EN25Q32
32 Megabit Serial Flash Memory with 4Kbyte Uniform Sector

FEATURES

- Single power supply operation
  - Full voltage range: 2.7-3.6 volt
- 32 M-bit Serial Flash
  - 32 M-bit/4096 K-byte/16384 pages
  - 256 bytes per programmable page
- Standard, Dual or Quad SPI
  - Standard SPI: CLK, CS#, DI, DO, WP#, HOLD#
  - Dual SPI: CLK, CS#, DQ_0, DQ_1, WP#, HOLD#
  - Quad SPI: CLK, CS#, DQ_0, DQ_1, DQ_2, DQ_3
- High performance
  - 100MHz clock rate for one data bit
  - 80MHz clock rate for two data bits
  - 80MHz clock rate for four data bits
- Low power consumption
  - 5 mA typical active current
  - 1 µA typical power down current
- Uniform Sector Architecture:
  - 1024 sectors of 4-Kbyte
  - 64 blocks of 64-Kbyte
  - Any sector or block can be erased individually
- Individual Block Protect/Unprotect Feature
  - Protect/Unprotect Blocks Command
- Software and Hardware Write Protection:
  - Write Protect all or portion of memory via software
  - Enable/Disable protection with WP# pin
- High performance program/erase speed
  - Page program time: 1.5ms typical
  - Sector erase time: 150ms typical
  - Block erase time 800ms typical
  - Chip erase time: 25 Seconds typical
- Lockable 512 byte OTP security sector
- Minimum 100K endurance cycle
- Package Options
  - 8 pins SOP 200mil body width
  - 8 contact VDFN
  - All Pb-free packages are RoHS compliant
- Industrial temperature Range

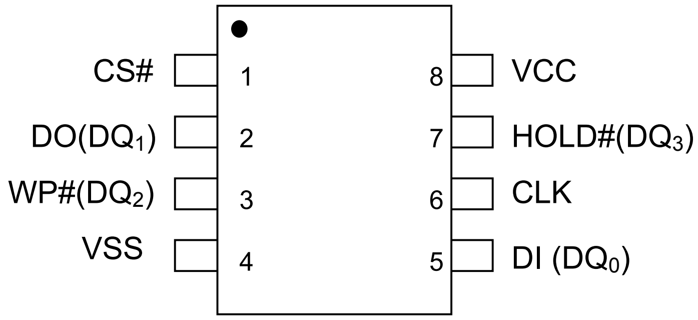
GENERAL DESCRIPTION

The EN25Q32 is a 32 Megabit (4096K-byte) Serial Flash memory, with advanced write protection mechanisms. The EN25Q32 supports the standard Serial Peripheral Interface (SPI), and a high performance Dual/Quad output as well as Dual/Quad I/O using SPI pins: Serial Clock, Chip Select, Serial DQ_0(DI), DQ_1(DO), DQ_2(WP#) and DQ_3(HOLD#). SPI clock frequencies of up to 80MHz are supported allowing equivalent clock rates of 160MHz for Dual Output and 320MHz for Quad Output when using the Dual/Quad Output Fast Read instructions. The memory can be programmed 1 to 256 bytes at a time, using the Page Program instruction.

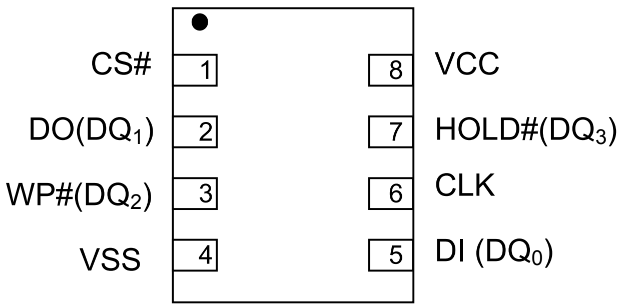
The EN25Q32 also offers a sophisticated method for protecting individual blocks against erroneous or malicious program and erase operations. By providing the ability to individually protect and unprotect blocks, a system can unprotect a specific block to modify its contents while keeping the remaining blocks of the memory array securely protected. This is useful in applications where program code is patched or updated on a subroutine or module basis, or in applications where data storage segments need to be modified without running the risk of errant modifications to the program code segments.

The EN25Q32 is designed to allow either single Sector at a time or full chip erase operation. The EN25Q32 can be configured to protect part of the memory as the software protected mode. The device can sustain a minimum of 100K program/erase cycles on each sector.

Figure.1 CONNECTION DIAGRAMS

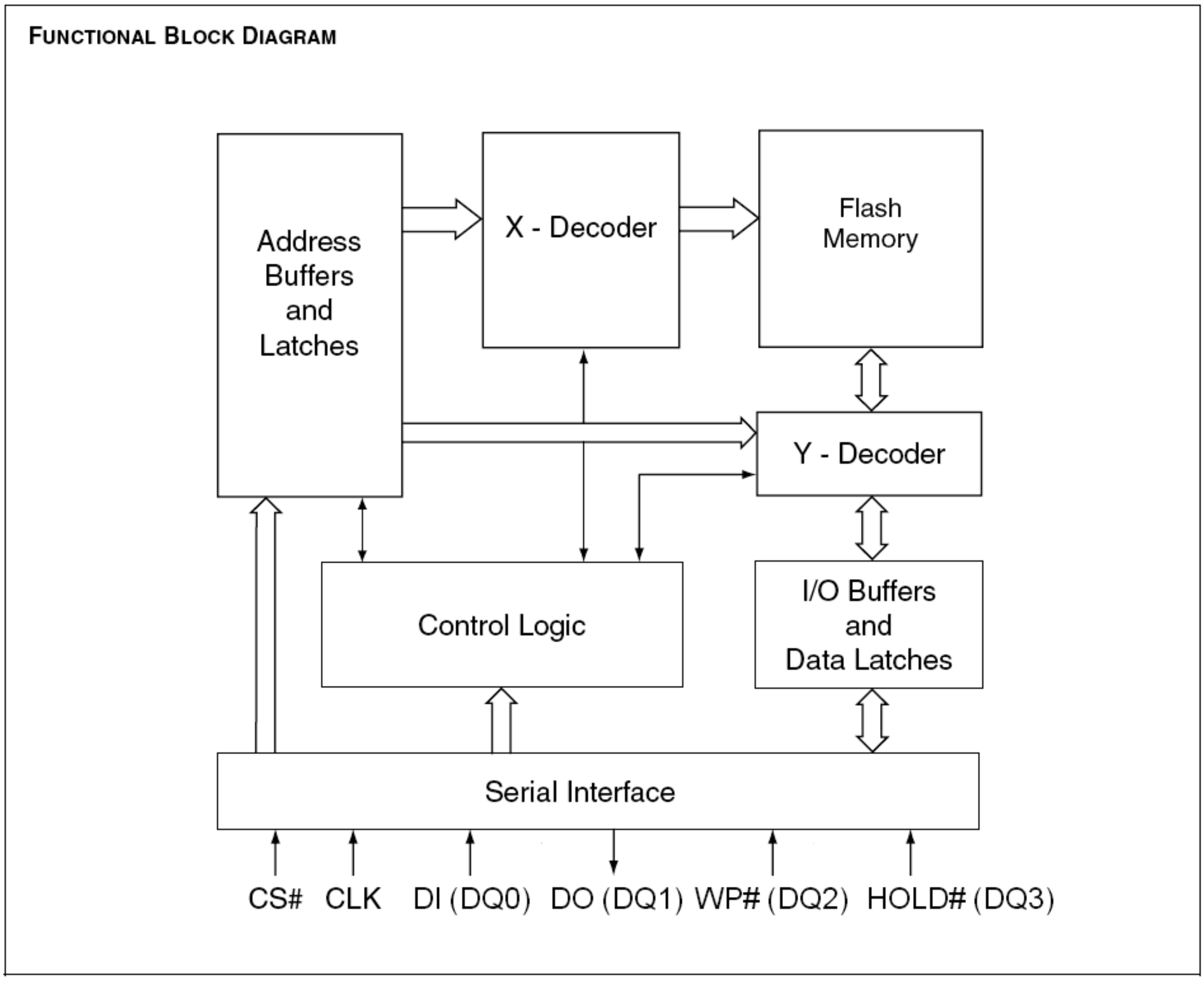


8 - LEAD SOP



8 - LEAD VDFN

Figure 2. BLOCK DIAGRAM



Note:

1. DQ_0 and DQ_1 are used for Dual and Quad instructions.
2. DQ_0 ~ DQ_3 are used for Quad instructions.

SIGNAL DESCRIPTION

Serial Data Input (DI)

The SPI Serial Data Input (DI) pin provides a means for instructions, addresses and data to be serially written to (shifted into) the device. Data is latched on the rising edge of the Serial Clock (CLK) input pin.

Serial Data Output (DO)

The SPI Serial Data Output (DO) pin provides a means for data and status to be serially read from (shifted out of) the device. Data is shifted out on the falling edge of the Serial Clock (CLK) input pin.

Serial Data IO (DQ_0, DQ_1, DQ_2, DQ_3)

Dual and Quad SPI instruction use the bidirectional IO pins to serially write instruction, addresses or data to the device on the rising edge of CLK and read data or status from the device on the falling edge of CLK.

Serial Clock (CLK)

The SPI Serial Clock Input (CLK) pin provides the timing for serial input and output operations. ("See SPI Mode")

Chip Select (CS#)

The SPI Chip Select (CS#) pin enables and disables device operation. When CS# is high the device is deselected and the Serial Data Output (DO, or DQ_0, DQ_1, DQ_2 and DQ_3) pins are at high impedance. When deselected, the devices power consumption will be at standby levels unless an internal erase, program or status register cycle is in progress. When CS# is brought low the device will be selected, power consumption will increase to active levels and instructions can be written to and data read from the device. After power-up, CS# must transition from high to low before a new instruction will be accepted.

HOLD (HOLD#)

The HOLD# pin allows the device to be paused while it is actively selected. When HOLD# is brought low, while CS# is low, the DO pin will be at high impedance and signals on the DI and CLK pins will be ignored (don't care). The HOLD# function can be useful when multiple devices are sharing the same SPI signals. The HOLD# function is only available for standard SPI and Dual SPI operation, when during Quad SPI, this pin is the Serial Data IO (DQ_3) for Quad I/O operation.

Write Protect (WP#)

The Write Protect (WP#) pin can be used to prevent the Status Register from being written. Used in conjunction with the Status Register's Block Protect (BP0, BP1and BP2) bits and Status Register Protect (SRP) bits, a portion or the entire memory array can be hardware protected. The WP# function is only available for standard SPI and Dual SPI operation, when during Quad SPI, this pin is the Serial Data IO (DQ_2) for Quad I/O operation.

Table 1. Pin Names

Symbol	Pin Name
CLK	Serial Clock Input
DI (DQ_0)	Serial Data Input (Data Input Output 0) *1
DO (DQ_1)	Serial Data Output (Data Input Output 1) *1
CS#	Chip Enable
WP# (DQ_2)	Write Protect (Data Input Output 2) *2
HOLD# (DQ_3)	Hold Input (Data Input Output 3) *2
Vcc	Supply Voltage (2.7-3.6V)
Vss	Ground
NC	No Connect

Note:
*1. DQ_0 and DQ_1 are used for Dual and Quad instructions.
*2. DQ_0 ~ DQ_3 are used for Quad instructions.

MEMORY ORGANIZATION

The memory is organized as:

- 4,194,304 bytes
- Uniform Sector Architecture
  64 blocks of 64-Kbyte
  1024 sectors of 4-Kbyte
- 16384 pages (256 bytes each)

Each page can be individually programmed (bits are programmed from 1 to 0). The device is Sector, Block or Chip Erasable but not Page Erasable.

Table 2. Uniform Block Sector Architecture (Continued)

Block	Sector	Address range	
63	1023	3FF000h	3FFFFFh
	⋮	⋮	⋮
	1008	3F0000h	3F0FFFh
62	1007	3EF000h	3EFFFFh
	⋮	⋮	⋮
	992	3E0000h	3E0FFFh
61	991	3DF000h	3DFFFFh
	⋮	⋮	⋮
	976	3D0000h	3D0FFFh
60	975	3CF000h	3CFFFFh
	⋮	⋮	⋮
	960	3C0000h	3C0FFFh
59	959	3BF000h	3BFFFFh
	⋮	⋮	⋮
	944	3B0000h	3B0FFFh
58	943	3AF000h	3AFFFFh
	⋮	⋮	⋮
	928	3A0000h	3A0FFFh
57	927	39F000h	39FFFFh
	⋮	⋮	⋮
	912	390000h	390FFFh
56	911	38F000h	38FFFFh
	⋮	⋮	⋮
	896	380000h	380FFFh
55	895	37F000h	37FFFFh
	⋮	⋮	⋮
	880	370000h	370FFFh
54	879	36F000h	36FFFFh
	⋮	⋮	⋮
	864	360000h	360FFFh
53	863	35F000h	35FFFFh
	⋮	⋮	⋮
	848	350000h	350FFFh
52	847	34F000h	34FFFFh
	⋮	⋮	⋮
	832	340000h	340FFFh
51	831	33F000h	33FFFFh
	⋮	⋮	⋮
	816	330000h	330FFFh
50	815	32F000h	32FFFFh
	⋮	⋮	⋮
	800	320000h	320FFFh
49	799	31F000h	31FFFFh
	⋮	⋮	⋮
	784	310000h	310FFFh
48	783	30F000h	30FFFFh
	⋮	⋮	⋮
	768	300000h	300FFFh
47	767	2FF000h	2FFFFFh
	⋮	⋮	⋮
	752	2F0000h	2F0FFFh
46	751	2EF000h	2EFFFFh
	⋮	⋮	⋮
	736	2E0000h	2E0FFFh
45	735	2DF000h	2DFFFFh
	⋮	⋮	⋮
	720	2D0000h	2D0FFFh
44	719	2CF000h	2CFFFFh
	⋮	⋮	⋮
	704	2C0000h	2C0FFFh
43	703	2BF000h	2BFFFFh
	⋮	⋮	⋮
	688	2B0000h	2B0FFFh

Table 2. Uniform Block Sector Architecture (Continued)

Block	Sector	Address range	
42	687	2AF000h	2AFFFFh
	⋮	⋮	⋮
	672	2A0000h	2A0FFFh
41	671	29F000h	29FFFFh
	⋮	⋮	⋮
	656	290000h	290FFFh
40	655	28F000h	28FFFFh
	⋮	⋮	⋮
	640	280000h	280FFFh
39	639	27F000h	27FFFFh
	⋮	⋮	⋮
	624	270000h	270FFFh
38	623	26F000h	26FFFFh
	⋮	⋮	⋮
	608	260000h	260FFFh
37	607	25F000h	25FFFFh
	⋮	⋮	⋮
	592	250000h	250FFFh
36	591	24F000h	24FFFFh
	⋮	⋮	⋮
	576	240000h	240FFFh
35	575	23F000h	23FFFFh
	⋮	⋮	⋮
	560	230000h	230FFFh
34	559	22F000h	22FFFFh
	⋮	⋮	⋮
	544	220000h	220FFFh
33	543	21F000h	21FFFFh
	⋮	⋮	⋮
	528	210000h	210FFFh
32	527	20F000h	20FFFFh
	⋮	⋮	⋮
	512	200000h	200FFFh
31	511	1FF000h	1FFFFFh
	⋮	⋮	⋮
	496	1F0000h	1F0FFFh
30	495	1EF000h	1EFFFFh
	⋮	⋮	⋮
	480	1E0000h	1E0FFFh
29	479	1DF000h	1DFFFFh
	⋮	⋮	⋮
	464	1D0000h	1D0FFFh
28	463	1CF000h	1CFFFFh
	⋮	⋮	⋮
	448	1C0000h	1C0FFFh
27	447	1BF000h	1BFFFFh
	⋮	⋮	⋮
	432	1B0000h	1B0FFFh
26	431	1AF000h	1AFFFFh
	⋮	⋮	⋮
	416	1A0000h	1A0FFFh
25	415	19F000h	19FFFF
	⋮	⋮	⋮
	400	190000h	190FFFh
24	399	18F000h	18FFFFh
	⋮	⋮	⋮
	384	180000h	180FFFh
23	383	17F000h	17FFFFh
	⋮	⋮	⋮
	368	170000h	170FFFh
22	367	16F000h	16FFFFh
	⋮	⋮	⋮
	352	160000	160FFFh

Table 2. Uniform Block Sector Architecture (Continued)

Block	Sector	Address range	
21	351	15F000	15FFFFh
	⋮	⋮	⋮
	336	150000h	150FFFh
20	335	14F000h	14FFFFh
	⋮	⋮	⋮
	320	140000h	140FFFh
19	319	13F000h	13FFFFh
	⋮	⋮	⋮
	304	130000h	130FFFh
18	303	12F000h	12FFFFh
	⋮	⋮	⋮
	288	120000h	120FFFh
17	287	11F000h	11FFFFh
	⋮	⋮	⋮
	272	110000h	110FFFh
16	271	10F000h	10FFFFh
	⋮	⋮	⋮
	256	100000h	100FFFh
15	255	0FF000h	0FFFFFh
	⋮	⋮	⋮
	240	0F0000h	0F0FFFh
14	239	0EF000h	0EFFFFh
	⋮	⋮	⋮
	224	0E0000h	0E0FFFh
13	223	0DF000h	0DFFFFh
	⋮	⋮	⋮
	208	0D0000h	0D0FFFh
12	207	0CF000h	0CFFFFh
	⋮	⋮	⋮
	192	0C0000h	0C0FFFh
11	191	0BF000h	0BFFFFh
	⋮	⋮	⋮
	176	0B0000h	0B0FFFh
10	175	0AF000h	0AFFFFh
	⋮	⋮	⋮
	160	0A0000h	0A0FFFh
9	159	09F000h	09FFFFh
	⋮	⋮	⋮
	144	090000h	090FFFh
8	143	08F000h	08FFFFh
	⋮	⋮	⋮
	128	080000h	080FFFh
7	127	07F000h	07FFFFh
	⋮	⋮	⋮
	112	070000h	070FFFh
6	111	06F000h	06FFFFh
	⋮	⋮	⋮
	96	060000h	060FFFh
5	95	05F000h	05FFFFh
	⋮	⋮	⋮
	80	050000h	050FFFh
4	79	04F000h	04FFFFh
	⋮	⋮	⋮
	64	040000h	040FFFh
3	63	03F000h	03FFFFh
	⋮	⋮	⋮
	48	030000h	030FFFh
2	47	02F000h	02FFFFh
	⋮	⋮	⋮
	32	020000h	020FFFh

Table 2. Uniform Block Sector Architecture (End)

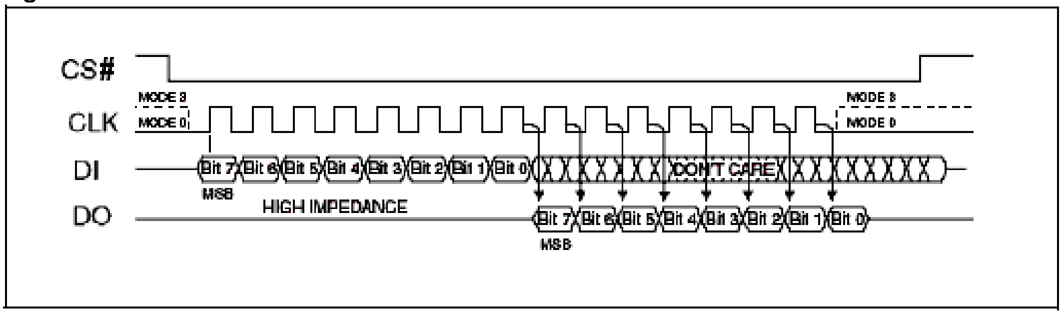
Block	Sector	Address range	
1	31	01F000h	01FFFFh
	⋮	⋮	⋮
	16	010000h	010FFFh
0	15	00F000h	00FFFFh
	⋮	⋮	⋮
	4	004000h	004FFFh
	3	003000h	003FFFh
	2	002000h	002FFFh
	1	001000h	001FFFh
	0	000000h	000FFFh

OPERATING FEATURES

Standard SPI Modes

The EN25Q32 is accessed through an SPI compatible bus consisting of four signals: Serial Clock (CLK), Chip Select (CS#), Serial Data Input (DI) and Serial Data Output (DO). Both SPI bus operation Modes 0 (0,0) and 3 (1,1) are supported. The primary difference between Mode 0 and Mode 3, as shown in Figure 3, concerns the normal state of the CLK signal when the SPI bus master is in standby and data is not being transferred to the Serial Flash. For Mode 0 the CLK signal is normally low. For Mode 3 the CLK signal is normally high. In either case data input on the DI pin is sampled on the rising edge of the CLK. Data output on the DO pin is clocked out on the falling edge of CLK.

Figure 3. SPI Modes



Dual SPI Instruction

The EN25Q32 supports Dual SPI operation when using the " Dual Output Fast Read and Dual I/ O FAST_READ " (3Bh and BBh) instructions. These instructions allow data to be transferred to or from the Serial Flash memory at two to three times the rate possible with the standard SPI. The Dual Read instructions are ideal for quickly downloading code from Flash to RAM upon power-up (code-shadowing) or for application that cache code-segments to RAM for execution. The Dual output feature simply allows the SPI input pin to also serve as an output during this instruction. When using Dual SPI instructions the DI and DO pins become bidirectional I/O pins; DQ_0 and DQ_1. All other operations use the standard SPI interface with single output signal.

Quad Output SPI Instruction

The EN25Q32 supports Quad output operation when using the Quad I/O Fast Read (EBh). This instruction allows data to be transferred to or from the Serial Flash memory at four to six times the rate possible with the standard SPI. The Quad Read instruction offer a significant improvement in continuous and random access transfer rates allowing fast code-shadowing to RAM or for application that cache code-segments to RAM for execution. When using Quad SPI instruction the DI and DO pins become bidirectional I/O pins; DQ_0 and DQ_1, and the WP# and HOLD# pins become DQ_2 and DQ_3 respectively.

Page Programming

To program one data byte, two instructions are required: Write Enable (WREN), which is one byte, and a Page Program (PP) sequence, which consists of four bytes plus data. This is followed by the internal Program cycle (of duration t_{PP}).
To spread this overhead, the Page Program (PP) instruction allows up to 256 bytes to be programmed at a time (changing bits from 1 to 0) provided that they lie in consecutive addresses on the same page of memory.

Sector Erase, Block Erase and Chip Erase

The Page Program (PP) instruction allows bits to be reset from 1 to 0. Before this can be applied, the bytes of memory need to have been erased to all 1s (FFh). This can be achieved a sector at a time, using the Sector Erase (SE) instruction, a block at a time using the Block Erase (BE) instruction or throughout the entire memory, using the Chip Erase (CE) instruction. This starts an internal Erase cycle (of duration t_{SE} t_{BE} or t_{CE}). The Erase instruction must be preceded by a Write Enable (WREN) instruction.

Polling During a Write, Program or Erase Cycle

A further improvement in the time to Write Status Register (WRSR), Program (PP) or Erase (SE, BE or CE) can be achieved by not waiting for the worst case delay (t_W, t_{PP}, t_{SE}, t_{BE} or t_{CE}). The Write In Progress (WIP) bit is provided in the Status Register so that the application program can monitor its value, polling it to establish when the previous Write cycle, Program cycle or Erase cycle is complete.

Active Power, Stand-by Power and Deep Power-Down Modes

When Chip Select (CS#) is Low, the device is enabled, and in the Active Power mode. When Chip Select (CS#) is High, the device is disabled, but could remain in the Active Power mode until all internal cycles have completed (Program, Erase, Write Status Register). The device then goes into the Stand-by Power mode. The device consumption drops to I_{CC1}.
The Deep Power-down mode is entered when the specific instruction (the Enter Deep Power-down Mode (DP) instruction) is executed. The device consumption drops further to I_{CC2}. The device remains in this mode until another specific instruction (the Release from Deep Power-down Mode and Read Device ID (RDI) instruction) is executed.
All other instructions are ignored while the device is in the Deep Power-down mode. This can be used as an extra software protection mechanism, when the device is not in active use, to protect the device from inadvertent Write, Program or Erase instructions.

Status Register. The Status Register contains a number of status and control bits that can be read or set (as appropriate) by specific instructions.
WIP bit. The Write In Progress (WIP) bit indicates whether the memory is busy with a Write Status Register, Program or Erase cycle.

WEL bit. The Write Enable Latch (WEL) bit indicates the status of the internal Write Enable Latch.

BP2, BP1, BP0 bits. The Block Protect (BP2, BP1, BP0) bits are non-volatile. They define the size of the area to be software protected against Program and Erase instructions.

SRP bit / OTP_LOCK bit The Status Register Protect (SRP) bit operates in conjunction with the Write Protect (WP#) signal. The Status Register Protect (SRP) bit and Write Protect (WP#) signal allow the device to be put in the Hardware Protected mode. In this mode, the non-volatile bits of the Status Register (SRP, BP2, BP1, BP0) become read-only bits.

In OTP mode, this bit serves as OTP_LOCK bit, user can read/program/erase OTP sector as normal sector while OTP_LOCK value is equal 0, after OTP_LOCK is programmed with 1 by WRSR command, the OTP sector is protected from program and erase operation. The OTP_LOCK bit can only be programmed once.

Note : In OTP mode, the WRSR command will ignore any input data and program OTP_LOCK bit to 1, user must clear the protect bits before entering OTP mode and program the OTP code, then execute WRSR command to lock the OTP sector before leaving OTP mode.

Write Protection

Applications that use non-volatile memory must take into consideration the possibility of noise and other adverse system conditions that may compromise data integrity. To address this concern the EN25Q32 provides the following data protection mechanisms:

- Power-On Reset and an internal timer (t_{PUW}) can provide protection against inadvertent changes while the power supply is outside the operating specification.
- Program, Erase and Write Status Register instructions are checked that they consist of a number of clock pulses that is a multiple of eight, before they are accepted for execution.
- All instructions that modify data must be preceded by a Write Enable (WREN) instruction to set the Write Enable Latch (WEL) bit . This bit is returned to its reset state by the following events:
  – Power-up
  – Write Disable (WRDI) instruction completion or Write Status Register (WRSR) instruction completion or Page Program (PP) instruction completion or Sector Erase (SE) instruction completion or Block Erase (BE) instruction completion or Chip Erase (CE) instruction completion
- The Block Protect (BP2, BP1, BP0) bits allow part of the memory to be configured as read-only. This is the Software Protected Mode (SPM).
- The Write Protect (WP#) signal allows the Block Protect (BP2, BP1, BP0) bits and Status Register Protect (SRP) bit to be protected. This is the Hardware Protected Mode (HPM).
- In addition to the low power consumption feature, the Deep Power-down mode offers extra software protection from inadvertent Write, Program and Erase instructions, as all instructions are ignored except one particular instruction (the Release from Deep Power-down instruction).

Table 3. Protected Area Sizes Sector Organization

Status Register Content			Memory Content			
BP2 Bit	**BP1 Bit**	**BP0 Bit**	**Protect Blocks**	**Addresses**	**Density(KB)**	**Portion**
0	0	0	None	None	None	None
0	0	1	Block 63	3F0000h-3FFFFFh	64KB	Upper 1/64
0	1	0	Block 62 to 63	3E0000h-3FFFFFh	128KB	Upper 1/32
0	1	1	Block 60 to 63	3C0000h-3FFFFFh	256KB	Upper 1/16
1	0	0	Block 56 to 63	380000h-3FFFFFh	512KB	Upper 1/8
1	0	1	Block 48 to 63	300000h-3FFFFFh	1024KB	Upper 1/4
1	1	0	Block 32 to 63	200000h-3FFFFFh	2048KB	Upper 1/2
1	1	1	All	000000h-3FFFFFh	4096KB	All

Hold Function

The Hold (HOLD#) signal is used to pause any serial communications with the device without resetting the clocking sequence. However, taking this signal Low does not terminate any Write Status Register, Program or Erase cycle that is currently in progress.

To enter the Hold condition, the device must be selected, with Chip Select (CS#) Low. The Hold condition starts on the falling edge of the Hold (HOLD#) signal, provided that this coincides with Serial Clock (CLK) being Low (as shown in Figure 4.).

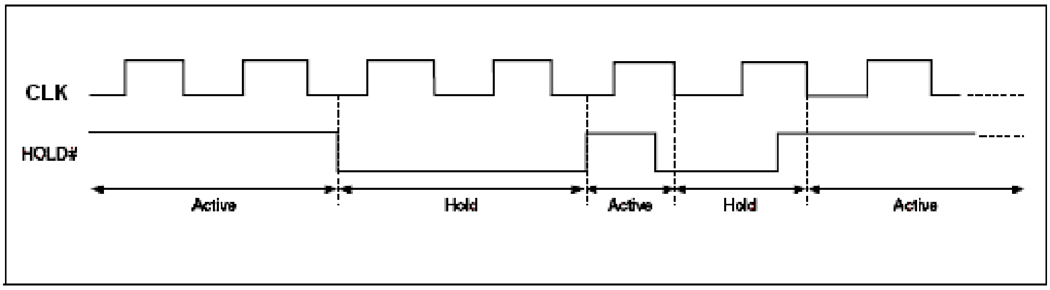
The Hold condition ends on the rising edge of the Hold (HOLD#) signal, provided that this coincides with Serial Clock (CLK) being Low.

If the falling edge does not coincide with Serial Clock (CLK) being Low, the Hold condition starts after Serial Clock (CLK) next goes Low. Similarly, if the rising edge does not coincide with Serial Clock (CLK) being Low, the Hold condition ends after Serial Clock (CLK) next goes Low. (This is shown in Figure 4.).

During the Hold condition, the Serial Data Output (DO) is high impedance, and Serial Data Input (DI) and Serial Clock (CLK) are Don't Care.

Normally, the device is kept selected, with Chip Select (CS#) driven Low, for the whole duration of the Hold condition. This is to ensure that the state of the internal logic remains unchanged from the moment of entering the Hold condition.
If Chip Select (CS#) goes High while the device is in the Hold condition, this has the effect of resetting the internal logic of the device. To restart communication with the device, it is necessary to drive Hold (HOLD#) High, and then to drive Chip Select (CS#) Low. This prevents the device from going back to the Hold condition.

Figure 4. Hold Condition Waveform



INSTRUCTIONS

All instructions, addresses and data are shifted in and out of the device, most significant bit first. Serial Data Input (DI) is sampled on the first rising edge of Serial Clock (CLK) after Chip Select (CS#) is driven Low. Then, the one-byte instruction code must be shifted in to the device, most significant bit first, on Serial Data Input (DI), each bit being latched on the rising edges of Serial Clock (CLK).

The instruction set is listed in Table 4. Every instruction sequence starts with a one-byte instruction code. Depending on the instruction, this might be followed by address bytes, or by data bytes, or by both or none. Chip Select (CS#) must be driven High after the last bit of the instruction sequence has been shifted in. In the case of a Read Data Bytes (READ), Read Data Bytes at Higher Speed (Fast_Read), Read Status Register (RDSR) or Release from Deep Power-down, and Read Device ID (RDI) instruction, the shifted-in instruction sequence is followed by a data-out sequence. Chip Select (CS#) can be driven High after any bit of the data-out sequence is being shifted out.

In the case of a Page Program (PP), Sector Erase (SE), Block Erase (BE), Chip Erase (CE), Write Status Register (WRSR), Write Enable (WREN), Write Disable (WRDI) or Deep Power-down (DP) instruction, Chip Select (CS#) must be driven High exactly at a byte boundary, otherwise the instruction is rejected, and is not executed. That is, Chip Select (CS#) must driven High when the number of clock pulses after Chip Select (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.

In the case of multi-byte commands of Page Program (PP), and Release from Deep Power Down (RES) minimum number of bytes specified has to be given, without which, the command will be ignored.

In the case of Page Program, if the number of byte after the command is less than 4 (at least 1 data byte), it will be ignored too. In the case of SE and BE, exact 24-bit address is a must, any less or more will cause the command to be ignored.

All attempts to access the memory array during a Write Status Register cycle, Program cycle or Erase cycle are ignored, and the internal Write Status Register cycle, Program cycle or Erase cycle continues unaffected.

Table 4A. Instruction Set

Instruction Name	Byte 1 Code	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	n-Bytes
Write Enable	06h						
Write Disable / Exit OTP mode	04h						
Protect Block	36h	A23-A16	A15-A8	A7-A0			
Unprotect Block	39h	A23-A16	A15-A8	A7-A0			
Read Block Protection Registers	3Ch	A23-A16	A15-A8	A7-A0	(BR7-BR0)(1)		continuous(2)
Read Status Register	05h	(S7-S0)(3)					continuous(4)
Write Status Register	01h	S7-S0					
Page Program	02h	A23-A16	A15-A8	A7-A0	D7-D0	Next byte	continuous
Sector Erase	20h	A23-A16	A15-A8	A7-A0			
Block Erase	D8h/ 52h	A23-A16	A15-A8	A7-A0			
Chip Erase	C7h/ 60h						
Deep Power-down	B9h						
Release from Deep Power-down, and read Device ID	ABh	dummy	dummy	dummy	(ID7-ID0)		(5)
Release from Deep Power-down							
Manufacturer/ Device ID	90h	dummy	dummy	00h(6)	(M7-M0)	(ID7-ID0)	
Read Identification	9Fh	(M7-M0)	(ID15-ID8)	(ID7-ID0)	(7)		
Enter OTP mode	3Ah						

Notes:
1. (BR7-BR0) : The output data of block protection register.
2. The Block Protection Registers contents will repeat continuously until CS# terminates the instruction.
3. Data bytes are shifted with Most Significant Bit first. Byte fields with data in parenthesis "( )" indicate data being read from the device on the DO pin.
4. The Status Register contents will repeat continuously until CS# terminate the instruction.
5. The Device ID will repeat continuously until CS# terminates the instruction.
6. The Manufacturer ID and Device ID bytes will repeat continuously until CS# terminates the instruction.
   00h on Byte 4 starts with MID and alternate with DID, 01h on Byte 4 starts with DID and alternate with MID.
7. (M7-M0) : Manufacturer, (ID15-ID8) : Memory Type, (ID7-ID0) : Memory Capacity.

Table 4B. Instruction Set (Read Instruction)

Instruction Name	Byte 1 Code	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	n-Bytes
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)	(Next Byte) continuous
Dual Output Fast Read	3Bh	A23-A16	A15-A8	A7-A0	dummy	(D7-D0, …) (1)	(one byte per 4 clocks, continuous)
Dual I/O Fast Read	BBh	A23-A8(2)	A7-A0, dummy (2)	(D7-D0, …) (1)			(one byte per 4 clocks, continuous)
Quad I/O Fast Read	EBh	A23-A0, dummy (4)	(dummy, D7-D0) (5)	(D7-D0, …) (3)			(one byte per 2 clocks, continuous)

Notes:

1. Dual Output data
   DQ_0 = (D6, D4, D2, D0)
   DQ_1 = (D7, D5, D3, D1)

2. Dual Input Address
   DQ_0 = A22, A20, A18, A16, A14, A12, A10, A8 ; A6, A4, A2, A0, dummy 6, dummy 4, dummy 2, dummy 0
   DQ_1 = A23, A21, A19, A17, A15, A13, A11, A9 ; A7, A5, A3, A1, dummy 7, dummy 5, dummy 3, dummy 1

3. Quad Data
   DQ_0 = (D4, D0, ……)
   DQ_1 = (D5, D1, ……)
   DQ_2 = (D6, D2, …...)
   DQ_3 = (D7, D3, …...)

4. Quad Input Address
   DQ_0 = A20, A16, A12, A8, A4, A0, dummy 4, dummy 0
   DQ_1 = A21, A17, A13, A9, A5, A1, dummy 5, dummy 1
   DQ_2 = A22, A18, A14, A10, A6, A2, dummy 6, dummy 2
   DQ_3 = A23, A19, A15, A11, A7, A3, dummy 7, dummy 3

5. Quad I/O Fast Read Data
   DQ_0 = (dummy 12, dummy 8, dummy 4, dummy 0, D4, D0)
   DQ_1 = (dummy 13, dummy 9, dummy 5, dummy 1, D5, D1)
   DQ_2 = (dummy 14, dummy 10, dummy 6, dummy 2, D6, D2)
   DQ_3 = (dummy 15, dummy 11, dummy 7, dummy 3, D7, D3)

Table 5. Manufacturer and Device Identification

OP Code	(M7-M0)	(ID15-ID0)	(ID7-ID0)
ABh			15h
90h	1Ch		15h
9Fh	1Ch	3316h	

Write Enable (WREN) (06h)

The Write Enable (WREN) instruction (Figure 5) sets 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) and Write Status Register (WRSR) instruction.
The Write Enable (WREN) instruction is entered by driving Chip Select (CS#) Low, sending the instruction code, and then driving Chip Select (CS#) High.

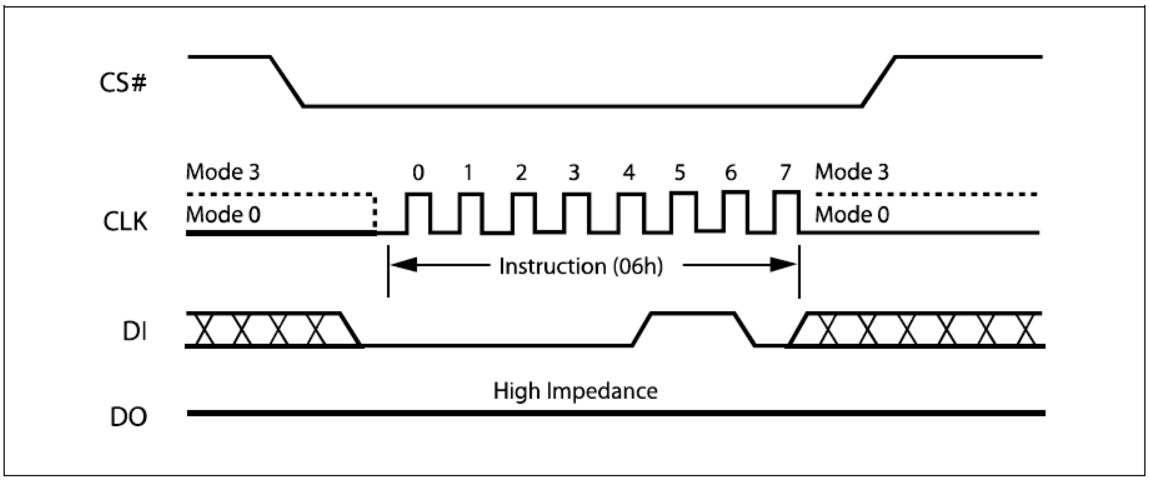


Figure 5. Write Enable Instruction Sequence Diagram

Write Disable (WRDI) (04h)

The Write Disable instruction (Figure 6) resets the Write Enable Latch (WEL) bit in the Status Register to a 0 or exit from OTP mode to normal mode. The Write Disable instruction is entered by driving Chip Select (CS#) low, shifting the instruction code “04h” into the DI pin and then driving Chip Select (CS#) high. Note that the WEL bit is automatically reset after Power-up and upon completion of the Write Status Register, Page Program, Sector Erase, Block Erase (BE) and Chip Erase instructions.

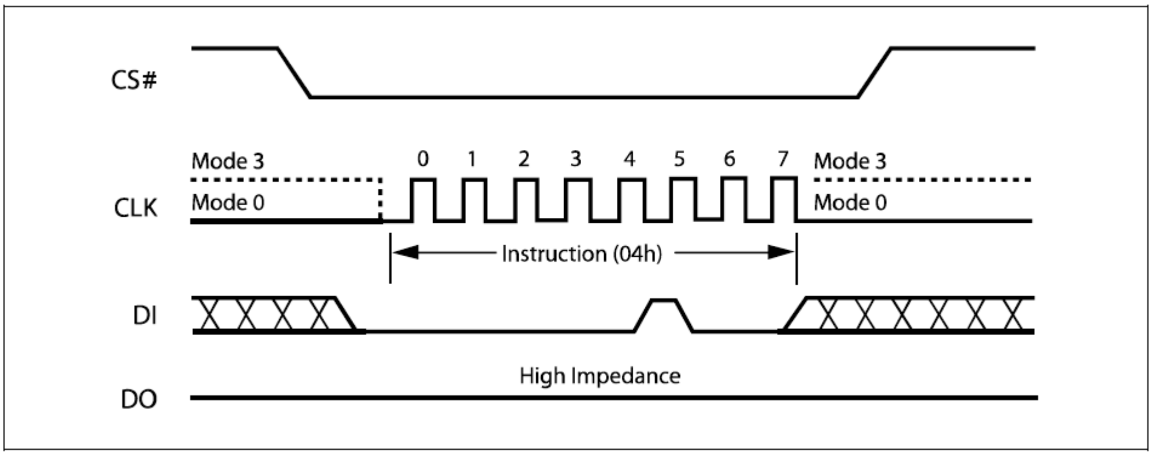


Figure 6. Write Disable Instruction Sequence Diagram

Protect Block (36h)

Every physical block of the device has a corresponding single-bit Block Protection Register that is used to control the software protection of a block. Upon device power-up or after a device reset, each Block Protection Register will default to the logical “0” state indicating that all blocks are unprotected and can be programmed or erased.

Issuing the Protect Block command to a particular block address will set the corresponding Block Protection Register to the logical “1” state. The following table outlines the two states of the Block Protection Registers.

Table 6. Block Protection Register Values

Value	Block Protection Status
0	Block is unprotected and can be programmed and erased.
1	Block is protected and cannot be programmed or erase. This is the default state.

Before the Protect Block command can be issued, the Write Enable command must have been previously issued to set the WEL bit in the Status Register to a logical “1”. The instruction sequence is shown in Figure 7. To issue the Protect Block command, the CS# pin must first be asserted and the instruction of 36h must be clocked into the device followed by three address bytes designating any address within the block to be locked. Any additional data clocked into device will be ignored. When the CS# pin is deasserted, the Block Protection Register corresponding to the physical block addressed by A23-A0 will be set to the logical “1” state, and the block itself will then be protected from program and erase operations. In addition, the WEL bit in the Status Register will be reset back to the logical “0” state.

The complete three address bytes must be clocked into the device before the CS# pin is deasserted; otherwise, the device will abort the operation, the state of the Block Protection Register will be unchanged, and the WEL bit in the Status Register will be reset to a logical “0”.

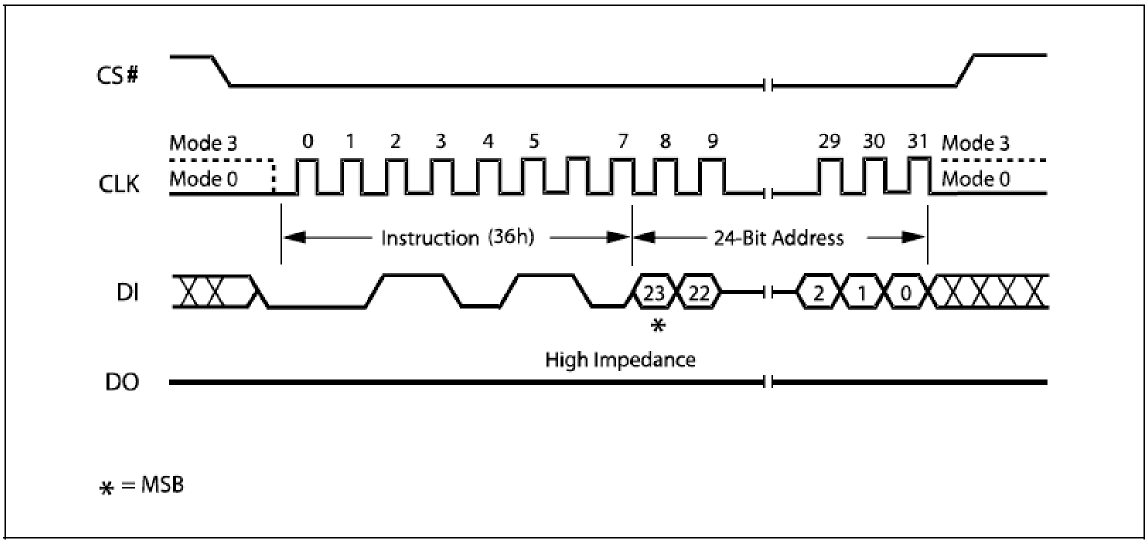


Figure 7. Protect Block

Unprotect Block (39h)

Issuing the Unprotect Block command to a particular block address will reset the corresponding Block Protection Register to the logical “0” state (see Table 6 for Block Protection Register Values). Every physical block of the device has a corresponding single-bit Block Protection Register that is used to control the software protection of a block.

Before the Unprotect Block command can be issued, the Write Enable Command must have been previously issued to set the WEL bit in the Status Register to a logical “1”. The instruction sequence is shown in Figure 8. To issue the Unprotect Block command, the CS# pin must first be asserted and the instruction of 39h must be clocked into the device. After the instruction of 39h clocked in, the three address bytes designating any address within the block to be unlocked must be clocked in. Any additional data clocked into the device after the address bytes will be ignored. When CS# pin is deasserted, the Block Protection Register corresponding to the block addressed by A23-A0 will be reset to the logical “0” state, and the block itself will be unprotected. In addition, the WEL bit in the Status Register will be reset back to the logical “0” state.

The complete three address bytes must be clocked into the device before the CS# pin is deasserted; otherwise, the device will abort the operation, the state of the Block Protection Register will be unchanged, and the WEL bit in the Status Register will be reset to a logical “0”.

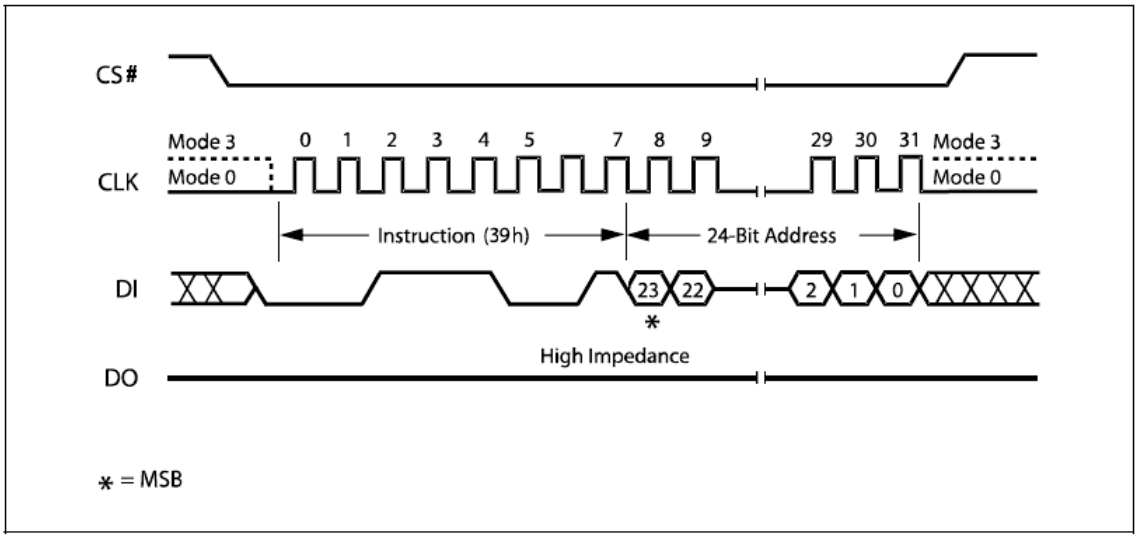


Figure 8. Unprotect Block

Read Block Protection Registers (3Ch)

The Block Protection Registers can be read to determine the current software protection status of each block. Reading the Block Protection Registers, however, will not determine the status of the WP# pin.

To read the Block Protection Register for a particular block, the CS# pin must first be asserted and instruction code of 3Ch must be clocked in. Once the instruction code has been clocked in, three address bytes designating any address within the block must be clocked in. After the last address byte has been clocked in, the device will begin outputting data on the DO pin during every subsequent clock cycle. The data being output will be a repeating byte of either FFh or 00h to denote the value of the appropriate Block Protection Register.

Table 7. Read Block Protection Register – Output Data

Output Data	Block Protection Register Value
00h	Block Protection Register value is 0 (block is unprotected).
FFh	Block Protection Register value is 1 (block is protected).

Deasserting the CS# pin will terminate the read operation and put the DO pin into a high-impedance state. The CS# pin can be deasserted at any time and does not require that a full byte of data be read. The instruction sequence is shown in Figure 9.

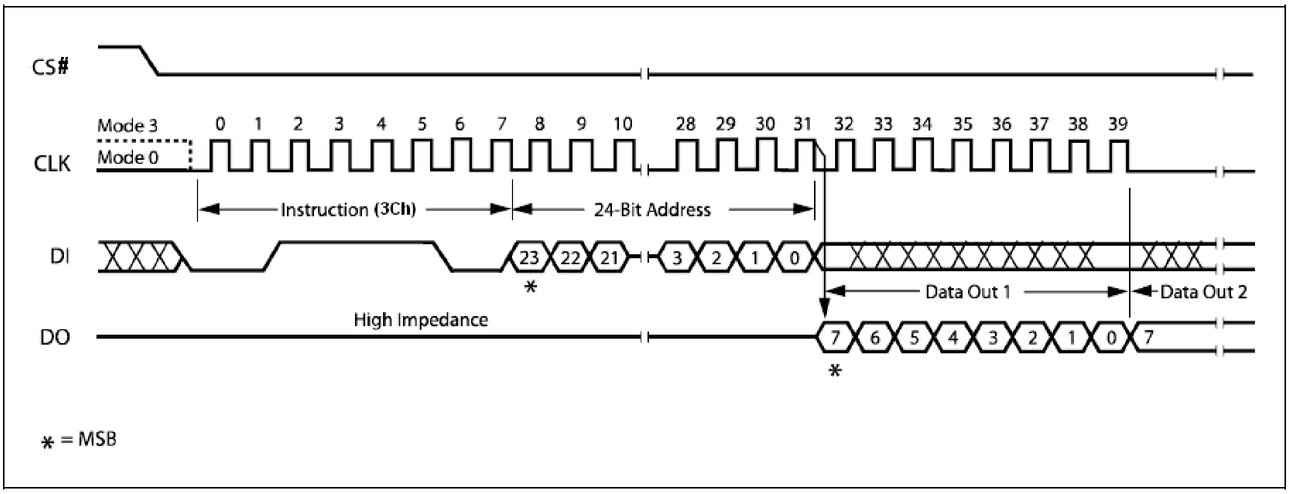


Figure 9. Read Block Protection Register

Read Status Register (RDSR) (05h)

The Read Status Register (RDSR) instruction allows the Status Register to be read. 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 instruction to the device. It is also possible to read the Status Register continuously, as shown in Figure 10.

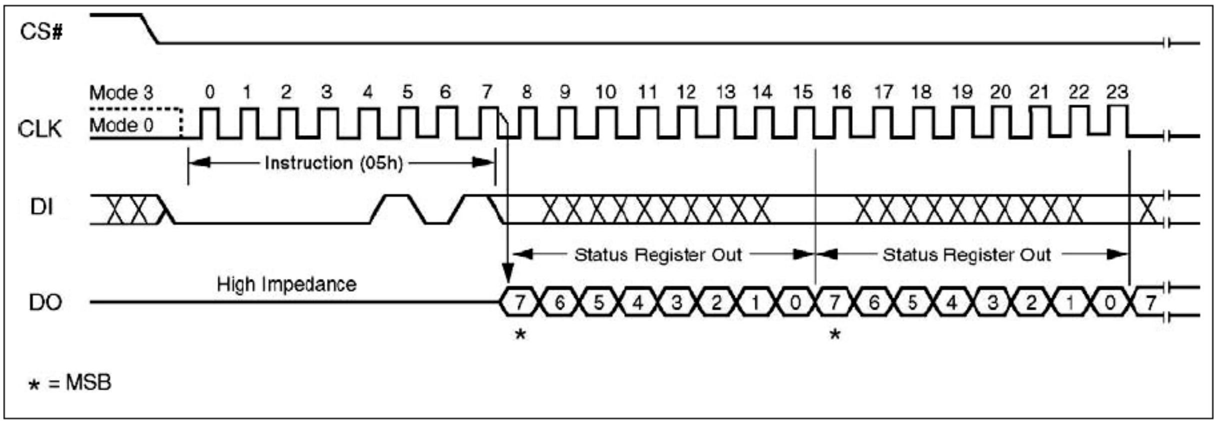
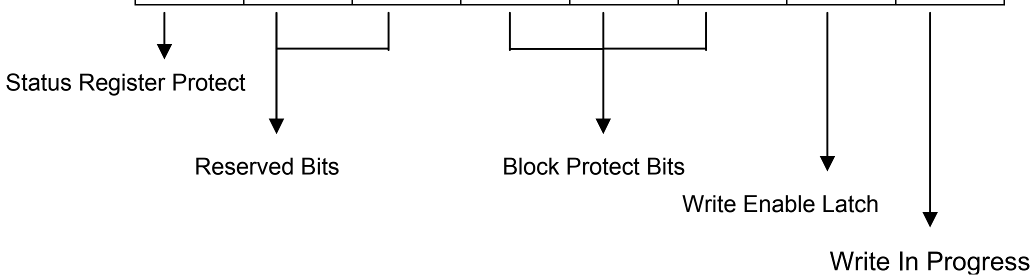


Figure 10. Read Status Register Instruction Sequence Diagram

Table 8. Status Register Bit Locations

S7	S6	S5	S4	S3	S2	S1	S0
SRP	0	0	BP2	BP1	BP0	WEL	WIP



Note : In OTP mode, SRP bit is served as OTP_LOCK bit.

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 with a Write Status Register, Program or Erase cycle. When set to 1, such a cycle is in progress, when reset to 0 no such cycle is in 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 instruction is accepted.

BP2, BP1, BP0 bits. The Block Protect (BP2, BP1, BP0) bits are non-volatile. They define the size of the area to be software protected against Program and Erase instructions. These bits are written with the Write Status Register (WRSR) instruction. When one or both of the Block Protect (BP2, BP1, BP0) bits is set to 1, the relevant memory area (as defined in Table 3.) becomes protected against Page Program (PP) Sector Erase (SE) and , Block Erase (BE), instructions. The Block Protect (BP2, BP1, BP0) bits can be written provided that the Hardware Protected mode has not been set. The Chip Erase (CE) instruction is executed if, and only if, all Block Protect (BP2, BP1, BP0) bits are 0.

Reserved bit. Status register bit locations 5 and 6 are reserved for future use. Current devices will read 0 for these bit locations. It is recommended to mask out the reserved bit when testing the Status Register. Doing this will ensure compatibility with future devices.

SRP bit / OTP_LOCK bit. The Status Register Protect (SRP) bit is operated in conjunction with the Write Protect (WP#) signal. The Status Register Write Protect (SRP) bit and Write Protect (WP#) signal allow the device to be put in the Hardware Protected mode (when the Status Register Protect (SRP) bit is set to 1, and Write Protect (WP#) is driven Low). In this mode, the non-volatile bits of the Status Register (SRP, BP2, BP1, BP0) become read-only bits and the Write Status Register (WRSR) instruction is no longer accepted for execution.

In OTP mode, this bit is served as OTP_LOCK bit, user can read/program/erase OTP sector as normal sector while OTP_LOCK value is equal 0, after OTP_LOCK is programmed with 1 by WRSR command, the OTP sector is protected from program and erase operation. The OTP_LOCK bit can only be programmed once.

Note : In OTP mode, the WRSR command will ignore any input data and program OTP_LOCK bit to 1, user must clear the protect bits before enter OTP mode and program the OTP code, then execute WRSR command to lock the OTP sector before leaving OTP mode.

Write Status Register (WRSR) (01h)

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

The Write Status Register (WRSR) instruction is entered by driving Chip Select (CS#) Low, followed by the instruction code and the data byte on Serial Data Input (DI).

The instruction sequence is shown in Figure 11. The Write Status Register (WRSR) instruction has no effect on S6, S5, S1 and S0 of the Status Register. S6 and S5 are always read as 0. Chip Select (CS#) must be driven High after the eighth bit of the data byte has been latched in. If not, the Write Status Register (WRSR) instruction is not executed. As soon as Chip Select (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) instruction allows the user to change the values of the Block Protect (BP2, BP1, BP0) bits, to define the size of the area that is to be treated as read-only, as defined in Table 3. The Write Status Register (WRSR) instruction also allows the user to set or reset the Status Register Protect (SRP) bit in accordance with the Write Protect (WP#) signal. The Status Register Protect (SRP) bit and Write Protect (WP#) signal allow the device to be put in the Hardware Protected Mode (HPM). The Write Status Register (WRSR) instruction is not executed once the Hardware Protected Mode (HPM) is entered.

NOTE : In the OTP mode, WRSR command will ignore input data and program OTP_LOCK bit to 1.

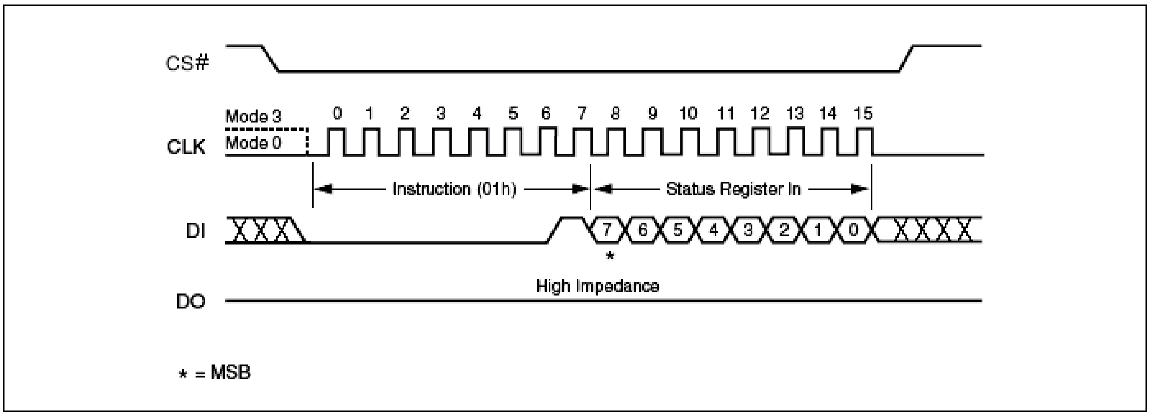


Figure 11. Write Status Register Instruction Sequence Diagram

Read Data Bytes (READ) (03h)

The device is first selected by driving Chip Select (CS#) Low. The instruction code for the Read Data Bytes (READ) instruction is followed by a 3-byte address (A23-A0), each bit being latched-in during the rising edge of Serial Clock (CLK). Then the memory contents, at that address, is shifted out on Serial Data Output (DO), each bit being shifted out, at a maximum frequency f_R, during the falling edge of Serial Clock (CLK).

The instruction sequence is shown in Figure 12. 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) instruction. When the highest address is reached, the address counter rolls over to 000000h, allowing the read sequence to be continued indefinitely.

The Read Data Bytes (READ) instruction is terminated by driving Chip Select (CS#) High. Chip Select (CS#) can be driven High at any time during data output. Any Read Data Bytes (READ) instruction, while an Erase, Program or Write cycle is in progress, is rejected without having any effects on the cycle that is in progress.

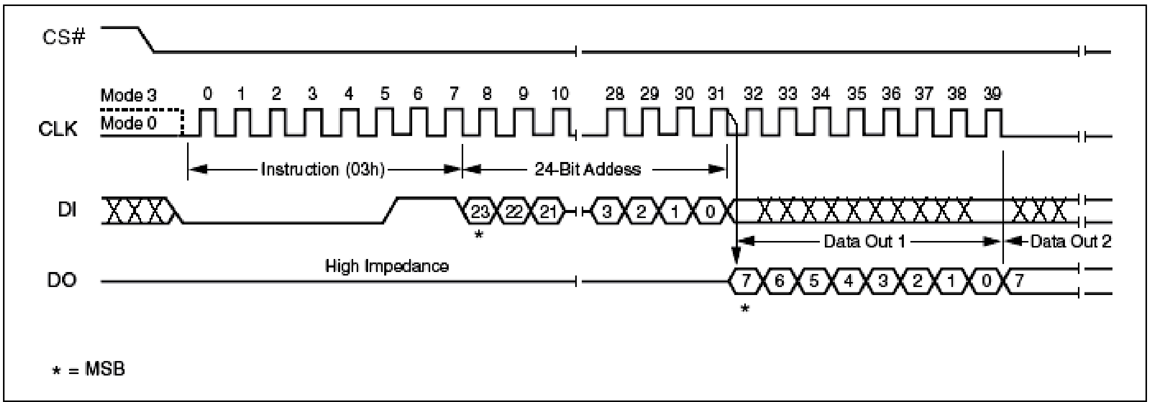


Figure 12. Read Data Instruction Sequence Diagram

Read Data Bytes at Higher Speed (FAST_READ) (0Bh)

The device is first selected by driving Chip Select (CS#) Low. The instruction code for the Read Data Bytes at Higher Speed (FAST_READ) instruction is followed by a 3-byte address (A23-A0) and a dummy byte, each bit being latched-in during the rising edge of Serial Clock (CLK). Then the memory contents, at that address, is shifted out on Serial Data Output (DO), each bit being shifted out, at a maximum frequency F_R, during the falling edge of Serial Clock (CLK).

The instruction sequence is shown in Figure 13. 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 at Higher Speed (FAST_READ) instruction. When the highest address is reached, the address counter rolls over to 000000h, allowing the read sequence to be continued indefinitely.

The Read Data Bytes at Higher Speed (FAST_READ) instruction is terminated by driving Chip Select (CS#) High. Chip Select (CS#) can be driven High at any time during data output. Any Read Data Bytes at Higher Speed (FAST_READ) instruction, while an Erase, Program or Write cycle is in progress, is rejected without having any effects on the cycle that is in progress.

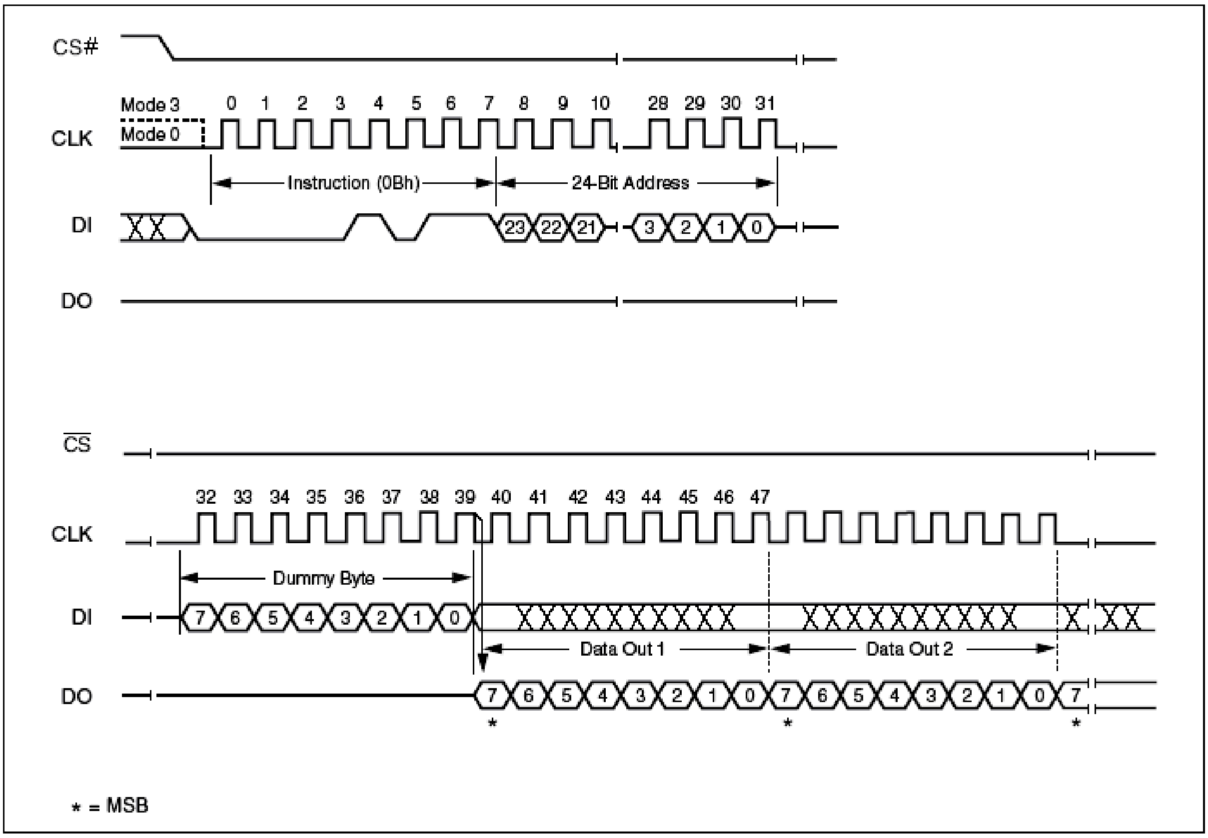


Figure 13. Fast Read Instruction Sequence Diagram

Dual Output Fast Read (3Bh)

The Dual Output Fast Read (3Bh) is similar to the standard Fast Read (0Bh) instruction except that data is output on two pins, DQ_0 and DQ_1, instead of just DQ_0. This allows data to be transferred from the EN25Q32 at twice the rate of standard SPI devices. The Dual Output Fast Read instruction is ideal for quickly downloading code from to RAM upon power-up or for applications that cache code-segments to RAM for execution.

Similar to the Fast Read instruction, the Dual Output Fast Read instruction can operation at the highest possible frequency of FR (see AC Electrical Characteristics). This is accomplished by adding eight "dummy clocks after the 24-bit address as shown in figure 14. The dummy clocks allow the device's internal circuits additional time for setting up the initial address. The input data during the dummy clock is "don't care". However, the DI pin should be high-impedance prior to the falling edge of the first data out clock.

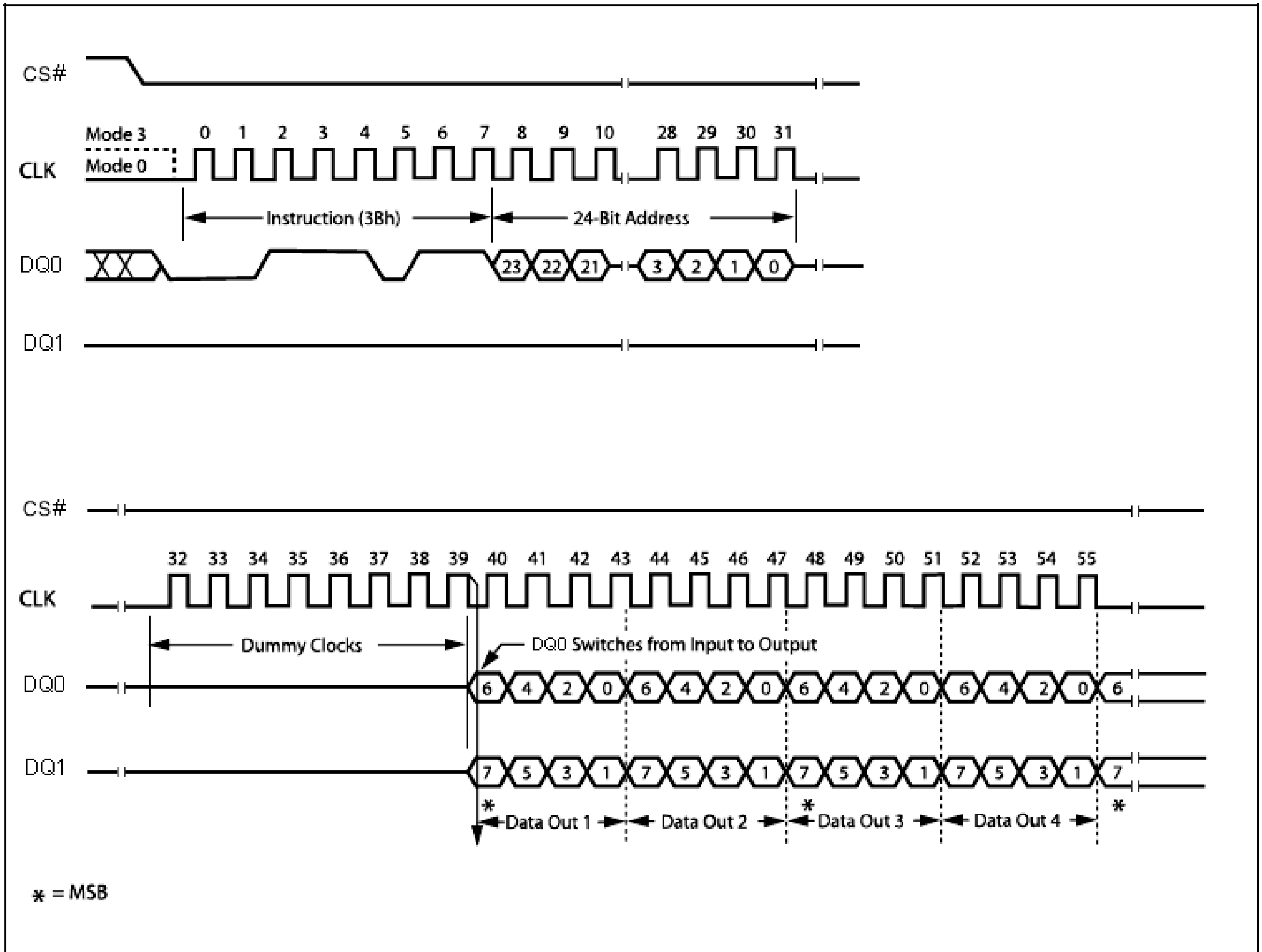


Figure 14. Dual Output Fast Read Instruction Sequence Diagram

Dual Input / Output FAST_READ (BBh)

The Dual I/O Fast Read (BBh) instruction allows for improved random access while maintaining two IO pins, DQ_0 and DQ_1. It is similar to the Dual Output Fast Read (3Bh) instruction but with the capability to input the Address bits (A23-0) two bits per clock. This reduced instruction overhead may allow for code execution (XIP) directly from the Dual SPI in some applications.

The Dual I/O Fast Read instruction enable double throughput of Serial Flash in read mode. The address is latched on rising edge of CLK, and data of every two bits (interleave 2 I/O pins) shift out on the falling edge of CLK at a maximum frequency. The first address can be at any location. The address is automatically increased to the next higher address after each byte data is shifted out, so the whole memory can be read out at a single Dual I/O Fast Read instruction. The address counter rolls over to 0 when the highest address has been reached. Once writing Dual I/O Fast Read instruction, the following address/dummy/data out will perform as 2-bit instead of previous 1-bit, as shown in Figure 15.

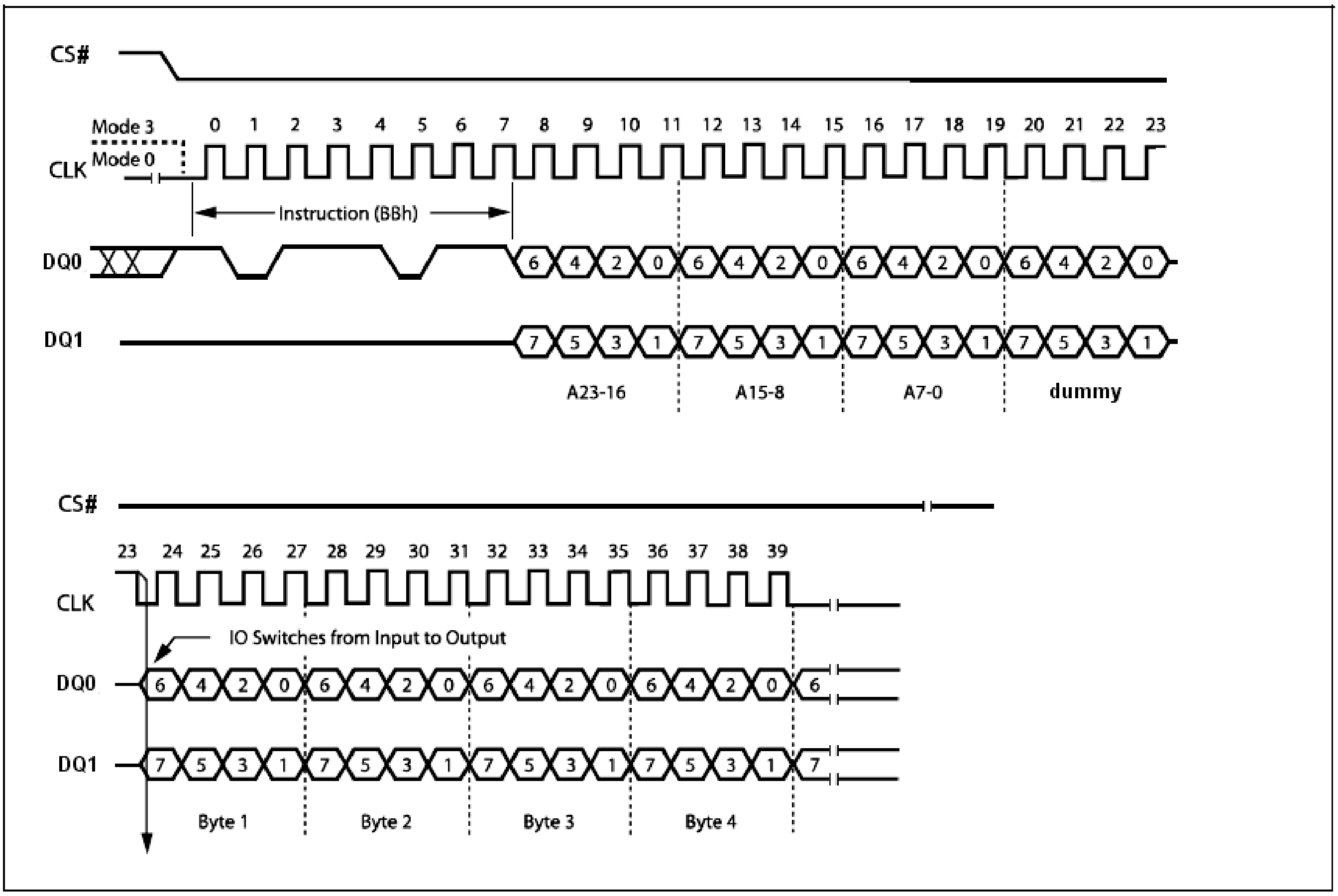


Figure 15. Dual Input / Output Fast Read Instruction Sequence Diagram

Quad Input / Output FAST_READ (EBh)

The Quad Input / Output FAST_READ (EBh) instruction is similar to the Dual I/O Fast Read (BBh) instruction except that address and data bits are input and output through four pins. DQ_0, DQ_1, DQ_2 and DQ_3 and four Dummy clocks are required prior to the data output. The Quad I/O dramatically reduces instruction overhead allowing faster random access for code execution (XIP) directly from the Quad SPI.

The Quad Input / Output FAST_READ (EBh) instruction enable quad throughput of Serial Flash in read mode. The address is latching on rising edge of CLK, and data of every four bits (interleave on 4 I/O pins) shift our on the falling edge of CLK at a maximum frequency. The first address can be any location. The address is automatically increased to the next higher address after each byte data is shifted out, so the whole memory can be read out at a single Quad Input / Output FAST_READ instruction. The address counter rolls over to 0 when the highest address has been reached. Once writing Quad Input / Output FAST_READ instruction, the following address/dummy/data out will perform as 4-bit instead of previous 1-bit, as shown in Figure 16.

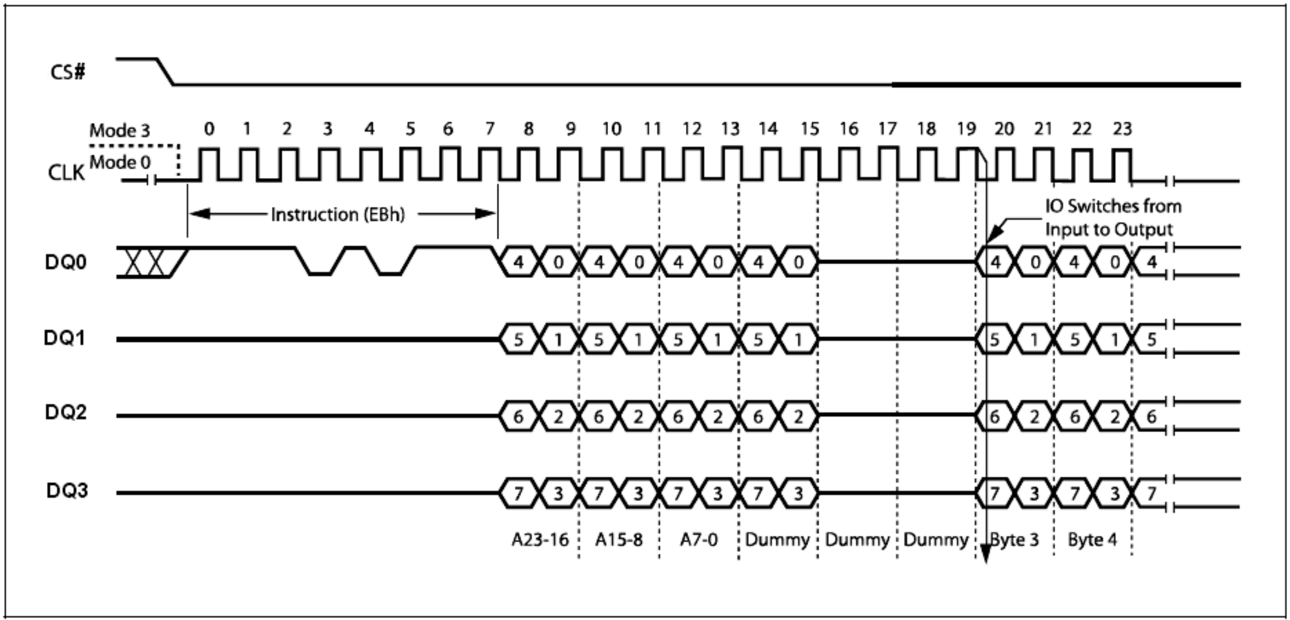


Figure 16. Quad Input / Output Fast Read Instruction Sequence Diagram

Page Program (PP) (02h)

The Page Program (PP) instruction allows bytes to be programmed in the memory. Before it can be accepted, a Write Enable (WREN) instruction must previously have been executed. After the Write Enable (WREN) instruction has been decoded, the device sets the Write Enable Latch (WEL).

The Page Program (PP) instruction is entered by driving Chip Select (CS#) Low, followed by the instruction code, three address bytes and at least one data byte on Serial Data Input (DI). 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). Chip Select (CS#) must be driven Low for the entire duration of the sequence.
The instruction sequence is shown in Figure 17. 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.

Chip Select (CS#) must be driven High after the eighth bit of the last data byte has been latched in, otherwise the Page Program (PP) instruction is not executed.

As soon as Chip Select (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) instruction applied to a page which is protected by the Block Protect (BP2, BP1, BP0) bits (see Table 3) is not executed.

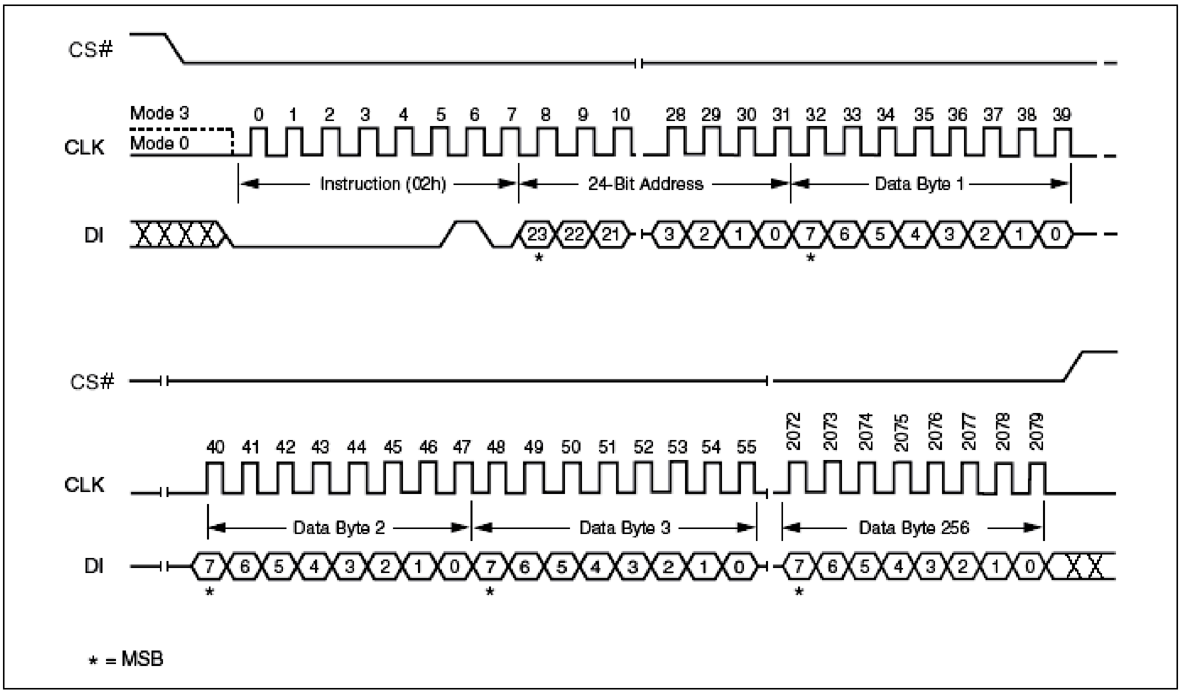


Figure 17. Page Program Instruction Sequence Diagram

Sector Erase (SE) (20h)

The Sector Erase (SE) instruction sets to 1 (FFh) all bits inside the chosen sector. Before it can be accepted, a Write Enable (WREN) instruction must previously have been executed. After the Write Enable (WREN) instruction has been decoded, the device sets the Write Enable Latch (WEL).

The Sector Erase (SE) instruction is entered by driving Chip Select (CS#) Low, followed by the instruction code, and three address bytes on Serial Data Input (DI). Any address inside the Sector (see Table 2) is a valid address for the Sector Erase (SE) instruction. Chip Select (CS#) must be driven Low for the entire duration of the sequence.

The instruction sequence is shown in Figure 18. Chip Select (CS#) must be driven High after the eighth bit of the last address byte has been latched in, otherwise the Sector Erase (SE) instruction is not executed. As soon as Chip Select (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) instruction applied to a sector which is protected by the Block Protect (BP2, BP1, BP0) bits (see Table 3) is not executed.

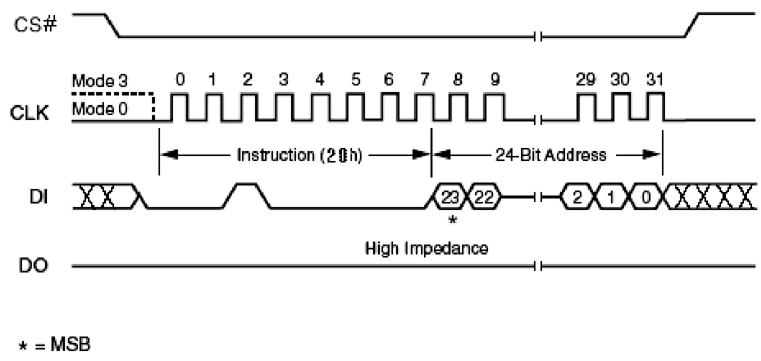


Figure 18. Sector Erase Instruction Sequence Diagram

Block Erase (BE) (D8h/52h)

The Block Erase (BE) instruction sets to 1 (FFh) all bits inside the chosen block. Before it can be accepted, a Write Enable (WREN) instruction must previously have been executed. After the Write Enable (WREN) instruction has been decoded, the device sets the Write Enable Latch (WEL).

The Block Erase (BE) instruction is entered by driving Chip Select (CS#) Low, followed by the instruction code, and three address bytes on Serial Data Input (DI). Any address inside the Block (see Table 2) is a valid address for the Block Erase (BE) instruction. Chip Select (CS#) must be driven Low for the entire duration of the sequence.

The instruction sequence is shown in Figure 19. Chip Select (CS#) must be driven High after the eighth bit of the last address byte has been latched in, otherwise the Block Erase (BE) instruction is not executed. As soon as Chip Select (CS#) is driven High, the self-timed Block Erase cycle (whose duration is t_{BE}) 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 Block Erase (BE) instruction applied to a block which is protected by the Block Protect (BP2, BP1, BP0) bits (see Table 3) is not executed.

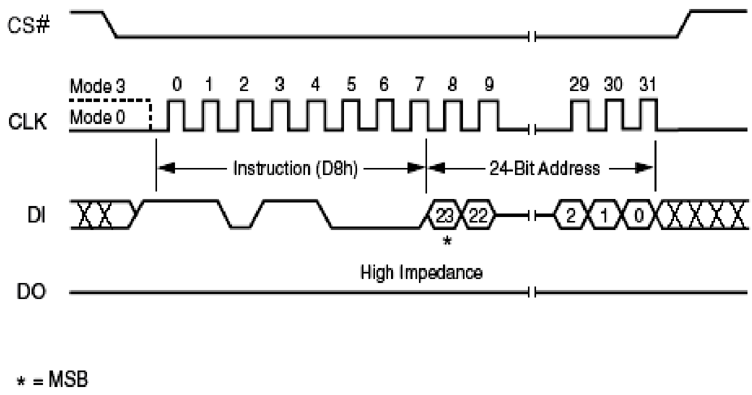


Figure 19. Block Erase Instruction Sequence Diagram

Chip Erase (CE) (C7h/60h)

The Chip Erase (CE) instruction sets all bits to 1 (FFh). Before it can be accepted, a Write Enable (WREN) instruction must previously have been executed. After the Write Enable (WREN) instruction has been decoded, the device sets the Write Enable Latch (WEL).

The Chip Erase (CE) instruction is entered by driving Chip Select (CS#) Low, followed by the instruction code on Serial Data Input (DI). Chip Select (CS#) must be driven Low for the entire duration of the sequence.

The instruction sequence is shown in Figure 20. Chip Select (CS#) must be driven High after the eighth bit of the instruction code has been latched in, otherwise the Chip Erase instruction is not executed. As soon as Chip Select (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) instruction is executed only if all Block Protect (BP2, BP1, BP0) bits are 0. The Chip Erase (CE) instruction is ignored if one, or more blocks are protected.

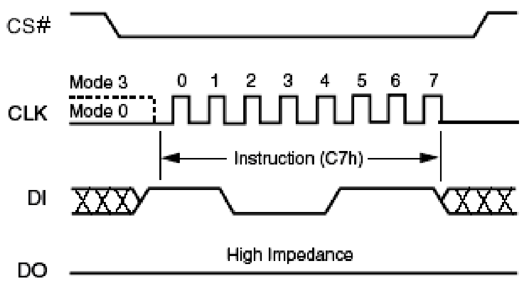


Figure 20. Chip Erase Instruction Sequence Diagram

Deep Power-down (DP) (B9h)

Executing the Deep Power-down (DP) instruction 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 instructions.

Driving Chip Select (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) instruction, to reduce the standby current (from I_{CC1} to I_{CC2}, as specified in Table 10.)

Once the device has entered the Deep Power-down mode, all instructions are ignored except the Release from Deep Power-down and Read Device ID (RDI) instruction. This releases the device from this mode. The Release from Deep Power-down and Read Device ID (RDI) instruction also allows the Device ID of the device to be output on Serial Data Output (DO).

The Deep Power-down mode automatically stops at Power-down, and the device always Powers-up in the Standby mode. The Deep Power-down (DP) instruction is entered by driving Chip Select (CS#) Low, followed by the instruction code on Serial Data Input (DI). Chip Select (CS#) must be driven Low for the entire duration of the sequence.

The instruction sequence is shown in Figure 21.Chip Select (CS#) must be driven High after the eighth bit of the instruction code has been latched in, otherwise the Deep Power-down (DP) instruction is not executed. As soon as Chip Select (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) instruction, while an Erase, Program or Write cycle is in progress, is rejected without having any effects on the cycle that is in progress.

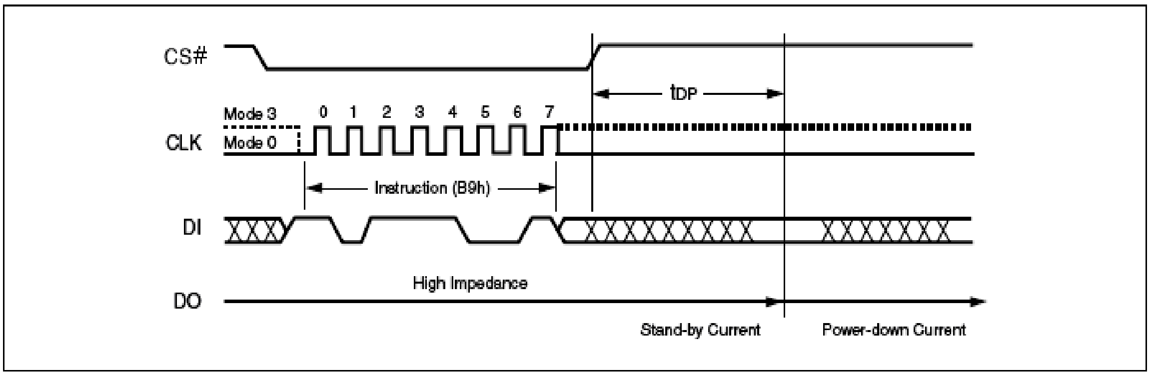


Figure 21. Deep Power-down Instruction Sequence Diagram

Release from Deep Power-down and Read Device ID (RDI)

Once the device has entered the Deep Power-down mode, all instructions are ignored except the Release from Deep Power-down and Read Device ID (RDI) instruction. Executing this instruction takes the device out of the Deep Power-down mode.

Please note that this is not the same as, or even a subset of, the JEDEC 16-bit Electronic Signature that is read by the Read Identifier (RDID) instruction. The old-style Electronic Signature is supported for reasons of backward compatibility, only, and should not be used for new designs. New designs should, instead, make use of the JEDEC 16-bit Electronic Signature, and the Read Identifier (RDID) instruction.

When used only to release the device from the power-down state, the instruction is issued by driving the CS# pin low, shifting the instruction code "ABh" and driving CS# high as shown in Figure 22. After the time duration of t_{RES1} (See AC Characteristics) the device will resume normal operation and other instructions will be 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 instruction is initiated by driving the CS# pin low and shifting the instruction code "ABh" followed by 3-dummy bytes. The Device ID bits are then shifted out on the falling edge of CLK with most significant bit (MSB) first as shown in

Figure 23. The Device ID value for the EN25Q32 are listed in Table 5. The Device ID can be read continuously. The instruction is completed by driving CS# high.
When Chip Select (CS#) is driven High, the device is put in the Stand-by Power mode. If the device was not previously in the Deep Power-down mode, the transition to the Stand-by Power mode is immediate. If the device was previously in the Deep Power-down mode, though, the transition to the Standby Power mode is delayed by t_{RES2}, and Chip Select (CS#) must remain High for at least t_{RES2} (max), as specified in Table 12. Once in the Stand-by Power mode, the device waits to be selected, so that it can receive, decode and execute instructions.
Except while an Erase, Program or Write Status Register cycle is in progress, the Release from Deep Power-down and Read Device ID (RDI) instruction always provides access to the 8bit Device ID of the device, and can be applied even if the Deep Power-down mode has not been entered.
Any Release from Deep Power-down and Read Device ID (RDI) instruction while an Erase, Program or Write Status Register cycle is in progress, is not decoded, and has no effect on the cycle that is in progress.

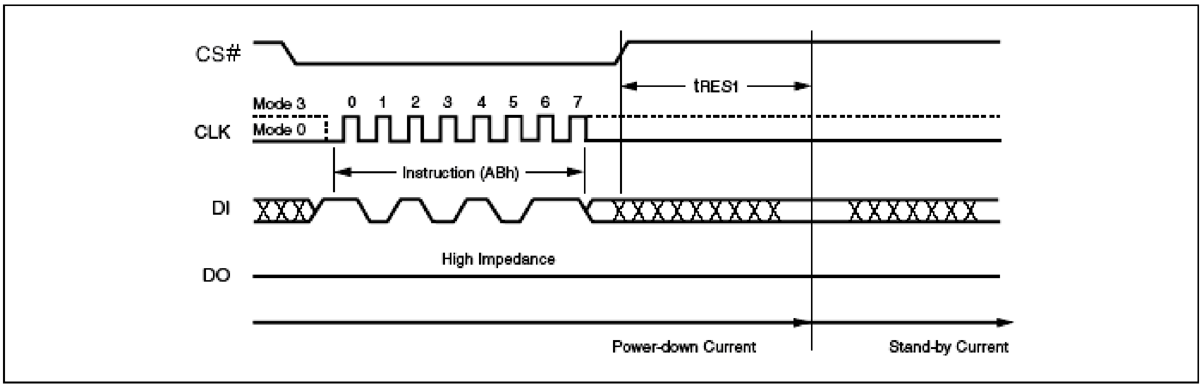


Figure 22. Release Power-down Instruction Sequence Diagram

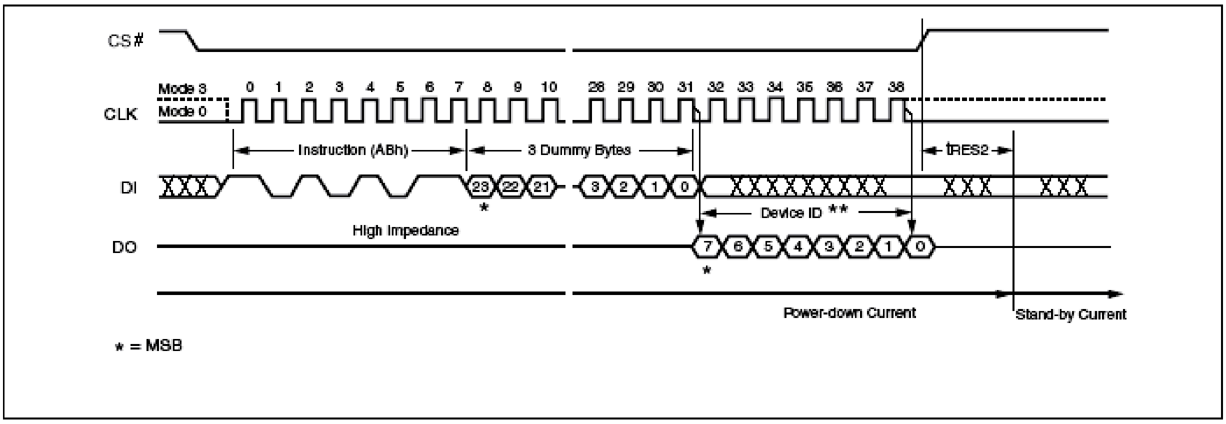


Figure 23. Release Power-down / Device ID Instruction Sequence Diagram

Read Manufacturer / Device ID (90h)

The Read Manufacturer/Device ID instruction is an alternative to the Release from Power-down / Device ID instruction that provides both the JEDEC assigned manufacturer ID and the specific device ID.

The Read Manufacturer/Device ID instruction is very similar to the Release from Power-down / Device ID instruction. The instruction is initiated by driving the CS# pin low and shifting the instruction code "90h" followed by a 24-bit address (A23-A0) of 000000h. After which, the Manufacturer ID for Eon (1Ch) and the Device ID are shifted out on the falling edge of CLK with most significant bit (MSB) first as shown in Figure 24. The Device ID values for the EN25Q32 are listed in Table 5. If the 24-bit address is initially set to 000001h the Device ID will be read first

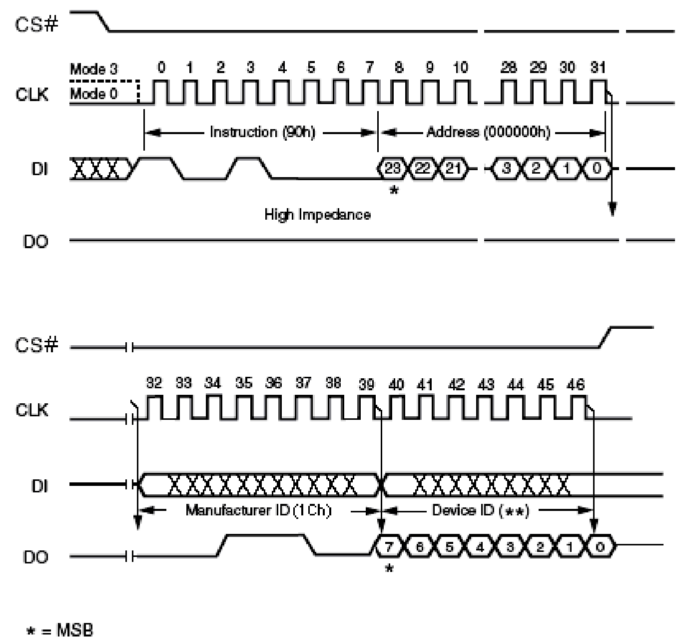


Figure 24. Read Manufacturer / Device ID Diagram

Read Identification (RDID) (9Fh)

The Read Identification (RDID) instruction 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 .

Any Read Identification (RDID) instruction 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) instruction should not be issued while the device is in Deep Power down mode.

The device is first selected by driving Chip Select Low. Then, the 8-bit instruction code for the instruction 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 instruction sequence is shown in Figure 25. The Read Identification (RDID) instruction is terminated by driving Chip Select High at any time during data output.

When Chip Select is driven High, the device is put in the Standby Power mode. Once in the Standby Power mode, the device waits to be selected, so that it can receive, decode and execute instructions.

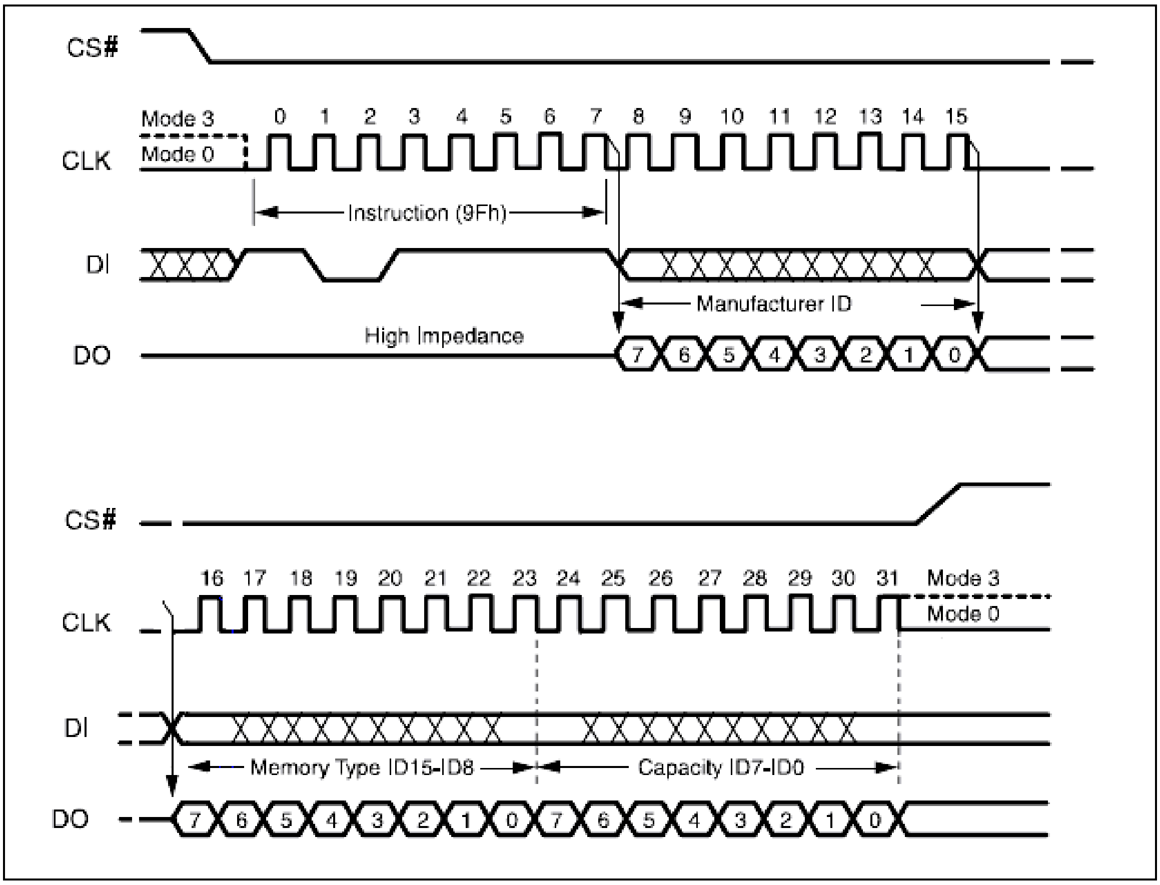


Figure 25. Read Identification (RDID)

Enter OTP Mode (3Ah)

This Flash has an extra 512 bytes OTP sector, user must issue ENTER OTP MODE command to read, program or erase OTP sector. After entering OTP mode, the OTP sector is mapping to sector 1023, **SRP bit** becomes OTP_LOCK bit and can be read with RDSR command. Program / Erase command will be disabled when OTP_LOCK is ‘1’

WRSR command will ignore the input data and program LOCK_BIT to 1.
User must clear the protect bits before enter OTP mode.
OTP sector can only be program and erase when LOCK_BIT is set to ‘0’ and BP [2:0] = ‘000’. In OTP mode, user can read other sectors, but program/erase other sectors only allowed when OTP_LOCK equal to ‘0’.
User can use WRDI (04H) command to exit OTP mode.

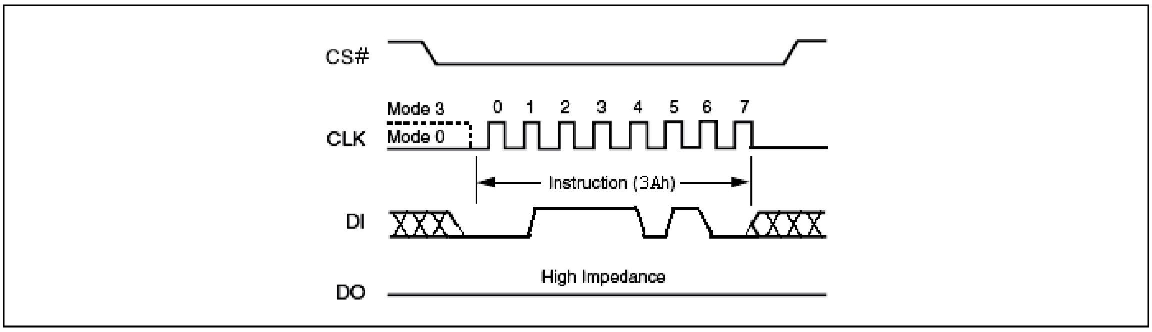


Figure 26. Enter OTP Mode

Power-up Timing

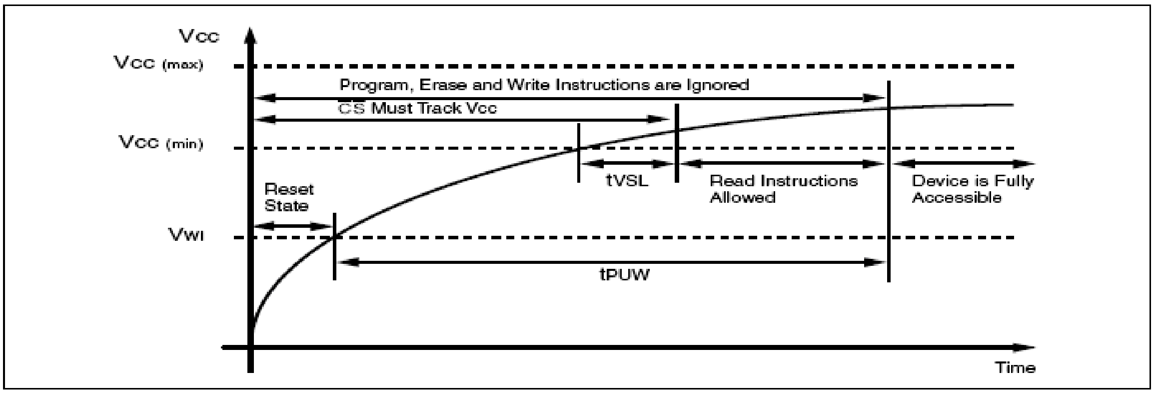


Figure 27. Power-up Timing

Table 9. Power-Up Timing and Write Inhibit Threshold

Symbol	Parameter	Min.	Max.	Unit
t_{VSL} (1)	VCC(min) to CS# low	10		µs
t_{PUW} (1)	Time delay to Write instruction	1	10	ms
V_{WI} (1)	Write Inhibit Voltage	1	2.5	V

Note:
1.The parameters are characterized only.

INITIAL DELIVERY STATE

The device is delivered with the memory array erased: all bits are set to 1 (each byte contains FFh). The Status Register contains 00h (all Status Register bits are 0).

Table 10. DC Characteristics

(T_a = - 40°C to 85°C; V_{CC} = 2.7-3.6V)

Symbol	Parameter	Test Conditions	Min.	Max.	Unit
I_{LI}	Input Leakage Current			± 2	μA
I_{LO}	Output Leakage Current			± 2	μA
I_{CC1}	Standby Current	CS# = V_{CC}, V_{IN} = V_{SS} or V_{CC}		5	μA
I_{CC2}	Deep Power-down Current	CS# = V_{CC}, V_{IN} = V_{SS} or V_{CC}		5	μA
I_{CC3}	Operating Current (READ)	CLK = 0.1 V_{CC} / 0.9 V_{CC} at 100MHz, DQ = open		25	mA
		CLK = 0.1 V_{CC} / 0.9 V_{CC} at 80MHz, DQ = open		20	mA
I_{CC4}	Operating Current (PP)	CS# = V_{CC}		15	mA
I_{CC5}	Operating Current (WRSR)	CS# = V_{CC}		15	mA
I_{CC6}	Operating Current (SE)	CS# = V_{CC}		15	mA
I_{CC7}	Operating Current (BE)	CS# = V_{CC}		15	mA
V_{IL}	Input Low Voltage		– 0.5	0.2 V_{CC}	V
V_{IH}	Input High Voltage		0.7V_{CC}	V_{CC}+0.4	V
V_{OL}	Output Low Voltage	I_{OL} = 1.6 mA		0.4	V
V_{OH}	Output High Voltage	I_{OH} = –100 μA	V_{CC}-0.2		V

Table 11. AC Measurement Conditions

Symbol	Parameter	Min.	Max.	Unit
C_L	Load Capacitance	20/30		pF
	Input Rise and Fall Times		5	ns
	Input Pulse Voltages	0.2V_{CC} to 0.8V_{CC}		V
	Input Timing Reference Voltages	0.3V_{CC} to 0.7V_{CC}		V
	Output Timing Reference Voltages	V_{CC} / 2		V

Notes:
1. C_L = 20 pF when CLK=100MHz, C_L = 30 pF when CLK=80MHz,

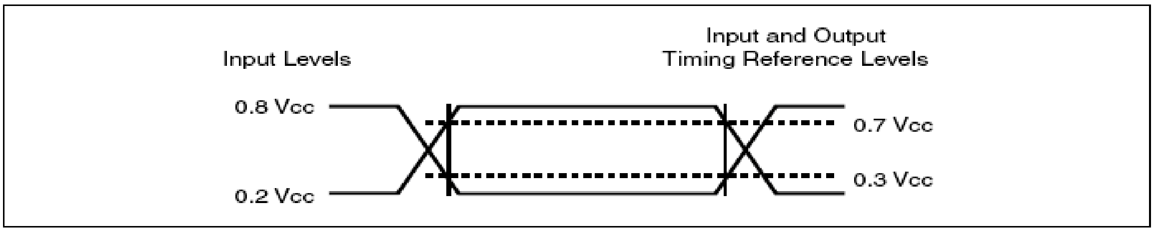


Figure 28. AC Measurement I/O Waveform

Table 12.100MHz AC Characteristics

(T_a = - 40°C to 85°C; V_{CC} = 2.7-3.6V)

Symbol	Alt	Parameter	Min	Typ	Max	Unit
F_R	f_C	Serial Clock Frequency for: FAST_READ, PP, SE, BE, DP, RES, WREN, WRDI, WRSR	D.C.		100	MHz
		Serial Clock Frequency for: Dual Fast Read 、Dual I/O and Quad I/O Fast Read	D.C.		80	MHz
f_R		Serial Clock Frequency for READ, RDSR, RDID	D.C.		66	MHz
t_{CLH} [1]		Serial Clock High Time	4			ns
t_{CLL} [1]		Serial Clock Low Time	4			ns
t_{CLCH} [2]		Serial Clock Rise Time (Slew Rate)	0.1			V / ns
t_{CHCL} [2]		Serial Clock Fall Time (Slew Rate)	0.1			V / ns
t_{SLCH}	t_{CSS}	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}	t_{CSH}	CS# High Time	100			ns
t_{SHQZ} [2]	t_{DIS}	Output Disable Time			6	ns
t_{CLQX}	t_{HO}	Output Hold Time	0			ns
t_{DVCH}	t_{DSU}	Data In Setup Time	2			ns
t_{CHDX}	t_{DH}	Data In Hold Time	5			ns
t_{HLCH}		HOLD# Low Setup Time (relative to CLK)	5			ns
t_{HHCH}		HOLD# High Setup Time (relative to CLK)	5			ns
t_{CHHH}		HOLD# Low Hold Time (relative to CLK)	5			ns
t_{CHHL}		HOLD# High Hold Time (relative to CLK)	5			ns
t_{HLQZ} [2]	t_{HZ}	HOLD# Low to High-Z Output			6	ns
t_{HHQX} [2]	t_{LZ}	HOLD# High to Low-Z Output			6	ns
t_{CLQV}	t_V	Output Valid from CLK			8	ns
t_{WHSL} [3]		Write Protect Setup Time before CS# Low	20			ns
t_{SHWL} [3]		Write Protect Hold Time after CS# High	100			ns
t_{DP} [2]		CS# High to Deep Power-down Mode			3	µs
t_{RES1} [2]		CS# High to Standby Mode without Electronic Signature read			3	µs
t_{RES2} [2]		CS# High to Standby Mode with Electronic Signature read			1.8	µs
t_W		Write Status Register Cycle Time		10	15	ms
t_{PP}		Page Programming Time		1.5	5	ms
t_{SE}		Sector Erase Time		0.15	0.3	s
t_{BE}		Block Erase Time		0.8	2	s
t_{CE}		Chip Erase Time		25	50	s

Note: 1. $T_{CLKH} + T_{CLKL}$ must be greater than or equal to 1/ F_{CLK}

2. Value guaranteed by characterization, not 100% tested in production.
3. Only applicable as a constraint for a Write status Register instruction when Status Register Protect Bit is set at 1.

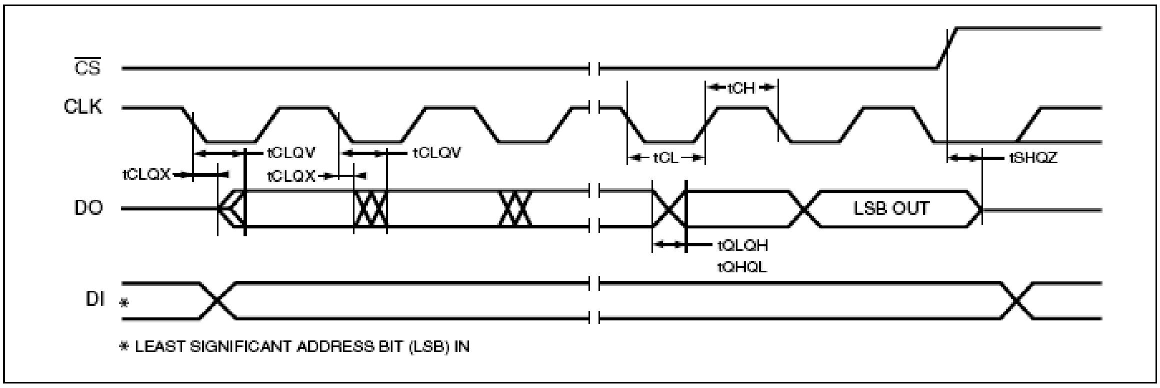


Figure 29. Serial Output Timing

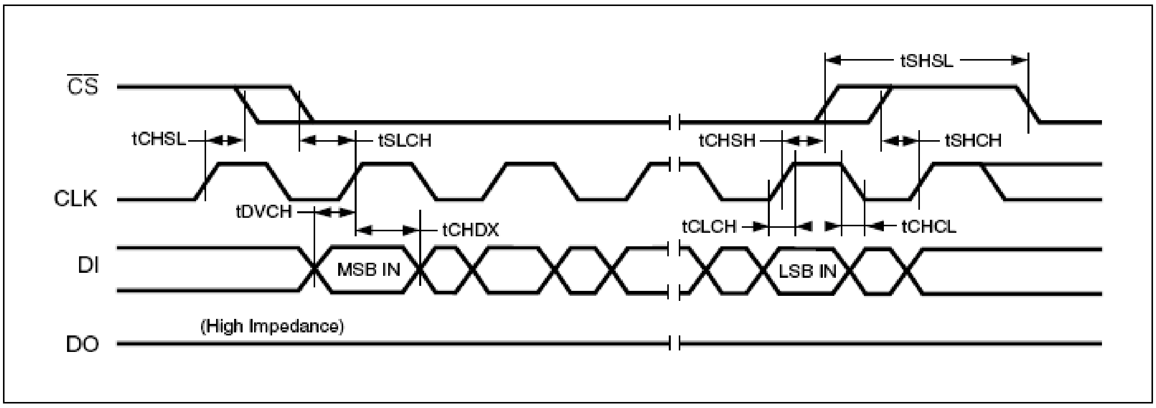


Figure 30. Input Timing

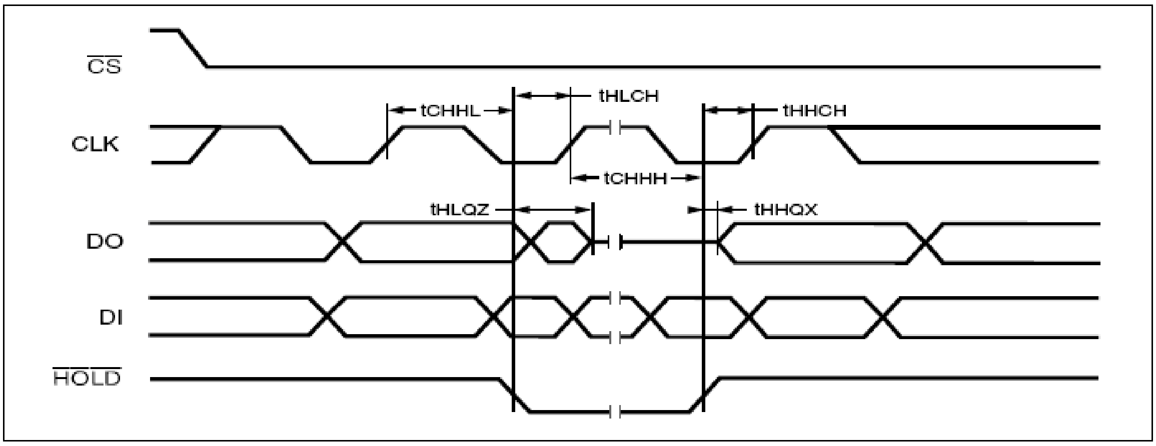


Figure 31. Hold Timing

ABSOLUTE MAXIMUM RATINGS

Stresses above the values so mentioned above may cause permanent damage to the device. These values are for a stress rating only and do not imply that the device should be operated at conditions up to or above these values. Exposure of the device to the maximum rating values for extended periods of time may adversely affect the device reliability.

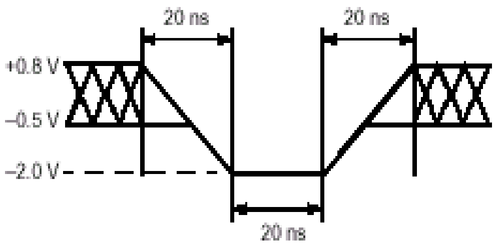
Parameter	Value	Unit
Storage Temperature	-65 to +150	°C
Plastic Packages	-65 to +125	°C
Output Short Circuit Current[1]	200	mA
Input and Output Voltage (with respect to ground)[2]	-0.5 to +4.0	V
Vcc	-0.5 to +4.0	V

Notes:
1. No more than one output shorted at a time. Duration of the short circuit should not be greater than one second.
2. Minimum DC voltage on input or I/O pins is –0.5 V. During voltage transitions, inputs may undershoot V_{ss} to –1.0V for periods of up to 50ns and to –2.0 V for periods of up to 20ns. See figure below. Maximum DC voltage on output and I/O pins is V_{cc} + 0.5 V. During voltage transitions, outputs may overshoot to V_{cc} + 1.5 V for periods up to 20ns. See figure below.

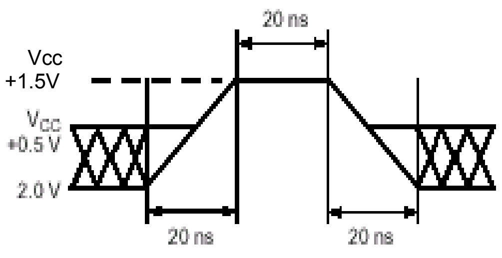
RECOMMENDED OPERATING RANGES [1]

Parameter	Value	Unit
Ambient Operating Temperature Industrial Devices	-40 to 85	°C
Operating Supply Voltage Vcc	Full: 2.7 to 3.6	V

Notes:
1. Recommended Operating Ranges define those limits between which the functionality of the device is guaranteed.



Maximum Negative Overshoot Waveform



Maximum Positive Overshoot Waveform

Table 13. DATA RETENTION and ENDURANCE

Parameter Description	Test Conditions	Min	Unit
Data Retention Time	150°C	10	Years
	125°C	20	Years
Erase/Program Endurance	-40 to 85 °C	100k	cycles

Table 14. CAPACITANCE

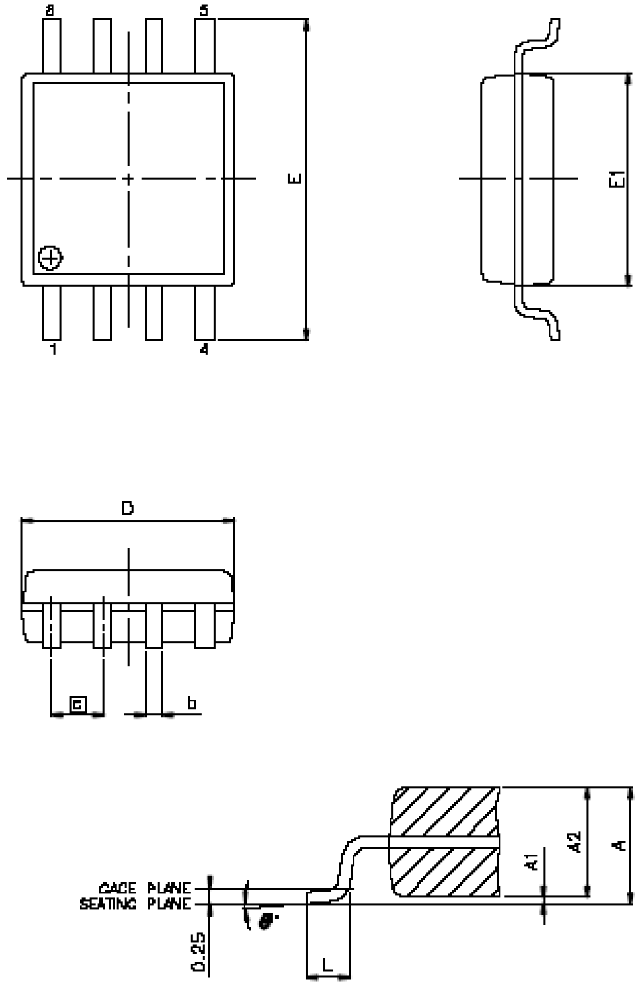
(V_{CC} = 2.7-3.6V)

Parameter Symbol	Parameter Description	Test Setup	Typ	Max	Unit
C_{IN}	Input Capacitance	$V_{IN} = 0$		6	pF
C_{OUT}	Output Capacitance	$V_{OUT} = 0$		8	pF

Note : Sampled only, not 100% tested, at T_A = 25°C and a frequency of 20MHz.

PACKAGE MECHANICAL

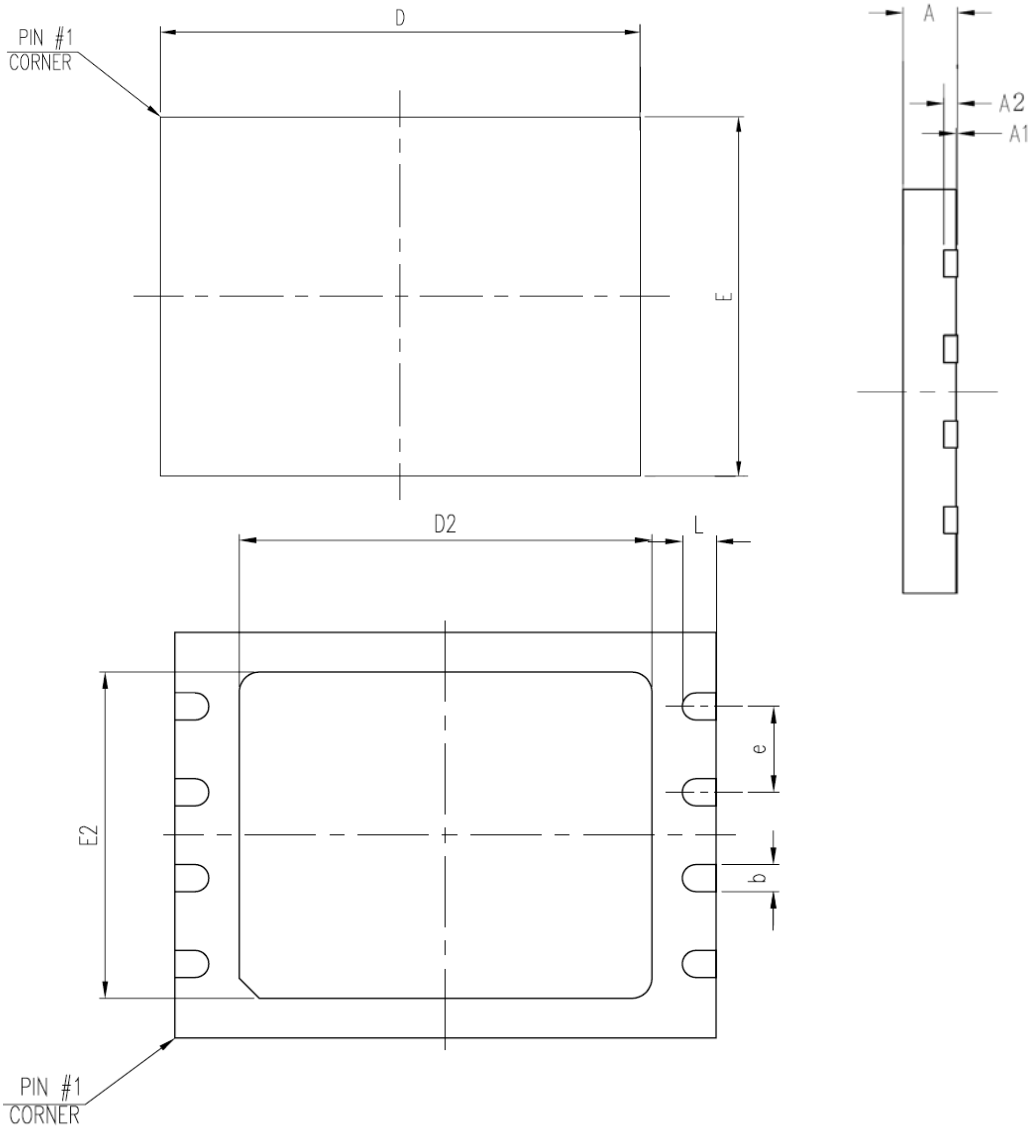
Figure 32. SOP 200 mil (official name = 208 mil)



SYMBOL	DIMENSION IN MM		
	MIN.	NOR	MAX
A	1.75	1.975	2.20
A1	0.05	0.15	0.25
A2	1.70	1.825	1.95
D	5.15	5.275	5.40
E	7.70	7.90	8.10
E1	5.15	5.275	5.40
e	- - -	1.27	- - -
b	0.35	0.425	0.50
L	0.5	0.65	0.80
θ	0^{0}	4^{0}	8^{0}

Note : 1. Coplanarity: 0.1 mm
2. Max. allowable mold flash is 0.15 mm at the pkg ends, 0.25 mm between leads.

Figure 33. VDFN8 (5x6mm)



SYMBOL	DIMENSION IN MM		
	MIN.	NOR	MAX
A	0.70	0.75	0.80
A1	0.00	0.02	0.04
A2	- - -	0.20	- - -
D	5.90	6.00	6.10
E	4.90	5.00	5.10
D2	3.30	3.40	3.50
E2	3.90	4.00	4.10
e	- - -	1.27	- - -
b	0.35	0.40	0.45
L	0.55	0.60	0.65

Note: 1. Coplanarity: 0.1 mm

ORDERING INFORMATION

EN25Q32 - 100 H I P

PACKAGING CONTENT
(Blank) = Conventional
P = RoHS compliant

TEMPERATURE RANGE
I = Industrial (-40°C to +85°C)

PACKAGE
H = 8-pin 200mil SOP
W = 8-pin VDFN

SPEED
100 = 100 Mhz

BASE PART NUMBER
EN = Eon Silicon Solution Inc.
25Q = 3V Serial Flash with 4KB Uniform-Sector,
Dual and Quad I/O
32 = 32 Megabit (4096K x 8)

Revisions List

Revision No	Description	Date
A	Initial Release	2008/09/18