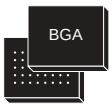
# M69AW024BE

## 16 Mbit (1M x16) 3V Asynchronous PSRAM

### FEATURES SUMMARY

- SUPPLY VOLTAGE: 2.7 to 3.3V
- ACCESS TIME: 60ns
- LOW STANDBY CURRENT: 70µA
- DEEP POWER DOWN CURRENT: 10µA
- COMPATIBLE WITH STANDARD LPSRAM
- TFBGA48 PACKAGE RoHS COMPLIANT (directive 2002/95/EC of the European Parliament)

**Figure 1. Package**




TFBGA48 (ZB)
6x8 mm

# TABLE OF CONTENTS

**FEATURES SUMMARY . . . . . 1**
Figure 1. Package . . . . . 1

**SUMMARY DESCRIPTION . . . . . 4**
Figure 2. Logic Diagram . . . . . 4
Table 1. Signal Names . . . . . 4
Figure 3. TFBGA Connections (Top view through package) . . . . . 5

**SIGNAL DESCRIPTIONS . . . . . 6**
Address Inputs (A0-A19). . . . . 6
Data Inputs/Outputs (DQ8-DQ15). . . . . 6
Data Inputs/Outputs (DQ0-DQ7). . . . . 6
Chip Enable ($\overline{E1}$). . . . . 6
Chip Enable ($\overline{E2}$). . . . . 6
Output Enable ($\overline{G}$). . . . . 6
Write Enable ($\overline{W}$). . . . . 6
Upper Byte Enable ($\overline{UB}$). . . . . 6
Lower Byte Enable ($\overline{LB}$). . . . . 6
$V_{CC}$ Supply Voltage. . . . . 6
VSS Ground. . . . . 6
Figure 4. Block Diagram . . . . . 7

**OPERATION . . . . . 8**
**Power On Sequence . . . . . 8**
**Read Mode . . . . . 8**
**Write Mode . . . . . 8**
**Standby Mode . . . . . 8**
**Deep Power-down Mode . . . . . 8**
Table 2. Operating Modes . . . . . 9

**MAXIMUM RATING. . . . . 10**
Table 3. Absolute Maximum Ratings . . . . . 10

**DC AND AC PARAMETERS. . . . . 11**
Table 4. Operating and AC Measurement Conditions . . . . . 11
Figure 5. AC Measurement Load Circuit. . . . . 11
Figure 6. AC Measurement I/O Waveform . . . . . 11
Table 5. Capacitance. . . . . 12
Table 6. DC Characteristics. . . . . 12
Table 7. Read and Standby Modes AC Characteristics . . . . . 13
Figure 7. Read Mode AC Waveforms . . . . . 14
Figure 8. Address Access after $\overline{G}$ Controlled Read AC Waveforms. . . . . 14
Figure 9. $\overline{UB}$/$\overline{LB}$ Controlled Read AC Waveforms . . . . . 15

Table 8. Write Mode AC Characteristics . . . . . 16
Figure 10.Write AC Waveforms . . . . . 17
Figure 11.W Controlled, Write AC Waveforms . . . . . 17
Figure 12.Write Enable and $\overline{UB}$/$\overline{LB}$ Controlled, Byte Write AC Waveforms 1 . . . . . 18
Figure 13.Write Enable and $\overline{UB}$/$\overline{LB}$ Controlled, Byte Write AC Waveforms 2 . . . . . 18
Figure 14.Write Enable and $\overline{UB}$/$\overline{LB}$ Controlled, Byte Write AC Waveforms 3 . . . . . 19
Figure 15.Write Enable and $\overline{UB}$/$\overline{LB}$ Controlled, Byte Write AC Waveforms 4 . . . . . 19
Table 9. Standby, Power-Down and Power-Up AC Parameters . . . . . 20
Figure 16.Power-up Mode AC Waveforms - 1 . . . . . 20
Figure 17.Power-up Mode AC Waveforms - 2 . . . . . 20
Figure 18.Power-Down Entry ad Exit AC Waveforms . . . . . 21
Figure 19.Standby Mode Entry AC Waveforms, after Read or Write . . . . . 21

**PACKAGE MECHANICAL . . . . . 22**

Figure 20.TFBGA48 6x8mm - 6x8 ball array, 0.75 mm pitch, Package Outline, Bottom View . . . . 22
Table 10. TFBGA48 6x8mm - 6x8 ball array, 0.75 mm pitch, Package Mechanical Data . . . . . 22

**PART NUMBERING . . . . . 23**

Table 11. Ordering Information Scheme . . . . . 23

**REVISION HISTORY . . . . . 24**

Table 12. Document Revision History . . . . . 24

## SUMMARY DESCRIPTION

The M69AW024BE is a 16 Mbit (16,777,216 bit) CMOS memory, organized as 1,024,576 words by 16 bits, and is supplied by a single 2.7V to 3.3V supply voltage range.

M69AW024BE is a member of STMicroelectronics PSRAM memory family, based on the one-transistor per-cell architecture. These devices are manufactured using dynamic random access memory cells, to minimize the cell size, and maximize the amount of memory that can be implemented in a given area.

However, through the use of internal control logic, the device is fully static in its operation, requiring no external clocks or timing strobes, and has a standard Asynchronous SRAM Interface.

The internal control logic of the M69AW024BE handles the periodic refresh cycle, automatically, and without user involvement.

Write cycles can be performed on a single byte by using Upper Byte Enable (UB) and Lower Byte Enable (LB).

The device can be put into standby mode using Chip Enable (E1) or in deep power down mode by using Chip Enable (E2).

Power-Down mode achieves a very low current consumption by halting all the internal activities. Since the refresh circuitry is halted, the duration of the power-down should be less than the maximum period for refresh, if the user has not finished with the data contents of the memory.

**Figure 2. Logic Diagram**

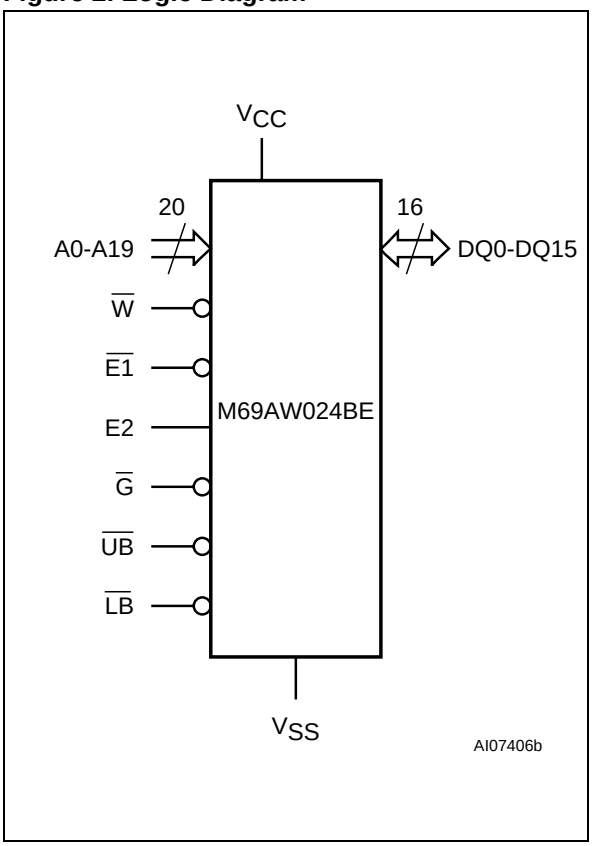
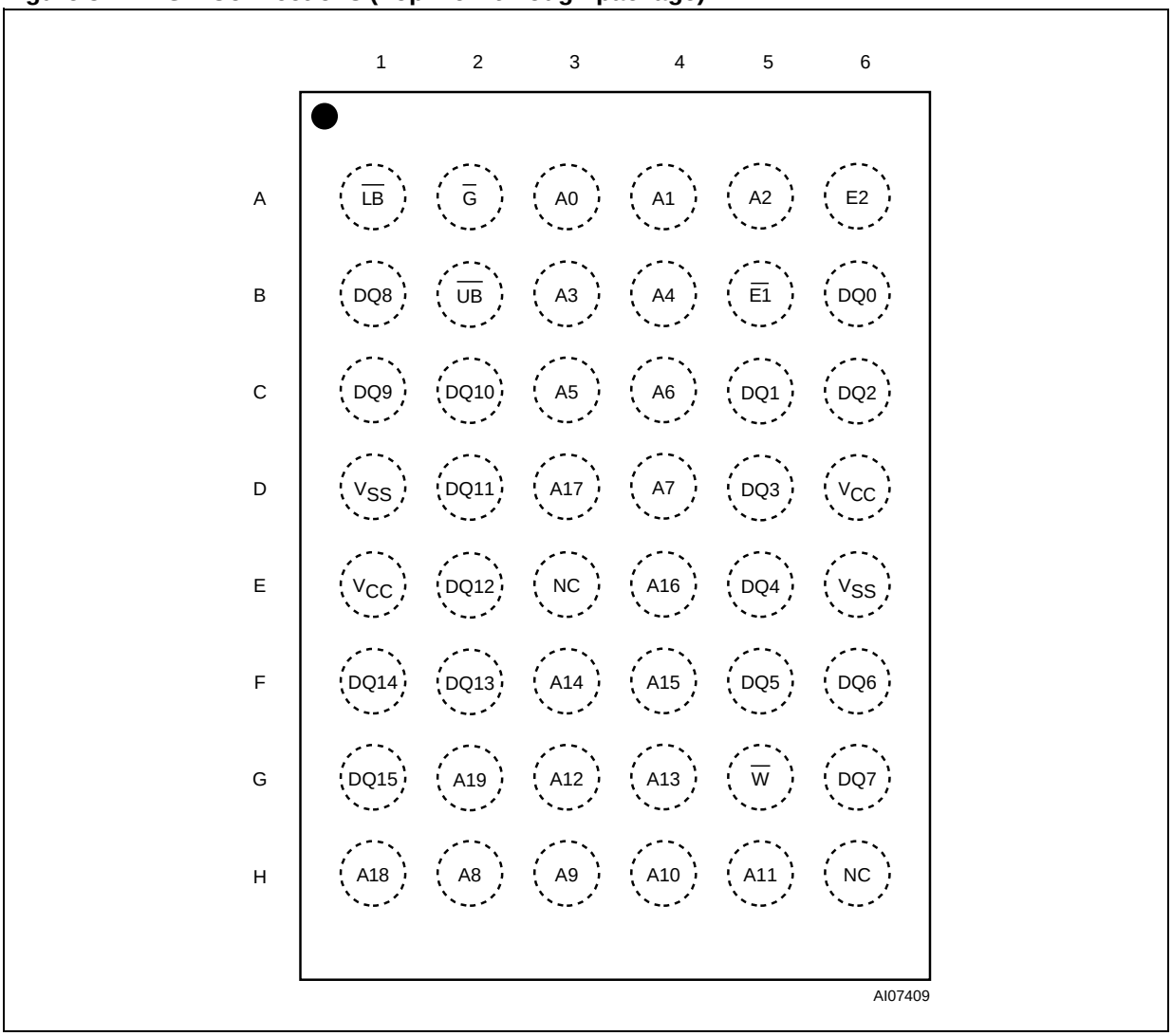



**Table 1. Signal Names**

| | |
|---|---|
| A0-A19 | Address Input |
| DQ0-DQ15 | Data Input/Output |
| $\overline{E1}$, E2 | Chip Enable, Power Down |
| $\overline{G}$ | Output Enable |
| $\overline{W}$ | Write Enable |
| $\overline{UB}$ | Upper Byte Enable |
| $\overline{LB}$ | Lower Byte Enable |
| $V_{CC}$ | Supply Voltage |
| $V_{SS}$ | Ground |
| NC | Not Connected<br>(no internal connection) |

**Figure 3. TFBGA Connections (Top view through package)**



## 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 (A0-A19).** The Address Inputs select the cells in the memory array to access during Read and Write operations.

**Data Inputs/Outputs (DQ8-DQ15).** The Upper Byte Data Inputs/Outputs carry the data to or from the upper part of the selected address during a Write or Read operation, when Upper Byte Enable (UB) is driven Low.

**Data Inputs/Outputs (DQ0-DQ7).** The Lower Byte Data Inputs/Outputs carry the data to or from the lower part of the selected address during a Write or Read operation, when Lower Byte Enable (LB) is driven Low.

**Chip Enable ($\overline{E1}$).** When asserted (Low), the Chip Enable, $\overline{E1}$, activates the memory state machine, address buffers and decoders, allowing Read and Write operations to be performed. When de-asserted (High), all other pins are ignored, and the device is put, automatically, in low-power Standby mode.

**Chip Enable (E2).** The Chip Enable, E2, puts the device in Deep Power-down mode when it is driven Low. This is the lowest power mode.

**Output Enable ($\overline{G}$).** The Output Enable, $\overline{G}$, provides a high speed tri-state control, allowing fast read/write cycles to be achieved with the common I/O data bus.

**Write Enable ($\overline{W}$).** The Write Enable, $\overline{W}$, controls the Bus Write operation of the memory's Command Interface.

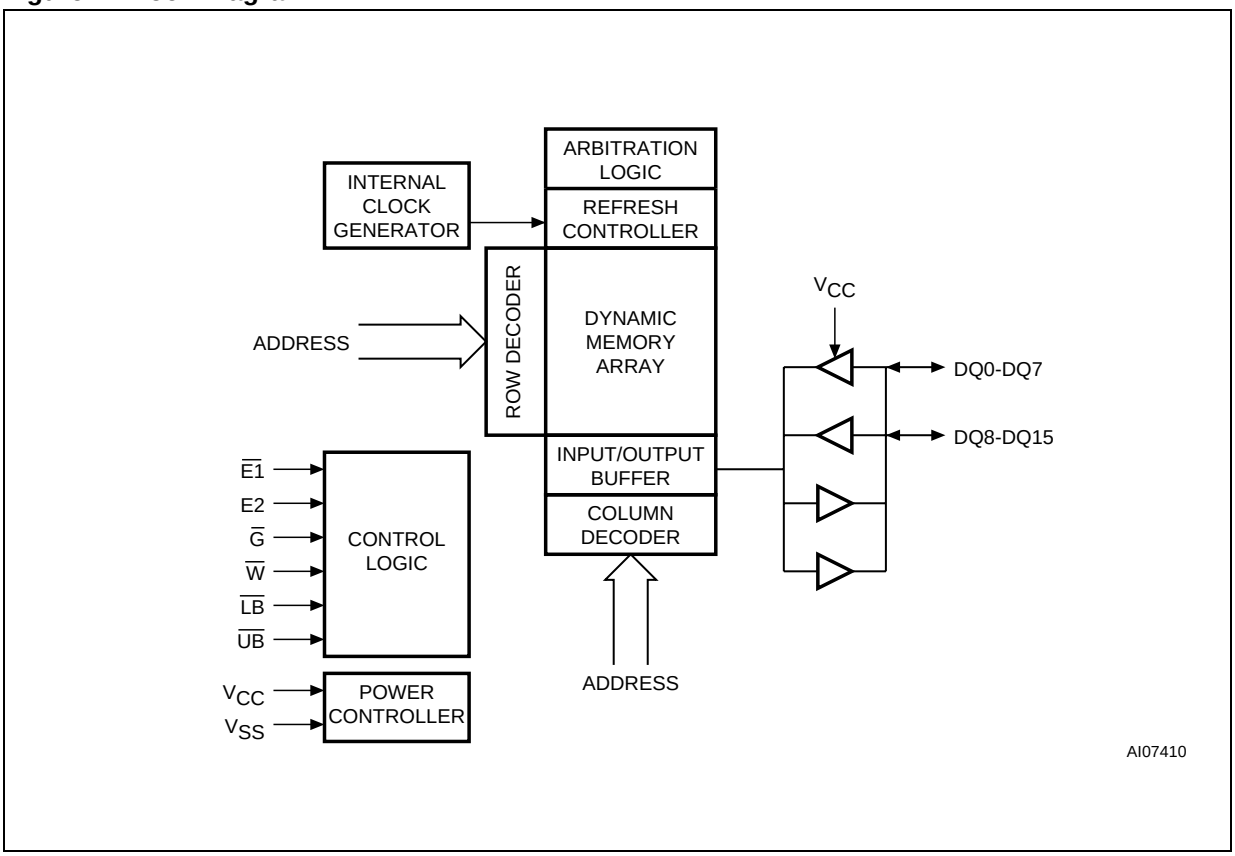
**Upper Byte Enable ($\overline{UB}$).** The Upper Byte Enable, $\overline{UB}$, gates the data on the Upper Byte Data Inputs/Outputs (DQ8-DQ15) to or from the upper part of the selected address during a Write or Read operation.

**Lower Byte Enable ($\overline{LB}$).** The Lower Byte Enable, $\overline{LB}$, gates the data on the Lower Byte Data Inputs/Outputs (DQ0-DQ7) to or from the lower part of the selected address during a Write or Read operation.

**$V_{CC}$ Supply Voltage.** The $V_{CC}$ Supply Voltage supplies the power for all operations (Read or Write) and for driving the refresh logic, even when the device is not being accessed.

**$V_{SS}$ Ground.** The $V_{SS}$ Ground is the reference for all voltage measurements.

**Figure 4. Block Diagram**



## OPERATION

Operational modes are determined by device control inputs W, E1, E2, LB and UB as summarized in the Operating Modes table (see Table 2.).

**Power On Sequence**

Because the internal control logic of the M69AW024BE needs to be initialized, the following power-on procedure must be followed before the memory is used:

- Apply power and wait for $V_{CC}$ to stabilize
- Wait $t_{CHEL}$ while driving both Chip Enable signals (E1 and E2) High
- Activate the memory by driving Chip Enable ($\overline{E1}$) Low.

**Read Mode**

The device is in Read mode when:

- Write Enable ($\overline{W}$) is High and
- Output Enable ($\overline{G}$) Low and
- the two Chip Enable signals are asserted (E1 is Low, and E2 is High).

The time taken to enter Read mode ($t_{ELQV}$, $t_{GLQV}$ or $t_{BLQV}$) depends on which of the above signals was the last to reach the appropriate level.

Data out (DQ15-DQ0) may be indeterminate during $t_{ELQX}$, $t_{GLQX}$ and $t_{BLQX}$, but data will always be valid during $t_{AVQV}$.

**Write Mode**

The device is in Write mode when

- Write Enable ($\overline{W}$) is Low and
- Chip Enable ($\overline{E1}$) is Low and
- the two Chip Enable signals are asserted (E1 is Low, and E2 is High)
- one of Upper Byte Enable ($\overline{UB}$) or Lower Byte Enable (LB) is Low, while the other is High.

The Write cycle begins just after the event (the falling edge) that causes the last of these conditions to become true ($t_{AVWL}$, $t_{AVEL}$ or $t_{AVBL}$).

The Write cycle is terminated by the earlier of a rising edge on Write Enable (W) or Chip Enable ($\overline{E1}$).

If the device is in Write mode (Chip Enable ($\overline{E1}$) is Low, Output Enable (G) is Low, Upper Byte Enable ($\overline{UB}$) or Lower Byte Enable ($\overline{LB}$) is Low), then Write Enable ($\overline{W}$) will return the outputs to high impedance within $t_{WHDZ}$ of its falling edge. Care must be taken to avoid bus contention in this type of operation. Data input must be valid for $t_{DVWH}$ before the rising edge of Write Enable (W), or for $t_{DVEH}$ before the rising edge of Chip Enable ($\overline{E1}$), whichever occurs first, and remain valid for $t_{BHDZ}$, $t_{WHDZ}$, $t_{EHDZ}$.

**Standby Mode**

The device is in Standby mode when:

- Chip Enable ($\overline{E1}$) is High and
- Chip Enable (E2) is High.

The input/output buffers and the decoding/control logic are switched off, but the dynamic array continues to be refreshed. In this mode, the memory current consumption, $I_{SB}$, is reduced, and the data remains valid.

**Deep Power-down Mode**

The device is in Deep Power-down mode when:

- Chip Enable (E2 is Low).

**Table 2. Operating Modes**

| Operation | E2 | $\overline{E1}$ | $\overline{W}$ | $\overline{G}$ | $\overline{LB}$ | $\overline{UB}$ | A0-A19 | DQ0-DQ7 | DQ8-DQ15 | $I_{CC}$ | Data Retention |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Standby (Deselect) | $V_{IH}$ | $V_{IH}$ | X (1) | X (1) | X (1) | X (1) | X (1) | Hi-Z | Hi-Z | $I_{SB}$ | Yes |
| Output Disabled (2) | $V_{IH}$ | $V_{IL}$ | $V_{IH}$ | $V_{IH}$ | X (1) | X (1) | Note (4) | Hi-Z | Hi-Z | $I_{CC}$ | Yes |
| Output Disabled (No Read) | $V_{IH}$ | $V_{IL}$ | $V_{IH}$ | $V_{IL}$ | $V_{IH}$ | $V_{IH}$ | Valid | Hi-Z | Hi-Z | $I_{CC}$ | Yes |
| Upper Byte Read | $V_{IH}$ | $V_{IL}$ | $V_{IH}$ | $V_{IL}$ | $V_{IH}$ | $V_{IL}$ | Valid | Hi-Z | Output Valid | $I_{CC}$ | Yes |
| Lower Byte Read | $V_{IH}$ | $V_{IL}$ | $V_{IH}$ | $V_{IL}$ | $V_{IL}$ | $V_{IH}$ | Valid | Output Valid | Hi-Z | $I_{CC}$ | Yes |
| Word Read | $V_{IH}$ | $V_{IL}$ | $V_{IH}$ | $V_{IL}$ | $V_{IL}$ | $V_{IL}$ | Valid | Output Valid | | $I_{CC}$ | Yes |
| Upper Byte Write | $V_{IH}$ | $V_{IL}$ | $V_{IL}$ | $V_{IH}$ | $V_{IH}$ | $V_{IL}$ | Valid | Invalid | Input Valid | $I_{CC}$ | Yes |
| Lower Byte Write | $V_{IH}$ | $V_{IL}$ | $V_{IL}$ | $V_{IH}$ | $V_{IL}$ | $V_{IH}$ | Valid | Input Valid | Invalid | $I_{CC}$ | Yes |
| Word Write | $V_{IH}$ | $V_{IL}$ | $V_{IL}$ | $V_{IH}$ | $V_{IL}$ | $V_{IL}$ | Valid | Input Valid | Input Valid | $I_{CC}$ | Yes |
| Power-down (3) | $V_{IL}$ | X (1) | X (1) | X (1) | X (1) | X (1) | X (1) | Hi-Z | Hi-Z | $I_{PD}$ | No |

Note: 1. X = $V_{IH}$ or $V_{IL}$.
2. Output Disable mode should not be kept longer than 1µs.
3. Power-down mode can be entered from Stand-by state, and all DQ pins are in Hi-Z state.
4. Can be either VIL or VIH but must be valid before Read or Write.

## MAXIMUM RATING

Stressing the device above the rating listed in the Absolute Maximum Ratings table may cause permanent damage to the device. Exposure to Absolute Maximum Rating conditions for extended periods may affect device reliability. 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.

**Table 3. Absolute Maximum Ratings**

| Symbol | Parameter | Min | Max | Unit |
|---|---|---|---|---|
| $I_O$ | Output Current | –50 | 50 | mA |
| $T_A$ | Ambient Operating Temperature | –30 | 85 | °C |
| $T_{LEAD}$ | Lead Temperature During Soldering | | (1) | °C |
| $T_{STG}$ | Storage Temperature | –55 | 125 | °C |
| $V_{CC}$ | Core Supply Voltage | –0.5 | 3.6 | V |
| $V_{IO}$ | Input or Output Voltage | –0.5 | 3.6 | V |

Note: 1. Compliant with the JEDEC Std J-STD-020B (for small body, Sn-Pb or Pb assembly), and the European directive on Restrictions on Hazardous Substances (RoHS) 2002/95/EU.

## DC AND AC PARAMETERS

This section summarizes the operating 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 Measurement Conditions summarized in Table 4., Operating and AC Measurement Conditions. Designers should check that the operating conditions in their circuit match the operating conditions when relying on the quoted parameters.

**Table 4. Operating and AC Measurement Conditions**

| Parameter | M69AW024BE | | Unit |
|---|---|---|---|
| | –60 | | |
| | Min | Max | |
| $V_{CC}$ Supply Voltage[1] | 2.7 | 3.3 | V |
| Ambient Operating Temperature | –30 | 85 | °C |
| Load Capacitance ($C_L$) | 50 | | pF |
| Output Circuit Protection Resistance ($R_1$) | 50 | | Ω |
| Input Rise and Fall Times | | 4 | ns |
| Input Pulse Voltages | 0 to $V_{CC}$ | | V |
| Input and Output Timing Ref. Voltages | $V_{CC}/2$ | | V |
| Output Transition Timing Ref. Voltages | $V_{RL} = 0.3V_{CC}$; $V_{RH} = 0.7V_{CC}$ | | V |
| Input Transition Time (tτ) between $V_{IL}$ and $V_{IH}$[(2)] | 5 | | ns |

Note: 1. All voltages are referenced to $V_{SS}$.
2. The Input Transition Time used in AC measurements is 5ns. For other input transition times, see Table 9.

**Figure 5. AC Measurement Load Circuit**

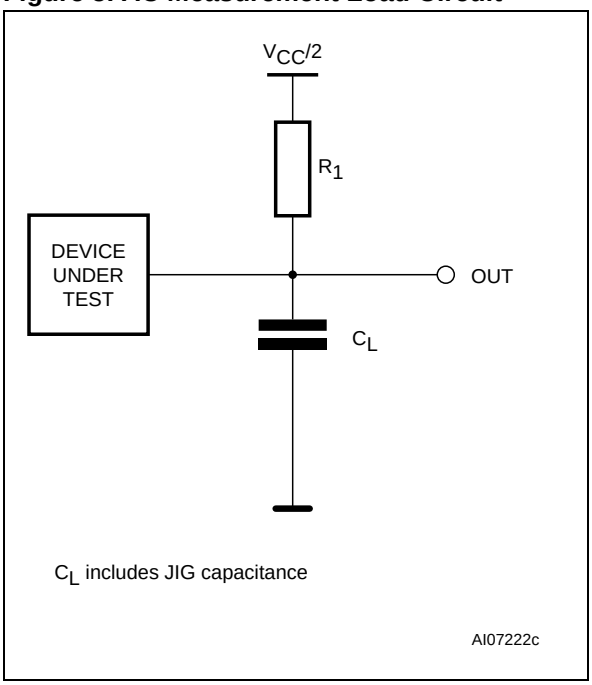
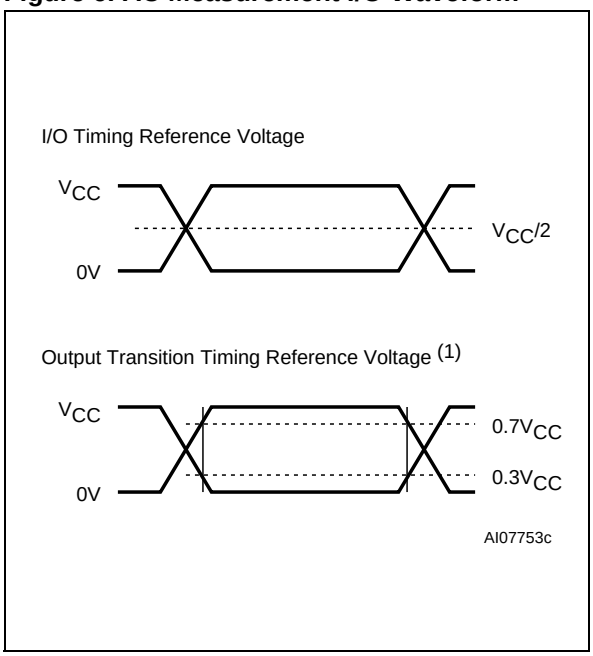



**Figure 6. AC Measurement I/O Waveform**




Note: 1. This waveform is given for Hi-Z and data transition AC parameters only (see Note 8. below Table 7., Read and Standby Modes AC Characteristics).

**Table 5. Capacitance**

| Symbol | Parameter | Test Condition | Min | Max | Unit |
|---|---|---|---|---|---|
| $C_{IN}$ | Input Capacitance on all pins (except DQ) | $V_{IN}$ = 0V | | 5 | pF |
| $C_{OUT}$ (1) | Output Capacitance | $V_{OUT}$ = 0V | | 8 | pF |

Note: 1. Outputs deselected.

**Table 6. DC Characteristics**

| Symbol | Parameter | Test Condition | | Min | Max | Unit |
|---|---|---|---|---|---|---|
| $I_{CC1}$ (1) | Operating Supply Current | $V_{CC}$ = 3.3V, $V_{IN} = V_{IH}$ or $V_{IL}$, $\overline{E1} = V_{IL}$, E2 = $V_{IH}$, $I_{OUT}$ = 0mA | $t_{RC}/t_{WC}$ = Min | | 20 | mA |
| | | | $t_{RC}/t_{WC}$ = 1µs | | 3.0 | mA |
| $I_{LI}$ | Input Leakage Current | 0V ≤ $V_{IN}$ ≤ $V_{CC}$ | | –1 | 1 | µA |
| $I_{LO}$ | Output Leakage Current | 0V ≤ $V_{OUT}$ ≤ $V_{CC}$ | | –1 | 1 | µA |
| $I_{PD}$ | Deep Power Down Current | $V_{CC}$ = 3.3V, $V_{IN} = V_{IH}$ or $V_{IL}$, E2 ≤ 0.2V | | | 10 | µA |
| $I_{SB}$ | Standby Supply Current CMOS | 3.1V ≤ $V_{CC}$ ≤ 3.3V, $V_{IN}$ ≤ 0.2V or ≥ $V_{CC}$ –0.2V, $\overline{E1}$ ≥ $V_{CC}$ –0.2V and E2 ≥ $V_{CC}$ –0.2V), $I_{OUT}$ = 0mA | | | 100 | µA |
| | | 2.7V ≤ $V_{CC}$ ≤ 3.1V, $V_{IN}$ ≤ 0.2V or ≥ $V_{CC}$ –0.2V, $\overline{E1}$ ≥ $V_{CC}$ –0.2V and E2 ≥ $V_{CC}$ –0.2V), $I_{OUT}$ = 0mA | | | 70 | µA |
| $V_{IH}$ (2) | Input High Voltage | 2.7V ≤ $V_{CC}$ ≤ 3.3V | | 0.8$V_{CC}$ | $V_{CC}$ + 0.2 | V |
| $V_{IL}$ (3) | Input Low Voltage | 2.7V ≤ $V_{CC}$ ≤ 3.3V | | –0.3 | 0.2$V_{CC}$ | V |
| $V_{OH}$ | Output High Voltage | 3.1V ≤ $V_{CC}$ ≤ 3.3V, $I_{OH}$ = –0.5mA | | 2.5 | | V |
| | | 2.7V ≤ $V_{CC}$ ≤ 3.1V, $I_{OH}$ = –0.5mA | | 2.2 | | V |
| $V_{OL}$ | Output Low Voltage | $I_{OL}$ = 1mA | | | 0.4 | V |

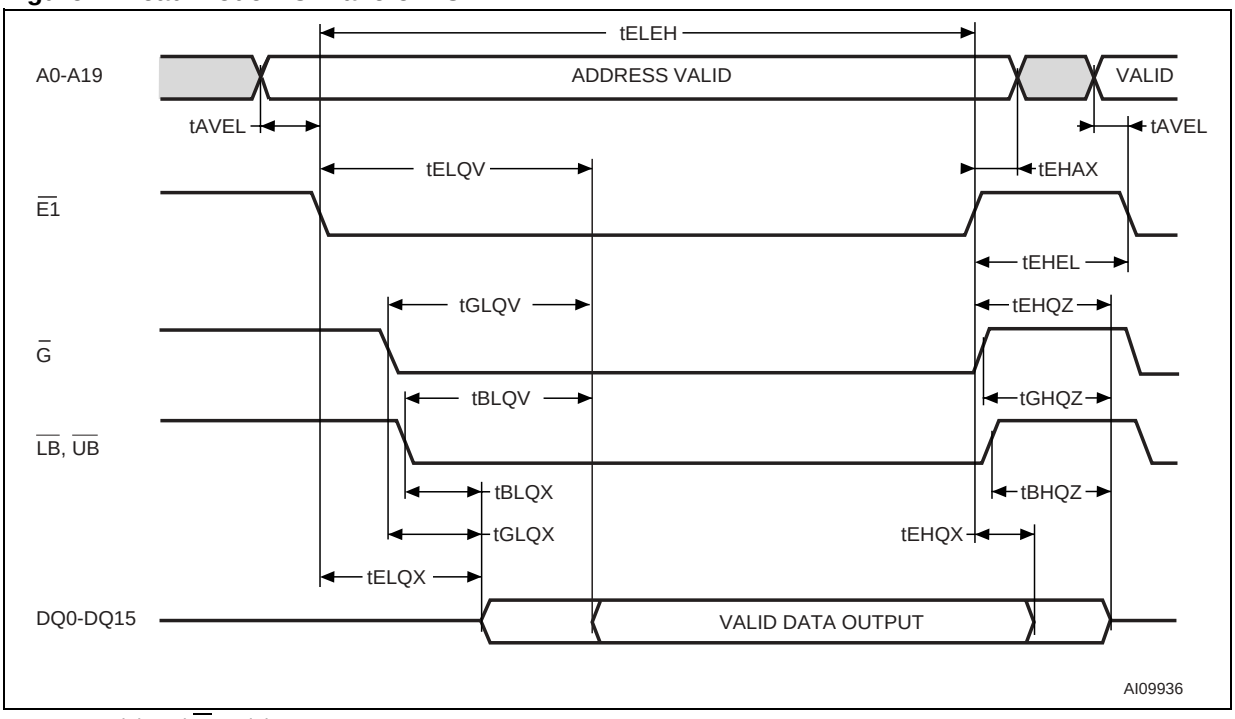
Note: 1. Average AC current, Outputs open, cycling at $t_{AVAX}$ (min).
2. Maximum DC voltage on inputs and I/O pins is $V_{CC}$ + 0.2V.
During voltage transitions, data inputs may overshoot to $V_{CC}$ + 1.0V for a period of up to 5ns.
3. Minimum DC voltage on input or I/O pins is –0.3V.
During voltage transitions, data inputs may overshoot to $V_{SS}$ + 1.0V for a period of up to 5ns.

**Table 7. Read and Standby Modes AC Characteristics**

| Symbol | Alt. | Parameter | M69AW024BE | | Unit |
|---|---|---|---|---|---|
| | | | –60 | | |
| | | | Min | Max | |
| $t_{AVAX}$, $t_{ELEH}$ (1,2) | $t_{RC}$ | Read Cycle Time | 70 | 1000 | ns |
| $t_{ELQV}$(3) | $t_{CE}$ | Chip Enable Access Time | | 60 | ns |
| $t_{GLQV}$(3) | $t_{OE}$ | Output Enable Access Time | | 40 | ns |
| $t_{AVQV}$(3,5) | $t_{AA}$ | Address Access Time | | 60 | ns |
| $t_{BLQV}$(3) | $t_{BA}$ | $\overline{LB}$, $\overline{UB}$ Low to Output Valid | | 30 | ns |
| $t_{AXQX}$, $t_{GHQX}$, $t_{BHQX}$, $t_{EHQX}$ (8) | $t_{OH}$ | Output Hold Time after Chip Enable Low | 5 | | ns |
| $t_{ELQX}$(4,8) | $t_{CLZ}$ | Chip Enable Low to Output Low-Z | 5 | | ns |
| $t_{GLQX}$(4,8) | $t_{OLZ}$ | Output Enable Low to Output Low-Z | 0 | | ns |
| $t_{BLQX}$(4,8) | $t_{BLZ}$ | $\overline{LB}$, $\overline{UB}$ Low to Output Low-Z | 0 | | ns |
| $t_{EHQZ}$(8) | $t_{CHZ}$ | Chip Enable High to Output Hi-Z | | 20 | ns |
| $t_{GHQZ}$(8) | $t_{OHZ}$ | Output Enable High to Output Hi-Z | | 20 | ns |
| $t_{BHQZ}$(8) | $t_{BHZ}$ | $\overline{LB}$, $\overline{UB}$ High to Output Hi-Z | | 20 | ns |
| $t_{AVEL}$ | $t_{ASC}$ | Address Set-up Time to Chip Enable Low | –5 | | ns |
| $t_{AVGL}$ | $t_{ASO}$ | Address Valid to Output Enable Low | 10 | | ns |
| $t_{AXAV}$(5) | $t_{AX}$ | Address Invalid Time | | 10 | ns |
| $t_{EHAX}$(6) | $t_{CHAH}$ | Chip Enable High to Address Hold Time | –5 | | ns |
| $t_{GHAX}$ | $t_{OHAH}$ | Output Enable High to Address Hold Time | –5 | | ns |
| $t_{WHGL}$(7) | $t_{WHOL}$ | Write Enable High to Output Enable Low (Read Operations) | 10 | 1000 | ns |
| $t_{EHEL}$ | $t_{CP}$ | Chip Enable High Pulse Width | 10 | | ns |

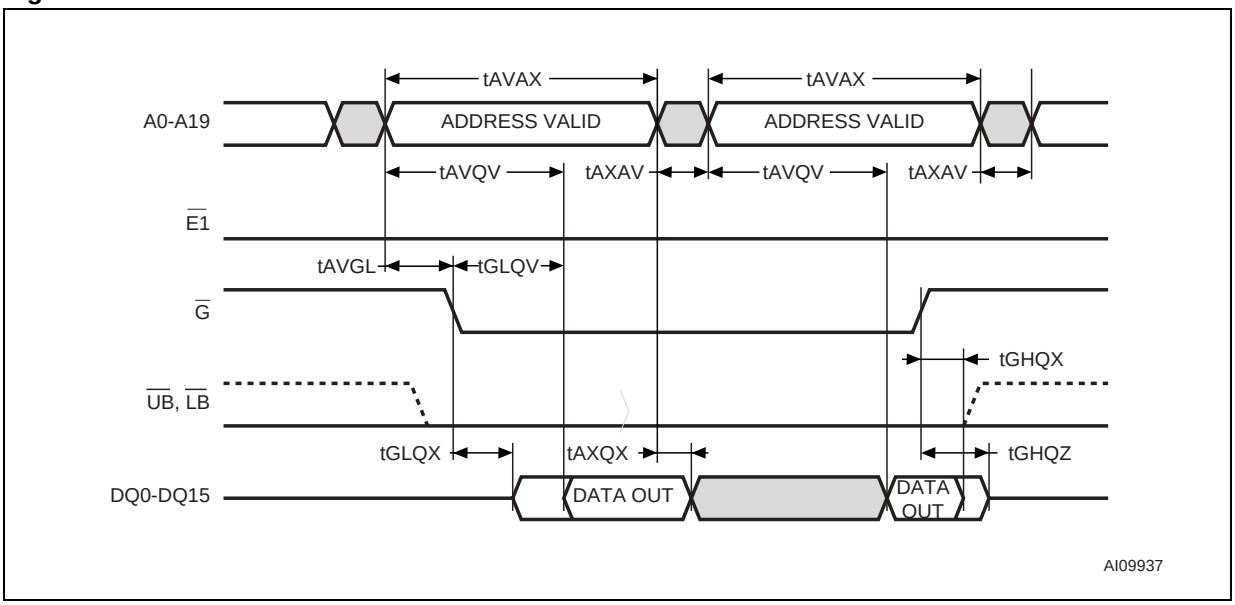
Note: 1. The maximum value of this timing is applicable if $\overline{E1}$ is kept Low with addresses unchanged.If needed by the system operation, please contact your local ST representative for relaxation of the 1000ns limitation.
2. Addresses should not be changed during $t_{AVAX}$(min).
3. These parameters are measured according to the conditions on input and output timing reference voltage shown on Figure 6., AC Measurement I/O Waveform.
4. The output load capacitance is 5pF without any other load.
5. These timings are given for $\overline{E1}$ Low.
6. $t_{AVAX}$(min) must be satisfied.
7. If the current value of $t_{WHGL}$ is lower than the minimum value given in the above table, $t_{AVQV}$ during the following Read operation may increase by $t_{WHGL}$(current) – $t_{WHGL}$(min).
8. All timings are measured according to the conditions for output transition timing reference voltage shown on Figure 6., AC Measurement I/O Waveform.

**Figure 7. Read Mode AC Waveforms**



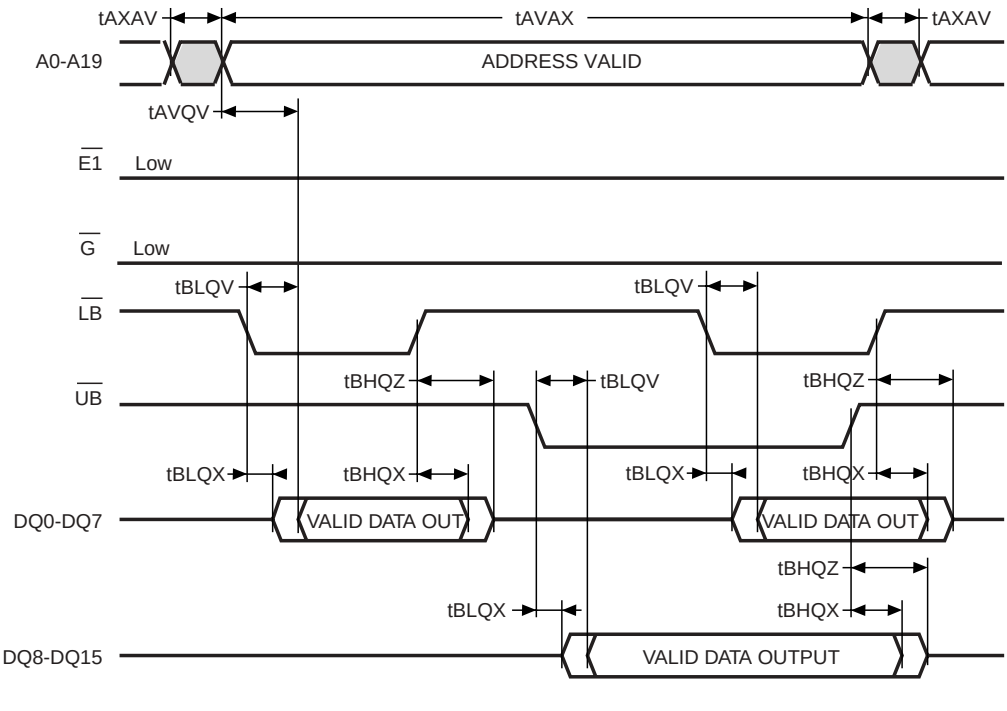

Note: E2 = High and $\overline{W}$ = High.

**Figure 8. Address Access after $\overline{G}$ Controlled Read AC Waveforms**




Note: 1. E2 = High and $\overline{W}$ = High.
2. During the two consecutive Read operations, the Output Enable signal, $\overline{G}$, can either remain Low, or be toggled.

**Figure 9. $\overline{UB}$/$\overline{LB}$ Controlled Read AC Waveforms**



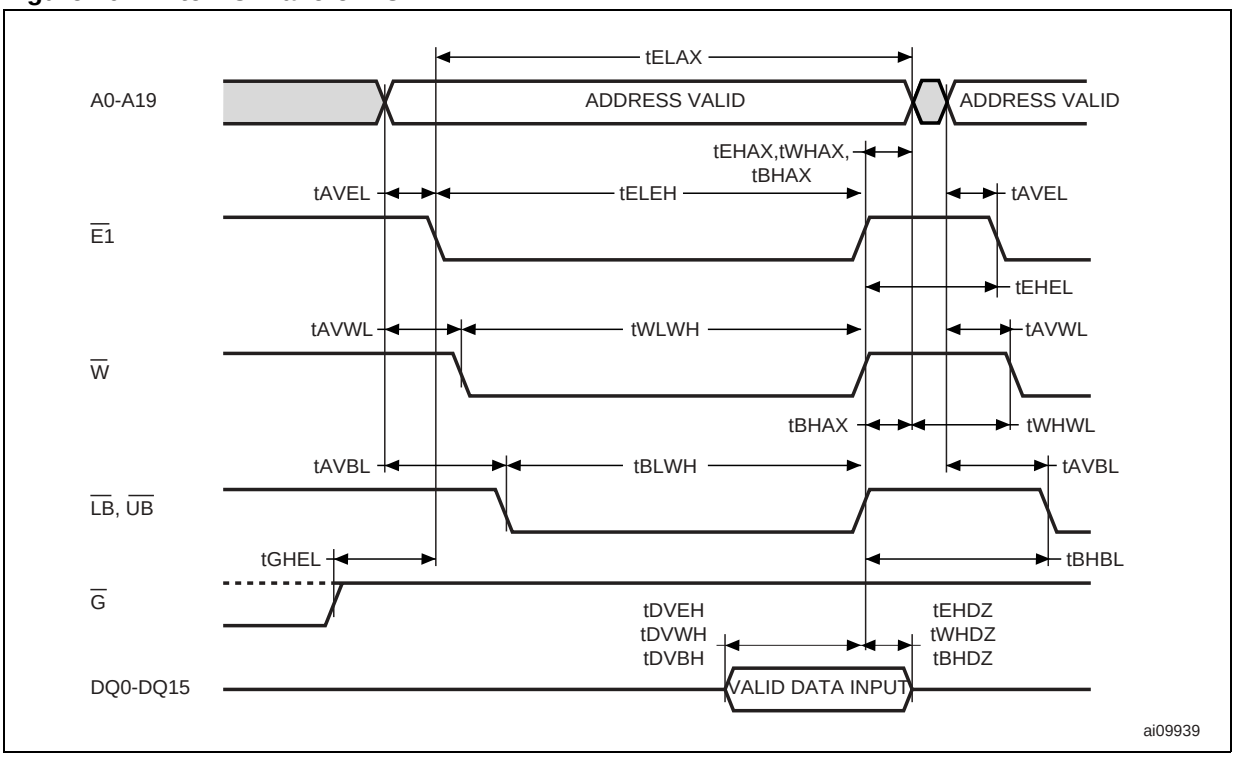

Note: E2 = High and $\overline{W}$ = High.

**Table 8. Write Mode AC Characteristics**

| Symbol | Alt. | Parameter | M69AW024BE | | Unit |
|---|---|---|---|---|---|
| | | | –60 | | |
| | | | Min | Max | |
| $t_{AVAX}$, $t_{ELAX}$(1,2) | $t_{WC}$ | Chip Enable Write Cycle Time | 70 | 1000 | ns |
| $t_{AVEL}$, $t_{AVBL}$, $t_{AVWL}$(2) | $t_{AS}$ | Address Set-up Time to Chip Enable Low | 0 | | ns |
| $t_{ELEH}$(3) | $t_{CW}$ | Chip Enable Write Pulse Width | 45 | | ns |
| $t_{WLBH}$, $t_{WLWH}$(3) | $t_{WP}$ | Write Enable Write Pulse Width | 45 | | ns |
| $t_{BLWH}$, $t_{BLBH}$(3) | $t_{BW}$ | $\overline{LB}$, $\overline{UB}$ Pulse (Write Operation) | 45 | | ns |
| $t_{BHWL}$(4) | $t_{BS}$ | $\overline{LB}$, $\overline{UB}$ Byte Masking Set-up Time | –5 | | ns |
| $t_{WHBL}$(5) | $t_{BH}$ | $\overline{LB}$, $\overline{UB}$ Hold Time | –5 | | ns |
| $t_{WHAX}$, $t_{EHAX}$, $t_{BHAX}$(6) | $t_{WR}$ | Write Recovery Time | 0 | | ns |
| $t_{EHEL}$ | $t_{CP}$ | Chip Enable High Pulse | 10 | | ns |
| $t_{WHWL}$ | $t_{WHP}$ | Write Enable High Pulse | 10 | 1000 | ns |
| $t_{BHBL}$ | $t_{BHP}$ | $\overline{LB}$, $\overline{UB}$ High Pulse | 10 | 1000 | ns |
| $t_{DVEH}$, $t_{DVWH}$, $t_{DVBH}$ | $t_{DS}$ | Data Set-up Time | 15 | | ns |
| $t_{EHDZ}$, $t_{WHDZ}$, $t_{BHDZ}$, $t_{GHDZ}$ | $t_{DH}$ | Data Hold Time | 0 | | ns |
| $t_{GHEL}$(7) | $t_{OHCL}$ | Output Enable High to Chip Enable Low Set-up Time | –5 | | ns |
| $t_{GHAV}$(8) | $t_{OES}$ | Output Enable Set-up Time | 0 | | ns |
| $t_{BLBH2}$ | $t_{BWO}$ | $\overline{LB}$, $\overline{UB}$ Low to $\overline{LB}$, $\overline{UB}$ High for Page Access | 30 | | ns |

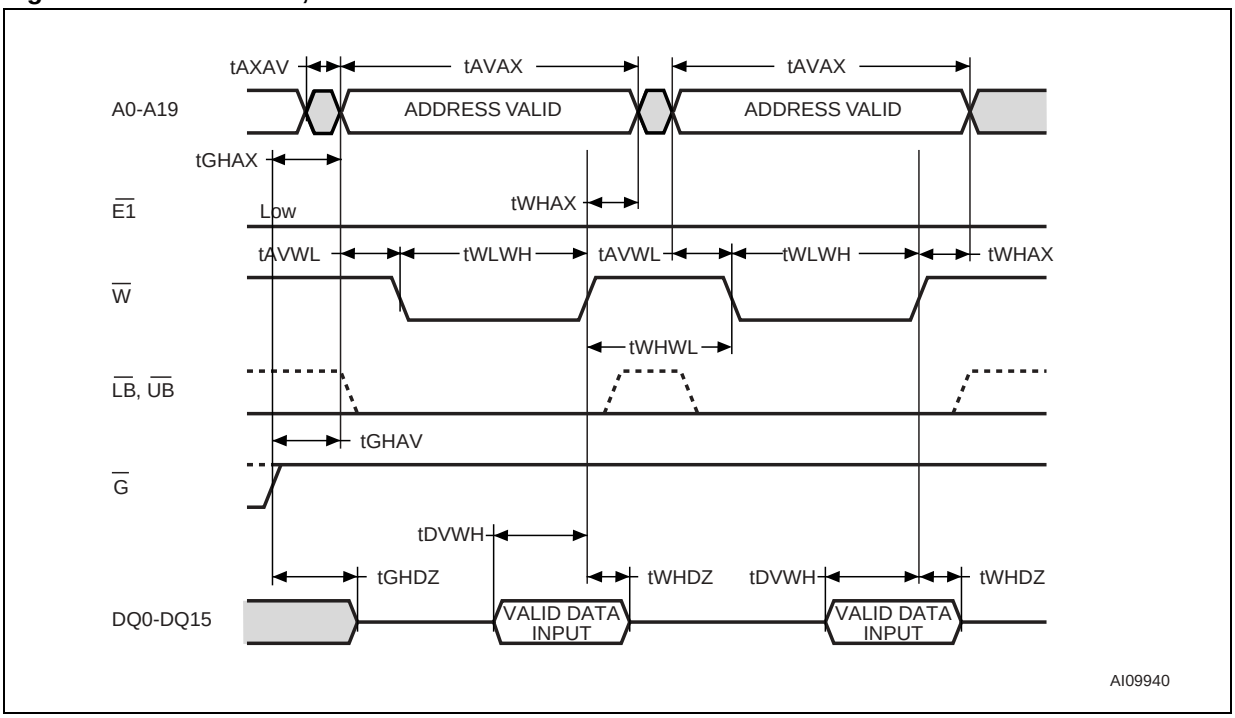
Note: 1. The maximum value of this timing is applicable if $\overline{E1}$ is kept Low without any address change. If needed by system operation, please contact your local ST representative for relaxation of the 1000ns limitation.
2. Minimum value must be equal to or greater than the sum of the write pulse ($t_{ELEH}$, $t_{WLBH}$ or $t_{BLBH}$ and the write recovery time $t_{WHAV}$.
3. Write pulse is defined from the falling edge of $\overline{E1}$, $\overline{W}$, or $\overline{LB}$/$\overline{UB}$, whichever occurs last.
4. Applicable to Byte Masking only. Byte Masking set-up time is defined from the falling edge of $\overline{E1}$ or $\overline{W}$ whichever occurs last.
5. Applicable to Byte Masking only. Byte Masking hold time is defined from the rising edge of $\overline{E1}$ or $\overline{W}$ whichever occurs first.
6. Write recovery is defined from the rising edge of $\overline{E1}$, $\overline{W}$, or $\overline{LB}$/$\overline{UB}$, whichever occurs first.
7. If $\overline{G}$ is Low after $t_{GHEL}$(min), the read cycle is initiated. In other words, $\overline{G}$ must be brought High within $t_{GHEL}$ (min) after $\overline{E1}$ is brought Low. Once the read cycle is initiated, new write pulse should be input after $t_{AVAX}$ or $t_{ELEH}$ minimum value.
8. If $\overline{G}$ is Low after new address input, the read cycle is initiated. In other words, $\overline{G}$ must be brought High at the same time or before new address valid. Once the read cycle is initiated, new write pulse should be input after $t_{AVAX}$ or $t_{ELEH}$ minimum value.

**Figure 10. Write AC Waveforms**



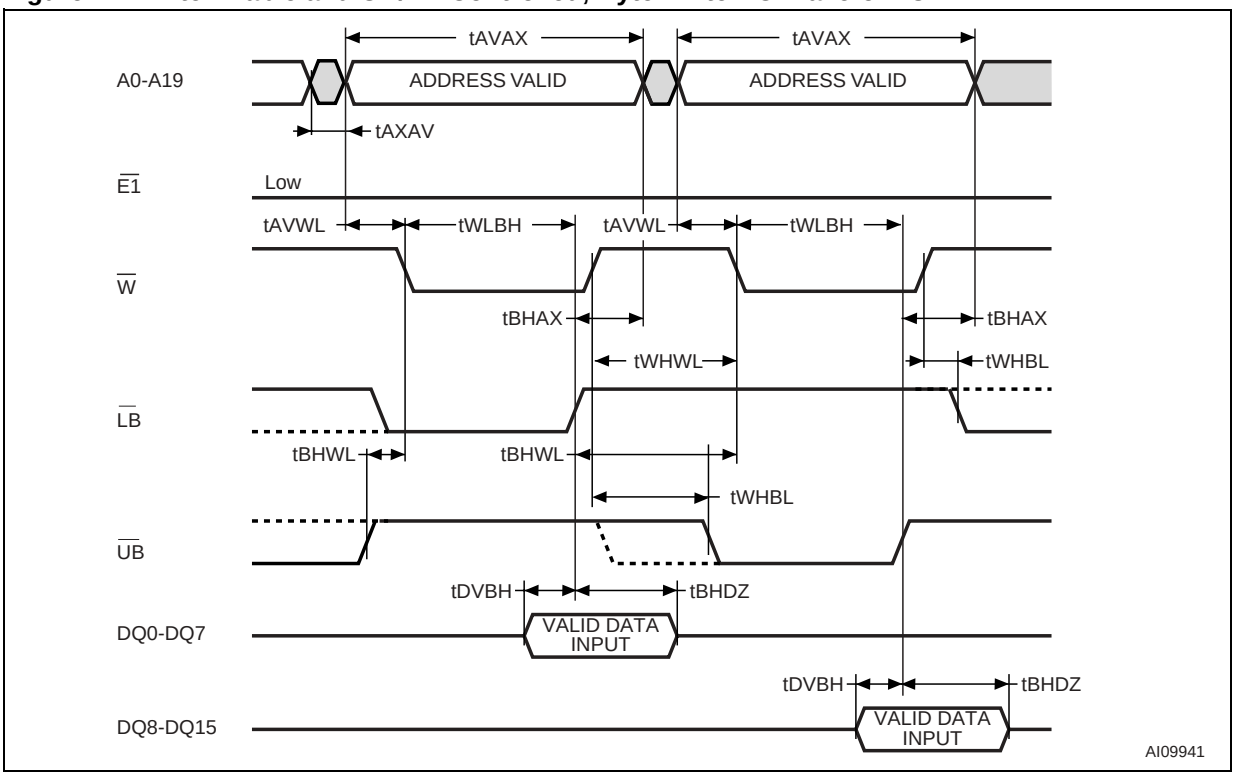

Note: 1. E2 must be High during the Write cycle.

**Figure 11. $\overline{W}$ Controlled, Write AC Waveforms**



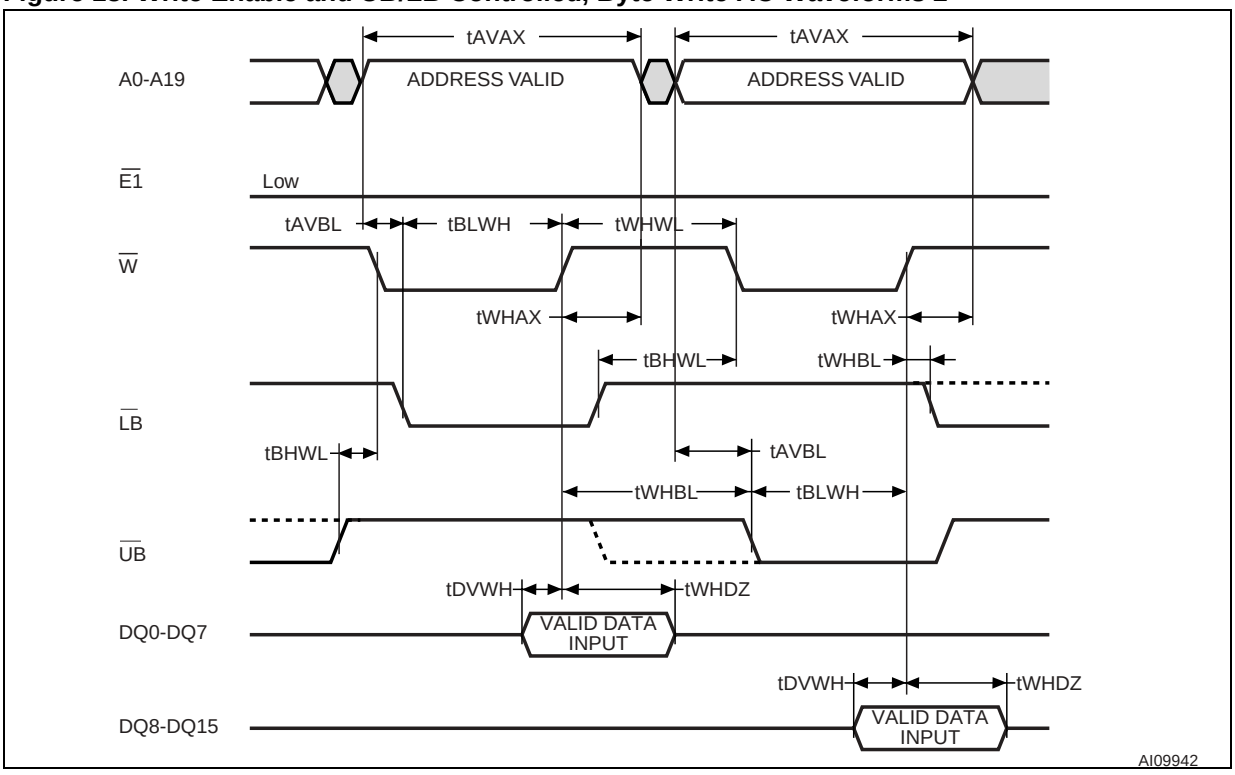

Note: 1. E2 must be High during the Write cycle.

**Figure 12. Write Enable and $\overline{UB}$/$\overline{LB}$ Controlled, Byte Write AC Waveforms 1**



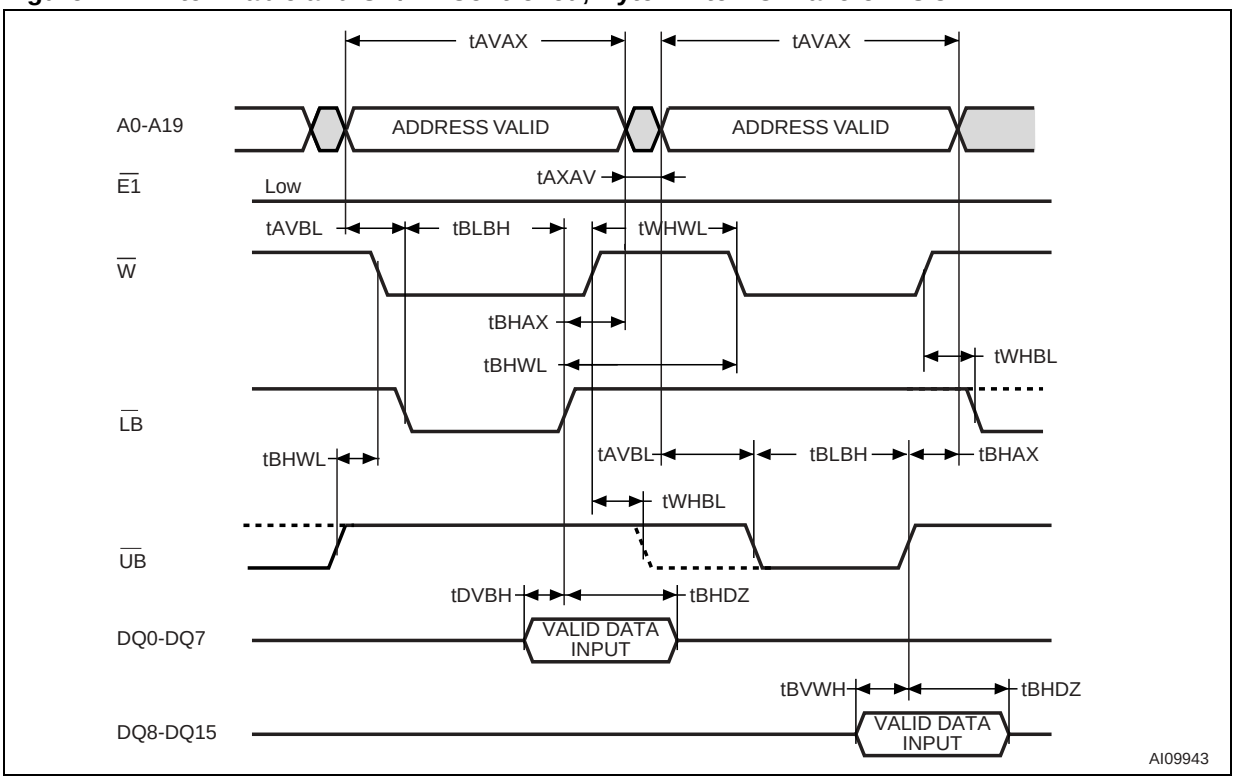

Note: 1. E2 and $\overline{G}$ must be High during the Write cycle.

**Figure 13. Write Enable and $\overline{UB}$/$\overline{LB}$ Controlled, Byte Write AC Waveforms 2**



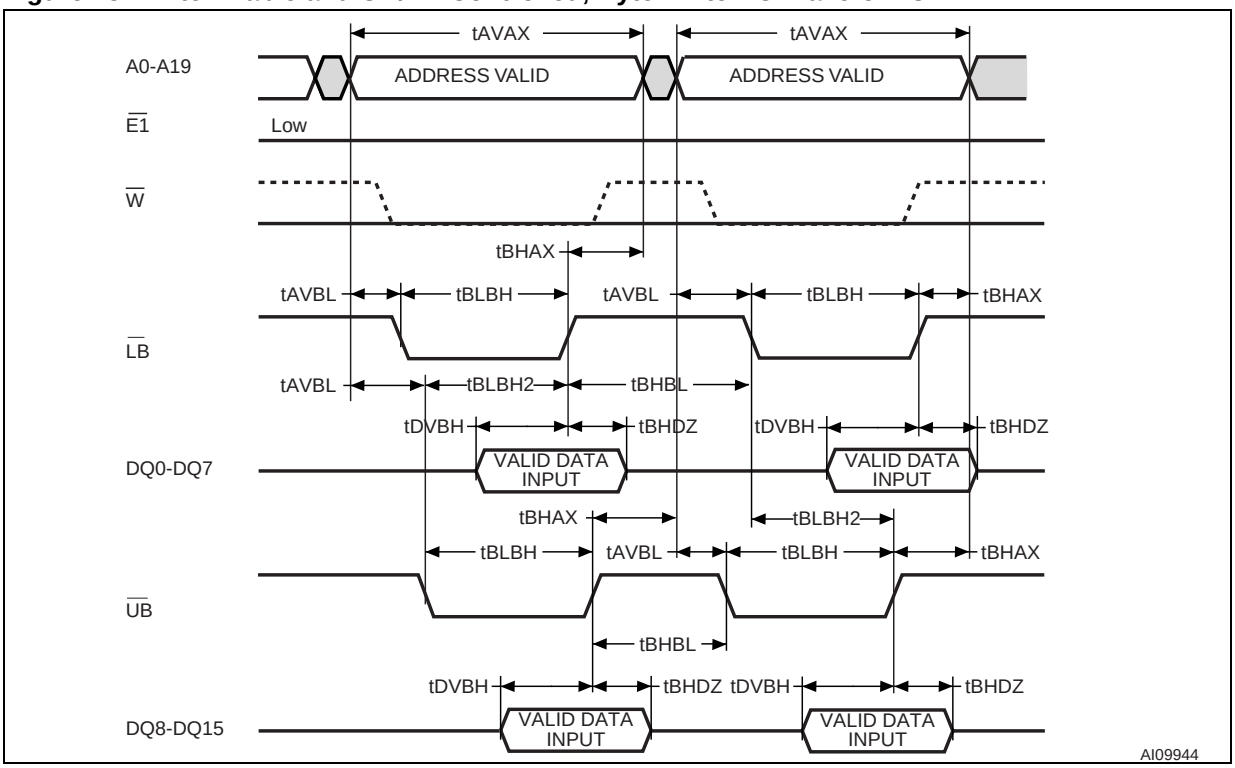

Note: 1. E2 and $\overline{G}$ must be High during the Write cycle.

**Figure 14. Write Enable and $\overline{UB}$/$\overline{LB}$ Controlled, Byte Write AC Waveforms 3**




Note: 1. E2 and $\overline{G}$ must be High during the Write cycle.

**Figure 15. Write Enable and $\overline{UB}$/$\overline{LB}$ Controlled, Byte Write AC Waveforms 4**



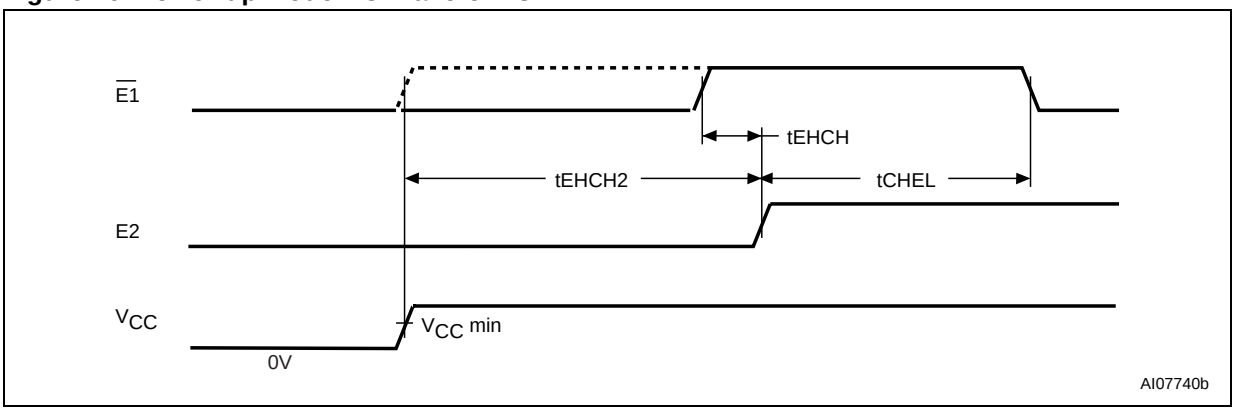

Note: 1. E2 and $\overline{G}$ must be High during the Write cycle.

**Table 9. Standby, Power-Down and Power-Up AC Parameters**

| Symbol | Alt. | Parameter | M69AW024BE | | Unit |
|---|---|---|---|---|---|
| | | | –60 | | |
| | | | Min | Max | |
| $t_{CLEL}$ | $t_{CSP}$ | E2 Low Setup Time for Power Down Entry | 10 | | ns |
| $t_{ELCH}$ | $t_{C2LP}$ | E2 Low Hold Time after Power Down Entry | 80 | | ns |
| $t_{CHEL}$(1) | $t_{CHH}$ | $\overline{E1}$ High Hold Time following E2 High after Power-Down Exit<br>$\overline{E1}$ High Hold Time following E2 High after Power-Up | 300 | | µs |
| $t_{EHCH}$ | $t_{CHS}$ | $\overline{E1}$ High Setup Time following E2 High after Power-Down Exit | 0 | | ns |
| $t_{EHGH}$ | $t_{CHOX}$ | $\overline{E1}$ High to $\overline{G}$ Invalid Time for Standby Entry | 10 | | ns |
| $t_{EHWH}$(2) | $t_{CHWX}$ | $\overline{E1}$ High to $\overline{W}$ Invalid Time for Standby Entry | 10 | | ns |
| $t_{\tau}$(3) | $t_{\tau}$ | Input Transition Time | 1 | 25 | ns |
| $t_{EHCH2}$ | $t_{C2LH}$ | Power-Up Time | 50 | | µs |

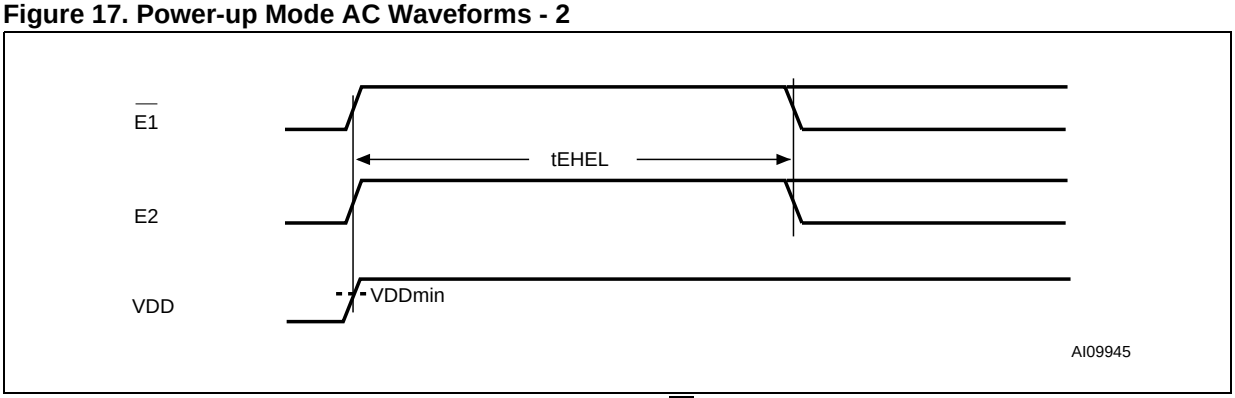
Note: 1. Applicable both to Power-Down and Power-Up.
2. Some data might be written into any address location if $t_{EHWL}$ (min) is not satisfied.
3. The Input Transition Time used in AC measurements is 5ns.
4. TBD = to be defined.

**Figure 16. Power-up Mode AC Waveforms - 1**



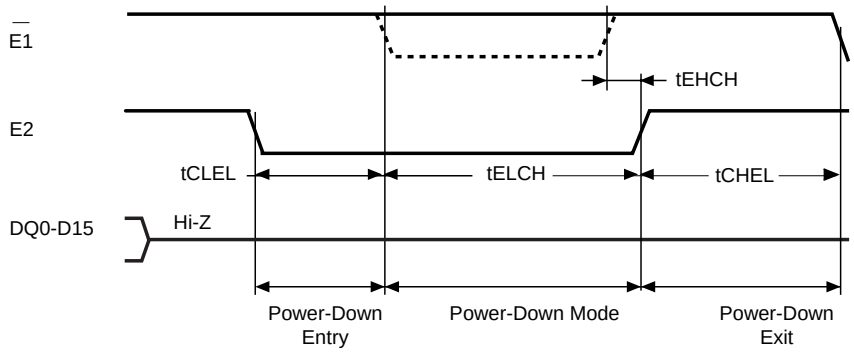

Note: $t_{EHCH2}$ is defined from $V_{CC}$ reaching $V_{CC}$(min).

**Figure 17. Power-up Mode AC Waveforms - 2**



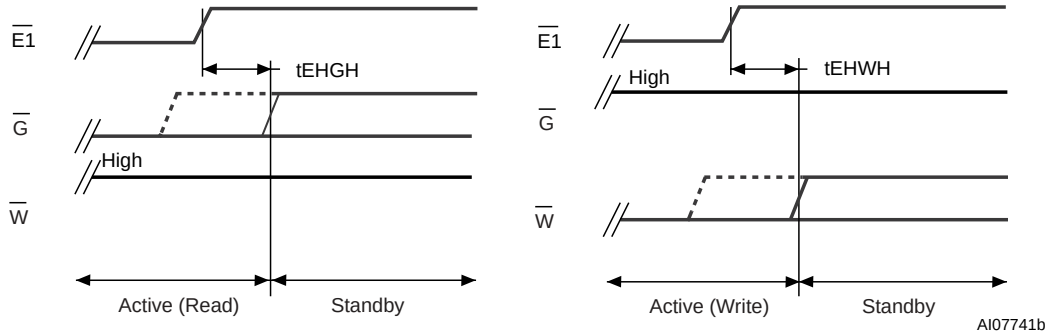

Note: $t_{CHEL}$ is defined from $V_{CC}$ reaching $V_{CC}$(min) and applicable both for $\overline{E1}$ and E2 signals.

**Figure 18. Power-Down Entry ad Exit AC Waveforms**




Note: The Power-Down mode timing can also be used as a Reset timing if the Power-up mode timing cannot be satisfied.

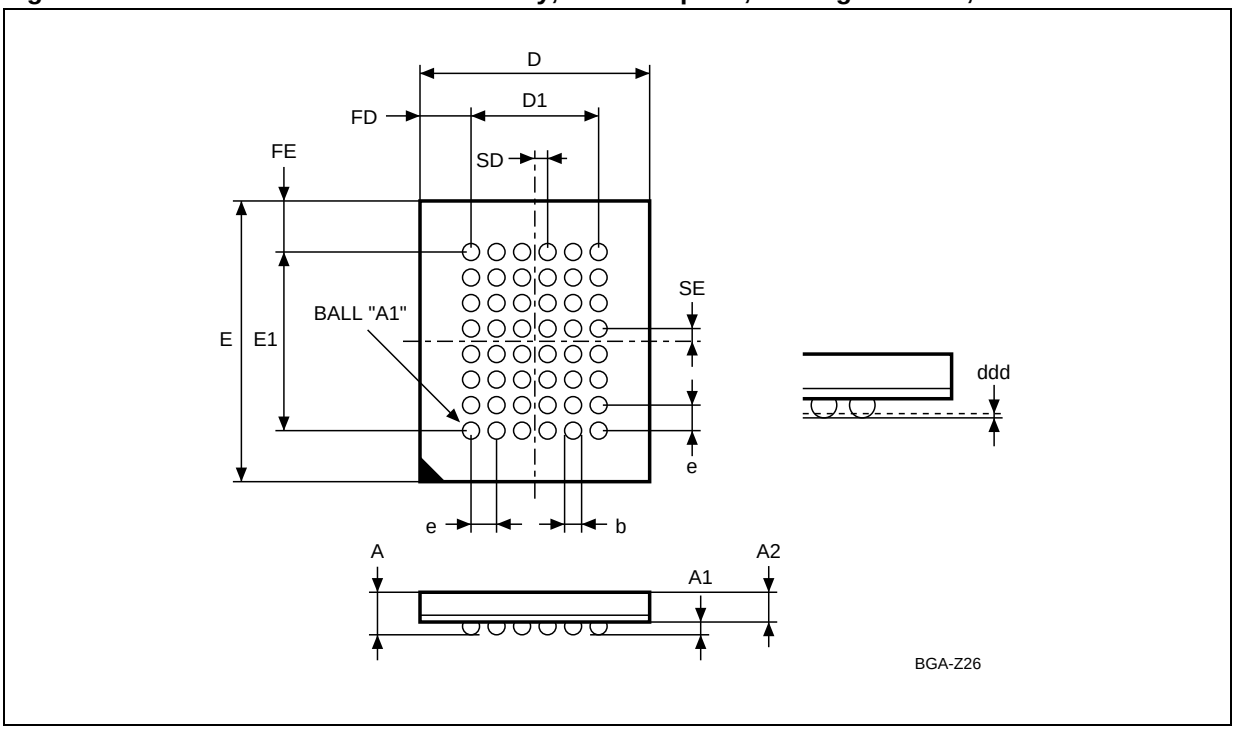
**Figure 19. Standby Mode Entry AC Waveforms, after Read or Write**




Note: Both $t_{EHGH}$ and $t_{EHWH}$ define the earliest entry timing for Standby mode. If one of these timings is not satisfied, it takes a $t_{AVAX}$(min) delay to enter Standby mode from $\overline{E1}$ rising edge.

## PACKAGE MECHANICAL

**Figure 20. TFBGA48 6x8mm - 6x8 ball array, 0.75 mm pitch, Package Outline, Bottom View**




Note: Drawing is not to scale.

**Table 10. TFBGA48 6x8mm - 6x8 ball array, 0.75 mm pitch, Package Mechanical Data**

| Symbol | millimeters | | | inches | | |
|---|---|---|---|---|---|---|
| | Typ | Min | Max | Typ | Min | Max |
| A | | | 1.200 | | | 0.0472 |
| A1 | | 0.260 | | | 0.0102 | |
| A2 | | | 0.900 | | | 0.0354 |
| b | | 0.350 | 0.450 | | 0.0138 | 0.0177 |
| D | 6.000 | 5.900 | 6.100 | 0.2362 | 0.2323 | 0.2402 |
| D1 | 3.750 | – | – | 0.1476 | – | – |
| ddd | | | 0.100 | | | 0.0039 |
| E | 8.000 | 7.900 | 8.100 | 0.3150 | 0.3110 | 0.3189 |
| E1 | 5.250 | – | – | 0.2067 | – | – |
| e | 0.750 | – | – | 0.0295 | – | – |
| FD | 1.125 | – | – | 0.0443 | – | – |
| FE | 1.375 | – | – | 0.0541 | – | – |
| SD | 0.375 | – | – | 0.0148 | – | – |
| SE | 0.375 | – | – | 0.0148 | – | – |

# PART NUMBERING

**Table 11. Ordering Information Scheme**

Example: M69AW024BE 60 ZB 8 F

**Device Type**
M69 = 1T/1C Memory Cell Architecture

**Mode**
A = Asynchronous

**Operating Voltage**
W = 2.7 to 3.3V

**Array Organization**
024 = 16 Mbit (1M x16)

**Option 1**
B = 2 Chip Enable

**Option 2**
E = E die

**Speed Class**
60 = 60ns

**Package**
ZB = TFBGA48 6x8mm - 6x8 ball array, 0.75 mm pitch

**Temperature Range**
8 = –30 to 85 °C

**Packing Option**
F = RoHS Compliant Package, Tape & Reel Packing

The notation used for the device number is as shown in Table 11.. For a list of available options (speed, package, etc.) or for further information on any aspect of this device, please contact your nearest STMicroelectronics Sales Office.

# REVISION HISTORY

**Table 12. Document Revision History**

| Date | Rev. | Revision Details |
|---|---|---|
| 28-Jun-2004 | 0.1 | First Issue |
| 29-Jun-2004 | 0.2 | Table 11., Ordering Information Scheme updated. |
| 22-Mar-2005 | 1.0 | $t_{EHQX}$ added in Table 7., Read and Standby Modes AC Characteristics.<br>$t_{GHDZ}$ and $t_{BHDZ}$ added in Table 8., Write Mode AC Characteristics.<br>Figure 19., Standby Mode Entry AC Waveforms, after Read or Write updated.<br>RoHS Packing option added in FEATURES SUMMARY and Table 11., Ordering Information Scheme. $T_{LEAD}$ parameter added in Table 3., Absolute Maximum Ratings |
| 05-Apr-2005 | 2.0 | Figure title modified and Note 2 added below Figure 8. |

Information furnished is believed to be accurate and reliable. However, STMicroelectronics assumes no responsibility for the consequences of use of such information nor for any infringement of patents or other rights of third parties which may result from its use. No license is granted by implication or otherwise under any patent or patent rights of STMicroelectronics. Specifications mentioned in this publication are subject to change without notice. This publication supersedes and replaces all information previously supplied. STMicroelectronics products are not authorized for use as critical components in life support devices or systems without express written approval of STMicroelectronics.

The ST logo is a registered trademark of STMicroelectronics.

All other names are the property of their respective owners

© 2005 STMicroelectronics - All rights reserved

STMicroelectronics group of companies
Australia - Belgium - Brazil - Canada - China - Czech Republic - Finland - France - Germany - Hong Kong - India - Israel - Italy - Japan - Malaysia - Malta - Morocco - Singapore - Spain - Sweden - Switzerland - United Kingdom - United States of America
**www.st.com**