MX25V512E

DATASHEET

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FEATURES

GENERAL

- Supports Serial Peripheral Interface -- Mode 0 and Mode 3
- 524,288 x 1 bit structure or 262,144 x 2 bits (Dual Output mode) Structure
- 16 Equal Sectors with 4K byte each
  - Any Sector can be erased individually
- Single Power Supply Operation
  - 2.35 to 3.6 volt for read, erase, and program operations
- Latch-up protected to 100mA from -1V to Vcc +1V

PERFORMANCE

- High Performance
  - Fast access time: 75MHz serial clock
  - Serial clock of Dual Output mode: 70MHz
  - Fast program time: 0.6ms(typ.) and 1ms(max.)/page (256-byte per page)
  - Byte program time: 9us
  - Fast erase time: 40ms(typ.)/sector (4K-byte per sector) ; 0.5s(typ.) and 1s(max.)/chip
- Low Power Consumption
  - Low active read current: 12mA(max.) at 75MHz and 4mA(max.) at 33MHz
  - Low active programming current: 15mA (typ.)
  - Low active sector erase current: 9mA (typ.)
  - Low standby current: 15uA (typ.)
  - Deep power-down mode 2uA (typ.)
- Minimum 100,000 erase/program cycles
- 20 years data retention

SOFTWARE FEATURES

- Input Data Format
  - 1-byte Command code
- Block Lock protection
  - The BP0~BP1 status bit defines the size of the area to be software protected against Program and Erase instructions.
- Auto Erase and Auto Program Algorithm
  - Automatically erases and verifies data at selected sector
  - Automatically programs and verifies data at selected page by an internal algorithm that automatically times the program pulse widths (Any page to be programed should have page in the erased state first)
- Status Register Feature
- Electronic Identification
  - JEDEC 2-byte Device ID
  - RES command, 1-byte Device ID

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HARDWARE FEATURES

- SCLK Input
  - Serial clock input
- SI/SIO0
  - Serial Data Input or Serial Data Output for Dual output mode
- SO/SIO1
  - Serial Data Output or Serial Data Output for Dual output mode
- WP# pin
  - Hardware write protection
- HOLD# pin
  - pause the chip without diselecting the chip
- PACKAGE
  - 8-USON (2x3mm)
  - 8-pin TSSOP (173mil)
  - 8-pin SOP (150mil)
  - **All devices are RoHS compliant and Halogen-free**

GENERAL DESCRIPTION

MX25V512E is a CMOS 524,288 bit serial Flash memory, which is configured as 65,536 x 8 internally. MX25V512E features a serial peripheral interface and software protocol allowing operation on a simple 3-wire bus. The three bus signals are a clock input (SCLK), a serial data input (SI), and a serial data output (SO). Serial access to the device is enabled by CS# input.

MX25V512E provides sequential read operation on whole chip.

After program/erase command is issued, auto program/erase algorithms which program/erase and verify the specified page or sector/block locations will be executed. Program command is executed on page (256 bytes) basis, and erase command is executed on chip or sector (4K-bytes).

To provide user with ease of interface, a status register is included to indicate the status of the chip. The status read command can be issued to detect completion status of a program or erase operation via the WIP bit.

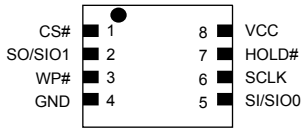
When the device is not in operation and CS# is high, it is put in standby mode and draws less than 25uA DC current.

The MX25V512E utilizes Macronix's proprietary memory cell, which reliably stores memory contents even after 100,000 program and erase cycles.

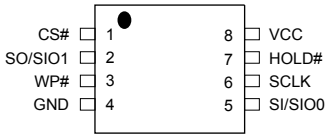
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PIN CONFIGURATIONS

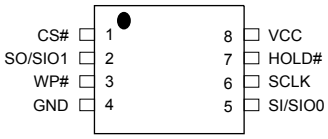
8-LAND USON (2x3mm)



8-PIN TSSOP (173mil)



8-PIN SOP (150mil)

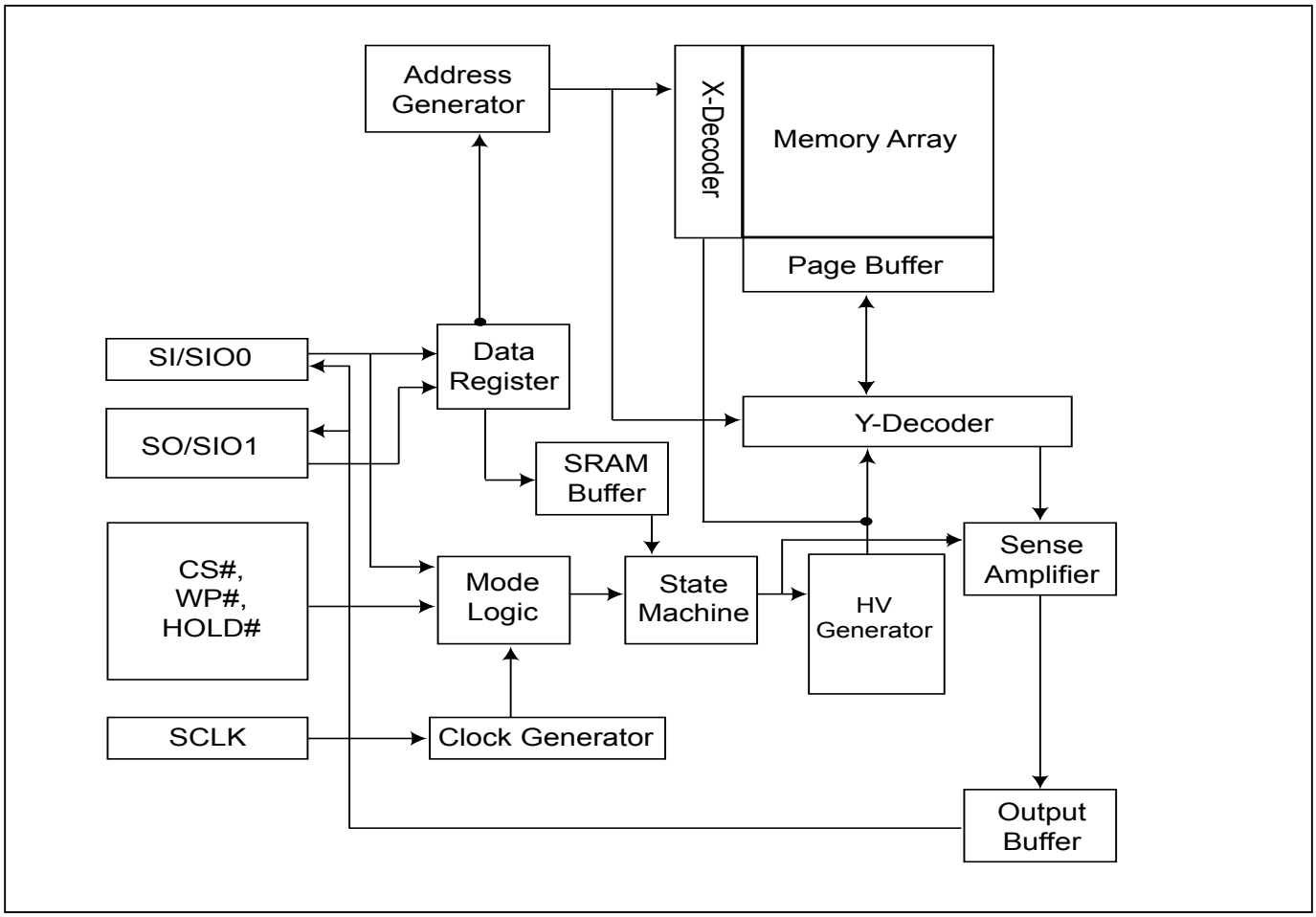


PIN DESCRIPTION

SYMBOL	DESCRIPTION
CS#	Chip Select
SI/SIO0	Serial Data Input (for 1 x I/O)/ Serial Data Input & Output (for Dual output mode)
SO/SIO1	Serial Data Output (for 1 x I/O)/ Serial Data Input & Output (for Dual output mode)
SCLK	Clock Input
HOLD#	Hold, to pause the device without deselecting the device
WP#	Write Protection
VCC	+ 3.3V Power Supply
GND	Ground

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BLOCK DIAGRAM



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DATA PROTECTION

During power transition, there may be some false system level signals which result in inadvertent erasure or programming. The device is designed to protect itself from these accidental write cycles.

The state machine will be reset as standby mode automatically during power up. In addition, the control register architecture of the device constrains that the memory contents can only be changed after specific command sequences have completed successfully.

In the following, there are several features to protect the system from the accidental write cycles during VCC power-up and power-down or from system noise.

- **Valid command length checking:** The command length will be checked whether it is at byte base and completed on byte boundary.
- **Write Enable (WREN) command:** WREN command is required to set the Write Enable Latch bit (WEL) before issuing other commands to change data. The WEL bit will return to reset stage under following situation:
  - Power-up
  - Write Disable (WRDI) command completion
  - Write Status Register (WRSR) command completion
  - Page Program (PP) command completion
  - Sector Erase (SE) command completion
  - Block Erase (BE) command completion
  - Chip Erase (CE) command completion
- **Software Protection Mode (SPM):** by using BP0-BP1 bits to set the part of Flash protected from data change.
- **Hardware Protection Mode (HPM):** by using WP# going low to protect the BP0-BP1 bits and SRWD bit from data change.
- **Deep Power Down Mode:** By entering deep power down mode, the flash device also is under protected from writing all commands except Release from Deep Power-down mode command (RDP) and Read Electronic Signature command (RES).

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Table 1. Protected Area Sizes

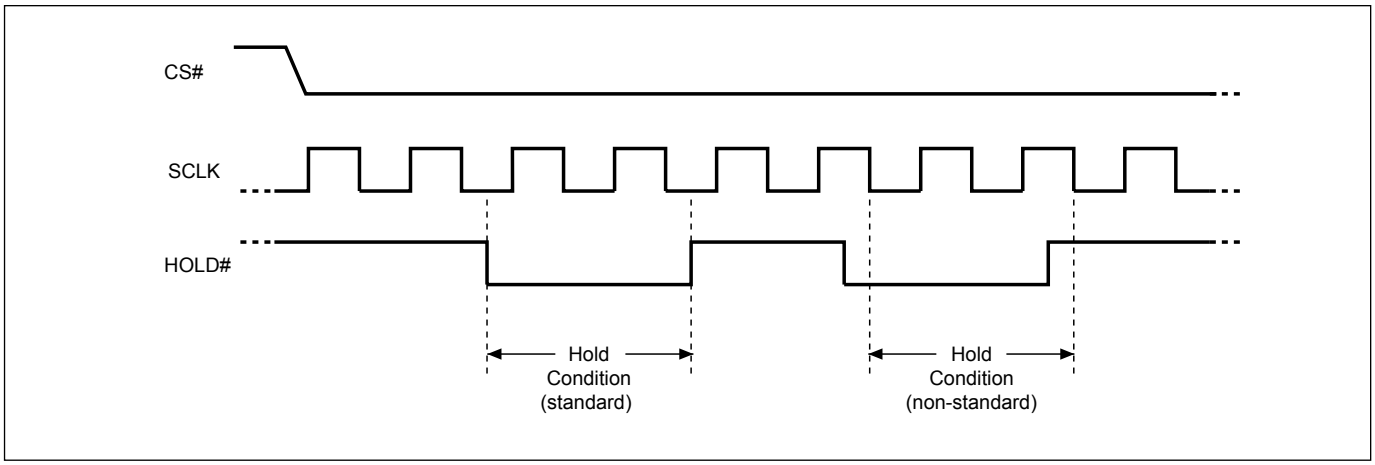
Status bit		Protect level	512b
BP1	BP0		
0	0	0 (none)	None
0	1	1 (All)	All
1	0	2 (All)	All
1	1	3 (All)	All

HOLD FEATURE

HOLD# pin signal goes low to hold any serial communications with the device. The HOLD feature will not stop the operation of write status register, programming, or erasing in progress.

The operation of HOLD requires Chip Select(CS#) keeping low and starts on falling edge of HOLD# pin signal while Serial Clock (SCLK) signal is being low (if Serial Clock signal is not being low, HOLD operation will not start until Serial Clock signal being low). The HOLD condition ends on the rising edge of HOLD# pin signal while Serial Clock(SCLK) signal is being low(if Serial Clock signal is not being low, HOLD operation will not end until Serial Clock being low), see *Figure 1*.

Figure 1. Hold Condition Operation



The Serial Data Output (SO) is high impedance, both Serial Data Input (SI) and Serial Clock (SCLK) are don't care during the HOLD operation. If Chip Select (CS#) drives high during HOLD operation, it will reset the internal logic of the device. To re-start communication with chip, the HOLD# must be at high and CS# must be at low.

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Table 2. COMMAND DEFINITION

COMMAND (byte)	WREN (Write Enable)	WRDI (Write Disable)	RDID (Read Identification)	RDSR (Read Status Register)	WRSR (Write Status Register)	READ (Read Data)
1st	06 (hex)	04 (hex)	9F (hex)	05 (hex)	01 (hex)	03 (hex)
2nd						AD1
3rd						AD2
4th						AD3
5th						
Action	sets the (WEL) write enable latch bit	resets the (WEL) write enable latch bit	outputs manufacturer ID and 2-byte device ID	to read out the status register	to write new values to the status register	n bytes read out until CS# goes high

COMMAND (byte)	Fast Read (Fast Read Data)	DREAD (Dual Output mode)	SE (Sector Erase)	BE (Block Erase) (2)	CE (Chip Erase)	PP (Page Program)
1st	0B (hex)	3B (hex)	20 (hex)	52 or D8 (hex)	60 or C7 (hex)	02 (hex)
2nd	AD1	AD1	AD1	AD1		AD1
3rd	AD2	AD2	AD2	AD2		AD2
4th	AD3	AD3	AD3	AD3		AD3
5th	x					
Action	n bytes read out until CS# goes high	n bytes read out until CS# goes high	to erase the selected sector	to erase the selected block	to erase the whole chip	to program the selected page

COMMAND (byte)	DP (Deep Power-down)	RDP (Release from Deep Power-down)	RES (Read Electronic ID)	REMS (Read Electronic Manufacturer & Device ID)
1st	B9 (hex)	AB (hex)	AB (hex)	90 (hex)
2nd			x	x
3rd			x	x
4th			x	ADD(1)
5th				
Action	enters deep power down mode	release from deep power down mode	to read out 1-byte Device ID	Output the manufacturer ID and device ID

(1) ADD=00H will output the manufacturer's ID first and ADD=01H will output device ID first.

(2) BE command may erase whole 512Kb chip.

(3) It is not recommended to adopt any other code which is not in the command definition table above.

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Table 3. Memory Organization

Sector	Address Range	
15	00F000h	00FFFFh
:	:	:
3	003000h	003FFFh
2	002000h	002FFFh
1	001000h	001FFFh
0	000000h	000FFFh

DEVICE OPERATION

1. Before a command is issued, status register should be checked to ensure the device is ready for the intended operation.

2. When incorrect command is inputted to this device, it enters standby mode and remains in standby mode until next CS# falling edge. In standby mode, SO pin of this LSI should be High-Z. The CS# falling time needs to follow tCHCL spec. (Please refer to *Table 6. AC CHARACTERISTICS*)

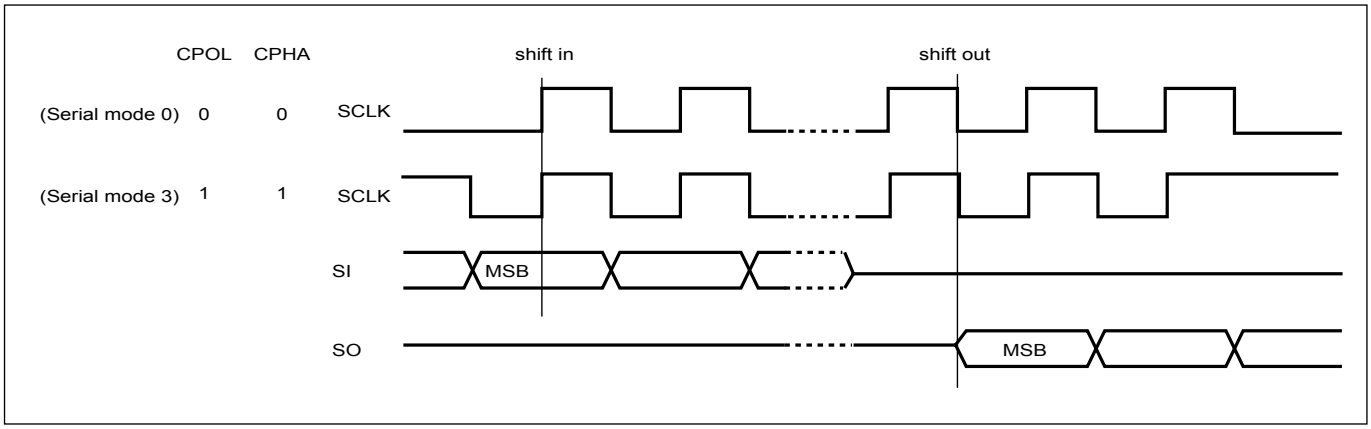
3. When correct command is inputted to this device, it enters active mode and remains in active mode until next CS# rising edge. The CS# rising time needs to follow tCLCH spec. (Please refer to *Table 6. AC CHARACTERISTICS*)

4. Input data is latched on the rising edge of Serial Clock (SCLK) and data is shifted out on the falling edge of SCLK. The difference of Serial mode 0 and mode 3 is shown as *Figure 2*.

5. For the following instructions: RDID, RDSR, READ, FAST_READ, DREAD, RES and REMS the shifted-in instruction sequence is followed by a data-out sequence. After any bit of data being shifted out, the CS# can be high. For the following instructions: WREN, WRDI, WRSR, SE, BE, CE, PP, RDP and DP the CS# must go high exactly at the byte boundary; otherwise, the instruction will be rejected and not executed.

6. While a Write Status Register, Program, or Erase operation is in progress, access to the memory array is neglected and will not affect the current operation of Write Status Register, Program, and Erase.

Figure 2. Serial Modes Supported



Note: *CPOL indicates clock polarity of Serial master:*
-CPOL=1 for SCLK high while idle,
-CPOL=0 for SCLK low while not transmitting.
CPHA indicates clock phase.
The combination of CPOL bit and CPHA bit decides which Serial mode is supported.

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COMMAND DESCRIPTION

(1) Write Enable (WREN)

The Write Enable (WREN) instruction is for setting Write Enable Latch (WEL) bit. For those instructions like PP, SE, BE, CE, and WRSR, which are intended to change the device content, should be set every time after the WREN instruction setting the WEL bit.

The sequence of issuing WREN instruction is: CS# goes low→ sending WREN instruction code→ CS# goes high. (see *Figure 11*)

(2) Write Disable (WRDI)

The Write Disable (WRDI) instruction is for resetting Write Enable Latch (WEL) bit.

The sequence of issuing WRDI instruction is: CS# goes low→ sending WRDI instruction code→ CS# goes high. (see *Figure 12*)

The WEL bit is reset by following situations:

- Power-up
- Write Disable (WRDI) instruction completion
- Write Status Register (WRSR) instruction completion
- Page Program (PP) instruction completion
- Sector Erase (SE) instruction completion
- Block Erase (BE) instruction completion
- Chip Erase (CE) instruction completion

(3) Read Identification (RDID)

RDID instruction is for reading the manufacturer ID of 1-byte and followed by Device ID of 2-byte. The Macronix Manufacturer ID is C2(hex), the memory type ID is 20(hex) as the first-byte device ID, and the individual device ID of second-byte ID is as followings: 10(hex) for MX25V512E.

The sequence of issuing RDID instruction is: CS# goes low→sending RDID instruction code→24-bits ID data out on SO→to end RDID operation can use CS# to high at any time during data out. (see *Figure. 13*)

While Program/Erase operation is in progress, it will not decode the RDID instruction, so there's no effect on the cycle of program/erase operation which is currently in progress. When CS# goes high, the device is at standby stage.

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(4) Read Status Register (RDSR)

The RDSR instruction is for reading Status Register Bits. The Read Status Register can be read at any time (even in program/erase/write status register condition) and continuously. It is recommended to check the Write in Progress (WIP) bit before sending a new instruction when a program, erase, or write status register operation is in progress.

The sequence of issuing RDSR instruction is: CS# goes low→sending RDSR instruction code→Status Register data out on SO (see *Figure. 14*)

The definition of the status register bits is as below:

WIP bit. The Write in Progress (WIP) bit, a volatile bit, indicates whether the device is busy in program/erase/write status register progress. When WIP bit sets to 1, which means the device is busy in program/erase/write status register progress. When WIP bit sets to 0, which means the device is not in progress of program/erase/write status register cycle.

WEL bit. The Write Enable Latch (WEL) bit, a volatile bit, indicates whether the device is set to internal write enable latch. When WEL bit sets to 1, which means the internal write enable latch is set, the device can accept program/erase/write status register instruction. When WEL bit sets to 0, which means no internal write enable latch; the device will not accept program/erase/write status register instruction.

BP1, BP0 bits. The Block Protect (BP1, BP0) bits, non-volatile bits, indicate the protected area(as defined in *table 1*) of the device to against the program/erase instruction without hardware protection mode being set. To write the Block Protect (BP1, BP0) bits requires the Write Status Register (WRSR) instruction to be executed. Those bits define the protected area of the memory to against Page Program (PP), Sector Erase (SE), Block Erase (BE) and Chip Erase(CE) instructions (only if all Block Protect bits set to 0, the CE instruction can be executed)

SRWD bit. The Status Register Write Disable (SRWD) bit, non-volatile bit, is operated together with Write Protection (WP#) pin for providing hardware protection mode. The hardware protection mode requires SRWD sets to 1 and WP# pin signal is low stage. In the hardware protection mode, the Write Status Register (WRSR) instruction is no longer accepted for execution and the SRWD bit and Block Protect bits (BP1, BP0) are read only.

Status Register

bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0
SRWD (status register write protect)	0	0	0	BP1 (level of protected block)	BP0 (level of protected block)	WEL (write enable latch)	WIP (write in progress bit)
1=status register write disable				**(Note 1)**	**(Note 1)**	1=write enable 0=not write enable	1=write operation 0=not in write operation

Notes: *1. See the table "Protected Area Sizes".*

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(5) Write Status Register (WRSR)

The WRSR instruction is for changing the values of Status Register Bits. Before sending WRSR instruction, the Write Enable (WREN) instruction must be decoded and executed to set the Write Enable Latch (WEL) bit in advance. The WRSR instruction can change the value of Block Protect (BP1, BP0) bits to define the protected area of memory (as shown in *table 1*). The WRSR also can set or reset the Status Register Write Disable (SRWD) bit in accordance with Write Protection (WP#) pin signal. The WRSR instruction cannot be executed once the Hardware Protected Mode (HPM) is entered.

The sequence of issuing WRSR instruction is: CS# goes low→ sending WRSR instruction code→ Status Register data on SI→ CS# goes high. (see *Figure 15*)

The WRSR instruction has no effect on b6, b5, b4, b1, b0 of the status register.

The CS# must go high exactly at the byte boundary; otherwise, the instruction will be rejected and not executed. The self-timed Write Status Register cycle time (tW) is initiated as soon as Chip Select (CS#) goes high. The Write in Progress (WIP) bit still can be check out during the Write Status Register cycle is in progress. The WIP sets 1 during the tW timing, and sets 0 when Write Status Register Cycle is completed, and the Write Enable Latch (WEL) bit is reset.

Table 4. Protection Modes

Mode	Status register condition	WP# and SRWD bit status	Memory
Software protection mode (SPM)	Status register can be written in (WEL bit is set to "1") and the SRWD, BP0-BP1 bits can be changed.	WP#=1 and SRWD bit=0, or WP#=0 and SRWD bit=0, or WP#=1 and SRWD=1	The protected area cannot be programmed or erased.
Hardware protection mode (HPM)	The SRWD, BP0-BP1 of status register bits cannot be changed.	WP#=0, SRWD bit=1	The protected area cannot be programmed or erased.

Note: *1. As defined by the values in the Block Protect (BP1, BP0) bits of the Status Register, as shown in Table 1.*

As the table above showing, the summary of the Software Protected Mode (SPM) and Hardware Protected Mode (HPM).

Software Protected Mode (SPM):

- When SRWD bit=0, no matter WP# is low or high, the WREN instruction may set the WEL bit and can change the values of SRWD, BP1, BP0. The protected area, which is defined by BP1, BP0, is at software protected mode (SPM).
- When SRWD bit=1 and WP# is high, the WREN instruction may set the WEL bit can change the values of SRWD, BP1, BP0. The protected area, which is defined by BP1, BP0, is at software protected mode (SPM)

Note: *If SRWD bit=1 but WP# is low, it is impossible to write the Status Register even if the WEL bit has previously been set. It is rejected to write the Status Register and not be executed.*

Hardware Protected Mode (HPM):

- When SRWD bit=1, and then WP# is low (or WP# is low before SRWD bit=1), it enters the hardware protected mode (HPM). The data of the protected area is protected by software protected mode by BP1, BP0 and hardware protected mode by the WP# to against data modification.

Note: *to exit the hardware protected mode, it requires WP# driving high once the hardware protected mode is entered. If the WP# pin is permanently connected to high, the hardware protected mode can never be entered; only can use software protected mode via BP1, BP0.*

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(6) Read Data Bytes (READ)

The read instruction is for reading data out. The address is latched on rising edge of SCLK, and data shifts out on the falling edge of SCLK at a maximum frequency fR. The first address byte can be at any location. The address is automatically increased to the next higher address after each byte data is shifted out, so the whole memory can be read out at a single READ instruction. The address counter rolls over to 0 when the highest address has been reached.

The sequence of issuing READ instruction is: CS# goes low→ sending READ instruction code→ 3-byte address on SI→ data out on SO→ to end READ operation can use CS# to high at any time during data out. (see *Figure. 16*)

(7) Read Data Bytes at Higher Speed (FAST_READ)

The FAST_READ instruction is for quickly reading data out. The address is latched on rising edge of SCLK, and data of each bit shifts out on the falling edge of SCLK at a maximum frequency fC. The first address byte can be at any location. The address is automatically increased to the next higher address after each byte data is shifted out, so the whole memory can be read out at a single FAST_READ instruction. The address counter rolls over to 0 when the highest address has been reached.

The sequence of issuing FAST_READ instruction is: CS# goes low→ sending FAST_READ instruction code→ 3-byte address on SI→ 1-dummy byte address on SI→data out on SO→ to end FAST_READ operation can use CS# to high at any time during data out. (see *Figure. 17*)

While Program/Erase/Write Status Register cycle is in progress, FAST_READ instruction is rejected without any impact on the Program/Erase/Write Status Register current cycle.

(8) Dual Output Mode (DREAD)

The DREAD instruction enable double throughput of Serial Flash in read mode. The address is latched on rising edge of SCLK, and data of every two bits(interleave on 1I/2O pins) shift out on the falling edge of SCLK at a maximum frequency fT. The first address byte can be at any location. The address is automatically increased to the next higher address after each byte data is shifted out, so the whole memory can be read out at a single DREAD instruction. The address counter rolls over to 0 when the highest address has been reached. Once writing DREAD instruction, the following data out will perform as 2-bit instead of previous 1-bit.

The sequence is shown as *Figure 18*.

While Program/Erase/Write Status Register cycle is in progress, DREAD instruction is rejected without any impact on the Program/Erase/Write Status Register current cycle.

The DREAD only performs read operation. Program/Erase /Read ID/Read status....operations do not support DREAD throughputs.

(9) Sector Erase (SE)

The Sector Erase (SE) instruction is for erasing the data of the chosen sector to be "1". A Write Enable (WREN) instruction must execute to set the Write Enable Latch (WEL) bit before sending the Sector Erase (SE). Any address of the sector (see *table 3*) is a valid address for Sector Erase (SE) instruction. The CS# must go high exactly at the byte boundary (the least significant bit of the address been latched-in); otherwise, the instruction will be rejected and not executed.

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Address bits [Am-A12] (Am is the most significant address) select the sector address.

The sequence of issuing SE instruction is: CS# goes low → sending SE instruction code→ 3-byte address on SI → CS# goes high. (see *Figure 20*)

The self-timed Sector Erase Cycle time (tSE) is initiated as soon as Chip Select (CS#) goes high. The Write in Progress (WIP) bit still can be checked while the Sector Erase cycle is in progress. The WIP sets during the tSE timing, and clears when Sector Erase Cycle is completed, and the Write Enable Latch (WEL) bit is cleared. If the page is protected by BP1, BP0 bits, the Sector Erase (SE) instruction will not be executed on the page.

(10) Block Erase (BE)

The Block Erase (BE) instruction is for erasing the data of the chosen block to be "1". A Write Enable (WREN) instruction must be executed to set the Write Enable Latch (WEL) bit before sending the Block Erase (BE). Any address of the block (see *table 3*) is a valid address for Block Erase (BE) instruction. The CS# must go high exactly at the byte boundary (the least significant bit of address byte been latched-in); otherwise, the instruction will be rejected and not executed.

The sequence of issuing BE instruction is: CS# goes low → sending BE instruction code→ 3-byte address on SI → CS# goes high. (see *Figure 21*)

The self-timed Block Erase Cycle time (tBE) is initiated as soon as Chip Select (CS#) goes high. The Write in Progress (WIP) bit still can be checked while the Sector Erase cycle is in progress. The WIP sets during the tBE timing, and clears when Sector Erase Cycle is completed, and the Write Enable Latch (WEL) bit is cleared. If the page is protected by BP1, BP0 bits, the Block Erase (BE) instruction will not be executed on the page.

(11) Chip Erase (CE)

The Chip Erase (CE) instruction is for erasing the data of the whole chip to be "1". A Write Enable (WREN) instruction must be executed to set the Write Enable Latch (WEL) bit before sending the Chip Erase (CE). Any address of the sector (see *table 3*) is a valid address for Chip Erase (CE) instruction. The CS# must go high exactly at the byte boundary(the latest eighth of address byte been latched-in); otherwise, the instruction will be rejected and not executed.

The sequence of issuing CE instruction is: CS# goes low→ sending CE instruction code→ CS# goes high. (see *Figure 22*)

The self-timed Chip Erase Cycle time (tCE) is initiated as soon as Chip Select (CS#) goes high. The Write in Progress (WIP) bit still can be checked while the Chip Erase cycle is in progress. The WIP sets during the tCE timing, and clears when Chip Erase Cycle is completed, and the Write Enable Latch (WEL) bit is cleared. If the chip is protected by BP1, BP0 bits, the Chip Erase (CE) instruction will not be executed. It will be only executed when BP1, BP0 all set to "0".

(12) Page Program (PP)

The Page Program (PP) instruction is for programming the memory to be "0". A Write Enable (WREN) instruction must be executed to set the Write Enable Latch (WEL) bit before sending the Page Program (PP). The last address byte (the 8 least significant address bits, A7-A0) should be set to 0 for 256 bytes page program. If A7-A0 are not all zero, transmitted data that exceed page length are programmed from the starting address (24-bit address that last 8 bit are all 0) of currently selected page. The CS# must keep during the whole Page Program cycle. The CS# must go high exactly at the byte boundary (the latest eighth of address byte been latched-in); otherwise, the

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instruction will be rejected and not executed. If the data bytes sent to the device exceeds 256, the last 256 data byte is programmed at the request page and previous data will be disregarded. If the data bytes sent to the device has not exceeded 256, the data will be programmed at the request address of the page. There will be no effort on the other data bytes of the same page.

The sequence of issuing PP instruction is: CS# goes low→ sending PP instruction code→ 3-byte address on SI→ at least 1-byte on data on SI→ CS# goes high. (see *Figure 19*)

The self-timed Page Program Cycle time (tPP) is initiated as soon as Chip Select (CS#) goes high. The Write in Progress (WIP) bit still can be checked while the Page Program cycle is in progress. The WIP sets during the tPP timing, and clears when Page Program Cycle is completed, and the Write Enable Latch (WEL) bit is cleared. If the page is protected by BP1, BP0 bits, the Page Program (PP) instruction will not be executed.

(13) Deep Power-down (DP)

The Deep Power-down (DP) instruction is for setting the device to minimum power consumption (the current is reduced from ISB1 to ISB2). The Deep Power-down mode requires the Deep Power-down (DP) instruction to enter, during the Deep Power-down mode, the device is not active and all Write/Program/Erase instruction are ignored. When CS# goes high, the device is still in standby mode, not deep power-down mode.

The sequence of issuing DP instruction is: CS# goes low→ sending DP instruction code→ CS# goes high. (see *Figure 22*)

Once the DP instruction is set, all instruction will be ignored except the Release from Deep Power-down mode (RDP) and Read Electronic Signature (RES) instruction. (RES instruction to allow the ID been read out). When Power-down, the deep power-down mode automatically stops, and when power-up, the device automatically is in standby mode. For RDP instruction the CS# must go high exactly at the byte boundary (the latest eighth bit of instruction code been latched-in); otherwise, the instruction will not executed. As soon as Chip Select (CS#) goes high, a delay of tDP is required before entering the Deep Power-down mode and reducing the current to ISB2.

(14) Release from Deep Power-down (RDP), Read Electronic Signature (RES)

The Release from Deep Power-down (RDP) instruction is completed by driving Chip Select (CS#) High. When Chip Select (CS#) is driven High, the device is put in the Stand-by Power mode. If the device was not previously in the Deep Power-down mode, the transition to the Stand-by Power mode is immediate. If the device was previously in the Deep Power-down mode, though, the transition to the Stand-by Power mode is delayed by tRES2, and Chip Select (CS#) must remain High for at least tRES2(max), as specified in *Table 6*. Once in the Stand-by Power mode, the device waits to be selected, so that it can receive, decode and execute instructions.

RES instruction is for reading out the old style of 8-bit Electronic Signature, whose values are shown as table of *ID Definitions*. This is not the same as RDID instruction. It is not recommended to use for new design. For new deisng, please use RDID instruction. Even in Deep power-down mode, the RDP and RES are also allowed to be executed, only except the device is in progress of program/erase/write cycle; there's no effect on the current program/erase/write cycle in progress.

The sequence is shown as *Figure 24* and *Figure 25*.

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The RES instruction is ended by CS# goes high after the ID been read out at least once. The ID outputs repeatedly if continuously send the additional clock cycles on SCLK while CS# is at low. If the device was not previously in Deep Power-down mode, the device transition to standby mode is immediate. If the device was previously in Deep Power-down mode, there's a delay of tRES2 to transit to standby mode, and CS# must remain to high at least tRES2(max). Once in the standby mode, the device waits to be selected, so it can be received, be decoded, and be executed instruction.

The RDP instruction is for releasing from Deep Power Down Mode.

(15) Read Electronic Manufacturer ID & Device ID (REMS)

The REMS instruction is an alternative to the Release from Power-down/Device ID instruction that provides both the JEDEC assigned manufacturer ID and the specific device ID.

The REMS instruction is very similar to the Release from Power-down/Device ID instruction. The instruction is initiated by driving the CS# pin low and shift the instruction code "90h" followed by two dummy bytes and one bytes address (A7~A0). After which, the Manufacturer ID for Macronix (C2h) and the Device ID are shifted out on the falling edge of SCLK with most significant bit (MSB) first as shown in *Figure 26*. The Device ID values are listed in Table of *ID Definitions*. If the one-byte address is initially set to 01h, then the device ID will be read first and then followed by the Manufacturer ID. The Manufacturer and Device IDs can be read continuously, alternating from one to the other. The instruction is completed by driving CS# high.

Table of ID Definitions

RDID Command	manufacturer ID	memory type	memory density
	C2	20	10
RES Command	electronic ID		
	05		
REMS Command	manufacturer ID	device ID	
	C2	05	

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POWER-ON STATE

The device is at the states as below after power-up:
- Standby mode *(please note it is not deep power-down mode)*
- Write Enable Latch (WEL) bit is reset

The device must not be selected during power-up and power-down stage until the VCC reaches the following levels (Please refer to the figure of "*power-up timing*"):
- VCC minimum at power-up stage and then after a delay of tVSL
- GND at power-down

Please note that a pull-up resistor on CS# may ensure a safe and proper power-up/down level.

An internal Power-On Reset (POR) circuit may protect the device from data corruption and inadvertent data change during power up state.

For further protection on the device, if the VCC does not reach the VCC minimum level, the correct operation is not guaranteed. The read, write, erase, and program command should be sent after the time delay: tVSL after VCC reached VCC minimum level. Please refer to the figure of "*power-up timing*".

The device can accept read command after VCC reached VCC minimum and a time delay of tVSL.

Note:
- *To stabilize the VCC level, the VCC rail decoupled by a suitable capacitor close to package pins is recommended.(generally around 0.1uF)*

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ELECTRICAL SPECIFICATIONS

ABSOLUTE MAXIMUM RATINGS

RATING	VALUE
Ambient Operating Temperature	-40°C to 85°C
Storage Temperature	-65°C to 150°C
Applied Input Voltage	-0.5V to VCC+0.5V
Applied Output Voltage	-0.5V to VCC+0.5V
VCC to Ground Potential	-0.5V to VCC+0.5V

NOTICE:

1. Stresses greater than those listed under ABSOLUTE MAXIMUM RATINGS may cause permanent damage to the device. This is stress rating only and functional operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended period may affect reliability.
2. Specifications contained within the following tables are subject to change.
3. During voltage transitions, all pins may overshoot to VCC+1.0V to VCC or -0.5V to GND for period up to 20ns.

Figure 3.Maximum Negative Overshoot Waveform

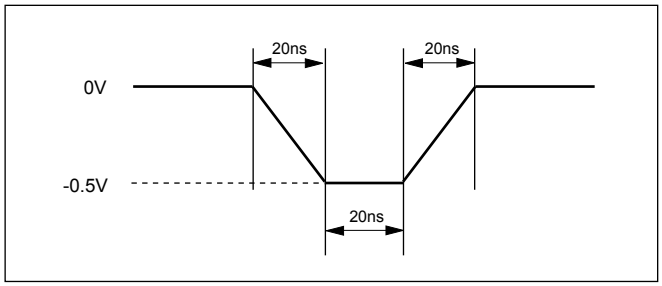
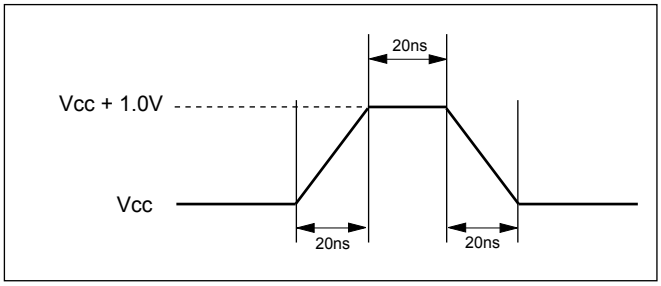


Figure 4. Maximum Positive Overshoot Waveform



CAPACITANCE TA = 25°C, f = 1.0 MHz

SYMBOL	PARAMETER	MIN.	TYP	MAX.	UNIT	CONDITIONS
CIN	Input Capacitance			6	pF	VIN = 0V
COUT	Output Capacitance			8	pF	VOUT = 0V

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Figure 5. INPUT TEST WAVEFORMS AND MEASUREMENT LEVEL

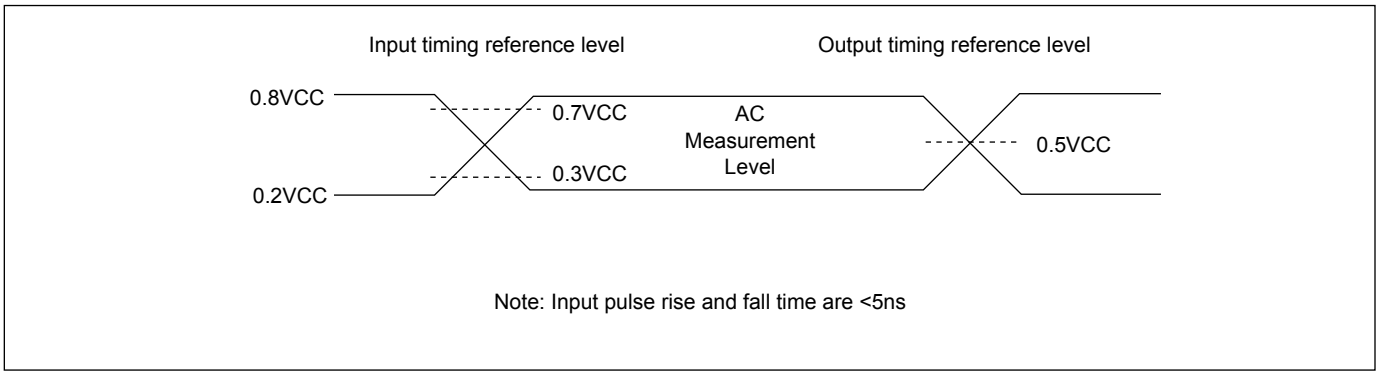
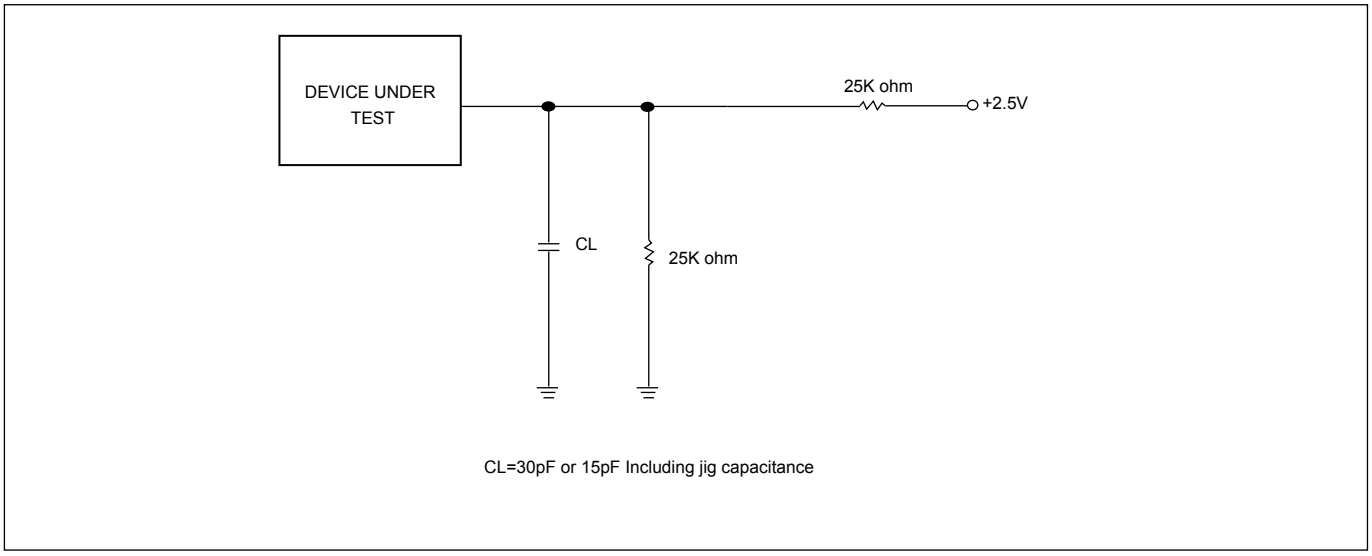


Figure 6. OUTPUT LOADING



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Table 5. DC CHARACTERISTICS

Symbol	Parameter	Notes	Min.	Typ.	Max.	Units	Test Conditions
ILI	Input Load Current	1			± 2	uA	VCC = VCC Max VIN = VCC or GND
ILO	Output Leakage Current	1			± 2	uA	VCC = VCC Max VOUT = VCC or GND
ISB1	VCC Standby Current	1		15	25	uA	VIN = VCC or GND CS#=VCC
ISB2	Deep Power-down Current			2	10	uA	VIN = VCC or GND CS#=VCC
ICC1	VCC Read	1			12	mA	f=75MHz fT=70MHz (Dual Output) SCLK=0.1VCC/0.9VCC, SO=Open
					10	mA	f=66MHz SCLK=0.1VCC/0.9VCC, SO=Open
					4	mA	f=33MHz SCLK=0.1VCC/0.9VCC, SO=Open
ICC2	VCC Program Current (PP)	1		15	20	mA	Program in Progress CS#=VCC
ICC3	VCC Write Status Register (WRSR) Current			3	15	mA	Program status register in progress CS#=VCC
ICC4	VCC Sector Erase Current (SE)	1		9	15	mA	Erase in Progress CS#=VCC
ICC5	VCC Chip Erase Current (CE)	1		15	20	mA	Erase in Progress CS#=VCC
VIL	Input Low Voltage		-0.5		0.3VCC	V	
VIH	Input High Voltage		0.7VCC		VCC+0.4	V	
VOL	Output Low Voltage				0.4	V	IOL = 1.6mA
VOH	Output High Voltage		VCC-0.2			V	IOH = -100uA
VWI	Low VCC Write Inhibit Voltage	3	1.5		2.3	V	

Notes :

1. *Typical values at VCC = 3.3V, T = 25°C. These currents are valid for all product versions (package and speeds).*
2. *Typical value is calculated by simulation.*
3. *Not 100% tested.*

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Table 6. AC CHARACTERISTICS

Symbol	Alt.	Parameter		Min.	Typ.	Max.	Unit
fSCLK	fC	Clock Frequency for the following instructions: FAST_READ, PP, SE, BE, CE, DP, RES, RDP, WREN, WRDI, RDID, RDSR, WRSR		DC		75	MHz
fRSCLK	fR	Clock Frequency for READ instructions		DC		33	MHz
fTSCLK	fT	Clock Frequency for DREAD instructions		DC		70	MHz
tCH(1)	tCLH	Clock High Time	@33MHz	13			ns
			@75MHz	6			ns
tCL(1)	tCLL	Clock Low Time	@33MHz	13			ns
			@75MHz	6			ns
tCLCH(2)		Clock Rise Time (3) (peak to peak)		0.1			V/ns
tCHCL(2)		Clock Fall Time (3) (peak to peak)		0.1			V/ns
tSLCH	tCSS	CS# Active Setup Time (relative to SCLK)		7			ns
tCHSL		CS# Not Active Hold Time (relative to SCLK)		7			ns
tDVCH	tDSU	Data In Setup Time		2			ns
tCHDX	tDH	Data In Hold Time		5			ns
tCHSH		CS# Active Hold Time (relative to SCLK)		7			ns
tSHCH		CS# Not Active Setup Time (relative to SCLK)		7			ns
tSHSL	tCSH	CS# Deselect Time	Read	15			ns
			Write	40			ns
tSHQZ(2)	tDIS	Output Disable Time				6	ns
tCLQV	tV	Clock Low to Output Valid	30pF			8	ns
			15pF			6	ns
tCLQX	tHO	Output Hold Time		0			ns
tHLCH		HOLD# Setup Time (relative to SCLK)		5			ns
tCHHH		HOLD# Hold Time (relative to SCLK)		5			ns
tHHCH		HOLD Setup Time (relative to SCLK)		5			ns
tCHHL		HOLD Hold Time (relative to SCLK)		5			ns
tHHQX(2)	tLZ	HOLD to Output Low-Z				6	ns
tHLQZ(2)	tHZ	HOLD# to Output High-Z				6	ns
tWHSL(4)		Write Protect Setup Time		20			ns
tSHWL(4)		Write Protect Hold Time		100			ns
tDP(2)		CS# High to Deep Power-down Mode				10	us
tRES1(2)		CS# High to Standby Mode without Electronic Signature Read				8.8	us
tRES2(2)		CS# High to Standby Mode with Electronic Signature Read				8.8	us
tW		Write Status Register Cycle Time			5	40	ms
tBP		Byte-Program			9	50	us
tPP		Page Program Cycle Time			0.6	1	ms
tSE		Sector Erase Cycle Time			40	200	ms
tBE		Block Erase Cycle Time			0.4	1	s
tCE		Chip Erase Cycle Time			0.5	1	s

Notes:
1. tCH + tCL must be greater than or equal to 1/f (fC or fR).
2. Value guaranteed by characterization, not 100% tested in production.
3. Expressed as a slew-rate.
4. Only applicable as a constraint for a WRSR instruction when SRWD is set at 1.
5. Test condition is shown as Figure 5.
6. The CS# rising time needs to follow tCLCH spec and CS# falling time needs to follow tCHCL spec.

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Table 7. Power-Up Timing

Symbol	Parameter	Min.	Max.	Unit
tVSL(1)	VCC(min) to CS# low	200		us

Note: *1. The parameter is characterized only.*

INITIAL DELIVERY STATE

The device is delivered with the memory array erased: all bits are set to 1 (each byte contains FFh). The Status Register contains 00h (all Status Register bits are 0).

Figure 7. Serial Input Timing

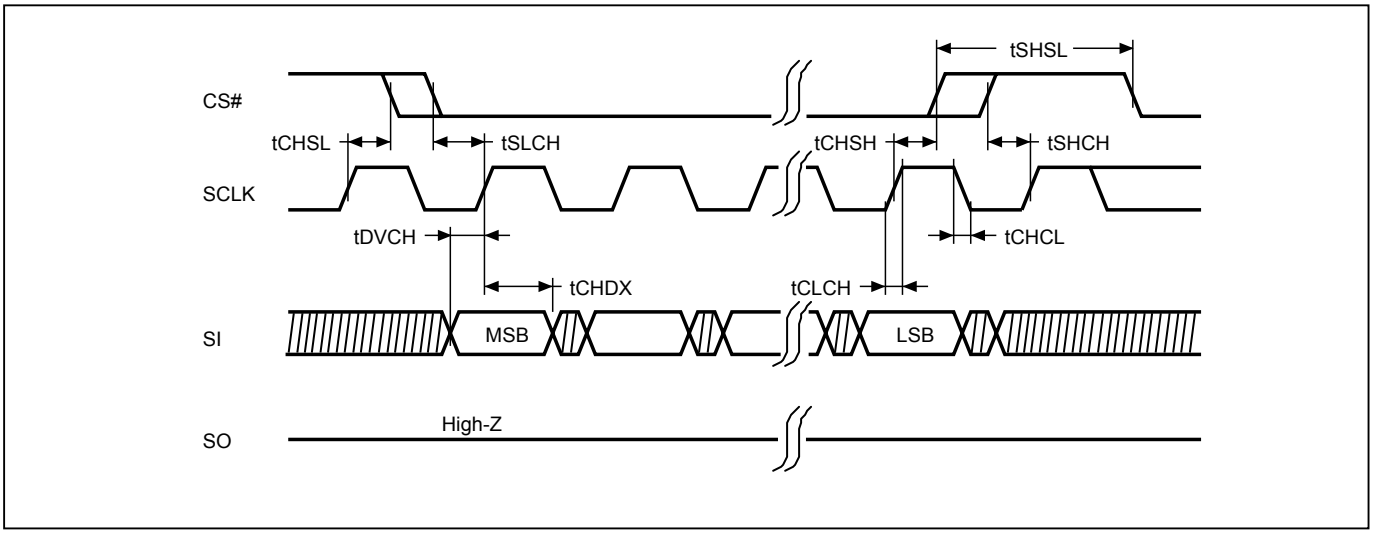
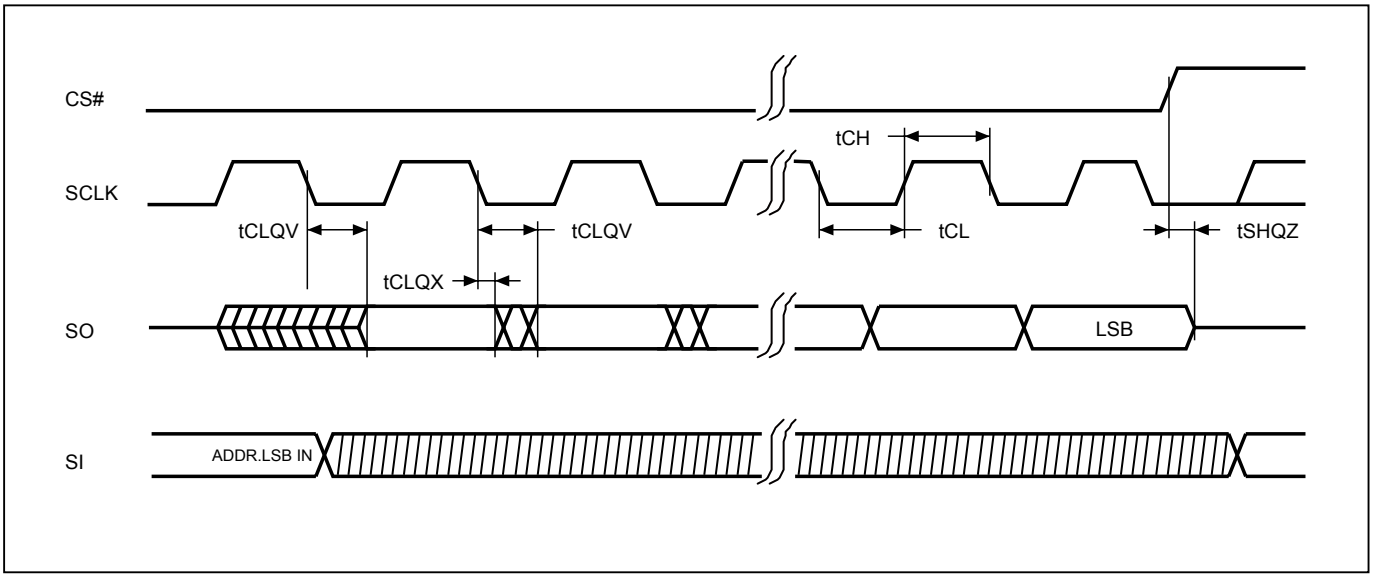
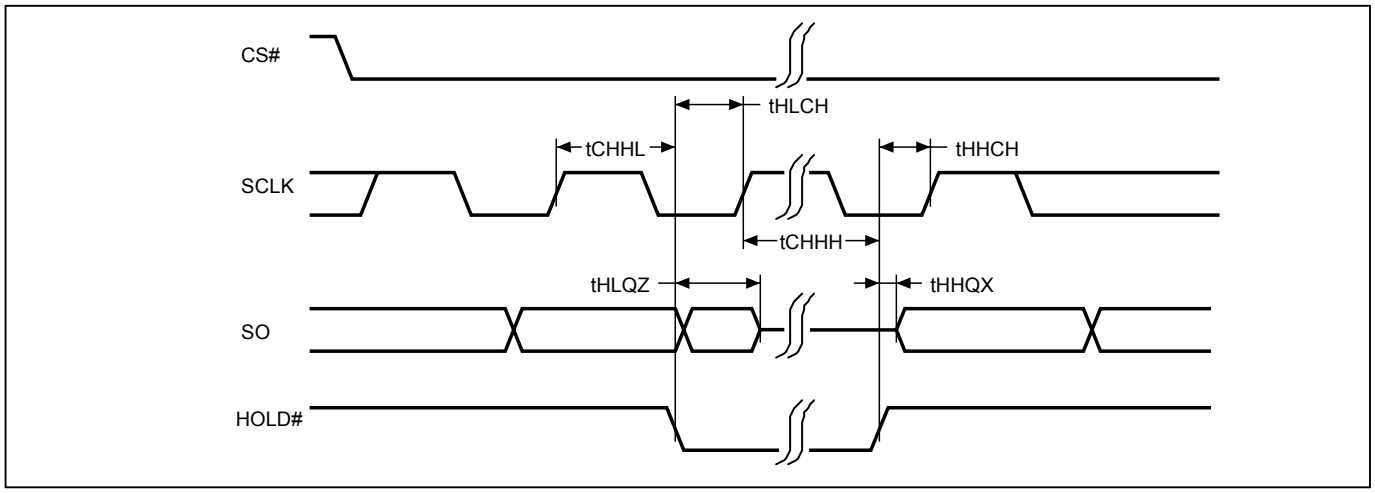


Figure 8. Output Timing



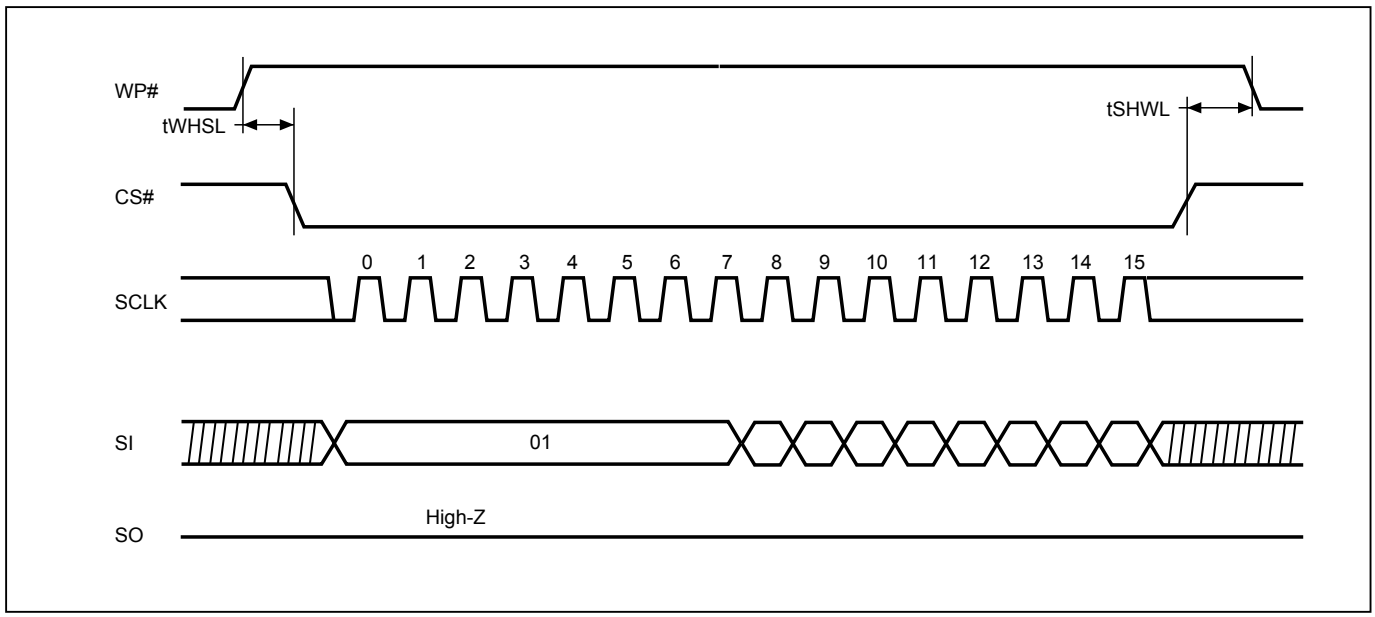
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Figure 9. Hold Timing



** SI is "don't care" during HOLD operation.*

Figure 10. WP# Disable Setup and Hold Timing during WRSR when SRWD=1



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Figure 11. Write Enable (WREN) Sequence (Command 06)

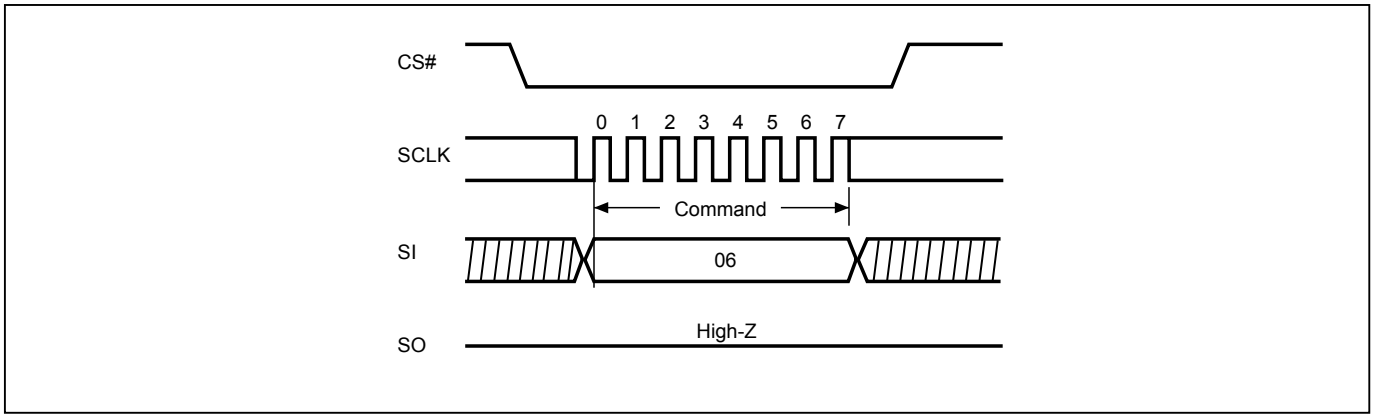


Figure 12. Write Disable (WRDI) Sequence (Command 04)

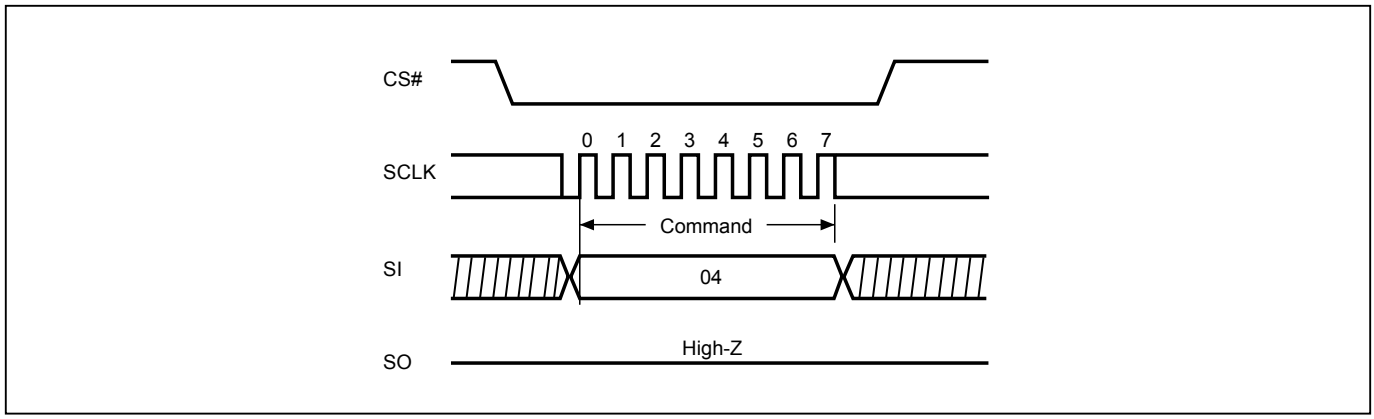
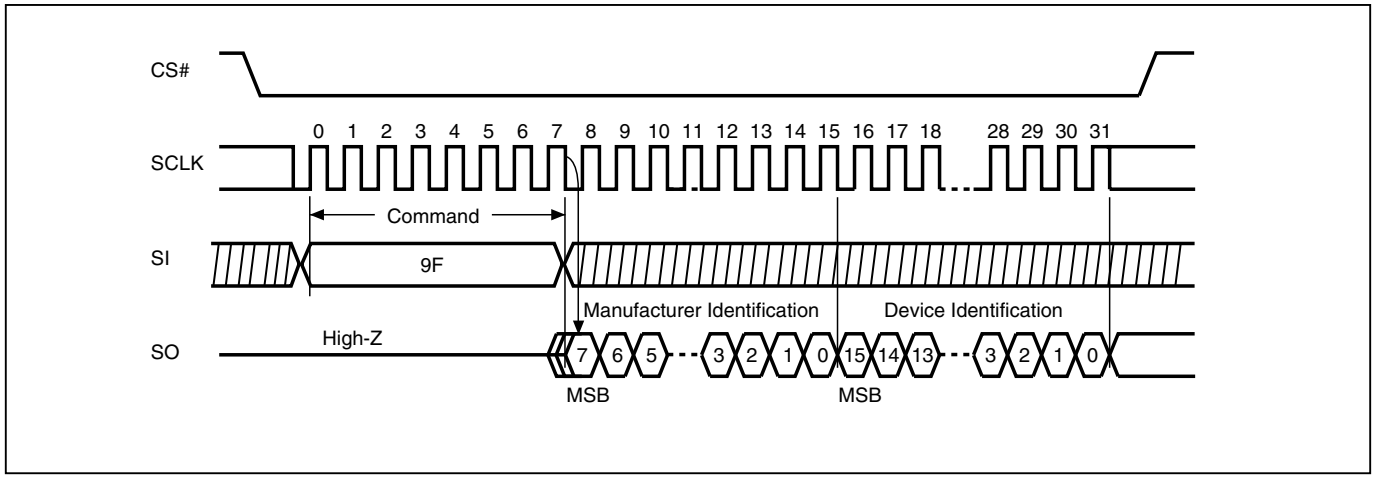


Figure 13. Read Identification (RDID) Sequence (Command 9F)



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Figure 14. Read Status Register (RDSR) Sequence (Command 05)

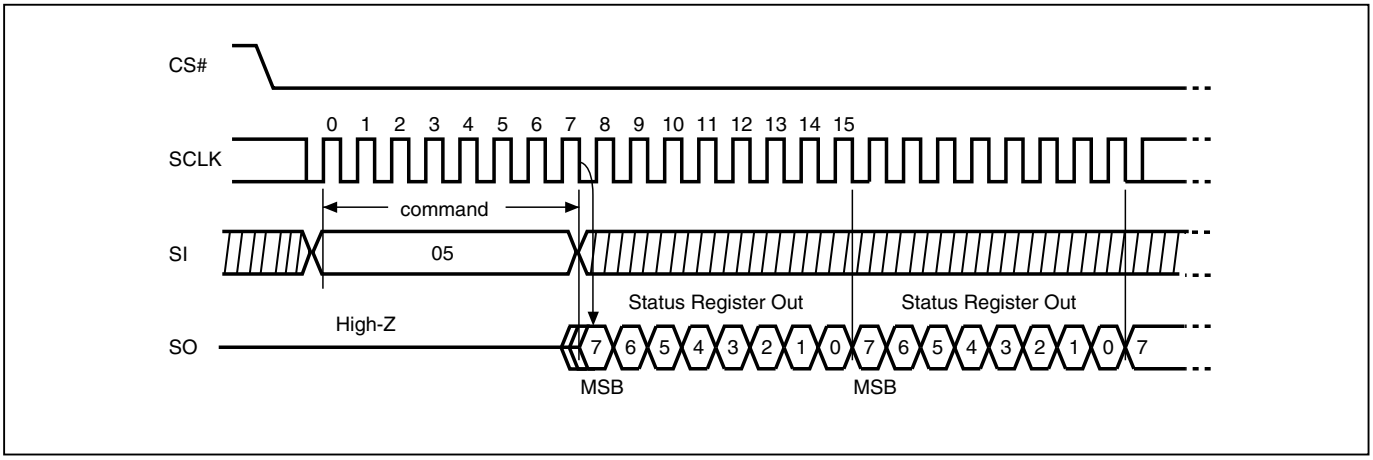


Figure 15. Write Status Register (WRSR) Sequence (Command 01)

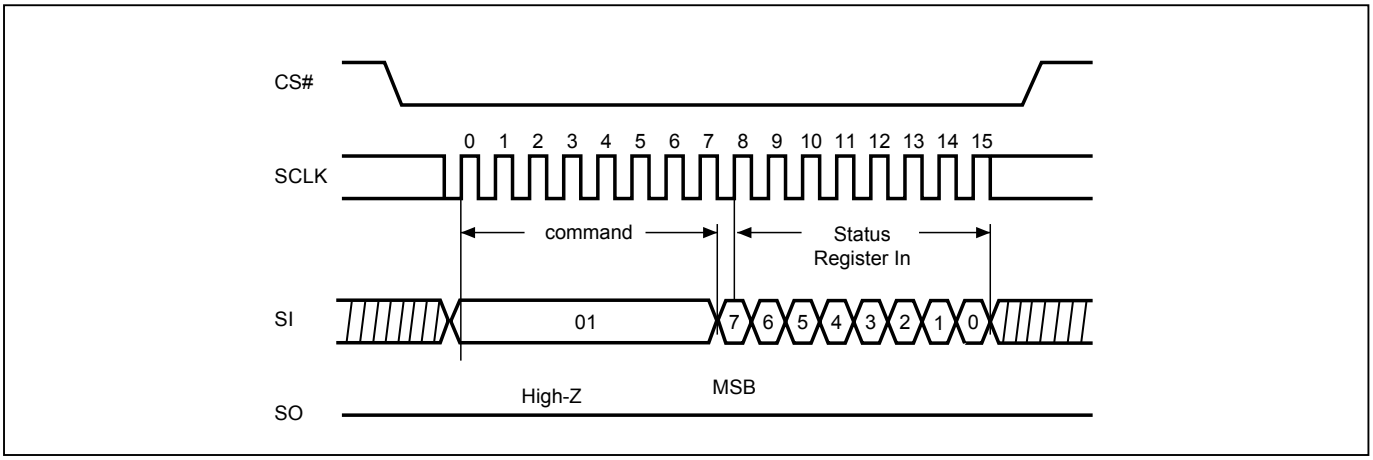
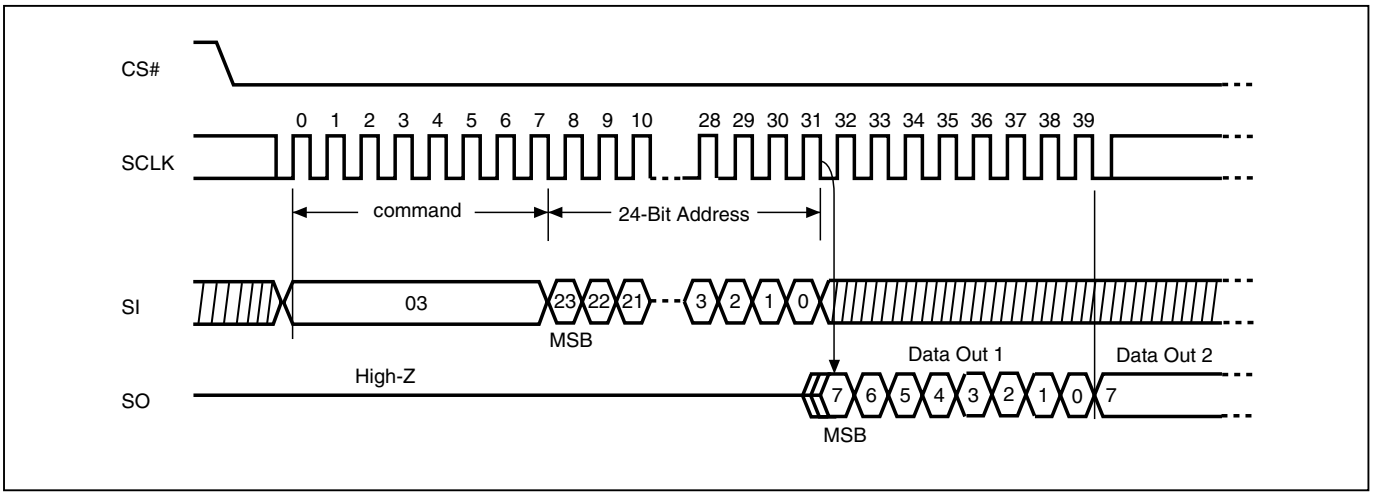


Figure 16. Read Data Bytes (READ) Sequence (Command 03)



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Figure 17. Read at Higher Speed (FAST_READ) Sequence (Command 0B)

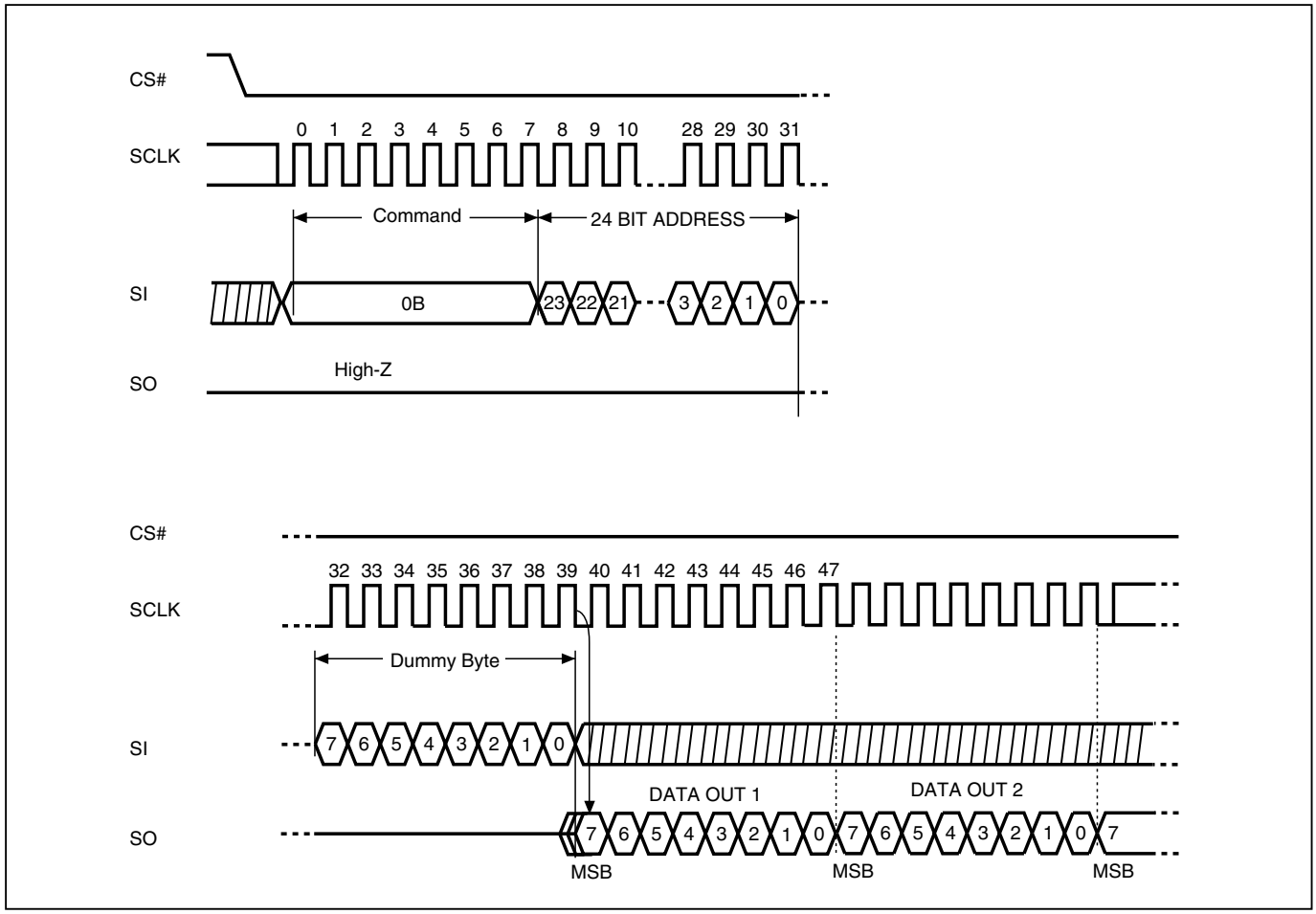


Figure 18. Dual Output Read Mode Sequence (Command 3B)

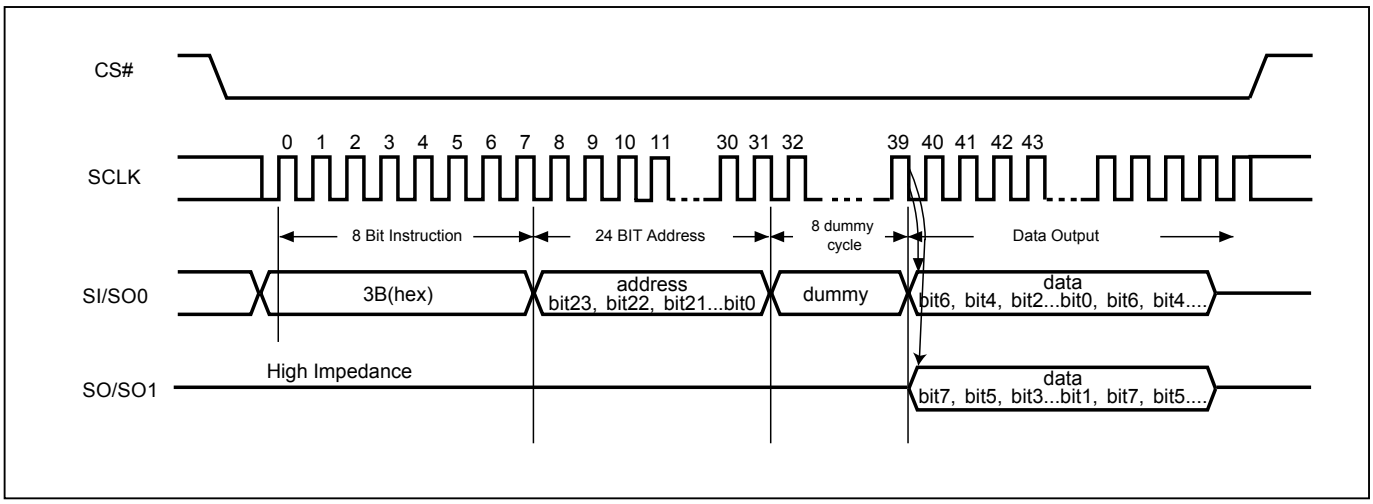
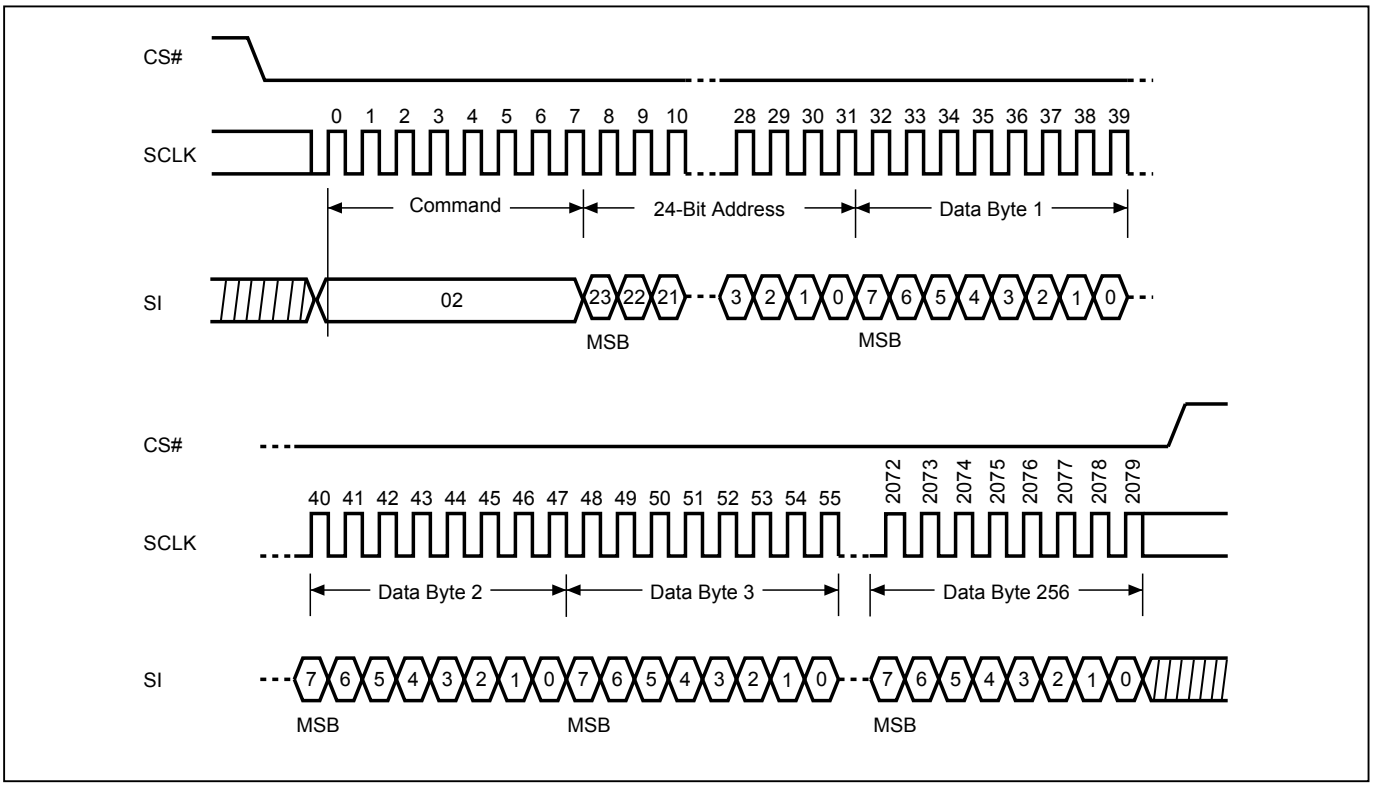
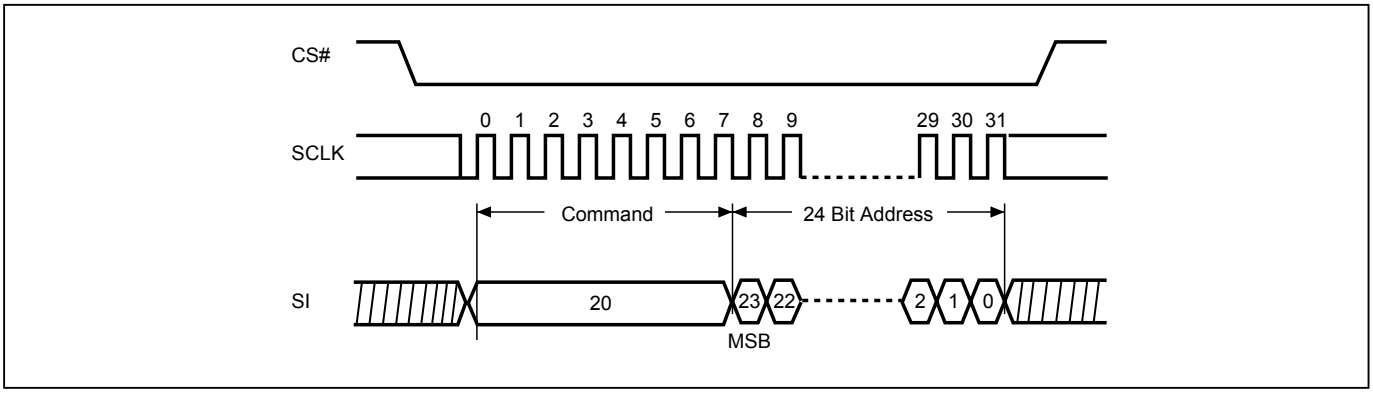


Figure 19. Page Program (PP) Sequence (Command 02)



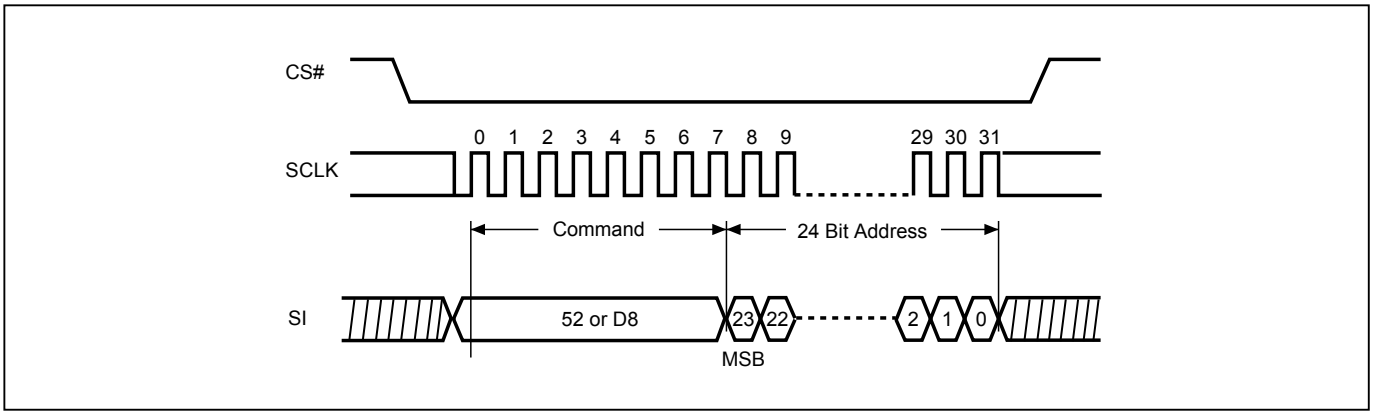
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Figure 20. Sector Erase (SE) Sequence (Command 20)



Note: *SE command is 20(hex).*

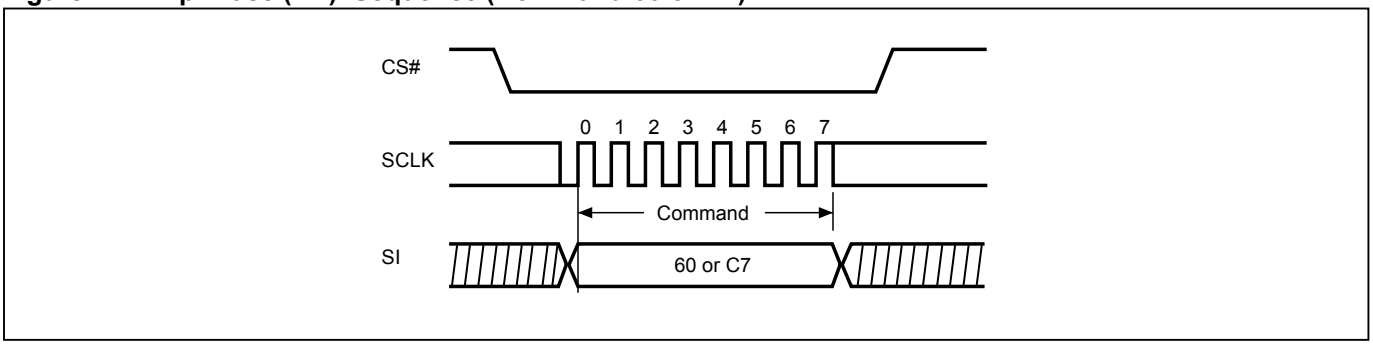
Figure 21. Block Erase (BE) Sequence (Command 52 or D8)



Note: *BE command is 52 or D8(hex).*

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Figure 22. Chip Erase (CE) Sequence (Command 60 or C7)



Note: *CE command is 60(hex) or C7(hex).*

Figure 23. Deep Power-down (DP) Sequence (Command B9)

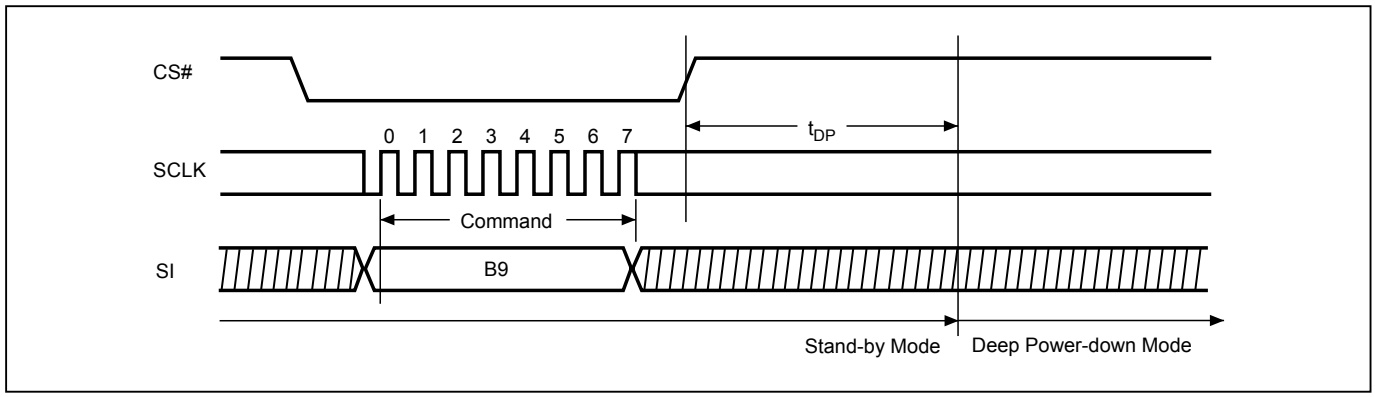
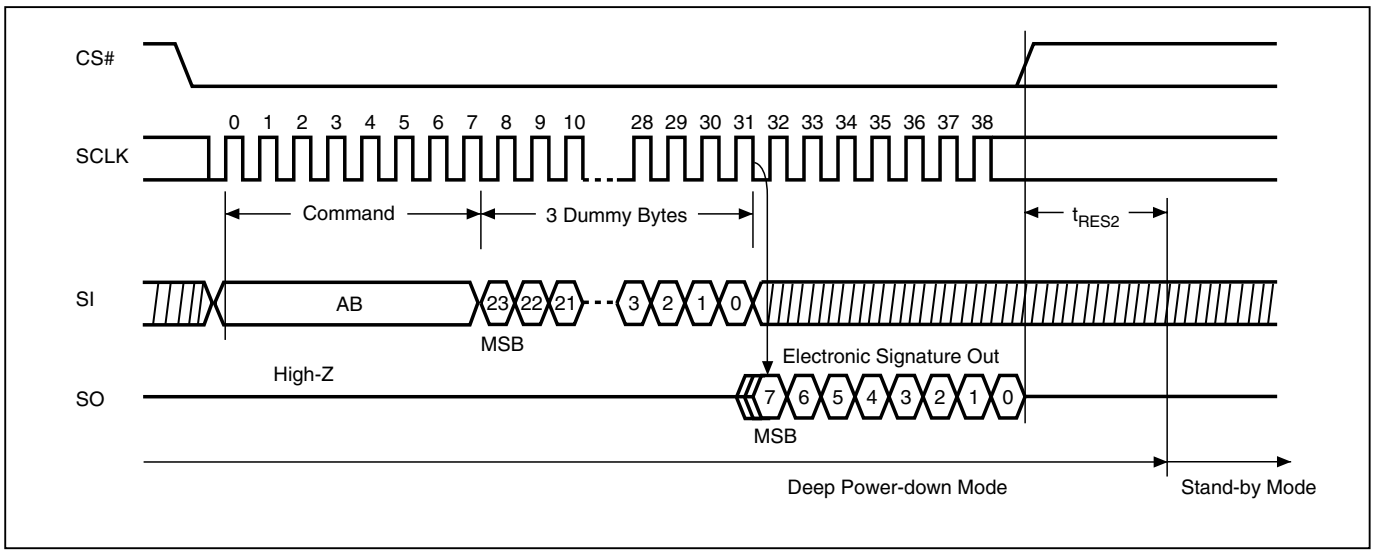


Figure 24. Read Electronic Signature (RES) Sequence (Command AB)



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Figure 25. Release from Deep Power-down (RDP) Sequence (Command AB)

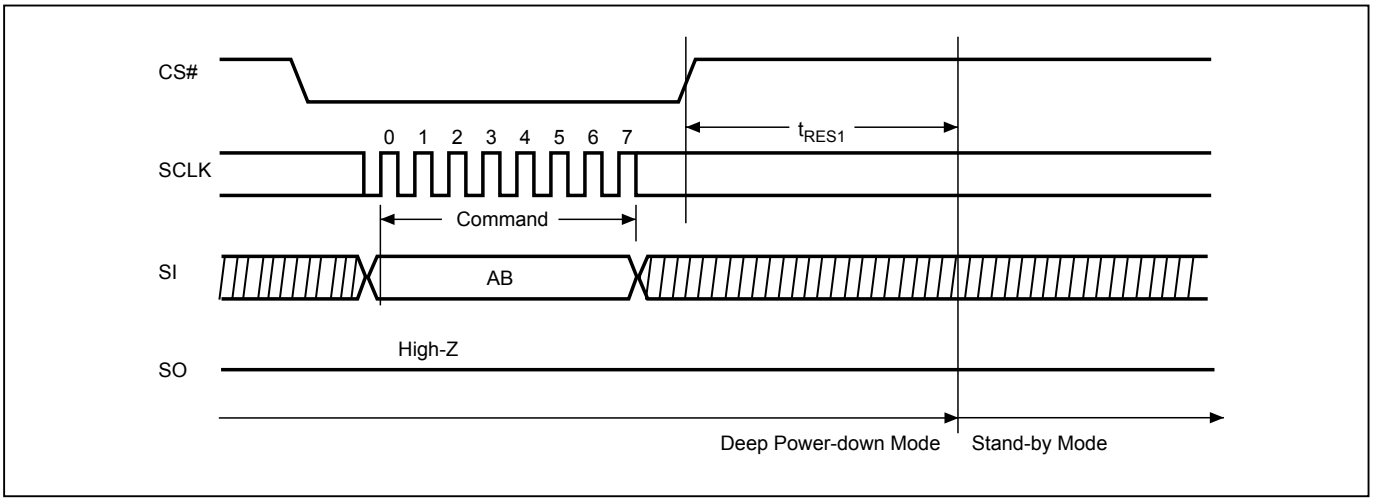
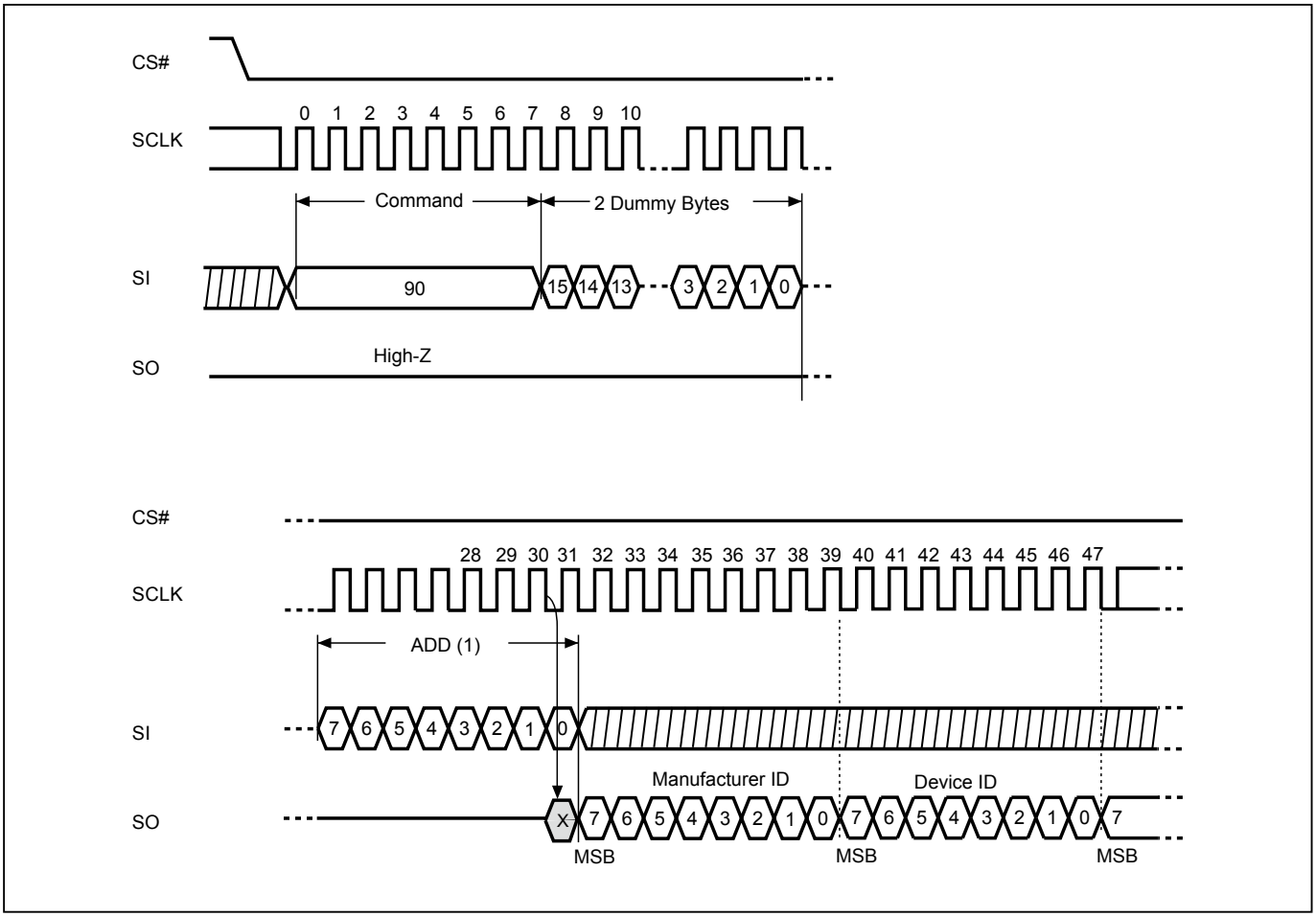


Figure 26. Read Electronic Manufacturer & Device ID (REMS) Sequence (Command 90)

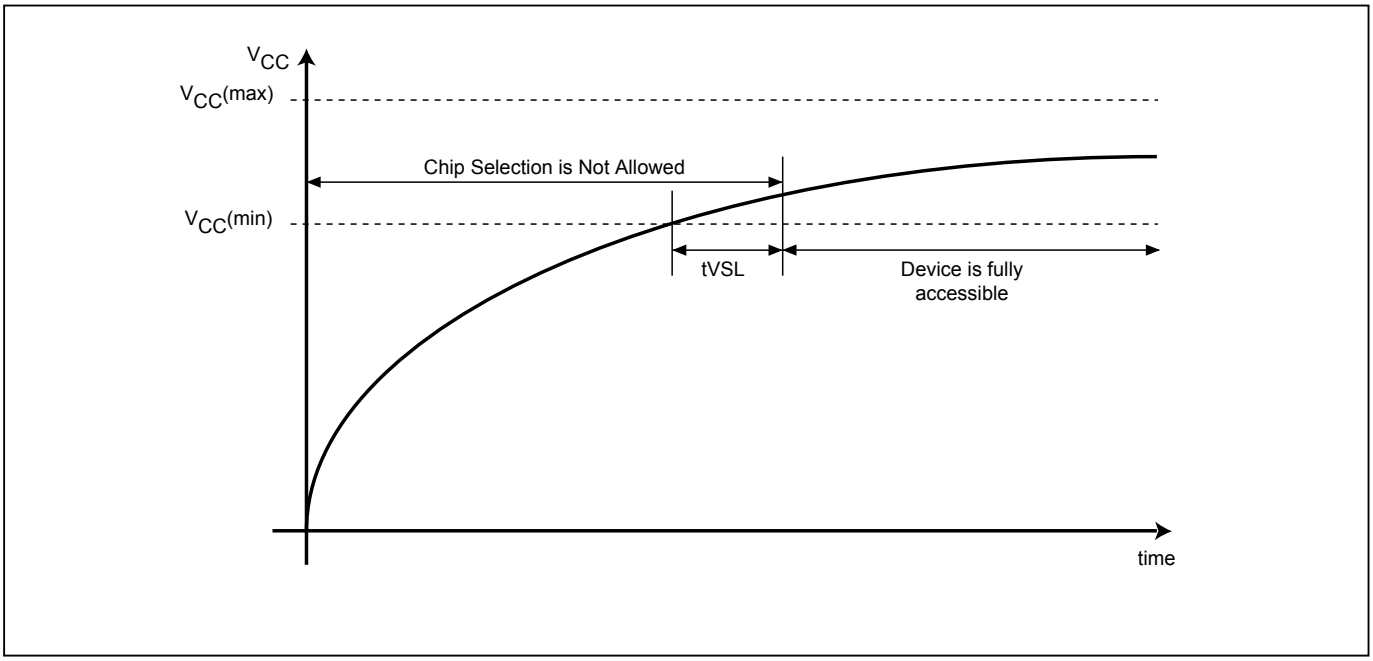


Notes:

(1) ADD=00H will output the manufacturer's ID first and ADD=01H will output device ID first

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Figure 27. Power-up Timing



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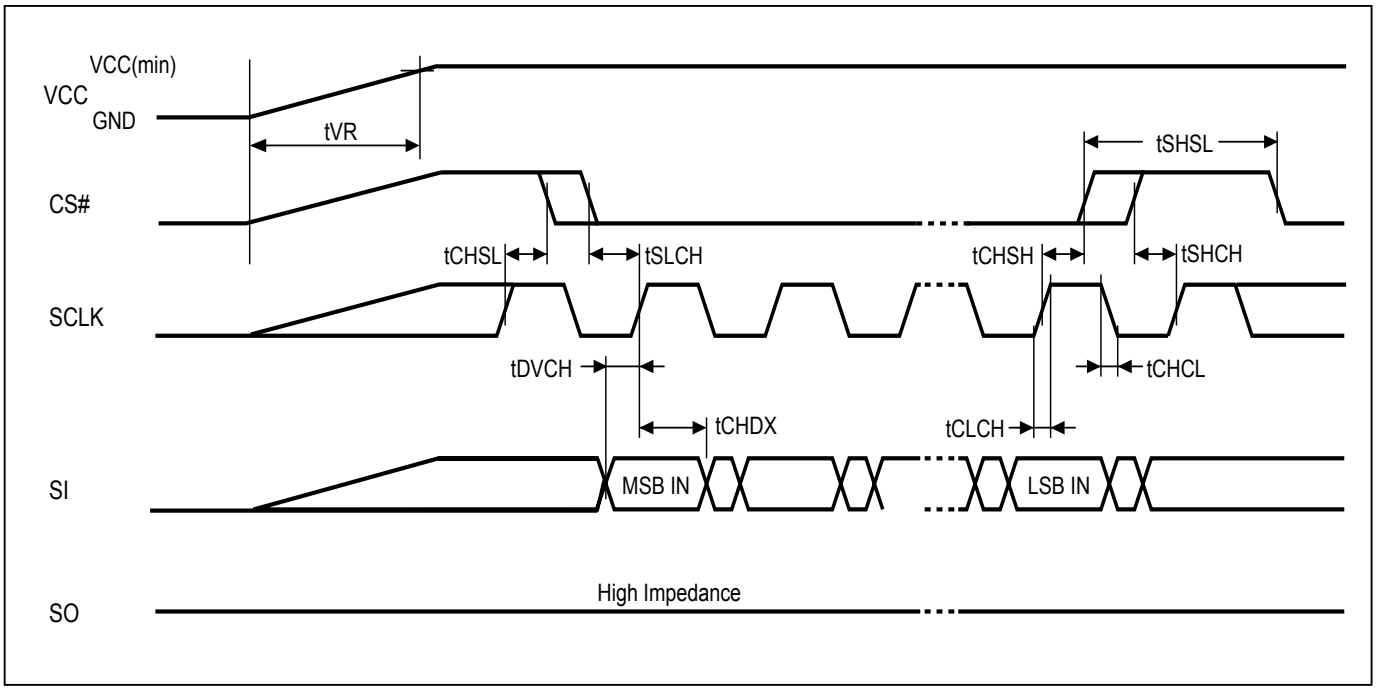
RECOMMENDED OPERATING CONDITIONS

At Device Power-Up

AC timing illustrated in *Figure 28* and *Figure 29* are for the supply voltages and the control signals at device power-up and power-down. If the timing in the figures is ignored, the device will not operate correctly.

During power-up and power-down, CS# needs to follow the voltage applied on VCC to keep the device not to be selected. The CS# can be driven low when VCC reach Vcc (min.) and wait a period of tVSL.

Figure 28. AC Timing at Device Power-Up



Symbol	Parameter	Notes	Min.	Max.	Unit
tVR	VCC Rise Time	1		500000	us/V

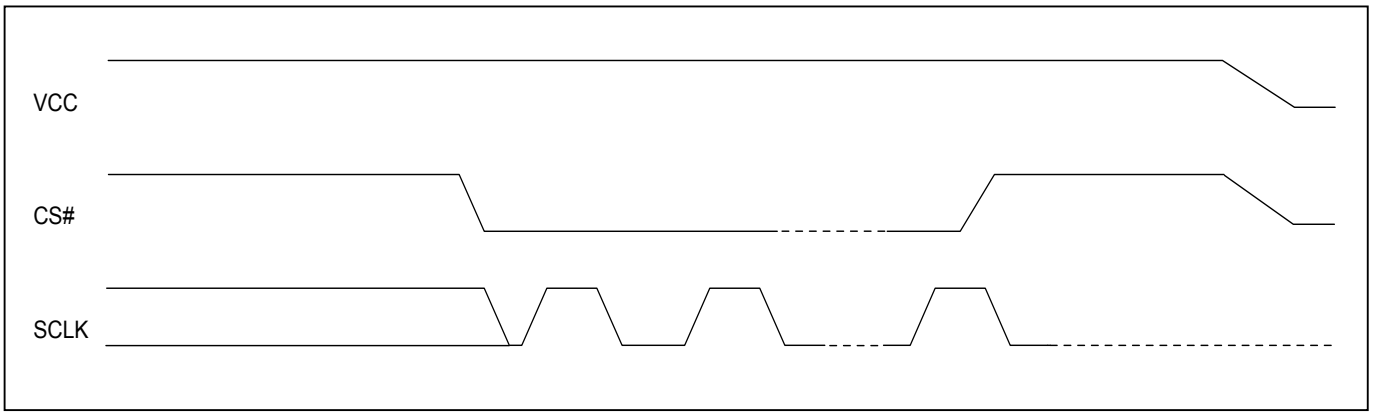
Notes :

1. *Sampled, not 100% tested.*
2. *For AC spec tCHSL, tSLCH, tDVCH, tCHDX, tSHSL, tCHSH, tSHCH, tCHCL, tCLCH in the figure, please refer to "AC CHARACTERISTICS" table.*

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Figure 29. Power-Down Sequence

During power-down, CS# needs to follow the voltage drop on VCC to avoid mis-operation.



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ERASE AND PROGRAMMING PERFORMANCE

Parameter	Min.	Typ. (1)	Max. (2)	Unit
Write Status Register Cycle Time		5	40	ms
Sector erase Time		40	200	ms
Block erase Time		0.4	1	s
Chip Erase Time		0.5	1	s
Byte Program Time (via page program command)		9	50	us
Page Program Time		0.6	1	ms
Erase/Program Cycle	100,000			cycles

Notes:
1. *Typical program and erase time assumes the following conditions: 25°C, 2.5V, and checker board pattern.*
2. *Under worst conditions of 85°C and 2.35V.*
3. *System-level overhead is the time required to execute the first-bus-cycle sequence for the programming command.*
4. *Erase/Program cycles comply with JEDEC: JESD47 & JESD22-A117 standard.*

DATA RETENTION

Parameter	Condition	Min.	Max.	Unit
Data retention	55˚C	20		years

LATCH-UP CHARACTERISTICS

	Min.	Max.
Input Voltage with respect to GND on all power pins, SI, CS#	-1.0V	2 VCCmax
Input Voltage with respect to GND on SO	-1.0V	VCC + 1.0V
Current	-100mA	+100mA
Includes all pins except VCC. Test conditions: VCC = 2.5V, one pin at a time.		

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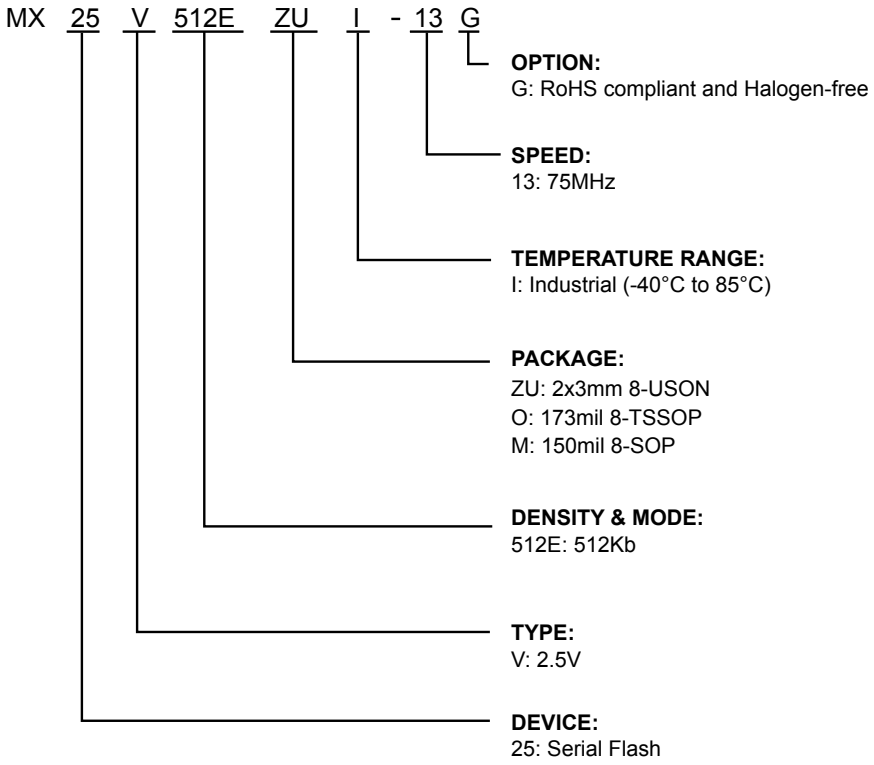
ORDERING INFORMATION

Please contact Macronix regional sales for the latest product selection and available form factors.

PART NO.	CLOCK (MHz)	Temperature	PACKAGE	Remark
MX25V512EZUI-13G	75	-40 to 85°C	8-USON (2x3mm)	
MX25V512EOI-13G	75	-40 to 85°C	8-TSSOP (173mil)	
MX25V512EMI-13G	75	-40 to 85°C	8-SOP (150mil)	

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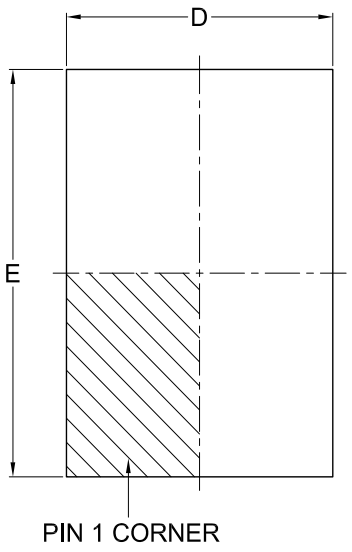
PART NAME DESCRIPTION



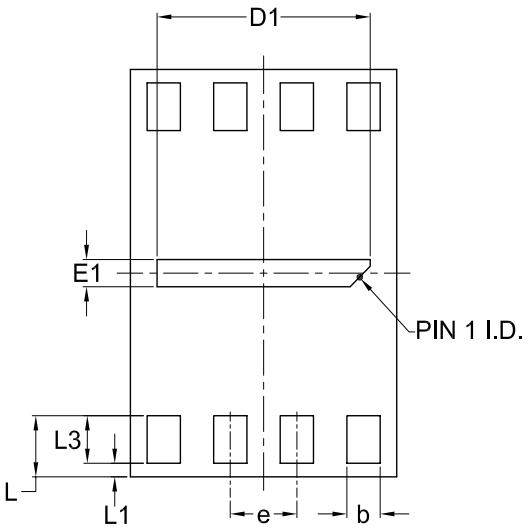
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PACKAGE INFORMATION

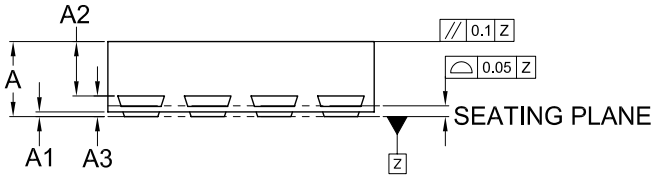
Doc. Title: Package Outline for USON 8L (2x3x0.6MM, LEAD PITCH 0.5MM)



TOP VIEW



BOTTOM VIEW



SIDE VIEW

Note:

This package has an exposed metal pad underneath the package. It is recommended to leave the metal pad floating or to connect it to the same ground as the GND pin of the package. Do not connect the metal pad to any other voltage or signal line on the PCB. Avoid placing vias or traces underneath the metal pad. Connection of this metal pad to any other voltage or signal line can result in shorts and/or electrical malfunction of the device.

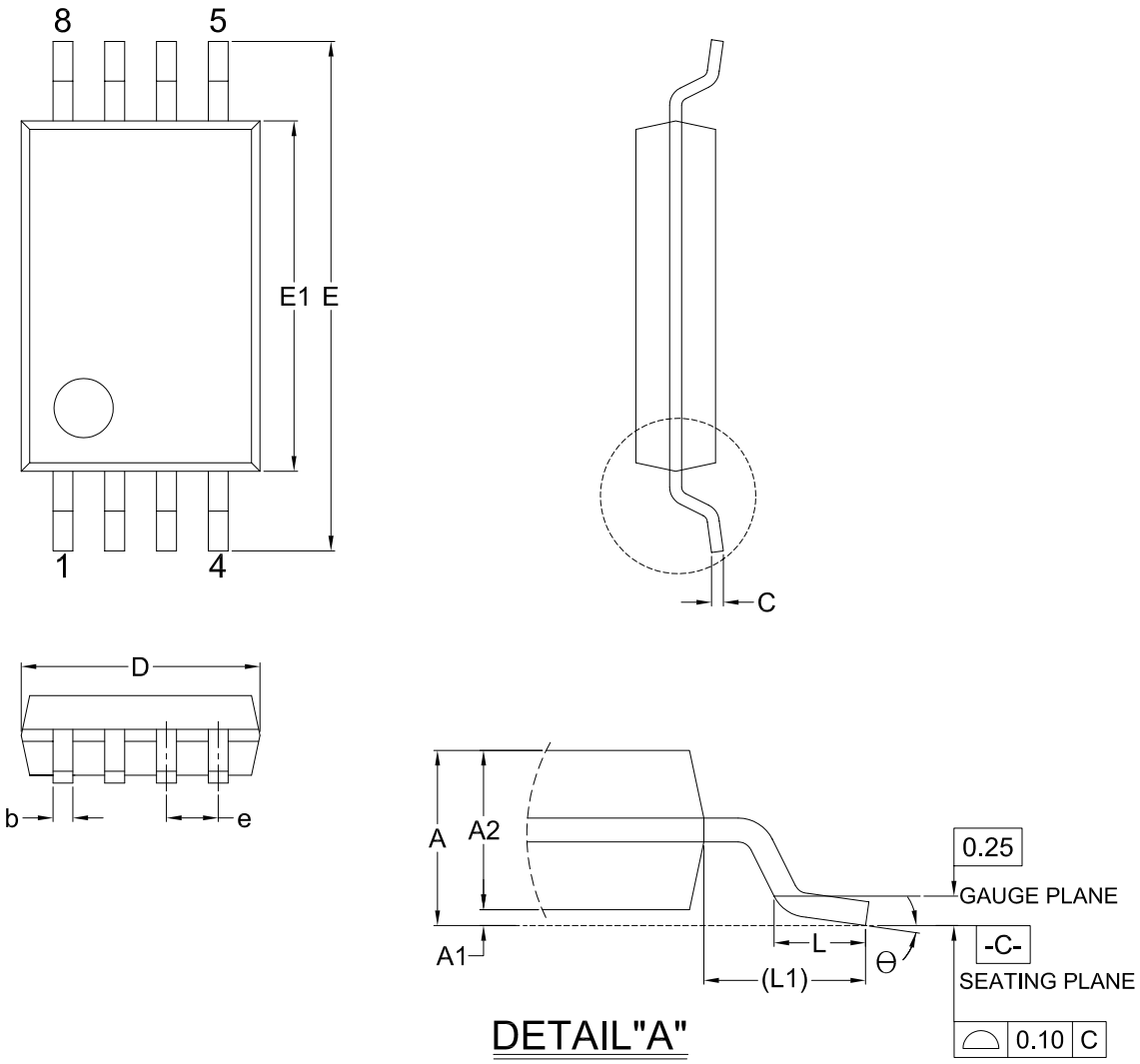
Dimensions (inch dimensions are derived from the original mm dimensions)

SYMBOL / UNIT		A	A1	A2	A3	b	D	D1	E	E1	e	L	L1	L3
mm	Min.	0.50	0	---	---	0.20	1.90	1.50	2.90	0.10	---	0.40	---	0.30
	Nom.	0.55	0.035	0.40	0.152	0.25	2.00	1.60	3.00	0.20	0.50	0.45	---	---
	Max.	0.60	0.05	0.425	---	0.30	2.10	1.70	3.10	0.30	---	0.50	0.15	---
Inch	Min.	0.020	0	---	---	0.008	0.075	0.059	0.114	0.004	---	0.016	---	0.012
	Nom.	0.022	0.0014	0.016	0.0060	0.010	0.079	0.063	0.118	0.008	0.020	0.018	---	---
	Max.	0.024	0.002	0.0167	---	0.012	0.083	0.067	0.122	0.012	---	0.020	0.006	---

Dwg. No.	Revision	Reference			
		JEDEC	EIAJ		
6110-3602	4	MO-252			

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Doe. Title: Package Outline for TSSOP 8L (173MIL)

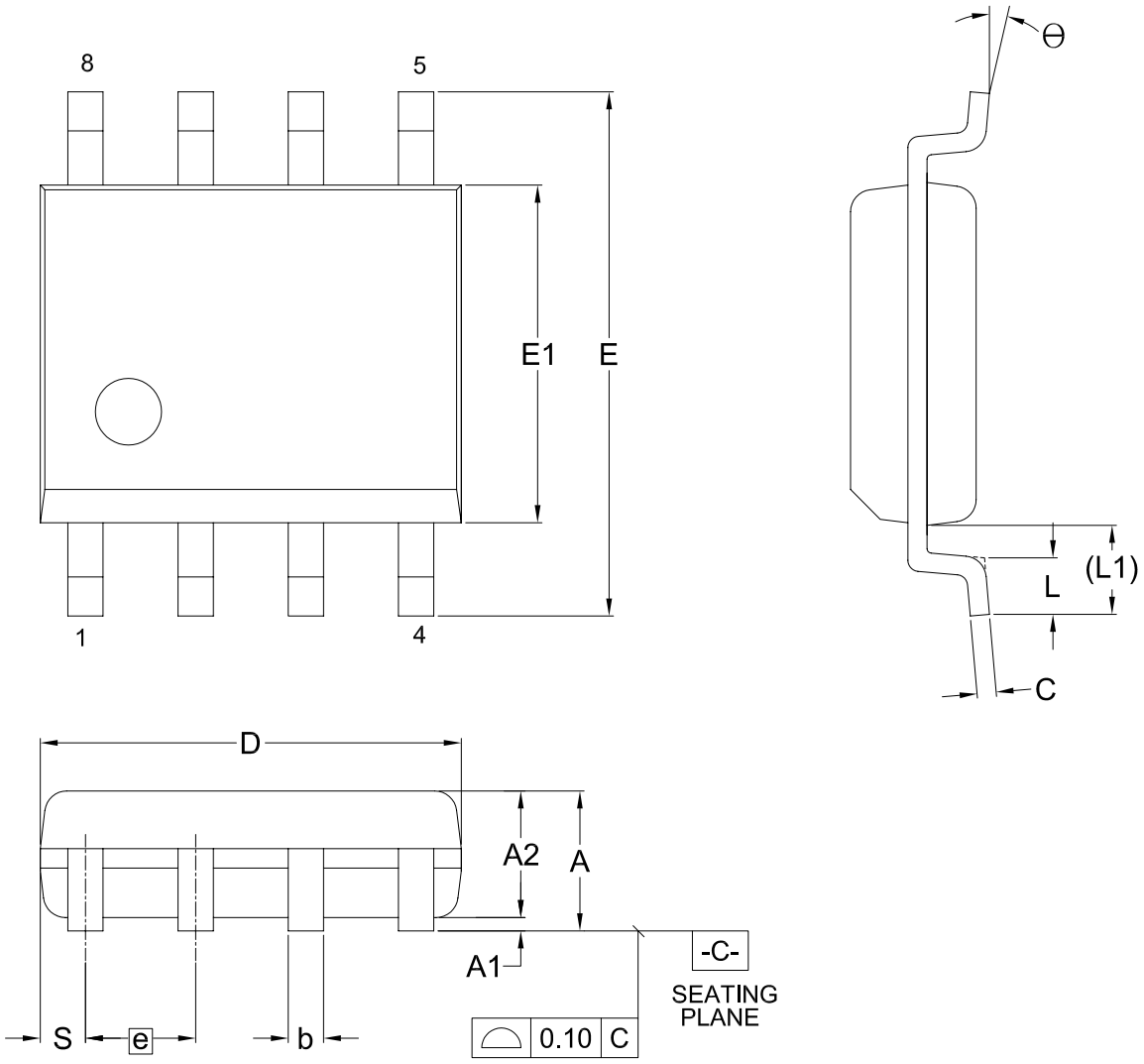


Dimensions (inch dimensions are derived from the original mm dimensions)

SYMBOL / UNIT		A	A1	A2	b	C	D	E	E1	e	L	L1	Θ
mm	Min.	---	0.05	0.80	0.20	0.10	2.90	6.30	4.30	---	0.45	0.85	0°
	Nom.	—	0.10	0.90	0.25	0.15	3.00	6.40	4.40	0.65	0.60	1.00	4°
	Max.	1.20	0.15	1.00	0.30	0.20	3.10	6.50	4.50	---	0.75	1.15	8°
Inch	Min.	—	0.002	0.031	0.008	0.004	0.114	0.248	0.169	—	0.018	0.033	0°
	Nom.	---	0.004	0.035	0.010	0.006	0.118	0.252	0.173	0.026	0.024	0.039	4°
	Max.	0.047	0.006	0.039	0.012	0.008	0.122	0.256	0.177	—	0.030	0.045	8°

Dwg. No.	Revision	Reference			
		JEDEC	EIAJ		
6110-1901.2	2	MO-153			

Doe. Title: Package Outline for SOP 8L (150MIL)



Dimensions (inch dimensions are derived from the original mm dimensions)

SYMBOL / UNIT		A	A1	A2	b	C	D	E	E1	e	L	L1	S	θ
mm	Min.	---	0.10	1.35	0.36	0.15	4.77	5.80	3.80	---	0.46	0.85	0.41	0°
	Nom.	---	0.15	1.45	0.41	0.20	4.90	5.99	3.90	1.27	0.66	1.05	0.54	5°
	Max.	1.75	0.20	1.55	0.51	0.25	5.03	6.20	4.00	---	0.86	1.25	0.67	8°
Inch	Min.	---	0.004	0.053	0.014	0.006	0.188	0.228	0.150	---	0.018	0.033	0.016	0°
	Nom.	---	0.006	0.057	0.016	0.008	0.193	0.236	0.154	0.050	0.026	0.041	0.021	5°
	Max.	0.069	0.008	0.061	0.020	0.010	0.198	0.244	0.158	---	0.034	0.049	0.026	8°

Dwg. No.	Revision	Reference			
		JEDEC	EIAJ		
6110-1401	8	MS-012			

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REVISION HISTORY

Revision No.	Description	Page	Date
1.0	1. Removed "Advanced Information"	P4	AUG/29/2011
1.1	1. Added 150mil 8-SOP package solution	P5,6,37, P38,41	MAY/16/2013
1.2	1. Removed "Advanced Information" status of MX25V512EMI-13G	P37	JUN/17/2013
1.3	1. Updated parameters for DC/AC Characteristics 2. Updated Erase and Programming Performance	P4,22,23 P4,36	NOV/13/2013
1.4	1. Description modification (For general features) 2. Updated tVR values 3. Added a statement for product ordering information	P4 P34 P37	JUN/07/2016

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