GD25LQ16

DATASHEET

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1 FEATURES

- 16M-bit Serial Flash
  - -2048K-byte
  - -256 bytes per programmable page

- Standard, Dual, Quad SPI, QPI
  - -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

- High Speed Clock Frequency
  - -120MHz for fast read with 30PF load
  - -Dual I/O Data transfer up to 240Mbits/s
  - -Quad I/O Data transfer up to 480Mbits/s
  - -QPI Mode Data transfer up to 480Mbits/s

- Software/Hardware Write Protection
  - -Write protect all/portion of memory via software
  - -Enable/Disable protection with WP# Pin
  - -Top or Bottom, Sector or Block selection

- Allows XIP(execute in place)operation⁽¹⁾
  - -Continuous Read With 8/16/32/64-byte Wrap

- Cycling endurance
  - -Minimum 100,000 Program/Erase Cycles

- Data retention
  - -20-year data retention typical

- Program/Erase Speed
  - -Page Program time: 0.4ms typical
  - -Sector Erase time: 60ms typical
  - -Block Erase time: 0.3/0.5s typical
  - -Chip Erase time: 10s typical

- Flexible Architecture
  - -Sector of 4K-byte
  - -Block of 32/64k-byte
  - -Erase/Program Suspend/Resume

- Low Power Consumption
  - -20mA maximum active current
  - -5uA maximum power down current

- Advanced security Features
  - -4*256-Byte Security Registers With OTP Lock

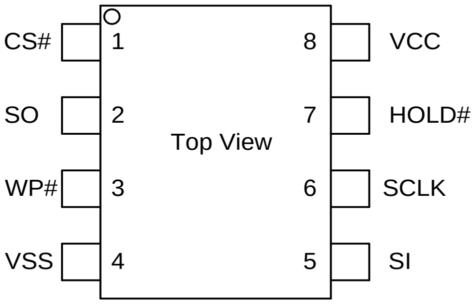
- Single Power Supply Voltage
  - -Full voltage range:1.65~2.0V

Note: 1.Please contact GigaDevice for details.

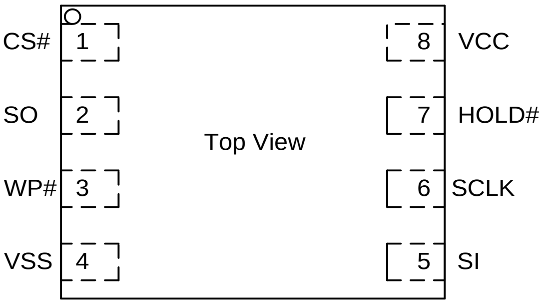
2 GENERAL DESCRIPTION

The GD25LQ16 (16M-bit) Serial flash supports the standard Serial Peripheral Interface (SPI), and supports the Dual/Quad SPI and QPI mode: Serial Clock, Chip Select, Serial Data I/O0 (SI), I/O1 (SO), I/O2 (WP#), and I/O3 (HOLD#). The Dual I/O data is transferred with speed of 240Mbits/s and the Quad I/O & Quad output data is transferred with speed of 480Mbits/s.

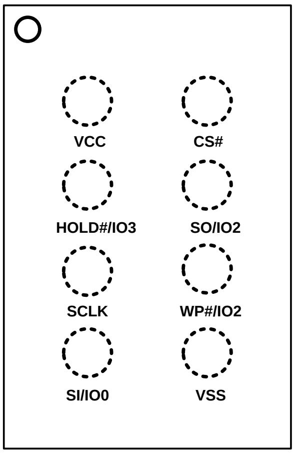
CONNECTION DIAGRAM



8 – LEAD VSOP/SOP



8 – LEAD WSON/USON



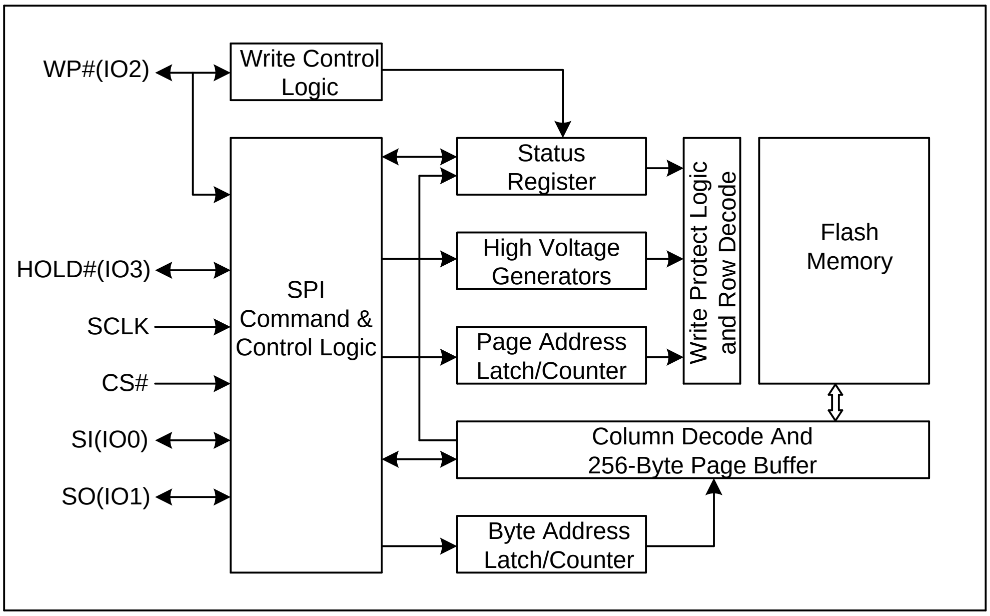
WLCSP

PIN DESCRIPTION

Pin Name	I/O	Description
CS#	**I**	Chip Select Input
SO (IO1)	**I/O**	Data Output (Data Input Output 1)
WP# (IO2)	**I/O**	Write Protect Input (Data Input Output 2)
VSS		Ground
SI (IO0)	**I/O**	Data Input (Data Input Output 0)
SCLK	**I**	Serial Clock Input
HOLD# (IO3)	**I/O**	Hold Input (Data Input Output 3)
VCC		Power Supply

Note: CS# must be driven high if chip is not selected. Please don’t leave CS# floating any time after power is on.

BLOCK DIAGRAM



3 MEMORY ORGANIZATION

GD25LQ16

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

UNIFORM BLOCK SECTOR ARCHITECTURE

GD25LQ16 64K Bytes Block Sector Architecture

Block	Sector	Address range	
31	511	1FF000H	1FFFFFH
	……	……	……
	496	1F0000H	1F0FFFH
30	495	1EF000H	1EFFFFH
	……	……	……
	480	1E0000H	1E0FFFH
……	……	……	……
	……	……	……
	……	……	……
……	……	……	……
	……	……	……
	……	……	……
2	47	02F000H	02FFFFH
	……	……	……
	32	020000H	020FFFH
1	31	01F000H	01FFFFH
	……	……	……
	16	010000H	010FFFH
0	15	00F000H	00FFFFH
	……	……	……
	0	000000H	000FFFH

4 DEVICE OPERATION

SPI Mode

Standard SPI

The GD25LQ16 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 GD25LQ16 supports Dual SPI operation when using the "Dual Output Fast Read" and "Dual I/O Fast Read" (3BH and 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 GD25LQ16 supports Quad SPI operation when using the "Quad Output Fast Read"," Quad I/O Fast Read", "Quad I/O Word Fast Read" (6BH, EBH, E7H) 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 GD25LQ16 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.

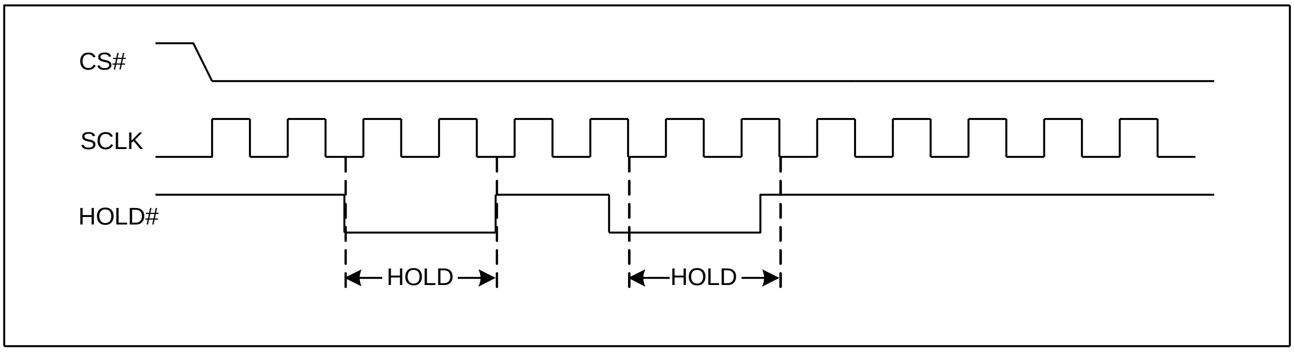
Hold

The HOLD# signal goes low to stop any serial communications with the device, but doesn't stop the operation of write status register, programming, or erasing in progress.

The operation of HOLD, need CS# keep low, and starts on falling edge of the HOLD# signal, with SCLK signal being low (if SCLK is not being low, HOLD operation will not start until SCLK being low). The HOLD condition ends on rising edge of HOLD# signal with SCLK being low (If SCLK is not being low, HOLD operation will not end until SCLK being low).

The SO is high impedance, both SI and SCLK don't care during the HOLD operation, if 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 then CS# must be at low.

Figure1. Hold Condition



5 Data Protection

The GD25LQ16 provide the following data protection methods:

- Write Enable (WREN) command: The WREN command is set the Write Enable Latch bit (WEL). The WEL bit will return to reset by the following situation:
  - -Power-Up
  - -Write Disable (WRDI)
  - -Write Status Register (WRSR)
  - -Page Program (PP)
  - -Sector Erase (SE) / Block Erase (BE) / Chip Erase (CE)
- 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~BP4 bits and SRP0~1 bits.
- Deep Power-Down Mode: In Deep Power-Down Mode, all commands are ignored except the Release from Deep Power-Down Mode command.

Table1. GD25LQ16 Protected area size (CMP=0)

Status Register Content					Memory Content			
BP4	**BP3**	**BP2**	**BP1**	**BP0**	**Blocks**	**Addresses**	**Density**	**Portion**
X	X	0	0	0	NONE	NONE	NONE	NONE
0	0	0	0	1	31	1F0000H-1FFFFFH	64KB	Upper 1/32
0	0	0	1	0	30 to 31	1E0000H-1FFFFFH	128KB	Upper 1/16
0	0	0	1	1	28 to 31	1C0000H-1FFFFFH	256KB	Upper 1/8
0	0	1	0	0	24 to 31	180000H-1FFFFFH	512KB	Upper 1/4
0	0	1	0	1	16 to 31	100000H-1FFFFFH	1M	Upper 1/2
0	1	0	0	1	0	000000H-00FFFFH	64KB	Lower 1/32
0	1	0	1	0	0 to 1	000000H-01FFFFH	128KB	Lower 1/16
0	1	0	1	1	0 to 3	000000H-03FFFFH	256KB	Lower 1/8
0	1	1	0	0	0 to 7	000000H-07FFFFH	512KB	Lower 1/4
0	1	1	0	1	0 to 15	000000H-0FFFFFH	1M	Lower 1/2
X	X	1	1	X	0 to 31	000000H-1FFFFFH	2M	ALL
1	0	0	0	1	31	1FF000H-1FFFFFH	4KB	Top Block
1	0	0	1	0	31	1FE000H-1FFFFFH	8KB	Top Block
1	0	0	1	1	31	1FC000H-1FFFFFH	16KB	Top Block
1	0	1	0	X	31	1F8000H-1FFFFFH	32KB	Top Block
1	1	0	0	1	0	000000H-000FFFH	4KB	Bottom Block
1	1	0	1	0	0	000000H-001FFFH	8KB	Bottom Block
1	1	0	1	1	0	000000H-003FFFH	16KB	Bottom Block
1	1	1	0	X	0	000000H-007FFFH	32KB	Bottom Block

Table1a. GD25LQ16 Protected area size (CMP=1)

Status Register Content					Memory Content			
BP4	**BP3**	**BP2**	**BP1**	**BP0**	**Blocks**	**Addresses**	**Density**	**Portion**
X	X	0	0	0	0 to 31	000000H-1FFFFFH	2M	ALL
0	0	0	0	1	0 to 30	000000H-1EFFFFH	1984KB	Lower 31/32
0	0	0	1	0	0 to 29	000000H-1DFFFFH	1920KB	Lower 15/16
0	0	0	1	1	0 to 27	000000H-1BFFFFH	1792KB	Lower 7/8
0	0	1	0	0	0 to 23	000000H-17FFFFH	1536KB	Lower 3/4
0	0	1	0	1	0 to 15	000000H-0FFFFFH	1M	Lower 1/2
0	1	0	0	1	1 to 31	010000H-1FFFFFH	1984KB	Upper 31/32
0	1	0	1	0	2 to 31	020000H-1FFFFFH	1920KB	Upper 15/16
0	1	0	1	1	4 to 31	040000H-1FFFFFH	1792KB	Upper 7/8
0	1	1	0	0	8 to 31	080000H-1FFFFFH	1536KB	Upper 3/4
0	1	1	0	1	16 to 31	100000H-1FFFFFH	1M	Upper 1/2
X	X	1	1	X	NONE	NONE	NONE	NONE
1	0	0	0	1	0 to 31	000000H-1FEFFFH	2044KB	L - 511/512
1	0	0	1	0	0 to 31	000000H-1FDFFFH	2040KB	L - 255/256
1	0	0	1	1	0 to 31	000000H-1FBFFFH	2032KB	L - 127/128
1	0	1	0	X	0 to 31	000000H-1F7FFFH	2016KB	L - 63/64
1	1	0	0	1	0 to 31	001000H-1FFFFFH	2044KB	U - 511/512
1	1	0	1	0	0 to 31	002000H-1FFFFFH	2040KB	U - 255/256
1	1	0	1	1	0 to 31	004000H-1FFFFFH	2032KB	U - 127/128
1	1	1	0	X	0 to 31	008000H-1FFFFFH	2016KB	U - 63/64

6 Status Register

S15	S14	S13	S12	S11	S10	S9	S8
SUS1	CMP	LB3	LB2	LB1	SUS2	QE	SRP1

S7	S6	S5	S4	S3	S2	S1	S0
SRP0	BP4	BP3	BP2	BP1	BP0	WEL	WIP

The status and control bits of the Status Register are as follows:

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 Table1).becomes protected against Page Program (PP), 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(1)	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.

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)

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 Status registers Memory Protection table for details. The default setting is CMP=0.

SUS1, SUS2 bit

The SUS1 and SUS2 bit are read only bit in the status register (S15 and S10) that are set to 1 after executing an Program/Erase Suspend (75H) command (The Erase Suspend will set the SUS1 to 1,and the Program Suspend will set the SUS2 to 1). The SUS1 and SUS2 bit are cleared to 0 by Program/Erase Resume (7AH) command as well as a power-down, power-up cycle.

7 COMMANDS DESCRIPTION

All commands, addresses and data are shifted in and out of the device, beginning with the most significant bit on the first rising edge of SCLK after CS# is driven low. Then, the one-byte command code must be shifted in to the device, most significant bit first on SI, each bit being latched on the rising edges of SCLK.

See Table2, every command sequence starts with a one-byte command code. Depending on the command, this might be followed by address bytes, or by data bytes, or by both or none. CS# must be driven high after the last bit of the command sequence has been shifted in. For the command of Read, Fast Read, Read Status Register or Release from Deep Power-Down, and Read Device ID, the shifted-in command sequence is followed by a data-out sequence. CS# can be driven high after any bit of the data-out sequence is being shifted out.

For the command of Page Program, Sector Erase, Block Erase, Chip Erase, Write Status Register, Write Enable, Write Disable or Deep Power-Down command, CS# must be driven high exactly at a byte boundary, otherwise the command is rejected, and is not executed. That is CS# must driven high when the number of clock pulses after CS# being driven low is an exact multiple of eight. For Page Program, if at any time the input byte is not a full byte, nothing will happen and WEL will not be reset.

Table2. Commands (Standard/Dual/Quad SPI)

Command Name	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	n-Bytes
Write Enable	06H						
Write Disable	04H						
Volatile SR Write Enable	50H						
Read Status Register	05H	(S7-S0)					(continuous)
Read Status Register-1	35H	(S15-S8)					(continuous)
Write Status Register	01H	(S7-S0)	(S15-S8)				
Read Data	03H	A23-A16	A15-A8	A7-A0	(D7-D0)	(Next byte)	(continuous)
Fast Read	0BH	A23-A16	A15-A8	A7-A0	dummy	(D7-D0)	(continuous)
Dual Output Fast Read	3BH	A23-A16	A15-A8	A7-A0	dummy	(D7-D0)(1)	(continuous)
Dual I/O Fast Read	BBH	A23-A8(2)	A7-A0 M7-M0(2)	(D7-D0)(1)			(continuous)
Quad Output Fast Read	6BH	A23-A16	A15-A8	A7-A0	dummy	(D7-D0)(3)	(continuous)
Quad I/O Fast Read	EBH	A23-A0 M7-M0(4)	dummy(5)	(D7-D0)(3)			(continuous)
Quad I/O Word Fast Read(7)	E7H	A23-A0 M7-M0(4)	dummy(6)	(D7-D0)(3)			(continuous)
Page Program	02H	A23-A16	A15-A8	A7-A0	(D7-D0)	Next byte	
Quad Page Program	32H	A23-A16	A15-A8	A7-A0	(D7-D0)(3)		

Sector Erase	20H	A23-A16	A15-A8	A7-A0			
Block Erase(32K)	52H	A23-A16	A15-A8	A7-A0			
Block Erase(64K)	D8H	A23-A16	A15-A8	A7-A0			
Chip Erase	C7/60H						
Enable QPI	38H						
Enable Reset	66H						
Reset	99H						
Set Burst with Wrap	77H	W6-W4					
Program/Erase Suspend	75H						
Program/Erase Resume	7AH						
Deep Power-Down	B9H						
Release From Deep Power-Down, And Read Device ID	ABH	dummy	dummy	dummy	(ID7-ID0)		(continuous)
Release From Deep Power-Down	ABH						
Manufacturer/ Device ID	90H	dummy	dummy	00H	(M7-M0)	(ID7-ID0)	(continuous)
Manufacturer/ Device ID by Dual I/O	92H	A23-A8	A7-A0, M[7:0]	(M7-M0) (ID7-ID0)			(continuous)
Manufacturer/ Device ID by Quad I/O	94H	A23-A0, M[7:0]	dummy	(M7-M0) (ID7-ID0)			(continuous)
Read Identification	9FH	(M7-M0)	(ID15-ID8)	(ID7-ID0)			(continuous)
Erase Security Registers(8)	44H	A23-A16	A15-A8	A7-A0			
Program Security Registers(8)	42H	A23-A16	A15-A8	A7-A0	(D7-D0)	(D7-D0)	
Read Security Registers(8)	48H	A23-A16	A15-A8	A7-A0	dummy	(D7-D0)	

Table2a. Commands (QPI)

Command Name	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6
Clock Number	(0,1)	(2,3)	(4,5)	(6,7)	(8,9)	(10,11)
Write Enable	06H					
Volatile SR Write Enable	50H					
Write Disable	04H					
Read Status Register	05H	(S7-S0)				
Read Status Register-1	35H	(S15-S8)				
Write Status Register	01H	(S7-S0)	(S15-S8)			
Page Program	02H	A23-A16	A15-A8	A7-A0	(D7-D0)	Next byte
Sector Erase	20H	A23-A16	A15-A8	A7-A0		
Block Erase(32K)	52H	A23-A16	A15-A8	A7-A0		
Block Erase(64K)	D8H	A23-A16	A15-A8	A7-A0		
Chip Erase	C7/60H					
Program/Erase Suspend	75H					
Program/Erase Resume	7AH					
Deep Power-Down	B9H					
Set Read Parameters	C0H	P7-P0				
Fast Read	0BH	A23-A16	A15-A8	A7-A0	dummy	(D7-D0)
Burst Read with Wrap	0CH	A23-A16	A15-A8	A7-A0	dummy	(D7-D0)
Quad I/O Fast Read	EBH	A23-A16	A15-A8	A7-A0	M7-M0	(D7-D0)
Release From Deep Power-Down, And Read Device ID	ABH	dummy	dummy	dummy	(ID7-ID0)	
Manufacturer/ Device ID	90H	dummy	dummy	00H	(M7-M0)	(ID7-ID0)
Read Identification	9FH	(M7-M0)	(ID15-ID8)	(ID7-ID0)		
Disable QPI	FFH					
Enable Reset	66H					
Reset	99H					

NOTE:

1. Dual Output data
IO0 = (D6, D4, D2, D0)
IO1 = (D7, D5, D3, D1)

2. Dual Input Address
IO0 = A22, A20, A18, A16, A14, A12, A10, A8 A6, A4, A2, A0, M6, M4, M2, M0
IO1 = 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 = A20, A16, A12, A8, A4, A0, M4, M0
IO1 = A21, A17, A13, A9, A5, A1, M5, M1
IO2 = A22, A18, A14, A10, A6, A2, M6, M2
IO3 = 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. Fast Word Read Quad I/O Data

IO0 = (x, x, D4, D0,…)
IO1 = (x, x, D5, D1,…)
IO2 = (x, x, D6, D2,…)
IO3 = (x, x, D7, D3,…)

7. Fast Word Read Quad I/O Data: the lowest address bit must be 0.

8. Security Registers Address:

Security Register0: A23-A16=00H, A15-A8=00H, A7-A0= Byte Address;
Security Register1: A23-A16=00H, A15-A8=10H, A7-A0= Byte Address;
Security Register2: A23-A16=00H, A15-A8=20H, A7-A0= Byte Address;
Security Register3: A23-A16=00H, A15-A8=30H, A7-A0= Byte Address.

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

CLK #0 1 2 3 4 5 6 7 8 9 10 11
IO0= C4, C0, A20, A16, A12, A8, A4, A0, D4, D0, D4, D0,
IO1= C5, C1, A21, A17, A13, A9, A5, A1, D5, D1, D5, D1
IO2= C6, C2, A22, A18, A14, A10, A6, A2, D6, D2, D6, D2
IO3= C7, C3, A23, A19, A15, A11, A7, A3, D7, D3, D7, D3

TABLE OF ID DEFINITIONS

GD25LQ16

Operation Code	M7-M0	ID15-ID8	ID7-ID0
9FH	C8	60	15
90H	C8		14
ABH			14

7.1 Write Enable (WREN) (06H)

The Write Enable (WREN) command is for setting the Write Enable Latch (WEL) bit. The Write Enable Latch (WEL) bit must be set prior to every Page Program (PP), Sector Erase (SE), Block Erase (BE), Chip Erase (CE), Write Status Register (WRSR) and Erase/Program Security Registers command. The Write Enable (WREN) command sequence: CS# goes low → sending the Write Enable command → CS# goes high.

Figure2. Write Enable Sequence Diagram

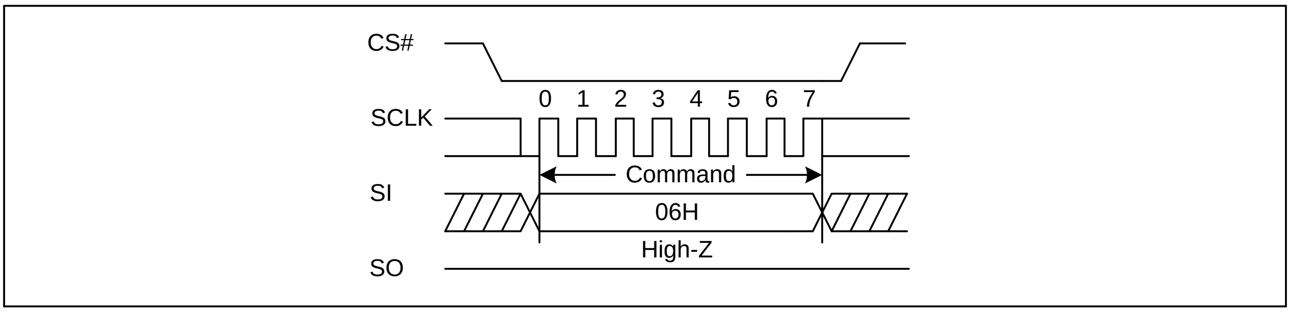
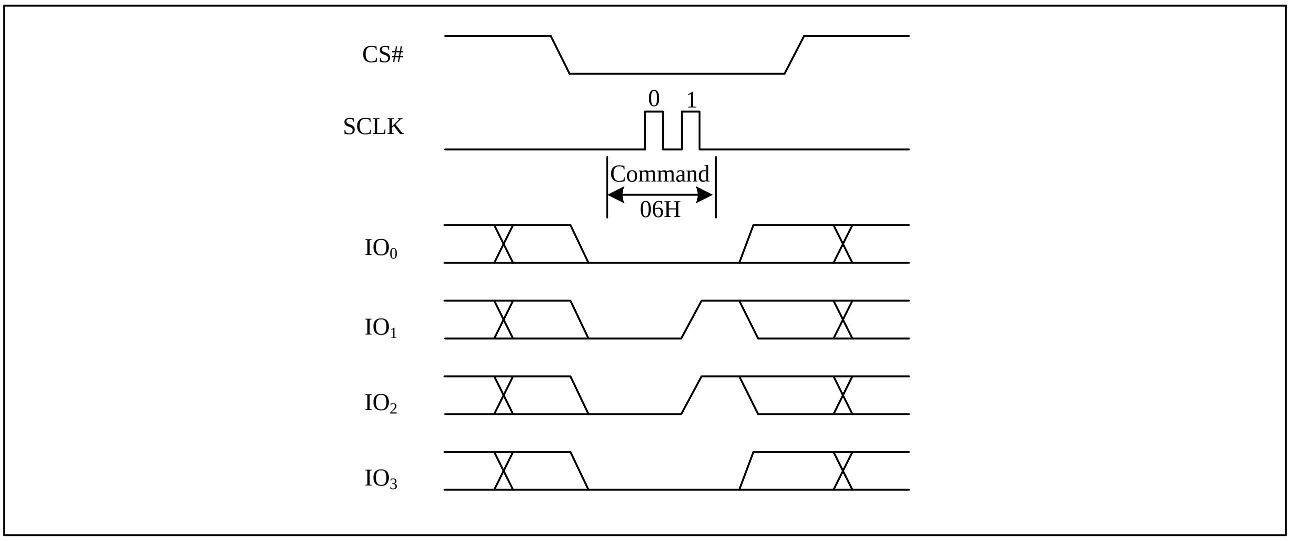


Figure2a. Write Enable Sequence Diagram (QPI)



7.2 Write Disable (WRDI) (04H)

The Write Disable command is for resetting the Write Enable Latch (WEL) bit. The Write Disable command sequence: CS# goes low →Sending the Write Disable command →CS# goes high. The WEL bit is reset by following condition: Power-up and upon completion of the Write Status Register, Page Program, Sector Erase, Block Erase, Chip Erase, Erase/Program Security Registers and Reset commands.

Figure3. Write Disable Sequence Diagram

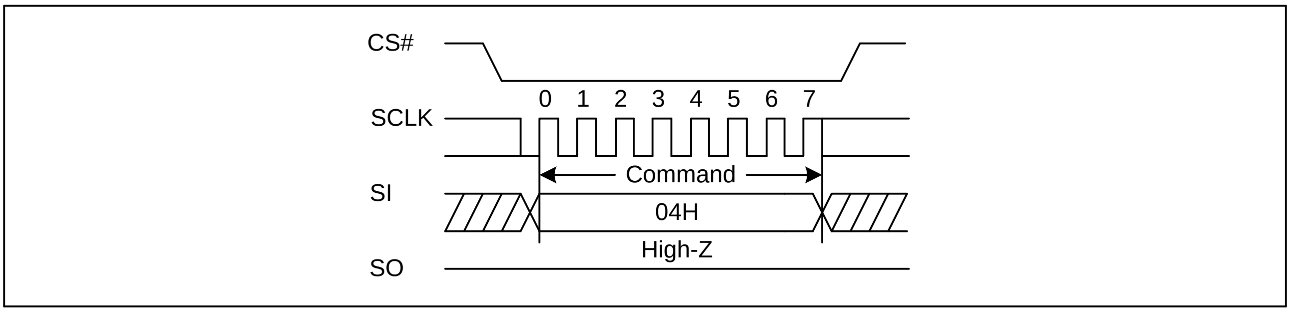
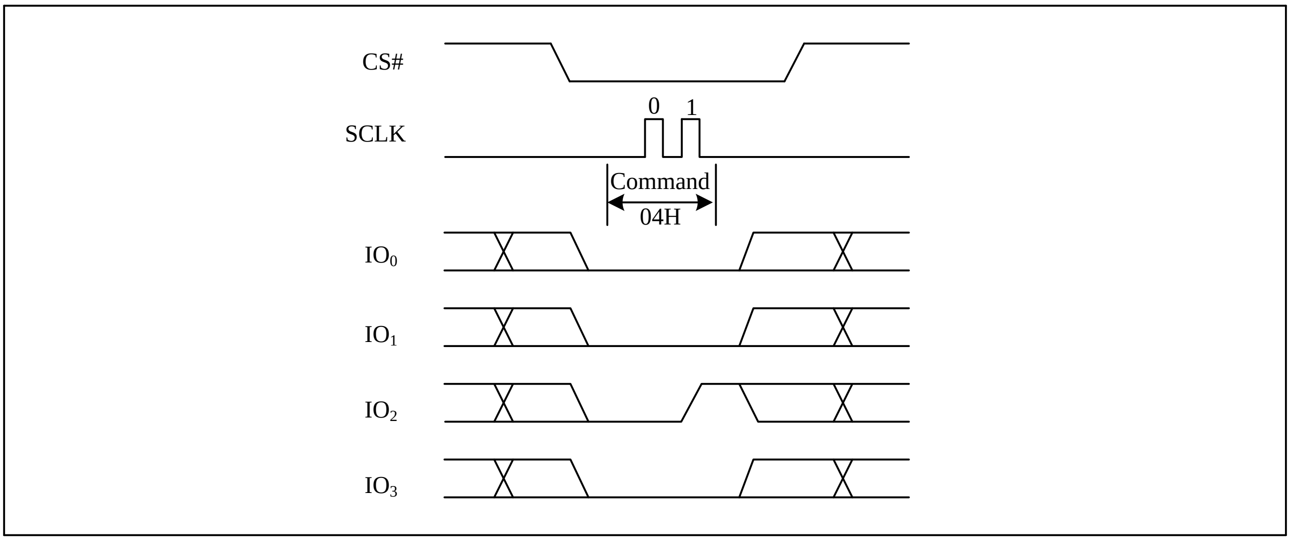


Figure3a. Write Disable Sequence Diagram (QPI)



7.3 Write Enable for Volatile Status Register (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.

Figure4. Write Enable for Volatile Status Register Sequence Diagram

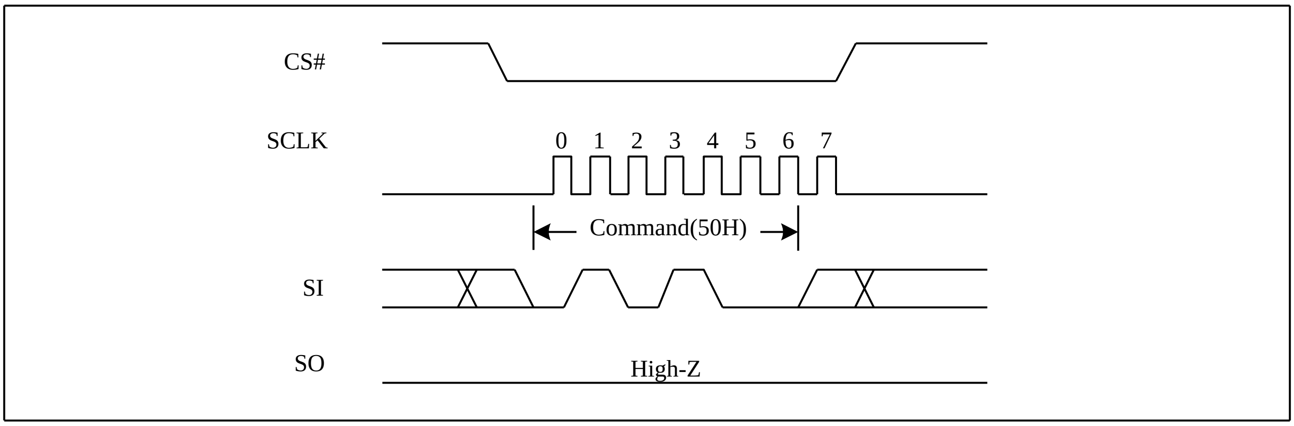
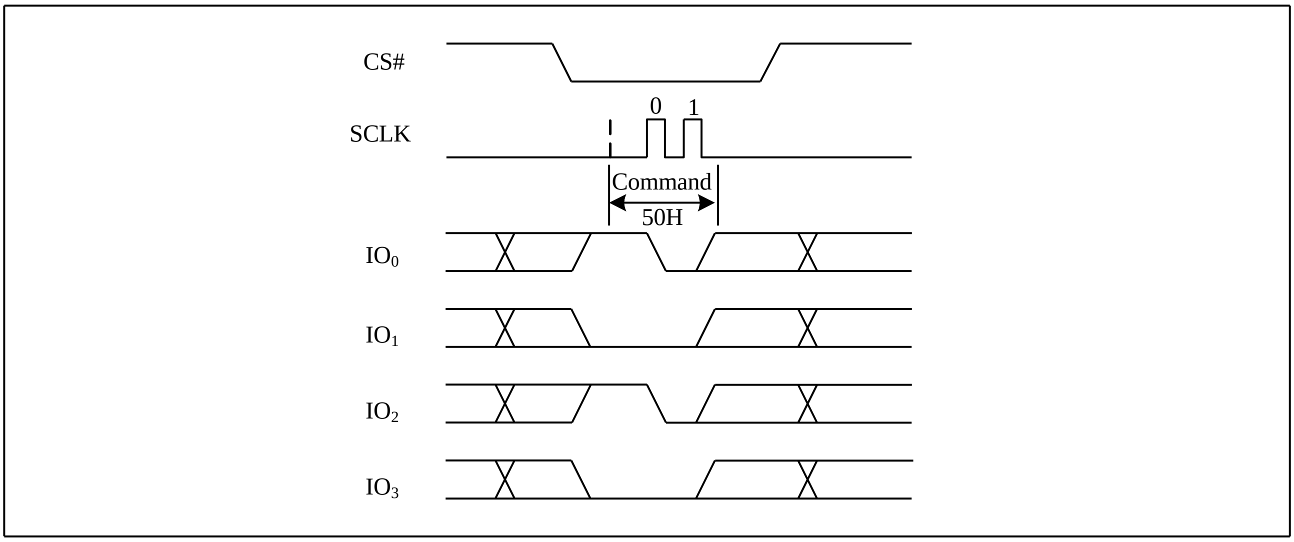


Figure4a. Write Enable for Volatile Status Register Sequence Diagram (QPI)



7.4 Read Status Register (RDSR) (05H or 35H)

The Read Status Register (RDSR) command is for reading the Status Register. The Status Register may be read at any time, even while a Program, Erase or Write Status Register cycle is in progress. When one of these cycles is in progress, it is recommended to check the Write in Progress (WIP) bit before sending a new command to the device. It is also possible to read the Status Register continuously. 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.

Figure5. Read Status Register Sequence Diagram

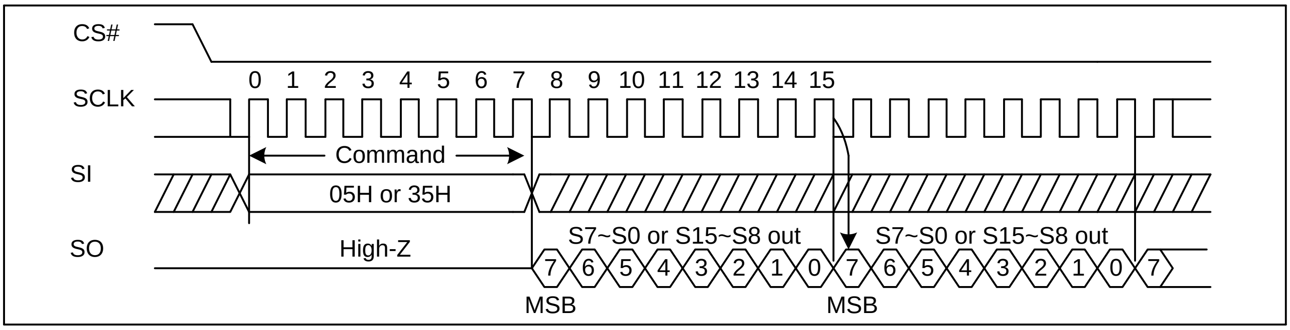
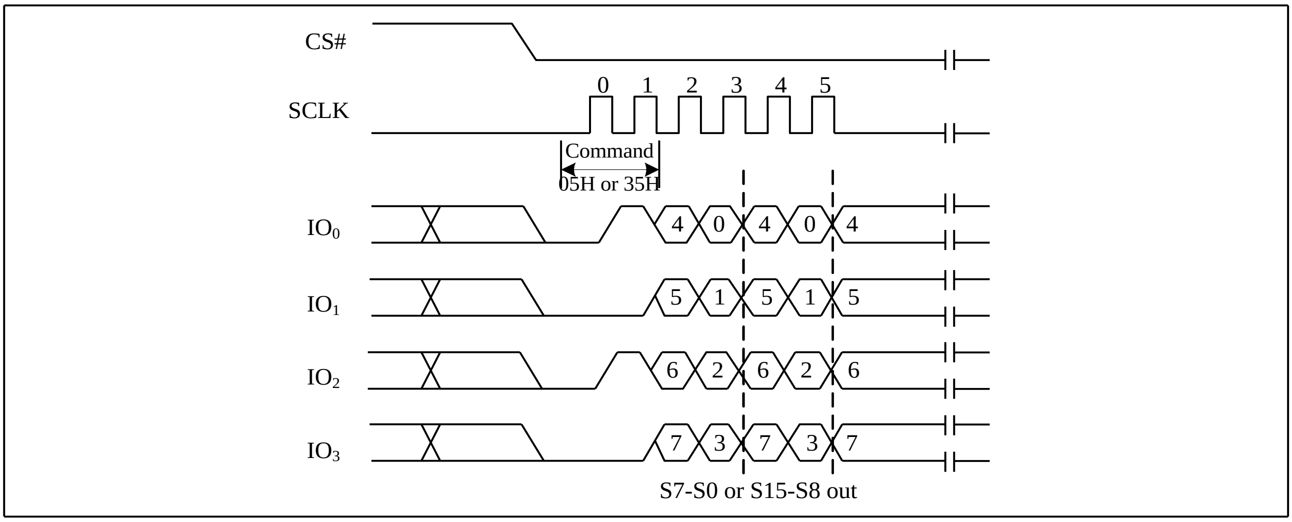


Figure5a. Read Status Register Sequence Diagram (QPI)



7.5 Write Status Register (WRSR) (01H)

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 CMP and QE and SRP1 bits will be cleared to 0. As soon as CS# is driven high, the self-timed Write Status Register cycle (whose duration is t_W) 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.

Figure6. Write Status Register Sequence Diagram

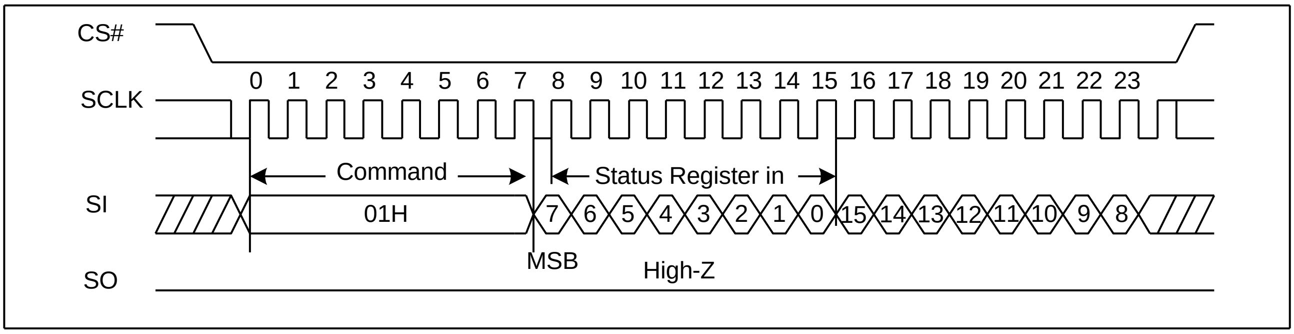
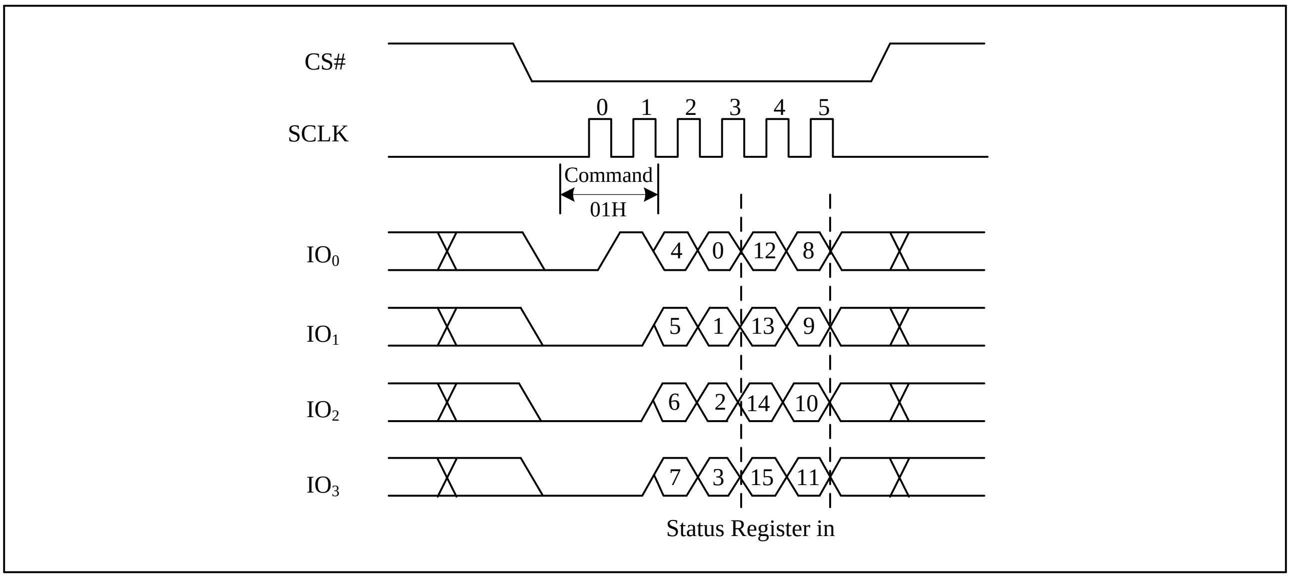


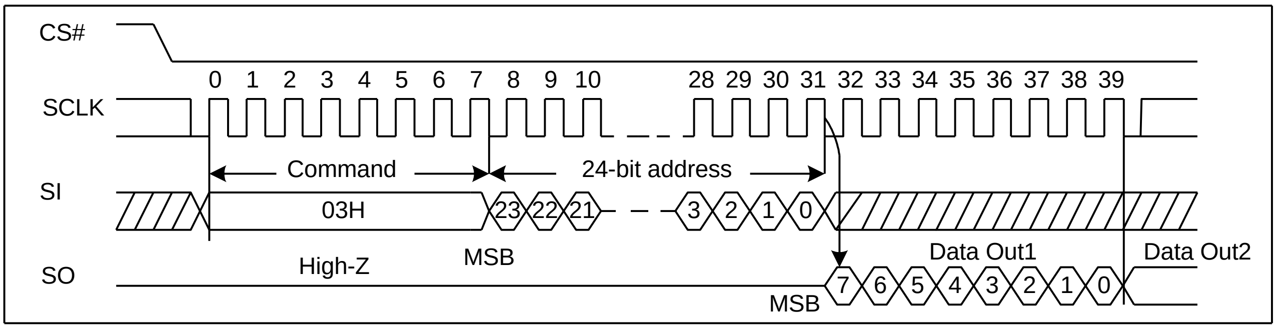
Figure6a. Write Status Register Sequence Diagram (QPI)



7.6 Read Data Bytes (READ) (03H)

The Read Data Bytes (READ) command is followed by a 3-byte address (A23-A0), 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 f_R, 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. The whole memory can, therefore, be read with a single Read Data Bytes (READ) command. Any Read Data Bytes (READ) command, while an Erase, Program or Write cycle is in progress, is rejected without having any effects on the cycle that is in progress.

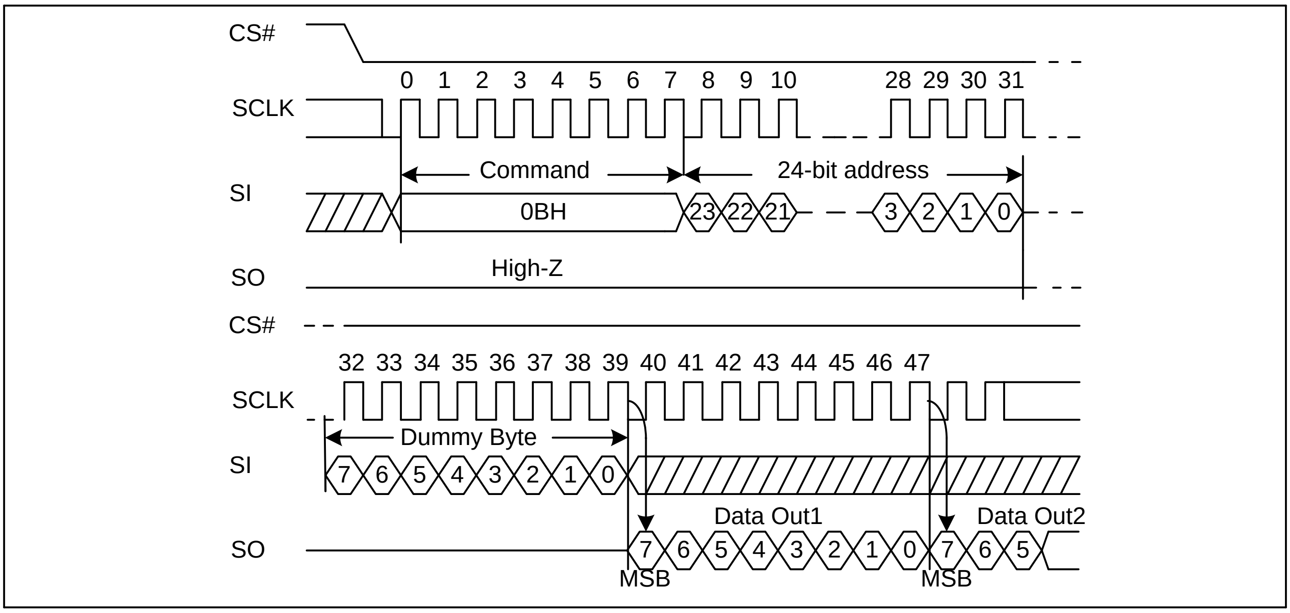
Figure7. Read Data Bytes Sequence Diagram



7.7 Read Data Bytes at Higher Speed (Fast Read) (0BH)

The Read Data Bytes at Higher Speed (Fast Read) command is for quickly reading data out. It is followed by a 3-byte address (A23-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 f_C, 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.

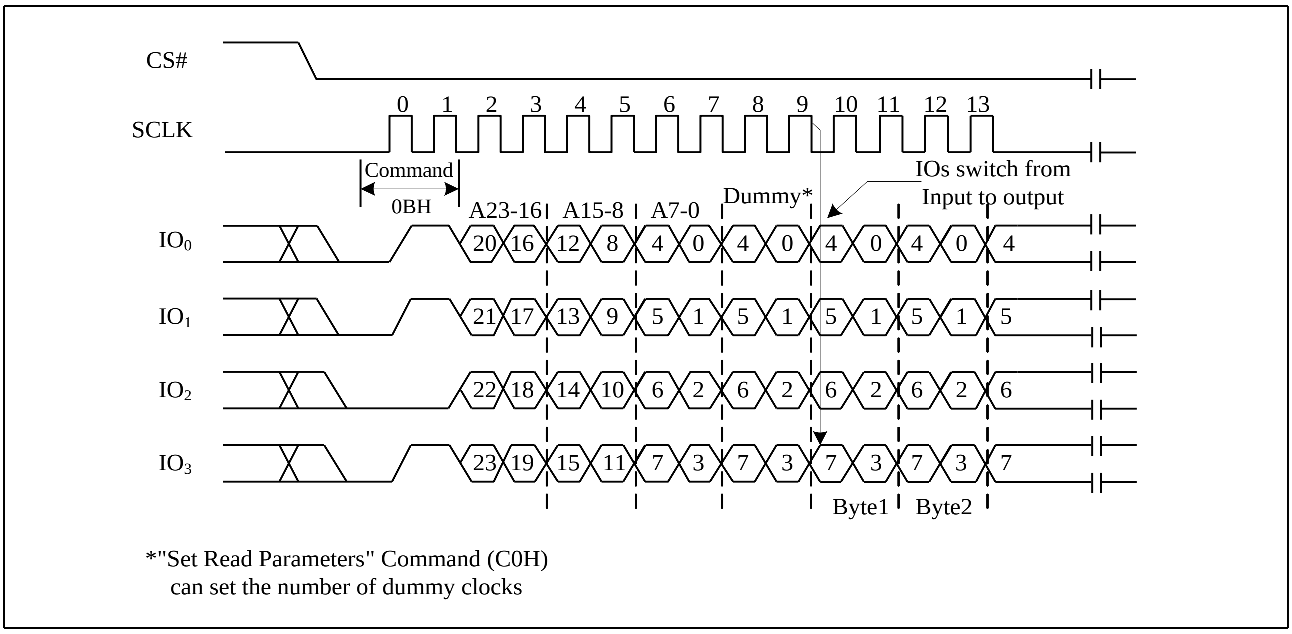
Figure8. Read Data Bytes at Higher Speed Sequence Diagram



7.8 Fast Read (0BH) 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 4/6/8.

Figure8a. Read Data Bytes at Higher Speed Sequence Diagram (QPI)

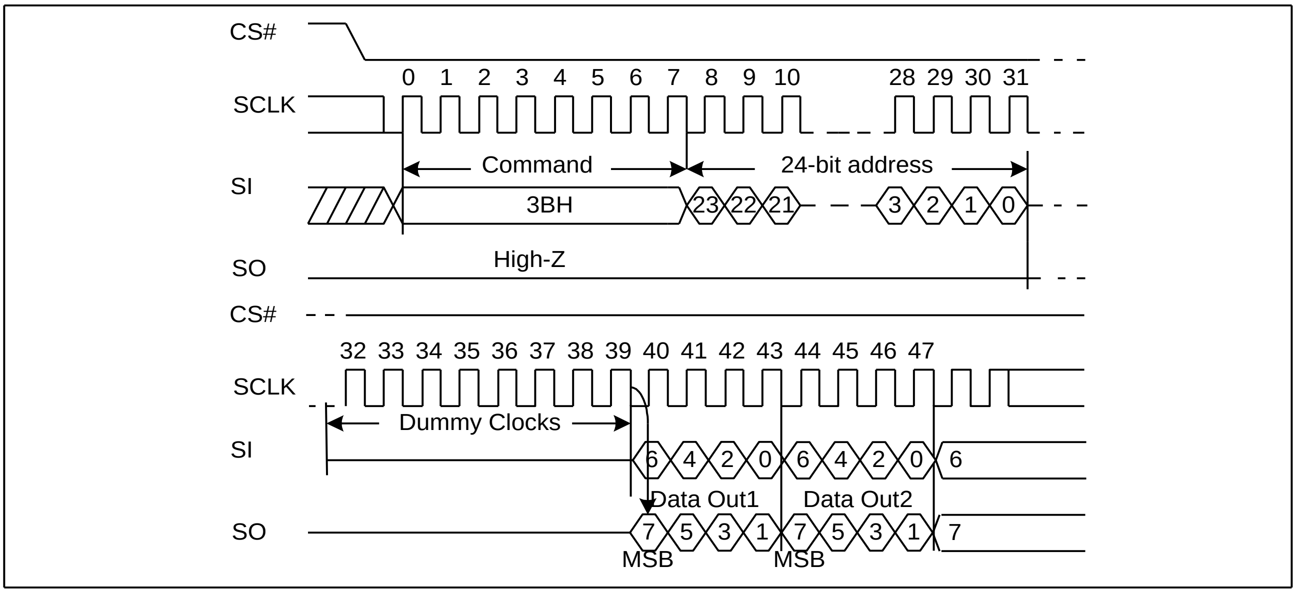


7.9 Dual Output Fast Read (3BH)

The Dual Output Fast Read command is followed by 3-byte address (A23-A0) and a dummy byte, each bit being latched in during the rising edge of SCLK, then the memory contents are shifted out 2-bit per clock cycle from SI and SO.

The command sequence is shown in followed Figure9. 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.

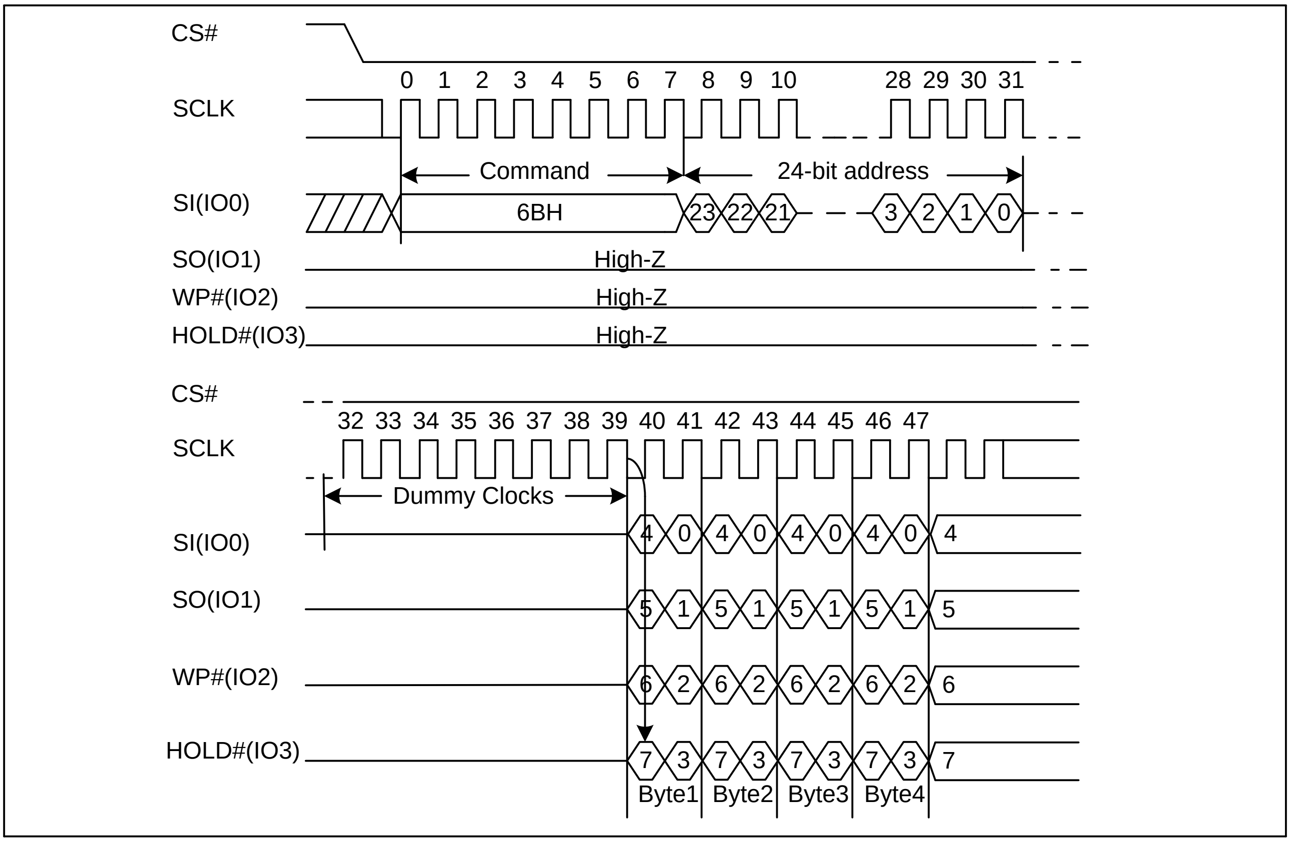
Figure9. Dual Output Fast Read Sequence Diagram



7.10 Quad Output Fast Read (6BH)

The Quad Output Fast Read command is followed by 3-byte address (A23-A0) and a dummy byte, each bit being latched in during the rising edge of SCLK, then the memory contents are shifted out 4-bit per clock cycle from IO3, IO2, IO1 and IO0. The command sequence is shown in followed Figure10. 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.

Figure10. Quad Output Fast Read Sequence Diagram



7.11 Dual I/O Fast Read (BBH)

The Dual I/O Fast Read command is similar to the Dual Output Fast Read command but with the capability to input the 3-byte address (A23-0) and a "Continuous Read Mode" byte 2-bit per clock by SI and SO, each bit being latched in during the rising edge of SCLK, then the memory contents are shifted out 2-bit per clock cycle from SI and SO. The command sequence is shown in followed Figure11. 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.

Dual I/O Fast Read with "Continuous Read Mode"

The Dual I/O Fast Read command can further reduce command overhead through setting the "Continuous Read Mode" bits (M7-0) after the input 3-byte address (A23-A0). If the "Continuous Read Mode" bits (M5-4) = (1, 0), then the next Dual I/O Fast Read command (after CS# is raised and then lowered) does not require the BBH command code. The command sequence is shown in followed Figure11. 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.

Figure11. Dual I/O Fast Read Sequence Diagram (M5-4≠ (1, 0))

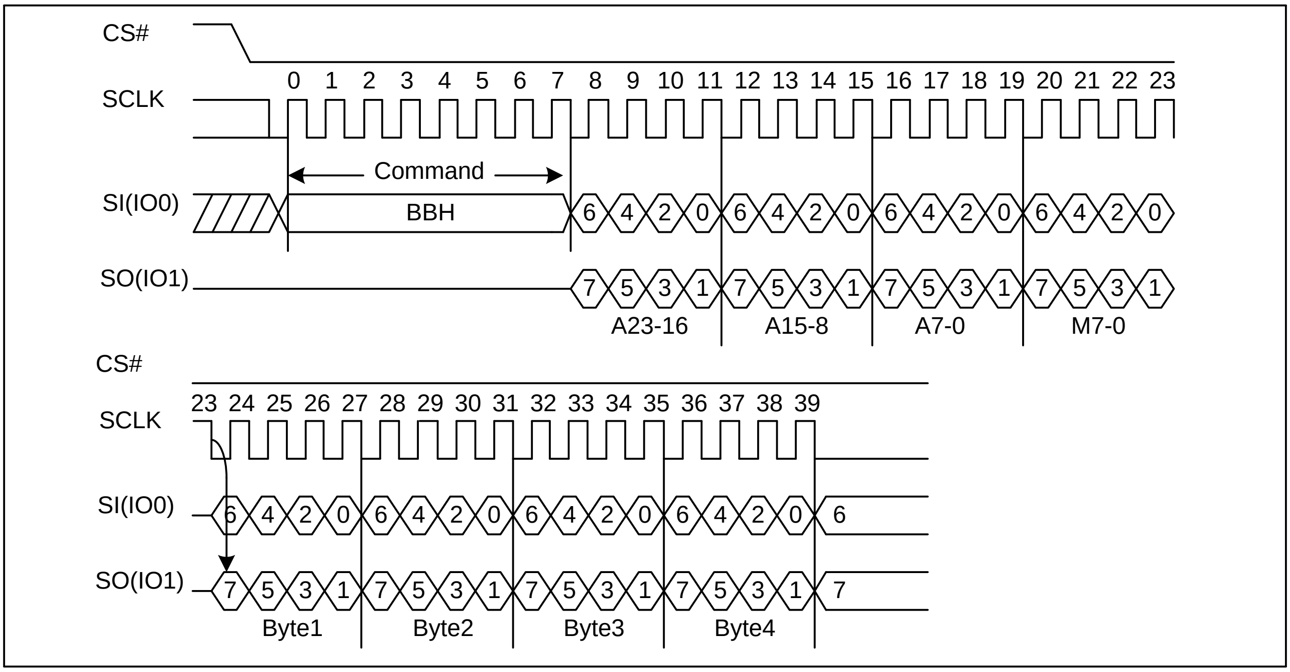
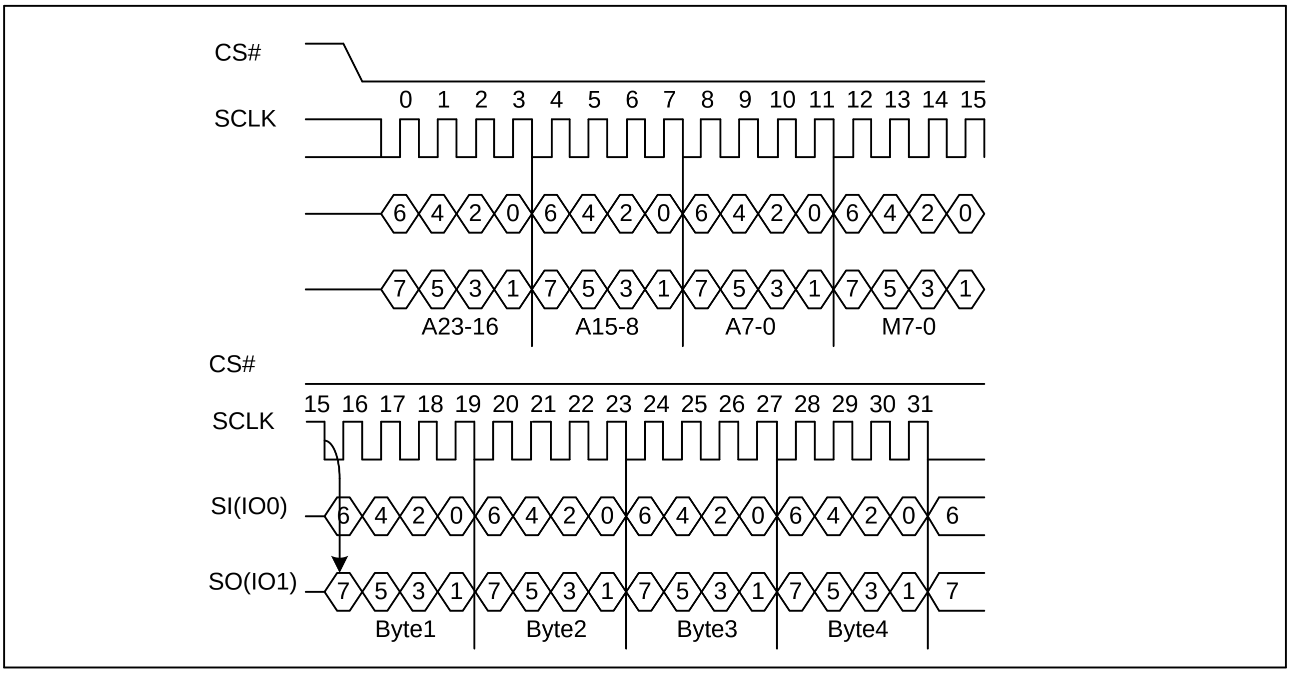


Figure11a. Dual I/O Fast Read Sequence Diagram (M5-4= (1, 0))



7.12 Quad I/O Fast Read (EBH)

The Quad I/O Fast Read command is similar to the Dual I/O Fast Read command but with the capability to input the 3-byte address (A23-0) and a “Continuous Read Mode” byte and 4-dummy clock 4-bit per clock by IO0, IO1, IO3, IO4, each bit being latched in during the rising edge of SCLK, then the memory contents are shifted out 4-bit per clock cycle from IO0, IO1, IO2, IO3. The command sequence is shown in followed Figure12. 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. The Quad Enable bit (QE) of Status Register (S9) must be set to enable for the Quad I/O Fast read command.

Quad I/O Fast Read with “Continuous Read Mode”

The Quad I/O Fast Read command can further reduce command overhead through setting the “Continuous Read Mode” bits (M7-0) after the input 3-byte address (A23-A0). If the “Continuous Read Mode” bits (M5-4) = (1, 0), then the next Quad I/O Fast Read command (after CS# is raised and then lowered) does not require the EBH command code. The command sequence is shown in followed Figure12a. If the “Continuous Read Mode” bits (M5-4) do not equal to (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.

Figure12. Quad I/O Fast Read Sequence Diagram (M5-4≠ (1, 0))

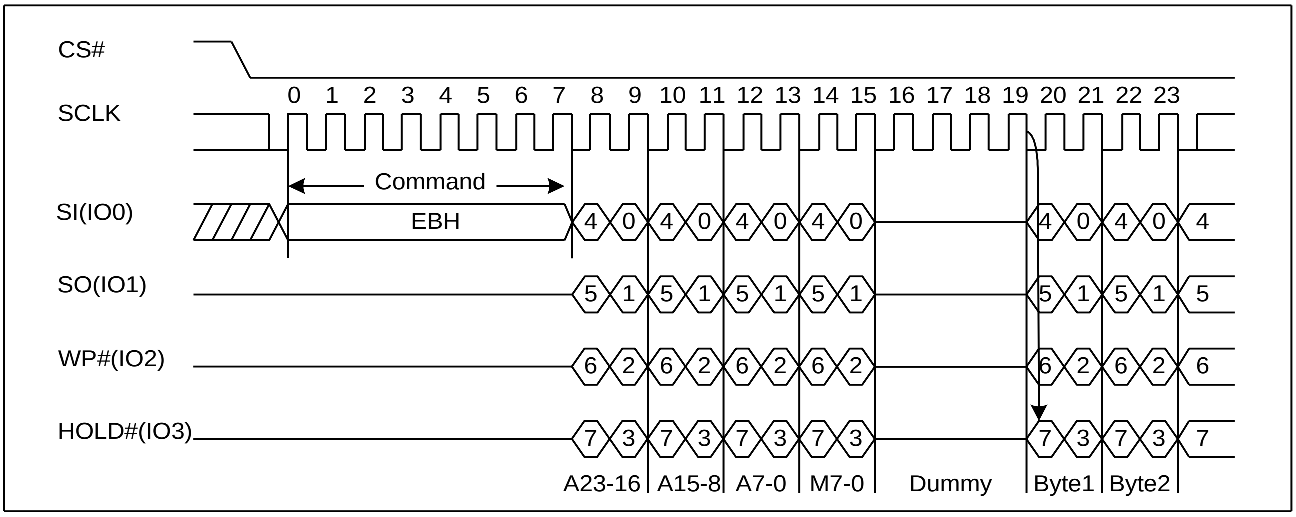
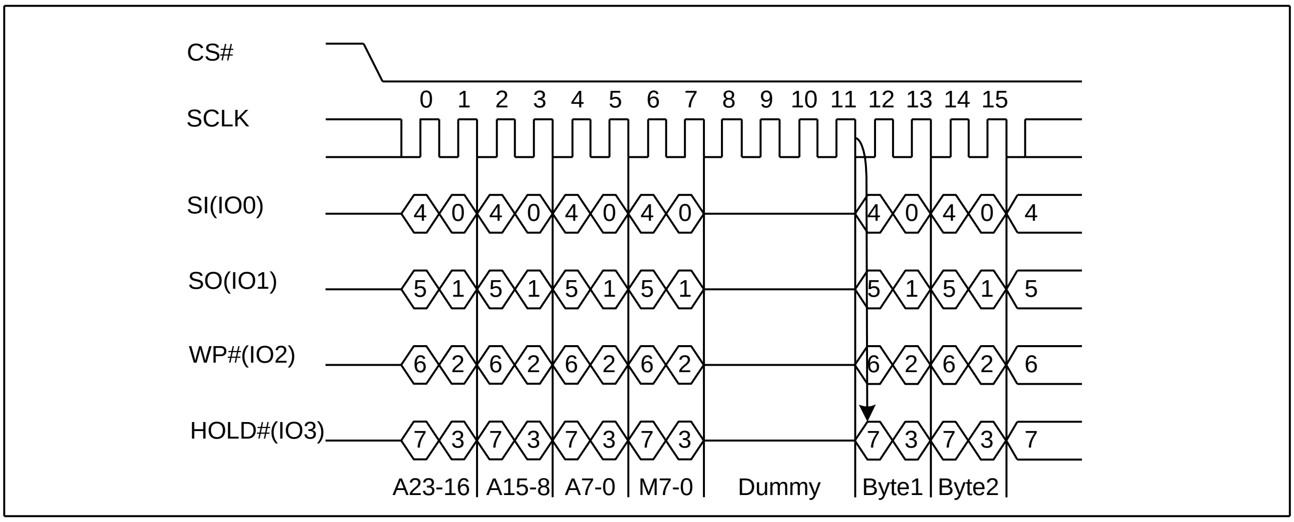


Figure12a. Quad I/O Fast Read Sequence Diagram (M5-4= (1, 0))



Quad I/O Fast Read with "8/16/32/64-Byte Wrap Around" in Standard SPI mode

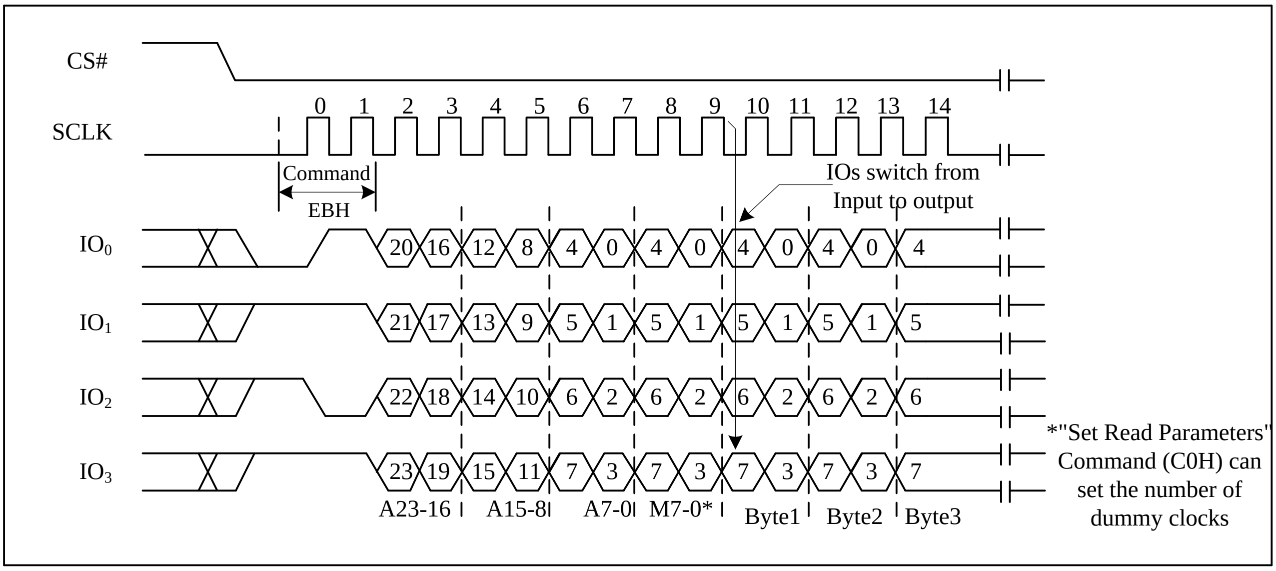
The Quad I/O Fast Read command can be used to access a specific portion within a page by issuing "Set Burst with Wrap" (77H) commands prior to EBH. The "Set Burst with Wrap" (77H) command can either enable or disable the "Wrap Around" feature for the following EBH commands. When "Wrap Around" is enabled, the data being accessed can be limited to either an 8/16/32/64-byte section of a 256-byte page. The output data starts at the initial address specified in the command, once it reaches the ending boundary of the 8/16/32/64-byte section, the output will wrap around the beginning boundary automatically until CS# is pulled high to terminate the command.

The Burst with Wrap feature allows applications that use cache to quickly fetch a critical address and then fill the cache afterwards within a fixed length (8/16/32/64-byte) of data without issuing multiple read commands. The "Set Burst with Wrap" command allows three "Wrap Bits" W6-W4 to be set. The W4 bit is used to enable or disable the "Wrap Around" operation while W6-W5 is used to specify the length of the wrap around section within a page.

Quad I/O Fast Read (EBH) in QPI mode

The Quad I/O Fast Read command is also supported in QPI mode. See Figure12b. 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 4/6/8. In QPI mode, the "Continuous Read Mode" bits M7-M0 are also considered as dummy clocks. "Continuous Read Mode" feature is also available in QPI mode for Quad I/O Fast Read command. "Wrap Around" feature is not available in QPI mode for Quad I/O Fast Read command. To perform a read operation with fixed data length wrap around in QPI mode, a dedicated "Burst Read with Wrap" (0CH) command must be used.

Figure12b. Quad I/O Fast Read Sequence Diagram (M5-4= (1, 0) QPI)



Quad I/O Word Fast Read (E7H)

The Quad I/O Word Fast Read command is similar to the Quad I/O Fast Read command except that the lowest address bit (A0) must equal 0 and only 2-dummy clock. The command sequence is shown in followed Figure14. 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. The Quad Enable bit (QE) of Status Register (S9) must be set to enable for the Quad I/O Word Fast read command.

Quad I/O Word Fast Read with "Continuous Read Mode"

The Quad I/O Word Fast Read command can further reduce command overhead through setting the "Continuous Read Mode" bits (M7-0) after the input 3-byte address (A23-A0). If the "Continuous Read Mode" bits (M5-4) = (1, 0), then the next Quad I/O Word Fast Read command (after CS# is raised and then lowered) does not require the E7H command code. The command sequence is shown in followed Figure13. If the "Continuous Read Mode" bits (M5-4) do not equal to (1, 0), the next command requires the first E7H command code, thus returning to normal operation. A "Continuous Read Mode" Reset command can be used to reset (M5-4) before issuing normal command.

Figure13. Quad I/O Word Fast Read Sequence Diagram (M5-4≠ (1, 0))

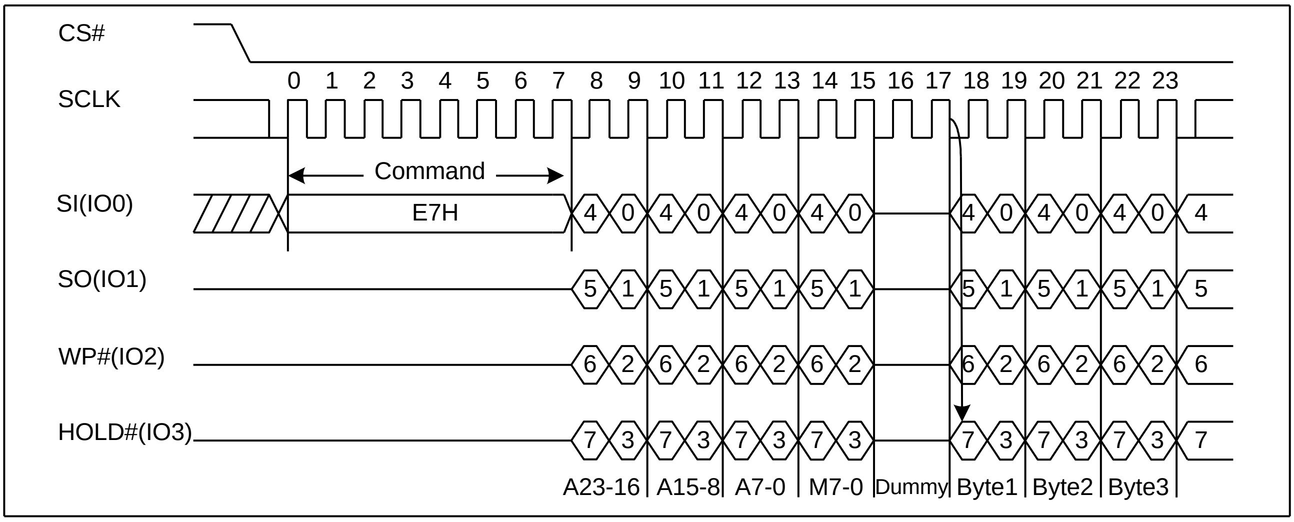
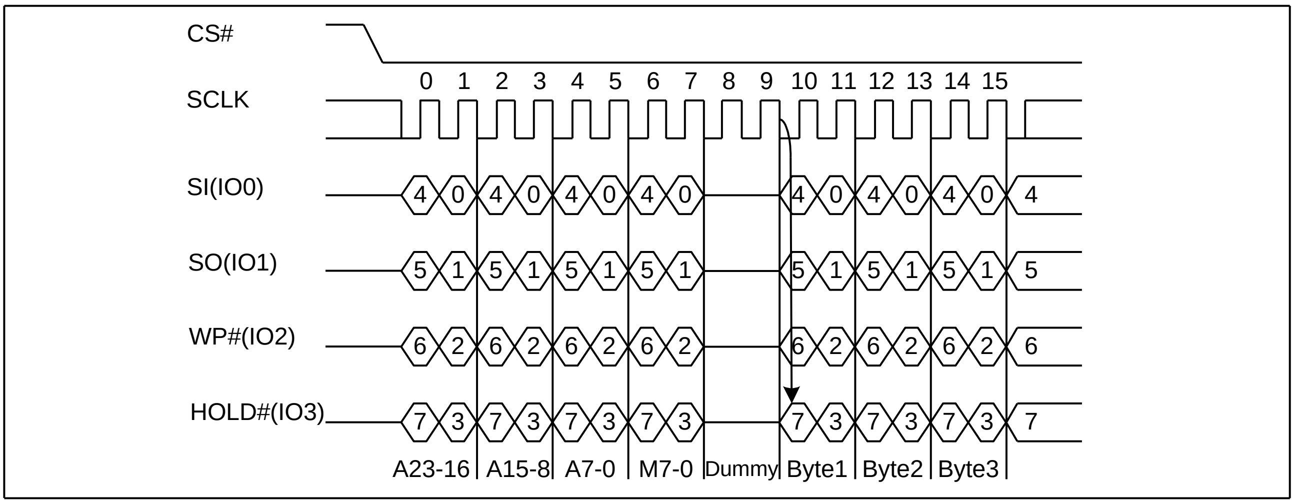


Figure13a. Quad I/O Word Fast Read Sequence Diagram (M5-4= (1, 0))



Quad I/O Word Fast Read with “8/16/32/64-Byte Wrap Around” in Standard SPI mode

The Quad I/O Word Fast Read command can be used to access a specific portion within a page by issuing “Set Burst with Wrap” (77H) commands prior to E7H. The “Set Burst with Wrap” (77H) command can either enable or disable the “Wrap Around” feature for the following E7H commands. When “Wrap Around” is enabled, the data being accessed can be limited to either an 8/16/32/64-byte section of a 256-byte page. The output data starts at the initial address specified in the command, once it reaches the ending boundary of the 8/16/32/64-byte section, the output will wrap around the beginning boundary automatically until CS# is pulled high to terminate the command.

The Burst with Wrap feature allows applications that use cache to quickly fetch a critical address and then fill the cache afterwards within a fixed length (8/16/32/64-byte) of data without issuing multiple read commands. The “Set Burst with Wrap” command allows three “Wrap Bits” W6-W4 to be set. The W4 bit is used to enable or disable the “Wrap Around” operation while W6-W5 is used to specify the length of the wrap around section within a page.

7.13 Set Burst with Wrap (77H)

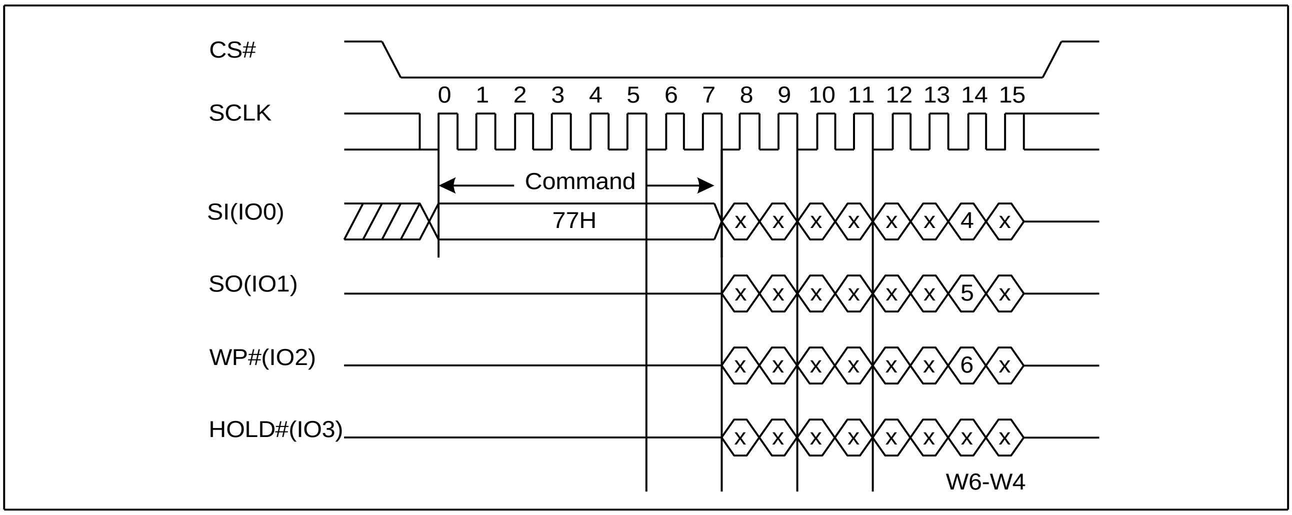
The Set Burst with Wrap command is used in conjunction with “Quad I/O Fast Read” and “Quad I/O Word Fast Read” command to access a fixed length of 8/16/32/64-byte section within a 256-byte page, in standard SPI mode.

The Set Burst with Wrap command sequence: CS# goes low → Send Set Burst with Wrap command → Send 24 dummy bits → Send 8 bits “Wrap bits” → CS# goes high.

W6,W5	**W4=0**		**W4=1 (default)**	
	Wrap Around	Wrap Length	Wrap Around	Wrap Length
0, 0	Yes	8-byte	No	N/A
0, 1	Yes	16-byte	No	N/A
1, 0	Yes	32-byte	No	N/A
1, 1	Yes	64-byte	No	N/A

If the W6-W4 bits are set by the Set Burst with Wrap command, all the following “Quad I/O Fast Read” and “Quad I/O Word Fast Read” command will use the W6-W4 setting to access the 8/16/32/64-byte section within any page. To exit the “Wrap Around” function and return to normal read operation, another Set Burst with Wrap command should be issued to set W4=1. In QPI mode, the “Burst Read with Wrap (0CH)” command should be used to perform the Read Operation with “Wrap Around” feature. The Wrap Length set by W5-W6 in Standard SPI mode is still valid in QPI mode and can also be re-configured by “Set Read Parameters (C0H) command.

Figure14. Set Burst with Wrap Sequence Diagram



7.14 Page Program (PP) (02H)

The Page Program (PP) command is for programming the memory. A Write Enable (WREN) command must previously have been executed to set the Write Enable Latch (WEL) bit before sending the Page Program command.

The Page Program (PP) command is entered by driving CS# Low, followed by the command code, three address bytes and at least one data byte on SI. If the 8 least significant address bits (A7-A0) are not all zero, all transmitted data that goes beyond the end of the current page are programmed from the start address of the same page (from the address whose 8 least significant bits (A7-A0) are all zero). CS# must be driven low for the entire duration of the sequence. The Page Program command sequence: CS# goes low → sending Page Program command → 3-byte address on SI → at least 1 byte data on SI → CS# goes high. The command sequence is shown in Figure15. If more than 256 bytes are sent to the device, previously latched data are discarded and the last 256 data bytes are guaranteed to be programmed correctly within the same page. If less than 256 data bytes are sent to device, they are correctly programmed at the requested addresses without having any effects on the other bytes of the same page. CS# must be driven high after the eighth bit of the last data byte has been latched in; otherwise the Page Program (PP) command is not executed.

As soon as CS# is driven high, the self-timed Page Program cycle (whose duration is t_{PP}) is initiated. While the Page Program 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 Page Program cycle, and is 0 when it is completed. At some unspecified time before the cycle is completed, the Write Enable Latch (WEL) bit is reset.

A Page Program (PP) command applied to a page which is protected by the Block Protect (BP4, BP3, BP2, BP1, and BP0) is not executed.

Figure15. Page Program Sequence Diagram

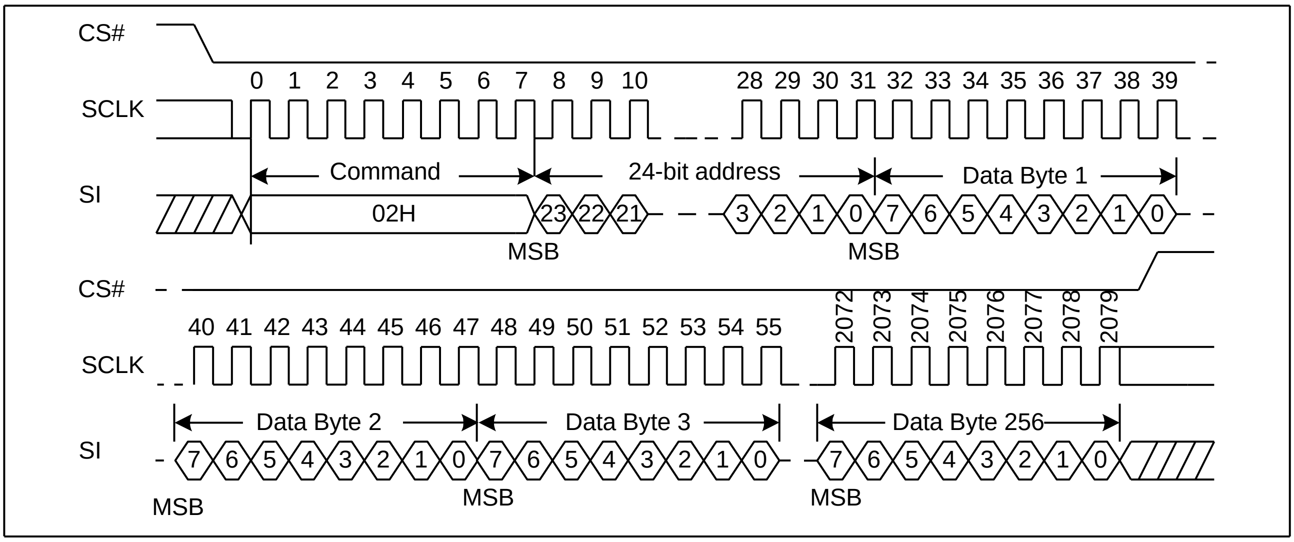
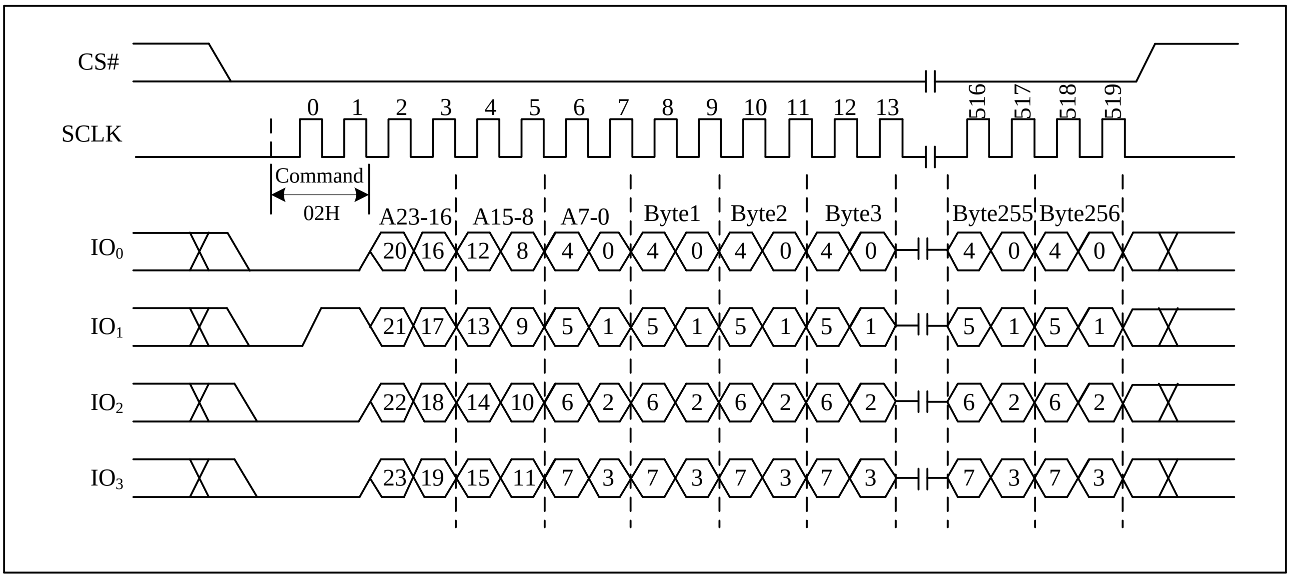


Figure15a. Page Program Sequence Diagram (QPI)



7.15 Quad Page Program (32H)

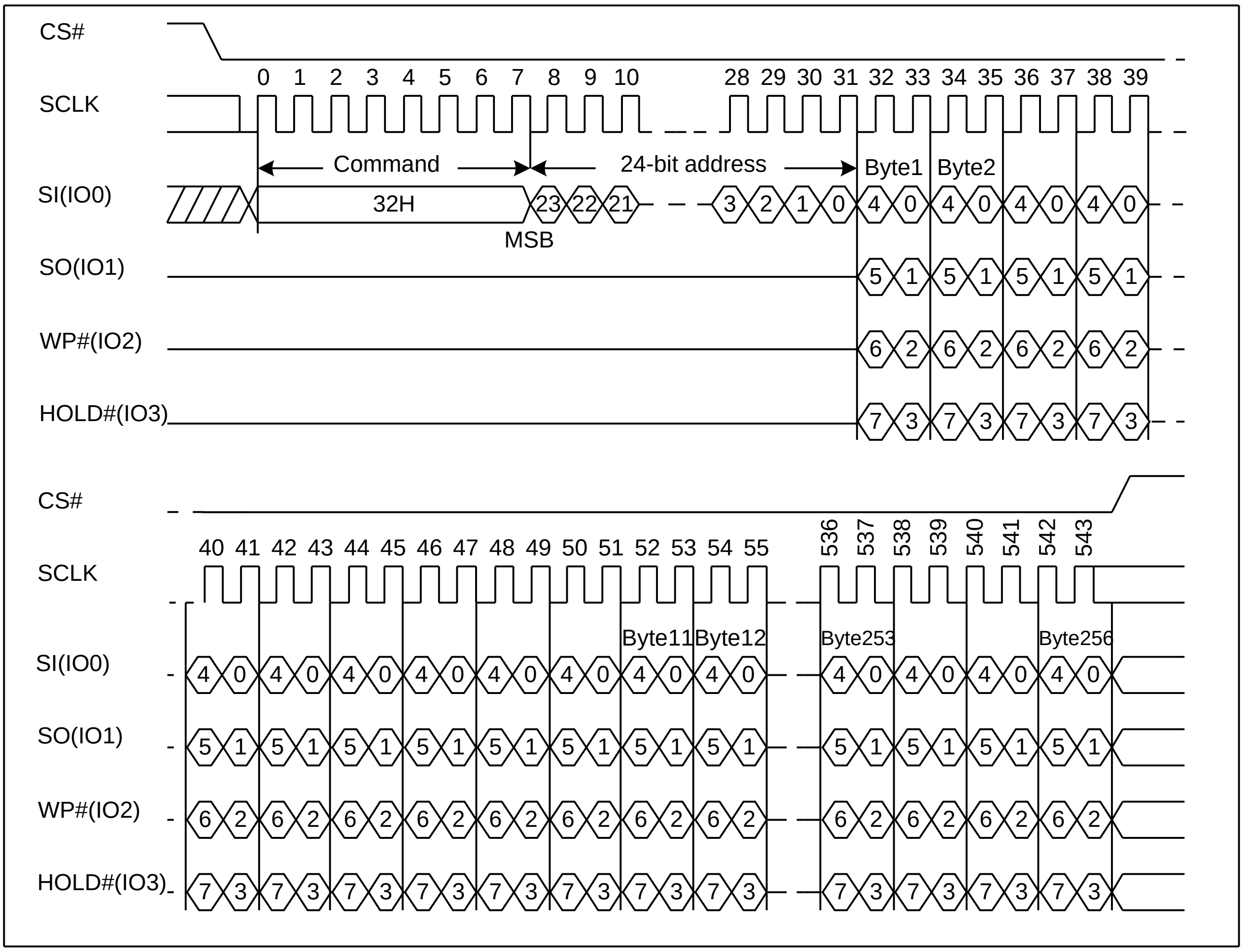
The Quad Page Program command is for programming the memory using four pins: IO0, IO1, IO2, and IO3. To use Quad Page Program the Quad enable in status register Bit9 must be set (QE=1). A Write Enable (WREN) command must previously have been executed to set the Write Enable Latch (WEL) bit before sending the Page Program command. The quad Page Program command is entered by driving CS# Low, followed by the command code (32H), three address bytes and at least one data byte on IO pins.

The command sequence is shown in Figure16. If more than 256 bytes are sent to the device, previously latched data are discarded and the last 256 data bytes are guaranteed to be programmed correctly within the same page. If less than 256 data bytes are sent to device, they are correctly programmed at the requested addresses without having any effects on the other bytes of the same page. CS# must be driven high after the eighth bit of the last data byte has been latched in; otherwise the Quad Page Program (PP) command is not executed.

As soon as CS# is driven high, the self-timed Quad Page Program cycle (whose duration is t_{PP}) is initiated. While the Quad Page Program 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 Quad Page Program cycle, and is 0 when it is completed. At some unspecified time before the cycle is completed, the Write Enable Latch (WEL) bit is reset.

A Quad Page Program command applied to a page which is protected by the Block Protect (BP4, BP3, BP2, BP1, and BP0) is not executed.

Figure16.Quad Page Program Sequence Diagram



7.16 Sector Erase (SE) (20H)

The Sector Erase (SE) command is for erasing the all data of the chosen sector. A Write Enable (WREN) command must previously have been executed to set the Write Enable Latch (WEL) bit. The Sector Erase (SE) command is entered by driving CS# low, followed by the command code, and 3-address byte on SI. Any address inside the sector is a valid address for the Sector Erase (SE) command. CS# must be driven low for the entire duration of the sequence.

The Sector Erase command sequence: CS# goes low → sending Sector Erase command → 3-byte address on SI → CS# goes high. The command sequence is shown in Figure17. CS# must be driven high after the eighth bit of the last address byte has been latched in; otherwise the Sector Erase (SE) command is not executed. As soon as CS# is driven high, the self-timed Sector Erase cycle (whose duration is t_{SE}) is initiated. While the Sector Erase 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 Sector Erase cycle, and is 0 when it is completed. At some unspecified time before the cycle is completed, the Write Enable Latch (WEL) bit is reset. A Sector Erase (SE) command applied to a sector which is protected by the Block Protect (BP4, BP3, BP2, BP1, and BP0) bit (see Table1&1a) is not executed.

Figure17. Sector Erase Sequence Diagram

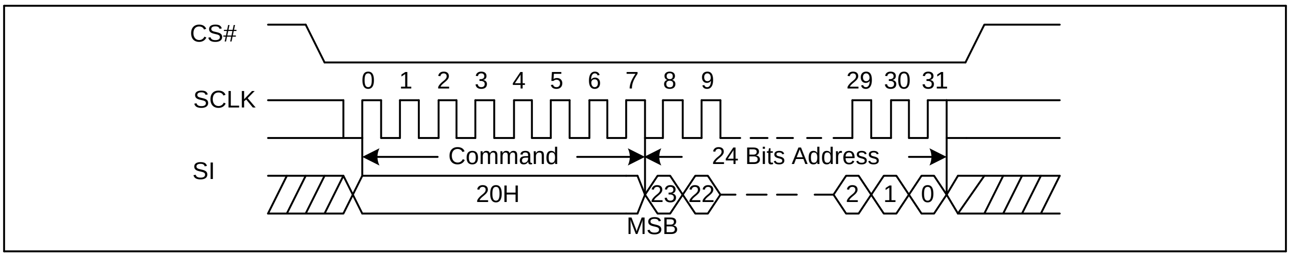
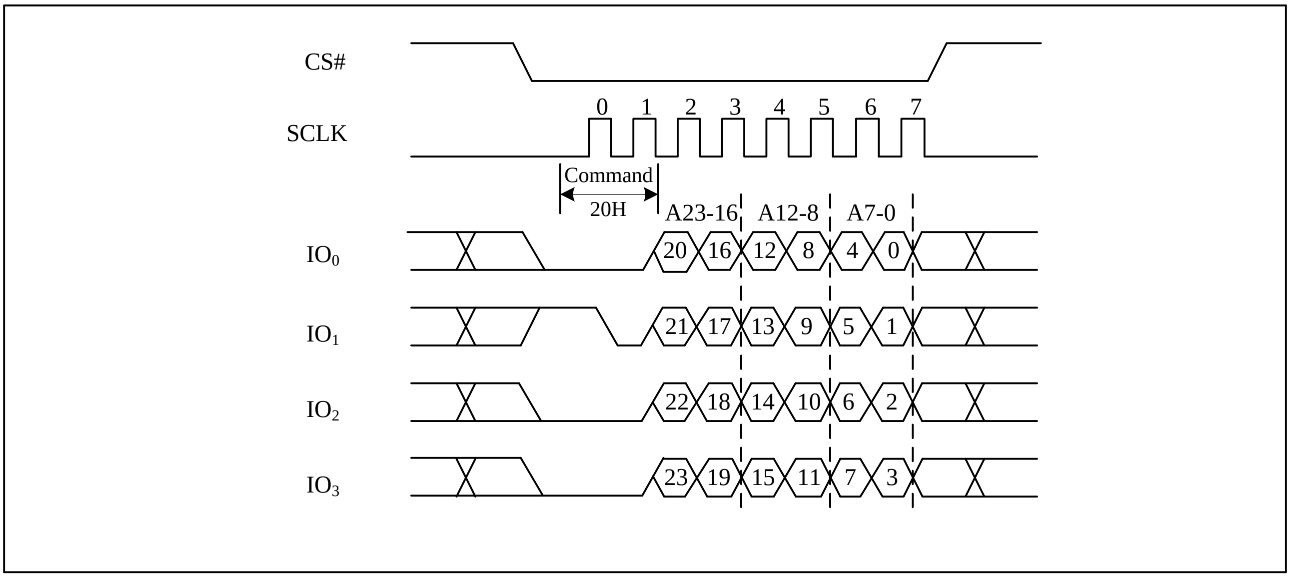


Figure17a. Sector Erase Sequence Diagram (QPI)



7.17 32KB Block Erase (BE) (52H)

The 32KB Block Erase (BE) command is for erasing the all data of the chosen block. A Write Enable (WREN) command must previously have been executed to set the Write Enable Latch (WEL) bit. The 32KB Block Erase (BE) command is entered by driving CS# low, followed by the command code, and three address bytes on SI. Any address inside the block is a valid address for the 32KB Block Erase (BE) command. CS# must be driven low for the entire duration of the sequence. The 32KB Block Erase command sequence: CS# goes low → sending 32KB Block Erase command → 3-byte address on SI → CS# goes high. The command sequence is shown in Figure18. CS# must be driven high after the eighth bit of the last address byte has been latched in; otherwise the 32KB Block Erase (BE) command is not executed. As soon as CS# is driven high, the self-timed Block Erase cycle (whose duration is t_{SE}) is initiated. While the Block Erase 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 Block Erase cycle, and is 0 when it is completed. At some unspecified time before the cycle is completed, the Write Enable Latch (WEL) bit is reset. A 32KB Block Erase (BE) command applied to a block which is protected by the Block Protect (BP4, BP3, BP2, BP1, and BP0) bits (see Table1&1a) is not executed.

Figure18. 32KB Block Erase Sequence Diagram

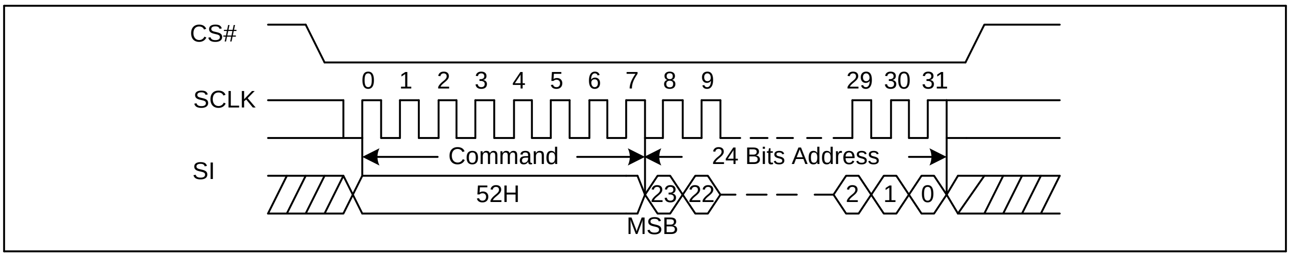
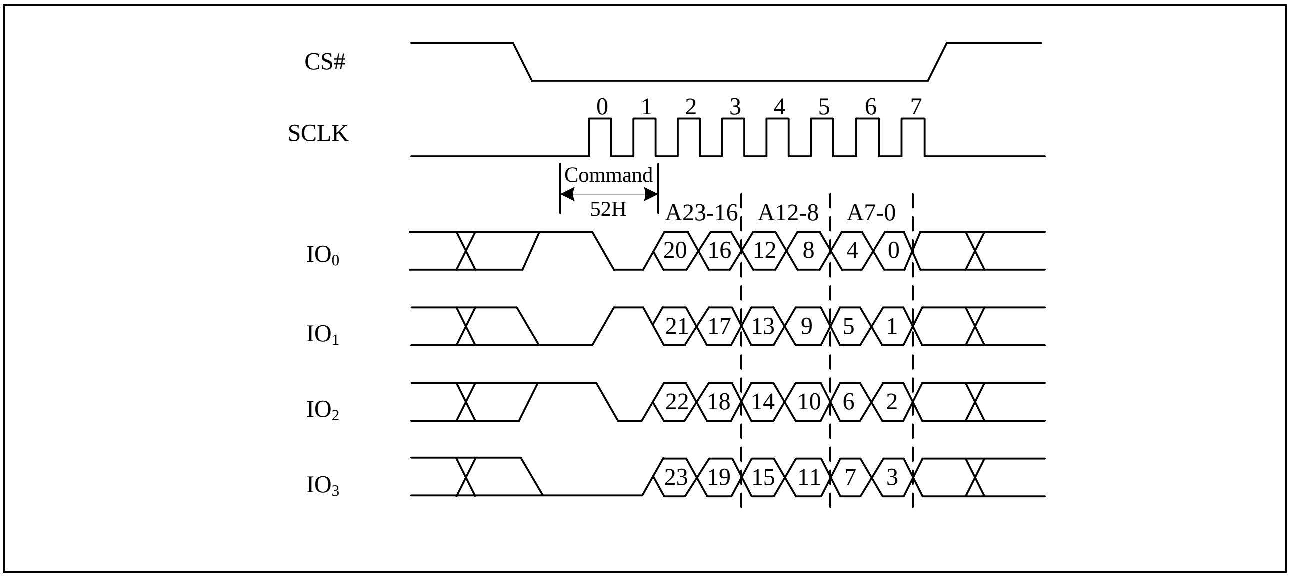


Figure18a. 32KB Block Erase Sequence Diagram (QPI)



7.18 64KB Block Erase (BE) (D8H)

The 64KB Block Erase (BE) command is for erasing the all data of the chosen block. A Write Enable (WREN) command must previously have been executed to set the Write Enable Latch (WEL) bit. The 64KB Block Erase (BE) command is entered by driving CS# low, followed by the command code, and three address bytes on SI. Any address inside the block is a valid address for the 64KB Block Erase (BE) command. CS# must be driven low for the entire duration of the sequence. The 64KB Block Erase command sequence: CS# goes low → sending 64KB Block Erase command → 3-byte address on SI → CS# goes high. The command sequence is shown in Figure19. CS# must be driven high after the eighth bit of the last address byte has been latched in; otherwise the 64KB Block Erase (BE) command is not executed. As soon as CS# is driven high, the self-timed Block Erase cycle (whose duration is t_{SE}) is initiated. While the Block Erase 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 Block Erase cycle, and is 0 when it is completed. At some unspecified time before the cycle is completed, the Write Enable Latch (WEL) bit is reset. A 64KB Block Erase (BE) command applied to a block which is protected by the Block Protect (BP4, BP3, BP2, BP1, and BP0) bits (see Table1&1a) is not executed.

Figure19. 64KB Block Erase Sequence Diagram

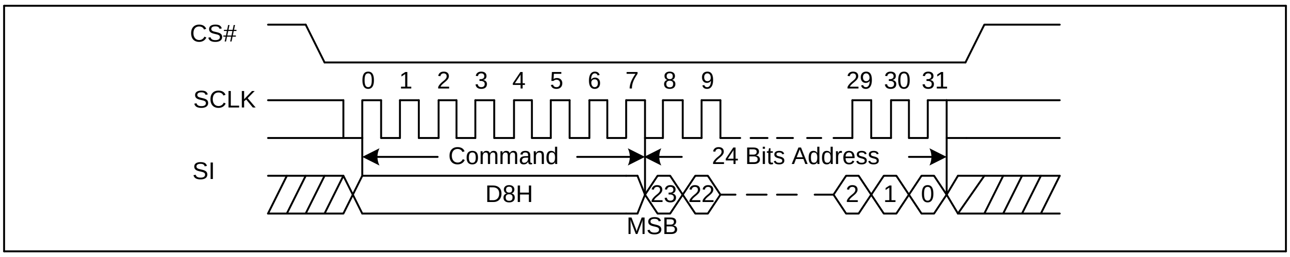
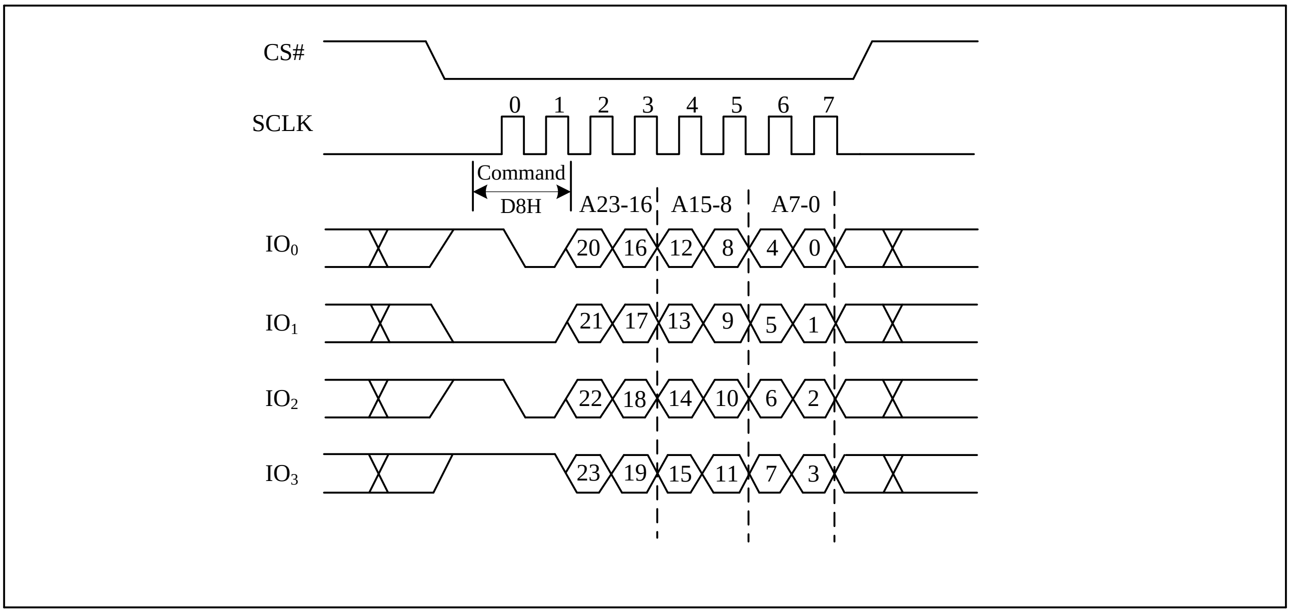


Figure19a. 64KB Block Erase Sequence Diagram (QPI)



7.19 Chip Erase (CE) (60/C7H)

The Chip Erase (CE) command is for erasing the all data of the chip. A Write Enable (WREN) command must previously have been executed to set the Write Enable Latch (WEL) bit .The Chip Erase (CE) command is entered by driving CS# Low, followed by the command code on Serial Data Input (SI). CS# must be driven Low for the entire duration of the sequence. The Chip Erase command sequence: CS# goes low → sending Chip Erase command → CS# goes high. The command sequence is shown in Figure20. CS# must be driven high after the eighth bit of the command code has been latched in; otherwise the Chip Erase command is not executed. As soon as CS# is driven high, the self-timed Chip Erase cycle (whose duration is t_{CE}) is initiated. While the Chip Erase 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 Chip Erase cycle, and is 0 when it is completed. At some unspecified time before the cycle is completed, the Write Enable Latch (WEL) bit is reset. The Chip Erase (CE) command is executed only if all Block Protect (BP4, BP3, BP2, BP1and BP0) are set to “None protected. The Chip Erase (CE) command is ignored if one or more sectors are protected.

Figure20. Chip Erase Sequence Diagram

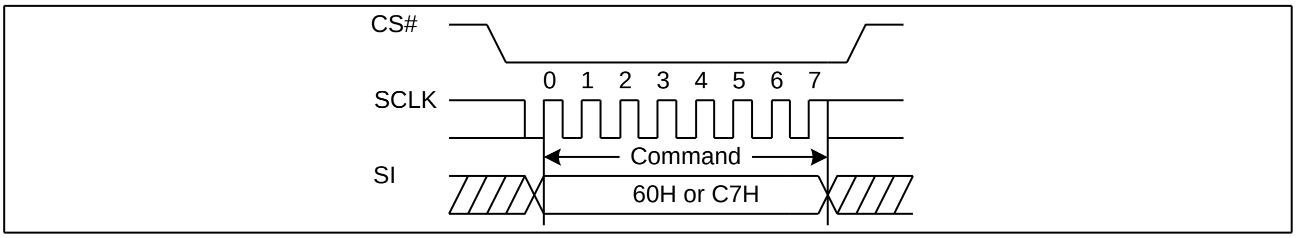
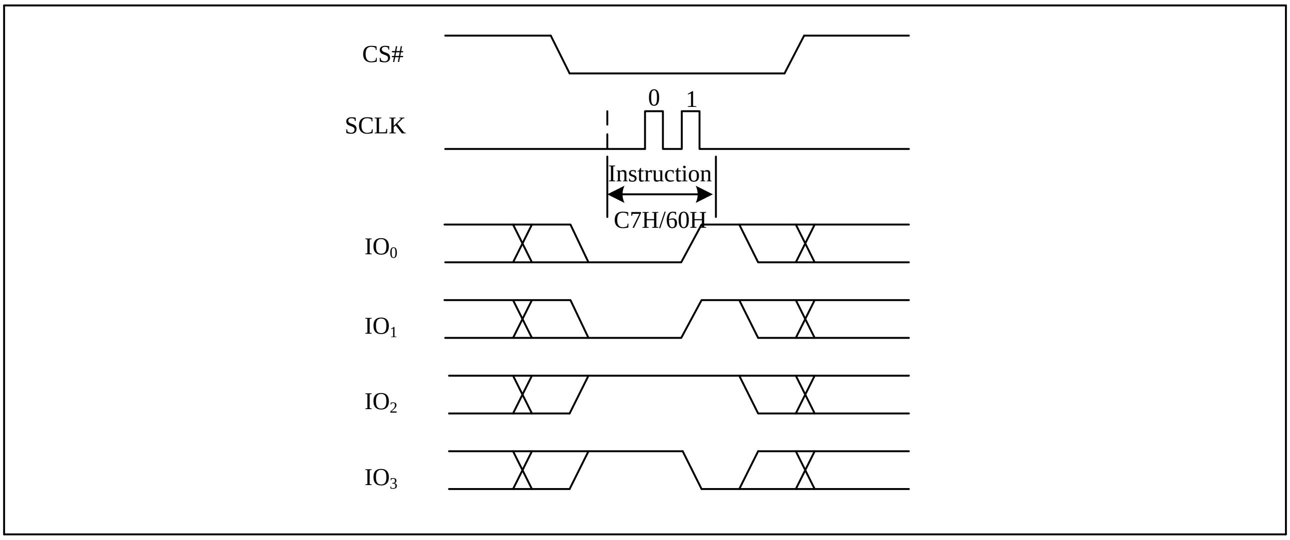


Figure20a. Chip Erase Sequence Diagram (QPI)



7.20 Deep Power-Down (DP) (B9H)

Executing the Deep Power-Down (DP) command is the only way to put the device in the lowest consumption mode (the Deep Power-Down Mode). It can also be used as an extra software protection mechanism, while the device is not in active use, since in this mode, the device ignores all Write, Program and Erase commands. Driving CS# high deselects the device, and puts the device in the Standby Mode (if there is no internal cycle currently in progress). But this mode is not the Deep Power-Down Mode. The Deep Power-Down Mode can only be entered by executing the Deep Power-Down (DP) command. Once the device has entered the Deep Power-Down Mode, all commands are ignored except the Release from Deep Power-Down and Read Device ID (RDI) command. This releases the device from this mode. The Release from Deep Power-Down and Read Device ID (RDI) command also allows the Device ID of the device to be output on SO.

The Deep Power-Down Mode automatically stops at Power-Down, and the device always Power-Up in the Standby Mode. The Deep Power-Down (DP) command is entered by driving CS# low, followed by the command code on SI. CS# must be driven low for the entire duration of the sequence.

The Deep Power-Down command sequence: CS# goes low → sending Deep Power-Down command → CS# goes high. The command sequence is shown in Figure21. CS# must be driven high after the eighth bit of the command code has been latched in; otherwise the Deep Power-Down (DP) command is not executed. As soon as CS# is driven high, it requires a delay of t_{DP} before the supply current is reduced to I_{CC2} and the Deep Power-Down Mode is entered. Any Deep Power-Down (DP) command, while an Erase, Program or Write cycle is in progress, is rejected without having any effects on the cycle that is in progress.

Figure21. Deep Power-Down Sequence Diagram

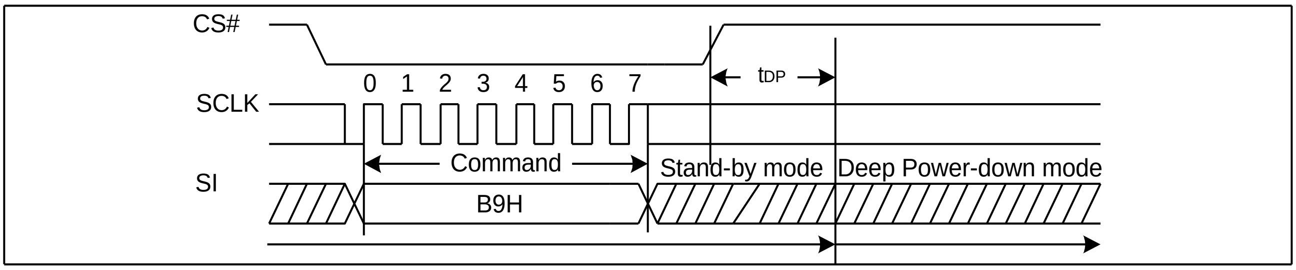
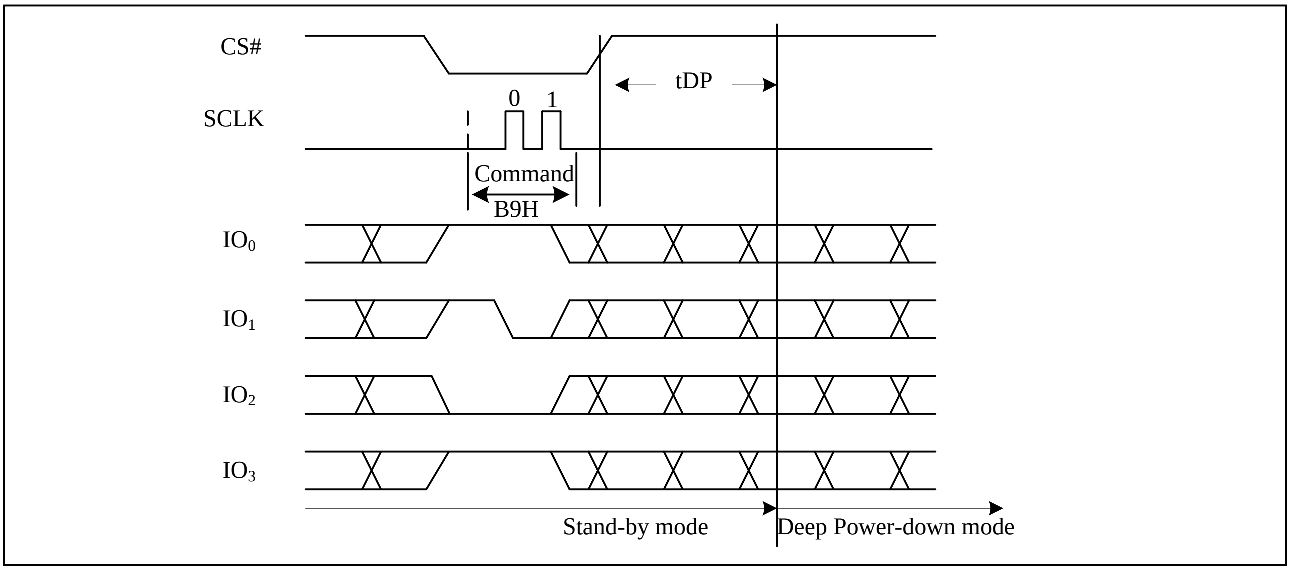


Figure21a. Deep Power-Down Sequence Diagram (QPI)



7.21 Release from Deep Power-Down and Read Device ID (RDI) (ABH)

The Release from Power-Down and Read Device ID command is a multi-purpose command. It can be used to release the device from the Power-Down state or obtain the devices electronic identification (ID) number.

To release the device from the Power-Down state, the command is issued by driving the CS# pin low, shifting the instruction code “ABH” and driving CS# high as shown in Figure22. Release from Power-Down will take the time duration of t_{RES1} (See AC Characteristics) before the device will resume normal operation and other command are accepted. The CS# pin must remain high during the t_{RES1} time duration.

When used only to obtain the Device ID while not in the Power-Down state, the command is initiated by driving the CS# pin low and shifting the instruction code “ABH” followed by 3-dummy byte. The Device ID bits are then shifted out on the falling edge of SCLK with most significant bit (MSB) first as shown in Figure23. The Device ID value for the GD25LQ16 is listed in Manufacturer and Device Identification table. The Device ID can be read continuously. The command is completed by driving CS# high.

When used to release the device from the Power-Down state and obtain the Device ID, the command is the same as previously described, and shown in Figure23, except that after CS# is driven high it must remain high for a time duration of t_{RES2} (See AC Characteristics). After this time duration the device will resume normal operation and other command will be accepted. If the Release from Power-Down / Device ID command is issued while an Erase, Program or Write cycle is in process (when WIP equal 1) the command is ignored and will not have any effects on the current cycle.

Figure22. Release Power-Down Sequence Diagram

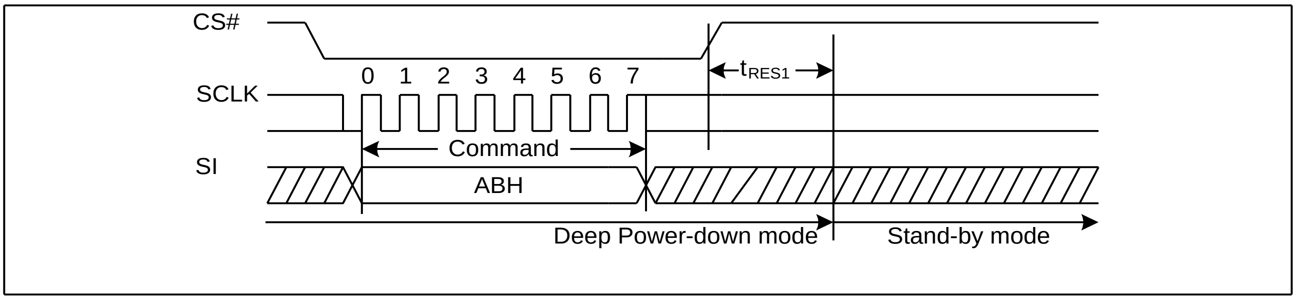


Figure22a. Release Power-Down Sequence Diagram (QPI)

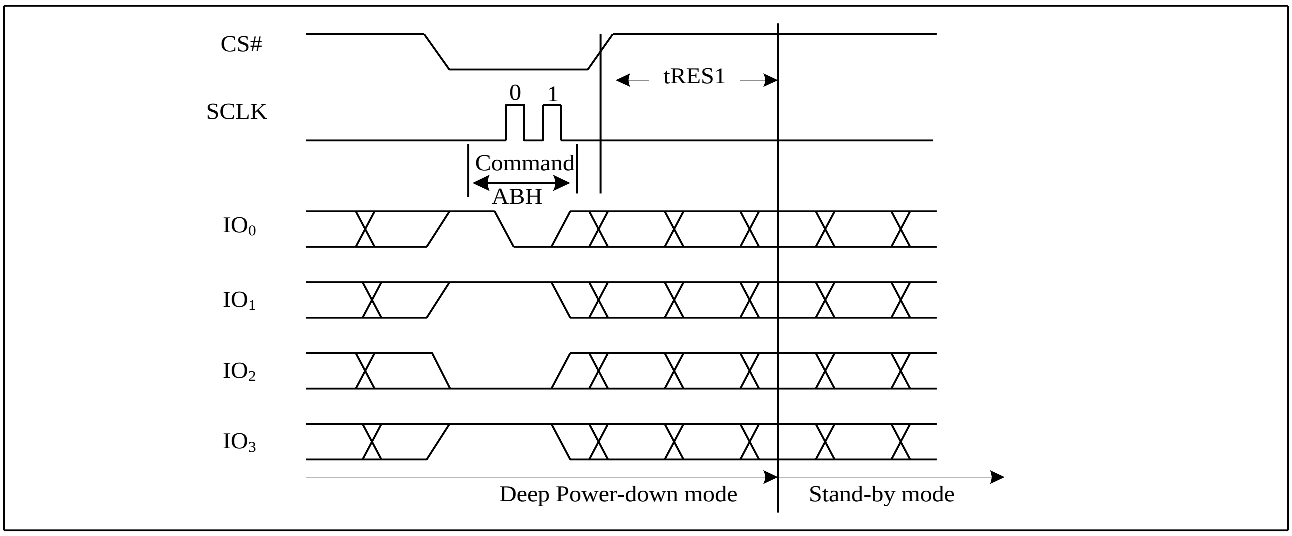


Figure23. Release Power-Down/Read Device ID Sequence Diagram

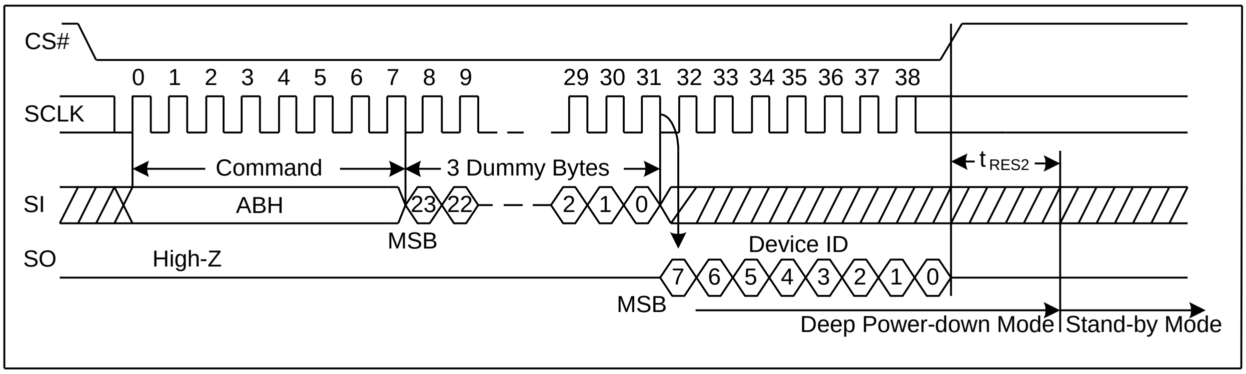
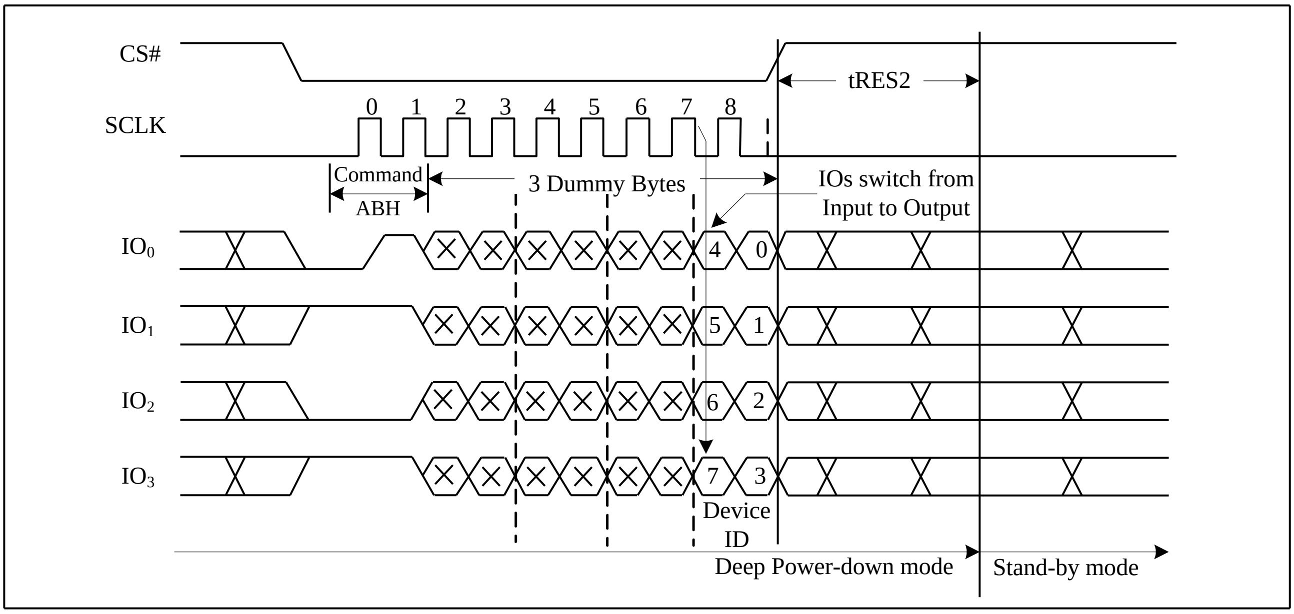


Figure23a. Release Power-Down/Read Device ID Sequence Diagram (QPI)



7.22 Read Manufacture Id/ Device Id (REMS) (90H)

The Read Manufacturer/Device ID command is an alternative to the Release from Power-Down / Device ID command that provides both the JEDEC assigned Manufacturer ID and the specific Device ID.

The command is initiated by driving the CS# pin low and shifting the command code "90H" followed by a 24-bit address (A23-A0) of 000000H. After which, the Manufacturer ID and the Device ID are shifted out on the falling edge of SCLK with most significant bit (MSB) first as shown in Figure24. If the 24-bit address is initially set to 000001H, the Device ID will be read first.

Figure24. Read Manufacture ID/ Device ID Sequence Diagram

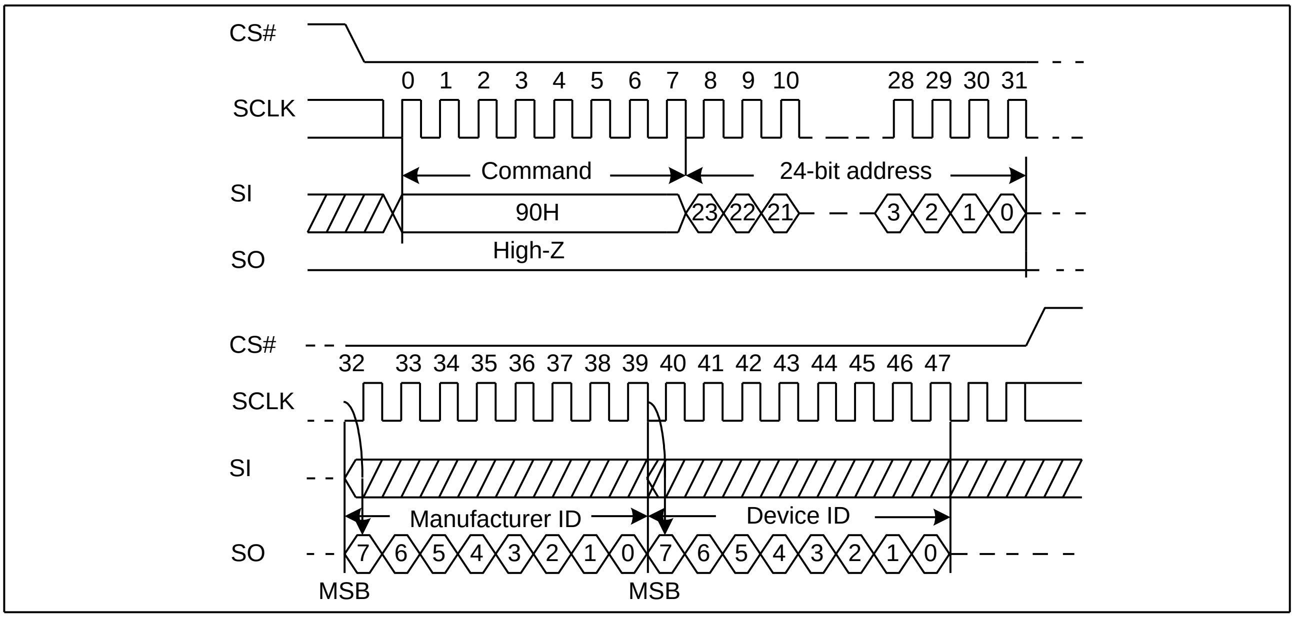
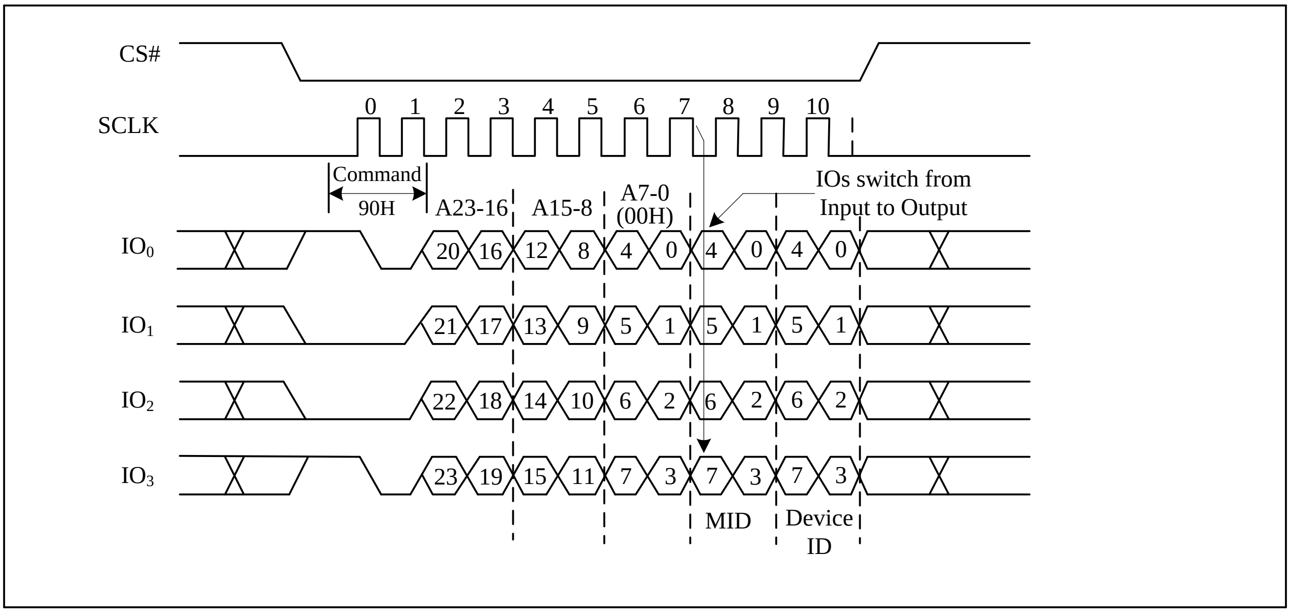


Figure24a. Read Manufacture ID/ Device ID Sequence Diagram (QPI)

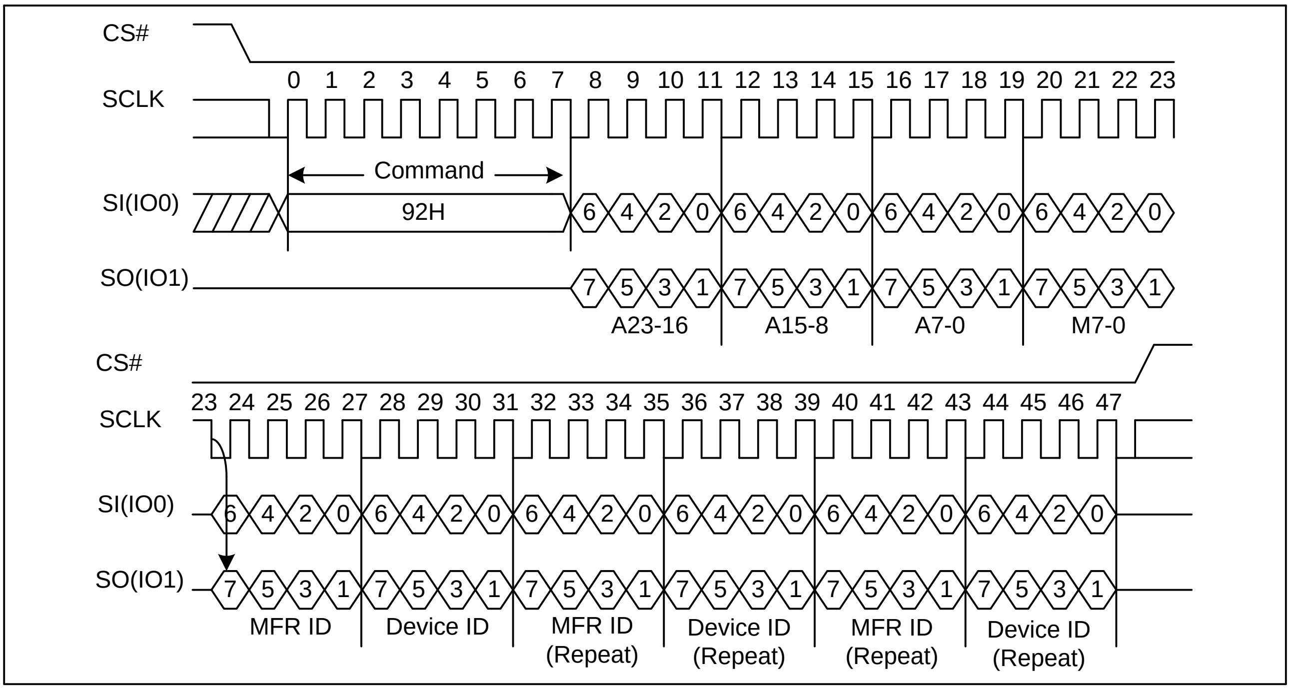


7.23 Read Manufacture ID/ Device ID Dual I/O (92H)

The Read Manufacturer/Device ID Dual I/O command is an alternative to the Release from Power-Down / Device ID command that provides both the JEDEC assigned Manufacturer ID and the specific Device ID by dual I/O.

The command is initiated by driving the CS# pin low and shifting the command code “92H” followed by a 24-bit address (A23-A0) of 000000H. After which, the Manufacturer ID and the Device ID are shifted out on the falling edge of SCLK with most significant bit (MSB) first as shown in Figure25. If the 24-bit address is initially set to 000001H, the Device ID will be read first.

Figure25. Read Manufacture ID/ Device ID Dual I/O Sequence Diagram

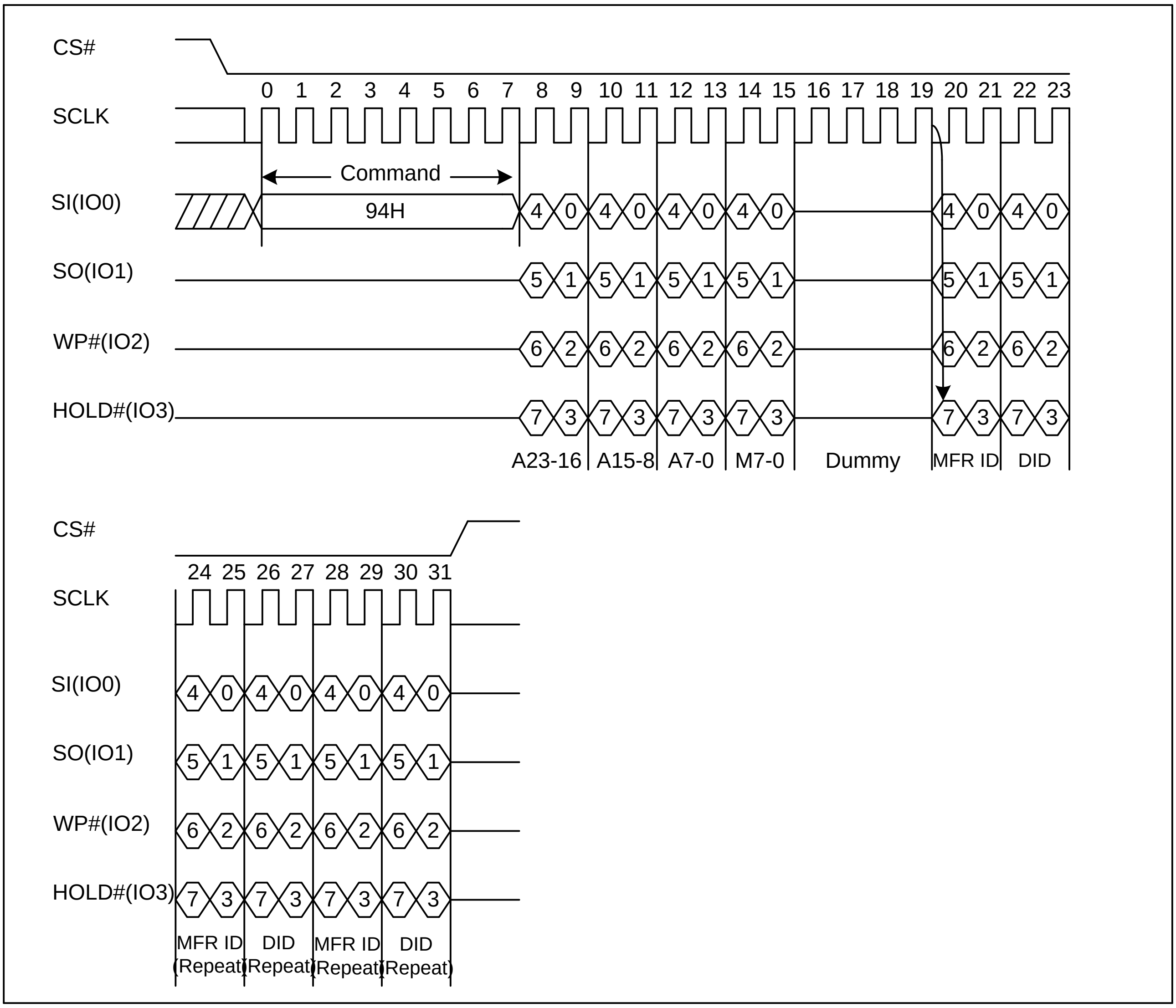


7.24 Read Manufacture ID/ Device ID Quad I/O (94H)

The Read Manufacturer/Device ID Quad I/O command is an alternative to the Release from Power-Down / Device ID command that provides both the JEDEC assigned Manufacturer ID and the specific Device ID by quad I/O.

The command is initiated by driving the CS# pin low and shifting the command code "94H" followed by a 24-bit address (A23-A0) of 000000H. After which, the Manufacturer ID and the Device ID are shifted out on the falling edge of SCLK with most significant bit (MSB) first as shown in Figure26. If the 24-bit address is initially set to 000001H, the Device ID will be read first.

Figure26. Read Manufacture ID/ Device ID Quad I/O Sequence Diagram



7.25 Read Identification (RDID) (9FH)

The Read Identification (RDID) command allows the 8-bit manufacturer identification to be read, followed by two bytes of device identification. The device identification indicates the memory type in the first byte, and the memory capacity of the device in the second byte. The Read Identification (RDID) command while an Erase or Program cycle is in progress, is not decoded, and has no effect on the cycle that is in progress. The Read Identification (RDID) command should not be issued while the device is in Deep Power-Down Mode.

The device is first selected by driving CS# to low. Then, the 8-bit command code for the command is shifted in. This is followed by the 24-bit device identification, stored in the memory, being shifted out on Serial Data Output, each bit being shifted out during the falling edge of Serial Clock. The command sequence is shown in Figure27. The Read Identification (RDID) command is terminated by driving CS# to high at any time during data output. When CS# is driven high, the device is put in the Standby Mode. Once in the Standby Mode, the device waits to be selected, so that it can receive, decode and execute commands.

Figure27. Read Identification ID Sequence Diagram

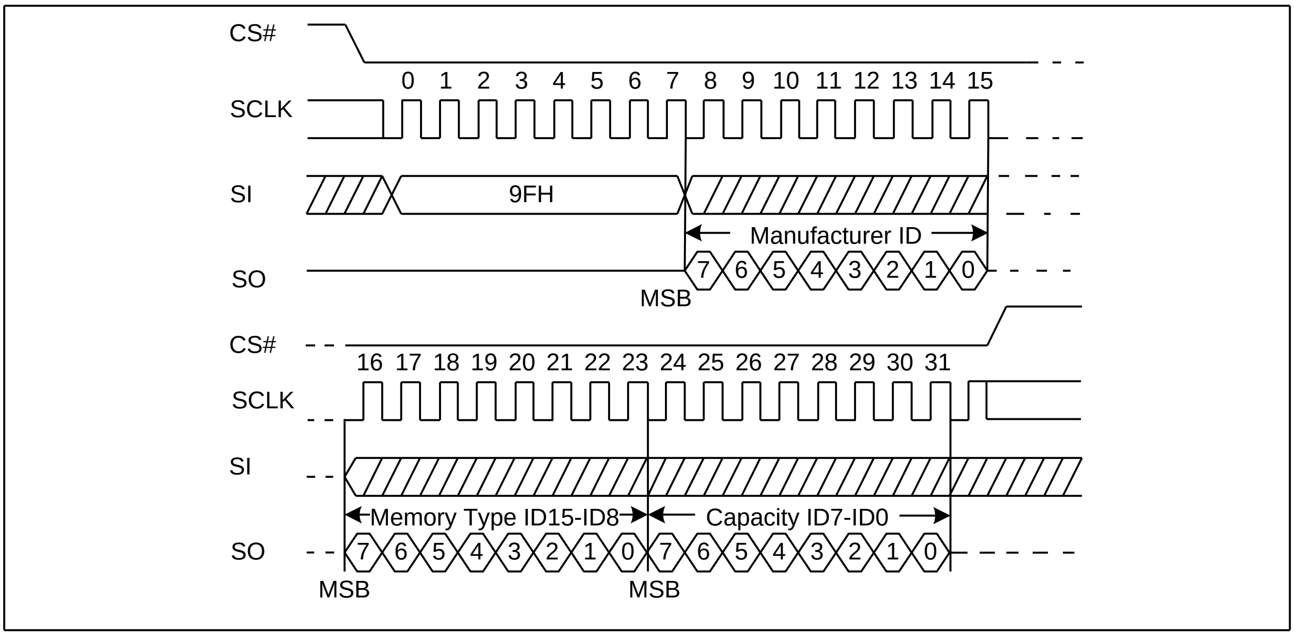
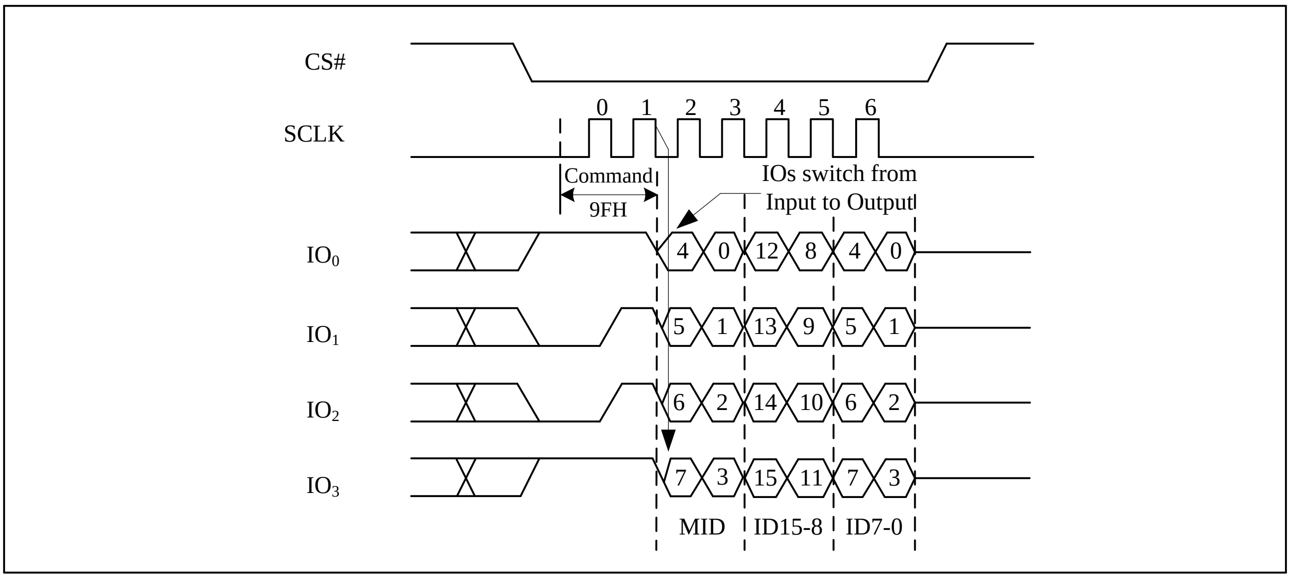


Figure27a. Read Identification ID Sequence Diagram (QPI)



7.26 Program/Erase Suspend (PES) (75H)

The Program/Erase Suspend command “75H”, allows the system to interrupt a page program or sector/block erase operation and then read data from any other sector or block. The Write Status Register command (01H) and Erase Security Registers (44H, 42H) and Erase commands (20H, 52H, D8H, C7H, 60H) and Page Program command are not allowed during Program/Erase suspend. Program/Erase Suspend is valid only during the page program or sector/block erase operation. A maximum of time of “tsus” (See AC Characteristics) is required to suspend the program/erase operation. The Program/Erase Suspend command will be accepted by the device only if the SUS2/SUS1 bit in the Status Register equal to 0 and WIP bit equal to 1 while a Page Program or a Sector or Block Erase operation is on-going. If the SUS2/SUS1 bit equal to 1 or WIP bit equal to 0, the Suspend command will be ignored by the device. The WIP bit will be cleared form 1 to 0 within “tsus” and the SUS2/SUS1 bit will be set from 0 to 1 immediately after Program/Erase Suspend. A power-off during the suspend period will reset the device and release the suspend state. The command sequence is show in Figure28.

Figure28. Program/Erase Suspend Sequence Diagram

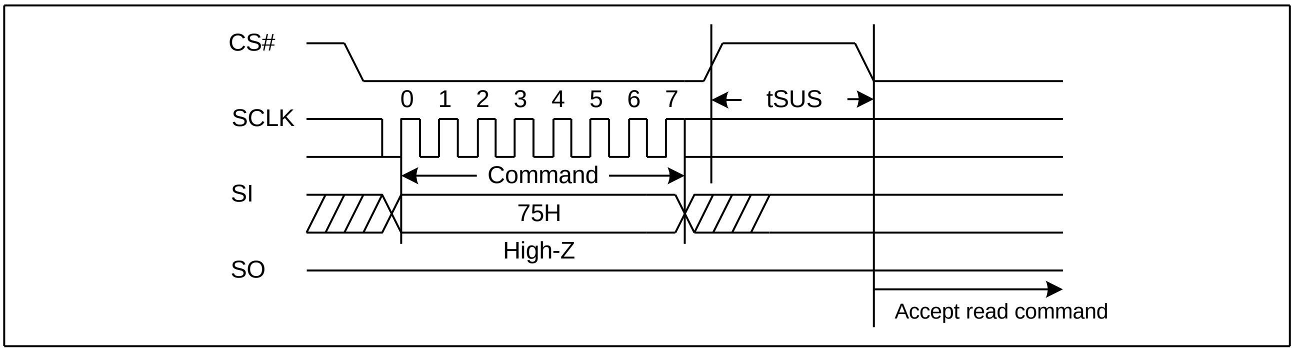
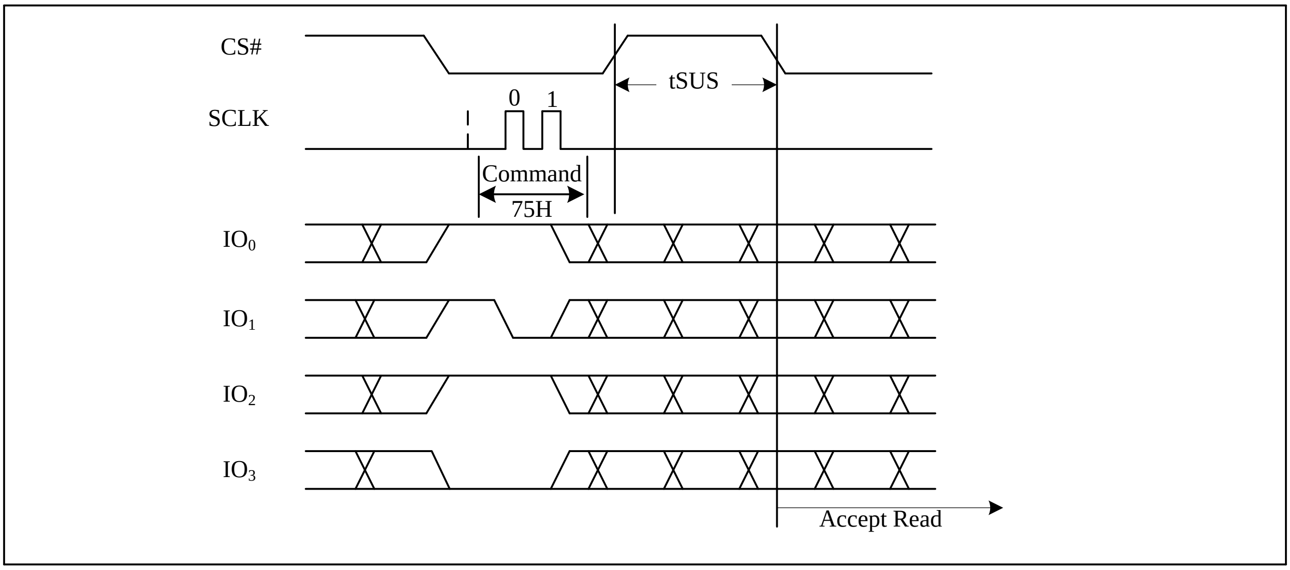


Figure28a. Program/Erase Suspend Sequence Diagram (QPI)



7.27 Program/Erase Resume (PER) (7AH)

The Program/Erase Resume command must be written to resume the program or sector/block erase operation after a Program/Erase Suspend command. The Program/Erase command will be accepted by the device only if the SUS2/SUS1 bit equal to 1 and the WIP bit equal to 0. After issued the SUS2/SUS1 bit in the status register will be cleared from 1 to 0 immediately, the WIP bit will be set from 0 to 1 within 200ns and the Sector or Block will complete the erase operation or the page will complete the program operation. The Program/Erase Resume command will be ignored unless a Program/Erase Suspend is active. The command sequence is show in Figure29.

Figure29. Program/Erase Resume Sequence Diagram

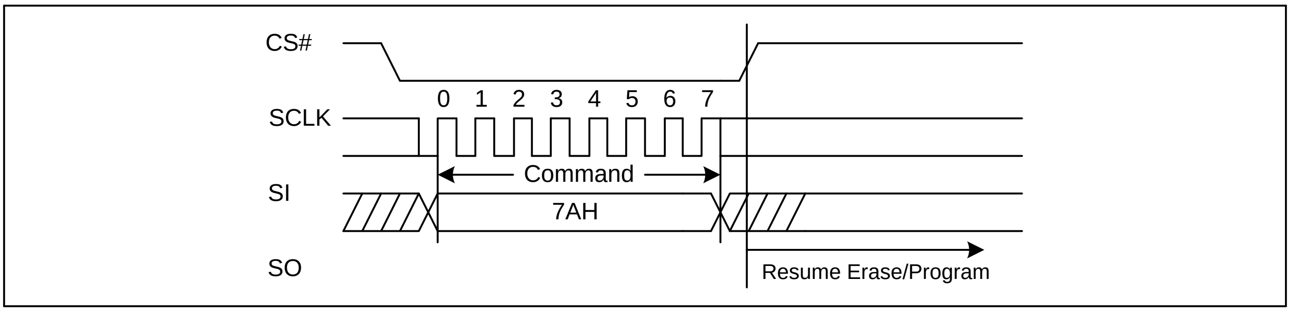
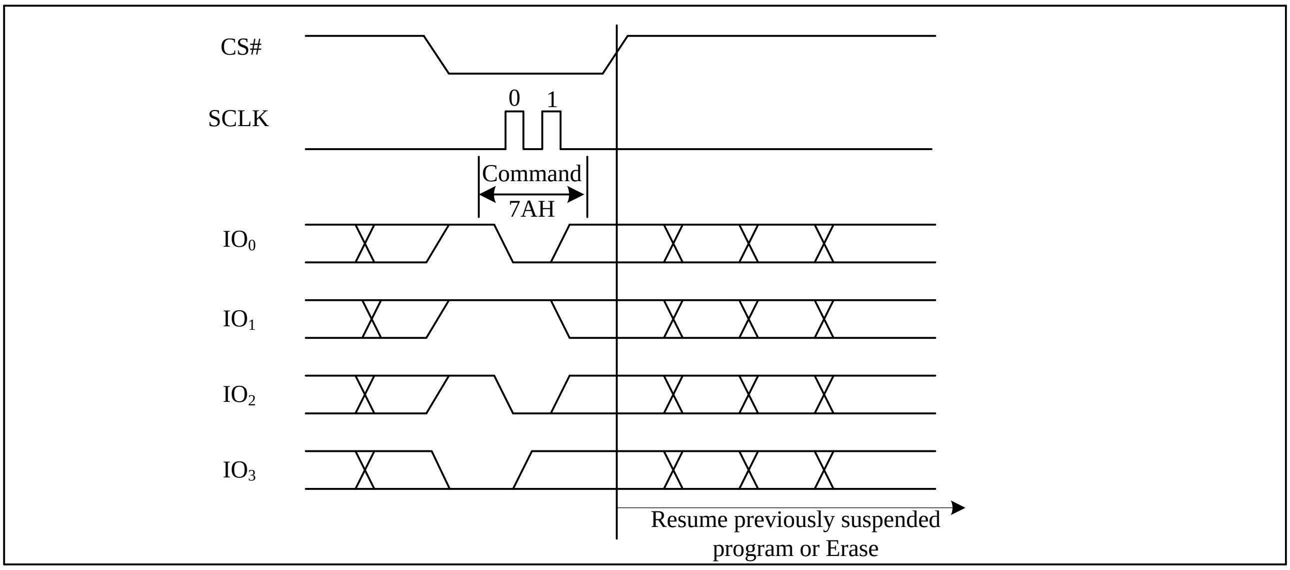


Figure29a. Program/Erase Resume Sequence Diagram (QPI)



7.28 Erase Security Registers (44H)

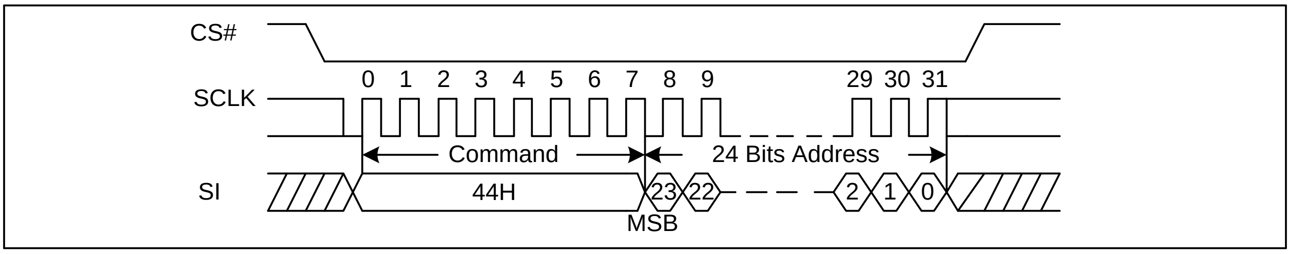
The GD25LQ16 provides three 256-byte Security Registers which can be erased and programmed individually. These registers may be used by the system manufacturers to store security and other important information separately from the main memory array.

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 Erase Security Registers command → CS# goes high. The command sequence is shown in Figure30. 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 (whose duration is t_{SE}) 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. At some unspecified time before the cycle is completed, the Write Enable Latch (WEL) bit is reset. 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	A23-16	A15-12	A11-8	A7-0
Security Register #1	00H	0 0 0 1	0 0 0 0	Do not care
Security Register #2	00H	0 0 1 0	0 0 0 0	Do not care
Security Register #3	00H	0 0 1 1	0 0 0 0	Do not care

Figure30. Erase Security Registers command Sequence Diagram



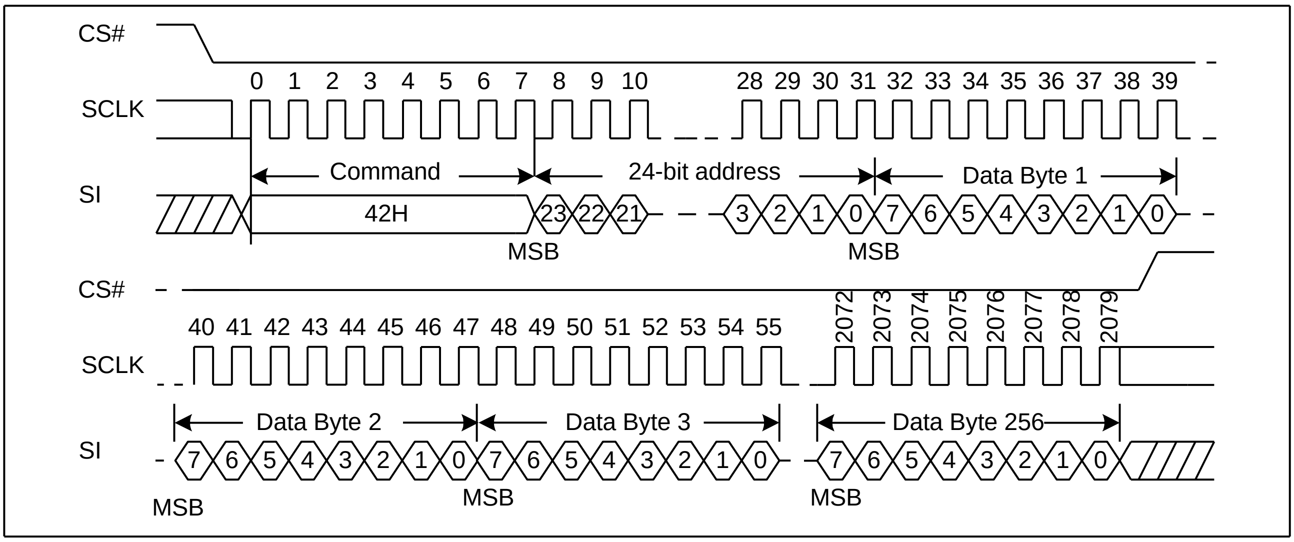
7.29 Program Security Registers (42H)

The Program Security Registers command is similar to the Page Program command. It allows from 1 to 256 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 is entered by driving CS# Low, followed by the command code (42H), three address bytes and at least one data byte on SI. As soon as CS# is driven high, the self-timed Program Security Registers cycle (whose duration is t_{PP}) 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. At some unspecified time before the cycle is completed, the Write Enable Latch (WEL) bit is reset.

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	A23-16	A15-12	A11-8	A7-0
Security Register #1	00H	0 0 0 1	0 0 0 0	Byte Address
Security Register #2	00H	0 0 1 0	0 0 0 0	Byte Address
Security Register #3	00H	0 0 1 1	0 0 0 0	Byte Address

Figure31. Program Security Registers command Sequence Diagram

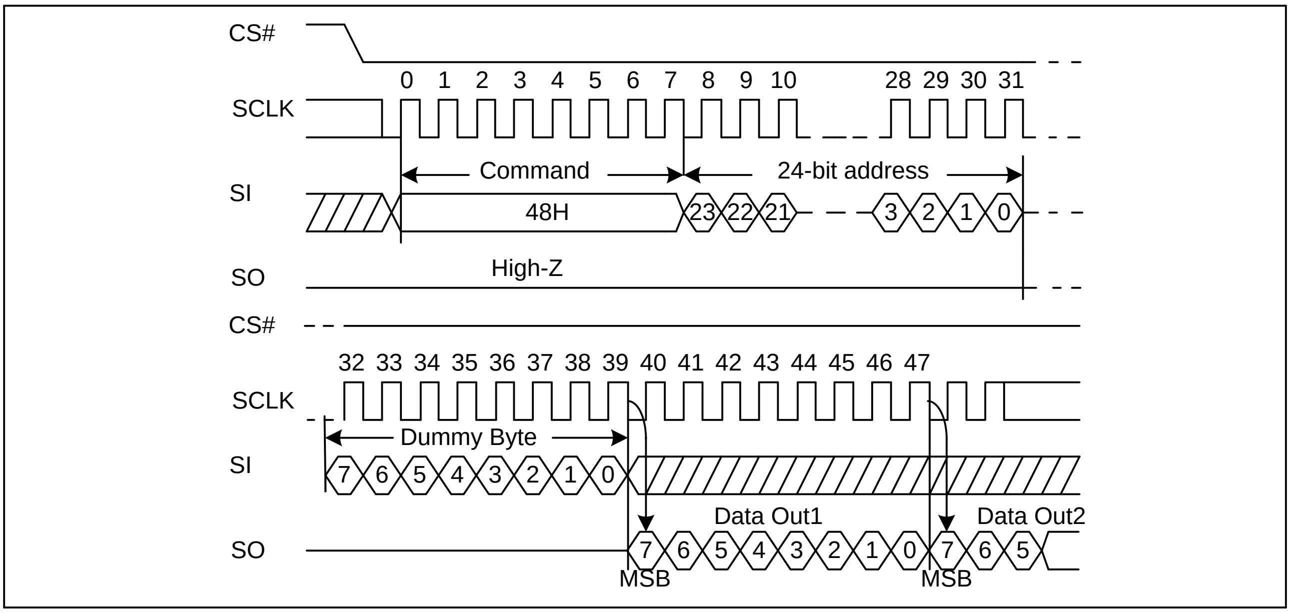


7.30 Read Security Registers (48H)

The Read Security Registers command is similar to Fast Read command. The command is followed by a 3-byte address (A23-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 f_C, 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.

Address	A23-16	A15-12	A11-8	A7-0
Security Register #0	00H	0 0 0 0	0 0 0 0	Byte Address
Security Register #1	00H	0 0 0 1	0 0 0 0	Byte Address
Security Register #2	00H	0 0 1 0	0 0 0 0	Byte Address
Security Register #3	00H	0 0 1 1	0 0 0 0	Byte Address

Figure32. Read Security Registers command Sequence Diagram

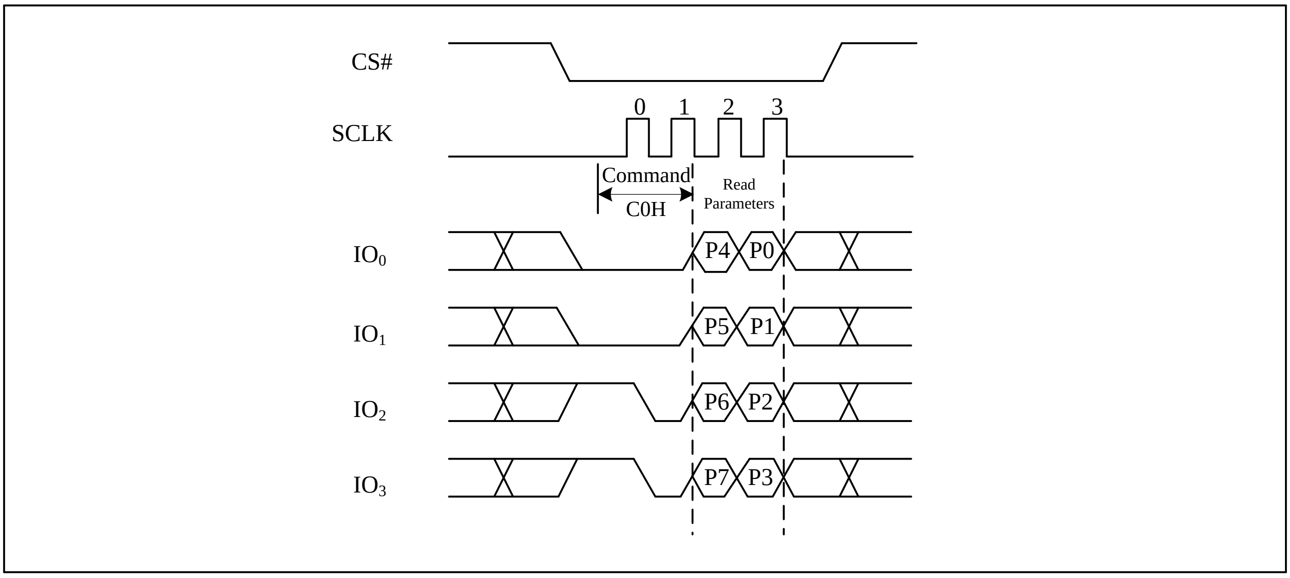


7.31 Set Read Parameters (C0H)

In QPI mode the "Set Read Parameters (C0H)" command can be used to configure the number of dummy clocks for "Fast Read (0BH)", "Quad I/O Fast Read (EBH)" and "Burst Read with Wrap (0CH)" command, and to configure the number of bytes of "Wrap Length" for the "Burst Read with Wrap (0CH)" command. The "Wrap Length" is set by W5-6 bit in the "Set Burst with Wrap (77H)" command. This setting will remain unchanged when the device is switched from Standard SPI mode to QPI mode.

P5-P4	Dummy Clocks	Maximum Read Freq.		P1-P0	Wrap Length
0 0	4	80MHz		0 0	8-byte
0 1	4	80MHz		0 1	16-byte
1 0	6	120MHz		1 0	32-byte
1 1	8	120MHz		1 1	64-byte

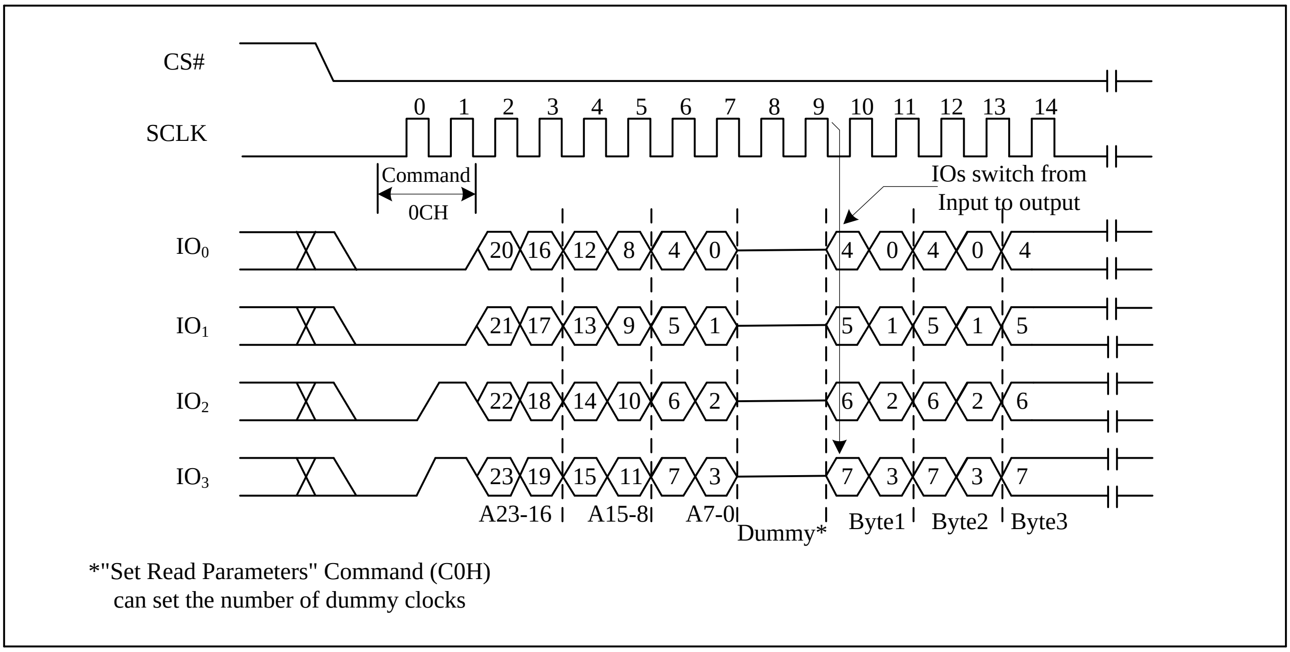
Figure33. Set Read Parameters command Sequence Diagram



7.32 BURST READ WITH WRAP (0CH)

The “Burst Read with Wrap (0CH)” command provides an alternative way to perform the read operation with “Wrap Around” in QPI mode. This command is similar to the “Fast Read (0BH)” command in QPI mode, except the addressing of the read operation will “Wrap Around” to the beginning boundary of the “Wrap Around” once the ending boundary is reached. The “Wrap Length” and the number of dummy clocks can be configured by the “Set Read Parameters (C0H)” command.

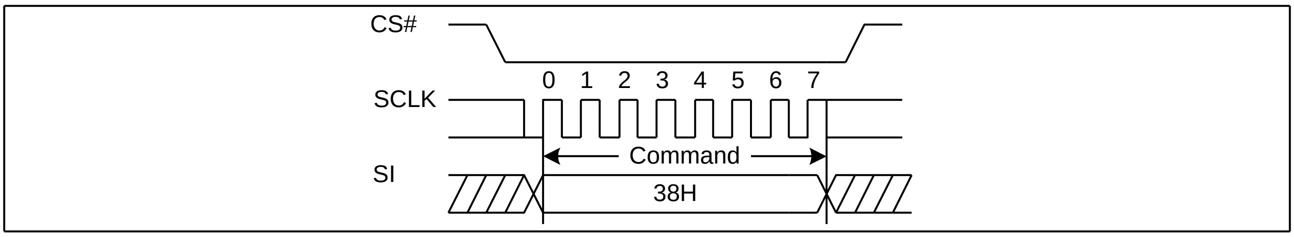
Figure34. Burst Read with Wrap command Sequence Diagram



7.33 Enable QPI (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. See the command Table 2a for all support QPI commands. 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, and the Wrap Length setting will remain unchanged.

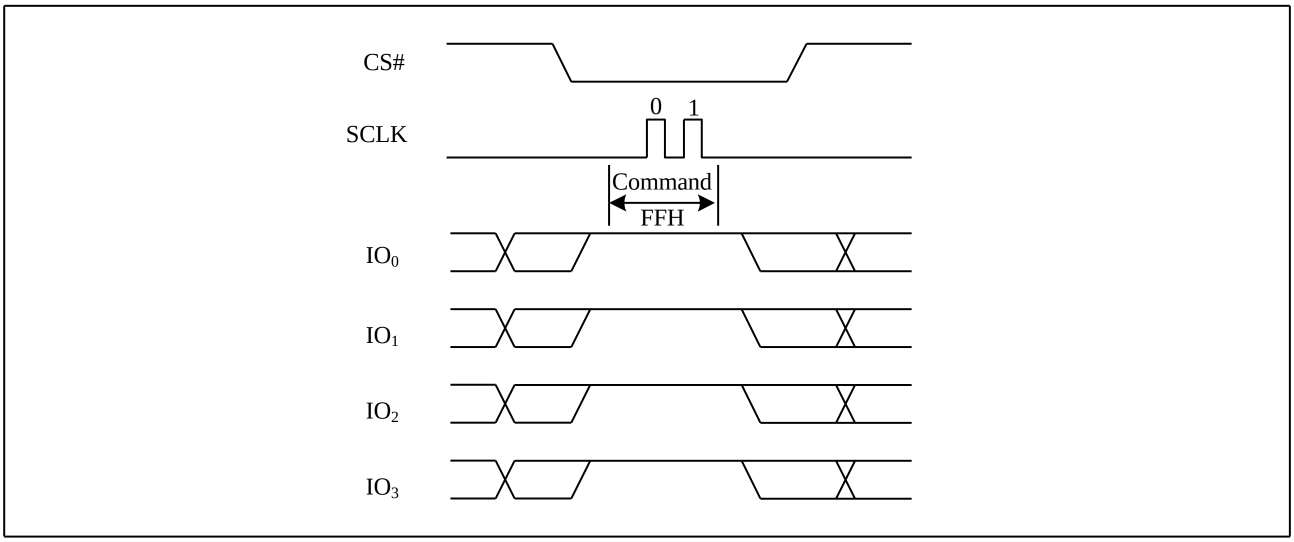
Figure35. Enable QPI mode command Sequence Diagram



7.34 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, and the Wrap Length setting will remain unchanged.

Figure36. Disable QPI mode command Sequence Diagram



7.35 Enable Reset (66H) and Reset (99H)

If the Reset command is accepted, any on-going internal operation will be terminated and the device will return to its default power-on state and lose all the current volatile settings, such as Volatile Status Register bits, Write Enable Latch status (WEL), Program/Erase Suspend status, Read Parameter setting (P7-P0), Continuous Read Mode bit setting (M7-M0) and Wrap Bit Setting (W6-W4).

The "Enable Reset (66H)" and the "Reset (99H)" commands can be issued in either SPI or QPI mode. The "Reset (99H)" command sequence as follow: CS# goes low → Sending Enable Reset command → CS# goes high → CS# goes low → Sending Reset command → CS# goes high. Once the Reset command is accepted by the device, the device will take approximately t_{RST_R} to reset. During this period, no command will be accepted. Data corruption may happen if there is an on-going or suspended internal Erase or Program operation when Reset command sequence is accepted by the device. It is recommended to check the BUSY bit and the SUS bit in Status Register before issuing the Reset command sequence.

Figure37. Enable Reset and Reset command Sequence Diagram

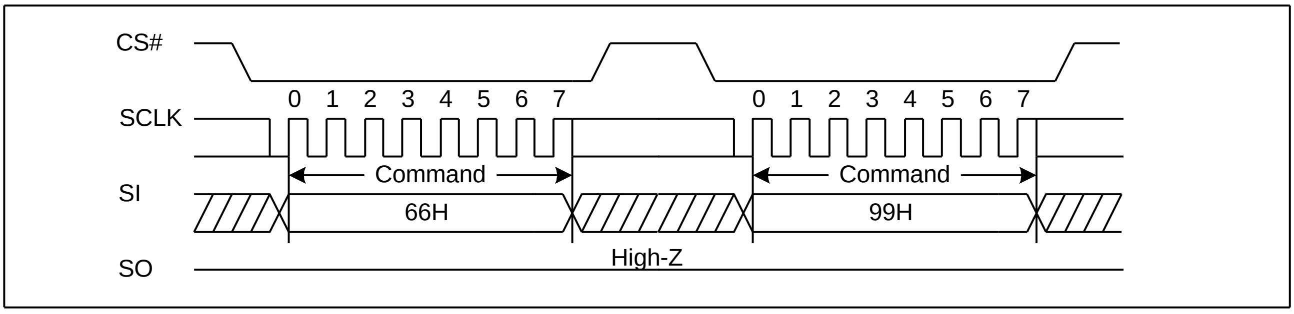
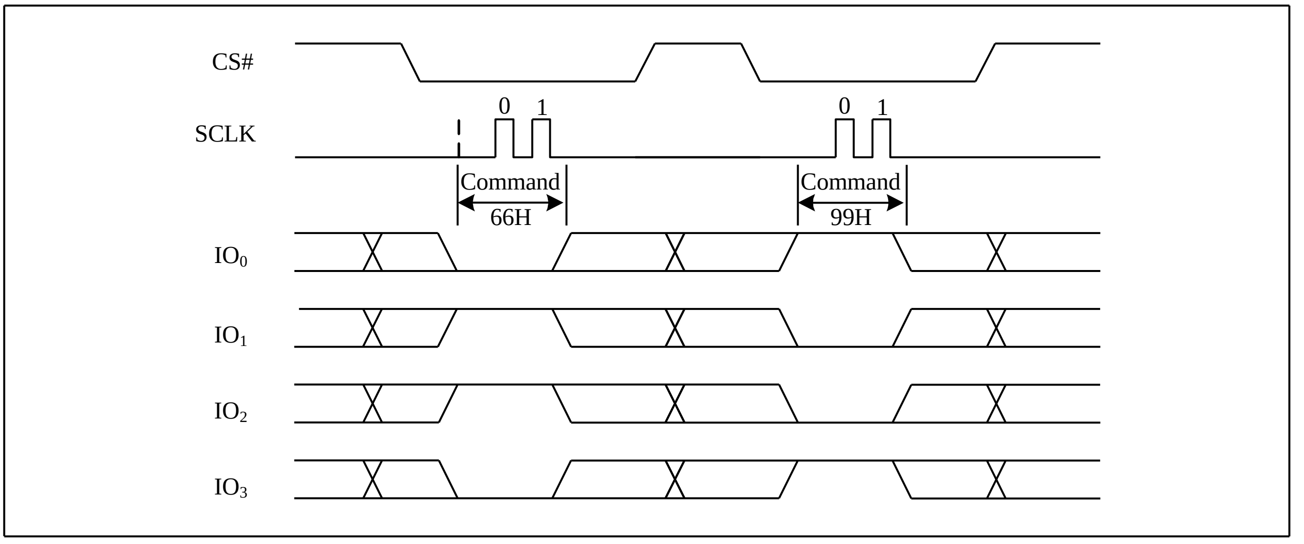


Figure38. Enable Reset and Reset command Sequence Diagram (QPI)



8 ELECTRICAL CHARACTERISTICS

8.1 POWER-ON TIMING

Figure39. Power-On Timing Sequence Diagram

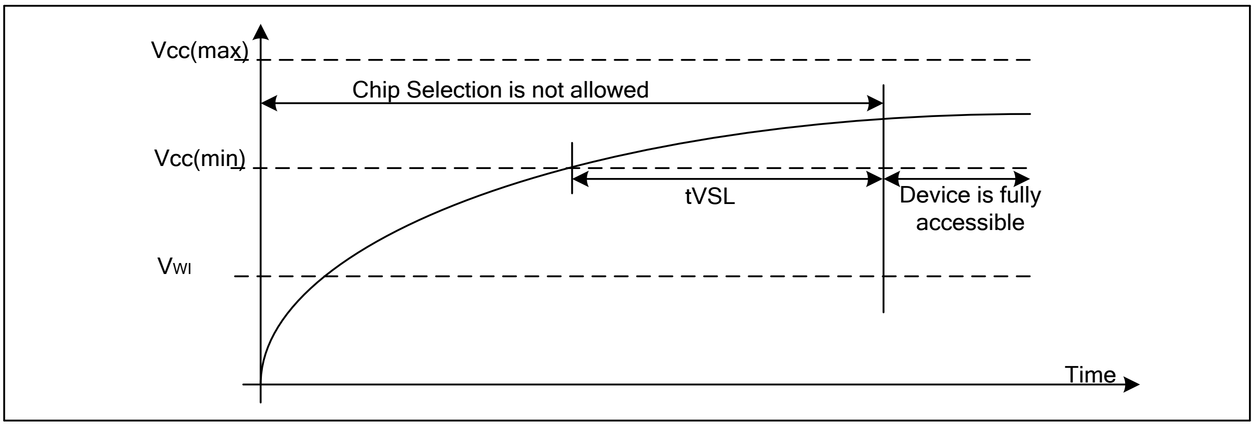


Table3. Power-Up Timing and Write Inhibit Threshold

Symbol	Parameter	Min	Max	Unit
tVSL	VCC(min) To CS# Low	5		ms
VWI	Write Inhibit Voltage VCC(min)	1	1.4	V

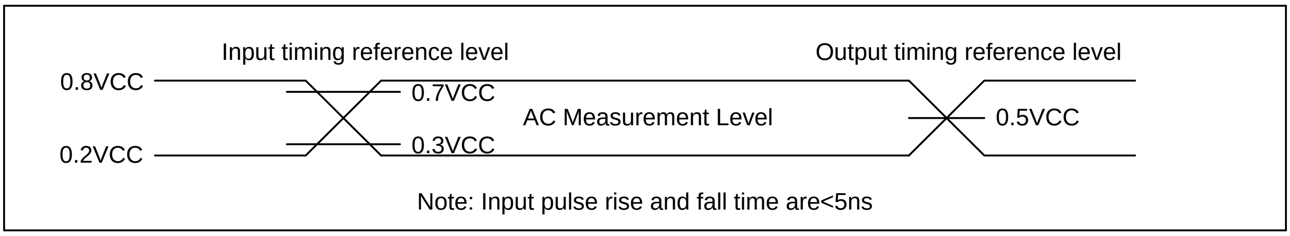
8.2 Initial Delivery State

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).

8.3 Absolute Maximum Ratings

Parameter	Value	Unit
Ambient Operating Temperature	-40 to 85	℃
Storage Temperature	-65 to 150	℃
Transient Input / Output Voltage(note: overshoot)	-2.0 to VCC+2.0	V
Applied Input/Output Voltage	-0.6 to VCC+0.4	V
VCC	-0.6 to 2.5	V

Figure40. Absolute Maximum Ratings Diagram

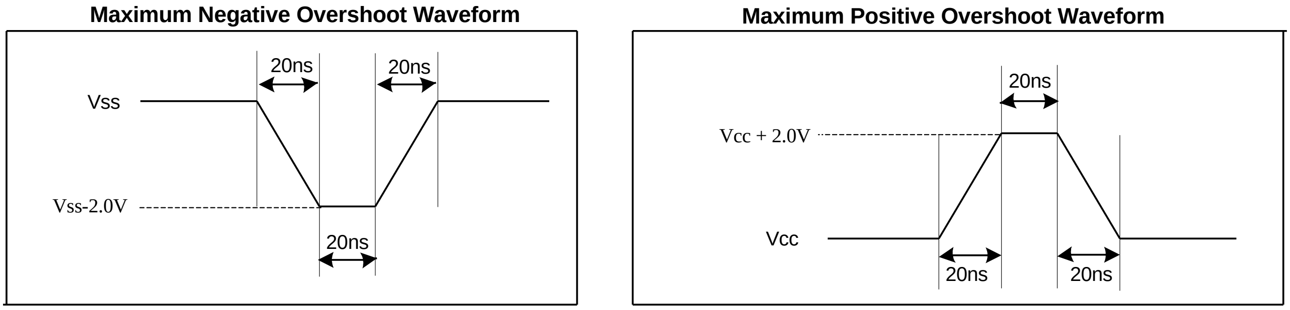


Note: Input pulse rise and fall time are<5ns

8.4 Capacitance Measurement Conditions

Symbol	Parameter	Min	Typ	Max	Unit	Conditions
CIN	Input Capacitance			6	pF	VIN=0V
COUT	Output Capacitance			8	pF	VOUT=0V
C_L	Load Capacitance	30			pF	
	Input Rise And Fall time			5	ns	
	Input Pause Voltage	0.2VCC to 0.8VCC			V	
	Input Timing Reference Voltage	0.3VCC to 0.7VCC			V	
	Output Timing Reference Voltage	0.5VCC			V	

Figure41. Input Test Waveform and Measurement Level



8.5 DC CHARACTERISTICS

(T= -40℃~85℃, VCC=1.65~2.0V)

Symbol	Parameter	Test Condition	Min.	Typ	Max.	Unit.
I_{LI}	Input Leakage Current				±2	μA
I_{LO}	Output Leakage Current				±2	μA
I_{CC1}	Standby Current	CS#=VCC, V_{IN}=VCC or VSS		20	40	μA
I_{CC2}	Deep Power-Down Current	CS#=VCC, V_{IN}=VCC or VSS		1	5	μA
I_{CC3}	Operating Current (Read)	CLK=0.1VCC / 0.9VCC at 120MHz, Q=Open(*1,*2,*4 I/O)		15	20	mA
		CLK=0.1VCC / 0.9VCC at 80MHz, Q=Open(*1,*2,*4 I/O)		13	18	mA
I_{CC4}	Operating Current (PP)	CS#=VCC			25	mA
I_{CC5}	Operating Current(WRSR)	CS#=VCC			25	mA
I_{CC6}	Operating Current (SE)	CS#=VCC			25	mA
I_{CC7}	Operating Current (BE)	CS#=VCC			25	mA
V_{IL}	Input Low Voltage		-0.5		0.3VCC	V
V_{IH}	Input High Voltage		0.7VCC		VCC+0.4	V
V_{OL}	Output Low Voltage	I_{OL} =100uA			0.2	V
V_{OH}	Output High Voltage	I_{OH} =-100μA	VCC-0.2			V

8.6 AC CHARACTERISTICS

(T= -40℃~85℃, VCC=1.65~2.0V, C_L=30pf)

Symbol	Parameter	Min.	Typ.	Max.	Unit.
f_C	Serial Clock Frequency For: 0BH, 3BH, BBH, 6BH, EBH, E7H	DC.		120	MHz
f_C	Serial Clock Frequency For: 0BH, 0CH, EBH with QPI mode (4 & 6 & 8 Dummy clocks)	DC.		80/120/120	MHz
f_R	Serial Clock Frequency For: Read(03H)	DC.		80	MHz
t_{CLH}	Serial Clock High Time	4			ns
t_{CLL}	Serial Clock Low Time	4			ns
t_{CLCH}	Serial Clock Rise Time (Slew Rate)	0.1			V/ns
t_{CHCL}	Serial Clock Fall Time (Slew Rate)	0.1			V/ns
t_{SLCH}	CS# Active Setup Time	5			ns
t_{CHSH}	CS# Active Hold Time	5			ns
t_{SHCH}	CS# Not Active Setup Time	5			ns
t_{CHSL}	CS# Not Active Hold Time	5			ns
t_{SHSL}	CS# High Time (read/write)	20			ns
t_{SHQZ}	Output Disable Time			6	ns
t_{CLQX}	Output Hold Time	1.2			ns
t_{DVCH}	Data In Setup Time	2			ns
t_{CHDX}	Data In Hold Time	2			ns
t_{HLCH}	Hold# Low Setup Time (relative to Clock)	5			ns
t_{HHCH}	Hold# High Setup Time (relative to Clock)	5			ns
t_{CHHL}	Hold# High Hold Time (relative to Clock)	5			ns
t_{CHHH}	Hold# Low Hold Time (relative to Clock)	5			ns
t_{HLQZ}	Hold# Low To High-Z Output			6	ns
t_{HHQX}	Hold# Low To Low-Z Output			6	ns
t_{CLQV}	Clock Low To Output Valid			7	ns
t_{WHSL}	Write Protect Setup Time Before CS# Low	20			ns
t_{SHWL}	Write Protect Hold Time After CS# High	100			ns
t_{DP}	CS# High To Deep Power-Down Mode			20	μs
t_{RES1}	CS# High To Standby Mode Without Electronic Signature Read			20	μs
t_{RES2}	CS# High To Standby Mode With Electronic Signature Read			20	μs
t_{RST_R}	CS# High To Next Command After Reset (from read)			20	μs
t_{RST_P}	CS# High To Next Command After Reset (from program)			20	μs
t_{RST_E}	CS# High To Next Command After Reset (from erase)			12	ms
t_{SUS}	CS# High To Next Command After Suspend			20	us
t_W	Write Status Register Cycle Time		5	15	ms
t_{PP}	Page Programming Time		0.4	2.4	ms

t_{SE}	Sector Erase Time		60	500	ms
t_{BE}	Block Erase Time(32K Bytes/64K Bytes)		0.3/0.5	1.0/1.2	s
t_{CE}	Chip Erase Time(GD25LQ16)		10	20	s

Figure42. Serial Input Timing

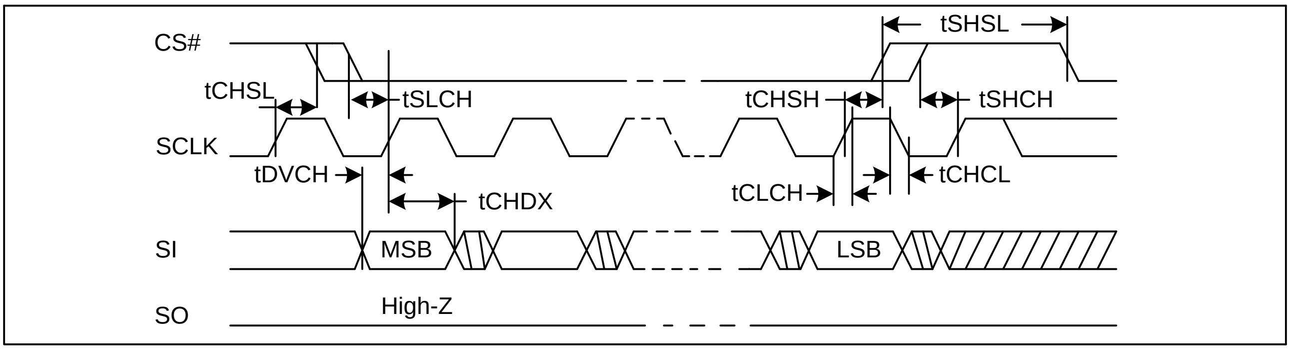


Figure43. Output Timing

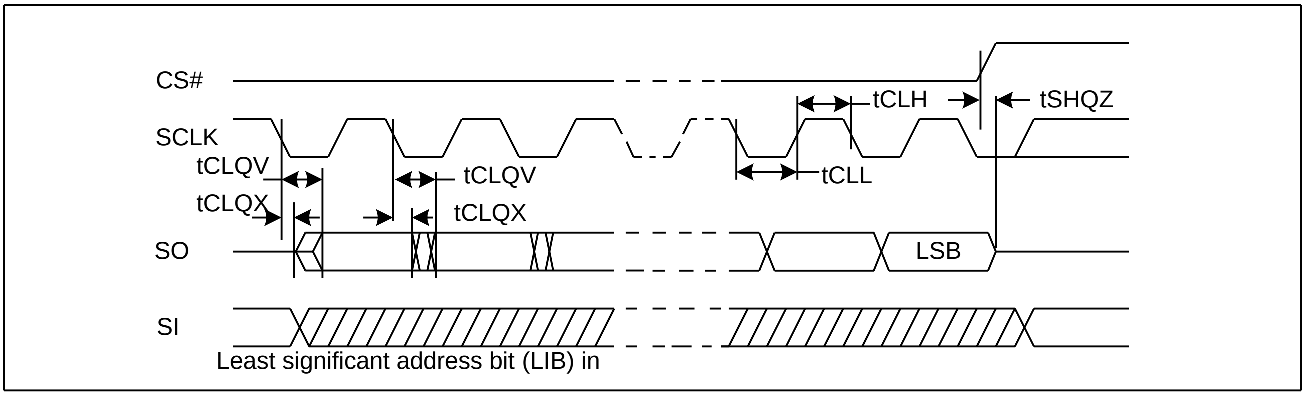
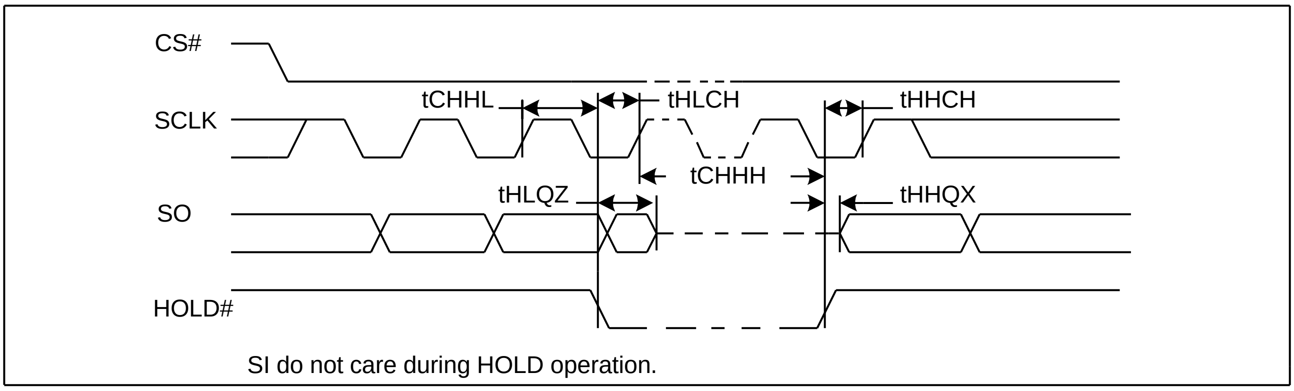
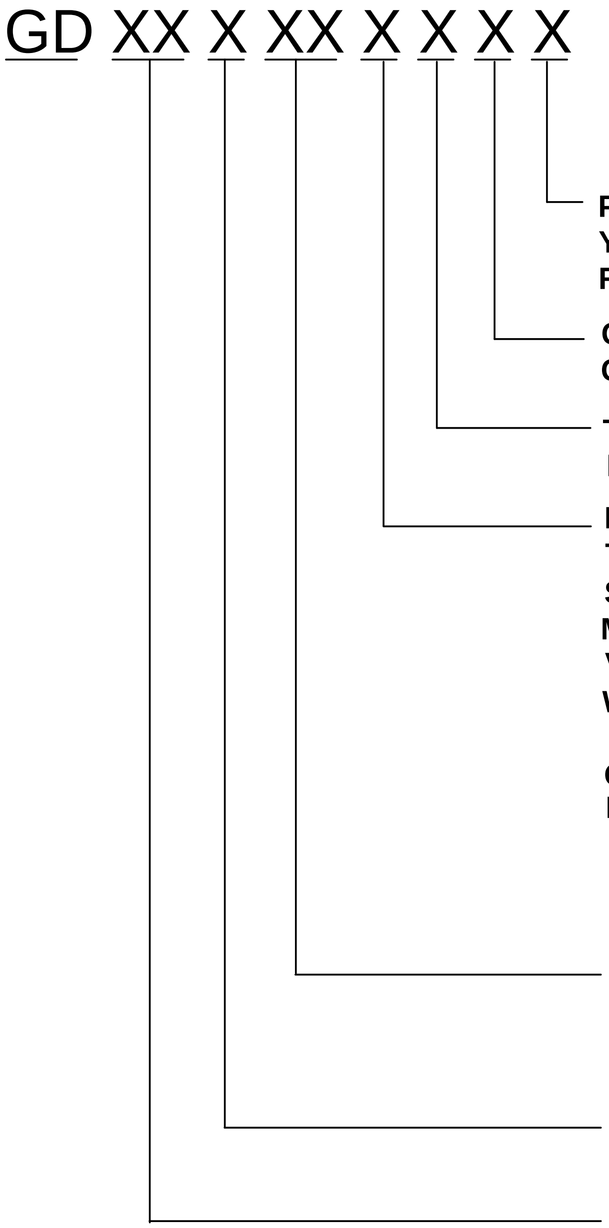


Figure44. Hold Timing



9 ORDERING INFORMATION



Packing Type
Y:Tray
R:Tape & Reel

Green Code
G:Pb Free & Halogen Free Green Package

Temperature Range
I:Industrial(-40℃ to +85℃)

Package Type
T: SOP8 150mil
S: SOP8 208mil
M: VSOP8 150mil
V: VSOP8 208mil
W: WSON (6*5mm)
N: USON8 (3*4mm)
Q: USON8 (4*4mm, 0.45 thickness)
H:USON8 (3*3mm)
L: WLCSP

Density
16:16Mb

Series
LQ:1.8V,4KB Uniform Sector

Product Family
25:SPI Interface Flash

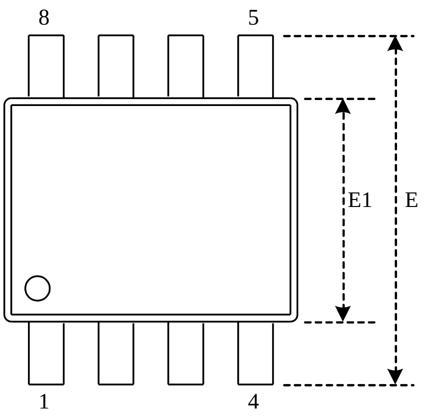
9.1. Valid Part Numbers

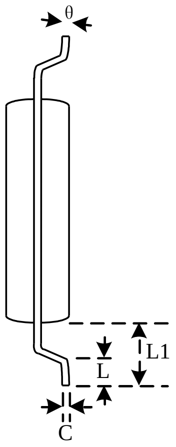
Please contact Gigadevice regional sales for the latest product selection and available from factors.

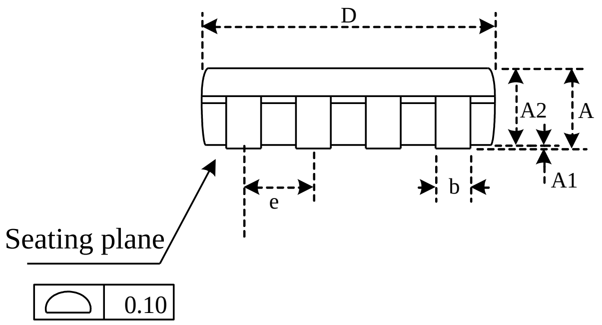
Product Number	Density	Package Type	Temperature
GD25LQ16TIG	16Mbit	SOP8 150mil	-40℃ to +85℃
GD25LQ16SIG	16Mbit	SOP8 208mil	-40℃ to +85℃
GD25LQ16MIG	16Mbit	VSOP8 150mil	-40℃ to +85℃
GD25LQ16VIG	16Mbit	VSOP8 208mil	-40℃ to +85℃
GD25LQ16WIG	16Mbit	WSON8 (6*5mm)	-40℃ to +85℃
GD25LQ16NIG	16Mbit	USON8(3*4mm)	-40℃ to +85℃
GD25LQ16QIG	16Mbit	USON8(4*4mm,thickness0.45mm)	-40℃ to +85℃
GD25LQ16HIG	16Mbit	USON8(3*3mm)	-40℃ to +85℃
GD25LQ16LIG	16Mbit	WLCSP	-40℃ to +85℃

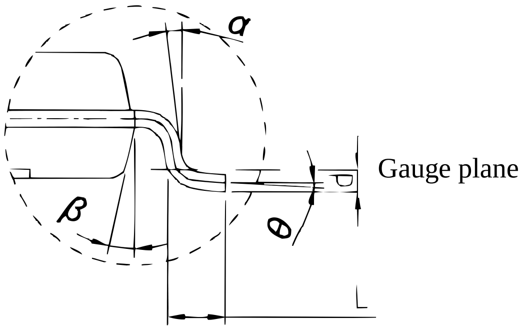
10 PACKAGE INFORMATION

10.1 Package SOP8 150MIL









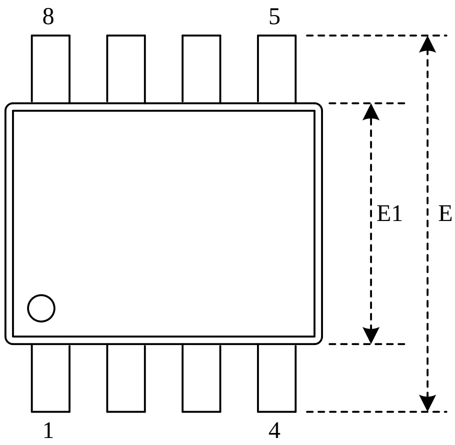
Detail "A"

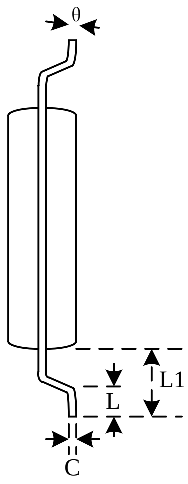
Dimensions

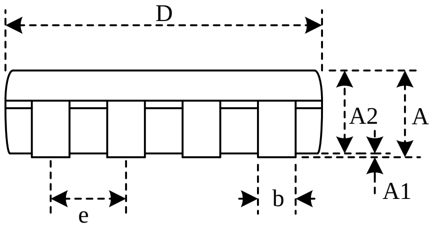
Symbol Unit		A	A1	A2	b	C	D	E	E1	e	L	L1	θ	α	β
mm	Min	1.35	0.05	1.35	0.31	0.15	4.77	5.80	3.80	-	0.40	0.85	0°	6°	11°
	Nom	-	-	-	-	-	4.90	6.00	3.90	1.27	-	1.06	-	7°	12°
	Max	1.75	0.25	1.55	0.51	0.25	5.03	6.20	4.00	-	0.90	1.27	8°	8°	13°
Inch	Min	0.053	0.002	0.053	0.012	0.006	0.188	0.228	0.149	-	0.016	0.033	0°	6°	11°
	Nom	-	-	-	0.016	-	0.193	0.236	0.154	0.050	-	0.042	-	7°	12°
	Max	0.069	0.010	0.061	0.020	0.010	0.198	0.244	0.158	-	0.035	0.050	8°	8°	13°

Note:Both package length and width include mold flash.

10.2 Package SOP8 208MIL





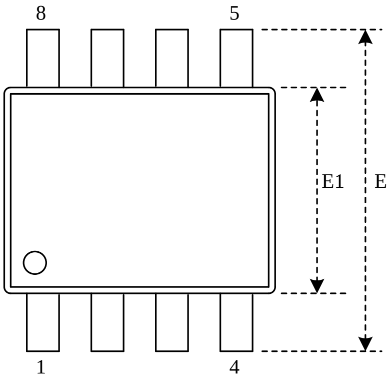


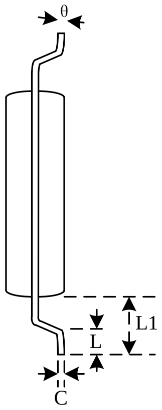
Dimensions

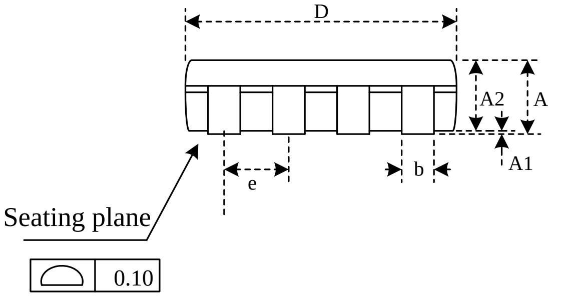
Symbol Unit		A	A1	A2	b	C	D	E	E1	e	L	L1	θ
mm	Min	1.75	0.05	1.70	0.31	0.18	5.13	7.70	5.18		0.50	1.21	0
	Nom	1.95	0.15	1.80	0.41	0.21	5.23	7.90	5.28	1.27	0.67	1.31	5
	Max	2.16	0.25	1.91	0.51	0.25	5.33	8.10	5.38		0.85	1.41	8
Inch	Min	0.069	0.002	0.067	0.012	0.007	0.202	0.303	0.204		0.020	0.048	0
	Nom	0.077	0.006	0.071	0.016	0.008	0.206	0.311	0.208	0.050	0.026	0.052	5
	Max	0.085	0.010	0.075	0.020	0.010	0.210	0.319	0.212		0.033	0.056	8

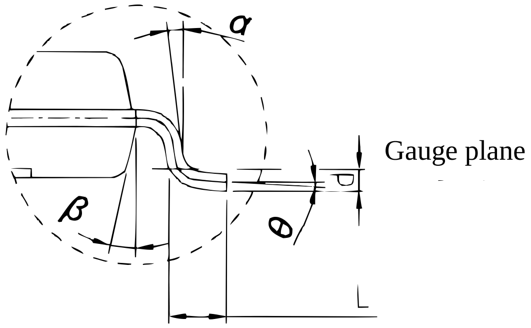
Note:Both package length and width do not include mold flash.

10.3 Package VSOP8 150MIL









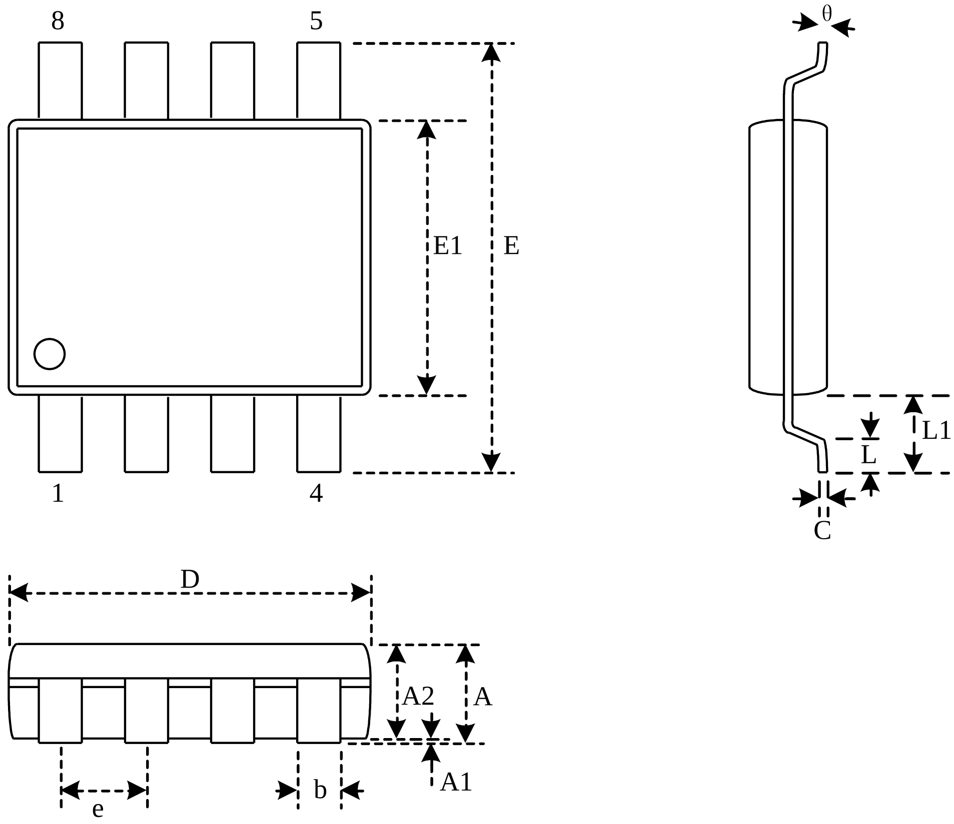
Detail "A"

Dimensions

Symbol Unit		A	A1	A2	b	C	D	E	E1	e	L	L1	θ	α	β
mm	Min	-	0.05	0.65	0.35	0.09	4.80	5.80	3.80	-	0.40	-	0°	-	-
	Nom	-	0.10	0.70	0.42	-	4.90	6.00	3.90	1.27	0.71	1.05	-	10°	10°
	Max	0.90	0.15	0.75	0.48	0.20	5.00	6.20	4.00	-	1.27	-	10°	-	-
Inch	Min	-	0.002	0.026	0.014	0.004	0.189	0.228	0.150	-	0.016	-	0°	-	-
	Nom	-	0.004	0.028	0.017	-	0.193	0.236	0.154	0.050	0.028	0.041	-	10°	10°
	Max	0.035	0.006	0.030	0.019	0.008	0.197	0.244	0.157	-	0.050	-	10°	-	-

Note:Both package length and width do not include mold flash.

10.4 Package VSOP8 208MIL

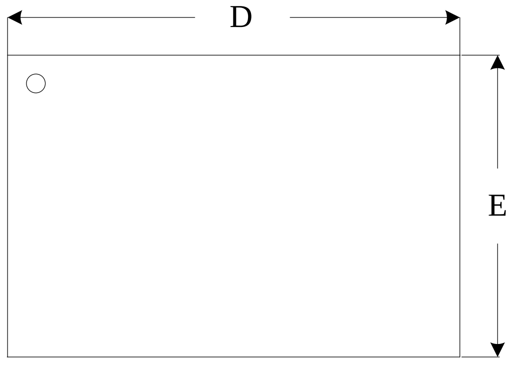


Dimensions

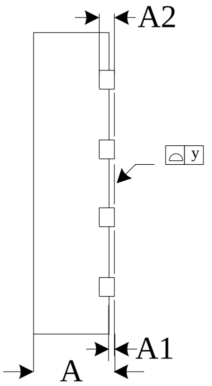
Symbol Unit		A	A1	A2	b	D	E	E1	e	L	L1	C	θ
mm	Min	0.80	0.05	0.75	0.35	5.18	7.70	5.18	-	0.50	1.31REF	0.09	0°
	Nom	0.90	0.10	0.80	0.42	5.28	7.90	5.28	1.27BSC	0.65		-	-
	Max	1.00	0.15	0.85	0.48	5.38	8.10	5.38	-	0.80		0.2	10°
Inch	Min	0.032	0.002	0.030	0.014	0.204	0.303	0.204	-	0.020	0.052REF	0.004	0°
	Nom	0.035	0.004	0.031	0.017	0.208	0.311	0.208	0.050BSC	0.026		0	-
	Max	0.04	0.006	0.033	0.019	0.212	0.319	0.212	-	0.031		0.008	10°

Note:Both package length and width include mold flash.

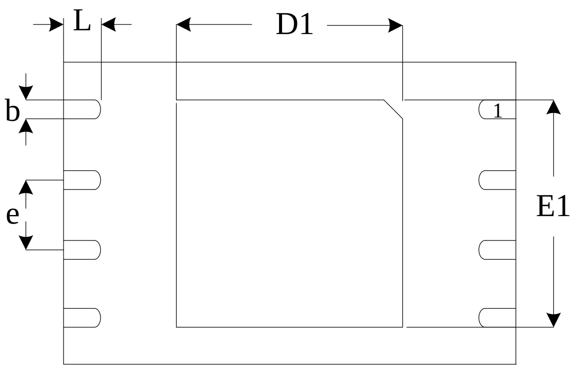
10.5 Package WSON 8 (6*5mm)



Top View



Side View



Bottom View

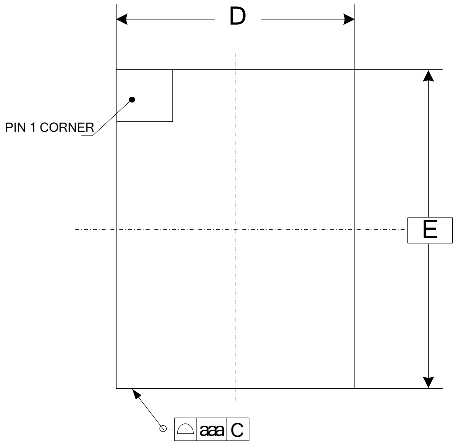
Dimensions

Symbol		A	A1	A2	b	D	D1	E	E1	e	y	L
Unit												
mm	**Min**	0.70		0.19	0.35	5.90	3.25	4.90	3.85		0.00	0.50
	Nom	0.75		0.22	0.42	6.00	3.37	5.00	3.97	1.27 BSC	0.04	0.60
	Max	0.80	0.05	0.25	0.48	6.10	3.50	5.10	4.10		0.08	0.75
Inch	**Min**	0.028		0.007	0.014	0.232	0.128	0.193	0.151		0.000	0.020
	Nom	0.030		0.009	0.016	0.236	0.133	0.197	0.156	0.05 BSC	0.001	0.024
	Max	0.032	0.002	0.010	0.019	0.240	0.138	0.201	0.161		0.003	0.030

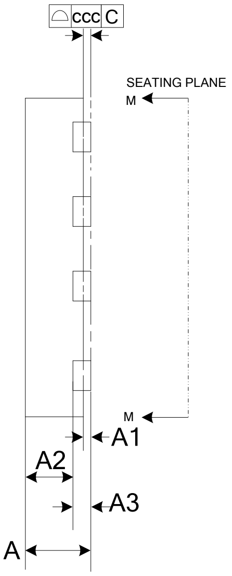
Note:

1. Both package length and width do not include mold flash.
2. The exposed metal pad area on the bottom of the package is connected to device ground (GND pin), so both Floating and connecting GND of exposed pad are also available.

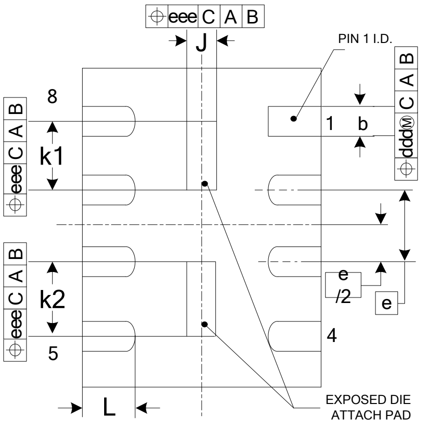
10.6 Package USON8 (3*4mm)



Top View



Side View



Bottom View

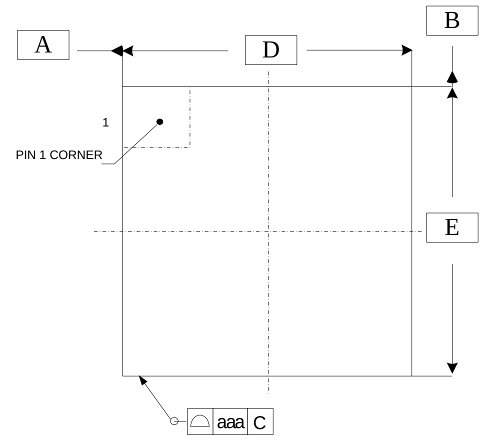
Dimensions

Symbol		A	A1	A2	A3	b	D	E	e	J	K1	K2	L
Unit													
mm	Min	0.50	0.00	0.35	0.15 REF	0.25	2.90	3.90	0.80 BSC	0.10	0.70	0.70	0.55
	Nom	0.55		0.40		0.30	3.00	4.00		0.20	0.80	0.80	0.60
	Max	0.60	0.05	0.45		0.35	3.10	4.10		0.30	0.90	0.90	0.65
Inch	Min	0.020	0.000	0.001	0.15 REF	0.010	0.114	0.153	0.80 BSC	0.000	0.002	0.002	0.001
	Nom	0.022		0.001		0.012	0.118	0.157		0.001	0.002	0.002	0.001
	Max	0.024	0.002	0.001		0.014	0.122	0.161		0.001	0.002	0.002	0.002

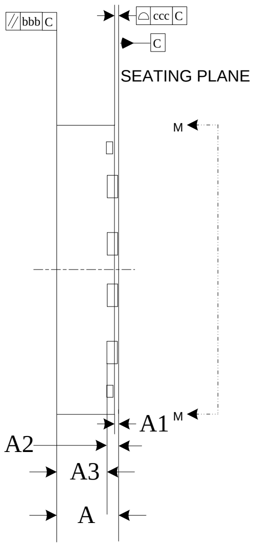
Note:

1. Both package length and width do not include mold flash.
2. The exposed metal pad area on the bottom of the package is connected to device ground (GND pin), so both Floating and connecting GND of exposed pad are also available.

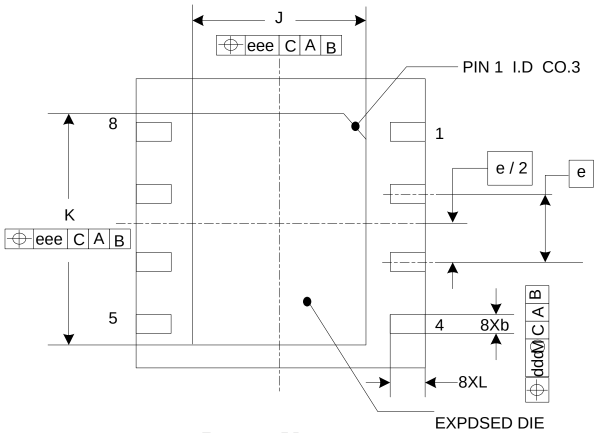
10.7 Package USON8 (4*4mm, 0.45 thickness)



Top View



Side View



Bottom View

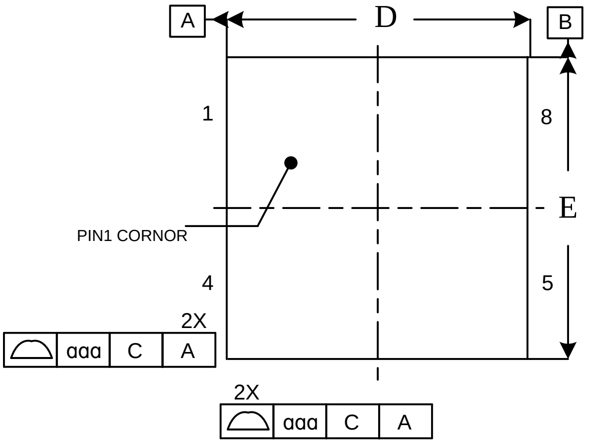
VIEW M-M

Dimensions

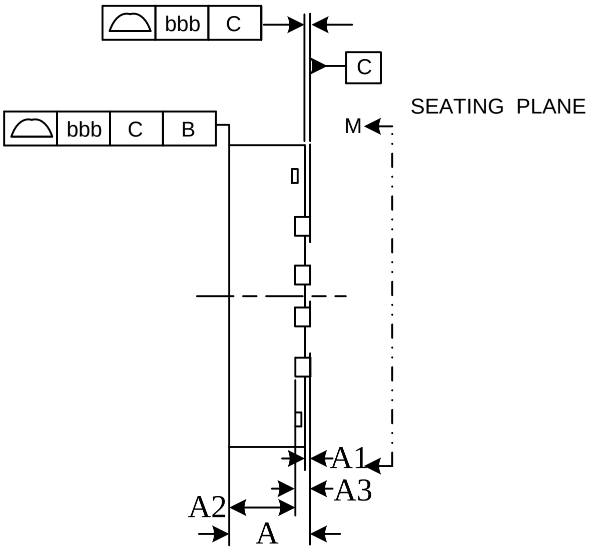
Symbol		A	A1	A2	A3	b	D	E	e	J	K	L
Unit												
mm	Min	0.40	0.00	0.15 REF	0.25	0.25	3.90	3.90	0.8 BSC	2.20	2.90	0.35
	Nom	0.45	- - -		0.30	0.30	4.00	4.00		2.30	3.00	0.40
	Max	0.50	0.05		0.35	0.35	4.10	4.10		2.40	3.10	0.45
Inch	Min	0.015	0.000		0.009	0.009	0.153	0.153		0.086	0.114	0.013
	Nom	0.017	- - -		0.011	0.011	0.157	0.157		0.090	0.118	0.015
	Max	0.019	0.001		0.013	0.013	0.161	0.161		0.094	0.122	0.017

Note:Both package length and width do not include mold flash.

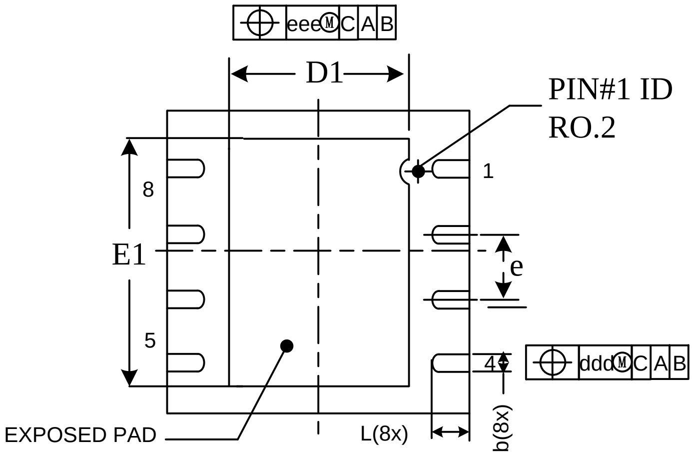
10.8 Package USON8 (3*3mm)



Top View



Side View



Bottom View

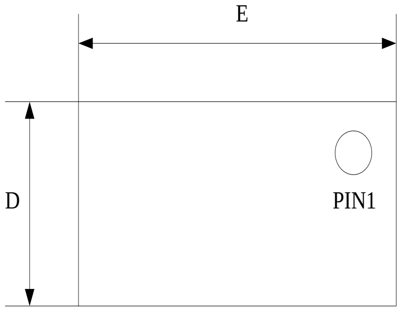
Dimensions

Symbol		A	A1	A2	A3	b	D	E	e	L	D1	E1
Unit												
mm	Min	0.40	0.00	0.25	0.15 REF	0.20	2.95	2.95	0.50 BSC	0.35	1.65	2.15
	Nom	0.45	---	0.30		0.25	3.00	3.00		0.40	1.70	2.20
	Max	0.50	0.05	0.35		0.30	3.05	3.05		0.45	1.75	2.25
Inch	Min	0.016	0.000	0.010	0.006 REF	0.008	0.116	0.116	0.020 BSC	0.014	0.065	0.085
	Nom	0.018	---	0.012		0.010	0.118	0.118		0.016	0.067	0.087
	Max	0.020	0.002	0.014		0.012	0.120	0.120		0.018	0.069	0.089

Note:

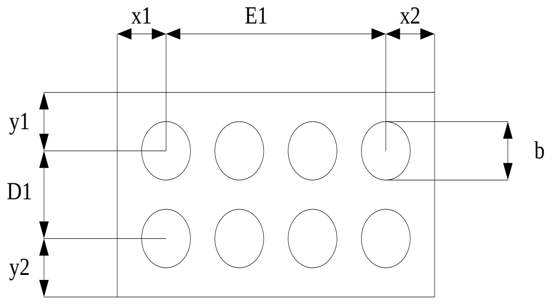
1. Both package length and width do not include mold flash.
2. The exposed metal pad area on the bottom of the package is connected to device ground (GND pin), so both Floating and connecting GND of exposed pad are also available.

10.9 Package WLCSP



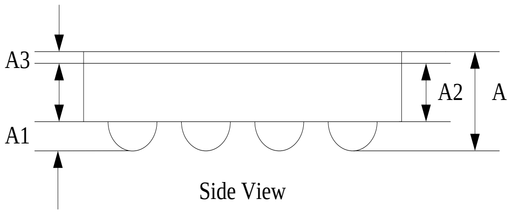
Top View

(Mark Side)



Bottom View

(Ball Side)



Side View

Dimensions

Symbol		A	A1	A2	A3	D	D1	E	E1	b	x1	x2	y1	y2
Unit														
mm	Min	0.460	0.130	0.260	0.030	1.481	0.500 BSC	2.495	1.500 BSC	0.270	0.5125 REF	0.5125 REF	0.5055 REF	0.5055 REF
	Nom	0.480	0.160	0.280	0.040	1.511		2.525		0.300				
	Max	0.500	0.190	0.300	0.050	1.541		2.555		0.330				
Inch	Min	0.018	0.005	0.010	0.001	0.058	0.020 BSC	0.098	0.059 BSC	0.012	0.020 REF	0.020 REF	0.020 REF	0.020 REF
	Nom	0.019	0.006	0.011	0.002	0.059		0.100		0.012				
	Max	0.020	0.007	0.012	0.002	0.061		0.101		0.013				

11 REVISION HISTORY

Version No	Description	Page	Date
1.0	Initial Release		May.21,2012
1.1	Update AC CHARACTERISTICS, Improve Tpp typ Update ORDERING INFORMATION		Jul.31,2012
1.2	Update AC CHARACTERISTICS, Improve Tclqx min		Feb.19,2013
1.3	Update AC CHARACTERISTICS, Tbe 32KB max 0.8s change to 1.0s, Update ORDERING INFORMATION, delete USON8 3x2mm, add USON8 4x3mm, Update PACKAGE INFORMATION, add package USON8 4x3mm		Jul. 5,2013
1.4	Update PACKAGE INFORMATION, add package VSOP8 150mil Update PACKAGE INFORMATION, package TSOP8 208mil rename to VSOP8 208mil Update ORDERING INFORMATION		Aug. 6,2013
1.5	Update ORDERING INFORMATION: add package SOP8 208mil Update PACKAGE INFORMATION: add package SOP8 208mil		Oct. 9, 2013
1.6	Update DC CHARACTERISTICS: I_{CC4}, I_{CC5}, I_{CC6}, I_{CC7} max 10Ma change to max 20Ma Update DC CHARACTERISTICS: I_{CC3} Test Condition Q=Open(*1 I/O) change to Q=Open(*1,*2,*4 I/O)		Jul. 11, 2014
1.7	Update DC CHARACTERISTICS: I_{CC4}, I_{CC5}, I_{CC6}, I_{CC7} max 20Ma change to max 25Ma		Aug. 22, 2014
1.8	Update Package SOP8 150mil Update Absolute Maximum Ratings		Sep. 10, 2014
1.9	Update Package USON8 4x4mm		May. 20,2015
2.0	Update Package WSON 8 (6*5mm) Update Package USON8 4x3mm Update Package USON8 4x4mm		Jun. 15, 2015
2.1	Add Package USON8 (4x4mm, 0.45 thickness)		July.3, 2015
2.2	Update Package SOP8 208MIL		July.14,2015
2.3	Add Package USON8 (3*3mm)		Sep.24,2015
2.4	Modify AC CHARACTERISTICS: tCHCL Min.0.2 V/ns Change to 0.1 V/ns tCLCH Min.0.2 V/ns Change to 0.1 V/ns Modify POWER-ON TIMING Modify Package USON8 (4*3mm)		Nov.11,2015
2.5	Modify POWER-ON TIMING Modify AC CHARACTERISTICS Modify ORDERING INFORMATION Add Package WLCSP		Feb.25,2016
2.6	Modify General Description Add Package WLCSP		Apr.18,2016
2.7	Modify Typo		Apr.19,2016

2.8	Modify Features: Add Data retention	P4	Jan.19,2017
	Modify Features: Add Allows XIP(execute in place)operation	P4	
	Delete Data Retention and Endurance	P56	
	Delete Latch Up Characteristics	P56	
	Modify Figure41. Input Test Waveform and Measurement Level	P56	
	Modify Storage Temperature: -55 to 125℃ Change to -65 to 150℃	P56	
	Delete Output Short Circuit Current:200mA	P56	
	Modify Applied Input/Output Voltage:-0.5 to VCC+0.5 V Change to -0.6 to VCC+0.4V	P56	
	Modify VCC:-0.5 to (VCC+2.5)V Change to -0.6 to 2.5V	P56	
	Add Transient Input/Output Volatge (note:overshoot):-2.0 to (VCC+2.0)V	P56	
	Modify AC Characteristics:Add t_{RST_R}, t_{RST_P}, t_{RST_E}	P59	
	Modify ORDERING INFORMATION	P61	
	Add Valid Part Numbers	P62	
	Update Package WOSN8(6*5mm)	P67	
	Update Package USON8(3*4mm)	P68	
	Delete Package USON8(4*4mm,0.55 thickness)	P68	
	Modify Package WLCSP Dimensions	P71	

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