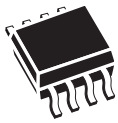
M95128
M95128-W M95128-R

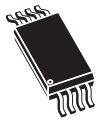
128 Kbit Serial SPI bus EEPROM with high speed clock

Feature summary

- Compatible with SPI Bus Serial Interface (Positive Clock SPI Modes)
- Single Supply Voltage:
  - 4.5 to 5.5V for M95128
  - 2.5 to 5.5V for M95128-W
  - 1.8 to 5.5V for M95128-R
- High Speed
  - 5MHz Clock Rate, 5ms Write Time
- Status Register
- Hardware Protection of the Status Register
- BYTE and PAGE WRITE (up to 64 Bytes)
- Self-Timed Programming Cycle
- Adjustable Size Read-Only EEPROM Area
- Enhanced ESD Protection
- More than 100,000 Write Cycles
- More than 40-Year Data Retention
- Packages
  - ECOPACK® (RoHS compliant)



SO8 (MN)
150 mil width



TSSOP8 (DW)
169 mil width

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1 Summary description

These electrically erasable programmable memory (EEPROM) devices are accessed by a high speed SPI-compatible bus. The memory array is organized as 16384 x 8 bits.

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 ($\overline{HOLD}$).

In order to meet environmental requirements, ST offers these devices in ECOPACK® packages. ECOPACK® packages are Lead-free and RoHS compliant.

ECOPACK is an ST trademark. ECOPACK specifications are available at: *www.st.com*.

Figure 1. Logic diagram

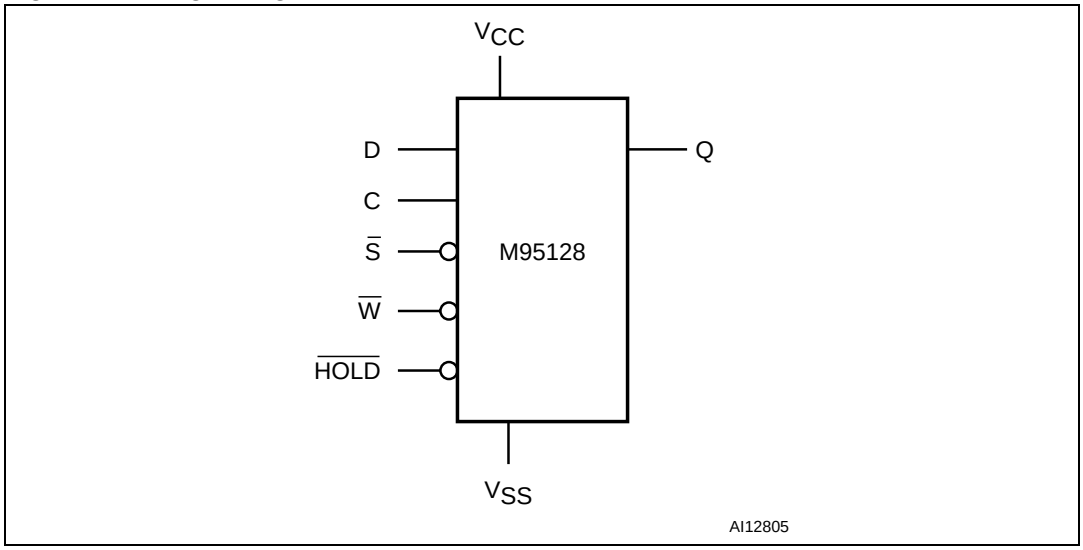
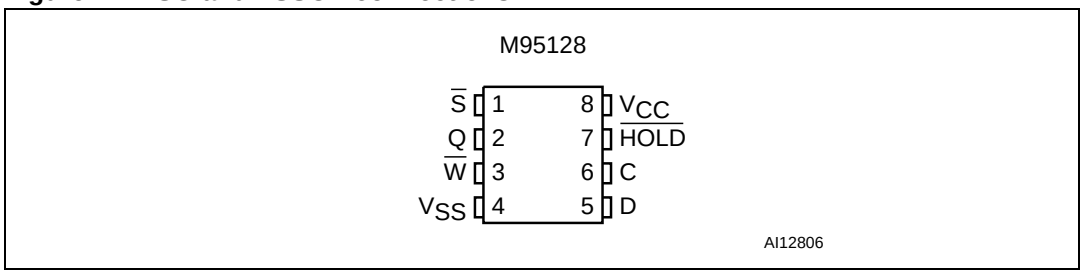


Figure 2. SO and TSSOP connections



1. See *Section 10: Package mechanical* for package dimensions, and how to identify pin-1.

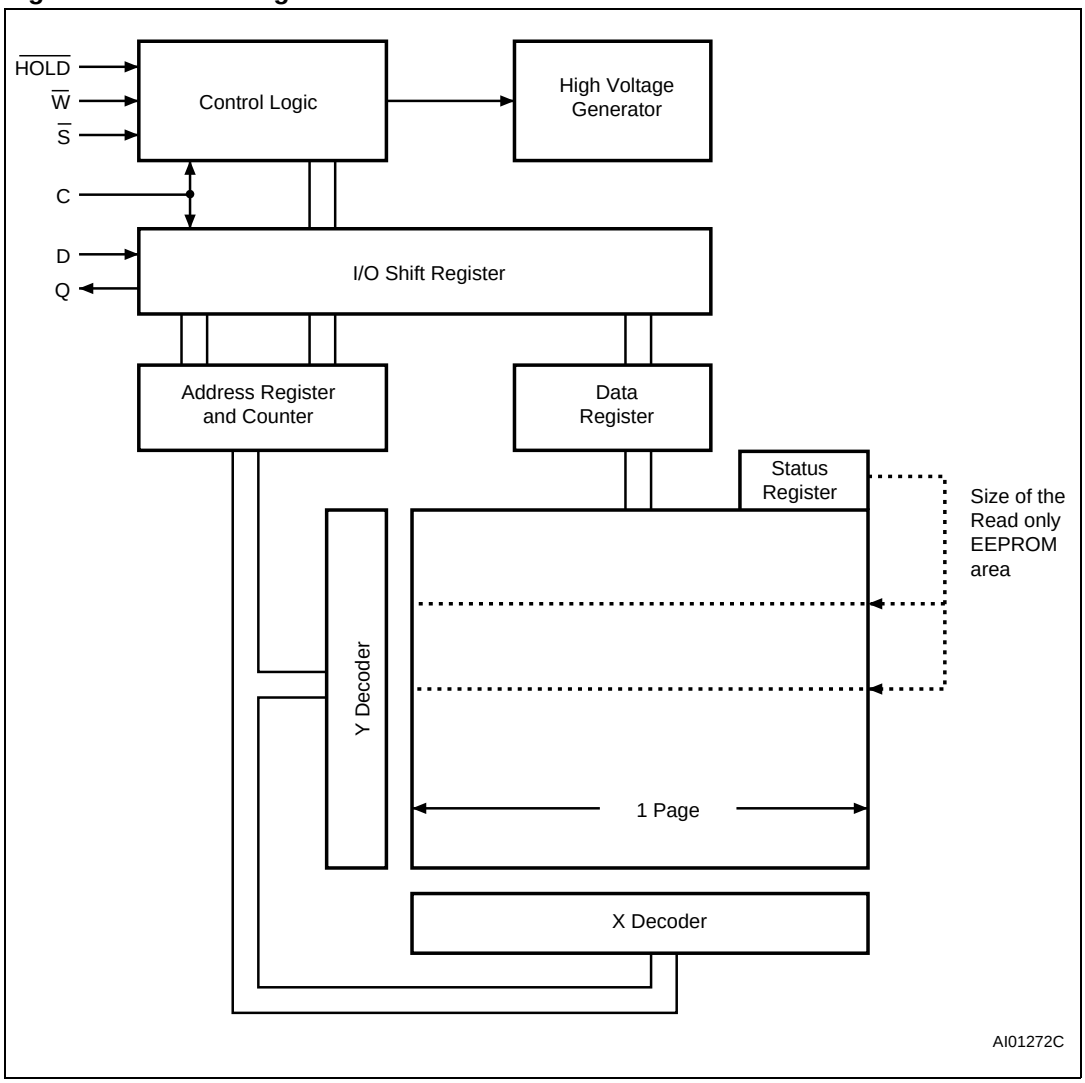
Table 1. Signal names

C	Serial Clock
D	Serial Data Input
Q	Serial Data Output
$\overline{S}$	Chip Select
$\overline{W}$	Write Protect
$\overline{HOLD}$	Hold
V_{CC}	Supply Voltage
V_{SS}	Ground

2 Memory organization

The memory is organized as shown in *Figure 3*.

Figure 3. Block diagram



3 Signal description

See *Figure 1: Logic diagram* and *Table 1: Signal names*, for a brief overview of the signals connected to this device.

3.1 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).

3.2 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).

3.3 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).

3.4 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.

3.5 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.

3.6 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.

3.7 Supply voltage (V_{CC})

3.7.1 Operating supply voltage V_{CC}

Prior to selecting the memory and issuing instructions to it, a valid and stable V_{CC} voltage must be applied: this voltage must be a DC voltage within the specified [V_{CC}(min), V_{CC}(max)] range, as defined in *Table 7*, *Table 8* and *Table 9*. 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 10nF to 100nF) close to the V_{CC}/V_{SS} package pins.

The V_{CC} 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).

3.7.2 Power-up conditions

When the power supply is turned on, V_{CC} rises from V_{SS} to V_{CC}. During this time, the Chip Select ($\overline{S}$) signal is not allowed to float and must follow the V_{CC} voltage. The $\overline{S}$ line should therefore be connected to V_{CC} via a suitable pull-up resistor.

In addition, the Chip Select ($\overline{S}$) input offers a built-in safety feature, as it is both edge sensitive and level sensitive. Practically this means that after power-up, the device cannot become selected until a falling edge has first been detected on Chip Select ($\overline{S}$). So the Chip Select ($\overline{S}$) signal must first have been High and then gone Low before the first operation can be started.

3.7.3 Internal device reset

In order to prevent inadvertent Write operations during Power-up, a Power On Reset (POR) circuit is included. At Power-up (continuous rise of V_{CC}), the device will not respond to any instruction until the V_{CC} has reached the Power On Reset threshold voltage (this threshold is lower than the minimum V_{CC} operating voltage defined in *Section 9: DC and AC parameters*).

When V_{CC} has passed the POR threshold voltage, the device is reset and in the following state:

- in Standby Power mode
- deselected (at next Power-up, a falling edge is required on Chip Select ($\overline{S}$) before any instructions can be executed)
- not in the Hold Condition Status Register state:
  - the Write Enable Latch (WEL) bit is reset to 0
  - the Write In Progress (WIP) bit is reset to 0.
    The SRWD, BP1 and BP0 bits of the Status Register are at the same logic level as when the device was last powered down (they are non-volatile bits).

3.7.4 Power-down

At Power-down, the device must be deselected and in Standby Power mode (that is, there should be no internal Write cycle in progress). Chip Select ($\overline{S}$) should be allowed to follow the voltage applied on V_{CC}.

4 Operating features

4.1 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.

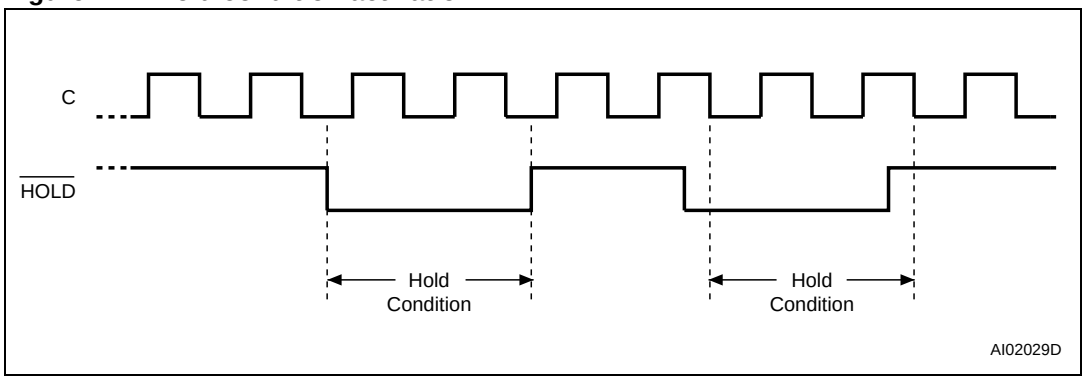
Normally, the device is kept selected, for the whole duration of the Hold condition. Deselecting the device while it is in the Hold condition, has the effect of resetting the state of the device, and this mechanism can be used if it is required to reset any processes that had been in progress.

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 4*).

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 4 also shows what happens if the rising and falling edges are not timed to coincide with Serial Clock (C) being Low.

Figure 4. Hold condition activation



4.2 Status Register

Figure 3 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. For a detailed description of the Status Register bits, see *Section 5.3: Read Status Register (RDSR)*.

4.3 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 allow part of the memory to be configured as read-only. This is the Software Protected Mode (SPM).
- The Write Protect ($\overline{W}$) signal allows the Block Protect (BP1, BP0) bits to be protected. This is the Hardware Protected Mode (HPM).

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		M95128, M95128-W, M95128-R
0	0	none	none
0	1	Upper quarter	3000h - 3FFFh
1	0	Upper half	2000h - 3FFFh
1	1	Whole memory	0000h - 3FFFh

5 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

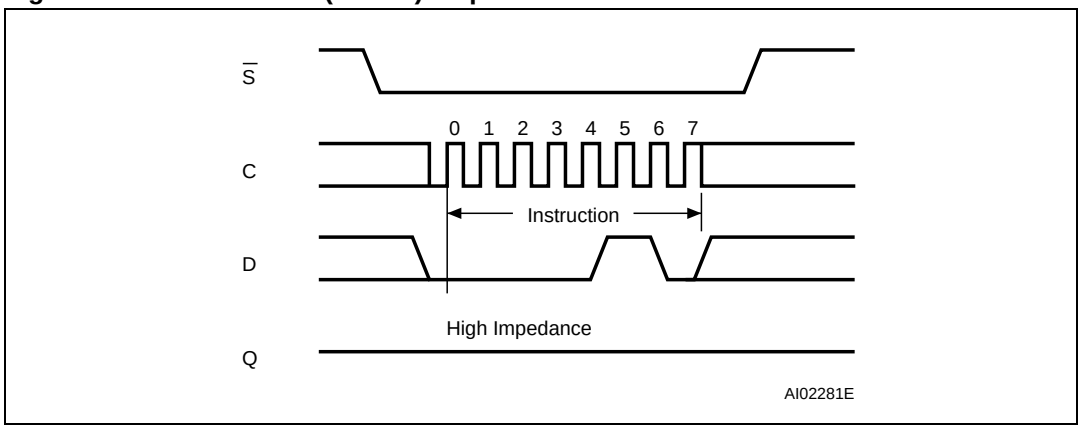
Instruction	Description	Instruction Format
WREN	Write Enable	0000 0110
WRDI	Write Disable	0000 0100
RDSR	Read Status Register	0000 0101
WRSR	Write Status Register	0000 0001
READ	Read from Memory Array	0000 0011
WRITE	Write to Memory Array	0000 0010

5.1 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 5*, 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 5. Write Enable (WREN) sequence



5.2 Write Disable (WRDI)

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

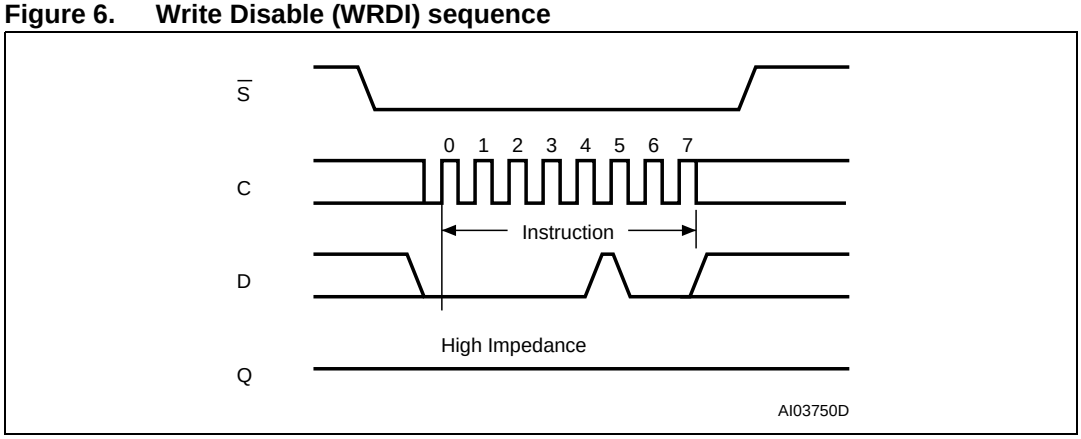
As shown in *Figure 6*, to send this instruction to the device, Chip Select ($\overline{S}$) is driven Low, and the bits of the instruction byte are shifted in, on Serial Data Input (D).

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

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 6. Write Disable (WRDI) sequence



5.3 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 7*.

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

5.3.1 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.

5.3.2 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.

5.3.3 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.

5.3.4 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

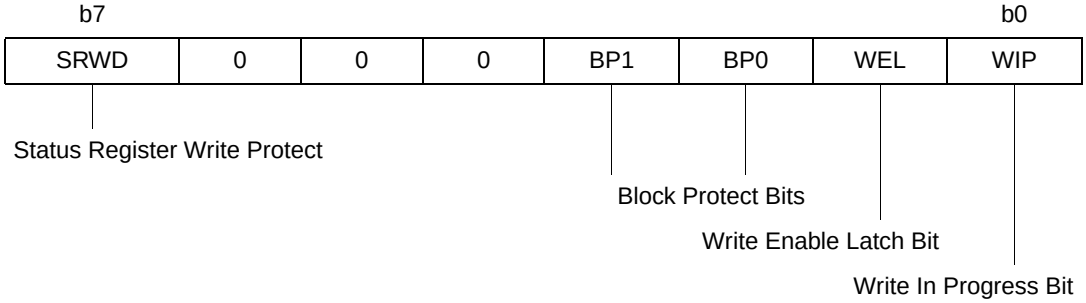
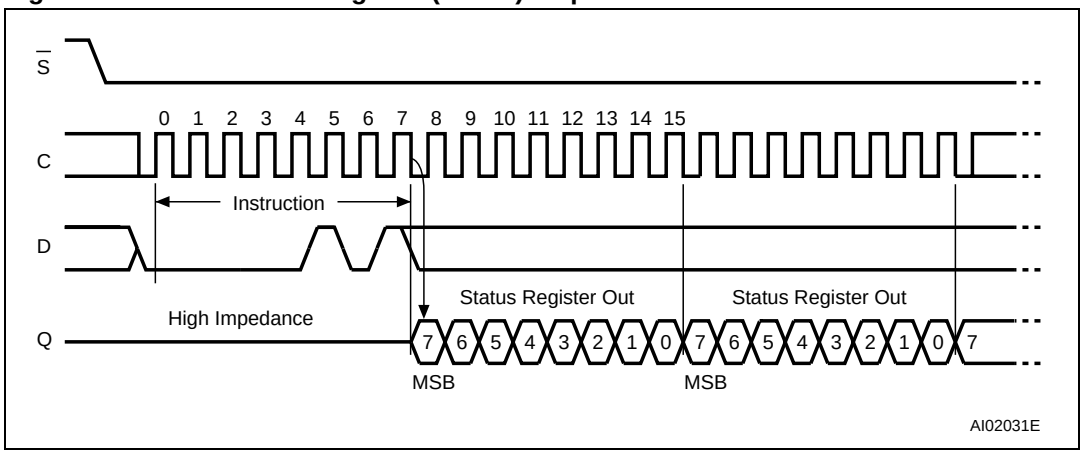


Figure 7. Read Status Register (RDSR) sequence



5.4 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 8*.

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.

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.

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) The values in the BP1 and BP0 bits can be changed	Write Protected	Ready to accept Write instructions
0	0				
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 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.

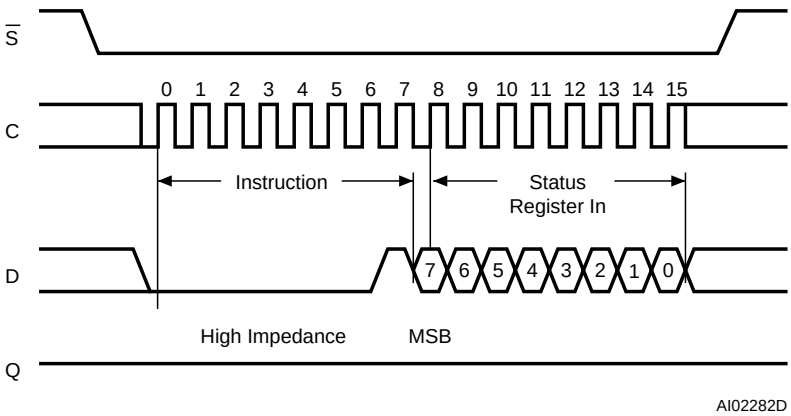
Regardless of the order of the two events, the Hardware Protected Mode (HPM) can be entered:

- 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.

Figure 8. Write Status Register (WRSR) sequence



5.5 Read from Memory Array (READ)

As shown in *Figure 9*, 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.

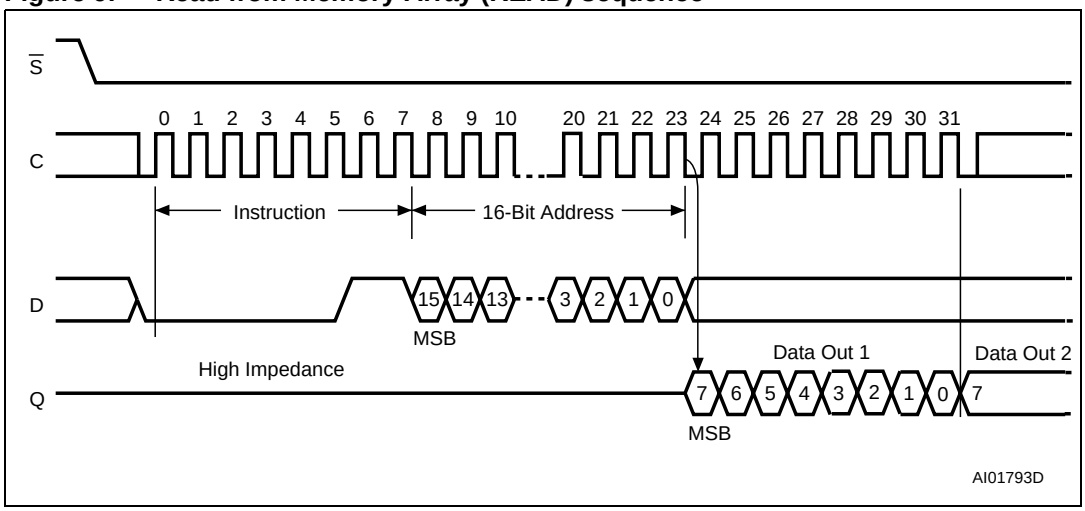
When the highest address is reached, the address counter rolls over to zero, allowing the Read cycle to be continued indefinitely. The whole memory can, therefore, be read with a single READ instruction.

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 9. Read from Memory Array (READ) sequence



1. The most significant address bits (b15, b14) are Don't Care.

5.6 Write to Memory Array (WRITE)

As shown in *Figure 10*, 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 10*, 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 16* to *Table 19*), at the end of which the Write in Progress (WIP) bit is reset to 0.

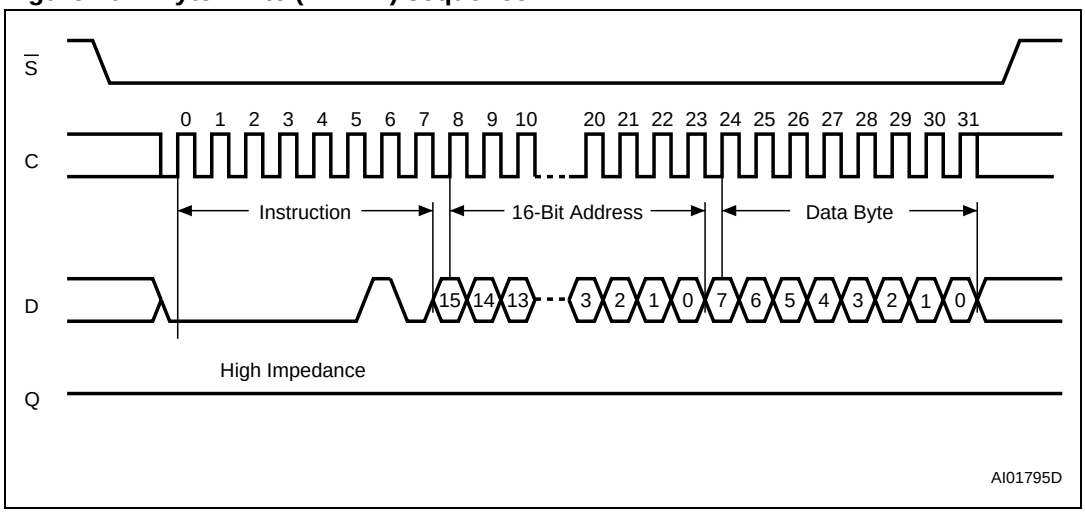
If, though, Chip Select ($\overline{S}$) continues to be driven Low, as shown in *Figure 11*, the next byte of input data is shifted in, so that more than a single byte, starting from the given address towards the end of the same page, can be written in a single internal Write cycle.

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 of these devices is 64 bytes).

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

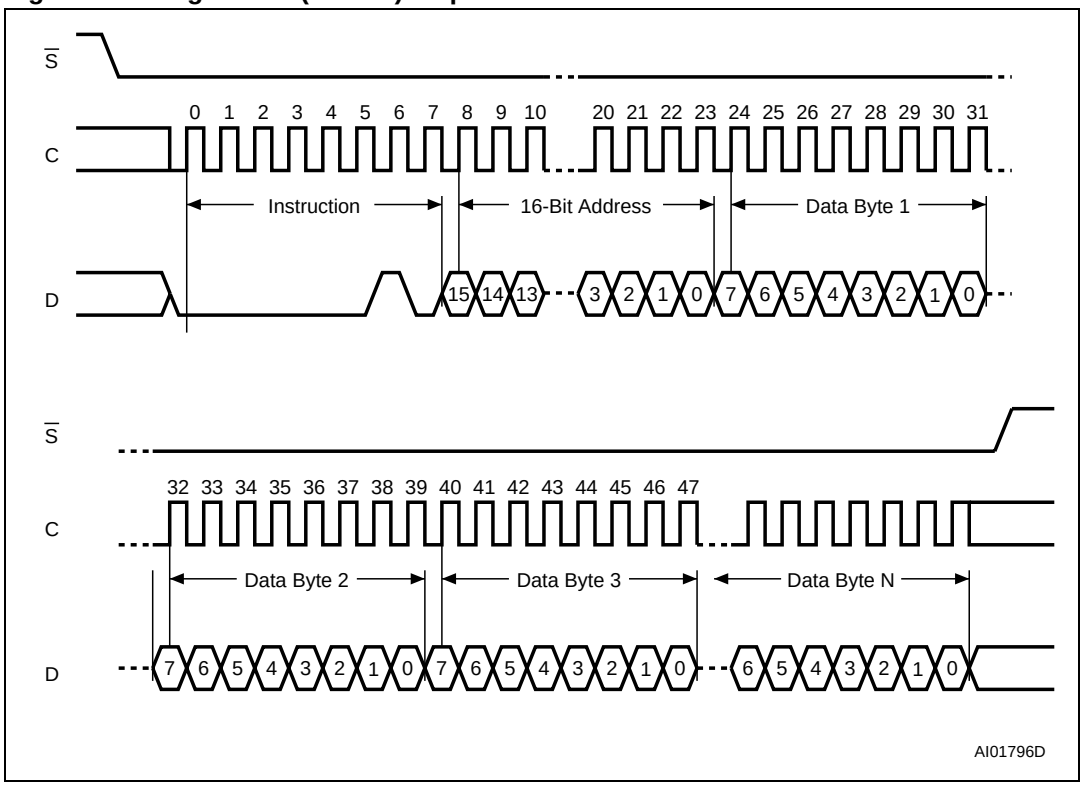
- if the Write Enable Latch (WEL) bit has not been set to 1 (by executing a Write Enable instruction just before)
- if a Write cycle is already in progress
- if the device has not been deselected, by Chip Select ($\overline{S}$) being driven High, at a byte boundary (after the eighth bit, b0, of the 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.

Figure 10. Byte Write (WRITE) sequence



1. The most significant address bits (b15, b14) are Don't Care.

Figure 11. Page Write (WRITE) sequence



1. The most significant address bits (b15, b14) are Don't Care.

5.6.1 ECC (Error Correction Code) and Write cycling

The M95128 (5V version, processed in F6DP26%, identified with letter "V") offers an ECC (Error Correction Code) logic which compares each 4-Byte packet with its associated ECC Word (6 EEPROM bits). 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 though a single Byte has to be written, 4 Bytes are internally modified (plus the ECC Word), that is, the addressed Byte is cycled together with the three other Bytes making up the packet. It is therefore recommended to Write by packets of 4 Bytes in order to benefit from the larger amount of Write cycles.

The maximum number of Write cycles for the M95128 device (5V version, processed in F6DP26%, identified with letter "V") is qualified as 100,000 Write cycles, using a cycling routine that writes to the device Page by Page (that is, by multiples of 4-Byte packets).

The M95128-W and M95128-R devices (2.5V and 1.8V versions, processed in F6DP36% and identified with the letter "A") do not offer the ECC logic and are qualified for a maximum number of 100,000 Write cycles.

6 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.

7 Connecting to the SPI bus

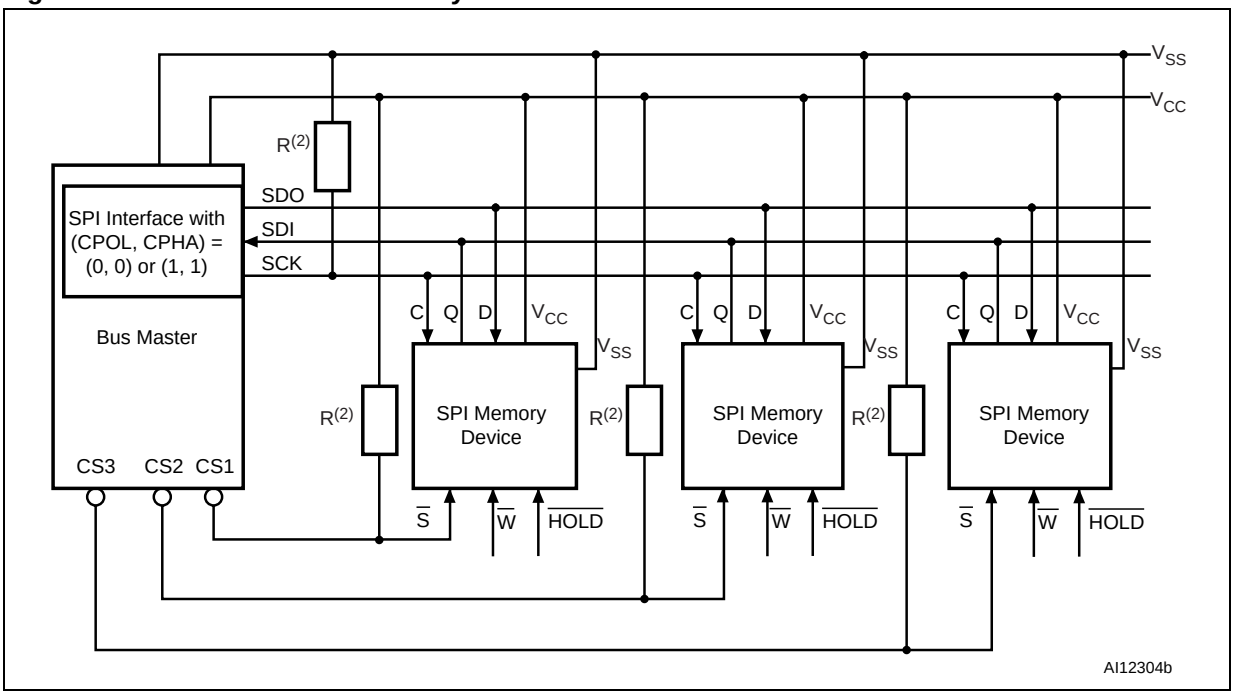
These devices are fully compatible with the SPI protocol.

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 12 shows three devices, connected to an MCU, on a SPI bus. Only one device is selected at a time, so only one device drives the Serial Data Output (Q) line at a time, all the others being high impedance.

Figure 12. 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.
2. These pull-up resistors, R, ensure that the M95128, M95128-W, M95128-R are not selected if the Bus Master leaves the $\overline{S}$ line in the high-impedance state. As the Bus Master may enter a state where all inputs/outputs are in high impedance at the same time (that is when the Bus Master is reset), the clock line (C) must be connected to an external pull-down resistor so that, when all inputs/outputs become high impedance, $\overline{S}$ is pulled High while C is pulled Low (thus ensuring that $\overline{S}$ and C do not become High at the same time, and so, that the t_{SHCH} requirement is met).

7.1 SPI modes

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

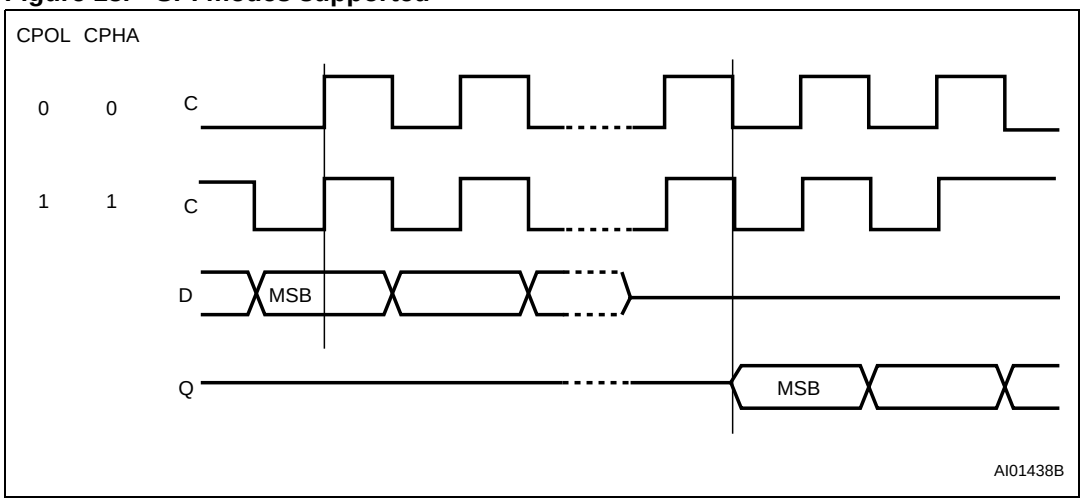
- CPOL=0, CPHA=0
- CPOL=1, CPHA=1

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 13*, is the clock polarity when the bus master is in Stand-by mode and not transferring data:

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

Figure 13. SPI modes supported



8 Maximum rating

Stressing the device outside the ratings listed in *Table 6* 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 6. Absolute maximum ratings

Symbol	Parameter	Min.	Max.	Unit
T_A	Ambient Operating Temperature	–40	130	°C
T_{STG}	Storage Temperature	–65	150	°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
V_{ESD}	Electrostatic Discharge Voltage (Human Body model)(1)	–4000	4000	V

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

9 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 7. Operating conditions (M95128)

Symbol	Parameter	Min.	Max.	Unit
V_{CC}	Supply Voltage	4.5	5.5	V
T_A	Ambient Operating Temperature (Device Grade 3)	–40	125	°C

Table 8. Operating conditions (M95128-W)

Symbol	Parameter	Min.	Max.	Unit
V_{CC}	Supply Voltage	2.5	5.5	V
T_A	Ambient Operating Temperature (Device Grade 6)	–40	85	°C
	Ambient Operating Temperature (Device Grade 3)	–40	125	°C

Table 9. Operating conditions (M95128-R)

Symbol	Parameter	Min.	Max.	Unit
V_{CC}	Supply Voltage	1.8	5.5	V
T_A	Ambient Operating Temperature	–40	85	°C

Table 10. AC measurement conditions(1)

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

1. Output Hi-Z is defined as the point where data out is no longer driven.

Figure 14. AC measurement I/O waveform

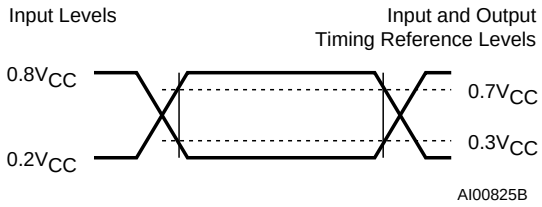


Table 11. Capacitance(1)

Symbol	Parameter	Test Condition	Min.	Max.	Unit
C_{OUT}	Output Capacitance (Q)	V_{OUT} = 0V		8	pF
C_{IN}	Input Capacitance (D)	V_{IN} = 0V		8	pF
	Input Capacitance (other pins)	V_{IN} = 0V		6	pF

1. Sampled only, not 100% tested, at T_A=25°C and a frequency of 5 MHz.

Table 12. DC characteristics (M95128, Device Grade 3)

Symbol	Parameter	Test Condition	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	C = 0.1V_{CC}/0.9V_{CC} at 5 MHz, V_{CC} = 5 V, Q = open		4	mA
I_{CC1}	Supply Current (Standby Power mode)	$\overline{S} = V_{CC}$, V_{CC} = 5 V, $V_{IN} = V_{SS}$ or V_{CC}		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}(1)	Output Low Voltage	I_{OL} = 2 mA, V_{CC} = 5 V		0.4	V
V_{OH}(1)	Output High Voltage	I_{OH} = –2 mA, V_{CC} = 5 V	0.8 V_{CC}		V

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

Table 13. DC characteristics (M95128-W, Device Grade 6)

Symbol	Parameter	Test Condition	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 5MHz, V_{CC} = 2.5V, Q = open		3	mA
		C = 0.1V_{CC}/0.9V_{CC} at 5MHz, V_{CC} = 5V, Q = open		5	mA
I_{CC0}(1)	Supply Current (Write)	During t_W, $\overline{S} = V_{CC}$, 2.5V < V_{CC} < 5.5V		5	mA
I_{CC1}	Supply Current (Standby Power mode)	$\overline{S} = V_{CC}$, $V_{IN} = V_{SS}$ or V_{CC}, 2.5V < V_{CC} < 5.5V		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} = 2.5V and I_{OL} = 1.5mA or V_{CC} = 5V and I_{OL} = 2mA		0.4	V
V_{OH}	Output High Voltage	V_{CC} = 2.5V and I_{OH} = –0.4mA or V_{CC} = 5V and I_{OH} = –2mA	0.8 V_{CC}		V

1. Characterized value, not tested in production.

Table 14. DC characteristics (M95128-W, Device Grade 3)

Symbol	Parameter	Test Condition	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 5MHz, V_{CC} = 2.5V, Q = open		3	mA
I_{CC0}(1)	Supply Current (Write)	During t_W, $\overline{S} = V_{CC}$, 2.5V < V_{CC} < 5.5V		6	mA
I_{CC1}	Supply Current (Standby Power mode)	$\overline{S} = V_{CC}$, $V_{IN} = V_{SS}$ or V_{CC} 2.5V < V_{CC} < 5.5V,		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} = 2.5V and I_{OL} = 1.5mA or V_{CC} = 5V and I_{OL} = 2mA		0.4	V
V_{OH}	Output High Voltage	V_{CC} = 2.5V and I_{OH} = –0.4mA or V_{CC} = 5V and I_{OH} = –2mA	0.8 V_{CC}		V

1. Characterized value, not tested in production.

Table 15. DC characteristics (M95128-R)

Symbol	Parameter	Test Condition	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 2 MHz, V_{CC} = 1.8 V, Q = open		1 (1)	mA
I_{CC0}(2)	Supply Current (Write)	During t_W, $\overline{S} = V_{CC}$, 1.8V < V_{CC} < 5.5V		3	mA
I_{CC1}	Supply Current (Standby Power mode)	$\overline{S} = V_{CC}$, $V_{IN} = V_{SS}$ or V_{CC}, 1.8V < V_{CC} < 5.5V		3(1)	µA
V_{IL}	Input Low Voltage		–0.45	0.25 V_{CC}	V
V_{IH}	Input High Voltage		0.7 V_{CC}	V_{CC}+1	V
V_{OL}	Output Low Voltage	I_{OL} = 0.15 mA, V_{CC} = 1.8 V		0.3	V
V_{OH}	Output High Voltage	I_{OH} = –0.1 mA, V_{CC} = 1.8 V	0.8 V_{CC}		V

1. This is preliminary data.
2. Characterized value, not tested in production.

Table 16. AC characteristics (M95128, Device Grade 3)

Test conditions specified in *Table 10* and *Table 7*					
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	90		ns
t_{SHCH}	t_{CSS2}	$\overline{S}$ Not Active Setup Time	90		ns
t_{SHSL}	t_{CS}	$\overline{S}$ Deselect Time	100		ns
t_{CHSH}	t_{CSH}	$\overline{S}$ Active Hold Time	90		ns
t_{CHSL}		$\overline{S}$ Not Active Hold Time	90		ns
t_{CH} (1)	t_{CLH}	Clock High Time	90		ns
t_{CL} (1)	t_{CLL}	Clock Low Time	90		ns
t_{CLCH} (2)	t_{RC}	Clock Rise Time		1	µs
t_{CHCL} (2)	t_{FC}	Clock Fall Time		1	µs
t_{DVCH}	t_{DSU}	Data In Setup Time	20		ns
t_{CHDX}	t_{DH}	Data In Hold Time	30		ns
t_{HHCH}		Clock Low Hold Time after $\overline{HOLD}$ not Active	70		ns
t_{HLCH}		Clock Low Hold Time after $\overline{HOLD}$ Active	40		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} (2)	t_{DIS}	Output Disable Time		100	ns
t_{CLQV}	t_V	Clock Low to Output Valid		60	ns
t_{CLQX}	t_{HO}	Output Hold Time	0		ns
t_{QLQH} (2)	t_{RO}	Output Rise Time		50	ns
t_{QHQL} (2)	t_{FO}	Output Fall Time		50	ns
t_{HHQV}	t_{LZ}	$\overline{HOLD}$ High to Output Valid		50	ns
t_{HLQZ} (2)	t_{HZ}	$\overline{HOLD}$ Low to Output High-Z		100	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.

Table 17. AC characteristics (M95128-W, Device Grade 6)

Test conditions specified in *Table 10* and *Table 8*					
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	90		ns
t_{SHCH}	t_{CSS2}	$\overline{S}$ Not Active Setup Time	90		ns
t_{SHSL}	t_{CS}	$\overline{S}$ Deselect Time	100		ns
t_{CHSH}	t_{CSH}	$\overline{S}$ Active Hold Time	90		ns
t_{CHSL}		$\overline{S}$ Not Active Hold Time	90		ns
t_{CH} (1)	t_{CLH}	Clock High Time	90		ns
t_{CL} (1)	t_{CLL}	Clock Low Time	90		ns
t_{CLCH} (2)	t_{RC}	Clock Rise Time		1	µs
t_{CHCL} (2)	t_{FC}	Clock Fall Time		1	µs
t_{DVCH}	t_{DSU}	Data In Setup Time	20		ns
t_{CHDX}	t_{DH}	Data In Hold Time	30		ns
t_{HHCH}		Clock Low Hold Time after $\overline{HOLD}$ not Active	70		ns
t_{HLCH}		Clock Low Hold Time after $\overline{HOLD}$ Active	40		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} (2)	t_{DIS}	Output Disable Time		100	ns
t_{CLQV}	t_V	Clock Low to Output Valid		60	ns
t_{CLQX}	t_{HO}	Output Hold Time	0		ns
t_{QLQH} (2)	t_{RO}	Output Rise Time		50	ns
t_{QHQL} (2)	t_{FO}	Output Fall Time		50	ns
t_{HHQV}	t_{LZ}	$\overline{HOLD}$ High to Output Valid		50	ns
t_{HLQZ} (2)	t_{HZ}	$\overline{HOLD}$ Low to Output High-Z		100	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.

Table 18. AC characteristics (M95128-W, Device Grade 3)

Test conditions specified in *Table 10* and *Table 8*					
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	90		ns
t_{SHCH}	t_{CSS2}	$\overline{S}$ Not Active Setup Time	90		ns
t_{SHSL}	t_{CS}	$\overline{S}$ Deselect Time	100		ns
t_{CHSH}	t_{CSH}	$\overline{S}$ Active Hold Time	90		ns
t_{CHSL}		$\overline{S}$ Not Active Hold Time	90		ns
t_{CH} (1)	t_{CLH}	Clock High Time	90		ns
t_{CL} (1)	t_{CLL}	Clock Low Time	90		ns
t_{CLCH} (2)	t_{RC}	Clock Rise Time		1	µs
t_{CHCL} (2)	t_{FC}	Clock Fall Time		1	µs
t_{DVCH}	t_{DSU}	Data In Setup Time	20		ns
t_{CHDX}	t_{DH}	Data In Hold Time	30		ns
t_{HHCH}		Clock Low Hold Time after $\overline{HOLD}$ not Active	70		ns
t_{HLCH}		Clock Low Hold Time after $\overline{HOLD}$ Active	40		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} (2)	t_{DIS}	Output Disable Time		100	ns
t_{CLQV}	t_V	Clock Low to Output Valid		60	ns
t_{CLQX}	t_{HO}	Output Hold Time	0		ns
t_{QLQH} (2)	t_{RO}	Output Rise Time		50	ns
t_{QHQL} (2)	t_{FO}	Output Fall Time		50	ns
t_{HHQV}	t_{LZ}	$\overline{HOLD}$ High to Output Valid		50	ns
t_{HLQZ} (2)	t_{HZ}	$\overline{HOLD}$ Low to Output High-Z		100	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.

Table 19. AC characteristics (M95128-R)

Test conditions specified in *Table 10* and *Table 9*					
Symbol	**Alt.**	**Parameter**	**Min.(1)**	**Max.(1)**	**Unit**
f_C	f_{SCK}	Clock Frequency	D.C.	2	MHz
t_{SLCH}	t_{CSS1}	$\overline{S}$ Active Setup Time	200		ns
t_{SHCH}	t_{CSS2}	$\overline{S}$ Not Active Setup Time	200		ns
t_{SHSL}	t_{CS}	$\overline{S}$ Deselect Time	200		ns
t_{CHSH}	t_{CSH}	$\overline{S}$ Active Hold Time	200		ns
t_{CHSL}		$\overline{S}$ Not Active Hold Time	200		ns
t_{CH} (2)	t_{CLH}	Clock High Time	200		ns
t_{CL} (2)	t_{CLL}	Clock Low Time	200		ns
t_{CLCH} (3)	t_{RC}	Clock Rise Time		1	µs
t_{CHCL} (3)	t_{FC}	Clock Fall Time		1	µs
t_{DVCH}	t_{DSU}	Data In Setup Time	40		ns
t_{CHDX}	t_{DH}	Data In Hold Time	50		ns
t_{HHCH}		Clock Low Hold Time after $\overline{HOLD}$ not Active	140		ns
t_{HLCH}		Clock Low Hold Time after $\overline{HOLD}$ Active	90		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		250	ns
t_{CLQV}	t_V	Clock Low to Output Valid		150	ns
t_{CLQX}	t_{HO}	Output Hold Time	0		ns
t_{QLQH} (3)	t_{RO}	Output Rise Time		100	ns
t_{QHQL} (3)	t_{FO}	Output Fall Time		100	ns
t_{HHQV}	t_{LZ}	$\overline{HOLD}$ High to Output Valid		100	ns
t_{HLQZ} (3)	t_{HZ}	$\overline{HOLD}$ Low to Output High-Z		250	ns
t_W	t_{WC}	Write Time		10	ms

1. This is preliminary data.
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.

Figure 15. Serial input timing

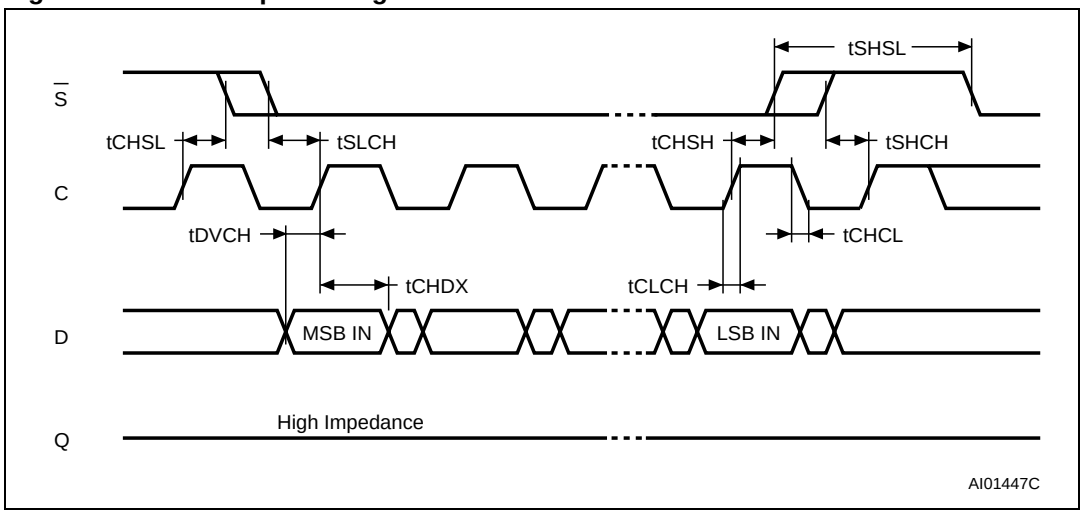


Figure 16. Hold timing

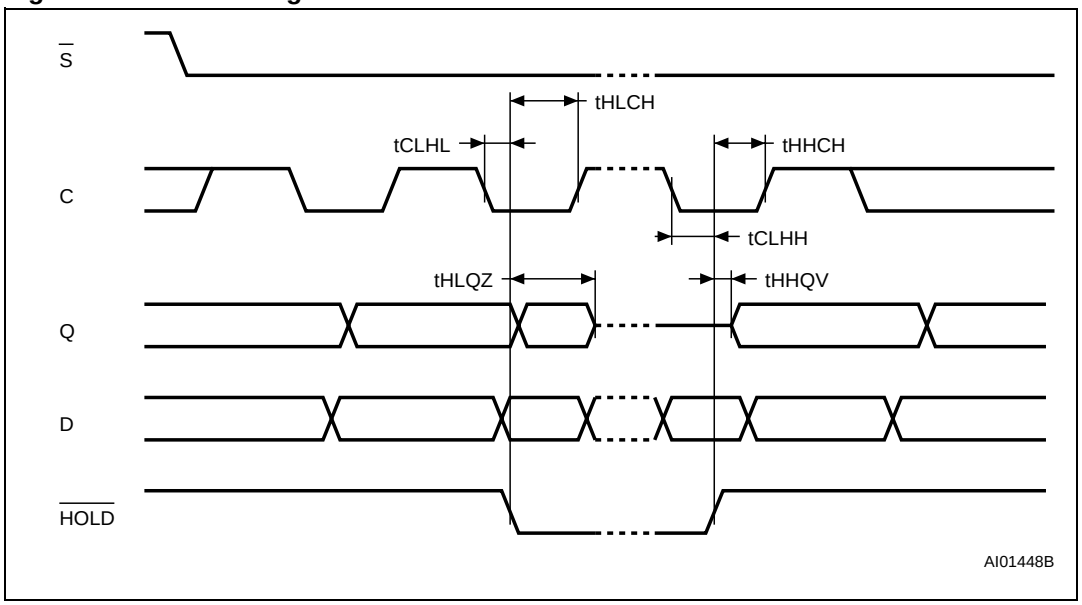
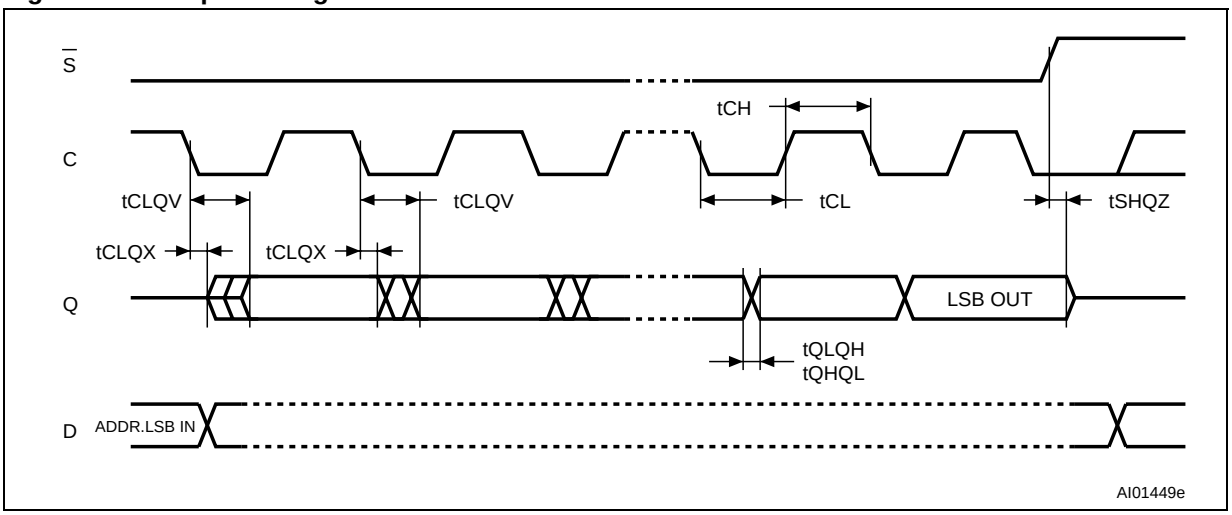
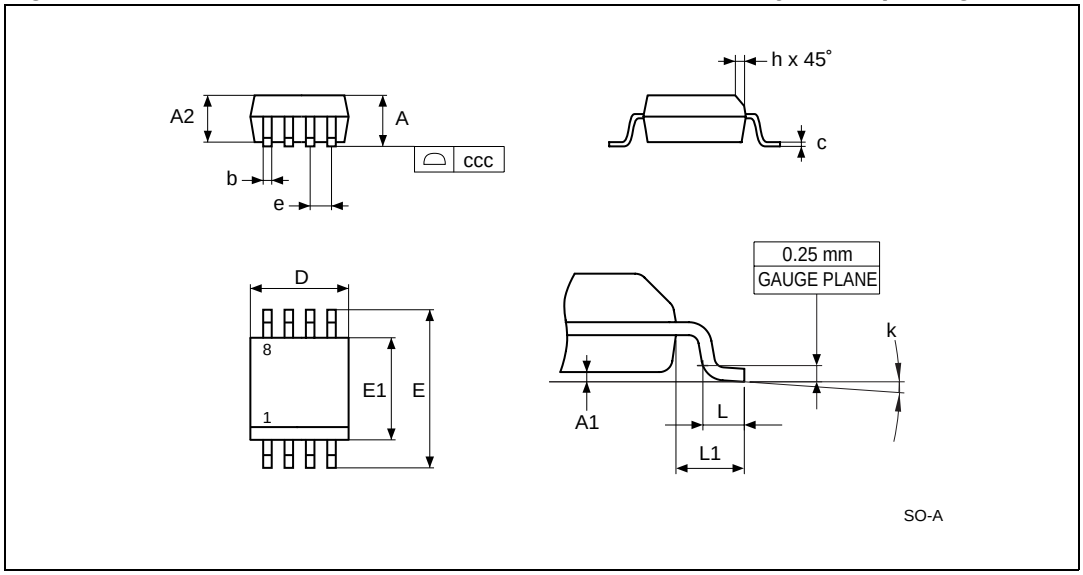


Figure 17. Output timing



10 Package mechanical

Figure 18. SO8N – 8 lead Plastic Small Outline, 150 mils body width, package outline

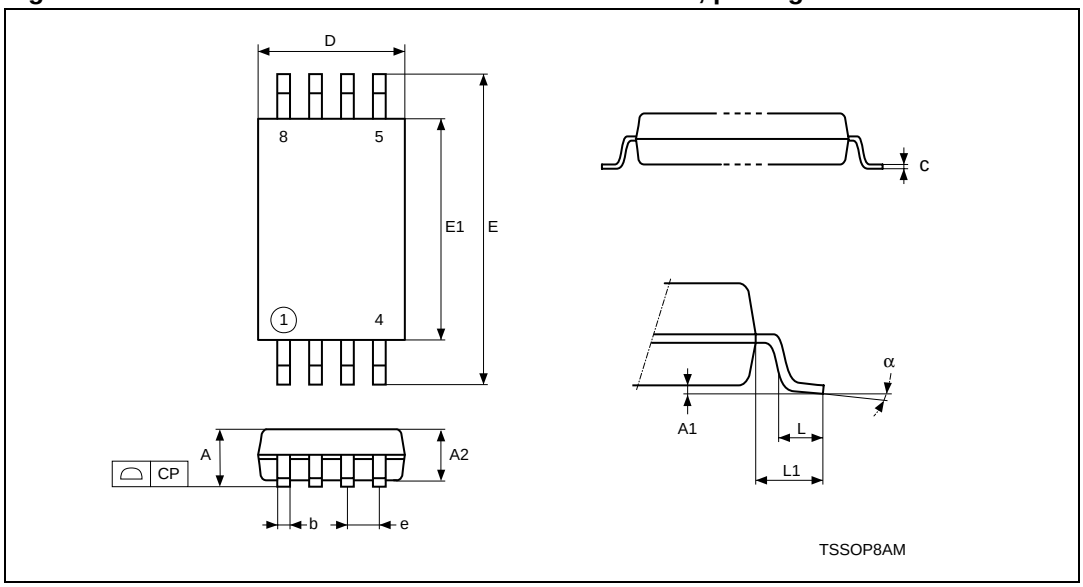


1. Drawing is not to scale.

Table 20. SO8N – 8 lead Plastic Small Outline, 150 mils body width, package mechanical data

Symbol	millimeters			inches		
	Typ	Min	Max	Typ	Min	Max
A			1.75			0.069
A1		0.10	0.25		0.004	0.010
A2		1.25			0.049	
b		0.28	0.48		0.011	0.019
c		0.17	0.23		0.007	0.009
ccc			0.10			0.004
D	4.90	4.80	5.00	0.193	0.189	0.197
E	6.00	5.80	6.20	0.236	0.228	0.244
E1	3.90	3.80	4.00	0.154	0.150	0.157
e	1.27	–	–	0.050	–	–
h		0.25	0.50		0.010	0.020
k		0	8		0	8
L		0.40	1.27		0.016	0.050
L1	1.04			0.041		

Figure 19. TSSOP8 – 8 lead Thin Shrink Small Outline, package outline



1. Drawing is not to scale.

Table 21. TSSOP8 – 8 lead Thin Shrink Small Outline, package mechanical data

Symbol	millimeters			inches		
	Typ	Min	Max	Typ	Min	Max
A			1.200			0.0472
A1		0.050	0.150		0.0020	0.0059
A2	1.000	0.800	1.050	0.0394	0.0315	0.0413
b		0.190	0.300		0.0075	0.0118
c		0.090	0.200		0.0035	0.0079
CP			0.100			0.0039
D	3.000	2.900	3.100	0.1181	0.1142	0.1220
e	0.650	–	–	0.0256	–	–
E	6.400	6.200	6.600	0.2520	0.2441	0.2598
E1	4.400	4.300	4.500	0.1732	0.1693	0.1772
L	0.600	0.450	0.750	0.0236	0.0177	0.0295
L1	1.000			0.0394		
α		0°	8°		0°	8°
N	8			8		

11 Part numbering

Table 22. Ordering information scheme

Example: M95128 – W MN 6 T P /P

Device Type

M95 = SPI serial access EEPROM

Device Function

128 = 128 Kbit (16384 x 8)

Operating Voltage

blank = V_{CC} = 4.5 to 5.5V(1)

W = V_{CC} = 2.5 to 5.5V

R = V_{CC} = 1.8 to 5.5V

Package

MN = SO8 (150 mils width)

DW = TSSOP8 (169 mils width)

Device Grade

6 = Industrial temperature range, –40 to 85 °C.
Device tested with standard test flow

3 = Device tested with High Reliability Certified Flow(2)
Automotive temperature range (–40 to 125 °C)

Option

blank = Standard Packing

T = Tape and Reel Packing

Plating Technology

blank = Standard SnPb plating

P or G = ECOPACK® (RoHs compliant)

Process

P = F6DP26% Chartered

V = F6DP26% Rsst

1. The M95128 5V part is offered in "V" process (F6DP26%) only.
2. 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.

The category of Second-Level Interconnect is marked on the package and on the inner box label, in compliance with JEDEC Standard JESD97. The maximum ratings related to soldering conditions are also marked on the inner box label.

12 Revision history

Table 23. Document revision history

Date	Revision	Changes
17-Nov-1999	2.1	New -V voltage range added (including the tables for DC characteristics, AC characteristics, and ordering information).
07-Feb-2000	2.2	New -V voltage range extended to M95256 (including AC characteristics, and ordering information).
22-Feb-2000	2.3	tCLCH and tCHCL, for the M95xxx-V, changed from 1µs to 100ns
15-Mar-2000	2.4	-V voltage range changed to 2.7-3.6V
29-Jan-2001	2.5	Lead Soldering Temperature in the Absolute Maximum Ratings table amended Illustrations and Package Mechanical data updated
12-Jun-2001	2.6	Correction to header of Table 12B TSSOP14 Illustrations and Package Mechanical data updated Document promoted from Preliminary Data to Full Data Sheet
08-Feb-2002	2.7	Announcement made of planned upgrade to 10 MHz clock for the 5V, –40 to 85°C, range.
09-Aug-2002	2.8	M95128 split off to its own datasheet. Data added for new and forthcoming products, including availability of the SO8 narrow package.
24-Feb-2003	2.9	Omission of SO8 narrow package mechanical data remedied
26-Jun-2003	2.10	-V voltage range removed
21-Nov-2003	3.0	Table of contents, and Pb-free options added. -S voltage range extended to -R. V_{IL}(min) improved to –0.45V
17-Mar-2004	4.0	Absolute Maximum Ratings for V_{IO}(min) and V_{CC}(min) changed. Soldering temperature information clarified for RoHS compliant devices. Device grade information clarified
21-Oct-2004	5.0	M95128 datasheet merged back in. Product List summary table added. AEC-Q100-002 compliance. Device Grade information clarified. tHHQX corrected to tHHQV. 10MHz product becomes standard

Table 23. Document revision history (continued)

Date	Revision	Changes
13-Apr-2006	6	New M95128 datasheet extracted from the M95128/256 datasheet. Order of sections modified. *ECC (Error Correction Code) and Write cycling* paragraph added. *Section 3.7: Supply voltage (V_{CC})* added and information removed below *Section 4: Operating features*. Power up state removed below *Section 6: Delivery state*. *Figure 13: SPI modes supported* modified and *Note 2* added. I_{CC1} specified over the whole V_{CC} range and I_{CC0} added to *Table 13*, *Table 14* and *Table 15*. I_{CC} specified over the whole V_{CC} range in *Table 13*. t_{CHHL} and t_{CHHH} replaced by t_{CLHL} and t_{CLHH}, respectively. *Figure 16: Hold timing* modified. *Process* letter and *Note 1* added to *Table 22: Ordering information scheme*. "*AC Characteristics (M95128, Device Grade 6)*" Table (for 10MHz frequency) removed. Note 1 removed from *Table 19: AC characteristics (M95128-R)*. T_A added to *Table 6: Absolute maximum ratings*. PDIP8 (BN) and SO8 wide (MW) packages removed. M95128-W and M95128-R are no longer under development. Test conditions changed for V_{OL} and V_{OH} in *Section Table 14.: DC characteristics (M95128-W, Device Grade 3)*.
27-Jun-2006	7	*Figure 12: Bus master and memory devices on the SPI bus* modified. SO8N package specifications updated (see *Table 20* and *Figure 18*). V Process specified and A Process replaced by P in *Table 22: Ordering information scheme*.

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