

NMC27CP128

131,072-Bit (16k x 8) UV Erasable CMOS PROM

General Description

The NMC27CP128 is a high-speed 128k UV erasable and electrically reprogrammable CMOS EPROM, ideally suited for applications where fast turnaround, pattern experimentation and low power consumption are important requirements.

The NMC27CP128 is designed to operate with a single +5V power supply with $\pm 10\%$ tolerance.

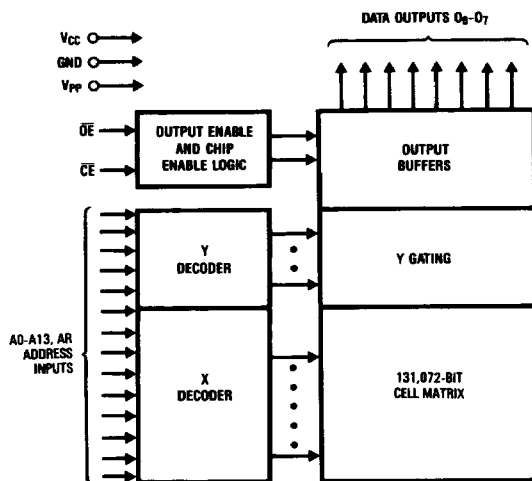
The NMC27CP128 is packaged in a 28-pin dual-in-line package with transparent lid. The transparent lid allows the user to expose the chip to ultraviolet light to erase the bit pattern. A new pattern can then be written electrically into the device by following the programming procedure.

This EPROM is fabricated with National's proprietary, time proven CMOS double-poly silicon gate technology which combines high performance and high density with low power consumption and excellent reliability.

Features

- Clocked sense amps for fast access time down to 200 ns
- Low CMOS power consumption
 - Active power: 55 mW max
 - Standby power: 0.55 mW max
- Single 5V power supply
- Fast and reliable programming
- Static operation—no clocks required
- TTL, CMOS compatible inputs/outputs
- TRI-STATE® output
- Optimum EPROM for total CMOS systems

Block Diagram



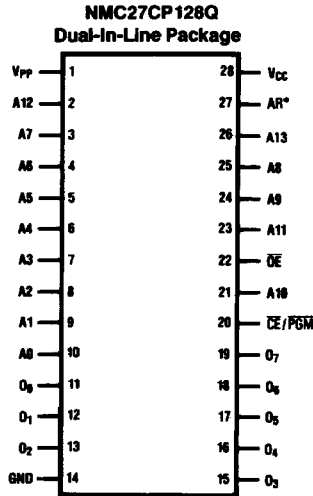
TL/D/8805-1

Pin Names

| | |
|--------------------------------|---------------|
| A0-A13 | Addresses |
| \overline{CE} | Chip Enable |
| \overline{OE} | Output Enable |
| O ₀ -O ₇ | Outputs |
| PGM | Program |
| NC | No Connect |
| AR | Block Select |

Connection Diagram

| 27C512 | 27C256 | 27C64 | 27C32 | 27C16 |
|----------------|-----------------|-----------------|----------------|----------------|
| 27512 | 27256 | 2764 | 2732 | 2716 |
| A15 | V _{PP} | V _{PP} | | |
| A12 | A12 | A12 | | |
| A7 | A7 | A7 | A7 | A7 |
| A6 | A6 | A6 | A6 | A6 |
| A5 | A5 | A5 | A5 | A5 |
| A4 | A4 | A4 | A4 | A4 |
| A3 | A3 | A3 | A3 | A3 |
| A2 | A2 | A2 | A2 | A2 |
| A1 | A1 | A1 | A1 | A1 |
| A0 | A0 | A0 | A0 | A0 |
| O ₀ | O ₀ | O ₀ | O ₀ | O ₀ |
| O ₁ | O ₁ | O ₁ | O ₁ | O ₁ |
| O ₂ | O ₂ | O ₂ | O ₂ | O ₂ |
| GND | GND | GND | GND | GND |



| 27C16 | 27C32 | 27C64 | 27C256 | 27C512 |
|-----------------|--------------------|-----------------|-----------------|--------------------|
| 2716 | 2732 | 2764 | 27256 | 27512 |
| | | V _{CC} | V _{CC} | V _{CC} |
| | | PGM | A14 | A14 |
| V _{CC} | V _{CC} | NC | A13 | A13 |
| A8 | A8 | A8 | A8 | A8 |
| A9 | A9 | A9 | A9 | A9 |
| V _{PP} | A11 | A11 | A11 | A11 |
| OE | OE/V _{PP} | OE | OE | OE/V _{PP} |
| A10 | A10 | A10 | A10 | A10 |
| CE/PGM | CE | CE | CE/PGM | CE |
| O ₇ | O ₇ | O ₇ | O ₇ | O ₇ |
| O ₆ | O ₆ | O ₆ | O ₆ | O ₆ |
| O ₅ | O ₅ | O ₅ | O ₅ | O ₅ |
| O ₄ | O ₄ | O ₄ | O ₄ | O ₄ |
| O ₃ | O ₃ | O ₃ | O ₃ | O ₃ |

TL/D/8805-2

*AR held at V_{IH}

Note: Socket compatible EPROM pin configurations are shown in the blocks adjacent to the NMC27CP128 pins.

Order Number NMC27CP128Q
See NS Package Number J28AQ

Commercial Temp Range
(0°C to +70°C) V_{CC} = 5V ± 10%

| Parameter/Order Number | Access Time (ns) |
|------------------------|------------------|
| NMC27CP128Q200 | 200 |
| NMC27CP128Q250 | 250 |
| NMC27CP128Q300 | 300 |

Absolute Maximum Ratings (Note 1)

| | |
|--|---------------------------------|
| Temperature Under Bias | -10°C to +80°C |
| Storage Temperature | -65°C to +150°C |
| All Input Voltages with Respect to Ground (Note 10) | +6.5V to -0.6V |
| All Output Voltages with Respect to Ground (Note 10) | $V_{CC} + 1.0V$ to $GND - 0.6V$ |
| V_{CC} Supply with Respect to Ground | +7.0V to -0.6V |

| | |
|---|-----------------|
| V_{PP} Supply Voltage with Respect to Ground During Programming | +14.0V to -0.6V |
| Power Dissipation | 1.0W |
| Lead Temperature (Soldering, 10 sec.) | 300°C |

Operating Conditions (Note 7)

| | |
|--------------------------|--------------|
| Temperature Range | 0°C to +70°C |
| V_{CC} Power Supply | 5V ±10% |
| NMC27CP128Q200, 250, 300 | |

READ OPERATION

DC Electrical Characteristics

| Symbol | Parameter | Conditions | Min | Typ | Max | Units |
|-----------------------|---|--|----------------|-----|--------------|---------|
| I_{LI} | Input Load Current | $V_{IN} = V_{CC}$ or GND | | | 10 | μA |
| I_{LO} | Output Leakage Current | $V_{OUT} = V_{CC}$ or GND , $\overline{CE} = V_{IH}$ | | | 10 | μA |
| I_{PP} | V_{PP} Current | $V_{PP} = V_{CC}$ | | | 10 | μA |
| I_{CC1} (Note 9) | V_{CC} Current (Active) TTL Inputs | $\overline{CE}/PGM = V_{IL}$, $f = 5$ MHz Inputs = V_{IH} or V_{IL} , $I/O = 0$ mA | | 5 | 20 | mA |
| I_{CC2} (Note 9) | V_{CC} Current (Active) CMOS Inputs | $\overline{CE}/PGM = GND$, $f = 5$ MHz Inputs = V_{CC} or GND , $I/O = 0$ mA | | 3 | 10 | mA |
| I_{CCSB1} | V_{CC} Current (Standby) TTL Inputs | $\overline{CE}/PGM = V_{IH}$ | | 0.1 | 1 | mA |
| I_{CCSB2} | V_{CC} Current (Standby) CMOS Inputs | $\overline{CE}/PGM = V_{CC}$ | | 0.5 | 100 | μA |
| I_{PP} | V_{PP} Load Current | $V_{PP} = V_{CC}$ | | | 10 | μA |
| V_{IL} | Input Low Voltage | | -0.1 | | 0.8 | V |
| V_{IH} | Input High Voltage | | 2.0 | | $V_{CC} + 1$ | V |
| V_{OL1} | Output Low Voltage | $I_{OL} = 2.1$ mA | | | 0.45 | V |
| V_{OH1} | Output High Voltage | $I_{OH} = -400$ μA | 2.4 | | | V |
| V_{OL2} | Output Low Voltage | $I_{OL} = 0$ μA | | | 0.1 | V |
| V_{OH2} | Output High Voltage | $I_{OH} = 0$ μA | $V_{CC} - 0.1$ | | | V |

AC Electrical Characteristics

| Symbol | Parameter | Conditions | NMC27CP128 | | | | | | Units |
|-----------|---|--|------------|-----|------|-----|------|-----|-------|
| | | | Q200 | | Q250 | | Q300 | | |
| | | | Min | Max | Min | Max | Min | Max | |
| t_{ACC} | Address to Output Delay | $\overline{CE}/PGM = \overline{OE} = V_{IL}$ | | 200 | | 250 | | 300 | ns |
| t_{CE} | \overline{CE}/PGM to Output Delay | $\overline{OE} = V_{IL}$ | | 200 | | 250 | | 300 | ns |
| t_{OE} | \overline{OE} to Output Delay | $\overline{CE}/PGM = V_{IL}$ | | 75 | | 100 | | 120 | ns |
| t_{DF} | \overline{OE} High to Output Float | $\overline{CE}/PGM = V_{IL}$ | 0 | 60 | 0 | 60 | 0 | 105 | ns |
| t_{CF} | \overline{CE} High to Output Float | $\overline{OE} = V_{IL}$ | 0 | 60 | 0 | 60 | 0 | 105 | ns |
| t_{OH} | Output Hold from Addresses, \overline{CE}/PGM or \overline{OE} , Whichever Occurred First | $\overline{CE}/PGM = \overline{OE} = V_{IL}$ | 0 | | 0 | | 0 | | ns |

Capacitance $T_A = +25^\circ\text{C}$, $f = 1\text{ MHz}$ (Note 2)

| Symbol | Parameter | Conditions | Typ | Max | Units |
|-----------|--------------------|-----------------------|-----|-----|-------|
| C_{IN} | Input Capacitance | $V_{IN} = 0\text{V}$ | 6 | 12 | pF |
| C_{OUT} | Output Capacitance | $V_{OUT} = 0\text{V}$ | 9 | 12 | pF |

AC Test Conditions

Output Load

1 TTL Gate and
 $C_L = 100\text{ pF}$ (Note 8)

Timing Measurement Reference Level

Input Rise and Fall Times

$\leq 5\text{ ns}$

Inputs

0.8V and 2V

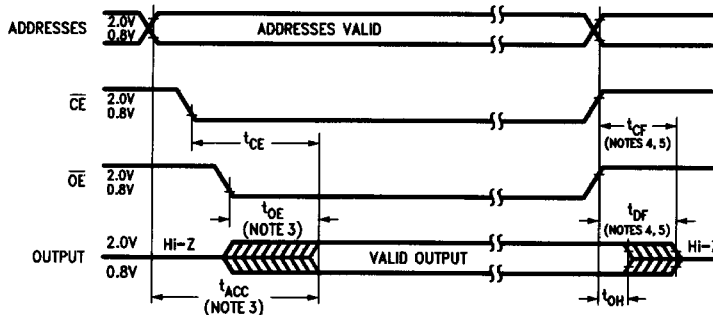
Input Pulse Levels

0.45V to 2.4V

Outputs

0.8V and 2V

AC Waveforms (Notes 6, 7 & 9)



TL/D/8805-3

Note 1: Stresses above those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

Note 2: This parameter is only sampled and is not 100% tested.

Note 3: \overline{OE} may be delayed up to $t_{ACC} - t_{OE}$ after the falling edge of \overline{CE} without impacting t_{ACC} .

Note 4: The t_{DF} and t_{CF} compare level is determined as follows:

High to TRI-STATE, the measured V_{OH1} (DC) - 0.10V;

Low to TRI-STATE, the measured V_{OL1} (DC) + 0.10V.

Note 5: TRI-STATE may be attained using OE or \overline{CE} .

Note 6: The power switching characteristics of EPROMs require careful device decoupling. It is recommended that at least a 0.1 μF ceramic capacitor be used on every device between V_{CC} and GND.

Note 7: The outputs must be restricted to $V_{CC} + 1.0\text{V}$ to avoid latch-up and device damage.

Note 8: 1 TTL Gate: $I_{OL} = 1.6\text{ mA}$, $I_{OH} = -400\text{ }\mu\text{A}$.

C_L : 100 pF includes fixture capacitance.

Note 9: V_{PP} may be connected to V_{CC} except during programming.

Note 10: Inputs and outputs can undershoot to -2.0V for 20 ns Max.

Note 11: AR held at V_{IH} .

Programming Characteristics (Notes 1, 2, 3 & 4)

| Symbol | Parameter | Conditions | Min | Typ | Max | Units |
|-----------|--|---|------|------|------|--------------------|
| t_{AS} | Address Setup Time | | 2 | | | μs |
| t_{OES} | \overline{OE} Setup Time | | 2 | | | μs |
| t_{VPS} | V_{PP} Setup Time | | 2 | | | μs |
| t_{VCS} | V_{CC} Setup Time | | 2 | | | μs |
| t_{DS} | Data Setup Time | | 2 | | | μs |
| t_{AH} | Address Hold Time | | 0 | | | μs |
| t_{DH} | Data Hold Time | | 2 | | | μs |
| t_{DF} | Output Enable to Output Float Delay | $\overline{CE} = V_{IL}$ | 0 | | 130 | ns |
| t_{PW} | Program Pulse Width | | 0.45 | 0.5 | 0.55 | ms |
| t_{OE} | Data Valid from \overline{OE} | $\overline{CE} = V_{IL}$ | | | 150 | ns |
| I_{PP} | V_{PP} Supply Current During Programming Pulse | $\overline{CE} = V_{IL}$ $\overline{PGM} = V_{IL}$ | | | 30 | mA |
| I_{CC} | V_{CC} Supply Current | | | | 10 | mA |
| T_A | Temperature Ambient | | 20 | 25 | 30 | $^{\circ}\text{C}$ |
| V_{CC} | Power Supply Voltage | | 5.75 | 6.0 | 6.25 | V |
| V_{PP} | Programming Supply Voltage | | 12.2 | 13.0 | 13.3 | V |
| t_{FR} | Input Rise, Fall Time | | 5 | | | ns |
| V_{IL} | Input Low Voltage | | | 0.0 | 0.45 | V |
| V_{IH} | Input High Voltage | | 2.4 | 4.0 | | V |
| t_{IN} | Input Timing Reference Voltage | | 0.8 | 1.5 | 2.0 | V |
| t_{OUT} | Output Timing Reference Voltage | | 0.8 | 1.5 | 2.0 | V |

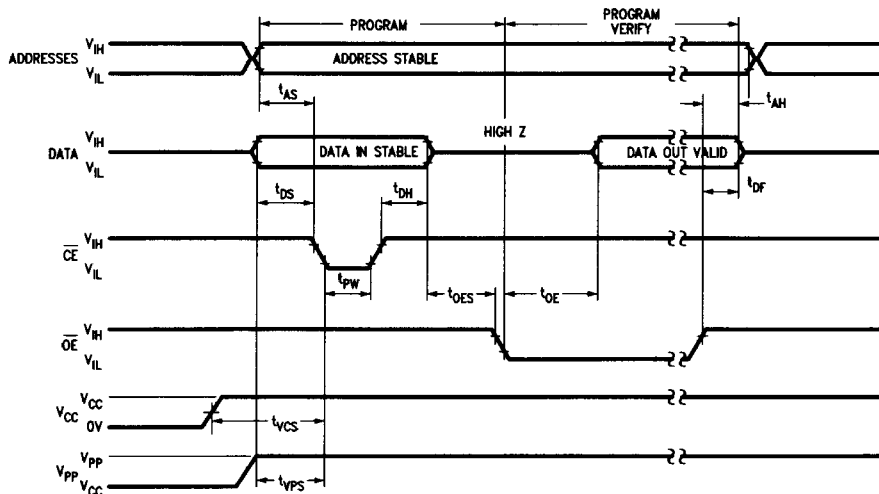
Note 1: National's standard product warranty applies only to devices programmed to specifications described herein.

Note 2: V_{CC} must be applied simultaneously or before V_{PP} and removed simultaneously or after V_{PP} . The EPROM must not be inserted into or removed from a board with voltage applied to V_{PP} or V_{CC} .

Note 3: The maximum absolute allowable voltage which may be applied to the V_{PP} pin during programming is 14V. Care must be taken when switching the V_{PP} supply to prevent any overshoot from exceeding this 14V maximum specification. At least a 0.1 μF capacitor is required across V_{PP} , V_{CC} to GND to suppress spurious voltage transients which may damage the device.

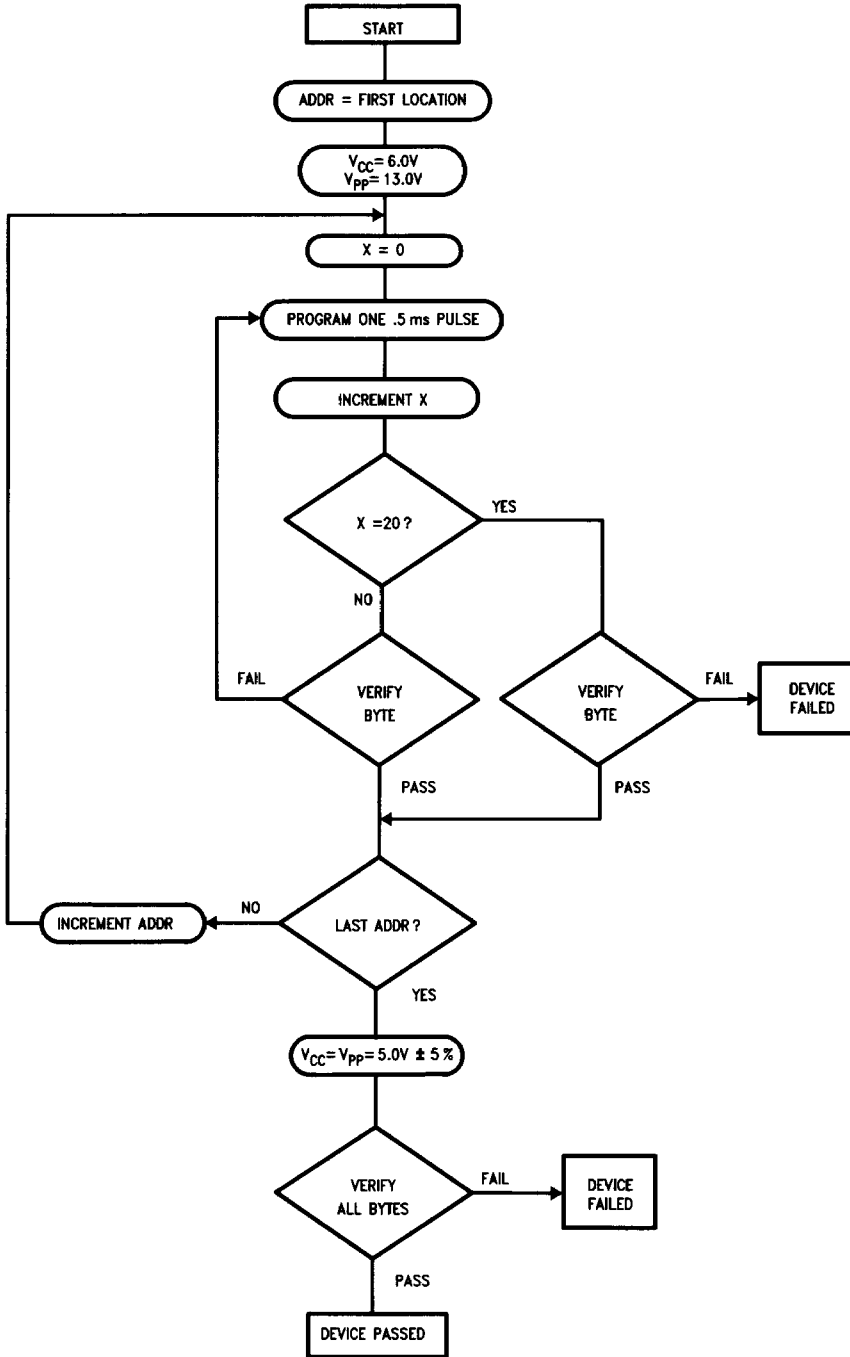
Note 4: Programming and program verify are tested with the Interactive Program Algorithm, at typical power supply voltages and timings.

Programming Waveforms (Note 3)



TL/D/8805-4

Interactive Programming Algorithm Flow Chart



TL/D/8805-5

Functional Description

DEVICE OPERATION

The six modes of operation of the NMC27CP128 are listed in Table I. It should be noted that all inputs for the six modes may be at TTL levels. The power supplies required are V_{CC} and V_{PP} . The V_{PP} power supply must be at 13.0V during the three programming modes, and must be at 5V in the other three modes. The V_{CC} power supply must be at 6V during the three programming modes, and at 5V in the other three modes.

Read Mode

The NMC27CP128 has two control functions, both of which must be logically active in order to obtain data at the outputs. Chip Enable ($\overline{CE}/\overline{PGM}$) is the power control and should be used for device selection. Output Enable (\overline{OE}) is the output control and should be used to gate data to the output pins, independent of device selection. Assuming that addresses are stable, address access time (t_{ACC}) is equal to the delay from $\overline{CE}/\overline{PGM}$ to output (t_{CE}). Data is available at the outputs t_{OE} after the falling edge of \overline{OE} , assuming that $\overline{CE}/\overline{PGM}$ has been low and addresses have been stable for at least $t_{ACC} - t_{OE}$.

The sense amps are clocked for fast access time. V_{CC} should therefore be maintained at operating voltage during read and verify. If V_{CC} temporarily drops below the spec. voltage (but not to ground) an address transition must be performed after the drop to insure proper output data.

Standby Mode

The NMC27CP128 has a standby mode which reduces the active power dissipation by 99%, from 55 mW to 0.55 mW. The NMC27CP128 is placed in the standby mode by applying a CMOS high signal to the $\overline{CE}/\overline{PGM}$ input. When in standby mode, the outputs are in a high impedance state, independent of the \overline{OE} input.

Output OR-Tying

Because NMC27CP128s are usually used in larger memory arrays, National has provided a 2-line control function that accommodates this use of multiple memory connections. The 2-line control function allows for:

- the lowest possible memory power dissipation, and
- complete assurance that output bus contention will not occur.

To most efficiently use these two control lines, it is recommended that $\overline{CE}/\overline{PGM}$ (pin 20) be decoded and used as the primary device selecting function, while \overline{OE} (pin 22) be

made a common connection to all devices in the array and connected to the READ line from the system control bus. This assures that all deselected memory devices are in their low power standby modes and that the output pins are active only when data is desired from a particular memory device.

Programming

CAUTION: Exceeding 14V on pin 1 (V_{PP}) will damage the NMC27CP128.

Initially, and after each erasure, all bits of the NMC27CP128 are in the "1" state. Data is introduced by selectively programming "0s" into the desired bit locations. Although only "0s" will be programmed, both "1s" and "0s" can be presented in the data word. The only way to change a "0" to a "1" is by ultraviolet light erasure.

The NMC27CP128 is in the programming mode when the V_{PP} power supply is at 13.0V and \overline{OE} is at V_{IH} . It is required that at least a 0.1 μF capacitor be placed across V_{PP} , V_{CC} to ground to suppress spurious voltage transients which may damage the device. The data to be programmed is applied 8 bits in parallel to the data output pins. The levels required for the address and data inputs may be TTL.

When the address and data are stable, an active low TTL program pulse is applied to the $\overline{CE}/\overline{PGM}$ input. A program pulse must be applied at each address location to be programmed. Any location may be programmed at any time—either individually, sequentially, or at random. The NMC27CP128 is designed to be programmed with interactive programming, where each address is programmed with a series of 0.5 ms pulses until it verifies (up to a maximum of 20 pulses or 10 ms). Since the NMC27CP128 employs the last 131,072 bits of a 262,144 bit memory array, **programming must be started at address 16,384** to provide correct data read. The NMC27CP128 must not be programmed with a DC signal applied to the $\overline{CE}/\overline{PGM}$ input.

Programming multiple NMC27CP128s in parallel with the same data can be easily accomplished due to the simplicity of the programming requirements. Like inputs of the paralleled NMC27CP128s may be connected together when they are programmed with the same data. A low level TTL pulse applied to the $\overline{CE}/\overline{PGM}$ input programs the paralleled NMC27CP128s.

The NMC27CP128 is a partial NMC27C256 and therefore is not program compatible with most 128k EPROMs.

The Manufacturer's Identification Code should not be used for programming control of the NMC27CP128.

TABLE I. Mode Selection

| Mode | Pins $\overline{CE}/\overline{PGM}$ (20) | \overline{OE} (22) | V_{PP} (1) | V_{CC} (28) | Outputs (11-13, 15-19) |
|-----------------|--|-------------------------|-----------------|------------------|---------------------------|
| Read | V_{IL} | V_{IL} | 5V | 5V | D_{OUT} |
| Standby | V_{IH} | Don't Care | 5V | 5V | Hi-Z |
| Program | Pulsed V_{IH} to V_{IL} | V_{IH} | 13.0V | 6V | D_{IN} |
| Program Verify | V_{IH} | V_{IL} | 13.0V | 6V | D_{OUT} |
| Program Inhibit | V_{IH} | V_{IH} | 13.0V | 5V | Hi-Z |
| Output Disable | Don't Care | V_{IH} | 5V | 5V | Hi-Z |

Functional Description (Continued)

Program Inhibit

Programming multiple NMC27CP128s in parallel with different data is also easily accomplished. Except for $\overline{CE}/\overline{PGM}$ all like inputs (including \overline{OE}) of the parallel NMC27CP128 may be common. A low level $\overline{CE}/\overline{PGM}$ input selects the devices to be programmed. A high level $\overline{CE}/\overline{PGM}$ input inhibits the other devices from being programmed.

Program Verify

A verify should be performed on the programmed bits to determine whether they were correctly programmed. The verify may be performed with V_{pp} at 13.0V. V_{pp} must be at V_{CC} , except during programming and program verify.

ERASURE CHARACTERISTICS

The erasure characteristics of the NMC27CP128 are such that erasure begins to occur when exposed to light with wavelengths shorter than approximately 4000 Angstroms (\AA). It should be noted that sunlight and certain types of fluorescent lamps have wavelengths in the 3000 \AA –4000 \AA range.

After programming, opaque labels should be placed over the NMC27CP128's window to prevent unintentional erasure. Covering the window will also prevent temporary functional failure due to the generation of photo currents.

The recommended erasure procedure for the NMC27CP128 is exposure to short wave ultraviolet light which has a wavelength of 2537 Angstroms (\AA). The integrated dose (i.e., UV intensity \times exposure time) for erasure should be a minimum of 15W-sec/cm².

The NMC27CP128 should be placed within 1 inch of the lamp tubes during erasure. Some lamps have a filter on their tubes which should be removed before erasure. Table II

shows the minimum NMC27CP128 erasure time for various light intensities.

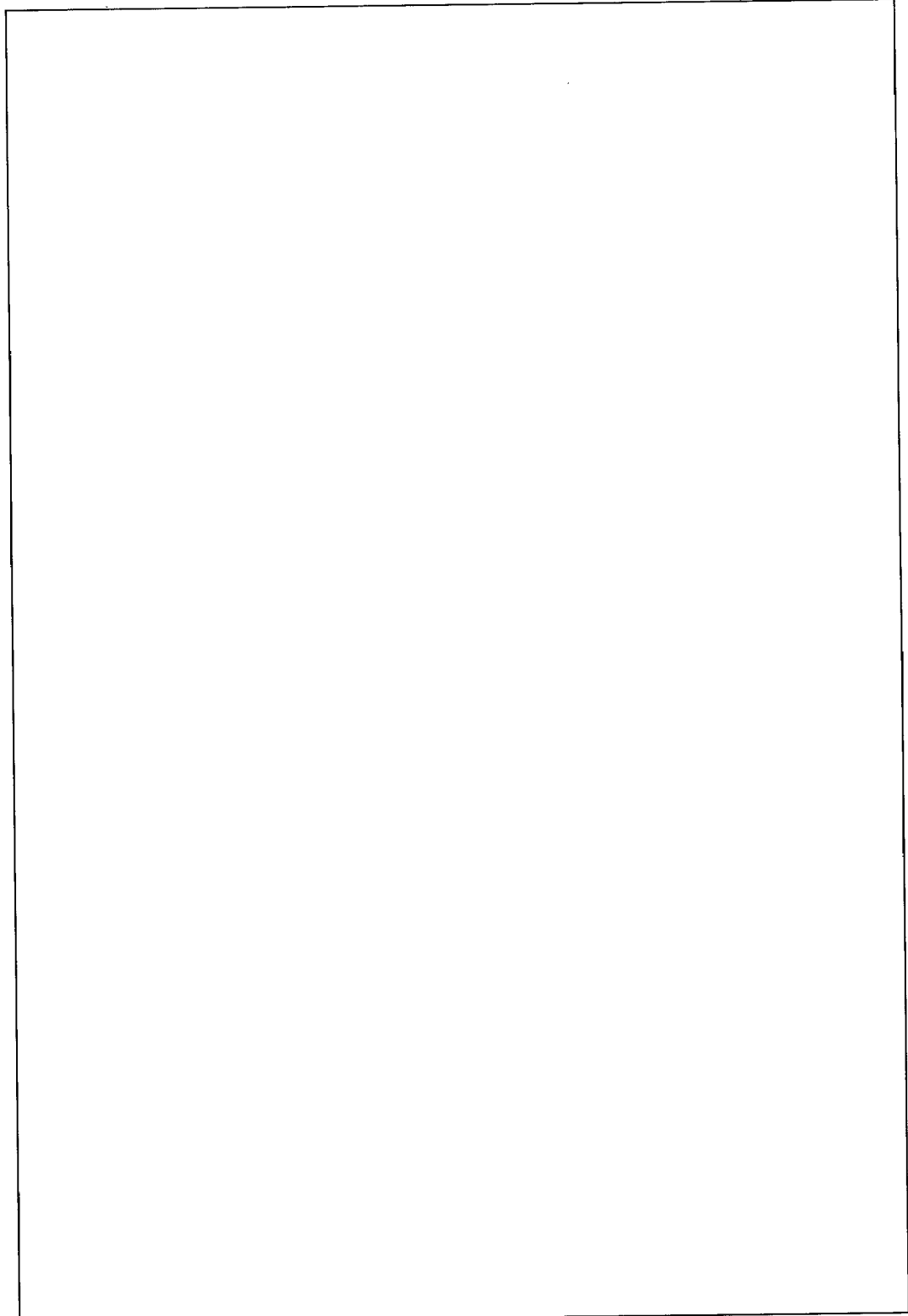
An erasure system should be calibrated periodically. The distance from lamp to unit should be maintained at one inch. The erasure time increases as the square of the distance. (If distance is doubled the erasure time increases by a factor of 4.) Lamps lose intensity as they age. When a lamp is changed, the distance has changed or the lamp has aged, the system should be checked to make certain full erasure is occurring. Incomplete erasure will cause symptoms that can be misleading. Programmers, components, and even system designs have been erroneously suspected when incomplete erasure was the problem.

SYSTEM CONSIDERATION

The power switching characteristics of EPROMs require careful decoupling of the devices. The supply current, I_{CC} , has three segments that are of interest to the system designer—the standby current level, the active current level, and the transient current peaks that are produced by voltage transitions on input pins. The magnitude of these transient current peaks is dependent on the output capacitance loading of the device. The associated V_{CC} transient voltage peaks can be suppressed by properly selected decoupling capacitors. It is recommended that at least a 0.1 μF ceramic capacitor be used on every device between V_{CC} and GND. This should be a high frequency capacitor of low inherent inductance. In addition, at least a 4.7 μF bulk electrolytic capacitor should be used between V_{CC} and GND for each eight devices. The bulk capacitor should be located near where the power supply is connected to the array. The purpose of the bulk capacitor is to overcome the voltage drop caused by the inductive effects of the PC board traces.

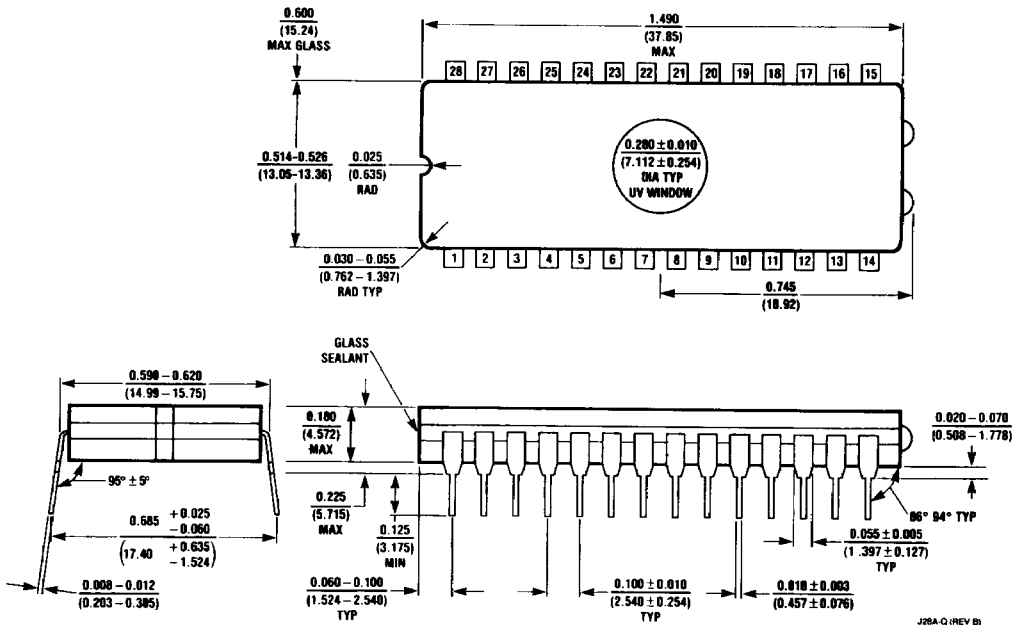
TABLE II. Minimum NMC27CP128 Erasure Time

| Light Intensity (Micro-Watts/cm ²) | Erasure Time (Minutes) |
|---|---------------------------|
| 15,000 | 20 |
| 10,000 | 25 |
| 5,000 | 50 |



Physical Dimensions inches (millimeters)

Lit. # 112315



UV Window Cavity Dual-In-Line Cerdip Package (JQ)
Order Number NMC27CP128Q
NS Package Number J28AQ

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National Semiconductor Corporation
 2900 Semiconductor Drive
 P.O. Box 58080
 Santa Clara, CA 95052-8080
 Tel: (408) 721-5000
 TWX: (910) 339-9240

National Semiconductor GmbH
 Westendstrasse 193-195
 D-8000 Munchen 21
 West Germany
 Tel: (089) 5 70 95 01
 Telex: 522772

NS Japan Ltd.
 Sanso Bldg. 5F
 4-15 Nishi Shinjuku
 Shinjuku-Ku,
 Tokyo 160, Japan
 Tel: 3-299-7001
 FAX: 3-299-7000

National Semiconductor Hong Kong Ltd.
 Southeast Asia Marketing
 Austin Tower, 4th Floor
 22-26A Austin Avenue
 Tsimshatsui, Kowloon, H.K.
 Tel: 3-7231290, 3-7243645
 Cable: NSSEAMKTG
 Telex: 52986 NSSEA HX

National Semicondutores Do Brasil Ltda.
 Av. Brig. Faria Lima, 830
 8 Andar
 01452 Sao Paulo, SP, Brazil
 Tel: (55/11) 212-5066
 Telex: 991-1131931 NSBR BR

National Semiconductor (Australia) Pty, Ltd.
 21/3 High Street
 Baywater, Victoria 3183
 Australia
 Tel: (03) 729-6333
 Telex: AA32096