# AN309010
# Migration Guide

## How to Migrate to Numonyx M29W320E from Spansion* S29GL032N Flash Memory

The objective of this application note is to explain how to migrate an application based on the S29GL032N Flash memory to an M29W320E Flash memory. The purpose of this document is not to provide detailed information on the devices, but to highlight the similarities and differences between them. The comparison takes into consideration the signal descriptions, packages, architecture, software command set, performance, and block protections.

## Introduction

The Numonyx M29W320E memory, manufactured on the mature 110nm technology, is ideal for all applications needing a reliable (min 100,000 cycles, 20 years data retention), fast, parallel NOR device (available in 70ns). More than 360 million devices[1] shipped worldwide on this technology.

Using the industry standard command set, the M29W320E can replace many competitors' parts such as the Spansion S29GL032N. Customers that value reliability will benefit from using the M29W320E based on single level cell, floating gate technology (100,000 cycles, 20 years retention minimum) compared to the S29GL016A based on MirrorBit technology (100,000 cycles, 20 years typical). M29W320E is offered in –40 °C to 85 °C, industrial temperature range. The version in -40° °C to 125 °C extended temperature range and related automotive compliance is called M29W320F, please refer to separate datasheet and contact your local sales for availability of your preferred combination. M29W320E and M29W320F are processed on the same technology and have equivalent timing. The compatibility with Spansion S29GL032N in most of the cases should be compared to the M29W320E. The option S29GL032Nxx 01,02 (Uniform with TSOP56) may be challenging, but not impossible, to be replaced with M29W320E. Please inquire with your sales office for further support.

In this document, the S29GL032N, top and bottom boot block, (03 and 04 models), will be referred to as S29GL032N, and the M29W320ET (top boot block) and the M29W320EB (bottom boot block) will be referred to as M29W320E unless otherwise specified.

Please refer to the S29GL032N and M29W320E datasheets for additional information on devices.

# Contents

## Memory architecture and protection groups

The S29GL032N comes in uniform and boot block architectures. The uniform versions have 64 blocks of 32 Kwords (64 Kbytes) each. The boot block versions have 63 main blocks of 32 Kwords (64 Kbytes) each, and 8 boot blocks of 4 Kwords (8 Kbytes) each. M29W320E is only available in a boot block architecture.

Both devices have an extended memory block. The S29GL032N has a block size of 128 words in x 16 mode or of 256 bytes in x 8 mode. The M29W320E has a block size of 32 Kwords in x16 mode and 16 Kbytes in x8 mode.

## Hardware migration

This section provides a detailed comparison between S29GL032N and M29W320E signals and package pin-out.

## Signal Descriptions

**Table 1** gives a comparison between the S29GL032N and M29W320E signals.

On the M29W320E devices, applying 12 V to the $V_{PP}$/WP pin will temporarily unprotect any block previously protected (including the two outermost blocks). However, the WP/ACC pin can be left floating or unconnected on S29GL032N, while VPP/WP can't be left floating or unconnected on M29W320E.

**Table 1: Signal description for the S29GL032N and M29W320E devices**

| Name | | Description | Direction |
|---|---|---|---|
| S29GL032N | M29W320E | | |
| A0-A20 | | Address inputs | Inputs |
| DQ0-DQ7 | | Data inputs/outputs | I/O |
| DQ8-DQ14 | | Data inputs/outputs | I/O |
| DQ15A–1 (or DQ15) | | Data input/output or address input (or data input/output) | I/O |
| CE# | $\overline{E}$ | Chip Enable | Input |
| OE# | $\overline{G}$ | Output Enable | Input |
| WE# | $\overline{W}$ | Write Enable | Input |
| RESET# | $\overline{RP}$ | Reset/Block Temporary Unprotect | Input |
| RY/BY# | $R\overline{B}$ | Ready/Busy output | Output |
| BYTE# | | Byte/word organization select | Input |
| $V_{CC}$ | | Supply voltage | Supply |
| WP#/ACC | $V_{PP}/\overline{WP}$ | Supply voltage for fast program (optional) or write | Input |
| $V_{SS}$ | | Ground | – |

## Packages

The S29GL032N and M29W320E are delivered in TSOP48 – 12 x 20 mm and TFBGA48 – 6 x 8 mm, 0.8 mm pitch packages. Compared with S29GL032N, the package size of M29W320E TFBGA48 is smaller than that of S29GL032N VBK48 – 6.15 x 8.15mm. In addition, M29W320E holds a different BGA ball size from what S29GL032N does. The BGA ball size of M29W320E ranges from 0.35mm to 0.45mm while the BGA ball size of S29GL032N ranges from 0.35mm to 0.43mm.

The M29W320E is fully pin-to-pin compatible with the S29GL032N. See Figure 1 and Figure 2, in conjunction with Table 1.

Refer to the S29GL032N and M29W320E datasheets for details on the packages.

**Figure 1 S29GL032N TSOP48 connections**

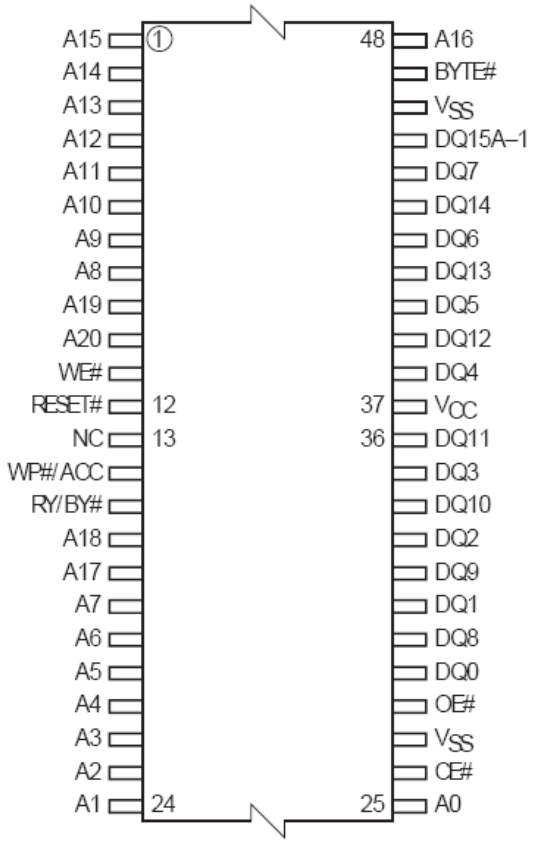



**Figure 2 M29W320E TSOP48 connections**

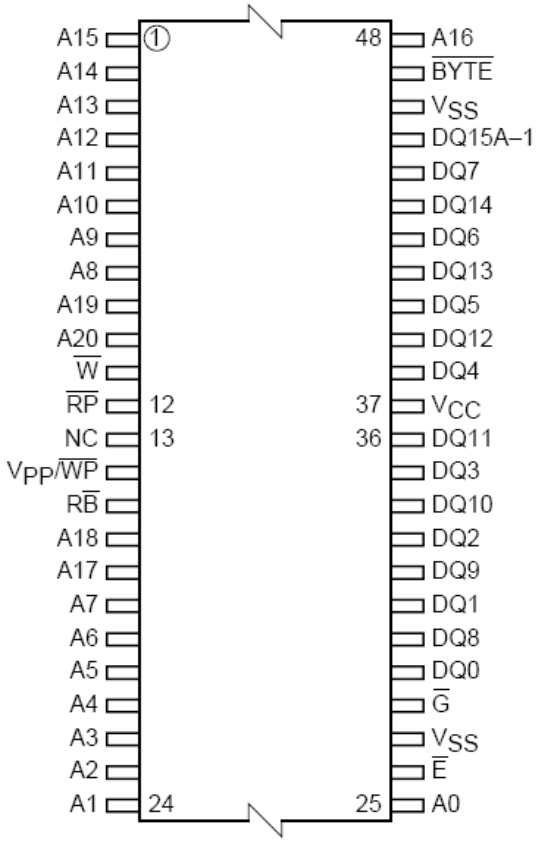
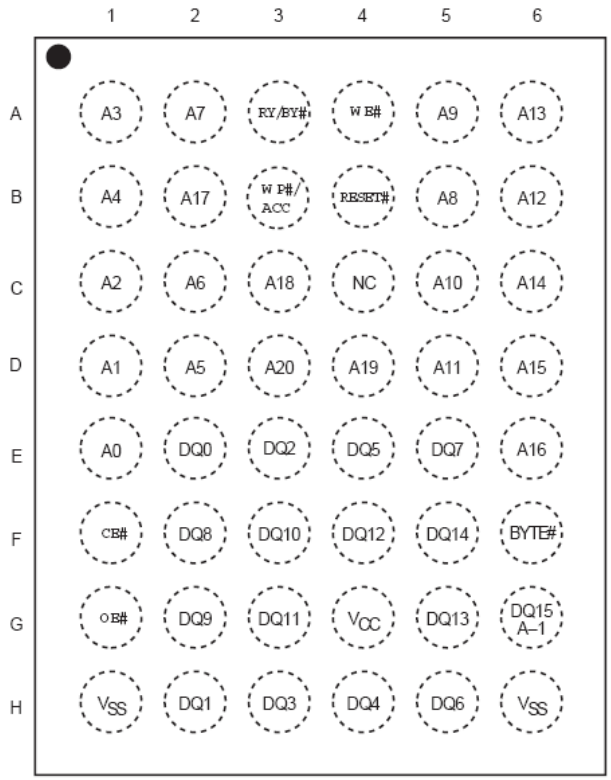
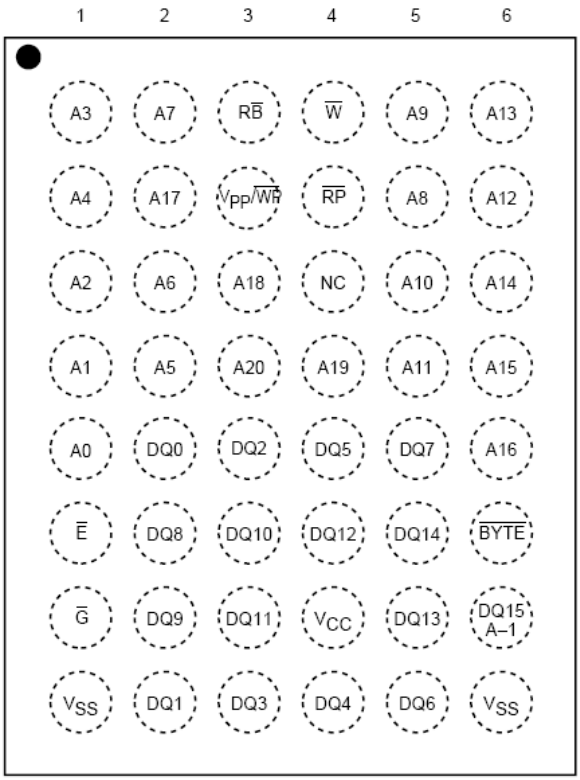


**Figure 3 S29GL032N VBK048 connections**




VBK048 dimensions are 6.15 mm x 8.15 mm

**Figure 4 M29W320E TFBGA48 connections**




TFBGA48 dimensions are 6 mm x 8 mm

**Figure 5 S29GL032N VBK064 connections**

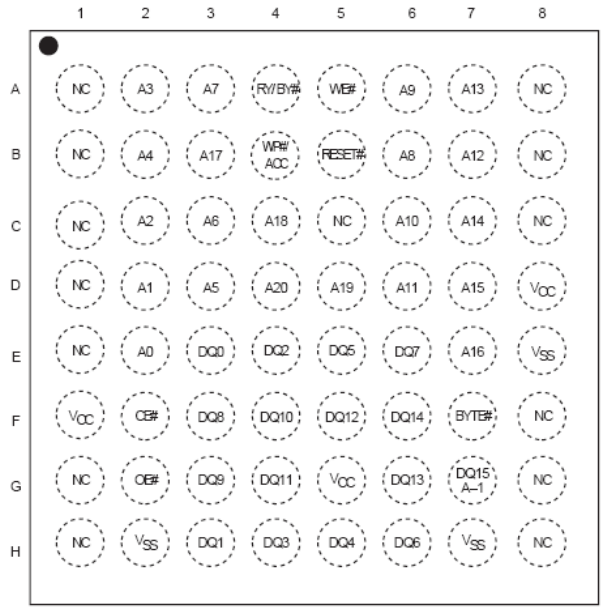
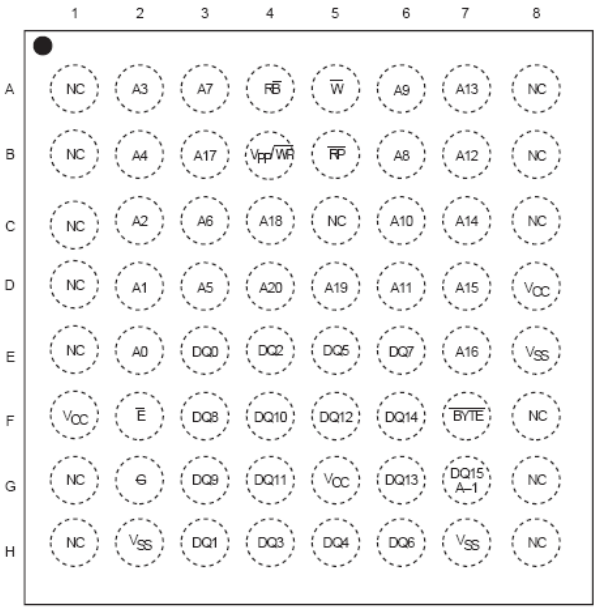



**Figure 6 M29W320E TFBGA64 connections**



## Software command set

The S29GL032N and M29W320E feature an identical set of standard commands. The commands are compliant with the JEDEC standard.

**Table 2: Software commands for the S29GL032N and M29W320E devices**

| Command | S29GL032N | M29W320E |
|---|---|---|
| Read/Reset | ✓ | ✓ |
| Auto Select | ✓ | ✓ |
| Program | ✓ | ✓ |
| Write Buffer | ✓ | - |
| Unlock Bypass | ✓ | ✓ |
| Unlock Bypass Program | ✓ | ✓ |
| Unlock Bypass Reset | ✓ | ✓ |
| Chip Erase | ✓ | ✓ |
| Block Erase | ✓ | ✓ |
| Program/Erase Suspend | ✓ | ✓ |
| Program/Erase Resume | ✓ | ✓ |
| Page Read | ✓ | - |
| Read CFI Query | ✓ | ✓ |
| Enter Extended Block | ✓ | ✓ |
| Exit Extended Block | ✓ | ✓ |
| Double Word Program | - | ✓ |
| Quadruple Byte Program | - | ✓ |

## Fast program commands

The S29GL032N and the M29W320E devices both feature fast program commands. S29GL032N has a 16 word write buffer. M29W320E has the capability to program 2 words, or 4 bytes at once to improve throughput.

**Table 3: M29W320E fast program commands (16-bit mode)**

| Command | Length | Bus write operations(1) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1st | | 2nd | | 3rd | | 4th | | 5th | | 6th | |
| | | Add | Data | Add | Data | Add | Data | Add | Data | Add | Data | Add | Data |
| Double word Program | 3 | 555 | 50 | PA0 | PD0 | PA1 | PD1 | | | | | | |

1. X Don't care, PA Program Address, PD Program Data.

**Table 4: S29GL032N Write to Buffer command (16-bit mode)**

| Command | Cycles | Bus write cycles | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1st | | 2nd | | 3rd | | 4th | | 5th | | 6th | |
| | | Add | Data | Add | Data | Add | Data | Add | Data | Add | Data | Add | Data |
| Write to Buffer(1) | WC + 5 | 555 | AA | 2AA | 55 | BA(2) | 25 | BA(2) | WC(2) | $PA_{(2)}$ | PD(2) | WBL(2) | PD(2) |

1. The total number of cycles in the command sequence is determined by the number of words to be written to the write buffer. The maximum number of cycles is 20.
2. BA Block Address, WC Number of words to be programmed - 1, PA Program Address, PD Program Data, WBL Write Buffer Location (address must be within the same write buffer page as PA).

**Table 5: M29W320E fast program commands (8-bit mode)**

| Command | Length | Bus write operations(1) | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1st | | 2nd | | 3rd | | 4th | | 5th | | 6th | | | 7th | | 8th | | 9th |
| | | Add | Data | Add | Data | Add | Data | Add | Data | Add | Data | Add | Data | Add | Data | Add | Data | Add | Data |
| Quadruple byte Program | 5 | AAA | 55 | PA0 | PD0 | PA1 | PD1 | PA2 | PD2 | PA3 | PD3 | | | | | | | | |

1. X Don't care, PA Program Address, PD Program Data.

**Table 6: S29GL032N Write to Buffer command (8-bit mode)**

| Command | Length | Bus write cycles | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1st | | 2nd | | 3rd | | 4th | | 5th | | 6th | |
| | | Add | Data | Add | Data | Add | Data | Add | Data | Add | Data | Add | Data |
| Write to Buffer(1) | BC+5 | AAA | AA | 555 | 55 | BA(2) | 25 | BA | BC(2) | PA(2) | PD(2) | WBL(2) | PD |

1. The total number of cycles in the command sequence is determined by the number of bytes to be written to the write buffer. The maximum number of cycles is 36.
2. BA Block Address, BC Number of bytes to be programmed - 1, PA Program Address, PD Program Data, WBL Write Buffer Location (address must be within the same write buffer page as PA).

## 0x554 Command Tolerance

In x8 mode, M29W320E does not allow 0x554 on the address for Read, Auto Select, Program, Erase, Unlock Bypass, or Extended Block commands. The address for these commands must be 0x555 as in the data sheet. S29GL032N allows 0x554 on the address for these commands.

## Device codes and auto select codes

The auto select codes are composed of the manufacturer code, the device code, the block protection status, and the extended memory block verify code.

The S29GL032N and M29W320E devices have different manufacturer code, device code, and extended memory block verify code.

The S29GL032N and M29W320E devices use identical commands and address inputs to read the auto select codes. Two methods are available to access the auto select codes:

- In the first method, an Auto Select command is issued (see Table 2 Command set) to place the device in auto select mode. The auto select codes can then be read by using a bus read operation with addresses and control signals set as shown in Table 7 Bus operations for accessing the auto select codes.
- In the high voltage method, the same sequence of bus read operations as in the first method is issued, except that A9 is set at $V_{ID}$.

**Table 7: Bus operations for accessing the auto select codes**

| Operation | $\overline{E}$ | $\overline{G}$ | $\overline{W}$ | Address inputs | | Data inputs/outputs | | |
|---|---|---|---|---|---|---|---|---|
| | | | | x 8 mode | x 16 mode | x 8 mode | | x 16 mode |
| | | | | DQ15A-1, A0-A20 | A0-A20 | DQ14-DQ8 | DQ7-DQ0 | DQ15A-1, DQ14-DQ0 |
| Read manufacturer code | $V_{IL}$ | $V_{IL}$ | $V_{IH}$ | A0-A3 = $V_{IL}$, A6 = $V_{IL}$, A9 = $V_{ID}$, others $V_{IL}$ or $V_{IH}$ | | Hi-Z | see *Table 8* | |
| Read device code | | | | A0 = $V_{IH}$, A1-A3 = $V_{IL}$, A6 = $V_{IL}$, A9 = $V_{ID}$, others $V_{IL}$ or $V_{IH}$ | | | | |
| Block protection status | | | | A0,A2,A3, A6= $V_{IL}$, A1= $V_{IH}$, A9 = $V_{ID}$, A12-A20 = Block address, others $V_{IL}$ or $V_{IH}$ | | | | |
| Extended memory block verify code | | | | A0-A1 = $V_{IH}$, A2-A3 = $V_{IL}$, A6 = $V_{IL}$, A9 = $V_{ID}$, others $V_{IL}$ or $V_{IH}$ | | | | |

**Table 8: Auto select codes Boot Block**

| Auto select code | Spansion | | Numonyx | | Spansion | | Numonyx | |
|---|---|---|---|---|---|---|---|---|
| | S29GL032N (03 model)[1] | S29GL032N (04 model)[2] | M29W320ET | M29W320EB | S29GL032N (03 model)[1] | S29GL032N (04 model)[2] | M29W320ET | M29W320EB |
| | x 16 mode | | | | x 8 mode | | | |
| Manufacturer code | 0001h | | 0020h | 0020h | 01h | | 20h | |
| Device code | 227Eh 221Ah 2201h | 227Eh 221Ah 2200h | 227Eh 221Ah 2201h | 227Eh 2210h 2200h | 7Eh+10h+01h | 7Eh+10h+00h | 7Eh+10h+01h | 7Eh+10h+00h |
| Block protection status | 01h (protected) 00h (unprotected)[3] | | 0001h (protected) 0000h (unprotected) | | 01h (protected) 00h (unprotected) | | | |
| Extended memory block verify indicator | XX9Ah (factory locked) XX1Ah (not factory locked)(3) | XX8Ah (factory locked) XX0Ah (not factory locked)(3) | 2288h (factory locked) 2208h (not factory locked) | 2288h (factory locked) 2208h (not factory locked) | 9Ah (factory locked) 1Ah (not factory locked)[3] | 8Ah (factory locked) 0Ah (not factory locked)[3] | 88h ( factory locked) 08h (not factory locked) | 88h (factor y locked) 08h (not factory locked) |

1. Top boot model.
2. Bottom boot model.
3. DQ8 to DQ15 are ‘don’t care’.

# Difference in CFI operation

When exiting CFI mode on M29W320E device, Read/Reset command (0xF0h) is used to return the device to the previous mode (Main Array Read or Auto Select Mode). S29GL032N will enter main array read mode when it is issued Read/Reset command (0xF0h).

Table 9 CFI exit sequence shows the detail exiting command sequence difference.

**Table 9: CFI exit sequence**

| Entering CFI Sequence | Exiting from CFI to main array read command sequence | |
|---|---|---|
| | S29GL032N | M29W320E |
| Main Array Read --> CFI | 0xF0h | 0xF0h |
| Main Array Read --> Auto Select Mode --> CFI | 0xF0h | 0xF0h --> 0xF0h (twice cmd) |

S29GL032N will enter main array read mode when it is issued Read/Reset command (0xF0h).

M29W320E reads out different CFI information in byte mode comparing with S29GL032N.

**Table 10 CFI difference comparison (byte mode only)**

| Address (x8) | S29GL32N | | M29W320E | |
|---|---|---|---|---|
| | Data | Description | Data | Description |
| 20h | 51h | Query Unique ASCII string "Q" | 51h | Query Unique ASCII string "Q" |
| 21h | 51h | Query Unique ASCII string "Q" | 00h | |
| 22h | 52h | Query Unique ASCII string "R" | 52h | Query Unique ASCII string "R" |
| 23h | 52h | Query Unique ASCII string "R" | 00h | |
| 24h | 53h | Query Unique ASCII string "Y" | 53h | Query Unique ASCII string "Y" |
| 21h | 53h | Query Unique ASCII string "Y" | 00h | |

**Table 11 CFI difference comparison**

| Address (x16) | Address (x8) | S29GL032N | | M29W320E | |
|---|---|---|---|---|---|
| | | Data | Description | Data | Description |
| 1Dh | 3Ah | 0000h | $V_{PP}$ Min = N/A | 00B5h | $V_{PP}$ Min = 11.5 V |
| 1Eh | 3Ch | 0000h | $V_{PP}$ Max = N/A | 00C5h | $V_{PP}$ Max = 12.5 V |
| 1Fh | 3Eh | 0007h | RFU | 0004h | Typical timeout per single Byte/Word Program = 2^n µs= 16uS |
| 20h | 40h | 0007h | Typical timeout for Min. size buffer write 2^N µs= 128uS | 0000h | Typical timeout for minimum size write buffer program = 2^n µs |
| 23h | 46h | 0003h | Max. timeout for byte/word program 2^N times typical. Max time=typ*8 | 0004h | Maximum timeout for Byte/Word Program = 2^n times typical. Max time=Typ*16 |
| 24h | 48h | 0005h | Max. timeout for buffer write 2N times typical | 0000h | Maximum timeout for write buffer program = 2^n µs |
| 25h | 4Ah | 0004h | Max. timeout per individual block erase 2^N times typical | 0003h | Maximum timeout per individual Block Erase = 2^n times typical |
| 28h | 50h | 000Xh | Flash Device Interface description (refer to CFI publication 100)<br>0001h = x16-only bus devices<br>0002h = x8/x16 bus devices | 0002h | Flash device interface code description |
| 2Ah | 54h | 0005h | Max. number of byte in multi-byte write = 2^n (00h = not supported) | 0000h | Maximum number of bytes in multi-byte program or page = 2^n |
| 44h | 88h | 0033h | Minor version number, ASCII | 0030h | Minor version number, ASCII |
| 45h | 8Ah | 00XXh | Address Sensitive Unlock (Bits 1-0)<br>0 = Required, 1 = Not Required<br>Process Technology (Bits 7-2) 0100b = 110 nm MirrorBit<br>0011h = x8-only bus devices<br>0010h = all other devices | 0000h | Address sensitive unlock (bits 1 to 0)<br>00h = required, 01h = not required<br>Silicon revision number (bits 7 to 2) |
| 48h | 90h | 0000h | Sector Temporary Unprotect<br>00 = Not Supported, 01 = Supported | 0001h | Temporary Block Unprotect<br>00h = not supported, 01h = supported |
| 49h | 92h | 0008h | Sector Protect/Unprotect scheme<br>0008h = Advanced sector Protection | 0004h | Block Protect /Unprotect |
| 4Ch | 98h | 0002h | Page Mode Type<br>02 = 8 Word Page | 0000h | Page mode: 00h = not supported, 01h = 4 page word, 02h = 8 page word |
| 4Fh | 9Eh | 00XXh | Top/Bottom Boot Sector Flag<br>02h = Bottom Boot Device, 03h = Top Boot Device, 04h = Uniform sectors bottom WP# protect, 05h = Uniform sectors top WP# protect | 00XXh | Top/Bottom Boot Block Flag<br>02h = Bottom Boot device<br>03h = Top Boot device |

## Performance and characteristics

The S29GL032N and the M29W320E have almost compatible DC and AC characteristics (see the respective datasheets for details). The M29W320E memories offer better performance in terms of access time than the S29GL032N devices.

## Access time

The M29W320E has a random access time of 70 ns or 90 ns, whereas the S29GL032N has an access time of 90 ns, or 110 ns.

## Page read mode

The page mode is available on the S29GL032N, while M29W320E doesn't support this feature.

## Program and erase times

The time required to program or erase the whole memory is lower on the M29W320E compared to the S29GL032N. The memory can be either programmed using a Fast Program or an Enhanced Buffered Program command (see Section 3.1), or using the word by word program command.

Refer to Section 3.1 for details on fast program commands.

**Table 12 M29W320E program and erase times**

| Parameter | Min | Typ[1][2] | Max[2] | Unit |
|---|---|---|---|---|
| Chip Erase | | 40 | 200[3] | s |
| Block Erase (64 Kbytes)[4] | | 0.8 | 6[3] | s |
| Erase Suspend latency time | | | 50 | µs |
| Program (byte or word) | | 10 | 200 | µs |
| Double Word / Quadruple Byte program | | 10 | 200 | µs |
| Chip Program (byte by byte) | | 40 | 200[3] | s |
| Chip Program (word by word) | | 20 | 100[3] | s |
| Chip Program (Double Word/Quadruple Byte Program) | | 10 | 100[3] | s |
| Program Suspend latency time | | | 4 | µs |
| Program/Erase cycles (per block) | 100,000 | | | cycles |
| Data retention | 20 | | | years |

1. Typical values measured at room temperature and nominal voltages.
2. Sampled, but not 100% tested.
3. Maximum value measured at worst case conditions for both temperature and $V_{CC}$ after 100,000 program/erase cycles.

**Table 13 Comparison: S29GL032N and M29W320E performance and characteristics**

| Parameter | S29GL032N | M29W320E |
|---|---|---|
| Access time | 90, 110 ns | 70, 90 ns |
| Page Read | 25 ns (8-word page) | - |
| Fast Program | Write to Buffer Program | Multi-Word Program |
| Chip Program time | 31.5 s | 20 s (word by word) |
| | | 10 s (double word programming) |
| Supply voltage | 2.7 to 3.6 V | 2.7 to 3.6 V |
| Temperature range | –40 to 85 °C | |
| Chip Erase time | 32 s (typical), except all 0000h programmed prior to erasing | 40 s (typical) |

## Block protection

The M29W320E memories offer similar hardware protection as the S29GL032N devices, while don't offer advanced protection feature as S29GL032N. The table below shows how the three techniques are called in the M29W320E and S29GL032N devices, respectively.

**Table 14 Block protection techniques in M29W320E and S29GL032N Flashes**

| M29W320E[(1)] | S29GL032N |
|---|---|
| Hardware method ($V_{PP}$/WP) | Hardware Data Protection (WP/ACC) |
| - | Advanced protection/unprotection |

1. Please refer to the M29W320E datasheet for further details.

## Hardware Protection

On both devices, the $V_{PP}$ function allows the memory to use an external high voltage power supply to reduce the time required for fast program operations. The Write Protect (WP) function provides a hardware method of protecting the outermost memory blocks:

- When $V_{PP}$/WP is Low, $V_{IL}$, the two highest or lowest blocks are protected on both the S29GL032N and M29W32E devices.
- When $V_{PP}$/WP is High, $V_{IH}$, the memory reverts to the previous protection status of the outermost blocks.

## Software Protection

The S29GL032N device has two additional protection features, Persistent Sector Protection and Password Sector Protection. These are not present on M29W320E. Customers requiring this functionality can use M29W640GS.

For more details, please refer to AN2392: OTP Irreversible Protection modes on the M29W640GSH/L and M29W640GST/B Secure Flash memories.

## Temporary block unprotect

In the M29W320E, when held at $V_{ID}$, the RP or $V_{PP}$/WP pin temporarily unprotects all the blocks.

This functionality is not available on S29GL032N devices.

## Conclusion

Applications can be easily migrated from an S29GL032N to an M29W320E Flash memory. In addition, the M29W320E features better performance with respect to the S29GL032N devices.

## Revision history

| Date | Revision | Changes |
|---|---|---|
| 30-Apr-2009 | 1 | Initial release |