# MBM29LV160TE/BE70/90

***Data Sheet*** *(Retired Product)*

This product has been retired and is not recommended for new designs. Availability of this document is retained for reference and historical purposes only.

## Continuity of Specifications

There is no change to this data sheet as a result of offering the device as a Spansion product. Any changes that have been made are the result of normal data sheet improvement and are noted in the document revision summary.

## For More Information

Please contact your local sales office for additional information about Spansion memory solutions.

**Publication Number** MBM29LV160TE/BE **Revision** DS05-20883-7E **Issue Date** July 31, 2007

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# 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.

AMD

FUJITSU

FUJITSU SEMICONDUCTOR
DATA SHEET

DS05-20883-7E

# FLASH MEMORY

## CMOS

# 16M (2M × 8/1M × 16) BIT

## MBM29LV160TE/BE70/90

## ■ GENERAL DESCRIPTION

The MBM29LV160TE/BE is a 16M-bit, 3.0 V-only Flash memory organized as 2M bytes of 8 bits each or 1M words of 16 bits each. The MBM29LV160TE/BE is offered in a 48-pin TSOP (1), 48-pin CSOP and 48-ball FBGA packages. The device is designed to be programmed in-system with the standard system 3.0 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 standard MBM29LV160TE/BE offers access times of 70 ns and 90 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 MBM29LV160TE/BE is pin and command set compatible with JEDEC standard $E^2$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 MBM29LV160TE/BE 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 margins. 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 times the erase pulse widths and verifies proper cell margins.

*(Continued)*

## ■ PRODUCT LINE UP

| Part No. | MBM29LV160TE/160BE | |
|---|---|---|
| | 70 | 90 |
| Power Supply Voltage $V_{CC}$ (V) | $V_{CC}$ = 3.0 V $^{+0.6\ V}_{-0.3\ V}$ | |
| Max Address Access Time (ns) | 70 | 90 |
| Max $\overline{CE}$ Access Time (ns) | 70 | 90 |
| Max $\overline{OE}$ Access Time (ns) | 30 | 35 |

*(Continued)*

Any individual sector is typically erased and verified in 1.0 second (if already preprogrammed).

The device also features sector erase architecture. The sector mode allows each sector to be erased and reprogrammed without affecting other sectors. The MBM29LV160TE/BE is erased when shipped from the factory. The device features single 3.0 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 $\overline{\text{Data}}$ Polling of $DQ_7$, by the Toggle Bit feature on $DQ_6$, or the RY/$\overline{\text{BY}}$ output pin. Once the end of a program or erase cycle has been completed, the device internally resets to the read mode.

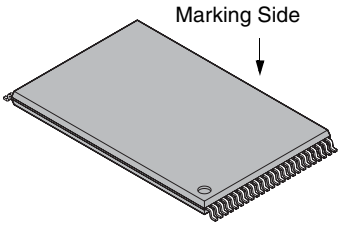
The MBM29LV160TE/BE also has a hardware $\overline{\text{RESET}}$ pin. When this pin is driven low, execution of any Embedded Program Algorithm or Embedded Erase Algorithm is terminated. The internal state machine is then reset to the read mode. The $\overline{\text{RESET}}$ pin may be tied to the system 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 Flash memory manufacturing experience to produce the highest levels of quality, reliability, and cost effectiveness. The MBM29LV160TE/BE memory electrically erases all bits within a sector simultaneously via Fowler-Nordhiem tunneling. The bytes/words are programmed one byte/word at a time using the EPROM programming mechanism of hot electron injection.

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

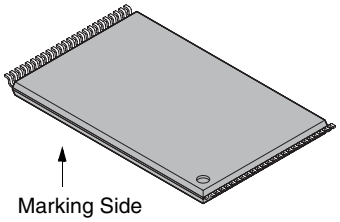
## ■ PACKAGES

48-pin plastic TSOP (1)



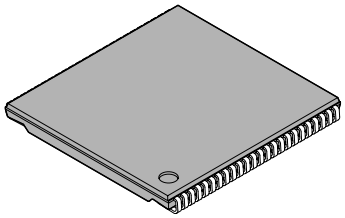

(FPT-48P-M19)

48-pin plastic TSOP (1)



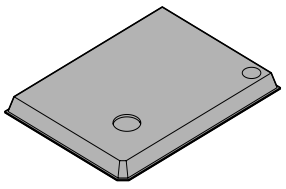

(FPT-48P-M20)

48-pin plastic CSOP



(LCC-48P-M03)

48-ball plastic FBGA



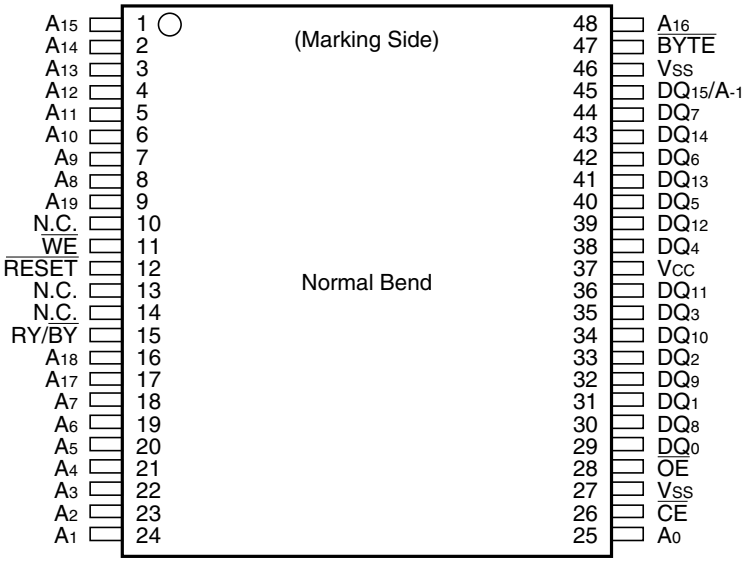
(BGA-48P-M11)

## ■ FEATURES

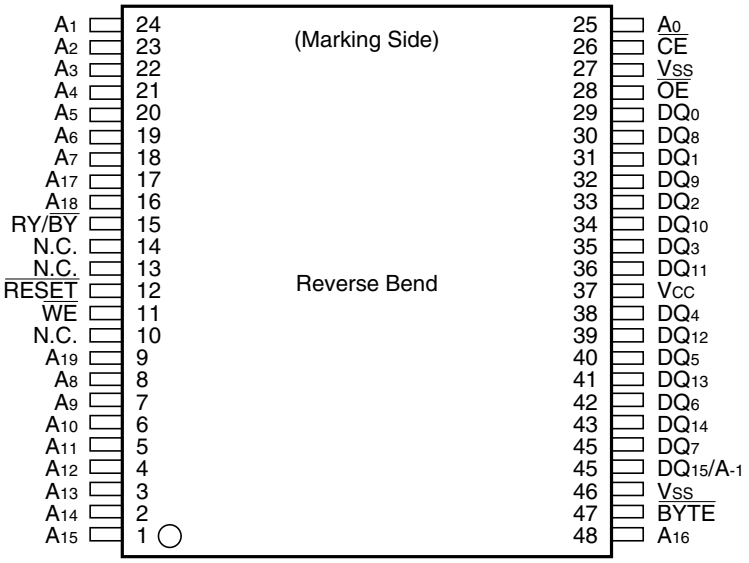
- **0.23 μm Process Technology**
- **Single 3.0 V Read, Program and Erase**
  Minimizes system level power requirements
- **Compatible with JEDEC-standard Commands**
  Uses same software commands as $E^2$PROMs
- **Compatible with JEDEC-standard Worldwide Pinouts**
  48-pin TSOP (1) (Package suffix: TN-Normal Bend Type, TR-Reversed Bend Type)
  48-pin CSOP (Package suffix: PCV)
  48-ball FBGA (Package suffix: PBT)
- **Minimum 100,000 Program/Erase Cycles**
- **High Performance**
  70 ns maximum access time
- **Sector Erase Architecture**
  One 8K word, two 4K words, one 16K word, and thirty-one 32K words sectors in word mode
  One 16K byte, two 8K bytes, one 32K byte, and thirty-one 64K bytes sectors in byte mode
  Any combination of sectors can be concurrently erased. Also supports full chip erase
- **Boot Code Sector Architecture**
  T = Top sector
  B = Bottom sector
- **Embedded Erase™ Algorithms**
  Automatically pre-programs and erases the chip or any sector
- **Embedded Program™ Algorithms**
  Automatically programs and verifies data at specified address
- **$\overline{\text{Data}}$ Polling and Toggle Bit Feature for Detection of Program or Erase Cycle Completion**
- **Ready/Busy Output (RY/$\overline{\text{BY}}$)**
  Hardware method for detection of program or erase cycle completion
- **Automatic Sleep Mode**
  When addresses remain stable, the device automatically switches to low power mode
- **Low $V_{CC}$ Write Inhibit ≤ 2.5 V**
- **Erase Suspend/Resume**
  Suspends the erase operation to allow to read data and/or program in another sector within the same device
- **Sector Protection**
  Hardware method disables any combination of sectors from program or erase operations
- **Sector Protection Set Function by Extended Sector Protection Command**
- **Fast Programming Function by Extended Command**
- **Temporary Sector Unprotection**
  Temporary sector unprotection via the $\overline{\text{RESET}}$ pin
- **In Accordance with CFI (Common Flash Memory Interface)**

## ■ PIN ASSIGNMENTS

**TSOP(1)**




(FPT-48P-M19)




(FPT-48P-M20)

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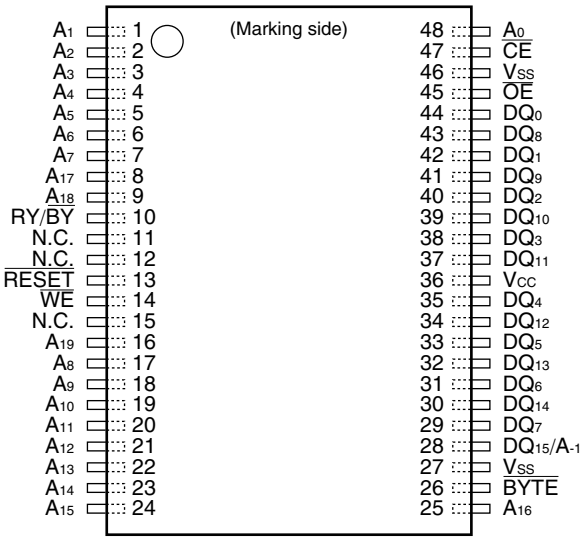
**CSOP**
(TOP VIEW)



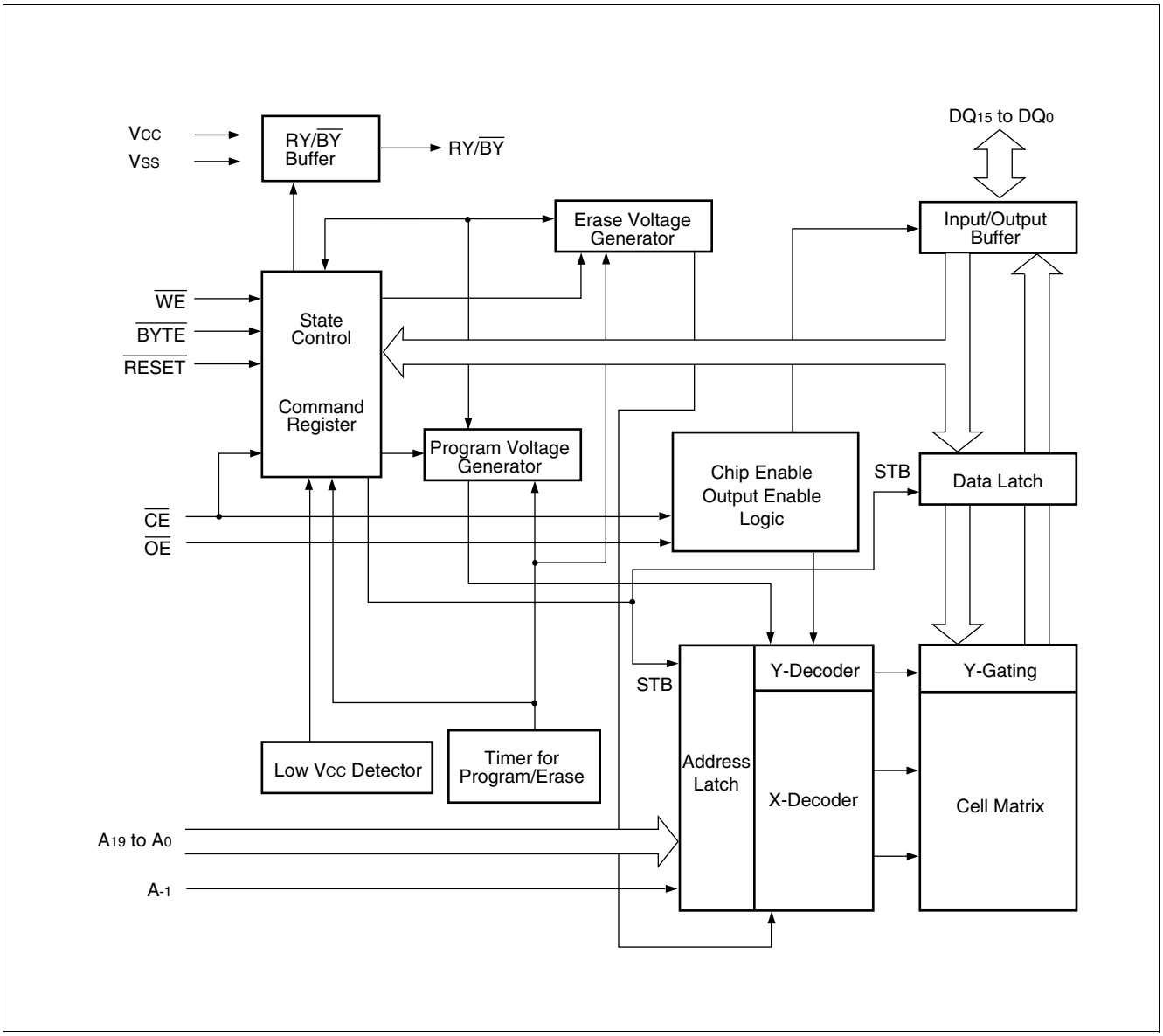

(LCC-48P-M03)

FBGA
(TOP VIEW)
Making side

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| A6 A13 | B6 A12 | C6 A14 | D6 A15 | E6 A16 | F6 BYTE | G6 DQ15/A-1 | H6 VSS |
| A5 A9 | B5 A8 | C5 A10 | D5 A11 | E5 DQ7 | F5 DQ14 | G5 DQ13 | H5 DQ6 |
| A4 WE | B4 RESET | C4 N.C. | D4 A19 | E4 DQ5 | F4 DQ12 | G4 VCC | H4 DQ4 |
| A3 RY/BY | B3 N.C. | C3 A18 | D3 N.C. | E3 DQ2 | F3 DQ10 | G3 DQ11 | H3 DQ3 |
| A2 A7 | B2 A17 | C2 A6 | D2 A5 | E2 DQ0 | F2 DQ8 | G2 DQ9 | H2 DQ1 |
| A1 A3 | B1 A4 | C1 A2 | D1 A1 | E1 A0 | F1 CE | G1 OE | H1 VSS |

(BGA-48P-M11)

## ■ BLOCK DIAGRAM

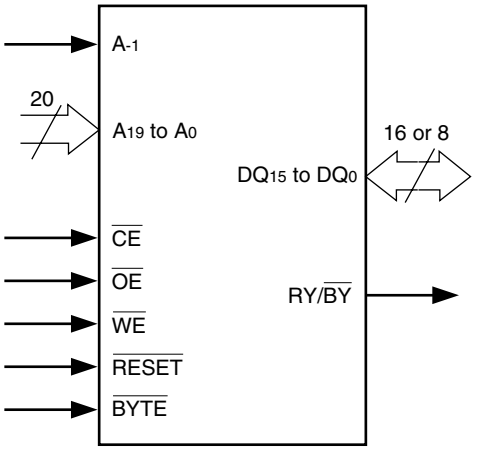


## ■ PIN DESCRIPTION

**MBM29LV160TE/BE Pin Configuration**

| Pin name | Function |
|---|---|
| $A_{19}$ to $A_0$, $A_{-1}$ | Address Inputs |
| $DQ_{15}$ to $DQ_0$ | Data Inputs/Outputs |
| $\overline{CE}$ | Chip Enable |
| $\overline{OE}$ | Output Enable |
| $\overline{WE}$ | Write Enable |
| RY/$\overline{BY}$ | Ready/Busy Output |
| $\overline{RESET}$ | Hardware Reset Pin/<br>Temporary Sector Unprotection |
| $\overline{BYTE}$ | Selects 8-bit or 16-bit mode |
| N.C. | Pin Not Connected Internally |
| $V_{SS}$ | Device Ground |
| $V_{CC}$ | Device Power Supply |

## ■ LOGIC SYMBOL



## ■ DEVICE BUS OPERATIONS

**MBM29LV160TE/BE User Bus Operation ($\overline{BYTE}$ = $V_{IH}$)**

| Operation | $\overline{CE}$ | $\overline{OE}$ | $\overline{WE}$ | $A_0$ | $A_1$ | $A_6$ | $A_9$ | $DQ_{15}$ to $DQ_0$ | $\overline{RESET}$ |
|---|---|---|---|---|---|---|---|---|---|
| Auto-Select Manufacture Code *1 | L | L | H | L | L | L | $V_{ID}$ | Code | H |
| Auto-Select Device Code *1 | L | L | H | H | L | L | $V_{ID}$ | Code | H |
| Read *3 | L | L | H | $A_0$ | $A_1$ | $A_6$ | $A_9$ | $D_{OUT}$ | H |
| Standby | H | X | X | X | X | X | X | High-Z | H |
| Output Disable | L | H | H | X | X | X | X | High-Z | H |
| Write (Program/Erase) | L | H | L | $A_0$ | $A_1$ | $A_6$ | $A_9$ | $D_{IN}$ | H |
| Enable Sector Protection *2, *4 | L | $V_{ID}$ | ⎍ | L | H | L | $V_{ID}$ | X | H |
| Verify Sector Protection *2, *4 | L | L | H | L | H | L | $V_{ID}$ | Code | H |
| Temporary Sector Unprotection *5 | X | X | X | X | X | X | X | X | $V_{ID}$ |
| Reset (Hardware)/Standby | X | X | X | X | X | X | X | High-Z | L |

**MBM29LV160TE/BE User Bus Operation ($\overline{BYTE}$ = $V_{IL}$)**

| Operation | $\overline{CE}$ | $\overline{OE}$ | $\overline{WE}$ | $DQ_{15}$/$A_{-1}$ | $A_0$ | $A_1$ | $A_6$ | $A_9$ | $DQ_7$ to $DQ_0$ | $\overline{RESET}$ |
|---|---|---|---|---|---|---|---|---|---|---|
| Auto-Select Manufacture Code *1 | L | L | H | L | L | L | L | $V_{ID}$ | Code | H |
| Auto-Select Device Code *1 | L | L | H | L | H | L | L | $V_{ID}$ | Code | H |
| Read *3 | L | L | H | $A_{-1}$ | $A_0$ | $A_1$ | $A_6$ | $A_9$ | $D_{OUT}$ | H |
| Standby | H | X | X | X | X | X | X | X | High-Z | H |
| Output Disable | L | H | H | X | X | X | X | X | High-Z | H |
| Write (Program/Erase) | L | H | L | $A_{-1}$ | $A_0$ | $A_1$ | $A_6$ | $A_9$ | $D_{IN}$ | H |
| Enable Sector Protection *2, *4 | L | $V_{ID}$ | ⎍ | L | L | H | L | $V_{ID}$ | X | H |
| Verify Sector Protection *2, *4 | L | L | H | L | L | H | L | $V_{ID}$ | Code | H |
| Temporary Sector Unprotection *5 | X | X | X | X | X | X | X | X | X | $V_{ID}$ |
| Reset (Hardware)/Standby | X | X | X | X | X | X | X | X | High-Z | L |

**Legend:** L = $V_{IL}$, H = $V_{IH}$, X = $V_{IL}$ or $V_{IH}$. ⎍ = Pulse input. See "■DC CHARACTERISTICS" for voltage levels.

*1: Manufacturer and device codes may also be accessed via a command register write sequence. See "MBM29LV160TE/BE Standard Command Definitions" Table in "■FLEXIBLE SECTOR-ERASE ARCHITECTURE".

*2: Refer to the section on Sector Protection.

*3: $\overline{WE}$ can be $V_{IL}$ if $\overline{OE}$ is $V_{IL}$, $\overline{OE}$ at $V_{IH}$ initiates the write operations.

*4: $V_{CC}$ = 3.3 V ±10%

*5: It is also used for the extended sector protection.

**MBM29LV160TE/BE Standard Command Definitions**

| 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 | — | — | — | — | — | — | — | — | — | — |
| | Byte | | | | | | | | | | | | | |
| Read/Reset | Word | 3 | 555h | AAh | 2AAh | 55h | 555h | F0h | RA | RD | — | — | — | — |
| | Byte | | AAAh | | 555h | | AAAh | | | | | | | |
| Autoselect | Word | 3 | 555h | AAh | 2AAh | 55h | 555h | 90h | — | — | — | — | — | — |
| | Byte | | AAAh | | 555h | | AAAh | | | | | | | |
| Program | Word | 4 | 555h | AAh | 2AAh | 55h | 555h | A0h | PA | PD | — | — | — | — |
| | Byte | | AAAh | | 555h | | AAAh | | | | | | | |
| Chip Erase | Word | 6 | 555h | AAh | 2AAh | 55h | 555h | 80h | 555h | AAh | 2AAh | 55h | 555h | 10h |
| | Byte | | AAAh | | 555h | | AAAh | | AAAh | | 555h | | AAAh | |
| Sector Erase | Word | 6 | 555h | AAh | 2AAh | 55h | 555h | 80h | 555h | AAh | 2AAh | 55h | SA | 30h |
| | Byte | | AAAh | | 555h | | AAAh | | AAAh | | 555h | | | |
| Erase Suspend | | 1 | XXXh | B0h | — | — | — | — | — | — | — | — | — | — |
| Erase Resume | | 1 | XXXh | 30h | — | — | — | — | — | — | — | — | — | — |
| Set to Fast Mode | Word | 3 | 555h | AAh | 2AAh | 55h | 555h | 20h | — | — | — | — | — | — |
| | Byte | | AAAh | | 555h | | AAAh | | | | | | | |
| Fast Program *1 | Word | 2 | XXXh | A0h | PA | PD | — | — | — | — | — | — | — | — |
| | Byte | | XXXh | | | | | | | | | | | |
| Reset from Fast Mode *1 | Word | 2 | XXXh | 90h | XXXh | *4 F0h | — | — | — | — | — | — | — | — |
| | Byte | | XXXh | | XXXh | | | | | | | | | |
| Extended Sector Protection *2 | Word | 4 | XXXh | 60h | SPA | 60h | SPA | 40h | SPA | SD | — | — | — | — |
| | Byte | | | | | | | | | | | | | |
| Query *3 | Word | 1 | 55h | 98h | — | — | — | — | — | — | — | — | — | — |
| | Byte | | AAh | | | | | | | | | | | |

*1: This command is valid while Fast Mode.

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

*3: The valid addresses are $A_6$ to $A_0$. The other addresses are "Don't care".

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

Notes : • Address bits $A_{19}$ to $A_{11}$ = X = "H" or "L" for all address commands except or Program Address (PA) and Sector Address (SA).
• Bus operations are defined in "MBM29LV160TE/BE User Bus Operation ($\overline{BYTE}$ = $V_{IH}$) and ($\overline{BYTE}$ = $V_{IL}$)" Tables in "■DEVICE BUS OPERATIONS".

- 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 $\overline{WE}$ pulse.
  SA =Address of the sector to be erased. The combination of $A_{19}$, $A_{18}$, $A_{17}$, $A_{16}$, $A_{15}$, $A_{14}$, $A_{13}$, and $A_{12}$ will uniquely select any sector.
- RD =Data read from location RA during read operation.
  PD =Data to be programmed at location PA. Data is latched on the rising edge of $\overline{WE}$.
- SPA =Sector address to be protected. Set sector address (SA) and ($A_6$, $A_1$, $A_0$) = (0, 1, 0).
  SD =Sector protection verify data. Output 01h at protected sector addressed and output 00h at unprotected sector addresses.
- The system should generate the following address patterns:
  Word Mode: 555h or 2AAh to addresses $A_0$ to $A_{10}$
  Byte Mode: AAAh or 555h to addresses $A_{-1}$ to $A_{10}$
- Both Read/Reset commands are functionally equivalent, resetting the device to the read mode.
- The command combinations not described in "MBM29LV160TE/BE Standard Command Definitions" are illegal.

**MBM29LV160TE/BE Sector Protection Verify Autoselect Code**

| Type | | | $A_{19}$ to $A_{12}$ | $A_6$ | $A_1$ | $A_0$ | $A_{-1}$*1 | Code (HEX) |
|---|---|---|---|---|---|---|---|---|
| Manufacture's Code | | | X | $V_{IL}$ | $V_{IL}$ | $V_{IL}$ | $V_{IL}$ | 04h |
| Device Code | MBM29LV160TE | Byte | X | $V_{IL}$ | $V_{IL}$ | $V_{IH}$ | $V_{IL}$ | C4h |
| | | Word | | | | | X | 22C4h |
| | MBM29LV160BE | Byte | X | $V_{IL}$ | $V_{IL}$ | $V_{IH}$ | $V_{IL}$ | 49h |
| | | Word | | | | | X | 2249h |
| Sector Protection | | | Sector Addresses | $V_{IL}$ | $V_{IH}$ | $V_{IL}$ | $V_{IL}$ | 01h*2 |

*1: $A_{-1}$ is for Byte mode.

*2: Outputs 01h at protected sector addresses and outputs 00h at unprotected sector addresses.

**Expanded Autoselect Code Table**

| Type | | | Code | $DQ_{15}$ | $DQ_{14}$ | $DQ_{13}$ | $DQ_{12}$ | $DQ_{11}$ | $DQ_{10}$ | $DQ_9$ | $DQ_8$ | $DQ_7$ | $DQ_6$ | $DQ_5$ | $DQ_4$ | $DQ_3$ | $DQ_2$ | $DQ_1$ | $DQ_0$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Manufacture's Code* | | | 04h | $A_{-1}$/0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| Device Code | MBM29LV160TE | (B) | C4h | $A_{-1}$ | HI-Z | HI-Z | HI-Z | HI-Z | HI-Z | HI-Z | HI-Z | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 |
| | | (W) | 22C4h | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 |
| | MBM29LV160BE | (B) | 49h | $A_{-1}$ | HI-Z | HI-Z | HI-Z | HI-Z | HI-Z | HI-Z | HI-Z | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 |
| | | (W) | 2249h | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 |
| Sector Protection* | | | 01h | $A_{-1}$/0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |

(B): Byte mode
(W): Word mode
HI-Z: High-Z

* : At byte mode, $DQ_{14}$ to $DQ_8$ are High-Z and $DQ_{15}$ is $A_{-1}$, the lowest address.

## ■ FLEXIBLE SECTOR-ERASE ARCHITECTURE

- One 8K word, two 4K words, one 16K word, and thirty-one 32K words sectors in word mode.
- One 16K byte, two 8K bytes, one 32K byte, and thirty-one 64K bytes sectors in byte mode.
- Individual-sector, multiple-sector, or bulk-erase capability.
- Individual or multiple-sector protection is user definable.

**MBM29LV160TE Top Boot Sector Architecture**

| Sector | Sector Size | (× 8) Address Range | (× 16) Address Range |
|---|---|---|---|
| SA0 | 64 Kbytes or 32 Kwords | 00000h to 0FFFFh | 00000h to 07FFFh |
| SA1 | 64 Kbytes or 32 Kwords | 10000h to 1FFFFh | 08000h to 0FFFFh |
| SA2 | 64 Kbytes or 32 Kwords | 20000h to 2FFFFh | 10000h to 17FFFh |
| SA3 | 64 Kbytes or 32 Kwords | 30000h to 3FFFFh | 18000h to 1FFFFh |
| SA4 | 64 Kbytes or 32 Kwords | 40000h to 4FFFFh | 20000h to 27FFFh |
| SA5 | 64 Kbytes or 32 Kwords | 50000h to 5FFFFh | 28000h to 2FFFFh |
| SA6 | 64 Kbytes or 32 Kwords | 60000h to 6FFFFh | 30000h to 37FFFh |
| SA7 | 64 Kbytes or 32 Kwords | 70000h to 7FFFFh | 38000h to 3FFFFh |
| SA8 | 64 Kbytes or 32 Kwords | 80000h to 8FFFFh | 40000h to 47FFFh |
| SA9 | 64 Kbytes or 32 Kwords | 90000h to 9FFFFh | 48000h to 4FFFFh |
| SA10 | 64 Kbytes or 32 Kwords | A0000h to AFFFFh | 50000h to 57FFFh |
| SA11 | 64 Kbytes or 32 Kwords | B0000h to BFFFFh | 58000h to 5FFFFh |
| SA12 | 64 Kbytes or 32 Kwords | C0000h to CFFFFh | 60000h to 67FFFh |
| SA13 | 64 Kbytes or 32 Kwords | D0000h to DFFFFh | 68000h to 6FFFFh |
| SA14 | 64 Kbytes or 32 Kwords | E0000h to EFFFFh | 70000h to 77FFFh |
| SA15 | 64 Kbytes or 32 Kwords | F0000h to FFFFFh | 78000h to 7FFFFh |
| SA16 | 64 Kbytes or 32 Kwords | 100000h to 10FFFFh | 80000h to 87FFFh |
| SA17 | 64 Kbytes or 32 Kwords | 110000h to 11FFFFh | 88000h to 8FFFFh |
| SA18 | 64 Kbytes or 32 Kwords | 120000h to 12FFFFh | 90000h to 97FFFh |
| SA19 | 64 Kbytes or 32 Kwords | 130000h to 13FFFFh | 98000h to 9FFFFh |
| SA20 | 64 Kbytes or 32 Kwords | 140000h to 14FFFFh | A0000h to A7FFFh |
| SA21 | 64 Kbytes or 32 Kwords | 150000h to 15FFFFh | A8000h to AFFFFh |
| SA22 | 64 Kbytes or 32 Kwords | 160000h to 16FFFFh | B0000h to B7FFFh |
| SA23 | 64 Kbytes or 32 Kwords | 170000h to 17FFFFh | B8000h to BFFFFh |
| SA24 | 64 Kbytes or 32 Kwords | 180000h to 18FFFFh | C0000h to C7FFFh |
| SA25 | 64 Kbytes or 32 Kwords | 190000h to 19FFFFh | C8000h to CFFFFh |
| SA26 | 64 Kbytes or 32 Kwords | 1A0000h to 1AFFFFh | D0000h to D7FFFh |
| SA27 | 64 Kbytes or 32 Kwords | 1B0000h to 1BFFFFh | D8000h to DFFFFh |
| SA28 | 64 Kbytes or 32 Kwords | 1C0000h to 1CFFFFh | E0000h to E7FFFh |
| SA29 | 64 Kbytes or 32 Kwords | 1D0000h to 1DFFFFh | E8000h to EFFFFh |
| SA30 | 64 Kbytes or 32 Kwords | 1E0000h to 1EFFFFh | F0000h to F7FFFh |
| SA31 | 32 Kbytes or 16 Kwords | 1F0000h to 1F7FFFh | F8000h to FBFFFh |
| SA32 | 8 Kbytes or 4 Kwords | 1F8000h to 1F9FFFh | FC000h to FCFFFh |
| SA33 | 8 Kbytes or 4 Kwords | 1FA000h to 1FBFFFh | FD000h to FDFFFh |
| SA34 | 16 Kbytes or 8 Kwords | 1FC000h to 1FFFFFh | FE000h to FFFFFh |

**MBM29LV160BE Bottom Boot Sector Architecture**

| Sector | Sector Size | (× 8) Address Range | (× 16) Address Range |
|---|---|---|---|
| SA0 | 16 Kbytes or 8 Kwords | 00000h to 03FFFh | 00000h to 01FFFh |
| SA1 | 8 Kbytes or 4 Kwords | 04000h to 05FFFh | 02000h to 02FFFh |
| SA2 | 8 Kbytes or 4 Kwords | 06000h to 07FFFh | 03000h to 03FFFh |
| SA3 | 32 Kbytes or 16 Kwords | 08000h to 0FFFFh | 04000h to 07FFFh |
| SA4 | 64 Kbytes or 32 Kwords | 10000h to 1FFFFh | 08000h to 0FFFFh |
| SA5 | 64 Kbytes or 32 Kwords | 20000h to 2FFFFh | 10000h to 17FFFh |
| SA6 | 64 Kbytes or 32 Kwords | 30000h to 3FFFFh | 18000h to 1FFFFh |
| SA7 | 64 Kbytes or 32 Kwords | 40000h to 4FFFFh | 20000h to 27FFFh |
| SA8 | 64 Kbytes or 32 Kwords | 50000h to 5FFFFh | 28000h to 2FFFFh |
| SA9 | 64 Kbytes or 32 Kwords | 60000h to 6FFFFh | 30000h to 37FFFh |
| SA10 | 64 Kbytes or 32 Kwords | 70000h to 7FFFFh | 38000h to 3FFFFh |
| SA11 | 64 Kbytes or 32 Kwords | 80000h to 8FFFFh | 40000h to 47FFFh |
| SA12 | 64 Kbytes or 32 Kwords | 90000h to 9FFFFh | 48000h to 4FFFFh |
| SA13 | 64 Kbytes or 32 Kwords | A0000h to AFFFFh | 50000h to 57FFFh |
| SA14 | 64 Kbytes or 32 Kwords | B0000h to BFFFFh | 58000h to 5FFFFh |
| SA15 | 64 Kbytes or 32 Kwords | C0000h to CFFFFh | 60000h to 67FFFh |
| SA16 | 64 Kbytes or 32 Kwords | D0000h to DFFFFh | 68000h to 6FFFFh |
| SA17 | 64 Kbytes or 32 Kwords | E0000h to EFFFFh | 70000h to 77FFFh |
| SA18 | 64 Kbytes or 32 Kwords | F0000h to FFFFFh | 78000h to 7FFFFh |
| SA19 | 64 Kbytes or 32 Kwords | 100000h to 10FFFFh | 80000h to 87FFFh |
| SA20 | 64 Kbytes or 32 Kwords | 110000h to 11FFFFh | 88000h to 8FFFFh |
| SA21 | 64 Kbytes or 32 Kwords | 120000h to 12FFFFh | 90000h to 97FFFh |
| SA22 | 64 Kbytes or 32 Kwords | 130000h to 13FFFFh | 98000h to 9FFFFh |
| SA23 | 64 Kbytes or 32 Kwords | 140000h to 14FFFFh | A0000h to A7FFFh |
| SA24 | 64 Kbytes or 32 Kwords | 150000h to 15FFFFh | A8000h to AFFFFh |
| SA25 | 64 Kbytes or 32 Kwords | 160000h to 16FFFFh | B0000h to B7FFFh |
| SA26 | 64 Kbytes or 32 Kwords | 170000h to 17FFFFh | B8000h to BFFFFh |
| SA27 | 64 Kbytes or 32 Kwords | 180000h to 18FFFFh | C0000h to C7FFFh |
| SA28 | 64 Kbytes or 32 Kwords | 190000h to 19FFFFh | C8000h to CFFFFh |
| SA29 | 64 Kbytes or 32 Kwords | 1A0000h to 1AFFFFh | D0000h to D7FFFh |
| SA30 | 64 Kbytes or 32 Kwords | 1B0000h to 1BFFFFh | D8000h to DFFFFh |
| SA31 | 64 Kbytes or 32 Kwords | 1C0000h to 1CFFFFh | E0000h to E7FFFh |
| SA32 | 64 Kbytes or 32 Kwords | 1D0000h to 1DFFFFh | E8000h to EFFFFh |
| SA33 | 64 Kbytes or 32 Kwords | 1E0000h to 1EFFFFh | F0000h to F7FFFh |
| SA34 | 64 Kbytes or 32 Kwords | 1F0000h to 1FFFFFh | F8000h to FFFFFh |

**Sector Address Table (MBM29LV160TE)**

| Sector Address | $A_{19}$ | $A_{18}$ | $A_{17}$ | $A_{16}$ | $A_{15}$ | $A_{14}$ | $A_{13}$ | $A_{12}$ | (× 8) Address Range | (× 16) Address Range |
|---|---|---|---|---|---|---|---|---|---|---|
| SA0 | 0 | 0 | 0 | 0 | 0 | X | X | X | 00000h to 0FFFFh | 00000h to 07FFFh |
| SA1 | 0 | 0 | 0 | 0 | 1 | X | X | X | 10000h to 1FFFFh | 08000h to 0FFFFh |
| SA2 | 0 | 0 | 0 | 1 | 0 | X | X | X | 20000h to 2FFFFh | 10000h to 17FFFh |
| SA3 | 0 | 0 | 0 | 1 | 1 | X | X | X | 30000h to 3FFFFh | 18000h to 1FFFFh |
| SA4 | 0 | 0 | 1 | 0 | 0 | X | X | X | 40000h to 4FFFFh | 20000h to 27FFFh |
| SA5 | 0 | 0 | 1 | 0 | 1 | X | X | X | 50000h to 5FFFFh | 28000h to 2FFFFh |
| SA6 | 0 | 0 | 1 | 1 | 0 | X | X | X | 60000h to 6FFFFh | 30000h to 37FFFh |
| SA7 | 0 | 0 | 1 | 1 | 1 | X | X | X | 70000h to 7FFFFh | 38000h to 3FFFFh |
| SA8 | 0 | 1 | 0 | 0 | 0 | X | X | X | 80000h to 8FFFFh | 40000h to 47FFFh |
| SA9 | 0 | 1 | 0 | 0 | 1 | X | X | X | 90000h to 9FFFFh | 48000h to 4FFFFh |
| SA10 | 0 | 1 | 0 | 1 | 0 | X | X | X | A0000h to AFFFFh | 50000h to 57FFFh |
| SA11 | 0 | 1 | 0 | 1 | 1 | X | X | X | B0000h to BFFFFh | 58000h to 5FFFFh |
| SA12 | 0 | 1 | 1 | 0 | 0 | X | X | X | C0000h to CFFFFh | 60000h to 67FFFh |
| SA13 | 0 | 1 | 1 | 0 | 1 | X | X | X | D0000h to DFFFFh | 68000h to 6FFFFh |
| SA14 | 0 | 1 | 1 | 1 | 0 | X | X | X | E0000h to EFFFFh | 70000h to 77FFFh |
| SA15 | 0 | 1 | 1 | 1 | 1 | X | X | X | F0000h to FFFFFh | 78000h to 7FFFFh |
| SA16 | 1 | 0 | 0 | 0 | 0 | X | X | X | 100000h to 10FFFFh | 80000h to 87FFFh |
| SA17 | 1 | 0 | 0 | 0 | 1 | X | X | X | 110000h to 11FFFFh | 88000h to 8FFFFh |
| SA18 | 1 | 0 | 0 | 1 | 0 | X | X | X | 120000h to 12FFFFh | 90000h to 97FFFh |
| SA19 | 1 | 0 | 0 | 1 | 1 | X | X | X | 130000h to 13FFFFh | 98000h to 9FFFFh |
| SA20 | 1 | 0 | 1 | 0 | 0 | X | X | X | 140000h to 14FFFFh | A0000h to A7FFFh |
| SA21 | 1 | 0 | 1 | 0 | 1 | X | X | X | 150000h to 15FFFFh | A8000h to AFFFFh |
| SA22 | 1 | 0 | 1 | 1 | 0 | X | X | X | 160000h to 16FFFFh | B0000h to B7FFFh |
| SA23 | 1 | 0 | 1 | 1 | 1 | X | X | X | 170000h to 17FFFFh | B8000h to BFFFFh |
| SA24 | 1 | 1 | 0 | 0 | 0 | X | X | X | 180000h to 18FFFFh | C0000h to C7FFFh |
| SA25 | 1 | 1 | 0 | 0 | 1 | X | X | X | 190000h to 19FFFFh | C8000h to CFFFFh |
| SA26 | 1 | 1 | 0 | 1 | 0 | X | X | X | 1A0000h to 1AFFFFh | D0000h to D7FFFh |
| SA27 | 1 | 1 | 0 | 1 | 1 | X | X | X | 1B0000h to 1BFFFFh | D8000h to DFFFFh |
| SA28 | 1 | 1 | 1 | 0 | 0 | X | X | X | 1C0000h to 1CFFFFh | E0000h to E7FFFh |
| SA29 | 1 | 1 | 1 | 0 | 1 | X | X | X | 1D0000h to 1DFFFFh | E8000h to EFFFFh |
| SA30 | 1 | 1 | 1 | 1 | 0 | X | X | X | 1E0000h to 1EFFFFh | F0000h to F7FFFh |
| SA31 | 1 | 1 | 1 | 1 | 1 | 0 | X | X | 1F0000h to 1F7FFFh | F8000h to FBFFFh |
| SA32 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 1F8000h to 1F9FFFh | FC000h to FCFFFh |
| SA33 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1FA000h to 1FBFFFh | FD000h to FDFFFh |
| SA34 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | X | 1FC000h to 1FFFFFh | FE000h to FEFFFh |

**Sector Address Table (MBM29LV160BE)**

| Sector Address | $A_{19}$ | $A_{18}$ | $A_{17}$ | $A_{16}$ | $A_{15}$ | $A_{14}$ | $A_{13}$ | $A_{12}$ | (× 8) Address Range | (× 16) Address Range |
|---|---|---|---|---|---|---|---|---|---|---|
| SA0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | X | 00000h to 03FFFh | 00000h to 01FFFh |
| SA1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 04000h to 05FFFh | 02000h to 02FFFh |
| SA2 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 06000h to 07FFFh | 03000h to 03FFFh |
| SA3 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | X | 08000h to 0FFFFh | 04000h to 07FFFh |
| SA4 | 0 | 0 | 0 | 0 | 1 | X | X | X | 10000h to 1FFFFh | 08000h to 0FFFFh |
| SA5 | 0 | 0 | 0 | 1 | 0 | X | X | X | 20000h to 2FFFFh | 10000h to 17FFFh |
| SA6 | 0 | 0 | 0 | 1 | 1 | X | X | X | 30000h to 3FFFFh | 18000h to 1FFFFh |
| SA7 | 0 | 0 | 1 | 0 | 0 | X | X | X | 40000h to 4FFFFh | 20000h to 27FFFh |
| SA8 | 0 | 0 | 1 | 0 | 1 | X | X | X | 50000h to 5FFFFh | 28000h to 2FFFFh |
| SA9 | 0 | 0 | 1 | 1 | 0 | X | X | X | 60000h to 6FFFFh | 30000h to 37FFFh |
| SA10 | 0 | 0 | 1 | 1 | 1 | X | X | X | 70000h to 7FFFFh | 38000h to 3FFFFh |
| SA11 | 0 | 1 | 0 | 0 | 0 | X | X | X | 80000h to 8FFFFh | 40000h to 47FFFh |
| SA12 | 0 | 1 | 0 | 0 | 1 | X | X | X | 90000h to 9FFFFh | 48000h to 4FFFFh |
| SA13 | 0 | 1 | 0 | 1 | 0 | X | X | X | A0000h to AFFFFh | 50000h to 57FFFh |
| SA14 | 0 | 1 | 0 | 1 | 1 | X | X | X | B0000h to BFFFFh | 58000h to 5FFFFh |
| SA15 | 0 | 1 | 1 | 0 | 0 | X | X | X | C0000h to CFFFFh | 60000h to 67FFFh |
| SA16 | 0 | 1 | 1 | 0 | 1 | X | X | X | D0000h to DFFFFh | 68000h to 6FFFFh |
| SA17 | 0 | 1 | 1 | 1 | 0 | X | X | X | E0000h to EFFFFh | 70000h to 77FFFh |
| SA18 | 0 | 1 | 1 | 1 | 1 | X | X | X | F0000h to FFFFFh | 78000h to 7FFFFh |
| SA19 | 1 | 0 | 0 | 0 | 0 | X | X | X | 100000h to 1FFFFFh | 80000h to 87FFFh |
| SA20 | 1 | 0 | 0 | 0 | 1 | X | X | X | 110000h to 11FFFFh | 88000h to 8FFFFh |
| SA21 | 1 | 0 | 0 | 1 | 0 | X | X | X | 120000h to 12FFFFh | 90000h to 97FFFh |
| SA22 | 1 | 0 | 0 | 1 | 1 | X | X | X | 130000h to 13FFFFh | 98000h to 9FFFFh |
| SA23 | 1 | 0 | 1 | 0 | 0 | X | X | X | 140000h to 14FFFFh | A0000h to A7FFFh |
| SA24 | 1 | 0 | 1 | 0 | 1 | X | X | X | 150000h to 15FFFFh | A8000h to 8FFFFh |
| SA25 | 1 | 0 | 1 | 1 | 0 | X | X | X | 160000h to 16FFFFh | B0000h to B7FFFh |
| SA26 | 1 | 0 | 1 | 1 | 1 | X | X | X | 170000h to 17FFFFh | B8000h to BFFFFh |
| SA27 | 1 | 1 | 0 | 0 | 0 | X | X | X | 180000h to 18FFFFh | C0000h to C7FFFh |
| SA28 | 1 | 1 | 0 | 0 | 1 | X | X | X | 190000h to 19FFFFh | C8000h to CFFFFh |
| SA29 | 1 | 1 | 0 | 1 | 0 | X | X | X | 1A0000h to 1AFFFFh | D0000h to D7FFFh |
| SA30 | 1 | 1 | 0 | 1 | 1 | X | X | X | 1B0000h to 1BFFFFh | D8000h to DFFFFh |
| SA31 | 1 | 1 | 1 | 0 | 0 | X | X | X | 1C0000h to 1CFFFFh | E0000h to E7FFFh |
| SA32 | 1 | 1 | 1 | 0 | 1 | X | X | X | 1D0000h to 1DFFFFh | E8000h to EFFFFh |
| SA33 | 1 | 1 | 1 | 1 | 0 | X | X | X | 1E0000h to 1EFFFFh | F0000h to F7FFFh |
| SA34 | 1 | 1 | 1 | 1 | 1 | X | X | X | 1F0000h to 1FFFFFh | F8000h to FFFFFh |

## Common Flash Memory Interface Code

| Description | $A_6$ to $A_0$ | $DQ_{15}$ to $DQ_0$ |
|---|---|---|
| Query-unique ASCII string "QRY" | 10h<br>11h<br>12h | 0051h<br>0052h<br>0059h |
| Primary OEM Command Set<br>02h: AMD/FJ standard type | 13h<br>14h | 0002h<br>0000h |
| Address for Primary Extended Table | 15h<br>16h | 0040h<br>0000h |
| Alternate OEM Command Set<br>(00h = not applicable) | 17h<br>18h | 0000h<br>0000h |
| Address for Alternate OEM Extended Table | 19h<br>1Ah | 0000h<br>0000h |
| $V_{CC}$ Min voltage (write/erase)<br>$DQ_7$ to $DQ_4$ : 1 V,<br>$DQ_3$ to $DQ_0$ : 100 mV | 1Bh | 0027h |
| $V_{CC}$ Max voltage (write/erase)<br>$DQ_7$ to $DQ_4$ : 1 V,<br>$DQ_3$ to $DQ_0$ : 100 mV | 1Ch | 0036h |
| $V_{PP}$ Min voltage | 1Dh | 0000h |
| $V_{PP}$ Max voltage | 1Eh | 0000h |
| Typical timeout per single byte/word write $2^N$ µs | 1Fh | 0004h |
| Typical timeout for Min size buffer write $2^N$ µs | 20h | 0000h |
| Typical timeout per individual block erase $2^N$ ms | 21h | 000Ah |
| Typical timeout for full chip erase $2^N$ ms | 22h | 0000h |
| Max timeout for byte/word write $2^N$ times typical | 23h | 0005h |
| Max timeout for buffer write $2^N$ times typical | 24h | 0000h |
| Max timeout per individual block erase $2^N$ times typical | 25h | 0004h |
| Max timeout for full chip erase $2^N$ times typical | 26h | 0000h |
| Device Size = $2^N$ byte | 27h | 0015h |
| Flash Device Interface description<br>02h : × 8/ × 16 | 28h<br>29h | 0002h<br>0000h |
| Max number of byte in multi-byte write = $2^N$ | 2Ah<br>2Bh | 0000h<br>0000h |
| Number of Erase Block Regions within device | 2Ch | 0004h |

| Description | $A_6$ to $A_0$ | $DQ_{15}$ to $DQ_0$ |
|---|---|---|
| Erase Block Region 1 Information<br>$bit_{15}$ to $bit_0$ : y = number of sectors<br>$bit_{31}$ to $bit_{16}$ : Z = size<br>(Z × 256 bytes) | 2Dh<br>2Eh<br>2Fh<br>30h | 0000h<br>0000h<br>0040h<br>0000h |
| Erase Block Region 2 Information<br>$bit_{15}$ to $bit_0$ : y = number of sectors<br>$bit_{31}$ to $bit_{16}$ : Z = size<br>(Z × 256 bytes) | 31h<br>32h<br>33h<br>34h | 0001h<br>0000h<br>0020h<br>0000h |
| Erase Block Region 3 Information<br>$bit_{15}$ to $bit_0$ : y = number of sectors<br>$bit_{31}$ to $bit_{16}$ : Z = size<br>(Z × 256 bytes) | 35h<br>36h<br>37h<br>38h | 0000h<br>0000h<br>0080h<br>0000h |
| Erase Block Region 4 Information<br>$bit_{15}$ to $bit_0$ : y = number of sectors<br>$bit_{31}$ to $bit_{16}$ : Z = size<br>(Z × 256 bytes) | 39h<br>3Ah<br>3Bh<br>3Ch | 001Eh<br>0000h<br>0000h<br>0001h |
| Query-unique ASCII string "PRI" | 40h<br>41h<br>42h | 0050h<br>0052h<br>0049h |
| Major version number, ASCII | 43h | 0031h |
| Minor version number, ASCII | 44h | 0031h |
| Address Sensitive Unlock<br>00h = Required | 45h | 0000h |
| Erase Suspend<br>02h = To Read & Write | 46h | 0002h |
| Sector Protect<br>00h = Not Supported<br>X = Number of sectors in per group | 47h | 0001h |
| Sector Temporary Unprotect<br>01h = Supported | 48h | 0001h |
| Sector Protection Algorithm | 49h | 04h |
| Number of Sector for Bank 2<br>00h = Not Supported | 4Ah | 00h |
| Burst Mode Type<br>00h = Not Supported | 4Bh | 00h |
| Page Mode Type<br>00h = Not Supported | 4Ch | 00h |

## ■ FUNCTIONAL DESCRIPTION

### • Read Mode

The MBM29LV160TE/BE has two control functions which must be satisfied in order to obtain 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 to 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 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 a data without changing addresses after power-up, it is necessary to input hardware reset or to change $\overline{CE}$ pin from “H” or “L”.

### • Standby Mode

There are two ways to implement the standby mode on the MBM29LV160TE/BE devices. One is by 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 $V_{CC}$ ±0.3 V. Under this condition the current consumed is less than 5 μA 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 the $\overline{RESET}$ input held at $V_{SS}$ ±0.3 V ($\overline{CE}$ = “H” or “L”). Under this condition the current consumed is less than 5 μA Max Once the $\overline{RESET}$ pin is taken high, the device requires $t_{RH}$ of wake up time before outputs are valid for read access.
In the standby mode, the outputs are in the high-impedance state, independent of the $\overline{OE}$ input.

### • Automatic Sleep Mode

There is a function called automatic sleep mode to restrain power consumption during read-out of MBM29LV160TE/BE data. This mode can be used effectively with an application requesting low power consumption such as handy terminals.
To activate this mode, MBM29LV160TE/BE automatically switches itself to low power mode when addresses remain stable for 150 ns. It is not necessary to control $\overline{CE}$, $\overline{WE}$, and $\overline{OE}$ in this mode. During such mode, the current consumed is typically 1 μA (CMOS Level).
Standard address access timings provide new data when addresses are changed. While in sleep mode, output data is latched and always available to the system.

### • Output Disable

If the $\overline{OE}$ input is 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. The intent is to allow programming equipment to automatically match the device to be programmed with its corresponding programming algorithm. The Autoselect command may also be used to check the status of write-protected sectors. (See “MBM29LV160TE/BE Sector Protection Verify Autoselect Code” and “Expanded Autoselect Code” Tables in “■FLEXIBLE SECTOR-ERASE ARCHITECTURE”.) This mode is functional over the entire temperature range of the device.
To activate this mode, the programming equipment must force $V_{ID}$ (11.5 V to 12.5 V) on address pin $A_9$. Two identifier bytes may then be sequenced from the devices outputs by toggling address $A_0$ from $V_{IL}$ to $V_{IH}$. All addresses are DON’T CARES except $A_0$, $A_1$, and $A_6$ ($A_{-1}$). (See “MBM29LV160TE/BE User Bus Operation ($\overline{BYTE}$ = $V_{IH}$) or ($\overline{BYTE}$ = $V_{IL}$)” Tables in “■DEVICE BUS OPERATIONS”) .
The manufacturer and device codes may also be read via the command register, for instances when the MBM29LV160TE/BE is erased or programmed in a system without access to high voltage on the $A_9$ pin. The

command sequence is illustrated in “MBM29LV160TE/BE Standard Command Definitions” Table.
Byte 0 ($A_0 = V_{IL}$) represents the manufacture’s code and byte 1 ($A_0 = V_{IH}$) represents the device identifier code. For the MBM29LV160TE/BE these two bytes are given in the Expanded Autoselect Code Table. All identifiers for manufactures and device will exhibit odd parity with $DQ_7$ defined as the parity bit. In order to read the proper device codes when executing the Autoselect, $A_1$ must be $V_{IL}$. (See “MBM29LV160TE/BE User Bus Operation ($\overline{BYTE} = V_{IH}$) or ($\overline{BYTE} = V_{IL}$)” Tables in “■DEVICE BUS OPERATIONS”.) For device identification in word mode ($\overline{BYTE} = V_{IH}$), $DQ_9$ and $DQ_{13}$ are equal to ‘1’ and $DQ_8$, $DQ_{10}$ to $DQ_{12}$, $DQ_{14}$, and $DQ_{15}$ are equal to ‘0’.
If $\overline{BYTE} = V_{IL}$ (for byte mode), the device code is C4h (for top boot block) or 49h (for bottom boot block). If $\overline{BYTE} = V_{IH}$ (for word mode), the device code is 22C4h (for top boot block) or 2249h (for bottom boot block).
In order to determine which sectors are write protected, $A_1$ must be at $V_{IH}$ while running through the sector addresses; if the selected sector is protected, a logical ‘1’ will be output on $DQ_0$ ($DQ_0$ =1).

### • 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 Protection

The MBM29LV160TE/BE features hardware sector protection. This feature will disable both program and erase operations in any number of sectors (0 through 34). The sector protection feature is enabled using programming equipment at the user’s site. The device is shipped with all sectors unprotected.
To activate this mode, the programming equipment must force $V_{ID}$ on address pin $A_9$ and control pin $\overline{OE}$, $\overline{CE} = V_{IL}$, $A_0 = A_6 = V_{IL}$, $A_1 = V_{IH}$. The sector addresses pins ($A_{19}$, $A_{18}$, $A_{17}$, $A_{16}$, $A_{15}$, $A_{14}$, $A_{13}$, and $A_{12}$) should be set to the sector to be protected. MBM29LV160TE’s/BE’s “Sector Address Table” define the sector address for each of the thirty five (35) individual 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 addresses must be held constant during the $\overline{WE}$ pulse. See “Sector Protection Timing Diagram” in “■TIMING DIAGRAM” and “Sector Protection Algorithm” in “■FLOW CHART” for sector 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 addresses ($A_{19}$, $A_{18}$, $A_{17}$, $A_{16}$, $A_{15}$, $A_{14}$, $A_{13}$, and $A_{12}$) while ($A_6$, $A_1$, $A_0$) = (0, 1, 0) will produce a logical “1” at device output $DQ_0$ for a protected sector. Otherwise the device will read 00h for an unprotected sector. In this mode, the lower order addresses, except for $A_0$, $A_1$, and $A_6$ are DON’T CARES. Address locations with $A_1 = V_{IL}$ are reserved for Autoselect manufacturer and device codes. $A_{-1}$ requires to $V_{IL}$ in byte mode.
It is also possible to determine if a sector is protected in the system by writing an Autoselect command. Performing a read operation at the address location XX02h, where the higher order addresses pins ($A_{19}$, $A_{18}$, $A_{17}$, $A_{16}$, $A_{15}$, $A_{14}$, $A_{13}$, and $A_{12}$) represents the sector address will produce a logical “1” at $DQ_0$ for a protected sector. See “MBM29LV160TE/BE Sector Protection Verify Autoselect Code and Expanded Autoselect Code” Tables for Autoselect codes.

### • Temporary Sector Unprotection

This feature allows temporary unprotection of previously protected sectors of the MBM29LV160TE/BE devices in order to change data. The Sector Unprotection mode is activated by setting the $\overline{RESET}$ pin to high voltage ($V_{ID}$). During this mode, formerly protected sectors can be programmed or erased by selecting the sector addresses. Once the $V_{ID}$ is taken away from the $\overline{RESET}$ pin, all the previously protected sectors will be protected again. (See “Temporary Sector Unprotection Timing Diagram” in “■TIMING DIAGRAM” and “Temporary Sector Unprotection Algorithm” in “■FLOW CHART”.)

## ■ COMMAND DEFINITIONS

Device operations are selected by writing specific address and data sequences into the command register. Writing incorrect address and data values or writing them in an improper sequence will reset the device to the read mode. “MBM29LV160TE/BE Standard Command Definitions” Table in “■FLEXIBLE SECTOR-ERASE ARCHITECTURE” 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 $DQ_7$ to $DQ_0$ and $DQ_{15}$ to $DQ_8$ bits are ignored.

### • Read/Reset Command

In order to return from Autoselect mode or Exceeded Timing Limits ($DQ_5$ = 1) to read 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 contents occurs during the power transition. Refer to the AC Read Characteristics and Waveforms for specific timing parameters. (See “Read Operation Timing Diagram” in “■TIMING DIAGRAM”.)

### • Autoselect Command

Flash memories are intended for use in applications where the local CPU alters memory contents. As such, manufactures and device codes must be accessible while the device resides in the target system. PROM programmers typically access the signature codes by raising $A_9$ 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. Following the last command write, a read cycle from address XX00h retrieves the manufacture code of 04h. A read cycle from address XX01h for ×16 (XX02h for ×8) retrieves the device code (MBM29LV160TE = C4h and MBM29LV160BE = 49h for ×8 mode; MBM29LV160TE = 22C4h and MBM29LV160BE = 2249h for ×16 mode). (See “MBM29LV160TE/BE Sector Protection Verify Autoselect Code and Expanded Autoselect Code” Tables in “■FLEXIBLE SECTOR-ERASE ARCHITECTURE”.)
All manufactures and device codes will exhibit odd parity with $DQ_7$ defined as the parity bit.
The sector state (protection or unprotection) will be indicated by address XX02h for ×16 (XX04h for ×8).
Scanning the sector addresses ($A_{19}$, $A_{18}$, $A_{17}$, $A_{16}$, $A_{15}$, $A_{14}$, $A_{13}$, and $A_{12}$) while ($A_6$, $A_1$, $A_0$) = (0, 1, 0) will produce a logical “1” at device output $DQ_0$ for a protected sector. The programming verification should be perform margin mode verification on the protected sector. (See “MBM29LV160TE/BE User Bus Operation ($\overline{BYTE}$ = $V_{IH}$) and ($\overline{BYTE}$ = $V_{IL}$)” Tables in “■DEVICE BUS OPERATIONS”.)
To terminate the operation, it is necessary to write the Read/Reset command sequence into the register and, also to write the Autoselect command during the operation, by executing it after writing the Read/Reset command sequence.

### • Byte/Word Programming

The device is programmed on a byte-by-byte (or 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 the last $\overline{CE}$ 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 will automatically provide adequate internally generated program pulses and verify the programmed cell margin. (See “Alternate $\overline{WE}$ Controlled Program Operation Timing Diagram” and “Alternate $\overline{CE}$ Controlled Program Operation Timing Diagram” in “■TIMING DIAGRAM”.)

The automatic programming operation is completed when the data on $DQ_7$ is equivalent to data written to this bit at which time the device return to the read mode and addresses are no longer latched. (See “Hardware Sequence Flags” Table.) Therefore, the device requires that a valid address be supplied by the system at this time. Hence, $\overline{\text{Data}}$ Polling must be performed at the memory location which is being programmed.
Any commands written to the chip during this period will be ignored. If hardware reset occurs during the programming operation, it is impossible to guarantee whether the data being written is correct or not.
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 CHART” 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 automatic erase begins on the rising edge of the last $\overline{\text{WE}}$ pulse in the command sequence and terminates when the data on $DQ_7$ is “1” (See Write Operation Status section.) at which time the device returns to read mode. (See “Chip/Sector Erase Operation Timing Diagram” in “■TIMING DIAGRAM”.)
“Embedded Erase™ Algorithm” in “■FLOW CHART” 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, 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 $\overline{\text{WE}}$, while the command (Data = 30h) is latched on the rising edge of $\overline{\text{WE}}$. After a time-out of “$t_{TOW}$” from the rising edge of the last sector erase command, the sector erase operation will begin.
Multiple sectors may be erased concurrently by writing six-bus cycle operations on “MBM29LV160TE/BE Standard Command Definitions” Table in “■FLEXIBLE SECTOR-ERASE ARCHITECTURE”. 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 will 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 “$t_{TOW}$” from the rising edge of the last $\overline{\text{WE}}$ will initiate the execution of the Sector Erase command(s). If another falling edge of the $\overline{\text{WE}}$ occurs within the “$t_{TOW}$” 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.) Any command other than Sector Erase or Erase Suspend during this time-out period will reset the device to the read mode, ignoring the previous command string. 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 34).
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 automatic sector erase begins after the “$t_{TOW}$” time out from the rising edge of the $\overline{\text{WE}}$ pulse 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. $\overline{\text{Data}}$ polling must be performed at an address within any of

the sectors being erased. Multiple Sector Erase Time; [Sector Program Time (Preprogramming) + Sector Erase Time] × Number of Sector Erase.
"Embedded Erase™ Algorithm" in "■FLOW CHART" illustrates the Embedded Erase™ Algorithm using typical command strings and bus operations.

### • Erase Suspend/Resume

The Erase Suspend command allows the user to interrupt a Sector Erase operation and then perform data reads from or program 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. The Erase Suspend command will be ignored if written during the Chip Erase operation or Embedded Program Algorithm. Writing the Erase Suspend command 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 resumes the erase operation. The addresses are "DON'T CARES" when writing the Erase Suspend or Erase Resume commands.
When the Erase Suspend command is written during the Sector Erase operation, the device will take a maximum of "$t_{SPD}$" to suspend the erase operation. When the devices have entered the erase-suspended mode, the RY/$\overline{BY}$ output pin and the $DQ_7$ bit will be at logic "1", and $DQ_6$ will stop toggling. The user must use the address of the erasing sector for reading $DQ_6$ and $DQ_7$ to determine if the erase operation has been 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 $DQ_2$ to toggle. (See the section on $DQ_2$.)
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 devices are in the erase-suspend-program mode will cause $DQ_2$ to toggle. The end of the erase-suspended Program operation is detected by the RY/$\overline{BY}$ output pin, $\overline{Data}$ polling of $DQ_7$, or the Toggle Bit ($DQ_6$) which is the same as the regular Program operation. Note that $DQ_7$ must be read from the Program address while $DQ_6$ can be read from any address.
To resume the operation of Sector Erase, the Resume command (30h) should be written. Any further writes of the Resume command at this point will be ignored. Another Erase Suspend command can be written after the chip has resumed erasing.

### • Extended Command

(1) Fast Mode

MBM29LV160TE/BE has Fast Mode function. This mode dispenses with the initial two unlock cycles required in the standard program command sequence 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. The read operation is also executed after exiting this mode. During the Fast mode, do not write any command other than the Fast program/Fast mode reset command. To exit this mode, it is necessary to write Fast Mode Reset command into the command register. (Refer to the "Embedded Programming Algorithm for Fast Mode" in "■FLOW CHART" Extended algorithm.) 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 the "Embedded Programming Algorithm for Fast Mode" in "■FLOW CHART" Extended algorithm.)

(3) Extended Sector Protection

In addition to normal sector protection, the MBM29LV160TE/BE has Extended Sector Protection as extended function. This function enable to protect sector by forcing $V_{ID}$ on $\overline{RESET}$ pin and write a commnad 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 protection in this mode. The extended sector protect 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 addresses pins ($A_{19}$, $A_{18}$, $A_{17}$, $A_{16}$, $A_{15}$, $A_{14}$, $A_{13}$ and $A_{12}$) and ($A_6$, $A_1$, $A_0$) = (0, 1, 0) should be set to the sector to be protected (recommend to set $V_{IL}$ for the other addresses pins), and write extended sector protect command (60h). A sector is typically protected in 250 μs. To verify programming of the protection circuitry, the sector addresses pins ($A_{19}$, $A_{18}$, $A_{17}$, $A_{16}$, $A_{15}$, $A_{14}$, $A_{13}$ and $A_{12}$) and ($A_6$, $A_1$, $A_0$) = (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 data is logical “0”, please repeat to write extended sector protect command (60h) again. To terminate the operation, it is necessary to set $\overline{RESET}$ pin to $V_{IH}$.

(4) CFI (Common Flash Memory Interface)

The CFI (Common Flash Memory Interface) specification outlines device and host system software interrogation handshake which allows specific vendor-specified software algorithms to be used for entire families of devices. This allows device-independent, JEDEC ID-independent, and forward-and backward-compatible software support for the specified flash device families. Refer to CFI specification in detail.

The operation is initiated by writing the query command (98h) into the command register. Following the command write, a read cycle from specific address retrives device information. Please note that output data of upper byte ($DQ_{15}$ to $DQ_8$) is “0” in word mode (16 bit) read. Refer to the CFI code table. To terminate operation, it is necessary to write the read/reset command sequence into the register.

## • Write Operation Status

**Hardware Sequence Flags**

| Status | | | $DQ_7$ | $DQ_6$ | $DQ_5$ | $DQ_3$ | $DQ_2$ |
|---|---|---|---|---|---|---|---|
| In Progress | Embedded Program Algorithm | | $\overline{DQ_7}$ | Toggle | 0 | 0 | 1 |
| | Embedded/Erase Algorithm | | 0 | Toggle | 0 | 1 | Toggle |
| | Erase Suspend 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 *1 | 0 | 0 | 1 *2 |
| Exceeded Time Limits | Embedded Program Algorithm | | $\overline{DQ_7}$ | Toggle | 1 | 0 | 1 |
| | Embedded/Erase Algorithm | | 0 | Toggle | 1 | 1 | N/A |
| | Erase Suspend Program (Non-Erase Suspended Sector) | | $\overline{DQ_7}$ | Toggle | 1 | 0 | N/A |

*1 : Performing successive read operations from any address will cause $DQ_6$ to toggle.

*2 : Reading the byte address being programmed while in the erase-suspend program mode will indicate logic “1” at the $DQ_2$ bit. However, successive reads from the erase-suspended sector will cause $DQ_2$ to toggle.

Notes: • $DQ_0$ and $DQ_1$ are reserve pins for future use.
• $DQ_4$ is Fujitsu internal use only.

- **$DQ_7$**

### $\overline{\text{Data}}$ Polling

The MBM29LV160TE/BE 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 the devices will produce the complement of the data last written to $DQ_7$. Upon completion of the Embedded Program Algorithm, an attempt to read the device will produce the true data last written to $DQ_7$. During the Embedded Erase Algorithm, an attempt to read the device will produce a "0" at the $DQ_7$ output. Upon completion of the Embedded Erase Algorithm an attempt to read the device will produce a "1" at the $DQ_7$ output. The flowchart for $\overline{\text{Data}}$ Polling ($DQ_7$) is shown in "$\overline{\text{Data}}$ Polling Algorithm" in "■FLOW CHART".

For chip erase and sector erase, $\overline{\text{Data}}$ Polling is valid after the rising edge of the sixth $\overline{\text{WE}}$ pulse in the six-write pulse sequence. $\overline{\text{Data}}$ Polling must be performed at a sector address within any of the sectors being erased and not at a protected sector. Otherwise, the status may not be valid. Once the Embedded Algorithm operation is close to being completed, the MBM29LV160TE/BE data pins ($DQ_7$) may change asynchronously while the output enable ($\overline{\text{OE}}$) is asserted low. This means that the device is driving status information on $DQ_7$ 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 $DQ_7$ output, it may read the status or valid data. Even if the device has completed the Embedded Program Algorithm operation and $DQ_7$ has a valid data, the data outputs on $DQ_6$ to $DQ_0$ may be still invalid. The valid data on $DQ_7$ to $DQ_0$ will be read on successive read attempts.

The $\overline{\text{Data}}$ Polling feature is only active during the Embedded Programming Algorithm, Embedded Erase Algorithm or sector erase time-out.

See "$\overline{\text{Data}}$ Polling during Embedded Algorithm Operation Timing Diagram" in "■TIMING DIAGRAM" for the $\overline{\text{Data}}$ Polling timing specifications and diagram.

- **$DQ_6$**

### Toggle Bit I

The MBM29LV160TE/BE also feature the "Toggle Bit I" as a method to indicate to the host system that the Embedded Algorithms are in progress or completed.

During an Embedded Program or Erase Algorithm cycle, successive attempts to read ($\overline{\text{OE}}$ toggling) data from the device will result in $DQ_6$ toggling between one and zero. Once the Embedded Program or Erase Algorithm cycle is completed, $DQ_6$ will stop toggling and valid data can be read on the next successive attempts. During programming, the Toggle Bit I is valid after the rising edge of the fourth $\overline{\text{WE}}$ 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 $\overline{\text{WE}}$ 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 to is protected, the toggle bit will toggle for about 2 μs and then stop toggling without the data having changed. In erase, the device will erase all the selected sectors except for the ones that are protected. If all selected sectors are protected, the chip will toggle the Toggle Bit I for about 200 μs and then drop back into read mode, having changed none of the data.

Either $\overline{\text{CE}}$ or $\overline{\text{OE}}$ toggling will cause the $DQ_6$ to toggle. In addition, an Erase Suspend/Resume command will cause the $DQ_6$ to toggle.

See "Toggle Bit I during Embedded Algorithm Operation Timing Diagram" in "■TIMING DIAGRAM" and "Toggle Bit Algorithm" in "■FLOW CHART" for the Toggle Bit I timing specifications and diagram.

- **$DQ_5$**

### Exceeded Timing Limits

$DQ_5$ will indicate if the program or erase time has exceeded the specified limits (internal pulse count). Under these conditions $DQ_5$ will produce a "1". This is a failure condition which indicates that the program or erase cycle was not successfully completed. $\overline{\text{Data}}$ Polling is the only operating function of the device under this condition. The $\overline{\text{CE}}$ circuit will partially power down the device under these conditions. The $\overline{\text{OE}}$ and $\overline{\text{WE}}$ pins will control the output disable functions as described in "MBM29LV160TE/BE User Bus Operation ($\overline{\text{BYTE}}$ = $V_{IH}$) and ($\overline{\text{BYTE}}$ = $V_{IL}$)" Tables in "■DEVICE BUS OPERATIONS".

The $DQ_5$ failure condition may also appear if a user tries to program a non blank location without erasing. In this case the device locks out and never completes the Embedded Algorithm operation. Hence, the system never reads a valid data on $DQ_7$ and $DQ_6$ never stops toggling. Once the device has exceeded timing limits, the $DQ_5$ bit will indicate a "1." Please note that this is not a device failure condition since the device was incorrectly used. If this occurs, reset the device with command sequence.

- **$DQ_3$**

Sector Erase Timer

After the completion of the initial sector erase command sequence the sector erase time-out will begin. $DQ_3$ will remain low until the time-out is complete. $\overline{\text{Data}}$ Polling and Toggle Bit I are valid after the initial sector erase command sequence.
If $\overline{\text{Data}}$ Polling or the Toggle Bit I indicates the device has been written with a valid erase command, $DQ_3$ may be used to determine if the sector erase timer window is still open. If $DQ_3$ is high ("1") the internally controlled erase cycle has begun; attempts to write subsequent commands to the device will be ignored until the erase operation is completed as indicated by $\overline{\text{Data}}$ Polling or Toggle Bit I. If $DQ_3$ 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 $DQ_3$ prior to and following each subsequent sector erase command. If $DQ_3$ is high on the second status check, the command may not have been accepted.
See "Hardware Sequence Flags" Table.

- **$DQ_2$**

Toggle Bit II

This Toggle Bit II, along with $DQ_6$, 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 $DQ_2$ 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 $DQ_2$ to toggle. When the device is in the erase-suspended-program mode, successive reads from the byte address of the non-erase suspended sector will indicate a logic "1" at $DQ_2$.
$DQ_6$ is different from $DQ_2$ in that $DQ_6$ toggles only when the standard program or Erase, or Erase Suspend Program operation is in progress.
For example, $DQ_2$ and $DQ_6$ can be used together to determine if the erase-suspend-read mode is in progress. ($DQ_2$ toggles while $DQ_6$ does not.) See also "Toggle Bit Status" Table and "$DQ_2$ vs. $DQ_6$" in "■TIMING DIAGRAM".
Furthermore, $DQ_2$ can also be used to determine which sector is being erased. When the device is in the erase mode, $DQ_2$ toggles if this bit is read from an erasing sector.

**Toggle Bit Status**

| Mode | $DQ_7$ | $DQ_6$ | $DQ_2$ |
|---|---|---|---|
| Program | $\overline{DQ_7}$ | Toggle | 1 |
| Erase | 0 | Toggle | Toggle |
| Erase Suspend Read (Erase Suspended Sector) *1 | 1 | 1 | Toggle |
| Erase-Suspend Program | $\overline{DQ_7}$ | Toggle *1 | 1 *2 |

*1 : Performing successive read operations from any address will cause $DQ_6$ to toggle.

*2 : Reading the byte address being programmed while in the erase-suspend program mode will indicate logic "1" at the $DQ_2$ bit. However, successive reads from the erase-suspended sector will cause $DQ_2$ to toggle.

- **RY/$\overline{BY}$**

Ready/Busy Pin

The MBM29LV160TE/BE provides a RY/$\overline{BY}$ open-drain output pin as a way to indicate to the host system that the Embedded Algorithms are either in progress or has been completed. If the output is low, the device is busy with either a program or erase operation. If the output is high, the device is ready to accept any read/write or erase operation. When the RY/$\overline{BY}$ pin is low, the devices will not accept any additional program or erase commands with the exception of the Erase Suspend command. If the MBM29LV160TE/BE is placed in an Erase Suspend mode, the RY/$\overline{BY}$ output will be high, by means of connecting with a pull-up resister to $V_{CC}$.
During programming, the RY/$\overline{BY}$ pin is driven low after the rising edge of the fourth $\overline{WE}$ pulse. During an erase operation, the RY/$\overline{BY}$ pin is driven low after the rising edge of the sixth $\overline{WE}$ pulse. The RY/$\overline{BY}$ pin will indicate a busy condition during the $\overline{RESET}$ pulse. See “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. The RY/$\overline{BY}$ pin is pulled high in standby mode.
Since this is an open-drain output, RY/$\overline{BY}$ pins can be tied together in parallel with a pull-up resistor to $V_{CC}$.

- **$\overline{RESET}$**

Hardware Reset Pin

The MBM29LV160TE/BE device may be reset by driving the $\overline{RESET}$ pin to $V_{IL}$. The $\overline{RESET}$ pin has 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 allows 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 RY/$\overline{BY}$ output signal should be ignored during the $\overline{RESET}$ pulse. Refer to “$\overline{RESET}$, RY/$\overline{BY}$ Timing Diagram” in “■TIMING DIAGRAM” for the timing diagram. Refer to Temporary Sector Unprotection for additional functionality.
If hardware reset occurs during Embedded Erase Algorithm, there is a possibility that the erasing sector(s) will need to be erased again before they can be programmed.

- **Byte/Word Configuration**

The $\overline{BYTE}$ pin selects the byte (8-bit) mode or word (16-bit) mode for the MBM29LV160TE/BE device. When this pin is driven high, the device operates in the word (16-bit) mode. The data is read and programmed at $DQ_{15}$ to $DQ_0$. When this pin is driven low, the device operates in byte (8-bit) mode. Under this mode, $DQ_{15}/A_{-1}$ pin becomes the lowest address bit and $DQ_{14}$ to $DQ_8$ bits are tri-stated. However, the command bus cycle is always an 8-bit operation and hence commands are written at $DQ_7$ to $DQ_0$ and $DQ_{15}$ to $DQ_8$ bits are ignored. Refer to “Timing Diagram for Word Mode Configuration”, “Timing Diagram for Byte Mode Configuration” and “$\overline{BYTE}$ Timing Diagram for Write Operations” in “■TIMING DIAGRAM” for the timing diagram.

- **Data Protection**

The MBM29LV160TE/BE 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 the device automatically resets the internal state machine to the Read mode. Also, with its control register architecture, alteration of the memory contents only occurs after successful completion of specific multi-bus cycle command sequence.
The device also incorporates several features to prevent inadvertent write cycles resulting form $V_{CC}$ power-up and power-down transitions or system noise.

- **Low $V_{CC}$ Write Inhibit**

To avoid initiation of a write cycle during $V_{CC}$ power-up and power-down, a write cycle is locked out for $V_{CC}$ less than $V_{LKO}$ (Min). If $V_{CC} < V_{LKO}$, the command register is disabled and all internal program/erase circuits are disabled. Under this condition, the device will reset to the read mode. Subsequent writes will be ignored until

the $V_{CC}$ level is greater than $V_{LKO}$. It is the users responsibility to ensure that the control pins are logically correct to prevent unintentional writes when $V_{CC}$ is above $V_{LKO}$ (Min).
If the Embedded Erase Algorithm is interrupted, there is possibility that the erasing sector(s) will need to be erased again prior to programming.

- **Write Pulse "Glitch" Protection**

Noise pulses of less than 3 ns (typical) on $\overline{OE}$, $\overline{CE}$, or $\overline{WE}$ will not change the command registers.

- **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, $\overline{CE}$ and $\overline{WE}$ must be a logical zero while $\overline{OE}$ is a logical one.

- **Power-up Write Inhibit**

Power-up of the devices 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 read mode on power-up.

## ■ ABSOLUTE MAXIMUM RATINGS

| Parameter | Symbol | Rating | | Unit |
|---|---|---|---|---|
| | | Min | Max | |
| Storage Temperature | Tstg | –55 | +125 | °C |
| Ambient Temperature with Power Applied | $T_A$ | –40 | +85 | °C |
| Voltage with Respect to Ground All pins except $A_9$, $\overline{OE}$, $\overline{RESET}$ *1 | $V_{IN}$, $V_{OUT}$ | –0.5 | $V_{CC}$ + 0.5 | V |
| Power Supply Voltage *1 | $V_{CC}$ | –0.5 | +5.5 | V |
| $A_9$, $\overline{OE}$, and $\overline{RESET}$ *2 | $V_{IN}$ | –0.5 | +13.0 | V |

*1: Minimum DC voltage on input or I/O pins is –0.5 V. During voltage transitions, inputs or I/O pins may undershoot $V_{SS}$ to –2.0 V for periods of up to 20 ns. Maximum DC voltage on input or I/O pins is $V_{CC}$ +0.5 V. During voltage transitions, inputs or I/O pins may overshoot to $V_{CC}$ +2.0 V for periods of up to 20 ns.

*2: Minimum DC input voltage on $A_9$, $\overline{OE}$, and $\overline{RESET}$ pins is –0.5 V. During voltage transitions, $A_9$, $\overline{OE}$, and $\overline{RESET}$ pins may undershoot $V_{SS}$ to –2.0 V for periods of up to 20 ns. Voltage difference between input and supply voltage ($V_{IN}$ – $V_{CC}$) does not exceed +9.0 V. Maximum DC input voltage on $A_9$, $\overline{OE}$, and $\overline{RESET}$ pins is +13.0 V which may overshoot to 14.0 V for periods of up to 20 ns.

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 CONDITIONS

| Parameter | Symbol | Value | | | Unit |
|---|---|---|---|---|---|
| | | Min | Typ | Max | |
| Ambient Temperature | $T_A$ | –40 | — | +85 | °C |
| Power Supply Voltage | $V_{CC}$ | +2.7 | — | +3.6 | V |

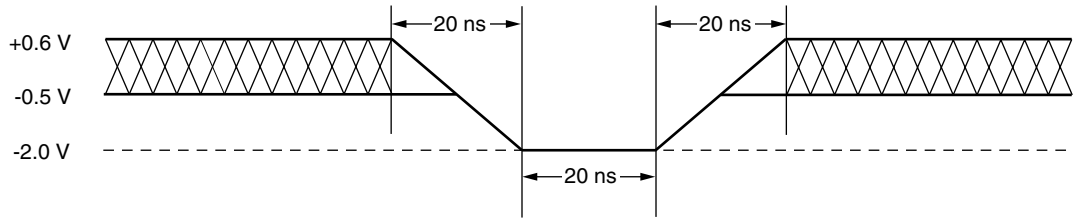
Note: Operating ranges define those limits between which the functionality of the device is guaranteed.

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.

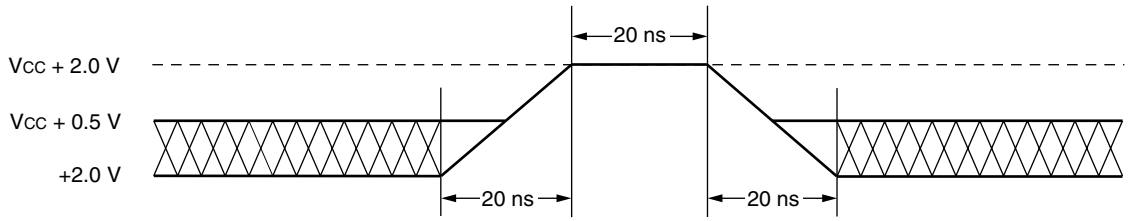
Always use semiconductor devices within their recommended operating condition ranges. Operation outside these ranges may adversely affect reliability and could result in device failure.

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.

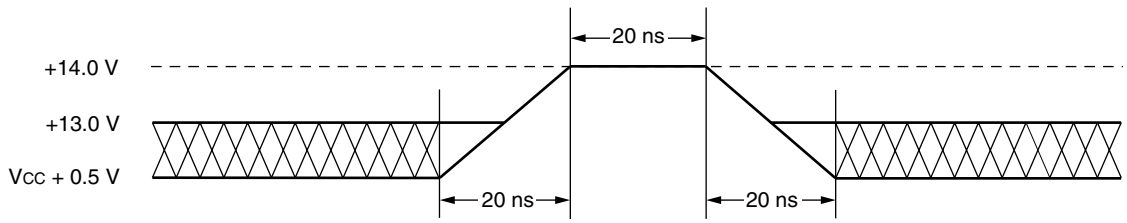
## ■ MAXIMUM OVERSHOOT/MAXIMUM UNDERSHOOT




**Maximum Undershoot Waveform**




**Maximum Overshoot Waveform 1**




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

**Maximum Overshoot Waveform 2**

## ■ DC CHARACTERISTICS

| Parameter | Symbol | Test Conditions | | Value Min | Value Max | Unit |
|---|---|---|---|---|---|---|
| Input Leakage Current | $I_{LI}$ | $V_{IN}$ = $V_{SS}$ to $V_{CC}$, $V_{CC}$ = $V_{CC}$ Max | | –1.0 | +1.0 | µA |
| Output Leakage Current | $I_{LO}$ | $V_{OUT}$ = $V_{SS}$ to $V_{CC}$, $V_{CC}$ = $V_{CC}$ Max | | –1.0 | +1.0 | µA |
| $A_9$, $\overline{OE}$, $\overline{RESET}$ Inputs Leakage Current | $I_{LIT}$ | $V_{CC}$ = $V_{CC}$ Max, $A_9$, $\overline{OE}$, $\overline{RESET}$ = 12.5 V | | — | 35 | µA |
| $V_{CC}$ Active Current *1 | $I_{CC1}$ | $\overline{CE}$ = $V_{IL}$, $\overline{OE}$ = $V_{IH}$, f = 10 MHz | Byte | — | 30 | mA |
| | | | Word | | 35 | |
| | | $\overline{CE}$ = $V_{IL}$, $\overline{OE}$ = $V_{IH}$, f = 5 MHz | Byte | — | 15 | mA |
| | | | Word | | 17 | |
| $V_{CC}$ Active Current *2 | $I_{CC2}$ | $\overline{CE}$ = $V_{IL}$, $\overline{OE}$ = $V_{IH}$ | | — | 35 | mA |
| $V_{CC}$ Current (Standby) | $I_{CC3}$ | $V_{CC}$ = $V_{CC}$ Max, $\overline{CE}$ = $V_{CC}$ ±0.3 V, $\overline{RESET}$ = $V_{CC}$ ±0.3 V | | — | 5 | µA |
| $V_{CC}$ Current (Standby, $\overline{RESET}$) | $I_{CC4}$ | $V_{CC}$ = $V_{CC}$ Max, $\overline{RESET}$ = $V_{SS}$ ±0.3 V | | — | 5 | µA |
| $V_{CC}$ Current (Automatic Sleep Mode) *3 | $I_{CC5}$ | $V_{CC}$ = $V_{CC}$ Max, $\overline{CE}$ = $V_{SS}$ ±0.3 V, $\overline{RESET}$ = $V_{CC}$ ±0.3 V, $V_{IN}$ = $V_{CC}$ ±0.3 V or $V_{SS}$ ±0.3 V | | — | 5 | µA |
| Input Low Level | $V_{IL}$ | — | | –0.5 | 0.6 | V |
| Input High Level | $V_{IH}$ | — | | 2.0 | $V_{CC}$ + 0.3 | V |
| Voltage for Autoselect, Sector Protection, and Temporary Sector Unprotection ($A_9$, $\overline{OE}$, $\overline{RESET}$) *4 | $V_{ID}$ | — | | 11.5 | 12.5 | V |
| Output Low Voltage Level | $V_{OL}$ | $I_{OL}$ = 4.0 mA, $V_{CC}$ = $V_{CC}$ Min | | — | 0.45 | V |
| Output High Voltage Level | $V_{OH1}$ | $I_{OH}$ = –2.0 mA, $V_{CC}$ = $V_{CC}$ Min | | 2.4 | — | V |
| | $V_{OH2}$ | $I_{OH}$ = –100 µA | | $V_{CC}$ – 0.4 | — | V |
| Low $V_{CC}$ Lock-Out Voltage | $V_{LKO}$ | — | | 2.3 | 2.5 | V |

*1: $I_{CC}$ current listed includes both the DC operating current and the frequency dependent component.

*2: $I_{CC}$ active while Embedded Erase or Embedded Program is in progress.

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

*4: ($V_{ID}$ – $V_{CC}$) do not exceed 9 V.

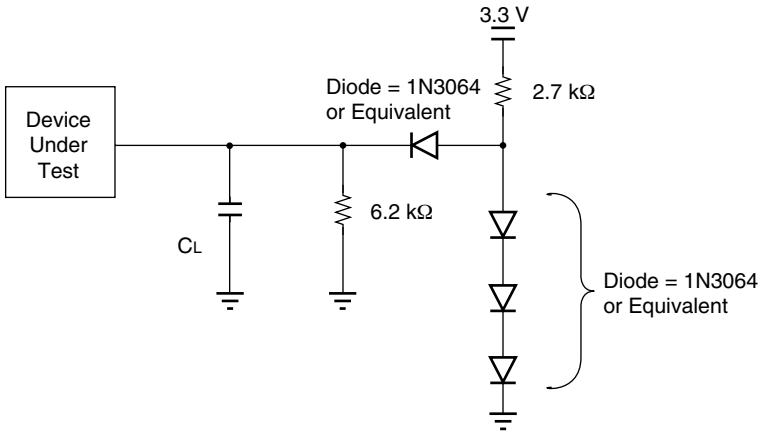
## ■ AC CHARACTERISTICS

- **Read Only Operations Characteristics**

| Parameter | Symbol | | Test Setup | Value (Note) | | | | Unit |
|---|---|---|---|---|---|---|---|---|
| | | | | 70 | | 90 | | |
| | JEDEC | Standard | | Min | Max | Min | Max | |
| Read Cycle Time | $t_{AVAV}$ | $t_{RC}$ | — | 70 | — | 90 | — | ns |
| Address to Output Delay | $t_{AVQV}$ | $t_{ACC}$ | $\overline{CE}$ = $V_{IL}$<br>$\overline{OE}$ = $V_{IL}$ | — | 70 | — | 90 | ns |
| Chip Enable to Output Delay | $t_{ELQV}$ | $t_{CE}$ | $\overline{OE}$ = $V_{IL}$ | — | 70 | — | 90 | ns |
| Output Enable to Output Delay | $t_{GLQV}$ | $t_{OE}$ | — | — | 30 | — | 35 | ns |
| Chip Enable to Output High-Z | $t_{EHQZ}$ | $t_{DF}$ | — | — | 25 | — | 30 | ns |
| Output Enable to Output High-Z | $t_{GHQZ}$ | $t_{DF}$ | — | — | 25 | — | 30 | ns |
| Output Hold Time From Address, $\overline{CE}$ or $\overline{OE}$, Whichever Occurs First | $t_{AXQX}$ | $t_{OH}$ | — | 0 | — | 0 | — | ns |
| $\overline{RESET}$ Pin Low to Read Mode | — | $t_{READY}$ | — | — | 20 | — | 20 | μs |
| $\overline{CE}$ to $\overline{BYTE}$ Switching Low or High | — | $t_{ELFL}$<br>$t_{ELFH}$ | — | — | 5 | — | 5 | ns |

Note: Test Conditions:

Output Load:1 TTL gate and 30 pF (MBM29LV160TE/BE70)
1 TTL gate and 100 pF (MBM29LV160TE/BE90)
Input rise and fall times: 5 ns
Input pulse levels: 0.0 V or 3.0 V
Timing measurement reference level
Input: 0.5 Vccf
Output: 0.5 Vccf




Notes : $C_L$ = 30 pF including jig capacitance (MBM29LV160TE/BE70)
$C_L$ = 100 pF including jig capacitance (MBM29LV160TE/BE90)

**Test Conditions**

- **Write (Erase/Program) Operations**

| Parameter | | | Symbol | | Value | | | | | | Unit |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 70 | | | 90 | | | |
| | | | JEDEC | Standard | Min | Typ | Max | Min | Typ | Max | |
| Write Cycle Time | | | $t_{AVAV}$ | $t_{WC}$ | 70 | — | — | 90 | — | — | ns |
| Address Setup Time | | | $t_{AVWL}$ | $t_{AS}$ | 0 | — | — | 0 | — | — | ns |
| Address Hold Time | | | $t_{WLAX}$ | $t_{AH}$ | 45 | — | — | 45 | — | — | ns |
| Data Setup Time | | | $t_{DVWH}$ | $t_{DS}$ | 35 | — | — | 45 | — | — | ns |
| Data Hold Time | | | $t_{WHDX}$ | $t_{DH}$ | 0 | — | — | 0 | — | — | ns |
| Output Enable Setup Time | | | — | $t_{OES}$ | 0 | — | — | 0 | — | — | ns |
| Output Enable Hold Time | Read | | — | $t_{OEH}$ | 0 | — | — | 0 | — | — | ns |
| | Toggle and $\overline{\text{Data}}$ Polling | | | | 10 | — | — | 10 | — | — | ns |
| Read Recover Time Before Write | | | $t_{GHWL}$ | $t_{GHWL}$ | 0 | — | — | 0 | — | — | ns |
| Read Recover Time Before Write ($\overline{OE}$ High to $\overline{CE}$ Low) | | | $t_{GHEL}$ | $t_{GHEL}$ | 0 | — | — | 0 | — | — | ns |
| $\overline{CE}$ Setup Time | | | $t_{ELWL}$ | $t_{CS}$ | 0 | — | — | 0 | — | — | ns |
| $\overline{WE}$ Setup Time | | | $t_{WLEL}$ | $t_{WS}$ | 0 | — | — | 0 | — | — | ns |
| $\overline{CE}$ Hold Time | | | $t_{WHEH}$ | $t_{CH}$ | 0 | — | — | 0 | — | — | ns |
| $\overline{WE}$ Hold Time | | | $t_{EHWH}$ | $t_{WH}$ | 0 | — | — | 0 | — | — | ns |
| Write Pulse Width | | | $t_{WLWH}$ | $t_{WP}$ | 35 | — | — | 45 | — | — | ns |
| $\overline{CE}$ Pulse Width | | | $t_{ELEH}$ | $t_{CP}$ | 35 | — | — | 45 | — | — | ns |
| Write Pulse Width High | | | $t_{WHWL}$ | $t_{WPH}$ | 25 | — | — | 25 | — | — | ns |
| $\overline{CE}$ Pulse Width High | | | $t_{EHEL}$ | $t_{CPH}$ | 25 | — | — | 25 | — | — | ns |
| Programming Operation | | Byte | $t_{WHWH1}$ | $t_{WHWH1}$ | — | 8 | — | — | 8 | — | µs |
| | | Word | | | — | 16 | — | — | 16 | — | |
| Sector Erase Operation *1 | | | $t_{WHWH2}$ | $t_{WHWH2}$ | — | 1 | — | — | 1 | — | s |
| $V_{CC}$ Setup Time | | | — | $t_{VCS}$ | 50 | — | — | 50 | — | — | µs |
| Rise Time to $V_{ID}$ *2 | | | — | $t_{VIDR}$ | 500 | — | — | 500 | — | — | ns |
| Voltage Transition Time *2 | | | — | $t_{VLHT}$ | 4 | — | — | 4 | — | — | µs |
| Write Pulse Width *2 | | | — | $t_{WPP}$ | 100 | — | — | 100 | — | — | µs |
| $\overline{OE}$ Setup Time to $\overline{WE}$ Active *2 | | | — | $t_{OESP}$ | 4 | — | — | 4 | — | — | µs |
| $\overline{CE}$ Setup Time to $\overline{WE}$ Active *2 | | | — | $t_{CSP}$ | 4 | — | — | 4 | — | — | µs |
| Recover Time From RY/$\overline{BY}$ | | | — | $t_{RB}$ | 0 | — | — | 0 | — | — | ns |
| $\overline{RESET}$ Pulse Width | | | — | $t_{RP}$ | 500 | — | — | 500 | — | — | ns |
| $\overline{RESET}$ High Level Period Before Read | | | — | $t_{RH}$ | 200 | — | — | 200 | — | — | ns |
| Program/Erase Valid to RY/$\overline{BY}$ Delay | | | — | $t_{BUSY}$ | — | — | 90 | — | — | 90 | ns |
| Delay Time from Embedded Output Enable | | | — | $t_{EOE}$ | — | — | 70 | — | — | 90 | ns |
| $\overline{BYTE}$ Switching Low to Output High-Z | | | — | $t_{FLQZ}$ | — | — | 30 | — | — | 35 | ns |

*(Continued)*

*(Continued)*

| Parameter | Symbol | | Value | | | | | | Unit |
|---|---|---|---|---|---|---|---|---|---|
| | | | 70 | | | 90 | | | |
| | JEDEC | Standard | Min | Typ | Max | Min | Typ | Max | |
| $\overline{\text{BYTE}}$ Switching High to Output Active | — | $t_{FHQV}$ | — | — | 70 | — | — | 90 | ns |
| Erase Time-out Time | — | $t_{TOW}$ | 50 | — | — | 50 | — | — | µs |
| Erase Suspend Transition Time | — | $t_{SPD}$ | — | — | 20 | — | — | 20 | µs |

*1: Does not include the preprogramming time.

*2: For Sector Protection operation.

## ■ ERASE AND PROGRAMMING PERFORMANCE

| Parameter | Limits | | | Unit | Comments |
|---|---|---|---|---|---|
| | Min | Typ | Max | | |
| Sector Erase Time | — | 1 | 10 | s | Excludes programming time prior to erasure |
| Byte Programming Time | — | 8 | 300 | µs | Excludes system-level overhead |
| Word Programming Time | — | 16 | 360 | | |
| Chip Programming Time | — | 16.8 | 50 | s | Excludes system-level overhead |
| Erase/Program Cycle | 100,000 | — | — | cycle | — |

## ■ PIN CAPACITANCE

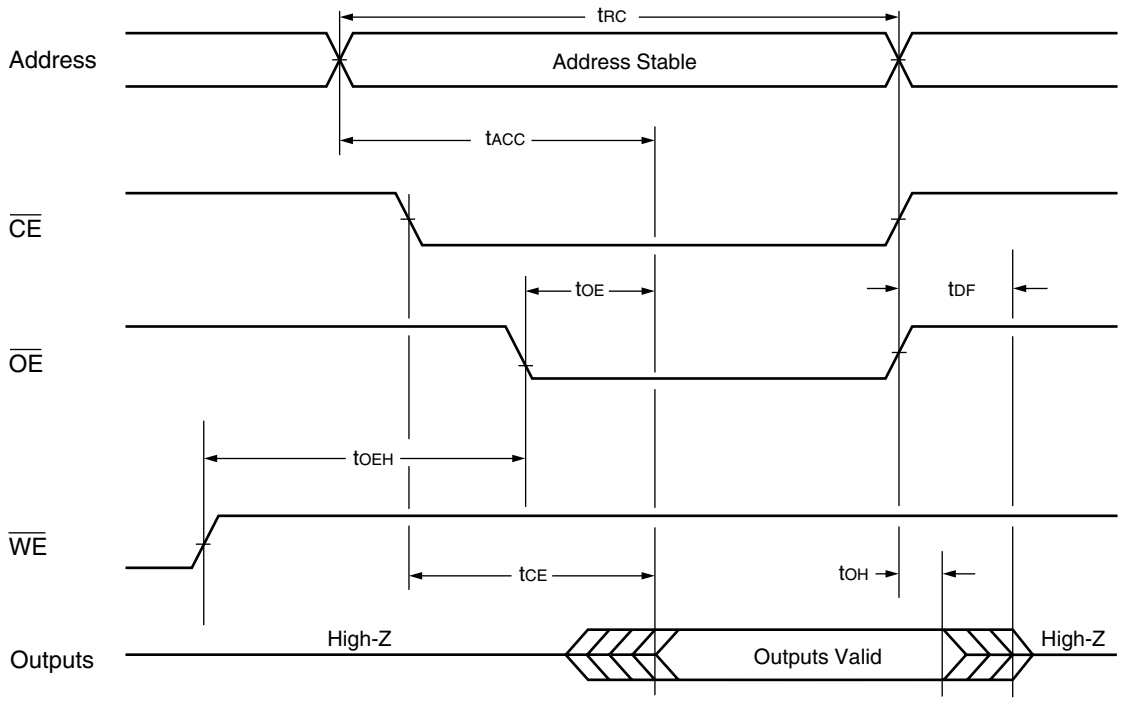
| Parameter | Symbol | Test Setup | Typ | Max | Unit |
|---|---|---|---|---|---|
| Input Capacitance | $C_{IN}$ | $V_{IN}$ = 0 | 6 | 7.5 | pF |
| Output Capacitance | $C_{OUT}$ | $V_{OUT}$ = 0 | 8 | 10 | pF |
| Control Pin Capacitance | $C_{IN2}$ | $V_{IN}$ = 0 | 7.5 | 9 | pF |

Notes : • Test conditions $T_A$ = +25°C, f = 1.0 MHz
• $DQ_{15}/A_{-1}$ pin capacitance is stipulated by output capacitance.

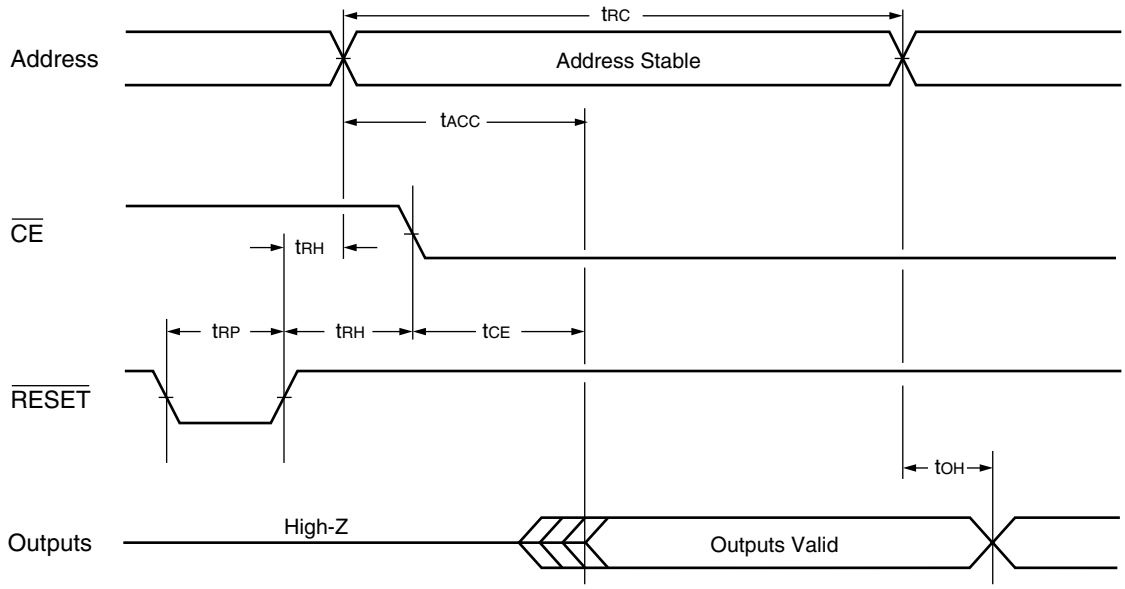
## ■ TIMING DIAGRAM

- **Key to Switching Waveforms**

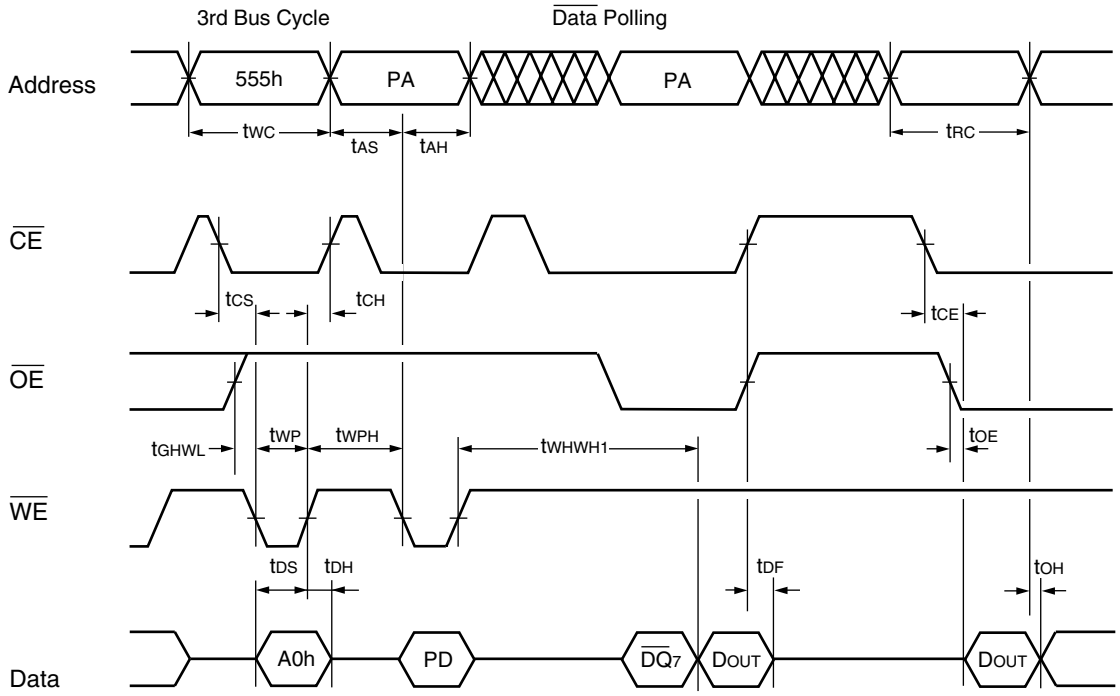
| WAVEFORM | INPUTS | OUTPUTS |
|---|---|---|
| | Must Be Steady | Will Be Steady |
| | May Change from H to L | Will Change from H to L |
| | May Change from L to H | Will Change from L to H |
| | H or L ; Any Change Permitted | Changing, State Unknown |
| | Does Not Apply | Center Line Is High-Impedance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




**Read Operation Timing Diagram**

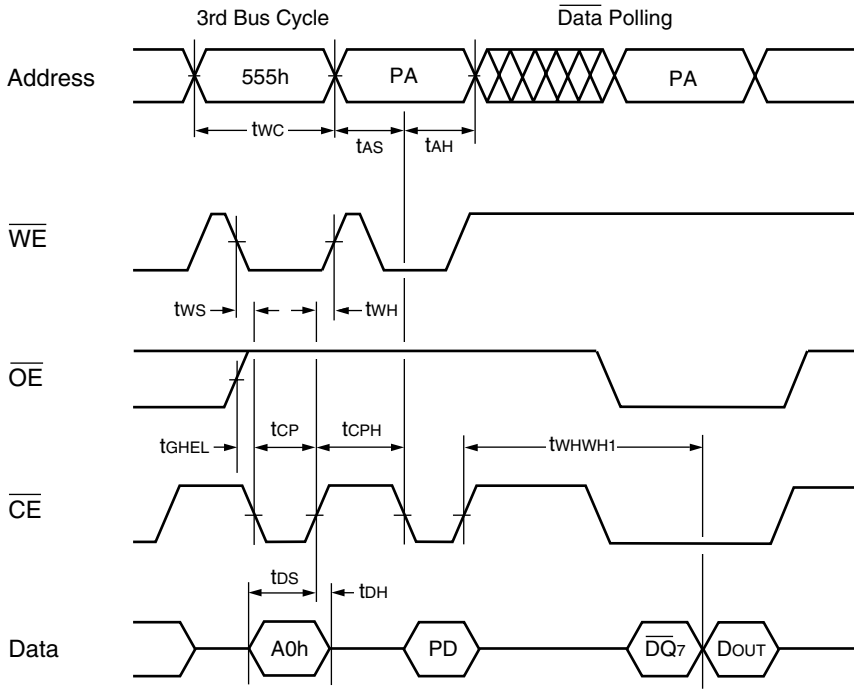



**Hardware Reset/Read Operation Timing Diagram**



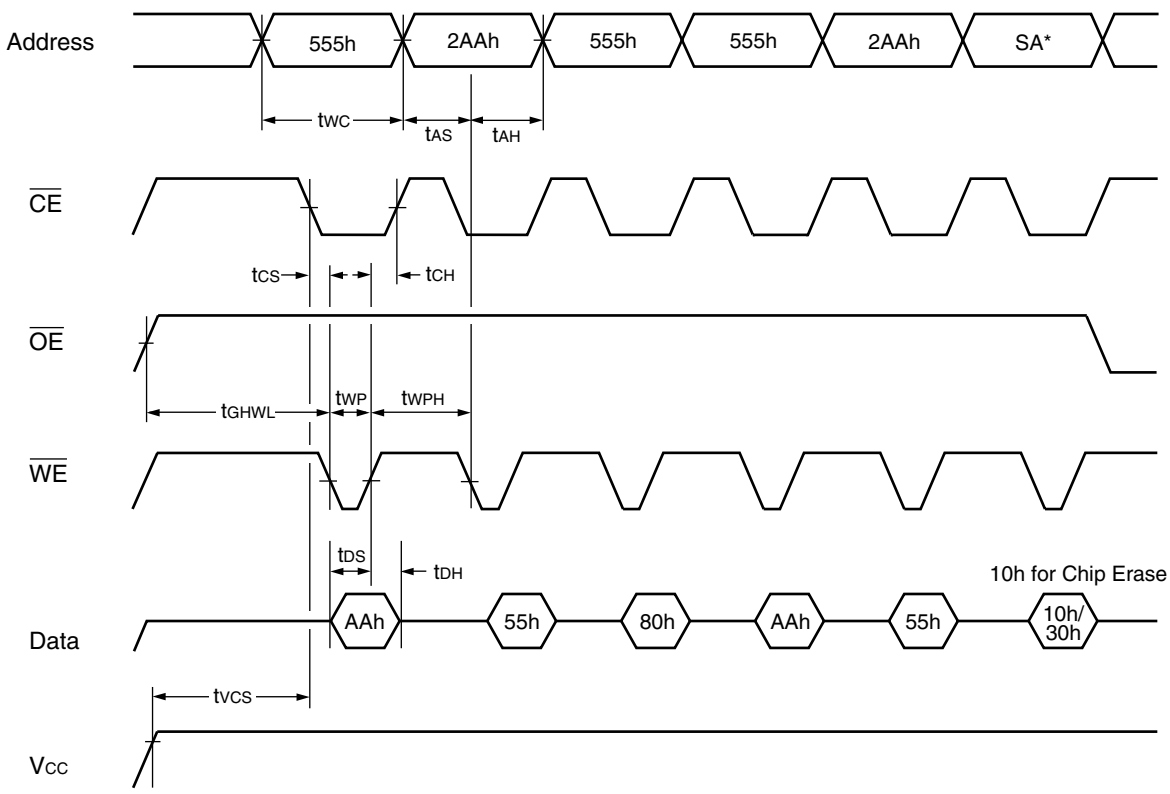

Notes:
- PA is address of the memory location to be programmed.
- PD is data to be programmed at word address.
- $\overline{DQ_7}$ is the output of the complement of the data written to the device.
- $D_{OUT}$ is the output of the data written to the device.
- Figure indicates last two bus cycles out of four bus cycle sequence.
- These waveforms are for the ×16 mode. (The addresses differ from ×8 mode.)

**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.
- $\overline{DQ}_7$ is the output of the complement of the data written to the device.
- $D_{OUT}$ is the output of the data written to the device.
- Figure indicates the last two bus cycles out of four bus cycle sequence.
- These waveforms are for the ×16 mode (the addresses differ from ×8 mode).

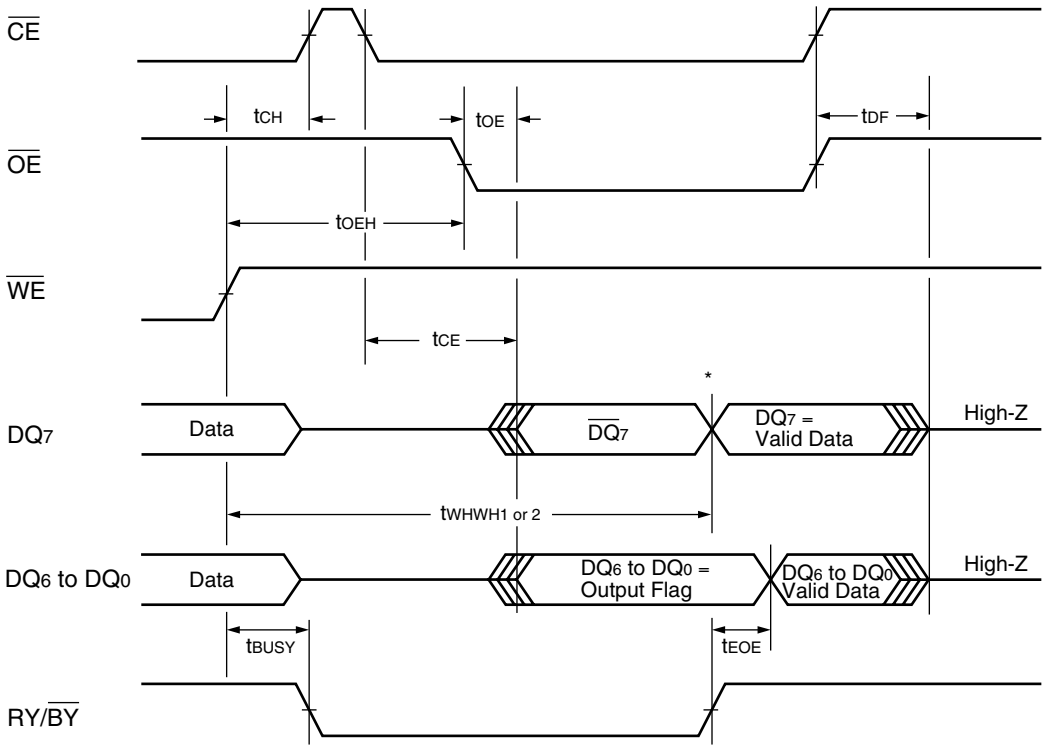
**Alternate $\overline{CE}$ Controlled Program Operation Timing Diagram**




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

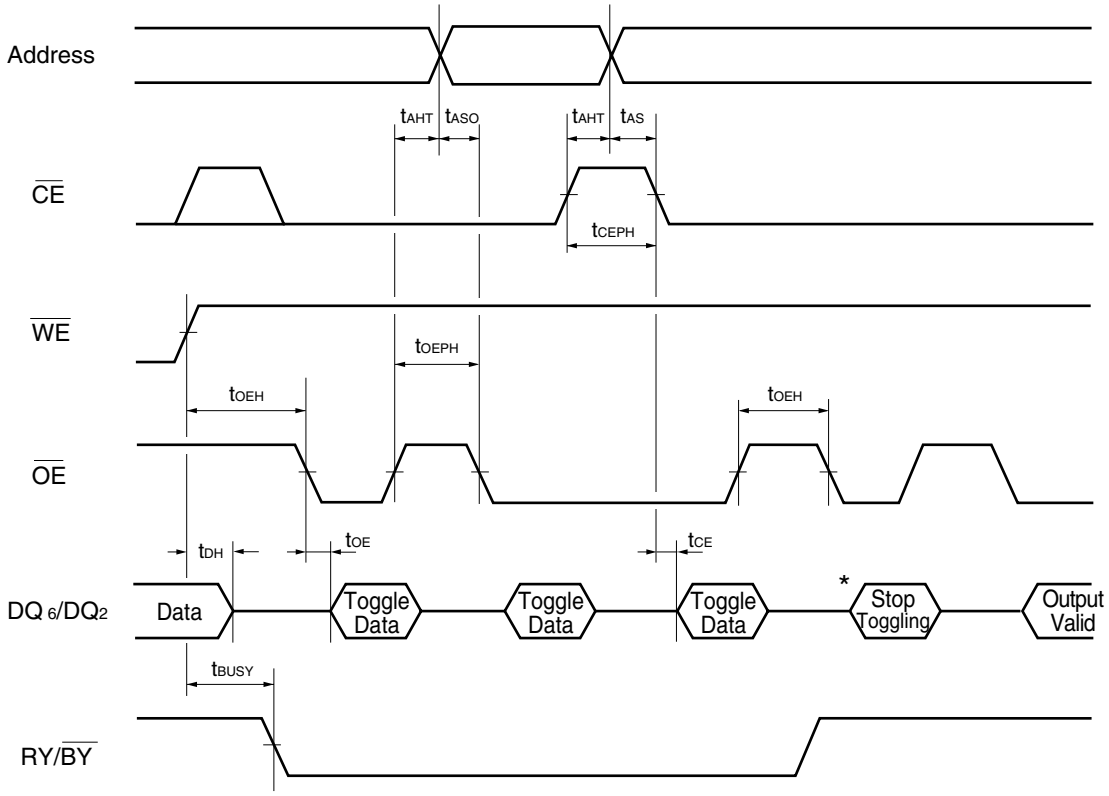
Note : These waveforms are for the ×16 mode. The addresses differ from ×8 mode.

**Chip/Sector Erase Operation Timing Diagram**



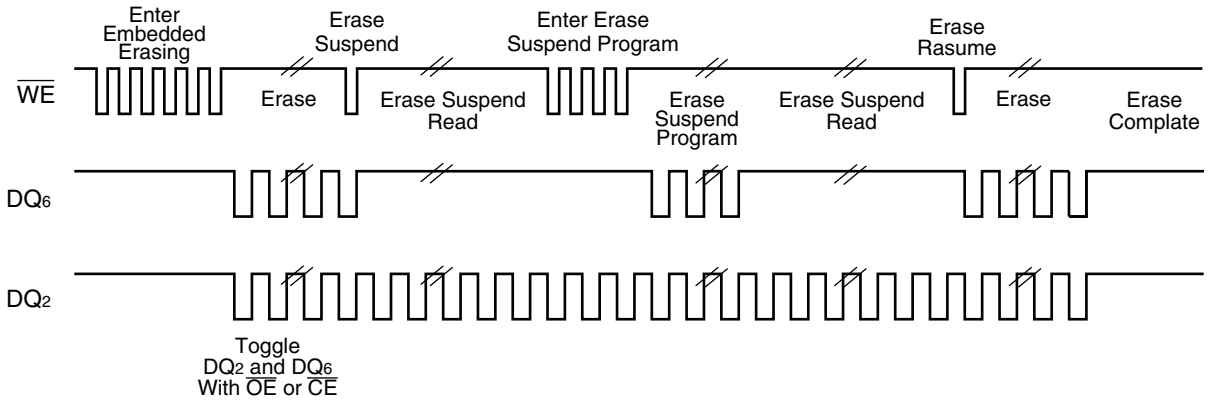

* : $DQ_7$ = Valid Data (The device has completed the Embedded operation).

**$\overline{\text{Data}}$ Polling during Embedded Algorithm Operation Timing Diagram**



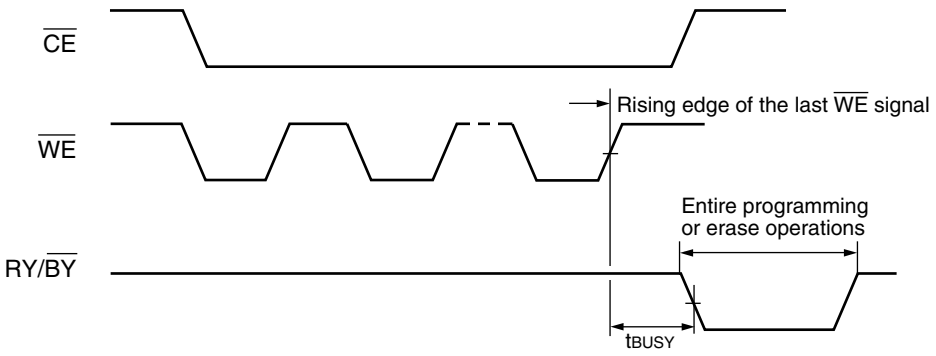

*: $DQ_6$ = Stops toggling. (The device has completed the Embedded operation.)

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

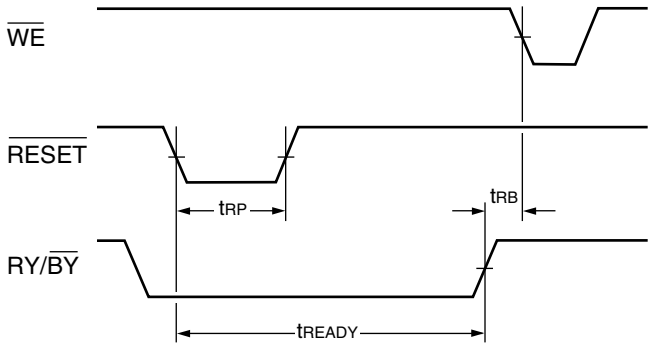



Note: $DQ_2$ is read from the erase-suspended sector.

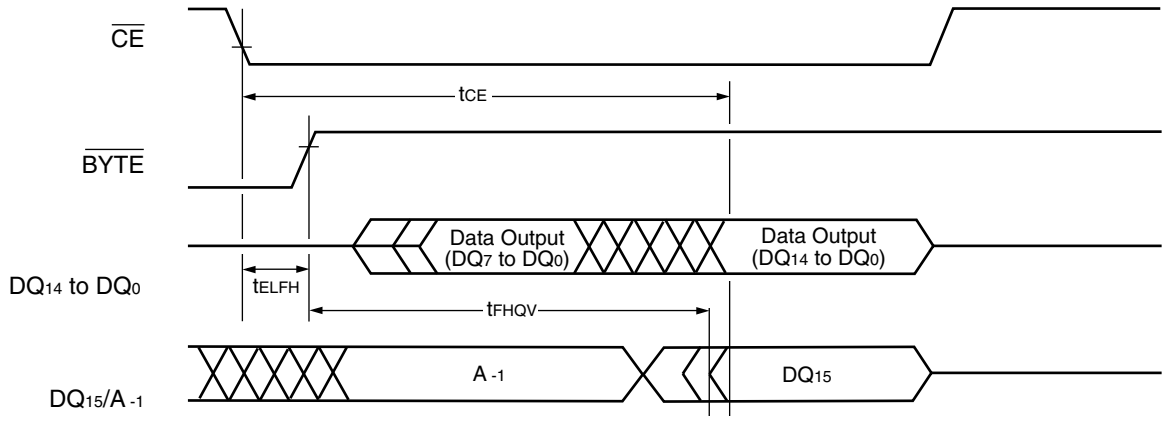
**$DQ_2$ vs. $DQ_6$**



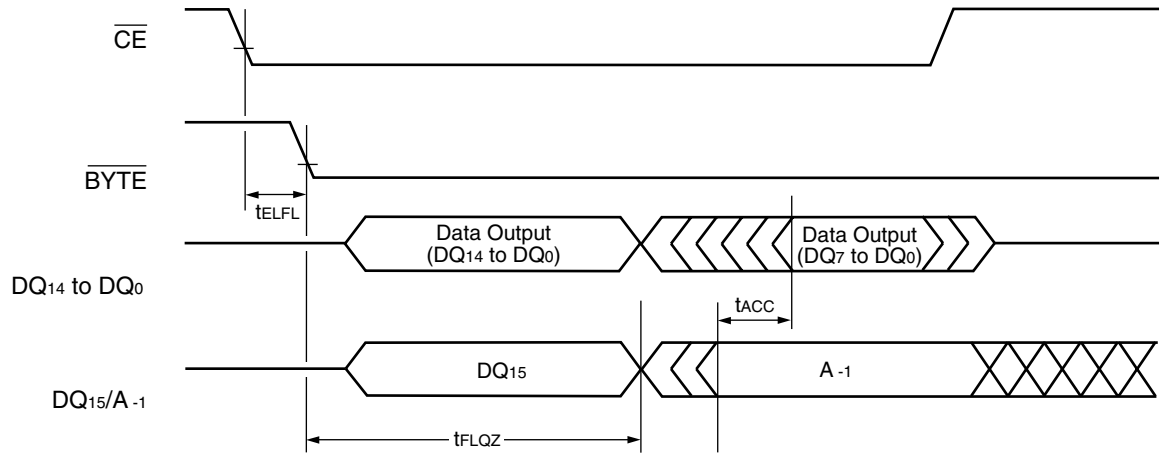

**RY/$\overline{BY}$ Timing Diagram during Program/Erase Operation Timing Diagram**



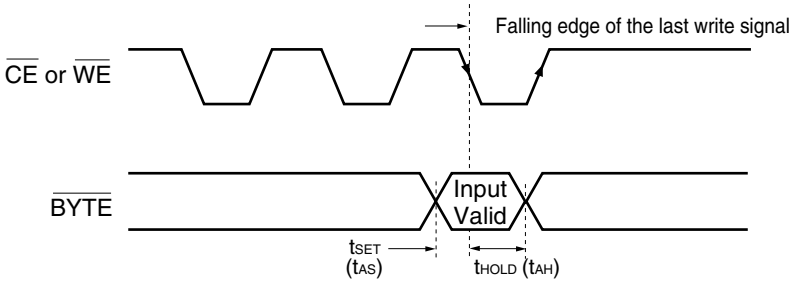

**$\overline{RESET}$, RY/$\overline{BY}$ Timing Diagram**



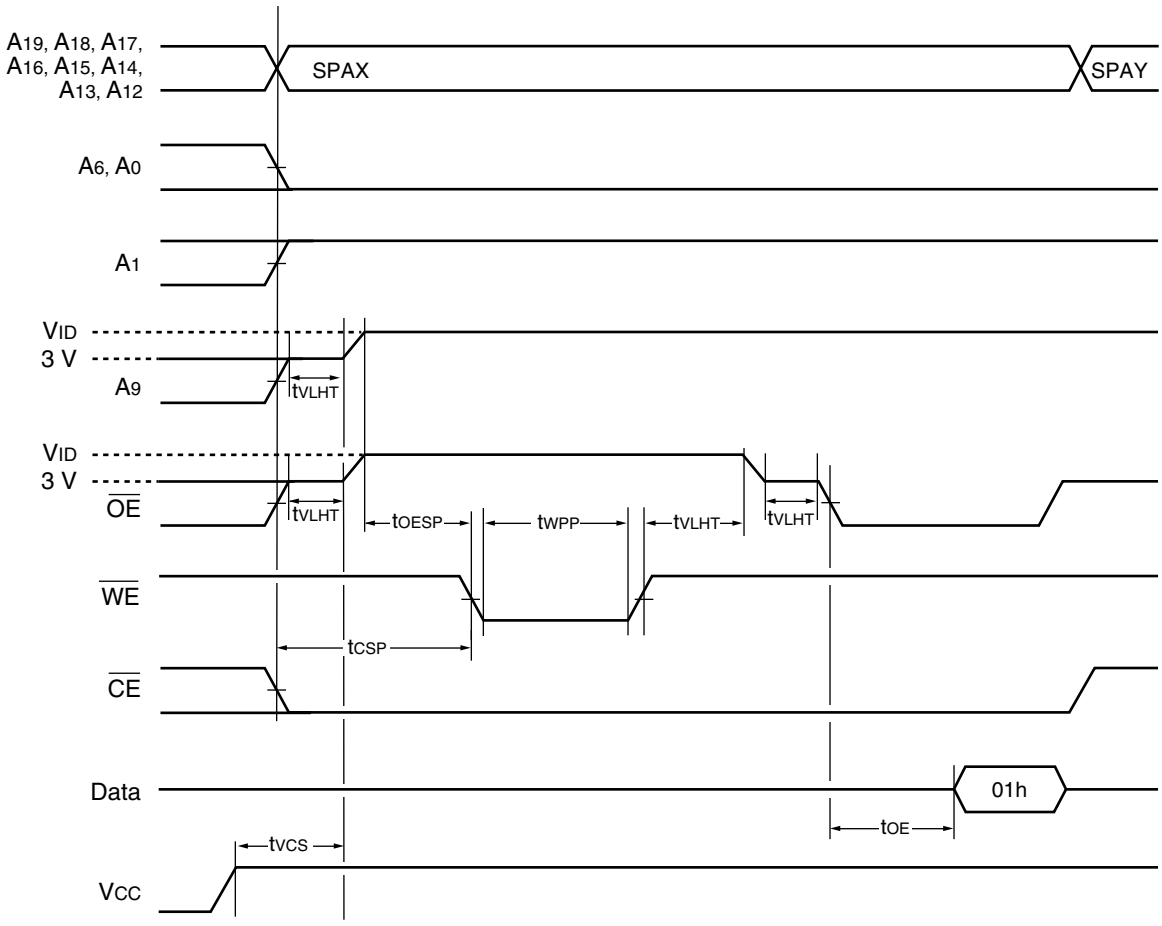

**Timing Diagram for Word Mode Configuration**




**Timing Diagram for Byte Mode Configuration**

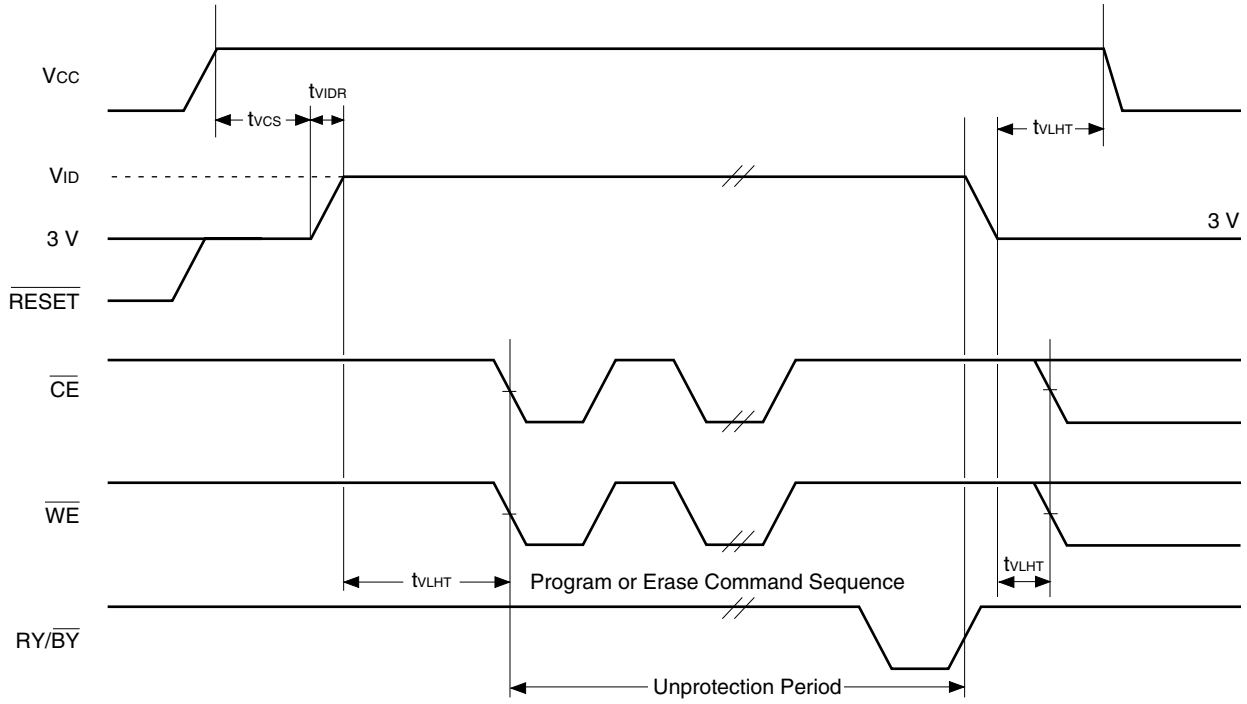



**BYTE Timing Diagram for Write Operations**

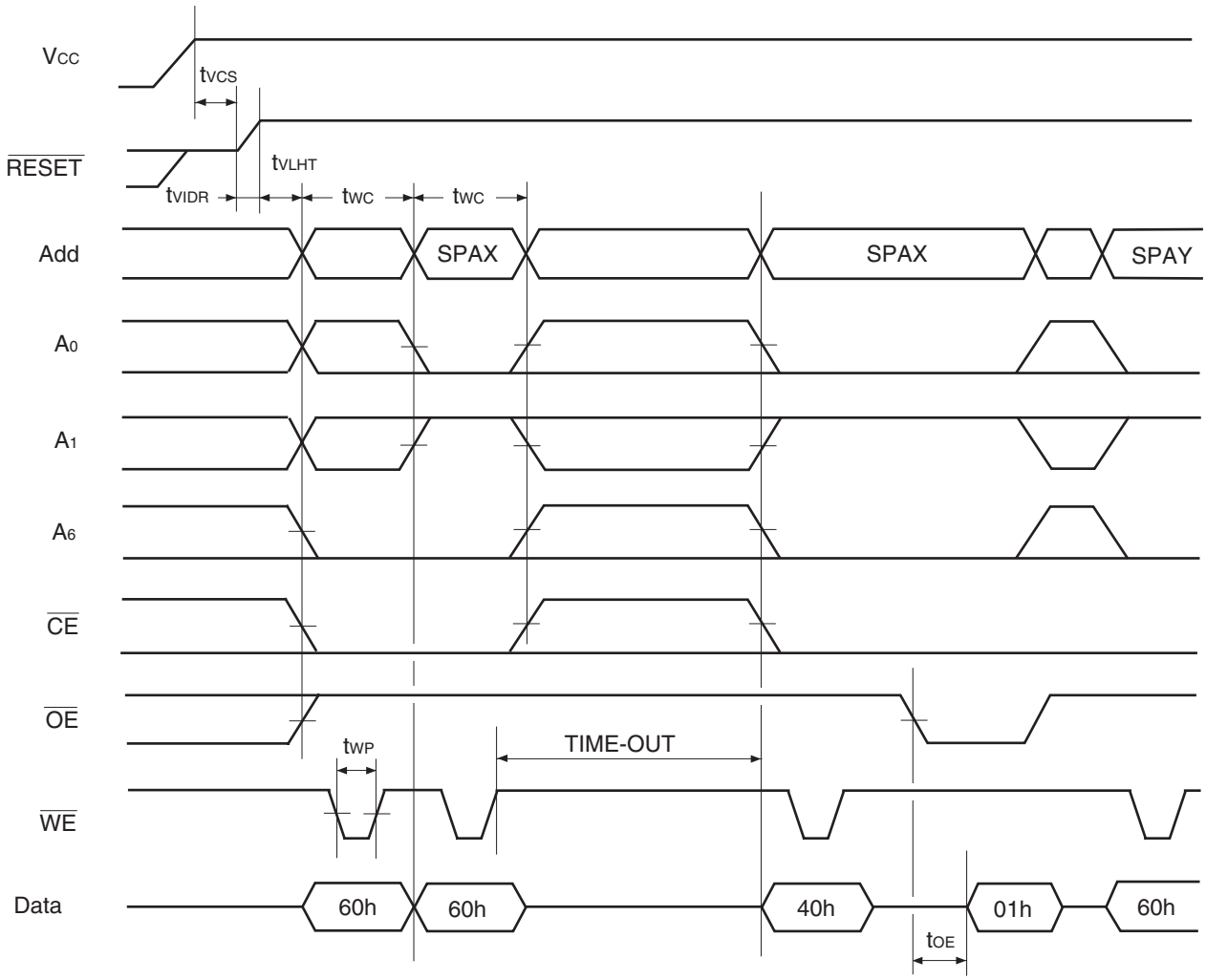



SPAX : Sector Address to be protected.
SPAY : Next Sector Address to be protected.
Note: $A_{-1}$ is $V_{IL}$ on byte mode.

**Sector Protection Timing Diagram**




**Temporary Sector Unprotection Timing Diagram**

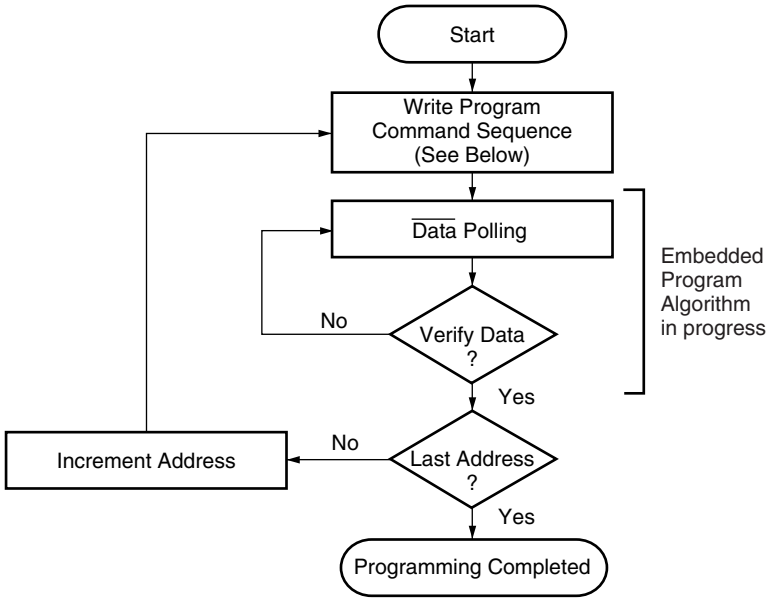



SPAX : Sector Address to be protected
SPAY : Next Sector Address to be protected
TIME-OUT : Time-Out window = 250 μs (Min)

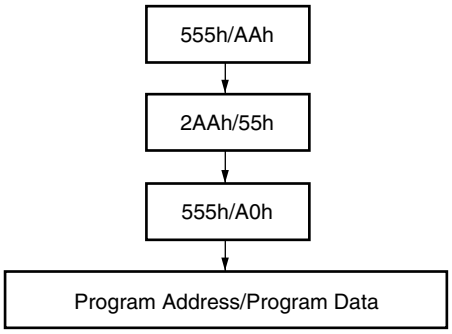
**Extended Sector Protection Timing Diagram**

## ■ FLOW CHART

### EMBEDDED ALGORITHM



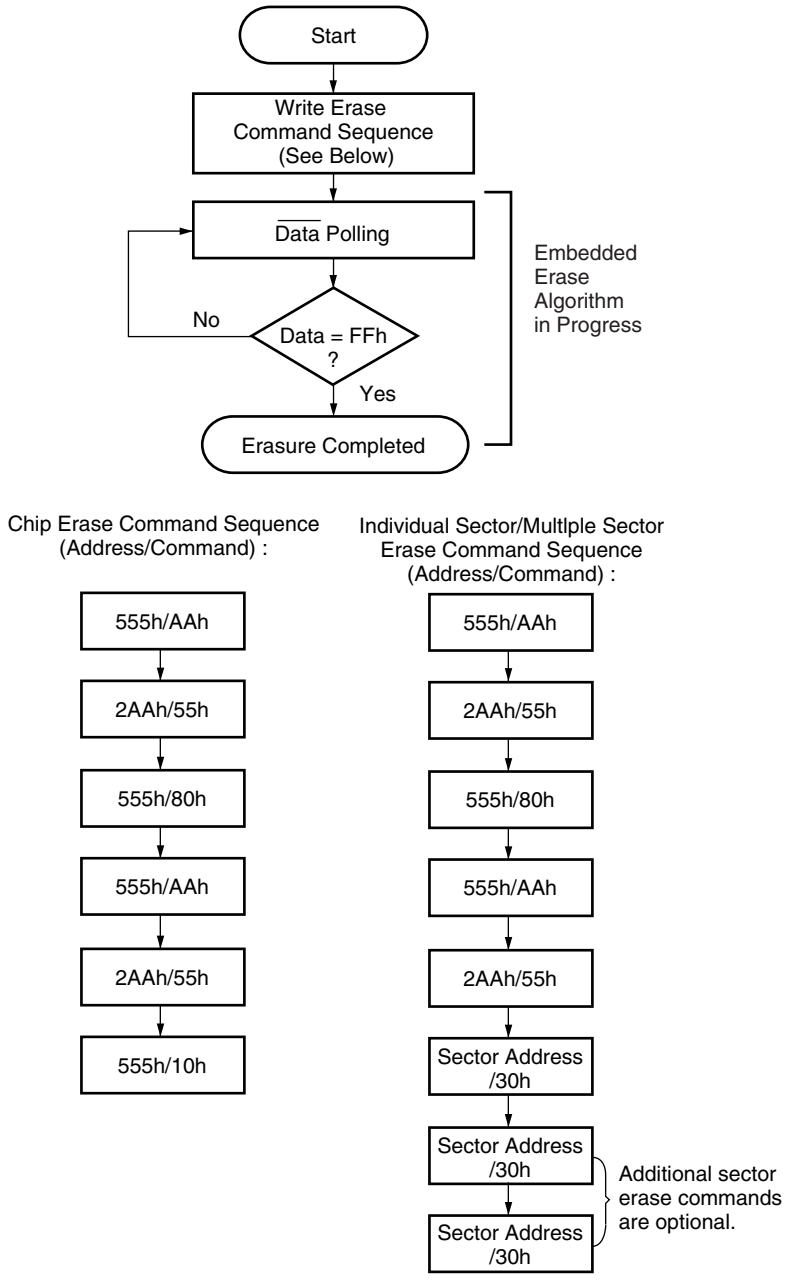

Program Command Sequence (Address/Command) :




Note : The sequence is applied for ×16 mode.
The addresses differ from ×8 mode.

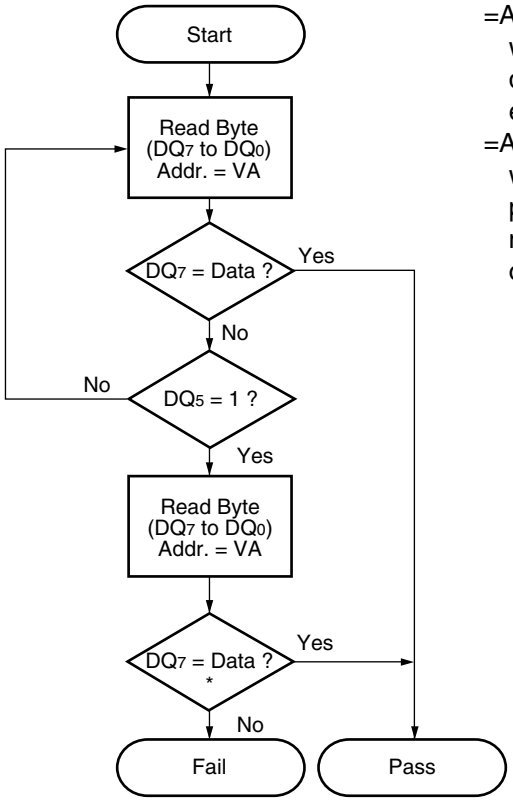
**Embedded Program™ Algorithm**

## EMBEDDED ALGORITHM




Note : The sequence is applied for ×16 mode.
The addresses differ from ×8 mode.

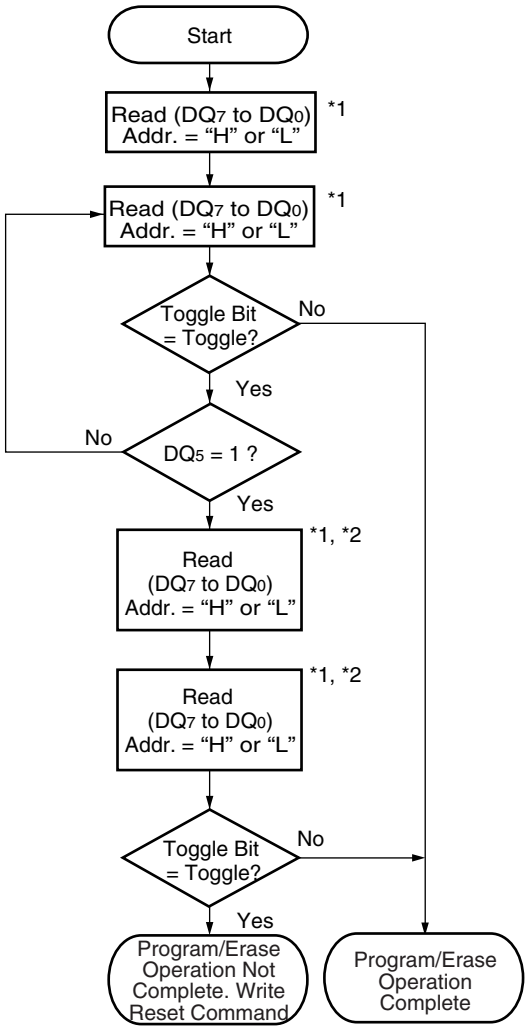
**Embedded Erase™ Algorithm**




VA =Address for programming
=Any of the sector addresses within the sector being erased during sector erase or multiple erases operation.
=Any of the sector addresses within the sector not being protected during sector erase or multiple sector erases operation.

* : $DQ_7$ is rechecked even if $DQ_5$ = “1” because $DQ_7$ may change simultaneously with $DQ_5$.

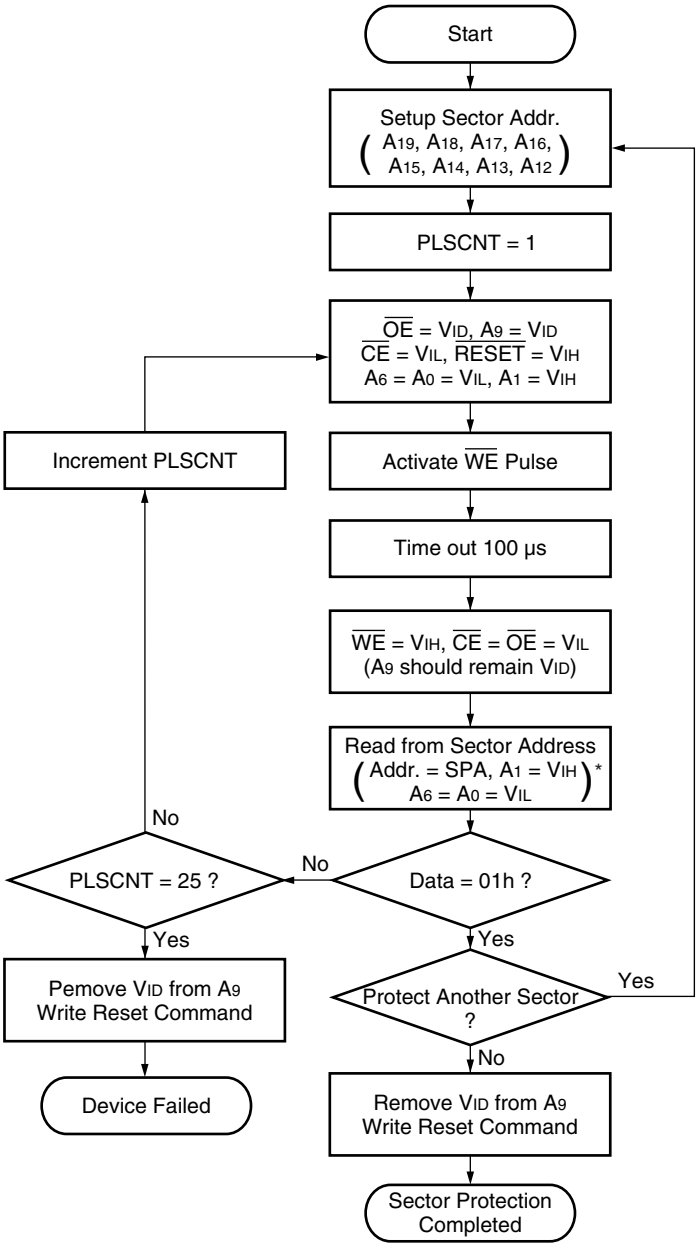
**$\overline{\text{Data}}$ Polling Algorithm**




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

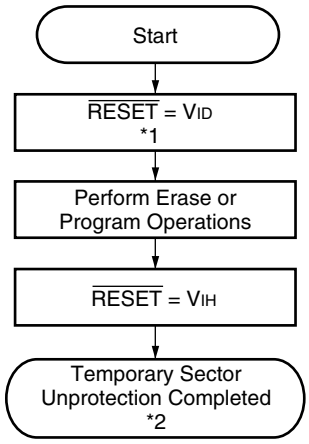
*2 : Recheck toggle bit because it may stop toggling as $DQ_5$ changes to "1".

**Toggle Bit Algorithm**




* : $A_{-1}$ is $V_{IL}$ on byte mode.

**Sector Protection Algorithm**

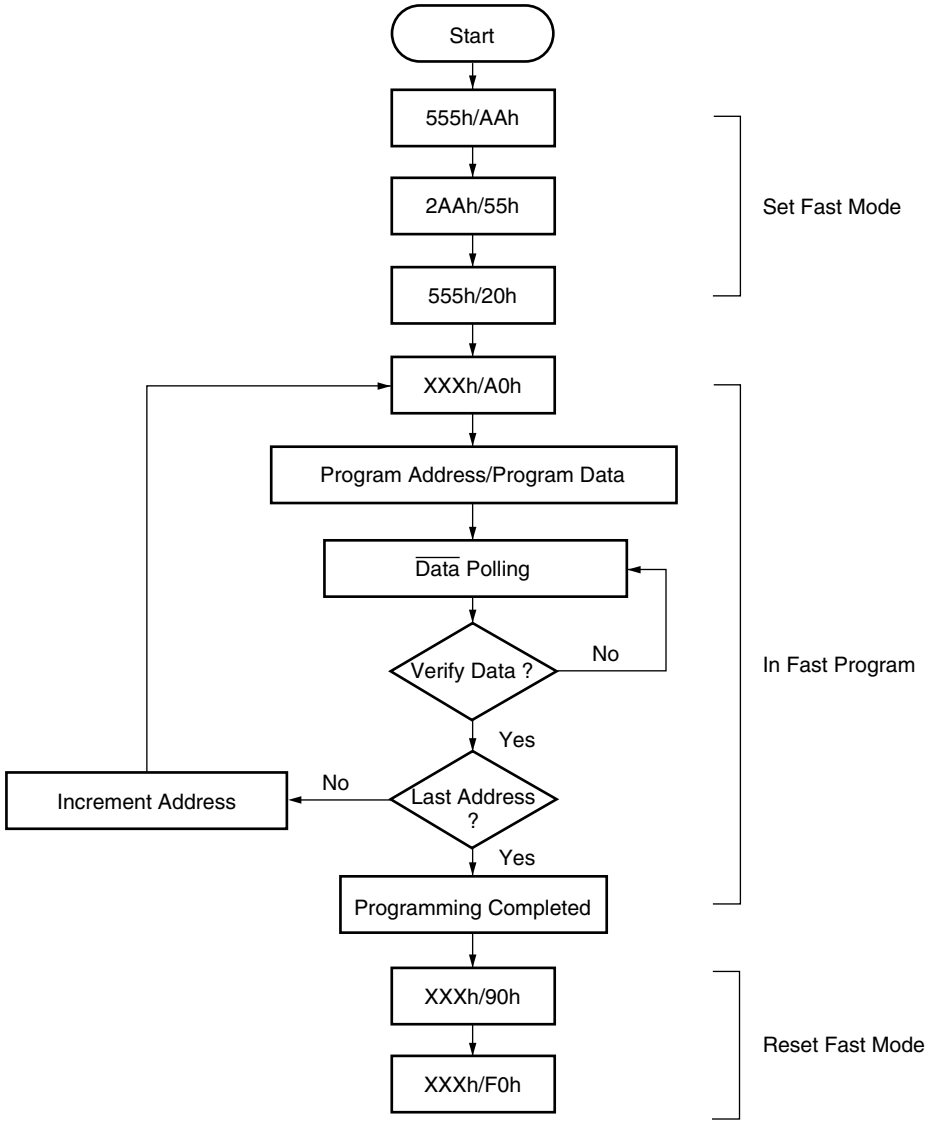



*1 : All protected sectors are unprotected.

*2 : All previously protected sectors are protected once again.

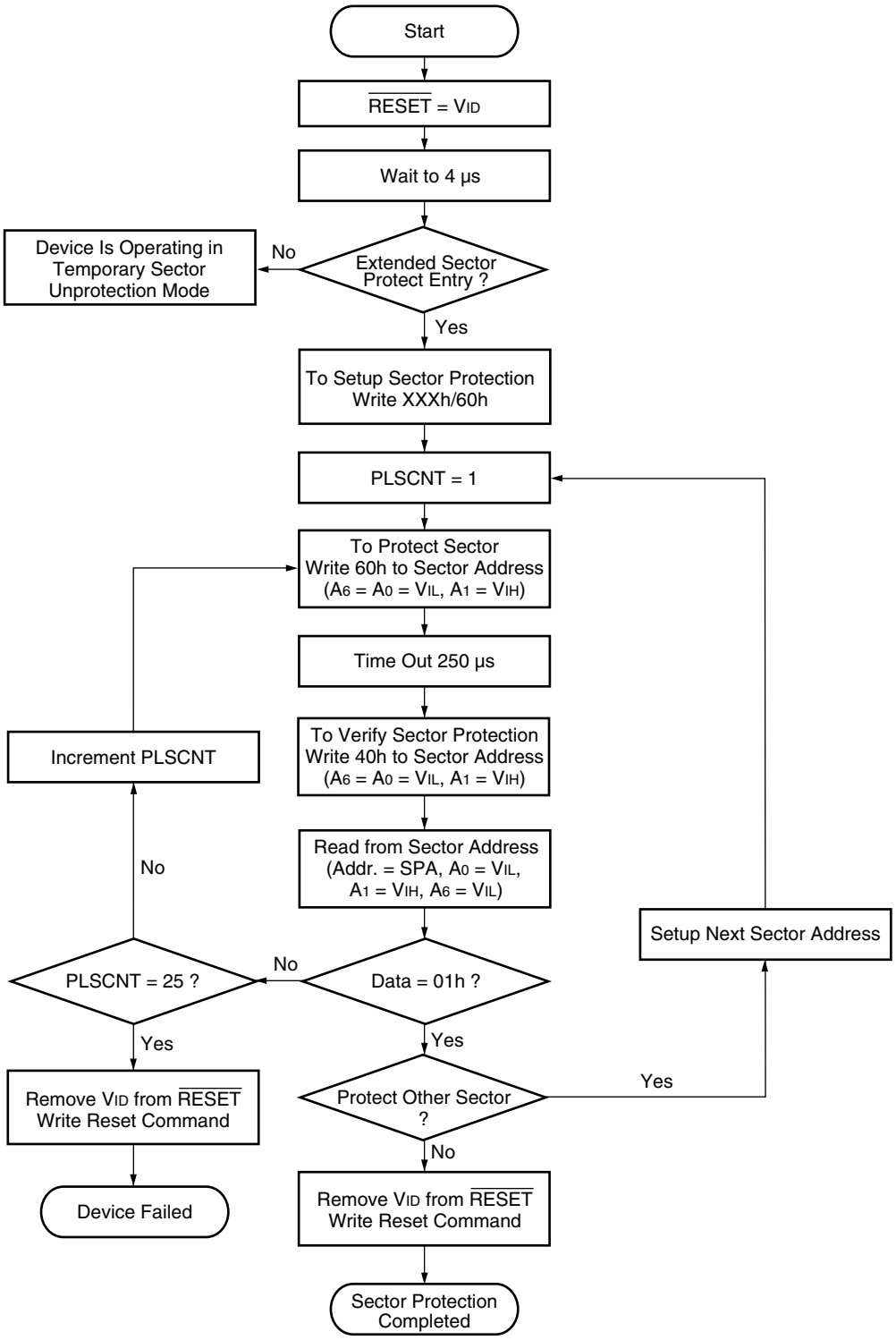
**Temporary Sector Unprotection Algorithm**

**FAST MODE ALGORITHM**




Note : The sequence is applied for ×16 mode.
The addresses differ from ×8 mode.

**Embedded Programming Algorithm for Fast Mode**

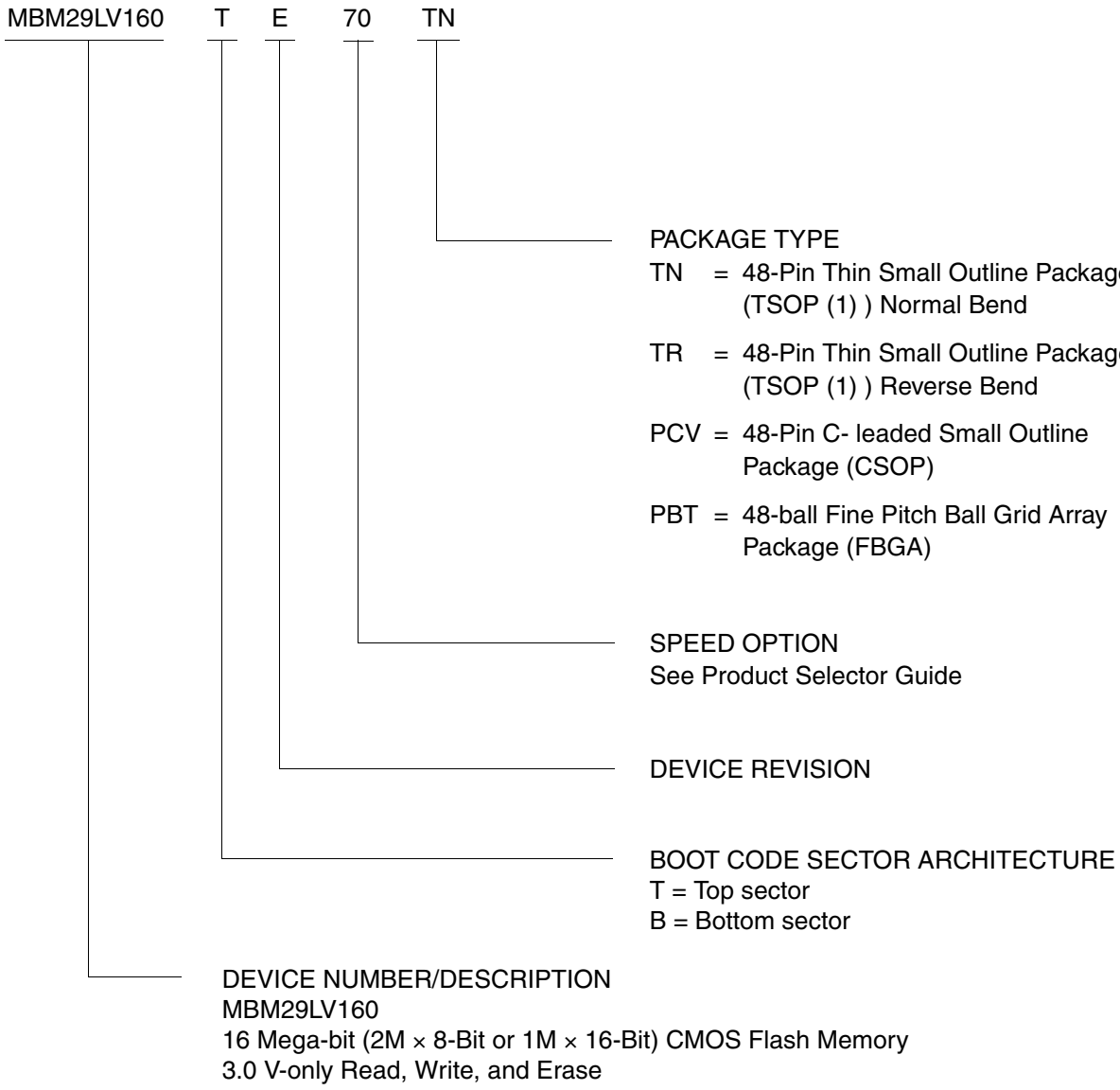



**Extended Sector Protection Algorithm**

## ■ ORDERING INFORMATION

### Standard Products

Fujitsu standard products are available in several packages. The order number is formed by a combination of:




| Valid Combinations | | |
|---|---|---|
| MBM29LV160TE/BE | 70<br>90 | TN<br>TR<br>PCV<br>PBT |

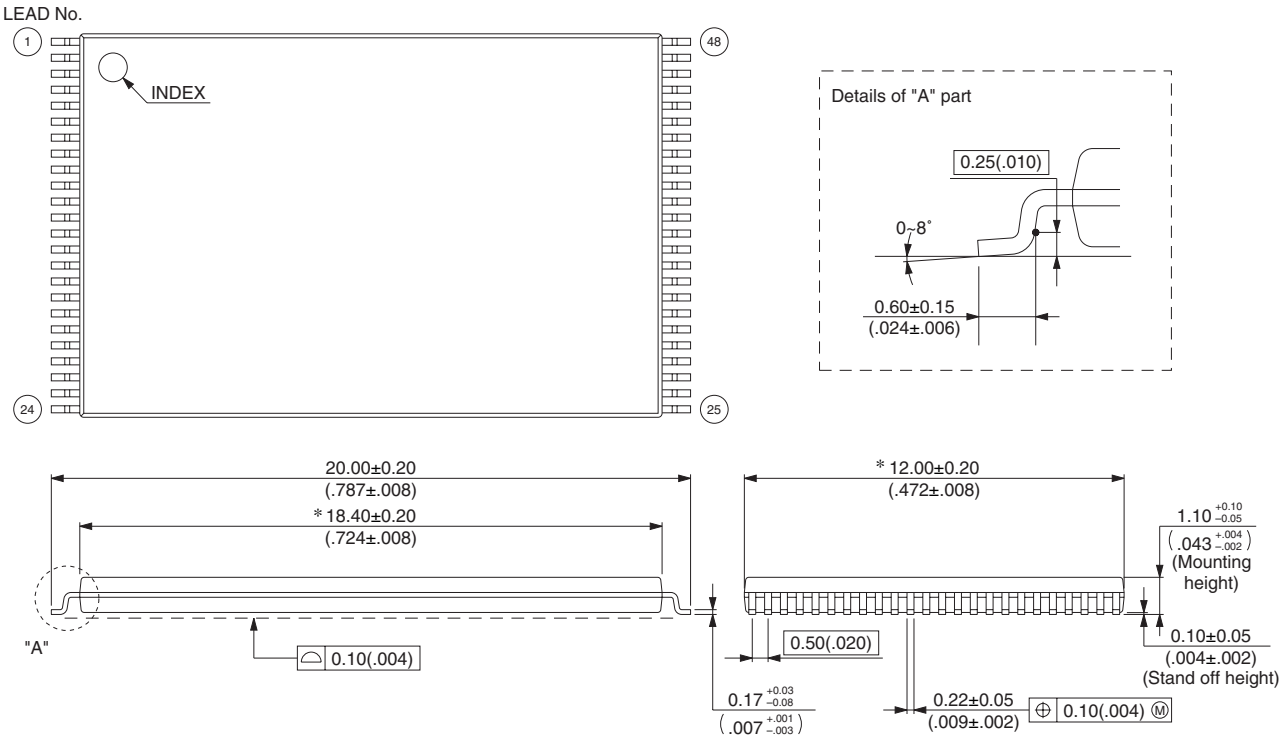
**Valid Combinations**

Valid Combinations list configurations planned to be supported in volume for this device. Consult the local Fujitsu sales office to confirm availability of specific valid combinations and to check on newly released combinations.

## ■ PACKAGE DIMENSIONS

48-pin plastic TSOP (1)
(FPT-48P-M19)

Note 1) * : Values do not include resin protrusion.
Resin protrusion and gate protrusion are +0.15 (.006) MAX (each side) .
Note 2) Pins width and pins thickness include plating thickness.
Note 3) Pins width do not include tie bar cutting remainder.



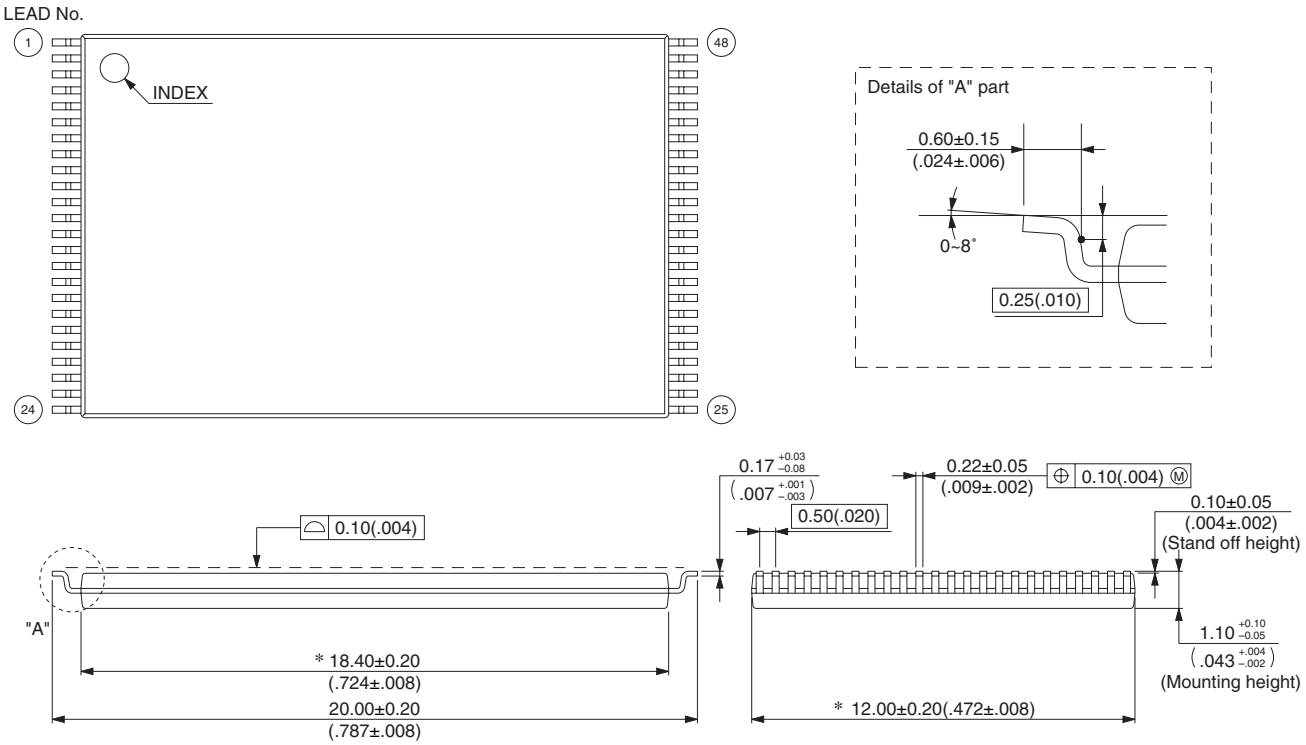



Dimensions in mm (inches) .
Note : The values in parentheses are reference values.

*(Continued)*

48-pin plastic TSOP (1)
(FPT-48P-M20)

Note 1) * : Values do not include resin protrusion.
Resin protrusion and gate protrusion are +0.15 (.006) MAX (each side) .
Note 2) Pins width and pins thickness include plating thickness.
Note 3) Pins width do not include tie bar cutting remainder.



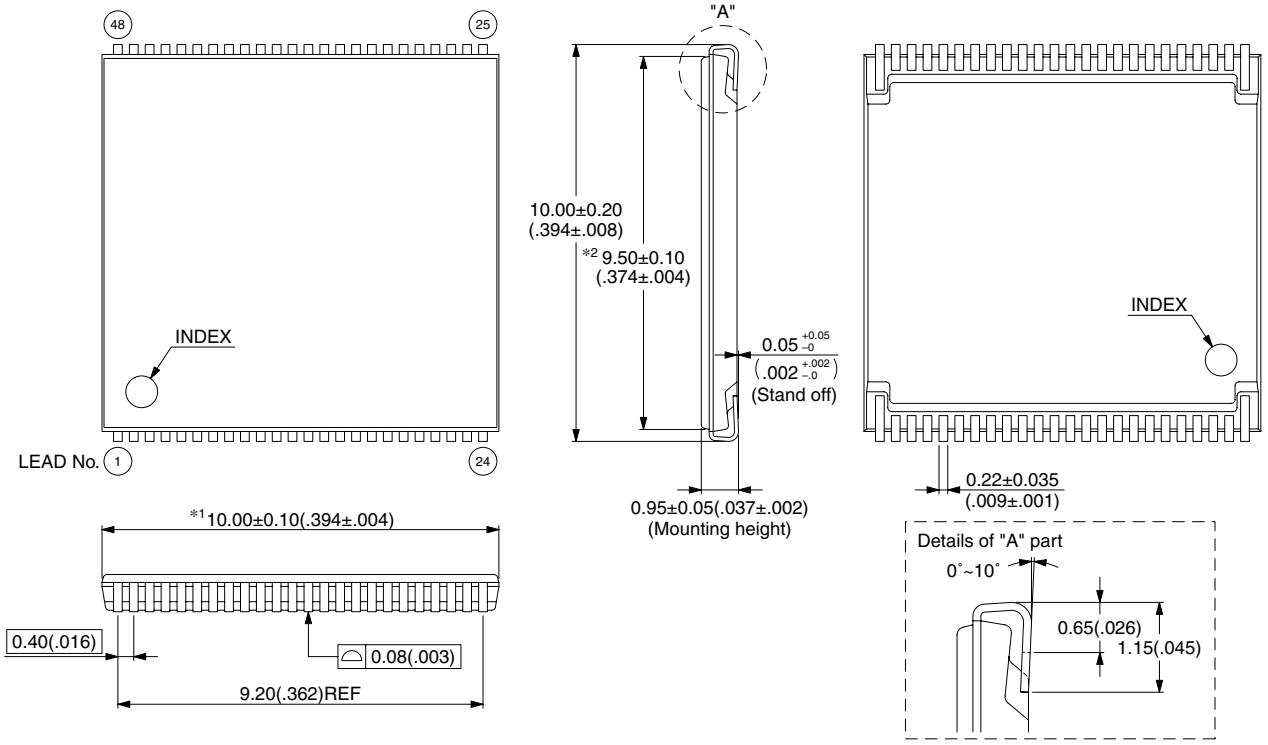



Dimensions in mm (inches) .
Note : The values in parentheses are reference values.

*(Continued)*

48-pin plastic CSOP
(LCC-48P-M03)

Note 1) *1 : Resin protrusion (Each side : +0.15 (.006) Max) .
Note 2) *2 : These dimensions do not include resin protrusion.
Note 3) Pins width includes plating thickness.
Note 4) Pins width do not include tie bar cutting remainder.



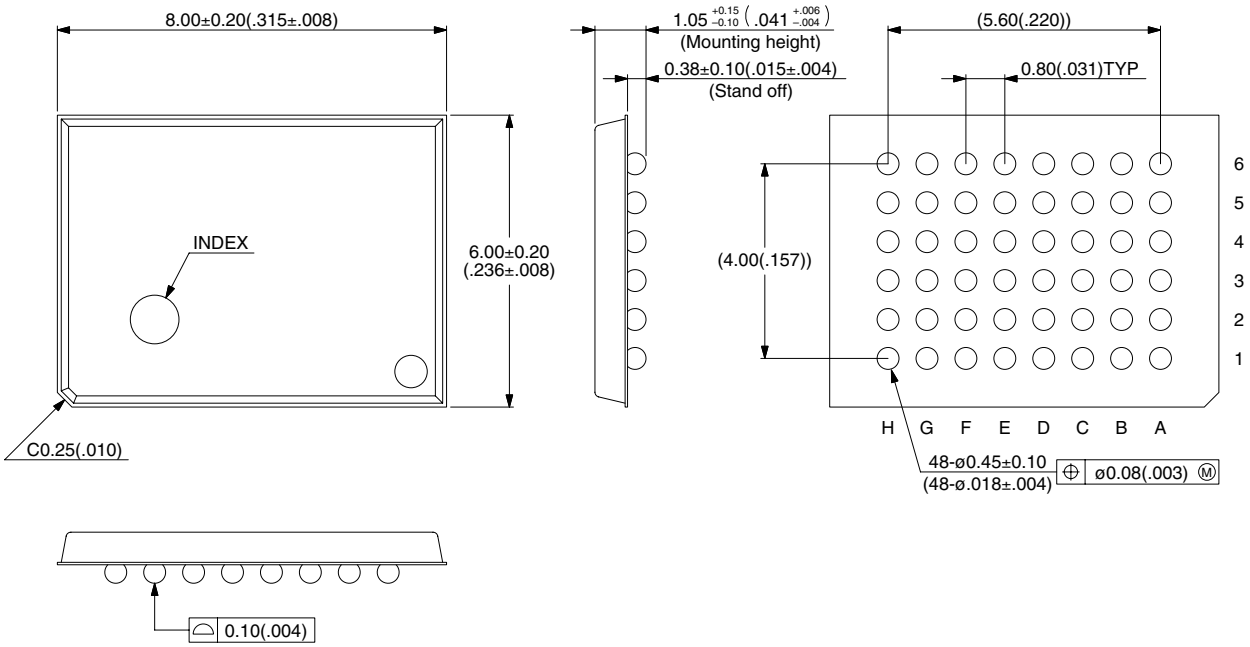



Dimensions in mm (inches) .
Note : The values in parentheses are reference values.

*(Continued)*

*(Continued)*

48-ball plastic FBGA
(BGA-48P-M11)






Dimensions in mm (inches) .
Note : The values in parentheses are reference values.

# MEMO

# MEMO

# Revision History

## Revision DS05-20883-7E（July 31, 2007）

**The following comment is added.**

This product has been retired and is not recommended for new designs. Availability of this document is retained for reference and historical purposes only.

# FUJITSU LIMITED

*For further information please contact:*

**Japan**

FUJITSU LIMITED
Marketing Division
Electronic Devices
Shinjuku Dai-Ichi Seimei Bldg. 7-1,
Nishishinjuku 2-chome, Shinjuku-ku,
Tokyo 163-0721, Japan
Tel: +81-3-5322-3353
Fax: +81-3-5322-3386

*http://edevice.fujitsu.com/*

**North and South America**

FUJITSU MICROELECTRONICS AMERICA, INC.
1250 E. Arques Avenue, M/S 333
Sunnyvale, CA 94088-3470, U.S.A.
Tel: +1-408-737-5600
Fax: +1-408-737-5999

*http://www.fma.fujitsu.com/*

**Europe**

FUJITSU MICROELECTRONICS EUROPE GmbH
Am Siebenstein 6-10,
D-63303 Dreieich-Buchschlag,
Germany
Tel: +49-6103-690-0
Fax: +49-6103-690-122

*http://www.fme.fujitsu.com/*

**Asia Pacific**

FUJITSU MICROELECTRONICS ASIA PTE LTD.
#05-08, 151 Lorong Chuan,
New Tech Park,
Singapore 556741
Tel: +65-6281-0770
Fax: +65-6281-0220

*http://www.fmal.fujitsu.com/*

**Korea**

FUJITSU MICROELECTRONICS KOREA LTD.
1702 KOSMO TOWER, 1002 Daechi-Dong,
Kangnam-Gu,Seoul 135-280
Korea
Tel: +82-2-3484-7100
Fax: +82-2-3484-7111

*http://www.fmk.fujitsu.com/*

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