FUJITSU SEMICONDUCTOR
DATA SHEET

DS05-20847-2E

FLASH MEMORY

CMOS

2M (256K × 8) BIT

MBM29F002T-90-X/-12-X/MBM29F002B-90-X/-12-X

■ FEATURES

- **Single 5.0 V read, program, and erase**
  Minimizes system level power requirements
- **Compatible with JEDEC-standard commands**
  Uses same software commands as E^2PROMs
- **Package option**
  32-pin TSOP (Package suffix: PFTN-Normal Bend Type, PFTR-Reversed Bend Type)
  ⋯ MBM29F002T-X/002B-X
  32-pin PLCC (Package suffix: PD) ⋯ MBM29F002T-X/002B-X
- **Minimum 100,000 write/erase cycles**
- **High performance**
  90 ns maximum access time
- **Sector erase architecture**
  One 16K byte, two 8K bytes, one 32K byte, and three 64K bytes.
  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 write and verifies data at specified address
- **$\overline{\text{Data}}$ Polling and Toggle Bit feature for detection of program or erase cycle completion**
- **Low Vcc write inhibit ≤ 3.2 V**
- **Hardware $\overline{\text{RESET}}$ pin**
  Resets internal state machine to the read mode
- **Sector protection**
  Hardware method disables any combination of sectors from write or erase operations

(Continued)

MBM29F002T-90-X/-12-X/MBM29F002B-90-X/-12-X

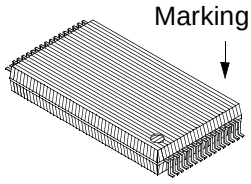
(Continued)

- **Temporary sector unprotection**
  Hardware method temporarily enables any combination of sectors from write or erase operations
- **Erase Suspend/Resume**
  Suspends the erase operation to allow a read in another sector within the same device
- **Extended operating temperature range: –40°C to +85°C**

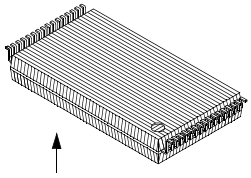
Please refer to “MBM29F002T/002B” in detailed specifications.

■ PACKAGE

32-pin plastic TSOP (I)

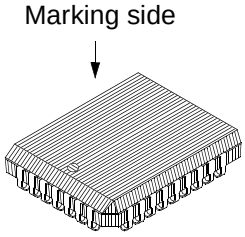


(FPT-32P-M24)



(FPT-32P-M25)

32-pin plastic QFJ (PLCC)



(LCC-32P-M02)

■ GENERAL DESCRIPTION

The MBM29F002T-X/B-X is a 2M-bit, 5.0 V-only Flash memory organized as 256K bytes of 8 bits each. The MBM29F002T-X/B-X is offered in a 32-pin TSOP (I) and 32-pin QFJ (PLCC) packages. The device is designed to be programmed in-system with the standard system 5.0 V V_{CC} supply. A 12.0 V V_{PP} is not required for write or erase operations. The device can also be reprogrammed in standard EPROM programmers.
The standard MBM29F002T-X/B-X offers access times 90 ns and 120 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 MBM29F002T-X/B-X is command set compatible with JEDEC standard E^2PROMs. 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 12.0 V Flash or EPROM devices.

The MBM29F002T-X/B-X is programmed by executing the program command sequence. This will invoke the Embedded Program Algorithm which is an internal algorithm that automatically times the program pulse widths and verifies proper cell margin. Typically, each sector can be programmed and verified in about 0.5 seconds. Erase is accomplished by executing the erase command sequence. This will invoke the Embedded Erase Algorithm which is an internal algorithm that automatically preprograms the array if it is not already programmed before executing the erase operation. During erase, the device automatically times the erase pulse widths and verifies proper cell margin.

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

The device also features a sector erase architecture. The sector mode allows each sector to be erased and reprogrammed without affecting other sectors. The MBM29F002T-X/B-X is erased when shipped from the factory.

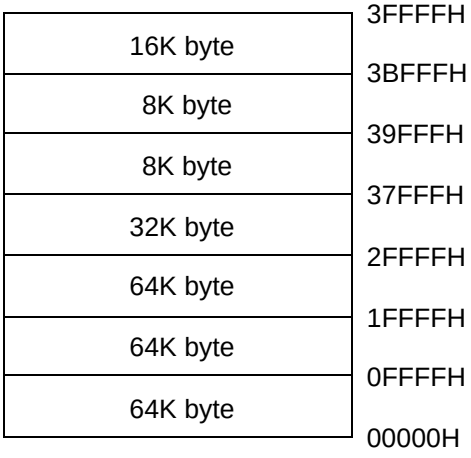
The device features single 5.0 V power supply operation for both read and write functions. Internally generated and regulated voltages are provided for the program and erase operations. A low V_{CC} detector automatically inhibits write operations on the loss of power. The end of program or erase is detected by $\overline{Data}$ Polling of DQ_7, by the Toggle Bit feature on DQ_6, or the RY/$\overline{BY}$ pin. Once the end of a program or erase cycle has been completed, the device internally resets to the read mode.

Fujitsu's Flash technology combines years of EPROM and E^2PROM experience to produce the highest levels of quality, reliability and cost effectiveness. The MBM29F002T-X/B-X memory electrically erases the entire chip or all bits within a sector simultaneously via Fowler-Nordhiem tunneling. The byte is programmed one byte at a time using the EPROM programming mechanism of hot electron injection.

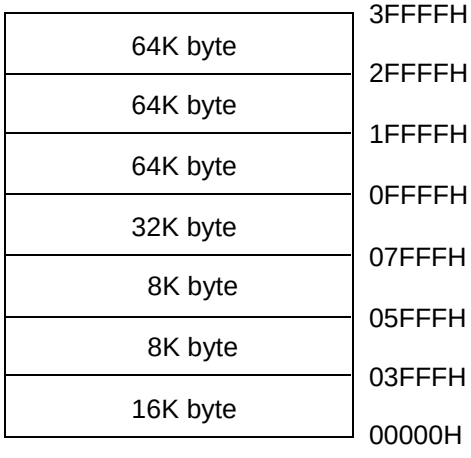
MBM29F002T-90-X/-12-X/MBM29F002B-90-X/-12-X

■ FLEXIBLE SECTOR-ERASE ARCHITECTURE

- One 16K byte, and two 8K bytes, one 32K byte, and three 64K bytes
- Individual-sector, multiple-sector, or bulk-erase capability
- Individual or multiple-sector protection is user definable.



MBM29F002T-X Sector Architecture



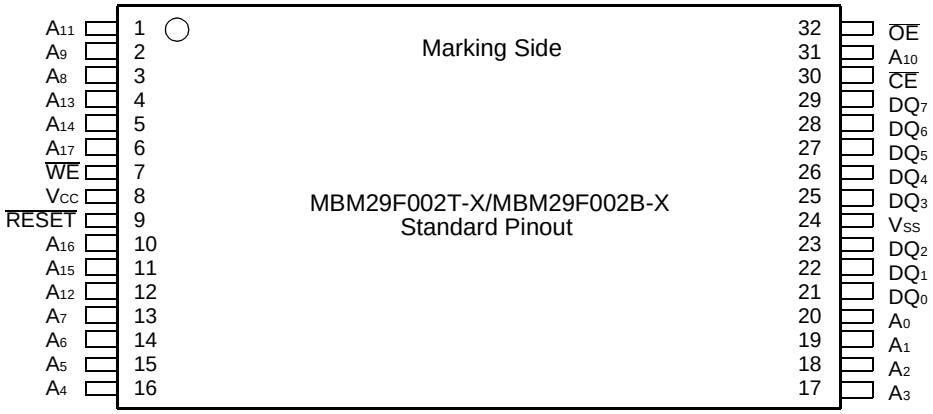
MBM29F002B-X Sector Architecture

■ PRODUCT LINE UP

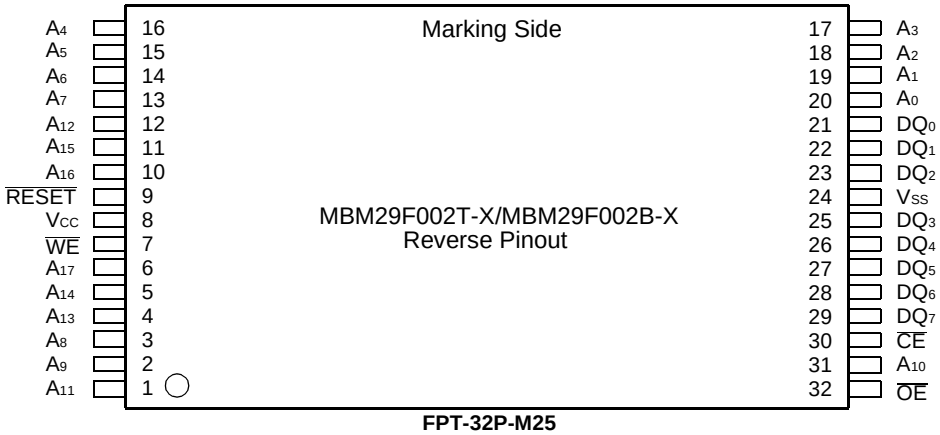
Part No.		**MBM29F002T-X/B-X**	
Ordering Part No.	V_{CC} = 5.0 V±10%	-90-X	-12-X
Max. Address Access Time (ns)		90	120
Max. $\overline{CE}$ Access Time (ns)		90	120
Max. $\overline{OE}$ Access Time (ns)		35	50

■ CONNECTION DIAGRAMS

TSOP (I)

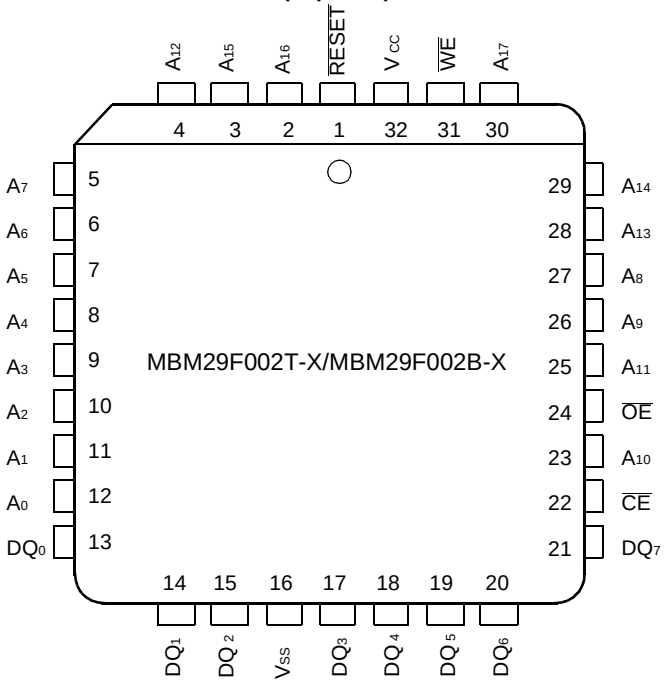


FPT-32P-M24



FPT-32P-M25

QFJ (PLCC)
(Top View)



LCC-32P-M02

■ LOGIC SYMBOL

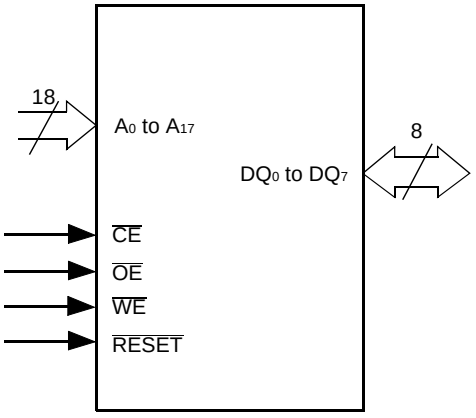


Table 1 MBM29F002T-X/B-X Pin Configuration

Pin	Function
A_0 to A_{17}	Address Inputs
DQ_0 to DQ_7	Data Inputs/Outputs
$\overline{CE}$	Chip Enable
$\overline{OE}$	Output Enable
$\overline{WE}$	Write Enable
$\overline{RESET}$	Hardware Reset Pin/Sector Protection Unlock
N.C.	No Internal Connection
V_{SS}	Device Ground
V_{CC}	Device Power Supply (5.0 V±10%)

MBM29F002T-90-X/-12-X/MBM29F002B-90-X/-12-X

■ ORDERING INFORMATION

Industrial Devices

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

MBM29F002 T -90 PFTN -X

OPERATING RANGE
Industrial Devices
Ambient Temperature (T_A) = –40°C to +85°C

PACKAGE TYPE
T, B:
PFTN = 32-Pin Plastic Thin Small Outline Package (TSOP) Standard Pinout
PFTR = 32-Pin Plastic Thin Small Outline Package (TSOP) Reverse Pinout
PD = 32-Pin Rectangular Plastic Leaded Chip Carrier (PLCC)

SPEED OPTION
See Product Selector Guide

BOOT CODE SECTOR ARCHITECTURE
T = Top sector
B = Bottom sector

DEVICE NUMBER/DESCRIPTION
MBM29F002
2 Mega-bit (256K × 8-Bit) CMOS Flash Memory
5.0 V-only Read, Program, and Erase

■ ABSOLUTE MAXIMUM RATINGS

Storage Temperature .....–55°C to +125°C
Ambient Temperature with Power Applied.....–40°C to +85°C
Voltage with Respect to Ground All pins except A_9, $\overline{OE}$, $\overline{RESET}$ (Note 1).....–2.0 V to +7.0 V
V_{CC} (Note 1).....–2.0 V to +7.0 V
A_9, $\overline{OE}$, and $\overline{RESET}$ (Note 2) .....–2.0 V to +13.5 V

Notes: 1. Minimum DC voltage on input or I/O pins are –0.5 V. During voltage transitions, inputs may negative overshoot V_{SS} to –2.0 V for periods of up to 20 ns. Maximum DC voltage on output and I/O pins are V_{CC} +0.5 V. During voltage transitions, outputs may positive 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 are –0.5 V. During voltage transitions, A_9, $\overline{OE}$, and $\overline{RESET}$ pins may negative overshoot V_{SS} to –2.0 V for periods of up to 20 ns. Maximum DC input voltage on A_9, $\overline{OE}$, and $\overline{RESET}$ pins are +13.0 V which may positive overshoot to 13.5 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 RANGES

Industrial Devices

Ambient Temperature (T_A) .....–40°C to +85°C
V_{CC} Supply Voltages.....+4.50 V to +5.50 V

Recommended operating ranges define those limits between which the functionality of the device is guaranteed.

WARNING: Recommended operating conditions are normal operating ranges for the semiconductor device. All the device's electrical characteristics are warranted when operated within these ranges.

Always use semiconductor devices within the recommended operating conditions. 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 representative beforehand.

■ MAXIMUM OVERSHOOT

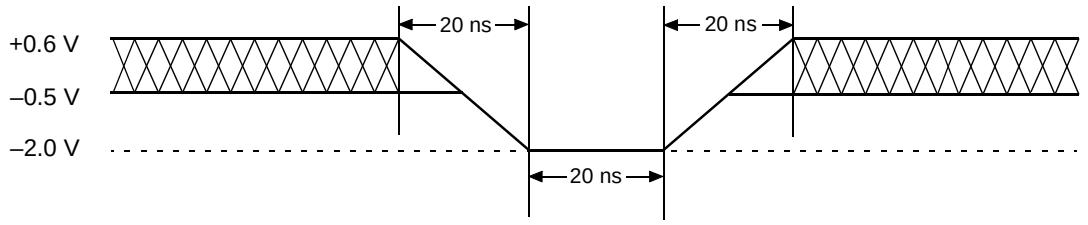


Figure 1 Maximum Negative Overshoot Waveform

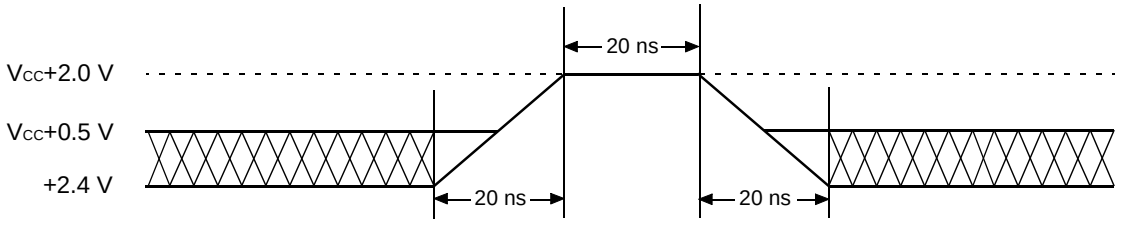
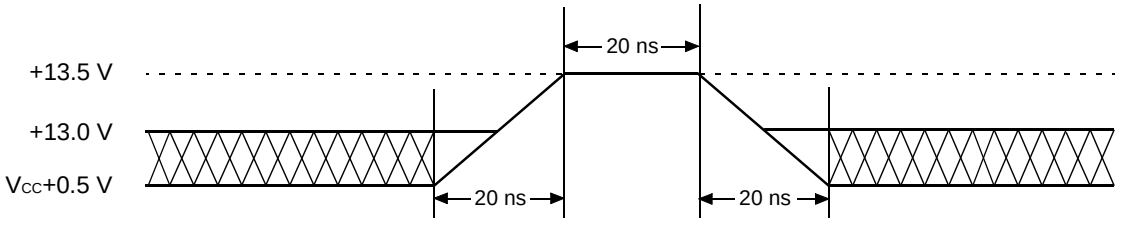


Figure 2 Maximum Positive Overshoot Waveform



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

Figure 3 Maximum Positive Overshoot Waveform

■ DC CHARACTERISTICS

- **TTL/NMOS Compatible**

Parameter Symbol	Parameter Description	Test Conditions	Min.	Max.	Unit
I_{LI}	Input Leakage Current	V_{IN} = V_{SS} to V_{CC}, V_{CC} = V_{CC} Max.	—	±1.0	µA
I_{LO}	Output Leakage Current	V_{OUT} = V_{SS} to V_{CC}, V_{CC} = V_{CC} Max.	—	±1.0	µA
I_{LIT}	A_9, $\overline{OE}$, $\overline{RESET}$ Inputs Leakage Current	V_{CC} = V_{CC} Max. A_9, $\overline{OE}$, $\overline{RESET}$ = 12.5 V	—	50	µA
I_{CC1}	V_{CC} Active Current (Note 1)	$\overline{CE}$ = V_{IL}, $\overline{OE}$ = V_{IH}	—	50	mA
I_{CC2}	V_{CC} Active Current (Note 2)	$\overline{CE}$ = V_{IL}, $\overline{OE}$ = V_{IH}	—	80	mA
I_{CC3}	V_{CC} Current (Standby)	V_{CC} = V_{CC} Max., $\overline{CE}$ = V_{IH}, $\overline{RESET}$ = V_{IH}	—	1.5	mA
I_{CC4}	V_{CC} Current (Standby, Reset)	V_{CC} = V_{CC} Max., $\overline{RESET}$ = V_{IL}	—	1.5	mA
V_{IL}	Input Low Level	—	–0.5	0.6	V
V_{IH}	Input High Level	—	2.4	V_{CC}+0.5	V
V_{ID}	Voltage for Autoselect and Sector Protection (A_9, $\overline{OE}$, $\overline{RESET}$) (Note 3)	V_{CC} = 5.0 V	11.5	12.5	V
V_{OL}	Output Low Voltage Level	I_{OL} = 5.8 mA, V_{CC} = V_{CC} Min.	—	0.45	V
V_{OH}	Output High Voltage Level	I_{OH} = –2.5 mA, V_{CC} = V_{CC} Min.	2.4	—	V
V_{LKO}	Low V_{CC} Lock-Out Voltage	—	3.2	4.2	V

Notes: 1. The I_{CC} current listed includes both the DC operating current and the frequency dependent component (at 6 MHz).
The frequency component typically is 2 mA/MHz.
2. I_{CC} active while Embedded Algorithm (program or erase) is in progress.
3. Applicable to sector protection function.

• **CMOS Compatible**

Parameter Symbol	Parameter Description	Test Conditions	Min.	Max.	Unit
I_{LI}	Input Leakage Current	V_{IN} = V_{SS} to V_{CC}, V_{CC} = V_{CC} Max.	—	±1.0	µA
I_{LO}	Output Leakage Current	V_{OUT} = V_{SS} to V_{CC}, V_{CC} = V_{CC} Max.	—	±1.0	µA
I_{LIT}	A_9, $\overline{OE}$, $\overline{RESET}$ Inputs Leakage Current	V_{CC} = V_{CC} Max. A_9, $\overline{OE}$, $\overline{RESET}$ = 12.5 V	—	50	µA
I_{CC1}	V_{CC} Active Current (Note 1)	$\overline{CE}$ = V_{IL}, $\overline{OE}$ = V_{IH}	—	50	mA
I_{CC2}	V_{CC} Active Current (Note 2)	$\overline{CE}$ = V_{IL}, $\overline{OE}$ = V_{IH}	—	80	mA
I_{CC3}	V_{CC} Current (Standby)	V_{CC} = V_{CC} Max., $\overline{CE}$ = V_{CC} ± 0.3 V, $\overline{RESET}$ = V_{CC} ± 0.3 V	—	100	µA
I_{CC4}	V_{CC} Current (Standby, Reset)	V_{CC} = V_{CC} Max., $\overline{RESET}$ = V_{SS} ± 0.3 V	—	100	µA
V_{IL}	Input Low Level	—	–0.5	0.6	V
V_{IH}	Input High Level	—	0.7×V_{CC}	V_{CC}+0.3	V
V_{ID}	Voltage for Autoselect and Sector Protection (A_9, $\overline{OE}$, $\overline{RESET}$) (Note 3)	V_{CC} = 5.0 V	11.5	12.5	V
V_{OL}	Output Low Voltage Level	I_{OL} = 5.8 mA, V_{CC} = V_{CC} Min.	—	0.45	V
V_{OH1}	Output High Voltage Level	I_{OH} = –2.5 mA, V_{CC} = V_{CC} Min.	0.85×V_{CC}	—	V
V_{OH2}		I_{OH} = –100 µA, V_{CC} = V_{CC} Min.	V_{CC}–0.4	—	V
V_{LKO}	Low V_{CC} Lock-Out Voltage	—	3.2	4.2	V

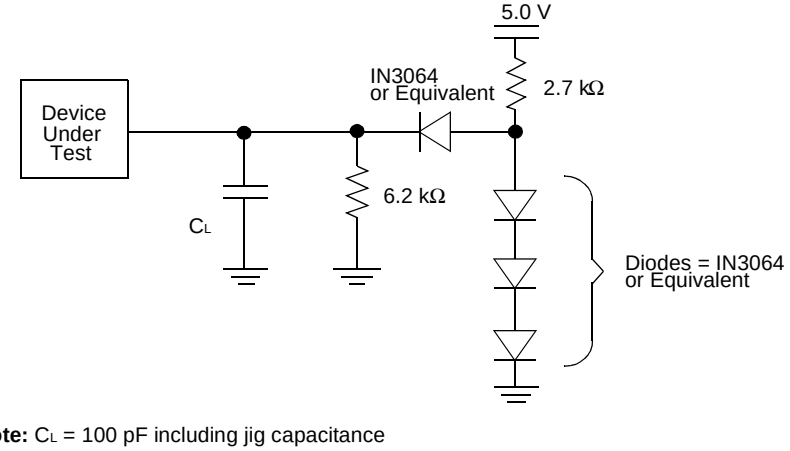
Notes: 1. The I_{CC} current listed includes both the DC operating current and the frequency dependent component (at 6 MHz).
The frequency component typically is 2 mA/MHz.
2. I_{CC} active while Embedded Algorithm (program or erase) is in progress.
3. Applicable to sector protection function.

■ AC CHARACTERISTICS

- **Read Only Operations Characteristics**

Parameter Symbols		Description	Test Setup		-90-X (Note)	-12-X (Note)	Unit
JEDEC	Standard						
t_{AVAV}	t_{RC}	Read Cycle Time	—	Min.	90	120	ns
t_{AVQV}	t_{ACC}	Address to Output Delay	$\overline{CE}$ = V_{IL} $\overline{OE}$ = V_{IL}	Max.	90	120	ns
t_{ELQV}	t_{CE}	Chip Enable to Output Delay	$\overline{OE}$ = V_{IL}	Max.	90	120	ns
t_{GLQV}	t_{OE}	Output Enable to Output Delay	—	Max.	35	50	ns
t_{EHQZ}	t_{DF}	Chip Enable to Output High-Z	—	Max.	20	30	ns
t_{GHQZ}	t_{DF}	Output Enable to Output High-Z	—	Max.	20	30	ns
t_{AXQX}	t_{OH}	Output Hold Time From Addresses, $\overline{CE}$ or $\overline{OE}$, Whichever Occurs First	—	Min.	0	0	ns
—	t_{READY}	$\overline{RESET}$ Pin Low to Read Mode	—	Max.	20	20	µs

Notes: Test Conditions:
Output Load: 1 TTL gate and 100 pF
Input rise and fall times: 20 ns
Input pulse levels: 0.45 V to 2.4 V
Timing measurement reference level
Input: 0.8 V and 2.0 V
Output: 0.8 V and 2.0 V



Note: C_L = 100 pF including jig capacitance

Figure 4 Test Conditions

- **Write/Erase/Program Operations**
  Alternate $\overline{WE}$ Controlled Writes

Parameter Symbols		Description			-90-X	-12-X	Unit
JEDEC	Standard						
t_{AVAV}	t_{WC}	Write Cycle Time		Min.	90	120	ns
t_{AVWL}	t_{AS}	Address Setup Time		Min.	0	0	ns
t_{WLAX}	t_{AH}	Address Hold Time		Min.	45	50	ns
t_{DVWH}	t_{DS}	Data Setup Time		Min.	45	50	ns
t_{WHDX}	t_{DH}	Data Hold Time		Min.	0	0	ns
—	t_{OES}	Output Enable Setup Time		Min.	0	0	ns
—	t_{OEH}	Output Enable Hold Time	Read	Min.	0	0	ns
			Toggle and $\overline{Data}$ Polling	Min.	10	10	ns
t_{GHWL}	t_{GHWL}	Read Recover Time Before Write		Min.	0	0	ns
t_{ELWL}	t_{CS}	$\overline{CE}$ Setup Time		Min.	0	0	ns
t_{WHEH}	t_{CH}	$\overline{CE}$ Hold Time		Min.	0	0	ns
t_{WLWH}	t_{WP}	Write Pulse Width		Min.	45	50	ns
t_{WHWL}	t_{WPH}	Write Pulse Width High		Min.	20	20	ns
t_{WHWH1}	t_{WHWH1}	Byte Programming Operation		Typ.	8	8	µs
t_{WHWH2}	t_{WHWH2}	Sector Erase Operation (Note 1)		Typ.	1	1	sec
				Max.	15	15	sec
—	t_{VCS}	V_{CC} Setup Time		Min.	50	50	µs
—	t_{VLHT}	Voltage Transition Time (Note 2)		Min.	4	4	µs
—	t_{WPP}	Write Pulse Width (Note 2)		Min.	100	100	µs
—	t_{OESP}	$\overline{OE}$ Setup Time to $\overline{WE}$ Active (Note 2)		Min.	4	4	µs
—	t_{CSP}	$\overline{CE}$ Setup Time to $\overline{WE}$ Active (Note 2)		Min.	4	4	µs
—	t_{RP}	$\overline{RESET}$ Pulse Width		Min.	500	500	ns

Notes: 1. This does not include the preprogramming time.
2. This timing is for Sector Protection operations.

- **Write/Erase/Program Operations**
  Alternate $\overline{CE}$ Controlled Writes

Parameter Symbols		Description			-90-X	-12-X	Unit
JEDEC	Standard						
t_{AVAV}	t_{WC}	Write Cycle Time		Min.	90	120	ns
t_{AVEL}	t_{AS}	Address Setup Time		Min.	0	0	ns
t_{ELAX}	t_{AH}	Address Hold Time		Min.	45	50	ns
t_{DVEH}	t_{DS}	Data Setup Time		Min.	45	50	ns
t_{EHDX}	t_{DH}	Data Hold Time		Min.	0	0	ns
—	t_{OES}	Output Enable Setup Time		Min.	0	0	ns
—	t_{OEH}	Output Enable Hold Time	Read	Min.	0	0	ns
			Toggle and $\overline{Data}$ Polling	Min.	10	10	ns
t_{GHEL}	t_{GHEL}	Read Recover Time Before Write		Min.	0	0	ns
t_{WLEL}	t_{WS}	$\overline{WE}$ Setup Time		Min.	0	0	ns
t_{EHWH}	t_{WH}	$\overline{WE}$ Hold Time		Min.	0	0	ns
t_{ELEH}	t_{CP}	$\overline{CE}$ Pulse Width		Min.	45	50	ns
t_{EHEL}	t_{CPH}	$\overline{CE}$ Pulse Width High		Min.	20	20	ns
t_{WHWH1}	t_{WHWH1}	Byte Programming Operation		Typ.	8	8	µs
t_{WHWH2}	t_{WHWH2}	Sector Erase Operation (Note)		Typ.	1	1	sec
				Max.	15	15	sec
—	t_{VCS}	V_{CC} Setup Time		Min.	50	50	µs
—	t_{RP}	$\overline{RESET}$ Pulse Width		Min.	500	500	ns

Note: This does not include the preprogramming time.

■ ERASE AND PROGRAMMING PERFORMANCE

Parameter	Limits			Unit	Comments
	Min.	Typ.	Max.		
Sector Erase Time	—	1	15	sec	Excludes 00H programming prior to erasure
Byte Programming Time	—	8	500	µs	Excludes system-level overhead
Chip Programming Time	—	2.1	13	sec	Excludes system-level overhead
Erase/Program Cycle	100,000	—	—	cycles	—

■ 32-PIN TSOP (I) PIN CAPACITANCE

Parameter Symbol	Parameter Description	Test Setup	Typ.	Max.	Unit
C_{IN}	Input Capacitance	V_{IN} = 0	7	8	pF
C_{OUT}	Output Capacitance	V_{OUT} = 0	8	10	pF
C_{IN2}	Control Pin Capacitance	V_{IN} = 0	8	10	pF

Note: Test conditions T_A = 25°C, f = 1.0 MHz

■ QFJ (PLCC) PIN CAPACITANCE

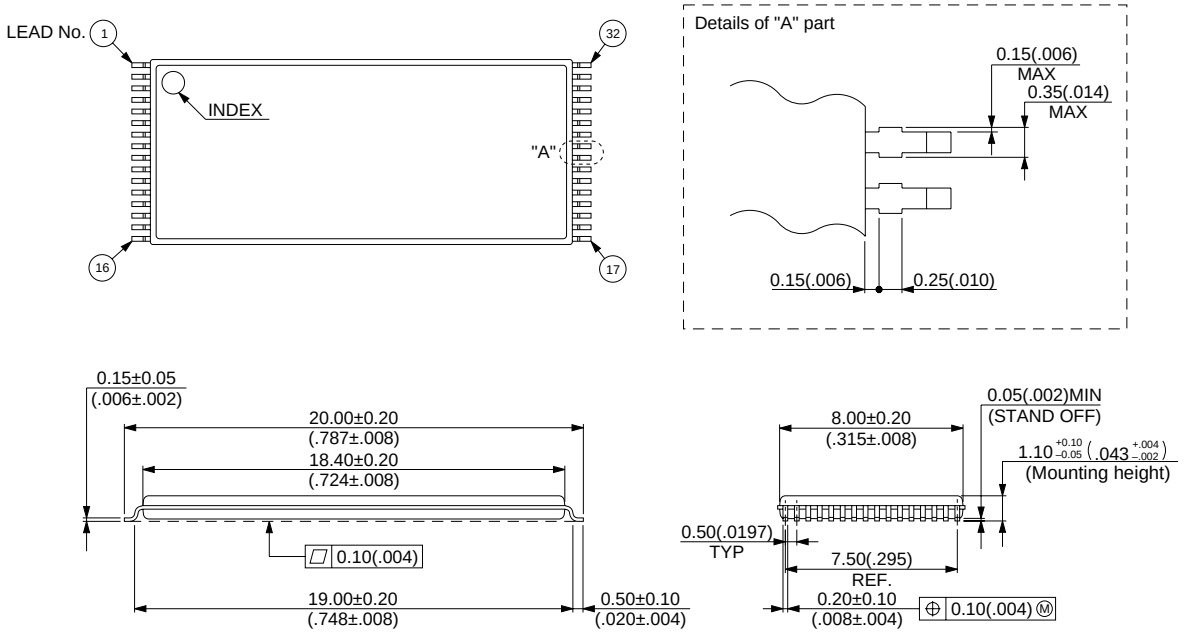
Parameter Symbol	Parameter Description	Test Setup	Typ.	Max.	Unit
C_{IN}	Input Capacitance	V_{IN} = 0	7	8	pF
C_{OUT}	Output Capacitance	V_{OUT} = 0	8	10	pF
C_{IN2}	Control Pin Capacitance	V_{IN} = 0	8	10	pF

Note: Test conditions T_A = 25°C, f = 1.0 MHz

MBM29F002T-90-X/-12-X/MBM29F002B-90-X/-12-X

■ PACKAGE DIMENSIONS

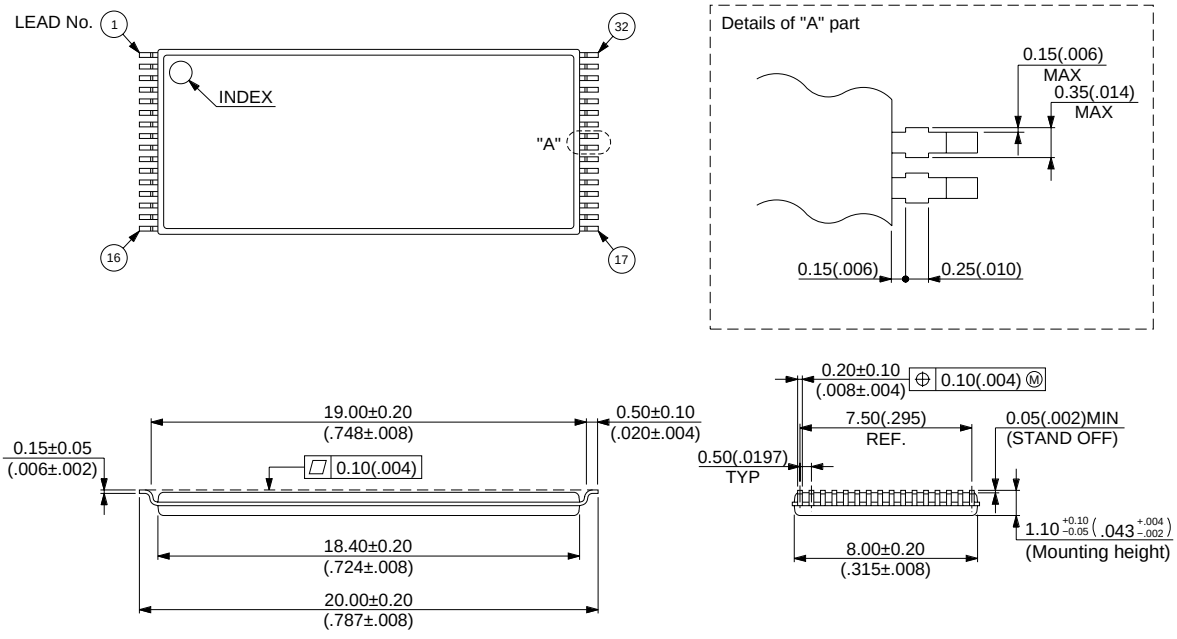
32-pin plastic TSOP (I)
(FPT-32P-M24)



Dimensions in mm (inches)

MBM29F002T-90-X/-12-X/MBM29F002B-90-X/-12-X

32-pin plastic TSOP (I)
(FPT-32P-M25)



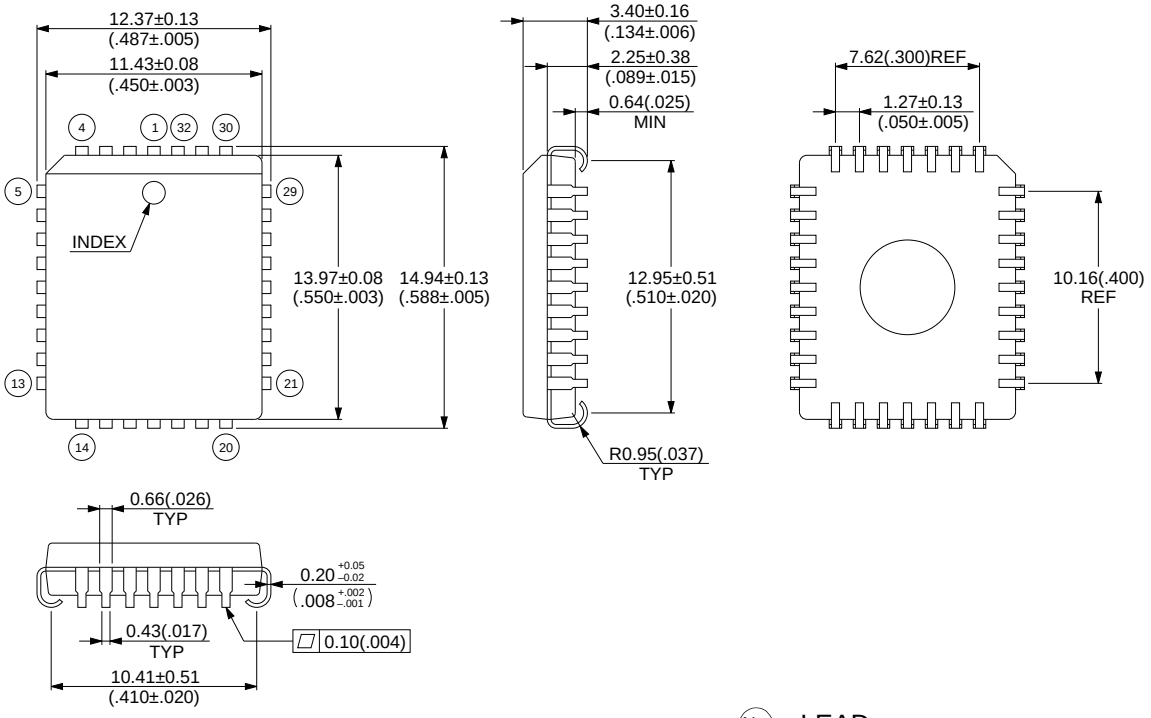
Dimensions in mm (inches)

(Continued)

MBM29F002T-90-X/-12-X/MBM29F002B-90-X/-12-X

(Continued)

32-pin plastic QFJ (PLCC)
(LCC-32P-M02)



No. : LEAD

Dimensions in mm (inches)

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