

MX25U1635E

**1.8V, 16M-BIT [x 1/x 2/x 4]
CMOS MXSMIO[®] (SERIAL MULTI I/O)
FLASH MEMORY**

Key Features

- *1.65 to 2.0 volt for read, erase, and program operations*
- *Multi I/O Support - Single I/O, Dual I/O and Quad I/O*
- *Fast read for SPI mode and QPI mode*
- *Additional 4k-bit secured OTP for unique identifier*
- *Auto Erase and Auto Program Algorithm*

Contents

| | |
|--|-----------|
| 1. FEATURES | 6 |
| 2. GENERAL DESCRIPTION | 7 |
| Table 1. Additional Feature Comparison | 8 |
| 3. PIN CONFIGURATIONS | 9 |
| 4. PIN DESCRIPTION | 9 |
| 5. BLOCK DIAGRAM | 10 |
| 6. DATA PROTECTION | 11 |
| Table 2. Protected Area Sizes | 12 |
| Table 3. 4K-bit Secured OTP Definition..... | 12 |
| 7. Memory Organization | 13 |
| Table 4. Memory Organization | 13 |
| 8. DEVICE OPERATION | 14 |
| Figure 1. Serial Modes Supported..... | 14 |
| 8-1. Quad Peripheral Interface (QPI) Read Mode..... | 15 |
| Figure 2. Enable QPI Sequence (Command 35H)..... | 15 |
| Figure 3. Reset QPI Mode (Command F5H)..... | 16 |
| Figure 4. Fast QPI Read Mode (FASTRDQ) (Command EBH) | 16 |
| 9. COMMAND DESCRIPTION | 17 |
| Table 5. Command Set..... | 17 |
| 9-1. Write Enable (WREN) | 19 |
| 9-2. Write Disable (WRDI)..... | 19 |
| 9-3. Read Identification (RDID) | 19 |
| 9-4. Read Status Register (RDSR) | 19 |
| Figure 5. Program/ Erase flow with read array data..... | 20 |
| Figure 6. Program/ Erase flow without read array data (read P_FAIL/E_FAIL flag)..... | 21 |
| Figure 7. WRSR flow..... | 22 |
| Table 6. Status Register | 23 |
| 9-5. Write Status Register (WRSR)..... | 24 |
| Table 7. Protection Modes..... | 24 |
| 9-6. Read Data Bytes (READ)..... | 25 |
| 9-7. Read Data Bytes at Higher Speed (FAST_READ)..... | 25 |
| 9-8. 2 x I/O Read Mode (2READ)..... | 26 |
| 9-9. 4 x I/O Read Mode (4READ)..... | 26 |
| 9-10. Burst Read | 27 |
| Table 8. Wrap Around Definition Table | 27 |
| Figure 8. Burst Read (SPI Mode)..... | 27 |
| Figure 9. Burst Read (QPI Mode)..... | 27 |

| | |
|--|-----------|
| 9-11. Performance Enhance Mode..... | 28 |
| 9-12. Sector Erase (SE) | 28 |
| 9-13. Block Erase (BE32K) | 28 |
| 9-14. Block Erase (BE)..... | 29 |
| 9-15. Chip Erase (CE)..... | 29 |
| 9-16. Page Program (PP)..... | 30 |
| 9-17. 4 x I/O Page Program (4PP) | 30 |
| 9-18. Deep Power-down (DP) | 31 |
| 9-19. Release from Deep Power-down (RDP), Read Electronic Signature (RES)..... | 31 |
| 9-20. Read Electronic Manufacturer ID & Device ID (REMS) | 32 |
| 9-21. QPI ID Read (QPIID)..... | 32 |
| Table 9. ID Definitions | 32 |
| 9-22. Enter Secured OTP (ENSO) | 33 |
| 9-23. Exit Secured OTP (EXSO)..... | 33 |
| 9-24. Read Security Register (RDSCUR) | 33 |
| Table 10. Security Register Definition | 34 |
| 9-25. Write Security Register (WRSCUR)..... | 34 |
| 9-26. Write Protection Selection (WPSEL)..... | 35 |
| Figure 10. BP and SRWD if WPSEL=0 | 35 |
| Figure 11. The individual block lock mode is effective after setting WPSEL=1 | 36 |
| Figure 12. WPSEL Flow | 37 |
| 9-27. Single Block Lock/Unlock Protection (SBLK/SBULK) | 38 |
| Figure 13. Block Lock Flow | 38 |
| Figure 14. Block Unlock Flow..... | 39 |
| 9-28. Read Block Lock Status (RDBLOCK) | 40 |
| 9-29. Gang Block Lock/Unlock (GBLK/GBULK)..... | 40 |
| 9-30. Program/Erase Suspend/Resume | 40 |
| 9-31. Erase Suspend..... | 41 |
| 9-32. Program Suspend | 41 |
| 9-33. Write-Resume | 42 |
| 9-34. No Operation (NOP)..... | 42 |
| 9-35. Software Reset (Reset-Enable (RSTEN) and Reset (RST))..... | 42 |
| 9-36. Reset Quad I/O (RSTQIO)..... | 42 |
| 9-37. Read SFDP Mode (RDSFDP)..... | 43 |
| Figure 15. Read Serial Flash Discoverable Parameter (RDSFDP) Sequence..... | 43 |
| Table 11. Signature and Parameter Identification Data Values | 44 |
| Table 12. Parameter Table (0): JEDEC Flash Parameter Tables | 45 |
| Table 13. Parameter Table (1): Macronix Flash Parameter Tables | 47 |
| 10. POWER-ON STATE | 49 |

| | |
|--|-----------|
| 11. ELECTRICAL SPECIFICATIONS | 50 |
| 11-1. Absolute Maximum Ratings | 50 |
| Figure 16. Maximum Negative Overshoot Waveform | 50 |
| 11-2. Capacitance | 50 |
| Figure 17. Maximum Positive Overshoot Waveform | 50 |
| Figure 18. Input Test Waveforms and Measurement Level | 51 |
| Figure 19. Output Loading | 51 |
| Table 14. DC Characteristics | 52 |
| Table 15. AC Characteristics | 53 |
| 12. Timing Analysis | 54 |
| Figure 20. Serial Input Timing | 54 |
| Figure 21. Output Timing | 54 |
| Figure 22. WP# Setup Timing and Hold Timing during WRSR when SRWD=1 | 55 |
| Figure 23. Write Enable (WREN) Sequence (Command 06) (SPI Mode) | 55 |
| Figure 24. Write Enable (WREN) Sequence (Command 06) (QPI Mode) | 55 |
| Figure 25. Write Disable (WRDI) Sequence (Command 04) (SPI Mode) | 56 |
| Figure 26. Write Disable (WRDI) Sequence (Command 04) (QPI Mode) | 56 |
| Figure 27. Read Identification (RDID) Sequence (Command 9F) (SPI mode only) | 56 |
| Figure 28. Read Status Register (RDSR) Sequence (Command 05) (SPI Mode) | 57 |
| Figure 29. Read Status Register (RDSR) Sequence (Command 05) (QPI Mode) | 57 |
| Figure 30. Write Status Register (WRSR) Sequence (Command 01) (SPI Mode) | 57 |
| Figure 31. Write Status Register (WRSR) Sequence (Command 01) (QPI Mode) | 58 |
| Figure 32. Read Data Bytes (READ) Sequence (Command 03) (SPI Mode only) (33MHz) | 58 |
| Figure 33. Read at Higher Speed (FAST_READ) Sequence (Command 0B) (SPI Mode) (104MHz) | 59 |
| Figure 34. Read at Higher Speed (FAST_READ) Sequence (Command 0B) (QPI Mode) (84MHz) | 59 |
| Figure 35. 2 x I/O Read Mode Sequence (Command BB) (SPI Mode only) (84MHz) | 60 |
| Figure 36. 4 x I/O Read Mode Sequence (Command EB) (SPI Mode) (104MHz) | 60 |
| Figure 37. 4 x I/O Read enhance performance Mode Sequence (Command EB) (SPI Mode) (104MHz) | 61 |
| Figure 38. 4 x I/O Read Performance Enhance Mode Sequence (Command EB) (QPI Mode) (104MHz) | 62 |
| Figure 39. Page Program (PP) Sequence (Command 02) (SPI Mode) | 62 |
| Figure 40. Page Program (PP) Sequence (Command 02) (QPI Mode) | 63 |
| Figure 41. 4 x I/O Page Program (4PP) Sequence (Command 38) (SPI Mode only) | 63 |
| Figure 42. Sector Erase (SE) Sequence (Command 20) (SPI Mode) | 64 |
| Figure 43. Sector Erase (SE) Sequence (Command 20) (QPI Mode) | 64 |
| Figure 44. Block Erase 32KB (BE32K) Sequence (Command 52) (SPI Mode) | 64 |
| Figure 45. Block Erase 32KB (BE32K) Sequence (Command 52) (QPI Mode) | 64 |
| Figure 46. Block Erase (BE) Sequence (Command D8) (SPI Mode) | 65 |
| Figure 47. Block Erase (BE) Sequence (Command D8) (QPI Mode) | 65 |
| Figure 48. Chip Erase (CE) Sequence (Command 60 or C7) (SPI Mode) | 65 |
| Figure 49. Chip Erase (CE) Sequence (Command 60 or C7) (QPI Mode) | 65 |

| | |
|--|-----------|
| Figure 50. Deep Power-down (DP) Sequence (Command B9) (SPI Mode) | 66 |
| Figure 51. Deep Power-down (DP) Sequence (Command B9) (QPI Mode)..... | 66 |
| Figure 52. RDP and Read Electronic Signature (RES) Sequence (Command AB) (SPI Mode)..... | 66 |
| Figure 53. Release from Deep Power-down (RDP) Sequence (Command AB) (SPI Mode) | 67 |
| Figure 54. Release from Deep Power-down (RDP) Sequence (Command AB) (QPI Mode)..... | 67 |
| Figure 55. Read Electronic Manufacturer & Device ID (REMS) Sequence (Command 90) (SPI Mode only).. | 68 |
| Figure 56. Read Security Register (RDSCUR) Sequence (Command 2B) (SPI Mode)..... | 69 |
| Figure 57. Read Security Register (RDSCUR) Sequence (Command 2B) (QPI Mode)..... | 69 |
| Figure 58. Write Security Register (WRSCUR) Sequence (Command 2F) (SPI Mode) | 70 |
| Figure 59. Write Security Register (WRSCUR) Sequence (Command 2F) (QPI Mode)..... | 70 |
| Figure 60. Word Read Quad I/O (W4READ) Sequence (Command E7) (SPI Mode only, 84MHz) | 71 |
| Figure 61. Reset Sequence (SPI mode) | 72 |
| Figure 62. Reset Sequence (QPI mode)..... | 72 |
| Figure 63. Enable Quad I/O Sequence | 72 |
| Figure 64. Suspend to Read Latency..... | 73 |
| Figure 65. Resume to Read Latency..... | 73 |
| Figure 66. Resume to Suspend Latency | 73 |
| Figure 67. Software Reset Recovery | 73 |
| Figure 68. Power-up Timing | 74 |
| Table 16. Power-Up Timing and VWI Threshold | 74 |
| 12-1. Initial Delivery State | 74 |
| 13. OPERATING CONDITIONS..... | 75 |
| Figure 69. AC Timing at Device Power-Up..... | 75 |
| Figure 70. Power-Down Sequence | 76 |
| 14. ERASE AND PROGRAMMING PERFORMANCE | 77 |
| 15. DATA RETENTION | 77 |
| 16. LATCH-UP CHARACTERISTICS | 77 |
| 17. ORDERING INFORMATION | 78 |
| 18. PART NAME DESCRIPTION..... | 79 |
| 19. PACKAGE INFORMATION..... | 80 |
| 19-1. 8-land USON (4x4mm)..... | 80 |
| 19-2. 8-pin SOP (150mil)..... | 81 |
| 19-3. 8-pin SOP (200mil)..... | 82 |
| 19-4. 8-land WSON (6x5mm)..... | 83 |
| 20. REVISION HISTORY | 84 |

16M-BIT [x 1/x 2/x 4] 1.8V CMOS MXSMIO® (SERIAL MULTI I/O) FLASH MEMORY**1. FEATURES****GENERAL**

- Supports Serial Peripheral Interface -- Mode 0 and Mode 3
- 16,777,216 x 1 bit structure or 8,388,608 x 2 bits (two I/O read mode) structure or 4,194,304 x 4 bits (four I/O read mode) structure
- Equal Sectors with 4K byte each, or Equal Blocks with 32K byte each or Equal Blocks with 64K byte each
 - Any Block can be erased individually
- Single Power Supply Operation
 - 1.65 to 2.0 volt for read, erase, and program operations
- Latch-up protected to 100mA from -1V to Vcc +1V
- Low Vcc write inhibit is from 1.0V to 1.4V

PERFORMANCE

- High Performance
 - Fast read for SPI mode
 - 1 I/O: 104MHz with 8 dummy cycles
 - 2 I/O: 84MHz with 4 dummy cycles, equivalent to 168MHz
 - 4 I/O: 104MHz with 6 dummy cycles, equivalent to 416MHz
 - Fast read for QPI mode
 - 4 I/O: 84MHz with 4 dummy cycles, equivalent to 336MHz
 - 4 I/O: 104MHz with 6 dummy cycles, equivalent to 416MHz
 - Fast program time: 1.2ms(typ.) and 3ms(max.)/page (256-byte per page)
 - Byte program time: 10us (typical)
 - 8/16/32/64 byte Wrap-Around Burst Read Mode
 - Fast erase time:
 - 45ms (typ.)/sector (4K-byte per sector);
 - 250ms(typ.) /block (32K-byte per block);
 - 500ms(typ.) /block (64K-byte per block);
 - 9s(typ.) /chip
- Low Power Consumption
 - Low active read current: 20mA(max.) at 104MHz, 15mA(max.) at 84MHz
 - Low active erase/programming current: 20mA (typ.)
 - Standby current: 25uA (typ.)
- Deep Power Down: 2uA(typ.)
- Typical 100,000 erase/program cycles
- 20 years data retention

SOFTWARE FEATURES

- Input Data Format
 - 1-byte Command code
- Advanced Security Features
 - Block lock protection
 - The BP0-BP3 status bit defines the size of the area to be software protection against program and erase instructions
 - Additional 4k-bit secured OTP for unique identifier
- Auto Erase and Auto Program Algorithm
 - Automatically erases and verifies data at selected sector or block
 - Automatically programs and verifies data at selected page by an internal algorithm that automatically times the program pulse widths (Any page to be programmed should have page in the erased state first)
- Status Register Feature
- Command Reset
- Program/Erase Suspend
- Electronic Identification
 - JEDEC 1-byte manufacturer ID and 2-byte device ID
 - RES command for 1-byte Device ID
 - REMS command 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 read mode and 4 x I/O read mode
- SO/SIO1
 - Serial Data Output or Serial Data Input/Output for 2 x I/O read mode and 4 x I/O read mode
- WP#/SIO2
 - Hardware write protection or serial data Input/Output for 4 x I/O read mode
- NC/SIO3
 - NC pin or Serial input & Output for 4 x I/O read mode
- PACKAGE
 - 8-pin SOP (150mil)
 - 8-pin SOP (200mil)
 - 8-land WSON (6x5mm)
 - 8-land USON (4x4mm)
 - **All devices are RoHS Compliant and Halogen-free**

2. GENERAL DESCRIPTION

The MX25U1635E are 16,777,216 bit Serial NOR Flash memory, which is configured as 2,097,152 x 8 internally. When it is in two or four I/O read mode, the structure becomes 8,388,608 bits x 2 or 4,194,304 bits x 4. MX25U1635E feature a serial peripheral interface and software protocol allowing operation on a simple 3-wire bus while it is in single I/O mode. 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.

When it is in two I/O read 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 four I/O read mode, the SI pin, SO pin, WP# pin and NC pin become SIO0 pin, SIO1 pin, SIO2 pin and SIO3 pin for address/dummy bits input and data output.

The MX25U1635E MXSMIO® (Serial Multi I/O) provides sequential read operation on the whole chip.

After program/erase command is issued, auto program/ erase algorithms which program/ erase and verify the specified page or sector/block locations will be executed. Program command is executed on byte basis, or page (256 bytes) basis, or word basis. Erase command is executed on 4K-byte sector, 32K-byte block, or 64K-byte block, 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.

Advanced security features enhance the protection and security functions, please see security features section for more details.

The MX25U1635E utilizes Macronix's proprietary memory cell, which reliably stores memory contents even after 100,000 program and erase cycles.

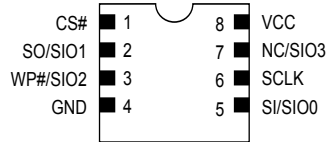
Table 1. Additional Feature Comparison

| Part Name | Additional Features | | Read Performance | | | | | |
|------------|-------------------------------------|---------------------|------------------|----------------|----------------|-----------------|----------------|-----------------|
| | Protection and Security | | SPI | | | | QPI | |
| | Flexible Block Protection (BP0-BP3) | 4K-bit security OTP | 1 I/O (104 MHz) | 2 I/O (84 MHz) | 4 I/O (84 MHz) | 4 I/O (104 MHz) | 4 I/O (84 MHz) | 4 I/O (104 MHz) |
| MX25U1635E | V | V | V | V | V | V | V | V |

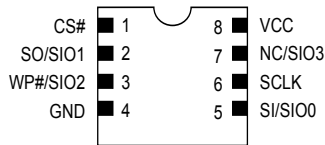
| Part Name | Additional Features | | | |
|------------|-----------------------|------------------------|------------------------|-------------------------|
| | Identifier | | | |
| | RES (command: AB hex) | REMS (command: 90 hex) | RDID (command: 9F hex) | QPIID (Command: AF hex) |
| MX25U1635E | 35 (hex) | C2 35 (hex) (if ADD=0) | C2 25 35 | C2 25 35 |

3. PIN CONFIGURATIONS

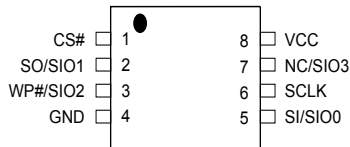
8-LAND USON (4x4mm)



8-LAND WSON (6x5mm)



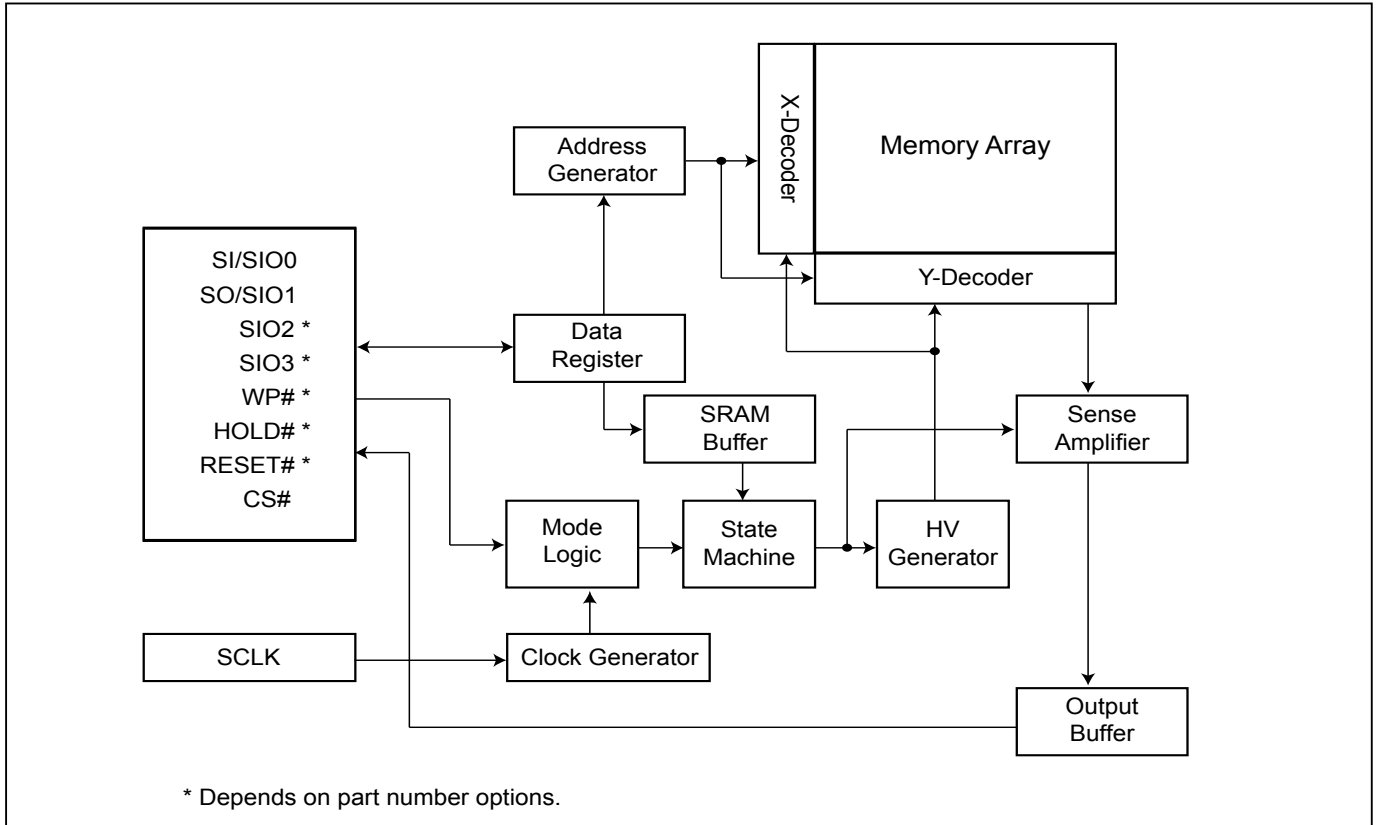
8-PIN SOP (150mil) / 8-PIN SOP (200mil)



4. PIN DESCRIPTION

| SYMBOL | DESCRIPTION |
|----------|---|
| CS# | Chip Select |
| SI/SIO0 | Serial Data Input (for 1 x I/O)/ Serial Data Input & Output (for 2xI/O or 4xI/O read mode) |
| SO/SIO1 | Serial Data Output (for 1 x I/O)/ Serial Data Input & Output (for 2xI/O or 4xI/O read mode) |
| SCLK | Clock Input |
| WP#/SIO2 | Write Protection Active Low or Serial Data Input & Output (for 4xI/O read mode) |
| NC/SIO3 | NC pin (Not connected) or Serial Data Input & Output (for 4xI/O read mode) |
| VCC | + 1.8V Power Supply |
| GND | Ground |

5. BLOCK DIAGRAM



6. DATA PROTECTION

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

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

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

- Power-on reset and tPUW: to avoid sudden power switch by system power supply transition, the power-on reset and tPUW (internal timer) may protect the Flash.
- Valid command length checking: The command length will be checked whether it is at byte base and completed on byte boundary.
- Write Enable (WREN) command: WREN command is required to set the Write Enable Latch bit (WEL) before issuing other commands to change data. The WEL bit will return to reset stage under following situation:
 - Power-up
 - Write Disable (WRDI) command completion
 - Write Status Register (WRSR) command completion
 - Page Program (PP) command completion
 - Quad I/O Page Program (4PP) command completion
 - Sector Erase (SE) command completion
 - Block Erase 32KB (BE32K) command completion
 - Block Erase (BE) command completion
 - Chip Erase (CE) command completion
 - Program/Erase Suspend
 - Softreset command completion
 - Write Security Register (WRSCUR) command completion
 - Write Protection Selection (WPSEL) command 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) and softreset command.
- Advanced Security Features: there are some protection and security features which protect content from inadvertent write and hostile access.

I. Block lock protection

- The Software Protected Mode (SPM) use (BP3, BP2, BP1, BP0) bits to allow part of memory to be protected as read only. The protected area definition is shown as "[Table 2. Protected Area Sizes](#)", the protected areas are more flexible which may protect various area by setting value of BP0-BP3 bits.
- The Hardware Protected Mode (HPM) use WP#/SIO2 to protect the (BP3, BP2, BP1, BP0) bits and Status Register Write Protect bit.
- In four I/O and QPI mode, the feature of HPM will be disabled.

Table 2. Protected Area Sizes

| Status bit | | | | Protect Level |
|------------|-----|-----|-----|---|
| BP3 | BP2 | BP1 | BP0 | |
| 0 | 0 | 0 | 0 | 0 (none) |
| 0 | 0 | 0 | 1 | 1 (1block, protected block 31st) |
| 0 | 0 | 1 | 0 | 2 (2blocks, protected block 30th~31st) |
| 0 | 0 | 1 | 1 | 3 (4blocks, protected block 28th~31st) |
| 0 | 1 | 0 | 0 | 4 (8blocks, protected block 24th~31st) |
| 0 | 1 | 0 | 1 | 5 (16blocks, protected block 16th~31st) |
| 0 | 1 | 1 | 0 | 6 (32blocks, protected all) |
| 0 | 1 | 1 | 1 | 7 (32blocks, protected all) |
| 1 | 0 | 0 | 0 | 8 (32blocks, protected all) |
| 1 | 0 | 0 | 1 | 9 (32blocks, protected all) |
| 1 | 0 | 1 | 0 | 10 (16blocks, protected block 0th~15th) |
| 1 | 0 | 1 | 1 | 11 (24blocks, protected block 0th~23rd) |
| 1 | 1 | 0 | 0 | 12 (28blocks, protected block 0th~27th) |
| 1 | 1 | 0 | 1 | 13 (30blocks, protected block 0th~29th) |
| 1 | 1 | 1 | 0 | 14 (31blocks, protected block 0th~30th) |
| 1 | 1 | 1 | 1 | 15 (32blocks, protected all) |

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 customer. 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 Enter Security OTP (ENSO) command), and going through normal program procedure, and then exiting 4K-bit secured OTP mode by writing Exit Security OTP (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 10. Security Register Definition"](#) for security register bit definition and ["Table 3. 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 | |

7. Memory Organization

Table 4. Memory Organization

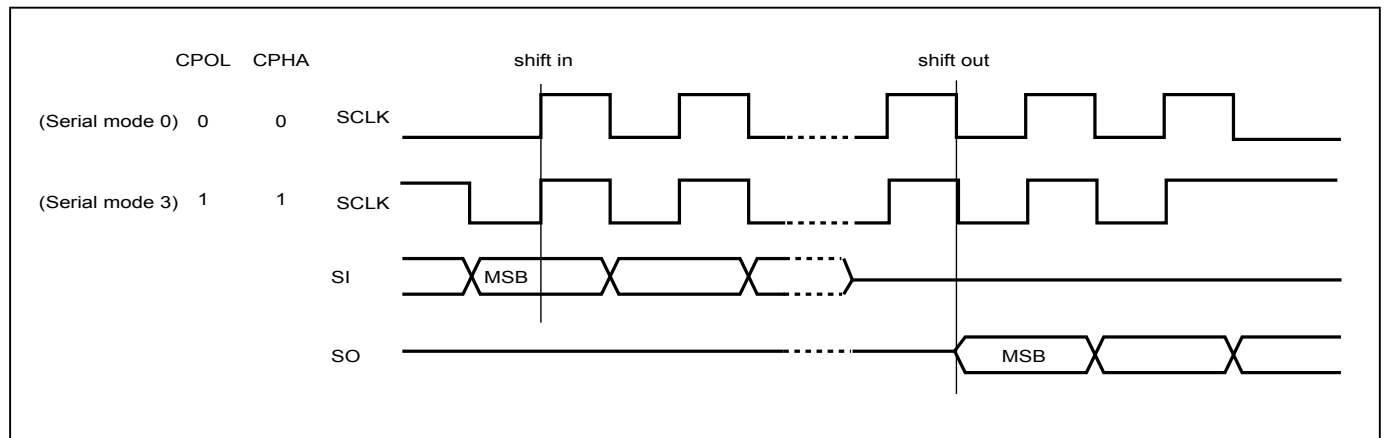
| Block (64KB) | Block (32KB) | Sector (4KB) | Address Range | |
|--------------|--------------|--------------|---------------|-----------|
| 31 | 63 | 511 | 1FF000h | 1FFFFFFh |
| | | : | : | : |
| 30 | 62 | 496 | 1F0000h | 1F0FFFFh |
| | | : | : | : |
| 29 | 61 | 495 | 1EF000h | 1EFFFFFFh |
| | | : | : | : |
| 28 | 60 | 480 | 1E0000h | 1E0FFFFh |
| | | : | : | : |
| 27 | 59 | 479 | 1DF000h | 1DFFFFFFh |
| | | : | : | : |
| 26 | 58 | 464 | 1D0000h | 1D0FFFFh |
| | | : | : | : |
| 25 | 57 | 463 | 1CF000h | 1CFFFFFFh |
| | | : | : | : |
| 24 | 56 | 448 | 1C0000h | 1C0FFFFh |
| | | : | : | : |
| 23 | 55 | 447 | 1BF000h | 1BFFFFFFh |
| | | : | : | : |
| 22 | 54 | 432 | 1B0000h | 1B0FFFFh |
| | | : | : | : |
| 21 | 53 | 431 | 1AF000h | 1AFFFFFFh |
| | | : | : | : |
| 20 | 52 | 416 | 1A0000h | 1A0FFFFh |
| | | : | : | : |
| 19 | 51 | 415 | 19F000h | 19FFFFFFh |
| | | : | : | : |
| 18 | 50 | 400 | 190000h | 190FFFFh |
| | | : | : | : |
| 17 | 49 | 399 | 18F000h | 18FFFFFFh |
| | | : | : | : |
| 16 | 48 | 384 | 180000h | 180FFFFh |
| | | : | : | : |
| 15 | 47 | 383 | 17F000h | 17FFFFFFh |
| | | : | : | : |
| 14 | 46 | 368 | 170000h | 170FFFFh |
| | | : | : | : |
| 13 | 45 | 367 | 16F000h | 16FFFFFFh |
| | | : | : | : |
| 12 | 44 | 352 | 160000h | 160FFFFh |
| | | : | : | : |
| 11 | 43 | 351 | 15F000h | 15FFFFFFh |
| | | : | : | : |
| 10 | 42 | 336 | 150000h | 150FFFFh |
| | | : | : | : |
| 9 | 41 | 335 | 14F000h | 14FFFFFFh |
| | | : | : | : |
| 8 | 40 | 320 | 140000h | 140FFFFh |
| | | : | : | : |
| 7 | 39 | 319 | 13F000h | 13FFFFFFh |
| | | : | : | : |
| 6 | 38 | 304 | 130000h | 130FFFFh |
| | | : | : | : |
| 5 | 37 | 303 | 12F000h | 12FFFFFFh |
| | | : | : | : |
| 4 | 36 | 288 | 120000h | 120FFFFh |
| | | : | : | : |
| 3 | 35 | 287 | 11F000h | 11FFFFFFh |
| | | : | : | : |
| 2 | 34 | 272 | 110000h | 110FFFFh |
| | | : | : | : |
| 1 | 33 | 271 | 10F000h | 10FFFFFFh |
| | | : | : | : |
| 0 | 32 | 256 | 100000h | 100FFFFh |
| | | : | : | : |

| Block (64KB) | Block (32KB) | Sector (4KB) | Address Range | |
|--------------|--------------|--------------|---------------|-----------|
| 15 | 31 | 255 | 0FF000h | 0FFFFFFh |
| | | : | : | : |
| 14 | 30 | 240 | 0F0000h | 0F0FFFFh |
| | | : | : | : |
| 13 | 29 | 239 | 0EF000h | 0EFFFFFFh |
| | | : | : | : |
| 12 | 28 | 224 | 0E0000h | 0E0FFFFh |
| | | : | : | : |
| 11 | 27 | 223 | 0DF000h | 0DFFFFFFh |
| | | : | : | : |
| 10 | 26 | 208 | 0D0000h | 0D0FFFFh |
| | | : | : | : |
| 9 | 25 | 207 | 0CF000h | 0CFFFFFFh |
| | | : | : | : |
| 8 | 24 | 192 | 0C0000h | 0C0FFFFh |
| | | : | : | : |
| 7 | 23 | 191 | 0BF000h | 0BFFFFFFh |
| | | : | : | : |
| 6 | 22 | 176 | 0B0000h | 0B0FFFFh |
| | | : | : | : |
| 5 | 21 | 175 | 0AF000h | 0AFFFFFFh |
| | | : | : | : |
| 4 | 20 | 160 | 0A0000h | 0A0FFFFh |
| | | : | : | : |
| 3 | 19 | 159 | 09F000h | 09FFFFFFh |
| | | : | : | : |
| 2 | 18 | 144 | 090000h | 090FFFFh |
| | | : | : | : |
| 1 | 17 | 143 | 08F000h | 08FFFFFFh |
| | | : | : | : |
| 0 | 16 | 128 | 080000h | 080FFFFh |
| | | : | : | : |
| 0 | 15 | 127 | 07F000h | 07FFFFFFh |
| | | : | : | : |
| 0 | 14 | 112 | 070000h | 070FFFFh |
| | | : | : | : |
| 0 | 13 | 111 | 06F000h | 06FFFFFFh |
| | | : | : | : |
| 0 | 12 | 96 | 060000h | 060FFFFh |
| | | : | : | : |
| 0 | 11 | 95 | 05F000h | 05FFFFFFh |
| | | : | : | : |
| 0 | 10 | 80 | 050000h | 050FFFFh |
| | | : | : | : |
| 0 | 9 | 79 | 04F000h | 04FFFFFFh |
| | | : | : | : |
| 0 | 8 | 64 | 040000h | 040FFFFh |
| | | : | : | : |
| 0 | 7 | 63 | 03F000h | 03FFFFFFh |
| | | : | : | : |
| 0 | 6 | 48 | 030000h | 030FFFFh |
| | | : | : | : |
| 0 | 5 | 47 | 02F000h | 02FFFFFFh |
| | | : | : | : |
| 0 | 4 | 32 | 020000h | 020FFFFh |
| | | : | : | : |
| 0 | 3 | 31 | 01F000h | 01FFFFFFh |
| | | : | : | : |
| 0 | 2 | 16 | 010000h | 010FFFFh |
| | | : | : | : |
| 0 | 1 | 15 | 00F000h | 00FFFFFFh |
| | | : | : | : |
| 0 | 0 | 2 | 002000h | 002FFFFh |
| | | : | : | : |
| 0 | 0 | 1 | 001000h | 001FFFFh |
| | | : | : | : |
| 0 | 0 | 0 | 000000h | 000FFFFh |
| | | : | : | : |

8. 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 device, it enters standby mode and remains in standby mode until next CS# falling edge. In standby mode, SO pin of the device is High-Z.
3. When correct command is inputted to this device, it enters active mode and remains in active mode until next CS# rising edge.
4. Input data is latched on the rising edge of Serial Clock (SCLK) and data is shifted out on the falling edge of SCLK. The difference of Serial mode 0 and mode 3 is shown as "Figure 1. Serial Modes Supported".
5. For the following instructions: RDID, RDSR, RDSCUR, READ, FAST_READ, RDSFDP, 2READ, 4READ, RES, REMS, SQIID, RDBLOCK, 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, BE32K, BE, CE, PP, 4PP, DP, ENSO, EXSO, WRSCUR, WPSEL, SBLK, SBULK, GBULK, SUSPEND, RESUME, NOP, RSTEN, RST, EQIO, RSTQIO the CS# must go high exactly at the byte boundary; otherwise, the instruction will be rejected and not executed.
6. While a Write Status Register, Program or Erase operation is in progress, access to the memory array is neglected and will not affect the current operation of Write Status Register, Program, Erase.

Figure 1. Serial Modes Supported



Note:

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

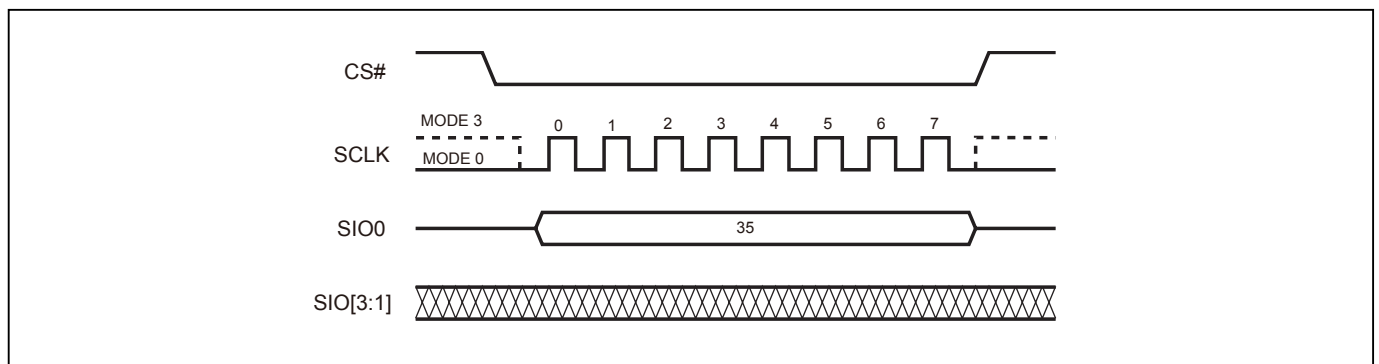
8-1. Quad Peripheral Interface (QPI) Read Mode

QPI protocol enables user to take full advantage of Quad I/O Serial Flash by providing the Quad I/O interface in command cycles, address cycles and as well as data output cycles.

Enable QPI mode

By issuing 35H command, the QPI mode is enabled.

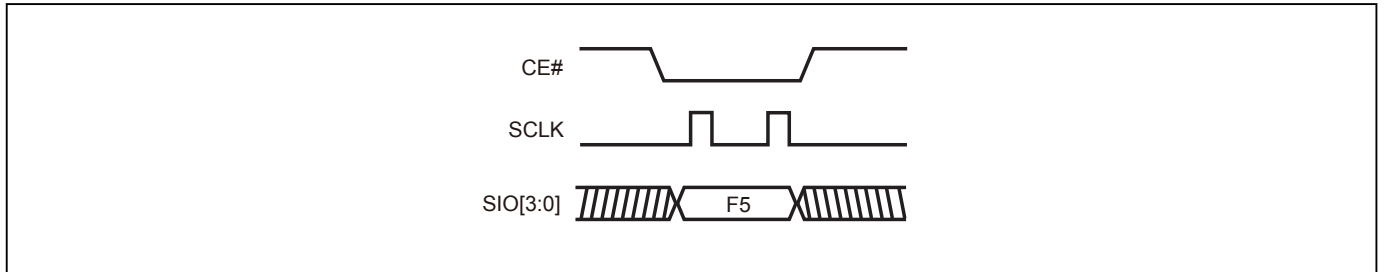
Figure 2. Enable QPI Sequence (Command 35H)



Reset QPI mode

By issuing F5H command, the device is reset to 1-I/O SPI mode.

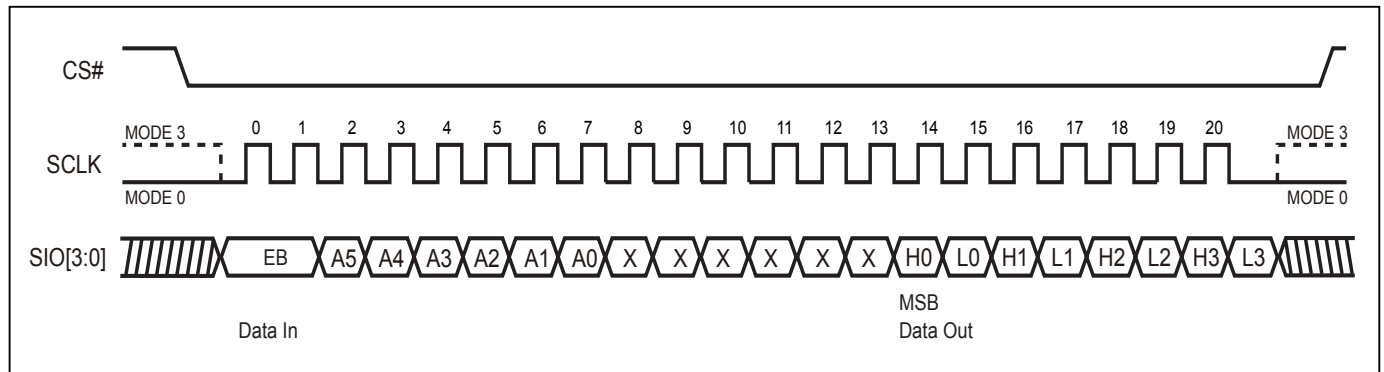
Figure 3. Reset QPI Mode (Command F5H)



Fast QPI Read mode (FASTRDQ)

To increase the code transmission speed, the device provides a "Fast QPI Read Mode" (FASTRDQ). By issuing command code EBH, the FASTRDQ mode is enabled. The number of dummy cycle increase from 4 to 6 cycles. The read cycle frequency will increase from 84MHz to 104MHz.

Figure 4. Fast QPI Read Mode (FASTRDQ) (Command EBH)



9. COMMAND DESCRIPTION

Table 5. Command Set

Read Commands

| I/O | 1 | 1 | 1 | 2 | 4 | 4 | 4 | 4 |
|------------------|--------------------------------------|--------------------------------------|--------------------|---|--|---|--------------------------------------|---|
| Read Mode | SPI | SPI | SPI | SPI | SPI | SPI | QPI | QPI |
| Command (byte) | READ (normal read) | FAST READ * (fast read data) | RDSFDP (Read SFDP) | 2READ (2 x I/O read command) Note1 | W4READ | 4READ * (4 x I/O read command) Note1 | FAST READ * (fast read data) | 4READ * (4 x I/O read command) Note1 |
| Clock rate (MHz) | 33 | 104 | 104 | 84 | 84 | 104 | 84 | 104 |
| 1st byte | 03 (hex) | 0B (hex) | 5A (hex) | BB (hex) | E7 (hex) | EB (hex) | 0B (hex) | EB (hex) |
| 2nd byte | AD1(8) | AD1(8) | AD1(8) | AD1(4) | AD1(2) | AD1(2) | AD1(2) | AD1(2) |
| 3rd byte | AD2(8) | AD2(8) | AD2(8) | AD2(4) | AD2(2) | AD2(2) | AD2(2) | AD2(2) |
| 4th byte | AD3(8) | AD3(8) | AD3(8) | AD3(4) | AD3(2) | AD3(2) | AD3(2) | AD3(2) |
| 5th byte | | Dummy(8) | Dummy(8) | Dummy(4) | Dummy(4) | Dummy(6) | Dummy(4) | Dummy(6) |
| Action | n bytes read out until CS# goes high | n bytes read out until CS# goes high | Read SFDP mode | n bytes read out by 2 x I/O until CS# goes high | Quad I/O read with 4 dummy cycles in 84MHz | Quad I/O read with 6 dummy cycles in 104MHz | n bytes read out until CS# goes high | Quad I/O read with 6 dummy cycles in 104MHz |

Program/Erase Commands

| Command (byte) | WREN* (write enable) | WRDI * (write disable) | RDSR * (read status register) | WRSR * (write status register) | 4PP (quad page program) | SE * (sector erase) | BE 32K * (block erase 32KB) |
|----------------|---------------------------------------|---|---|--|---|------------------------------|---------------------------------|
| 1st byte | 06 (hex) | 04 (hex) | 05 (hex) | 01 (hex) | 38 (hex) | 20 (hex) | 52 (hex) |
| 2nd byte | | | | Values | AD1 | AD1 | AD1 |
| 3rd byte | | | | | AD2 | AD2 | AD2 |
| 4th byte | | | | | AD3 | AD3 | AD3 |
| Action | sets the (WEL) write enable latch bit | resets the (WEL) write enable latch bit | to read out the values of the status register | to write new values of the status register | quad input to program the selected page | to erase the selected sector | to erase the selected 32K block |

| Command (byte) | BE * (block erase 64KB) | CE * (chip erase) | PP * (page program) | DP * (Deep power down) | RDP * (Release from deep power down) | PGM/ERS Suspend * (Suspends Program/ Erase) | PGM/ERS Resume * (Resumes Program/ Erase) |
|----------------|-----------------------------|---------------------|------------------------------|-----------------------------|--------------------------------------|---|---|
| 1st byte | D8 (hex) | 60 or C7 (hex) | 02 (hex) | B9 (hex) | AB (hex) | B0 (hex) | 30 (hex) |
| 2nd byte | AD1 | | AD1 | | | | |
| 3rd byte | AD2 | | AD2 | | | | |
| 4th byte | AD3 | | AD3 | | | | |
| Action | to erase the selected block | to erase whole chip | to program the selected page | enters deep power down mode | release from deep power down mode | | |

Security/ID/Mode Setting/Reset Commands

| Command (byte) | RDID (read identification) | RES (read electronic ID) | REMS (read electronic manufacturer & device ID) | ENSO * (enter secured OTP) | EXSO * (exit secured OTP) | RDSCUR * (read security register) | WRSCUR * (write security register) |
|----------------|---|------------------------------|---|--------------------------------------|-------------------------------------|------------------------------------|--|
| 1st byte | 9F (hex) | AB (hex) | 90 (hex) | B1 (hex) | C1 (hex) | 2B (hex) | 2F (hex) |
| 2nd byte | | x | x | | | | |
| 3rd byte | | x | x | | | | |
| 4th byte | | x | ADD (Note 2) | | | | |
| 5th byte | | | | | | | |
| Action | outputs JEDEC ID: 1-byte Manufacturer ID & 2-byte Device ID | to read out 1-byte Device ID | output the Manufacturer 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 update) |

| COMMAND (byte) | SBLK * (single block lock) | SBULK * (single block unlock) | RDBLOCK * (block protect read) | GBLK * (gang block lock) | GBULK * (gang block unlock) | NOP * (No Operation) | RSTEN * (Reset Enable) |
|----------------|---|---|--|--------------------------|-----------------------------|----------------------|------------------------|
| 1st byte | 36 (hex) | 39 (hex) | 3C (hex) | 7E (hex) | 98 (hex) | 00 (hex) | 66 (hex) |
| 2nd byte | AD1 | AD1 | AD1 | | | | |
| 3rd byte | AD2 | AD2 | AD2 | | | | |
| 4th byte | AD3 | AD3 | AD3 | | | | |
| Action | individual block (64K-byte) or sector (4K-byte) write protect | individual block (64K-byte) or sector (4K-byte) unprotect | read individual block or sector write protect status | whole chip write protect | whole chip unprotect | | |

| COMMAND (byte) | RST * (Reset Memory) | EQIO (Enable Quad I/O) | RSTQIO (Reset Quad I/O) | QPIID (QPI ID Read) | SBL * (Set Burst Length) | WPSEL * (Write Protect Selection) |
|----------------|----------------------|------------------------|-------------------------|---------------------|--------------------------|---|
| 1st byte | 99 (hex) | 35 (hex) | F5 (hex) | AF (hex) | C0 (hex) | 68 (hex) |
| 2nd byte | | | | | Value | |
| 3rd byte | | | | | | |
| 4th byte | | | | | | |
| Action | | Entering the QPI mode | Exiting the QPI mode | ID in QPI interface | to set Burst length | to enter and enable individual block protect mode |

Note 1: Command set highlighted with (*) are supported both in SPI and QPI mode.

Note 2: The count base is 4-bit for ADD(2) and Dummy(2) because of 2 x I/O. And the MSB is on SI/SIO1 which is different from 1 x I/O condition.

Note 3: ADD=00H will output the manufacturer ID first and ADD=01H will output device ID first.

Note 4: It is not recommended to adopt any other code not in the command definition table, which will potentially enter the hidden mode.

Note 5: Before executing RST command, RSTEN command must be executed. If there is any other command to interfere, the reset operation will be disabled.

9-1. Write Enable (WREN)

The Write Enable (WREN) instruction is for setting Write Enable Latch (WEL) bit. For those instructions like PP, 4PP, SE, BE32K, BE, CE, and WRSR, which are intended to change the device content WEL bit 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.

Both SPI (8 clocks) and QPI (2 clocks) command cycle can accept by this instruction. The SIO[3:1] are don't care in SPI mode. (Please refer to "[Figure 23. Write Enable \(WREN\) Sequence \(Command 06\) \(SPI Mode\)](#)" and "[Figure 24. Write Enable \(WREN\) Sequence \(Command 06\) \(QPI Mode\)](#)")

9-2. Write Disable (WRDI)

The Write Disable (WRDI) instruction is to reset Write Enable Latch (WEL) bit.

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

Both SPI (8 clocks) and QPI (2 clocks) command cycle can accept by this instruction. The SIO[3:1] are don't care in SPI mode. (Please refer to "[Figure 26. Write Disable \(WRDI\) Sequence \(Command 04\) \(QPI Mode\)](#)" and "[Figure 25. Write Disable \(WRDI\) Sequence \(Command 04\) \(SPI Mode\)](#)")

The WEL bit is reset by following situations:

- Power-up
- Completion of Write Disable (WRDI) instruction
- Completion of Write Status Register (WRSR) instruction
- Completion of Page Program (PP) instruction
- Completion of Quad Page Program (4PP) instruction
- Completion of Sector Erase (SE) instruction
- Completion of Block Erase 32KB (BE32K) instruction
- Completion of Block Erase (BE) instruction
- Completion of Chip Erase (CE) instruction
- Completion of Write Security Register (WRSCUR) instruction
- Completion of Single Block Lock (SBLK) instruction
- Completion of Gang Block Lock (GBLK) instruction
- Completion of Write Protect Selection (WPSEL) instruction
- Pgm/Ers Suspend

9-3. Read Identification (RDID)

The RDID instruction is for reading the manufacturer ID of 1-byte and followed by Device ID of 2-byte. The Macronix Manufacturer ID and Device ID are listed as "[Table 9. ID Definitions](#)" ID Definitions.

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 drive CS# to high at any time during data out.

While Program/Erase operation is in progress, it will not decode the RDID instruction, therefore 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.

9-4. Read Status Register (RDSR)

The RDSR instruction is for reading Status Register Bits. The Read Status Register can be read at any time (even in program/erase/write status register condition). 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.

Both SPI (8 clocks) and QPI (2 clocks) command cycle can accept by this instruction. The SIO[3:1] are don't care when during SPI mode. (Please refer to "Figure 28. Read Status Register (RDSR) Sequence (Command 05) (SPI Mode)" and "Figure 29. Read Status Register (RDSR) Sequence (Command 05) (QPI Mode)")

For user to check if Program/Erase operation is finished or not, RDSR instruction flow are shown as follows:

Figure 5. Program/ Erase flow with read array data

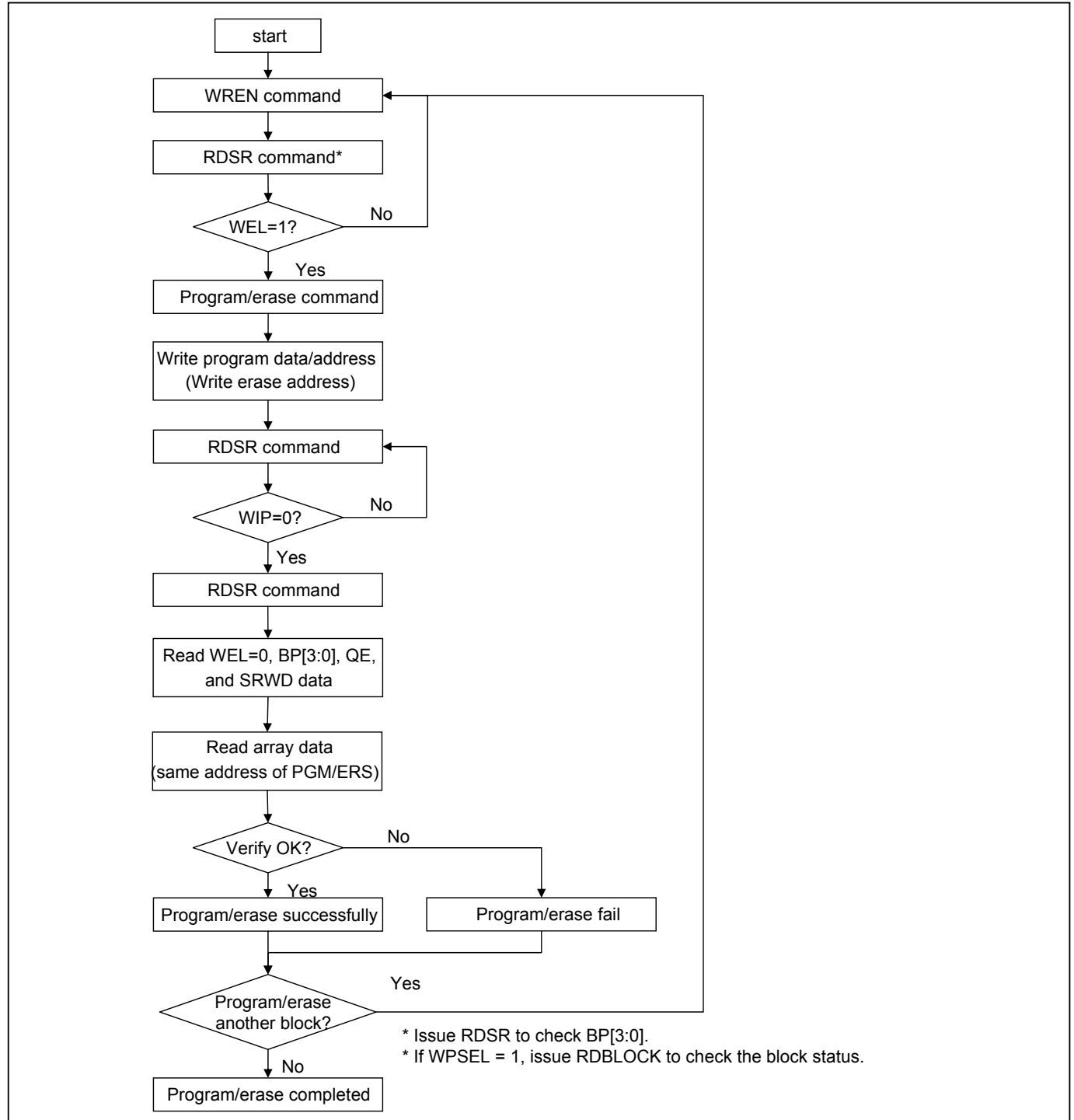


Figure 6. Program/ Erase flow without read array data (read P_FAIL/E_FAIL flag)

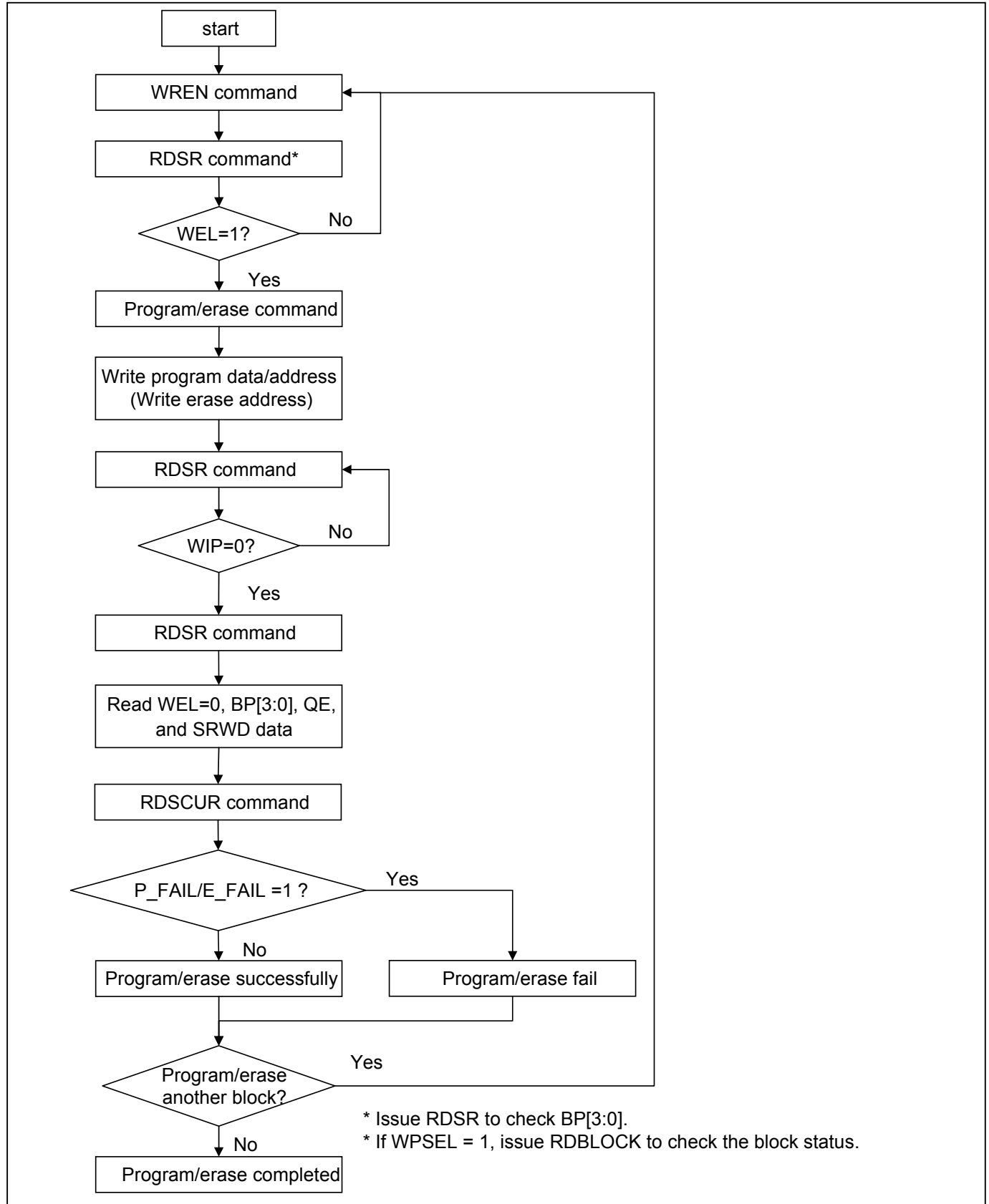
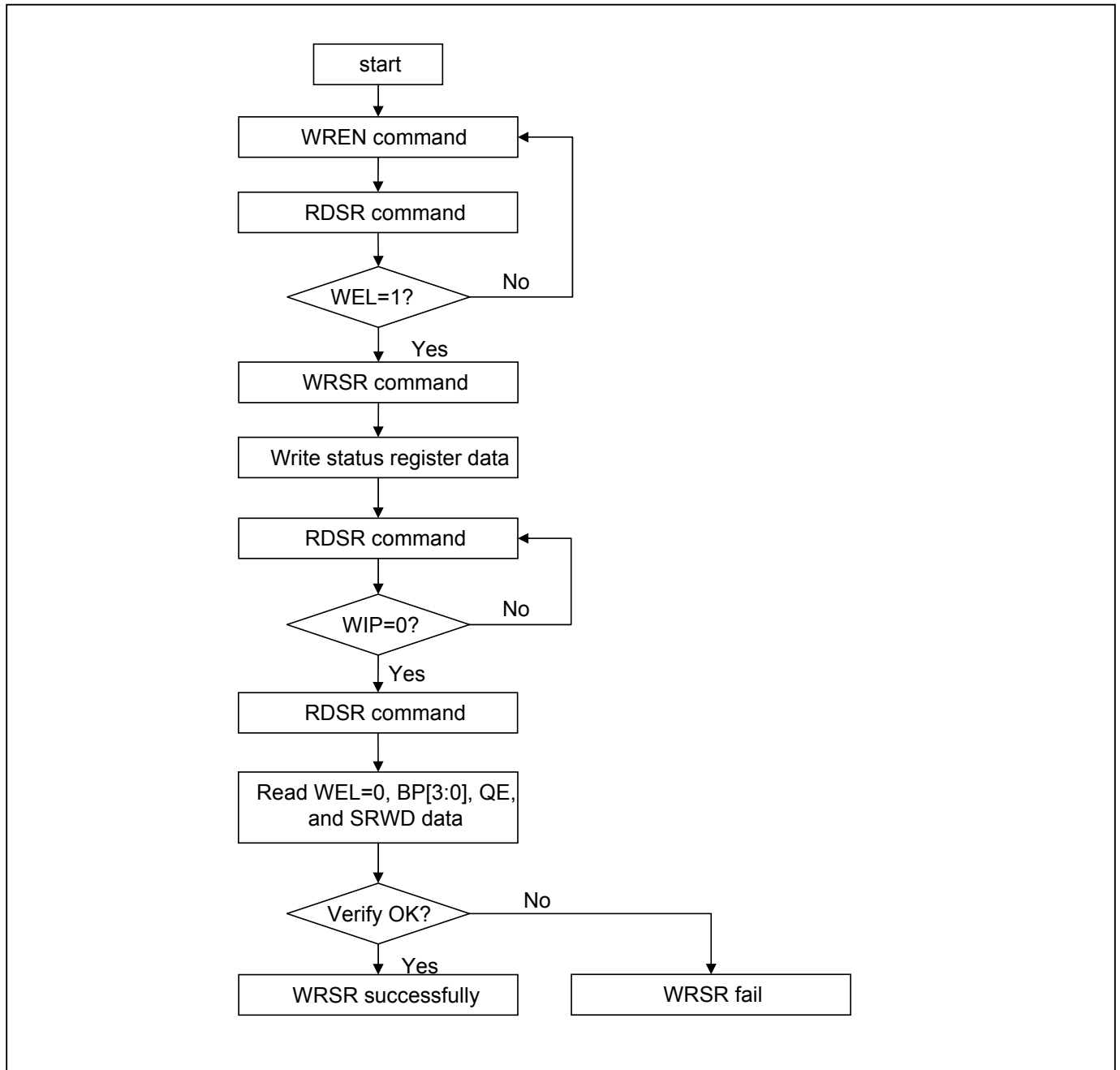


Figure 7. WRSR flow

The definitions of the status register bits are 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 is a volatile bit that is set to “1” by the WREN instruction. WEL needs to be set to “1” before the device can accept program and erase instructions, otherwise the program and erase instructions are ignored. WEL automatically clears to “0” when a program or erase operation completes. To ensure that both WIP and WEL are “0” and the device is ready for the next program or erase operation, it is recommended that WIP be confirmed to be “0” before checking that WEL is also “0”. If a program or erase instruction is applied to a protected memory area, the instruction will be ignored and WEL will clear to “0”.

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. Protected Area Sizes"](#)) 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 32KB (BE32K), Block Erase (BE) and Chip Erase (CE) instructions (only if Block Protect bits (BP3:BP0) set to 0, the CE instruction can be executed). The BP3, BP2, BP1, BP0 bits are "0" as default. Which is unprotected.

QE bit. The Quad Enable (QE) bit, non-volatile bit, performs SPI Quad modes when it is reset to "0" (factory default) to enable WP# or is set to "1" to enable Quad SIO2 and SIO3. QE bit is only valid for SPI mode. When operate in SPI mode, and quad IO read is desired (for command EBh/E7h, or quad IO program, 38h). WRSR command has to be set the through Status Register bit 6, the QE bit. Then the SPI Quad I/O commands (EBh/E7h/38h) will be accepted by flash. If QE bit is not set, SPI Quad I/O commands (EBh/E7h/38h) will be invalid commands, the device will not respond to them. Once QE bit is set, all SPI commands are valid. 1/I/O commands and 2 I/O commands can be issued no matter QE bit is "0" or "1". When in QPI mode, QE bit will not affect the operation of QPI mode at all. Therefore either "0" or "1" value of QE bit does not affect the QPI mode operation.

SRWD bit. The Status Register Write Disable (SRWD) bit, non-volatile 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. The SRWD bit defaults to be "0".

Table 6. 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 disabled 0=status register write enabled | 1=Quad Enable 0=not Quad Enable | <i>(note 1)</i> | <i>(note 1)</i> | <i>(note 1)</i> | <i>(note 1)</i> | 1=write enabled 0=not write enabled | 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: Please refer to the ["Table 2. Protected Area Sizes"](#).

9-5. 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. Protected Area Sizes"). 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.

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 30. Write Status Register (WRSR) Sequence (Command 01) (SPI Mode)" and "Figure 31. Write Status Register (WRSR) Sequence (Command 01) (QPI Mode)")

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

Table 7. 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:

1. As defined by the values in the Block Protect (BP3, BP2, BP1, BP0) bits of the Status Register, as shown in "Table 2. Protected Area Sizes".

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)

Note:

If SRWD bit=1 but WP#/SIO2 is low, it is impossible to write the Status Register even if the WEL bit has previously been set. It is rejected to write the Status Register and not be executed.

Hardware Protected Mode (HPM):

- When SRWD bit=1, and then WP#/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 enter QPI or set QE=1, the feature of HPM will be disabled.

9-6. Read Data Bytes (READ)

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

The sequence of issuing READ instruction is: CS# goes low→sending READ instruction code→ 3-byte address on SI→ data out on SO→to end READ operation can use CS# to high at any time during data out. (Please refer to "[Figure 32. Read Data Bytes \(READ\) Sequence \(Command 03\) \(SPI Mode only\) \(33MHz\)](#)")

9-7. Read Data Bytes at Higher Speed (FAST_READ)

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

Read on SPI Mode The sequence of issuing FAST_READ instruction is: CS# goes low→ sending FAST_READ instruction code→ 3-byte address 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 33. Read at Higher Speed \(FAST_READ\) Sequence \(Command 0B\) \(SPI Mode\) \(104MHz\)](#)")

Read on QPI Mode The sequence of issuing FAST_READ instruction in QPI mode is: CS# goes low→ sending FAST_READ instruction, 2 cycles→ 24-bit address interleave on SIO3, SIO2, SIO1 & SIO0→4 dummy cycles→data out interleave on SIO3, SIO2, SIO1 & SIO0→ to end QPI FAST_READ operation can use CS# to high at any time during data out. (Please refer to "[Figure 34. Read at Higher Speed \(FAST_READ\) Sequence \(Command 0B\) \(QPI Mode\) \(84MHz\)](#)")

In the performance-enhancing mode, 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 and afterwards CS# is raised and then lowered, the system then will escape from performance enhance mode and return to normal operation.

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.

9-8. 2 x I/O Read Mode (2READ)

The 2READ instruction enable double throughput of Serial NOR 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 sequence of issuing 2READ instruction is: CS# goes low→ sending 2READ instruction→ 24-bit address interleave on SIO1 & SIO0→ 4 dummy cycles 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 35. 2 x I/O Read Mode Sequence \(Command BB\) \(SPI Mode only\) \(84MHz\)"](#)).

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.

9-9. 4 x I/O Read Mode (4READ)

The 4READ instruction enable quad throughput of Serial NOR 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.

4 x I/O Read on SPI Mode (4READ) The sequence of issuing 4READ instruction is: CS# goes low→ sending 4READ instruction→ 24-bit address interleave on SIO3, SIO2, SIO1 & SIO0→2+4 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 36. 4 x I/O Read Mode Sequence \(Command EB\) \(SPI Mode\) \(104MHz\)"](#).

W4READ instruction (E7) is also available is SPI mode for 4 I/O read. The sequence is similar to 4READ, but with only 4 dummy cycles. The clock rate runs at 84MHz. Please refer to ["Figure 60. Word Read Quad I/O \(W4READ\) Sequence \(Command E7\) \(SPI Mode only, 84MHz\)"](#).

4 x I/O Read on QPI Mode (4READ) The 4READ instruction also support on QPI command mode. The sequence of issuing 4READ instruction QPI mode is: CS# goes low→ sending 4READ instruction→ 24-bit address interleave on SIO3, SIO2, SIO1 & SIO0→2+4 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 36. 4 x I/O Read Mode Sequence \(Command EB\) \(SPI Mode\) \(104MHz\)"](#)).

Another sequence of issuing 4READ instruction is especially useful in random access: CS# goes low→send 4READ instruction→3-bytes address interleave on SIO3, SIO2, SIO1 & SIO0→performance enhance toggling bit P[7:0]→ 4 dummy cycles (Default)→data out until CS# goes high→CS# goes low (The following 4READ instruction is not allowed, hence 8 cycles of 4READ can be saved comparing to normal 4READ mode)→24-bit random access address (Please refer to ["Figure 37. 4 x I/O Read enhance performance Mode Sequence \(Command EB\) \(SPI Mode\) \(104MHz\)"](#) and ["Figure 38. 4 x I/O Read Performance Enhance Mode Sequence \(Command EB\) \(QPI Mode\) \(104MHz\)"](#)).

In the performance-enhancing mode, 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 and afterwards CS# is raised and then lowered, the system then will escape from performance enhance mode and 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.

9-10. Burst Read

The Burst Read feature allows applications to fill a cache line with a fixed length of data without using multiple read commands. Burst Read is disabled by default at power-up or reset. Burst Read is enabled by setting the Burst Length. When the Burst Length is set, reads will wrap on the selected boundary (8/16/32/64-bytes) containing the initial target address. For example if an 8-byte Wrap Depth is selected, reads will wrap on the 8-byte-page-aligned boundary containing the initial read address.

To set the Burst Length, drive CS# low → send SET BURST LENGTH instruction code → send WRAP CODE → drive CS# high. Refer to the table below for valid 8-bit Wrap Codes and their corresponding Wrap Depth.

Table 8. Wrap Around Definition Table

| Data | Wrap Around | Wrap Depth | Data | Wrap Around | Wrap Depth |
|------|-------------|------------|------|-------------|------------|
| 1xh | No | X | 00h | Yes | 8-byte |
| 1xh | No | X | 01h | Yes | 16-byte |
| 1xh | No | X | 02h | Yes | 32-byte |
| 1xh | No | X | 03h | Yes | 64-byte |

Once Burst Read is enabled, it will remain enabled until the device is power-cycled or reset. The SPI and QPI mode 4READ read commands support the wrap around feature after Burst Read is enabled. To change the wrap depth, resend the Burst Read instruction with the appropriate Wrap Code. To disable Burst Read, send the Burst Read instruction with Wrap Code 1xh. QPI “0Bh” “EBh” and SPI “EBh” “E7h” support wrap around feature after wrap around is enabled. Both SPI (8 clocks) and QPI (2 clocks) command cycle can be accepted by this instruction. The SIO[3:1] are don't care during SPI mode.

Figure 8. Burst Read (SPI Mode)

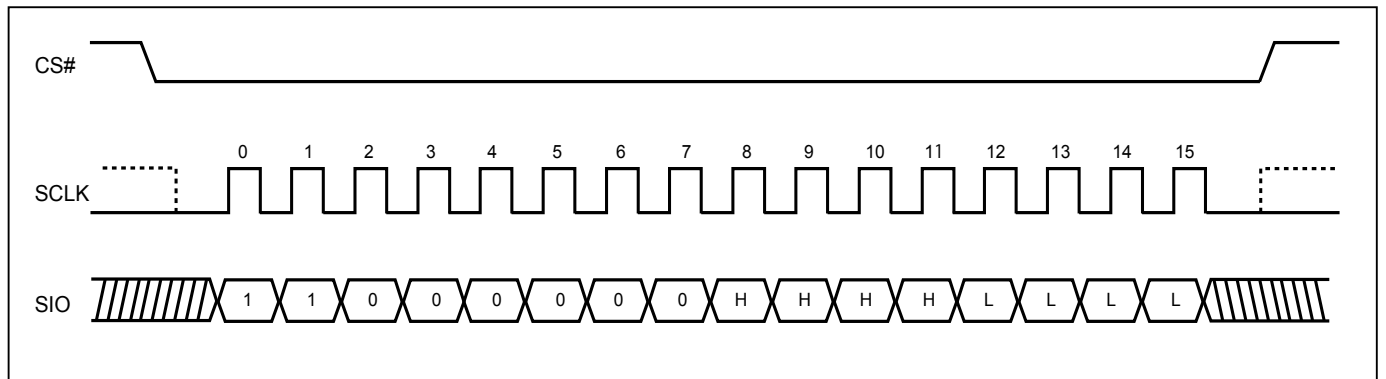
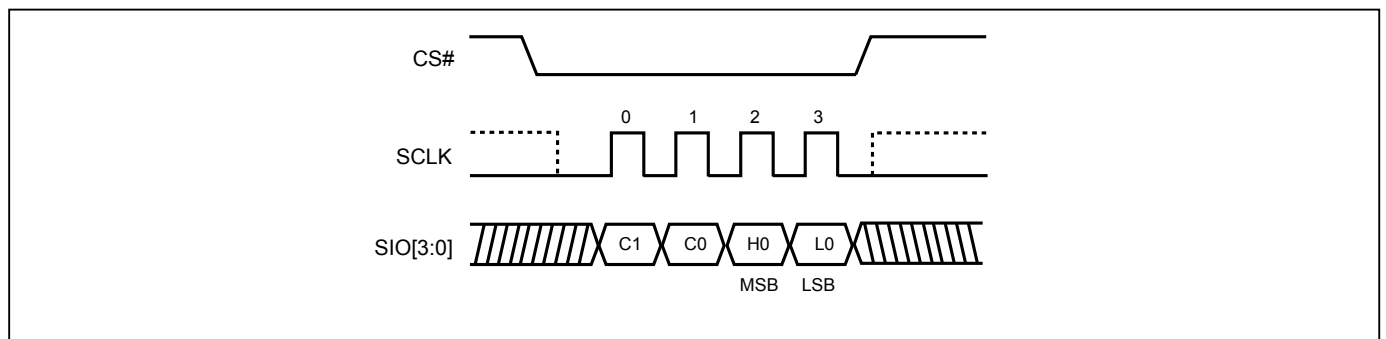


Figure 9. Burst Read (QPI Mode)



Note: MSB=Most Significant Bit
LSB=Least Significant Bit

9-11. Performance Enhance Mode

The device could waive the command cycle bits if the two cycle bits after address cycle toggles. (Please refer to ["Figure 37. 4 x I/O Read enhance performance Mode Sequence \(Command EB\) \(SPI Mode\) \(104MHz\)"](#) and ["Figure 38. 4 x I/O Read Performance Enhance Mode Sequence \(Command EB\) \(QPI Mode\) \(104MHz\)"](#)).

Performance enhance mode is supported in both SPI and QPI mode.

In QPI mode, "EBh" "0Bh" and SPI "EBh" "E7h" commands support enhance mode. The performance enhance mode is not supported in dual I/O mode.

After entering enhance mode, following CS# go high, the device will stay in the read mode and treat CSB go low of the first clock as address instead of command cycle.

To exit enhance mode, a new fast read command whose first two dummy cycles is not toggle then exit. Or issue "FFh" data cycle to exit enhance mode.

If the system controller is being Reset during operation, the flash device will return to the standard SPI operation.

Upon Reset of main chip, SPI instruction would be issued from the system. Instructions like Read ID (9Fh) or Fast Read (0Bh) would be issued.

9-12. 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 be executed to set the Write Enable Latch (WEL) bit before sending the Sector Erase (SE). Any address of the sector (Please refer to ["Table 4. Memory Organization"](#)) is a valid address for Sector Erase (SE) instruction. The CS# must go high exactly at the byte boundary (the least significant bit of the address been latched-in); otherwise, the instruction will be rejected and not executed.

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

The sequence of issuing SE instruction is: CS# goes low→ sending SE instruction code→ 3-byte address on SI→ CS# goes high.

Both SPI (8 clocks) and QPI (2 clocks) command cycle can accept by this instruction. The SIO[3:1] are don't care when during SPI mode. (Please refer to ["Figure 42. Sector Erase \(SE\) Sequence \(Command 20\) \(SPI Mode\)"](#), ["Figure 43. Sector Erase \(SE\) Sequence \(Command 20\) \(QPI Mode\)"](#))

The self-timed Sector Erase Cycle time (tSE) is initiated as soon as Chip Select (CS#) goes high. The Write in Progress (WIP) bit still can be checked while the Sector Erase cycle is in progress. The WIP sets during the tSE timing, and clears when Sector Erase Cycle is completed, and the Write Enable Latch (WEL) bit is cleared. If the sector is protected by BP3, BP2, BP1, BP0 bits, the Sector Erase (SE) instruction will not be executed on the sector.

9-13. Block Erase (BE32K)

The Block Erase (BE32K) 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 be executed to set the Write Enable Latch (WEL) bit before sending the Block Erase (BE32K). Any address of the block (Please refer to ["Table 4. Memory Organization"](#)) is a valid address for Block Erase (BE32K) instruction. The CS# must go high exactly at the byte boundary (the least significant bit of address byte been latched-in); otherwise, the instruction will be rejected and not executed.

The sequence of issuing BE32K instruction is: CS# goes low→ sending BE32K instruction code→ 3-byte address on SI→CS# goes high.

Both SPI (8 clocks) and QPI (2 clocks) command cycle can accept by this instruction. The SIO[3:1] are don't care when during SPI mode. (Please refer to "[Figure 44. Block Erase 32KB \(BE32K\) Sequence \(Command 52\) \(SPI Mode\)](#)" and "[Figure 45. Block Erase 32KB \(BE32K\) Sequence \(Command 52\) \(QPI Mode\)](#)")

The self-timed Block Erase Cycle time (tBE32K) is initiated as soon as Chip Select (CS#) goes high. The Write in Progress (WIP) bit still can be checked while the Block Erase cycle is in progress. The WIP sets during the tBE32K timing, and clears when Block Erase Cycle is completed, and the Write Enable Latch (WEL) bit is cleared. If the block is protected by BP3, BP2, BP1, BP0 bits, the Block Erase (BE32K) instruction will not be executed on the block.

9-14. 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 be executed to set the Write Enable Latch (WEL) bit before sending the Block Erase (BE). Any address of the block (Please refer to "[Table 4. Memory Organization](#)") is a valid address for Block Erase (BE) instruction. The CS# must go high exactly at the byte boundary (the least significant bit of address byte been latched-in); otherwise, the instruction will be rejected and not executed.

The sequence of issuing BE instruction is: CS# goes low→ sending BE instruction code→ 3-byte address on SI→ CS# goes high.

Both SPI (8 clocks) and QPI (2 clocks) command cycle can accept by this instruction. The SIO[3:1] are don't care when during SPI mode. (Please refer to "[Figure 46. Block Erase \(BE\) Sequence \(Command D8\) \(SPI Mode\)](#)" and "[Figure 47. Block Erase \(BE\) Sequence \(Command D8\) \(QPI Mode\)](#)")

The self-timed Block Erase Cycle time (tBE) is initiated as soon as Chip Select (CS#) goes high. The Write in Progress (WIP) bit still can be checked while the Block Erase cycle is in progress. The WIP sets during the tBE timing, and clears when Block Erase Cycle is completed, and the Write Enable Latch (WEL) bit is cleared. If the block is protected by BP3, BP2, BP1, BP0 bits, the Block Erase (BE) instruction will not be executed on the block.

9-15. Chip Erase (CE)

The Chip Erase (CE) instruction is for erasing the data of the whole chip to be "1". A Write Enable (WREN) instruction must be executed to set the Write Enable Latch (WEL) bit before sending the Chip Erase (CE). 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.

Both SPI (8 clocks) and QPI (2 clocks) command cycle can accept by this instruction. The SIO[3:1] are don't care when during SPI mode. (Please refer to "[Figure 48. Chip Erase \(CE\) Sequence \(Command 60 or C7\) \(SPI Mode\)](#)", "[Figure 49. Chip Erase \(CE\) Sequence \(Command 60 or C7\) \(QPI Mode\)](#)")

The self-timed Chip Erase Cycle time (tCE) is initiated as soon as Chip Select (CS#) goes high. The Write in Progress (WIP) bit still can be checked while the Chip Erase cycle is in progress. The WIP sets during the tCE timing, and clears when Chip Erase Cycle is completed, and the Write Enable Latch (WEL) bit is cleared. If the chip is protected by BP3, BP2, BP1, BP0 bits, the Chip Erase (CE) instruction will not be executed. It will be only executed when BP3, BP2, BP1, BP0 all set to "0".

9-16. Page Program (PP)

The Page Program (PP) instruction is for programming memory bits to "0". One to 256 bytes can be sent to the device to be programmed. A Write Enable (WREN) instruction must be executed to set the Write Enable Latch (WEL) bit before sending the Page Program (PP). If more than 256 data bytes are sent to the device, only the last 256 data bytes will be accepted and the previous data bytes will be disregarded. The Page Program instruction requires that all the data bytes fall within the same 256-byte page. The low order address byte A[7:0] specifies the starting address within the selected page. Bytes that will cross a page boundary will wrap to the beginning of the selected page. The device can accept (256 minus A[7:0]) data bytes without wrapping. If 256 data bytes are going to be programmed, A[7:0] should be set to 0.

The sequence of issuing PP instruction is: CS# goes low→ sending PP instruction code→ 3-byte address on SI→ at least 1-byte on data on SI→ CS# goes high. (Please refer to *"Figure 39. Page Program (PP) Sequence (Command 02) (SPI Mode)"* and *"Figure 40. Page Program (PP) Sequence (Command 02) (QPI Mode)"*)

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 checked while the Page Program cycle is in progress. The WIP sets during the tPP timing, and clears when Page Program Cycle is completed, and the Write Enable Latch (WEL) bit is cleared. If the page is protected by BP3, BP2, BP1, BP0 bits, the Page Program (PP) instruction will not be executed.

Both SPI (8 clocks) and QPI (2 clocks) command cycle can accept by this instruction. The SIO[3:1] are don't care when during SPI mode.

9-17. 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 be executed 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 as address and data input, which can improve programmer performance and the effectiveness of application of lower clock less than Max. fRSCLK. For system with faster clock, the Quad page program cannot provide more performance, 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 Max. fRSCLK below. The other function descriptions are as same as standard page program.

The sequence of issuing 4PP instruction is: CS# goes low→ sending 4PP instruction code→ 3-byte address on SIO[3:0]→ at least 1-byte on data on SIO[3:0]→CS# goes high.

9-18. Deep Power-down (DP)

The Deep Power-down (DP) instruction places the device into a minimum power consumption state, Deep Power-down mode, in which the quiescent current is reduced from ISB1 to ISB2.

The sequence of issuing DP instruction: CS# goes low→ send DP instruction code→ CS# goes high. The CS# must go high at the byte boundary (after exactly eighth bits of the instruction code have been latched-in); otherwise the instruction will not be executed. Both SPI (8 clocks) and QPI (2 clocks) command cycle can be accepted by this instruction. SIO[3:1] are "don't care". (Please refer to ["Figure 50. Deep Power-down \(DP\) Sequence \(Command B9\) \(SPI Mode\)"](#) and ["Figure 51. Deep Power-down \(DP\) Sequence \(Command B9\) \(QPI Mode\)"](#))

After CS# goes high there is a delay of tDP before the device transitions from Stand-by mode to Deep Powerdown mode and before the current reduces from ISB1 to ISB2. Once in Deep Power-down mode, all instructions will be ignored except Release from Deep Power-down (RDP).

The device exits Deep Power-down mode and returns to Stand-by mode if it receives a Release from Deep Power-down (RDP) instruction, power-cycle, or reset. Please refer to ["Figure 53. Release from Deep Power-down \(RDP\) Sequence \(Command AB\) \(SPI Mode\)"](#) and ["Figure 54. Release from Deep Power-down \(RDP\) Sequence \(Command AB\) \(QPI Mode\)"](#).

9-19. Release from Deep Power-down (RDP), Read Electronic Signature (RES)

The Release from Deep Power-down (RDP) instruction is completed by driving Chip Select (CS#) High. When Chip Select (CS#) is driven High, the device is put in the Stand-by Power mode. If the device was not previously in the Deep Power-down mode, the transition to the Stand-by Power mode is immediate. If the device was previously in the Deep Power-down mode, though, the transition to the Stand-by Power mode is delayed by tRES2, and Chip Select (CS#) must remain High for at least tRES2(max), as specified in ["Table 15. AC Characteristics"](#). Once in the Stand-by Power mode, the device waits to be selected, so that it can receive, decode and execute instructions. The RDP instruction is only for releasing 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 9. ID Definitions"](#) on next page. This is not the same as RDID instruction. It is not recommended to use for new design. For new design, please use RDID instruction.

The sequence is shown as ["Figure 52. RDP and Read Electronic Signature \(RES\) Sequence \(Command AB\) \(SPI Mode\)"](#), ["Figure 53. Release from Deep Power-down \(RDP\) Sequence \(Command AB\) \(SPI Mode\)"](#) and ["Figure 54. Release from Deep Power-down \(RDP\) Sequence \(Command AB\) \(QPI Mode\)"](#). Even in Deep power-down mode, the RDP and RES are also allowed to be executed, only except the device is in progress of program/erase/write cycle; there's no effect on the current program/erase/write cycle in progress.

SPI (8 clocks) command cycle can accept by this instruction. The SIO[3:1] are don't care when during SPI mode.

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.

9-20. Read Electronic Manufacturer ID & Device ID (REMS)

The REMS instruction returns both the JEDEC assigned manufacturer ID and the device ID. The Device ID values are listed in ["Table 9. ID Definitions"](#).

The REMS instruction is initiated by driving the CS# pin low and sending the instruction code "90h" followed by two dummy bytes and one address byte (A7~A0). After which the manufacturer ID for Macronix (C2h) and the device ID are shifted out on the falling edge of SCLK with the most significant bit (MSB) first as shown in ["Figure 55. Read Electronic Manufacturer & Device ID \(REMS\) Sequence \(Command 90\) \(SPI Mode only\)"](#). If the address byte is 00h, the manufacturer ID will be output first, followed by the device ID. If the address byte is 01h, then the device ID will be output first, followed by the manufacturer ID. While CS# is low, the manufacturer and device IDs can be read continuously, alternating from one to the other. The instruction is completed by driving CS# high.

9-21. QPI ID Read (QPIID)

User can execute this QPIID Read instruction to identify the Device ID and Manufacturer ID. The sequence of issue QPIID instruction is CS# goes low→sending QPI ID instruction→Data out on SO→CS# goes high. Most significant bit (MSB) first.

After the command cycle, the device will immediately output data on the falling edge of SCLK. The manufacturer ID, memory type, and device ID data byte will be output continuously, until the CS# goes high.

Table 9. ID Definitions

| Command Type | MX25U1635E | | |
|-----------------|-----------------|-------------|----------------|
| RDID (JEDEC ID) | Manufacturer ID | Memory Type | Memory Density |
| | C2 | 25 | 35 |
| RES | Electronic ID | | |
| | 35 | | |
| REMS | Manufacturer ID | Device ID | |
| | C2 | 35 | |

9-22. Enter Secured OTP (ENSO)

The ENSO instruction is for entering the additional 4K-bit secured OTP mode. While the device is in 4K-bit secured OTP mode, main array access is not available. The additional 4K-bit secured OTP is independent from main array, and may be used to store unique serial number for system identifier. After entering the Secured OTP mode, 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.

Both SPI (8 clocks) and QPI (2 clocks) command cycle can accept by this instruction. The SIO[3:1] are don't care when during SPI mode.

Please note that WRSR/WRSCUR commands are not acceptable during the access of secure OTP region, once security OTP is lock down, only read related commands are valid.

9-23. 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.

Both SPI (8 clocks) and QPI (2 clocks) command cycle can accept by this instruction. The SIO[3:1] are don't care when during SPI mode.

9-24. Read Security Register (RDSCUR)

The RDSCUR instruction is for reading the value of Security Register bits. 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.

Both SPI (8 clocks) and QPI (2 clocks) command cycle can accept by this instruction. The SIO[3:1] are don't care when during SPI mode. Please see "[Figure 56. Read Security Register \(RDSCUR\) Sequence \(Command 2B\) \(SPI Mode\)](#)" & "[Figure 57. Read Security Register \(RDSCUR\) Sequence \(Command 2B\) \(QPI Mode\)](#)".

The definition of the Security Register bits is as below:

Secured OTP Indicator bit. The Secured OTP indicator bit shows the chip is locked by 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 updated any more.

Table 10. Security Register Definition

| bit7 | bit6 | bit5 | bit4 | bit3 | bit2 | bit1 | bit0 |
|--|--|--|--------------|---|---|--|--|
| WPSEL | E_FAIL | P_FAIL | Reserved | ESB (Erase Suspend bit) | PSB (Program Suspend bit) | LDSO (indicate if lock-down) | Secured OTP indicator bit |
| 0=normal WP mode 1=individual mode (default=0) | 0=normal Erase succeed 1=indicate Erase failed (default=0) | 0=normal Program succeed 1=indicate Program failed (default=0) | - | 0=Erase is not suspended 1= Erase suspended (default=0) | 0=Program is not suspended 1= Program suspended (default=0) | 0 = not lock-down 1 = lock-down (cannot program/erase OTP) | 0 = non-factory lock 1 = factory lock |
| Non-volatile bit (OTP) | Volatile bit | Volatile bit | Volatile bit | Volatile bit | Volatile bit | Non-volatile bit (OTP) | Non-volatile bit (OTP) |

9-25. Write Security Register (WRSCUR)

The WRSCUR instruction is for setting the values of Security Register Bits. The WREN (Write Enable) instruction is required before issuing WRSCUR instruction. 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 LDSO bit is an OTP bit. Once the LDSO bit is set, the value of LDSO bit can not be altered any more.

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

Both SPI (8 clocks) and QPI (2 clocks) command cycle can accept by this instruction. The SIO[3:1] are don't care when during SPI mode. Please see "[Figure 58. Write Security Register \(WRSCUR\) Sequence \(Command 2F\) \(SPI Mode\)](#)" & "[Figure 59. Write Security Register \(WRSCUR\) Sequence \(Command 2F\) \(QPI Mode\)](#)".

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

9-26. 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, the Security Register bit 7 is checked. If WPSEL=1, all the blocks and sectors will be write protected by default. User may only unlock the blocks or sectors via SBULK and GBULK instructions. Program or erase functions can only be operated after the Unlock instruction is executed.

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, bit 7 in the 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:

Figure 10. BP and SRWD if WPSEL=0

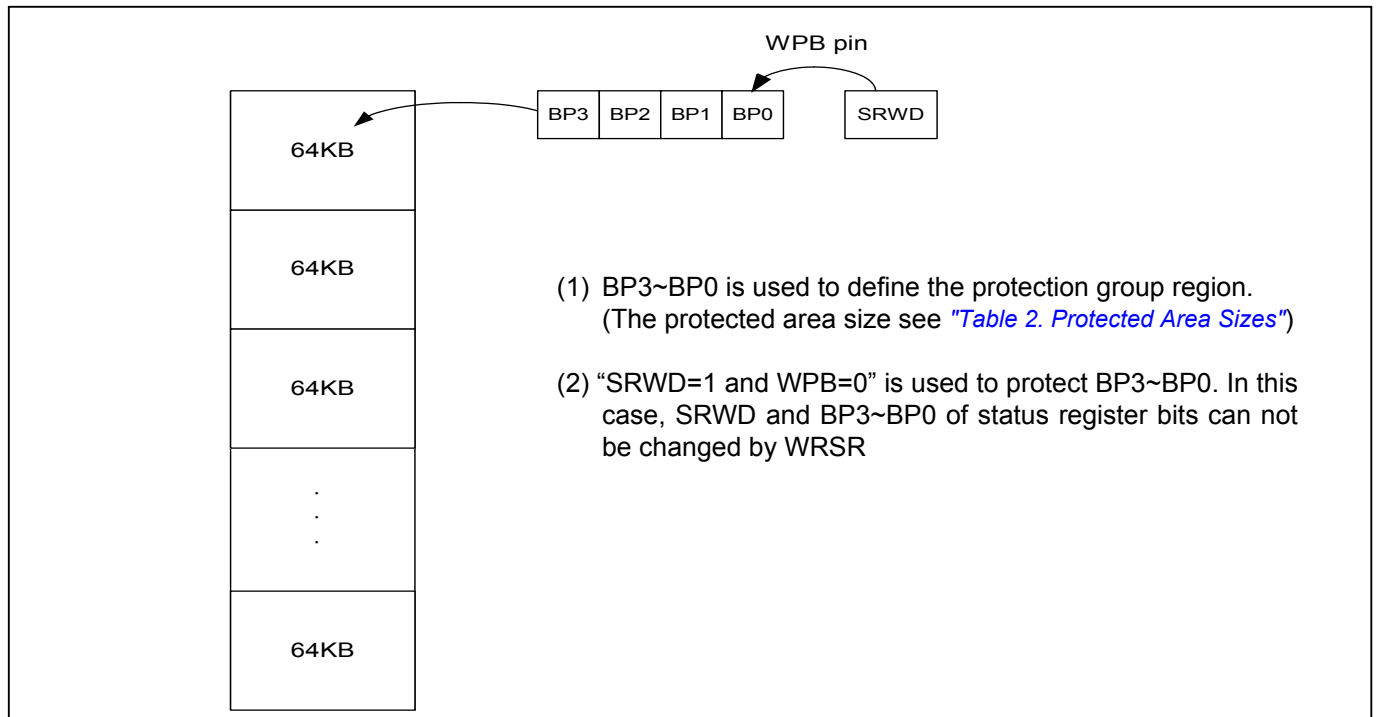


Figure 11. The individual block lock mode is effective after setting WPSEL=1

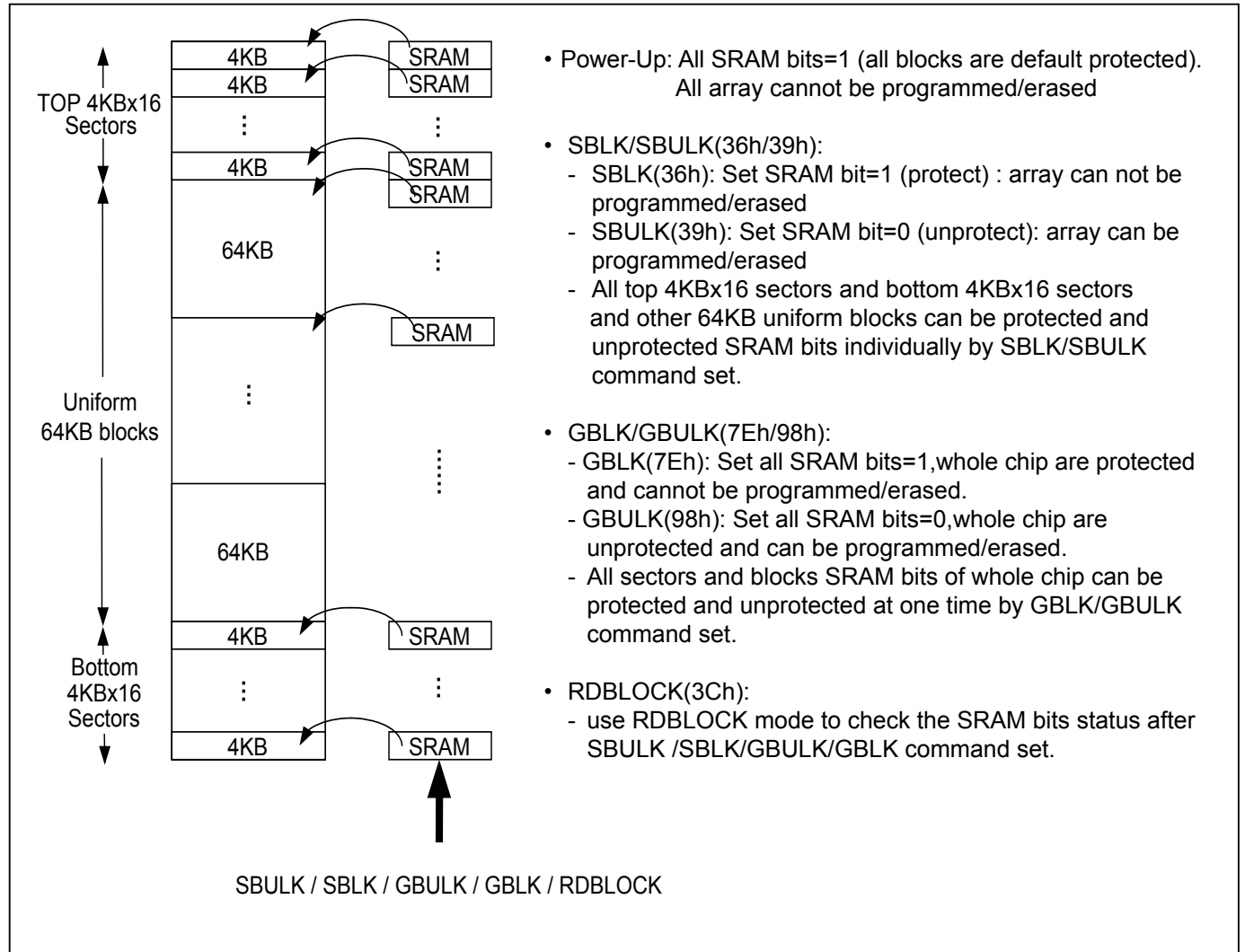
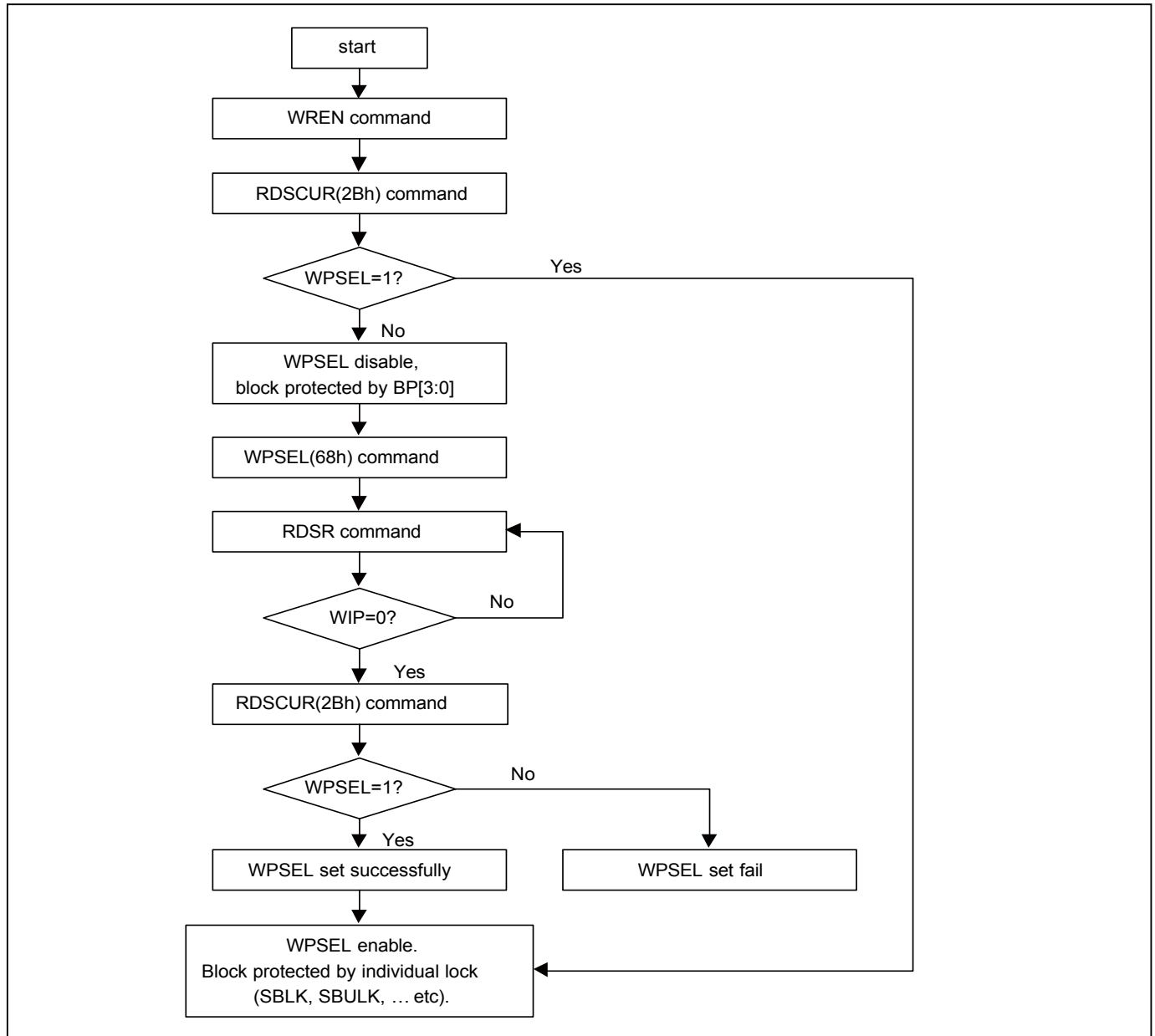


Figure 12. WPSEL Flow

9-27. 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 $A_{MAX}-A16$ or ($A_{MAX}-A12$) 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 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 address bytes assign one block (or sector) to be protected on SI pin → CS# goes high. The CS# must go high exactly at the byte boundary, otherwise the instruction will be rejected and not be executed.

Both SPI (8 clocks) and QPI (2 clocks) command cycle can accept by this instruction. The SIO[3:1] are don't care when during SPI mode.

SBLK/SBULK instruction function flow is as follows:

Figure 13. Block Lock Flow

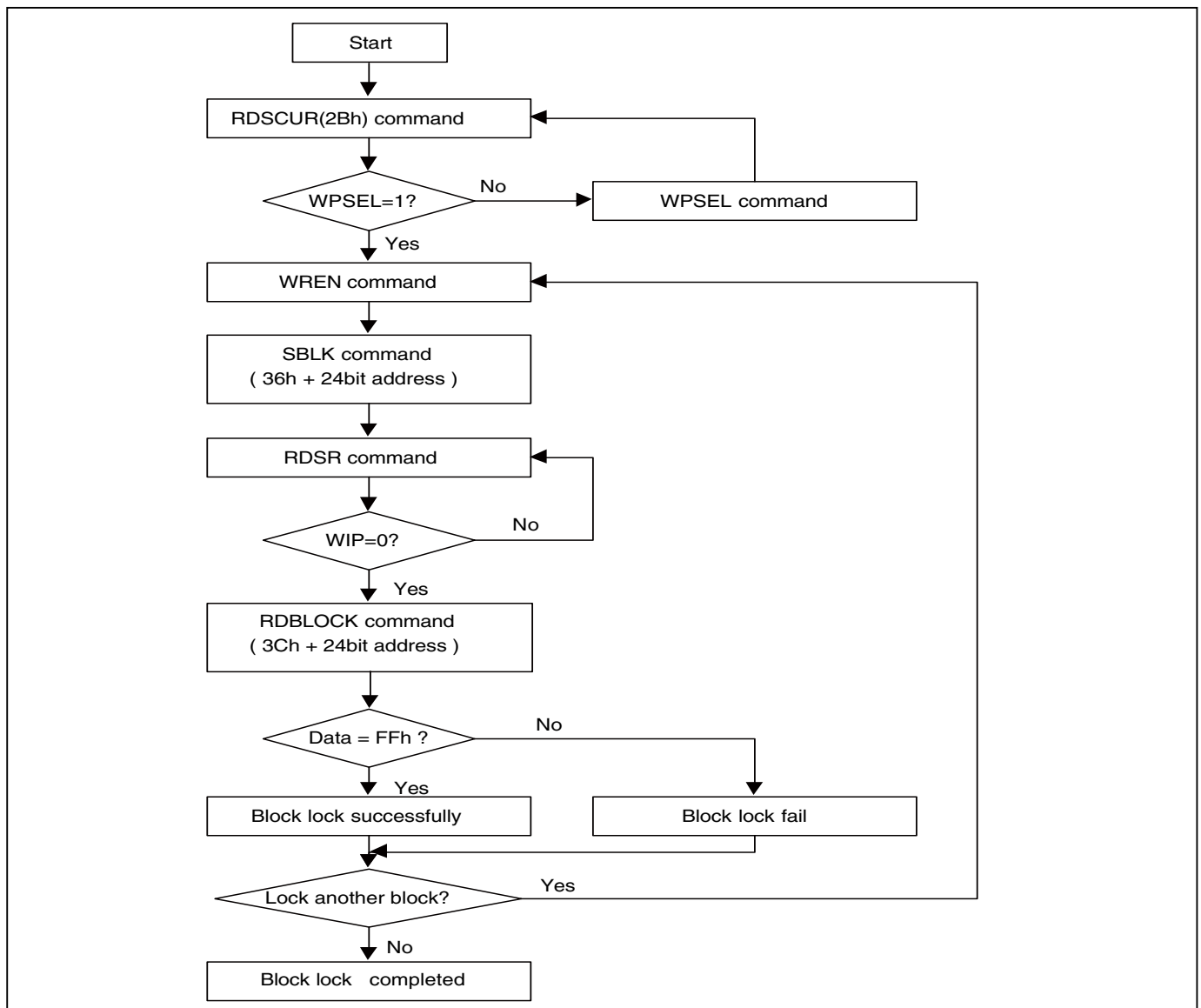
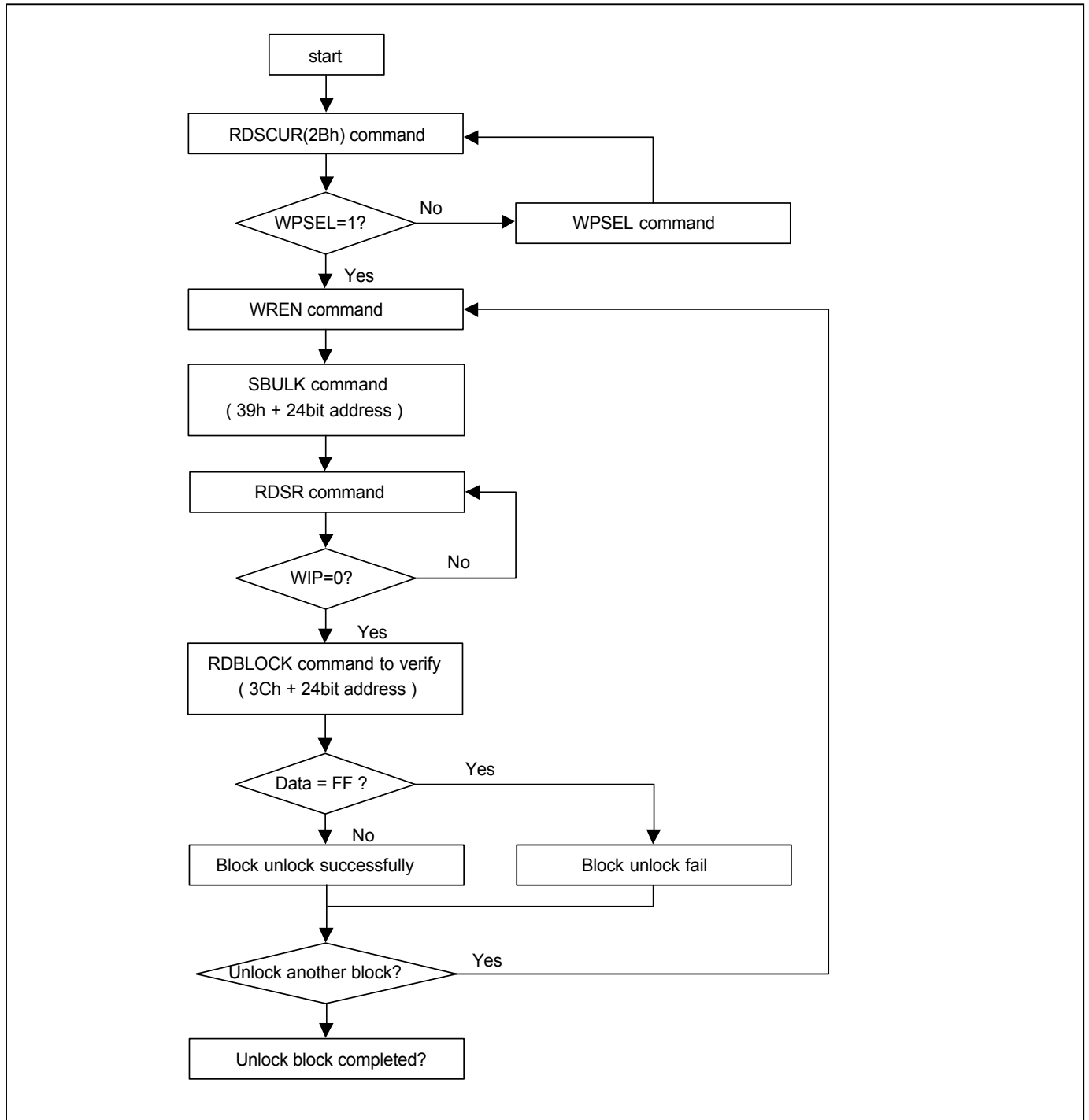


Figure 14. Block Unlock Flow



9-28. 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 A_{MAX} -A16 (or A_{MAX} -A12) 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 been 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 been protected, and user can read and write this block.

The sequence of issuing RDBLOCK instruction is: CS# goes low → send RDBLOCK (3Ch) instruction → send 3 address bytes to assign one block on SI pin → read block's protection lock status bit on SO pin → CS# goes high.

Both SPI (8 clocks) and QPI (2 clocks) command cycle can accept by this instruction. The SIO[3:1] are don't care when during SPI mode.

9-29. 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.

Both SPI (8 clocks) and QPI (2 clocks) command cycle can accept by this instruction. The SIO[3:1] are don't care when during SPI mode.

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

9-30. Program/Erase Suspend/Resume

The device allow the interruption of Sector-Erase, Block-Erase or Page-Program operations and conduct other operations. Details as follows.

To enter the suspend/resume mode: issuing B0h for suspend; 30h for resume (SPI/QPI all acceptable)

Read security register bit2 (PSB) and bit3 (ESB) (please refer to ["Table 10. Security Register Definition"](#)) to check suspend ready information.

For "Suspend to Read", "Resume to Read", "Resume to Suspend" timing specification please note ["Figure 64. Suspend to Read Latency"](#), ["Figure 65. Resume to Read Latency"](#) and ["Figure 66. Resume to Suspend Latency"](#).

Both SPI (8 clocks) and QPI (2 clocks) command cycle can accept by this instruction. The SIO[3:1] are don't care when during SPI mode.

9-31. Erase Suspend

Erase suspend allow the interruption of all erase operations.

After erase suspend, WEL bit will be clear, only read related, resume and reset command can be accepted unconditionally. (including: 03h, 0Bh, BBh, EBh, E7h, 9Fh, AFh, 90h, 05h, 2Bh, B1h, C1h, 5Ah, 3Ch, 30h, 66h, 99h, C0h, 35h, F5h, 00h, ABh)

For erase suspend to program operation, the programming command (38, 02) can be accepted under conditions as follows:

The device is divided into 4 banks, each bank's density is 4Mb. While conducting erase suspend in one bank, the programming operation that follows can only be conducted in one of the other banks and cannot be conducted in the bank executing the suspend operation. The boundaries of the banks are illustrated as below table.

| MX25U1635E | |
|---------------|-------------------|
| BANK (4M bit) | Address Range |
| 3 | 180000h-1FFFFFFh |
| 2 | 100000h-17FFFFFFh |
| 1 | 080000h-0FFFFFFh |
| 0 | 000000h-07FFFFFFh |

After erase suspend command has been issued, latency time 18us is needed before issue another command. For "Suspend to Read", "Resume to Read", "Resume to Suspend" timing specification please note ["Figure 64. Suspend to Read Latency"](#), ["Figure 65. Resume to Read Latency"](#) and ["Figure 66. Resume to Suspend Latency"](#).

Erase Suspend Bit (ESB) indicates the status of Erase Suspend operation. Users may use ESB to identify the state of flash memory. After the flash memory is suspended by Erase Suspend command, ESB is set to "1". ESB is cleared to "0" after erase operation resumes.

Both SPI (8 clocks) and QPI (2 clocks) command cycle can accept by this instruction. The SIO[3:1] are don't care when during SPI mode.

When ESB bit is issued, the Write Enable Latch (WEL) bit will be reset. See ["Figure 64. Suspend to Read Latency"](#) for Suspend to Read latency.

9-32. Program Suspend

Program suspend allows the interruption of all program operations.

After program suspend, WEL bit will be cleared, only read related, resume and reset command can be accepted. (including: 03h, 0Bh, BBh, EBh, E7h, 9Fh, AFh, 90h, 05h, 2Bh, B1h, C1h, 5Ah, 3Ch, 30h, 66h, 99h, C0h, 35h, F5h, 00h, ABh)

After program suspend command has been issued, latency time 18us is needed before issue another command. For "Suspend to Read", "Resume to Read", "Resume to Suspend" timing specification please note ["Figure 64. Suspend to Read Latency"](#), ["Figure 65. Resume to Read Latency"](#) and ["Figure 66. Resume to Suspend Latency"](#).

Program Suspend Bit (PSB) indicates the status of Program Suspend operation. Users may use PSB to identify the state of flash memory. After the flash memory is suspended by Program Suspend command, PSB is set to "1". PSB is cleared to "0" after program operation resumes.

Both SPI (8 clocks) and QPI (2 clocks) command cycle can accept by this instruction. The SIO[3:1] are don't care when during SPI mode.

9-33. Write-Resume

The Write operation is being resumed when Write-Resume instruction issued. ESB or PSB (suspend status bit) in Status register will be changed back to "0"

The operation of Write-Resume is as follows: CS# drives low → send write resume command cycle (30H) → drive CS# high. By polling Busy Bit in status register, the internal write operation status could be checked to be completed or not. The user may also wait the time lag of TSE, TBE, TPP for Sector-erase, Block-erase or Page-programming. WREN (command "06" is not required to issue before resume. Resume to another suspend operation requires latency time. Please refer to ["Figure 66. Resume to Suspend Latency"](#).

Please note that, if "performance enhance mode" is executed during suspend operation, the device can not be resume. To restart the write command, disable the "performance enhance mode" is required. After the "performance enhance mode" is disable, the write-resume command is effective.

9-34. No Operation (NOP)

The "No Operation" command is only able to terminate the Reset Enable (RSTEN) command and will not affect any other command.

Both SPI (8 clocks) and QPI (2 clocks) command cycle can accept by this instruction. The SIO[3:1] are don't care when during SPI mode.

9-35. Software Reset (Reset-Enable (RSTEN) and Reset (RST))

The Software Reset operation combines two instructions: Reset-Enable (RSTEN) command and Reset (RST) command. It returns the device to a standby mode. All the volatile bits and settings will be cleared then, which makes the device return to the default status as power on.

To execute Reset command (RST), the Reset-Enable (RSTEN) command must be executed first to perform the Reset operation. If there is any other command to interrupt after the Reset-Enable command, the Reset-Enable will be invalid.

Both SPI (8 clocks) and QPI (2 clocks) command cycle can accept by this instruction. The SIO[3:1] are don't care when during SPI mode. Please refer to ["Figure 61. Reset Sequence \(SPI mode\)"](#) and ["Figure 62. Reset Sequence \(QPI mode\)"](#).

If the Reset command is executed during program or erase operation, the operation will be disabled, the data under processing could be damaged or lost.

The reset time is different depending on the last operation. Longer latency time is required to recover from a program operation than from other operations.

9-36. Reset Quad I/O (RSTQIO)

To reset the QPI mode, the RSTQIO (F5H) command is required. After the RSTQIO command is issued, the device returns from QPI mode (4 I/O interface in command cycles) to SPI mode (1 I/O interface in command cycles).

Note:

For EQIO and RSTQIO commands, CS# high width has to follow "write spec" tSHSL for next instruction.

9-37. 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 JEDEC Standard, JESD216.

Figure 15. Read Serial Flash Discoverable Parameter (RDSFDP) Sequence

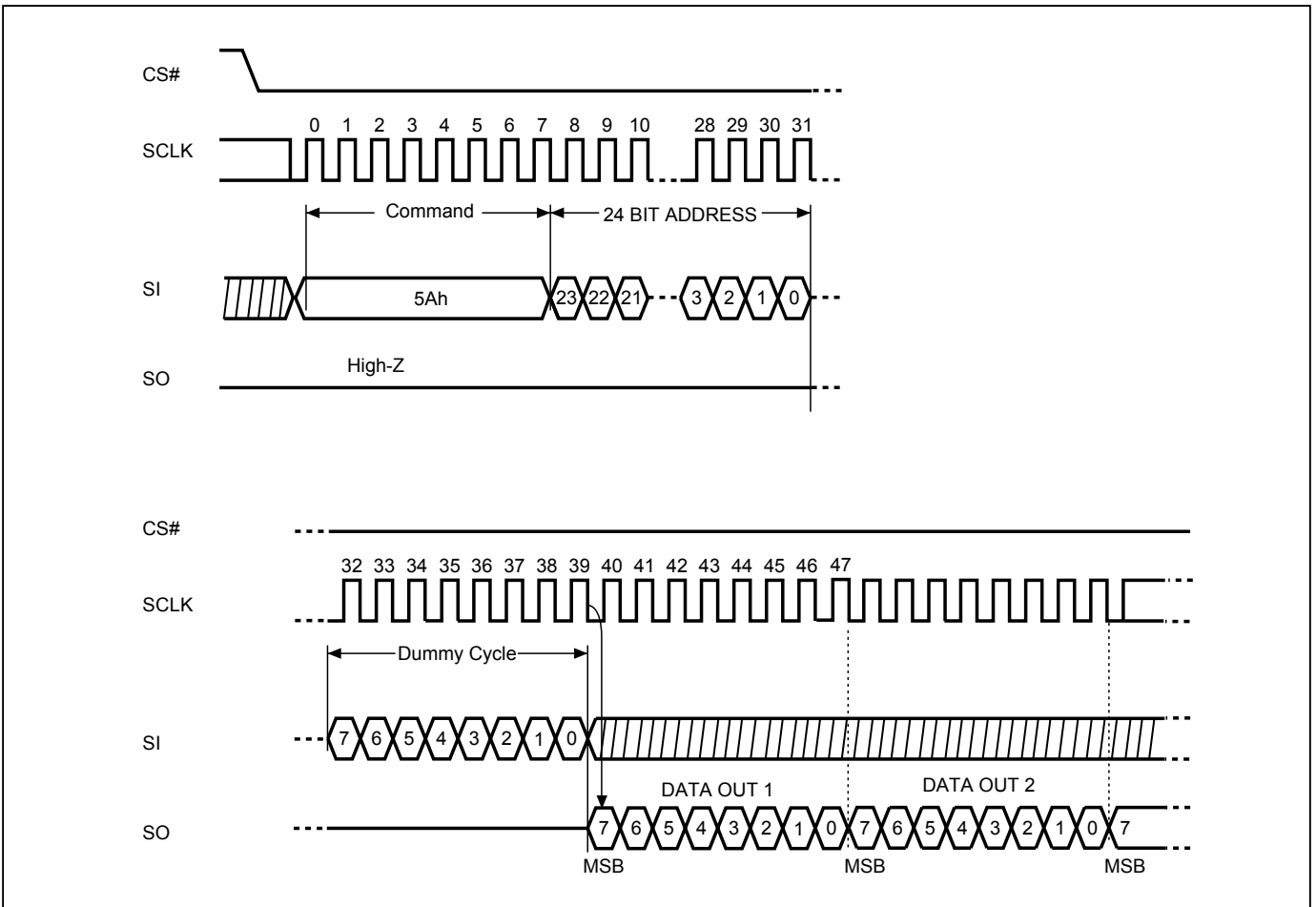


Table 11. Signature and Parameter Identification Data Values

SFDP Table below is for MX25U1635EM1I-10G, MX25U1635EM2I-10G, MX25U1635EZNI-10G and MX25U1635EZUI-10G

| 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 | This number is 0-based. Therefore, 0 indicates 1 parameter header. | 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 12. Parameter Table (0): JEDEC Flash Parameter Tables

SFDP Table below is for MX25U1635EM1I-10G, MX25U1635EM2I-10G, MX25U1635EZNI-10G and MX25U1635EZUI-10G

| 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 support 4KB erase | 30h | 01:00 | 01b | E5h |
| Write Granularity | 0: 1Byte, 1: 64Byte or larger | | 02 | 1b | |
| Write Enable Instruction Required for Writing to Volatile Status Registers | 0: not required 1: required 00h to be written to the status register | | 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 | 0b | B0h |
| Address Bytes Number used in addressing flash array | 00: 3Byte only, 01: 3 or 4Byte, 10: 4Byte only, 11: Reserved | | 18:17 | 00b | |
| Double Transfer Rate (DTR) Clocking | 0=not support 1=support | | 19 | 0b | |
| (1-2-2) Fast Read | 0=not support 1=support | | 20 | 1b | |
| (1-4-4) Fast Read | 0=not support 1=support | | 21 | 1b | |
| (1-1-4) Fast Read | 0=not support 1=support | | 22 | 0b | |
| Unused | | | 23 | 1b | |
| Unused | | 33h | 31:24 | FFh | FFh |
| Flash Memory Density | | 37h:34h | 31:00 | 00FF FFFFh | |
| (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 0000b | 00h |
| (1-1-4) Fast Read Number of Mode Bits | 000b: Mode Bits not support | | 23:21 | 000b | |
| (1-1-4) Fast Read Opcode | | 3Bh | 31:24 | FFh | FFh |

SFDP Table below is for MX25U1635EM1I-10G, MX25U1635EM2I-10G, MX25U1635EZNI-10G and MX25U1635EZUI-10G

| 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 0000b | 00h |
| (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 | FFh | FFh |
| (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 | FEh |
| Unused | | | 03:01 | 111b | |
| (4-4-4) Fast Read | 0=not support 1=support | | 04 | 1b | |
| Unused | | | 07:05 | 111b | |
| Unused | | 43h:41h | 31:08 | FFh | FFh |
| Unused | | 45h:44h | 15:00 | FFh | FFh |
| (2-2-2) Fast Read Number of Wait states | 0 0000b: Wait states (Dummy Clocks) not support | 46h | 20:16 | 0 0000b | 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 | FFh | FFh |
| (4-4-4) Fast Read Number of Wait states | 0 0000b: Wait states (Dummy Clocks) not support | 4Ah | 20:16 | 0 0100b | 44h |
| (4-4-4) Fast Read Number of Mode Bits | 000b: Mode Bits not support | | 23:21 | 010b | |
| (4-4-4) Fast Read Opcode | | 4Bh | 31:24 | EBh | EBh |
| 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 |

Table 13. Parameter Table (1): Macronix Flash Parameter Tables

SFDP Table below is for MX25U1635EM1I-10G, MX25U1635EM2I-10G, MX25U1635EZNI-10G and MX25U1635EZUI-10G

| 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 20h | 00h 20h | |
| Vcc Supply Minimum Voltage | 1650h=1.650V 2250h=2.250V 2350h=2.350V 2700h=2.700V | 63h:62h | 23:16 31:24 | 50h 16h | 50h 16h | |
| H/W Reset# pin | 0=not support 1=support | 65h:64h | 00 | 0b | F99Ch | |
| H/W Hold# pin | 0=not support 1=support | | 01 | 0b | | |
| Deep Power Down Mode | 0=not support 1=support | | 02 | 1b | | |
| S/W Reset | 0=not support 1=support | | 03 | 1b | | |
| S/W Reset Opcode | Reset Enable (66h) should be issued before Reset Opcode | | 11:04 | 1001 1001b (99h) | | |
| Program Suspend/Resume | 0=not support 1=support | | 12 | 1b | | |
| Erase Suspend/Resume | 0=not support 1=support | | 13 | 1b | | |
| Unused | | | 14 | 1b | | |
| Wrap-Around Read mode | 0=not support 1=support | | 15 | 1b | | |
| Wrap-Around Read mode Opcode | | | 66h | 23:16 | | C0h |
| 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 | 64h | 64h | |
| Individual block lock | 0=not support 1=support | 6Bh:68h | 00 | 1b | C8D9h | |
| 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 | FFh | | FFh |
| Unused | | | 6Fh:6Ch | 31:00 | | FFh |

Note 1: h/b is hexadecimal or binary.

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

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

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

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

Note 6: All unused and undefined area data is blank FFh for SFDP Tables that are defined in Parameter Identification Header. All other areas beyond defined SFDP Table are reserved by Macronix.

10. POWER-ON STATE

The device is at the following states when power-up:

- Standby mode (please note it is not deep power-down mode)
- Write Enable Latch (WEL) bit is reset

The device must not be selected during power-up and power-down stage until the VCC reaches the following levels:

- 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. When VCC is lower than VWI (POR threshold voltage value), the internal logic is reset and the flash device has no response to any command.

For further protection on the device, after VCC reaching the VWI level, a tPUW time delay is required before the device is fully accessible for commands like write enable (WREN), page program (PP), quad page program (4PP), sector erase (SE), block erase 32KB (BE32K), block erase (BE), chip erase (CE), WRSCUR and write status register (WRSR). If the VCC does not reach the VCC minimum level, the correct operation is not guaranteed. The write, erase, and program command should be sent after the below time delay:

- tPUW after VCC reached VWI level
- tVSL after VCC reached VCC minimum level

The device can accept read command after VCC reached VCC minimum and a time delay of tVSL, even time of tPUW has not passed.

Please refer to the figure of ["Figure 68. 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)
- At power-down stage, the VCC drops below VWI level, all operations are disable and device has no response to any command. The data corruption might occur during this stage if a write, program, erase cycle is in progress.

11. ELECTRICAL SPECIFICATIONS

11-1. Absolute Maximum Ratings

| Rating | | Value |
|-------------------------------|------------------|-------------------|
| Ambient Operating Temperature | Industrial grade | -40°C to 85°C |
| Storage Temperature | | -65°C to 150°C |
| Applied Input Voltage | | -0.5V to VCC+0.5V |
| Applied Output Voltage | | -0.5V to VCC+0.5V |
| VCC to Ground Potential | | -0.5V to +2.5V |

NOTICE:

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

Figure 16. Maximum Negative Overshoot Waveform

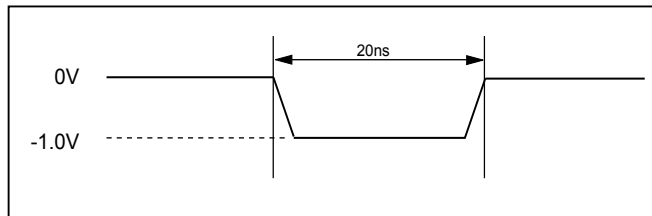
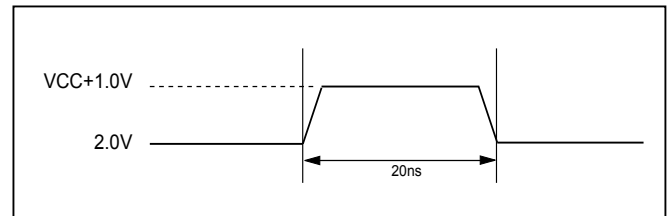


Figure 17. Maximum Positive Overshoot Waveform



11-2. Capacitance

TA = 25°C, f = 1.0 MHz

| Symbol | Parameter | Min. | Typ. | Max. | Unit | Conditions |
|--------|--------------------|------|------|------|------|------------|
| CIN | Input Capacitance | | | 10 | pF | VIN = 0V |
| COUT | Output Capacitance | | | 25 | pF | VOOUT = 0V |

Figure 18. Input Test Waveforms and Measurement Level

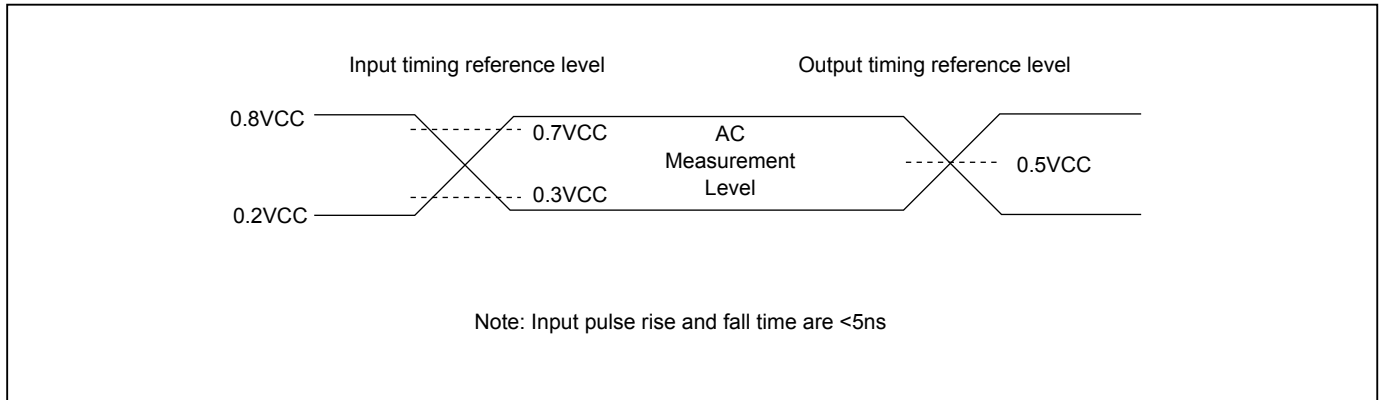


Figure 19. Output Loading

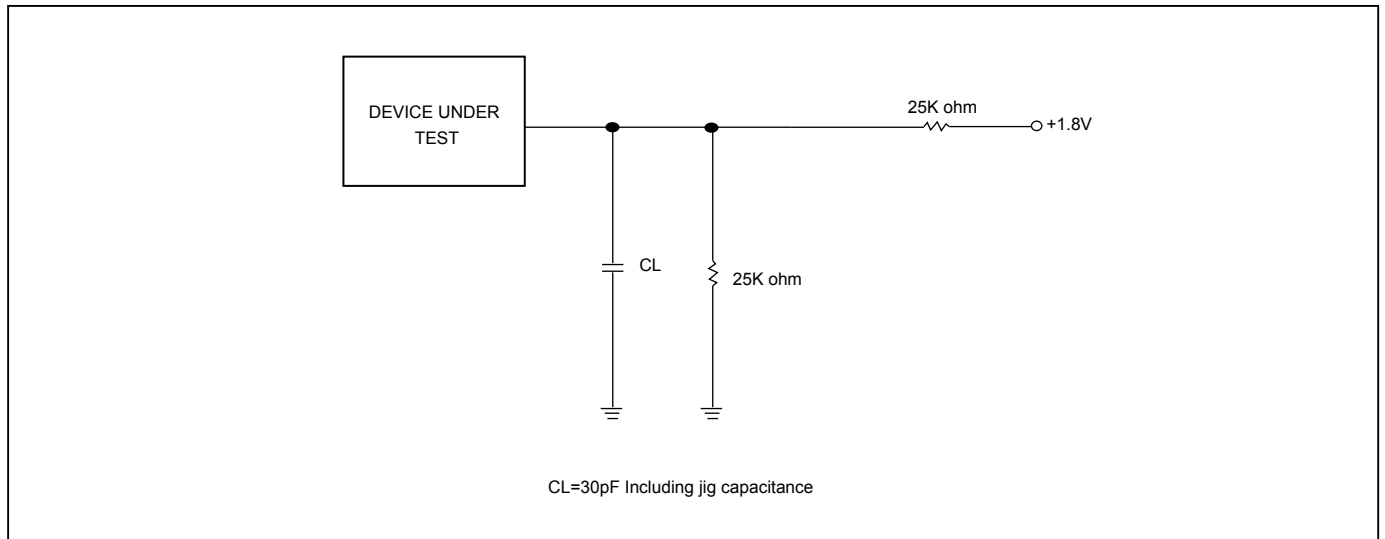


Table 14. DC Characteristics

Temperature = -40°C to 85°C, VCC = 1.65V ~ 2.0V

| Symbol | Parameter | Notes | Min. | Typ. | Max. | Units | Test Conditions |
|--------|---|-------|---------|------|---------|-------|--|
| ILI | Input Load Current | 1 | | | ±2 | uA | VCC = VCC Max, VIN = VCC or GND |
| ILO | Output Leakage Current | 1 | | | ±2 | uA | VCC = VCC Max, VOUT = VCC or GND |
| ISB1 | VCC Standby Current | 1 | | 25 | 80 | uA | VIN = VCC or GND, CS# = VCC |
| ISB2 | Deep Power-down Current | | | 2 | 15 | uA | VIN = VCC or GND, CS# = VCC |
| ICC1 | VCC Read | 1 | | | 20 | mA | f=104MHz, (4 x I/O read) SCLK=0.1VCC/0.9VCC, SO=Open |
| | | | | | 15 | mA | f=84MHz, SCLK=0.1VCC/0.9VCC, SO=Open |
| | | | | | 7 | mA | f=33MHz, SCLK=0.1VCC/0.9VCC, SO=Open |
| ICC2 | VCC Program Current (PP) | 1 | | 20 | 25 | mA | Program in Progress, CS# = VCC |
| ICC3 | VCC Write Status Register (WRSR) Current | | | 10 | 15 | mA | Program status register in progress, CS#=VCC |
| ICC4 | VCC Sector/Block (32K, 64K) Erase Current (SE/BE/BE32K) | 1 | | 20 | 25 | mA | Erase in Progress, CS#=VCC |
| ICC5 | VCC Chip Erase Current (CE) | 1 | | 20 | 25 | mA | Erase in Progress, CS#=VCC |
| VIL | Input Low Voltage | | -0.5 | | 0.2VCC | V | |
| VIH | Input High Voltage | | 0.8VCC | | VCC+0.4 | V | |
| VOL | Output Low Voltage | | | | 0.2 | V | IOL = 100uA |
| VOH | Output High Voltage | | VCC-0.2 | | | V | IOH = -100uA |

Notes :

1. Typical values at VCC = 1.8V, T = 25°C. These currents are valid for all product versions (package and speeds).
2. Typical value is calculated by simulation.

Table 15. AC Characteristics

Temperature = -40°C to 85°C, VCC = 1.65V - 2.0V

| Symbol | Alt. | Parameter | Min. | Typ. | Max. | Unit |
|-----------------------|------|--|---|------|--------|------|
| fSCLK | fC | Clock Frequency for the following instructions: FAST_READ, RDSFDP, PP, 4PP, SE, BE, CE, DP, RES, RDP, WREN, WRDI, RDID, RDSR, WRSR | D.C. | | 104 | MHz |
| fRSCLK | fR | Clock Frequency for READ instructions | | | 33 | MHz |
| fTCLK | fT | Clock Frequency for 2READ instructions | | | 84 | MHz |
| | fQ | Clock Frequency for 4READ instructions ⁽⁵⁾ | | | 84/104 | MHz |
| tCH ⁽¹⁾⁽²⁾ | tCLH | Clock High Time | Others (fSCLK) | 4.5 | | ns |
| | | | Normal Read (fRSCLK) | 13 | | ns |
| tCL ⁽¹⁾⁽²⁾ | tCLL | Clock Low Time | Others (fSCLK) | 4.5 | | ns |
| | | | Normal Read (fRSCLK) | 13 | | 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 ⁽²⁾ | tCSS | CS# Active Setup Time (relative to SCLK) | 4 | | | ns |
| tCHSL ⁽²⁾ | | CS# Not Active Hold Time (relative to SCLK) | 4 | | | ns |
| tDVCH | tDSU | Data In Setup Time | 2 | | | ns |
| tCHDX ⁽²⁾ | tDH | Data In Hold Time | 3 | | | ns |
| tCHSH | | CS# Active Hold Time (relative to SCLK) | 5 | | | ns |
| tSHCH | | CS# Not Active Setup Time (relative to SCLK) | 7 | | | ns |
| tSHSL | tCSH | CS# Deselect Time | From Read to next Read | 12 | | ns |
| | | | From Write/Erase/Program to Read Status Register | 30 | | ns |
| tSHQZ ⁽²⁾ | tDIS | Output Disable Time | | | 8 | ns |
| tCLQV | tV | Clock Low to Output Valid Loading: 30pF/15pF | Loading: 30pF | | 8 | ns |
| | | | Loading: 15pF | | 6 | ns |
| tCLQX | tHO | Output Hold Time | 1 | | | ns |
| tWHSL ⁽³⁾ | | Write Protect Setup Time | 20 | | | ns |
| tSHWL ⁽³⁾ | | Write Protect Hold Time | 100 | | | ns |
| tDP ⁽²⁾ | | CS# High to Deep Power-down Mode | | | 10 | us |
| tRES1 ⁽²⁾ | | CS# High to Standby Mode without Electronic Signature Read | | | 10 | us |
| tRES2 ⁽²⁾ | | CS# High to Standby Mode with Electronic Signature Read | | | 10 | us |
| tRCR | | Recovery Time from Read | | | 20 | us |
| tRCP | | Recovery Time from Program | | | 20 | us |
| tRCE | | Recovery Time from Erase | | | 12 | ms |
| tW | | Write Status Register Cycle Time | | | 40 | ms |
| tBP | | Byte-Program | | 10 | 30 | us |
| tPP | | Page Program Cycle Time | | 1.2 | 3 | ms |
| tSE | | Sector Erase Cycle Time | | 45 | 200 | ms |
| tBE32 | | Block Erase (32KB) Cycle Time | | 250 | 1000 | ms |
| tBE | | Block Erase (64KB) Cycle Time | | 500 | 2000 | ms |
| tCE | | Chip Erase Cycle Time | | 9 | 20 | s |

Notes:

1. tCH + tCL must be greater than or equal to 1/ Frequency.
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.
4. Test condition is shown as "Figure 18. Input Test Waveforms and Measurement Level" and "Figure 19. Output Loading"
5. When dummy cycle=4 (In both QPI & SPI mode), clock rate=84MHz; when dummy cycle=6 (In both QPI & SPI mode), clock rate=104MHz.

12. Timing Analysis

Figure 20. Serial Input Timing

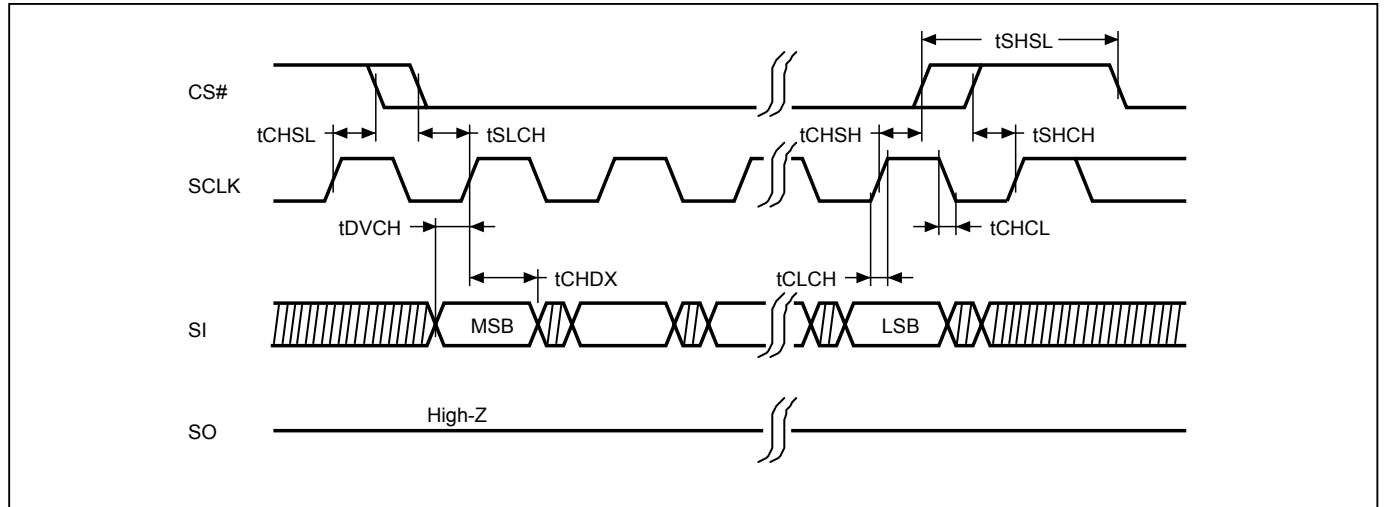


Figure 21. Output Timing

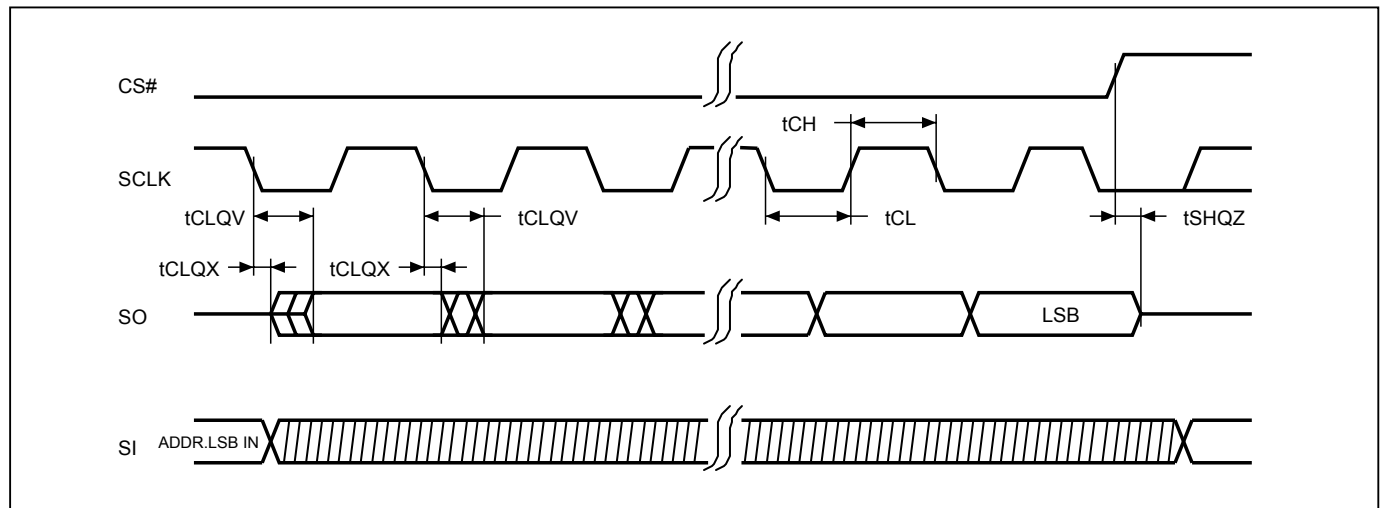


Figure 22. WP# Setup Timing and Hold Timing during WRSR when SRWD=1

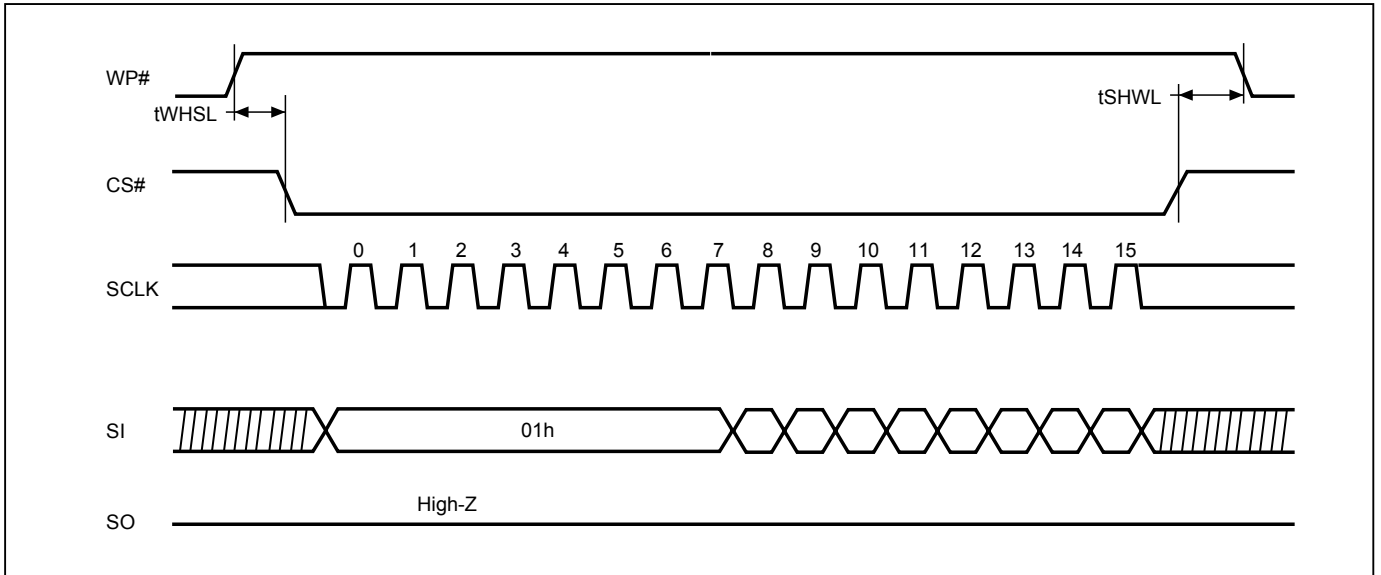


Figure 23. Write Enable (WREN) Sequence (Command 06) (SPI Mode)

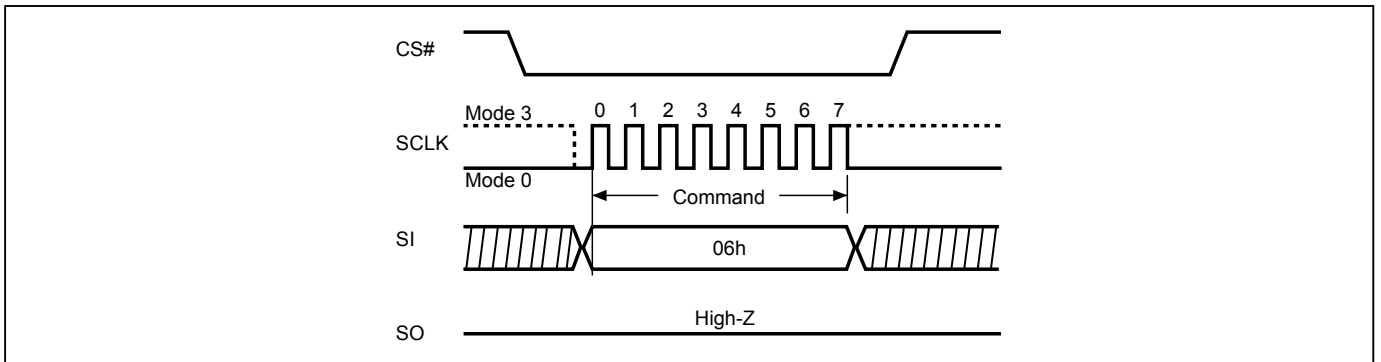


Figure 24. Write Enable (WREN) Sequence (Command 06) (QPI Mode)

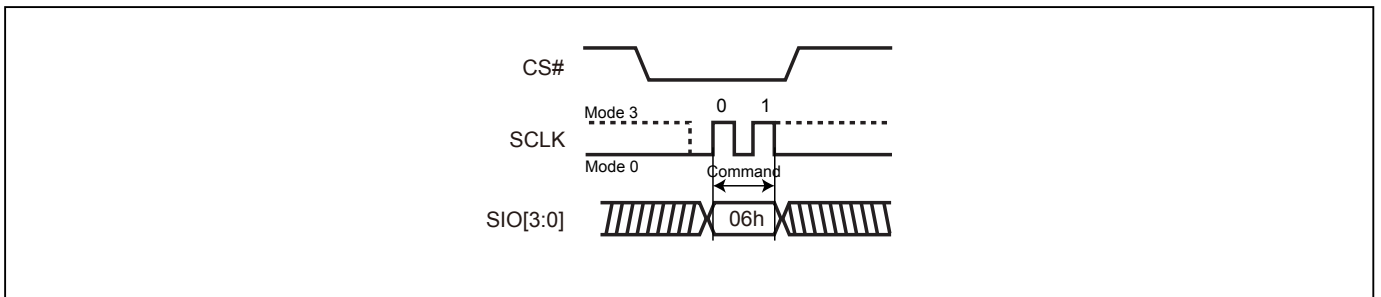


Figure 25. Write Disable (WRDI) Sequence (Command 04) (SPI Mode)

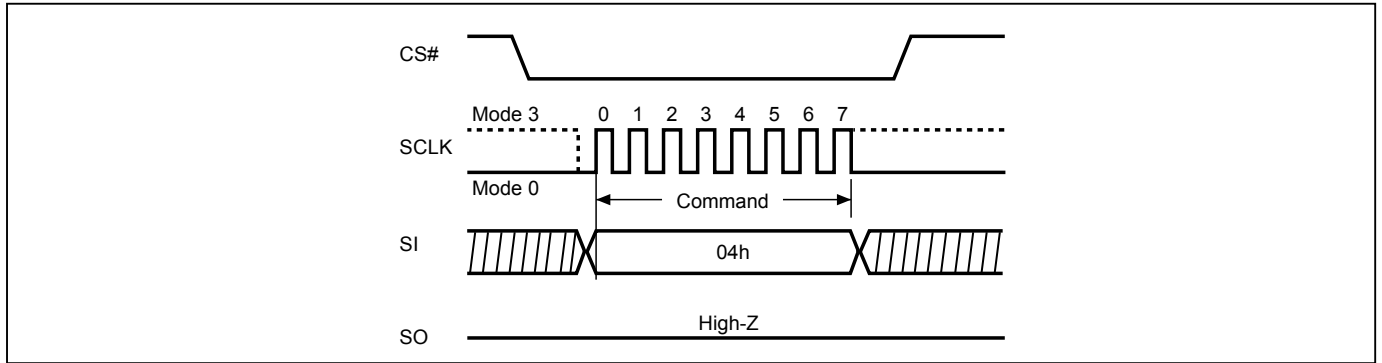


Figure 26. Write Disable (WRDI) Sequence (Command 04) (QPI Mode)

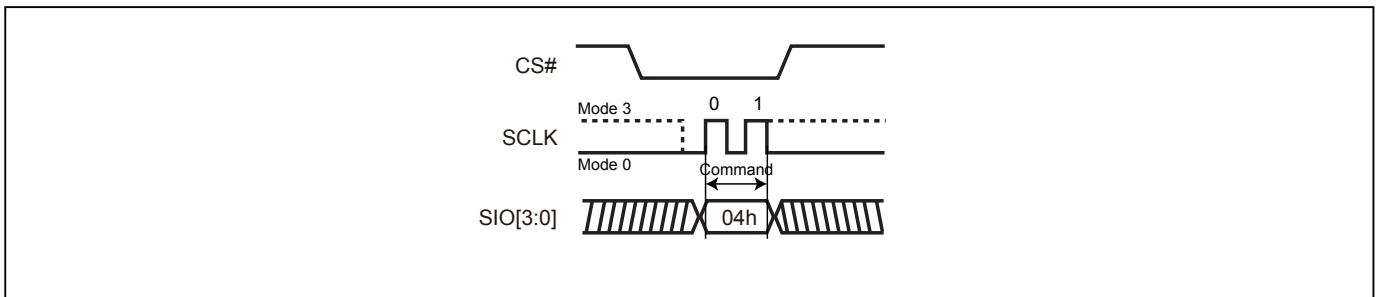


Figure 27. Read Identification (RDID) Sequence (Command 9F) (SPI mode only)

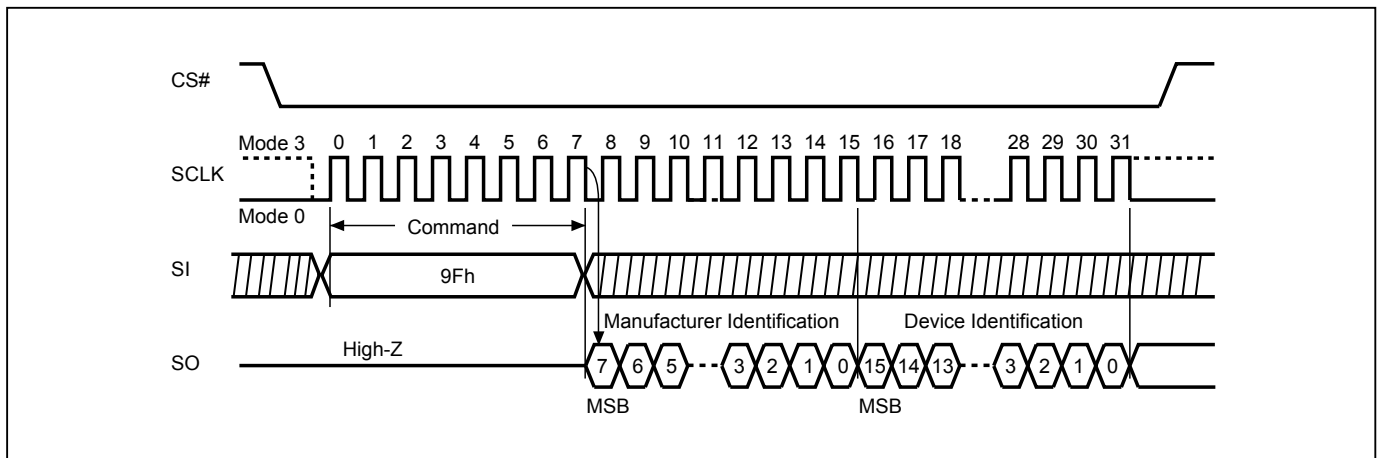


Figure 28. Read Status Register (RDSR) Sequence (Command 05) (SPI Mode)

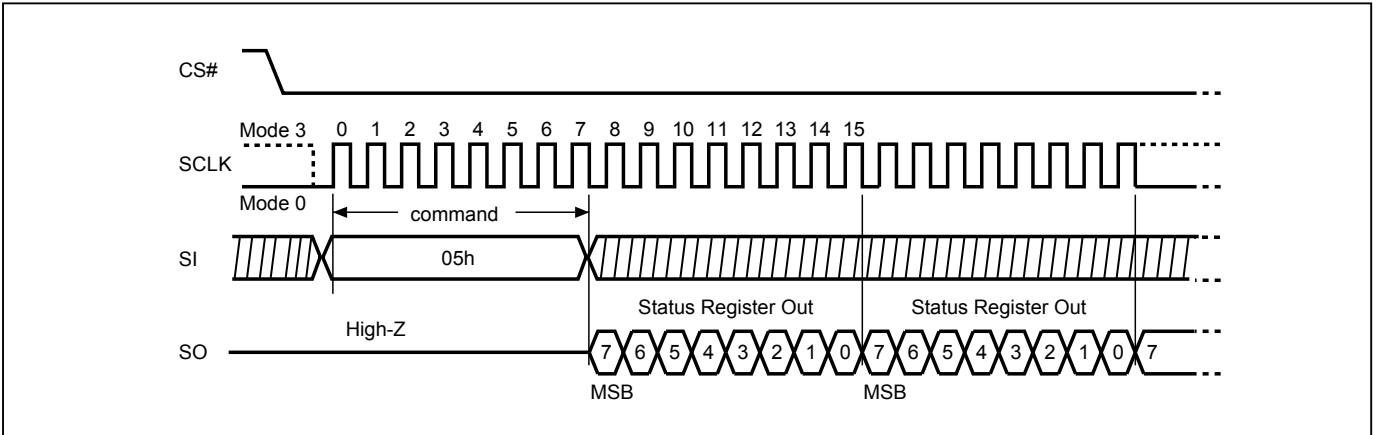


Figure 29. Read Status Register (RDSR) Sequence (Command 05) (QPI Mode)

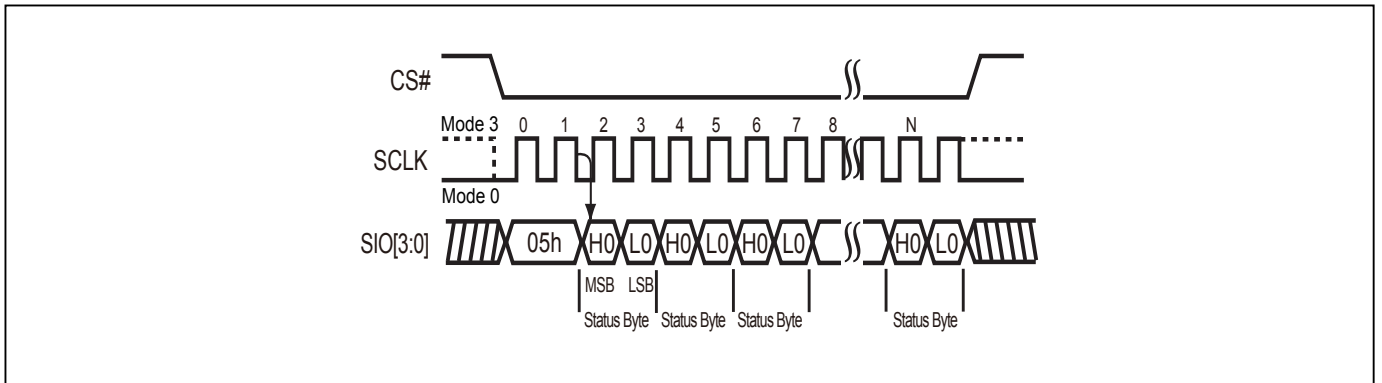
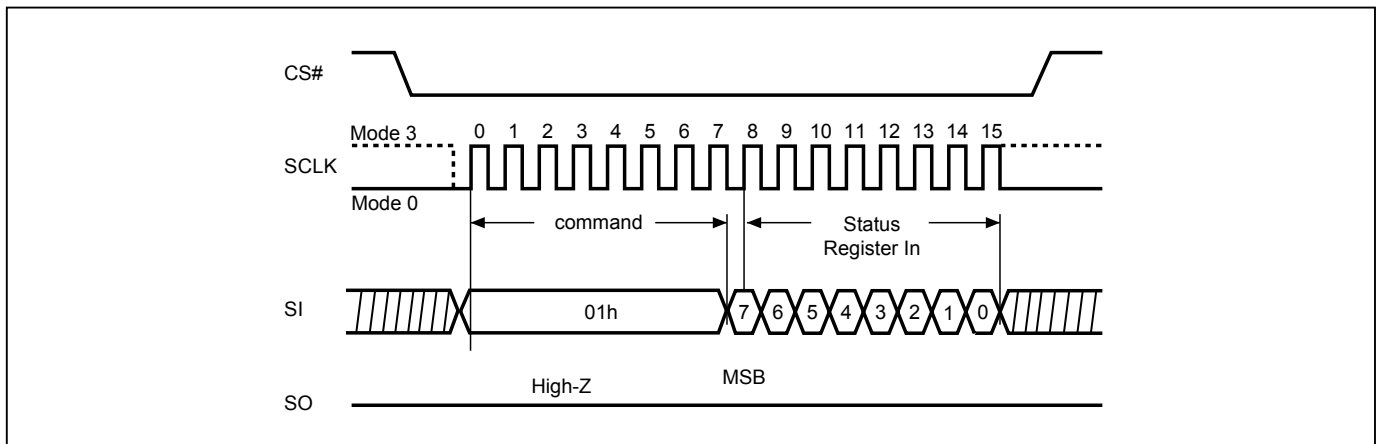


Figure 30. Write Status Register (WRSR) Sequence (Command 01) (SPI Mode)



Note : Also supported in QPI mode with command and subsequent input/output in Quad I/O mode.

Figure 31. Write Status Register (WRSR) Sequence (Command 01) (QPI Mode)

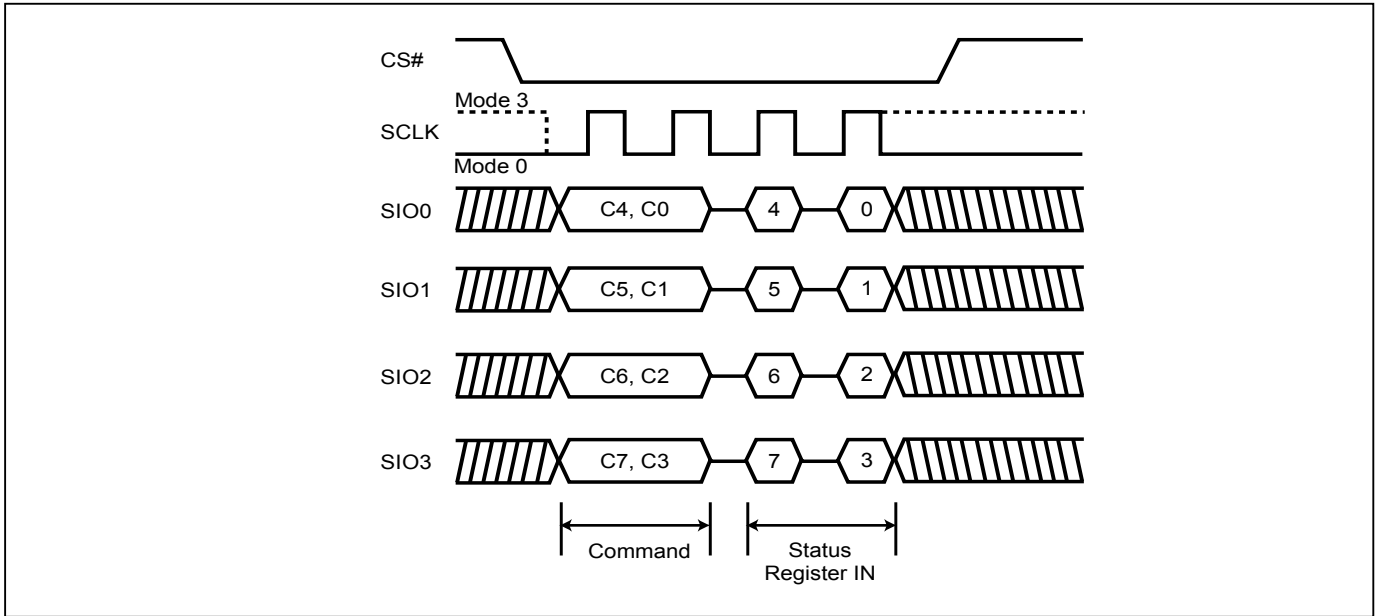


Figure 32. Read Data Bytes (READ) Sequence (Command 03) (SPI Mode only) (33MHz)

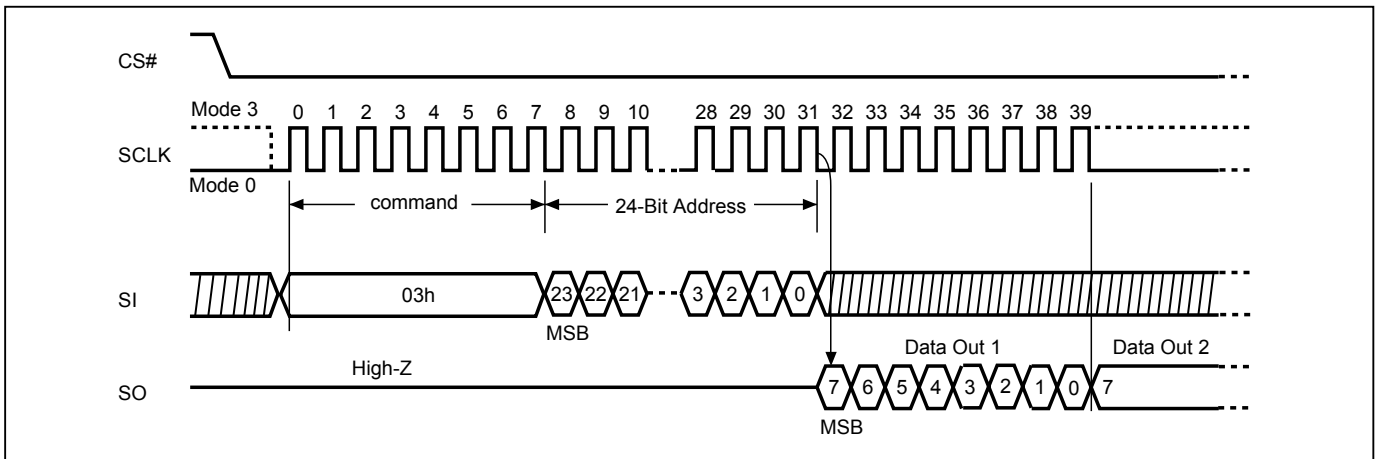


Figure 33. Read at Higher Speed (FAST_READ) Sequence (Command 0B) (SPI Mode) (104MHz)

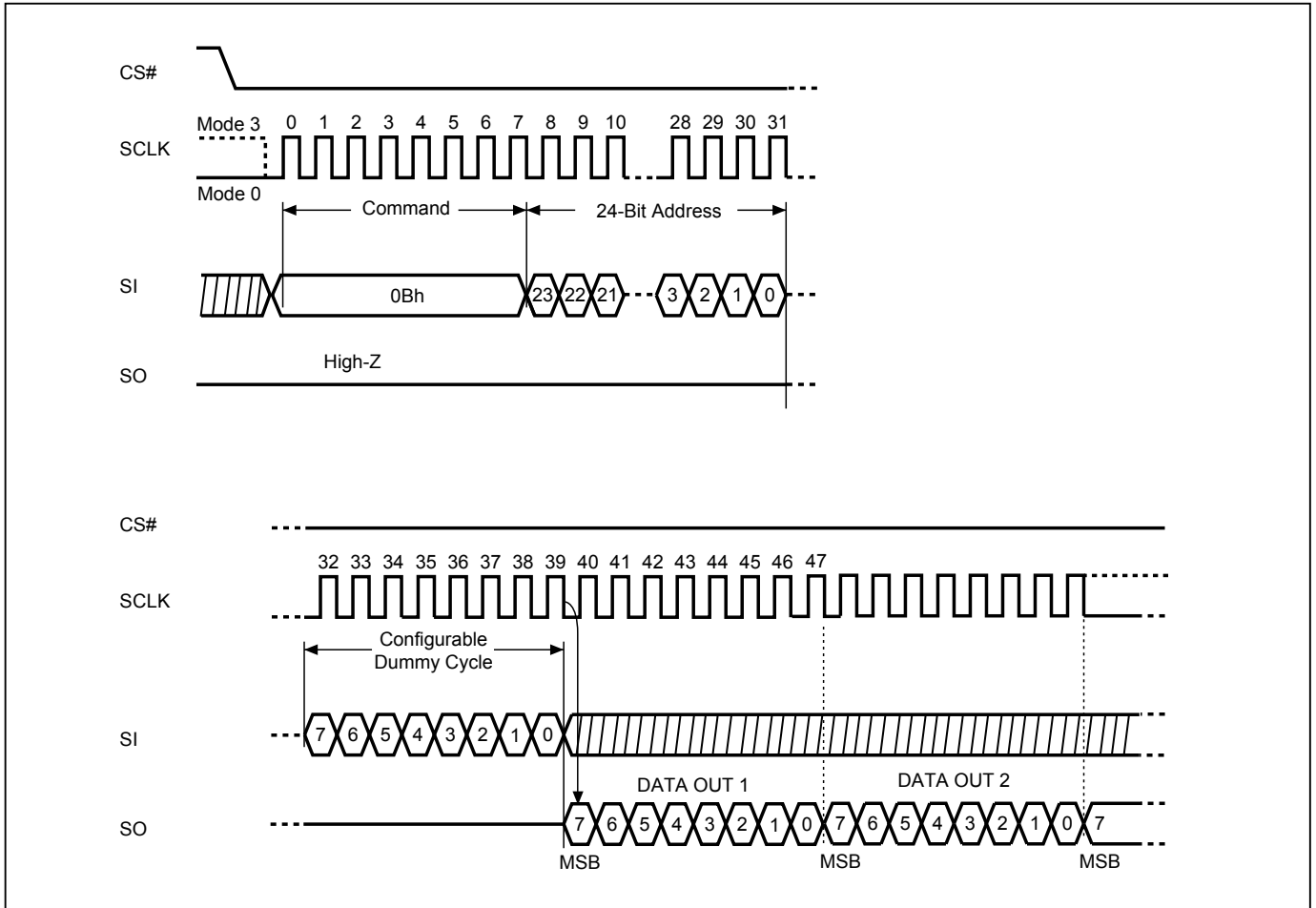


Figure 34. Read at Higher Speed (FAST_READ) Sequence (Command 0B) (QPI Mode) (84MHz)

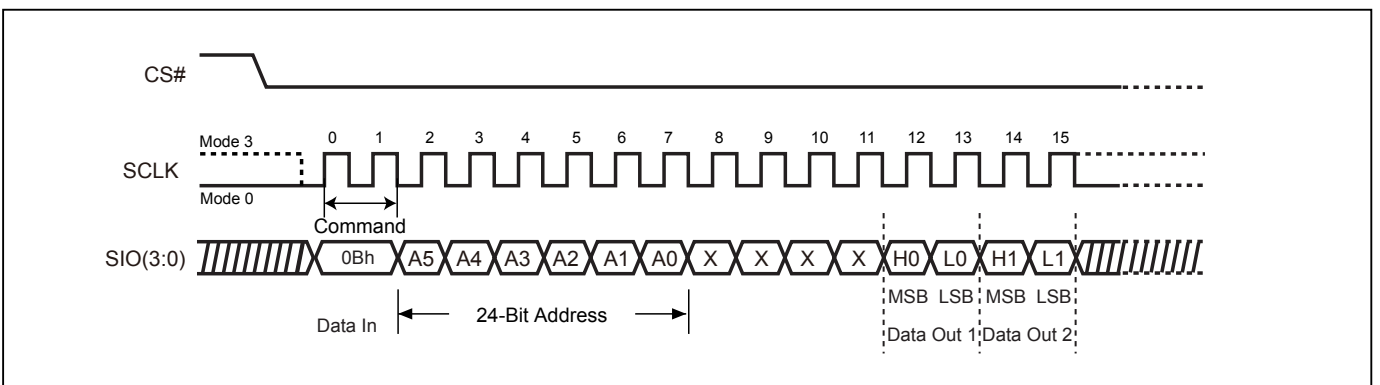


Figure 35. 2 x I/O Read Mode Sequence (Command BB) (SPI Mode only) (84MHz)

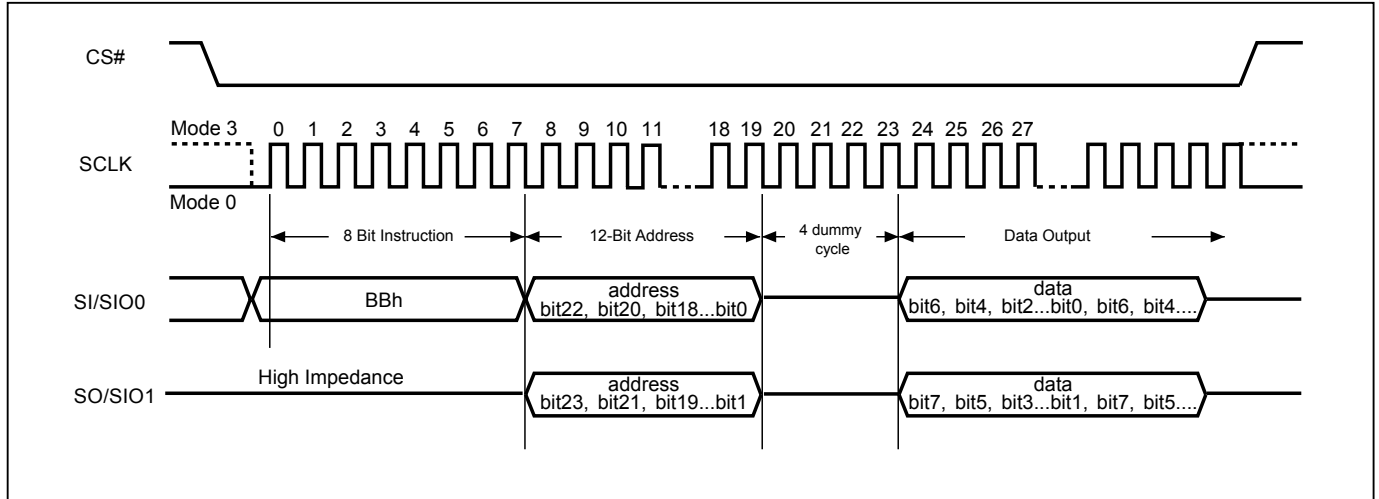
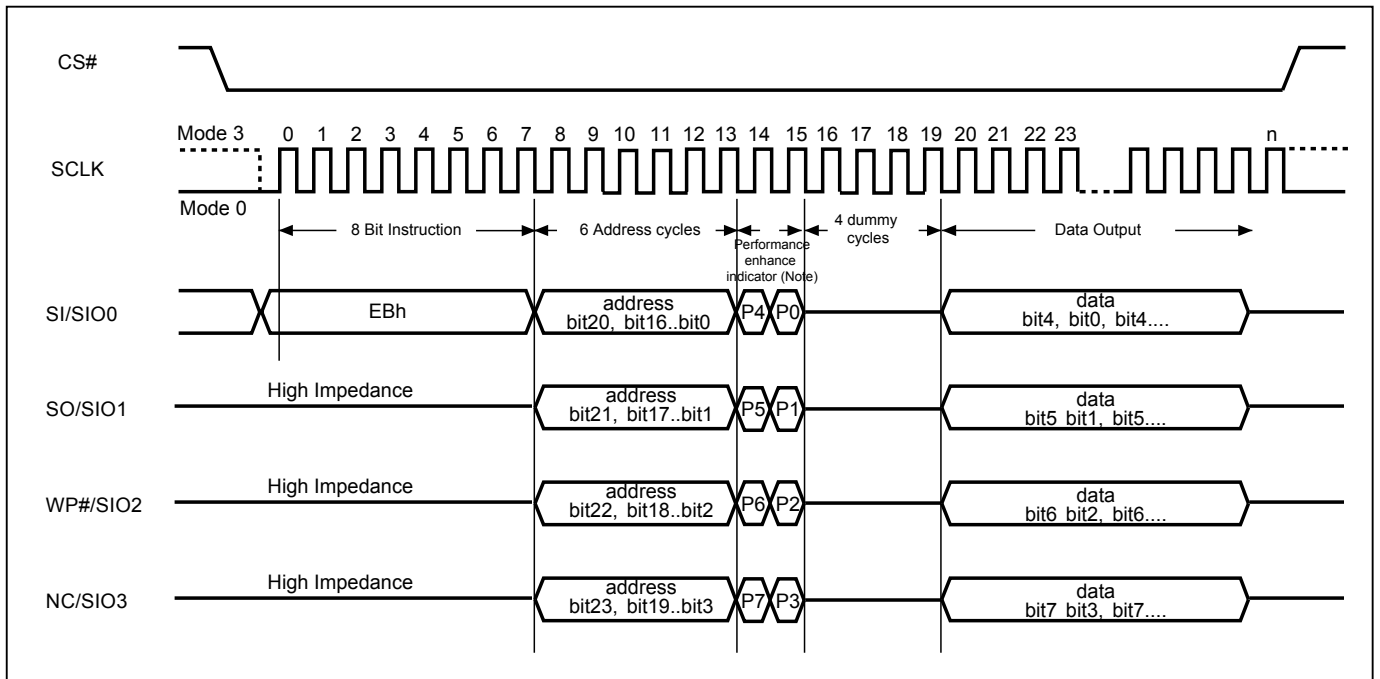


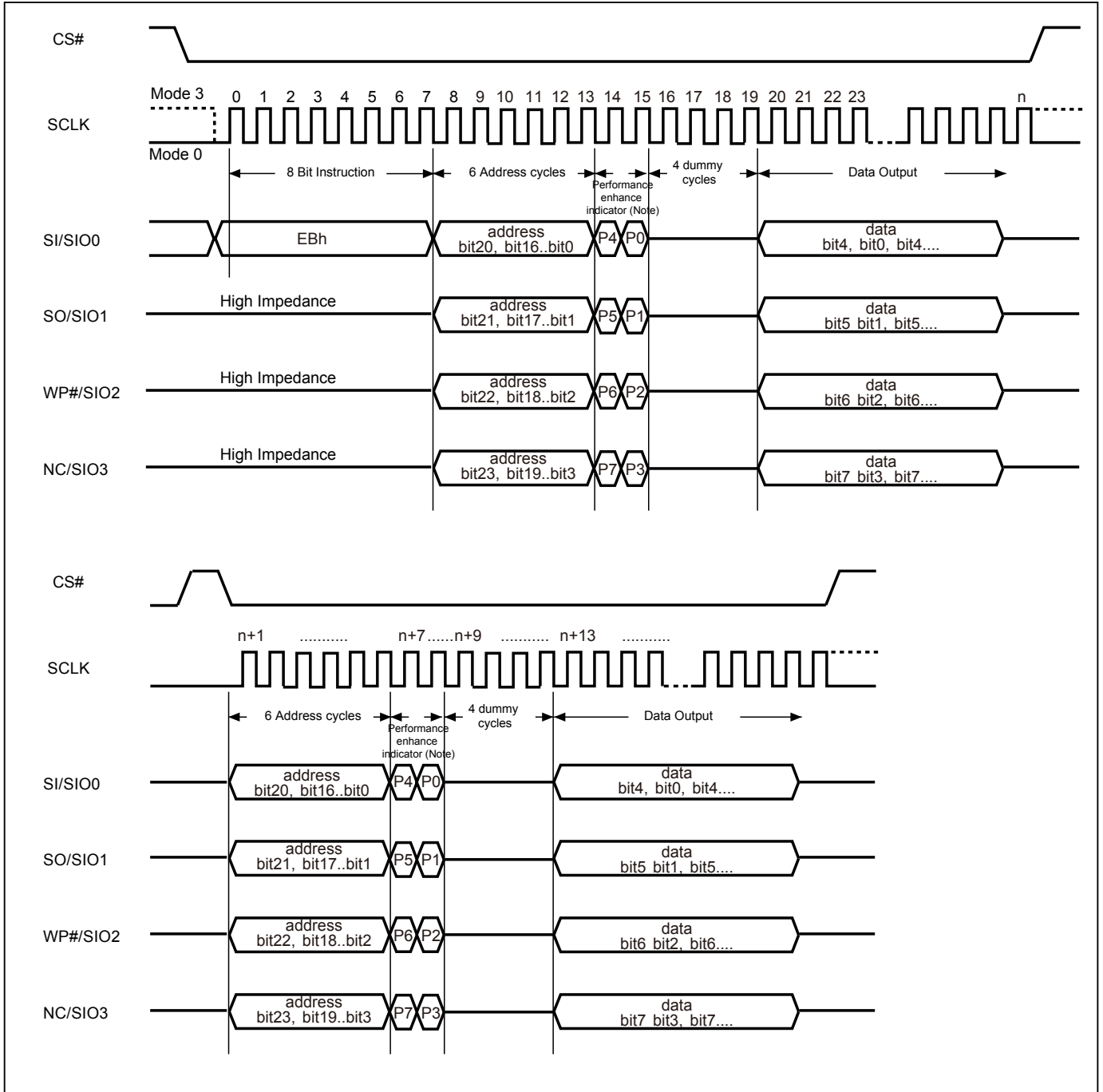
Figure 36. 4 x I/O Read Mode Sequence (Command EB) (SPI Mode) (104MHz)



Note:

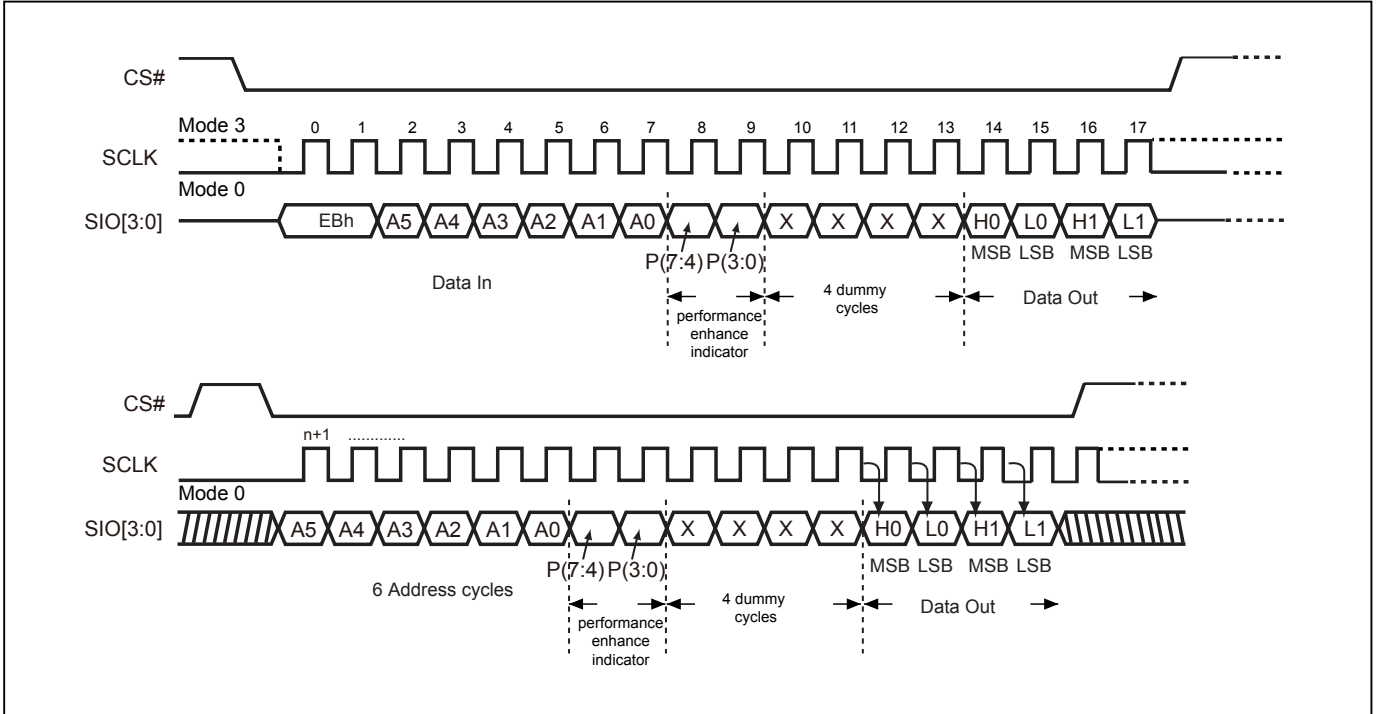
1. Also supported in QPI mode with command and subsequent input/output in Quad I/O mode and runs at 104MHz.
2. Hi-impedance is inhibited for the two clock cycles.
3. P7#P3, P6#P2, P5#P1 & P4#P0 (Toggling) is inhibited.

Figure 37. 4 x I/O Read enhance performance Mode Sequence (Command EB) (SPI Mode) (104MHz)



Note: Performance enhance mode, if P7≠P3 & P6≠P2 & P5≠P1 & P4≠P0 (Toggling), ex: A5, 5A, 0F, if not using performance enhance recommend to keep 1 or 0 in performance enhance indicator.
Reset the performance enhance mode, if P7=P3 or P6=P2 or P5=P1 or P4=P0, ex: AA, 00, FF

Figure 38. 4 x I/O Read Performance Enhance Mode Sequence (Command EB) (QPI Mode) (104MHz)



Note: Reset the performance enhance mode, if P7=P3 or P6=P2 or P5=P1 or P4=P0, ex: AA, 00, FF

Figure 39. Page Program (PP) Sequence (Command 02) (SPI Mode)

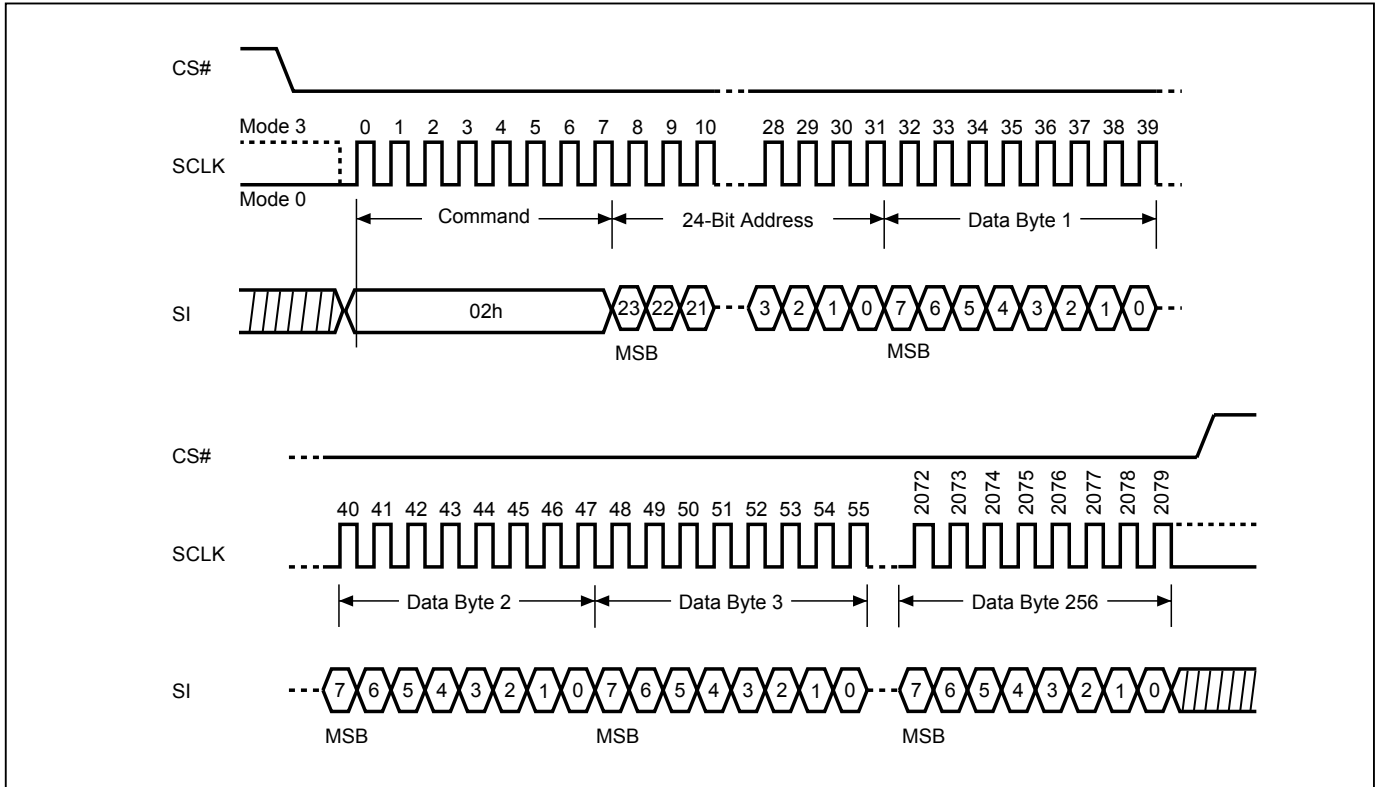


Figure 40. Page Program (PP) Sequence (Command 02) (QPI Mode)

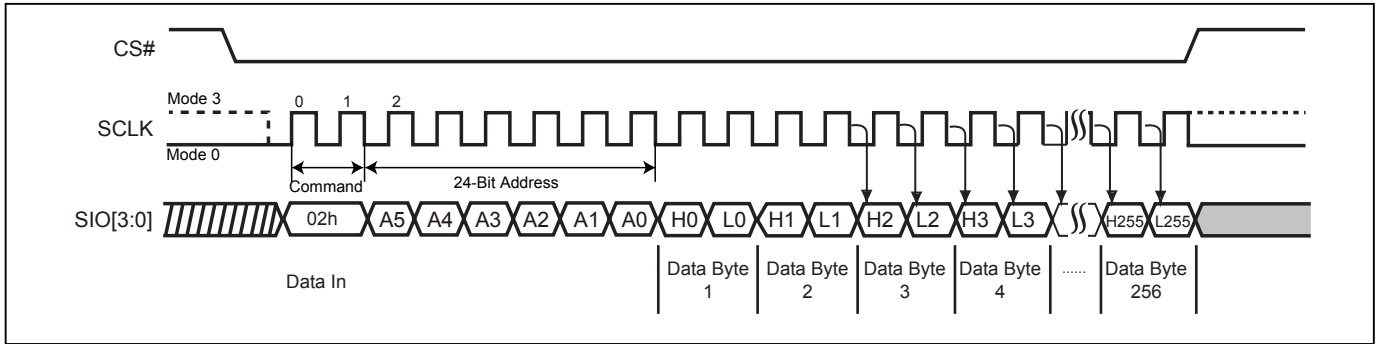


Figure 41. 4 x I/O Page Program (4PP) Sequence (Command 38) (SPI Mode only)

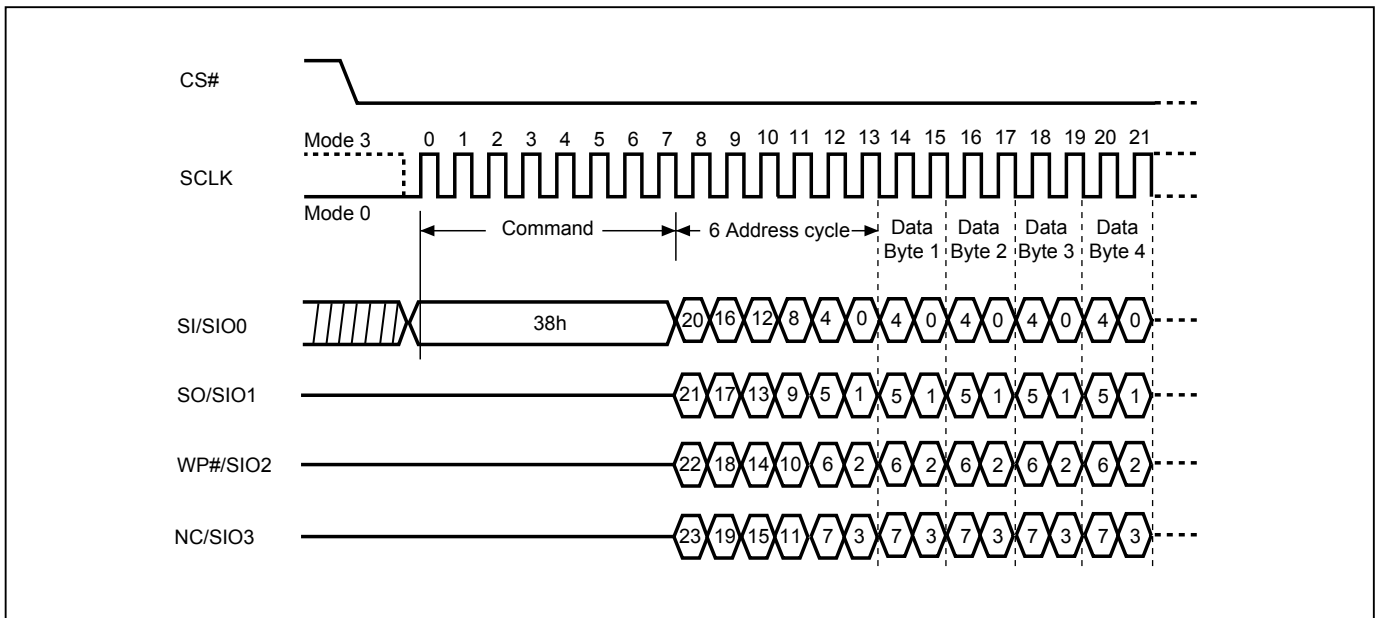


Figure 42. Sector Erase (SE) Sequence (Command 20) (SPI Mode)

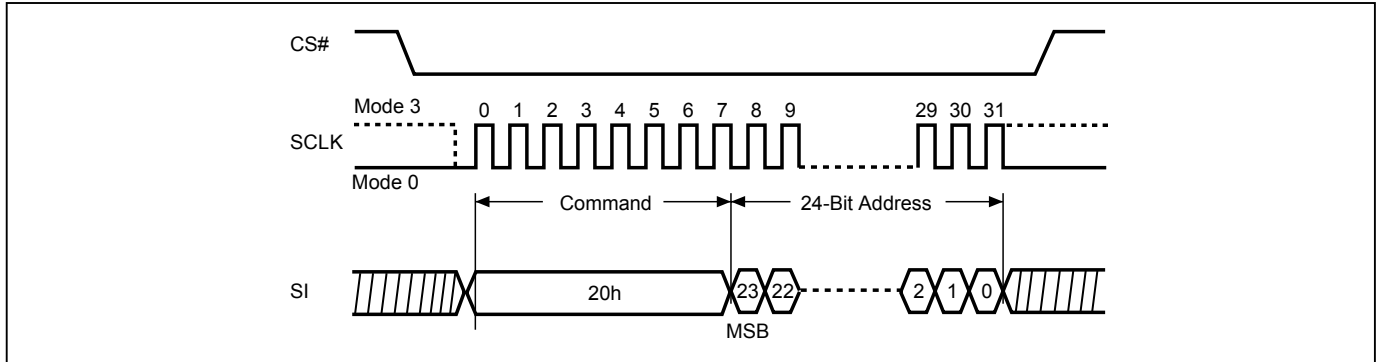


Figure 43. Sector Erase (SE) Sequence (Command 20) (QPI Mode)

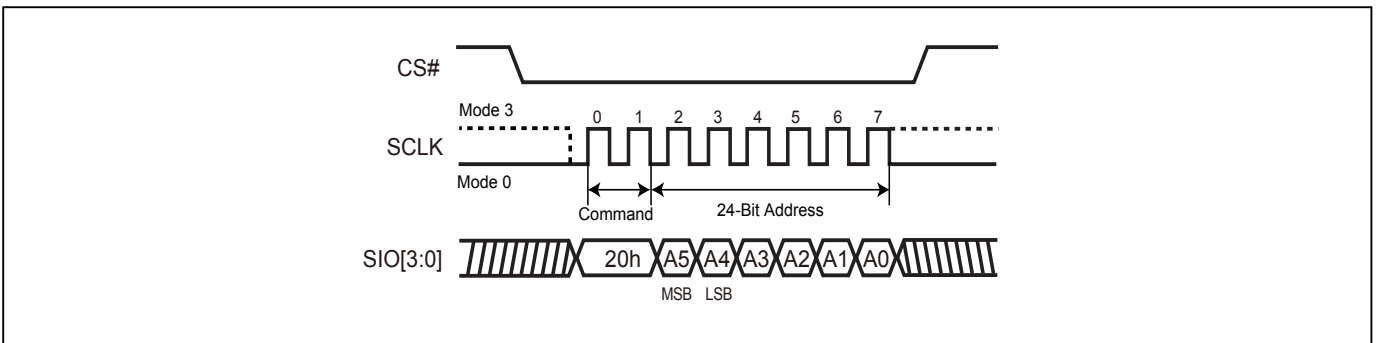


Figure 44. Block Erase 32KB (BE32K) Sequence (Command 52) (SPI Mode)

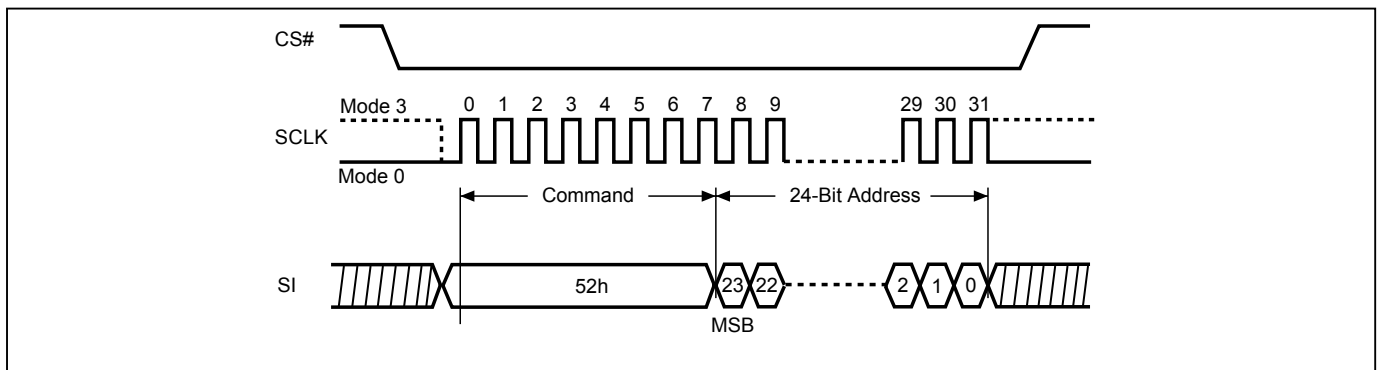


Figure 45. Block Erase 32KB (BE32K) Sequence (Command 52) (QPI Mode)

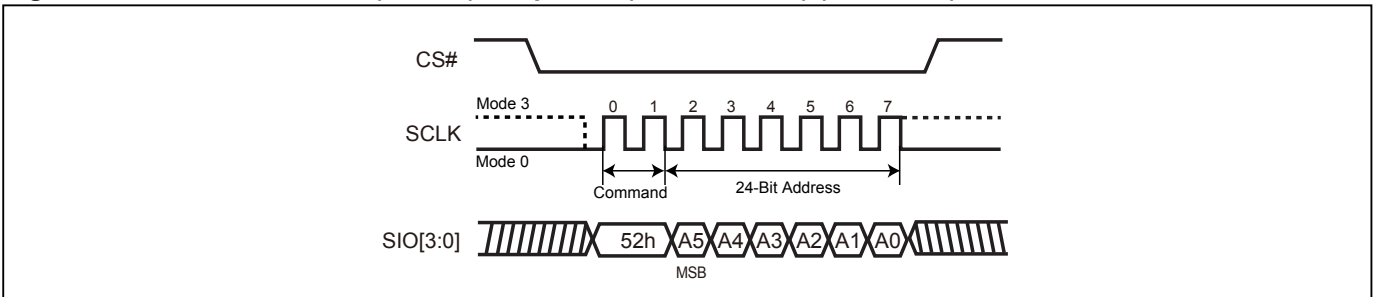


Figure 46. Block Erase (BE) Sequence (Command D8) (SPI Mode)

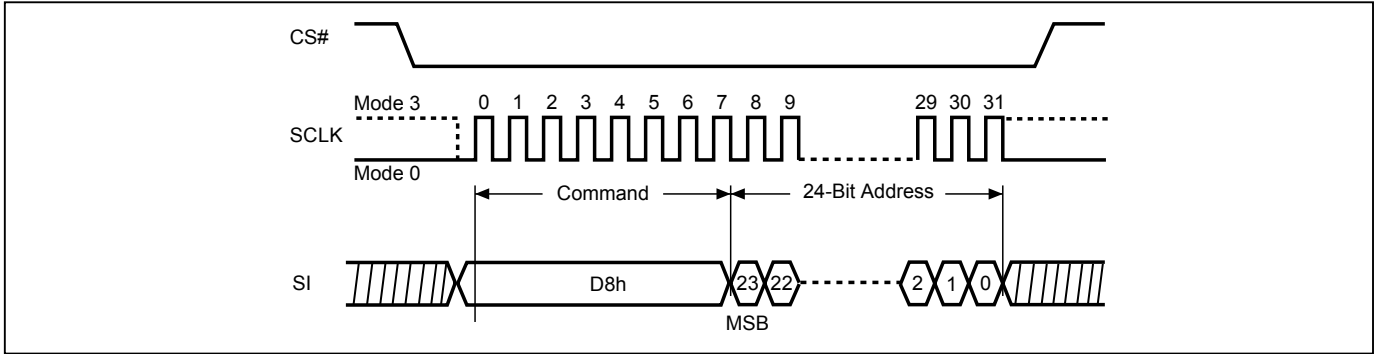


Figure 47. Block Erase (BE) Sequence (Command D8) (QPI Mode)

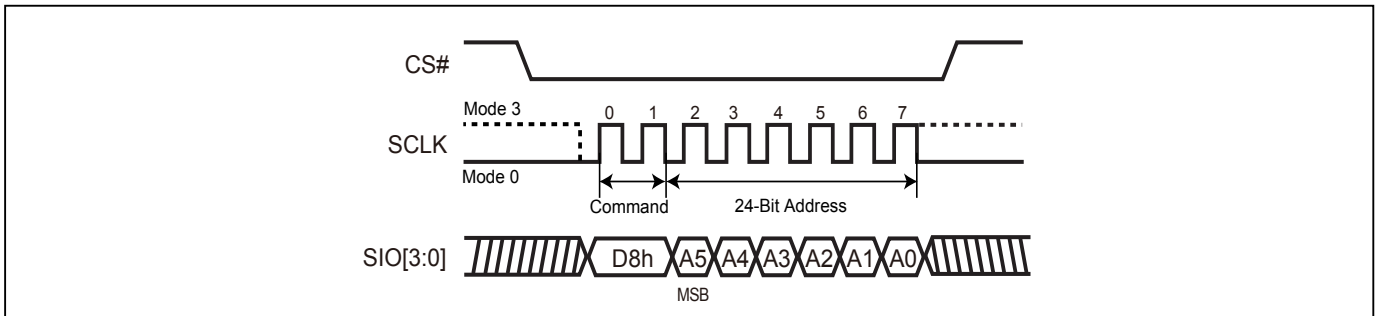


Figure 48. Chip Erase (CE) Sequence (Command 60 or C7) (SPI Mode)

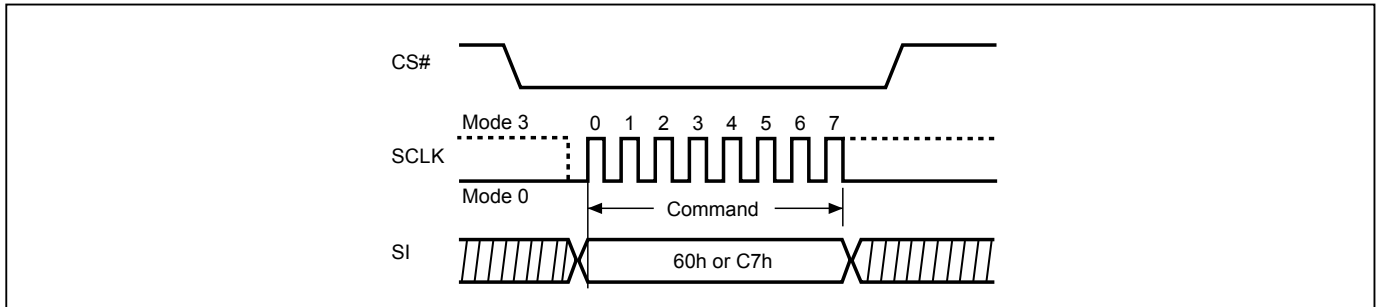


Figure 49. Chip Erase (CE) Sequence (Command 60 or C7) (QPI Mode)

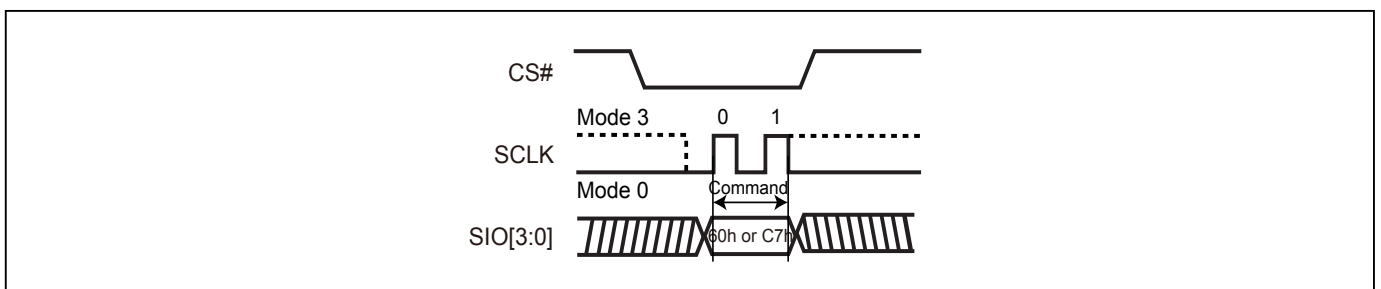


Figure 50. Deep Power-down (DP) Sequence (Command B9) (SPI Mode)

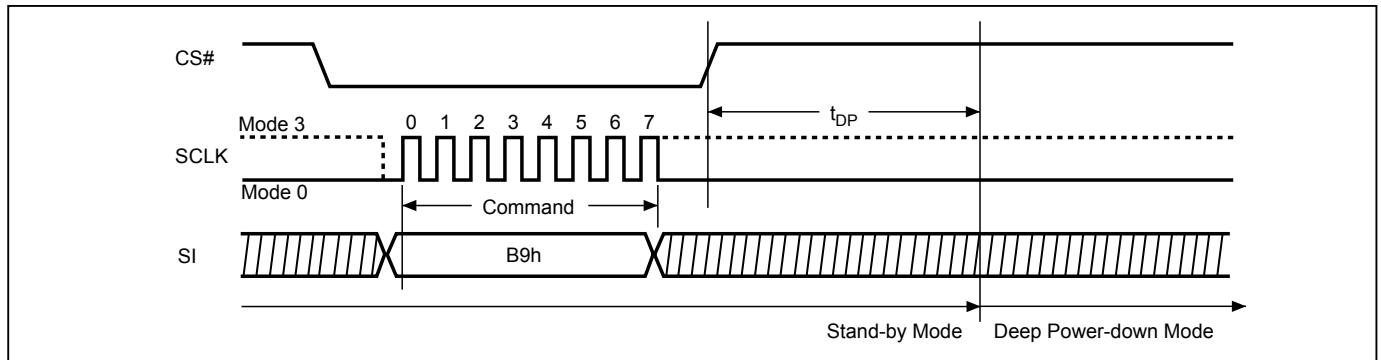


Figure 51. Deep Power-down (DP) Sequence (Command B9) (QPI Mode)

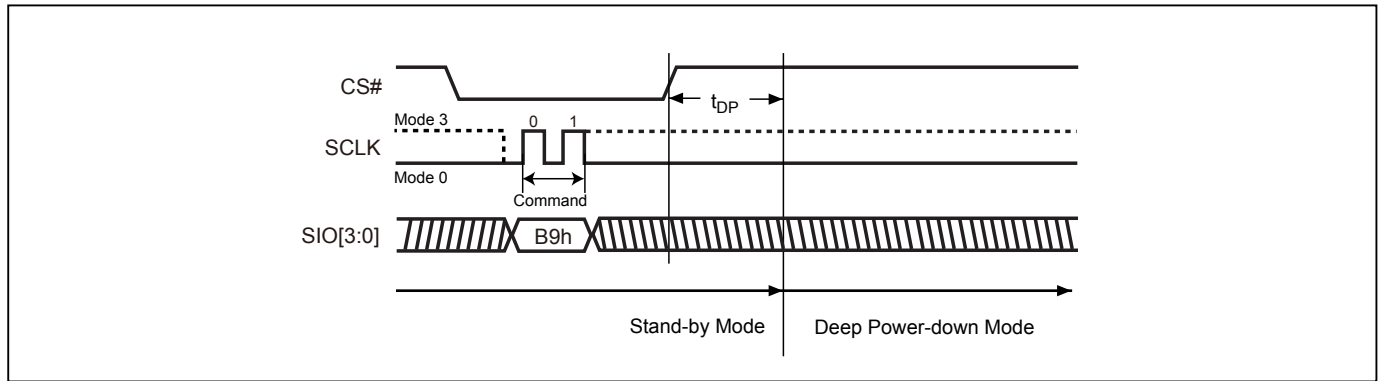


Figure 52. RDP and Read Electronic Signature (RES) Sequence (Command AB) (SPI Mode)

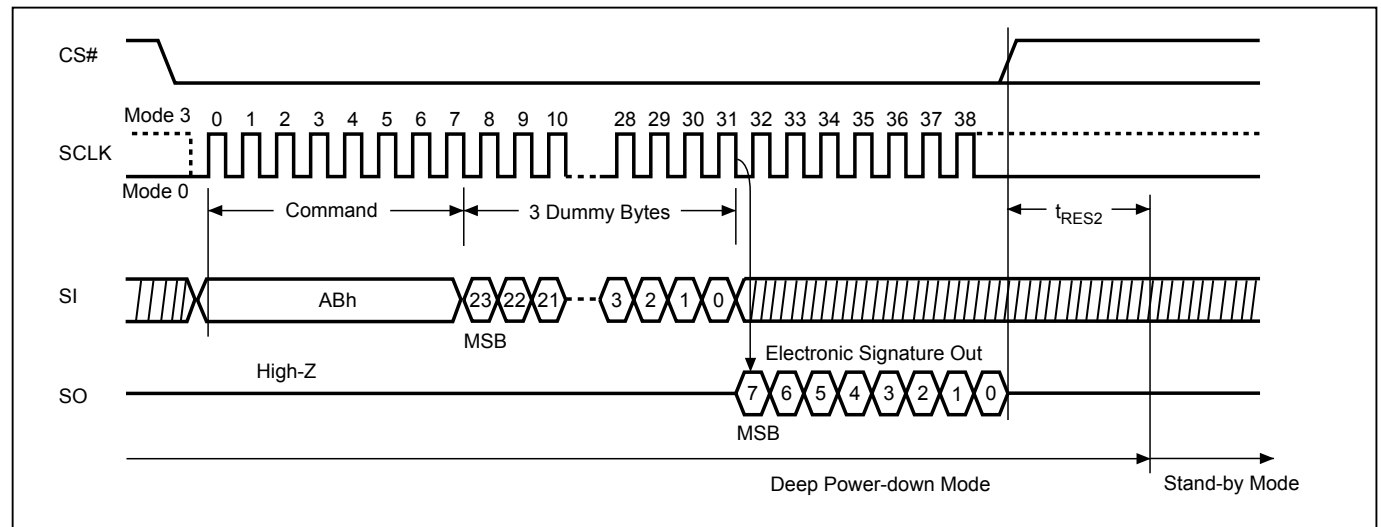


Figure 53. Release from Deep Power-down (RDP) Sequence (Command AB) (SPI Mode)

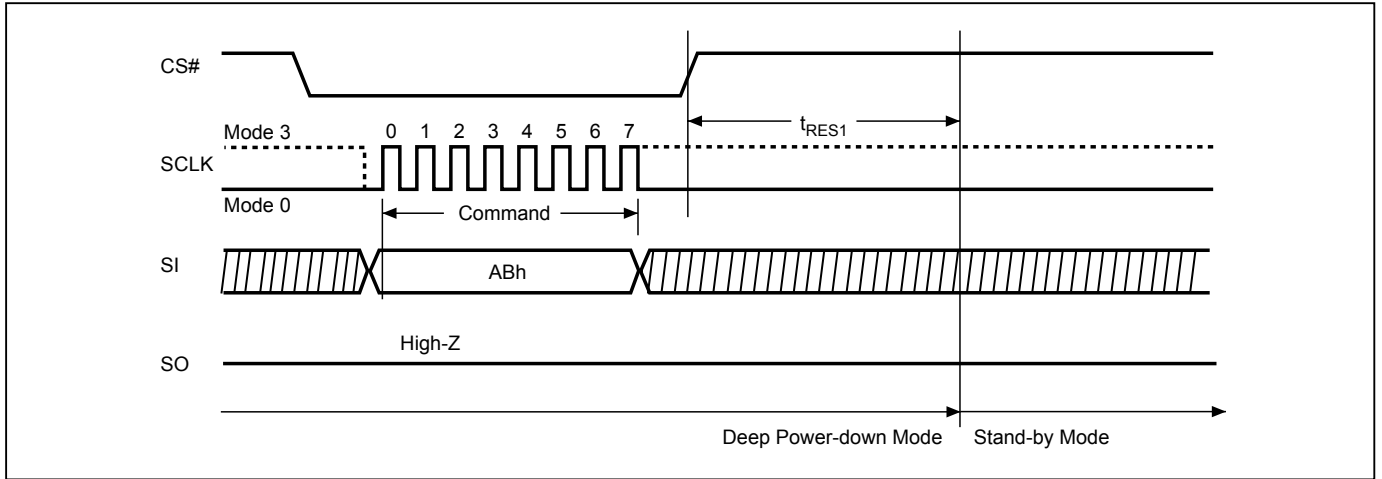


Figure 54. Release from Deep Power-down (RDP) Sequence (Command AB) (QPI Mode)

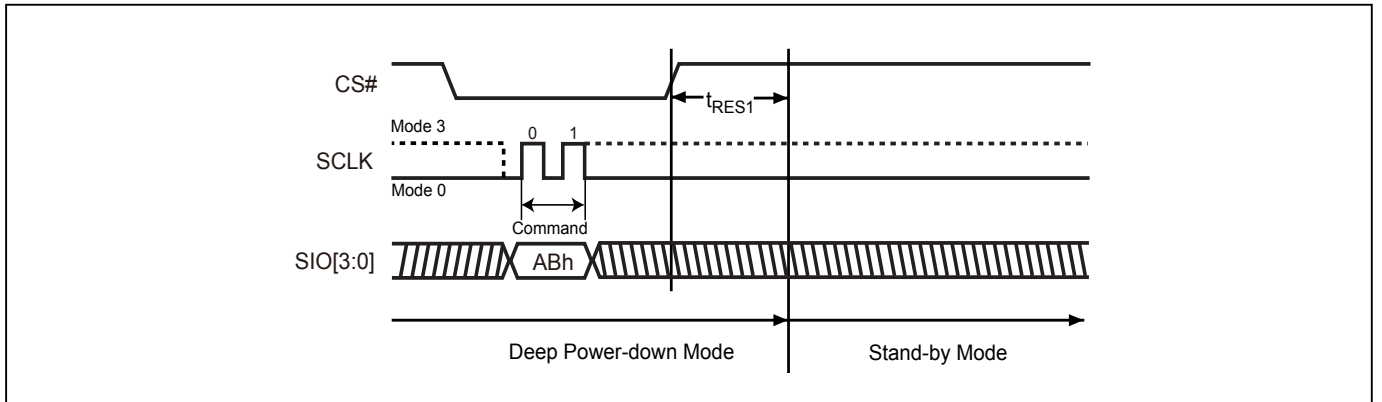
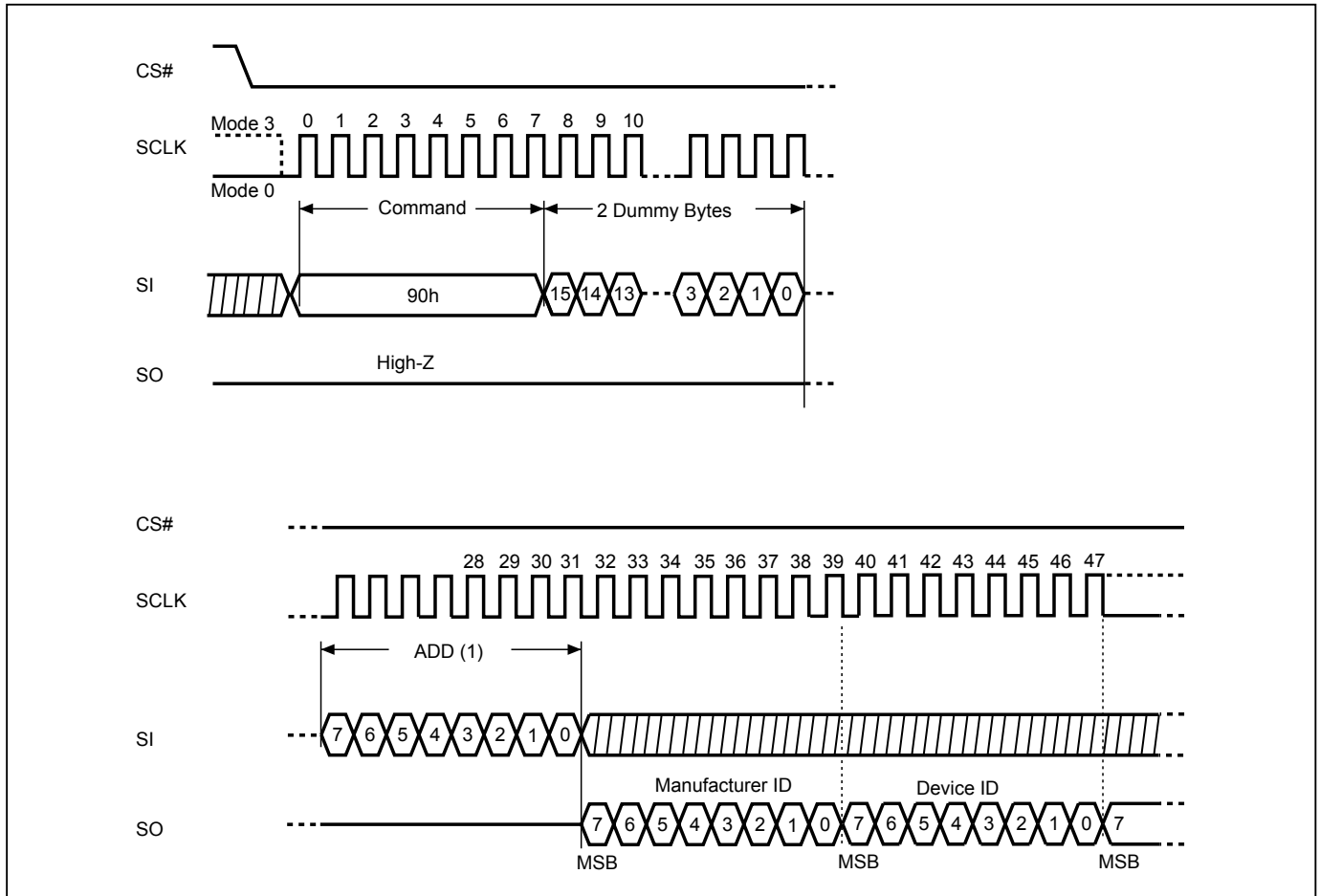


Figure 55. Read Electronic Manufacturer & Device ID (REMS) Sequence (Command 90) (SPI Mode only)



Notes:

- (1) ADD=00H will output the manufacturer's ID first and ADD=01H will output device ID first.
- (2) Instruction is either 90(hex).

Figure 56. Read Security Register (RDSCUR) Sequence (Command 2B) (SPI Mode)

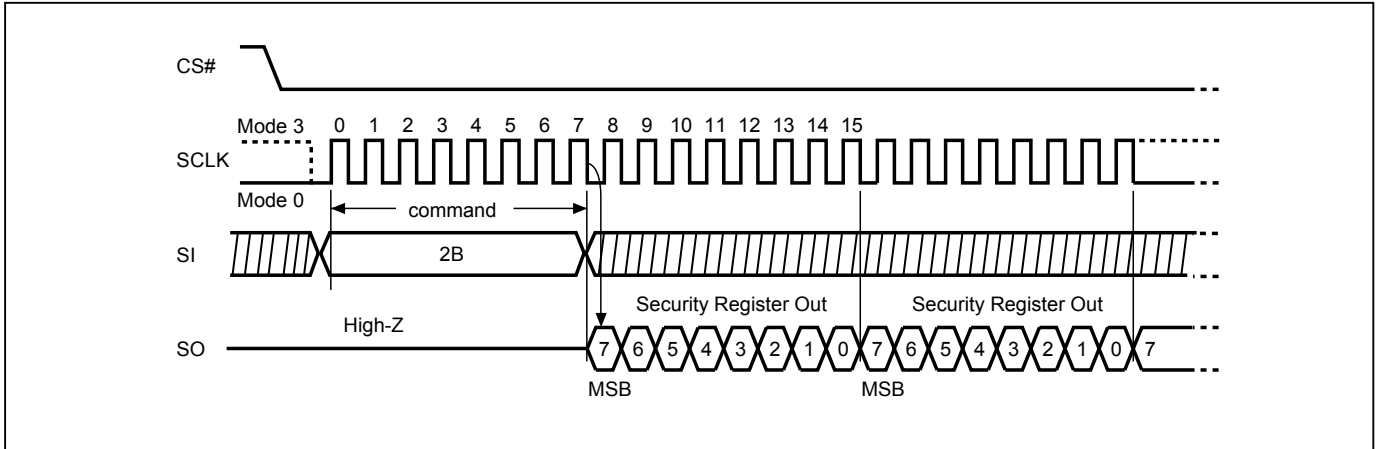


Figure 57. Read Security Register (RDSCUR) Sequence (Command 2B) (QPI Mode)

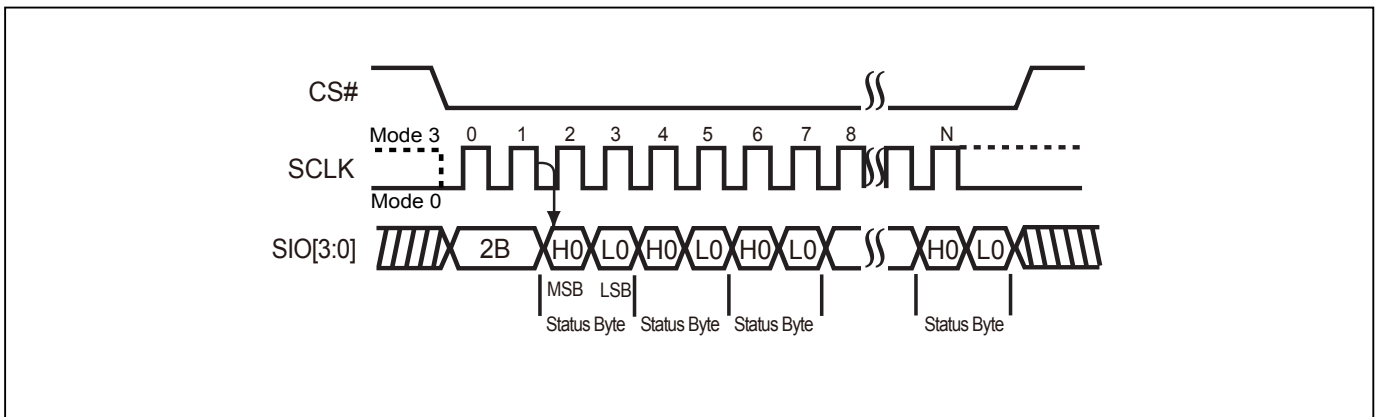


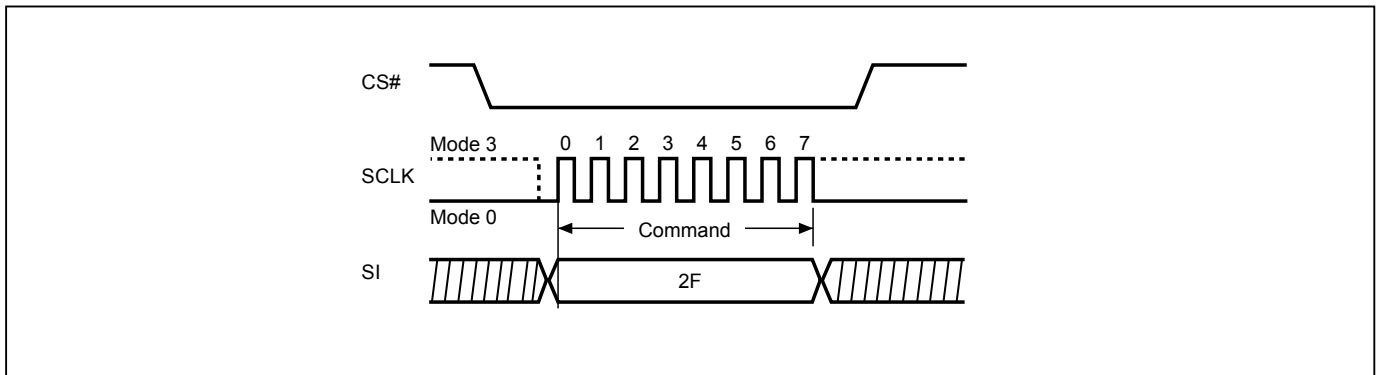
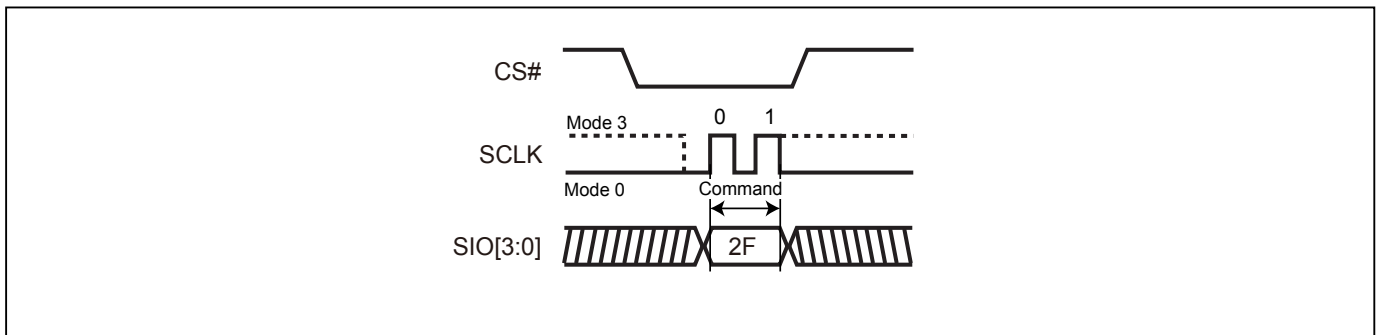
Figure 58. Write Security Register (WRSCUR) Sequence (Command 2F) (SPI Mode)**Figure 59. Write Security Register (WRSCUR) Sequence (Command 2F) (QPI Mode)**

Figure 60. Word Read Quad I/O (W4READ) Sequence (Command E7) (SPI Mode only, 84MHz)

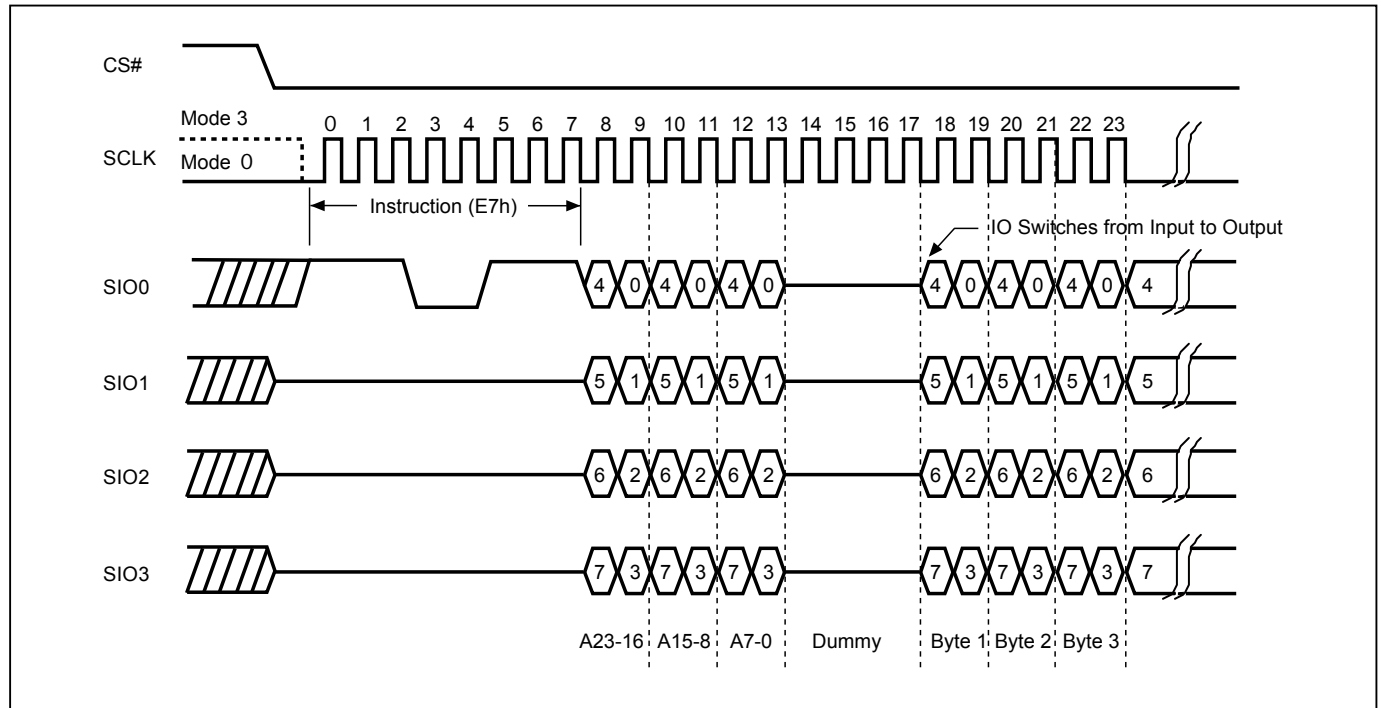


Figure 61. Reset Sequence (SPI mode)

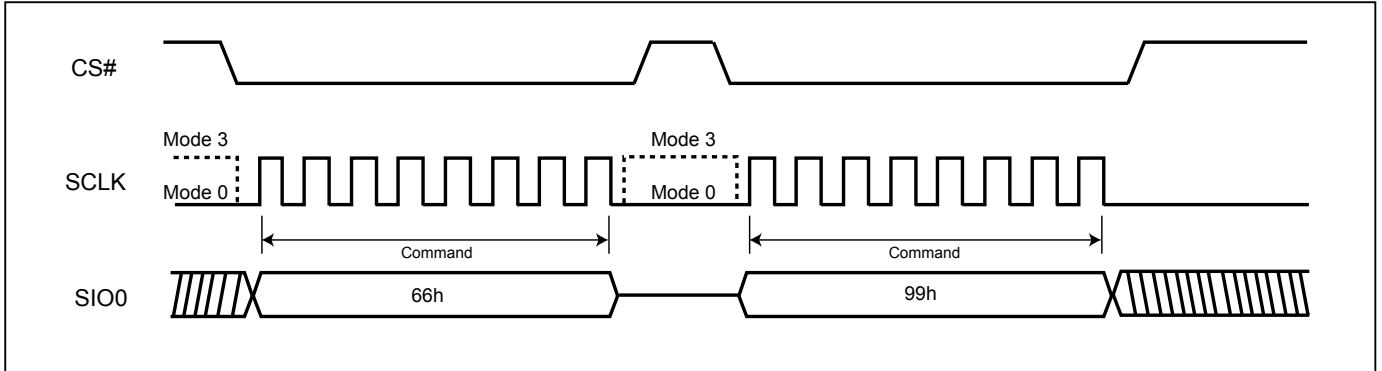


Figure 62. Reset Sequence (QPI mode)

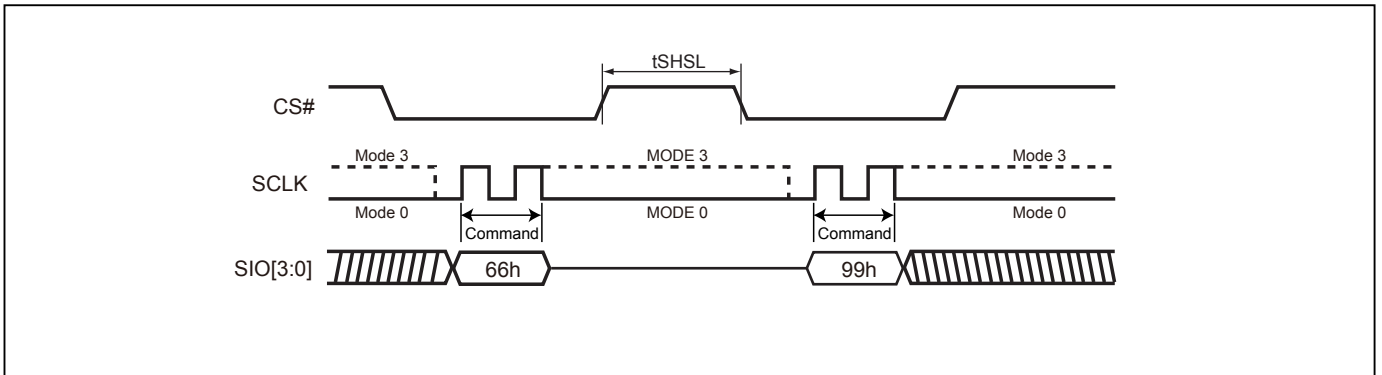


Figure 63. Enable Quad I/O Sequence

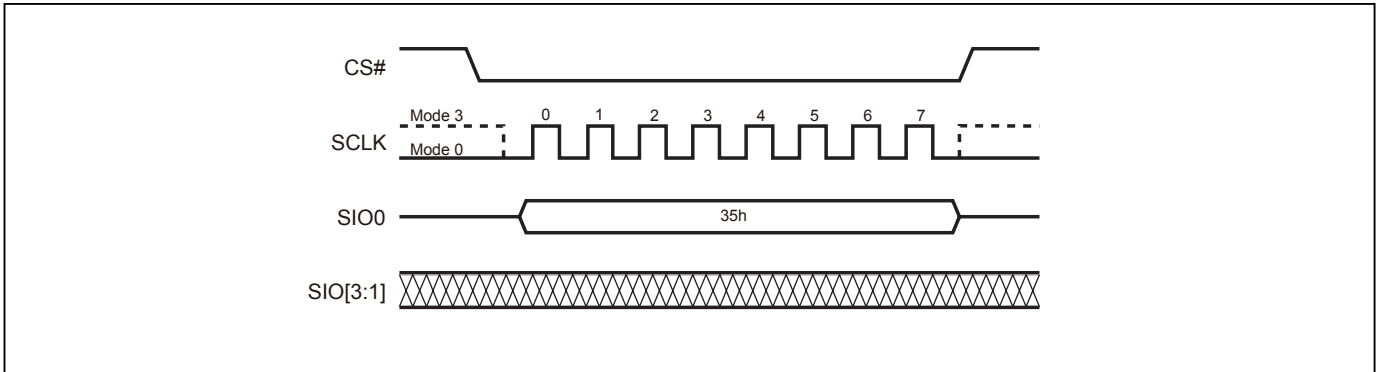


Figure 64. Suspend to Read Latency

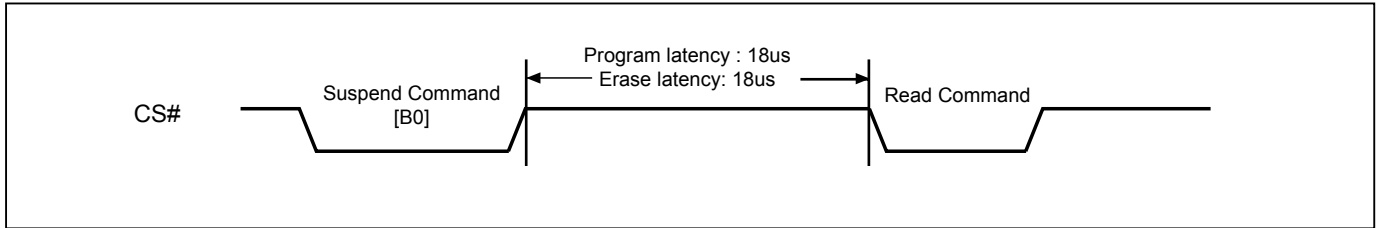


Figure 65. Resume to Read Latency

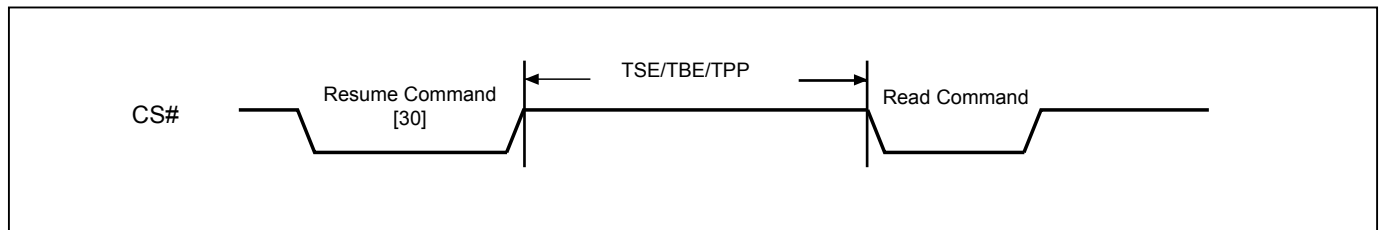


Figure 66. Resume to Suspend Latency

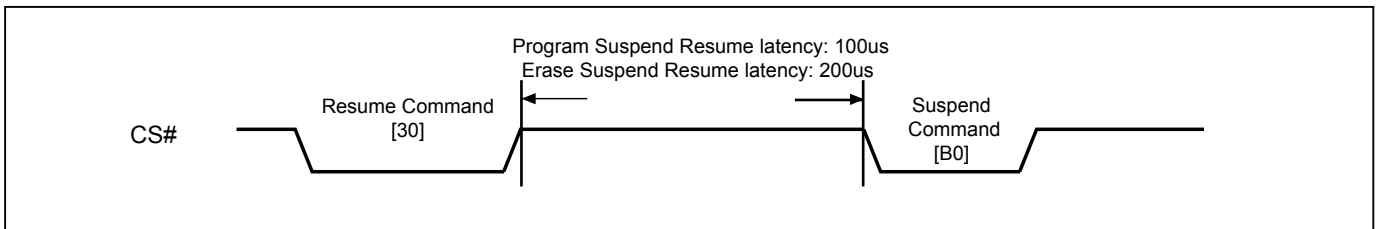


Figure 67. Software Reset Recovery

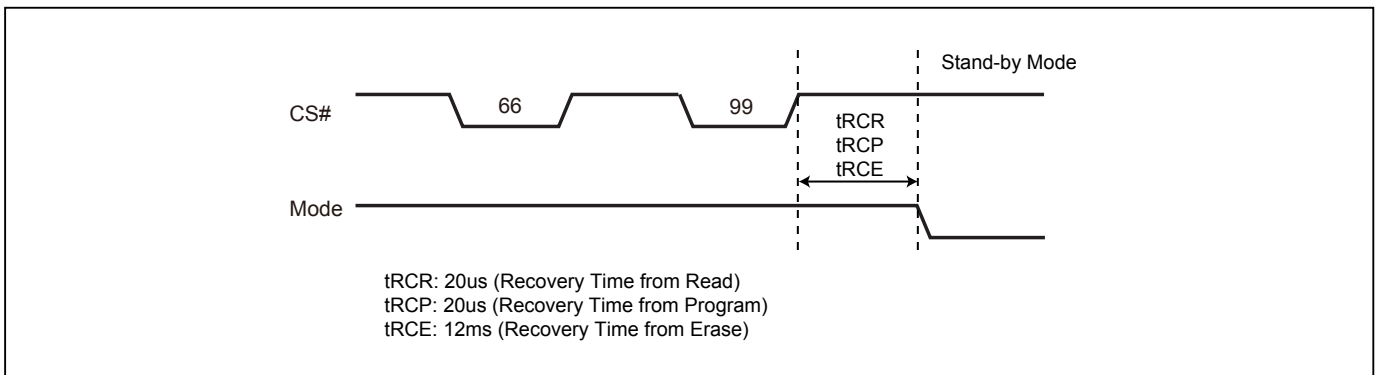
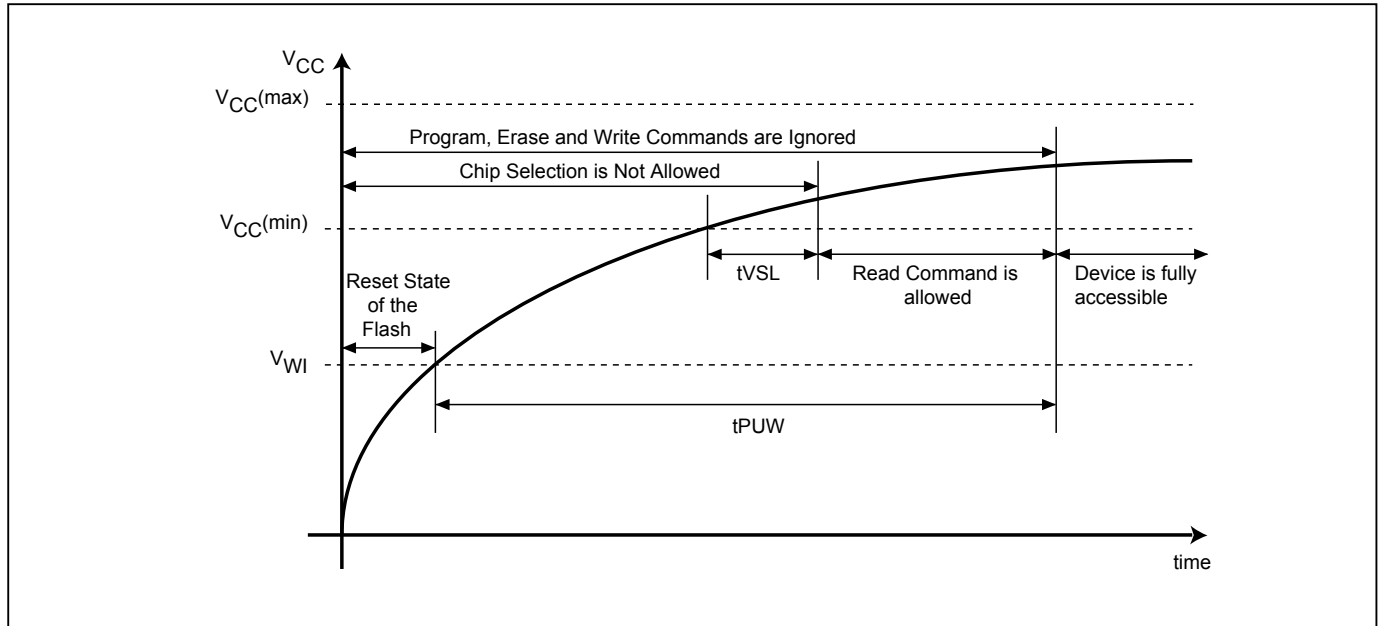


Figure 68. Power-up Timing



Note: $V_{CC(max)}$ is 2.0V and $V_{CC(min)}$ is 1.65V.

Table 16. Power-Up Timing and VWI Threshold

| Symbol | Parameter | Min. | Max. | Unit |
|--------------|--|------|------|------|
| $t_{VSL}(1)$ | $V_{CC(min)}$ to CS# low (V_{CC} Rise Time) | 300 | | us |
| $t_{PUW}(1)$ | Time delay to Write instruction | 1 | 10 | ms |
| $V_{WI}(1)$ | Command Inhibit Voltage | 1.0 | 1.4 | V |

Note: 1. These parameters are characterized only.

12-1. 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).

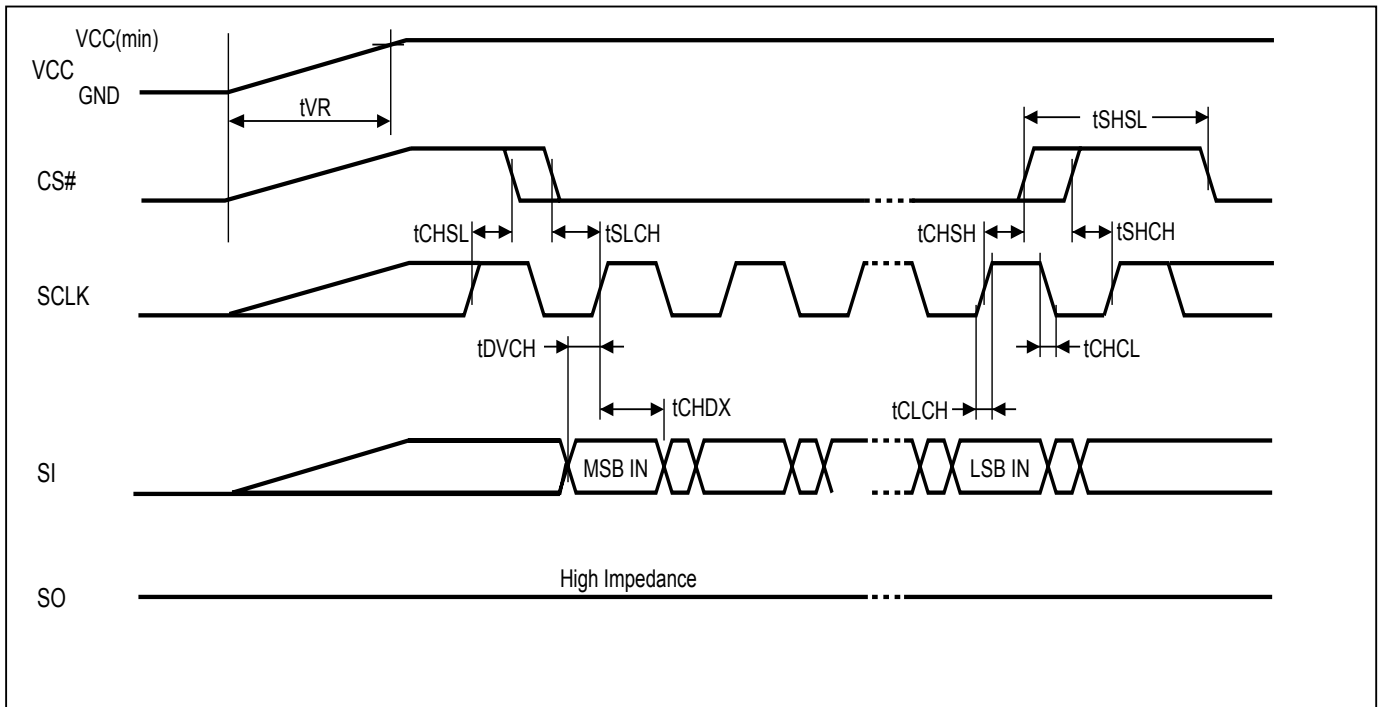
13. OPERATING CONDITIONS

At Device Power-Up and Power-Down

AC timing illustrated in "Figure 69. AC Timing at Device Power-Up" and "Figure 70. Power-Down Sequence" 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 69. AC Timing at Device Power-Up



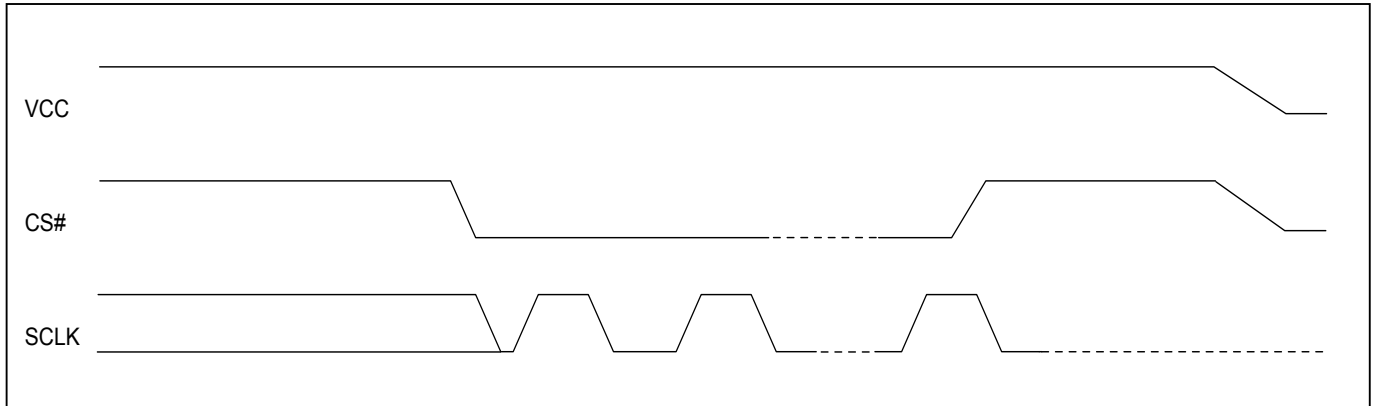
| Symbol | Parameter | Notes | Min. | Max. | Unit |
|--------|---------------|-------|------|--------|------|
| tVR | VCC Rise Time | 1 | | 500000 | us/V |

Notes :

1. Sampled, not 100% tested.
2. For AC spec tCHSL, tSLCH, tDVCH, tCHDX, tSHSL, tCHSH, tSHCH, tCHCL, tCLCH in the figure, please refer to "Table 15. AC Characteristics".

Figure 70. Power-Down Sequence

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



14. ERASE AND PROGRAMMING PERFORMANCE

| Parameter | Min. | Typ. (1) | Max. (2) | Unit |
|--|------|----------|----------|--------|
| Write Status Register Cycle Time | | | 40 | ms |
| Sector Erase Cycle Time (4KB) | | 45 | 200 | ms |
| Block Erase Cycle Time (32KB) | | 250 | 1000 | ms |
| Block Erase Cycle Time (64KB) | | 500 | 2000 | ms |
| Chip Erase Cycle Time | | 9 | 20 | s |
| Byte Program Time (via page program command) | | 10 | 30 | us |
| Page Program Time | | 1.2 | 3 | ms |
| Erase/Program Cycle | | 100,000 | | cycles |

Note:

1. Typical program and erase time assumes the following conditions: 25°C, 1.8V, and checkerboard pattern.
2. Under worst conditions of 85°C and 1.65V.
3. System-level overhead is the time required to execute the first-bus-cycle sequence for the programming command.
4. The maximum chip programming time is evaluated under the worst conditions of 0C, VCC=1.8V, and 100K cycle with 90% confidence level.

15. DATA RETENTION

| PARAMETER | Condition | Min. | Max. | UNIT |
|----------------|-----------|------|------|-------|
| Data retention | 55°C | 20 | | years |

16. LATCH-UP CHARACTERISTICS

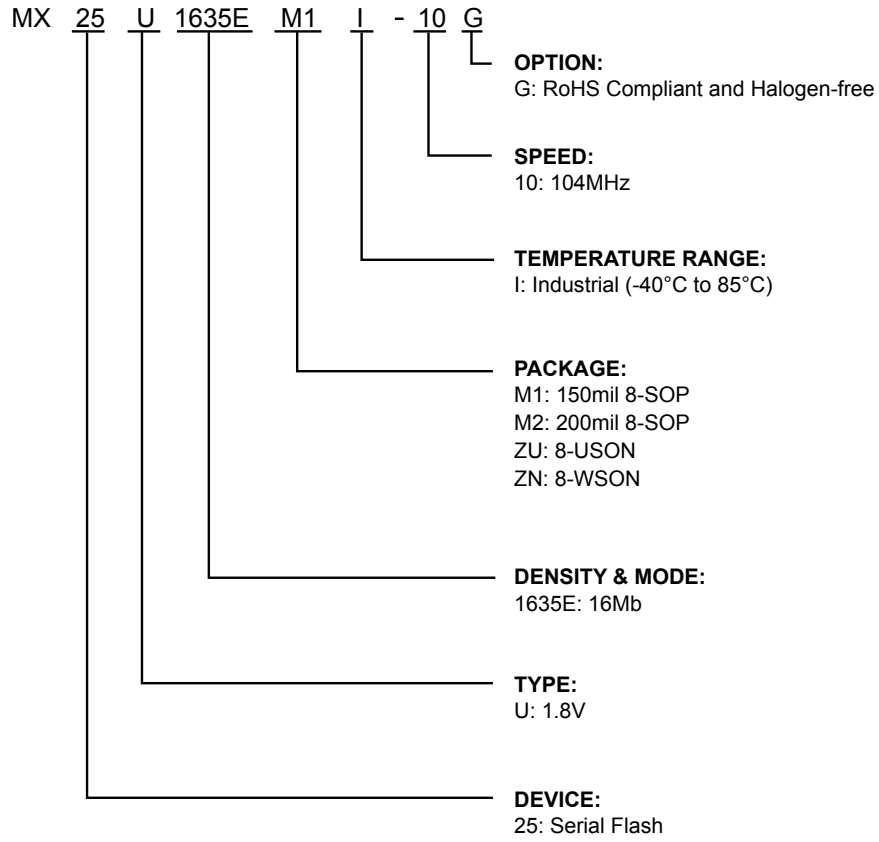
| | Min. | Max. |
|---|--------|------------|
| Input Voltage with respect to GND on all power pins, SI, CS# | -1.0V | 2 VCCmax |
| Input Voltage with respect to GND on SO | -1.0V | VCC + 1.0V |
| Current | -100mA | +100mA |
| Includes all pins except VCC. Test conditions: VCC = 1.8V, one pin at a time. | | |



17. ORDERING INFORMATION

| Part No. | Clock (MHz) | Temperature | Package | Remark |
|-------------------|-------------|---------------|-------------------|--------|
| MX25U1635EM1I-10G | 104 | -40°C to 85°C | 8-SOP (150mil) | |
| MX25U1635EM2I-10G | 104 | -40°C to 85°C | 8-SOP (200mil) | |
| MX25U1635EZUI-10G | 104 | -40°C to 85°C | 8-USON (4x4mm) | |
| MX25U1635EZNI-10G | 104 | -40°C to 85°C | 8-WSON (6x5mm) | |

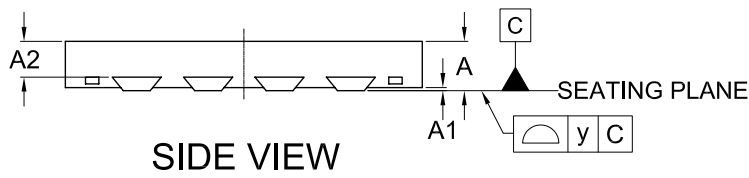
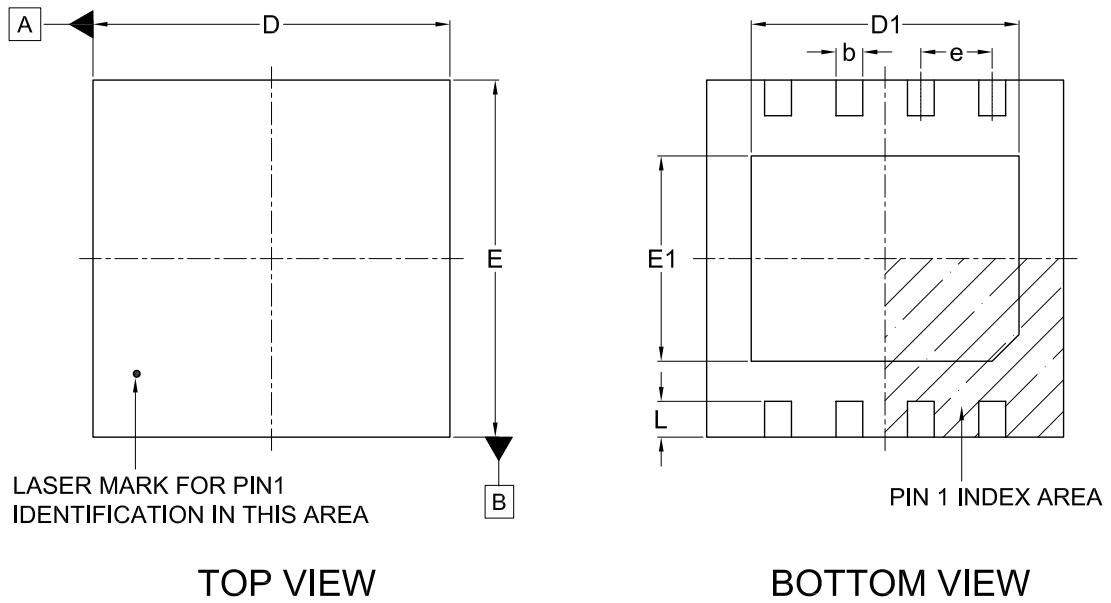
18. PART NAME DESCRIPTION



19. PACKAGE INFORMATION

19-1. 8-land USON (4x4mm)

Doc. Title: Package Outline for USON 8L (4x4x0.6MM, LEAD PITCH 0.8MM)



Note:

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

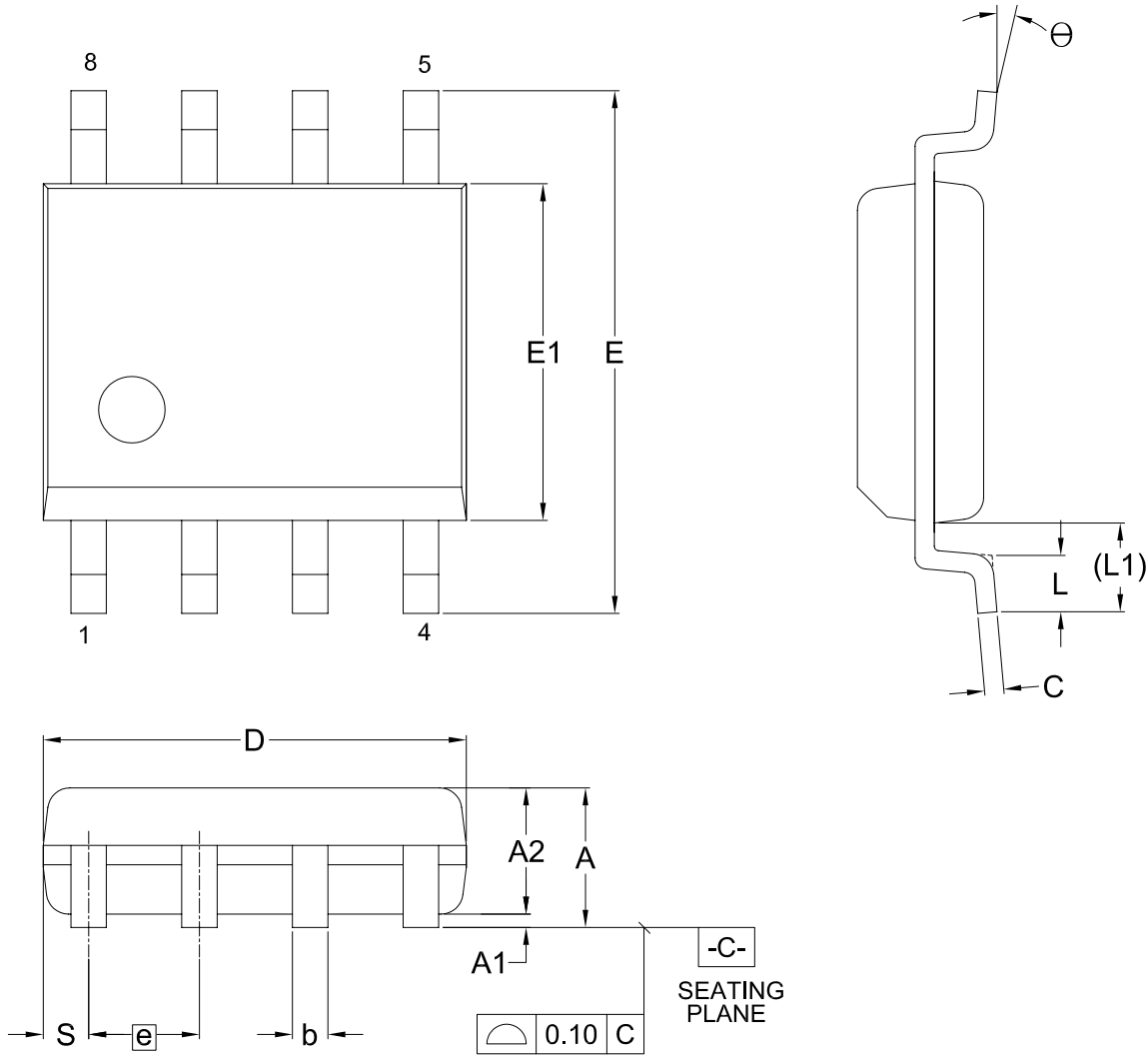
Dimensions (inch dimensions are derived from the original mm dimensions)

| SYMBOL | | A | A1 | A2 | b | D | D1 | E | E1 | L | e | y |
|--------|------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| mm | Min. | 0.50 | --- | --- | 0.25 | 3.90 | 2.90 | 3.90 | 2.20 | 0.35 | --- | 0.00 |
| | Nom. | 0.55 | 0.04 | 0.40 | 0.30 | 4.00 | 3.00 | 4.00 | 2.30 | 0.40 | 0.80 | --- |
| | Max. | 0.60 | 0.05 | 0.43 | 0.35 | 4.10 | 3.10 | 4.10 | 2.40 | 0.45 | --- | 0.08 |
| Inch | Min. | 0.020 | --- | --- | 0.010 | 0.154 | 0.114 | 0.154 | 0.087 | 0.014 | --- | 0.00 |
| | Nom. | 0.022 | 0.002 | 0.016 | 0.011 | 0.157 | 0.118 | 0.157 | 0.091 | 0.016 | 0.031 | --- |
| | Max. | 0.024 | 0.002 | 0.017 | 0.014 | 0.161 | 0.122 | 0.161 | 0.094 | 0.018 | --- | 0.003 |

| Dwg. No. | Revision | Reference | | |
|-----------|----------|-----------|------|--|
| | | JEDEC | EIAJ | |
| 6110-3601 | 5 | MO-252 | | |

19-2. 8-pin SOP (150mil)

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



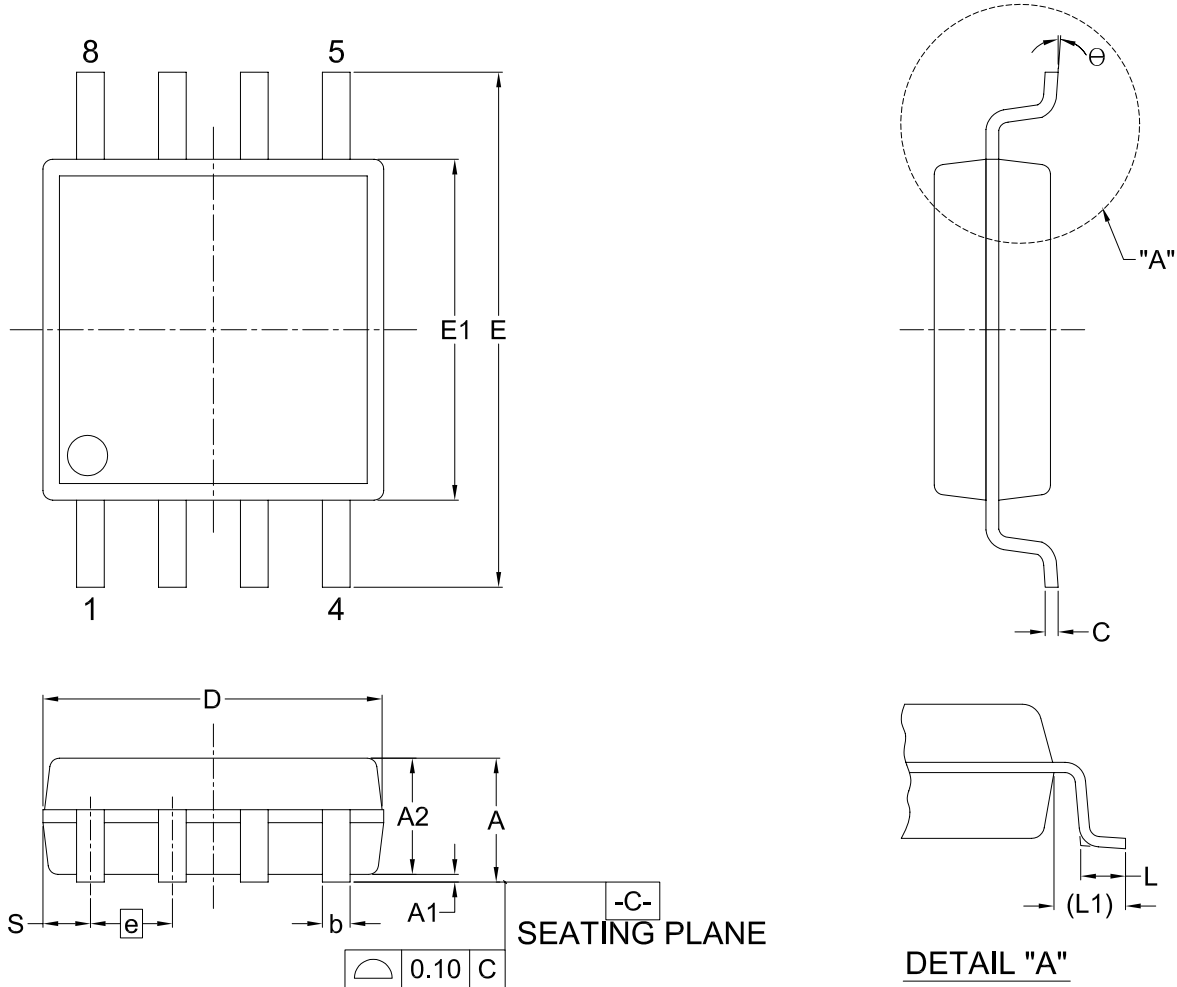
Dimensions (inch dimensions are derived from the original mm dimensions)

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

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

19-3. 8-pin SOP (200mil)

Doc. Title: Package Outline for SOP 8L 200MIL (official name - 209MIL)



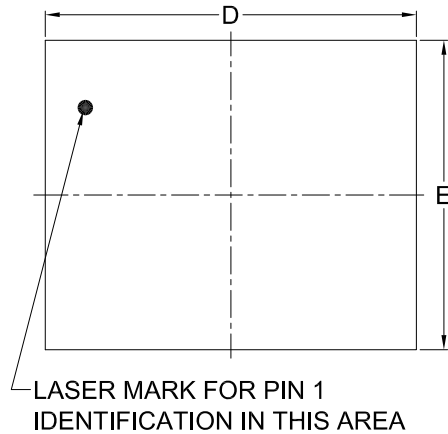
Dimensions (inch dimensions are derived from the original mm dimensions)

| SYMBOL | | A | A1 | A2 | b | C | D | E | E1 | e | L | L1 | S | Θ |
|--------|------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|----------|
| UNIT | | | | | | | | | | | | | | |
| mm | Min. | 1.75 | 0.05 | 1.70 | 0.36 | 0.19 | 5.13 | 7.70 | 5.18 | -- | 0.50 | 1.21 | 0.62 | 0° |
| | Nom. | 1.95 | 0.15 | 1.80 | 0.41 | 0.20 | 5.23 | 7.90 | 5.28 | 1.27 | 0.65 | 1.31 | 0.74 | 5° |
| | Max. | 2.16 | 0.20 | 1.91 | 0.51 | 0.25 | 5.33 | 8.10 | 5.38 | -- | 0.80 | 1.41 | 0.88 | 8° |
| Inch | Min. | 0.069 | 0.002 | 0.067 | 0.014 | 0.007 | 0.202 | 0.303 | 0.204 | -- | 0.020 | 0.048 | 0.024 | 0° |
| | Nom. | 0.077 | 0.006 | 0.071 | 0.016 | 0.008 | 0.206 | 0.311 | 0.208 | 0.050 | 0.026 | 0.052 | 0.029 | 5° |
| | Max. | 0.085 | 0.008 | 0.075 | 0.020 | 0.010 | 0.210 | 0.319 | 0.212 | -- | 0.031 | 0.056 | 0.035 | 8° |

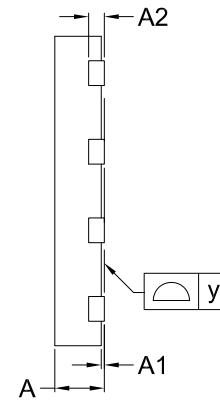
| Dwg. No. | Revision | Reference | | |
|-----------|----------|-----------|------|--|
| | | JEDEC | EIAJ | |
| 6110-1406 | 5 | | | |

19-4. 8-land WSON (6x5mm)

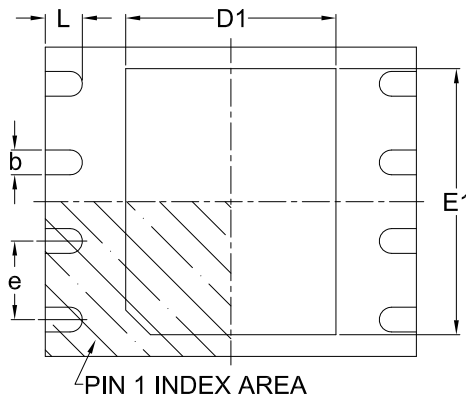
Doc. Title: Package Outline for WSON 8L (6x5x0.8MM, LEAD PITCH 1.27MM)



TOP VIEW



SIDE VIEW



BOTTOM VIEW

Note:

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

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

| SYMBOL | | A | A1 | A2 | b | D | D1 | E | E1 | L | e | y |
|--------|------|-------|-------|-------|-------|-------|-------|-------|-------|-------|------|-------|
| mm | Min. | 0.70 | --- | --- | 0.35 | 5.90 | 3.30 | 4.90 | 3.90 | 0.50 | --- | 0.00 |
| | Nom. | --- | --- | 0.20 | 0.40 | 6.00 | 3.40 | 5.00 | 4.00 | 0.60 | 1.27 | --- |
| | Max. | 0.80 | 0.05 | --- | 0.48 | 6.10 | 3.50 | 5.10 | 4.10 | 0.75 | --- | 0.05 |
| Inch | Min. | 0.028 | --- | --- | 0.014 | 0.232 | 0.129 | 0.193 | 0.154 | 0.020 | --- | 0.00 |
| | Nom. | --- | --- | 0.008 | 0.016 | 0.236 | 0.134 | 0.197 | 0.157 | 0.024 | 0.05 | --- |
| | Max. | 0.032 | 0.002 | --- | 0.019 | 0.240 | 0.138 | 0.201 | 0.161 | 0.030 | --- | 0.002 |

| Dwg. No. | Revision | Reference | | |
|-----------|----------|-----------|------|--|
| | | JEDEC | EIAJ | |
| 6110-3401 | 8 | MO-220 | | |

20. REVISION HISTORY

| Revision No. | Description | Page | Date |
|---------------------|---|-------------|-------------|
| 0.01 | 1. Added MXSMIO™ logo and 4 I/O 104MHz specifications | P6 | JUL/24/2009 |
| | 2. Take out 8WSON and 200mil 8-SOP package outline | P9 | |
| | 3. Added software reset | P11 | |
| | 4. Corrected supporting instructions | P16 | |
| | 5. Modified dummy cycle numbers (from 2 to 4) | P17 | |
| | 6. Added QPI, Write suspend/resume commands | P19 | |
| | 7. Added QPI operations in the command descriptions | ALL | |
| | 8. AC/DC modifications; Write suspend features modify | P6,38,39,45 | |
| | 9. Updated SPI & QPI commands & descriptions | ALL | |
| | 10. Remove loading relevance to clock rate | P6 | |
| | 11. Modify 32Mb WSON package as USON package | P7 | |
| | 12. Add WIP, WEL polling sequence description | P22 | |
| | 13. Add description about performance enhance mode not supported in 2-I/O mode | P27 | |
| | 14. Add 104MHz note in fTSCCLK | P45 | |
| | 15. Added 8-SOP 200mil package for 16Mb; modified 32Mb from USON to WSON | P7 | |
| | 16. Added 8WSON package information | P9 | |
| | 17. Added RDSR flow charts | P22~24 | |
| | 18. Change CFIRD command from A5 to 5A | P19,40,41 | |
| | 19. Modified EPN for package information correction and speed grade (from -12G to -10G) | P70,71 | |
| | 20. Modified Erase/Program time spec | P6,48,69 | |
| | 21. Added program/erase flow description | P22,23 | |
| | 22. Modified performance enhance mode toggling description | P56 | |
| | 23. Revised fast program time and byte program time | P6 | |
| | 24. Added WRSCUR and WPSEL in WEL reset situation | P11 | |
| | 25. Modified Recovery Time from Read | P48,66 | |
| 0.02 | 1. Modified "QE bit" description | P25 | |
| | 2. Modified four I/O and QPI mode description | P11,20 | |
| | 3. Modified Release read Enable description | P19,28 | |
| | 4. Changed title from "Advanced Information" to "Preliminary" | P6 | |
| | 5. Added MX25U8035E and MX25U8035E function | All | |
| 0.03 | 1. Revised tCE | P50,71 | JAN/27/2009 |
| | 2. Deleted tREHZ | P50 | |
| 1.0 | 1. Removed "Preliminary" | P6 | APR/01/2010 |
| | 2. Low Power Consumption: modified current description | P6,49 | |
| | 3. Table 10. AC CHARACTERISTICS: modified Min. tSLCH/tCHSH | P50 | |
| | 4. Modified Figure 40 | P70 | |
| | 5. Added Figure 41 | P71 | |
| | 6. Modified General Description | P8 | |
| | 7. Modified Fast Erase Time | P6 | |
| | 8. Modified Page Program Cycle Time from 0.9ms to 1.2ms | P6,50 | |
| | 9. Modified "Read DMC mode (RDDMC)" description | P42 | |
| | 10. Changed the naming "CFI mode" as "DMC mode" | P18,22,42 | |
| | 11. Added dummy description | P22 | |
| | 12. Modified figure 38 | P68 | |

| Revision No. | Description | Page | Date |
|---------------------|---|-------------------------------|-------------|
| 1.1 | 1. Removed DMC sequence description & content table | P18,22,42 | JUL/06/2010 |
| 1.2 | 1. Remove "Advanced Information" in the package information and part number section | P7,74 | SEP/16/2010 |
| | 2. Added NC/SIO3 description | P7,10 | |
| | 3. Added RDSCUR & WRSCUR waveforms | P65,66 | |
| | 4. Modified WRSCUR description | P38 | |
| 1.3 | 1. Removed MX25U8035E | | NOV/26/2010 |
| 1.4 | 1. Removed the QPI support in RES command | P21,34,63 | SEP/29/2011 |
| | 2. Modified tCH/tCL(4PP and Normal Read) from 15ns to 4.5ns | P50 | |
| | 3. Modified Write Protection Selection (WPSEL) description | P38,39 | |
| | 4. Modified tSLCH, tCHSL & tCHDX | P50 | |
| | 5. Modified CIN/COUT (max.) from 6pF/8pF to 10pF/25pF | P47 | |
| | 6. Revised Ordering Information table | P75 | |
| 1.5 | 1. Added Read SFDP (RDSFDP) Mode | P7,17,20, P46~55,60 | FEB/10/2012 |
| 1.6 | 1. Modified Program/Erase Suspend/Resume latency | P43~44,80 | NOV/07/2012 |
| | 2. Modified content and descriptions | P18,23~25,33 P43~44,64,76 | |
| 1.7 | 1. Modified tCLQX value in AC Characteristics Table | P60 | DEC/12/2012 |
| 1.8 | 1. Modified Data Retention value | P6,78 | MAY/03/2013 |
| | 2. Modified tCH, tCL and its value in AC Characteristics Table | P54 | |
| | 3. Modified Features Page to sync with AC Characteristics Table | P6 | |
| | 4. Correct Symbol in Reset Sequence (QPI mode) Figure | P73 | |
| | 5. Removed MX25U3235E | All | |
| 1.9 | 1. Updated parameters for DC/AC Characteristics | P6,53,54 | NOV/08/2013 |
| | 2. Updated Erase and Programming Performance | P6,78 | |
| | 3. Modified VCC to Ground Potential | P51 | |
| 2.0 | 1. Modified content in Section 9-32. Erase Suspend | P42 | APR/22/2014 |
| 2.1 | 1. Updated "19-2. 8-pin SOP (150mil)" | P82 | SEP/29/2016 |
| | 2. Updated "19-3. 8-pin SOP (200mil)" | P83 | |
| | 3. Updated "19-4. 8-land WSON (6x5mm)" | P84 | |
| | 4. Updated "5. BLOCK DIAGRAM" | P11 | |
| | 5. Modified Note 6 of SFDP Tables | P49 | |
| | 6. Content modification | P1,7,19,23, 26~27,30~32,53 | |
| | 7. Revised the Performance Enhance Mode descriptions | P28,62,71~72 | |
| | 8. Updated tVR values. | P75 | |



Except for customized products which have been expressly identified in the applicable agreement, Macronix's products are designed, developed, and/or manufactured for ordinary business, industrial, personal, and/or household applications only, and not for use in any applications which may, directly or indirectly, cause death, personal injury, or severe property damages. In the event Macronix products are used in contradicted to their target usage above, the buyer shall take any and all actions to ensure said Macronix's product qualified for its actual use in accordance with the applicable laws and regulations; and Macronix as well as it's suppliers and/or distributors shall be released from any and all liability arisen therefrom.

Copyright© Macronix International Co., Ltd. 2009~2016. All rights reserved, including the trademarks and tradename thereof, such as Macronix, MXIC, MXIC Logo, MX Logo, Integrated Solutions Provider, NBit, Nbit, NBiit, Macronix NBit, eLiteFlash, HybridNVM, HybridFlash, XtraROM, Phines, KH Logo, BE-SONOS, KSMC, Kingtech, MXSMIO, Macronix vEE, Macronix MAP, Rich Audio, Rich Book, Rich TV, and FitCAM. The names and brands of third party referred thereto (if any) are for identification purposes only.

Looking for pricing, stock, or lifecycle information?

Click below to explore more details on WIN SOURCE:

 [View MX25U1635EM1I-10G on WIN SOURCE](#)

 [Macronix Information](#)

Optimize Your Supply Chain with WIN SOURCE Solutions

-  Global Sourcing Solution
-  Obsolete Management
-  Cost Control Management
-  Shortage Management
-  Alternative Solution
-  Excess Inventory Management