

# SPANSION™ Flash Memory

Data Sheet



September 2003

This document specifies SPANSION™ memory products that are now offered by both Advanced Micro Devices and Fujitsu. Although the document is marked with the name of the company that originally developed the specification, these products will be offered to customers of both AMD and Fujitsu.

## **Continuity of Specifications**

There is no change to this datasheet as a result of offering the device as a SPANSION™ product. Future routine revisions will occur when appropriate, and changes will be noted in a revision summary.

## **Continuity of Ordering Part Numbers**

AMD and Fujitsu continue to support existing part numbers beginning with "Am" and "MBM". To order these products, please use only the Ordering Part Numbers listed in this document.

## **For More Information**

Please contact your local AMD or Fujitsu sales office for additional information about SPANSION™ memory solutions.



# FLASH MEMORY

CMOS

## 32M (2M × 16) BIT Page Dual Operation

**MBM29PDS322TE**<sub>10/11</sub>**MBM29PDS322BE**<sub>10/11</sub>

### DESCRIPTION

The MBM29PDS322TE/BE is 32M-bit, 1.8 V-only Flash memory organized as 2M words of 16 bits each. The device is offered in 63-ball FBGA package. This device is designed to be programmed in system with standard system 1.8 V  $V_{CC}$  supply. 12.0 V  $V_{PP}$  and 5.0 V  $V_{CC}$  are not required for write or erase operations. The device can also be reprogrammed in standard EPROM programmers.

The device is organized into two banks, Bank 1 and Bank 2, which are considered to be two separate memory arrays for operations are concerned. It is the Fujitsu's standard 1.8 V only Flash memories with the additional capability of allowing a normal non-delayed read access from a non-busy bank of the array while an embedded write (either a program or an erase) operation is simultaneously taking place on the other bank.

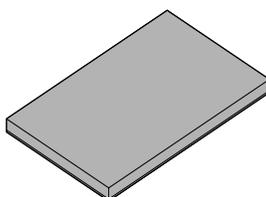
*(Continued)*

### PRODUCT LINE-UP

Part No.	MBM29PDS322TE/BE	
	10	11
Power Supply Voltage $V_{CC}$ (V)	2.0 V $\begin{matrix} +0.2V \\ -0.2V \end{matrix}$	
Max Random Address Access Time (ns)	100	115
Max Page Address Access Time (ns)	40	50
Max $\overline{CE}$ Access Time (ns)	100	115
Max $\overline{OE}$ Access Time (ns)	35	45

### PACKAGE

63-ball plastic FBGA



(BGA-63P-M01)

(Continued)

The device provides truly high performance non-volatile Flash memory solution. The device offers fast page access times of 45 ns with random access times of 100 ns and 115 ns, allowing operation of high-speed microprocessors without wait states. To eliminate bus contention the device has separate chip enable ( $\overline{CE}$ ), write enable ( $\overline{WE}$ ), and output enable ( $\overline{OE}$ ) controls. The page size is 4 words.

The device is pin and command set compatible with JEDEC standard E<sup>2</sup>PROMs. Commands are written to the command register using standard microprocessor write timings. Register contents serve as input to an internal state-machine which controls the erase and programming circuitry. Write cycles also internally latch addresses and data needed for the programming and erase operations. Reading data out of the device is similar to reading from 5.0 V and 12.0 V Flash or EPROM devices.

The device is programmed by executing the program command sequence. This will invoke the Embedded Program Algorithm which is an internal algorithm that automatically times the program pulse widths and verifies proper cell margin. Typically, each sector can be programmed and verified in about 0.5 seconds. Erase is accomplished by executing the erase command sequence. This will invoke the Embedded Erase Algorithm which is an internal algorithm that automatically preprograms the array if it is not already programmed before executing the erase operation. During erase, the device automatically time the erase pulse widths and verify proper cell margin.

A sector is typically erased and verified in 1.0 second. (If already completely preprogrammed.)

The device also features a sector erase architecture. The sector mode allows each sector to be erased and reprogrammed without affecting other sectors. The device is erased when shipped from the factory.

The device features single 1.8 V power supply operation for both read and write functions. Internally generated and regulated voltages are provided for the program and erase operations. A low  $V_{CC}$  detector automatically inhibits write operations on the loss of power. The end of program or erase is detected by  $\overline{Data}$  Polling of DQ<sub>7</sub>, by the Toggle Bit feature on DQ<sub>6</sub>, or the RY/ $\overline{BY}$  output pin. Once the end of a program or erase cycle has been completed, the device internally resets to the read mode.

The device also has a hardware  $\overline{RESET}$  pin. When this pin is driven low, execution of any Embedded Program Algorithm or Embedded Erase Algorithm is terminated. The internal state machine is then reset to the read mode. The  $\overline{RESET}$  pin may be tied to the system reset circuitry. Therefore, if a system reset occurs during the Embedded Program Algorithm or Embedded Erase Algorithm, the device is automatically reset to the read mode and will have erroneous data stored in the address locations being programmed or erased. These locations need re-writing after the Reset. Resetting the device enables the system's microprocessor to read the boot-up firmware from the Flash memory.

Fujitsu's Flash technology combines years of EPROM and E<sup>2</sup>PROM experience to produce the highest levels of quality, reliability, and cost effectiveness. The device memory electrically erase the entire chip or all bits within a sector simultaneously via Fowler-Nordhiem tunneling. The words are programmed one word at a time using the EPROM programming mechanism of hot electron injection.

## ■ FEATURES

- **0.23  $\mu$ m Process Technology**
- **Simultaneous Read/Write Operations (Dual Bank)**  
Host system can program or erase in one bank, and then read immediately and simultaneously from the other bank with zero latency between read and write operations.  
Read-while-erase  
Read-while-program
- **High Performance Page Mode**  
45 ns maximum page access time (100 ns random access time)  
4 words Page Size
- **Single 1.8 V Read, Program, and Erase**  
Minimized system level power requirements
- **Compatible with JEDEC-standard Commands**  
Use the same software commands as E<sup>2</sup>PROMs.
- **Compatible with JEDEC-standard World-wide Pinouts**  
63-ball FBGA (Package suffix: PBT)
- **Minimum 100,000 Program/Erase Cycles**
- **Sector Erase Architecture**  
Eight 4 K word and sixty-three 32 K word sectors in word mode  
Any combination of sectors can be concurrently erased. Also supports full chip erase.
- **Boot Code Sector Architecture**  
T = Top sector  
B = Bottom sector
- **HiddenROM Region**  
32 K word of HiddenROM, accessible through a new “HiddenROM Enable” command sequence  
Factory serialized and protected to provide a secure electronic serial number (ESN)
- **WP/ACC Input Pin**  
At V<sub>IL</sub>, allows protection of boot sectors, regardless of sector protection/unprotection status.  
At V<sub>ACC</sub>, increases program performance.
- **Embedded Erase™\* Algorithms**  
Automatically pre-programs and erases the chip or any sector.
- **Embedded Program™\* Algorithms**  
Automatically writes and verifies data at specified address.
- **Data Polling and Toggle Bit Feature for Detection of Program or Erase Cycle Completion**
- **Ready/Busy Output (RY/BY)**  
Hardware method for detection of program or erase cycle completion
- **Automatic Sleep Mode**  
When addresses remain stable, automatically switch themselves to low power mode.
- **Erase Suspend/Resume**  
Suspends the erase operation to allow a read data and/or program in another sector within the same device.
- **Sector Group Protection**  
Hardware method disables any combination of sector groups from program or erase operations.
- **Sector Group Protection Set Function by Extended Sector Group Protection Command**
- **Fast Programming Function by Extended Command**
- **Temporary Sector Group Unprotection**  
Temporary sector group unprotection via the  $\overline{\text{RESET}}$  pin.

\* : Embedded Erase™ and Embedded Program™ are trademarks of Advanced Micro Devices, Inc.

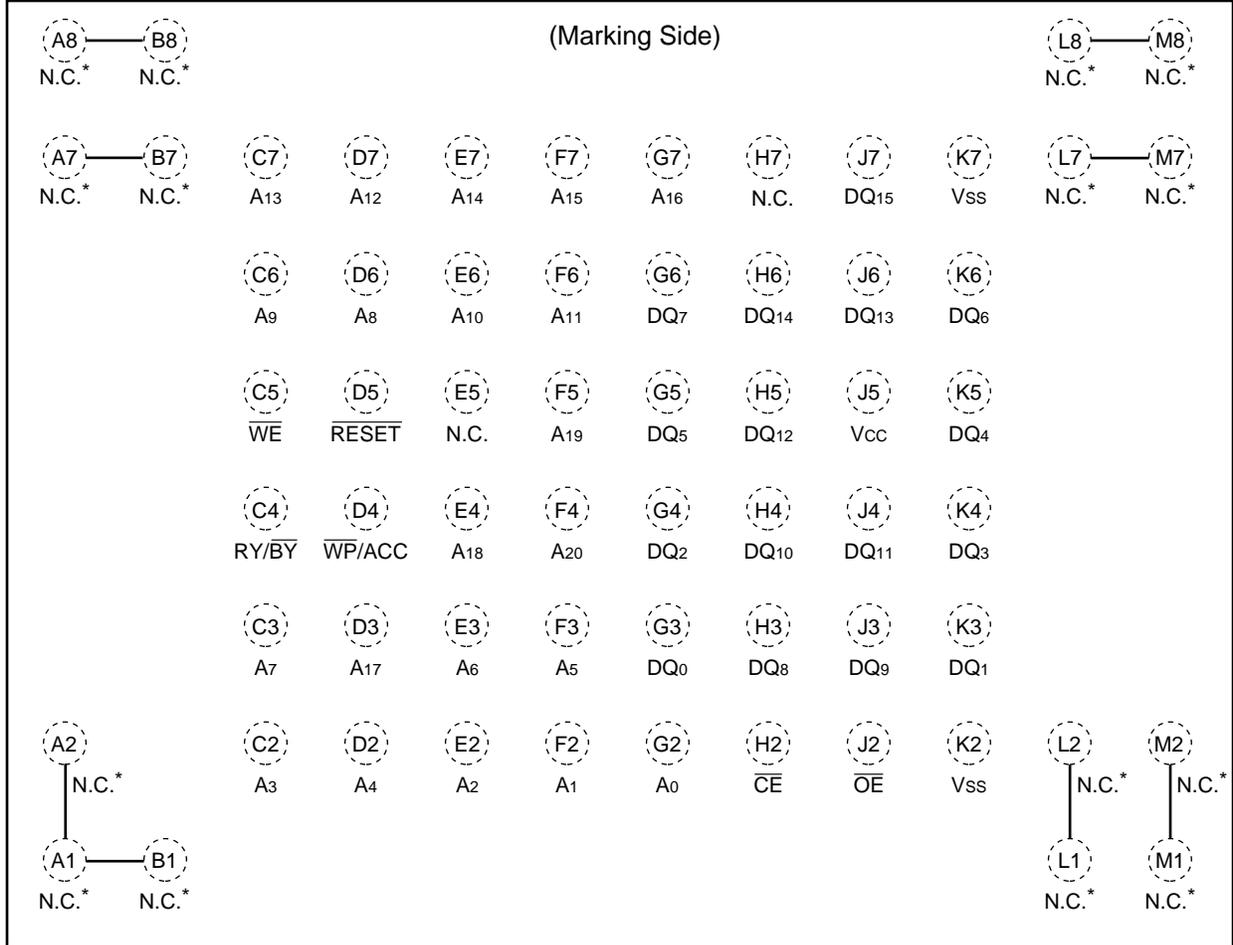
# MBM29PDS322TE<sub>10/11</sub>/MBM29PDS322BE<sub>10/11</sub>

MBM29PDS322TE/BE Device Bank Division

Device Part Number	Organization	Bank 1		Bank 2	
		Megabits	Sector Sizes	Megabits	Sector Sizes
MBM29PDS322TE/BE	× 16	4 Mbit	Eight 4 K word, seven 32 K word	28 Mbit	Fifty-six 32 K word

## ■ PIN ASSIGNMENT

(TOP VIEW)



(BGA-63P-M01)

\*: Peripheral balls on each corner are shorted together via the substrate but not connected to the die.

# MBM29PDS322TE<sub>10/11</sub>/MBM29PDS322BE<sub>10/11</sub>

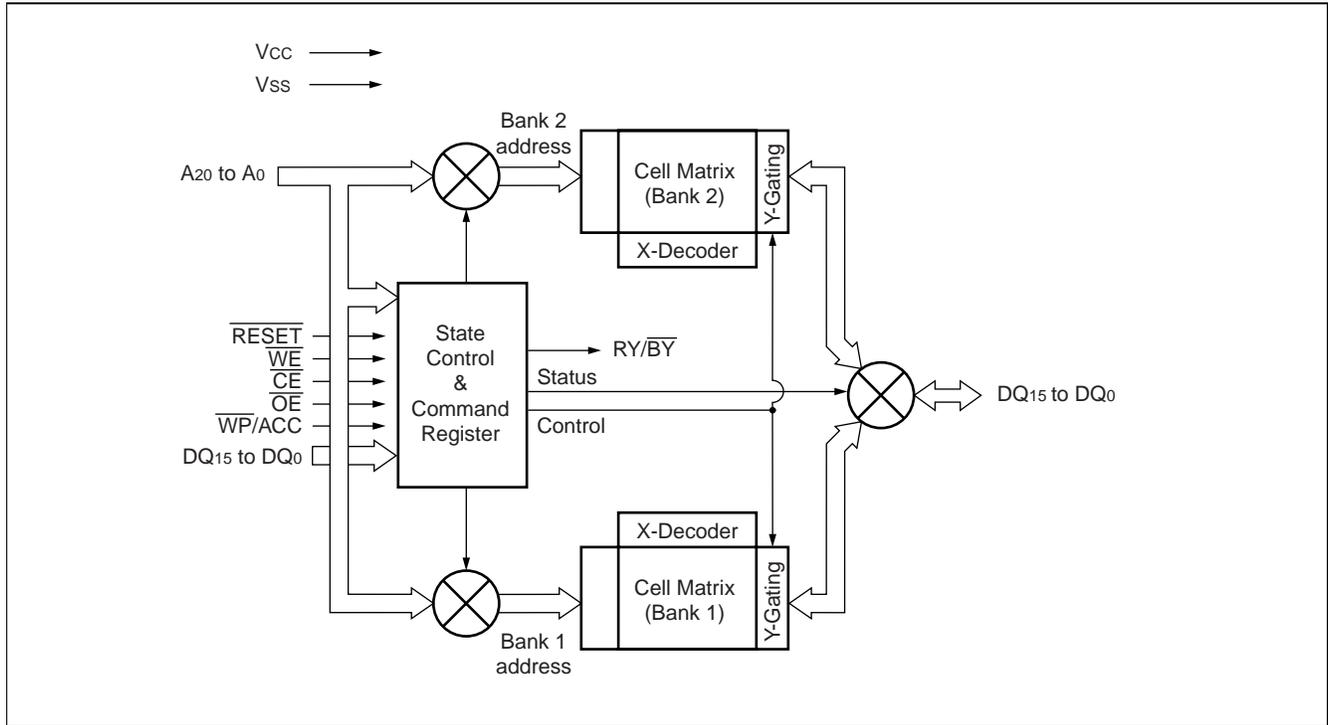
## ■ PIN DESCRIPTION

MBM29PDS322TE/BE Pin Configuration

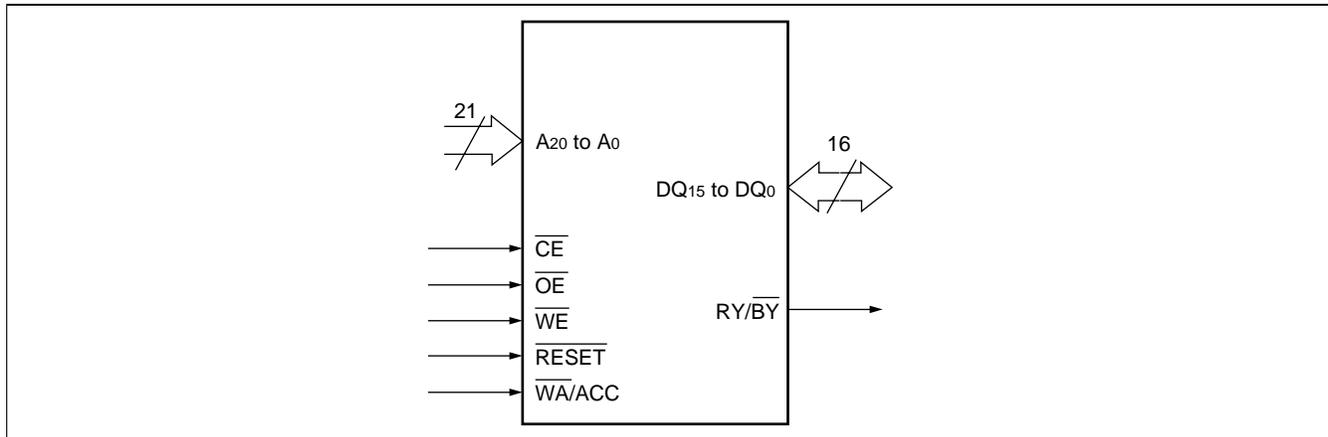
Pin name	Function
A <sub>20</sub> to A <sub>0</sub>	Address Inputs
DQ <sub>15</sub> to DQ <sub>0</sub>	Data Inputs/Outputs
$\overline{\text{CE}}$	Chip Enable
$\overline{\text{OE}}$	Output Enable
$\overline{\text{WE}}$	Write Enable
RY/ $\overline{\text{BY}}$	Ready/Busy Output
$\overline{\text{RESET}}$	Hardware Reset Pin/Temporary Sector Group Unprotection
$\overline{\text{WP/ACC}}$	Hardware Write Protection/Program Acceleration
N.C.	No Internal Connection
V <sub>SS</sub>	Device Ground
V <sub>CC</sub>	Device Power Supply

# MBM29PDS322TE<sub>10/11</sub>/MBM29PDS322BE<sub>10/11</sub>

## ■ BLOCK DIAGRAM



## ■ LOGIC SYMBOL



# MBM29PDS322TE<sub>10/11</sub>/MBM29PDS322BE<sub>10/11</sub>

## ■ DEVICE BUS OPERATION

MBM29PDS322TE/BE User Bus Operations Table

Operation	$\overline{CE}$	$\overline{OE}$	$\overline{WE}$	A <sub>0</sub>	A <sub>1</sub>	A <sub>2</sub>	A <sub>3</sub>	A <sub>6</sub>	A <sub>9</sub>	DQ <sub>15</sub> to DQ <sub>0</sub>	RESET	WP/ACC
Auto-Select Manufacturer Code *1	L	L	H	L	L	L	L	L	V <sub>ID</sub>	Code	H	X
Auto-Select Device Code *1	L	L	H	H	L	L	L	L	V <sub>ID</sub>	Code	H	X
Extended Auto-Select Device Code *1	L	L	H	L/H	H	H	H	L	V <sub>ID</sub>	Code	H	X
Read *3	L	L	H	A <sub>0</sub>	A <sub>1</sub>	A <sub>2</sub>	A <sub>3</sub>	A <sub>6</sub>	A <sub>9</sub>	D <sub>OUT</sub>	H	X
Standby	H	X	X	X	X	X	X	X	X	High-Z	H	X
Output Disable	L	H	H	X	X	X	X	X	X	High-Z	H	X
Write (Program/Erase)	L	H	L	A <sub>0</sub>	A <sub>1</sub>	A <sub>2</sub>	A <sub>3</sub>	A <sub>6</sub>	A <sub>9</sub>	D <sub>IN</sub>	H	X
Enable Sector Group Protection *2, *4	L	V <sub>ID</sub>		L	H	L	L	L	V <sub>ID</sub>	X	H	X
Verify Sector Group Protection *2, *4	L	L	H	L	H	L	L	L	V <sub>ID</sub>	Code	H	X
Temporary Sector Group Unprotection *5	X	X	X	X	X	X	X	X	X	X	V <sub>ID</sub>	X
Reset (Hardware) / Standby	X	X	X	X	X	X	X	X	X	High-Z	L	X
Boot Block Sector Write Protection *6	X	X	X	X	X	X	X	X	X	X	X	L

Legend: L = V<sub>IL</sub>, H = V<sub>IH</sub>, X = V<sub>IL</sub> or V<sub>IH</sub>,  = Pulse input. See “■ DC CHARACTERISTICS” for voltage levels.

\*1: Manufacturer and device codes may also be accessed via a command register write sequence. See “MBM29PDS322TE/BE User Bus Operations” Table.

\*2: Refer to section on Sector Group Protection.

\*3:  $\overline{WE}$  can be V<sub>IL</sub> if  $\overline{OE}$  is V<sub>IL</sub>,  $\overline{OE}$  at V<sub>IH</sub> initiates the write operations.

\*4: V<sub>CC</sub> must be between the minimum and maximum of the operation range.

\*5: Also used for the extended sector group protection.

\*6: Protect “outermost” 2 × 4 K words of the boot block sectors.

# MBM29PDS322TE<sub>10/11</sub>/MBM29PDS322BE<sub>10/11</sub>

MBM29PDS322TE/BE Command Definitions Table

Command Sequence		Bus Write Cycles Req'd	First Bus Write Cycle		Second Bus Write Cycle		Third Bus Write Cycle		Fourth Bus Read/Write Cycle		Fifth Bus Write Cycle		Sixth Bus Write Cycle	
			Addr.	Data	Addr.	Data	Addr.	Data	Addr.	Data	Addr.	Data	Addr.	Data
Read/Reset	Word	1	XXXh	F0h	—	—	—	—	—	—	—	—	—	—
Read/Reset	Word	3	555h	AAh	2AAh	55h	555h	F0h	RA	RD	—	—	—	—
Auto select	Word	3	555h	AAh	2AAh	55h	(BA) 555h	90h	—	—	—	—	—	—
Program	Word	4	555h	AAh	2AAh	55h	555h	A0h	PA	PD	—	—	—	—
Chip Erase	Word	6	555h	AAh	2AAh	55h	555h	80h	555h	AAh	2AAh	55h	555h	10h
Sector Erase	Word	6	555h	AAh	2AAh	55h	555h	80h	555h	AAh	2AAh	55h	SA	30h
Erase Suspend		1	BA	B0h	—	—	—	—	—	—	—	—	—	—
Erase Resume		1	BA	30h	—	—	—	—	—	—	—	—	—	—
Set to Fast Mode	Word	3	555h	AAh	2AAh	55h	555h	20h	—	—	—	—	—	—
Fast Program *1	Word	2	XXXh	A0h	PA	PD	—	—	—	—	—	—	—	—
Reset from Fast Mode *1	Word	2	BA	90h	XXXh	*4 F0h	—	—	—	—	—	—	—	—
Extended Sector Group Protection *2	Word	4	XXXh	60h	SPA	60h	SPA	40h	SPA	SD	—	—	—	—
HiddenROM Entry	Word	3	555h	AAh	2AAh	55h	555h	88h	—	—	—	—	—	—
HiddenROM Program *3	Word	4	555h	AAh	2AAh	55h	555h	A0h	(HRA) PA	PD	—	—	—	—
HiddenROM Erase *3	Word	6	555h	AAh	2AAh	55h	555h	80h	555h	AAh	2AAh	55h	HRA	30h
HiddenROM Exit *3	Word	4	555h	AAh	2AAh	55h	(HRBA) 555h	90h	XXXh	00h	—	—	—	—

\*1: This command is valid during Fast Mode.

\*2: This command is valid while  $\overline{\text{RESET}} = V_{\text{ID}}$ .

\*3: This command is valid during HiddenROM mode.

\*4: The data "00h" is also acceptable.

Notes : • Address bits  $A_{20}$  to  $A_{12} = X = \text{"H"} \text{ or } \text{"L"}$  for all address commands except or Program Address (PA), Sector Address (SA), and Bank Address (BA).

• Bus operations are defined in "Simultaneous Operation Table" in "FUNCTIONAL DESCRIPTION".

• RA = Address of the memory location to be read

PA = Address of the memory location to be programmed  
Addresses are latched on the falling edge of the write pulse.

SA = Address of the sector to be erased. The combination of  $A_{20}$ ,  $A_{19}$ ,  $A_{18}$ ,  $A_{17}$ ,  $A_{16}$ ,  $A_{15}$ ,  $A_{14}$ ,  $A_{13}$ , and  $A_{12}$  will uniquely select any sector.

BA = Bank Address ( $A_{20}$  to  $A_{15}$ )

# MBM29PDS322TE<sub>10/11</sub>/MBM29PDS322BE<sub>10/11</sub>

- RD = Data read from location RA during the read operation.
- PD = Data to be programmed at location PA. Data is latched on the rising edge of write pulse.
- SPA = Sector group address to be protected. Set sector group address (SGA) and  $(A_6, A_1, A_0) = (0, 1, 0)$ .
- SD = Sector group protection verify data. Output 01h at protected sector group addresses and output 00h at unprotected sector group addresses.
- HRA = Address of the HiddenROM area  
29PDS322TE (Top Boot Type) Word Mode: 1F8000h to 1FFFFFh  
29PDS322BE (Bottom Boot Type) Word Mode: 000000h to 007FFFh
- HRBA = Bank Address of the HiddenROM area  
29PDS322TE (Top Boot Type):  $A_{20} = A_{19} = A_{18} = A_{17} = A_{16} = A_{15} = 1$   
29PDS322BE (Bottom Boot Type):  $A_{20} = A_{19} = A_{18} = A_{17} = A_{16} = A_{15} = 0$
- The system should generate the following address patterns:  
Word Mode: 555h or 2AAh to addresses  $A_{10}$  to  $A_0$
- Both Read/Reset commands are functionally equivalent, resetting the device to the read mode.
- The command combinations not described MBM29PDS322TE/BE command definitions are illegal.

# MBM29PDS322TE<sub>10/11</sub>/MBM29PDS322BE<sub>10/11</sub>

**MBM29PDS322TE Sector Group Protection Verify Autoselect Codes Table**

Type		A <sub>20</sub> to A <sub>12</sub>	A <sub>6</sub>	A <sub>3</sub>	A <sub>2</sub>	A <sub>1</sub>	A <sub>0</sub>	Code (HEX)
Manufacturer's Code		BA <sup>*2</sup>	V <sub>IL</sub>	04h				
Device Code	Word	BA <sup>*2</sup>	V <sub>IL</sub>	V <sub>IL</sub>	V <sub>IL</sub>	V <sub>IL</sub>	V <sub>IH</sub>	227Eh
Extended Device Code <sup>*3</sup>	Word	BA <sup>*2</sup>	V <sub>IL</sub>	V <sub>IH</sub>	V <sub>IH</sub>	V <sub>IH</sub>	V <sub>IL</sub>	2206h
	Word	BA <sup>*2</sup>	V <sub>IL</sub>	V <sub>IH</sub>	V <sub>IH</sub>	V <sub>IH</sub>	V <sub>IH</sub>	2201h
Sector Group Protection		Sector Group Addresses	V <sub>IL</sub>	V <sub>IL</sub>	V <sub>IL</sub>	V <sub>IH</sub>	V <sub>IL</sub>	01h <sup>*1</sup>

\*1 : Outputs 01h at protected sector group addresses and outputs 00h at unprotected sector group addresses.

\*2 : When V<sub>ID</sub> is applied, both Bank 1 and Bank 2 become Autoselect mode, which leads to the simultaneous operation unable to be executed. Consequently, specifying the bank address is not demanded. However, the bank address needs to be indicated when Autoselect mode is read out at command mode; because then it becomes OK to activate simultaneous operation.

\*3 : A read cycle at address (BA)01h outputs device code. When 227Eh was output, this indicates that there will require two additional codes, called Extended Device Codes. Therefore, the system may continue reading out these Extended Device Codes at the address of (BA)0Eh, as well as at (BA)0Fh.

**Expanded Autoselect Code Table**

Type		Code	DQ <sub>15</sub>	DQ <sub>14</sub>	DQ <sub>13</sub>	DQ <sub>12</sub>	DQ <sub>11</sub>	DQ <sub>10</sub>	DQ <sub>9</sub>	DQ <sub>8</sub>	DQ <sub>7</sub>	DQ <sub>6</sub>	DQ <sub>5</sub>	DQ <sub>4</sub>	DQ <sub>3</sub>	DQ <sub>2</sub>	DQ <sub>1</sub>	DQ <sub>0</sub>
Manufacturer's Code		04h	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Device Code	(W)	227Eh	0	0	1	0	0	0	1	0	0	1	1	1	1	1	1	0
Extended Device Code	(W)	2206h	0	0	1	0	0	0	1	0	0	0	0	0	0	1	1	0
	(W)	2201h	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	1
Sector Group Protection		01h	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1

(W): Word mode

# MBM29PDS322TE<sub>10/11</sub>/MBM29PDS322BE<sub>10/11</sub>

**MBM29PDS322BE Sector Group Protection Verify Autoselect Codes Table**

Type		A <sub>20</sub> to A <sub>12</sub>	A <sub>6</sub>	A <sub>3</sub>	A <sub>2</sub>	A <sub>1</sub>	A <sub>0</sub>	Code (HEX)
Manufacturer's Code		BA <sup>*2</sup>	V <sub>IL</sub>	04h				
Device Code	Word	BA <sup>*2</sup>	V <sub>IL</sub>	V <sub>IL</sub>	V <sub>IL</sub>	V <sub>IL</sub>	V <sub>IH</sub>	227Eh
Extended Device Code <sup>*3</sup>	Word	BA <sup>*2</sup>	V <sub>IL</sub>	V <sub>IH</sub>	V <sub>IH</sub>	V <sub>IH</sub>	V <sub>IL</sub>	2206h
	Word	BA <sup>*2</sup>	V <sub>IL</sub>	V <sub>IH</sub>	V <sub>IH</sub>	V <sub>IH</sub>	V <sub>IH</sub>	2200h
Sector Group Protection		Sector Group Addresses	V <sub>IL</sub>	V <sub>IL</sub>	V <sub>IL</sub>	V <sub>IH</sub>	V <sub>IL</sub>	01h <sup>*1</sup>

\*1 : Outputs 01h at protected sector group addresses and outputs 00h at unprotected sector group addresses.

\*2 : When V<sub>ID</sub> is applied, both Bank 1 and Bank 2 become Autoselect mode, which leads to the simultaneous operation unable to be executed. Consequently, specifying the bank address is not demanded. However, the bank address needs to be indicated when Autoselect mode is read out at command mode; because then it becomes OK to activate simultaneous operation.

\*3 : A read cycle at address (BA)01h outputs device code. When 227Eh was output, this indicates that there will require two additional codes, called Extended Device Codes. Therefore, the system may continue reading out these Extended Device Codes at the address of (BA)0Eh, as well as at (BA)0Fh.

**Expanded Autoselect Code Table**

Type		Code	DQ <sub>15</sub>	DQ <sub>14</sub>	DQ <sub>13</sub>	DQ <sub>12</sub>	DQ <sub>11</sub>	DQ <sub>10</sub>	DQ <sub>9</sub>	DQ <sub>8</sub>	DQ <sub>7</sub>	DQ <sub>6</sub>	DQ <sub>5</sub>	DQ <sub>4</sub>	DQ <sub>3</sub>	DQ <sub>2</sub>	DQ <sub>1</sub>	DQ <sub>0</sub>
Manufacturer's Code		04h	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Device Code	(W)	227Eh	0	0	1	0	0	0	1	0	0	1	1	1	1	1	1	0
Extended Device Code	(W)	2206h	0	0	1	0	0	0	1	0	0	0	0	0	0	1	1	0
	(W)	2200h	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0
Sector Group Protection		01h	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1

(W): Word mode

# MBM29PDS322TE<sub>10/11</sub>/MBM29PDS322BE<sub>10/11</sub>

## ■ FLEXIBLE SECTOR-ERASE ARCHITECTURE

Sector Address Table (MBM29PDS322TE)

Bank	Sector	Sector Address									Sector Size (Kwords)	(×16) Address Range
		Bank Address						A <sub>14</sub>	A <sub>13</sub>	A <sub>12</sub>		
		A <sub>20</sub>	A <sub>19</sub>	A <sub>18</sub>	A <sub>17</sub>	A <sub>16</sub>	A <sub>15</sub>					
Bank 2	SA0	0	0	0	0	0	0	X	X	X	32	000000h to 007FFFh
	SA1	0	0	0	0	0	1	X	X	X	32	008000h to 00FFFFh
	SA2	0	0	0	0	1	0	X	X	X	32	010000h to 017FFFh
	SA3	0	0	0	0	1	1	X	X	X	32	018000h to 01FFFFh
	SA4	0	0	0	1	0	0	X	X	X	32	020000h to 027FFFh
	SA5	0	0	0	1	0	1	X	X	X	32	028000h to 02FFFFh
	SA6	0	0	0	1	1	0	X	X	X	32	030000h to 037FFFh
	SA7	0	0	0	1	1	1	X	X	X	32	038000h to 03FFFFh
	SA8	0	0	1	0	0	0	X	X	X	32	040000h to 047FFFh
	SA9	0	0	1	0	0	1	X	X	X	32	048000h to 04FFFFh
	SA10	0	0	1	0	1	0	X	X	X	32	050000h to 057FFFh
	SA11	0	0	1	0	1	1	X	X	X	32	058000h to 05FFFFh
	SA12	0	0	1	1	0	0	X	X	X	32	060000h to 067FFFh
	SA13	0	0	1	1	0	1	X	X	X	32	068000h to 06FFFFh
	SA14	0	0	1	1	1	0	X	X	X	32	070000h to 077FFFh
	SA15	0	0	1	1	1	1	X	X	X	32	078000h to 07FFFFh
	SA16	0	1	0	0	0	0	X	X	X	32	080000h to 087FFFh
	SA17	0	1	0	0	0	1	X	X	X	32	088000h to 08FFFFh
	SA18	0	1	0	0	1	0	X	X	X	32	090000h to 097FFFh
	SA19	0	1	0	0	1	1	X	X	X	32	098000h to 09FFFFh
	SA20	0	1	0	1	0	0	X	X	X	32	0A0000h to 0A7FFFh
	SA21	0	1	0	1	0	1	X	X	X	32	0A8000h to 0AFFFFh
	SA22	0	1	0	1	1	0	X	X	X	32	0B0000h to 0B7FFFh
	SA23	0	1	0	1	1	1	X	X	X	32	0B8000h to 0BFFFFh
	SA24	0	1	1	0	0	0	X	X	X	32	0C0000h to 0C7FFFh
	SA25	0	1	1	0	0	1	X	X	X	32	0C8000h to 0CFFFFh
	SA26	0	1	1	0	1	0	X	X	X	32	0D0000h to 0D7FFFh
	SA27	0	1	1	0	1	1	X	X	X	32	0D8000h to 0DFFFFh
	SA28	0	1	1	1	0	0	X	X	X	32	0E0000h to 0E7FFFh
	SA29	0	1	1	1	0	1	X	X	X	32	0E8000h to 0EFFFFh
	SA30	0	1	1	1	1	0	X	X	X	32	0F0000h to 0F7FFFh
	SA31	0	1	1	1	1	1	X	X	X	32	0F8000h to 0FFFFFh
	SA32	1	0	0	0	0	0	X	X	X	32	100000h to 107FFFh
	SA33	1	0	0	0	0	1	X	X	X	32	108000h to 10FFFFh
SA34	1	0	0	0	1	0	X	X	X	32	110000h to 117FFFh	

(Continued)

# MBM29PDS322TE<sub>10/11</sub>/MBM29PDS322BE<sub>10/11</sub>

(Continued)

Bank	Sector	Sector Address									Sector Size (Kwords)	(x16) Address Range
		Bank Address						A <sub>14</sub>	A <sub>13</sub>	A <sub>12</sub>		
		A <sub>20</sub>	A <sub>19</sub>	A <sub>18</sub>	A <sub>17</sub>	A <sub>16</sub>	A <sub>15</sub>					
Bank 2	SA35	1	0	0	0	1	1	X	X	X	32	118000h to 11FFFFh
	SA36	1	0	0	1	0	0	X	X	X	32	120000h to 127FFFh
	SA37	1	0	0	1	0	1	X	X	X	32	128000h to 12FFFFh
	SA38	1	0	0	1	1	0	X	X	X	32	130000h to 137FFFh
	SA39	1	0	0	1	1	1	X	X	X	32	138000h to 13FFFFh
	SA40	1	0	1	0	0	0	X	X	X	32	140000h to 147FFFh
	SA41	1	0	1	0	0	1	X	X	X	32	148000h to 14FFFFh
	SA42	1	0	1	0	1	0	X	X	X	32	150000h to 157FFFh
	SA43	1	0	1	0	1	1	X	X	X	32	158000h to 15FFFFh
	SA44	1	0	1	1	0	0	X	X	X	32	160000h to 167FFFh
	SA45	1	0	1	1	0	1	X	X	X	32	168000h to 16FFFFh
	SA46	1	0	1	1	1	0	X	X	X	32	170000h to 177FFFh
	SA47	1	0	1	1	1	1	X	X	X	32	178000h to 17FFFFh
	SA48	1	1	0	0	0	0	X	X	X	32	180000h to 187FFFh
	SA49	1	1	0	0	0	1	X	X	X	32	188000h to 18FFFFh
	SA50	1	1	0	0	1	0	X	X	X	32	190000h to 197FFFh
	SA51	1	1	0	0	1	1	X	X	X	32	198000h to 19FFFFh
	SA52	1	1	0	1	0	0	X	X	X	32	1A0000h to 1A7FFFh
SA53	1	1	0	1	0	1	X	X	X	32	1A8000h to 1AFFFFh	
SA54	1	1	0	1	1	0	X	X	X	32	1B0000h to 1B7FFFh	
SA55	1	1	0	1	1	1	X	X	X	32	1B8000h to 1BFFFFh	
Bank 1	SA56	1	1	1	0	0	0	X	X	X	32	1C0000h to 1C7FFFh
	SA57	1	1	1	0	0	1	X	X	X	32	1C8000h to 1CFFFFh
	SA58	1	1	1	0	1	0	X	X	X	32	1D0000h to 1D7FFFh
	SA59	1	1	1	0	1	1	X	X	X	32	1D8000h to 1DFFFFh
	SA60	1	1	1	1	0	0	X	X	X	32	1E0000h to 1E7FFFh
	SA61	1	1	1	1	0	1	X	X	X	32	1E8000h to 1EFFFFh
	SA62	1	1	1	1	1	0	X	X	X	32	1F0000h to 1F7FFFh
	SA63	1	1	1	1	1	1	0	0	0	4	1F8000h to 1F8FFFh
	SA64	1	1	1	1	1	1	0	0	1	4	1F9000h to 1F9FFFh
	SA65	1	1	1	1	1	1	0	1	0	4	1FA000h to 1FAFFFh
	SA66	1	1	1	1	1	1	0	1	1	4	1FB000h to 1FBFFFh
	SA67	1	1	1	1	1	1	1	0	0	4	1FC000h to 1FCFFFh
	SA68	1	1	1	1	1	1	1	0	1	4	1FD000h to 1FDFFFh
	SA69	1	1	1	1	1	1	1	1	0	4	1FE000h to 1FEFFFh
	SA70	1	1	1	1	1	1	1	1	1	4	1FF000h to 1FFFFFFh

# MBM29PDS322TE<sub>10/11</sub>/MBM29PDS322BE<sub>10/11</sub>

**Sector Address Table (MBM29PDS322BE)**

Bank	Sector	Sector Address									Sector Size (Kwords)	(×16) Address Range
		Bank Address						A <sub>14</sub>	A <sub>13</sub>	A <sub>12</sub>		
		A <sub>20</sub>	A <sub>19</sub>	A <sub>18</sub>	A <sub>17</sub>	A <sub>16</sub>	A <sub>15</sub>					
Bank 2	SA70	1	1	1	1	1	1	X	X	X	32	1F8000h to 1FFFFFFh
	SA69	1	1	1	1	1	0	X	X	X	32	1F0000h to 1F7FFFh
	SA68	1	1	1	1	0	1	X	X	X	32	1E8000h to 1EFFFFh
	SA67	1	1	1	1	0	0	X	X	X	32	1E0000h to 1E7FFFh
	SA66	1	1	1	0	1	1	X	X	X	32	1D8000h to 1DFFFFh
	SA65	1	1	1	0	1	0	X	X	X	32	1D0000h to 1D7FFFh
	SA64	1	1	1	0	0	1	X	X	X	32	1C8000h to 1CFFFFh
	SA63	1	1	1	0	0	0	X	X	X	32	1C0000h to 1C7FFFh
	SA62	1	1	0	1	1	1	X	X	X	32	1B8000h to 1BFFFFh
	SA61	1	1	0	1	1	0	X	X	X	32	1B0000h to 1B7FFFh
	SA60	1	1	0	1	0	1	X	X	X	32	1A8000h to 1AFFFFh
	SA59	1	1	0	1	0	0	X	X	X	32	1A0000h to 1A7FFFh
	SA58	1	1	0	0	1	1	X	X	X	32	198000h to 19FFFFh
	SA57	1	1	0	0	1	0	X	X	X	32	190000h to 197FFFh
	SA56	1	1	0	0	0	1	X	X	X	32	188000h to 18FFFFh
	SA55	1	1	0	0	0	0	X	X	X	32	180000h to 187FFFh
	SA54	1	0	1	1	1	1	X	X	X	32	178000h to 17FFFFh
	SA53	1	0	1	1	1	0	X	X	X	32	170000h to 177FFFh
	SA52	1	0	1	1	0	1	X	X	X	32	168000h to 16FFFFh
	SA51	1	0	1	1	0	0	X	X	X	32	160000h to 167FFFh
	SA50	1	0	1	0	1	1	X	X	X	32	158000h to 15FFFFh
	SA49	1	0	1	0	1	0	X	X	X	32	150000h to 157FFFh
	SA48	1	0	1	0	0	1	X	X	X	32	148000h to 14FFFFh
	SA47	1	0	1	0	0	0	X	X	X	32	140000h to 147FFFh
	SA46	1	0	0	1	1	1	X	X	X	32	138000h to 13FFFFh
	SA45	1	0	0	1	1	0	X	X	X	32	130000h to 137FFFh
	SA44	1	0	0	1	0	1	X	X	X	32	128000h to 12FFFFh
	SA43	1	0	0	1	0	0	X	X	X	32	120000h to 127FFFh
	SA42	1	0	0	0	1	1	X	X	X	32	118000h to 11FFFFh
	SA41	1	0	0	0	1	0	X	X	X	32	110000h to 117FFFh
	SA40	1	0	0	0	0	1	X	X	X	32	108000h to 10FFFFh
	SA39	1	0	0	0	0	0	X	X	X	32	100000h to 107FFFh
SA38	0	1	1	1	1	1	X	X	X	32	0F8000h to 0FFFFFFh	
SA37	0	1	1	1	1	0	X	X	X	32	0F0000h to 0F7FFFh	
SA36	0	1	1	1	0	1	X	X	X	32	0E8000h to 0EFFFFh	
SA35	0	1	1	1	0	0	X	X	X	32	0E0000h to 0E7FFFh	

*(Continued)*

# MBM29PDS322TE<sub>10/11</sub>/MBM29PDS322BE<sub>10/11</sub>

(Continued)

Bank	Sector	Sector Address									Sector Size (Kwords)	(x16) Address Range
		Bank Address						A <sub>14</sub>	A <sub>13</sub>	A <sub>12</sub>		
		A <sub>20</sub>	A <sub>19</sub>	A <sub>18</sub>	A <sub>17</sub>	A <sub>16</sub>	A <sub>15</sub>					
Bank 2	SA34	0	1	1	0	1	1	X	X	X	32	0D8000h to 0DFFFFh
	SA33	0	1	1	0	1	0	X	X	X	32	0D0000h to 0D7FFFh
	SA32	0	1	1	0	0	1	X	X	X	32	0C8000h to 0CFFFFh
	SA31	0	1	1	0	0	0	X	X	X	32	0C0000h to 0C7FFFh
	SA30	0	1	0	1	1	1	X	X	X	32	0B8000h to 0BFFFFh
	SA29	0	1	0	1	1	0	X	X	X	32	0B0000h to 0B7FFFh
	SA28	0	1	0	1	0	1	X	X	X	32	0A8000h to 0AFFFFh
	SA27	0	1	0	1	0	0	X	X	X	32	0A0000h to 0A7FFFh
	SA26	0	1	0	0	1	1	X	X	X	32	098000h to 09FFFFh
	SA25	0	1	0	0	1	0	X	X	X	32	090000h to 097FFFh
	SA24	0	1	0	0	0	1	X	X	X	32	088000h to 08FFFFh
	SA23	0	1	0	0	0	0	X	X	X	32	080000h to 087FFFh
	SA22	0	0	1	1	1	1	X	X	X	32	078000h to 07FFFFh
	SA21	0	0	1	1	1	0	X	X	X	32	070000h to 077FFFh
	SA20	0	0	1	1	0	1	X	X	X	32	068000h to 06FFFFh
	SA19	0	0	1	1	0	0	X	X	X	32	060000h to 067FFFh
	SA18	0	0	1	0	1	1	X	X	X	32	058000h to 05FFFFh
SA17	0	0	1	0	1	0	X	X	X	32	050000h to 057FFFh	
SA16	0	0	1	0	0	1	X	X	X	32	048000h to 04FFFFh	
SA15	0	0	1	0	0	0	X	X	X	32	040000h to 047FFFh	
Bank 1	SA14	0	0	0	1	1	1	X	X	X	32	038000h to 03FFFFh
	SA13	0	0	0	1	1	0	X	X	X	32	030000h to 037FFFh
	SA12	0	0	0	1	0	1	X	X	X	32	028000h to 02FFFFh
	SA11	0	0	0	1	0	0	X	X	X	32	020000h to 027FFFh
	SA10	0	0	0	0	1	1	X	X	X	32	018000h to 01FFFFh
	SA9	0	0	0	0	1	0	X	X	X	32	010000h to 017FFFh
	SA8	0	0	0	0	0	1	X	X	X	32	008000h to 00FFFFh
	SA7	0	0	0	0	0	0	1	1	1	4	007000h to 007FFFh
	SA6	0	0	0	0	0	0	1	1	0	4	006000h to 006FFFh
	SA5	0	0	0	0	0	0	1	0	1	4	005000h to 005FFFh
	SA4	0	0	0	0	0	0	1	0	0	4	004000h to 004FFFh
	SA3	0	0	0	0	0	0	0	1	1	4	003000h to 003FFFh
	SA2	0	0	0	0	0	0	0	1	0	4	002000h to 002FFFh
SA1	0	0	0	0	0	0	0	0	1	4	001000h to 001FFFh	
SA0	0	0	0	0	0	0	0	0	0	4	000000h to 000FFFh	

# MBM29PDS322TE<sub>10/11</sub>/MBM29PDS322BE<sub>10/11</sub>

**Sector Group Address Table (MBM29PDS322TE) (Top Boot Block)**

Sector Group	A <sub>20</sub>	A <sub>19</sub>	A <sub>18</sub>	A <sub>17</sub>	A <sub>16</sub>	A <sub>15</sub>	A <sub>14</sub>	A <sub>13</sub>	A <sub>12</sub>	Sectors
SGA0	0	0	0	0	0	0	X	X	X	SA0
SGA1	0	0	0	0	0	1	X	X	X	SA1 to SA3
					1	0				
					1	1				
SGA2	0	0	0	1	X	X	X	X	X	SA4 to SA7
SGA3	0	0	1	0	X	X	X	X	X	SA8 to SA11
SGA4	0	0	1	1	X	X	X	X	X	SA12 to SA15
SGA5	0	1	0	0	X	X	X	X	X	SA16 to SA19
SGA6	0	1	0	1	X	X	X	X	X	SA20 to SA23
SGA7	0	1	1	0	X	X	X	X	X	SA24 to SA27
SGA8	0	1	1	1	X	X	X	X	X	SA28 to SA31
SGA9	1	0	0	0	X	X	X	X	X	SA32 to SA35
SGA10	1	0	0	1	X	X	X	X	X	SA36 to SA39
SGA11	1	0	1	0	X	X	X	X	X	SA40 to SA43
SGA12	1	0	1	1	X	X	X	X	X	SA44 to SA47
SGA13	1	1	0	0	X	X	X	X	X	SA48 to SA51
SGA14	1	1	0	1	X	X	X	X	X	SA52 to SA55
SGA15	1	1	1	0	X	X	X	X	X	SA56 to SA59
SGA16	1	1	1	1	0	0	X	X	X	SA60 to SA62
					0	1				
					1	0				
SGA17	1	1	1	1	1	1	0	0	0	SA63
SGA18	1	1	1	1	1	1	0	0	1	SA64
SGA19	1	1	1	1	1	1	0	1	0	SA65
SGA20	1	1	1	1	1	1	0	1	1	SA66
SGA21	1	1	1	1	1	1	1	0	0	SA67
SGA22	1	1	1	1	1	1	1	0	1	SA68
SGA23	1	1	1	1	1	1	1	1	0	SA69
SGA24	1	1	1	1	1	1	1	1	1	SA70

# MBM29PDS322TE<sub>10/11</sub>/MBM29PDS322BE<sub>10/11</sub>

Sector Group Address Table (MBM29PDS322BE) (Bottom Boot Block)

Sector Group	A <sub>20</sub>	A <sub>19</sub>	A <sub>18</sub>	A <sub>17</sub>	A <sub>16</sub>	A <sub>15</sub>	A <sub>14</sub>	A <sub>13</sub>	A <sub>12</sub>	Sectors
SGA0	0	0	0	0	0	0	0	0	0	SA0
SGA1	0	0	0	0	0	0	0	0	1	SA1
SGA2	0	0	0	0	0	0	0	1	0	SA2
SGA3	0	0	0	0	0	0	0	1	1	SA3
SGA4	0	0	0	0	0	0	1	0	0	SA4
SGA5	0	0	0	0	0	0	1	0	1	SA5
SGA6	0	0	0	0	0	0	1	1	0	SA6
SGA7	0	0	0	0	0	0	1	1	1	SA7
SGA8	0	0	0	0	0	1	X	X	X	SA8 to SA10
					1	0				
					1	1				
SGA9	0	0	0	1	X	X	X	X	X	SA11 to SA14
SGA10	0	0	1	0	X	X	X	X	X	SA15 to SA18
SGA11	0	0	1	1	X	X	X	X	X	SA19 to SA22
SGA12	0	1	0	0	X	X	X	X	X	SA23 to SA26
SGA13	0	1	0	1	X	X	X	X	X	SA27 to SA30
SGA14	0	1	1	0	X	X	X	X	X	SA31 to SA34
SGA15	0	1	1	1	X	X	X	X	X	SA35 to SA38
SGA16	1	0	0	0	X	X	X	X	X	SA39 to SA42
SGA17	1	0	0	1	X	X	X	X	X	SA43 to SA46
SGA18	1	0	1	0	X	X	X	X	X	SA47 to SA50
SGA19	1	0	1	1	X	X	X	X	X	SA51 to SA54
SGA20	1	1	0	0	X	X	X	X	X	SA55 to SA58
SGA21	1	1	0	1	X	X	X	X	X	SA59 to SA62
SGA22	1	1	1	0	X	X	X	X	X	SA63 to SA66
SGA23	1	1	1	1	0	0	X	X	X	SA67 to SA69
					0	1				
					1	0				
SGA24	1	1	1	1	1	1	X	X	X	SA70

## ■ FUNCTIONAL DESCRIPTION

### Simultaneous Operation

The device has a feature that is capable of reading data from one bank of memory while a program or erase operation is in progress in the other bank of memory (simultaneous operation), in addition to the conventional features (read, program, erase, erase-suspend read, and erase-suspend program). The bank selection can be selected by bank address ( $A_{20}$  to  $A_{15}$ ) with zero latency.

The device has two banks which contain

Bank 1 (4 KW × eight sectors, 32 KW × seven sectors) and Bank 2 (32 KW × fifty-six sectors).

The simultaneous operation cannot execute multi-function mode in the same bank. “Simultaneous Operation” Table shows the possible combinations for simultaneous operation. (Refer to “Bank-to-Bank Read/Write Timing Diagram” in “■TIMING DIAGRAM”.)

**Simultaneous Operation Table**

Case	Bank 1 Status	Bank 2 Status
1	Read mode	Read mode
2	Read mode	Autoselect mode
3	Read mode	Program mode
4	Read mode	Erase mode *
5	Autoselect mode	Read mode
6	Program mode	Read mode
7	Erase mode *	Read mode

\*: Erase operation may also be suspended to read from or program to a sector not being erased.

### Read Mode

The device has two control functions to be satisfied for obtaining data at the outputs.  $\overline{CE}$  is the power control and should be used for a device selection.  $\overline{OE}$  is the output control and should be used as the gate data to the output pins if a device is selected.

Address access time ( $t_{ACC}$ ) is equal to the delay from stable addresses to valid output data. The chip enable access time ( $t_{CE}$ ) is the delay from stable addresses and stable  $\overline{CE}$  to valid data at the output pins. The output enable access time ( $t_{OE}$ ) is the delay from the falling edge of  $\overline{OE}$  to valid data at the output pins (assuming the addresses have been stable for at least  $t_{ACC}-t_{OE}$  time). When reading out data without changing addresses after power-up, it is necessary to input hardware reset or to change  $\overline{CE}$  pin from “H” or “L”.

### Page Mode Read

The device is capable of fast Page mode read operation. This mode provides faster read access speed for random locations within a page. The Page size of the device is 4 words, within the appropriate Page being selected by the higher address bits  $A_{20}$  to  $A_2$  and the LSB bits  $A_1$  and  $A_0$  within that page. This is an asynchronous operation with the microprocessor supplying the specific word location.

The random or initial page access is equal to  $t_{ACC}$  and subsequent Page read access (as long as the locations specified by the microprocessor fall within that Page) is equivalent to  $t_{PACC}$ . Here again,  $\overline{CE}$  selects the device and  $\overline{OE}$  is the output control and should be used to gate data to the output pins if the device is selected. Fast Page mode accesses are obtained by keeping  $A_{20}$  to  $A_2$  constant and changing  $A_1$  and  $A_0$  to select the specific word, within that page.

## Standby Mode

There are two ways to implement the standby mode on the device, one using both the  $\overline{CE}$  and  $\overline{RESET}$  pins; the other via the  $\overline{RESET}$  pin only.

When using both pins, a CMOS standby mode is achieved with  $\overline{CE}$  and  $\overline{RESET}$  inputs both held at  $V_{CC} \pm 0.3$  V. Under this condition, the current consumed is less than 5  $\mu$ A Max During Embedded Algorithm operation,  $V_{CC}$  active current ( $I_{CC2}$ ) is required even  $\overline{CE} = "H"$ . The device can be read with standard access time ( $t_{CE}$ ) from either of these standby modes.

When using the  $\overline{RESET}$  pin only, a CMOS standby mode is achieved with  $\overline{RESET}$  input held at  $V_{SS} \pm 0.3$  V ( $\overline{CE} = "H"$  or  $"L"$ ). Under this condition the current consumed is less than 5  $\mu$ A Max Once the  $\overline{RESET}$  pin is taken high, the device requires  $t_{RH}$  as wake up time for outputs to be valid for read access.

In the standby mode, the outputs are in the high impedance state, independently of the  $\overline{OE}$  input.

## Automatic Sleep Mode

There is a function called automatic sleep mode to restrain power consumption during read-out of the device data. This mode can be useful in the application such as a handy terminal which requires low power consumption.

To activate this mode, the device automatically switches themselves to low power mode when the device addresses remain stable during access time of 150 ns. It is not necessary to control  $\overline{CE}$ ,  $\overline{WE}$ , and  $\overline{OE}$  on the mode. Under the mode, the current consumed is typically 50  $\mu$ A (CMOS Level).

During simultaneous operation,  $V_{CC}$  active current ( $I_{CC2}$ ) is required.

Since the data are latched during this mode, the data are read-out continuously. If the addresses are changed, the mode is canceled automatically, and the device reads the data for changed addresses.

## Output Disable

With the  $\overline{OE}$  input at a logic high level ( $V_{IH}$ ), output from the device is disabled. This will cause the output pins to be in a high impedance state.

## Autoselect

The autoselect mode allows the reading out of a binary code from the device and will identify its manufacturer and type. This mode is intended for use by programming equipment for the purpose of automatically matching the device to be programmed with its corresponding programming algorithm. This mode is functional over the entire temperature range of the device.

To activate this mode, the programming equipment must force  $V_{ID}$  (10.0 V to 11.0 V) on address pin  $A_9$ . Two identifier bytes may then be sequenced from the device outputs by toggling address  $A_0$  from  $V_{IL}$  to  $V_{IH}$ . All addresses are DON'T CARES except  $A_6$ ,  $A_3$ ,  $A_2$ ,  $A_1$ , and  $A_0$ . (See "MBM29PDS322TE/BE User Bus Operations" Table in "■DEVICE BUS OPERATION".)

The manufacturer and device codes may also be read via the command register, for instances when the device is erased or programmed in a system without access to high voltage on the  $A_9$  pin. The command sequence is illustrated in "MBM29PDS322TE/BE Command Definitions" Table in "■DEVICE BUS OPERATION". (Refer to Autoselect Command section.)

In the command Autoselect mode, the bank addresses  $BA_i$ ; ( $A_{20}$  to  $A_{12}$ ) must point to a specific bank  $BA$  during the third write bus cycle of the Autoselect command. Then the Autoselect data will be read from that bank while array data can be read from the other bank.

A read cycle from address (BA)00h returns the manufacturer's code (Fujitsu = 04h). And a read cycle from address (BA)01h, (BA)0Eh to (BA)0Fh returns the device code. (See MBM29PDS322TE's/BE's "Sector Group Protection Verify Autoselect Codes" Tables and "Expanded Autoselect Code" Tables in "■DEVICE BUS OPERATION".)

In case of applying  $V_{ID}$  on  $A_9$ , since both Bank 1 and Bank 2 enter Autoselect mode, the simultaneous operation can not be executed.

## Write

Device erasure and programming are accomplished via the command register. The contents of the register serve as inputs to the internal state machine. The state machine outputs dictate the function of the device.

The command register itself does not occupy any addressable memory location. The register is a latch used to store the commands, along with the address and data information needed to execute the command. The command register is written by bringing  $\overline{WE}$  to  $V_{IL}$ , while  $\overline{CE}$  is at  $V_{IL}$  and  $\overline{OE}$  is at  $V_{IH}$ . Addresses are latched on the falling edge of  $\overline{WE}$  or  $\overline{CE}$ , whichever happens later; while data is latched on the rising edge of  $\overline{WE}$  or  $\overline{CE}$ , whichever happens first. Standard microprocessor write timings are used.

Refer to AC Write Characteristics and the Erase/Programming Waveforms for specific timing parameters.

## Sector Group Protection

The device features hardware sector group protection. This feature will disable both program and erase operations in any combination of twenty five sector groups of memory. (See MBM29PDS322TE's/BE's "Sector Group Address" Tables in "■FLEXIBLE SECTOR-ERASE ARCHITECTURE".) The sector group protection feature is enabled using programming equipment at the user's site. The device is shipped with all sector groups unprotected.

To activate this mode, the programming equipment must force  $V_{ID}$  on address pin  $A_9$  and control pin  $\overline{OE}$ , (suggest  $V_{ID} = 11.5\text{ V}$ ),  $\overline{CE} = V_{IL}$  and  $(A_6, A_3, A_2, A_1, A_0) = (0, 0, 0, 1, 0)$ . The sector group addresses ( $A_{20}, A_{19}, A_{18}, A_{17}, A_{16}, A_{15}, A_{14}, A_{13}$ , and  $A_{12}$ ) should be set to the sector to be protected. "Sector Address" Tables (MBM29PDS322TE and MBM29PDS322BE) in "■FLEXIBLE SECTOR-ERASE ARCHITECTURE" define the sector address for each of the seventy one (71) individual sectors, and "Sector Group Address" Tables (MBM29PDS322TE and MBM29PDS322BE) in "■FLEXIBLE SECTOR-ERASE ARCHITECTURE" define the sector group address for each of the twenty five (25) individual group sectors. Programming of the protection circuitry begins on the falling edge of the  $\overline{WE}$  pulse and is terminated with the rising edge of the same. Sector group addresses must be held constant during the  $\overline{WE}$  pulse. See "Sector Group Protection Timing Diagram" in "■TIMING DIAGRAM" and "Sector Group Protection Algorithm" in "■FLOW CHARTS" for sector group protection waveforms and algorithm.

To verify programming of the protection circuitry, the programming equipment must force  $V_{ID}$  on address pin  $A_9$  with  $\overline{CE}$  and  $\overline{OE}$  at  $V_{IL}$  and  $\overline{WE}$  at  $V_{IH}$ . Scanning the sector group addresses ( $A_{20}, A_{19}, A_{18}, A_{17}, A_{16}, A_{15}, A_{14}, A_{13}$ , and  $A_{12}$ ) while  $(A_6, A_3, A_2, A_1, A_0) = (0, 0, 0, 1, 0)$  will produce a logical "1" code at device output  $DQ_0$  for a protected sector. Otherwise the device will produce "0" for unprotected sector. In this mode, the lower order addresses, except for  $A_0, A_1, A_2, A_3$ , and  $A_6$  are DON'T CARES. Address locations with  $A_1 = V_{IL}$  are reserved for Autoselect manufacturer and device codes.

It is also possible to determine if a sector group is protected in the system by writing an Autoselect command. Performing a read operation at the address location  $XX02h$ , where the higher order addresses ( $A_{20}, A_{19}, A_{18}, A_{17}, A_{16}, A_{15}, A_{14}, A_{13}$ , and  $A_{12}$ ) are the desired sector group address will produce a logical "1" at  $DQ_0$  for a protected sector group. See MBM29PDS322TE's/BE's "Sector Group Protection Verify Autoselect Codes" Tables and "Expanded Autoselect Code" Tables in "■DEVICE BUS OPERATION" for Autoselect codes.

## Temporary Sector Group Unprotection

This feature allows temporary unprotection of previously protected sector groups of the device in order to change data. The Sector Group Unprotection mode is activated by setting the  $\overline{RESET}$  pin to high voltage ( $V_{ID}$ ). During this mode, formerly protected sector groups can be programmed or erased by selecting the sector group addresses. Once the  $V_{ID}$  is taken away from the  $\overline{RESET}$  pin, all the previously protected sector groups will be protected again. Refer to "Temporary Sector Group Unprotection Timing Diagram" in "■TIMING DIAGRAM" and "Temporary Sector Group Unprotection Algorithm" in "■FLOW CHARTS".

## Extended Sector Group Protection

In addition to normal sector group protection, the device has Extended Sector Group Protection as extended function. This function enables to protect sector group by forcing  $V_{ID}$  on  $\overline{RESET}$  pin and write a command sequence. Unlike conventional procedure, it is not necessary to force  $V_{ID}$  and control timing for control pins. The only  $\overline{RESET}$  pin requires  $V_{ID}$  for sector group protection in this mode. The extended sector group protection requires  $V_{ID}$  on  $\overline{RESET}$  pin. With this condition, the operation is initiated by writing the set-up command (60h) into the command register. Then, the sector group addresses pins ( $A_{20}, A_{19}, A_{18}, A_{17}, A_{16}, A_{15}, A_{14}, A_{13}$  and  $A_{12}$ ) and ( $A_6, A_3, A_2, A_1, A_0$ ) = (0, 0, 0, 1, 0) should be set to the sector group to be protected (recommend to set  $V_{IL}$  for the other addresses pins), and write extended sector group protection command (60h). A sector group is typically protected in 250  $\mu$ s. To verify programming of the protection circuitry, the sector group addresses pins ( $A_{20}, A_{19}, A_{18}, A_{17}, A_{16}, A_{15}, A_{14}, A_{13}$  and  $A_{12}$ ) and ( $A_6, A_3, A_2, A_1, A_0$ ) = (0, 0, 0, 1, 0) should be set and write a command (40h). Following the command write, a logical "1" at device output  $DQ_0$  will produce for protected sector in the read operation. If the output is logical "0", please repeat to write extended sector group protection command (60h) again. To terminate the operation, it is necessary to set  $\overline{RESET}$  pin to  $V_{IH}$ . (Refer to "Extended Sector Group Protection Timing Diagram" in "■TIMING DIAGRAM" and "Extended Sector Group Protection Algorithm" in "■FLOW CHARTS".)

## $\overline{RESET}$

### Hardware Reset

The device may be reset by driving the  $\overline{RESET}$  pin to  $V_{IL}$ . The  $\overline{RESET}$  pin vs. a pulse requirement and has to be kept low ( $V_{IL}$ ) for at least " $t_{RP}$ " in order to properly reset the internal state machine. Any operation in the process of being executed will be terminated and the internal state machine will be reset to the read mode " $t_{READY}$ " after the  $\overline{RESET}$  pin is driven low. Furthermore, once the  $\overline{RESET}$  pin goes high, the device requires an additional " $t_{RH}$ " before it will allow read access. When the  $\overline{RESET}$  pin is low, the device will be in the standby mode for the duration of the pulse and all the data output pins will be tri-stated. If a hardware reset occurs during a program or erase operation, the data at that particular location will be corrupted. Please note that the  $R\overline{Y}/\overline{B}Y$  output signal should be ignored during the  $\overline{RESET}$  pulse. See " $\overline{RESET}, R\overline{Y}/\overline{B}Y$  Timing Diagram" in "■TIMING DIAGRAM" for the timing diagram. Refer to Temporary Sector Group Unprotection for additional functionality.

## Boot Block Sector Protection

The Write Protection function provides a hardware method of protecting certain boot sectors without using  $V_{ID}$ . This function is one of two provided by the  $\overline{WP}/ACC$  pin.

If the system asserts  $V_{IL}$  on the  $\overline{WP}/ACC$  pin, the device disables program and erase functions in the two "outermost" 4K word boot sectors independently of whether those sectors are protected or unprotected using the method described in "Sector Protection/Unprotection". The two outermost 4K word boot sectors are the two sectors containing the lowest addresses in a bottom-boot-configured device, or the two sectors containing the highest addresses in a top-boot-configured device.

(MBM29PDS322TE: SA69 and SA70, MBM29PDS322BE: SA0 and SA1)

If the system asserts  $V_{IH}$  on the  $\overline{WP}/ACC$  pin, the device reverts to whether the two outermost 4K word boot sectors were last set to be protected or unprotected. That is, sector protection or unprotection for these two sectors depends on whether they were last protected or unprotected using the method described in "Sector protection/unprotection".

## Accelerated Program Operation

The device offers accelerated program operation which enables the programming in high speed. If the system asserts  $V_{ACC}$  to the  $\overline{WP}/ACC$  pin, the device automatically enters the acceleration mode and the time required for program operation will reduce to about 60%. This function is primarily intended to allow high speed program, so caution is needed as the sector group will temporarily be unprotected.

The system would use a fast program command sequence when programming during acceleration mode. Set command to fast mode and reset command from fast mode are not necessary. When the device enters the

acceleration mode, the device automatically set to fast mode. Therefore, the present sequence could be used for programming and detection of completion during acceleration mode.

Removing  $V_{ACC}$  from the  $\overline{WP}/ACC$  pin returns the device to normal operation. Do not remove  $V_{ACC}$  from  $\overline{WP}/ACC$  pin while programming. See “Accelerated Program Timing Diagram” in “■TIMING DIAGRAM”.

Erase operation during Accelerated Program Operation is strictly prohibited.

## ■ COMMAND DEFINITIONS

The device operations are selected by writing specific address and data sequences into the command register. Some commands require Bank Address (BA) input. When command sequences are inputted to bank being read, the commands have priority over reading. “MBM29PDS322TE/BE Command Definitions” Table in “■DEVICE BUS OPERATION” defines the valid register command sequences. Note that the Erase Suspend (B0h) and Erase Resume (30h) commands are valid only while the Sector Erase operation is in progress. Moreover, both Read/Reset commands are functionally equivalent, resetting the device to the read mode. Please note that commands are always written at DQ<sub>7</sub> to DQ<sub>0</sub> and DQ<sub>15</sub> to DQ<sub>8</sub> bits are ignored.

### Read/Reset Command

In order to return from Autoselect mode or Exceeded Timing Limits (DQ<sub>5</sub> = 1) to Read/Reset mode, the Read/Reset operation is initiated by writing the Read/Reset command sequence into the command register. Microprocessor read cycles retrieve array data from the memory. The device remains enabled for reads until the command register contents are altered.

The device will automatically power-up in the Read/Reset state. In this case, a command sequence is not required to read data. Standard microprocessor read cycles will retrieve array data. This default value ensures that no spurious alteration of the memory content occurs during the power transition. Refer to the AC Read Characteristics and Waveforms for the specific timing parameters.

### Autoselect Command

Flash memories are intended for use in applications where the local CPU alters memory contents. As such, manufacture and device codes must be accessible while the device resides in the target system. PROM programmers typically access the signature codes by raising A<sub>9</sub> to a high voltage. However, multiplexing high voltage onto the address lines is not generally desired system design practice.

The device contains an Autoselect command operation to supplement traditional PROM programming methodology. The operation is initiated by writing the Autoselect command sequence into the command register.

The Autoselect command sequence is initiated by firstly writing two unlock cycles. This is followed by a third write cycle that contains the bank address (BA) and the Autoselect command. Then the manufacture and device codes can be read from the bank, and actual data of memory cell can be read from the another bank.

Following the command write, a read cycle from address (BA)00h retrieves the manufacture code of 04h. A read cycle at address (BA)01h returns 7Eh to indicate that this device uses extended device code. The successive read cycle from (BA)0Eh to (BA)0Fh returns this extended device code for this device. (See MBM29PDS322TE's/BE's “Sector Group Protection Verify Autoselect Codes” Tables and “Expanded Autoselect Code” Tables in “■DEVICE BUS OPERATION”.)

The sector state (protection or unprotection) will be informed by address (BA)02h. Scanning the sector group addresses (A<sub>20</sub>, A<sub>19</sub>, A<sub>18</sub>, A<sub>17</sub>, A<sub>16</sub>, A<sub>15</sub>, A<sub>14</sub>, A<sub>13</sub>, and A<sub>12</sub>) while (A<sub>6</sub>, A<sub>3</sub>, A<sub>2</sub>, A<sub>1</sub>, A<sub>0</sub>) = (0, 0, 0, 1, 0) will produce a logical “1” at device output DQ<sub>0</sub> for a protected sector group. The programming verification should be performed by verify sector group protection on the protected sector. (See “MBM29PDS322TE/BE User Bus Operations” Table in “■DEVICE BUS OPERATION”.)

The manufacture and device codes can be allowed to read from selected bank. To read the manufacture and device codes and sector protection status from non-selected bank, it is necessary to write Read/Reset command sequence into the register and then Autoselect command should be written into the bank to be read.

If the software (program code) for Autoselect command is stored into the Flash memory, the device and manufacture codes should be read from the other bank which doesn't contain the software.

To terminate the operation, it is necessary to write the Read/Reset command sequence into the register. To execute the Autoselect command during the operation, writing Read/Reset command sequence must precede the Autoselect command.

## Word Programming

The device is programmed on a word-by-word basis. Programming is a four bus cycle operation. There are two “unlock” write cycles. These are followed by the program set-up command and data write cycles. Addresses are latched on the falling edge of  $\overline{CE}$  or  $\overline{WE}$ , whichever happens later and the data is latched on the rising edge of  $\overline{CE}$  or  $\overline{WE}$ , whichever happens first. The rising edge of  $\overline{CE}$  or  $\overline{WE}$  (whichever happens first) begins programming. Upon executing the Embedded Program Algorithm command sequence, the system is not required to provide further controls or timings. The device automatically provides adequate internally generated program pulses and verify programmed cell margin.

The system can determine the status of the program operation by using  $DQ_7$  ( $\overline{Data}$  Polling),  $DQ_6$  (Toggle Bit), or  $RY/\overline{BY}$ . The  $\overline{Data}$  Polling and Toggle Bit must be performed at the memory location being programmed.

The automatic programming operation is completed when the data on  $DQ_7$  is equivalent to data written to this bit at which the device returns to the read mode and addresses are no longer latched. (See “Hardware Sequence Flags” Table.) Therefore the device requires that a valid address to the device be supplied by the system at this particular moment. Hence  $\overline{Data}$  Polling must be performed at the memory location which is being programmed.

If hardware reset occurs during the programming operation, it is impossible to guarantee the data being written.

Programming is allowed in any sequence and across sector boundaries. Beware that a data “0” cannot be programmed back to a “1”. Attempting to do so may either hang up the device or result in an apparent success according to the data polling algorithm but a read from Read/Reset mode will show that the data is still “0”. Only erase operations can convert “0”s to “1”s.

“Embedded Program™ Algorithm” in “■FLOW CHARTS” illustrates the Embedded Program™ Algorithm using typical command strings and bus operations.

## Chip Erase

Chip erase is a six bus cycle operation. There are two “unlock” write cycles. These are followed by writing the “set-up” command. Two more “unlock” write cycles are then followed by the chip erase command.

Chip erase does not require the user to program the device prior to erase. Upon executing the Embedded Erase Algorithm command sequence the device will automatically program and verify the entire memory for an all zero data pattern prior to electrical erase (Preprogram function). The system is not required to provide any controls or timings during these operations.

The system can determine the status of the erase operation by using  $DQ_7$  ( $\overline{Data}$  Polling),  $DQ_6$  (Toggle Bit), or  $RY/\overline{BY}$ . The chip erase begins on the rising edge of the last  $\overline{CE}$  or  $\overline{WE}$ , whichever happens first in the command sequence and terminates when the data on  $DQ_7$  is “1” (See Write Operation Status section.) at which the device returns to read the mode.

Chip Erase Time : Sector Erase Time × All sectors + Chip Program Time (Preprogramming)

“Embedded Erase™ Algorithm” in “■FLOW CHARTS” illustrates the Embedded Erase™ Algorithm using typical command strings and bus operations.

## Sector Erase

Sector erase is a six bus cycle operation. There are two “unlock” write cycles. These are followed by writing the “set-up” command. Two more “unlock” write cycles are then followed by the Sector Erase command. The sector address (any address location within the desired sector) is latched on the falling edge of  $\overline{CE}$  or  $\overline{WE}$  whichever happens later, while the command (Data = 30h) is latched on the rising edge of  $\overline{CE}$  or  $\overline{WE}$  which happens first. After time-out of “ $t_{TOW}$ ” from the rising edge of the last sector erase command, the sector erase operation begins.

Multiple sectors are erased concurrently by writing the six bus cycle operations on “MBM29PDS322TE/BE Command Definitions” Table in “■DEVICE BUS OPERATION”. This sequence is followed with writes of the Sector Erase command to addresses in other sectors desired to be concurrently erased. The time between writes must be less than “ $t_{TOW}$ ” otherwise that command will not be accepted and erasure does not start. It is recommended that processor interrupts be disabled during this time to guarantee this condition. The interrupts can be re-enabled after the last Sector Erase command is written. A time-out of “ $t_{row}$ ” from the rising edge of last  $\overline{CE}$  or  $\overline{WE}$  whichever happens first will initiate the execution of the Sector Erase command(s). If another falling edge of  $\overline{CE}$  or  $\overline{WE}$ , whichever happens first occurs within the “ $t_{row}$ ” time-out window the timer is reset. (Monitor  $DQ_3$  to determine if the sector erase timer window is still open, see section  $DQ_3$ , Sector Erase Timer.) Resetting the device once execution has begun will corrupt the data in the sector. In that case, restart the erase on those sectors and allow them to complete. (Refer to the Write Operation Status section for Sector Erase Timer operation.) Loading the sector erase buffer may be done in any sequence and with any number of sectors (0 to 70).

Sector erase does not require the user to program the device prior to erase. The device automatically programs all memory locations in the sector(s) to be erased prior to electrical erase (Preprogram function). When erasing a sector or sectors the remaining unselected sectors are not affected. The system is not required to provide any controls or timings during these operations.

The system can determine the status of the erase operation by using  $DQ_7$  ( $\overline{Data}$  Polling),  $DQ_6$  (Toggle Bit), or  $RY/\overline{BY}$ .

The sector erase begins after the “ $t_{row}$ ” time out from the rising edge of  $\overline{CE}$  or  $\overline{WE}$  whichever happens first for the last sector erase command pulse and terminates when the data on  $DQ_7$  is “1” (See Write Operation Status section.) at which time the device returns to the read mode.  $\overline{Data}$  polling and Toggle Bit must be performed at an address within any of the sectors being erased.

Multiple Sector Erase Time : [Sector Erase Time + Sector Program Time (Preprogramming)] × Number of Sector Erase

In case of multiple sector erase across bank boundaries, a read from bank (read-while-erase) can not perform.

“Embedded Erase™ Algorithm” in “■FLOW CHARTS” illustrates the Embedded Erase™ Algorithm using typical command strings and bus operations.

## Erase Suspend/Resume

The Erase Suspend command allows the user to interrupt Sector Erase operation and then perform data reads from or programs to a sector not being erased. This command is applicable ONLY during the Sector Erase operation which includes the time-out period for sector erase. Writing the Erase Suspend command (B0h) during the Sector Erase time-out results in immediate termination of the time-out period and suspension of the erase operation.

Writing the Erase Resume command (30h) resumes the erase operation. The bank addresses of sector being erased or erase-suspended should be set when writing the Erase Suspend or Erase Resume command.

When the Erase Suspend command is written during the Sector Erase operation, the device takes a maximum of “ $t_{SPD}$ ” to suspend the erase operation. When the device has entered the erase-suspended mode, the RY/ $\overline{BY}$  output pin is at Hi-Z and the DQ<sub>7</sub> bit is at logic “1”, and DQ<sub>6</sub> stops toggling. The user must use the address of the erasing sector for reading DQ<sub>6</sub> and DQ<sub>7</sub> to determine if the erase operation is suspended. Further writes of the Erase Suspend command are ignored.

When the erase operation has been suspended, the device defaults to the erase-suspend-read mode. Reading data in this mode is the same as reading from the standard read mode except that the data must be read from sectors that have not been erase-suspended. Successively reading from the erase-suspended sector while the device is in the erase-suspend-read mode will cause DQ<sub>2</sub> to toggle. (See the section on DQ<sub>2</sub>.)

After entering the erase-suspend-read mode, the user can program the device by writing the appropriate command sequence for Program. This program mode is known as the erase-suspend-program mode. Again, programming in this mode is the same as programming in the regular Program mode except that the data must be programmed to sectors that are not erase-suspended. Successively reading from the erase-suspended sector while the device is in the erase-suspend-program mode will cause DQ<sub>2</sub> to toggle. The end of the erase-suspended Program operation is detected by the RY/ $\overline{BY}$  output pin,  $\overline{Data}$  polling of DQ<sub>7</sub> or by the Toggle Bit I (DQ<sub>6</sub>) which is the same as the regular Program operation. Note that DQ<sub>7</sub> must be read from the Program address while DQ<sub>6</sub> can be read from any address within bank being erase-suspended.

To resume the operation of Sector Erase, the Resume command (30h) should be written to the bank being erase suspended. Any further writes of the Resume command at this point will be ignored. Another Erase Suspend command is written after the chip has resumed erasing.

## Extended Command

### (1) Fast Mode

The device has Fast Mode function. This mode dispenses with the initial two unlock cycles required in the standard program command sequence by writing Fast Mode command into the command register. In this mode, the required bus cycle for programming is two cycles instead of four bus cycles in standard program command. (Do not write erase command in this mode.) The read operation is also executed after exiting this mode. In continuous mode, do not write any command other than the continuous program/continuous mode reset command. To exit this mode, it is necessary to write Fast Mode Reset command into the command register. The first cycle must contain the bank address. (Refer to “Embedded Program™ Algorithm for Fast Mode” in “■FLOW CHARTS”.) The  $V_{CC}$  active current is required even  $\overline{CE} = V_{IH}$  during Fast Mode.

### (2) Fast Programming

During Fast Mode, the programming can be executed with two bus cycles operation. The Embedded Program Algorithm is executed by writing program set-up command (A0h) and data write cycles (PA/PD). (Refer to “Embedded Program™ Algorithm for Fast Mode” in “■FLOW CHARTS”.)

## HiddenROM Region

The HiddenROM feature provides Flash memory region that the system may access through a new command sequence. This is primarily intended for customers who wish to use an Electronic Serial Number (ESN) in the device with the ESN protected against modification. Once the HiddenROM region is protected, any further modification of that region is not allowed. This ensures the security of the ESN once the product is shipped to the field.

The HiddenROM region is 32 K words in length and is stored at the same address as the 4 KW ×8 sectors. The MBM29PDS322TE occupies the address of the word mode 1F8000h to 1FFFFFh and the MBM29PDS322BE type occupies the address of the word mode 000000h to 007FFFh. After the system writes the Enter HiddenROM command sequence, the system reads the HiddenROM region by using the addresses normally occupied by the boot sectors. That is, the device sends all commands that would normally be sent to the boot sectors to the HiddenROM region. This mode of operation continues until the system issues the Exit HiddenROM command sequence, or until power is removed from the device. On power-up, or following a hardware reset, the device reverts to sending commands to the boot sectors.

When reading the HiddenROM region, either change addresses or change  $\overline{CE}$  pin from “H” to “L”. The same procedure should be taken (changing addresses or  $\overline{CE}$  pin from “H” to “L”) after the system issues the Exit HiddenROM command sequence to read actual data of memory cell.

## HiddenROM Entry Command

The device has HiddenROM area with One Time Protect function. This area is to enter the security code and to enable the change of the code once set. Program/erase is possible in this area until it becomes protected. However once it is protected, it is impossible to unprotect, use this command with caution.

HiddenROM area is 32 K words and in the same address area as 4 KW sector. The address of top boot is 1F8000h to 1FFFFFh at word mode and the bottom boot is 000000h to 007FFFh at word mode. These areas are normally the boot block area (4 KW ×8 sector). Therefore write the HiddenROM entry command sequence to enter the HiddenROM area. This is called HiddenROM mode as the HiddenROM area appears.

Sector other than the boot block area could be read during HiddenROM mode. Read/program/erase of the HiddenROM area is allowed during HiddenROM mode. Write the HiddenROM reset command sequence to exit the HiddenROM mode. The bank address of the HiddenROM should be set on the third cycle of this reset command sequence. Note that any other commands should not be issued than the HiddenROM program/protection/reset commands during the HiddenROM mode. When you issue the other commands including the suspend resume capability, send the HiddenROM reset command first to exit the HiddenROM mode and then issue each command.

## HiddenROM Program Command

To program data to the HiddenROM area, write the HiddenROM program command sequence during HiddenROM mode. This command is the same as the program command in usual except to write the command during HiddenROM mode. Therefore the detection of completion method is the same as described, using the DQ<sub>7</sub> data polling, DQ<sub>6</sub> toggle bit and RY/ $\overline{BY}$  pin. It is necessary to pay attention to the address to be programmed. If the address other than the HiddenROM area is selected to program, data of the address will be changed. During the write into the HiddenROM region, the program suspend command issuance is prohibited.

## HiddenROM Erase Command

To erase the HiddenROM area, write the HiddenROM erase command sequence during HiddenROM mode. This command is same as the sector erase command in the past except to write the command during HiddenROM mode. Therefore the detection of completion method is the same as in the past, using the DQ<sub>7</sub> data polling, DQ<sub>6</sub> toggle bit and RY/ $\overline{BY}$  pin. It is necessary to pay attention to the sector address to be erased. If the sector address other than the HiddenROM area is selected, the data of the sector will be changed.

## HiddenROM Protect Command

There are two methods to protect the HiddenROM area. One is to write the sector group protect setup command (60h), set the sector address in the HiddenROM area and  $(A_6, A_3, A_2, A_1, A_0) = (0, 0, 0, 1, 0)$ , and write the sector group protect command (60h) during the HiddenROM mode. The same command sequence could be used because, it is just as the extension sector group protect in the past except that it is in the HiddenROM mode and it does not apply high voltage to  $\overline{\text{RESET}}$  pin. Please refer to "Function Explanation Extended Sector Group Protection" for details of extension sector group protect setting.

The other method is to apply high voltage ( $V_{ID}$ ) to  $A_9$  and  $\overline{\text{OE}}$ , set the sector address in the HiddenROM area and  $(A_6, A_3, A_2, A_1, A_0) = (0, 0, 0, 1, 0)$ , and apply the write pulse during the HiddenROM mode. To verify the protect circuit, apply high voltage ( $V_{ID}$ ) to  $A_9$ , specify  $(A_6, A_3, A_2, A_1, A_0) = (0, 0, 0, 1, 0)$  and the sector address in the HiddenROM area, and read. When "1" appears on  $DQ_0$ , the protect setting is completed. "0" will appear on  $DQ_0$  if it is not protected. Please apply write pulse again. The same command sequence could be used for the above method because other than the HiddenROM mode, it is the same with the sector group protect previously mentioned. Refer to "Function Explanation Sector Group Protection" for details of the sector group protect setting.

Other sector group will be effected if the address other than those for HiddenROM area is selected for the sector group address. Once it is protected, protection cannot be cancelled, so please pay the closest attention.

## Write Operation Status

Detailed in "Hardware Sequence Flags" Table are all the status flags that determine the status of the bank for the current mode operation. The read operation from the bank which does not operate Embedded Algorithm returns data of memory cells. These bits offer a method for determining whether a Embedded Algorithm is properly completed. The information on  $DQ_2$  is address sensitive. This means that if an address from an erasing sector is consecutively read, then the  $DQ_2$  bit will toggle. However  $DQ_2$  will not toggle if an address from a non-erasing sector is consecutively read. This allows users to determine which sectors are in erase.

The status flag is not output from bank (non-busy bank) which does not execute Embedded Algorithm. For example, there is bank (busy bank), now executing Embedded Algorithm. When the read sequence is [1] <busy bank>, [2] <non-busy bank>, [3] <busy bank>, the  $DQ_6$  is toggling in the case of [1] and [3]. In case of [2], the data of memory cells are outputted. In the erase-suspend read mode with the same read sequence,  $DQ_6$  will not be toggled in the [1] and [3].

In the erase suspend read mode,  $DQ_2$  is toggled in the [1] and [3]. In case of [2], the data of memory cell is outputted.

**Hardware Sequence Flags Table**

Status		DQ <sub>7</sub>	DQ <sub>6</sub>	DQ <sub>5</sub>	DQ <sub>3</sub>	DQ <sub>2</sub>	
In Progress	Embedded Program Algorithm	$\overline{DQ}_7$	Toggle	0	0	1	
	Embedded Erase Algorithm	0	Toggle	0	1	Toggle * <sup>1</sup>	
	Erase Suspended Mode	Erase Suspend Read (Erase Suspended Sector)	1	1	0	0	Toggle
		Erase Suspend Read (Non-Erase Suspended Sector)	Data	Data	Data	Data	Data
		Erase Suspend Program (Non-Erase Suspended Sector)	$\overline{DQ}_7$	Toggle	0	0	1 * <sup>2</sup>
	Program Suspend Mode	Program Suspend Read (Program Suspended Sector)	Data	Data	Data	Data	Data
Program Suspend Read (Non-Program Suspended Sector)		Data	Data	Data	Data	Data	
Exceeded Time Limits	Embedded Program Algorithm	$\overline{DQ}_7$	Toggle	1	0	1	
	Embedded Erase Algorithm	0	Toggle	1	1	N/A	
	Erase Suspended Mode	Erase Suspend Program (Non-Erase Suspended Sector)	$\overline{DQ}_7$	Toggle	1	0	N/A

\*1: Successive reads from the erasing or erase-suspend sector causes DQ<sub>2</sub> to toggle.

\*2: Reading from non-erase suspend sector address will indicate logic “1” at the DQ<sub>2</sub> bit.

## DQ<sub>7</sub>

### Data Polling

The device features  $\overline{\text{Data}}$  Polling as a method to indicate to the host that the Embedded Algorithms are in progress or completed. During the Embedded Program Algorithm an attempt to read device will produce a complement of data last written to DQ<sub>7</sub>. Upon completion of the Embedded Program Algorithm, an attempt to read device will produce true data last written to DQ<sub>7</sub>. During the Embedded Erase Algorithm, an attempt to read device will produce a “0” at the DQ<sub>7</sub> output. Upon completion of the Embedded Erase Algorithm an attempt to read device will produce a “1” on DQ<sub>7</sub>. The flowchart for  $\overline{\text{Data}}$  Polling (DQ<sub>7</sub>) is shown in “Toggle Bit Algorithm” in “■FLOW CHARTS”.

For programming, the  $\overline{\text{Data}}$  Polling is valid after the rising edge of the fourth write pulse in the four write pulse sequence.

For chip erase and sector erase, the  $\overline{\text{Data}}$  Polling is valid after the rising edge of the sixth write pulse in the six write pulse sequence.  $\overline{\text{Data}}$  Polling must be performed at sector address of sectors being erased, not protected sectors. Otherwise, the status may be invalid.

If a program address falls within a protected sector,  $\overline{\text{Data}}$  Polling on DQ<sub>7</sub> is active for approximately 1  $\mu\text{s}$ , then that bank returns to the read mode. After an erase command sequence is written, if all sectors selected for erasing are protected,  $\overline{\text{Data}}$  Polling on DQ<sub>7</sub> is active for approximately 400  $\mu\text{s}$ , then the bank returns to read mode.

Once the Embedded Algorithm operation is close to completion, the device data pins (DQ<sub>7</sub>) may change asynchronously while the output enable ( $\overline{\text{OE}}$ ) is asserted low. This means that device is driving status information on DQ<sub>7</sub> at one instant of time and then that byte's valid data at the next instant of time. Depending on when the system samples the DQ<sub>7</sub> output, it may read the status or valid data. Even if device has completed the Embedded Algorithm operation and DQ<sub>7</sub> has a valid data, data outputs on DQ<sub>0</sub> to DQ<sub>6</sub> may be still invalid. The valid data on DQ<sub>0</sub> to DQ<sub>7</sub> will be read on the successive read attempts.

The  $\overline{\text{Data}}$  Polling feature is active only during the Embedded Programming Algorithm, Embedded Erase Algorithm or sector erase time-out. (See “Hardware Sequence Flags” Table.)

See “Toggle Bit I during Embedded Algorithm Operation Timing Diagram” in “■TIMING DIAGRAM” for the  $\overline{\text{Data}}$  Polling timing specifications and diagrams.

## DQ<sub>6</sub>

### Toggle Bit I

The device also features the “Toggle Bit I” as a method to indicate to the host system that the Embedded Algorithms are in progress or completed.

During Embedded Program or Erase Algorithm cycle, successive attempts to read ( $\overline{\text{OE}}$  toggling) data from the device will result in DQ<sub>6</sub> toggling between one and zero. Once the Embedded Program or Erase Algorithm cycle is completed, DQ<sub>6</sub> will stop toggling and valid data will be read on the next successive attempts. During programming, the Toggle Bit I is valid after the rising edge of the fourth write pulse in the four write pulse sequence. For chip erase and sector erase, the Toggle Bit I is valid after the rising edge of the sixth write pulse in the six write pulse sequence. The Toggle Bit I is active during the sector time out.

In programming, if the sector being written is protected, the toggle bit will toggle for about 1  $\mu\text{s}$  and then stop toggling with data unchanged. In erase, device will erase all selected sectors except for ones that are protected. If all selected sectors are protected, the chip will toggle the toggle bit for about 400  $\mu\text{s}$  and then drop back into read mode, having data unchanged.

Either  $\overline{\text{CE}}$  or  $\overline{\text{OE}}$  toggling will cause DQ<sub>6</sub> to toggle. In addition, an Erase Suspend/Resume command will cause DQ<sub>6</sub> to toggle.

The system can use DQ<sub>6</sub> to determine whether a sector is actively erased or is erase-suspended. When a bank is actively erased (that is, the Embedded Erase Algorithm is in progress), DQ<sub>6</sub> toggles. When a bank enters the Erase Suspend mode, DQ<sub>6</sub> stops toggling. Successive read cycles during erase-suspend-program cause DQ<sub>6</sub> to toggle.

To operate toggle bit function properly,  $\overline{CE}$  or  $\overline{OE}$  must be high when bank address is changed.

See “Bank-to-Bank Read/Write Timing Diagram” in “■TIMING DIAGRAM” for the Toggle Bit I timing specifications and diagrams.

## DQ<sub>5</sub>

### Exceeded Timing Limits

DQ<sub>5</sub> will indicate if the program or erase time has exceeded the specified limits (internal pulse count). Under these conditions DQ<sub>5</sub> will produce a “1”. This is a failure condition which indicates that the program or erase cycle was not successfully completed.  $\overline{Data}$  Polling is the only operating function of device under this condition. The  $\overline{CE}$  circuit will partially power down device under these conditions (to approximately 2 mA). The  $\overline{OE}$  and  $\overline{WE}$  pins will control the output disable functions as described in “Simultaneous Operation” Table in “■FUNCTIONAL DESCRIPTION”.

The DQ<sub>5</sub> failure condition may also appear if a user tries to program a non blank location without pre-erase. In this case the device locks out and never complete the Embedded Algorithm operation. Hence, the system never read valid data on DQ<sub>7</sub> bit and DQ<sub>6</sub> never stop toggling. Once device has exceeded timing limits, the DQ<sub>5</sub> bit will indicate a “1.” Please note that this is not a device failure condition since device was incorrectly used. If this occurs, reset device with command sequence.

## DQ<sub>3</sub>

### Sector Erase Timer

After completion of the initial sector erase command sequence sector erase time-out will begin. DQ<sub>3</sub> will remain low until the time-out is completed.  $\overline{Data}$  Polling and Toggle Bit are valid after the initial sector erase command sequence.

If  $\overline{Data}$  Polling or the Toggle Bit I indicates device has been written with a valid erase command, DQ<sub>3</sub> may be used to determine if the sector erase timer window is still open. If DQ<sub>3</sub> is high (“1”) the internally controlled erase cycle has begun. If DQ<sub>3</sub> is low (“0”), the device will accept additional sector erase commands. To insure the command has been accepted, the system software should check the status of DQ<sub>3</sub> prior to and following each subsequent Sector Erase command. If DQ<sub>3</sub> were high on the second status check, the command may not have been accepted.

See “Hardware Sequence Flags” Table.

## DQ<sub>2</sub>

### Toggle Bit II

This toggle bit II, along with DQ<sub>6</sub>, can be used to determine whether the device is in the Embedded Erase Algorithm or in Erase Suspend.

Successive reads from the erasing sector will cause DQ<sub>2</sub> to toggle during the Embedded Erase Algorithm. If the device is in the erase-suspended-read mode, successive reads from the erase-suspended sector will cause DQ<sub>2</sub> to toggle. When the device is in the erase-suspended-program mode, successive reads from the word address of the non-erase suspended sector will indicate a logic “1” at the DQ<sub>2</sub> bit.

DQ<sub>6</sub> is different from DQ<sub>2</sub> in that DQ<sub>6</sub> toggles only when the standard program or Erase, or Erase Suspend Program operation is in progress. The behavior of these two status bits, along with that of DQ<sub>7</sub>, is summarized as follows:

For example, DQ<sub>2</sub> and DQ<sub>6</sub> can be used together to determine if the erase-suspend-read mode is in progress. (DQ<sub>2</sub> toggles while DQ<sub>6</sub> does not.) See also and.

Furthermore, DQ<sub>2</sub> can also be used to determine which sector is being erased. When device is in the erase mode, DQ<sub>2</sub> toggles if this bit is read from an erasing sector.

To operate toggle bit function properly,  $\overline{CE}$  or  $\overline{OE}$  must be high when bank address is changed.

## Reading Toggle Bits DQ<sub>6</sub>/DQ<sub>2</sub>

Whenever the system initially begins reading toggle bit status, it must read DQ<sub>7</sub> to DQ<sub>0</sub> at least twice in a row to determine whether a toggle bit is toggling. Typically, a system would note and store the value of the toggle bit after the first read. After the second read, the system would compare the new value of the toggle bit with the first. If the toggle bit is not toggling, the device has completed the program or erase operation. The system can read array data on DQ<sub>7</sub> to DQ<sub>0</sub> on the following read cycle.

However, if after the initial two read cycles, the system determines that the toggle bit is still toggling, the system also should note whether the value of DQ<sub>5</sub> is high (see the section on DQ<sub>5</sub>). If it is the system should then determine again whether the toggle bit is toggling, since the toggle bit may have stopped toggling just as DQ<sub>5</sub> went high. If the toggle bit is no longer toggling, the device has successfully completed the program or erase operation. If it is still toggling, the device did not complete the operation successfully, and the system must write the reset command to return to reading array data.

The remaining scenario is that the system initially determines that the toggle bit is toggling and DQ<sub>5</sub> has not gone high. The system may continue to monitor the toggle bit and DQ<sub>5</sub> through successive read cycles, determining the status as described in the previous paragraph. Alternatively, it may choose to perform other system tasks. In this case, the system must start at the beginning of the algorithm when it returns to determine the status of the operation. (Refer to “Toggle Bit Algorithm” in “■FLOW CHARTS”.)

**Toggle Bit Status Table**

Mode	DQ <sub>7</sub>	DQ <sub>6</sub>	DQ <sub>2</sub>
Program	$\overline{DQ_7}$	Toggle	1
Erase	0	Toggle	Toggle * <sup>1</sup>
Erase-Suspend Read (Erase-Suspended Sector)	1	1	Toggle
Erase-Suspend Program	$\overline{DQ_7}$	Toggle	1 * <sup>2</sup>

\*1: Successive reads from the erasing or erase-suspend sector will cause DQ<sub>2</sub> to toggle.

\*2: Reading from the non-erase suspend sector address will indicate logic “1” at the DQ<sub>2</sub> bit.

## RY/ $\overline{BY}$

### Ready/Busy

The device provides a RY/ $\overline{BY}$  open-drain output pin as a way to indicate to the host system that Embedded Algorithms are either in progress or has been completed. If output is low, device is busy with either a program or erase operation. If output is high, device is ready to accept any read/write or erase operation. If the device is placed in an Erase Suspend mode, RY/ $\overline{BY}$  output will be high.

During programming, RY/ $\overline{BY}$  pin is driven low after the rising edge of the fourth write pulse. During an erase operation, RY/ $\overline{BY}$  pin is driven low after the rising edge of the sixth write pulse. RY/ $\overline{BY}$  pin will indicate a busy condition during  $\overline{RESET}$  pulse. Refer to “RY/ $\overline{BY}$  Timing Diagram during Program/Erase Operation Timing Diagram” and “ $\overline{RESET}$ , RY/ $\overline{BY}$  Timing Diagram” in “■TIMING DIAGRAM” for a detailed timing diagram. RY/ $\overline{BY}$  pin is pulled high in standby mode.

Since this is an open-drain output, the pull-up resistor needs to be V<sub>CC</sub> ; multiples of devices may be connected to the best system via more than one RY/ $\overline{BY}$  pin in parallel.

## Data Protection

The device is designed to offer protection against accidental erasure or programming caused by spurious system level signals that may exist during power transitions. During power up device automatically resets internal state machine in Read mode. Also, with its control register architecture, alteration of memory contents only occurs after successful completion of specific multi-bus cycle command sequences.

The device also incorporates several features to prevent inadvertent write cycles resulting from  $V_{CC}$  power-up and power-down transitions or system noise.

## Power On/Off Timing

The RESET pin must be held low during  $V_{CC}$  ramp up to insure that device power up correctly. (Refer to “Page Read Operation Timing Diagram” in “■TIMING DIAGRAM”.)

## Write Pulse “Glitch” Protection

Noise pulses of less than 3 ns (typical) on  $\overline{OE}$ ,  $\overline{CE}$  or  $\overline{WE}$  will not initiate a write cycle.

## Logical Inhibit

Writing is inhibited by holding any one of  $\overline{OE} = V_{IL}$ ,  $\overline{CE} = V_{IH}$ , or  $\overline{WE} = V_{IH}$ . To initiate a write cycle  $\overline{CE}$  and  $\overline{WE}$  must be a logical zero while  $\overline{OE}$  is a logical one.

## Power-Up Write Inhibit

Power-up of the device with  $\overline{WE} = \overline{CE} = V_{IL}$  and  $\overline{OE} = V_{IH}$  will not accept commands on the rising edge of  $\overline{WE}$ . The internal state machine is automatically reset to the read mode on power-up.

## Sector Protection

Device user is able to protect each sector group individually to store and protect data.

Protection circuit voids both write and erase commands that are addressed to protected sectors.

Any commands to write or erase addressed to protected sector are ignore (see “Sector Group Protection” in “■FUNCTIONAL DESCRIPTION”).

## ■ ABSOLUTE MAXIMUM RATINGS

Parameter	Symbol	Rating		Unit
		Min	Max	
Storage Temperature	T <sub>stg</sub>	-55	+125	°C
Ambient Temperature with Power Applied	T <sub>A</sub>	-40	+85	°C
Voltage with Respect to Ground All pins except A <sub>9</sub> , $\overline{OE}$ , and $\overline{RESET}$ *1	V <sub>IN</sub> , V <sub>OUT</sub>	-0.5	V <sub>CC</sub> +0.5	V
Power Supply Voltage *1	V <sub>CC</sub>	-0.5	+2.7	V
A <sub>9</sub> , $\overline{OE}$ , and $\overline{RESET}$ *2	V <sub>IN</sub>	-0.5	+11.0	V
$\overline{WP}/ACC$ *3	V <sub>ACC</sub>	-0.5	+12.6	V

\*1: Minimum DC voltage on input or I/O pins is -0.5 V. During voltage transitions, input or I/O pins may undershoot V<sub>SS</sub> to -2.0 V for periods of up to 20 ns. Maximum DC voltage on input or I/O pins is V<sub>CC</sub> +0.5 V. During voltage transitions, input or I/O pins may overshoot to V<sub>CC</sub> +2.0 V for periods of up to 20 ns.

\*2: Minimum DC input voltage on A<sub>9</sub>,  $\overline{OE}$  and  $\overline{RESET}$  pins is -0.5 V. During voltage transitions, A<sub>9</sub>,  $\overline{OE}$  and  $\overline{RESET}$  pins may undershoot V<sub>SS</sub> to -2.0 V for periods of up to 20 ns. Voltage difference between input and supply voltage (V<sub>IN</sub>-V<sub>CC</sub>) does not exceed +9.0V. Maximum DC input voltage on A<sub>9</sub>,  $\overline{OE}$  and  $\overline{RESET}$  pins is +11.0 V which may positive overshoot to +12.5 V for periods of up to 20 ns.

\*3: Minimum DC input voltage on  $\overline{WP}/ACC$  pin is -0.5 V. During voltage transitions,  $\overline{WP}/ACC$  pin may undershoot V<sub>SS</sub> to -2.0 V for periods of up to 20 ns. Maximum DC input voltage on  $\overline{WP}/ACC$  pin is +12.6 V which may positive overshoot to +13.0 V for periods of up to 20ns when V<sub>CC</sub> is applied.

**WARNING:** Semiconductor devices can be permanently damaged by application of stress (voltage, current, temperature, etc.) in excess of absolute maximum ratings. Do not exceed these ratings.

## ■ RECOMMENDED OPERATING RANGES

Parameter	Symbol	Value		Unit
		Min	Max	
Ambient Temperature	T <sub>A</sub>	-40	+85	°C
Power Supply Voltage	V <sub>CC</sub>	+1.8	+2.2	V

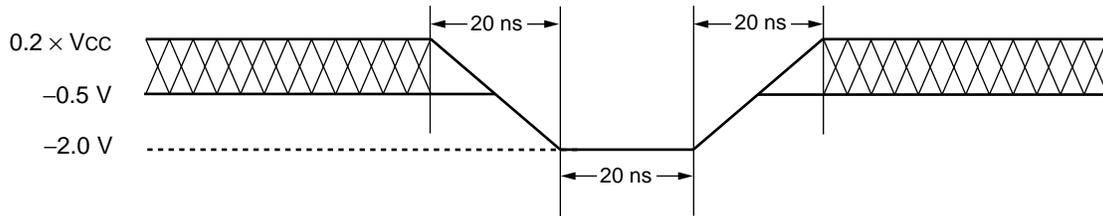
Note: Operating ranges define those limits between which the functionality of the device is guaranteed.

**WARNING:** The recommended operating conditions are required in order to ensure the normal operation of the semiconductor device. All of the device's electrical characteristics are warranted when the device is operated within these ranges.

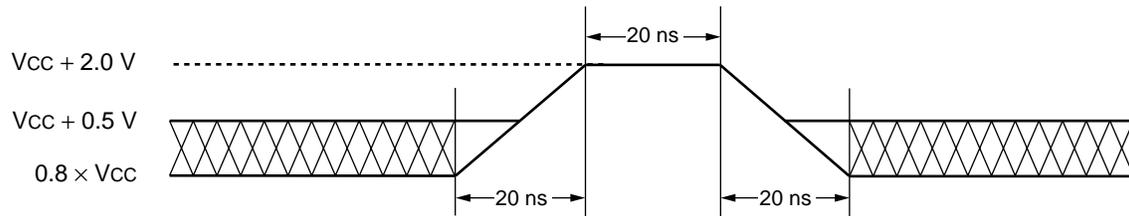
Always use semiconductor devices within their recommended operating condition ranges. Operation outside these ranges may adversely affect reliability and could result in device failure.

No warranty is made with respect to uses, operating conditions, or combinations not represented on the data sheet. Users considering application outside the listed conditions are advised to contact their FUJITSU representatives beforehand.

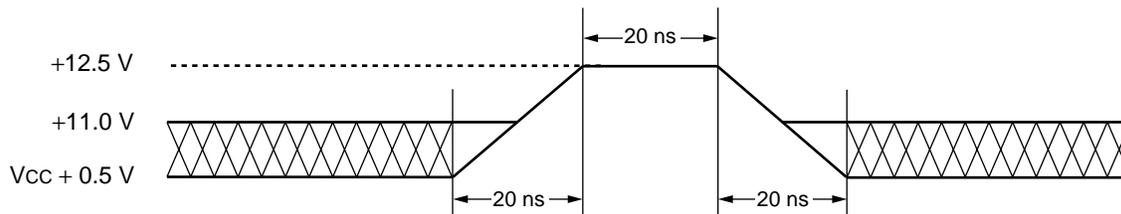
## ■ MAXIMUM OVERSHOOT / MAXIMUM UNDERSHOOT



**Maximum Undershoot Waveform**



**Maximum Overshoot Waveform 1**



Note: This waveform is applied for  $A_9$ ,  $\overline{OE}$  and  $\overline{RESET}$

**Maximum Overshoot Waveform 2**

## ■ ELECTRICAL CHARACTERISTICS

### 1. DC Characteristics

Parameter	Symbol	Conditions	Value		Unit
			Min	Max	
Input Leakage Current	I <sub>LI</sub>	V <sub>IN</sub> = V <sub>SS</sub> to V <sub>CC</sub> , V <sub>CC</sub> = V <sub>CC</sub> Max	-1.0	+1.0	μA
Output Leakage Current	I <sub>LO</sub>	V <sub>OUT</sub> = V <sub>SS</sub> to V <sub>CC</sub> , V <sub>CC</sub> = V <sub>CC</sub> Max	-1.0	+1.0	μA
A <sub>9</sub> , $\overline{\text{OE}}$ , $\overline{\text{RESET}}$ Inputs Leakage Current	I <sub>LIT</sub>	V <sub>CC</sub> = V <sub>CC</sub> Max, A <sub>9</sub> , $\overline{\text{OE}}$ , $\overline{\text{RESET}}$ = 11.0 V	—	35	μA
V <sub>CC</sub> Active Current *1	I <sub>CC1</sub>	$\overline{\text{CE}}$ = V <sub>IL</sub> , $\overline{\text{OE}}$ = V <sub>IH</sub> , f = 10 MHz	—	28	mA
		$\overline{\text{CE}}$ = V <sub>IL</sub> , $\overline{\text{OE}}$ = V <sub>IH</sub> , f = 1 MHz	—	3	mA
V <sub>CC</sub> Active Current *2	I <sub>CC2</sub>	$\overline{\text{CE}}$ = V <sub>IL</sub> , $\overline{\text{OE}}$ = V <sub>IH</sub>	—	30	mA
V <sub>CC</sub> Current (Standby)	I <sub>CC3</sub>	V <sub>CC</sub> = V <sub>CC</sub> Max, $\overline{\text{CE}}$ = V <sub>CC</sub> ± 0.3 V, $\overline{\text{RESET}}$ = V <sub>CC</sub> ± 0.3 V	—	5	μA
V <sub>CC</sub> Current (Standby, Reset)	I <sub>CC4</sub>	V <sub>CC</sub> = V <sub>CC</sub> Max, $\overline{\text{WE/ACC}}$ = V <sub>CC</sub> ± 0.3 V, $\overline{\text{RESET}}$ = V <sub>SS</sub> ± 0.3 V	—	5	μA
V <sub>CC</sub> Current (Automatic Sleep Mode) *3	I <sub>CC5</sub>	V <sub>CC</sub> = V <sub>CC</sub> Max, $\overline{\text{CE}}$ = V <sub>SS</sub> ± 0.3 V, $\overline{\text{RESET}}$ = V <sub>CC</sub> ± 0.3 V V <sub>IN</sub> = V <sub>CC</sub> ± 0.3 V or V <sub>SS</sub> ± 0.3 V	—	5	μA
V <sub>CC</sub> Active Current *5 (Read-While-Program)	I <sub>CC6</sub>	$\overline{\text{CE}}$ = V <sub>IL</sub> , $\overline{\text{OE}}$ = V <sub>IH</sub>	—	55	mA
V <sub>CC</sub> Active Current *5 (Read-While-Erase)	I <sub>CC7</sub>	$\overline{\text{CE}}$ = V <sub>IL</sub> , $\overline{\text{OE}}$ = V <sub>IH</sub>	—	55	mA
V <sub>CC</sub> Active Current (Erase-Suspend-Program)	I <sub>CC8</sub>	$\overline{\text{CE}}$ = V <sub>IL</sub> , $\overline{\text{OE}}$ = V <sub>IH</sub>	—	35	mA
$\overline{\text{WP/ACC}}$ Accelerated Program Current	I <sub>ACC</sub>	V <sub>CC</sub> = V <sub>CC</sub> Max, $\overline{\text{WP/ACC}}$ = V <sub>ACC</sub> Max	—	20	mA
Input Low Level	V <sub>IL</sub>	—	-0.5	0.2× V <sub>CC</sub>	V
Input High Level	V <sub>IH</sub>	—	0.8× V <sub>CC</sub>	V <sub>CC</sub> +0.3	V
Voltage for $\overline{\text{WP/ACC}}$ Sector Protection/Unprotection and Program Acceleration *4	V <sub>ACC</sub>	—	8.5	12.5	V
Voltage for Autoselect and Sector Protection (A <sub>9</sub> , $\overline{\text{OE}}$ , $\overline{\text{RESET}}$ ) *4	V <sub>ID</sub>	—	10.0	11.0	V
Output Low Voltage Level	V <sub>OL</sub>	I <sub>OL</sub> = 100 μA, V <sub>CC</sub> = V <sub>CC</sub> Min	—	0.1	V
Output High Voltage Level	V <sub>OH</sub>	I <sub>OH</sub> = -100 μA	V <sub>CC</sub> -0.1	—	V
Low V <sub>CC</sub> Lock-Out Voltage	V <sub>LKO</sub>	—	1.2	1.5	V

\*1: The I<sub>CC</sub> current listed includes both the DC operating current and the frequency dependent component.

\*2: I<sub>CC</sub> is active while Embedded Algorithm (program or erase) is in progress.

\*3: Automatic sleep mode enables the low power mode when address remains stable for 150 ns.

\*4: Applicable for only V<sub>CC</sub> applying.

\*5: Embedded Algorithm (program or erase) is in progress. (@5 MHz)

# MBM29PDS322TE<sub>10/11</sub>/MBM29PDS322BE<sub>10/11</sub>

## 2. AC Characteristics

### • Read Only Operations Characteristics

Parameter	Symbol		Conditions	Value(Note)				Unit
	JEDEC	Standard		10		11		
				Min	Max	Min	Max	
Read Cycle Time	t <sub>AVAV</sub>	t <sub>RC</sub>	—	100	—	115	—	ns
Address to Output Delay	t <sub>AVQV</sub>	t <sub>ACC</sub>	$\overline{CE} = V_{IL}$ , $\overline{OE} = V_{IL}$	—	100	—	115	ns
Page Read Cycle Time	—	t <sub>PRC</sub>	—	40	—	50	—	ns
Page Address to Output Delay	—	t <sub>PACC</sub>	$\overline{CE} = V_{IL}$ , $\overline{OE} = V_{IL}$	—	40	—	50	ns
Chip Enable to Output Delay	t <sub>ELQV</sub>	t <sub>CE</sub>	$\overline{OE} = V_{IL}$	—	100	—	115	ns
Output Enable to Output Delay	t <sub>GLQV</sub>	t <sub>OE</sub>	—	—	35	—	45	ns
Chip Enable to Output High-Z	t <sub>EHQZ</sub>	t <sub>DF</sub>	—	—	30	—	30	ns
Output Enable to Output High-Z	t <sub>GHQZ</sub>	t <sub>DF</sub>	—	—	30	—	30	ns
Output Hold Time From Addresses, $\overline{CE}$ or $\overline{OE}$ , Whichever Occurs First	t <sub>AXQX</sub>	t <sub>OH</sub>	—	0	—	0	—	ns
$\overline{RESET}$ Pin Low to Read Mode	—	t <sub>READY</sub>	—	—	20	—	20	μs

Note: Test Conditions:

Output Load: 30 pF (MBM29PDS322TE10/BE10)

100 pF (MBM29PDS322TE11/BE11)

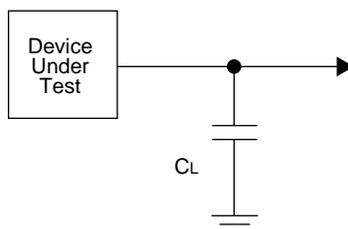
Input rise and fall times: 5 ns

Input pulse levels: 0.0 V or 2.0 V

Timing measurement reference level

Input: 1.0 V

Output: 1.0 V



Note : C<sub>L</sub> = 30 pF including jig capacitance (MBM29PDS322TE10/BE10)

C<sub>L</sub> = 100 pF including jig capacitance (MBM29PDS322TE11/BE11)

**Test Conditions**

# MBM29PDS322TE<sub>10/11</sub>/MBM29PDS322BE<sub>10/11</sub>

## • Write/Erase/Program Operations

Parameter	Symbol		Value						Unit
			10			11			
	JEDEC	Standard	Min	Typ	Max	Min	Typ	Max	
Write Cycle Time	t <sub>AVAV</sub>	t <sub>WC</sub>	100	—	—	115	—	—	ns
Address Setup Time	t <sub>AVWL</sub>	t <sub>AS</sub>	0	—	—	0	—	—	ns
Address Setup Time to $\overline{OE}$ Low During Toggle Bit Polling	—	t <sub>ASO</sub>	15	—	—	15	—	—	ns
Address Hold Time	t <sub>WLAX</sub>	t <sub>AH</sub>	60	—	—	60	—	—	ns
Address Hold Time from $\overline{CE}$ or $\overline{OE}$ High During Toggle Bit Polling	—	t <sub>AHT</sub>	0	—	—	0	—	—	ns
Data Setup Time	t <sub>DVWH</sub>	t <sub>DS</sub>	60	—	—	60	—	—	ns
Data Hold Time	t <sub>WHDX</sub>	t <sub>DH</sub>	0	—	—	0	—	—	ns
Output Enable Hold Time	Read	t <sub>OEH</sub>	0	—	—	0	—	—	ns
	Toggle and $\overline{Data}$ Polling		10	—	—	10	—	—	ns
$\overline{CE}$ High During Toggle Bit Polling	—	t <sub>CEPH</sub>	20	—	—	20	—	—	ns
$\overline{OE}$ High During Toggle Bit Polling	—	t <sub>OEPH</sub>	20	—	—	20	—	—	ns
Read Recover Time Before Write	t <sub>GHWL</sub>	t <sub>GHWL</sub>	0	—	—	0	—	—	ns
Read Recover Time Before Write	t <sub>GHEL</sub>	t <sub>GHEL</sub>	0	—	—	0	—	—	ns
$\overline{CE}$ Setup Time	t <sub>ELWL</sub>	t <sub>CS</sub>	0	—	—	0	—	—	ns
$\overline{WE}$ Setup Time	t <sub>WLLEL</sub>	t <sub>WS</sub>	0	—	—	0	—	—	ns
$\overline{CE}$ Hold Time	t <sub>WHEH</sub>	t <sub>CH</sub>	0	—	—	0	—	—	ns
$\overline{WE}$ Hold Time	t <sub>EHWH</sub>	t <sub>WH</sub>	0	—	—	0	—	—	ns
Write Pulse Width	t <sub>WLWH</sub>	t <sub>WP</sub>	60	—	—	60	—	—	ns
$\overline{CE}$ Pulse Width	t <sub>LEH</sub>	t <sub>CP</sub>	60	—	—	60	—	—	ns
Write Pulse Width High	t <sub>WHWL</sub>	t <sub>WPH</sub>	60	—	—	60	—	—	ns
$\overline{CE}$ Pulse Width High	t <sub>EHEL</sub>	t <sub>CPH</sub>	60	—	—	60	—	—	ns
Programming Operation	t <sub>WHWH1</sub>	t <sub>WHWH1</sub>	—	16	—	—	16	—	μs
Sector Erase Operation *1	t <sub>WHWH2</sub>	t <sub>WHWH2</sub>	—	1	—	—	1	—	s
V <sub>CC</sub> Setup Time	—	t <sub>VCS</sub>	50	—	—	50	—	—	μs
Rise Time to V <sub>ID</sub> *2	—	t <sub>VIDR</sub>	500	—	—	500	—	—	ns
Rise Time to V <sub>ACC</sub> *3	—	t <sub>VACCR</sub>	500	—	—	500	—	—	ns
Voltage Transition Time *2	—	t <sub>VLHT</sub>	4	—	—	4	—	—	μs
Write Pulse Width *2	—	t <sub>WPP</sub>	100	—	—	100	—	—	μs
$\overline{OE}$ Setup Time to $\overline{WE}$ Active *2	—	t <sub>OESP</sub>	4	—	—	4	—	—	μs

(Continued)

# MBM29PDS322TE<sub>10/11</sub>/MBM29PDS322BE<sub>10/11</sub>

(Continued)

Parameter	Symbol		Value						Unit
			10			11			
	JEDEC	Standard	Min	Typ	Max	Min	Typ	Max	
$\overline{CE}$ Setup Time to $\overline{WE}$ Active *2	—	t <sub>CSP</sub>	4	—	—	4	—	—	μs
Recover Time from RY/ $\overline{BY}$	—	t <sub>RB</sub>	0	—	—	0	—	—	ns
$\overline{RESET}$ Pulse Width	—	t <sub>RP</sub>	500	—	—	500	—	—	ns
$\overline{RESET}$ High Level Period Before Read	—	t <sub>RH</sub>	200	—	—	200	—	—	ns
Program/Erase Valid to RY/ $\overline{BY}$ Delay	—	t <sub>BUSY</sub>	—	—	90	—	—	90	ns
Delay Time from Embedded Output Enable	—	t <sub>EOE</sub>	—	—	100	—	—	115	ns
Erase Time-out Time	—	t <sub>TOW</sub>	50	—	—	50	—	—	μs
Erase Suspend Transition Time	—	t <sub>SPD</sub>	—	—	20	—	—	20	μs
Power On / Off Time	—	t <sub>PS</sub>	—	—	100	—	—	115	ns

\*1: This does not include the preprogramming time.

\*2: This timing is for Sector Group Protection operation.

\*3: This timing is for Accelerated Program operation.

## ■ ERASE AND PROGRAMMING PERFORMANCE

Parameter	Limits			Unit	Comments
	Min	Typ	Max		
Sector Erase Time	—	1	10	s	Excludes programming time prior to erasure
Word Programming Time	—	16	360	μs	Excludes system-level overhead
Chip Programming Time	—	—	100	s	Excludes system-level overhead
Program/Erase Cycle	100,000	—	—	cycle	—

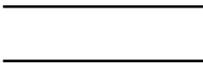
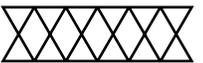
## FBGA PIN CAPACITANCE

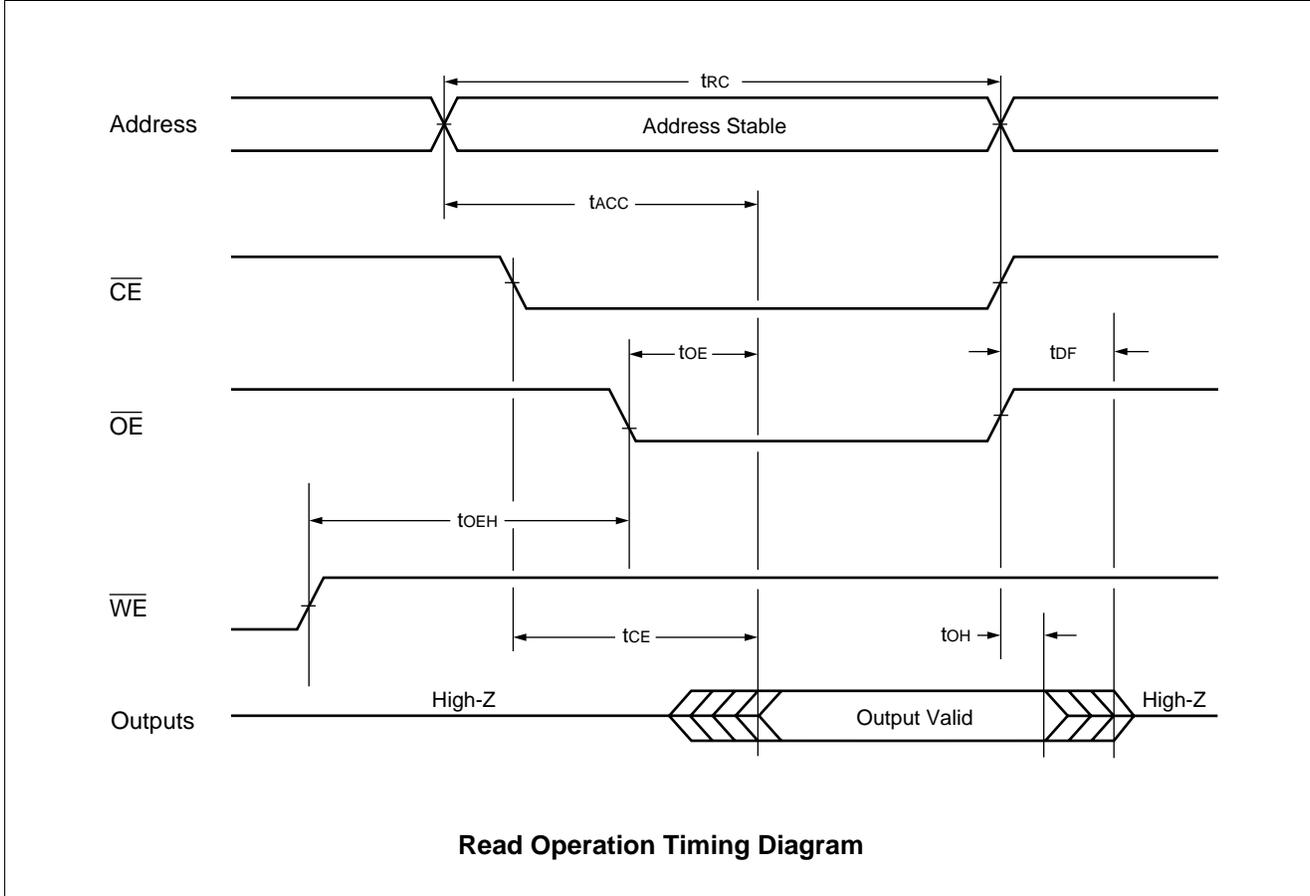
Parameter	Symbol	Condition	Value		Unit
			Typ	Max	
Input Capacitance	C <sub>IN</sub>	V <sub>IN</sub> = 0	6.0	7.5	pF
Output Capacitance	C <sub>OUT</sub>	V <sub>OUT</sub> = 0	8.5	12.0	pF
Control Pin Capacitance	C <sub>IN2</sub>	V <sub>IN</sub> = 0	7.5	9.0	pF
WP/ACC Pin Capacitance	C <sub>IN3</sub>	V <sub>IN</sub> = 0	13.0	16.0	pF

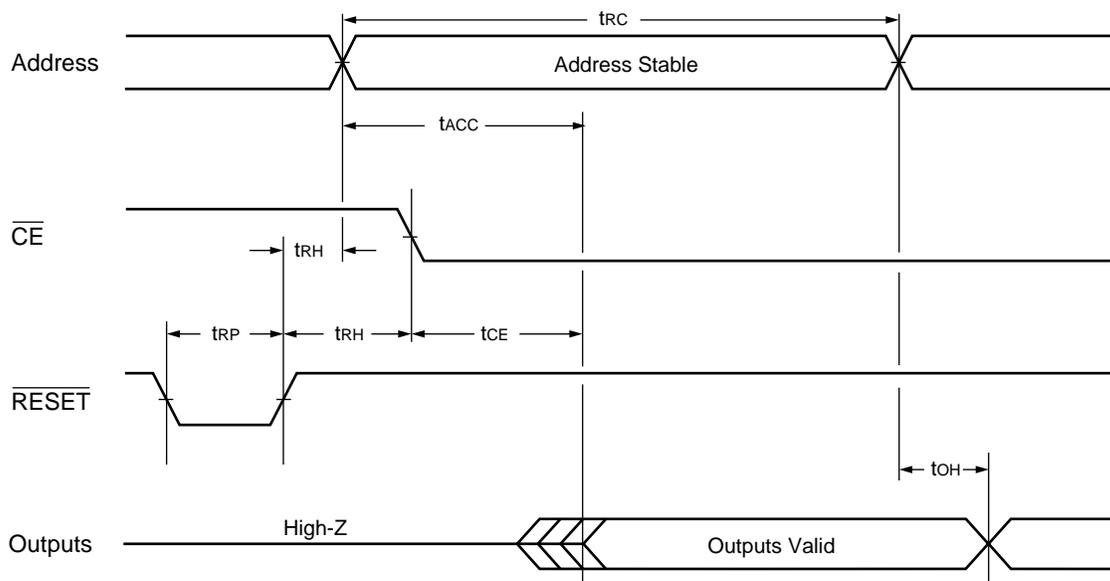
Note: Test conditions T<sub>A</sub> = 25°C, f = 1.0 MHz

## ■ TIMING DIAGRAM

- Key to Switching Waveforms

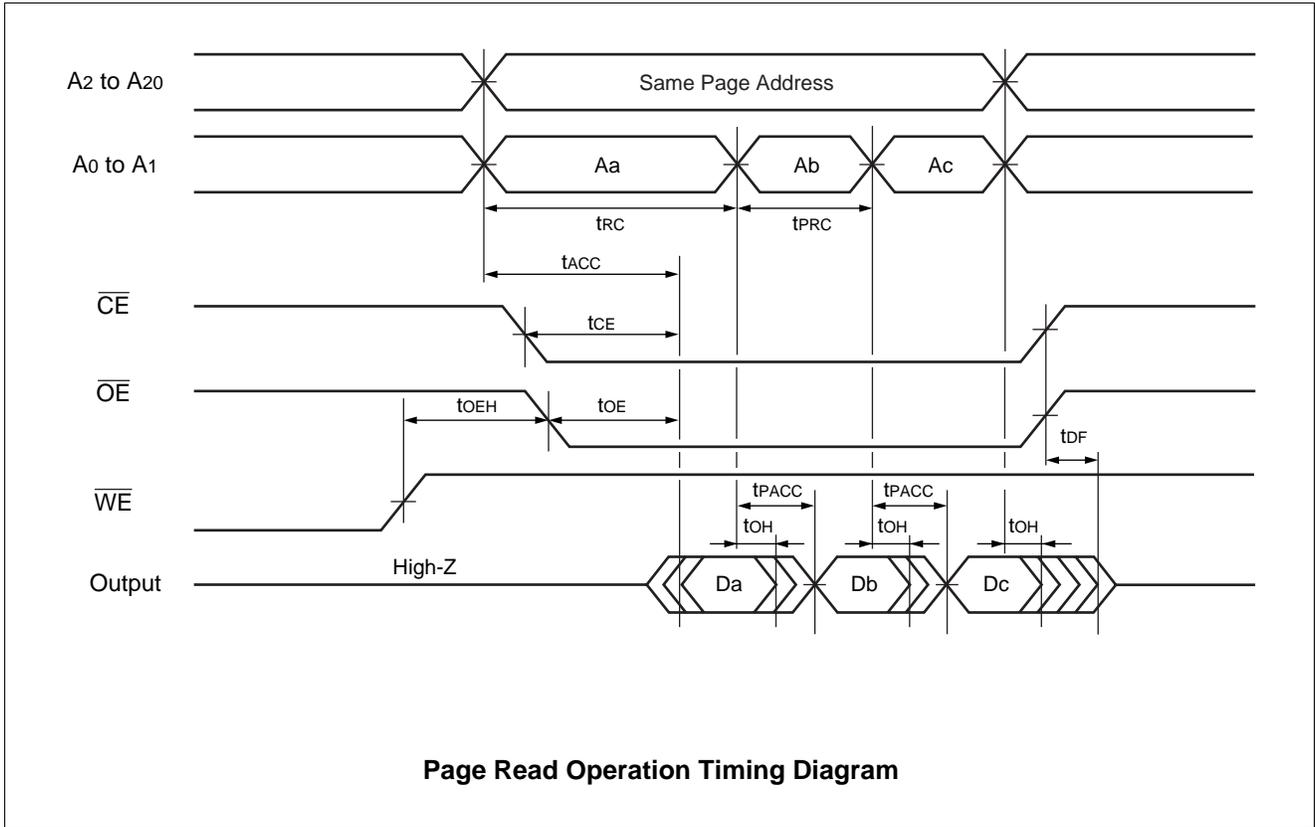
WAVEFORM	INPUTS	OUTPUTS
	Must Be Steady	Will Be Steady
	May Change from H to L	Will Be Changing from H to L
	May Change from L to H	Will Be Changing from L to H
	"H" or "L": Any Change Permitted	Changing, State Unknown
	Does Not Apply	Center Line is High-Impedance "Off" State

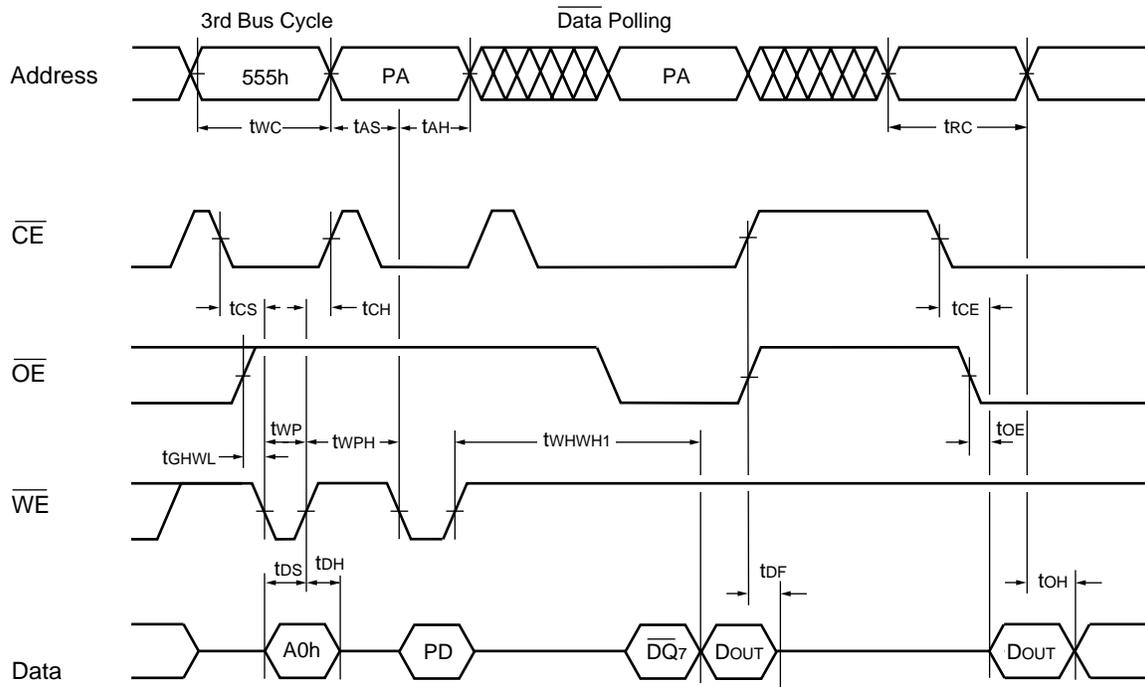




**Hardware Reset/Read Operation Timing Diagram**

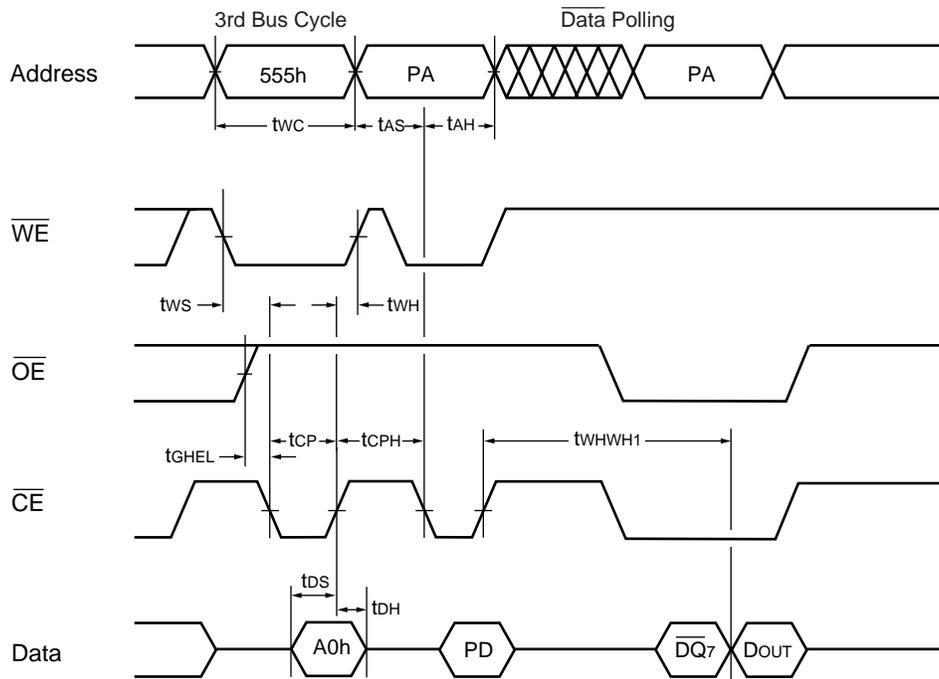
# MBM29PDS322TE<sub>10/11</sub>/MBM29PDS322BE<sub>10/11</sub>





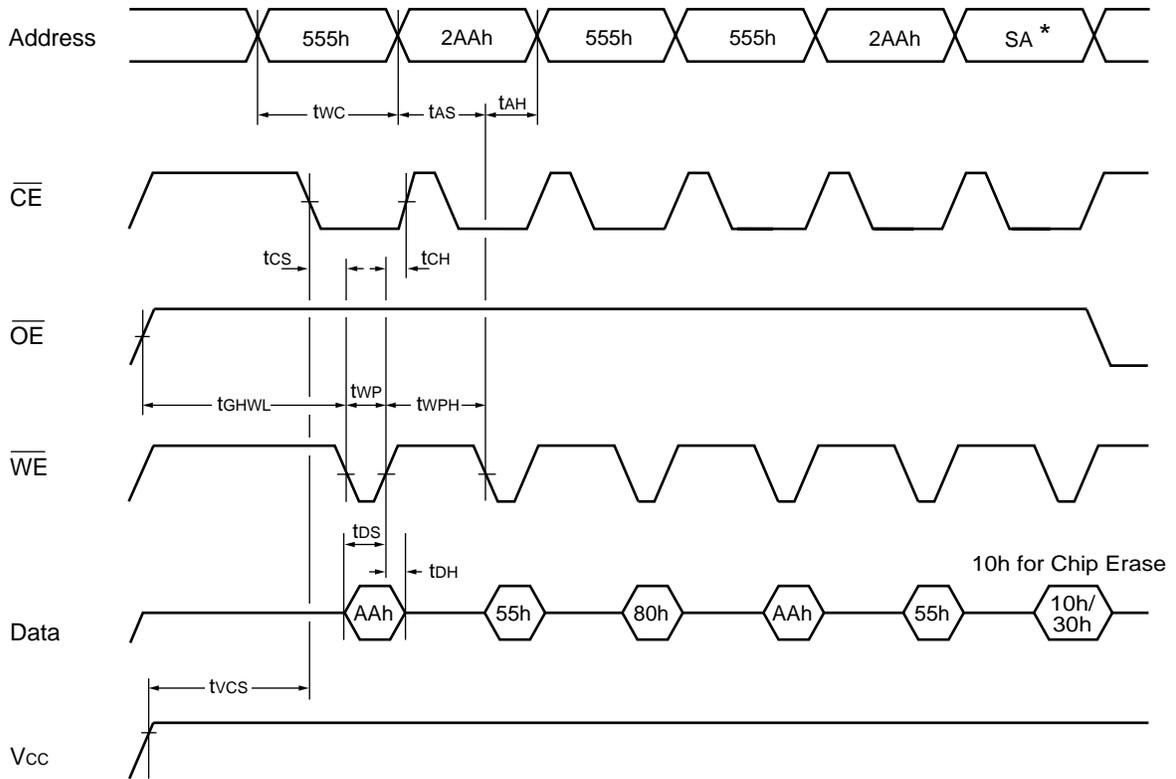
- Notes:
- PA is address of the memory location to be programmed.
  - PD is data to be programmed at word address.
  - $\overline{DQ}_7$  is the output of the complement of the data written to the device.
  - D<sub>OUT</sub> is the output of the data written to the device.
  - Figure indicates last two bus cycles out of four bus cycle sequence.

**Alternate  $\overline{WE}$  Controlled Program Operation Timing Diagram**



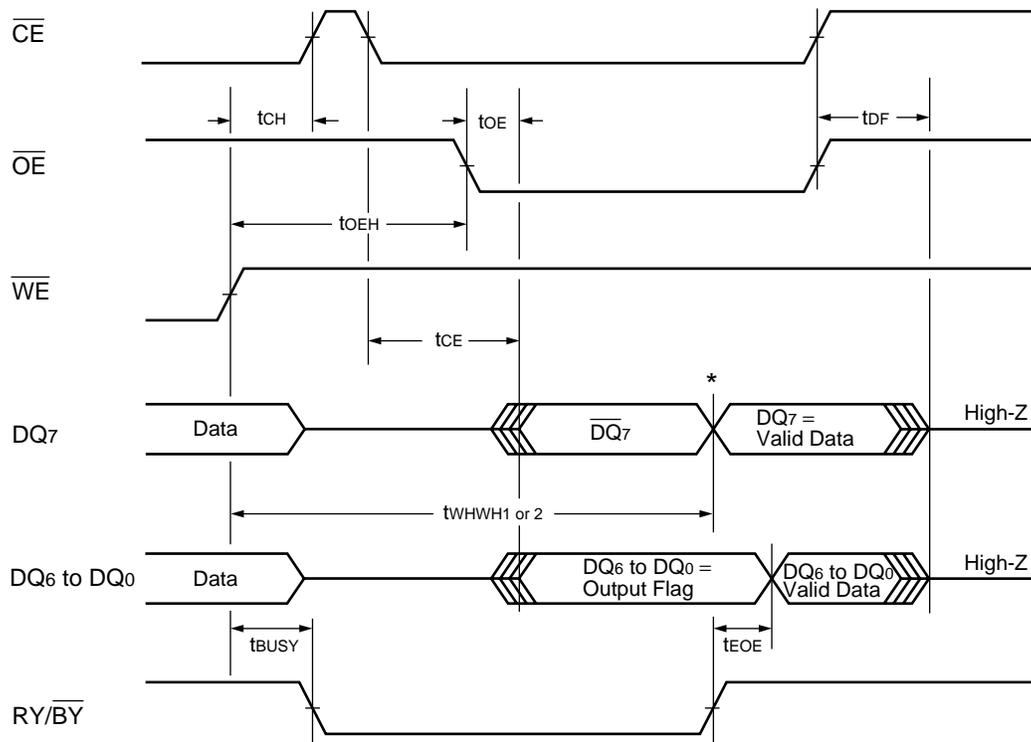
- Notes:
- PA is address of the memory location to be programmed.
  - PD is data to be programmed at word address.
  - $\overline{DQ7}$  is the output of the complement of the data written to the device.
  - D<sub>OUT</sub> is the output of the data written to the device.
  - Figure indicates last two bus cycles out of four bus cycle sequence.

**Alternate  $\overline{CE}$  Controlled Program Operation Timing Diagram**



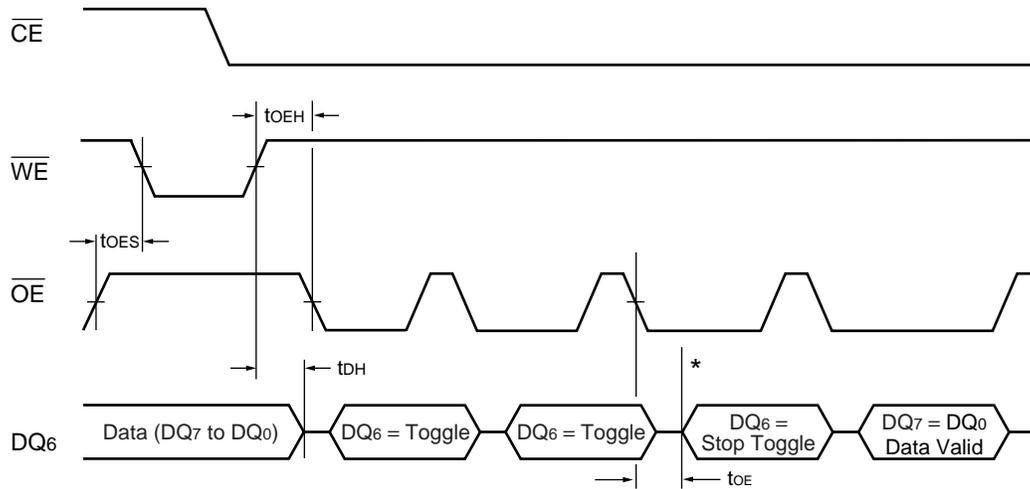
\*: SA is the sector address for Sector Erase. Addresses = 555h for Chip Erase.

**Chip/Sector Erase Operation Timing Diagram**



\*:  $DQ_7$  = Valid Data (The device has completed the Embedded operation).

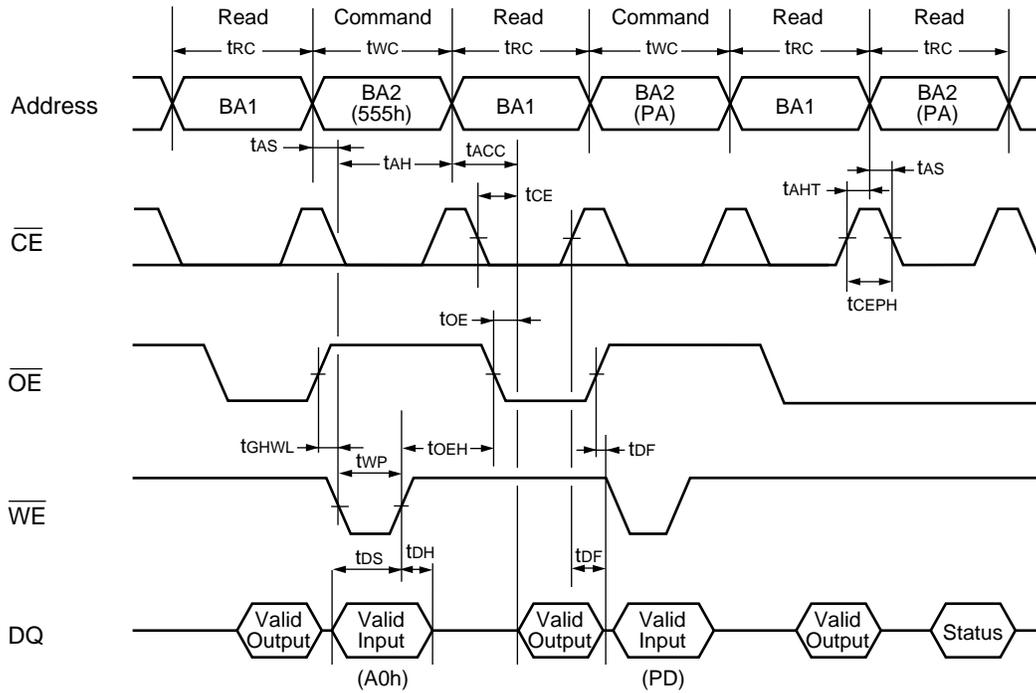
**Data Polling during Embedded Algorithm Operation Timing Diagram**



\*:  $DQ_6$  stops toggling (The device has completed the Embedded operation).

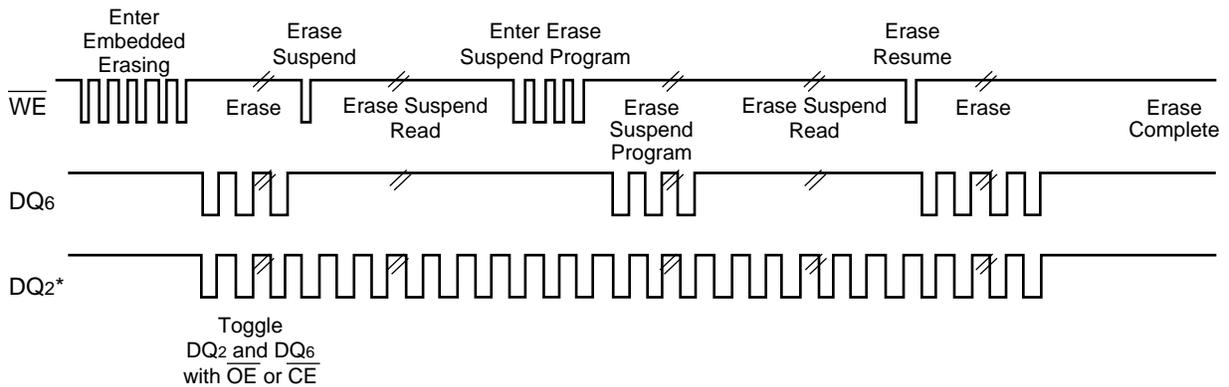
### Toggle Bit I during Embedded Algorithm Operation Timing Diagram

# MBM29PDS322TE<sub>10/11</sub>/MBM29PDS322BE<sub>10/11</sub>



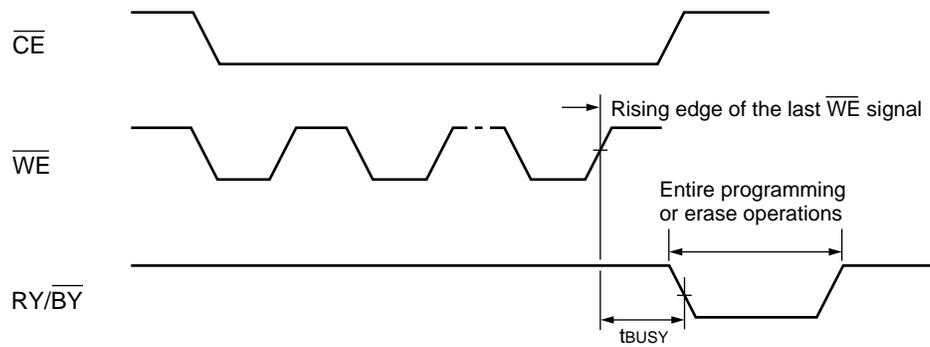
Note: This is example of Read for Bank 1 and Embedded Algorithm (program) for Bank 2.  
 BA1: Address corresponding to Bank 1.  
 BA2: Address corresponding to Bank 2.

**Bank-to-Bank Read/Write Timing Diagram**

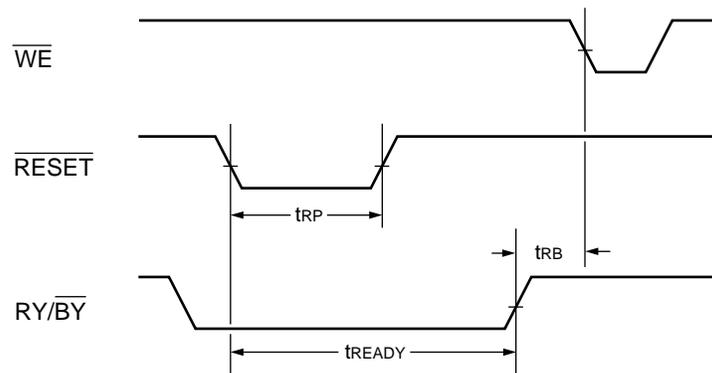


\* : DQ<sub>2</sub> is read from the erase-suspended sector.

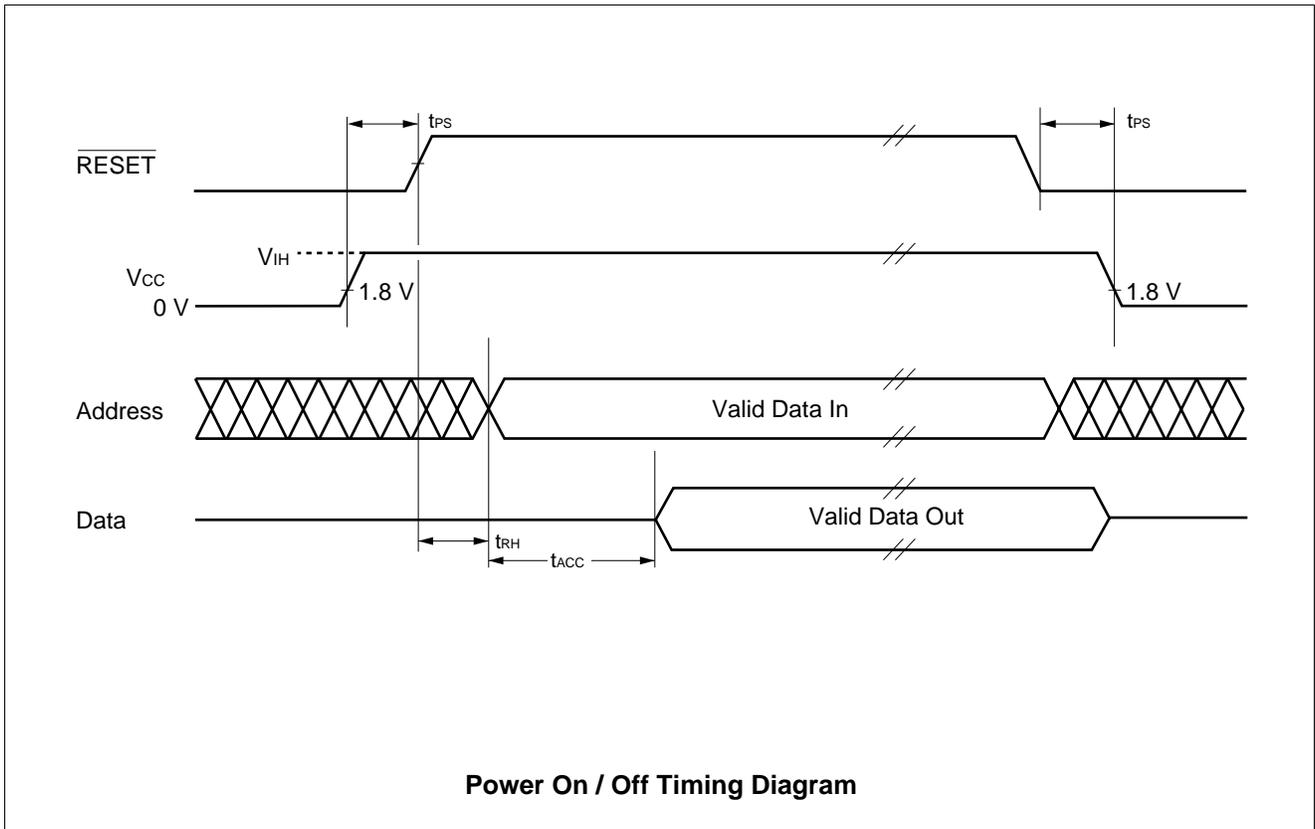
**DQ<sub>2</sub> vs. DQ<sub>6</sub>**

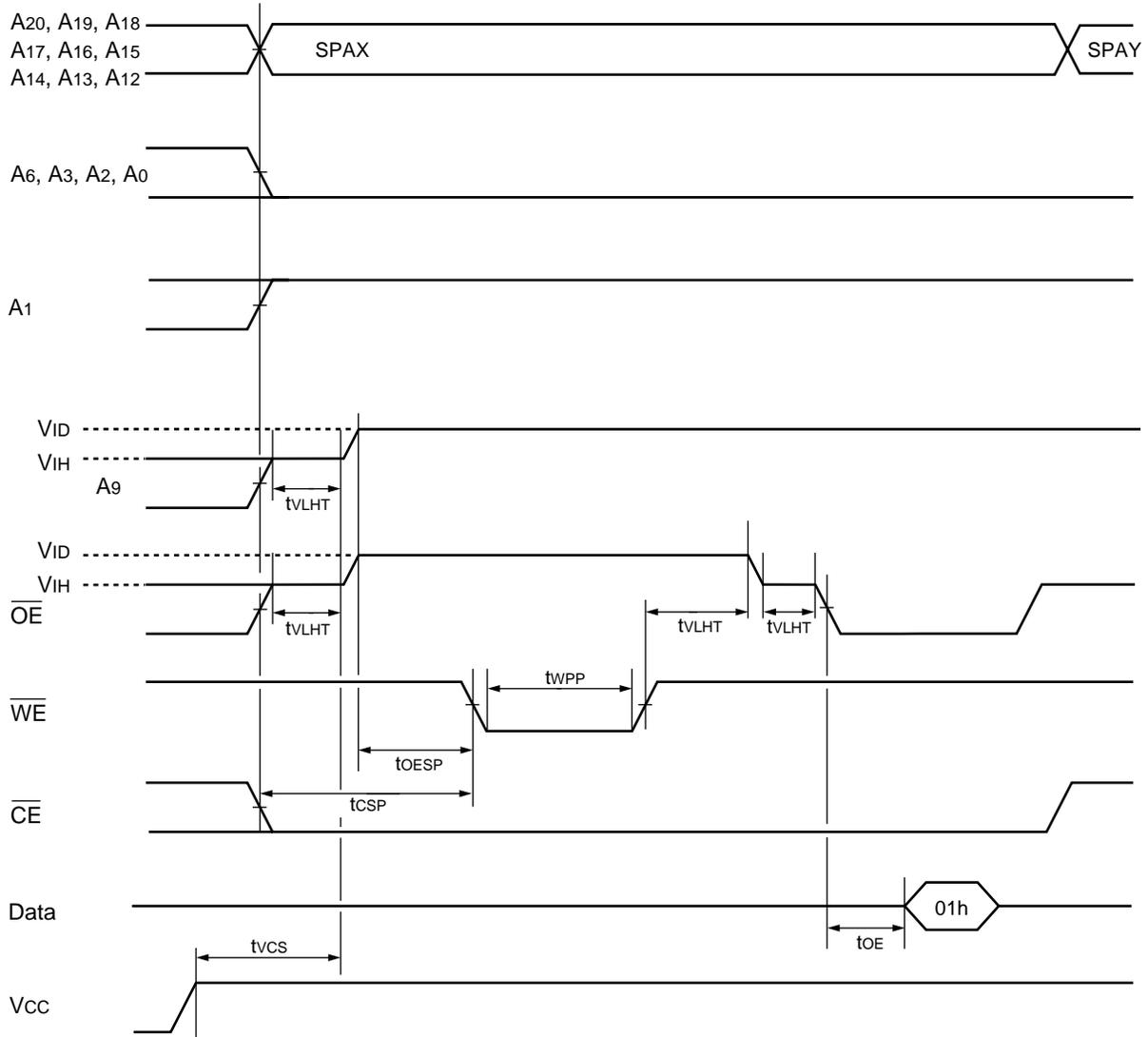


**$RY/\overline{BY}$  Timing Diagram during Program/Erase Operation Timing Diagram**



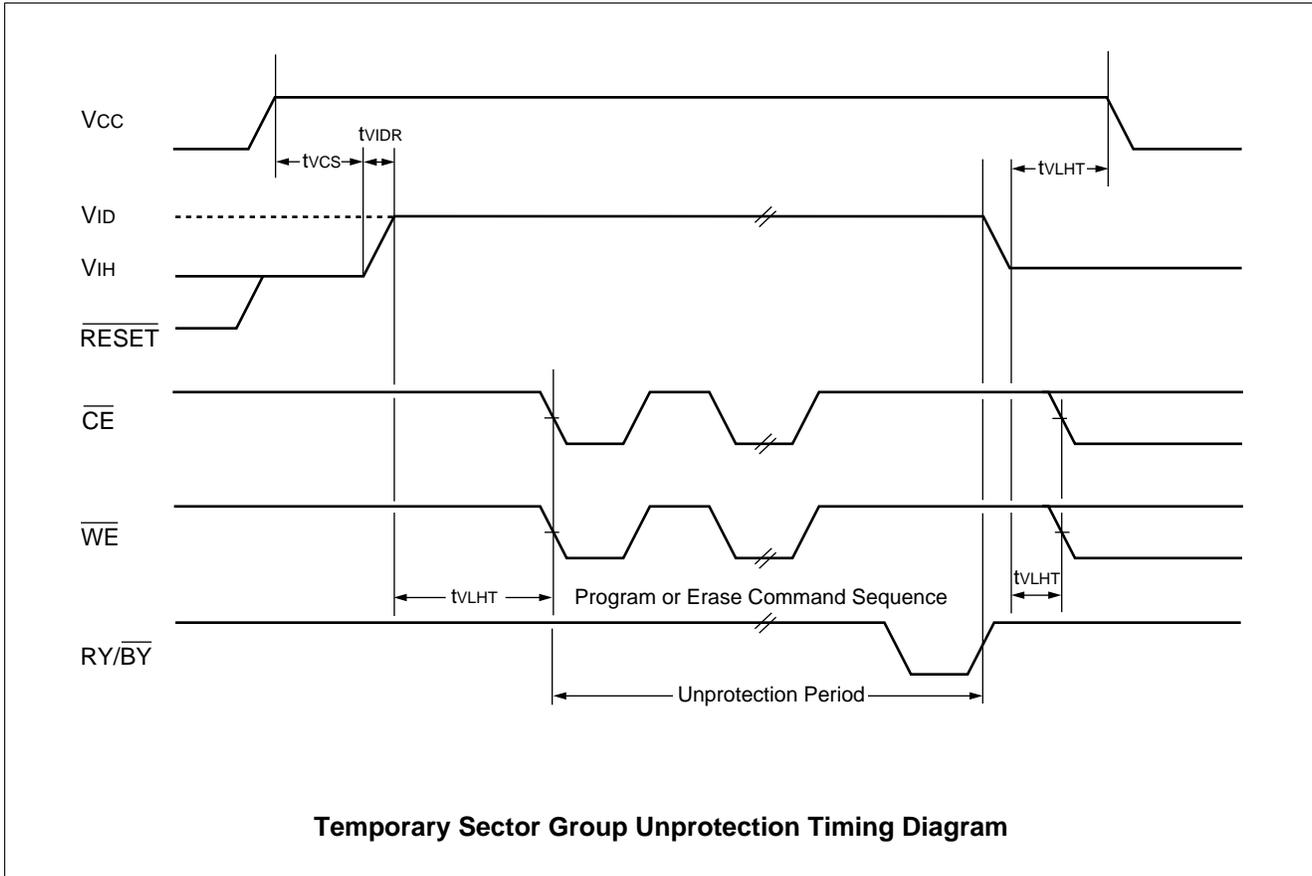
**$\overline{RESET}$ ,  $RY/\overline{BY}$  Timing Diagram**

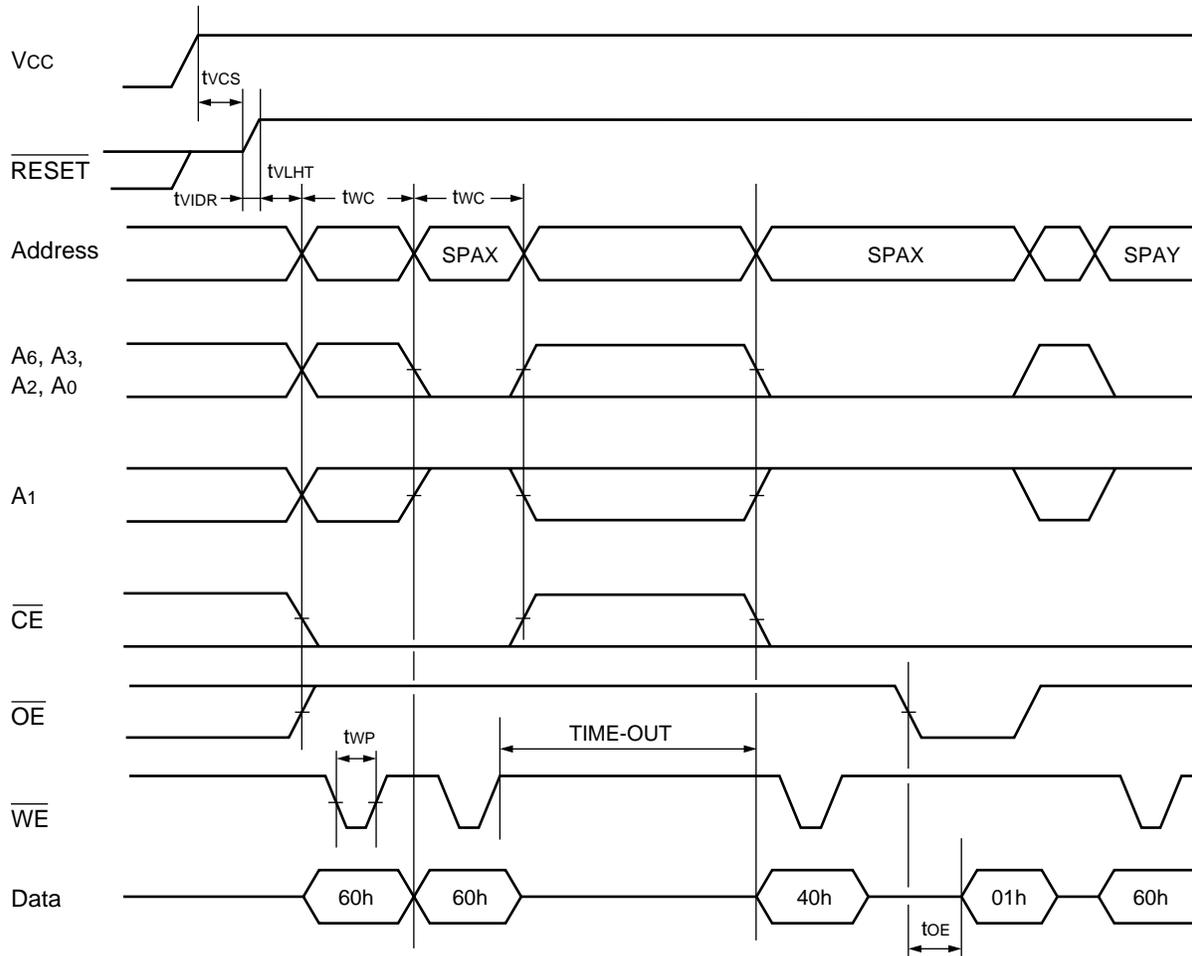




SPAX: Sector Group Address to be protected  
 SPAY: Next Sector Group Address to be protected

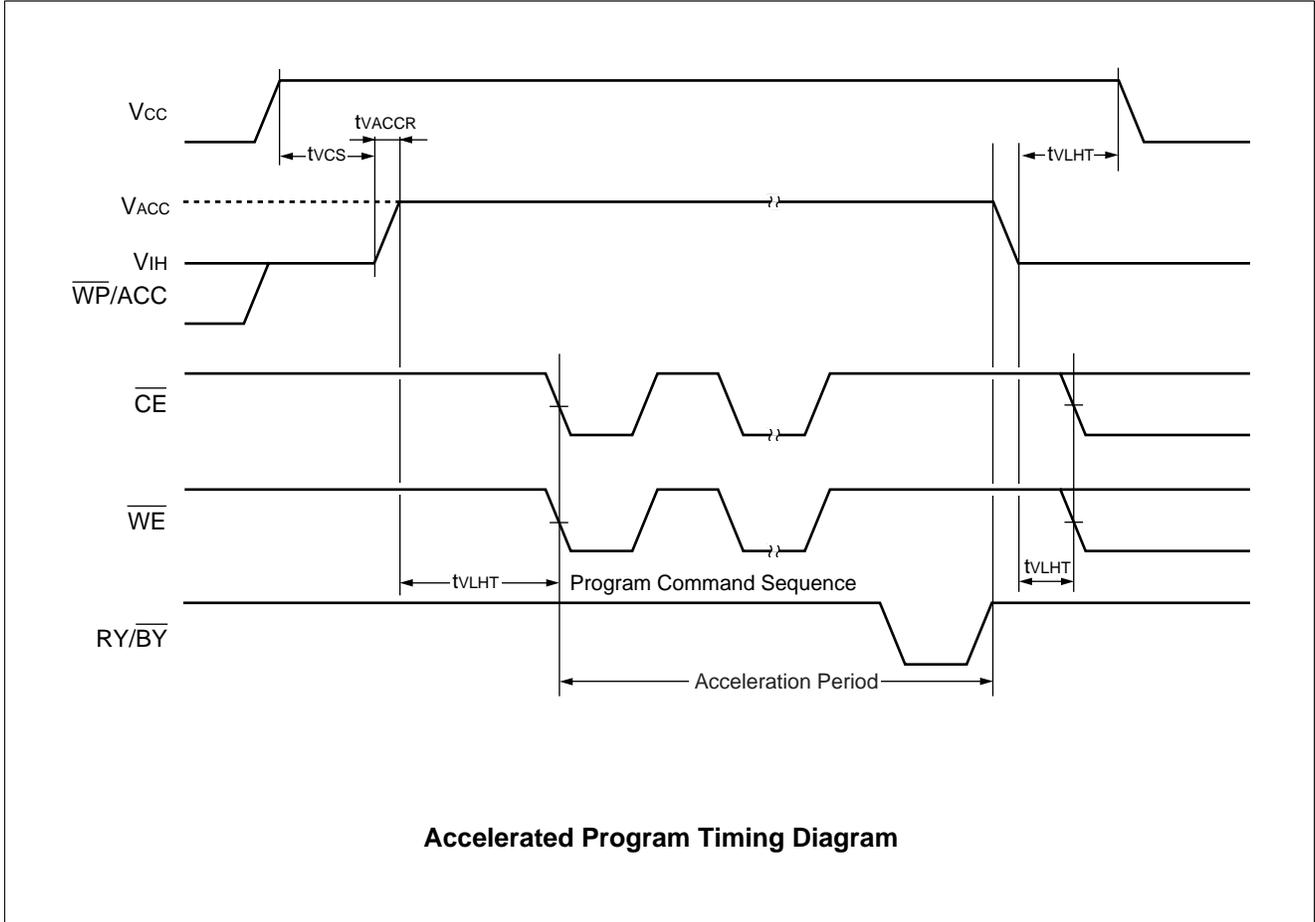
**Sector Group Protection Timing Diagram**





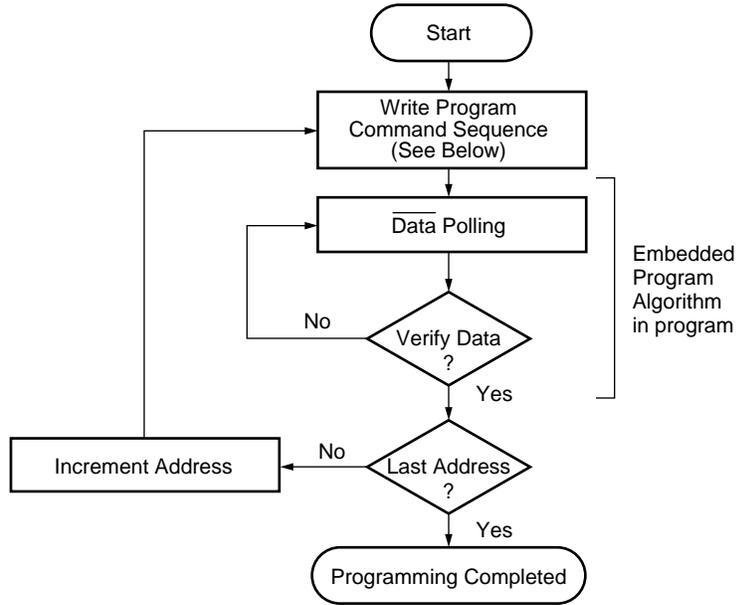
SPAX: Sector Group Address to be protected  
 SPAY: Next Sector Group Address to be protected  
 TIME-OUT: Time-Out window = 250  $\mu$ s (Min)

**Extended Sector Group Protection Timing Diagram**

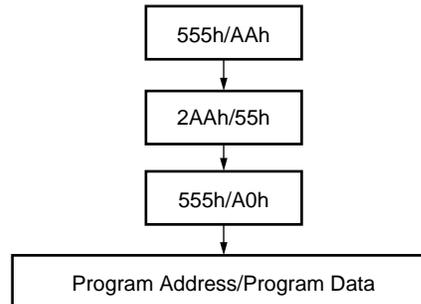


## ■ FLOW CHARTS

### EMBEDDED ALGORITHM

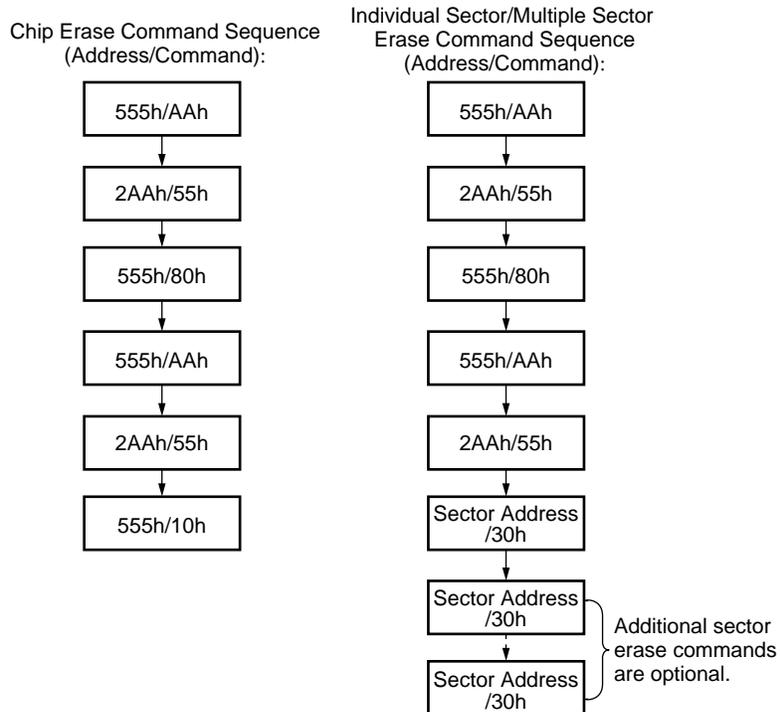
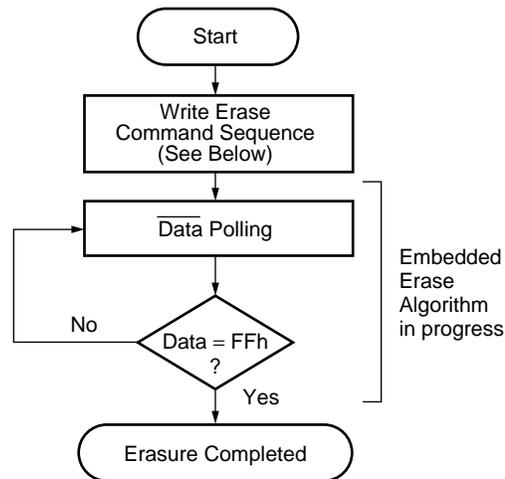


Program Command Sequence (Address/Command):

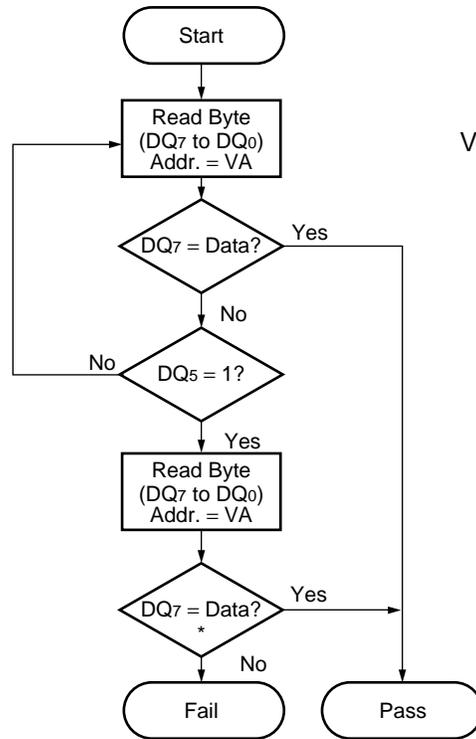


**Embedded Program™ Algorithm**

## EMBEDDED ALGORITHM



### Embedded Erase™ Algorithm

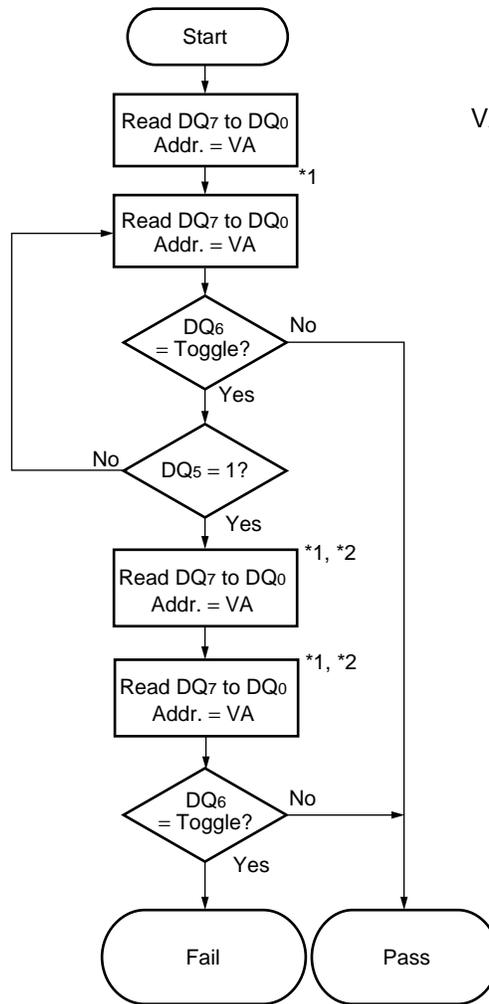


VA=Address for programming  
 =Any of the sector address within  
 the sector being erased during  
 sector erase or multiple sector  
 erases operation

=Any of the sector addresses  
 within the sector not being  
 protected during chip erase  
 operation.

\*: DQ<sub>7</sub> is rechecked even if DQ<sub>5</sub> = "1" because DQ<sub>7</sub> may change simultaneously with DQ<sub>5</sub>.

## Data Polling Algorithm

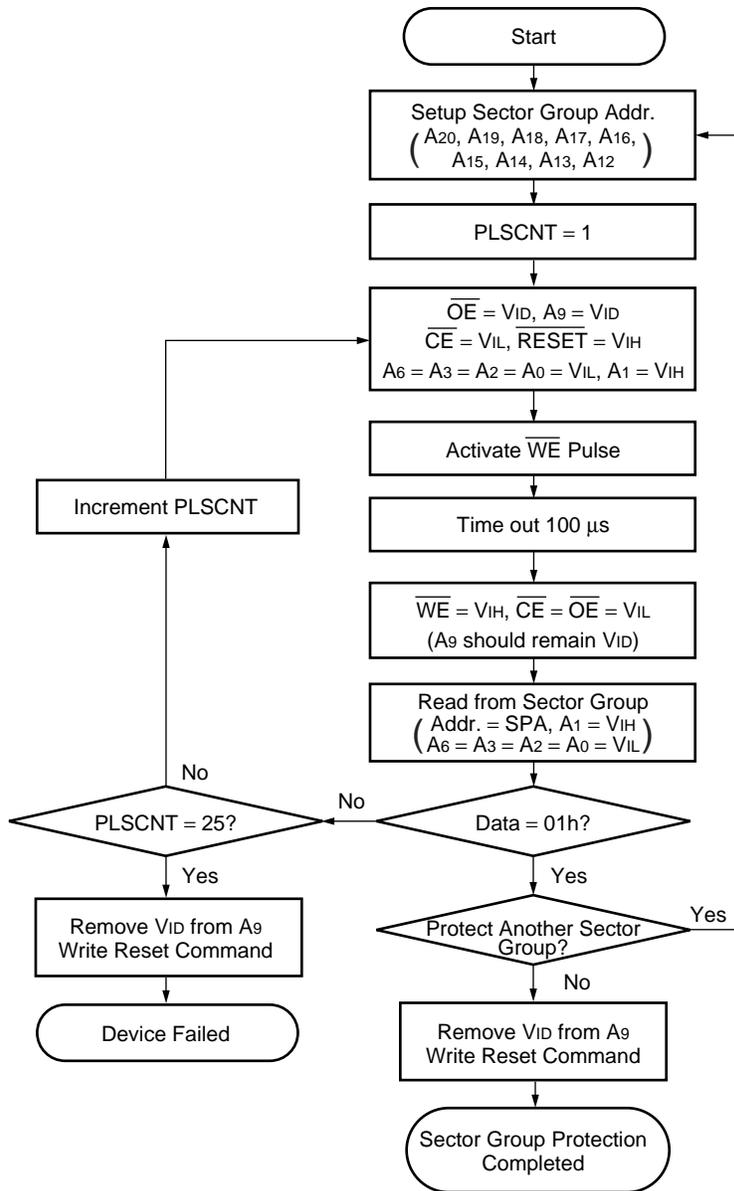


VA=Bank address being executed  
Embedded Algorithm.

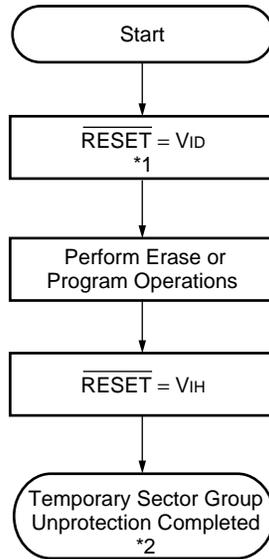
\*1: Read toggle bit twice to determine whether it is toggling.

\*2: Recheck toggle bit because it may stop toggling as DQ<sub>5</sub> changes to "1".

### Toggle Bit Algorithm



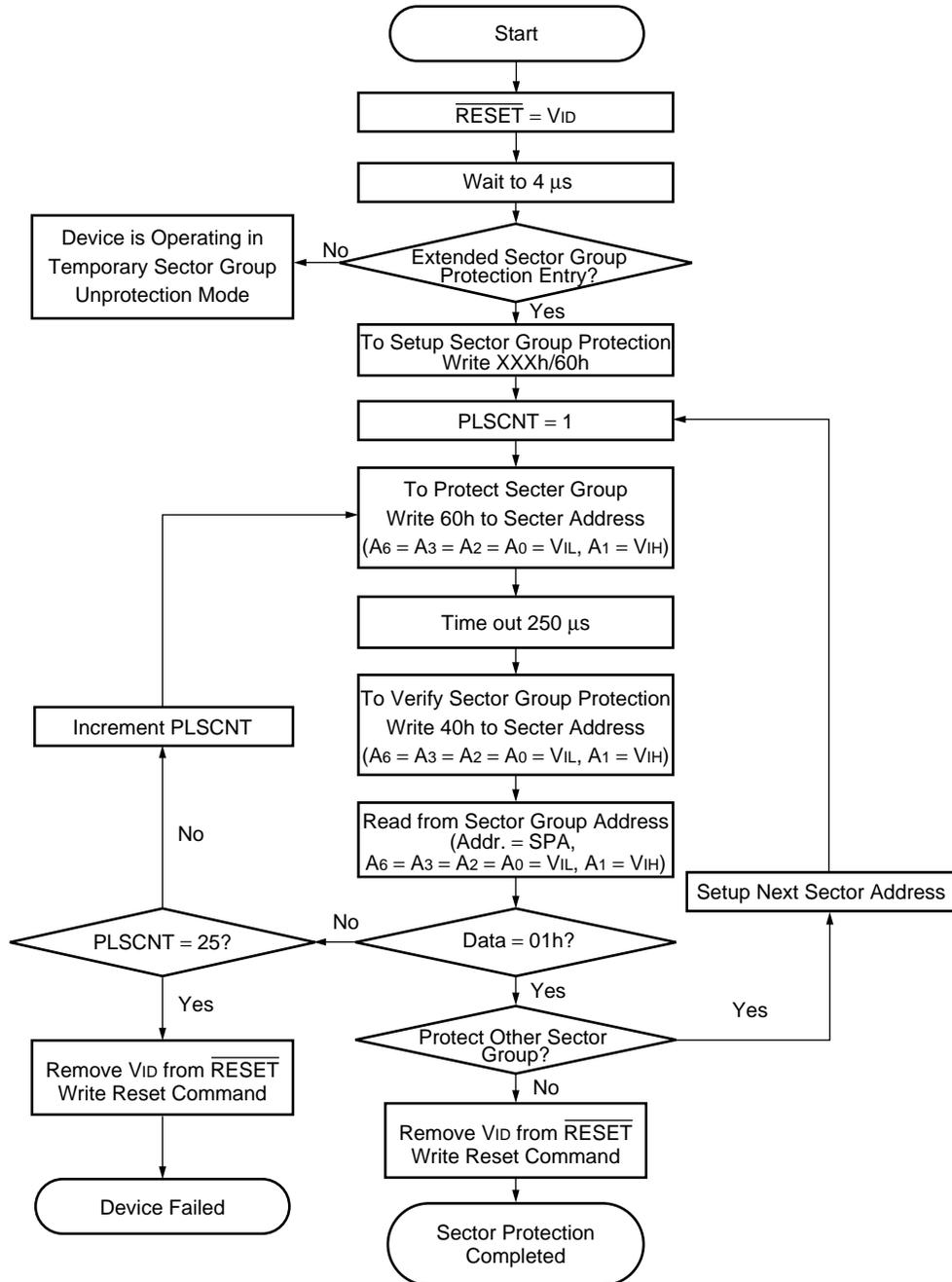
**Sector Group Protection Algorithm**



\*1: All protected sector groups are unprotected.

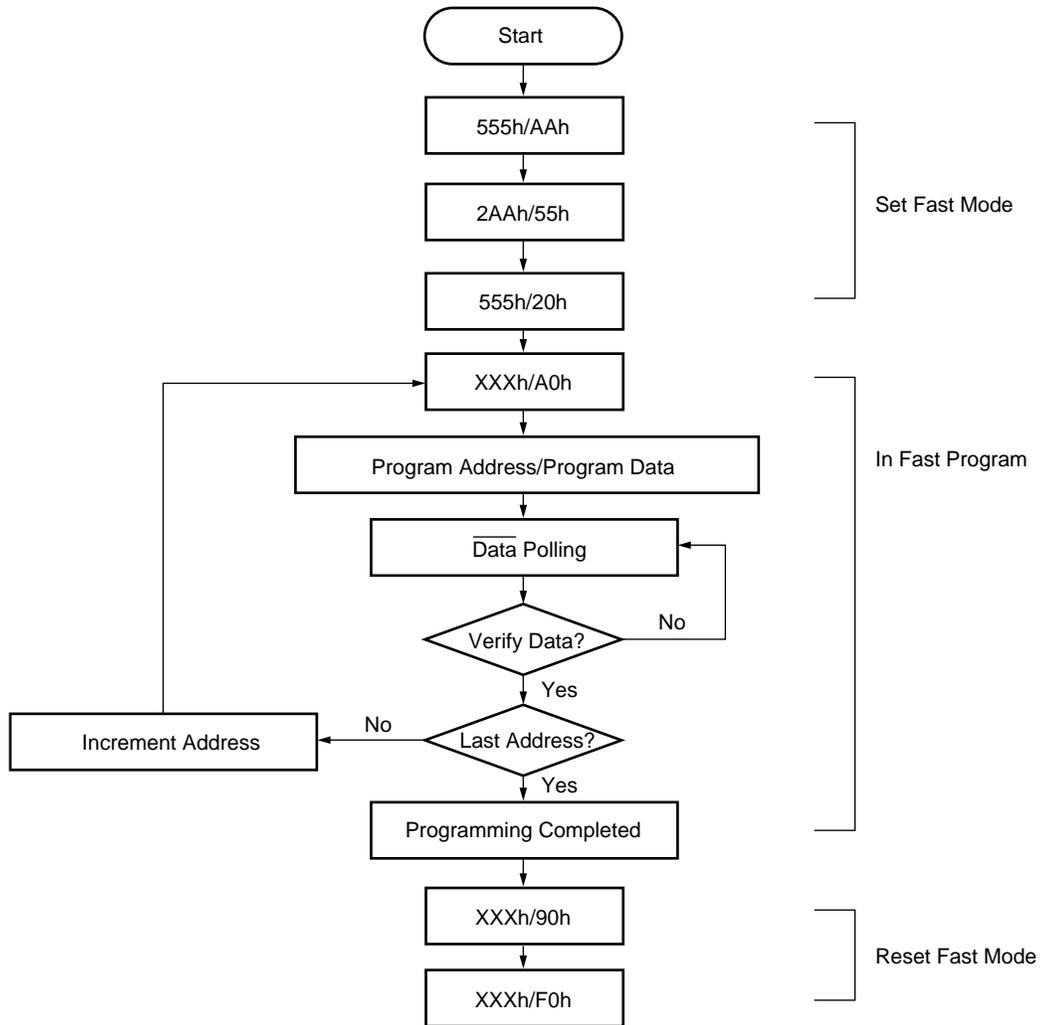
\*2: All previously protected sector groups are protected once again.

**Temporary Sector Group Unprotection Algorithm**



**Extended Sector Group Protection Algorithm**

## FAST MODE ALGORITHM

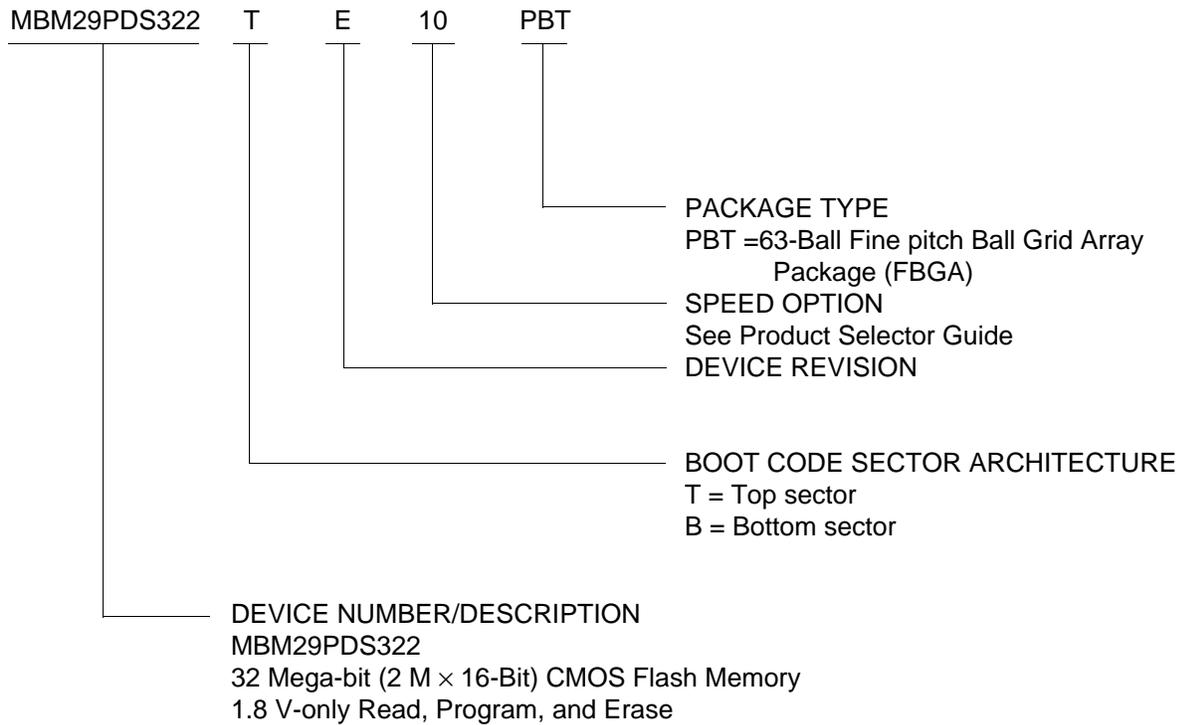


**Embedded Program™ Algorithm for Fast Mode**

# MBM29PDS322TE<sub>10/11</sub>/MBM29PDS322BE<sub>10/11</sub>

## ■ ORDERING INFORMATION

Part No.	Package	Access Time (ns)	Sector Architecture
MBM29PDS322TE10PBT MBM29PDS322TE11PBT	63-pin plastic FBGA (BGA-63P-M01)	100 115	Top sector
MBM29PDS322BE10PBT MBM29PDS322BE11PBT	63-pin plastic FBGA (BGA-63P-M01)	100 115	Bottom sector





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