FUJITSU SEMICONDUCTOR
DATA SHEET

DS05-30333-1E

MEMORY

5V-ONLY FLASH MEMORY CARD

MB98A81063-/81183-/81273-/81373-/81473-/81573-15

1M/2M/4M/8M/16M/32M-BYTE 5V-ONLY FLASH ERASABLE AND PROGRAMMABLE MEMORY CARD

■ DESCRIPTION

The Fujitsu 5V-Only Flash memory cards are electrically erasable and programmable memory cards capable of storing and retrieving large amounts of data. The memory circuits are housed in a credit-card sized 68-pin package. Internal circuit is protected by two metal panels, one at the top and the other at the bottom of the card, that help to reduce chip damage from electrostatic discharge.

A unique feature of the Fujitsu memory cards allows the user to organize the card into either an 8-bit or a 16-bit bus configuration. All cards are portable and operate on low power at high speed.

In accordance with the Personal Computer Memory Card Internal Association (PCMCIA) and Japan Electrical Industry Development Association (JEIDA) industry standard specifications, Flash memory cards offer additional EEPROM memory that is used to store attribute data. The attribute memory is a Flash memory card option. (See page 3 for description of the three available options.)

■ ABSOLUTE MAXIMUM RATINGS (*1)

Parameter	Symbol	Value	Unit
Supply Voltage	V_{CC}	–0.5 to +6.0	V
Input Voltage	V_{IN}	–0.5 to V_{CC} +0.5	V
Output Voltage	V_{OUT}	–0.5 to V_{CC} +0.5	V
Temperature under Bias	T_A	0 to +60	°C
Storage Tmperature	T_{STG}	–30 to +70	°C

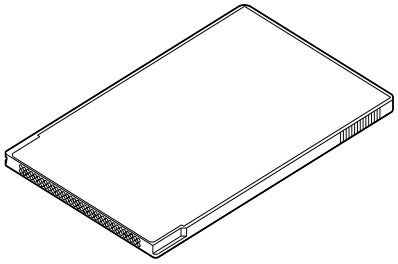
*1: Permanent device damage may occur if the above Absolute Maximum Ratings are exceeded. Functional operation should be restricted to the conditions as detailed in the operational sections of this data sheet. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

This device contains circuitry to protect the inputs against damage due to high static voltages or electric fields. However, it is advised that normal precautions be taken to avoid application of any voltage higher than maximum rated voltages to this high impedance circuit.

■ PRODUCT LINE & FEATURES

- Meet PCMCIA and JEIDA industry standards for 68-pin memory card
- Credit card size : 85.6 mm (length) × 54.0 mm (width) × 3.3 mm (thickness)
- +5 V±5% power supply program and erase
- Command control for Automated Program / Automated Erase operation
- Erase Suspend Read / Program Capability (Only Erase Suspend Read is possible for MB98A81063)
- 128 KB Sector Erase (at ×16 mode)
- Any Combination of Sectors Erase and Full Chip Erase
- Detection of completion of program/erase operation with $\overline{\text{Data}}$ Polling or Toggle bit.
- Ready/Busy Output with R/$\overline{\text{B}}$ (Except for MB98A81063)
- Reset Function with RESET pin (Except for MB98A81063)
- Write protect function with WP switch
- Low V_{CC} Write Inhibit

■ PACKAGE



CRD-68P-M05

■ DESCRIPTIONS

DESCRIPTION TABLE

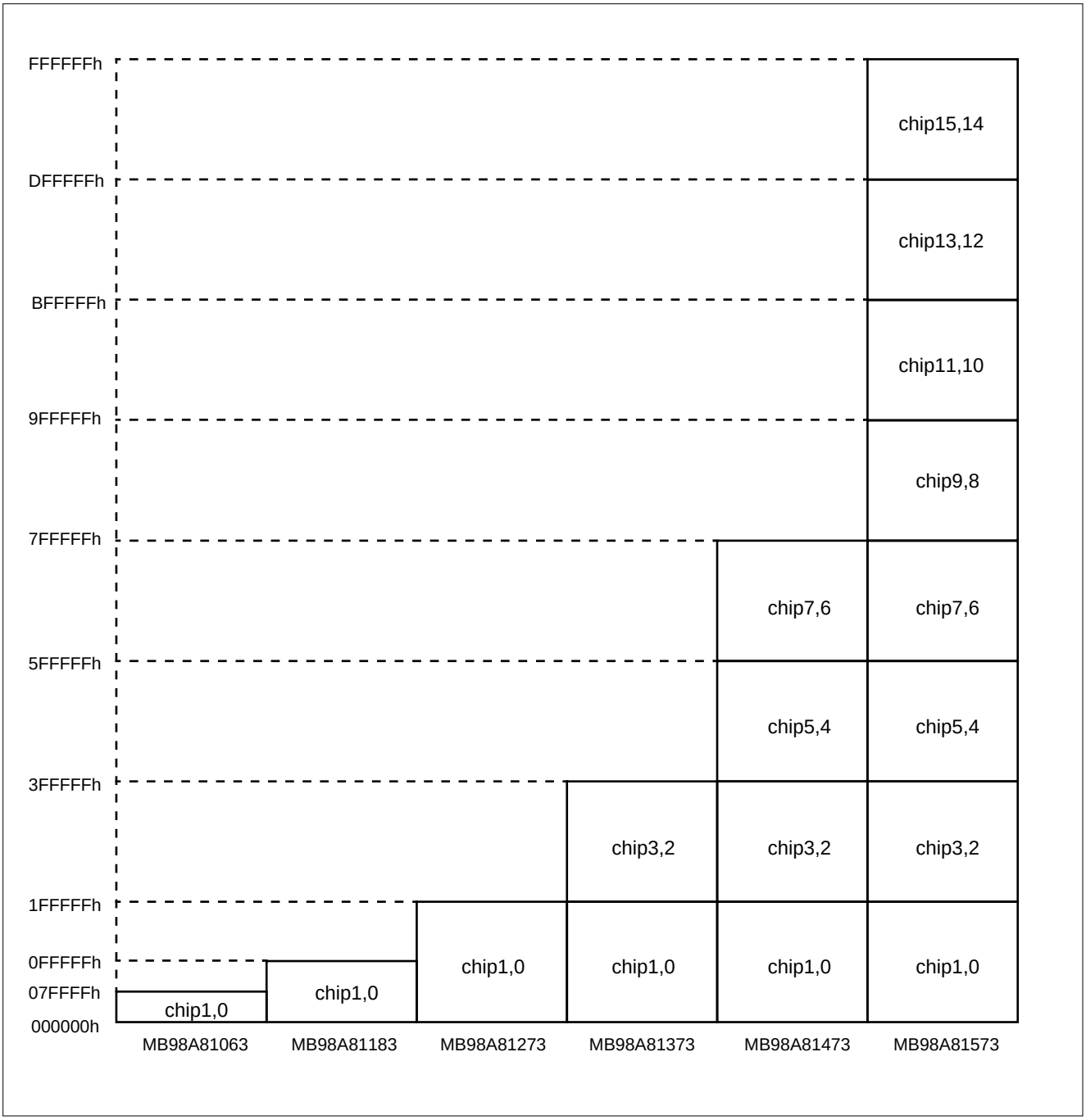
Part Number	Common Memory			Attribute Memory		
	Memory Device	Organization (W × bit)	Access Time	Memory Device	Organization (W × bit)	Access Time
MB98A81063	4M bit Flash Memory × 2	1M × 8/512K × 16	max 150 ns	16k bit EEPROM × 1	2k × 8	max 250 ns
MB98A81183	8M bit Flash Memory × 2	2M × 8/1M × 16				
MB98A81273	16M bit Flash Memory × 2	4M × 8/2M × 16				
MB98A81373	16M bit Flash Memory × 4	8M × 8/4M × 16				
MB98A81473	16M bit Flash Memory × 8	16M × 8/8M × 16				
MB98A81573	16M bit Flash Memory × 16	32M × 8/16M × 16				

DIFFERENCES

	MB98A81063	MB98A81183	MB98A81273	MB98A81373	MB98A81473	MB98A81573
Density	1MB	2MB	4MB	8MB	16MB	32MB
Memory Device	4M bit	8M bit	16M bit	←	←	←
Quantity	2	2	2	4	8	16
Read	1 B unit	←	←	←	←	←
Program	1 B unit	←	←	←	←	←
Chip Erase	512 kB unit	1 MB unit	2 MB unit	←	←	←
Sector Erase	64 kB unit	←	←	←	←	←
Number of Sectors	16	32	64	128	256	512
Erase Suspend Read	Yes	Yes	Yes	Yes	Yes	Yes
Erase Suspend Program	No	Yes	Yes	Yes	Yes	Yes
Address	A_0 to A_{19}	A_0 to A_{20}	A_0 to A_{21}	A_0 to A_{22}	A_0 to A_{23}	A_0 to A_{24}
RESET	No	Yes	Yes	Yes	Yes	Yes
R/$\overline{B}$	No	Yes	Yes	Yes	Yes	Yes

■ DESCRIPTIONS (Continued)

ADDRESS MAP (for x 16 mode, not contained A_0)



■ PIN ASSIGNMENTS

Pin No.	Symbol	Pin No.	Symbol	Pin No.	Symbol	Pin No.	Symbol
1	GND	18	NC.	35	GND	52	NC.
2	D_3	19	A_{16}	36	$\overline{CD}1$	53	A_{22}/NC.*
3	D_4	20	A_{15}	37	D_{11}	54	A_{23}/NC.*
4	D_5	21	A_{12}	38	D_{12}	55	A_{24}/NC.*
5	D_6	22	A_7	39	D_{13}	56	NC.
6	D_7	23	A_6	40	D_{14}	57	NC.
7	$\overline{CE}1$	24	A_5	41	D_{15}	58	RESET/NC.
8	A_{10}	25	A_4	42	$\overline{CE}2$	59	NC.
9	$\overline{OE}$	26	A_3	43	NC.	60	NC.
10	A_{11}	27	A_2	44	NC.	61	$\overline{REG}$
11	A_{12}	28	A_1	45	NC.	62	BVD2
12	A_{12}	29	A_0	46	A_{17}	63	BVD1
13	A_{13}	30	D_0	47	A_{18}	64	D_8
14	A_{14}	31	D_1	48	A_{19}	65	D_9
15	$\overline{WE}$	32	D_2	49	A_{20}/NC.*	66	D_{10}
16	R/$\overline{B}$/NC.*	33	WP	50	A_{21}/NC.*	67	$\overline{CD}2$
17	V_{CC}	34	GND	51	V_{CC}	68	GND

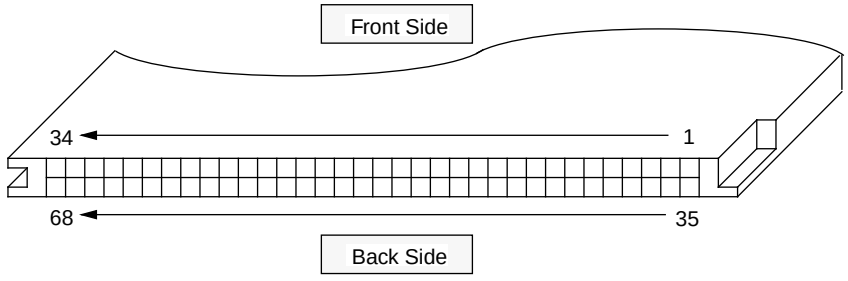
* : See “DESCRIPTIONS”.

■ PIN DESCRIPTIONS

Symbol	Pin Name	Input/Output	Function
A_0 to A_{24}	Address Input	Input	Address Inputs, A_0 to A_{24}.
D_0 to D_{15}	Data Input/Output	Input/Output	Data Inputs/Outputs. This data bus size (8-bit or 16-bit) is selected with $\overline{CE}1$ and $\overline{CE}2$.
$\overline{CE}1$	Card Enable for Lower Byte	Input	Active Low. -Lower byte (D_0 to D_7) is selected for read/write/ erase function of flash memory cards.
$\overline{CE}2$	Card Enable for Upper Byte	Input	Active Low. -Upper byte (D_8 to D_{15}) is selected for read/write / erase function of flash memory cards.
$\overline{REG}$	Attribute Memory Select	Input	Active Low. -Attribute memory is selected for read/write function of identification data of flash memory cards. (NC or “FF” data or attribute data.)
$\overline{OE}$	Output Enable	Input	Active Low. -Output enable for flash memory cards.
$\overline{WE}$	Write Enable	Input	Active Low. -Write enable for flash memory cards.
$\overline{CD}1$, $\overline{CD}2$	Card Detect	Output	These pins detect if the card has been correctly inserted. Both pins are tied to GND internally.
WP	Write Protect	Output	Write controller for flash memory cards. This pin outputs the Protect/Non Protect status of “WP Switch”.
BVD1, BVD2	Battery Voltage Detect	Output	Both pins are tied to V_{CC} internally.
RESET	Hardware Reset	Input	The card may be reset by driving the RESET pin to V_{IL}.
R/$\overline{B}$	Ready/Busy	Output	System can be detect the completion of program or erase operation.
V_{CC}	Power Supply	—	Power Supply Voltage. (+5.0 V ±5%)
GND	Ground	—	System Ground.
NC	Non Connection	—	

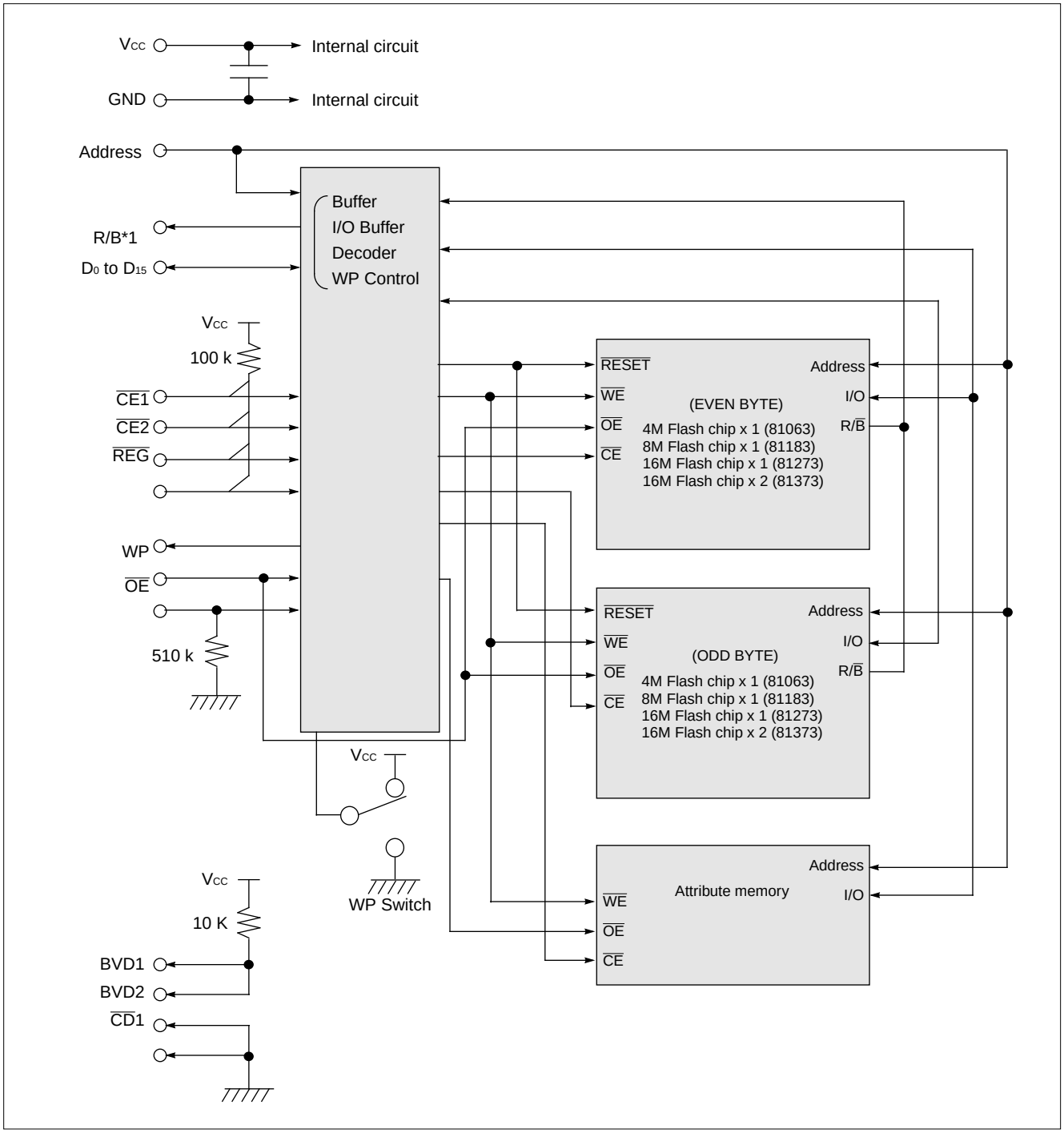
■ PIN LOCATIONS

Fig. 1 - BOTTOM VIEW (CONNECTOR SIDE)



■ BLOCK DIAGRAM

MB98A81063, MB98A81183, MB98A81273 AND MB98A81373



*1: Not available for MB98A81063.

Fig. 2.1 - Block Diagram

■ BLOCK DIAGRAM (Continued)

MB98A81473 and MB98A81573

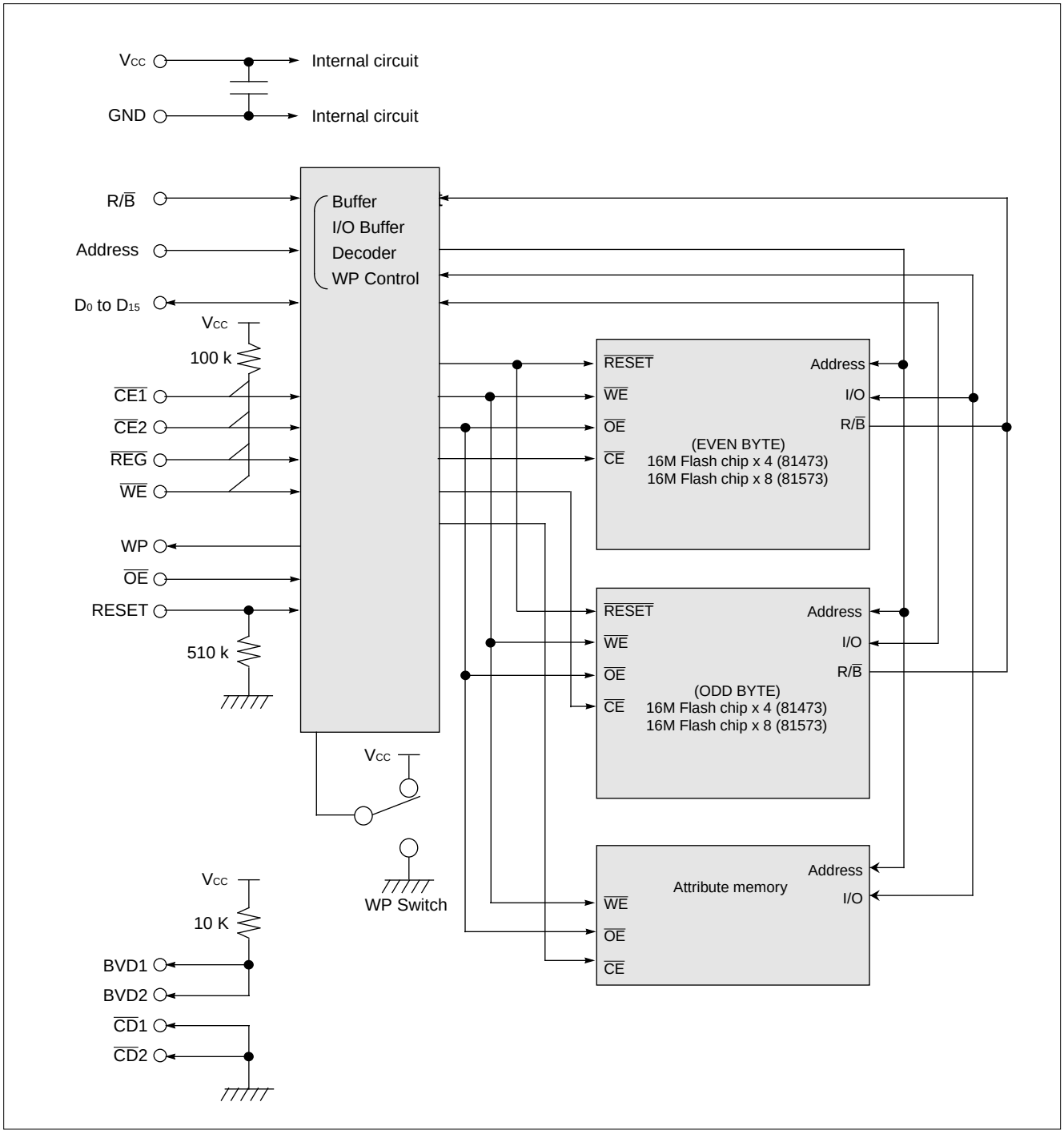


Fig. 2.2 - Block Diagram

■ CHIP AND SECTOR DECODING

- Chip can be selected with;
  - A_0, A_{22}, A_{23} and A_{24} for X8-bit mode NO.1.
  - A_{22}, A_{23}, and A_{24} for X8-bit mode NO.2 and X16-bit mode.
- Sector per each chip can be selected with A_{17}, A_{18}, A_{19}, A_{20} and A_{21}.

PROGRAM / ERASE CHIP DECODING TABLE

Bus Organization	$\overline{CE}2$	$\overline{CE}1$	A_{24}*3	A_{23}*2	A_{22}*1	A_0	Decode Chips
8-bit Bus	H	L	L	L	L	L	Chip 0
						H	Chip 1
					H	L	Chip 2
						H	Chip 3
				H	L	L	Chip 4
						H	Chip 5
					H	L	Chip 6
						H	Chip 7
			H	L	L	L	Chip 8
						H	Chip 9
					H	L	Chip 10
						H	Chip 11
				H	L	L	Chip 12
						H	Chip 13
					H	L	Chip 14
						H	Chip 15
	L	H	L	L	L	X	Chip 1
					H		Chip 3
				H	L		Chip 5
					H		Chip 7
			H	L	L		Chip 9
					H		Chip 11
				H	L		Chip 13
					H		Chip 15
16-bit Bus	L	L	L	L	L	X	Chip 0, Chip 1
					H		Chip 2, Chip 3
				H	L		Chip 4, Chip 5
					H		Chip 6, Chip 7
			H	L	L		Chip 8, Chip 9
					H		Chip 10, Chip 11
				H	L		Chip 12, Chip 13
					H		Chip 14, Chip 15

Note:

H = V_{IH}, L = V_{IL}, X = Either V_{IH} or V_{IL}

*1: Available for MB98A81373, 81473 and 81573 only.

*2: Available for MB98A81473 and 81573 only.

*3: Available for MB98A81573 only.

■ CHIP AND SECTOR DECODING (Continued)

ERASE SECTOR DECODING TABLE

	Sector Address (SA)				
	A_{21}*2	A_{20}*1	A_{19}	A_{18}	A_{17}
Sector 31	1	1	1	1	1
Sector 30	1	1	1	1	0
Sector 29	1	1	1	0	1
Total 32 sectors*1*2 per 1 chip	• • •	• • •	• • •	• • •	• • •
Sector 2	0	0	0	1	0
Sector 1	0	0	0	0	1
Sector 0	0	0	0	0	0

*1: A_{20} is not available for MB98A81063. MB98A81063 has 8 sectors.

*2: A_{21} is not available for MB98A81063 and MB98A81183. MB98A81063 has 8 sectors and MB98A81183 has 16 sectors.

CARD CHIP / SECTOR CONFIGURATION

A

D_{15} ← D_8	D_7 ← D_0
UPPER BYTE	LOWER BYTE
	EVEN ADDRESS BYTE
	ODD ADDRESS BYTE

x 16 bit mode

x 8 bit mode No. 1

Chip 15	Chip 14
Chip 13	Chip 12
Chip 11	Chip 10
Chip 9	Chip 8
Chip 7	Chip 6
Chip 5	Chip 4
Chip 3	Chip 2
Chip1	**Chip 0**

Card Chip Configuration for 32MB Card

Chip 1 (16M Flash Chip*1)	**Chip 0** (16M Flash Chip*1)
Sector 31*2(64K × 8 bits)	Sector 31*2(64K × 8 bits)
• • •	• • •
Sector 2 (64K × 8 bits)	Sector 2 (64K × 8 bits)
Sector 1 (64K × 8 bits)	Sector 1 (64K × 8 bits)
Sector 0 (64K × 8 bits)	Sector 0 (64K × 8 bits)

Sector Configuration for 2 Chips

*1: 4M Flash Chip for MB98A81063. 8M Flash chip for MB98A81183.

*2: Sector 7 for MB98A81063. Sector 15 for MB98A81183.

■ FUNCTION DESCRIPTIONS

1. Read Mode

The data in the common and attribute memory can be read with "$\overline{OE}$=V_{IL}" and "$\overline{WE}$=V_{IH}". The address is selected with A_0 to A_{24}. And $\overline{CE}$1 and $\overline{CE}$2 select output mode (x8/x16 output mode, See "FUNCTION TRUTH TABLES".). The following 1) and 2) are the descriptions for Common Memory Read and Attribute Memory Read mode.

(1) Common Memory Read
- Two modes of Common Memory Read, reading the data in memory array and Intelligent ID are available. The card entered each Read mode by writing "Read Memory/Reset Command" or "Intelligent ID Read Command".
  The card automatically resets to the condition of Common Memory Read mode upon initial power-up.

(2) Attribute Memory Read
- The data on the attribute memory can be read with "$\overline{REG}$=V_{IL}", "$\overline{OE}$=V_{IL}" and "$\overline{WE}$=V_{IH}".
- An address on attribute memory can be selected with A_0 to A_{11} pin. And $\overline{CE}$1 and $\overline{CE}$2 select output mode.

2. Standby Mode

- $\overline{CE}$1 and $\overline{CE}$2 at "V_{IH}" place the card in Standby mode. D_0 to D_{15} are placed in a high-Z state independent of the status "$\overline{OE}$", "$\overline{WE}$" and "$\overline{REG}$".

3. Output Disable Mode

- The outputs are disabled with $\overline{OE}$ and $\overline{WE}$ at "V_{IH}". D_0 to D_{15} are placed in high-Z state.

4. Write Mode

(1) Common Memory Write
- The card is in Write mode with "$\overline{OE}$=V_{IH}" and "$\overline{WE}$ and $\overline{CE}$=V_{IL}".
- Commands can be written at the Write mode. See "5.Command Definitions".
- Two types of the Write mode, "$\overline{WE}$ control" and "$\overline{CE}$ control" are available.

(2) Attribute Memory Write
- $\overline{REG}$ at L-level selects Attribute memory and "$\overline{OE}$=V_{IH}", "$\overline{WE}$ and $\overline{CE}$=V_{IL}" place it in write mode. Two types of the write mode, "$\overline{WE}$ control" and "$\overline{CE}$ control" are available.
- Attribute memory is not controlled by writing Commands. And attribute memory has the $\overline{Data}$ polling function, which can detect whether the attribute memory status is in programming operation. When the read operation is executed at programming cycle, the opposite data is output from D_7 ($\overline{I7}$), and the same data (O_7) as the written data is output from D_7 pin at the completion of programming operation.

5. Command Definitions

- User can select the card operation by writing the specific address and data sequences into the command register. If incollect address and data are written or improper sequence is done, the card is reseted to read mode. See "COMMAND DEFINISION TABLE".

6. Automated Program Capability

- Programming operation can swich the data from "1" to "0".
- The data is programmed on a byte-by-byte or word-by-word basis.
- The card will automatically provide adequate internally generated programming pulses and verify the programmed cell margine by writing four bus cycle operation. The card returns to Common Memory Read mode automatically after the programming is completed.
- Addresses are latched at falling edge of $\overline{WE}$ or $\overline{CE}$ and data is latched at rising edge of $\overline{WE}$ or $\overline{CE}$. The fourth rising edge of $\overline{WE}$ or $\overline{CE}$ on the command write cycle begins programming operation.
- We can check whether a byte (word) programming operation is completed successfully by sequence flug with R/$\overline{B}$ (for MB98A81183, MB98A8xx73), $\overline{Data}$ Polling or Toggle Bit function. See "WRITE OPERATION STATUS".
- Any commands written to the chip during programming operation will be ignored.

■ FUNCTION DESCRIPTIONS (Continued)

7. Automated Chip Erase Capability

- We can execute chip erase operation by 6 bus cycle operation. Chip erase does not require the user to program the chip prior to erase. Upon executing the Erase command sequence the chip automatically will program and verify the entire memory for an all zero data pattern prior to electrical erase. The system is not required to provide any controls or timing during these operations.
- The card returns to Common Memory Read mode automatically after the chip erasing is completed.
- Whether or not chip erase operation is completed successfully can be checked by sequence flug with R/$\overline{B}$ (for MB98A81183, 8xx73 only), $\overline{Data}$ Polling or Toggle Bit function. See “WRITE OPERATION STATUS”.
- Any commands written to the chip during programming operation will be ignored.

8. Automated Sector Erase Capability

- We can execute the erase operation on any sectors by 6 bus cycle operation.
- A time-out of 50 μs (typ.) from the rising edge of the last Sector Erase command will initiate the Sector Erase command(s).
- Multiple sectors in a chip can be erased concurrently. This sequence is followed with writes of 30H to addresses in other sectors desired to be concurrently erased. The time between writes 30H must be less than 50 μs, otherwise that command will not be accepted. Any command other than Sector Erase or Erase Suspend during this time-out period will reset the chip to Read mode. The automated sector erase begins after the 50 μs (typ.) time out from the rising edge of $\overline{WE}$ pulse for the last Sector Erase command pulse. Whether the sector erase window is still open can be monitored with D_3 and D_{11}.
- Sector Erase does not require the user to program the chip prior to erase. The chip automatically programs “0” to all memory locations in the sector(s) prior to electrical erase. The system is not required to provide any controls or timing during these operations.
- The card returns to Common Memory Read mode automatically after the chip erasing is completed.
- Whether or not sector erase operation is completed successfully can be checked by sequence flug with R/$\overline{B}$, $\overline{Data}$ Polling or Toggle Bit function. The sequence flug must be read from the address of the sector involved in erase operation. See “WRITE OPERATION STATUS”.

9. Erase Suspend

- Erase Suspend command allows the user to interrupt the sector erase operation and then do data reads or program from or to a non-busy sector in the chip which has the sector(s) suspended erase (only data read is possible for MB98A81063). This command is applicable only during the sector erase operation (including the sector erase time-out period after the sector erase commands 30H) and will be ignored if written during the chip erase or programming operation. Writing this command during the time-out will result in immediate termination of the time-out period. The addresses are “don’t cares” in wrinting the Erase Suspend or Resume commands in the chip.
- When the Erase Suspend command is written during a Sector Erase operation, the chip will enter the Erase Suspend Read mode. User can read the data from other sectors than those in suspention. The read operation from sectors in suspention results D_2/D_{10} toggling for MB98A81183 and MB98A8xx73. User can program to non-busy sectors by writing program commands for MB98A81183 and MB98A8xx73.
- A read from a sector being erase suspended may result in invalid data.

10. Intelligent Identifier (ID) Read Mode

- Each common memory can execute an Intelligent Identifier operation, initiated by writing Intelligent ID command (90H). Following the command write, a read cycle from address 00H retrieves the manufacture code, and a read cycle from address 01H returns the device code as follows. To terminate the operation, it is necessary to write Read/Reset command.

11. Hardware Reset (not applied for MB98A81063)

- The Card may be reset by driving the RESET pin to V_{IH}. The RESET pin must be kept High (V_{IH}) for at least 500 ns. Any operation in progress will be terminated and the card will be reset to the read mode 20 μs after the RESET pin is driven High. If a hardware reset occurs during a program operation, the data at that particular location will be indeterminate.
- When the RESET pin is high and the internal reset is complete, the Card goes to standby mode and cannot be accessed. Also, note that all the data output pins are High-Z for the duration of the RESET pulse. Once the RESET pin is taken low, the Card requires 500 ns of wake up time until outputs are valid for read access.
- If hardware reset occurs during a erase operation, there is a possibility that the erasing sector(s) cannot be used.

■ FUNCTION DESCRIPTIONS (Continued)

12. Data Protection

- The card has WP (Write Protect) switch for write lockout.
- To avoid initiation of a write cycle during V_{CC} power-up and power-down, a write cycle is locked out for V_{CC} less than 3.2 V (typically 3.7 V). If $V_{CC} < V_{LKO}$, the command register is disabled and all internal program/erase circuits are disabled. Under this condition the device will reset to the read mode. Subsequent writes will be ignored until the V_{CC} level is greater than V_{LKO}. It is the users responsibility to ensure that the control pins are logically correct to prevent unintentional writes when V_{CC} is above 3.2 V.
- If V_{CC} would be less than V_{LKO} during program/erase operation, the operation will stop. And after that, the operation will not resume even if V_{CC} returns recommended voltage level. Therefore, program command must be written again because the data on the address interrupted program operation is invalid. And regarding interrupting erase operation, there is possibility that the erasing sector(s) cannot be used.
- Noise pulses of less than 5 ns (typical) on $\overline{OE}$, $\overline{CE}$ or $\overline{WE}$ will not initiate a write cycle.

■ FUNCTION TRUTH TABLE

MAIN MEMORY FUNCTION*1

<table>
<tr><th rowspan="2">Mode</th><th rowspan="2">RESET*3</th><th rowspan="2">$\overline{REG}$</th><th rowspan="2">$\overline{CE2}$</th><th rowspan="2">$\overline{CE1}$</th><th rowspan="2">A_0</th><th rowspan="2">$\overline{OE}$</th><th rowspan="2">$\overline{WE}$</th><th rowspan="2">WP*2</th><th colspan="2">Data Input/Output</th><th rowspan="2">WP SW</th></tr>
<tr><th>D_8 to D_{15}</th><th>D_0 to D_7</th></tr>
<tr><td>Hardware Reset</td><td>H</td><td>X</td><td>X</td><td>X</td><td>X</td><td>X</td><td>X</td><td>X</td><td colspan="2">High-Z</td><td rowspan="5">P or NP</td></tr>
<tr><td>Standby</td><td rowspan="15">L</td><td>X</td><td>H</td><td>H</td><td>X</td><td>X</td><td>X</td><td>X</td><td colspan="2">High-Z</td></tr>
<tr><td>Read (x8 No.1)</td><td rowspan="14">H</td><td rowspan="2">H</td><td rowspan="2">L</td><td>L</td><td rowspan="4">L</td><td rowspan="4">H</td><td rowspan="4">X</td><td rowspan="2">High-Z</td><td>D_{OUT} (Even Byte)</td></tr>
<tr><td>Read (x8 No.1)</td><td>H</td><td>D_{OUT} (Odd Byte)</td></tr>
<tr><td>Read (x8 No.2)</td><td rowspan="2">L</td><td>H</td><td rowspan="2">X</td><td>D_{OUT} (Odd Byte)</td><td>High-Z</td></tr>
<tr><td>Read (x16)</td><td>L</td><td colspan="2">D_{OUT}</td></tr>
<tr><td>Write (x8 No.1)</td><td rowspan="3">H</td><td rowspan="3">L</td><td>L</td><td rowspan="8">H</td><td rowspan="8">L</td><td>L</td><td rowspan="4">High-Z</td><td>D_{IN} (Even Byte)</td><td>NP</td></tr>
<tr><td>Output Disable</td><td>H</td><td>High-Z</td><td>P</td></tr>
<tr><td>Write (x8 No.1)</td><td rowspan="2">H</td><td>L</td><td>D_{IN} (Odd Byte)</td><td>NP</td></tr>
<tr><td>Output Disable</td><td>H</td><td rowspan="3">High-Z</td><td>P</td></tr>
<tr><td>Write (x8 No.2)</td><td rowspan="4">L</td><td rowspan="2">H</td><td rowspan="4">X</td><td>L</td><td>D_{IN} (Odd Byte)</td><td>NP</td></tr>
<tr><td>Output Disable</td><td>H</td><td>High-Z</td><td>P</td></tr>
<tr><td>Write (x16)</td><td rowspan="2">L</td><td>L</td><td colspan="2">D_{IN}</td><td>NP</td></tr>
<tr><td>Output Disable</td><td>H</td><td colspan="2">High-Z</td><td>P</td></tr>
<tr><td>Output Disable</td><td>X</td><td>X</td><td>X</td><td>X</td><td>H</td><td>H</td><td>X</td><td colspan="2">High-Z</td><td>P or NP</td></tr>
</table>

Notes:

*1: H =V_{IH}, L = V_{IL}, X = Either V_{IL} or V_{IH}, WP SW = Write Protect Switch, P = Protect, NP = Non Protect

*2: L-level is output when WPSW = NP. H-level is output when WPSW = P.

*3: Not available for MB98A81063.

■ FUNCTION TRUTH TABLE (Continued)

ATTRIBUTE MEMORY FUNCTION*1

Mode	RESET*3	$\overline{REG}$	$\overline{CE2}$	$\overline{CE1}$	A_0	$\overline{OE}$	$\overline{WE}$	WP*2	Data Input/Output		WP SW
									D_8 to D_{15}	D_0 to D_7	
Standby	L	X	H	H	X	X	X	X	High-Z		P or NP
Read (x8 No.1)	L	H	H	L	L	L	H	X	High-Z	D_{OUT}	P or NP
Read (x8 No.1)					H					H	
Read (x8 No.2)			L	H	X				H	High-Z	
Read (x16)				L						D_{OUT}	
Write (x8 No.1)		H	H	L	L	H	L	L	High-Z	D_{IN}	NP
Output Disable								H		High-Z	P
Write (x8 No.1)					H			L		INVALID D_{IN}	NP
Output Disable								H		High-Z	P
Write (x8 No.2)			L	H	X			L	INVALID D_{IN}		NP
Output Disable								H	High-Z		P
Write (x16)				L				L	INVALID D_{IN}	D_{IN}	NP
Output Disable								H	High-Z		P
Output Disable		X	X	X	X	H	H	X	High-Z		P or NP

Notes:

*1: H = V_{IH}, L = V_{IL}, X = Either V_{IL} or V_{IH}, WP SW = Write Protect Switch, P = Protect, NP = Non Protect

*2: L-level is output when WPSW = NP. H-level is output when WPSW = P.

*3: Not available for MB98A81063.

■ COMMAND DEFINITION TABLE

Command table for 8-bit Mode

Command	Bus Cycle	1st Bus Write Cycle		2nd Bus Write/Read Cycle		3rd Bus Write Cycle		4th Bus Write/Read Cycle		5th Bus Write Cycle		6th Bus Write Cycle	
Read/Reset 1	2	Write		Read									
		CA	F0H	RA	RD								
Read/Reset 2	4	Write		Write		Write		Read					
		RCMA1	AAH	RCMA2	55H	RCMA1	F0H	RA	RD				
Read Intelligent ID Codes	4	Write		Write		Write		Read					
		ICMA1	AAH	ICMA2	55H	ICMA1	90H	IA	ID				
Byte Program	4	Write		Write		Write		Write					
		PCMA1	AAH	PCMA2	55H	PCMA1	A0H	PA	PD				
Sector Erase	6	Write		Write		Write		Write		Write		Write	
		SCMA1	AAH	SCMA2	55H	SCMA1	80H	SCMA1	AAH	SCMA2	55H	SA	30H
Chip Erase	6	Write		Write		Write		Write		Write		Write	
		CCMA1	AAH	CCMA2	55H	CCMA1	80H	CCMA1	AAH	CCMA2	55H	CCMA1	10H
Sector Erase Suspend	1	Write											
		CA	B0H										
Sector Erase Resume	1	Write											
		CA	30H										

Notes:

CA: Chip Address. (address in chip selected by A_0, A_{22}, A_{23} and A_{24})
SA: Sector Address (address in 64 KB selected by A_0, A_{17}, A_{18}, A_{19}, A_{20}, A_{21}, A_{22}, A_{23} and A_{24})
PA: Program Address (address to be programmed)
RA: Read Address (address to be read)
IA: Intelligent ID read address (Manufacture Code 0000H, Device Code 0002H)

PD: Programming data
RD: Read data
ID: Intelligent Identifier (ID) Code

CCMA1, CCMA2: Command adddress for chip erase
SCMA1, SCMA2: Command address for sector erase
PCMA1, PCMA2: Command address for program
RCMA1, RCMA2: Command address for Read/Reset
ICMA1, ICMA2: Command address for intelligent ID read

See “Command Address Table for 8-bit Mode” in page 17.

Command Table for 16-bit Mode*1

Command	Bus Cycle	1st Bus Write Cycle		2nd Bus Write/Read Cycle		3rd Bus Write Cycle		4th Bus Write/Read Cycle		5th Bus Write Cycle		6th Bus Write Cycle	
Read/Reset 1	2	Write		Read									
		—	F0F0H	RA	RD								
Read/Reset 2	4	Write		Write		Write		Read					
		RCMA1	AAAAH	RCMA2	5555H	RCMA1	F0F0H	RA	RD				
Read Intelligent ID Codes	4	Write		Write		Write		Read					
		ICMA1	AAAAH	ICMA2	5555H	ICMA1	9090H	IA	ID				
Byte Program	4	Write		Write		Write		Write					
		PCMA1	AAAAH	PCMA2	5555H	PCMA1	A0A0H	PA	PD				
Sector Erase	6	Write		Write		Write		Write		Write		Write	
		SCMA1	AAAAH	SCMA2	5555H	SCMA1	8080H	SCMA1	AAAAH	SCMA2	5555H	SA	3030H
Chip Erase	6	Write		Write		Write		Write		Write		Write	
		CCMA1	AAAAH	CCMA2	5555H	CCMA1	8080H	CCMA1	AAAAH	CCMA2	5555H	CCMA1	1010H
Sector Erase Suspend	1	Write											
		CA	B0B0H										
Sector Erase Resume	1	Write											
		CA	3030H										

Notes:

CA: Chip Address. (address in chip selected by A_{22}, A_{23} and A_{24})
SA: Sector Address (address in 128 KB selected by A_{17}, A_{18}, A_{19}, A_{20}, A_{21}, A_{22}, A_{23} and A_{24})
PA: Program Address (address to be programmed)
RA: Read Address (address to be read)
IA: Intelligent ID read address (Manufacture Code 0000H, Device Code 0001H)

PD: Programming data
RD: Read data
ID: Intelligent Identifier (ID) Code

CCMA1, CCMA2: Command address for chip erase
SCMA1, SCMA2: Command address for sector erase
PCMA1, PCMA2: Command address for program
RCMA1, RCMA2: Command address for Read/Reset
ICMA1, ICMA2: Command address for intelligent ID read

See “Command Address Table for 16-bit Mode” in page 17.

*1: Address number is not contained “A_0”.

■ COMMAND DEFINITION TABLE (Continued)

Command Address Table for 8-bit Mode

Command Address	MB98A81063	MB98A81183	MB98A81273, 81373, 81473, 81573
CCMA1	(CA AND 000001h) OR AAAAh	(CA AND 000001h) OR AAAh	CA
CCMA2	(CA AND 000001h) OR 5554h	(CA AND 000001h) OR 554h	CA
SCMA1	(SA AND 000001h) OR AAAAh	(SA AND 000001h) OR AAAh	CA
SCMA2	(SA AND 000001h) OR 5554h	(SA AND 000001h) OR 554h	CA
PCMA1	(PA AND 000001h) OR AAAAh	(PA AND 000001h) OR AAAh	CA
PCMA2	(PA AND 000001h) OR 5554h	(PA AND 000001h) OR 554h	CA
RCMA1	(RA AND 000001h) OR AAAAh	(RA AND 000001h) OR AAAh	CA
RCMA2	(RA AND 000001h) OR 5554h	(RA AND 000001h) OR 554h	CA
ICMA1	(IA AND 000001h) OR AAAAh	(IA AND 000001h) OR AAAh	CA
ICMA1	(IA AND 000001h) OR 5554h	(IA AND 000001h) OR 554h	CA

Command Address Table for 16-bit Mode

Command Address	MB98A81063	MB98A81183	MB98A81273, 81373, 81473, 81573
CCMA1	5555h	555h	CA
CCMA2	2AAAh	2AAh	CA
SCMA1	5555h	555h	CA
SCMA2	2AAAh	2AAh	CA
PCMA1	5555h	555h	CA
PCMA2	2AAAh	2AAh	CA
RCMA1	5555h	555h	CA
RCMA2	2AAAh	2AAh	CA
ICMA1	5555h	555h	CA
ICMA1	2AAAh	2AAh	CA

■ WRITE OPERATION STATUS

Hardware Sequence Flag Table

Status			D_7, D_{15}	D_6, D_{14}	D_5, D_{13}	D_3, D_{11}	D_2, D_{10}*4	R/$\overline{B}$*4
In Progress	Programming		$\overline{D_7}$, $\overline{D_{15}}$	Toggle	0	0	1	0
	Erasing		0	Toggle	0	1	Toggle	0
	Erase Suspend Read	(1)	1	1	0	1	*1	1
		(2)	Data	Data	Data	Data	Data	1
	Erase Suspend*4 Program		$\overline{D_7}$, $\overline{D_{15}}$	*2	0	1	*1, *3	0
Exceeded Time Limits	Programming		$\overline{D_7}$, $\overline{D_{15}}$	Toggle	1	0	1	0
	Erasing		0	Toggle	1	1	N/A	0
	Erase Suspend*4 Program		$\overline{D_7}$, $\overline{D_{15}}$	Toggle	1	1	N/A	0

Notes:

(1): Erase Suspended Sector (2): Non-Erase Suspended Sector

*1. Performing successive read operations from the erase-suspended sector will cause D_2, D_{10} to toggle.

*2. Performing successive read operations from any address will cause D_6, D_{14} to toggle.

*3. Reading the byte address being programmed while in the erase-suspend program mode will indicate logic "1" at the D_2, D_{10} bit. However, successive reads from the erase-suspended sector will cause D_2, D_{10} to toggle.

*4. Not applied for MB98A81063.

D_7, D_{15} ($\overline{Data}$ Polling)

The card features $\overline{Data}$ Polling as a method to indicate to the host that the Program/Erase Operation are in progress or completed. During the program operation an attempt to read the program address will produce the compliment of the data last written to D_7/D_{15}. Upon completion of the program operation, an attempt to read the program address will produce the true data last written to D_7/D_{15}. During the erase operation, an attempt to read the program address will produce a "0" at the D_7/D_{15} output. Upon completion of the erase operation an attempt to read the device will produce a "1" at the D_7/D_{15} output.
For Chip Erase, the $\overline{Data}$ Polling is valid after the rising edge of the sixth $\overline{WE}$ pulse in the six write pulse sequence. For sector erase, the $\overline{Data}$ Polling is valid after the last rising edge of the sector erase $\overline{WE}$ pulse. Even if the device has completed the operation and D_7/D_{15} has a valid data, the data outputs on D_0 to D_6/D_8 to D_{14} may be still invalid. The valid data on D_0 to D_7/D_8 to D_{15} will be read on the successive read attempts.

The $\overline{Data}$ Polling feature is only active during the programming operation, erase operation, sector erase time-out, Erase Suspend Read mode and Erase Suspend Program mode.

D_6, D_{14} (Toggle Bit I)

The card also features the "Toggle Bit" as a method to indicate to the host system that the Program/Erase Operation are in progress or completed.

During an Program or Erase cycle, successive attempts to read ($\overline{OE}$ or $\overline{CE}$ toggling) data from the card will result in D_6/D_{14} toggling between one and zero. Once the Program or Erase cycle is completed, D_6/D_{14} will stop toggling and valid data will be read on the next successive attempts. During programming, the Toggle Bit is valid after the rising edge of the fourth $\overline{WE}$ pulse in the four write pulse sequence. For chip erase, the Toggle Bit is valid after the rising edge of the sixth $\overline{WE}$ pulse in the six write pulse sequence. For sector erase, the Toggle Bit is valid after the last rising edge of the sector erase $\overline{WE}$ pulse. The Toggle Bit is also active during the sector time out.
Either $\overline{CE}$ or $\overline{OE}$ toggling will cause the D_6/D_{14} to toggle.

D_5, D_{13} (Exceeded Timing Limits)

D_5/D_{13} will indicate if the program or erase time has exceeded the specified limits (internal pulse count). Under these conditions D_5/D_{13} will produce a "1". This is a failure condition which indicates that the program or erase cycle was not successfully completed. $\overline{\text{Data}}$ Polling is the only operating function of the card under this condition. If this failure condition occurs during sector erase operation, it specifies that a particular sector is bad and it may not be reused, however, other sectors are still functional and may be used for the program or erase operation. The chip must be reset to use other sectors. Write the Reset command sequence to the chip, and then execute Program or Erase command sequence. This allows the system to continue to use the other active sectors in the chip.

If this failure condition occurs during the chip erase operation, it specifies that the entire chip is bad or combination of sectors are bad.

If this failure condition occurs during the byte programming operation, it specifies that the entire sector containing that byte is bad and this sector may not be reused, (other sectors are still functional and can be reused).

The D_5/D_{13} failure condition may also appear if a user tries to program a non blank location without erasing. In this case the card locks out and never completes the card operation. Hence, the system never reads a valid data on D_7/D_{15} bit and D_6/D_{14} never stops toggling. Once the card has exceeded timing limits, the D_5/D_{13} bit will indicate a "1". Please note that this is not a device failure condition since the device was incorrectly used.

D_3, D_{11} (Sector Erase Timer)

After the completion of the initial sector erase command sequence the sector erase time-out will begin. D_3/D_{11} will remain low until the time-out is complete. $\overline{\text{Data}}$ Polling and Toggle Bit are valid after the initial sector erase command sequence.
If $\overline{\text{Data}}$ Polling or the Toggle Bit indicates the card has been written with a valid erase command, D_3/D_{11} may be used to determine if the sector erase timer window is still open. If D_3/D_{11} is high ("1") the internally controlled erase cycle has begun; attempts to write subsequent commands to the card will be ignored until the erase operation is completed as indicated by $\overline{\text{Data}}$ Polling or Toggle Bit. If D_3/D_{11} is low ("0"), the card will accept additional sector erase commands. To insure the command has been accepted, the system software should check the status of D_3/D_{11} prior to and following each subsequent sector erase command. If D_3/D_{11} were high on the second status check, the command may not have been accepted.

Refer to Table : Hardware Sequence Flags.

D_2, D_{10} (Toggle Bit ll, not applied for MB98A81063)

This Toggle bit, along with D_6, can be used to determine whether the card is in the Erase operation or in Erase Suspend.

Successive reads from the erasing sector will cause D_2 to toggle during the Erase operation. If the card is in the erase-suspended-read mode, successive reads from the erase-suspended sector will cause D_2 to toggle. When the card is in the erase-suspended-program mode, successive reads from the byte address of the non-erase suspended sector will indicate a logic '1' at the D_2 bit.

D_6 is different from D_2 in that D_6 toggles only when the standard Program or Erase, or Erase Suspend Program operation is in progress.

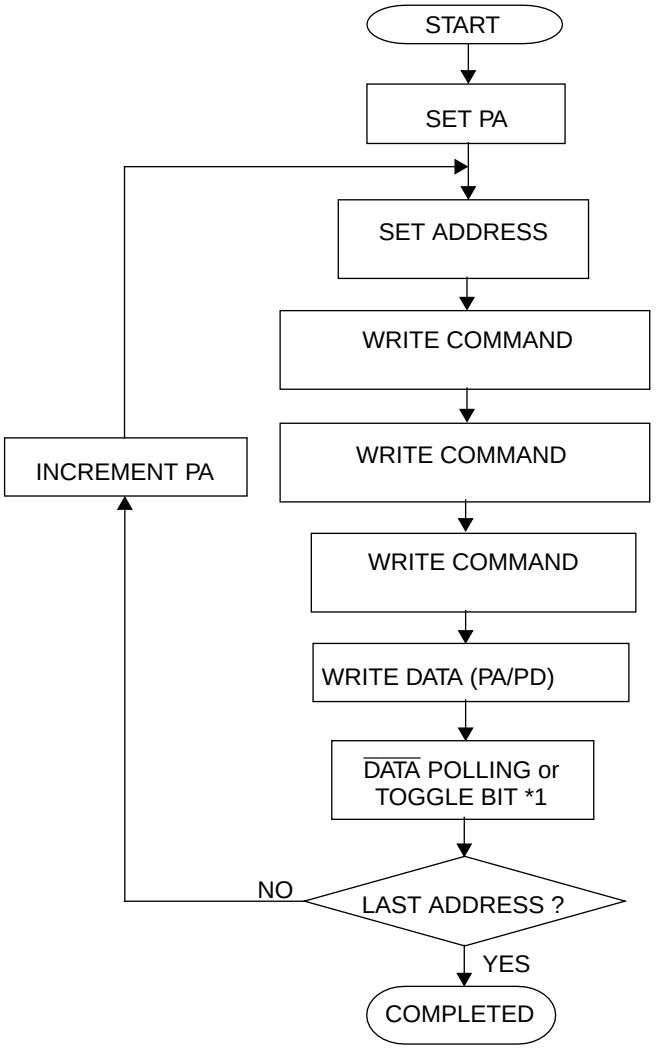
R/$\overline{\text{B}}$ (Ready/$\overline{\text{Busy}}$, not applied for MB98A81063)

The card provides a R/$\overline{\text{B}}$ open-drain output pin as a way to indicate to the system that the program or erase operation are either in progress or has been completed. If the output is low, the card is busy with either a program or erase operation. If the card is placed in an Erase Suspend mode, the R/$\overline{\text{B}}$ output will be high.

During programming, the R/$\overline{\text{B}}$ pin is driven low after the rising edge of the fourth $\overline{\text{WE}}$ pulse. During an erase operation, the R/$\overline{\text{B}}$ pin is driven low after the rising edge of the sixth $\overline{\text{WE}}$ pulse. The R/$\overline{\text{B}}$ pin will indicate a busy condition during the RESET pulse.

■ PROGRAM / ERASE FLOWCHART

Fig. 3 - PROGRAM FLOWCHART



*1 See Fig. 7, 6, 9, 10.

*2 See “COMMAND DEFINITION TABLE”.

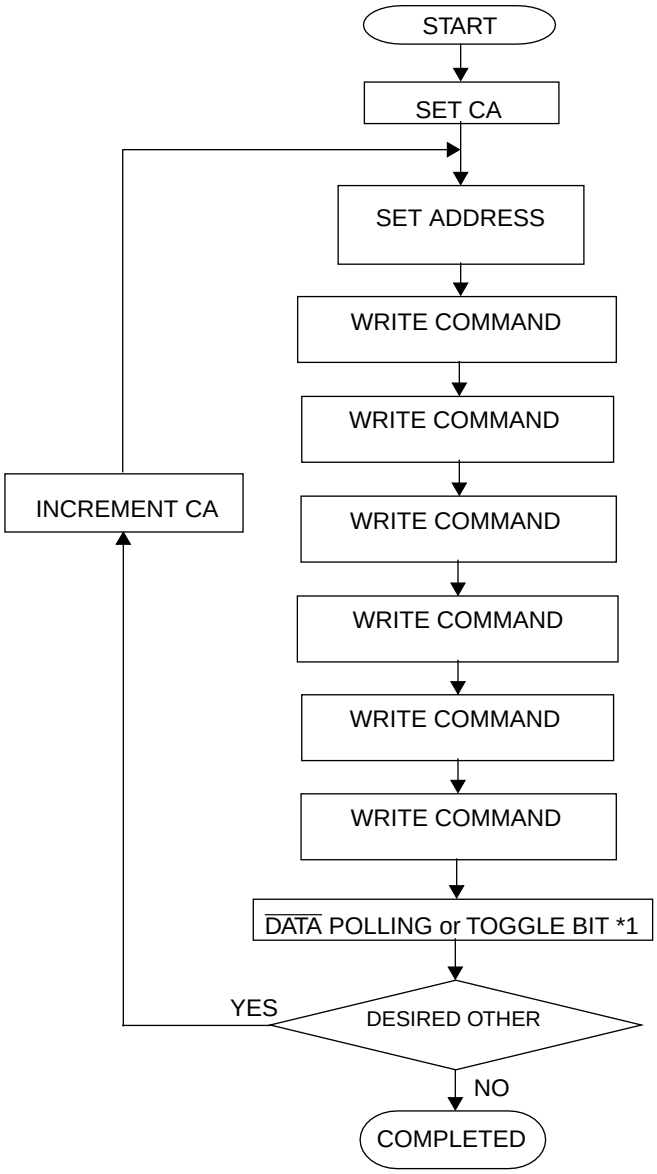
Notes:

PD : PROGRAM DATA

PA : PROGRAM ADDRESS

■ PROGRAM / ERASE FLOWCHART (Continued)

Fig. 4 - CHIP ERASE FLOWCHART



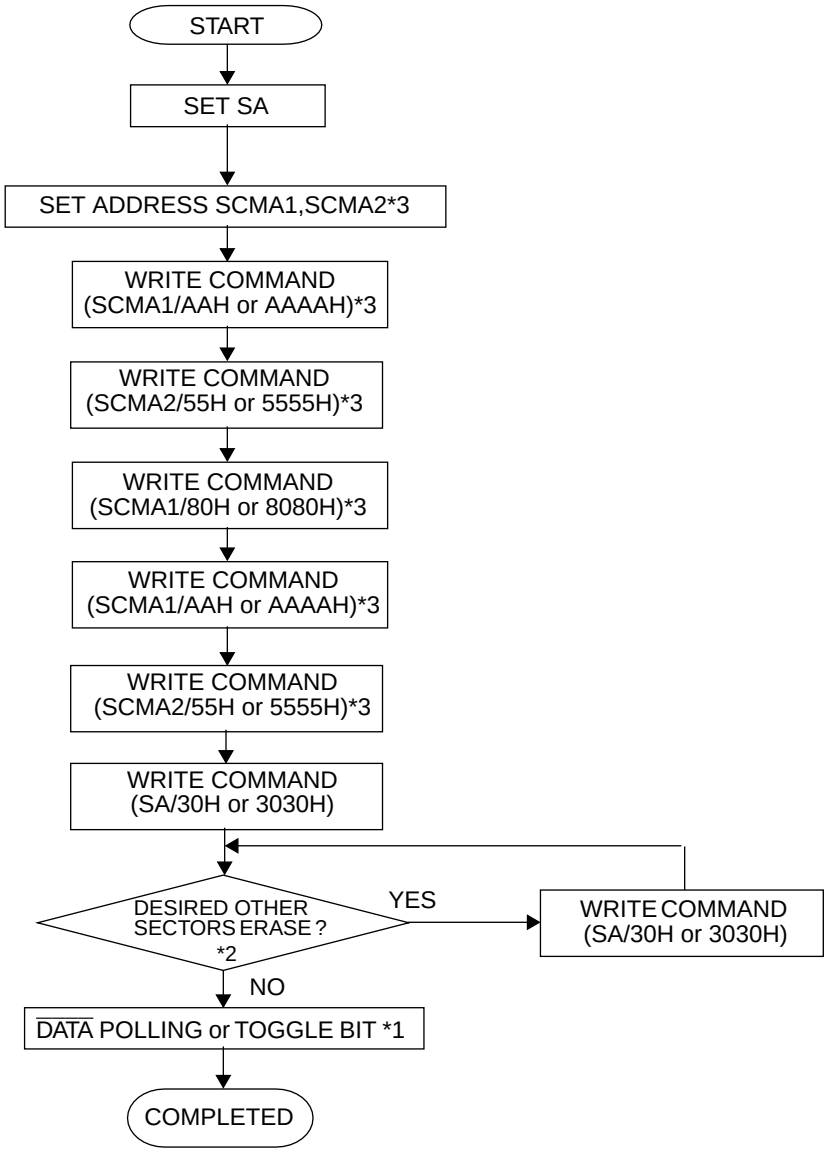
*1 See Fig. 7, 8, 9, 10.
*2 See “COMMAND DEFINITION TABLE”.

Note:

CA : CHIP ADDRESS

■ PROGRAM / ERASE FLOWCHART (Continued)

Fig. 5 - SECTOR ERASE FLOWCHART



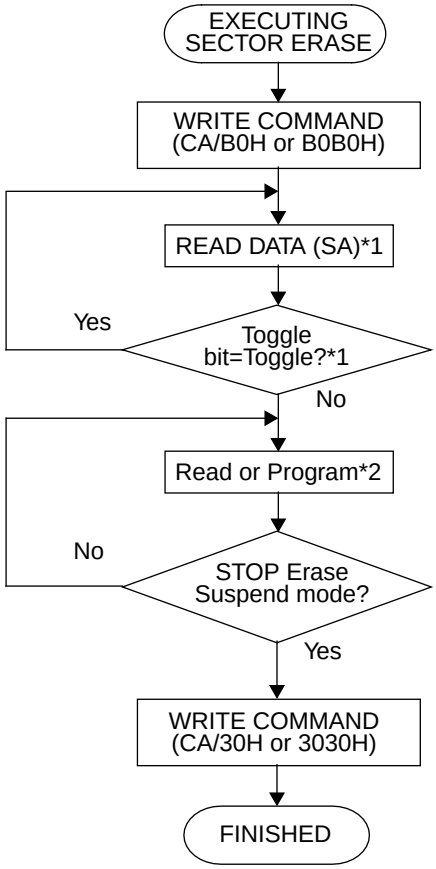
*1 See Fig.7, 8, 9, 10.
*2 Possible for the sectors in a chip
*3 See “COMMAND DEFINITION TABLE”.

Note:

SA : SECTOR ADDRESS

■ PROGRAM / ERASE FLOWCHART (Continued)

Fig. 6 - ERASE SUSPEND FLOWCHART



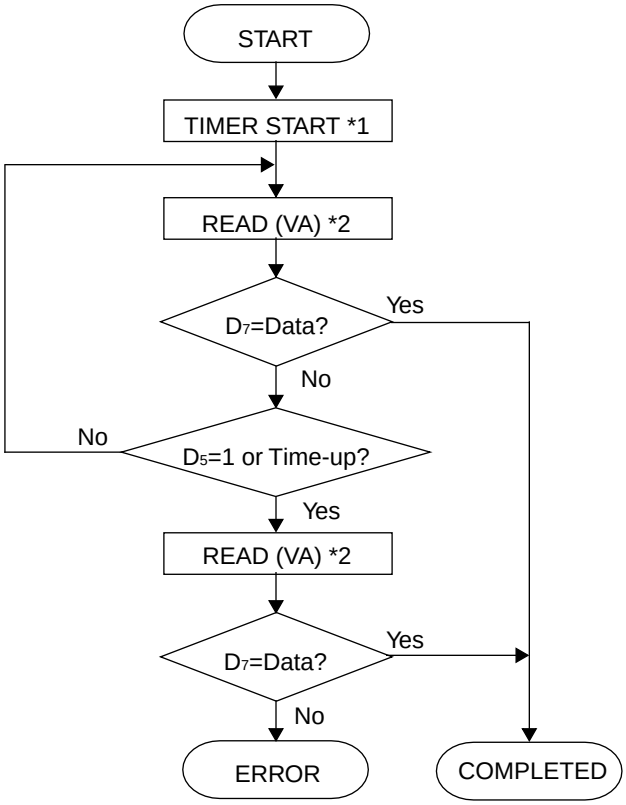
*1 Detection whether suspend mode is valid can be done by Data Polling and R/B also. (MB98A81063 does not have R/B).
*2 Only Read operation for MB98A81063.

Notes:

CA: CHIP ADDRESS
SA: SECTOR ADDRESS
RA: READ ADDRESS

■ PROGRAM / ERASE FLOWCHART (Continued)

Fig. 7 - $\overline{DATA}$ POLLING FLOWCHART: x8 bit mode No.1

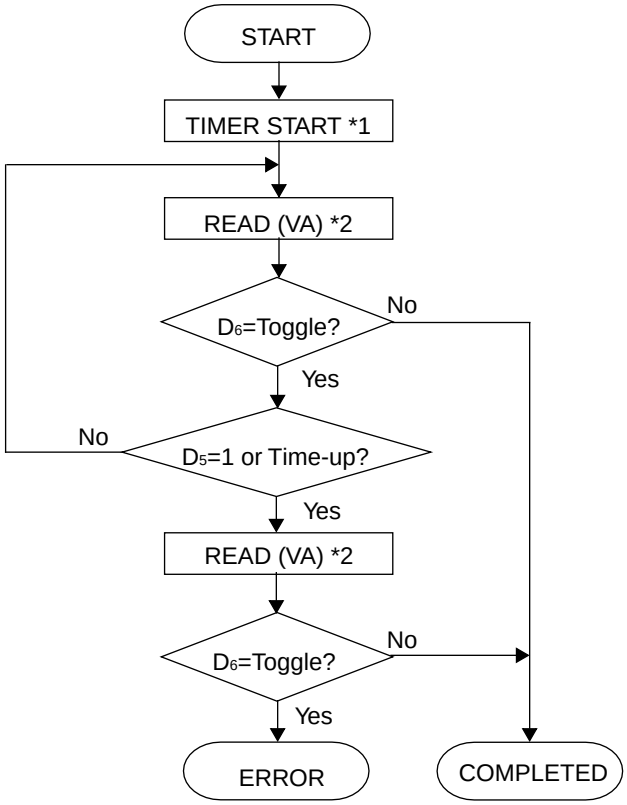


*1 User sets the time period referring to "PROGRAM AND ERASE PERFORMANCES".

*2 ProgramVA=PA
Chip EraseVA=CA
Sector EraseVA=SA

■ PROGRAM / ERASE FLOWCHART (Continued)

Fig. 8 - TOGGLE BIT FLOWCHART: x8 bit mode No.1

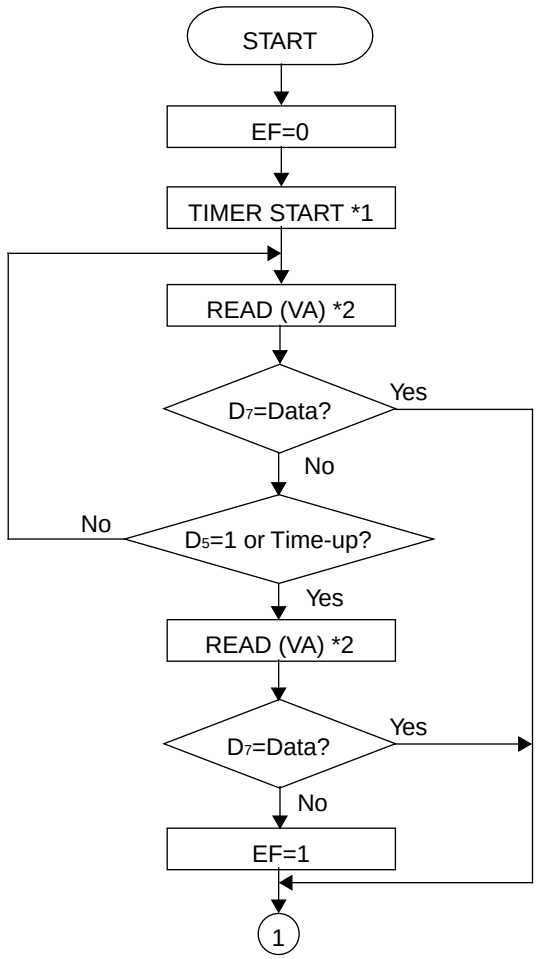


*1 User sets the time period referring to
"PROGRAM AND ERASE PERFORMANCES".

*2 Program VA=PA
Chip Erase VA=CA
Sector Erase VA=SA

■ PROGRAM / ERASE FLOWCHART (Continued)

Fig. 9 - $\overline{\text{DATA}}$ POLLING FLOWCHART: x16 bit mode

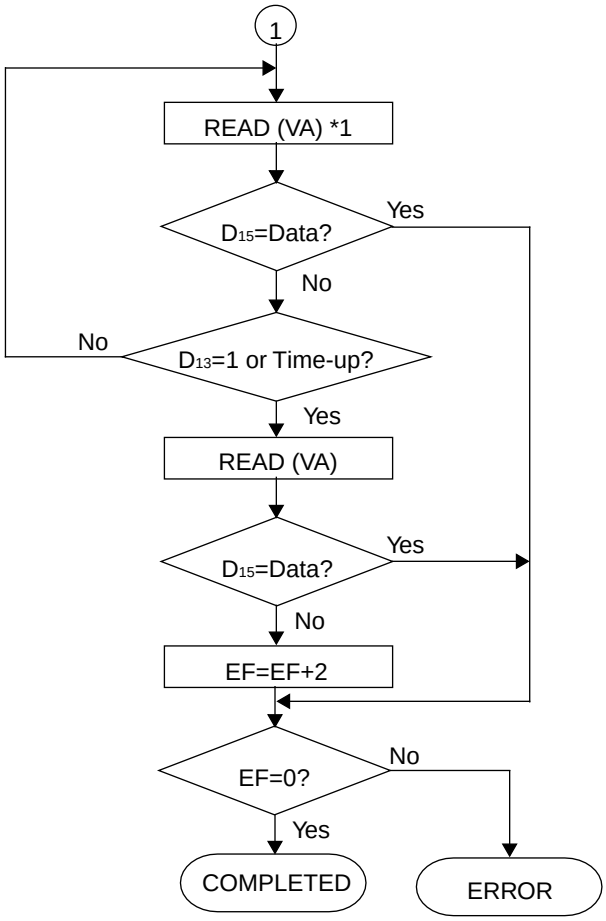


*1 User sets the time period referring to "PROGRAM AND ERASE PERFORMANCES".

*2 Program VA=PA
Chip Erase VA=CA
Sector Erase VA=SA

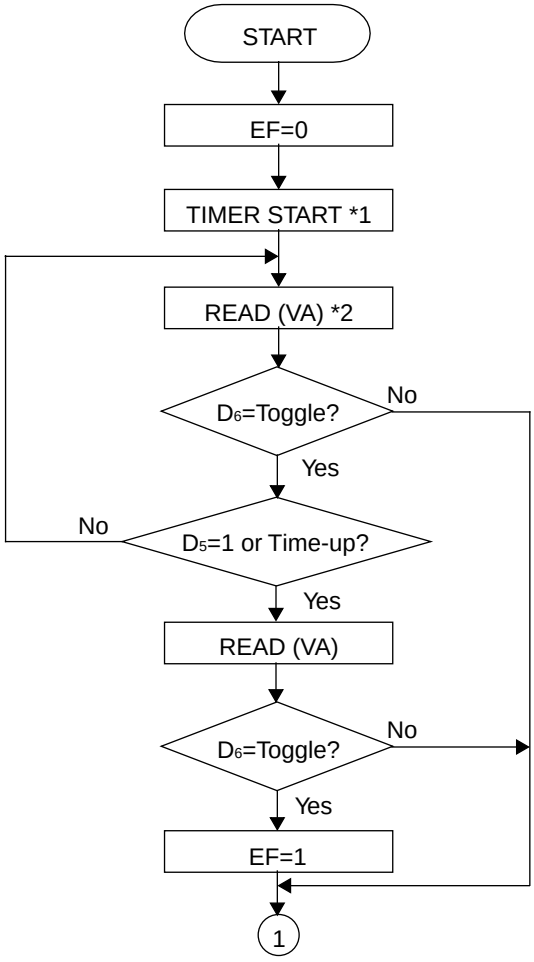
Notes:

EF: Error Flag
EF=0: Operation Completed
EF=1: Lower Byte Error
EF=2: Upper Byte Error
EF=3: Lower/Upper Byte Error



■ PROGRAM / ERASE FLOWCHART (Continued)

Fig. 10 - TOGGLE BIT FLOWCHART: x16 bit mode

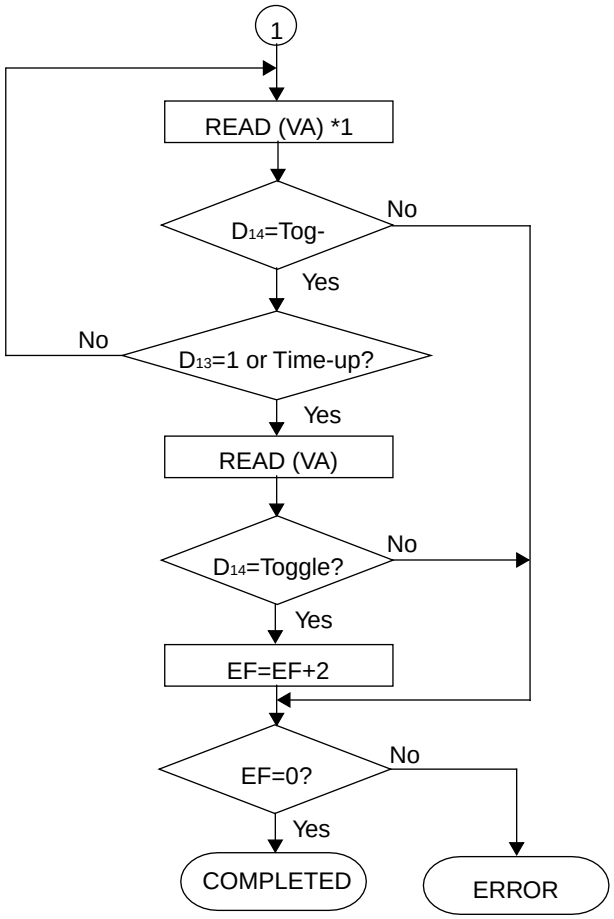


*1 User sets the time period referring to "PROGRAM AND ERASE PERFORMANCES".

*2 Program VA=PA
Chip Erase VA=CA
Sector Erase VA=SA

Notes:

EF: Error Flag
EF=0: Operation Completed
EF=1: Lower Byte Error
EF=2: Upper Byte Error
EF=3: Lower/Upper Byte Error



■ RECOMMENDED OPERATING CONDITIONS

Parameter	Symbol	Min.	Typ.	Max.	Unit
V_{CC} Supply Voltage	V_{CC}	4.75	5.0	5.25	V
Ground	GND		0		V
Ambient Temperature	T_A	0		55	°C

■ DC CHARACTERISTICS

Parameter	Test Conditons	Symbol	Value			Unit
			Min.	Typ.	Max.	
Input Leakage Current *1	V_{CC} = V_{CC} max., V_{IN} = 0 V or V_{CC}	I_{LI}		±1.0	±20	µA
Output Leakage Current *2	V_{CC} = V_{CC} max., V_{IN} = 0 V or V_{CC}	I_{LO}		±1.0	±20	µA
Standby Current	V_{CC} = V_{CC} max. $\overline{CE}1$, $\overline{CE}2$ = V_{CC} V_{IN} = 0 V or V_{CC}	I_{SB1}		0.5	1.7	mA
	V_{CC} = V_{CC} max., $\overline{CE}1$, $\overline{CE}2$ = V_{IH} V_{IN} = V_{IL} or V_{IH}	I_{SB2}		4.0	8.0	mA
Active Read Current	V_{CC} = V_{CC} max., $\overline{CE}1$, $\overline{CE}2$ = V_{IL} Cycle = 200 ns, I_{OUT} = 0 mA	I_{CC1}		100	160	mA
Program Current	Program in progress (x16 mode)	I_{CC2}			120	mA
Erase Current	Erase in progress (x16 mode)	I_{CC3}			120	mA
Input Low Voltage	—	V_{IL}	–0.3	—	0.8	V
Input High Voltage	—	V_{IH}	2.4	—	V_{CC}+0.3	V
Output Low Voltage	I_{OL} = 3.2 mA, V_{CC} = V_{CC} min.	V_{OL}			0.4	V
Output High Voltage *3	I_{OH} = 2.0 mA, V_{CC} = V_{CC} min.	V_{OH}	3.8			V
Low V_{CC} Lock-out Voltage	Common Memory Attribute Memory	V_{LKO}	3.2 —	3.7 3.8	4.2 —	V V

Notes:
*1 This value does not apply to $\overline{CE}1$, $\overline{CE}2$, $\overline{WE}$ and $\overline{REG}$.
*2 This value does not apply to BVD1, BVD2, CD1 and CD2.
*3 This value does not apply to BVD1 and BVD2.

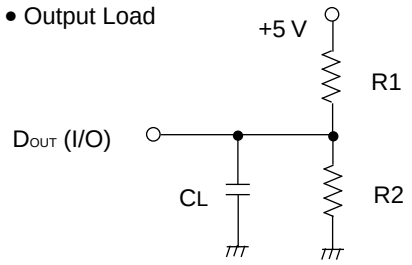
■ CAPACITANCE (T_A = 25°C, f = 1 MHz, V_{IN} = $V_{I/O}$ = GND)

Parameter	Symbol	Min.	Max.	Unit
Input Capacitance *1	C_{IN}		75	pF
I/O Capacitance *2	$C_{I/O}$		50	pF

Notes:
*1 This value does not apply to $\overline{CE}1$, $\overline{CE}2$, $\overline{WE}$, $\overline{REG}$ and RESET.
*2 This value does not apply to $\overline{CD}1$, $\overline{CD}2$, BVD1 and BVD2.

■ AC TEST CONDITIONS

Fig. 11 - AC TEST CONDITIONS



- Input Pulse Levels: V_{IH} = 2.6 V, V_{IL} = 0.6 V
- Input Pulse Rise and Fall Times: 5 ns
  (Transient between 0.8 V and 2.4 V)

Input: V_{IL} = 0.8 V, V_{IH} = 2.4 V
Output: V_{OL} = 0.8 V, V_{OH} = 2.0 V

* Including jig and stray capacitance

	R1	R2	CL	Parameter Measured
Load I	1.8 kΩ	990 Ω	100 pF	All parameters except tCLZ, tOLZ, tCHZ, tOHZ, tRCLZ, tROLZ,
Load II	1.8 kΩ	990 Ω	5 pF	tCLZ, tOLZ, tCHZ, tOHZ, tRCLZ, tROLZ, tRCHZ and tROHZ

■ PROGRAM AND ERASE PERFORMANCES

MAIN MEMORY PROGRAM / ERASE PERFORMANCE

(MB98A81063)

Parameter	Min.	Typ.	Max.	Unit
Byte Program Time *1		16	1000	µs
Chip Programming Time *1		8.5	50	Sec.
Sector Erase Time *2		1.5	30	Sec.
Program/Erase Cycles	100,000	1,000,000		Cycles

Notes:
*1 Excludes system-level overhead.
*2 Excludes 00H programming prior to erasure.

(MB98A81183)

Parameter	Min.	Typ.	Max.	Unit
Byte Program Time *1		8	2000	µs
Chip Programming Time *1		8	25	Sec.
Sector Erase Time *2		1	15	Sec.
Program/Erase Cycles	100,000	1,000,000		Cycles

Notes:
*1 Excludes system-level overhead.
*2 Excludes 00H programming prior to erasure.

■ PROGRAM AND ERASE PERFORMANCES (Continued)

(MB98A81273, 81373, 81473, 81573)

Parameter	Min.	Typ.	Max.	Unit
Byte Programming Time *1		8	2000	µs
Chip Programming Time *1		16	50	Sec.
Sector Erase Time *2		1	15	Sec.
Program/Erase Cycles	100,000	1,000,000		Cycles

Notes:
*1 Excludes system-level overhead.
*2 Excludes 00H programming prior to erasure.

ATTRIBUTE MEMORY PROGRAM PERFORMANCE

Parameter	Min.	Typ.	Max.	Unit
Byte Program Time			1	ms
Number of Program per Byte	100,000			Times

■ AC CHARACTERISTICS

(Recommended operating conditions unless otherwise noted.)

MAIN MEMORY READ CYCLE*1

Parameter	Symbol	Min.	Max.	Unit
Read Cycle Time	tRC	150		ns
Card Enable Access Time	tCE		150	ns
Address Access Time	tACC		150	ns
Output Enable Access Time	tOE		75	ns
Card Enable to Output in Low-Z*2	tCLZ	5		ns
Card Disable to Output in High-Z*2	tCHZ		60	ns
Output Enable to Output in Low-Z*2	tOLZ	5		ns
Output Disable to Output in High-Z*2	tOHZ		60	ns
Output Hold from Address, $\overline{CE}$, or $\overline{OE}$ Change *3	tOH	5		ns
Ready Time from RESET	tRDY		20	ms

Notes:
*1 Rise/Fall time < 5 ns.
*2 Transition is measured at the point of ±500 mV from steady state voltage. This parameter is specified using Load ll in Fig. 11.
*3 This parameter is specified from the rising edge of $\overline{OE}$, $\overline{CE}$1 or $\overline{CE}$2, whichever occurs first.

■ AC CHARACTERISTICS (Continued)

(Recommended operating conditions unless otherwise noted.)

MAIN MEMORY PROGRAM / ERASE CYCLE*1 *2

Parameter	Symbol	Min.	Typ.	Max.	Unit
Write Cycle Time	tWC	150			ns
Address Setup Time	tAS	20			ns
Address Hold Time	tAH	20			ns
Data Setup Time	tDS	50			ns
Data Hold Time	tDH	20			ns
Read Recovery Time ($\overline{WE}$ control)	tGHWL	10			ns
Read Recovery Time ($\overline{CE}$ control)	tGHEL	10			ns
Output Enable Hold Time	tOEH	10			ns
Card Enable Setup Time	tCS	20			ns
Card Enable Hold Time	tCH	0			ns
Write Enable Pulse Width	tWP	80			ns
Write Enable Setup Time	tWS	0			ns
Write Enable Hold Time	tWH	0			ns
Card Enable Pulse Width	tCP	100			ns
Duration of Byte Program Operation (/$\overline{WE}$ control)	tWHWH1		8		µs
Duration of Erase Operation *3 (/$\overline{WE}$ control)	tWHWH2		1	15	s
Duration of Byte Program Operation (/$\overline{CE}$ control)	tEHEH1		8		µs
Duration of Erase Operation *3 (/$\overline{CE}$ control)	tEHEH2		1	15	s
V_{CC} Setup Time *4	tVCS	50			µs
Reset Pulse Width	tRP	500			ns
Busy Delay Time	tBSY	100			ns

Notes:

*1 Read timing parameters during Program/Erase operations are the same as those during read only operations. Refer to AC characteristics for Main Memory Read Cycle.

*2 Rise/Fall time ≤ 5 ns.

*3 These do not include the preprogramming time.

*4 Not 100% tested.

■ AC CHARACTERISTICS (Continued)

ATTRIBUTE MEMORY READ CYCLE *1

Parameter	Symbol	Min.	Max.	Unit
Read Cycle Time	tRRC	250		ns
Address Access Time	tRAA		250	ns
Card Enable Access Time	tRCE		250	ns
Output Enable Access Time	tROE		125	ns
Output Hold from Address Change	tROH	5		ns
Card Enable to Output Low-Z *2	tRCLZ	5		ns
Output Enable to Output Low-Z *2	tROLZ	5		ns
Card Enable to Output High-Z *2	tRCHZ		60	ns
Output Enable to Output High-Z *2*3	tROHZ		60	ns

Notes:

*1 Rise/Fall time < 5 ns.

*2 Transition is measured at the point of ±500 mV from steady state voltage. This parameter is specified using Load ll in Fig. 3.

*3 This parameter is specified from the rising edge of $\overline{OE}$, $\overline{CE}$1 or $\overline{CE}$2, whichever occurs first.

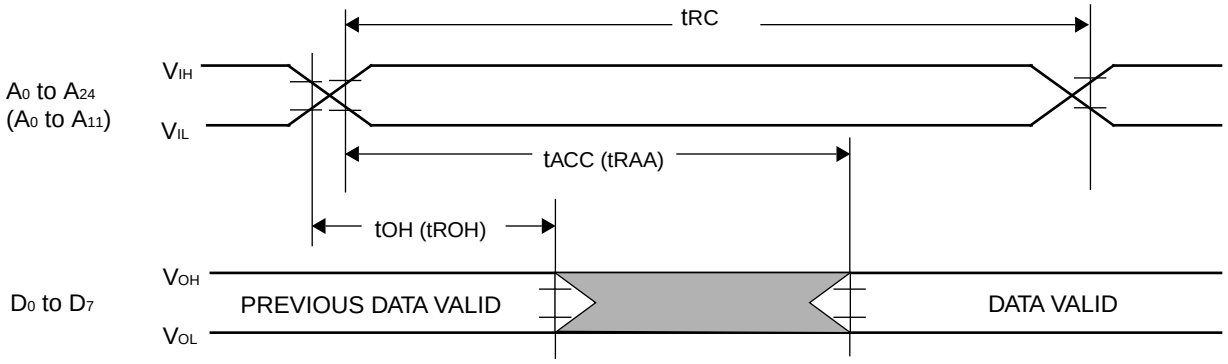
ATTRIBUTE MEMORY PROGRAM CYCLE

Parameter	Symbol	Min.	Max.	Unit
Address Setup Time	tRAS	20		ns
Card Enable Setup Time	tRCS	0		ns
Output Enable Setup Time	tOES	20		ns
Write Pulse Width	tRWP	100	1000	ns
Address Hold Time	tRAH	50		ns
Data Setup Time	tRDS	50		ns
Data Hold Time	tRDH	20		ns
Card Enable Hold Time	tRCH	0		ns
Output Enable Hold Time	tROEH	20		ns
Program Time	tRWR		1	ms

■ TIMING DIAGRAM

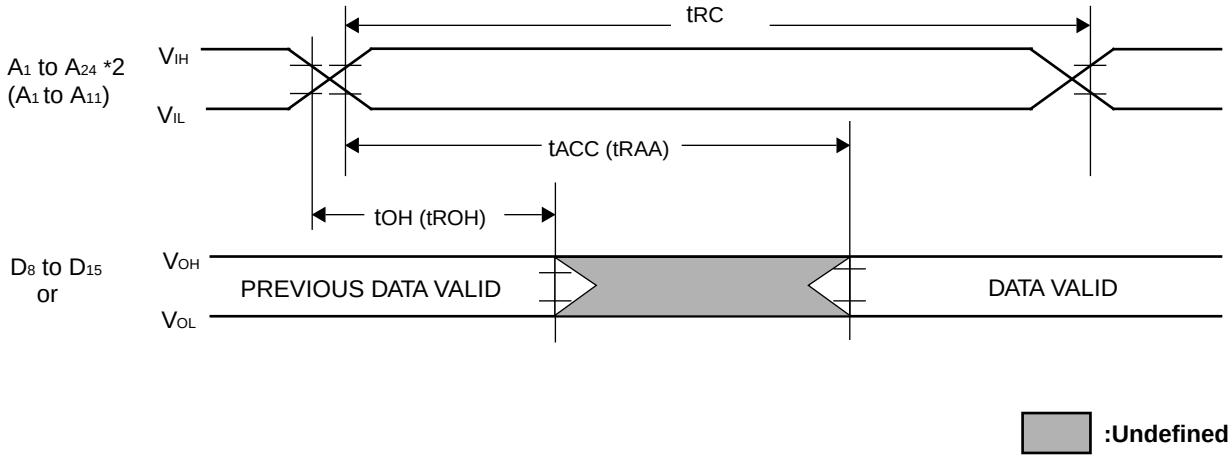
MAIN / ATTRIBUTE MEMORY READ CYCLE TIMING DIAGRAM ($\overline{WE}$ = V_{IH}, $\overline{REG}$ = V_{IH})*1

READ CYCLE 1: $\overline{CE}1$ = $\overline{OE}$ = V_{IL}, $\overline{CE}2$ = V_{IH}: x 8-bit No.1 Bus Organization



READ CYCLE 2: $\overline{CE}1$ = V_{IH}, $\overline{CE}2$ = $\overline{OE}$ = V_{IL}: x 8-bit No.2 Bus Organization

$\overline{CE}1$ = $\overline{CE}2$ = $\overline{OE}$ = V_{IL}: x 16-bit Bus Organization



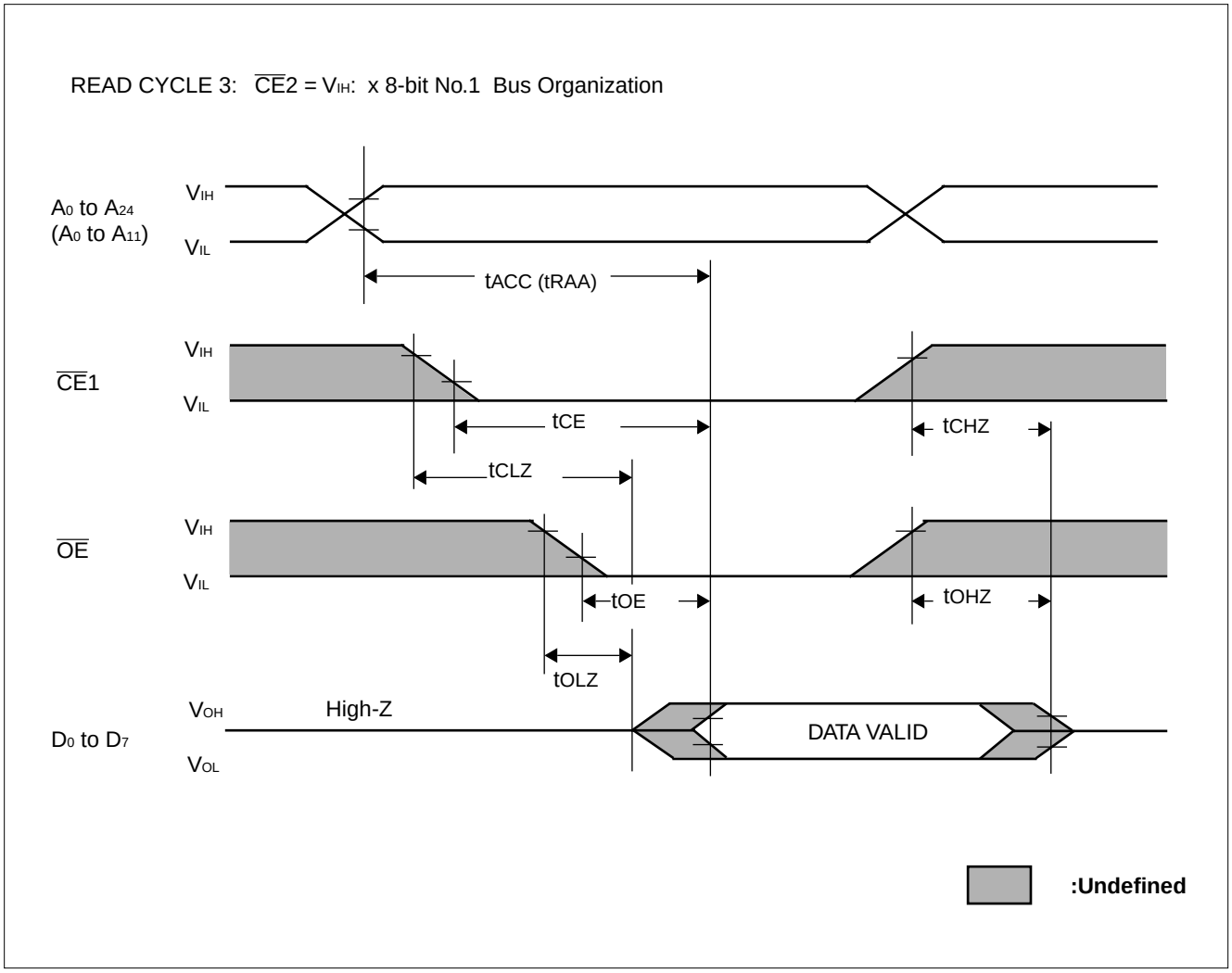
Notes:

*1 The addresses and parameters in ( ) are applied for attribute memory access.

*2 A0 = Either V_{IH} or V_{IL}.

■ TIMING DIAGRAM (Continued)

MAIN / ATTRIBUTE MEMORY READ CYCLE TIMING DIAGRAM (Continued) ($\overline{WE}$ = V_{IH}, $\overline{REG}$ = V_{IH})*1



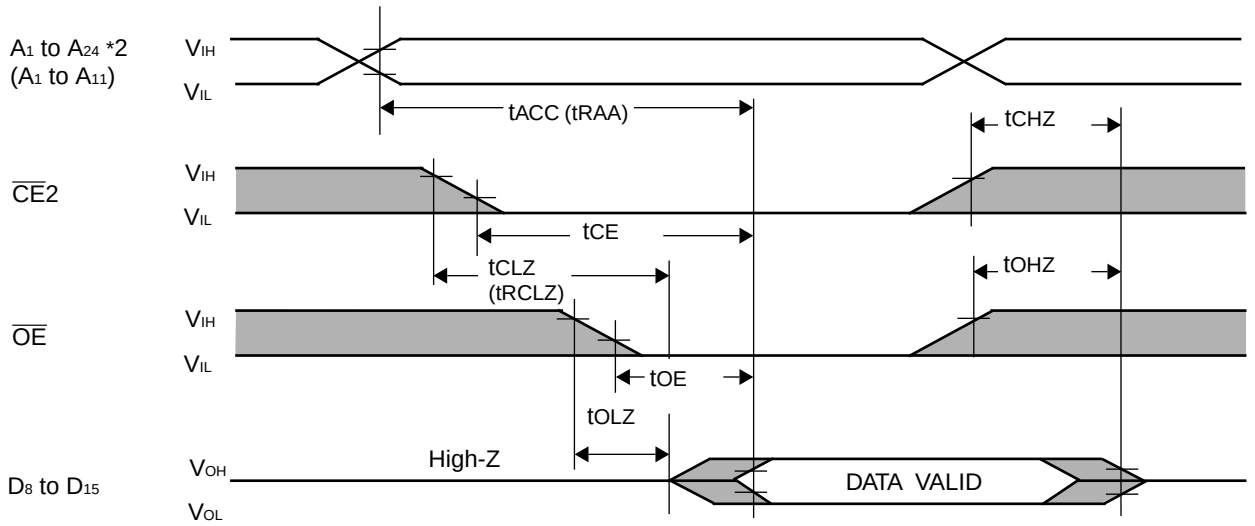
Note:

*1 The addresses and parameters in ( ) are applied for attribute memory access.

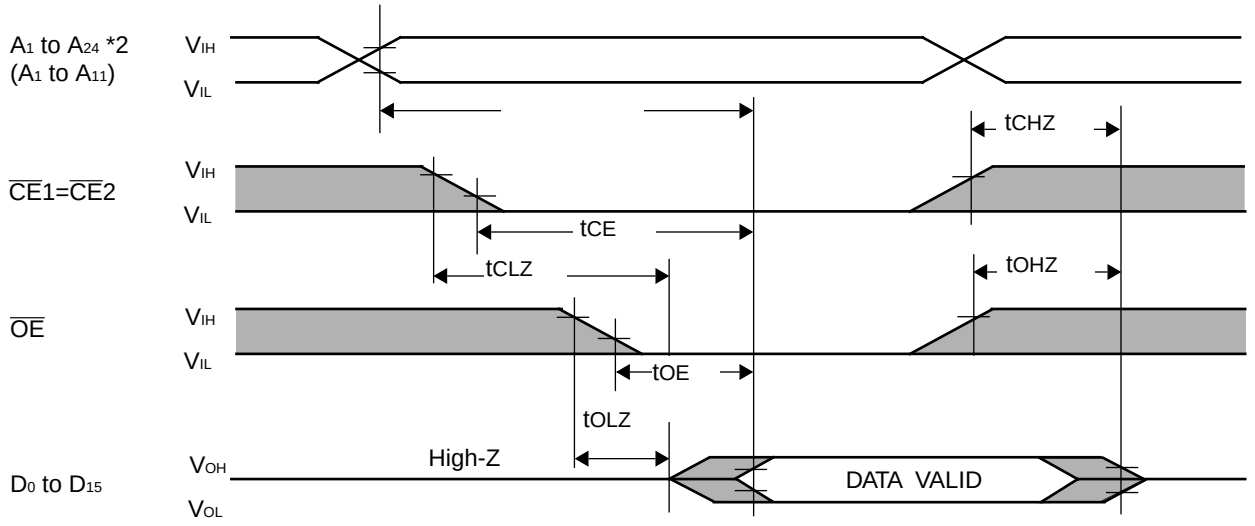
■ TIMING DIAGRAM (Continued)

MAIN / ATTRIBUTE MEMORY READ CYCLE TIMING DIAGRAM(Continued)($\overline{WE}$ = V_{IH}, $\overline{REG}$ = V_{IH})*1

READ CYCLE 4: $\overline{CE}1$ = V_{IH}: x 8-bit No.2 Bus Organization



READ CYCLE 5: $\overline{CE}1$ = $\overline{CE}2$ = V_{IL}: x 16-bit Bus Organization



:Undefined

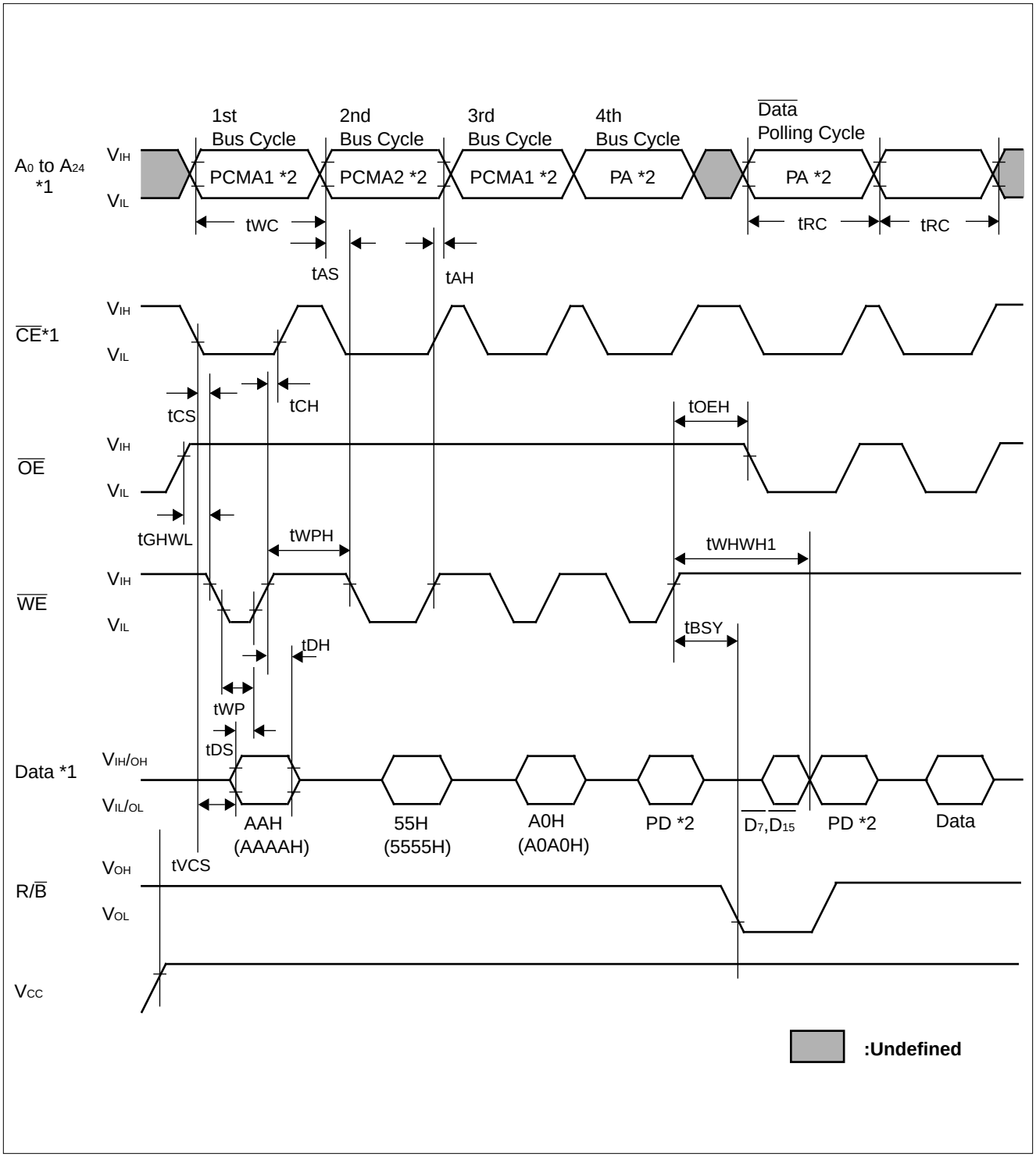
Notes:

*1 The addresses and parameters in ( ) are applied for attribute memory access.

*2 A_0 = Either V_{IH} or V_{IL}.

■ TIMING DIAGRAM (Continued)

MAIN MEMORY PROGRAM CYCLE TIMING DIAGRAM ($\overline{WE}$ = CONTROLLED, $\overline{REG}$ = V_{IH})



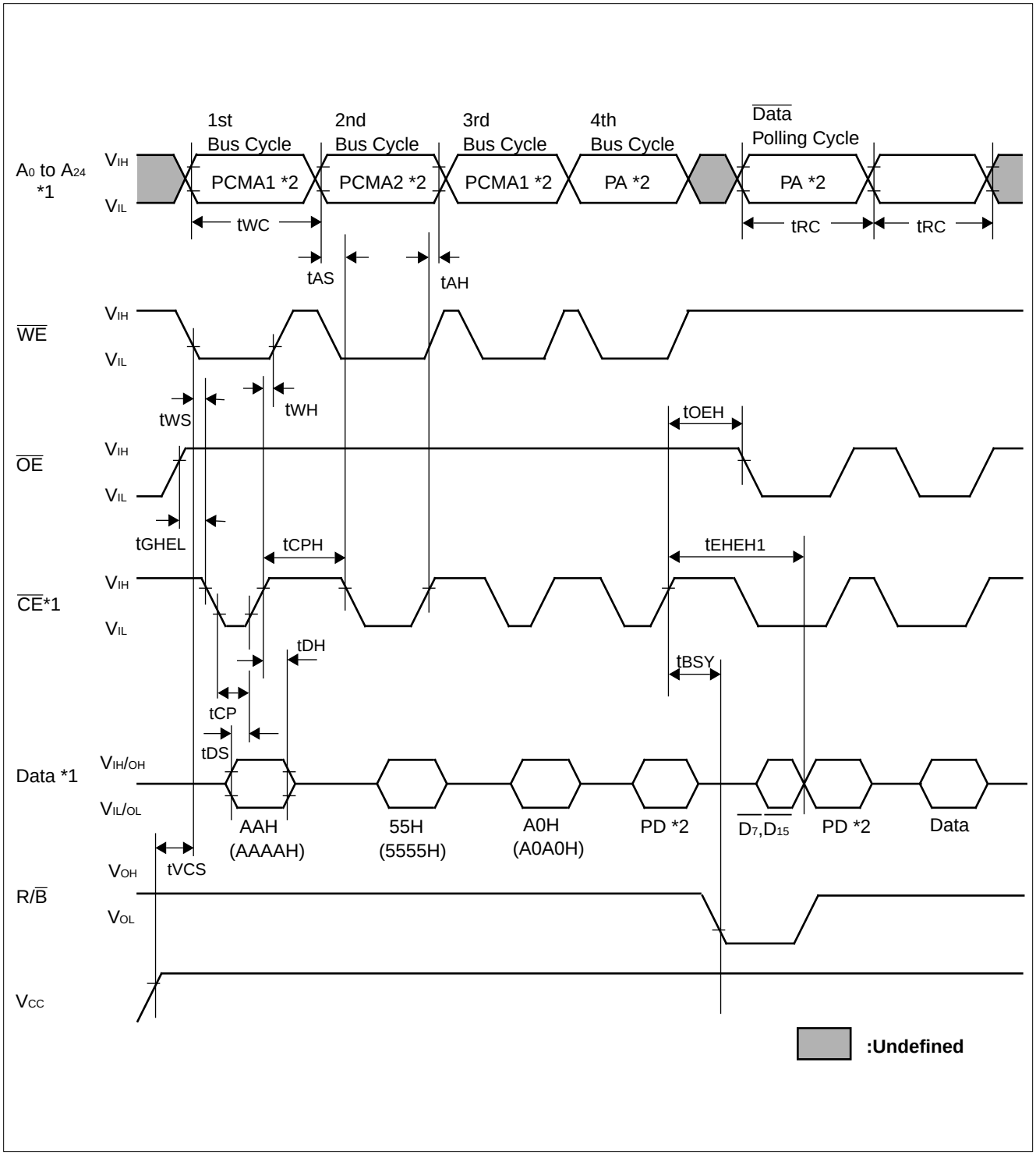
Notes:

*1 See “FUNCTION TRUTH TABLE”.

*2 PCMA1/PCMA2 = Command Address for Program, PA = Program Address, PD = Program Data. See “COMMAND DEFINITION TABLE”.

■ TIMING DIAGRAM (Continued)

MAIN MEMORY PROGRAM CYCLE TIMING DIAGRAM ($\overline{CE}$ = CONTROLLED, $\overline{REG}$ = V_{IH})



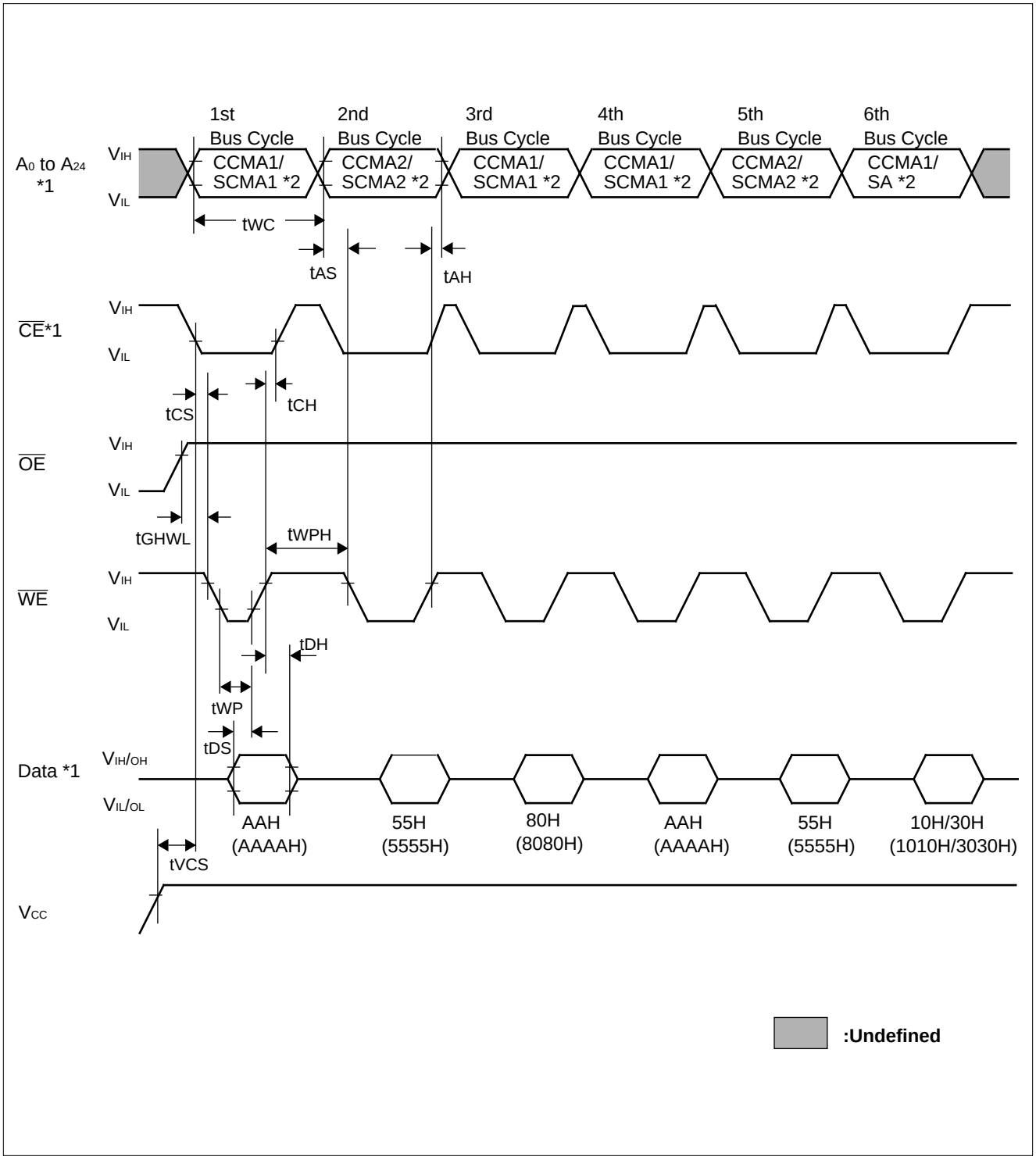
Notes:

*1 See “FUNCTION TRUTH TABLE”.

*2 PCMA1/PCMA2 = Command Address for Program, PA = Program Address, PD = Program Data. See “COMMAND DEFINITION TABLE”.

■ TIMING DIAGRAM (Continued)

MAIN MEMORY ERASE CYCLE TIMING DIAGRAM ($\overline{WE}$ = CONTROLLED, $\overline{REG}$ = V_{IH})



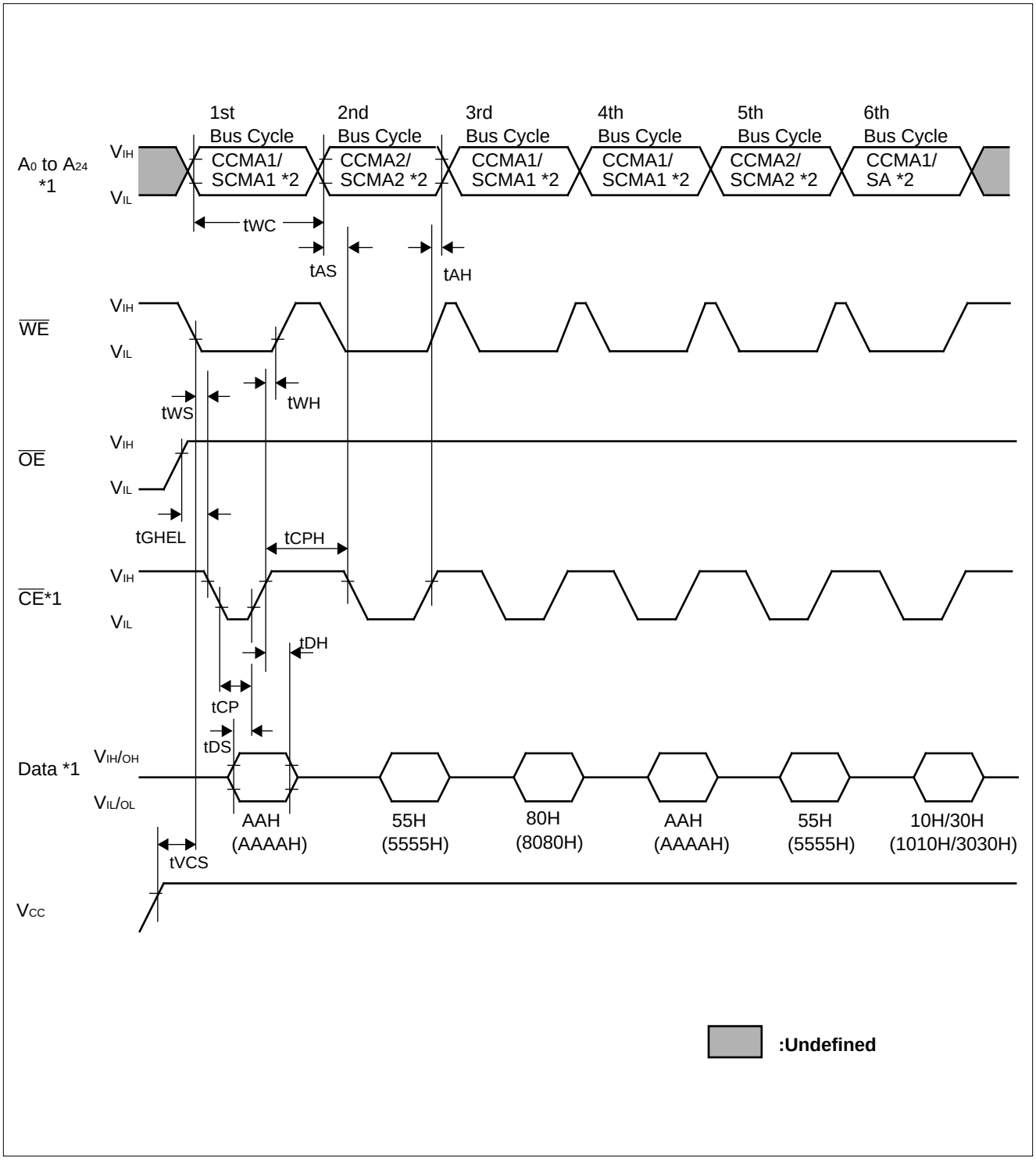
Notes:

*1 See “FUNCTION TRUTH TABLE”.

*2 CCMA1/CCMA2 = Command Address for Chip Erase, SCMA1/SCMA2 = Command Address for Sector Erase, SA = Sector Address. See “COMMAND DEFINITION TABLE”.

■ TIMING DIAGRAM (Continued)

MAIN MEMORY ERASE CYCLE TIMING DIAGRAM ($\overline{CE}$ = CONTROLLED, $\overline{REG}$ = V_{IH})



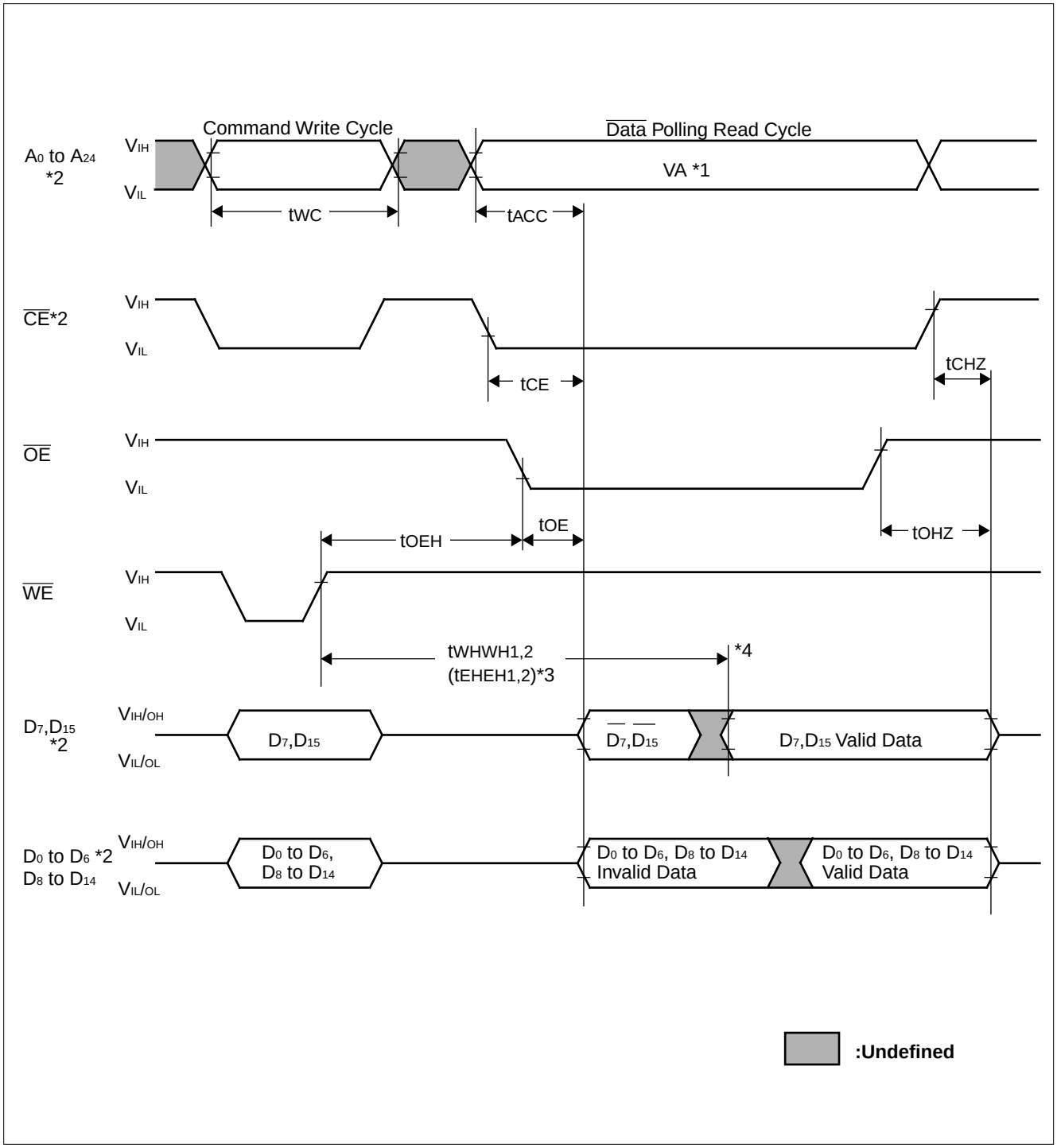
Notes:

*1 See “FUNCTION TRUTH TABLE”.

*2 CCMA1/CCMA2 = Command Address for Chip Erase, SCMA1/SCMA2 = Command Address for Sector Erase, SA = Sector Address. See “COMMAND DEFINITION TABLE”.

■ TIMING DIAGRAM (Continued)

MAIN MEMORY $\overline{DATA}$ POLLING CYCLE TIMING DIAGRAM ($\overline{REG}$ = V_{IH})



Notes:

*1 VA = PA for Programming Cycle, VA = SA for Sector Erase, VA = CA for Chip Erase.

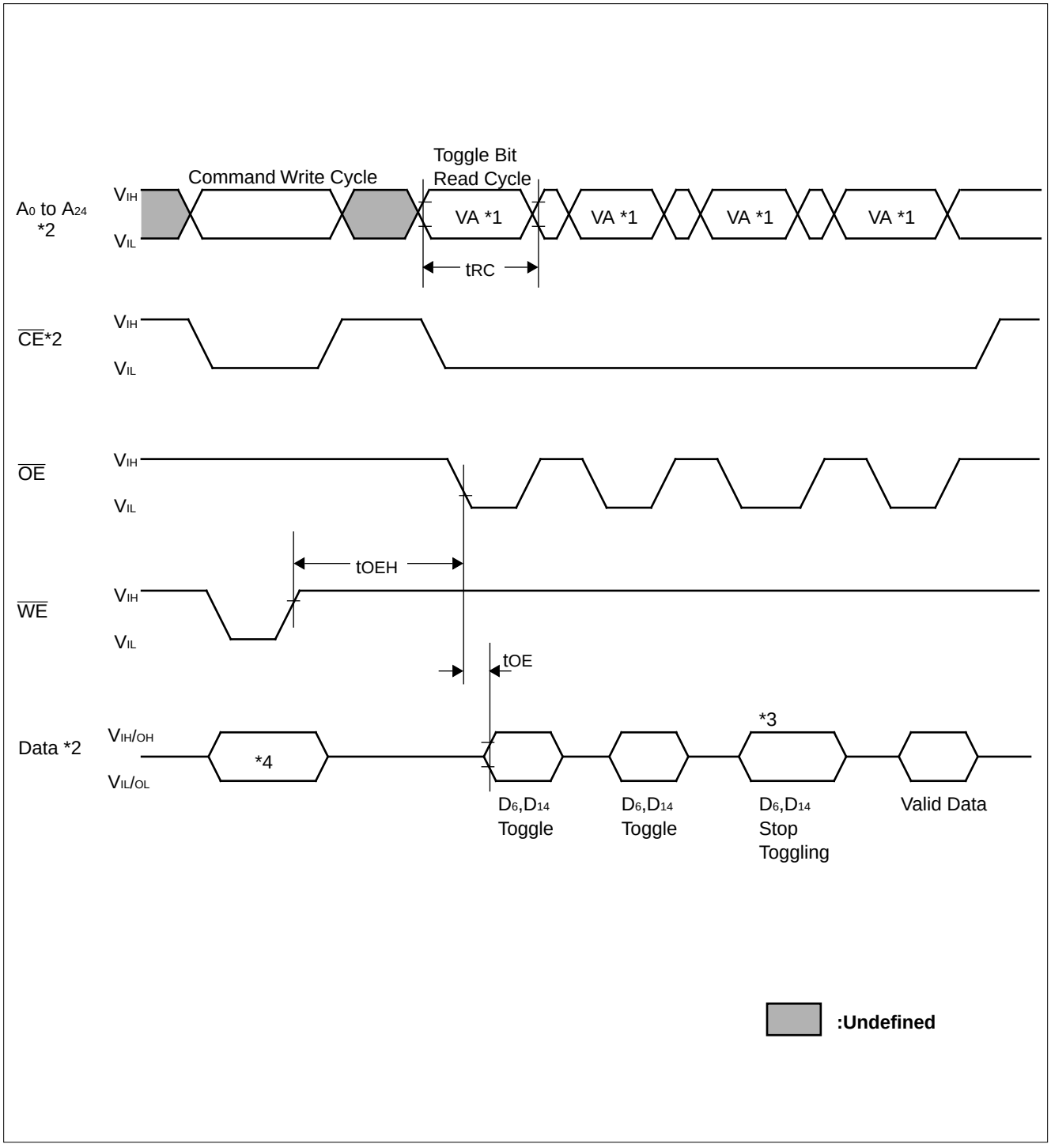
*2 See “FUNCTION TRUTH TABLE”.

*3 tEHEH1, 2 for $\overline{CE}$ Control.

*4 Program/Erase operation is finished.

■ TIMING DIAGRAM (Continued)

MAIN MEMORY TOGGLE BIT TIMING DIAGRAM ($\overline{REG}$ = V_{IH})



Notes:

*1 VA = PA for Programming Cycle, VA = SA for Sector Erase, VA = CA for Chip Erase.

*2 See “FUNCTION TRUTH TABLE”.

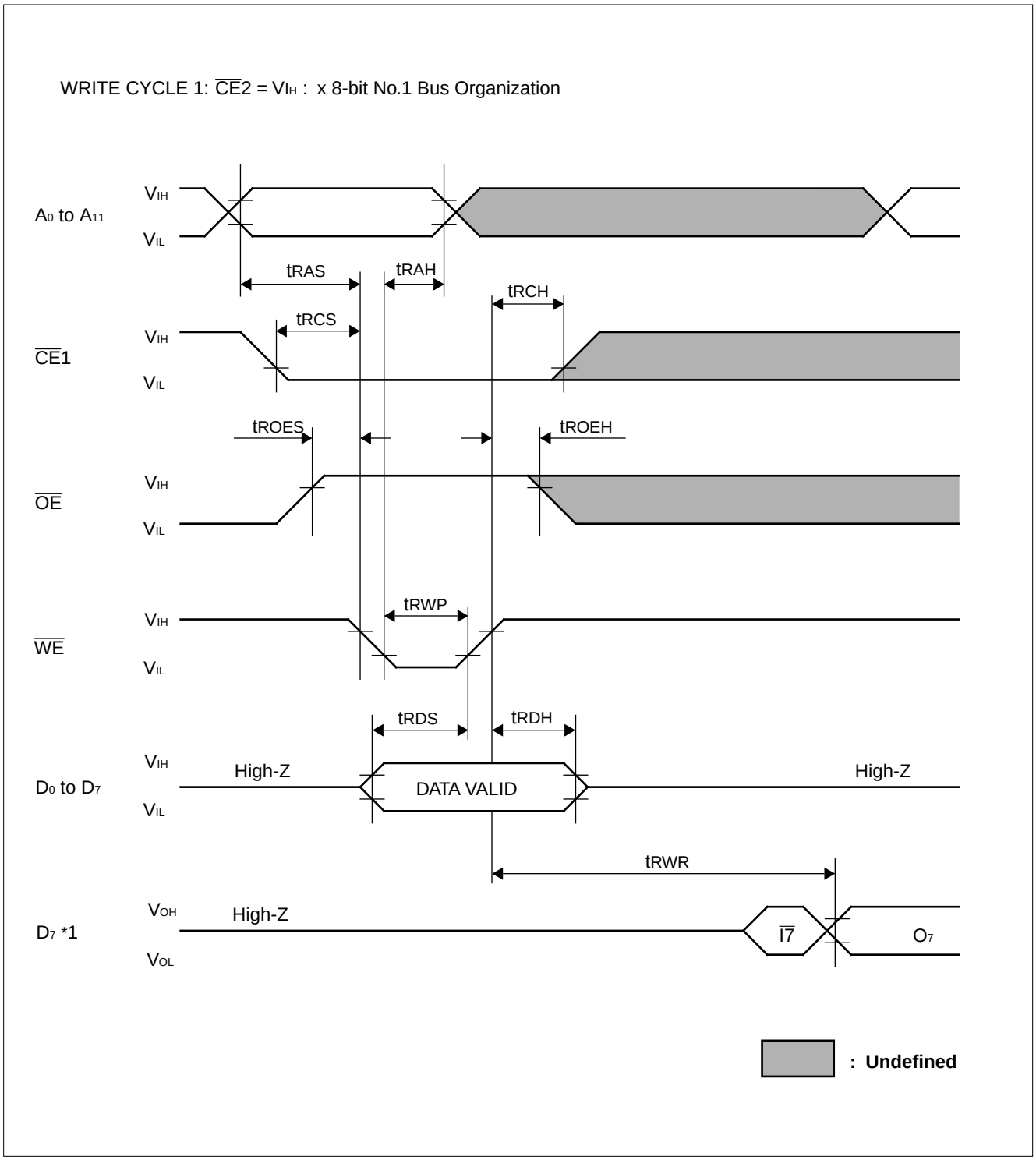
*3 Program/Erase operation is finished.

*4 PD, 10H (1010H) or 30H (3030H)

■ AC CHARACTERISTICS (Continued)

(Recommended operating conditions unless otherwise noted.)

ATTRIBUTE MEMORY WRITE CYCLE TIMING DIAGRAM ($\overline{WE}$ = CONTROLLED, $\overline{REG}$ = V_{IL})



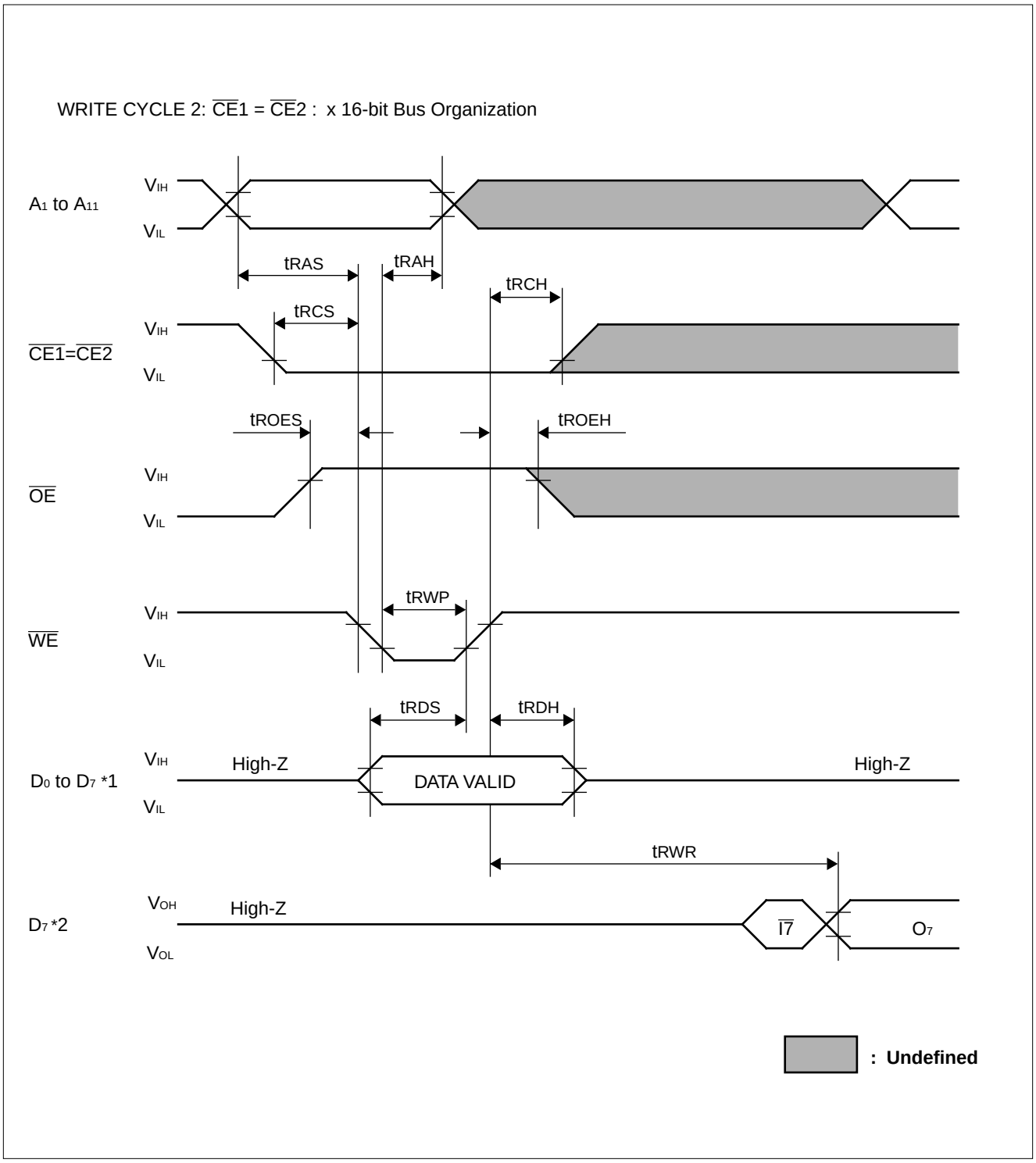
Note:

*1 Data polling operation.

■ AC CHARACTERISTICS (Continued)

(Recommended operating conditions unless otherwise noted.)

ATTRIBUTE MEMORY WRITE CYCLE TIMING DIAGRAM ($\overline{WE}$ = CONTROLLED, $\overline{REG}$ = V_{IL})



Notes:

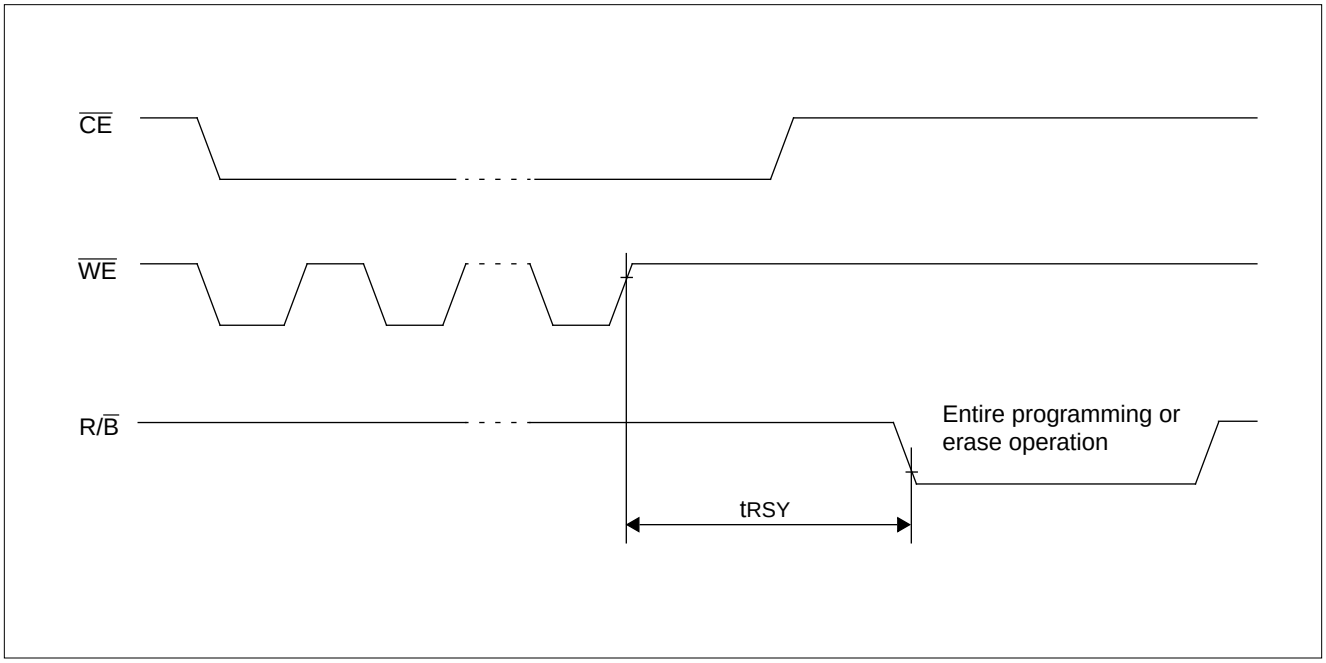
*1 Inputs from D_8 to D_{15} are not defined.

*2 Data polling operation.

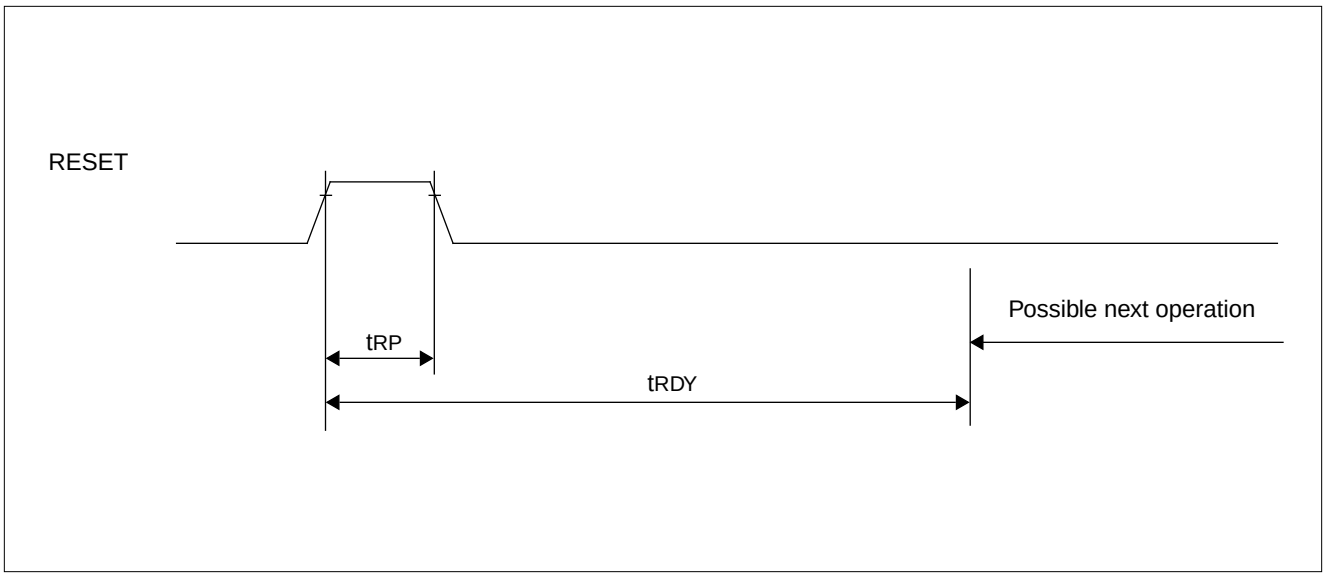
■ AC CHARACTERISTICS (Continued)

(Recommended operating conditions unless otherwise noted.)

R/$\overline{B}$ Timing Diagram During Program / Erase Operations (except for MB98A81063)



RESET Timing Diagram (except for MB98A81063)

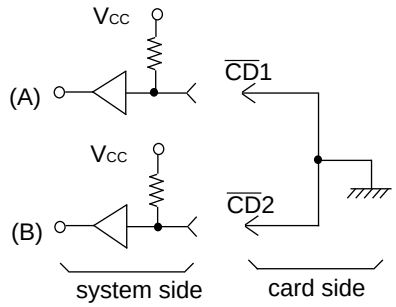


■ UNIQUE FEATURES FOR FLASH MEMORY CARD

1. SPECIAL MONITORING PINS

1.1 CD1, CD2: Card Detection Pins

$\overline{CD}$1 and $\overline{CD}$2 are to detect whether or not the card has been correctly inserted. (See Fig. 12.)
When the memory card has been correctly inserted, $\overline{CD}$1 and $\overline{CD}$2 are detected by the system. $\overline{CD}$1, $\overline{CD}$2 are tied to ground on the card side as shown in Fig. 12.



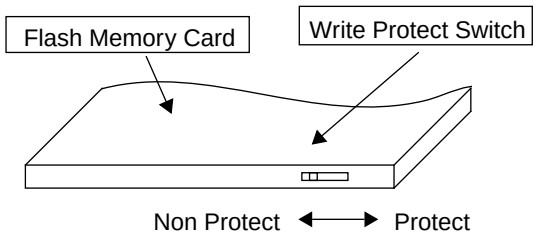
- Fig. 12-

1.2 WP: Write Protect Pins

This pin monitors the position of the Write Protect switch. As shown in Fig. 13, the Flash memory card has a Write Protect switch at the top of the card.

To write to the card, the switch must be turned to the “Non Protect” position and the $\overline{WE}$ pin low. And at that time, L-level is output on the WP pin.

To prevent writing to the card, the switch must be turned to the ”Protect” position. At that time, H-level is output on the WP pin.

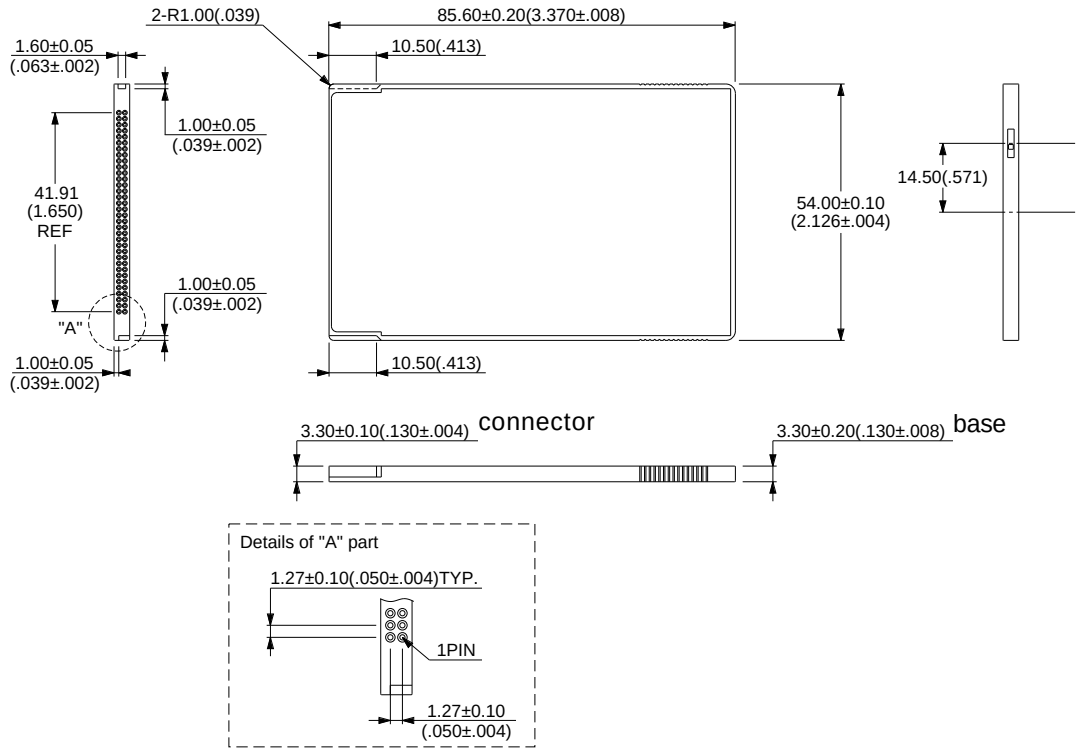


- Fig. 13 -

WP Switch	WP (output)
Protect	H
Non Protect	L

■ PACKAGE DIMENSIONS

68 pin, Plastic Memory Card
(CRD-68P-M05)



Dimensions in mm(inches).

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