



# M95640, M95320 M95160, M95080

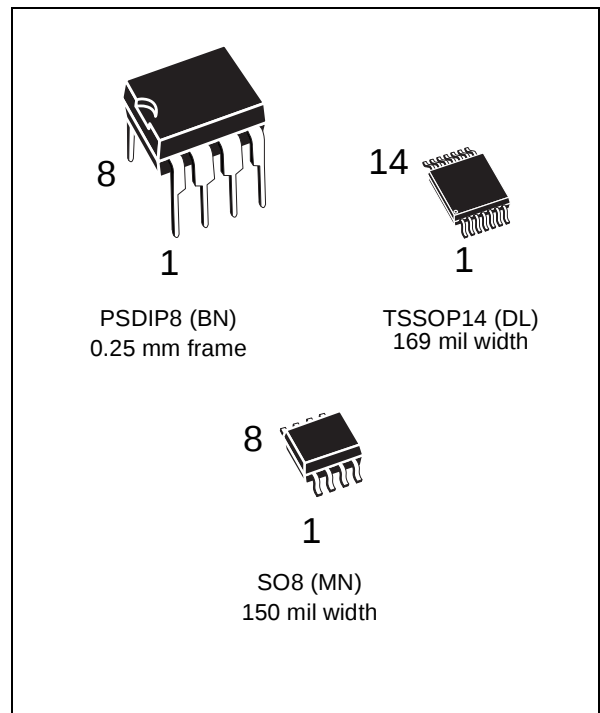
## 64/32/16/8 Kbit Serial SPI Bus EEPROM With High Speed Clock

PRELIMINARY DATA

- SPI Bus Compatible Serial Interface
- Supports Positive Clock SPI Modes
- 5 MHz Clock Rate (maximum)
- Single Supply Voltage:
  - 4.5V to 5.5V for M95xxx
  - 2.7V to 5.5V for M95xxx-V
  - 2.5V to 5.5V for M95xxx-W
  - 1.8V to 3.6V for M95xxx-R
- Status Register
- Hardware and Software Protection of the Status Register
- BYTE and PAGE WRITE (up to 32 Bytes)
- Self-Timed Programming Cycle
- Adjustable Size Read-Only EEPROM Area
- Enhanced ESD Protection
- 100,000 Erase/Write Cycles (minimum)
- 40 Year Data Retention (minimum)

### DESCRIPTION

These electrically erasable programmable memory (EEPROM) devices are fabricated with STMicroelectronics' High Endurance, Double Polysilicon, CMOS technology. This guarantees an endurance typically well above one hundred



**Table 1. Signal Names**

|                   |                    |
|-------------------|--------------------|
| C                 | Serial Clock       |
| D                 | Serial Data Input  |
| Q                 | Serial Data Output |
| $\bar{S}$         | Chip Select        |
| $\bar{W}$         | Write Protect      |
| $\overline{HOLD}$ | Hold               |
| V <sub>CC</sub>   | Supply Voltage     |
| V <sub>SS</sub>   | Ground             |

**Figure 1. Logic Diagram**

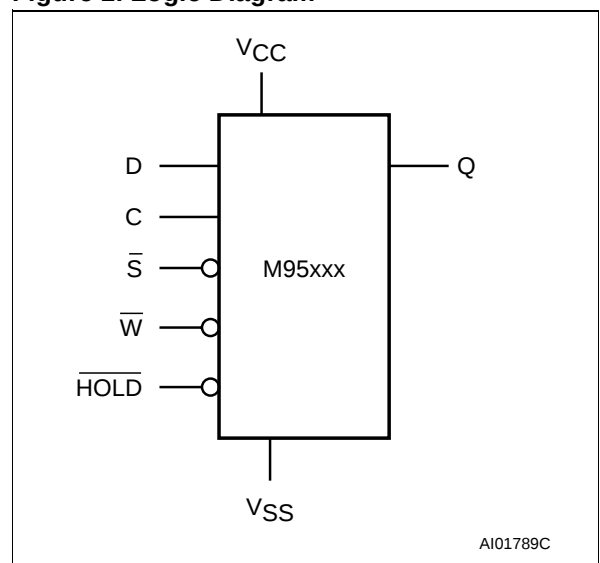


Figure 2A. DIP Connections

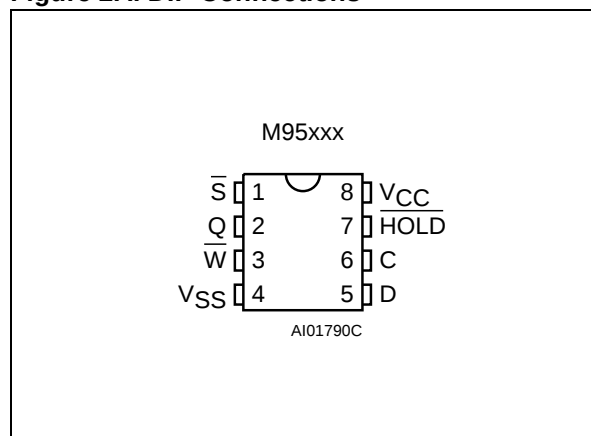
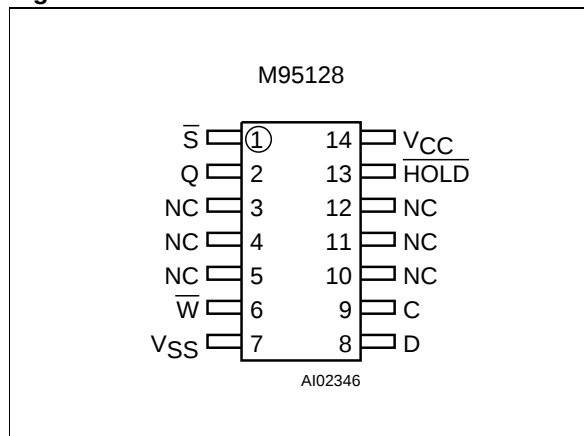
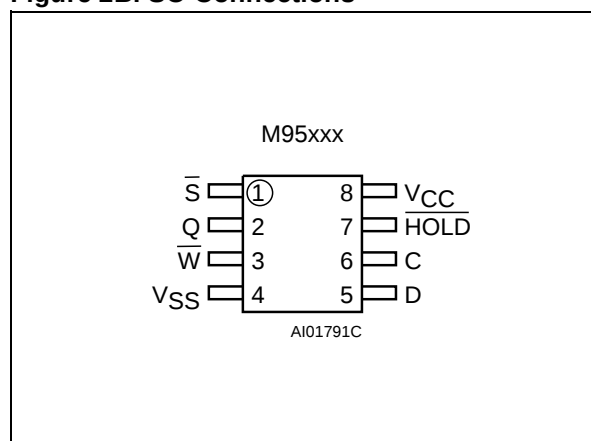


Figure 2C. TSSOP Connections



Note: 1. NC = Not Connected

Figure 2B. SO Connections



thousand Erase/Write cycles, with a data retention of 40 years. The memories are organised as 8K x 8 bits and 4K x 8 bits (M95640, M95320) and 2K x 8 bits and 1K x 8 bits (M95160, M95080), and operate down to 2.5 V (for the -W version of each device), and down to 1.8 V (for the -R version of each device).

The M95640, M95320 and M95160, M95080 are available in Plastic Dual-in-Line, Plastic Small Outline and Thin Shrink Small Outline packages.

Each memory device is accessed by a simple serial interface that is SPI bus compatible. The bus signals are C, D and Q, as shown in Table 1 and Figure 3.

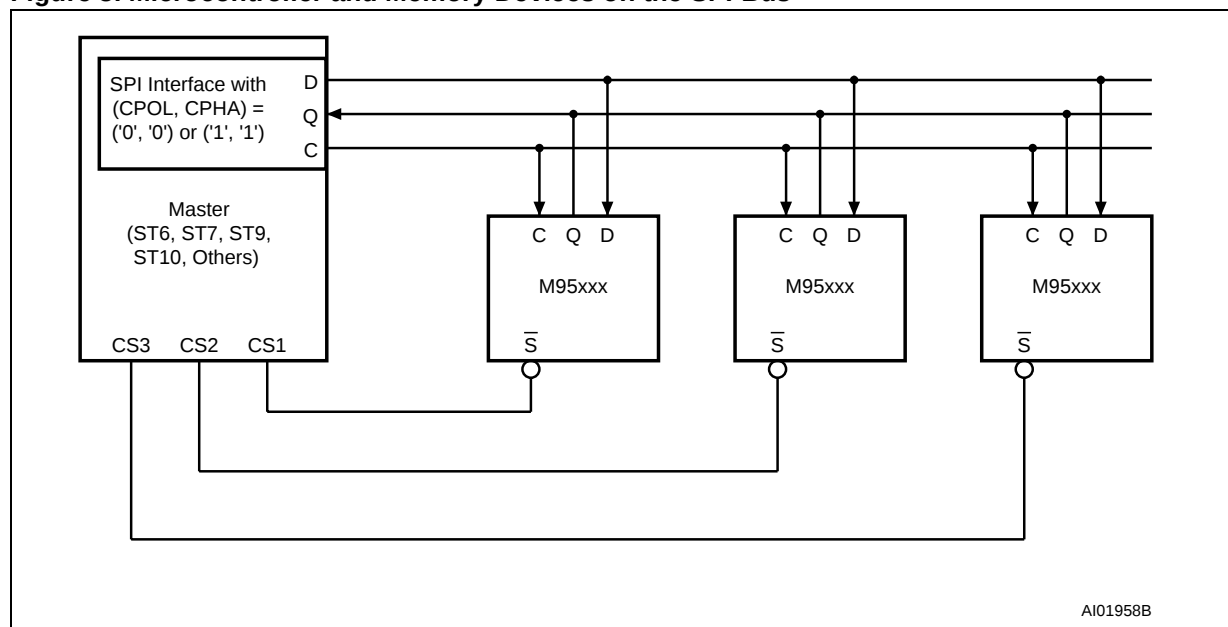
The device is selected when the chip select input ( $\bar{S}$ ) is held low. Communications with the chip can be interrupted using the hold input (HOLD).

Table 2. Absolute Maximum Ratings <sup>1</sup>

| Symbol     | Parameter                                                       | Value                                            | Unit |
|------------|-----------------------------------------------------------------|--------------------------------------------------|------|
| $T_A$      | Ambient Operating Temperature                                   | -40 to 125                                       | °C   |
| $T_{STG}$  | Storage Temperature                                             | -65 to 150                                       | °C   |
| $T_{LEAD}$ | Lead Temperature during Soldering                               | PSDIP8: 10 sec<br>SO8: 40 sec<br>TSSOP14: t.b.c. | °C   |
| $V_O$      | Output Voltage Range                                            | -0.3 to $V_{CC}+0.6$                             | V    |
| $V_I$      | Input Voltage Range                                             | -0.3 to 6.5                                      | V    |
| $V_{CC}$   | Supply Voltage Range                                            | -0.3 to 6.5                                      | V    |
| $V_{ESD}$  | Electrostatic Discharge Voltage (Human Body model) <sup>2</sup> | 4000                                             | V    |

Note: 1. Except for the rating "Operating Temperature Range", stresses above those listed in the Table "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and operation of the device at these or any other conditions above those indicated in the Operating sections of this specification is not implied. Exposure to Absolute Maximum Rating conditions for extended periods may affect device reliability. Refer also to the ST SURE Program and other relevant quality documents.

2. MIL-STD-883C, 3015.7 (100 pF, 1500  $\Omega$ )

**Figure 3. Microcontroller and Memory Devices on the SPI Bus****SIGNAL DESCRIPTION****Serial Output (Q)**

The output pin is used to transfer data serially out of the Memory. Data is shifted out on the falling edge of the serial clock.

**Serial Input (D)**

The input pin is used to transfer data serially into the device. Instructions, addresses, and the data to be written, are each received this way. Input is latched on the rising edge of the serial clock.

**Serial Clock (C)**

The serial clock provides the timing for the serial interface (as shown in Figure 4). Instructions, addresses, or data are latched, from the input pin, on the rising edge of the clock input. The output data on the Q pin changes state after the falling edge of the clock input.

**Chip Select ( $\bar{S}$ )**

When  $\bar{S}$  is high, the memory device is deselected, and the Q output pin is held in its high impedance state. Unless an internal write operation is underway, the memory device is placed in its stand-by power mode.

After power-on, a high-to-low transition on  $\bar{S}$  is required prior to the start of any operation.

**Write Protect ( $\bar{W}$ )**

The protection features of the memory device are summarized in Table 3.

The hardware write protection, controlled by the  $\bar{W}$  pin, restricts write access to the Status Register

(though not to the WIP and WEL bits, which are set or reset by the device internal logic).

Bit 7 of the status register (as shown in Table 5) is the Status Register Write Disable bit (SRWD). When this is set to 0 (its initial delivery state) it is possible to write to the status register if the WEL bit (Write Enable Latch) has been set by the WREN instruction (irrespective of the level being applied to the  $\bar{W}$  input).

When bit 7 (SRWD) of the status register is set to 1, the ability to write to the status register depends on the logic level being presented at pin  $\bar{W}$ :

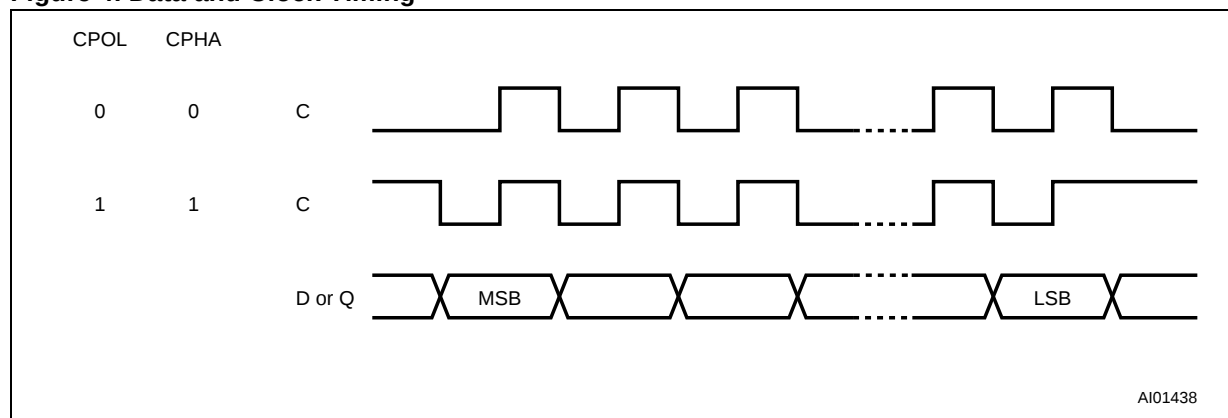
- If  $\bar{W}$  pin is high, it is possible to write to the status register, after having set the WEL bit using the WREN instruction (Write Enable Latch).
- If  $\bar{W}$  pin is low, any attempt to modify the status register is ignored by the device, even if the WEL bit has been set. As a consequence, all the data bytes in the EEPROM area, protected by the BPn bits of the status register, are also hardware protected against data corruption, and appear as a Read Only EEPROM area for the microcontroller. This mode is called the Hardware Protected Mode (HPM).

It is possible to enter the Hardware Protected Mode (HPM) either by setting the SRWD bit after pulling low the  $\bar{W}$  pin, or by pulling low the  $\bar{W}$  pin after setting the SRWD bit.

The only way to abort the Hardware Protected Mode, once entered, is to pull high the  $\bar{W}$  pin.

If  $\bar{W}$  pin is permanently tied to the high level, the Hardware Protected Mode is never activated, and the memory device only allows the user to protect

Figure 4. Data and Clock Timing



a part of the memory, using the BPn bits of the status register, in the Software Protected Mode (SPM).

#### Hold (HOLD)

The  $\overline{\text{HOLD}}$  pin is used to pause the serial communications between the SPI memory and controller, without losing bits that have already been decoded in the serial sequence. For a hold condition to occur, the memory device must already have been selected ( $\overline{\text{S}} = 0$ ). The hold condition starts when the  $\overline{\text{HOLD}}$  pin is held low while the clock pin (C) is also low (as shown in Figure 14).

During the hold condition, the Q output pin is held in its high impedance state, and the levels on the input pins (D and C) are ignored by the memory device.

It is possible to deselect the device when it is still in the hold state, thereby resetting whatever transfer had been in progress. The memory remains in the hold state as long as the  $\overline{\text{HOLD}}$  pin is low. To restart communication with the device, it is necessary both to remove the hold condition (by taking  $\overline{\text{HOLD}}$  high) and to select the memory (by taking  $\overline{\text{S}}$  low).

#### OPERATIONS

All instructions, addresses and data are shifted serially in and out of the chip. The most significant bit is presented first, with the data input (D) sampled on the first rising edge of the clock (C) after the chip select ( $\overline{\text{S}}$ ) goes low.

Every instruction starts with a single-byte code, as summarised in Table 4. This code is entered via the data input (D), and latched on the rising edge of the clock input (C). To enter an instruction code, the product must have been previously selected ( $\overline{\text{S}}$  held low). If an invalid instruction is sent (one not contained in Table 4), the chip automatically deselects itself.

#### Write Enable (WREN) and Write Disable (WRDI)

The write enable latch, inside the memory device, must be set prior to each WRITE and WRSR operation. The WREN instruction (write enable) sets this latch, and the WRDI instruction (write disable) resets it.

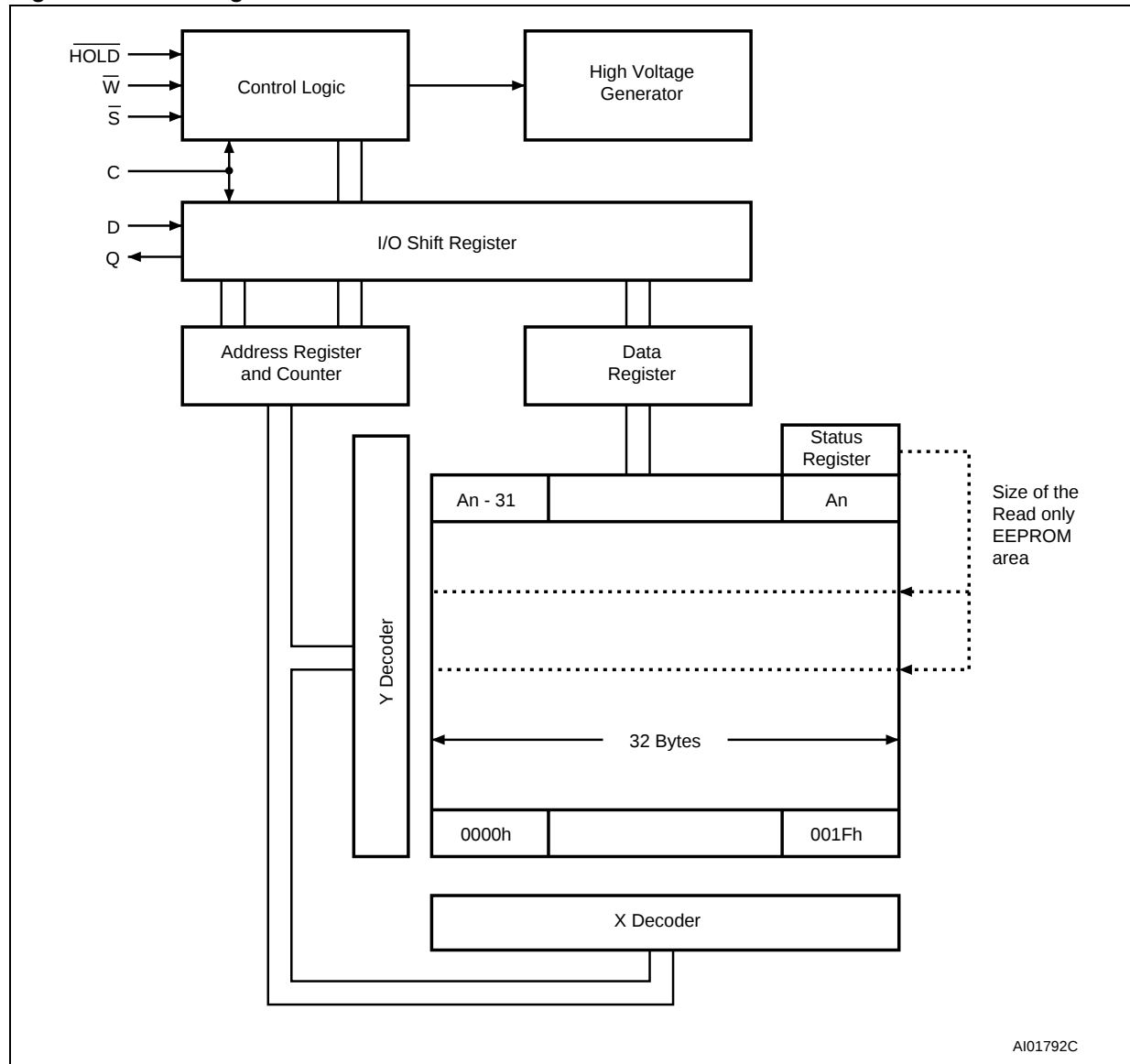
The latch becomes reset by any of the following events:

- Power on
- WRDI instruction completion
- WRSR instruction completion
- WRITE instruction completion.

Table 3. Write Protection Control on the M95640, M95320, M95160, M95080

| $\overline{\text{W}}$ | SRWD Bit | Mode                     | Status Register                                         | Data Bytes                                                      |                                                         |
|-----------------------|----------|--------------------------|---------------------------------------------------------|-----------------------------------------------------------------|---------------------------------------------------------|
|                       |          |                          |                                                         | Protected Area                                                  | Unprotected Area                                        |
| 0 or 1                | 0        | Software Protected (SPM) | Writeable (if the WREN instruction has set the WEL bit) | Software write protected by the BPn of the status register      | Writeable (if the WREN instruction has set the WEL bit) |
| 1                     | 1        |                          |                                                         |                                                                 |                                                         |
| 0                     | 1        | Hardware Protected (HPM) | Hardware write protected                                | Hardware write protected by the BPn bits of the status register | Writeable (if the WREN instruction has set the WEL bit) |

Figure 5. Block Diagram



Note: 1. The cell  $A_n$  represents the byte at the highest address in the memory

As soon as the WREN or WRDI instruction is received, the memory device first executes the instruction, then enters a wait mode until the device is deselected.

#### Read Status Register (RDSR)

The RDSR instruction allows the status register to be read, and can be sent at any time, even during a Write operation. Indeed, when a Write is in progress, it is recommended that the value of the Write-In-Progress (WIP) bit be checked. The value in the WIP bit (whose position in the status register is shown in Table 5) can be continuously polled, before sending a new WRITE instruction. This can be performed in one of two ways:

- Repeated RDSR instructions (each one consisting of  $\overline{S}$  being taken low, C being clocked 8 times for the instruction and 8 times for the read operation, and  $\overline{S}$  being taken high)
- A single, prolonged RDSR instruction (consisting of  $\overline{S}$  being taken low, C being clocked 8 times for the instruction and kept running for repeated read operations), as shown in Figure 6.

The Write-In-Process (WIP) bit is read-only, and indicates whether the memory is busy with a Write

**Table 4. Instruction Set**

| Instruction | Description                 | Instruction Format |
|-------------|-----------------------------|--------------------|
| WREN        | Set Write Enable Latch      | 0000 0110          |
| WRDI        | Reset Write Enable Latch    | 0000 0100          |
| RDSR        | Read Status Register        | 0000 0101          |
| WRSR        | Write Status Register       | 0000 0001          |
| READ        | Read Data from Memory Array | 0000 0011          |
| WRITE       | Write Data to Memory Array  | 0000 0010          |

**Table 5. Status Register Format**

|      |   |   |   |     |     |     |     |
|------|---|---|---|-----|-----|-----|-----|
| b7   |   |   |   |     |     |     | b0  |
| SRWD | X | X | X | BP1 | BP0 | WEL | WIP |

Note: 1. SRWD, BP0 and BP1 are Read and write bits.  
 2. WEL and WIP are Read only bits.

operation. A '1' indicates that a write is in progress, and a '0' that no write is in progress.

The Write Enable Latch (WEL) bit indicates the status of the write enable latch. It, too, is read-only. Its value can only be changed by one of the events listed in the previous paragraph, or as a result of executing WREN or WRDI instruction. It cannot be changed using a WRSR instruction. A '1' indicates that the latch is set (the forthcoming Write instruction will be executed), and a '0' that it is reset (and any forthcoming Write instructions will be ignored).

The Block Protect (BP0 and BP1) bits indicate the amount of the memory that is to be write-protected. These two bits are non-volatile. They are set using a WRSR instruction.

During a Write operation (whether it be to the memory area or to the status register), all bits of the status register remain valid, and can be read

using the RDSR instruction. However, during a Write operation, the values of the non-volatile bits (SRWD, BP0, BP1) become frozen at a constant value. The updated value of these bits becomes available when a new RDSR instruction is executed, after completion of the write cycle. On the other hand, the two read-only bits (WEL, WIP) are dynamically updated during internal write cycles. Using this facility, it is possible to poll the WIP bit to detect the end of the internal write cycle.

#### Write Status Register (WRSR)

The format of the WRSR instruction is shown in Figure 7. After the instruction and the eight bits of the status register have been latched-in, the internal Write cycle is triggered by the rising edge of the  $\bar{S}$  line. This must occur after the falling edge of the 16<sup>th</sup> clock pulse, and before the rising edge of the 17<sup>th</sup> clock (as indicated in Figure 7), otherwise the internal write sequence is not performed.

The WRSR instruction is used for the following:

- to select the size of memory area that is to be write-protected
- to select between SPM (Software Protected Mode) and HPM (Hardware Protected Mode).

The size of the write-protection area applies equally in SPM and HPM. The BP1 and BP0 bits of the status register have the appropriate value (see Table 6) written into them after the contents of the protected area of the EEPROM have been written.

The initial delivery state of the BP1 and BP0 bits is 00, indicating a write-protection size of 0.

#### Software Protected Mode (SPM)

The act of writing a non-zero value to the BP1 and BP0 bits causes the Software Protected Mode (SPM) to be started. All attempts to write a byte or page in the protected area are ignored, even if the Write Enable Latch is set. However, writing is still allowed in the unprotected area of the memory ar-

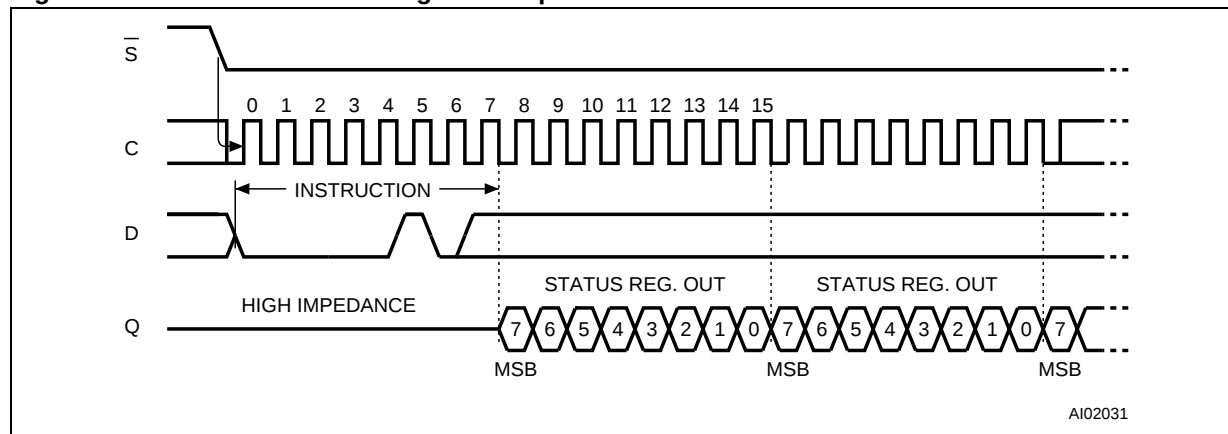
**Figure 6. RDSR: Read Status Register Sequence**

Table 6. Write Protected Block Size

| Status Register Bits |     | Protected Block | Array Addresses Protected |               |               |               |
|----------------------|-----|-----------------|---------------------------|---------------|---------------|---------------|
| BP1                  | BP0 |                 | M95640                    | M95320        | M95160        | M95080        |
| 0                    | 0   | none            | none                      | none          | none          | none          |
| 0                    | 1   | Upper quarter   | 1800h - 1FFFh             | 0C00h - 0FFFh | 0600h - 07FFh | 0300h - 03FFh |
| 1                    | 0   | Upper half      | 1000h - 1FFFh             | 0800h - 0FFFh | 0400h - 07FFh | 0200h - 03FFh |
| 1                    | 1   | Whole memory    | 0000h - 1FFFh             | 0000h - 0FFFh | 0000h - 07FFh | 0000h - 03FFh |

ray and to the SRWD, BP1 and BP0 bits of the status register, provided that the WEL bit is first set.

#### Hardware Protected Mode (HPM)

The Hardware Protected Mode (HPM) offers a higher level of protection, and can be selected by setting the SRWD bit after pulling down the  $\bar{W}$  pin or by pulling down the  $\bar{W}$  pin after setting the SRWD bit. The SRWD is set by the WSR instruction, provided that the WEL bit is first set. The setting of the SRWD bit can be made independently of, or at the same time as, writing a new value to the BP1 and BP0 bits.

Once the device is in the Hardware Protected Mode, the data bytes in the protected area of the memory array, and the content of the status register, are write-protected. The only way to re-enable writing new values to the status register is to pull the  $\bar{W}$  pin high. This causes the device to leave the Hardware Protected Mode, and to revert to being in the Software Protected Mode. (The value in the BP1 and BP0 bits will not have been changed).

Further details of the operation of the Write Protect pin ( $\bar{W}$ ) are given earlier, on page 3.

#### Typical Use of HPM and SPM

The  $\bar{W}$  pin can be dynamically driven by an output port of a microcontroller. It is also possible, though, to connect it permanently to  $V_{SS}$  (by a solder connection, or through a pull-down resistor). The manufacturer of such a printed circuit board can take the memory device, still in its initial delivery state, and can solder it directly on to the board. After power on, the microcontroller can be instructed to write the protected data into the appropriate area of the memory. When it has finished, the appropriate values are written to the BP1, BP0 and SRWD bits, thereby putting the device in the hardware protected mode.

An alternative method is to write the protected data, and to set the BP1, BP0 and SRWD bits, before soldering the memory device to the board. Again, this results in the memory device being placed in its hardware protected mode.

If the  $\bar{W}$  pin has been connected to  $V_{SS}$  by a pull-down resistor, the memory device can be taken out of the hardware protected mode by driving the  $\bar{W}$  pin high, to override the pull-down resistor.

If the  $\bar{W}$  pin has been directly soldered to  $V_{SS}$ , there is only one way of taking the memory device out of the hardware protected mode: the memory

Figure 7. WRSR: Write Status Register Sequence

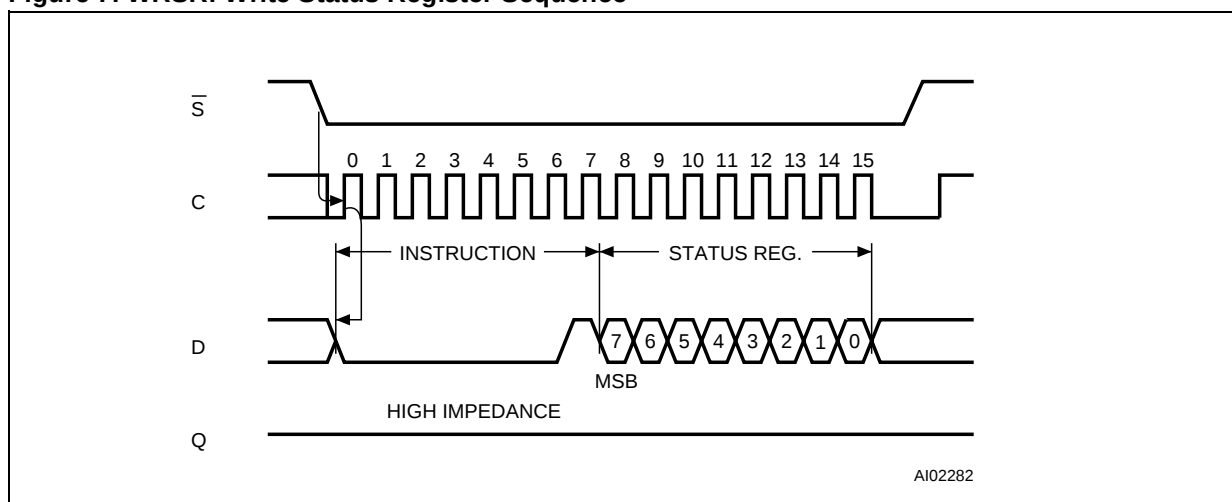
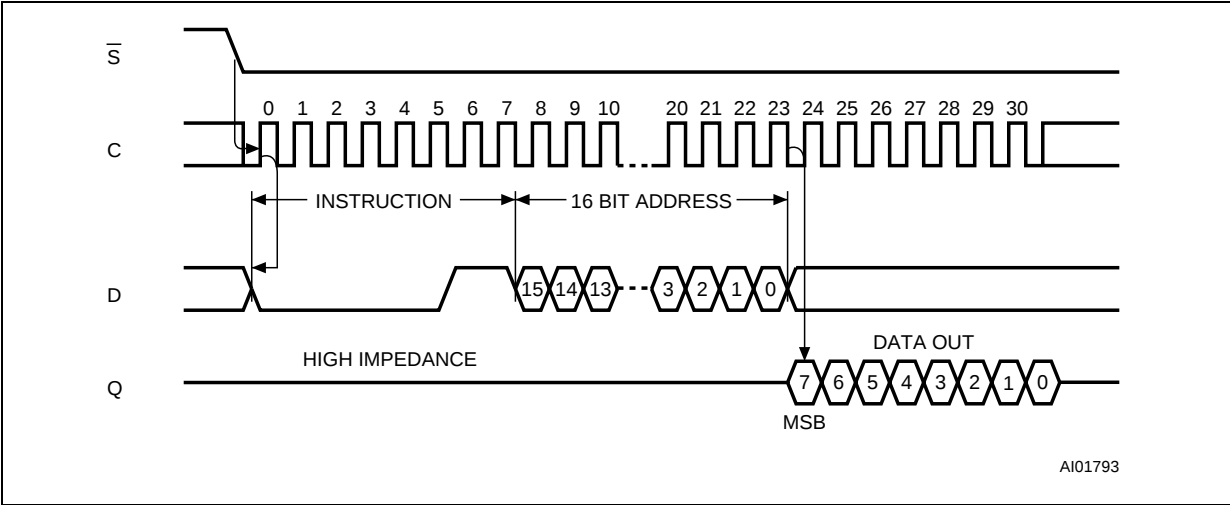


Figure 8. Read EEPROM Array Operation Sequence



Note: 1. Depending on the memory size, as shown in Table 7, the most significant address bits are Don't Care.

Table 7. Address Range Bits

| Device       | M95640 | M95320 | M95160 | M95080 |
|--------------|--------|--------|--------|--------|
| Address Bits | A12-A0 | A11-A0 | A10-A0 | A9-A0  |

Note: 1. Address bits up to b15 are treated as Don't Care.

device must be de-soldered from the board, and connected to external equipment in which the  $\overline{W}$  pin is allowed to be taken high.

**Read Operation**

The chip is first selected by holding  $\overline{S}$  low. The serial one byte read instruction is followed by a two byte address (A15-A0), each bit being latched-in during the rising edge of the clock (C).

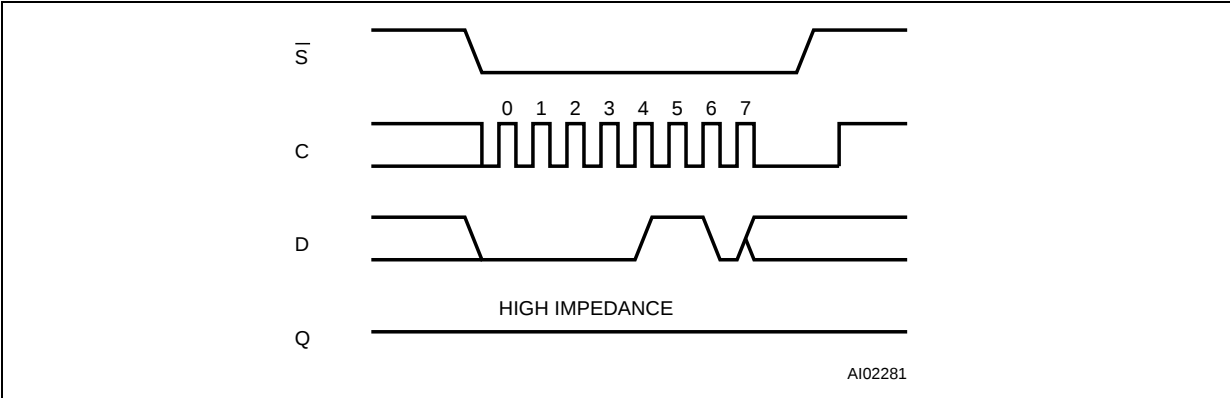
The data stored in the memory, at the selected address, is shifted out on the Q output pin. Each bit is shifted out during the falling edge of the clock (C) as shown in Figure 8. The internal address

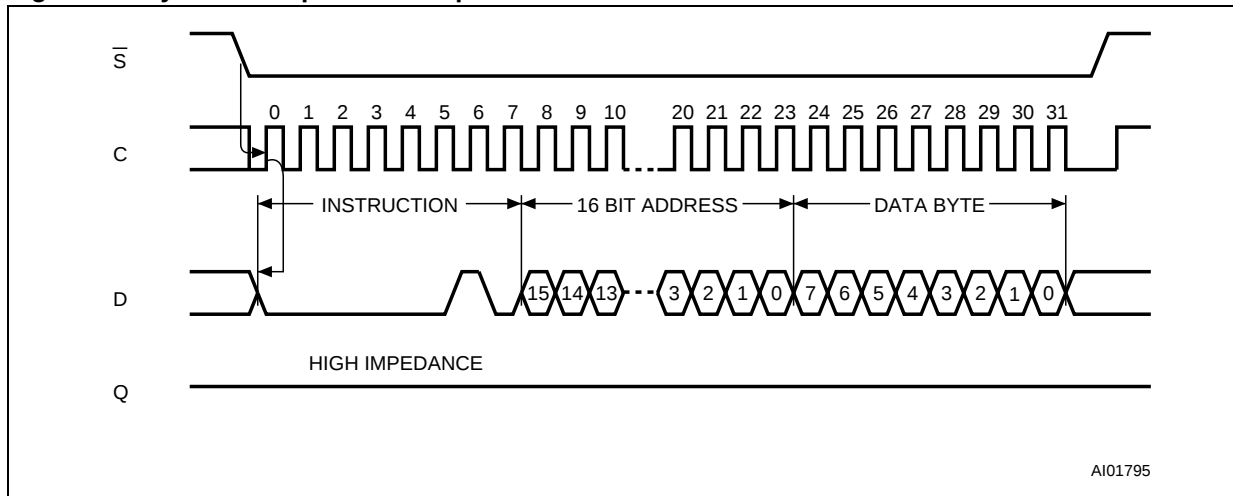
counter is automatically incremented to the next higher address after each byte of data has been shifted out. The data stored in the memory, at the next address, can be read by successive clock pulses. When the highest address is reached, the address counter rolls over to "0000h", allowing the read cycle to be continued indefinitely. The read operation is terminated by deselecting the chip. The chip can be deselected at any time during data output. If a read instruction is received during a write cycle, it is rejected, and the memory device deselects itself.

**Byte Write Operation**

Before any write can take place, the WEL bit must be set, using the WREN instruction. The write state is entered by selecting the chip, issuing three bytes of instruction and address, and one byte of data. Chip Select ( $\overline{S}$ ) must remain low throughout the operation, as shown in Figure 10. The product must be deselected just after the eighth bit of the

Figure 9. Write Enable Latch Sequence



**Figure 10. Byte Write Operation Sequence**

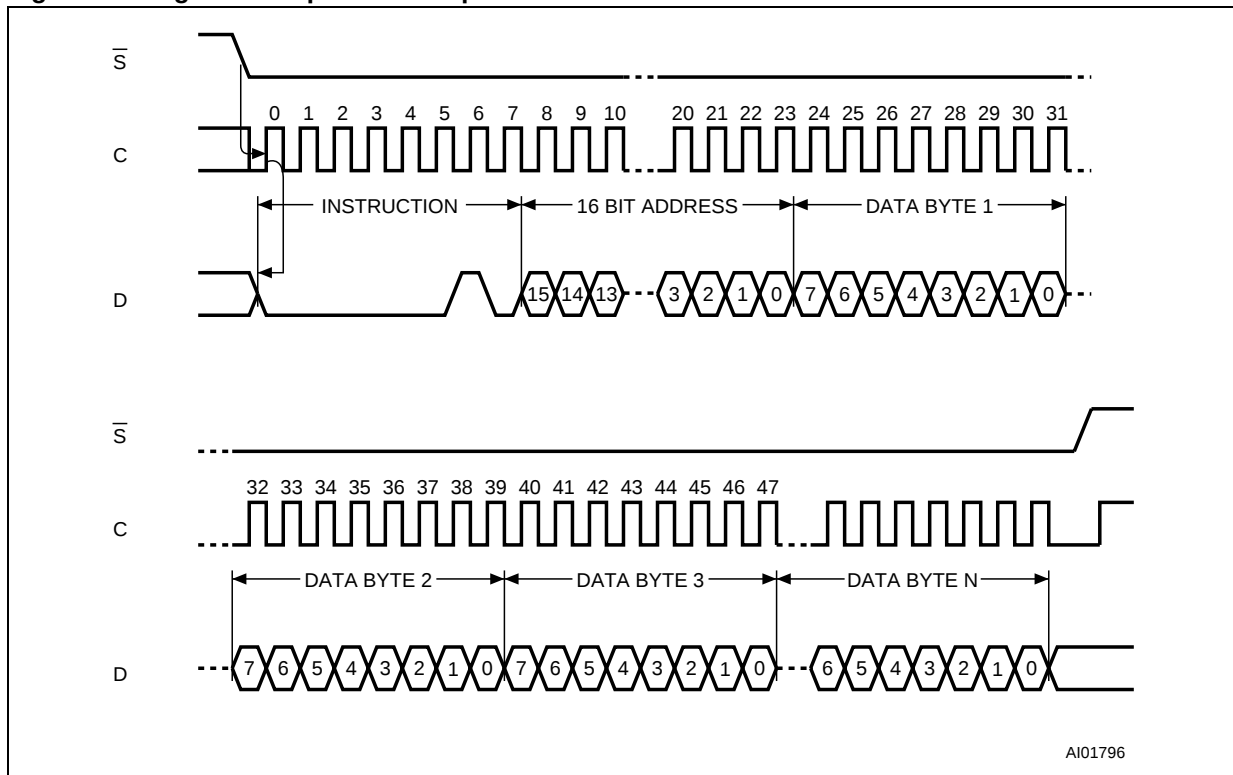
Note: 1. Depending on the memory size, as shown in Table 7, the most significant address bits are Don't Care.

data byte has been latched in, as shown in Figure 10, otherwise the write process is cancelled. As soon as the memory device is deselected, the self-timed internal write cycle is initiated. While the write is in progress, the status register may be read to check the status of the SRWD, BP1, BP0, WEL and WIP bits. In particular, WIP contains a '1'

during the self-timed write cycle, and a '0' when the cycle is complete, (at which point the write enable latch is also reset).

#### Page Write Operation

A maximum of 32 bytes of data can be written during one Write time,  $t_w$ , provided that they are all to

**Figure 11. Page Write Operation Sequence**

Note: 1. Depending on the memory size, as shown in Table 7, the most significant address bits are Don't Care.

the same page (see Figure 5). The Page Write operation is the same as the Byte Write operation, except that instead of deselecting the device after the first byte of data, up to 31 additional bytes can be shifted in (and then the device is deselected after the last byte).

Any address of the memory can be chosen as the first address to be written. If the address counter reaches the end of the page (an address of the form xxxx xxxx xxx1 1111) and the clock continues, the counter rolls over to the first address of the same page (xxxx xxxx xxx0 0000) and overwrites any previously written data.

As before, the Write cycle only starts if the  $\overline{S}$  transition occurs just after the eighth bit of the last data byte has been received, as shown in Figure 11.

#### DATA PROTECTION AND PROTOCOL SAFETY

To protect the data in the memory from inadvertent corruption, the memory device only responds to correctly formulated commands. The main security measures can be summarised as follows:

- The WEL bit is reset at power-up.
- $\overline{S}$  must rise after the eighth clock count (or multiple thereof) in order to start a non-volatile write cycle (in the memory array or in the status register).
- Accesses to the memory array are ignored during the non-volatile programming cycle, and the programming cycle continues unaffected.
- After execution of a WREN, WRDI, or RDSR instruction, the chip enters a wait state, and waits to be deselected.
- Invalid  $\overline{S}$  and  $\overline{HOLD}$  transitions are ignored.

#### POWER ON STATE

After power-on, the memory device is in the following state:

- low power stand-by state
- deselected (after power-on, a high-to-low transition is required on the  $\overline{S}$  input before any operations can be started).
- not in the hold condition
- the WEL bit is reset
- the SRWD, BP1 and BP0 bits of the status register are unchanged from the previous power-down (they are non-volatile bits).

#### INITIAL DELIVERY STATE

The device is delivered with the memory array in a fully erased state (all data set at all "1's" or FFh). The status register bits are initialized to 00h, as shown in Table 8.

**Table 8. Initial Status Register Format**

| b7 |   |   |   |   |   |   | b0 |
|----|---|---|---|---|---|---|----|
| 0  | 0 | 0 | 0 | 0 | 0 | 0 | 0  |

**Table 9. Input Parameters<sup>1</sup>** ( $T_A = 25\text{ }^{\circ}\text{C}$ ,  $f = 5\text{ MHz}$ )

| Symbol    | Parameter                      | Test Condition | Min. | Max. | Unit |
|-----------|--------------------------------|----------------|------|------|------|
| $C_{OUT}$ | Output Capacitance (Q)         |                |      | 8    | pF   |
| $C_{IN}$  | Input Capacitance (other pins) |                |      | 6    | pF   |

Note: 1. Sampled only, not 100% tested.

**Table 10. DC Characteristics**(T<sub>A</sub> = 0 to 70 °C, -40 to 85 °C or -40 to 125 °C; V<sub>CC</sub> = 4.5 to 5.5 V)(T<sub>A</sub> = 0 to 70 °C or -40 to 85 °C; V<sub>CC</sub> = 2.7 to 5.5 V)(T<sub>A</sub> = 0 to 70 °C or -40 to 85 °C; V<sub>CC</sub> = 2.5 to 5.5 V)(T<sub>A</sub> = 0 to 70 °C or -20 to 85 °C; V<sub>CC</sub> = 1.8 to 3.6 V)

| Symbol                       | Parameter                 | Voltage Range | Temp. Range | Test Condition                                                                                                    | Min.                | Max.                | Unit |
|------------------------------|---------------------------|---------------|-------------|-------------------------------------------------------------------------------------------------------------------|---------------------|---------------------|------|
| I <sub>LI</sub>              | Input Leakage Current     | all           | all         |                                                                                                                   |                     | ± 2                 | μA   |
| I <sub>LO</sub>              | Output Leakage Current    | all           | all         |                                                                                                                   |                     | ± 2                 | μA   |
| I <sub>CC</sub>              | Supply Current            | 4.5-5.5       | 6           | C = 0.1 V <sub>CC</sub> /0.9. V <sub>CC</sub> at 5 MHz, V <sub>CC</sub> = 5 V, Q = open                           |                     | 4                   | mA   |
|                              |                           | 4.5-5.5       | 3           | C = 0.1 V <sub>CC</sub> /0.9. V <sub>CC</sub> at 2 MHz, V <sub>CC</sub> = 5 V, Q = open                           |                     | 4                   | mA   |
|                              |                           | 2.7-5.5       | 6           | C = 0.1 V <sub>CC</sub> /0.9. V <sub>CC</sub> at 5 MHz, V <sub>CC</sub> = 2.7 V, Q = open                         |                     | 3                   | mA   |
|                              |                           | 2.5-5.5       | 6           | C = 0.1 V <sub>CC</sub> /0.9. V <sub>CC</sub> at 2 MHz, V <sub>CC</sub> = 2.5 V, Q = open                         |                     | 2                   | mA   |
|                              |                           | 1.8-3.6       | 5           | C = 0.1 V <sub>CC</sub> /0.9. V <sub>CC</sub> at 1 MHz, V <sub>CC</sub> = 1.8 V, Q = open                         |                     | 2                   | mA   |
| I <sub>CC1</sub>             | Supply Current (Stand-by) | 4.5-5.5       | 6           | $\overline{S}$ = V <sub>CC</sub> , V <sub>IN</sub> = V <sub>SS</sub> or V <sub>CC</sub> , V <sub>CC</sub> = 5 V   |                     | 10                  | μA   |
|                              |                           | 4.5-5.5       | 3           | $\overline{S}$ = V <sub>CC</sub> , V <sub>IN</sub> = V <sub>SS</sub> or V <sub>CC</sub> , V <sub>CC</sub> = 5 V   |                     | 10                  | μA   |
|                              |                           | 2.7-5.5       | 6           | $\overline{S}$ = V <sub>CC</sub> , V <sub>IN</sub> = V <sub>SS</sub> or V <sub>CC</sub> , V <sub>CC</sub> = 2.7 V |                     | 2                   | μA   |
|                              |                           | 2.5-5.5       | 6           | $\overline{S}$ = V <sub>CC</sub> , V <sub>IN</sub> = V <sub>SS</sub> or V <sub>CC</sub> , V <sub>CC</sub> = 2.5 V |                     | 2                   | μA   |
|                              |                           | 1.8-3.6       | 5           | $\overline{S}$ = V <sub>CC</sub> , V <sub>IN</sub> = V <sub>SS</sub> or V <sub>CC</sub> , V <sub>CC</sub> = 1.8 V |                     | 1                   | μA   |
| V <sub>IL</sub>              | Input Low Voltage         | all           | all         |                                                                                                                   | - 0.3               | 0.3 V <sub>CC</sub> | V    |
| V <sub>IH</sub>              | Input High Voltage        | all           | all         |                                                                                                                   | 0.7 V <sub>CC</sub> | V <sub>CC</sub> +1  | V    |
| V <sub>OL</sub> <sup>1</sup> | Output Low Voltage        | 4.5-5.5       | 6           | I <sub>OL</sub> = 2 mA, V <sub>CC</sub> = 5 V                                                                     |                     | 0.4                 | V    |
|                              |                           | 4.5-5.5       | 3           | I <sub>OL</sub> = 2 mA, V <sub>CC</sub> = 5 V                                                                     |                     | 0.4                 | V    |
|                              |                           | 2.7-5.5       | 6           | I <sub>OL</sub> = 1.5 mA, V <sub>CC</sub> = 2.7 V                                                                 |                     | 0.4                 | V    |
|                              |                           | 2.5-5.5       | 6           | I <sub>OL</sub> = 1.5 mA, V <sub>CC</sub> = 2.5 V                                                                 |                     | 0.4                 | V    |
|                              |                           | 1.8-3.6       | 5           | I <sub>OL</sub> = 0.15 mA, V <sub>CC</sub> = 1.8 V                                                                |                     | 0.3                 | V    |
| V <sub>OH</sub> <sup>1</sup> | Output High Voltage       | 4.5-5.5       | 6           | I <sub>OH</sub> = -2 mA, V <sub>CC</sub> = 5 V                                                                    | 0.8 V <sub>CC</sub> |                     | V    |
|                              |                           | 4.5-5.5       | 3           | I <sub>OH</sub> = -2 mA, V <sub>CC</sub> = 5 V                                                                    | 0.8 V <sub>CC</sub> |                     | V    |
|                              |                           | 2.7-5.5       | 6           | I <sub>OH</sub> = -0.4 mA, V <sub>CC</sub> = 2.7 V                                                                | 0.8 V <sub>CC</sub> |                     | V    |
|                              |                           | 2.5-5.5       | 6           | I <sub>OH</sub> = -0.4 mA, V <sub>CC</sub> = 2.5 V                                                                | 0.8 V <sub>CC</sub> |                     | V    |
|                              |                           | 1.8-3.6       | 5           | I <sub>OH</sub> = -0.1 mA, V <sub>CC</sub> = 1.8 V                                                                | 0.8 V <sub>CC</sub> |                     | V    |

Note: 1. For all 5V range devices, the device meets the output requirements for both TTL and CMOS standards.

Table 11A. AC Characteristics

| Symbol                         | Alt.              | Parameter                                                 | M95640, M95320, M95160, M95080                                               |     |                                                               |     | Unit |
|--------------------------------|-------------------|-----------------------------------------------------------|------------------------------------------------------------------------------|-----|---------------------------------------------------------------|-----|------|
|                                |                   |                                                           | V <sub>CC</sub> =4.5 to 5.5 V<br>T <sub>A</sub> =0 to 70°C or<br>-40 to 85°C |     | V <sub>CC</sub> =4.5 to 5.5 V<br>T <sub>A</sub> =-40 to 125°C |     |      |
|                                |                   |                                                           | Min                                                                          | Max | Min                                                           | Max |      |
| f <sub>C</sub>                 | f <sub>SCK</sub>  | Clock Frequency                                           | D.C.                                                                         | 5   | D.C.                                                          | 2   | MHz  |
| t <sub>SLCH</sub>              | t <sub>CSS1</sub> | $\overline{S}$ Active Setup Time                          | 90                                                                           |     | 200                                                           |     | ns   |
| t <sub>SHCH</sub>              | t <sub>CSS2</sub> | $\overline{S}$ Not Active Setup Time                      | 90                                                                           |     | 200                                                           |     | ns   |
| t <sub>SHSL</sub>              | t <sub>CS</sub>   | $\overline{S}$ Deselect Time                              | 100                                                                          |     | 200                                                           |     | ns   |
| t <sub>CHSH</sub>              | t <sub>CSH</sub>  | $\overline{S}$ Active Hold Time                           | 90                                                                           |     | 200                                                           |     | ns   |
| t <sub>CHSL</sub>              |                   | $\overline{S}$ Not Active Hold Time                       | 90                                                                           |     | 200                                                           |     | ns   |
| t <sub>CH</sub> <sup>1</sup>   | t <sub>CLH</sub>  | Clock High Time                                           | 90                                                                           |     | 200                                                           |     | ns   |
| t <sub>CL</sub> <sup>1</sup>   | t <sub>CLL</sub>  | Clock Low Time                                            | 90                                                                           |     | 200                                                           |     | ns   |
| t <sub>CLCH</sub> <sup>2</sup> | t <sub>RC</sub>   | Clock Rise Time                                           |                                                                              | 1   |                                                               | 1   | μs   |
| t <sub>CHCL</sub> <sup>2</sup> | t <sub>FC</sub>   | Clock Fall Time                                           |                                                                              | 1   |                                                               | 1   | μs   |
| t <sub>DVCH</sub>              | t <sub>DSU</sub>  | Data In Setup Time                                        | 20                                                                           |     | 40                                                            |     | ns   |
| t <sub>CHDX</sub>              | t <sub>DH</sub>   | Data In Hold Time                                         | 30                                                                           |     | 50                                                            |     | ns   |
| t <sub>DLDH</sub> <sup>2</sup> | t <sub>RI</sub>   | Data In Rise Time                                         |                                                                              | 1   |                                                               | 1   | μs   |
| t <sub>DHDL</sub> <sup>2</sup> | t <sub>FI</sub>   | Data In Fall Time                                         |                                                                              | 1   |                                                               | 1   | μs   |
| t <sub>HHCH</sub>              | t <sub>CD</sub>   | Clock Low Hold Time after $\overline{HOLD}$ not Active    | 70                                                                           |     | 140                                                           |     | ns   |
| t <sub>HLCH</sub>              |                   | Clock Low Hold Time after $\overline{HOLD}$ Active        | 40                                                                           |     | 90                                                            |     | ns   |
| t <sub>CLHL</sub>              |                   | Clock Low Set-up Time before $\overline{HOLD}$ Active     | 0                                                                            |     | 0                                                             |     | ns   |
| t <sub>CLHH</sub>              |                   | Clock Low Set-up Time before $\overline{HOLD}$ not Active | 0                                                                            |     | 0                                                             |     | ns   |
| t <sub>SHQZ</sub> <sup>2</sup> | t <sub>DIS</sub>  | Output Disable Time                                       |                                                                              | 100 |                                                               | 250 | ns   |
| t <sub>CLQV</sub>              | t <sub>V</sub>    | Clock Low to Output Valid                                 |                                                                              | 60  |                                                               | 150 | ns   |
| t <sub>CLQX</sub>              | t <sub>HO</sub>   | Output Hold Time                                          | 0                                                                            |     | 0                                                             |     | ns   |
| t <sub>QLQH</sub> <sup>2</sup> | t <sub>RO</sub>   | Output Rise Time                                          |                                                                              | 50  |                                                               | 100 | ns   |
| t <sub>QHQL</sub> <sup>2</sup> | t <sub>FO</sub>   | Output Fall Time                                          |                                                                              | 50  |                                                               | 100 | ns   |
| t <sub>HHQX</sub> <sup>2</sup> | t <sub>LZ</sub>   | $\overline{HOLD}$ High to Output Low-Z                    |                                                                              | 50  |                                                               | 100 | ns   |
| t <sub>HLQZ</sub> <sup>2</sup> | t <sub>HZ</sub>   | $\overline{HOLD}$ Low to Output High-Z                    |                                                                              | 100 |                                                               | 250 | ns   |
| t <sub>W</sub>                 | t <sub>WC</sub>   | Write Time                                                |                                                                              | 10  |                                                               | 10  | ms   |

Note: 1. t<sub>CH</sub> + t<sub>CL</sub> ≥ 1 / f<sub>C</sub>.

2. Value guaranteed by characterization, not 100% tested in production.

Table 11B. AC Characteristics

| Symbol                         | Alt.             | Parameter                                                 | M95xxx-V                                                                     |     | M95xxx-W                                                                     |     | M95xxx-R                                                                     |     | Unit |
|--------------------------------|------------------|-----------------------------------------------------------|------------------------------------------------------------------------------|-----|------------------------------------------------------------------------------|-----|------------------------------------------------------------------------------|-----|------|
|                                |                  |                                                           | V <sub>CC</sub> =2.7 to 5.5 V<br>T <sub>A</sub> =0 to 70°C or<br>-40 to 85°C |     | V <sub>CC</sub> =2.5 to 5.5 V<br>T <sub>A</sub> =0 to 70°C or<br>-40 to 85°C |     | V <sub>CC</sub> =1.8 to 3.6 V<br>T <sub>A</sub> =0 to 70°C or<br>-20 to 85°C |     |      |
|                                |                  |                                                           | Min                                                                          | Max | Min                                                                          | Max | Min                                                                          | Max |      |
| f <sub>C</sub>                 | f <sub>CLK</sub> | Clock Frequency                                           | D.C.                                                                         | 5   | D.C.                                                                         | 2   | D.C.                                                                         | 1   | MHz  |
| t <sub>SLCH</sub>              | t <sub>CS1</sub> | $\overline{S}$ Active Setup Time                          | 90                                                                           |     | 200                                                                          |     | 400                                                                          |     | ns   |
| t <sub>SHCH</sub>              | t <sub>CS2</sub> | $\overline{S}$ Not Active Setup Time                      | 90                                                                           |     | 200                                                                          |     | 400                                                                          |     | ns   |
| t <sub>SHSL</sub>              | t <sub>CS</sub>  | $\overline{S}$ Deselect Time                              | 100                                                                          |     | 200                                                                          |     | 300                                                                          |     | ns   |
| t <sub>CHSH</sub>              | t <sub>CSH</sub> | $\overline{S}$ Active Hold Time                           | 90                                                                           |     | 200                                                                          |     | 400                                                                          |     | ns   |
| t <sub>CHSL</sub>              |                  | $\overline{S}$ Not Active Hold Time                       | 90                                                                           |     | 200                                                                          |     | 400                                                                          |     | ns   |
| t <sub>CH</sub> <sup>1</sup>   | t <sub>CLH</sub> | Clock High Time                                           | 90                                                                           |     | 200                                                                          |     | 400                                                                          |     | ns   |
| t <sub>CL</sub> <sup>1</sup>   | t <sub>CLL</sub> | Clock Low Time                                            | 90                                                                           |     | 200                                                                          |     | 400                                                                          |     | ns   |
| t <sub>CLCH</sub> <sup>2</sup> | t <sub>RC</sub>  | Clock Rise Time                                           |                                                                              | 1   |                                                                              | 1   |                                                                              | 1   | μs   |
| t <sub>CHCL</sub> <sup>2</sup> | t <sub>FC</sub>  | Clock Fall Time                                           |                                                                              | 1   |                                                                              | 1   |                                                                              | 1   | μs   |
| t <sub>DVCH</sub>              | t <sub>DSU</sub> | Data In Setup Time                                        | 20                                                                           |     | 40                                                                           |     | 60                                                                           |     | ns   |
| t <sub>CHDX</sub>              | t <sub>DH</sub>  | Data In Hold Time                                         | 30                                                                           |     | 50                                                                           |     | 100                                                                          |     | ns   |
| t <sub>DLDH</sub> <sup>2</sup> | t <sub>RI</sub>  | Data In Rise Time                                         |                                                                              | 1   |                                                                              | 1   |                                                                              | 1   | μs   |
| t <sub>DHDL</sub> <sup>2</sup> | t <sub>FI</sub>  | Data In Fall Time                                         |                                                                              | 1   |                                                                              | 1   |                                                                              | 1   | μs   |
| t <sub>HHCH</sub>              | t <sub>CD</sub>  | Clock Low Hold Time after $\overline{HOLD}$ not Active    | 70                                                                           |     | 140                                                                          |     | 350                                                                          |     | ns   |
| t <sub>HLCH</sub>              |                  | Clock Low Hold Time after $\overline{HOLD}$ Active        | 40                                                                           |     | 90                                                                           |     | 200                                                                          |     | ns   |
| t <sub>CLHL</sub>              |                  | Clock Low Set-up Time before $\overline{HOLD}$ Active     | 0                                                                            |     | 0                                                                            |     | 0                                                                            |     | ns   |
| t <sub>CLHH</sub>              |                  | Clock Low Set-up Time before $\overline{HOLD}$ not Active | 0                                                                            |     | 0                                                                            |     | 0                                                                            |     | ns   |
| t <sub>SHQZ</sub> <sup>2</sup> | t <sub>DIS</sub> | Output Disable Time                                       |                                                                              | 100 |                                                                              | 250 |                                                                              | 500 | ns   |
| t <sub>CLQV</sub>              | t <sub>V</sub>   | Clock Low to Output Valid                                 |                                                                              | 60  |                                                                              | 150 |                                                                              | 380 | ns   |
| t <sub>CLQX</sub>              | t <sub>HO</sub>  | Output Hold Time                                          | 0                                                                            |     | 0                                                                            |     | 0                                                                            |     | ns   |
| t <sub>QLQH</sub> <sup>2</sup> | t <sub>RO</sub>  | Output Rise Time                                          |                                                                              | 50  |                                                                              | 100 |                                                                              | 200 | ns   |
| t <sub>QHQL</sub> <sup>2</sup> | t <sub>FO</sub>  | Output Fall Time                                          |                                                                              | 50  |                                                                              | 100 |                                                                              | 200 | ns   |
| t <sub>HHQX</sub> <sup>2</sup> | t <sub>LZ</sub>  | $\overline{HOLD}$ High to Output Low-Z                    |                                                                              | 50  |                                                                              | 100 |                                                                              | 250 | ns   |
| t <sub>HLQZ</sub> <sup>2</sup> | t <sub>HZ</sub>  | $\overline{HOLD}$ Low to Output High-Z                    |                                                                              | 100 |                                                                              | 250 |                                                                              | 500 | ns   |
| t <sub>W</sub>                 | t <sub>WC</sub>  | Write Time                                                |                                                                              | 10  |                                                                              | 10  |                                                                              | 10  | ms   |

Note: 1. t<sub>CH</sub> + t<sub>CL</sub> ≥ 1 / f<sub>C</sub>.

2. Value guaranteed by characterization, not 100% tested in production.

**Figure 12. AC Testing Input Output Waveforms**

\_\_\_\_\_

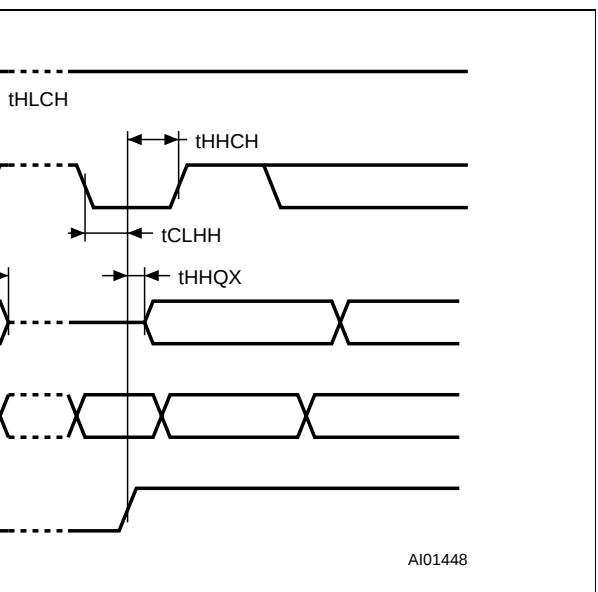
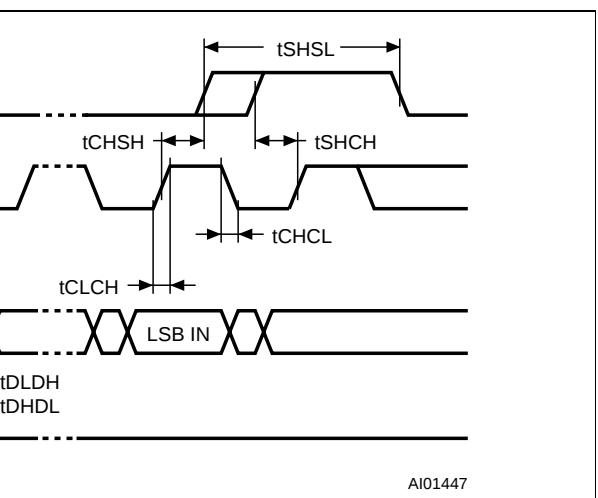
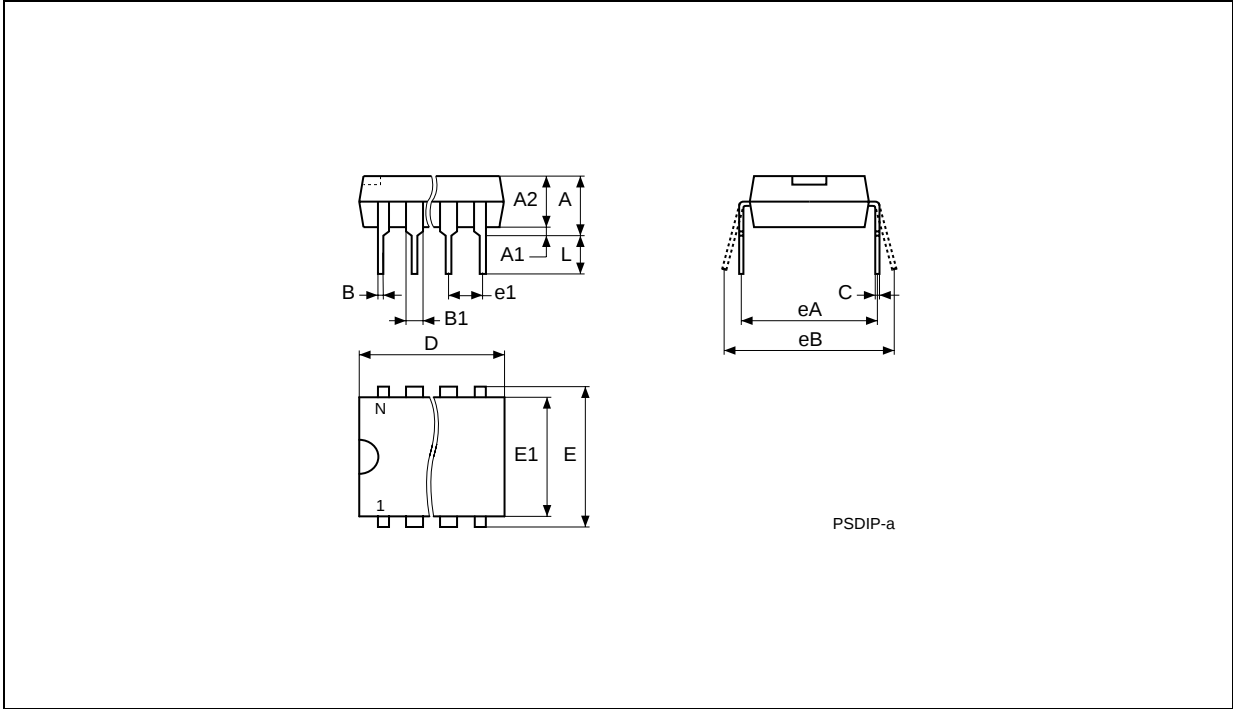




Table 14. PSDIP8 - 8 pin Plastic Skinny DIP, 0.25mm lead frame

| Symb. | mm   |      |       | inches |       |       |
|-------|------|------|-------|--------|-------|-------|
|       | Typ. | Min. | Max.  | Typ.   | Min.  | Max.  |
| A     |      | 3.90 | 5.90  |        | 0.154 | 0.232 |
| A1    |      | 0.49 | –     |        | 0.019 | –     |
| A2    |      | 3.30 | 5.30  |        | 0.130 | 0.209 |
| B     |      | 0.36 | 0.56  |        | 0.014 | 0.022 |
| B1    |      | 1.15 | 1.65  |        | 0.045 | 0.065 |
| C     |      | 0.20 | 0.36  |        | 0.008 | 0.014 |
| D     |      | 9.20 | 9.90  |        | 0.362 | 0.390 |
| E     | 7.62 | –    | –     | 0.300  | –     | –     |
| E1    |      | 6.00 | 6.70  |        | 0.236 | 0.264 |
| e1    | 2.54 | –    | –     | 0.100  | –     | –     |
| eA    |      | 7.80 | –     |        | 0.307 | –     |
| eB    |      |      | 10.00 |        |       | 0.394 |
| L     |      | 3.00 | 3.80  |        | 0.118 | 0.150 |
| N     | 8    |      |       | 8      |       |       |

Figure 16. PSDIP8 (BN)

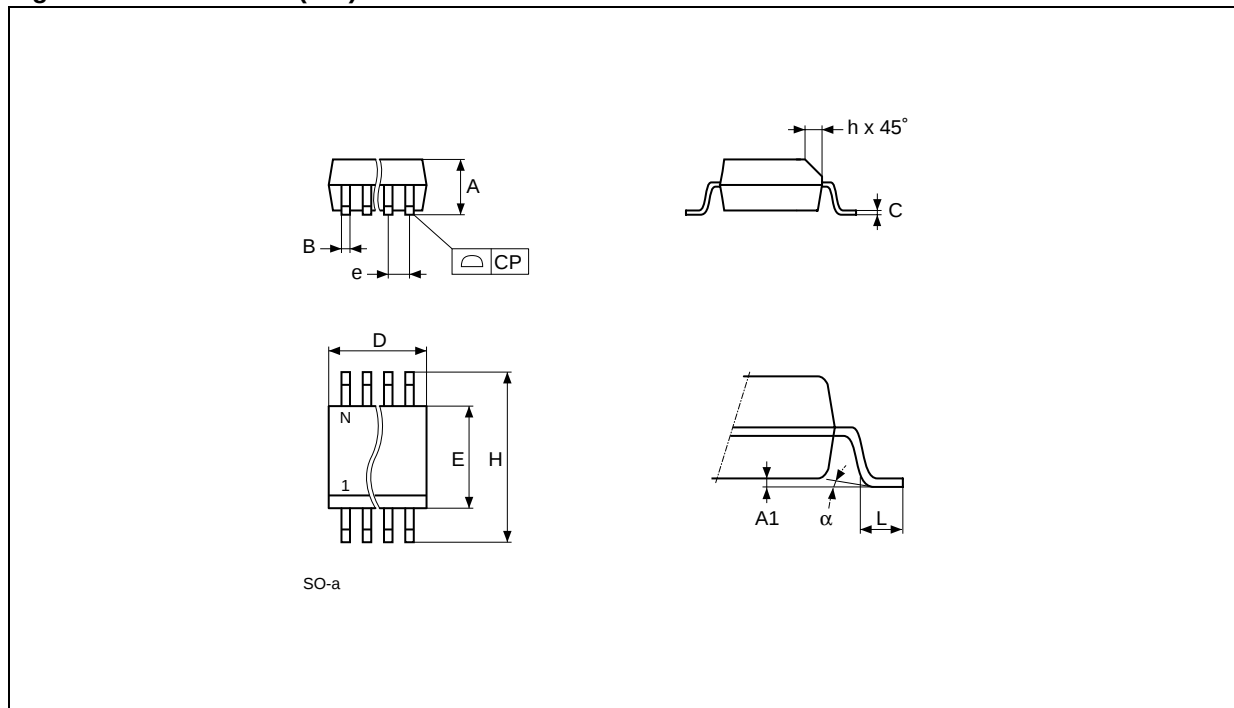


Note: 1. Drawing is not to scale.

Table 15. SO8 - 8 lead Plastic Small Outline, 150 mils body width

| Symb.    | mm   |      |      | inches |       |       |
|----------|------|------|------|--------|-------|-------|
|          | Typ. | Min. | Max. | Typ.   | Min.  | Max.  |
| A        |      | 1.35 | 1.75 |        | 0.053 | 0.069 |
| A1       |      | 0.10 | 0.25 |        | 0.004 | 0.010 |
| B        |      | 0.33 | 0.51 |        | 0.013 | 0.020 |
| C        |      | 0.19 | 0.25 |        | 0.007 | 0.010 |
| D        |      | 4.80 | 5.00 |        | 0.189 | 0.197 |
| E        |      | 3.80 | 4.00 |        | 0.150 | 0.157 |
| e        | 1.27 | —    | —    | 0.050  | —     | —     |
| H        |      | 5.80 | 6.20 |        | 0.228 | 0.244 |
| h        |      | 0.25 | 0.50 |        | 0.010 | 0.020 |
| L        |      | 0.40 | 0.90 |        | 0.016 | 0.035 |
| $\alpha$ |      | 0°   | 8°   |        | 0°    | 8°    |
| N        | 8    |      |      | 8      |       |       |
| CP       |      |      | 0.10 |        |       | 0.004 |

Figure 17. SO8 narrow (MN)

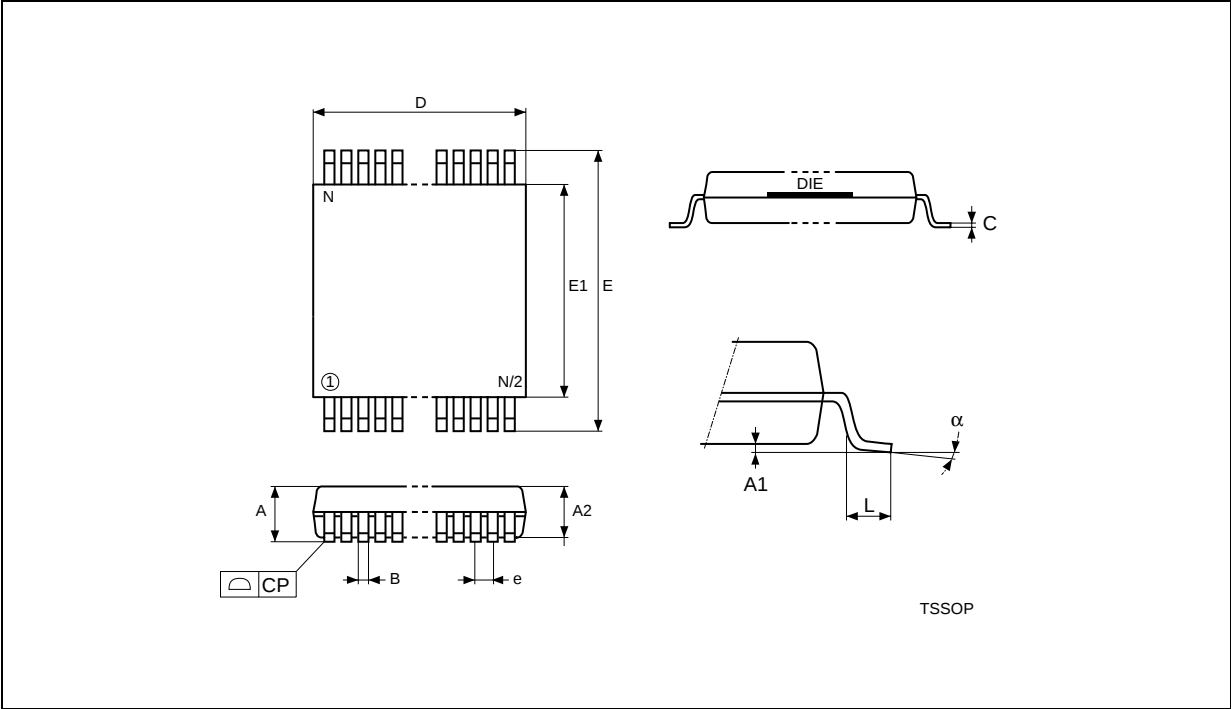


Note: 1. Drawing is not to scale.

Table 16. TSSOP14 - 14 lead Thin Shrink Small Outline

| Symb.    | mm   |      |      | inches |       |       |
|----------|------|------|------|--------|-------|-------|
|          | Typ. | Min. | Max. | Typ.   | Min.  | Max.  |
| A        |      |      | 1.10 |        |       | 0.043 |
| A1       |      | 0.05 | 0.15 |        | 0.002 | 0.006 |
| A2       |      | 0.85 | 0.95 |        | 0.033 | 0.037 |
| B        |      | 0.19 | 0.30 |        | 0.007 | 0.012 |
| C        |      | 0.09 | 0.20 |        | 0.004 | 0.008 |
| D        |      | 4.90 | 5.10 |        | 0.193 | 0.197 |
| E        |      | 6.25 | 6.50 |        | 0.246 | 0.256 |
| E1       |      | 4.30 | 4.50 |        | 0.169 | 0.177 |
| e        | 0.65 | –    | –    | 0.026  | –     | –     |
| L        |      | 0.50 | 0.70 |        | 0.020 | 0.028 |
| $\alpha$ |      | 0°   | 8°   |        | 0°    | 8°    |
| N        | 14   |      |      | 14     |       |       |
| CP       |      |      | 0.08 |        |       | 0.003 |

Figure 18. TSSOP14 (DL)



Note: 1. Drawing is not to scale.

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