FUJITSU SEMICONDUCTOR
DATA SHEET

DS05-30338-2E

FLASH MEMORY CARD

5V-ONLY
FLASH MINIATURE CARD

MB98C81013(1MB)/81123(2MB)/81233(4MB)/81333(8MB)-10

1M/2M/4M/8M-BYTE 5 V-ONLY FLASH MINIATURE CARD

PRELIMINARY

The Fujitsu Flash Miniature cards conform to “Miniature Card Specification” pubulished by MCIF; Miniature Card Implementers Forum.

The Fujitsu Flash Miniature cards are small form factor Flash memory cards targeted various markets; digital photography, audio recording, hand held PCs and other small portable equipments. Miniature cards’ high performance, small size (38 mm × 33 mm × 3.5 mm), low cost and simple interface are ideal for portable applications that require high speed flash disk drives or eXecute In Place (XIP).

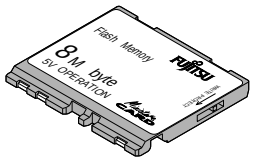
The Flash Miniature cards are 5 V-only operational and allow the users to use as ×8 or ×16 organization on low power at high speed.

- Small size : 33.0 mm (length) × 38.0 mm (width) × 3.5 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 MB98C81013)
- 128 KB Sector Erase (at ×16 mode)
- Any Combination of Sectors Erase and Full Chip Erase
- Detection of completion of program/erase operation with Data# Polling or Toggle bit.
- Ready/Busy Output with BUSY# (Except for MB98C81013)
- Reset Function with RESET# pin (Except for MB98C81013)
- Write protect function with WP switch
- Low VCC Write Inhibit
- AIS (Attribute Information Structure) is available from the address “0000H” of Lower Byte.

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.

■ PACKAGE

5 V - ONLY FLASH MINIATURE CARD



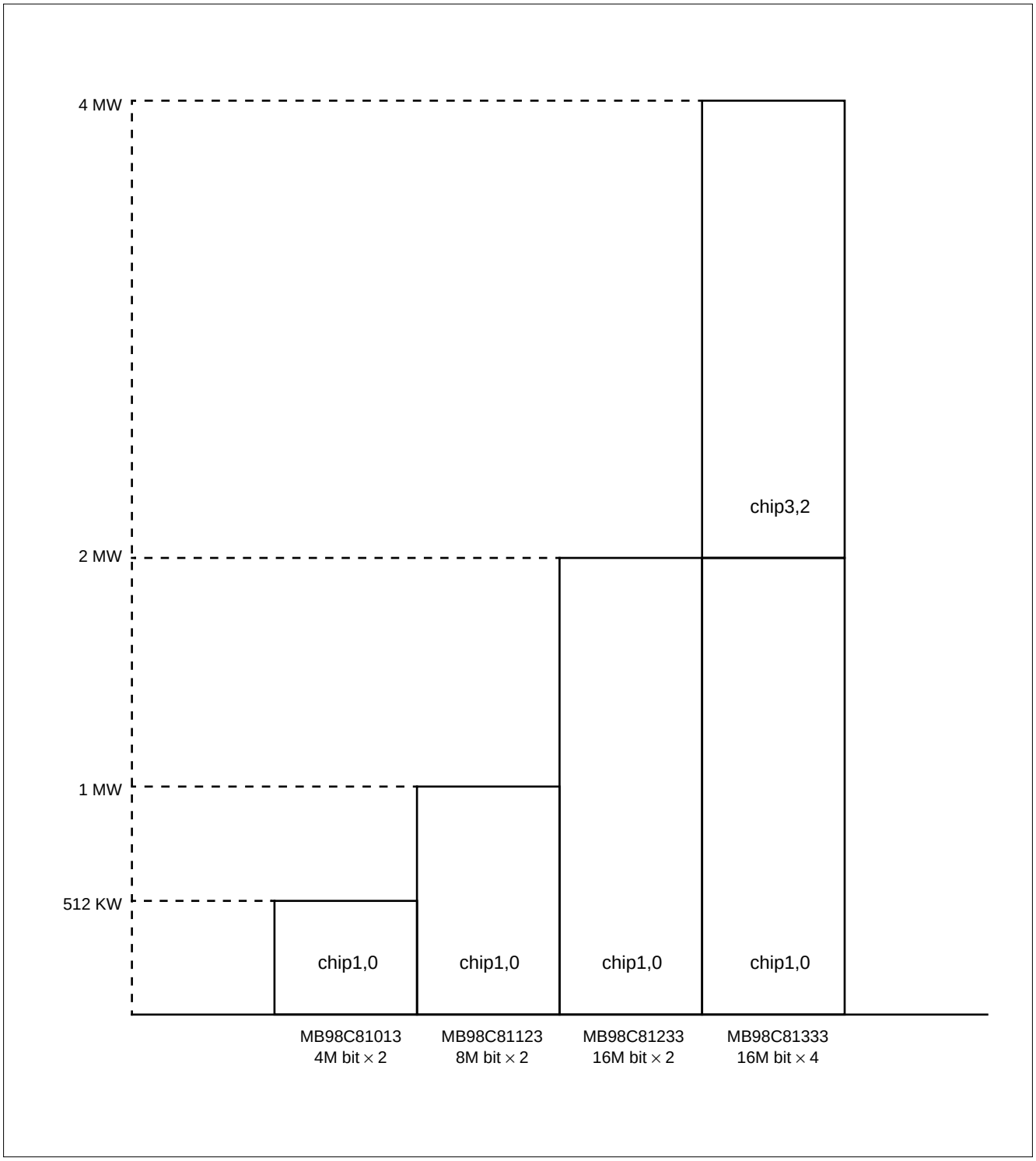
(CRD-60P-M01)

■ DESCRIPTIONS

DIFFERENCES

	MB98C81013	MB98C81123	MB98C81233	MB98C81333
Density	1 MB	2 MB	4 MB	8 MB
Memory Device	4 M bit	8 M bit	16 M bit	←
Quantity	2	2	2	4
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
Erase Suspend Read	Yes	Yes	Yes	Yes
Erase Suspend Program	No	Yes	Yes	Yes
Address	A0 to A18	A0 to A19	A0 to A20	A0 to A21
RESET#	No	Yes	Yes	Yes
BUSY#	No	Yes	Yes	Yes

MEMORY MAP


4 MW
2 MW
1 MW
512 KW
chip3,2
chip1,0
chip1,0
chip1,0
chip1,0
MB98C81013
4M bit × 2
MB98C81123
8M bit × 2
MB98C81233
16M bit × 2
MB98C81333
16M bit × 4

■ PAD ASSIGNMENTS

Pad No	Symbol	Pad No	Symbol	Pad No	Symbol	Pad No	Symbol
1	A_{18}	16	N.C.	31	A_{19} *	46	CD#
2	A_{16}	17	N.C.	32	A_{17}	47	A_{21} *
3	A_{14}	18	OE#	33	A_{15}	48	BUSY#
4	N.C.	19	D_{15}	34	A_{13}	49	WE#
5	CEH#	20	D_{13}	35	A_{12}	50	D_{14}
6	A_{11}	21	D_{12}	36	RESET#	51	RFU
7	A_9	22	D_{10}	37	A_{10}	52	D_{11}
8	A_8	23	D_9	38	VS1#	53	VS2#
9	A_6	24	D_0	39	A_7	54	D_8
10	A_5	25	D_2	40	N.C.	55	D_1
11	A_3	26	D_4	41	A_4	56	D_3
12	A_2	27	N.C.	42	CEL#	57	D_5
13	A_0	28	D_7	43	A_1	58	D_6
14	N.C.	29	N.C.	44	N.C.	59	N.C.
15	N.C.	30	N.C.	45	N.C.	60	A_{20} *
EX 1	V_{CC}	EX 2	GND	EX 3	CINS#		

* : A_{19}, A_{20}, A_{21} are “N.C.” for each product. See “DESCRIPTIONS”.

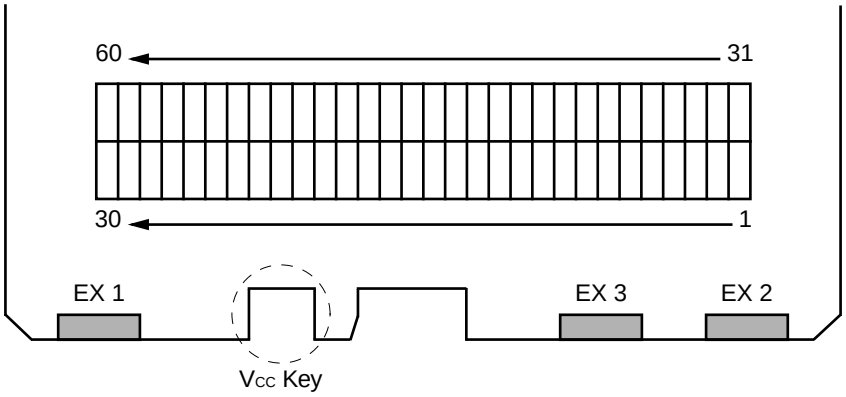
■ PAD DESCRIPTIONS

Symbol	I/O	Pad Name	Symbol	I/O	Pad Name
A_0 to A_{21}	I	Address Input	BUSY#	O	Ready/Busy
D_0 to D_{15}	I/O	Data Input/Output	CD#	O	Card Detect *
CEL#	I	Card Enable for Lower Byte	VS1#, VS2#	O	Voltage Sense
CEH#	I	Card Enable for Upper Byte	N.C.	—	Non Connection
OE#	I	Output Enable	V_{CC}	—	Power Supply
WE#	I	Write Enable	GND	—	Ground
RESET#	I	Hardware Reset	CINS#	O	Card Insertion *

* : Take notice that those pads are connected internally.

■ PAD LOCATIONS

Fig. 1 — BOTTOM VIEW

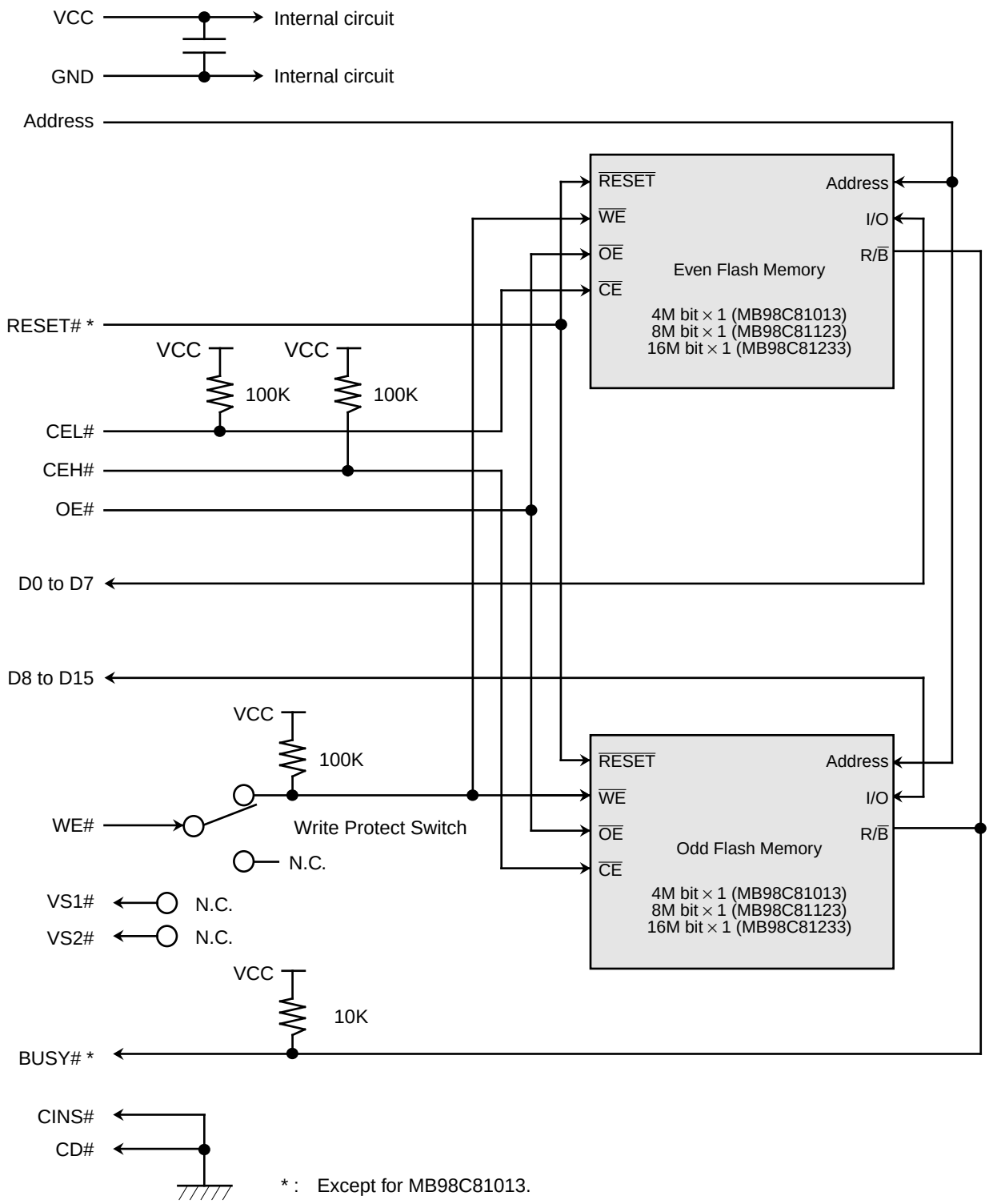


V_{CC} Key: See “UNIQUE FEATURES”.

■ BLOCK DIAGRAM

MB98C81013, MB98C81123 and MB98C81233

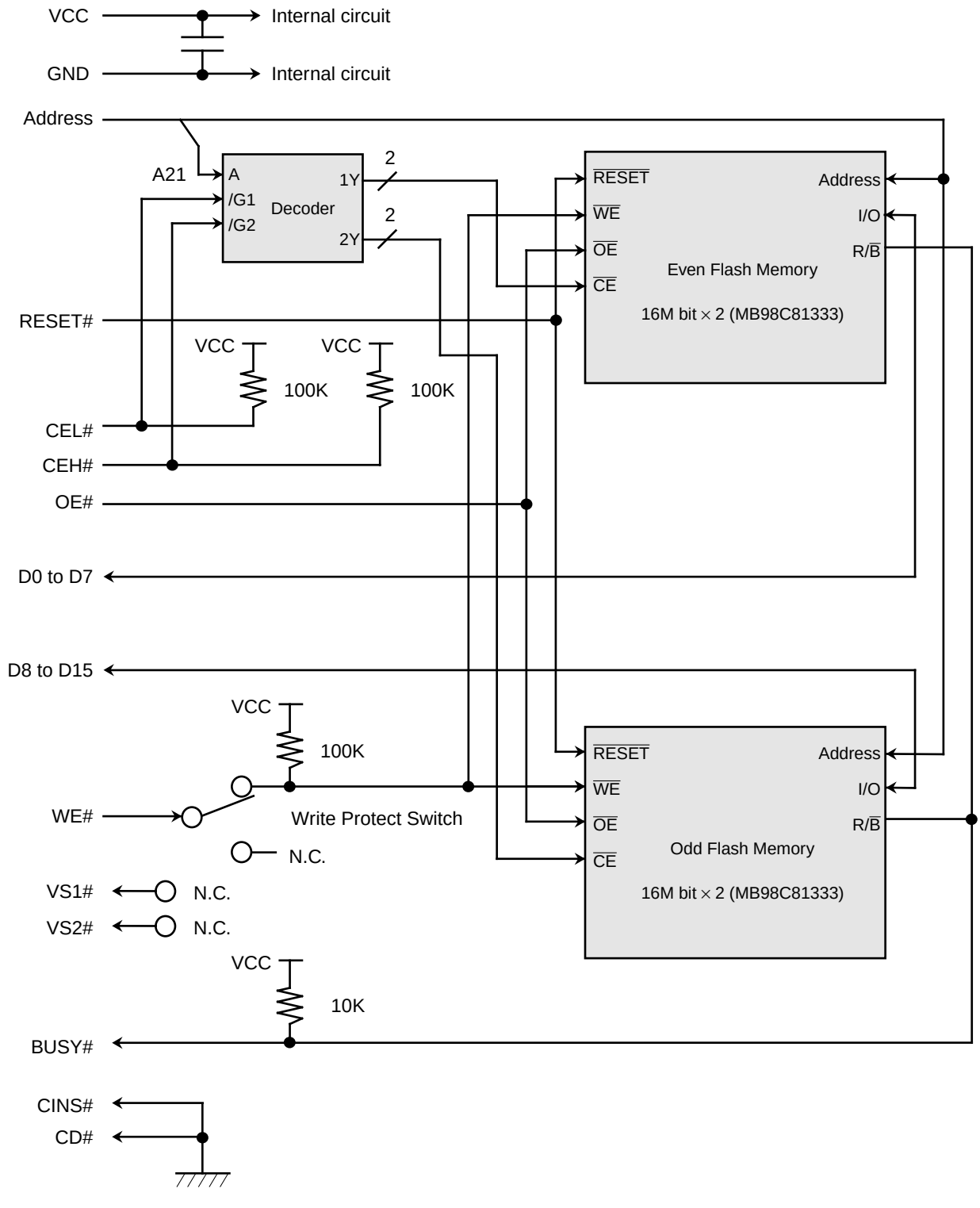
Fig. 2.1 — BLOCK DIAGRAM



* : Except for MB98C81013.

MB98C81333

Fig. 2.2 — BLOCK DIAGRAM



■ CHIP AND SECTOR DECODING

ERASE SECTOR DECODING TABLE

	Sector Address (SA)				
	A_{20} *2	A_{19} *1	A_{18}	A_{17}	A_{16}
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

Notes: *1. A_{19} is not availabe for MB98C81013. MB98C81013 has 8 sectors.
*2. A_{20} is not availabe for MB98C81013 and MB98C81123. MB98C81013 has 8 sectors and MB98C81123 has 16 sectors.

■ CHIP CONFIGURATION

The miniature cards use 2 or 4 pcs of Flash Memory. 2 pcs of Flash Memory are operated simultaneously at 16 bit mode and even number of chip is applied to lower byte and odd number of chip is applied to upper byte. At ×8 bit mode, even address and odd address are selected with CEL# and CEH#.

① × 16 bit mode

CEL# = “L”, CEH# = “L”

:	
:	
Odd Number of Chip + Even Number of Chip	003h
Odd Number of Chip + Even Number of Chip	002h
Odd Number of Chip + Even Number of Chip	001h
Odd Number of Chip + Even Number of Chip	000h

D15 • • • • • • • • • • • • • • • D0

② × 8 bit mode

CEL# = “H”, CEH# = “L”

:	
:	
odd Number of Chip	003h
odd Number of Chip	002h
odd Number of Chip	001h
odd Number of Chip	000h

D15 • • • • D8

CEL# = “L”, CEH# = “H”

:	
:	
even Number of Chip	003h
even Number of Chip	002h
even Number of Chip	001h
even Number of Chip	000h

D7 • • • • • D0

■ FUNCTION DESCRIPTIONS

1. Read Mode

The data in the common can be read with “OE# = VIL” and “WE# = VIH”. The address is selected with A0-A21. And CEL# and CEH# select output mode.

2. Standby Mode

– CEL# and CEH# at “VIH” place the card in Standby mode. D0-D15 are placed in a high-Z state independent of the status “OE#” and “WE#”.

3. Output Disable Mode

– The outputs are disabled with OE# and WE# at “VIH”. D0-D15 are placed in high-Z state.

4. Write Mode

– The card is in Write mode with “OE# = VIH” and “WE# and CE# = VIL”.
– Commands can be written at the Write mode.
– Two types of the Write mode, “WE# control” and “CE# control” are available.

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 switch 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 margin 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 WE# or CE# and data is latched at rising edge of WE# or CE#. The fourth rising edge of WE# or 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 BUSY# (except MB98C81013), Data# Polling or Toggle Bit function. See “WRITE OPERATION STATUS”.
– Any commands written to the chip during programming operation will be ignored.

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 BUSY# (except MB98C81013), 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 WE# pulse for the last Sector Erase command pulse. Whether the sector erase window is still open can be monitored with D3 and D11.
– 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 BUSY#, 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 MB98C81013). 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 except MB98C81013. User can program to non-busy sectors by writing program commands except MB98C81013.
– 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 MB98C81013)

– The Card may be reset by driving the RESET# pin to VIL. The RESET# pin must be kept High (VIL) 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 Low. If a hardware reset occurs during a program operation, the data at that particular location will be indeterminate.
– When the RESET# pin is Low 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 high, 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.

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. 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 OE#, CE# or WE# will not initiate a write cycle.

■ FUNCTION TRUTH TABLE

Mode	RESET# *2	CEH#	CEL#	OE#	WE#	WPSW *1	Data Input/Output	
							D8 to D15	D0 to D7
Hardware Reset	L	X	X	X	X	P or NP	High-Z	High-Z
Standby	H	H	H	X	X	P or NP	High-Z	High-Z
Read (×8 bit)		H	L	L	H	P or NP	High-Z	DOUT
		L	H				DOUT	High-Z
Read (×16 bit)		L	L				DOUT	DOUT
Write (×8 bit)		H	L	H	L	NP	High-Z	DIN
		L	H				DIN	High-Z
Write (×16 bit)		L	L				DIN	DIN
Output Disable		H	L			P	High-Z	High-Z
		L	H				High-Z	High-Z
		L	L				High-Z	High-Z

H : “H” level, L : “L” level , X : “H” or “L”

Notes: *1. WPSW = Write Protect Switch, NP = NON-PROTECT, P = PROTECT
*2. Except for MB98C81013.

■ 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										

Note: CA: Chip Address. (address in chip selected by A21 for MB98C81333)
SA: Sector Address (address in 64 KB selected by A16, A17, A18, A19, A20 and A21)
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 8-bit Mode” in page 16.

Command Table for 16-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	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										

Note: CA: Chip Address. (address in chip selected by A21 for MB98C81333)
SA: Sector Address (address in 128 KB selected by A16, A17, A18, A19, A20 and A21)
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 16.

Command Address Table for 8-bit and 16-bit Mode

Command Address	MB98C81013	MB98C81123	MB98C81233, MB98C81333
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
ICMA2	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/B# *4
In Progress	Programming		D_7#, D_{15}#	Toggle	0	0	1	0
	Erasing		0	Toggle	0	1	Toggle	0
	Erase Suspend Read	(1)	1	1	0	0	Toggle *1	1
		(2)	Data	Data	Data	Data	Data	1
	Erase Suspend Program *4		D_7#, D_{15}#	Toggle *2	0	0	*1, *3	0
Exceeded Time Limits	Programming		D_7#, D_{15}#	Toggle	1	0	1	0
	Erasing		0	Toggle	1	1	N/A	0
	Erase Suspend Program *4		D_7#, D_{15}#	Toggle	1	0	N/A	0

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

Notes: *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 MB98C81013.

D7, D15 (Data# Polling)

The card features 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 Data# Polling is valid after the rising edge of the sixth WE# pulse in the six write pulse sequence. For sector erase, the Data# Polling is valid after the last rising edge of the sector erase 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 Data# Polling feature is only active during the programming operation, erase operation, sector erase time-out, Erase Suspend Read mode and Erase Supend Program mode.

D6, D14 (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 (OE# or 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 WE# pulse in the four write pulse sequence. For chip erase, the Toggle Bit is valid after the rising edge of the sixth 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 WE# pulse. The Toggle Bit is also active during the sector time out.
Either CE# or OE# toggling will cause the D_6/D_{14} to toggle.

D5, D13 (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. 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.

D3, D11 (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. Data# Polling and Toggle Bit are valid after the initial sector erase command sequence.
If 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 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.

D2, D10 (Toggle Bit II, not applied for MB98C81013)

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.

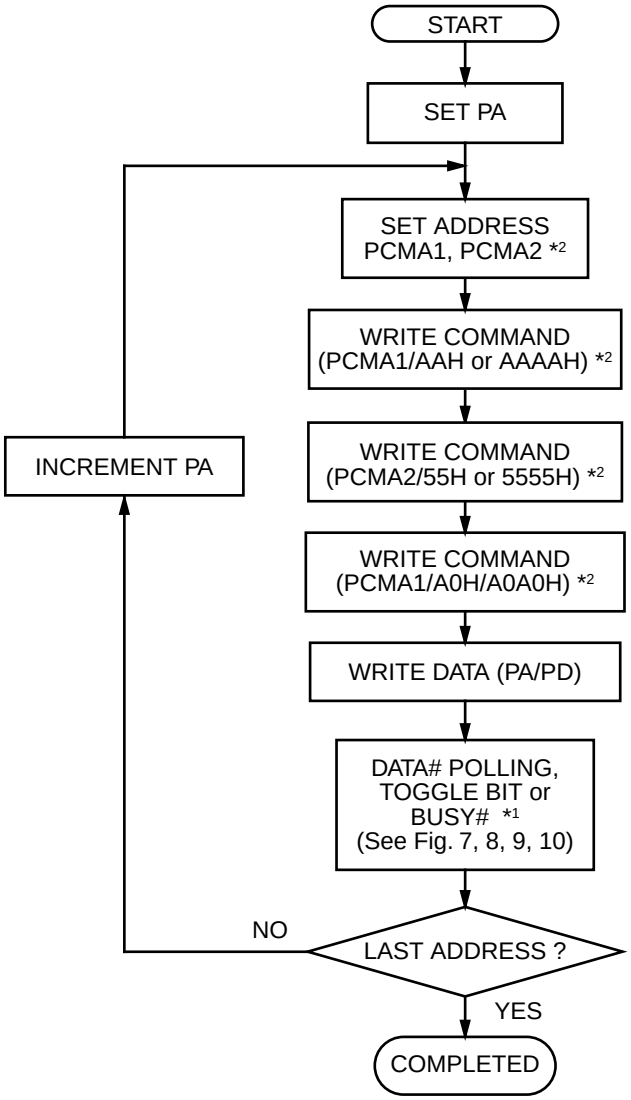
BUSY# (Ready/Busy, not applied for MB98C81013)

The card provides a BUSY# 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 BUSY# output will be high.

During programming, the BUSY# pin is driven low after the rising edge of the fourth WE# pulse. During an erase operation, the BUSY# pin is driven low after the rising edge of the sixth WE# pulse. The BUSY# pin will indicate a busy condition during the RESET# pulse.

■ PROGRAM/ERASE FLOWCHART

Fig. 3 — PROGRAM FLOWCHART

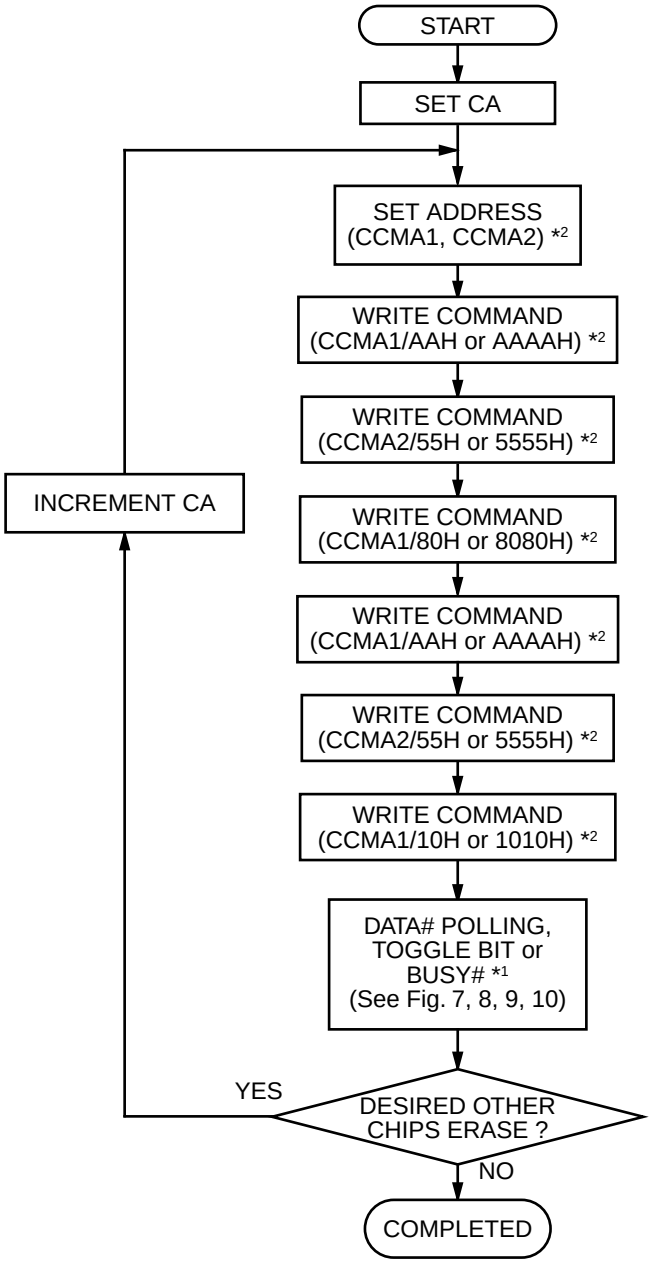


PD : PROGRAM DATA
PA : PROGRAM ADDRESS

*1. Except MB98C81013

*2. See “COMMAND DEFINITION TABLE”.

Fig. 4 — CHIP ERASE FLOWCHART

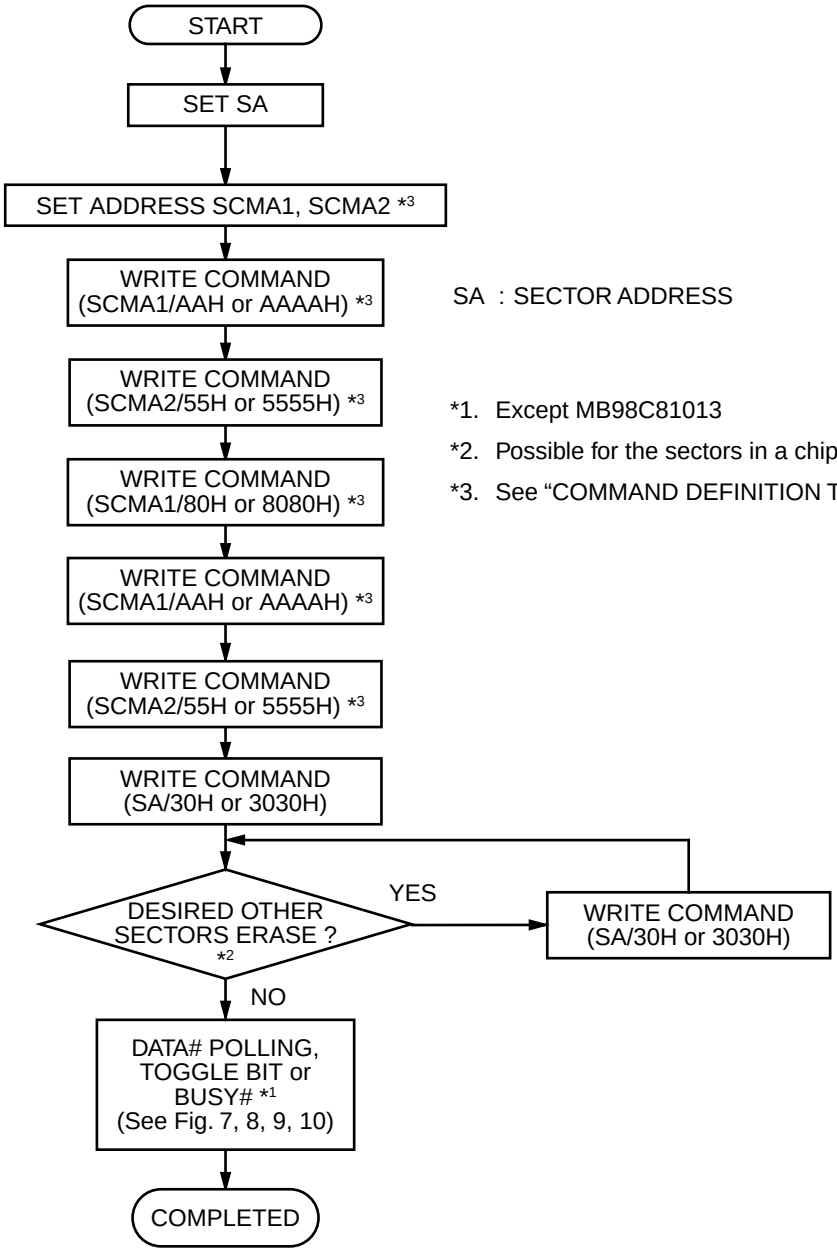


CA : CHIP ADDRESS

*1. Except MB98C81013

*2. See “COMMAND DEFINITION TABLE”.

Fig. 5 — SECTOR ERASE FLOWCHART



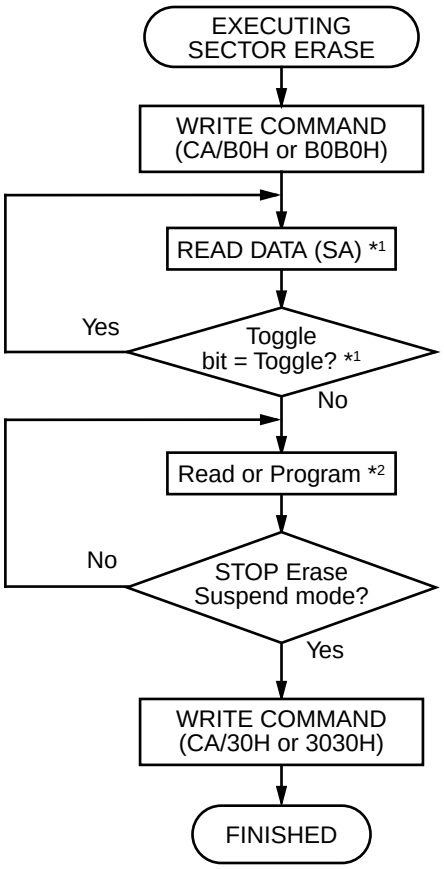
SA : SECTOR ADDRESS

*1. Except MB98C81013

*2. Possible for the sectors in a chip

*3. See “COMMAND DEFINITION TABLE”.

Fig. 6 — ERASE SUSPEND FLOWCHART

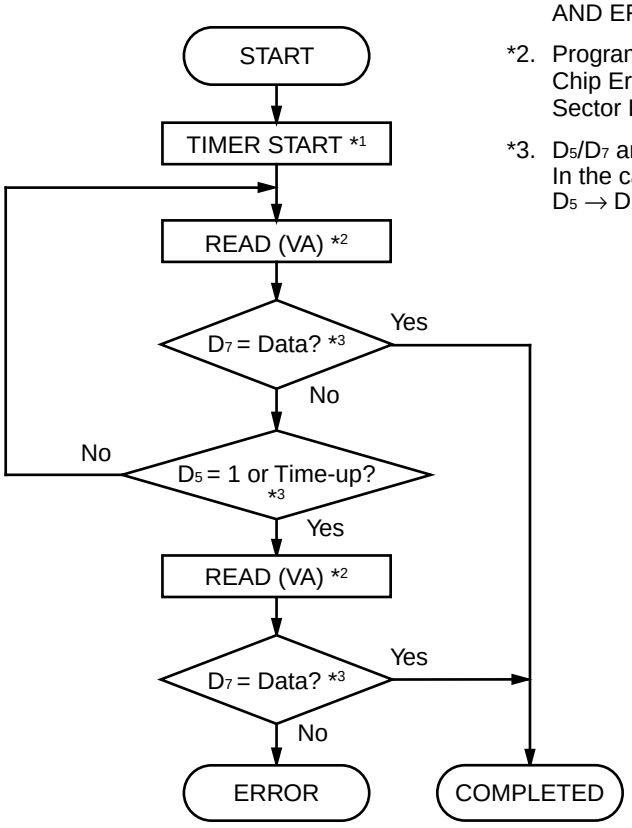


CA : CHIP ADDRESS
SA : SECTOR ADDRESS
RA : READ ADDRESS

*1. Detection whether suspend mode is valid can be done by Data# Polling and BUSY# also. (MB98C81013 does not have BUSY#).

*2. Only Read operation for MB98C81013.

Fig. 7 — DATA# POLLING FLOWCHART: x8 bit mode

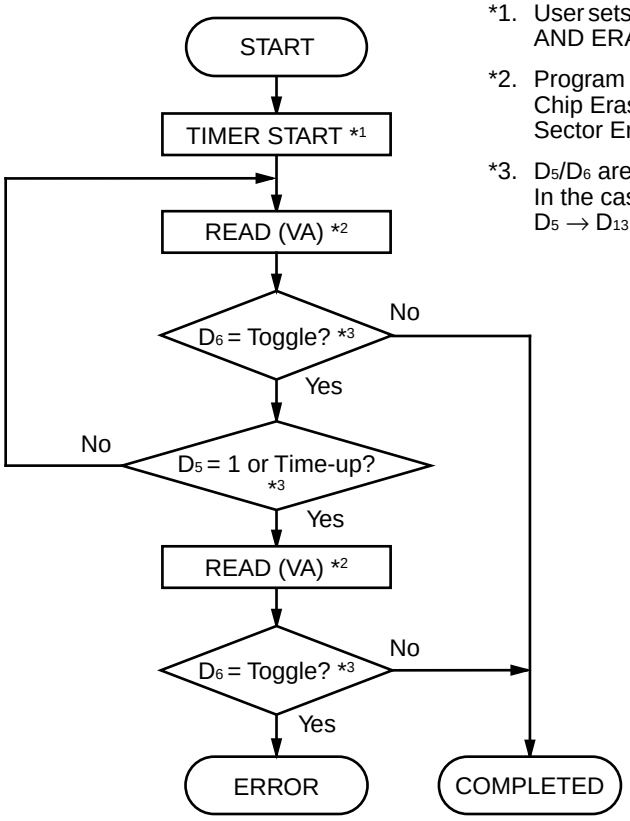


*1. User sets the time period referring to “PROGRAM AND ERASE PERFORMANCES”.

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

*3. D_5/D_7 are for even chip(s).
In the case of odd chip(s),
$D_5 \rightarrow D_{13}$ and $D_7 \rightarrow D_{15}$ are applied.

Fig. 8 — TOGGLE BIT FLOWCHART: x8 bit mode

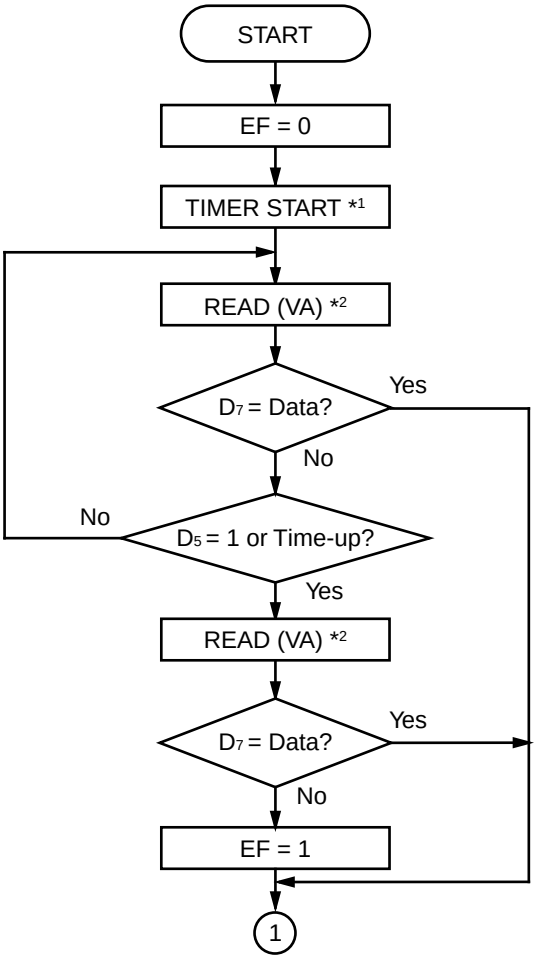


*1. User sets the time period referring to "PROGRAM AND ERASE PERFORMANCES".

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

*3. D_5/D_6 are for even chip(s).
In the case of odd chip(s),
$D_5 \rightarrow D_{13}$ and $D_6 \rightarrow D_{14}$ are applied.

Fig. 9 — 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

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

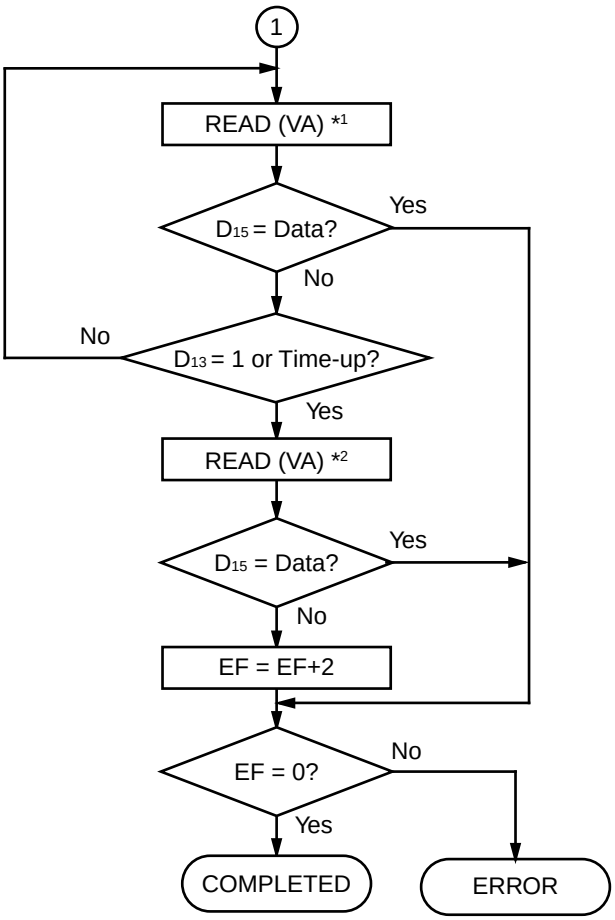
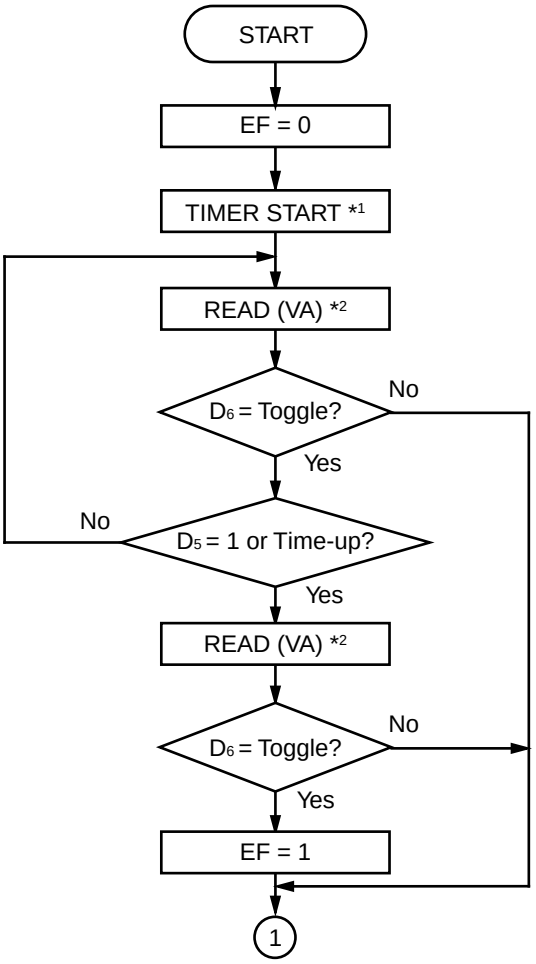
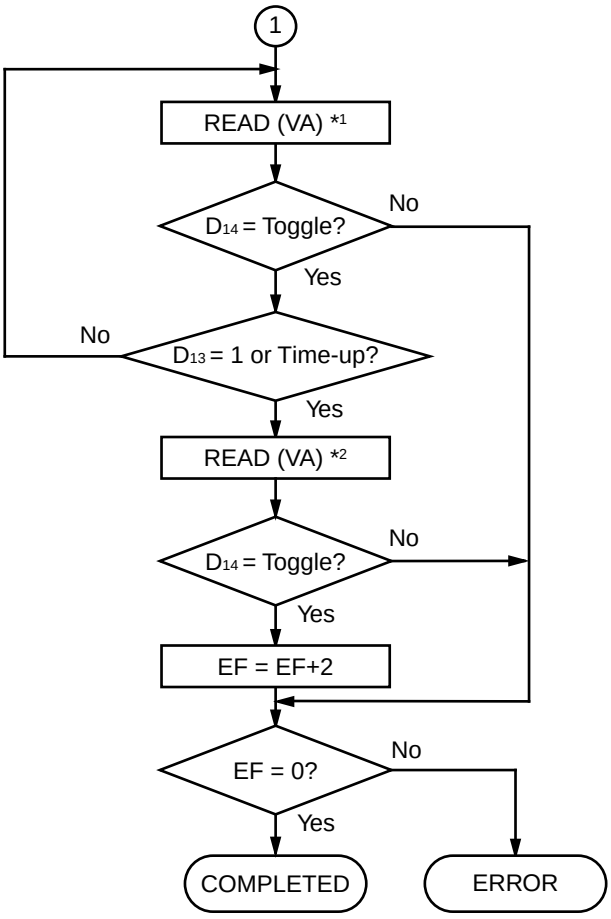


Fig. 10 — TOGGLE BIT FLOWCHART: x16 bit mode





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

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

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

■ 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 Temperature	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.

■ 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 Conditions	Symbol	Value			Unit
			Min	Typ	Max	
Input Leakage Current *1	V_{CC} = V_{CC} max., V_{IN} = GND or V_{CC}	I_{LI}			±10	µA
Output Leakage Current *2	V_{CC} = V_{CC} max., V_{IN} = GND or V_{CC}	I_{LO}			±10	µA
Standby Current	V_{CC} = V_{CC} max., CEL#, CEH# = V_{CC} V_{IN} = GND or V_{CC}	I_{SB1}		20	100 (250 *3)	µA
	CEL#, CEH#, RESET# = V_{IH}	I_{SB2}			5.0	mA
Active Read Current	CEL#, CEH# = V_{IL}, Cycle = 150 ns OE# = V_{IH}	I_{CC1}		70	100	mA
Program Current	Program in progress (×16 mode)	I_{CC2}		80	150	mA
Erase Current	Erase in progress (×16 mode)	I_{CC3}		80	150	mA
Input Low Voltage	—	V_{IL}	–0.5	—	0.8	V
Input High Voltage	—	V_{IH}	0.7 V_{CC}	—	V_{CC}+0.5	V
Output Low Voltage	I_{OL} = 12 mA, V_{CC} = V_{CC} min.	V_{OL}			0.45	V
Output High Voltage	I_{OH} = –2.5 mA, V_{CC} = V_{CC} min.	V_{OH}	2.4			V
Low V_{CC} Lock-out Voltage	—	V_{LKO}	3.2	3.7	4.2	V

Notes: *1. This value does not apply to CEL#, CEH# and WE#.
*2. This value does not apply to CD# and CINS#.
*3. for MB98C81013.

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

Parameter	Symbol	Min	Max	Unit
Input Capacitance *1	C_{IN}		40	pF
I/O Capacitance *2	$C_{I/O}$		40	pF

Notes: *1. This value does not apply to CEL#, CEH# and WE#.
*2. This value does not apply to CD# and CINS#.

■ AC TEST CONDITIONS

- Input Pulse Levels: V_{IH} = 4.2 V, V_{IL} = 0.45 V
- Input Pulse Rise and Fall Times: 5 ns
- Timing Reference Levels
  Input: V_{IL} = 0.8 V, V_{IH} = 3.8 V
  Output: V_{OL} = 0.8 V, V_{OH} = 2.0 V
  Output Load: 1TTL +100 pF

■ PROGRAM AND ERASE PERFORMANCES

(MB98C81013)

Parameter	Min	Typ	Max	Unit
Byte Program Time *1		8	500	µs
Chip Programming Time *1		4.2	25	Sec.
Sector Erase Time *2		1	15	Sec.
Program/Erase Cycles	100,000			Cycles

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

(MB98C81123)

Parameter	Min	Typ	Max	Unit
Byte Program Time *1		8	2000	µs
Chip Programming Time *1		8.4	50	Sec.
Sector Erase Time *2		1	15	Sec.
Program/Erase Cycles	100,000			Cycles

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

(MB98C81233, 81333)

Parameter	Min	Typ	Max	Unit
Byte Program Time *1		8	500	µs
Chip Programming Time *1		16.8	100	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.

■ AC CHARACTERISTICS

(Recommended operating conditions unless otherwise noted.)

READ CYCLE *1

Parameter	Symbol	Min	Max	Unit
Read Cycle Time	t_{RC}	100		ns
Card Enable Access Time	t_{CE}		100	ns
Address Access Time	t_{ACC}		100	ns
Output Enable Access Time	t_{OE}		50	ns
Card Enable to Output in Low-Z *2	t_{CLZ}	5		ns
Card Disable to Output in High-Z *2	t_{CHZ}		50	ns
Output Enable to Output in Low-Z *2	t_{OLZ}	5		ns
Output Disable to Output in High-Z *2	t_{OHZ}		50	ns
Output Hold from Address Change	t_{OH}	0		ns
Ready Time from RESET#	t_{RDY}		20	µs

Notes: *1. Rise/Fall time < 5 ns.
*2. Transition is measured at the point of ±500 mV from steady state voltage.

PROGRAM/ERASE CYCLE

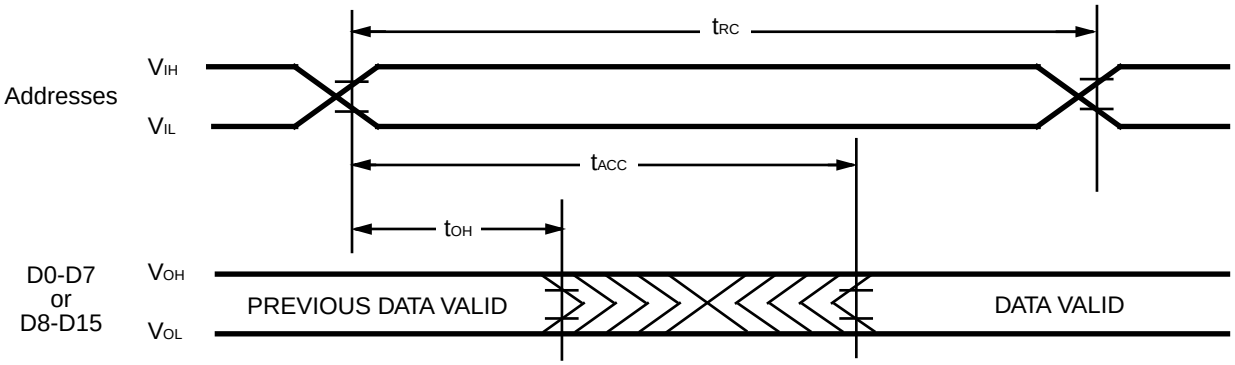
Parameter	Symbol	Min	Typ	Max	Unit
Write Cycle Time	t_{WC}	100			ns
Address Setup Time	t_{AS}	10			ns
Address Hold Time	t_{AH}	10			ns
Data Setup Time	t_{DS}	40			ns
Data Hold Time	t_{DH}	15			ns
Read Recovery Time (WE# control)	t_{GHWL}	10			ns
Read Recovery Time (CE# control)	t_{GHEL}	10			ns
Output Enable Hold Time	t_{OEH}	20			ns
Card Enable Setup Time	t_{CS}	20			ns
Card Enable Hold Time	t_{CH}	10			ns
Write Enable Pulse Width	t_{WP}	60			ns
Write Enable Setup Time	t_{WS}	0			ns
Write Enable Hold Time	t_{WH}	10			ns
Card Enable Pulse Width	t_{CP}	80			ns
Duration of Byte Program Operation (/WE Control)	t_{WHWH1}		8		µs
Duration of Erase Operation *1 (/WE Control)	t_{WHWH2}		1	15	s
Duration of Byte Program Operation (/CE Control)	t_{EHEH1}		8		µs
Duration of Erase Operation *1 (/CE Control)	t_{EHEH2}		1	15	s
V_{CC} Setup Time *2	t_{VCS}	50			µs
Reset Pulse Width	t_{RP}	500			ns
Busy Delay Time	t_{BSY}	40			ns

Notes: *1. These do not include the preprogramming time.
*2. Not 100% tested.

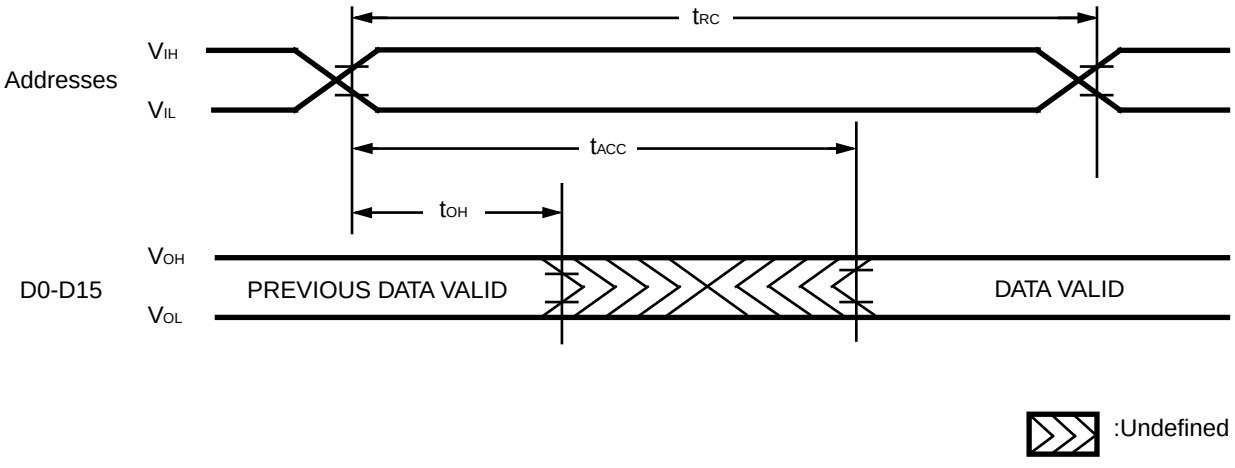
■ TIMING DIAGRAM

READ CYCLE TIMING DIAGRAM (WE# = V_{IH}, RESET# = V_{IH})

READ CYCLE (×8 bit mode): "CEL# = OE# = V_{IL}, CEH# = V_{IH}" or "CEH# = OE# = V_{IL}, CEL# = V_{IH}"

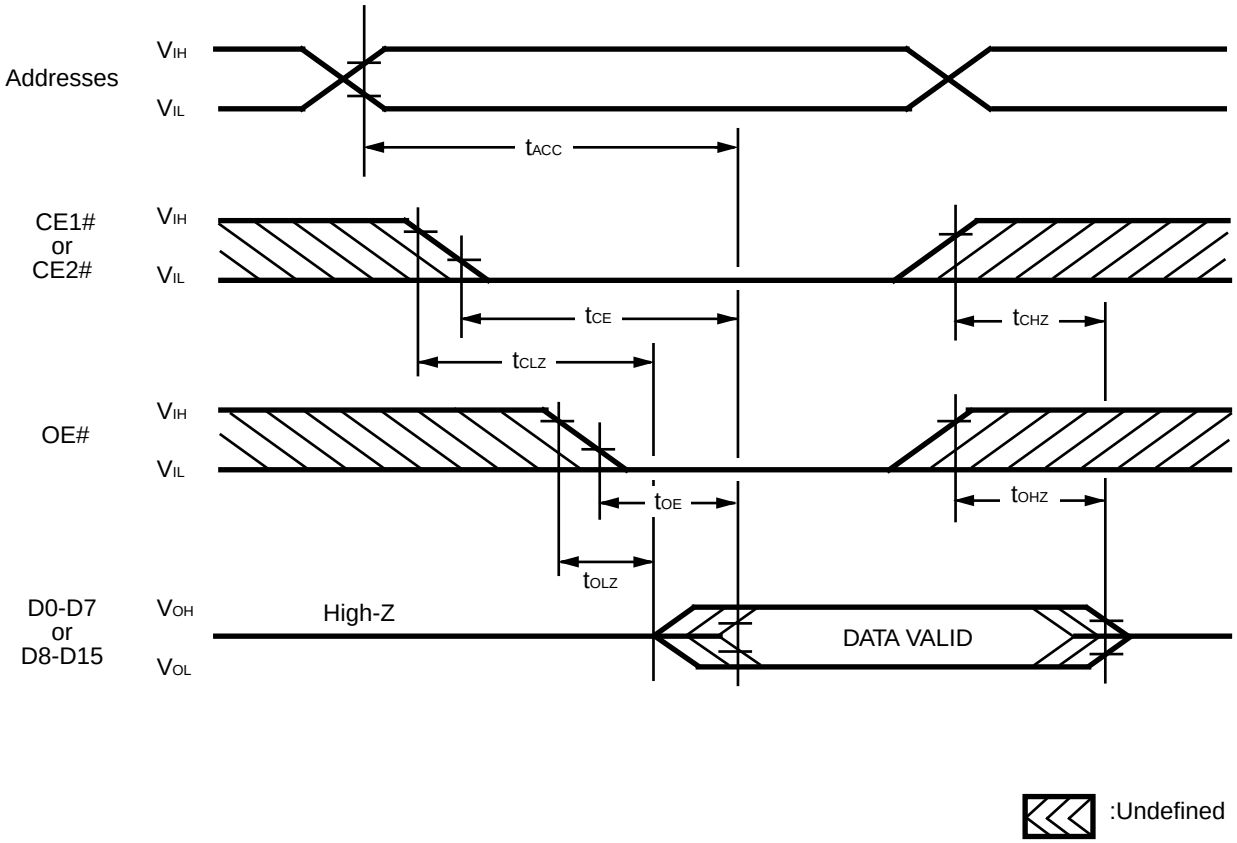


READ CYCLE (×16 bit mode): CEL# = CEH# = OE# = V_{IL}



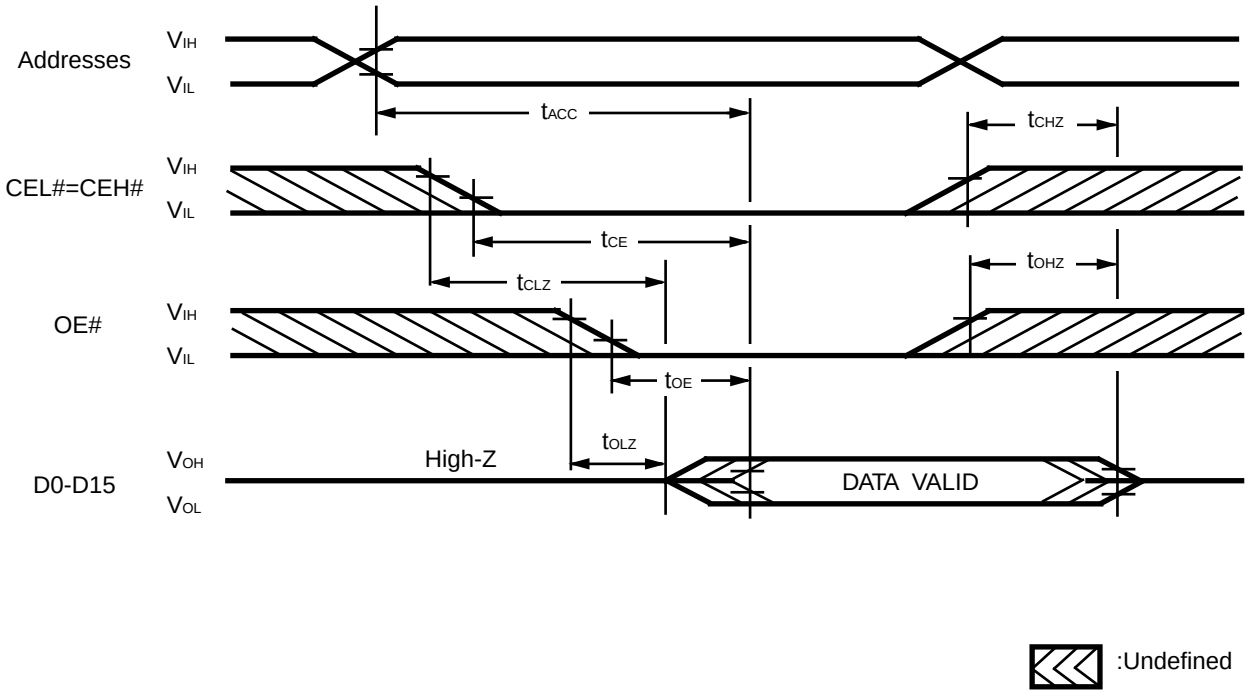
READ CYCLE TIMING DIAGRAM (continued) (WE# = V_{IH}, RESET# = V_{IH})

READ CYCLE 3: ×8-bit Bus Organization

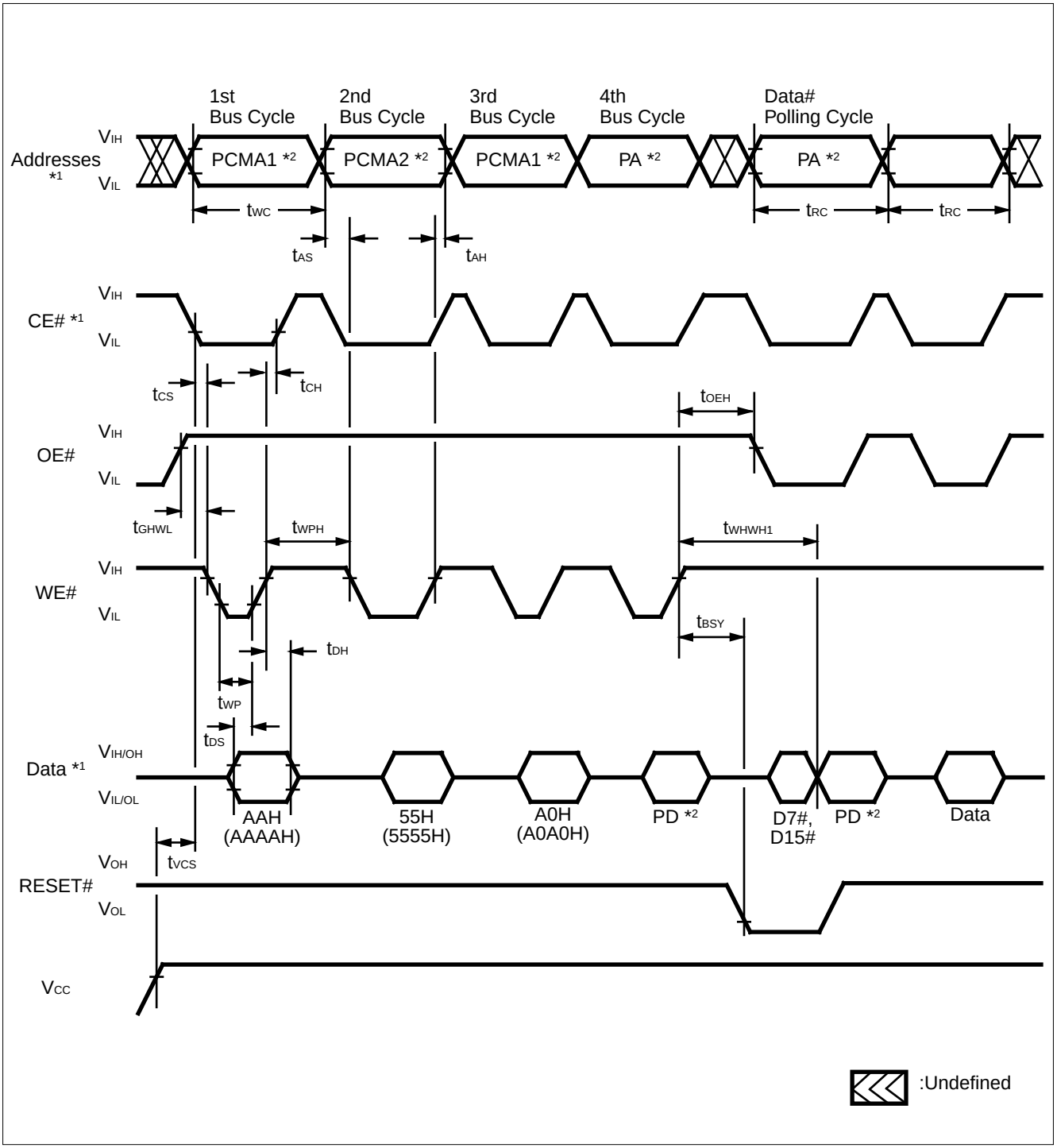


READ CYCLE TIMING DIAGRAM (continued) (WE# = V_{IH}, RESET# = V_{IH})

READ CYCLE 4: CEL# = CEH# = V_{IL}: ×16-bit Bus Organization

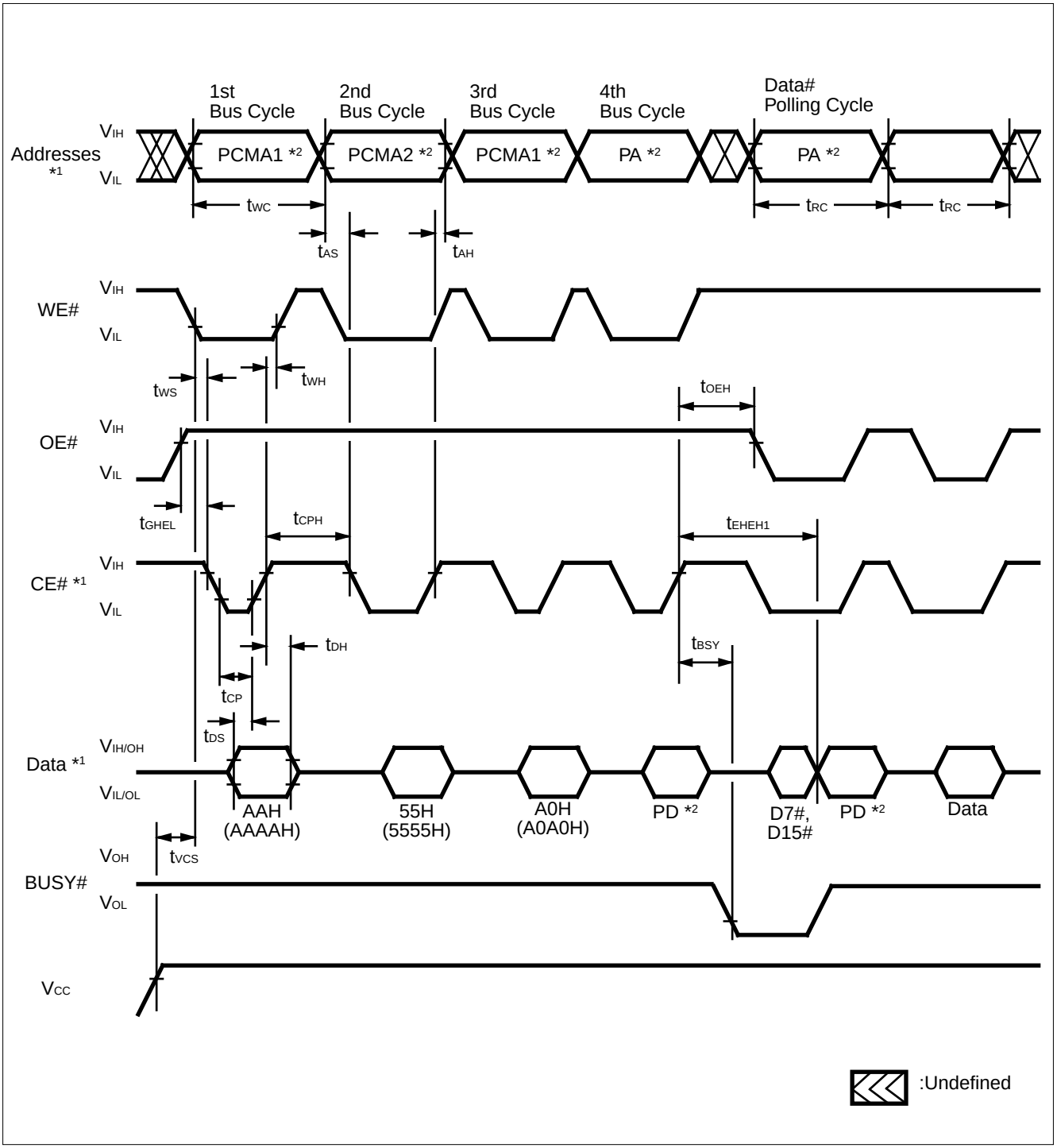


PROGRAM CYCLE TIMING DIAGRAM (WE# = CONTROLLED, RESET# = V_{IH})



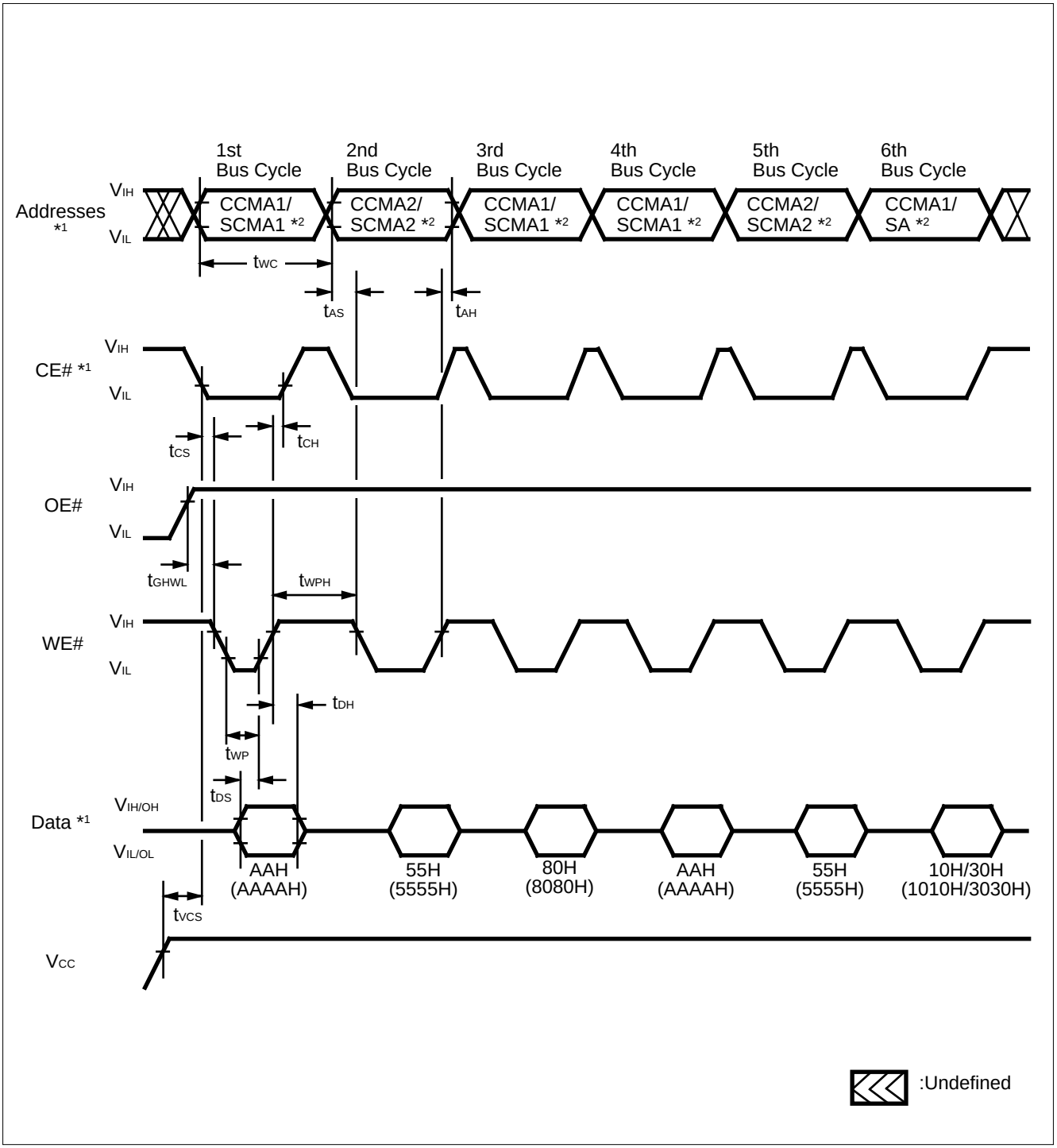
Notes: *1. See “FUNCTION TRUTH TABLE”.
*2. PCMA1/PCMA2 = Command Address for Program, PA = Program Address, PD = Program Data. See “COMMAND DEFINITION TABLE”.

PROGRAM CYCLE TIMING DIAGRAM (CE# = CONTROLLED, RESET# = V_{IH})



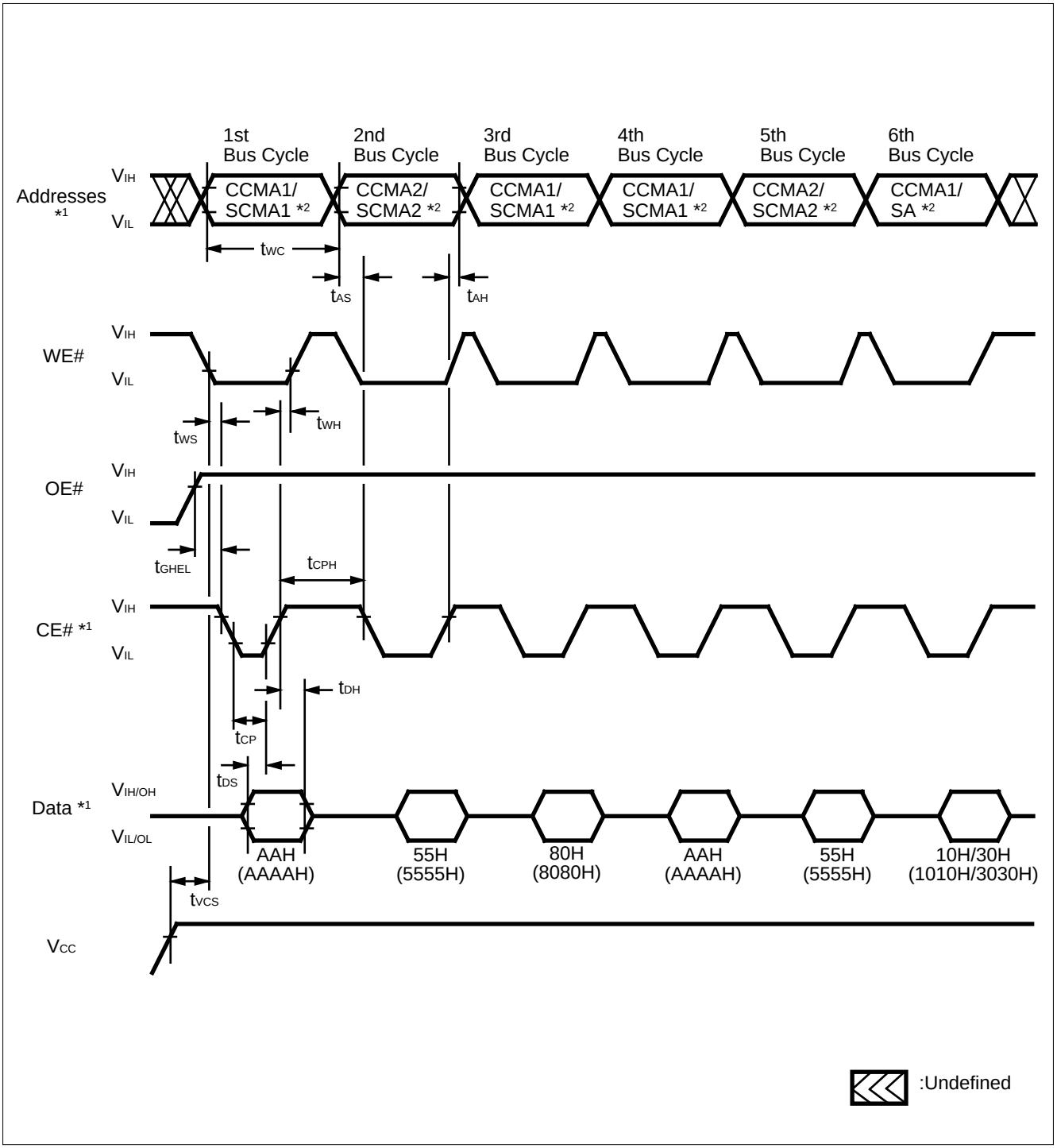
Notes: *1. See “FUNCTION TRUTH TABLE”.
*2. PCMA1/PCMA2 = Command Address for Program, PA = Program Address, PD = Program Data. See “COMMAND DEFINITION TABLE”.

ERASE CYCLE TIMING DIAGRAM (WE# = CONTROLLED, RESET# = V_{IH})



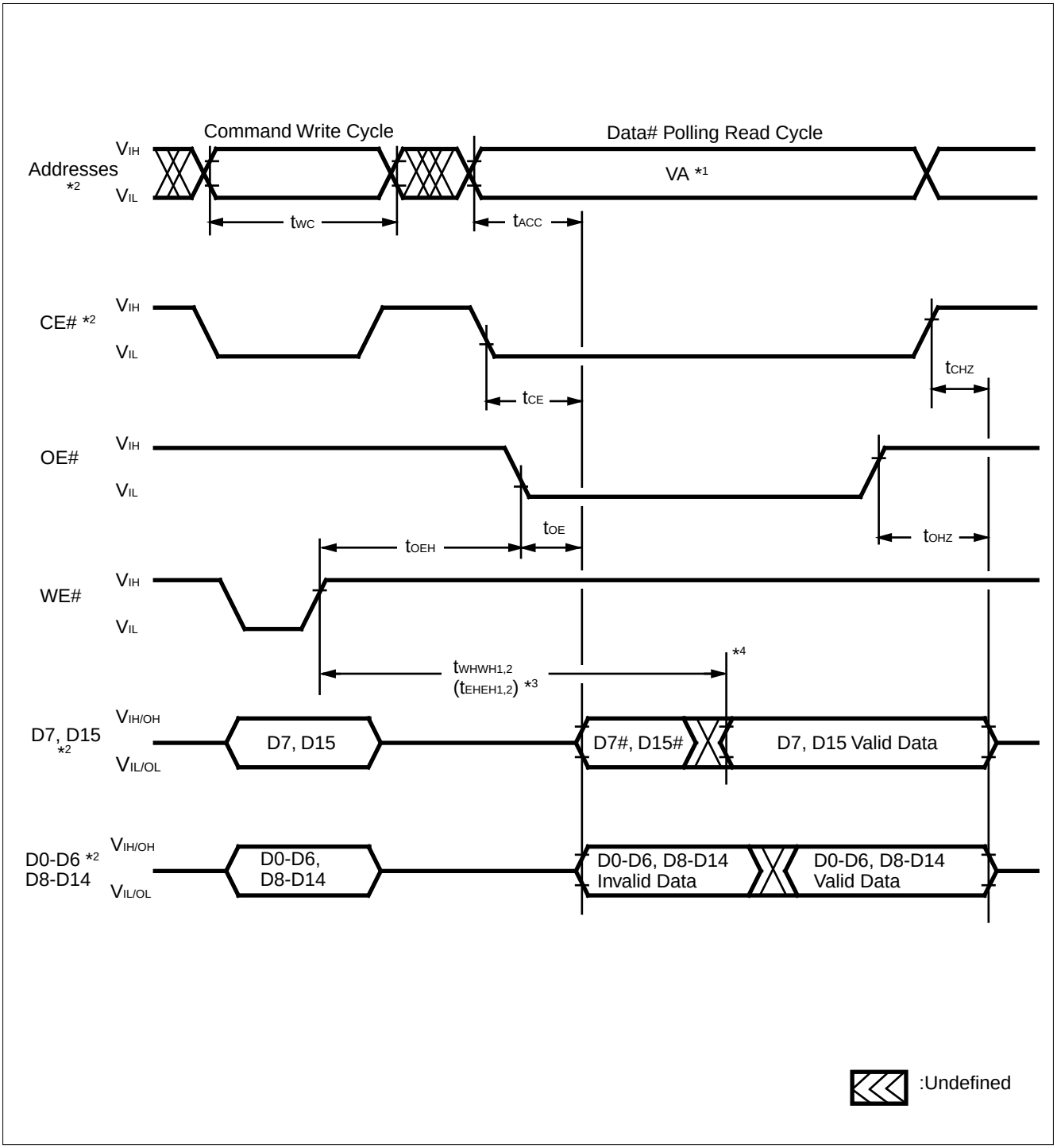
Notes: *1. See “FUNCTION TRUTH TABLE”.
*2. CCMA1/CCMA2 = Command Address for Chip Erase, SCMA1/SCMA2 = Command Address for Sector Erase, SA = Sector Address. See “COMMAND DEFINITION TABLE”.

ERASE CYCLE TIMING DIAGRAM (CE# = CONTROLLED, RESET# = V_{IH})



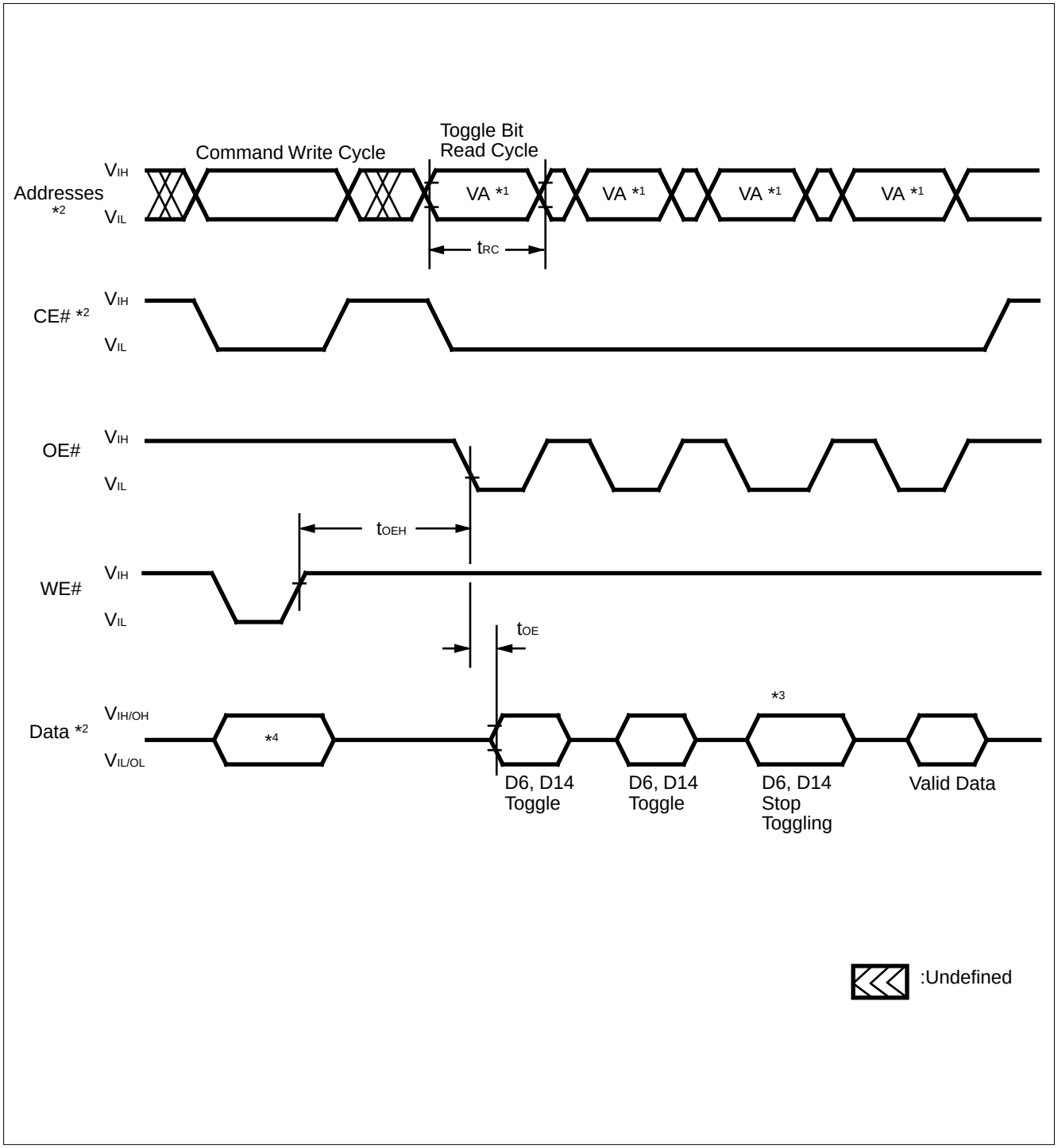
Notes: *1. See “FUNCTION TRUTH TABLE”.
*2. CCMA1/CCMA2 = Command Address for Chip Erase, SCMA1/SCMA2 = Command Address for Sector Erase, SA = Sector Address. See “COMMAND DEFINITION TABLE”.

DATA# POLLING CYCLE TIMING DIAGRAM (RESET# = V_{IH})



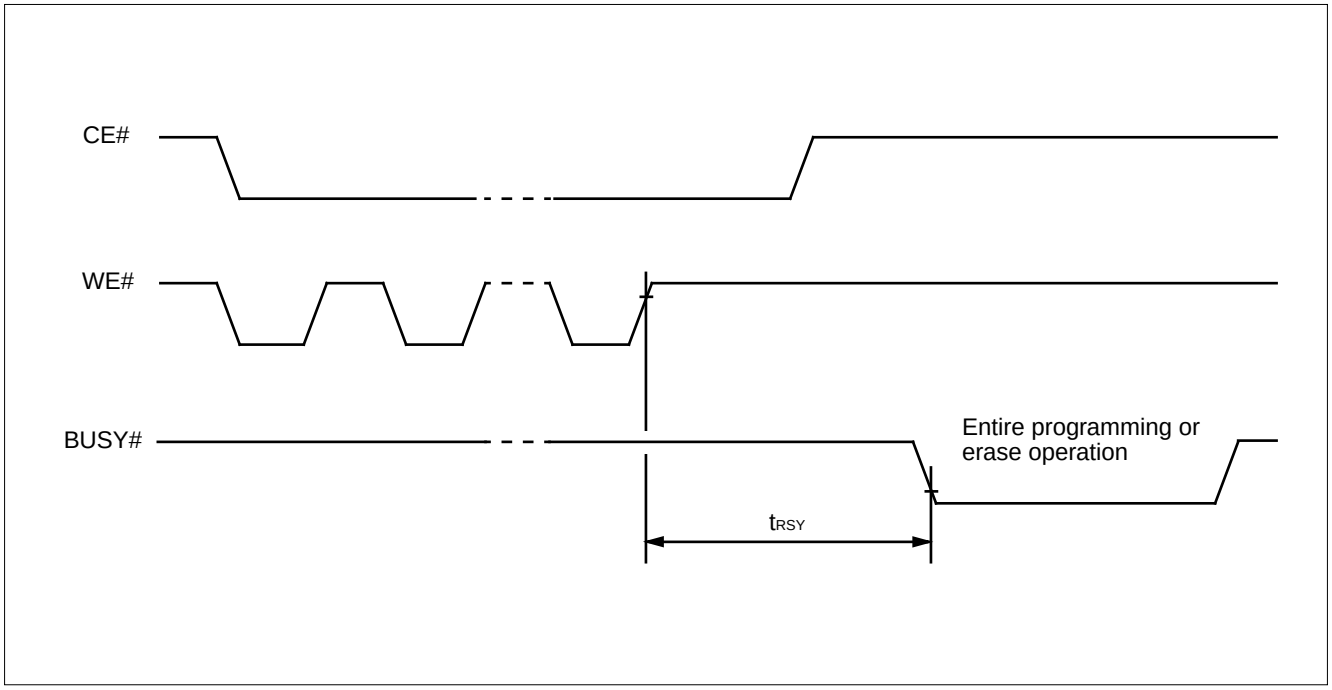
Notes: *1. VA = PA for Programming Cycle, VA = SA for Sector Erase, VA = CA for Chip Erase.
*2. See “FUNCTION TRUTH TABLE”.
*3. $t_{EHEH1,2}$ for CE# Control.
*4. Program/Erase operation is finished.

TOGGLE BIT TIMING DIAGRAM (RESET# = V_{IH})

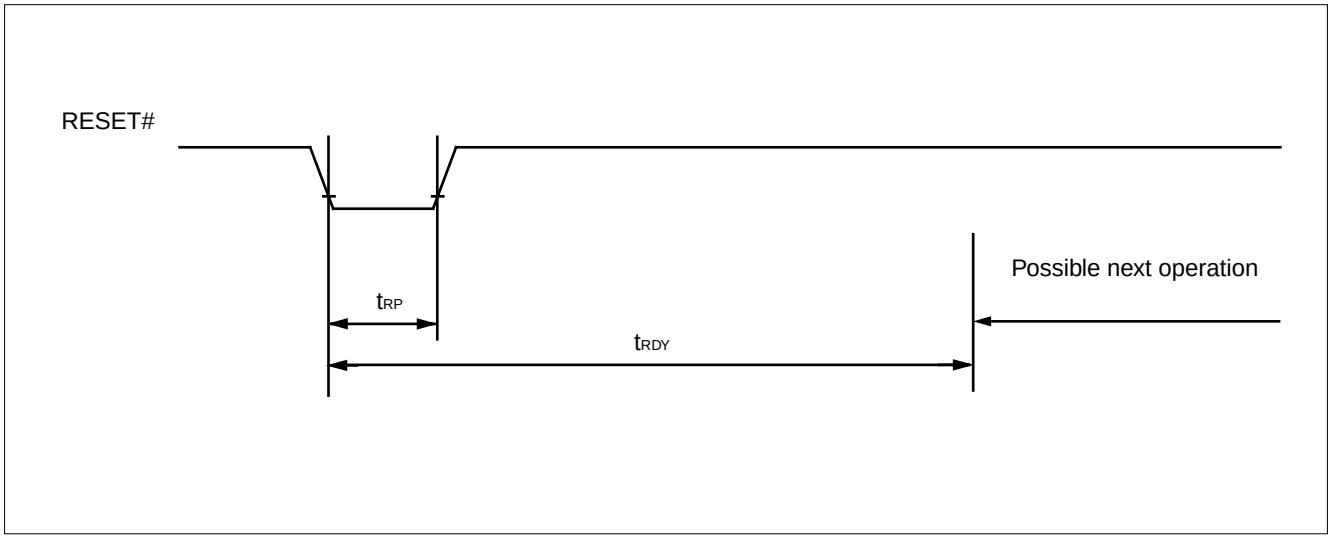


Notes: *1. VA = PA for Programming Cycle, VA = SA for Sector Erase, VA = CA for Chip Erase.
*2. See “FUNCTION TRUTH TABLE”.
*3. Program/Erase operation is finished.
*4. PD, 10H (1010H) or 30H (3030H)

BUSY# Timing Diagram During Program/Erase Operations (except for MB98C81013)

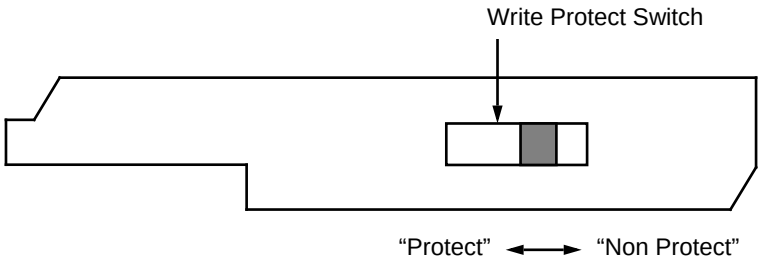


RESET# Timing Diagram (except for MB98C81013)



■ UNIQUE FEATURES

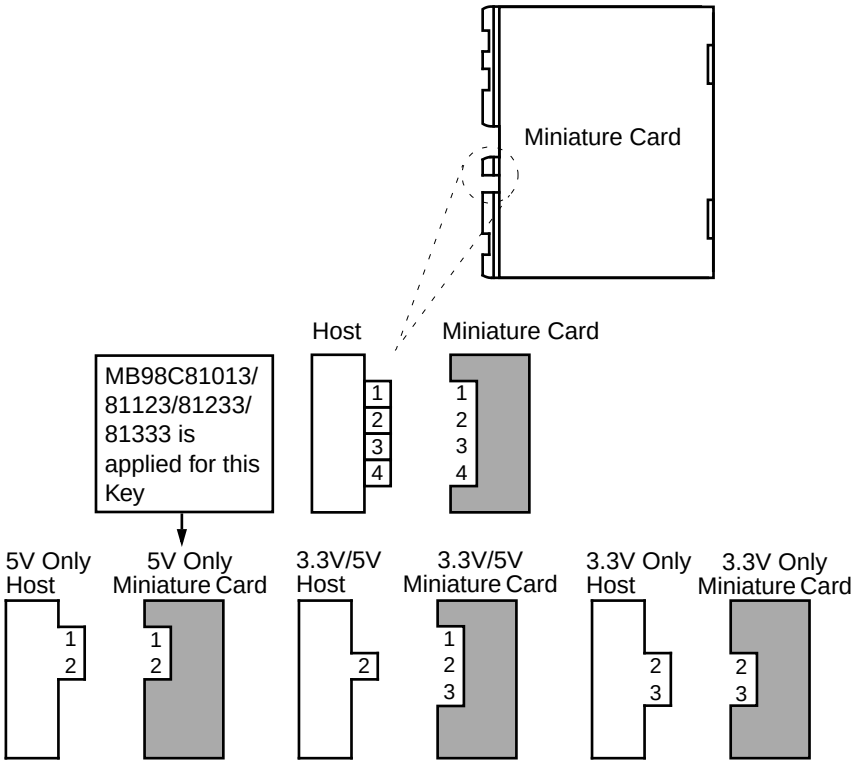
Write Protect Switch



Voltage Selection

The Miniature Card voltage is identified by both a mechanical key and voltage sense signals (VS1#, VS2#). The combination of the two allow the host to determine the proper voltage required to operate the Miniature Card, as well as a physical means to keep cards out of host systems that may damage the cards because of improper operational voltage.

Six different voltage key combinations are defined in "Miniature Card Specification": 5 volt only, 3.3 volt only, x.x volt only, 3V/5V, x.xV/3V, and x.xV/3V/5V. These keys consist of notches in the Miniature Card and corresponding tabs in the socket. The socket tabs are located in the front of the Miniature Card socket and are used to keep out cards that do not contain the corresponding notch. See Voltage Keying Mechanism below. (Now only defined about 5.0V and 3.3V)



■ ATTRIBUTE INFORMATION STRUCTURE (AIS)

Address	Data	Attribute
0000	01	[Common Memory device information tuple]
0001	03	Link to next tuple
0002	54	Flash memory with 100ns access time
0003	0D	1MB device size for common memory [MB98C81013]
	1D	2MB device size for common memory [MB98C81123]
	0E	4MB device size for common memory [MB98C81223]
	1E	8MB device size for common memory [MB98C81333]
0004	FF	End of list
05 - 0D	00	[Nulltuple-ignore]
000E	80	[Vendor unique tuple]
000F	F1	Link to next tuple
0010	99	“Miniature Card Identifier”
0011	10	“Level of Compliance”
0012	2F	“AIS Checksum” (B00-AD1=2F) [MB98C81013]
	FC	“AIS Checksum” (C00-B04=FC) [MB98C81123]
	91	“AIS Checksum” (B00-A6F=91) [MB98C81233]
	8D	“AIS Checksum” (B00-A73=8D) [MB98C81333]
0013	46	“Manufacture Name” (F)
0014	55	(U)
0015	4A	(J)
0016	49	(I)
0017	54	(T)
0018	53	(S)
0019	55	(U)
001A	00	
001B	4C	(L)
001C	49	(I)
001D	4D	(M)
001E	49	(I)
001F	54	(T)
0020	45	(E)
0021	44	(D)

■ ATTRIBUTE INFORMATION STRUCTURE (AIS) (continued)

Address	Data	Attribute
0022	00	
0023	00	
0024	00	
0025	00	
0026	00	
0027	4D	“Card Name” (M)
0028	42	(B)
0029	39	(9)
002A	38	(8)
002B	43	(C)
002C	38	(8)
002D	30	(0)
002E	30	(0)
002F	31	(1) MB98C81013
	32	(2) MB98C81123
	33	(3) MB98C81233, MB98C81333
0030	33	(3)
0031	00	
0032	73	(s)
0033	65	(e)
0034	72	(r)
0035	69	(i)
0036	65	(e)
0037	73	(s)
0038	00	
0039	00	
003A	00	
003B	01	“Technology Count” (1)
003C	00	“Reserved”
003D	00	“Reserved”
003E	00	“Reserved”
003F	00	“Reserved”

■ ATTRIBUTE INFORMATION STRUCTURE (AIS) (continued)

Address	Data	Attribute
0040	00	“Memory Type” (Flash)
0041	04	“JEDEC Manufacture ID” (FUJITSU)
0042	A4	“JEDEC Component ID” (MBM29F040A) [MB98C81013]
	D5	“JEDEC Component ID” (MBM29F080) [MB98C81123]
	3D	“JEDEC Component ID” (MBM29F017) [MB98C81233, MB98C81333]
0043	00	“Memory Size” (1MB) [MB98C81013]
	01	“Memory Size” (2MB) [MB98C81123]
	03	“Memory Size” (4MB) [MB98C81233]
	07	“Memory Size” (8MB) [MB98C81333]
0044	00	“x.x V Access time” (Not supported)
0045	00	“3.3 V Access time” (Not supported)
0046	0A	“5.0 V Access time” (100 ns)
0047	00	“x.x V Read/Write” (Not supported)
0048	00	“3.3 V Read/Write” (Not supported)
0049	78	“5.0 V Read/Write” (70 mA/80 mA)
004A	01	“Standby Current” (100 μA)
004B	00	“Reserved”
004C	00	“Reserved”
004D	00	“Reserved”
004E	00	“Reserved”
004F	00	“Reserved”
↓		
00FF	00	“Reserved”
0100	FF	End of list
0101	15	[Level 1 version/product-information tuple]
0102	1C	Link to next tuple
0103	05	PC Card Standard, February 1995
0104	00	
0105	46	(F)
0106	55	(U)
0107	4A	(J)
0108	49	(I)
0109	54	(T)

■ ATTRIBUTE INFORMATION STRUCTURE (AIS) (continued)

Address	Data	Attribute
010A	53	(S)
010B	55	(U)
010C	00	
010D	4D	(M)
010E	42	(B)
010F	39	(9)
0110	38	(8)
0111	43	(C)
0112	38	(8)
0113	30	(0)
0114	30	(0)
0115	31	(1)
	32	(2)
	33	(3)
0116	33	(3)
0117	73	(s)
0118	65	(e)
0119	72	(r)
011A	69	(i)
011B	65	(e)
011C	73	(s)
011D	00	
011E	FF	End of list
011F	18	[JEDEC programming information for Common Memory tuple]
0120	03	Link to next tuple
0121	04	JEDEC Manufacture ID (FUJITSU)
0122	A4	JEDEC Device ID (MB29F040A) [MB98C81013]
	D5	JEDEC Device ID (MB29F080) [MB98C81123]
	3D	JEDEC Device ID (MB29F017) [MB98C81233, MB98C81333]
0123	FF	End of list
0124	1E	[Device geometry information for Common Memory device tuple]
0125	07	Link to next tuple

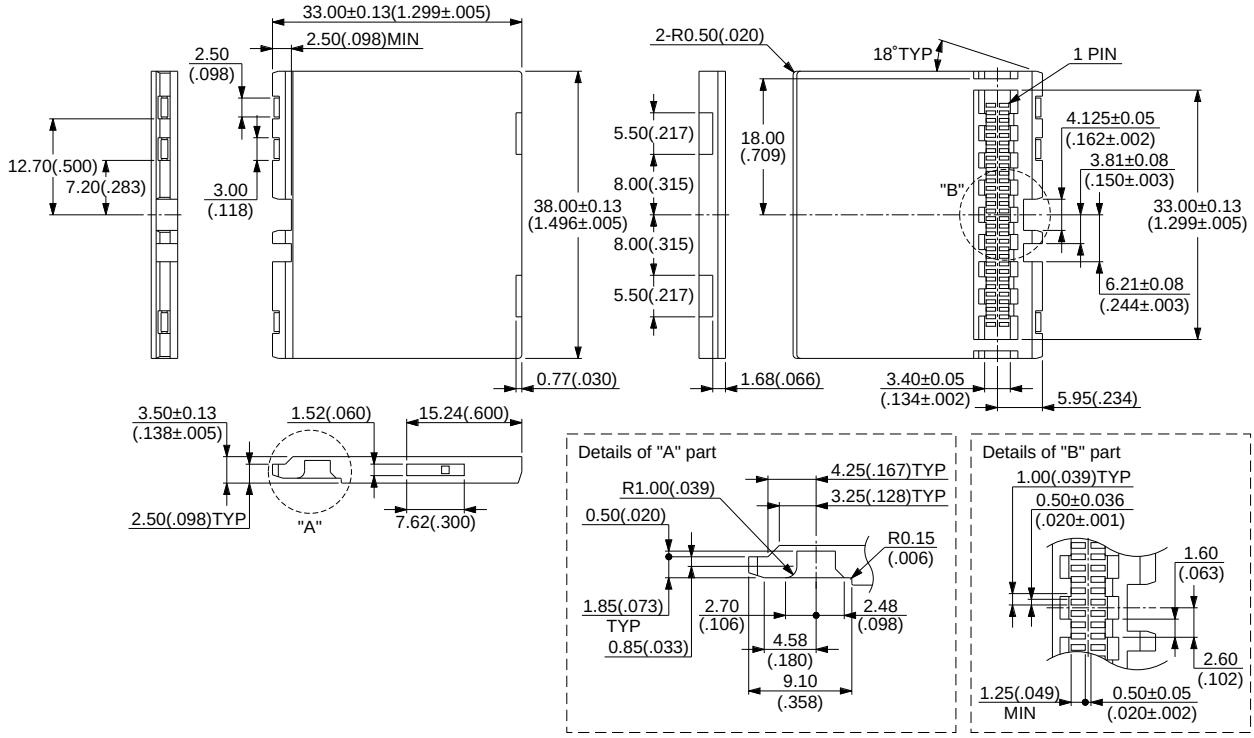
■ ATTRIBUTE INFORMATION STRUCTURE (AIS) (continued)

Address	Data	Attribute
0126	02	System bus width is 2 Bytes
0127	11	Erase block size is 64 KBytes
0128	01	Read block size is 1 Bytes
0129	01	Write block size is 1 Bytes
012A	01	No special partitioning requirements
012B	01	Non interleaved
012C	FF	End of list
012D	12	[Longlink to Common Memory]
012E	05	Link to next tuple
012F	00	Target address; stored as an unsigned long, low-order byte first
0130	00	
0131	02	
0132	00	
0133	FF	End of list
0134	FF	[The end-of-chain tuple]

Notice: AIS is programed from the address “0000H” of Lower Byte. This AIS may be deleted on the driver software which does not consider AIS.

■ PACKAGE DIMENSIONS

60-PIN MINIATURE CARD
(CASE No.: CRD-60P-M01)



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Dimension mm (in inches)

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