



复旦微电子

FM25512
512K-BIT SPI Serial EEPROM
With unique ID and Security Sector

Data Sheet

May. 2014

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1. Description

The FM25512 provides 524,288 bits of serial electrically erasable and programmable read-only memory (EEPROM) organized as 65,536 words of 8 bits each, with 128-bit UID and 128-byte Security Sector. The device is accessed through the SPI bus, and is optimized for use in many industrial and commercial applications where low-power and low-voltage operations are essential.

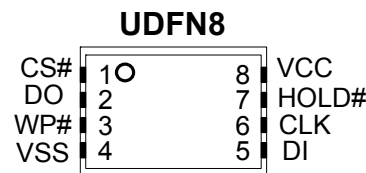
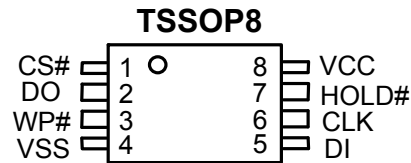
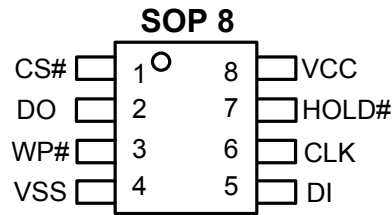
2. Features

- Low Operation Voltage: $V_{CC} = 1.7V$ to 5.5V
- Serial Peripheral Interface (SPI) compatible
- Supports SPI Modes 0(0,0) and 3(1,1)
- 20MHz clock rate(4.5V~5.5V) and 5MHz (1.7V)
- 128-byte Page Mode and Byte Write operation supported
- Block write protection
 - Protect 1/4, 1/2, or entire array
- Write Protect (WP#) pin and Write Disable instructions for Hardware and software Data Protection
- Lockable 128-Byte Security Sector
- 128-Bit Unique ID for each device
- Self-timed Write Cycle (5 ms max)
- High-reliability
 - Endurance: 1,000,000 Write Cycles
 - Data Retention: 40 Years
- SOP8, TSSOP8 and UDFN8 Packages (RoHS Compliant and Halogen-free)

3. Pin Configurations

| PIN NO. | PIN NAME | I/O | FUNCTION |
|---------|----------|-----|---------------------|
| 1 | CS# | I | Chip Select Input |
| 2 | DO | O | Data Output |
| 3 | WP# | I | Write Protect Input |
| 4 | VSS | | Ground |
| 5 | DI | I | Data Input |
| 6 | CLK | I | Serial Clock Input |
| 7 | HOLD# | I | Hold Input |
| 8 | VCC | | Power Supply |

4. Packaging Type



5. Absolute Maximum Ratings

| | |
|---|-----------------|
| Operating Temperature (Plastic Package) | -55°C to +125°C |
| Operating Temperature (Module Package) | -20°C to +60°C |
| Storage Temperature (Plastic Package) | -65°C to +150°C |
| Storage Temperature (Module Package) | -25°C to +70°C |
| Voltage on Any Pin with Respect to Ground | -1.0V to +7.0V |
| Maximum Operating Voltage | 6.25V |
| DC Output Current | 5.0 mA |

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

6. Block Diagram

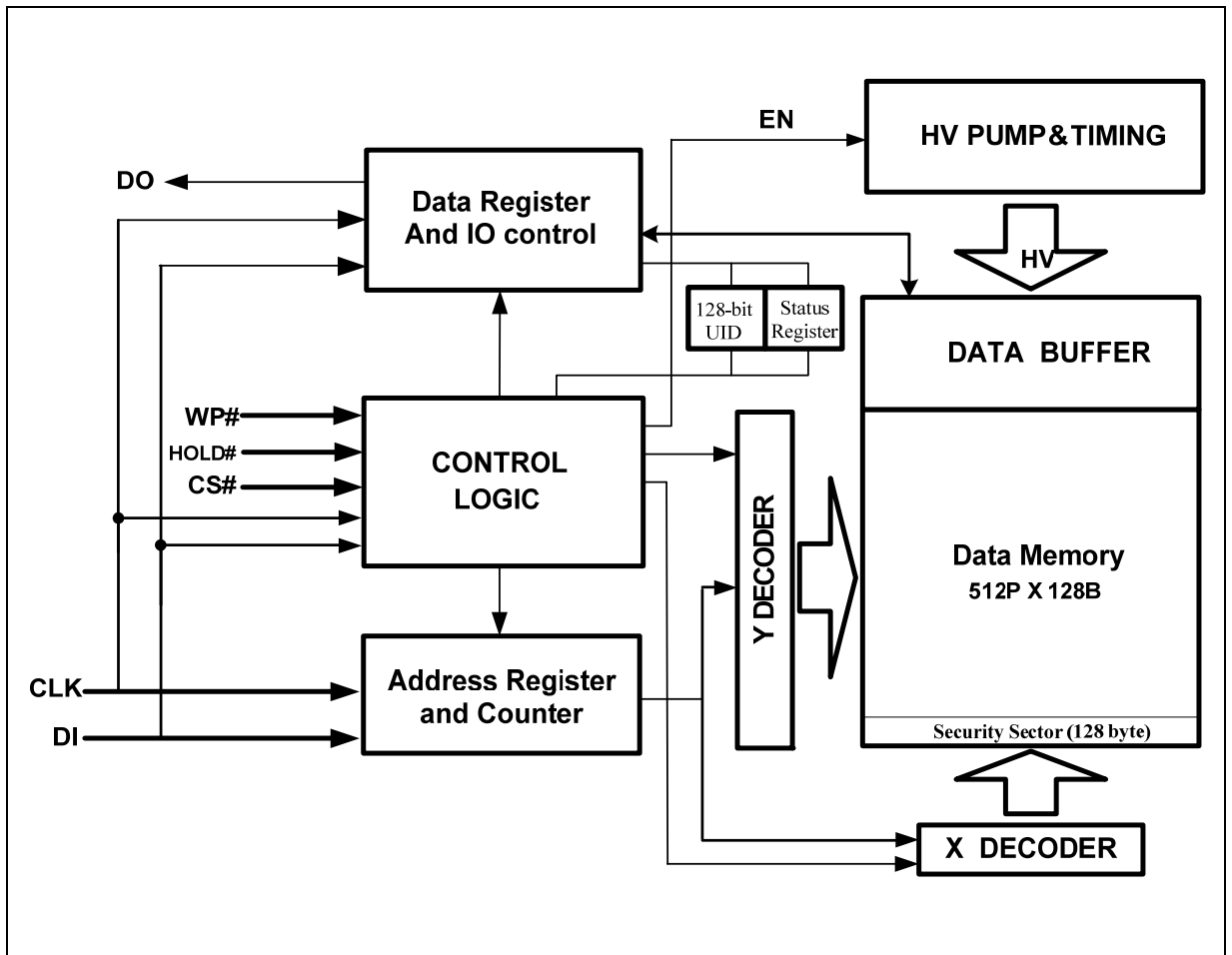


Figure 1 Block Diagram

7. Pin Descriptions

Serial Clock (CLK): The SPI Serial Clock Input (CLK) pin provides the timing for serial input and output operations.

Serial Data Input (DI): The SPI Serial data input (DI) is used to serially receive write instructions, addresses or data to the device on the rising edge of the Serial Clock (CLK) input pin.

Serial Data Output (DO): The SPI Serial data output (DO) is used to read data or status from the device on the falling edge of CLK.

Chip Select (CS#): The SPI Chip Select (CS#) pin enables and disables device operation. When CS# is high, the device is deselected and the Serial Data Output (DO) pins are at high impedance. When deselected, the devices power consumption will be at standby levels unless an internal write cycle is in progress. When CS# is brought low, the device will be selected, power consumption will increase to active levels and instructions can be written to and data read from the device. After power-up, CS# must transition from high to low before a new instruction will be accepted.

HOLD (HOLD#): The HOLD# pin allows the device to be paused while it is actively selected. When HOLD# is brought low, while CS# is low, the DO pin will be at high impedance and signals on the DI and CLK pins will be ignored (don't care). When HOLD# is brought high, device operation can resume. The HOLD# function can be useful when multiple devices are sharing the same SPI signals. The HOLD# pin is active low.

Write Protect (WP#): The Write Protect (WP#) pin is used in conjunction with the Status Register Write Disable (SRWD) Bit to prevent the Status Registers from being written. Write Protect (WP#) pin and Status Register Write Disable (SRWD) Bit enable the device to be put in the Hardware Protected mode (when Status Register Write Disable (SRWD) Bit is set to 1, and Write Protect (WP#) pin is driven low).

8. Memory Organization

Table 1 Memory Organization

| Instruction | Page ADDR | Byte Number | | |
|-------------|-------------------------------------|-----------------------------|-----|---|
| | | 127 | ... | 0 |
| 0xh | 0 | Data Memory (512P X 128B) | | |
| | 1 | | | |
| | 2 | | | |
| | ... | | | |
| | 511 | | | |
| 8xh | xxxx x00x xxxx xxxx ¹ | Security Sector (128 Bytes) | | |
| 83h | xxxx xx1x xxxx xxxx ² | Unique ID (128 Bits) | | |

Note:

- Address bits A10A9 must be 00, A6~A0 define byte address, other bits are don't care
- Address bits A10A9 must be x1, A3~A0 define byte address, other bits are don't care

9. Device Operations

9.1. Standard SPI

The FM25512 is accessed through an SPI compatible bus consisting of four signals: Serial Clock (CLK), Chip Select (CS#), Serial Data Input (DI) and Serial Data Output (DO). Standard SPI instructions use the DI input pin to serially write instructions, addresses or data to the device on the rising edge of CLK. The DO output pin is used to read data or status from the device on the falling edge of CLK.

SPI bus operation Mode 0 (0,0) and 3 (1,1) are supported. The primary difference between Mode 0 and Mode 3 concerns the normal state of the CLK signal when the SPI bus master is in standby and data is not being transferred to the Serial Flash. For Mode 0, the CLK signal is normally low on the falling and rising edges of CS#. For Mode 3, the CLK signal is normally high on the falling and rising edges of CS#.

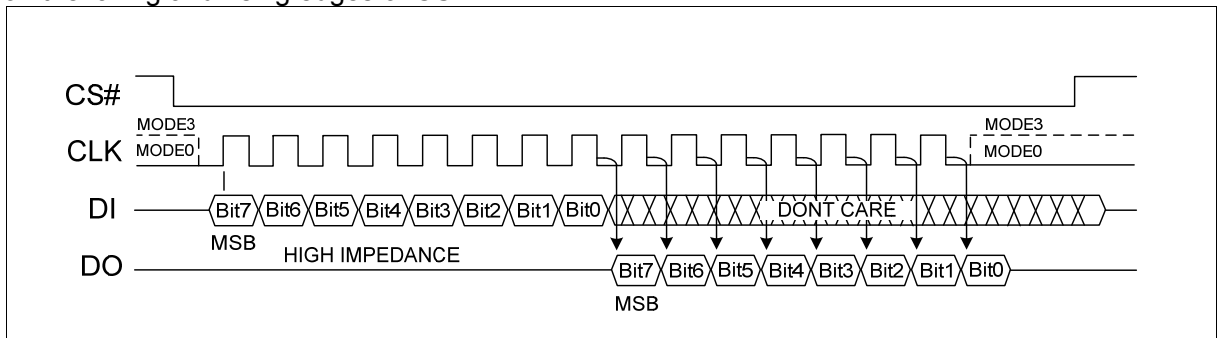


Figure 1 The difference between Mode 0 and Mode 3

9.2. Hold

For Standard SPI, the HOLD# signal allows the FM25512 operation to be paused while it is actively selected (when CS# is low). The HOLD# function may be useful in cases where the SPI data and clock signals are shared with other devices. For example, consider if the page buffer was only partially written when a priority interrupt requires use of the SPI bus. In this case the HOLD# function can save the state of the instruction and the data in the buffer so programming can resume where it left off once the bus is available again.

To initiate a HOLD# condition, the device must be selected with CS# low. A HOLD# condition will activate on the falling edge of the HOLD# signal if the CLK signal is already low. If the CLK is not already low the HOLD# condition will activate after the next falling edge of CLK. The HOLD# condition will terminate on the rising edge of the HOLD# signal if the CLK signal is already low. If the CLK is not already low the HOLD# condition will terminate after the next falling edge of CLK. During a HOLD# condition, the Serial Data Output (DO) is high impedance, and Serial Data Input (DI) and Serial Clock (CLK) are ignored. The Chip Select (CS#) signal should be kept active (low) for the full duration of the HOLD# operation to avoid resetting the internal logic state of the device.

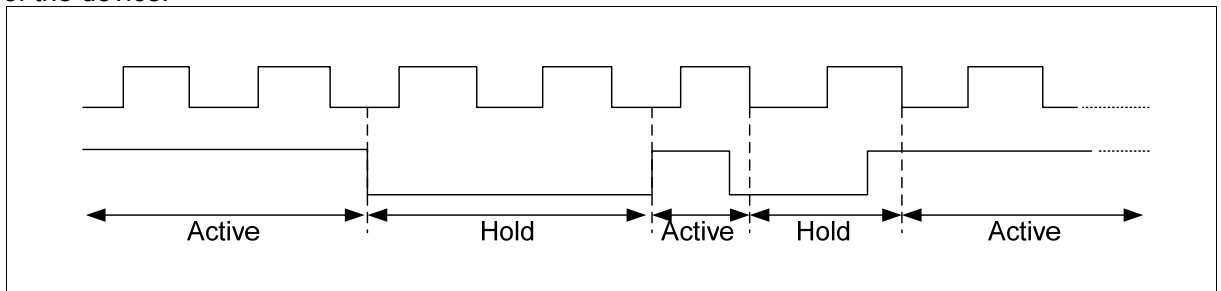


Figure 2 Hold Condition Waveform

10. Write Protection

Applications that use non-volatile memory must take into consideration the possibility of noise and other adverse system conditions that may compromise data integrity. To address this concern, the FM25512 provides several means to protect the data from inadvertent writes.

Write Protect Features

- Write enable/disable instructions and automatic write disable after write
- Checking whether the number of clock pulses comprised in the instruction is a multiple of eight, before executing a write operation
- Software and Hardware (WP# pin) write protection using Status Register

After power-up the device is automatically placed in a write-disabled state with the Status Register Write Enable Latch (WEL) set to a 0. A Write Enable instruction must be issued before a Write or Write Status Register instruction will be accepted. After completing a write instruction the Write Enable Latch (WEL) is automatically cleared to a write-disabled state of 0.

Software controlled write protection is facilitated using the Write Status Register instruction and setting the Block Protect (BP1 and BP0) bits. These settings allow top quarter (1/4), top half (1/2), or the entire memory array to be configured as read only. Used in conjunction with the Write Protect (WP#) pin, changes to the Status Register can be enabled or disabled under hardware control. See Status Register section for further information.

11. Status Register

The Read Status Register instruction can be used to provide status on the availability of the memory array, if the device is write enabled or disabled, the state of write protection. The Write Status Register instruction can be used to configure the device write protection features. Write access to the Status Register is controlled by the state of the non-volatile Status Register Write Disable bit (SRWD), the Write Enable instruction, and the WP# pin.

Factory default for all Status Register bits are 0.

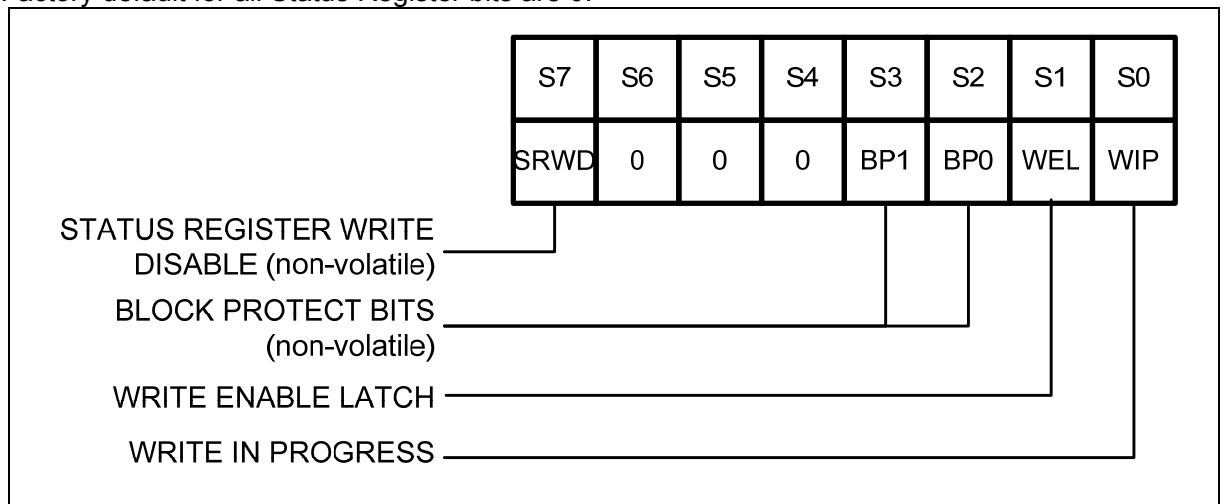


Figure 4 Status Register

11.1. WIP Bit

WIP is a read only bit in the status register (S0) that is set to a 1 state when the device is executing a Write, Write Status Register instruction, Write Security Sector or Lock Security Sector. During this time the device will ignore further instructions except for the Read Status Register (see t_w in “12.6 AC Electrical Characteristics”). When the write, write status register, write Security Sector or lock Security Sector instruction has completed, the WIP bit will be cleared to a 0 state indicating the device is ready for further instructions.

11.2. Write Enable Latch bit (WEL)

Write Enable Latch (WEL) is a read only bit in the status register (S1) that is set to 1 after executing a Write Enable Instruction. The WEL status bit is cleared to 0 when the device is write disabled. A write disable state occurs upon power-up or after any of the following instructions: Write Disable, Write, Write Status Register, Write Security Sector, Lock Security Sector .

11.3. Block Protect Bits (BP1, BP0)

The Block Protect Bits (BP1, BP0) are non-volatile read/write bits in the status register (S3, and S2) that provide Write Protection control and status. Block Protect bits can be set using the Write Status Register Instruction (see t_w in “12.6 AC Electrical Characteristics”). Top quarter (1/4), top half (1/2), or the entire memory array can be protected from write instructions (see Table 2 Status Register Memory Protection). The factory default setting for the Block Protection Bits is 0, none of the array protected.

11.4. Status Register Write Disable bit (SRWD)

The Status Register Write Disable(SRWD) bit is operated in conjunction with the Write Protect (WP#) signal. The Status Register Write Disable(SRWD) bit and Write Protect (WP#) signal allow the device to be put in the Hardware Protected mode (when the Status Write Disable(SRWD) bit is set to 1, and Write Protect (WP#) 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.

11.5. Status Register Memory Protection

Table 2 Status Register Memory Protection

| level | Status Register Bits | | Array Addresses Protected |
|--------|----------------------|-----|---------------------------|
| | BP1 | BP0 | FM25512 |
| 0 | 0 | 0 | None |
| 1(1/4) | 0 | 1 | C000H – FFFFH |
| 2(1/2) | 1 | 0 | 8000H – FFFFH |
| 3(All) | 1 | 1 | 0000H – FFFFH |

12. Instructions

The Standard SPI instruction set of the FM25512 consists of 11 basic instructions that are fully controlled through the SPI bus (see [Table 3](#) Instruction Set). Instructions are initiated with the falling edge of Chip Select (CS#). The first byte of data clocked into the DI input provides the instruction code. Data on the DI input is sampled on the rising edge of clock with most significant bit (MSB) first.

Instructions vary in length from a single byte to several bytes and may be followed by address bytes, data bytes, and in some cases, a combination. Instructions are completed with the rising edge of edge CS#. Clock relative timing diagrams for each instruction are included in [Figure 3](#) through [Figure 19](#). All read instructions can be completed after any clocked bit. However, all instructions that Write must complete on a byte boundary (CS# driven high after a full 8-bits have been clocked) otherwise the instruction will be ignored. This feature further protects the device from inadvertent writes. Additionally, while the memory is being written, or when the Status Register is being written, all instructions except for Read Status Register will be ignored until the write cycle has completed.

12.1. Standard SPI Instructions Set

Table 3 Standard SPI Instructions Set⁽¹⁾

| Instruction Name | Instruction Format | Operation |
|-----------------------|--------------------------|---|
| WREN | 0000 0110 | Set Write Enable Latch |
| WRDI | 0000 0100 | Reset Write Enable Latch |
| RDSR | 0000 0101 | Read Status Register |
| WRSR | 0000 0001 | Write Status Register |
| READ | 0000 0011 | Read Data from Memory Array |
| WRITE | 0000 0010 | Write Data to Memory Array |
| Read Security Sector | 1000 0011 ⁽¹⁾ | Read Security Sector |
| Write Security Sector | 1000 0010 ⁽¹⁾ | Write Security Sector |
| Lock Security Sector | 1000 0010 ⁽²⁾ | Lock the Security Sector in Read-Only mode |
| Read Lock Status | 1000 0011 ⁽²⁾ | Read the lock status of the Security Sector |
| Read UID Number | 1000 0011 ⁽³⁾ | Read Unique ID Number |

Note:

1. Address bits A10A9 must be 00, A6~A0 define byte address, all other bits are don't care
2. Address bits A10A9 must be 10, all other bits are don't care
3. Address bits A9 must be 1, A3~A0 define byte address, all other bits are don't care

12.2. Write Enable (WREN)

The Write Enable (WREN) instruction ([Figure 4](#)) sets the Write Enable Latch (WEL) bit in the Status Register to a 1. The WEL bit must be set prior to every Write and Write Status Register instruction. The Write Enable (WREN) instruction is entered by driving CS# low, shifting the instruction code "06h" into the Data Input (DI) pin on the rising edge of CLK, and then driving CS# high.

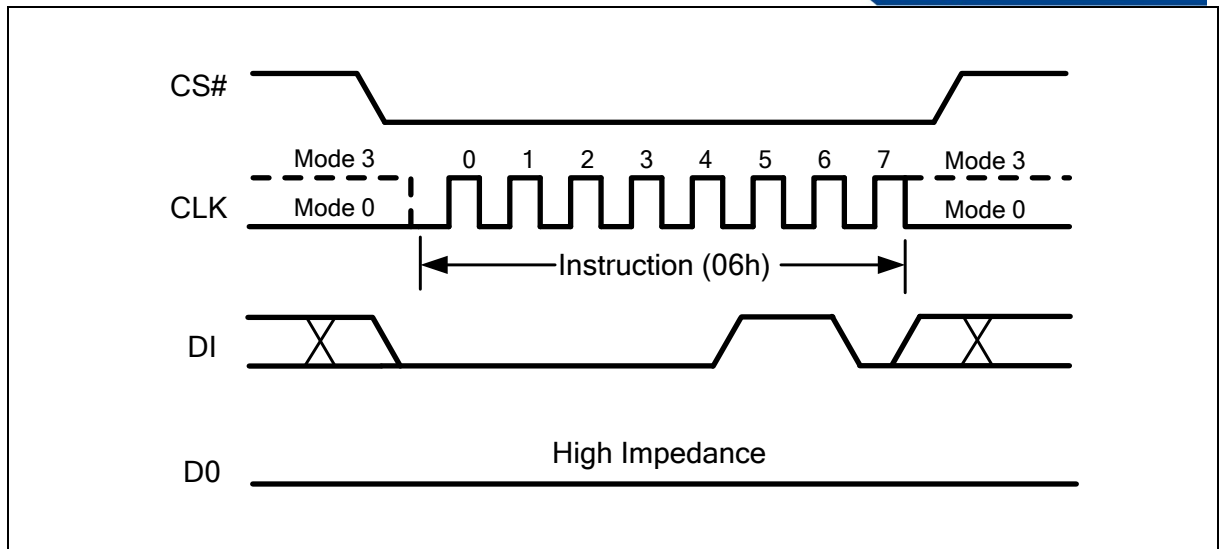


Figure 5 Write Enable Instruction

12.3. Write Disable (WRDI) (04h)

The Write Disable (WRDI) instruction ([Figure 6](#)) resets the Write Enable Latch (WEL) bit in the Status Register to a 0. The Write Disable (WRDI) instruction is entered by driving CS# low, shifting the instruction code “04h” into the DI pin and then driving CS# high. Note that the WEL bit is automatically reset after Power-up and upon completion of the Write Status Register, Write instructions.

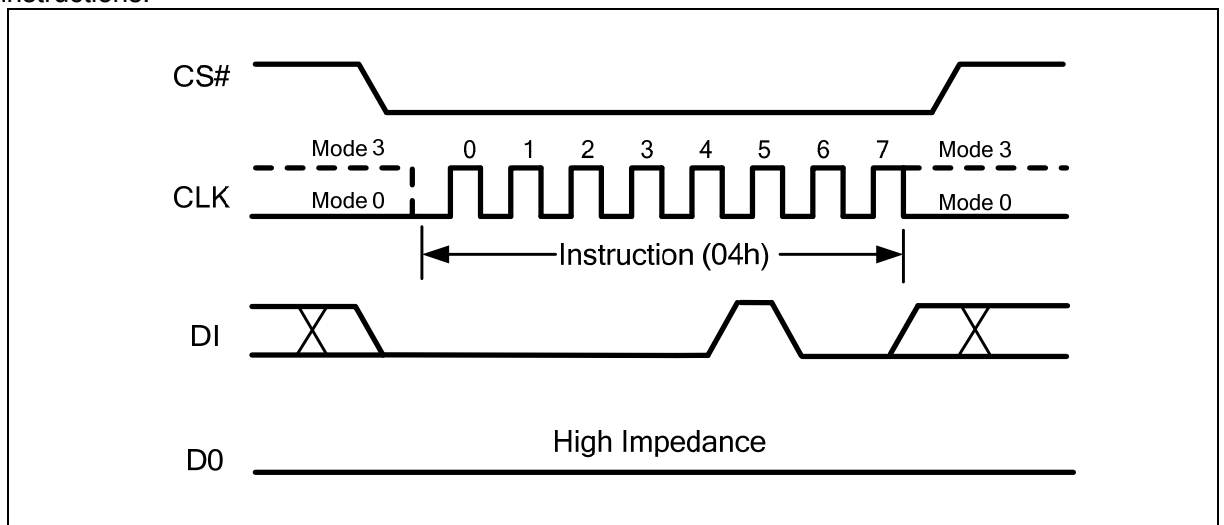


Figure 6 Write Disable Instruction

12.4. Read Status Register (RDSR) (05h)

The Read Status Register instructions allow the 8-bit Status Registers to be read. The instruction is entered by driving CS# low and shifting the instruction code “05h” into the DI pin on the rising edge of CLK. The status register bits are then shifted out on the DO pin at the falling edge of CLK with most significant bit (MSB) first as shown in [Figure 7](#). The Status Register bits are shown in [Figure 4](#) and include the WIP, WEL, BP1-BP0 and SRWD bits.

The Read Status Register instruction may be used at any time, even while a Write or Write Status Register cycle is in progress. This allows the WIP status bit to be checked to determine when the cycle is complete and if the device can accept another instruction. The Status Register can be read continuously. The instruction is completed by driving CS# high.

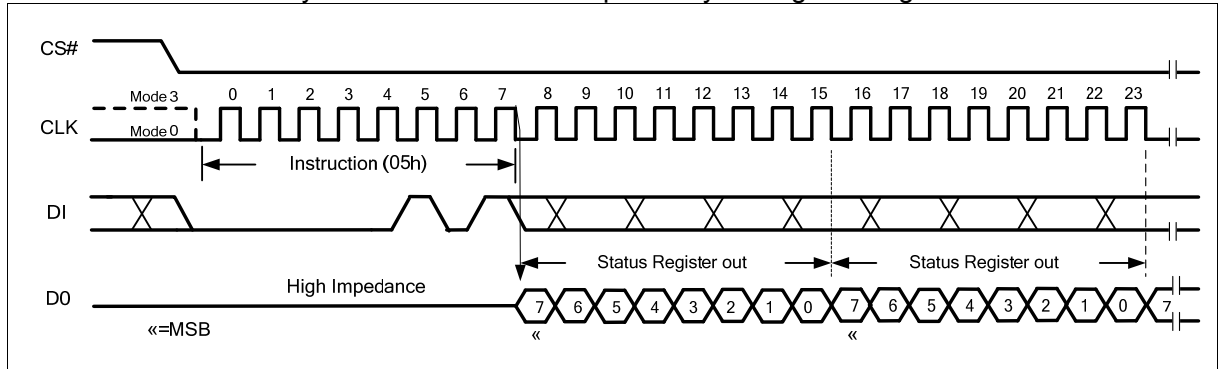


Figure 7 Read Status Register Instruction

12.5. Write Status Register (WRSR) (01h)

The Write Status Register (WRSR) instruction allows the Status Register to be written. Only non-volatile Status Register bits SRWD, BP1, BP0 can be written to. All other Status Register bit locations are read-only and will not be affected by the Write Status Register (WRSR) instruction. The Status Register bits are shown in [Figure 4](#), and described in 11 Status Register.

To write non-volatile Status Register bits, a standard Write Enable (06h) instruction must previously have been executed for the device to accept the Write Status Register (WRSR) instruction (Status Register bit WEL must equal 1). Once write enabled, the instruction is entered by driving CS# low, sending the instruction code “01h”, and then writing the status register data byte as illustrated in [Figure 8](#).

To complete the Write Status Register (WRSR) instruction, the CS# pin must be driven high after the eighth bit of data that is clocked in. If this is not done the Write Status Register (WRSR) instruction will not be executed.

During non-volatile Status Register write operation (06h combined with 01h), after CS# is driven high, the self-timed Write Status Register cycle will commence for a time duration of t_w (See “AC Electrical Characteristics”). While the Write Status Register cycle is in progress, the Read Status Register instruction may still be accessed to check the status of the WIP bit. The WIP bit is a 1 during the Write Status Register cycle and a 0 when the cycle is finished and ready to accept other instructions again. After the Write Status Register cycle has finished, the Write Enable Latch (WEL) bit in the Status Register will be cleared to 0.

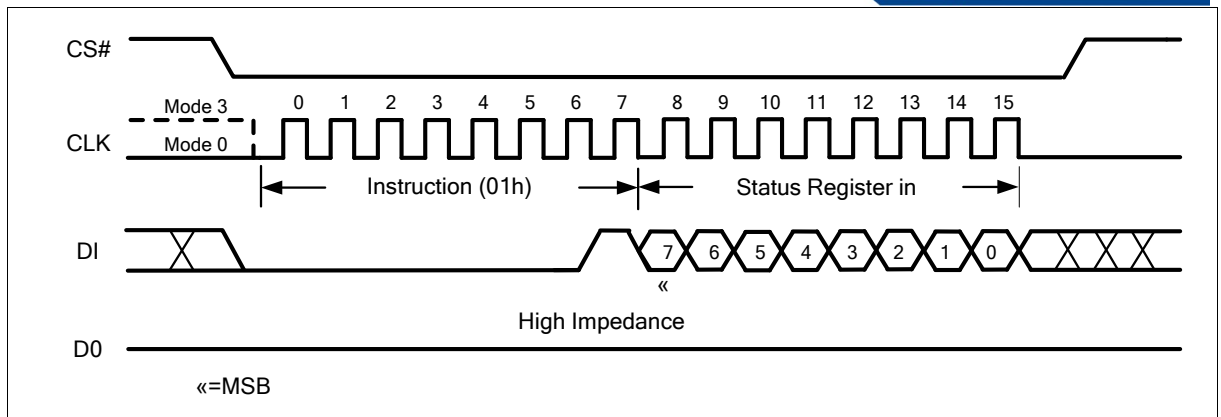


Figure 8 Write Status Register Instruction

12.6. Read from Memory Array (03h)

The Read instruction allows one or more data bytes to be sequentially read from the memory. The instruction is initiated by driving the CS# pin low and then shifting the instruction code “03h” followed by a 16-bit address A15-A0 into the DI pin. The code and address bits are latched on the rising edge of the CLK pin. After the address is received, the data byte of the addressed memory location will be shifted out on the DO pin at the falling edge of CLK with most significant bit (MSB) first. The address is automatically incremented to the next higher address after each byte of data is shifted out allowing for a continuous stream of data. This means that the entire memory can be accessed with a single instruction as long as the clock continues. The instruction is completed by driving CS# high.

The Read instruction sequence is shown in [Figure 9](#). If a Read Data instruction is issued while an Write cycle is in process (WIP =1) the instruction is ignored and will not have any effect on the current cycle. The Read Data instruction allows clock rates from D.C. to a maximum of f_c (see “13.4 AC Electrical Characteristics”).

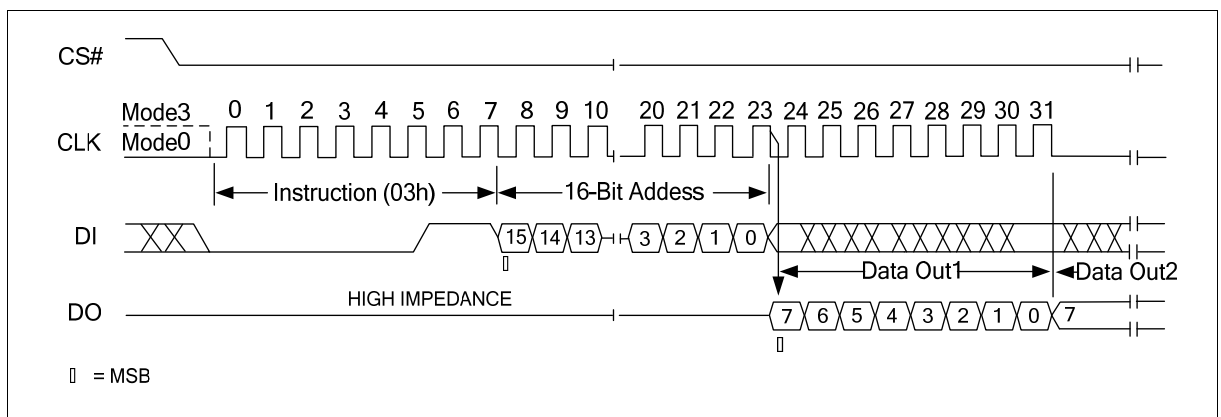


Figure 9 Read Data Instruction

12.7. Write to Memory Array (02h)

The Write instruction allows from one byte to 128 bytes (a page) of data to be written. A Write Enable instruction must be executed before the device will accept the Write Instruction (Status Register bit WEL= 1). The instruction is initiated by driving the CS# pin low then shifting the instruction code “02h” followed by a 16-bit address A15-A0 and at least one data byte, into the DI pin. The CS# pin must be held low for the entire length of the instruction while data is being sent to the device. The Write instruction sequence is shown in [Figure 10](#).

If an entire 128 byte page is to be programmed, the last address byte (the 7 least significant address bits) should be set to 0. If the last address byte is not zero, and the number of clocks exceeds the remaining page length, the addressing will wrap to the beginning of the page. In some cases, less than 128 bytes (a partial page) can be programmed without having any effect on other bytes within the same page. One condition to perform a partial page program is that the number of clocks can not exceed the remaining page length. If more than 128 bytes are sent to the device the addressing will wrap to the beginning of the page and overwrite previously sent data.

The CS# pin must be driven high after the eighth bit of the last byte has been latched. If this is not done the Write instruction will not be executed. After CS# is driven high, the self-timed Write instruction will commence for a time duration of t_w (See “13.4 AC Electrical Characteristics”). While the Write cycle is in progress, the Read Status Register instruction may still be accessed for checking the status of the WIP bit. The WIP bit is a 1 during the Write cycle and becomes a 0 when the cycle is finished and the device is ready to accept other instructions again. After the Write cycle has finished the Write Enable Latch (WEL) bit in the Status Register is cleared to 0. The Write instruction will not be executed if the addressed page is protected by the Block Protect (BP1 and BP0) bits.

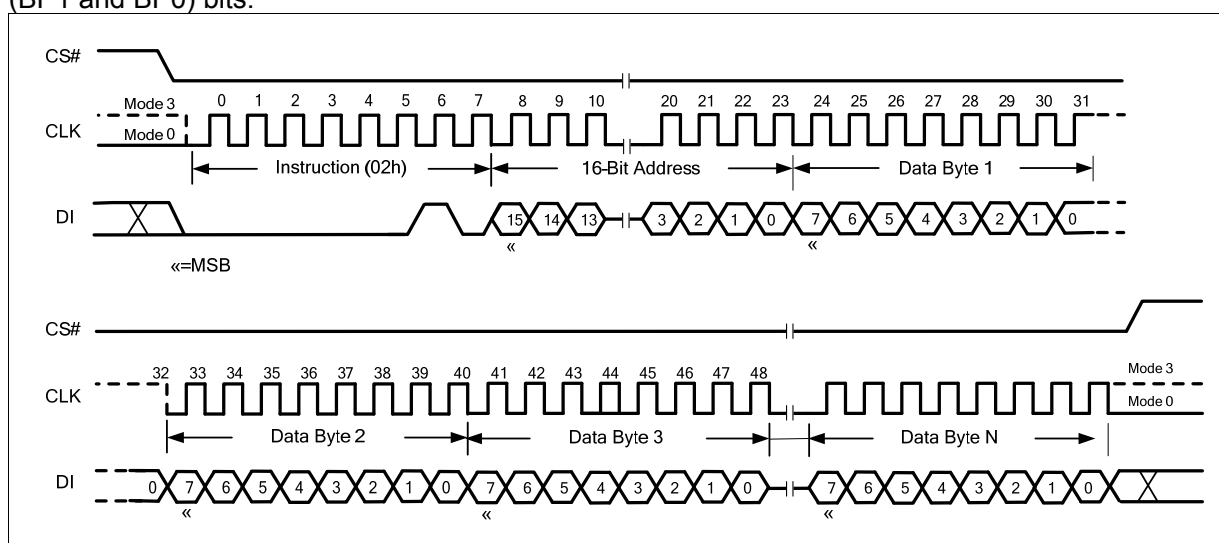


Figure 10 Page Program Instruction

12.8. Read Security Sector (83h)

The FM25512 offers 128-byte Security Sector which can be written and (later) permanently locked in Read-only mode.

The Read Security Sector instruction is similar to the Read instruction and allows one or more data bytes to be sequentially read from Security Sector. The instruction is initiated by driving the CS# pin low and then shifting the instruction code “83h” followed by a 16-bit address A15-A0 into the DI pin. Address bits A10A9 must be 00, upper address bits are don't care. The data byte pointed to by the lower address bits [A6:A0] is shifted out on DO pin. If Chip Select (CS#) continues to be driven low, the byte address is automatically incremented to the next byte address after each byte of data is shifted out. Once the byte address reaches the last byte of the register (byte 7Fh), it will be reset to 00h, the first byte of the register, and continue to increment. The instruction is completed by driving CS# high. The Read Security Sector instruction sequence is shown in Figure 11.

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

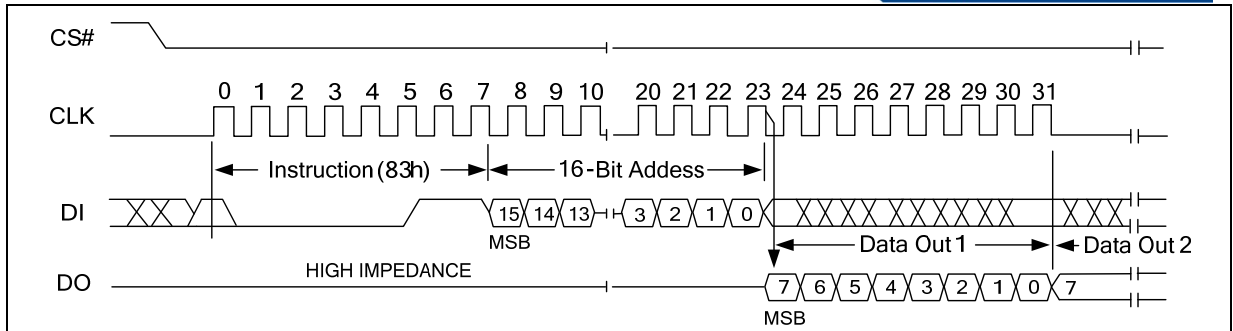


Figure 11 Read Security Sector Sequence

12.9. Write Security Sector (82h)

The Write Security Sector instruction is similar to the Write instruction. It allows from one byte to 128 bytes of Security Sector data to be written. A Write Enable instruction must be executed before the device will accept the Write Security Sector Instruction (Status Register bit WEL= 1). The instruction is initiated by driving the CS# pin low then shifting the instruction code “82h” followed by a 16-bit address A15-A0 and at least one data byte, into the DI pin. Address bit A10A9 must be 00, upper address bits are don't care, the lower address bits [A6:A0] address bits define the byte address inside the Security Sector. The CS# pin must be held low for the entire length of the instruction while data is being sent to the device.

The instruction is discarded, and is not executed if the Block Protect bits (BP1,BP0) = (1,1) or the Security Sector has been locked.

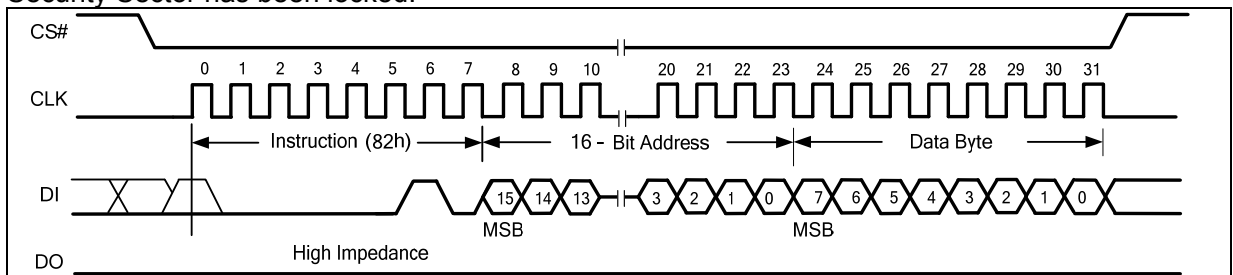


Figure 12 Write Security Sector Sequence

12.10. Lock Security Sector (82h)

The Lock Security Sector instruction permanently locks the Security Sector in Read-only mode. Before this instruction can be accepted, a Write Enable instruction must have been executed. The Lock Security Sector instruction is initiated by driving the CS# pin low, then shifting the instruction code “82h” followed by a 16-bit address A15-A0 and one data byte, into the DI pin. Address bits A10A9 must be 10, all other address bits are Don't Care. The data byte sent must be equal to the binary value xxxx xx1x, where x = Don't Care.

The CS# pin must be driven high after the rising edge of CLK that latches in the eighth bit of the data byte, and before the next rising edge of CLK. Otherwise, the Lock Security Sector instruction is not executed.

The instruction is discarded, and is not executed if the Block Protect bits (BP1,BP0) = (1,1) or the Security Sector has been locked.

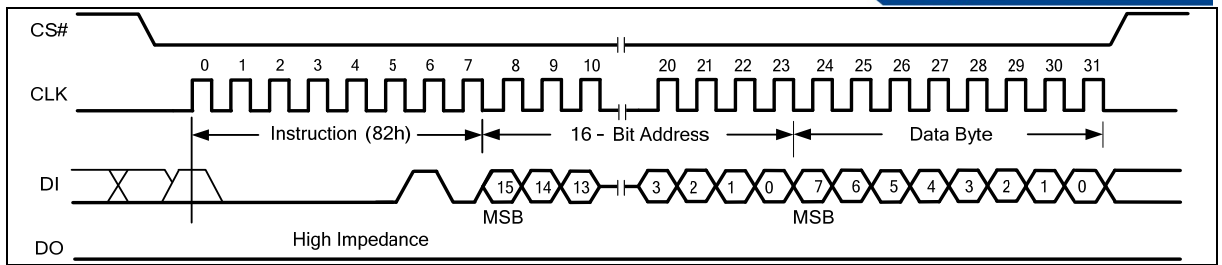


Figure 13 Lock Security Sector Sequence

12.11. Read Lock Status (83h)

The Read Lock Status instruction is used to check whether the Security Sector is locked or not in Read-only mode. The Read Lock Status instruction is initiated by driving the CS# pin low, then shifting the instruction code “83h” followed by a 16-bit address A15-A0 into the DI pin. Address bits A10A9 must be 10, all other address bits are Don't Care. The Lock bit is the BIT1 of the byte read on DO pin. It is at “1” when the lock is active and at “0” when the lock is not active. If CS# pin continues to be driven low, the same data byte is shifted out. The read cycle is terminated by driving CS# pin high.

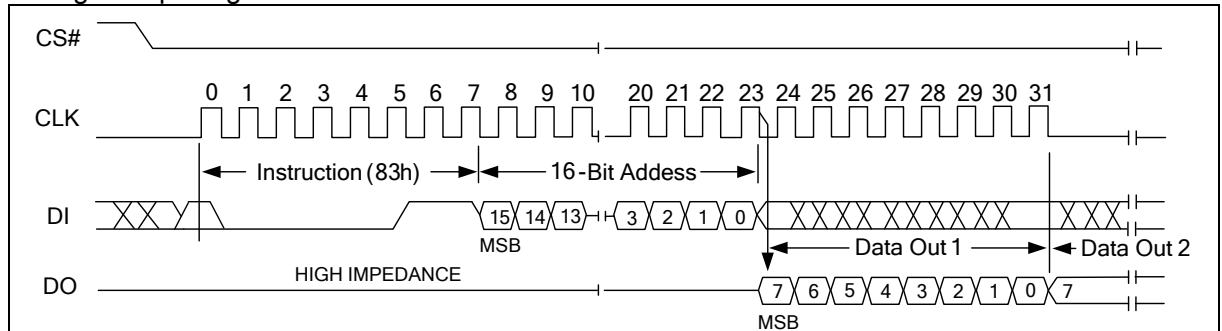


Figure 14 Read Lock Status Sequence

12.12. Read UID Number (83h)

The Read Unique ID Number instruction accesses a factory-set read-only 128-bit number that is unique to each FM2512 device. The ID number can be used in conjunction with user software methods to help prevent copying or cloning of a system. The Read Unique ID instruction is initiated by driving the CS# pin low and shifting the instruction code “83h” followed by a 16-bit address A15-A0 into the DI pin. Address bit A10A9 must be ‘01b’, upper address bits are don't care, the lower address bits [A3:A0] define the byte address inside the UID. After which, the 128-bit ID is shifted out on the falling edge of CLK as shown in [Figure 15](#). When the end of the 128-bit UID number is reached (16 bytes of data), the data word address will roll-over back to the beginning of the 128-bit UID number. The read UID cycle is terminated by driving CS# pin high.

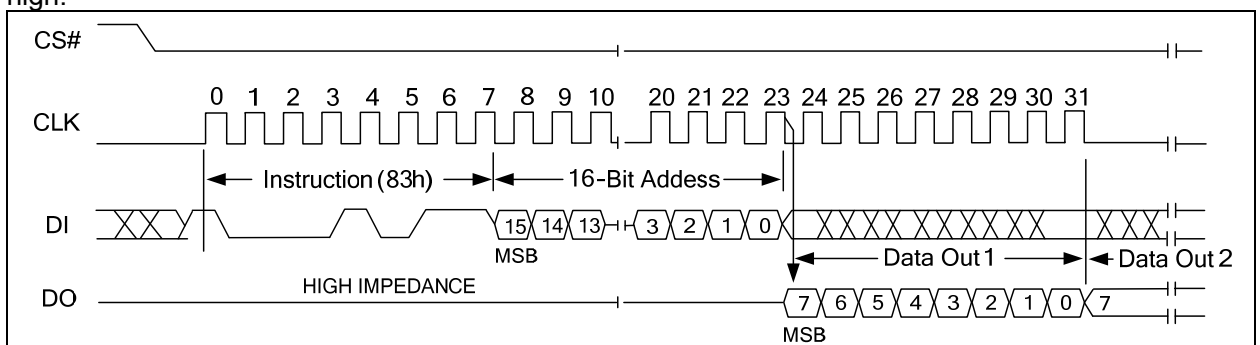


Figure 15 Read UID Number Sequence



13. Electrical Characteristics

13.1. Pin Capacitance

Table 4 Pin Capacitance

| PARAMETER | SYMBOL | CONDITIONS | Max | Units |
|--------------------|-----------------|-----------------------------------|-----|-------|
| Input Capacitance | $C_{IN}^{(1)}$ | $V_{IN} = 0V, f = 5 \text{ MHz}$ | 6 | pF |
| Output Capacitance | $C_{OUT}^{(1)}$ | $V_{OUT} = 0V, f = 5 \text{ MHz}$ | 8 | pF |

Note: 1. This parameter is characterized and is not 100% tested.

13.2. DC Electrical Characteristics

Table 5 DC Electrical Characteristics

Applicable over recommended operating range from: $T_A = -40^\circ\text{C}$ to $+85^\circ\text{C}$, $V_{CC} = +1.7V$ to $+5.5V$, (unless otherwise noted).

| Symbol | Parameter | Test Condition | Min | Max | Units |
|------------|------------------------|---|---------------------|---------------------|-------|
| V_{CC} | Supply Voltage | | 1.7 | 5.5 | V |
| I_{CC1} | Supply Current (Read) | $V_{CC} = 5.5V$ at 20 MHz DO = Open, CLK=0.1V _{CC} /0.9V _{CC} | | 5.0 | mA |
| | | $V_{CC} = 1.7V$ at 5 MHz DO = Open, CLK=0.1V _{CC} /0.9V _{CC} | | 2.0 | mA |
| I_{CC2} | Supply Current (Write) | $V_{CC} = 5.5V$, during tw, CS# = V _{CC} | | 3.0 | mA |
| | | $V_{CC} = 1.7V$, during tw, CS# = V _{CC} | | 2.0 | mA |
| I_{SB1} | Standby Current | $V_{CC} = 1.7V, CS\# = V_{CC}$ | | 1.0 | μA |
| I_{SB2} | Standby Current | $V_{CC} = 5.0V, CS\# = V_{CC}$ | | 5.0 | μA |
| I_{LI} | Input Leakage Current | $V_{IN} = V_{CC}/V_{SS}$ | -2.0 | 2.0 | μA |
| I_{LO} | Output Leakage Current | $V_{OUT} = V_{CC}/V_{SS}$ | -2.0 | 2.0 | μA |
| V_{IL}^1 | Input Low Level | | -0.6 | $V_{CC} \times 0.3$ | V |
| V_{IH}^1 | Input High Level | | $V_{CC} \times 0.7$ | $V_{CC} + 0.5$ | V |
| V_{OL1} | Output Low Level 1 | $V_{CC} = 3.6V, I_{OL} = 3.0 \text{ mA}$ | | 0.4 | V |
| V_{OH1} | Output High Level 1 | $V_{CC} = 3.6V, I_{OH} = -1.6 \text{ mA}$ | $V_{CC} - 0.8$ | | |
| V_{OL2} | Output Low Level 2 | $V_{CC} = 1.7V, I_{OL} = 0.15 \text{ mA}$ | | 0.2 | V |
| V_{OH2} | Output High Level 2 | $V_{CC} = 1.7V, I_{OH} = -100 \text{ uA}$ | $V_{CC} - 0.2$ | | |

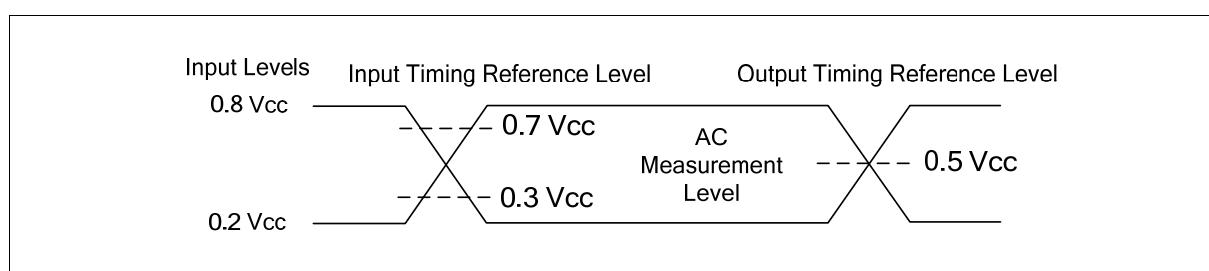
Note: 1. V_{IL} min and V_{IH} max are reference only and are not tested.

13.3. AC Measurement Conditions

Table 6 AC Measurement Conditions

| SYMBOL | PARAMETER | SPEC | | UNIT |
|--------|----------------------------------|--|--------------------------|------|
| | | MIN. | MAX. | |
| CL | Load Capacitance | | 30 or 100 ⁽¹⁾ | pF |
| TR, TF | Input Rise and Fall Times | | 25 | ns |
| VIN | Input Pulse Voltages | 0.2 V _{CC} to 0.8 V _{CC} | | V |
| IN | Input Timing Reference Voltages | 0.3 V _{CC} to 0.7 V _{CC} | | V |
| OUT | Output Timing Reference Voltages | 0.5V _{CC} | | V |

1. 100 pF when the clock frequency f_c is less than 10 MHz, 30 pF when the clock frequency f_c is equal to or greater than 10 MHz.


Figure 16 AC Measurement I/O Waveform

13.4. AC Characteristics

Table 7 AC Characteristics

Recommended operating conditions: $T_A = -40^\circ\text{C}$ to $+85^\circ\text{C}$, $V_{CC} = +1.7\text{V}$ to $+5.5\text{V}$.

| SYMBOL | PARAMETER | $V_{CC} \geq 1.7\text{V}$ | | $V_{CC} \geq 2.5\text{V}$ | | $V_{CC} \geq 4.5\text{V}$ | | UNIT |
|------------------|--|---------------------------|------|---------------------------|------|---------------------------|------|------|
| | | MIN. | MAX. | MIN. | MAX. | MIN. | MAX. | |
| f_c | Clock frequency | | 5 | | 10 | | 20 | MHz |
| t_{SLCH} | CS# active setup time | 60 | | 30 | | 15 | | ns |
| t_{SHCH} | CS# not active setup time | 60 | | 30 | | 15 | | ns |
| t_{SHSL} | CS# deselect time | 90 | | 40 | | 20 | | ns |
| t_{CHSH} | CS# active hold time | 60 | | 30 | | 15 | | ns |
| t_{CHSL} | CS# not active hold time | 60 | | 30 | | 15 | | ns |
| $t_{CH}^{(1)}$ | Clock high time | 80 | | 40 | | 20 | | ns |
| $t_{CL}^{(1)}$ | Clock low time | 80 | | 40 | | 20 | | ns |
| $t_{CLCH}^{(2)}$ | Clock rise time | | 2 | | 2 | | 2 | us |
| $t_{CHCL}^{(2)}$ | Clock fall time | | 2 | | 2 | | 2 | us |
| t_{DVCH} | Data in setup time | 20 | | 10 | | 5 | | ns |
| t_{CHDX} | Data in hold time | 20 | | 10 | | 10 | | ns |
| t_{HHCH} | Clock low hold time after HOLD# not active | 60 | | 30 | | 15 | | ns |
| t_{HLCH} | Clock low hold time after HOLD# active | 60 | | 30 | | 15 | | ns |
| t_{CLHL} | Clock low setup time before HOLD# active | 0 | | 0 | | 0 | | ns |
| t_{CLHH} | Clock low setup time before HOLD# not active | 0 | | 0 | | 0 | | ns |
| t_{SHQZ} | Output disable time | | 80 | | 40 | | 20 | ns |
| t_{CLQV} | Clock low to output valid | | 80 | | 40 | | 20 | ns |
| t_{CLQX} | Output hold time | 0 | | 0 | | 0 | | ns |

| SYMBOL | PARAMETER | $V_{CC} \geq 1.7V$ | | $V_{CC} \geq 2.5V$ | | $V_{CC} \geq 4.5V$ | | UNIT |
|------------|----------------------------|--------------------|------|--------------------|------|--------------------|------|------|
| | | MIN. | MAX. | MIN. | MAX. | MIN. | MAX. | |
| t_{QLQH} | Output rise time | | 20 | | 20 | | 10 | ns |
| t_{QHQL} | Output fall time | | 20 | | 20 | | 10 | ns |
| t_{HHQV} | HOLD# high to output valid | | 80 | | 40 | | 20 | ns |
| t_{HLQZ} | HOLD# low to output High-Z | | 80 | | 40 | | 20 | ns |
| t_w | Write time | | 5 | | 5 | | 5 | ms |

Notes:

- $t_{CH} + t_{CL} \geq 1/f_C$;
- This parameter is characterized and is not 100% tested.

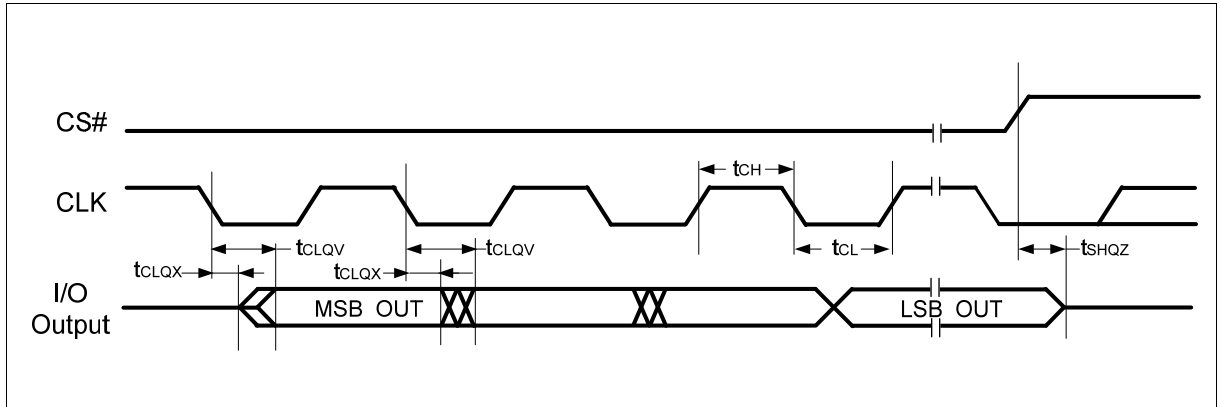


Figure 17 Serial Output Timing

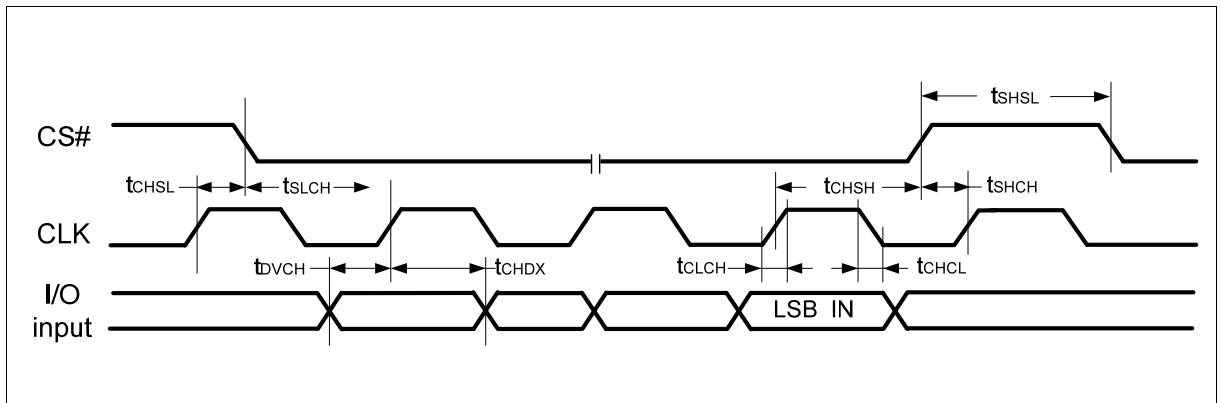


Figure 18 Serial Input Timing

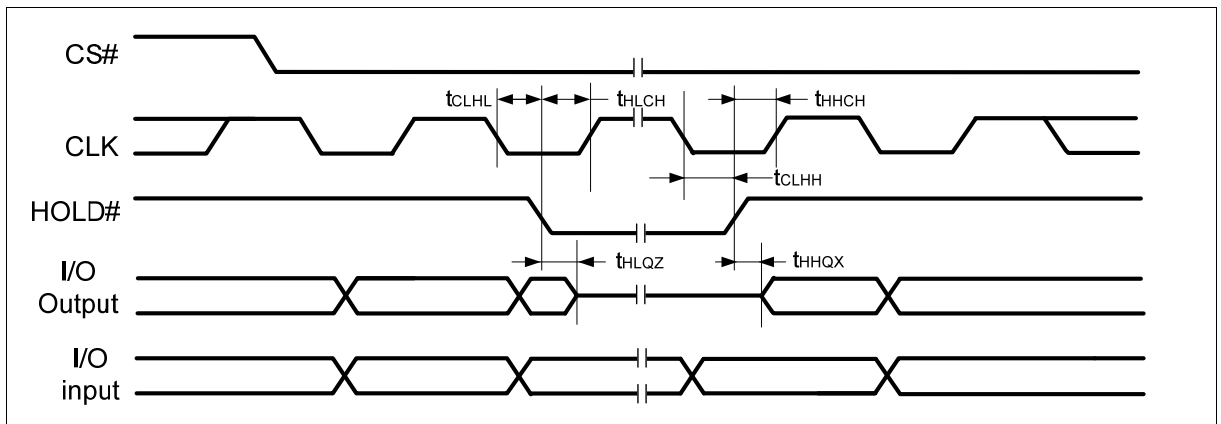


Figure 19 Hold Timing



14. Ordering Information

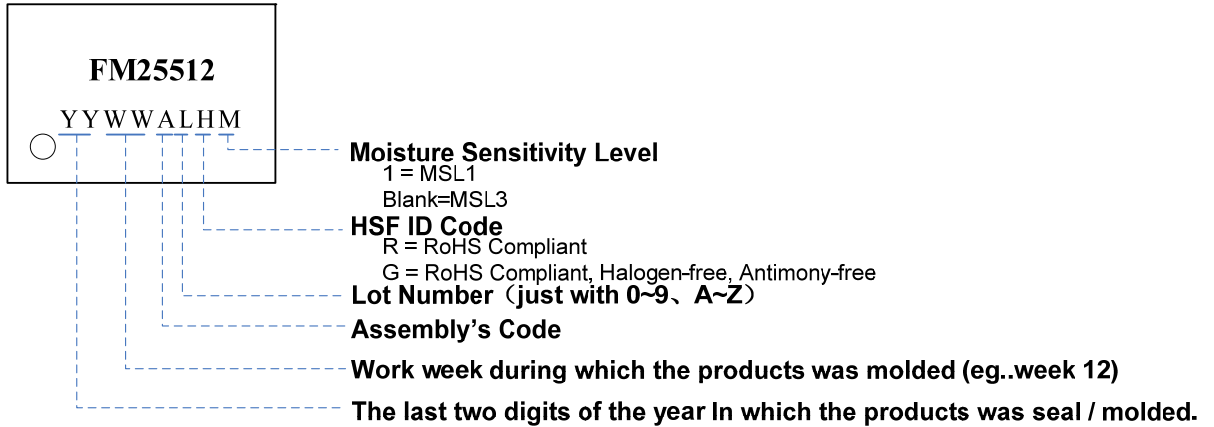
| | FM | 25 | 512 | -PP | -C | -H |
|---|----|----|-----|-----|----|----|
| Company Prefix | | | | | | |
| FM = Shanghai Fudan Microelectronics Group Co.,Ltd | | | | | | |
| Product Family | | | | | | |
| 25 = SPI Serial EEPROM | | | | | | |
| Product Density | | | | | | |
| 512 = 512K-bit | | | | | | |
| Package Type⁽¹⁾ | | | | | | |
| SO =8- pin SOP | | | | | | |
| TS =8- pin TSSOP | | | | | | |
| UD =8- pin UDFN | | | | | | |
| Product Carrier | | | | | | |
| U = Tube T = Tape and Reel | | | | | | |
| HSF ID Code⁽²⁾ | | | | | | |
| Blank or R= RoHS Compliant G = RoHS Compliant, Halogen-free, Antimony-free | | | | | | |

Note:

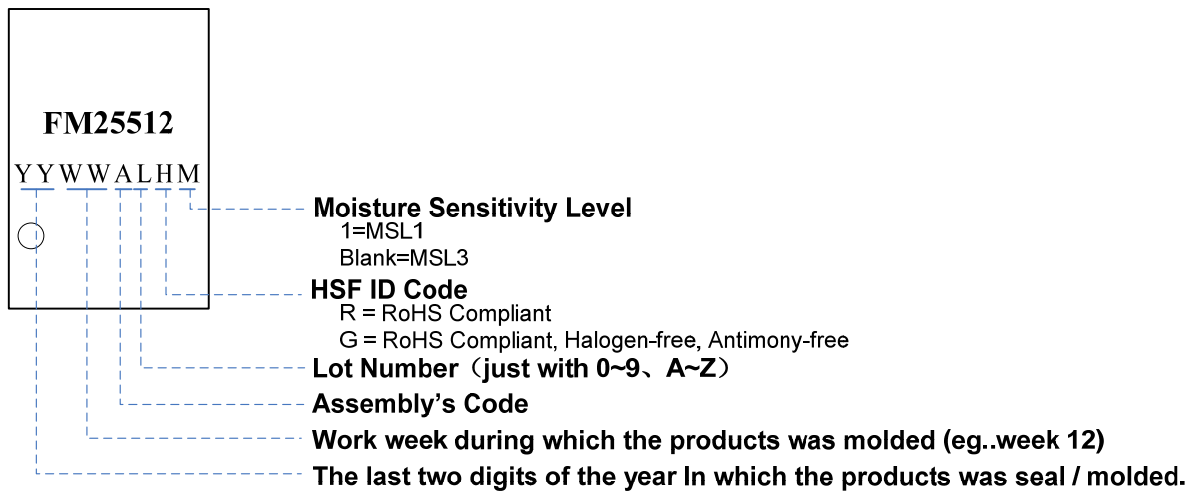
- For SO, TS, UD package, MSL1 package are available, for detail please contact local sales office.
- For SO, TS and UD package: G class only.

15. Part Marking Scheme

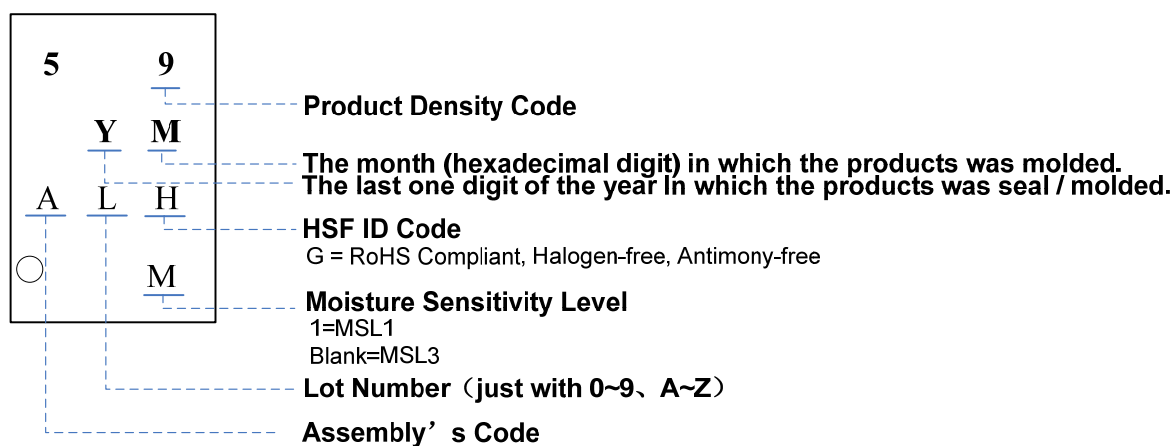
15.1. SOP8



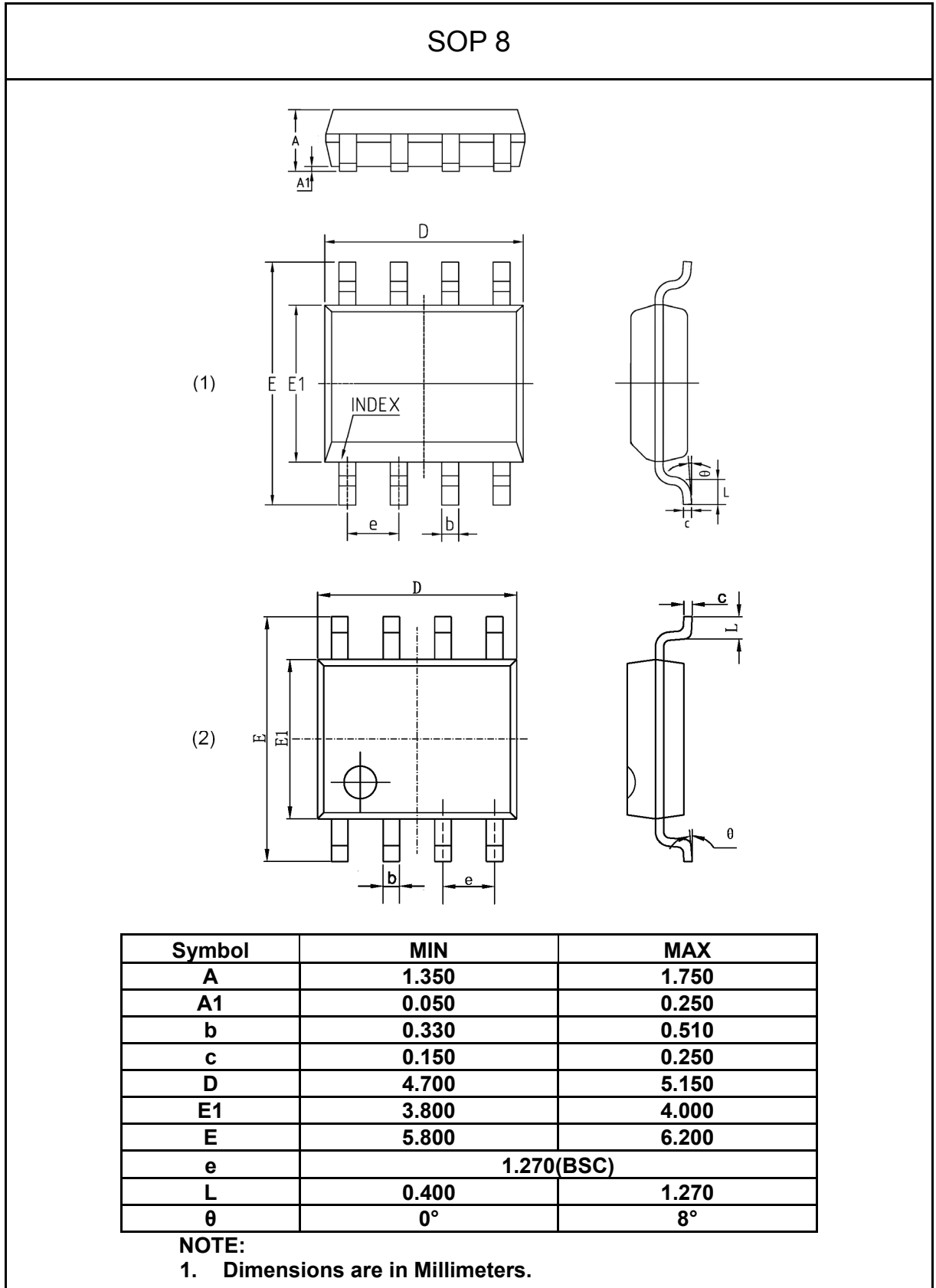
15.2. TSSOP8



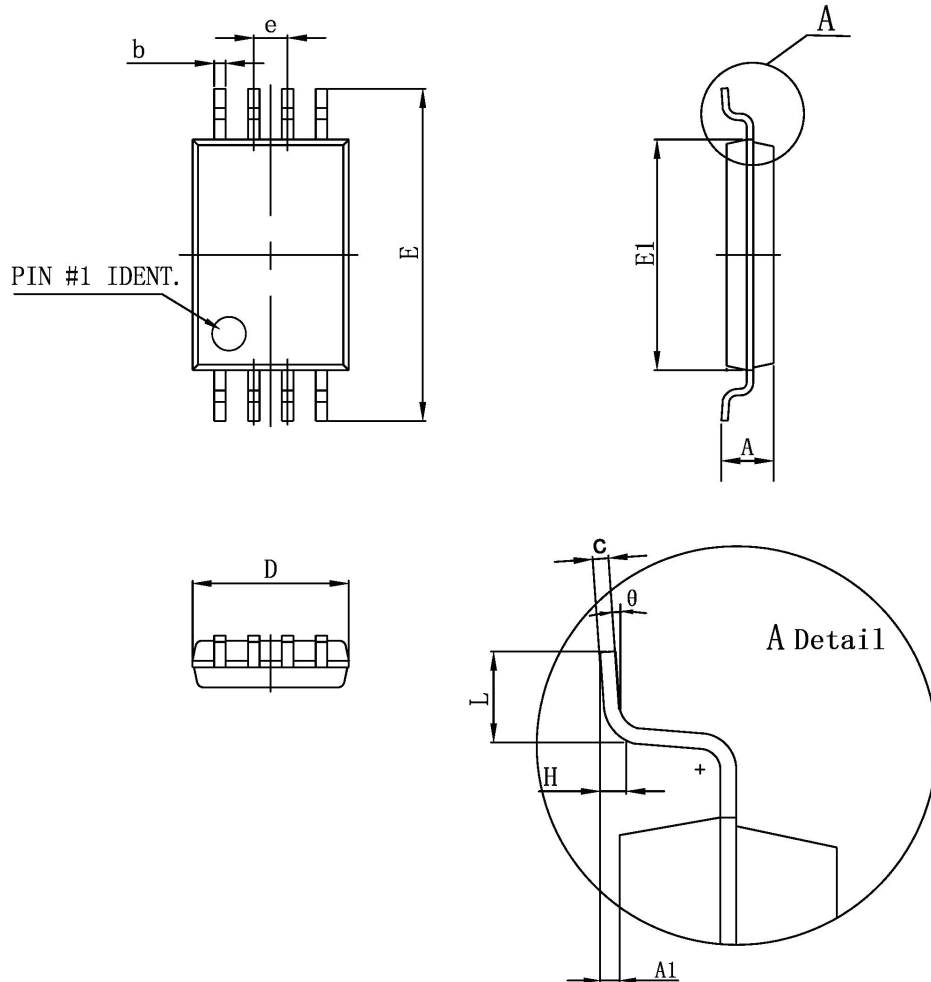
15.3. UDFN8



16. Packaging Information



TSSOP8

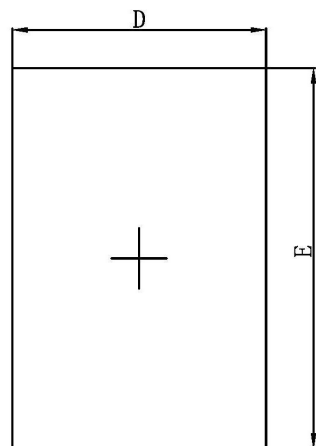


| Symbol | MIN | MAX |
|----------|-------------|-------|
| D | 2.900 | 3.100 |
| E1 | 4.300 | 4.500 |
| b | 0.190 | 0.300 |
| c | 0.090 | 0.200 |
| E | 6.250 | 6.550 |
| A | | 1.200 |
| A1 | 0.050 | 0.150 |
| e | 0.650 (BSC) | |
| L | 0.450 | 0.750 |
| θ | 0° | 8° |

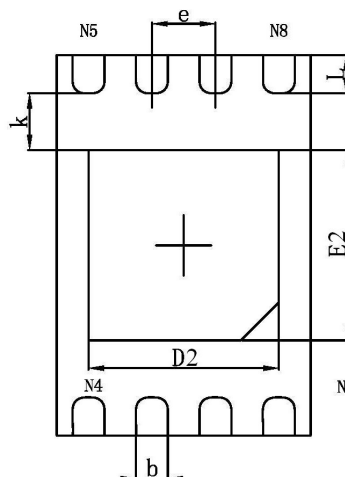
NOTE:

1. Dimensions are in Millimeters.

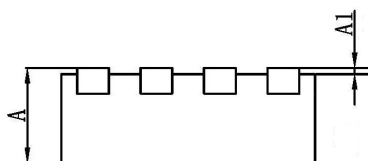
UDFN8



Top View



Bottom View



Side View

| Symbol | MIN | MAX |
|--------|------------|-------|
| A | 0.500 | 0.600 |
| A1 | 0.000 | 0.050 |
| D | 1.900 | 2.100 |
| E | 2.900 | 3.100 |
| D2 | 1.400 | 1.600 |
| E2 | 1.300 | 1.500 |
| k | 0.200(MIN) | |
| b | 0.200 | 0.300 |
| e | 0.500(TYP) | |
| L | 0.200 | 0.400 |

NOTE:

1. Dimensions are in Millimeters.



17. Revision History

| Version | Publication date | Pages | Paragraph or Illustration | Revise Description |
|---------|------------------|-------|---------------------------|---------------------------|
| 1.0 | May 2014 | 26 | | Initial document Release. |
| | | | | |
| | | | | |
| | | | | |



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