**National Semiconductor**

# MM4204/MM5204 4096-Bit (512 × 8) UV Erasable PROM

## General Description

The MM4204/MM5204 is a 4096-bit static read only memory which is electrically programmable and uses silicon gate technology to achieve bipolar compatibility. The device is a non-volatile memory organized as 512 words by 8 bits per word. Programming of the memory is accomplished by storing a charge in a cell location by applying a −50V pulse. A logic input, Power Saver, is provided which gives a 5:1 decrease in power when the memory is not being accessed.

- Static operation—no clock required
- Easy memory expansion—TRI-STATE® output Chip Select input (CS)
- "Q" quartz lid version erasable with short wave ultra-violet light (i.e., 253.7 nm)
- Low power dissipation
- "Power Saver" control for low power applications
- Compatible with SC/MP II N-channel microprocessor

## Features

- Field programmable
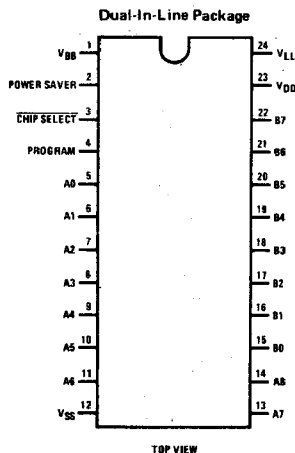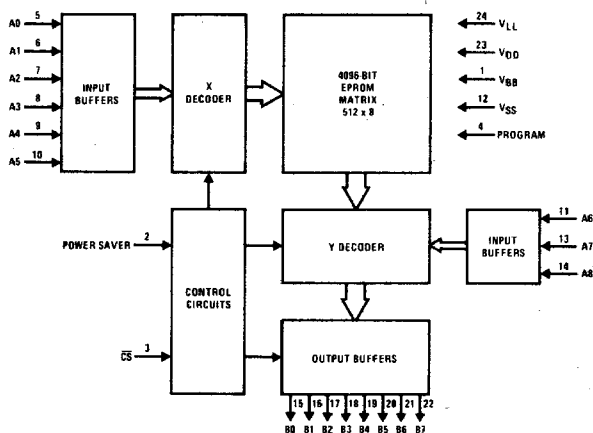- Fast program time: ten seconds typical for 4096 bits
- Fast access time
  - MM4204       1.25 $\mu$s
  - MM5204       1 $\mu$s
- DTL/TTL compatibility
- Standard power supplies    5V, −12V

## Applications

- Code conversion
- Random logic synthesis
- Table look-up
- Character generator
- Microprogramming
- Electronic keyboards

## Block and Connection Diagrams



Dual-In-Line Package

TOP VIEW

Order Number MM4204D or MM5204D
See NS Package D24C

Order Number MM4204Q or MM5204Q
See NS Package J24CQ

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## Absolute Maximum Ratings (Note 1)

All Input or Output Voltages with
Respect to $V_{BB}$ Except During Programming     +0.3V to −20V
Power Dissipation     750 mW
Storage Temperature Range     −65°C to +125°C
Lead Temperature (Soldering, 10 seconds)     300°C

## Operating Conditions

Operating Temperature Range
    MM5204     0°C to +70°C
    MM4204     −55°C to +85°C

## DC Electrical Characteristics

$T_A$ within operating temperature range, $V_{LL}$ = 0V, $V_{BB}$ = PROGRAM = $V_{SS}$.
MM4204: $V_{SS}$ = 5V ±10%, $V_{DD}$ = −12V ±10%, MM5204: $V_{SS}$ = 5V ±5%, $V_{DD}$ = −12V ±5%, unless otherwise noted.

| SYMBOL | PARAMETER | CONDITIONS | MIN | TYP (Note 7) | MAX | UNITS |
|---|---|---|---|---|---|---|
| $V_{IL}$ | Input Low Voltage | | $V_{SS}$−14 | | $V_{SS}$−4.2 | V |
| $V_{IH}$ | Input High Voltage | | $V_{SS}$−1.5 | | $V_{SS}$+0.3 | V |
| $I_{LI}$ | Input Current | $V_{IN}$ = 0V | | | 1.0 | μA |
| $V_{OL}$ | Output Low Voltage | $I_{OL}$ = 1.6 mA | $V_{LL}$ | | 0.4 | V |
| $V_{OH}$ | Output High Voltage | $I_{OH}$ = −0.8 mA | 2.4 | | $V_{SS}$ | V |
| $I_{LO}$ | Output Leakage Current | $V_{OUT}$ = 0V, $\overline{CS}$ = $V_{IH}$ | | | 1.0 | μA |
| $I_{DD}$ | Power Supply Current | MM5204   $T_A$ = 0°C, $\overline{CS}$ = $V_{IH}$, Power Saver = $V_{IL}$ | | 28 | 40.0 | mA |
| | | MM4204   $T_A$ = 0°C, $\overline{CS}$ = $V_{IH}$, Power Saver = $V_{IL}$ | | | 50.0 | mA |
| | | MM5204   $T_A$ = 0°C, $\overline{CS}$ = $V_{IH}$, Power Saver = $V_{IH}$ | | 6.0 | 8.0 | mA |
| | | MM4204   $T_A$ = 0°C, $\overline{CS}$ = $V_{IH}$, Power Saver = $V_{IH}$ | | | 10.0 | mA |
| | | MM5204   $T_A$ = 0°C, $\overline{CS}$ = $V_{IH}$, Power Saver = $V_{IL}$ | | | 42 | mA |
| | | MM4204   $T_A$ = 0°C, $\overline{CS}$ = $V_{IH}$, Power Saver = $V_{IL}$ | | | 52 | mA |
| $I_{SS}$ | | MM5204   $T_A$ = 0°C, $\overline{CS}$ = $V_{IH}$, Power Saver = $V_{IH}$ | | | 10 | mA |
| | | MM4204   $T_A$ = 0°C, $\overline{CS}$ = $V_{IH}$, Power Saver = $V_{IH}$ | | | 12 | mA |

## AC Electrical Characteristics

$T_A$ within operating temperature range, $V_{LL}$ = 0V, $V_{BB}$ = PROGRAM = $V_{SS}$,
MM4204: $V_{SS}$ = 5V ±10%, $V_{DD}$ = −12V ±10%, MM5204: $V_{SS}$ = 5V ±5%, $V_{DD}$ = −12V ±5%, unless otherwise noted.

| SYMBOL | PARAMETER | CONDITIONS | MIN | TYP (Note 7) | MAX | UNITS |
|---|---|---|---|---|---|---|
| $t_{ACC}$ | Access Time | | | | | |
| | MM5204 | $T_A$ = 70°C, (Figure 1), (Note 4) | | 0.75 | 1.0 | μs |
| | MM4204 | $T_A$ = 85°C, (Figure 1), (Note 4) | | | 1.25 | μs |
| $t_{PO}$ | Power Saver Set-Up Time | | | | | |
| | MM5204 | (Figure 1) | | | 1.8 | μs |
| | MM4204 | (Figure 1) | | | 2.0 | μs |
| $t_{CO}$ | Chip Select Delay | | | | | |
| | MM5204 | (Figure 1) | | | 500 | ns |
| | MM4204 | (Figure 1) | | | 600 | ns |
| $t_{OH}$ | Data Hold Time | (Figure 1) | 30 | 50 | | ns |
| $t_{ODC}$ | Chip Select Deselect Time | | | | | |
| | MM5204 | (Figure 1) | 30 | 300 | 500 | ns |
| | MM4204 | (Figure 1) | 30 | 300 | 600 | ns |
| $t_{ODP}$ | Power Saver Deselect Time | | | | | |
| | MM5204 | (Figure 1) | 30 | 300 | 500 | ns |
| | MM4204 | (Figure 1) | 30 | 300 | 600 | ns |
| $C_{IN}$ | Input Capacitance (All Inputs) | $V_{IN}$ = $V_{SS}$, f = 1.0 MHz, (Note 2) | | 5.0 | 8.0 | pF |
| $C_{OUT}$ | Output Capacitance (All Outputs) | $V_{OUT}$ = $V_{SS}$, $\overline{CS}$ = $V_{IH}$, f = 1.0 MHz, (Note 2) | | 8.0 | 15 | pF |

## Programmer Electrical Characteristics

$T_A = 25°C$, $V_{SS} = \overline{CS}$ = Power Saver = 0V, $V_{LL}$ = 0V to −14V, unless otherwise specified, *(Figure 2)*, (Note 5).

| SYMBOL | PARAMETER | CONDITIONS | MIN | TYP (Note 7) | MAX | UNITS |
|--------|-----------|------------|-----|--------------|-----|-------|
| $I_{LD}$ | Data Input Load Current | $V_{IN} = -18V$ | | | −10 | mA |
| $I_{ALD}$ | Address Input Load Current | $V_{IN} = -50V$ | | | −10 | mA |
| $I_{LP}$ | Program Load Current | $V_{IN} = -50V$ | | | −10 | mA |
| $I_{LBB}$ | $V_{BB}$ Load Current | | | | 50 | mA |
| $I_{LDD}$ | $V_{DD}$ Load Current | $V_{DD}$ = PROGRAM = −50V | | | −200 | mA |
| $V_{IHP}$ | Address Data and Power Saver Input High Voltage | | −2.0 | | 0.3 | V |
| $V_{ILP}$ | Address Input Low Voltage | | −50 | | −11 | V |
| | Data Input Low Voltage | | −18 | | −11 | V |
| $V_{DHP}$ | $V_{DD}$ and Program High Voltage | | −2.0 | | 0.5 | V |
| $V_{DLP}$ | $V_{DD}$ and Program Low Voltage | | −50 | | −48 | V |
| $V_{BLP}$ | $V_{BB}$ Low Voltage | | 0 | | 0.4 | V |
| $V_{BHP}$ | $V_{BB}$ High Voltage | | 11.4 | | 12.6 | V |
| $V_{DD}$ | Pulse Duty Cycle | | | | 25 | % |
| $t_{PW}$ | Program Pulse Width | | 0.5 | | 5.0 | ms |
| $t_{DS}$ | Data and Address Set-Up Time | | 40 | | | $\mu s$ |
| $t_{DH}$ | Data and Address Hold Time | | 0 | | | $\mu s$ |
| $t_{SS}$ | Pulsed $V_{DD}$ Set-Up Time | | 40 | | 100 | $\mu s$ |
| $t_{SH}$ | Pulsed $V_{DD}$ Hold Time | | 1.0 | | | $\mu s$ |
| $t_{BS}$ | Pulsed $V_{BB}$ Set-Up Time | | 1.0 | | | $\mu s$ |
| $t_{BH}$ | Pulsed $V_{BB}$ Hold Time | | 1.0 | | | $\mu s$ |
| $t_{PSS}$ | Power Saver Set-Up Time | | 1.0 | | | $\mu s$ |
| $t_{PSH}$ | Power Saver Hold Time | | 1.0 | | | $\mu s$ |
| $t_R, t_F$ | $V_{DD}$, Program, Address and Data Rise and Fall Time | | | | 1.0 | $\mu s$ |

**Note 1:** "Absolute Maximum Ratings" are those values beyond which the safety of the device cannot be guaranteed. Except for "Operating Temperature Range" they are not meant to imply that the devices should be operated at these limits. The table of "Electrical Characteristics" provides conditions for actual device operation.

**Note 2:** Capacitance is guaranteed by periodic testing.

**Note 3:** Positive true logic notation is used except on data inputs during programming
Logic "1" = most positive voltage level
Logic "0" = most negative voltage level

**Note 4:** $t_{ACC}$ = 700 ns + 25 (N-1) where N is the number of devices wire−OR'd together.

**Note 5:** The program cycle should be repeated until the data reads true, then over-programmed 5 times that number of cycles. (Symbolized as X + 5X programming).

**Note 6:** The EPROM is initially programmed with all "0's." A $V_{IHP}$ on any data input B0−B7 will leave the stored "0's" undisturbed, and a $V_{ILP}$ on any data input B0−B7 will write a logic "1" into that location.

**Note 7:** Typical values are for nominal voltages and $T_A = 25°C$, unless otherwise specified.

## Erase Specification

The recommended dosage of ultraviolet light exposure is 6W sec/cm².

## Programming

The MM4204/MM5204 is normally shipped in the un-programmed state. All 4096-bits are at logic "0" state. The table of electrical programming characteristics and *Figure 2* give the conditions for programming of the device. In the program mode the device effectively becomes a RAM with the 512 word locations selected by address inputs A0−A8. Data inputs are B0−B7 and write operation is controlled by pulsing the Program input. Since the EROM is initially shipped with all "0's," a $V_{IHP}$ on any data input B0−B7 will leave the stored "0's" undisturbed and a $V_{ILP}$ on any data input B0−B7 will write a logic "1" into that location.

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## Programming (Continued)

National offers programmer options with both the IMP16-P and the PACE IPC-16P Microprocessor Development Systems.

| Microprocessor System | Programmer Part Number |
|---|---|
| IMP16-P | IMP16-P/805 |
| IPC-16P | IPC-16P/805 |

Contact the local sales office for further information. There are also several commercial programmers available such as the Data I/O Model V.

Most National distributors have programming capabilities available. Those distributors should be contacted directly to determine which data entry formats are available.

In addition, data may be submitted to National Semiconductor for factory programming. One of the following formats should be observed:

## Preferred Format

The custom patterns may be sent in on a Telex or submitted as a paper tape in a 7-bit ASCII code from model 33 teletype or TWX. The paper tape should be as the following example:
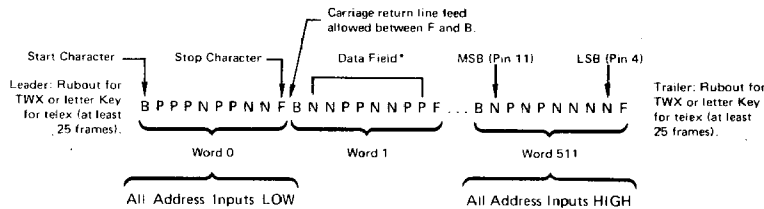


*Data Field: Must have only P's or N's typed between B and F. No nulls or rubouts. Must have exactly eight P and N characters between B and F. Any characters except B and F may be typed between the F stop character and the B start character. If an error is made in preparing a tape the entire word including the B and F start and stop characters must be rubbed out. Data for exactly 512 words must be entered beginning with word 0.

## Alternate Format [Punched Tape (Note 1) or Cards]
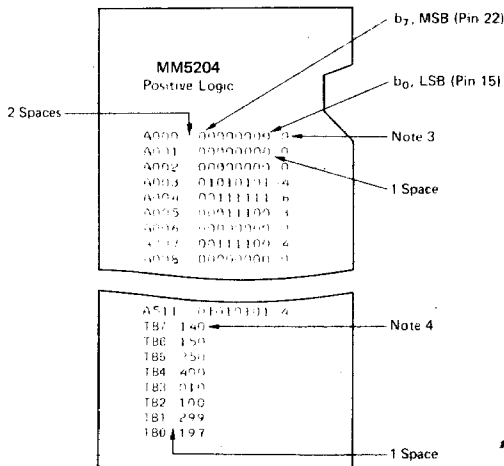


**Note 1:** The code is a 7-bit ASCII code on 8 punch tape. The tape should begin and end with 25 or more "RUBOUT" punches.

**Note 2:** The ROM input address is expressed in decimal form and is preceded by the latter A.

**Note 3:** The total number of "1" bits in the output word.

**Note 4:** The total number of "1" bits in each output column or bit position.

## Erasing Procedure

The MM4204Q/MM5204Q may be erased by exposure to short-wave ultraviolet light—253.7 nm. There exists no absolute rule for erasing time or distance from source. The erasing equipment output capability should be calibrated. Establish a worse case time required with the equipment. Then over-erase by a factor of 2, i.e., if the device appears erased after 8 minutes, continue exposure for an additional 16 minutes for a total of 24 minutes. Examples of UV sources include the Model UVS-54 and Model S-52 manufactured by Ultra-Violet Products, Inc. (5114 Walnut Grove Avenue, San Gabriel, California). The lamps should be used without short-wave filters. The MM4204/MM5204 should be placed about one inch away from the lamp for about 20–30 minutes.
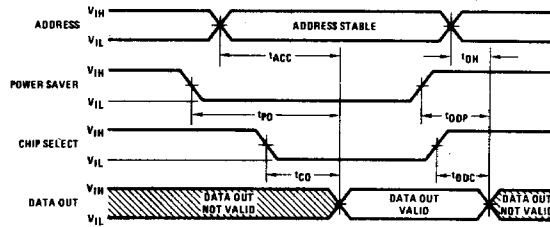
## AC Test Circuit
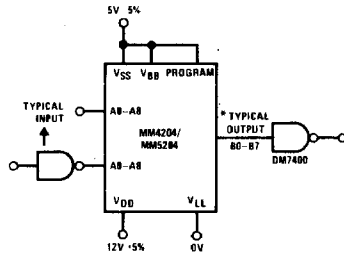


*$t_{ACC}$, $t_{OH}$, $t_{CD}$, and $t_{OD}$ measured
at output of MM4204/MM5204.

## Typical Application
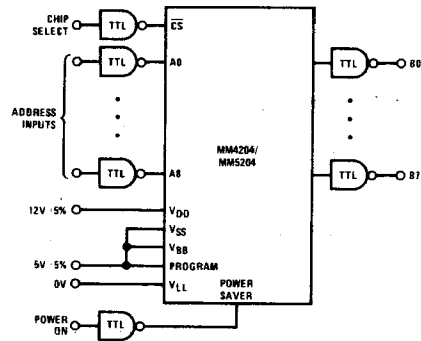


## Switching Time Waveforms



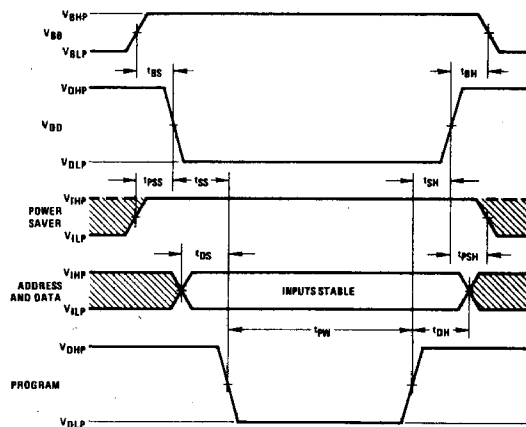Note. All times measured with respect to 1.5V level with $t_r$ and $t_f \leq$ 20 ns

FIGURE 1. Read Operation

## Programming Waveforms



FIGURE 2. Programming Waveforms