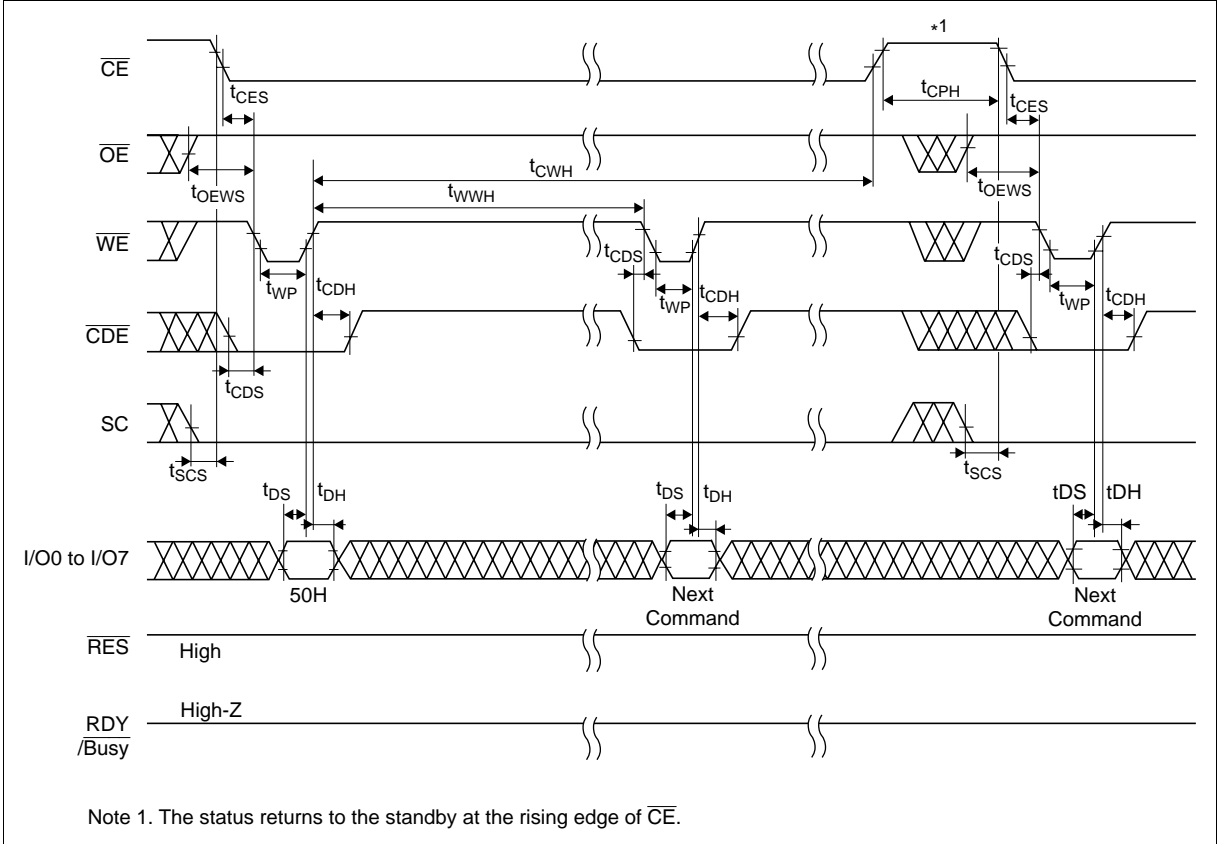








Clear Status Register Timing Waveform



Function Description

**Status Register:** The HN29W12811 outputs the operation status data as follows: I/O7 pin outputs a  $V_{OL}$  to indicate that the memory is in either erase or program operation. The level of I/O7 pin turns to a  $V_{OH}$  when the operation finishes. I/O5 and I/O4 pins output  $V_{OL}$ s to indicate that the erase and program operations complete in a finite time, respectively. If these pins output  $V_{OH}$ s, it indicates that these operations have timed out. When these pins monitor, I/O7 pin must turn to a  $V_{OH}$ . To execute other erase and program operation, the status data must be cleared after a time out occurs. From I/O0 to I/O3 pins are reserved for future use. The pins output  $V_{OL}$ s and should be masked out during the status data read mode. The function of the status register is summarized in the following table.

I/O	Flag definition	Definition
I/O7	Ready/ $\overline{\text{Busy}}$	$V_{OH}$ = Ready, $V_{OL}$ = Busy
I/O6	Reserved	Outputs a $V_{OL}$ and should be masked out during the status data poling mode.
I/O5	Erase check	$V_{OH}$ = Fail, $V_{OL}$ = Pass
I/O4	Program check	$V_{OH}$ = Fail, $V_{OL}$ = Pass
I/O3	Reserved	Outputs a $V_{OL}$ and should be masked out during the status data poling mode.
I/O2	Reserved	
I/O1	Reserved	
I/O0	Reserved	

Requirement for System

Specifications

Item	Min	Typ	Max	Unit
Usable sectors (initially)	8,029	—	8,192	sector
Spare sectors	145	—	—	sector
ECC (Error Correction Code)	1	—	—	bit/sector
Program/Erase endurance	—	—	$3 \times 10^5$	cycle

Unusable Sector

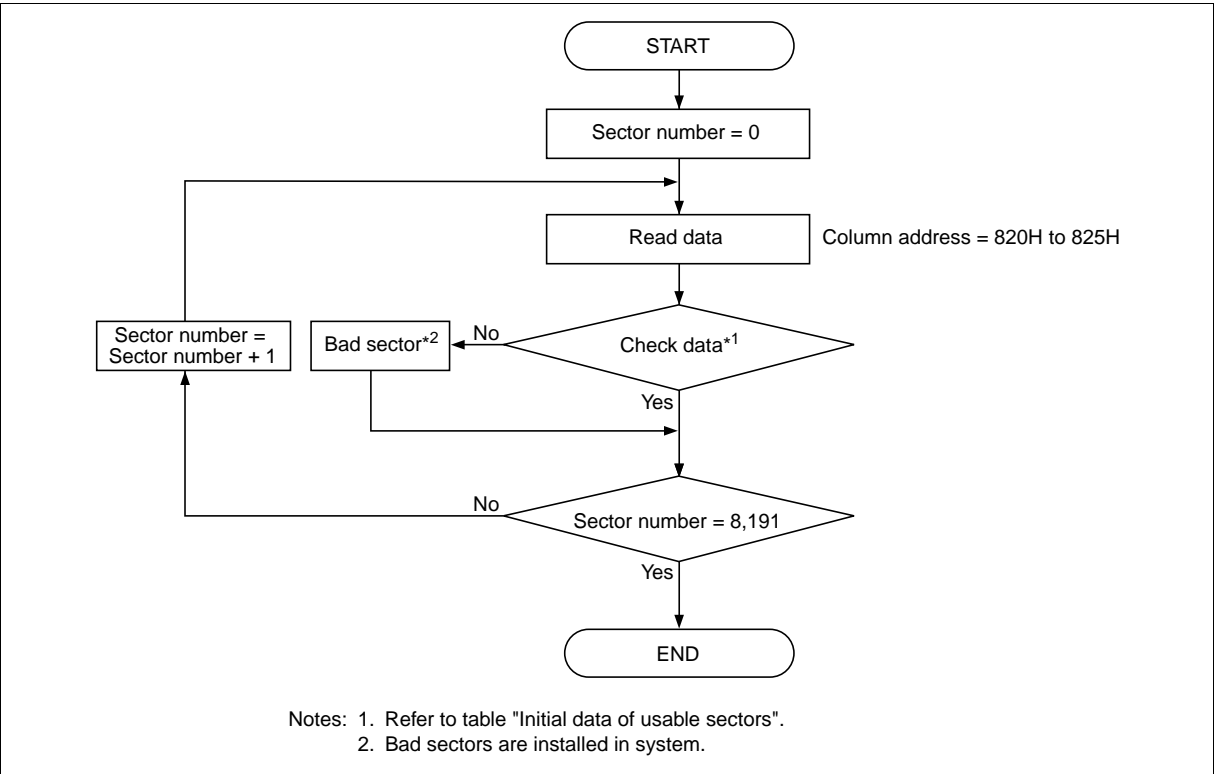
Initially, the HN29W12811 includes unusable sectors. The unusable sectors must be distinguished from the usable sectors by the system as follows.

1. Check the partial invalid sectors in the devices on the system. The usable sectors were programmed the following data. Refer to the flowchart “The Unusable Sector Indication Flow”.

Initial Data of Usable Sectors

Column address	0H to 81FH	820H	821H	822H	823H	824H	825H	826H to 83FH
Data	FFH	1CH	71H	C7H	1CH	71H	C7H	FFH

2. Do not erase and program to the partial invalid sectors by the system.

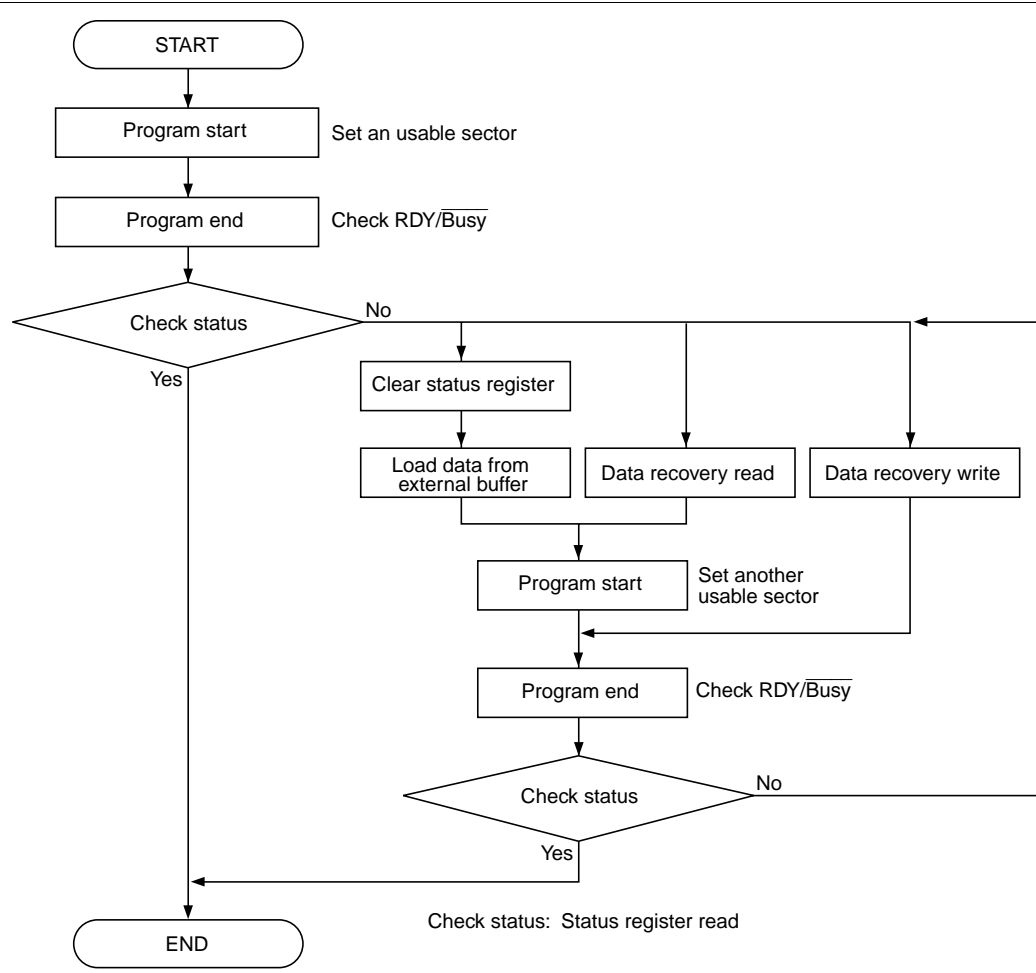


The Unusable Sector Indication Flow

### Requirements for High System Reliability

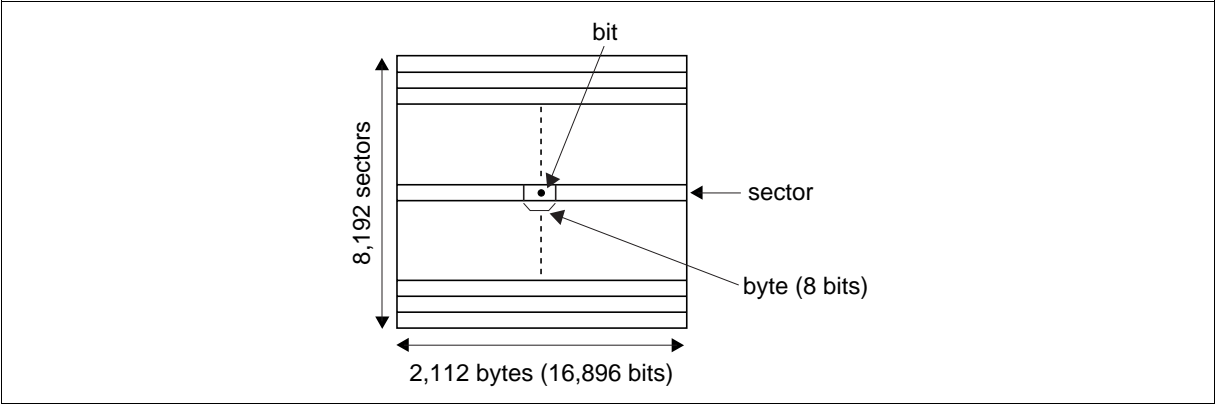
The device may fail during a program, erase or read operation due to write or erase cycles. The following architecture will enable high system reliability if a failure occurs.

1. For an error in read operation: An error correction more than 1-bit error correction per each sector read is required for data reliability. Contact Hitachi's sales office for data storage during long time under high temperature.
2. For errors in program or erase operations: The device may fail during a program or erase operation due to write or erase cycles. The status register indicates if the erase and program operation complete in a finite time. When an error occurred in the sector, try to reprogram the data into another sector. Avoid further system access to the sector that error happens. Typically, recommended number of a spare sectors are 1.8% of initial usable 8,029 sectors by each device. The recommended number of the spare sectors are confirmed from 4-level data pattern(39●/39) program. If the number of failed sectors exceeds the number of the spare sectors, usable data area in the device decreases. For the reprogramming, do not use the data from the failed sectors, because the data from the failed sectors are not fixed. So the reprogram data must be the data reloaded from external buffer, or use the Data recovery read mode or the Data recovery write mode (see the "Mode Description" and under figure "Spare Sector Replacement Flow after Program Error"). To avoid consecutive sector failures, choose addresses of spare sectors as far as possible from the failed sectors.



Spare Sector Replacement Flow after Program Error

**Memory Structure**



Bit: Minimum unit of data.

Byte: Input/output data unit in programming and reading. (1 byte = 8 bits)

Sector: Page unit in erase, programming and reading. (1 sector = 2,112 bytes = 16,896 bits)

Device: 1 device = 8,192 sectors.





## Cautions

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