MX25L25635E
HIGH PERFORMANCE
SERIAL FLASH SPECIFICATION

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Contents

FEATURES **5**
GENERAL DESCRIPTION **7**
Table 1. Additional Features 7
PIN CONFIGURATION **8**
PIN DESCRIPTION **8**
BLOCK DIAGRAM **9**
DATA PROTECTION **10**
Table 2. Protected Area Sizes 11
Table 3. 4K-bit Secured OTP Definition 11
Memory Organization **12**
Table 4. Memory Organization 12
DEVICE OPERATION **13**
Figure 1. Serial Modes Supported (for Normal Serial mode) 13
HOLD FEATURES **14**
Figure 2. Hold Condition Operation 14
COMMAND DESCRIPTION **15**
Table 5. Command Sets 15
(1) Write Enable (WREN) 17
(2) Write Disable (WRDI) 17
(3) Read Identification (RDID) 17
(4) Read Status Register (RDSR) 18
(5) Write Status Register (WRSR) 19
Protection Modes 19
(6) Enter 4-byte mode (EN4B) 20
(7) Exit 4-byte mode (EX4B) 20
(8) Read Data Bytes (READ) 20
(9) Read Data Bytes at Higher Speed (FAST_READ) 20
(10) 2 x I/O Read Mode (2READ) 21
(11) Dual Read Mode (DREAD) 21
(12) 4 x I/O Read Mode (4READ) 21
(13) Quad Read Mode (QREAD) 22
(14) Sector Erase (SE) 22
(15) Block Erase (BE) 23
(16) Block Erase (BE32K) 23
(17) Chip Erase (CE) 24
(18) Page Program (PP) 24
(19) 4 x I/O Page Program (4PP) 24
Program/Erase Flow(1) - verify by reading array data 26
Program/Erase Flow(2) - verify by reading program/erase fail flag bit 27
(20) Continuously program mode (CP mode) 28
(21) Deep Power-down (DP) 29
(22) Release from Deep Power-down (RDP), Read Electronic Signature (RES) 29
(23) Read Electronic Manufacturer ID & Device ID (REMS), (REMS2), (REMS4) 29
Table 6. ID Definitions 30

(24) Enter Secured OTP (ENSO) 30
(25) Exit Secured OTP (EXSO) 30
(26) Read Security Register (RDSCUR) 30
Security Register Definition 31
(27) Write Security Register (WRSCUR) 31
(28) Write Protection Selection (WPSEL) 32
BP and SRWD if WPSEL=0 32
The individual block lock mode is effective after setting WPSEL=1 33
WPSEL Flow 34
(29) Single Block Lock/Unlock Protection (SBLK/SBULK) 35
Block Lock Flow 35
Block Unlock Flow 36
(30) Read Block Lock Status (RDBLOCK) 37
(31) Gang Block Lock/Unlock (GBLK/GBULK) 37
(32) Clear SR Fail Flags (CLSR) 37
(33) Enable SO to Output RY/BY# (ESRY) 37
(34) Disable SO to Output RY/BY# (DSRY) 37
(35) Read SFDP Mode (RDSFDP) 38
Read Serial Flash Discoverable Parameter (RDSFDP) Sequence 38
Table a. Signature and Parameter Identification Data Values 39
Table b. Parameter Table (0): JEDEC Flash Parameter Tables 40
Table c. Parameter Table (1): Macronix Flash Parameter Tables 42
POWER-ON STATE 44
ELECTRICAL SPECIFICATIONS 45
ABSOLUTE MAXIMUM RATINGS 45
Figure 3. Maximum Negative Overshoot Waveform 45
CAPACITANCE TA = 25°C, f = 1.0 MHz 45
Figure 4. Maximum Positive Overshoot Waveform 45
Figure 5. OUTPUT LOADING 46
Table 7. DC CHARACTERISTICS (Temperature = -40°C to 85°C for Industrial grade, VCC = 2.7V ~ 3.6V) . 47
Table 8. AC CHARACTERISTICS (Temperature = -40°C to 85°C for Industrial grade, VCC = 2.7V ~ 3.6V) 48
Timing Analysis 50
Figure 6. Serial Input Timing 50
Figure 7. Output Timing 50
Figure 8. Hold Timing 51
Figure 9. WP# Setup Timing and Hold Timing during WRSR when SRWD=1 51
Figure 10. Write Enable (WREN) Sequence (Command 06) 52
Figure 11. Write Disable (WRDI) Sequence (Command 04) 52
Figure 12. Read Identification (RDID) Sequence (Command 9F) 53
Figure 13. Read Status Register (RDSR) Sequence (Command 05) 53
Figure 14. Write Status Register (WRSR) Sequence (Command 01) 53
Figure 15. Read Data Bytes (READ) Sequence (Command 03) 54
Figure 16. Read at Higher Speed (FAST_READ) Sequence (Command 0B) 54
Figure 17. 2 x I/O Read Mode Sequence (Command BB) 55
Figure 18. Dual Read Mode Sequence (Command 3B) 55
Figure 19. 4 x I/O Read Mode Sequence (Command EB) 56

Figure 20. Quad Read Mode Sequence (Command 6B) 56
Figure 21. 4 x I/O Read Enhance Performance Mode Sequence (Command EB) 57
Figure 22. Sector Erase (SE) Sequence (Command 20) 58
Figure 23. Block Erase (BE/EB32K) Sequence (Command D8/52) 58
Figure 24. Chip Erase (CE) Sequence (Command 60 or C7) 58
Figure 25. Page Program (PP) Sequence (Command 02) 59
Figure 26. 4 x I/O Page Program (4PP) Sequence (Command 38) 59
Figure 27. Continuously Program (CP) Mode Sequence with Hardware Detection (Command AD) 60
Figure 28. Deep Power-down (DP) Sequence (Command B9) 61
Figure 29. Read Electronic Signature (RES) Sequence (Command AB) 61
Figure 30. Release from Deep Power-down (RDP) Sequence (Command AB) 61
Figure 31. Read Electronic Manufacturer & Device ID (REMS) Sequence (Command 90 or EF or DF) 62
Figure 32. Write Protection Selection (WPSEL) Sequence (Command 68) 62
Figure 33. Single Block Lock/Unlock Protection (SBLK/SBULK) Sequence (Command 36/39) 63
Figure 34. Read Block Protection Lock Status (RDBLOCK) Sequence (Command 3C) 63
Figure 35. Gang Block Lock/Unlock (GBLK/GBULK) Sequence (Command 7E/98) 63
RESET 64
Figure 36. RESET Timing 64
Table 9. Reset Timing 64
Figure 37. Power-up Timing 65
Table 10. Power-Up Timing 65
INITIAL DELIVERY STATE 65
OPERATING CONDITIONS 66
Figure 38. AC Timing at Device Power-Up 66
Figure 39. Power-Down Sequence 67
ERASE AND PROGRAMMING PERFORMANCE 68
DATA RETENTION 68
LATCH-UP CHARACTERISTICS 68
ORDERING INFORMATION 69
PART NAME DESCRIPTION 70
PACKAGE INFORMATION 71
REVISION HISTORY 73

256M-BIT [x 1/x 2/x 4] CMOS MXSMIO™ (SERIAL MULTI I/O) FLASH MEMORY

FEATURES

GENERAL

- Serial Peripheral Interface compatible -- Mode 0 and Mode 3
- 268,435,456 x 1 bit structure or 134,217,728 x 2 bits (two I/O mode) structure or 67,108,864 x 4 bits (four I/O mode) structure
- 8192 Equal Sectors with 4K bytes each
  - Any Sector can be erased individually
- 1024 Equal Blocks with 32K bytes each
  - Any Block can be erased individually
- 512 Equal Blocks with 64K bytes each
  - Any Block can be erased individually
- 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
  VCC = 2.7~3.6V
  - Normal read
    - 50MHz
  - Fast read
    - 1 I/O: 80MHz with 8 dummy cycles
    - 2 I/O: 70MHz with 4 dummy cycles
    - 4 I/O: 70MHz with 6 dummy cycles
  - Fast program time: 1.4ms(typ.) and 5ms(max.)/page (256-byte per page)
  - Byte program time: 9us (typical)
  - Continuously Program mode (automatically increase address under word program mode)
  - Fast erase time: 60ms (typ.)/sector (4K-byte per sector) ; 0.5s(typ.) /block (32K-byte per block); 0.7s(typ.) /block (64K-byte per block); 160s(typ.) /chip
- Low Power Consumption
  - Low active read current: 45mA(max.) at 80MHz, 40mA(max.) at 70MHz and 30mA(max.) at 50MHz
  - Low active programming current: 25mA (max.)
  - Low active erase current: 25mA (max.)
  - Standby current: 200uA (max.)
  - Deep power down current: 80uA (max.)
- Typical 100,000 erase/program cycles

SOFTWARE FEATURES

- Input Data Format
  - 1-byte Command code
- Advanced Security Features
  - BP0-BP3 block group protect
  - Flexible individual block protect when OTP WPSEL=1

- Additional 4K bits secured OTP for unique identifier

• Auto Erase and Auto Program Algorithms
- 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 width (Any page to be programed should have page in the erased state first.)

• Status Register Feature

• Electronic Identification
- JEDEC 1-byte Manufacturer ID and 2-byte Device ID
- RES command for 1-byte Device ID
- Both REMS,REMS2, REMS4 commands for 1-byte Manufacturer ID and 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 Input/Output for 2 x I/O mode and 4 x I/O mode

• SO/SIO1
- Serial Data Output or Serial Data Input/Output for 2 x I/O mode and 4 x I/O mode

• WP#/SIO2
- Hardware write protection or serial data Input/Output for 4 x I/O mode

• HOLD#/SIO3
- HOLD# pin or serial data Input/Output for 4 x I/O mode, an internal weak pull up on the pin
- The weak pull up on the HOLD# pin will be disabled after QE bit is enabled, until next power-on cycle starts.
- HOLD# function is only available on 16 SOP package

• RESET#
- Hardware reset pin

• PACKAGE
- 16-pin SOP (300mil)
- 8 WSON (8x6mm)
- **All devices are RoHS Compliant**

GENERAL DESCRIPTION

MX25L25635E is 268,435,456 bits serial Flash memory, which is configured as 33,554,432 x 8 internally. When it is in two or four I/O mode, the structure becomes 134,217,728 bits x 2 or 67,108,864 bits x 4. The MX25L25635E 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.

MX25L25635E, MXSMIO™ (Serial Multi I/O) flash memory, provides sequential read operation on whole chip and multi-I/O features.

When it is in dual I/O mode, the SI pin and SO pin become SIO0 pin and SIO1 pin for address/dummy bits input and data output. When it is in quad I/O mode, the SI pin, SO pin, WP# pin and HOLD# pin become SIO0 pin, SIO1 pin, SIO2 pin and SIO3 pin for address/dummy bits input and data Input/Output.

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 byte basis, or page (256 bytes) basis, or word basis for Continuously Program mode, and erase command is executes on sector (4K-byte), block (32K-byte/64K-byte), or whole chip basis.

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 200uA DC current.

The MX25L25635E utilizes Macronix's proprietary memory cell, which reliably stores memory contents even after 100,000 program and erase cycles.

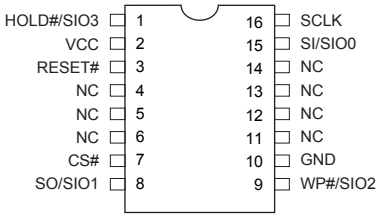
Table 1. Additional Features

Additional Features / Part Name	Protection and Security		Read Performance		
	Flexible or Individual block (or sector) protection	4K-bit secured OTP	1 I/O Read (80 MHz)	2 I/O Read (70 MHz)	4 I/O Read (70 MHz)
MX25L25635E	V	V	V	V	V

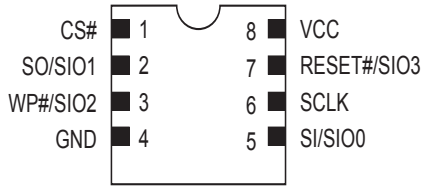
Additional Features / Part Name	Identifier				
	RES (command: AB hex)	REMS (command: 90 hex)	REMS2 (command: EF hex)	REMS4 (command: DF hex)	RDID (command: 9F hex)
MX25L25635E	18 (hex)	C2 18 (hex)	C2 18 (hex)	C2 18 (hex)	C2 20 19 (hex)

PIN CONFIGURATION

16-PIN SOP (300mil)



8-WSON (8x6mm) *

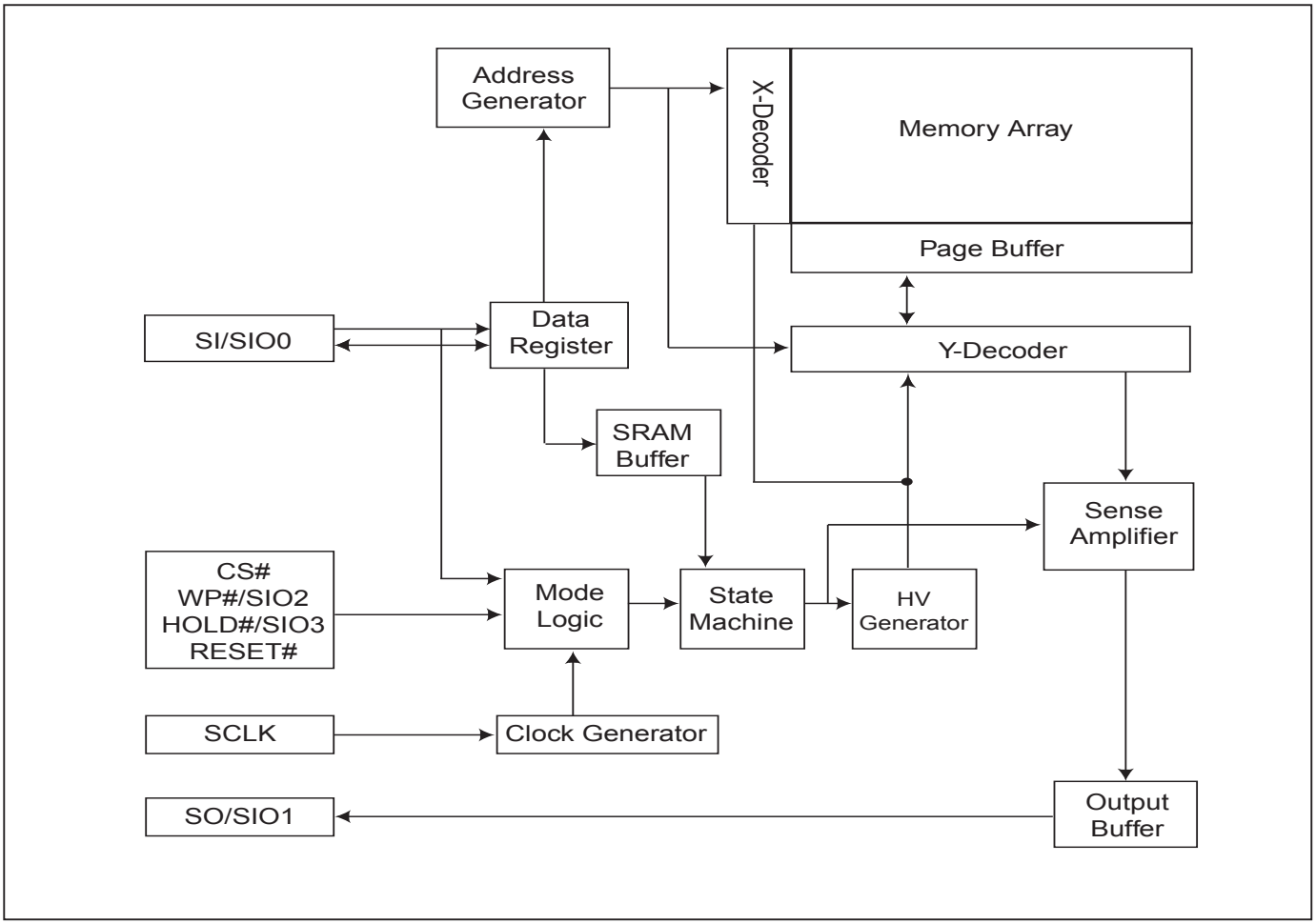


PIN DESCRIPTION

SYMBOL	DESCRIPTION
CS#	Chip Select
SI/SIO0	Serial Data Input (for 1xI/O)/ Serial Data Input & Output (for 2xI/O or 4xI/O mode)
SO/SIO1	Serial Data Output (for 1xI/O)/Serial Data Input & Output (for 2xI/O or 4xI/O mode)
SCLK	Clock Input
WP#/SIO2	Write protection: connect to GND or Serial Data Input & Output (for 4xI/O mode)
HOLD#(1,2)/ SIO3	HOLD# pin or Serial Data Input & Output (for 4xI/O mode)
VCC	+ 3.3V Power Supply
GND	Ground
RESET#(3)	Hardware Reset Pin, Active low
NC	No Connection

Note:
(1). HOLD# function is only available on 16-SOP package.
(2). The weak pull up on the HOLD# pin will be disabled after QE bit is enabled, until next power-on cycle starts.
(3). RESET# pin has internal pull up.

BLOCK DIAGRAM



DATA PROTECTION

MX25L25635E 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
  - Reset# Pin driven low
  - Write Disable (WRDI) command completion
  - Write Status Register (WRSR) command completion
  - Page Program (PP, 4PP) command completion
  - Continuously Program mode (CP) instruction completion
  - Sector Erase (SE) command completion
  - Block Erase (BE, BE32K) command completion
  - Chip Erase (CE) command completion
  - Single Block Lock/Unlock (SBLK/SBULK) instruction completion
  - Gang Block Lock/Unlock (GBLK/GBULK) instruction completion
  - Write Security Register (WRSCUR) instruction completion
  - Write Protection Selection (WPSEL) instruction completion

- 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).

I. Block lock protection

- The Software Protected Mode (SPM) uses (BP3, BP2, BP1, BP0) bits to allow part of memory to be protected as read only. The protected area definition is shown as table of "Protected Area Sizes", the protected areas are more flexible which may protect various area by setting value of BP0-BP3 bits. Please refer to table of "Protected Area Sizes".

- The Hardware Protected Mode (HPM) use WP#/SIO2 to protect the (BP3, BP2, BP1, BP0) bits and SRWD bit. If the system goes into four I/O mode, the feature of HPM will be disabled.

- MX25L25635E provide individual block (or sector) write protect & unprotect. User may enter the mode with WPSEL command and conduct individual block (or sector) write protect with SBLK instruction, or SBULK for individual block (or sector) unprotect. Under the mode, user may conduct whole chip (all blocks) protect with GBLK instruction and unlock the whole chip with GBULK instruction.

Table 2. Protected Area Sizes

Status bit				Protection Area
BP3	BP2	BP1	BP0	256Mb
0	0	0	0	0 (none)
0	0	0	1	1 (2 blocks, block 510th-511th)
0	0	1	0	2 (4 blocks, block 508th-511th)
0	0	1	1	3 (8 blocks, block 504th-511th)
0	1	0	0	4 (16 blocks, block 496th-511th)
0	1	0	1	5 (32 blocks, block 480th-511th)
0	1	1	0	6 (64 blocks, block 448nd-511th)
0	1	1	1	7 (128 blocks, block 384th-511th)
1	0	0	0	8 (256 blocks, block 256th-511th)
1	0	0	1	9 (512 blocks, all)
1	0	1	0	10 (512 blocks, all)
1	0	1	1	11 (512 blocks, all)
1	1	0	0	12 (512 blocks, all)
1	1	0	1	13 (512 blocks, all)
1	1	1	0	14 (512 blocks, all)
1	1	1	1	15 (512 blocks, all)

Note: The device is ready to accept a Chip Erase instruction if, and only if, all Block Protect (BP3, BP2, BP1, BP0) are 0.

II. **Additional 4K-bit secured OTP** for unique identifier: to provide 4K-bit One-Time Program area for setting device unique serial number - Which may be set by factory or system maker. Please refer to Table 3. 4K-bit Secured OTP Definition.

- Security register bit 0 indicates whether the chip is locked by factory or not.
- To program the 4K-bit secured OTP by entering 4K-bit secured OTP mode (with ENSO command), and going through normal program procedure, and then exiting 4K-bit secured OTP mode by writing EXSO command.
- Customer may lock-down the customer lockable secured OTP by writing WRSCUR(write security register) command to set customer lock-down bit1 as "1". Please refer to table of "Security Register Definition" for security register bit definition and table of "4K-bit Secured OTP Definition" for address range definition.
- Note: Once lock-down whatever by factory or customer, it cannot be changed any more. While in 4K-bit Secured OTP mode, array access is not allowed.

Table 3. 4K-bit Secured OTP Definition

Address range	Size	Standard Factory Lock	Customer Lock
xxx000~xxx00F	128-bit	ESN (electrical serial number)	Determined by customer
xxx010~xxx1FF	3968-bit	N/A	

Memory Organization

Table 4. Memory Organization

Block(64K-byte)	Block(32K-byte)	Sector	Address Range	
511	1023	8191	1FFF000h	1FFFFFFh
		⋮	⋮	⋮
		8184	1FF8000h	1FF8FFFh
	1022	8183	1FF7000h	1FF7FFFh
		⋮	⋮	⋮
		8176	1FF0000h	1FF0FFFh
510	1021	8175	1FEF000h	1FEFFFFh
		⋮	⋮	⋮
		8168	1FE8000h	1FE8FFFh
	1020	8167	1FE7000h	1FE7FFFh
		⋮	⋮	⋮
		8160	1FE0000h	1FE0FFFh
509	1019	8159	1FDF000h	1FDFFFFh
		⋮	⋮	⋮
		8152	1FD8000h	1FD8FFFh
	1018	8151	1FD7000h	1FD7FFFh
		⋮	⋮	⋮
		8144	1FD0000h	1FD0FFFh
2	5	47	002F000h	002FFFFh
		⋮	⋮	⋮
		40	0028000h	0028FFFh
	4	39	027000h	0027FFFh
		⋮	⋮	⋮
		32	0020000h	0020FFFh
1	3	31	001F000h	001FFFFh
		⋮	⋮	⋮
		24	0018000h	0018FFFh
	2	23	0017000h	0017FFFh
		⋮	⋮	⋮
		16	0010000h	0010FFFh
0	1	15	000F000h	000FFFFh
		⋮	⋮	⋮
		8	0008000h	0008FFFh
	0	7	0007000h	0007FFFh
		⋮	⋮	⋮
		0	0000000h	0000FFFh

individual 16 sectors lock/unlock unit:4K-byte

individual block lock/unlock unit:64K-byte

individual block lock/unlock unit:64K-byte

individual block lock/unlock unit:64K-byte

individual 16 sectors lock/unlock unit:4K-byte

DEVICE OPERATION

1. Before a command is issued, status register should be checked to ensure 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.

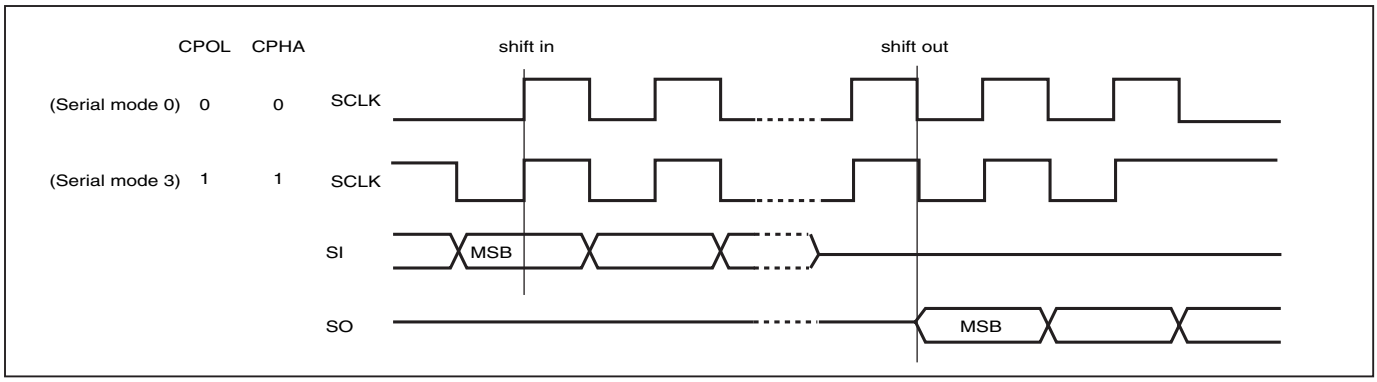
3. When correct command is inputted to this LSI, this LSI becomes active mode and keeps the active mode until next CS# rising edge.

4. For standard single data rate serial mode, 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 1.

5. For the following instructions: RDID, RDSR, RDSCUR, READ, FAST_READ, RDSFDP, 2READ, DREAD, 4READ, QREAD, RDBLOCK, RES, REMS, REMS2, and REMS4 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, BE32K, HPM, CE, PP, CP, 4PP, RDP, DP, WPSEL, SBLK, SBULK, GBLK, GBULK, ENSO, EXSO, WRSCUR, EN4B, EX4B, ENPLM, EXPLM, ESRY, DSRY and CLSR 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, Erase.

Figure 1. Serial Modes Supported (for Normal Serial mode)



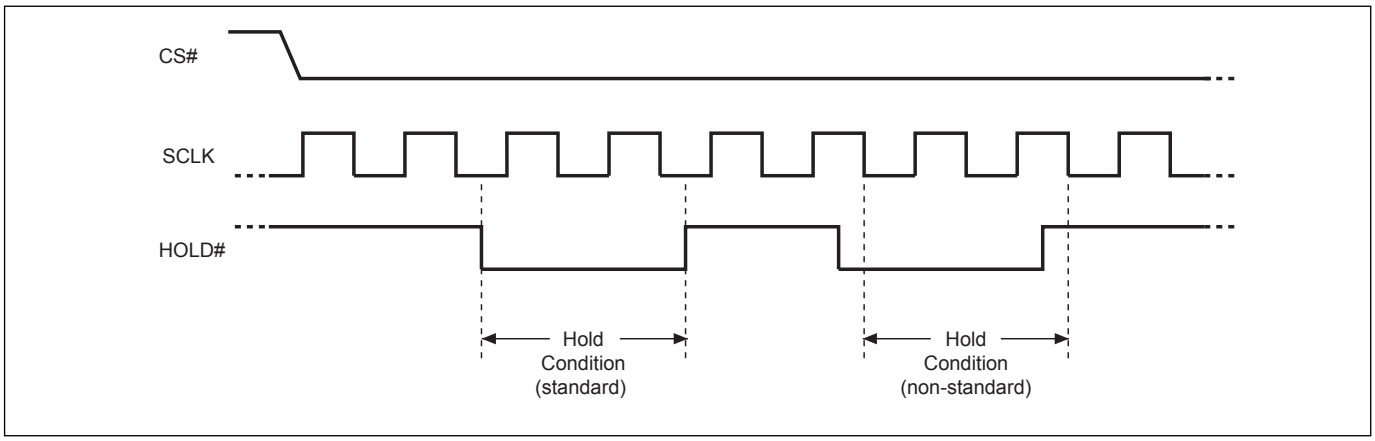
Note:
CPOL indicates clock polarity of Serial master, CPOL=1 for SCLK high while idle, CPOL=0 for SCLK low while not transmitting. CPHA indicates clock phase. The combination of CPOL bit and CPHA bit decides which Serial mode is supported.

HOLD FEATURES

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 2.

Figure 2. 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.

Note 1: The HOLD feature is disabled during Quad I/O mode in 16-SOP package.

COMMAND DESCRIPTION

Table 5. Command Sets

COMMAND (byte)	WREN (write enable)	WRDI (write disable)	RDID (read identification)	RDSR (read status register)	WRSR (write status register)	EN4B (enter 4-byte mode)	EX4B (exit 4-byte mode)	READ (read data)
Command (hex)	06	04	9F	05	01	B7	E9	03
Input Cycles					Data(8)			ADD(24)
Dummy Cycles								
Action	sets the (WEL) write enable latch bit	resets the (WEL) write enable latch bit	outputs JEDEC ID: 1-byte Manufacturer ID & 2-byte Device ID	to read out the values of the status register	to write new values to the status register	to enter 4-byte mode and set 4BYTE bit as "1"	to exit 4-byte mode and clear 4BYTE bit to be "0"	n bytes read out until CS# goes high

COMMAND (byte)	FAST READ (fast read data)	RDSFDP (Read SFDP)	2READ (2 x I/O read command) Note1	DREAD (1I 2O read)	4READ (4 x I/O read command)	QREAD (1I 4O read)	4PP (quad page program)	SE (sector erase)
Command (hex)	0B	5A	BB	3B	EB	6B	38	20
Input Cycles	ADD(24)	ADD(24)	ADD(12)	ADD(24)	ADD(6)+ indicator(2)	ADD(24)	ADD(6)+ Data(512)	ADD(24)
Dummy Cycles	8	8	4	8	4	8		
Action	n bytes read out until CS# goes high	Read SFDP mode	n bytes read out by 2 x I/O until CS# goes high	n bytes read out by Dual output until CS# goes high	n bytes read out by 4 x I/O until CS# goes high	n bytes read out by Quad output until CS# goes high	quad input to program the selected page	to erase the selected sector

COMMAND (byte)	BE (block erase 64KB)	BE 32K (block erase 32KB)	CE (chip erase)	PP (Page program)	CP (Continuously program mode)	DP (Deep power down)	RDP (Release from deep power down)	RES (read electronic ID)
Command (hex)	D8	52	60 or C7	02	AD	B9	AB	AB
Input Cycles	ADD(24)	ADD(24)		ADD(24)+ Data(2048)	ADD(24)+ Data(16)			
Dummy Cycles								24
Action	to erase the selected 64KB block	to erase the selected 32KB block	to erase whole chip	to program the selected page	continously program whole chip, the address is automatically increase	enters deep power down mode	release from deep power down mode	to read out 1-byte Device ID

COMMAND (byte)	REMS (read electronic manufacturer & device ID)	REMS2 (read ID for 2x I/O mode)	REMS4 (read ID for 4x I/O mode)	ENSO (enter secured OTP)	EXSO (exit secured OTP)	RDSCUR (read security register)	WRSCUR (write security register)
Command (hex)	90	EF	DF	B1	C1	2B	2F
Input Cycles	ADD(8)	ADD(8)	ADD(8)				
Dummy Cycles	16	16	16				
Action	output the Manufacturer ID & Device ID	output the Manufacturer ID & Device ID	output the Manufact-urer ID & device ID	to enter the 4K-bit Secured OTP mode	to exit the 4K-bit Secured OTP mode	to read value of security register	to set the lock-down bit as "1" (once lock-down, cannot be updated)

COMMAND (byte)	ESRY (enable SO to output RY/BY#)	DSRY (disable SO to output RY/BY#)	CLSR (Clear SR Fail Flags)	HPM (High Perform-ance Enable Mode)	WPSEL (write protection selection)	SBLK (single block lock) *Note 2	SBULK (single block unlock)
Command (hex)	70	80	30	A3	68	36	39
Input Cycles						ADD(24)	ADD(24)
Dummy Cycles							
Action	to enable SO to output RY/BY# during CP mode	to disable SO to output RY/BY# during CP mode	clear security register bit 6 and bit 5	Quad I/O high Perform-ance mode	to enter and enable individal block protect mode	individual block (64K-byte) or sector (4K-byte) write protect	individual block (64K-byte) or sector (4K-byte) unprotect

COMMAND (byte)	RDBLOCK (block protect read)	GBLK (gang block lock)	GBULK (gang block unlock)
Command (hex)	3C	7E	98
Input Cycles	ADD(24)		
Dummy Cycles			
Action	read individual block or sector write protect status	whole chip write protect	whole chip unprotect

Note 1: It is not recommended to adopt any other code not in the command definition table, which will potentially enter the hidden mode.

Note 2: In individual block write protection mode, all blocks/sectors is locked as defualt.

Note 3: The number in parentheses afer "ADD" or "Data" stands for how many clock cycles it has. For example, "Data(8)" represents there are 8 clock cycles for the data in. Please note the number after "ADD" are based on 3-byte address mode, for 4-byte address mode, which will be increased.

(1) Write Enable (WREN)

The Write Enable (WREN) instruction is for setting Write Enable Latch (WEL) bit. For those instructions like PP, 4PP, CP, SE, BE, BE32K, CE, WRSR, WRSCUR, WPSEL, SBLK, SBULK, GBLK and GBULK, 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. (Please refer to Figure 10)

(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. (Please refer to Figure 11)

The WEL bit is reset by following situations:

- Power-up
- Reset# pin driven low
- Write Disable (WRDI) instruction completion
- Write Status Register (WRSR) instruction completion
- Page Program (PP, 4PP) instruction completion
- Sector Erase (SE) instruction completion
- Block Erase (BE, BE32K) instruction completion
- Chip Erase (CE) instruction completion
- Continuously Program mode (CP) instruction completion
- Single Block Lock/Unlock (SBLK/SBULK) instruction completion
- Gang Block Lock/Unlock (GBLK/GBULK) instruction completion
- Write Security Register (WRSCUR) instruction completion
- Write Protection Selection (WPSEL) instruction completion

(3) Read Identification (RDID)

The 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 are listed as table of "ID Definitions". (Please refer to Table 6)

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. (Please refer to Figure 12)

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. 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 (Please refer to Figure 13).

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. The program/erase command will be ignored and will reset WEL bit if it is applied to a protected memory area.

BP3, BP2, BP1, BP0 bits. The Block Protect (BP3, BP2, BP1, BP0) bits, non-volatile bits, indicate the protected area (as defined in Table 2) of the device to against the program/erase instruction without hardware protection mode being set. To write the Block Protect (BP3, BP2, 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).

QE bit. The Quad Enable (QE) bit, non-volatile bit, while it is "0" (factory default), it performs non-Quad and WP#, HOLD#, RESET# are enable. While QE is "1", it performs Quad I/O mode and WP#, HOLD#, RESET# are disabled. In the other word, if the system goes into four I/O mode (QE=1), the feature of HPM and HOLD (16SOP package) or RESET (8 WSON package) will be disabled.

SRWD bit. The Status Register Write Disable (SRWD) bit, non-volatile bit, default value is "0". SRWD bit is operated together with Write Protection (WP#/SIO2) pin for providing hardware protection mode. The hardware protection mode requires SRWD sets to 1 and WP#/SIO2 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 (BP3, BP2, BP1, BP0) are read only.

Status Register

bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0
SRWD (status register write protect)	QE (Quad Enable)	BP3 (level of protected block)	BP2 (level of protected block)	BP1 (level of protected block)	BP0 (level of protected block)	WEL (write enable latch)	WIP (write in progress bit)
1=status register write disable	1= Quad Enable 0=not Quad Enable	(note 1)	(note 1)	(note 1)	(note 1)	1=write enable 0=not write enable	1=write operation 0=not in write operation
Non-volatile bit	Non-volatile bit	Non-volatile bit	Non-volatile bit	Non-volatile bit	Non-volatile bit	volatile bit	volatile bit

Note 1: see the Table 2 "Protected Area Size" in page 11.

(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 (BP3, BP2, BP1, BP0) bits to define the protected area of memory (as shown in Table 2). The WRSR also can set or reset the Quad enable (QE) bit and set or reset the Status Register Write Disable (SRWD) bit in accordance with Write Protection (WP#/SIO2) pin signal, but has no effect on bit1(WEL) and bit0 (WIP) of the status register. The WRSR instruction cannot be executed once the Hardware Protected Mode (HPM) is entered.

If Reset# goes low while Write Status Register (WRSR) execution is on going, the operation of WRSR will finish after tw timing before entering Reset mode.

The sequence of issuing WRSR instruction is: CS# goes low→ sending WRSR instruction code→ Status Register data on SI→ CS# goes high. (Please refer to Figure 14)

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.

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-BP3 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 program or erase.
Hardware protection mode (HPM)	The SRWD, BP0-BP3 of status register bits cannot be changed	WP#=0, SRWD bit=1	The protected area cannot be program or erase.

Note: As defined by the values in the Block Protect (BP3, BP2, BP1, BP0) bits of the Status Register, as shown in Table 2.

As the above table 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#/SIO2 is low or high, the WREN instruction may set the WEL bit and can change the values of SRWD, BP3, BP2, BP1, BP0. The protected area, which is defined by BP3, BP2, BP1, BP0, is at software protected mode (SPM).
- When SRWD bit=1 and WP#/SIO2 is high, the WREN instruction may set the WEL bit can change the values of SRWD, BP3, BP2, BP1, BP0. The protected area, which is defined by BP3, BP2, BP1, BP0, is at software protected mode (SPM)

Hardware Protected Mode (HPM):
- When SRWD bit=1, and then WP#/SIO2 is low (or WP#/SIO2 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 BP3, BP2, BP1, BP0 and hardware protected mode by the WP#/SIO2 to against data modification.

Note:
To exit the hardware protected mode requires WP#/SIO2 driving high once the hardware protected mode is entered. If the WP#/SIO2 pin is permanently connected to high, the hardware protected mode can never be entered; only can use software protected mode via BP3, BP2, BP1, BP0.
If the system goes into four I/O mode, the feature of HPM will be disabled.

(6) Enter 4-byte mode (EN4B)

The EN4B instruction enables accessing the address length of 32-bit for the memory area of higher density (larger than 128Mb). The device default is in 24-bit address mode; after sending out the EN4B instruction, the bit2 (4BTYE bit) of security register will be automatically set to "1" to indicate the 4-byte address mode has been enabled. Once the 4-byte address mode is enabled, the address length becomes 32-bit instead of the default 24-bit. There are three methods to exit the 4-byte mode: writing exit 4-byte mode (EX4B) instruction, Hardware Reset or power-off.

All instructions are accepted normally, and just the address bit is changed from 24-bit to 32-bit.

The sequence of issuing EN4B instruction is: CS# goes low → sending EN4B instruction to enter 4-byte mode(automatically set 4BYTE bit as "1") → CS# goes high.

(7) Exit 4-byte mode (EX4B)

The EX4B instruction is executed to exit the 4-byte address mode and return to the default 3-bytes address mode. After sending out the EX4B instruction, the bit2 (4BTYE bit) of security register will be cleared to be "1" to indicate the exit of the 4-byte address mode. Once exiting the 4-byte address mode, the address length will return to 24-bit.

The sequence of issuing EX4B instruction is: CS# goes low → sending EX4B instruction to exit 4-byte mode (automatically clear the 4BYTE bit to be "0") → CS# goes high.

(8) 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 default read mode is 3-byte address, to access higher address (4-byte address) which requires to enter the 4-byte address read mode. To enter the 4-byte mode, please refer to the enter 4-byte mode (EN4B) Mode section.

The sequence of issuing READ instruction is: CS# goes low → sending READ instruction code→ 3-byte or 4-byte address (depending on mode state) on SI → data out on SO → to end READ operation can use CS# to high at any time during data out. (Please refer to Figure 15)

(9) 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 default read mode is 3-byte address, to access higher address (4-byte address) which requires to enter the 4-byte address read mode. To enter the 4-byte mode, please refer to the enter 4-byte mode (EN4B) Mode section.

The sequence of issuing FAST_READ instruction is: CS# goes low → sending FAST_READ instruction code → 3-byte or 4-byte address (depending on mode state) on SI → 1-dummy byte (default) address on SI → data out on

SO → to end FAST_READ operation can use CS# to high at any time during data out. (Please refer to Figure 16)
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.

(10) 2 x I/O Read Mode (2READ)

The 2READ instruction enables 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 2 I/O 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 2READ instruction. The address counter rolls over to 0 when the highest address has been reached. Once writing 2READ instruction, the following address/dummy/data out will perform as 2-bit instead of previous 1-bit.

The default read mode is 3-byte address, to access higher address (4-byte address) which requires to enter the 4-byte address read mode. To enter the 4-byte mode, please refer to the enter 4-byte mode (EN4B) Mode section.

The sequence of issuing 2READ instruction is: CS# goes low → sending 2READ instruction → 3-byte or 4-byte address (depending on mode state) interleave on SIO1 & SIO0 → 4-bit dummy cycle on SIO1 & SIO0 → data out interleave on SIO1 & SIO0 → to end 2READ operation can use CS# to high at any time during data out (Please refer to Figure 17 for 2 x I/O Read Mode Timing Waveform).

While Program/Erase/Write Status Register cycle is in progress, 2READ instruction is rejected without any impact on the Program/Erase/Write Status Register current cycle.

(11) Dual Read 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 2 I/O 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 of issuing DREAD instruction is: CS# goes low → sending DREAD instruction → 3-byte or 4-byte address on SI → 8-bit dummy cycle → data out interleave on SO1 & SO0 → to end DREAD operation can use CS# to high at any time during data out (Please refer to Figure 18 for Dual Read Mode Timing Waveform).

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.

(12) 4 x I/O Read Mode (4READ)

The 4READ instruction enables quad throughput of Serial Flash in read mode. A Quad Enable (QE) bit of status Register must be set to "1" before sending the 4READ instruction. The address is latched on rising edge of SCLK, and data of every four bits (interleave on 4 I/O pins) shift out on the falling edge of SCLK at a maximum frequency fQ. 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 4READ instruction. The address counter rolls over to 0 when the highest address has been reached. Once writing 4READ instruction, the following address/dummy/data out will perform as 4-bit instead of previous 1-bit.

The default read mode is 3-byte address, to access higher address (4-byte address) which requires to enter the 4-byte address read mode. To enter the 4-byte mode, please refer to the enter 4-byte mode (EN4B) Mode section.

The sequence of issuing 4READ instruction is: CS# goes low → sending 4READ instruction → 3-byte or 4-byte address (depending on mode state) interleave on SIO3, SIO2, SIO1 & SIO0 → 6 dummy cycles → data out interleave on SIO3, SIO2, SIO1 & SIO0→ to end 4READ operation can use CS# to high at any time during data out (Please refer to Figure 19 for 4 x I/O Read Mode Timing Waveform).

Another sequence of issuing 4 READ instruction especially useful in random access is : CS# goes low→ sending 4 READ instruction → 3-byte or 4-byte address (depending on mode state) interleave on SIO3, SIO2, SIO1 & SIO0 → performance enhance toggling bit P[7:0]→ 4 dummy cycles → data out still CS# goes high → CS# goes low (reduce 4 Read instruction) → 3-byte or 4-byte address (depending on mode state) random access address (Please refer to Figure 21 for 4x I/O Read Enhance Performance Mode timing waveform).

In the performance-enhancing mode (the waveform figure), P[7:4] must be toggling with P[3:0] ; likewise P[7:0]=A5h,5Ah,F0h or 0Fh can make this mode continue and reduce the next 4READ instruction. Once P[7:4] is no longer toggling with P[3:0]; likewise P[7:0]=FFh,00h,AAh or 55h. These commands will reset the performance enhance mode. And afterwards CS# is raised and then lowered, the system then will return to normal operation.
While Program/Erase/Write Status Register cycle is in progress, 4READ instruction is rejected without any impact on the Program/Erase/Write Status Register current cycle.

(13) Quad Read Mode (QREAD)

The QREAD instruction enable quad throughput of Serial Flash in read mode. A Quad Enable (QE) bit of status register must be set to "1" before sending the QREAD. The address is latched on rising edge of SCLK, and data of every four bits (interleave on 4 I/O pins) shift out on the falling edge of SCLK at a maximum frequency fQ. 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 QREAD instruction. The address counter rolls over to 0 when the highest address has been reached. Once writing QREAD instruction, the following data out will perform as 4-bit instead of previous 1-bit.

The sequence of issuing QREAD instruction is: CS# goes low→ sending QREAD instruction → 3-byte or 4-byte address on SI → 8-bit dummy cycle → data out interleave on SO3, SO2, SO1 & SO0→ to end QREAD operation can use CS# to high at any time during data out (Please refer to Figure 20 for Quad Read Mode Timing Waveform).

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

(14) Sector Erase (SE)

The Sector Erase (SE) instruction is for erasing the data of the chosen sector to be "1". The instruction is used for any 4K-byte sector. 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 (Table of memory organization) 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.

The default mode is 3-byte address, to access higher address (4-byte address) which requires to enter the 4-byte address read mode.

If RESET# goes low while Sector Erase (SE) execution is on going, the operation of SE will finish after tSE timing before entering Reset mode.

The sequence of issuing SE instruction is: CS# goes low → sending SE instruction code→ 3-byte or 4-byte address (depending on mode state) on SI → CS# goes high. (Please refer to Figure 22)

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 check 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 sector is protected by BP3~0 (WPSEL=0) or by individual lock (WPSEL=1), the array data will be protected (no change) and the WEL bit still be reset.

(15) Block Erase (BE)

The Block Erase (BE) instruction is for erasing the data of the chosen block to be "1". The instruction is used for 64K-byte block erase operation. 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 (Table of memory organization) 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 default mode is 3-byte address, to access higher address (4-byte address) which requires to enter the 4-byte address read mode.

The sequence of issuing BE instruction is: CS# goes low → sending BE instruction code → 3-byte or 4-byte address (depending on mode state) on SI → CS# goes high. (Please refer to Figure 23)

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 block is protected by BP3~0 (WPSEL=0) or by individual lock (WPSEL=1), the array data will be protected (no change) and the WEL bit still be reset.

(16) Block Erase (BE32K)

The Block Erase (BE32) instruction is for erasing the data of the chosen block to be "1". The instruction is used for 32K-byte block erase operation. A Write Enable (WREN) instruction must execute to set the Write Enable Latch (WEL) bit before sending the Block Erase (BE32). Any address of the block (Table of memory organization) is a valid address for Block Erase (BE32) 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 default mode is 3-byte address, to access higher address (4-byte address) which requires to enter the 4-byte address read mode.

If RESET# goes low while Block Erase (BE32K) execution is on going, the operation of BE32K will finish after tBE (32KB) timing before entering Reset mode.

The sequence of issuing BE32 instruction is: CS# goes low → sending BE32 instruction code → 3-byte or 4-byte address (depending on mode state) on SI → CS# goes high. (Please refer to Figure 23)

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 block is protected by BP3~0 (WPSEL=0) or by individual lock (WPSEL=1), the array data will be protected (no change) and the WEL bit still be reset.

(17) 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). The CS# must go high exactly at the byte boundary; 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. (Please refer to Figure 24)

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 the Chip Erase (CE) instruction will not be executed, but WEL will be reset.

(18) 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). The device programs only the last 256 data bytes sent to the device. If the entire 256 data bytes are going to be programmed, A7-A0 (The eight least significant address bits) should be set to 0. If the eight least significant address bits (A7-A0) are not all 0, all transmitted data going beyond the end of the current page are programmed from the start address of the same page (from the address A7-A0 are all 0). If more than 256 bytes are sent to the device, the data of the last 256-byte is programmed at the request page and previous data will be disregarded. If less than 256 bytes are sent to the device, the data is programmed at the requested address of the page without effect on other address of the same page.

The default mode is 3-byte address, to access higher address (4-byte address) which requires to enter the 4-byte address read mode.

The sequence of issuing PP instruction is: CS# goes low→ sending PP instruction code→ 3-byte or 4-byte address (depending on mode state) on SI→ at least 1-byte on data on SI→ CS# goes high. (Please refer to Figure 25)

The CS# must be kept to low during the whole Page Program cycle; The CS# must go high exactly at the byte boundary (the latest eighth bit of data being latched in), otherwise, the instruction will be rejected and will not be executed.

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 check out during the Page Program cycle is in progress. The WIP sets 1 during the tPP timing, and sets 0 when Page Program Cycle is completed, and the Write Enable Latch (WEL) bit is reset. If the page is protected by BP3~0 (WPSEL=0) or by individual lock (WPSEL=1), the array data will be protected (no change) and the WEL bit will still be reset.

(19) 4 x I/O Page Program (4PP)

The Quad Page Program (4PP) instruction is for programming the memory to be "0". A Write Enable (WREN) instruction must execute to set the Write Enable Latch (WEL) bit and Quad Enable (QE) bit must be set to "1" before sending the Quad Page Program (4PP). The Quad Page Programming takes four pins: SIO0, SIO1, SIO2, and SIO3, which can raise programer performance and and the effectiveness of application of lower clock less than 20MHz. For system with faster clock, the Quad page program cannot provide more actual favors, because

the required internal page program time is far more than the time data flows in. Therefore, we suggest that while executing this command (especially during sending data), user can slow the clock speed down to 20MHz below. The other function descriptions are as same as standard page program.

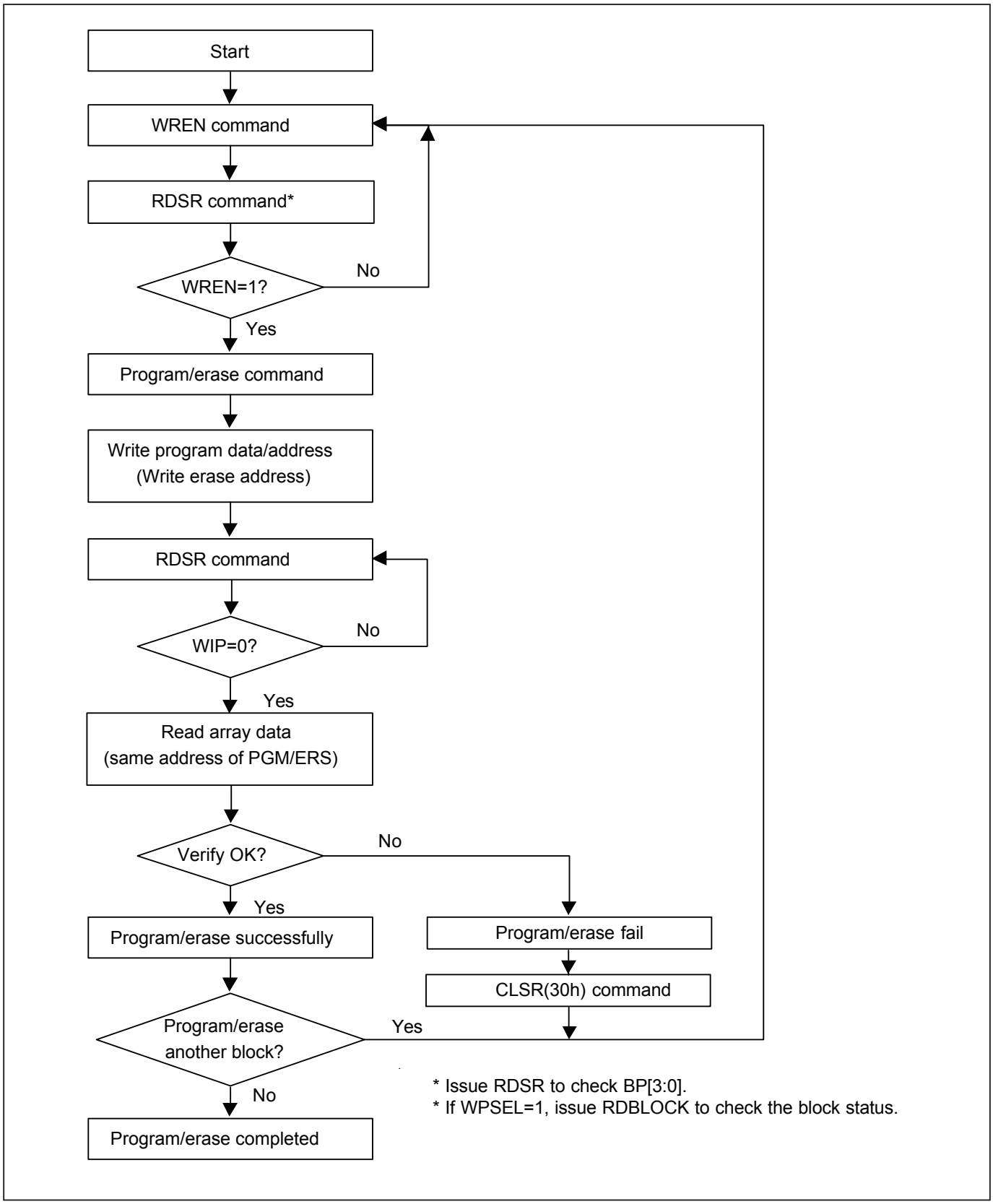
The default mode is 3-byte address, to access higher address(4-byte address) which requires to enter the 4-byte address read mode.

The sequence of issuing 4PP instruction is: CS# goes low→ sending 4PP instruction code→ 3-byte or 4-byte address (depending on mode state) on SIO[3:0]→ at least 1-byte on data on SIO[3:0]→ CS# goes high. (Please refer to Figure 26)

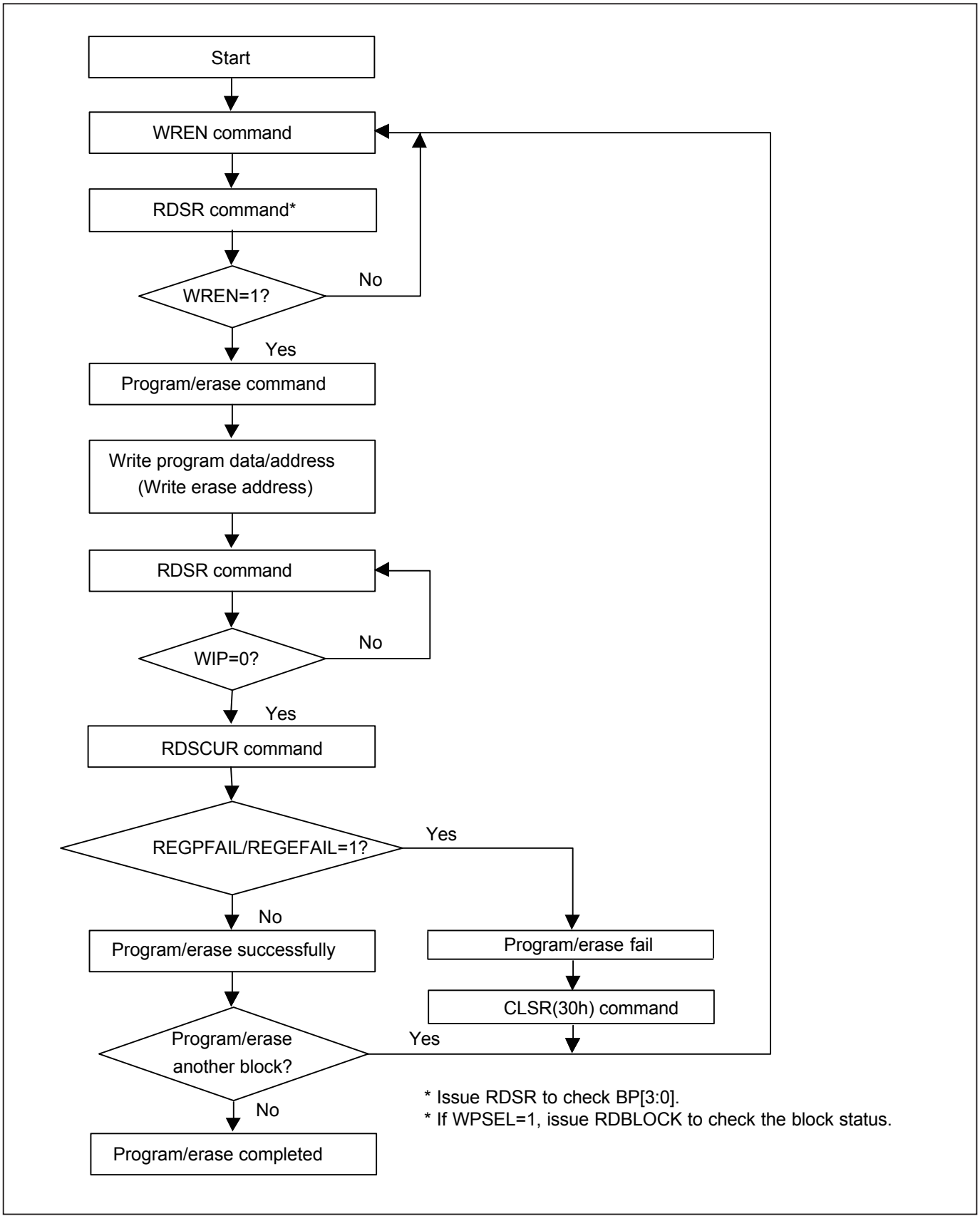
If the page is protected by BP3~0 (WPSEL=0) or by individual lock (WPSEL=1), the array data will be protected (no change) and the WEL bit will still be reset.

The Program/Erase function instruction function flow is as follows:

Program/Erase Flow(1) - verify by reading array data



Program/Erase Flow(2) - verify by reading program/erase fail flag bit



(20) Continuously program mode (CP mode)

The CP mode may enhance program performance by automatically increasing address to the next higher address after each byte data has been programmed.

The Continuously program (CP) instruction is for multiple byte program to Flash. A write Enable (WREN) instruction must execute to set the Write Enable Latch (WEL) bit before sending the Continuously program (CP) instruction. CS# requires to go high before CP instruction is executing. After CP instruction and address input, two bytes of data is input sequentially from MSB(bit7) to LSB(bit0). The first byte data will be programmed to the initial address range with A0=0 and second byte data with A0=1. If only one byte data is input, the CP mode will not process. If more than two bytes data are input, the additional data will be ignored and only two byte data are valid. Any byte to be programmed should be in the erase state (FF) first. It will not roll over during the CP mode, once the last unprotected address has been reached, the chip will exit CP mode and reset write Enable Latch bit (WEL) as "0" and CP mode bit as "0". Please check the WIP bit status if it is not in write progress before entering next valid instruction. During CP mode, the valid commands are CP command (AD hex), WRDI command (04 hex), RDSR command (05 hex), and RDSCUR command (2B hex). And the WRDI command is valid after completion of a CP programming cycle, which means the WIP bit=0.

The default mode is 3-byte address, to access higher address (4-byte address) which requires to enter the 4-byte address read mode.

The sequence of issuing CP instruction is : CS# goes low → sending CP instruction code → 3-byte or 4-byte address (depending on mode state) on SI pin → two data bytes on SI → CS# goes high to low → sending CP instruction and then continue two data bytes are programmed → CS# goes high to low → till last desired two data bytes are programmed → CS# goes high to low → sending WRDI (Write Disable) instruction to end CP mode → send RDSR instruction to verify if CP mode word program ends, or send RDSCUR to check bit4 to verify if CP mode ends. (Please refer to Figure 27 of CP mode timing waveform)

Three methods to detect the completion of a program cycle during CP mode:
1) Software method-I: by checking WIP bit of Status Register to detect the completion of CP mode.
2) Software method-II: by waiting for a tBP time out to determine if it may load next valid command or not.
3) Hardware method: by writing ESRY (enable SO to output RY/BY#) instruction to detect the completion of a program cycle during CP mode. The ESRY instruction must be executed before CP mode execution. Once it is enable in CP mode, the CS# goes low will drive out the RY/BY# status on SO, "0" indicates busy stage, "1" indicates ready stage, SO pin outputs tri-state if CS# goes high. DSRY (disable SO to output RY/BY#) instruction to disable the SO to output RY/BY# and return to status register data output during CP mode. Please note that the ESRY/DSRY command are not accepted unless the completion of CP mode.

If the page is protected by BP3~0 (WPSEL=0) or by individual lock (WPSEL=1), the array data will be protected (no change) and the WEL bit will still be reset.

(21) Deep Power-down (DP)

The Deep Power-down (DP) instruction is for setting the device on the minimizing the power consumption (to entering the Deep Power-down mode), the standby 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, it's only in standby mode not deep power-down mode. It's different from Standby mode.

The sequence of issuing DP instruction is: CS# goes low→ sending DP instruction code→ CS# goes high. (Please refer to Figure 28)

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. (those instructions allow the ID being reading 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.

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

The Release from Deep Power-down (RDP) instruction is terminated by driving Chip Select (CS#) High. When Chip Select (CS#) is driven High, the device is put in the standby Power mode. If the device was not previously in the Deep Power-down mode, the transition to the standby Power mode is immediate. If the device was previously in the Deep Power-down mode, though, the transition to the standby Power mode is delayed by tRES2, and Chip Select (CS#) must remain High for at least tRES2(max), as specified in Table 8. Once in the standby mode, the device waits to be selected, so that it can receive, decode and execute instructions. Reset# pin goes low will release the Flash from deep power down mode.

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 design, 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 cycles; there's no effect on the current program/erase/write cycles in progress. The sequence is shown as Figure 29, 30.

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 receive, decode, and execute instruction.

The RDP instruction is for releasing from Deep Power-down Mode.

(23) Read Electronic Manufacturer ID & Device ID (REMS), (REMS2), (REMS4)

The REMS, REMS2, and REMS4 instruction provides both the JEDEC assigned Manufacturer ID and the specific Device ID.

The instruction is initiated by driving the CS# pin low and shift the instruction code "90h", "DFh" or "EFh" 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 28. 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 6. ID Definitions

Command Type	MX25L25635E		
RDID	manufacturer ID	memory type	memory density
	C2	20	19
RES	electronic ID		
	18		
REMS/REMS2/REMS4	manufacturer ID	device ID	
	C2	18	

(24) Enter Secured OTP (ENSO)

The ENSO instruction is for entering the additional 4K-bit Secured OTP mode. The additional 4K-bit Secured OTP is independent from main array, which may use to store unique serial number for system identifier. After entering the Secured OTP mode, and then follow standard read or program, procedure to read out the data or update data. The Secured OTP data cannot be updated again once it is lock-down.

The sequence of issuing ENSO instruction is: CS# goes low → sending ENSO instruction to enter Secured OTP mode → CS# goes high.

Please note that WRSR/WRSCUR/WPSEL/SBLK/GBLK/SBULK/GBULK/CE/BE/SE/BE32K commands are not acceptable during the access of secure OTP region, once Security OTP is lock down, only read related commands are valid.

(25) Exit Secured OTP (EXSO)

The EXSO instruction is for exiting the additional 4K-bit Secured OTP mode.

The sequence of issuing EXSO instruction is: CS# goes low → sending EXSO instruction to exit Secured OTP mode → CS# goes high.

(26) Read Security Register (RDSCUR)

The RDSCUR instruction is for reading the value of Security Register. The Read Security Register can be read at any time (even in program/erase/write status register/write security register condition) and continuously.

The sequence of issuing RDSCUR instruction is : CS# goes low → sending RDSCUR instruction → Security Register data out on SO → CS# goes high.

The definition of the Security Register is as below:

Secured OTP Indicator bit. The Secured OTP indicator bit shows the chip is locked by factory before ex- factory or not. When it is "0", it indicates non-factory lock; "1" indicates factory- lock.

Lock-down Secured OTP (LDSO) bit. By writing WRSCUR instruction, the LDSO bit may be set to "1" for customer lock-down purpose. However, once the bit is set to "1" (lock-down), the LDSO bit and the 4K-bit Secured OTP area cannot be update any more. While it is in 4K-bit Secured OTP mode, array access is not allowed.

4BYTE Indicator bit. By writing EN4B instruction, the 4BYTE bit may be set to "1" to access the address length of 32-bit for higher density (large than 128Mb) memory area. The default state is "0", which means the mode of 24-bit address. The 4BYTE bit may be clear by power off or writing EX4B instruction to reset the state to be "0".

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Continuously Program Mode (CP mode) bit. The Continuously Program Mode bit indicates the status of CP mode, "0" indicates not in CP mode; "1" indicates in CP mode.

Program Fail Flag bit. While a program failure happened, the Program Fail Flag bit would be set. This bit will also be set when the user attempts to program a protected main memory region or a locked OTP region. This bit can indicate whether one or more of program operations fail, and can be reset by command CLSR (30h)

Erase Fail Flag bit. While a erase failure happened, the Erase Fail Flag bit would be set. This bit will also be set when the user attempts to erase a protected main memory region or a locked OTP region. This bit can indicate whether one or more of erase operations fail, and can be reset by command CLSR (30h)

Write Protection Select bit. The Write Protection Select bit indicates that WPSEL has been executed successfully. Once this bit has been set (WPSEL=1), all the blocks or sectors will be write-protected after the power-on every time. Once WPSEL has been set, it cannot be changed again, which means it's only for individual WP mode.

Under the individual block protection mode (WPSEL=1), hardware protection is performed by driving WP#=0. Once WP#=0 all array blocks/sectors are protected regardless of the contents of SRAM lock bits.

Security Register Definition

bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0
WPSEL	E_FAIL	P_FAIL	Continuously Program mode (CP mode)	x	4BYTE	LDSO (lock-down 4K-bit Secured OTP)	4K-bit Secured OTP
0=normal WP mode 1=individual WP mode (default=0)	0=normal Erase succeed 1=indicate Erase failed (default=0)	0=normal Program succeed 1=indicate Program failed (default=0)	0=normal Program mode 1=CP mode (default=0)	reserved	0=3-byte address mode, 1=4-byte address mode (default=0)	0 = not lockdown 1 = lock-down (cannot program/ erase OTP)	0 = nonfactory lock 1 = factory lock
non-volatile bit	volatile bit	volatile bit	volatile bit	volatile bit	volatile bit	non-volatile bit	non-volatile bit
OTP	Read Only	Read Only	Read Only	Read Only	Read Only	OTP	Read Only

(27) Write Security Register (WRSCUR)

The WRSCUR instruction is for changing the values of Security Register Bits. The WRSCUR instruction may change the values of bit1 (LDSO bit) for customer to lock-down the 4K-bit Secured OTP area. Once the LDSO bit is set to "1", the Secured OTP area cannot be updated any more.

The sequence of issuing WRSCUR instruction is :CS# goes low→ sending WRSCUR instruction → CS# goes high.

The CS# must go high exactly at the boundary; otherwise, the instruction will be rejected and not executed.

(28) Write Protection Selection (WPSEL)

There are two write protection methods, (1) BP protection mode (2) individual block protection mode. If WPSEL=0, flash is under BP protection mode . If WPSEL=1, flash is under individual block protection mode. The default value of WPSEL is "0". WPSEL command can be used to set WPSEL=1. **Please note that WPSEL is an OTP bit. Once WPSEL is set to 1, there is no chance to recovery WPSEL back to "0".** If the flash is put on BP mode, the individual block protection mode is disabled. Contrarily, if flash is on the individual block protection mode, the BP mode is disabled.

Every time after the system is powered-on, and the Security Register bit 7 is checked to be WPSEL=1, all the blocks or sectors will be write protected by default. User may only unlock the blocks or sectors via SBULK and GBULK instruction. Program or erase functions can only be operated after the Unlock instruction is conducted.

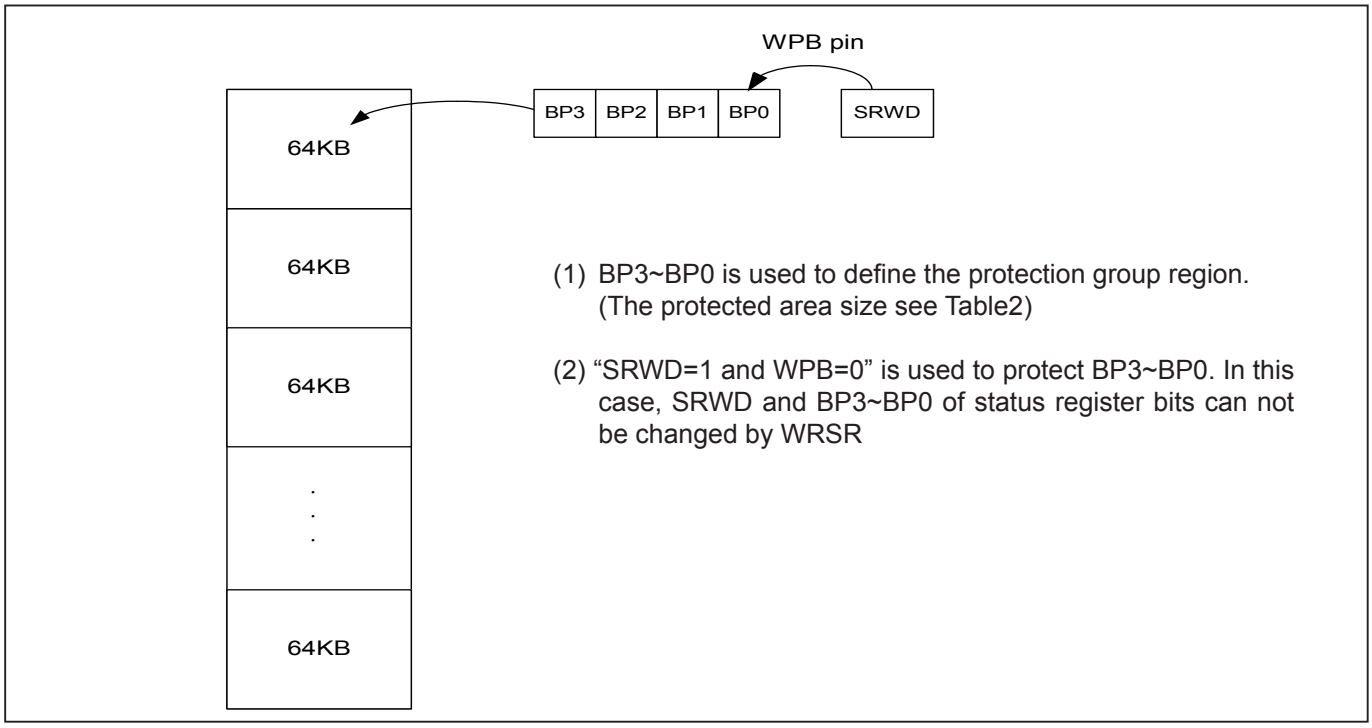
BP protection mode, WPSEL=0:
ARRAY is protected by BP3~BP0 and BP3~BP0 bits are protected by "SRWD=1 and WP#=0", where SRWD is bit 7 of status register that can be set by WRSR command.

Individual block protection mode, WPSEL=1:
Blocks are individually protected by their own SRAM lock bits which are set to "1" after power up. SBULK and SBLK command can set SRAM lock bit to "0" and "1". When the system accepts and executes WPSEL instruction, the bit 7 in security register will be set. It will activate SBLK, SBULK, RDBLOCK, GBLK, GBULK etc instructions to conduct block lock protection and replace the original Software Protect Mode (SPM) use (BP3~BP0) indicated block methods. Under the individual block protection mode (WPSEL=1), hardware protection is performed by driving WP#=0. Once WP#=0 all array blocks/sectors are protected regardless of the contents of SRAM lock bits.

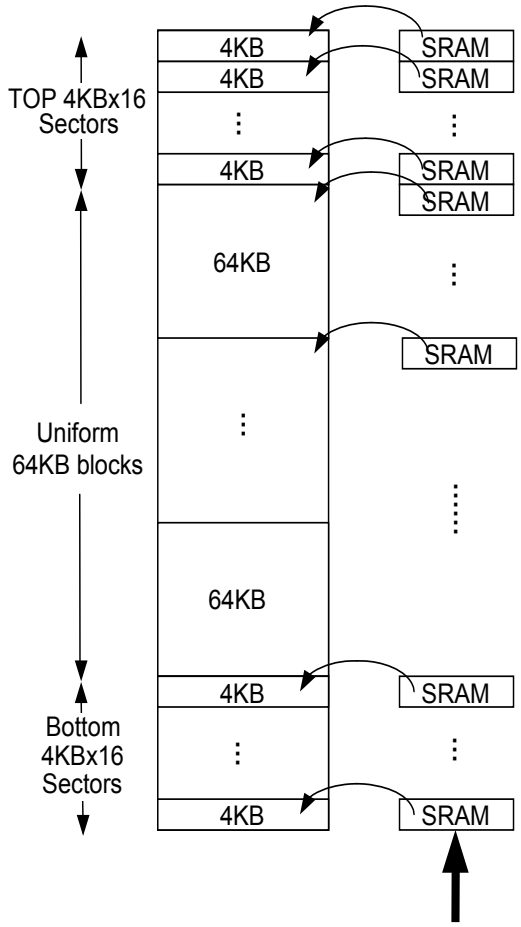
The sequence of issuing WPSEL instruction is: CS# goes low → sending WPSEL instruction to enter the individual block protect mode → CS# goes high.

WPSEL instruction function flow is as follows:

BP and SRWD if WPSEL=0



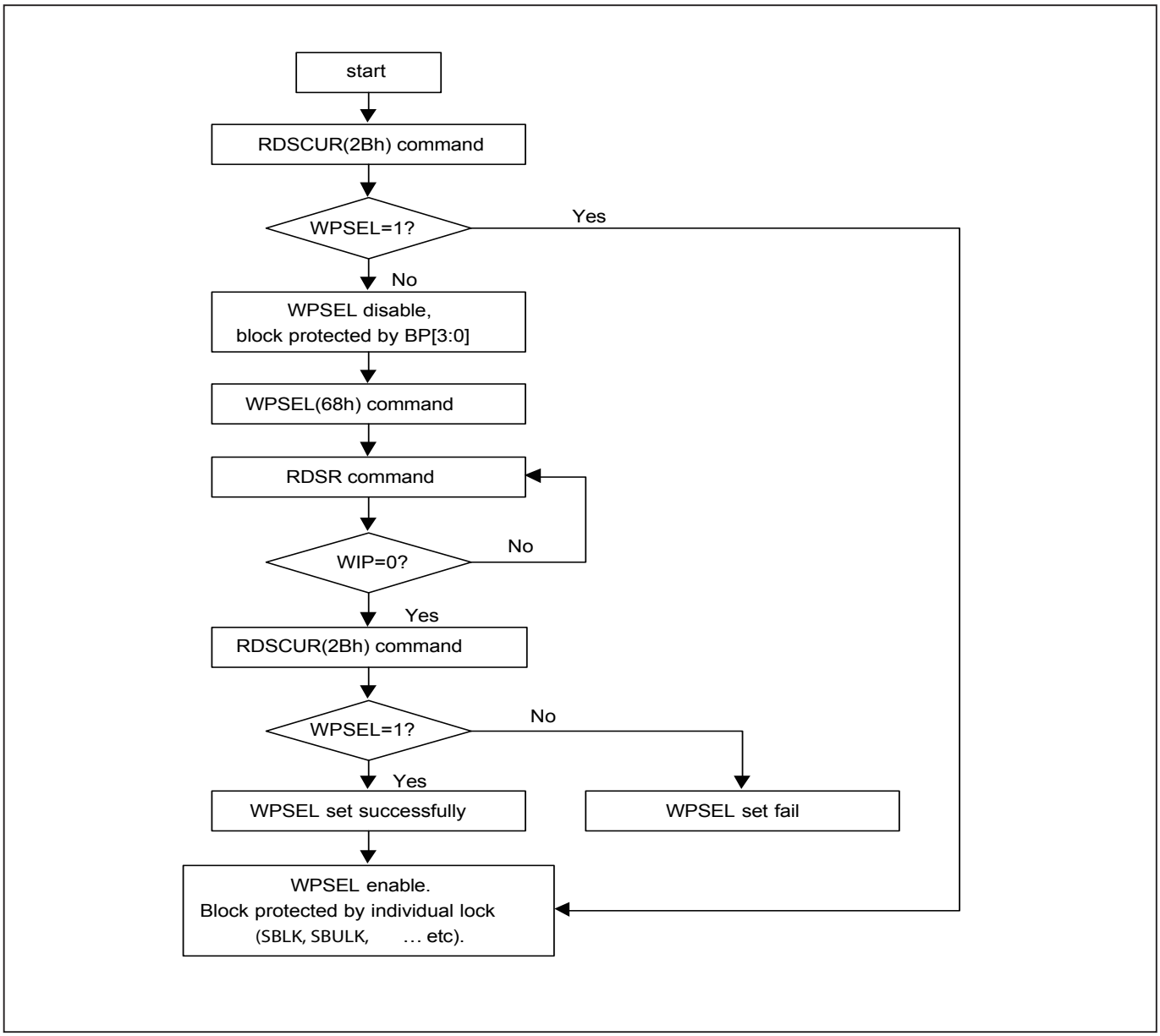
The individual block lock mode is effective after setting WPSEL=1



SBULK / SBLK / GBULK / GBLK / RDBLOCK

- Power-Up: All SRAM bits=1 (all blocks are default protected). All array cannot be programmed/erased
- SBLK/SBULK(36h/39h):
  - SBLK(36h) : Set SRAM bit=1 (protect) : array can not be programmed /erased
  - SBULK(39h): Set SRAM bit=0 (unprotect): array can be programmed /erased
  - All top 4KBx16 sectors and bottom 4KBx16 sectors and other 64KB uniform blocks can be protected and unprotected SRAM bits individually by SBLK/SBULK command set.
- GBLK/ GBULK(7Eh/98h):
  - GBLK(7Eh):Set all SRAM bits=1,whole chip are protected and cannot be programmed / erased.
  - GBULK(98h):Set all SRAM bits=0,whole chip are unprotected and can be programmed / erased.
  - All sectors and blocks SRAM bits of whole chip can be protected and unprotected at one time by GBLK/GBULK command set.
- RDBLOCK(3Ch):
  - use RDBLOCK mode to check the SRAM bits status after SBULK /SBLK/GBULK/GBLK command set.

WPSEL Flow


start
RDSCUR(2Bh) command
WPSEL=1?
Yes
No
WPSEL disable,
block protected by BP[3:0]
WPSEL(68h) command
RDSR command
WIP=0?
No
Yes
RDSCUR(2Bh) command
WPSEL=1?
No
Yes
WPSEL set successfully
WPSEL set fail
WPSEL enable.
Block protected by individual lock
(SBLK, SBULK, … etc).

(29) Single Block Lock/Unlock Protection (SBLK/SBULK)

These instructions are only effective after WPSEL was executed. The SBLK instruction is for write protection a specified block(or sector) of memory, using address bits to assign a 64Kbyte block (or 4K bytes sector) to be protected as read only. The SBULK instruction will cancel the block (or sector) write protection state. This feature allows user to stop protecting the entire block (or sector) through the chip unprotect command (GBULK).

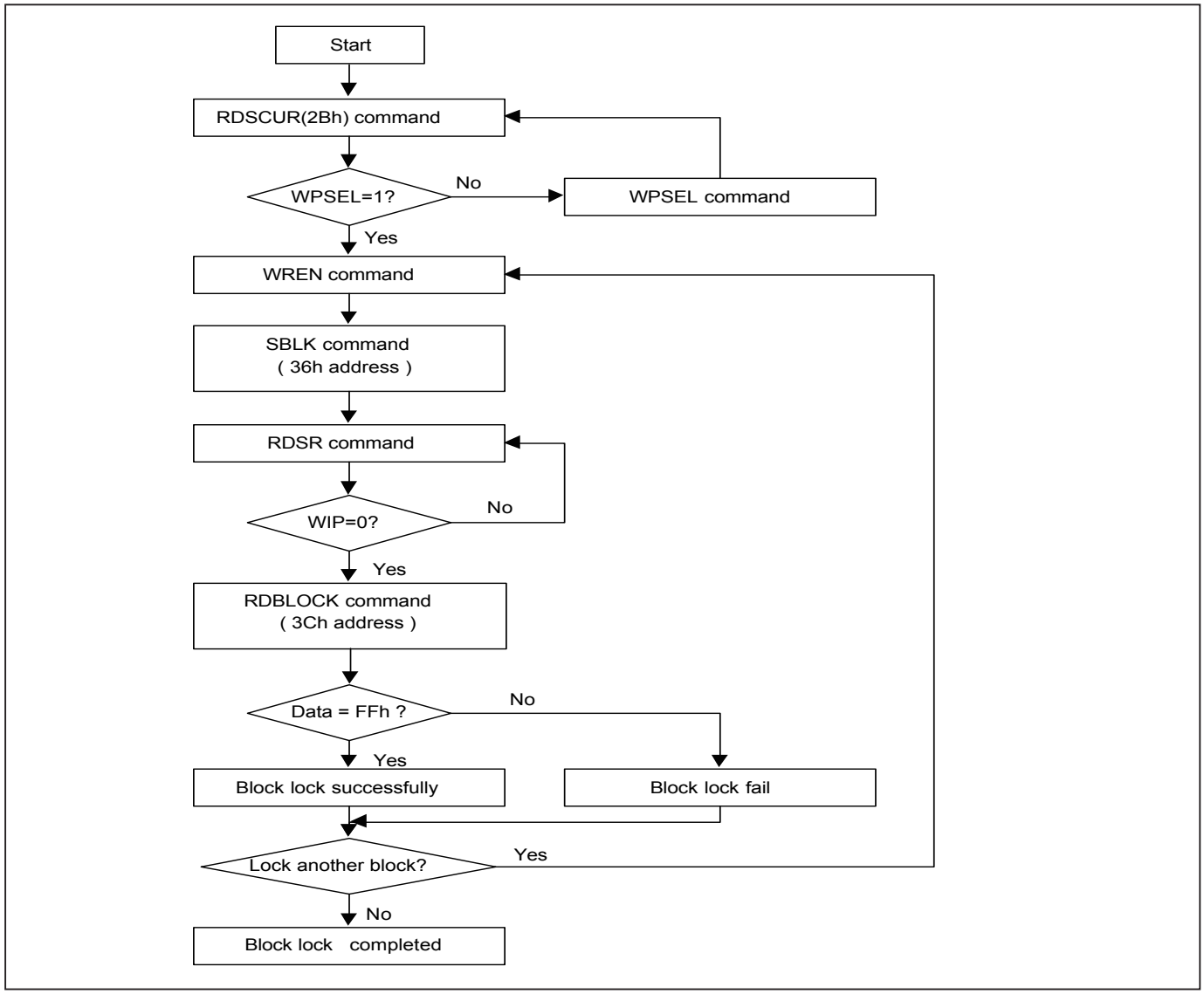
The default mode is 3-byte address, to access higher address (4-byte address) which requires to enter the 4-byte address read mode.

The WREN (Write Enable) instruction is required before issuing SBLK/SBULK instruction.
The sequence of issuing SBLK/SBULK instruction is: CS# goes low → send SBLK/SBULK (36h/39h) instruction → send 3-byte or 4-byte address (depending on mode state) assign one block (or sector) to be protected on SI pin → CS# goes high. (Please refer to Figure 33)

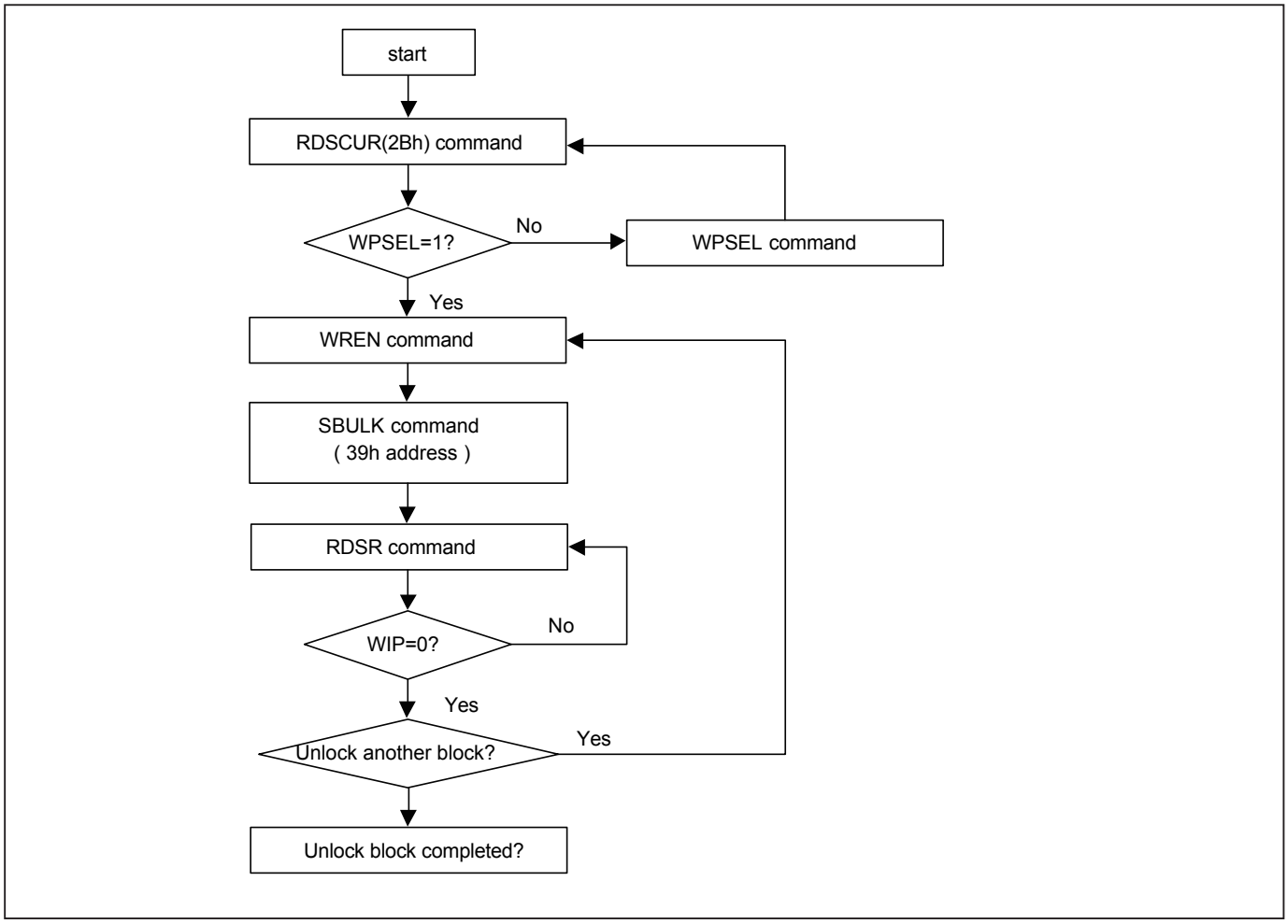
The CS# must go high exactly at the byte boundary, otherwise the instruction will be rejected and not be executed.

SBLK/SBULK instruction function flow is as follows:

Block Lock Flow



Block Unlock Flow



(30) Read Block Lock Status (RDBLOCK)

This instruction is only effective after WPSEL was executed. The RDBLOCK instruction is for reading the status of protection lock of a specified block(or sector), using address bits to assign a 64K bytes block (4K bytes sector) and read protection lock status bit which the first byte of Read-out cycle. The status bit is"1" to indicate that this block has be protected, that user can read only but cannot write/program /erase this block. The status bit is "0" to indicate that this block hasn't be protected, and user can read and write this block.

The default mode is 3-byte address, to access higher address (4-byte address) which requires to enter the 4-byte address read mode.

The sequence of issuing RDBLOCK instruction is: CS# goes low → send RDBLOCK (3Ch) instruction → send 3-byte or 4-byte address (depending on mode state) to assign one block on SI pin → read block's protection lock status bit on SO pin → CS# goes high. (Please refer to Figure 34)

(31) Gang Block Lock/Unlock (GBLK/GBULK)

These instructions are only effective after WPSEL was executed. The GBLK/GBULK instruction is for enable/disable the lock protection block of the whole chip.

The WREN (Write Enable) instruction is required before issuing GBLK/GBULK instruction.
The sequence of issuing GBLK/GBULK instruction is: CS# goes low → send GBLK/GBULK (7Eh/98h) instruction → CS# goes high. (Please refer to Figure 35)

The CS# must go high exactly at the byte boundary, otherwise, the instruction will be rejected and not be executed.

(32) Clear SR Fail Flags (CLSR)

The CLSR instruction is for resetting the Program/Erase Fail Flag bit of Security Register. It should be executed before program/erase another block during programming/erasing flow without read array data.

The sequence of issuing CLSR instruction is: CS# goes low → send CLSR instruction code → CS# goes high.
The CS# must go high exactly at the byte boundary; otherwise, the instruction will be rejected and not executed.

(33) Enable SO to Output RY/BY# (ESRY)

The ESRY instruction is for outputting the ready/busy status to SO during CP mode.
The sequence of issuing ESRY instruction is: CS# goes low → sending ESRY instruction code → CS# goes high.
The CS# must go high exactly at the byte boundary; otherwise, the instruction will be rejected and not executed.

(34) Disable SO to Output RY/BY# (DSRY)

The DSRY instruction is for resetting ESRY during CP mode. The ready/busy status will not output to SO after DSRY issued.

The sequence of issuing DSRY instruction is: CS# goes low → send DSRY instruction code → CS# goes high.
The CS# must go high exactly at the byte boundary; otherwise, the instruction will be rejected and not executed.

(35) 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

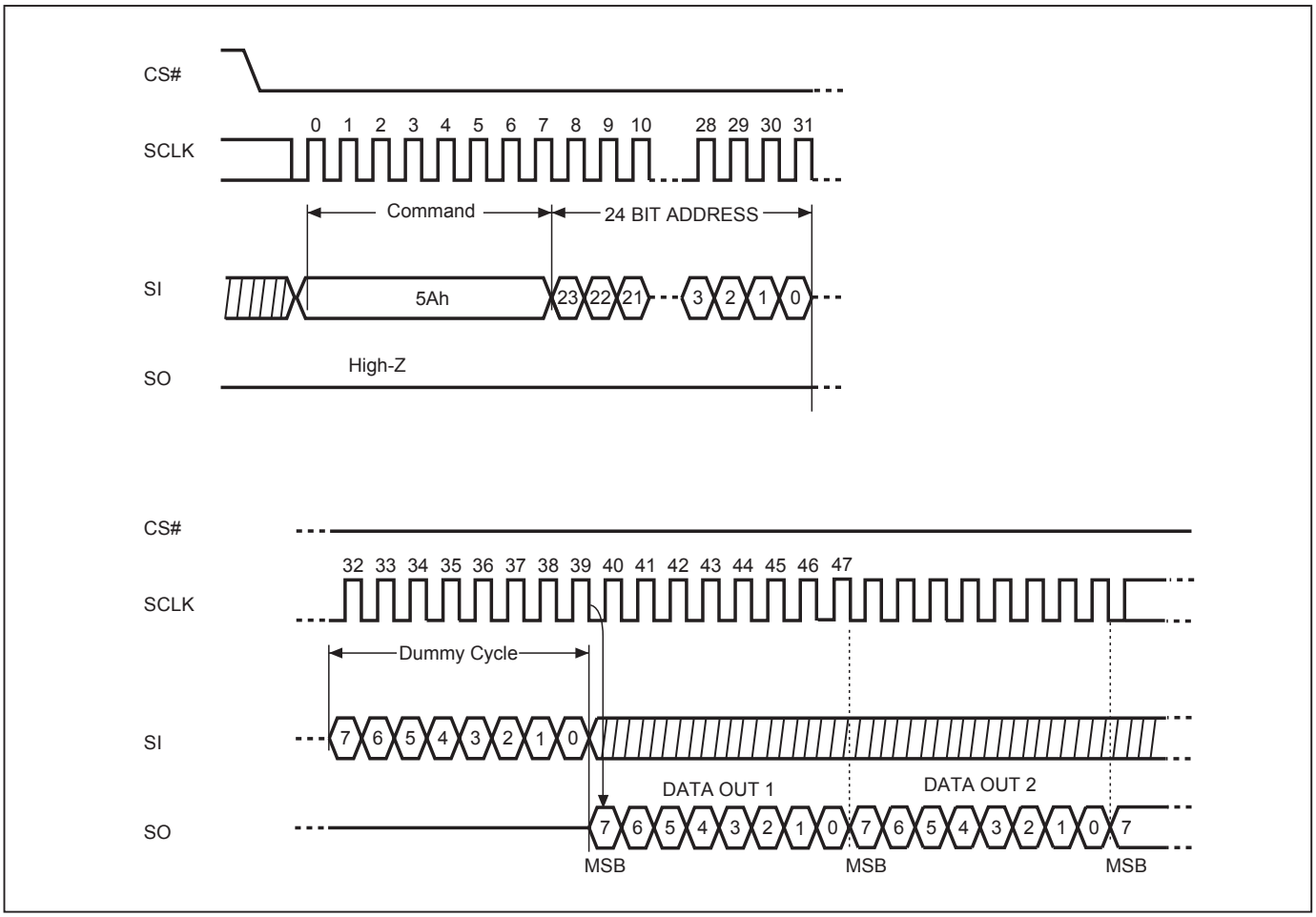


Table a. Signature and Parameter Identification Data Values

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: Nonvolatitle status bit 1: Volatitle 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	F3h
Address Bytes Number used in addressing flash array	00: 3Byte only, 01: 3 or 4Byte, 10: 4Byte only, 11: Reserved		18:17	01b	
Double Transfer Rate (DTR) Clocking	0=not support 1=support		19	0b	
(1-2-2) Fast Read	0=not support 1=support		20	1b	
(1-4-4) Fast Read	0=not support 1=support		21	1b	
(1-1-4) Fast Read	0=not support 1=support		22	1b	
Unused			23	1b	
Unused		33h	31:24	FFh	FFh
Flash Memory Density		37h:34h	31:00	0FFFFFFFh	
(1-4-4) Fast Read Number of Wait states (Note3)	0 0000b: Wait states (Dummy Clocks) not support	38h	04:00	0 0100b	44h
(1-4-4) Fast Read Number of Mode Bits (Note4)	000b: Mode Bits not support		07:05	010b	
(1-4-4) Fast Read Opcode		39h	15:08	EBh	EBh
(1-1-4) Fast Read Number of Wait states	0 0000b: Wait states (Dummy Clocks) not support	3Ah	20:16	0 1000b	08h
(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	6Bh	6Bh

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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 0100b	04h
(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	BBh	BBh
(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	0Fh	0Fh
Sector Type 2 erase Opcode		4Fh	31:24	52h	52h
Sector Type 3 Size	Sector/block size = 2^N bytes 0x00b: this sector type doesn't exist	50h	07:00	10h	10h
Sector Type 3 erase Opcode		51h	15:08	D8h	D8h
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

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Table c. Parameter Table (1): Macronix Flash Parameter Tables

Description	Comment	Add (h) (Byte)	DW Add (Bit)	Data (h/b) (Note1)	Data (h)
Vcc Supply Maximum Voltage	2000h=2.000V 2700h=2.700V 3600h=3.600V	61h:60h	07:00 15:08	00h 36h	00h 36h
Vcc Supply Minimum Voltage	1650h=1.650V 2250h=2.250V 2350h=2.350V 2700h=2.700V	63h:62h	23:16 31:24	00h 27h	00h 27h
HW Reset# pin	0=not support 1=support	65h:64h	00	1b	4FF7h
HW Hold# pin	0=not support 1=support		01	1b	
Deep Power Down Mode	0=not support 1=support		02	1b	
SW Reset	0=not support 1=support		03	0b	
SW Reset Opcode	Reset Enable (66h) should be issued before Reset command		11:04	1111 1111b (FFh)	
Program Suspend/Resume	0=not support 1=support		12	0b	
Erase Suspend/Resume	0=not support 1=support		13	0b	
Unused			14	1b	
Wrap-Around Read mode	0=not support 1=support		15	0b	
Wrap-Around Read mode Opcode		66h	23:16	FFh	FFh
Wrap-Around Read data length	08h:support 8B wrap-around read 16h:8B&16B 32h:8B&16B&32B 64h:8B&16B&32B&64B	67h	31:24	FFh	FFh
Individual block lock	0=not support 1=support	6Bh:68h	00	1b	C8D9
Individual block lock bit (Volatile/Nonvolatile)	0=Volatile 1=Nonvolatile		01	0b	
Individual block lock Opcode			09:02	0011 0110b (36h)	
Individual block lock Volatile protect bit default protect status	0=protect 1=unprotect		10	0b	
Secured OTP	0=not support 1=support		11	1b	
Read Lock	0=not support 1=support		12	0b	
Permanent Lock	0=not support 1=support		13	0b	
Unused			15:14	11b	
Unused			31:16	0xFFh	0xFFh
Unused		6Fh:6Ch	31:00	0xFFh	0xFFh

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 below states when power-up:
- Standby mode (please note it is not Deep Power-down mode)
- Write Enable Latch (WEL) bit is reset
- 3-byte address mode

The device must not be selected during power-up and power-down stage unless the VCC achieves below correct level:
- 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

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

Please refer to the figure of "Power-up Timing".

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	Industrial grade	-40°C to 85°C
Storage Temperature		-55°C to 125°C
Applied Input Voltage		-0.5V to 4.6V
Applied Output Voltage		-0.5V to 4.6V
VCC to Ground Potential		-0.5V to 4.6V

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 Vss to -2.0V and Vcc to +2.0V for periods up to 20ns, see Figure 3, 4.

Figure 3. Maximum Negative Overshoot Waveform

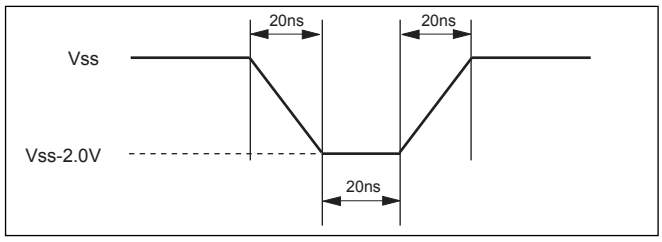
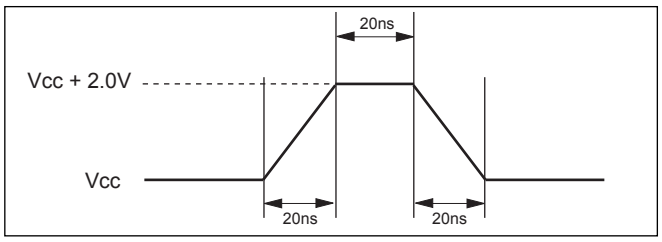


Figure 4. Maximum Positive Overshoot Waveform



CAPACITANCE TA = 25°C, f = 1.0 MHz

Symbol	Parameter	Min.	Typ.	Max.	Unit	Conditions
CIN	Input Capacitance			30	pF	VIN = 0V
COUT	Output Capacitance			30	pF	VOUT = 0V

Figure 5. OUTPUT LOADING

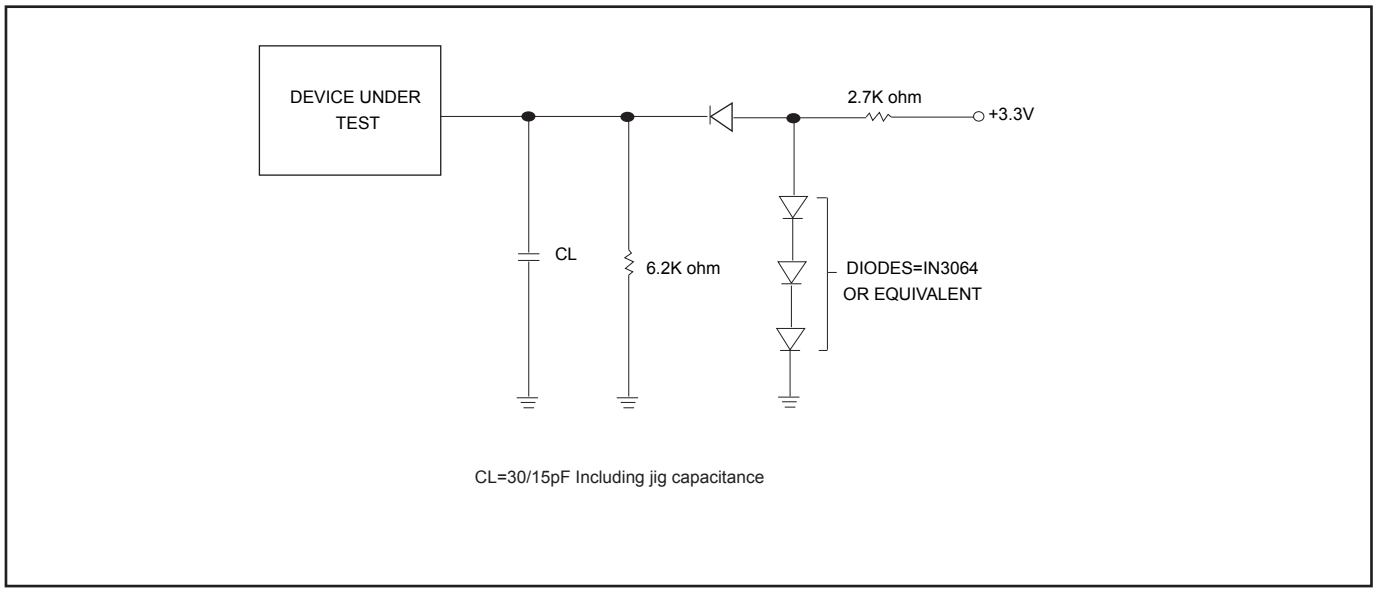


Table 7. DC CHARACTERISTICS (Temperature = -40°C to 85°C for Industrial grade, VCC = 2.7V ~ 3.6V)

Symbol	Parameter	Notes	Min.	Max.	Units	Test Conditions
ILI	Input Load Current	1		± 4	uA	VCC = VCC Max, VIN = VCC or GND, HOLD# = VCC
ILO	Output Leakage Current	1		± 4	uA	VCC = VCC Max, VOUT = VCC or GND
ISB1	VCC Standby Current	1		200	uA	VIN = VCC or GND, CS# = VCC, HOLD# = VCC
ISB2	Deep Power-down Current			80	uA	VIN = VCC or GND, CS# = VCC, HOLD# = VCC
ICC1	VCC Read	1		45	mA	f=80MHz, fQ=70MHz (4 x I/O read) SCLK=0.1VCC/0.9VCC, SO=Open
				40	mA	fT=70MHz (2 x I/O read) SCLK=0.1VCC/0.9VCC, SO=Open
				30	mA	f=50MHz, SCLK=0.1VCC/0.9VCC, SO=Open
ICC2	VCC Program Current (PP)	1		25	mA	Program in Progress, CS# = VCC
ICC3	VCC Write Status Register (WRSR) Current			40	mA	Program status register in progress, CS#=VCC
ICC4	VCC Sector Erase Current (SE)	1		25	mA	Erase in Progress, CS#=VCC
ICC5	VCC Chip Erase Current (CE)	1		40	mA	Erase in Progress, CS#=VCC
VIL	Input Low Voltage		-0.5	0.8	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

Table 8. AC CHARACTERISTICS (Temperature = -40°C to 85°C for Industrial grade, VCC = 2.7V ~ 3.6V)

Symbol	Alt.	Parameter				Min.	Typ.	Max.	Unit
fSCLK	fC	Clock Frequency for the following instructions: FAST_READ, RDSFDP, PP, SE, BE, CE, DP, RES, RDP, WREN, WRDI, RDID, RDSR, WRSR				D.C.		80	MHz
fRSCLK	fR	Clock Frequency for READ instructions						50	MHz
fTSCLK	fT	Clock Frequency for 2READ/DREAD instructions						70	MHz
	fQ	Clock Frequency for 4READ/QREAD instructions						70	MHz
f4PP		Clock Frequency for 4PP (Quad page program)						20	MHz
tCH(1)	tCLH	Clock High Time			Fast_Read	5.5			ns
					Read	9			ns
tCL(1)	tCLL	Clock Low Time			Fast_Read	5.5			ns
					Read	9			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)				8			ns
tCHSL		CS# Not Active Hold Time (relative to SCLK)				5			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)				5			ns
tSHCH		CS# Not Active Setup Time (relative to SCLK)				8			ns
tSHSL(3)	tCSH	CS# Deselect Time			Read	15			ns
					Write/Erase/ Program	100			ns
tSHQZ(2)	tDIS	Output Disable Time			2.7V-3.6V			12	ns
					3.0V-3.6V			10	ns
tCLQV	tV	Clock Low to Output Valid	VCC=2.7V~3.6V	Loading: 15pF	1 I/O			12	ns
					2 I/O & 4 I/O			12	ns
				Loading: 30pF	2 I/O & 4 I/O			15	ns
			VCC=3.0V~3.6V	Loading: 15pF	1 I/O			12	ns
					2 I/O & 4 I/O			12	ns
				Loading: 30pF	2 I/O & 4 I/O			13	ns
tCLQX	tHO	Output Hold Time				2			ns
tHLCH		HOLD# Setup Time (relative to SCLK)				8			ns
tCHHH		HOLD# Hold Time (relative to SCLK)				5			ns
tHHCH		HOLD Setup Time (relative to SCLK)				8			ns
tCHHL		HOLD Hold Time (relative to SCLK)				5			ns
tHHQX(2)	tLZ	HOLD to Output Low-Z			2.7V-3.6V			12	ns
					3.0V-3.6V			10	ns
tHLQZ(2)	tHZ	HOLD# to Output High-Z			2.7V-3.6V			12	ns
					3.0V-3.6V			10	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

Symbol	Alt.	Parameter	Min.	Typ.	Max.	Unit
tRES1(2)		CS# High to Standby Mode without Electronic Signature Read			100	us
tRES2(2)		CS# High to Standby Mode with Electronic Signature Read			100	us
tW		Write Status Register Cycle Time		40	100	ms
tBP		Byte-Program		9	300	us
tPP		Page Program Cycle Time		1.4	5	ms
tSE		Sector Erase Cycle Time (4KB)		60	300	ms
tBE		Block Erase Cycle Time (32KB)		0.5	2	s
tBE		Block Erase Cycle Time (64KB)		0.7	2	s
tCE		Chip Erase Cycle Time		160	400	s
tWPS		Write Protection Selection Time			1	ms
tWSR		Write Security Register Time			1	ms

Notes:
1. tCH + tCL must be greater than or equal to 1/ fC.
2. Value guaranteed by characterization, not 100% tested in production.
3.Only applicable as a constraint for a WRSR instruction when SRWD is set at 1.

Timing Analysis

Figure 6. Serial Input Timing

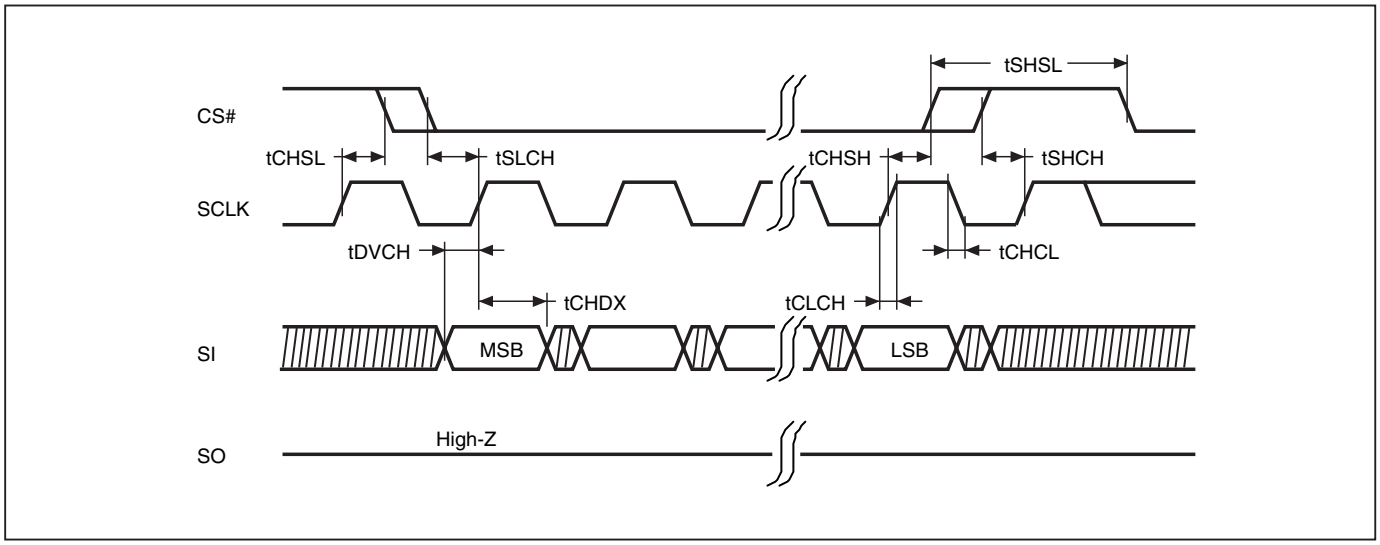


Figure 7. Output Timing

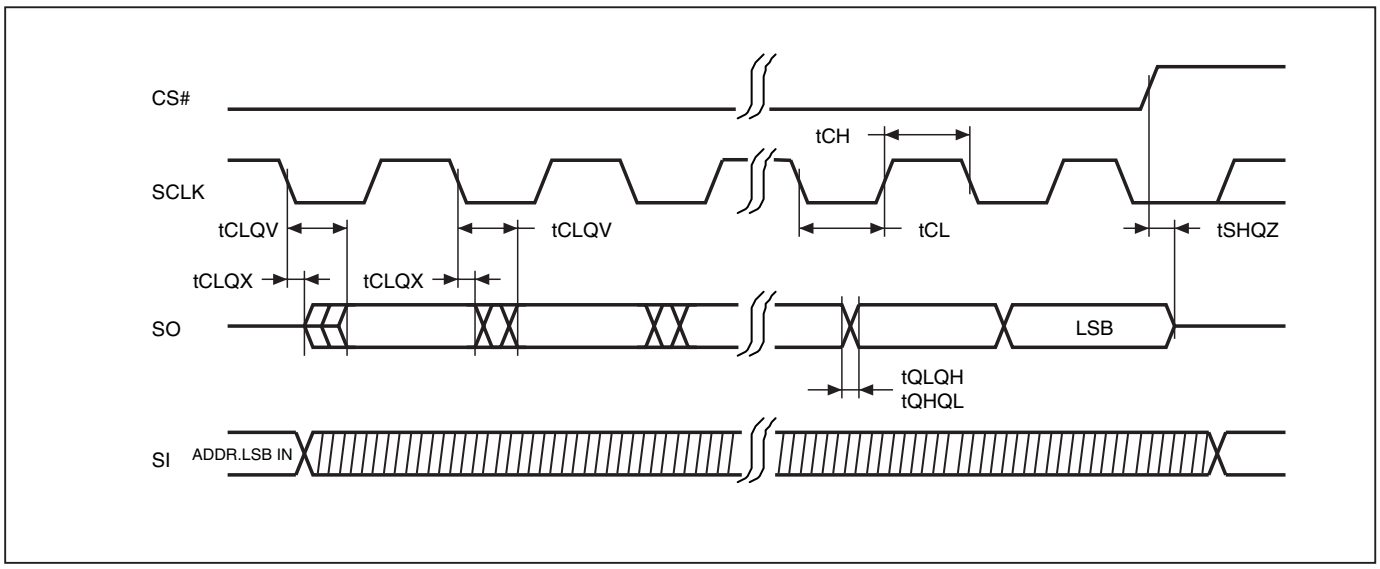
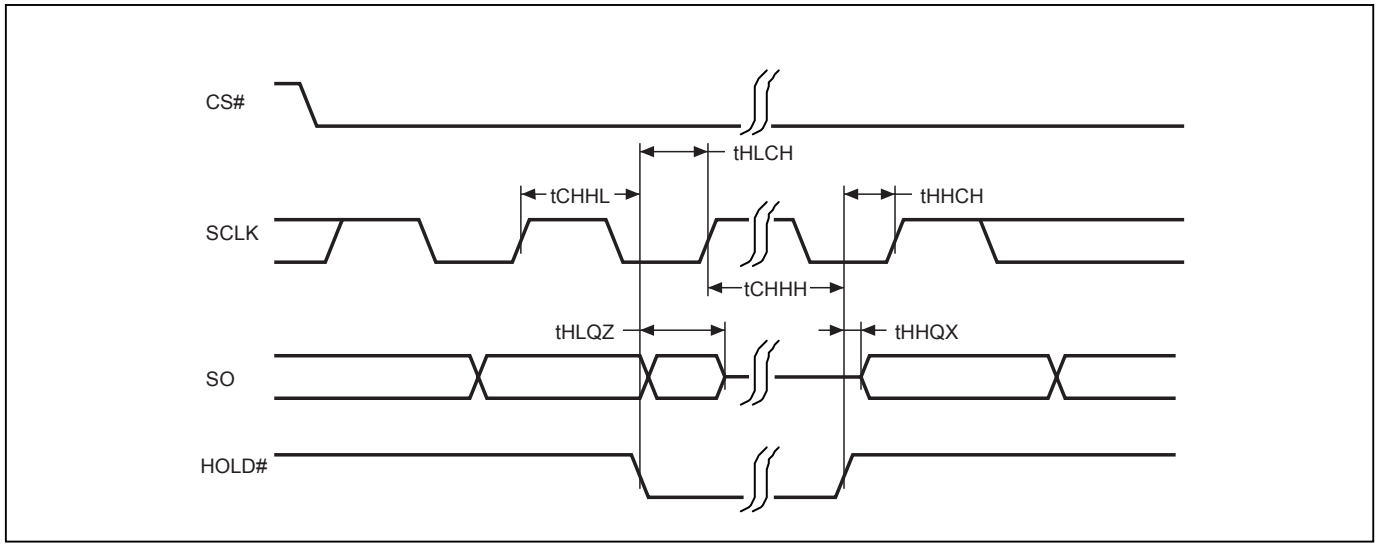


Figure 8. Hold Timing



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

Figure 9. WP# Setup Timing and Hold Timing during WRSR when SRWD=1

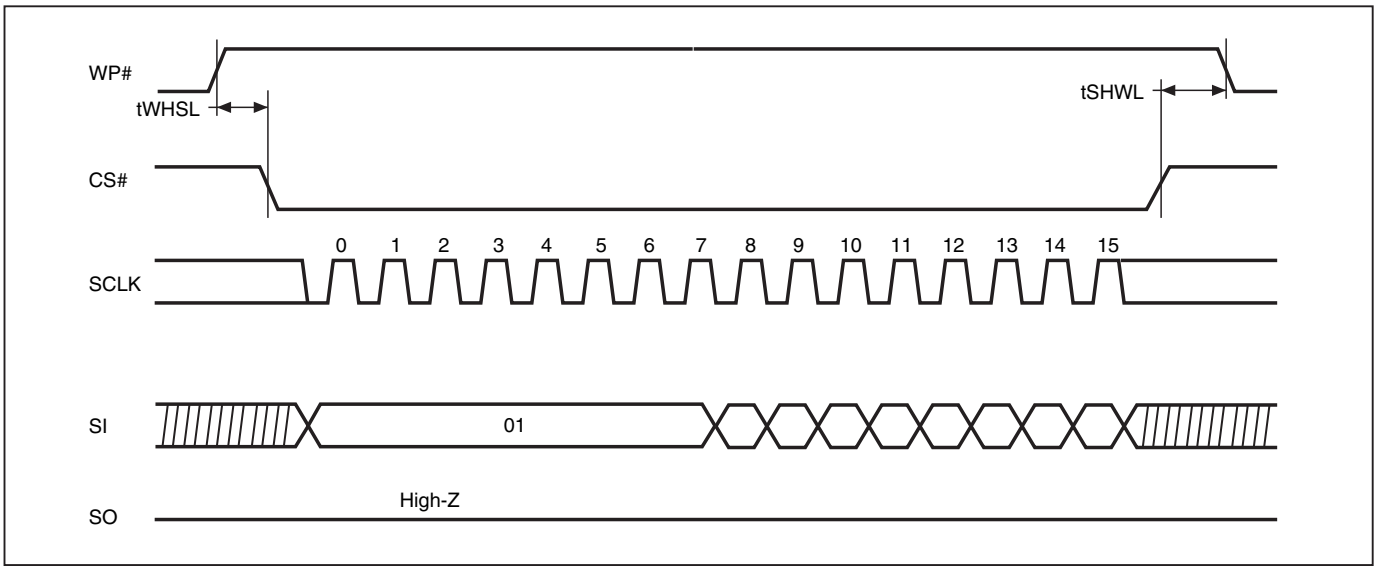


Figure 10. Write Enable (WREN) Sequence (Command 06)

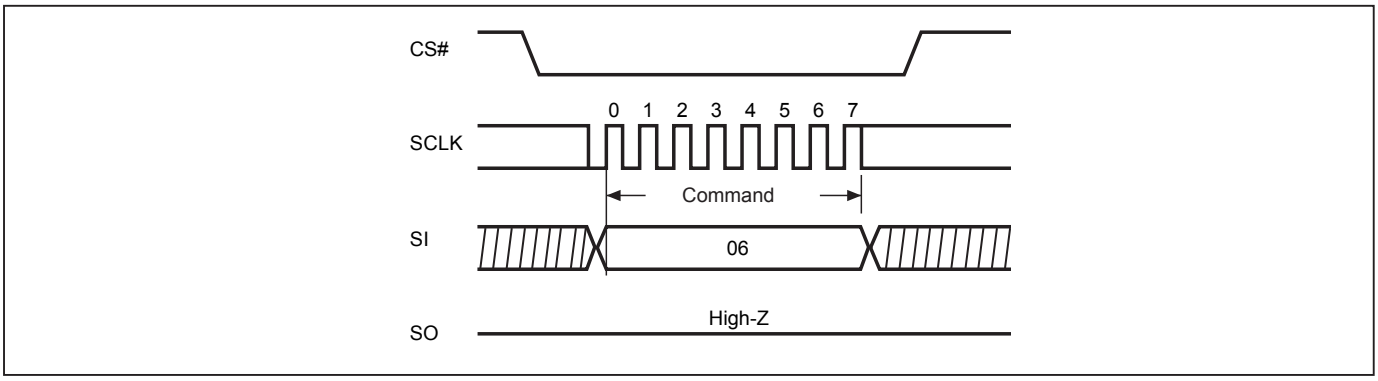


Figure 11. Write Disable (WRDI) Sequence (Command 04)

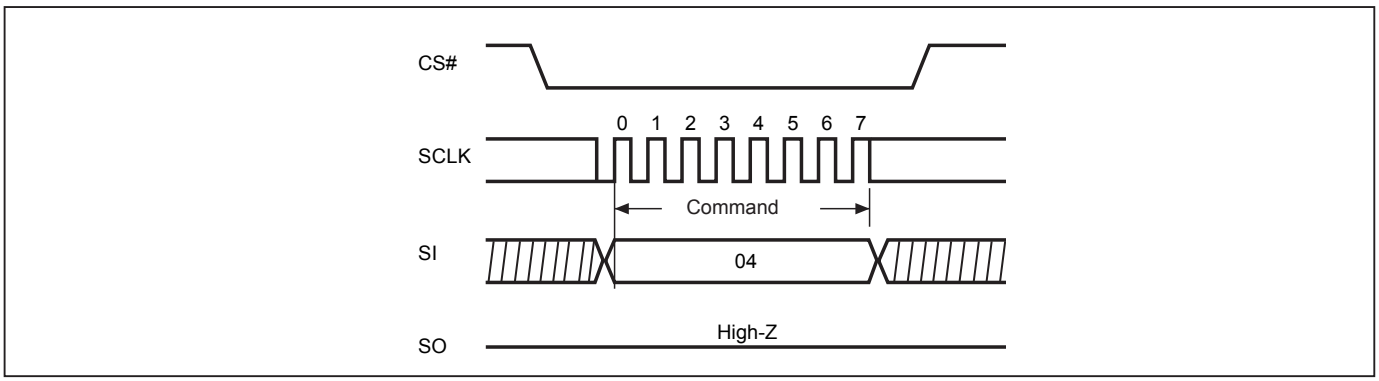


Figure 12. Read Identification (RDID) Sequence (Command 9F)

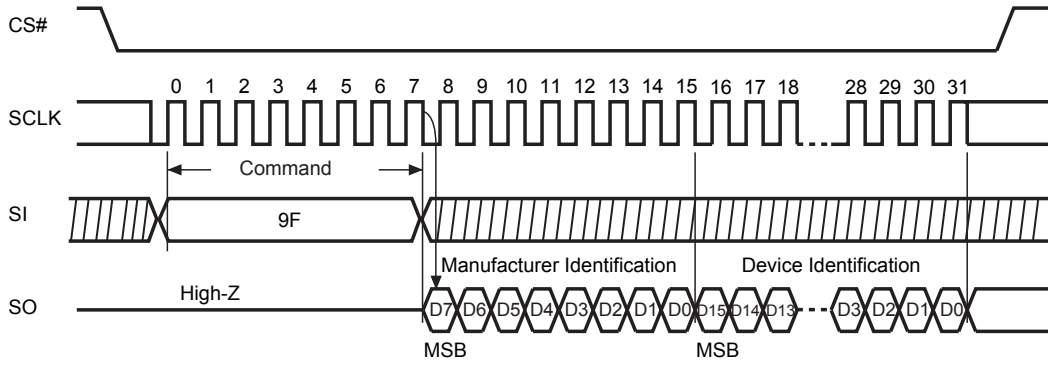


Figure 13. Read Status Register (RDSR) Sequence (Command 05)

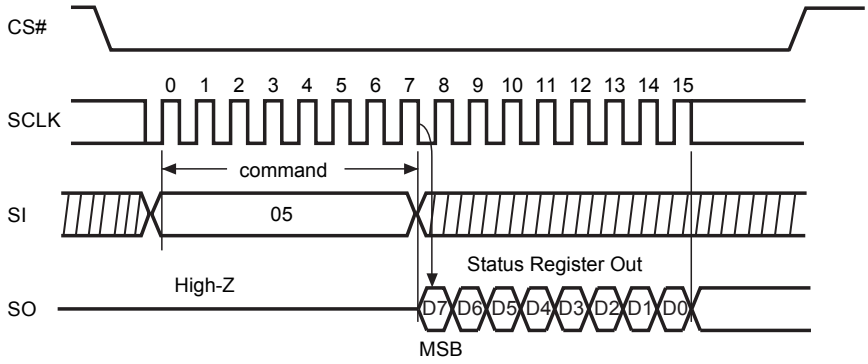


Figure 14. Write Status Register (WRSR) Sequence (Command 01)

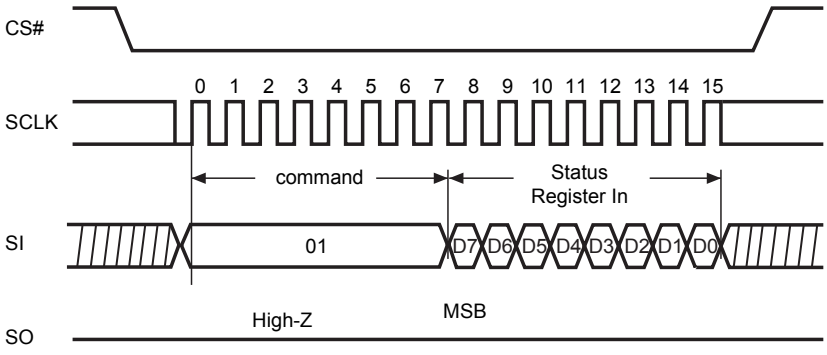
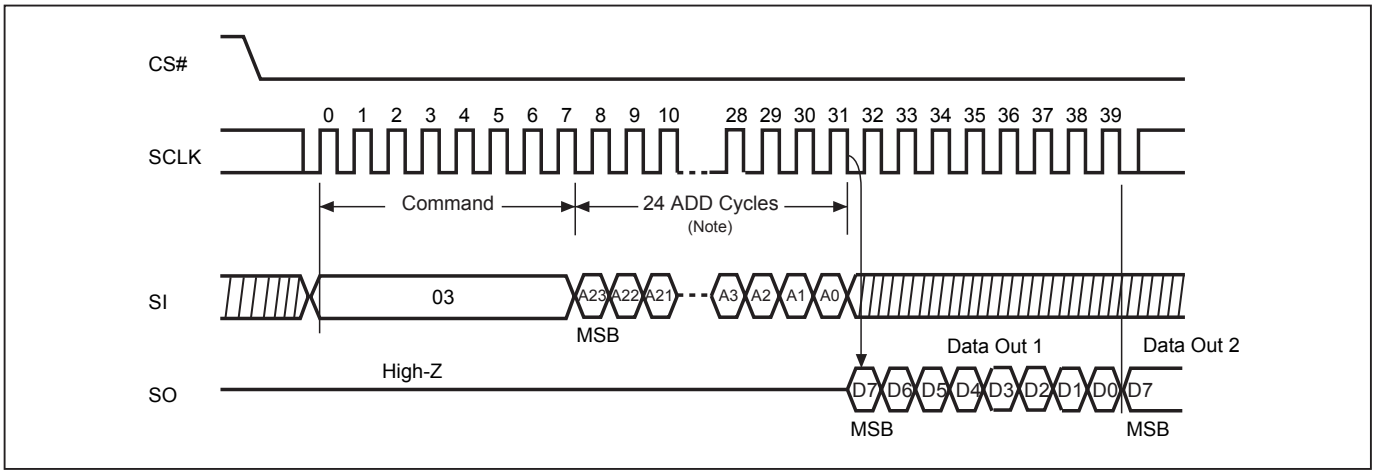
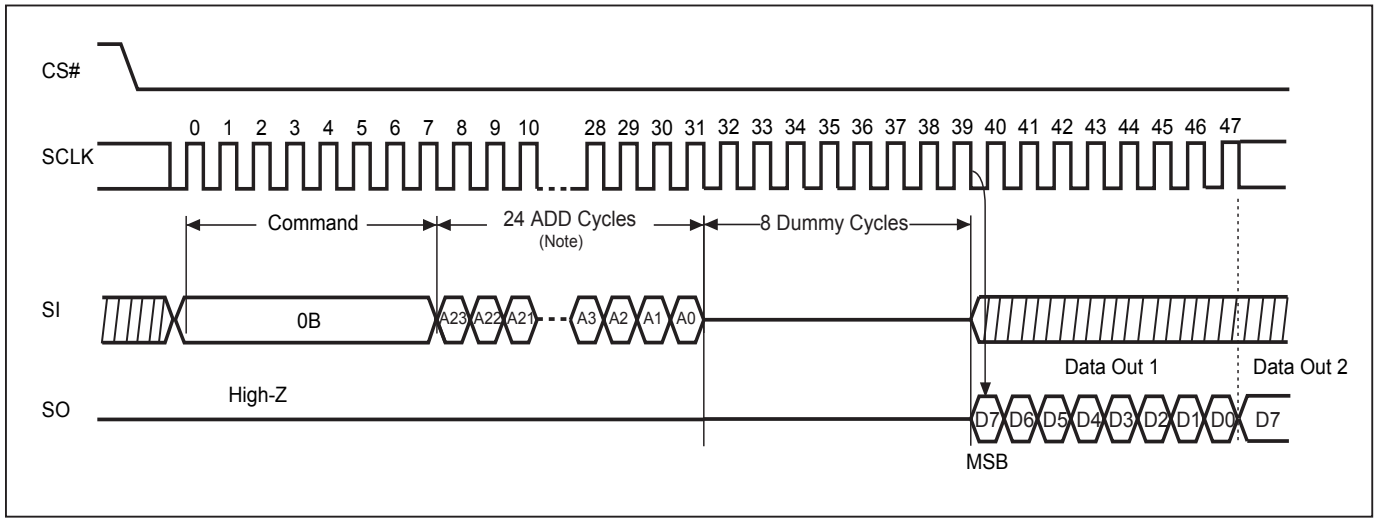


Figure 15. Read Data Bytes (READ) Sequence (Command 03)



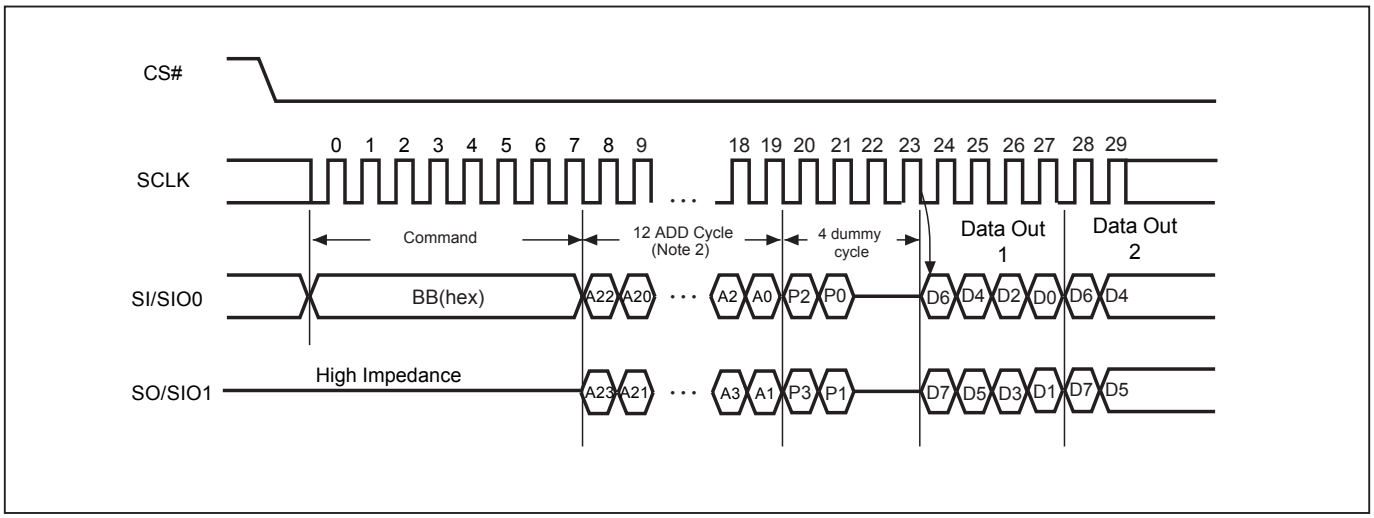
Note: Please note the above address cycles are based on 3-byte address mode, for 4-byte address mode, the address cycles will be increased.

Figure 16. Read at Higher Speed (FAST_READ) Sequence (Command 0B)



Note: Please note the above address cycles are based on 3-byte address mode, for 4-byte address mode, the address cycles will be increased.

Figure 17. 2 x I/O Read Mode Sequence (Command BB)



Note:
1. SI/SIO0 or SO/SIO1 should be kept "0h" or "Fh" in the first two dummy cycles. In other words, P2=P0 or P3=P1 is necessary.
2. Please note the above address cycles are based on 3-byte address mode, for 4-byte address mode, the address cycles will be increased.

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

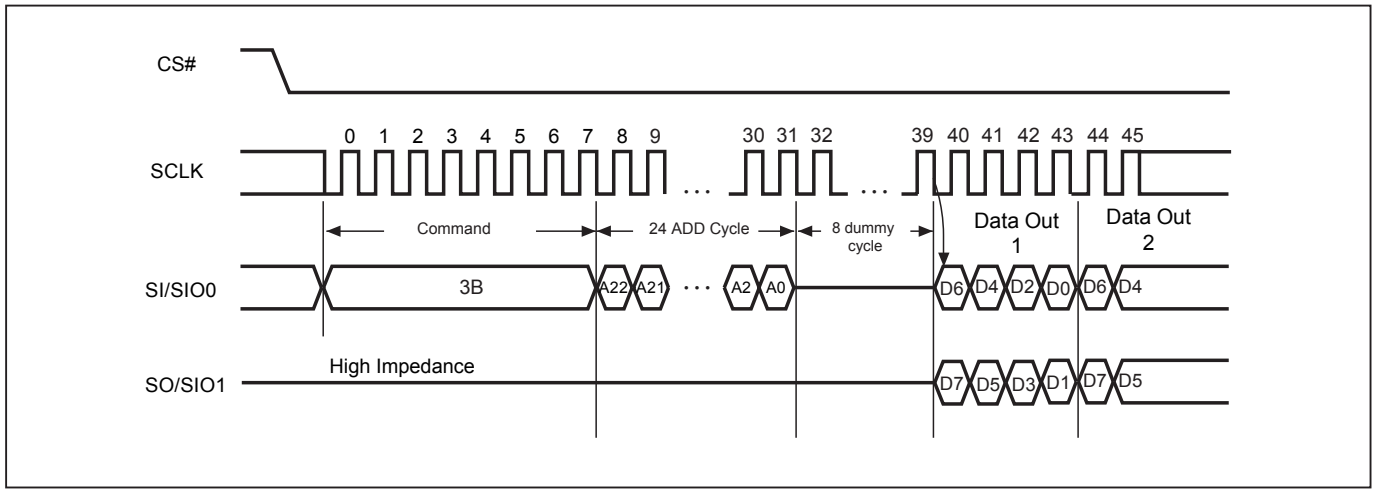
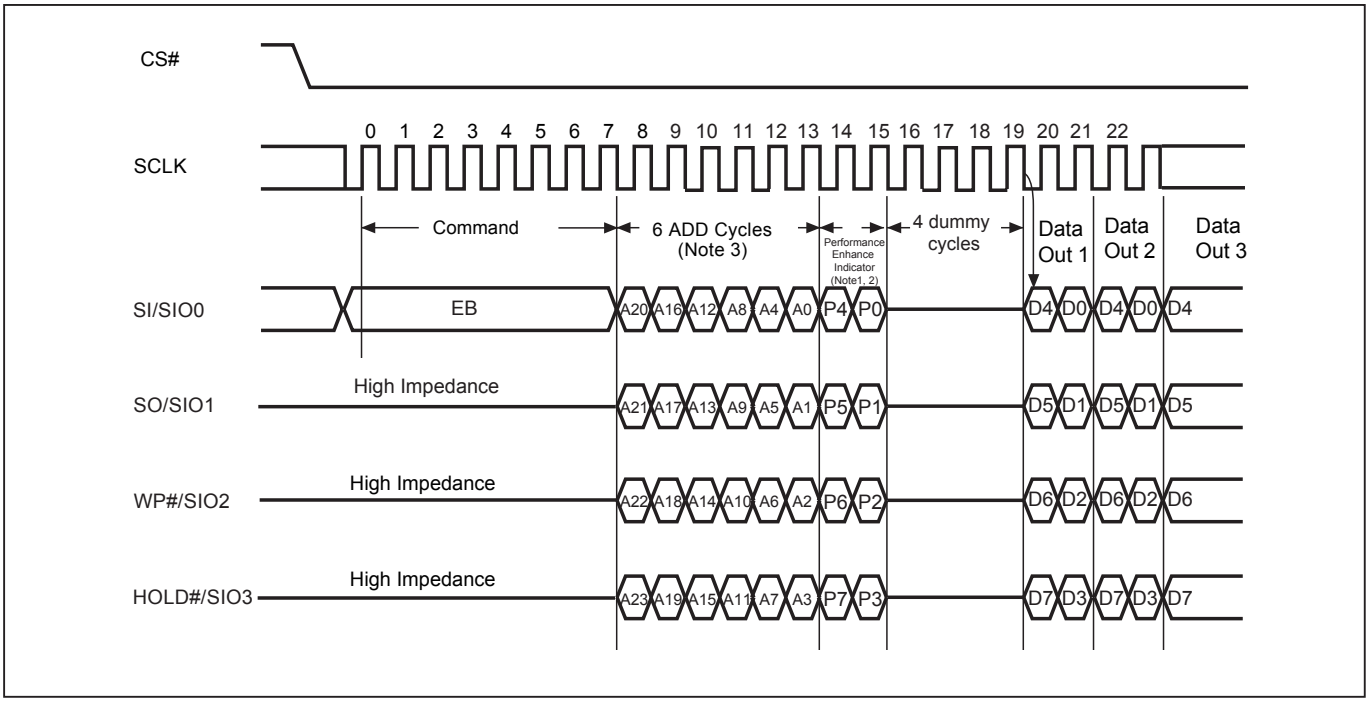


Figure 19. 4 x I/O Read Mode Sequence (Command EB)



Note:
1. Hi-impedance is inhibited for the two clock cycles.
2. P7≠P3, P6≠P2, P5≠P1 & P4≠P0 (Toggling) will result in entering the performance enhance mode.
3. Please note the above address cycles are based on 3-byte address mode, for 4-byte address mode, the address cycles will be increased.

Figure 20. Quad Read Mode Sequence (Command 6B)

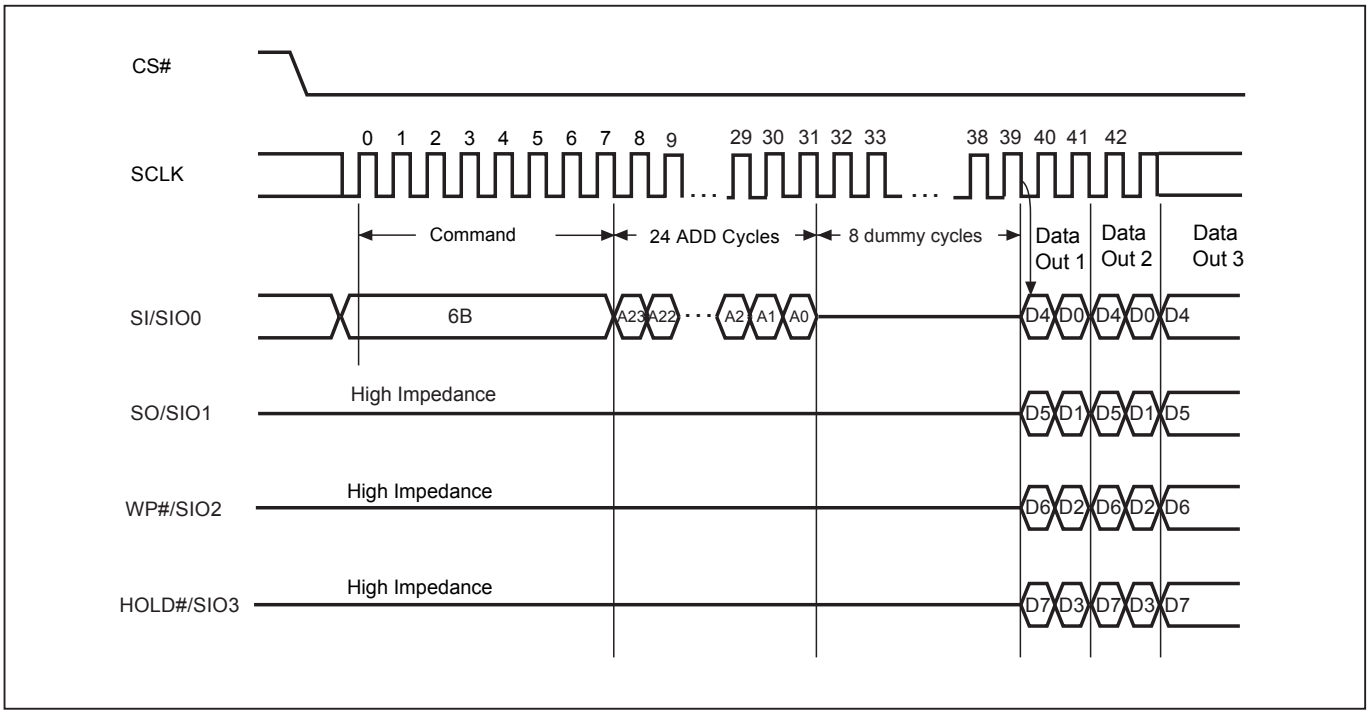
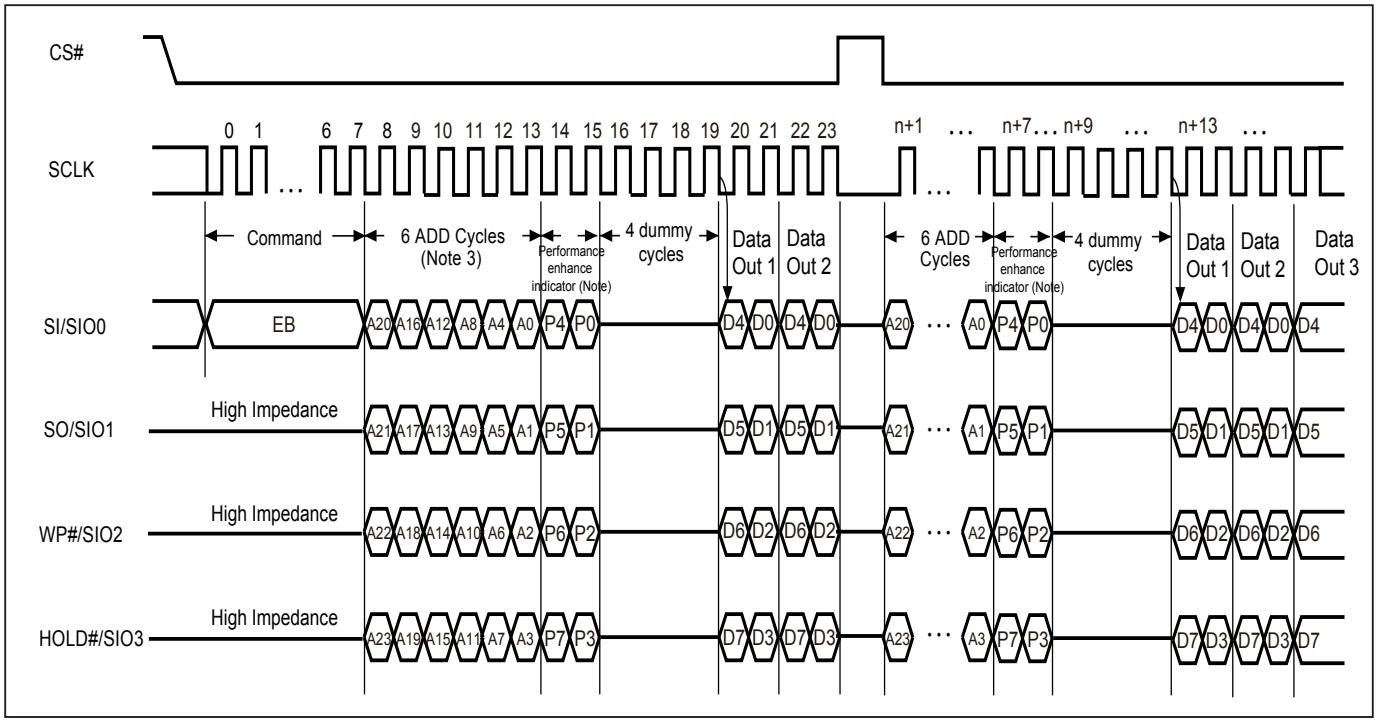
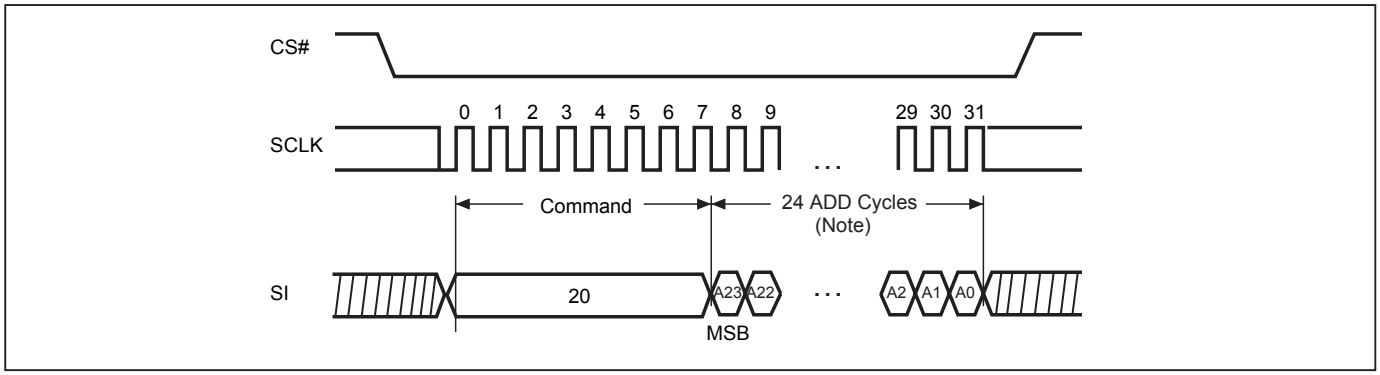


Figure 21. 4 x I/O Read Enhance Performance Mode Sequence (Command EB)



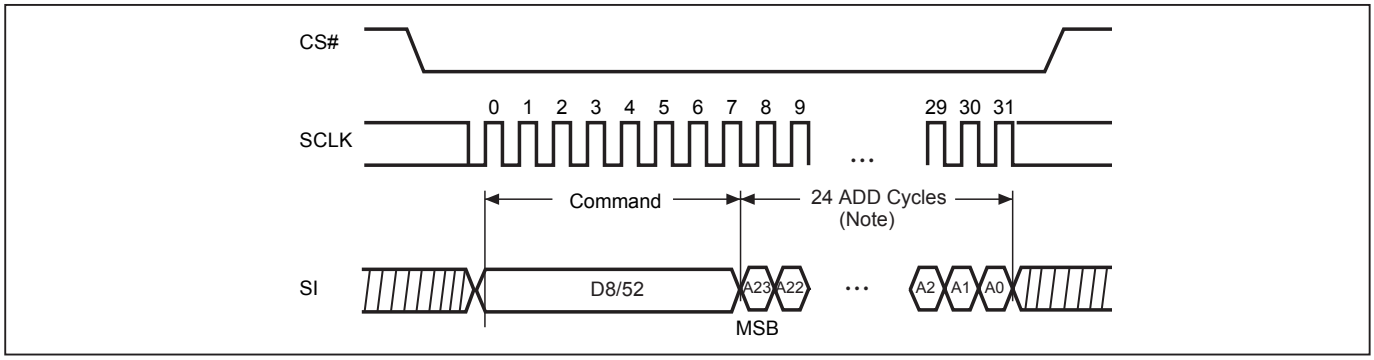
Note:
1. Performance enhance mode, if P7≠P3 & P6≠P2 & P5≠P1 & P4≠P0 (Toggling), ex: A5, 5A, 0F
2. Reset the performance enhance mode, if P7=P3 or P6=P2 or P5=P1 or P4=P0, ex: AA, 00, FF
3. Please note the above address cycles are based on 3-byte address mode, for 4-byte address mode, the address cycles will be increased.

Figure 22. Sector Erase (SE) Sequence (Command 20)



Note: Please note the above address cycles are based on 3-byte address mode, for 4-byte address mode, the address cycles will be increased.

Figure 23. Block Erase (BE/EB32K) Sequence (Command D8/52)



Note: Please note the above address cycles are based on 3-byte address mode, for 4-byte address mode, the address cycles will be increased.

Figure 24. Chip Erase (CE) Sequence (Command 60 or C7)

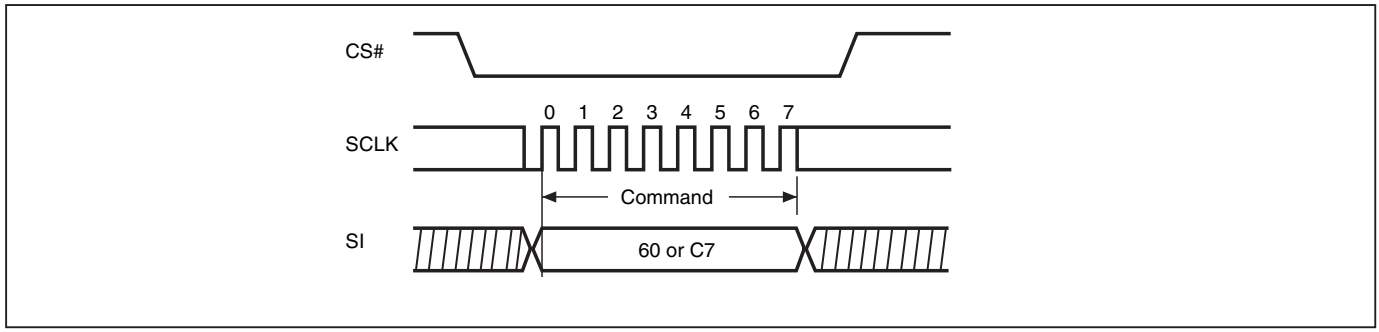
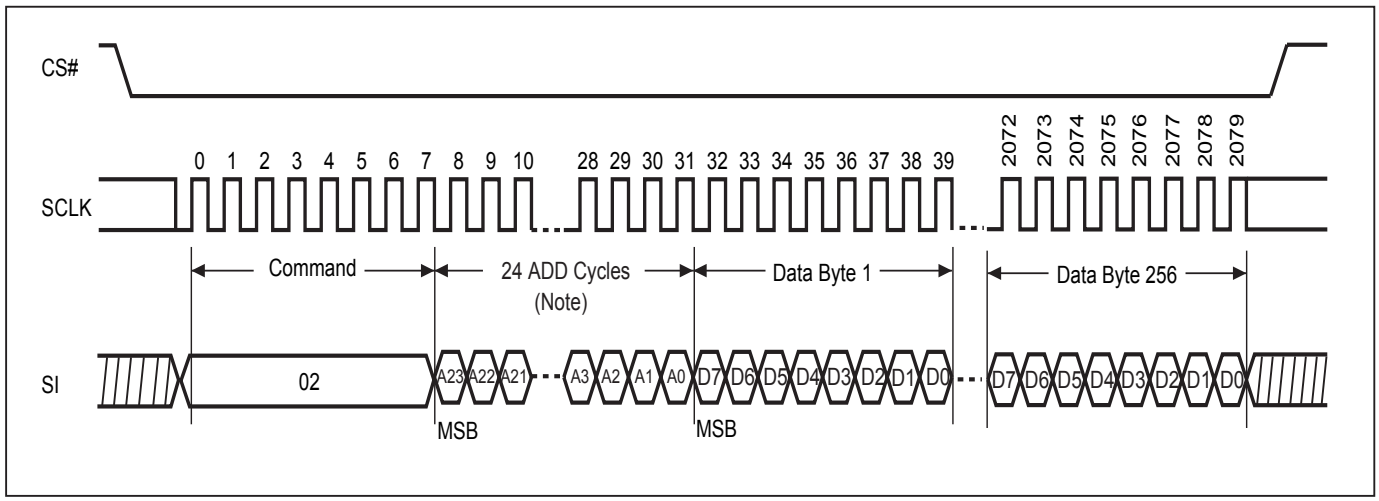
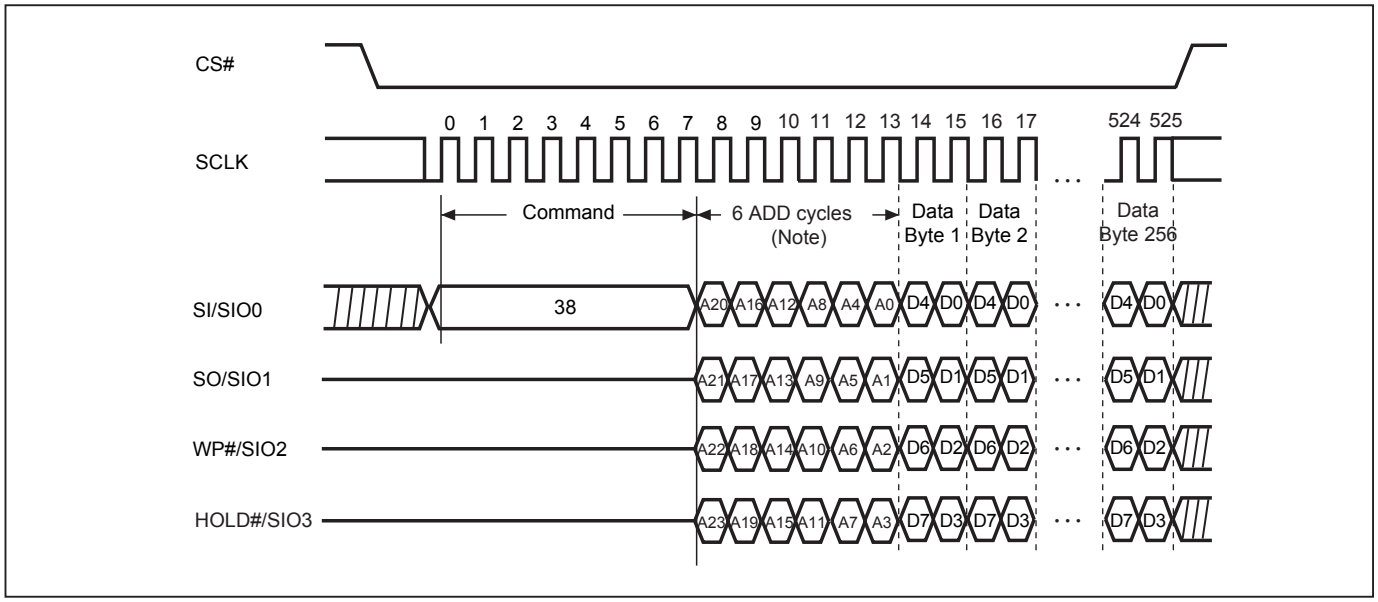


Figure 25. Page Program (PP) Sequence (Command 02)



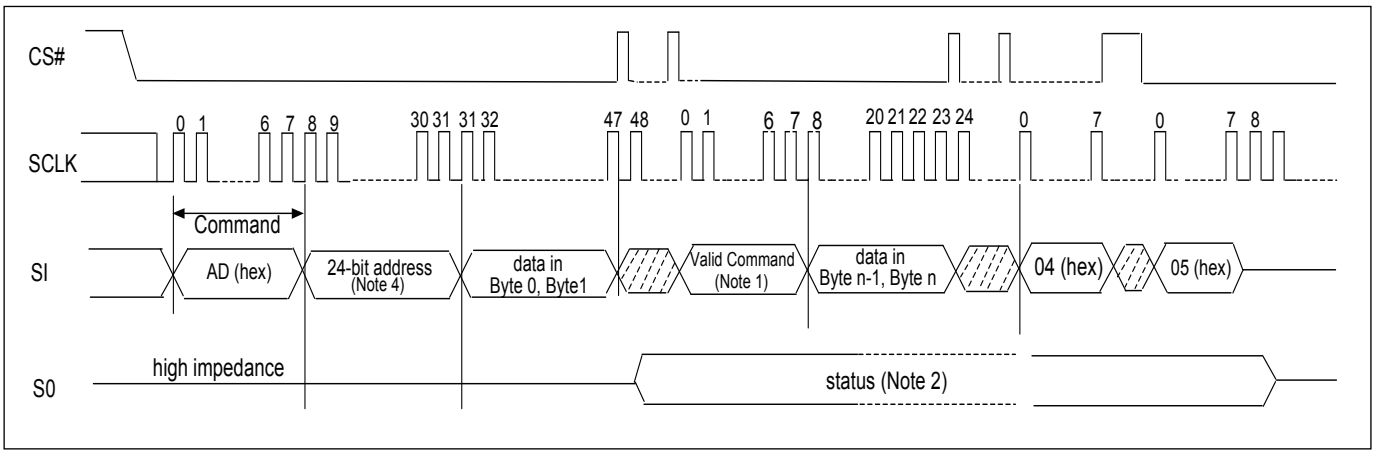
Note: Please note the above address cycles are based on 3-byte address mode, for 4-byte address mode, the address cycles will be increased.

Figure 26. 4 x I/O Page Program (4PP) Sequence (Command 38)



Note: Please note the above address cycles are based on 3-byte address mode, for 4-byte address mode, the address cycles will be increased.

Figure 27. Continuously Program (CP) Mode Sequence with Hardware Detection (Command AD)



Note:
1. During CP mode, the valid commands are CP command (AD hex), WRDI command (04 hex), RDSR command (05 hex), and RDSCUR command (2B hex).
2. Once an internal programming operation begins, CS# goes low will drive the status on the SO pin and CS# goes high will return the SO pin to tri-state.
3. To end the CP mode, either reaching the highest unprotected address or sending Write Disable (WRDI) command (04 hex) may achieve it and then it is recommended to send RDSR command (05 hex) to verify if CP mode is ended.
4. Please note the above address cycles are based on 3-byte address mode, for 4-byte address mode, the address cycles will be increased.

Figure 28. Deep Power-down (DP) Sequence (Command B9)

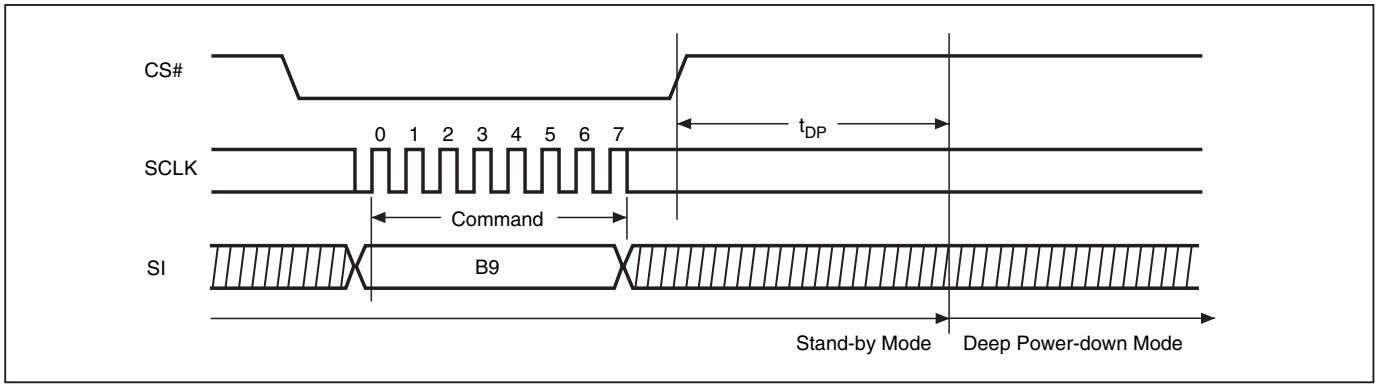


Figure 29. Read Electronic Signature (RES) Sequence (Command AB)

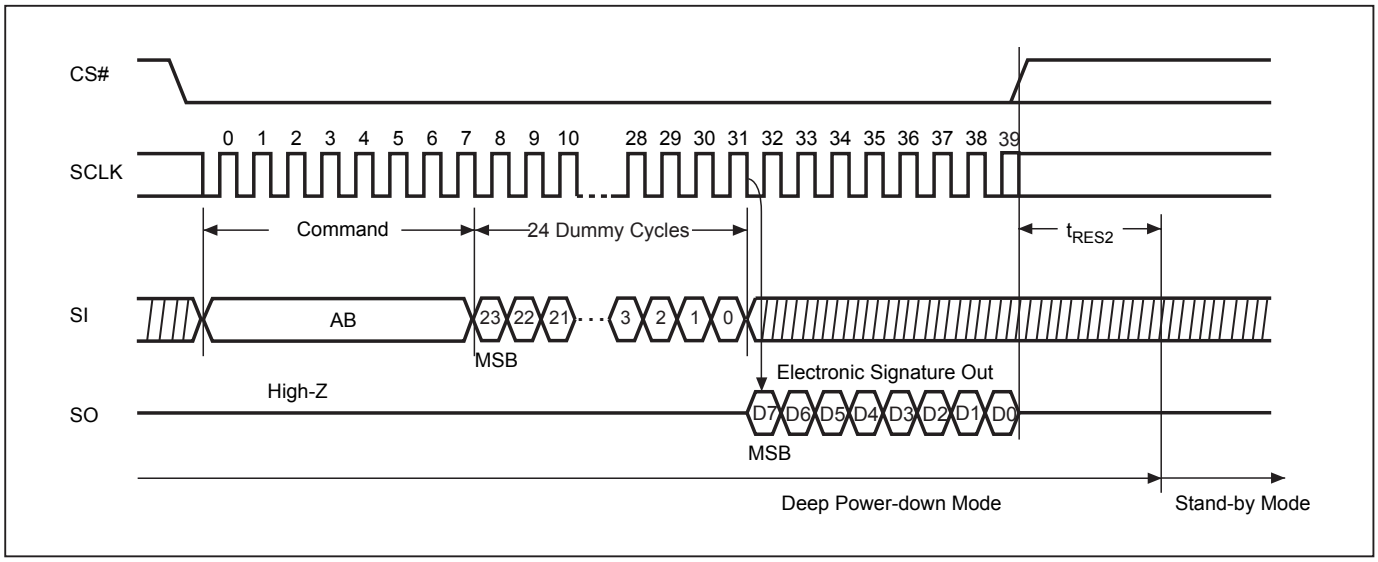


Figure 30. Release from Deep Power-down (RDP) Sequence (Command AB)

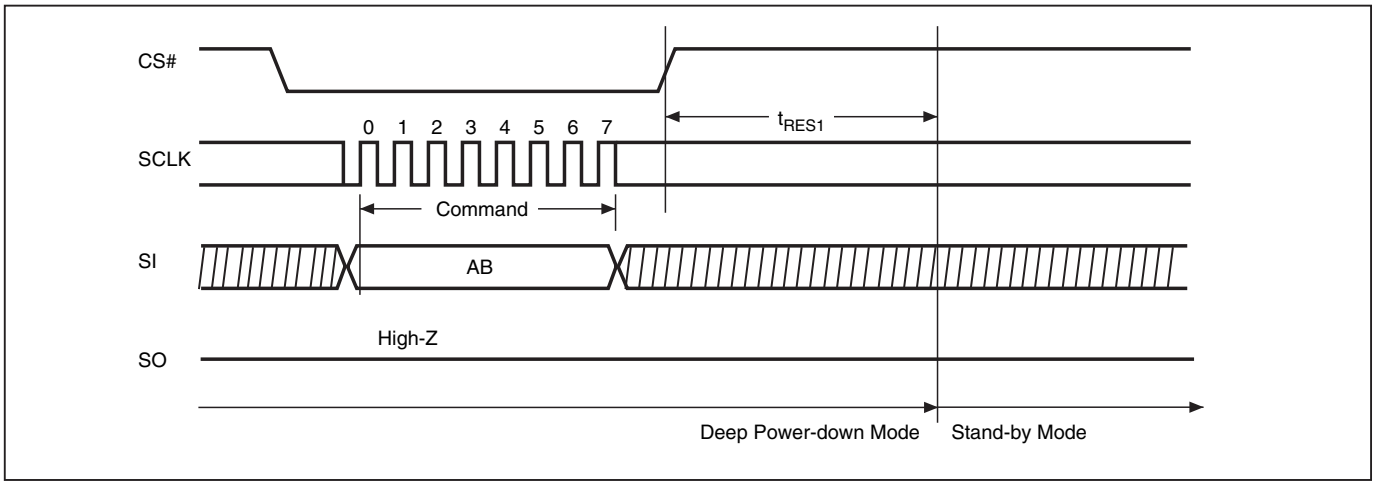
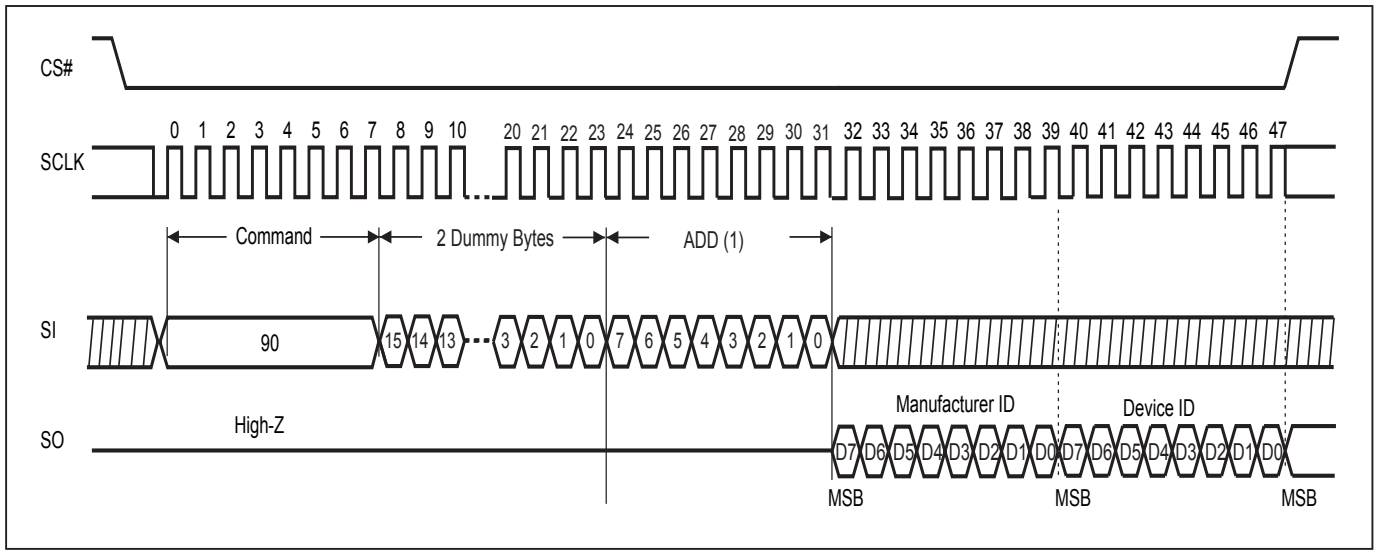


Figure 31. Read Electronic Manufacturer & Device ID (REMS) Sequence (Command 90 or EF or DF)



Notes:
1. A0=0 will output the Manufacturer ID first and A0=1 will output Device ID first. A1~A23 is don't care.
2. Instruction is either 90(hex) or EF(hex) or DF(hex).

Figure 32. Write Protection Selection (WPSEL) Sequence (Command 68)

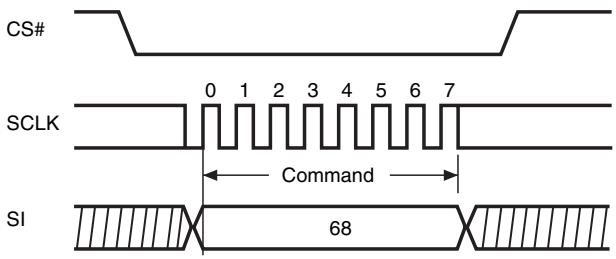
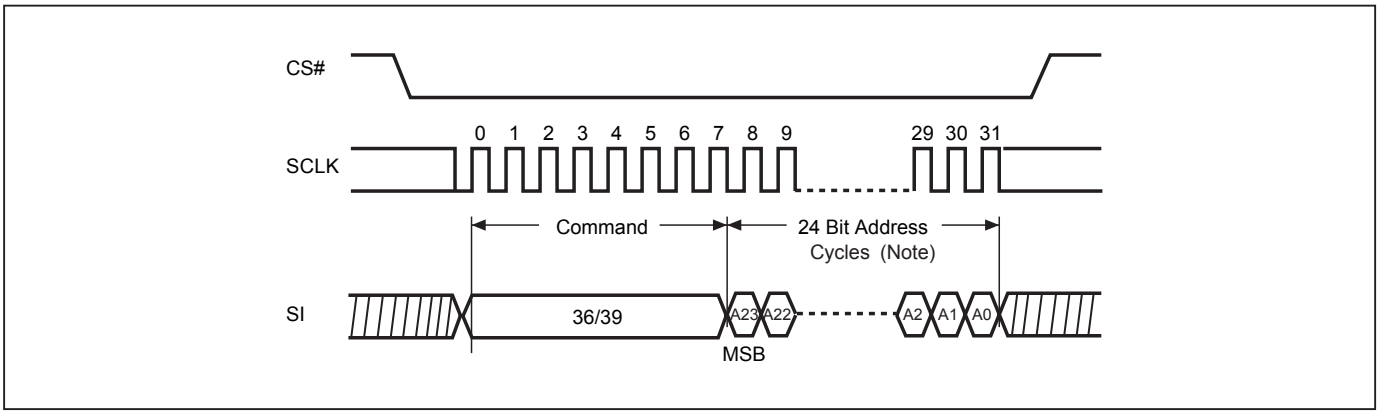
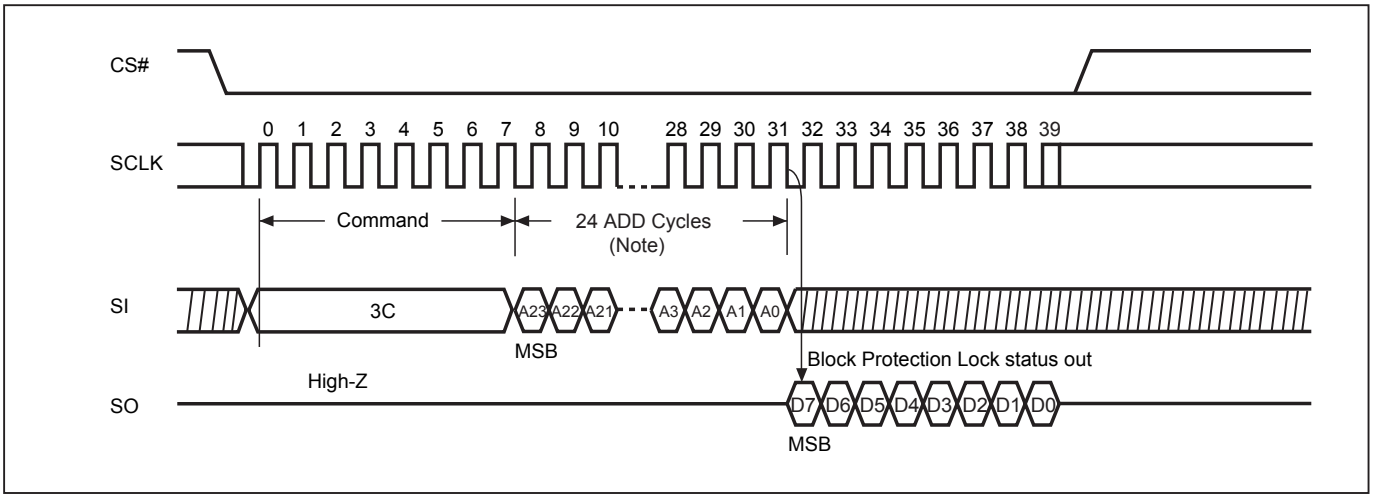


Figure 33. Single Block Lock/Unlock Protection (SBLK/SBULK) Sequence (Command 36/39)



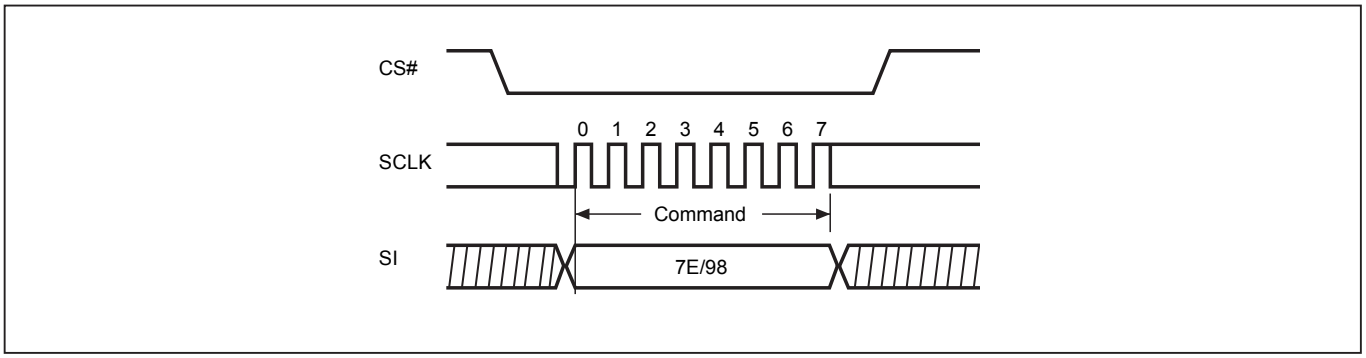
Note: Please note the above address cycles are based on 3-byte address mode, for 4-byte address mode, the address cycles will be increased.

Figure 34. Read Block Protection Lock Status (RDBLOCK) Sequence (Command 3C)



Note: Please note the above address cycles are based on 3-byte address mode, for 4-byte address mode, the address cycles will be increased.

Figure 35. Gang Block Lock/Unlock (GBLK/GBULK) Sequence (Command 7E/98)



RESET

Driving the RESET# pin low for a period of tRLRH or longer will reset the device. After reset cycle, the device is at the following states:
- Standby mode
- All the volatile bits such as WEL/WIP/SRAM lock bit will return to the default status as power on.
- 3-byte address mode

If the device is under programming or erasing, driving the RESET# pin low will also terminate the operation and data could be lost. During the resetting cycle, the SO data becomes high impedance and the current will be reduced to minimum.

Figure 36. RESET Timing

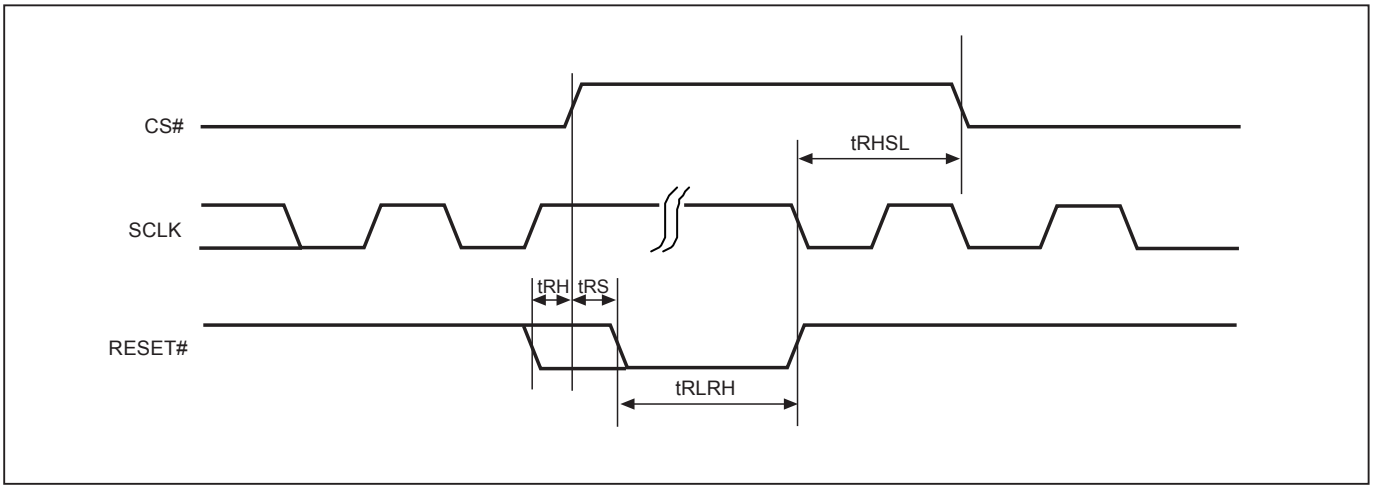
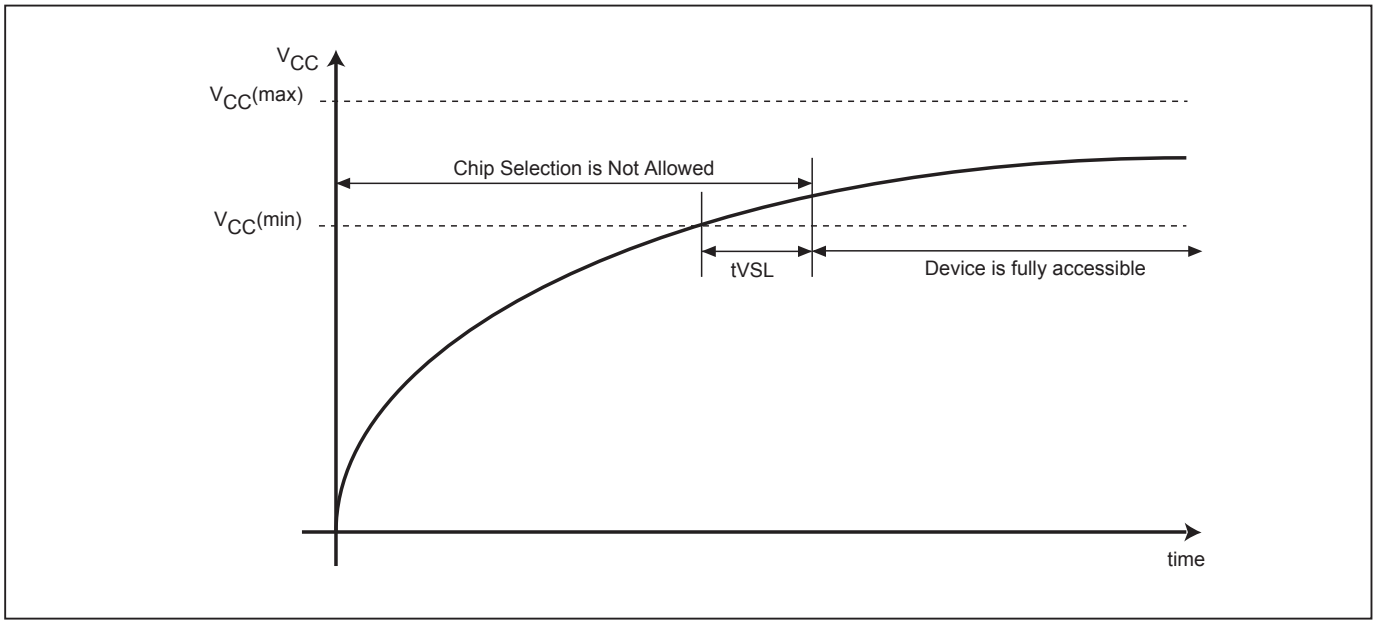


Table 9. Reset Timing

Symbol	Alt.	Parameter	Min.	Typ.	Max.	Unit
tRLRH		Reset Pulse Width	10			us
tRS		Reset Setup Time	15			ns
tRH		Reset Hold Time	15			ns
tRHSL		Reset Recovery Time (During instruction decoding)	30			us
		Reset Recovery Time (For Read operation)	30			us
		Reset Recovery Time (For Erase or Program operation)	300			us
		Reset Recovery Time (For SE/4KB Sector Erase operation)	tSE (1)			ms
		Reset Recovery Time (For BE32K/32KB Block Erase operation)	tBE (32KB) (1)			s
		Reset Recovery Time (for WRSR operation)	tW (1)			ms

Notes:
1. See Table 8 for tSE/tBE (32KB)/tW data.

Figure 37. Power-up Timing



Note: VCC (max.) is 3.6V and VCC (min.) is 2.7V.

Table 10. Power-Up Timing

Symbol	Parameter	Min.	Max.	Unit
tVSL(1)	VCC(min) to CS# low	300		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).

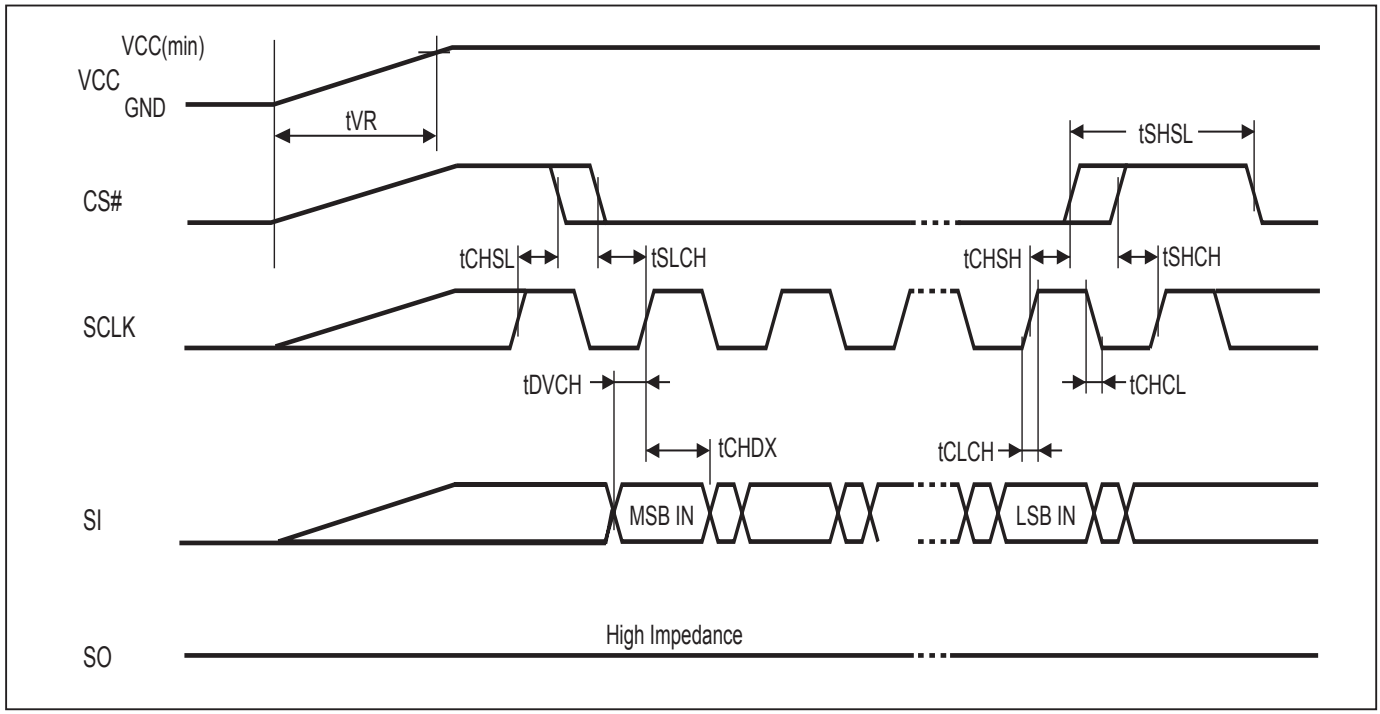
OPERATING CONDITIONS

At Device Power-Up and Power-Down

AC timing illustrated in Figure 38 and Figure 39 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 38. AC Timing at Device Power-Up

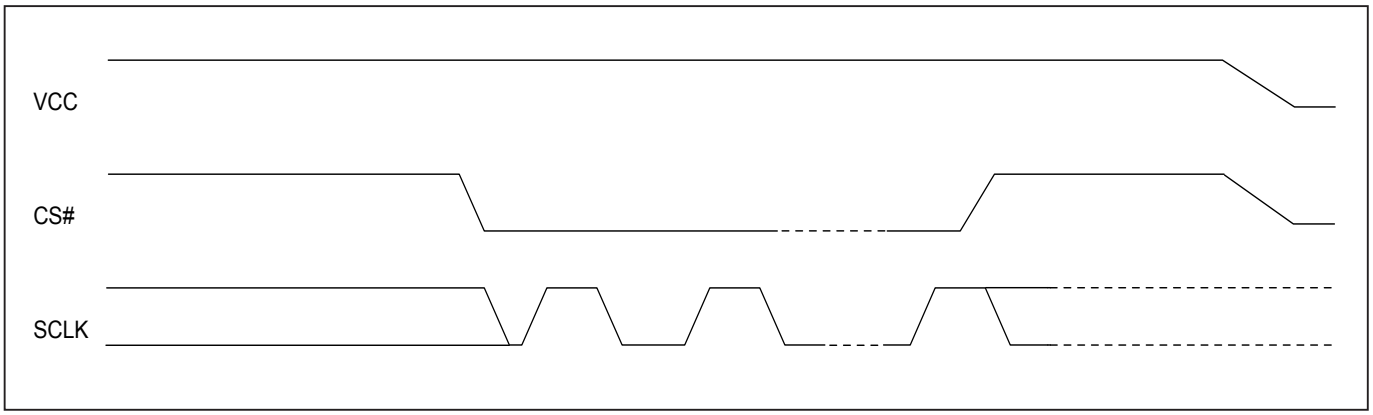


Symbol	Parameter	Notes	Min.	Max.	Unit
tVR	VCC Rise Time	1	20	500000	us/V

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.

Figure 39. Power-Down Sequence

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



ERASE AND PROGRAMMING PERFORMANCE

Parameter	Typ. (1)	Max. (2)	Unit
Write Status Register Cycle Time	40	100	ms
Sector Erase Time (4KB)	60	300	ms
Block Erase Time (64KB)	0.7	2	s
Block Erase Time (32KB)	0.5	2	s
Chip Erase Time	160	400	s
Byte Program Time (via page program command)	9	300	us
Page Program Time	1.4	5	ms
Erase/Program Cycle	100,000		cycles

Note:
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.

DATA RETENTION

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

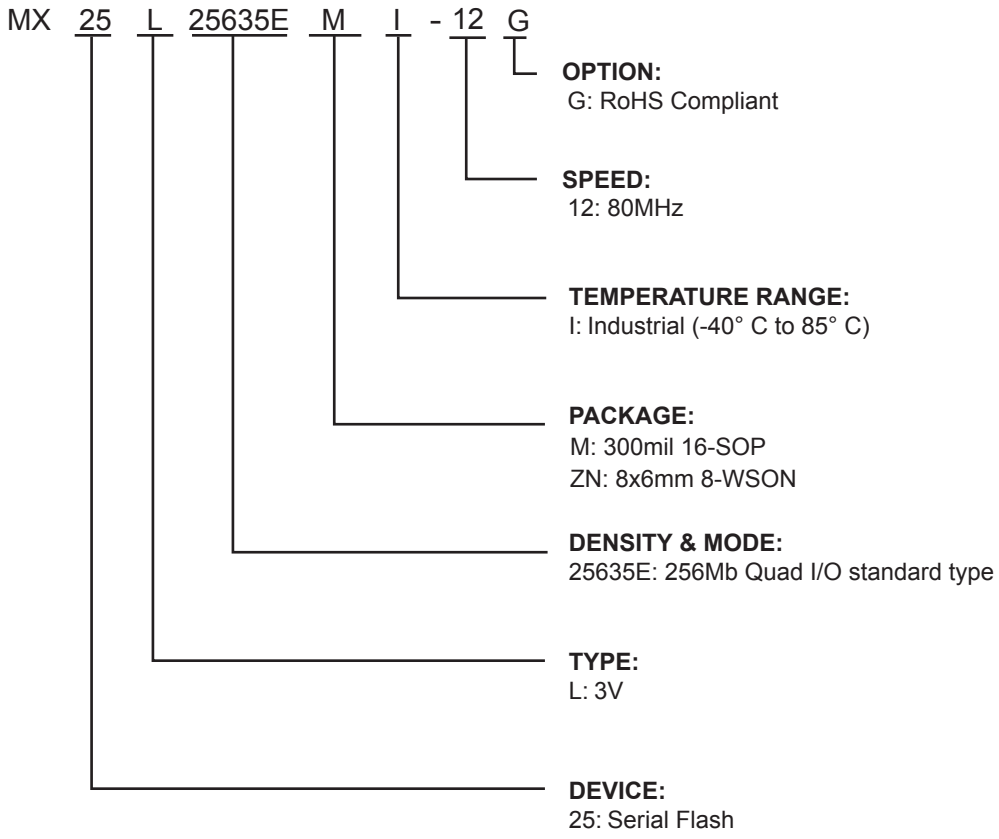
LATCH-UP CHARACTERISTICS

	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

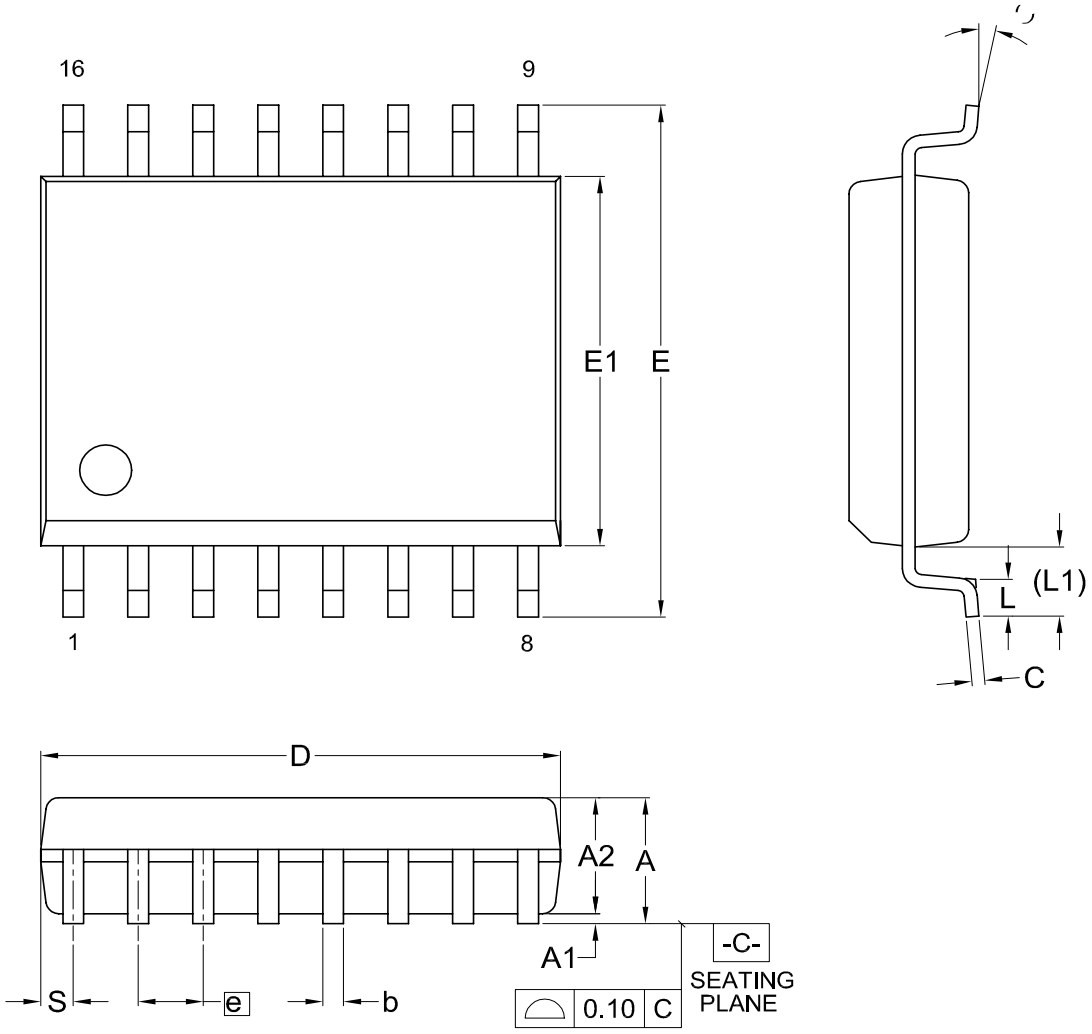
PART NO.	CLOCK (MHz)	TEMPERATURE	PACKAGE	Remark
MX25L25635EMI-12G	80	-40°C~85°C	16-SOP (300mil)	RoHS Compliant
MX25L25635EZNI-12G	80	-40°C~85°C	8-WSON (8x6mm)	RoHS Compliant

PART NAME DESCRIPTION



PACKAGE INFORMATION

Doc. Title: Package Outline for SOP 16L (300MIL)

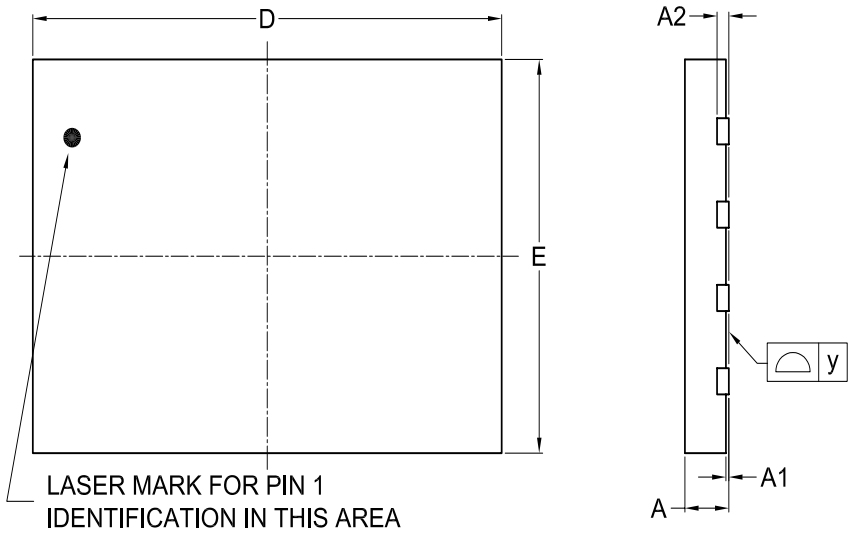


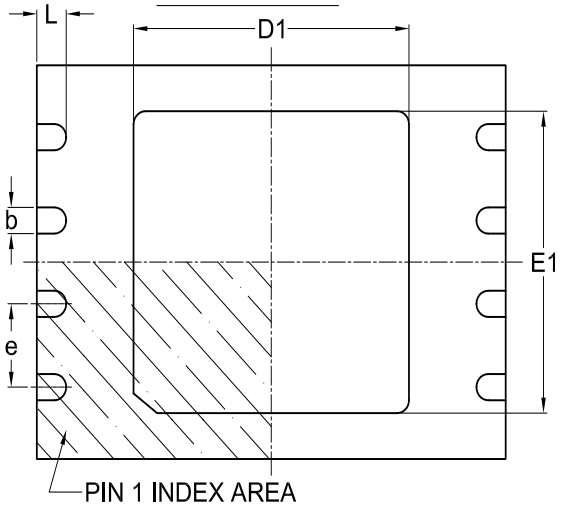
Dimensions (inch dimensions are derived from the original mm dimensions)

SYMBOL / UNIT		A	A1	A2	b	C	D	E	E1	e	L	L1	S	Θ
mm	Min.	---	0.10	2.34	0.36	0.20	10.10	10.10	7.42	---	0.40	1.31	0.51	0
	Nom.	---	0.20	2.39	0.41	0.25	10.30	10.30	7.52	1.27	0.84	1.44	0.64	5
	Max.	2.65	0.30	2.44	0.51	0.30	10.50	10.50	7.60	---	1.27	1.57	0.77	8
Inch	Min.	---	0.004	0.092	0.014	0.008	0.397	0.397	0.292	---	0.016	0.052	0.020	0
	Nom.	---	0.008	0.094	0.016	0.010	0.405	0.405	0.296	0.050	0.033	0.057	0.025	5
	Max.	0.104	0.012	0.096	0.020	0.012	0.413	0.413	0.299	---	0.050	0.062	0.030	8

Dwg. No.	Revision	Reference			
		JEDEC	EIAJ		
6110-1402	10	MS-013			

Doc. Title: Package Outline for WSON 8L (8x6x0.8MM, LEAD PITCH 1.27MM)





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 separtion requirement, 0.2mm with terminals.

SYMBOL / UNIT		A	A1	A2	b	D	D1	E	E1	L	e	y
mm	Min.	0.70	—	—	0.35	7.90	4.60	5.90	4.50	0.40	—	0.00
	Nom.	—	—	0.20	0.40	8.00	4.70	6.00	4.60	0.50	1.27	—
	Max.	0.80	0.05	—	0.48	8.10	4.80	6.10	4.70	0.60	—	0.08
Inch	Min.	0.028	—	—	0.014	0.311	0.181	0.232	0.177	0.016	—	0.00
	Nom.	—	—	0.008	0.016	0.315	0.185	0.236	0.181	0.020	0.05	—
	Max.	0.032	0.002	—	0.019	0.319	0.189	0.240	0.185	0.024	—	0.003

Dwg. No.	Revision	Reference			
		JEDEC	EIAJ		
6110-3402	7	MO-220			

REVISION HISTORY

Revision No.	Description	Page	Date
0.01	1. Changed title from "Advanced Information" to "Preliminary".	P5	NOV/18/2009
	2. Rename CFI to DMC.	P6,13,16,37	
	3. Added DMC contents.	P37~39	
	4. Added HOLD# pin condition for ILI/ISB1/ISB2, revised VCC read test conditions and deleted notes of typical values.	P43	
	5. Revised GBLK from 78h to 7Eh.	P32	
	6. Revised Figure number in NOTICE.	P41	
	7. Revised Figure 17. 2 x I/O Read Mode Sequence.	P51	
	8. Added HOLD# in 4 x I/O Sequence.	P51-52,54	
	9. Deleted CF (hex).	P60	
	10. Added VCC and CS# ramp up example in device power-up	P63	
	11. Deleted chip programming time evaluation conditions	P64	
0.02	1. Modified DMC table: 1Ch data from 28h to 30h	P37	JAN/19/2010
0.03	1. Added Hardware Reset (RESET#) function	P6,8,10,19,23 P28,44,59	APR/13/2010
	2. Removed Parallel mode feature	P43,44	
	3. Modified Figure 35. and Table 10. Power-up Timing	P60	
	4. Modified Figure 36. AC Timing at Device Power-Up	P61	
	5. Added Figure 37. Power-Down Sequence	P62	
	6. Added 8-WSON package information	P6,8,14,18,39 P63,64	
	7. Added "DREAD" & "QREAD" information	P13,15,21,22, P45,52,53	
1.0	1. Removed DMC sequence description & content table	P6,13,16	JUL/01/2010
	2. Removed command WREN in WPSEL and WRSCUR flows	P31,32,34	
	3. Revised EN4B description	P20	
	4. Removed "Preliminary"	P5	
1.1	1. Modified tCLQV for Table 8. AC CHARACTERISTICS	P42	MAR/22/2011
	2. Modified description for RoHS compliance	P6,64	
	3. Modified CIN/COUT(max.) from 6/8(pF) to 30/30(pF)	P39	
1.2	1. Modified Figure 36. RESET Timing	P58	DEC/29/2011
	2. Modified ILO test conditions from VIN to VOUT	P41	
	3. Changed ordering information format	P63	
	4. Added HOLD# pin description	P6,8	
	5. Modified Figure 39. Power-Down Sequence	P61	
	6. Modified tRHSL spec from max. to min.	P58	
	7. Modified Power-up Timing & table	P59	
1.3	1. Added Read SFDP (RDSFDP) Mode	P6,13,15, P38~43,48	FEB/10/2012

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