



PY25Q01GLC

Ultra Low Power, 1G-bit Serial Multi I/O Flash Memory Datasheet

Performance Highlight

- ◆ *Supply Range from 1.65 to 2.0V for Read, Erase and Program*
- ◆ *Ultra Low Power consumption for Read, Erase and Program*
- ◆ *X1, X2 and X4 Multi I/O, QPI, DTR Support*
- ◆ *High reliability with 100K cycling and 20 Year-retention*



1 Overview

General

- **Single 1.65 to 2.0V supply**
- **Industrial Temperature Range -40C to 85C**
- **Serial Peripheral Interface (SPI) Compatible: Mode 0 and Mode 3**
- **Single, Dual, Quad SPI, QPI, DTR**
 - Standard SPI: SCLK, CS#, SI, SO, WP#, HOLD#
 - Dual SPI: SCLK, CS#, IO0, IO1, WP#, HOLD#
 - Quad SPI: SCLK, CS#, IO0, IO1, IO2, IO3
 - QPI: SCLK, CS#, IO0, IO1, IO2, IO3
 - DTR: Double Transfer Rate Read
- **Flexible Architecture for Code and Data Storage**
 - Uniform 256-byte Page Program
 - Uniform 4K-byte Sector Erase
 - Uniform 32K/64K-byte Block Erase
 - Full Chip Erase
- **Hardware Controlled Locking of Protected Sectors by WP# Pin**
- **One Time Programmable (OTP) Security Register**
 - 3*1024-Byte Security Registers with OTP Lock
- **128-bit Unique ID for each device**
- **Fast Program and Erase Speed Typical**
 - 0.25ms Page program time
 - 20ms 4K-byte sector erase time
 - 0.10/0.15s 32K/64K-byte block erase time
 - 64s Full chip erase time
- **JEDEC Standard Manufacturer and Device ID Read Methodology**
- **Ultra-Low Power Consumption Typical**
 - 3uA Deep Power Down current
 - 40uA Standby current
 - 8mA Active Read current at 80MHz 4IO
 - 12mA Active Program or Erase current
- **High Reliability**
 - 100,000 Program / Erase Cycles
 - 20-year Data Retention
- **Industry Standard Green Package Options**
 - 16-Lead SOP (300mil)
 - 24-Ball TFBGA(6x8mm)



2 Description

The PY25Q01GLC is a serial interface Flash memory device designed for use in a wide variety of high-volume consumer-based applications in which program code is shadowed from Flash memory into embedded or external RAM for execution. The flexible erase architecture of the device, with its page erase granularity it is ideal for data storage as well, eliminating the need for additional data storage devices.

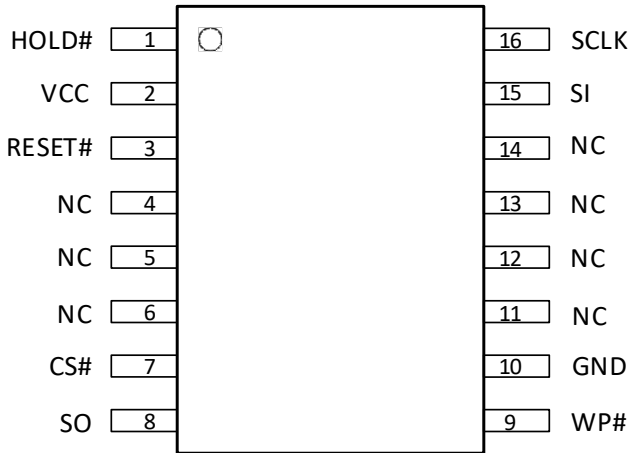
The erase block sizes of the device have been optimized to meet the needs of today's code and data storage applications. By optimizing the size of the erase blocks, the memory space can be used much more efficiently. Because certain code modules and data storage segments must reside by themselves in their own erase regions, the wasted and unused memory space that occurs with large sectored and large block erase Flash memory devices can be greatly reduced. This increased memory space efficiency allows additional code routines and data storage segments to be added while still maintaining the same overall device density.

The device also contains an additional 3*1024-byte security registers with OTP lock (One-Time Programmable), can be used for purposes such as unique device serialization, system-level Electronic Serial Number (ESN) storage, locked key storage, etc.

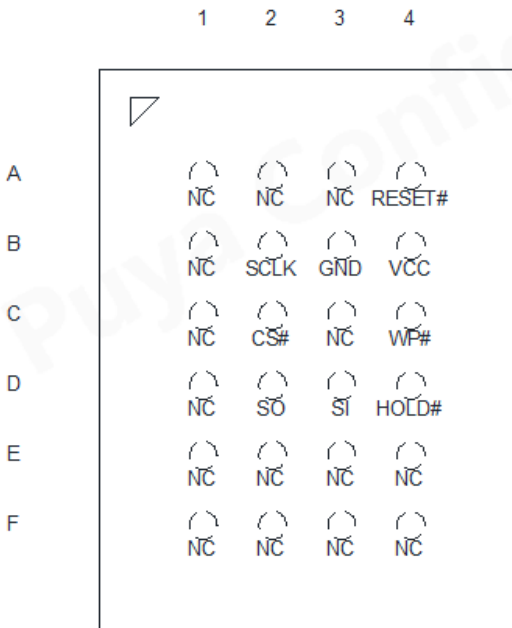
Specifically designed for use in many different systems, the device supports read, program, and erase operations with a supply voltage range of 1.65V to 2.0V. No separate voltage is required for programming and erasing.

3 Pin Definition

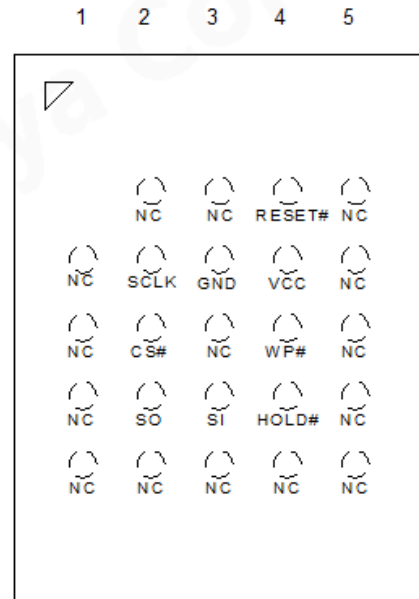
3.1 Pin Configurations



16-Pin SOP (300mil)



24-Ball TFBGA (4x6 Array)



24-Ball TFBGA (5x5 Array)



3.2 Pin Descriptions

Table 3-2-1 Pin Descriptions 16-Pin SOP

| No. | Symbol | Extension | Remarks |
|-----|--------|-----------|--|
| 1 | HOLD# | SIO3 | To pause the device without deselecting the device Serial data input and output for 4 x I/O read mode |
| 2 | VCC | - | Power supply of the device |
| 3 | RESET# | - | Hardware Reset Pin Active low |
| 4 | NC | - | No Connect |
| 5 | NC | - | No Connect |
| 6 | NC | - | No Connect |
| 7 | CS# | | Chip select |
| 8 | SO | SIO1 | Serial data output for 1 x I/O Serial data input and output for 4 x I/O read mode |
| 9 | WP# | SIO2 | Write protection active low Serial data input and output for 4 x I/O read mode |
| 10 | GND | - | Ground of the device |
| 11 | NC | - | No Connect |
| 12 | NC | - | No Connect |
| 13 | NC | - | No Connect |
| 14 | NC | - | No Connect |
| 15 | SI | SIO0 | Serial data input for 1x I/O Serial data input and output for 4 x I/O read mode |
| 16 | SCLK | - | Serial interface clock input |

Table 3-2-2 Pin Descriptions 24-Ball TFBGA

| NO | Symbol | Extension | Remarks |
|----|--------|-----------|--|
| A4 | RESET# | | Hardware Reset Pin Active Low |
| B2 | SCLK | | Serial interface clock input |
| B3 | GND | | Ground of the device |
| B4 | VCC | | Power supply of the device |
| C2 | CS# | | Chip select |
| C4 | WP# | SIO2 | Write protection active low Serial data input and output for 4 x I/O read mode |
| D2 | SO | SIO1 | Serial data output for 1 x I/O Serial data input and output for 4 x I/O read mode |
| D3 | SI | SIO0 | Serial data input for 1x I/O Serial data input and output for 4 x I/O read mode |
| D4 | HOLD# | SIO3 | To pause the device without deselecting the device Serial data input and output for 4 x I/O read mode |

Note:

1. SIO0 and SIO1 are used for Standard and Dual SPI instructions
2. SIO0 – SIO3 are used for Quad SPI instructions, WP#& HOLD# (or RESET#) functions are only available for Standard/Dual SPI.
3. The RESET# pin on SOP-16 package is a dedicated hardware reset pin regardless of device settings. If the reset function is not used, this pin is suggested not left floating in the system.



5 Electrical Specifications

5.1 Absolute Maximum Ratings

- Storage Temperature-65°C to +150°C
- Operation Temperature-40°C to +85°C
- Maximum Operation Voltage..... 2.5V
- Voltage on Any Pin with respect to Ground.....-0.6V to + 2.5V
- DC Output Current5.0 mA

NOTICE: Stresses above those listed under “Absolute Maximum Ratings” may cause permanent damage to the device. This is a stress rating only and functional operation of the device at those or any other conditions above those indicated in the operational listings of this specification is not implied. Exposure to maximum rating conditions for extended periods may affect device reliability.

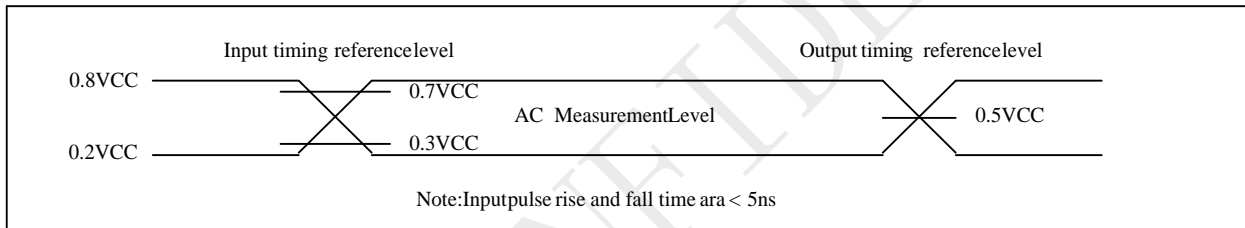
Table 5-1 Pin Capacitance [1]

| Symbol | Parameter | Max. | Units | Test Condition |
|------------------|--------------------|------|-------|-----------------------|
| C _{OUT} | Output Capacitance | 32 | pF | V _{OUT} =GND |
| C _{IN} | Input Capacitance | 24 | pF | V _{IN} =GND |

Note:

1. Test Conditions: T_A= 25°C, F = 1MHz, V_{cc} = 1.8V.

Figure 5-1 Input Test Waveforms and Measurement Level



5.2 DC Characteristics

Table 5-2 DC parameters (Ta=-40°C ~ +85°C)

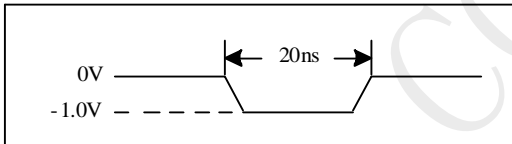
| Symbol | Parameter | Conditions | 1.65V~2.0V | | | Units |
|------------------|------------------------------------|---|------------|--------------------|---------|-------|
| | | | Min | Typ ⁽¹⁾ | Max | |
| I _{DPD} | Deep power down current | CS#=Vcc, all other inputs at 0V or Vcc | | 3 | 60 | uA |
| I _{SB} | Standby current | CS#, HOLD#, WP#=VIH all inputs at CMOS levels | | 40 | 200 | uA |
| I _{CC1} | Read current (STR) (1, 2, 4 IO) | f=80MHz; IOU=0mA | | 8 | 17 | mA |
| | | f=104MHz; IOU=0mA | | 10 | 22 | mA |
| | | f=133MHz; IOU=0mA | | 12 | 27 | mA |
| I _{CC2} | Read current (DTR) (1, 2, 4 IO) | f=50MHz; IOU=0mA | | 10 | 17 | mA |
| | | f=80MHz; IOU=0mA | | 12 | 27 | mA |
| I _{CC3} | Program current | CS#=Vcc | | 12 | 20 | mA |
| I _{CC4} | Erase current | CS#=Vcc | | 12 | 27 | mA |
| I _{LI} | Input load current | All inputs at CMOS level | | | 8.0 | uA |
| I _{LO} | Output leakage | All inputs at CMOS level | | | 8.0 | uA |
| V _{IL} | Input low voltage | | -0.5 | | 0.3Vcc | V |
| V _{IH} | Input high voltage | | 0.7Vcc | | Vcc+0.3 | V |
| V _{OL} | Output low voltage | IOL=100uA | | | 0.2 | V |
| V _{OH} | Output high voltage | IOH=-100uA | Vcc-0.2 | | | V |

Note:

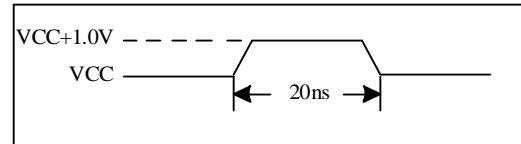
1. Typical value at 1.8V @ 25°C.
2. The value guaranteed by characterization, not 100% tested in production.

Figure 5-2 Maximum Overshoot Waveform

Maximum Negative Overshoot Waveform



Maximum Positive Overshoot Waveform



During DC conditions, input or I/O signals should remain equal to or between VSS and VCC. During voltage transitions, inputs or I/Os may negative overshoot to -1.0V or positive overshoot to VCC + 1.0 V, for periods up to 20 ns.



5.3 AC Characteristics

Table 5-3 AC parameters (Ta=-40°C ~ +85°C)

| Symbol | Alt. | Parameter | 1.65~2.0V | | | Units |
|-----------------------|------|--|-----------|--------------------|-----|-------|
| | | | Min | Typ ⁽¹⁾ | Max | |
| fSCLK | fC | Clock Frequency for all instructions except for special marking | | | 133 | MHz |
| fRSCLK | fR | Clock Frequency for READ instructions | | | 80 | MHz |
| fDSCLK | fD | Clock Frequency for DTR instructions | | | 50 | MHz |
| tCH ⁽³⁾ | tCLH | Clock High Time, 45% x (1/fSCLK) | 3.3 | | | ns |
| tCL ⁽³⁾ | tCLL | Clock Low Time, 45% x (1/fSCLK) | 3.3 | | | ns |
| tCLCH | | Clock Rise Time (peak to peak) | 0.1 | | | v/ns |
| tCHCL | | Clock Fall Time (peak to peak) | 0.1 | | | v/ns |
| tSLCH | tCSS | CS# Active Setup Time (relative to SCLK) | 5 | | | ns |
| tCHSL | | CS# Not Active Hold Time (relative to SCLK) | 5 | | | ns |
| tDVCH | tDSU | Data In Setup Time | 2 | | | ns |
| tCHDX | tDH | Data In Hold Time | 2 | | | ns |
| tCHSH | | CS# Active Hold Time (relative to SCLK) | 5 | | | ns |
| tSHCH | | CS# Not Active Setup Time (relative to SCLK) | 5 | | | ns |
| tSHSL | | CS# Deselect Time from Read to next Read | 20 | | | ns |
| | | CS# Deselect Time from Write, Erase, Program to Read Status Register | 30 | | | ns |
| tSHQZ | tDIS | Output Disable Time | | | 6 | ns |
| tCLQV | tV | Clock Low to Output Valid Loading 30pF | | | 7 | ns |
| | | Clock Low to Output Valid Loading 15pF | | | 6 | ns |
| tCLQX | tHO | Output Hold Time | 1 | | | ns |
| tCSH | | CS# High Time for reset signaling protocol | 500 | | | ns |
| tCSL | | CS# Low Time for reset signaling protocol | 500 | | | ns |
| tSHDX | | Data hold time to CS# for reset signaling protocol | 5 | | | ns |
| tDVSH | | Data setup time to CS# for reset signaling protocol | 5 | | | ns |
| tHLCH | | HOLD# Active Setup Time (relative to SCLK) | 5 | | | ns |
| tCHHH | | HOLD# Active Hold Time (relative to SCLK) | 5 | | | ns |
| tHHCH | | HOLD# Not Active Setup Time (relative to SCLK) | 5 | | | ns |
| tCHHL | | HOLD# Not Active Hold Time (relative to SCLK) | 5 | | | ns |
| tHHQX | tLZ | HOLD# to Output Low-Z | | | 6 | ns |
| tHLQZ | tHZ | HOLD# to Output High-Z | | | 6 | ns |
| tWHSL ⁽⁴⁾ | | Write Protect Setup Time | 20 | | | ns |
| tSHWL ⁽⁴⁾ | | Write Protect Hold Time | 100 | | | ns |
| tDP | | CS# High to Deep Power-down Mode | | | 3 | us |
| tRES1 | | CS# High to Standby Mode Without Electronic Signature Read | | | 20 | us |
| tRES2 | | CS# High to Standby Mode with Electronic Signature Read | | | 20 | us |
| tW | | Write Status Register Cycle Time | | 2 | 12 | ms |
| tReady ⁽⁵⁾ | | Reset recovery time (except Erase/WRSR/WRCR) | | | 30 | us |
| | | Reset recovery time (for WRSR/WRCR operation) | | tW | | ms |
| | | Reset recovery time (for 4KB Erase operation) | | tSE | | ms |
| | | Reset recovery time (for 32KB Erase operation) | | tBE1 | | ms |
| | | Reset recovery time (for 64KB Erase operation) | | tBE2 | | ms |

Note:

1. Typical value at 25°C, VCC=1.8V.
2. The value guaranteed by design or characterization, not 100% tested in production.
3. tCH + tCL must be greater than or equal to 1/ Frequency.
4. Only applicable as a constraint for a WRSR instruction.
5. Suggest to add checking SR WIP Bit to make sure Reset flow finished.



Table 5-3-2 SPI Read Command Performance Comparison (MHz)

| Read command | Dummy Cycles (VCC=1.65V~2.0V) | | | | |
|--------------|-------------------------------|--------------|-----|-------------|-----|
| | 4 | 6 | 8 | 10 | 12 |
| FREAD | - | - | 133 | - | |
| DREAD | - | - | 133 | - | |
| 2READ | 104(default) | - | 133 | - | |
| QREAD | - | - | 133 | - | |
| 4READ | - | 104(default) | 120 | 133 | 133 |
| DTR_FREAD | - | 50(default) | 50 | - | |
| DTR_2READ | - | 50(default) | 50 | - | |
| DTR_4READ | - | 50 | 50 | 50(default) | 50 |

Table 5-3-3 QPI Read Command Performance Comparison (MHz)

| Read command | Dummy Cycles (VCC=1.65V~2.0V) | | | |
|--------------|-------------------------------|-----|-------------|--------------|
| | 6 | 8 | 10 | 12 |
| FREAD | 104 | 120 | 133 | 133(default) |
| 4READ | 104 | 120 | 133 | 133(default) |
| DTR_FREAD | 50 | 50 | 50(default) | 50 |
| DTR_4READ | 50 | 50 | 50(default) | 50 |

5.4 AC Characteristics for Program and Erase

Table 5-4 AC parameters for program and erase (Ta=-40°C ~ +85°C)

| Symbol | Parameter | 1.65V~2.0V | | | Units |
|---------------------------------|---|------------|--------------------|-----|-------|
| | | Min | Typ ⁽²⁾ | Max | |
| T _{ESL} ⁽⁴⁾ | Erase Suspend Latency | | | 25 | us |
| T _{PSL} ⁽⁴⁾ | Program Suspend Latency | | | 20 | us |
| T _{PRS} ⁽²⁾ | Latency between Program Resume and next Suspend | 1 | | | us |
| T _{ERS} ⁽³⁾ | Latency between Erase Resume and next Suspend | 1 | | | us |
| t _{PP} | Page program time (up to 256 bytes) | | 0.25 | 2.4 | ms |
| t _{SE} | Sector erase time | | 20 | 240 | ms |
| t _{BE1} | Block erase time for 32K bytes | | 0.10 | 0.8 | s |
| t _{BE2} | Block erase time for 64K bytes | | 0.15 | 1.2 | s |
| t _C | Chip erase time | | 64 | 160 | s |

Note:

1. Typical values given for T_A=25°C. Not 100% tested.
2. Program operation may be interrupted as often as system request. The minimum timing of t_{PRS} must be observed before issuing the next program suspend command. However, in order for a Program operation to make progress, t_{PRS} ≥ 100us must be included in resume-to-suspend loop(s). Not 100% tested.
3. Erase operation may be interrupted as often as system request. The minimum timing of t_{ERS} must be observed before issuing the next erase suspend command. However, in order for an Erase operation to make progress, t_{ERS} ≥ 100us must be included in resume-to-suspend loop(s). Notes. Not 100% tested.
4. Latency time is required to complete Erase/Program Suspend operation.
5. The value guaranteed by characterization, not 100% tested in production.

Figure 5-4 Serial Input Timing

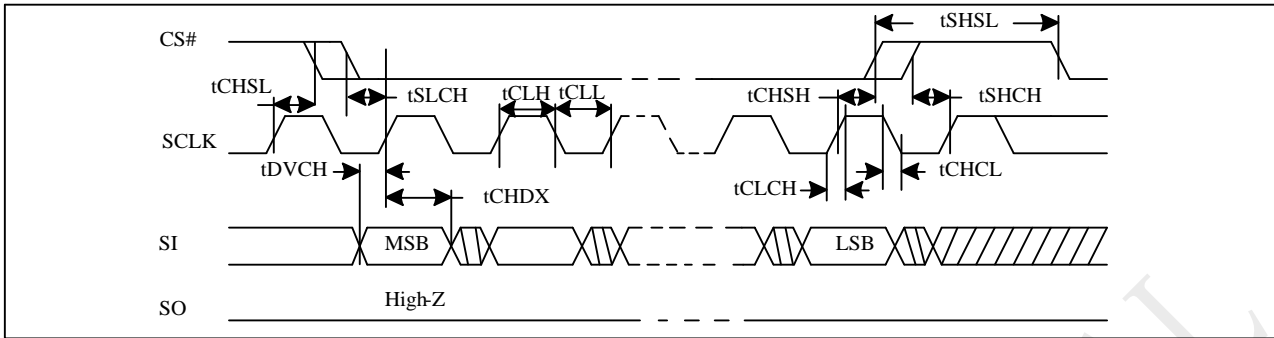


Figure 5-5 Output Timing

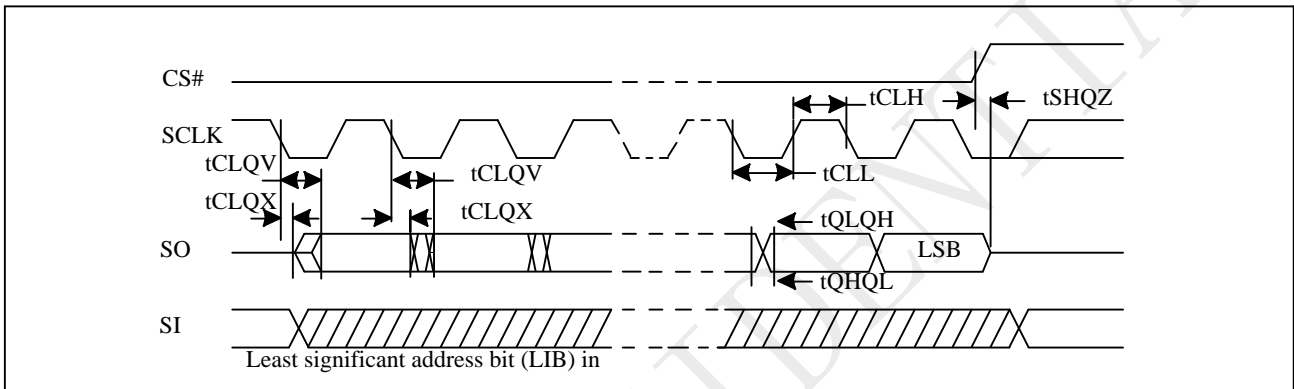


Figure 5-6 Hold Timing

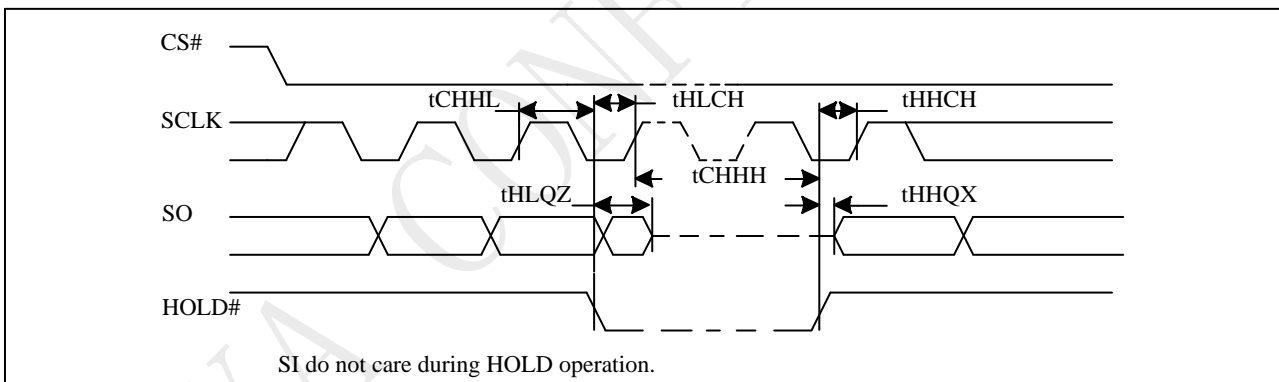
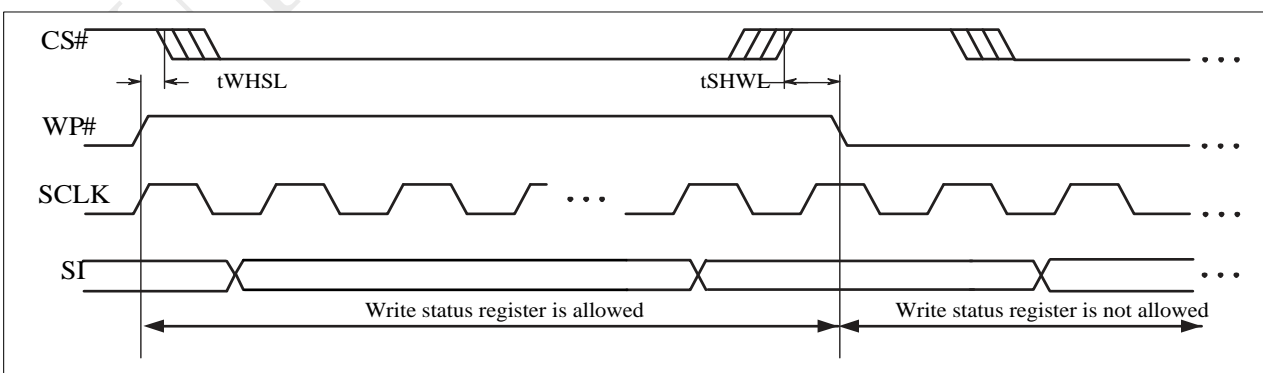


Figure 5-7 WP Timing



5.5 Operation Conditions

At Device Power-Up and Power-Down

AC timing illustrated in "Figure AC Timing at Device Power-Up" and "Figure 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 $V_{cc(min)}$ and wait a period of t_{VSL} .

Figure 5-8 AC Timing at Device Power-Up

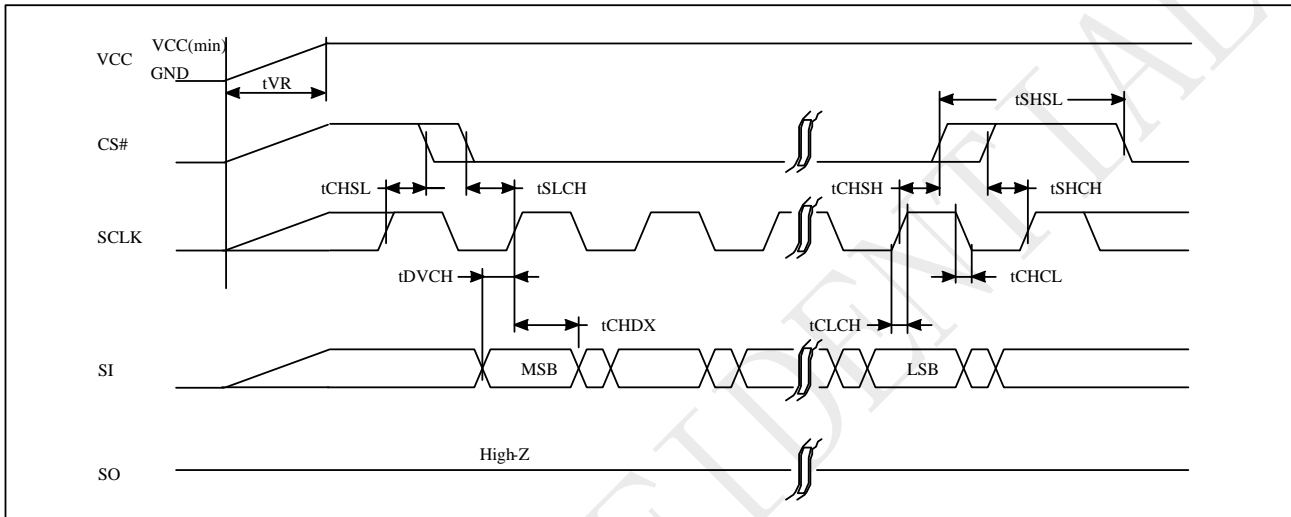
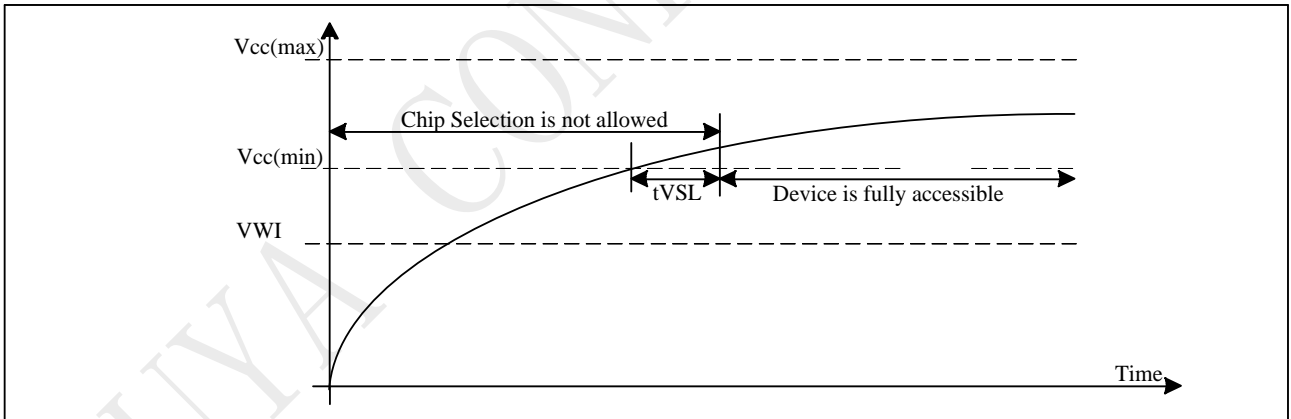


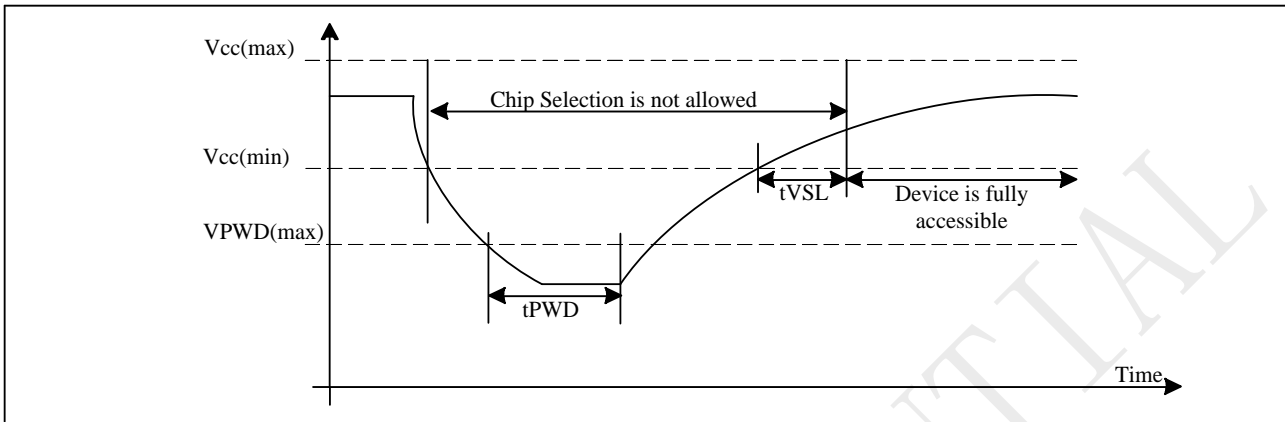
Figure 5-9 Power-up Timing



Power Up/Down and Voltage Drop

For Power-down to Power-up operation, the VCC of flash device must below VPWD for at least tPWD timing. Please check the table below for more detail.

Figure 5-10 Power down-up Timing



| Symbol | Parameter | Min | Max | Units |
|---------------------|---|--------------------|---------|-------|
| VPWD | VCC voltage needed to below VPWD for ensuring initialization will occur | | 1 | V |
| tPWD | The minimum duration for ensuring initialization will occur | 300 | | us |
| tVSL ⁽¹⁾ | VCC(min.) to device operation | 1 ^[1,2] | | ms |
| tVR | VCC Rise Time | 1 | 500,000 | us/V |
| VWI | Write Inhibit Voltage | 1.0 | 1.5 | V |

1. tVSL min time is 1ms without abnormal power down when erase.
2. If an event happens causing a subsector erase operation interrupt (for example, power down during erase operation), the time for tVSL on the next power up may be up to 4.5ms in case of 4KB subsector erase interrupt, and up to 70ms in case of 64KB subsector erase interrupt. This accounts for erase recovery embedded operation.

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).



6 Data Protection

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

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

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

- Power-on reset: to avoid sudden power switch by system power supply transition, the power-on reset may protect the Flash.
- Valid command length checking: The command length will be checked whether it is at byte base and completed on byte boundary.
- Write Enable (WREN) command: WREN command is required to set the Write Enable Latch bit (WEL) before issuing other commands to change data.
- Software Protection Mode: The Block Protect (BP4, BP3, BP2, BP1, and BP0) bits define the section of the memory array that can be read but not change.
- Hardware Protection Mode: WP# going low to protected the BP0~BP4bits and SRP0~1bits
- Deep Power-Down Mode: By entering deep power down mode, the flash device is under protected from writing all commands except the Release from Deep Power-Down Mode command.

Protected Area Sizes

Table 6-1. PY25Q01GLC Protected Area Sizes (WPS=0, CMP=0)

| Status Register | | | | | Memory content | | | |
|-----------------|-----|-----|-----|-----|----------------|------------------------|---------|--------------|
| BP4 | BP3 | BP2 | BP1 | BP0 | Blocks | Addresses | Density | Portion |
| X | 0 | 0 | 0 | 0 | NONE | NONE | NONE | NONE |
| 0 | 0 | 0 | 0 | 1 | 2047 | 07FF0000h - 07FFFFFFh | 64KB | Upper 1/2048 |
| 0 | 0 | 0 | 1 | 0 | 2046 thru 2047 | 07FE0000h - 07FFFFFFh | 128KB | Upper 1/1024 |
| 0 | 0 | 0 | 1 | 1 | 2044 thru 2047 | 07FC0000h - 07FFFFFFh | 256KB | Upper 1/512 |
| 0 | 0 | 1 | 0 | 0 | 2040 thru 2047 | 07F80000h - 07FFFFFFh | 512KB | Upper 1/256 |
| 0 | 0 | 1 | 0 | 1 | 2032 thru 2047 | 07F00000h - 07FFFFFFh | 1MB | Upper 1/128 |
| 0 | 0 | 1 | 1 | 0 | 2016 thru 2047 | 07E00000h - 07FFFFFFh | 2MB | Upper 1/64 |
| 0 | 0 | 1 | 1 | 1 | 1984 thru 2047 | 07C00000h - 07FFFFFFh | 4MB | Upper 1/32 |
| 0 | 1 | 0 | 0 | 0 | 1920 thru 2047 | 07800000h - 07FFFFFFh | 8MB | Upper 1/16 |
| 0 | 1 | 0 | 0 | 1 | 1792 thru 2047 | 07000000h - 07FFFFFFh | 16MB | Upper 1/8 |
| 0 | 1 | 0 | 1 | 0 | 1536 thru 2047 | 06000000h - 07FFFFFFh | 32MB | Upper 1/4 |
| 0 | 1 | 0 | 1 | 1 | 1024 thru 2047 | 04000000h - 07FFFFFFh | 64MB | Upper 1/2 |
| 0 | 1 | 1 | x | x | All | 00000000h - 07FFFFFFh | 128MB | ALL |
| 1 | 0 | 0 | 0 | 1 | 0 | 00000000h - 0000FFFFh | 64KB | Lower 1/2048 |
| 1 | 0 | 0 | 1 | 0 | 0 thru 1 | 00000000h - 0001FFFFh | 128KB | Lower 1/1024 |
| 1 | 0 | 0 | 1 | 1 | 0 thru 3 | 00000000h - 0003FFFFh | 256KB | Lower 1/512 |
| 1 | 0 | 1 | 0 | 0 | 0 thru 7 | 00000000h - 0007FFFFh | 512KB | Lower 1/256 |
| 1 | 0 | 1 | 0 | 1 | 0 thru 15 | 00000000h - 000FFFFFFh | 1MB | Lower 1/128 |
| 1 | 0 | 1 | 1 | 0 | 0 thru 31 | 00000000h - 001FFFFFFh | 2MB | Lower 1/64 |



| Status Register | | | | | Memory content | | | |
|-----------------|-----|-----|-----|-----|----------------|------------------------|---------|------------|
| BP4 | BP3 | BP2 | BP1 | BP0 | Blocks | Addresses | Density | Portion |
| 1 | 0 | 1 | 1 | 1 | 0 thru 63 | 00000000h - 003FFFFFFh | 4MB | Lower 1/32 |
| 1 | 1 | 0 | 0 | 0 | 0 thru 127 | 00000000h - 007FFFFFFh | 8MB | Lower 1/16 |
| 1 | 1 | 0 | 0 | 1 | 0 thru 255 | 00000000h - 00FFFFFFh | 16MB | Lower 1/8 |
| 1 | 1 | 0 | 1 | 0 | 0 thru 511 | 00000000h - 01FFFFFFh | 32MB | Lower 1/4 |
| 1 | 1 | 0 | 1 | 1 | 0 thru 1023 | 00000000h - 03FFFFFFh | 64MB | Lower 1/2 |
| 1 | 1 | 1 | X | X | ALL | 00000000h - 07FFFFFFh | 128MB | ALL |

Table 6-2. PY25Q01GLC Protected Area Sizes (WPS=0, CMP=1)

| Status Register | | | | | Memory content | | | |
|-----------------|-----|-----|-----|-----|----------------|-----------------------|-----------|-----------------|
| BP4 | BP3 | BP2 | BP1 | BP0 | Blocks | Addresses | Density | Portion |
| X | 0 | 0 | 0 | 0 | ALL | 00000000h - 07FFFFFFh | ALL | ALL |
| 0 | 0 | 0 | 0 | 1 | 0 thru 2046 | 00000000h - 07FEFFFFh | 131,008KB | Lower 2047/2048 |
| 0 | 0 | 0 | 1 | 0 | 0 thru 2045 | 00000000h - 07FDFFFFh | 130,944KB | Lower 1023/1024 |
| 0 | 0 | 0 | 1 | 1 | 0 thru 2043 | 00000000h - 07FBFFFFh | 130,816KB | Lower 511/512 |
| 0 | 0 | 1 | 0 | 0 | 0 thru 2039 | 00000000h - 07F7FFFFh | 130,560KB | Lower 255/256 |
| 0 | 0 | 1 | 0 | 1 | 0 thru 2031 | 00000000h - 07EFFFFh | 127MB | Lower 127/128 |
| 0 | 0 | 1 | 1 | 0 | 0 thru 2015 | 00000000h - 07DFFFFh | 126MB | Lower 63/64 |
| 0 | 0 | 1 | 1 | 1 | 0 thru 1983 | 00000000h - 07BFFFFh | 124MB | Lower 31/32 |
| 0 | 1 | 0 | 0 | 0 | 0 thru 1919 | 00000000h - 077FFFFh | 120MB | Lower 15/16 |
| 0 | 1 | 0 | 0 | 1 | 0 thru 1791 | 00000000h - 06FFFFh | 112MB | Lower 7/8 |
| 0 | 1 | 0 | 1 | 0 | 0 thru 1535 | 00000000h - 05FFFFh | 96MB | Lower 3/4 |
| 0 | 1 | 0 | 1 | 1 | 0 thru 1023 | 00000000h - 03FFFFh | 64MB | Lower 1/2 |
| 0 | 1 | 1 | X | X | NONE | NONE | NONE | NONE |
| 1 | 0 | 0 | 0 | 1 | 1 thru 2047 | 00010000h - 07FFFFFFh | 131,008KB | Upper 2047/2048 |
| 1 | 0 | 0 | 1 | 0 | 2 thru 2047 | 00020000h - 07FFFFFFh | 130,944KB | Upper 1023/1024 |
| 1 | 0 | 0 | 1 | 1 | 4 thru 2047 | 00040000h - 07FFFFFFh | 130,816KB | Upper 511/512 |
| 1 | 0 | 1 | 0 | 0 | 8 thru 2047 | 00080000h - 07FFFFFFh | 130,560KB | Upper 255/256 |
| 1 | 0 | 1 | 0 | 1 | 16 thru 2047 | 00100000h - 07FFFFFFh | 127MB | Upper 127/128 |
| 1 | 0 | 1 | 1 | 0 | 32 thru 2047 | 00200000h - 07FFFFFFh | 126MB | Upper 63/64 |
| 1 | 0 | 1 | 1 | 1 | 64 thru 2047 | 00400000h - 07FFFFFFh | 124MB | Upper 31/32 |
| 1 | 1 | 0 | 0 | 0 | 128 thru 2047 | 00800000h - 07FFFFFFh | 120MB | Upper 15/16 |
| 1 | 1 | 0 | 0 | 1 | 256 thru 2047 | 01000000h - 07FFFFFFh | 112MB | Upper 7/8 |
| 1 | 1 | 0 | 1 | 0 | 512 thru 2047 | 02000000h - 07FFFFFFh | 96MB | Upper 3/4 |
| 1 | 1 | 0 | 1 | 1 | 1024 thru 2047 | 04000000h - 07FFFFFFh | 64MB | Upper 1/2 |
| 1 | 1 | 1 | X | X | NONE | NONE | NONE | NONE |

Note:

1. X=don't care
2. If any erase or program command specifies a memory that contains protected data portion, this command will be ignored.



Table 6-3. PY25Q01GLC Individual Block Protection (WPS=1)

| Block | Sector/Block | |
|--------------|-------------------|---|
| Block 2047 | Sector 15 (4KB) | ← |
| | Sector 14 (4KB) | ← |
| | - | |
| | - | |
| | Sector 1 (4KB) | ← |
| Block 2046 | Sector 0 (4KB) | ← |
| | Block 2046 (64KB) | ← |
| Block2 ~2045 | ----- | ← |
| Block 1 | | ← |
| | Block 1 (64KB) | ← |
| Block 0 | Sector 15 (4KB) | ← |
| | Sector 14 (4KB) | ← |
| | - | |
| | - | |
| | Sector 1 (4KB) | ← |
| | Sector 0 (4KB) | ← |

**Individual Block Locks:
32 Sectors(Top/Bottom)
2046 Blocks**

Individual Block Lock:
36h+Address

Individual Block Unlock:
39h+Address

Read Block Lock:
3Dh+Address

Global Block Lock:
7Eh

Global Block Unlock:
98h

Notes:

1. Individual Block/Sector protection is only valid when WPS=1.
2. All individual block/sector lock bits are set to 1 by default after power up, all memory array is protected.
3. Global Block Unlock instruction (98H) must previously have been executed before Chip Erase instruction when WPS=1.



7 Memory Address Mapping

The memory array can be erased in three levels of granularity including a full chip erase. The size of the erase blocks is optimized for both code and data storage applications, allowing both code and data segments to reside in their own erase regions.

| Each device has | Each block has | Each sector has | Each page has | |
|-----------------|----------------|-----------------|---------------|---------|
| 128M | 64/32K | 4K | 256 | bytes |
| 512K | 256/128 | 16 | - | pages |
| 32K | 16/8 | - | - | sectors |
| 2K/4K | - | - | - | blocks |

PY25Q01GLC Memory Organization

| Block | Sector | Address range | |
|-------|--------|---------------|------------|
| 2047 | 32767 | 07FF_F000H | 07FF_FFFFH |
| | | | |
| | 32752 | 07FF_0000H | 07FF_0FFFH |
| 2046 | 32751 | 07FE_F000H | 07FE_FFFFH |
| | | | |
| | 32736 | 07FE_0000H | 07FE_0FFFH |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| 2 | 47 | 0002_F000H | 0002_FFFFH |
| | | | |
| | 32 | 0002_0000H | 0002_0FFFH |
| 1 | 31 | 0001_F000H | 0001_FFFFH |
| | | | |
| | 16 | 0001_0000H | 0001_0FFFH |
| 0 | 15 | 0000_F000H | 0000_FFFFH |
| | | | |
| | 0 | 0000_0000H | 0000_0FFFH |

8 Device Operation

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

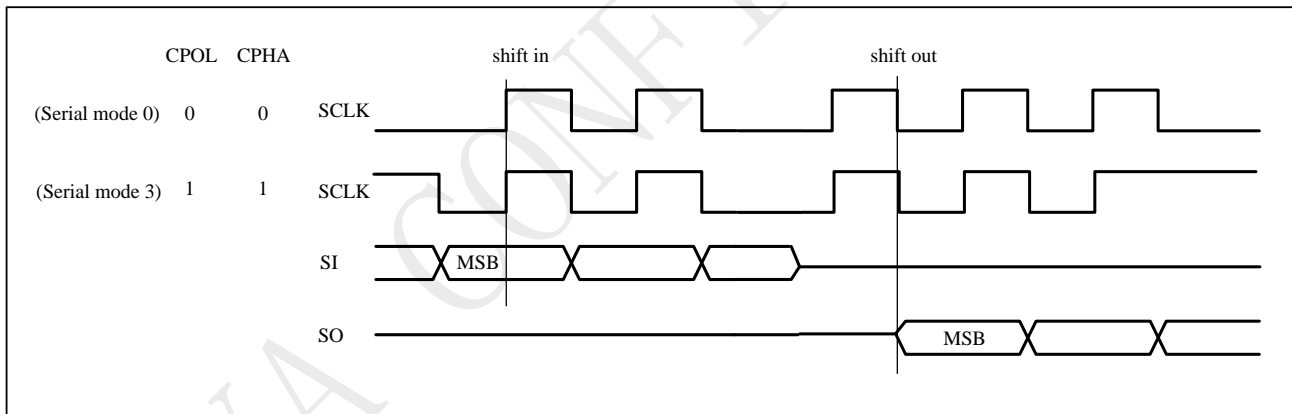
When incorrect command is inputted to this LSI, this LSI becomes standby mode and keeps the standby mode until next CS# falling edge. In standby mode, SO pin of this LSI should be High-Z. When correct command is inputted to this LSI, this LSI becomes active mode and keeps the active mode until next CS# rising edge.

Input data is latched on the rising edge of Serial Clock (SCLK) and data shifts out on the falling edge of SCLK. The difference of serial peripheral interface mode 0 and mode 3 is shown as Figure 8-1.

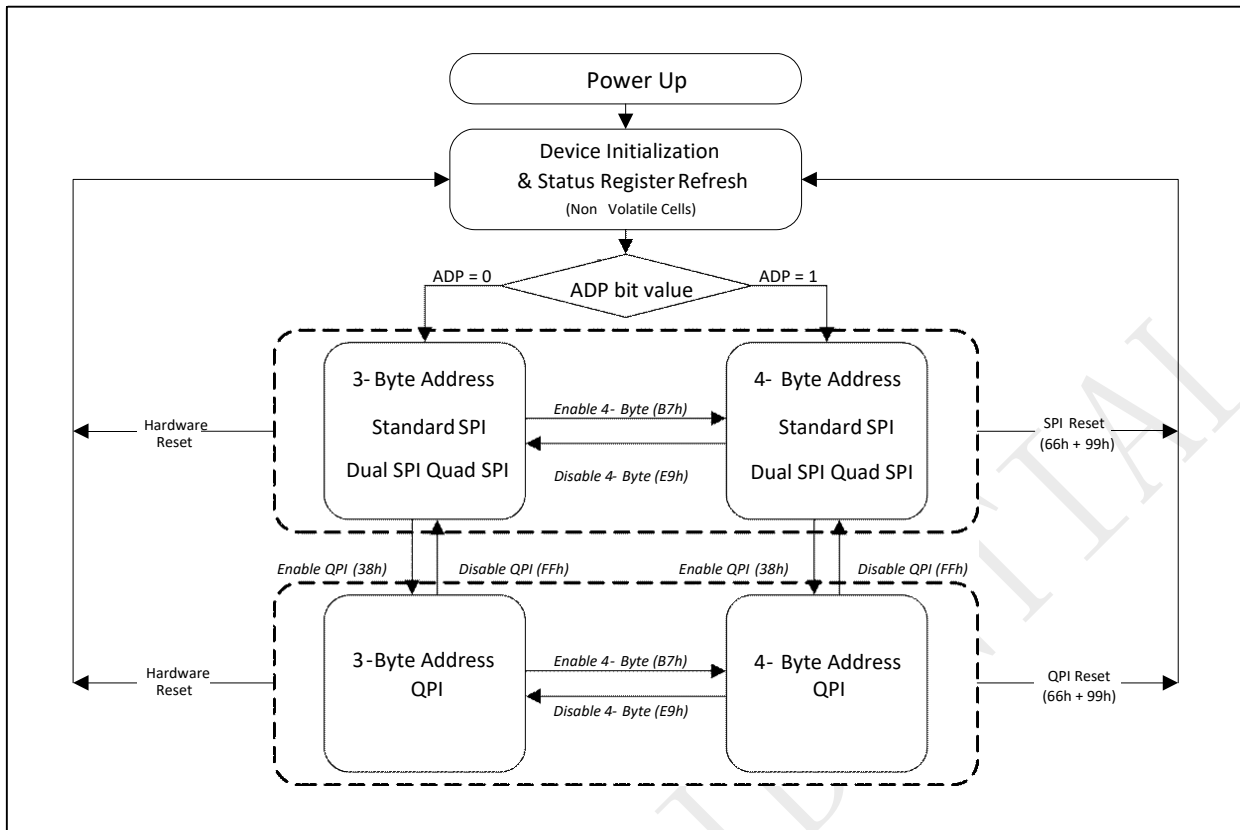
For the following instructions: RDID, RDSR, RDSR1, RDCR, RDSCUR, READ, FREAD, DREAD, 2READ, 4READ, QREAD, RDSFDP, RES, REMS, DREMS, QREMS, the shifted-in instruction sequence is followed by a data-out sequence. After any bit of data being shifted out, the CS# can be high. For the following instructions: WREN, WRDI, WRSR, WRSR1, WRCR, SE, BE32K, BE, CE, PP, QPP, DP, ERSCUR, PRSCUR, SUSPEND, RESUME, RSTEN, RST, the CS# must go high exactly at the byte boundary; otherwise, the instruction will be rejected and not executed.

During the progress of Write Status Register, Program, Erase operation, to access the memory array is neglected and not affect the current operation of Write Status Register, Program, Erase.

Figure 8-1 Serial Peripheral Interface 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.



Standard SPI

The PY25Q01GLC features a serial peripheral interface on 4 signals bus: Serial Clock (SCLK), Chip Select (CS#), Serial Data Input (SI) and Serial Data Output (SO). Both SPI bus mode 0 and 3 are supported. Input data is latched on the rising edge of SCLK and data shifts out on the falling edge of SCLK.

Dual SPI

The PY25Q01GLC supports Dual SPI operation when using the “Dual Output Fast Read” and “Dual I/O Fast Read” (3BHand BBH) commands. These commands allow data to be transferred to or from the device at two times the rate of the standard SPI. When using the Dual SPI command the SI and SO pins become bidirectional I/O pins: IO0 and IO1.

Quad SPI

The PY25Q01GLC supports Quad SPI operation when using the “Quad Output Fast Read”, “Quad I/O Fast Read” (6BH, EBH) commands. These commands allow data to be transferred to or from the device at four times the rate of the standard SPI. When using the Quad SPI command the SI and SO pins become bidirectional I/O pins: IO0 and IO1, and WP# and HOLD# pins become IO2 and IO3. Quad SPI commands require the non-volatile Quad Enable bit (QE) in Status Register to be set.

QPI

The PY25Q01GLC supports Quad Peripheral Interface (QPI) operations only when the device is switched from Standard/Dual/Quad SPI mode to QPI mode using the “Enable the QPI (38H)” command. The QPI mode utilizes all four IO pins to input the command code. Standard/Dual/Quad SPI mode and QPI mode are exclusive. Only one mode can be active at any given times. “Enable the QPI (38H)” and “Disable the QPI (FFH)” commands are used to switch between these two modes. Upon power-up and after software reset using “Reset (99H)” command, the default state of the device is Standard/Dual/Quad SPI mode. The QPI mode requires the non-volatile Quad Enable bit (QE) in Status Register to be set.



SPI / QPI DTR Read Instructions

To effectively improve the read operation throughput without increasing the serial clock frequency, PY25Q01GLC introduces multiple DTR (Double Transfer Rate) Read instructions that support Standard/Dual/Quad SPI and QPI modes. The byte-long instruction code is still latched into the device on the rising edge of the serial clock similar to all other SPI/QPI instructions. Once a DTR instruction code is accepted by the device, the address input and data output will be latched on both rising and falling edges of the serial clock.

3-Byte / 4-Byte Address Modes

The PY25Q01GLC provides two Address Modes that can be used to specify any byte of data in the memory array. The 3-Byte Address Mode is backward compatible to older generations of serial flash memory that only support up to 128M-bit data. To address the 256M-bit or more data in 3-Byte Address Mode, Extended Address Register must be used in addition to the 3-Byte addresses.

4-Byte Address Mode is designed to support Serial Flash Memory devices from 256M-bit to 32G-bit. The extended Address Register is not necessary when the 4-Byte Address Mode is enabled.

Upon power up, the PY25Q01GLC can operate in either 3-Byte Address Mode or 4-Byte Address Mode, depending on the Configure Register Bit ADP setting. If ADP=0, the device will operate in 3-Byte Address Mode; if ADP=1, the device will operate in 4-Byte Address Mode. The factory default value for ADP is 0.

To switch between the 3-Byte or 4-Byte Address Modes, “Enter 4-Byte Mode (B7h)” or “Exit 4-Byte Mode (E9h)” instructions must be used. The current address mode is indicated by the Configure Register Bit ADS.

PY25Q01GLC also supports a set of basic SPI instructions which requires dedicated 4-Byte address regardless the device Address Mode setting.

Software Reset & Hardware RESET# pin

The PY25Q01GLC can be reset to the initial power-on state by a software Reset sequence, either in SPI mode or QPI mode. This sequence must include two consecutive commands: Enable Reset (66h) & Reset (99h). If the command sequence is successfully accepted, the device will take approximately tReady to reset. No command will be accepted during the reset period.

The PY25Q01GLC can also be configured to utilize a hardware RESET# pin. The HOLD/RST bit in the Configure Register is the configuration bit for HOLD# pin function or RESET# pin function. When HOLD/RST=0 (factory default), the pin acts as a HOLD# pin as described above; when HOLD/RST=1, the pin acts as a RESET# pin. Drive the RESET# pin low for a minimum period of ~1us(tRLRH) will reset the device to its initial power-on state. Any on-going Program/Erase operation will be interrupted and data corruption may happen. While RESET# is low, the device will not accept any command input.

If QE bit is set to 1, the HOLD or RESET function will be disabled, the pin will become one of the four data I/O pins.

Hardware RESET# pin has the highest priority among all the input signals. Drive RESET# low for a minimum period of ~1us(tRLRH) will interrupt any on-going external/internal operations, regardless the status of other SPI signals (/CS, CLK, IOs, WP# and/or HOLD#).

Note:

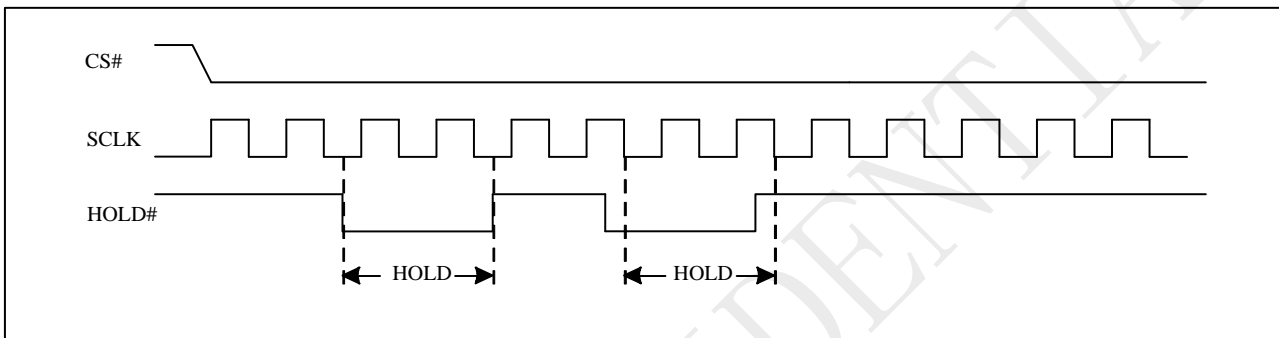
- 1.While a faster RESET# pulse (as short as a few hundred nanoseconds) will often reset the device, a 1us minimum is recommended to ensure reliable operation.
- 2.There is an internal pull-up resistor for the dedicated RESET# pin. If the reset function is not needed, this pin is suggested not left floating in the system.

9 Hold Feature

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

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

Figure 9-1 Hold Condition Operation



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

Note: The HOLD feature is disabled during Quad I/O mode.



10 Commands

10.1 Commands listing

10.1.1 SPI Commands listing

Table 10-1 Command set (Standard/Dual/Quad SPI,3-Byte Address Mode)

| Commands | Abbr. | Code | ADR Bytes | DMY Cycles | Data Bytes | Function description |
|---|---------|---------|-----------|------------|------------|---|
| Read | | | | | | |
| Read Array (fast) | FREAD | 0Bh | 3 | 8 | 1+ | n bytes read out until CS# goes high |
| Read Array (fast) 4byte address | FREAD4B | 0Ch | 4 | 8 | 1+ | n bytes read out until CS# goes high |
| Read Array | READ | 03h | 3 | 0 | 1+ | n bytes read out until CS# goes high |
| Read Array 4byte address | READ4B | 13h | 4 | 0 | 1+ | n bytes read out until CS# goes high |
| Read Dual Output | DREAD | 3Bh | 3 | 8 | 1+ | n bytes read out by Dual output |
| Read Dual Output 4 byte address | DREAD4B | 3Ch | 4 | 8 | 1+ | n bytes read out by Dual output |
| Read 2IO | 2READ | BBh | 3 | 4/8 | 1+ | n bytes read out by 2IO |
| Read 2IO 4 byte address | 2READ4B | BCh | 4 | 4/8 | 1+ | n bytes read out by 2IO |
| Read Quad Output | QREAD | 6Bh | 3 | 8 | 1+ | n bytes read out by Quad output |
| Read Quad Output 4 byte address | QREAD4B | 6Ch | 4 | 8 | 1+ | n bytes read out by Quad output |
| Read 4IO | 4READ | EBh | 3 | 6/12/8/10 | 1+ | n bytes read out by 4IO |
| Read 4IO 4 byte address | 4READ4B | ECh | 4 | 6/12/8/10 | 1+ | n bytes read out by 4IO |
| Program and Erase | | | | | | |
| Sector Erase (4K) | SE | 20h | 3 | 0 | 0 | erase selected sector |
| Sector Erase (4K) 4byte address | SE4B | 21h | 4 | 0 | 0 | erase selected sector |
| Block Erase (32K) | BE32K | 52h | 3 | 0 | 0 | erase selected 32K block |
| Block Erase (32K) 4 byte address | BE32K4B | 5Ch | 4 | 0 | 0 | erase selected 32K block |
| Block Erase (64K) | BE | D8h | 3 | 0 | 0 | erase selected 64K block |
| Block Erase (64K) 4byte address | BE4B | DCh | 4 | 0 | 0 | erase selected 64K block |
| Chip Erase | CE | 60h/C7h | 0 | 0 | 0 | erase whole chip |
| Page Program | PP | 02h | 3 | 0 | 1+ | program selected page |
| Page Program 4byte address | PP4B | 12h | 4 | 0 | 1+ | program selected page |
| Quad data-in page program | QPP | 32h | 3 | 0 | 1+ | Quad data input to program selected page |
| Quad data-in page program 4byte address | QPP4B | 34h | 4 | 0 | 1+ | Quad data input to program selected page |
| Quad-in page program | QIPP | C2h | 3 | 0 | 1+ | quad input to program selected page |
| Quad-in page program 4byte address | QIPP4B | 3Eh | 4 | 0 | 1+ | quad input to program selected page |
| Program/Erase Suspend | PES | 75h | 0 | 0 | 0 | suspend program/erase operation |
| Program/Erase Resume | PER | 7Ah | 0 | 0 | 0 | continue program/erase operation |
| Protection | | | | | | |
| Write Enable | WREN | 06h | 0 | 0 | 0 | sets the write enable latch bit |
| Write Disable | WRDI | 04h | 0 | 0 | 0 | resets the write enable latch bit |
| Volatile SR Write Enable | VWREN | 50h | 0 | 0 | 0 | Write enable for volatile SR |
| Individual Block Lock | SBLK | 36h | 3 | 0 | 0 | Individual block lock |
| Individual Block Unlock | SBULK | 39h | 3 | 0 | 0 | Individual block unlock |
| Read Block Lock Status | RDBLOCK | 3Dh | 3 | 0 | 1 | Read individual block lock register |
| Global Block Lock | GBLK | 7Eh | 0 | 0 | 0 | Whole chip block protect |
| Global Block Unlock | GBULK | 98h | 0 | 0 | 0 | Whole chip block unprotect |
| Security | | | | | | |
| Erase Security Registers | ERSCUR | 44h | 3 | 0 | 0 | Erase security registers |
| Program Security Registers | PRSCUR | 42h | 3 | 0 | 1+ | Program security registers |
| Read Security Registers | RDSCUR | 48h | 3 | 8 | 1+ | Read value of security register |
| Status Register | | | | | | |
| Read Status Register1 | RDSR | 05h | 0 | 0 | 1 | read out status register1 |
| Read Status Register2 | RDSR2 | 35h | 0 | 0 | 1 | Read out status register2 |
| Read Configure Register | RDCR | 15h | 0 | 0 | 1 | Read out configure register |
| Write Status Register1 | WRSR | 01h | 0 | 0 | 1-2 | Write data to status registers1 and status registers2 |
| Write Status Register2 | WRSR2 | 31h | 0 | 0 | 1 | Write data to status registers2 |
| Write Configure Register | WRCR | 11h | 0 | 0 | 1 | Write data to configuration register |
| Read Extended Address Register | RDEAR | C8h | 0 | 0 | 1 | Read out extended address register |
| Write Extended Address Register | WREAR | C5h | 0 | 0 | 1 | Write data to extended address register |
| Other Commands | | | | | | |
| Reset Enable | RSTEN | 66h | 0 | 0 | 0 | Enable reset |



| Commands | Abbr. | Code | ADR Bytes | DMY Cycles | Data Bytes | Function description |
|--|---------|------|-----------|------------|------------|--|
| Reset | RST | 99h | 0 | 0 | 0 | Reset |
| Enable QPI | QPIEN | 38h | 0 | 0 | 0 | Enable QPI mode |
| Enter 4-Byte Address | EN4B | B7h | 0 | 0 | 0 | Enter 4-Byte Address Mode |
| Exit 4-Byte Address | EX4B | E9h | 0 | 0 | 0 | Exit 4-Byte Address Mode |
| Read Manufacturer/device ID | RDID | 9Fh | 0 | 0 | 1 to 3 | output JEDEC ID: 1-byte manufacturer ID & 2-byte device ID |
| Read Manufacture ID | REMS | 90h | 3 | | 1+ | Read manufacturer ID/device ID data |
| Dual Read Manufacture ID | DREMS | 92h | 3 | 4 | 1+ | Dual output read manufacture/device ID |
| Quad Read Manufacture ID | QREMS | 94h | 3 | 6 | 1+ | Quad output read manufacture/device ID |
| Deep Power-down | DP | B9h | 0 | 0 | 0 | enters deep power-down mode |
| Release Deep Power-down/Read Electronic ID | RDP/RES | ABh | 3 | 0 | 1 | Read electronic ID data |
| Read SFDP | RDSFDP | 5Ah | 3 | 8 | 1+ | Read SFDP parameter |
| Release read enhanced | | FFh | 0 | 0 | 0 | Release from read enhanced |
| Read unique ID | RUID | 4Bh | 3 | 8 | 1+ | Read unique ID |

Table 10-2 Command set (Standard/Dual/Quad SPI,4-Byte Address Mode)

| Commands | Abbr. | Code | ADR Bytes | DMY Cycles | Data Bytes | Function description |
|---|---------|---------|-----------|------------|------------|--------------------------------------|
| Read | | | | | | |
| Read Array (fast) | FREAD | 0Bh | 4 | 8 | 1+ | n bytes read out until CS# goes high |
| Read Array (fast) 4byte address | FREAD4B | 0Ch | 4 | 8 | 1+ | n bytes read out until CS# goes high |
| Read Array | READ | 03h | 4 | 0 | 1+ | n bytes read out until CS# goes high |
| Read Array 4byte address | READ4B | 13h | 4 | 0 | 1+ | n bytes read out until CS# goes high |
| Read Dual Output | DREAD | 3Bh | 4 | 8 | 1+ | n bytes read out by Dual output |
| Read Dual Output 4 byte address | DREAD4B | 3Ch | 4 | 8 | 1+ | n bytes read out by Dual output |
| Read 2IO | 2READ | BBh | 4 | 4/8 | 1+ | n bytes read out by 2IO |
| Read 2IO 4 byte address | 2READ4B | BCh | 4 | 4/8 | 1+ | n bytes read out by 2IO |
| Read Quad Output | QREAD | 6Bh | 4 | 8 | 1+ | n bytes read out by Quad output |
| Read Quad Output 4 byte address | QREAD4B | 6Ch | 4 | 8 | 1+ | n bytes read out by Quad output |
| Read 4IO | 4READ | EBh | 4 | 6/12/8/10 | 1+ | n bytes read out by 4IO |
| Read 4IO 4 byte address | 4READ4B | ECh | 4 | 6/12/8/10 | 1+ | n bytes read out by 4IO |
| Program and Erase | | | | | | |
| Sector Erase (4K) | SE | 20h | 4 | 0 | 0 | erase selected sector |
| Sector Erase (4K) 4byte address | SE4B | 21h | 4 | 0 | 0 | erase selected sector |
| Block Erase (32K) | BE32K | 52h | 4 | 0 | 0 | erase selected 32K block |
| Block Erase (32K) 4 byte address | BE32K4B | 5Ch | 4 | 0 | 0 | erase selected 32K block |
| Block Erase (64K) | BE | D8h | 4 | 0 | 0 | erase selected 64K block |
| Block Erase (64K) 4byte address | BE4B | DCh | 4 | 0 | 0 | erase selected 64K block |
| Chip Erase | CE | 60h/C7h | 0 | 0 | 0 | erase whole chip |
| Page Program | PP | 02h | 4 | 0 | 1+ | program selected page |
| Page Program 4byte address | PP4B | 12h | 4 | 0 | 1+ | program selected page |
| Quad data-in page program | QPP | 32h | 4 | 0 | 1+ | quad input to program selected page |
| Quad data-in page program 4byte address | QPP4B | 34h | 4 | 0 | 1+ | quad input to program selected page |
| Quad-in page program | QIPP | C2h | 3 | 0 | 1+ | quad input to program selected page |
| Quad-in page program 4byte address | QIPP4B | 3Eh | 4 | 0 | 1+ | quad input to program selected page |
| Program/Erase Suspend | PES | 75h | 0 | 0 | 0 | suspend program/erase operation |
| Program/Erase Resume | PER | 7Ah | 0 | 0 | 0 | continue program/erase operation |
| Protection | | | | | | |
| Write Enable | WREN | 06h | 0 | 0 | 0 | sets the write enable latch bit |
| Write Disable | WRDI | 04h | 0 | 0 | 0 | resets the write enable latch bit |
| Volatile SR Write Enable | VWREN | 50h | 0 | 0 | 0 | Write enable for volatile SR |
| Individual Block Lock | SBLK | 36h | 4 | 0 | 0 | Individual block lock |
| Individual Block Unlock | SBULK | 39h | 4 | 0 | 0 | Individual block unlock |
| Read Block Lock Status | RDBLOCK | 3Dh | 4 | 0 | 1 | Read individual block lock register |
| Global Block Lock | GBLK | 7Eh | 0 | 0 | 0 | Whole chip block protect |
| Global Block Unlock | GBULK | 98h | 0 | 0 | 0 | Whole chip block unprotect |
| Security | | | | | | |
| Erase Security Registers | ERSCUR | 44h | 4 | 0 | 0 | Erase security registers |
| Program Security Registers | PRSCUR | 42h | 4 | 0 | 1+ | Program security registers |
| Read Security Registers | RDSCUR | 48h | 4 | 8 | 1+ | Read value of security register |
| Status Register | | | | | | |



| Commands | Abbr. | Code | ADR Bytes | DMY Cycles | Data Bytes | Function description |
|--|---------|------|-----------|------------|------------|--|
| Read Status Register1 | RDSR | 05h | 0 | 0 | 1 | read out status register1 |
| Read Status Register2 | RDSR2 | 35h | 0 | 0 | 1 | Read out status register2 |
| Read Configure Register | RDCR | 15h | 0 | 0 | 1 | Read out configure register |
| Write Status Register1 | WRSR | 01h | 0 | 0 | 1-2 | Write data to status registers1 and status registers2 |
| Write Status Register2 | WRSR2 | 31h | 0 | 0 | 1 | Write data to status registers2 |
| Write Configure Register | WRCR | 11h | 0 | 0 | 1 | Write data to configuration register |
| Read Extended Address Register | RDEAR | C8h | 0 | 0 | 1 | Read out extended address register |
| Write Extended Address Register | WREAR | C5h | 0 | 0 | 1 | Write data to extended address register |
| Other Commands | | | | | | |
| Reset Enable | RSTEN | 66h | 0 | 0 | 0 | Enable reset |
| Reset | RST | 99h | 0 | 0 | 0 | Reset |
| Enable QPI | QPIEN | 38h | 0 | 0 | 0 | Enable QPI mode |
| Enter 4-Byte Address | EN4B | B7h | 0 | 0 | 0 | Enter 4-Byte Address Mode |
| Exit 4-Byte Address | EX4B | E9h | 0 | 0 | 0 | Exit 4-Byte Address Mode |
| Read Manufacturer/device ID | RDID | 9Fh | 0 | 0 | 1 to 3 | output JEDEC ID: 1-byte manufacturer ID & 2-byte device ID |
| Read Manufacture ID | REMS | 90h | 3 | | 1+ | Read manufacturer ID/device ID data |
| Dual Read Manufacture ID | DREMS | 92h | 4 | 4 | 1+ | Dual output read manufacture/device ID |
| Quad Read Manufacture ID | QREMS | 94h | 4 | 6 | 1+ | Quad output read manufacture/device ID |
| Deep Power-down | DP | B9h | 0 | 0 | 0 | enters deep power-down mode |
| Release Deep Power-down/Read Electronic ID | RDP/RES | ABh | 3 | 0 | 1 | Read electronic ID data |
| Read SFDP | RDSFDP | 5Ah | 3 | 8 | 1+ | Read SFDP parameter |
| Release read enhanced | | FFh | 0 | 0 | 0 | Release from read enhanced |
| Read unique ID | RUID | 4Bh | 4 | 8 | 1+ | Read unique ID |

10.1.2 QPI Commands listing

Table 10-3 Command set (QPI Instructions, 3-Byte Address Mode)

| Commands | Abbr. | Code | ADR Bytes | DMY Bytes | Data Bytes | Function description |
|---------------------------------------|---------|---------|-----------|-----------|------------|--|
| Read | | | | | | |
| Fast read | FREAD | 0Bh | 3 | 12/6/8/10 | 1+ | n bytes read out by 4IO |
| Read 4x I/O | 4READ | EBh | 3 | 12/6/8/10 | 1+ | n bytes read out by 4IO |
| Read 4x I/O 4byte address | 4READ4B | ECh | 4 | 12/6/8/10 | 1+ | n bytes read out by 4IO |
| Program and Erase | | | | | | |
| Page Program | PP | 02h | 3 | 0 | 1+ | program selected page |
| Page Program 4byte address | PP4B | 12h | 4 | 0 | 1+ | program selected page |
| Sector Erase (4K bytes) | SE | 20h | 3 | 0 | 0 | erase selected sector |
| Sector Erase 4byte address (4K bytes) | SE4B | 21h | 4 | 0 | 0 | erase selected sector |
| Block Erase (32K bytes) | BE32K | 52h | 3 | 0 | 0 | erase selected 32K block |
| Block Erase 4byte address (32K bytes) | BE32K4B | 5Ch | 4 | 0 | 0 | erase selected 32K block |
| Block Erase (64K bytes) | BE | D8h | 3 | 0 | 0 | erase selected 64K block |
| Block Erase 4byte address (64K bytes) | BE4B | DCh | 4 | 0 | 0 | erase selected 64K block |
| Chip Erase | CE | 60h/C7h | 0 | 0 | 0 | erase whole chip |
| Program/Erase Suspend | PES | 75h | 0 | 0 | 0 | suspend program/erase operation |
| Program/Erase Resume | PER | 7Ah | 0 | 0 | 0 | continue program/erase operation |
| Protection | | | | | | |
| Write Enable | WREN | 06h | 0 | 0 | 0 | sets the write enable latch bit |
| Volatile SR Write Enable | WRDI | 50h | 0 | 0 | 0 | Write enable for volatile status register |
| Write Disable | VWREN | 04h | 0 | 0 | 0 | resets the write enable latch bit |
| Individual Block Lock | SBLK | 36h | 3 | 0 | 0 | Individual block lock |
| Individual Block Unlock | SBULK | 39h | 3 | 0 | 0 | Individual block unlock |
| Read Block Lock Status | RDBLOCK | 3Dh | 3 | 0 | 1 | Read individual block lock register |
| Global Block Lock | GBLK | 7Eh | 0 | 0 | 0 | Whole chip block protect |
| Global Block Unlock | GBULK | 98h | 0 | 0 | 0 | Whole chip block unprotect |
| Status Register | | | | | | |
| Read Status Register1 | RDSR | 05h | 0 | 0 | 1 | read out status register1 |
| Read Status Register2 | RDSR2 | 35h | 0 | 0 | 1 | Read out status register2 |
| Read Configure Register | RDCR | 15h | 0 | 0 | 1 | Read out configure register |
| Write Status Register1 | WRSR | 01h | 0 | 0 | 1-2 | Write data to status registers1 and status |



| Commands | Abbr. | Code | ADR Bytes | DMY Bytes | Data Bytes | Function description |
|--|---------|------|-----------|-----------|------------|--|
| | | | | | | registers2 |
| Write Status Register2 | WRSR2 | 31h | 0 | 0 | 1 | Write data to status registers2 |
| Write Configure Register | WRCR | 11h | 0 | 0 | 1 | Write data to configuration register |
| Read Extended Address Register | RDEAR | C8h | | | 1 | Read out extended address register |
| Write Extended Address Register | WREAR | C5h | | | 1 | Write data to extended address register |
| Other Commands | | | | | | |
| Deep Power-down | DP | B9h | 0 | 0 | 0 | enters deep power-down mode |
| Release Deep Power-down/Read Electronic ID | RDP/RES | ABh | 3 | 0 | 1 | Read electronic ID data |
| Set Read Parameters | | C0h | 0 | 0 | 1 | Set read dummy |
| Read Manufacture ID | REMS | 90h | 3 | 0 | 1+ | Read manufacturer ID/device ID data |
| Read Manufacturer/device ID | RDID | 9Fh | 0 | 0 | 1 to 3 | output JEDEC ID: 1-byte manufacturer ID & 2-byte device ID |
| Read SFDP | RDSFDP | 5Ah | 3 | 12/6/8/10 | 1+ | Read SFDP parameter |
| Read unique ID | RDUID | 4Bh | 3 | 12/6/8/10 | 1+ | Read SFDP parameter |
| Enter 4-Byte Address | EN4B | B7h | 0 | 0 | 0 | Enter 4-Byte Address Mode |
| Exit 4-Byte Address | EX4B | E9h | 0 | 0 | 0 | Exit 4-Byte Address Mode |
| Disable QPI | | FFh | 0 | 0 | 0 | Release from read enhanced |
| Reset Enable | RSTEN | 66h | 0 | 0 | 0 | Enable reset |
| Reset | RST | 99h | 0 | 0 | 0 | Reset |

Table 10-4 Command set (QPI Instructions, 4-Byte Address Mode)

| Commands | Abbr. | Code | ADR Bytes | DMY Bytes | Data Bytes | Function description |
|---------------------------------------|---------|---------|-----------|-----------|------------|---|
| Read | | | | | | |
| Fast read | FREAD | 0Bh | 4 | 12/6/8/10 | 1+ | n bytes read out until CS# goes high |
| Read 4x I/O | 4READ | EBh | 4 | 12/6/8/10 | 1+ | n bytes read out by 4I/O |
| Read 4x I/O 4byte address | 4READ4B | ECh | 4 | 12/6/8/10 | 1+ | n bytes read out by 4I/O |
| Program and Erase | | | | | | |
| Page Program | PP | 02h | 4 | 0 | 1+ | program selected page |
| Page Program 4byte address | PP4B | 12h | 4 | 0 | 1+ | program selected page |
| Sector Erase (4K bytes) | SE | 20h | 4 | 0 | 0 | erase selected sector |
| Sector Erase 4byte address (4K bytes) | SE4B | 21h | 4 | 0 | 0 | erase selected sector |
| Block Erase (32K bytes) | BE32K | 52h | 4 | 0 | 0 | erase selected 32K block |
| Block Erase 4byte address (32K bytes) | BE32K4B | 5Ch | 4 | 0 | 0 | erase selected 32K block |
| Block Erase (64K bytes) | BE | D8h | 4 | 0 | 0 | erase selected 64K block |
| Block Erase 4byte address (64K bytes) | BE4B | DCh | 4 | 0 | 0 | erase selected 64K block |
| Chip Erase | CE | 60h/C7h | 0 | 0 | 0 | erase whole chip |
| Program/Erase Suspend | PES | 75h | 0 | 0 | 0 | suspend program/erase operation |
| Program/Erase Resume | PER | 7Ah | 0 | 0 | 0 | continue program/erase operation |
| Protection | | | | | | |
| Write Enable | WREN | 06h | 0 | 0 | 0 | sets the write enable latch bit |
| Volatile SR Write Enable | WRDI | 50h | 0 | 0 | 0 | Write enable for volatile status register |
| Write Disable | VWREN | 04h | 0 | 0 | 0 | resets the write enable latch bit |
| Individual Block Lock | SBLK | 36h | 4 | 0 | 0 | Individual block lock |
| Individual Block Unlock | SBULK | 39h | 4 | 0 | 0 | Individual block unlock |
| Read Block Lock Status | RDBLOCK | 3Dh | 4 | 0 | 1 | Read individual block lock register |
| Global Block Lock | GBLK | 7Eh | 0 | 0 | 0 | Whole chip block protect |
| Global Block Unlock | GBULK | 98h | 0 | 0 | 0 | Whole chip block unprotect |
| Status Register | | | | | | |
| Read Status Register1 | RDSR | 05h | 0 | 0 | 1 | read out status register1 |
| Read Status Register2 | RDSR2 | 35h | 0 | 0 | 1 | Read out status register2 |
| Read Configure Register | RDCR | 15h | 0 | 0 | 1 | Read out configure register |
| Write Status Register1 | WRSR | 01h | 0 | 0 | 1-2 | Write data to status registers1 and status registers2 |
| Write Status Register2 | WRSR2 | 31h | 0 | 0 | 1 | Write data to status registers2 |
| Write Configure Register | WRCR | 11h | 0 | 0 | 1 | Write data to configuration register |
| Read Extended Address Register | RDEAR | C8h | 0 | 0 | 1 | Read out extended address register |
| Write Extended Address Register | WREAR | C5h | 0 | 0 | 1 | Write data to extended address register |
| Other Commands | | | | | | |
| Deep Power-down | DP | B9h | 0 | 0 | 0 | enters deep power-down mode |



| Commands | Abbr. | Code | ADR Bytes | DMY Bytes | Data Bytes | Function description |
|--|---------|------|-----------|-----------|------------|--|
| Release Deep Power-down/Read Electronic ID | RDP/RES | ABh | 3 | 0 | 1 | Read electronic ID data |
| Set Read Parameters | | C0h | 0 | 0 | 1 | Set read dummy |
| Read Manufacture ID | REMS | 90h | 3 | | 1+ | Read manufacturer ID/device ID data |
| Read Manufacturer/device ID | RDID | 9Fh | 0 | 0 | 1 to 3 | output JEDEC ID: 1-byte manufacturer ID & 2-byte device ID |
| Read SFDP | RDSFDP | 5Ah | 3 | 12/6/8/10 | 1+ | Read SFDP parameter |
| Read unique ID | RDUID | 4Bh | 3 | 12/6/8/10 | 1+ | Read SFDP parameter |
| Enter 4-Byte Address | EN4B | B7h | 0 | 0 | 0 | Enter 4-Byte Address Mode |
| Exit 4-Byte Address | EX4B | E9h | 0 | 0 | 0 | Exit 4-Byte Address Mode |
| Disable QPI | | FFh | 0 | 0 | 0 | Release from read enhanced |
| Reset Enable | RSTEN | 66h | 0 | 0 | 0 | Enable reset |
| Reset | RST | 99h | 0 | 0 | 0 | Reset |

10.1.3 DTR Commands listing

Table 10-5 Command set (DTR Instructions, 3-Byte Address Mode)

| Commands | Abbr. | Code | ADR Bytes | DMY Cycles | Data Bytes | Function description |
|----------------------------------|---------|------|-----------|------------|------------|----------------------------|
| DTR Fast Read | DTRFRD | 0Dh | 3 | 6/8 | 1+ | DTR n byte fast read out |
| DTR 2IO Read | 2DTRD | BDh | 3 | 6/8 | 1+ | DTR n byte read out by 2IO |
| DTR 4IO Read | 4DTRD | EDh | 3 | 10/8/6/12 | 1+ | DTR n byte read out by 4IO |
| DTR 4IO Read with 4-Byte Address | 4DTRD4B | EEH | 4 | 10/8/6/12 | 1+ | DTR n byte read out by 4IO |

Table 10-6 Command set (DTR Instructions, 4-Byte Address Mode)

| Commands | Abbr. | Code | ADR Bytes | DMY Cycles | Data Bytes | Function description |
|----------------------------------|---------|------|-----------|------------|------------|----------------------------|
| DTR Fast Read | DTRFRD | 0Dh | 4 | 6/8 | 1+ | DTR n byte fast read out |
| DTR 2IO Read | 2DTRD | BDh | 4 | 6/8 | 1+ | DTR n byte read out by 2IO |
| DTR 4IO Read | 4DTRD | EDh | 4 | 10/8/6/12 | 1+ | DTR n byte read out by 4IO |
| DTR 4IO Read with 4-Byte Address | 4DTRD4B | EEH | 4 | 10/8/6/12 | 1+ | DTR n byte read out by 4IO |

Table 10-7 Command set (DTR QPI Instructions, 3-Byte Address Mode)

| Commands | Abbr. | Code | ADR Bytes | DMY Cycles | Data Bytes | Function description |
|----------------------------------|---------|------|-----------|------------|------------|---------------------------------|
| DTR Fast Read | DTRFRD | 0Dh | 3 | 10/8/6/12 | 1+ | DTR n byte fast read out by 4IO |
| DTR 4IO Read | 4DTRD | EDh | 3 | 10/8/6/12 | 1+ | DTR n byte fast read out by 4IO |
| DTR 4IO Read with 4-Byte Address | 4DTRD4B | EEH | 4 | 10/8/6/12 | 1+ | DTR n byte read out by 4IO |

Table 10-8 Command set (DTR QPI Instructions, 4-Byte Address Mode)

| Commands | Abbr. | Code | ADR Bytes | DMY Cycles | Data Bytes | Function description |
|----------------------------------|---------|------|-----------|------------|------------|----------------------------|
| DTR Fast Read | DTRFRD | 0Dh | 4 | 10/8/6/12 | 1+ | DTR n byte fast read out |
| DTR 4IO Read | 4DTRD | EDh | 4 | 10/8/6/12 | 1+ | DTR n byte fast read out |
| DTR 4IO Read with 4-Byte Address | 4DTRD4B | EEH | 4 | 10/8/6/12 | 1+ | DTR n byte read out by 4IO |

NOTE:

1. Dual Output data

IO0 = (D6, D4, D2, D0)

IO1 = (D7, D5, D3, D1)

2. Dual Input Address

IO0 = (A30, A28, A26, A24,) A22, A20, A18, A16, A14, A12, A10, A8 A6, A4, A2, A0, M6, M4, M2, M0

IO1 = (A31, A29, A27, A25,) A23, A21, A19, A17, A15, A13, A11, A9 A7, A5, A3, A1, M7, M5, M3, M1



3. Quad Output Data

IO0 = (D4, D0, ...)

IO1 = (D5, D1, ...)

IO2 = (D6, D2, ...)

IO3 = (D7, D3, ...)

4. Quad Input Address

IO0 = (A28, A24,) A20, A16, A12, A8, A4, A0, M4, M0

IO1 = (A29, A25,) A21, A17, A13, A9, A5, A1, M5, M1

IO2 = (A30, A26,) A22, A18, A14, A10, A6, A2, M6, M2

IO3 = (A31, A27,) A23, A19, A15, A11, A7, A3, M7, M3

5. Fast Read Quad I/O Data

IO0 = (x, x, x, x, D4, D0, ...)

IO1 = (x, x, x, x, D5, D1, ...)

IO2 = (x, x, x, x, D6, D2, ...)

IO3 = (x, x, x, x, D7, D3, ...)

6. QPI Command, Address, Data input/output format:

CLK #0 1 2 3 4 5 6 7 8 9 10 11

IO0= C4, C0, (A28, A24,) A20, A16, A12, A8, A4, A0, D4, D0, D4, D0,

IO1= C5, C1, (A29, A25,) A21, A17, A13, A9, A5, A1, D5, D1, D5, D1

IO2= C6, C2, (A30, A26,) A22, A18, A14, A10, A6, A2, D6, D2, D6, D2

IO3= C7, C3, (A31, A27,) A23, A19, A15, A11, A7, A3, D7, D3, D7, D3

7. Security Registers Address:

Security Register1: (A31-A24=00H), A23-A16=00H, A15-A10=000100, A9-A0= Byte Address;

Security Register2: (A31-A24=00H), A23-A16=00H, A15-A10=001000, A9-A0= Byte Address;

Security Register3: (A31-A24=00H), A23-A16=00H, A15-A10=001100, A9-A0= Byte Address;

10.2 Write Enable (WREN 06H)

The Write Enable (WREN) instruction is for setting Write Enable Latch (WEL) bit. For those instructions like PP/PP4B, QPP/QPP4B, QIPP/QIPP4B, SE/SE4B, BE32K/BE32K4B, BE/BE4B, CE, and WRSR, WRCR, ERSCUR, PRSCUR, SBLK/SBULK/GBLK/GBULK, WREAR which are intended to change the device content, should be set every time after the WREN instruction setting the WEL bit.

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

Figure 10-2 Write Enable (WREN) Sequence (SPI)

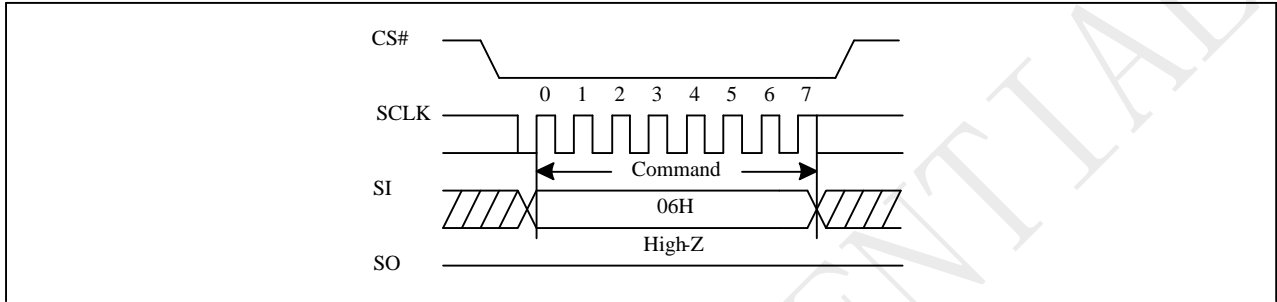
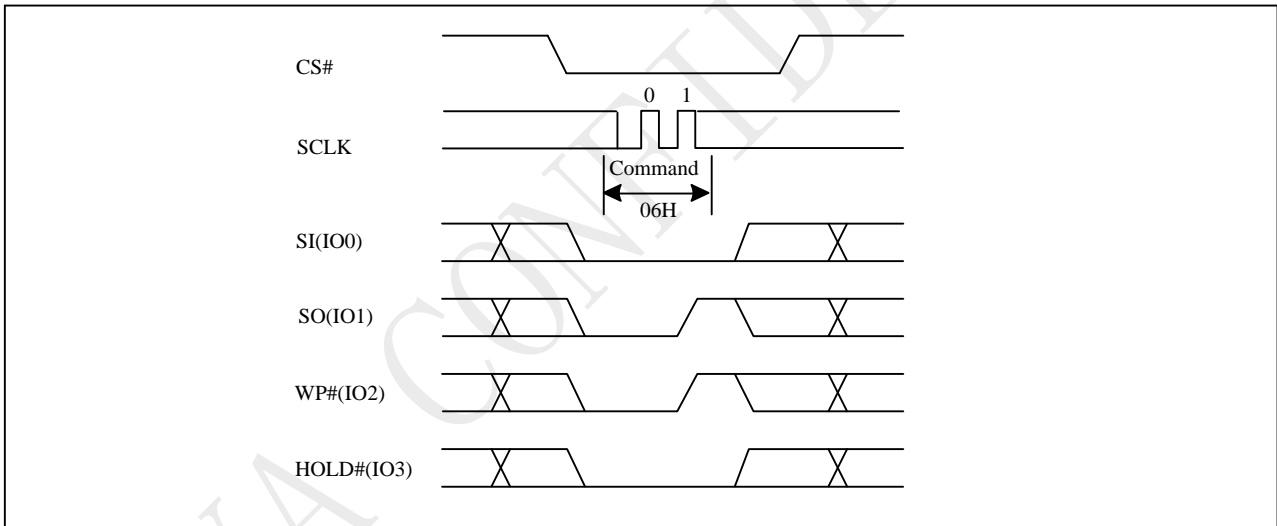


Figure 10-2a Write Enable (WREN) Sequence (QPI)



10.3 Write Disable (WRDI 04H)

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

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

The WEL bit is reset by following situations:

- Power-up
- Write Disable (WRDI) instruction completion
- Write Status Register (WRSR/WRCR) instruction completion
- Page Program (PP/PP4B) instruction completion
- Quad Page Program (QPP/QPP4B) instruction completion
- Quad-In Page Program (QIPP/QIPP4B) instruction completion
- Sector Erase (SE/SE4B) instruction completion
- Block Erase (BE32K/BE32K4B, BE/BE4B) instruction completion
- Chip Erase (CE) instruction completion
- SBLK/SBULK/GBLK/GBULK instruction completion
- Erase Security Register (ERSCUR) instruction completion
- Program Security Register (PRSCUR) instruction completion
- Write Extended Address Register (WREAR) instruction completion
- Reset (RST) instruction completion

Figure 10-3 Write Disable (WRDI) Sequence (SPI)

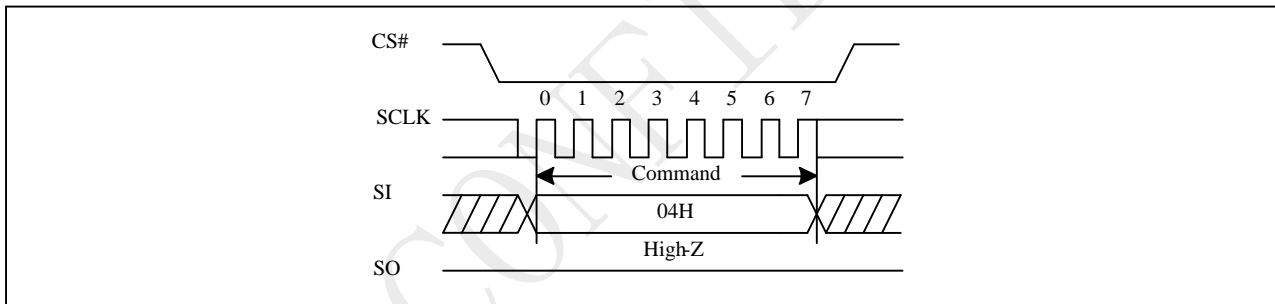
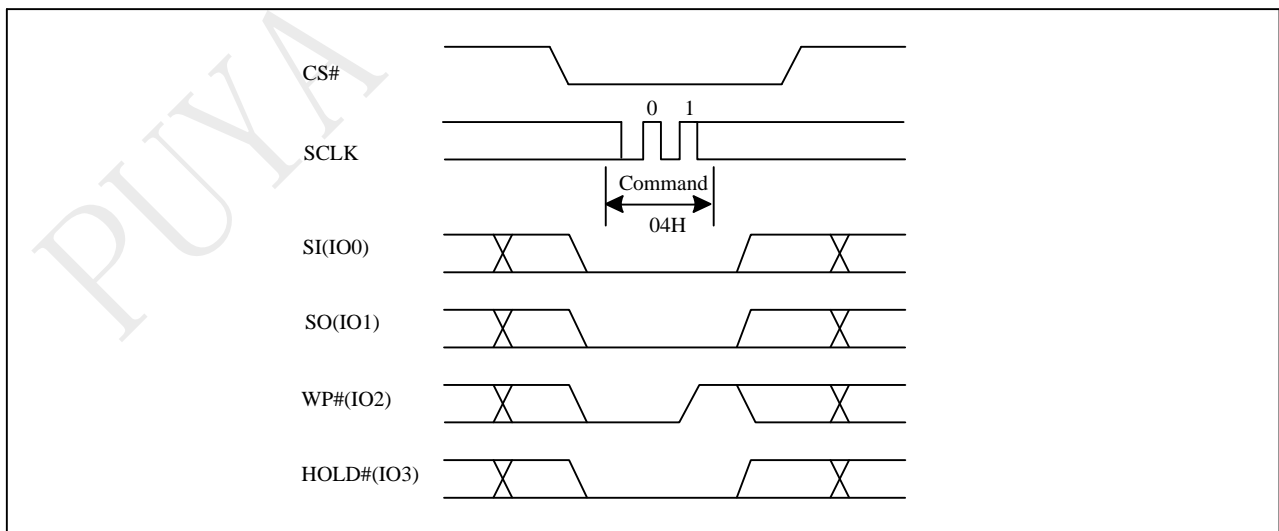


Figure 10-3a Write Disable (WRDI) Sequence (QPI)



10.4 Write Enable for Volatile Status Register (VWREN 50H)

The non-volatile Status Register bits can also be written to as volatile bits. This gives more flexibility to change the system configuration and memory protection schemes quickly without waiting for the typical non-volatile bit write cycles or affecting the endurance of the Status Register non-volatile bits. The Write Enable for Volatile Status Register command must be issued prior to a Write Status Register command. The Write Enable for Volatile Status Register command will not set the Write Enable Latch bit, it is only valid for the Write Status Register command to change the volatile Status Register bit values.

The sequence of issuing Write Enable for Volatile Status Register instruction is: CS# goes low → sending Write Enable for Volatile Status Register instruction code → CS# goes high.

Figure 10-4 Write Enable for Volatile Status Register Sequence (SPI)

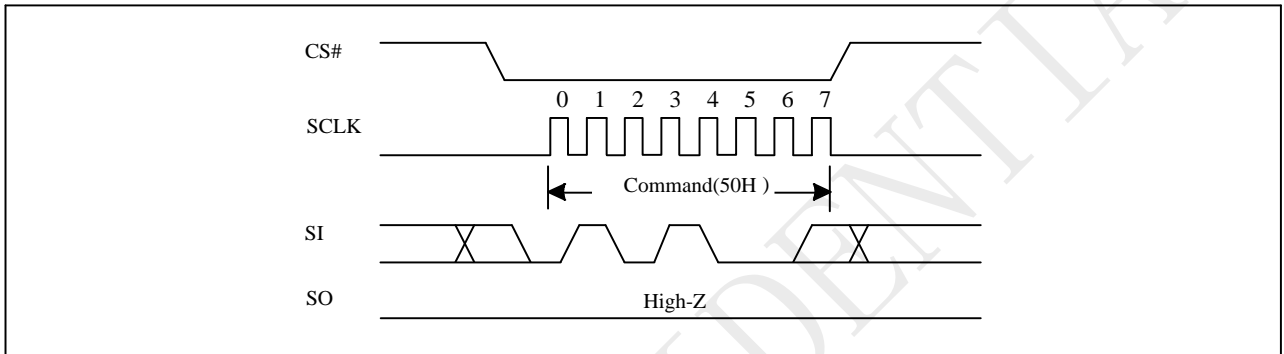
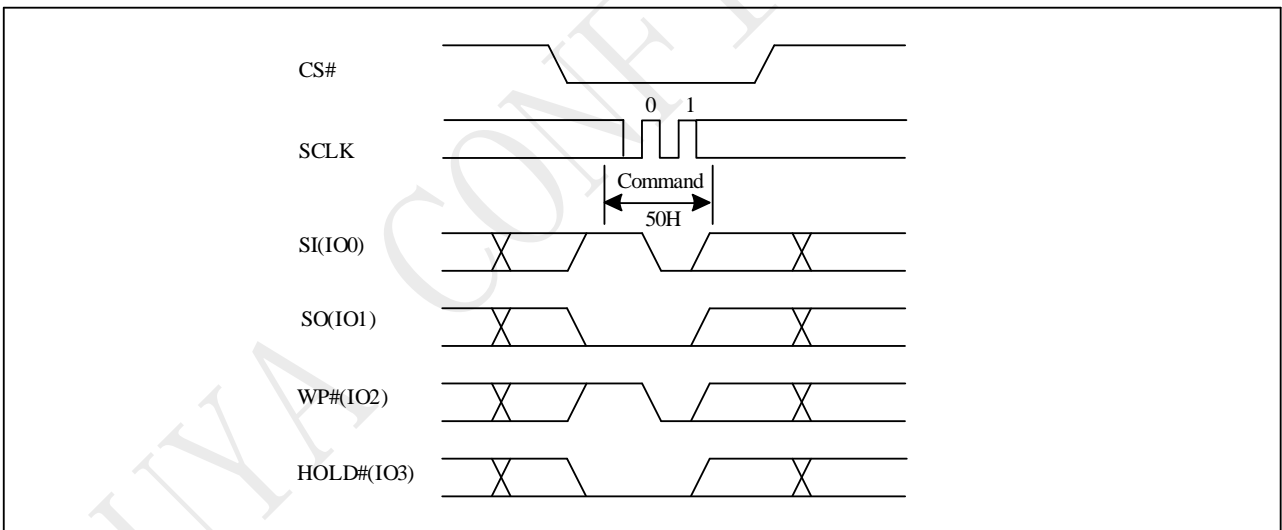


Figure 10-4a Write Enable for Volatile Status Register Sequence (QPI)



10.5 Read Status Register (RDSR 05H/35H)

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. For command code “05H”, the SO will output Status Register bits S7~S0. The command code “35H”, the SO will output Status Register bits S15~S8.

The sequence of issuing RDSR instruction is: CS# goes low→ sending RDSR instruction code→ Status Register data out on SO. The SIO[3:1] are "don't care".

Figure 10-5 Read Status Register (RDSR) Sequence (SPI)

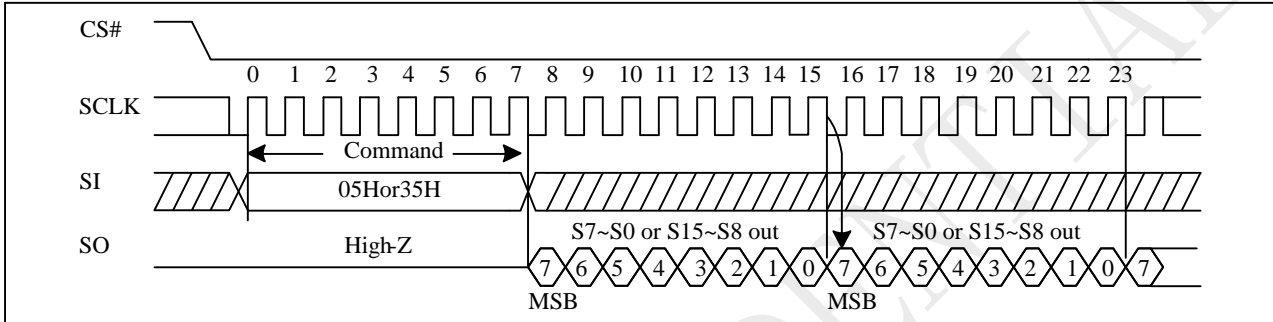
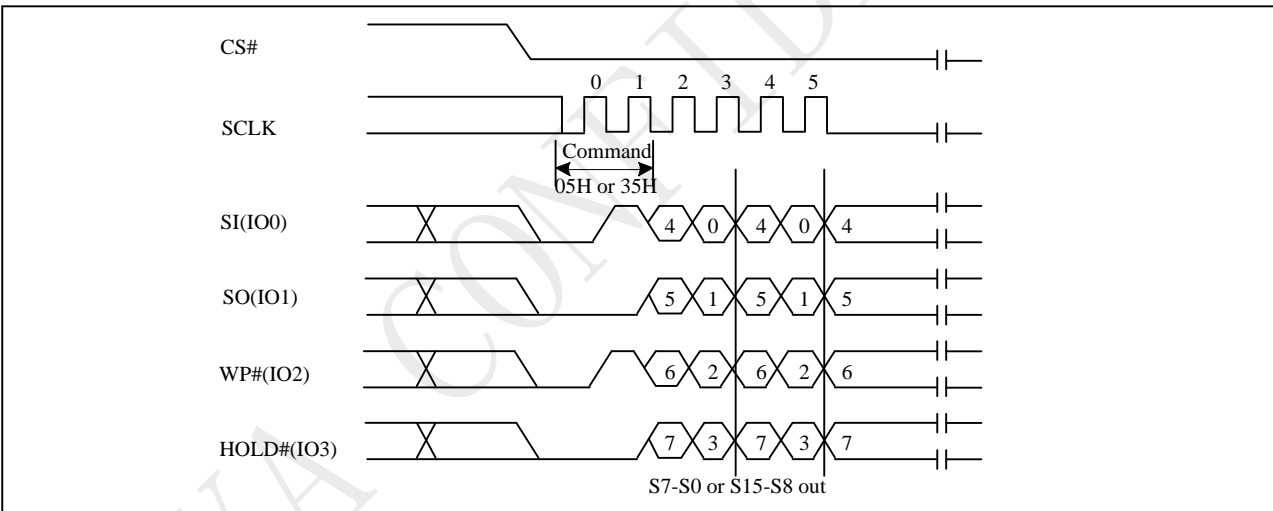


Figure 10-5a Read Status Register (RDSR) Sequence (QPI)



Status Register

| BIT | S15 | S14 | S13 | S12 | S11 | S10 | S9 | S8 |
|------------|-----|-----|-----|-----|-----|---------|----|------|
| Definition | SUS | CMP | LB3 | LB2 | LB1 | EP_FAIL | QE | SRP1 |
| Volatile | RO | N | OTP | OTP | OTP | RO | N | N |
| Default | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| BIT | S7 | S6 | S5 | S4 | S3 | S2 | S1 | S0 |
|------------|------|-----|-----|-----|-----|-----|-----|-----|
| Definition | SRP0 | BP4 | BP3 | BP2 | BP1 | BP0 | WEL | WIP |
| Volatile | N | N | N | N | N | N | V | RO |
| Default | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Note:

1. RO=read only, N=non-volatile, V= volatile, OTP=one time program

The definition of the status register bits is as below:

WIP bit.



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

WEL bit.

The Write Enable Latch (WEL) bit indicates the status of the internal Write Enable Latch. When set to 1 the internal Write Enable Latch is set, when set to 0 the internal Write Enable Latch is reset and no Write Status Register, Program or Erase command is accepted.

BP4, BP3, BP2, BP1, BP0 bits.

The Block Protect (BP4, BP3, BP2, BP1, and BP0) bits are non-volatile. They define the size of the area to be software protected against Program and Erase commands. These bits are written with the Write Status Register (WRSR) command. When the Block Protect (BP4, BP3, BP2, BP1, BP0) bits are set to 1, the relevant memory area (as defined in Table "Protected Area Sizes").becomes protected against Page Program (PP), Page Erase (PE), Sector Erase (SE) and Block Erase (BE) commands. The Block Protect (BP4, BP3, BP2, BP1, and BP0) bits can be written provided that the Hardware Protected mode has not been set. The Chip Erase (CE) command is executed, only if the Block Protect (BP4, BP3, BP2, BP1and BP0) are set to "None protected".

SRP1, SRP0 bits.

The Status Register Protect (SRP1 and SRP0) bits are non-volatile Read/Write bits in the status register. The SRP bits control the method of write protection: software protection, hardware protection, power supply lock-down or one time programmable protection

| SRP1 | SRP0 | WP# | Status Register | Description |
|------|------|-----|---------------------------|---|
| 0 | 0 | x | Software Protected | The Status Register can be written to after a Write Enable command, WEL=1.(Default) |
| 0 | 1 | 0 | Hardware Protected | WP#=0,the Status Register locked and can not be written to. |
| 0 | 1 | 1 | Hardware Unprotected | WP#=1,the Status Register is unlocked and can be written to after a Write Enable command, WEL=1. |
| 1 | 0 | x | Power Supply Lock-Down(1) | Status Register is protected and can not be written to again until the next Power-Down, Power-Up cycle. |
| 1 | 1 | x | One Time Program(2) | Status Register is permanently protected and can not be written to. |

NOTE:

1. When SRP1, SRP0=(1, 0), a Power-Down, Power-Up cycle will change SRP1, SRP0 to (0, 0) state.
2. This feature is available on special order. Please contact PUYA for details.

QE bit.

The Quad Enable (QE) bit is a non-volatile Read/Write bit in the Status Register that allows Quad operation. When the QE bit is set to 0 (Default) the WP# pin and HOLD# pin are enable. When the QE pin is set to 1, the Quad IO2 and IO3 pins are enabled. (The QE bit should never be set to 1 during standard SPI or Dual SPI operation if the WP# or HOLD# pins are tied directly to the power supply or ground)

EP_FAIL bit.

The Erase/Program Fail bit is a read only bit which shows the status of the last Program/Erase (PP, QPP, SE, BE32K, BE, CE and ERSCUR, PRSCUR) operation. The bit will be set to "1"if the program/erase operation failed or interrupted by reset or the program/erase region was protected. It will be automatically cleared to "0" if the next program/erase operation succeeds. Please note that it will not interrupt or stop any operation in the flash memory.

LB3, LB2, LB1, bits.

The LB3, LB2, LB1, bits are non-volatile One Time Program (OTP) bits in Status Register (S13-S11) that provide the write protect control and status to the Security Registers. The default state of LB3-LB1 are 0, the security registers are unlocked. The LB3-LB1 bits can be set to 1 individually using the Write Register instruction. The LB3-LB1 bits are One Time Programmable, once its set to 1, the Security Registers will become read-only permanently.

CMP bit

The CMP bit is a non-volatile Read/Write bit in the Status Register (S14). It is used in conjunction the BP4-BP0 bits to provide more flexibility for the array protection. Please see the table "Protected Area Size" for details. The default setting is CMP=0.

SUS bit

The SUS bit is read only bit in the status register (S15) that is set to 1 after executing a Suspend (75H) command in Program/Erase progress. The SUS bit is cleared to 0 by Program/Erase Resume (7AH) command and a power-down power-up cycle, soft reset, hard reset.

10.6 Read Configure Register (RDCR 15H)

The RDCR instruction is for reading Configure Register Bits. The Read Configure 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 RDCR instruction is: CS# goes low → sending RDCR instruction code → Configure Register data out on SO. The SIO[3:1] are "don't care" in SPI mode.

Figure 10-6 Read Status Register (RDCR) Sequence (SPI)

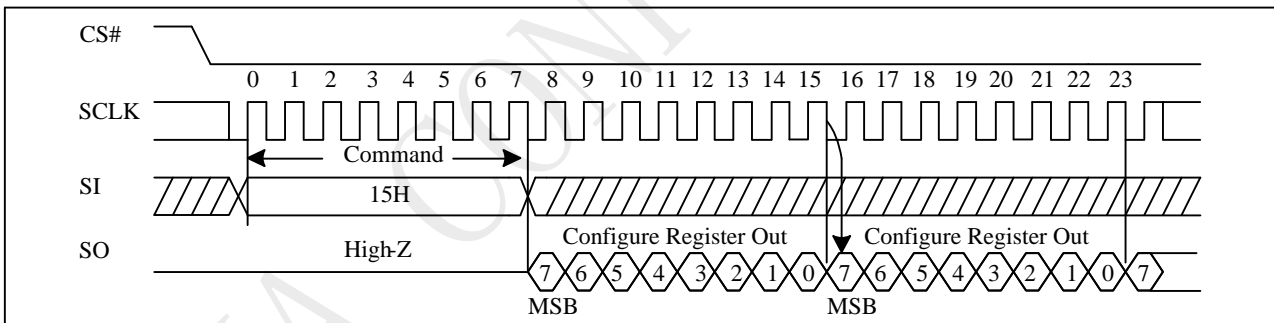
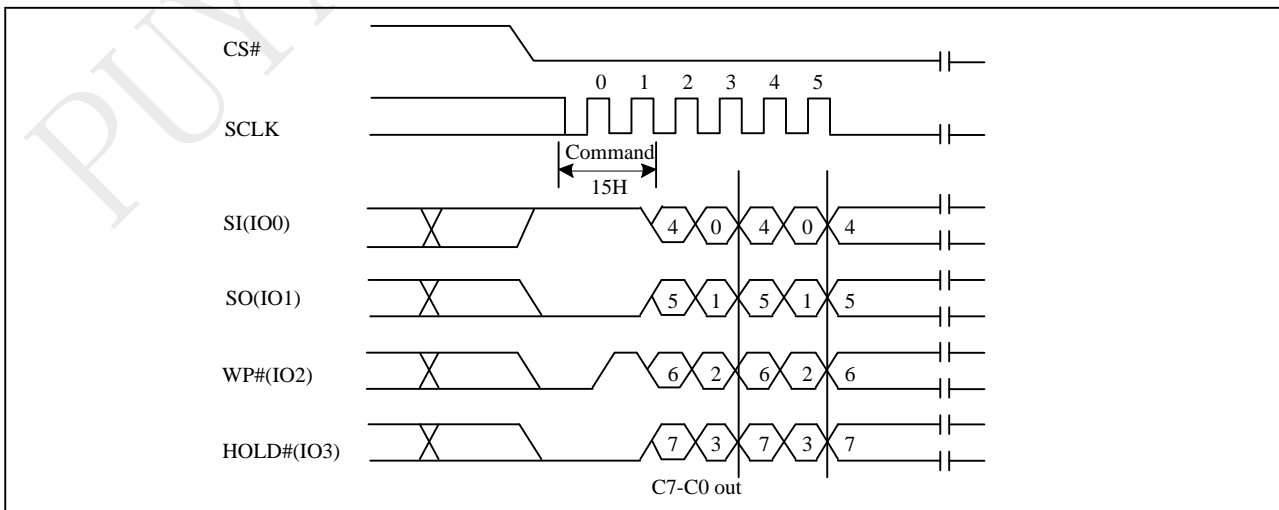


Figure 10-6a Read Status Register (RDCR) Sequence (QPI)



**Configure Register**

| BIT | Bit7 | Bit6 | Bit5 | Bit4 | Bit3 | Bit2 | Bit1 | Bit0 |
|------------|----------|------|------|------|------|------|------|------|
| Definition | HOLD/RST | DRV1 | DRV0 | DC1 | DC0 | WPS | ADP | ADS |
| Type | N | N | N | N | N | N | N | RO |
| Default | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Note: RO=read only, N=non-volatile, V= volatile

HOLD/RST bit.

The HOLD/RST bit is a non-volatile Read/Write bit which is used to determine whether /HOLD or /RESET function should be implemented on the hardware pin for 8-pin packages. When HOLD/RST=0 (factory default), the pin acts as /HOLD; when HOLD/RST=1, the pin acts as /RESET. However, /HOLD or /RESET functions are only available when QE=0. If QE is set to 1, the /HOLD and /RESET functions are disabled, the pin acts as a dedicated data I/O pin.

DRV1 & DRV0 bit.

The DRV1 & DRV0 bits are non-volatile Read/Write bits which are used to determine the output driver strength for the Read operations.

| DRV1, DRV0 | Drive Strength |
|--------------|----------------|
| 0,0(default) | 100% |
| 0,1 | 67% |
| 1,0 | 133% |
| 1,1 | 167% |

DC1 & DC0 bit

The Dummy Cycle (DC) bits are non-volatile bits. The Dummy Cycle (DC) bits can be used to configure the number of dummy clocks for "SPI 2 X IO Read (BBH/BCH)" command, "SPI 4X I/O Read (EBH/ECH)" command, "DTR 2IO read(0DH)", "DTR 2IO read(BDH)", "DTR 4IO read(EDH/EEH)" in SPI mode.

Table Dummy Cycle Table

| Mode | Command | DC bit | Number of dummy cycles |
|----------|---------|-------------|------------------------|
| SPI mode | BBH/BCH | 00(default) | 4 |
| | | 01/10/11 | 8 |
| | EBH/ECH | 00(default) | 6 |
| | | 01 | 12 |
| | | 10 | 8 |
| | | 11 | 10 |
| | 0DH | 00(default) | 6 |
| | | 01/10/11 | 8 |
| | BDH | 00(default) | 6 |
| | | 01/10/11 | 8 |
| | EDH/EEH | 00(default) | 10 |
| | | 01 | 8 |
| | | 10 | 6 |
| | | 11 | 12 |

WPS bit.

The WPS bit is a non-volatile Read/Write bit which is used to select which Write Protect scheme should be used. When WPS=0(default), the device will use the combination of CMP, BP[4:0] bits to protect a specific area of the memory array. When WPS=1, the device will utilize the Individual Block Locks to protect any individual sector or blocks. The default value for all Individual Block Lock bits is 1 upon device power on or after reset.

ADP bit.

The ADP bit is a non-volatile Read/Write bit that determines the initial address mode when the device is powered on or reset. This bit is only used during the power on or device reset initialization period, and it is only writable by the non-volatile Write Status sequence (06h + 11h). When ADP=0 (factory default), the device will power up into 3-Byte Address Mode, the Extended Address Register must be used to access memory regions beyond 128Mb. When ADP=1, the device will power up into 4-Byte Address Mode directly.

ADS bit.

The Current Address Mode bit is a read only bit that indicates which address mode the device is currently operating in. When ADS=0, the device is in the 3-Byte Address Mode, when ADS=1, the device is in the 4-Byte Address Mode.

10.7 Write Status Register (WRSR 01H/31H)

The Write Status Register (WRSR) command allows new values to be written to the Status Register. Before it can be accepted, a Write Enable (WREN) command must previously have been executed. After the Write Enable (WREN) command has been decoded and executed, the device sets the Write Enable Latch (WEL).

The Write Status Register (WRSR) command has no effect on S15, S10, S1 and S0 of the Status Register. CS# must be driven high after the eighth or sixteen bit of the data byte has been latched in. If not, the Write Status Register (WRSR) command is not executed. If CS# is driven high after eighth bit of the data byte, the S15~S8 bits will keep the previous value. As soon as CS# is driven high, the self-timed Write Status Register cycle (whose duration is tW) is initiated. While the Write Status Register cycle is in progress, the Status Register may still be read to check the value of the Write In Progress (WIP) bit. The Write In Progress (WIP) bit is 1 during the self-timed Write Status Register cycle, and is 0 when it is completed. When the cycle is completed, the Write Enable Latch (WEL) is reset.

The Write Status Register (WRSR) command allows the user to change the values of the Block Protect (BP4, BP3, BP2, BP1, and BP0) bits, to define the size of the area that is to be treated as read-only, as defined in Table1. The Write Status Register (WRSR) command also allows the user to set or reset the Status Register Protect (SRP1 and SRP0) bits in accordance with the Write Protect (WP#) signal. The Status Register Protect (SRP1 and SRP0) bits and Write Protect (WP#) signal allow the device to be put in the Hardware Protected Mode. The Write Status Register (WRSR) command is not executed once the Hardware Protected Mode is entered.

The sequence of issuing WRSR instruction is: CS# goes low → sending WRSR instruction code → Status Register data on SI → CS# goes high.

The CS# must go high exactly at the 8 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 checked 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 10-7 Write Status Register (WRSR) Sequence (SPI)

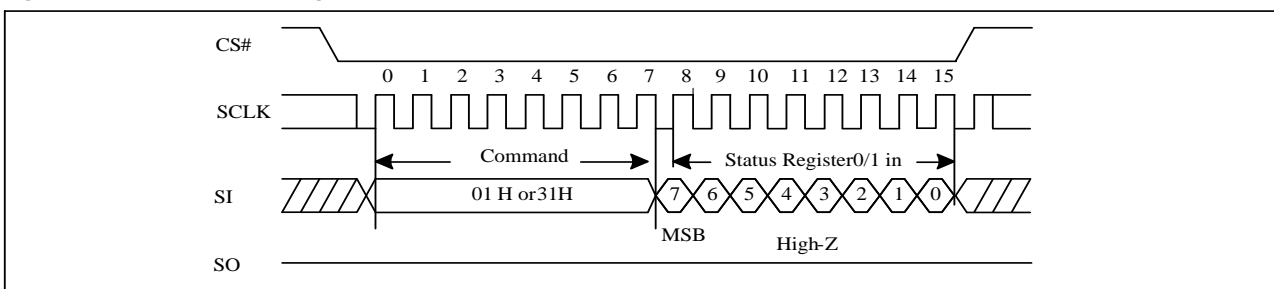
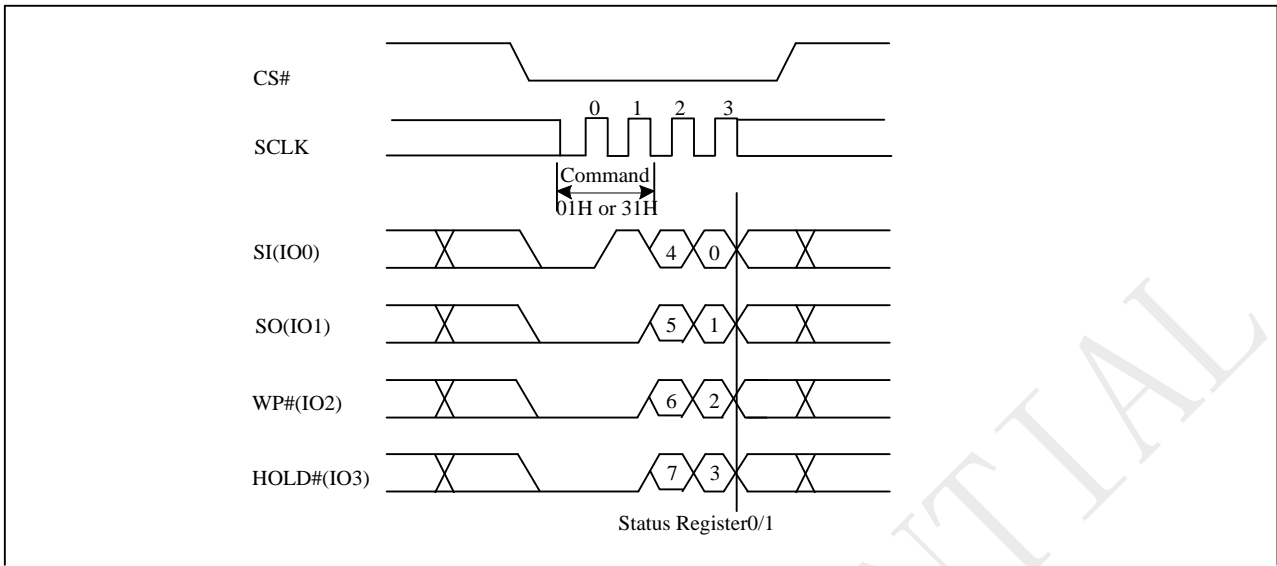


Figure 10-7a Write Status Register (WRSR) Sequence (QPI)



To be backward compatible to Puya’s previous serial flash product, The Write Status Register (WRSR) command also support to write Status Register-0 and Status Register-1 in same time. To complete this function, CS# must be driven high after the sixteenth bit of the data byte has been latched in. If CS# is driven high after the eighth clock, the Write Status Register (01h) command will only program the Status Register-0, the Status Register-1 will not be affected (Previous product will clear CMP and QE bits).

Figure 10-7b Write Status Register (WRSR) with 2 Byte data Sequence (SPI)

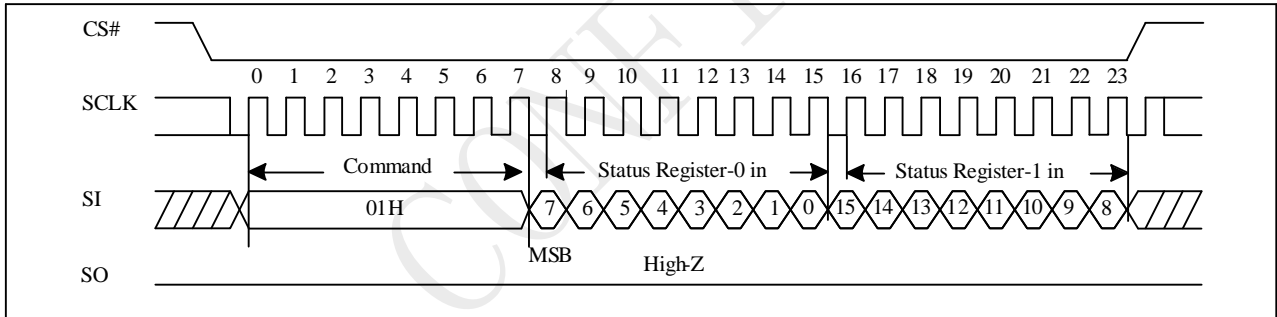
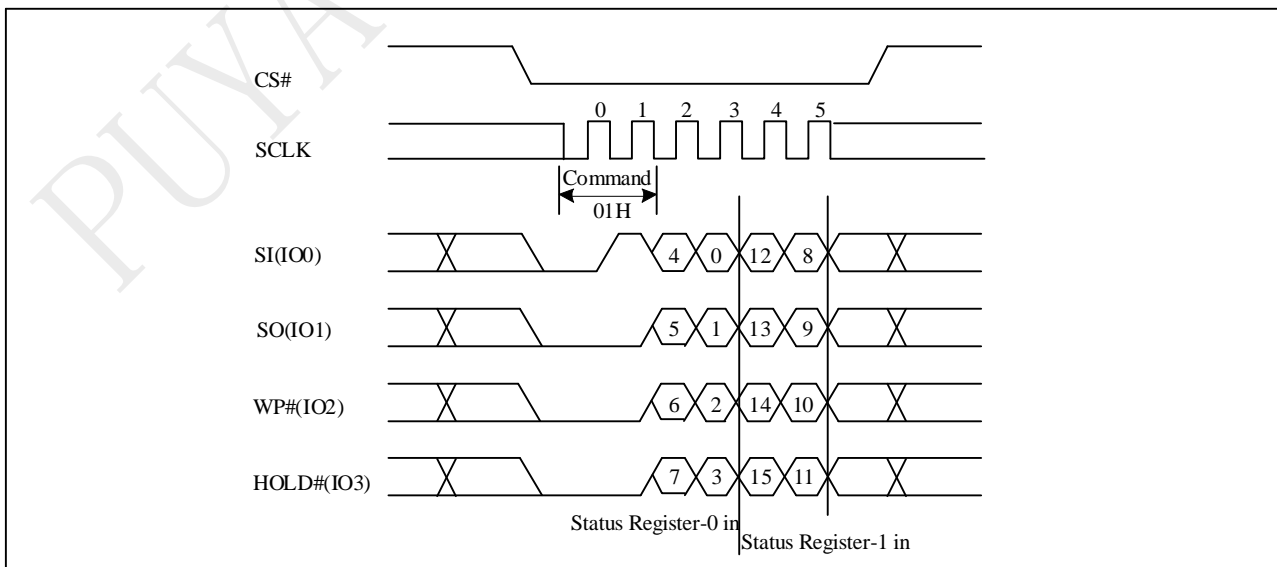


Figure 10-7c Write Status Register (WRSR) with 2 Byte data Sequence (QPI)



10.8 Write Configure Register (WRCR 11H)

The Write Configure Register (WRCR) command allows new values to be written to the Configure Register. Before it can be accepted, a Write Enable (WREN) command must previously have been executed. After the Write Enable (WREN) command has been decoded and executed, the device sets the Write Enable Latch (WEL).

The sequence of issuing WRCR instruction is: CS# goes low → sending WRCR instruction code → Configure Register data on SI → CS# goes high.

The CS# must go high exactly at the 8 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 checked during the Write Status Register cycle is in progress. The WIP sets 1 during the tW timing, and sets 0 when Write Configure Register Cycle is completed, and the Write Enable Latch (WEL) bit is reset.

Figure 10-8 Write Configure Register (WRCR) Sequence (SPI)

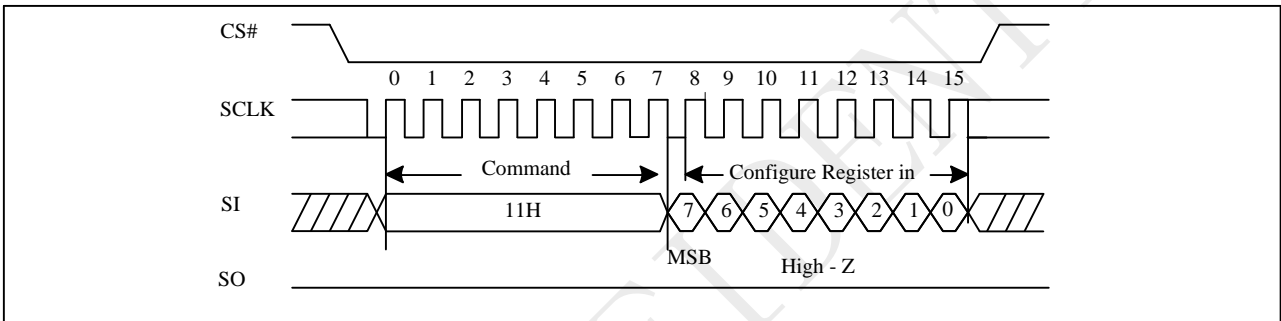
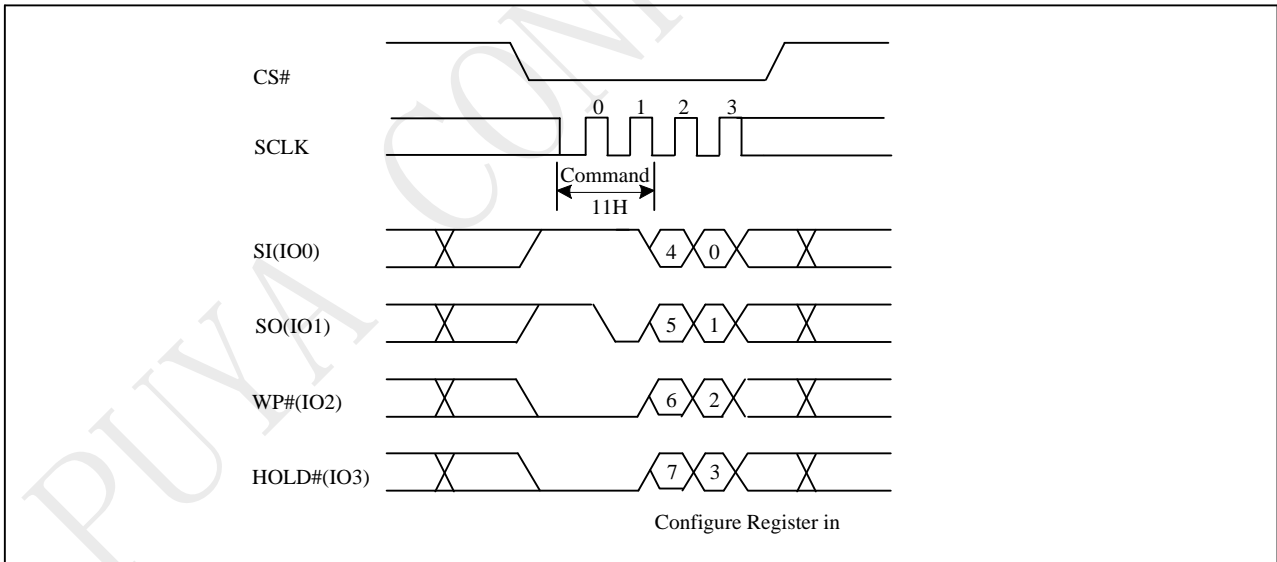


Figure 10-8a Write Configure Register (WRCR) Sequence (QPI)



10.9 Read Extended Address Register (RDEAR C8H)

When the device is in the 3-Byte Address Mode, the Extended Address Register is used as the 4th address byte A[31:24] to access memory regions beyond 128Mb.

The Read Extended Address Register instruction is entered by driving CS# low and shifting the instruction code “C8h” into the SI pin on the rising edge of SCLK. The Extended Address Register bits are then shifted out on the SO pin at the falling edge of SCLK with most significant bit (MSB) first.

When the device is in the 4-Byte Address Mode, the Extended Address Register is not used.

Figure 10-9 Read Extended Address Register Sequence (SPI)

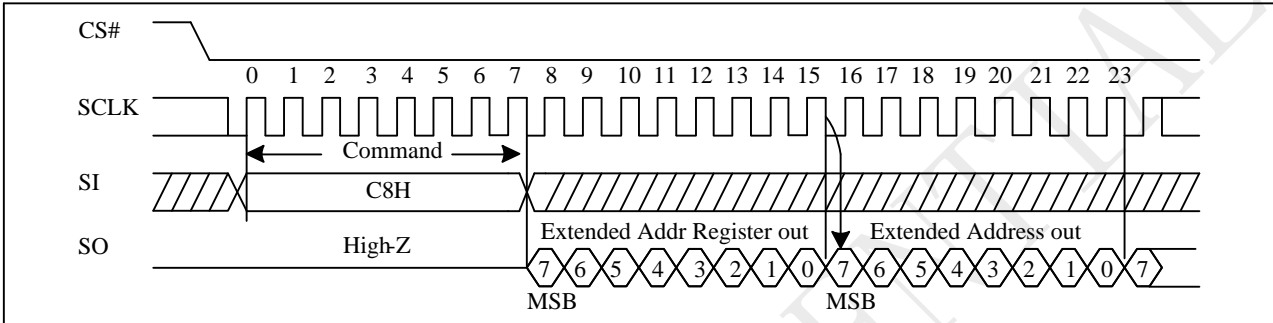
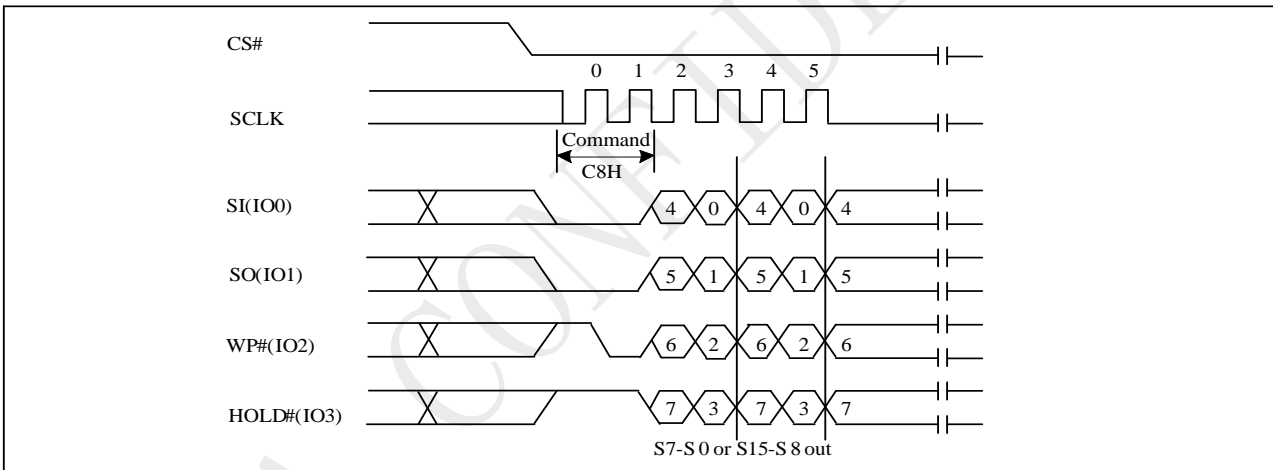


Figure 10-9a Read Extended Address Register Sequence (QPI)



Extend Address Register

| EA | EA7 | EA6 | EA5 | EA4 | EA3 | EA2 | EA1 | EA0 |
|------------|----------|----------|----------|----------|----------|----------|----------|----------|
| Definition | DLP | Reserved | Reserved | Reserved | Reserved | A26 | A25 | A24 |
| Type | Volatile | - | - | - | - | Volatile | Volatile | Volatile |
| Default | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

DLP bit.

The DLP bit is Data Learning Pattern Enable bit, which is volatile writable by C8H command. For Read commands, a pre-defined “Data Learning Pattern” can be used by the flash memory controller to determine the flash data output timing on I/O pins. When DLP=1, in dummy cycles, the flash will output “00110100” Data Learning Pattern sequence on each of the I/O pins. During this period, controller can fine tune the data latching timing for each I/O pins to achieve optimum system performance. DLP=0(default) will disable the Data Learning Pattern output.

A26-A24 bit.

The Extended Address Bit A26-A24 is used only when the device is operating in the 3-Byte Address Mode (ADS=0), which is volatile writable by C5H command.

If the device is in 4-Byte Address Mode, the device will require 4-Byte address input for all address related

instructions, and the Extended Address Bit A25-A24 setting will be ignored.

Figure 10-9 EAR Operation Segments

| A26-A24 | DIE | Address |
|---------|-----|-------------------------|
| 000 | 0 | 0000_0000H – 00FF_FFFFH |
| 001 | 0 | 0100_0000H – 01FF_FFFFH |
| 010 | 1 | 0200_0000H – 02FF_FFFFH |
| 011 | 1 | 0300_0000H – 03FF_FFFFH |
| 100 | 2 | 0400_0000H – 04FF_FFFFH |
| 101 | 2 | 0500_0000H – 05FF_FFFFH |
| 110 | 3 | 0600_0000H – 06FF_FFFFH |
| 111 | 3 | 0700_0000H – 07FF_FFFFH |

10.10 Write Extended Address Register (WREAR C5H)

The Extended Address Register is a volatile register that stores 4th byte address (A31-A24) When the device is operating in the 3-Byte Address Mode (ADS=0). To write the Extended Address Register bits, a Write Enable (06h) instruction must previously have been executed for the device to accept the Write Extended Address Register instruction (Status Register bit WEL must equal to 1). Once write enabled, the instruction is entered by driving CS# low, sending the instruction code “C5h”, and then writing the Extended Address Register data byte.

Upon power up or the execution of a Software/Hardware Reset, the Extended Address Register bit values will be cleared to 0.

Figure 10-10 Write Extended Address Register Sequence (SPI)

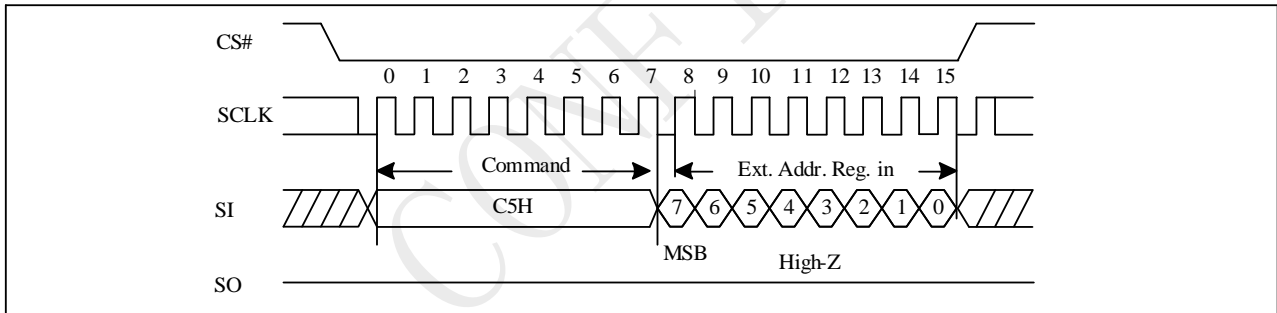
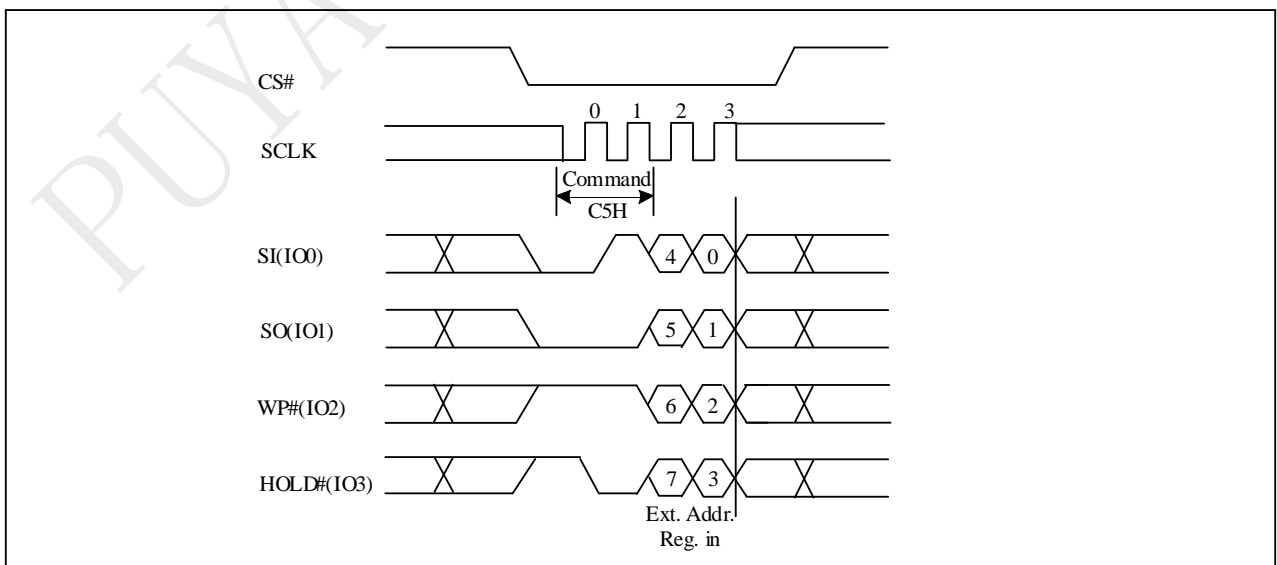


Figure 10-10a Write Extended Address Register Sequence (QPI)



10.11 Enter 4-Byte Address Mode (B7H)

The Enter 4-Byte Address Mode instruction will allow 32-bit address (A31-A0) to be used to access the memory array beyond 128Mb. The Enter 4-Byte Address Mode instruction is entered by driving CS# low, shifting the instruction code “B7h” into the SI pin and then driving CS# high.

Figure 10-11 Enter 4-Byte Address Mode Sequence (SPI)

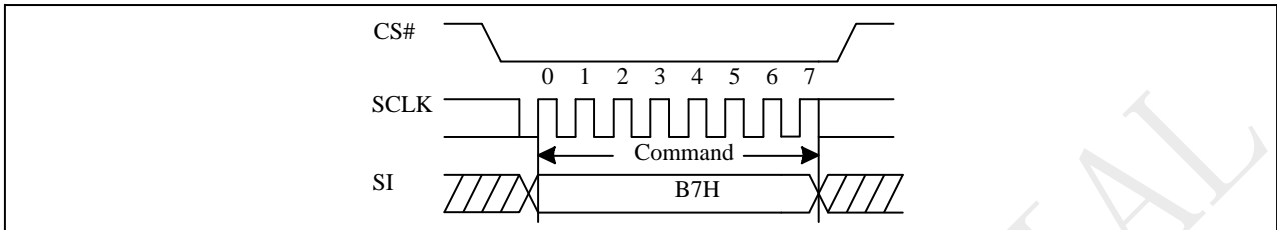
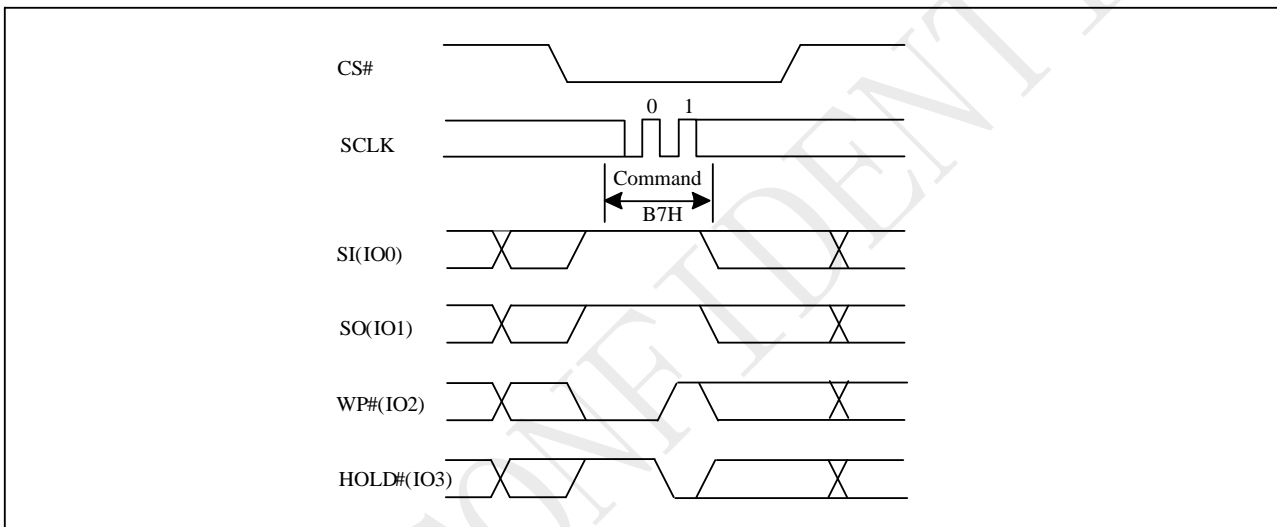


Figure 10-11a Enter 4-Byte Address Mode Sequence (QPI)



10.12 Exit 4-Byte Address Mode (E9H)

In order to be backward compatible, the Exit 4-Byte Address Mode instruction will only allow 24-bit address (A23-A0) to be used to access the memory array up to 128Mb. The Extended Address Register must be used to access the memory array beyond 128Mb. The Exit 4-Byte Address Mode instruction is entered by driving CS# low, shifting the instruction code “E9h” into the SI pin and then driving CS# high.

Figure 10-12 Exit 4-Byte Address Mode Sequence (SPI)

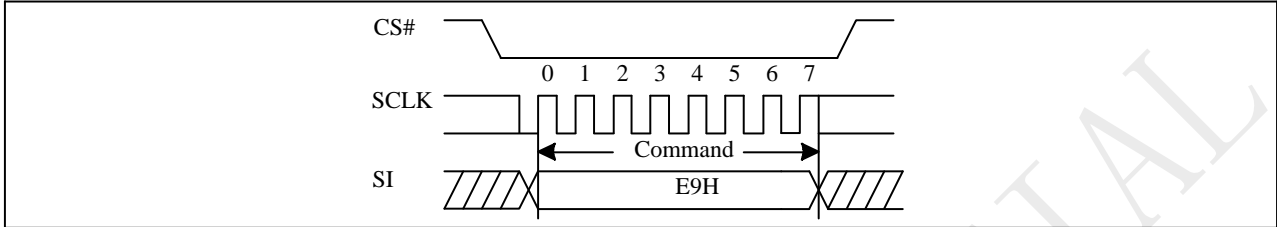
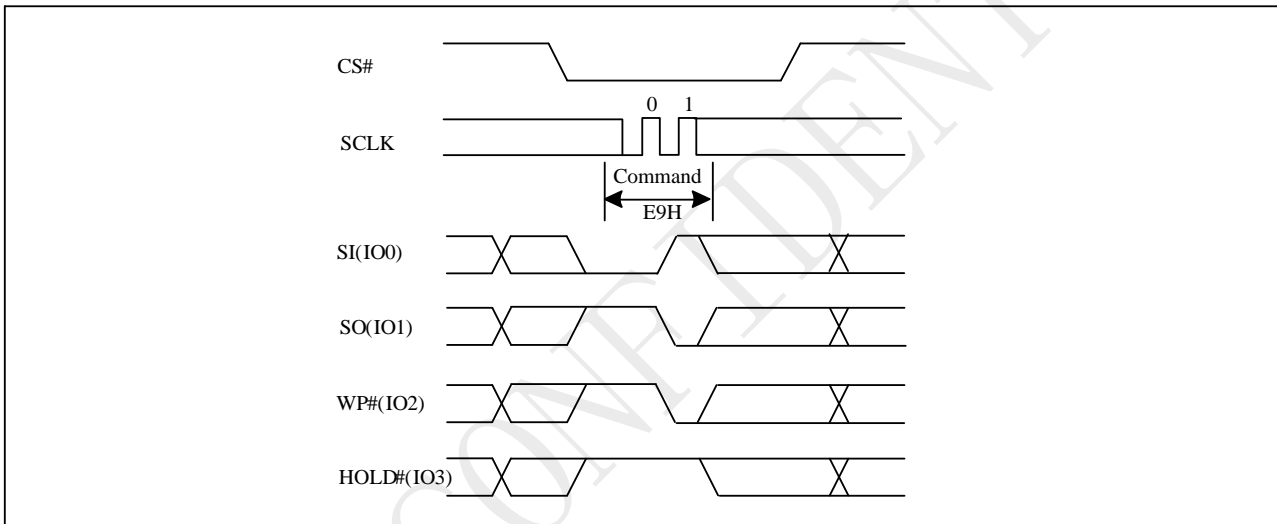


Figure 10-12a Exit 4-Byte Address Mode Sequence (QPI)

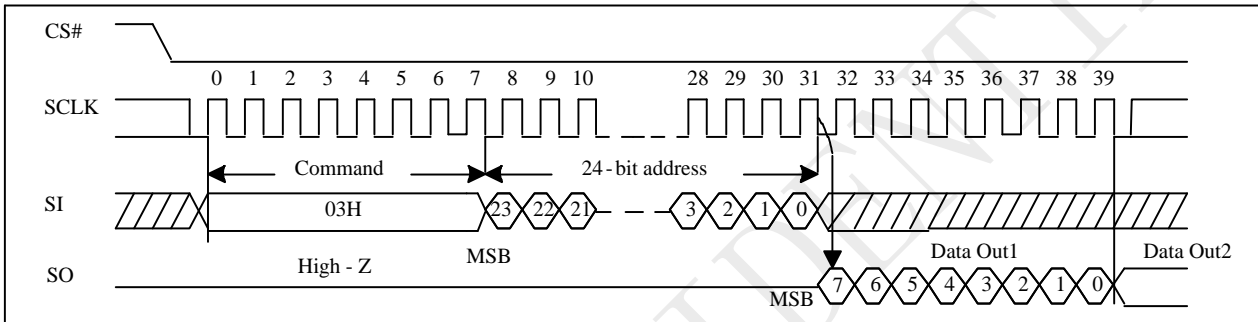


10.13 Read Data Bytes (READ 03H)

The Read Data instruction allows one or more data bytes to be sequentially read from the memory. The instruction is initiated by driving the CS# pin low and then shifting the instruction code “03h” followed by a 24/32-bit address (A23/A31-A0) into the SI pin. The code and address bits are latched on the rising edge of the SCLK pin. After the address is received, the data byte of the addressed memory location will be shifted out on the SO pin at the falling edge of SCLK with most significant bit (MSB) first. The address is automatically incremented to the next higher address after each byte of data is shifted out allowing for a continuous stream of data. This means that the entire memory can be accessed with a single instruction as long as the clock continues. The instruction is completed by driving CS# high.

If a Read Data instruction is issued while an Erase, Program or Write cycle is in process (BUSY=1) the instruction is ignored and will not have any effects on the current cycle.

Figure 10-13 Read Data Bytes (READ) Sequence (SPI)



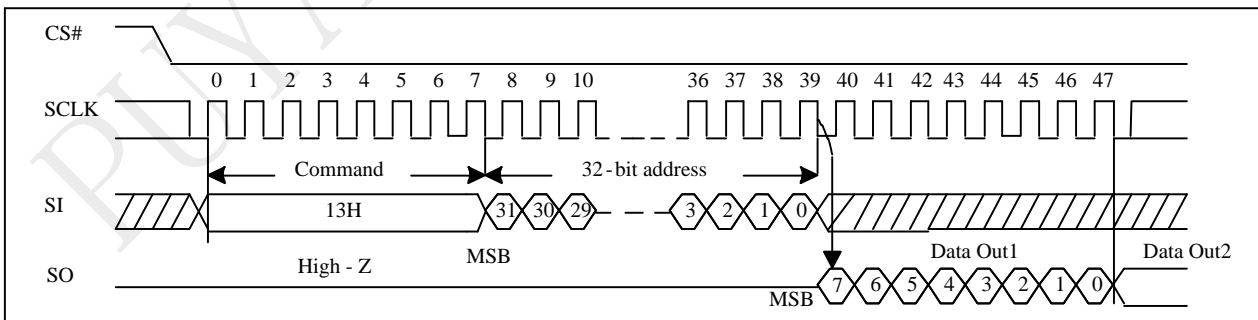
Note: 32-bit address is required when the device is operation in 4-Byte Address Mode.

10.14 Read Data Bytes with 4-Byte Address (READ4B 13H)

The Read Data with 4-Byte Address instruction is similar to the Read Data (03h) instruction. Instead of 24-bit address, 32-bit address is needed following the instruction code 13h. No matter the device is operating in 3-Byte Address Mode or 4-Byte Address Mode, the Read Data with 4-Byte Address instruction will always require 32-bit address to access the entire 1Gb memory.

If this instruction is issued while an Erase, Program or Write cycle is in process (BUSY=1) the instruction is ignored and will not have any effects on the current cycle.

Figure 10-14 Read Data Bytes with 4-Byte Address Sequence (SPI)

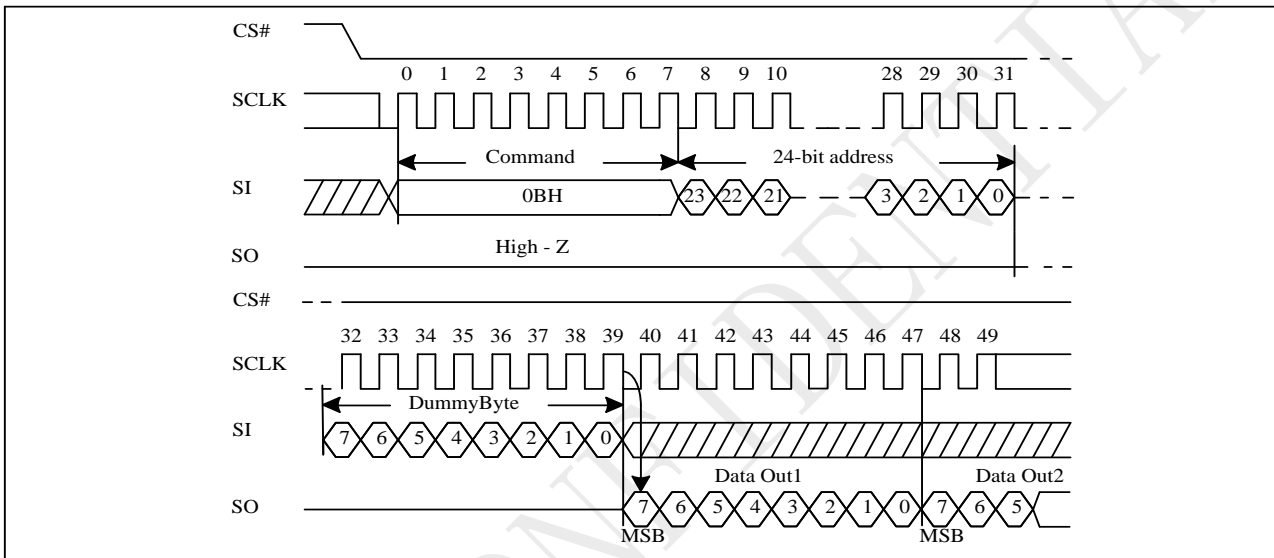


10.15 Fast Read (FREAD 0BH)

The FASTREAD instruction is similar to the Read Data instruction except that it can quickly reading data out. The 24/32-bit address is latched on rising edge of SCLK, and data of each bit shifts out on the falling edge of SCLK at a maximum frequency f_C . The first address byte can be at any location. The address is automatically increased to the next higher address after each byte data is shifted out, so the whole memory can be read out at a single FREAD instruction. The address counter rolls over to 0 when the highest address has been reached.

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

Figure 10-15 Fast Read (FREAD) Sequence (SPI)

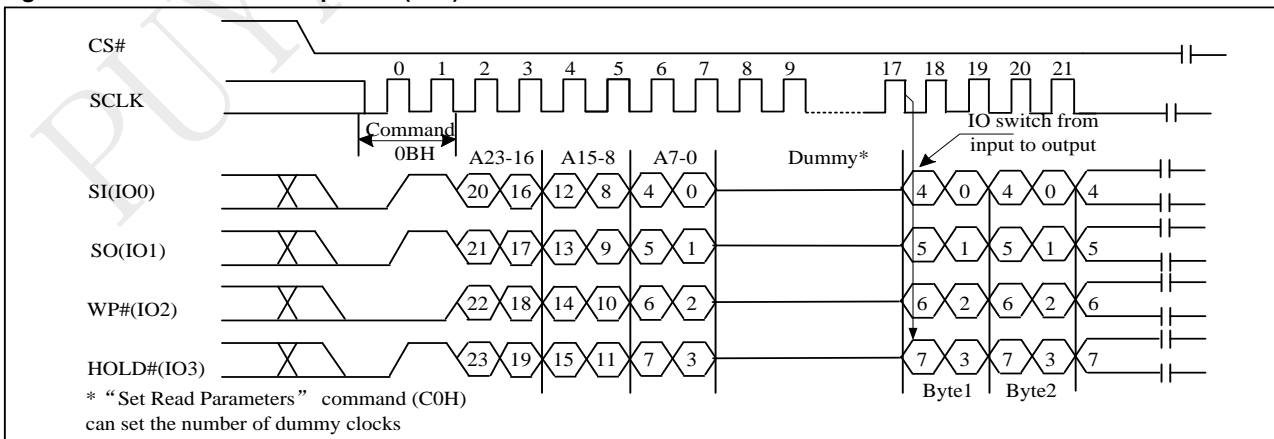


Note: 32-bit address is required when the device is operation in 4-Byte Address Mode.

Fast Read in QPI mode

The Fast Read command is also supported in QPI mode. In QPI mode, the number of dummy clocks is configured by the “Set Read Parameters (C0H)” command to accommodate a wide range application with different needs for either maximum Fast Read frequency or minimum data access latency. Depending on the Read Parameter Bits P[5:4] setting, the number of dummy clocks can be configured as either 10/4/6/8.

Figure 10-15a Fast Read Sequence (QPI)



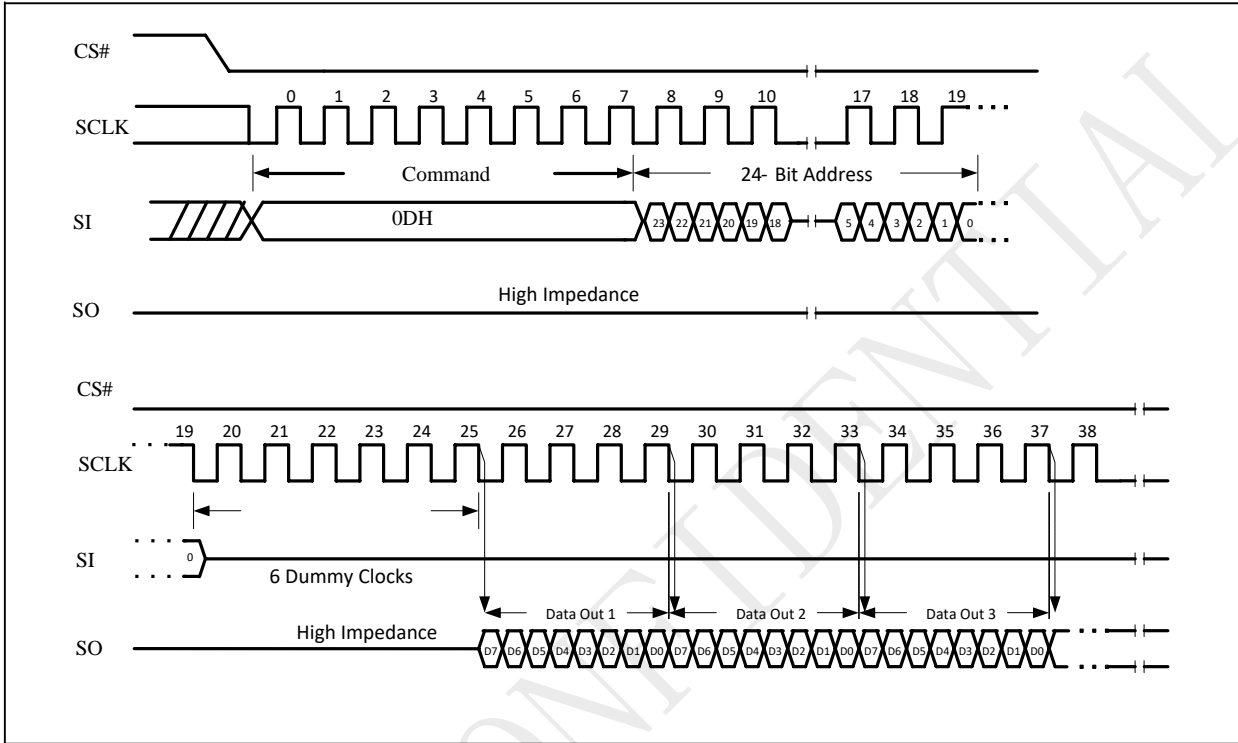
Note:

1. 32-bit address is required when the device is operation in 4-Byte Address Mode.
2. C0H command can set the number of dummy clocks

10.16 DTR Fast Read (DTR_FREAD 0DH)

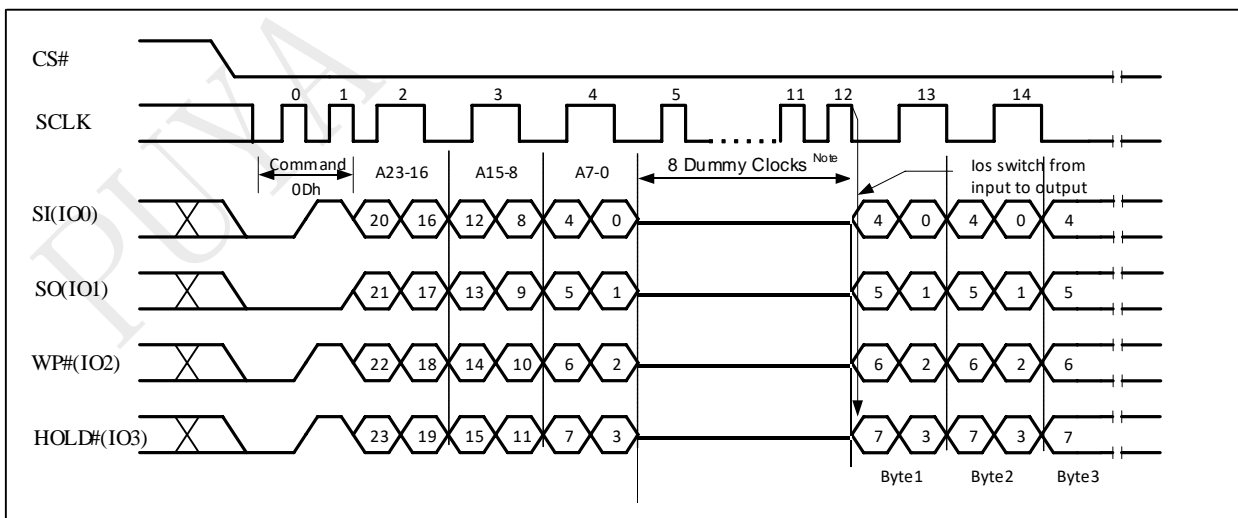
The DTR Fast Read instruction is similar to the Fast Read instruction except that the 24/32-bit address input and the data output require DTR (Double Transfer Rate) operation. This is accomplished by adding six “dummy” clocks after the 24/32-bit address. The dummy clocks allow the devices internal circuits additional time for setting up the initial address. During the dummy clocks the data value on the DO pin is a “don’t care”.

Figure 10-16 DTR Fast Read Sequence (SPI)



Note: 32-bit address is required when the device is operation in 4-Byte Address Mode. The DTR Fast Read instruction is also supported in QPI mode.

Figure 10-16a DTR Fast Read Sequence (QPI)



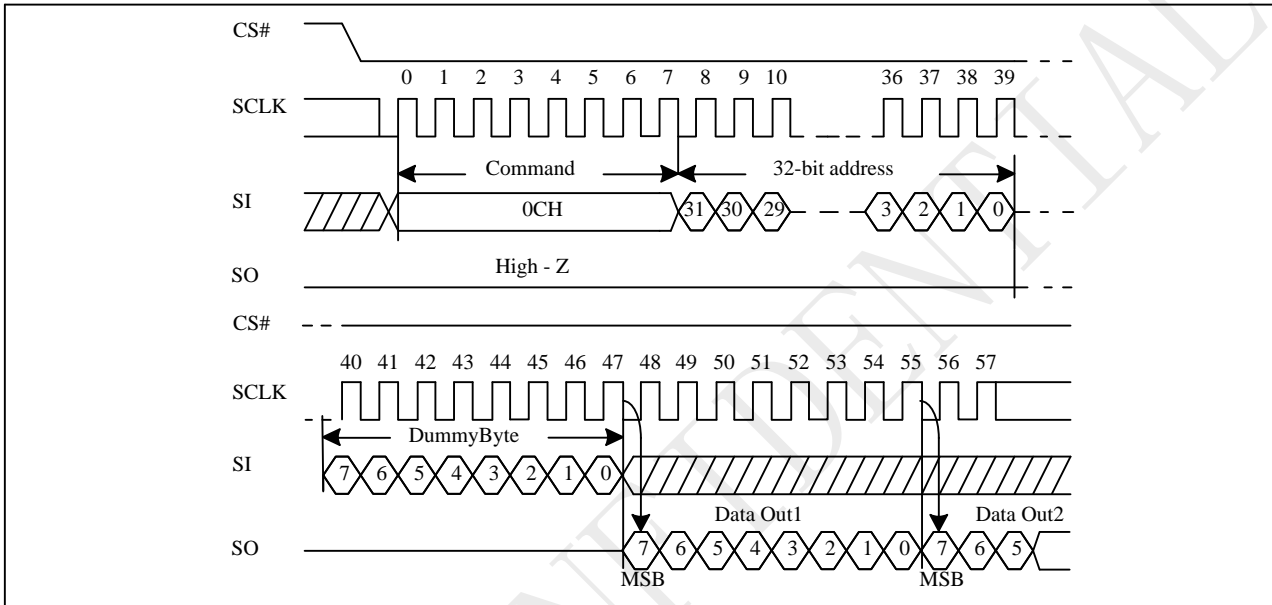
Note: 32-bit address is required when the device is operation in 4-Byte Address Mode.

10.17 Fast Read with 4-Byte Address (FREAD 0Ch)

The Fast Read with 4-Byte Address instruction is similar to the Fast Read instruction except that it requires 32-bit address instead of 24-bit address. No matter the device is operating in 3-Byte Address Mode or 4-Byte Address Mode, the Read Data with 4-Byte Address instruction will always require 32-bit address to access the entire 1Gb memory.

The Fast Read with 4-Byte Address (0Ch) instruction is only supported in Standard SPI mode. In QPI mode, the instruction code 0Ch is used for the “Burst Read with Wrap” instruction.

Figure 10-17 Fast Read with 4-Byte Address Sequence (SPI)



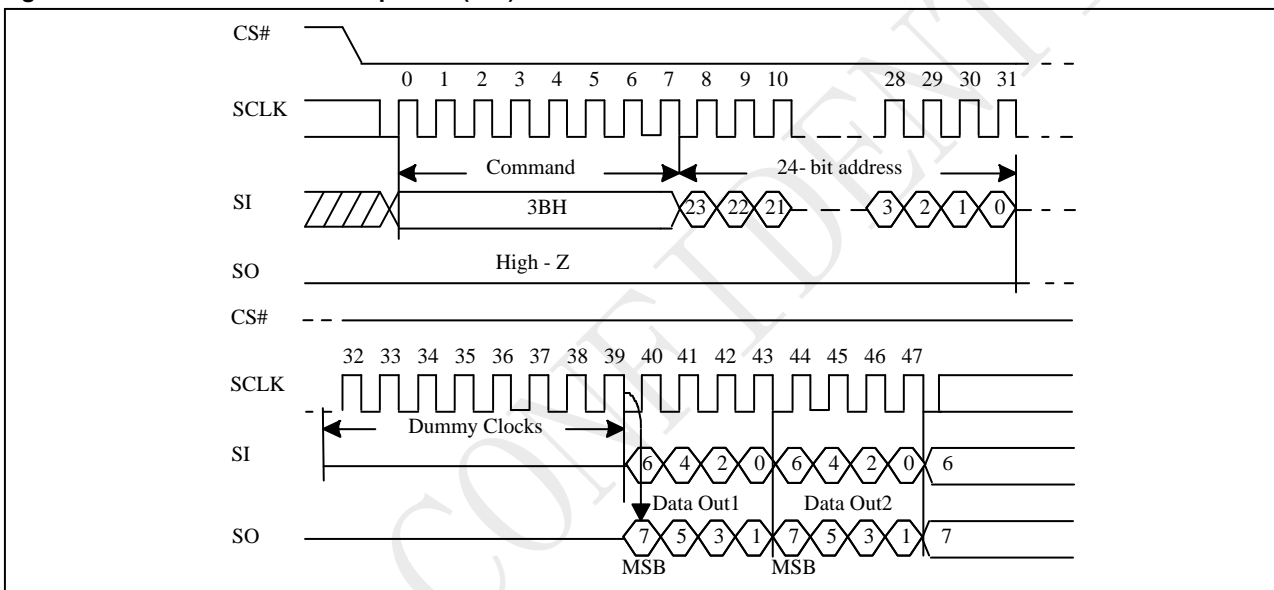
10.18 Dual Read (DREAD 3BH)

The DREAD instruction enable double throughput of Serial NOR Flash in read mode. The address is latched on rising edge of SCLK, and data of every two bits (interleave on 2 I/O pins) shift out on the falling edge of SCLK at a maximum frequency f_T . The first address byte can be at any location. The address is automatically increased to the next higher address after each byte data is shifted out, so the whole memory can be read out at a single DREAD instruction. The address counter rolls over to 0 when the highest address has been reached. Once writing DREAD instruction, the following data out will perform as 2-bit instead of previous 1-bit.

The sequence of issuing DREAD instruction is: CS# goes low → sending DREAD instruction → 3/4-byte address on SI → 8-bit dummy cycle → 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 10-18 Dual Read Mode Sequence (SPI)



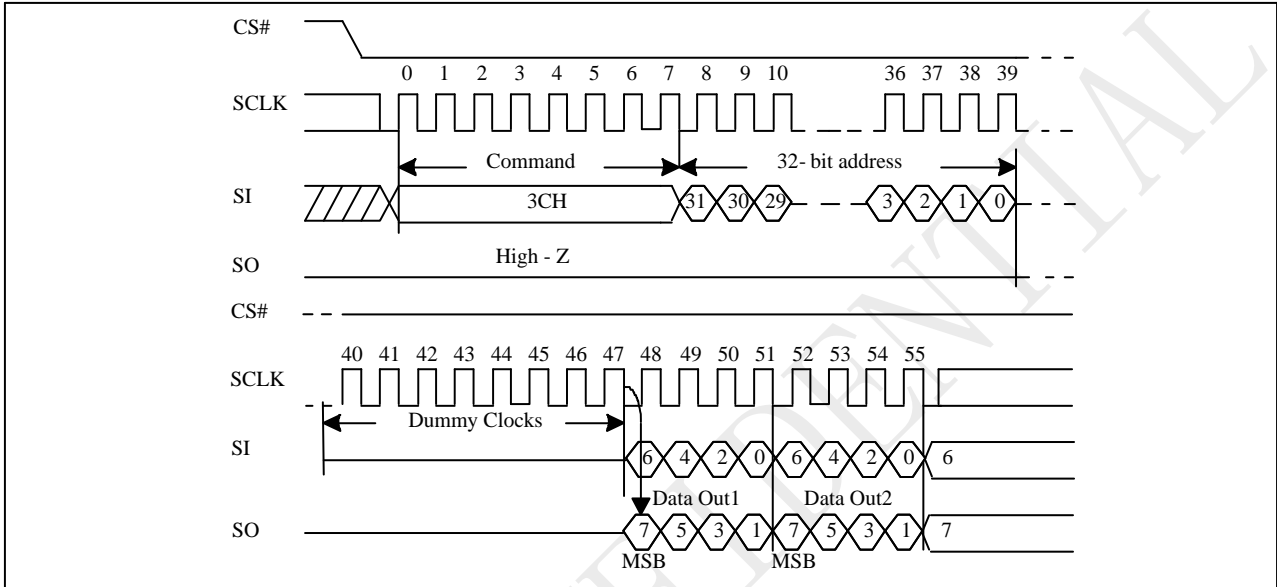
Note: 32-bit address is required when the device is operation in 4-Byte Address Mode.

10.19 Dual Read with 4-Byte Address (DREAD4B 3CH)

The Dual Read with 4-Byte Address instruction is similar to the Dual Read instruction except that it requires 32-bit address instead of 24-bit address. No matter the device is operating in 3-Byte Address Mode or 4-Byte Address Mode, the Dual Read with 4-Byte Address instruction will always require 32-bit address to access the entire 1Gb memory.

The Dual Read with 4-Byte Address (3Ch) instruction is only supported in Standard SPI mode.

Figure 10-19 Dual Read with 4-Byte Address Mode Sequence (SPI)



10.20 2IO Read (2READ BBH)

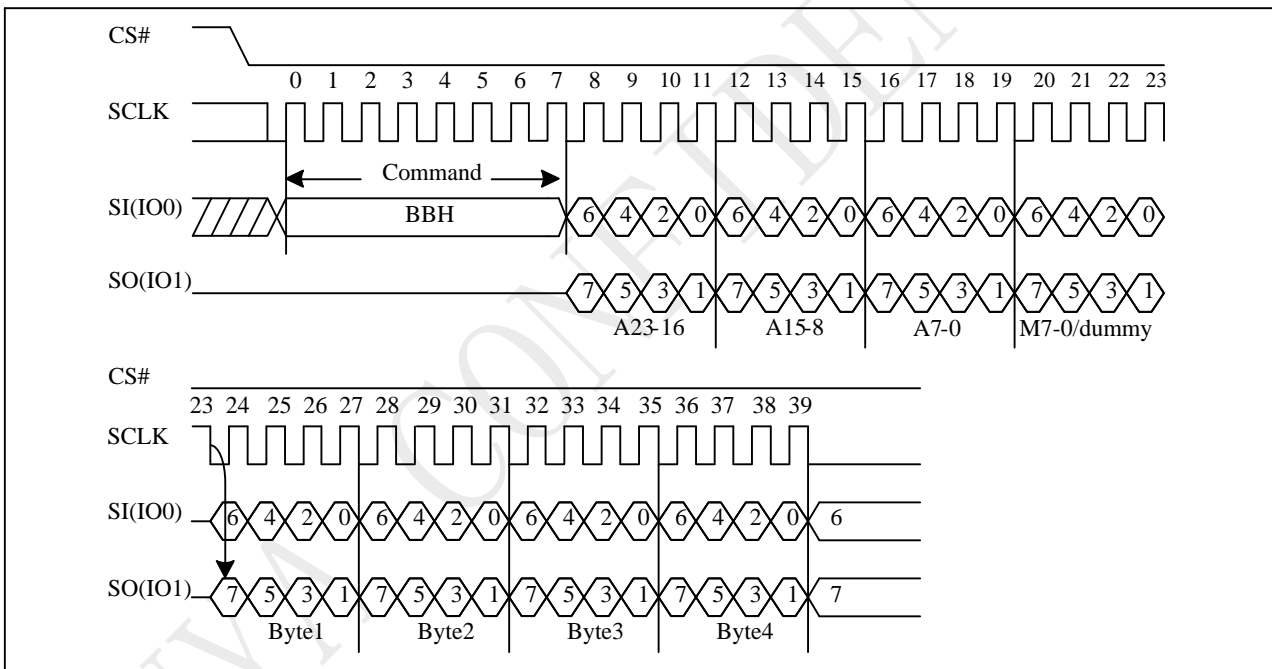
The 2READ instruction enables Double Transfer Rate of Serial NOR Flash in read mode. The address is latched on rising edge of SCLK, and data of every two bits (interleave on 2 I/O pins) shift out on the falling edge of SCLK at a maximum frequency f_T . The first address byte can be at any location. The address is automatically increased to the next higher address after each byte data is shifted out, so the whole memory can be read out at a single 2READ instruction. The address counter rolls over to 0 when the highest address has been reached.

Once writing 2READ instruction, the following address/dummy/data out will perform as 2-bit instead of previous 1-bit.

The sequence of issuing 2READ instruction is: CS# goes low → sending 2READ instruction → 24/32-bit address interleave on SIO1 & SIO0 → 8-bit dummy cycle on SIO1 & SIO0 → data out interleave on SIO1 & SIO0 → to end 2READ operation can drive 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 10-20 2IO Read Sequence (SPI, M5-4 ≠ (1,0))



Note:

1. 32-bit address is required when the device is operation in 4-Byte Address Mode.
2. M[5-4] = (1,0) is inhibited.
3. DC bit can set the number of dummy clocks.

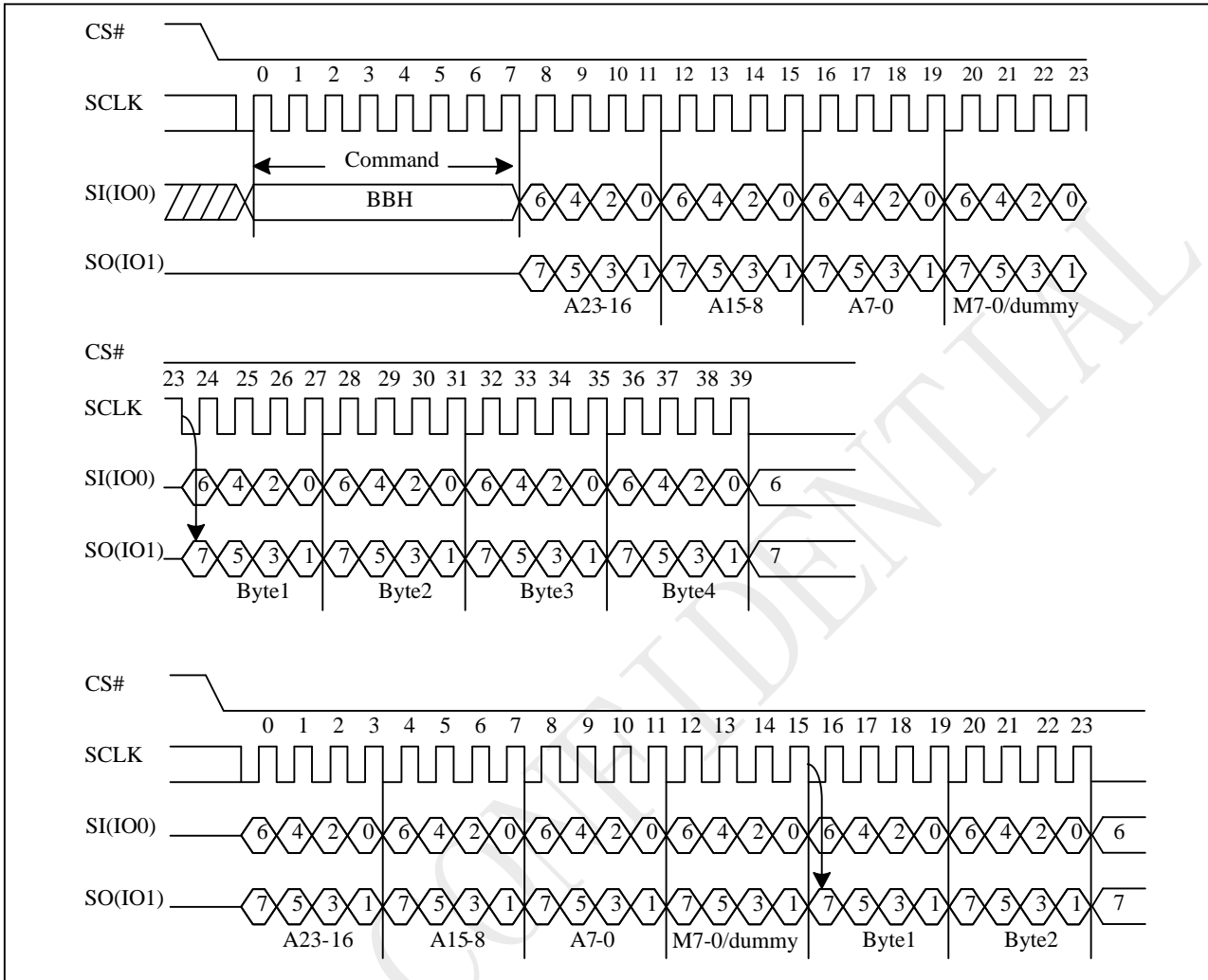
2IO Continuous Read

“BBh” command supports 2IO Continuous Read which can further reduce command overhead through setting the “Continuous Read Mode” bits (M7-0) after the input 3/4-byte address. If the “Continuous Read Mode” bits (M5-4) = (1, 0), then the next 2IO Read command (after CS# is raised and then lowered) does not require the BBH command code.

If the “Continuous Read Mode” bits (M5-4) do not equal (1, 0), the next command requires the first BBH command code, thus returning to normal operation. A “Continuous Read Mode” Reset command can be used

to reset (M5-4) before issuing normal command.

Figure 10-20a 2IO Continue Read (SPI, M5-4 = (1,0))



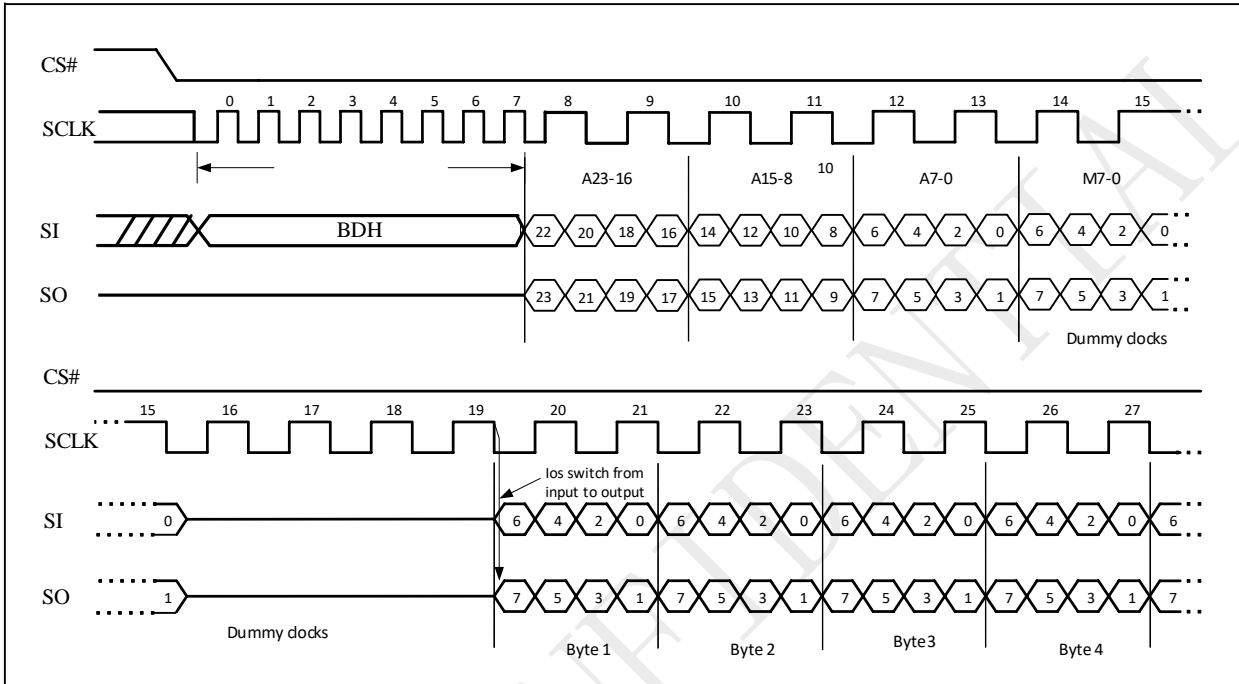
Note:

1. 32-bit address is required when the device is operation in 4-Byte Address Mode.
2. 2IO Continue Read, if M5-4 = 1, 0. If not using Continue Read recommend to set M5-4 ≠ 1, 0.
3. DC bit can set the number of dummy clocks.

10.21 DTR 2IO Read (DTR_2READ BDH)

The DTR 2IO Read (BDh) instruction allows for improved random access while maintaining two IO pins, IO0 and IO1. It is similar to the DREAD (3Bh) instruction but with the capability to input the Address bits (A23/A31-0) two bits per clock. This reduced instruction overhead may allow for code execution (XIP) directly from the Dual SPI in some applications.

Figure 10-21 DTR 2IO Read Sequence (SPI, M5-4 ≠ (1,0))



Note:

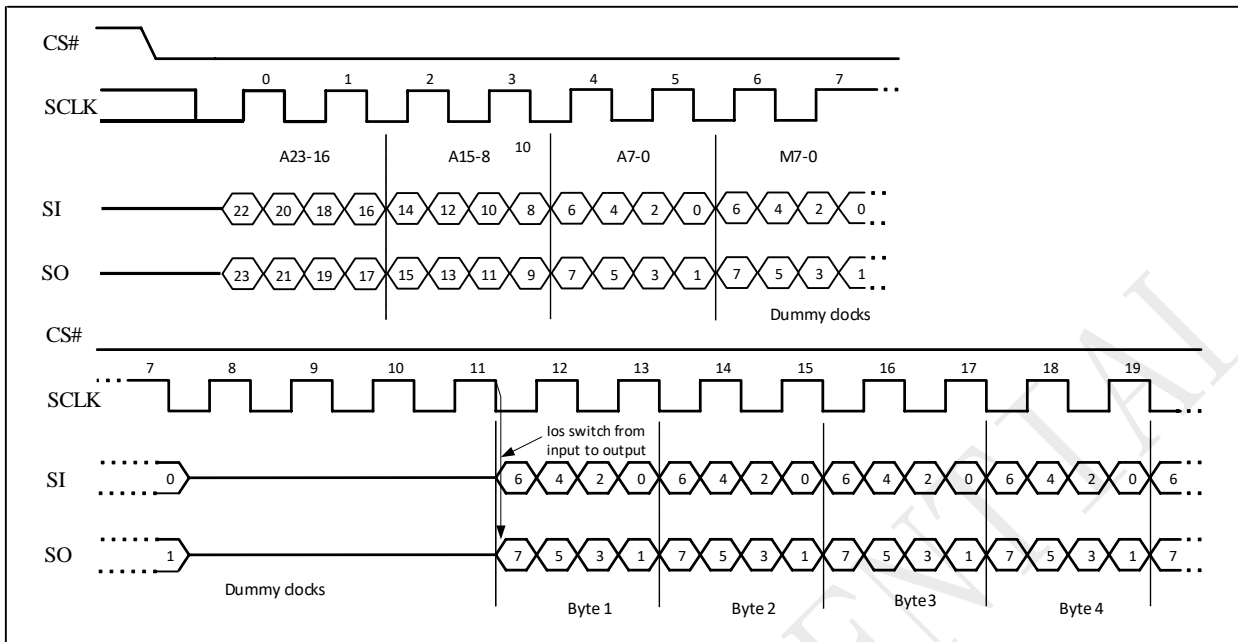
1. 32-bit address is required when the device is operation in 4-Byte Address Mode.
2. DC bit can set the number of dummy clocks.

DTR 2IO Continuous Read

The BDh instruction supports Continuous Read Mode which can further reduce overhead through setting the "continuous Read Mode" bits(M7-0) after the input address (A23/A31-A0). If the "Continuous Read Mode" bits (M5-4) = (1, 0), then the next Read command (after CS# is raised and then lowered) does not require the BDH command code.

If the "Continuous Read Mode" bits (M5-4) do not equal (1, 0), the next command requires the first BDH command code, thus returning to normal operation. It is recommended to input FFFFh on IO0 for the next instruction (16 clocks), to ensure M4 = 1 and return the device to normal operation.

Figure 10-21a DTR 2IO Continuous Read Sequence (SPI, M5-4 = (1,0))

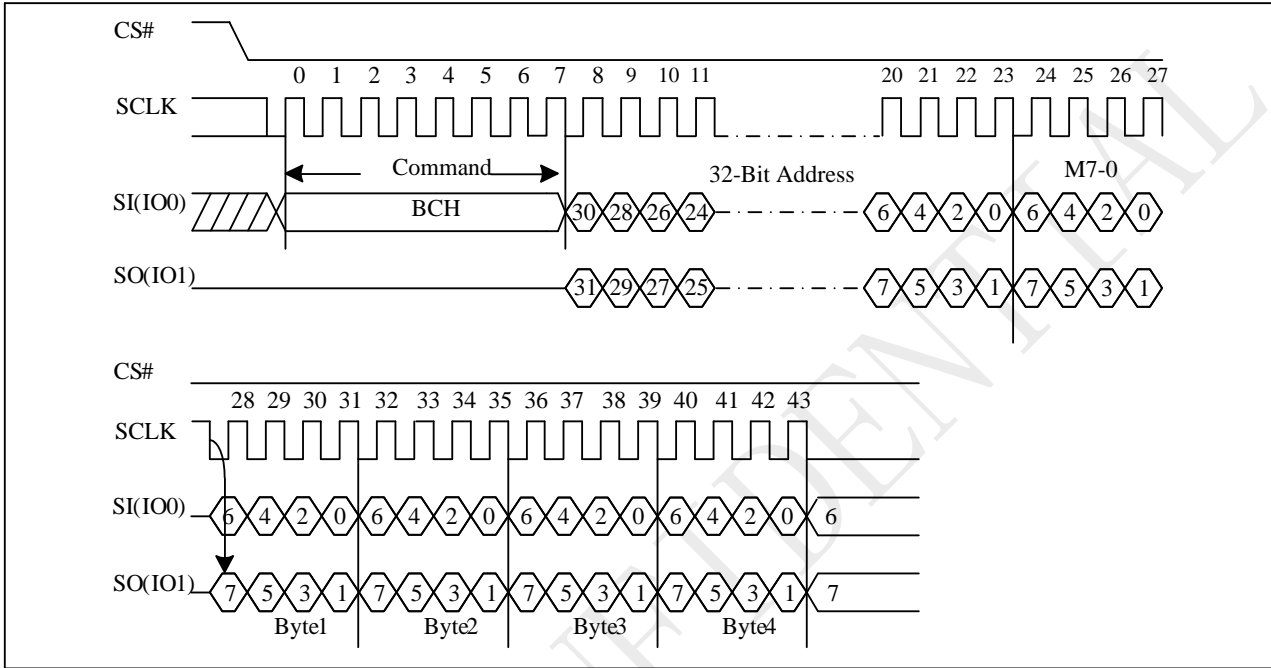


Note: 32-bit address is required when the device is operation in 4-Byte Address Mode.

10.22 2IO Read with 4-Byte Address (2READ4B BCH)

The 2IO Read with 4-Byte Address instruction is similar to the 2IO Read instruction except that it requires 32-bit address instead of 24-bit address. No matter the device is operating in 3-Byte Address Mode or 4-Byte Address Mode, the 2IORead with 4-Byte Address instruction will always require 32-bit address to access the entire 1Gb memory.

Figure 10-22 2IO Read with 4-Byte Address Sequence (SPI, M5-4 ≠ (1,0))

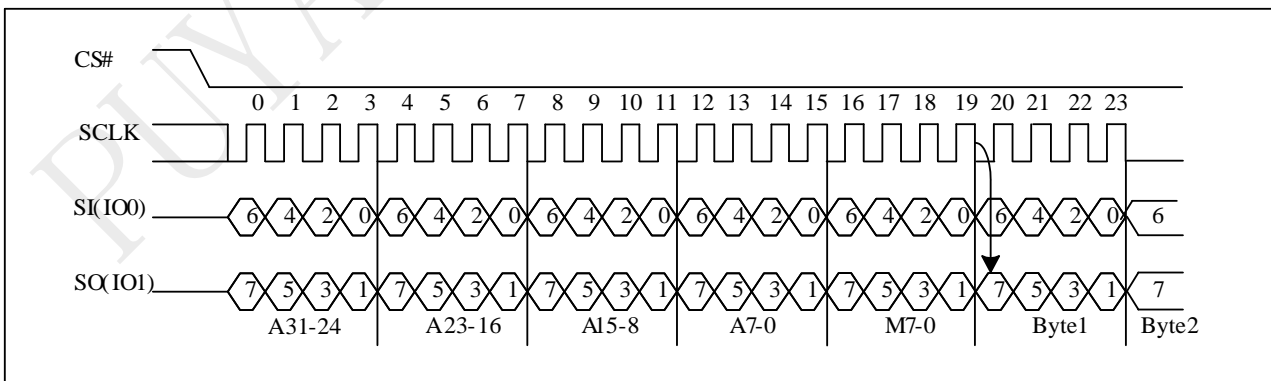


2IO Continuous Read with 4-Byte Address

If the “Continuous Read Mode” bits (M5-4) = (1, 0), then the next Read command (after CS# is raised and then lowered) does not require the BCH command code.

If the “Continuous Read Mode” bits (M5-4) do not equal (1, 0), the next command requires the first BCH command code, thus returning to normal operation. It is recommended to input FFFFh on IO0 for the next instruction (16 clocks), to ensure M4 = 1 and return the device to normal operation.

Figure 10-22a 2IO Continuous Read with 4-Byte Address Sequence (SPI, M5-4 = (1,0))



Note: 2IO Continue Read with 4-Byte Address, if M5-4 = 1, 0. If not using Continue Read recommend to set M5-4 ≠ 1, 0.

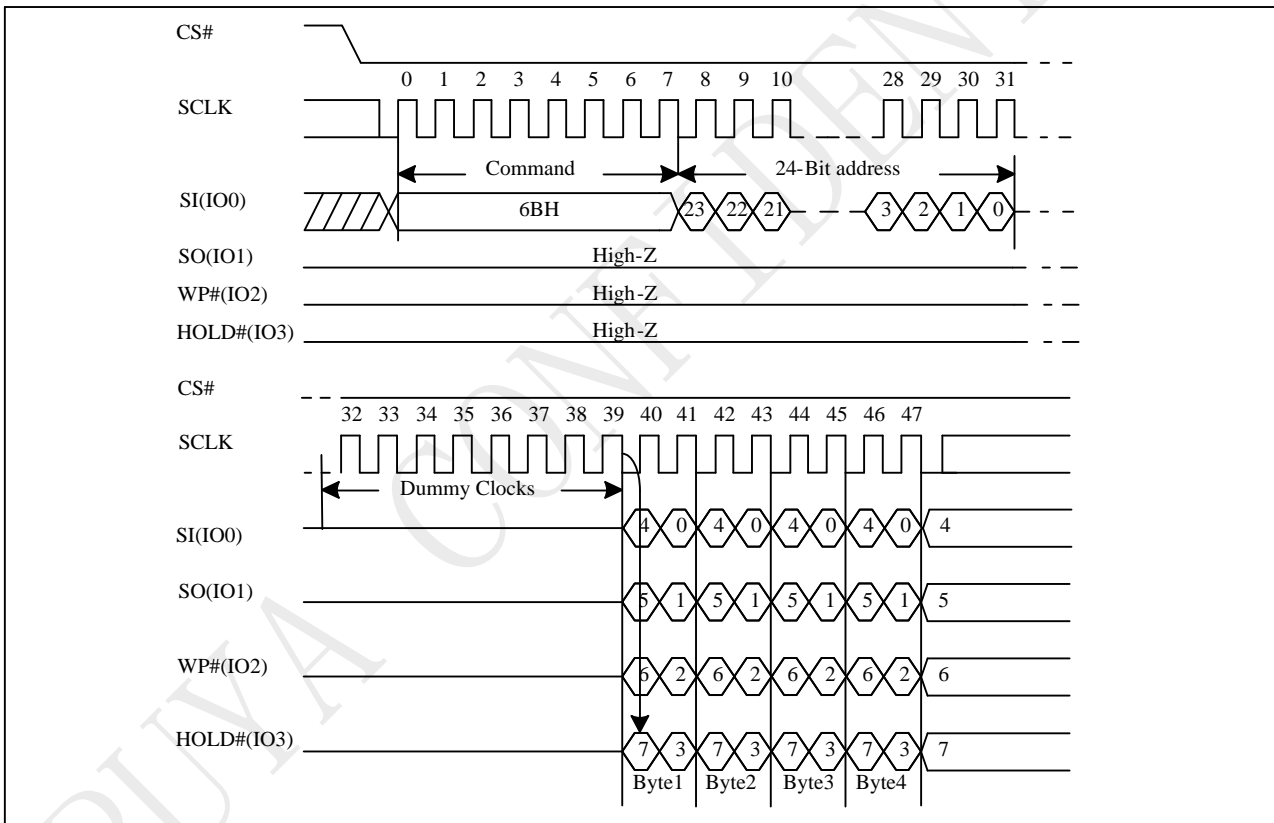
10.23 Quad Read (QREAD 6BH)

The QREAD instruction enable quad throughput of Serial NOR Flash in read mode. A Quad Enable (QE) bit of status Register must be set to "1" before sending the 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 → 3/4-byte address on SI → 8-bit dummy cycle → 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 10-23 Quad Read Sequence (SPI)



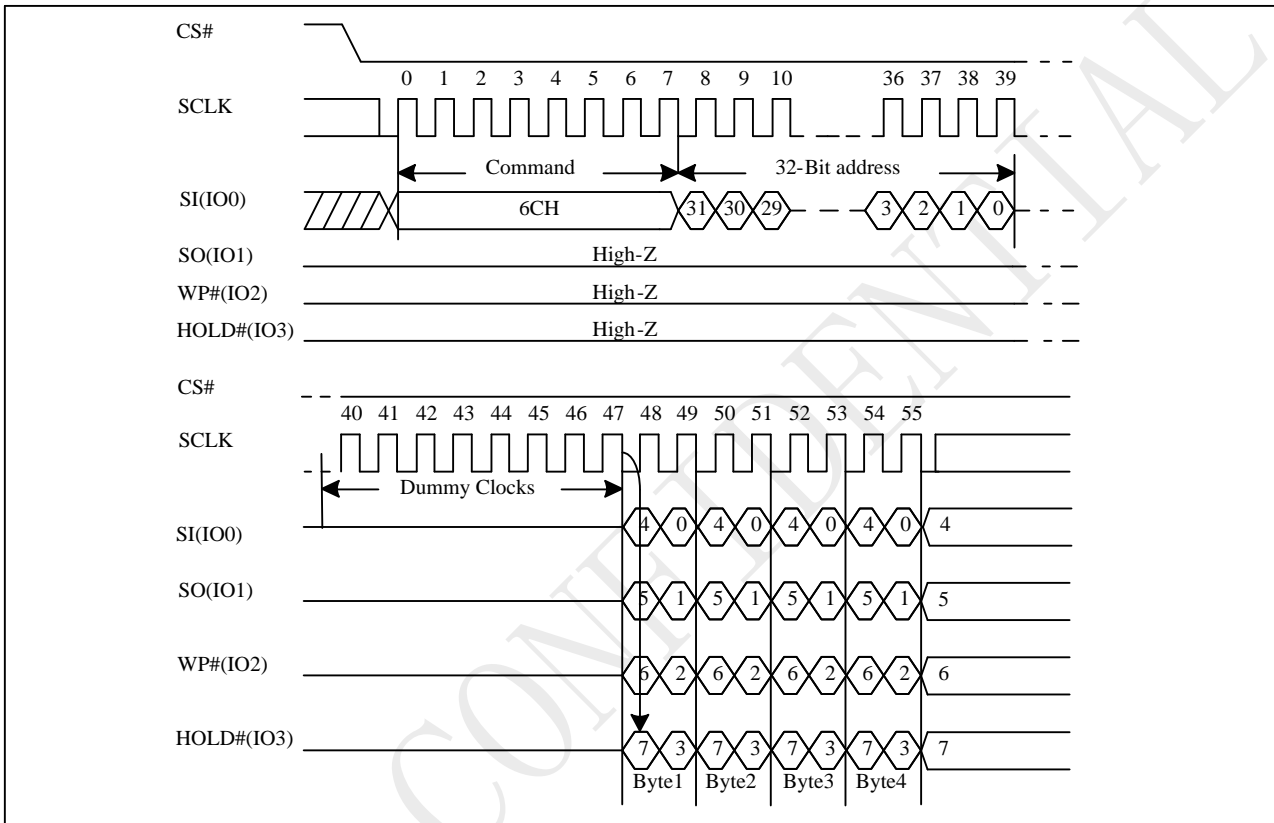
Note: 32-bit address is required when the device is operation in 4-Byte Address Mode.

10.24 Quad Read with 4-Byte Address (QREAD4B 6CH)

The Quad Read with 4-Byte Address instruction is similar to the Quad Read instruction except that it requires 32-bit address instead of 24-bit address. No matter the device is operating in 3-Byte Address Mode or 4-Byte Address Mode, the Quad Read with 4-Byte Address instruction will always require 32-bit address to access the entire 1Gb memory.

The Quad Read with 4-Byte Address (6Ch) instruction is only supported in Standard SPI mode.

Figure 10-24 Quad Read with 4-Byte Address Sequence (SPI)



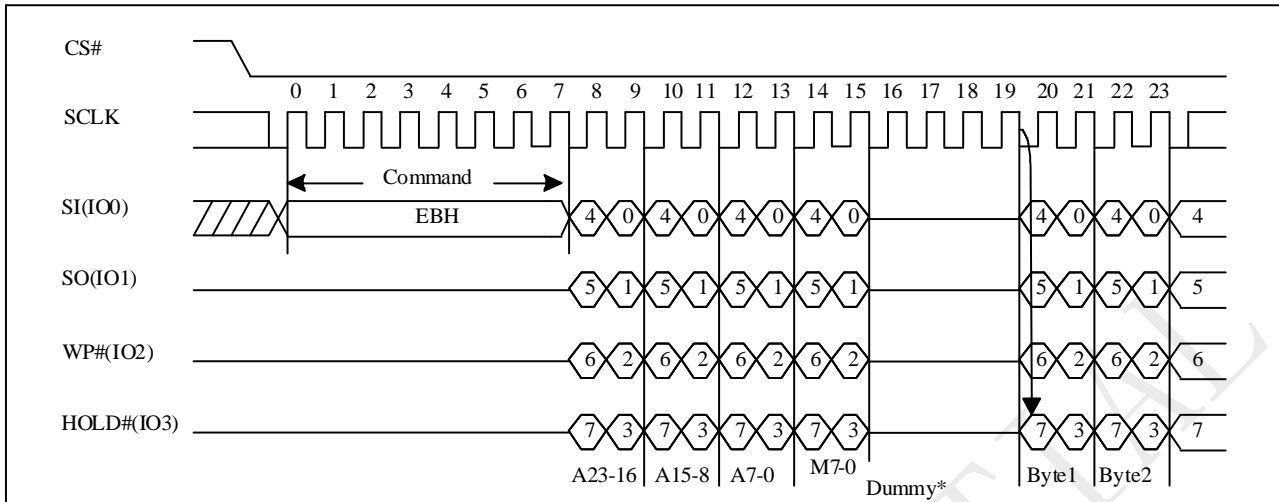
10.25 4IO Read (4READ EBH)

The 4READ instruction enable quad throughput of Serial NOR Flash in read mode. A Quad Enable (QE) bit of status Register must be set to "1" before sending the 4READ instruction. The address is latched on rising edge of SCLK, and data of every four bits (interleave on 4 I/O pins) shift out on the falling edge of SCLK at a maximum frequency f_Q. The first address byte can be at any location. The address is automatically increased to the next higher address after each byte data is shifted out, so the whole memory can be read out at a single 4READ instruction. The address counter rolls over to 0 when the highest address has been reached. Once writing 4READ instruction, the following address/dummy/data out will perform as 4-bit instead of previous 1-bit.

The sequence of issuing 4READ instruction is: CS# goes low → sending 4READ instruction → 24/32-bit address interleave on SIO3, SIO2, SIO1 & SIO0 → 2+4 dummy cycles → data out interleave on SIO3, SIO2, SIO1 & SIO0 → to end 4READ operation can drive CS# to 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.

Figure 10-25 4IO Read Sequence (SPI, M5-4 ≠ (1,0))



Note:

1. Hi-impedance is inhibited for the two clock cycles.
2. M[5-4] = (1,0) is inhibited.
3. 32-bit address is required when the device is operation in 4-Byte Address Mode.
4. DC bit can set the number of dummy clocks.

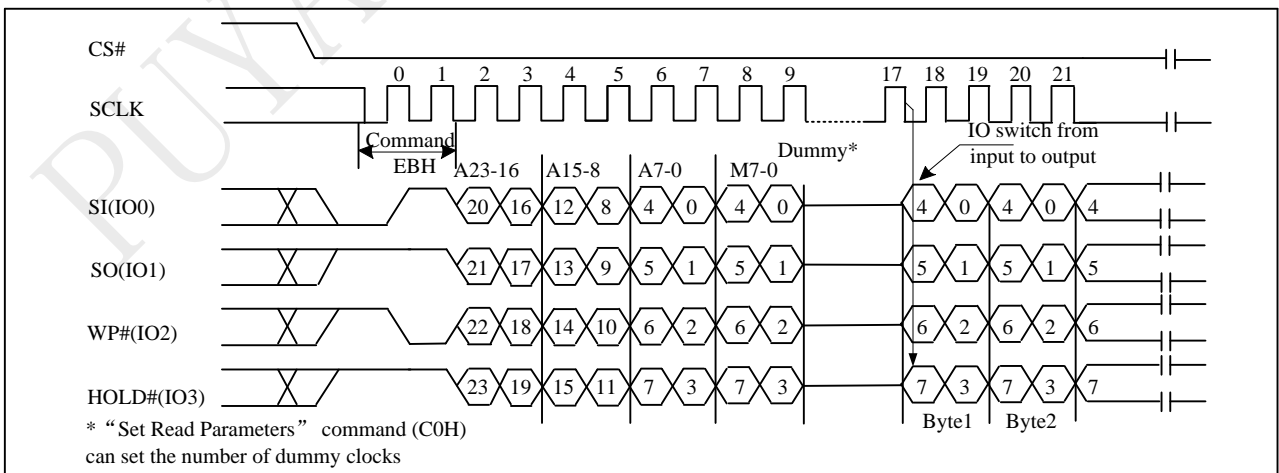
4IO Read in QPI mode

The 4READ instruction is also supported in QPI mode. When QPI mode is enabled, the number of dummy clocks is configured by the “Set Read Parameters (C0h)” instruction to accommodate a wide range of applications with different needs for either maximum Fast Read frequency or minimum data access latency. Depending on the Read Parameter Bits P[5:4] setting, the number of dummy clocks can be configured as either 2, 4, 6 or 8. The default number of dummy clocks upon power up or after a Reset instruction is 2. In QPI mode, the “Continuous Read Mode” bits M7- 0 are also considered as dummy clocks. In the default setting, the data output will follow the Continuous Read Mode bits immediately.

“Continuous Read Mode” feature is also available in QPI mode for 4IO Read instruction. Please refer to the description on next pages.

“Wrap Around” feature is not available in QPI mode for 4IO Read instruction.

Figure 10-25a 4IO Read in QPI mode Sequence (QPI, M5-4 ≠ (1,0))



Note:

1. Hi-impedance is inhibited for the two clock cycles.
2. M[5-4] = (1,0) is inhibited.

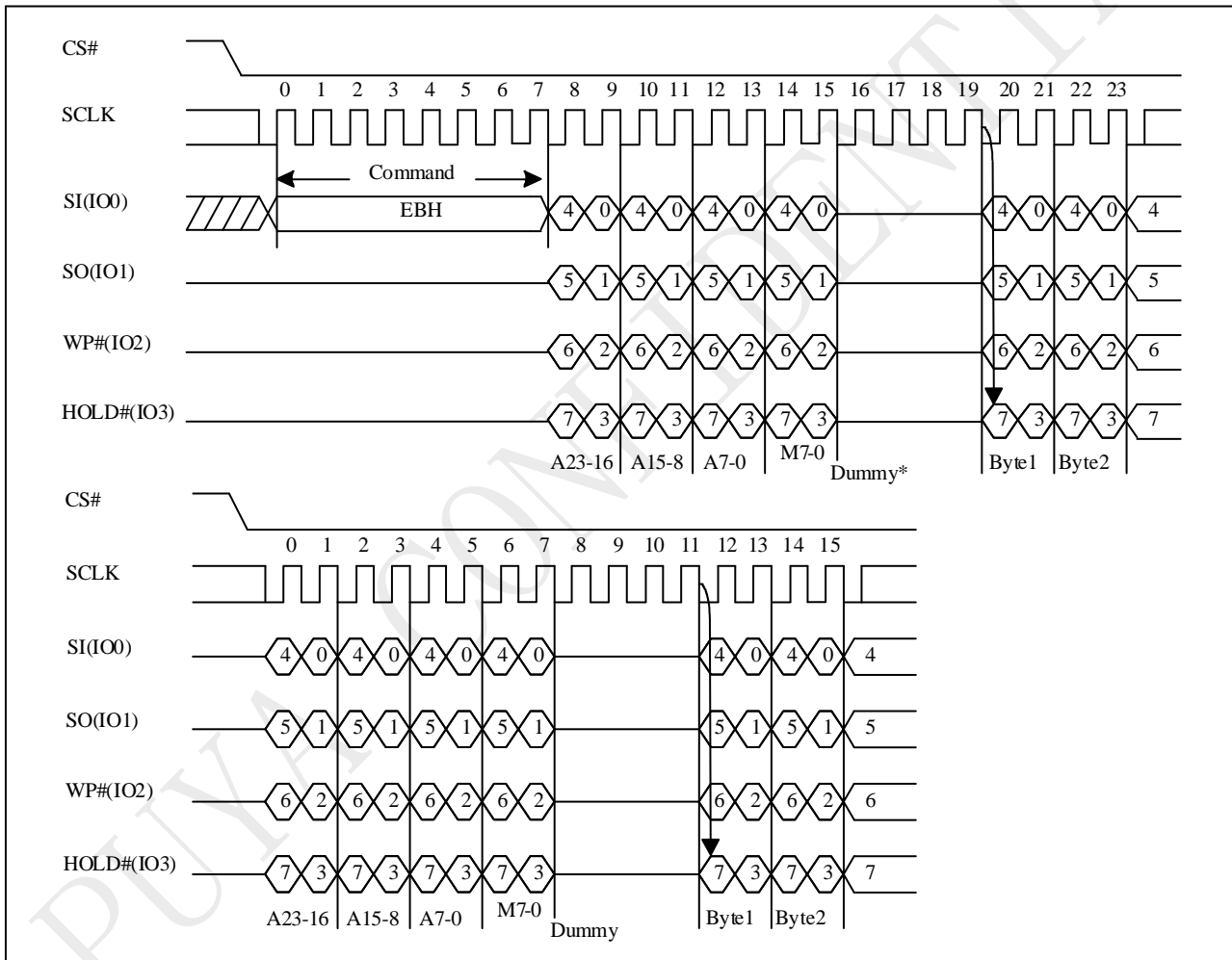
3. 32-bit address is required when the device is operation in 4-Byte Address Mode.
4. C0H command can set the number of dummy clocks.

4IO Continuous Read

“EBh” command supports 4IO Continuous Read which can further reduce command overhead through setting the “Continuous Read Mode” bits (M7-0) after the input 3/4-byte address (A23/31-A0). If the “Continuous Read Mode” bits (M5-4) = (1, 0), then the next 4IO Read command (after CS# is raised and then lowered) does not require the EBH command code.

If the “Continuous Read Mode” bits (M5-4) do not equal (1, 0), the next command requires the first EBH command code, thus returning to normal operation. A “Continuous Read Mode” Reset command can be used to reset (M5-4) before issuing normal command.

Figure 10-25b 4IO Continuous Read Sequence (SPI, M5-4 = (1,0))



Note:

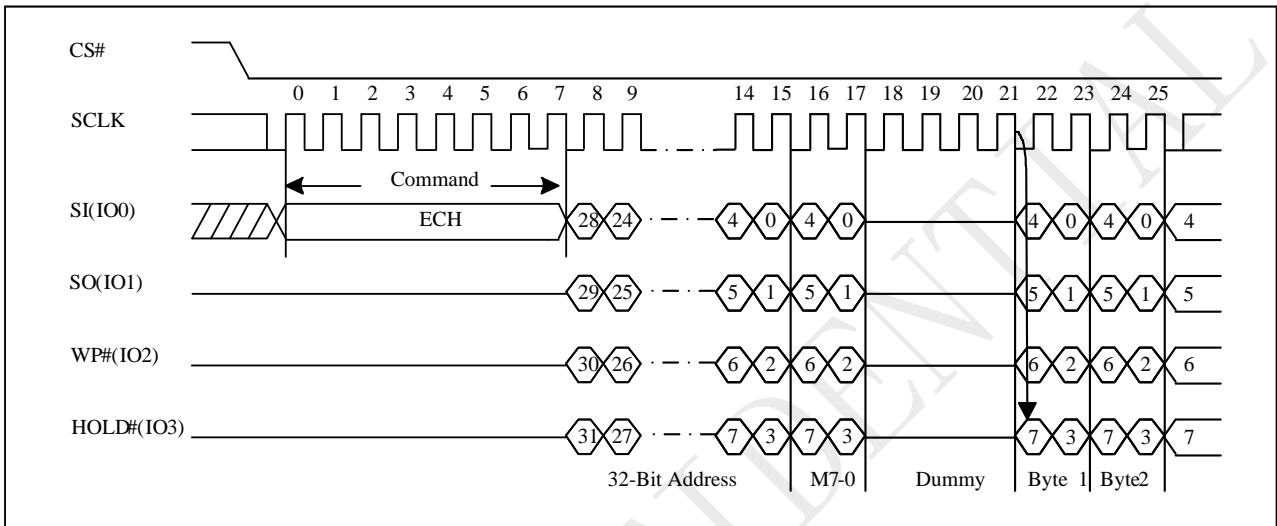
1. 4IO Continuous Read Mode, if M5-4 = 1, 0. If not using Continuous Read recommend to set M5-4 ≠ 1, 0.
2. 32-bit address is required when the device is operation in 4-Byte Address Mode.
3. DC bit can set the number of dummy clocks.

10.26 4IO Read with 4-Byte Address (4READ4B ECH)

The 4IO Read with 4-Byte Address (ECH) instruction is similar to the 4IO Read (EBh) instruction except that it requires 32-bit address instead of 24-bit address. No matter the device is operating in 3-Byte Address Mode or 4-Byte Address Mode, the 4IO Read with 4-Byte Address instruction will always require 32-bit address to access the entire 1Gb memory.

The 4IO Read with 4-Byte Address (ECH) instruction is only supported in Standard SPI mode.

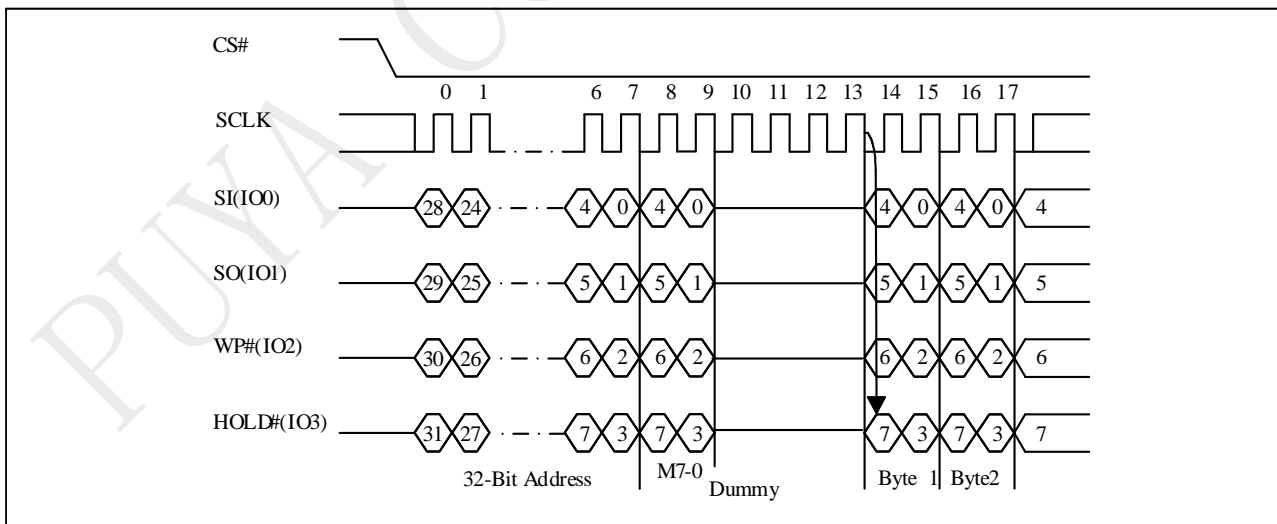
Figure 10-26 4IO Read with 4-Byte Address Sequence (SPI, M5-4 ≠ (1,0))



Note:

1. Hi-impedance is inhibited for the mode clock cycles.
2. M[5-4] = (1,0) is inhibited.
3. DC bit can set the number of dummy clocks.

Figure 10-26a 4IO Continuous Read with 4-Byte Address Sequence (M5-4 = (1,0))



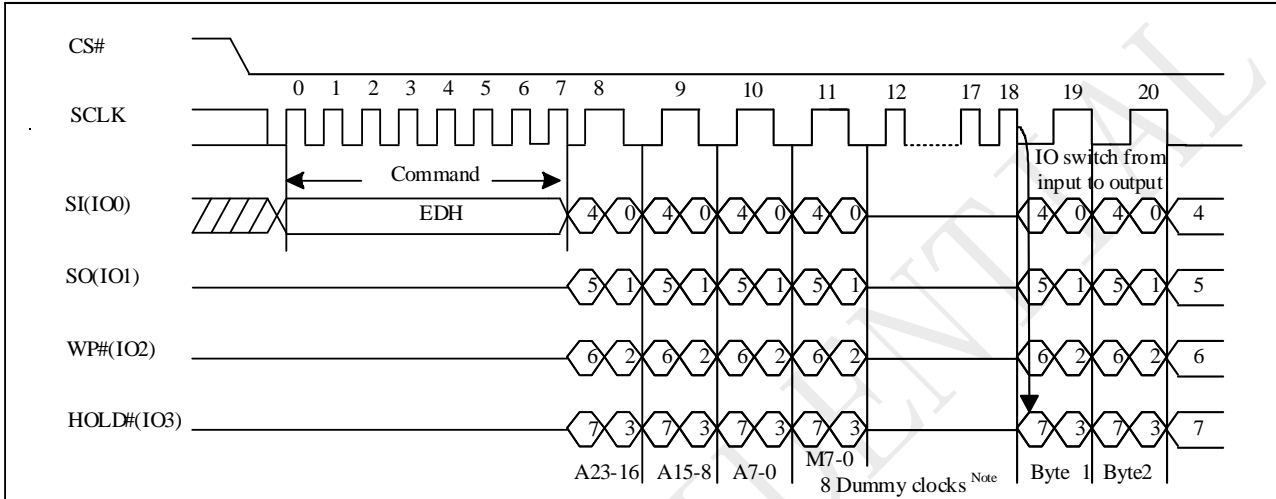
Note:

1. Hi-impedance is inhibited for the mode clock cycles.
2. 4IO Continue Read with 4-Byte Address, if M5-4 = 1, 0. If not using Continue Read recommend to set M5-4 ≠ 1, 0.
3. DC bit can set the number of dummy clocks.

10.27 DTR 4IO Read (DTR_4READ EDH)

The DTR 4IO Read (EDh) instruction is similar to the DTR 2IO Read (BDh) instruction except that address and data bits are input and output through four pins IO0, IO1, IO2 and IO3 and four Dummy clocks are required in SPI mode prior to the data output. The Quad I/O dramatically reduces instruction overhead allowing faster random access for code execution (XIP) directly from the Quad SPI. The Quad Enable bit (QE) of Status Register-2 must be set to enable the DTR 4IO Read Instruction.

Figure 10-27 DTR 4IO Read Mode Sequence (SPI, M5-4 ≠ (1,0))



Note:

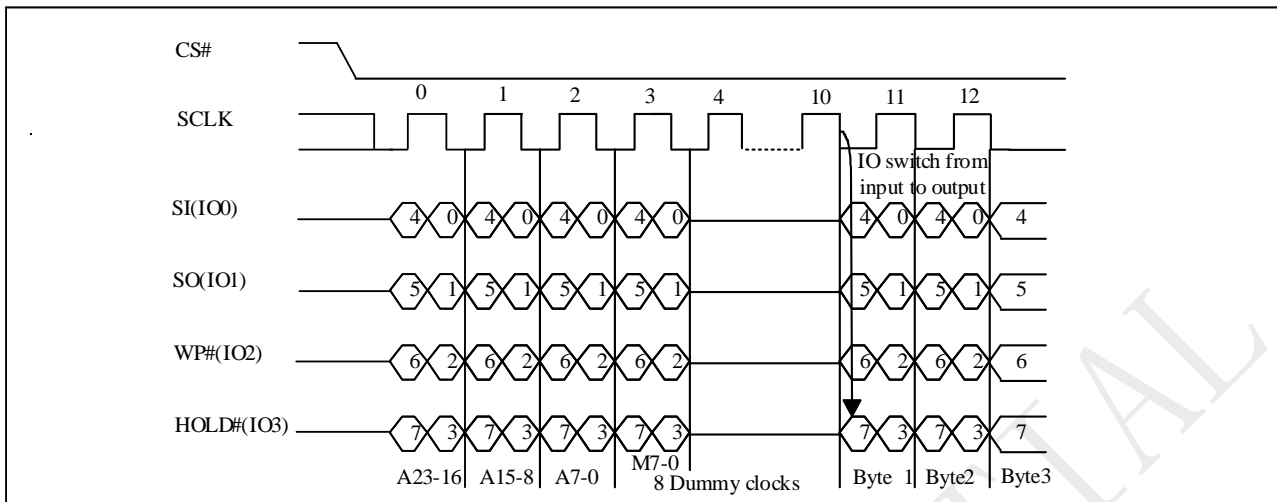
1. Hi-impedance is inhibited for the mode clock cycles.
2. M[5-4] = (1,0) is inhibited.
3. 32-bit address is required when the device is operation in 4-Byte Address Mode.
4. DC bit can set the number of dummy clocks.

DTR 4IO Continuous Read

The DTR 4IO Read instruction can further reduce instruction overhead through setting the “Continuous Read Mode” bits (M7-0) after the input Address bits (A23/A31-0). The upper nibble of the (M7-4) controls the length of the next DTR 4IO Read instruction through the inclusion or exclusion of the first byte instruction code. The lower nibble bits of the (M3-0) are don't care (“x”). However, the IO pins should be high-impedance prior to the falling edge of the first data out clock.

If the “Continuous Read Mode” bits M5-4 = (1,0), then the next DTR 4IO Read instruction (after CS# is raised and then lowered) does not require the EDh instruction code. This reduces the instruction sequence by eight clocks and allows the Read address to be immediately entered after CS# is asserted low. If the “Continuous Read Mode” bits M5-4 do not equal to (1,0), the next instruction (after CS# is raised and then lowered) requires the first byte instruction code, thus returning to normal operation. It is recommended to input FFh/3FFh on IO0 for the next instruction (8/10 clocks), to ensure M4 = 1 and return the device to normal operation.

Figure 10-27a DTR 4IO Continuous Read Mode Sequence (M5-4 = (1,0))



Note:

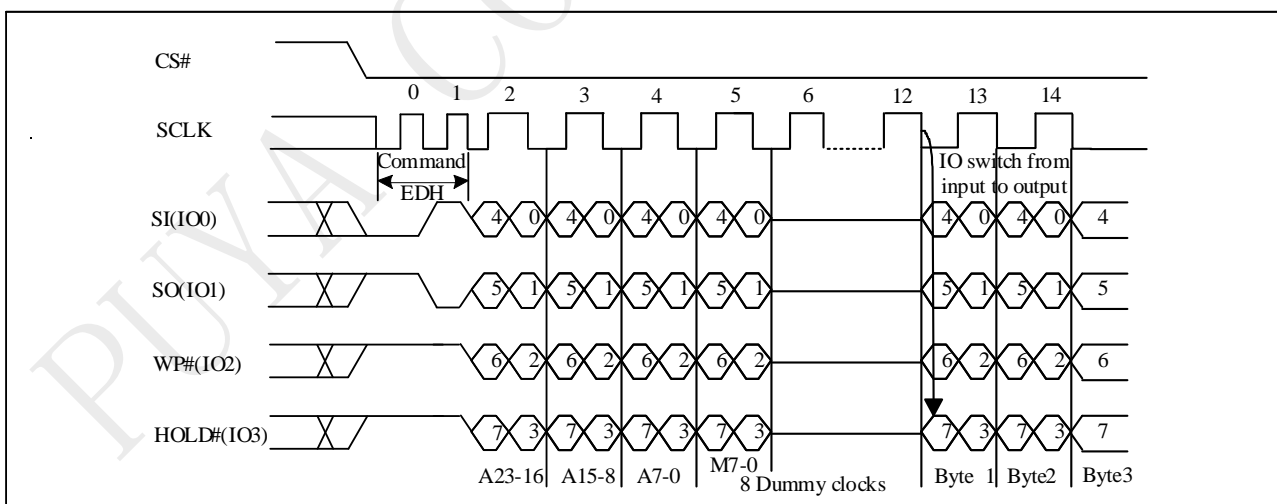
1. Hi-impedance is inhibited for the mode clock cycles.
2. DTR 4IO Continuous Read, if M5-4 = 1, 0. If not using Continuous Read recommend to set M5-4 ≠ 1, 0.
3. 32-bit address is required when the device is operation in 4-Byte Address Mode.
4. DC bit can set the number of dummy clocks.

DTR 4IO Read (EDh) in QPI Mode

The DTR 4IO Read instruction is also supported in QPI mode. In QPI mode, the “Continuous Read Mode” bits M7-0 are also considered as dummy clocks. In the default setting, the data output will follow the Continuous Read Mode bits immediately.

“Continuous Read Mode” feature is also available in QPI mode for DTR 4IO Read instruction. “Wrap Around” feature is not available in QPI mode for DTR 4IO Read instruction.

Figure 10-27b DTR 4IO Read Mode Sequence (QPI, M5-4 ≠ (1,0))



Note:

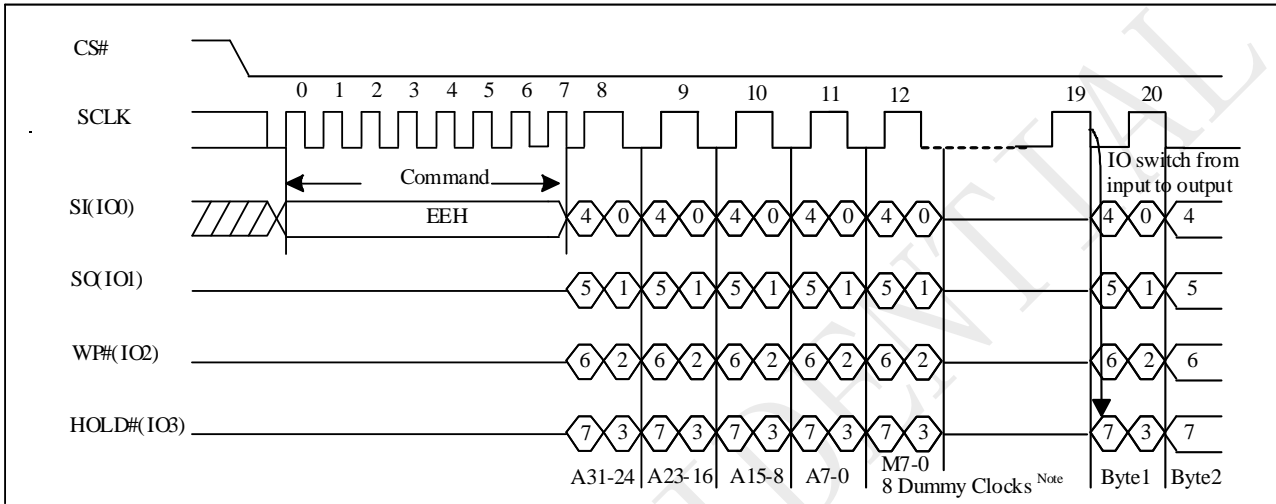
1. Hi-impedance is inhibited for the two clock cycles.
2. M[5-4] = (1,0) is inhibited.
3. 32-bit address is required when the device is operation in 4-Byte Address Mode.
4. C0H command can set the number of dummy clocks.

10.28 DTR 4IO Read with 4-Byte Address (DTR_4READ4B EEH)

The DTR 4IO Read with 4-Byte Address (EEh) instruction is similar to the DTR 4IO Read (EDh) instruction except that it requires 32-bit address instead of 24-bit address. No matter the device is operating in 3-Byte Address Mode or 4-Byte Address Mode, the DTR 4IO Read with 4-Byte Address instruction will always require 32-bit address to access the entire 1Gb memory.

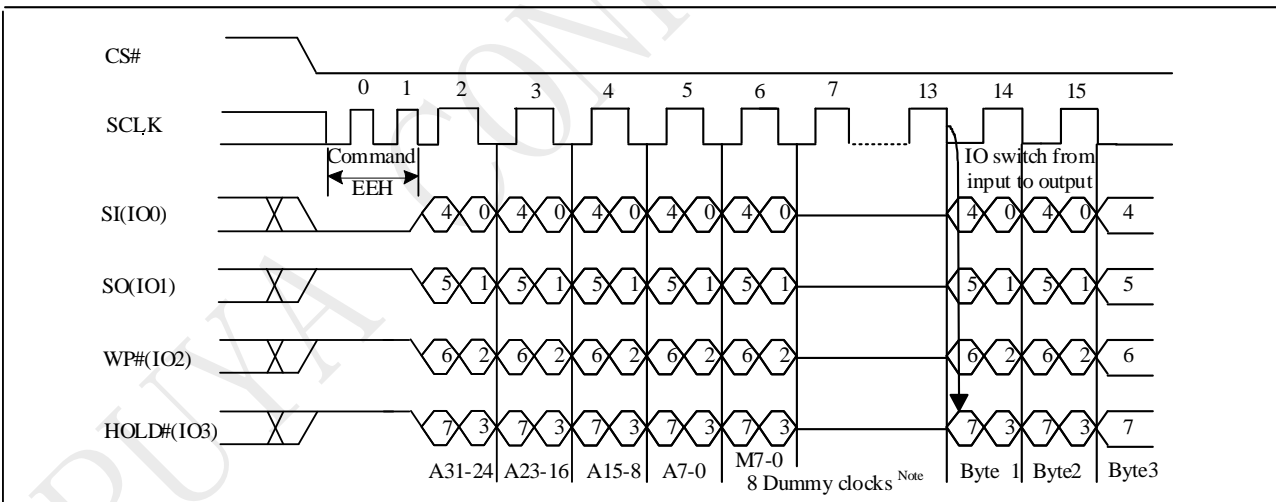
The DTR 4IO Read with 4-Byte Address (EEh) instruction is only supported in Standard SPI mode.

Figure 10-28 DTR 4IO Read with 4-Byte Address Sequence (SPI, M5-4 ≠ (1,0))



Note: DC bit can set the number of dummy clocks.

Figure 10-28a DTR 4IO Read with 4-Byte Address Sequence (QPI, M5-4 ≠ (1,0))



Note:

1. Hi-impedance is inhibited for the mode clock cycles.
2. M[5-4] = (1,0) is inhibited.
3. DC bit can set the number of dummy clocks.

10.29 Set Read Parameters (C0h)

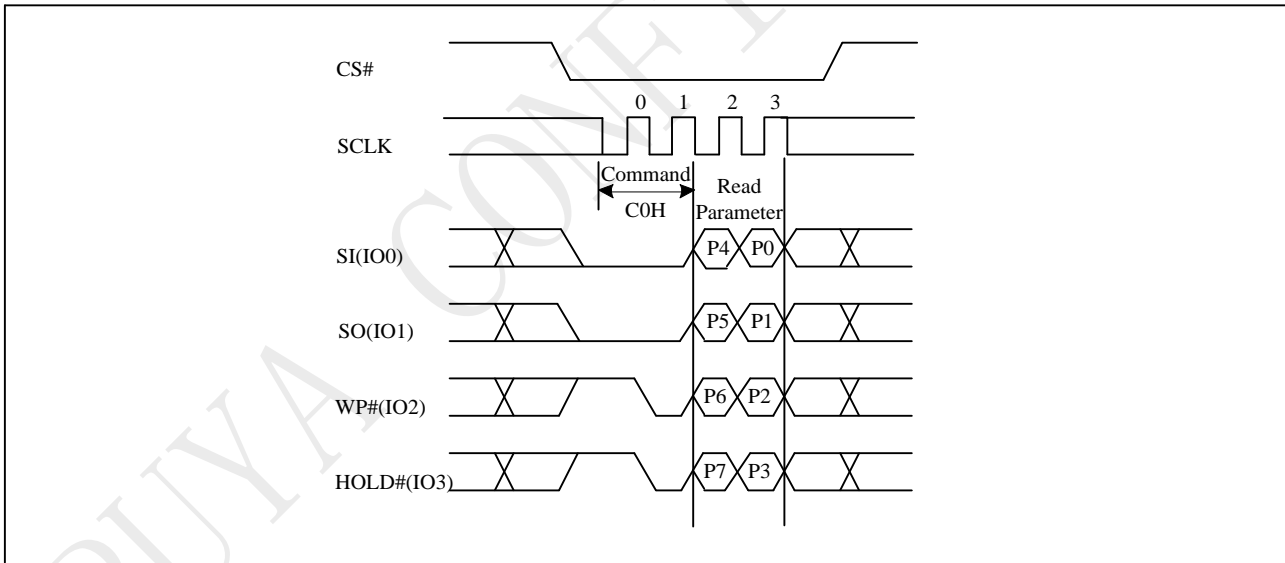
In QPI mode, to accommodate a wide range of applications with different needs for either maximum read frequency or minimum data access latency, “Set Read Parameters (C0h)” instruction can be used to configure the number of dummy clocks for “Fast Read (0Bh)”, “4IO Read (EBh)”, “DTR 4IO Read (EDh)” and “Read SFDP Mode (5Ah)” instructions.

In Standard SPI mode, the “Set Read Parameters (C0h)” instruction is not accepted. The dummy clocks for various Fast Read instructions in Standard/Dual/Quad SPI mode are configured by DC bit. This setting will remain unchanged when the device is switched from Standard SPI mode to QPI mode.

The default number of dummy clocks after a power up or a Reset instruction is 12 for STR mode and 10 for DTR mode. The number of dummy clocks is only programmable for “Fast Read (0Bh)”, “4IO Read (EBh)”, “DTR Fast Read (0Dh)”, “DTR 4IO Read (EDh)” instructions in the QPI mode. Whenever the device is switched from SPI mode to QPI mode, the number of dummy clocks should be set again, prior to any read instructions.

| P5-P4 | STR Fast Read | DTR Fast Read |
|-------|---------------|---------------|
| | Dummy Clocks | Dummy Clocks |
| 0,0 | 12 | 10 |
| 0,1 | 6 | 8 |
| 1,0 | 8 | 6 |
| 1,1 | 10 | 12 |

Figure 10-29 Set Read Parameters Sequence (QPI)



10.30 Data Learning Pattern

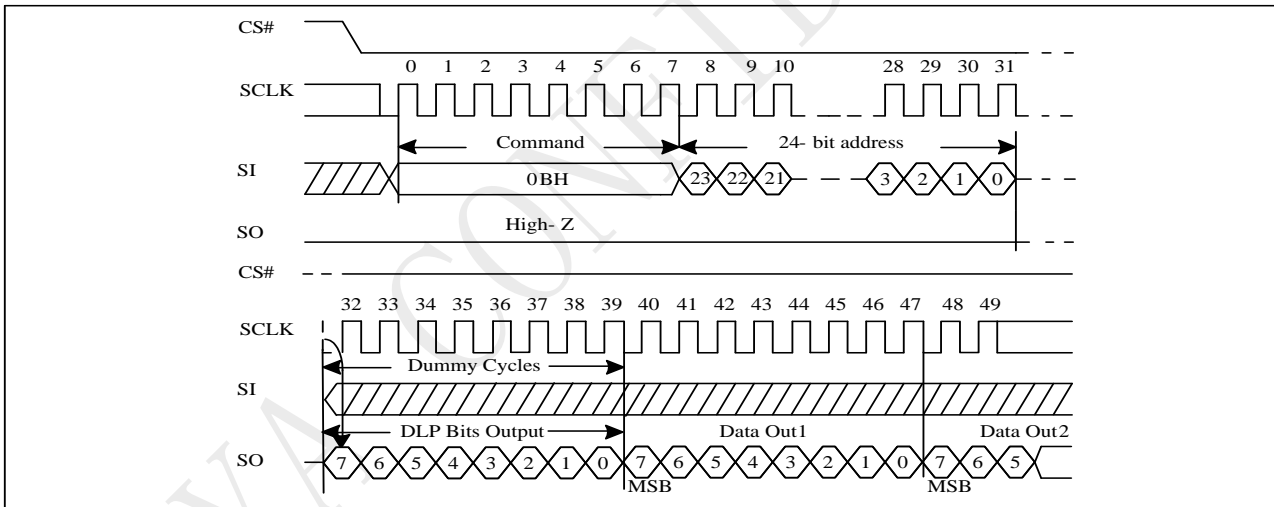
The data learning pattern supports system/memory controller determine valid window of data output more easily and improve data capture reliability while the flash memory is running in high frequency.

Data learning pattern can be enabled or disabled by setting the bit7 of EA Register (DLP bit). Once the DLP bit is set, the data learning pattern is outputted in the dummy cycles. Enabling data learning pattern bit (DLP bit) will not affect the function of continue read mode bit. In dummy cycles, continuous mode bit still operates with the same function. Data learning pattern will output after continuous mode bit.

The data learning pattern is a fixed 8-bit data pattern (00110100). For STR (single transfer rate) 1 x I/O and Dual Read (3BH) instructions, the complete 8 bits will start to output right after the last address bit. For Quad Read (6BH) instruction, complete 8 bits will start to output right after 2 dummy cycles. For DTR (double transfer rate) 1 x I/O instructions, the complete 8 bits will start to output right after 2 dummy cycles. For STR/DTR (double transfer rate) 2x I/O instructions, the complete 8 bits will start to output right after 4 dummy/M7-0 cycles. For STR/DTR (double transfer rate) 4x I/O instructions, the complete 8 bits will start to output right after 2 dummy/M7-0 cycles. While DLP output cycle is not sufficient of 8 cycles, the rest of the DLP bits will be cut. While DLP output cycle exceeds 8 cycles, the DLP output data will repeat with the data pattern.

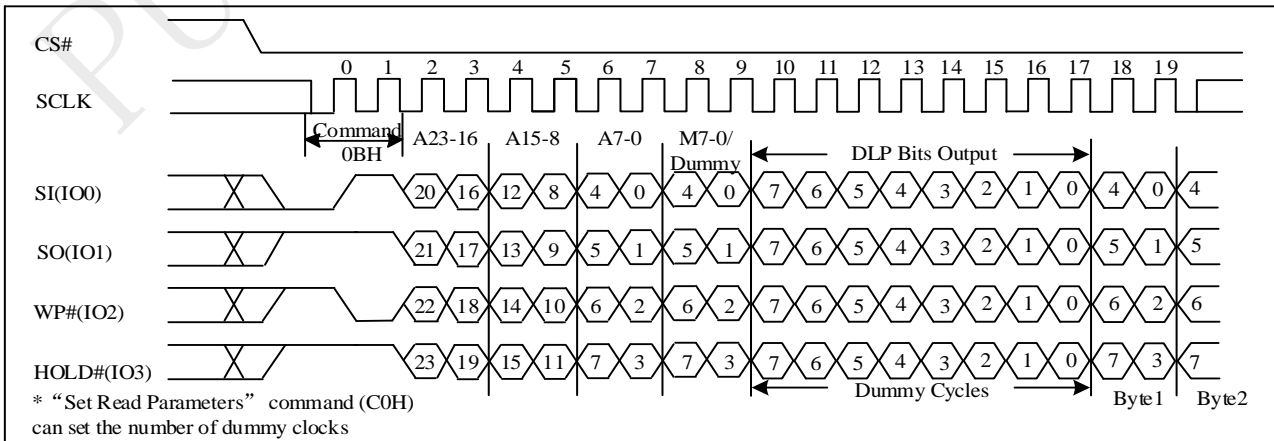
For Read UID, Read Security Register and Read SFDP instructions, the DLP output is same as STR Fast Read command in both SPI and QPI mode.

Figure 10-30 Fast Read with DLP bits output Sequence (SPI)



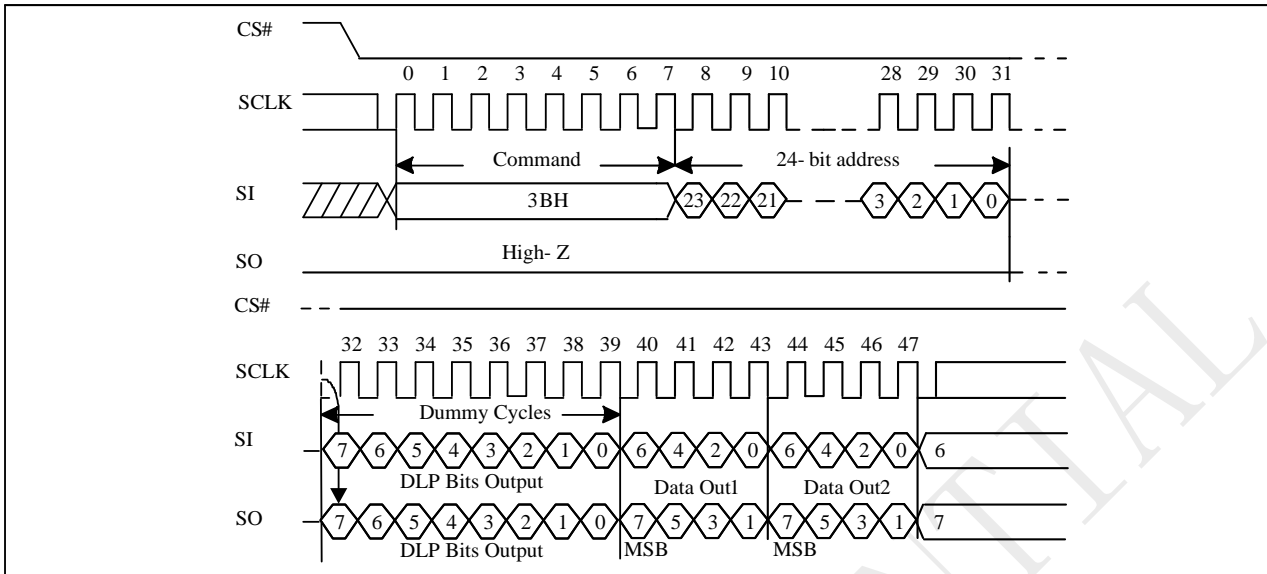
Note: The DLP bit is also valid for 4-byte 0BH and 0CH instruction.

Figure 10-30a Fast Read with DLP bits output Sequence (QPI)



* "Set Read Parameters" command (C0H) can set the number of dummy clocks

Figure 10-30b Dual Read with DLP bits output Sequence (SPI)



Note: The DLP bit is also valid for 4-byte 3BH and 3CH instruction

Figure 10-30c Quad Read with DLP bits output Sequence (SPI)

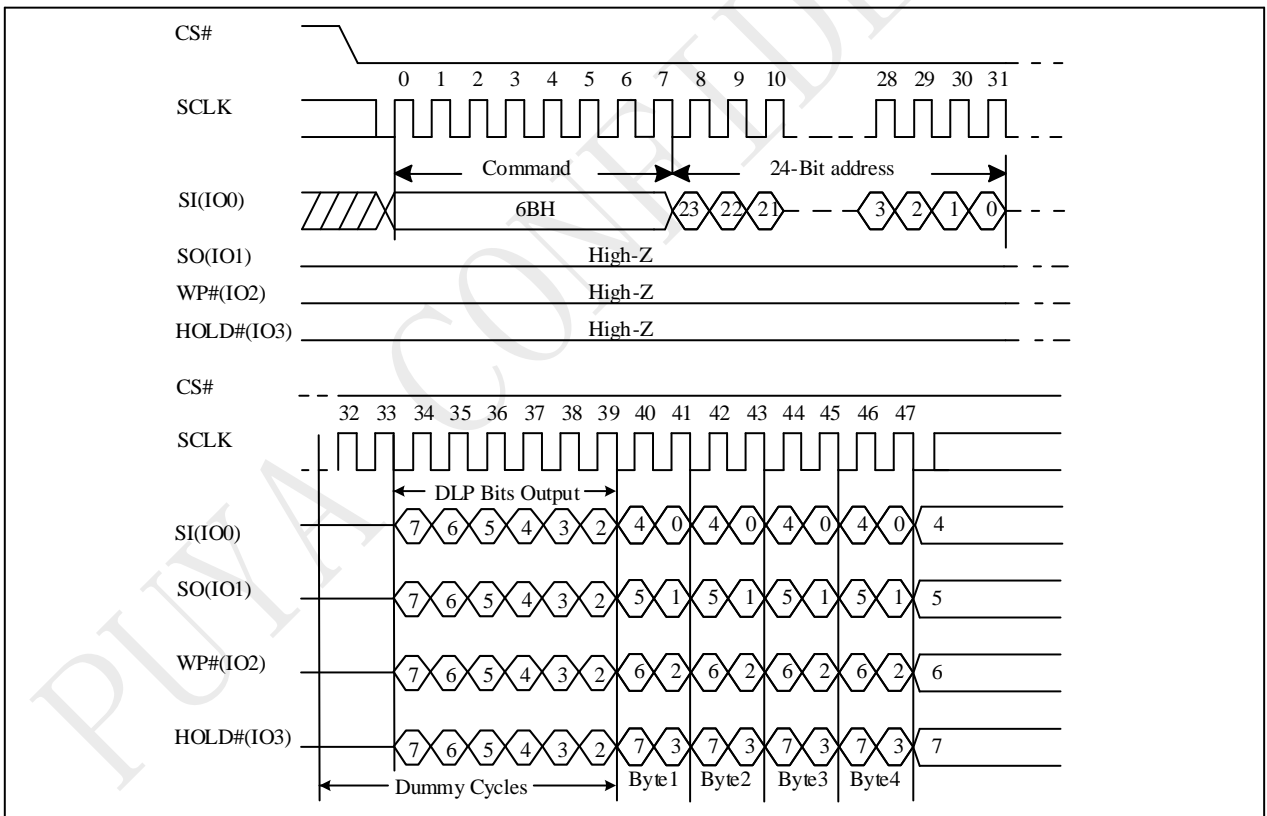
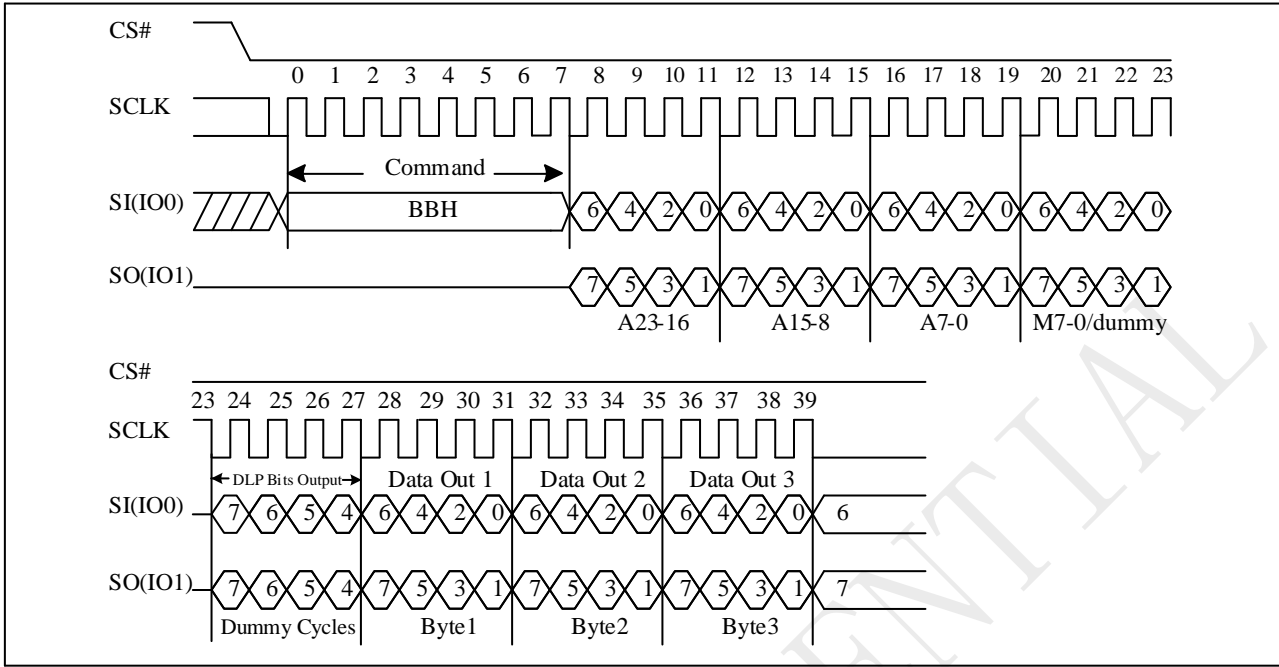
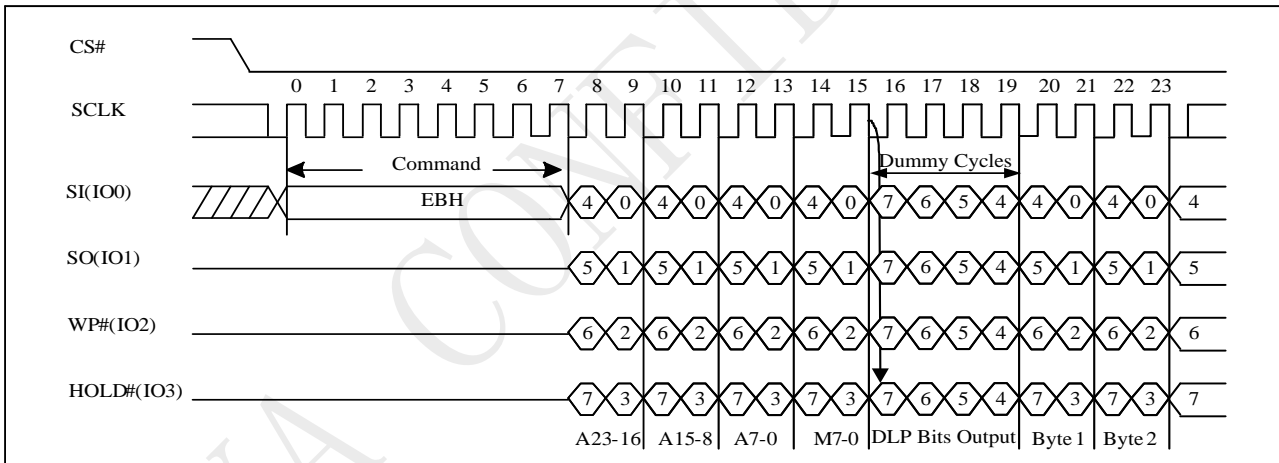


Figure 10-30d 2IO Read with DLP bits output Sequence (SPI)



Note: The DLP bit is also valid for 4-byte BBH and BCH instruction

Figure 10-30e 4IO Read with DLP bits output Sequence (SPI)



Note: The DLP bit is also valid for 4-byte EBH and ECH instruction

Figure 10-30f 4IO Read with DLP bits output Sequence (QPI)

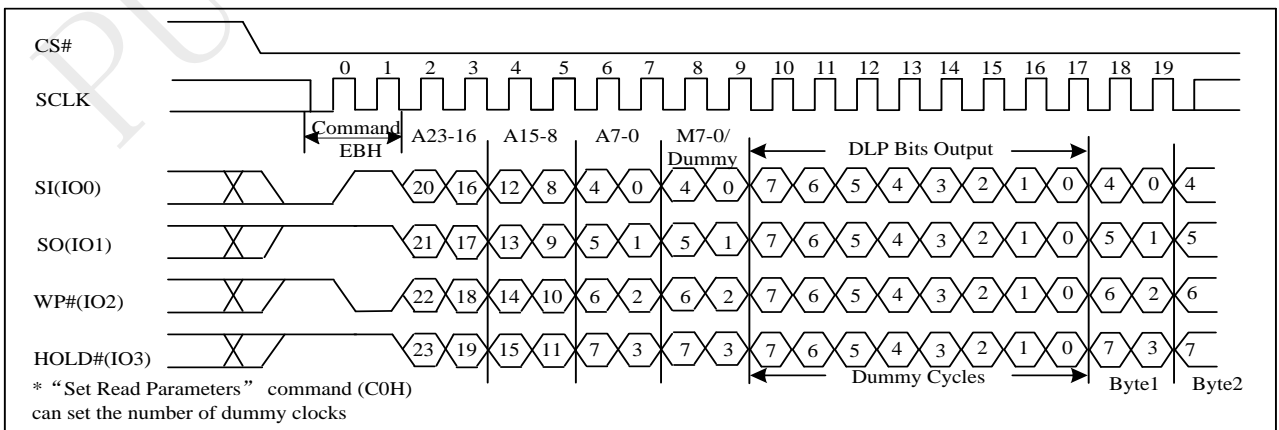
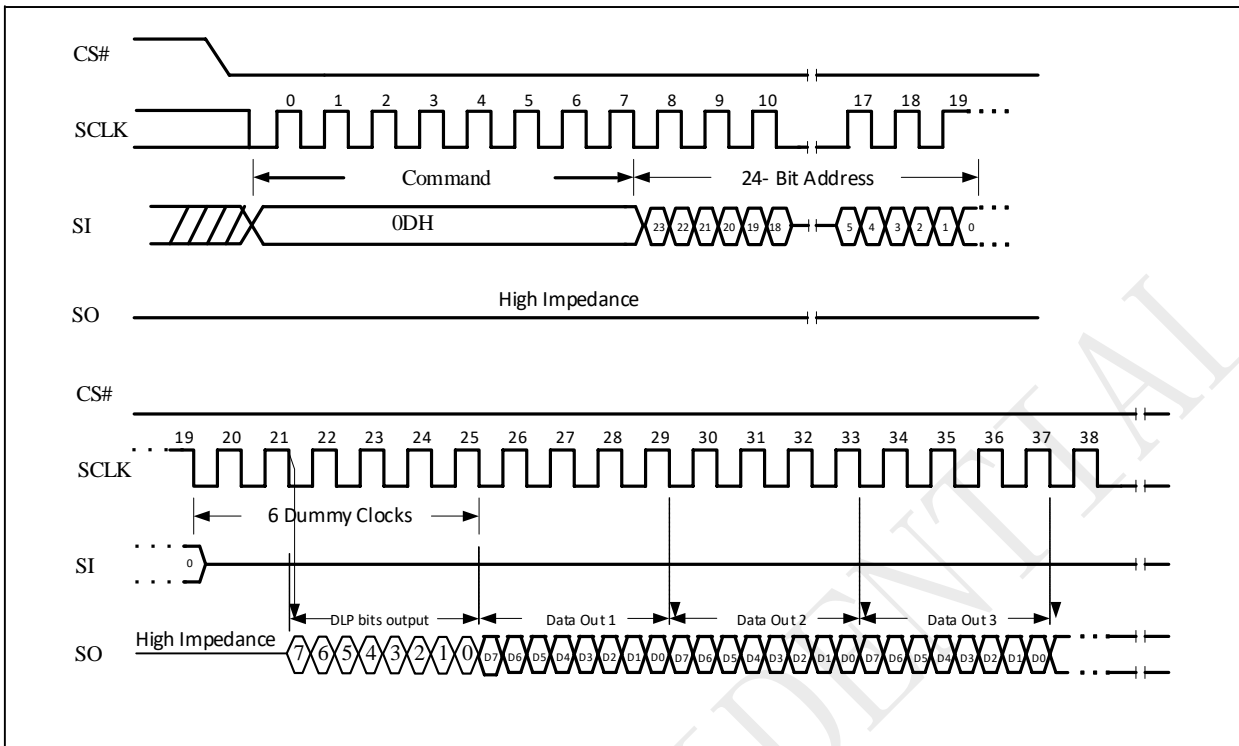


Figure 10-30g DTR 1IO Read with DLP bits output Sequence (SPI)



Note: The DLP bit is also valid for SPI 4-byte 0DH instruction

Figure 10-30h DTR 1IO Read with DLP bits output Sequence (QPI)

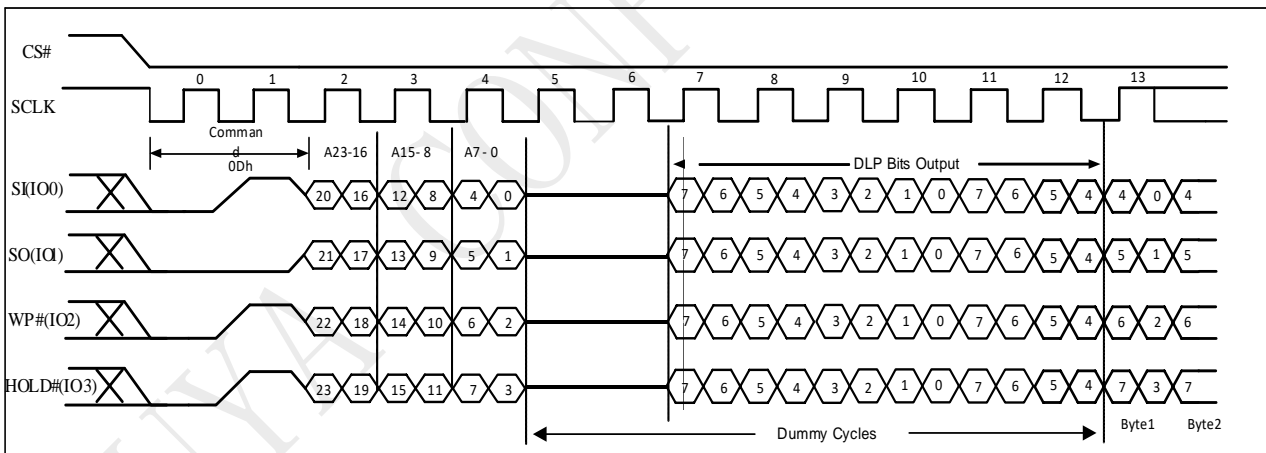
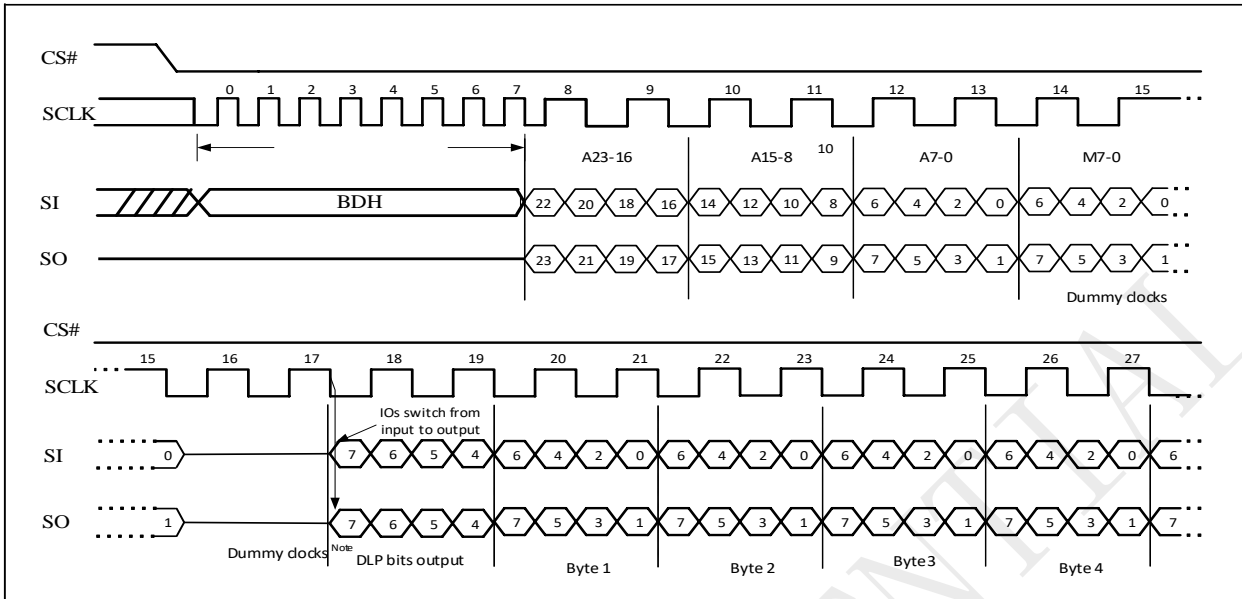
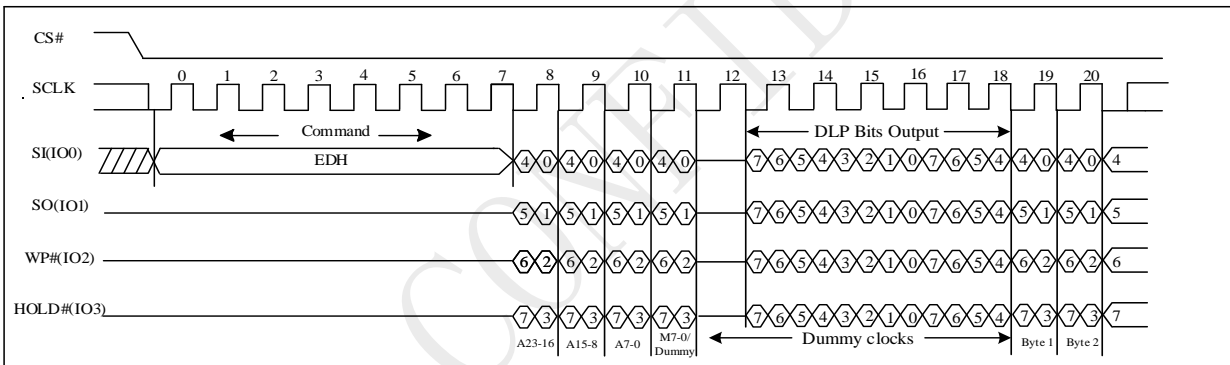


Figure 10-30i DTR 2IO Read with DLP bits output Sequence (SPI)



Note: 1. The DLP bit is also valid for 4-byte BDH instruction

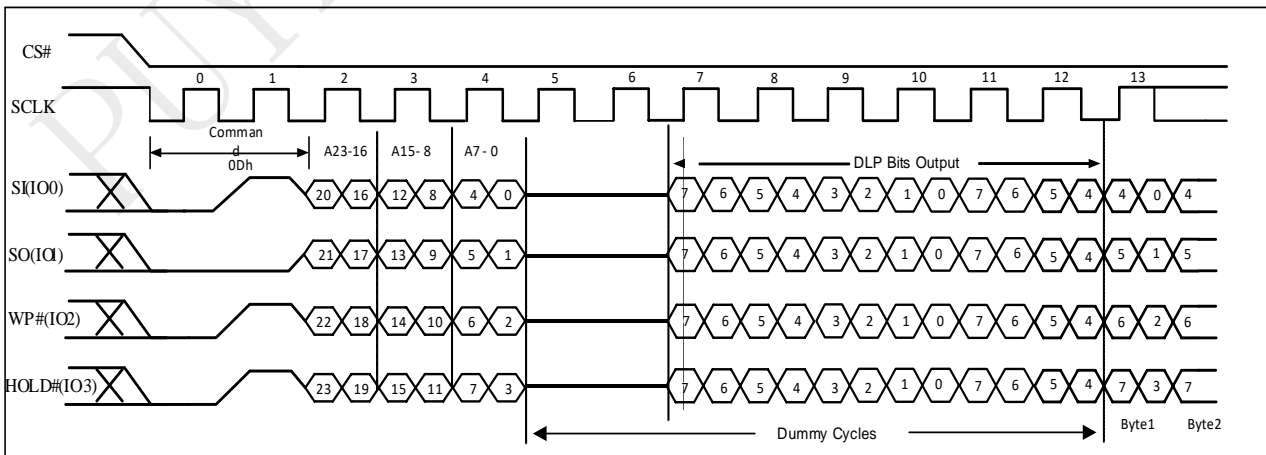
Figure 10-30j DTR 4IO Read with DLP bits output Sequence (SPI)



Note:

1. The DLP bit is also valid for 4-byte EDH and EEH instruction and QPI 4IO DTR read instruction.

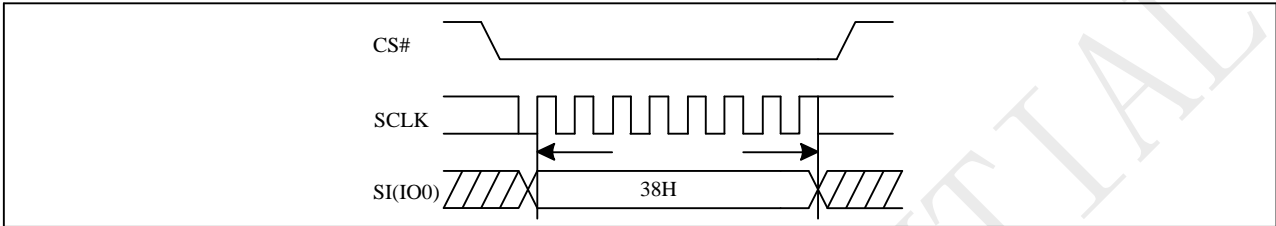
Figure 10-30k DTR 4IO Read with DLP bits output Sequence (QPI)



10.31 Enable QPI (QPIEN 38H)

The device support both Standard/Dual/Quad SPI and QPI mode. The “Enable QPI (38H)” command can switch the device from SPI mode to QPI mode. In order to switch the device to QPI mode, the Quad Enable (QE) bit in Status Register-1 must be set to 1 first, and “Enable QPI (38H)” command must be issued. If the QE bit is 0, the “Enable QPI (38H)” command will be ignored and the device will remain in SPI mode. When the device is switched from SPI mode to QPI mode, the existing Write Enable Latch and Program/Erase Suspend status will remain unchanged.

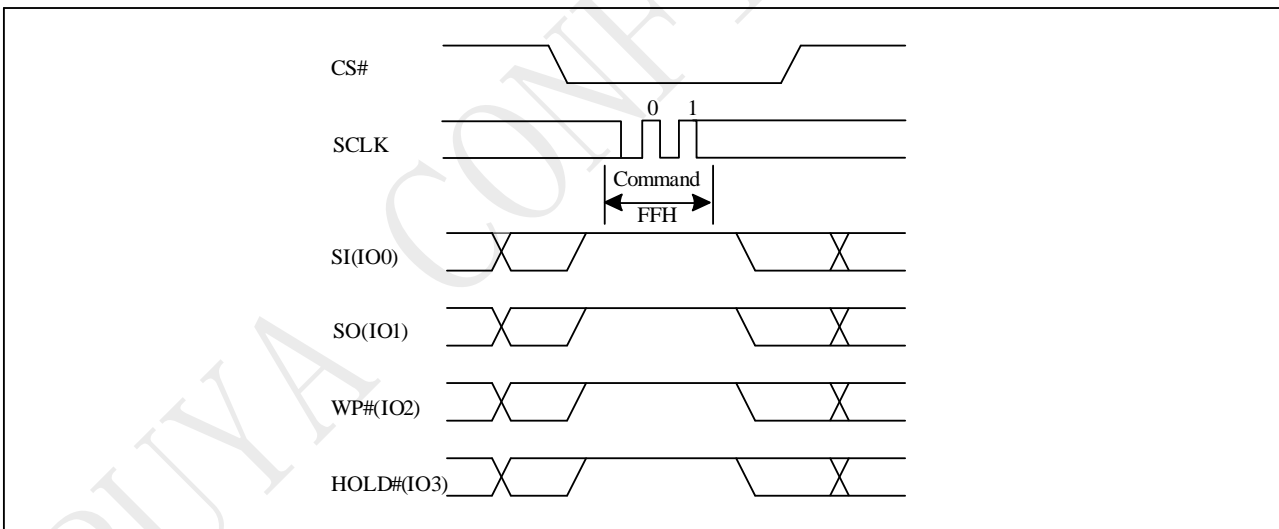
Figure 10-31 Enable QPI Sequence (SPI)



10.32 Disable QPI (FFH)

To exit the QPI mode and return to Standard/Dual/Quad SPI mode, the “Disable QPI (FFH)” command must be issued. When the device is switched from QPI mode to SPI mode, the existing Write Enable Latch and Program/Erase Suspend status will remain unchanged.

Figure 10-32 Disable QPI Sequence (QPI)



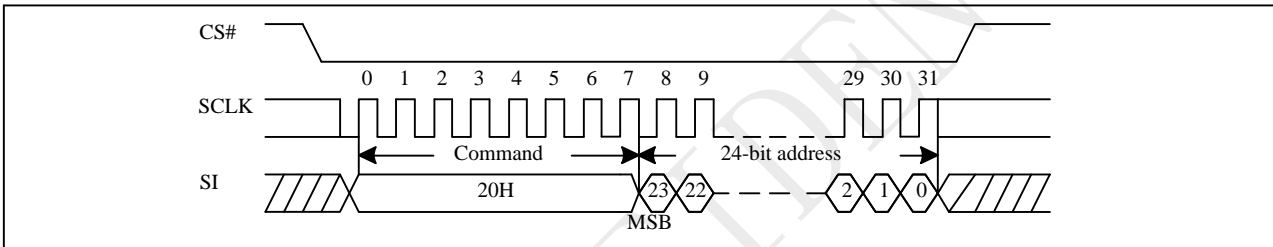
10.33 Sector Erase (SE 20H)

The Sector Erase (SE) instruction is for erasing the data of the chosen sector to be "1". A Write Enable (WREN) instruction must execute to set the Write Enable Latch (WEL) bit before sending the Sector Erase (SE). Any address of the sector is a valid address for Sector Erase (SE) instruction. The CS# must go high exactly at the byte boundary (the latest eighth of address byte been latched-in); otherwise, the instruction will be rejected and not executed. Address bits [Am-A12] (Am is the most significant address) select the sector address.

The sequence of issuing SE instruction is: CS# goes low → sending SE instruction code → 3/4-byte address on SI → CS# goes high.

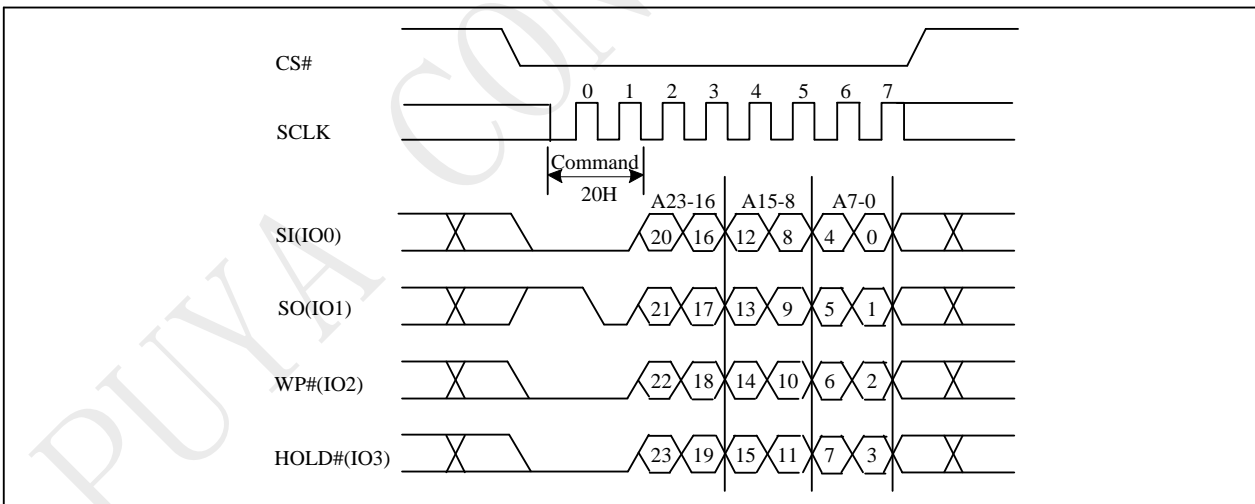
The self-timed Sector Erase Cycle time (tSE) is initiated as soon as Chip Select (CS#) goes high. The Write in progress (WIP) bit still can be check out during the Sector Erase cycle is in progress. The WIP sets 1 during the tSE timing, and sets 0 when Sector Erase Cycle is completed, and the Write Enable Latch (WEL) bit is reset. If the sector is protected by BP4, BP3, BP2, BP1, BP0 bits, the Sector Erase (SE) instruction will not be executed on the sector.

Figure 10-33 Sector Erase (SE) Sequence (SPI)



Note:32-bit address is required when the device is operation in 4-Byte Address Mode.

Figure 10-33a Sector Erase (SE) Sequence (QPI)

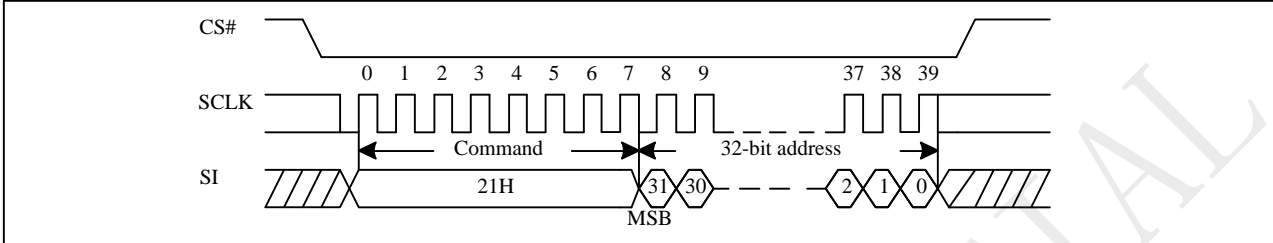


Note:32-bit address is required when the device is operation in 4-Byte Address Mode.

10.34 Sector Erase with 4-Byte Address (SE4B 21H)

The Sector Erase with 4-Byte Address instruction is similar to the Sector Erase instruction except that it requires 32-bit address instead of 24-bit address. No matter the device is operating in 3-Byte Address Mode or 4-Byte Address Mode, the Sector Erase with 4-Byte Address instruction will always require 32-bit address to access the entire 1Gb memory.

Figure 10-34 Sector Erase with 4-Byte Address Sequence (SPI)

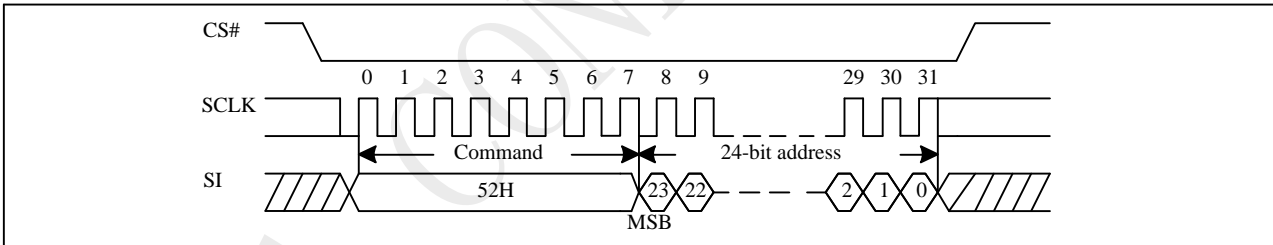


10.35 32K Block Erase (BE32K 52H)

The 32K Block Erase (BE32K) instruction is for erasing the data of the chosen block to be "1". The instruction is used for 32K-byte block erase operation. A Write Enable (WREN) instruction must be executed to set the Write Enable Latch (WEL) bit before sending the Block Erase (BE32K). Any address of the block 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 has been latched-in); otherwise, the instruction will be rejected and not executed.

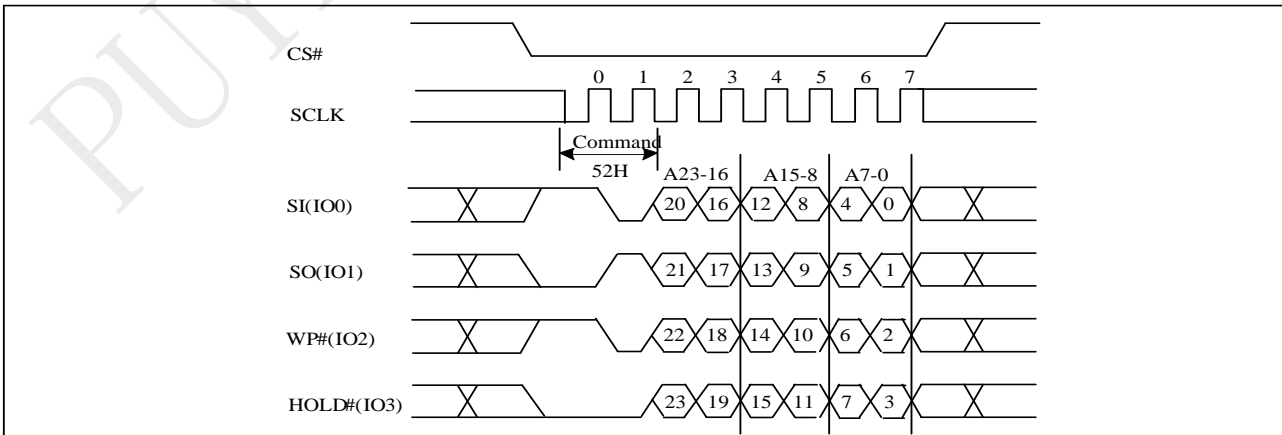
The sequence of issuing BE32K instruction is: CS# goes low → sending BE32K instruction code → 3/4-byte address on SI → CS# goes high.

Figure 10-35 Block Erase 32K(BE32K) Sequence (SPI)



Note: 32-bit address is required when the device is operation in 4-Byte Address Mode.

Figure 10-35a Block Erase 32K(BE32K) Sequence (QPI)

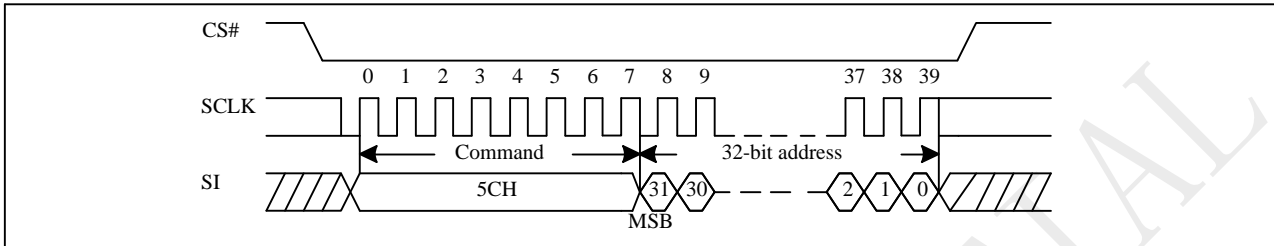


Note: 32-bit address is required when the device is operation in 4-Byte Address Mode.

10.36 32K Block Erase with 4-Byte Address (BE32K4B 5CH)

The 32K Block Erase with 4-Byte Address instruction is similar to the 32K Block Erase instruction except that it requires 32-bit address instead of 24-bit address. No matter the device is operating in 3-Byte Address Mode or 4-Byte Address Mode, the 32K Block Erase with 4-Byte Address instruction will always require 32-bit address to access the entire 1Gb memory.

Figure 10-36 Block Erase 32K with 4-Byte Address (BE32K4B) Sequence (SPI)



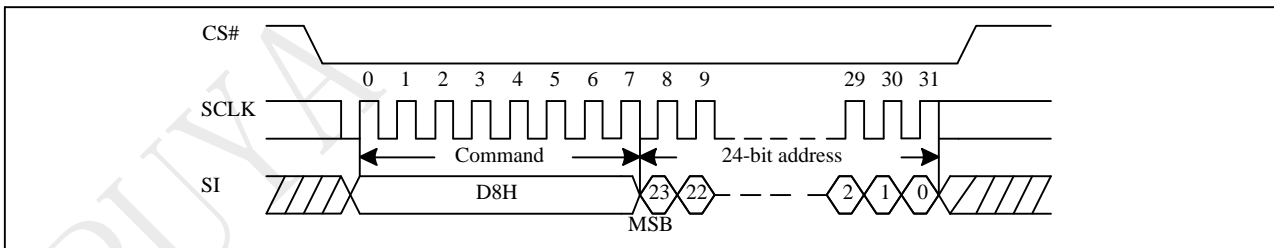
10.37 Block Erase (BE D8H)

The Block Erase (BE) instruction is for erasing the data of the chosen block to be "1". The instruction is used for 64K-byte block erase operation. A Write Enable (WREN) instruction must execute to set the Write Enable Latch (WEL) bit before sending the Block Erase (BE). Any address of the block is a valid address for Block Erase (BE) instruction. The CS# must go high exactly at the byte boundary (the latest eighth of address byte been latched-in); otherwise, the instruction will be rejected and not executed.

The sequence of issuing BE instruction is: CS# goes low → sending BE instruction code → 3/4-byte address on SI → CS# goes high.

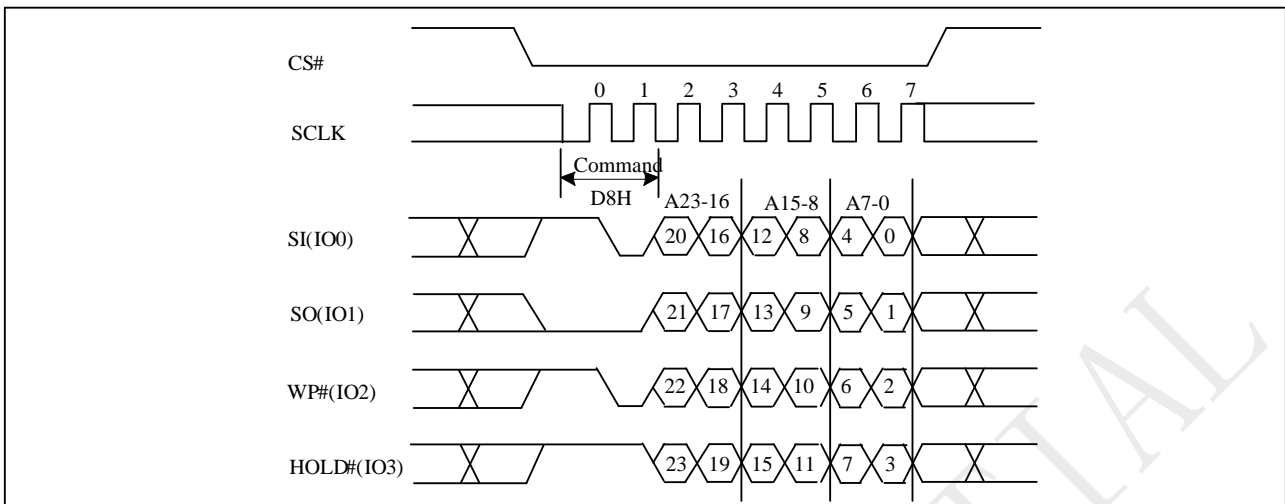
The self-timed Block Erase Cycle time (tBE) is initiated as soon as Chip Select (CS#) goes high. The Write in Progress (WIP) bit still can be checked during the Block Erase cycle is in progress. The WIP sets 1 during the tBE timing, and sets 0 when Block Erase Cycle is completed, and the Write Enable Latch (WEL) bit is reset. If the block is protected by BP4, BP3, BP2, BP1, BP0 bits, the Block Erase (BE32K/BE) instruction will not be executed on the block.

Figure 10-37 Block Erase (BE) Sequence (SPI)



Note: 32-bit address is required when the device is operation in 4-Byte Address Mode.

Figure 10-37a Block Erase (BE) Sequence (QPI)

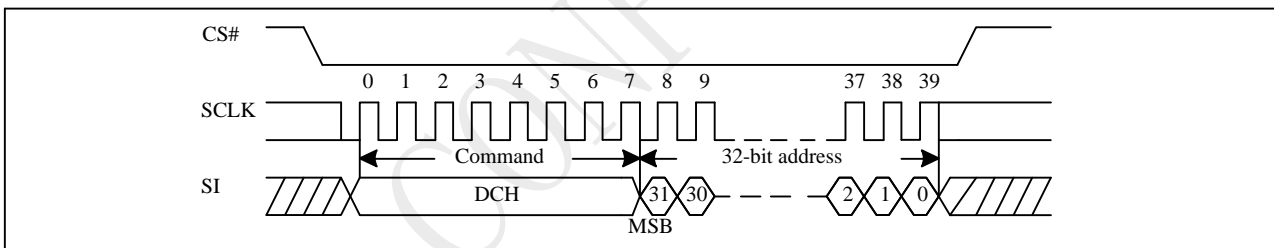


Note: 32-bit address is required when the device is operation in 4-Byte Address Mode.

10.38 Block Erase with 4-Byte Address (BE4B DCH)

The Block Erase with 4-Byte Address instruction is similar to the Block Erase instruction except that it requires 32-bit address instead of 24-bit address. No matter the device is operating in 3-Byte Address Mode or 4-Byte Address Mode, the Block Erase with 4-Byte Address instruction will always require 32-bit address to access the entire 1Gb memory.

Figure 10-38 Block Erase with 4-Byte Address Sequence (SPI)



10.39 Chip Erase (CE 60H/C7H)

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

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

The self-timed Chip Erase Cycle time (t_{CE}) is initiated as soon as Chip Select (CS#) goes high. The Write in Progress (WIP) bit still can be checked during the Chip Erase cycle is in progress. The WIP sets 1 during the t_{CE} timing, and sets 0 when Chip Erase Cycle is completed, and the Write Enable Latch (WEL) bit is reset. If the chip is protected by BP4, BP3, BP2, BP1, BP0 bits, the Chip Erase (CE) instruction will not be executed.

It is noted that in Individual Protect Mode (WPS=1), the GBULK(98H) instruction must previously have been executed before each Chip Erase instruction.

Figure 10-39 Chip Erase (CE) Sequence (SPI)

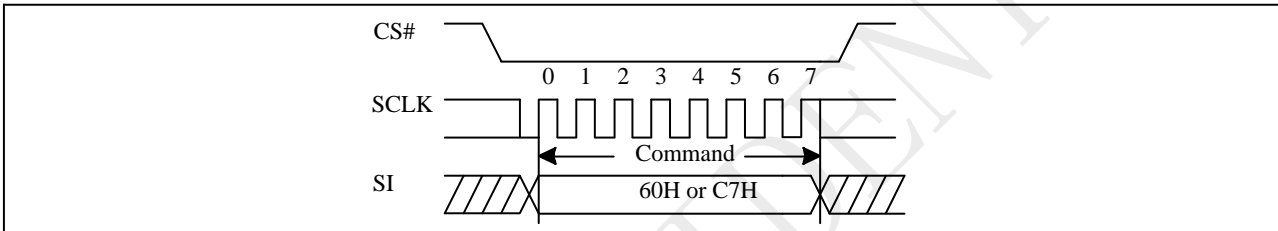
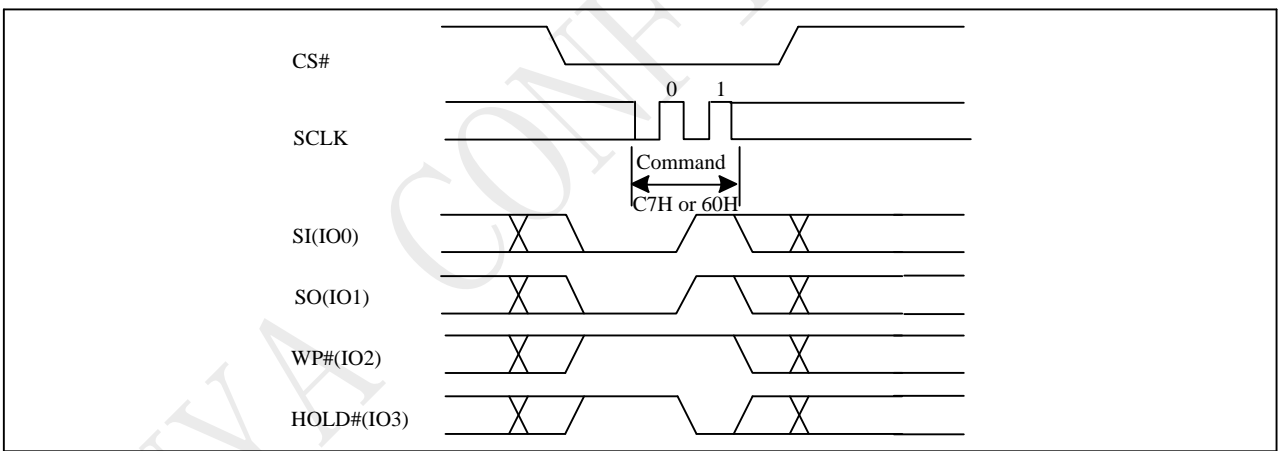


Figure 10-39a Chip Erase (CE) Sequence (QPI)



10.40 Page Program (PP 02H)

The Page Program (PP) instruction is for programming the memory to be "0". A Write Enable (WREN) instruction must execute to set the Write Enable Latch (WEL) bit before sending the Page Program (PP). The device programs only the last 256 data bytes sent to the device. If the entire 256 data bytes are going to be programmed, A7-A0 (The eight least significant address bits) should be set to 0. If the eight least significant address bits (A7-A0) are not all 0, all transmitted data going beyond the end of the current page are programmed from the start address of the same page (from the address A7-A0 are all 0). If more than 256 bytes are sent to the device, the data of the last 256-byte is programmed at the request page and previous data will be disregarded. If less than 256 bytes are sent to the device, the data is programmed at the requested address of the page.

For the very best performance, programming should be done in full pages of 256 bytes aligned on 256 byte boundaries with each Page being programmed only once. Using the Page Program (PP) command to load an entire page, within the page boundary, will save overall programming time versus loading less than a page into the program buffer.

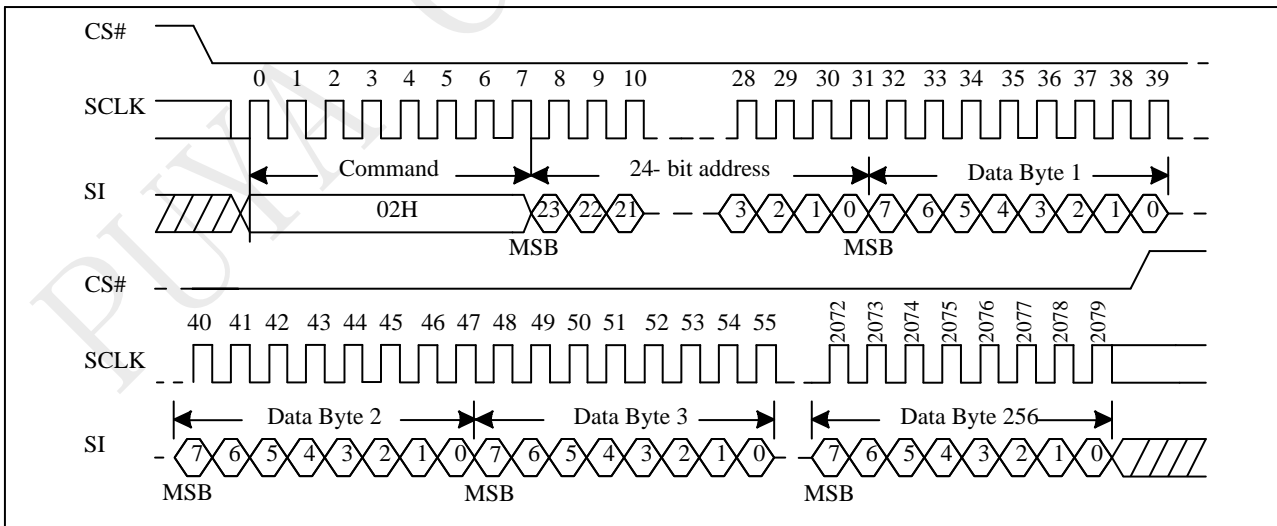
It is possible to program from one byte up to a page size in each Page programming operation. Please refer to the P25Q serial flash application note for multiple byte program operation within one page.

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

The CS# must be kept 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.

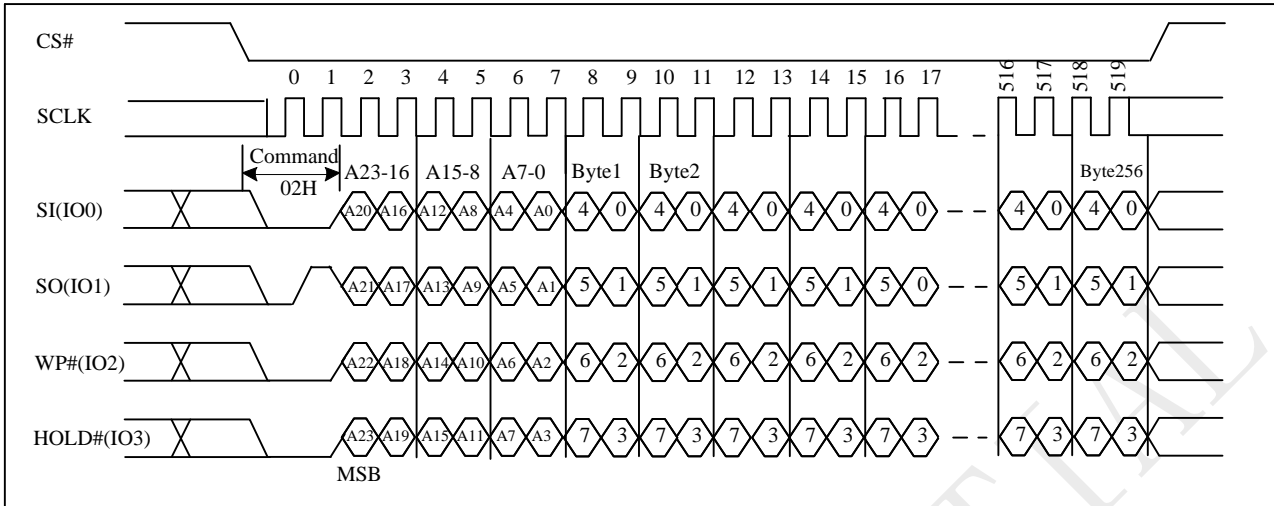
The self-timed Page Program Cycle time (t_{PP}) is initiated as soon as Chip Select (CS#) goes high. The Write in Progress (WIP) bit still can be checked during the Page Program cycle is in progress. The WIP sets 1 during the t_{PP} timing, and sets 0 when Page Program Cycle is completed, and the Write Enable Latch (WEL) bit is reset. If the page is protected by BP4, BP3, BP2, BP1, BP0 bits, the Page Program (PP) instruction will not be executed.

Figure 10-40 Page Program (PP) Sequence (SPI)



Note: 32-bit address is required when the device is operation in 4-Byte Address Mode.

Figure 10-40a Page Program (PP) Sequence (QPI)

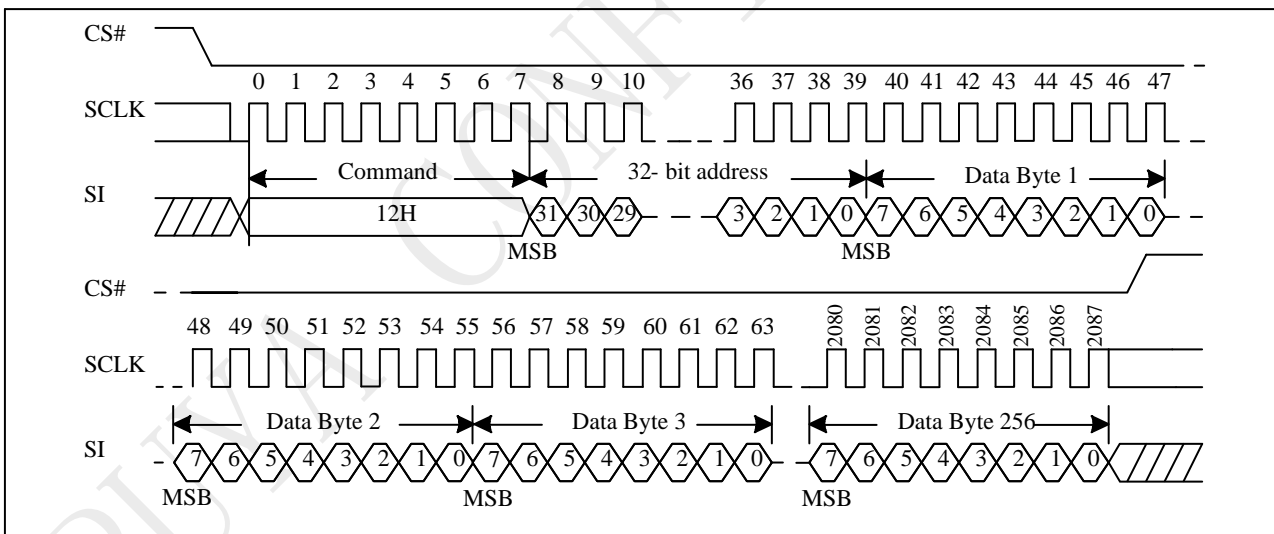


Note:32-bit address is required when the device is operation in 4-Byte Address Mode.

10.41 Page Program with 4-Byte Address (PP4B 12H)

The Page Program with 4-Byte Address instruction is similar to the Page Program instruction except that it requires 32-bit address instead of 24-bit address. No matter the device is operating in 3-Byte Address Mode or 4-Byte Address Mode, the Page Program with 4-Byte Address instruction will always require 32-bit address to access the entire 1Gb memory

Figure 10-41 Page Program with 4-Byte Address Sequence (SPI)

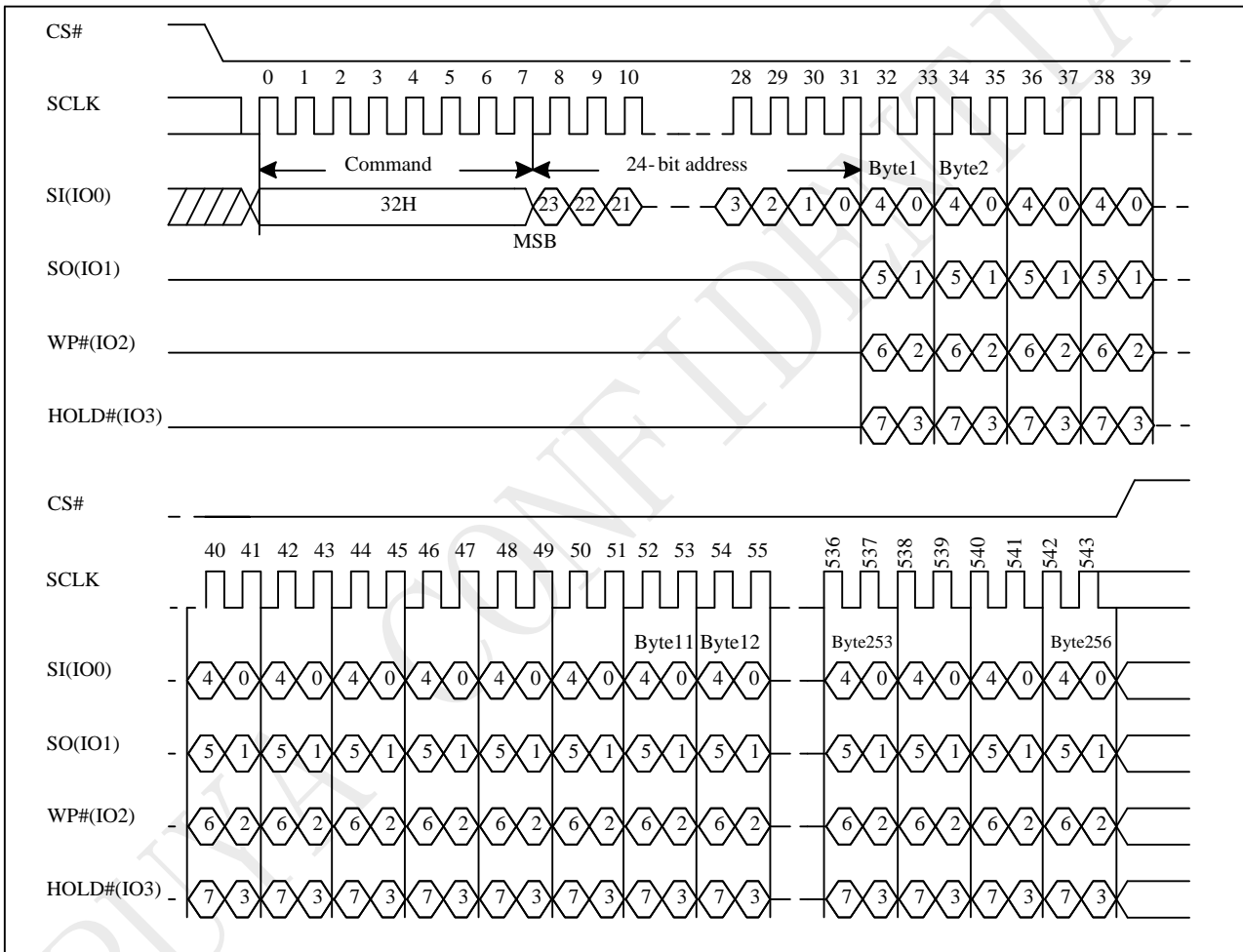


10.42 Quad Page Program (QPP 32H)

The Quad Page Program (QPP) instruction is for programming the memory to be "0". A Write Enable (WREN) instruction must execute to set the Write Enable Latch (WEL) bit and Quad Enable (QE) bit must be set to "1" before sending the Quad Page Program (QPP). The Quad Page Programming takes four pins: SIO0, SIO1, SIO2, and SIO3 as data input, which can improve programmer performance and the effectiveness of application. The QPP operation frequency supports as fast as fQPP. The other function descriptions are as same as standard page program.

The sequence of issuing QPP instruction is: CS# goes low → sending QPP instruction code → 3/4-byte address on SIO0 → at least 1-byte on data on SIO[3:0] → CS# goes high.

Figure 10-42 Quad Page Program (QPP) Sequence (SPI)

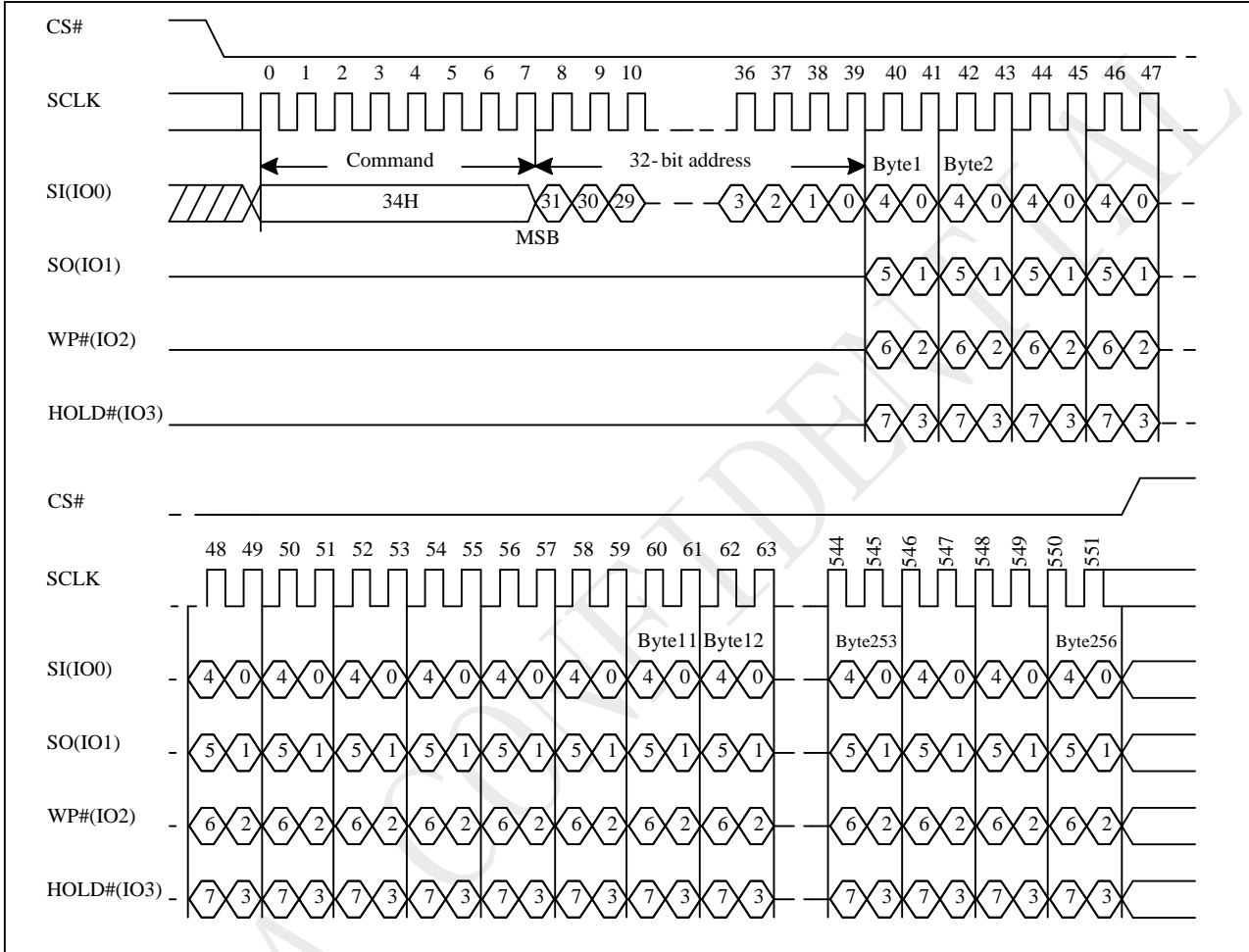


Note: 32-bit address is required when the device is operation in 4-Byte Address Mode.

10.43 Quad Page Program with 4-Byte Address (QPP4B 34H)

The Quad Page Program with 4-Byte Address instruction is similar to the Quad Page Program instruction except that it requires 32-bit address instead of 24-bit address. No matter the device is operating in 3-Byte Address Mode or 4-Byte Address Mode, the Quad Input Page Program with 4-Byte Address instruction will always require 32-bit address to access the entire 1Gb memory.

Figure 10-43 Quad Page Program with 4-Byte Address Sequence (SPI)

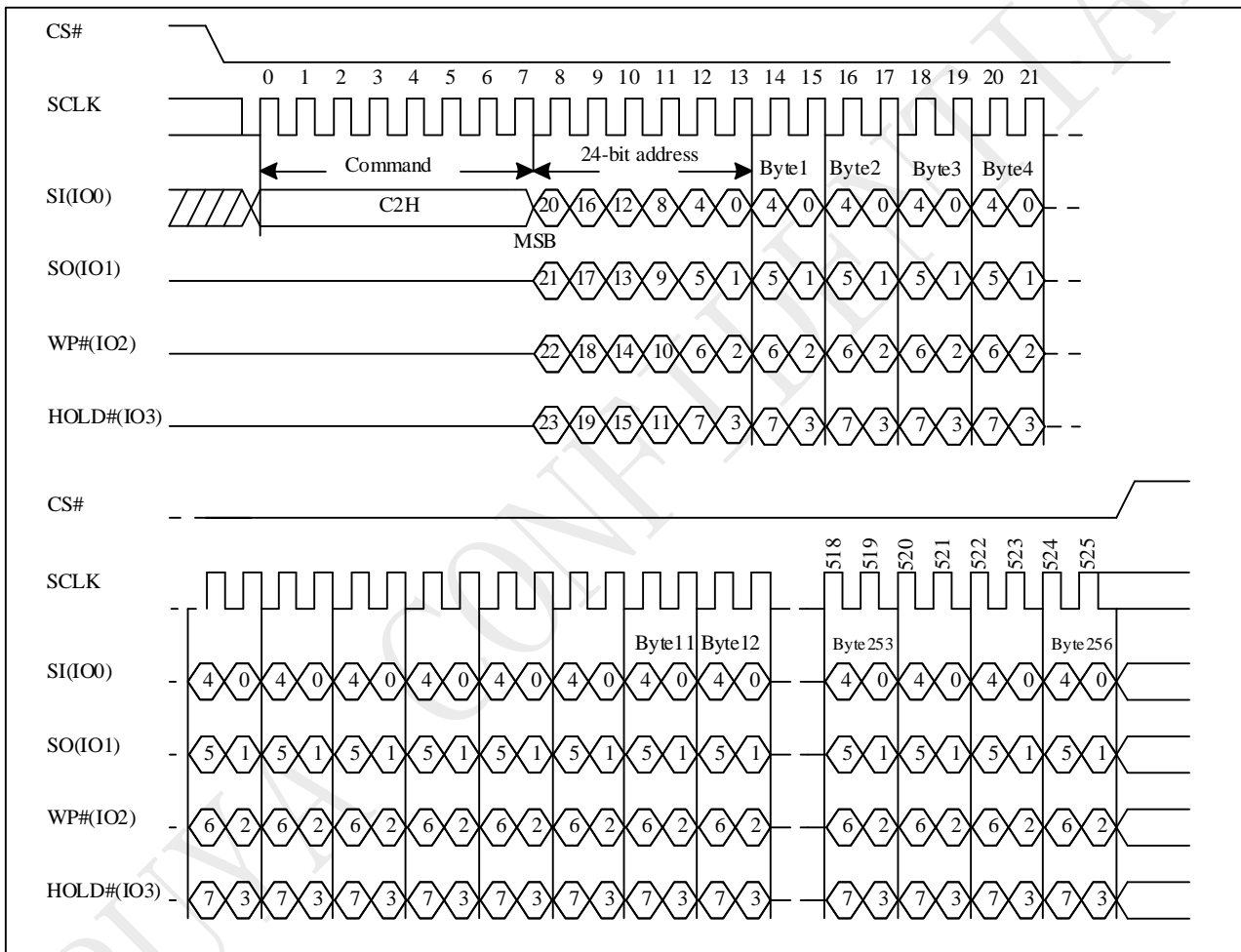


10.44 Quad-In Page Program (QIPP C2H)

The Quad-In Page Program (QIPP) instruction is for programming the memory to be "0". A Write Enable (WREN) instruction must execute to set the Write Enable Latch (WEL) bit and Quad Enable (QE) bit must be set to "1" before sending the Quad-In Page Program (QIPP). The Quad-In 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 QIPP operation frequency supports as fast as fQPP. The other function descriptions are as same as standard page program.

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

Figure 10-44 Quad Page Program (QPP) Sequence (SPI)

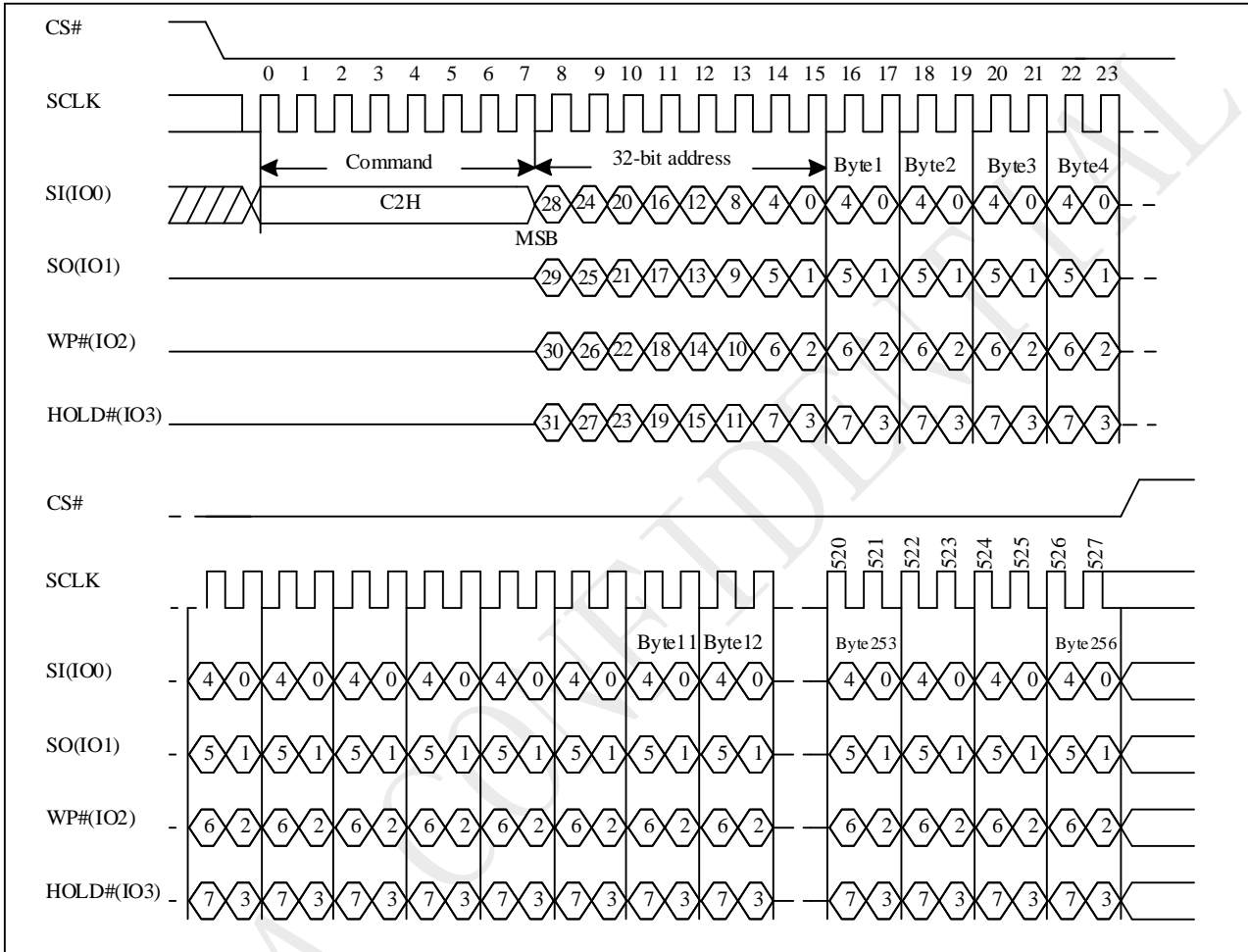


Note: 32-bit address is required when the device is operation in 4-Byte Address Mode.

10.45 Quad-In Page Program with 4-Byte Address (QIPP4B 3EH)

The Quad-In Page Program with 4-Byte Address instruction is similar to the Quad-In Page Program instruction except that it requires 32-bit address instead of 24-bit address. No matter the device is operating in 3-Byte Address Mode or 4-Byte Address Mode, the Quad Input Page Program with 4-Byte Address instruction will always require 32-bit address to access the entire 1Gb memory.

Figure 10-45 Quad-In Page Program with 4-Byte Address Sequence (SPI)



10.46 Erase Security Registers (ERSCUR 44H)

The product provides three 1024-byte Security Registers which can be erased and programmed individually. These registers may be used by the system manufacturers to store security and other important information separately from the main memory array. The Erase Security Registers command is similar to Sector/Block Erase command. A Write Enable (WREN) command must previously have been executed to set the Write Enable Latch (WEL) bit.

The Erase Security Registers command sequence: CS# goes low → sending ERSCUR instruction → sending 24/32-bit address → CS# goes high.

CS# must be driven high after the eighth bit of the command code has been latched in; otherwise the Erase Security Registers command is not executed. As soon as CS# is driven high, the self-timed Erase Security Registers cycle (tSE) is initiated. While the Erase Security Registers cycle is in progress, the Status Register may be read to check the value of the Write in Progress (WIP) bit. The Write in Progress (WIP) bit is 1 during the self-timed Erase Security Registers cycle, and is 0 when it is completed. The Security Registers Lock Bit (LB3-1) in the Status Register can be used to OTP protect the security registers. Once the LB bit is set to 1, the Security Registers will be permanently locked; the Erase Security Registers command will be ignored.

| Address | A31-16/A23-16 | A15-12 | A11-10 | A9-0 |
|----------------------|---------------|--------|--------|------------|
| Security Register #1 | 0000H/00H | 0001 | 00 | Don't care |
| Security Register #2 | 0000H/00H | 0010 | 00 | Don't care |
| Security Register #3 | 0000H/00H | 0011 | 00 | Don't care |

Figure 10-46 Erase Security Registers (ERSCUR) Sequence (SPI)

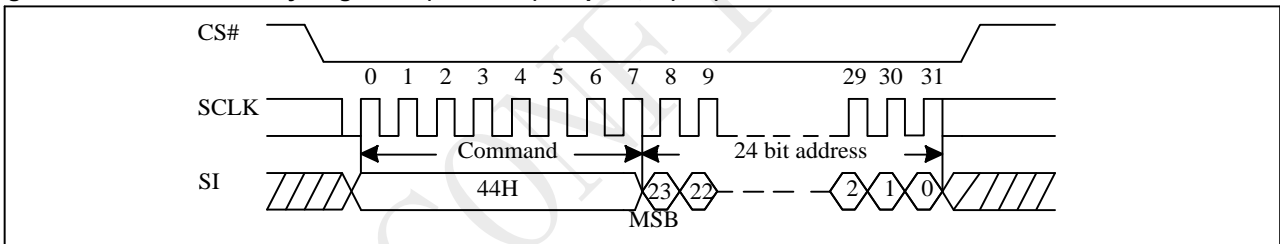
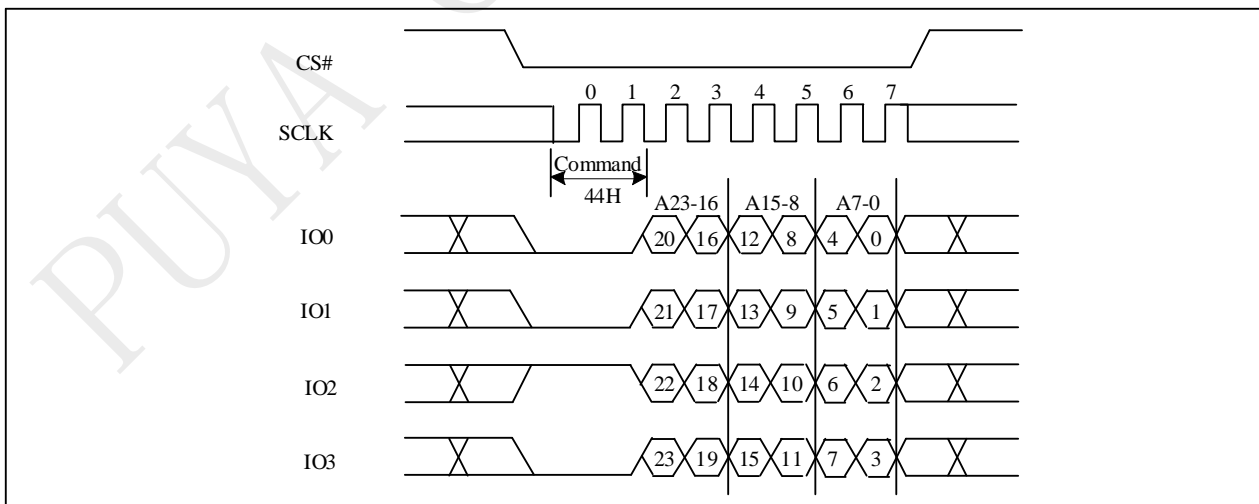


Figure 10-46a Erase Security Registers (ERSCUR) Sequence (QPI)



Note: 32-bit address is required when the device is operation in 4-Byte Address Mode.

10.47 Program Security Registers (PRSCUR 42H)

The Program Security Registers command is similar to the Page Program command. It allows from 1 to 1024 bytes Security Registers data to be programmed. A Write Enable (WREN) command must previously have been executed to set the Write Enable Latch (WEL) bit before sending the Program Security Registers command.

The Program Security Registers command sequence: CS# goes low → sending PRSCUR instruction → sending 24/32 bit address → sending at least one byte data → CS# goes high.

As soon as CS# is driven high, the self-timed Program Security Registers cycle (whose duration is tPP) is initiated. While the Program Security Registers cycle is in progress, the Status Register may be read to check the value of the Write in Progress (WIP) bit. The Write in Progress (WIP) bit is 1 during the self-timed Program Security Registers cycle, and is 0 when it is completed.

If the Security Registers Lock Bit (LB3-1) is set to 1, the Security Registers will be permanently locked. Program Security Registers command will be ignored.

| Address | A31-16/A23-16 | A15-12 | A11-10 | A9-0 |
|----------------------|---------------|--------|--------|--------------|
| Security Register #1 | 0000H/00H | 0001 | 00 | Byte Address |
| Security Register #2 | 0000H/00H | 0010 | 00 | Byte Address |
| Security Register #3 | 0000H/00H | 0011 | 00 | Byte Address |

Figure 10-47 Program Security Registers (PRSCUR) Sequence (SPI)

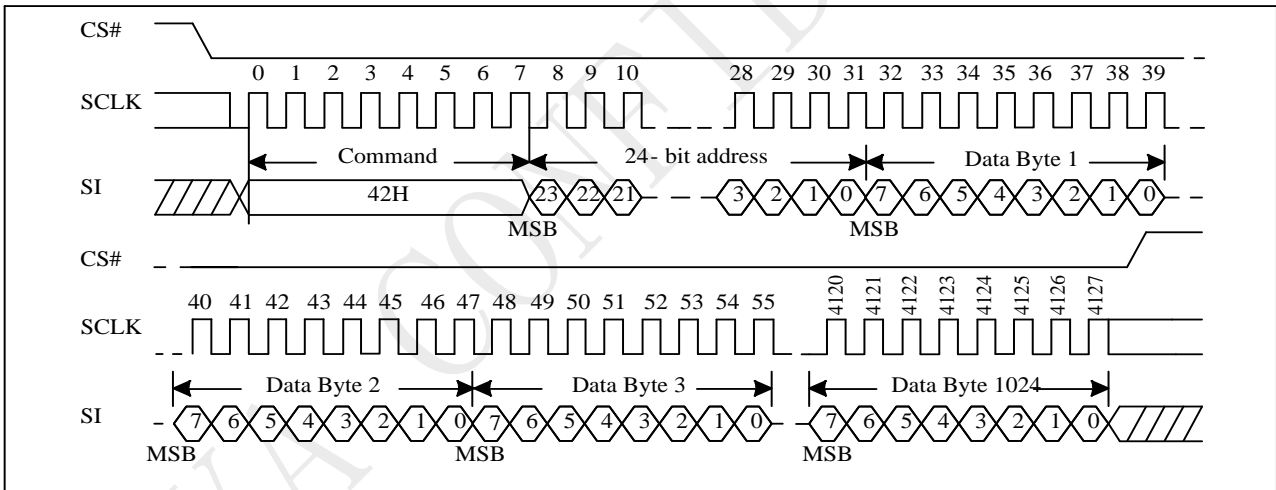
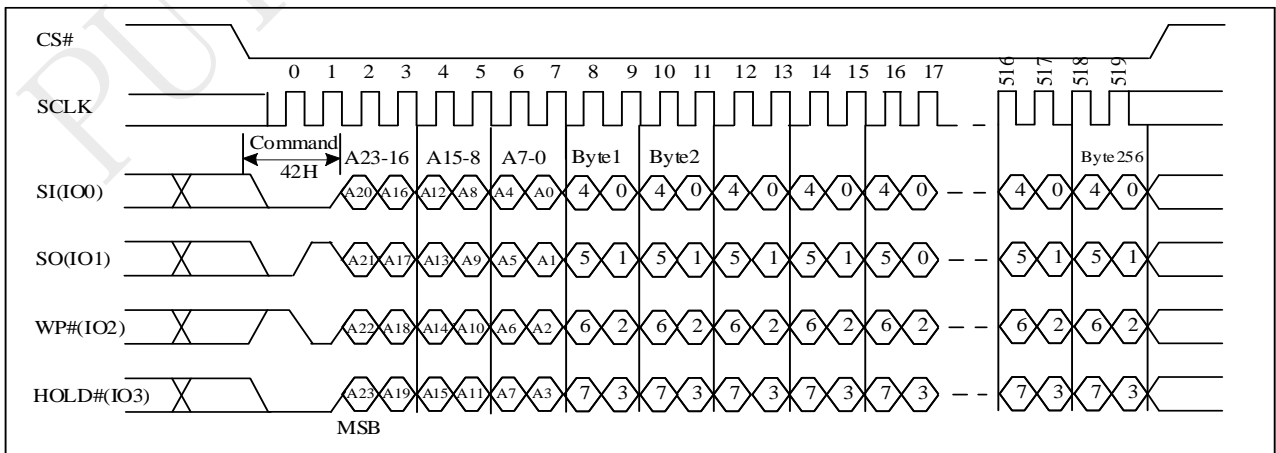


Figure 10-47a Program Security Registers (PRSCUR) Sequence (QPI)



Note: 32-bit address is required when the device is operation in 4-Byte Address Mode.

10.48 Read Security Registers (RDSCUR 48H)

The Read Security Registers command is similar to Fast Read command. The command is followed by a 3/4-byte address (A23/31-A0) and a dummy byte, each bit being latched-in during the rising edge of SCLK. Then the memory content, at that address, is shifted out on SO, each bit being shifted out, at a Max frequency fC, during the falling edge of SCLK. The first byte addressed can be at any location. The address is automatically incremented to the next higher address after each byte of data is shifted out. Once the A9-A0 address reaches the last byte of the register (Byte 3FFH), it will reset to 000H, the command is completed by driving CS# high.

The sequence of issuing RDSCUR instruction is: CS# goes low → sending RDSCUR instruction → sending 24/32 bit address → 8 bit dummy byte → Security Register data out on SO → CS# goes high.

| Address | A31-16/A23-16 | A15-12 | A11-10 | A9-0 |
|----------------------|---------------|--------|--------|--------------|
| Security Register #1 | 0000H/00H | 0001 | 00 | Byte Address |
| Security Register #2 | 0000H/00H | 0010 | 00 | Byte Address |
| Security Register #3 | 0000H/00H | 0011 | 00 | Byte Address |

Figure 10-48 Read Security Registers (RDSCUR) Sequence (SPI)

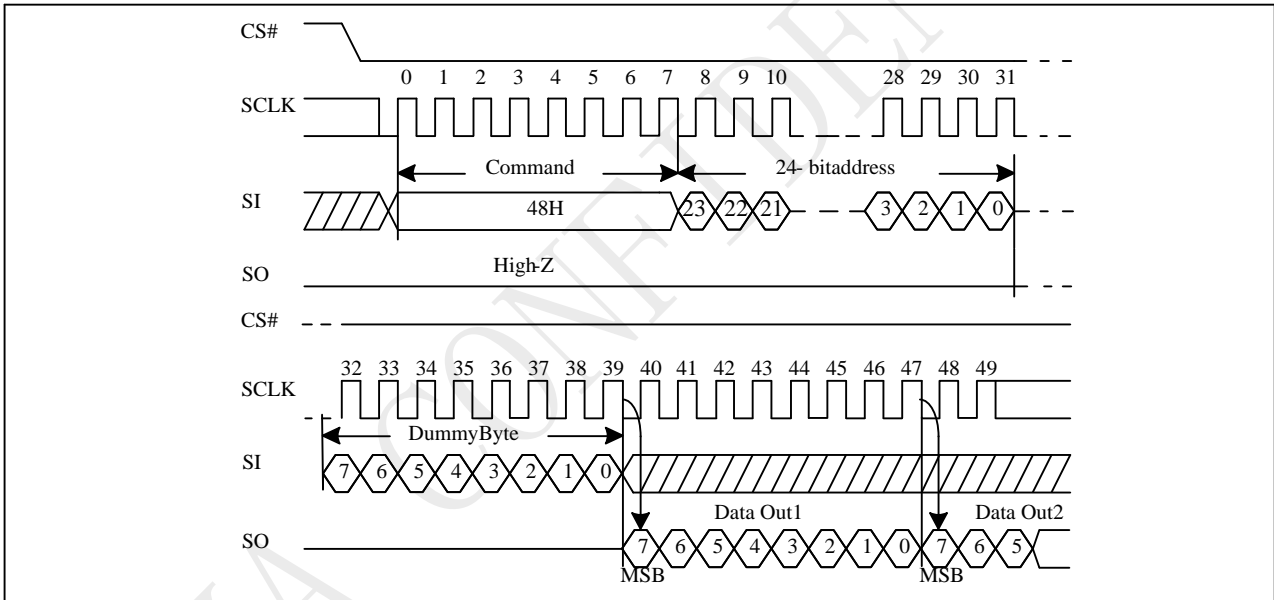
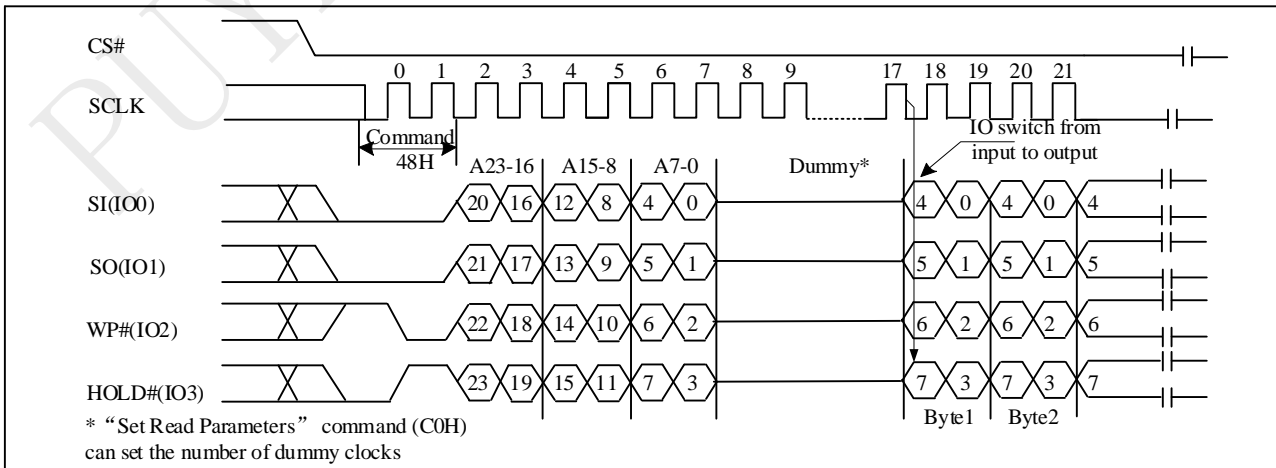


Figure 10-48a Read Security Registers (RDSCUR) Sequence (QPI)



Note:32-bit address is required when the device is operation in 4-Byte Address Mode.

10.49 Deep Power-down (DP B9H)

The Deep Power-down (DP) instruction is for setting the device into the minimizing the power consumption mode (to entering the Deep Power-down mode, the standby current is reduced from ISB1 to ISB2). The Deep Power-down mode requires the Deep Power-down (DP) instruction to enter, during the Deep Power-down mode, the device is not active and all Write/Program/Erase instruction are ignored. When CS# goes high, it's only in standby mode not deep power-down mode. It's different from Standby mode.

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

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

In SPI Deep Power-down mode, the SPI software reset instruction(66H+99H) can exit Deep Power-down mode; while in QPI Deep Power-down mode, the QPI software reset instruction(66H+99H) can exit Deep Power-down mode.

Figure 10-49 Deep Power-down (DP) Sequence (SPI)

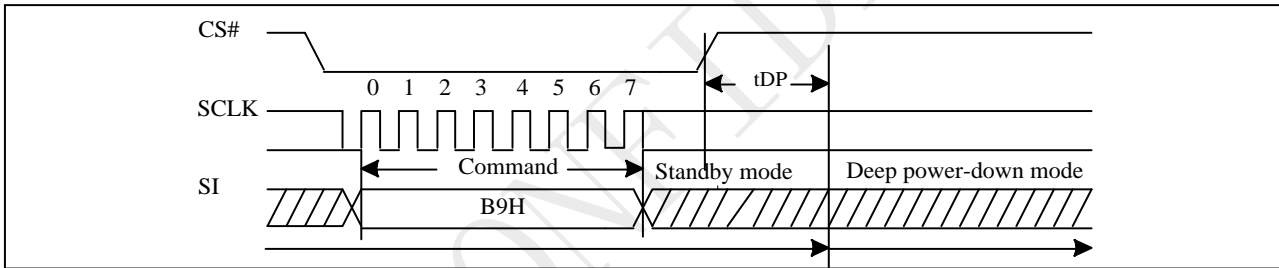
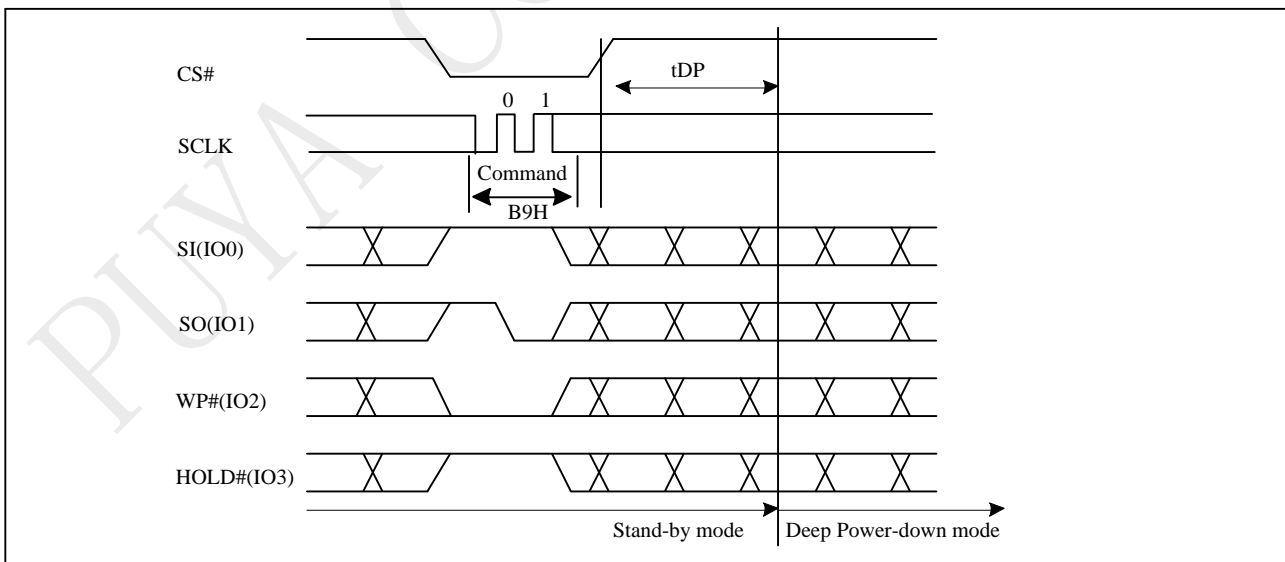


Figure 10-49a Deep Power-down (DP) Sequence (QPI)



10.50 Release from Deep Power-Down (RDP), Read Electronic Signature (RES ABH)

The Release from Deep Power-down (RDP) instruction is terminated by driving Chip Select (CS#) High. When Chip Select (CS#) is driven high, the device is put in the 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 t_{RES2} , and Chip Select (CS#) must remain High for at least $t_{RES2(max)}$. Once in the Stand-by Power mode, the device waits to be selected, so that it can receive, decode and execute instructions.

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

The RES instruction is ended by CS# goes high after the ID been read out at least once. The ID outputs repeatedly if continuously send the additional clock cycles on SCLK while CS# is at low. If the device was not previously in Deep Power-down mode, the device transition to standby mode is immediate. If the device was previously in Deep Power-down mode, there's a delay of t_{RES2} to transit to standby mode, and CS# must remain to high at least t_{RES2} (max). Once in the standby mode, the device waits to be selected, so it can be receive, decode, and execute instruction.

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

Figure 10-50 Read Electronic Signature (RES) Sequence (SPI)

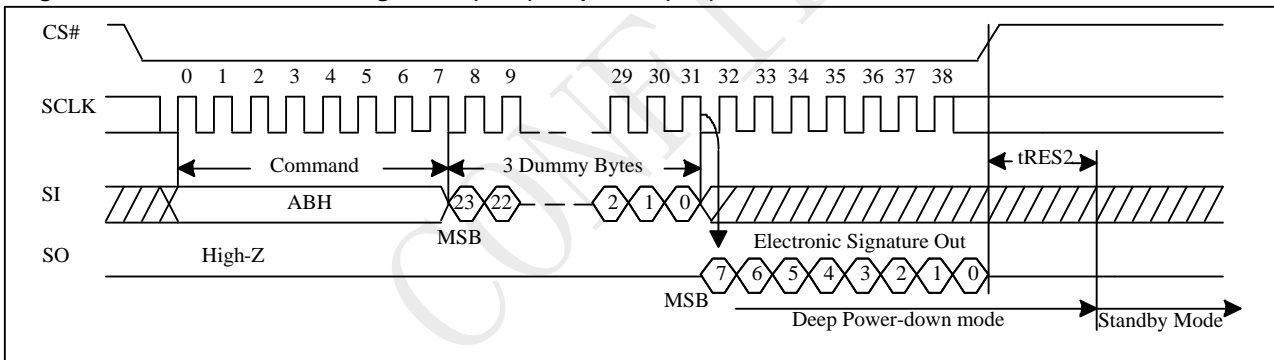


Figure 10-50a Read Electronic Signature (RES) Sequence (QPI)

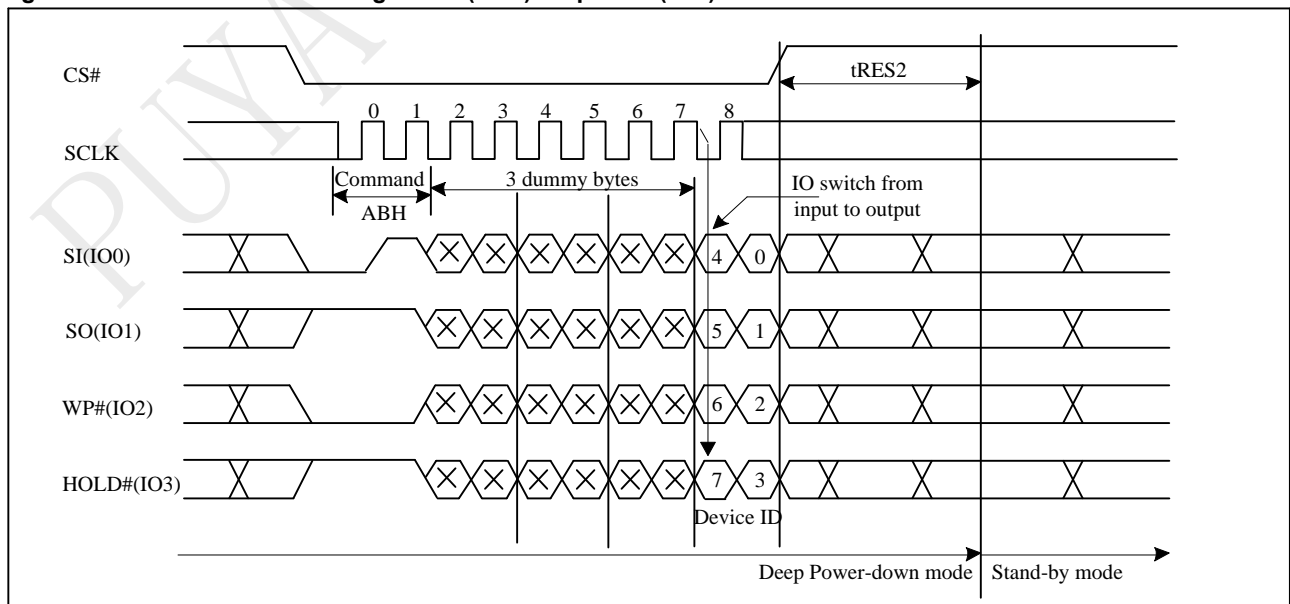


Figure 10-50b Release from Deep Power-down (RDP) Sequence (SPI)

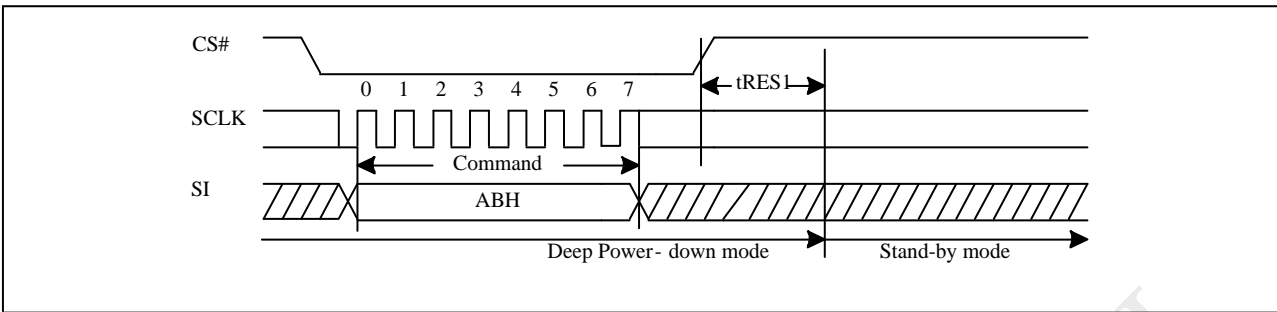
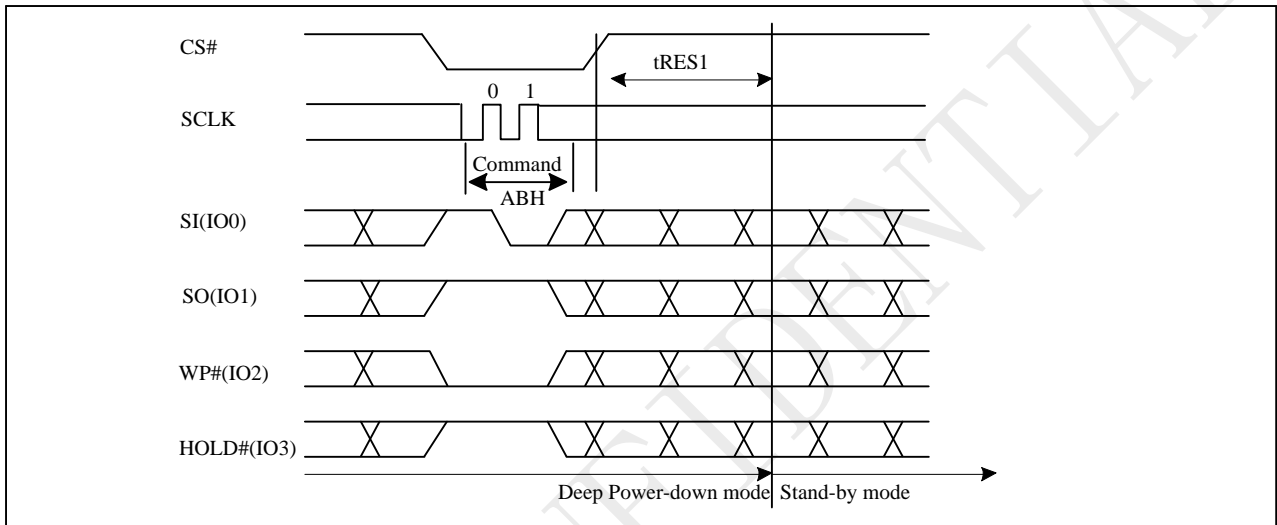


Figure 10-50c Release from Deep Power-down (RDP) Sequence (QPI)



10.51 Read Electronic Manufacturer ID & Device ID (REMS 90H)

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

The REMS instruction is initiated by driving the CS# pin low and sending the instruction code "90h" followed by a 24-bit address (A23 -A0) of 000000H. After which the manufacturer ID for PUYA (85h) and the device ID are shifted out on the falling edge of SCLK with the most significant bit (MSB) first. 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 10-51 Read Electronic Manufacturer & Device ID (REMS) Sequence (SPI)

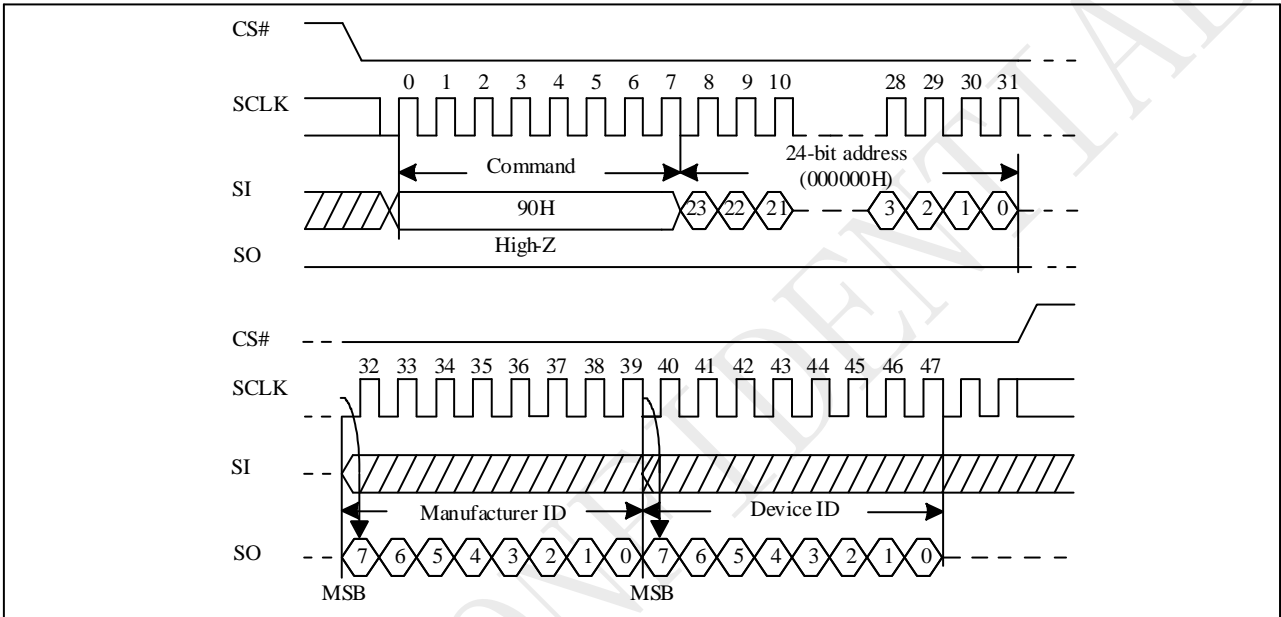
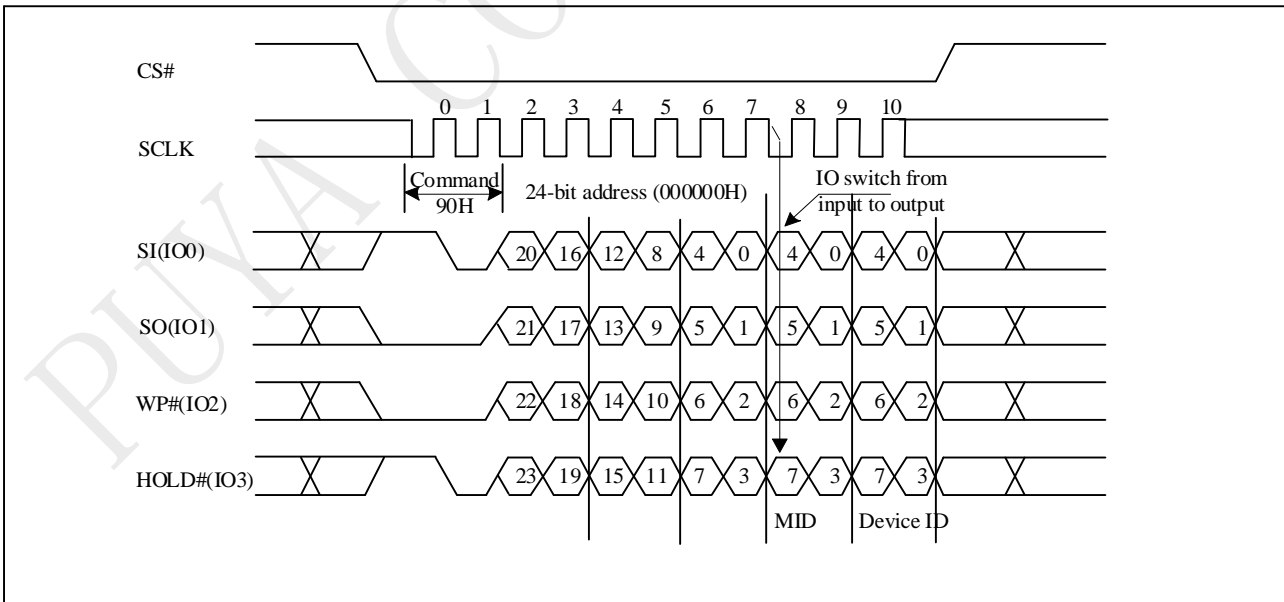


Figure 10-51a Read Electronic Manufacturer & Device ID (REMS) Sequence (QPI)

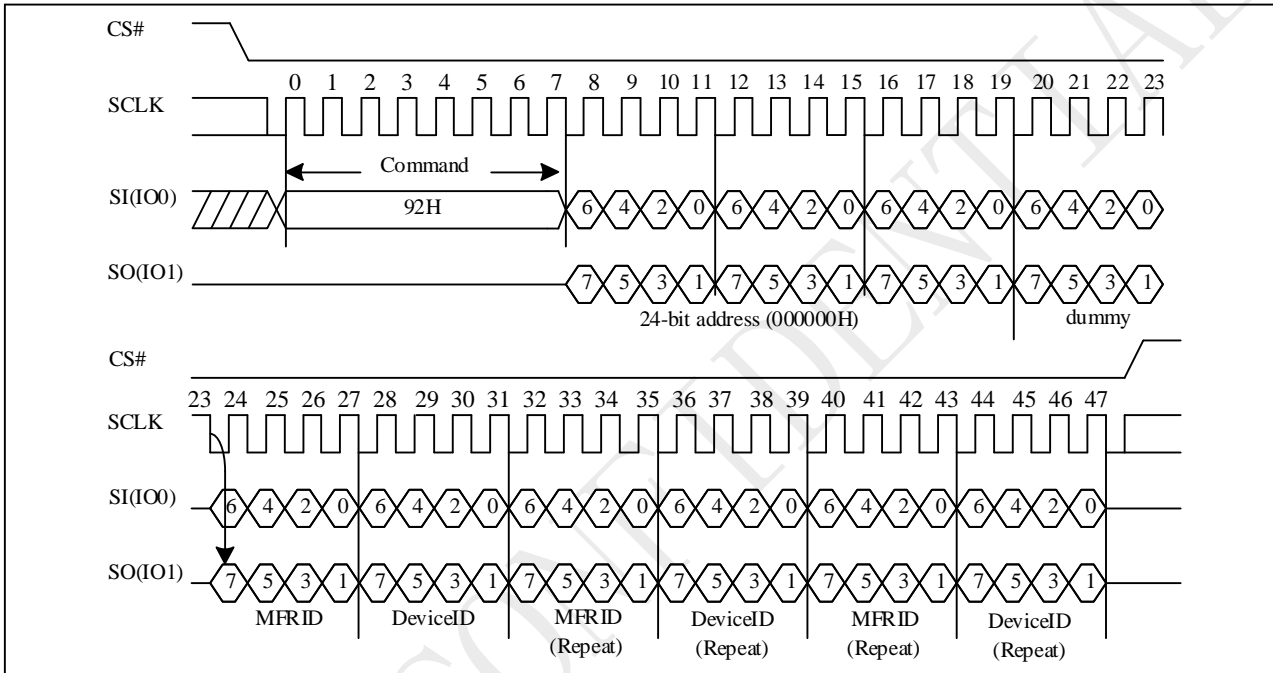


10.52 Dual I/O Read Electronic Manufacturer ID & Device ID (DREMS 92H)

The DREMS instruction is similar to the REMS command and returns the JEDEC assigned manufacturer ID which takes two pins: SIO0, SIO1 as address input and ID output I/O

The instruction is initiated by driving the CS# pin low and shift the instruction code "92h" followed by a 24/32-bit address (A23/A31-A0) of 000000h and 1byte dummy, but with the capability to input the Address bits two bits per clock. After which, the Manufacturer ID for PUYA (85h) and the Device ID are shifted out on the falling edge of SCLK with most significant bit (MSB) first. The Manufacturer and Device IDs can be read continuously, alternating from one to the other. The instruction is completed by driving CS# high.

Figure 10-52 DUAL I/O Read Electronic Manufacturer & Device ID (DREMS) Sequence (SPI)



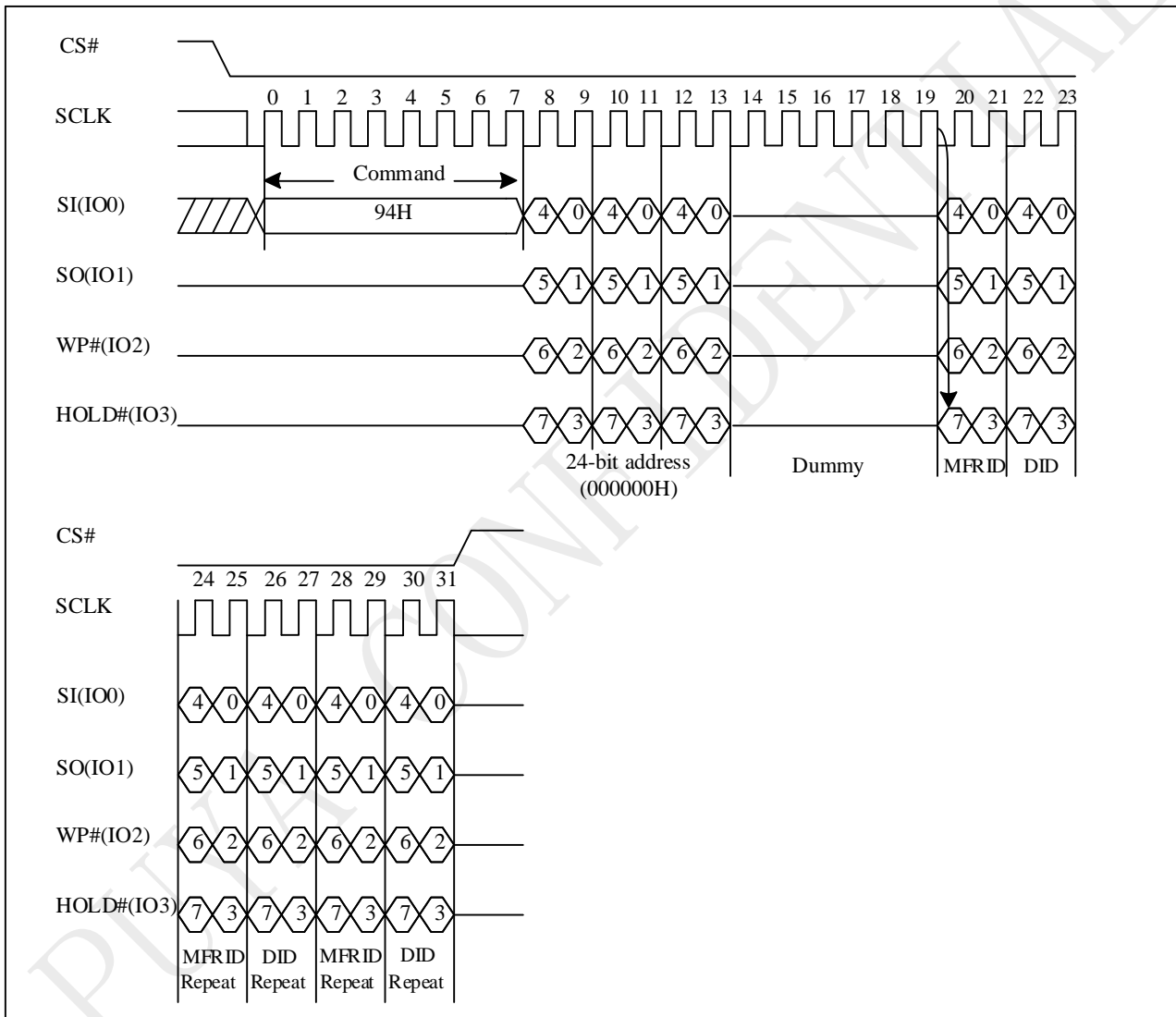
Note: 32-bit address (0000_0000H) are required when the device is operation in 4-Byte Address Mode.

10.53 Quad I/O Read Electronic Manufacturer ID & Device ID (QREMS 94H)

The QREMS instruction is similar to the REMS command and returns the JEDEC assigned manufacturer ID which takes four pins: SIO0, SIO1, SIO2, SIO3 as address input and ID output I/O

The instruction is initiated by driving the CS# pin low and shift the instruction code "94h" followed by a 24/32-bit address (A23/A31-A0) of 000000h, and 3 bytes dummy, but with the capability to input the Address bits four bits per clock. After which, the Manufacturer ID for PUYA (85h) and the Device ID are shifted out on the falling edge of SCLK with most significant bit (MSB) first. The Manufacturer and Device IDs can be read continuously, alternating from one to the other. The instruction is completed by driving CS# high.

Figure 10-53 QUAD I/O Read Electronic Manufacturer & Device ID (QREMS) Sequence (SPI)



Note: 32-bit address (0000_0000H) are required when the device is operation in 4-Byte Address Mode.

10.54 Read Identification (RDID 9FH)

The RDID instruction is for reading the manufacturer ID of 1-byte and followed by Device ID of 2-byte. The PUYA Manufacturer ID and Device ID are list as "Table. 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 use CS# to high at any time during data out. While Program/Erase operation is in progress, it will not decode the RDID instruction, so there's no effect on the cycle of program/erase operation which is currently in progress. When CS# goes high, the device is at standby stage.

Figure 10-54 Read Identification (RDID) Sequence (SPI)

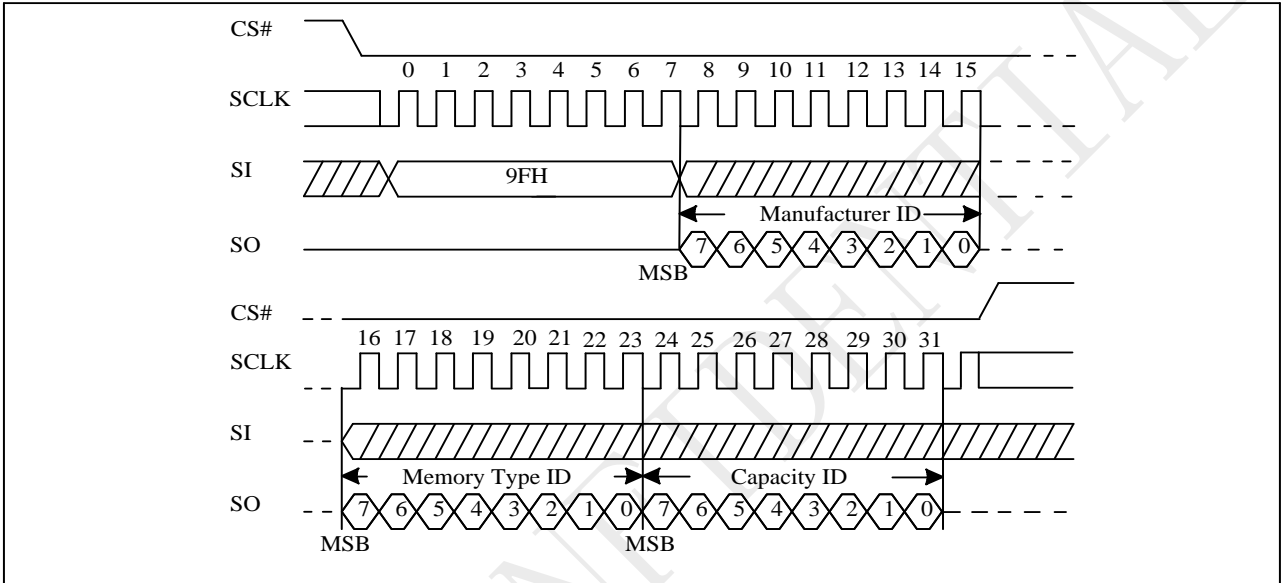


Figure 10-54a Read Identification (RDID) Sequence (QPI)

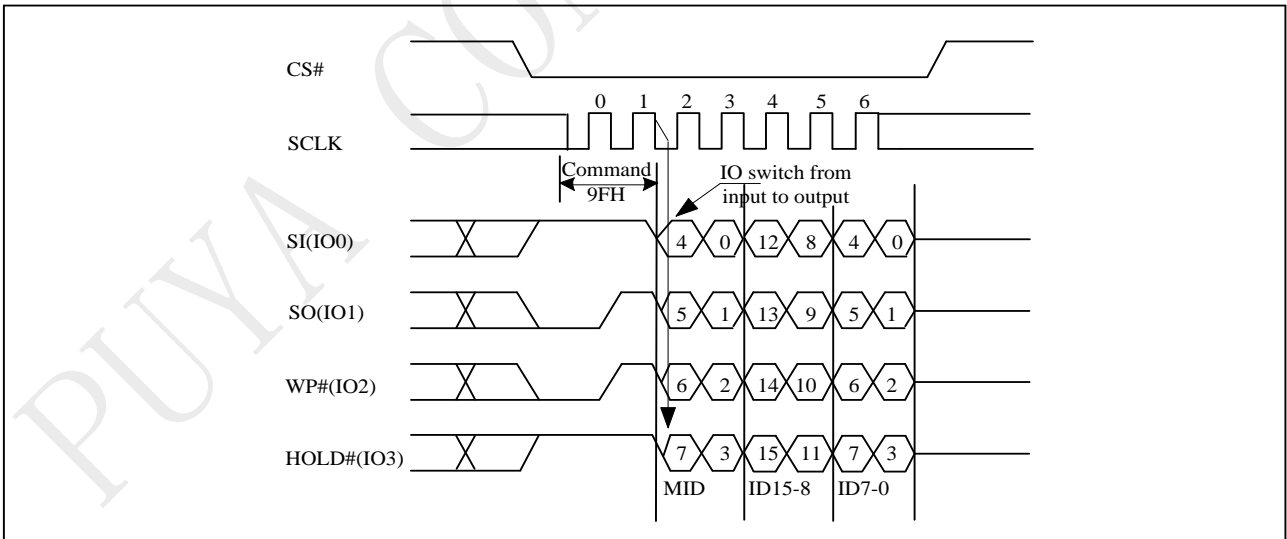


Table ID Definitions

| | | | | |
|------------|--------------|-----------------|-------------|----------------|
| PY25Q01GLC | RDID command | manufacturer ID | memory type | memory density |
| | | 85 | 65 | 1B |
| | RES command | electronic ID | | |
| | | 1A | | |
| | REMS command | manufacturer ID | device ID | |
| | | 85 | 1A | |



10.55 Program/Erase Suspend (75H)

The Suspend instruction interrupts a Page Program, Sector Erase, or Block Erase operation and then allow access to the memory array. After the program or erase operation has entered the suspended state, the memory array can be read except for the page being programmed or the sector or block being erased.

Readable Area of Memory While a Program or Erase Operation is Suspended

| Suspended Operation | Readable Region of Memory Array |
|---------------------|-------------------------------------|
| Page Program | All but the Page being programmed |
| Sector Erase(4KB) | All but the 4KB Sector being erased |
| Block Erase(32KB) | All but the 32KB Block being erased |
| Block Erase(64KB) | All but the 64KB Block being erased |

When the Serial NOR Flash receives the Suspend instruction, there is a latency of tPSL or tESL before the Write Enable Latch (WEL) bit clears to "0" and the SUS sets to "1", after which the device is ready to accept one of the commands listed in "Table Acceptable Commands During Program/Erase Suspend after tPSL/tESL" (e.g. FAST READ). Refer to "AC Characteristics" for tPSL and tESL timings. "Table Acceptable Commands During Suspend (tPSL/tESL not required)" lists the commands for which the tPSL and tESL latencies do not apply. For example, RDSR, RDSCUR, RSTEN, and RST can be issued at any time after the Suspend instruction.

Status Register bit 15 (SUS) can be read to check the suspend status. The SUS (Program/Erase Suspend Bit) sets to "1" when a program or erase operation is suspended. The SUS clears to "0" when the program or erase operation is resumed.

Acceptable Commands During Program/Erase Suspend after tPSL/tESL

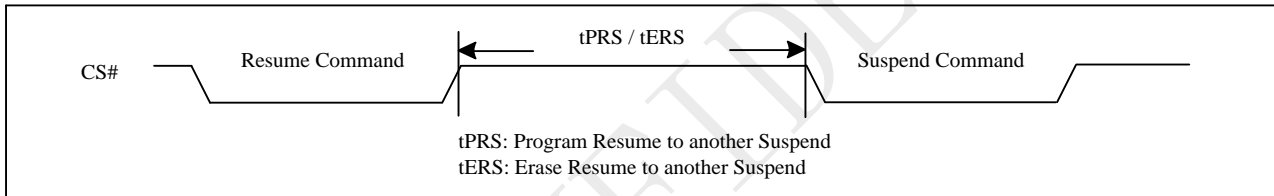
| Command name | Command Code | Suspend Type | |
|--------------------|--------------|-----------------|---------------|
| | | Program Suspend | Erase Suspend |
| READ | 03H | • | • |
| READ4B | 13H | • | • |
| FREAD | 0BH | • | • |
| DTRFRD | 0DH | • | • |
| FREAD4B | 0CH | • | • |
| DREAD | 3BH | • | • |
| DREAD4B | 3CH | • | • |
| QREAD | 6BH | • | • |
| 2READ | BBH | • | • |
| 2DTRD | BDH | • | • |
| 2READ4B | BCH | • | • |
| 4READ | EBH | • | • |
| 4READ4B | ECH | • | • |
| 4DTRD | EDH | • | • |
| 4DTRD4B | EEH | • | • |
| QPIEN | 38H | • | • |
| Disable QPI | FFH | • | • |
| RDSFDP | 5AH | • | • |
| RDID | 9FH | • | • |
| EN4B | B7H | • | • |
| EX4B | E9H | • | • |
| REMS | 90H | • | • |
| DREMS | 92H | • | • |
| QREMS | 94H | • | • |
| RDSCUR | 48H | • | • |
| SBL | 77H | • | • |
| Set Read Parameter | C0H | • | • |
| WREN | 06H | • | • |
| RESUME | 7AH | • | • |



| Command name | Command Code | Suspend Type | |
|--------------|--------------|-----------------|---------------|
| | | Program Suspend | Erase Suspend |
| PP | 02H | | • |
| PP4B | 12H | | • |
| QPP | 32H | | |
| QPP4B | 34H | | |
| QIPP | C2H | | • |
| QIPP4B | 3EH | | • |

Acceptable Commands During Suspend (tPSL/tESL not required)

| Command name | Command Code | Suspend Type | |
|--------------|--------------|-----------------|---------------|
| | | Program Suspend | Erase Suspend |
| WRDI | 04H | • | • |
| RDSR | 05H | • | • |
| RDSR2 | 35H | • | • |
| RDCR | 15H | • | • |
| RES | ABH | • | • |
| RSTEN | 66H | • | • |
| RST | 99H | • | • |
| NOP | 00H | • | • |

Figure 10-55 Resume to Suspend Latency

10.56 Erase Suspend to Program

The “Erase Suspend to Program” feature allows Page Programming while an erase operation is suspended. Page Programming is permitted in any unprotected memory except within the sector of a suspended Sector Erase operation or within the block of a suspended Block Erase operation. The Write Enable (WREN) instruction must be issued before any Page Program instruction.

A Page Program operation initiated within a suspended erase cannot itself be suspended and must be allowed to finish before the suspended erase can be resumed. The Status Register can be polled to determine the status of the Page Program operation. The WEL and WIP bits of the Status Register will remain “1” while the Page Program operation is in progress and will both clear to “0” when the Page Program operation completes.

Figure 10-56 Suspend to Read/Program Latency

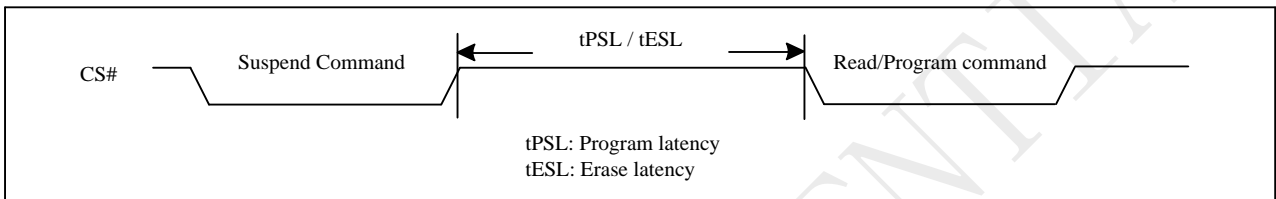
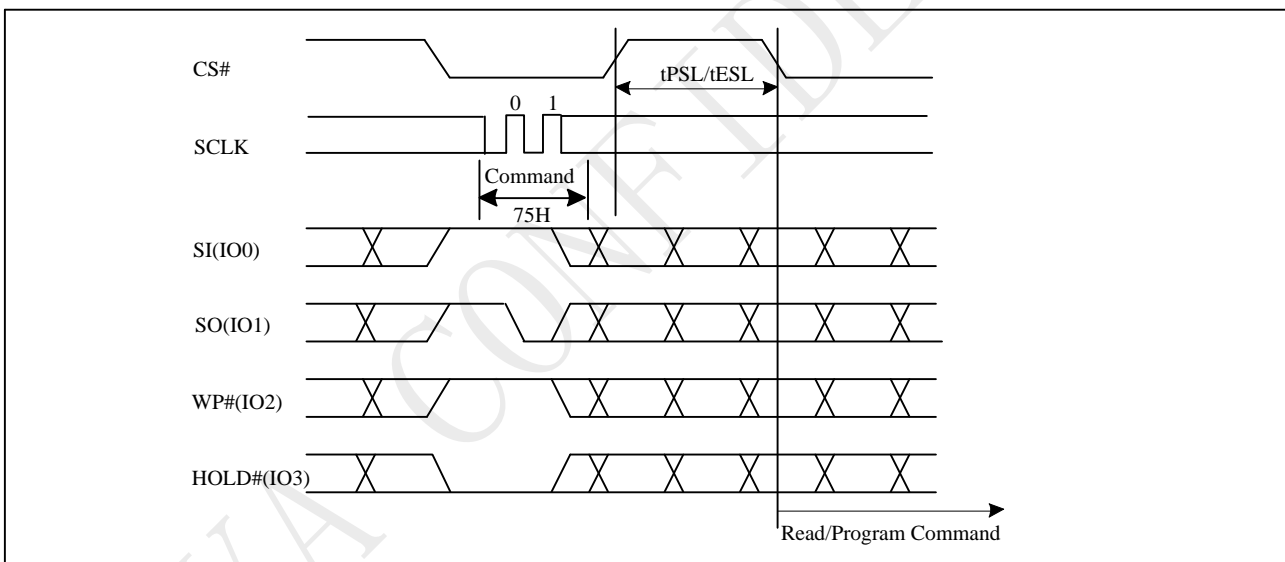


Figure 10-56a Suspend to Read/Program Latency(QPI)



Notes:

1. Please note that Program only available after the Erase-Suspend operation.
2. To check suspend ready information, please read status register bit15 (SUS).

10.57 Program Resume and Erase Resume (7AH)

The Resume instruction resumes a suspended Page Program, Page Erase, Sector Erase, or Block Erase operation. Before issuing the Resume instruction to restart a suspended erase operation, make sure that there is no Page Program operation in progress.

Immediately after the Serial NOR Flash receives the Resume instruction, the WEL and WIP bits are set to "1" and the SUS bit is cleared to "0". The program or erase operation will continue until finished ("Resume to Read Latency") or until another Suspend instruction is received. A resume-to-suspend latency of t_{PRS} or t_{ERS} must be observed before issuing another Suspend instruction ("Resume to Suspend Latency").

Figure 10-57 Resume to Read Latency

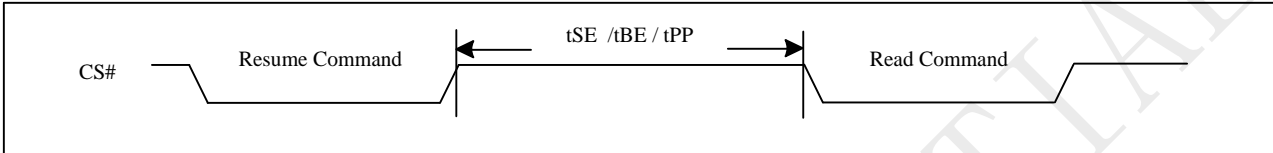
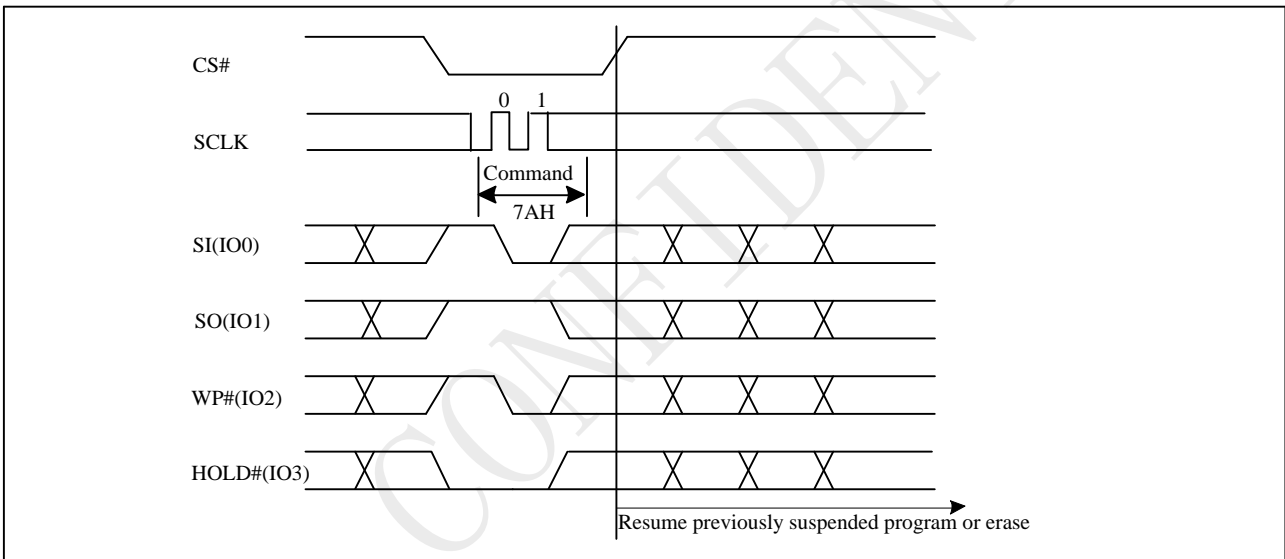


Figure 10-57a Resume to Read Latency (QPI)



10.58 No Operation (NOP)

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

The SIO[3:1] are don't care.

10.59 Individual Block Lock (SBLK 36H)

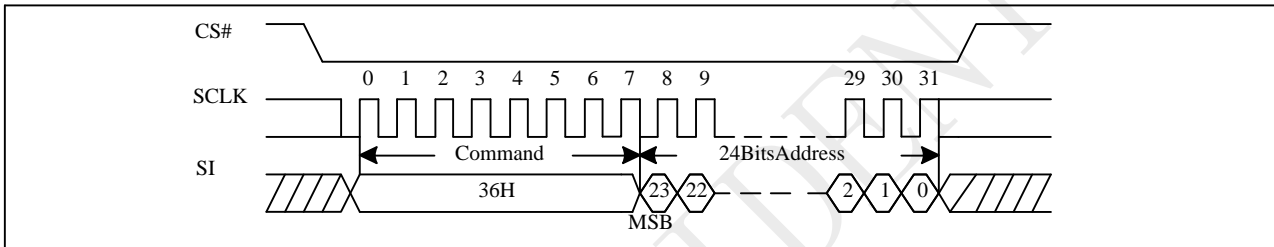
The Individual Block Lock provides an alternative way to protect the memory array from adverse Erase/Program. In order to use the Individual Block Locks, the WPS bit in Configure Register must be set to 1. If WPS=0, the write protection will be determined by the combination of CMP, BP[4:0] bits in the Status Registers. The Individual Block Lock bits are volatile bits. The default values after device power up or after a Reset are 1, so the entire memory array is being protected.

The SBLK instruction is for write protection a specified block (or sector) of memory, using AMAX-A16 or (AMAX-A12) address bits to assign a 64Kbyte block (or 4K bytes sector) to be protected as read only.

The WREN (Write Enable) instruction is required before issuing SBLK instruction.

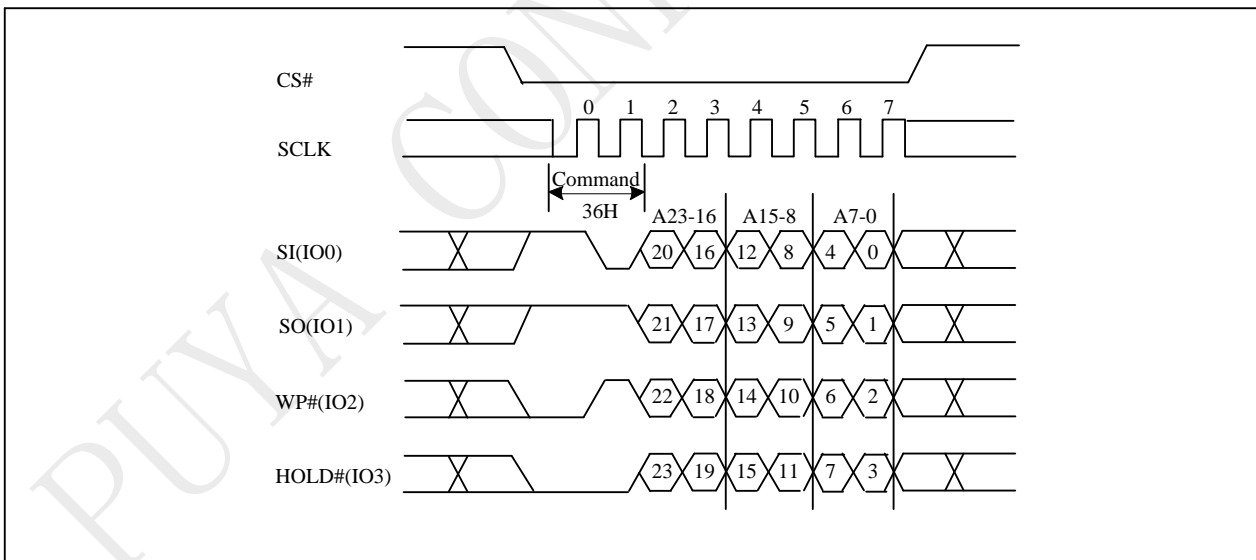
The sequence of issuing SBLK instruction is: CS# goes low → send SBLK (36h) instruction → send 3/4-byte address assign one block (or sector) to be protected on SI pin → CS# goes high. The CS# must go high exactly at the byte boundary, otherwise the instruction will be rejected and not be executed.

Figure 10-59 Individual Block Lock (SPI)



Note: 32-bit address is required when the device is operation in 4-Byte Address Mode.

Figure 10-59a Individual Block Lock(QPI)



Note: 32-bit address is required when the device is operation in 4-Byte Address Mode.

10.60 Individual Block Unlock (SBULK 39H)

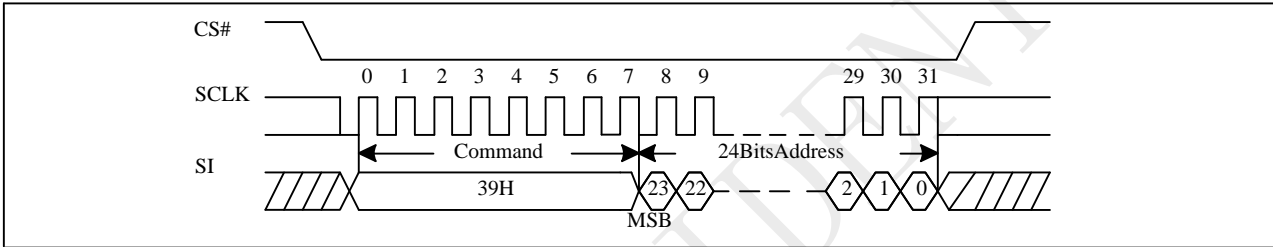
The Individual Block Lock provides an alternative way to protect the memory array from adverse Erase/Program. In order to use the Individual Block Locks, the WPS bit in Configure Register must be set to 1. If WPS=0, the write protection will be determined by the combination of CMP, BP[4:0] bits in the Status Registers. The Individual Block Lock bits are volatile bits. The default values after device power up or after a Reset are 1, so the entire memory array is being protected.

The SBULK instruction will cancel the block (or sector) write protection state using AMAX-A16 or (AMAX-A12) address bits to assign a 64Kbyte block (or 4K bytes sector) to be unprotected.

The WREN (Write Enable) instruction is required before issuing SBULK instruction.

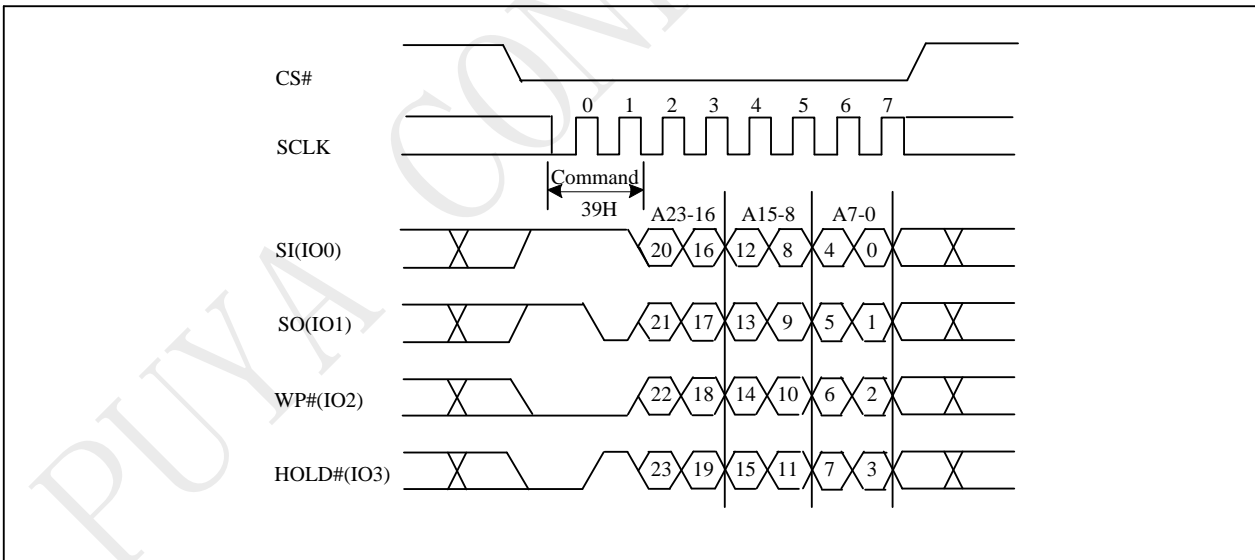
The sequence of issuing SBULK instruction is: CS# goes low → send SBULK (39h) instruction → send 3/4-byte address assign one block (or sector) to be protected on SI pin → CS# goes high. The CS# must go high exactly at the byte boundary, otherwise the instruction will be rejected and not be executed.

Figure 10-60 Individual Block Unlock (SPI)



Note: 32-bit address is required when the device is operation in 4-byte address mode.

Figure 10-60a Individual Block Unlock (QPI)



Note: 32-bit address is required when the device is operation in 4-Byte Address Mode.

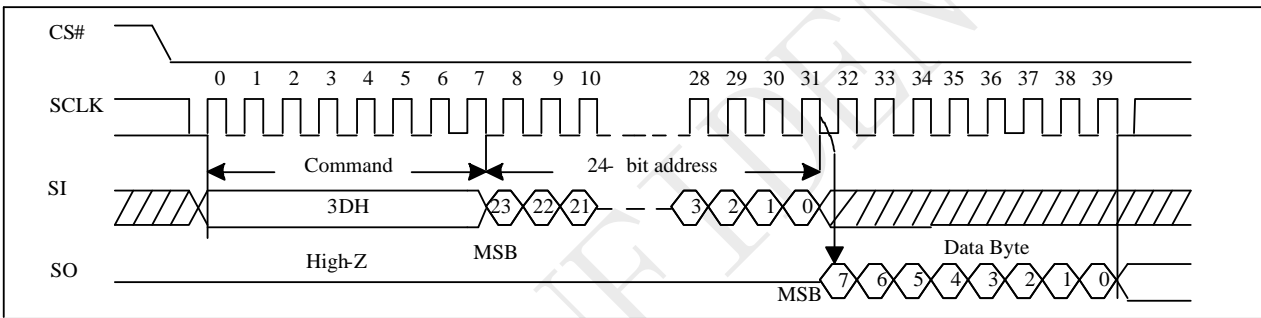
10.61 Read Block Lock Status (RDBLK 3DH)

The Individual Block Lock provides an alternative way to protect the memory array from adverse Erase/Program. In order to use the Individual Block Locks, the WPS bit in Configure Register must be set to 1. If WPS=0, the write protection will be determined by the combination of CMP, BP[4:0] bits in the Status Registers. The Individual Block Lock bits are volatile bits. The default values after device power up or after a Reset are 1, so the entire memory array is being protected.

The RDBLOCK instruction is for reading the status of protection lock of a specified block (or sector), using AMAX-A16 (or AMAX-A12) address bits to assign a 64K bytes block (4K bytes sector) and read protection lock status bit which the first byte of Read-out cycle. The status bit is "1" to indicate that this block has be protected, that user can read only but cannot program /erase this block. The status bit is "0" to indicate that this block hasn't be protected, and user can read and write this block.

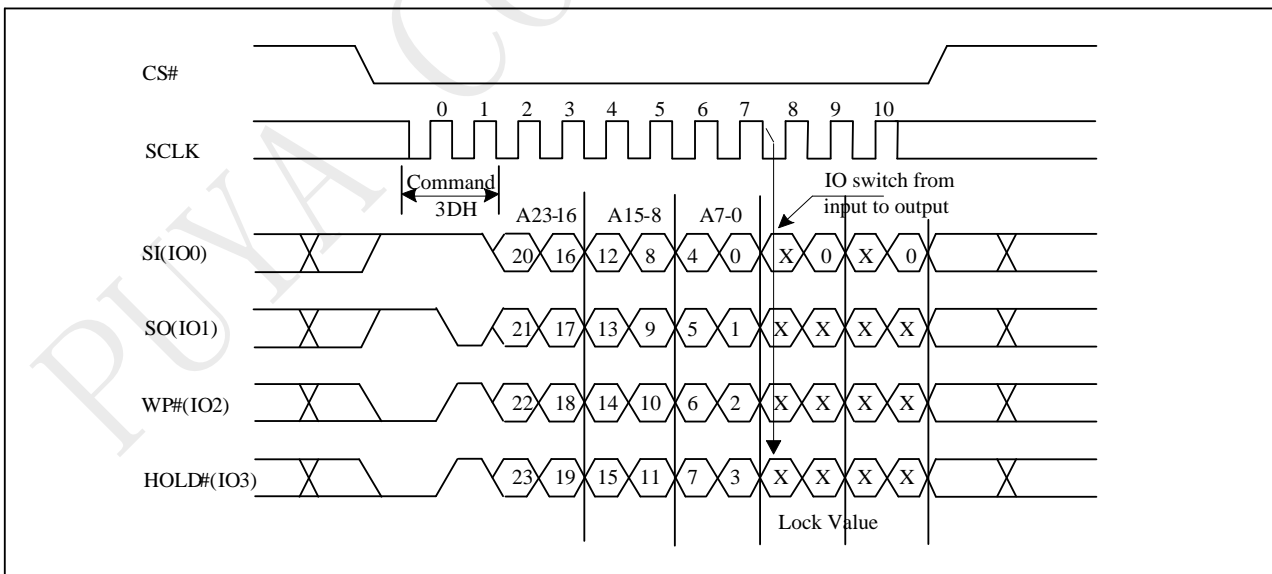
The sequence of issuing RDBLOCK instruction is: CS# goes low → send RDBLOCK (3Dh) instruction → send 3/4-byte address to assign one block on SI pin → read block's protection lock status bit on SO pin → CS# goes high. Both SPI (8 clocks) and QPI (2 clocks) command cycle can accept by this instruction.

Figure 10-61 Read Block Lock Status (SPI)



Note: 32-bit address is required when the device is operation in 4-Byte Address Mode.

Figure 10-61a Read Block Lock Status (QPI)



Note: 32-bit address is required when the device is operation in 4-Byte Address Mode.

10.62 Global Block Lock (GBLK 7EH)

The GBLK instruction is for enable the lock protection block of the whole chip.

The WREN (Write Enable) instruction is required before issuing GBLK instruction.

The sequence of issuing GBLK instruction is: CS# goes low → send GBLK (7Eh) instruction → CS# goes high.

Both SPI (8 clocks) and QPI (2 clocks) command cycle can accept this instruction. The SIO[3:1] are "don't care" in SPI mode. The CS# must go high exactly at the byte boundary, otherwise, the instruction will be rejected and not be executed.

Figure 10-62 Global Block Lock (SPI)

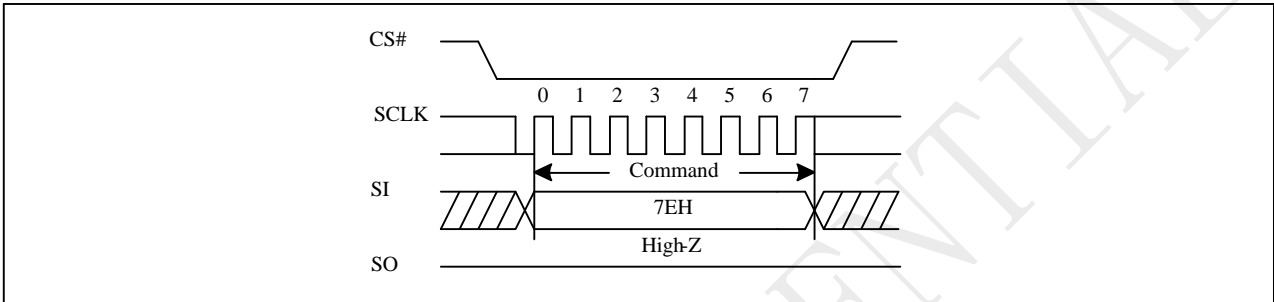
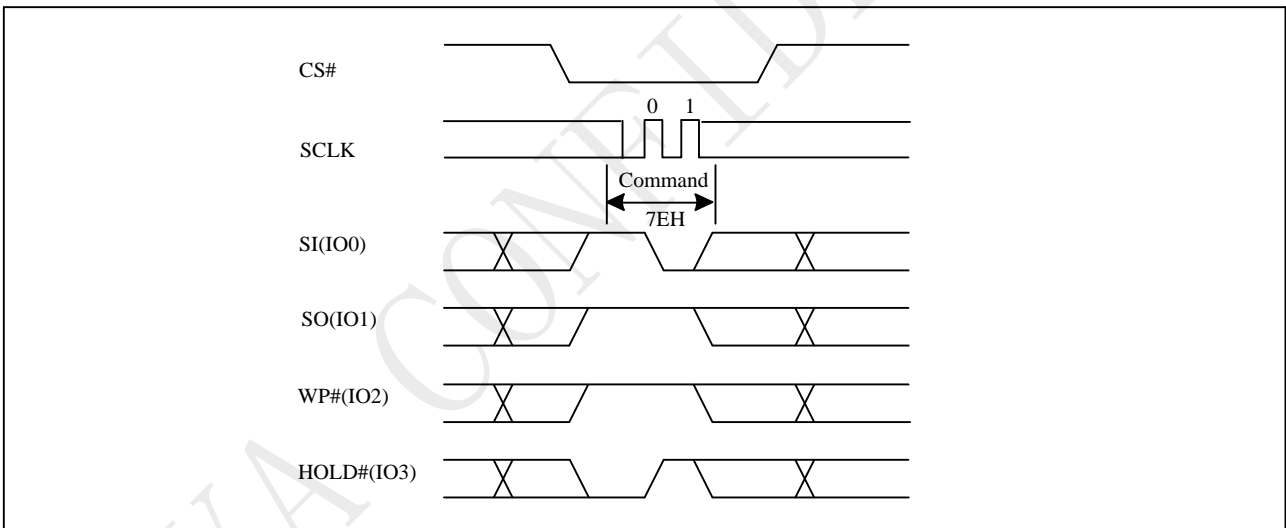


Figure 10-62a Global Block Lock (QPI)



10.63 Global Block Unlock (GBULK 98H)

The GBULK instruction is for disable the lock protection block of the whole chip.

The WREN (Write Enable) instruction is required before issuing GBULK instruction.

The sequence of issuing GBULK instruction is: CS# goes low → send GBULK (98h) instruction → CS# goes high.

Both SPI (8 clocks) and QPI (2 clocks) command cycle can accept this instruction. The SIO[3:1] are "don't care" in SPI mode. The CS# must go high exactly at the byte boundary, otherwise, the instruction will be rejected and not be executed.

Figure 10-63 Global Block Unlock (SPI)

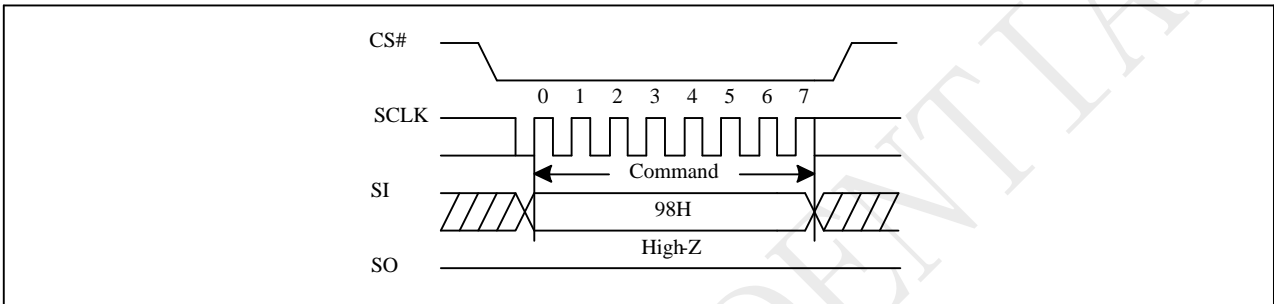
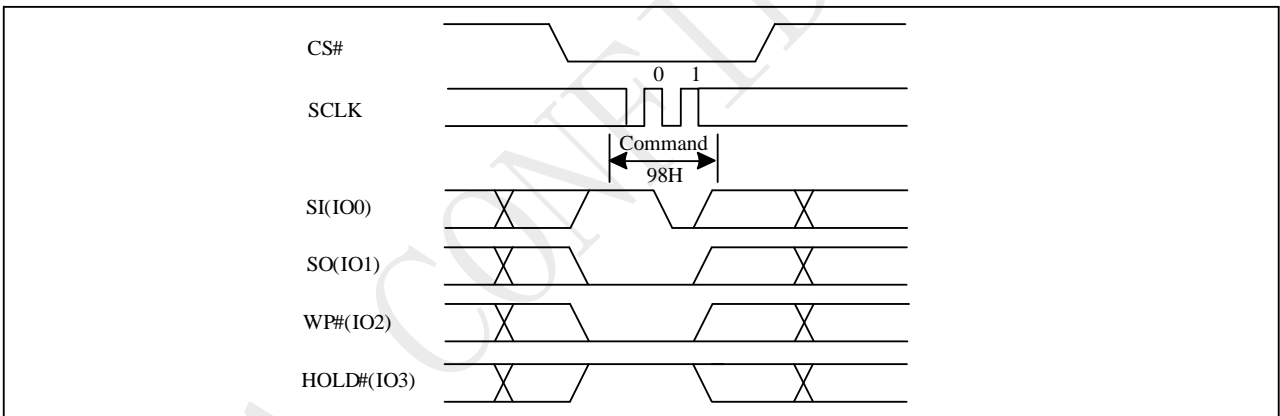


Figure 10-63a Global Block Unlock (QPI)



10.64 Software Reset (RSTEN/RST 66H/99H)

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

To execute Reset command (RST), the Reset-Enable (RSTEN) command must be executed first to perform the Reset operation. If there is any other command to interrupt after the Reset-Enable command, the Reset-Enable will be invalid. The SIO[3:1] are "don't care".

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.

Figure 10-64 Software Reset Recovery

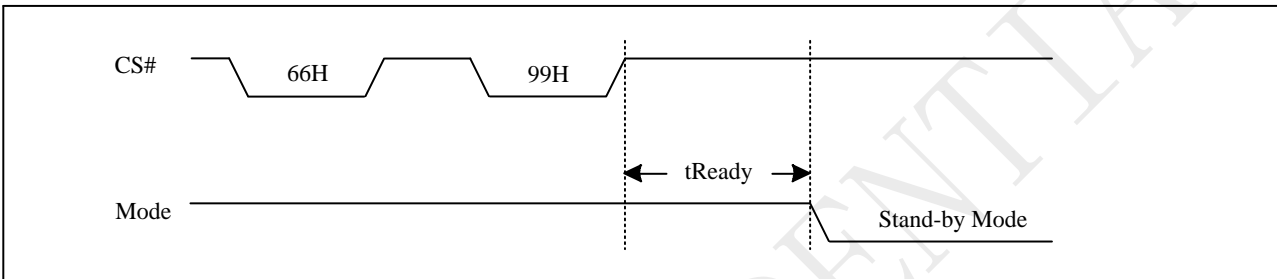


Figure 10-64a Software Reset Sequence (SPI)

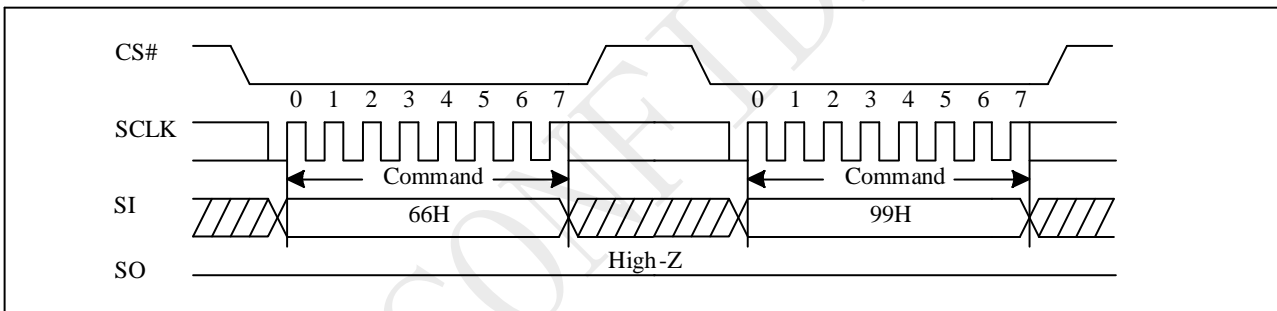
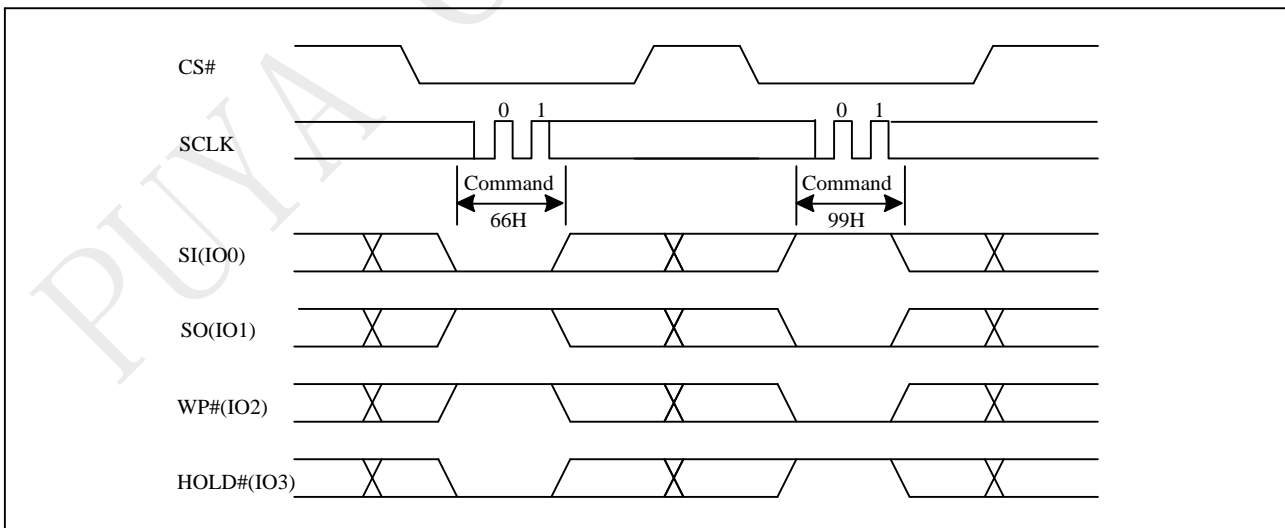


Figure 10-64b Software Reset Sequence (QPI)



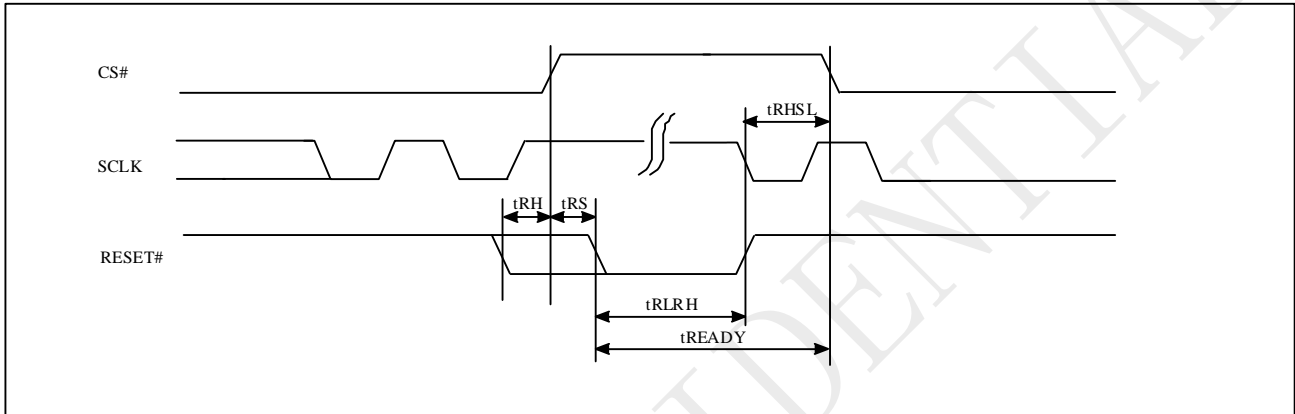
10.65 RESET

Driving the HOLD#/RESET# (in RESET mode) pin or RESET# (for 16-pin package) pin low for a period of t_{RLRH} 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 10-65 RESET Timing



RESET Timing (Other Operation)

| Symbol | Parameter | Min | Typ | Max | Unit |
|------------|----------------------------|-----|-----|-----|------|
| t_{RHSL} | Reset# high before CS# low | 1 | | | us |
| t_{RS} | Reset# setup time | 15 | | | ns |
| t_{RH} | Reset# hold time | 15 | | | ns |
| t_{RLRH} | Reset# low pulse width | 1 | | | us |

10.66 Reset Signaling Protocol

The Reset Signaling Protocol is another method to issue reset function, which consists of two phases: reset request, and completion (a device internal reset).

Reset Request

1. CS# is driven active low to select the SPI target (Note 1),
2. Clock (SCLK) remains stable in either a high or low state (Note 2),
3. SI / IO0 is driven low by the bus initiator, simultaneously with CS# going active low, (Note 3), and
4. CS# is driven inactive (Note 4).

Repeat the steps 1-4 each time alternating the state of SI (Note 5).

NOTE 1 This powers up the SPI target.

NOTE 2 This prevents any confusion with a command, as no command bits are transferred (clocked).

NOTE 3 No SPI bus target drives SI during CS# low before a transition of SCK, i.e., target streaming output active is not allowed until after the first edge of SCK.

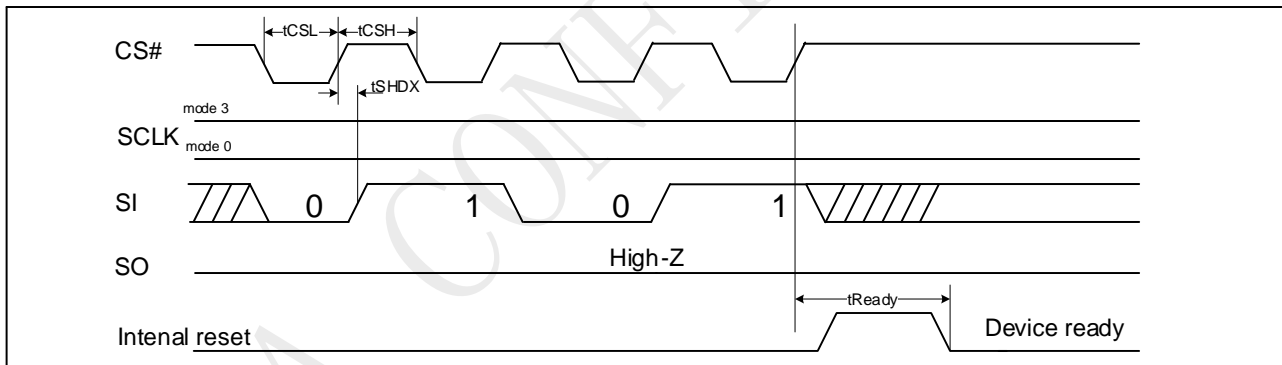
NOTE 4 The target captures the state of SI on the rising edge of CS#.

NOTE 5 SI is low on the first CS#, high on the second, low on the third, high on the fourth (This provides a 5h pattern, to differentiate it from random noise).

Reset Completion

After the fourth CS# pulse, the target triggers its internal reset.

Figure 10-66 Timing Diagram and Timing Parameters



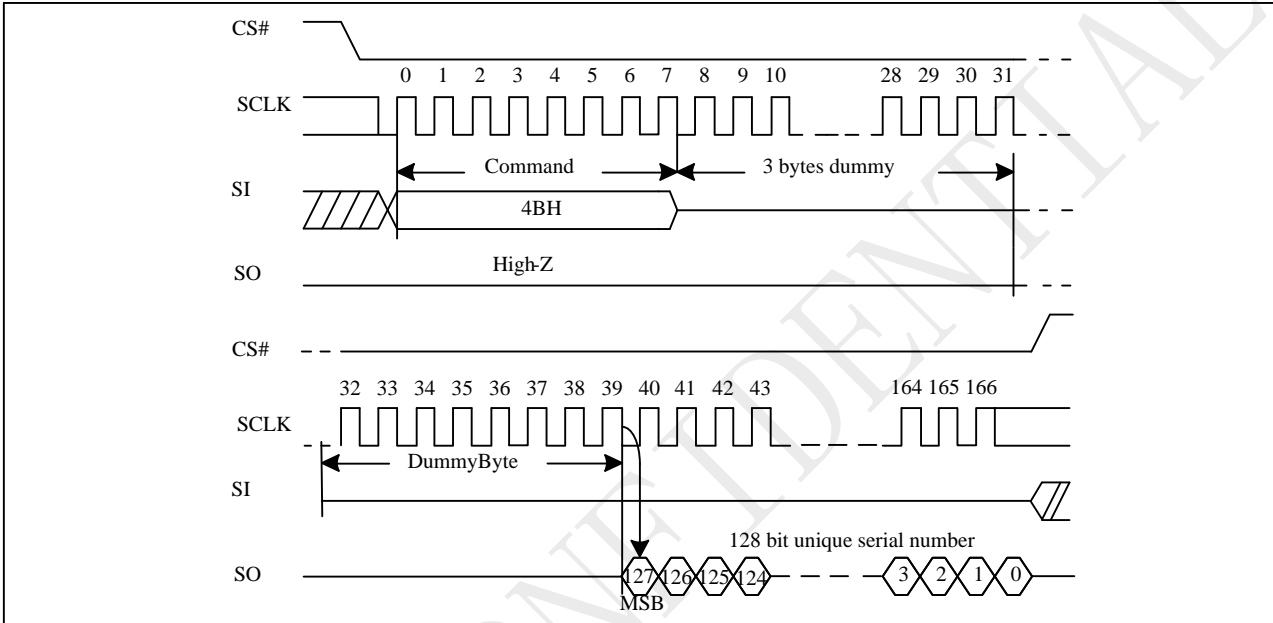
10.67 Read Unique ID (RUID 4BH)

The Read Unique ID command accesses a factory-set read-only 128bit number that is unique to each PY25Q01GLC device. The Unique ID can be used in conjunction with user software methods to help prevent copying or cloning of a system.

The Read Unique ID command sequence: CS# goes low → sending Read Unique ID command → Dummy Byte1 → Dummy Byte2 → Dummy Byte3 → Dummy Byte4 → 128bit Unique ID Out → CS# goes high.

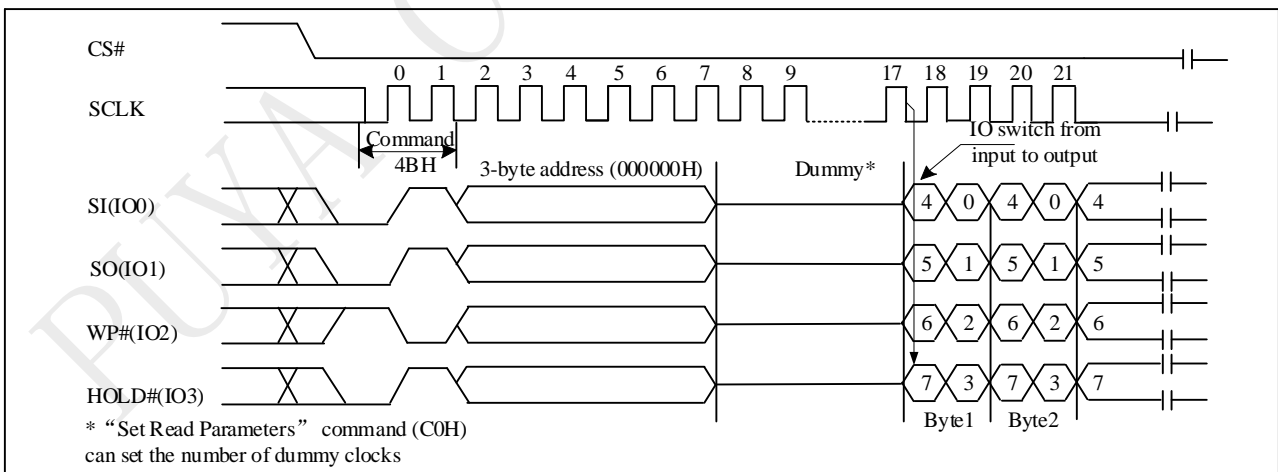
The command sequence is show below.

Figure 10-67 Read Unique ID (RUID) Sequence (SPI)



Note: 5 bytes dummy is required when the device is operation in 4-Byte Address Mode.

Figure 10-67a Read Unique ID (RUID) Sequence (QPI)



Note: 4 bytes address 0000_0000H is required when the device is operation in 4-Byte Address Mode.

10.68 Read SFDP Mode (RDSFDP 5AH)

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 same as FREAD: 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 drive CS# to high at any time during data out.

SFDP is a JEDEC Standard, JESD216B.

Figure 10-68 Read Serial Flash Discoverable Parameter (RDSFDP) Sequence (SPI)

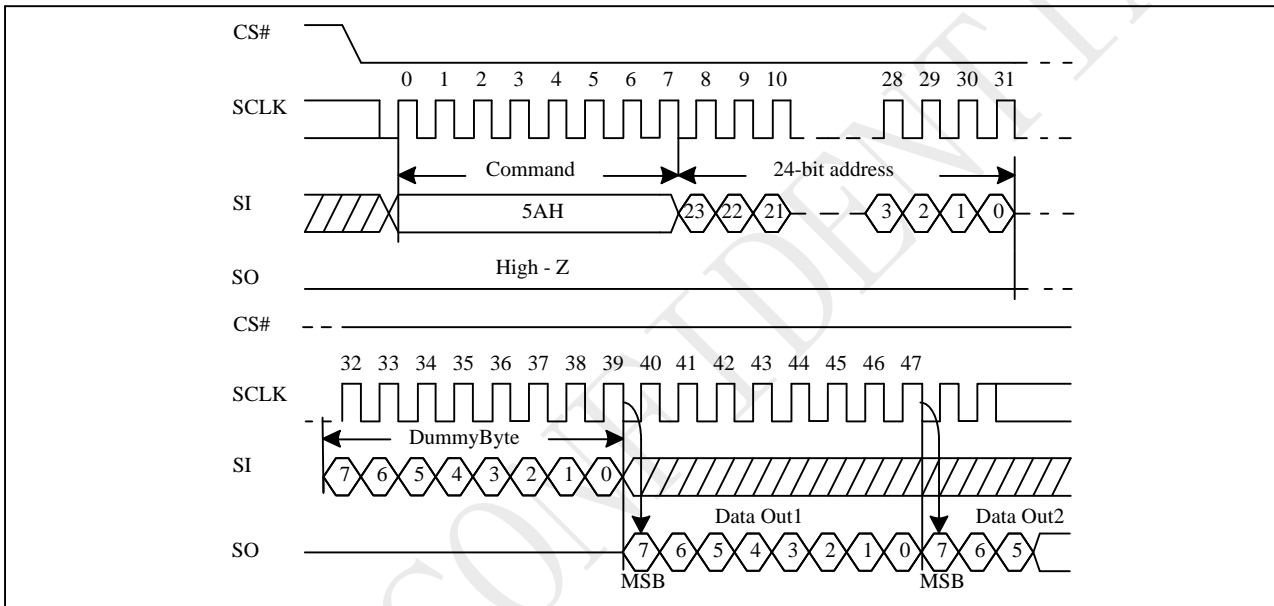
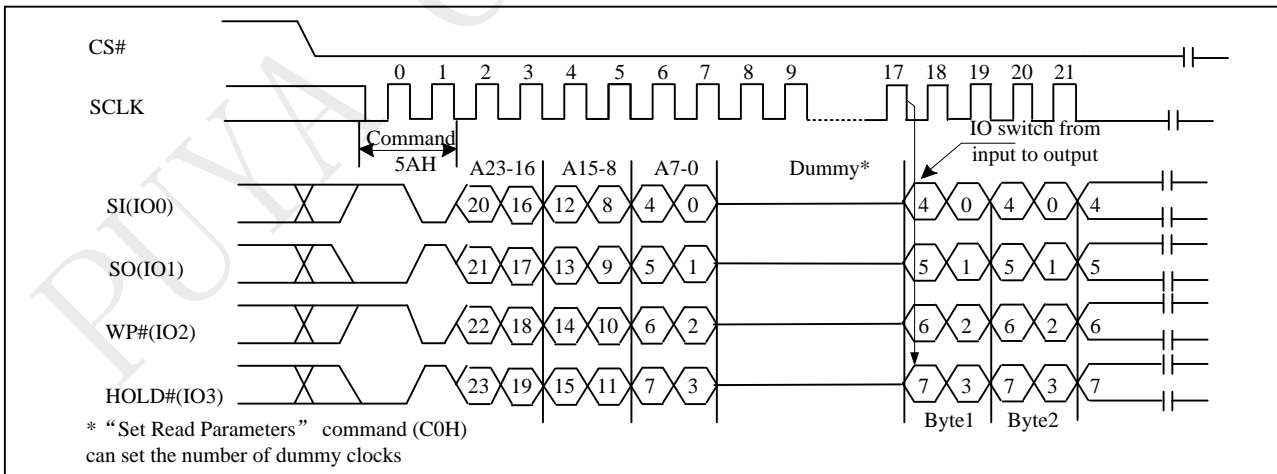


Figure 10-68a Read Serial Flash Discoverable Parameter (RDSFDP) Sequence (QPI)



**Serial Flash Discoverable Parameter (SFDP) Table**

Table Signature and Parameter Identification Data Values

| Description | Comment | Add(H) (Byte) | DW Add (Bit) | Data | Data |
|---|--|------------------|-----------------|------|------|
| SFDP Signature | Fixed:50444653H | 00H | 07:00 | 53H | 53H |
| | | 01H | 15:08 | 46H | 46H |
| | | 02H | 23:16 | 44H | 44H |
| | | 03H | 31:24 | 50H | 50H |
| SFDP Minor Revision Number | Start from 00H | 04H | 07:00 | 00H | 00H |
| SFDP Major Revision Number | Start from 01H | 05H | 15:08 | 01H | 01H |
| Number of Parameters Headers | Start from 00H | 06H | 23:16 | 01H | 01H |
| Unused | Contains 0xFFH and can never be changed | 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 0x00H | 09H | 15:08 | 00H | 00H |
| Parameter Table Major Revision Number | Start from 0x01H | 0AH | 23:16 | 01H | 01H |
| Parameter Table Length (in double word) | How many DWORDs in the Parameter table | 0BH | 31:24 | 09H | 09H |
| Parameter Table Pointer (PTP) | First address of JEDEC Flash Parameter table | 0CH | 07:00 | 30H | 30H |
| | | 0DH | 15:08 | 00H | 00H |
| | | 0EH | 23:16 | 00H | 00H |
| Unused | Contains 0xFFH and can never be changed | 0FH | 31:24 | FFH | FFH |
| ID Number (PUYA Device Manufacturer ID) | It indicates PUYA manufacturer ID | 10H | 07:00 | 85H | 85H |
| Parameter Table Minor Revision Number | Start from 0x00H | 11H | 15:08 | 00H | 00H |
| Parameter Table Major Revision Number | Start from 0x01H | 12H | 23:16 | 01H | 01H |
| Parameter Table Length (in double word) | How many DWORDs in the Parameter table | 13H | 31:24 | 03H | 03H |
| Parameter Table Pointer (PTP) | First address of PUYA Flash Parameter table | 14H | 07:00 | 60H | 60H |
| | | 15H | 15:08 | 00H | 00H |
| | | 16H | 23:16 | 00H | 00H |
| Unused | Contains 0xFFH and can never be changed | 17H | 31:24 | FFH | FFH |



Table Parameter Table (0): JEDEC Flash Parameter Tables

| Description | Comment | Add(H) (Byte) | DW Add (Bit) | Data | Data |
|---|--|------------------|-----------------|----------|------|
| Block/Sector Erase Size | 00: Reserved; 01: 4KB erase; 10: Reserved; 11: not support 4KB erase | 30H | 01:00 | 01b | E5H |
| Write Granularity | 0: 1Byte, 1: 64Byte or larger | | 02 | 1b | |
| Write Enable Instruction Requested for Writing to Volatile Status Registers | 0: Nonvolatile status bit 1: Volatile status bit (BP status register bit) | | 03 | 0b | |
| Write Enable Opcode Select for Writing to Volatile Status Registers | 0: Use 50H Opcode, 1: Use 06H Opcode, Note: If target flash status register is Nonvolatile, then bits3 and 4 must be set to 00b. | | 04 | 0b | |
| Unused | Contains 111b and can never be changed | | 07:05 | 111b | |
| 4KB Erase Opcode | | 31H | 15:08 | 20H | 20H |
| (1-1- 2) Fast Read | 0=Not support, 1=Support | 32H | 16 | 1b | FBH |
| Address Bytes Number used in addressing flash array | 00: 3Byte only, 01: 3 or 4Byte, 10: 4Byte only, 11: Reserved | | 18:17 | 01b | |
| Double Transfer Rate (DTR) clocking | 0=Not support, 1=Support | | 19 | 1b | |
| (1-2- 2) FastRead | 0=Not support, 1=Support | | 20 | 1b | |
| (1-4- 4) Fast Read | 0=Not support, 1=Support | | 21 | 1b | |
| (1-1- 4) Fast Read | 0=Not support, 1=Support | | 22 | 1b | |
| Unused | | | 23 | 1b | |
| Unused | | 33H | 31:24 | FFH | FFH |
| Flash Memory Density | | 37H:34H | 31:00 | 3FFFFFFH | |
| (1-4- 4) Fast Read Number of Wait states | 0 0000b: Wait states (Dummy Clocks) not support | 38H | 04:00 | 00100b | 44H |
| (1-4- 4) Fast Read Number of Mode Bits | 000b:Mode Bits not support | | 07:05 | 010b | |
| (1-4- 4) Fast Read Opcode | | 39H | 15:08 | EBH | EBH |
| (1-1- 4) Fast Read Number of Wait states | 0 0000b: Wait states (Dummy Clocks) not support | 3AH | 20:16 | 01000b | 08H |
| (1-1- 4) Fast Read Number of Mode Bits | 000b:Mode Bits not support | | 23:21 | 000b | |
| (1-1- 4) Fast Read Opcode | | 3BH | 31:24 | 6BH | 6BH |



| Description | Comment | Add(H) (Byte) | DW Add (Bit) | Data | Data |
|--|---|------------------|-----------------|--------|-------|
| (1-1-2) Fast Read Number of Wait states | 0 0000b: Wait states (Dummy Clocks) not support | 3CH | 04:00 | 01000b | 08H |
| (1-1- 2) Fast Read Number of Mode Bits | 000b: Mode Bits not support | | 07:05 | 000b | |
| (1-1- 2) Fast Read Opcode | | 3DH | 15:08 | 3BH | 3BH |
| (1-2- 2) Fast Read Number of Wait states | 0 0000b: Wait states (Dummy Clocks) not support | 3EH | 20:16 | 00000b | 80H |
| (1-2- 2) Fast Read Number of Mode Bits | 000b: Mode Bits not support | | 23:21 | 100b | |
| (1-2- 2) Fast Read Opcode | | 3FH | 31:24 | BBH | BBH |
| (2-2- 2) Fast Read | 0=not support 1=support | 40H | 00 | 0b | EEH |
| Unused | | | 03:01 | 111b | |
| (4-4- 4) Fast Read | 0=not support 1=support | | 04 | 0b | |
| Unused | | | 07:05 | 111b | |
| Unused | | 43H:41H | 31:08 | 0xFFH | 0xFFH |
| Unused | | 45H:44H | 15:00 | 0xFFH | 0xFFH |
| (2-2-2) Fast Read Number of Wait states | 0 0000b: Wait states (Dummy Clocks) not support | 46H | 20:16 | 00000b | 00H |
| (2-2- 2) Fast Read Number of Mode Bits | 000b: Mode Bits not support | | 23:21 | 000b | |
| (2-2- 2) Fast Read Opcode | | 47H | 31:24 | FFH | FFH |
| Unused | | 49H:48H | 15:00 | 0xFFH | 0xFFH |
| (4-4-4) Fast Read Number of Wait states | 0 0000b: Wait states (Dummy Clocks) not support | 4AH | 20:16 | 00000b | 00H |
| (4-4- 4) Fast Read Number of Mode Bits | 000b: Mode Bits not support | | 23:21 | 000b | |
| (4-4- 4) Fast Read Opcode | | 4BH | 31:24 | FFH | FFH |
| Sector Type 1 Size | Sector/block size=2 ^N bytes 0x00b: this sector type don't exist | 4CH | 07:00 | 0CH | 0CH |
| Sector Type 1 erase Opcode | | 4DH | 15:08 | 20H | 20H |
| Sector Type 2 Size | Sector/block size=2 ^N bytes 0x00b: this sector type don't exist | 4EH | 23:16 | 0FH | 0FH |
| Sector Type 2 erase Opcode | | 4FH | 31:24 | 52H | 52H |
| Sector Type 3 Size | Sector/block size=2 ^N bytes 0x00b: this sector type don't exist | 50H | 07:00 | 10H | 10H |
| Sector Type 3 erase Opcode | | 51H | 15:08 | D8H | D8H |
| Sector Type 4 Size | Sector/block size=2 ^N bytes 0x00b: this sector type don't exist | 52H | 23:16 | 00H | 00H |
| Sector Type 4 erase Opcode | | 53H | 31:24 | FFH | FFH |



Table Parameter Table (1): PUYA Flash Parameter Tables

| Description | Comment | Add(H) (Byte) | DW Add (Bit) | Data | Data |
|---|--|------------------|-----------------|---------------------|-------|
| Vcc Supply Maximum Voltage | 2000H=2.000V 2700H=2.700V 3600H=3.600V | 61H:60H | 15:00 | 2000H | 2000H |
| Vcc Supply Minimum Voltage | 1650H=1.650V 2250H=2.250V 2350H=2.350V 2700H=2.700V | 63H:62H | 31:16 | 1650H | 1650H |
| HW Reset# pin | 0=not support 1=support | 65H:64H | 00 | 0b | F99EH |
| HW Hold# pin | 0=not support 1=support | | 01 | 1b | |
| Deep Power Down Mode | 0=not support 1=support | | 02 | 1b | |
| SW Reset | 0=not support 1=support | | 03 | 1b | |
| SW Reset Opcode | Should be issue Reset Enable(66H) before Reset cmd. | | 11:04 | 1001 1001b (99H) | |
| Program Suspend/Resume | 0=not support 1=support | | 12 | 1b | |
| Erase Suspend/Resume | 0=not support 1=support | | 13 | 1b | |
| Unused | | | 14 | 1b | |
| Wrap Around Read mode | 0=not support 1=support | | 15 | 1b | |
| Wrap - Around Read mode Opcode | | | 66H | 23:16 | |
| Wrap - Around Read data length | 08H:support 8B wraparound read 16H:8B&16B 32H:8B&16B&32B 64H:8B&16B&32B&64B | 67H | 31:24 | 64H | 64H |
| Individual block lock | 0=not support 1=support | 6BH:68H | 00 | 1b | C8D9H |
| Individual block lock bit (Volatile/Nonvolatile) | 0=Volatile 1=Nonvolatile | | 01 | 0b | |
| Individual block lock Opcode | | | 09:02 | 36H | |
| Individual blocklock Volatile protect bit default protect status | 0=protect 1=unprotect | | 10 | 0b | |
| Secured OTP | 0=not support 1=support | | 11 | 1b | |
| Read Lock | 0=not support 1=support | | 12 | 0b | |
| Permanent Lock | 0=not support 1=support | | 13 | 0b | |
| Unused | | | 15:14 | 11b | |
| Unused | | | 31:16 | FFFFH | |



11 Ordering Information

PY 25 Q 01 GL C - SM H - I T

Company Designator

PY= Puya Semiconductor

Product Family

25 = SPI interface flash

Product Serial

Q = Q serial

Memory Density

01G = 1Gb

Operation Voltage

L = 1.65V~2.0V

Generation

C = GE

Package Type

SM = SOP16 300mil

TF = TFBGA 24ball 6x8mm (5x5 Array)

TB = TFBGA 24ball 6x8mm (4x6 Array)

Plating Technology

H: RoHS Compliant, Halogen free, Antimony free

Device Grade

I = -40~85C

Packing Type

T = TUBE

R = TAPE & REEL

Y = TRAY



12 Valid Part Numbers and Top Marking

The following table provides the valid part numbers for the PY25Q01GLC Flash Memory. Please contact PUYA for specific availability by density and package type. PUYA Flash memories use a 15-digit Product Number for ordering.

| Package Type | Product Number | Density | Top Side Marking | Temp. | Packing Type |
|-------------------------------------|-------------------|---------|-----------------------|-------|--------------|
| SM SOP16 300mil | PY25Q01GLC-SMH-IT | 1G-bit | PY25Q01GLC xxxxxxx | 85C | Tube |
| SM SOP16 300mil | PY25Q01GLC-SMH-IR | 1G-bit | PY25Q01GLC xxxxxxx | 85C | Reel |
| TF* TFBGA 24-Ball (5x5 Array) | PY25Q01GLC-TFH-IY | 1G-bit | PY25Q01GLC xxxxxxx | 85C | Tray |
| TB* TFBGA 24-Ball (4x6 Array) | PY25Q01GLC-TBH-IY | 1G-bit | PY25Q01GLC xxxxxxx | 85C | Tray |

Note: There is no mass production of the package marked with "*", if necessary, please contact Puya sales.

13 Package Information

13.1 16-Lead SOP (300mil)

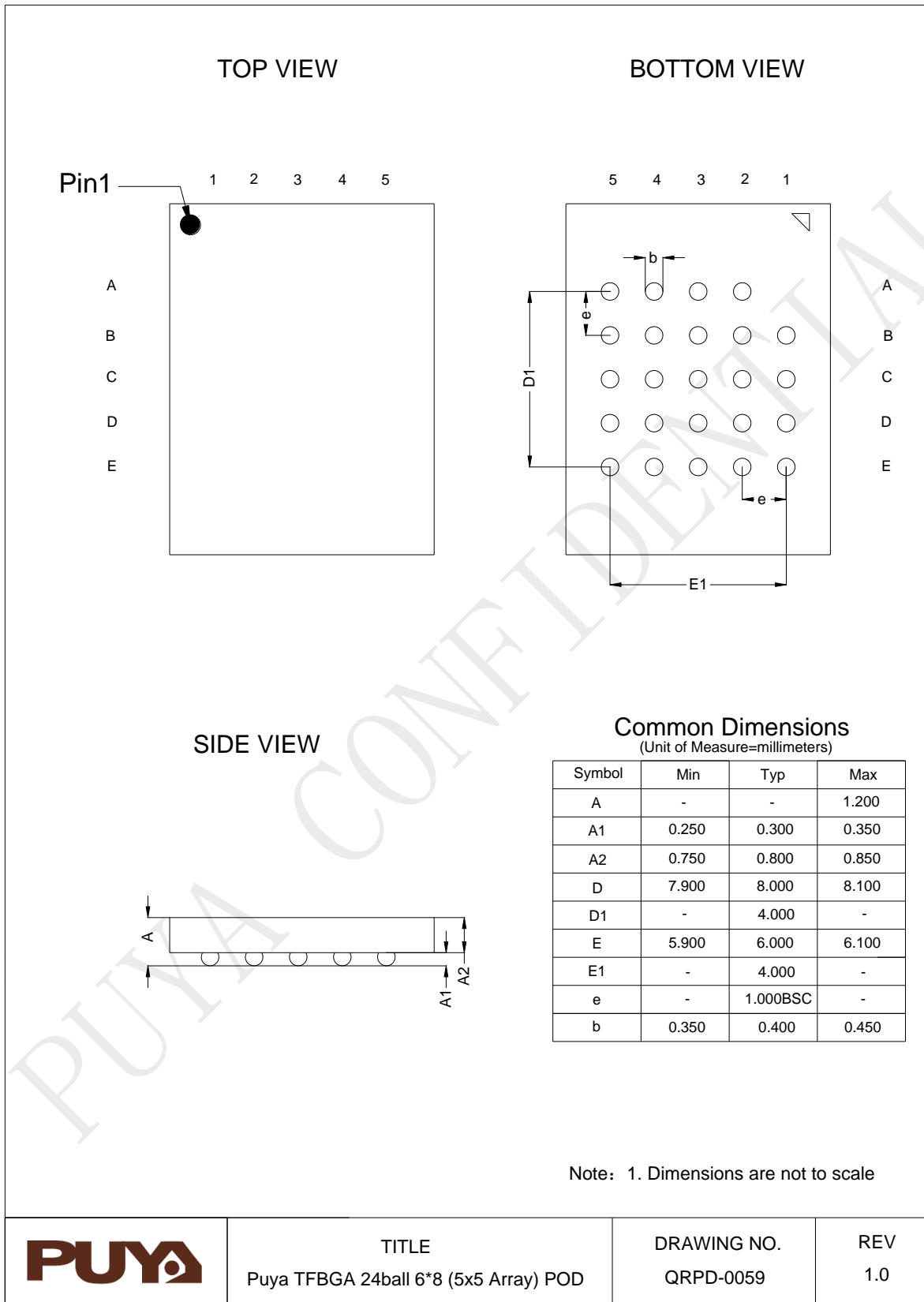
Common Dimensions
(Unit of Measure=millimeters)

| Symbol | Min | Typ | Max |
|--------|---------|------|-------|
| A | - | - | 2.65 |
| A1 | 0.10 | - | 0.30 |
| A2 | - | 2.30 | - |
| b | 0.33 | - | 0.51 |
| c | 0.23 | - | 0.32 |
| D | 10.10 | - | 10.50 |
| E | 10.00 | - | 10.65 |
| E1 | 7.40 | - | 7.60 |
| e | 1.27BSC | | |
| L | 0.40 | - | 1.27 |
| θ | 0 | - | 8° |

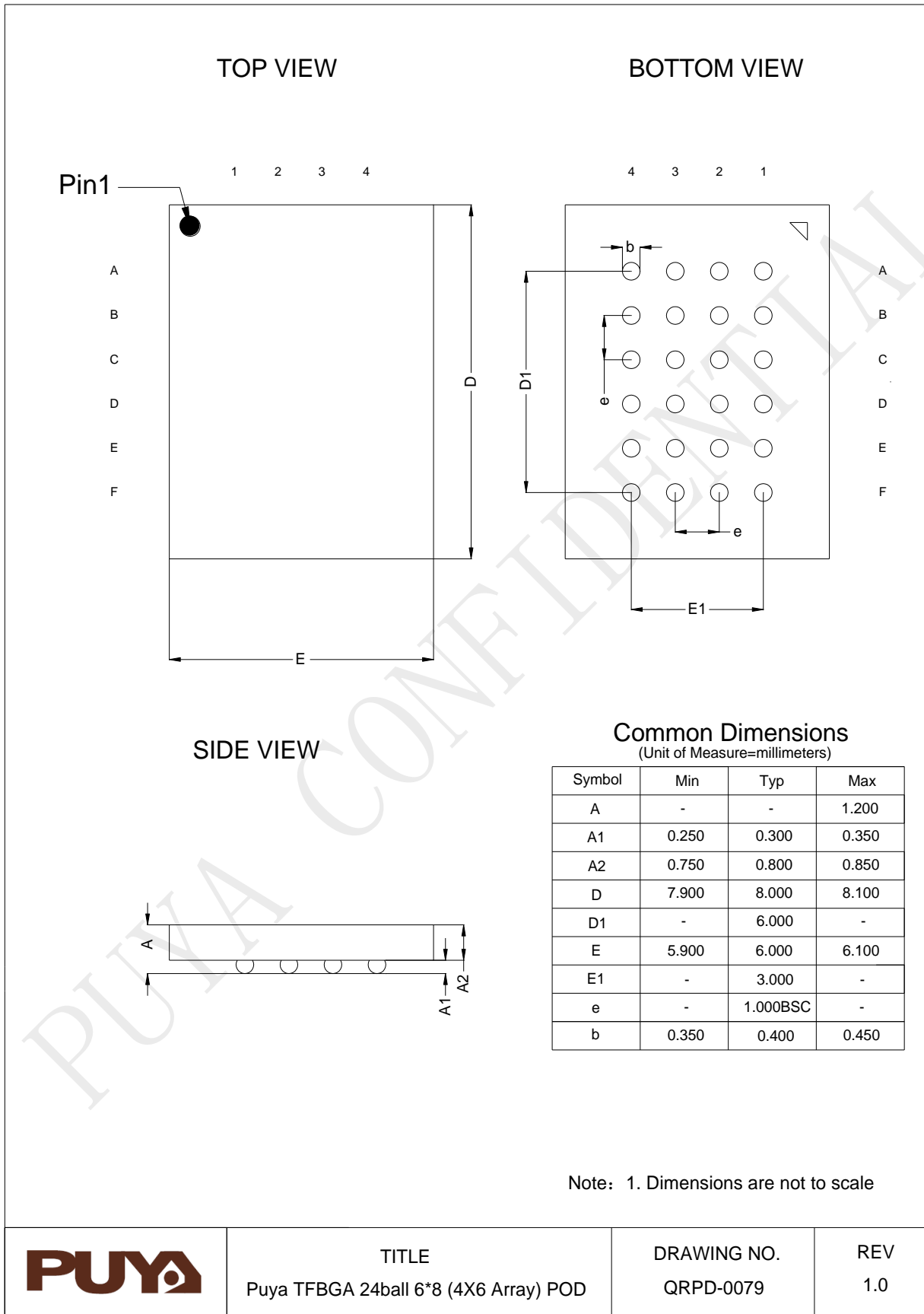
Note: Dimensions are not to scale.

| | | | |
|--|-------------------------|-------------|-----|
| | TITLE | DRAWING NO. | REV |
| | PUYA SOP16 (300mil) POD | QRPD-0055 | 1.0 |

13.2 24-Ball TFBGA(5x5 Array)



13.3 24-Ball TFBGA(4x6 Array)





14 Revision History

| Rev. | Date | Description | Note |
|------|------------|-----------------|------|
| 1.0 | 2024-04-01 | Initial release | - |

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