



# **NM93CS06L/CS46L/CS56L/CS66L** **256-/1024-/2048-/4096-Bit Serial EEPROM** **with Extended Voltage (2.0V to 5.5V) and Data Protect**

## **General Description**

The NM93CS06L/CS46L/CS56L/CS66L devices are 256/1024/2048/4096 bits, respectively, of non-volatile electrically erasable memory divided into 16/64/128/256 x 16-bit registers (addresses). The NM93CSxxL Family functions in an extended voltage operating range and is fabricated using National Semiconductor's floating gate CMOS technology for high reliability, high endurance and low power consumption. N registers ( $N \leq 16$ ,  $N \leq 64$ ,  $N \leq 128$ ,  $N \leq 256$ ) can be protected against data modification by programming the Protect Register with the address of the first register to be protected against data modification. Additionally, this address can be "locked" into the device, making all future attempts to change data impossible.

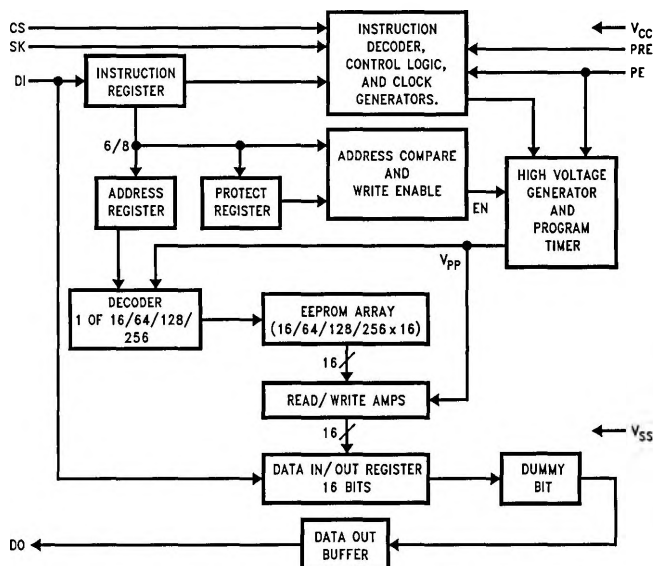
These devices are available in an SO package for small space considerations.

The serial interface that control these EEPROMs is MICROWIRE™ compatible, providing simple interfacing to standard microcontrollers and microprocessors. There are a total of 10 instructions, 5 which operate on the EEPROM memory and 5 which operate on the Protect Register. The memory instructions are READ, WRITE, WRITE ALL, WRITE ENABLE, and WRITE DISABLE. The Protect register instructions are PPREAD, PRWRITE, PREN, PRCLEAR, and PRDS.

## **Features**

- Sequential register read
- Write protection in a user defined section of memory
- 2.0V to 5.5V operating range in read mode
- 2.5V to 5.5V operating range in other modes
- Typical active current of 400  $\mu$ A; typical standby current of 25  $\mu$ A
- Direct Write
- Reliable CMOS floating gate technology
- MICROWIRE compatible serial I/O
- Self timed write cycle
- Device status during programming mode
- 40 year data retention
- Endurance:  $10^6$  data changes
- Packages Available: 8-pin SO, 8-pin DIP

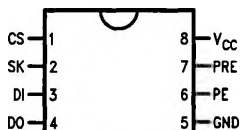
## **Block Diagram**



TL/D/10044-1

## Connection Diagrams

**Dual-In-Line Package (N)  
and 8-Pin SO Package (M8)**



TL/D/10044-2

**Top View**

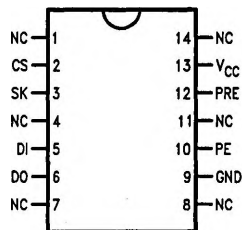
See NS Package Number N08E (N)  
See NS Package Number M08A (M8)

**Pin Names**

| CS  | Chip Select             |
|-----|-------------------------|
| SK  | Serial Data Clock       |
| DI  | Serial Data Input       |
| DO  | Serial Data Output      |
| GND | Ground                  |
| PE  | Program Enable          |
| PRE | Protect Register Enable |
| VCC | Power Supply            |

**PIN OUT:**

**SO Package (M)**



TL/D/10044-3

**Top View**

See NS Package Number M14A (M)

## Ordering Information

### Commercial Temp. Range (0°C to +70°C)

| Order Number                                                                                   |
|------------------------------------------------------------------------------------------------|
| NM93CS06LN/NM93CS46LN/NM93CS56LN/NM93CS66LN<br>NM93CS06LM8/NM93CS46LM8/NM93CS56LM8/NM93CS66LM* |

### Extended Temp. Range (-40°C to +85°C)

| Order Number                                                                                           |
|--------------------------------------------------------------------------------------------------------|
| NM93CS06LEN/NM93CS46LEN/NM93CS56LEN/NM93CS66LEN<br>NM93CS06LEM8/NM93CS46LEM8/NM93CS56LEM8/NM93CS66LEM* |

\*The NM93CS66 is available in 8-pin DIP and 14-pin SO only.

**Note:** 14-pin SO availability on the 93CS06, CS46 and CS56, contact your local National Semiconductor Sales Office.

## LOW VOLTAGE (<4.5) SPECIFICATIONS

### Absolute Maximum Ratings (Note 1)

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/Distributors for availability and specifications.

|                                                     |                 |
|-----------------------------------------------------|-----------------|
| Ambient Storage Temperature                         | -65°C to +150°C |
| All Input or Output Voltages with Respect to Ground | +6.5V to -0.3V  |
| Lead Temperature (Soldering, 10 sec.)               | +300°C          |
| ESD rating                                          | 2000V           |

### Operating Conditions

|                                       |                                |
|---------------------------------------|--------------------------------|
| Ambient Operating Temperature         | 0°C to +70°C<br>-40°C to +85°C |
| NM93CSxxL<br>NM93CSxxLE               |                                |
| Power Supply (V <sub>CC</sub> ) Range |                                |
| Read Mode                             | 2.0V to 5.5V                   |
| All Other Modes                       | 2.5V to 5.5V                   |

### DC and AC Electrical Characteristics

| Symbol                               | Parameter                                 | Part Number                                  | Conditions                                                                             | Min                         | Max                                         | Units |
|--------------------------------------|-------------------------------------------|----------------------------------------------|----------------------------------------------------------------------------------------|-----------------------------|---------------------------------------------|-------|
| V <sub>RPP</sub>                     | Power Supply Ripple                       |                                              | Peak-to-Peak (Note 5)                                                                  |                             | 0.1 V <sub>CC</sub>                         | V     |
| I <sub>CC1</sub>                     | Operating Current<br>CMOS Input Levels    | NM93CS06L-NM93CS66L<br>NM93CS06LE-NM93CS66LE | CS = V <sub>IH</sub> , SK = 250 kHz                                                    |                             | 2<br>2                                      | mA    |
| I <sub>CC2</sub>                     | Operating Current<br>TTL Input Levels     | NM93CS06L-NM93CS66L<br>NM93CS06LE-NM93CS66LE | CS = V <sub>IH</sub> , SK = 250 kHz<br>4.5V ≤ V <sub>CC</sub> ≤ 5.5V                   |                             | 3<br>3                                      | mA    |
| I <sub>CC3</sub>                     | Standby Current                           | NM93CS06L-NM93CS66L<br>NM93CS06LE-NM93CS66LE | CS = 0V                                                                                |                             | 50<br>50                                    | μA    |
| I <sub>IL</sub>                      | Input Leakage                             | NM93CS06L-NM93CS66L<br>NM93CS06LE-NM93CS66LE | V <sub>IN</sub> = 0V to V <sub>CC</sub>                                                | -2.5<br>-10                 | 2.5<br>10                                   | μA    |
| I <sub>OL</sub>                      | Output Leakage                            | NM93CS06L-NM93CS66L<br>NM93CS06LE-NM93CS66LE | V <sub>OUT</sub> = 0V to V <sub>CC</sub>                                               | -2.5<br>-10                 | 2.5<br>10                                   | μA    |
| V <sub>IL1</sub><br>V <sub>IH1</sub> | Input Low Voltage<br>Input High Voltage   |                                              | 4.5V ≤ V <sub>CC</sub> ≤ 5.5V                                                          | 2                           | 0.8                                         | V     |
| V <sub>IL2</sub><br>V <sub>IH2</sub> | Input Low Voltage<br>Input High Voltage   |                                              | 2V ≤ V <sub>CC</sub> ≤ 4.5V                                                            | -0.1<br>0.8 V <sub>CC</sub> | 0.15 V <sub>CC</sub><br>V <sub>CC</sub> + 1 | V     |
| V <sub>OL1</sub><br>V <sub>OH1</sub> | Output Low Voltage<br>Output High Voltage |                                              | 4.5V ≤ V <sub>CC</sub> ≤ 5.5V<br>I <sub>OL</sub> = 2.1 mA<br>I <sub>OH</sub> = -400 μA | 2.4                         | 0.4                                         | V     |
| V <sub>OL2</sub><br>V <sub>OH2</sub> | Output Low Voltage<br>Output High Voltage |                                              | 2V ≤ V <sub>CC</sub> ≤ 4.5V<br>I <sub>OL</sub> = 10 μA<br>I <sub>OH</sub> = -10 μA     | 0.9 V <sub>CC</sub>         | 0.1 V <sub>CC</sub>                         | V     |
| f <sub>SK</sub>                      | SK Clock Frequency                        | NM93CS06L-NM93CS66L<br>NM93CS06LE-NM93CS66LE |                                                                                        | 0<br>0                      | 250<br>250                                  | kHz   |
| t <sub>SKH</sub>                     | SK High Time                              | NM93CS06L-NM93CS66L<br>NM93CS06LE-NM93CS66LE | (Note 2)                                                                               | 1<br>1                      |                                             | μs    |
| t <sub>SKL</sub>                     | SK Low Time                               | NM93CS06L-NM93CS66L<br>NM93CS06LE-NM93CS66LE | (Note 2)                                                                               | 1<br>1                      |                                             | μs    |
| t <sub>SKS</sub>                     | SK Setup Time                             | NM93CS06L-NM93CS66L<br>NM93CS06LE-NM93CS66LE | Relative to CS                                                                         | 50<br>50<br>100             |                                             | ns    |
| t <sub>CS</sub>                      | Minimum CS<br>Low Time                    | NM93CS06L-NM93CS66L<br>NM93CS06LE-NM93CS66LE | (Note 3)                                                                               | 1<br>1                      |                                             | μs    |
| t <sub>CSS</sub>                     | CS Setup Time                             | NM93CS06L-NM93CS66L<br>NM93CS06LE-NM93CS66LE | Relative to SK                                                                         | 0.2<br>0.2                  |                                             | μs    |
| t <sub>PRES</sub>                    | PRE Setup Time                            | NM93CS06L-NM93CS66L<br>NM93CS06LE-NM93CS66LE | Relative to SK                                                                         | 0.2<br>0.2                  |                                             | μs    |

## LOW VOLTAGE (< 4.5) SPECIFICATIONS (Continued)

### DC and AC Electrical Characteristics (Continued)

| Symbol     | Parameter              | Part Number                                  | Conditions                       | Min        | Max        | Units   |
|------------|------------------------|----------------------------------------------|----------------------------------|------------|------------|---------|
| $t_{PE}$   | PE Setup Time          | NM93CS06L–NM93CS66L<br>NM93CS06LE–NM93CS66LE | Relative to SK                   | 0.2<br>0.2 |            | $\mu$ s |
| $t_{DIS}$  | DI Setup Time          | NM93CS06L–NM93CS66L<br>NM93CS06LE–NM93CS66LE | Relative to SK                   | 0.4<br>0.4 |            | $\mu$ s |
| $t_{DH}$   | DO Hold Time           |                                              | Relative to SK                   | 10         |            | ns      |
| $t_{CSH}$  | CS Hold Time           |                                              | Relative to SK                   | 0          |            | $\mu$ s |
| $t_{PEH}$  | PE Hold Time           | NM93CS06L–NM93CS66L<br>NM93CS06LE–NM93CS66LE | Relative to CS<br>Relative to CS | 0.4<br>0.4 |            | $\mu$ s |
| $t_{PREH}$ | PRE Hold Time          |                                              | Relative to SK                   | 0          |            | $\mu$ s |
| $t_{DIH}$  | DI Hold Time           |                                              | Relative to SK                   | 0.4        |            | $\mu$ s |
| $t_{PD1}$  | Output Delay to "1"    | NM93CS06L–NM93CS66L<br>NM93CS06LE–NM93CS66LE | AC Test                          |            | 2<br>2     | $\mu$ s |
| $t_{PD0}$  | Output Delay to "0"    | NM93CS06L–NM93CS66L<br>NM93CS06LE–NM93CS66LE | AC Test                          |            | 2<br>2     | $\mu$ s |
| $t_{SV}$   | CS to Status Valid     | NM93CS06L–NM93CS66L<br>NM93CS06LE–NM93CS66LE | AC Test                          |            | 1<br>1     | $\mu$ s |
| $t_{DF}$   | CS to DO in TRI-STATE® | NM93CS06L–NM93CS66L<br>NM93CS06LE–NM93CS66LE | CS = $V_{IL}$<br>AC Test         |            | 0.4<br>0.4 | $\mu$ s |
| $t_{WP}$   | Write Cycle Time       |                                              |                                  |            | 15         | ms      |

### Capacitance (Note 4)

$T_A = 25^\circ\text{C}$ ,  $f = 1\text{MHz}$

| Symbol    | Test               | Max | Units |
|-----------|--------------------|-----|-------|
| $C_{OUT}$ | Output Capacitance | 5   | pF    |
| $C_{IN}$  | Input Capacitance  | 5   | pF    |

### AC Test Conditions

| Output Load: 1 TTL Gate and $C_L = 100\text{ pF}$ |                                                                                                                                                                                                                                                                  |
|---------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| $V_{CC}$ Range                                    | AC Test Conditions                                                                                                                                                                                                                                               |
| $4.5\text{V} < V_{CC} < 5.5\text{V}$              | Input Pulse Levels: 0.8V and 2.0V<br>Timing Measurement Level ( $V_{IL}/V_{IH}$ ): 0.9V and 1.9V<br>Timing Measurement Level ( $V_{OL}/V_{OH}$ ): 0.8V and 2.0V<br>(TTL Load Conditions: $I_{OL} = 2.1\text{ mA}$ ; $I_{OH} = -0.4\text{ mA}$ )                  |
| $2.0\text{V} < V_{CC} < 4.5\text{V}$              | Input Pulse Levels: 0.3V and 1.8V<br>Timing Measurement Level ( $V_{IL}/V_{IH}$ ): 0.4V and 1.6V<br>Timing Measurement Level ( $V_{OL}/V_{OH}$ ): 0.8V and 1.6V<br>(CMOS Load Conditions: $I_{OL} = 10\text{ }\mu\text{A}$ ; $I_{OH} = -10\text{ }\mu\text{A}$ ) |

**Note 1:** Stress 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 the specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

**Note 2:** The above SK frequency specifies a minimum SK clock period of 4  $\mu$ s; therefore, in an SK clock cycle,  $t_{SKH} + t_{SKL}$  must be greater than or equal to 4  $\mu$ s. For example, if  $t_{SKL} = 1\text{ }\mu\text{s}$ , then the minimum  $t_{SKH} = 3\text{ }\mu\text{s}$  in order to meet the SK frequency specification.

**Note 3:** CS must be brought low for a minimum of 1  $\mu$ s ( $t_{CS}$ ) between consecutive instruction cycles.

**Note 4:** This parameter is periodically sampled and not 100% tested.

**Note 5:** Rate of voltage change must be less than 0.5 V/ms.

## STANDARD VOLTAGE ( $4.5 \leq V \leq 5.5$ ) SPECIFICATIONS

### Absolute Maximum Ratings (Note 1)

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/Distributors for availability and specifications.

Ambient Storage Temperature  $-65^{\circ}\text{C}$  to  $+150^{\circ}\text{C}$

All Input or Output Voltages with Respect to Ground  $+6.5\text{V}$  to  $-0.3\text{V}$

Lead Temp. (Soldering, 10 second)  $+300^{\circ}\text{C}$

ESD Rating 2000V

### Operating Conditions

Ambient Operating Temperature

NM93CSxxL

NM93CSxxLE

Power Supply ( $V_{CC}$ )

$0^{\circ}\text{C}$  to  $+70^{\circ}\text{C}$

$-40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$

4.5V to 5.5V

**DC and AC Electrical Characteristics**  $V_{CC} = 4.5\text{V}$  to  $5.5\text{V}$  unless otherwise specified  
Throughout this table "M" refers to temperature range ( $-55^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$ ) not package.

| Symbol                 | Parameter                                 | Part Number                                    | Conditions                                                            | Min            | Max                 | Units         |
|------------------------|-------------------------------------------|------------------------------------------------|-----------------------------------------------------------------------|----------------|---------------------|---------------|
| $I_{CC1}$              | Operating Current<br>CMOS Input Levels    | NM93CS06L-NM93CS66L<br>NM93CS06LE-NM93CS66LE   | $CS = V_{IH}$ , SK = 1.0 MHz<br>SK = 1.0 MHz                          |                | 2<br>2              | mA            |
| $I_{CC2}$              | Operating Current<br>TTL Input Levels     | NM93CS06L-NM93CS66L<br>NM93CS06LE-NM93CS66LE   | $CS = V_{IH}$ , SK = 1.0 MHz<br>SK = 1.0 MHz                          |                | 3<br>3              | mA            |
| $I_{CC3}$              | Standby Current                           | NM93CS06L-NM93CS66L<br>NM93CS06LE-NM93CS66LE   | $CS = 0\text{V}$                                                      |                | 50<br>50            | $\mu\text{A}$ |
| $I_{IL}$               | Input Leakage                             | NM93CS06L-NM93CS66L<br>NM93CS06LE-NM93CS66LE   | $V_{IN} = 0\text{V}$ to $V_{CC}$                                      | -2.5<br>-10    | 2.5<br>10           | $\mu\text{A}$ |
| $I_{OL}$               | Output Leakage                            | NM93CS06L-NM93CS66L<br>NM93CS06LE-NM93CS66LE   | $V_{OUT} = 0\text{V}$ to $V_{CC}$                                     | -2.5<br>-10    | 2.5<br>10           | $\mu\text{A}$ |
| $V_{IL}$<br>$V_{IH}$   | Input Low Voltage<br>Input High Voltage   |                                                |                                                                       | -0.1<br>2      | 0.8<br>$V_{CC} + 1$ | V             |
| $V_{OL1}$              | Output Low Voltage                        | NM93CS06LE-NM93CS66LE<br>NM93CS06LE-NM93CS66LE | $I_{OL} = 2.1\text{ mA}$<br>$I_{OL} = 2.1\text{ mA}$                  |                | 0.4<br>0.4          | V             |
| $V_{OL2}$<br>$V_{OH2}$ | Output Low Voltage<br>Output High Voltage |                                                | $I_{OL} = 10\text{ }\mu\text{A}$<br>$I_{OL} = -10\text{ }\mu\text{A}$ | $V_{CC} - 0.2$ | 0.2                 | V             |
| $f_{SK}$               | SK Clock Frequency                        | NM93CS06L-NM93CS66L<br>NM93CS06LE-NM93CS66LE   |                                                                       | 0<br>0         | 1<br>1              | MHz           |
| $t_{SKH}$              | SK High Time                              | NM93CS06L-NM93CS66L<br>NM93CS06LE-NM93CS66LE   | (Note 2)<br>(Note 2)                                                  | 250<br>300     |                     | ns            |
| $t_{SKL}$              | SK Low Time                               | NM93CS06L-NM93CS66L<br>NM93CS06LE-NM93CS66LE   | (Note 2)<br>(Note 2)                                                  | 250<br>250     |                     | ns            |
| $t_{CS}$               | Minimum CS<br>Low Time                    | NM93CS06L-NM93CS66L<br>NM93CS06LE-NM93CS66LE   | (Note 4)<br>(Note 4)                                                  | 250<br>250     |                     | ns            |
| $t_{CSS}$              | CS Setup Time                             | NM93CS06L-NM93CS66L<br>NM93CS06LE-NM93CS66LE   | Relative to SK                                                        | 50<br>50       |                     | ns            |
| $t_{PRES}$             | PRE Setup Time                            | NM93CS06L-NM93CS66L<br>NM93CS06LE-NM93CS66LE   | Relative to SK                                                        | 50<br>50       |                     | ns            |
| $t_{DH}$               | DO Hold Time                              |                                                | Relative to SK                                                        | 10             |                     | ns            |

# STANDARD VOLTAGE ( $4.5 \leq V \leq 5.5$ ) SPECIFICATIONS (Continued)

**DC and AC Electrical Characteristics**  $V_{CC} = 4.5V$  to  $5.5V$  unless otherwise specified  
Throughout this table "M" refers to temperature range ( $-55^{\circ}C$  to  $+125^{\circ}C$ ) not package. (Continued)

| Symbol     | Parameter                 | Part Number                                  | Conditions                       | Min        | Max        | Units |
|------------|---------------------------|----------------------------------------------|----------------------------------|------------|------------|-------|
| $t_{PE}$   | PE Setup Time             | NM93CS06L-NM93CS66L<br>NM93CS06LE-NM93CS66LE | Relative to SK                   | 50<br>50   |            | ns    |
| $t_{DIS}$  | DI Setup Time             | NM93CS06L-NM93CS66L<br>NM93CS06LE-NM93CS66LE | Relative to SK                   | 100<br>100 |            | ns    |
| $t_{CSH}$  | CS Hold Time              |                                              | Relative to SK                   | 0          |            | ns    |
| $t_{PEH}$  | PE Hold Time              | NM93CS06L-NM93CS66L<br>NM93CS06LE-NM93CS66LE | Relative to CS<br>Relative to CS | 250<br>250 |            | ns    |
| $t_{PREH}$ | PRE Hold Time             |                                              | Relative to SK                   | 0          |            | ns    |
| $t_{DIH}$  | DI Hold Time              |                                              | Relative to SK                   | 20         |            | ns    |
| $t_{PD1}$  | Output Delay to "1"       | NM93CS06L-NM93CS66L<br>NM93CS06LE-NM93CS66LE | AC Test                          |            | 500<br>500 | ns    |
| $t_{PD0}$  | Output Delay to "0"       | NM93CS06L-NM93CS66L<br>NM93CS06LE-NM93CS66LE | AC Test                          |            | 500<br>500 | ns    |
| $t_{SV}$   | CS to Status Valid        | NM93CS06L-NM93CS66L<br>NM93CS06LE-NM93CS66LE | AC Test                          |            | 500<br>500 | ns    |
| $t_{DF}$   | CS to DO in<br>TRI-STATE® | NM93CS06L-NM93CS66L<br>NM93CS06LE-NM93CS66LE | AC Test<br>CS = $V_{IL}$         |            | 100<br>100 | ns    |
| $t_{WP}$   | Write Cycle Time          |                                              |                                  |            | 10         | ms    |

## Capacitance (Note 6)

$T_A = 25^{\circ}C$   $f = 1$  MHz

| Symbol    | Test               | Max | Units |
|-----------|--------------------|-----|-------|
| $C_{OUT}$ | Output Capacitance | 5   | pF    |
| $C_{IN}$  | Input Capacitance  | 5   | pF    |

**Note 1:** Stress 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 the specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

**Note 2:** The SK frequency specification for Commercial and Extended parts specifies a minimum SK clock period of 1 microsecond; therefore, in an SK clock cycle,  $t_{SKH} + t_{SKL}$  must be greater than or equal to 1 microsecond. For example, if  $t_{SKL} = 250$  ns, then the minimum  $t_{SKH} = 750$  ns in order to meet the SK frequency specification.

**Note 3:** The SK frequency specification for Military Temperature parts specifies a minimum SK clock period of 2 microseconds; therefore, in an SK clock cycle,  $t_{SKH} + t_{SKL}$  must be greater than or equal to 2 microseconds. For example, if  $t_{SKL} = 500$  ns, then the minimum  $t_{SKH} = 1.5$  microseconds in order to meet the SK frequency specification.

**Note 4:** For Commercial and Extended parts, CS must be brought low for a minimum of 250 ns ( $t_{CS}$ ) between consecutive instruction cycles.

**Note 5:** For Military Temperature parts, CS must be brought low for a minimum of 500 ns ( $t_{CS}$ ) between consecutive instruction cycles.

**Note 6:** This parameter is periodically sampled and not 100% tested.

## Functional Description

The extended voltage EEPROMs of the NM93CSxxL Family have 10 instructions as described below. Note that there is a difference in the length of the instruction for the NM93CS06L and NM93CS46L vs. the NM93CS56L and NM93CS66L since the two larger devices require 2 additional address bits which are not required for the smaller devices. Within the two groups of devices the number of address bits remain constant even though in some cases the most significant bit(s) are not used. In every instruction, the first bit is always a "1" and is viewed as a start bit. The next 8 or 10 bits, depending on device size, carry the op code and address. The address is either 6 or 8 bits, depending on the device size.

### Read and Sequential Register Read (READ):

The Read (READ) instruction outputs serial data on the D0 pin. After a READ instruction is received, the instruction and address are decoded, followed by data transfer from the selected memory register into a 16-bit serial-out shift register. A dummy bit (logical 0) precedes the 16-bit data output string. Output data changes are initiated by a low to high transition of the SK clock. In the **Sequential Read** mode of operation, the memory automatically cycles to the next register after each 16 data bits are clocked out. The dummy-bit is suppressed in this mode and a continuous string of data is obtained.

### Write Enable (WEN):

When  $V_{CC}$  is applied to the part, it "powers up" in the Write Disable (WDS) state. Therefore, all programming modes must be preceded by a Write Enable (WEN) instruction. Once a Write Enable instruction is executed, programming remains enabled until a Write Disable (WDS) instruction is executed or  $V_{CC}$  is removed from the part.

### Write (WRITE):

The Write (WRITE) instruction is followed by 16 bits of data to be written into the specified address. After the last bit of data is allocated to the data-in (DI) pin, CS must be brought low before the next rising edge of the SK clock. This falling edge of the CS initiates the self-timed programming cycle. The PE pin **MUST** be held high while loading the WRITE instruction; however, after loading the WRITE instruction, the PE pin becomes a "don't care". The D0 pin indicates the READY/BUSY status of the chip if CS is brought high after a minimum of 250 ns ( $t_{CS}$ ). D0 = logical 0 indicates that programming is still in progress. D0 = logical 1 indicates that the register at the address specified in the instruction has been written with the data pattern specified in the instruction and that the part is ready for another instruction.

### Write All (WRALL):

The Write All (WRALL) instruction is valid only when the Protect Register has been cleared by executing a PRCLEAR instruction. The WRALL instruction will simultaneously program all registers with the data pattern specified in the instruction. Like the WRITE instruction, the PE pin **MUST** be held high while loading the WRALL instruction; however, after loading the WRITE instruction, the PE pin becomes a "don't care". As in the WRITE mode, the D0 pin indicates the READY/BUSY status of the chip if CS is brought high after a minimum of 250 ns ( $t_{CS}$ ).

### Write Disable (WDS):

To protect against accidental data disturb, the Write Disable (WDS) instruction disables all programming modes and should follow all programming operations. Execution of a READ instruction is independent of both the WEN and WDS instructions.

### Protect Register Read (PRREAD):

The Protect Register Read (PRREAD) instruction outputs the address stored in the Protect Register on the DO pin. The PRE pin **MUST** be held high while loading the instruction. Following the PRREAD instruction the 6- or 8-bit address stored in the memory protect register is transferred to the serial out shift register. As in the READ mode, a dummy bit (logical 0) precedes the 6- or 8-bit address string.

### Protect Register Enable (PREN):

The Protect Register Enable (PREN) instruction is used to enable the PRCLEAR, PRWRITE, and PRDS modes. Before the PREN mode can be entered, the part must be in the Write Enable (WEN) mode. Both the PRE and PE pins **MUST** be held high while loading the instruction.

Note that a PREN instruction must **immediately** precede a PRCLEAR, PRWRITE, or PRDS instruction.

### Protect Register Clear (PRCLEAR):

The Protect Register Clear (PRCLEAR) instruction clears the address stored in the Protect Register and therefore enables all registers for the WRITE and WRALL instruction. The PRE and PE pins **must** be held high while loading the instruction; however, after loading the PRCLEAR instruction, the PRE and PE pins become "don't care". Note that a PREN instruction must **immediately** precede a PRCLEAR instruction. The Protect Register will be read as 0s after it is cleared.

### Protect Register Write (PRWRITE):

The Protect Register Write (PRWRITE) instruction is used to write into the Protect Register which is the address of the first register to be protected. After the PRWRITE instruction is executed, all memory registers whose addresses are greater than or equal to the address specified in the Protect Register are protected from the WRITE operation. Note that before executing a PRWRITE instruction, the Protect Register must first be cleared by executing a PRCLEAR operation and the PRE and PE pins **must** be held high while loading the instruction; however, after loading the PRWRITE instruction, the PRE and PE pins become "don't care". Note that a PREN instruction must **immediately** precede a PRWRITE instruction.

### Protect Register Disable (PRDS):

The Protect Register Disable (PRDS) instruction is a **one** time only instruction which renders the Protect Register unalterable in the future. Therefore, the specified registers become **PERMANENTLY** protected against data changes. As in the PRWRITE instruction the PRE and PE pins **must** be held high while loading the instruction, and after loading the PRDS instruction the PRE and PE pins become "don't care".

Note that a PREN instruction must **immediately** precede a PRDS instruction.

### Instruction Set for the NM93CS06L and NM93CS46L

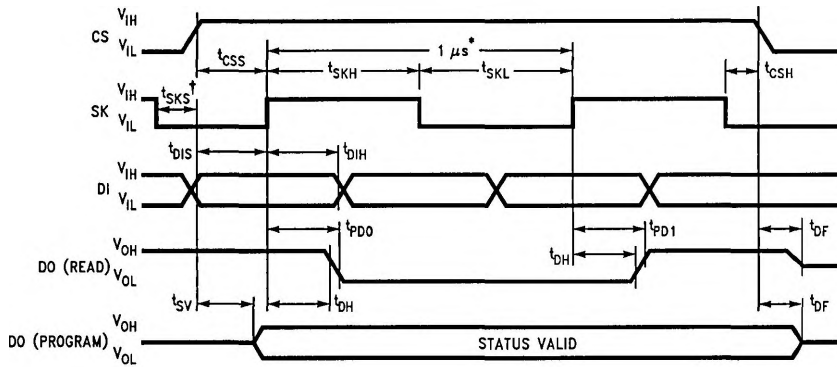
| Instruction | SB | Op Code | Address | Data   | PRE | PE | Comments                                                                                                                              |
|-------------|----|---------|---------|--------|-----|----|---------------------------------------------------------------------------------------------------------------------------------------|
| READ        | 1  | 10      | A5-A0   |        | 0   | X  | Reads data stored in memory, starting at specified address.                                                                           |
| WEN         | 1  | 00      | 11XXXX  |        | 0   | 1  | Write enable must precede all programming modes.                                                                                      |
| WRITE       | 1  | 01      | A5-A0   | D15-D0 | 0   | 1  | Writes register if address is unprotected.                                                                                            |
| WRALL       | 1  | 00      | 01XXXX  | D15-D0 | 0   | 1  | Writes all registers. Valid only when Protect Register is cleared.                                                                    |
| WDS         | 1  | 00      | 00XXXX  |        | 0   | X  | Disables all programming instructions.                                                                                                |
| PRREAD      | 1  | 10      | XXXXXX  |        | 1   | X  | Reads address stored in Protect Register.                                                                                             |
| PREN        | 1  | 00      | 11XXXX  |        | 1   | 1  | Must immediately precede PRCLEAR, PRWRITE, and PRDS instructions.                                                                     |
| PRCLEAR     | 1  | 11      | 111111  |        | 1   | 1  | Clears the Protect Register so that no registers are protected from WRITE. Cleared state is read as 0's.                              |
| PRWRITE     | 1  | 01      | A5-A0   |        | 1   | 1  | Programs address into Protect Register. Thereafter, memory addresses $\geq$ the address in Protect Register are protected from WRITE. |
| PRDS        | 1  | 00      | 000000  |        | 1   | 1  | One time only instruction after which the address in the Protect Register cannot be altered.                                          |

### Instruction Set for the NM93CS56L and NM93CS66L

| Instruction | SB | Op Code | Address  | Data   | PRE | PE | Comments                                                                                                                              |
|-------------|----|---------|----------|--------|-----|----|---------------------------------------------------------------------------------------------------------------------------------------|
| READ        | 1  | 10      | A7-A0    |        | 0   | X  | Reads data stored in memory, starting at specified address.                                                                           |
| WEN         | 1  | 00      | 11XXXXXX |        | 0   | 1  | Write enable must precede all programming modes.                                                                                      |
| WRITE       | 1  | 01      | A7-A0    | D15-D0 | 0   | 1  | Writes register if address is unprotected.                                                                                            |
| WRALL       | 1  | 00      | 01XXXXXX | D15-D0 | 0   | 1  | Writes all registers. Valid only when Protect Register is cleared.                                                                    |
| WDS         | 1  | 00      | 00XXXXXX |        | 0   | X  | Disables all programming instructions.                                                                                                |
| PRREAD      | 1  | 10      | XXXXXXXX |        | 1   | X  | Reads address stored in Protect Register.                                                                                             |
| PREN        | 1  | 00      | 11XXXXXX |        | 1   | 1  | Must immediately precede PRCLEAR, PRWRITE, and PRDS instructions.                                                                     |
| PRCLEAR     | 1  | 11      | 11111111 |        | 1   | 1  | Clears the "protect register" so that no registers are protected from WRITE. Cleared state is read as 0's.                            |
| PRWRITE     | 1  | 01      | A7-A0    |        | 1   | 1  | Programs address into Protect Register. Thereafter, memory addresses $\geq$ the address in Protect Register are protected from WRITE. |
| PRDS        | 1  | 00      | 00000000 |        | 1   | 1  | One time only instruction after which the address in the Protect Register cannot be altered.                                          |

# Timing Diagrams

## Synchronous Data Timing

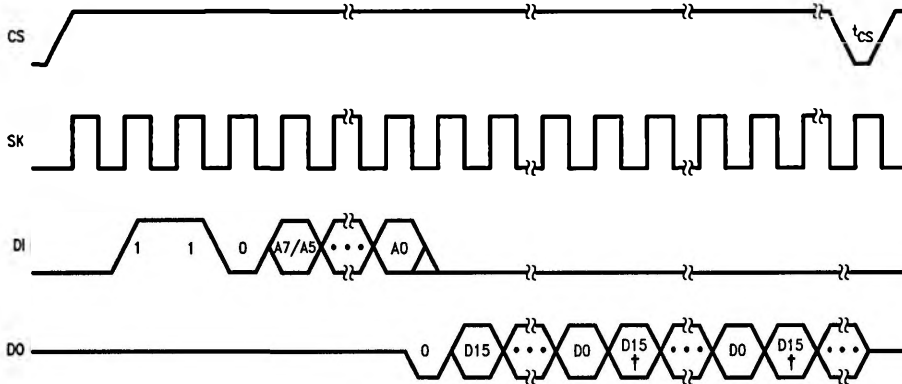


TL/D/10044-15

\*This is the minimum SK period (Note 2).

$t_{SKS}$  is not needed if  $DI = V_{IL}$  when CS is going active (HIGH).

## READ: PRE = 0, PE = X



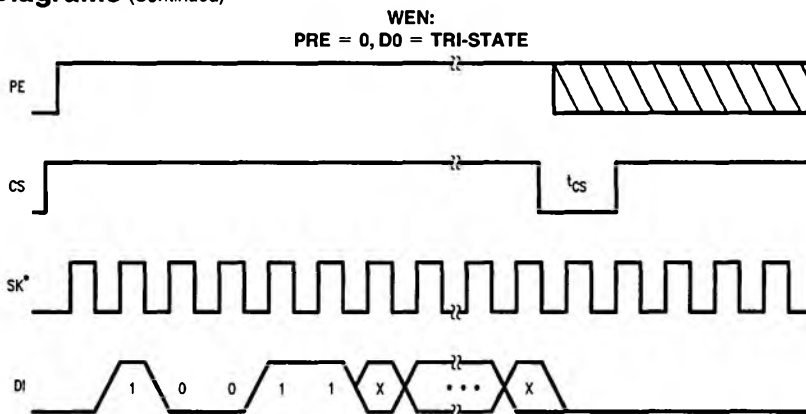
\*Address bit A7 becomes "don't care" for NM93CS56L.

\*Address bits A5 and A4 become "don't cares" for NM93CS06L.

†The memory automatically cycles to the next register.

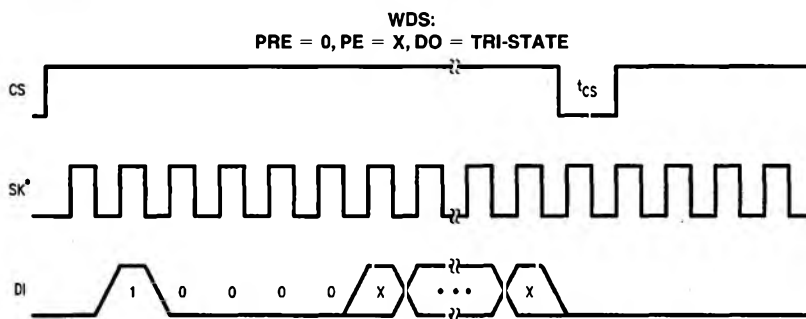
TL/D/10044-5

# Timing Diagrams (Continued)



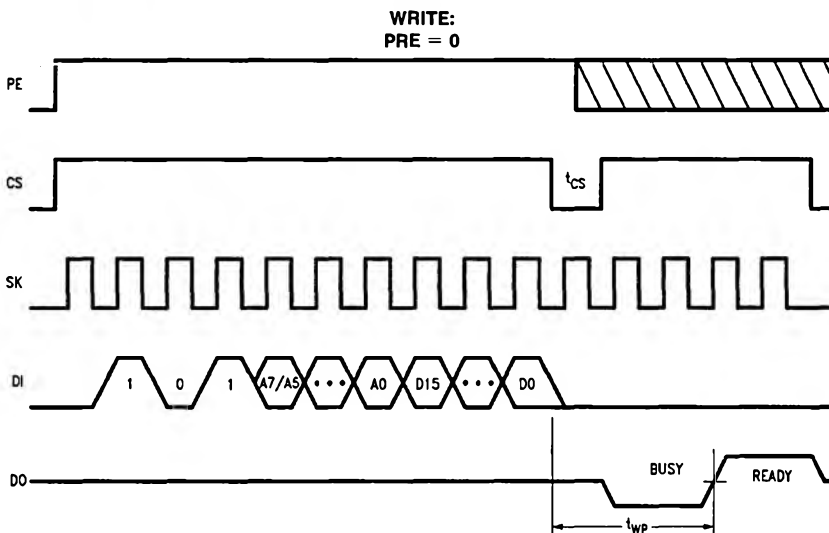
TL/D/10044-6

\*The NM93CS56L and NM93CS66L require a minimum of 11 clock cycles. The NM93CS06L and NM93CS46L require a minimum of 9 clock cycles.



TL/D/10044-7

\*The NM93CS56L and NM93CS66L require a minimum of 11 clock cycles. The NM93CS06L and NM93CS46L require a minimum of 9 clock cycles.

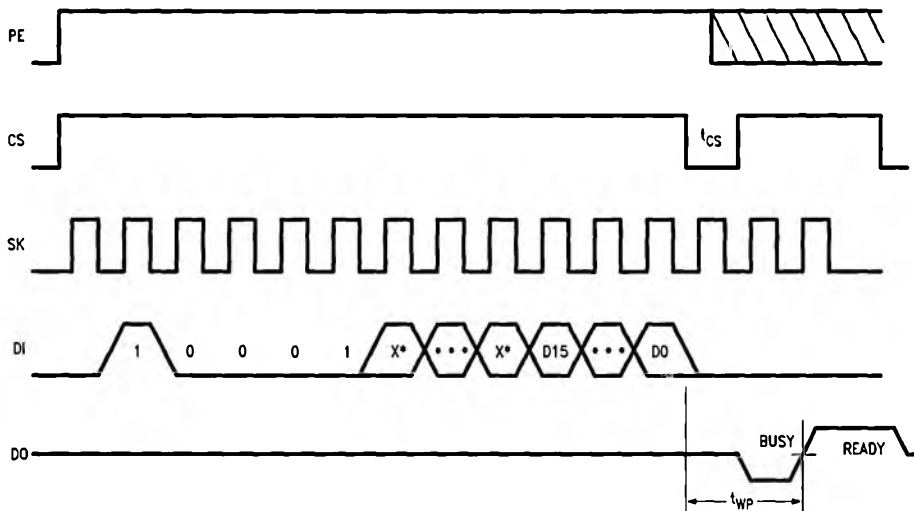


TL/D/10044-8

- \* Address bit A7 becomes a "don't care" for NM93CS56L.
- \* Address bits A5 and A4 become "don't cares" for NM93CS06L.

# Timing Diagrams (Continued)

WRALL:  
PRE = 0

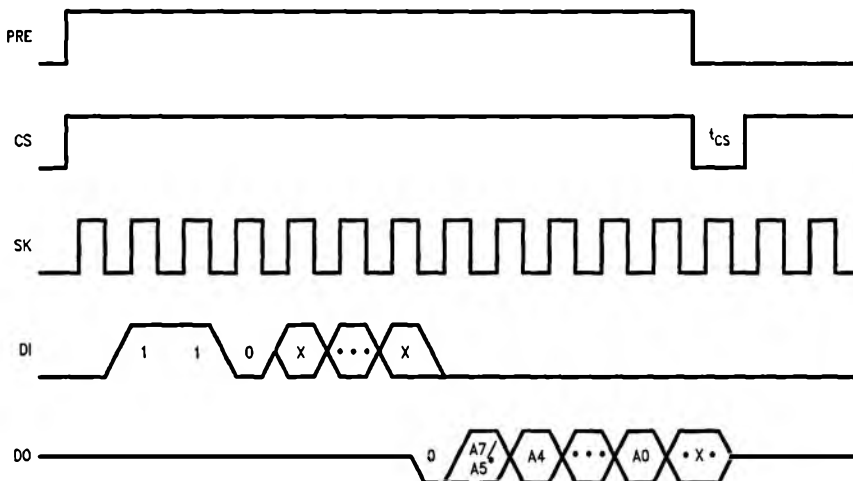


\*Don't care

†Protect Register **MUST** be cleared.

TL/D/10044-9

PRREAD:  
PE = X



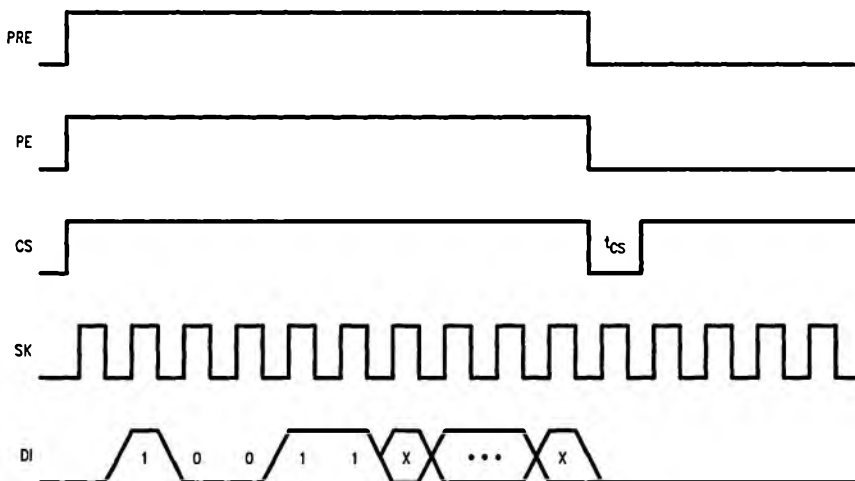
•Address bits A5 and A4 become "don't cares" for NM93CS06L.

•Address bit A7 becomes "don't care" for NM93CS56L.

TL/D/10044-10

# Timing Diagrams (Continued)

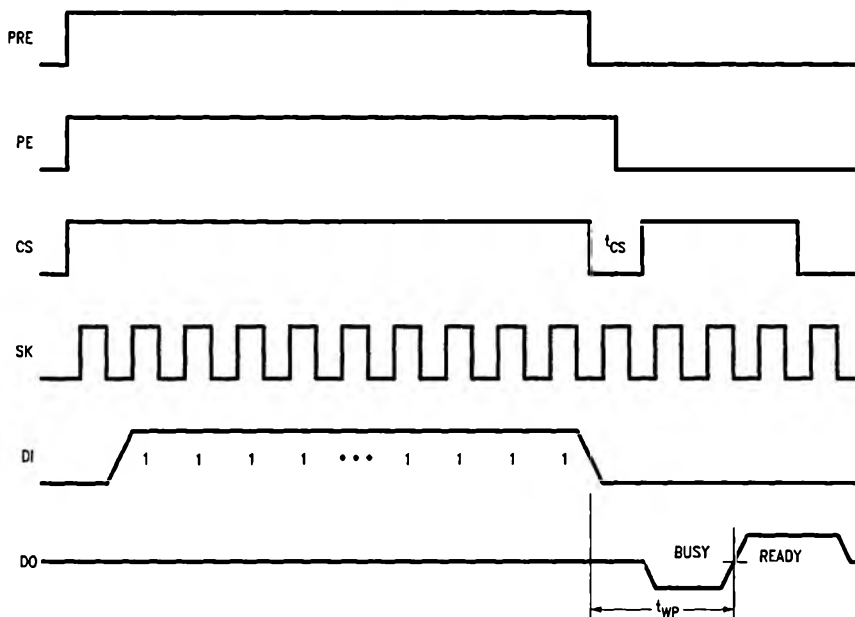
**PREN\*:**  
D0 = TRI-STATE



TL/D/10044-11

\*A WEN cycle must precede a PREN cycle.

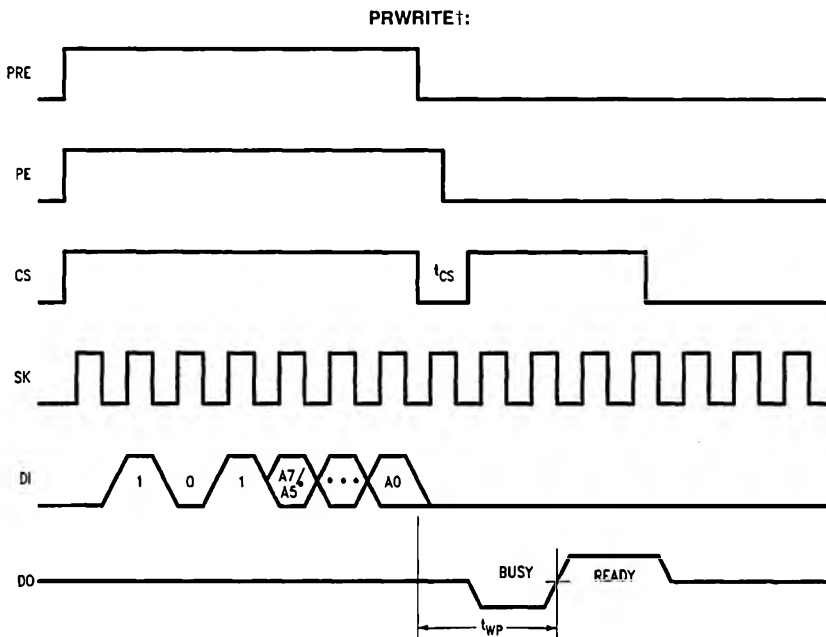
**PRCLEAR\*:**



\*A PREN cycle must immediately precede a PRCLEAR cycle.

TL/D/10044-12

# Timing Diagrams (Continued)

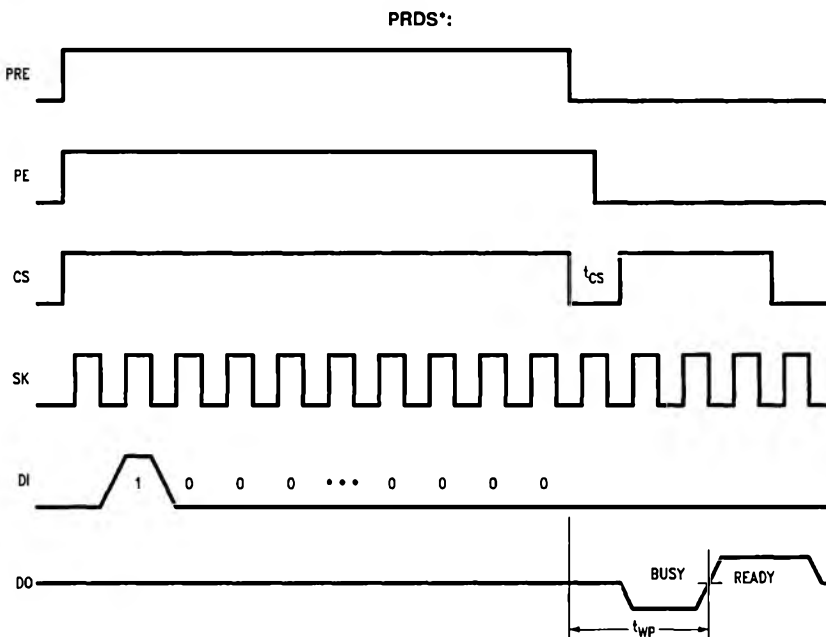


TL/D/10044-13

\*Address bit A7 becomes a "don't care" for NM93CS56L.

\*Address bits A5 and A4 become "don't cares" for NM93CS06L.

†Protect Register **MUST** be cleared before a PRWRITE cycle. A PREN cycle must **immediately** precede a PRWRITE cycle.



TL/D/10044-14

\***ONE TIME ONLY** instruction. A PREN cycle must **immediately** precede a PRDS cycle.