

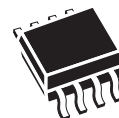


M95M01-R M95M01-W

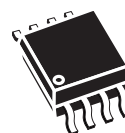
1 Mbit serial SPI bus EEPROM
with high speed clock

Features

- Compatible with SPI bus serial interface (Positive Clock SPI modes)
- Schmitt trigger inputs for enhanced noise margin
- Single supply voltage: 1.8 V to 5.5 V
- High speed
 - 5 MHz clock rate
 - 5 ms Write time
- Status Register
- Hardware Protection of the Status Register
- Byte and Page Write (up to 256 bytes)
- Self-timed programming cycle
- Adjustable size read-only EEPROM area
- Enhanced ESD Protection
- More than 1 000 000 Write cycles
- More than 40-year data retention
- Packages
 - ECOPACK® (RoHS compliant)



SO8N (MN)
150 mils width



SO8W (MW)
208 mils width



WLCSP (CS)

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1 Description

The M95M01-R and M95M01-W are electrically erasable programmable memory (EEPROM) devices. They are accessed by a high speed SPI-compatible bus. The memory array is organized as 131 072 × 8 bit. It can also be seen as 512 pages of 256 bytes each.

The device is accessed by a simple serial interface that is SPI-compatible. The bus signals are C, D and Q, as shown in [Table 1](#) and [Figure 1](#).

The device is selected when Chip Select (\overline{S}) is taken low. Communications with the device can be interrupted using Hold (\overline{HOLD}).

Figure 1. Logic diagram

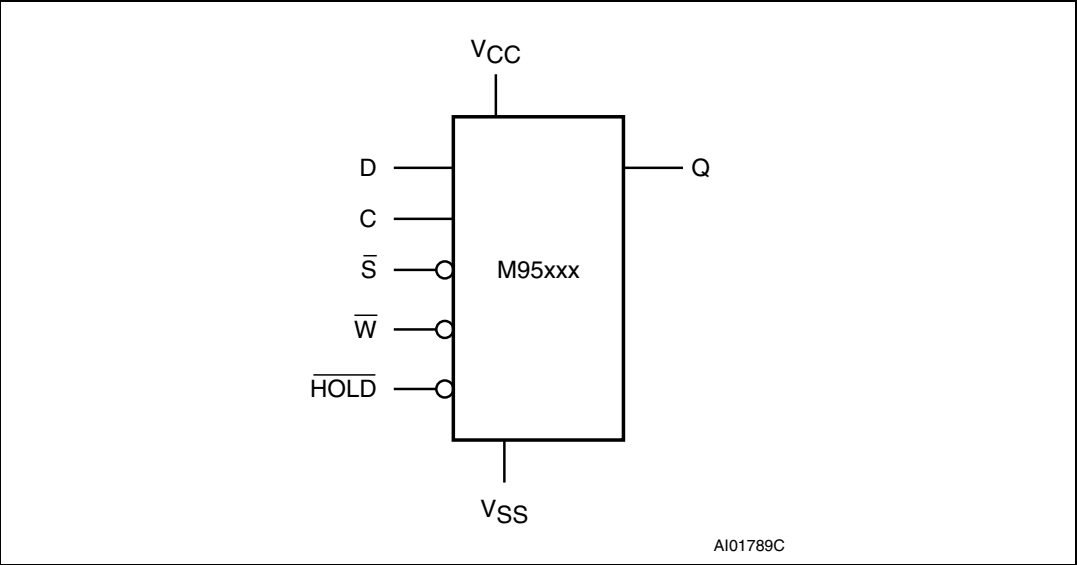
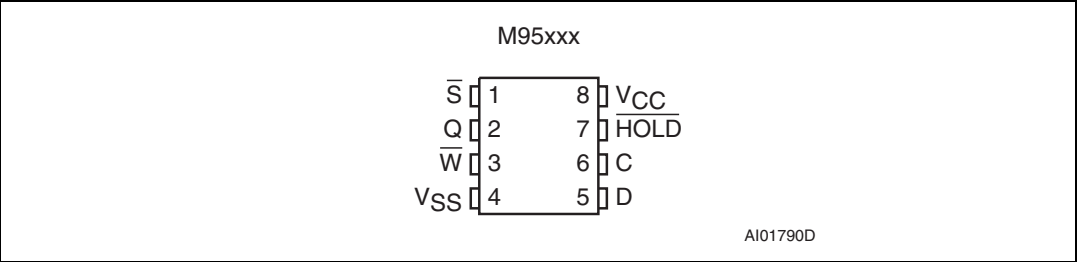


Table 1. Signal names

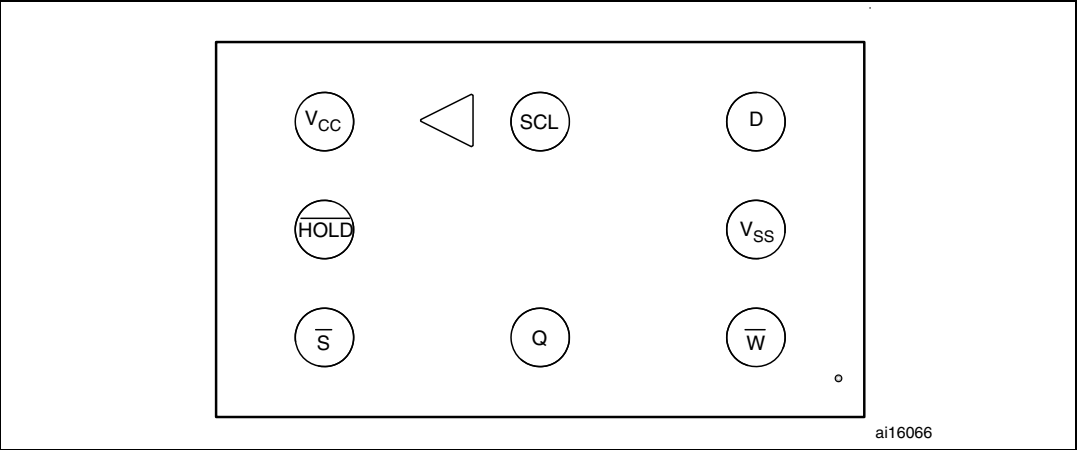
| Signal name | Function | Direction |
|-------------------|--------------------|-----------|
| C | Serial Clock | Input |
| D | Serial Data Input | Input |
| Q | Serial Data Output | Output |
| S | Chip Select | Input |
| \overline{W} | Write Protect | Input |
| \overline{HOLD} | Hold | Input |
| V _{CC} | Supply voltage | |
| V _{SS} | Ground | |

Figure 2. SO connections



1. See [Section 11: Package mechanical data](#) for package dimensions, and how to identify pin-1.

Figure 3. WLCSP connections (bottom view, bump side)



2 Signal description

During all operations, V_{CC} must be held stable and within the specified valid range: $V_{CC}(\min)$ to $V_{CC}(\max)$.

All of the input and output signals must be held high or low (according to voltages of V_{IH} , V_{OH} , V_{IL} or V_{OL} , as specified in [Table 12](#)). These signals are described next.

2.1 Serial Data output (Q)

This output signal is used to transfer data serially out of the device. Data is shifted out on the falling edge of Serial Clock (C).

2.2 Serial Data input (D)

This input signal is used to transfer data serially into the device. It receives instructions, addresses, and the data to be written. Values are latched on the rising edge of Serial Clock (C).

2.3 Serial Clock (C)

This input signal provides the timing of the serial interface. Instructions, addresses, or data present at Serial Data Input (D) are latched on the rising edge of Serial Clock (C). Data on Serial Data Output (Q) changes after the falling edge of Serial Clock (C).

2.4 Chip Select (\overline{S})

When this input signal is high, the device is deselected and Serial Data Output (Q) is at high impedance. Unless an internal Write cycle is in progress, the device will be in the Standby Power mode. Driving Chip Select (\overline{S}) low selects the device, placing it in the Active Power mode.

After Power-up, a falling edge on Chip Select (\overline{S}) is required prior to the start of any instruction.

2.5 Hold (\overline{HOLD})

The Hold (\overline{HOLD}) signal is used to pause any serial communications with the device without deselecting the device.

During the Hold condition, the Serial Data Output (Q) is high impedance, and Serial Data Input (D) and Serial Clock (C) are Don't Care.

To start the Hold condition, the device must be selected, with Chip Select (\overline{S}) driven low.

2.6 Write Protect (\overline{W})

The main purpose of this input signal is to freeze the size of the area of memory that is protected against Write instructions (as specified by the values in the BP1 and BP0 bits of the Status Register).

This pin must be driven either high or low, and must be stable during all write instructions.

2.7 V_{CC} supply voltage

V_{CC} is the supply voltage.

2.8 V_{SS} ground

V_{SS} is the reference for the V_{CC} supply voltage.

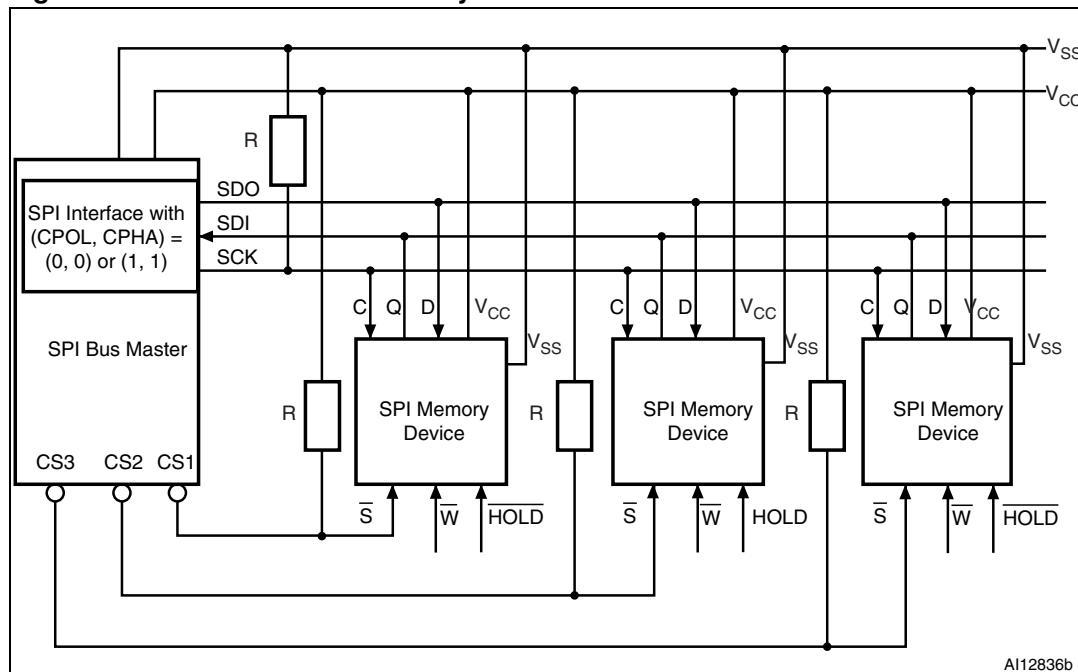
3 Connecting to the SPI bus

These devices are fully compatible with the SPI protocol.

All instructions, addresses and input data bytes are shifted in to the device, most significant bit first. The Serial Data Input (D) is sampled on the first rising edge of the Serial Clock (C) after Chip Select (\overline{S}) goes low.

All output data bytes are shifted out of the device, most significant bit first. The Serial Data Output (Q) is latched on the first falling edge of the Serial Clock (C) after the instruction (such as the Read from Memory Array and Read Status Register instructions) have been clocked into the device.

Figure 4. Bus master and memory devices on the SPI bus



1. The Write Protect (\overline{W}) and Hold (\overline{HOLD}) signals should be driven high or low as appropriate.

[Figure 4](#) shows an example of three memory devices connected to an MCU, on an SPI bus. Only one device is selected at a time, so only one device drives the Serial Data Output (Q) line at a time, the other devices are high impedance.

The pull-up resistor R (represented in [Figure 4](#)) ensures that no device is selected if the bus master leaves the \overline{S} line in the high impedance state.

In applications where the bus master might enter a state where the whole input/output SPI bus is high-impedance at a given time (for example, if the bus master is reset during the transmission of an instruction), the clock line (C) must be connected to an external pull-down resistor so that, if all inputs/outputs become high impedance, the C line is pulled low (while the \overline{S} line is pulled high). This ensures that \overline{S} and C do not become high at the same time, and so, that the t_{SHCH} requirement is met. The typical value of R is 100 k Ω .

3.1 SPI modes

These devices can be driven by a microcontroller with its SPI peripheral running in either of the two following modes:

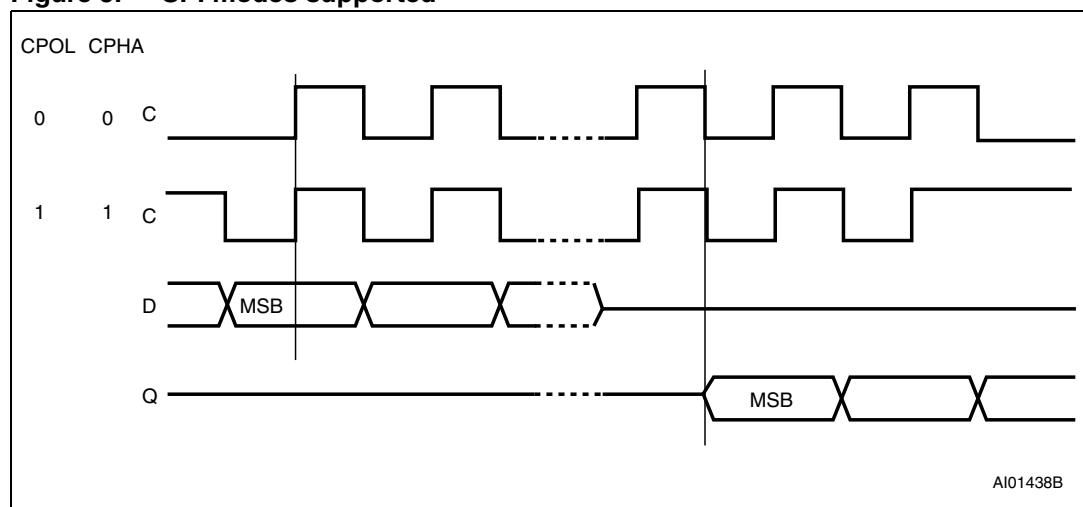
- CPOL=0, CPHA=0
- CPOL=1, CPHA=1

For these two modes, input data is latched in on the rising edge of Serial Clock (C), and output data is available from the falling edge of Serial Clock (C).

The difference between the two modes, as shown in [Figure 5](#), is the clock polarity when the bus master is in Standby mode and not transferring data:

- C remains at 0 for (CPOL=0, CPHA=0)
- C remains at 1 for (CPOL=1, CPHA=1)

Figure 5. SPI modes supported



4 Operating features

4.1 Supply voltage (V_{CC})

4.1.1 Operating supply voltage V_{CC}

Prior to selecting the memory and issuing instructions to it, a valid and stable V_{CC} voltage within the specified [$V_{CC}(\min)$, $V_{CC}(\max)$] range must be applied (see [Table 8](#)). This voltage must remain stable and valid until the end of the transmission of the instruction and, for a Write instruction, until the completion of the internal write cycle (t_W). In order to secure a stable DC supply voltage, it is recommended to decouple the V_{CC} line with a suitable capacitor (usually of the order of 10 nF to 100 nF) close to the V_{CC}/V_{SS} package pins.

4.1.2 Device reset

In order to prevent inadvertent write operations during power-up, a power on reset (POR) circuit is included. At power-up, the device does not respond to any instruction until V_{CC} reaches the internal reset threshold voltage (this threshold is lower than the minimum V_{CC} operating voltage defined in [Table 8](#)).

When V_{CC} passes over the POR threshold, the device is reset and in the following state:

- in Standby Power mode
- deselected (note that, to be executed, an instruction must be preceded by a falling edge on Chip Select (\overline{S}))
- Status Register value:
 - the Write Enable Latch (WEL) is reset to 0
 - Write In Progress (WIP) is reset to 0
 - The SRWD, BP1 and BP0 bits remain unchanged (non-volatile bits)

When V_{CC} passes over the POR threshold, the device is reset and enters the Standby Power mode. The device must not be accessed until V_{CC} reaches a valid and stable V_{CC} voltage within the specified [$V_{CC}(\min)$, $V_{CC}(\max)$] range defined in [Table 8](#).

4.1.3 Power-up conditions

When the power supply is turned on, V_{CC} rises continuously from V_{SS} to V_{CC} . During this time, the Chip Select (\overline{S}) line is not allowed to float but should follow the V_{CC} voltage, it is therefore recommended to connect the \overline{S} line to V_{CC} via a suitable pull-up resistor (see [Figure 4](#)).

In addition, the Chip Select (\overline{S}) input offers a built-in safety feature, as the \overline{S} input is edge-sensitive as well as level-sensitive: after power-up, the device does not become selected until a falling edge has first been detected on Chip Select (\overline{S}). This ensures that Chip Select (\overline{S}) must have been high, prior to going low to start the first operation.

The V_{CC} voltage has to rise continuously from 0 V up to the minimum V_{CC} operating voltage defined in [Table 8](#) and the rise time must not vary faster than 1 V/ μ s.

4.1.4 Power-down

During power-down (continuous decrease in the V_{CC} supply voltage below the minimum V_{CC} operating voltage defined in [Table 8](#)), the device must be:

- deselected (Chip Select \overline{S} should be allowed to follow the voltage applied on V_{CC})
- in Standby Power mode (there should not be any internal write cycle in progress).

4.2 Active Power and Standby Power modes

When Chip Select (\overline{S}) is low, the device is selected, and in the Active Power mode. The device consumes I_{CC} , as specified in [Table 12](#).

When Chip Select (\overline{S}) is high, the device is deselected. If a Write cycle is not currently in progress, the device then goes in to the Standby Power mode, and the device consumption drops to I_{CC1} .

4.3 Hold condition

The Hold (\overline{HOLD}) signal is used to pause any serial communications with the device without resetting the clocking sequence.

During the Hold condition, the Serial Data Output (Q) is high impedance, and Serial Data Input (D) and Serial Clock (C) are Don't Care.

To enter the Hold condition, the device must be selected, with Chip Select (\overline{S}) low.

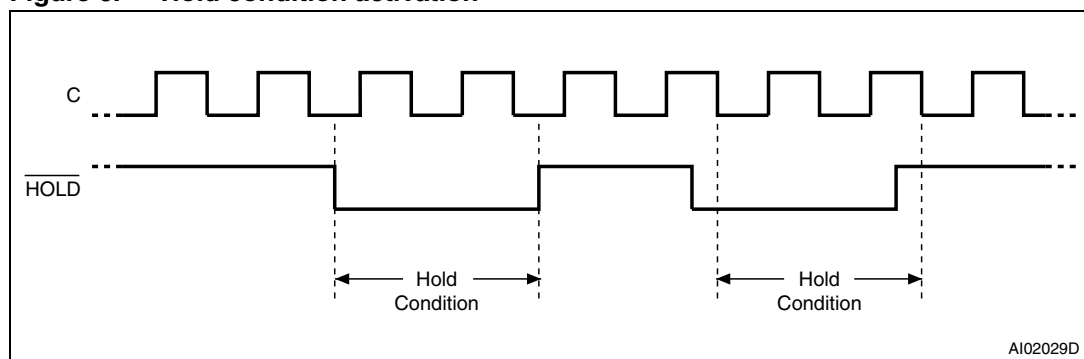
Normally, the device is kept selected, for the whole duration of the Hold condition. Deselecting the device while it is in the Hold condition, has the effect of resetting the state of the device, and this mechanism can be used if it is required to reset any processes that had been in progress.

The Hold condition starts when the Hold (\overline{HOLD}) signal is driven low at the same time as Serial Clock (C) already being low (as shown in [Figure 6](#)).

The Hold condition ends when the Hold (\overline{HOLD}) signal is driven high at the same time as Serial Clock (C) already being low.

[Figure 6](#) also shows what happens if the rising and falling edges are not timed to coincide with Serial Clock (C) being low.

Figure 6. Hold condition activation



4.4 Status Register

[Figure 7](#) shows the position of the Status Register in the control logic of the device. The Status Register contains a number of status and control bits that can be read or set (as appropriate) by specific instructions. See [Section 6.3: Read Status Register \(RDSR\)](#) for a detailed description of the Status Register bits

4.5 Data protection and protocol control

Non-volatile memory devices can be used in environments that are particularly noisy, and within applications that could experience problems if memory bytes are corrupted. Consequently, the device features the following data protection mechanisms:

- Write and Write Status Register instructions are checked that they consist of a number of clock pulses that is a multiple of eight, before they are accepted for execution.
- All instructions that modify data must be preceded by a Write Enable (WREN) instruction to set the Write Enable Latch (WEL) bit. This bit is returned to its reset state by the following events:
 - Power-up
 - Write Disable (WRDI) instruction completion
 - Write Status Register (WRSR) instruction completion
 - Write (WRITE) instruction completion
- The Block Protect (BP1, BP0) bits in the Status Register allow part of the memory to be configured as read-only.
- The Write Protect (\overline{WP}) signal allows the Block Protect (BP1, BP0) bits of the Status Register to be protected.

For any instruction to be accepted, and executed, Chip Select (\overline{S}) must be driven high after the rising edge of Serial Clock (C) for the last bit of the instruction, and before the next rising edge of Serial Clock (C).

Two points need to be noted in the previous sentence:

- The 'last bit of the instruction' can be the eighth bit of the instruction code, or the eighth bit of a data byte, depending on the instruction (except for Read Status Register (RDSR) and Read (READ) instructions).
- The 'next rising edge of Serial Clock (C)' might (or might not) be the next bus transaction for some other device on the SPI bus.

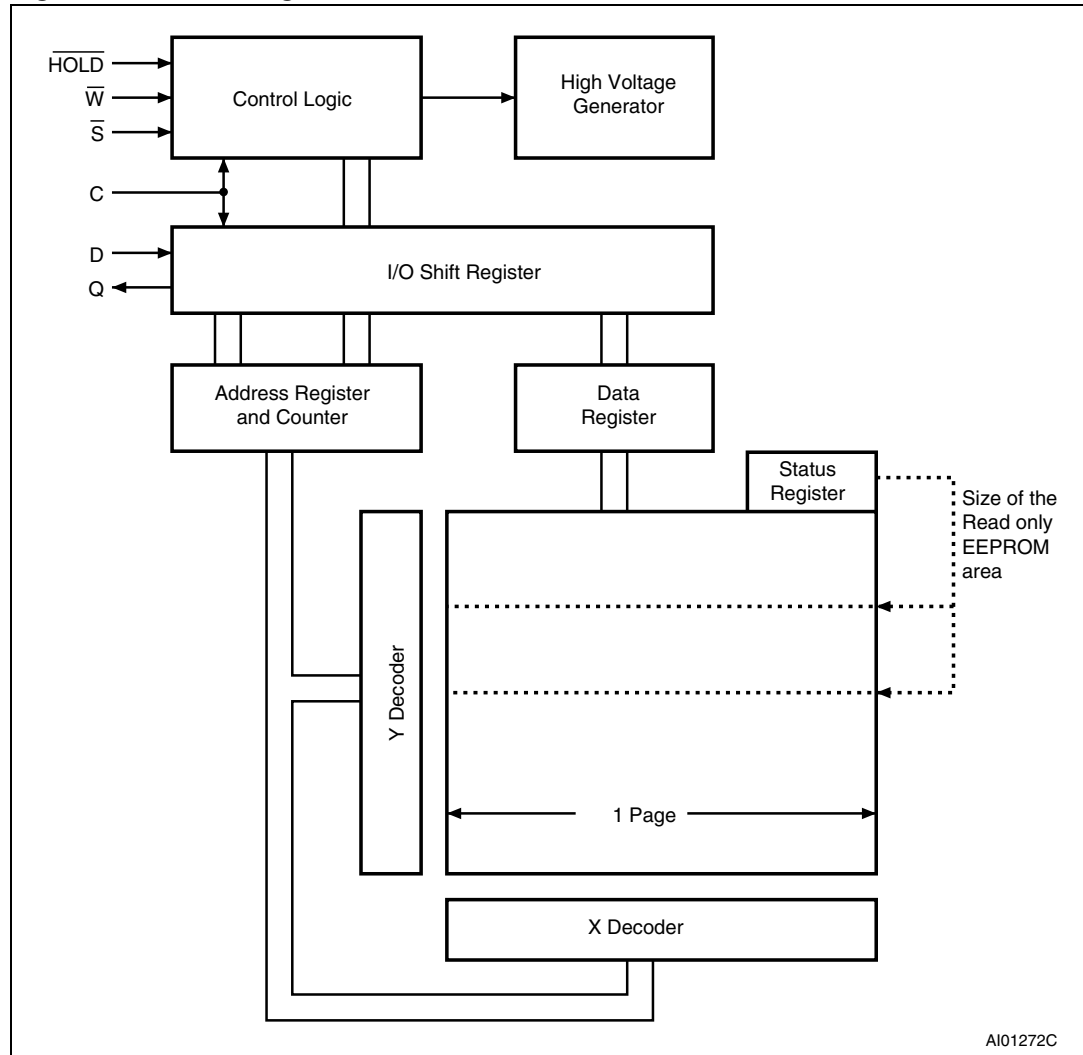
Table 2. Write-protected block size

| Status Register bits | | Protected block | Array addresses protected |
|----------------------|-----|-----------------|---------------------------|
| BP1 | BP0 | | |
| 0 | 0 | none | none |
| 0 | 1 | Upper quarter | 1 8000h - 1 FFFFh |
| 1 | 0 | Upper half | 1 0000h - 1 FFFFh |
| 1 | 1 | Whole memory | 0 0000h - 1 FFFFh |

5 Memory organization

The memory is organized as shown in [Figure 7](#).

Figure 7. Block diagram



6 Instructions

Each instruction starts with a single-byte code, as summarized in [Table 3](#).
If an invalid instruction is sent (one not contained in [Table 3](#)), the device automatically deselects itself.

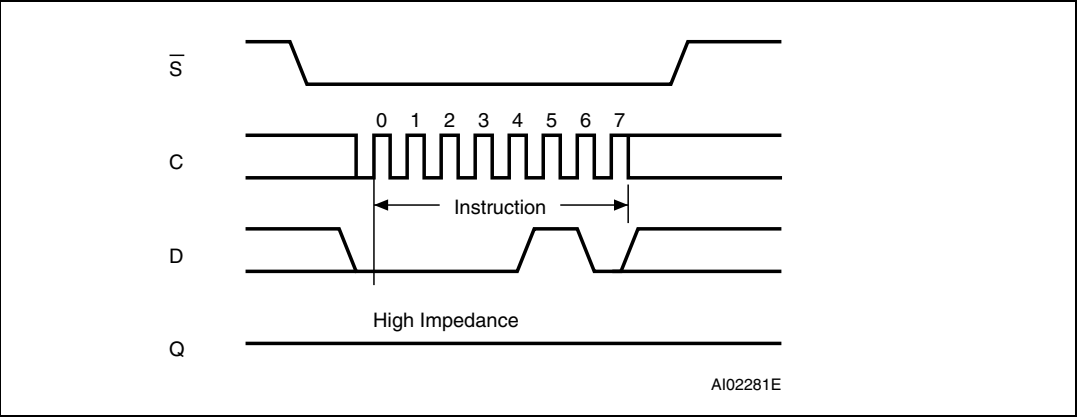
Table 3. Instruction set

| Instruction | Description | Instruction format |
|-------------|------------------------|--------------------|
| WREN | Write Enable | 0000 0110 |
| WRDI | Write Disable | 0000 0100 |
| RDSR | Read Status Register | 0000 0101 |
| WRSR | Write Status Register | 0000 0001 |
| READ | Read from Memory Array | 0000 0011 |
| WRITE | Write to Memory Array | 0000 0010 |

6.1 Write Enable (WREN)

The Write Enable Latch (WEL) bit must be set prior to each WRITE and WRSR instruction. The only way to do this is to send a Write Enable instruction to the device.
As shown in [Figure 8](#), to send this instruction to the device, Chip Select (\overline{S}) is driven low, and the bits of the instruction byte are shifted in, on Serial Data Input (D). The device then enters a wait state. It waits for a the device to be deselected, by Chip Select (\overline{S}) being driven high.

Figure 8. Write Enable (WREN) sequence



6.2 Write Disable (WRDI)

One way of resetting the Write Enable Latch (WEL) bit is to send a Write Disable instruction to the device.

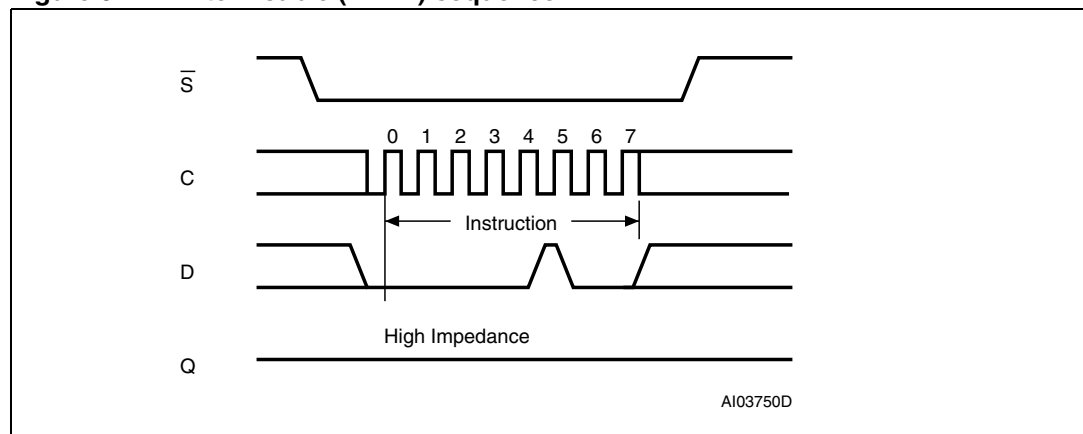
As shown in [Figure 9](#), to send this instruction to the device, Chip Select (\overline{S}) is driven low, and the bits of the instruction byte are shifted in, on Serial Data Input (D).

The device then enters a wait state. It waits for the device to be deselected, by Chip Select (\overline{S}) being driven high.

The Write Enable Latch (WEL) bit, in fact, becomes reset by any of the following events:

- Power-up
- WRDI instruction execution
- WRSR instruction completion
- WRITE instruction completion.

Figure 9. Write Disable (WRDI) sequence



6.3 Read Status Register (RDSR)

The Read Status Register (RDSR) instruction allows the Status Register to be read. The Status Register may be read at any time, even while a Write or Write Status Register cycle is in progress. When one of these cycles is in progress, it is recommended to check the Write In Progress (WIP) bit before sending a new instruction to the device. It is also possible to read the Status Register continuously, as shown in [Figure 10](#).

The status and control bits of the Status Register are as follows:

6.3.1 WIP bit

The Write In Progress (WIP) bit indicates whether the memory is busy with a Write or Write Status Register cycle. When set to 1, such a cycle is in progress, when reset to 0 no such cycle is in progress.

6.3.2 WEL bit

The Write Enable Latch (WEL) bit indicates the status of the internal Write Enable Latch. When set to 1 the internal Write Enable Latch is set, when set to 0 the internal Write Enable Latch is reset and no Write or Write Status Register instruction is accepted.

6.3.3 BP1, BP0 bits

The Block Protect (BP1, BP0) bits are non-volatile. They define the size of the area to be software protected against Write instructions. These bits are written with the Write Status Register (WRSR) instruction. When one or both of the Block Protect (BP1, BP0) bits is set to 1, the relevant memory area (as defined in [Table 4](#)) becomes protected against Write (WRITE) instructions. The Block Protect (BP1, BP0) bits can be written provided that the Hardware Protected mode has not been set.

6.3.4 SRWD bit

The Status Register Write Disable (SRWD) bit is operated in conjunction with the Write Protect (\overline{W}) signal. The Status Register Write Disable (SRWD) bit and Write Protect (\overline{W}) signal allow the device to be put in the Hardware Protected mode (when the Status Register Write Disable (SRWD) bit is set to 1, and Write Protect (\overline{W}) is driven low). In this mode, the non-volatile bits of the Status Register (SRWD, BP1, BP0) become read-only bits and the Write Status Register (WRSR) instruction is no longer accepted for execution.

Table 4. Status Register format

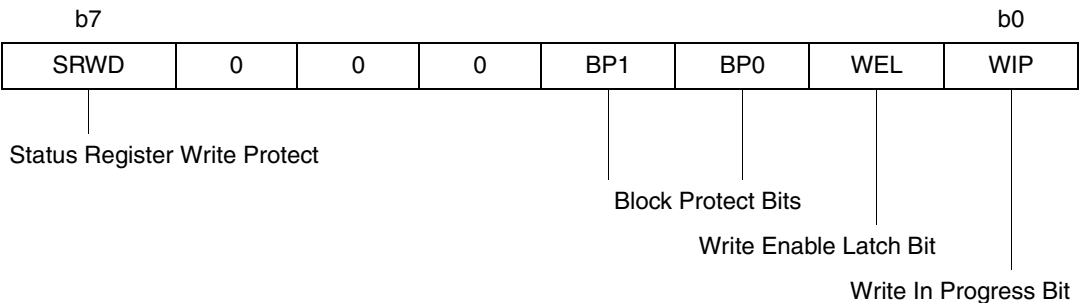
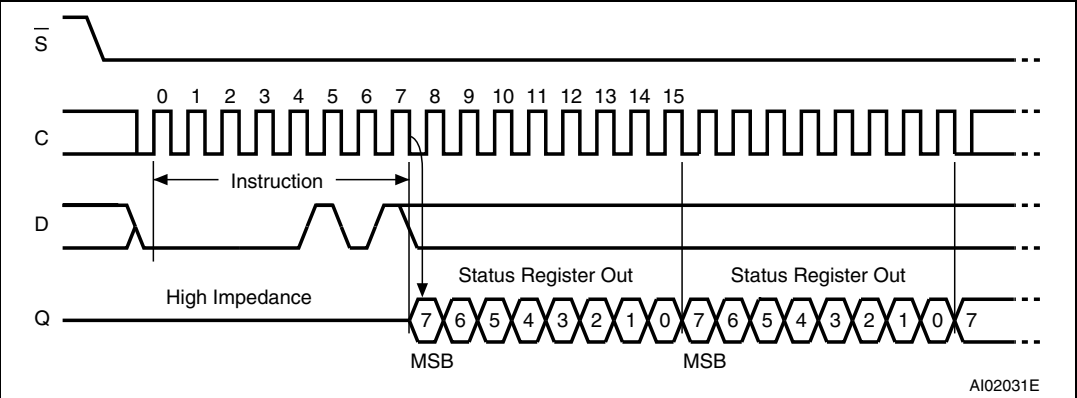


Figure 10. Read Status Register (RDSR) sequence



6.4 Write Status Register (WRSR)

The Write Status Register (WRSR) instruction allows new values to be written to the Status Register. Before it can be accepted, a Write Enable (WREN) instruction must previously have been executed. After the Write Enable (WREN) instruction has been decoded and executed, the device sets the Write Enable Latch (WEL).

The Write Status Register (WRSR) instruction is entered by driving Chip Select (\overline{S}) low, followed by the instruction code and the data byte on Serial Data Input (D).

The instruction sequence is shown in [Figure 11](#).

The Write Status Register (WRSR) instruction has no effect on b6, b5, b4, b1 and b0 of the Status Register. b6, b5 and b4 are always read as 0.

Chip Select (\overline{S}) must be driven high after the rising edge of Serial Clock (C) that latches in the eighth bit of the data byte, and before the next rising edge of Serial Clock (C). Otherwise, the Write Status Register (WRSR) instruction is not executed. As soon as Chip Select (\overline{S}) is driven high, the self-timed Write Status Register cycle (whose duration is t_{W}) is initiated. While the Write Status Register cycle is in progress, the Status Register may still be read to check the value of the Write In Progress (WIP) bit. The Write In Progress (WIP) bit is 1 during the self-timed Write Status Register cycle, and is 0 when it is completed. When the cycle is completed, the Write Enable Latch (WEL) is reset.

Figure 11. Write Status Register (WRSR) sequence

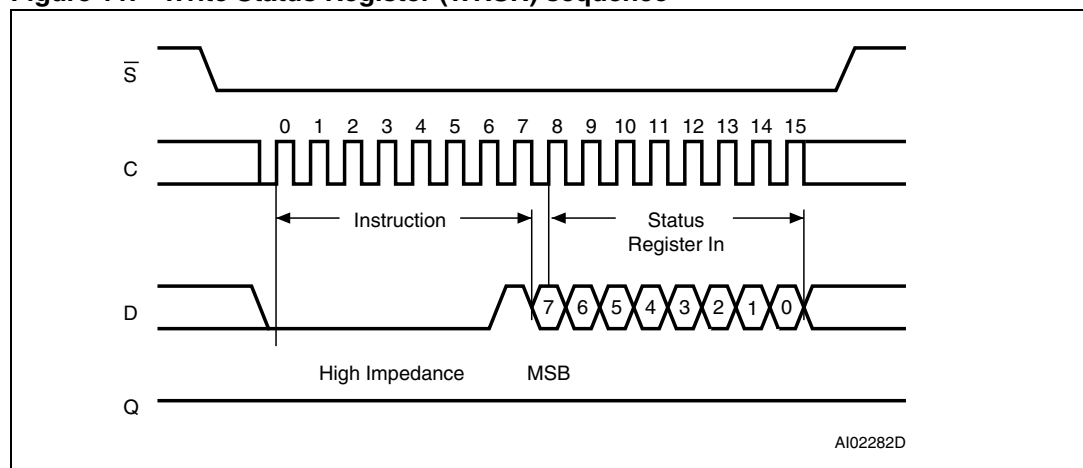


Table 5. Protection modes

| \overline{W} Signal | SRWD Bit | Mode | Write Protection of the Status Register | Memory content | |
|--------------------------|-------------|--------------------------------|--|-------------------------------|---------------------------------------|
| | | | | Protected area ⁽¹⁾ | Unprotected area ⁽¹⁾ |
| 1 | 0 | Software Protected (SPM) | Status Register is Writable (if the WREN instruction has set the WEL bit) | Write Protected | Ready to accept Write instructions |
| 0 | 0 | | The values in the BP1 and BP0 bits can be changed | | |
| 1 | 1 | | | | |
| 0 | 1 | Hardware Protected (HPM) | Status Register is Hardware write protected The values in the BP1 and BP0 bits cannot be changed | Write Protected | Ready to accept Write instructions |

1. As defined by the values in the Block Protect (BP1, BP0) bits of the Status Register, as shown in [Table 5](#).

The Write Status Register (WRSR) instruction allows the user to change the values of the Block Protect (BP1, BP0) bits, to define the size of the area that is to be treated as read-only, as defined in [Table 4](#).

The Write Status Register (WRSR) instruction also allows the user to set or reset the Status Register Write Disable (SRWD) bit in accordance with the Write Protect (\overline{W}) signal. The Status Register Write Disable (SRWD) bit and Write Protect (\overline{W}) signal allow the device to be put in the Hardware Protected Mode (HPM). The Write Status Register (WRSR) instruction is not executed once the Hardware Protected Mode (HPM) is entered.

The contents of the Status Register Write Disable (SRWD) and Block Protect (BP1, BP0) bits are frozen at their current values from just before the start of the execution of Write Status Register (WRSR) instruction. The new, updated, values take effect at the moment of completion of the execution of Write Status Register (WRSR) instruction.

The protection features of the device are summarized in [Table 2](#).

When the Status Register Write Disable (SRWD) bit of the Status Register is 0 (its initial delivery state), it is possible to write to the Status Register provided that the Write Enable Latch (WEL) bit has previously been set by a Write Enable (WREN) instruction, regardless of the whether Write Protect (\overline{W}) is driven high or low.

When the Status Register Write Disable (SRWD) bit of the Status Register is set to 1, two cases need to be considered, depending on the state of Write Protect (\overline{W}):

- If Write Protect (\overline{W}) is driven high, it is possible to write to the Status Register provided that the Write Enable Latch (WEL) bit has previously been set by a Write Enable (WREN) instruction.
- If Write Protect (\overline{W}) is driven low, it is *not* possible to write to the Status Register *even* if the Write Enable Latch (WEL) bit has previously been set by a Write Enable (WREN) instruction. (Attempts to write to the Status Register are rejected, and are not accepted for execution). As a consequence, all the data bytes in the memory area that are software protected (SPM) by the Block Protect (BP1, BP0) bits of the Status Register, are also hardware protected against data modification.

Regardless of the order of the two events, the Hardware Protected Mode (HPM) can be entered:

- by setting the Status Register Write Disable (SRWD) bit after driving Write Protect (\overline{W}) low
- or by driving Write Protect (\overline{W}) low after setting the Status Register Write Disable (SRWD) bit.

The only way to exit the Hardware Protected Mode (HPM) once entered is to pull Write Protect (\overline{W}) high.

If Write Protect (\overline{W}) is permanently tied high, the Hardware Protected Mode (HPM) can never be activated, and only the Software Protected Mode (SPM), using the Block Protect (BP1, BP0) bits of the Status Register, can be used.

6.5 Read from Memory Array (READ)

As shown in [Figure 12](#), to send this instruction to the device, Chip Select (\overline{S}) is first driven low. The bits of the instruction byte and address bytes are then shifted in, on Serial Data Input (D). The address is loaded into an internal address register, and the byte of data at that address is shifted out, on Serial Data Output (Q).

If Chip Select (\overline{S}) continues to be driven low, the internal address register is automatically incremented, and the byte of data at the new address is shifted out.

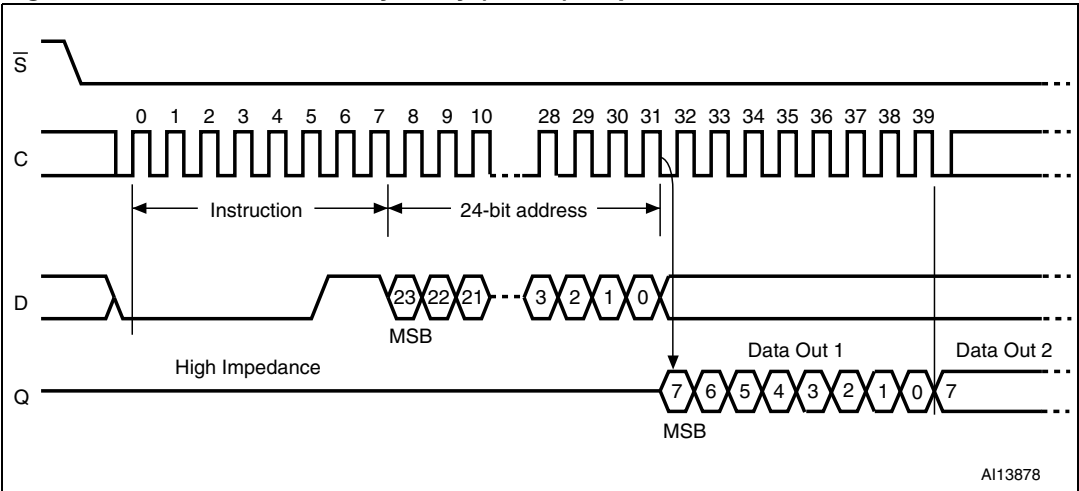
When the highest address is reached, the address counter rolls over to zero, allowing the Read cycle to be continued indefinitely. The whole memory can, therefore, be read with a single READ instruction.

The Read cycle is terminated by driving Chip Select (\overline{S}) high. The rising edge of the Chip Select (\overline{S}) signal can occur at any time during the cycle.

The first byte addressed can be any byte within any page.

The instruction is not accepted, and is not executed, if a Write cycle is currently in progress.

Figure 12. Read from Memory Array (READ) sequence



- 1. As shown in [Table 6](#), the most significant address bits are Don't Care.

Table 6. Address range bits⁽¹⁾

| M95M01-R and M95M01-W | |
|-----------------------|--------|
| Address bits | A16-A0 |

- 1. Bits A23 to A17 are Don't Care.

6.6 Write to Memory Array (WRITE)

As shown in [Figure 13](#), to send this instruction to the device, Chip Select (\overline{S}) is first driven low. The bits of the instruction byte, address byte, and at least one data byte are then shifted in, on Serial Data Input (D).

The instruction is terminated by driving Chip Select (\overline{S}) high at a byte boundary of the input data. In the case of [Figure 13](#), this occurs after the eighth bit of the data byte has been latched in, indicating that the instruction is being used to write a single byte. The self-timed Write cycle starts, and continues for a period t_{WC} (as specified in [Table 15](#)), at the end of which the Write in Progress (WIP) bit is reset to 0.

If, though, Chip Select (\overline{S}) continues to be driven low, as shown in [Figure 14](#), the next byte of input data is shifted in, so that more than a single byte, starting from the given address towards the end of the same page, can be written in a single internal Write cycle. The self-timed Write cycle starts, and continues, for a period t_{WC} (as specified in [Table 15](#)), at the end of which the Write in Progress (WIP) bit is reset to 0.

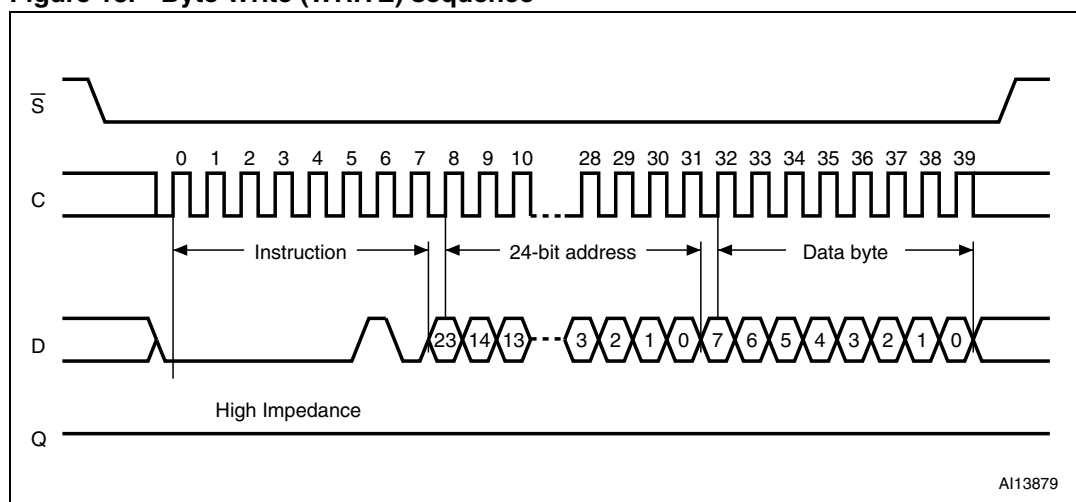
Each time a new data byte is shifted in, the least significant bits of the internal address counter are incremented. If the number of data bytes sent to the device exceeds the page boundary, the internal address counter rolls over to the beginning of the page, and the previous data there are overwritten with the incoming data. (The page size is 256 bytes).

The instruction is not accepted, and is not executed, under the following conditions:

- if the Write Enable Latch (WEL) bit has not been set to 1 (by executing a Write Enable instruction just before)
- if a Write cycle is already in progress
- if the device has not been deselected, by Chip Select (\overline{S}) being driven high, at a byte boundary (after the eighth bit, b0, of the last data byte that has been latched in)
- if the addressed page is in the region protected by the Block Protect (BP1 and BP0) bits.

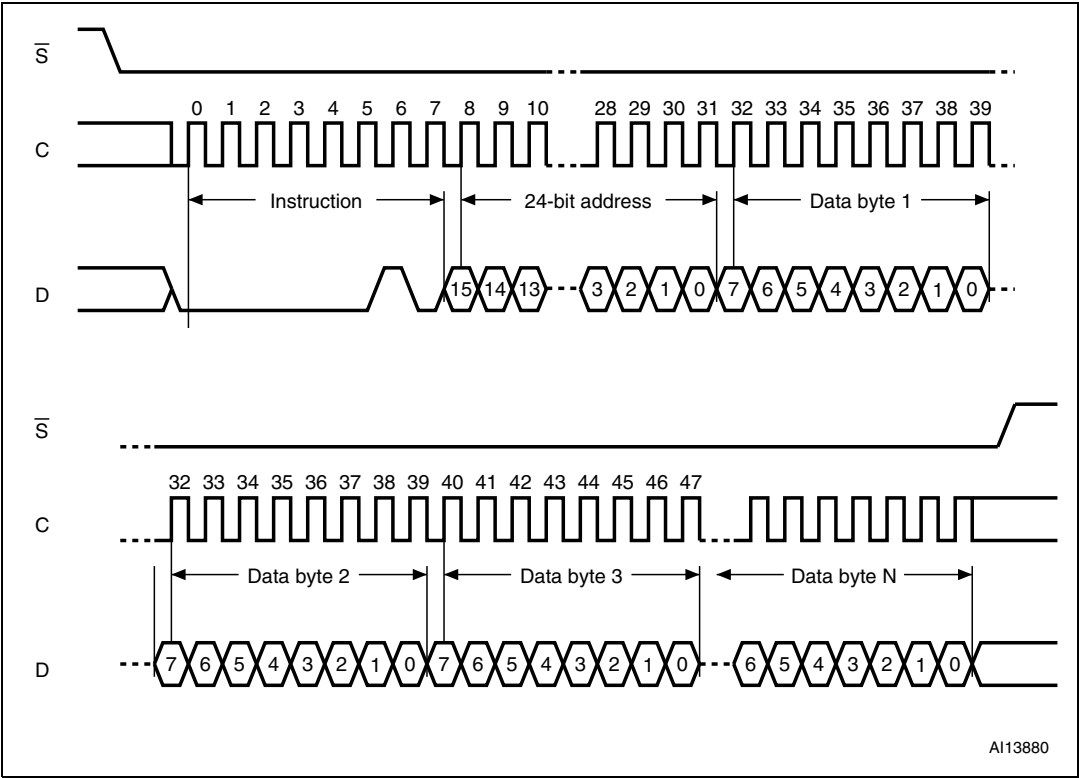
Note: The self-timed write cycle, t_{Wt} is internally executed as a sequence of two consecutive events: [Erase addressed byte(s)], followed by [Program addressed byte(s)]. An erased bit is read as "0" and a programmed bit is read as "1".

Figure 13. Byte Write (WRITE) sequence



1. As shown in [Table 6](#), the most significant address bits are Don't Care.

Figure 14. Page Write (WRITE) sequence



1. As shown in [Table 6](#), the most significant address bits are Don't Care.

7 ECC (error correction code) and write cycling

The M95M01-R and M95M01-W devices offer an ECC (error correction code) logic which compares each 4-byte word with its associated 6 EEPROM bits of ECC. As a result, if a single bit out of 4 bytes of data happens to be erroneous during a read operation, the ECC detects it and replaces it by the correct value. The read reliability is therefore much improved by the use of this feature.

Note however that even if a single byte has to be written, 4 bytes are internally modified (plus the ECC bits), that is, the addressed byte is cycled together with the other three bytes making up the word. It is therefore recommended to write by words of 4 bytes in order to benefit from the larger amount of Write cycles.

The M95M01-R and M95M01-W devices are qualified at 1 million (1 000 000) write cycles, using a cycling routine that writes to the device by multiples of 4-byte packets.

8 Power-up and delivery state

8.1 Power-up state

After power-up, the device is in the following state:

- Standby Power mode
- Deselected (after power-up, a falling edge is required on Chip Select (\overline{S}) before any instructions can be started).
- Not in the Hold condition
- Write Enable Latch (WEL) is reset to 0
- Write In Progress (WIP) is reset to 0

The SRWD, BP1 and BP0 bits of the Status Register are unchanged from the previous power-down (they are non-volatile bits).

8.2 Initial delivery state

The device is delivered with the memory array set at all 1s (FFh). The Status Register Write Disable (SRWD) and Block Protect (BP1 and BP0) bits are initialized to 0.

9 Maximum rating

Stressing the device outside the ratings listed in [Table 7](#) may cause permanent damage to the device. These are stress ratings only, and operation of the device at these, or any other conditions outside 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 STMicroelectronics SURE Program and other relevant quality documents.

Table 7. Absolute maximum ratings

| Symbol | Parameter | Min. | Max. | Unit |
|------------|---|-------------------------|--------------|------|
| T_A | Ambient operating temperature | -40 | 130 | °C |
| T_{STG} | Storage temperature | -65 | 150 | °C |
| T_{LEAD} | Lead temperature during soldering | See note ⁽¹⁾ | | °C |
| V_O | Output voltage | -0.50 | $V_{CC}+0.6$ | V |
| V_I | Input voltage | -0.50 | 6.5 | V |
| V_{CC} | Supply voltage | -0.50 | 6.5 | V |
| I_{OL} | DC output current ($Q = 0$) | | 5 | mA |
| I_{OH} | DC output current ($Q = 1$) | | -5 | mA |
| V_{ESD} | Electrostatic discharge voltage (human body model) ⁽²⁾ | -4000 | 4000 | V |

1. Compliant with JEDEC Std J-STD-020C (for small body, Sn-Pb or Pb assembly), the ST ECOPACK® 7191395 specification, and the European directive on Restrictions on Hazardous Substances (RoHS) 2002/95/EU

2. AEC-Q100-002 (compliant with JEDEC Std JESD22-A114A, C1=100pF, R1=1500Ω, R2=500Ω)

10 DC and AC parameters

This section summarizes the operating and measurement conditions, and the DC and AC characteristics of the device. The parameters in the DC and AC characteristic tables that follow are derived from tests performed under the measurement conditions summarized in the relevant tables. Designers should check that the operating conditions in their circuit match the measurement conditions when relying on the quoted parameters.

Table 8. Operating conditions (M95M01-R6)

| Symbol | Parameter | Min. | Max. | Unit |
|----------|-------------------------------|------|------|------|
| V_{CC} | Supply voltage | 1.8 | 5.5 | V |
| T_A | Ambient operating temperature | -40 | 85 | °C |

Table 9. Operating conditions (M95M01-W3)

| Symbol | Parameter | Min. | Max. | Unit |
|----------|-------------------------------|------|------|------|
| V_{CC} | Supply voltage | 2.5 | 5.5 | V |
| T_A | Ambient operating temperature | -40 | 125 | °C |

Table 10. AC measurement conditions

| Symbol | Parameter | Min. | Max. | Unit |
|--------|--|----------------------------|------|------|
| C_L | Load capacitance | 100 | | pF |
| | Input rise and fall times | | 50 | ns |
| | Input pulse voltages | $0.2V_{CC}$ to $0.8V_{CC}$ | | V |
| | Input and output timing reference voltages | $0.3V_{CC}$ to $0.7V_{CC}$ | | V |

Figure 15. AC measurement I/O waveform

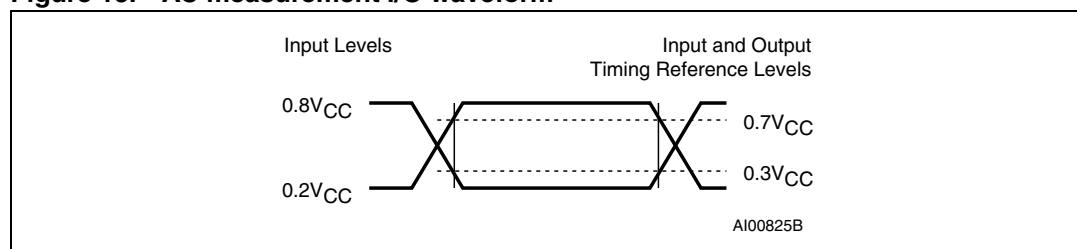


Table 11. Capacitance⁽¹⁾

| Symbol | Parameter | Test condition | Min. | Max. | Unit |
|-----------|--------------------------------|------------------------|------|------|------|
| C_{OUT} | Output capacitance (Q) | $V_{OUT} = 0\text{ V}$ | | 8 | pF |
| C_{IN} | Input capacitance (D) | $V_{IN} = 0\text{ V}$ | | 8 | pF |
| | Input capacitance (other pins) | $V_{IN} = 0\text{ V}$ | | 6 | pF |

1. Not 100% tested.

Table 12. DC characteristics (M95M01-R6)

| Symbol | Parameter | Test condition | Min | Max | Unit |
|-----------------|-------------------------------------|---|---------------|---------------|---------|
| I_{LI} | Input leakage current | $V_{IN} = V_{SS} \text{ or } V_{CC}$ | | ± 2 | μA |
| I_{LO} | Output leakage current | $\overline{S} = V_{CC}, V_{OUT} = V_{SS} \text{ or } V_{CC}$ | | ± 2 | μA |
| I_{CC} | Supply current (Read) | $C = 0.1V_{CC}/0.9V_{CC}$ at 2 MHz, $V_{CC} = 1.8 \text{ V}$, $Q = \text{open}$ | | 1.5 | mA |
| | | $C = 0.1V_{CC}/0.9V_{CC}$ at 5 MHz, $V_{CC} = 2.5 \text{ V}$, $Q = \text{open}$ | | 4 | mA |
| | | $C = 0.1V_{CC}/0.9V_{CC}$ at 5 MHz, $V_{CC} = 5 \text{ V}$, $Q = \text{open}$ | | 5 | mA |
| $I_{CC0}^{(1)}$ | Supply current (Write) | During t_W , $\overline{S} = V_{CC}$, | | 5 | mA |
| I_{CC1} | Supply current (Standby Power mode) | $\overline{S} = V_{CC}, V_{IN} = V_{SS} \text{ or } V_{CC}$, $1.8 \text{ V} \leq V_{CC} < 2.5 \text{ V}$ | | 3 | μA |
| | | $\overline{S} = V_{CC}, V_{IN} = V_{SS} \text{ or } V_{CC}$, $2.5 \text{ V} \leq V_{CC} \leq 5.5 \text{ V}$ | | 5 | μA |
| V_{IL} | Input low voltage | $1.8 \text{ V} \leq V_{CC} < 2.5 \text{ V}$ | -0.45 | $0.25 V_{CC}$ | V |
| | | $2.5 \text{ V} \leq V_{CC} \leq 5.5 \text{ V}$ | -0.45 | $0.3 V_{CC}$ | |
| V_{IH} | Input high voltage | $1.8 \text{ V} \leq V_{CC} < 2.5 \text{ V}$ | $0.75 V_{CC}$ | $V_{CC}+1$ | V |
| | | $2.5 \text{ V} \leq V_{CC} \leq 5.5 \text{ V}$ | $0.7 V_{CC}$ | $V_{CC}+1$ | |
| V_{OL} | Output low voltage | $I_{OL} = 0.15 \text{ mA}$, $V_{CC} = 1.8 \text{ V}$ | | 0.3 | V |
| | | $V_{CC} = 2.5 \text{ V}$, $I_{OL} = 1.5 \text{ mA}$ or $V_{CC} = 5 \text{ V}$, $I_{OL} = 2 \text{ mA}$ | | 0.4 | V |
| V_{OH} | Output high voltage | $I_{OH} = -0.1 \text{ mA}$, $V_{CC} = 1.8 \text{ V}$ | $0.8 V_{CC}$ | | V |
| | | $V_{CC} = 2.5 \text{ V}$, $I_{OH} = -0.4 \text{ mA}$ or $V_{CC} = 5 \text{ V}$, $I_{OH} = -2 \text{ mA}$ | | | |

1. Characterized value, not tested in production.

Table 13. DC characteristics (M95M01-W3)⁽¹⁾

| Symbol | Parameter | Test conditions) | Min. | Max. | Unit |
|-----------------|--|---|--------------|--------------|---------|
| I_{LI} | Input leakage current | $V_{IN} = V_{SS}$ or V_{CC} | | ± 2 | μA |
| I_{LO} | Output leakage current | $\overline{S} = V_{CC}$, $V_{OUT} = V_{SS}$ or V_{CC} | | ± 2 | μA |
| I_{CC} | Supply current (Read) | $C = 0.1V_{CC}/0.9V_{CC}$ at 5 MHz, $V_{CC} = 2.5 V$, $Q = \text{open}$ | | 4 | mA |
| | | $C = 0.1V_{CC}/0.9V_{CC}$ at 5 MHz, $V_{CC} = 5 V$, $Q = \text{open}$ | | 5 | mA |
| $I_{CC0}^{(2)}$ | Supply current (Write) | During t_W , $\overline{S} = V_{CC}$, $2.5 V < V_{CC} < 5.5 V$ | | 6 | mA |
| I_{CC1} | Supply current (Standby Power mode) | $\overline{S} = V_{CC}$, $V_{IN} = V_{SS}$ or V_{CC} , $2.5 V < V_{CC} < 5.5 V$ | | 5 | μA |
| V_{IL} | Input low voltage | | -0.45 | $0.3 V_{CC}$ | V |
| V_{IH} | Input high voltage | | $0.7 V_{CC}$ | $V_{CC}+1$ | V |
| V_{OL} | Output low voltage | $V_{CC} = 2.5 V$ and $I_{OL} = 1.5 mA$ or $V_{CC} = 5 V$ and $I_{OL} = 2 mA$ | | 0.4 | V |
| V_{OH} | Output high voltage | $V_{CC} = 2.5 V$ and $I_{OH} = -0.4 mA$ or $V_{CC} = 5 V$ and $I_{OH} = -2 mA$ | $0.8 V_{CC}$ | | V |

1. Preliminary data.

2. Characterized value, not tested in production.

Table 14. AC characteristics (M95M01-R6 and M95M01-W3⁽¹⁾, $V_{CC} \geq 2.5$ V)

| Test conditions specified in Table 10 | | | | | |
|---|------------|---|------|------|---------|
| Symbol | Alt. | Parameter | Min. | Max. | Unit |
| f_C | f_{SCK} | Clock frequency | D.C. | 5 | MHz |
| t_{SLCH} | t_{CSS1} | \overline{S} active setup time | 60 | | ns |
| t_{SHCH} | t_{CSS2} | \overline{S} not active setup time | 60 | | ns |
| t_{SHSL} | t_{CS} | \overline{S} Deselect time | 60 | | ns |
| t_{CHSH} | t_{CSH} | \overline{S} active hold time | 60 | | ns |
| t_{CHSL} | | \overline{S} not active hold time | 60 | | ns |
| $t_{CH}^{(2)}$ | t_{CLH} | Clock high time | 90 | | ns |
| $t_{CL}^{(2)}$ | t_{CLL} | Clock low time | 90 | | ns |
| $t_{CLCH}^{(3)}$ | t_{RC} | Clock rise time | | 2 | μ s |
| $t_{CHCL}^{(3)}$ | t_{FC} | Clock fall time | | 2 | μ s |
| t_{DVCH} | t_{DSU} | Data in setup time | 20 | | ns |
| t_{CHDX} | t_{DH} | Data in hold time | 20 | | ns |
| t_{HHCH} | | Clock low hold time after \overline{HOLD} not active | 60 | | ns |
| t_{HLCH} | | Clock low hold time after \overline{HOLD} active | 60 | | ns |
| t_{CLHL} | | Clock low set-up time before \overline{HOLD} active | 0 | | ns |
| t_{CLHH} | | Clock low set-up time before \overline{HOLD} not active | 0 | | ns |
| $t_{SHQZ}^{(3)}$ | t_{DIS} | Output disable time | | 80 | ns |
| t_{CLQV} | t_V | Clock low to output valid | | 80 | ns |
| t_{CLQX} | t_{HO} | Output hold time | 0 | | ns |
| $t_{QLQH}^{(3)}$ | t_{RO} | Output rise time | | 80 | ns |
| $t_{QHQL}^{(3)}$ | t_{FO} | Output fall time | | 80 | ns |
| t_{HHQV} | t_{LZ} | \overline{HOLD} high to output valid | | 80 | ns |
| $t_{HLQZ}^{(3)}$ | t_{HZ} | \overline{HOLD} low to output high-Z | | 80 | ns |
| t_W | t_{WC} | Write time | | 5 | ms |

1. Data concerning the M95M01-W3 are preliminary.
2. $t_{CH} + t_{CL}$ must never be less than the shortest possible clock period, $1 / f_C(\max)$
3. Value guaranteed by characterization, not 100% tested in production.

Table 15. AC characteristics (M95M01-R6, $V_{CC} < 2.5$ V)

| Test conditions specified in Table 10 | | | | | |
|---|------------|--|------|------|---------|
| Symbol | Alt. | Parameter | Min. | Max. | Unit |
| f_C | f_{SCK} | Clock frequency | D.C. | 2 | MHz |
| t_{SLCH} | t_{CSS1} | \overline{S} active setup time | 150 | | ns |
| t_{SHCH} | t_{CSS2} | \overline{S} not active setup time | 150 | | ns |
| t_{SHSL} | t_{CS} | \overline{S} deselect time | 200 | | ns |
| t_{CHSH} | t_{CSH} | \overline{S} active hold time | 150 | | ns |
| t_{CHSL} | | \overline{S} not active hold time | 150 | | ns |
| $t_{CH}^{(1)}$ | t_{CLH} | Clock high time | 200 | | ns |
| $t_{CL}^{(1)}$ | t_{CLL} | Clock low time | 200 | | ns |
| $t_{CLCH}^{(2)}$ | t_{RC} | Clock rise time | | 2 | μ s |
| $t_{CHCL}^{(2)}$ | t_{FC} | Clock fall time | | 2 | μ s |
| t_{DVCH} | t_{DSU} | Data in setup time | 50 | | ns |
| t_{CHDX} | t_{DH} | Data in hold time | 50 | | ns |
| t_{HHCH} | | Clock low hold time after \overline{HOLD} not active | 150 | | ns |
| t_{HLCH} | | Clock low hold time after \overline{HOLD} active | 150 | | ns |
| t_{CLHL} | | Clock low setup time before \overline{HOLD} active | 0 | | ns |
| t_{CLHH} | | Clock low setup time before \overline{HOLD} not active | 0 | | ns |
| $t_{SHQZ}^{(2)}$ | t_{DIS} | Output Disable time | | 200 | ns |
| $t_{CLQV}^{(3)}$ | t_V | Clock low to output valid | | 200 | ns |
| t_{CLQX} | t_{HO} | Output hold time | 0 | | ns |
| $t_{QLQH}^{(2)}$ | t_{RO} | Output rise time | | 200 | ns |
| $t_{QHQL}^{(2)}$ | t_{FO} | Output fall time | | 200 | ns |
| t_{HHQV} | t_{LZ} | \overline{HOLD} high to output valid | | 200 | ns |
| $t_{HLQZ}^{(2)}$ | t_{HZ} | \overline{HOLD} low to output high-Z | | 200 | ns |
| t_W | t_{WC} | Write time | | 5 | ms |

1. $t_{CH} + t_{CL}$ must never be less than the shortest possible clock period, $1 / f_C(\max)$
2. Value guaranteed by characterization, not 100% tested in production.
3. t_{CLQV} must be compatible with t_{CL} (clock low time): if the SPI bus master offers a read setup time $t_{SU} = 0$ ns, t_{CL} can be equal to (or greater than) t_{CLQV} ; in all other cases, t_{CL} must be equal to (or greater than) $t_{CLQV} + t_{SU}$.

Figure 16. Serial input timing

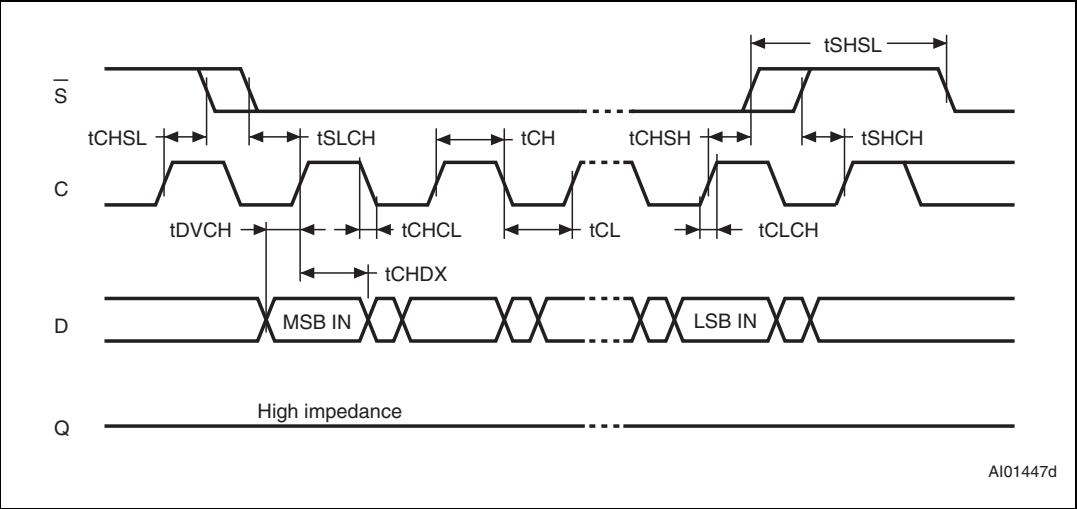


Figure 17. Hold timing

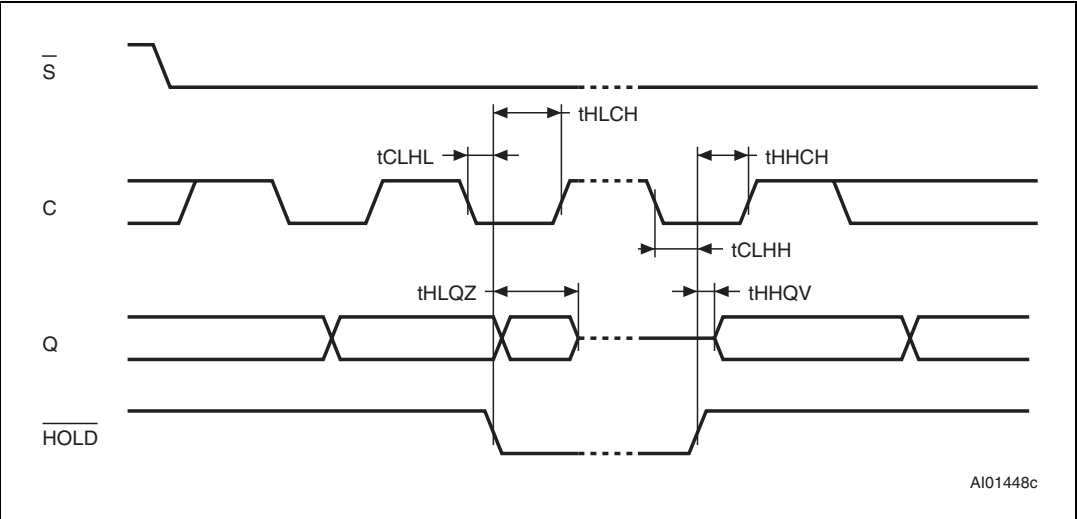
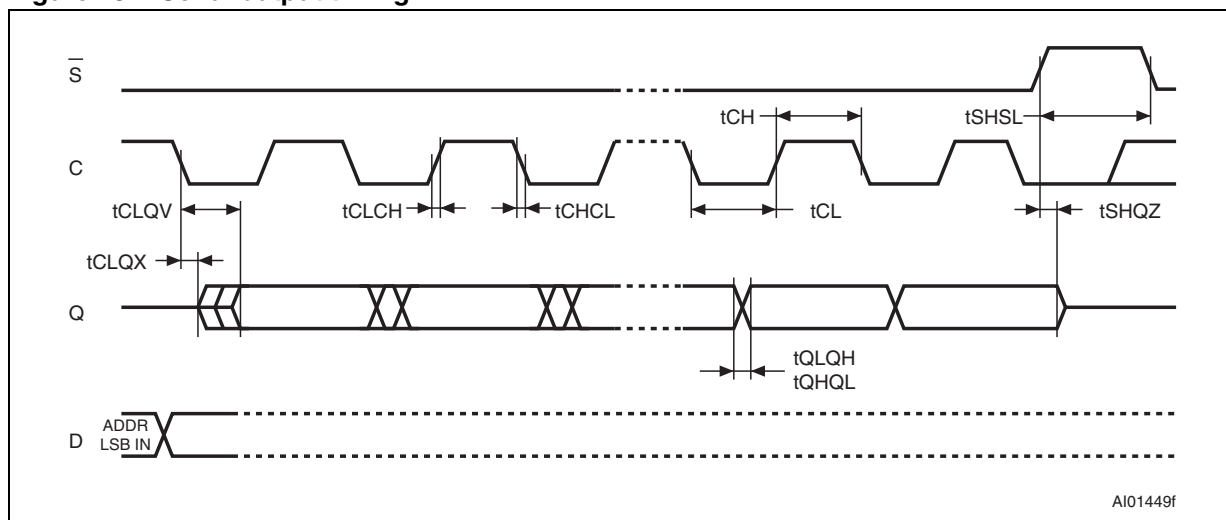


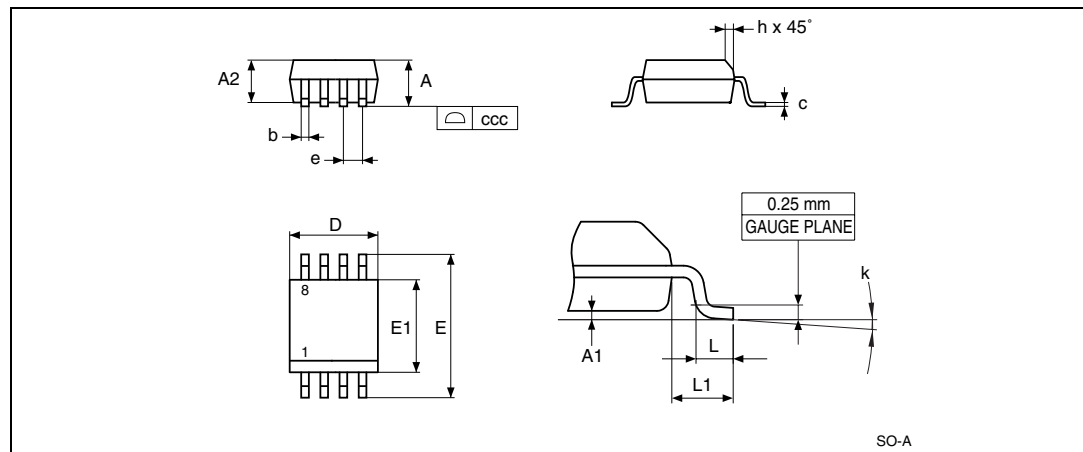
Figure 18. Serial output timing



11 Package mechanical data

In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK® packages, depending on their level of environmental compliance. ECOPACK® specifications, grade definitions and product status are available at: www.st.com. ECOPACK® is an ST trademark.

Figure 19. SO8 narrow – 8 lead plastic small outline, 150 mils body width, package outline

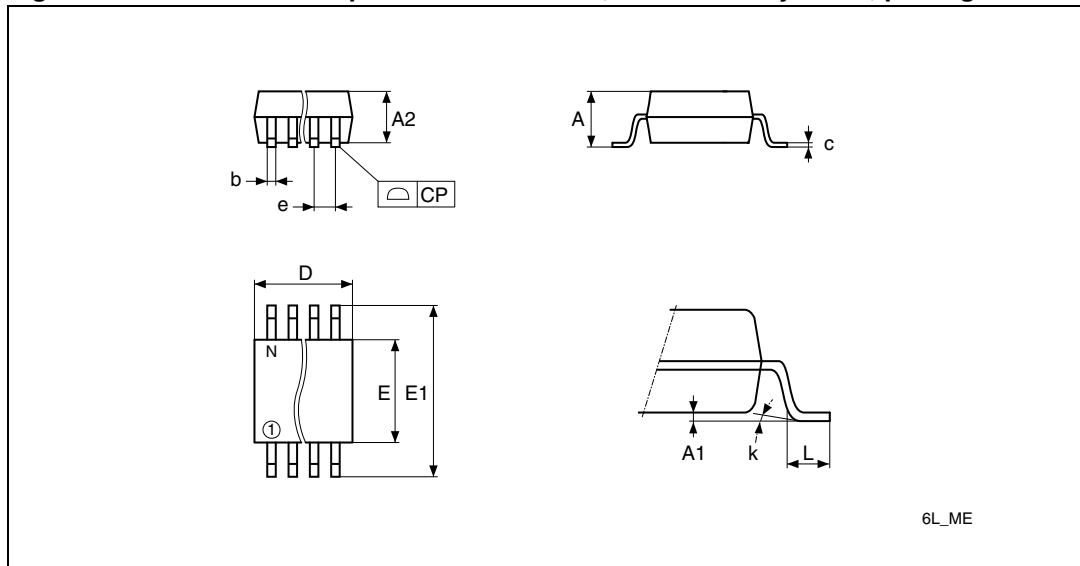


1. Drawing is not to scale.

Table 16. SO8 narrow – 8 lead plastic small outline, 150 mils body width, package mechanical data

| Symbol | millimeters | | | inches ⁽¹⁾ | | |
|--------|-------------|-------|-------|-----------------------|--------|--------|
| | Typ | Min | Max | Typ | Min | Max |
| A | | | 1.750 | | | 0.0689 |
| A1 | | 0.100 | 0.250 | | 0.0039 | 0.0098 |
| A2 | | 1.250 | | | 0.0492 | |
| b | | 0.280 | 0.480 | | 0.0110 | 0.0189 |
| c | | 0.170 | 0.230 | | 0.0067 | 0.0091 |
| ccc | | | 0.100 | | | 0.0039 |
| D | 4.900 | 4.800 | 5.000 | 0.1929 | 0.1890 | 0.1969 |
| E | 6.000 | 5.800 | 6.200 | 0.2362 | 0.2283 | 0.2441 |
| E1 | 3.900 | 3.800 | 4.000 | 0.1535 | 0.1496 | 0.1575 |
| e | 1.270 | – | – | 0.0500 | – | – |
| h | | 0.250 | 0.500 | | 0.0098 | 0.0197 |
| k | | 0° | 8° | | 0° | 8° |
| L | | 0.400 | 1.270 | | 0.0157 | 0.0500 |
| L1 | 1.040 | | | 0.0409 | | |

1. Values in inches are converted from mm and rounded to 4 decimal digits.

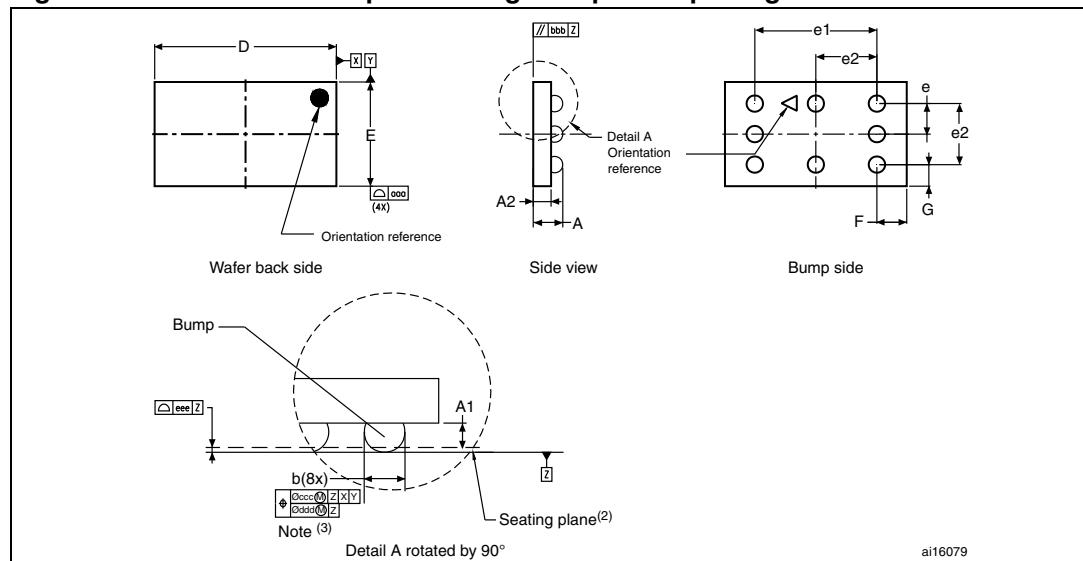
Figure 20. SO8W – 8 lead plastic small outline, 208 mils body width, package outline

1. Drawing is not to scale.

Table 17. SO8W – 8 lead plastic small outline, 208 mils body width, package mechanical data

| Symbol | millimeters | | | inches ⁽¹⁾ | | |
|--------|-------------|------|------|-----------------------|--------|--------|
| | Typ | Min | Max | Typ | Min | Max |
| A | | | 2.50 | | | 0.0984 |
| A1 | | 0.00 | 0.25 | | 0.0000 | 0.0098 |
| A2 | | 1.51 | 2.00 | | 0.0594 | 0.0787 |
| b | 0.40 | 0.35 | 0.51 | 0.0157 | 0.0138 | 0.0201 |
| c | 0.20 | 0.10 | 0.35 | 0.0079 | 0.0039 | 0.0138 |
| CP | | | 0.10 | | | 0.0039 |
| D | | | 6.05 | | | 0.2382 |
| E | | 5.02 | 6.22 | | 0.1976 | 0.2449 |
| E1 | | 7.62 | 8.89 | | 0.3000 | 0.3500 |
| e | 1.27 | – | – | 0.0500 | – | – |
| k | | 0 | 10 | | 0° | 10° |
| L | | 0.50 | 0.80 | | 0.0197 | 0.0315 |
| N | 8 | | | 8 | | |

1. Values in inches are converted from mm and rounded to 4 decimal digits.

Figure 21. WLCSP – 8 bump wafer length chip scale package

1. Drawing is not to scale.
2. Primary datum Z and seating plane are defined by the spherical crowns of the bump.
3. Bump position designation as per JESD 95-1, SPP-010.

Table 18. WLCSP – 8 bump wafer length chip scale package

| Symbol | millimeters | | | inches ⁽¹⁾ | | |
|---------------------|-------------|-------|-------|-----------------------|--------|--------|
| | Typ | Min | Max | Typ | Min | Max |
| A | 0.580 | 0.555 | 0.605 | 0.0228 | 0.0219 | 0.0238 |
| A1 | 0.230 | | | 0.0091 | | |
| A2 | 0.350 | | | 0.0138 | | |
| b | 0.322 | | | 0.0127 | | |
| D | 3.570 | | 3.685 | 0.1406 | | 0.1451 |
| E | 2.050 | | 2.165 | 0.0807 | | 0.0852 |
| e | 0.600 | | | 0.0236 | | |
| e1 | 2.400 | | | 0.0945 | | |
| e2 | 1.200 | | | 0.0472 | | |
| F | 0.585 | | | 0.0230 | | |
| G | 0.425 | | | 0.0167 | | |
| N (number of bumps) | 8 | | | | | |
| aaa | 0.110 | | | 0.0043 | | |
| bbb | 0.110 | | | 0.0043 | | |
| ccc | 0.110 | | | 0.0043 | | |
| ddd | 0.060 | | | 0.0024 | | |
| eee | 0.060 | | | 0.0024 | | |

1. Values in inches are converted from mm and rounded to 4 decimal digits.

12 Part numbering

Table 19. Ordering information scheme

| | | | | | | | |
|---|--------|---|---|----|---|---|---|
| Example: | M95M01 | – | R | MN | 6 | T | P |
| Device type | | | | | | | |
| M95 = SPI serial access EEPROM | | | | | | | |
| Device function | | | | | | | |
| M01 = 1024 Kbits (131 072 × 8) | | | | | | | |
| Operating voltage | | | | | | | |
| R = V _{CC} = 1.8 V to 5.5 V | | | | | | | |
| W = V _{CC} = 2.5 V to 5.5 V | | | | | | | |
| Package | | | | | | | |
| MN = SO8N (150 mils width) | | | | | | | |
| MW = SO8W (208 mils width) | | | | | | | |
| CS = WLCSP | | | | | | | |
| Device grade | | | | | | | |
| 6 = Industrial temperature range, –40 to 85 °C. | | | | | | | |
| Device tested with standard test flow | | | | | | | |
| 3 = Automotive temperature range (–40 to 125 °C) | | | | | | | |
| Device tested with high reliability certified flow ⁽¹⁾ | | | | | | | |
| Option | | | | | | | |
| blank = standard packing | | | | | | | |
| T = tape and reel packing | | | | | | | |
| Plating technology | | | | | | | |
| P or G = ECOPACK® (RoHS compliant) | | | | | | | |

1. ST strongly recommends the use of the Automotive Grade devices for use in an automotive environment. The high reliability certified flow (HRCF) is described in the quality note QNEE9801. Please ask your nearest ST sales office for a copy.

For a list of available options (speed, package, etc.) or for further information on any aspect of this device, please contact your nearest ST sales office.



Table 20. Available products (package, voltage range, temperature grade)

| Package | M95M01-R (1.8 V to 5.5 V) | M95M01-W (2.5 V to 5.5 V) |
|----------------|--------------------------------------|--------------------------------------|
| SO8 (MN) | Range 6 | Range 3 |
| SO8wide (MW) | Range 6 | - |
| WLCSP (CS) | Range 6 | - |

13 Revision history

Table 21. Document revision history

| Date | Revision | Changes |
|-------------|----------|---|
| 13-Mar-2007 | 1 | Initial release. |
| 15-May-2007 | 2 | V _{CC} conditions modified in Table 15: AC characteristics (M95M01-R6, VCC < 2.5 V) . Small text changes. |
| 21-Jun-2007 | 3 | The device endurance is specified at more than 1 000 000 (1 million) cycles (corrected on page 1). |
| 17-Jul-2007 | 4 | Schmitt trigger inputs for enhanced noise margin added to Features on page 1 . V _{IL} and V _{IH} values modified according to voltage range in Table 12: DC characteristics (M95M01-R6) . |
| 24-Jan-2008 | 5 | Document status promoted from preliminary data to full datasheet. I _{CC0} modified in Table 12: DC characteristics (M95M01-R6) . In Section 11: Package mechanical data , values in inches are converted from mm and rounded to 4 decimal digits. Table 20: Available products (package, voltage range, temperature grade) added. Small text changes. |
| 07-May-2009 | 6 | WLCSP package added (see Figure 3: WLCSP connections (bottom view, bump side) and Section 11: Package mechanical data). Section 3: Connecting to the SPI bus updated. Section 4.1: Supply voltage (VCC) updated. Note added to Section 6.6: Write to Memory Array (WRITE) . Note added to Table 15: AC characteristics (M95M01-R6, VCC < 2.5 V) . Figure 16: Serial input timing , Figure 17: Hold timing and Figure 18: Serial output timing updated. ECOPACK text updated under Section 11: Package mechanical data . |
| 30-Jul-2009 | 7 | M95M01-W device grade 3 devices added (see Table 9: Operating conditions (M95M01-W3) , Table 13: DC characteristics (M95M01-W3) , Table 14: AC characteristics (M95M01-R6 and M95M01-W3, VCC ≥ 2.5 V) and Table 19: Ordering information scheme). |

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