

# UV ERASABLE 65536-BIT READ ONLY MEMORY

**MBM 2764-20**  
**MBM 2764-25**  
**MBM 2764-30**

January 1984  
Edition 4.0

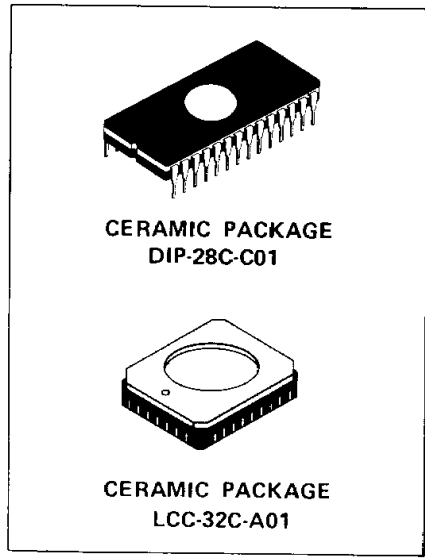
## MOS 8192x8BIT UV ERASABLE AND ELECTRICALLY PROGRAMMABLE READ ONLY MEMORY

The Fujitsu MBM 2764 is a high speed 65,536-bit static N-channel MOS erasable and electrically reprogrammable read only memory (EPROM). It is especially well suited for applications where rapid turn-around and/or bit pattern experimentation are important.

A 28-pin Dual-In-Line package and a 32-pad Leadless-Chip-Carrier with a transparent lid are used to package the MBM 2764. The transparent lid allows the user to expose the device to ultraviolet light in order to erase the memory bit pattern previously programmed. At the completion of erasure, a new pattern can then be written into the memory.

The MBM 2764 is fabricated using N-MOS double polysilicon gate technology with single transistor stacked gate cells. It is organized as 8192 words by 8 bits for use in microprocessor applications. Single +5V operation greatly facilitates its use in systems.

- 8192 words x 8 bits organization, fully decoded
- Simple programming requirements
- Single location programming
- Programmable utilizing the Quick Pro™ Algorithm
- Programs with one 50ms or 1ms pulse
- Low power requirement
  - Active : 788mW (550mW)
  - Standby : 184mW (193mW)
  - (Value in parentheses is for "AB" version.)
- No clocks required (fully static operation)
- TTL compatible inputs/outputs
- Three-state output with OR-tie capability
- Output Enable ( $\overline{OE}$ ) pin for simplified memory expansion
- Fast access time:
  - 200ns max. (MBM 2764-20)
  - 250ns max. (MBM 2764-25)
  - 300ns max. (MBM 2764-30)
- Single +5V operation
- Standard 28-pin DIP package and 32-pad LCC
- Interchangeable with Intel 2764



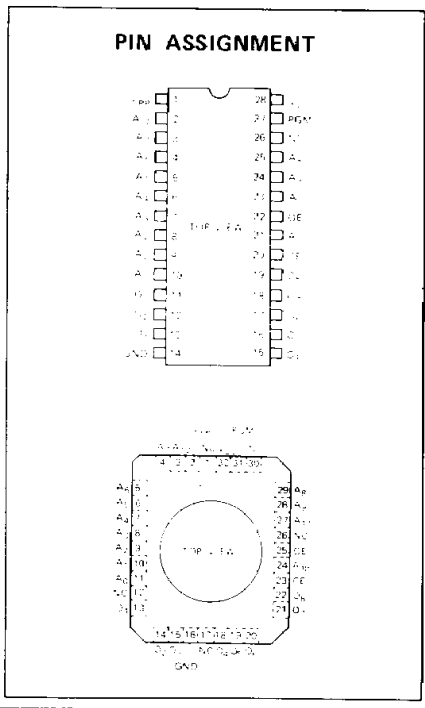
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### ABSOLUTE MAXIMUM RATINGS (see NOTE)

Rating	Symbol	Value	Unit
Temperature under Bias	$T_{BIAS}$	-25 to +85	°C
Storage Temperature	$T_{STG}$	-65 to +125	°C
All Inputs/Outputs Voltage with Respect to GND	$V_{IN}, V_{OUT}$	-0.6 to +7	V
$V_{PP}$ Voltage with Respect to GND	$V_{PP}$	-0.6 to +22	V
Supply Voltage with Respect to GND	$V_{CC}$	-0.6 to +7	V

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

Quick Pro™ is a trademark of FUJITSU LIMITED

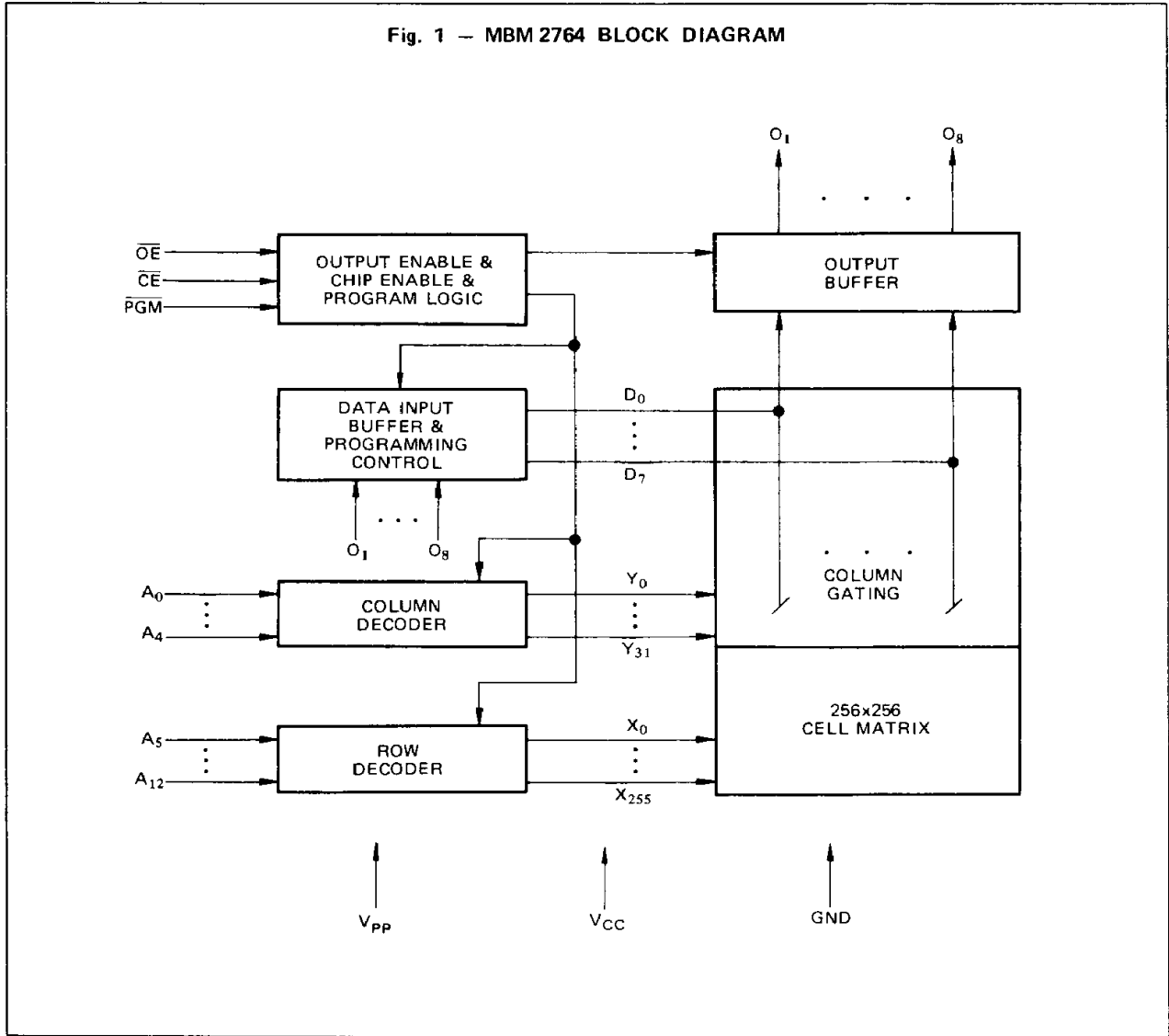


This device contains circuitry to protect the inputs against damage due to high static voltages or electric fields. However, it is advised that normal precautions be taken to avoid application of any voltage higher than maximum rated voltages to this high impedance circuit.



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**CAPACITANCE** ( $T_A = 25^\circ\text{C}$ ,  $f = 1\text{ MHz}$ )

Parameter	Symbol	Min	Typ	Max	Unit
Input Capacitance ( $V_{IN} = 0V$ )	$C_{IN}$	—	4	6	pF
Output Capacitance ( $V_{OUT} = 0V$ )	$C_{OUT}$	—	8	12	pF

## FUNCTIONS AND PIN CONNECTIONS

Function (Pin No.) Mode	Address Input (2~10, 23~25, 21)	Data I/O (11~13, 15~19)	$\overline{CE}$ (20)	$\overline{OE}$ (22)	$\overline{PGM}$ (27)	$V_{CC}$ (28)	$V_{PP}$ (1)	GND (14)
Read	$A_{IN}$	$D_{OUT}$	$V_{IL}$	$V_{IL}$	$V_{IH}$	$V_{CC}$	$V_{CC}$	GND
Output Disable	Don't Care	High-Z	$V_{IL}$	$V_{IH}$	Don't Care	$V_{CC}$	$V_{CC}$	GND
				Don't Care	$V_{IL}$			
Standby	Don't Care	High-Z	$V_{IH}$	Don't Care	Don't Care	$V_{CC}$	$V_{CC}$	GND
Program	$A_{IN}$	$D_{IN}$	$V_{IL}$	$V_{IH}$	$V_{IL}$	$V_{CC}$	$V_{PP}$	GND
Program Verify	$A_{IN}$	$D_{OUT}$	$V_{IL}$	$V_{IL}$	$V_{IH}$	$V_{CC}$	$V_{PP}$	GND
Program Inhibit	Don't Care	High-Z	$V_{IH}$	Don't Care	Don't Care	$V_{CC}$	$V_{PP}$	GND

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## RECOMMENDED OPERATING CONDITIONS

(Referenced to GND)

Parameter	Symbol	Min	Typ	Max	Unit
$V_{CC}$ Supply Voltage*1	$V_{CC}$	4.75 (4.5)*2	5.0	5.25 (5.5)*2	V
$V_{PP}$ Supply Voltage	$V_{PP}$	$V_{CC} - 0.6$	—	$V_{CC} + 0.6$	V
Input High Voltage	$V_{IH}$	2.0	—	$V_{CC} + 1$	V
Input Low Voltage	$V_{IL}$	-0.1	—	0.8	V
Operating Temperature	$T_A$	0		70	°C

Note: \*1  $V_{CC}$  must be applied either before or coincident with  $V_{PP}$  and removed either after or coincident with  $V_{PP}$ .  
\*2 Value in parentheses is for "AB" version.

## DC CHARACTERISTICS

(Recommended operating conditions unless otherwise noted)

Parameter	Symbol	Min	Typ	Max	Unit
Input Load Current ( $V_{IN} = 5.25V$ )*1	$I_{LI}$			10	$\mu A$
Output Leakage Current ( $V_{OUT} = 5.25V$ )*1	$I_{LO}$			10	$\mu A$
$V_{CC}$ Standby Current ( $\overline{CE} = V_{IH}$ )	$I_{CC1}$			35	mA
$V_{CC}$ Supply Current ( $\overline{CE} = V_{IL}$ )	$I_{CC2}$			150 (100)*2	mA
$V_{PP}$ Supply Current ( $V_{PP} = V_{CC} \pm 0.6V$ )	$I_{PP}$			15	mA
Output Low Voltage ( $I_{OL} = 2.1mA$ )	$V_{OL}$			0.45	V
Output High Voltage ( $I_{OH} = -400\mu A$ )	$V_{OH}$	2.4			V

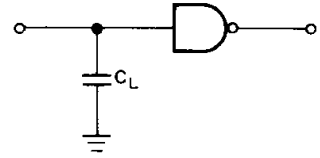
Note: \*1  $V_{IN}$  and  $V_{OUT}$  voltage for "AB" parts is 5.5V.  
\*2 Value in parentheses is for "AB" version.



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**Fig. 2 – AC TEST CONDITIONS (INCLUDING PROGRAMMING)**

Input Pulse Levels: 0.8V to 2.2V  
 Input Rise and Fall Times:  $\leq 20\text{ns}$   
 Timing Measurement Reference Levels: 1.0V and 2.0V for inputs  
 0.8V and 2.0V for outputs  
 Output Load: 1 TTL gate and  $C_L = 100\text{pF}$



## AC CHARACTERISTICS

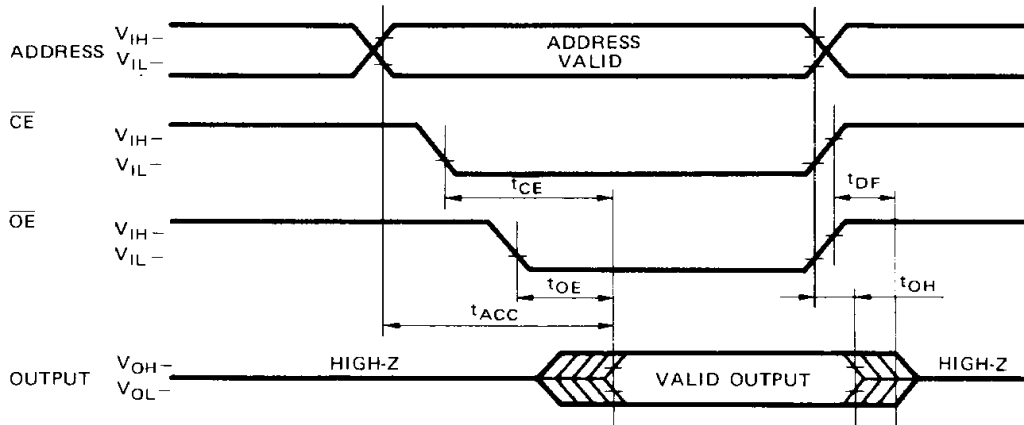
(Recommended operating conditions unless otherwise noted)

Parameter	Symbol	MBM 2764-20			MBM 2764-25			MBM 2764-30			Unit
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Address Access Time* <sup>1</sup>	$t_{ACC}$			200			250			300	ns
$\overline{CE}$ to Output Delay	$t_{CE}$			200			250			300	ns
$\overline{OE}$ to Output Delay* <sup>1</sup>	$t_{OE}$	10		70	10		100	10		120	ns
Address to Output Hold	$t_{OH}$	0			0			0			ns
Output Enable High to Output Float* <sup>2</sup>	$t_{DF}$	0		60	0		60	0		105	ns

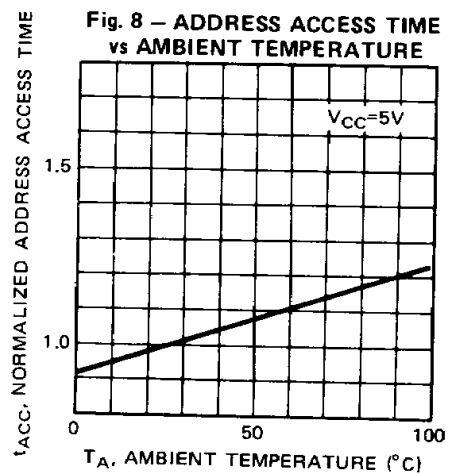
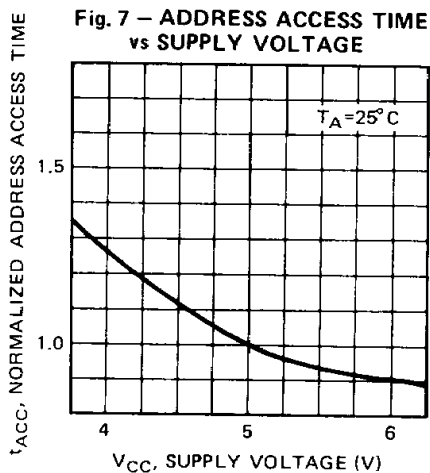
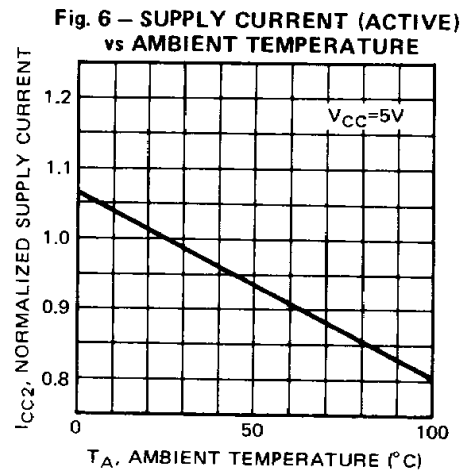
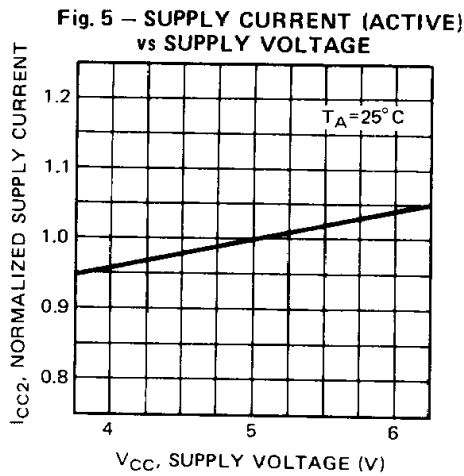
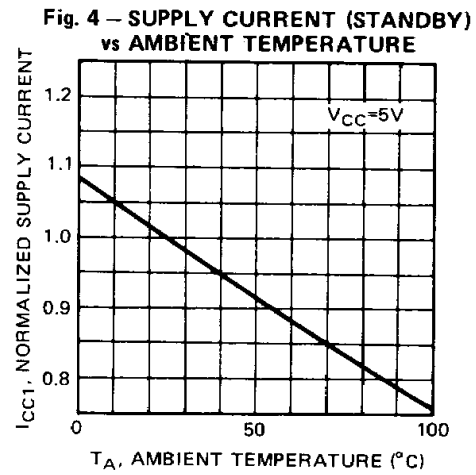
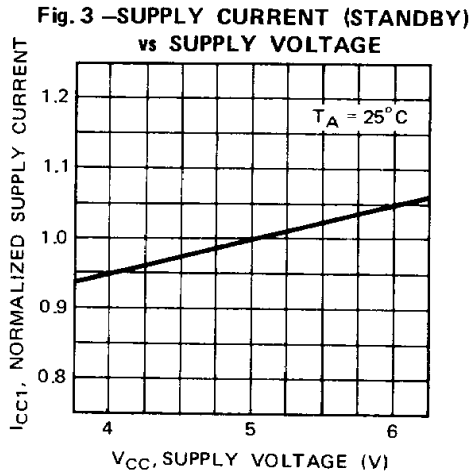
**Notes:** \*1  $\overline{OE}$  may be delayed up to  $t_{ACC} - t_{OE}$  after the falling edge of  $\overline{CE}$  without impact on  $t_{ACC}$ .

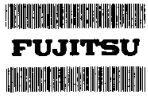
\*2  $t_{DF}$  is specified from  $\overline{OE}$  or  $\overline{CE}$ , whichever occurs first.  
 Output Float is defined as the point where data is no longer driven.

**OPERATION TIMING DIAGRAM**

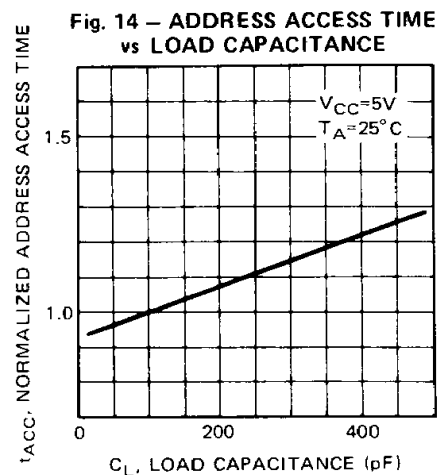
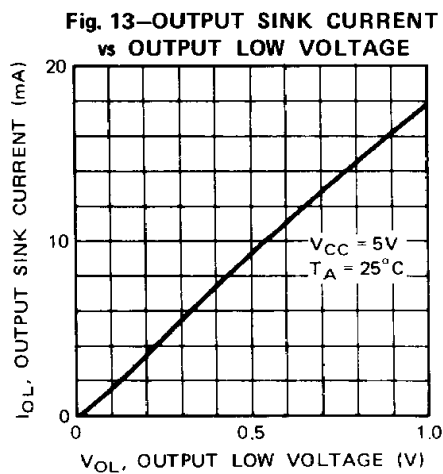
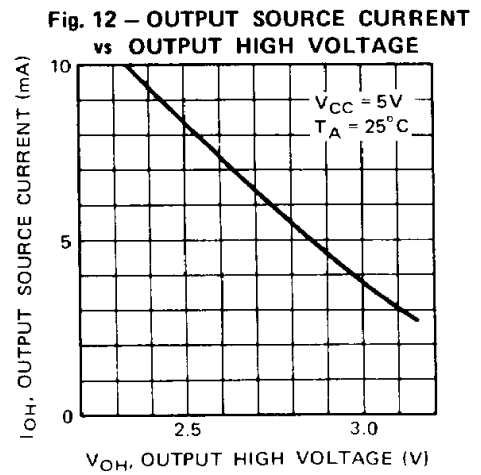
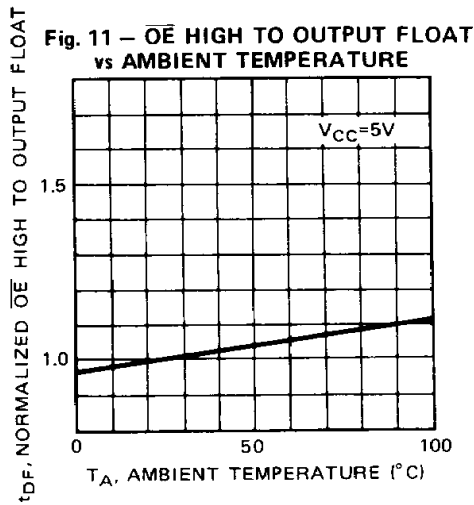
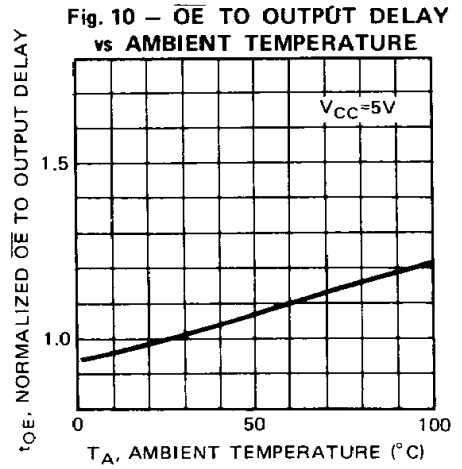
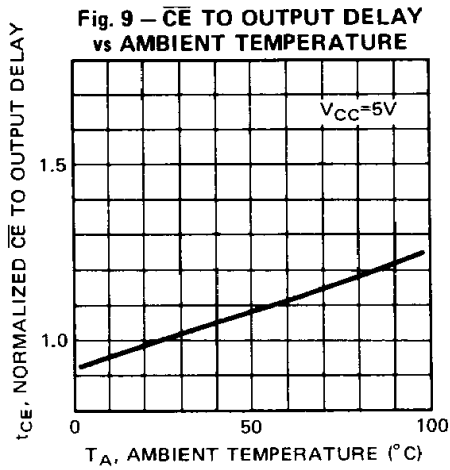


## CHARACTERISTICS CURVES





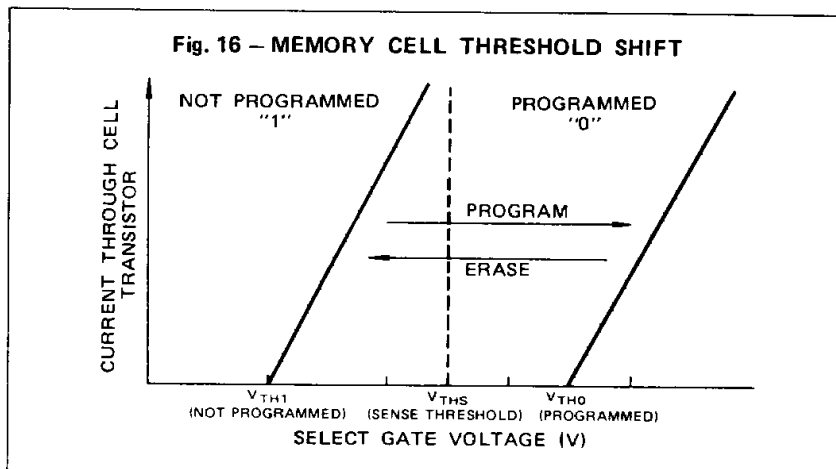
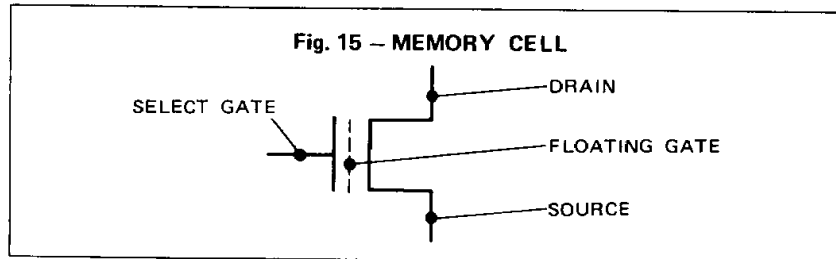
## CHARACTERISTICS CURVES (continued)



## PROGRAMMING/ERASING INFORMATION

### MEMORY CELL DESCRIPTION

The MBM 2764 is fabricated using a single-transistor stacked gate cell construction, implemented via double-layer polysilicon technology. The individual cells consist of a bottom floating gate and a top select gate (see Fig. 15). The top gate is connected to the row decoder, while the floating gate is used for charge storage. The cell is programmed by the injection of high energy electrons through the oxide and onto the floating gate. The presence of the charge on the floating gate causes a shift in the cell threshold (refer to Fig. 16). In the initial state, the cell has a low threshold ( $V_{TH1}$ ) which will enable the transistor to be turned on when the cell is selected (via the top select gate). Programming shifts the threshold to a higher level ( $V_{TH0}$ ), thus preventing the cell transistor from turning on when selected. The status of the cell (i.e., whether programmed or not) can be determined by examining its state at the sense threshold ( $V_{THS}$ ), as indicated by the dotted line in Fig. 16.



### PROGRAMMING

Upon delivery from Fujitsu, or after each erasure (see Erasure section), the MBM 2764 has all 65,536 bits in the "1", or high, state. "0's" are loaded into the MBM 2764 through the procedure of programming.

#### Normal Programming

The programming mode is entered when +21V is applied to the  $V_{PP}$  pin and  $\overline{CE}$  and  $\overline{PGM}$  are both at  $V_{IL}$ . During programming,  $\overline{CE}$  is kept at  $V_{IL}$ . A  $0.1\mu F$  capacitor between  $V_{PP}$  and GND is needed to prevent excessive voltage transients, which could damage the device. The address to be programmed is applied to the proper address pins. 8 bit patterns are placed on the respective data output pins. The voltage levels should be standard TTL levels. When both the address and data are stable, a 50 msec, TTL

low-level pulse is applied to the  $\overline{PGM}$  input to accomplish the programming. The procedure can be done manually, address by address, randomly, or automatically via the proper circuitry. All that is required is that one 50 msec program pulse be applied at each address to be programmed. It is necessary that this program pulse width not exceed 55 msec. Therefore, applying a DC level to the  $\overline{PGM}$  input is prohibited when programming.

#### Quick Programming

In addition to the standard 50 msec pulse width programming procedure, the MBM 2764 can be programmed with a fast programming algorithm designed by Fujitsu called Quick Pro<sup>TM</sup>. The algorithm (shown Fig. 17) utilizes a sequence of ONE millisecond pulse to program each location.

The programming mode is entered when

+21V and +6V are applied to the  $V_{PP}$  pin and  $V_{CC}$  pin respectively, and  $\overline{PGM}$  and  $\overline{OE}$  are  $V_{IH}$ . During programming,  $\overline{CE}$  is kept at  $V_{IL}$ . A  $0.1\mu F$  capacitor between  $V_{PP}$  and GND is needed to prevent excessive voltage transients which could damage the device. The address to be programmed is applied to the proper address pins. The 8 bit pattern are placed on the respective data output pins. The voltage levels should be standard TTL levels. When both the address and data are stable, a 1 msec, TTL low-level pulse is applied to the  $\overline{PGM}$  pin and after that additional pulse is applied to the  $\overline{PGM}$  pin to accomplish the programming.

Procedure of Quick Pro<sup>TM</sup> (Refer to Fig. 17.)

- 1) Input the start address (Address=G)
- 2) Set the  $V_{CC} = 6V$  and  $V_{PP} = 21V$

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## PROGRAMMING/ERASING INFORMATION (continued)

- 3) Data input.
- 4) Compare the input data. If data are FF, jump to the 11). If data are not FF, proceed the next step.
- 5) Set the number of programming pulse to 0. (X=0)
- 6) Apply ONE programming pulse to PGM pin ( $t_{PW} = 1 \text{ ms Typ.}$ ).
- 7) Count the programming pulse (X=X+1)
- 8) Compare the number of programming pulse. If X=20, jump to the 10). If X<20, proceed the next step.
- 9) Verify the data. If programmed data are the same as input data, proceed the next step. If programming data are not the same as input data, repeat the 6) thru 8).
- 10) Apply the additional programming pulse to the PGM pin (1 ms x X or X ms x 1).
- 11) Compare the address. If the programmed address is end address,

proceed the next step.

If the programmed address is not end address, proceed from step 3) for next address (G+1).

- 12) Verify the data. If programmed data are not the same as input data, the part is no good. If programmed data are the same as input data, programming is end.

All that is required is that one 1 msec program pulse be applied at each address to be programmed. It is necessary that one program pulse width does not exceed 1.05 msec. Therefore, applying a DC level to the PGM input is prohibited when programming.

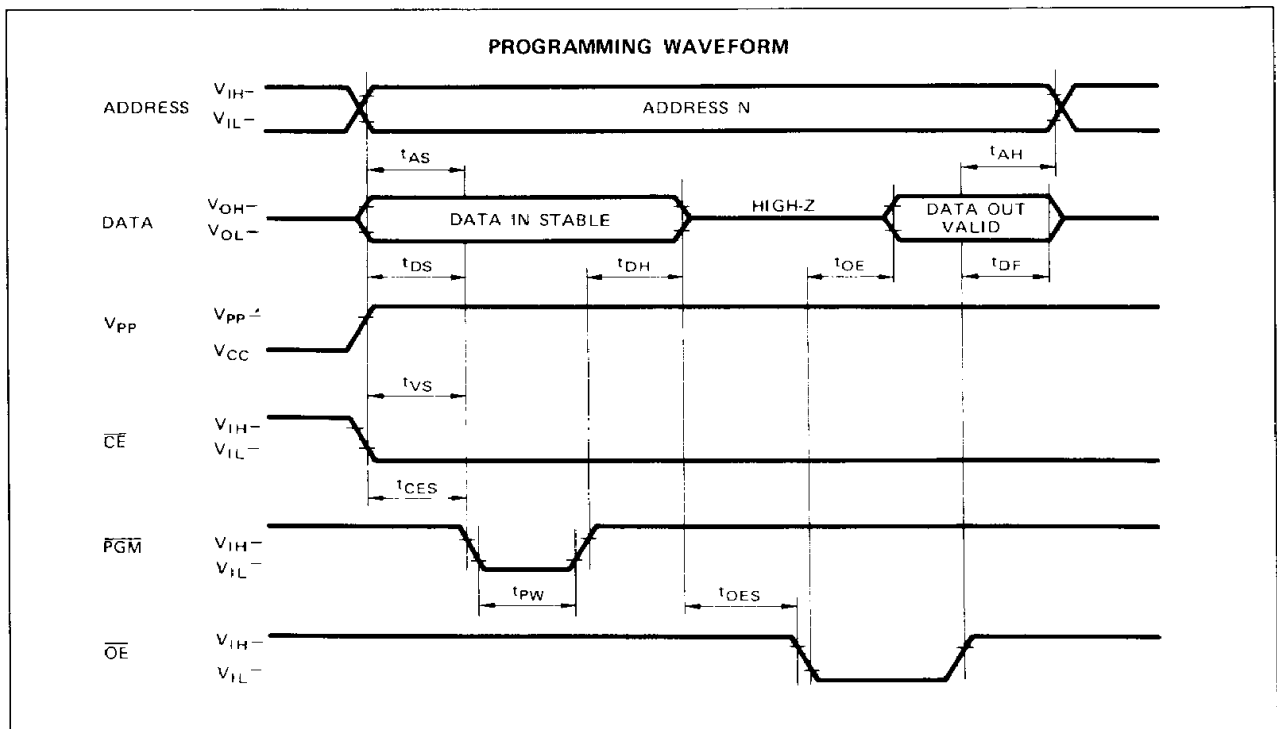
### ERASURE

In order to clear all locations of their programmed contents, it is necessary to expose the MBM 2764 to an ultraviolet light source. A dosage of 15 W-seconds/cm<sup>2</sup> is required to completely erase an

MBM 2764. This dosage can be obtained by exposure to an ultraviolet lamp (wavelength of 2537 Angstroms (Å)) with intensity of 12000μW/cm<sup>2</sup> for 15 to 20 minutes. The MBM 2764 should be about one inch from the source and all filters should be removed from the UV light source prior to erasure.

It is important to note that the MBM 2764 and similar devices, will erase with light sources having wavelengths shorter than 4000Å. Although erasure time will be much longer than with UV source at 2537Å, nevertheless the exposure to fluorescent light and sunlight will eventually erase the MBM 2764, and exposure to them should be prevented to realize maximum system reliability. If used in such an environment, the package windows should be covered by an opaque label or substance.

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**1. Nomal Programming**

**DC CHARACTERISTICS**

( $T_A = 25 \pm 5^\circ\text{C}$ ,  $V_{CC} = 5V \pm 5\%$ ,  $V_{PP} = 21 \pm 0.5V$ )

Parameter	Symbol	Min	Typ	Max	Unit
Input Leakage Current ( $V_{IN} = 5.25V/0.45V$ )	$I_{LI}$			10	$\mu\text{A}$
$V_{PP}$ Supply Current During Programming Pulse ( $\overline{CE} = \overline{PGM} = V_{IL}$ )	$I_{PP}$			30	mA
$V_{CC}$ Supply Current	$I_{CC}$			150 (100) <sup>*3</sup>	mA
Input Low Level	$V_{IL}$	-0.1		0.8	V
Input High Level	$V_{IH}$	2.0		$V_{CC}+1$	V
Output Low Voltage During Verify ( $I_{OL} = 2.1\text{mA}$ )	$V_{OL}$			0.45	V
Output High Voltage During Verify ( $I_{OH} = -400\mu\text{A}$ )	$V_{OH}$	2.4			V

- Note:**
- \*1  $V_{CC}$  must be applied either coincidently or before  $V_{PP}$  and removed either coincidently or after  $V_{PP}$ .
  - \*2  $V_{PP}$  must not be greater than 22 volts including overshoot. Permanent device damage may occur if the device is taken out or put into socket remaining  $V_{PP} = 21$  volts. Also, during  $\overline{CE} = \overline{PGM} = V_{IL}$ ,  $V_{PP}$  must not be switched from  $V_{CC}$  to 21 volts or vice-versa.
  - \*3 Value in parentheses is for "AB" version.

**AC CHARACTERISTICS**

( $T_A = 25 \pm 5^\circ\text{C}$ ,  $V_{CC} = 5V \pm 5\%$ ,  $V_{PP} = 21 \pm 0.5V$ )

Parameter	Symbol	Min	Typ	Max	Unit
Address Setup Time	$t_{AS}$	2			$\mu\text{s}$
Chip Enable Setup Time	$t_{CES}$	2			$\mu\text{s}$
Output Enable	$t_{OES}$	2			$\mu\text{s}$
Data Setup Time	$t_{DS}$	2			$\mu\text{s}$
Address Hold Time	$t_{AH}$	0			$\mu\text{s}$
Data Hold Time	$t_{DH}$	2			$\mu\text{s}$
Output Enable to Output Float Delay	$t_{DF}$	0		130	ns
Data Valid from Output Enable	$t_{OE}$			150	ns
$V_{PP}$ Setup Time	$t_{VS}$	2			$\mu\text{s}$
PGM Pulse Width	$t_{PW}$	45	50	55	ms



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MBM 2764-25



MBM 2764-30

## PROGRAMMING/ERASING INFORMATION (continued)

### 2. Quick Programming

#### DC CHARACTERISTICS

( $T_A = 25 \pm 5^\circ\text{C}$ ,  $V_{CC}^{*1} = 6V \pm 0.25V$ ,  $V_{PP}^{*2} = 21V \pm 0.5V$ )

Parameter	Symbol	Min	Typ	Max	Unit
Input Leakage Current ( $V_{IN} = 6.25V/0.45V$ )	$I_{LI}$			10	$\mu\text{A}$
$V_{PP}$ Supply Current During Programming Pulse ( $\overline{CE} = \overline{PGM} = V_{IL}$ )	$I_{PP}$			30	mA
$V_{CC}$ Supply Current	$I_{CC}$			150 (100) <sup>*3</sup>	mA
Input Low Level	$V_{IL}$	-0.1		0.8	V
Input High Level	$V_{IH}$	2.0		$V_{CC}+1$	V
Output Low Voltage During Verify ( $I_{OL} = 2.1\text{mA}$ )	$V_{OL}$			0.45	V
Output High Voltage During Verify ( $I_{OH} = -400\mu\text{A}$ )	$V_{OH}$	2.4			V

Note: \*1  $V_{CC}$  must be applied either coincidentally or before  $V_{PP}$  and removed either coincidentally or after  $V_{PP}$ .

\*2  $V_{PP}$  must not be greater than 22 volts including overshoot. Permanent device damage may occur if the device is taken out or put into socket remaining  $V_{PP} = 21$  volts. Also, during  $\overline{CE} = \overline{PGM} = V_{IL}$ ,  $V_{PP}$  must not be switched from  $V_{IL}$  to  $V_{PP}$  volts or vice-versa.

\*3 Value in parentheses is for "AB" version.

#### AC CHARACTERISTICS

( $T_A = 25 \pm 5^\circ\text{C}$ ,  $V_{CC} = 6V \pm 0.25V$ ,  $V_{PP} = 21V \pm 0.5V$ )

Parameter	Symbol	Min	Typ	Max	Unit
Address Setup Time	$t_{AS}$	2			$\mu\text{s}$
Chip Enable Setup Time	$t_{CES}$	2			$\mu\text{s}$
Output Enable Setup Time	$t_{OES}^*$	2			$\mu\text{s}$
Data Setup Time	$t_{DS}$	2			$\mu\text{s}$
Address Hold Time	$t_{AH}$	0			$\mu\text{s}$
Data Hold Time	$t_{DH}^*$	2			$\mu\text{s}$
Output Enable to Output Float Delay	$t_{DF}$	0		130	ns
Data Valid from Output Enable	$t_{OE}$			150	ns
$V_{PP}$ Setup Time	$t_{VS}$	2			$\mu\text{s}$
PGM Pulse Width	$t_{PW}$	0.95	1	1.05	ms

\*  $t_{DH} + t_{OES} \geq 50\mu\text{s}$

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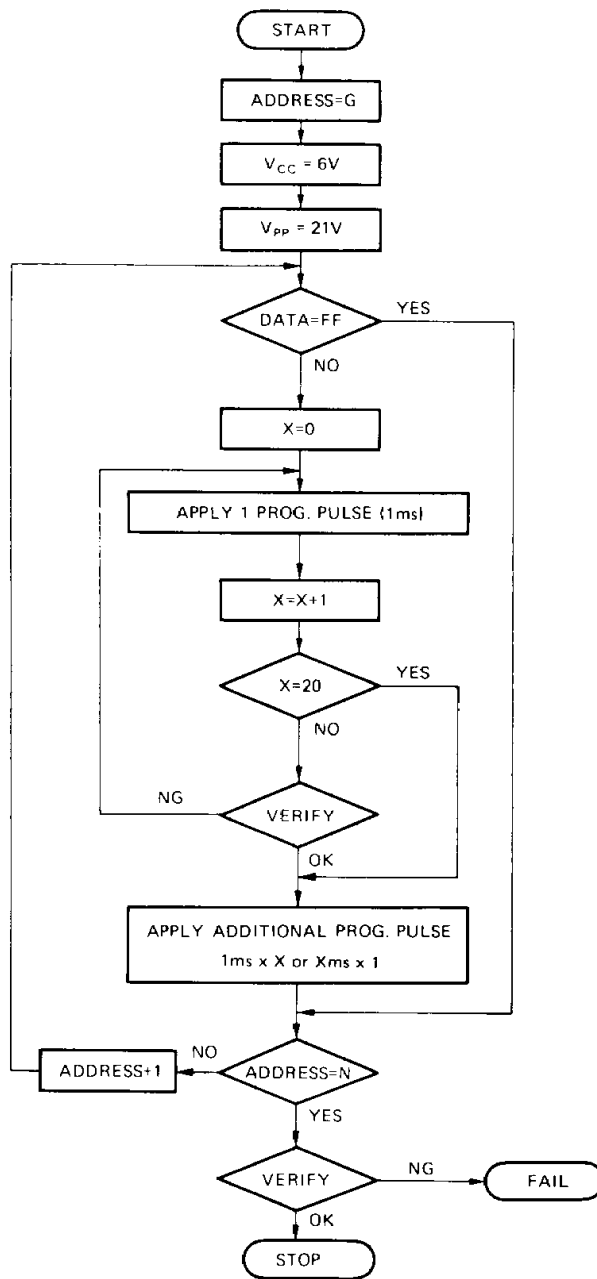
Fig. 17—PROGRAMMING FLOW CHART FOR Quick Pro™

$V_{CC} = 6V \pm 0.25V$   
 $V_{PP} = 21V \pm 0.5V$

$T_{pw} = 1ms \pm 50\mu s$   
 (\*= $Xms \pm 5\%$ )

G : START ADDRESS  
 N : STOP ADDRESS

MAXIMUM  $40ms + \alpha/BYTE$   
 MINIMUM  $2ms + \alpha/BYTE$   
 (FOR EXAMPLE)  
 64K BIT EPROM  
 MAXIMUM  $320sec + \beta$   
 MINIMUM  $16sec + \beta$

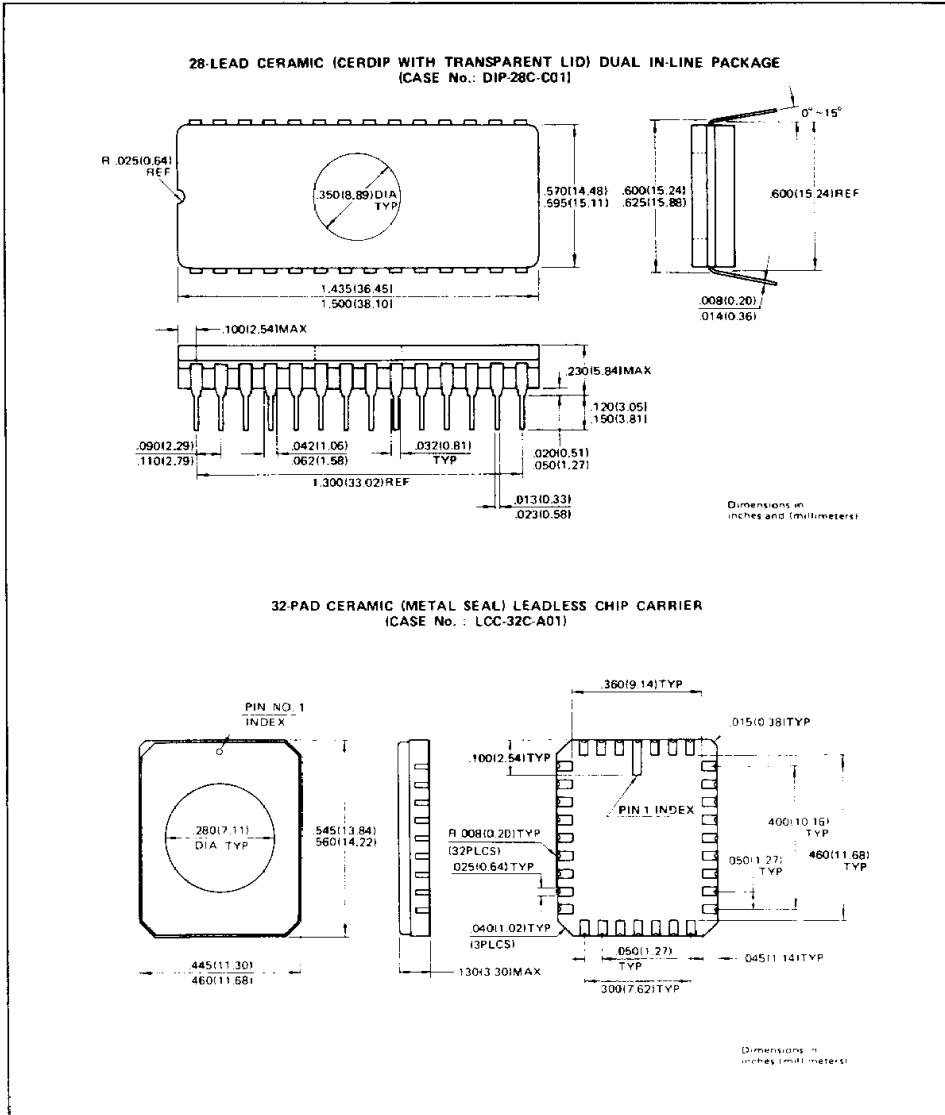


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## PACKAGE DIMENSIONS



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