



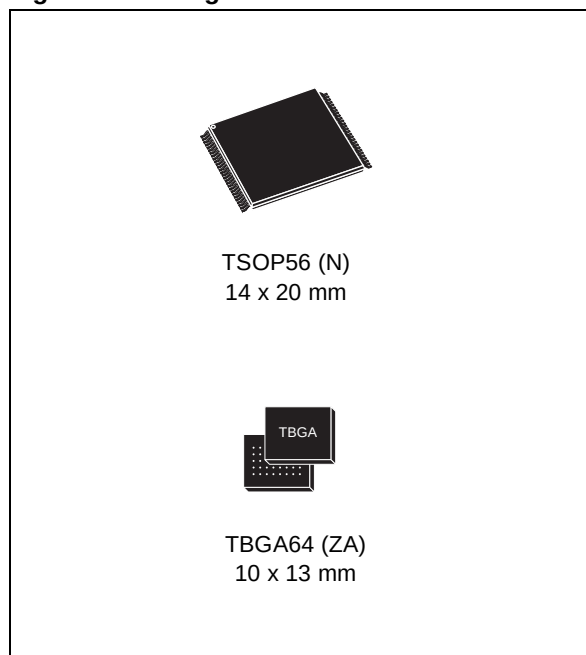
# M58LW032A

32 Mbit (2Mb x16, Uniform Block, Burst)  
3V Supply Flash Memory

## FEATURES SUMMARY

- WIDE x16 DATA BUS for HIGH BANDWIDTH
- SUPPLY VOLTAGE
  - $V_{DD}$  = 2.7 to 3.6V core supply voltage for Program, Erase and Read operations
  - $V_{DDQ}$  = 1.8V to  $V_{DD}$  for I/O Buffers
- SYNCHRONOUS/ASYNCHRONOUS READ
  - Synchronous Burst read
  - Asynchronous Random Read
  - Asynchronous Address Latch Controlled Read
  - Page Read
- ACCESS TIME
  - Synchronous Burst Read up to 56MHz
  - Asynchronous Page Mode Read 90/25ns and 110/25ns
  - Random Read 90ns, 110ns.
- PROGRAMMING TIME
  - 16 Word Write Buffer
  - 18 $\mu$ s Word effective programming time
- 64 UNIFORM 32 KWord MEMORY BLOCKS
- BLOCK PROTECTION/ UNPROTECTION
- PROGRAM and ERASE SUSPEND
- 128 bit PROTECTION REGISTER
- COMMON FLASH INTERFACE
- 100, 000 PROGRAM/ERASE CYCLES per BLOCK
- ELECTRONIC SIGNATURE
  - Manufacturer Code: 0020h
  - Device Code M58LW032A: 8816h

Figure 1. Packages



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**SUMMARY DESCRIPTION**

The M58LW032 is a 32 Mbit (2Mb x16) non-volatile memory that can be read, erased and reprogrammed. These operations can be performed using a single low voltage (2.7V to 3.6V) core supply. On power-up the memory defaults to Read mode with an asynchronous bus where it can be read in the same way as a non-burst Flash memory.

The memory is divided into 64 blocks of 512Kbit that can be erased independently so it is possible to preserve valid data while old data is erased. Program and Erase commands are written to the Command Interface of the memory. An on-chip Program/Erase Controller simplifies the process of programming or erasing the memory by taking care of all of the special operations that are required to update the memory contents. The end of a Program or Erase operation can be detected and any error conditions identified in the Status Register. The command set required to control the memory is consistent with JEDEC standards.

The Write Buffer allows the microprocessor to program from 1 to 16 Words in parallel, both speeding up the programming and freeing up the microprocessor to perform other work. A Word Program command is available to program a single word.

Erase can be suspended in order to perform either Read or Program in any other block and then resumed. Program can be suspended to Read data in any other block and then resumed. Each block can be programmed and erased over 100,000 cycles.

Individual block protection against Program or Erase is provided for data security. All blocks are

protected during power-up. The protection of the blocks is non-volatile; after power-up the protection status of each block is restored to the state when power was last removed. Software commands are provided to allow protection of some or all of the blocks and to cancel all block protection bits simultaneously. All Program or Erase operations are blocked when the Program Erase Enable input Vpp is low.

The Reset/Power-Down pin is used to apply a Hardware Reset to the memory and to set the device in power-down mode.

In asynchronous mode Chip Enable, Output Enable and Write Enable signals control the bus operation of the memory. An Address Latch input can be used to latch addresses. Together they allow simple, yet powerful, connection to most microprocessors, often without additional logic.

In synchronous mode all Bus Read operations are synchronous with the Clock. Chip Enable and Output Enable select the Bus Read operation and the address is Latched using the Latch Enable input. The signals are compatible with most microprocessor burst interfaces.

The device includes a 128 bit Protection Register. The Protection Register is divided into two 64 bit segments, the first one is written by the manufacturer (contact STMicroelectronics to define the code to be written here), while the second one is programmable by the user. The user programmable segment can be locked.

The memory is available in TSOP56 (14 x 20 mm) and TBGA64 (10 x 13mm, 1mm pitch) packages.

Figure 2. Logic Diagram

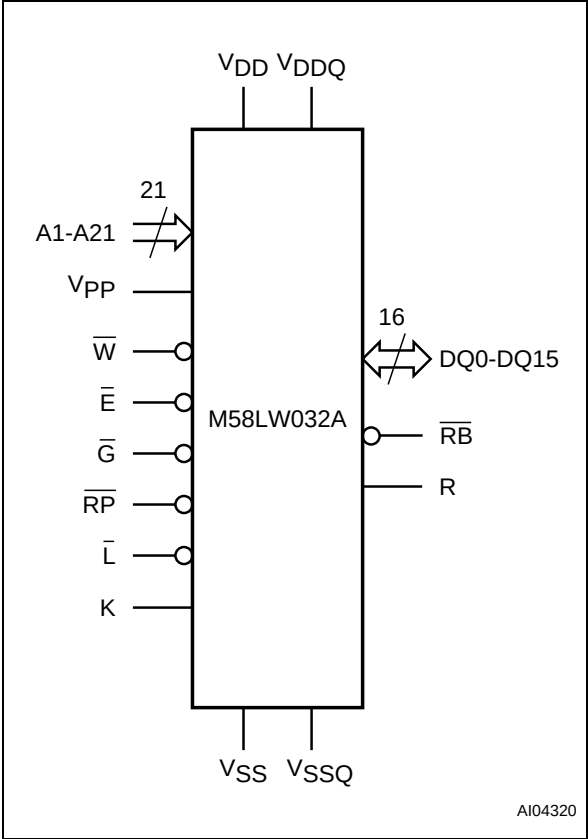


Table 1. Signal Names

|                 |                             |
|-----------------|-----------------------------|
| A1-A21          | Address inputs              |
| DQ0-DQ15        | Data Inputs/Outputs         |
| $\overline{E}$  | Chip Enable                 |
| $\overline{G}$  | Output Enable               |
| K               | Clock                       |
| $\overline{L}$  | Latch Enable                |
| R               | Valid Data Ready            |
| $\overline{RB}$ | Ready/Busy                  |
| $\overline{RP}$ | Reset/Power-Down            |
| VPP             | Program/Erase Enable        |
| $\overline{W}$  | Write Enable                |
| VDD             | Supply Voltage              |
| VDDQ            | Input/Output Supply Voltage |
| VSS             | Ground                      |
| VSSQ            | Input/Output Ground         |
| NC              | Not Connected Internally    |
| DU              | Do Not Use                  |

Figure 3. TSOP56 Connections

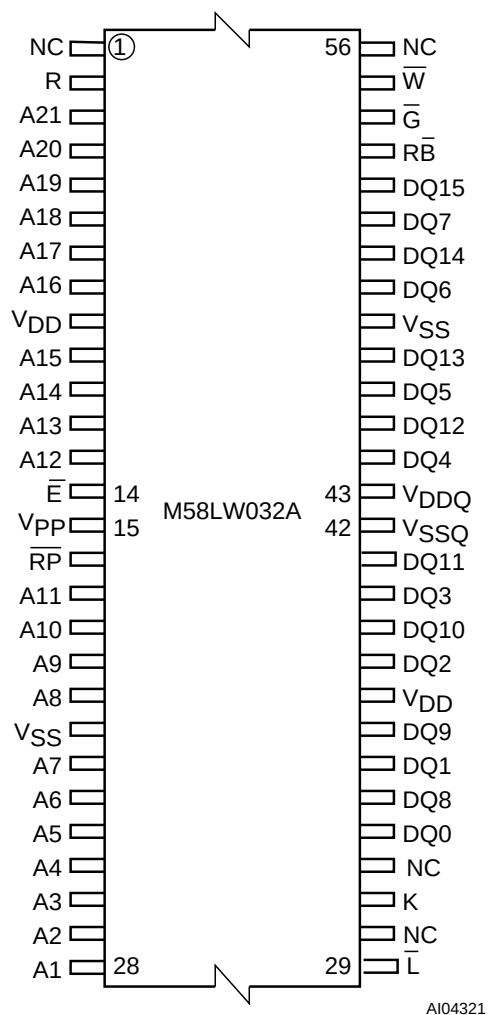
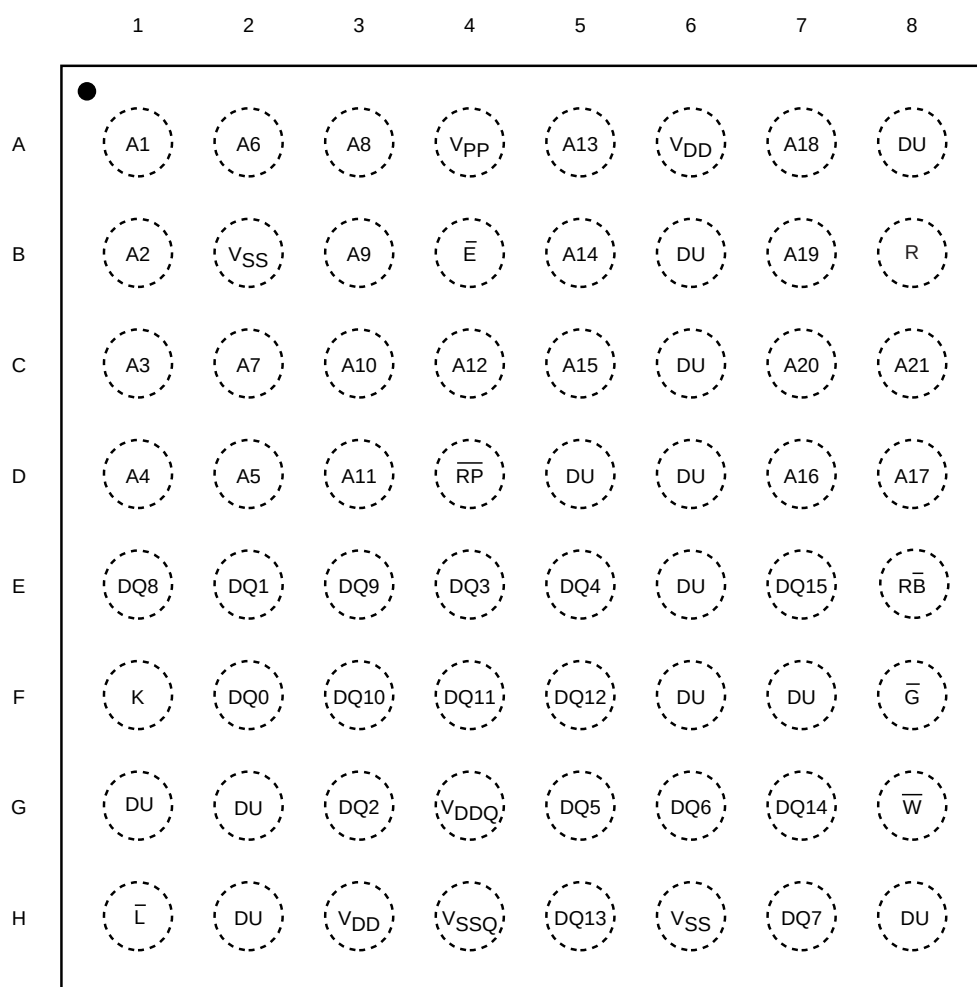
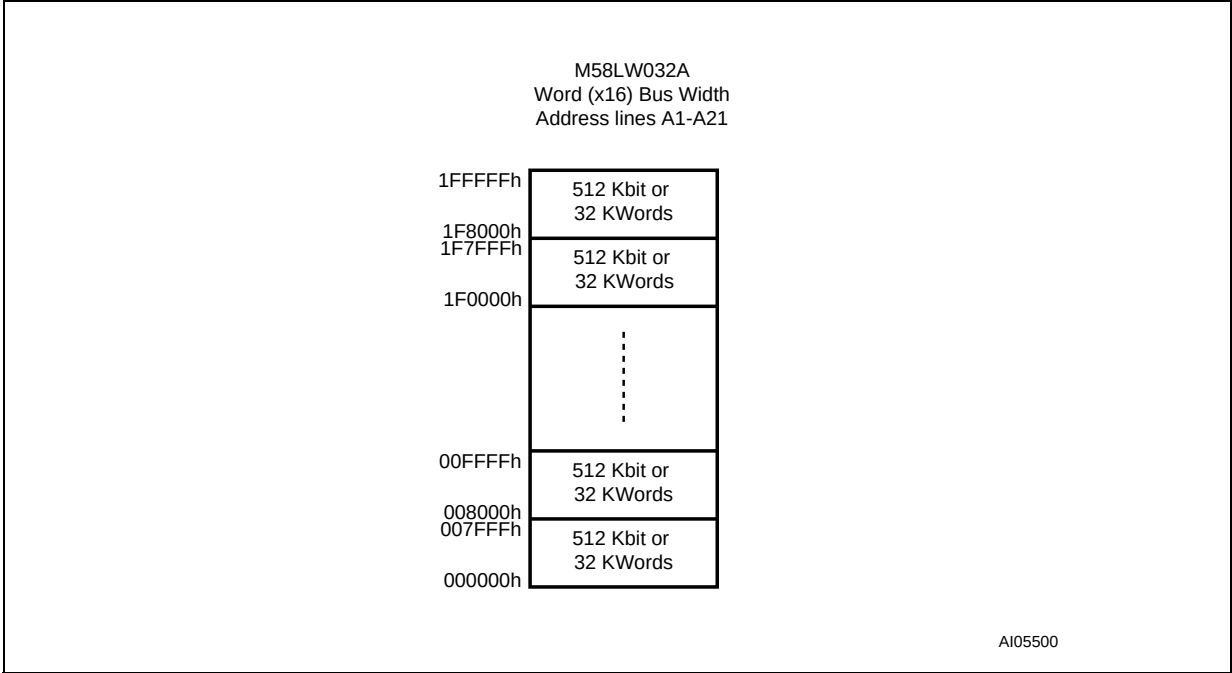


Figure 4. TBGA64 Connections (Top view through package)



AI04322

Figure 5. Block Addresses



Note: Also see Appendix A, Table 25 for a full listing of the Block Addresses

## SIGNAL DESCRIPTIONS

See Figure 2, Logic Diagram and Table 1, Signal Names, for a brief overview of the signals connected to this device.

**Address Inputs (A1-A21).** The Address Inputs are used to select the cells to access in the memory array during Bus Read operations either to read or to program data to. During Bus Write operations they control the commands sent to the Command Interface of the internal state machine. Chip Enable and Latch Enable must be low when selecting the addresses.

The address inputs are latched on the rising edge of Chip Enable, Write Enable or Latch Enable, whichever occurs first in a Write operation. The address latch is transparent when Latch Enable is low,  $V_{IL}$ . The address is internally latched in an Erase or Program operation.

**Data Inputs/Outputs (DQ0-DQ15).** The Data Inputs/Outputs output the data stored at the selected address during a Bus Read operation, or are used to input the data during a program operation. During Bus Write operations they represent the commands sent to the Command Interface of the internal state machine. When used to input data or Write commands they are latched on the rising edge of Write Enable or Chip Enable, whichever occurs first.

When Chip Enable and Output Enable are both low,  $V_{IL}$ , the data bus outputs data from the memory array, the Electronic Signature, the Block Protection status, the CFI Information or the contents of the Status Register. The data bus is high impedance when the chip is deselected, Output Enable is high,  $V_{IH}$ , or the Reset/Power-Down signal is low,  $V_{IL}$ . When the Program/Erase Controller is active the Ready/Busy status is given on DQ7.

**Chip Enable ( $\bar{E}$ ).** The Chip Enable,  $\bar{E}$ , input activates the memory control logic, input buffers, decoders and sense amplifiers. Chip Enable,  $\bar{E}$ , at  $V_{IH}$  deselects the memory and reduces the power consumption to the Standby level,  $I_{DD1}$ .

**Output Enable ( $\bar{G}$ ).** The Output Enable,  $\bar{G}$ , gates the outputs through the data output buffers during a read operation. When Output Enable,  $\bar{G}$ , is at  $V_{IH}$  the outputs are high impedance. Output Enable,  $\bar{G}$ , can be used to inhibit the data output during a burst read operation.

**Write Enable ( $\bar{W}$ ).** The Write Enable input,  $\bar{W}$ , controls writing to the Command Interface, Input Address and Data latches. Both addresses and data can be latched on the rising edge of Write Enable (also see Latch Enable, L).

**Reset/Power-Down ( $\bar{RP}$ ).** The Reset/Power-Down pin can be used to apply a Hardware Reset to the memory.

A Hardware Reset is achieved by holding Reset/Power-Down Low,  $V_{IL}$ , for at least  $t_{PLPH}$ . When Reset/Power-Down is Low,  $V_{IL}$ , the Status Register information is cleared and the power consumption is reduced to power-down level. The device is deselected and outputs are high impedance. If Reset/Power-Down goes low,  $V_{IL}$ , during a Block Erase, a Write to Buffer and Program or a Block Protect/Unprotect the operation is aborted and the data may be corrupted. In this case the Ready/Busy pin stays low,  $V_{IL}$ , for a maximum timing of  $t_{PLPH} + t_{PHRH}$ , until the completion of the Reset/Power-Down pulse.

After Reset/Power-Down goes High,  $V_{IH}$ , the memory will be ready for Bus Read and Bus Write operations after  $t_{PHQV}$ . Note that Ready/Busy does not fall during a reset, see Ready/Busy Output section.

In an application, it is recommended to either associate the Reset/Power-Down pin,  $\bar{RP}$ , with the reset signal of the microprocessor, or to ensure that the Reset/Power-Down pin is kept Low during Power-on. Otherwise, if a reset operation occurs while the memory is performing an Erase or Program operation, the memory may output the Status Register information instead of being initialized to the default Asynchronous Random Read.

**Latch Enable ( $\bar{L}$ ).** The Bus Interface is configured to latch the Address Inputs on the rising edge of Latch Enable, L. In synchronous bus operations the address is latched on the active edge of the Clock when Latch Enable is Low,  $V_{IL}$  or on the rising of Latch Enable, whichever occurs first. Once latched, the addresses may change without affecting the address used by the memory. When Latch Enable is Low,  $V_{IL}$ , the latch is transparent.

**Clock (K).** The Clock, K, is used to synchronize the memory with the external bus during Synchronous Bus Read operations. The Clock can be configured to have an active rising or falling edge. Bus signals are latched on the active edge of the Clock during synchronous bus operations. In Synchronous Burst Read mode the address is latched on the first active clock edge when Latch Enable is low,  $V_{IL}$ , or on the rising edge of Latch Enable, whichever occurs first.

During asynchronous bus operations the Clock is not used.

**Valid Data Ready (R).** The Valid Data Ready output, R, is an open drain output that can be used to identify if the memory is ready to output data or not. The Valid Data Ready output is only active during Synchronous Burst Read operations when the Burst Length is set to Continuous. The Valid Data Ready output can be configured to be active on the clock edge of the invalid data read cycle or

one cycle before. Valid Data Ready Low,  $V_{OL}$ , indicates that the data is not, or will not be valid. Valid Data Ready in a high-impedance state indicates that valid data is or will be available.

Unless Synchronous Burst Read has been selected, Valid Data Ready is high-impedance. It may be tied to other components with the same Valid Data Ready signal to create a unique System Ready signal.

The Valid Data Ready,  $R$ , output has an internal pull-up resistor of approximately  $1\text{ M}\Omega$  powered from  $V_{DDQ}$ , designers should use an external pull-up resistor of the correct value to meet the external timing requirements for Valid Data Ready rising. Refer to Figure 19.

**Ready/Busy ( $\overline{RB}$ ).** The Ready/Busy output,  $\overline{RB}$ , is an open-drain output that can be used to identify if the Program/Erase Controller is currently active. When Ready/Busy is high impedance, the memory is ready for any Read, Program or Erase operation. Ready/Busy is Low,  $V_{OL}$ , during Program and Erase operations. When the device is busy it will not accept any additional Program or Erase commands except Program/Erase Suspend. When the Program/Erase Controller is idle, or suspended, Ready Busy can float High through a pull-up resistor.

The use of an open-drain output allows the Ready/Busy pins from several memories to be connected to a single pull-up resistor. A Low will then indicate that one, or more, of the memories is busy.

Ready/Busy is not Low during a reset unless the reset was applied when the Program/Erase Con-

troller was active; Ready/Busy can rise before Reset/Power-Down rises.

**Program/Erase Enable ( $V_{PP}$ ).** The Program/Erase Enable input,  $V_{PP}$ , is used to protect all blocks, preventing Program and Erase operations from affecting their data.

Program/Erase Enable must be kept High during all Program/Erase Controller operations, otherwise the operations is not guaranteed to succeed and data may become corrupt.

**$V_{DD}$  Supply Voltage.**  $V_{DD}$  provides the power supply to the internal core of the memory device. It is the main power supply for all operations (Read, Program and Erase).

**$V_{DDQ}$  Supply Voltage.**  $V_{DDQ}$  provides the power supply to the I/O pins and enables all Outputs to be powered independently from  $V_{DD}$ .  $V_{DDQ}$  can be tied to  $V_{DD}$  or can use a separate supply.

It is recommended to power-up and power-down  $V_{DD}$  and  $V_{DDQ}$  together to avoid any condition that would result in data corruption.

**$V_{SS}$  Ground.** Ground,  $V_{SS}$ , is the reference for the core power supply. It must be connected to the system ground.

**$V_{SSQ}$  Ground.**  $V_{SSQ}$  ground is the reference for the input/output circuitry driven by  $V_{DDQ}$ .  $V_{SSQ}$  must be connected to  $V_{SS}$ .

**Note:** Each device in a system should have  $V_{DD}$  and  $V_{DDQ}$  decoupled with a  $0.1\mu\text{F}$  ceramic capacitor close to the pin (high frequency, inherently low inductance capacitors should be as close as possible to the package). See Figure 10, AC Measurement Load Circuit.

## BUS OPERATIONS

There are 12 bus operations that control the memory. Each of these is described in this section, see Tables 2 and 3, Bus Operations, for a summary. The bus operation is selected through the Burst Configuration Register; the bits in this register are described at the end of this section.

On Power-up or after a Hardware Reset the memory defaults to Asynchronous Latch Enable Controlled Read and Asynchronous Bus Write, no other bus operation can be performed until the Burst Control Register has been configured.

The Electronic Signature, CFI or Status Register will be read in asynchronous mode or single synchronous burst mode.

Typically glitches of less than 5ns on Chip Enable or Write Enable are ignored by the memory and do not affect bus operations.

### Asynchronous Bus Operations

For asynchronous bus operations refer to Table 3 together with the text below.

**Asynchronous Bus Read.** Asynchronous Bus Read operations read from the memory cells, or specific registers (Electronic Signature, Status Register, CFI and Block Protection Status) in the Command Interface. A valid bus operation involves setting the desired address on the Address Inputs, applying a Low signal,  $V_{IL}$ , to Chip Enable, Output Enable and Latch Enable and keeping Write Enable High,  $V_{IH}$ . The Data Inputs/Outputs will output the value, see Figure 11, Asynchronous Bus Read AC Waveforms, and Table 15, Asynchronous Bus Read AC Characteristics, for details of when the output becomes valid.

### Asynchronous Latch Controlled Bus Read.

Asynchronous Latch Controlled Bus Read operations read from the memory cells or specific registers in the Command Interface. The address is latched in the memory before the value is output on the data bus, allowing the address to change during the cycle without affecting the address that the memory uses.

A valid bus operation involves setting the desired address on the Address Inputs, setting Chip Enable and Latch Enable Low,  $V_{IL}$  and keeping Write Enable High,  $V_{IH}$ ; the address is latched on the rising edge of Address Latch. Once latched, the Address Inputs can change. Set Output Enable Low,  $V_{IL}$ , to read the data on the Data Inputs/Outputs; see Figure 12, Asynchronous Latch Controlled Bus Read AC Waveforms and Table 16, Asynchronous Latch Controlled Bus Read AC Characteristics for details on when the output becomes valid.

Note that, since the Latch Enable input is transparent when set Low,  $V_{IL}$ , Asynchronous Bus Read

operations can be performed when the memory is configured for Asynchronous Latch Enable bus operations by holding Latch Enable Low,  $V_{IL}$  throughout the bus operation.

**Asynchronous Page Read.** Asynchronous Page Read operations are used to read from several addresses within the same memory page. Each memory page is 4 Words and has the same A3-A21, only A1 and A2 may change.

Valid bus operations are the same as Asynchronous Bus Read operations but with different timings. The first read operation within the page has identical timings, subsequent reads within the same page have much shorter access times. If the page changes then the normal, longer timings apply again. See Figure 13, Asynchronous Page Read AC Waveforms and Table 17, Asynchronous Page Read AC Characteristics for details on when the outputs become valid.

**Asynchronous Bus Write.** Asynchronous Bus Write operations write to the Command Interface in order to send commands to the memory or to latch addresses and input data to program. Bus Write operations are asynchronous, the clock, K, is don't care during Bus Write operations.

A valid Asynchronous Bus Write operation begins by setting the desired address on the Address Inputs and setting Latch Enable Low,  $V_{IL}$ . The Address Inputs are latched by the Command Interface on the rising edge of Chip Enable or Write Enable, whichever occurs first. The Data Inputs/Outputs are latched by the Command Interface on the rising edge of Chip Enable or Write Enable, whichever occurs first. Output Enable must remain High,  $V_{IH}$ , during the whole Asynchronous Bus Write operation. See Figures 14, and 16, Asynchronous Write AC Waveforms, and Tables 18 and 19, Asynchronous Write and Latch Controlled Write AC Characteristics, for details of the timing requirements.

### Asynchronous Latch Controlled Bus Write.

Asynchronous Latch Controlled Bus Write operations write to the Command Interface in order to send commands to the memory or to latch addresses and input data to program. Bus Write operations are asynchronous, the clock, K, is don't care during Bus Write operations.

A valid Asynchronous Latch Controlled Bus Write operation begins by setting the desired address on the Address Inputs and pulsing Latch Enable Low,  $V_{IL}$ . The Address Inputs are latched by the Command Interface on the rising edge of Latch Enable, Chip Enable or Write Enable, whichever occurs first. The Data Inputs/Outputs are latched by the Command Interface on the rising edge of Chip Enable or Write Enable, whichever occurs first. Out-

put Enable must remain High,  $V_{IH}$ , during the whole Asynchronous Bus Write operation. See Figures 15 and 17 Asynchronous Latch Controlled Write AC Waveforms, and Tables 18 and 19, Asynchronous Write and Latch Controlled Write AC Characteristics, for details of the timing requirements.

**Output Disable.** The Data Inputs/Outputs are in the high impedance state when the Output Enable is High.

**Standby.** When Chip Enable is High,  $V_{IH}$ , the memory enters Standby mode and the Data Inputs/Outputs pins are placed in the high impedance state regardless of Output Enable or Write Enable. The Supply Current is reduced to the Standby Supply Current,  $I_{DD1}$ .

During Program or Erase operations the memory will continue to use the Program/Erase Supply

Current,  $I_{DD3}$ , for Program or Erase operations until the operation completes.

**Automatic Low Power.** If there is no change in the state of the bus for a short period of time during Asynchronous Bus Read operations the memory enters Auto Low Power mode where the internal Supply Current is reduced to the Auto-Standby Supply Current,  $I_{DD5}$ . The Data Inputs/Outputs will still output data if a Bus Read operation is in progress.

Automatic Low Power is only available in Asynchronous Read modes.

**Power-Down.** The memory is in Power-Down mode when Reset/Power-Down,  $\overline{RP}$ , is Low. The power consumption is reduced to the Power-Down level,  $I_{DD2}$ , and the outputs are high impedance, independent of Chip Enable, Output Enable or Write Enable.

**Table 2. Asynchronous Bus Operations**

| Bus Operation                           | Step          | $\overline{E}$ | $\overline{G}$ | $\overline{W}$ | $\overline{RP}$ | $\overline{L}$ | A1-A21  | DQ0-DQ15    |
|-----------------------------------------|---------------|----------------|----------------|----------------|-----------------|----------------|---------|-------------|
| Asynchronous Bus Read                   |               | $V_{IL}$       | $V_{IL}$       | $V_{IH}$       | High            | $V_{IL}$       | Address | Data Output |
| Asynchronous Latch Controlled Bus Read  | Address Latch | $V_{IL}$       | $V_{IL}$       | $V_{IH}$       | High            | $V_{IL}$       | Address | High Z      |
|                                         | Read          | $V_{IL}$       | $V_{IL}$       | $V_{IH}$       | High            | $V_{IH}$       | X       | Data Output |
| Asynchronous Page Read                  |               | $V_{IL}$       | $V_{IL}$       | $V_{IH}$       | High            | $V_{IL}$       | Address | Data Output |
| Asynchronous Bus Write                  |               | $V_{IL}$       | $V_{IH}$       | $V_{IL}$       | High            | $V_{IL}$       | Address | Data Input  |
| Asynchronous Latch Controlled Bus Write | Address Latch | $V_{IL}$       | $V_{IH}$       | $V_{IL}$       | High            | $V_{IL}$       | Address | Data Input  |
| Output Disable                          |               | $V_{IL}$       | $V_{IH}$       | $V_{IH}$       | High            | X              | X       | High Z      |
| Standby                                 |               | $V_{IH}$       | X              | X              | High            | X              | X       | High Z      |
| Power-Down                              |               | X              | X              | X              | $V_{IL}$        | X              | X       | High Z      |

Note: 1. X = Don't Care  $V_{IL}$  or  $V_{IH}$ . High =  $V_{IH}$  or  $V_{HH}$ .

## Synchronous Bus Operations

For synchronous bus operations refer to Table 3 together with the text below.

**Synchronous Burst Read.** Synchronous Burst Read operations are used to read from the memory at specific times synchronized to an external reference clock. The burst type, length and latency can be configured. The different configurations for Synchronous Burst Read operations are described in the Burst Configuration Register section.

A valid Synchronous Burst Read operation begins when the address is set on the Address Inputs, Write Enable is High,  $V_{IH}$ , and Chip Enable and Latch Enable are Low,  $V_{IL}$ , during the active edge of the Clock. The address is latched on the first active clock edge when Latch Enable is low, or on the rising edge of Latch Enable, whichever occurs first. The data becomes available for output after

the X-latency specified in the Burst Control Register has expired. The output buffers are activated by setting Output Enable Low,  $V_{IL}$ . See Figures 6 and 7 for examples of Synchronous Burst Read operations.

In Continuous Burst mode one Burst Read operation can access the entire memory sequentially. If the starting address is not associated with a page (4 Word) boundary the Valid Data Ready, R, output goes Low,  $V_{IL}$ , to indicate that the data will not be ready in time and additional wait-states are required. The Valid Data Ready output timing (bit M8) can be changed in the Burst Configuration Register.

The Synchronous Burst Read timing diagrams and AC Characteristics are described in the AC and DC Parameters section. See Figures 18, 19 and Table 20.

**Table 3. Synchronous Burst Read Bus Operations**

| Bus Operation          | Step          | $\bar{E}$ | $\bar{G}$ | $\overline{RP}$ | $K^{(3)}$ | $\bar{L}$ | A1-A21<br>DQ0-DQ15 |
|------------------------|---------------|-----------|-----------|-----------------|-----------|-----------|--------------------|
| Synchronous Burst Read | Address Latch | $V_{IL}$  | X         | $V_{IH}$        | T         | $V_{IL}$  | Address Input      |
|                        | Read          | $V_{IL}$  | $V_{IL}$  | $V_{IH}$        | T         | X         | Data Output        |
|                        | Read Abort    | $V_{IH}$  | X         | $V_{IH}$        | X         | X         | High Z             |

Note: 1. X = Don't Care,  $V_{IL}$  or  $V_{IH}$ .

2. M15 = 0, Bit M15 is in the Burst Configuration Register.

3. T = transition, see M6 in the Burst Configuration Register for details on the active edge of K.

### Burst Configuration Register

The Burst Configuration Register is used to configure the type of bus access that the memory will perform. The Burst Configuration Register bits are described in Table 4. They specify the selection of the burst length, burst type, burst X and Y latencies and the Read operation. See figures 6 and 7 for examples of Synchronous Burst Read configurations.

The Burst Configuration Register is set through the Command Interface and will retain its information until it is re-configured, the device is reset, or the device goes into Reset/Power-Down mode. The Burst Configuration Register is read using the Read Electronic Signature Command at address 05h.

**Read Select Bit (M15).** The Read Select bit, M15, is used to switch between asynchronous and synchronous Bus Read operations. When the Read Select bit is set to '1', Bus Read operations are asynchronous; when the Read Select bit is set to '0', Bus Read operations are synchronous.

On reset or power-up the Read Select bit is set to '1' for asynchronous access.

**X-Latency Bits (M13-M11).** The X-Latency bits are used during Synchronous Bus Read operations to set the number of clock cycles between the address being latched and the first data becoming available. For correct operation the X-Latency bits can only assume the values in Table 4, Burst Configuration Register.

**Internal Clock Divider Bit (M10).** The Internal Clock Divider Bit is used to divide the internal clock by two. When M10 is set to '1' the internal clock is divided by two, which effectively means that the X and Y-Latency values are multiplied by two, that is the number of clock cycles between the address being latched and the first data becoming available will be twice the value set in M13-M11, and the number of clock cycles between consecutive reads will be twice the value set in M9. For example 8-1-1-1 will become 16-2-2-2. When M10 is set to '0' the internal clock runs normally and the X and Y-Latency values are those set in M13-M11 and M9.

**Y-Latency Bit (M9).** The Y-Latency bit is used during Synchronous Bus Read operations to set the number of clock cycles between consecutive reads. The Y-Latency value depends on both the X-Latency value and the setting in M9.

When the Y-Latency is 1 the data changes each clock cycle; when the Y-Latency is 2 the data changes every second clock cycle. See Table 4, Burst Configuration Register for valid combinations of the Y-Latency, the X-Latency and the Clock frequency.

**Valid Data Ready Bit (M8).** The Valid Data Ready bit controls the timing of the Valid Data Ready output pin, R. When the Valid Data Ready bit is '0' the Valid Data Ready output pin is driven Low for the active clock edge when invalid data is output on the bus. When the Valid Data Ready bit is '1' the Valid Data Ready output pin is driven Low one clock cycle prior to invalid data being output on the bus.

**Burst Type Bit (M7).** The Burst Type bit is used to configure the sequence of addresses read as sequential or interleaved. When the Burst Type bit is '0' the memory outputs from interleaved addresses; when the Burst Type bit is '1' the memory outputs from sequential addresses. See Tables 5, Burst Type Definition, for the sequence of addresses output from a given starting address in each mode.

**Valid Clock Edge Bit (M6).** The Valid Clock Edge bit, M6, is used to configure the active edge of the Clock, K, during Synchronous Burst Read operations. When the Valid Clock Edge bit is '0' the falling edge of the Clock is the active edge; when the Valid Clock Edge bit is '1' the rising edge of the Clock is active.

**Burst Length Bit (M2-M0).** The Burst Length bits set the maximum number of Words that can be output during a Synchronous Burst Read operation.

Table 4, Burst Configuration Register gives the valid combinations of the Burst Length bits that the memory accepts; Tables 5, Burst Type Definition, give the sequence of addresses output from a given starting address for each length.

**M5 M4 and M3** are reserved for future use.

Table 4. Burst Configuration Register

| Address Bit | Mnemonic | Bit Name                 | Reset Value | Value | Description                                                         |
|-------------|----------|--------------------------|-------------|-------|---------------------------------------------------------------------|
| 16          | M15      | Read Select              | 1           | 0     | Synchronous Burst Read                                              |
|             |          |                          |             | 1     | Asynchronous Bus Read (default at power-up)                         |
| 15          | M14      | Reserved                 |             |       |                                                                     |
| 14 to 12    | M13-M11  | X-Latency <sup>(2)</sup> | XXX         | 001   | Reserved                                                            |
|             |          |                          |             | 010   | X-Latency = 4, 4-1-1-1 (use only with Y-Latency = 1) <sup>(1)</sup> |
|             |          |                          |             | 011   | X-Latency = 5, 5-1-1-1, 5-2-2-2                                     |
|             |          |                          |             | 100   | X-Latency = 6, 6-1-1-1, 6-2-2-2                                     |
|             |          |                          |             | 101   | X-Latency = 7, 7-1-1-1, 7-2-2-2                                     |
|             |          |                          |             | 110   | X-Latency = 8, 8-1-1-1, 8-2-2-2                                     |
| 11          | M10      | Internal Clock Divider   | X           | 0     | X and Y-Latencies remains as set in M13-M11 and M9                  |
|             |          |                          |             | 1     | Divides internal clock, X and Y-Latencies multiplied by 2           |
| 10          | M9       | Y-Latency <sup>(3)</sup> | X           | 0     | Y-Latency = 1                                                       |
|             |          |                          |             | 1     | Y-Latency = 2                                                       |
| 9           | M8       | Valid Data Ready         | X           | 0     | R valid Low during valid Clock edge                                 |
|             |          |                          |             | 1     | R valid Low one cycle before valid Clock edge                       |
| 8           | M7       | Burst Type               | X           | 0     | Interleaved                                                         |
|             |          |                          |             | 1     | Sequential                                                          |
| 7           | M6       | Valid Clock Edge         | X           | 0     | Falling Clock edge                                                  |
|             |          |                          |             | 1     | Rising Clock edge                                                   |
| 6 to 4      | M5-M3    | Reserved                 |             |       |                                                                     |
| 3 to 1      | M2-M0    | Burst Length             | XXX         | 001   | 4 Words                                                             |
|             |          |                          |             | 010   | 8 Words                                                             |
|             |          |                          |             | 111   | Continuous                                                          |

Note: 1. 4 - 2 - 2 - 2 (represents X-Y-Y-Y) is not allowed.

2. X latencies can be calculated as:  $(t_{AVQV} - t_{LLKH} + t_{QVKH}) + t_{SYSTEM\ MARGIN} < (X - 1) t_K$ . (X is an integer number from 4 to 8 and  $t_K$  is the clock period).

3. Y latencies can be calculated as:  $t_{KHQV} + t_{SYSTEM\ MARGIN} + t_{QVKH} < Y t_K$ .

4.  $t_{SYSTEM\ MARGIN}$  is the time margin required for the calculation.

Table 5. Burst Type Definition

| Starting Address | x4 Sequential | x4 Interleaved | x8 Sequential   | x8 Interleaved  | Continuous                    |
|------------------|---------------|----------------|-----------------|-----------------|-------------------------------|
| 0                | 0-1-2-3       | 0-1-2-3        | 0-1-2-3-4-5-6-7 | 0-1-2-3-4-5-6-7 | 0-1-2-3-4-5-6-7-8-9-10..      |
| 1                | 1-2-3-0       | 1-0-3-2        | 1-2-3-4-5-6-7-0 | 1-0-3-2-5-4-7-6 | 1-2-3-4-5-6-7-8-9-10-11..     |
| 2                | 2-3-0-1       | 2-3-0-1        | 2-3-4-5-6-7-0-1 | 2-3-0-1-6-7-4-5 | 2-3-4-5-6-7-8-9-10-11-12..    |
| 3                | 3-0-1-2       | 3-2-1-0        | 3-4-5-6-7-0-1-2 | 3-2-1-0-7-6-5-4 | 3-4-5-6-7-8-9-10-11-12-13..   |
| 4                | —             | —              | 4-5-6-7-0-1-2-3 | 4-5-6-7-0-1-2-3 | 4-5-6-7-8-9-10-11-2-13-14..   |
| 5                | —             | —              | 5-6-7-0-1-2-3-4 | 5-4-7-6-1-0-3-2 | 5-6-7-8-9-10-11-12-13-14..    |
| 6                | —             | —              | 6-7-0-1-2-3-4-5 | 6-7-4-5-2-3-0-1 | 6-7-8-9-10-11-12-13-14-15..   |
| 7                | —             | —              | 7-0-1-2-3-4-5-6 | 7-6-5-4-3-2-1-0 | 7-8-9-10-11-12-13-14-15-16..  |
| 8                | —             | —              | —               | —               | 8-9-10-11-12-13-14-15-16-17.. |

Figure 6. Burst Configuration X-1-1-1

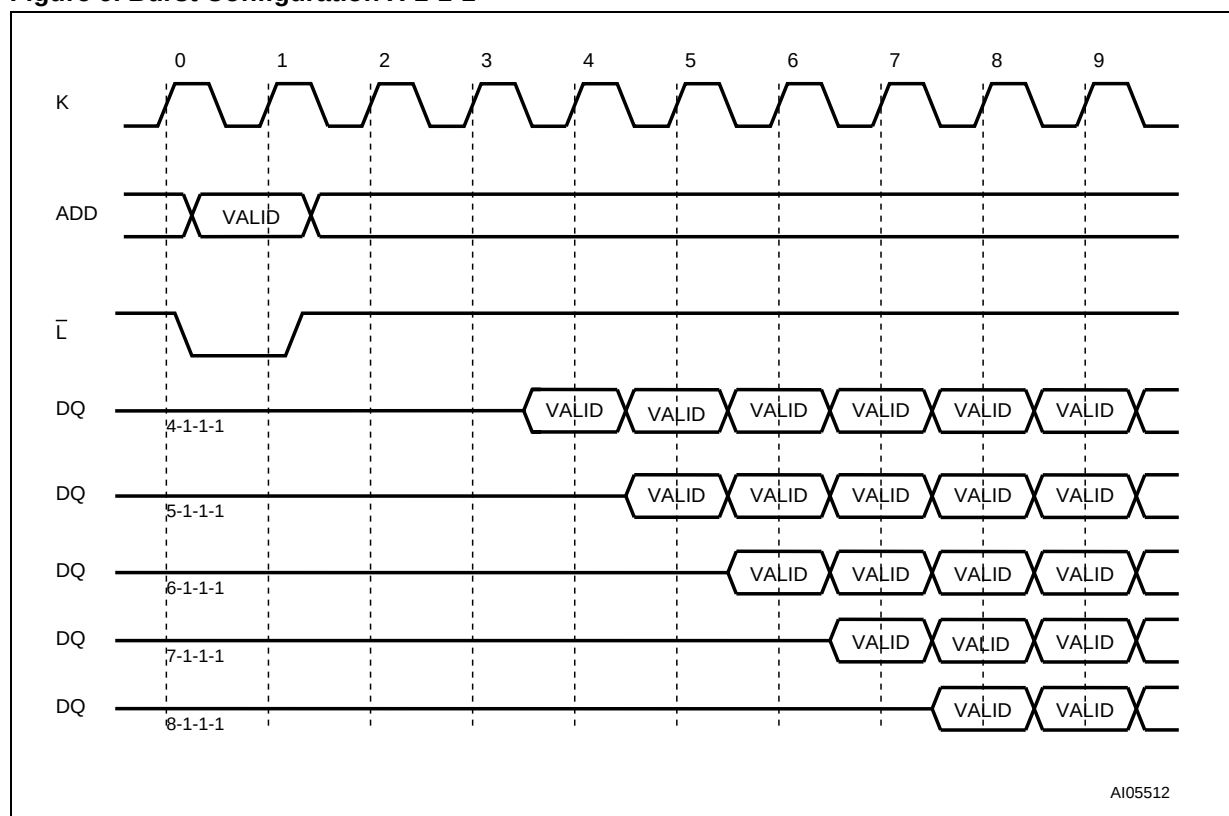
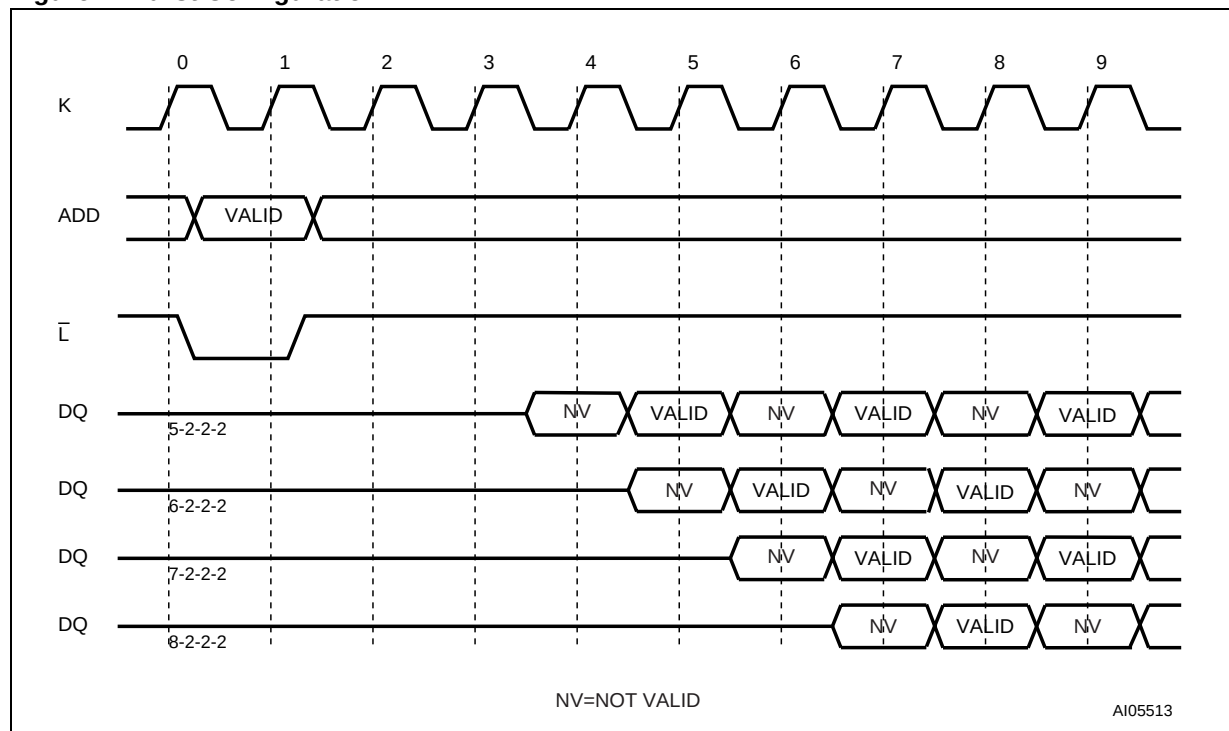


Figure 7. Burst Configuration X-2-2-2



## COMMAND INTERFACE

All Bus Write operations to the memory are interpreted by the Command Interface. Commands consist of one or more sequential Bus Write operations. The Commands are summarized in Table 6, Commands. Refer to Table 6 in conjunction with the text descriptions below.

After power-up or a Reset operation the memory enters Read mode.

Synchronous Read operations and Latch Controlled Bus Read operations can only be used to read the memory array. The Electronic Signature, CFI or Status Register will be read in asynchronous mode or single synchronous burst mode. Once the memory returns to Read Memory Array mode the bus will resume the setting in the Burst Configuration Register automatically.

**Read Memory Array Command.** The Read Memory Array command returns the memory to Read mode. One Bus Write cycle is required to issue the Read Memory Array command and return the memory to Read mode. Once the command is issued the memory remains in Read mode until another command is issued. From Read mode Bus Read commands will access the memory array.

While the Program/Erase Controller is executing a Program, Erase, Block Protect, Blocks Unprotect or Protection Register Program operation the memory will not accept the Read Memory Array command until the operation completes.

**Read Electronic Signature Command.** The Read Electronic Signature command is used to read the Manufacturer Code, the Device Code, the Block Protection Status, the Burst Configuration Register and the Protection Register. One Bus Write cycle is required to issue the Read Electronic Signature command. Once the command is issued subsequent Bus Read operations read the Manufacturer Code, the Device Code, the Block Protection Status, the Burst Configuration Register or the Protection Register until another command is issued. Refer to Table 7, Read Electronic Signature, Table 8, Read Protection Register and Figure 8, Protection Register Memory Map for information on the addresses.

**Read Query Command.** The Read Query Command is used to read data from the Common Flash Interface (CFI) Memory Area. One Bus Write cycle is required to issue the Read Query Command. Once the command is issued subsequent Bus Read operations read from the Common Flash Interface Memory Area. See Appendix B, Tables 26, 27, 28, 29, 30 and 31 for details on the information contained in the Common Flash Interface (CFI) memory area.

**Read Status Register Command.** The Read Status Register command is used to read the Status

Register. One Bus Write cycle is required to issue the Read Status Register command. Once the command is issued subsequent Bus Read operations read the Status Register until another command is issued.

The Status Register information is present on the output data bus (DQ1-DQ7) when both Chip Enable and Output Enable are low,  $V_{IL}$ .

See the section on the Status Register and Table 10 for details on the definitions of the Status Register bits

**Clear Status Register Command.** The Clear Status Register command can be used to reset bits 1, 3, 4 and 5 in the Status Register to '0'. One Bus Write is required to issue the Clear Status Register command.

The bits in the Status Register are sticky and do not automatically return to '0' when a new Write to Buffer and Program, Erase, Block Protect, Blocks Unprotect or Protection Register Program command is issued. If any error occurs then it is essential to clear any error bits in the Status Register by issuing the Clear Status Register command before attempting a new Program, Erase or Resume command.

**Block Erase Command.** The Block Erase command can be used to erase a block. It sets all of the bits in the block to '1'. All previous data in the block is lost. If the block is protected then the Erase operation will abort, the data in the block will not be changed and the Status Register will output the error.

Two Bus Write operations are required to issue the command; the second Bus Write cycle latches the block address in the internal state machine and starts the Program/Erase Controller. Once the command is issued subsequent Bus Read operations read the Status Register. See the section on the Status Register for details on the definitions of the Status Register bits.

During the Erase operation the memory will only accept the Read Status Register command and the Program/Erase Suspend command. All other commands will be ignored. Typical Erase times are given in Table 9.

See Appendix C, Figure 25, Block Erase Flowchart and Pseudo Code, for a suggested flowchart on using the Block Erase command.

**Word Program Command.** The Word Program command is used to program a single word in the memory array. Two Bus Write operations are required to issue the command; the first write cycle sets up the Word Program command, the second write cycle latches the address and data to be programmed in the internal state machine and starts the Program/Erase Controller.

If the block being programmed is protected an error will be set in the Status Register and the operation will abort without affecting the data in the memory array. The block must be unprotected using the Blocks Unprotect command.

**Write to Buffer and Program Command.** The Write to Buffer and Program command is used to program the memory array.

Up to 16 Words can be loaded into the Write Buffer and programmed into the memory. Each Write Buffer has the same A5-A21 addresses.

Four successive steps are required to issue the command.

1. One Bus Write operation is required to set up the Write to Buffer and Program Command. Issue the set up command with the selected memory Block Address where the program operation should occur (any address in the block where the values will be programmed can be used). Any Bus Read operations will start to output the Status Register after the 1st cycle.
2. Use one Bus Write operation to write the same block address along with the value N on the Data Inputs/Output, where N+1 is the number of Words to be programmed.
3. Use N+1 Bus Write operations to load the address and data for each Word into the Write Buffer. The addresses must have the same A5-A21.
4. Finally, use one Bus Write operation to issue the final cycle to confirm the command and start the Program operation.

Invalid address combinations or failing to follow the correct sequence of Bus Write cycles will set an error in the Status Register and abort the operation without affecting the data in the memory array. The Status Register should be cleared before re-issuing the command.

If the block being programmed is protected an error will be set in the Status Register and the operation will abort without affecting the data in the memory array. The block must be unprotected using the Blocks Unprotect command.

See Appendix C, Figure 23, Write to Buffer and Program Flowchart and Pseudo Code, for a suggested flowchart on using the Write to Buffer and Program command.

**Program/Erase Suspend Command.** The Program/Erase Suspend command is used to pause a Write to Buffer and Program or Erase operation. The command will only be accepted during a Program or an Erase operation. It can be issued at any time during an Erase operation but will only be accepted during a Write to Buffer and Program command if the Program/Erase Controller is running.

One Bus Write cycle is required to issue the Program/Erase Suspend command and pause the Program/Erase Controller. Once the command is issued it is necessary to poll the Program/Erase Controller Status bit (bit 7) to find out when the Program/Erase Controller has paused; no other commands will be accepted until the Program/Erase Controller has paused. After the Program/Erase Controller has paused, the memory will continue to output the Status Register until another command is issued.

During the polling period between issuing the Program/Erase Suspend command and the Program/Erase Controller pausing it is possible for the operation to complete. Once the Program/Erase Controller Status bit (bit 7) indicates that the Program/Erase Controller is no longer active, the Program Suspend Status bit (bit 2) or the Erase Suspend Status bit (bit 6) can be used to determine if the operation has completed or is suspended. For timing on the delay between issuing the Program/Erase Suspend command and the Program/Erase Controller pausing see Table 9.

During Program/Erase Suspend the Read Memory Array, Read Status Register, Read Electronic Signature, Read Query and Program/Erase Resume commands will be accepted by the Command Interface. Additionally, if the suspended operation was Erase then the Word Program, Write to Buffer and Program, and the Program Suspend commands will also be accepted. When a program operation is completed inside a Block Erase Suspend the Read Memory Array command must be issued to reset the device in Read mode, then the Erase Resume command can be issued to complete the whole sequence. Only the blocks not being erased may be read or programmed correctly.

See Appendix C, Figure 24, Program Suspend & Resume Flowchart and Pseudo Code, and Figure 26, Erase Suspend & Resume Flowchart and Pseudo Code, for suggested flowcharts on using the Program/Erase Suspend command.

**Program/Erase Resume Command.** The Program/Erase Resume command can be used to restart the Program/Erase Controller after a Program/Erase Suspend operation has paused it. One Bus Write cycle is required to issue the Program/Erase Resume command. Once the command is issued subsequent Bus Read operations read the Status Register.

**Set Burst Configuration Register Command.**

The Set Burst Configuration Register command is used to write a new value to the Burst Configuration Control Register which defines the burst length, type, X and Y latencies, Synchronous/Asynchronous Read mode and the valid Clock edge configuration.

Two Bus Write cycles are required to issue the Set Burst Configuration Register command. Once the command is issued the memory returns to Read mode as if a Read Memory Array command had been issued.

The value for the Burst Configuration Register is presented on A1-A16. M0 is on A1, M1 on A2, etc.; the other address bits are ignored.

**Block Protect Command.** The Block Protect command is used to protect a block and prevent Program or Erase operations from changing the data in it. Two Bus Write cycles are required to issue the Block Protect command; the second Bus Write cycle latches the block address in the internal state machine and starts the Program/Erase Controller. Once the command is issued subsequent Bus Read operations read the Status Register. See the section on the Status Register for details on the definitions of the Status Register bits. Typical Block Protection times are given in Table 9.

The Block Protection bits are non-volatile, once set they remain set through reset and power-down/power-up. They are cleared by a Blocks Unprotect command.

See Appendix C, Figure 27, Block Protect Flowchart and Pseudo Code, for a suggested flowchart on using the Block Protect command.

**Blocks Unprotect Command.** The Blocks Unprotect command is used to unprotect all of the blocks. Two Bus Write cycles are required to issue the Blocks Unprotect command; the second Bus Write cycle starts the Program/Erase Controller. Once the command is issued subsequent Bus Read operations read the Status Register. See the section on the Status Register for details on the definitions of the Status Register bits. Typical Block Protection times are given in Table 9.

See Appendix C, Figure 28, Blocks Unprotect Flowchart and Pseudo Code, for a suggested flowchart on using the Blocks Unprotect command.

**Protection Register Program Command.** The Protection Register Program command is used to Program the 64 bit user segment of the Protection Register. The segment is programmed 16 bits at a time. The memory must be reset by issuing the Read Memory Array command before the Protection Register Program command can be issued. Two write cycles are required to issue the Protection Register Program command.

- The first bus cycle sets up the Protection Register Program command.
- The second latches the Address and the Data to be written to the Protection Register and starts the Program/Erase Controller.

Read operations output the Status Register content after the programming has started.

The user-programmable segment can be locked by programming bit 1 of the Protection Register Lock location to '0' (see Table 8). Bit 0 of the Protection Register Lock location locks the factory programmed segment and is programmed to '0' in the factory. The locking of the Protection Register is not reversible, once the lock bits are programmed no further changes can be made to the values stored in the Protection Register, see Figure 8, Protection Register Memory Map. Attempting to program a previously protected Protection Register will result in a Status Register error.

The Protection Register Program cannot be suspended. See Appendix C, Figure 29, Protection Register Program Flowchart and Pseudo Code, for the flowchart for using the Protection Register Program command.

Table 6. Commands

| Command                          | Cycles | Bus Operations |       |            |           |                    |                    |            |       |      |       |       |      |
|----------------------------------|--------|----------------|-------|------------|-----------|--------------------|--------------------|------------|-------|------|-------|-------|------|
|                                  |        | 1st Cycle      |       |            | 2nd Cycle |                    |                    | Subsequent |       |      | Final |       |      |
|                                  |        | Op.            | Addr. | Data       | Op.       | Addr.              | Data               | Op.        | Addr. | Data | Op.   | Addr. | Data |
| Read Memory Array                | ≥ 2    | Write          | X     | FFh        | Read      | RA                 | RD                 |            |       |      |       |       |      |
| Read Electronic Signature        | ≥ 2    | Write          | X     | 90h        | Read      | IDA <sup>(3)</sup> | IDD <sup>(3)</sup> |            |       |      |       |       |      |
| Read Status Register             | 2      | Write          | X     | 70h        | Read      | X                  | SRD                |            |       |      |       |       |      |
| Read Query                       | ≥ 2    | Write          | X     | 98h        | Read      | QA <sup>(4)</sup>  | QD <sup>(4)</sup>  |            |       |      |       |       |      |
| Clear Status Register            | 1      | Write          | X     | 50h        |           |                    |                    |            |       |      |       |       |      |
| Block Erase                      | 2      | Write          | X     | 20h        | Write     | BA                 | D0                 |            |       |      |       |       |      |
| Word Program                     | 2      | Write          | X     | 40h<br>10h | Write     | PA                 | PD                 |            |       |      |       |       |      |
| Write to Buffer and Program      | 4 + N  | Write          | BA    | E8h        | Write     | BA                 | N                  | Write      | PA    | PD   | Write | X     | D0h  |
| Program/Erase Suspend            | 1      | Write          | X     | B0h        |           |                    |                    |            |       |      |       |       |      |
| Program/Erase Resume             | 1      | Write          | X     | D0h        |           |                    |                    |            |       |      |       |       |      |
| Set Burst Configuration Register | 2      | Write          | X     | 60h        | Write     | BCR                | 03h                |            |       |      |       |       |      |
| Block Protect                    | 2      | Write          | X     | 60h        | Write     | BA                 | 01h                |            |       |      |       |       |      |
| Blocks Unprotect                 | 2      | Write          | X     | 60h        | Write     | X                  | D0h                |            |       |      |       |       |      |
| Protection Register Program      | 2      | Write          | X     | C0h        | Write     | PRA                | PRD                |            |       |      |       |       |      |

Note: 1. X Don't Care; RA Read Address, RD Read Data, IDA Identifier Address, IDD Identifier Data, SRD Status Register Data, PA Program Address; PD Program Data, QA Query Address, QD Query Data, BA Any address in the Block, BCR Burst Configuration Register value.

2. Base Address, refer to Figure 8 and Table 8 for more information.

3. For Identifier addresses and data refer to table 7, Read Electronic Signature.

4. For Query Address and Data refer to Appendix B, CFI.

Table 7. Read Electronic Signature

| Code                         | Address (A21-A1)       | Data (DQ15-DQ0)                                      |
|------------------------------|------------------------|------------------------------------------------------|
| Manufacturer Code            | 000000h                | 0020h                                                |
| Device Code                  | 000001h                | 8816h                                                |
| Block Protection Status      | SBA+02h                | 0000h (Block Unprotected)<br>0001h (Block Protected) |
| Burst Configuration Register | 000005h                | BCR                                                  |
| Protection Register          | 000080h <sup>(2)</sup> | PRD                                                  |

Note: 1. SBA is the Start Base Address of each block, BCR is Burst Configuration Register data, PRD is Protection Register Data.

2. Base Address, refer to Figure 8 and Table 8 for more information.

Table 8. Read Protection Register

| Word | Use                 | A8 | A7 | A6 | A5 | A4 | A3 | A2 | A1 |
|------|---------------------|----|----|----|----|----|----|----|----|
| Lock | Factory, User       | 1  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| 0    | Factory (Unique ID) | 1  | 0  | 0  | 0  | 0  | 0  | 0  | 1  |
| 1    | Factory (Unique ID) | 1  | 0  | 0  | 0  | 0  | 0  | 1  | 0  |
| 2    | Factory (Unique ID) | 1  | 0  | 0  | 0  | 0  | 0  | 1  | 1  |
| 3    | Factory (Unique ID) | 1  | 0  | 0  | 0  | 0  | 1  | 0  | 0  |
| 4    | User                | 1  | 0  | 0  | 0  | 0  | 1  | 0  | 1  |
| 5    | User                | 1  | 0  | 0  | 0  | 0  | 1  | 1  | 0  |
| 6    | User                | 1  | 0  | 0  | 0  | 0  | 1  | 1  | 1  |
| 7    | User                | 1  | 0  | 0  | 0  | 1  | 0  | 0  | 0  |

Figure 8. Protection Register Memory Map

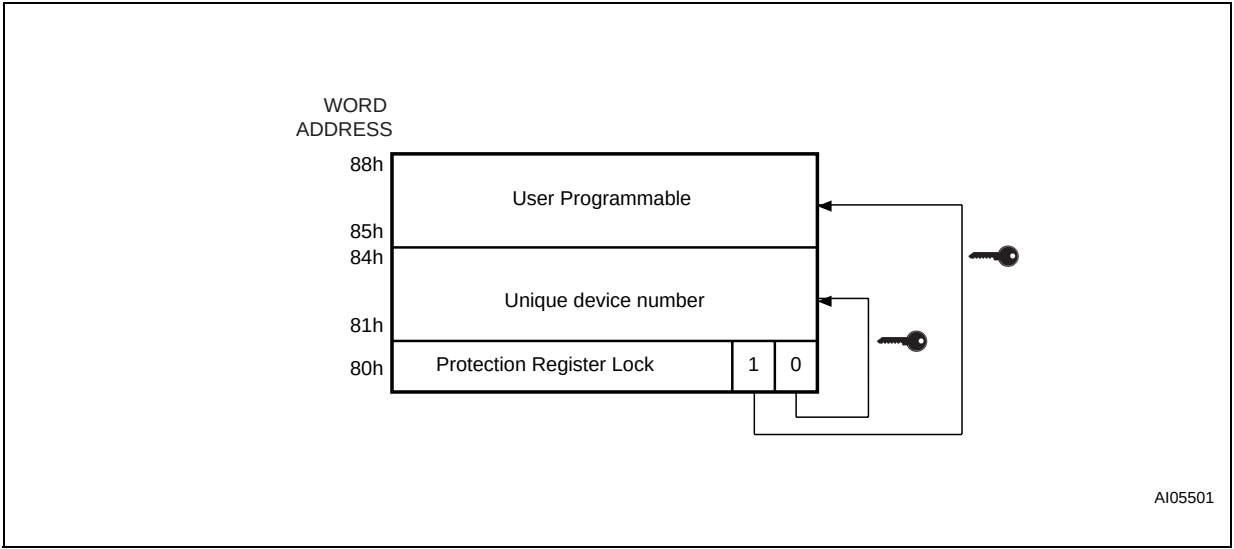


**Table 9. Program, Erase Times and Program Erase Endurance Cycles**

| Parameters                       | M58LW032A |      |     | Unit   |
|----------------------------------|-----------|------|-----|--------|
|                                  | Min       | Typ  | Max |        |
| Block (521Kb) Erase              |           | 1.1  |     | s      |
| Program Write Buffer             |           | 290  |     | μs     |
| Program Suspend Latency Time     |           |      | 20  | μs     |
| Erase Suspend Latency Time       |           |      | 25  | μs     |
| Block Protect Time               |           | 18   |     | μs     |
| Blocks Unprotect Time            |           | 0.75 |     | s      |
| Program/Erase Cycles (per block) | 100,000   |      |     | cycles |

Note:  $T_A = 0$  to  $70^{\circ}\text{C}$ ;  $V_{DD} = 2.7\text{V}$  to  $3.6\text{V}$ ;  $V_{DDQ} = 1.8\text{V}$

## STATUS REGISTER

The Status Register provides information on the current or previous Program, Erase, Block Protect or Blocks Unprotect operation. The various bits in the Status Register convey information and errors on the operation. They are output on DQ7-DQ0.

To read the Status Register the Read Status Register command can be issued. The Status Register is automatically read after Program, Erase, Block Protect, Blocks Unprotect and Program/Erase Resume commands. The Status Register can be read from any address.

The Status Register can only be read using Asynchronous Bus Read operations. Once the memory returns to Read Memory Array mode the bus will resume the setting in the Burst Configuration Register automatically.

The contents of the Status Register can be updated during an Erase or Program operation by toggling the Output Enable pin or by dis-activating (Chip Enable,  $V_{IH}$ ) and then reactivating (Chip Enable and Output Enable,  $V_{IL}$ ) the device.

Status Register bits 5, 4, 3 and 1 are associated with various error conditions and can only be reset with the Clear Status Register command. The Status Register bits are summarized in Table 10, Status Register Bits. Refer to Table 10 in conjunction with the following text descriptions.

**Program/Erase Controller Status (Bit 7).** The Program/Erase Controller Status bit indicates whether the Program/Erase Controller is active or inactive. When the Program/Erase Controller Status bit is Low,  $V_{OL}$ , the Program/Erase Controller is active and all other Status Register bits are High Impedance; when the bit is High,  $V_{OH}$ , the Program/Erase Controller is inactive.

The Program/Erase Controller Status is Low immediately after a Program/Erase Suspend command is issued until the Program/Erase Controller pauses. After the Program/Erase Controller pauses the bit is High.

During Program, Erase, Block Protect and Blocks Unprotect operations the Program/Erase Controller Status bit can be polled to find the end of the operation. The other bits in the Status Register should not be tested until the Program/Erase Controller completes the operation and the bit is High.

After the Program/Erase Controller completes its operation the Erase Status, Program Status and Block Protection Status bits should be tested for errors.

**Erase Suspend Status (Bit 6).** The Erase Suspend Status bit indicates that an Erase operation has been suspended and is waiting to be resumed. The Erase Suspend Status should only be considered valid when the Program/Erase Controller Status bit is High (Program/Erase Controller

inactive); after a Program/Erase Suspend command is issued the memory may still complete the operation rather than entering the Suspend mode.

When the Erase Suspend Status bit is Low,  $V_{OL}$ , the Program/Erase Controller is active or has completed its operation; when the bit is High,  $V_{OH}$ , a Program/Erase Suspend command has been issued and the memory is waiting for a Program/Erase Resume command.

When a Program/Erase Resume command is issued the Erase Suspend Status bit returns Low.

**Erase Status (Bit 5).** The Erase Status bit can be used to identify if the memory has failed to verify that the block has erased correctly or that all blocks have been unprotected successfully. The Erase Status bit should be read once the Program/Erase Controller Status bit is High (Program/Erase Controller inactive).

When the Erase Status bit is Low,  $V_{OL}$ , the memory has successfully verified that the block has erased correctly or all blocks have been unprotected successfully. When the Erase Status bit is High,  $V_{OH}$ , the erase operation has failed. Depending on the cause of the failure other Status Register bits may also be set to High,  $V_{OH}$ .

- If only the Erase Status bit (bit 5) is set High,  $V_{OH}$ , then the Program/Erase Controller has applied the maximum number of pulses to the block and still failed to verify that the block has erased correctly or that all the blocks have been unprotected successfully.
- If the failure is due to an erase or blocks unprotect with  $V_{PP}$  low,  $V_{OL}$ , then  $V_{PP}$  Status bit (bit 3) is also set High,  $V_{OH}$ .
- If the failure is due to an erase on a protected block then Block Protection Status bit (bit 1) is also set High,  $V_{OH}$ .
- If the failure is due to a program or erase incorrect command sequence then Program Status bit (bit 4) is also set High,  $V_{OH}$ .

Once set High, the Erase Status bit can only be reset Low by a Clear Status Register command or a hardware reset. If set High it should be reset before a new Program or Erase command is issued, otherwise the new command will appear to fail.

**Program Status (Bit 4).** The Program Status bit is used to identify a Program or Block Protect failure. The Program Status bit should be read once the Program/Erase Controller Status bit is High (Program/Erase Controller inactive).

When the Program Status bit is Low,  $V_{OL}$ , the memory has successfully verified that the Write Buffer has programmed correctly or the block is protected. When the Program Status bit is High,  $V_{OH}$ , the program or block protect operation has

failed. Depending on the cause of the failure other Status Register bits may also be set to High,  $V_{OH}$ .

- If only the Program Status bit (bit 4) is set High,  $V_{OH}$ , then the Program/Erase Controller has applied the maximum number of pulses to the byte and still failed to verify that the Write Buffer has programmed correctly or that the Block is protected.
- If the failure is due to a program or block protect with  $V_{PP}$  low,  $V_{OL}$ , then  $V_{PP}$  Status bit (bit 3) is also set High,  $V_{OH}$ .
- If the failure is due to a program on a protected block then Block Protection Status bit (bit 1) is also set High,  $V_{OH}$ .
- If the failure is due to a program or erase incorrect command sequence then Erase Status bit (bit 5) is also set High,  $V_{OH}$ .

Once set High, the Program Status bit can only be reset Low by a Clear Status Register command or a hardware reset. If set High it should be reset before a new Program or Erase command is issued, otherwise the new command will appear to fail.

**$V_{PP}$  Status (Bit 3).** The  $V_{PP}$  Status bit can be used to identify if a Word Program, Erase, Block Protection or Blocks Unprotection operation has been attempted when  $V_{PP}$  is Low,  $V_{IL}$ . The  $V_{PP}$  Status bit cannot be used during a Write to Buffer and Program operation.

When the  $V_{PP}$  Status bit is Low,  $V_{OL}$ , no Word Program, Erase, Block Protection or Blocks Unprotection operations have been attempted with  $V_{PP}$  Low,  $V_{IL}$ , since the last Clear Status Register command, or hardware reset. When the  $V_{PP}$  Status bit is High,  $V_{OH}$ , a Word Program, Erase, Block Protection or Blocks Unprotection operation has been attempted with  $V_{PP}$  Low,  $V_{IL}$ .

Once set High, the  $V_{PP}$  Status bit can only be reset by a Clear Status Register command or a hardware reset. If set High it should be reset before a new Program, Erase, Block Protection or Blocks

Unprotection command is issued, otherwise the new command will appear to fail.

**Program Suspend Status (Bit 2).** The Program Suspend Status bit indicates that a Program operation has been suspended and is waiting to be resumed. The Program Suspend Status should only be considered valid when the Program/Erase Controller Status bit is High (Program/Erase Controller inactive); after a Program/Erase Suspend command is issued the memory may still complete the operation rather than entering the Suspend mode.

When the Program Suspend Status bit is Low,  $V_{OL}$ , the Program/Erase Controller is active or has completed its operation; when the bit is High,  $V_{OH}$ , a Program/Erase Suspend command has been issued and the memory is waiting for a Program/Erase Resume command.

When a Program/Erase Resume command is issued the Program Suspend Status bit returns Low.

**Block Protection Status (Bit 1).** The Block Protection Status bit can be used to identify if a Program or Erase operation has tried to modify the contents of a protected block.

When the Block Protection Status bit is Low,  $V_{OL}$ , no Program or Erase operations have been attempted to protected blocks since the last Clear Status Register command or hardware reset; when the Block Protection Status bit is High,  $V_{OH}$ , a Program (Program Status bit 4 set High) or Erase (Erase Status bit 5 set High) operation has been attempted on a protected block.

Once set High, the Block Protection Status bit can only be reset Low by a Clear Status Register command or a hardware reset. If set High it should be reset before a new Program or Erase command is issued, otherwise the new command will appear to fail.

**Reserved (Bit 0).** Bit 0 of the Status Register is reserved. Its value should be masked.

Table 10. Status Register Bits

| OPERATION                                                          | Bit 7 | Bit 6           | Bit 5           | Bit 4           | Bit 3           | Bit 2           | Bit 1           | R $\overline{B}$ | Result (Hex) |
|--------------------------------------------------------------------|-------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|------------------|--------------|
| Program/Erase Controller active                                    | 0     | V <sub>OL</sub> | V <sub>OL</sub> | V <sub>OL</sub> | V <sub>OL</sub> | V <sub>OL</sub> | V <sub>OL</sub> | V <sub>OL</sub>  | N/A          |
| Write Buffer not ready                                             | 0     | V <sub>OL</sub> | V <sub>OL</sub> | V <sub>OL</sub> | V <sub>OL</sub> | V <sub>OL</sub> | V <sub>OL</sub> | V <sub>OL</sub>  | N/A          |
| Write Buffer ready                                                 | 1     | 0               | 0               | 0               | 0               | 0               | 0               | Hi-Z             | 80h          |
| Write Buffer ready in Erase Suspend                                | 1     | 1               | 0               | 0               | 0               | 0               | 0               | Hi-Z             | C0h          |
| Program suspended                                                  | 1     | 0               | 0               | 0               | 0               | 1               | 0               | Hi-Z             | 84h          |
| Program suspended in Erase Suspend                                 | 1     | 1               | 0               | 0               | 0               | 1               | 0               | Hi-Z             | C4h          |
| Program/Block Protect completed successfully                       | 1     | 0               | 0               | 0               | 0               | 0               | 0               | Hi-Z             | 80h          |
| Program completed successfully in Erase Suspend                    | 1     | 1               | 0               | 0               | 0               | 0               | 0               | Hi-Z             | C0h          |
| Program/Block protect failure due to incorrect command sequence    | 1     | 0               | 1               | 1               | 0               | 0               | 0               | Hi-Z             | B0h          |
| Program failure due to incorrect command sequence in Erase Suspend | 1     | 1               | 1               | 1               | 0               | 0               | 0               | Hi-Z             | F0h          |
| Word Program/Block Protect failure due to V <sub>PP</sub> error    | 1     | 0               | 0               | 1               | 1               | 0               | 0               | Hi-Z             | 98h          |
| Word Program failure due to V <sub>PP</sub> error in Erase Suspend | 1     | 1               | 0               | 1               | 1               | 0               | 0               | Hi-Z             | D8h          |
| Program failure due to Block Protection                            | 1     | 0               | 0               | 1               | 0               | 0               | 1               | Hi-Z             | 92h          |
| Program failure due to Block Protection in Erase Suspend           | 1     | 1               | 0               | 1               | 0               | 0               | 1               | Hi-Z             | D2h          |
| Program/Block Protect failure due to cell failure                  | 1     | 0               | 0               | 1               | 0               | 0               | 0               | Hi-Z             | 90h          |
| Program failure due to cell failure in Erase Suspend               | 1     | 1               | 0               | 1               | 0               | 0               | 0               | Hi-Z             | D0h          |
| Erase Suspended                                                    | 1     | 1               | 0               | 0               | 0               | 0               | 0               | Hi-Z             | C0h          |
| Erase/Blocks Unprotect completed successfully                      | 1     | 0               | 0               | 0               | 0               | 0               | 0               | Hi-Z             | 80h          |
| Erase/Blocks Unprotect failure due to incorrect command sequence   | 1     | 0               | 1               | 1               | 0               | 0               | 0               | Hi-Z             | B0h          |
| Erase/Blocks Unprotect failure due to V <sub>PP</sub> error        | 1     | 0               | 1               | 0               | 1               | 0               | 0               | Hi-Z             | A8h          |
| Erase failure due to Block Protection                              | 1     | 0               | 1               | 0               | 0               | 0               | 1               | Hi-Z             | A2h          |
| Erase/Blocks Unprotect failure due to failed cells in Block        | 1     | 0               | 1               | 0               | 0               | 0               | 0               | Hi-Z             | A0h          |

**MAXIMUM RATING**

Stressing the device above the ratings listed in Table 11, Absolute Maximum Ratings, may cause permanent damage to the device. These are stress ratings only and operation of the device at these or any other conditions above those indicated in the Operating sections of this specification is

not implied. Exposure to Absolute Maximum Rating conditions for extended periods may affect device reliability. Refer also to the STMicroelectronics SURE Program and other relevant quality documents.

**Table 11. Absolute Maximum Ratings**

| Symbol                             | Parameter               | Value |                       | Unit |
|------------------------------------|-------------------------|-------|-----------------------|------|
|                                    |                         | Min   | Max                   |      |
| T <sub>BIAS</sub>                  | Temperature Under Bias  | −40   | 125                   | °C   |
| T <sub>STG</sub>                   | Storage Temperature     | −55   | 150                   | °C   |
| V <sub>IO</sub>                    | Input or Output Voltage | −0.6  | V <sub>DDQ</sub> +0.6 | V    |
| V <sub>DD</sub> , V <sub>DDQ</sub> | Supply Voltage          | −0.6  | 5.0                   | V    |

DC AND AC PARAMETERS

This section summarizes the operating and measurement conditions, and the DC and AC characteristics of the device. The parameters in the DC and AC characteristics Tables that follow, are derived from tests performed under the Measure-

ment Conditions summarized in Table 12, Operating and AC Measurement Conditions. Designers should check that the operating conditions in their circuit match the measurement conditions when relying on the quoted parameters.

Table 12. Operating and AC Measurement Conditions

| Parameter                                       |         | M58LW032A             |                 |                       |                 | Units |
|-------------------------------------------------|---------|-----------------------|-----------------|-----------------------|-----------------|-------|
|                                                 |         | 90                    |                 | 110                   |                 |       |
|                                                 |         | Min                   | Max             | Min                   | Max             |       |
| Supply Voltage (V <sub>DD</sub> )               |         | 2.7                   | 3.6             | 2.7                   | 3.6             | V     |
| Input/Output Supply Voltage (V <sub>DDQ</sub> ) |         | 1.8                   | V <sub>DD</sub> | 1.8                   | V <sub>DD</sub> | V     |
| Ambient Temperature (T <sub>A</sub> )           | Grade 1 | 0                     | 70              | 0                     | 70              | °C    |
|                                                 | Grade 6 | −40                   | 85              | −40                   | 85              | °C    |
| Load Capacitance (C <sub>L</sub> )              |         | 30                    |                 | 30                    |                 | pF    |
| Clock Rise and Fall Times                       |         |                       | 3               |                       | 3               | ns    |
| Input Rise and Fall Times                       |         |                       | 4               |                       | 4               | ns    |
| Input Pulses Voltages                           |         | 0 to V <sub>DDQ</sub> |                 | 0 to V <sub>DDQ</sub> |                 | V     |
| Input and Output Timing Ref. Voltages           |         | 0.5 V <sub>DDQ</sub>  |                 | 0.5 V <sub>DDQ</sub>  |                 | V     |

Figure 9. AC Measurement Input Output Waveform

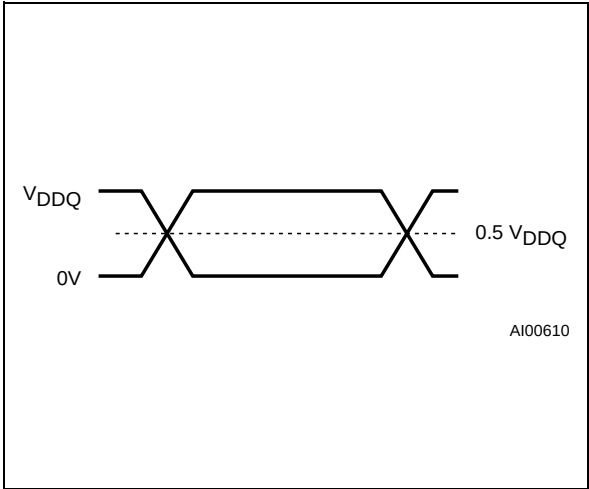


Figure 10. AC Measurement Load Circuit

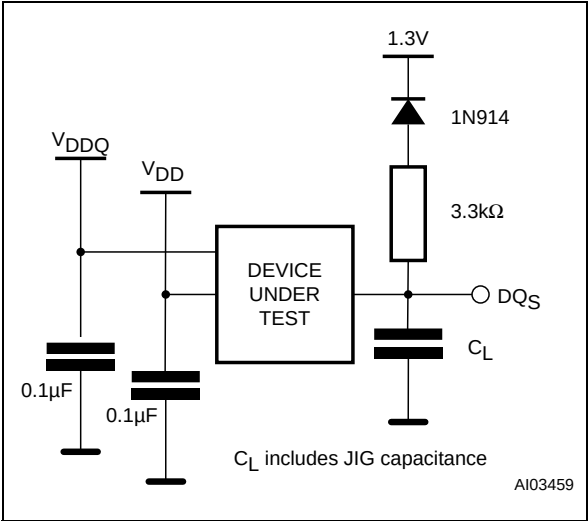


Table 13. Capacitance

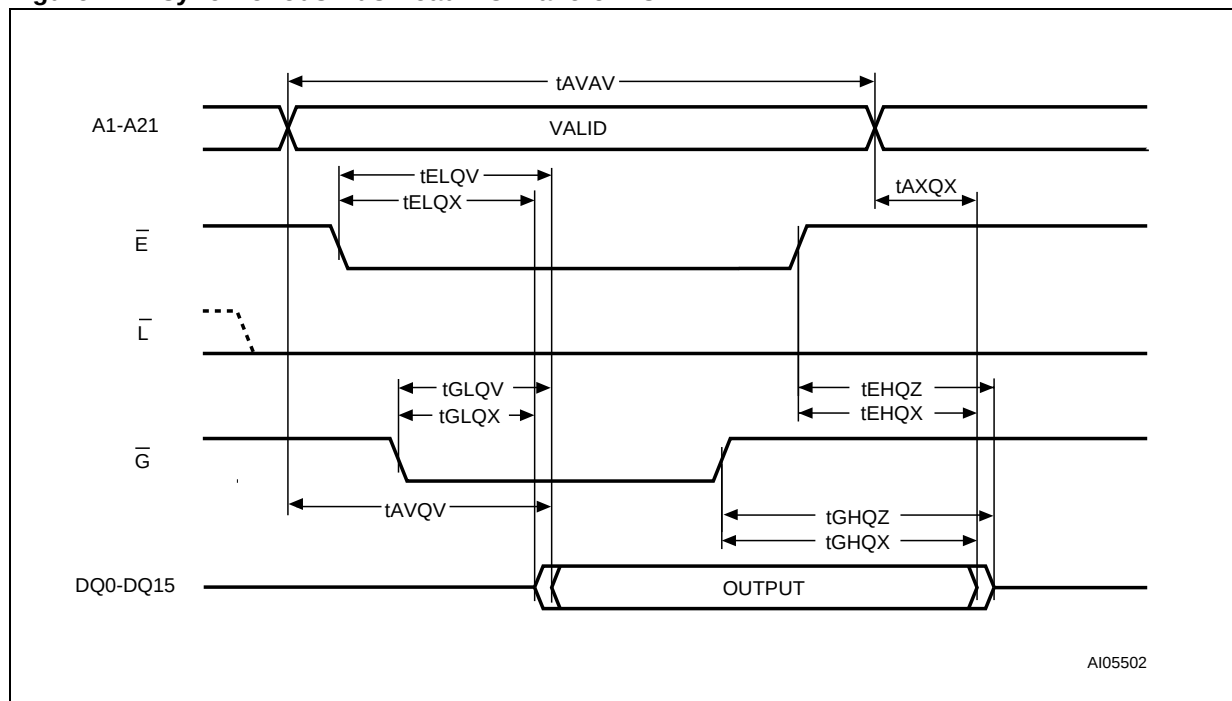
| Symbol    | Parameter          | Test Condition | Typ | Max | Unit |
|-----------|--------------------|----------------|-----|-----|------|
| $C_{IN}$  | Input Capacitance  | $V_{IN} = 0V$  | 6   | 8   | pF   |
| $C_{OUT}$ | Output Capacitance | $V_{OUT} = 0V$ | 8   | 12  | pF   |

Note: 1.  $T_A = 25^{\circ}C$ ,  $f = 1\text{ MHz}$   
2. Sampled only, not 100% tested.

Table 14. DC Characteristics

| Symbol    | Parameter                                                          | Test Condition                                          | Min                  | Max                  | Unit    |
|-----------|--------------------------------------------------------------------|---------------------------------------------------------|----------------------|----------------------|---------|
| $I_{LI}$  | Input Leakage Current                                              | $0V \leq V_{IN} \leq V_{DDQ}$                           |                      | $\pm 1$              | $\mu A$ |
| $I_{LO}$  | Output Leakage Current                                             | $0V \leq V_{OUT} \leq V_{DDQ}$                          |                      | $\pm 5$              | $\mu A$ |
| $I_{DD}$  | Supply Current (Random Read)                                       | $\bar{E} = V_{IL}, \bar{G} = V_{IH}, f_{add} = 6MHz$    |                      | 20                   | mA      |
| $I_{DDB}$ | Supply Current (Burst Read)                                        | $\bar{E} = V_{IL}, \bar{G} = V_{IH}, f_{clock} = 50MHz$ |                      | 30                   | mA      |
| $I_{DD1}$ | Supply Current (Standby)                                           | $\bar{E} = V_{IH}, \bar{RP} = V_{IH}$                   |                      | 40                   | $\mu A$ |
| $I_{DD5}$ | Supply Current (Auto Low-Power)                                    | $\bar{E} = V_{IL}, \bar{RP} = V_{IH}$                   |                      | 40                   | $\mu A$ |
| $I_{DD2}$ | Supply Current (Reset/Power-Down)                                  | $\bar{RP} = V_{IL}$                                     |                      | 40                   | $\mu A$ |
| $I_{DD3}$ | Supply Current (Program or Erase, Block Protect, Blocks Unprotect) | Program or Erase operation in progress                  |                      | 30                   | mA      |
| $I_{DD4}$ | Supply Current (Erase/Program Suspend)                             | $\bar{E} = V_{IH}$                                      |                      | 40                   | $\mu A$ |
| $V_{IL}$  | Input Low Voltage                                                  |                                                         | -0.5                 | $0.3 \times V_{DDQ}$ | V       |
| $V_{IH}$  | Input High Voltage                                                 |                                                         | $0.7 \times V_{DDQ}$ | $V_{DDQ} + 0.5$      | V       |
| $V_{OL}$  | Output Low Voltage                                                 | $I_{OL} = 100\mu A$                                     |                      | 0.2                  | V       |
| $V_{OH}$  | Output High Voltage                                                | $I_{OH} = -100\mu A$                                    | $V_{DDQ} - 0.2$      |                      | V       |
| $V_{LKO}$ | $V_{DD}$ Supply Voltage (Erase and Program lockout)                |                                                         |                      | 2                    | V       |

Figure 11. Asynchronous Bus Read AC Waveforms

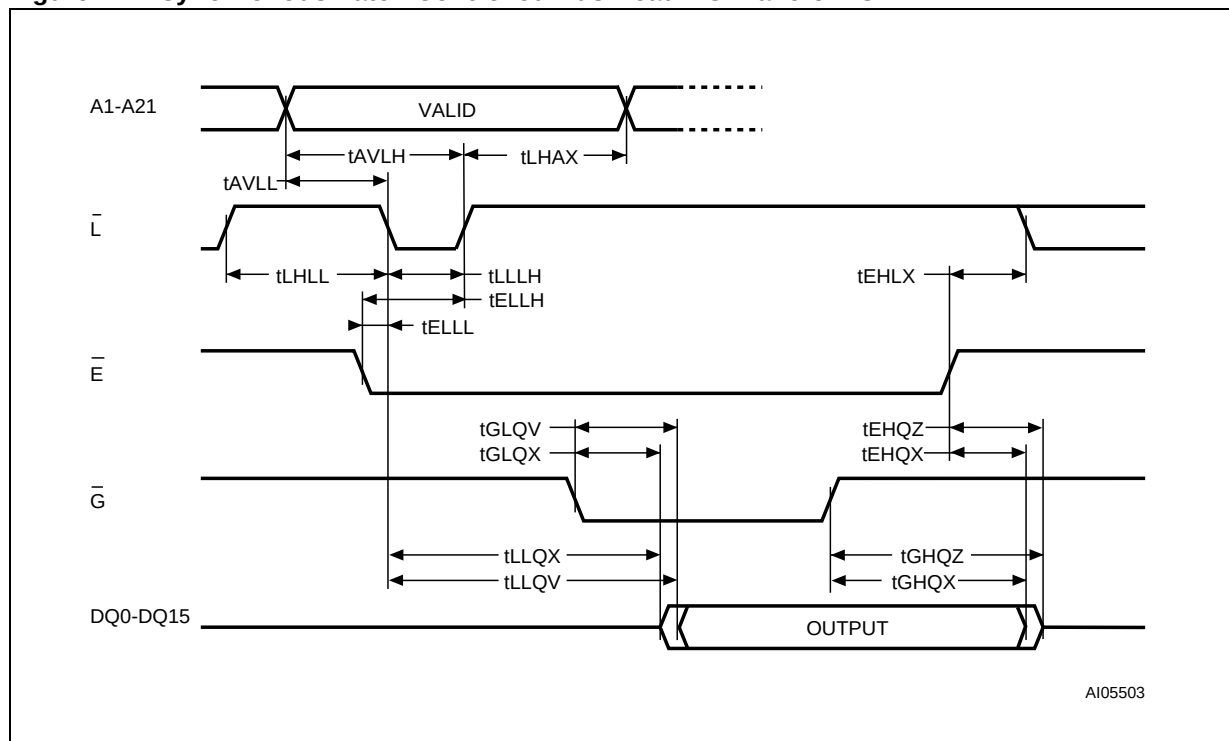


Note: Asynchronous Read M15 = 1

Table 15. Asynchronous Bus Read AC Characteristics.

| Symbol     | Parameter                               | Test Condition                       |     | M58LW032A |     | Unit |
|------------|-----------------------------------------|--------------------------------------|-----|-----------|-----|------|
|            |                                         |                                      |     | 90        | 110 |      |
| $t_{AVAV}$ | Address Valid to Address Valid          | $\bar{E} = V_{IL}, \bar{G} = V_{IL}$ | Min | 90        | 110 | ns   |
| $t_{AVQV}$ | Address Valid to Output Valid           | $\bar{E} = V_{IL}, \bar{G} = V_{IL}$ | Max | 90        | 110 | ns   |
| $t_{ELQX}$ | Chip Enable Low to Output Transition    | $\bar{G} = V_{IL}$                   | Min | 0         | 0   | ns   |
| $t_{ELQV}$ | Chip Enable Low to Output Valid         | $\bar{G} = V_{IL}$                   | Max | 90        | 110 | ns   |
| $t_{GLQX}$ | Output Enable Low to Output Transition  | $\bar{E} = V_{IL}$                   | Min | 0         | 0   | ns   |
| $t_{GLQV}$ | Output Enable Low to Output Valid       | $\bar{E} = V_{IL}$                   | Max | 25        | 25  | ns   |
| $t_{EHQX}$ | Chip Enable High to Output Transition   | $\bar{G} = V_{IL}$                   | Min | 0         | 0   | ns   |
| $t_{GHQX}$ | Output Enable High to Output Transition | $\bar{E} = V_{IL}$                   | Min | 0         | 0   | ns   |
| $t_{AXQX}$ | Address Transition to Output Transition | $\bar{E} = V_{IL}, \bar{G} = V_{IL}$ | Min | 0         | 0   | ns   |
| $t_{EHQZ}$ | Chip Enable High to Output Hi-Z         | $\bar{G} = V_{IL}$                   | Max | 25        | 25  | ns   |
| $t_{GHQZ}$ | Output Enable High to Output Hi-Z       | $\bar{E} = V_{IL}$                   | Max | 20        | 20  | ns   |

Figure 12. Asynchronous Latch Controlled Bus Read AC Waveforms



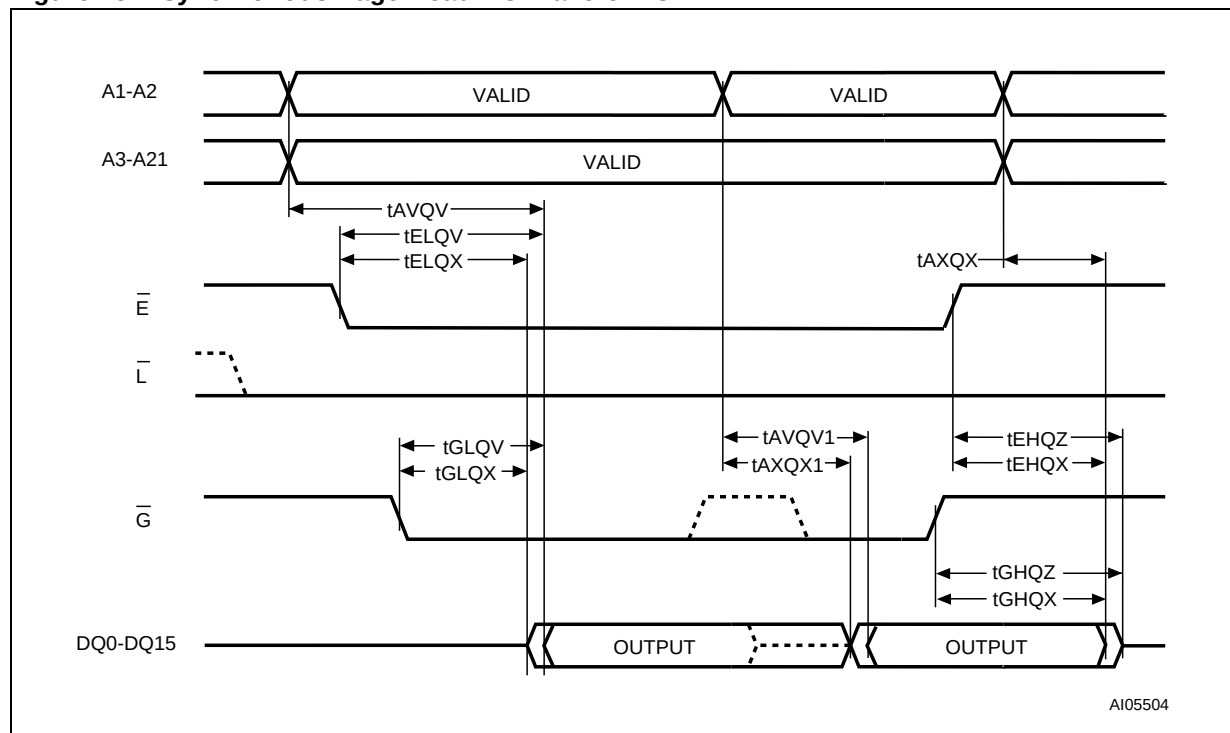
Note: Asynchronous Read M15 = 1

Table 16. Asynchronous Latch Controlled Bus Read AC Characteristics

| Symbol     | Parameter                                   | Test Condition                       |     | M58LW032A |     | Unit |
|------------|---------------------------------------------|--------------------------------------|-----|-----------|-----|------|
|            |                                             |                                      |     | 90        | 110 |      |
| $t_{AVLL}$ | Address Valid to Latch Enable Low           | $\bar{E} = V_{IL}$                   | Min | 0         | 0   | ns   |
| $t_{AVLH}$ | Address Valid to Latch Enable High          | $\bar{E} = V_{IL}$                   | Min | 10        | 10  | ns   |
| $t_{LHLL}$ | Latch Enable High to Latch Enable Low       |                                      | Min | 10        | 10  | ns   |
| $t_{LLLH}$ | Latch Enable Low to Latch Enable High       | $\bar{E} = V_{IL}$                   | Min | 10        | 10  | ns   |
| $t_{ELLL}$ | Chip Enable Low to Latch Enable Low         |                                      | Min | 0         | 0   | ns   |
| $t_{ELLH}$ | Chip Enable Low to Latch Enable High        |                                      | Min | 10        | 10  | ns   |
| $t_{LLQX}$ | Latch Enable Low to Output Transition       | $\bar{E} = V_{IL}, \bar{G} = V_{IL}$ | Min | 0         | 0   | ns   |
| $t_{LLQV}$ | Latch Enable Low to Output Valid            | $\bar{E} = V_{IL}, \bar{G} = V_{IL}$ | Min | 90        | 110 | ns   |
| $t_{LHAX}$ | Latch Enable High to Address Transition     | $\bar{E} = V_{IL}$                   | Min | 6         | 6   | ns   |
| $t_{GLQX}$ | Output Enable Low to Output Transition      | $\bar{E} = V_{IL}$                   | Min | 0         | 0   | ns   |
| $t_{GLQV}$ | Output Enable Low to Output Valid           | $\bar{E} = V_{IL}$                   | Max | 25        | 25  | ns   |
| $t_{EHLX}$ | Chip Enable High to Latch Enable Transition |                                      | Min | 0         | 0   | ns   |

Note: For other timings see Table 15, Asynchronous Bus Read Characteristics.

Figure 13. Asynchronous Page Read AC Waveforms



Note: Asynchronous Read M15 = 1

Table 17. Asynchronous Page Read AC Characteristics

| Symbol      | Parameter                               | Test Condition                       |     | M58LW032A |     | Unit |
|-------------|-----------------------------------------|--------------------------------------|-----|-----------|-----|------|
|             |                                         |                                      |     | 90        | 110 |      |
| $t_{AXQX1}$ | Address Transition to Output Transition | $\bar{E} = V_{IL}, \bar{G} = V_{IL}$ | Min | 6         | 6   | ns   |
| $t_{AVQV1}$ | Address Valid to Output Valid           | $\bar{E} = V_{IL}, \bar{G} = V_{IL}$ | Max | 25        | 25  | ns   |

Note: For other timings see Table 15, Asynchronous Bus Read Characteristics.

Figure 14. Asynchronous Write AC Waveform, Write Enable Controlled

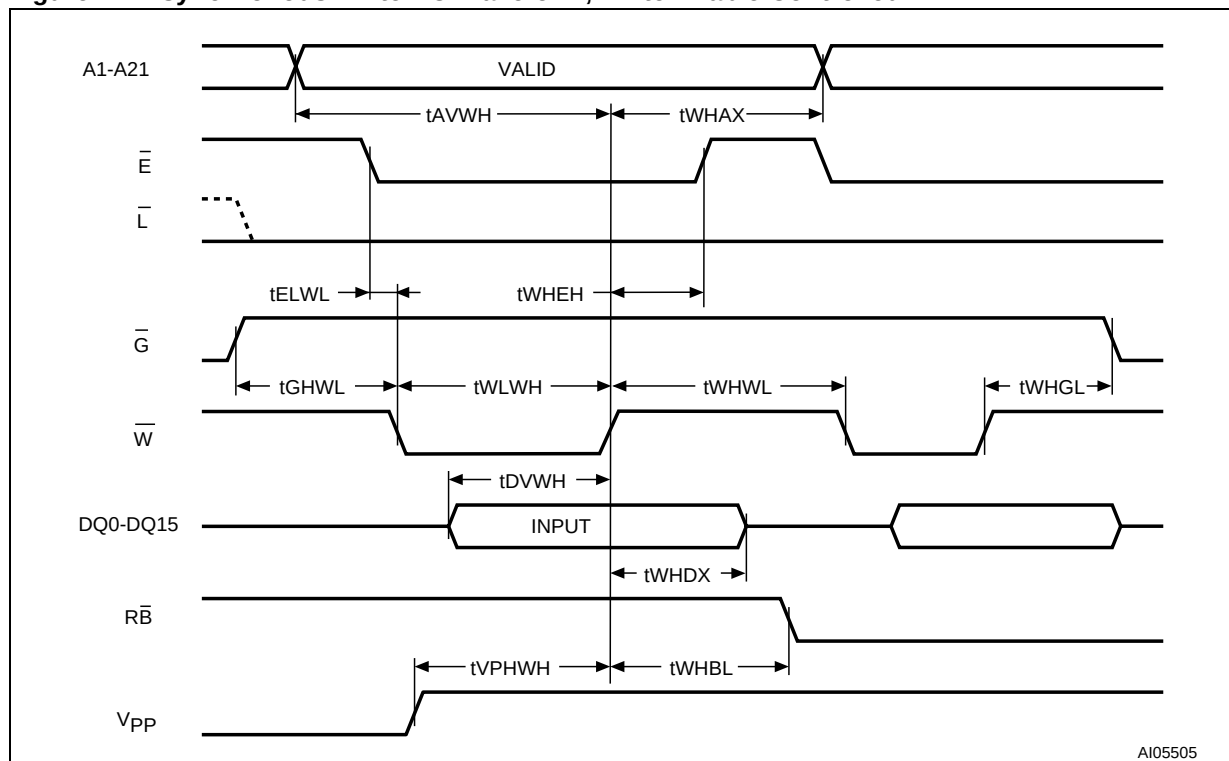


Figure 15. Asynchronous Latch Controlled Write AC Waveform, Write Enable Controlled

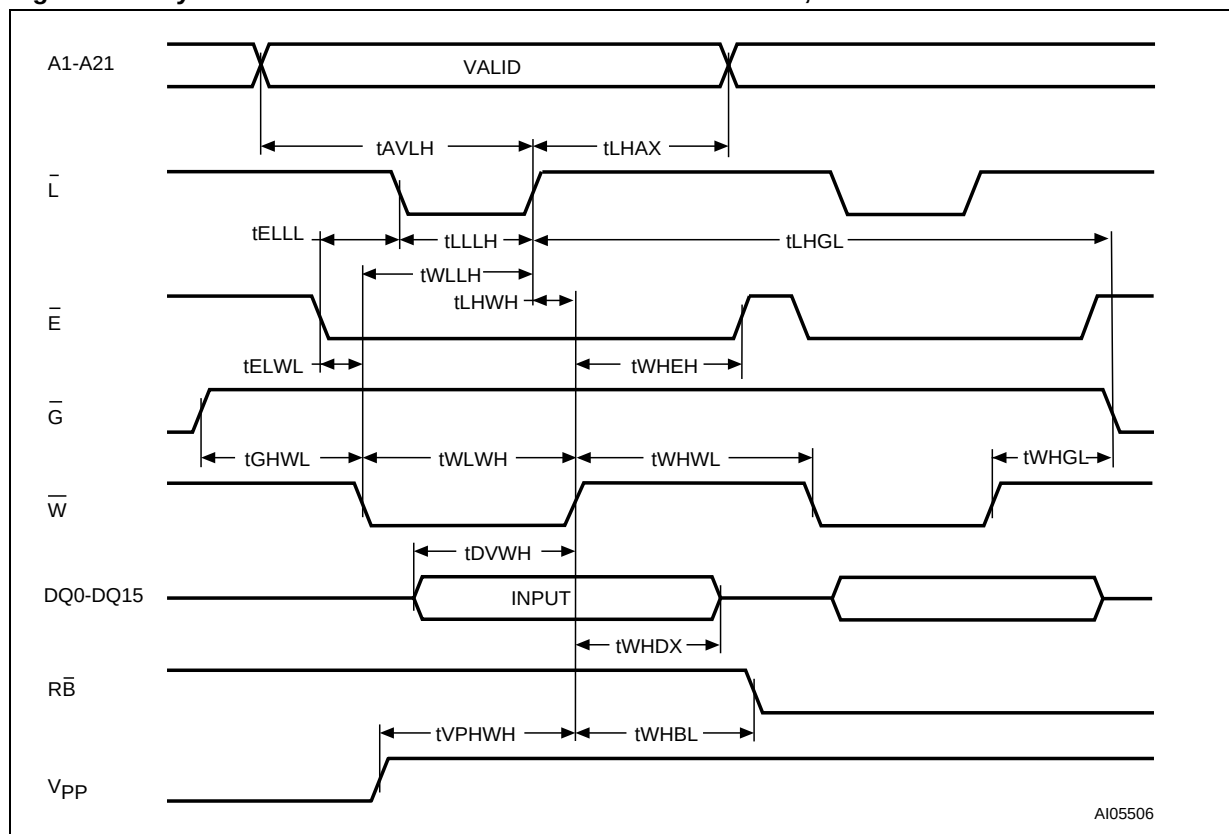


**Table 18. Asynchronous Write and Latch Controlled Write AC Characteristics, Write Enable Controlled.**

| Symbol      | Parameter                                      | Test Condition          |     | M58LW032A |     | Unit |
|-------------|------------------------------------------------|-------------------------|-----|-----------|-----|------|
|             |                                                |                         |     | 90        | 110 |      |
| $t_{AVLH}$  | Address Valid to Latch Enable High             |                         | Min | 10        | 10  | ns   |
| $t_{AVWH}$  | Address Valid to Write Enable High             | $\overline{E} = V_{IL}$ | Min | 50        | 50  | ns   |
| $t_{DVWH}$  | Data Input Valid to Write Enable High          | $\overline{E} = V_{IL}$ | Min | 50        | 50  | ns   |
| $t_{ELWL}$  | Chip Enable Low to Write Enable Low            |                         | Min | 0         | 0   | ns   |
| $t_{ELLL}$  | Chip Enable Low to Latch Enable Low            |                         | Min | 0         | 0   | ns   |
| $t_{LHAX}$  | Latch Enable High to Address Transition        |                         | Min | 6         | 6   | ns   |
| $t_{LHGL}$  | Latch Enable High to Output Enable Low         |                         | Min | 95        | 95  | ns   |
| $t_{LHWH}$  | Latch Enable High to Write Enable High         |                         | Min | 0         | 0   | ns   |
| $t_{LLLH}$  | Latch Enable low to Latch Enable High          |                         | Min | 10        | 10  | ns   |
| $t_{LLWH}$  | Latch Enable Low to Write Enable High          |                         | Min | 50        | 50  | ns   |
| $t_{VPHWH}$ | Program/Erase Enable High to Write Enable High |                         | Min | 0         | 0   | ns   |
| $t_{WHAX}$  | Write Enable High to Address Transition        | $\overline{E} = V_{IL}$ | Min | 10        | 10  | ns   |
| $t_{WHBL}$  | Write Enable High to Ready/Busy low            |                         | Max | 500       | 500 | ns   |
| $t_{WHDX}$  | Write Enable High to Input Transition          | $\overline{E} = V_{IL}$ | Min | 10        | 10  | ns   |
| $t_{WHEH}$  | Write Enable High to Chip Enable High          |                         | Min | 0         | 0   | ns   |
| $t_{GHWL}$  | Output Enable High to Write Enable Low         |                         | Min | 20        | 20  | ns   |
| $t_{WHGL}$  | Write Enable High to Output Enable Low         |                         | Min | 35        | 35  | ns   |
| $t_{WHWL}$  | Write Enable High to Write Enable Low          |                         | Min | 30        | 30  | ns   |
| $t_{WLWH}$  | Write Enable Low to Write Enable High          | $\overline{E} = V_{IL}$ | Min | 70        | 70  | ns   |
| $t_{WLLH}$  | Write Enable Low to Latch Enable High          | $\overline{E} = V_{IL}$ | Min | 10        | 10  | ns   |

Figure 16. Asynchronous Write AC Waveforms, Chip Enable Controlled

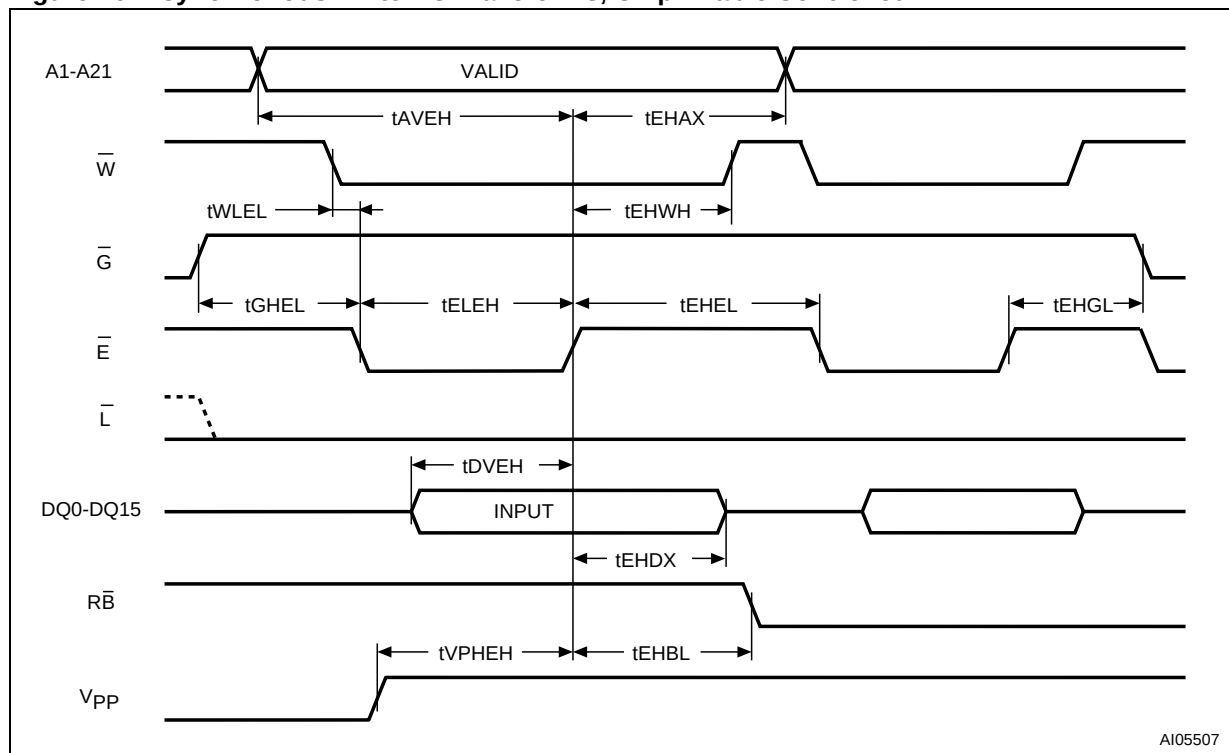


Figure 17. Asynchronous Latch Controlled Write AC Waveforms, Chip Enable Controlled

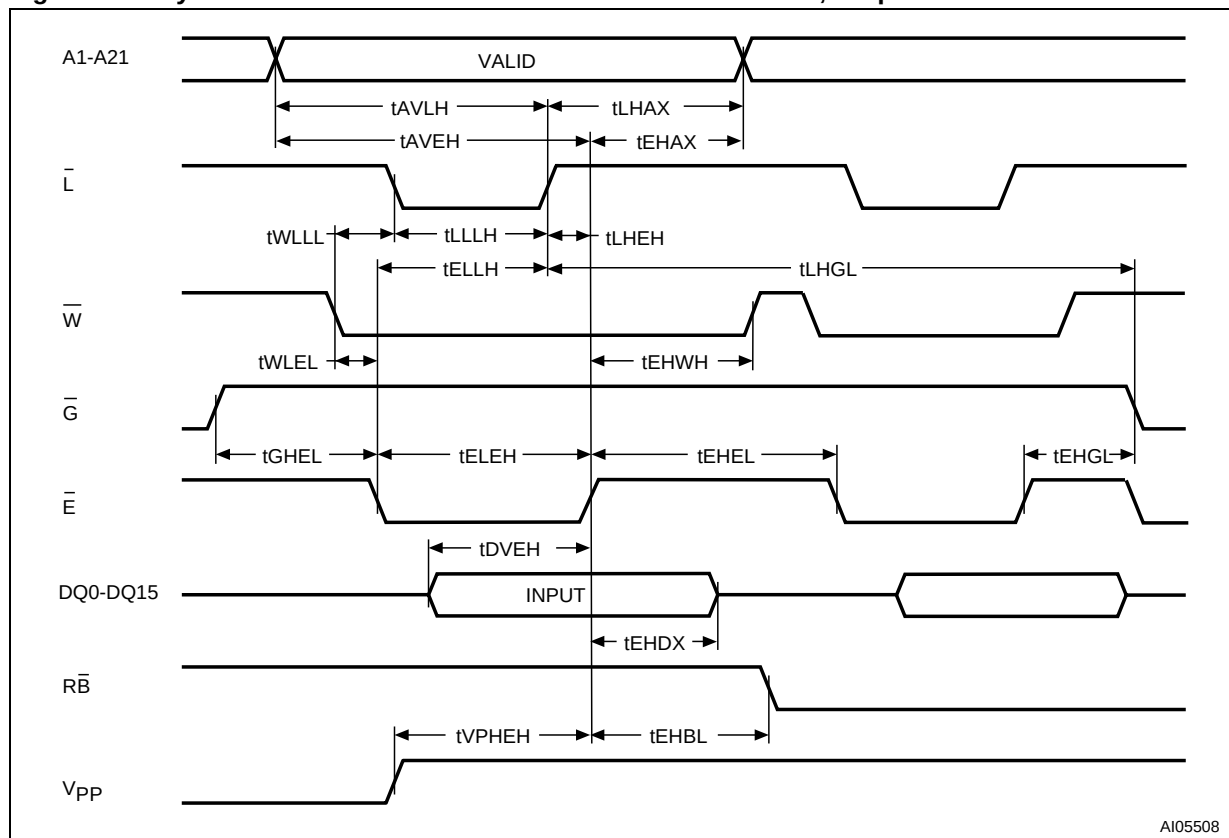
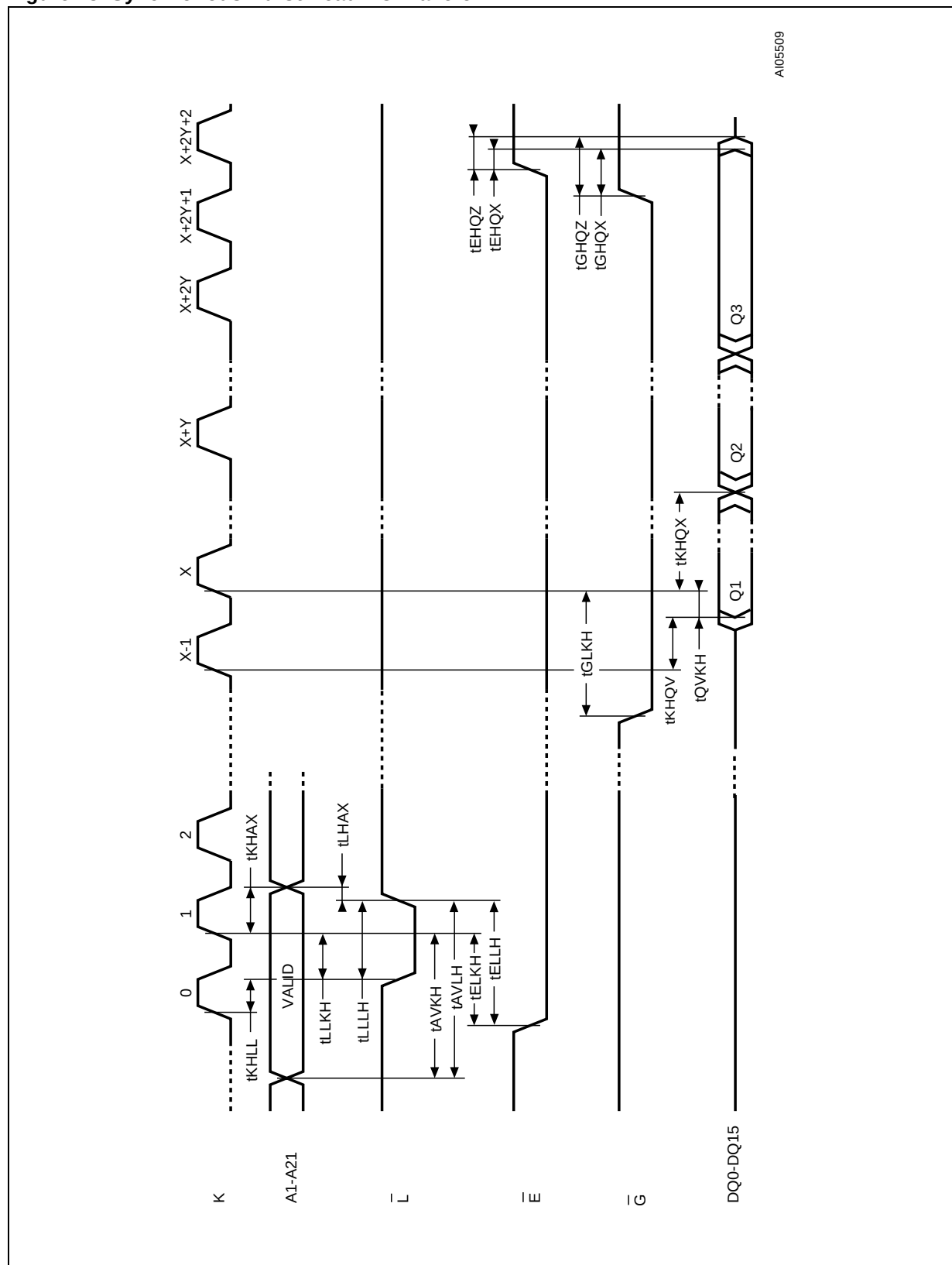


**Table 19. Asynchronous Write and Latch Controlled Write AC Characteristics, Chip Enable Controlled**

| Symbol      | Parameter                                     | Test Condition          |     | M58LW032A |     | Unit |
|-------------|-----------------------------------------------|-------------------------|-----|-----------|-----|------|
|             |                                               |                         |     | 90        | 110 |      |
| $t_{AVLH}$  | Address Valid to Latch Enable High            |                         | Min | 10        | 10  | ns   |
| $t_{AVEH}$  | Address Valid to Chip Enable High             | $\overline{W} = V_{IL}$ | Min | 50        | 50  | ns   |
| $t_{DVEH}$  | Data Input Valid to Chip Enable High          | $\overline{W} = V_{IL}$ | Min | 50        | 50  | ns   |
| $t_{WLEL}$  | Write Enable Low to Chip Enable Low           |                         | Min | 0         | 0   | ns   |
| $t_{WLLL}$  | Write Enable Low to Latch Enable Low          |                         | Min | 0         | 0   | ns   |
| $t_{LHAX}$  | Latch Enable High to Address Transition       |                         | Min | 6         | 6   | ns   |
| $t_{LHGL}$  | Latch Enable High to Output Enable Low        |                         | Min | 35        | 35  | ns   |
| $t_{LHEH}$  | Latch Enable High to Chip Enable High         |                         | Min | 0         | 0   | ns   |
| $t_{LLLH}$  | Latch Enable low to Latch Enable High         |                         | Min | 10        | 10  | ns   |
| $t_{LLEH}$  | Latch Enable Low to Chip Enable High          |                         | Min | 50        | 50  | ns   |
| $t_{VPHEH}$ | Program/Erase Enable High to Chip Enable High |                         | Min | 0         | 0   | ns   |
| $t_{EHAX}$  | Chip Enable High to Address Transition        | $\overline{W} = V_{IL}$ | Min | 10        | 10  | ns   |
| $t_{EHBL}$  | Chip Enable High to Ready/Busy low            |                         | Max | 500       | 500 | ns   |
| $t_{EHDX}$  | Chip Enable High to Input Transition          | $\overline{W} = V_{IL}$ | Min | 10        | 10  | ns   |
| $t_{EHWH}$  | Chip Enable High to Write Enable High         |                         | Min | 0         | 0   | ns   |
| $t_{GHEL}$  | Output Enable High to Chip Enable Low         |                         | Min | 20        | 20  | ns   |
| $t_{EHGL}$  | Chip Enable High to Output Enable Low         |                         | Min | 35        | 35  | ns   |
| $t_{EHEL}$  | Chip Enable High to Chip Enable Low           |                         | Min | 30        | 30  | ns   |
| $t_{ELEH}$  | Chip Enable Low to Chip Enable High           | $\overline{W} = V_{IL}$ | Min | 70        | 70  | ns   |
| $t_{ELLH}$  | Chip Enable Low to Latch Enable High          | $\overline{W} = V_{IL}$ | Min | 10        | 10  | ns   |

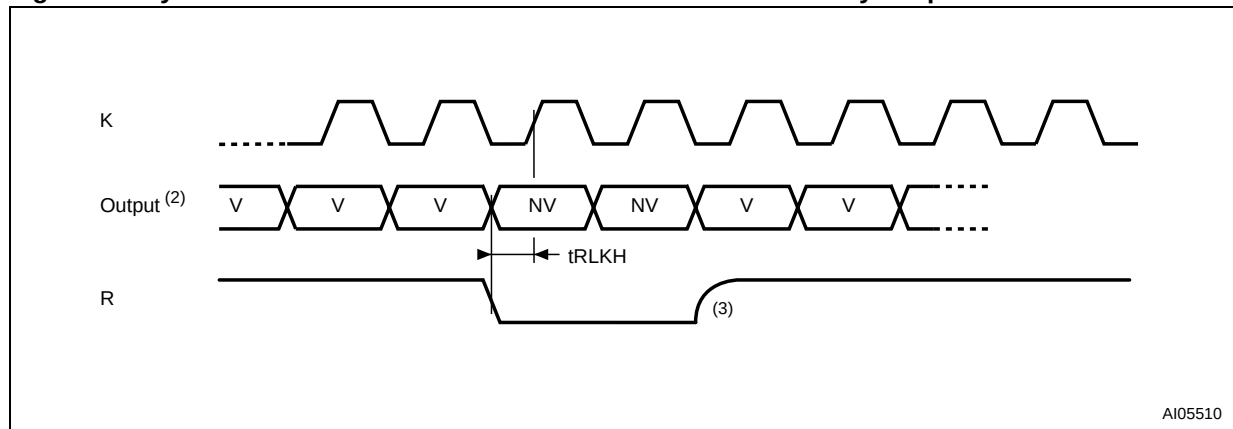
Figure 18. Synchronous Burst Read AC Waveform



AI05509

Note: Valid Clock Edge = Rising (M6 = 1)

Figure 19. Synchronous Burst Read - Continuous - Valid Data Ready Output



AI05510

Note: 1. Valid Data Ready = Valid Low during valid clock edge (M8 = 0)

2. V= Valid output, NV= Not Valid output.

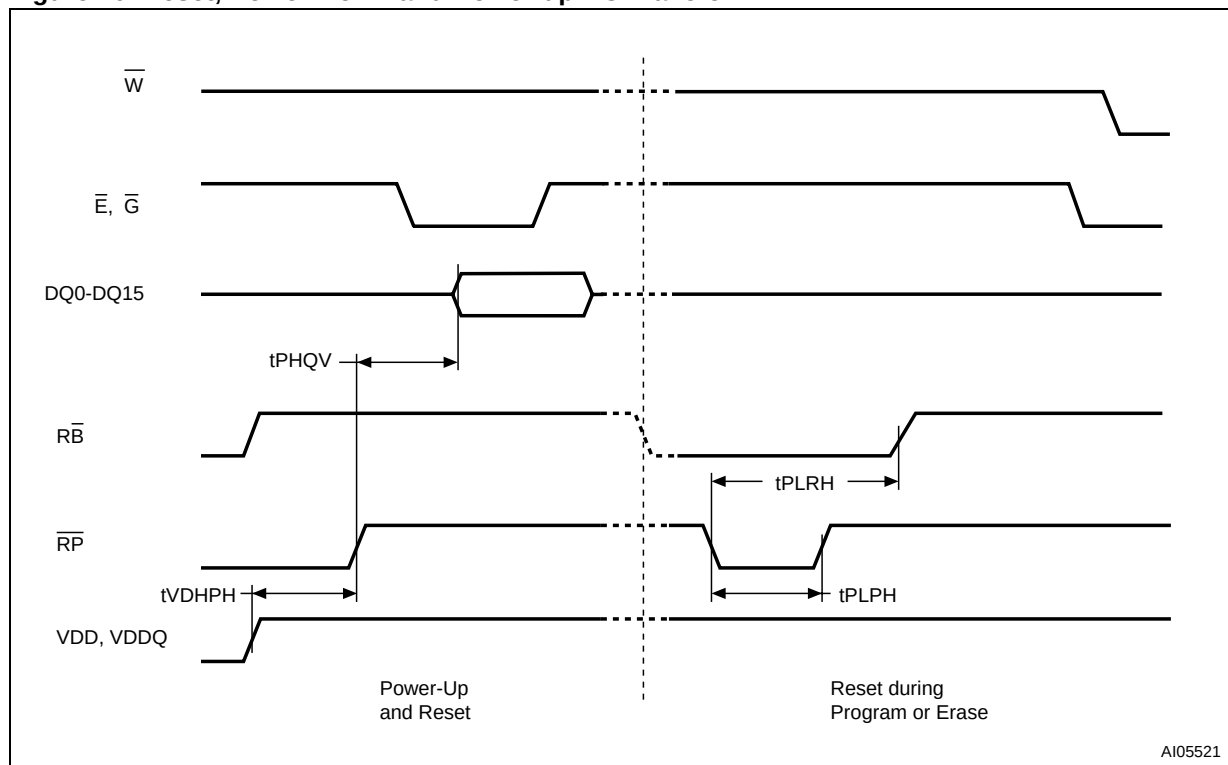
3. R is an open drain output with an internal pull up resistor of 1M $\Omega$ . Depending on the Valid Data Ready pin capacitance load an external pull up resistor must be chosen according to the system clock period.

Table 20. Synchronous Burst Read AC Characteristics

| Symbol            | Parameter                                | Test Condition                                         |     | M58LW032A |     | Unit |
|-------------------|------------------------------------------|--------------------------------------------------------|-----|-----------|-----|------|
|                   |                                          |                                                        |     | 90        | 110 |      |
| t <sub>AVKH</sub> | Address Valid to Active Clock Edge       | $\bar{E} = V_{IL}$                                     | Min | 7         | 7   | ns   |
| t <sub>AVLH</sub> | Address Valid to Latch Enable High       | $\bar{E} = V_{IL}$                                     | Min | 10        | 10  | ns   |
| t <sub>ELKH</sub> | Chip Enable Low to Active Clock Edge     | $\bar{E} = V_{IL}$                                     | Min | 10        | 10  | ns   |
| t <sub>ELLH</sub> | Chip Enable Low to Latch Enable High     | $\bar{E} = V_{IL}$                                     | Min | 10        | 10  | ns   |
| t <sub>GLKH</sub> | Output Enable Low to Valid Clock Edge    | $\bar{E} = V_{IL}, \bar{L} = V_{IH}$                   | Min | 20        | 20  | ns   |
| t <sub>KHAX</sub> | Valid Clock Edge to Address Transition   | $\bar{E} = V_{IL}$                                     | Min | 5         | 5   | ns   |
| t <sub>KHLL</sub> | Valid Clock Edge to Latch Enable Low     | $\bar{E} = V_{IL}$                                     | Min | 0         | 0   | ns   |
| t <sub>KHLH</sub> | Valid Clock Edge to Latch Enable High    | $\bar{E} = V_{IL}$                                     | Min | 0         | 0   | ns   |
| t <sub>KHQX</sub> | Valid Clock Edge to Output Transition    | $\bar{E} = V_{IL}, \bar{G} = V_{IL}, \bar{L} = V_{IH}$ | Min | 3         | 3   | ns   |
| t <sub>LLKH</sub> | Latch Enable Low to Valid Clock Edge     | $\bar{E} = V_{IL}$                                     | Min | 6         | 6   | ns   |
| t <sub>LLLH</sub> | Latch Enable Low to Latch Enable High    | $\bar{E} = V_{IL}$                                     | Min | 6         | 6   | ns   |
| t <sub>KHQV</sub> | Valid Clock Edge to Output Valid         | $\bar{E} = V_{IL}, \bar{G} = V_{IL}, \bar{L} = V_{IH}$ | Max | 10        | 10  | ns   |
| t <sub>QVKH</sub> | Output Valid to Active Clock Edge        | $\bar{E} = V_{IL}, \bar{G} = V_{IL}, \bar{L} = V_{IH}$ | Min | 5         | 5   | ns   |
| t <sub>RLKH</sub> | Valid Data Ready Low to Valid Clock Edge | $\bar{E} = V_{IL}, \bar{G} = V_{IL}, \bar{L} = V_{IH}$ | Min | 5         | 5   | ns   |

Note: For other timings see Table 15, Asynchronous Bus Read Characteristics.

Figure 20. Reset, Power-Down and Power-up AC Waveform



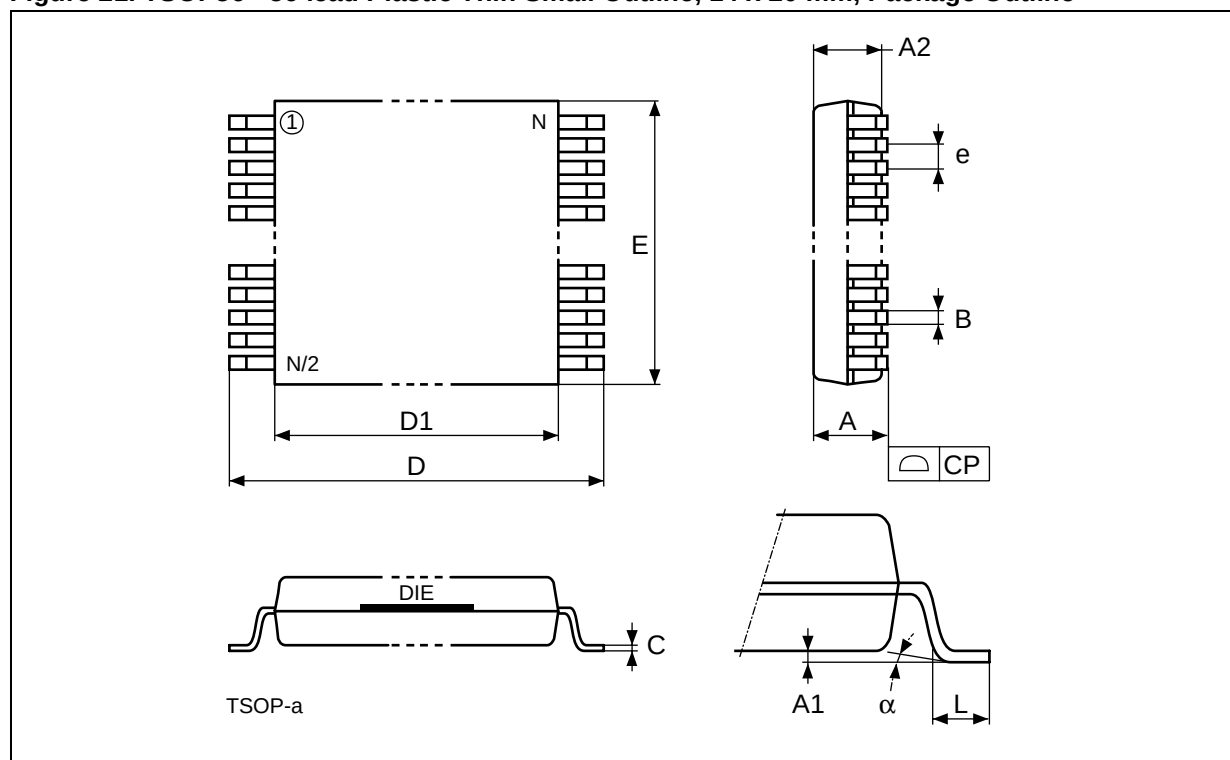
AI05521

Table 21. Reset, Power-Down and Power-up AC Characteristics

| Symbol      | Parameter                                     |     | M58LW032A |     | Unit    |
|-------------|-----------------------------------------------|-----|-----------|-----|---------|
|             |                                               |     | 90        | 110 |         |
| $t_{PHQV}$  | Reset/Power-Down High to Data Valid           | Max | 150       | 150 | ns      |
| $t_{PLPH}$  | Reset/Power-Down Low to Reset/Power-Down High | Min | 100       | 100 | ns      |
| $t_{PLRH}$  | Reset/Power-Down Low to Ready High            | Max | 30        | 30  | $\mu$ s |
| $t_{VDHPH}$ | Supply Voltages High to Reset/Power-Down High | Min | 0         | 0   | $\mu$ s |

## PACKAGE MECHANICAL

Figure 21. TSOP56 - 56 lead Plastic Thin Small Outline, 14 x 20 mm, Package Outline

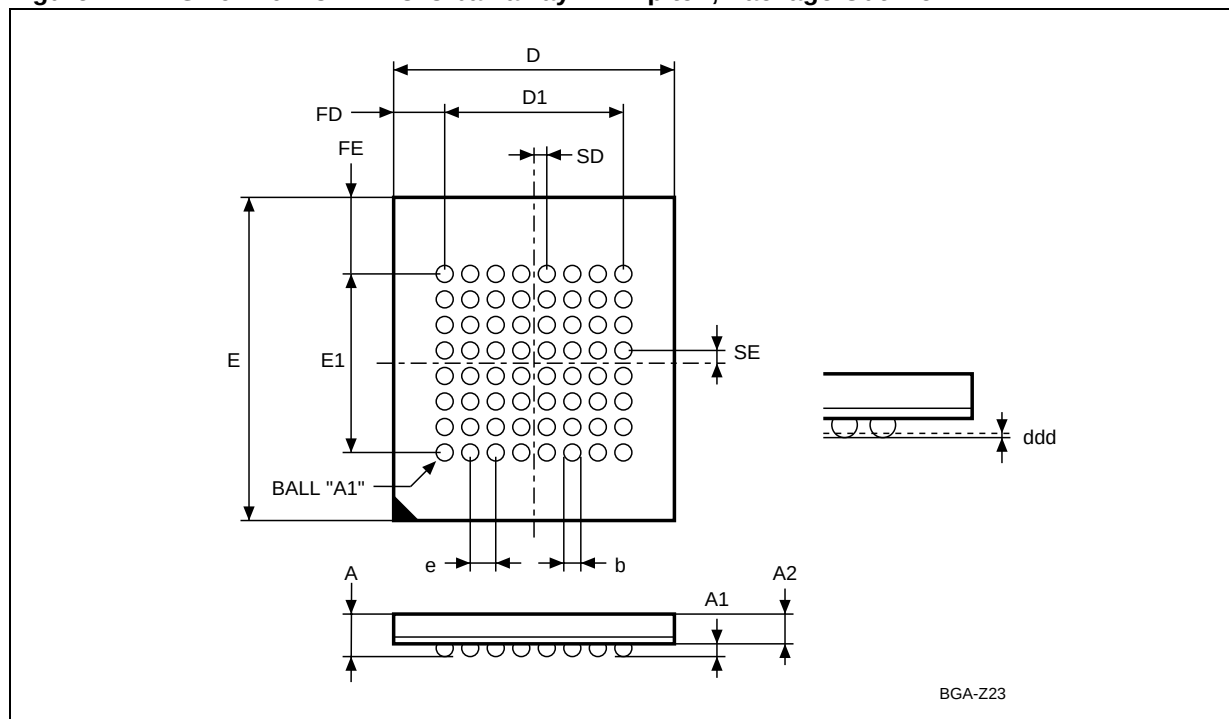


Note: Drawing is not to scale.

Table 22. TSOP56 - 56 lead Plastic Thin Small Outline, 14 x 20 mm, Package Mechanical Data

| Symbol   | mm   |       |       | inches |        |        |
|----------|------|-------|-------|--------|--------|--------|
|          | Typ  | Min   | Max   | Typ    | Min    | Max    |
| A        |      |       | 1.20  |        |        | 0.0472 |
| A1       |      | 0.05  | 0.15  |        | 0.0020 | 0.0059 |
| A2       |      | 0.95  | 1.05  |        | 0.0374 | 0.0413 |
| B        |      | 0.17  | 0.27  |        | 0.0067 | 0.0106 |
| C        |      | 0.10  | 0.21  |        | 0.0039 | 0.0083 |
| D        |      | 19.80 | 20.20 |        | 0.7795 | 0.7953 |
| D1       |      | 18.30 | 18.50 |        | 0.7205 | 0.7283 |
| E        |      | 13.90 | 14.10 |        | 0.5472 | 0.5551 |
| e        | 0.50 | –     | –     | 0.0197 | –      | –      |
| L        |      | 0.50  | 0.70  |        | 0.0197 | 0.0276 |
| $\alpha$ |      | 0°    | 5°    |        | 0°     | 5°     |
| N        | 56   |       |       | 56     |        |        |
| CP       |      |       | 0.10  |        |        | 0.0039 |

Figure 22. TBGA64 10x13mm - 8x8 ball array 1mm pitch, Package Outline



Note: Drawing is not to scale.

Table 23. TBGA64 10x13mm - 8x8 ball array, 1mm pitch, Package Mechanical Data

| Symbol | millimeters |        |        | inches |        |        |
|--------|-------------|--------|--------|--------|--------|--------|
|        | Typ         | Min    | Max    | Typ    | Min    | Max    |
| A      |             |        | 1.200  |        |        | 0.0472 |
| A1     | 0.300       | 0.200  | 0.350  | 0.0118 | 0.0079 | 0.0138 |
| A2     |             |        | 0.850  |        |        | 0.0335 |
| b      |             | 0.400  | 0.500  |        | 0.0157 | 0.0197 |
| D      | 10.000      | 9.900  | 10.100 | 0.3937 | 0.3898 | 0.3976 |
| D1     | 7.000       | —      | —      | 0.2756 | —      | —      |
| ddd    |             |        | 0.100  |        |        | 0.0039 |
| e      | 1.000       | —      | —      | 0.0394 | —      | —      |
| E      | 13.000      | 12.900 | 13.100 | 0.5118 | 0.5079 | 0.5157 |
| E1     | 7.000       | —      | —      | 0.2756 | —      | —      |
| FD     | 1.500       | —      | —      | 0.0591 | —      | —      |
| FE     | 3.000       | —      | —      | 0.1181 | —      | —      |
| SD     | 0.500       | —      | —      | 0.0197 | —      | —      |
| SE     | 0.500       | —      | —      | 0.0197 | —      | —      |

PART NUMBERING

Table 24. Ordering Information Scheme

|                                                                                                            |           |    |   |   |   |
|------------------------------------------------------------------------------------------------------------|-----------|----|---|---|---|
| Example:                                                                                                   | M58LW032A | 90 | N | 1 | T |
| <b>Device Type</b><br>M58                                                                                  |           |    |   |   |   |
| <b>Architecture</b><br>L = Page Mode, Burst Mode                                                           |           |    |   |   |   |
| <b>Operating Voltage</b><br>W = V <sub>DD</sub> = 2.7V to 3.6V; V <sub>DDQ</sub> = 1.8V to V <sub>DD</sub> |           |    |   |   |   |
| <b>Device Function</b><br>032A = 32 Mbit (x16), Uniform Block                                              |           |    |   |   |   |
| <b>Speed</b><br>90 = 90ns<br>110 = 110ns                                                                   |           |    |   |   |   |
| <b>Package</b><br>N = TSOP56: 14 x 20 mm<br>ZA = TBGA64: 10 x 13 mm, 1mm pitch                             |           |    |   |   |   |
| <b>Temperature Range</b><br>1 = 0 to 70 °C<br>6 = -40 to 85 °C                                             |           |    |   |   |   |
| <b>Option</b><br>T = Tape & Reel Packing                                                                   |           |    |   |   |   |

Note: Devices are shipped from the factory with the memory content bits erased to '1'.  
For a list of available options (Speed, Package, etc...) or for further information on any aspect of this device, please contact the ST Sales Office nearest to you.

## APPENDIX A. BLOCK ADDRESS TABLE

Table 25. Block Addresses

| Block Number | Address Range<br>(x16 Bus Width) |
|--------------|----------------------------------|
| 64           | 1F8000h-1FFFFFFh                 |
| 63           | 1F0000h-1F7FFFh                  |
| 62           | 1E8000h-1EFFFFh                  |
| 61           | 1E0000h-1E7FFFh                  |
| 60           | 1D8000h-1DFFFFh                  |
| 59           | 1D0000h-1D7FFFh                  |
| 58           | 1C8000h-1CFFFFh                  |
| 57           | 1C0000h-1C7FFFh                  |
| 56           | 1B8000h-1BFFFFh                  |
| 55           | 1B0000h-1B7FFFh                  |
| 54           | 1A8000h-1AFFFFh                  |
| 53           | 1A0000h-1A7FFFh                  |
| 52           | 198000h-19FFFFh                  |
| 51           | 190000h-197FFFh                  |
| 50           | 188000h-18FFFFh                  |
| 49           | 180000h-187FFFh                  |
| 48           | 178000h-17FFFFh                  |
| 47           | 170000h-177FFFh                  |
| 46           | 168000h-16FFFFh                  |
| 45           | 160000h-167FFFh                  |
| 44           | 158000h-15FFFFh                  |
| 43           | 150000h-157FFFh                  |
| 42           | 148000h-14FFFFh                  |
| 41           | 140000h-147FFFh                  |
| 40           | 138000h-13FFFFh                  |
| 39           | 130000h-137FFFh                  |
| 38           | 128000h-12FFFFh                  |
| 37           | 120000h-127FFFh                  |
| 36           | 118000h-11FFFFh                  |
| 35           | 110000h-117FFFh                  |
| 34           | 108000h-10FFFFh                  |
| 33           | 100000h-107FFFh                  |

| Block Number | Address Range<br>(x16 Bus Width) |
|--------------|----------------------------------|
| 32           | 0F8000h-0FFFFFFh                 |
| 31           | 0F0000h-0F7FFFh                  |
| 30           | 0E8000h-0EFFFFh                  |
| 29           | 0E0000h-0E7FFFh                  |
| 28           | 0D8000h-0DFFFFh                  |
| 27           | 0D0000h-0D7FFFh                  |
| 26           | 0C8000h-0CFFFFh                  |
| 25           | 0C0000h-0C7FFFh                  |
| 24           | 0B8000h-0BFFFFh                  |
| 23           | 0B0000h-0B7FFFh                  |
| 22           | 0A8000h-0AFFFFh                  |
| 21           | 0A0000h-0A7FFFh                  |
| 20           | 098000h-09FFFFh                  |
| 19           | 090000h-097FFFh                  |
| 18           | 088000h-08FFFFh                  |
| 17           | 080000h-087FFFh                  |
| 16           | 078000h-07FFFFh                  |
| 15           | 070000h-077FFFh                  |
| 14           | 068000h-06FFFFh                  |
| 13           | 060000h-067FFFh                  |
| 12           | 058000h-05FFFFh                  |
| 11           | 050000h-057FFFh                  |
| 10           | 048000h-04FFFFh                  |
| 9            | 040000h-047FFFh                  |
| 8            | 038000h-03FFFFh                  |
| 7            | 030000h-037FFFh                  |
| 6            | 028000h-02FFFFh                  |
| 5            | 020000h-027FFFh                  |
| 4            | 018000h-01FFFFh                  |
| 3            | 010000h-017FFFh                  |
| 2            | 008000h-00FFFFh                  |
| 1            | 000000h-007FFFh                  |

## APPENDIX B. COMMON FLASH INTERFACE - CFI

The Common Flash Interface is a JEDEC approved, standardized data structure that can be read from the Flash memory device. It allows a system software to query the device to determine various electrical and timing parameters, density information and functions supported by the memory. The system can interface easily with the de-

vice, enabling the software to upgrade itself when necessary.

When the CFI Query Command (RCFI) is issued the device enters CFI Query mode and the data structure is read from the memory. Tables 26, 27, 28, 29, 30 and 31 show the addresses used to retrieve the data.

**Table 26. Query Structure Overview**

| Offset              | Sub-section Name                                  | Description                                                           |
|---------------------|---------------------------------------------------|-----------------------------------------------------------------------|
| 00h                 |                                                   | Manufacturer Code                                                     |
| 01h                 |                                                   | Device Code                                                           |
| 10h                 | CFI Query Identification String                   | Command set ID and algorithm data offset                              |
| 1Bh                 | System Interface Information                      | Device timing and voltage information                                 |
| 27h                 | Device Geometry Definition                        | Flash memory layout                                                   |
| P(h) <sup>(1)</sup> | Primary Algorithm-specific Extended Query Table   | Additional information specific to the Primary Algorithm (optional)   |
| A(h) <sup>(2)</sup> | Alternate Algorithm-specific Extended Query Table | Additional information specific to the Alternate Algorithm (optional) |
| (SBA+02)h           | Block Status Register                             | Block-related Information                                             |

Note: 1. Offset 15h defines P which points to the Primary Algorithm Extended Query Address Table.  
 2. Offset 19h defines A which points to the Alternate Algorithm Extended Query Address Table.  
 3. SBA is the Start Base Address for each block.

**Table 27. CFI - Query Address and Data Output**

| Address A21-A1     | Data |     | Instruction                                                    |
|--------------------|------|-----|----------------------------------------------------------------|
| 10h                | 51h  | "Q" | Query ASCII String<br>51h; "Q"<br>52h; "R"<br>59h; "Y"         |
| 11h                | 52h  | "R" |                                                                |
| 12h                | 59h  | "Y" |                                                                |
| 13h                | 01h  |     | Primary Vendor:<br>Command Set and Control Interface ID Code   |
| 14h                | 00h  |     |                                                                |
| 15h                | 31h  |     | Primary algorithm extended Query Address Table: P(h)           |
| 16h                | 00h  |     |                                                                |
| 17h                | 00h  |     | Alternate Vendor:<br>Command Set and Control Interface ID Code |
| 18h                | 00h  |     |                                                                |
| 19h                | 00h  |     | Alternate Algorithm Extended Query address Table               |
| 1Ah <sup>(2)</sup> | 00h  |     |                                                                |

Note: 1. Query Data are always presented on DQ7-DQ0. DQ15-DQ8 are set to '0'.  
 2. Offset 19h defines A which points to the Alternate Algorithm Extended Query Address Table.

**Table 28. CFI - Device Voltage and Timing Specification**

| Address A21-A1 | Data               | Description                                                             |
|----------------|--------------------|-------------------------------------------------------------------------|
| 1Bh            | 27h <sup>(1)</sup> | V <sub>DD</sub> Min, 2.7V                                               |
| 1Ch            | 36h <sup>(1)</sup> | V <sub>DD</sub> max, 3.6V                                               |
| 1Dh            | 00h <sup>(2)</sup> | V <sub>PP</sub> min – Not Available                                     |
| 1Eh            | 00h <sup>(2)</sup> | V <sub>PP</sub> max – Not Available                                     |
| 1Fh            | 04h                | 2 <sup>n</sup> μs typical time-out for Word, DWord prog – Not Available |
| 20h            | 08h                | 2 <sup>n</sup> μs, typical time-out for max buffer write                |
| 21h            | 0Ah                | 2 <sup>n</sup> ms, typical time-out for Erase Block                     |
| 22h            | 00h <sup>(3)</sup> | 2 <sup>n</sup> ms, typical time-out for chip erase – Not Available      |
| 23h            | 04h                | 2 <sup>n</sup> x typical for Word Dword time-out max – Not Available    |
| 24h            | 04h                | 2 <sup>n</sup> x typical for buffer write time-out max                  |
| 25h            | 04h                | 2 <sup>n</sup> x typical for individual block erase time-out maximum    |
| 26h            | 00h <sup>(3)</sup> | 2 <sup>n</sup> x typical for chip erase max time-out – Not Available    |

Note: 1. Bits are coded in Binary Code Decimal, bit7 to bit4 are scaled in Volts and bit3 to bit0 in mV.

2. Bit7 to bit4 are coded in Hexadecimal and scaled in Volts while bit3 to bit0 are in Binary Code Decimal and scaled in 100mV.

3. Not supported.

**Table 29. Device Geometry Definition**

| Address A21-A1 | Data       | Description                                             |
|----------------|------------|---------------------------------------------------------|
| 27h            | 16h        | n where 2 <sup>n</sup> is number of bytes memory Size   |
| 28h<br>29h     | 01h<br>00h | Device Interface                                        |
| 2Ah            | 05h        | Maximum number of bytes in Write Buffer, 2 <sup>n</sup> |
| 2Bh            | 00h        |                                                         |
| 2Ch            | 01h        | Bit7-0 = number of Erase Block Regions in device        |
| 2Dh            | 3Fh        | Number (n-1) of Erase Blocks of identical size; n=64    |
| 2Eh            | 00h        |                                                         |
| 2Fh            | 00h        | Erase Block Region Information                          |
| 30h            | 01h        | x 256 bytes per Erase block (128K bytes)                |

Table 30. Block Status Register

| Address A21-A1         | Data   |   | Selected Block Information                                 |
|------------------------|--------|---|------------------------------------------------------------|
| (BA+2)h <sup>(1)</sup> | bit0   | 0 | Block Unprotected                                          |
|                        |        | 1 | Block Protected                                            |
|                        | bit1   | 0 | Last erase operation ended successfully <sup>(2)</sup>     |
|                        |        | 1 | Last erase operation not ended successfully <sup>(2)</sup> |
|                        | bit7-2 | 0 | Reserved for future features                               |

Note: 1. BA specifies the block address location, A21-A17.

2. Not Supported.

Table 31. Extended Query information

| Address offset | Address A21-A2 | Data (Hex)<br>x16 Bus Width |     | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|----------------|----------------|-----------------------------|-----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| (P)h           | 31h            | 50h                         | "P" | Query ASCII string - Extended Table                                                                                                                                                                                                                                                                                                                                                                                                                              |
| (P+1)h         | 32h            | 52h                         | "R" |                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| (P+2)h         | 33h            | 49h                         | "I" |                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| (P+3)h         | 34h            | 31h                         |     | Major version number                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| (P+4)h         | 35h            | 31h                         |     | Minor version number                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| (P+5)h         | 36h            | CEh                         |     | Optional Feature: (1=yes, 0=no)<br>bit0, Chip Erase Supported (0=no)<br>bit1, Suspend Erase Supported (1=yes)<br>bit2, Suspend Program Supported (1=yes)<br>bit3, Protect/Unprotect Supported (1=yes)<br>bit4, Queue Erase Supported (0=no)<br>bit5, Instant Individual Block locking (0=no)<br>bit6, Protection bits supported (1=yes)<br>bit7, Page Read supported (1=yes)<br>bit8, Synchronous Read supported (1=yes)<br>Bits 9 to 31 reserved for future use |
| (P+6)h         | 37h            | 01h                         |     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| (P+7)h         | 38h            | 00h                         |     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| (P+8)h         | 39h            | 00h                         |     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| (P+9)h         | 3Ah            | 01h                         |     | Function allowed after Suspend:<br>Program allowed after Erase Suspend (1=yes)<br>Bit 7-1 reserved for future use                                                                                                                                                                                                                                                                                                                                                |
| (P+A)h         | 3Bh            | 01h                         |     | Block Status Register<br>bit0, Block Protect Bit status active (1=yes)<br>bit1, Block Lock-Down Bit status, not supported<br>bits 2 to 15 reserved for future use                                                                                                                                                                                                                                                                                                |
| (P+B)h         | 3Ch            | 00h                         |     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| (P+C)h         | 3Dh            | 33h                         |     | V <sub>DD</sub> OPTIMUM Program/Erase voltage conditions                                                                                                                                                                                                                                                                                                                                                                                                         |
| (P+D)h         | 3Eh            | 00h                         |     | V <sub>PP</sub> OPTIMUM Program/Erase voltage conditions                                                                                                                                                                                                                                                                                                                                                                                                         |
| (P+E)h         | 3Fh            | 01h                         |     | OTP protection: No. of protection register fields                                                                                                                                                                                                                                                                                                                                                                                                                |
| (P+F)h         | 40h            | 80h                         |     | Protection Register's start address, least significant bits                                                                                                                                                                                                                                                                                                                                                                                                      |
| (P+10)h        | 41h            | 00h                         |     | Protection Register's start address, most significant bits                                                                                                                                                                                                                                                                                                                                                                                                       |
| (P+11)h        | 42h            | 03h                         |     | n where 2 <sup>n</sup> is number of factory reprogrammed bytes                                                                                                                                                                                                                                                                                                                                                                                                   |
| (P+12)h        | 43h            | 03h                         |     | n where 2 <sup>n</sup> is number user programmable bytes                                                                                                                                                                                                                                                                                                                                                                                                         |
| (P+13)h        | 44h            | 04h                         |     | Page Read: 2 <sup>n</sup> Bytes (n = bits 0-7)                                                                                                                                                                                                                                                                                                                                                                                                                   |
| (P+14)h        | 45h            | 03h                         |     | Synchronous mode configuration fields                                                                                                                                                                                                                                                                                                                                                                                                                            |
| (P+15)h        | 46h            | 01h                         |     | n where 2 <sup>n+1</sup> is the number of Words for the burst Length = 4                                                                                                                                                                                                                                                                                                                                                                                         |
| (P+16)h        | 47h            | 02h                         |     | n where 2 <sup>n+1</sup> is the number of Words for the burst Length = 8                                                                                                                                                                                                                                                                                                                                                                                         |
| (P+17)h        | 48h            | 07h                         |     | Burst Continuous                                                                                                                                                                                                                                                                                                                                                                                                                                                 |

Note: 1. Bit7 to bit4 are coded in Hexadecimal and scaled in Volt while bit3 to bit0 are in Binary Code Decimal and scaled in mV.

## APPENDIX C. FLOW CHARTS

Figure 23. Write to Buffer and Program Flowchart and Pseudo Code

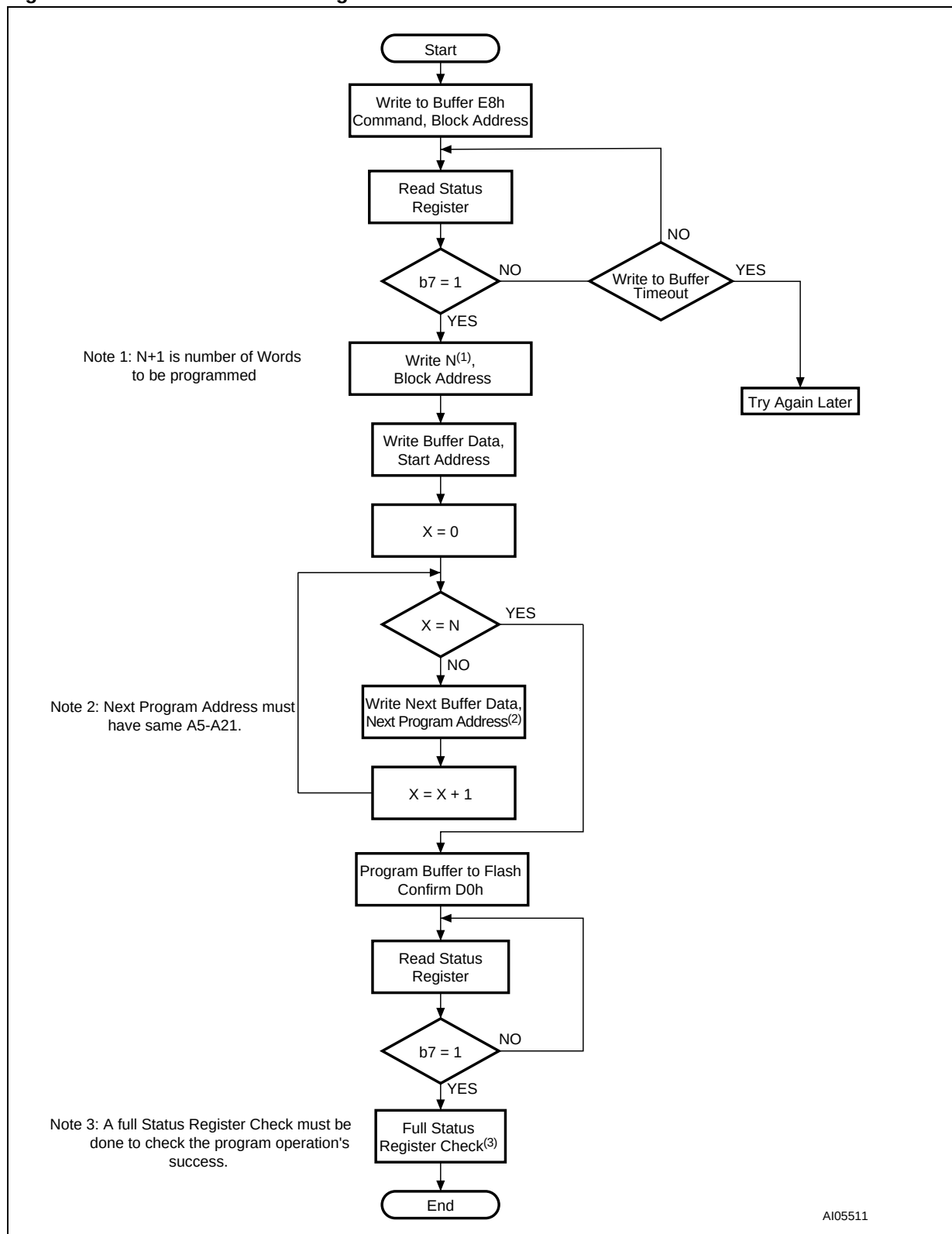
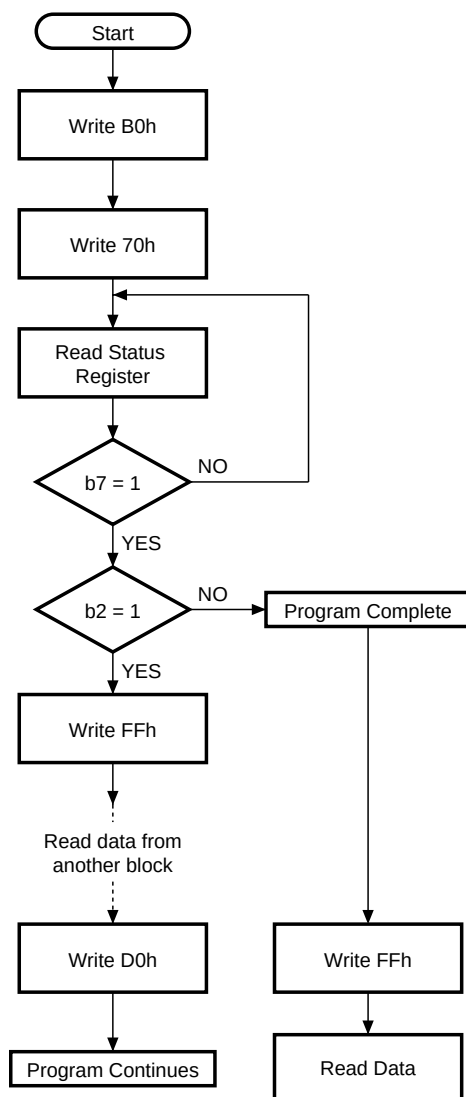


Figure 24. Program Suspend &amp; Resume Flowchart and Pseudo Code



Program/Erase Suspend Command:

- write B0h
- write 70h

do:

- read status register

while b7 = 1

If b2 = 0, Program completed

Read Memory Array instruction:

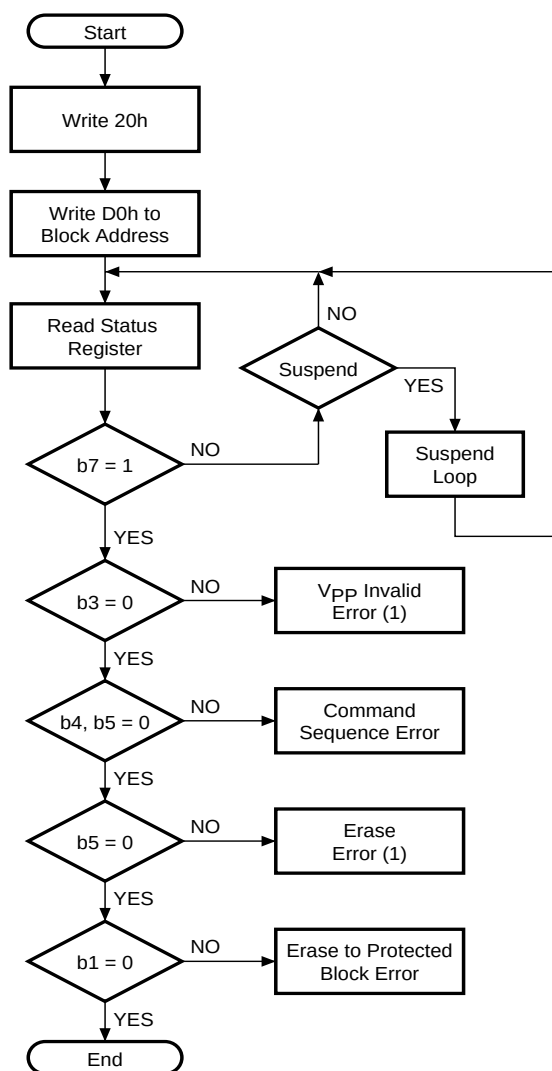
- write FFh
- one or more data reads from other blocks

Program Erase Resume Command:

- write D0h to resume erasure
- if the program operation completed then this is not necessary. The device returns to Read Array as normal (as if the Program/Erase Suspend command was not issued).

AI00612

Figure 25. Erase Flowchart and Pseudo Code



Erase command:

- write 20h
- write D0h to Block Address (A12-A17)
- (memory enters read Status Register after the Erase command)

do:

- read status register
- if Program/Erase Suspend command given execute suspend erase loop

while b7 = 1

If b3 = 1, V<sub>PP</sub> invalid error:  
– error handler

If b4, b5 = 1, Command Sequence error:  
– error handler

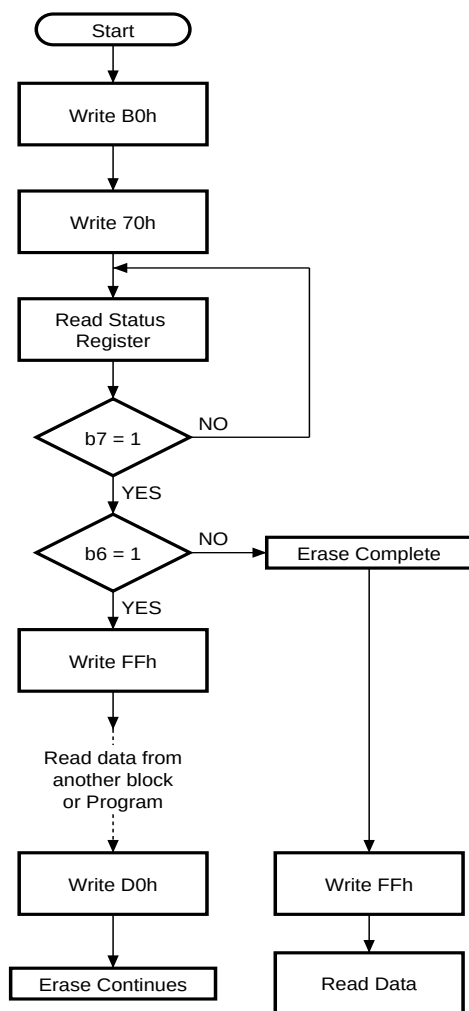
If b5 = 1, Erase error:  
– error handler

If b1 = 1, Erase to Protected Block Error:  
– error handler

AI00613B

Note: 1. If an error is found, the Status Register must be cleared (Clear Status Register Command) before further Program or Erase operations.

Figure 26. Erase Suspend &amp; Resume Flowchart and Pseudo Code



Program/Erase Suspend Command:

- write B0h
- write 70h

do:

- read status register

while b7 = 1

If b6 = 0, Erase completed

Read Memory Array command:

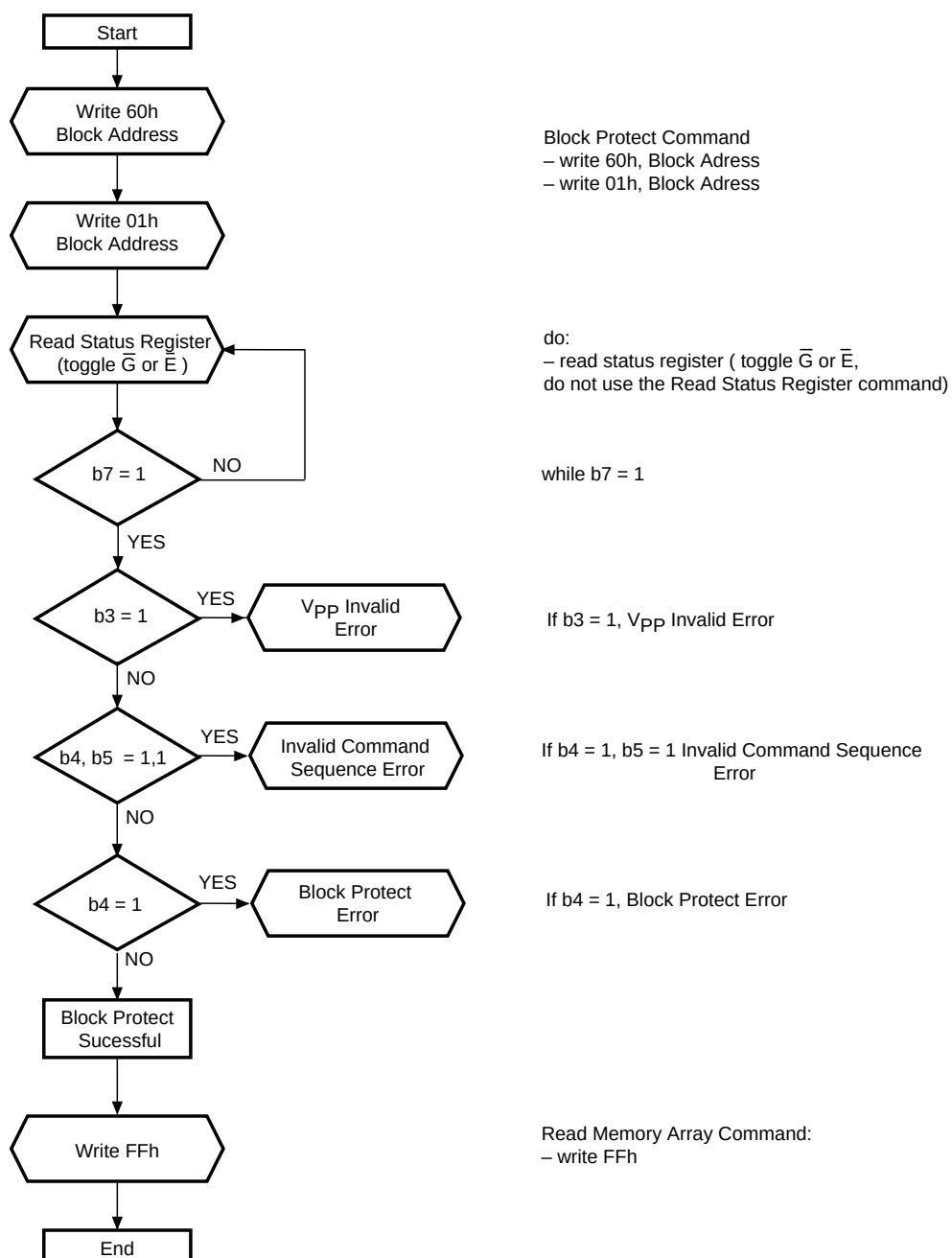
- write FFh
- one or more data reads from other blocks

Program/Erase Resume command:

- write D0h to resume the Erase operation
- if the Program operation completed then this is not necessary. The device returns to Read mode as normal (as if the Program/Erase suspend was not issued).

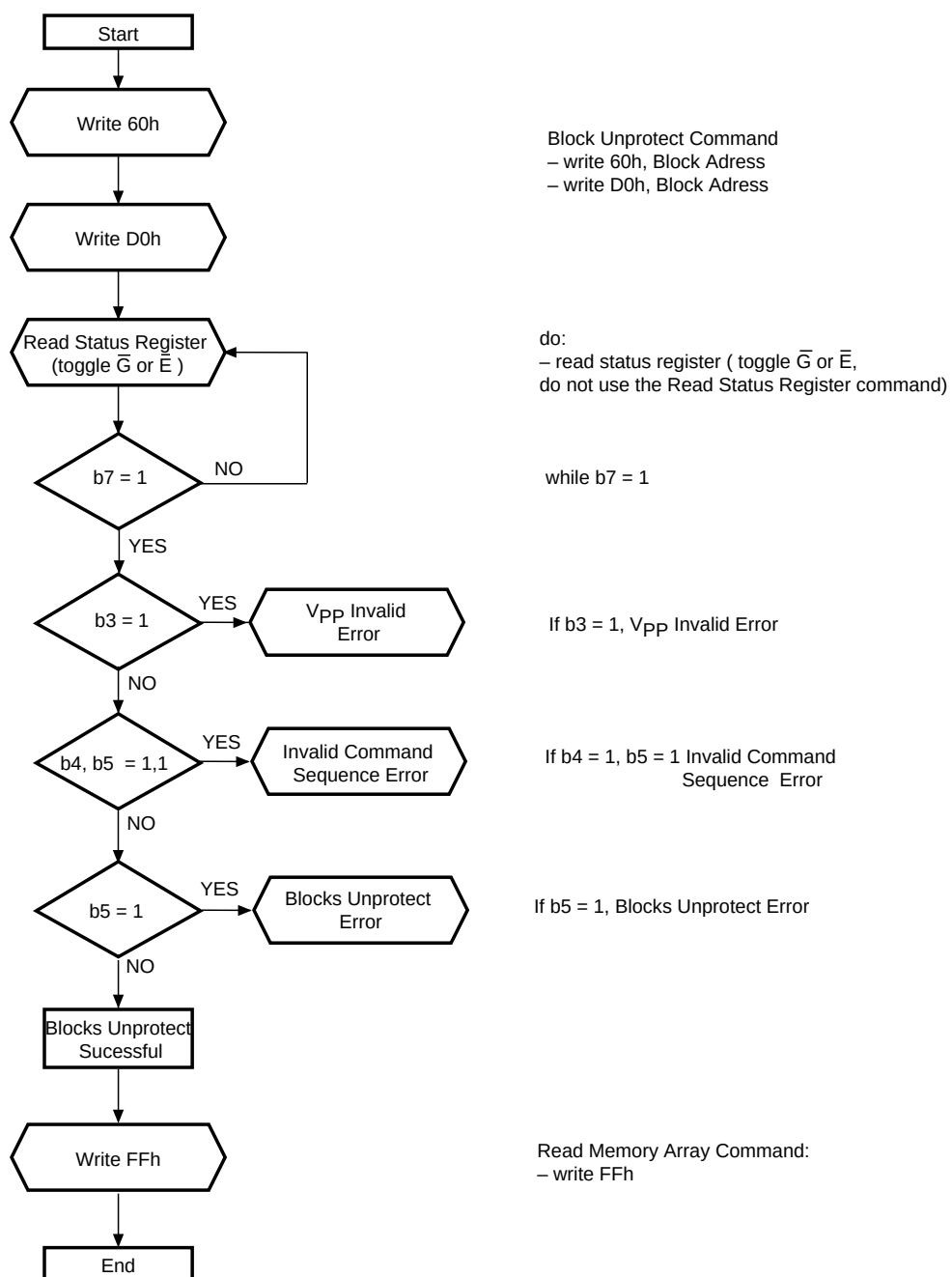
AI00615

Figure 27. Block Protect Flowchart and Pseudo Code



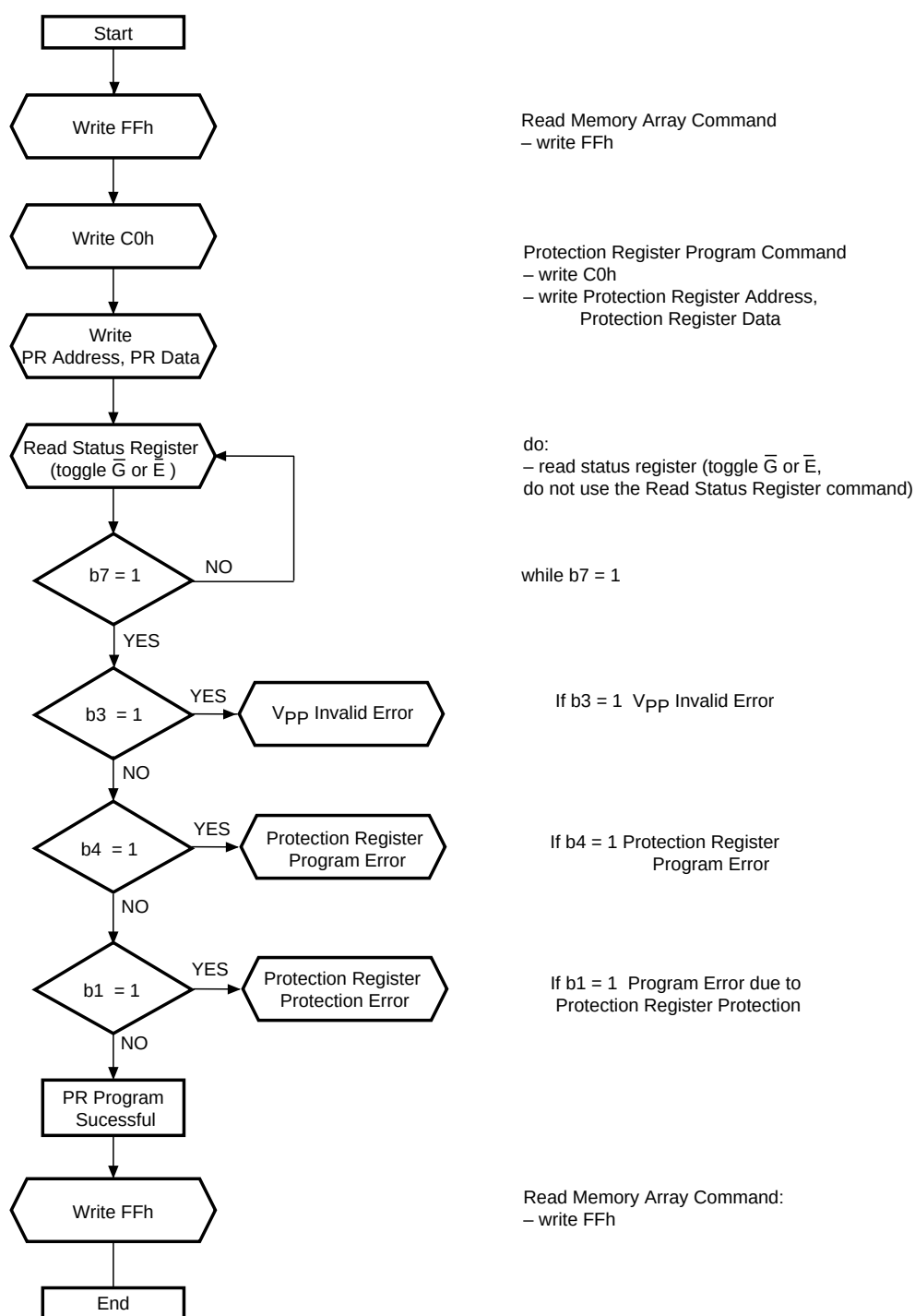
AI06157b

Figure 28. Blocks Unprotect Flowchart and Pseudo Code



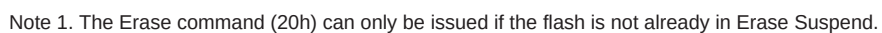
AI06158b

Figure 29. Protection Register Program Flowchart and Pseudo Code



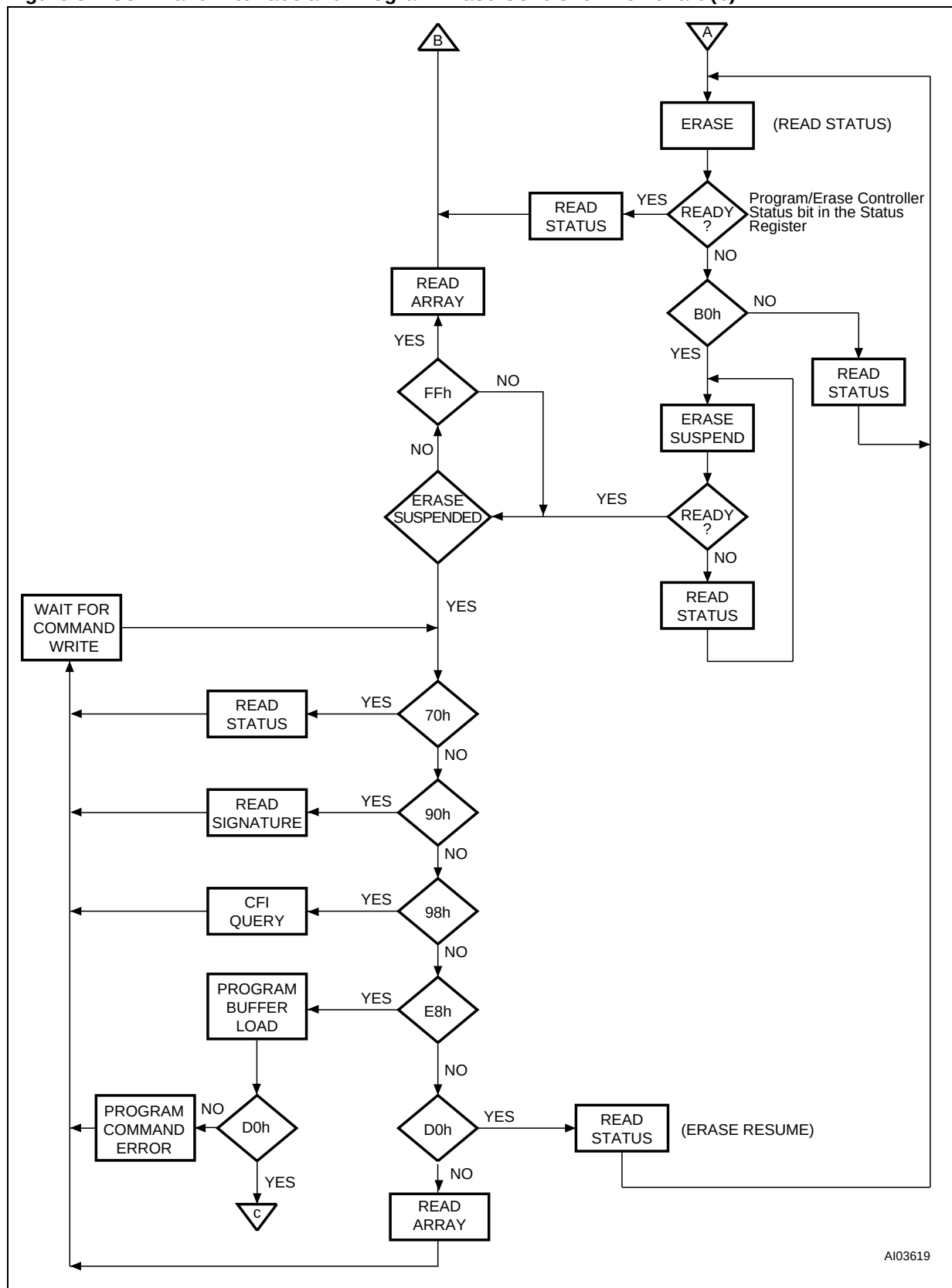
AI06159b

Note: PR = Protection Register



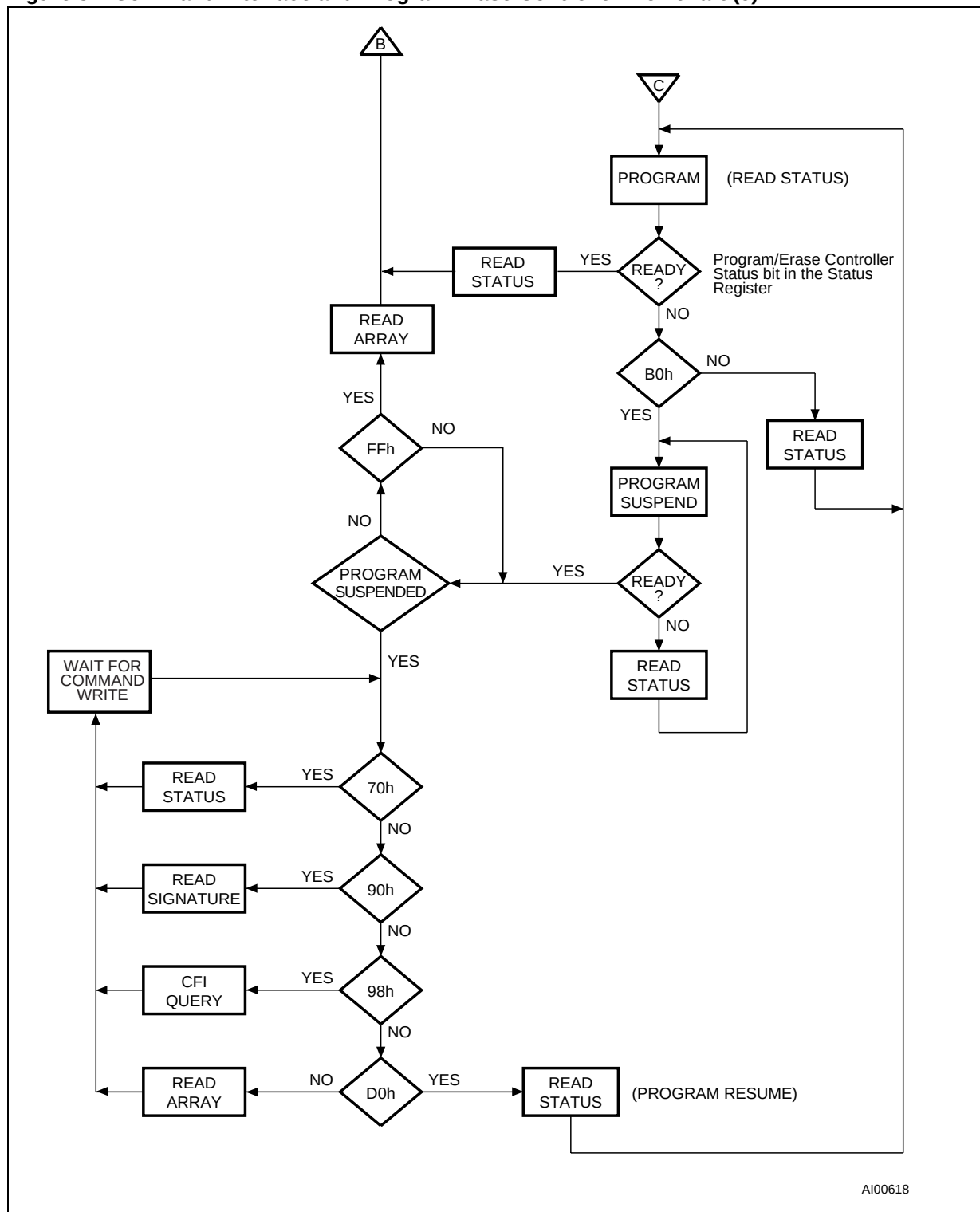
AI03618

Figure 31. Command Interface and Program Erase Controller Flowchart (b)



AI03619

**Figure 32. Command Interface and Program Erase Controller Flowchart (c).**



## REVISION HISTORY

Table 32. Document Revision History

| Date          | Version | Revision Details                                                                                                                                                                                                                                                                                                                                                                                                                     |
|---------------|---------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| February 2001 | -01     | First Issue (Data Brief)                                                                                                                                                                                                                                                                                                                                                                                                             |
| 17-Sep-2001   | -02     | Expanded to full Product Preview.                                                                                                                                                                                                                                                                                                                                                                                                    |
| 27-Sep-2001   | -03     | Changes on Table 18, Asynchronous Write and Latch Controlled Write AC Characteristics, Write Enable Controlled<br>Changes on Table 20, Synchronous Burst Read AC Characteristics                                                                                                                                                                                                                                                     |
| 1-Feb-2002    | -04     | Status Register section and Table clarified, Burst Configuration Register Table clarified, Block Protect, Blocks Unprotect and Protection Register Program flowcharts added, Reset, Power-Down and Power-up AC Characteristics Table modified.                                                                                                                                                                                       |
| 12-Mar-2002   | -05     | Document Status changed to Preliminary Data. Table 18, tWHGL timing modified, Table 19, tLHGL and tEHGL timings modified. I <sub>DD5</sub> modified in DC Characteristics table, T <sub>LEAD</sub> removed from Absolute Maximum Ratings table. TFBGA64 Not Connected pins changed to Do Not Use.                                                                                                                                    |
| 07-May-2002   | -06     | Reference to Temporary Unprotect removed from Word Program Command section, TFBGA package dimensions added to description. Block Protect and Blocks Unprotect Flowcharts clarified, Protection Register Program description and Flowchart clarified, Status Register V <sub>PP</sub> Status bit description clarified. Document Status changed to Datasheet.                                                                         |
| 04-Jul-2002   | -07     | 110ns speed class added.                                                                                                                                                                                                                                                                                                                                                                                                             |
| 06-Aug-2002   | 7.1     | Revision numbering modified: a minor revision will be indicated by incrementing the digit after the dot, and a major revision, by incrementing the digit before the dot. (revision version 07 equals 7.0).<br>Description of Reset/Power-Down pin, $\overline{RP}$ , specified. V <sub>DD</sub> , V <sub>DDQ</sub> , V <sub>SS</sub> and V <sub>SSQ</sub> pin descriptions modified. Table 24, Ordering Information Scheme modified. |
| 11-Feb-2003   | 7.2     | Revision History moved to end of document. Block Protect setup command address modified in Table 6, Commands. CFI, Extended Query Information table descriptions clarified. Protection Register Program Flowchart and Pseudo code clarified. Table 9, Program, Erase Times and Program Erase Endurance Cycles modified.                                                                                                              |

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