

# FUJITSU

## PROGRAMMABLE SCHOTTKY 4096-BIT READ ONLY MEMORY

**MB7121E/H  
MB7122E/H/Y  
MB7121L  
MB7122L**

### SCHOTTKY 4096-BT DEAP PROM (1024 WORDS X 4 BITS)

The Fujitsu MB7121 and MB7122 are high speed Schottky TTL electrically field programmable read only memories organized as 1024 words by 4 bits. With uncommitted collector outputs provided on the MB7121 and three-state outputs on the MB7122, memory expansion is simple.

The memory is fabricated with all logic "zeros" (positive logic). Logic level "ones" can be programmed by the highly reliable DEAP (Diffused Eutectic Aluminum Process) according to simple programming procedures.

The sophisticated passive isolation termed IOP (Isolation by Oxide and Polysilicon) with thin epitaxial layer and Schottky TTL process permits minimal chip size and fast access time.

The extra test cells and unique testing methods provide enhanced correlation between programmed and unprogrammed circuits in order to perform AC, DC and programming test prior to shipment. This results in extremely high programmability.

- Single +5V supply voltage.
- 1024 words x 4 bits organization, fully decoded.
- Proven high programmability and reliability.
- Programming by DEAP (Diffused Eutectic Aluminum Process).
- Simplified and lower power programming.
- Low current PNP inputs.
- AC characteristics guaranteed over full operating voltage and temperature range via unique testing techniques.
- Fast access time  
Y : 25ns typ, 30ns max.  
H : 25ns typ, 35ns max.
- E : 25ns typ, 45ns max.  
L : 40ns typ, 60ns max.
- TTL compatible inputs and outputs.
- Open collector outputs (MB7121)
- 3 state outputs (MB7122)
- Two chip enable leads for simplified memory expansion.
- Standard 18 - pin Ceramic (Cerdip) DIP (Suffix: -Z)
- Standard 18 - pin Plastic DIP (Suffix: -M)
- Standard 20 - pad Ceramic (Frit Seal) LCC (Suffix: -TV)
- JEDEC approved pin output.

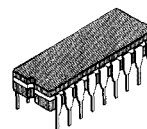
### ABSOLUTE MAXIMUM RATINGS (See NOTE)

| Rating                                    | Symbol     | Value            | Unit |
|-------------------------------------------|------------|------------------|------|
| Power Supply Voltage                      | $V_{CC}$   | -0.5 to +7.0     | V    |
| Power Supply Voltage (during programming) | $V_{CCP}$  | -0.5 to +7.5     | V    |
| Input Voltage                             | $V_{IN}$   | -1.5 to +5.5     | V    |
| Input Voltage (during programming)        | $V_{IPRG}$ | 22.5             | V    |
| Output Voltage (during programming)       | $V_{OPRG}$ | -0.5 to +22.5    | V    |
| Input Current                             | $I_{IN}$   | -20              | mA   |
| Input Current (during programming)        | $I_{IPRG}$ | +270             | mA   |
| Output Current                            | $I_{OUT}$  | +100             | mA   |
| Output Current (during programming)       | $I_{OPRG}$ | +150             | mA   |
| Storage Temperature                       | Ceramic    | $T_{STG}$        | °C   |
|                                           | Plastic    |                  |      |
| Output Voltage                            | $V_{OUT}$  | -0.5 to $V_{CC}$ | V    |

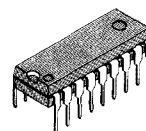
**NOTE:** Permanent device damage may occur if ABSOLUTE MAXIMUM RATINGS are exceeded. Functional operation should be restricted to the conditions as detailed in the operational sections of this data sheet. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

December 1987  
Edition 3.0

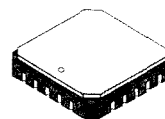
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**CERAMIC PACKAGE  
DIP-18C-C01**

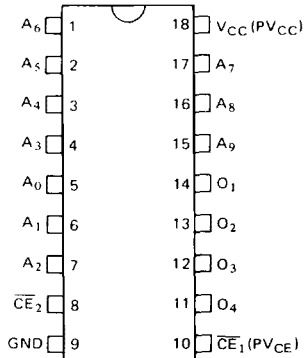


**PLASTIC PACKAGE  
DIP-18P-M02**



**CERAMIC PACKAGE  
LCC-20C-F02**

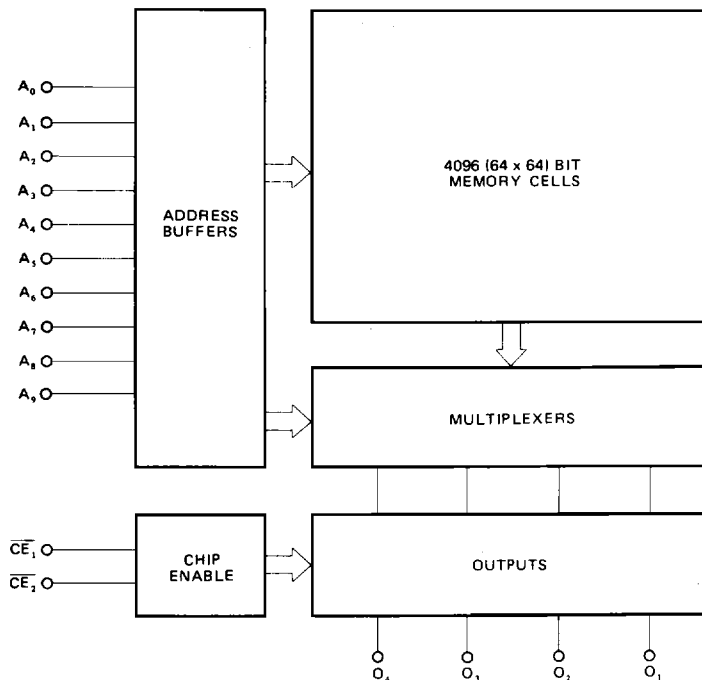
### PIN ASSIGNMENT



LCC PAD CONFIGURATION: See page 16

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.

Fig. 1 - MB 7122 BLOCK DIAGRAM



# CAPACITANCE (f=1MHz, V<sub>CC</sub>=+5V, V<sub>IN</sub>=+2V, T<sub>A</sub>=25°C)

| Parameter          | Symbol         | Min | Typ | Max | Unit |
|--------------------|----------------|-----|-----|-----|------|
| Input Capacitance  | C <sub>I</sub> | —   | —   | 10  | pF   |
| Output Capacitance | C <sub>O</sub> | —   | —   | 12  | pF   |

## GUARANTEED OPERATING CONDITIONS

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| Parameter           | Symbol   | Min  | Typ | Max  | Unit |
|---------------------|----------|------|-----|------|------|
| Supply Voltage      | $V_{CC}$ | 4.75 | 5.0 | 5.25 | V    |
| Input Low Voltage   | $V_{IL}$ | 0    | —   | 0.8  | V    |
| Input High Voltage  | $V_{IH}$ | 2.0  | —   | 5.5  | V    |
| Ambient Temperature | $T_A$    | 0    | —   | 75   | °C   |

## DC CHARACTERISTICS

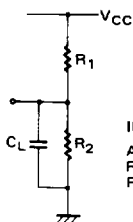
(Full guaranteed operating conditions unless otherwise noted.)

| Parameter                                                 |        | Symbol    | Min | Typ   | Max  | Unit    |
|-----------------------------------------------------------|--------|-----------|-----|-------|------|---------|
| Input Leakage Current<br>( $V_{IH} = 5.5V$ )              |        | $I_R$     |     |       | 40   | $\mu A$ |
| Input Load Current<br>( $V_{IL} = 0.45V$ )                |        | $I_F$     |     |       | -250 | $\mu A$ |
| Output Low Voltage<br>( $I_{OL} = 10mA$ )                 |        | $V_{OL}$  |     |       | 0.45 | V       |
| Output Low Voltage<br>( $I_{OL} = 16mA$ )                 |        | $V_{OL}$  |     |       | 0.50 | V       |
| Output Leakage Current<br>( $V_O = 2.4V$ , chip disabled) | MB7121 | $I_{OLK}$ |     |       | 40   | $\mu A$ |
| Output Leakage Current<br>( $V_O = 2.4V$ , chip disabled) | MB7122 | $I_{OIH}$ |     |       | 40   | $\mu A$ |
| Output Leakage Current<br>( $V_O = 0.5V$ , chip disabled) | MB7122 | $I_{OIL}$ |     |       | -40  | $\mu A$ |
| Input Clamp Voltage<br>( $I_{IN} = -18mA$ )               |        | $V_{IC}$  |     |       | -1.2 | V       |
| Power Supply Current<br>( $V_{IN} = OPEN$ or GND)         | E/H/Y  | $I_{CC}$  |     | 105** | 150  | mA      |
|                                                           | L      |           |     | 40**  | 50   |         |
| Output High Voltage<br>( $I_O = -2.4mA$ )                 | MB7122 | $V_{OH*}$ | 2.4 |       |      | V       |
| Output Short Circuit Current<br>( $V_O = GND$ )           | MB7122 | $I_{OS*}$ | -15 |       | -60  | mA      |

**Note:** \*Denotes guaranteed characteristics of the output high-level (ON) state when the chip is enabled ( $V_{CE} = 0.4V$ ) and the programmed bit is addressed. These characteristics cannot be tested prior to

programming, but are guaranteed by factor testing.  
\*\*This value denotes conditions at  $T_A = 25^\circ C$  and  $V_{CC} = +5.0V$ .

**Fig. 2 – AC TEST CONDITIONS**



**INPUT CONDITIONS**

Amplitude ..... 0V to 3V  
 Rise and Fall Time ..... 5ns from 1V to 2V  
 Frequency ..... 1MHz

|                  | MB 7121/MB 7122 |                |                |
|------------------|-----------------|----------------|----------------|
|                  | R <sub>1</sub>  | R <sub>2</sub> | C <sub>L</sub> |
| t <sub>AA</sub>  | 300Ω            | 600Ω           | 30pF           |
| t <sub>DIS</sub> | 300Ω            | 600Ω           | 30pF           |
| t <sub>EN</sub>  | 300Ω            | 600Ω           | 30pF           |

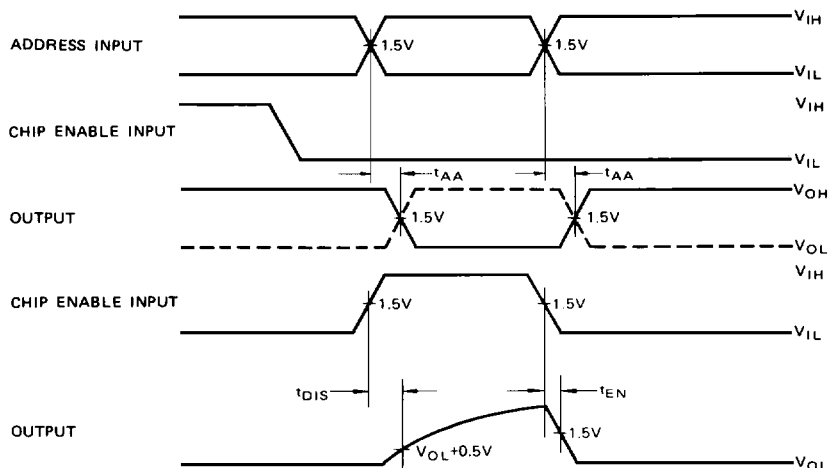
## AC CHARACTERISTICS

(Full guaranteed operating conditions unless otherwise noted.)

| Parameter                       | Symbol           | L   |      | E   |     | H   |     | MB7122Y |     | Unit |
|---------------------------------|------------------|-----|------|-----|-----|-----|-----|---------|-----|------|
|                                 |                  | Typ | Max  | Typ | Max | Typ | Max | Typ     | Max |      |
| Access Time (via address input) | t <sub>AA</sub>  | 40* | 60** | 25  | 45  | 25  | 35  | 25      | 30  | ns   |
| Output Disable Time             | t <sub>DIS</sub> | 20  | 50   | 15  | 30  | 15  | 30  | 15      | 25  | ns   |
| Output Enable Time              | t <sub>EN</sub>  | 30  | 50   | 15  | 30  | 15  | 30  | 15      | 25  | ns   |

(\* 7121L: 45ns \*\*7121L: 70ns)

### OPERATION TIMING DIAGRAM



**Note:** Output disable time is the time taken for the output to reach a high resistance state when either chip enable is taken high. Output enable time is the time taken for the output to become active

when both chip enables are taken low. The high resistance state is defined as a point on the output waveform equal to a  $\Delta V$  of 0.5V from the active output level.

## INPUT/OUTPUT CIRCUIT INFORMATION

### INPUT

In the input circuit, Schottky TTL circuit technology is used to achieve high-speed operation. A PNP transistor in the first stage of input circuit remarkably improves input high/low current characteristics. Also, the input circuit includes a protection diode for reliable operation.

### OPEN-COLLECTOR OUTPUT

The open-collector output is often utilized in high speed applications where power dissipation must be minimized. When the device is switched, there is no current sourced from the supply rail. Consequently, the current spike normally associated with TTL totem-pole outputs is eliminated. In high frequency applications, this minimizes noise problems (false triggering) as well as power drain. For example, the transient current (low impedance high-level to low impedance low-level) is typically 30mA for the MB 7122 (3-state) compared to 0mA for the MB 7121 (open-collector).

### THREE-STATE OUTPUT

A "three-state" output is a logic element which has three distinct output states of ZERO, ONE and OFF (wherein OFF represents a high impedance condition which can neither sink nor source current at a definable logic level). Effectively, then, the device has all the desirable features of a totem-pole TTL output (e.g., greater noise immunity, good rise time, line driving capacity), plus the ability to connect to bus-organized systems.

In the case where two devices are on at the same time, the possibility exists

Fig. 3 — MB 7121/7122 INPUT

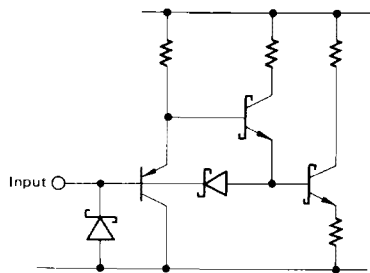
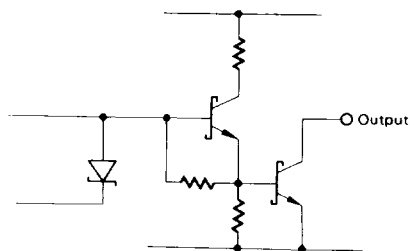


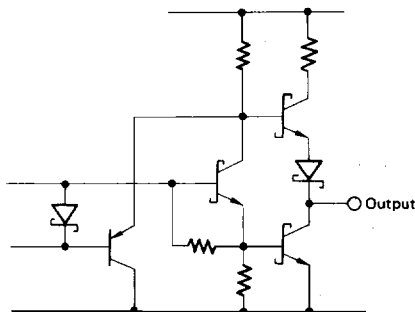
Fig. 4 — MB 7121 OUTPUT



that they may be in opposite low impedance states simultaneously; thus, the short circuit current from one enabled device may flow through the other enabled device. While physical damage under these conditions is unlikely, system noise problems could result. Therefore, the system designer should consider these factors to ensure that this condition does not exist.

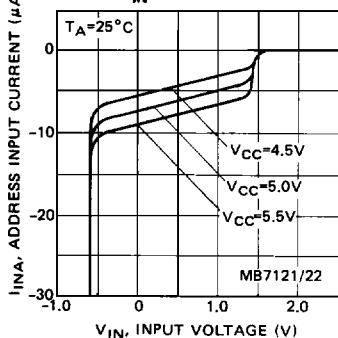
Also in the output circuit, Schottky TTL circuit technology is used to achieve high-speed operation. Also, a PNP transistor provided in the output circuit is effective to decrease a load for the Chip Enable circuit.

**Fig. 5 – MB 7122 OUTPUT**



## TYPICAL CHARACTERISTICS CURVES

**Fig. 6 –  $I_{INA}$  INPUT CURRENT vs  $V_{IN}$  INPUT VOLTAGE**



**Fig. 7 –  $I_{OL}$  OUTPUT LOW CURRENT vs  $V_{OL}$  OUTPUT LOW VOLTAGE**

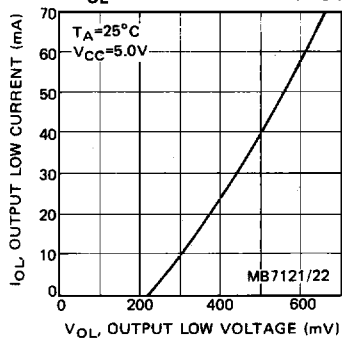


Fig. 8 –  $I_{OH}$  OUTPUT HIGH CURRENT  
vs  $V_{OH}$  OUTPUT HIGH VOLTAGE

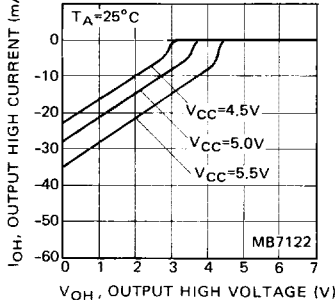


Fig. 9 –  $t_{AA}$  ACCESS TIME  
vs AMBIENT TEMPERATURE

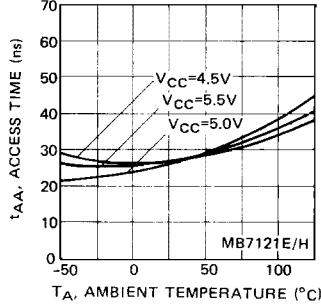


Fig. 10 –  $t_{AA}$  ACCESS TIME  
vs AMBIENT TEMPERATURE

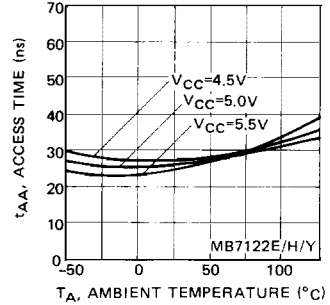


Fig. 11 –  $t_{AA}$  ACCESS TIME  
vs AMBIENT TEMPERATURE

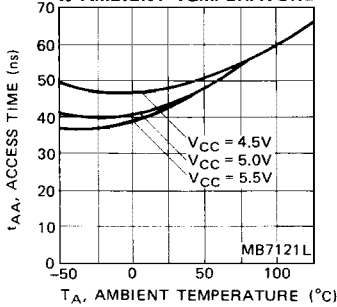


Fig. 12 –  $t_{AA}$  ACCESS TIME  
vs AMBIENT TEMPERATURE

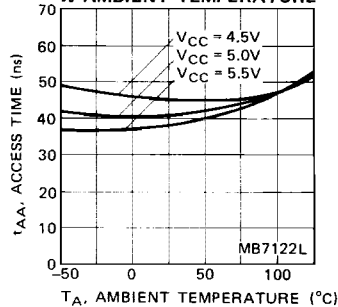


Fig. 13 –  $t_{DS}$  DISABLE TIME  
vs AMBIENT TEMPERATURE

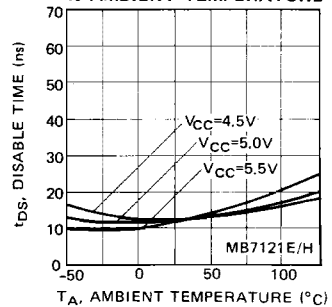


Fig. 14 –  $t_{DIS}$  DISABLE TIME  
vs AMBIENT TEMPERATURE

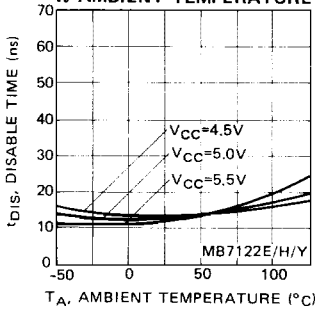


Fig. 15 –  $t_{DIS}$  DISABLE TIME  
vs AMBIENT TEMPERATURE

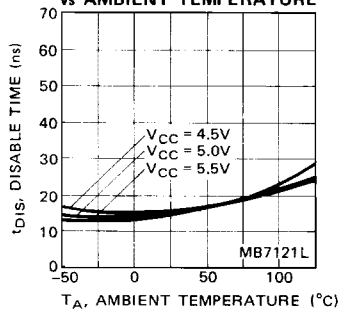
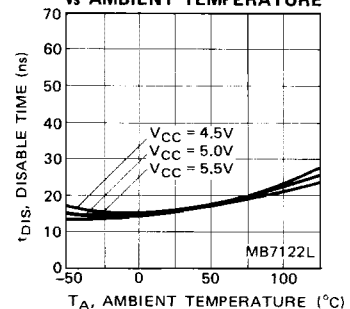


Fig. 16 –  $t_{DIS}$  DISABLE TIME  
vs AMBIENT TEMPERATURE





MB7121E/H  
MB7122E/H/Y  
MB7121L  
MB7122L

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Fig. 17 —  $t_{EN}$  ENABLE TIME  
vs AMBIENT TEMPERATURE

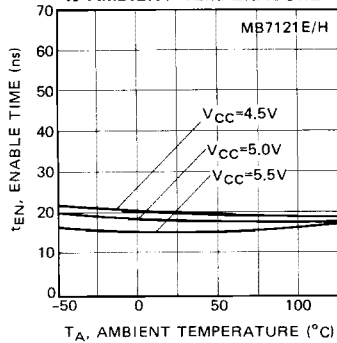


Fig. 18 —  $t_{EN}$  ENABLE TIME  
vs AMBIENT TEMPERATURE

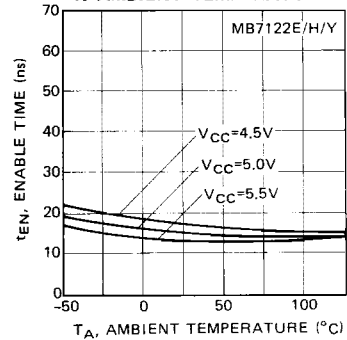


Fig. 19 —  $t_{EN}$  ENABLE TIME  
vs AMBIENT TEMPERATURE

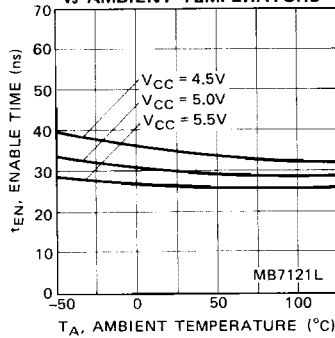


Fig. 20 —  $t_{EN}$  ENABLE TIME  
vs AMBIENT TEMPERATURE

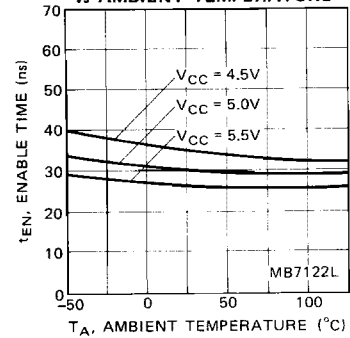


Fig. 21 — DELAY TIME INCREASE  
vs  $C_L$  LOAD CAPACITANCE

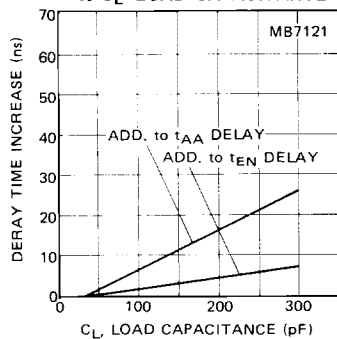
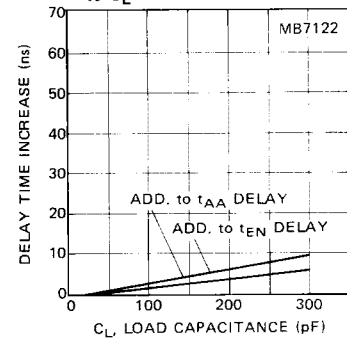


Fig. 22 — DELAY TIME INCREASE  
vs  $C_L$  LOAD CAPACITANCE



## PROGRAMMING INFORMATION

### FUJITSU PROM TECHNOLOGY

The Fujitsu MB 7100 series is the junction-shorting Schottky PROM. A memory cell consists of a programmable element of a PN diode and a vertically connected PNP transistor. The current blocking state of the reverse diode is changed to the current conducting state of the shorted-junction diode by programming. The programming element of the PN diode uses the N<sup>+</sup> and P<sup>+</sup> diffusion layer, the PNP transistor uses a P<sup>+</sup> diffusion layer, an N<sup>+</sup> epitaxial layer, and a P<sup>-</sup> substrate (Fig. 23).

Each word line island is divided by passive isolations named IOP (Isolation by Oxide and Poly-silicon), and each memory cell in the same island is divided by the passive isolation named SVG (Shallow V-Groove). The vertical structure of the junction-shorting memory cell makes a high packing density possible.

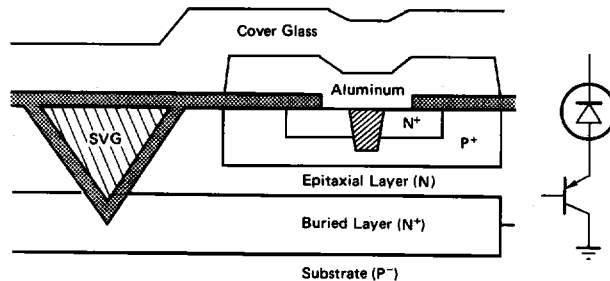
In programming, reverse current pulses are applied to the cathode of the PN diode. This increases the temperature at the junction. When the temperature reaches the point where the silicon and aluminum form a eutectic, the eutectic diffuses from the surface of the metal-silicon contact region to the anode of the PN diode, and results in junction shorting. This program technique was therefore named "Diffused Eutectic Aluminum Process" (DEAP).

Once the junction is shorted, the power dissipation at the function decreases to less than one fifth, and the temperature decreases. This drop in temperature stops further diffusion of the eutectic, and protects the PNP transistor from destruction.

### SPECIAL FACTORY TESTING

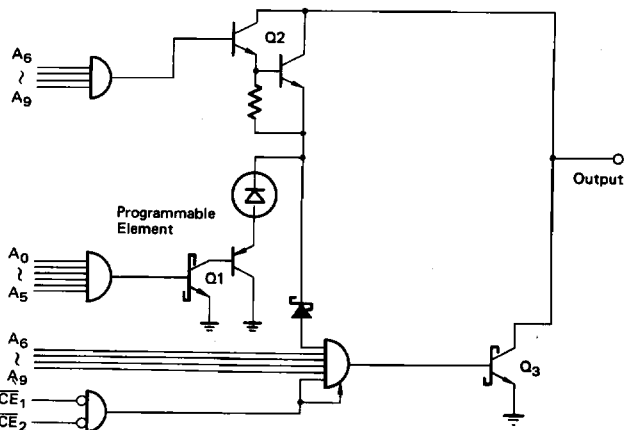
Extra rows and extra columns of test cells, plus additional circuitry built into the PROM chip, allow improved factory testing of DC, AC and programming characteristics. These test

Fig. 23 – PROGRAMMED CELL (CROSS SECTION)



Programmed by DEAP (Diffused Eutectic Aluminum Process)

Fig. 24 – INTERNAL PROGRAMMING CIRCUIT





MB7121E/H  
MB7122E/H/Y  
MB7121L  
MB7122L

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## PROGRAMMING INFORMATION (continued)

### SPECIAL FACTORY TESTING

Extra rows and extra columns of test cells, plus additional circuitry built into the PROM chip, allow improved factory testing of DC, AC and programming characteristics. These test cells and test circuitry provide enhanced correlation between programmed and unprogrammed circuits in order to guarantee high programmability and reliability.

### PROGRAMMING (in electrical view)

The device is manufactured with outputs low (positive logic "zero") in all storage cells. An output at the selected cell is changed to high (logic "one") by programming.

"As shown in Fig. 24, transistors,  $Q_1$  and  $Q_2$ , are turned on to select the desired bit for programming by using eight address inputs. By applying the  $PV_{CE}$  pulse voltage, the chip is dis-

abled and transistor  $Q_3$  is held off. Then, a train of programming pulses applied to the desired output flows through transistor  $Q_2$  and memory cell into transistor  $Q_1$ . This programming current changes the programmable element to the conducting state.

The pulse train is stopped and two additional programming pulses are then applied to assure that the element is programmed properly, as soon as the output voltage indicates that the selected cell is in the logic "one" state. One output must be programmed at a time since the internal decoding circuit is capable of sinking only one unit of programming current at a time.

### VERIFICATION

After the device has been programmed, the correct program pattern can be verified by taking chip enable input low. To guarantee full supply voltage

and full temperature range operation, a programmed device should source 2.4mA at  $V_{OH} = 2.4V$  and  $V_{CC} = 7.0V$  at 25°C ambient temperature.

### LIABILITY

Fujitsu utilizes an extensive testing procedure to ensure device performance prior to shipment. However, 100% programmability is not guaranteed, and it is imperative that this specification be rigorously adhered to in order to achieve a satisfactory programming yield. Fujitsu will not accept responsibility for any device found defective if it was not programmed according to this specification. Devices returned to Fujitsu as defective must be accompanied by a complete truth table with clearly indicated locations of supposedly defective memory cells.

### DC SPECIFICATIONS ( $T_A = 25^\circ C$ )

| Parameter                         | Symbol    | Min | Typ  | Max  | Unit |
|-----------------------------------|-----------|-----|------|------|------|
| Input Low Voltage                 | $V_{IL}$  | 0   | —    | 0.8  | V    |
| Input High Voltage                | $V_{IH}$  | 2.0 | —    | 5.25 | V    |
| Power Supply Voltage              | $PV_{CC}$ | P:  | 6.7  | 7.0  | V    |
|                                   |           | R:  | 4.75 | 5.0  |      |
| Programming Pulse Current         | $I_{PRG}$ | 120 | —    | 130  | mA   |
| $PV_{CE}$ Pulse Voltage           | $PV_{CE}$ | 20  | 20   | 22   | V    |
| Programming Pulse Clamp Voltage   | $V_{PRG}$ | 20  | 20   | 22   | V    |
| $PV_{CE}$ Pulse Clamp Current     | $PI_{CE}$ | 230 | —    | 260  | mA   |
| Reference Voltage for a Prog. "1" | $V_{REF}$ | 1.0 | 1.5  | 2.4  | V    |

**AC SPECIFICATIONS ( $T_A = 25^\circ\text{C}$ )**

| Parameter                                                | Symbol                | Min | Typ | Max  | Unit              |
|----------------------------------------------------------|-----------------------|-----|-----|------|-------------------|
| Programming Pulse Cycle Time                             | $t_{\text{CYC}}$      | 40  | 50  | 60   | $\mu\text{s}$     |
| Programming Pulse Width                                  | $t_{\text{PW}}^{(1)}$ | 10  | 11  | 12   | $\mu\text{s}$     |
| Programming Pulse Rise Time                              | $t_r^{(2)}$           | —   | —   | 2    | $\mu\text{s}$     |
| PV <sub>CE</sub> Pulse Rise Time                         | $t_r^{(2)}$           | —   | —   | 2    | $\mu\text{s}$     |
| PV <sub>CC</sub> Pulse Rise Time                         | $t_r^{(3)}$           | —   | —   | 2    | $\mu\text{s}$     |
| Programming Pulse Fall Time                              | $t_f^{(4)}$           | —   | —   | 2    | $\mu\text{s}$     |
| PV <sub>CE</sub> Pulse Fall Time                         | $t_f^{(4)}$           | —   | —   | 2    | $\mu\text{s}$     |
| PV <sub>CC</sub> Pulse Fall Time                         | $t_f^{(5)}$           | —   | —   | 2    | $\mu\text{s}$     |
| Address Input Set-up Time                                | $t_{\text{SA}}$       | 2   | —   | —    | $\mu\text{s}$     |
| Chip Enable Input Set-up Time                            | $t_{\text{SC}}$       | 2   | —   | —    | $\mu\text{s}$     |
| PV <sub>CE</sub> Set-up Time                             | $t_{\text{SP}}^{(6)}$ | 4   | —   | —    | $\mu\text{s}$     |
| Address Input Hold Time                                  | $t_{\text{HA}}$       | 2   | —   | —    | $\mu\text{s}$     |
| Chip Enable Input Hold Time                              | $t_{\text{HC}}$       | 2   | —   | —    | $\mu\text{s}$     |
| PV <sub>CE</sub> Hold Time                               | $t_{\text{HP}}^{(7)}$ | 2   | —   | —    | $\mu\text{s}$     |
| PV <sub>CE</sub> Pulse Trailing Edge to Read Strobe Time | $t_{\text{PR}}^{(8)}$ | 10  | —   | —    | $\mu\text{s}$     |
| Programming Pulse Number                                 | —                     | —   | —   | 100  | Times             |
| Programming Time/Bit                                     | —                     | 120 | 150 | 6120 | $\mu\text{s/bit}$ |
| Additional Programming Pulse Number                      | —                     | 2   | 2   | 2    | Times             |

**Notes:** (1) Stipulated 200 $\Omega$  load and 15V.

(2) From 1V to 19V (200 $\Omega$  load).

(3) From 5.2V to 6.8V (30 $\Omega$  load).

(4) From 19V to 1V (200 $\Omega$  load).

(5) From 6.8V to 5.2V (30 $\Omega$  load).

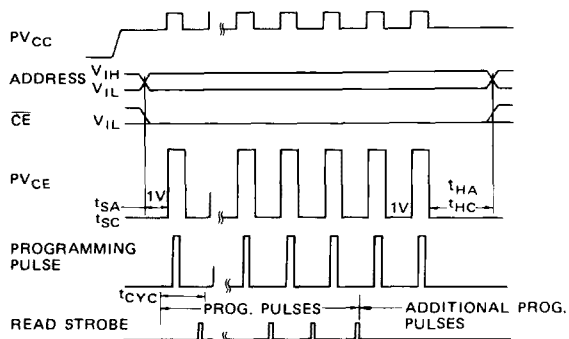
(6) From PV<sub>CE</sub> pulse 19V to programming pulse 1V.

(7) From programming pulse 1V to PV<sub>CE</sub> pulse 19V.

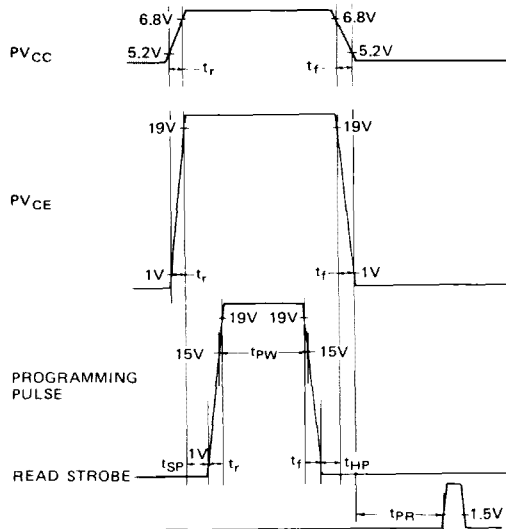
(8) From PV<sub>CE</sub> pulse 1V to read strobe.

# 1 PROGRAMMING INFORMATION (continued)

## TYPICAL WAVEFORMS



## ONE DETAILED PROGRAMMING CYCLE



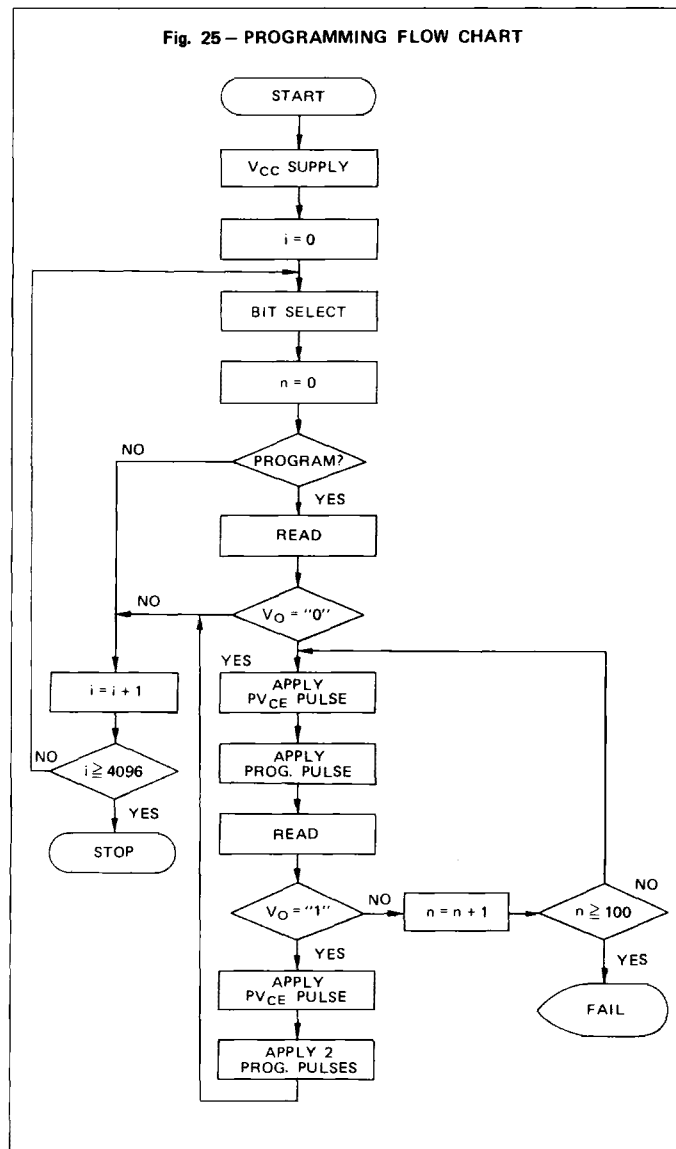
# PROGRAMMING PROCEDURE

1. Apply power;  $V_{CC}=PV_{CC}$ , GND=0V.
2. Select the desired bit.
3. Read the output to confirm the voltage  $V_O$ =low. (In the case of  $V_O$ =high, select the next desired bit.)
4. Apply a 20V pulse voltage to the  $PV_{CE}$  input.
5. Apply a programming pulse with amplitude of 120 mA and duration of  $t_{PW}$  (10 $\mu$ s) after a delay of  $t_{SP}$  (4 $\mu$ s).
6. Read the output  $V_O$  after a delay of  $t_{PR}$  (10 $\mu$ s).
  - a) In the case of  $V_O$ =low, repeat steps "4", "5" and "6" with cycle time of  $t_{CYC}$  (50 $\mu$ s).
  - b) In the case of  $V_O$ =high, apply 2 additional programming pulses to provide a highly reliable memory cell.
7. Select the next desired bit after a delay of  $t_{HA}$  (2 $\mu$ s).

**Note 1)** Programming must be done bit by bit.

**2)** Ambient temperature during programming must be room temperature. (25°C $\pm$ 2°C)

Fig. 25 – PROGRAMMING FLOW CHART





MB7121E/H  
MB7122E/H/Y  
MB7121L  
MB7122L

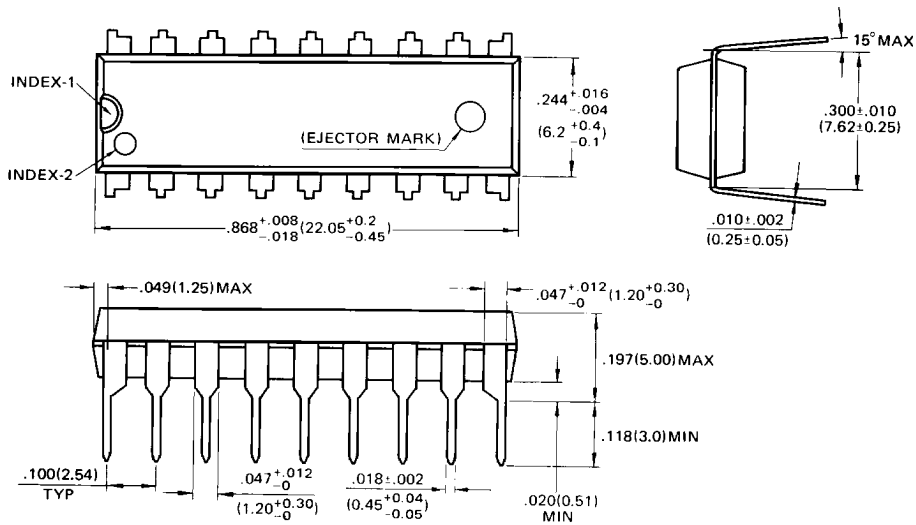


## PACKAGE DIMENSIONS

(Suffix: -M)

1

18-LEAD PLASTIC DUAL-IN-LINE PACKAGE  
(CASE No.: DIP-18P-M02)



Dimensions in  
inches (millimeters)

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