# MX25L12845G

## 3V, 128M-BIT [x 1/x 2/x 4]
## CMOS MXSMIO® (SERIAL MULTI I/O)
## FLASH MEMORY

### *Key Features*

- *Protocol Support - Single I/O, Dual I/O and Quad I/O*
- *Supports DTR (Double Transfer Rate) Mode*
- *Supports clock frequencies up to 133MHz*

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# 3V 128M-BIT [x 1/x 2/x 4] CMOS MXSMIO® (SERIAL MULTI I/O) FLASH MEMORY

## 1. FEATURES

### GENERAL

- Supports Serial Peripheral Interface -- Mode 0 and Mode 3
- Single Power Supply Operation
  - 2.7 to 3.6 volts for read, erase, and program operations
- 134,217,728 x 1 bit structure
  or 67,108,864 x 2 bits (two I/O mode) structure
  or 33,554,432 x 4 bits (four I/O mode) structure
- Protocol Support
  - Single I/O, Dual I/O and Quad I/O
- Latch-up protected to 100mA from -1V to Vcc +1V
- Low Vcc write inhibit is from 1.5V to 2.5V
- Fast read for SPI mode
  - Supports clock frequency up to 133MHz for all protocols
  - Supports Fast Read, 2READ, DREAD, 4READ, QREAD instructions
  - Supports DTR (Double Transfer Rate) Mode
  - Configurable dummy cycle number for fast read operation
- Supports Performance Enhance Mode - XIP (execute-in-place)
- Quad Peripheral Interface (QPI) available
- Equal 4K byte sectors, or Equal Blocks with 32K bytes or 64K bytes each
  - Any Block can be erased individually
- Programming:
  - 256byte page buffer
  - Quad Input/Output page program(4PP) to enhance program performance
- 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 and T/B status bits define the size of the area to be protected against program and erase instructions
  - Individual sector protection function (Solid Protect)
- Additional 4K bit security OTP
  - Features unique identifier
  - Factory locked identifiable, and customer lockable
- Command Reset
- Program/Erase Suspend and Resume operation
- 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
- Supports 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
  - No connection or Serial Data Input/Output for 4 x I/O read mode
- RESET#
  - Hardware Reset pin
- RESET#/SIO3
  - Hardware Reset pin or Serial Data Input/Output for 4 x I/O read mode
- PACKAGE
  - 16-pin SOP (300mil)
  - 8-pins SOP (200mil)
  - 8-land WSON (8x6mm, 6x5mm)
  - 24-ball BGA (4x6 ball array)
  - 24-Ball BGA (5x5 ball array)
  - **All devices are RoHS Compliant and Halogen-free**



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## 2. GENERAL DESCRIPTION

MX25L12845G is 128Mb bits Serial NOR Flash memory, which is configured as 16,777,216 x 8 internally. When it is in two or four I/O mode, the structure becomes 67,108,864 bits x 2 or 33,554,432 bits x 4. MX25L12845G features 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# and RESET# pin (of the 8-pin packages) become SIO0 pin, SIO1 pin, SIO2 pin and SIO3 pin for address/dummy bits input and data output.

The MX25L12845G 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.

When the device is not in operation and CS# is high, it is put in standby mode.

The MX25L12845G utilizes Macronix's proprietary memory cell, which reliably stores memory contents even after 100,000 program and erase cycles.

**Table 1. Read performance Comparison**

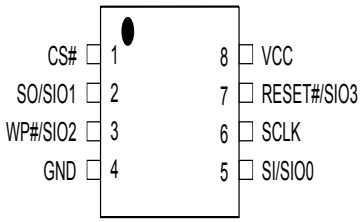
| Numbers of Dummy Cycles | Fast Read (MHz) | Dual Output Fast Read (MHz) | Quad Output Fast Read (MHz) | Dual IO Fast Read (MHz) | Quad IO Fast Read (MHz) | Quad I/O DT Read (MHz) |
|---|---|---|---|---|---|---|
| 4 | - | - | - | 80* | 54 | - |
| 6 | - | - | - | - | 80* | 54* |
| 8 | 120*/133R | 120*/133R | 120*/133R | 120/133R | 84/104R | 70/80R |
| 10 | - | - | - | - | 120/133R | 84/100R |

**Notes:**
1. * Default Status.
2. R mean VCC range = 3.0V-3.6V.

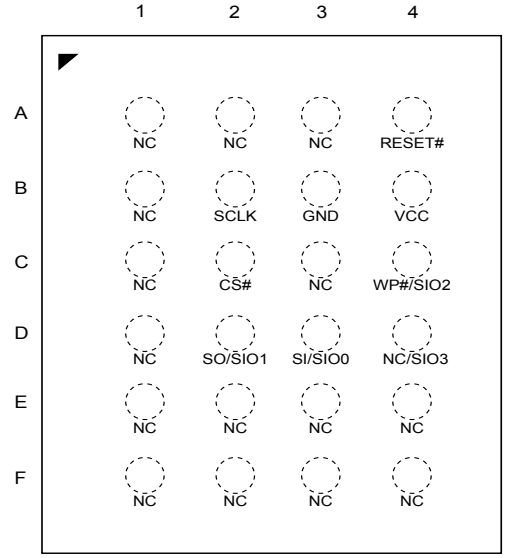

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## 3. PIN CONFIGURATIONS

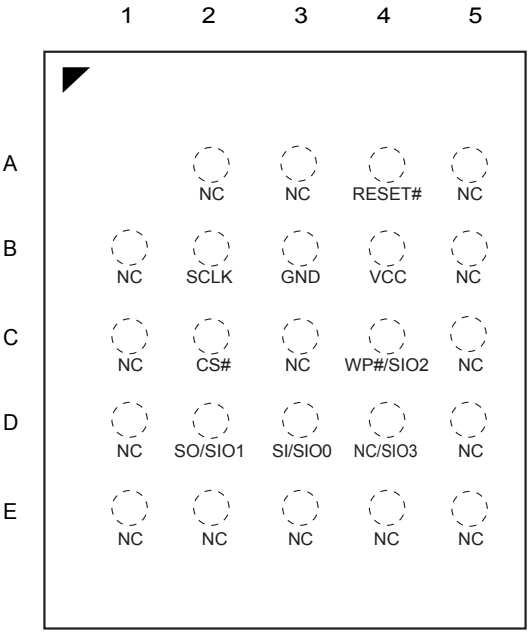
### 8-PIN SOP (200mil)



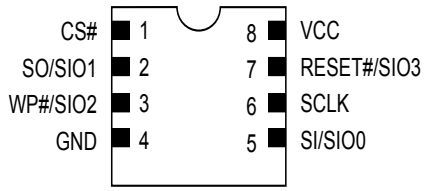

### 24-Ball BGA (4x6 ball array)



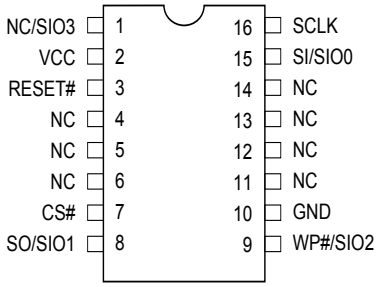

### 24-Ball BGA (5x5 ball array)




### 8-WSON (8x6mm, 6x5mm)




### 16-PIN SOP (300mil)




## 4. PIN DESCRIPTION

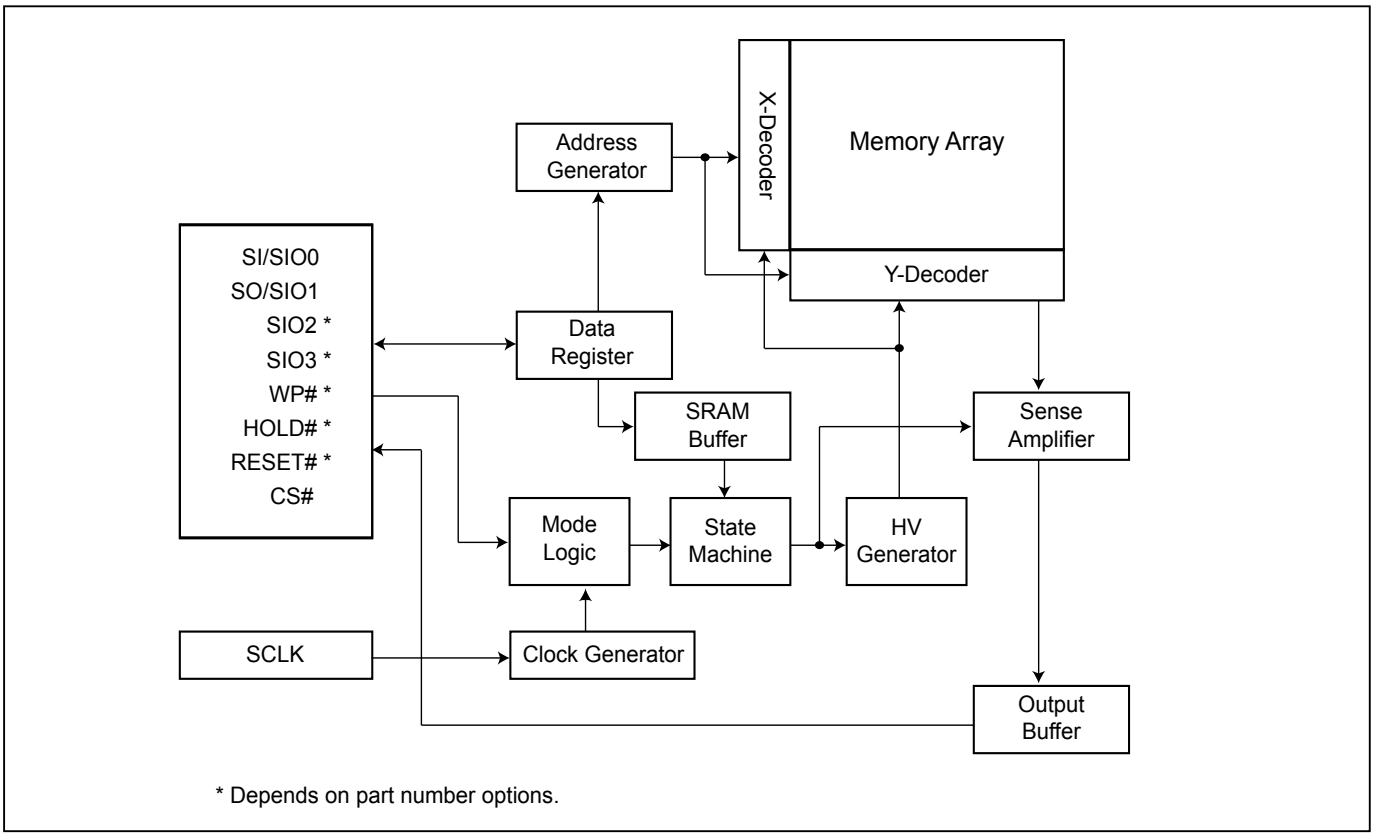
| SYMBOL | DESCRIPTION |
|---|---|
| CS# | Chip Select |
| SI/SIO0 | Serial Data Input (for 1 x I/O)/ Serial Data Input & Output (for 2xI/O or 4xI/O read mode) |
| SO/SIO1 | Serial Data Output (for 1 x I/O)/ Serial Data Input & Output (for 2xI/O or 4xI/O read mode) |
| SCLK | Clock Input |
| WP#*/SIO2 | Write Protection Active Low or Serial Data Input & Output (for 4xI/O read mode) |
| RESET#*/SIO3 | Hardware Reset Pin Active low or Serial Data Input & Output (for 4xI/O read mode) |
| NC/SIO3 | NC or Serial Data Input & Output (for 4xI/O read mode) |
| RESET#* | Hardware Reset Pin Active low |
| VCC | + 3V Power Supply |
| GND | Ground |
| NC | No Connection |

***Notes:***

1. The pin of RESET# or WP#/SIO2 will remain internal pull up function while this pin is not physically connected in system configuration. However, the internal pull up function will be disabled if the system has physical connection to RESET# or WP#/SIO2 pin.
2. RESET#/SIO3 pin must be controlled by the system, while it functions as hardware RESET pin.
3. RESET#/SIO3 pin must be connected to VCC (Floating is not allowed), if the system is not using the functions of either 4 x IO or hardware RESET.


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## 5. BLOCK DIAGRAM





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## 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.

- Valid command length checking: The command length will be checked whether it is at byte base and completed on byte boundary.
- Write Enable (WREN) command: WREN command is required to set the Write Enable Latch bit (WEL) before other commands to change data.
- 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.


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**I. Block lock protection**

- The Software Protected Mode (SPM) use (BP3, BP2, BP1, BP0 and T/B) 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**

**Protected Area Sizes (T/B bit = 0)**

| Status bit | | | | Protect Level |
|---|---|---|---|---|
| BP3 | BP2 | BP1 | BP0 | 128Mb |
| 0 | 0 | 0 | 0 | 0 (none) |
| 0 | 0 | 0 | 1 | 1 (1 block, protected block 255th) |
| 0 | 0 | 1 | 0 | 2 (2 blocks, block 254th-255th) |
| 0 | 0 | 1 | 1 | 3 (4 blocks, block 252nd-255th) |
| 0 | 1 | 0 | 0 | 4 (8 blocks, block 248th-255th) |
| 0 | 1 | 0 | 1 | 5 (16 blocks, block 240th-255th) |
| 0 | 1 | 1 | 0 | 6 (32 blocks, block 224th-255th) |
| 0 | 1 | 1 | 1 | 7 (64 blocks, block 192nd-255th) |
| 1 | 0 | 0 | 0 | 8 (128 blocks, block 128th-255th) |
| 1 | 0 | 0 | 1 | 9 (256 blocks, protected all) |
| 1 | 0 | 1 | 0 | 10 (256 blocks, protected all) |
| 1 | 0 | 1 | 1 | 11 (256 blocks, protected all) |
| 1 | 1 | 0 | 0 | 12 (256 blocks, protected all) |
| 1 | 1 | 0 | 1 | 13 (256 blocks, protected all) |
| 1 | 1 | 1 | 0 | 14 (256 blocks, protected all) |
| 1 | 1 | 1 | 1 | 15 (256 blocks, protected all) |

**Protected Area Sizes (T/B bit = 1)**

| Status bit | | | | Protect Level |
|---|---|---|---|---|
| BP3 | BP2 | BP1 | BP0 | 128Mb |
| 0 | 0 | 0 | 0 | 0 (none) |
| 0 | 0 | 0 | 1 | 1 (1 block, protected block 0th) |
| 0 | 0 | 1 | 0 | 2 (2 blocks, protected block 0th-1st) |
| 0 | 0 | 1 | 1 | 3 (4 blocks, protected block 0th-3rd) |
| 0 | 1 | 0 | 0 | 4 (8 blocks, protected block 0th-7th) |
| 0 | 1 | 0 | 1 | 5 (16 blocks, protected block 0th-15th) |
| 0 | 1 | 1 | 0 | 6 (32 blocks, protected block 0th-31st) |
| 0 | 1 | 1 | 1 | 7 (64 blocks, protected block 0th-63rd) |
| 1 | 0 | 0 | 0 | 8 (128 blocks, protected block 0th-127th) |
| 1 | 0 | 0 | 1 | 9 (256 blocks, protected all) |
| 1 | 0 | 1 | 0 | 10 (256 blocks, protected all) |
| 1 | 0 | 1 | 1 | 11 (256 blocks, protected all) |
| 1 | 1 | 0 | 0 | 12 (256 blocks, protected all) |
| 1 | 1 | 0 | 1 | 13 (256 blocks, protected all) |
| 1 | 1 | 1 | 0 | 14 (256 blocks, protected all) |
| 1 | 1 | 1 | 1 | 15 (256 blocks, protected all) |


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**II. Additional 4K-bit secured OTP** for an unique identifier to provide an 4K-bit one-time program area for setting a device unique serial number. This may be accomplished in the factory or by an end systems customer.

- Security register bit 0 indicates whether the secured OTP area is locked by factory or not.

- The 4K-bit secured OTP area is programmed by entering secured OTP mode (with the Enter Security OTP command), and going through a normal program procedure. Exiting secured OTP mode is done by issuing the Exit Security OTP 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 12. 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 | |


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## 7. Memory Organization

### Table 4. Memory Organization

| Block(64K-byte) | Block(32K-byte) | Sector | Address Range | |
|---|---|---|---|---|
| 255 | 511 | 4095 | FFF000h | FFFFFFh |
| | | ⋮ | | |
| | | 4088 | FF8000h | FF8FFFh |
| | 510 | 4087 | FF7000h | FF7FFFh |
| | | ⋮ | | |
| | | 4080 | FF0000h | FF0FFFh |
| 254 | 509 | 4079 | FEF000h | FEFFFFh |
| | | ⋮ | | |
| | | 4072 | FE8000h | FE8FFFh |
| | 508 | 4071 | FE7000h | FE7FFFh |
| | | ⋮ | | |
| | | 4064 | FE0000h | FE0FFFh |
| 253 | 507 | 4063 | FDF000h | FDFFFFh |
| | | ⋮ | | |
| | | 4056 | FD8000h | FD8FFFh |
| | 506 | 4055 | FD7000h | FD7FFFh |
| | | ⋮ | | |
| | | 4048 | FD0000h | FD0FFFh |
| 2 | 5 | 47 | 02F000h | 02FFFFh |
| | | ⋮ | | |
| | | 40 | 028000h | 028FFFh |
| | 4 | 39 | 027000h | 027FFFh |
| | | ⋮ | | |
| | | 32 | 020000h | 020FFFh |
| 1 | 3 | 31 | 01F000h | 01FFFFh |
| | | ⋮ | | |
| | | 24 | 018000h | 018FFFh |
| | 2 | 23 | 017000h | 017FFFh |
| | | ⋮ | | |
| | | 16 | 010000h | 010FFFh |
| 0 | 1 | 15 | 00F000h | 00FFFFh |
| | | ⋮ | | |
| | | 8 | 008000h | 008FFFh |
| | 0 | 7 | 007000h | 007FFFh |
| | | ⋮ | | |
| | | 0 | 000000h | 000FFFh |

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

individual block lock/unlock unit:64K-byte

individual block lock/unlock unit:64K-byte

individual block lock/unlock unit:64K-byte

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


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## 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 an incorrect command is written to this device, it enters standby mode and stays in standby mode until the next CS# falling edge. In standby mode, This device's SO pin should be High-Z.

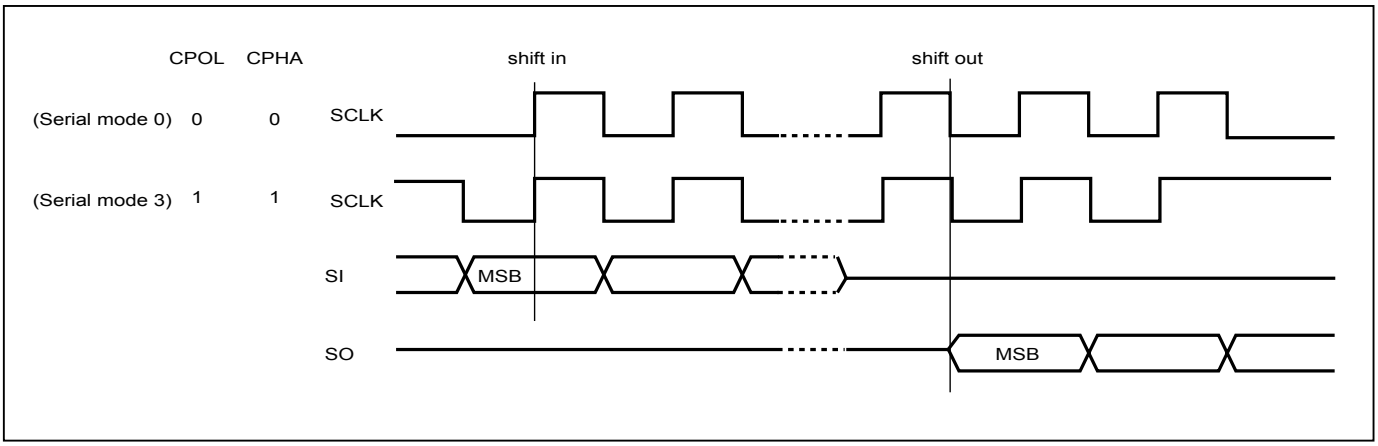
3. When a correct command is written to this device, it enters active mode and stays in active mode until the next CS# rising edge.

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, 2READ, DREAD, 4READ, QREAD, RDSFDP, RES, REMS, QPIID, RDDPB, RDSPB, RDLR, RDCR, 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, GBLK, 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 ignored and will not affect the current operation of Write Status Register, Program, or 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.


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**Figure 2. Serial Input Timing**

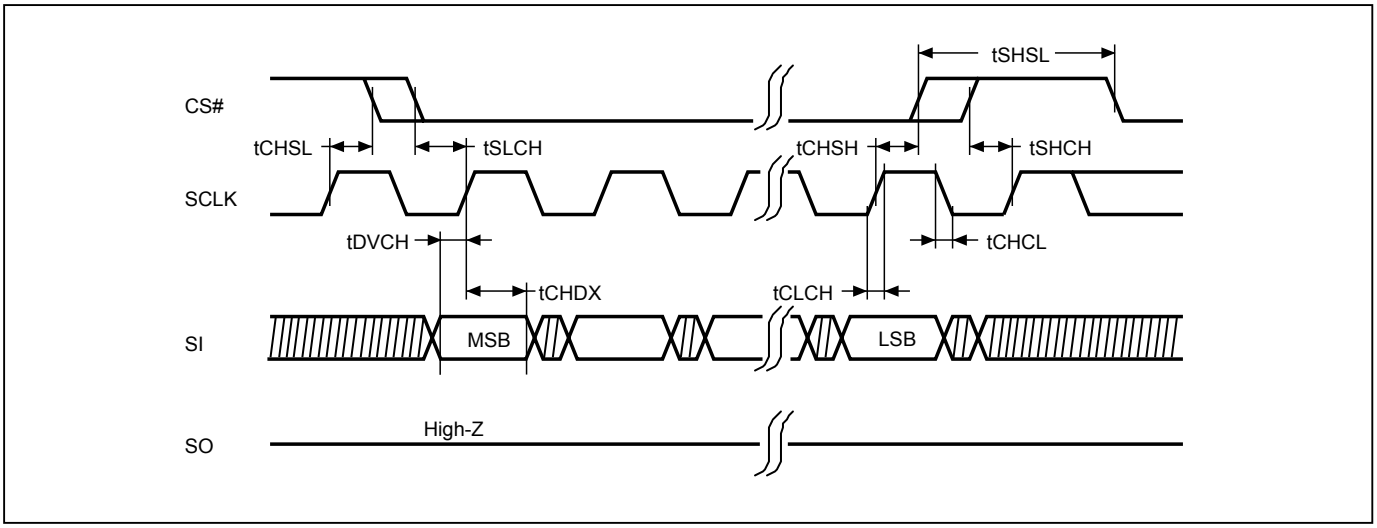
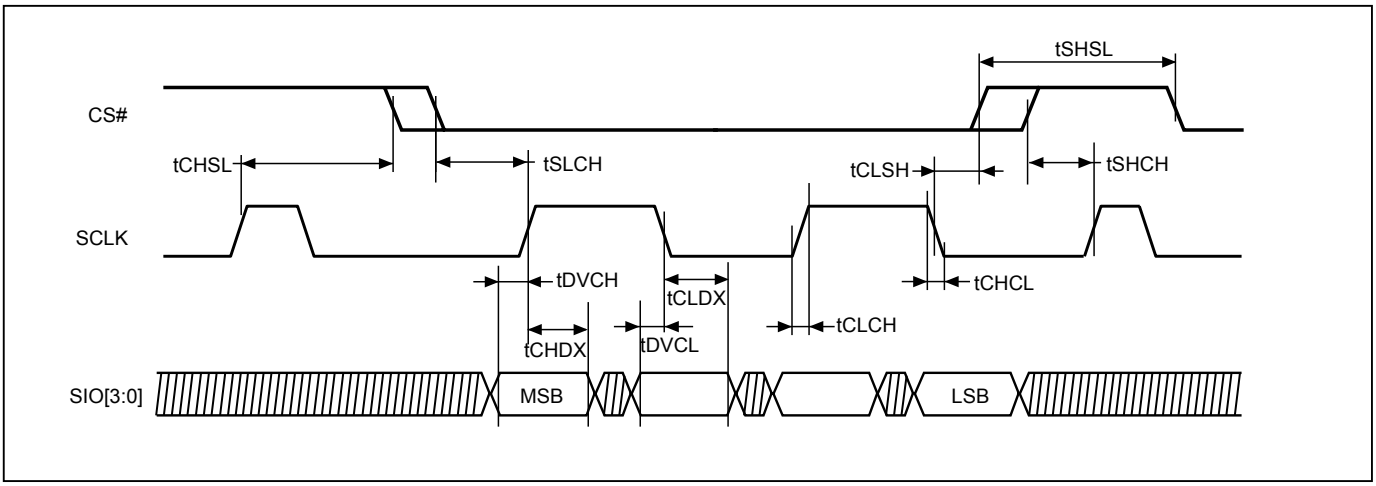



**Figure 3. Serial Input Timing (DTR mode)**





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**Figure 4. Output Timing (STR mode)**

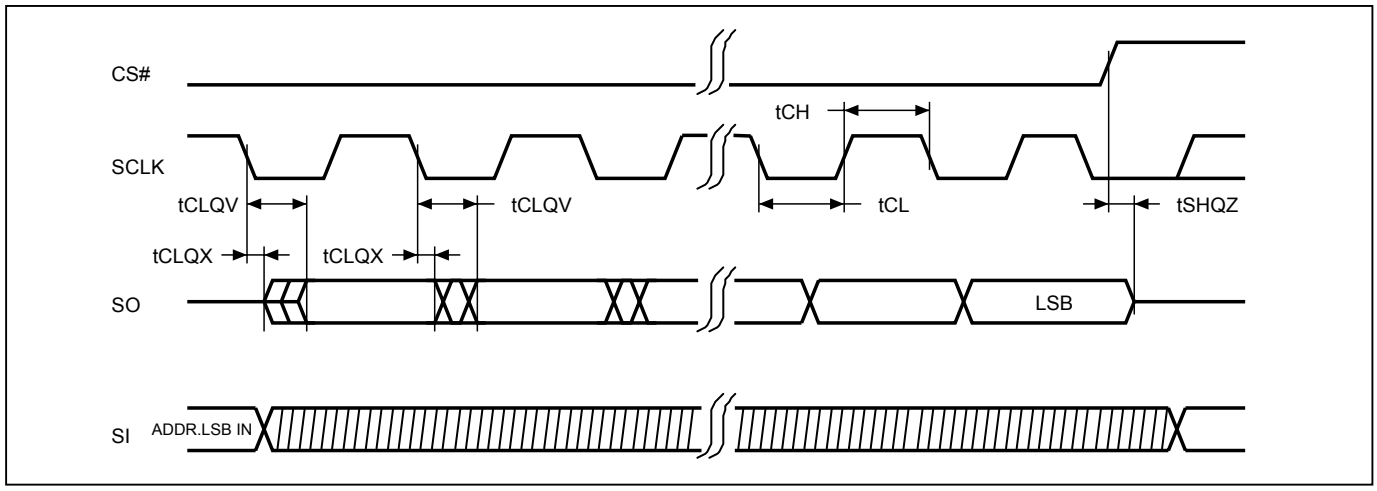
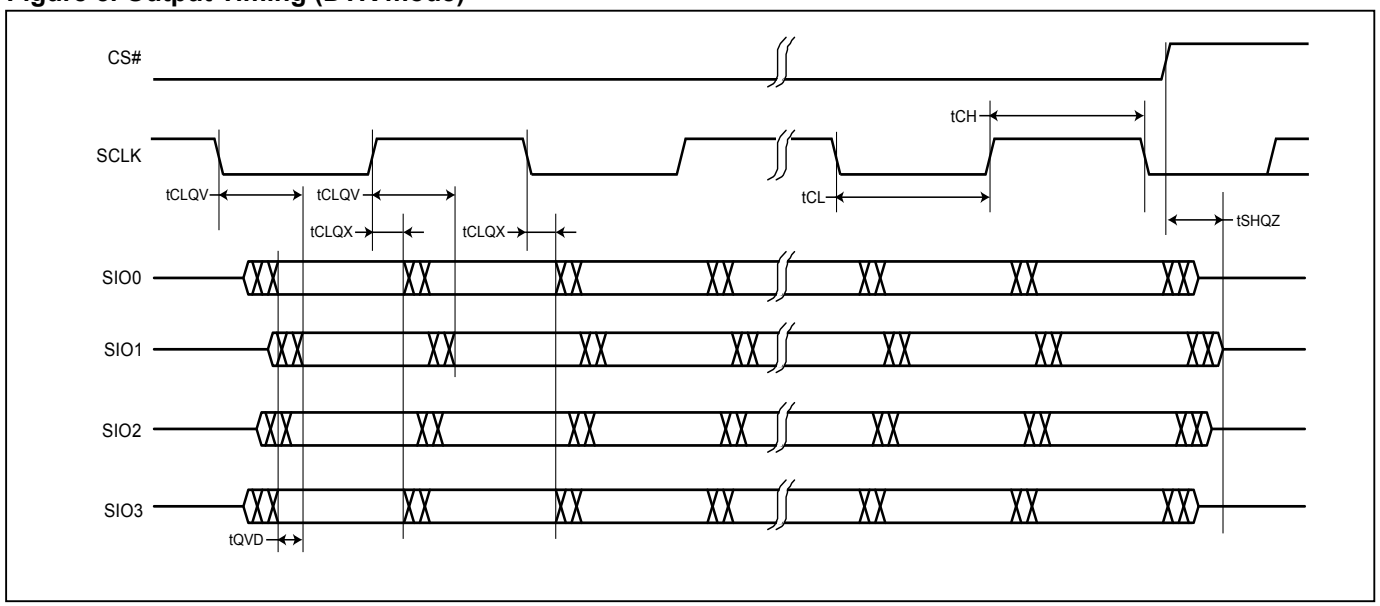



**Figure 5. Output Timing (DTR mode)**





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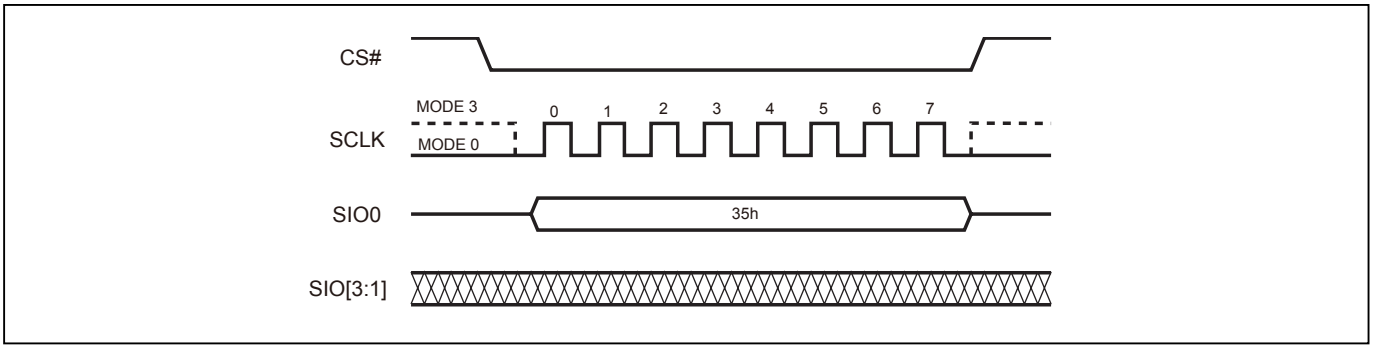
## 8-1. Quad Peripheral Interface (QPI) Read Mode

QPI protocol enables user to take full advantage of Quad I/O Serial NOR 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 EQIO(35h) command, the QPI mode is enabled. After QPI mode is enabled, the device enters quad mode (4-4-4) without QE bit status changed.

**Figure 6. Enable QPI Sequence**

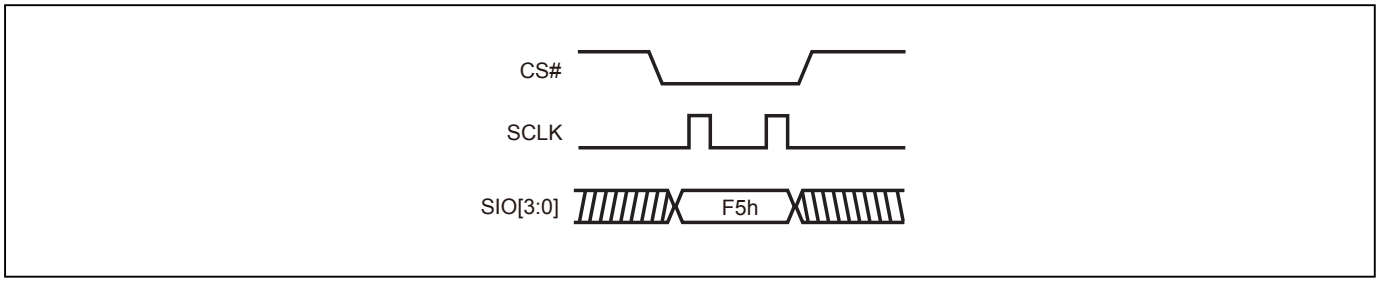



### Reset QPI (RSTQIO)

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 "From Write/Erase/Program to Read Status Register" specification of tSHSL (as defined by *"Table 25. AC CHARACTERISTICS (Temperature = -40°C to 85°C, VCC = 2.7V - 3.6V)"*) for next instruction.

**Figure 7. Reset QPI Mode**





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## 9. COMMAND DESCRIPTION

### Table 5. Command Set

**Read/Write Array Commands**

| Command (byte) | READ (normal read) | FAST READ (fast read data) | 2READ (2 x I/O read command)(Note 1) | DREAD (1I 2O read) | 4READ (4 I/O read) | QREAD (1I 4O read) | 4DTRD (Quad I/O DT Read) |
|---|---|---|---|---|---|---|---|
| Mode | SPI | SPI | SPI | SPI | SPI/QPI | SPI | SPI/QPI |
| Address Bytes | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| 1st byte | 03 (hex) | 0B (hex) | BB (hex) | 3B (hex) | EB (hex) | 6B (hex) | ED (hex) |
| 2nd byte | ADD1 | ADD1 | ADD1 | ADD1 | ADD1 | ADD1 | ADD1 |
| 3rd byte | ADD2 | ADD2 | ADD2 | ADD2 | ADD2 | ADD2 | ADD2 |
| 4th byte | ADD3 | ADD3 | ADD3 | ADD3 | ADD3 | ADD3 | ADD3 |
| 5th byte | | Dummy* | Dummy* | Dummy* | Dummy* | Dummy* | Dummy* |
| Data Cycles | | | | | | | |
| Action | n bytes read out until CS# goes high | n bytes read out until CS# goes high | n bytes read out by 2 x I/O until CS# goes high | n bytes read out by Dual output until CS# goes high | n bytes read out by 4 x I/O until CS# goes high | n bytes read out by Quad output until CS# goes high | n bytes read out (Double Transfer Rate) by 4xI/O until CS# goes high |

| Command (byte) | PP (page program) | 4PP (quad page program) | SE (sector erase) | BE 32K (block erase 32KB) | BE (block erase 64KB) | CE (chip erase) |
|---|---|---|---|---|---|---|
| Mode | SPI/QPI | SPI | SPI/QPI | SPI/QPI | SPI/QPI | SPI/QPI |
| Address Bytes | 3 | 3 | 3 | 3 | 3 | 0 |
| 1st byte | 02 (hex) | 38 (hex) | 20 (hex) | 52 (hex) | D8 (hex) | 60 or C7 (hex) |
| 2nd byte | | ADD1 | ADD1 | ADD1 | ADD1 | |
| 3rd byte | | ADD2 | ADD2 | ADD2 | ADD2 | |
| 4th byte | | ADD3 | ADD3 | ADD3 | ADD3 | |
| 5th byte | | | | | | |
| Data Cycles | 1-256 | 1-256 | | | | |
| Action | to program the selected page | quad input to program the selected page | to erase the selected sector | to erase the selected 32K block | to erase the selected block | to erase whole chip |

* Dummy cycle numbers will be different depending on the bit6 & bit 7 (DC0 & DC1) setting in configuration register.


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**Register/Setting Commands**

| Command (byte) | WREN (write enable) | WRDI (write disable) | FMEN (factory mode enable) | RDSR (read status register) | RDCR (read configuration register) | WRSR (write status/ configuration register) | WPSEL (Write Protect Selection) |
|---|---|---|---|---|---|---|---|
| Mode | SPI/QPI | SPI/QPI | SPI/QPI | SPI/QPI | SPI/QPI | SPI/QPI | SPI |
| 1st byte | 06 (hex) | 04 (hex) | 41 (hex) | 05 (hex) | 15 (hex) | 01 (hex) | 68 (hex) |
| 2nd byte | | | | | | Values | |
| 3rd byte | | | | | | Values | |
| 4th byte | | | | | | | |
| 5th byte | | | | | | | |
| Data Cycles | | | | | | 1-2 | |
| Action | sets the (WEL) write enable latch bit | resets the (WEL) write enable latch bit | enable factory mode | to read out the values of the status register | to read out the values of the configuration register | to write new values of the status/ configuration register | to enter and enable individal block protect mode |

| Command (byte) | EQIO (Enable QPI) | RSTQIO (Reset QPI) | PGM/ERS Suspend (Suspends Program/ Erase) | PGM/ERS Resume (Resumes Program/ Erase) | DP (Deep power down) | RDP (Release from deep power down) | SBL (Set Burst Length) |
|---|---|---|---|---|---|---|---|
| Mode | SPI | QPI | SPI/QPI | SPI/QPI | SPI/QPI | SPI/QPI | SPI/QPI |
| 1st byte | 35 (hex) | F5 (hex) | B0 (hex) | 30 (hex) | B9 (hex) | AB (hex) | C0 (hex) |
| 2nd byte | | | | | | | |
| 3rd byte | | | | | | | |
| 4th byte | | | | | | | |
| 5th byte | | | | | | | |
| Data Cycles | | | | | | | |
| Action | Entering the QPI mode | Exiting the QPI mode | | | enters deep power down mode | release from deep power down mode | to set Burst length |


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## ID/Security Commands

| Command (byte) | RDID (read identific-ation) | RES (read electronic ID) | REMS (read electronic manufacturer & device ID) | QPIID (QPI ID Read) | RDSFDP | ENSO (enter secured OTP) | EXSO (exit secured OTP) |
|---|---|---|---|---|---|---|---|
| Mode | SPI | SPI/QPI | SPI | QPI | SPI/QPI | SPI/QPI | SPI/QPI |
| Address Bytes | 0 | 0 | 0 | 0 | 3 | 0 | 0 |
| 1st byte | 9F (hex) | AB (hex) | 90 (hex) | AF (hex) | 5A (hex) | B1 (hex) | C1 (hex) |
| 2nd byte | | x | x | | ADD1 | | |
| 3rd byte | | x | x | | ADD2 | | |
| 4th byte | | | ADD1 | | ADD3 | | |
| 5th byte | | | | | Dummy(8)(Note 5) | | |
| Data Cycles | | | | | | | |
| 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(Note 2) | ID in QPI interface | Read SFDP mode | to enter the 4K-bit secured OTP mode | to exit the 4K-bit secured OTP mode |

| Command (byte) | RDSCUR (read security register) | WRSCUR (write security register) | WRSPB (SPB bit program) | ESSPB (all SPB bit erase) | RDSPB (read SPB status) | WRDPB (write DPB register) | RDDPB (read DPB register) |
|---|---|---|---|---|---|---|---|
| Mode | SPI/QPI | SPI/QPI | SPI | SPI | SPI | SPI | SPI |
| Address Bytes | 0 | 0 | 4 | 0 | 4 | 4 | 4 |
| 1st byte | 2B (hex) | 2F (hex) | E3 (hex) | E4 (hex) | E2 (hex) | E1 (hex) | E0 (hex) |
| 2nd byte | | | ADD1 | | ADD1 | ADD1 | ADD1 |
| 3rd byte | | | ADD2 | | ADD2 | ADD2 | ADD2 |
| 4th byte | | | ADD3 | | ADD3 | ADD3 | ADD3 |
| 5th byte | | | ADD4 | | ADD4 | ADD4 | ADD4 |
| Data Cycles | | | | | 1 | 1 | 1 |
| Action | to read value of security register | to set the lock-down bit as "1" (once lock-down, cannot be updated) | | | | | |

| Command (byte) | GBLK (gang block lock) | GBULK (gang block unlock) | WRLR (write lock register) | RDLR (read lock register) |
|---|---|---|---|---|
| Mode | SPI | SPI | SPI | SPI |
| Address Bytes | 0 | 0 | 0 | 0 |
| 1st byte | 7E (hex) | 98 (hex) | 2C (hex) | 2D (hex) |
| 2nd byte | | | | |
| 3rd byte | | | | |
| 4th byte | | | | |
| 5th byte | | | | |
| Data Cycles | | | 2 | 2 |
| Action | whole chip write protect | whole chip unprotect | | |


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### Reset Commands

| Command (byte) | NOP (No Operation) | RSTEN (Reset Enable) | RST (Reset Memory) |
|---|---|---|---|
| Mode | SPI/QPI | SPI/QPI | SPI/QPI |
| 1st byte | 00 (hex) | 66 (hex)(Note 4) | 99 (hex) |
| 2nd byte | | | |
| 3rd byte | | | |
| 4th byte | | | |
| 5th byte | | | |
| Action | | | |

Note 1: The count base is 4-bit for ADD(2) and Dummy(2) because of 2 x I/O. And the MSB is on SO/SIO1 which is different from 1 x I/O condition.
Note 2: ADD=00H will output the manufacturer ID first and ADD=01H will output device ID first.
Note 3: It is not recommended to adopt any other code not in the command definition table, which will potentially enter the hidden mode.
Note 4: The RSTEN command must be executed before executing the RST command. If any other command is issued in-between RSTEN and RST, the RST command will be ignored.
Note 5: The number in parentheses after "Dummy" stands for how many clock cycles it has.


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### 9-1. Write Enable (WREN)

The Write Enable (WREN) instruction sets the Write Enable Latch (WEL) bit. Instructions like PP, 4PP, SE, BE32K, BE, CE, and WRSR that are intended to change the device content, should be preceded by the WREN instruction.

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.

**Figure 8. Write Enable (WREN) Sequence (SPI Mode)**

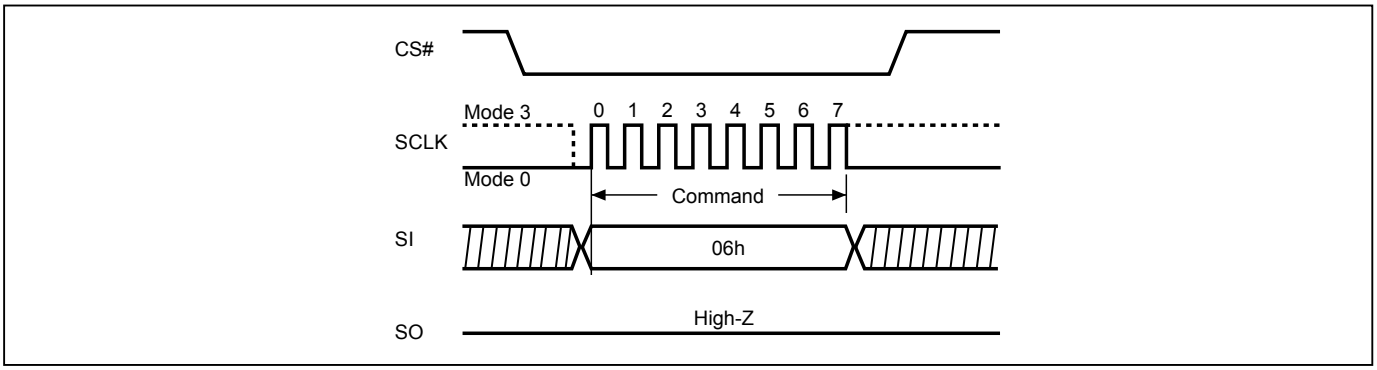
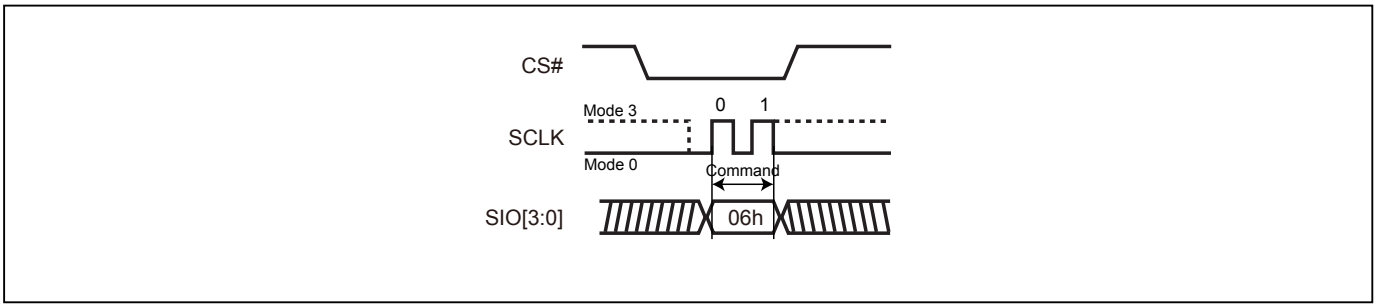



**Figure 9. Write Enable (WREN) Sequence (QPI Mode)**





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### 9-2. Write Disable (WRDI)

The Write Disable (WRDI) instruction resets the Write Enable Latch (WEL) bit.

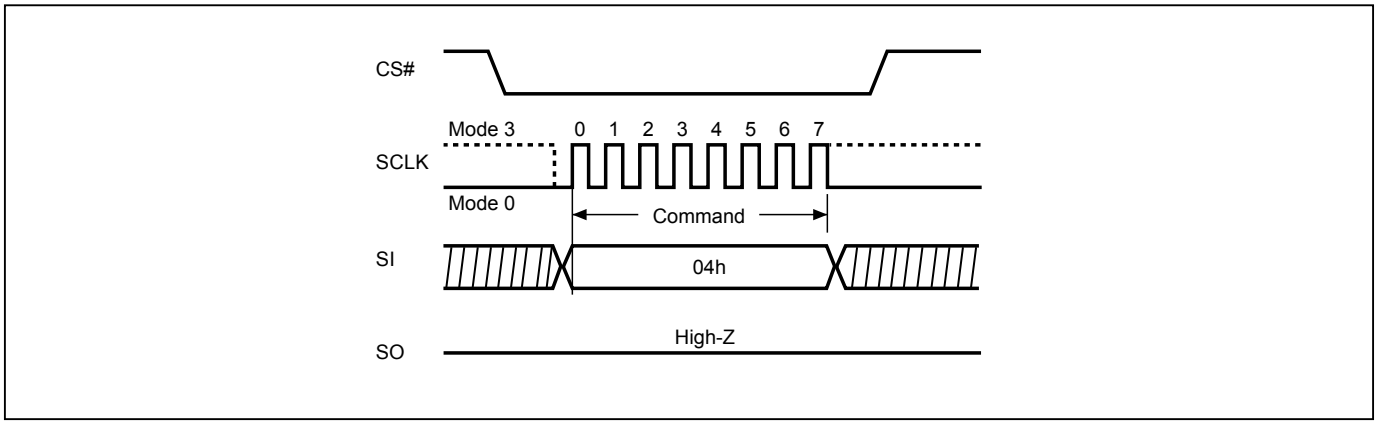
The sequence of issuing WRDI instruction is: CS# goes low→sending WRDI instruction code→CS# goes high.

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.

The WEL bit is reset in the following situations:

- Power-up
- Reset# pin driven low
- WRDI command completion
- WRSR command completion
- PP command completion
- 4PP command completion
- SE command completion
- BE32K command completion
- BE command completion
- CE command completion
- PGM/ERS Suspend command completion
- Softreset command completion
- WRSCUR command completion
- WPSEL command completion
- GBLK command completion
- GBULK command completion
- WRLR command completion
- WRSPB command completion
- WRDPB command completion
- ESSPB command completion

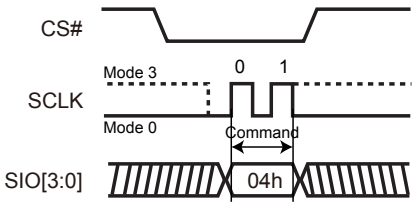
**Figure 10. Write Disable (WRDI) Sequence (SPI Mode)**





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**Figure 11. Write Disable (WRDI) Sequence (QPI Mode)**




### 9-3. Factory Mode Enable (FMEN)

The Factory Mode Enable (FMEN) instruction is for enhance Program and Erase performance for increase factory production throughput. The FMEN instruction need to combine with the instructions which are intended to change the device content, like PP, 4PP, SE, BE32K, BE, and CE.

The sequence of issuing FMEN instruction is: CS# goes low→sending FMEN instruction code→ CS# goes high. A valid factory mode operation need to included three sequences: WREN instruction → FMEN instruction→ Program or Erase instruction.

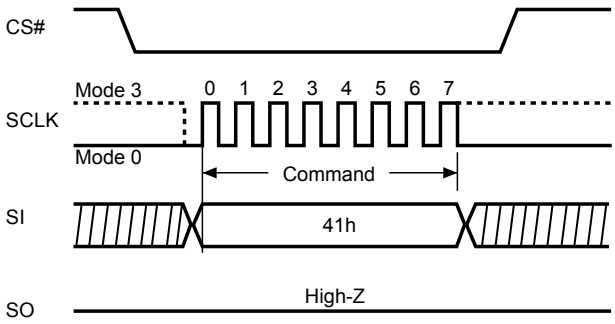
Suspend command is not acceptable under factory mode.

The FMEN is reset by following situations

- Power-up
- Reset# pin driven low
- PP command completion
- 4PP command completion
- SE command completion
- BE32K command completion
- BE command completion
- CE command completion
- Softreset command completion

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.

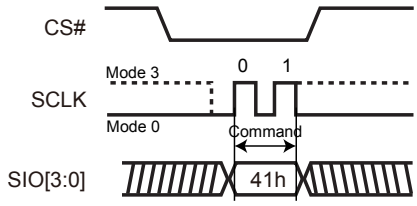
**Figure 12. Factory Mode Enable (FMEN) Sequence (SPI Mode)**





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**Figure 13. Factory Mode Enable (FMEN) Sequence (QPI Mode)**



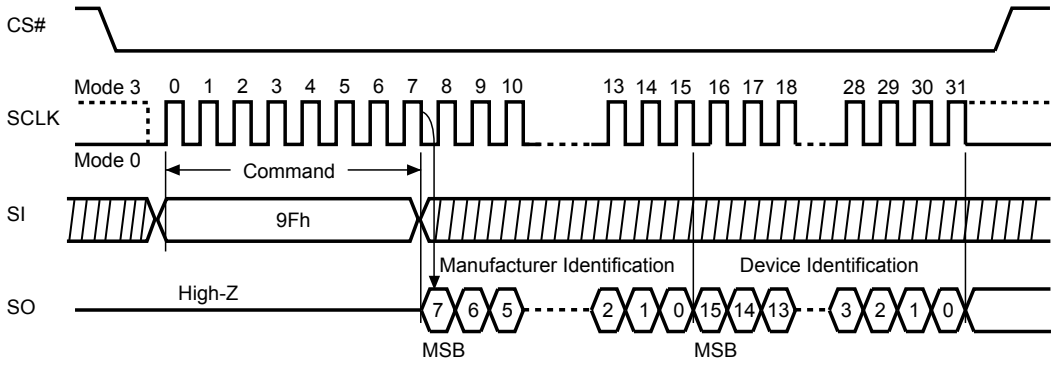

## 9-4. Read Identification (RDID)

The RDID instruction is for reading the 1-byte manufacturer ID and the 2-byte Device ID that follows. The Macronix Manufacturer ID and Device ID are listed as *"Table 6. 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.

**Figure 14. Read Identification (RDID) Sequence (SPI mode only)**





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### 9-5. 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 tRES1, and Chip Select (CS#) must remain High for at least tRES1(max), as specified in *"Table 25. AC CHARACTERISTICS (Temperature = -40°C to 85°C, VCC = 2.7V - 3.6V)"*. 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. Reset# pin goes low will release the Flash from deep power down mode.

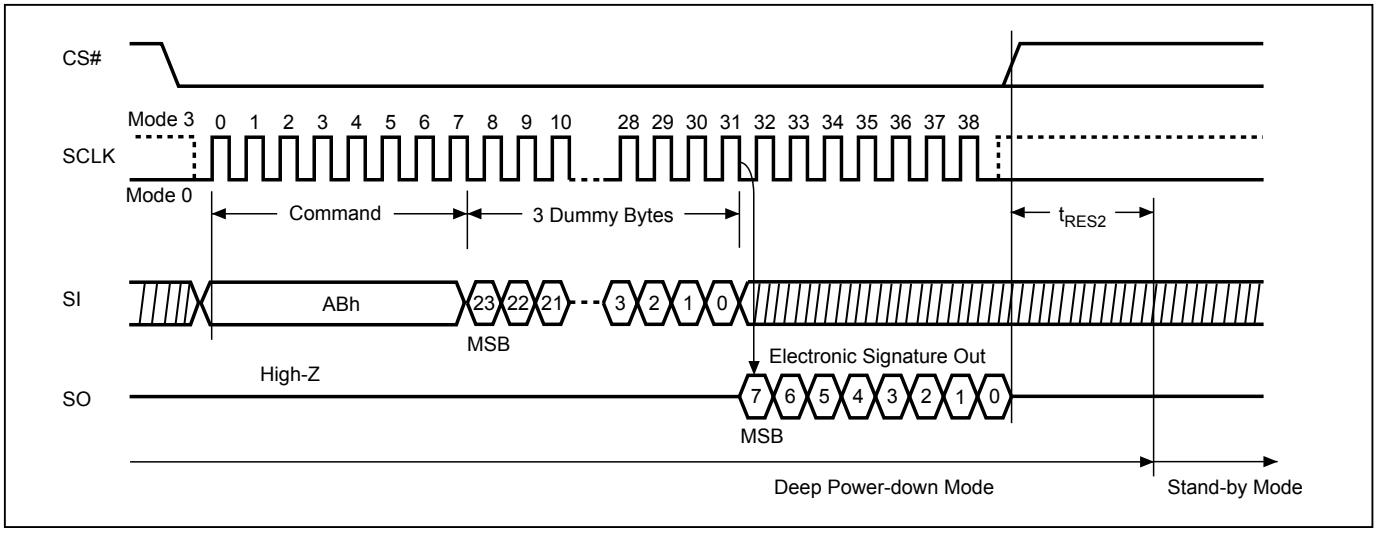
RES instruction is for reading out the old style of 8-bit Electronic Signature, whose values are shown as *"Table 6. ID Definitions"*. This is not the same as RDID instruction. It is not recommended to use for new design. For new design, please use RDID instruction.

The RDP and RES are allowed to execute in Deep power-down mode, except if the device is in progress of program/erase/write cycle; In this case, there is no effect on the current program/erase/write cycle that is in progress.

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 RES instruction ends when 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.

**Figure 15. Read Electronic Signature (RES) Sequence (SPI Mode)**





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**Figure 16. Read Electronic Signature (RES) Sequence (QPI Mode)**

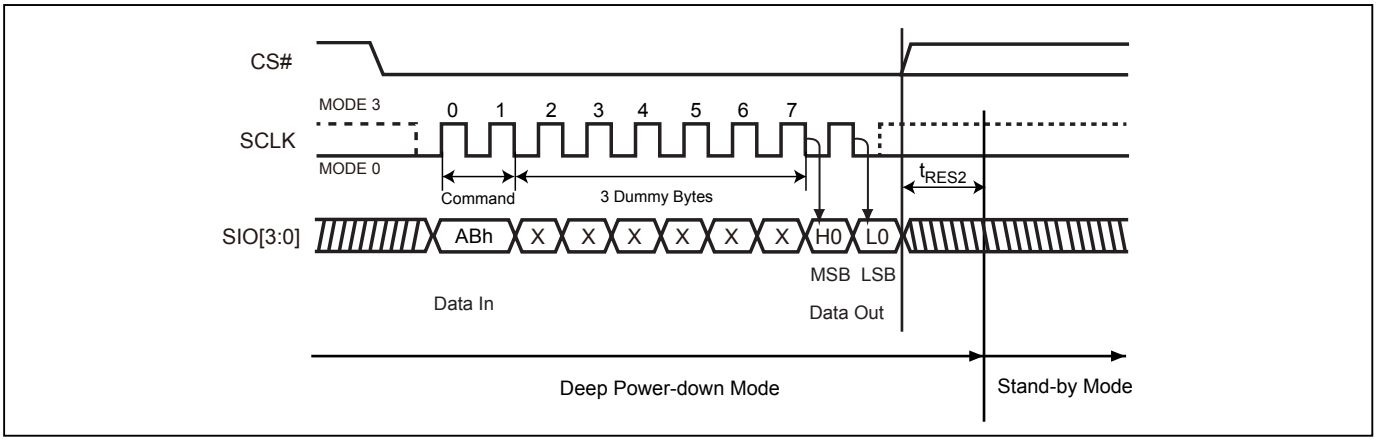



**Figure 17. Release from Deep Power-down (RDP) Sequence (SPI Mode)**

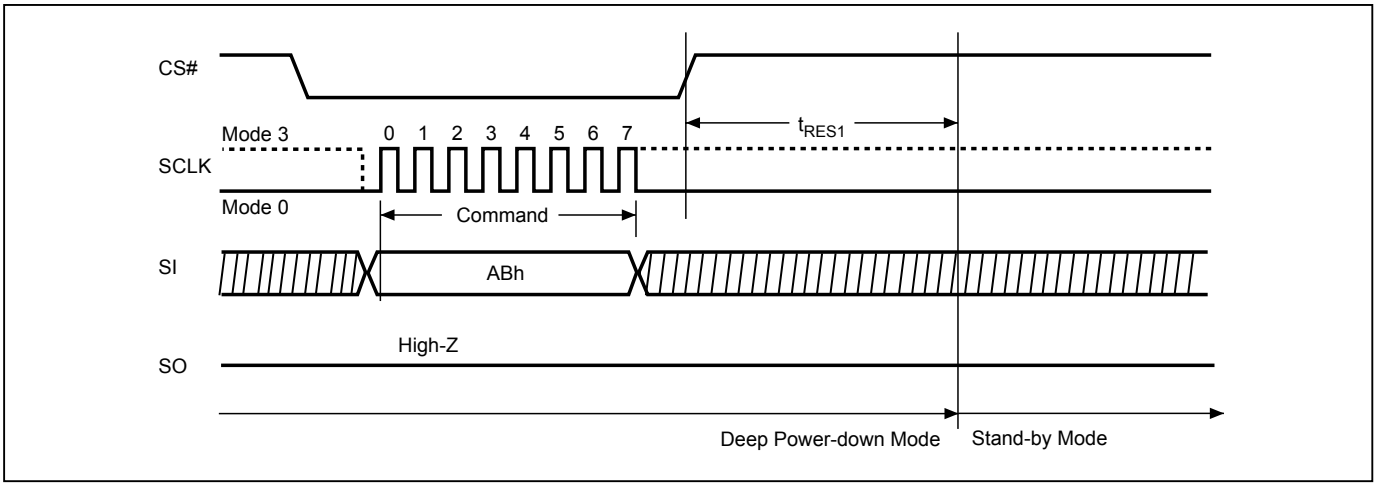
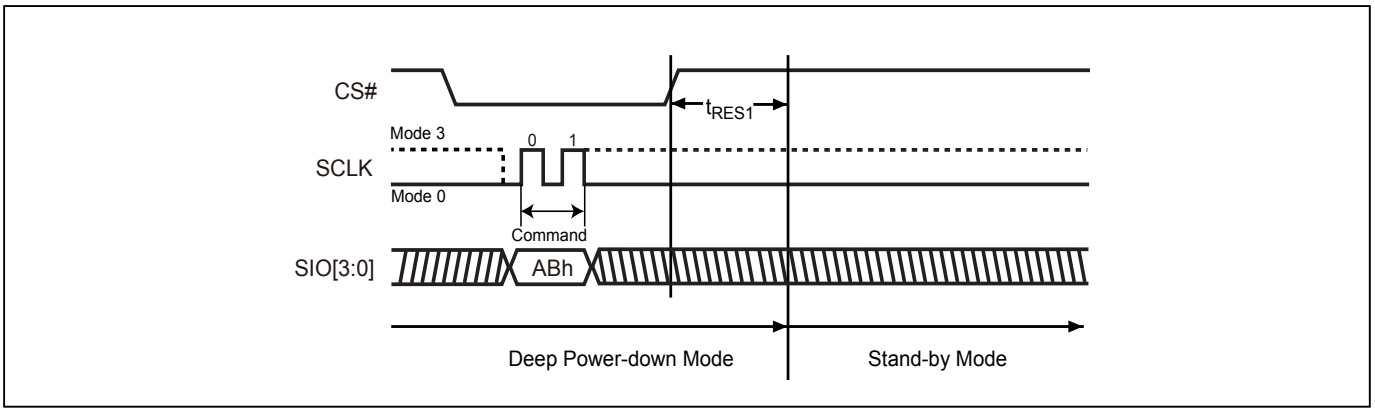



**Figure 18. Release from Deep Power-down (RDP) Sequence (QPI Mode)**





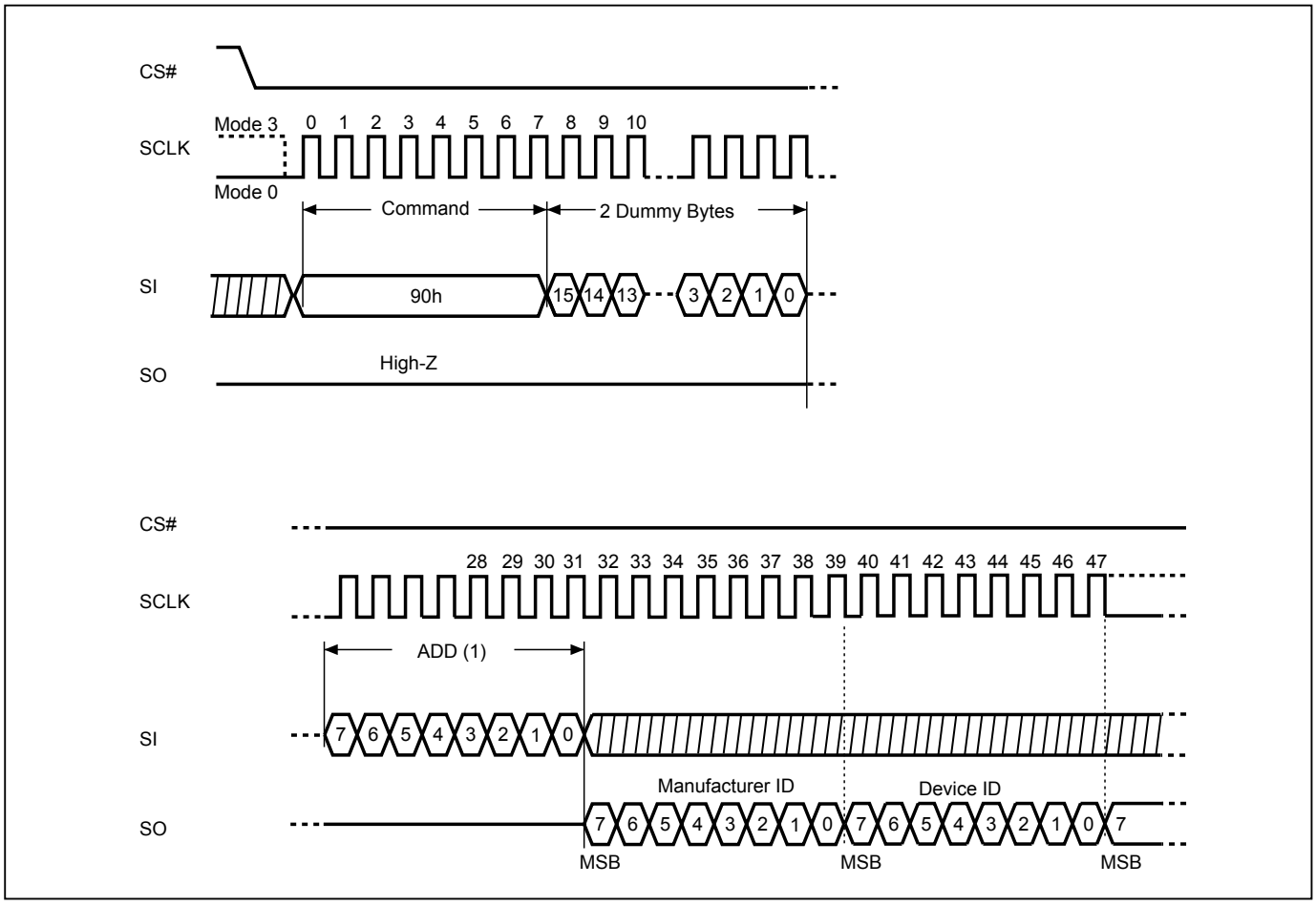
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### 9-6. Read Electronic Manufacturer ID & Device ID (REMS)

The REMS instruction returns both the JEDEC assigned manufacturer ID and the device ID. The Device ID values are listed in *"Table 6. 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. 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.

**Figure 19. Read Electronic Manufacturer & Device ID (REMS) Sequence (SPI Mode only)**




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


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### 9-7. QPI ID Read (QPIID)

The QPIID Read instruction can be used to identify the Device ID and Manufacturer ID. The sequence of issuing the QPIID instruction is as follows: CS# goes low→send 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 6. ID Definitions**

| Command Type | | MX25L12845G | | |
|---|---|---|---|---|
| RDID | 9Fh | Manufacturer ID | Memory Type | Memory Density |
| | | C2 | 20 | 18 |
| RES | ABh | Electronic ID | | |
| | | 17 | | |
| REMS | 90h | Manufacturer ID | Device ID | |
| | | C2 | 17 | |
| QPIID | AFh | Manufacturer ID | Memory Type | Memory Density |
| | | C2 | 20 | 18 |


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### 9-8. 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.

**Figure 20. Read Status Register (RDSR) Sequence (SPI Mode)**

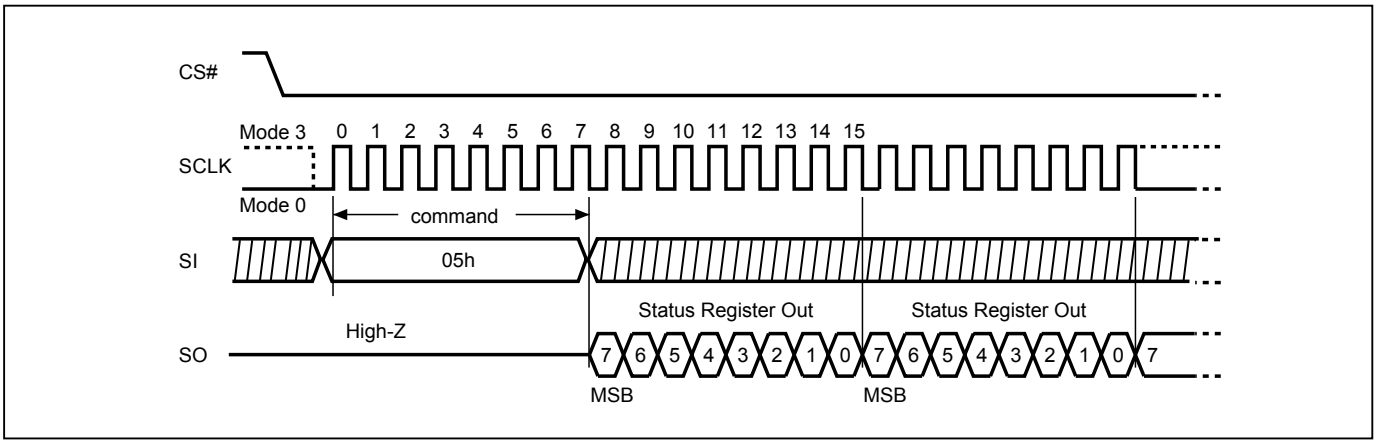
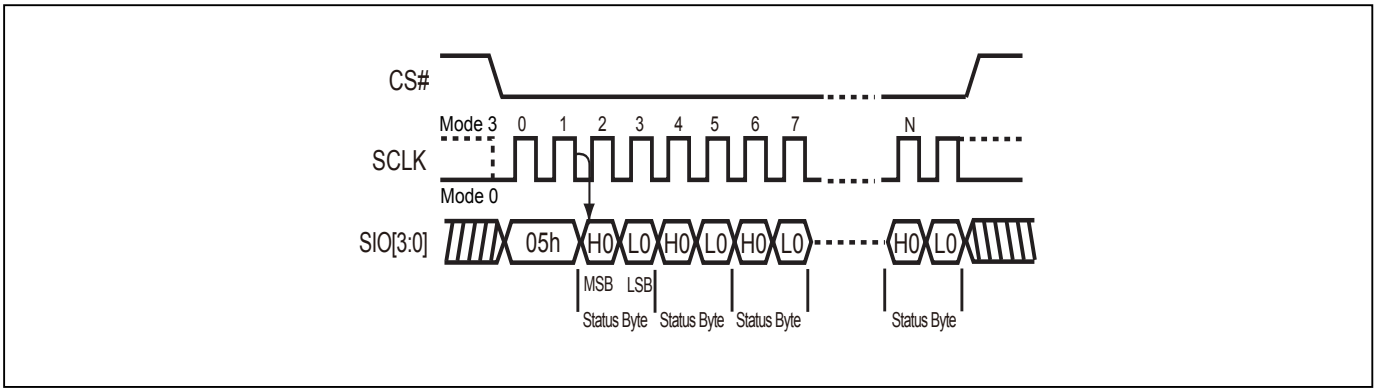



**Figure 21. Read Status Register (RDSR) Sequence (QPI Mode)**





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### 9-9. Read Configuration Register (RDCR)

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

The sequence of issuing RDCR instruction is: CS# goes low→ sending RDCR instruction code→ Configuration 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.

**Figure 22. Read Configuration Register (RDCR) Sequence (SPI Mode)**

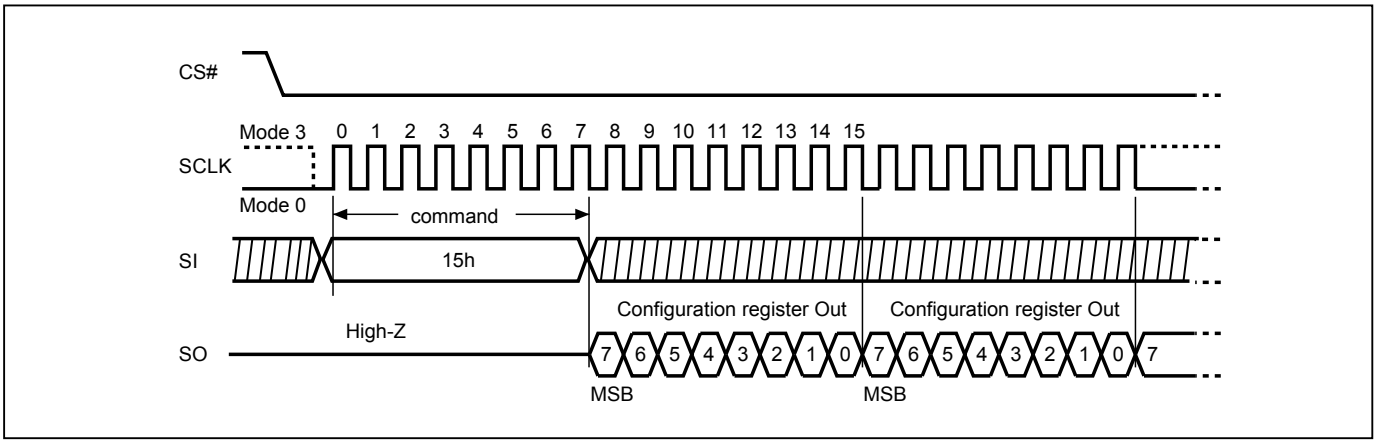
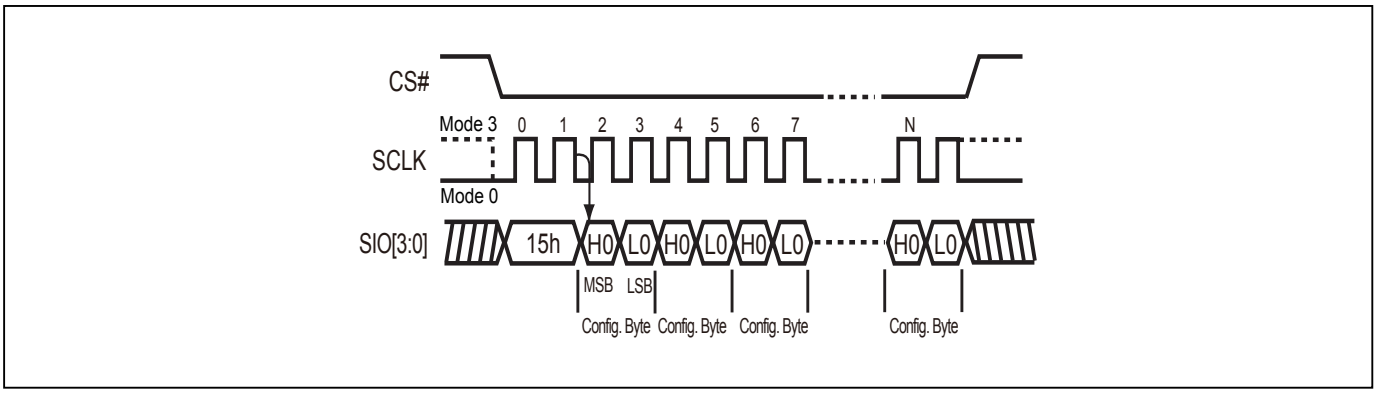



**Figure 23. Read Configuration Register (RDCR) Sequence (QPI Mode)**

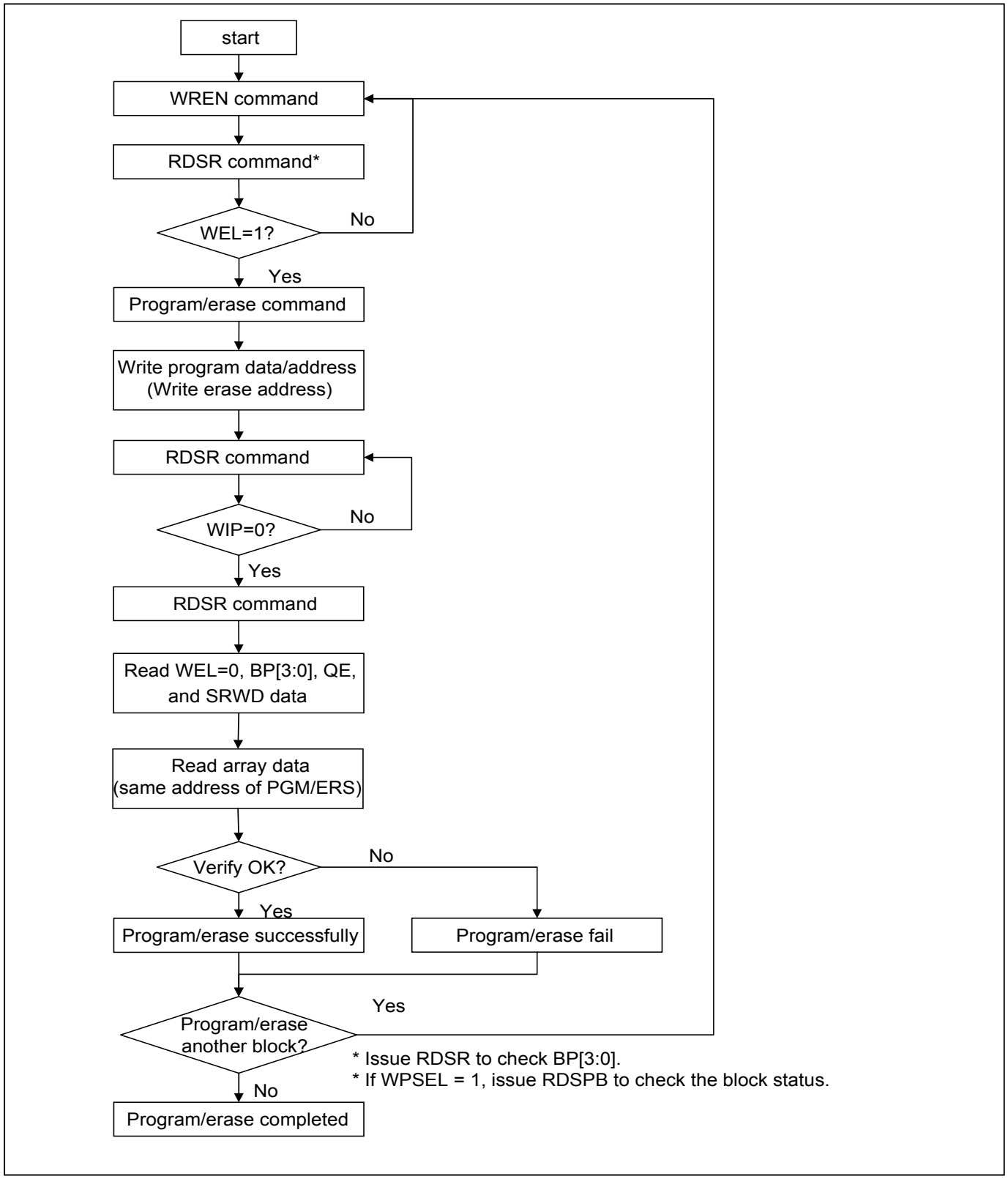




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For user to check if Program/Erase operation is finished or not, RDSR instruction flow are shown as follows:

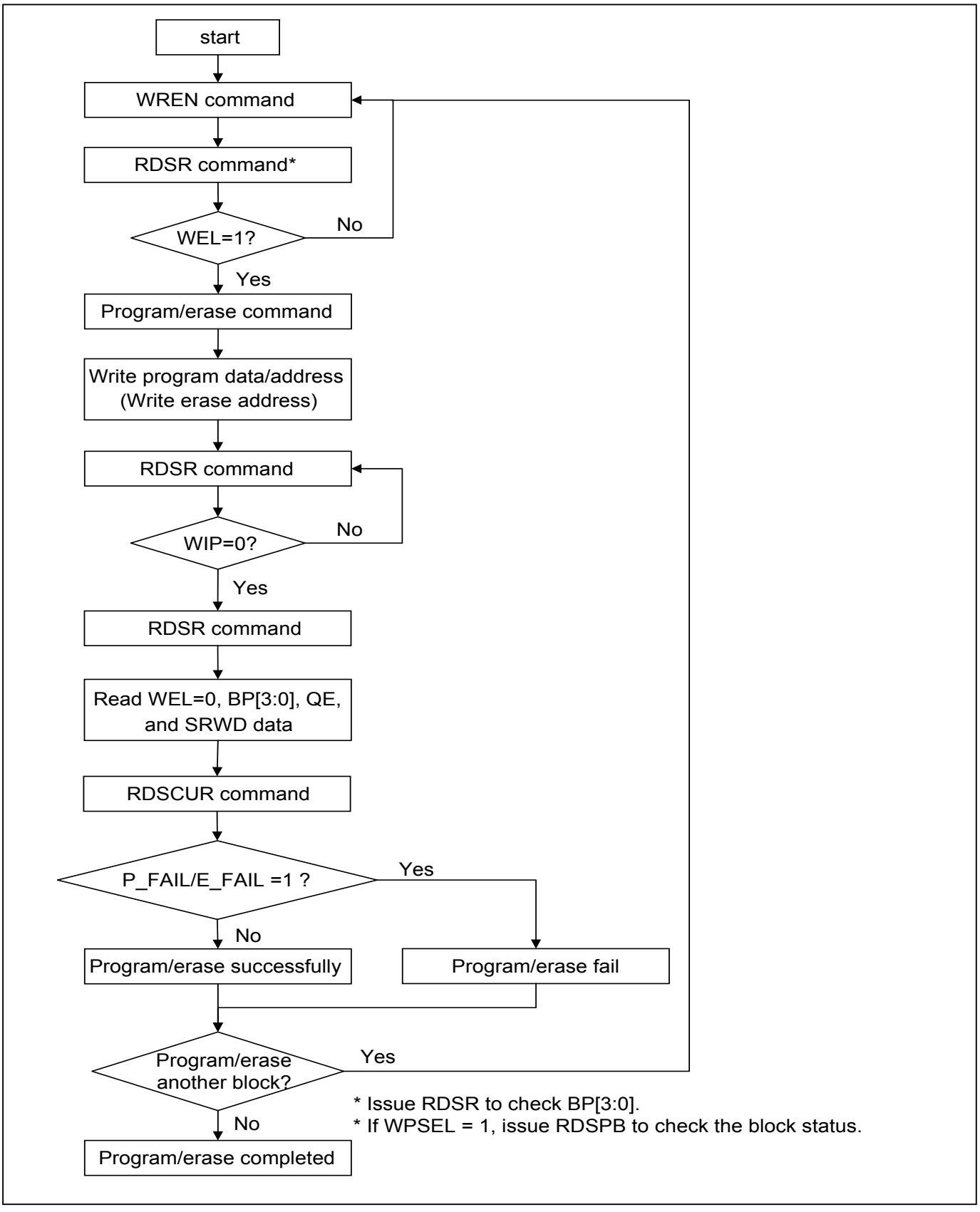
**Figure 24. Program/Erase flow with read array data**





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**Figure 25. Program/Erase flow without read array data (read P_FAIL/E_FAIL flag)**





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### Status Register

The definition of the status register bits is as below:

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

**WEL bit.** The Write Enable Latch (WEL) bit 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" (Please refer to *"Figure 28. WRSR flow"*). 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 un-protected.

**QE bit.** The Quad Enable (QE) bit is a non-volatile bit with a factory default of "0". When QE is "0", Quad mode commands are ignored; pins WP#/SIO2, NC/SIO3 and the RESET#/SIO3 of 8-pin package function as WP#, NC pin and RESET#, respectively. When QE is "1", Quad mode is enabled and Quad mode commands are supported along with Single and Dual mode commands. Pins WP#/SIO2, NC/SIO3 and the RESET#/SIO3 of 8-pin package function as SIO2 and SIO3, respectively, and their alternate pin functions are disabled. Enabling Quad mode also disables the HPM feature and the RESET feature of 8-pin package.

**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 7. 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 Enabled 0=not Quad Enabled | *(note 1)* | *(note 1)* | *(note 1)* | *(note 1)* | 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 *"Table 2. Protected Area Sizes"*.


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### Configuration Register

The Configuration Register is able to change the default status of Flash memory. Flash memory will be configured after the CR bit is set.

**ODS bit**
The output driver strength (ODS1, ODS0) bits are volatile bits, which indicate the output driver level (as defined in *"Table 9. Output Driver Strength Table"*) of the device. The Output Driver Strength is defaulted as 30 Ohms when delivered from factory. To write the ODS bits requires the Write Status Register (WRSR) instruction to be executed.

**TB bit**
The Top/Bottom (TB) bit is a non-volatile OTP bit. The Top/Bottom (TB) bit is used to configure the Block Protect area by BP bit (BP3, BP2, BP1, BP0), starting from TOP or Bottom of the memory array. The TB bit is defaulted as "0", which means Top area protect. When it is set as "1", the protect area will change to Bottom area of the memory device. To write the TB bits requires the Write Status Register (WRSR) instruction to be executed.

**PBE bit**
The Preamble Bit Enable (PBE) bit is a volatile bit. It is used to enable or disable the preamble bit data pattern output on dummy cycles. The PBE bit is defaulted as "0", which means preamble bit is disabled. When it is set as "1", the preamble bit will be enabled, and inputted into dummy cycles. To write the PBE bits requires the Write Status Register (WRSR) instruction to be executed.

**Table 8. Configuration Register**

| bit7 | bit6 | bit5 | bit4 | bit3 | bit2 | bit1 | bit0 |
|---|---|---|---|---|---|---|---|
| DC1 (Dummy cycle 1) | DC0 (Dummy cycle 0) | Reserved | PBE (Preamble bit Enable) | TB (top/bottom selected) | Reserved | ODS 1 (output driver strength) | ODS 0 (output driver strength) |
| *(Note 2)* | *(Note 2)* | x | 0=Disable<br>1=Enable | 0=Top area protect<br>1=Bottom area protect (Default=0) | x | *(Note 1)* | *(Note 1)* |
| volatile bit | volatile bit | x | volatile bit | OTP | x | volatile bit | volatile bit |

Note 1: Please refer to *"Table 9. Output Driver Strength Table"*
Note 2: Please refer to *"Table 10. Dummy Cycle and Frequency Table (MHz)"*


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**Table 9. Output Driver Strength Table**

| ODS1 | ODS0 | Resistance (Ohm) | Note |
|---|---|---|---|
| 0 | 0 | 30 Ohms (Default) | Impedance at VCC/2 |
| 0 | 1 | 45 Ohms | |
| 1 | 0 | 90 Ohms | |
| 1 | 1 | 15 Ohms | |

**Table 10. Dummy Cycle and Frequency Table (MHz)**

**(STR Mode)**

| DC[1:0] | Numbers of Dummy clock cycles | Fast Read | Dual Output Fast Read | Quad Output Fast Read |
|---|---|---|---|---|
| **00 (default)** | 8 | 120/133R | 120/133R | 120/133R |
| **01** | 8 | 120/133R | 120/133R | 120/133R |
| **10** | 8 | 120/133R | 120/133R | 120/133R |
| **11** | 8 | 120/133R | 120/133R | 120/133R |

| DC[1:0] | Numbers of Dummy clock cycles | Dual IO Fast Read |
|---|---|---|
| **00 (default)** | 4 | 80 |
| **01** | 8 | 120/133R |
| **10** | 4 | 80 |
| **11** | 8 | 120/133R |

| DC[1:0] | Numbers of Dummy clock cycles | Quad IO Fast Read |
|---|---|---|
| **00 (default)** | 6 | 80 |
| **01** | 4 | 54 |
| **10** | 8 | 84/104R |
| **11** | 10 | 120/133R |

**(DTR Mode)**

| DC[1:0] | Numbers of Dummy clock cycles | Quad IO DTR Read |
|---|---|---|
| **00 (default)** | 6 | 54 |
| **01** | 6 | 54 |
| **10** | 8 | 70/80R |
| **11** | 10 | 84/100R |

**Note:** "R" mean VCC range= 3.0V-3.6V.


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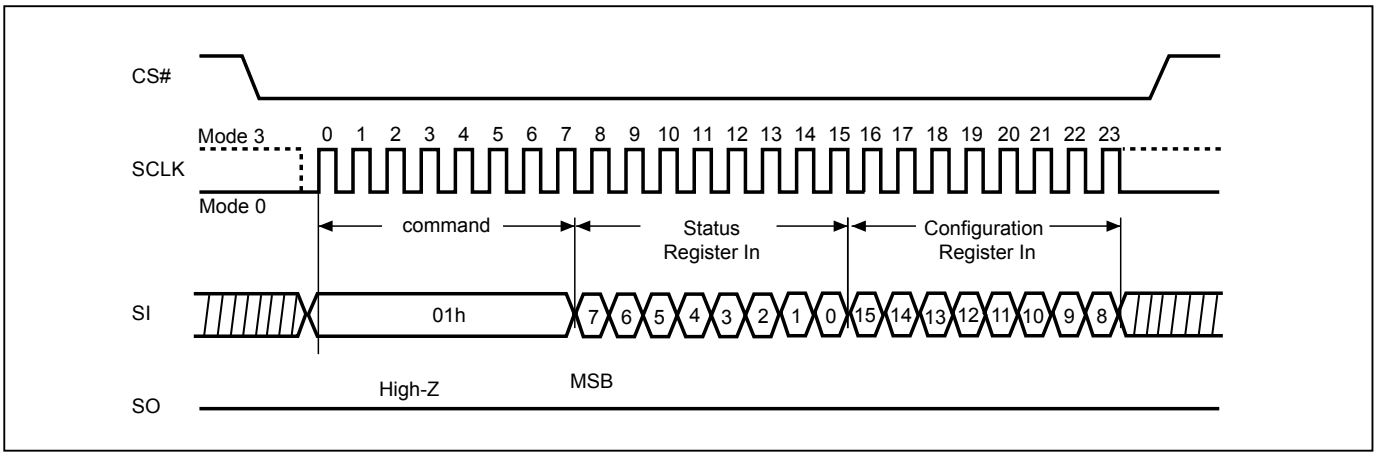
### 9-10. Write Status Register (WRSR)

The WRSR instruction is for changing the values of Status Register Bits and Configuration 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→ send WRSR instruction code→ Status Register data on SI→Configuration Register data on SI→CS# goes high.

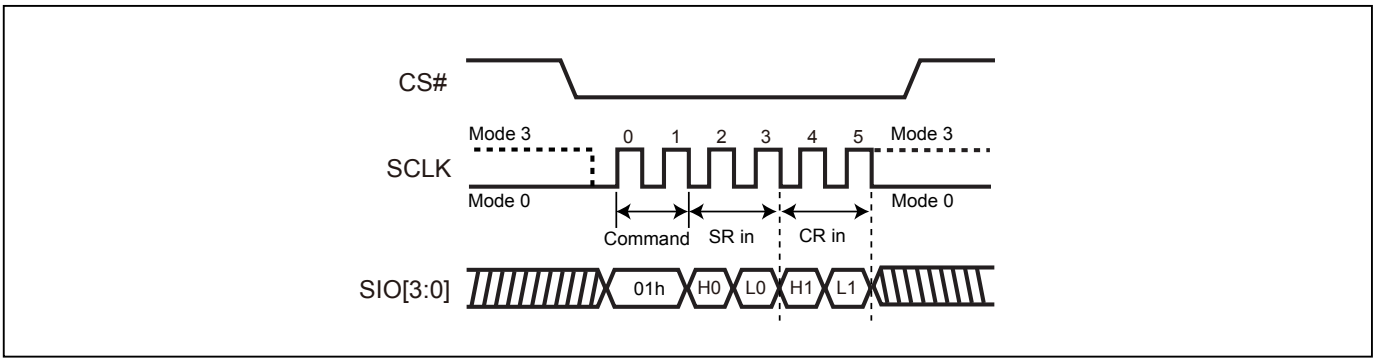
The CS# must go high exactly at the 8 bits or 16 bits data boundary; otherwise, the instruction will be rejected and not executed. The self-timed Write Status Register cycle time (tW) is initiated as soon as Chip Select (CS#) goes high. The Write in Progress (WIP) bit still can be check out during the 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.

**Figure 26. Write Status Register (WRSR) Sequence (SPI Mode)**




**Note:** The CS# must go high exactly at 8 bits or 16 bits data boundary to completed the write register command.

**Figure 27. Write Status Register (WRSR) Sequence (QPI Mode)**





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**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 and T/B bit, 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 and T/B bit, 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 T/B bit 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 and T/B bit.
If the system enter QPI or set QE=1, the feature of HPM will be disabled.

**Table 11. Protection Modes**

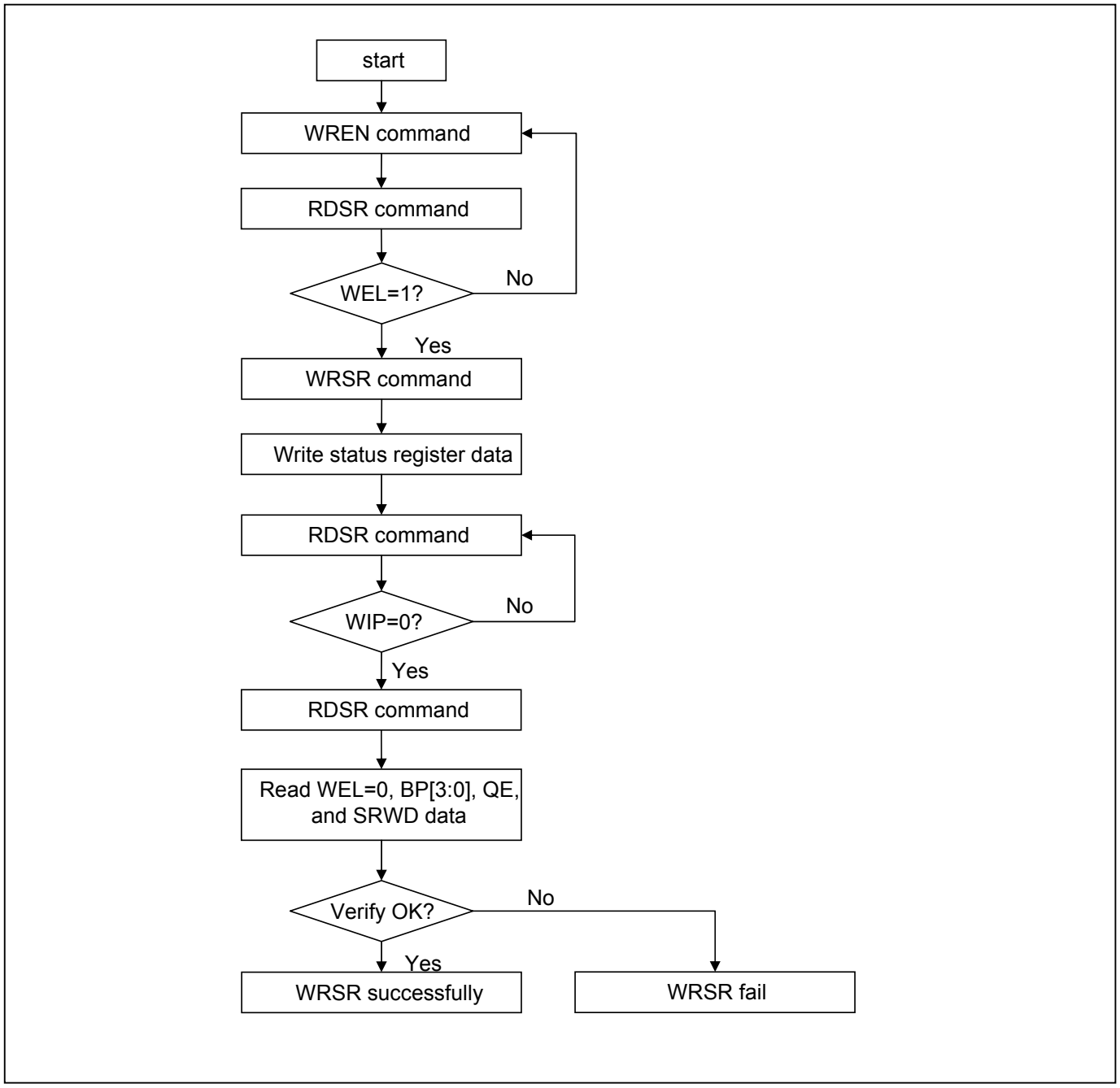
| Mode | Status register condition | WP# and SRWD bit status | Memory |
|---|---|---|---|
| Software protection mode (SPM) | Status register can be written in (WEL bit is set to "1") and the SRWD, BP0-BP3 bits can be changed | WP#=1 and SRWD bit=0, or WP#=0 and SRWD bit=0, or WP#=1 and SRWD=1 | The protected 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"*.


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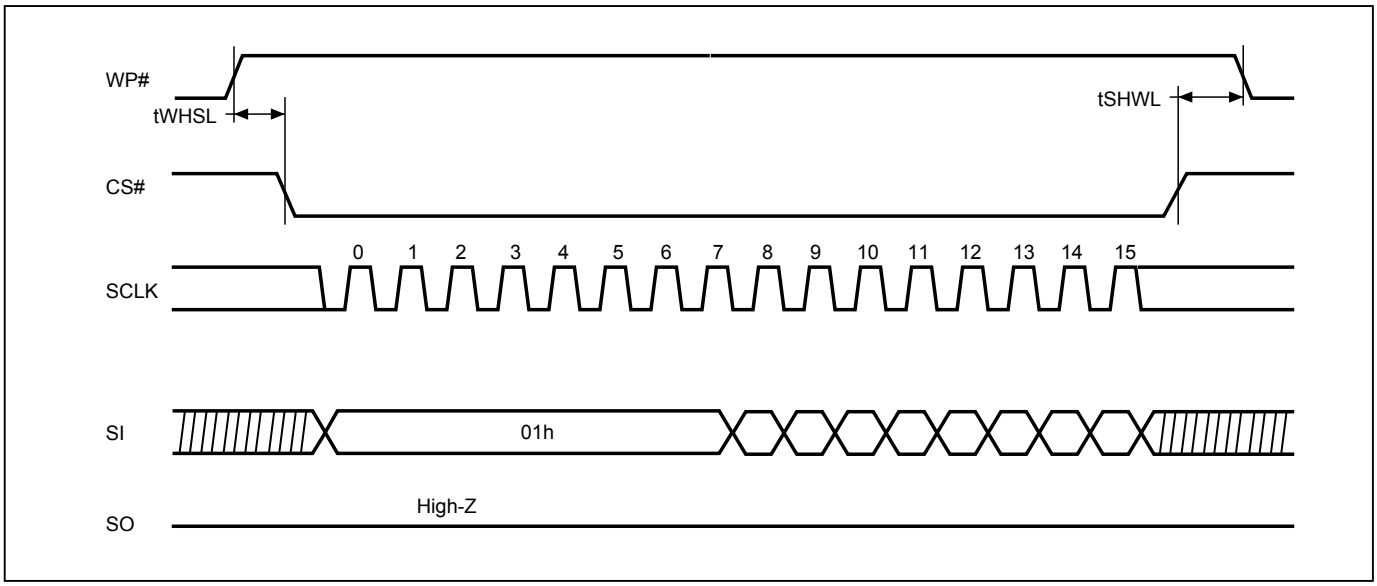
**Figure 28. WRSR flow**





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**Figure 29. WP# Setup Timing and Hold Timing during WRSR when SRWD=1**




**Note:** WP# must be kept high until the embedded operation finish.


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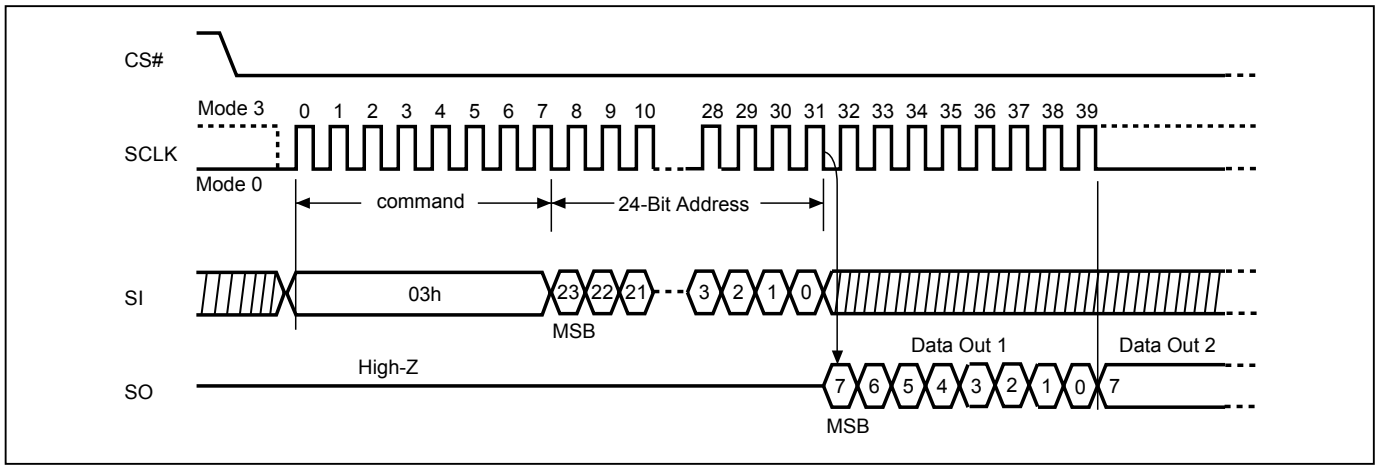
### 9-11. Read Data Bytes (READ)

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.

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

**Figure 30. Read Data Bytes (READ) Sequence (SPI Mode only)**





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### 9-12. Read Data Bytes at Higher Speed (FAST_READ)

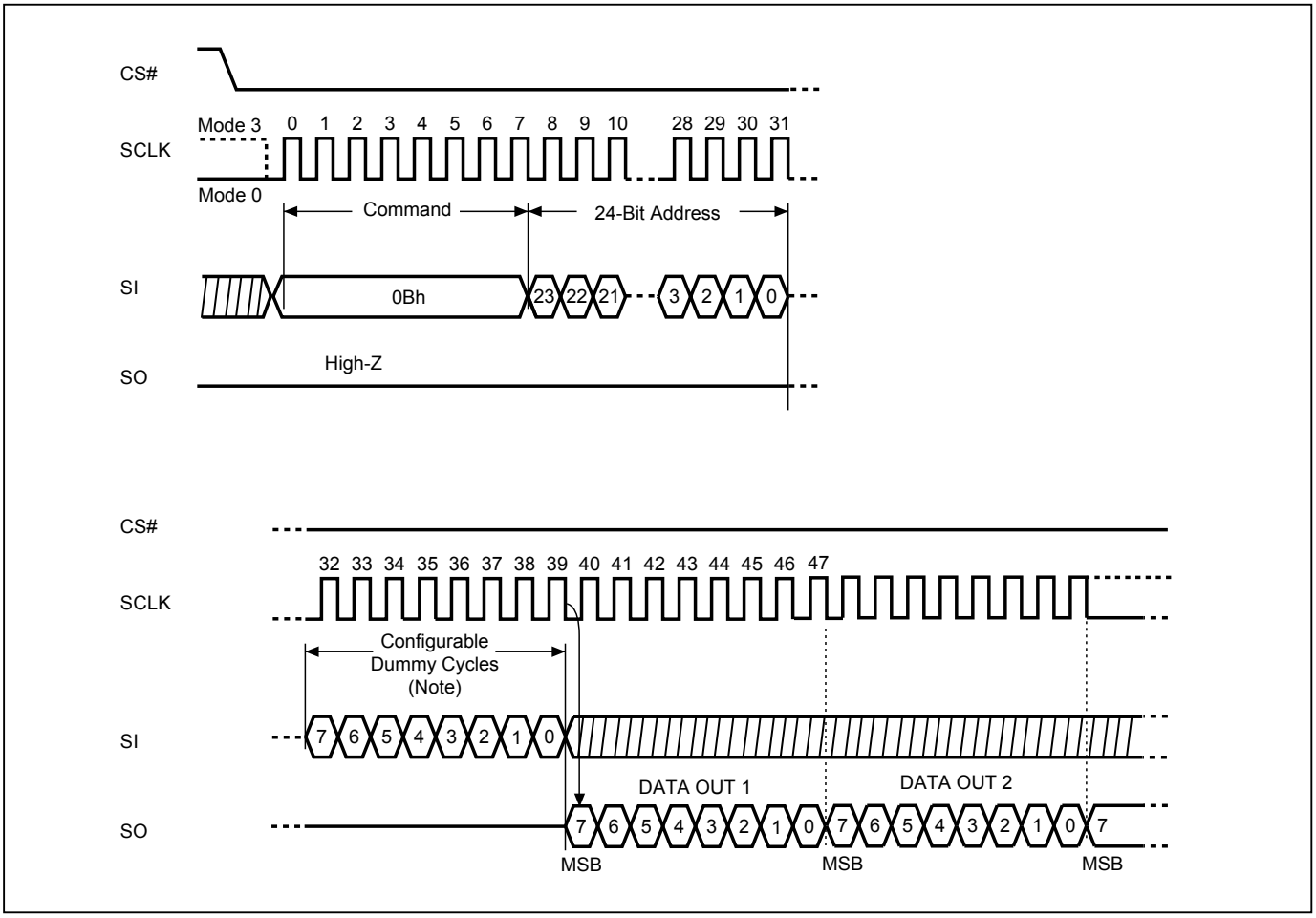
The FAST_READ instruction is for quickly reading data out. The address is latched on rising edge of SCLK, and data of each bit shifts out on the falling edge of SCLK at a maximum frequency fC. The first address byte can be at any location. The address is automatically increased to the next higher address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

The sequence of issuing FAST_READ instruction is: CS# goes low→ send FAST_READ instruction code→ 3-byte address on SI→ 8 dummy cycles (default)→ data out on SO→ to end FAST_READ operation can use CS# to high at any time during data out.

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.


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**Figure 31. Read at Higher Speed (FAST_READ) Sequence (SPI Mode)**




**Note:** Configuration Dummy cycle numbers will be different depending on the bit6 & bit 7 (DC0 & DC1) setting in configuration register.


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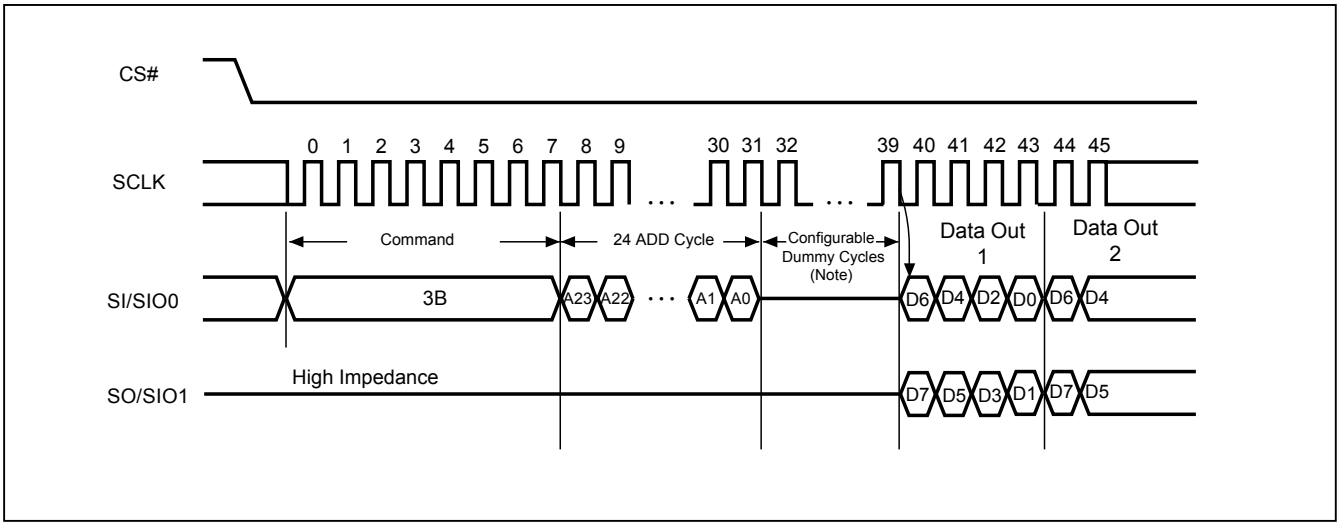
### 9-13. Dual Output Read Mode (DREAD)

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

The sequence of issuing DREAD instruction is: CS# goes low→ send DREAD instruction→3-byte address on SIO0→ 8 dummy cycles (default) on SIO0→ data out interleave on SIO1 & SIO0→ to end DREAD operation can use CS# to high at any time during data out.

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

**Figure 32. Dual Read Mode Sequence (SPI Mode only)**




**Note:** Configuration Dummy cycle numbers will be different depending on the bit6 & bit 7 (DC0 & DC1) setting in configuration register.


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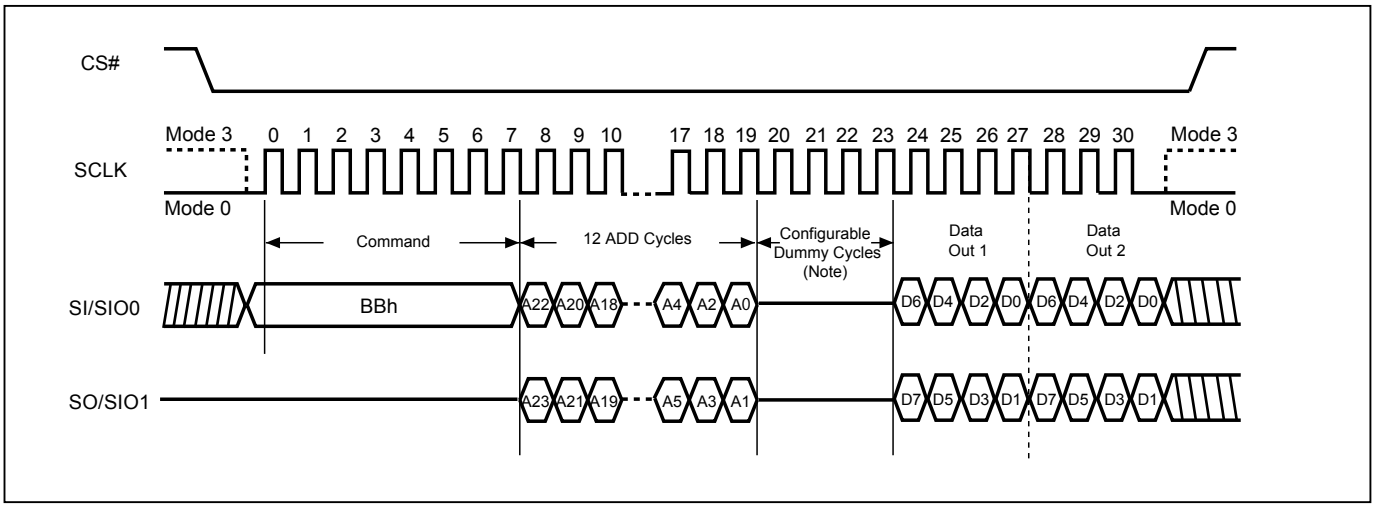
### 9-14. 2 x I/O Read Mode (2READ)

The 2READ instruction enables double throughput of the 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→ 3-byte address interleave on SIO1 & SIO0→ 4 dummy cycles (default) on SIO1 & SIO0→ data out interleave on SIO1 & SIO0→ to end 2READ operation can use CS# to high at any time during data out.

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.

**Figure 33. 2 x I/O Read Mode Sequence (SPI Mode only)**




**Note:** Configuration Dummy cycle numbers will be different depending on the bit6 & bit 7 (DC0 & DC1) setting in configuration register.


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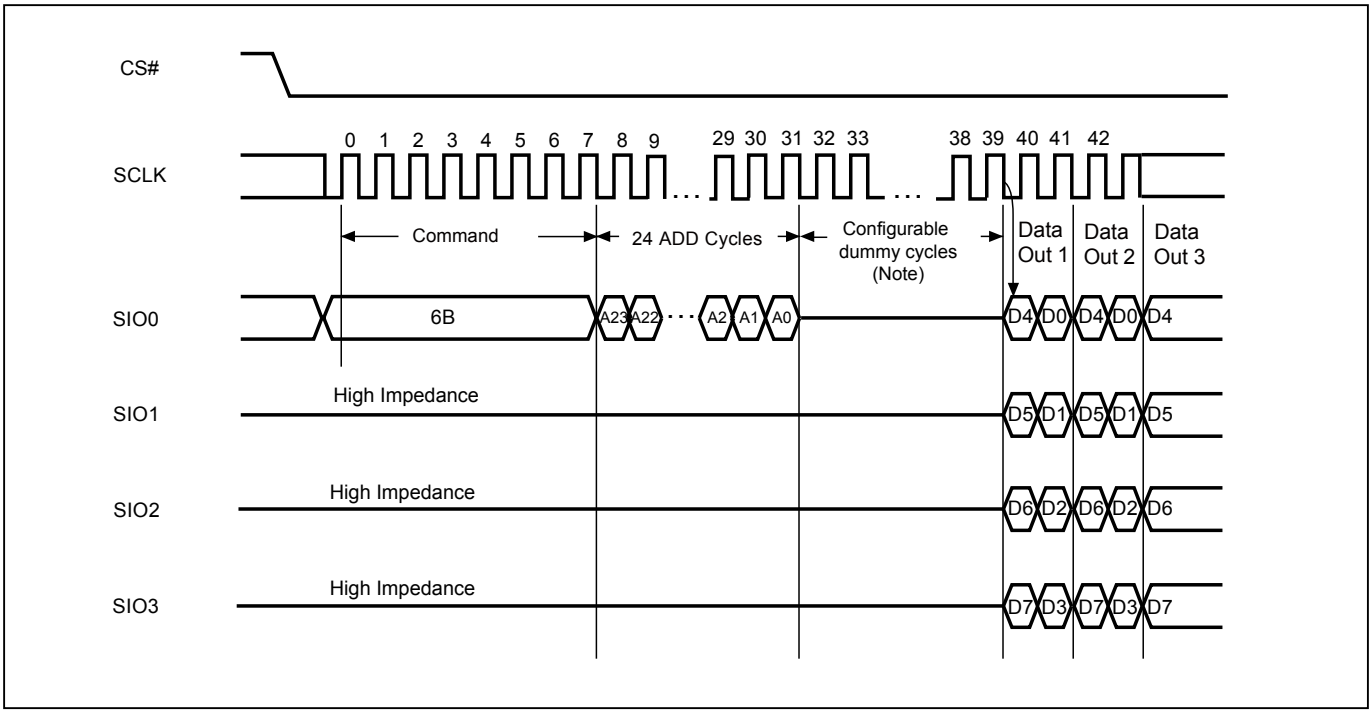
### 9-15. Quad Read Mode (QREAD)

The QREAD instruction enables quad throughput of the Serial NOR Flash in read mode. A Quad Enable (QE) bit of status Register must be set to "1" before sending the QREAD 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 QREAD instruction. The address counter rolls over to 0 when the highest address has been reached. Once writing QREAD instruction, the following data out will perform as 4-bit instead of previous 1-bit.

The sequence of issuing QREAD instruction is: CS# goes low→ sending QREAD instruction → 3-byte address on SI → 8 dummy cycle (Default) → data out interleave on SIO3, SIO2, SIO1 & SIO0→ to end QREAD operation can use CS# to high at any time during data out.

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

**Figure 34. Quad Read Mode Sequence (SPI Mode only)**




**Note:** Configuration Dummy cycle numbers will be different depending on the bit6 & bit 7 (DC0 & DC1) setting in configuration register.


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### 9-16. 4 x I/O Read Mode (4READ)

The 4READ instruction enables quad throughput of the 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.

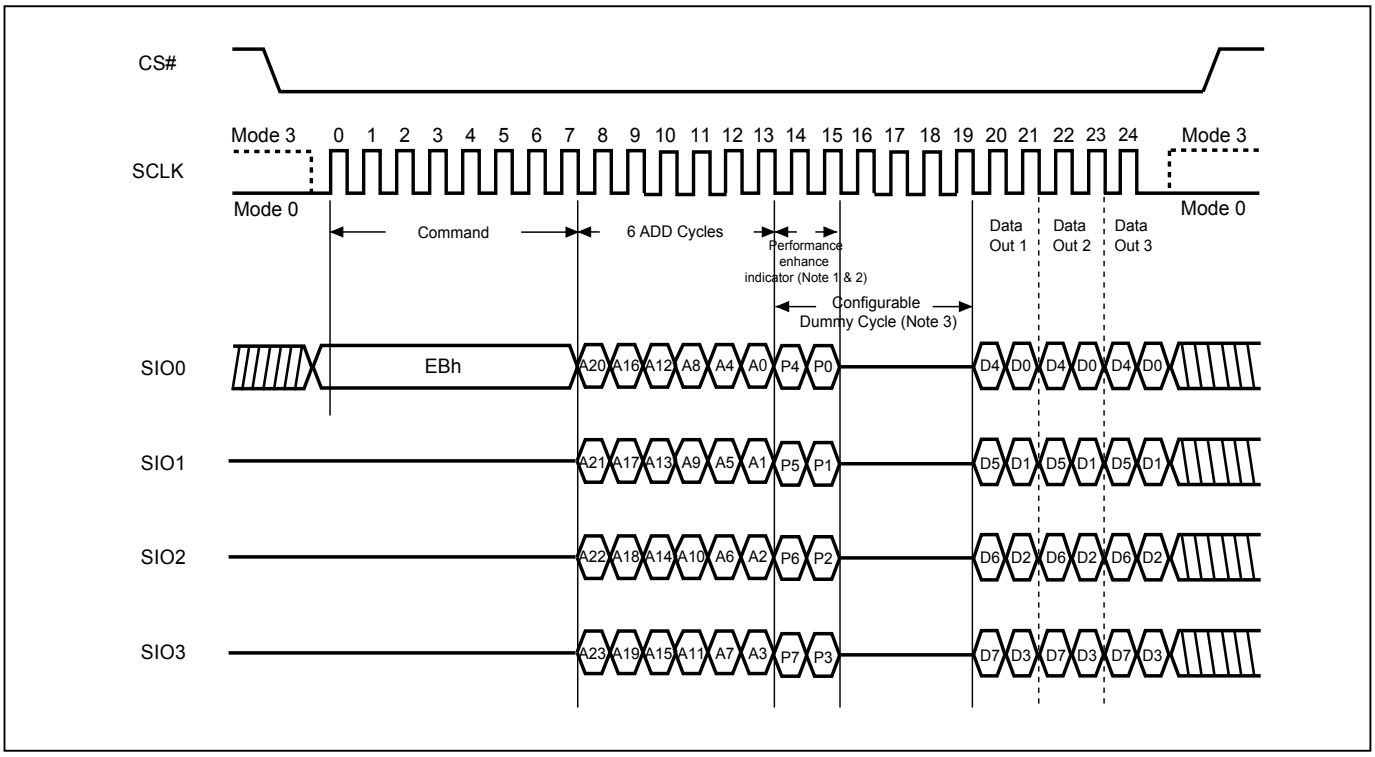
**4 x I/O Read on SPI Mode (4READ)** The sequence of issuing 4READ instruction is: CS# goes low→ send 4READ instruction→ 3-byte address interleave on SIO3, SIO2, SIO1 & SIO0→ 6 dummy cycles (Default) →data out interleave on SIO3, SIO2, SIO1 & SIO0→ to end 4READ operation, raise CS# high at any time during data out.

**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→ send 4READ instruction→ 3-byte address interleave on SIO3, SIO2, SIO1 & SIO0→ 6 dummy cycles (Default) →data out interleave on SIO3, SIO2, SIO1 & SIO0→ to end 4READ operation, raise CS# high at any time during data out.

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.

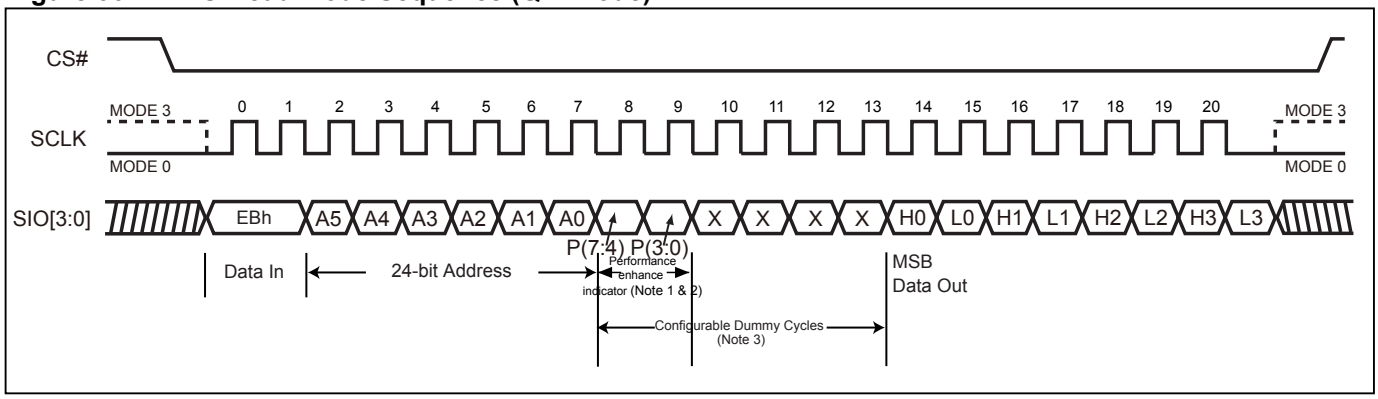

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**Figure 35. 4 x I/O Read Mode Sequence (SPI Mode)**




**Notes:**
1. Hi-impedance is inhibited for the two clock cycles.
2. P7≠P3, P6≠P2, P5≠P1 & P4≠P0 (Toggling) is inhibited.
3. Configuration Dummy cycle numbers will be different depending on the bit6 & bit 7 (DC0 & DC1) setting in configuration register.

**Figure 36. 4 x I/O Read Mode Sequence (QPI Mode)**




**Notes:**
1. Hi-impedance is inhibited for the two clock cycles.
2. P7≠P3, P6≠P2, P5≠P1 & P4≠P0 (Toggling) is inhibited.
3. Configuration Dummy cycle numbers will be different depending on the bit6 & bit 7 (DC0 & DC1) setting in configuration register.


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### 9-17. 4 x I/O Double Transfer Rate Read Mode (4DTRD)

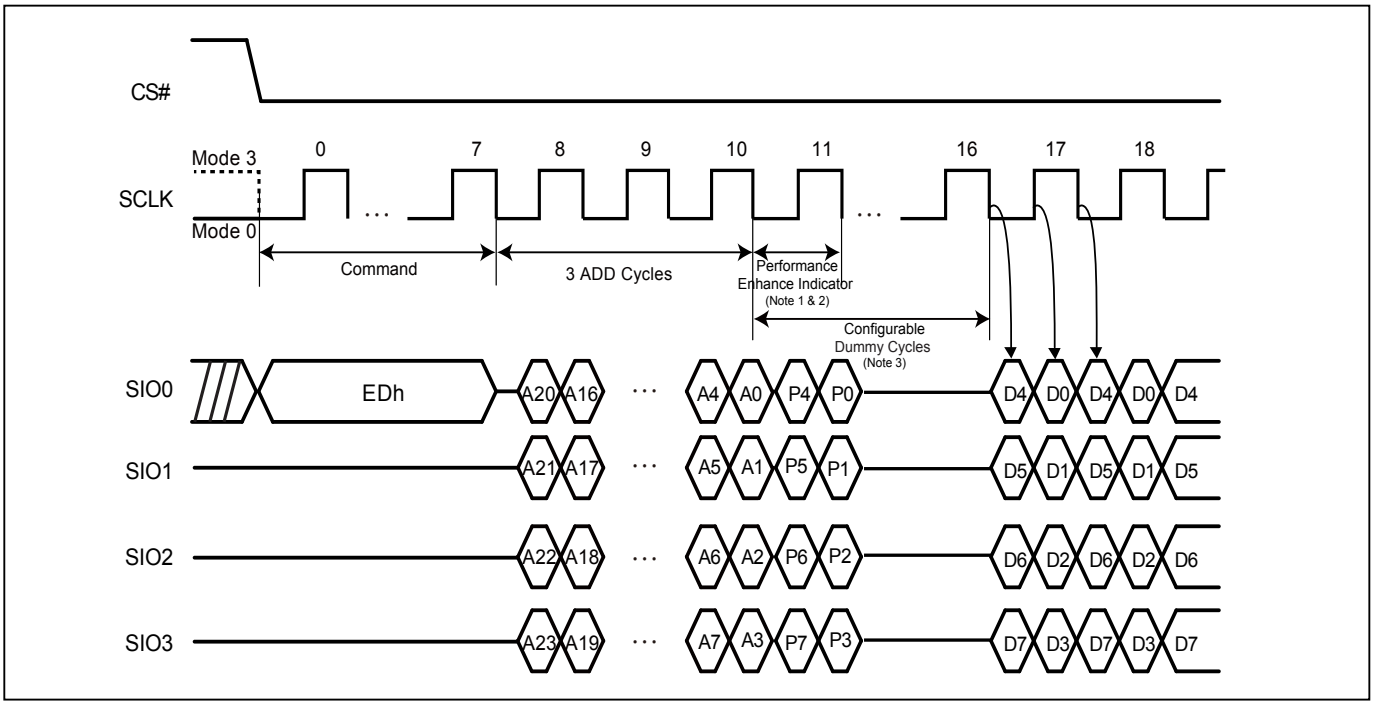
The 4DTRD instruction enables Double Transfer Rate throughput on quad I/O of the Serial NOR Flash in read mode. A Quad Enable (QE) bit of status Register must be set to "1" before sending the 4DTRD instruction. The address (interleave on 4 I/O pins) is latched on both rising and falling edge of SCLK, and data (interleave on 4 I/O pins) shift out on both rising and falling edge of SCLK. The 8-bit address can be latched-in at one clock, and 8-bit data can be read out at one clock, which means four bits at rising edge of clock, the other four bits at falling edge of clock. 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 4DTRD instruction. The address counter rolls over to 0 when the highest address has been reached. Once writing 4DTRD instruction, the following address/dummy/data out will perform as 8-bit instead of previous 1-bit.

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.

While Program/Erase/Write Status Register cycle is in progress, 4DTRD instruction is rejected without any impact on the Program/Erase/Write Status Register current cycle.

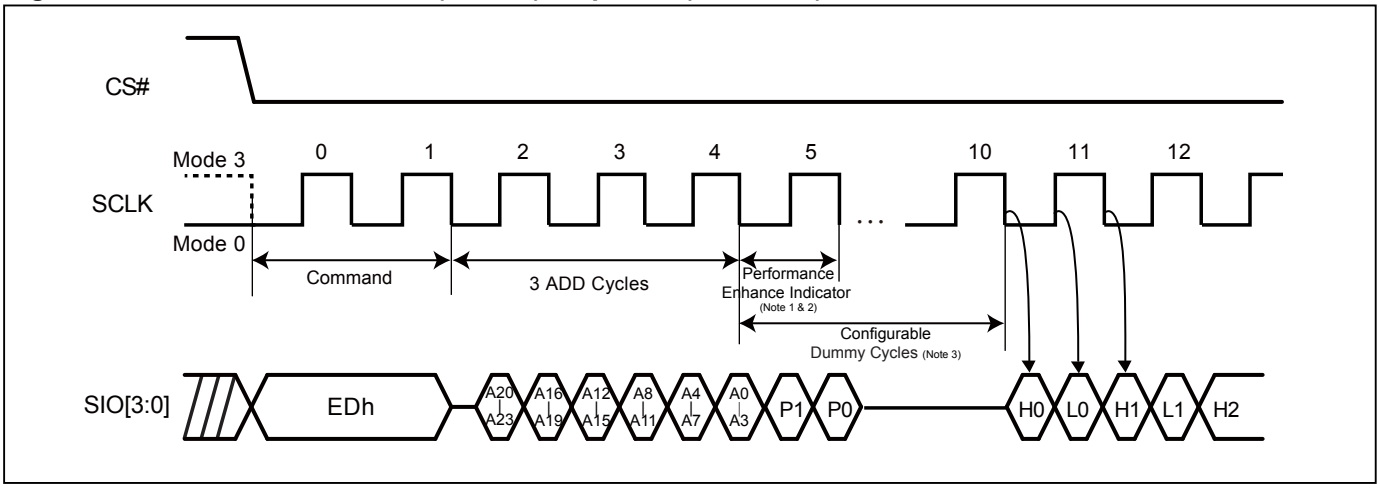

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**Figure 37. Fast Quad I/O DT Read (4DTRD) Sequence (SPI Mode)**




**Notes:**
1. Hi-impedance is inhibited for this clock cycle.
2. P7≠P3, P6≠P2, P5≠P1 & P4≠P0 (Toggling) will result in entering the performance enhance mode.
3. Configuration Dummy cycle numbers will be different depending on the bit6 & bit 7 (DC0 & DC1) setting in configuration register.

**Figure 38. Fast Quad I/O DT Read (4DTRD) Sequence (QPI Mode)**




**Notes:**
1. Hi-impedance is inhibited for this clock cycle.
2. P7≠P3, P6≠P2, P5≠P1 & P4≠P0 (Toggling) will result in entering the performance enhance mode.
3. Configuration Dummy cycle numbers will be different depending on the bit6 & bit 7 (DC0 & DC1) setting in configuration register.


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### 9-18. Preamble Bit

The Preamble Bit data pattern supports system/memory controller to determine valid window of data output more easily and improve data capture reliability while the flash memory is running in high frequency.

Preamble Bit data pattern can be enabled or disabled by setting the bit4 of Configuration register (Preamble bit Enable bit). Once the CR<4> is set, the preamble bit is inputted into dummy cycles.

Enabling preamble bit will not affect the function of enhance mode bit. In Dummy cycles, performance enhance mode bit still operates with the same function. Preamble bit will output after performance enhance mode bit.

The preamble bit is a fixed 8-bit data pattern (00110100). While dummy cycle number reaches 10, the complete 8 bits will start to output right after the performance enhance mode bit. While dummy cycle is not sufficient of 10 cycles, the rest of the preamble bits will be cut. For example, 8 dummy cycles will cause 6 preamble bits to output, and 6 dummy cycles will cause 4 preamble bits to output.

**Figure 39. SDR 1I/O (10DC)**

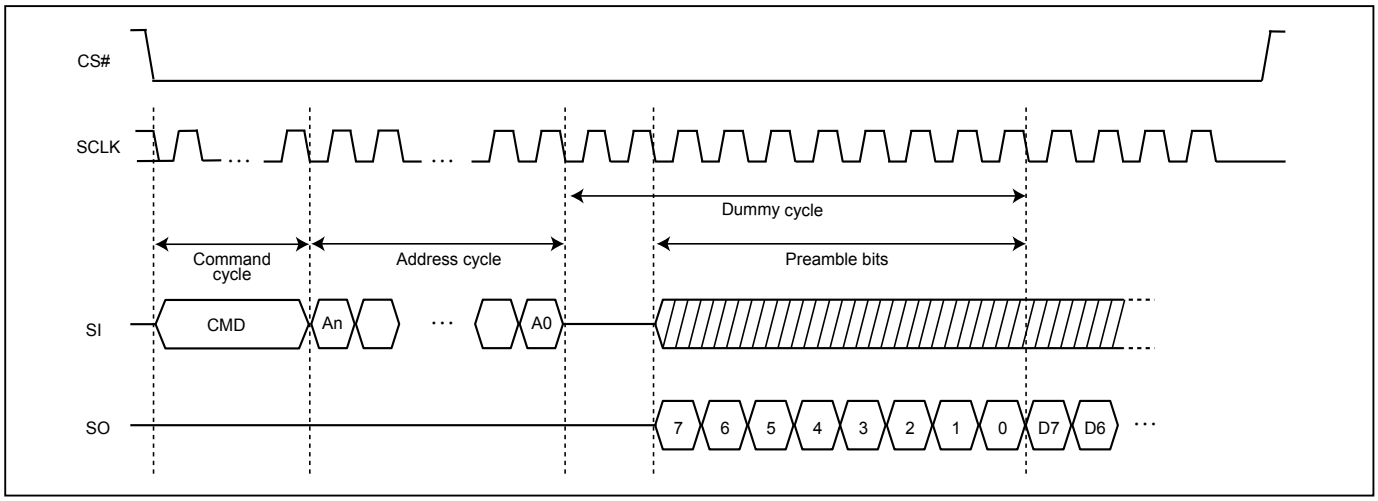
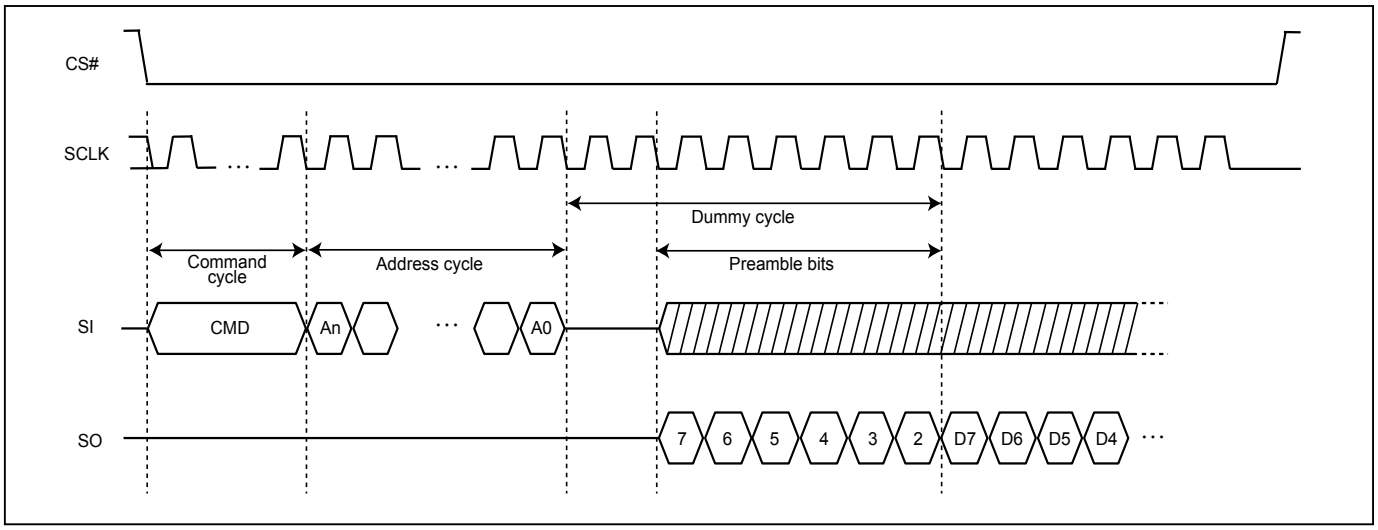



**Figure 40. SDR 1I/O (8DC)**





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**Figure 41. SDR 2I/O (10DC)**

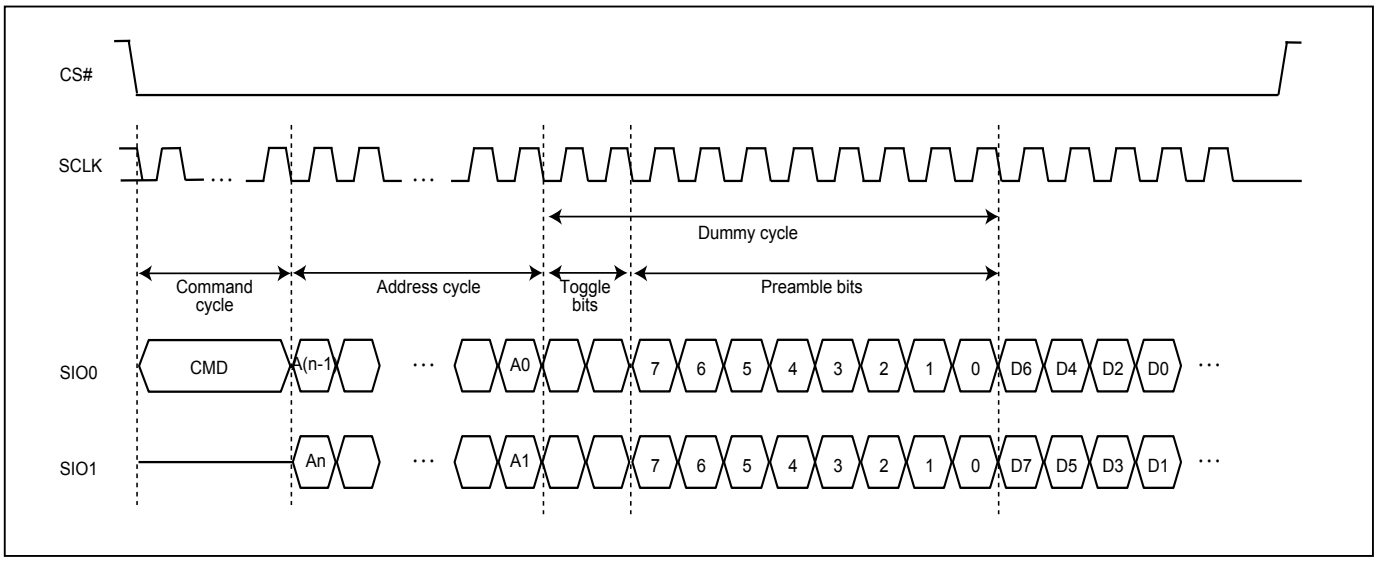
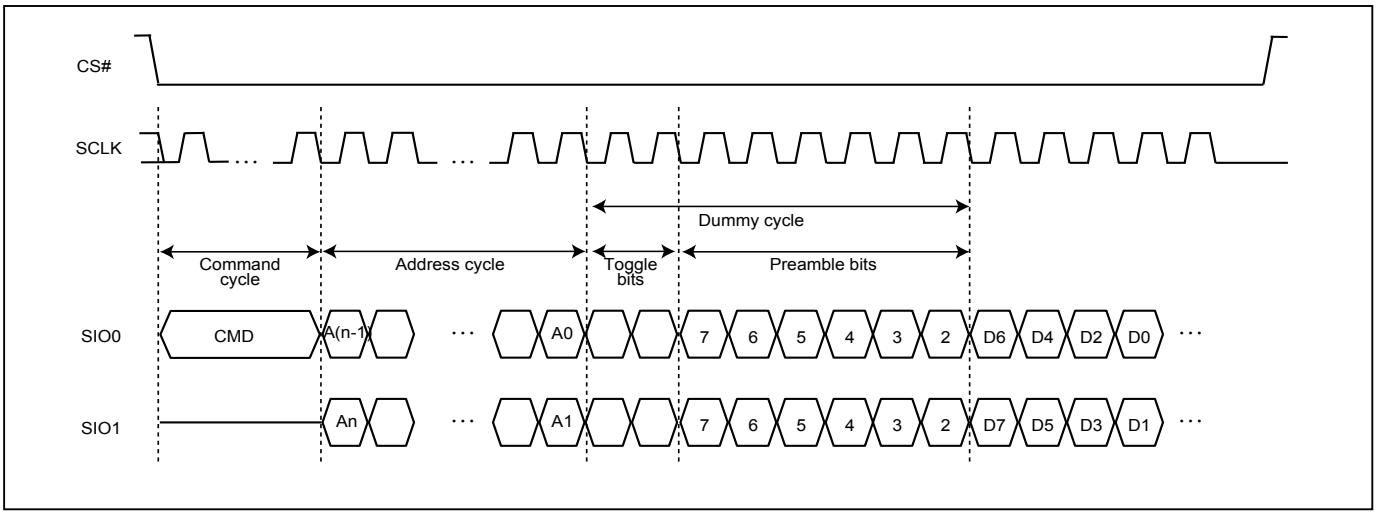



**Figure 42. SDR 2I/O (8DC)**





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**Figure 43. SDR 4I/O (10DC)**

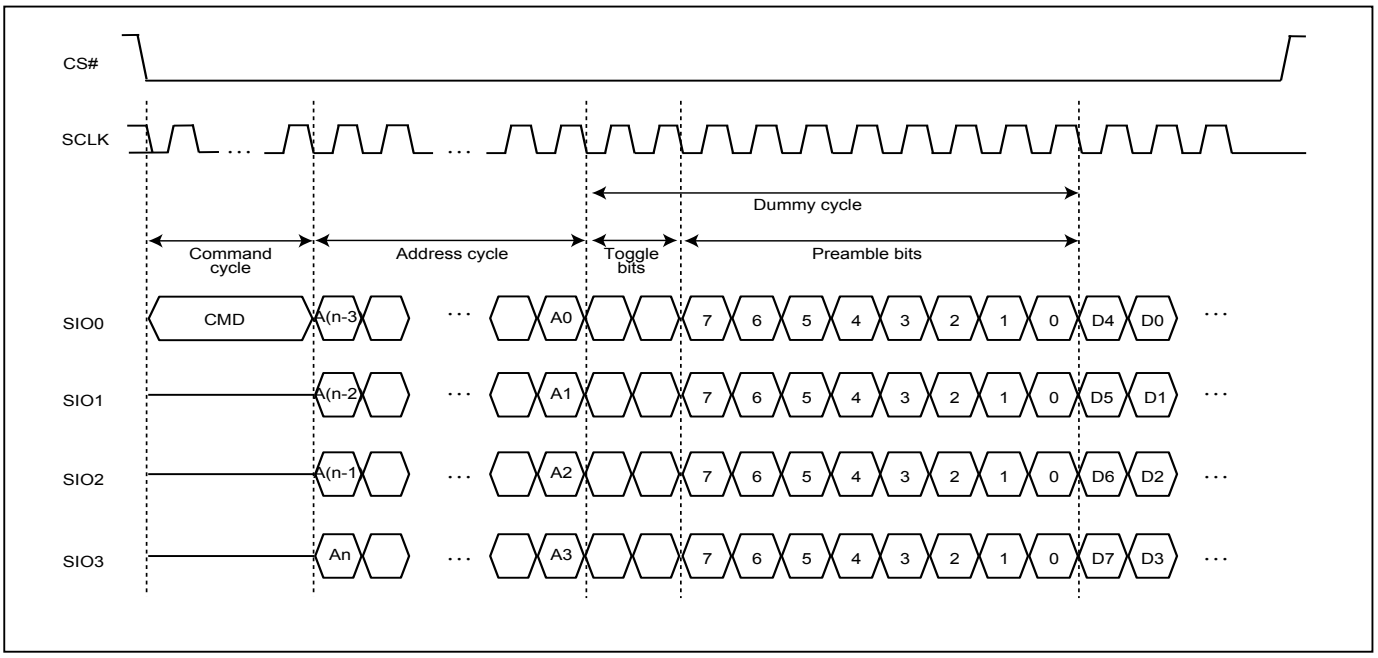



**Figure 44. SDR 4I/O (8DC)**

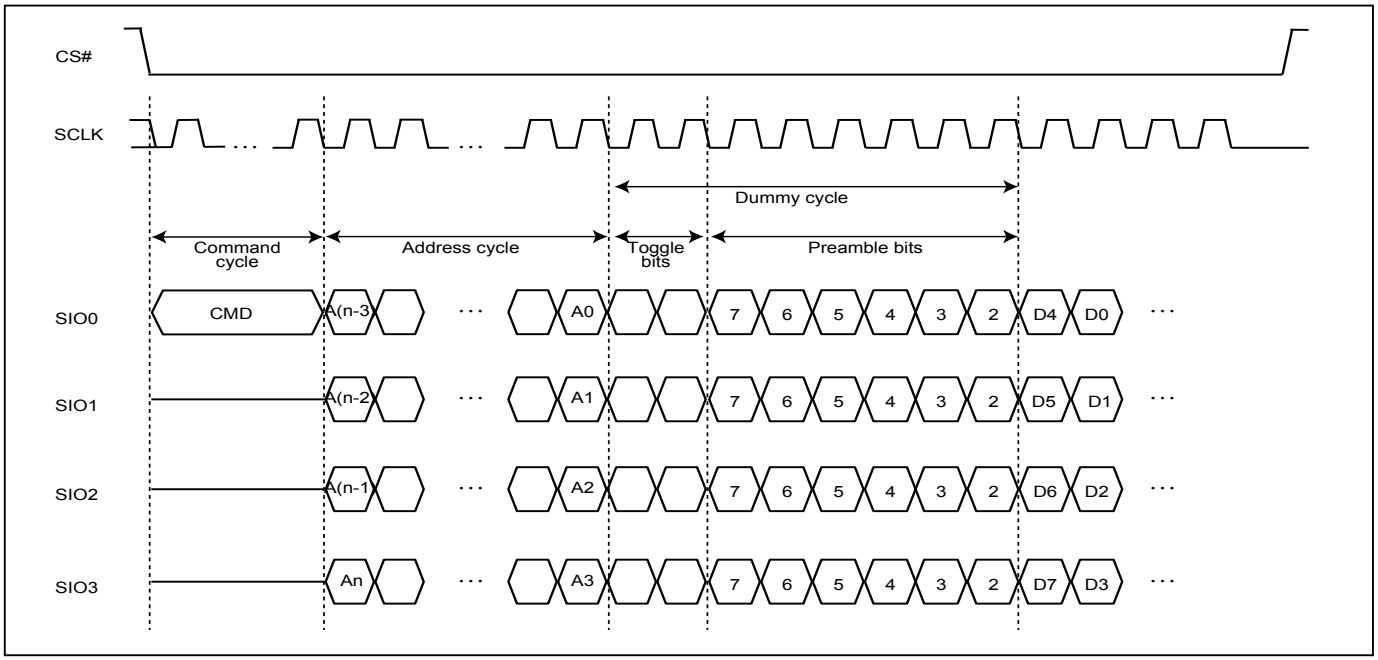
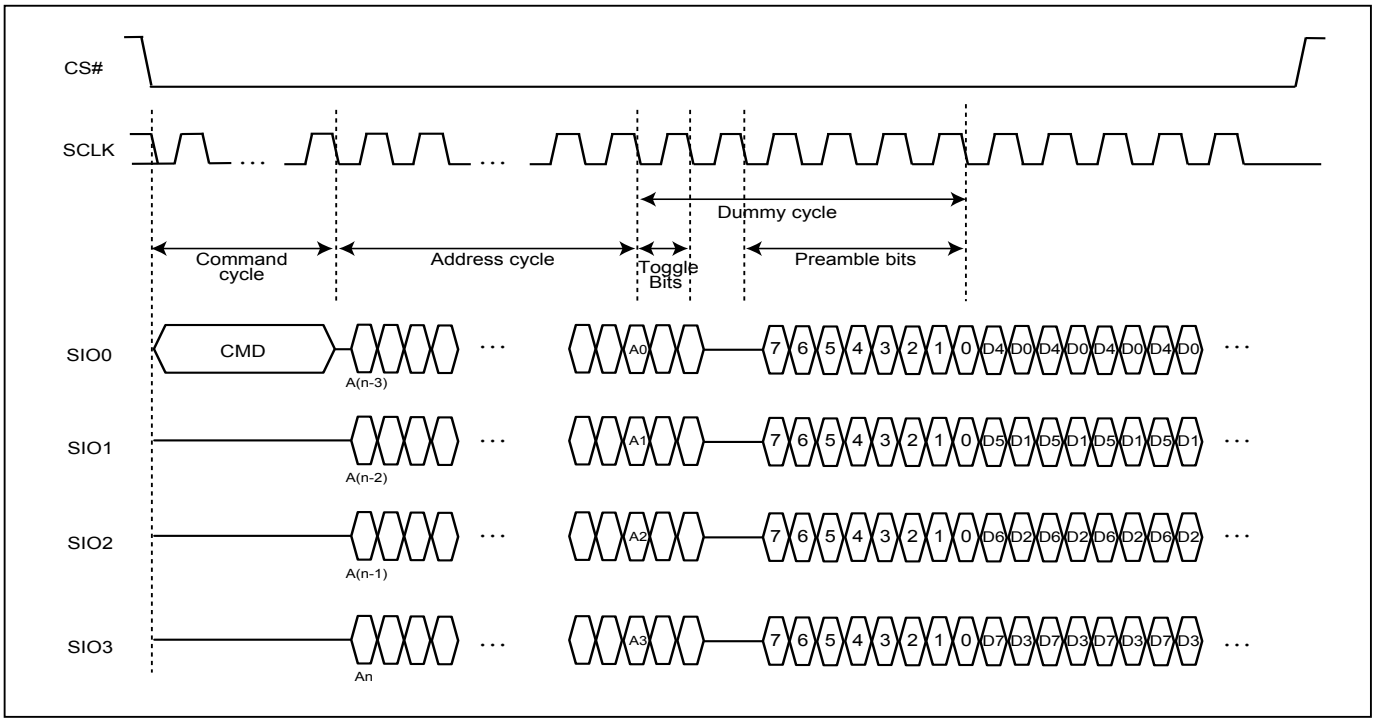


**Figure 45. DTR4IO (6DC)**





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### 9-19. 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 (C0h) → send WRAP CODE →drive CS# high. Refer to the table below for valid 8-bit Wrap Codes and their corresponding Wrap Depth.

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

Once Burst Read is enabled, it will remain enabled until the device is power-cycled or reset. The SPI and QPI mode 4READ read command supports 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 and SPI “EBh” 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 46. Burst Read (SPI Mode)**

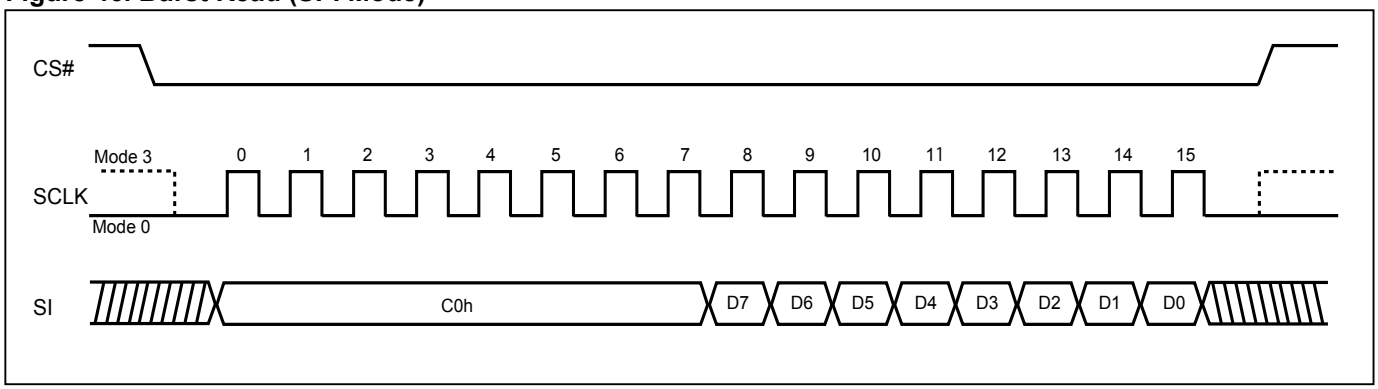
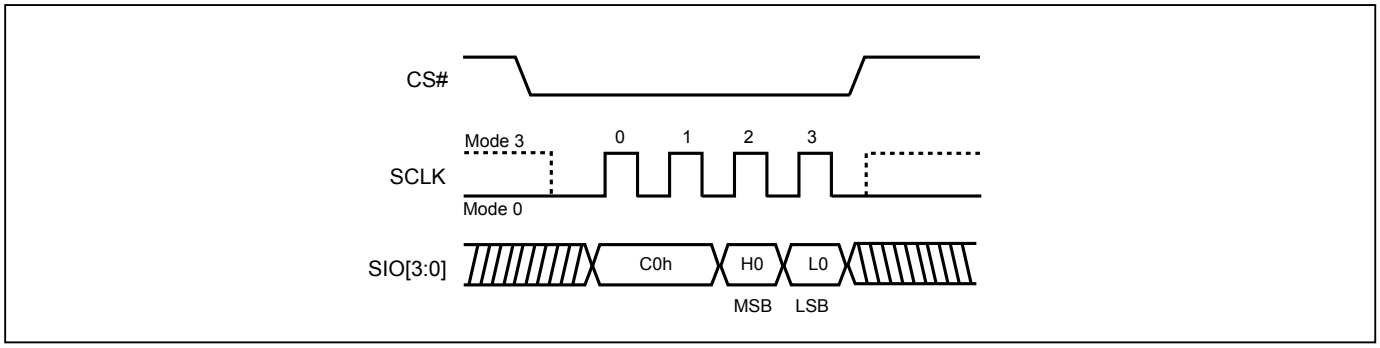



**Figure 47. Burst Read (QPI Mode)**




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


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### 9-20. Performance Enhance Mode - XIP (execute-in-place)

The device could waive the command cycle bits if the two cycle bits after address cycle toggles.

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

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

To enter 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 skip the next 4READ instruction. To leave enhance mode, P[7:4] is no longer toggling with P[3:0]; likewise P[7:0]=FFh, 00h, AAh or 55h along with CS# is afterwards raised and then lowered. Issuing ”FFh” data cycle can also exit enhance mode. The system then will leave performance enhance mode and return to normal operation.

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

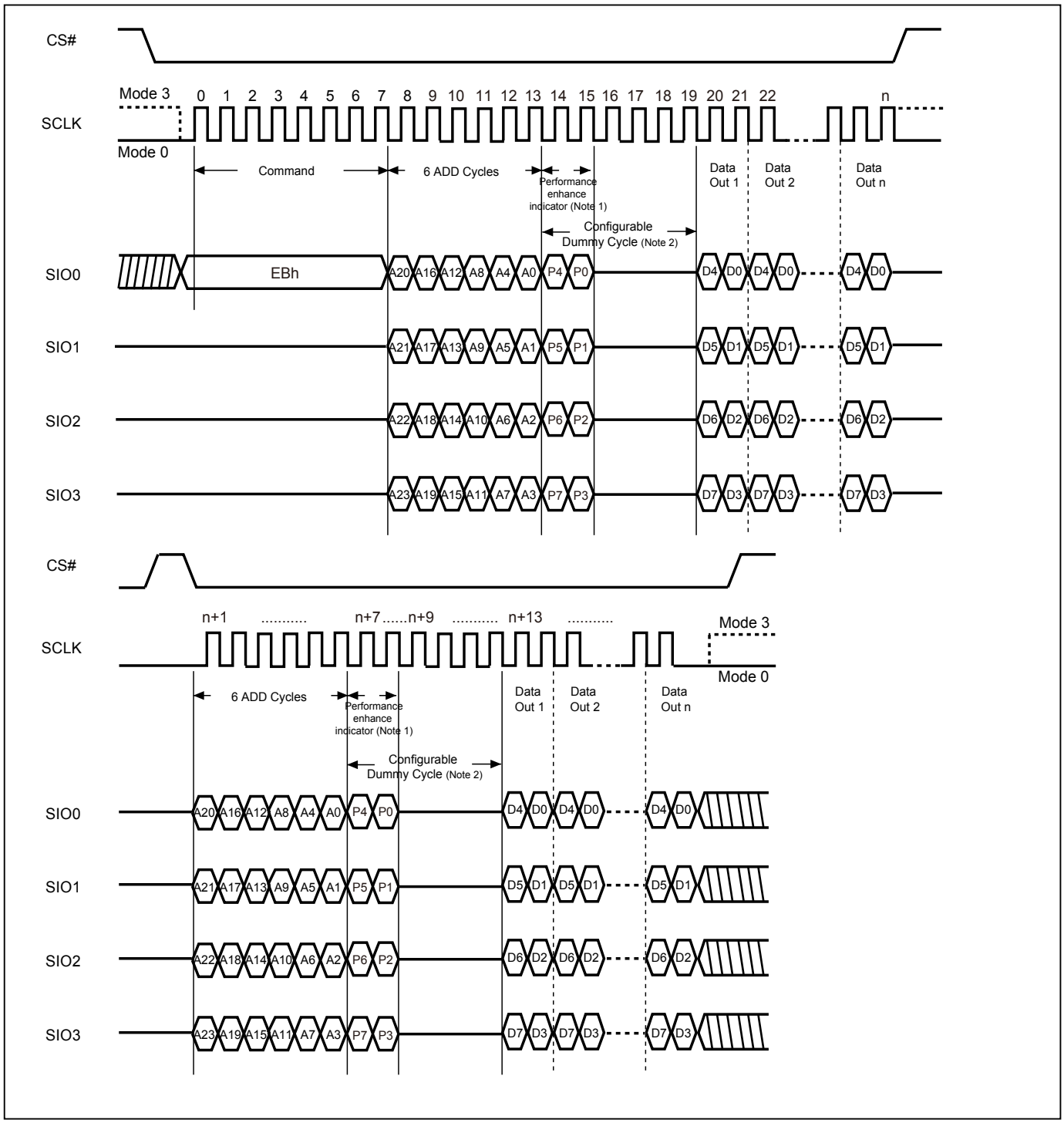
This sequence of issuing 4READ instruction especially useful in random access: CS# goes low→send 4READ instruction→3-bytes address interleave on SIO3, SIO2, SIO1 & SIO0→performance enhance toggling bit P[7:0]→ 4 dummy cycles (Default) →data out until CS# goes high → CS# goes low (The following 4READ instruction is not allowed, hence 8 cycles of 4READ can be saved comparing to normal 4READ mode) → 3-bytes random access address.

To conduct the Performance Enhance Mode Reset operation in SPI mode, FFh data should be issued in 1I/O sequence. In QPI Mode, FFFFFFFFh data cycle, in 4 I/O should be issued.

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


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**Figure 48. 4 x I/O Read Performance Enhance Mode Sequence (SPI Mode)**

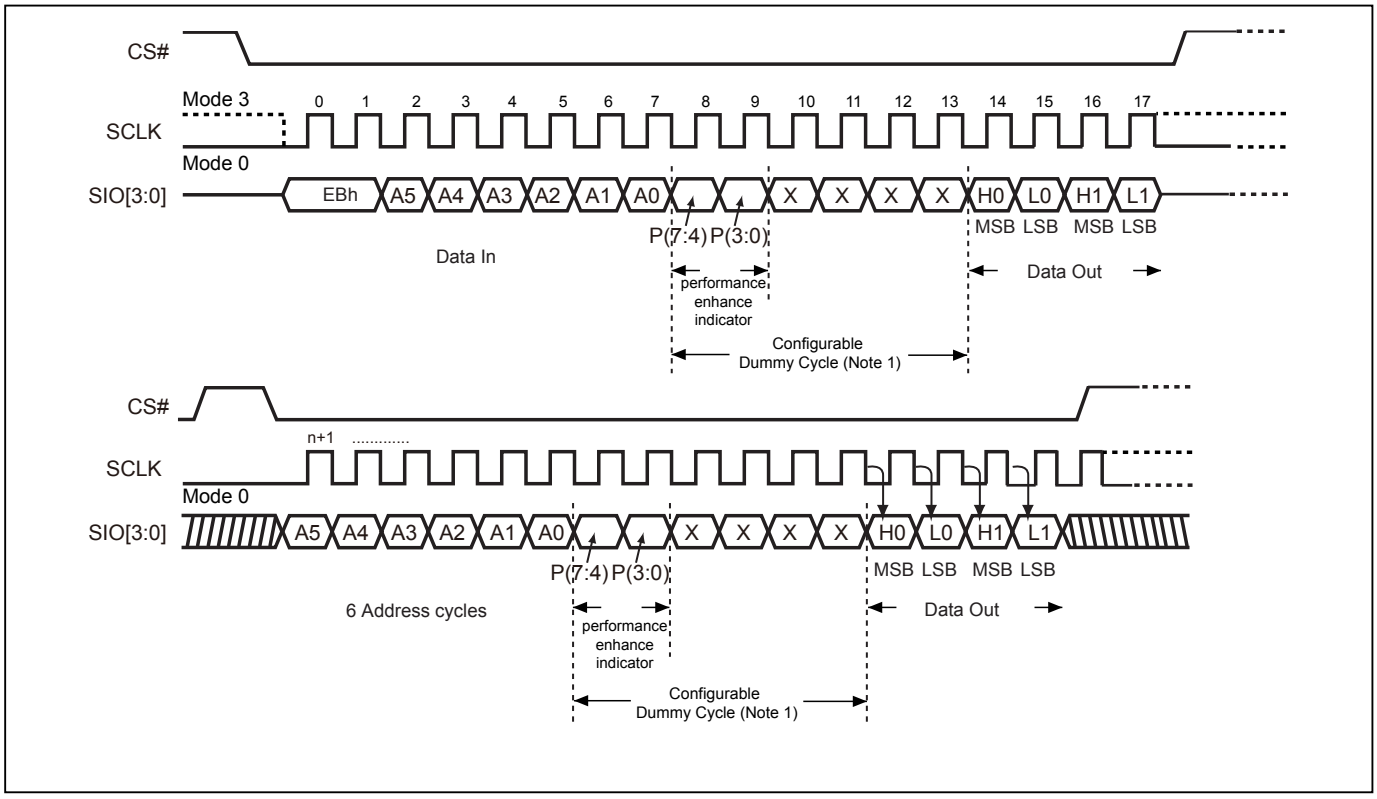



***Notes:***

1. 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.
2. Configuration Dummy cycle numbers will be different depending on the bit6 & bit 7 (DC0 & DC1) setting in configuration register.


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**Figure 49. 4 x I/O Read Performance Enhance Mode Sequence (QPI Mode)**




***Note:***

1. Configuration Dummy cycle numbers will be different depending on the bit6 & bit 7 (DC0 & DC1) setting in configuration register.
2. Reset the performance enhance mode, if P7=P3 or P6=P2 or P5=P1 or P4=P0, ex: AA, 00, FF.


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### 9-21. Sector Erase (SE)

The Sector Erase (SE) instruction is for erasing the data of the chosen sector to be "1". The instruction is used for any 4K-byte sector. A Write Enable (WREN) instruction must execute to set the Write Enable Latch (WEL) bit before sending the Sector Erase (SE). Any address of the sector (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 byte been latched-in); otherwise, the instruction will be rejected and not executed.

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

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 1 during the tSE timing, and clears when Sector Erase Cycle is completed, and the Write Enable Latch (WEL) bit is cleared. If the Block is protected by BP bits (WPSEL=0; Block Protect Mode) or SPB (WPSEL=1; Individual Sector Protect Mode), the Sector Erase (SE) instruction will not be executed on the block.

**Figure 50. Sector Erase (SE) Sequence (SPI Mode)**

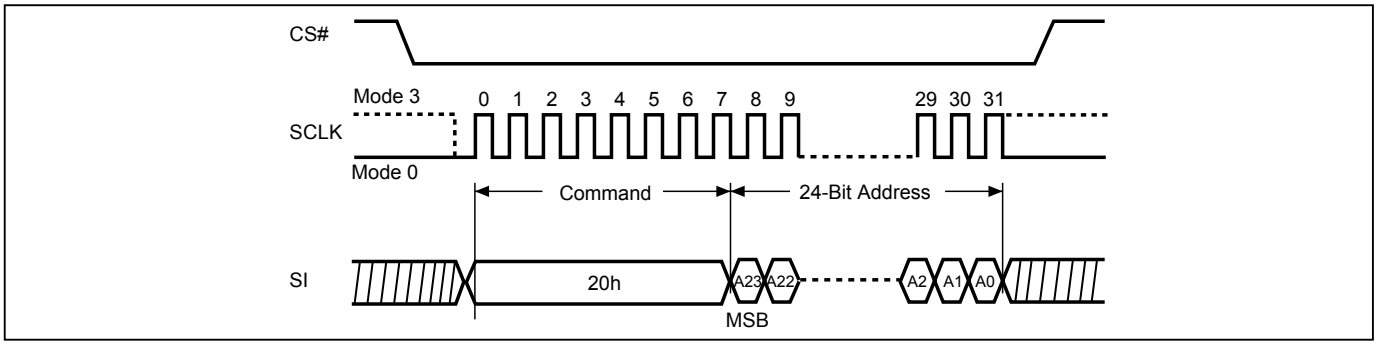
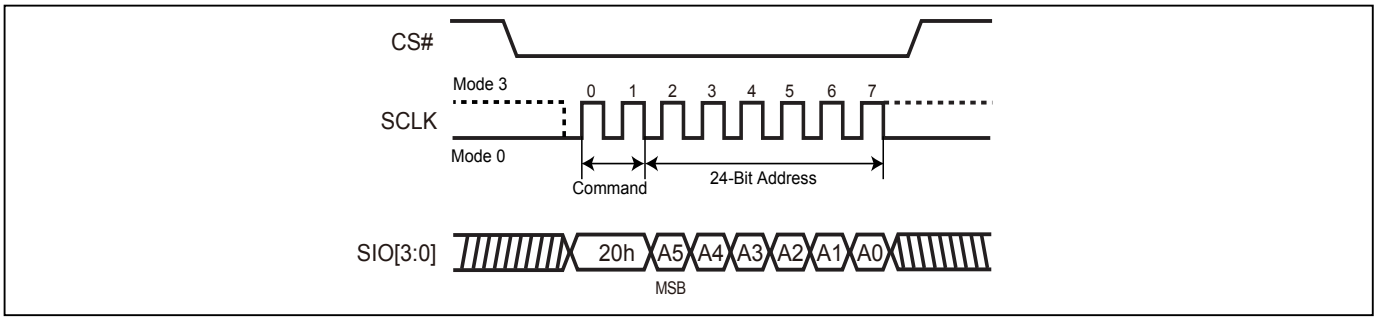



**Figure 51. Sector Erase (SE) Sequence (QPI Mode)**





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### 9-22. 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 be executed to set the Write Enable Latch (WEL) bit before sending the Block Erase (BE32K). Any address of the block (as shown in *"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.

Address bits [Am-A15] (Am is the most significant address) select the 32KB block address.

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.

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 during 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 BP bits (WPSEL=0; Block Protect Mode) or SPB (WPSEL=1; Individual Sector Protect Mode), the Block Erase (BE32K) instruction will not be executed on the block.

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

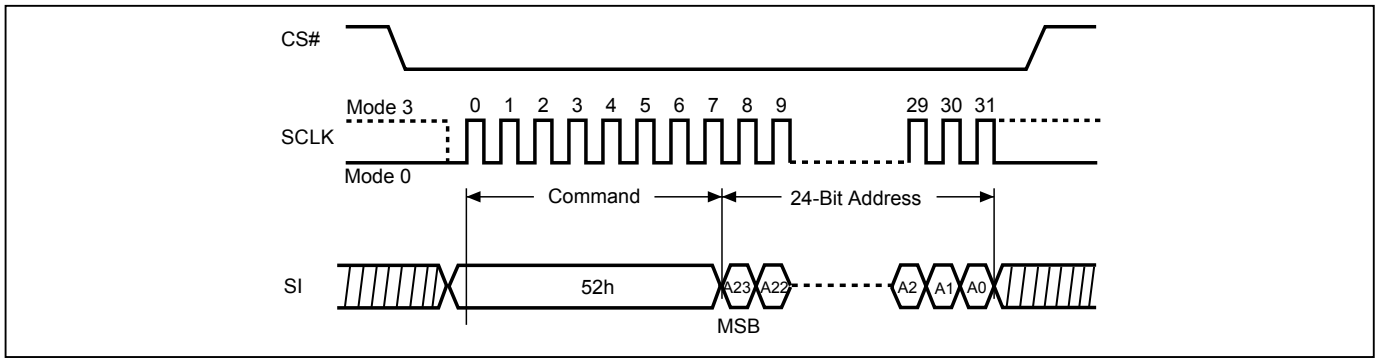
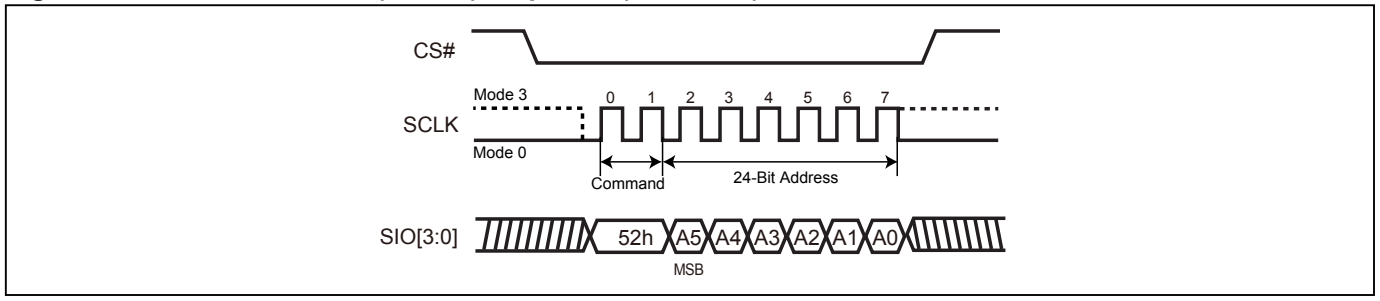



**Figure 53. Block Erase 32KB (BE32K) Sequence (QPI Mode)**





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### 9-23. 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→ send 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.

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 reset. If the Block is protected by BP bits (WPSEL=0; Block Protect Mode) or SPB (WPSEL=1; Individual Sector Protect Mode), the Block Erase (BE) instruction will not be executed on the block.

**Figure 54. Block Erase (BE) Sequence (SPI Mode)**

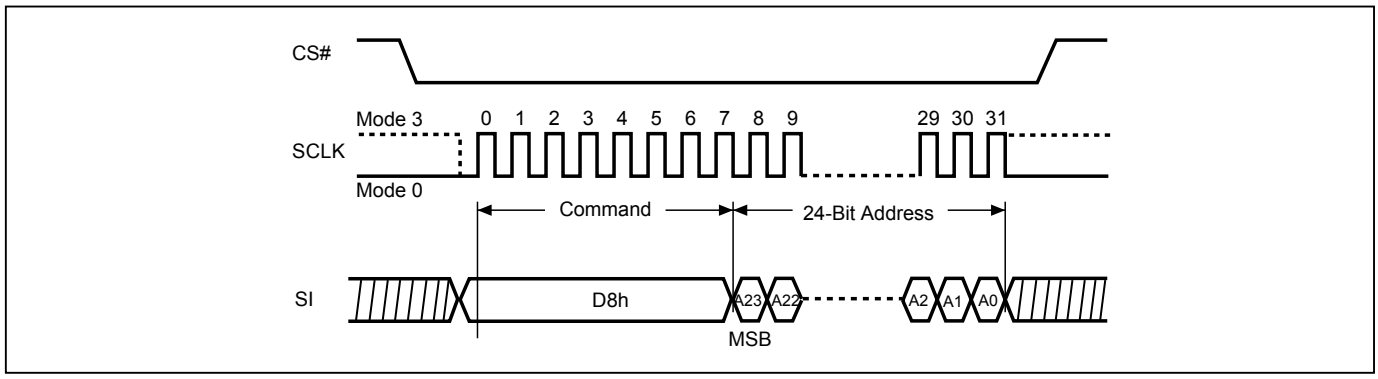
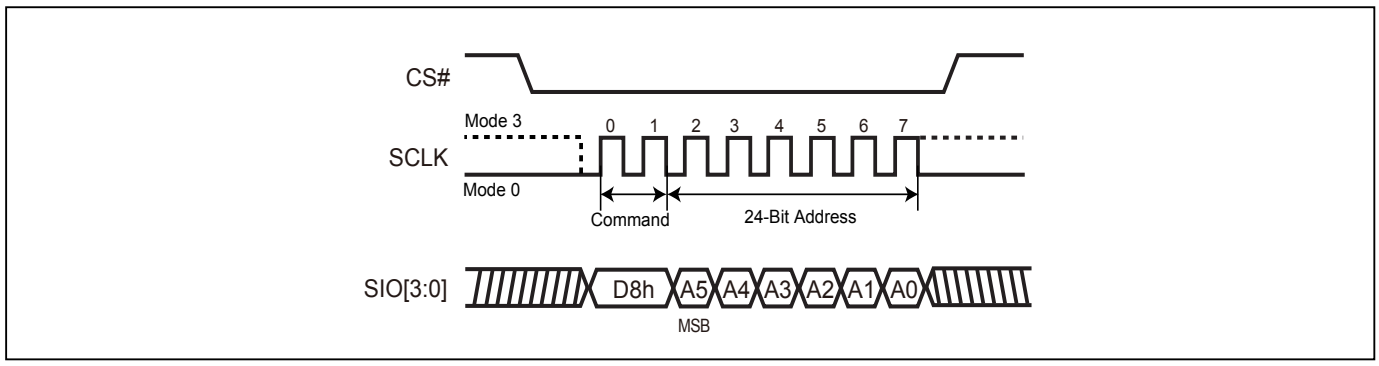



**Figure 55. Block Erase (BE) Sequence (QPI Mode)**





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### 9-24. 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.

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.

When the chip is under "Block protect (BP) Mode" (WPSEL=0). The Chip Erase (CE) instruction will not be executed, if one (or more) sector is protected by BP3-BP0 bits. It will be only executed when BP3-BP0 all set to "0".

When the chip is under "Advances Sector Protect Mode" (WPSEL=1). The Chip Erase (CE) instruction will be executed on unprotected block. The protected Block will be skipped. If one (or more) 4K byte sector was protected in top or bottom 64K byte block, the protected block will also skip the chip erase command.

**Figure 56. Chip Erase (CE) Sequence (SPI Mode)**

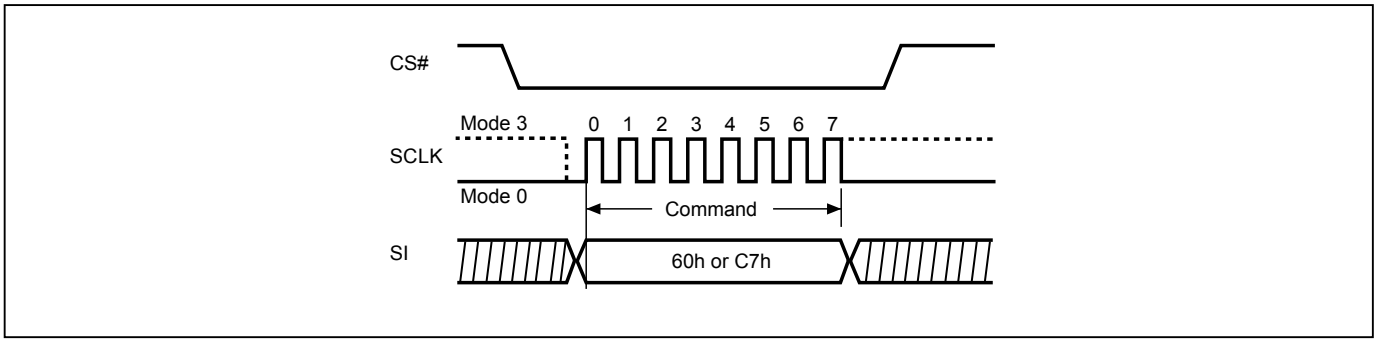
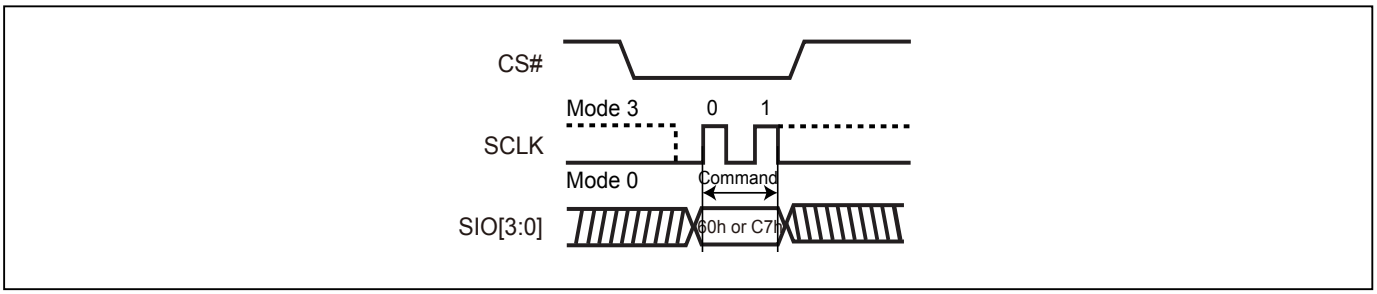



**Figure 57. Chip Erase (CE) Sequence (QPI Mode)**





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### 9-25. 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→ send PP instruction code→ 3-byte address on SI→ at least 1-byte on data on SI→ CS# goes high.

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 BP bits (WPSEL=0; Block Protect Mode) or SPB (WPSEL=1; Individual Sector Protect Mode), 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.


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**Figure 58. Page Program (PP) Sequence (SPI Mode)**

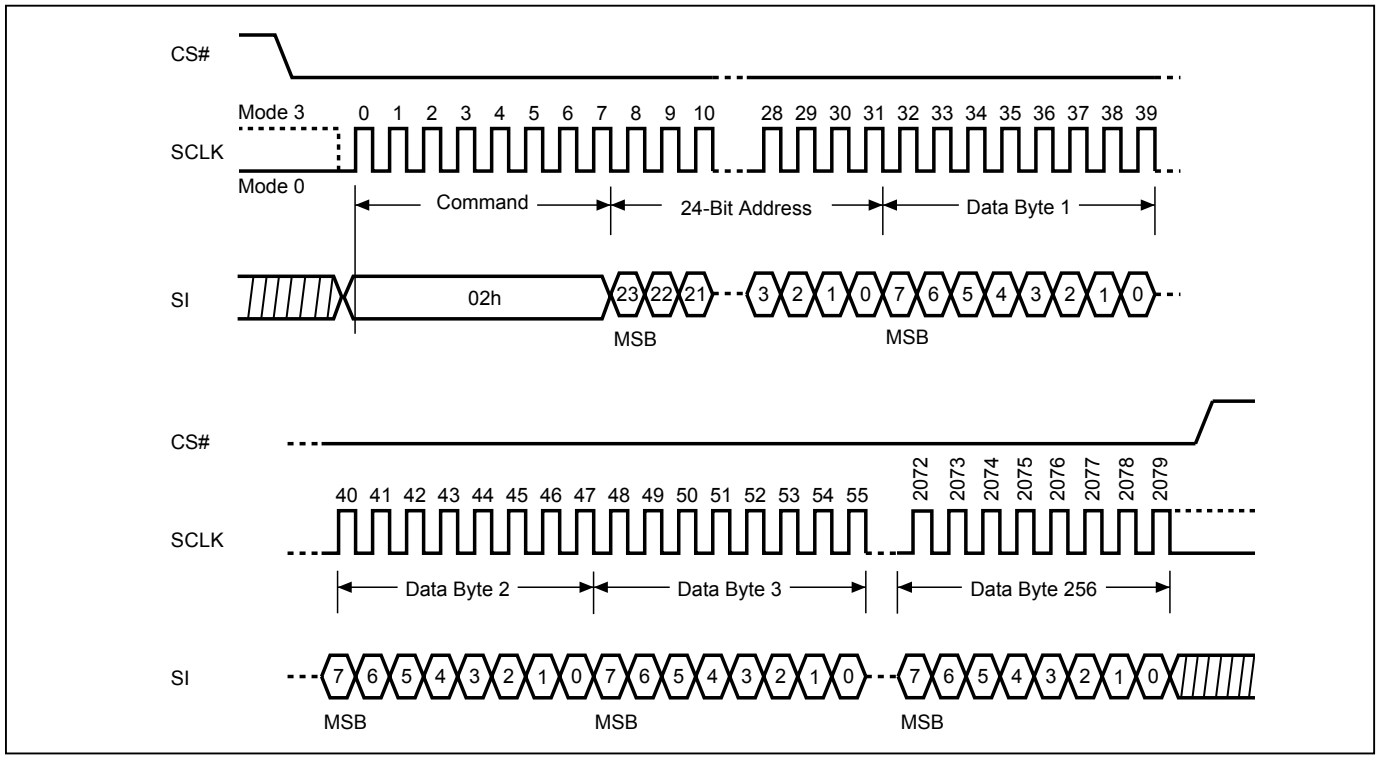
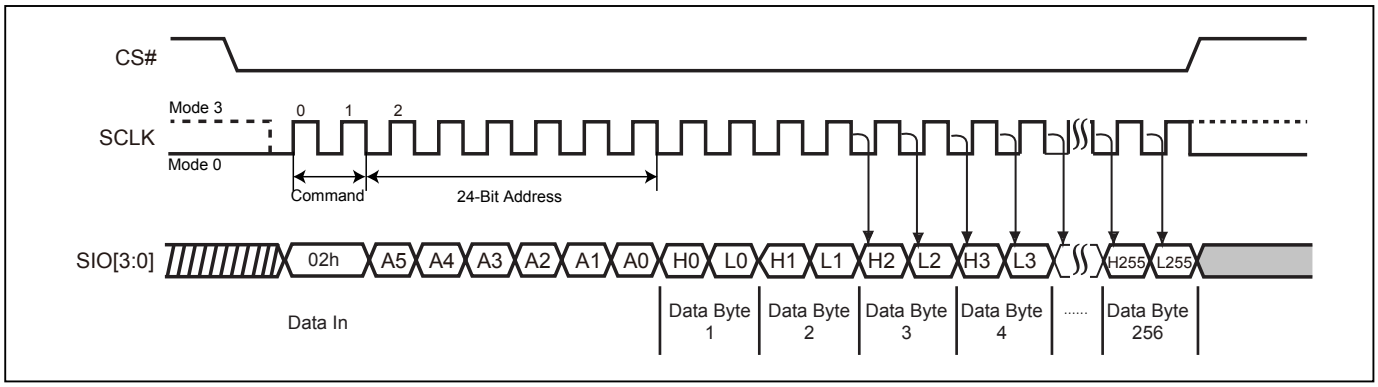



**Figure 59. Page Program (PP) Sequence (QPI Mode)**





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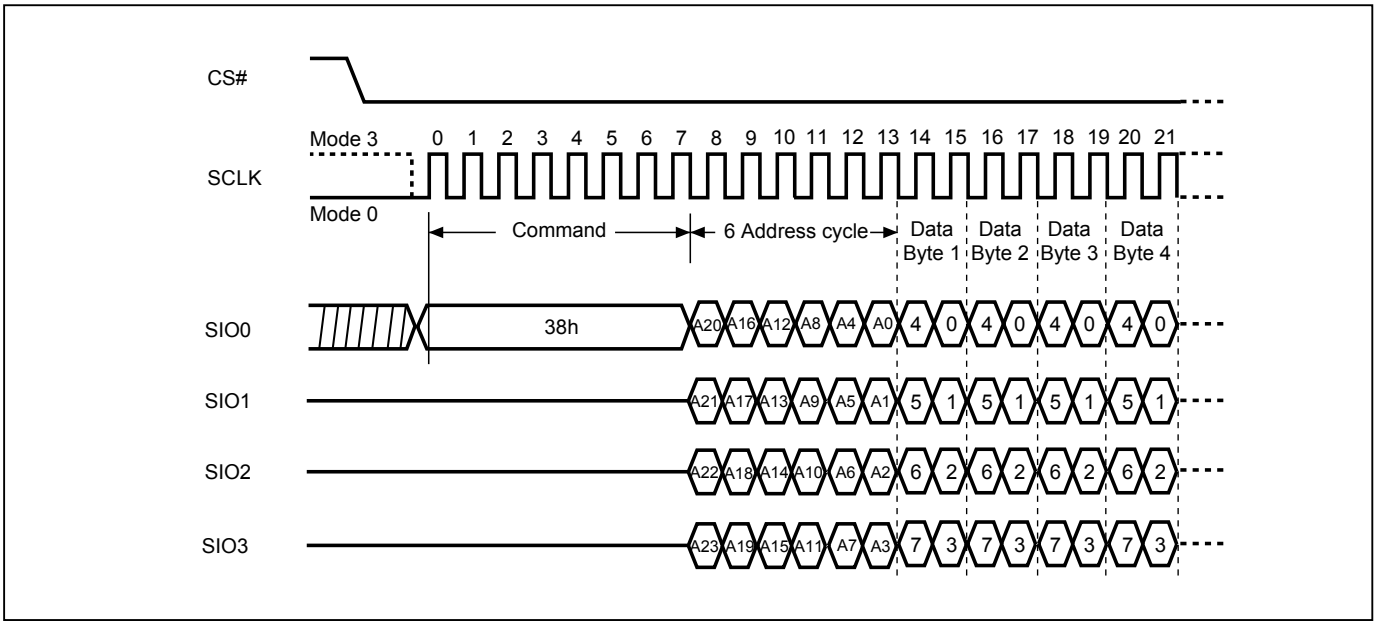
### 9-26. 4 x I/O Page Program (4PP)

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. 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.

If the page is protected by BP bits (WPSEL=0; Block Protect Mode) or SPB (WPSEL=1; Individual Sector Protect Mode), the Quad Page Program (4PP) instruction will not be executed.

**Figure 60. 4 x I/O Page Program (4PP) Sequence (SPI Mode only)**





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### 9-27. 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".

After CS# goes high there is a delay of tDP before the device transitions from Stand-by mode to Deep Power-down 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 Powerdown (RDP) instruction, power-cycle, or reset. Please refer to *"Figure 17. Release from Deep Power-down (RDP) Sequence (SPI Mode)"* and *"Figure 18. Release from Deep Power-down (RDP) Sequence (QPI Mode)"*.

**Figure 61. Deep Power-down (DP) Sequence (SPI Mode)**

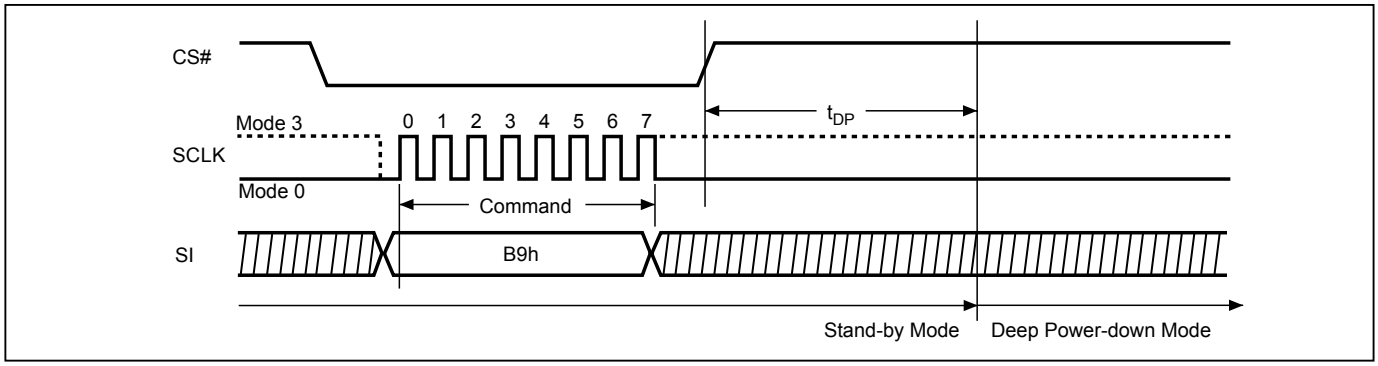
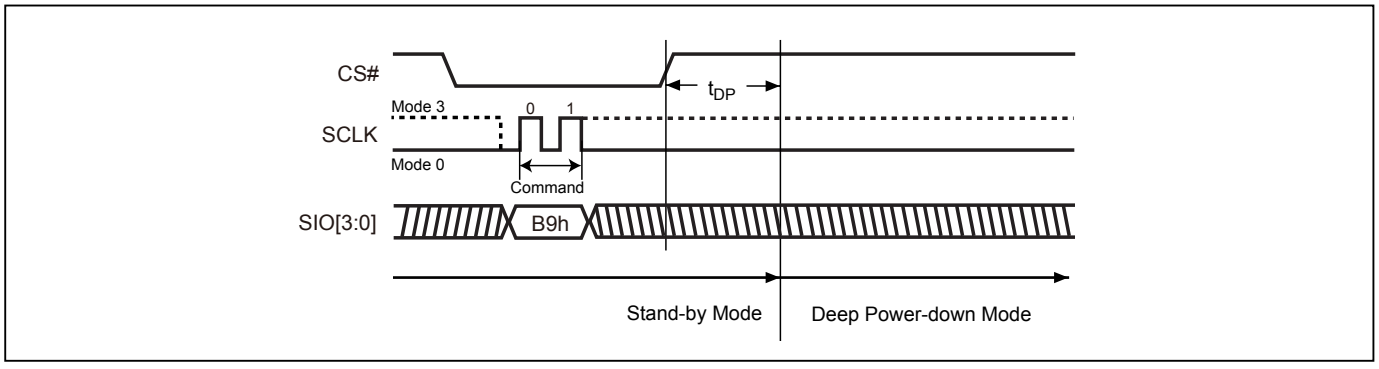



**Figure 62. Deep Power-down (DP) Sequence (QPI Mode)**





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### 9-28. Write Security Register (WRSCUR)

The WRSCUR instruction is for changing 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 sequence of issuing WRSCUR instruction is : CS# goes low→ send 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.

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

**Figure 63. Write Security Register (WRSCUR) Sequence (SPI Mode)**

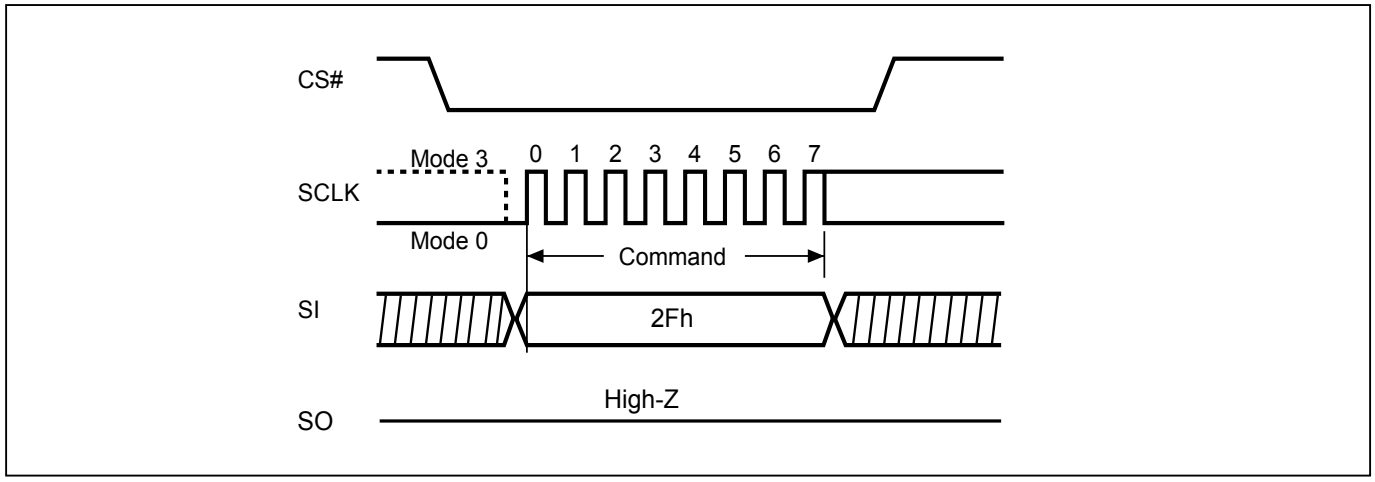
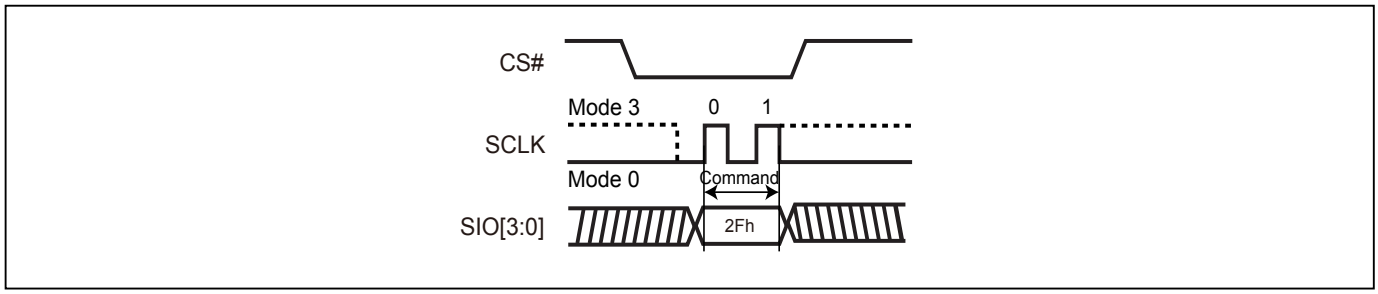



**Figure 64. Write Security Register (WRSCUR) Sequence (QPI Mode)**





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### 9-29. 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.

**Figure 65. Read Security Register (RDSCUR) Sequence (SPI Mode)**

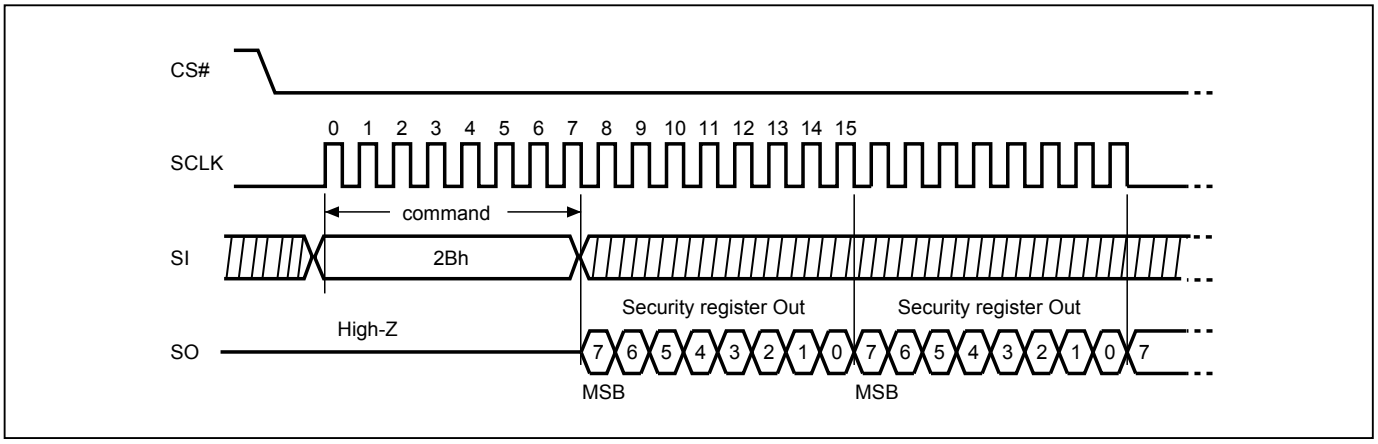
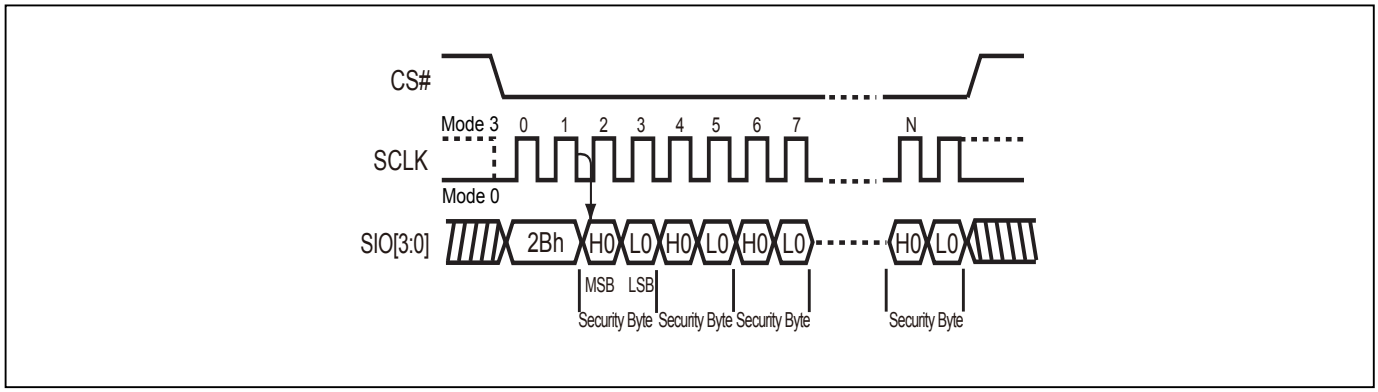



**Figure 66. Read Security Register (RDSCUR) Sequence (QPI Mode)**





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### 9-30. Enter Secured OTP (ENSO)

The ENSO instruction is for entering the additional 4K-bit secured OTP mode. While device is in 4K-bit secured OTPmode, 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 after issuing ENSO command user can only access secure OTP region with standard read or program procedure. Furthermore, once security OTP is lock down, only read related commands are valid.

### 9-31. 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.


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**Security Register**

The definition of the Security Register bits is as below:

**Write Protection Selection bit.** Please reference to "*Write Protection Selection bit*"

**Erase Fail bit.** The Erase Fail bit indicates the status of last Erase operation. The bit will be set to "1" if the erase operation failed or the erase region is protected. It will be automatically cleared to "0" if the next erase operation succeeds. Please note that it does not interrupt or stop any operation in the flash memory.

**Program Fail bit.** The Program Fail bit indicates the status of last Program operation. The bit will be set to "1" if the program operation failed or the program region is protected. It will be automatically cleared to "0" if the next program operation succeeds. Please note that it does not interrupt or stop any operation in the flash memory.

**Erase Suspend bit.** 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.

**Program Suspend bit.** 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.

**Secured OTP Indicator bit.** The Secured OTP indicator bit indicates the Secured OTP area 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. While it is in 4K-bit secured OTP mode, main array access is not allowed.

**Table 12. 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=Block Lock (BP) protection mode 1=Individual Sector protection 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) |


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### 9-32. Write Protection Selection (WPSEL)

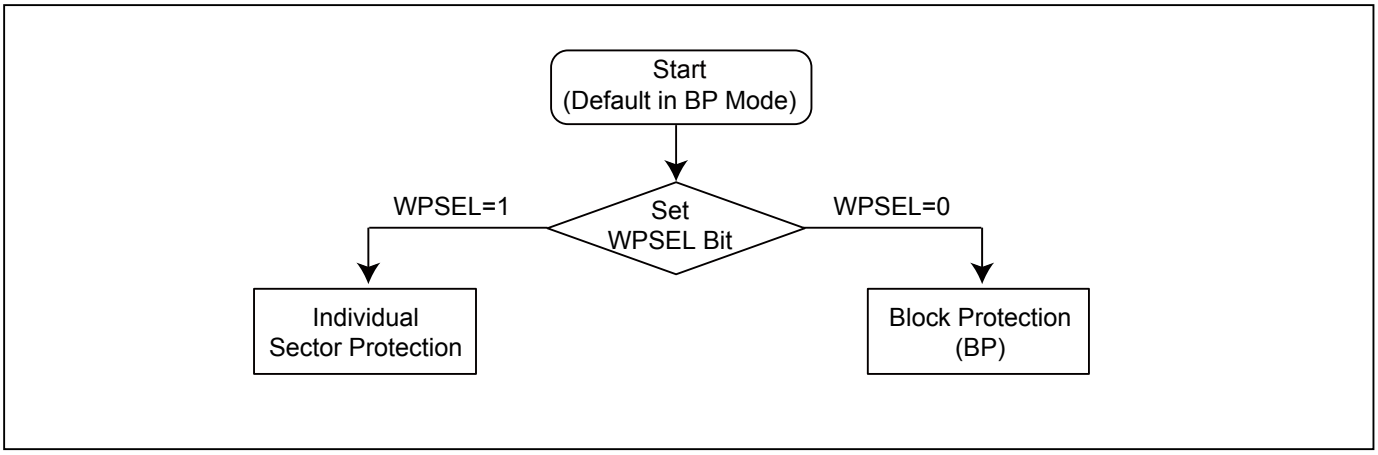
There are two write protection methods provided on this device, (1) Block Protection (BP) mode or (2) Individual Sector Protection mode. The protection modes are mutually exclusive. The WPSEL bit selects which protection mode is enabled. If WPSEL=0 (factory default), BP mode is enabled and Individual Sector Protection mode is disabled. If WPSEL=1, Individual Sector Protection mode is enabled and BP mode is disabled. The WPSEL command is used to set WPSEL=1. A WREN command must be executed to set the WEL bit before sending the WPSEL command. Please note that the WPSEL bit is an OTP bit. Once WPSEL is set to "1", it cannot be programmed back to "0".

When WPSEL = 0: Block Lock (BP) protection mode,
The memory array is write protected by the BP3-BP0 bits.

When WPSEL =1: Individual Sector protection mode,
Blocks are individually protected by their own SPB or DPB. On power-up, all blocks are write protected by the Dynamic Protection Bits (DPB) by default. The Individual Sector Protection instructions WRLR, RDLR, WRSPB, ESSPB, WRDPB, RDDPB, GBLK, and GBULK are activated. The BP3-BP0 bits of the Status Register are disabled and have no effect. Hardware protection is performed by driving WP#=0. Once WP#=0 all blocks and sectors are write protected regardless of the state of each SPB or DPB.

The sequence of issuing WPSEL instruction is: CS# goes low → send WPSEL instruction to enable the Individual Sector Protect mode → CS# goes high.

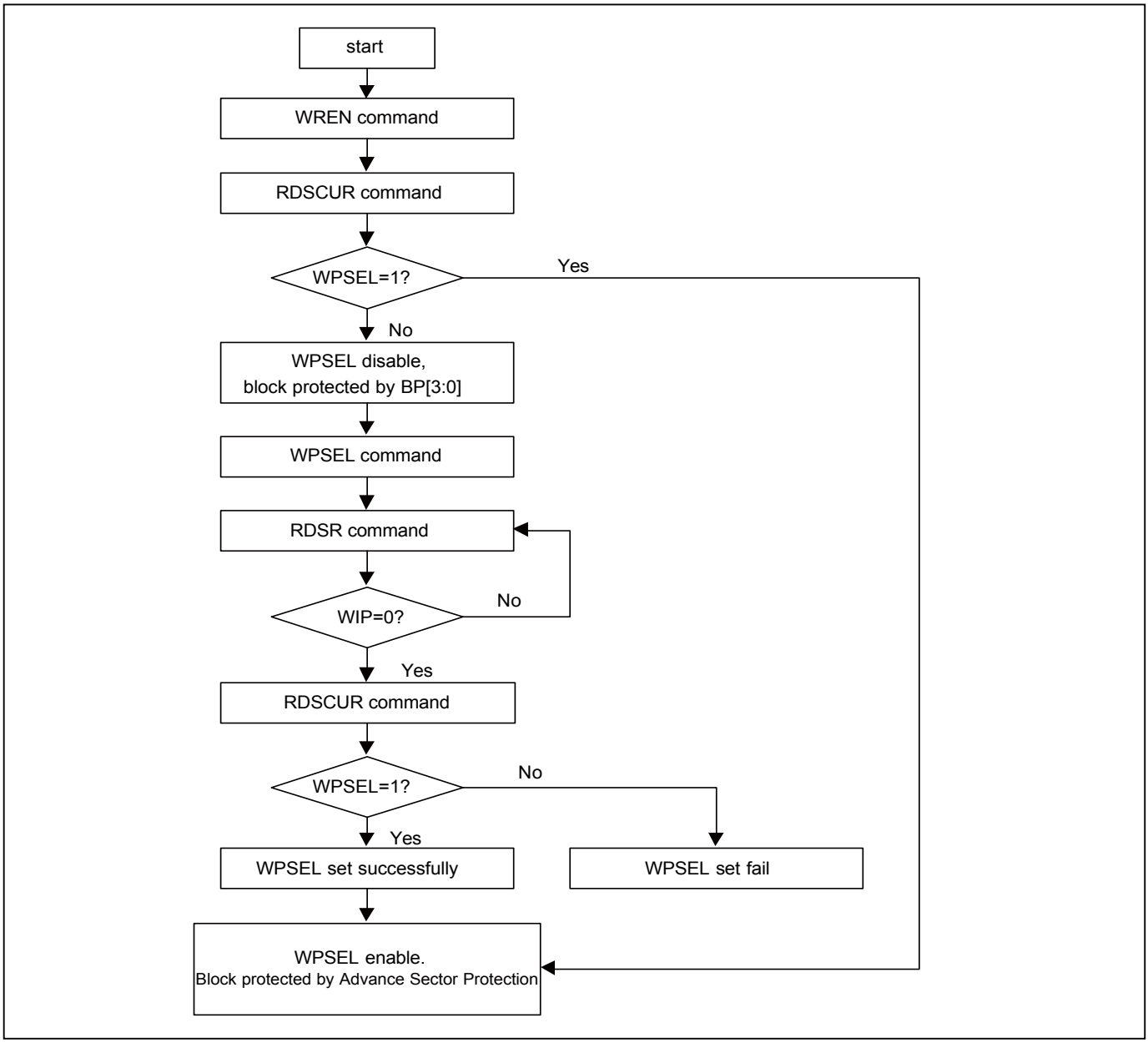
**Figure 67. Write Protection Selection**





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**Figure 68. WPSEL Flow**





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### 9-33. Advanced Sector Protection

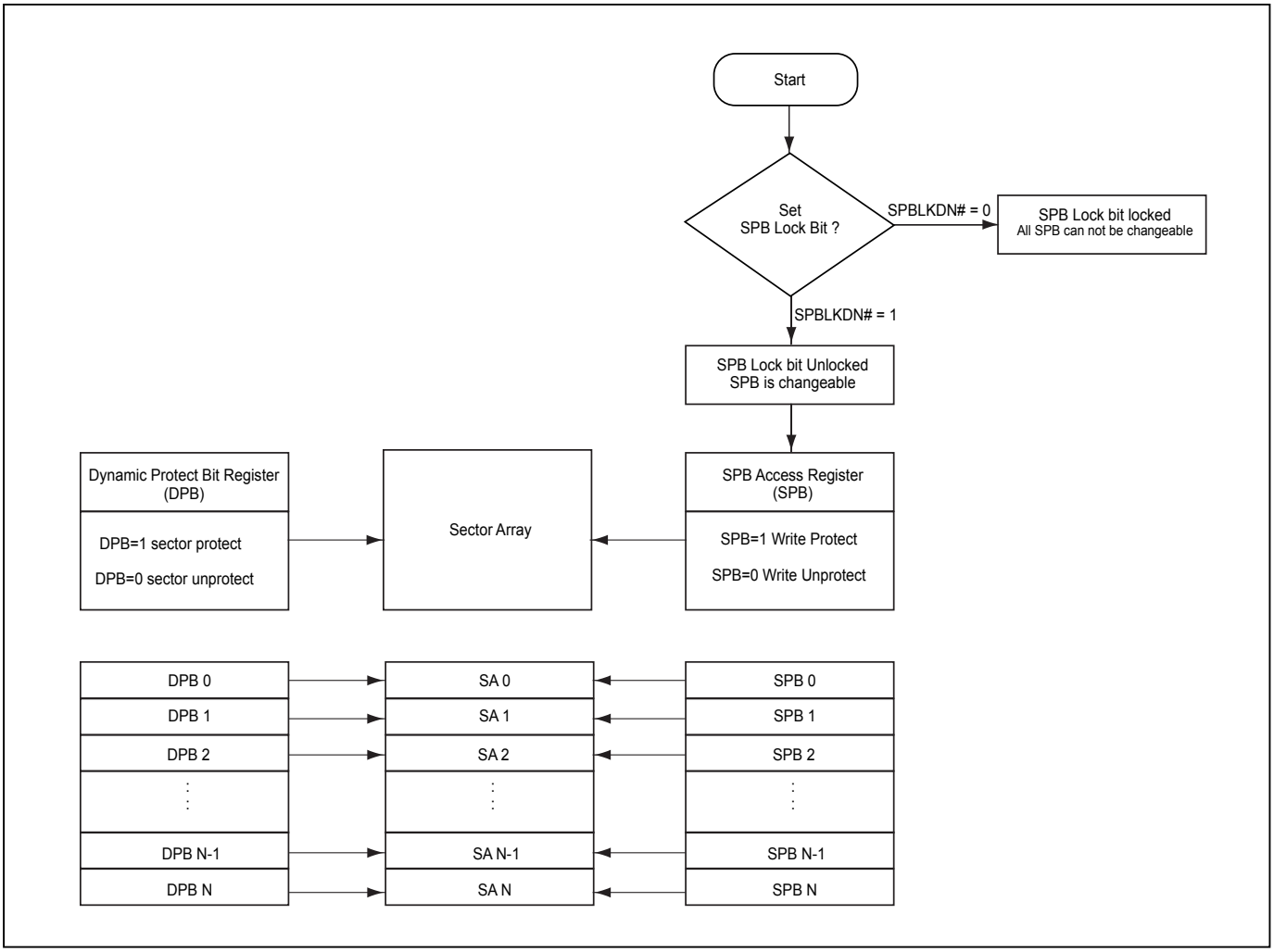
Advanced Sector Protection can protect individual 4KB sectors in the bottom and top 64KB of memory and protect individual 64KB blocks in the rest of memory.

There is one non-volatile Solid Protection Bit (SPB) and one volatile Dynamic Protection Bit (DPB) assigned to each 4KB sector at the bottom and top 64KB of memory and to each 64KB block in the rest of memory. A sector or block is write-protected from programming or erasing when its associated SPB or DPB is set to "1". Please refer to *"9-33-5. Sector Protection States Summary Table"* for the sector state with the protection status of DPB/SPB bits.

The figure below helps describing an overview of these methods. The device is default to the Solid mode when shipped from factory. The detail algorithm of advanced sector protection is shown as follows:

Solid Protection mode permits the SPB bits to be modified after power-on or a reset. The figure below is an overview of Advanced Sector Protection

**Figure 69. Advanced Sector Protection Overview**





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### 9-33-1. Lock Register

The Lock Register is a 16-bit one-time programmable register. Lock Register bit [6] is SPB Lock Down Bit (SPBLKDN) which is an unique bit assigned to control all SPB bit status.

When SPBLKDN is 1, SPB can be changed. When it is locked as 0, all SPB can not be changed anymore, and SPBLKDN bit itself can not be altered anymore, either.

The Lock Register is programmed using the WRLR (Write Lock Register) command. A WREN command must be executed to set the WEL bit before sending the WRLR command.

**Table 13. Lock Register**

| Bits | Field Name | Function | Type | Default State | Description |
|---|---|---|---|---|---|
| 15 to 7 | RFU | Reserved | OTP | 1 | Reserved for Future Use |
| 6 | SPBLKDN | SPB Lock Down | OTP | 1 | 1 = SPB changeable<br>0 = freeze SPB |
| 5 to 0 | RFU | Reserved | OTP | 1 | Reserved for Future Use |

**Figure 70. Read Lock Register (RDLR) Sequence**

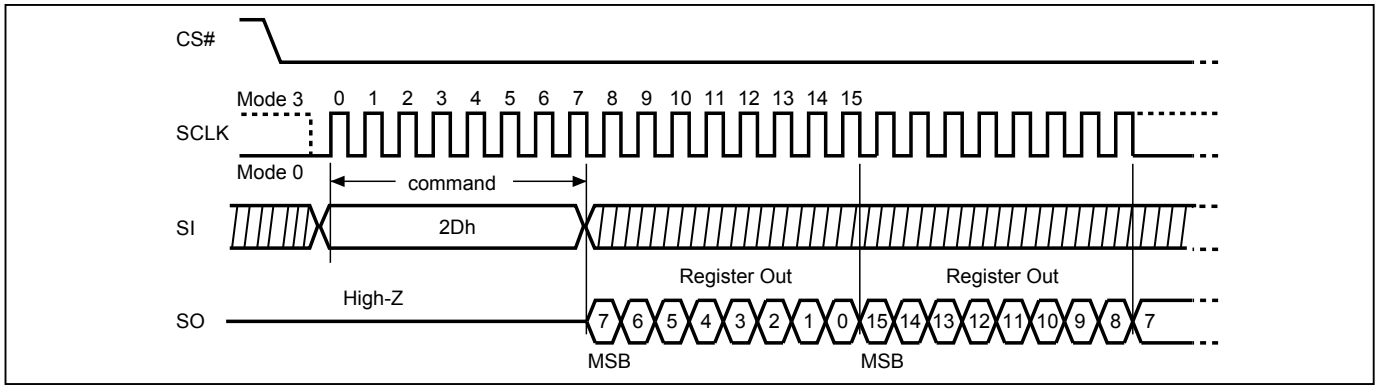
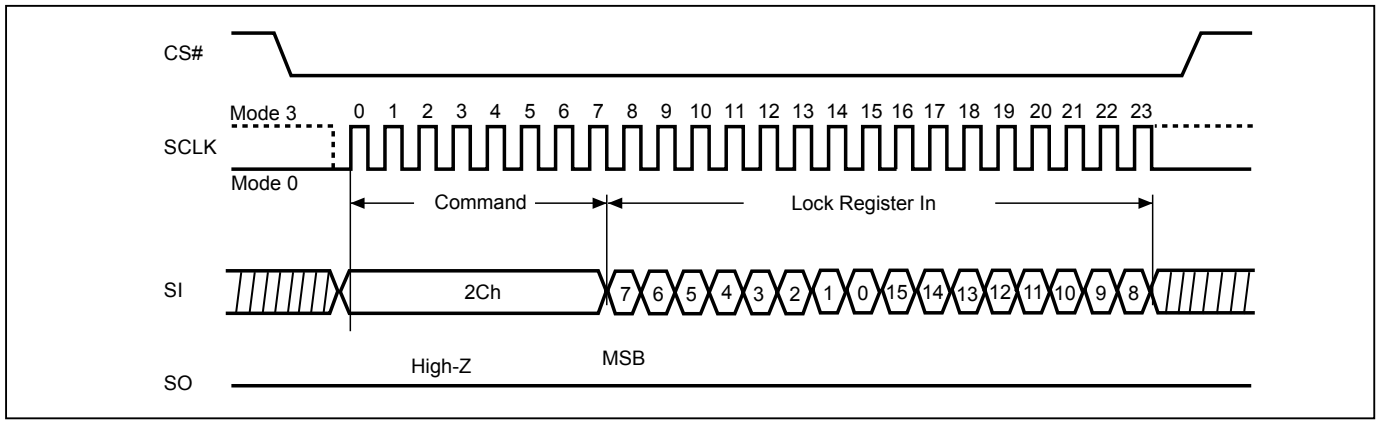



**Figure 71. Write Lock Register (WRLR) Sequence**





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### 9-33-2. Solid Protection Bits

The Solid Protection Bits (SPBs) are nonvolatile bits for enabling or disabling write-protection to sectors and blocks. The SPB bits have the same endurance as the Flash memory. An SPB is assigned to each 4KB sector in the bottom and top 64KB of memory and to each 64KB block in the remaining memory. The factory default state of the SPB bits is “0”, which has the sector/block write-protection disabled.

When an SPB is set to “1”, the associated sector or block is write-protected. Program and erase operations on the sector or block will be inhibited. SPBs can be individually set to “1” by the WRSPB command. However, the SPBs cannot be individually cleared to “0”. Issuing the ESSPB command clears all SPBs to “0”. A WREN command must be executed to set the WEL bit before sending the WRSPB or ESSPB command.

The RDSPB command reads the status of the SPB of a sector or block. The RDSPB command returns 00h if the SPB is “0”, indicating write-protection is disabled. The RDSPB command returns FFh if the SPB is “1”, indicating write-protection is enabled.

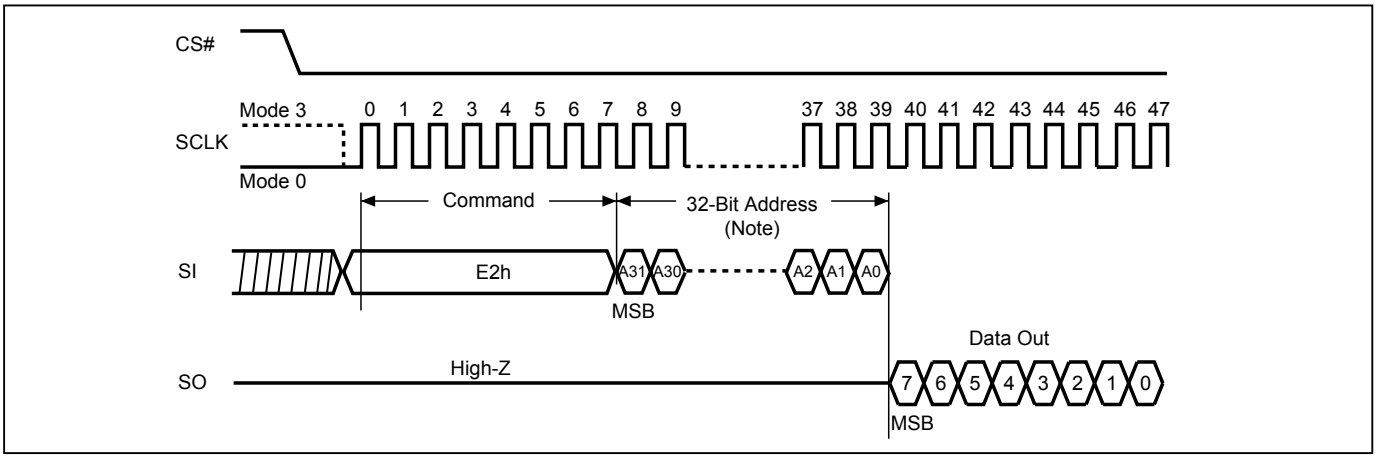
***Note:*** If SPBLKDN=0, commands to set or clear the SPB bits will be ignored.

**Table 14. SPB Register**

| Bit | Description | Bit Status | Default | Type |
|---|---|---|---|---|
| 7 to 0 | SPB (Solid Protection Bit) | 00h = Unprotect Sector / Block<br>FFh = Protect Sector / Block | 00h | Non-volatile |


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**Figure 72. Read SPB Status (RDSPB) Sequence**




**Note:** A31-A24 are don't care.

**Figure 73. SPB Erase (ESSPB) Sequence**

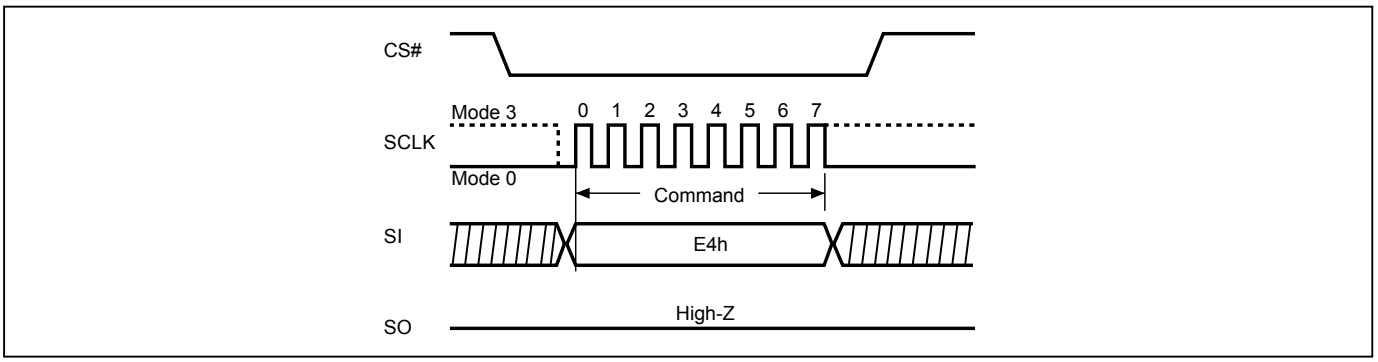
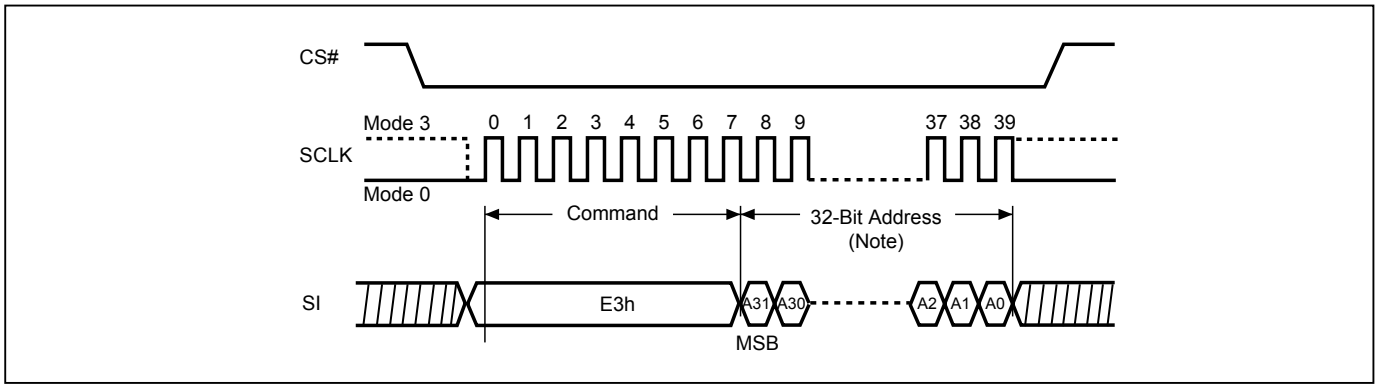



**Figure 74. SPB Program (WRSPB) Sequence**




**Note:** A31-A24 are don't care.


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### 9-33-3. Dynamic Protection Bits

The Dynamic Protection Bits (DPBs) are volatile bits for quickly and easily enabling or disabling write-protection to sectors and blocks. A DPB is assigned to each 4KB sector in the bottom and top 64KB of memory and to each 64KB block in the rest of the memory. The DBPs can enable write-protection on a sector or block regardless of the state of the corresponding SPB. However, the DPB bits can only unprotect sectors or blocks whose SPB bits are “0” (unprotected).

When a DPB is “1”, the associated sector or block will be write-protected, preventing any program or erase operation on the sector or block. All DPBs default to “1” after power-on or reset. When a DPB is cleared to “0”, the associated sector or block will be unprotected if the corresponding SPB is also “0”.

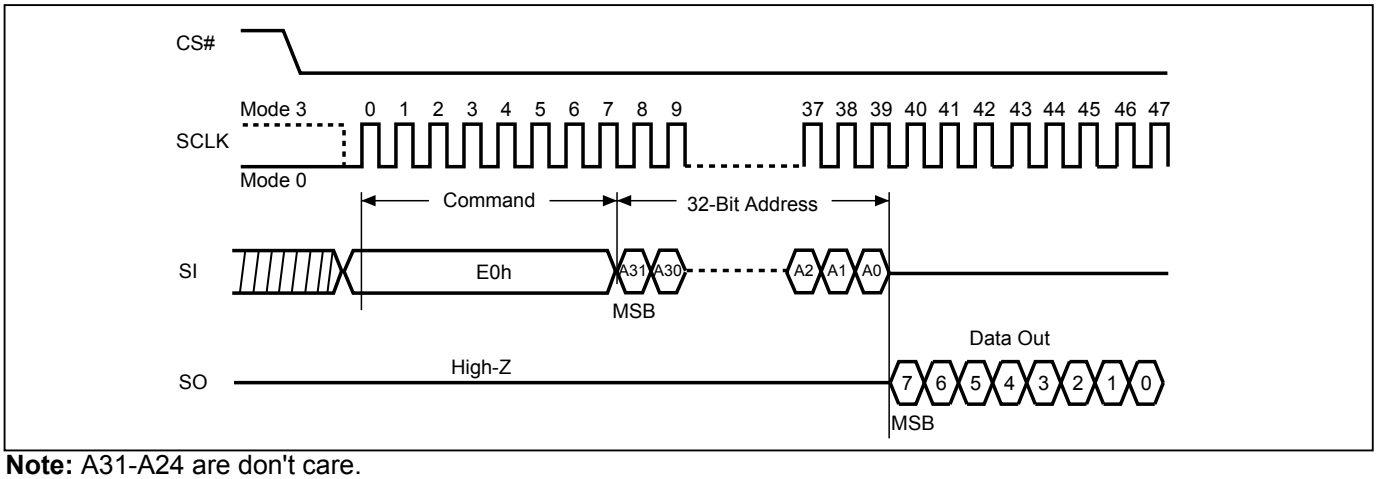
DPB bits can be individually set to “1” or “0” by the WRDPB command. The DBP bits can also be globally cleared to “0” with the GBULK command or globally set to “1” with the GBLK command. A WREN command must be executed to set the WEL bit before sending the WRDPB, GBULK, or GBLK command.

The RDDPB command reads the status of the DPB of a sector or block. The RDDPB command returns 00h if the DPB is “0”, indicating write-protection is disabled. The RDDPB command returns FFh if the DPB is “1”, indicating write-protection is enabled.

**Table 15. DPB Register**

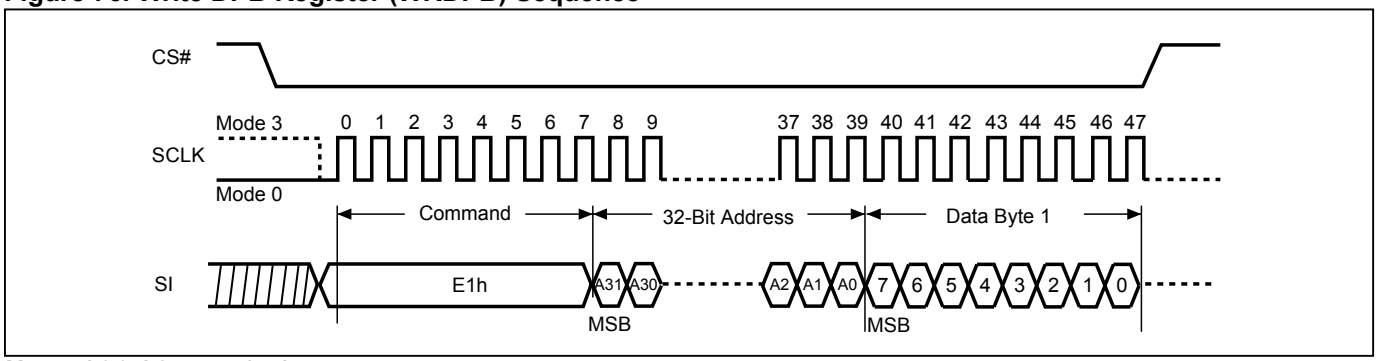
| Bit | Description | Bit Status | Default | Type |
|---|---|---|---|---|
| 7 to 0 | DPB (Dynamic Protection Bit) | 00h = Unprotect Sector / Block<br>FFh = Protect Sector / Block | FFh | Volatile |

**Figure 75. Read DPB Register (RDDPB) Sequence**




**Note:** A31-A24 are don't care.

**Figure 76. Write DPB Register (WRDPB) Sequence**




**Note:** A31-A24 are don't care


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### 9-33-4. Gang Block Lock/Unlock (GBLK/GBULK)

These instructions are only effective if WPSEL=1. The GBLK and GBULK instructions provide a quick method to set or clear all DPB bits at once.

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

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

### 9-33-5. Sector Protection States Summary Table

| Protection Status | | Sector/Block Protection State |
|---|---|---|
| DPB | SPB | |
| 0 | 0 | Unprotected |
| 0 | 1 | Protected |
| 1 | 0 | Protected |
| 1 | 1 | Protected |


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### 9-34. Program/Erase Suspend/Resume

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

After issue suspend command, the system can determine if the device has entered the Erase-Suspended mode through Bit2 (PSB) and Bit3 (ESB) of security register. (please refer to *"Table 12. Security Register Definition"*)

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. Erase Suspend

Erase suspend allow the interruption of all erase operations. After the device has entered Erase-Suspended mode, the system can read any sector(s) or Block(s) except those being erased by the suspended erase operation. Reading the sector or Block being erase suspended is invalid.

After erase suspend, WEL bit will be clear, only read related, resume and reset command can be accepted, including: 03h, 0Bh, 3Bh, 6Bh, BBh, EBh, 5Ah, C0h, 06h, 04h, 2Bh, 9Fh, AFh, 05h, ABh, 90h, B1h, C1h, B0h, 30h, 66h, 99h, 00h, 35h, F5h, 15h, 2Dh, E2h, E0h.

If the system issues an Erase Suspend command after the sector erase operation has already begun, the device will not enter Erase-Suspended mode until tESL time has elapsed.

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.

### 9-36. Program Suspend

Program suspend allows the interruption of all program operations. After the device has entered Program-Suspended mode, the system can read any sector(s) or Block(s) except those being programmed by the suspended program operation. Reading the sector or Block being program suspended is invalid.

After program suspend, WEL bit will be cleared, only read related, resume and reset command can be accepted, including: 03h, 0Bh, 3Bh, 6Bh, BBh, EBh, 5Ah, C0h, 06h, 04h, 2Bh, 9Fh, AFh, 05h, ABh, 90h, B1h, C1h, B0h, 30h, 66h, 99h, 00h, 35h, F5h, 15h, 2Dh, E2h, E0h.

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.


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**Figure 77. Suspend to Read Latency**

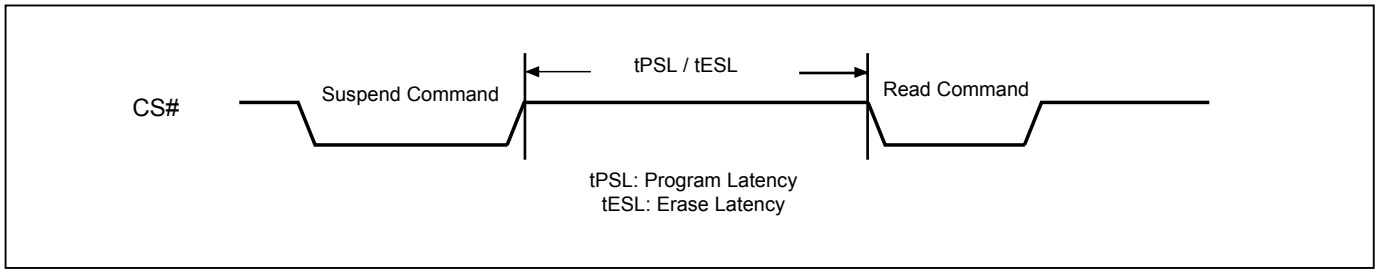



**Figure 78. Resume to Read Latency**

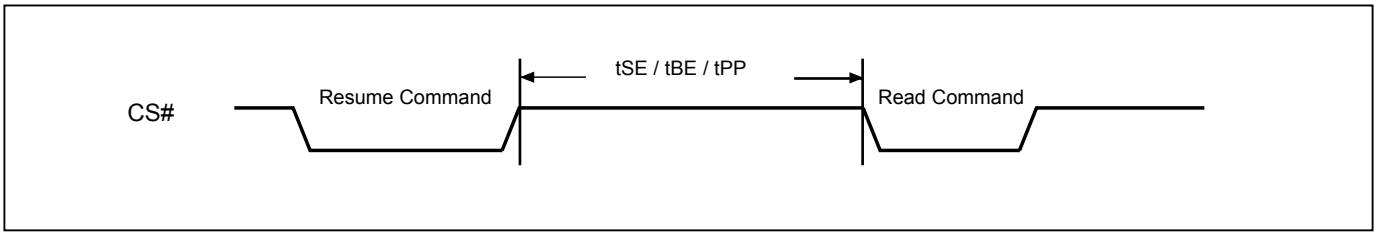
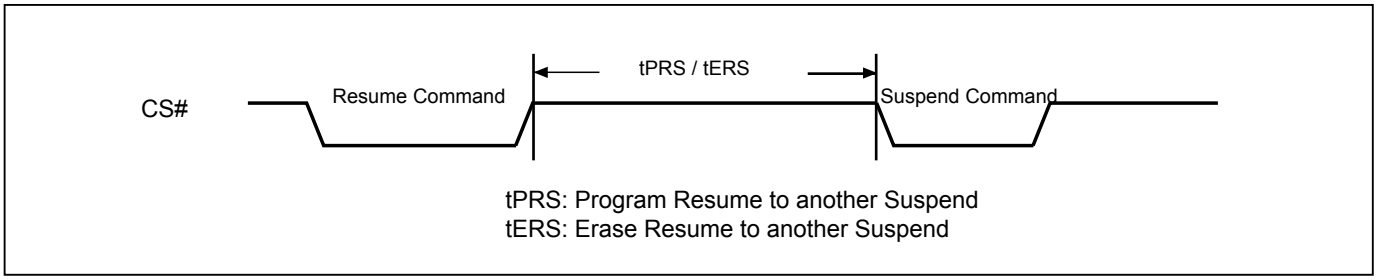



**Figure 79. Resume to Suspend Latency**





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### 9-37. 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 "06h") is not required to issue before resume.

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

### 9-38. 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 during SPI mode.

### 9-39. 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 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.

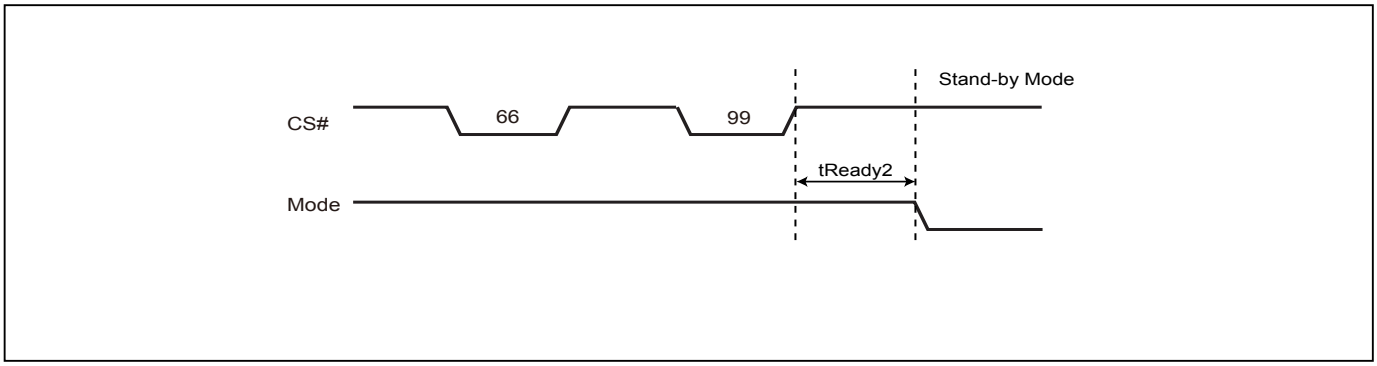
Both SPI (8 clocks) and QPI (2 clocks) command cycle can accept by this instruction. The SIO[3:1] are don't care when during SPI mode.

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. For details, please refer to *"Table 21. Reset Timing-(Other Operation)"* for tREADY2.


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**Figure 80. Software Reset Recovery**




**Note:** Refer to *"Table 21. Reset Timing-(Other Operation)"* for tREADY2 data.

**Figure 81. Reset Sequence (SPI mode)**

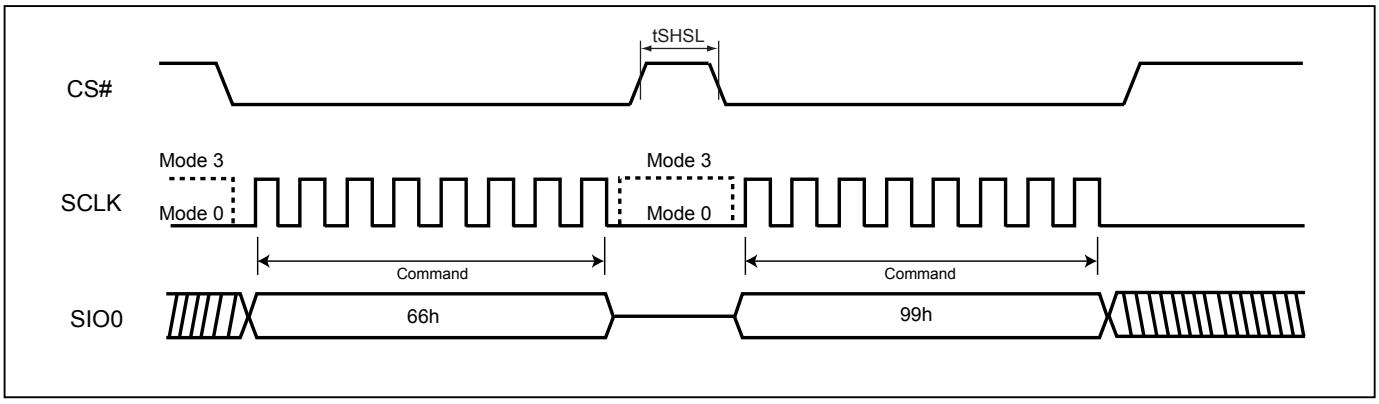
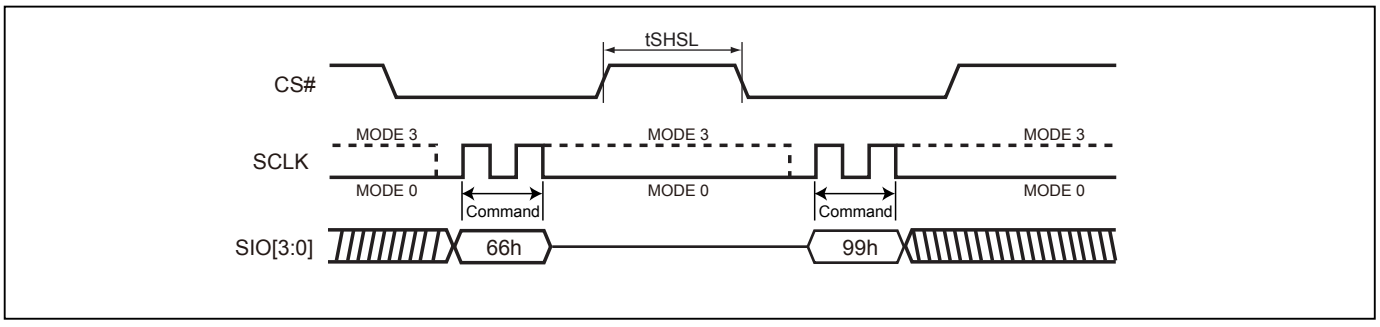



**Figure 82. Reset Sequence (QPI mode)**





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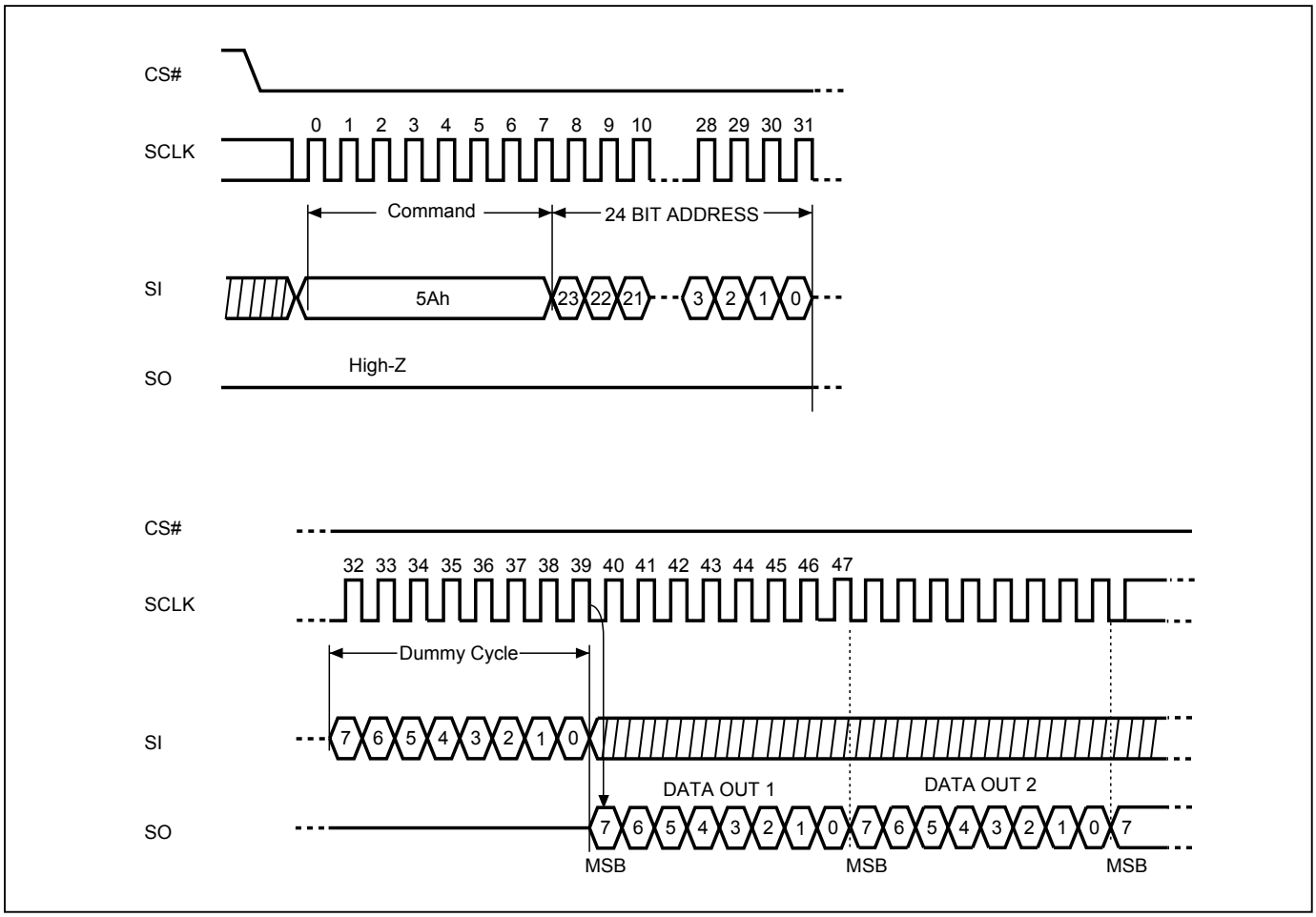
### 9-40. Read SFDP Mode (RDSFDP)

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, JESD216B.

**Figure 83. Read Serial Flash Discoverable Parameter (RDSFDP) Sequence**





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**Table 16. Signature and Parameter Identification Data Values**

| Description | Comment | Add (h) (Byte) | DW Add (Bit) | Data (h/b) (Note1) | Data (h) |
|---|---|---|---|---|---|
| SFDP Signature | Fixed: 50444653h | 00h | 07:00 | 53h | 53h |
| | | 01h | 15:08 | 46h | 46h |
| | | 02h | 23:16 | 44h | 44h |
| | | 03h | 31:24 | 50h | 50h |
| SFDP Minor Revision Number | Start from 00h | 04h | 07:00 | 06h | 06h |
| 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 | 02h | 02h |
| 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 | 06h | 06h |
| 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 | 10h | 10h |
| 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 |


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| Description | Comment | Add (h) (Byte) | DW Add (Bit) | Data (h/b) (Note1) | Data (h) |
|---|---|---|---|---|---|
| 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 | 10h | 10h |
| | | 15h | 15:08 | 01h | 01h |
| | | 16h | 23:16 | 00h | 00h |
| Unused | | 17h | 31:24 | FFh | FFh |
| ID number (4-byte Address Instruction) | 4-byte Address Instruction parameter ID | 18h | 07:00 | 84h | 84h |
| Parameter Table Minor Revision Number | Start from 00h | 19h | 15:08 | 00h | 00h |
| Parameter Table Major Revision Number | Start from 01h | 1Ah | 23:16 | 01h | 01h |
| Parameter Table Length (in double word) | How many DWORDs in the Parameter table | 1Bh | 31:24 | 02h | 02h |
| Parameter Table Pointer (PTP) | First address of 4-byte Address Instruction table | 1Ch | 07:00 | C0h | C0h |
| | | 1Dh | 15:08 | 00h | 00h |
| | | 1Eh | 23:16 | 00h | 00h |
| Unused | | 1Fh | 31:24 | FFh | FFh |


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**Table 17. Parameter Table (0): JEDEC Flash Parameter Tables**

| Description | Comment | Add (h) (Byte) | DW Add (Bit) | Data (h/b) (Note1) | Data (h) |
|---|---|---|---|---|---|
| Block/Sector Erase sizes | 00: Reserved, 01: 4KB erase,<br>10: Reserved,<br>11: not supported 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<br>1: required 00h to be written to the status register | | 03 | 0b | |
| Write Enable Instruction Select for Writing to Volatile Status Registers | 0: use 50h instruction<br>1: use 06h instruction<br>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 Instruction | | 31h | 15:08 | 20h | 20h |
| (1-1-2) Fast Read (Note2) | 0=not supported 1=supported | 32h | 16 | 1b | F9h |
| Address Bytes Number used in addressing flash array | 00: 3Byte only, 01: 3 or 4Byte,<br>10: 4Byte only, 11: Reserved | | 18:17 | 00b | |
| Double Transfer Rate (DTR) Clocking | 0=not supported 1=supported | | 19 | 1b | |
| (1-2-2) Fast Read | 0=not supported 1=supported | | 20 | 1b | |
| (1-4-4) Fast Read | 0=not supported 1=supported | | 21 | 1b | |
| (1-1-4) Fast Read | 0=not supported 1=supported | | 22 | 1b | |
| Unused | | | 23 | 1b | |
| Unused | | 33h | 31:24 | FFh | FFh |
| Flash Memory Density | | 37h:34h | 31:00 | 07FF FFFFh | |
| (1-4-4) Fast Read Number of Wait states (Note3) | 0 0000b: Not supported; 0 0100b: 4<br>0 0110b: 6; 0 1000b: 8 | 38h | 04:00 | 0 0100b | 44h |
| (1-4-4) Fast Read Number of Mode Bits (Note4) | Mode Bits:<br>000b: Not supported; 010b: 2 bits | | 07:05 | 010b | |
| (1-4-4) Fast Read Instruction | | 39h | 15:08 | EBh | EBh |
| (1-1-4) Fast Read Number of Wait states | 0 0000b: Not supported; 0 0100b: 4<br>0 0110b: 6; 0 1000b: 8 | 3Ah | 20:16 | 0 1000b | 08h |
| (1-1-4) Fast Read Number of Mode Bits | Mode Bits:<br>000b: Not supported; 010b: 2 bits | | 23:21 | 000b | |
| (1-1-4) Fast Read Instruction | | 3Bh | 31:24 | 6Bh | 6Bh |


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| Description | Comment | Add (h) (Byte) | DW Add (Bit) | Data (h/b) (Note1) | Data (h) |
|---|---|---|---|---|---|
| (1-1-2) Fast Read Number of Wait states | 0 0000b: Not supported; 0 0100b: 4<br>0 0110b: 6; 0 1000b: 8 | 3Ch | 04:00 | 0 1000b | 08h |
| (1-1-2) Fast Read Number of Mode Bits | Mode Bits:<br>000b: Not supported; 010b: 2 bits | | 07:05 | 000b | |
| (1-1-2) Fast Read Instruction | | 3Dh | 15:08 | 3Bh | 3Bh |
| (1-2-2) Fast Read Number of Wait states | 0 0000b: Not supported; 0 0100b: 4<br>0 0110b: 6; 0 1000b: 8 | 3Eh | 20:16 | 0 0100b | 04h |
| (1-2-2) Fast Read Number of Mode Bits | Mode Bits:<br>000b: Not supported; 010b: 2 bits | | 23:21 | 000b | |
| (1-2-2) Fast Read Instruction | | 3Fh | 31:24 | BBh | BBh |
| (2-2-2) Fast Read | 0=not supported 1=supported | 40h | 00 | 0b | FEh |
| Unused | | | 03:01 | 111b | |
| (4-4-4) Fast Read | 0=not supported 1=supported | | 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: Not supported; 0 0100b: 4<br>0 0110b: 6; 0 1000b: 8 | 46h | 20:16 | 0 0000b | 00h |
| (2-2-2) Fast Read Number of Mode Bits | Mode Bits:<br>000b: Not supported; 010b: 2 bits | | 23:21 | 000b | |
| (2-2-2) Fast Read Instruction | | 47h | 31:24 | FFh | FFh |
| Unused | | 49h:48h | 15:00 | FFh | FFh |
| (4-4-4) Fast Read Number of Wait states | 0 0000b: Not supported; 0 0100b: 4<br>0 0110b: 6; 0 1000b: 8 | 4Ah | 20:16 | 0 0100b | 44h |
| (4-4-4) Fast Read Number of Mode Bits | Mode Bits:<br>000b: Not supported; 010b: 2 bits | | 23:21 | 010b | |
| (4-4-4) Fast Read Instruction | | 4Bh | 31:24 | EBh | EBh |
| Erase Type 1 Size | Sector/block size = 2^N bytes (Note5)<br>0Ch: 4KB; 0Fh: 32KB; 10h: 64KB | 4Ch | 07:00 | 0Ch | 0Ch |
| Erase Type 1 Erase Instruction | | 4Dh | 15:08 | 20h | 20h |
| Erase Type 2 Size | Sector/block size = 2^N bytes<br>00h: N/A; 0Fh: 32KB; 10h: 64KB | 4Eh | 23:16 | 0Fh | 0Fh |
| Erase Type 2 Erase Instruction | | 4Fh | 31:24 | 52h | 52h |
| Erase Type 3 Size | Sector/block size = 2^N bytes<br>00h: N/A; 0Fh: 32KB; 10h: 64KB | 50h | 07:00 | 10h | 10h |
| Erase Type 3 Erase Instruction | | 51h | 15:08 | D8h | D8h |
| Erase Type 4 Size | 00h: N/A, This sector type doesn't exist | 52h | 23:16 | 00h | 00h |
| Erase Type 4 Erase Instruction | | 53h | 31:24 | FFh | FFh |


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| Description | Comment | Add (h) (Byte) | DW Add (Bit) | Data (h/b) (Note1) | Data (h) |
|---|---|---|---|---|---|
| Multiplier from typical erase time to maximum erase time | Multiplier value: 0h~Fh (0~15)<br>Max. time = 2 * (Multiplier + 1) * Typical Time | 54h | 03:00 | 0110b | D6h |
| Erase Type 1 Erase Time (Typical) | Count value: 00h~1Fh (0~31)<br>Typical Time = (Count + 1) * Units | | 07:04 | 1 1101b | |
| | Units<br>00: 1ms, 01: 16ms<br>10b: 128ms, 11b: 1s | 55h | 08<br>10:09 | 00b | 59h |
| EraseType 2 Erase Time (Typical) | Count value: 00h~1Fh (0~31)<br>Typical Time = (Count + 1) * Units | | 15:11 | 0 1011b | |
| | Units<br>00: 1ms, 01: 16ms<br>10b: 128ms, 11b: 1s | 56h | 17:16 | 01b | DDh |
| Erase Type 3 Erase Time (Typical) | Count value: 00h~1Fh (0~31)<br>Typical Time = (Count + 1) * Units | | 22:18 | 1 0111b | |
| | Units<br>00: 1 ms, 01: 16 ms<br>10b: 128ms, 11b: 1s | | 24:23 | 01b | |
| Erase Type 4 Erase Time (Typical) | Count value: 00h~1Fh (0~31)<br>Typical Time = (Count + 1) * Units | 57h | 29:25 | 0 0000b | 00h |
| | Units<br>00: 1ms, 01: 16ms<br>10b: 128 ms, 11b: 1 s | | 31:30 | 00b | |
| Multiplier from typical time to max time for Page or byte program | Multiplier value: 0h~Fh (0~15)<br>Max. time = 2 * (Multiplier + 1)<br>*Typical Time | 58h | 03:00 | 0010b | 82h |
| Page Program Size | Page size = 2^N bytes<br>2^8 = 256 bytes, 8h = 1000b | | 07:04 | 1000h | |
| Page Program Time (Typical) | Count value: 00h~1Fh (0~31)<br>Typical Time = (Count + 1) * Units | 59h | 12:08 | 1 1111b | 9Fh |
| | Units<br>0: 8us, 1: 64us | | 13 | 0b | |
| Byte Program Time, First Byte (Typical) | Count value: 0h~Fh (0~15)<br>Typical Time = (Count + 1) * Units | | 15:14<br>17:16 | 1110b | |
| | Units<br>0: 1us, 1: 8us | | 18 | 0b | |
| Byte Program Time, Additional Byte (Typical) | Count value: 0h~Fh (0~15)<br>Typical Time = (Count + 1) * Units | 5Ah | 22:19 | 0000b | 03h |
| | Units<br>0: 1us, 1: 8us | | 23 | 0b | |


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| Description | Comment | Add (h) (Byte) | DW Add (Bit) | Data (h/b) (Note1) | Data (h) |
|---|---|---|---|---|---|
| Chip Erase Time (Typical) | Count value: 00h~1Fh (0~31)<br>Typical Time = (Count + 1) * Units | 5Bh | 27:24 | 0 1101b | CDh |
| | | | 28 | | |
| | Units<br>00: 16ms, 01: 256ms<br>10: 4s, 11: 64s | | 30:29 | 10b | |
| Reserved | Reserved: 1b | | 31 | 1b | |
| Prohibited Operations During Program Suspend | ◆ xxx0b: May not initiate a new erase anywhere<br>◆ xx0xb: May not initiate a new page program anywhere<br>◆ x1xxb: May not initiate a read in the program suspended page size<br>◆ 1xxxb: The erase and program restrictions in bits 1:0 are sufficient | 5Ch | 03:00 | 0100b | 44h |
| Prohibited Operations During Erase Suspend | ◆ xxx0b: May not initiate a new erase anywhere<br>◆ xx1xb: May not initiate a page program in the erase suspended sector size<br>◆ xx0xb: May not initiate a page program anywhere<br>◆ x1xxb: May not initiate a read in the erase suspended sector size<br>◆ 1xxxb: The erase and program restrictions in bits 5:4 are sufficient | | 07:04 | 0100b | |
| Reserved | Reserved: 1b | 5Dh | 08 | 1b | 03h |
| Program Resume to Suspend Interval (Typical) | Count value: 0h~Fh (0~15)<br>Typical Time = (Count + 1) * 64us | | 12:09 | 0001b | |
| Program Suspend Latency (Max.) | Count value: 00h~1Fh (0~31)<br>Maximum Time = (Count + 1) * Units | 5Eh | 15:13 | 1 1000b | 67h |
| | | | 17:16 | | |
| | Units<br>00: 128ns, 01: 1us<br>10: 8us, 11: 64us | | 19:18 | 01b | |
| Erase Resume to Suspend Interval (Typical) | Count value: 0h~Fh (0~15)<br>Typical Time = (Count + 1) * 64us | | 23:20 | 0110b | |
| Erase Suspend Latency (Max.) | Count value: 00h~1Fh (0~31)<br>Maximum Time = (Count + 1) * Units | 5Fh | 28:24 | 1 1000b | 38h |
| | Units<br>00: 128ns, 01: 1us<br>10: 8us, 11: 64us | | 30:29 | 01b | |
| Suspend / Resume supported | 0= Support 1= Not supported | | 31 | 0b | |
| Program Resume Instruction | Instruction to Resume a Program | 60h | 07:00 | 30h | 30h |
| Program Suspend Instruction | Instruction to Suspend a Program | 61h | 15:08 | B0h | B0h |
| Erase Resume Instruction | Instruction to Resume Write/Erase | 62h | 23:16 | 30h | 30h |
| Erase Suspend Instruction | Instruction to Suspend Write/Erase | 63h | 31:24 | B0h | B0h |


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| Description | Comment | Add (h) (Byte) | DW Add (Bit) | Data (h/b) (Note1) | Data (h) |
|---|---|---|---|---|---|
| Reserved | Reserved: 11b | 64h | 01:00 | 11b | F7h |
| Status Register Polling Device Busy | ◆ Bit 2: Read WIP bit [0] by 05h Read instruction<br>◆ Bit 3: Read bit 7 of Status Register by 70h Read instruction (0=not supported 1=support)<br>◆ Bit 07:04, Reserved: 1111b | | 07:02 | 11 1101b | |
| Release from Deep Power-down (RDP) Delay (Max.) | Count value: 00h~1Fh (0~31)<br>Maximum Time = (Count + 1) * Units | 65h | 12:08 | 1 1101b | BDh |
| | Units<br>00: 128ns, 01: 1us<br>10: 8us, 11: 64us | | 14:13 | 01b | |
| Release from Deep Power-down (RDP) Instruction | Instruction to Exit Deep Power Down | | 15 | 1010 1011b (ABh) | |
| Enter Deep Power Down Instruction | Instruction to Enter Deep Power Down | 66h | 22:16 | | D5h |
| | | | 23 | 1011 1001b (B9h) | |
| | | 67h | 30:24 | | 5Ch |
| Deep Power Down Supported | 0: Supported 1: Not supported | | 31 | 0b | |
| 4-4-4 Mode Disable Sequences | Methods to exit 4-4-4 mode<br>◆ xx1xb: issue F5h instruction | 68h | 03:00 | 1010b | 4Ah |
| 4-4-4 Mode Enable Sequences | Methods to enter 4-4-4 mode<br>◆ x_x1xxb: issue instruction 35h | | 07:04 | 0 0100b | |
| | | 69h | 08 | | BEh |
| 0-4-4 Mode Supported | Performance Enhance Mode, Continuous Read, Execute in Place<br>0: Not supported 1: Supported | | 09 | 1b | |
| 0-4-4 Mode Exit Method | ◆ xx_xxx1b: Mode Bits[7:0] = 00h will terminate this mode at the end of the current read operation.<br>◆ xx_xx1xb: If 3-Byte address active, input Fh on DQ0-DQ3 for 8 clocks. If 4-Byte address active, input Fh on DQ0-DQ3 for 10 clocks.<br>◆ xx_x1xxb: Reserved<br>◆ xx_1xxxb: Input Fh (mode bit reset) on DQ0-DQ3 for 8 clocks.<br>◆ x1_xxxxb: Mode Bit[7:0]≠Axh<br>◆ 1x_xxxxb: Reserved | | 15:10 | 10 1111b | |
| 0-4-4 Mode Entry Method | ◆ xxx1b: Mode Bits[7:0] = A5h Note: QE must be set prior to using this mode<br>◆ x1xxb: Mode Bit[7:0]=Axh<br>◆ 1xxxb: Reserved | 6Ah | 19:16 | 1001h | 29h |
| Quad Enable (QE) bit Requirements | ◆ 000b: No QE bit. Detects 1-1-4/1-4-4 reads based on instruction<br>◆ 010b: QE is bit 6 of Status Register. where 1=Quad Enable or 0=not Quad Enable<br>◆ 111b: Not Supported | | 22:20 | 010b | |
| HOLD and RESET Disable by bit 4 of Ext. Configuration Register | 0: Not supported | | 23 | 0b | |


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| Description | Comment | Add (h) (Byte) | DW Add (Bit) | Data (h/b) (Note1) | Data (h) |
|---|---|---|---|---|---|
| Reserved | | 6Bh | 31:24 | FFh | FFh |
| Volatile or Non-Volatile Register and Write Enable Instruction for Status Register 1 | ◆ xxx_xxx1b: Non-Volatile Status Register 1, powers-up to last written value, use instruction 06h to enable write<br>◆ x1x_xxxxb: Reserved<br>◆ 1xx_xxxxb: Reserved | 6Ch | 06:00 | 111 0000b | F0h |
| Reserved | | | 07 | 1b | |
| Soft Reset and Rescue Sequence Support | Return the device to its default power-on state<br>◆ x1_xxxxb: issue reset enable instruction 66h, then issue reset instruction 99h. | 6Dh | 13:08 | 01 0000b | D0h |
| Exit 4-Byte Addressing | ◆ xx_xxxx_xxx1b: issue instruction E9h to exit 4-Byte address mode (write enable instruction 06h is not required)<br>◆ xx_xxxx_x1xxb: 8-bit volatile extended address register used to define A[31:A24] bits. Read with instruction C8h. Write instruction is C5h, data length is 1 byte. Return to lowest memory segment by setting A[31:24] to 00h and use 3-Byte addressing.<br>◆ xx_xx1x_xxxxb: Hardware reset<br>◆ xx_x1xx_xxxxb: Software reset (see bits 13:8 in this DWORD)<br>◆ xx_1xxx_xxxxb: Power cycle<br>◆ x1_xxxx_xxxxb: Reserved<br>◆ 1x_xxxx_xxxxb: Reserved | | 15:14 | 11b | |
| | | 6Eh | 23:16 | 1111 1111b | FFh |


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| Description | Comment | Add (h) (Byte) | DW Add (Bit) | Data (h/b) (Note1) | Data (h) |
|---|---|---|---|---|---|
| Enter 4-Byte Addressing | ◆ xxxx_xxx1b: issue instruction B7h (preceding write enable not required)<br>◆ xxxx_x1xxb: 8-bit volatile extended address register used to define A[31:24] bits. Read with instruction C8h. Write instruction is C5h with 1 byte of data. Select the active 128 Mbit memory segment by setting the appropriate A[31:24] bits and use 3-Byte addressing.<br>◆ xx1x_xxxxb: Supports dedicated 4-Byte address instruction set. Consult vendor data sheet for the instruction set definition.<br>◆ 1xxx_xxxxb: Reserved | 6Fh | 31:24 | 1111 1111b | FFh |


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**Table 18. Parameter Table (1): 4-Byte Instruction Tables**

| Description | Comment | Add (h) (Byte) | DW Add (Bit) | Data (h/b) (Note1) | Data (h) |
|---|---|---|---|---|---|
| Support for (1-1-1) READ Command, Instruction=13h | 0=not supported 1=supported | C0h | 00 | 0b | 00h |
| Support for (1-1-1) FAST_READ Command, Instruction=0Ch | 0=not supported 1=supported | | 01 | 0b | |
| Support for (1-1-2) FAST_READ Command, Instruction=3Ch | 0=not supported 1=supported | | 02 | 0b | |
| Support for (1-2-2) FAST_READ Command, Instruction=BCh | 0=not supported 1=supported | | 03 | 0b | |
| Support for (1-1-4) FAST_READ Command, Instruction=6Ch | 0=not supported 1=supported | | 04 | 0b | |
| Support for (1-4-4) FAST_READ Command, Instruction=ECh | 0=not supported 1=supported | | 05 | 0b | |
| Support for (1-1-1) Page Program Command, Instruction=12h | 0=not supported 1=supported | | 06 | 0b | |
| Support for (1-1-4) Page Program Command, Instruction=34h | 0=not supported 1=supported | | 07 | 0b | |
| Support for (1-4-4) Page Program Command, Instruction=3Eh | 0=not supported 1=supported | C1h | 08 | 0b | 00h |
| Support for Erase Command – Type 1 size, Instruction lookup in next Dword | 0=not supported 1=supported | | 09 | 0b | |
| Support for Erase Command – Type 2 size, Instruction lookup in next Dword | 0=not supported 1=supported | | 10 | 0b | |
| Support for Erase Command – Type 3 size, Instruction lookup in next Dword | 0=not supported 1=supported | | 11 | 0b | |
| Support for Erase Command – Type 4 size, Instruction lookup in next Dword | 0=not supported 1=supported | | 12 | 0b | |
| Support for (1-1-1) DTR_Read Command, Instruction=0Eh | 0=not supported 1=supported | | 13 | 0b | |
| Support for (1-2-2) DTR_Read Command, Instruction=BEh | 0=not supported 1=supported | | 14 | 0b | |
| Support for (1-4-4) DTR_Read Command, Instruction=EEh | 0=not supported 1=supported | | 15 | 0b | |


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| Description | Comment | Add (h) (Byte) | DW Add (Bit) | Data (h/b) (Note1) | Data (h) |
|---|---|---|---|---|---|
| Support for volatile individual sector lock Read command, Instruction=E0h | 0=not supported 1=supported | C2h | 16 | 1b | FFh |
| Support for volatile individual sector lock Write command, Instruction=E1h | 0=not supported 1=supported | | 17 | 1b | |
| Support for non-volatile individual sector lock read command, Instruction=E2h | 0=not supported 1=supported | | 18 | 1b | |
| Support for non-volatile individual sector lock write command, Instruction=E3h | 0=not supported 1=supported | | 19 | 1b | |
| Reserved | Reserved | | 23:20 | 1111b | |
| Reserved | Reserved | C3h | 31:24 | FFh | FFh |
| Instruction for Erase Type 1 | FFh=not supported | C4h | 07:00 | FFh | FFh |
| Instruction for Erase Type 2 | FFh=not supported | C5h | 15:08 | FFh | FFh |
| Instruction for Erase Type 3 | FFh=not supported | C6h | 23:16 | FFh | FFh |
| Instruction for Erase Type 4 | FFh=not supported | C7h | 31:24 | FFh | FFh |


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**Table 19. Parameter Table (2): Macronix Flash Parameter Tables**

| Description | Comment | Add (h) (Byte) | DW Add (Bit) | Data (h/b) (Note1) | Data (h) |
|---|---|---|---|---|---|
| Vcc Supply Maximum Voltage | 2000h=2.000V<br>2700h=2.700V<br>3600h=3.600V | 111h:110h | 07:00<br>15:08 | 00h<br>36h | 00h<br>36h |
| Vcc Supply Minimum Voltage | 1650h=1.650V, 1750h=1.750V<br>2250h=2.250V, 2300h=2.300V<br>2350h=2.350V, 2650h=2.650V<br>2700h=2.700V | 113h: 112h | 23:16<br>31:24 | 00h<br>27h | 00h<br>27h |
| H/W Reset# pin | 0=not supported 1=supported | 115h: 114h | 00 | 1b | F99Dh |
| H/W Hold# pin | 0=not supported 1=supported | | 01 | 0b | |
| Deep Power Down Mode | 0=not supported 1=supported | | 02 | 1b | |
| S/W Reset | 0=not supported 1=supported | | 03 | 1b | |
| S/W Reset Instruction | Reset Enable (66h) should be issued before Reset Instruction | | 11:04 | 1001 1001b (99h) | |
| Program Suspend/Resume | 0=not supported 1=supported | | 12 | 1b | |
| Erase Suspend/Resume | 0=not supported 1=supported | | 13 | 1b | |
| Unused | | | 14 | 1b | |
| Wrap-Around Read mode | 0=not supported 1=supported | | 15 | 1b | |
| Wrap-Around Read mode Instruction | | 116h | 23:16 | C0h | C0h |
| Wrap-Around Read data length | 08h:support 8B wrap-around read<br>16h:8B&16B<br>32h:8B&16B&32B<br>64h:8B&16B&32B&64B | 117h | 31:24 | 64h | 64h |
| Individual block lock | 0=not supported 1=supported | 11Bh: 118h | 00 | 1b | CB85h |
| Individual block lock bit (Volatile/Nonvolatile) | 0=Volatile 1=Nonvolatile | | 01 | 0b | |
| Individual block lock Instruction | | | 09:02 | 1110 0001b (E1h) | |
| Individual block lock Volatile protect bit default protect status | 0=protect 1=unprotect | | 10 | 0b | |
| Secured OTP | 0=not supported 1=supported | | 11 | 1b | |
| Read Lock | 0=not supported 1=supported | | 12 | 0b | |
| Permanent Lock | 0=not supported 1=supported | | 13 | 0b | |
| Unused | | | 15:14 | 11b | |
| Unused | | | 31:16 | FFh | FFh |
| Unused | | 11Fh: 11Ch | 31:00 | FFh | FFh |


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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.


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## 10. RESET

Driving the RESET# pin low for a period of tRLRH or longer will reset the device. After reset cycle, the device is at the following states:

- Standby mode
- All the volatile bits such as WEL/WIP/SRAM lock bit will return to the default status as power on.

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

**Figure 84. RESET Timing**

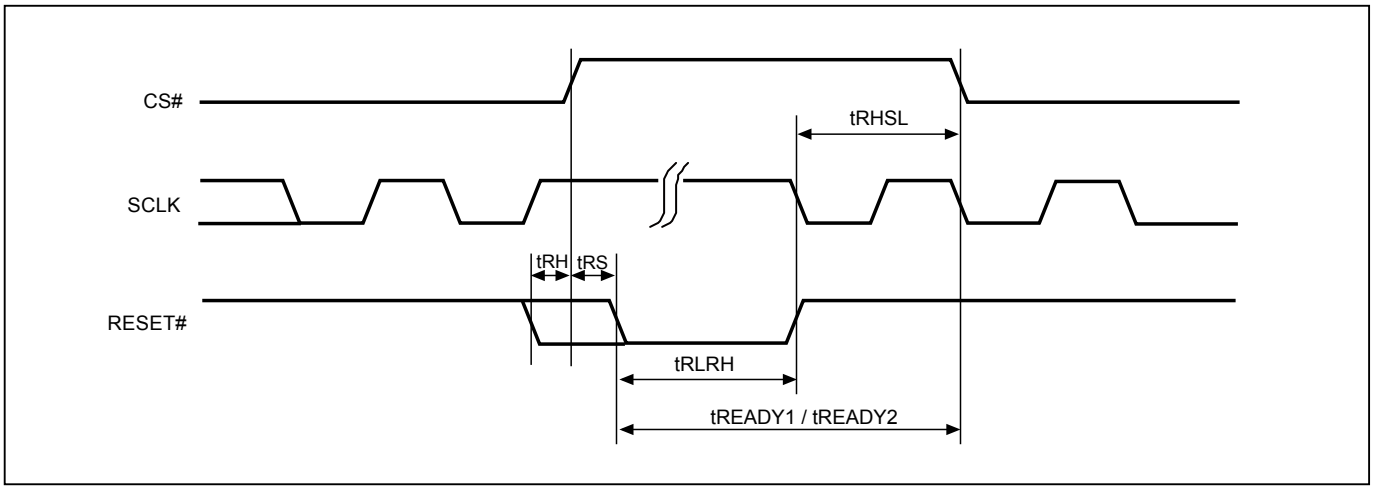



**Table 20. Reset Timing-(Power On)**

| Symbol | Parameter | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|
| tRHSL | Reset# high before CS# low | 10 | | | us |
| tRS | Reset# setup time | 15 | | | ns |
| tRH | Reset# hold time | 15 | | | ns |
| tRLRH | Reset# low pulse width | 10 | | | us |
| tREADY1 | Reset Recovery time | 35 | | | us |

**Table 21. Reset Timing-(Other Operation)**

| Symbol | Parameter | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|
| tRHSL | Reset# high before CS# low | 10 | | | us |
| tRS | Reset# setup time | 15 | | | ns |
| tRH | Reset# hold time | 15 | | | ns |
| tRLRH | Reset# low pulse width | 10 | | | us |
| tREADY2 | Reset Recovery time (During instruction decoding) | 40 | | | us |
| | Reset Recovery time (for read operation) | 35 | | | us |
| | Reset Recovery time (for program operation) | 310 | | | us |
| | Reset Recovery time(for SE4KB operation) | 12 | | | ms |
| | Reset Recovery time (for BE64K/BE32KB operation) | 25 | | | ms |
| | Reset Recovery time (for Chip Erase operation) | 100 | | | ms |
| | Reset Recovery time (for WRSR operation) | 40 | | | ms |

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## 11. POWER-ON STATE

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

The device must not be selected during power-up and power-down stage 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, 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:
- tVSL after VCC reached VCC minimum level

The device can accept read command after VCC reached VCC minimum and a time delay of tVSL.
Please refer to the *"Figure 92. 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.


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## 12. ELECTRICAL SPECIFICATIONS

### Table 22. 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 4.0V |

**NOTICE:**

1. Stresses greater than those listed under ABSOLUTE MAXIMUM RATINGS may cause permanent damage to the device. This is stress rating only and functional operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended period may affect reliability.
2. Specifications contained within the following tables are subject to change.
3. During voltage transitions, all pins may overshoot Vss to -2.0V and Vcc to +2.0V for periods up to 20ns, see *"Figure 85. Maximum Negative Overshoot Waveform"* and *"Figure 86. Maximum Positive Overshoot Waveform"*.

**Figure 85. Maximum Negative Overshoot Waveform**

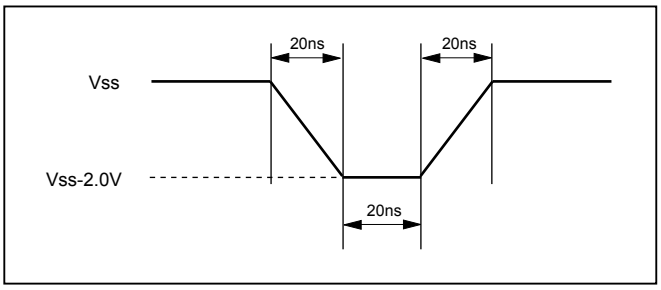
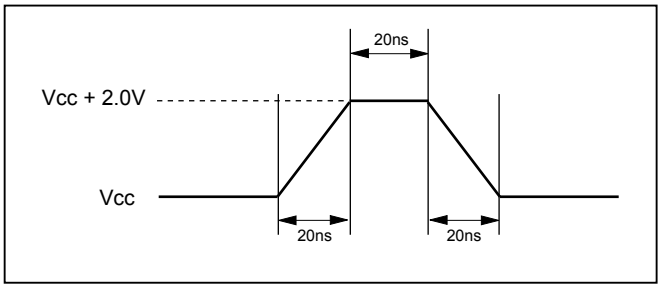



**Figure 86. Maximum Positive Overshoot Waveform**

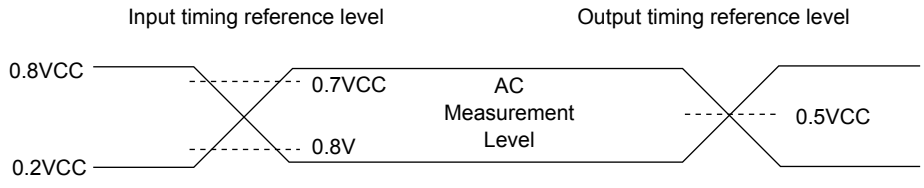



### Table 23. CAPACITANCE TA = 25°C, f = 1.0 MHz

| Symbol | Parameter | Min. | Typ. | Max. | Unit | Conditions |
|---|---|---|---|---|---|---|
| CIN | Input Capacitance | | | 8 | pF | VIN = 0V |
| COUT | Output Capacitance | | | 10 | pF | VOUT = 0V |

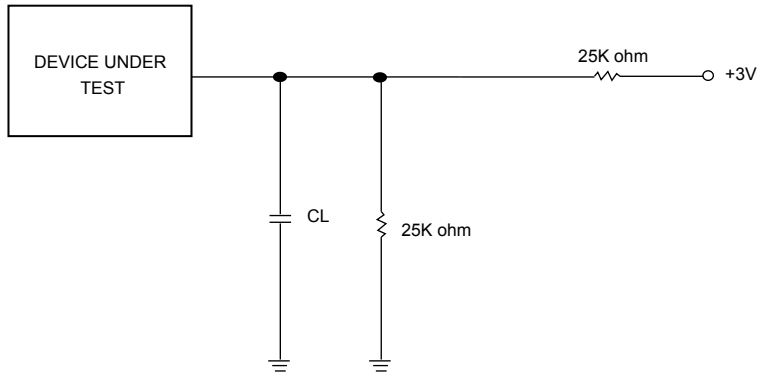

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**Figure 87. DATA INPUT TEST WAVEFORMS AND MEASUREMENT LEVEL**



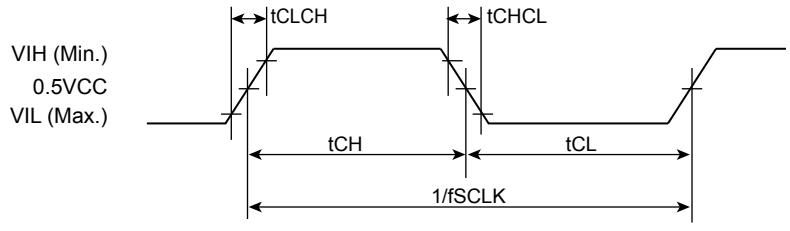

Note: Input pulse rise and fall time are <5ns

**Figure 88. OUTPUT LOADING**




CL=30pF Including jig capacitance

**Figure 89. SCLK TIMING DEFINITION**





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**Table 24. DC CHARACTERISTICS (Temperature = -40°C to 85°C, VCC = 2.7V - 3.6V)**

| Symbol | Parameter | Notes | Min. | Typ. | Max. | Units | Test Conditions |
|---|---|---|---|---|---|---|---|
| ILI | Input Load Current | 1 | | | ±2 | uA | VCC = VCC Max, VIN = VCC or GND |
| ILO | Output Leakage Current | 1 | | | ±2 | uA | VCC = VCC Max, VOUT = VCC or GND |
| ISB1 | VCC Standby Current | 1 | | 15 | 100 | uA | VIN = VCC or GND, CS# = VCC |
| ISB2 | Deep Power-down Current | | | 3 | 20 | uA | VIN = VCC or GND, CS# = VCC |
| ICC1 | VCC Read | 1 | | 12 | 25 | mA | f=133MHz, (4 x I/O read) SCLK=0.1VCC/0.9VCC, SO=Open |
| | | | | | 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 |
| ICC2 | VCC Program Current (PP) | 1 | | 12 | 20 | mA | Program in Progress, CS# = VCC |
| ICC3 | VCC Write Status Register (WRSR) Current | | | 10 | 12 | mA | Program status register in progress, CS#=VCC |
| ICC4 | VCC Sector/Block (32K, 64K) Erase Current (SE/BE/BE32K) | 1 | | 10 | 25 | mA | Erase in Progress, CS#=VCC |
| ICC5 | VCC Chip Erase Current (CE) | 1 | | 14 | 25 | mA | Erase in Progress, CS#=VCC |
| VIL | Input Low Voltage | | -0.5 | | 0.8 | V | |
| VIH | Input High Voltage | | 0.7VCC | | VCC+0.4 | V | |
| VOL | Output Low Voltage | | | | 0.2 | V | IOL = 100uA |
| VOH | Output High Voltage | | VCC-0.2 | | | V | IOH = -100uA |

***Notes :***

1. Typical values at VCC = 3.3V, T = 25°C. These currents are valid for all product versions (package and speeds).
2. Typical value is calculated by simulation.


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**Table 25. AC CHARACTERISTICS (Temperature = -40°C to 85°C, VCC = 2.7V - 3.6V)**

| Symbol | Alt. | Parameter | | | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|---|---|
| fSCLK | fC | Clock Frequency for all commands (except Read) | | | D.C. | | 120 | MHz |
| fRSCLK | fR | Clock Frequency for READ instructions | | | | | 50 | MHz |
| fTSCLK | fT | Clock Frequency for 2READ/DREAD instructions | | | Please refer to *"Table 10. Dummy Cycle and Frequency Table (MHz)"*. | | | MHz |
| | fQ | Clock Frequency for 4READ/QREAD instructions | | | | | | MHz |
| tCH(1) | tCLH | Clock High Time | Others (fSCLK/fTSCLK) | > 66MHz | 45% x (1/fSCLK) | | | ns |
| | | | | ≤ 66MHz | 7 | | | ns |
| | | | Normal Read (fRSCLK) | | 7 | | | ns |
| tCL(1) | tCLL | Clock Low Time | Others (fSCLK/fTSCLK) | > 66MHz | 45% x (1/fSCLK) | | | ns |
| | | | | ≤ 66MHz | 7 | | | ns |
| | | | Normal Read (fRSCLK) | | 7 | | | ns |
| tCLCH(5) | | Clock Rise Time (peak to peak) | | | 0.1 | | | V/ns |
| tCHCL(5) | | Clock Fall Time (peak to peak) | | | 0.1 | | | V/ns |
| tSLCH | tCSS | CS# Active Setup Time (relative to SCLK) | | | 3 | | | ns |
| tCHSL | | CS# Not Active Hold Time (relative to SCLK) | | | 3 | | | ns |
| tDVCH/ tDVCL | tDSU | Data In Setup Time | | | 2 | | | ns |
| tCHDX/ tCLDX(9) | tDH | Data In Hold Time | VCC: 2.7V - 3.6V | | 2 | | | ns |
| | | | VCC: 3.0V - 3.6V (Loading: 15pF/10pF) | | 1 | | | ns |
| tCHSH | | CS# Active Hold Time (relative to SCLK) | | | 3 | | | ns |
| tSHCH | | CS# Not Active Setup Time (relative to SCLK) | | | 3 | | | ns |
| tSHSL | tCSH | CS# Deselect Time | From Read to next Read | | 7 | | | ns |
| | | | From Write/Erase/Program to Read Status Register | | 30 | | | ns |
| tSHQZ(5) | tDIS | Output Disable Time | | | | | 8 | ns |
| tCLQV(9) | tV | Clock Low to Output Valid Loading | VCC: 2.7V - 3.6V | Loading: 30pF | | | 8 | ns |
| | | | | Loading: 15pF | | | 6 | ns |
| | | | VCC: 3.0V - 3.6V(10) | Loading: 15pF ODS (1,1) | | | 5 | ns |
| | | | | Loading: 10pF ODS (0,0) | | | 4.5 | ns |
| tCLQX(9) | tHO | Output Hold Time | Loading: 30pF | | 1 | | | ns |
| | | | Loading: 15pF/10pF | | 1 | | | ns |
| tWHSL(3) | | Write Protect Setup Time | | | 20 | | | ns |
| tSHWL(3) | | Write Protect Hold Time | | | 100 | | | ns |
| tDP(5) | | CS# High to Deep Power-down Mode | | | | | 10 | us |
| tRES1(5) | | CS# High to Standby Mode without Electronic Signature Read | | | | | 30 | us |
| tRES2(5) | | CS# High to Standby Mode with Electronic Signature Read | | | | | 30 | us |
| tW | | Write Status/Configuration Register Cycle Time | | | | | 40 | ms |
| tBP | | Byte-Program | | | | 15 | 30 | us |
| tPP | | Page Program Cycle Time | | | | 0.25 | 0.75 | ms |
| tSE | | Sector Erase Cycle Time | | | | 30 | 400 | ms |
| tBE32 | | Block Erase (32KB) Cycle Time | | | | 180 | 1000 | ms |
| tBE | | Block Erase (64KB) Cycle Time | | | | 380 | 2000 | ms |
| tCE | | Chip Erase Cycle Time | | | | 55 | 100 | s |
| tESL(6) | | Erase Suspend Latency | | | | | 25 | us |
| tPSL(6) | | Program Suspend Latency | | | | | 25 | us |
| tPRS(7) | | Latency between Program Resume and next Suspend | | | 0.3 | 100 | | us |
| tERS(8) | | Latency between Erase Resume and next Suspend | | | 0.3 | 400 | | us |
| tQVD(9) | | Data Output Valid Time Difference among all SIO pins | | | | | 600 | ps |


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**Notes:**

1. tCH + tCL must be greater than or equal to 1/ Frequency.
2. Typical values given for TA=25°C. Not 100% tested.
3. Only applicable as a constraint for a WRSR instruction when SRWD is set at 1.
4. Test condition is shown as *"Figure 87. DATA INPUT TEST WAVEFORMS AND MEASUREMENT LEVEL"* and *"Figure 88. OUTPUT LOADING"*.
5. The value guaranteed by characterization, not 100% tested in production.
6. Latency time is required to complete Erase/Program Suspend operation until WIP bit is "0".
7. For tPRS, minimum timing must be observed before issuing the next program suspend command. However, a period equal to or longer than the typical timing is required in order for the program operation to make progress.
8. For tERS, minimum timing must be observed before issuing the next erase suspend command. However, a period equal to or longer than the typical timing is required in order for the erase operation to make progress.
9. Not 100% tested.
10. For tCLQV, please note that the output driver strength (ODS1, ODS0) bits must be configured correctly according to *"Table 9. Output Driver Strength Table"*.


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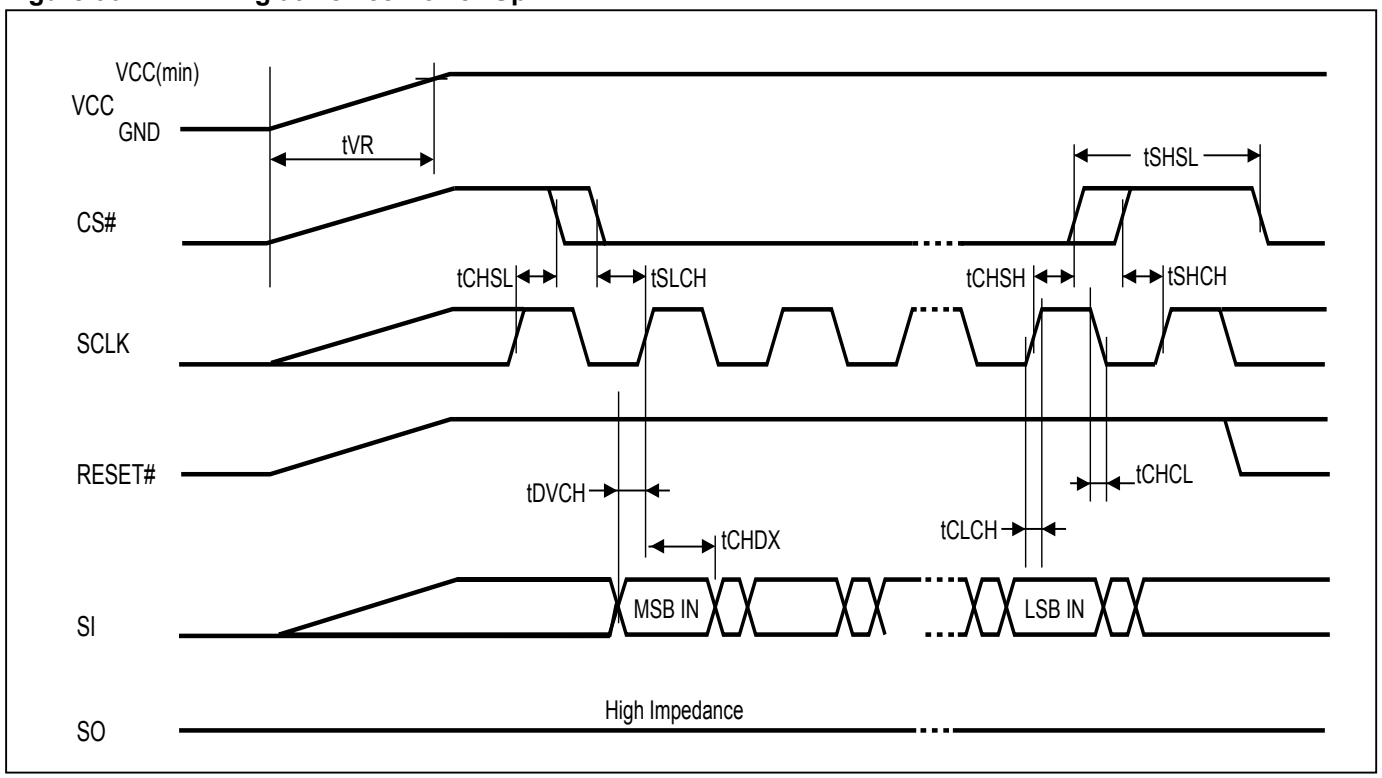
## 13. OPERATING CONDITIONS

### At Device Power-Up and Power-Down

AC timing illustrated in *"Figure 90. AC Timing at Device Power-Up"* and *"Figure 91. 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 90. 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 25. AC CHARACTERISTICS (Temperature = -40°C to 85°C, VCC = 2.7V - 3.6V)"*.


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**Figure 91. Power-Down Sequence**

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

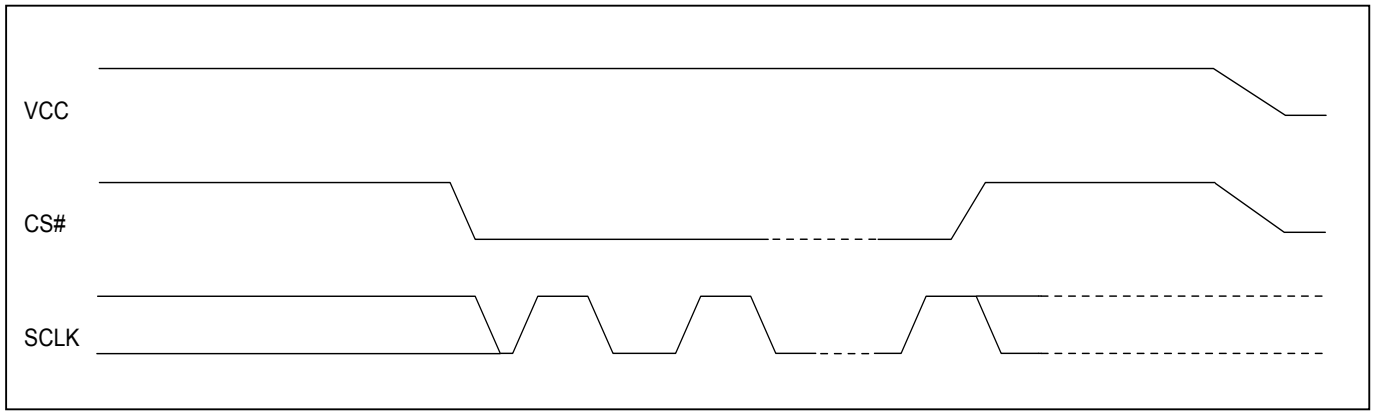
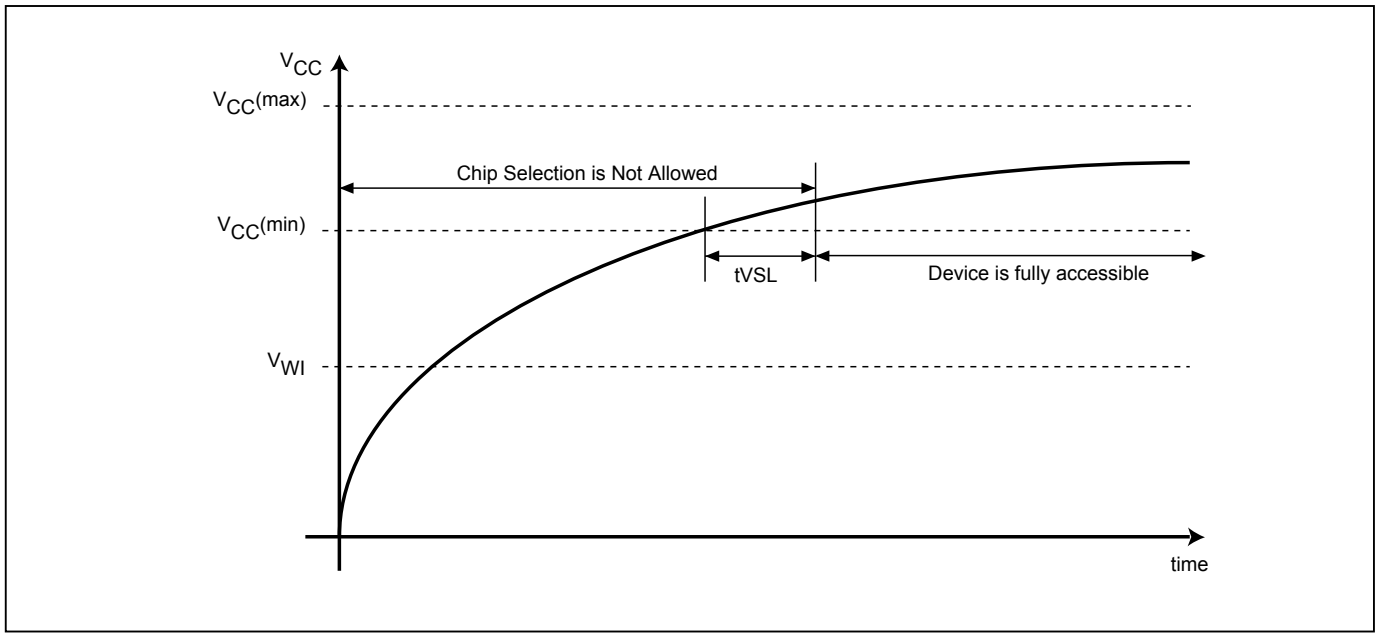



**Figure 92. Power-up Timing**





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**Figure 93. Power Up/Down and Voltage Drop**

When powering down the device, VCC must drop below $V_{PWD}$ for at least tPWD to ensure the device will initialize correctly during power up. Please refer to *"Figure 93. Power Up/Down and Voltage Drop"* and *"Table 26. Power-Up/Down Voltage and Timing"* below for more details.

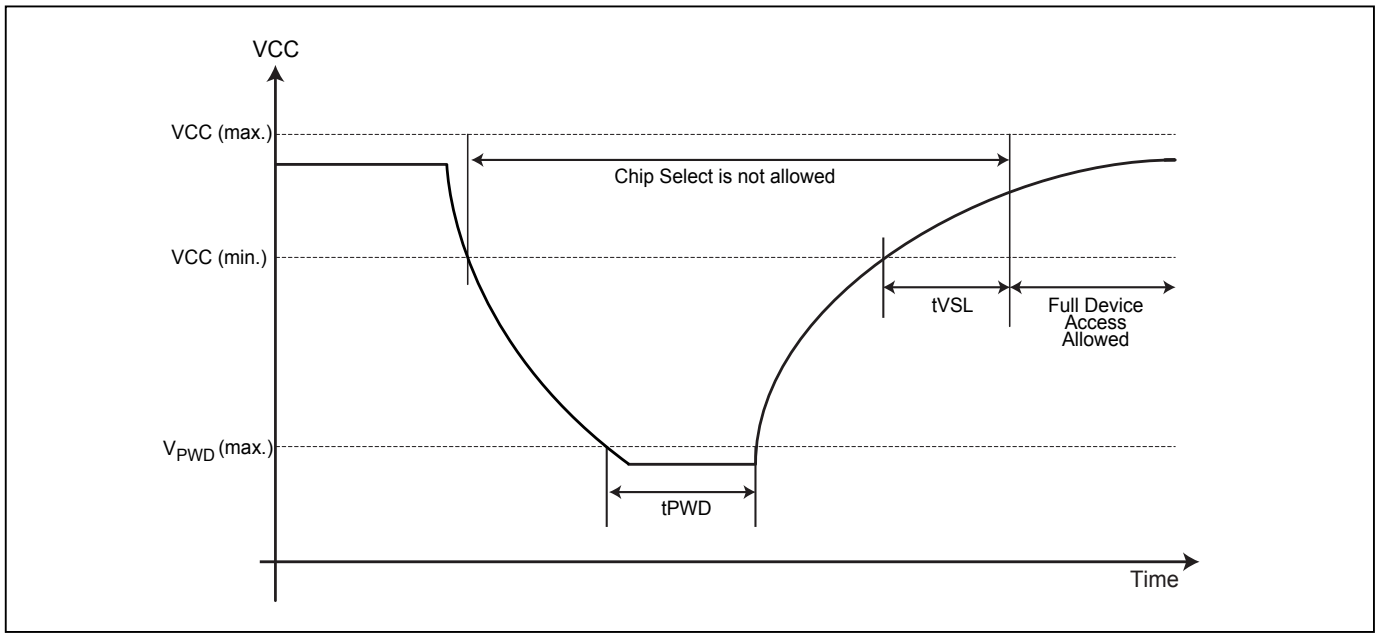



**Table 26. Power-Up/Down Voltage and Timing**

| Symbol | Parameter | Min. | Max. | Unit |
|---|---|---|---|---|
| tVSL | VCC(min.) to device operation | 1200 | | us |
| VWI | Write Inhibit Voltage | 1.5 | 2.5 | V |
| $V_{PWD}$ | VCC voltage needed to below $V_{PWD}$ for ensuring initialization will occur | | 0.9 | V |
| tPWD | The minimum duration for ensuring initialization will occur | 300 | | us |
| VCC | VCC Power Supply | 2.7 | 3.6 | V |

**Note:** These parameters are characterized only.

## 13-1. 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).


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## 14. ERASE AND PROGRAMMING PERFORMANCE

| Parameter | Min. | Typ. (1) | Max. (2) | Unit |
|---|---|---|---|---|
| Write Status Register Cycle Time | | | 40 | ms |
| Sector Erase Cycle Time (4KB) | | 30 | 400 | ms |
| Block Erase Cycle Time (32KB) | | 0.18 | 1 | s |
| Block Erase Cycle Time (64KB) | | 0.38 | 2 | s |
| Chip Erase Cycle Time | | 55 | 100 | s |
| Byte Program Time (via page program command) | | 15 | 30 | us |
| Page Program Time | | 0.25 | 0.75 | ms |
| Erase/Program Cycle | | 100,000 | | cycles |

**Note:**
1. Typical program and erase time assumes the following conditions: 25°C, 3.3V, and all zero pattern.
2. Under worst conditions of 2.7V, highest operation temperature, post program/erase cycling.
3. System-level overhead is the time required to execute the first-bus-cycle sequence for the programming command.

## 15. ERASE AND PROGRAMMING PERFORMANCE (Factory Mode)

| Parameter | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|
| Sector Erase Cycle Time (4KB) | | 18 | | ms |
| Block Erase Cycle Time (32KB) | | 100 | | ms |
| Block Erase Cycle Time (64KB) | | 200 | | ms |
| Chip Erase Cycle Time | | 45 | | s |
| Page Program Time | | 0.16 | | ms |
| Erase/Program Cycle | | | 50 | cycles |

**Notice:**
1. Factory Mode must be operated in 20°C to 45°C and VCC 3.0V-3.6V.
2. In Factory mode, the Erase/Program operation should not exceed 50 cycles, and "ERASE AND PROGRAMMING PERFORMANCE" 100k cycles will not be affected.
3. During factory mode, Suspend command (B0h) cannot be executed.


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## 16. DATA RETENTION

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

## 17. LATCH-UP CHARACTERISTICS

| | Min. | Max. |
|---|---|---|
| Input Voltage with respect to GND on all power pins | | 1.5 VCCmax |
| Input Current on all non-power pins | -100mA | +100mA |
| Test conditions: VCC = VCCmax, one pin at a time (compliant to JEDEC JESD78 standard). | | |


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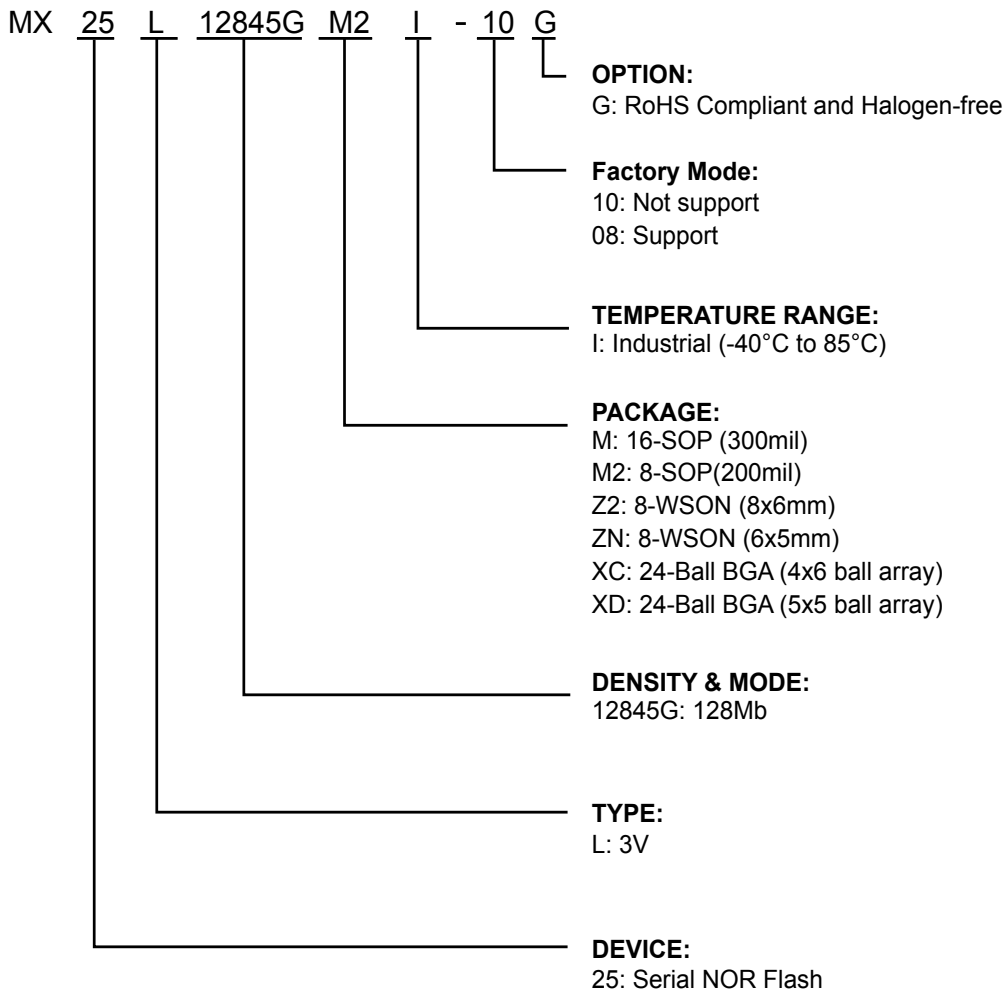
## 18. ORDERING INFORMATION

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

| PART NO. | TEMPERATURE | PACKAGE | Remark |
|---|---|---|---|
| MX25L12845GMI-10G | -40°C to 85°C | 16-SOP (300mil) | |
| MX25L12845GM2I-10G | -40°C to 85°C | 8-SOP(200mil) | |
| MX25L12845GZNI-10G | -40°C to 85°C | 8-WSON (6x5mm) | |
| MX25L12845GMI-08G | -40°C to 85°C | 16-SOP (300mil) | Support Factory Mode |
| MX25L12845GM2I-08G | -40°C to 85°C | 8-SOP(200mil) | Support Factory Mode |
| MX25L12845GZNI-08G | -40°C to 85°C | 8-WSON (6x5mm) | Support Factory Mode |
| MX25L12845GZ2I-08G | -40°C to 85°C | 8-WSON (8x6mm) | Support Factory Mode |
| MX25L12845GXCI-08G | -40°C to 85°C | 24-Ball BGA<br>(4x6 ball array) | Support Factory Mode |
| MX25L12845GXDI-08G | -40°C to 85°C | 24-Ball BGA<br>(5x5 ball array) | Support Factory Mode |


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## 19. PART NAME DESCRIPTION



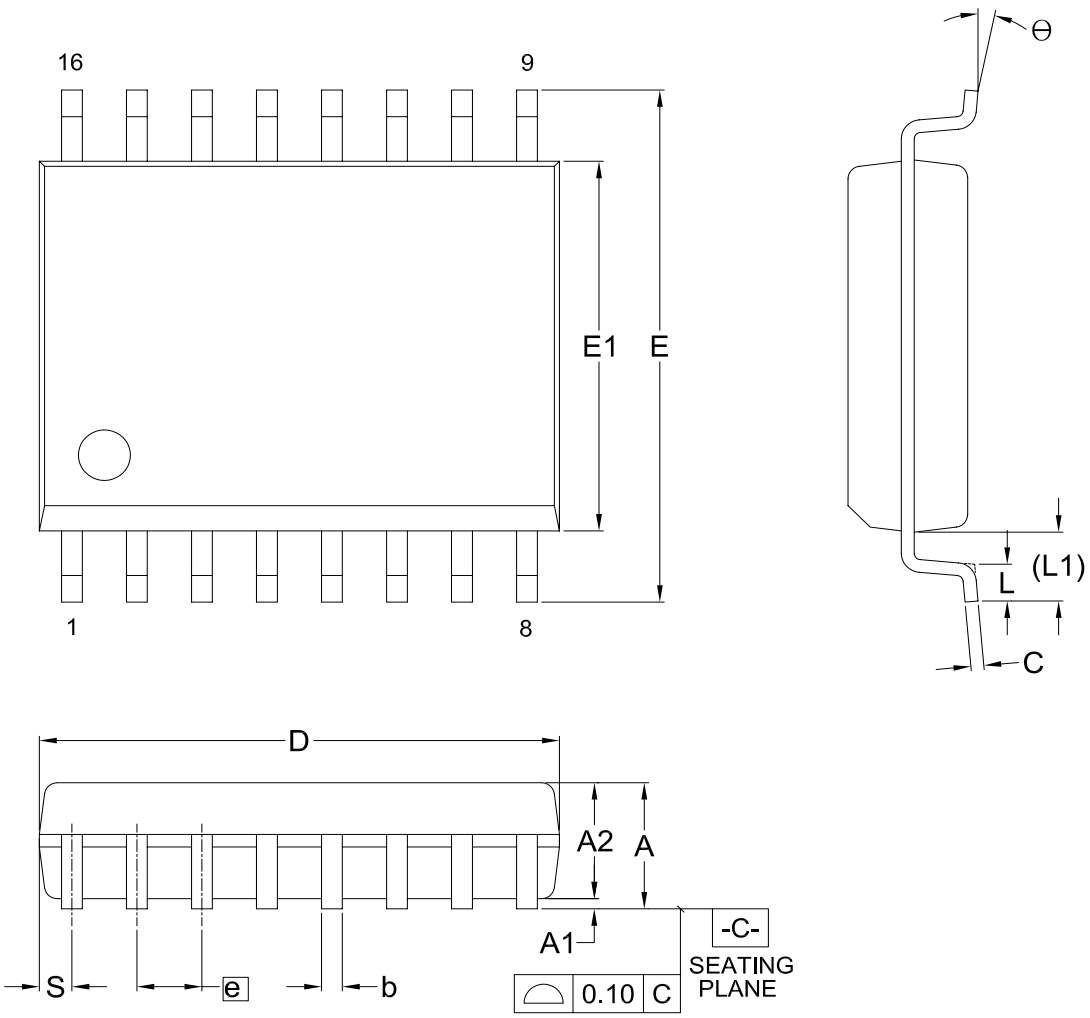


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## 20. PACKAGE INFORMATION

### 20-1. 16-PIN SOP (300mil)

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



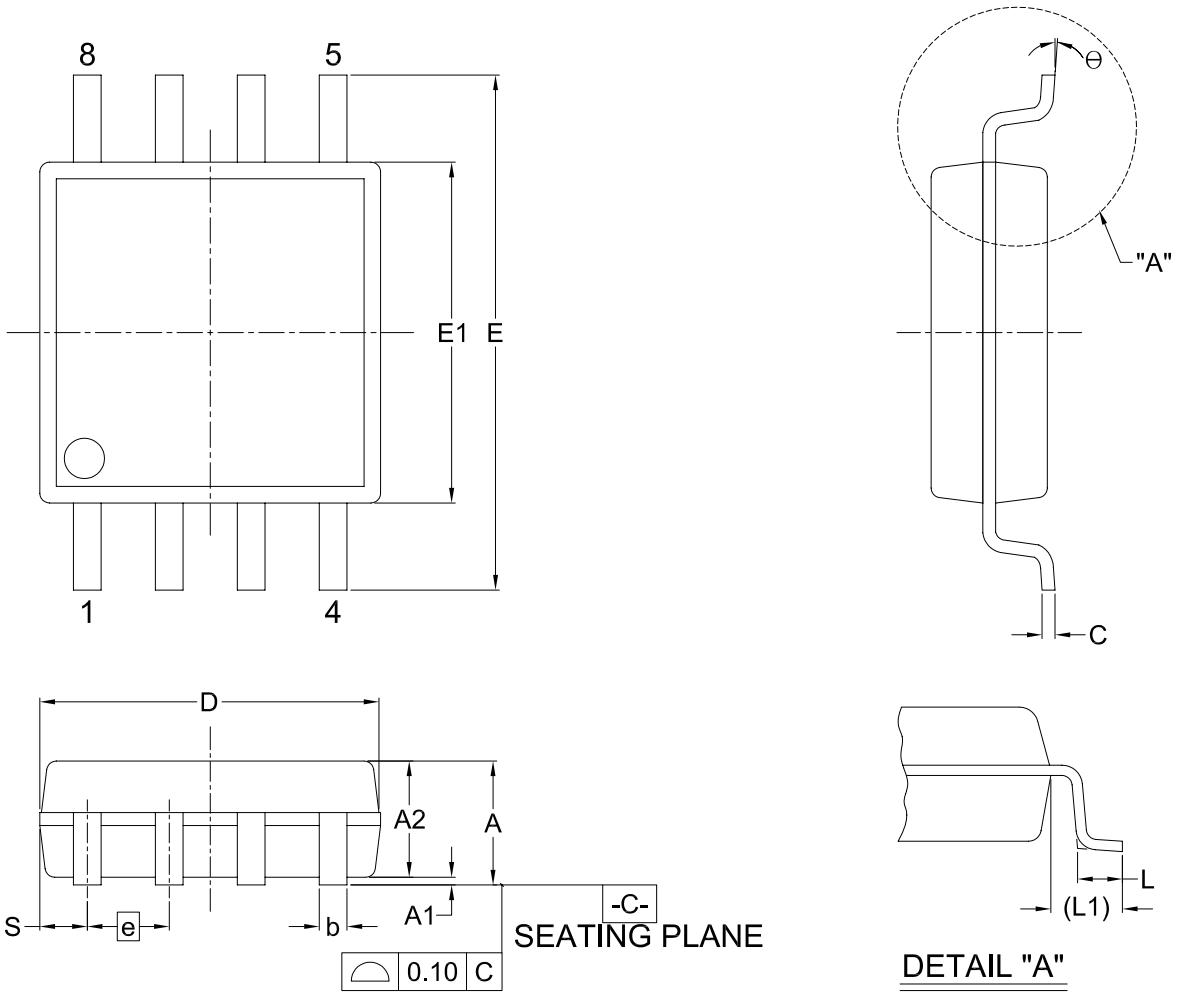

Dimensions (inch dimensions are derived from the original mm dimensions)

| SYMBOL / UNIT | | A | A1 | A2 | b | C | D | E | E1 | e | L | L1 | S | θ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| mm | Min. | --- | 0.10 | 2.25 | 0.31 | 0.20 | 10.10 | 10.10 | 7.42 | --- | 0.40 | 1.31 | 0.51 | 0° |
| | Nom. | --- | 0.20 | 2.35 | 0.41 | 0.25 | 10.30 | 10.30 | 7.52 | 1.27 | 0.84 | 1.44 | 0.64 | 5° |
| | Max. | 2.65 | 0.30 | 2.45 | 0.51 | 0.30 | 10.50 | 10.50 | 7.60 | --- | 1.27 | 1.57 | 0.77 | 8° |
| Inch | Min. | --- | 0.004 | 0.089 | 0.012 | 0.008 | 0.397 | 0.397 | 0.292 | --- | 0.016 | 0.052 | 0.020 | 0° |
| | Nom. | --- | 0.008 | 0.093 | 0.016 | 0.010 | 0.405 | 0.405 | 0.296 | 0.050 | 0.033 | 0.057 | 0.025 | 5° |
| | Max. | 0.104 | 0.012 | 0.096 | 0.020 | 0.012 | 0.413 | 0.413 | 0.299 | --- | 0.050 | 0.062 | 0.030 | 8° |


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### 20-2. 8-pins SOP (200mil)

Doc. Title: Package Outline for SOP 8L 200MIL



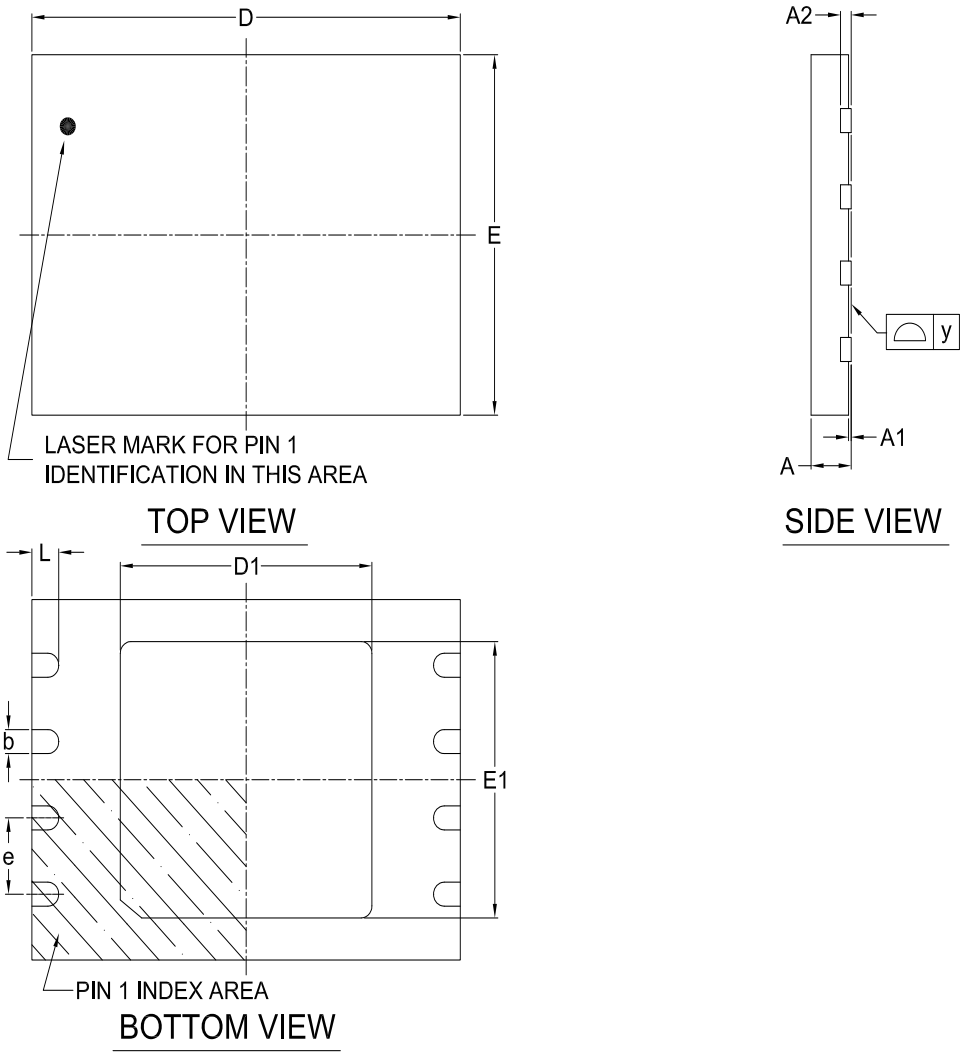

Dimensions (inch dimensions are derived from the original mm dimensions)

| SYMBOL / UNIT | | A | A1 | A2 | b | C | D | E | E1 | e | L | L1 | S | θ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| mm | Min. | 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° |


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### 20-3. 8-land WSON (8x6mm)

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




Note:

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

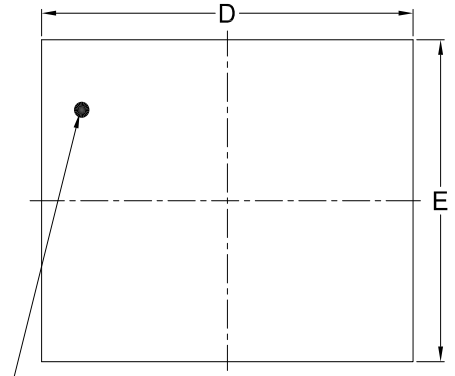
Dimensions (inch dimensions are derived from the original mm dimensions)

| SYMBOL / UNIT | | A | A1 | A2 | b | D | D1 | E | E1 | L | e | y |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| mm | Min. | 0.70 | — | — | 0.35 | 7.90 | 4.65 | 5.90 | 4.55 | 0.45 | — | 0.00 |
| | Nom. | — | — | 0.20 | 0.40 | 8.00 | 4.70 | 6.00 | 4.60 | 0.50 | 1.27 | --- |
| | Max. | 0.80 | 0.05 | — | 0.48 | 8.10 | 4.75 | 6.10 | 4.65 | 0.55 | — | 0.05 |
| Inch | Min. | 0.028 | — | — | 0.014 | 0.311 | 0.183 | 0.232 | 0.179 | 0.018 | — | 0.00 |
| | Nom. | — | — | 0.008 | 0.016 | 0.315 | 0.185 | 0.236 | 0.181 | 0.020 | 0.05 | --- |
| | Max. | 0.032 | 0.002 | — | 0.019 | 0.319 | 0.187 | 0.240 | 0.183 | 0.022 | — | 0.002 |

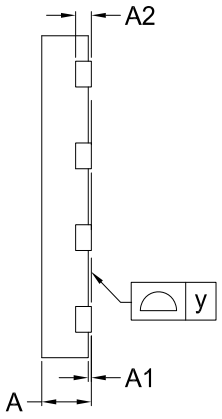

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### 20-4. 8-land WSON (6x5mm)

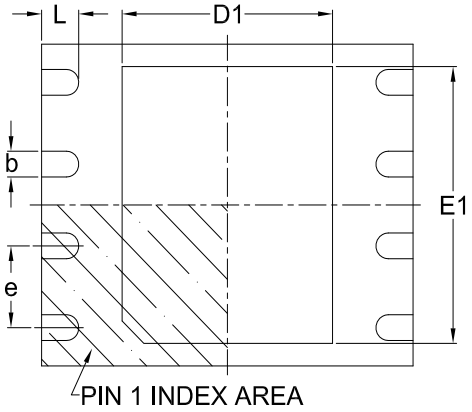
**Doc. Title: Package Outline for WSON 8L (6x5x0.8MM, LEAD PITCH 1.27MM)**




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.

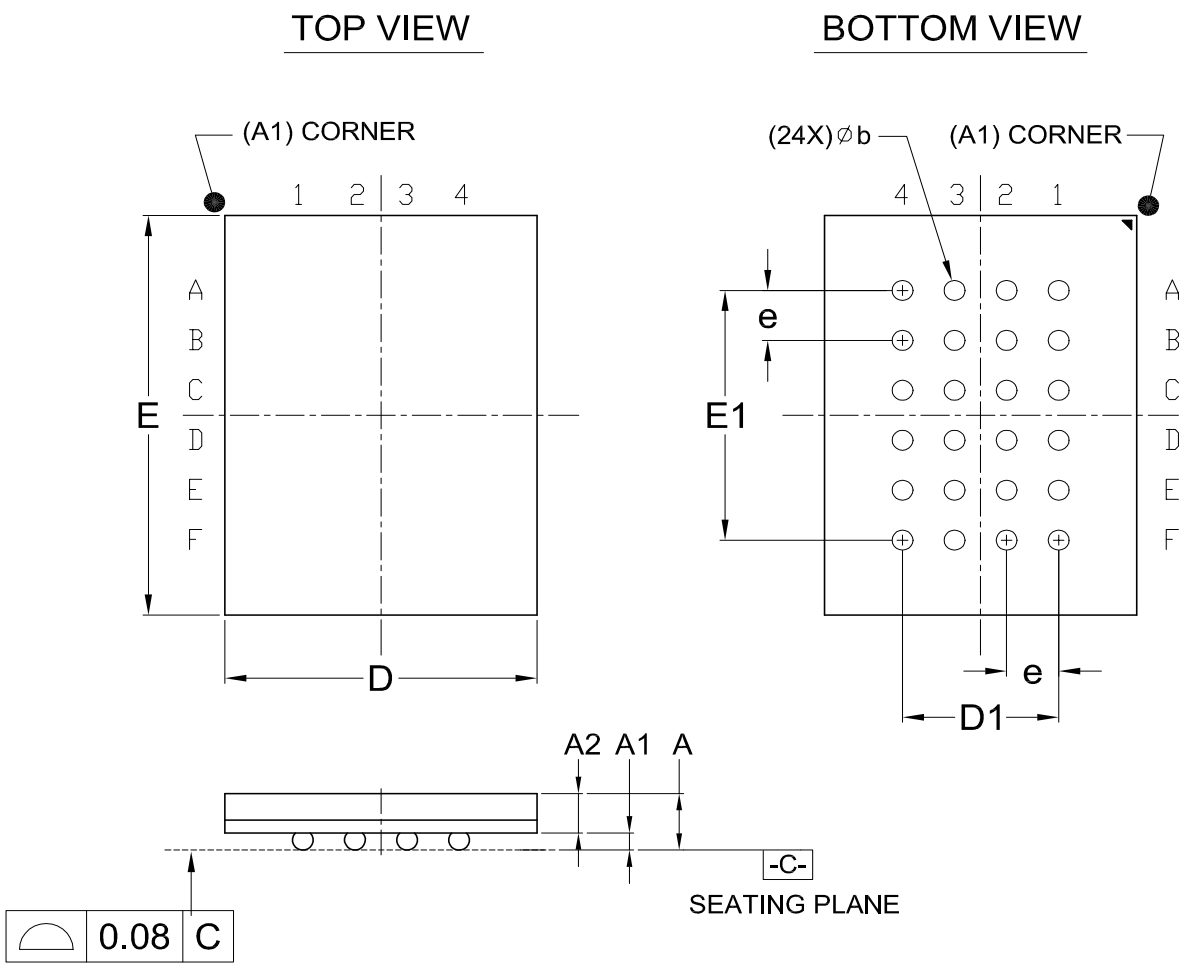
Dimensions (inch dimensions are derived from the original mm dimensions)

| SYMBOL / UNIT | | A | A1 | A2 | b | D | D1 | E | E1 | L | e | y |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| mm | Min. | 0.70 | --- | --- | 0.35 | 5.90 | 3.35 | 4.90 | 3.95 | 0.55 | --- | 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 | 3.45 | 5.10 | 4.05 | 0.65 | --- | 0.05 |
| Inch | Min. | 0.028 | --- | --- | 0.014 | 0.232 | 0.132 | 0.193 | 0.156 | 0.022 | --- | 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 | 0.136 | 0.201 | 0.159 | 0.026 | --- | 0.002 |


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### 20-5. 24-Ball BGA (4x6 ball array)

Doc. Title: Package Outline for CSP 24BALL (6x8x1.2MM, BALL PITCH 1.0MM, BALL DIAMETER 0.4MM)



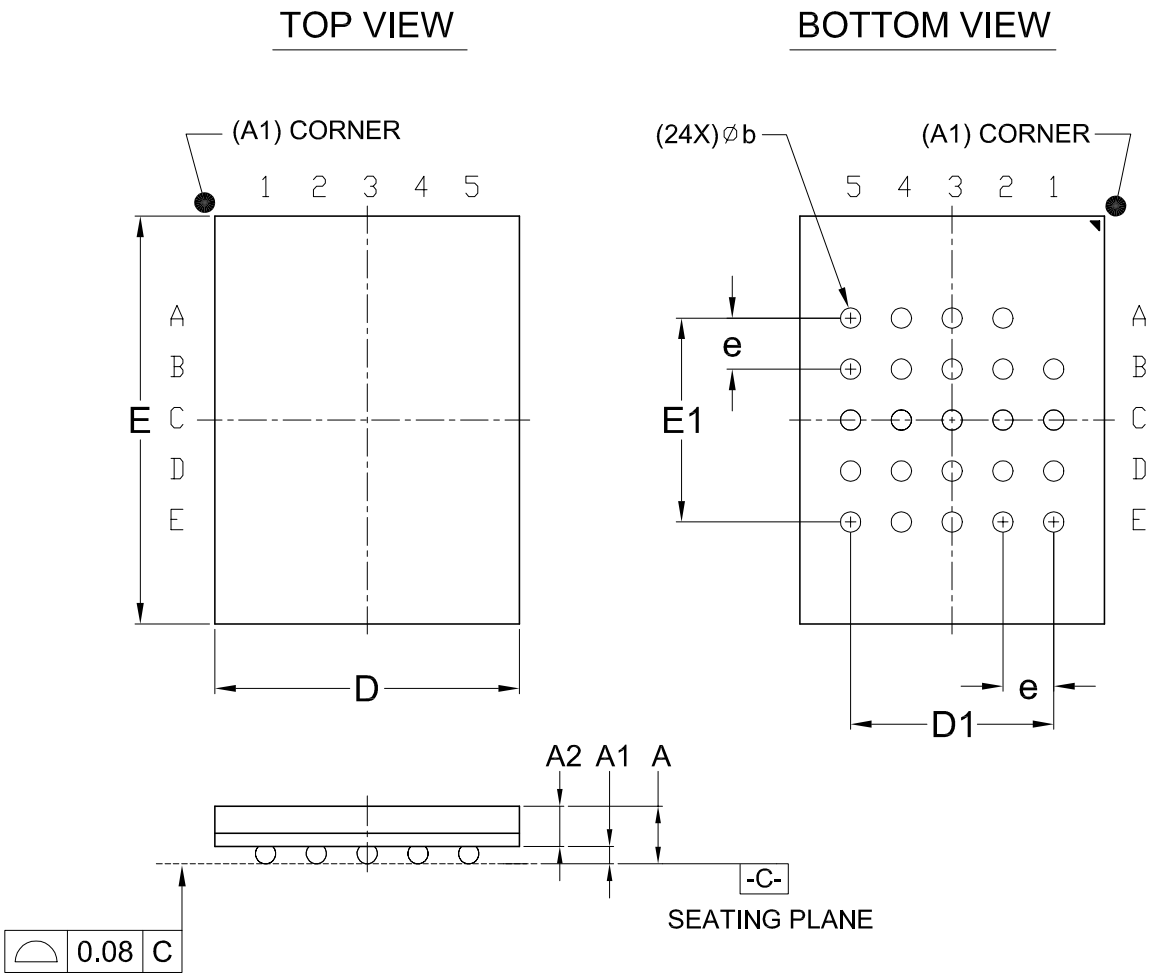

Dimensions (inch dimensions are derived from the original mm dimensions)

| SYMBOL / UNIT | | A | A1 | A2 | b | D | D1 | E | E1 | e |
|---|---|---|---|---|---|---|---|---|---|---|
| mm | Min. | --- | 0.25 | 0.65 | 0.35 | 5.90 | — | 7.90 | --- | --- |
| | Nom. | --- | 0.30 | — | 0.40 | 6.00 | 3.00 | 8.00 | 5.00 | 1.00 |
| | Max. | 1.20 | 0.35 | — | 0.45 | 6.10 | — | 8.10 | --- | --- |
| Inch | Min. | --- | 0.010 | 0.026 | 0.014 | 0.232 | — | 0.311 | --- | --- |
| | Nom. | --- | 0.012 | --- | 0.016 | 0.236 | 0.120 | 0.315 | 0.200 | 0.039 |
| | Max. | 0.047 | 0.014 | --- | 0.018 | 0.240 | — | 0.319 | --- | --- |


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### 20-6. 24-Ball BGA (5x5 ball array)

Doc. Title: Package Outline for CSP 24BALL (6x8x1.2MM, BALL PITCH 1.0MM, BALL DIAMETER 0.4MM, 5x5 BALL ARRAY)




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

| SYMBOL / UNIT | | A | A1 | A2 | b | D | D1 | E | E1 | e |
|---|---|---|---|---|---|---|---|---|---|---|
| mm | Min. | --- | 0.25 | 0.65 | 0.35 | 5.90 | --- | 7.90 | --- | --- |
| | Nom. | --- | 0.30 | --- | 0.40 | 6.00 | 4.00 | 8.00 | 4.00 | 1.00 |
| | Max. | 1.20 | 0.35 | --- | 0.45 | 6.10 | --- | 8.10 | --- | --- |
| Inch | Min. | --- | 0.010 | 0.026 | 0.014 | 0.232 | --- | 0.311 | --- | --- |
| | Nom. | --- | 0.012 | --- | 0.016 | 0.236 | 0.157 | 0.315 | 0.157 | 0.039 |
| | Max. | 0.047 | 0.014 | --- | 0.018 | 0.240 | --- | 0.319 | --- | --- |

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## 21. REVISION HISTORY

| Revision No. | Description | Page | Date |
|---|---|---|---|
| 1.0 | 1. Content correction | P4,8,69,72,96 | JUN/05/2015 |
| | 2. Removed "ADVANCED INFORMATION" to align with product status | All | |
| | 3. Updated Max. ISB1, Typ. Block/Chip Erase cycle time and Typ. Byte Program Time | P84-85,95-96<br>P101 | |
| | 4. Added Preamble Bit | P32,48-51 | |
| | 5. Updated SFDP tables | P79-91 | |
| | 6. Added DPB and USPB, GBLK and GBULK information to Advanced Sector Protection chapter | P13,18,21<br>67,73-74 | |
| | 7. Added tQVD parameter and updated Output Timing (DTR mode) figure. | P98-99<br>P14 | |
| 1.1 | 1. Added MX25L12845GMI-08G, MX25L12845GM2I-08G and MX25L12845GZNI-08G Part No. | P106,107 | FEB/18/2016 |
| | 2. Added Factory Mode information | P17,22-23,104 | |
| | 3. Added a statement for product ordering information | P106 | |
| 1.2 | 1. Revised the descriptions of erase/program cycle in Factory Mode. | P103 | JUL/05/2016 |
| | 2. Updated tVR descriptions. | P100,102 | |
| | 3. Added 24-TFBGA (4x6 and 5x5 ball array) and 8-WSON (8x6mm) packages. | P5, 7, 105-106, 109, 111-112 | |
| | 4. Modified Performance Enhance Mode Reset descriptions. | P54 | |
| | 5. Content modification. | P6, 16, 46, 49-52 53-54, 102 | |
| | 6. Modified *"9-25. Page Program (PP)"* descriptions. | P61 | |
| 1.3 | 1. Updated tCH/tCL/tCE/tPP values | P98,103 | SEP/02/2016 |
| 1.4 | 1. Updated tCLQV descriptions and tCLQX values. | P98 | NOV/04/2016 |
| | 2. Updated the note for the internal pull up status of RESET# and WP#/SIO2 pins. | P7 | |
| | 3. Performance Enhance Mode description modification. | P54-56 | |
| | 4. Content correction. | P22, 33, 59 | |
| 1.5 | 1. Updated the Status Register descriptions: Quad Enable (QE) bit. | P32 | FEB/08/2017 |
| | 2. Revised *"Table 9. Output Driver Strength Table"*. | P34 | |
| | 3. Added Key Features on the cover page. | P1 | |
| | 4. Added *"Figure 89. SCLK TIMING DEFINITION"*. | P96 | |


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| Revision No. | Description | Page | Date |
|---|---|---|---|
| 1.6 | 1. Removed QPI support for WPSEL/GBLK/GBULK commands as a typo correction. | P17-18, 74 | OCT/05/2017 |
| | 2. Corrected Release from Deep Power-down (RDP) descriptions. | P24 | |
| | 3. Modified *"9-27. Deep Power-down (DP)"* descriptions. | P64 | |
| | 4. Added WRSCUR and RDSCUR command figures. | P65-66 | |
| | 5. Added Note for RDDPB and WRDPB figures. | P73 | |
| | 6. Modified Note descriptions of AC Tables. | P98-99 | |
| | 7. Modified *"19. PART NAME DESCRIPTION"*. | P106 | |
| | 8. Updated *"20-4. 8-land WSON (6x5mm)"* and *"20-3. 8-land WSON (8x6mm)"* in Min./Max. D1, E1 and L values. | P110-111 | |
| | 9. Content modification. | P11, 15, 26, P32, 44, 68 | |
| | 10. Format modification. | P107-112 | |
| 1.7 | 1. Updated the note for the internal pull up status of RESET#/SIO3 pin. | P7 | JUN/04/2020 |
| | 2. Modified 24-Ball BGA TOP View. | P7 | |
| | 3. Added "Support Performance Enhance Mode - XIP (execute-in-place)". | P5, 55 | |
| | 4. Modified Serial Input Timing. | P14 | |
| | 5. Added tDVCL and tCLDX values. | P14, 101 | |
| | 6. Revised the descriptions of Performance Enhance Mode. | P47, 49 | |
| | 7. Figure 87 title modification. | P99 | |
| | 8. Content modification. | P1, 5, 11, 13, 17, 21, 25, 33, 35-36, 40, 42-45, 53, 69, 96 | |
| | 9. fTSCLK description modification. | P101-102 | |
| | 10. Added RESET# in *"Figure 90. AC Timing at Device Power-Up"*. | P103 | |
| | 11. Modified the notes of ERASE AND PROGRAMMING PERFORMANCE Table. | P106 | |
| | 12. Revised LATCH-UP testing descriptions. | P107 | |
| | 13. Revised Doc. Title of package outline. | P111 | |
| | 14. Added "Macronix Proprietary" footnote. | All | |
| 1.8 | 1. Added tCHDX/tCLDX descriptions & tCLQV/tCLQX descriptions for VCC=3.0V-3.6V. | P101-102 | AUG/06/2020 |
| | 2. Corrected "Read Electronic Signature (RES) Sequence" figures. | P25-26 | |
| | 3. Description modifications. | P46, 101 | |
| | 4. Removed USPB descriptions. | P72, 74, 77 | |


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