



# **Conversion Guide: Numonyx™ StrataFlash® Embedded Memory P33 (256-Mbit, 256-Mbit/256- Mbit) 130nm to 65nm**

**Application Note - 909**

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***Nov 2008***

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## Revision History

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| Date of Revision | Revision | Description  |
|------------------|----------|--|
| May 2008         | 001      | Initial Release.   |
| July 2008        | 02       | Removed buffer programming difference; added in its place <a href="#">Section 5.7, "Performance Improvements in P33 65nm"</a> on page 16.  |
| Sep 2008         | 03       | Updated Axcell trademark<br>Removed 64M related contents.  |
| Nov 2008         | 04       | Returned to StrataFlash1 trademark<br>Removed 128M related contents<br>Clarify package options for each density<br>Align Address to start from A1<br>Remove Numonyx Confidential<br>Remove Enhanced Configuration Register command |

## 1.0 Introduction

This application note describes the migration from the Numonyx™ StrataFlash® Embedded Memory (P33-130nm) device to the Numonyx™ StrataFlash® Embedded Memory (P33-65nm) device.

*Note:* Unless otherwise indicated, throughout the rest of this document, the Numonyx™ StrataFlash® Embedded Memory (P33-130nm) device is referred to as the P33 130nm device and the Numonyx™ StrataFlash® Embedded Memory (P33-65nm) device is referred to as the P33 65nm device.

This document was written based on device information available at the time. Any changes in specifications to either device might not be reflected in this document. Refer to the appropriate documents or sales personnel for the current product information before finalizing any design.

## 2.0 Device Overview

The following sections provide a brief overview of the feature differences between the P33 130nm and the P33 65nm devices.

### 2.1 P33 130nm Device

The P33 130nm device features 64-Mbit through 512-Mbit densities and AC/DC specifications for 52MHz operation. Other features include high performance synchronous-burst read, Buffered Enhanced Factory Programming (BEFP) with a 32-word buffer, and an expanded OTP register space. Packaging options include industry-standard Easy BGA, TSOP and Quad+ packages.

### 2.2 P33 65nm Device

The P33 65nm device features 64-Mbit through 2-Gbit densities and AC/DC specifications for 52 MHz operation. This document covers specially 256-Mbit and 512-Mbit (256M/256M) product information. Other features include high performance synchronous-burst read, Buffered Enhanced Factory Programming (BEFP) with a 512-word buffer, and an expanded OTP register space. The P33 65nm device also features enhanced protection via a password access feature, which allows users to protect write access to the pre-defined blocks. Please contact the Numonyx Sales for further details concerning password access. Packaging options include industry-standard Easy BGA and TSOP packages.

## 2.3 P33 130nm and 65nm Features Comparison

**Table 1: P33 130nm and 65nm Feature Comparison**

| Features / Specifications        |                                   | P33 130nm          | P33 65nm           |
|----------------------------------|-----------------------------------|--------------------|--------------------|
| Available Densities (Monolithic) | 64 Mbit                           | Yes                | Yes*               |
|                                  | 128 Mbit                          | Yes                | Yes*               |
|                                  | 256 Mbit                          | Yes                | Yes                |
| Available Densities (Stack)      | 512 Mbit                          | Yes                | Yes                |
| Performance                      | Speed                             | 52 MHz             | 52 MHz             |
|                                  | Initial Access Time (Easy BGA)    | 85 ns              | 95 ns              |
|                                  | Initial Access Time (TSOP)        | 95 ns              | 105 ns             |
| Block Architecture               | Parameter Blocks                  | Four: 32-kByte     | Four: 32-kByte     |
|                                  | Main Blocks                       | 128-kByte          | 128-kByte          |
|                                  | 16-bit data bus                   | Yes                | Yes                |
| Operating Voltage                | Logic Core (V <sub>CC</sub> )     | 2.3 V to 3.6 V     | 2.3 V to 3.6 V     |
|                                  | I/O (V <sub>CCQ</sub> )           | 2.3 V to 3.6 V     | 2.3 V to 3.6 V     |
| Features                         | OTP Register Space                | 128-bits + 2 Kbits | 128-bits + 2 Kbits |
|                                  | Flexible Block Locking            | Yes                | Yes                |
|                                  | Buffered Enhanced Factory Program | 32-word buffer     | 512-word buffer    |
|                                  | Password Access                   | No                 | Yes                |
|                                  | Blank Check                       | No                 | Yes                |
| Reliability                      | Operating Temperature             | -40 °C to +85 °C   | -40 °C to +85 °C   |
|                                  | Cycles                            | 100,000            | 100,000            |

**Note:** This document doesn't cover 64-Mbit and 128-Mbit die information. Please refer to Numonyx local Sales for detail.

### 3.0 Device Packaging and Ballout

The following section provides a brief overview of the package and ballout differences between the P33 130nm and P33 65nm devices.

**Table 2: Package Comparison**

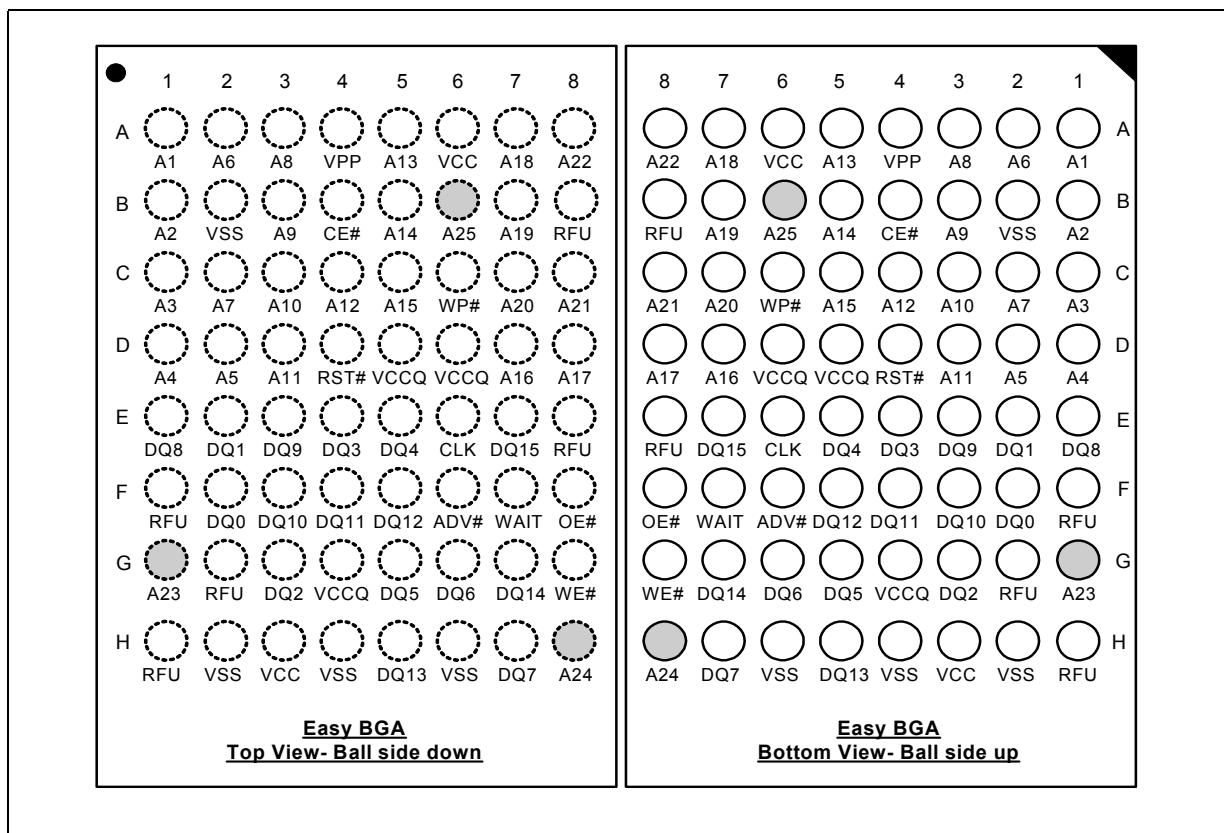
| Features / Specifications |              | P33 130nm | P33 65nm |
|---------------------------|--------------|-----------|----------|
| Monolithic Densities      | Easy BGA     | Yes       | Yes      |
|                           | TSOP         | Yes       | Yes      |
|                           | QUAD+ (SCSP) | Yes       | No       |
| Stack Densities           | Easy BGA     | Yes       | Yes      |
|                           | TSOP         | Yes       | See Note |
|                           | QUAD+ (SCSP) | Yes       | No       |

**Note:** For 256M/256M stack TSOP migration options, please contact your local Numonyx local Sales representative.

### 3.1 Easy BGA Ballout

The Easy BGA ballout is available for both P33 130nm and P33 65nm products. Ball pitch of the Easy BGA ballout is 1.0 mm. The package has an 8 x 8 active-ball matrix.

**Figure 1: 64-Ball Easy BGA Ballout (256/512-Mbit)**



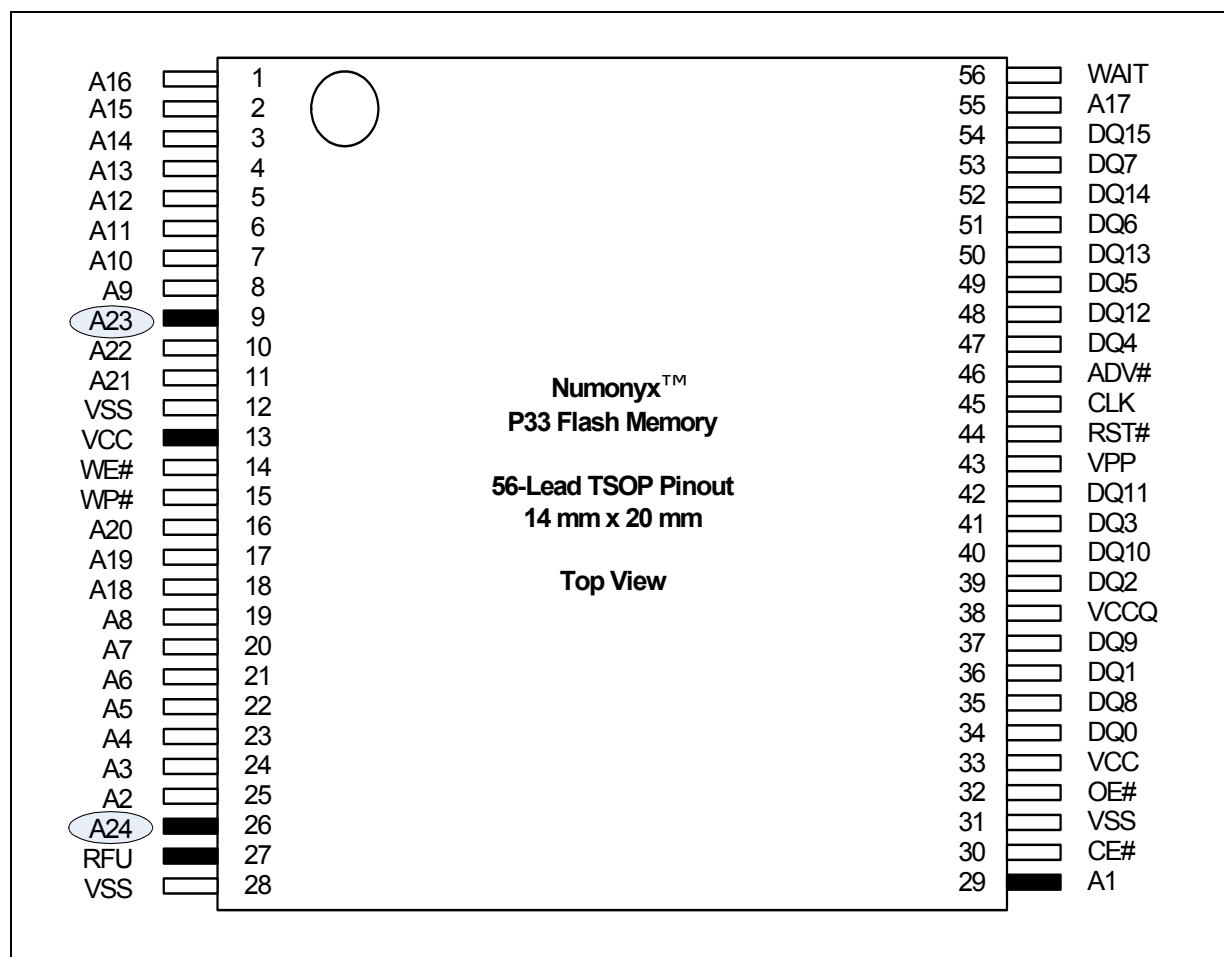
**Notes:**

1. A1 is the least significant address bit.
2. A24 is valid for 256-Mbit densities and above; otherwise, it is a no connect (NC).
3. A25 is valid for 512-Mbit densities; otherwise, it is a no connect (NC).

### 3.2 TSOP Pinout

The TSOP Pinout is available and compatible for both P33 130nm and P33 65nm products. Pin 13 on P33 130nm is connected to Vcc. For P33 65nm this pin has no internal connection; it may be driven or left floated

**Figure 2: 56-Lead TSOP Pinout (256-Mbit)**



1. A1 is the least significant address bit.
2. A24 is valid for 256-Mbit densities; otherwise, it is a no connect (NC).
3. No Internal Connection on VCC Pin 13; it may be driven or floated. For legacy designs, pin can be tied to Vcc



## 4.0 Hardware Design Considerations

The P33 130nm and P33 65nm flash memory devices provide reliable, two-bit-per-cell storage technology for embedded applications. They satisfy the need for more density in less space, with a high-speed interface. Both flash devices feature asymmetrically-blocked architecture, Buffered Enhanced Factory Programming, and synchronous-burst read mode. The following sections discuss hardware design considerations when converting from the P33 130nm device to the P33 65nm device.

### 4.1 AC Read Specifications

Refer to the product datasheet for detailed list of all read timing specifications:

- Numonyx™ StrataFlash® Embedded Memory (P33-130nm) Datasheet (314749)
- Numonyx™ StrataFlash® Embedded Memory (P33-65nm) Datasheet (320003)

**Table 3: Key AC Read Specification Comparison**

| Features / Specifications |  | P33 130nm              | P33 65nm              |
|---------------------------|--|------------------------|-----------------------|
| Performance               | Clock Frequency (Max)                                    | 52 MHz                 | 52 MHz                |
|                           | Asynchronous Access ( $t_{AVQV}$ $t_{VLQV}$ $t_{ELQV}$ ) | Easy BGA: 85 ns        | Easy BGA: 95 ns       |
|                           |  | TSOP: 95 ns            | TSOP: 105 ns          |
|                           | Asynch Page Access time ( $t_{APA}$ )                    | 25 ns                  | 25 ns                 |
|                           | Clock-to-Data Burst Access ( $t_{CHQV}$ )                | 17 ns                  | 17 ns                 |
|                           | Burst Data Hold Time ( $t_{CHQX}$ )                      | 3 ns                   | 3ns                   |
|                           | Address and ADV# Setup Time ( $t_{AVCH}$ , $t_{VLCH}$ )  | 9 ns                   | 9 ns                  |
|                           | CE# Setup Time ( $t_{ELCH}$ )                            | 9 ns                   | 9 ns                  |
|                           | Rise/Fall Time ( $t_{FCLK/LCLK}$ )                       | 3.0 ns                 | 3.0 ns                |
|                           | Clock High/Low Time ( $t_{CH/CL}$ )                      | 5 ns                   | 5ns                   |
|                           | Vcc power valid to RST# de-assertion (high)              | 60 us                  | 300 us                |
|                           | Async Page Size  | 4 words                | 16 words              |
|                           | Synchronous Burst Length (word)                          | 4-, 8-, 16-, and Cont. | 4-, 8-, 16- and Cont. |
|                           | Burst Suspend Mode                                       | Yes                    | Yes                   |

### 4.2 AC Write/Erase Specifications

*Note:* Refer to the product datasheet for detailed list of all write and erase timing specifications.

- Numonyx™ StrataFlash® Embedded Memory (P33-130nm) Datasheet (314749)
- Numonyx™ StrataFlash® Embedded Memory (P33-65nm) Datasheet (320003)

**Table 4: Key AC Write-Erase Specification Comparison**

| Features / Specifications  |  | P33 130nm   | P33 65nm   |
|----------------------------|--|---|--|
| <b>Program Performance</b> | Program Buffer Size                          | 64 Bytes  | 1024 Bytes   |
|                            | Single Word Program Time (typ/max)           | 90/200 $\mu$ s  | 150/456 $\mu$ s                                      |
|                            | Aligned 32-word Buffered Program Time (typ)  | 145 KBytes/s ( $V_{PP_L}$ )<br>188 KByte/s ( $V_{PP_H}$ ) | 364 KBytes/s   |
|                            | Aligned 64-word Buffered Program Time (typ)  | —   | 593 KBytes/s   |
|                            | Aligned 128-word Buffered Program Time (typ) | —   | 941 KBytes/s   |
|                            | Aligned 256-word Buffered Program Time (typ) | —   | 1.29 MBytes/s  |
|                            | Aligned 512-word Buffered Program Time (typ) | —   | 1.46 MBytes/s  |
|                            | BEFP Environment Requirement                 | 25 $^{\circ}$ C +/- 5 $^{\circ}$ C<br>100 P/E cycles      | 30 $^{\circ}$ C +/- 10 $^{\circ}$ C<br>50 P/E cycles |
|                            | BEFP Time                                    | 188KB/s   | 2.0MB/s  |
| <b>Erase Performance</b>   | Erase Time - 16KW Param. Block (typ/max)     | 0.4/2.5 s   | 0.8/4.0 s  |
|                            | Erase Time - 64KW Main Block (typ/max)       | 0.8/4.0 s   | 0.8/4.0 s  |
|                            | Program/Erase Suspend Latency (typ)          | 20 $\mu$ s  | 20 $\mu$ s   |
|                            | Blank Check                                  | No  | Yes  |

### 4.3 DC Current Specification

The P33 65nm device consumes higher power than the P33 130nm device in standby mode under MAX condition.

**Table 5: Key DC Read Specification Comparison**

| Features / Specifications         |                                     | P33 130nm                 | P33 65nm                  |
|-----------------------------------|-------------------------------------|---------------------------|---------------------------|
| <b>DC Current Characteristics</b> | Standby Current (typ/max)           | 70/195 $\mu$ A (256-Mbit) | 65/210 $\mu$ A (256-Mbit) |
|                                   | Continuous Burst Read Current (max) | 28 mA (52 MHz)            | 24 mA (52 MHz)            |
|                                   | Program/Erase Current (typ/max)     | 35/50 mA                  | 35/50 mA                  |
|                                   | VPP Factory Program Current (max)   | 22 mA                     | Less than 1 mA            |

## 5.0 Flash Software Design Considerations

The following sections discuss software design considerations when converting from the P33 130nm device to the P33 65nm device.

### 5.1 Device Identification

The P33 130nm and P33 65nm flash devices have identical device identification codes.

**Table 6: P33 Device ID Codes**

| Code Type             | Address Offset | Device Density | P33-130nm Codes |        | P33-65nm Codes |        |
|-----------------------|----------------|----------------|-----------------|--------|----------------|--------|
|                       |                |                | Top             | Bottom | Top            | Bottom |
| Device Identification | 0x01           | 256 Mbit       | 891F            | 8922   | 891F           | 8922   |

### 5.2 Read Configuration Register (RCR)

Read configurations for both the P33 130nm and P33 65nm devices are configured using the Read Configuration Register (RCR). For example, to place the device in synchronous burst-read mode, you set the read mode bit in the RCR. The P33 65nm RCR includes the following modifications to the RCR:

- Latency Count *RCR[14:11]*: an additional bit, RCR14, has been added to the P33 65nm device; RCR14 was reserved on P33 130nm. P33 65nm supports latency counts of 8, 9, 10, 11, 12, 13, 14, and 15.
- WAIT Polarity *RCR[10]*: P33 130nm default setting high and P33 65nm default setting is low.
- Data Hold *RCR[9]*: P33 130nm supports 1-clock or 2-clock cycle data hold. RCR[9] is reserved for P33 65nm and supports a data hold of one cycle only.
- WAIT Delay *RCR[8]*: Same values for P33 130nm and P33-65nm.
- Burst Sequence *RCR[7]*: P33 130nm supports Linear "1" and Intel "0" burst order. P33 65nm supports linear "0" only. Setting P33 65nm to "1" will not affect the burst order; the burst order will always be linear.
- Clock Edge *RCR[6]*: Same values for P33 130nm and P33 65nm.
- Reserved *RCR[5:4]*: Same values for P33 130nm and P33 65nm.
- Burst Wrap *RCR[3]*: Same values for P33 130nm and P33 65nm.
- Burst Length *RCR[2:0]*: Same values for P33 130nm and P33 65nm.

*Note:* The differences are summarized in the table below.

**Table 7: Read Configuration Register Differences**

| Register Field | Value   | P33 130nm                               | P33 65nm           |
|----------------|---|---|--------------------|
| Latency Count  | 1000 =Code 8<br>1001 = Code 9<br>1010 = Code 10<br>1011 = Code 11<br>1100 = Code 12   | NA                                      | Available          |
| WAIT Polarity  | 0 =WAIT signal is active low<br>1 =WAIT signal is active high   | Default High                            | Default Low        |
| Data Hold      | 0 =Data held for a 1-clock data cycle<br>1 =Data held for a 2-clock data cycle  | Available                               | 1-clock cycle only |
| Burst Sequence | 0 =Reserved<br>1 =Linear  | Intel Burst Order<br>Linear Burst Order | Linear Burst Order |
| Clock Edge     | 0 = Falling edge<br>1 = Rising edge   | Available                               | Available          |
| Burst Wrap     | 0 =Wrap; Burst accesses wrap within burst length set by BL[2:0]<br>1 =No Wrap; Burst accesses do not wrap within burst length | Available                               | Available          |
| Burst Length   | 001 =4-word burst<br>010 =8-word burst<br>011 =16-word burst<br>111 =Continuous-word burst                                    | Available                               | Available          |

### 5.3 Blank Check

Blank Check is used to confirm whether a main-array block is completely erased. A Blank Check operation is performed one block at a time, and cannot be used during Program Suspend or Erase Suspend.

To use Blank Check, issue the Blank Check setup command then the confirm command. The addressed partition is automatically changed to Read Status Register mode, which remains in effect until another read-mode command is issued. During a blank check operation, the Status Register indicates a busy status (SR7 = 0). Upon completion, the Status Register indicates a ready status (SR7 = 1).

The Status Register should be checked for any errors, and then cleared. If the Blank Check operation fails, which means the block is not completely erased, the Status Register will indicate a Blank Check error (SR[7,5] = 1).

## 5.4 Device Commands

The command set for the P33 65nm and P33 130nm devices are fully compatible. However, the P33 65nm device includes new features such as the blank check operation and the enhanced configuration operation. Command set operations are compared here:

**Table 8: Command Bus Operations**

| Command                  |                                     | P33 130nm Code<br>(Setup/Confirm) | P33 65nm Code<br>(Setup/Confirm) |
|--------------------------|-------------------------------------|-----------------------------------|----------------------------------|
| Read Modes               | Read Array                          | 00FFh                             | 00FFh                            |
|                          | Read Status Register                | 0070h                             | 0070h                            |
|                          | Clear Status Register               | 0050h                             | 0050h                            |
|                          | Read Device Information             | 0090h                             | 0090h                            |
|                          | CFI Query                           | 0098h                             | 0098h                            |
| Program/Erase Operations | Word Program                        | 0040h                             | 0040h                            |
|                          | Buffered Program                    | 00E8h/00D0h                       | 00E8h/00D0h                      |
|                          | Buffered Enhanced Factory Program   | 0080h/00D0h                       | 0080h/00D0h                      |
|                          | Block Erase                         | 0020h/00D0h                       | 0020h/00D0h                      |
|                          | Program/Erase Suspend               | 00B0h                             | 00B0h                            |
|                          | Program/Erase Resume                | 00D0h                             | 00D0h                            |
|                          | Blank Check                         | N/A                               | 00BCh/00D0h                      |
| Security                 | Lock Block                          | 0060h/0001h                       | 0060h/0001h                      |
|                          | Unlock Block                        | 0060h/00D0h                       | 0060h/00D0h                      |
|                          | Lock Down Block                     | 0060h/002Fh                       | 0060h/002Fh                      |
|                          | Password Access                     | N/A                               | 00EBh                            |
| Registers                | Program Read Configuration Register | 0060h/0003h                       | 0060h/0003h                      |
|                          | Program OTP Register                | 00C0h                             | 00C0h                            |

**Note:** During Buffered Program command (E8h) sequence, if a read of the Main Array Data needs to be performed during the loading of the program buffer, then a write to an address outside of current block will abort the Buffer Programming Operation. Issuing the Read Array command (FFh) will put the device into Read Array mode. After Main Array read operation has been completed, the Buffer Program Operation must be restarted.

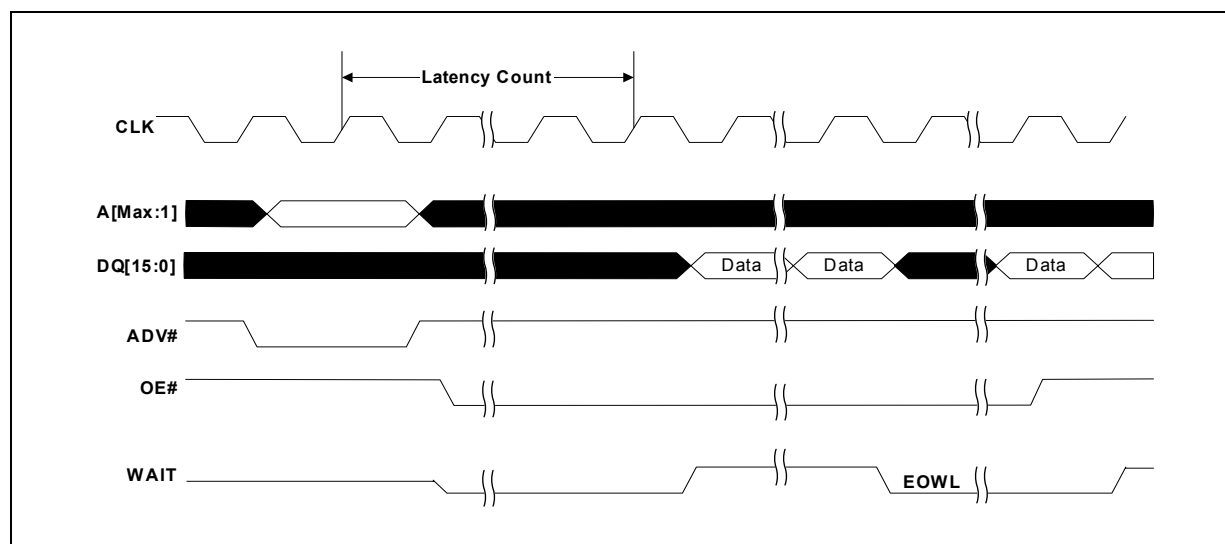
## 5.5 WAIT State Comparison

This section will compare the difference between the WAIT states on the P33 130nm and the P33 65nm.

### 5.5.1 WAIT State P33 65nm

End of wordline (EOWL) WAIT states can result when the starting address of the burst operation is not aligned to a 16-word boundary; that is, A[3:0] of start address does not equal 0x0. [Figure 3, "End of Wordline Timing Diagram" on page 14](#) illustrates the end of wordline WAIT state(s), which occur after the first 16-word boundary is reached. The number of data words and the number of WAIT states for both P33 130nm and P33 65nm are summarized in [Table 9, "End of Wordline Data and WAIT State Comparison" on page 14](#).

**Figure 3: End of Wordline Timing Diagram**



**Table 9: End of Wordline Data and WAIT State Comparison**

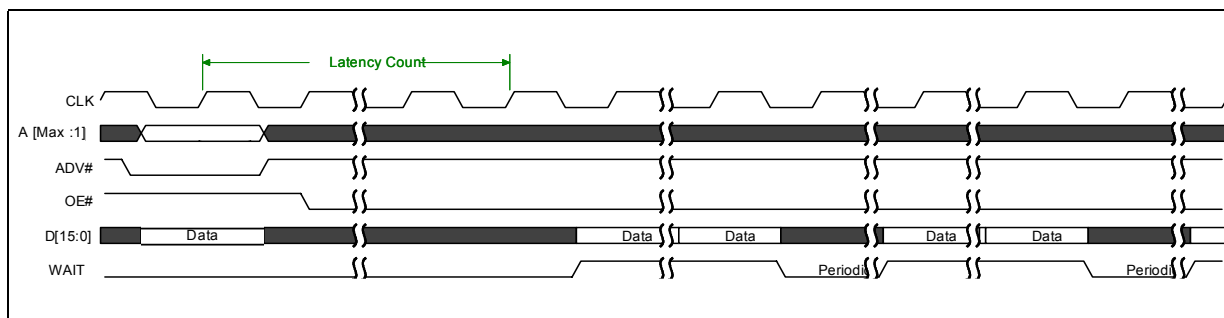
| Latency Count | P33 130nm     |               | P33 65nm      |               |
|---------------|---------------|---------------|---------------|---------------|
|               | Data States   | WAIT States   | Data States   | WAIT States   |
| 1             | Not Supported | Not Supported | Not Supported | Not Supported |
| 2             | 4             | 0 to 1        | Not Supported | Not Supported |
| 3             | 4             | 0 to 2        | 16            | 0 to 2        |
| 4             | 4             | 0 to 3        | 16            | 0 to 3        |
| 5             | 4             | 0 to 4        | 16            | 0 to 4        |
| 6             | 4             | 0 to 5        | 16            | 0 to 5        |
| 7             | 4             | 0 to 6        | 16            | 0 to 6        |
| 8             | Not Supported | Not Supported | 16            | 0 to 7        |
| 9             |               |               | 16            | 0 to 8        |
| 10            |               |               | 16            | 0 to 9        |
| 11            |               |               | 16            | 0 to 10       |
| 12            |               |               | 16            | 0 to 11       |
| 13            |               |               | 16            | 0 to 12       |
| 14            |               |               | 16            | 0 to 13       |
| 15            |               |               | 16            | 0 to 14       |

### 5.5.2 WAIT State P33 130nm

After encountering an EOWL situation, periodic WAIT states can occur in general as illustrated in [Figure 4, "Periodic WAIT State Timing Diagram" on page 15](#).

[Figure 10, "Periodic Data and WAIT State Comparison" on page 15](#) shows that P33 130nm has periodic WAIT states, but P33 65nm does not.

**Figure 4: Periodic WAIT State Timing Diagram**



**Table 10: Periodic Data and WAIT State Comparison**

| Latency Count | P33 130nm     |               | P33 65nm      |               |
|---------------|---------------|---------------|---------------|---------------|
|               | Data States   | WAIT States   | Data States   | WAIT States   |
| 1             | Not Supported | Not Supported | Not Supported | Not Supported |
| 2             | 4             | 0             | Not Supported | Not Supported |
| 3             | 4             | 0             | 16            | 0             |
| 4             | 4             | 0             | 16            | 0             |
| 5             | 4             | 1             | 16            | 0             |
| 6             | 4             | 2             | 16            | 0             |
| 7             | 4             | 3             | 16            | 0             |
| 8             | Not Supported | Not Supported | 16            | 0             |
| 9             |               |               | 16            | 0             |
| 10            |               |               | 16            | 0             |
| 11            |               |               | 16            | 0             |
| 12            |               |               | 16            | 0             |
| 13            |               |               | 16            | 0             |
| 14            |               |               | 16            | 0             |
| 15            |               |               | 16            | 0             |

## 5.6 CFI Differences

P33 65nm has a different CFI revision. During adoption of Numonyx or third party software, several differences must be taken into account. This section will describe the changes.

### 5.6.1 CFI revision

The CFI minor revision sorted in offset (P+4)h remains as 5.

CFI version 1.5 is supported in the software provided by Numonyx.

### 5.6.2 Time-out changes

All CFI time-out changes are listed in [Table 11, "Value Changes"](#)

**Table 11: Value Changes**

| Num | Difference  | 130nm   |       | 65nm    |        |
|-----|---|---------|-------|---------|--------|
|     |   | offset  | value | offset  | Values |
| 1   | "n" such that typical max. buffer write time-out = 2 <sup>n</sup> μ-sec   | 20h     | 512   | 20h     | 1024   |
| 2   | "n" such that maximum buffer write time-out = 2 <sup>n</sup> times typical  | 24h     | 1024  | 24h     | 4096   |
| 3   | "n" such that maximum number of bytes in write buffer = 2 <sup>n</sup>  | 2Ah     | 64    | 2Ah     | 1024   |
| 4   | Page Mode Read capability bits 0-7 = "n" such that 2 <sup>n</sup> HEX value represents the number of read-page bytes. See offset 28h for device word width to determine page-mode data output width. 00h indicates no read page buffer. | (P+1D)h | 8     | (P+1D)h | 32     |

## 5.7 Performance Improvements in P33 65nm

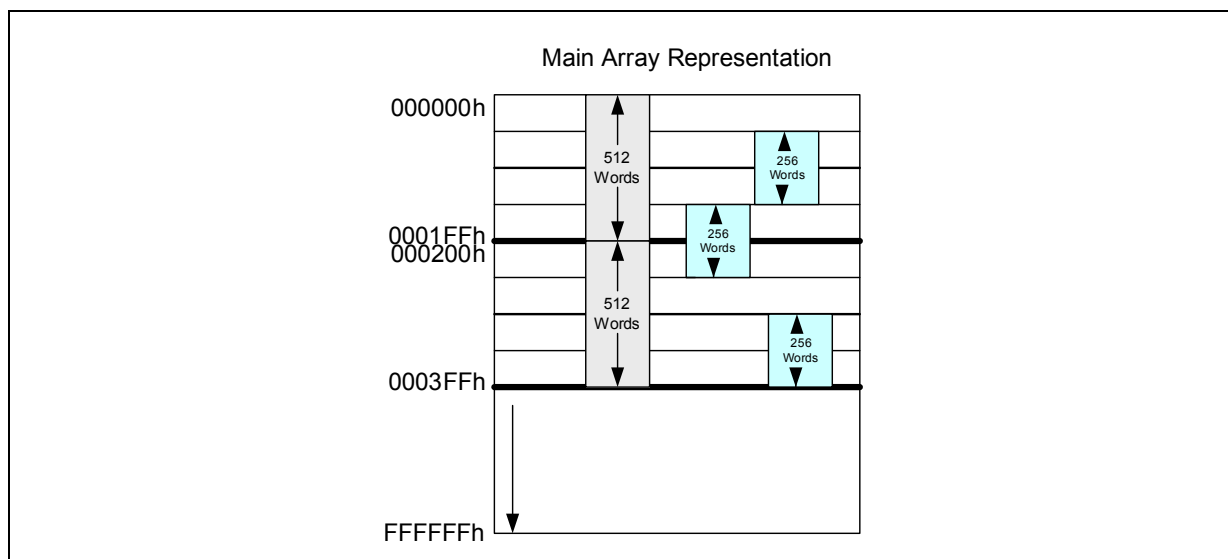
The write performance can be increased on P33 65nm by using the 1024 Byte/512 Word buffer. If buffered programming is being done using the 16 word buffer (similar to 130nm devices), no software changes need to be implemented.

To achieve maximum performance using the 1024 Byte/ 512 Word buffer on 65nm devices, the following considerations apply during software modifications:

1. Use the Full 1024 Byte/ 512 Word Buffer
2. If 1024 Byte/ 512 Word Buffer is being used, the programming addresses should be aligned in 512 word address boundaries. For example: Start Programming address is 000000h and End Programming Address is 0001FFh. Please refer to Figure 3.
3. If the addresses must be mis-aligned, they must be in chunks of 256 Words. For example: Start Programming Address to Start Programming Address + 0000FFh (256 Words). Please refer to Figure 3.

The Read performance can be improved by providing read page buffer up to 16 Words (P+1Dh).

**Figure 5: Main Array Representation**





## 6.0 Conversion Considerations

P33 65nm has a larger program buffer size to greatly improve the write performance. Users should use appropriate program and read modes to take advantage of this improved performance.

## Appendix A Additional Information

| Order/Document Number | Document/Tool   |
|-----------------------|---|
| 314749                | Numonyx™ StrataFlash® Embedded Memory (P33-130nm) Datasheet |
| 320003                | Numonyx™ StrataFlash® Embedded Memory (P33-65nm) Datasheet  |

**Note:** Contact your local Numonyx or distribution sales office or visit Numonyx's World Wide Web home page at <http://www.Numonyx.com> for technical documentation, tools, and additional information.

