



MACRONIX
INTERNATIONAL Co., LTD.

MX25L512E

MX25L512E

DATASHEET

Contents

FEATURES	4
GENERAL	4
PERFORMANCE	4
SOFTWARE FEATURES	4
HARDWARE FEATURES	5
GENERAL DESCRIPTION	5
PIN CONFIGURATIONS	6
8-PIN SOP (150mil)	6
8-PIN TSSOP (173mil)	6
8-LAND USON (2x3mm)	6
PIN DESCRIPTION	6
BLOCK DIAGRAM	7
DATA PROTECTION	8
Table 1. Protected Area Sizes	9
HOLD FEATURE	9
Figure 1. Hold Condition Operation	9
Table 2. Command Definition	10
Table 3. Memory Organization	11
DEVICE OPERATION	11
Figure 2. Serial Modes Supported.....	11
COMMAND DESCRIPTION	12
(1) Write Enable (WREN).....	12
(2) Write Disable (WRDI).....	12
(3) Read Identification (RDID).....	12
(4) Read Status Register (RDSR)	13
Status Register.....	13
(5) Write Status Register (WRSR).....	14
Table 4. Protection Modes.....	14
(6) Read Data Bytes (READ)	15
(7) Read Data Bytes at Higher Speed (FAST_READ)	15
(9) Sector Erase (SE).....	15
(10) Block Erase (BE).....	16
(11) Chip Erase (CE).....	16
(12) Page Program (PP).....	16
(13) Deep Power-down (DP).....	17
(14) Release from Deep Power-down (RDP), Read Electronic Signature (RES)	17
(15) Read Electronic Manufacturer ID & Device ID (REMS).....	18
Table of ID Definitions	18
(16) Read SFDP Mode (RDSFDP).....	19
Read Serial Flash Discoverable Parameter (RDSFDP) Sequence.....	19
Table a. Signature and Parameter Identification Data Values	20
Table b. Parameter Table (0): JEDEC Flash Parameter Tables	21
Table c. Parameter Table (1): Macronix Flash Parameter Tables.....	23

POWER-ON STATE	25
ELECTRICAL SPECIFICATIONS	26
ABSOLUTE MAXIMUM RATINGS	26
Figure 3. Maximum Negative Overshoot Waveform	26
CAPACITANCE TA = 25°C, f = 1.0 MHz	26
Figure 4. Maximum Positive Overshoot Waveform	26
Figure 5. INPUT TEST WAVEFORMS AND MEASUREMENT LEVEL	27
Figure 6. OUTPUT LOADING	27
Table 5. DC CHARACTERISTICS (Temperature = -40°C to 85°C for Industrial grade, VCC = 2.7V ~ 3.6V)	28
Table 6. AC CHARACTERISTICS (Temperature = -40°C to 85°C for Industrial grade, VCC = 2.7V ~ 3.6V)	29
Table 7. Power-Up Timing	30
INITIAL DELIVERY STATE	30
Figure 7. Serial Input Timing	30
Figure 8. Output Timing	30
Figure 9. Hold Timing	31
Figure 10. WP# Disable Setup and Hold Timing during WRSR when SRWD=1	31
Figure 11. Write Enable (WREN) Sequence (Command 06)	32
Figure 12. Write Disable (WRDI) Sequence (Command 04)	32
Figure 13. Read Identification (RDID) Sequence (Command 9F)	32
Figure 14. Read Status Register (RDSR) Sequence (Command 05)	33
Figure 15. Write Status Register (WRSR) Sequence (Command 01)	33
Figure 16. Read Data Bytes (READ) Sequence (Command 03)	33
Figure 17. Read at Higher Speed (FAST_READ) Sequence (Command 0B)	34
Figure 18. Dual Output Read Mode Sequence (Command 3B)	34
Figure 19. Page Program (PP) Sequence (Command 02)	35
Figure 20. Sector Erase (SE) Sequence (Command 20)	36
Figure 21. Block Erase (BE) Sequence (Command 52 or D8)	36
Figure 22. Chip Erase (CE) Sequence (Command 60 or C7)	37
Figure 23. Deep Power-down (DP) Sequence (Command B9)	37
Figure 24. Read Electronic Signature (RES) Sequence (Command AB)	37
Figure 25. Release from Deep Power-down (RDP) Sequence (Command AB)	38
Figure 26. Read Electronic Manufacturer & Device ID (REMS) Sequence (Command 90)	38
Figure 27. Power-up Timing	39
RECOMMENDED OPERATING CONDITIONS	40
Figure 28. AC Timing at Device Power-Up	40
Figure 29. Power-Down Sequence	41
ERASE AND PROGRAMMING PERFORMANCE	42
DATA RETENTION	42
LATCH-UP CHARACTERISTICS	42
ORDERING INFORMATION	43
PART NAME DESCRIPTION	44
PACKAGE INFORMATION	45
REVISION HISTORY	48

FEATURES**GENERAL**

- Serial Peripheral Interface compatible -- 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
 - 2.7 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: 104MHz serial clock
 - Serial clock of Dual Output mode: 80MHz
 - Fast program time: 1.4ms(typ.) and 5ms(max.)/page (256-byte per page)
 - Byte program time: 9us
 - Fast erase time: 60ms(typ.)/sector (4K-byte per sector) ; 0.7s(typ.) and 2s(max.)/chip
- Low Power Consumption
 - Low active read current: 12mA(max.) at 104MHz and 4mA(max.) at 33MHz
 - Low active programming current: 20mA (max.)
 - Low active sector erase current: 15mA (max.)
 - Low standby current: 25uA (max.)
 - Deep power-down mode 5uA (typical)
- 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 programmed should have page in the erased state first)
- Status Register Feature
- Electronic Identification
 - JEDEC 2-byte Device ID
 - RES command, 1-byte Device ID
- Support Serial Flash Discoverable Parameters (SFDP) mode

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 deselecting the chip
- PACKAGE
 - 8-pin SOP (150mil)
 - 8-USON (2x3mm)
 - 8-pin TSSOP (173mil)
 - **All devices are RoHS Compliant**

GENERAL DESCRIPTION

MX25L512E is a CMOS 524,288 bit serial Flash memory, which is configured as 65,536 x 8 internally. MX25L512E 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.

MX25L512E 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).

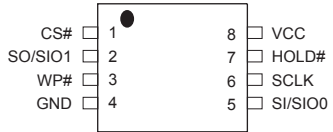
To provide user with ease of interface, a status register is included to indicate the status of the chip. The status read command can be issued to detect completion status of a program or erase operation via WIP bit.

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

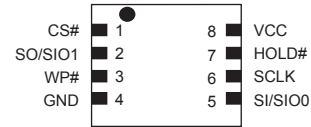
The MX25L512E utilizes Macronix's proprietary memory cell, which reliably stores memory contents even after 100,000 program and erase cycles.

PIN CONFIGURATIONS

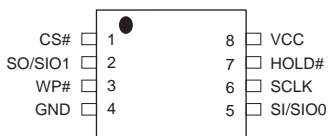
8-PIN SOP (150mil)



8-LAND USON (2x3mm)



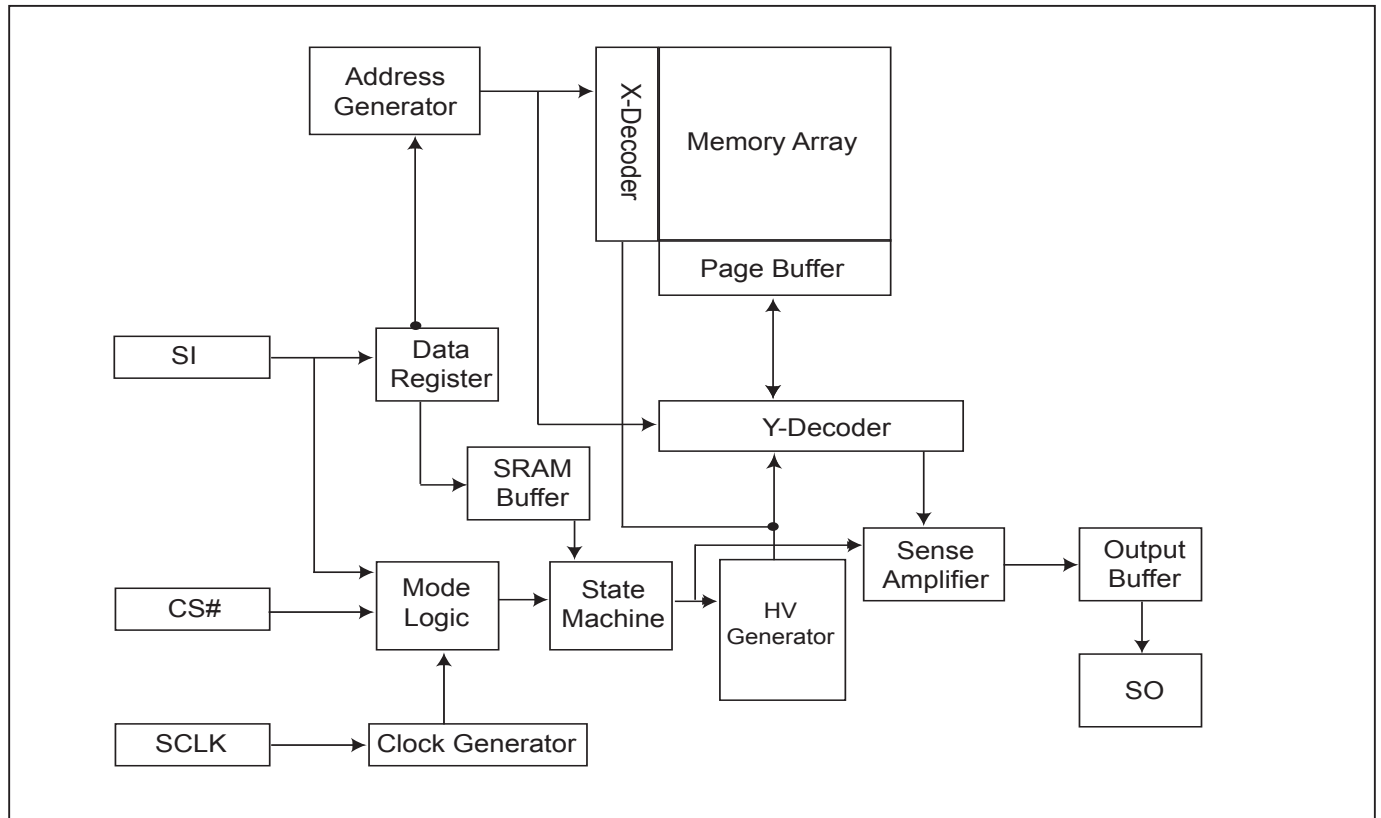
8-PIN TSSOP (173mil)



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

BLOCK DIAGRAM



DATA PROTECTION

MX25L512E is designed to offer protection against accidental erasure or programming caused by spurious system level signals that may exist during power transition. During power up the device automatically resets the state machine in the standby mode. In addition, with its control register architecture, alteration of the memory contents only occurs after successful completion of specific command sequences. The device also incorporates several features to prevent inadvertent write cycles resulting from VCC power-up and power-down transition or 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 other command 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).

Table 1. Protected Area Sizes

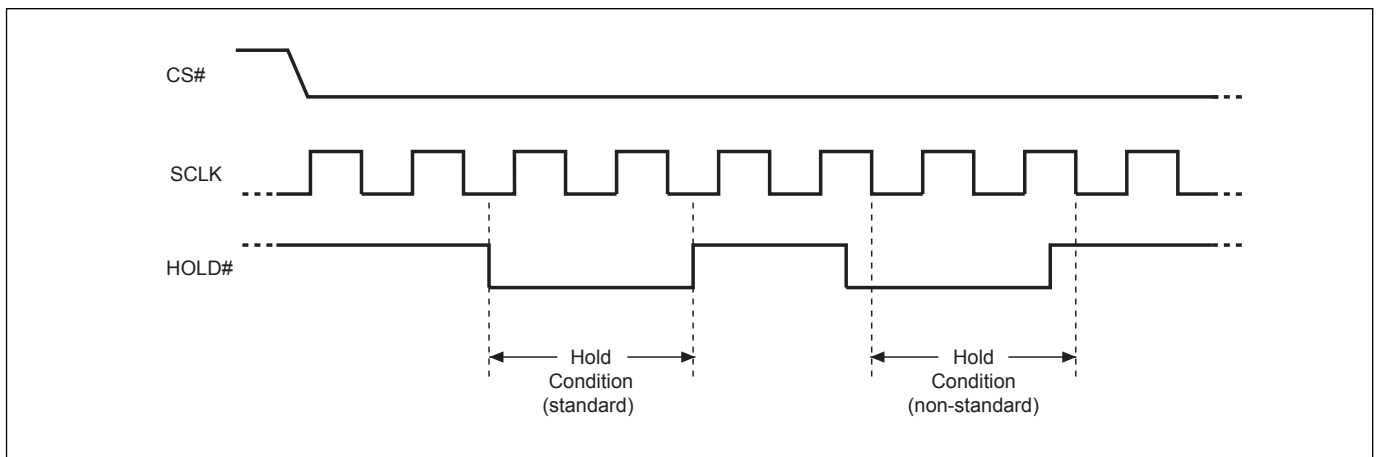
Status bit		Protect level	512b
BP1	BP0		
0	0	0 (none)	None
0	1	1 (All)	All
1	0	2 (All)	All
1	1	3 (All)	All

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.

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)	RDSFDP (Read SFDP)	DREAD (Dual Output mode)	SE (Sector Erase)	BE (Block Erase) (2)	CE (Chip Erase)
1st	0B (hex)	5A (hex)	3B (hex)	20 (hex)	52 or D8 (hex)	60 or C7 (hex)
2nd	AD1	AD1	AD1	AD1	AD1	
3rd	AD2	AD2	AD2	AD2	AD2	
4th	AD3	AD3	AD3	AD3	AD3	
5th	Dummy	Dummy				
Action	n bytes read out until CS# goes high	Read SFDP mode	n bytes read out until CS# goes high	to erase the selected sector	to erase the selected block	to erase the whole chip

COMMAND (byte)	PP (Page Program)	DP (Deep Power-down)	RDP (Release from Deep Power-down)	RES (Read Electronic ID)	REMS (Read Electronic Manufacturer & Device ID)
1st	02 (hex)	B9 (hex)	AB (hex)	AB (hex)	90 (hex)
2nd	AD1			x	x
3rd	AD2			x	x
4th	AD3			x	ADD(1)
5th					
Action	to program the selected page	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.

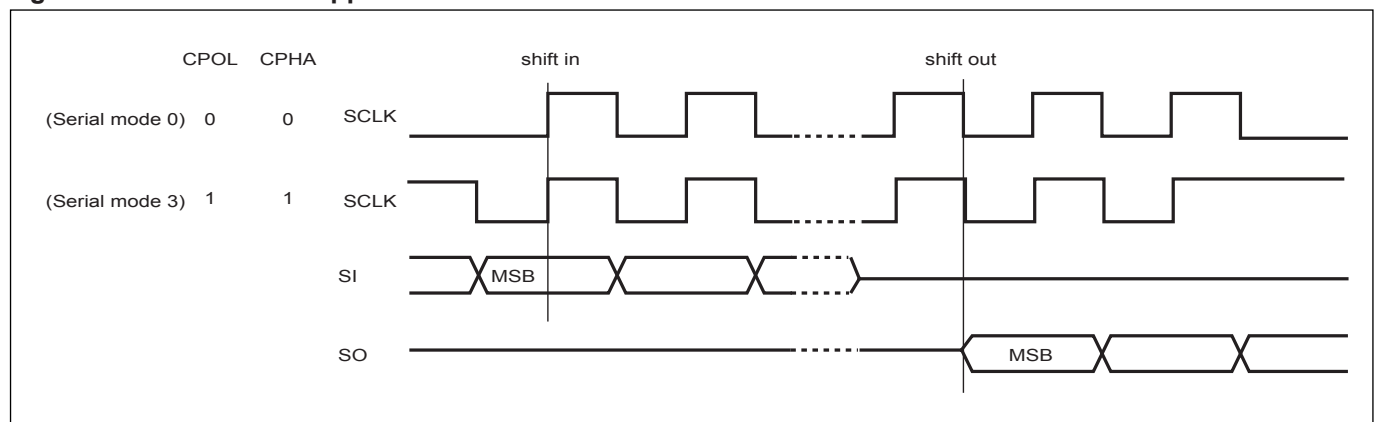
Table 3. Memory Organization

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 LSI, this LSI becomes standby mode and keeps the 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 LSI, this LSI becomes active mode and keeps the 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 shifts 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, RDSFDP, 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. During the progress of Write Status Register, Program, Erase operation, to access the memory array is neglected and 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.

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 MXIC 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 MX25L512E.

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.

(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](#)".

(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.

(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 f_R . 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 f_C . 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 f_T . 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 latest eighth of address byte been latched-in); otherwise, the instruction will be rejected and not executed.

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 out during the Sector Erase cycle is in progress. The WIP sets 1 during the tSE timing, and sets 0 when Sector Erase Cycle is completed, and the Write Enable Latch (WEL) bit is reset. 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 execute 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 latest eighth 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 check out during the Sector Erase cycle is in progress. The WIP sets 1 during the tBE timing, and sets 0 when Sector Erase Cycle is completed, and the Write Enable Latch (WEL) bit is reset. 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 execute 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 check out during the Chip Erase cycle is in progress. The WIP sets 1 during the tCE timing, and sets 0 when Chip Erase Cycle is completed, and the Write Enable Latch (WEL) bit is reset. 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 execute to set the Write Enable Latch (WEL) bit before sending the Page Program (PP). If the eight least significant address bits (A7-A0) are not all 0, all transmitted data which goes beyond the end of the current page are programmed from the start address if the same page (from the address whose 8 least significant address bits (A7-A0) are all 0). 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 instruction will be rejected and not

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 MXIC (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	

(16) Read SFDP Mode (RDSFDP)

The Serial Flash Discoverable Parameter (SFDP) standard provides a consistent method of describing the functional and feature capabilities of serial flash devices in a standard set of internal parameter tables. These parameter tables can be interrogated by host system software to enable adjustments needed to accommodate divergent features from multiple vendors. The concept is similar to the one found in the Introduction of JEDEC Standard, JESD68 on CFI.

The sequence of issuing RDSFDP instruction is CS# goes low→send RDSFDP instruction (5Ah)→send 3 address bytes on SI pin→send 1 dummy byte on SI pin→read SFDP code on SO→to end RDSFDP operation can use CS# to high at any time during data out.

SFDP is a standard of JEDEC. JESD216. v1.0.

Read Serial Flash Discoverable Parameter (RDSFDP) Sequence

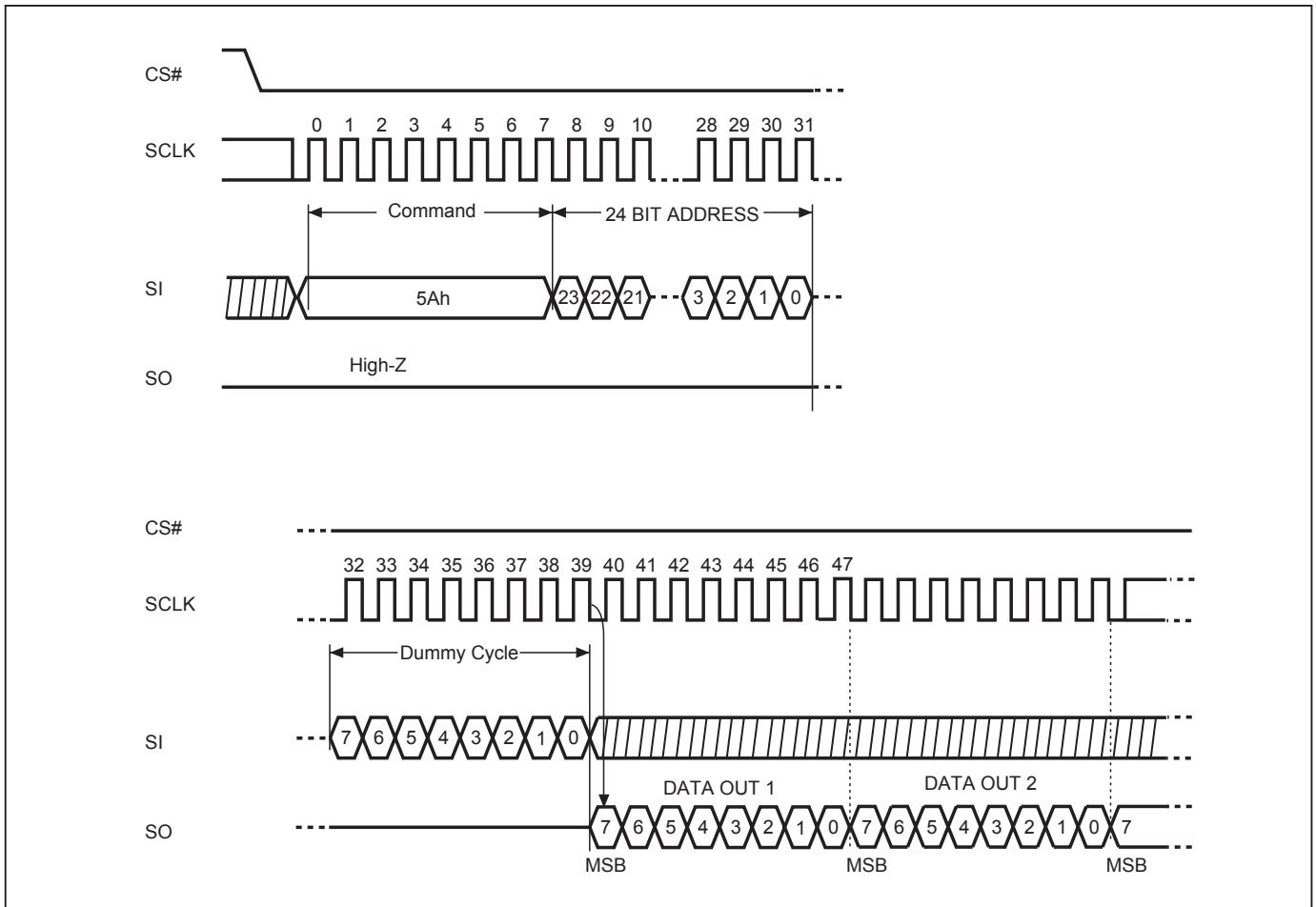


Table a. Signature and Parameter Identification Data Values

Description	Comment	Add (h) (Byte)	DW Add (Bit)	Data (h/b) (Note1)	Data (h)
SFDP Signature	Fixed: 50444653h	00h	07:00	53h	53h
		01h	15:08	46h	46h
		02h	23:16	44h	44h
		03h	31:24	50h	50h
SFDP Minor Revision Number	Start from 00h	04h	07:00	00h	00h
SFDP Major Revision Number	Start from 01h	05h	15:08	01h	01h
Number of Parameter Headers	Start from 01h	06h	23:16	01h	01h
Unused		07h	31:24	FFh	FFh
ID number (JEDEC)	00h: it indicates a JEDEC specified header.	08h	07:00	00h	00h
Parameter Table Minor Revision Number	Start from 00h	09h	15:08	00h	00h
Parameter Table Major Revision Number	Start from 01h	0Ah	23:16	01h	01h
Parameter Table Length (in double word)	How many DWORDs in the Parameter table	0Bh	31:24	09h	09h
Parameter Table Pointer (PTP)	First address of JEDEC Flash Parameter table	0Ch	07:00	30h	30h
		0Dh	15:08	00h	00h
		0Eh	23:16	00h	00h
Unused		0Fh	31:24	FFh	FFh
ID number (Macronix manufacturer ID)	it indicates Macronix manufacturer ID	10h	07:00	C2h	C2h
Parameter Table Minor Revision Number	Start from 00h	11h	15:08	00h	00h
Parameter Table Major Revision Number	Start from 01h	12h	23:16	01h	01h
Parameter Table Length (in double word)	How many DWORDs in the Parameter table	13h	31:24	04h	04h
Parameter Table Pointer (PTP)	First address of Macronix Flash Parameter table	14h	07:00	60h	60h
		15h	15:08	00h	00h
		16h	23:16	00h	00h
Unused		17h	31:24	FFh	FFh

Table b. Parameter Table (0): JEDEC Flash Parameter Tables

Description	Comment	Add (h) (Byte)	DW Add (Bit)	Data (h/b) (Note1)	Data (h)
Block/Sector Erase sizes	00: Reserved, 01: 4KB erase, 10: Reserved, 11: not suport 4KB erase	30h	01:00	01b	E5h
Write Granularity	0: 1Byte, 1: 64Byte or larger		02	1b	
Write Enable Instruction Requested for Writing to Volatile Status Registers	0: Nonvolatile status bit 1: Volatile status bit (BP status register bit)		03	0b	
Write Enable Opcode Select for Writing to Volatile Status Registers	0: use 50h opcode, 1: use 06h opcode Note: If target flash status register is nonvolatile, then bits 3 and 4 must be set to 00b.		04	0b	
Unused	Contains 111b and can never be changed		07:05	111b	
4KB Erase Opcode		31h	15:08	20h	20h
(1-1-2) Fast Read (Note2)	0=not support 1=support	32h	16	1b	81h
Address Bytes Number used in addressing flash array	00: 3Byte only, 01: 3 or 4Byte, 10: 4Byte only, 11: Reserved		18:17	00b	
Double Transfer Rate (DTR) Clocking	0=not support 1=support		19	0b	
(1-2-2) Fast Read	0=not support 1=support		20	0b	
(1-4-4) Fast Read	0=not support 1=support		21	0b	
(1-1-4) Fast Read	0=not support 1=support		22	0b	
Unused			23	1b	
Unused		33h	31:24	FFh	FFh
Flash Memory Density		37h:34h	31:00	0007FFFFh	
(1-4-4) Fast Read Number of Wait states (Note3)	0 0000b: Wait states (Dummy Clocks) not support	38h	04:00	0 0000b	00h
(1-4-4) Fast Read Number of Mode Bits (Note4)	000b: Mode Bits not support		07:05	000b	
(1-4-4) Fast Read Opcode		39h	15:08	FFh	FFh
(1-1-4) Fast Read Number of Wait states	0 0000b: Wait states (Dummy Clocks) not support	3Ah	20:16	0 0000b	00h
(1-1-4) Fast Read Number of Mode Bits	000b: Mode Bits not support		23:21	000b	
(1-1-4) Fast Read Opcode		3Bh	31:24	FFh	FFh

Description	Comment	Add (h) (Byte)	DW Add (Bit)	Data (h/b) (Note1)	Data (h)
(1-1-2) Fast Read Number of Wait states	0 0000b: Wait states (Dummy Clocks) not support	3Ch	04:00	0 1000b	08h
(1-1-2) Fast Read Number of Mode Bits	000b: Mode Bits not support		07:05	000b	
(1-1-2) Fast Read Opcode		3Dh	15:08	3Bh	3Bh
(1-2-2) Fast Read Number of Wait states	0 0000b: Wait states (Dummy Clocks) not support	3Eh	20:16	0 0000b	00h
(1-2-2) Fast Read Number of Mode Bits	000b: Mode Bits not support		23:21	000b	
(1-2-2) Fast Read Opcode		3Fh	31:24	FFh	FFh
(2-2-2) Fast Read	0=not support 1=support	40h	00	0b	EEh
Unused			03:01	111b	
(4-4-4) Fast Read	0=not support 1=support		04	0b	
Unused			07:05	111b	
Unused		43h:41h	31:08	0xFFh	0xFFh
Unused		45h:44h	15:00	0xFFh	0xFFh
(2-2-2) Fast Read Number of Wait states	0 0000b: Wait states (Dummy Clocks) not support	46h	20:16	0 000b	00h
(2-2-2) Fast Read Number of Mode Bits	000b: Mode Bits not support		23:21	000b	
(2-2-2) Fast Read Opcode		47h	31:24	FFh	FFh
Unused		49h:48h	15:00	0xFFh	0xFFh
(4-4-4) Fast Read Number of Wait states	0 0000b: Wait states (Dummy Clocks) not support	4Ah	20:16	0 0000b	00h
(4-4-4) Fast Read Number of Mode Bits	000b: Mode Bits not support		23:21	000b	
(4-4-4) Fast Read Opcode		4Bh	31:24	FFh	FFh
Sector Type 1 Size	Sector/block size = 2 ^N bytes (Note5) 0x00b: this sector type doesn't exist	4Ch	07:00	0Ch	0Ch
Sector Type 1 erase Opcode		4Dh	15:08	20h	20h
Sector Type 2 Size	Sector/block size = 2 ^N bytes 0x00b: this sector type doesn't exist	4Eh	23:16	10h	10h
Sector Type 2 erase Opcode		4Fh	31:24	D8h	D8h
Sector Type 3 Size	Sector/block size = 2 ^N bytes 0x00b: this sector type doesn't exist	50h	07:00	00h	00h
Sector Type 3 erase Opcode		51h	15:08	FFh	FFh
Sector Type 4 Size	Sector/block size = 2 ^N bytes 0x00b: this sector type doesn't exist	52h	23:16	00h	00h
Sector Type 4 erase Opcode		53h	31:24	FFh	FFh

Note 1: h/b is hexadecimal or binary.

Note 2: **(x-y-z)** means I/O mode nomenclature used to indicate the number of active pins used for the opcode (x), address (y), and data (z). At the present time, the only valid Read SFDP instruction modes are: (1-1-1), (2-2-2), and (4-4-4)

Note 3: **Wait States** is required dummy clock cycles after the address bits or optional mode bits.

Note 4: **Mode Bits** is optional control bits that follow the address bits. These bits are driven by the system controller if they are specified. (eg, read performance enhance toggling bits)

Note 5: 4KB=2^{0Ch}, 32KB=2^{0Fh}, 64KB=2^{10h}

Note 6: 0xFFh means all data is blank ("1b").

POWER-ON STATE

The device is at the states as below when 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 unless the VCC achieves below correct level (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)*

Figure 5. INPUT TEST WAVEFORMS AND MEASUREMENT LEVEL

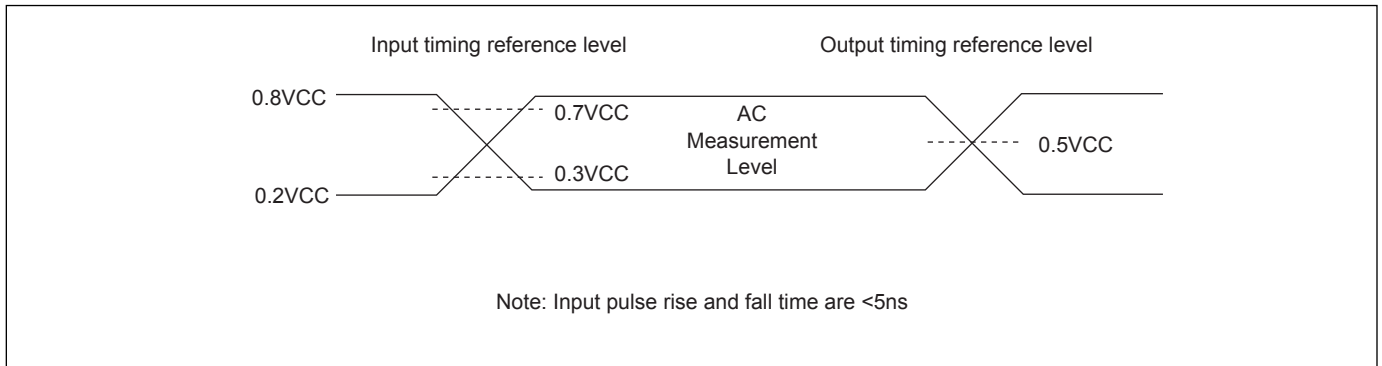


Figure 6. OUTPUT LOADING

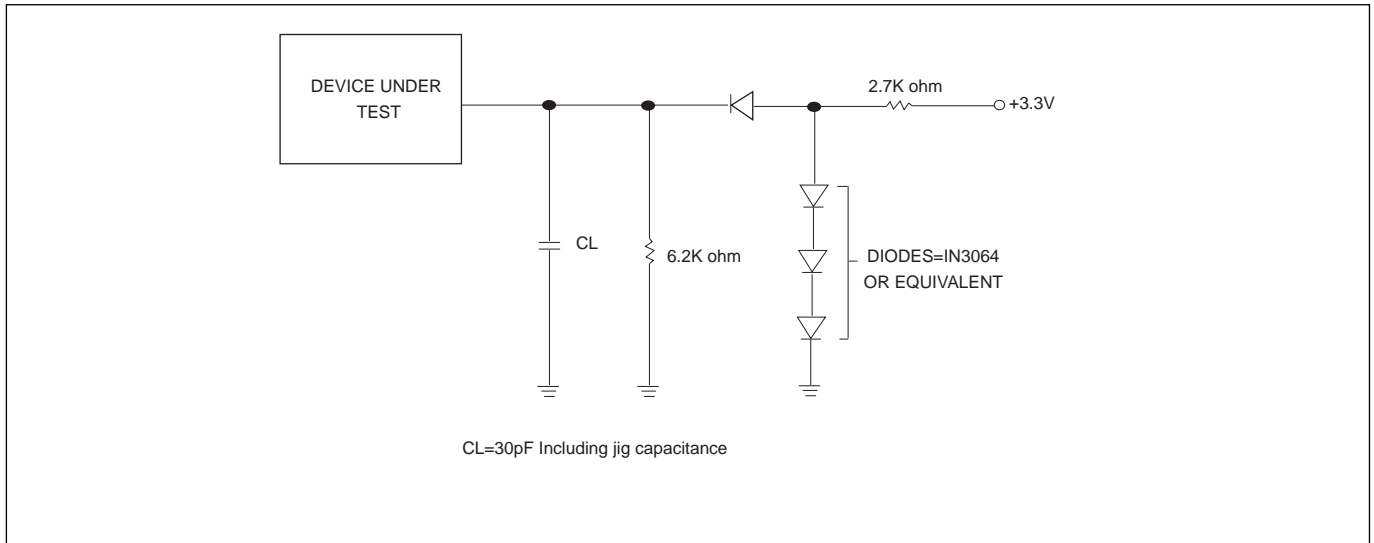


Table 7. Power-Up Timing

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

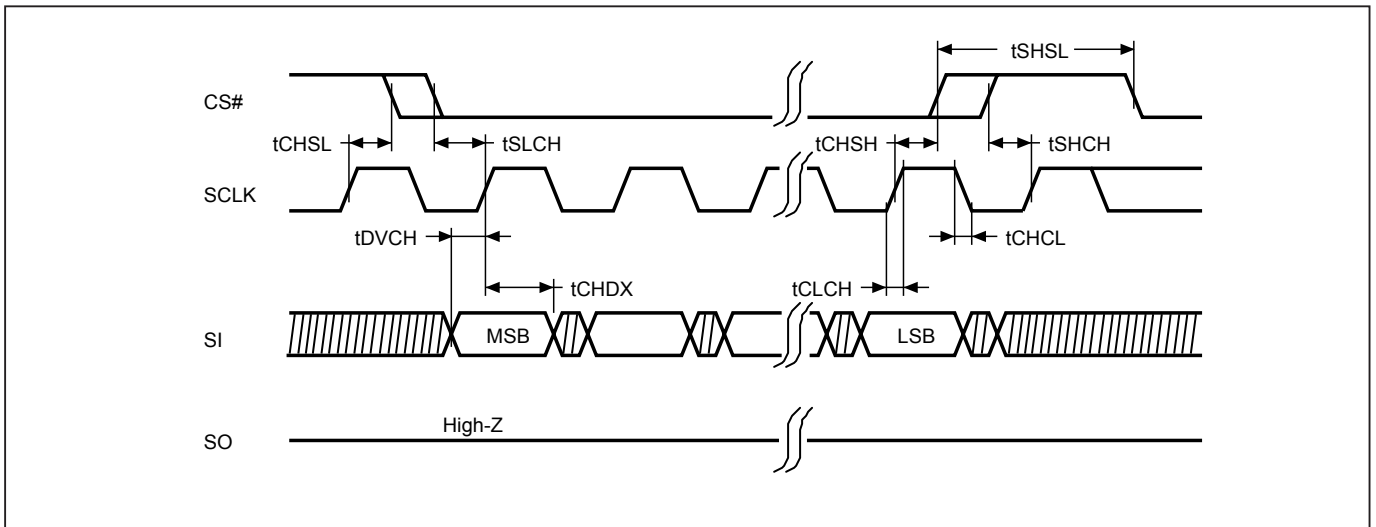


Figure 8. Output Timing

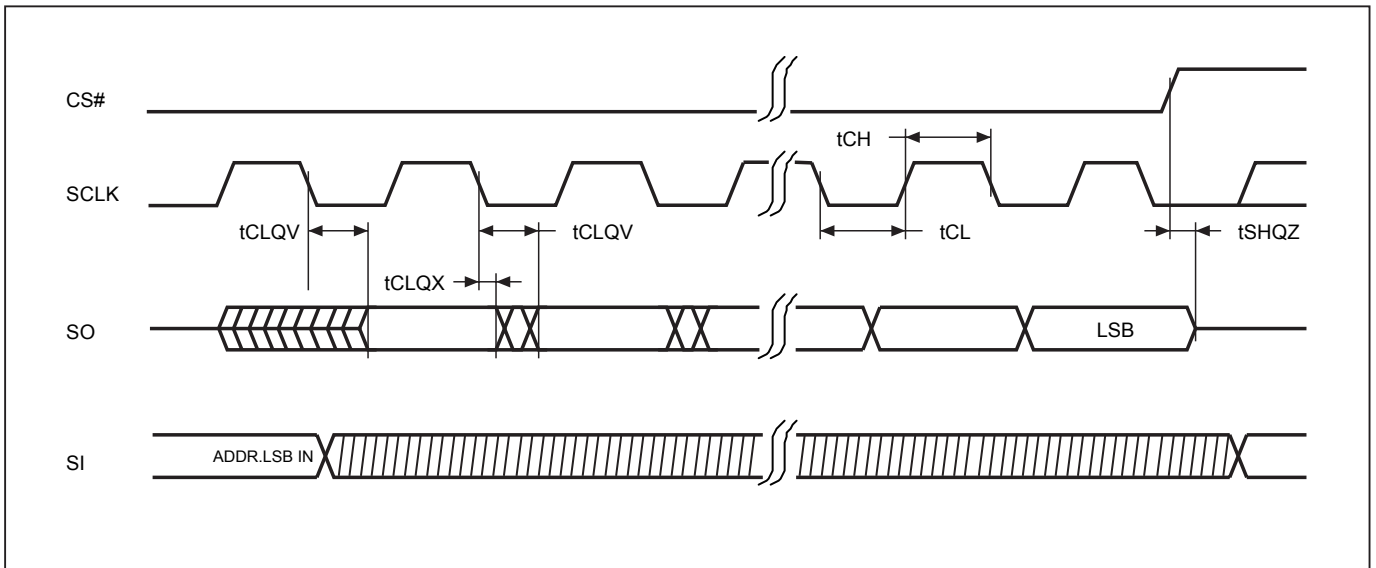
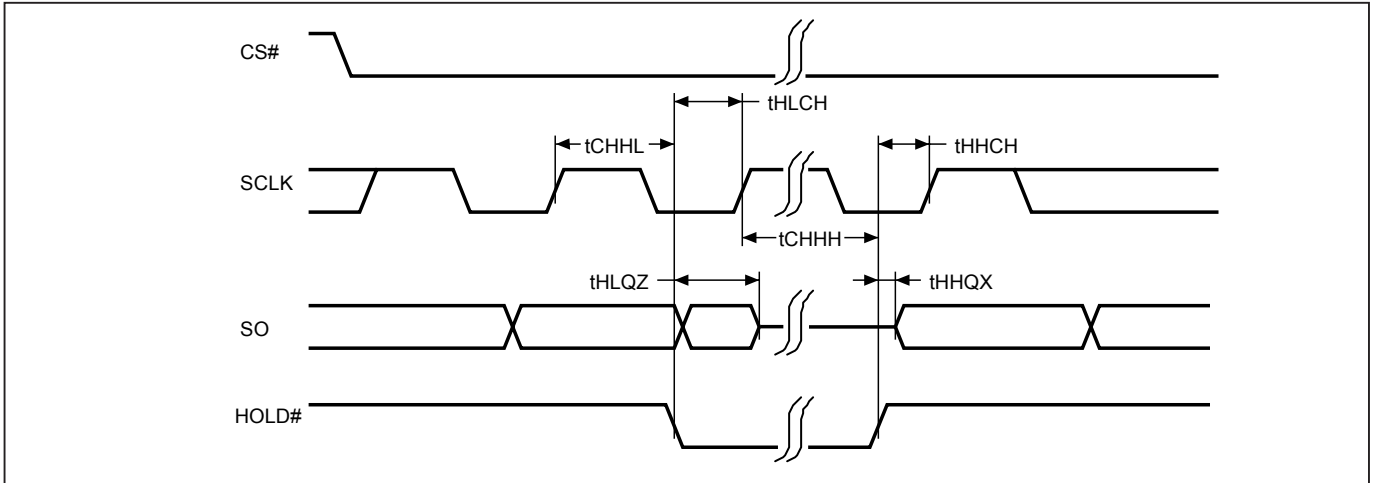


Figure 9. Hold Timing



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

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

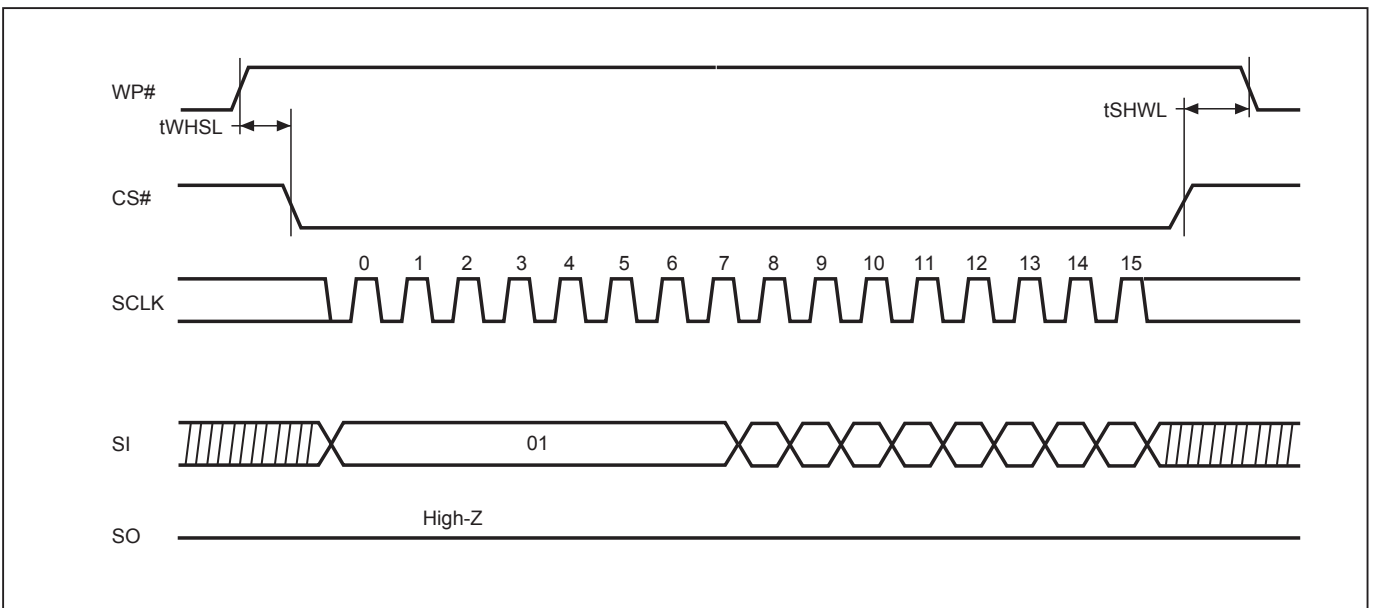


Figure 11. Write Enable (WREN) Sequence (Command 06)

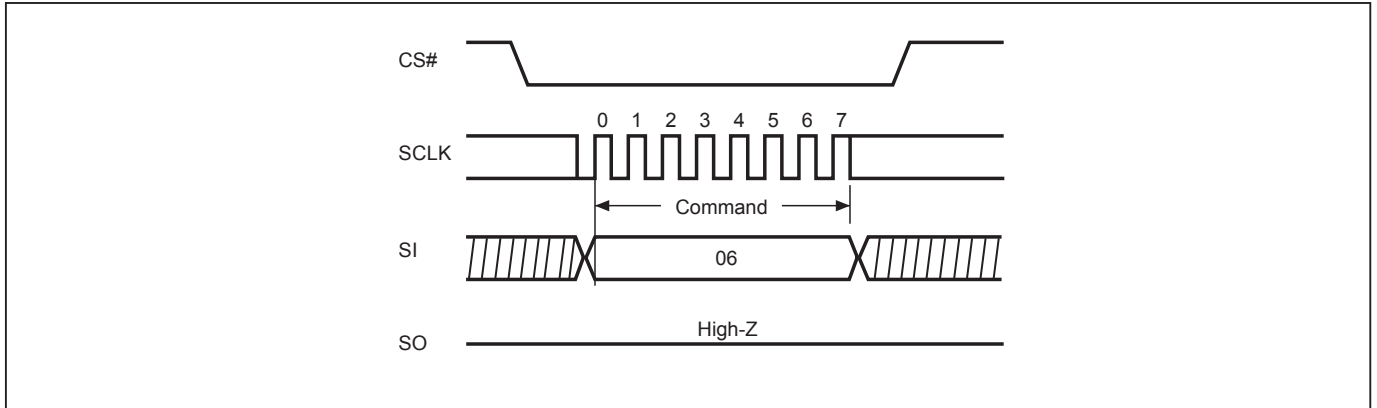


Figure 12. Write Disable (WRDI) Sequence (Command 04)

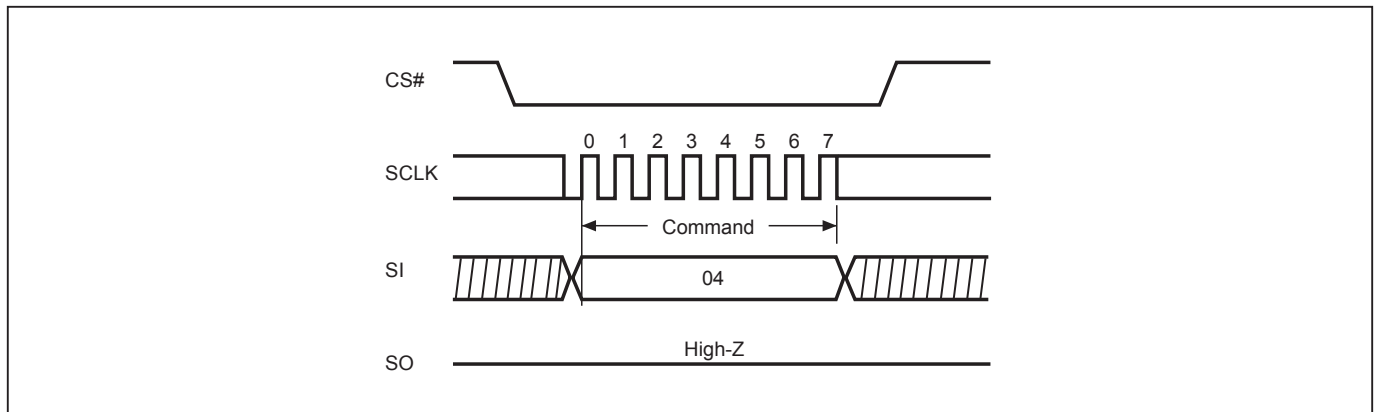


Figure 13. Read Identification (RDID) Sequence (Command 9F)

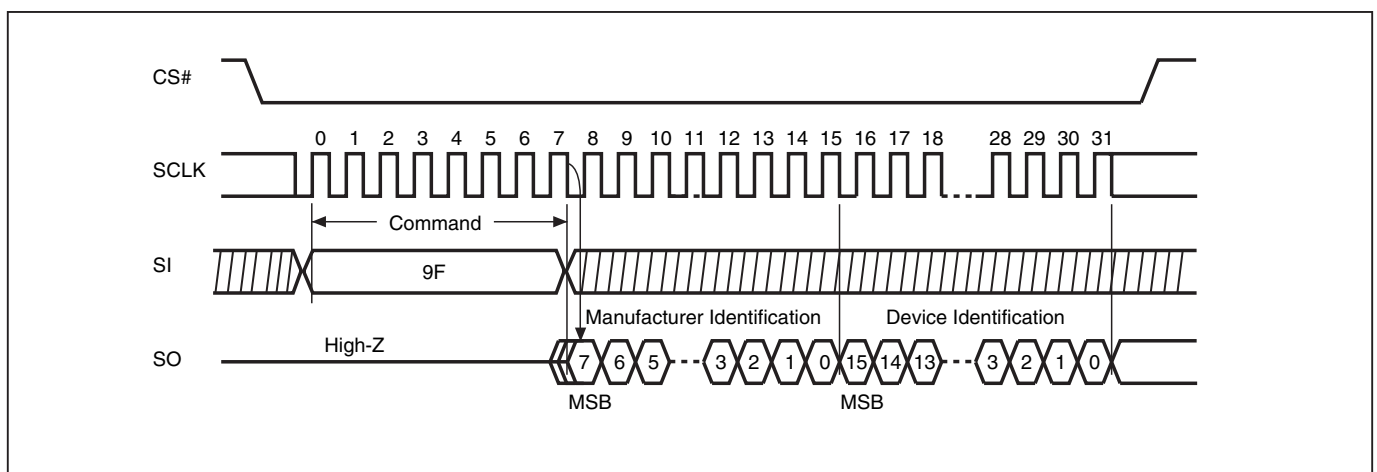


Figure 14. Read Status Register (RDSR) Sequence (Command 05)

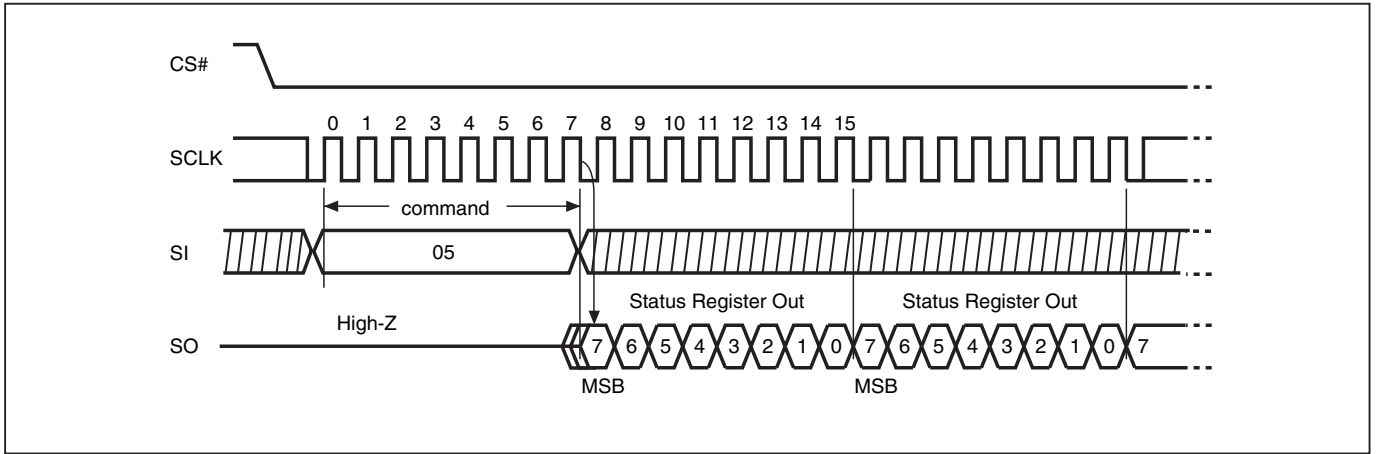


Figure 15. Write Status Register (WRSR) Sequence (Command 01)

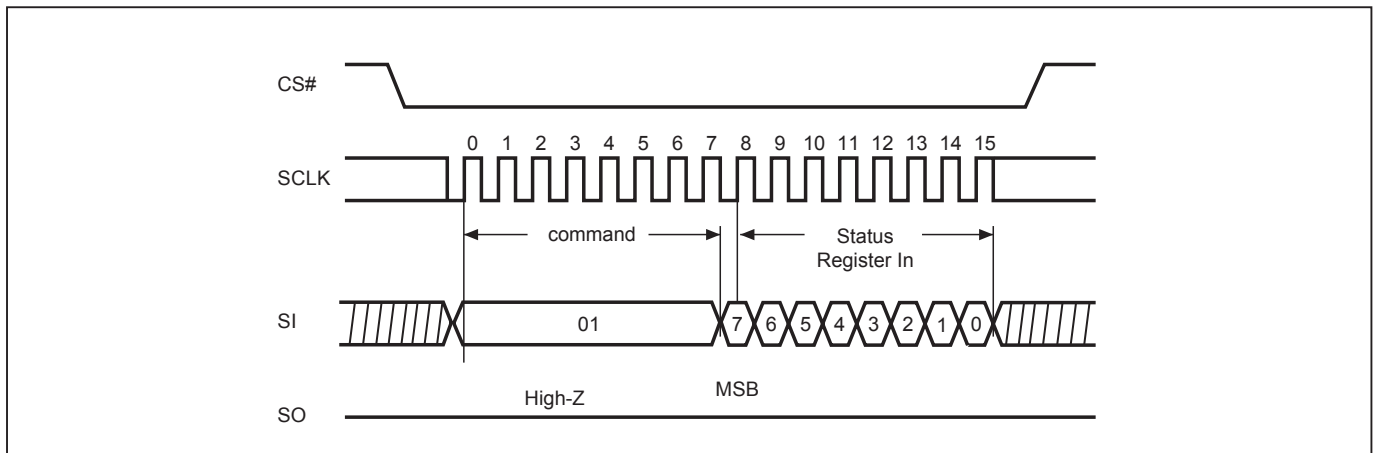


Figure 16. Read Data Bytes (READ) Sequence (Command 03)

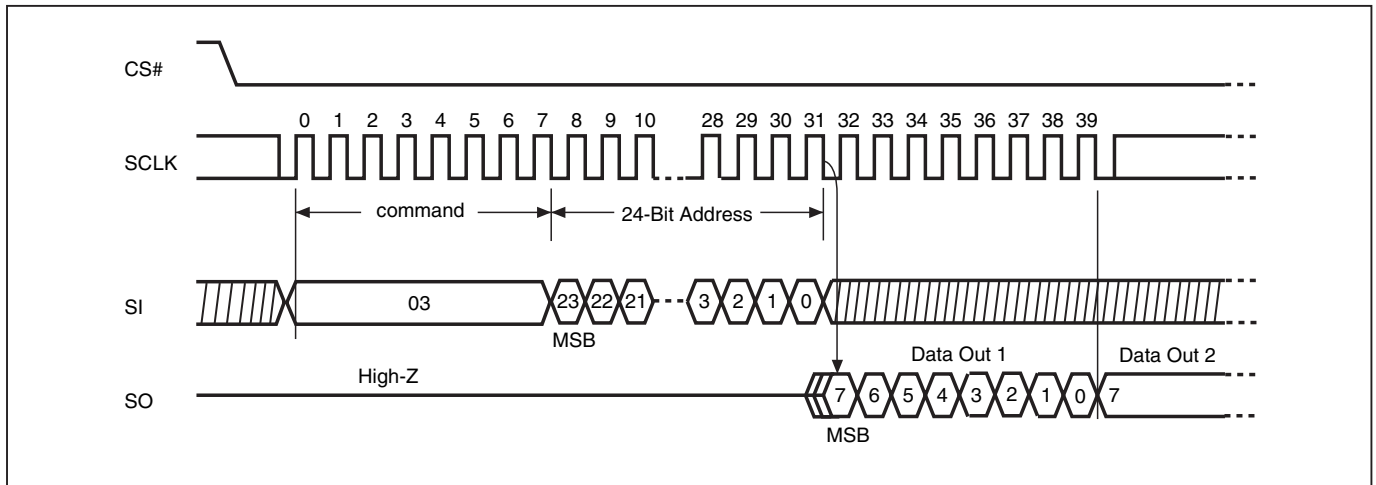


Figure 17. Read at Higher Speed (FAST_READ) Sequence (Command 0B)

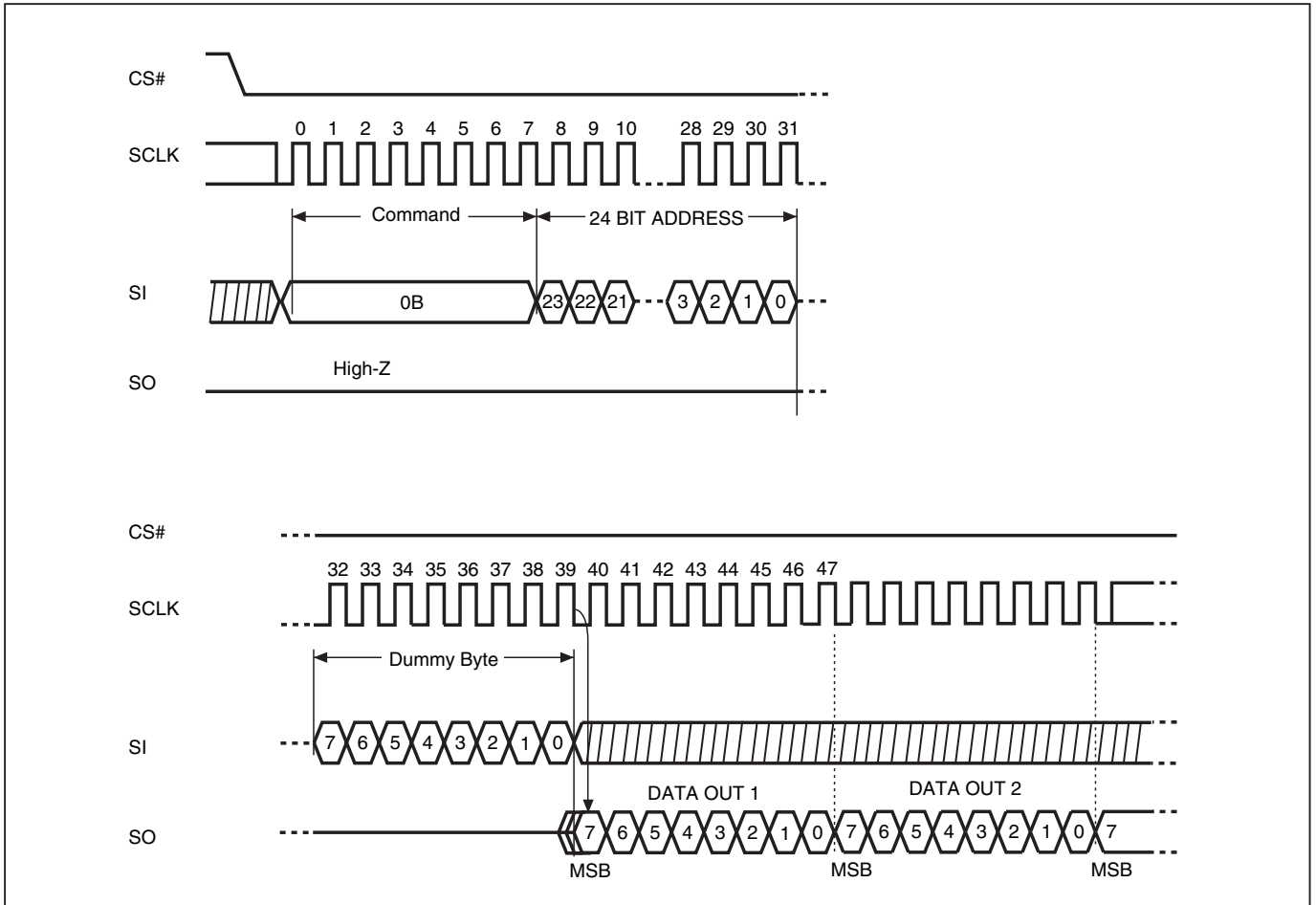


Figure 18. Dual Output Read Mode Sequence (Command 3B)

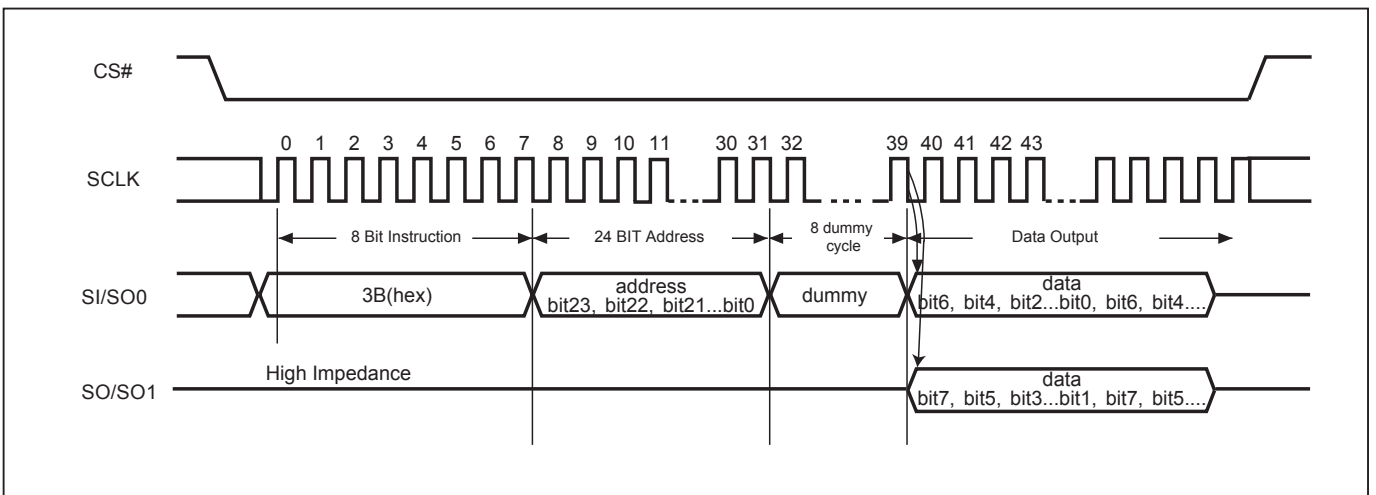


Figure 19. Page Program (PP) Sequence (Command 02)

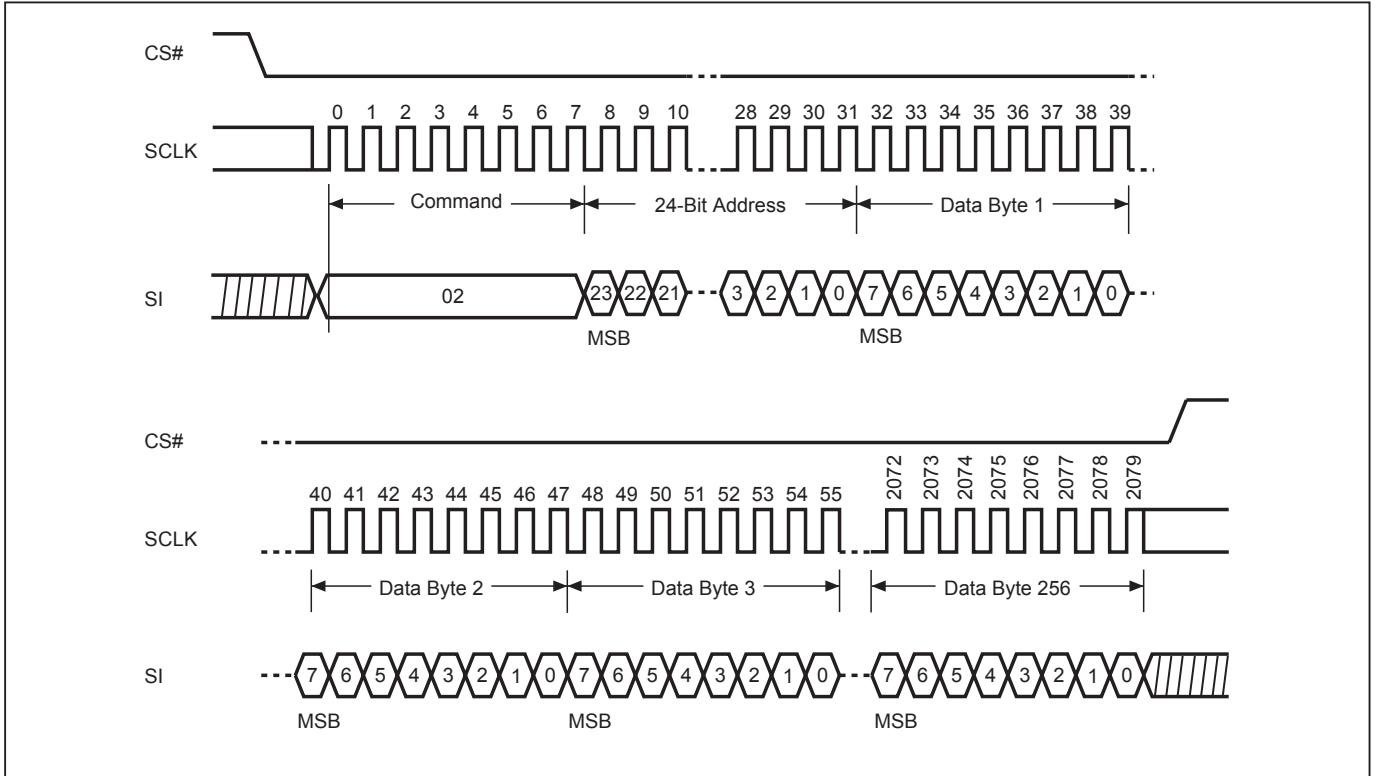
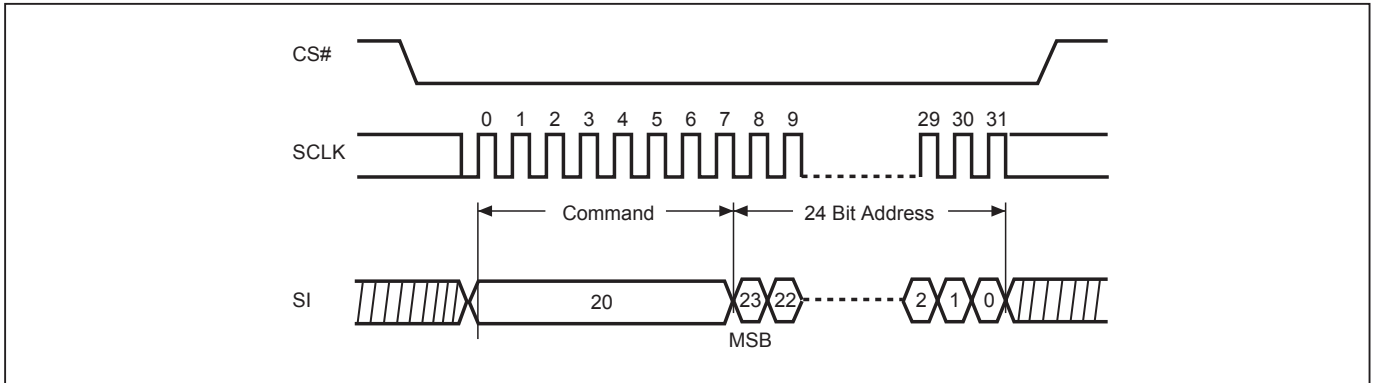
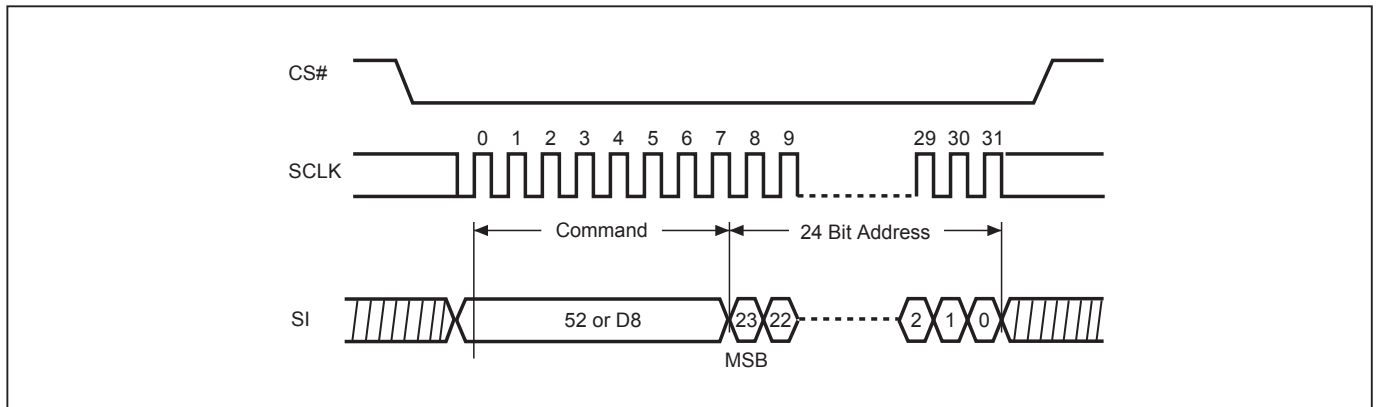


Figure 20. Sector Erase (SE) Sequence (Command 20)



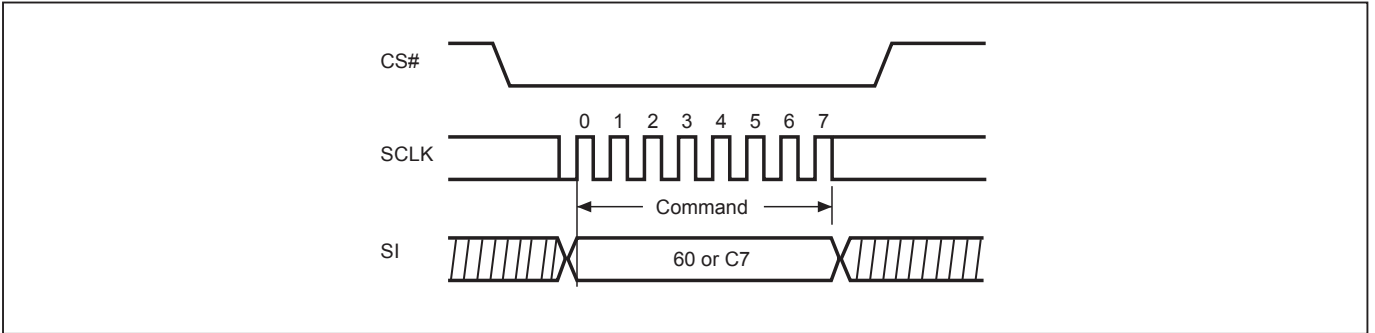
Note: SE command is 20(hex).

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



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

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)

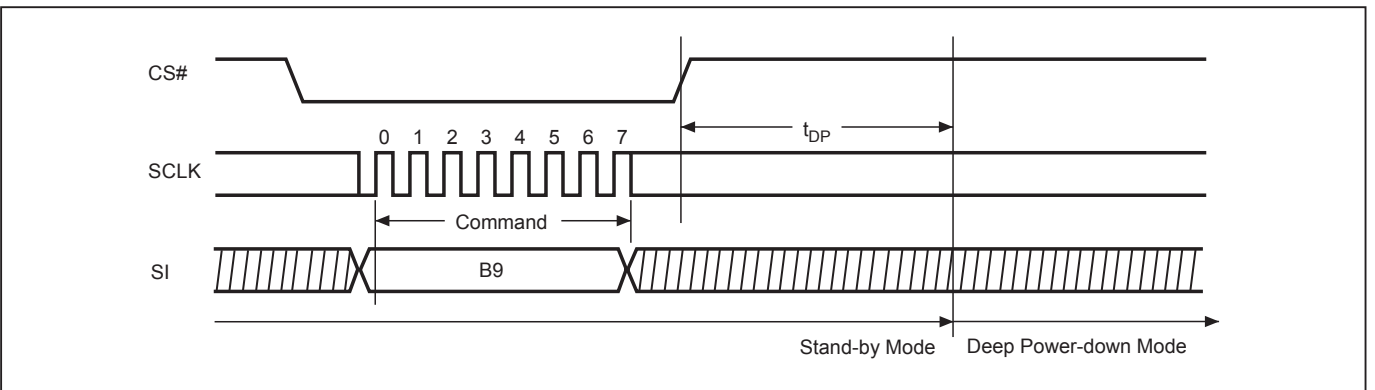


Figure 24. Read Electronic Signature (RES) Sequence (Command AB)

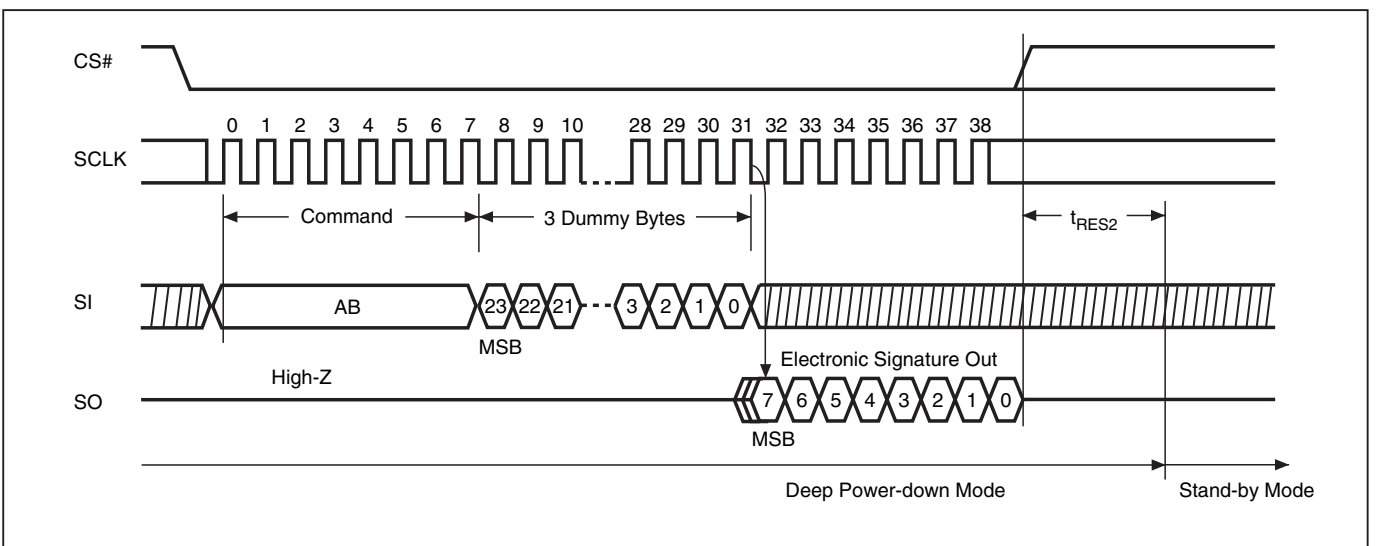


Figure 25. Release from Deep Power-down (RDP) Sequence (Command AB)

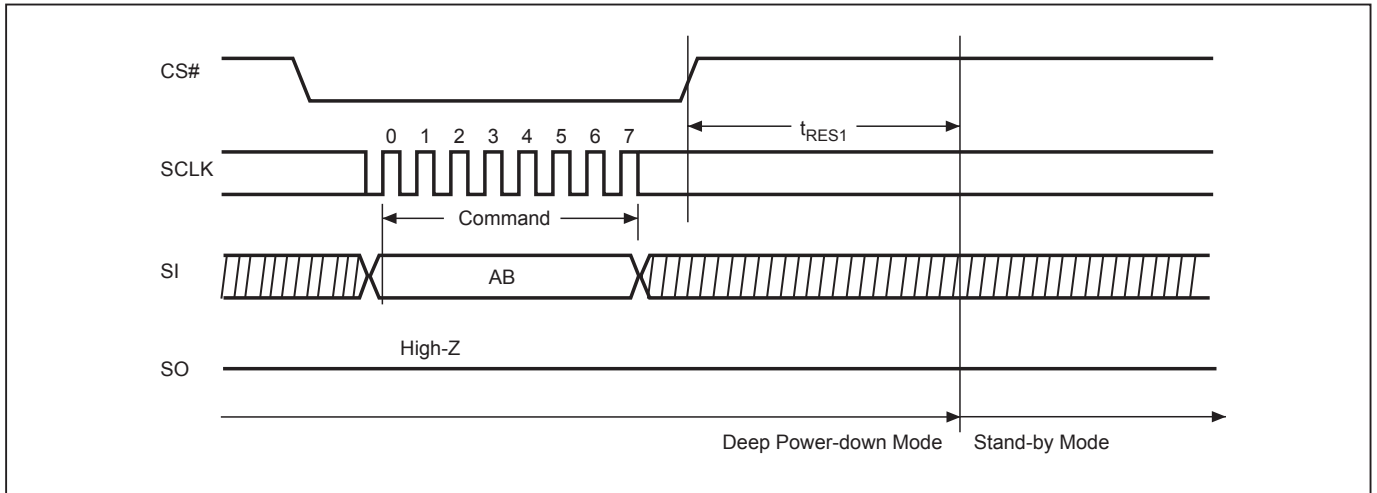
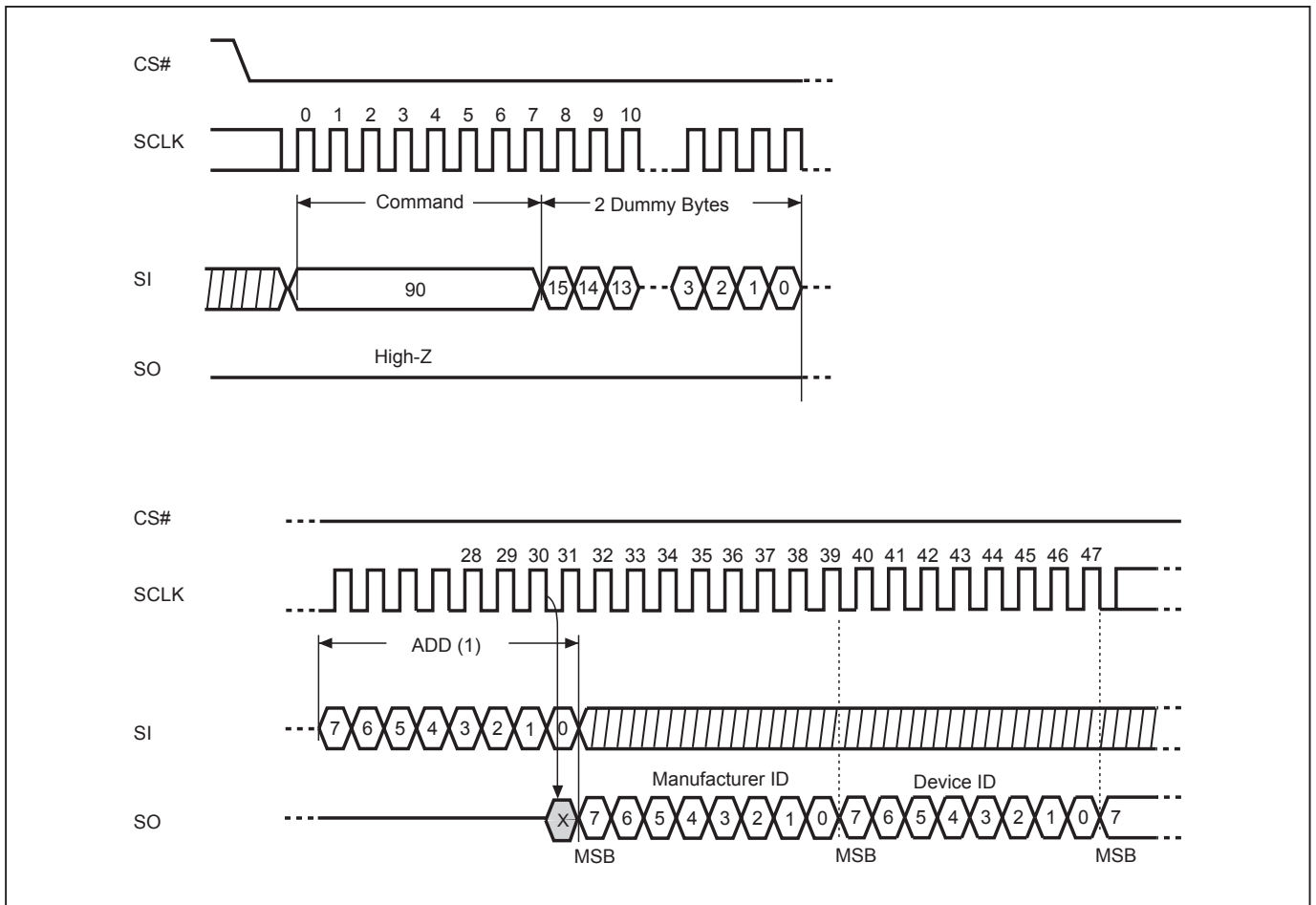


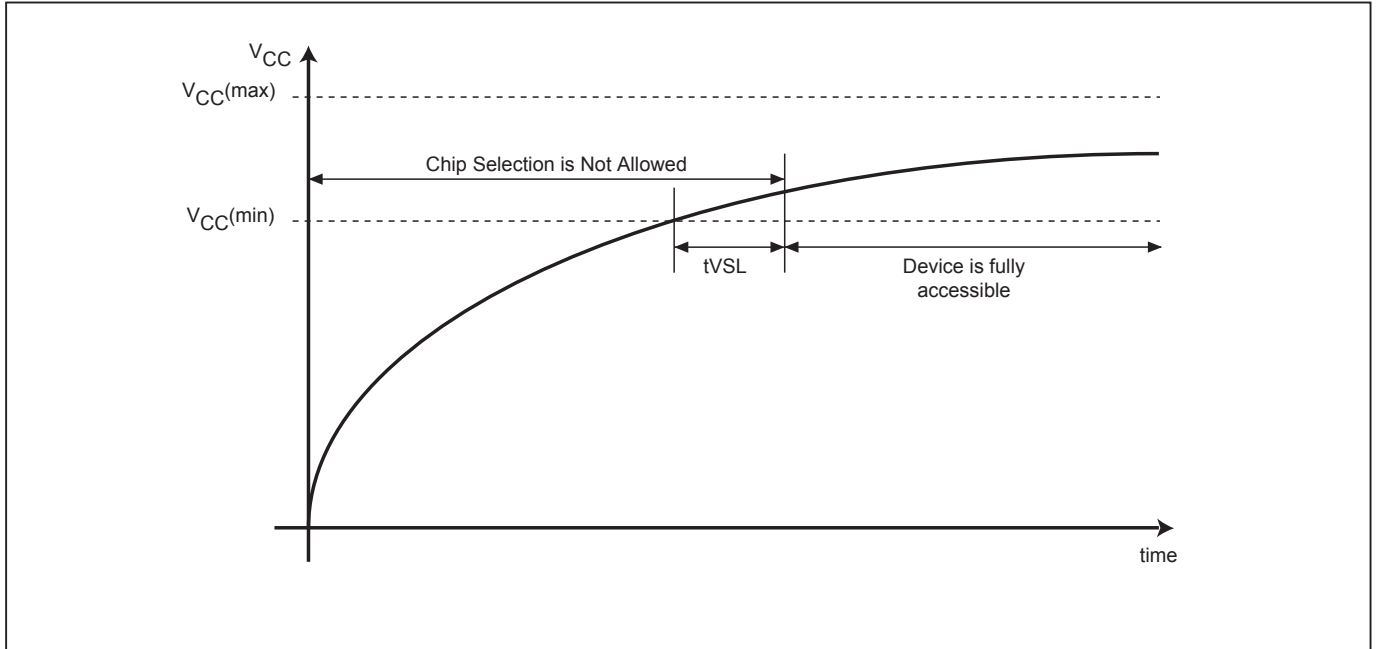
Figure 26. Read Electronic Manufacturer & Device ID (REMS) Sequence (Command 90)



Notes:

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

Figure 27. Power-up Timing



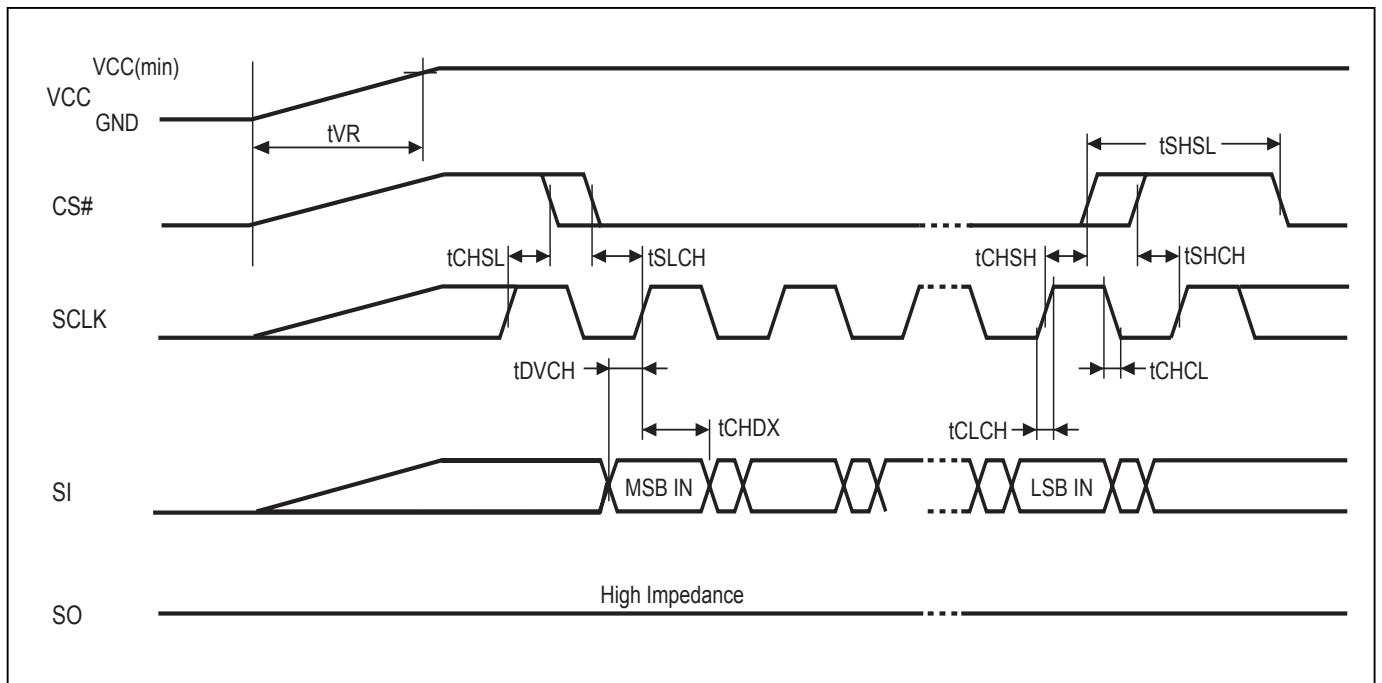
RECOMMENDED OPERATING CONDITIONS

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 $V_{cc}(min.)$ and wait a period of t_{VSL} .

Figure 28. AC Timing at Device Power-Up



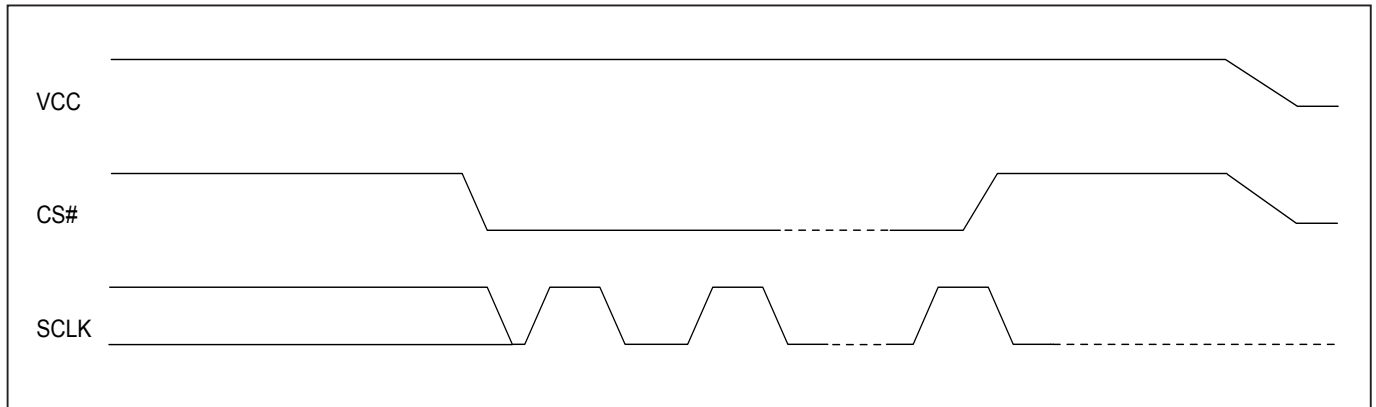
Symbol	Parameter	Notes	Min.	Max.	Unit
tVR	VCC Rise Time	1	5	500000	us/V

Notes :

1. Sampled, not 100% tested.
2. For AC spec t_{CHSL} , t_{SLCH} , t_{DVCH} , t_{CHDX} , t_{SHSL} , t_{CHSH} , t_{SHCH} , t_{CHCL} , t_{CLCH} in the figure, please refer to "[AC CHARACTERISTICS](#)" table.

Figure 29. Power-Down Sequence

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



ERASE AND PROGRAMMING PERFORMANCE

Parameter	Min.	Typ. (1)	Max. (2)	Unit
Write Status Register Cycle Time		5	40	ms
Sector erase Time		60	300	ms
Block erase Time		0.7	2	s
Chip Erase Time		0.7	2	s
Byte Program Time (via page program command)		9	300	us
Page Program Time		1.4	5	ms
Erase/Program Cycle	100,000			cycles

Notes:

1. Typical program and erase time assumes the following conditions: 25°C, 3.3V, and checker board pattern.
2. Under worst conditions of 85°C and 2.7V.
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

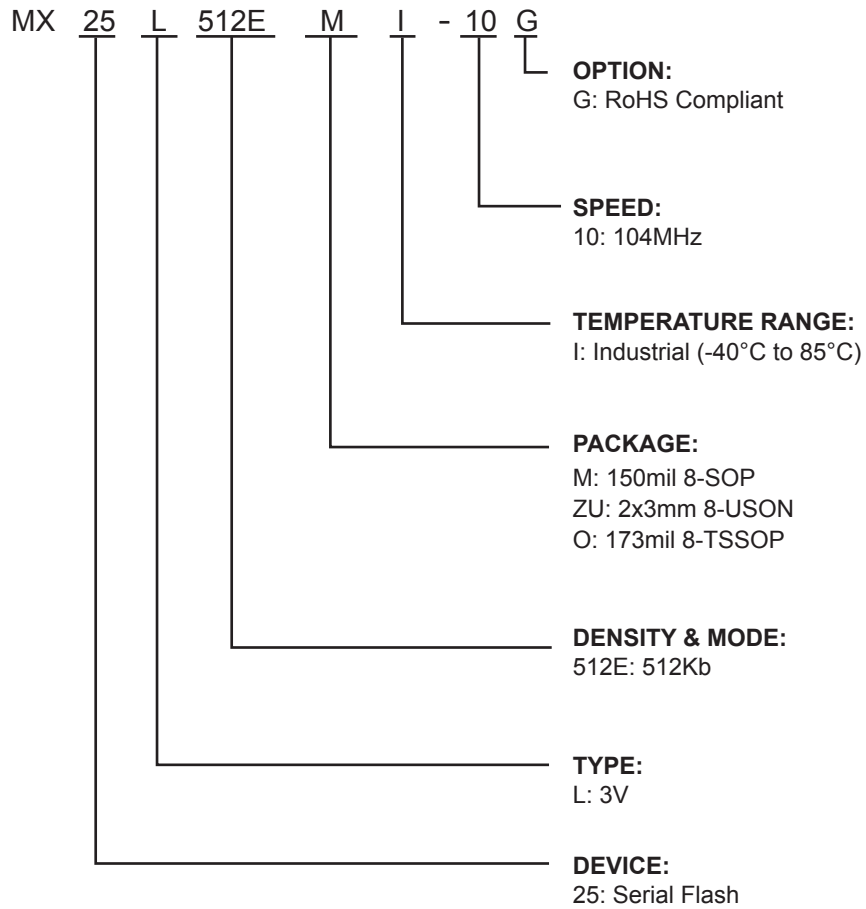
	Min.	Max.
Input Voltage with respect to GND on all power pins, SI, CS#	-1.0V	2 VCCmax
Input Voltage with respect to GND on SO	-1.0V	VCC + 1.0V
Current	-100mA	+100mA

Includes all pins except VCC. Test conditions: VCC = 3.0V, one pin at a time.

ORDERING INFORMATION

PART NO.	CLOCK (MHz)	OPERATING CURRENT MAX. (mA)	STANDBY CURRENT MAX. (uA)	Temperature	PACKAGE	Remark
MX25L512EMI-10G	104	12	25	-40 to 85°C	8-SOP (150mil)	RoHS Compliant
MX25L512EZUI-10G	104	12	25	-40 to 85°C	8-USON (2x3mm)	RoHS Compliant
MX25L512EOI-10G	104	12	25	-40 to 85°C	8-TSSOP (173mil)	RoHS Compliant

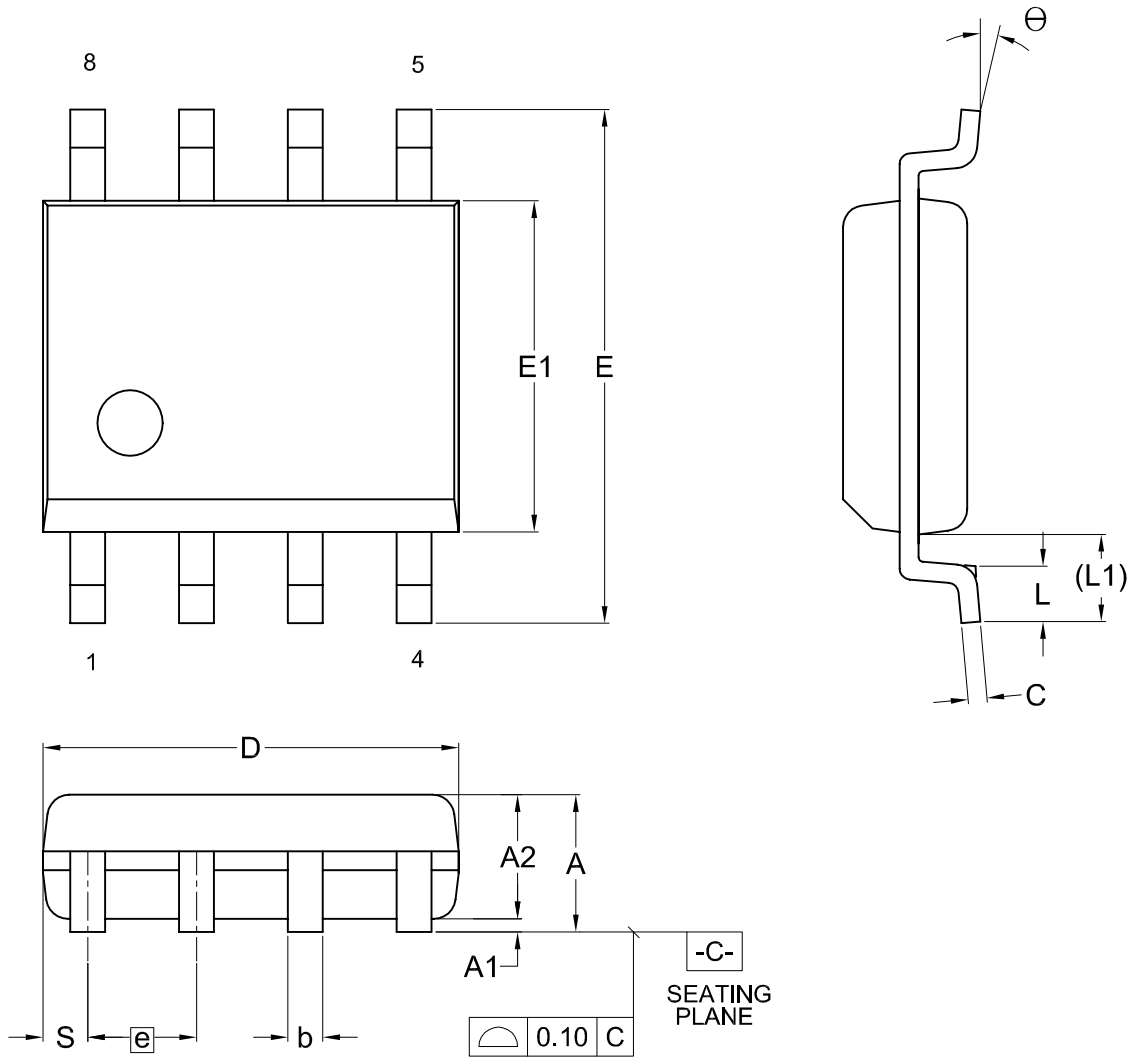
PART NAME DESCRIPTION



PACKAGE INFORMATION

8-PIN SOP (150mil)

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



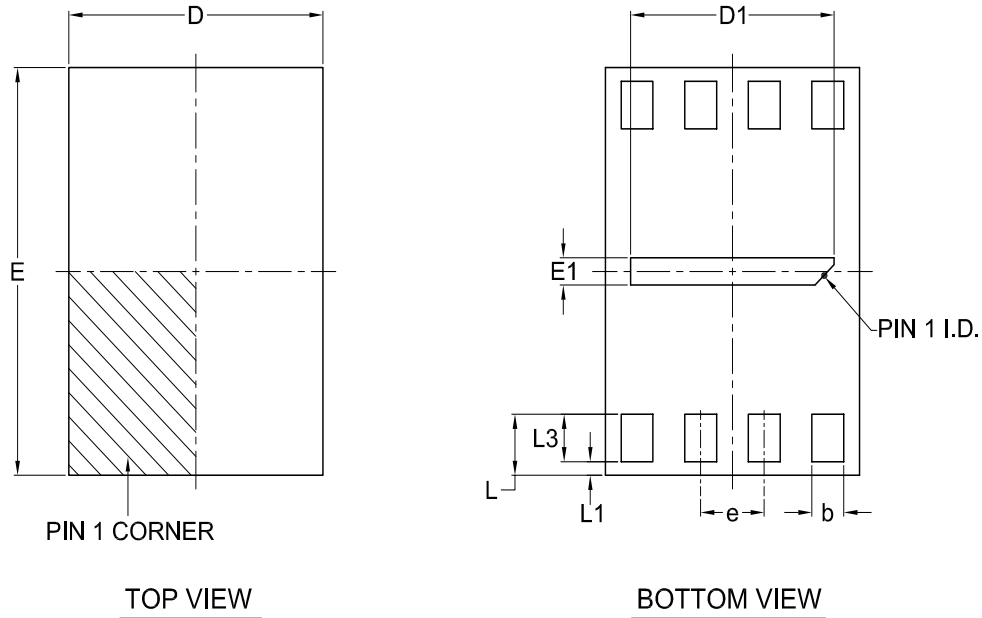
Dimensions (inch dimensions are derived from the original mm dimensions)

SYMBOL		A	A1	A2	b	C	D	E	E1	e	L	L1	S	θ
UNIT														
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	7	MS-012		

8-LAND USON (2x3mm)

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



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

*1: This package has exposed metal pad underneath the package , it can't contact to metal trace or pad on board.

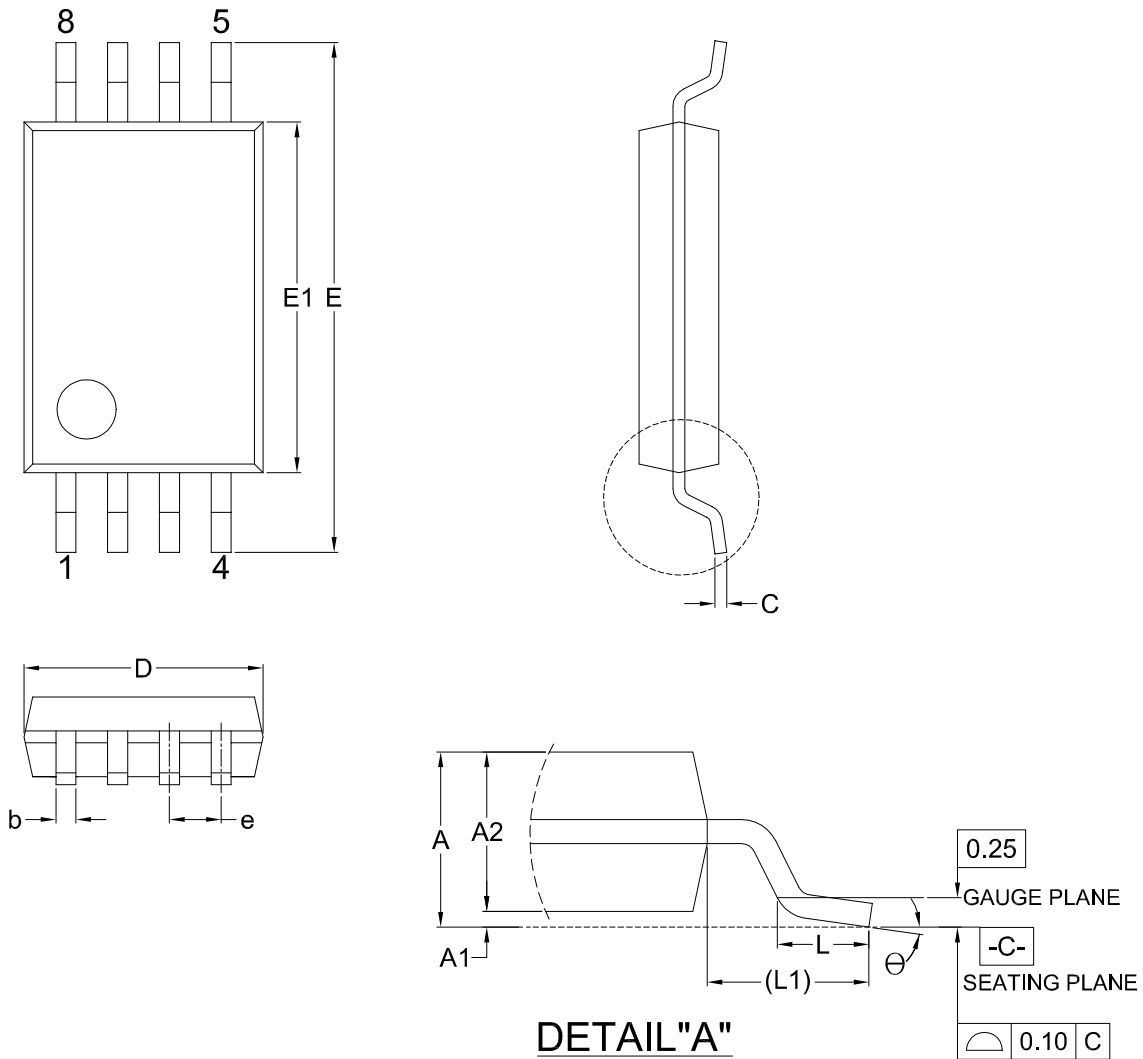
*2: The exposed pad size must not violate the min. metal separation requirement, 0.2mm with terminals.

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	--
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	3	MO-252		

8-PIN TSSOP (173mil)

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



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

SYMBOL		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	1	MO-153		

REVISION HISTORY

Revision No.	Description	Page	Date
0.01	1. Modified fSCLK specs from 86MHz to 104MHz.	P4,22,23,37,38	MAR/21/2011
1.0	1. Removed "Preliminary"	P4	APR/15/2011
	2. Modified pin name from SI to SI/SIO0 and from SO to SO/SIO1	P5,6	
1.1	1. Added Read SFDP (RDSFDP) Mode	P4,10,11,19~24, P29	FEB/10/2012



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