

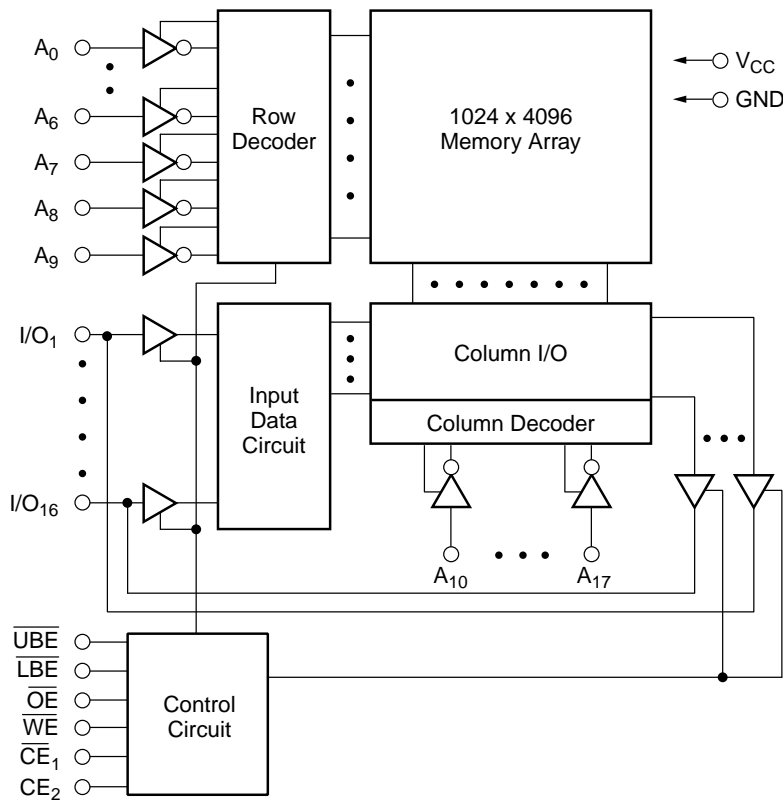
**Features**

- High-speed: 70, 85 ns
- Ultra low CMOS standby current of 4μA (max.)
- Fully static operation
- All inputs and outputs directly TTL compatible
- Three state outputs
- Ultra low data retention current ( $V_{CC} = 1.2V$ )
- Operating voltage: 2.3V – 3.0V
- Packages
  - 44-pin TSOP (Standard)
  - 48-Ball CSP BGA (8mm x 10mm)

**Description**

The V62C21164096 is a 4,194,304-bit static random-access memory organized as 262,144 words by 16 bits. Inputs and three-state outputs are TTL compatible and allow for direct interfacing with common system bus structures.

**Functional Block Diagram**



**Device Usage Chart**

| Operating Temperature Range | Package Outline |   | Access Time (ns) |    | Power |    | Temperature Mark |
|-----------------------------|-----------------|---|------------------|----|-------|----|------------------|
|                             | T               | B | 70               | 85 | L     | LL |                  |
| 0°C to 70°C                 | •               | • | •                | •  | •     | •  | Blank            |
| -40°C to +85°C              | •               | • | •                | •  |       | •  | I                |

**Pin Descriptions**

**A<sub>0</sub>–A<sub>17</sub> Address Inputs**

These 18 address inputs select one of the 256K x 16 bit segments in the RAM.

**$\overline{CE}_1$ , CE<sub>2</sub>\* Chip Enable Inputs**

$\overline{CE}_1$  is active LOW and CE<sub>2</sub> is active HIGH. Both chip enables must be active to read from or write to the device. If either chip enable is not active, the device is deselected and is in a standby power mode. The I/O pins will be in the high-impedance state when deselected.

**$\overline{OE}$  Output Enable Input**

The output enable input is active LOW. With chip enabled, when  $\overline{OE}$  is Low and  $\overline{WE}$  High, data will be presented on the I/O pins. The I/O pins will be in the high impedance state when  $\overline{OE}$  is High.

**$\overline{UBE}$ ,  $\overline{LBE}$  Byte Enable**

Active low inputs. These inputs are used to enable the upper or lower data byte.

**$\overline{WE}$  Write Enable Input**

The write enable input is active LOW and controls read and write operations. With the chip enabled, when  $\overline{WE}$  is HIGH and  $\overline{OE}$  is LOW, output data will be present at the I/O pins; when  $\overline{WE}$  is LOW and  $\overline{OE}$  is HIGH, the data present on the I/O pins will be written into the selected memory locations.

**I/O<sub>1</sub>–I/O<sub>16</sub> Data Input and Data Output Ports**

These 16 bidirectional ports are used to read data from and write data into the RAM.

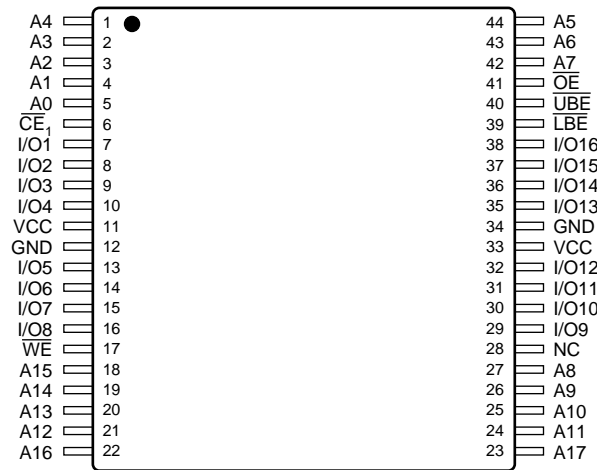
**V<sub>CC</sub> Power Supply**

**GND Ground**

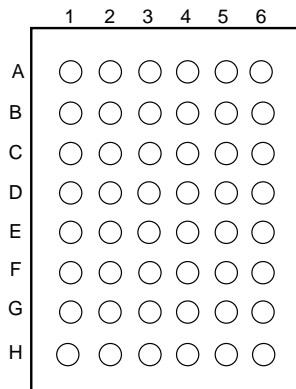
\*CE<sub>2</sub> is available on BGA package only.

**Pin Configurations (Top View)**

**44-Pin TSOP-II (Standard)**



**48 BGA**



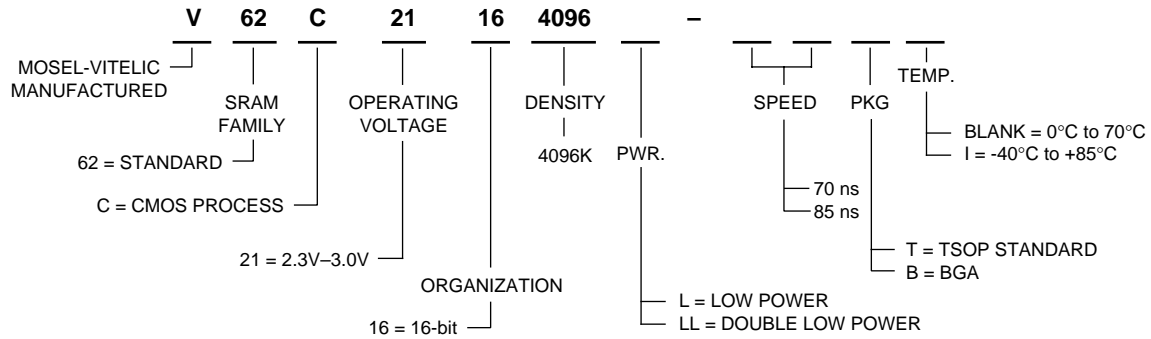
TOP VIEW

|   |                  |                  |     |     |                   |                 |
|---|------------------|------------------|-----|-----|-------------------|-----------------|
|   | 1                | 2                | 3   | 4   | 5                 | 6               |
| A | $\overline{BLE}$ | $\overline{OE}$  | A0  | A1  | A2                | CE <sub>2</sub> |
| B | I/O9             | $\overline{BHE}$ | A3  | A4  | $\overline{CE}_1$ | I/O1            |
| C | I/O10            | I/O11            | A5  | A6  | I/O2              | I/O3            |
| D | VSS              | I/O12            | A17 | A7  | I/O4              | VCC             |
| E | VCC              | I/O13            | NC  | A16 | I/O5              | VSS             |
| F | I/O15            | I/O14            | A14 | A15 | I/O6              | I/O7            |
| G | I/O16            | NC               | A12 | A13 | $\overline{WE}$   | I/O8            |
| H | NC               | A8               | A9  | A10 | A11               | NC              |

Note: NC means no connect.

TOP VIEW

**Part Number Information**



**Absolute Maximum Ratings (1)**

| Symbol            | Parameter                    | Commercial                    | Industrial                    | Units |
|-------------------|------------------------------|-------------------------------|-------------------------------|-------|
| V <sub>CC</sub>   | Supply Voltage               | -0.5 to V <sub>CC</sub> + 0.5 | -0.5 to V <sub>CC</sub> + 0.5 | V     |
| V <sub>N</sub>    | Input Voltage                | -0.5 to V <sub>CC</sub> + 0.5 | -0.5 to V <sub>CC</sub> + 0.5 | V     |
| V <sub>DQ</sub>   | Input/Output Voltage Applied | V <sub>CC</sub> + 0.3         | V <sub>CC</sub> + 0.3         | V     |
| T <sub>BIAS</sub> | Temperature Under Bias       | -10 to +125                   | -65 to +135                   | °C    |
| T <sub>STG</sub>  | Storage Temperature          | -55 to +125                   | -65 to +150                   | °C    |

**NOTE:**

- Stresses greater than those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect reliability.

**Capacitance\* T<sub>A</sub> = 25°C, f = 1.0MHz**

| Symbol           | Parameter          | Conditions            | Max. | Unit |
|------------------|--------------------|-----------------------|------|------|
| C <sub>IN</sub>  | Input Capacitance  | V <sub>IN</sub> = 0V  | 6    | pF   |
| C <sub>OUT</sub> | Output Capacitance | V <sub>I/O</sub> = 0V | 8    | pF   |

**NOTE:**

- This parameter is guaranteed and not tested.

**Truth Table**

| Mode           | $\overline{CE}_1$ | CE <sub>2</sub> | $\overline{OE}$ | $\overline{WE}$ | $\overline{UBE}$ | $\overline{LBE}$ | I/O <sub>9-16</sub> Operation | I/O <sub>1-8</sub> Operation |
|----------------|-------------------|-----------------|-----------------|-----------------|------------------|------------------|-------------------------------|------------------------------|
| Standby        | H                 | X               | X               | X               | X                | X                | High Z                        | High Z                       |
| Standby        | X                 | L               | X               | X               | X                | X                | High Z                        | High Z                       |
| Output Disable | L                 | H               | X               | X               | H                | H                | High Z                        | High Z                       |
| Output Disable | L                 | H               | H               | H               | X                | X                | High Z                        | High Z                       |
| Read           | L                 | H               | L               | H               | L                | L                | D <sub>OUT</sub>              | D <sub>OUT</sub>             |
| Read           | L                 | H               | L               | H               | L                | H                | D <sub>OUT</sub>              | High Z                       |
| Read           | L                 | H               | L               | H               | H                | L                | High Z                        | D <sub>OUT</sub>             |
| Write          | L                 | H               | X               | L               | L                | L                | D <sub>IN</sub>               | D <sub>IN</sub>              |
| Write          | L                 | H               | X               | L               | L                | H                | D <sub>IN</sub>               | High Z                       |
| Write          | L                 | H               | X               | L               | H                | L                | High Z                        | D <sub>IN</sub>              |

**NOTE:**

X = Don't Care, L = LOW, H = HIGH

**DC Electrical Characteristics** (over all temperature ranges,  $V_{CC} = 2.3V - 3.0V$ )

| Symbol   | Parameter                          | Test Conditions  | Min.           | Typ. | Max.           | Units   |
|----------|------------------------------------|--|----------------|------|----------------|---------|
| $V_{IL}$ | Input LOW Voltage <sup>(1,2)</sup> |  | -0.3           | —    | 0.4            | V       |
| $V_{IH}$ | Input HIGH Voltage <sup>(1)</sup>  |  | 2.0            | —    | $V_{CC} + 0.3$ | V       |
| $I_{IL}$ | Input Leakage Current              | $V_{CC} = \text{Max}, V_{IN} = 0V \text{ to } V_{CC}$                          | -1             | —    | 1              | $\mu A$ |
| $I_{OL}$ | Output Leakage Current             | $V_{CC} = \text{Max}, \overline{CE} = V_{IH}, V_{OUT} = 0V \text{ to } V_{CC}$ | -1             | —    | 1              | $\mu A$ |
| $V_{OL}$ | Output LOW Voltage                 | $V_{CC} = \text{Min}, I_{OL} = 2.1mA$  | —              | —    | 0.4            | V       |
| $V_{OH}$ | Output HIGH Voltage                | $V_{CC} = \text{Min}, I_{OH} = -0.5mA$   | $V_{CC} - 0.4$ | —    | —              | V       |

| Symbol    | Parameter   | Power               | Com. <sup>(3)</sup> | Ind. <sup>(3)</sup> | Units   |
|-----------|---|---------------------|---------------------|---------------------|---------|
| $I_{CC1}$ | Average Operating Current, $\overline{CE}_1 = V_{IL}, CE_2 = V_{CC} - 0.2V$ , Output Open, $V_{CC} = \text{Max}$ .  | $f = f_{max}$       | 35                  | 40                  | mA      |
|           |   | $f = 1 \text{ MHz}$ | 4                   | 5                   |         |
| $I_{SB}$  | TTL Standby Current<br>$\overline{CE} \geq V_{IH}, V_{CC} = \text{Max.}, f = 0$   | L                   | 0.5                 | 1                   | mA      |
|           |   | LL                  | 0.3                 | 1                   |         |
| $I_{SB1}$ | CMOS Standby Current, $\overline{CE}_1 \geq V_{CC} - 0.2V, CE_2 < 0.2V$<br>$V_{IN} \geq V_{CC} - 0.2V$ or $V_{IN} \leq 0.2V, V_{CC} = \text{Max.}, f = 0$ | L                   | 10                  | 15                  | $\mu A$ |
|           |   | LL                  | 4                   | 6                   |         |

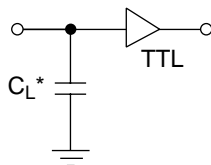
**NOTES:**

1. These are absolute values with respect to device ground and all overshoots due to system or tester noise are included.
2.  $V_{IL}$  (Min.) = -3.0V for pulse width < 20ns.
3. Maximum values.

**AC Test Conditions**

|                           |           |
|---------------------------|-----------|
| Input Pulse Levels        | 0 to 2.0V |
| Input Rise and Fall Times | 5 ns      |
| Timing Reference Levels   | 1.1V      |
| Output Load               | see below |

**AC Test Loads and Waveforms**



\* Includes scope and jig capacitance  
 $C_L = 30 \text{ pF} + 1 \text{ TTL Load}$

**Key to Switching Waveforms**

| WAVEFORM | INPUTS                           | OUTPUTS                                   |
|----------|----------------------------------|---|
|          | MUST BE STEADY                   | WILL BE STEADY                            |
|          | MAY CHANGE FROM H TO L           | WILL BE CHANGING FROM H TO L              |
|          | MAY CHANGE FROM L TO H           | WILL BE CHANGING FROM L TO H              |
|          | DON'T CARE: ANY CHANGE PERMITTED | CHANGING: STATE UNKNOWN                   |
|          | DOES NOT APPLY                   | CENTER LINE IS HIGH IMPEDANCE "OFF" STATE |

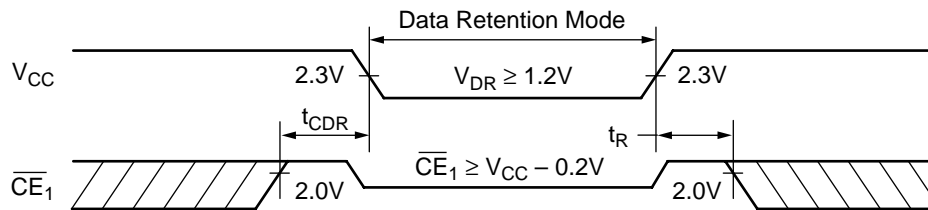
**Data Retention Characteristics**

| Symbol     | Parameter   | Power | Min.           | Typ. <sup>(2)</sup> | Max. | Units |         |
|------------|---|-------|----------------|---------------------|------|-------|---------|
| $V_{DR}$   | $V_{CC}$ for Data Retention<br>$\overline{CE}_1 \geq V_{CC} - 0.2V$ , $CE_2 < 0.2V$ , $V_{IN} \geq V_{CC} - 0.2V$ ,<br>or $V_{IN} \leq 0.2V$              |       | 1.2            | —                   | 3.0  | V     |         |
| $I_{CCDR}$ | Data Retention Current<br>$\overline{CE}_1 \geq V_{DR} - 0.2V$ , $CE_2 < 0.2V$ , $V_{IN} \geq V_{CC} - 0.2V$ ,<br>or $V_{IN} \leq 0.2V$ , $V_{DR} = 1.2V$ | Com'l | L              | —                   | 1    | 3     | $\mu A$ |
|            |   |       | LL             | —                   | 0.5  | 2     |         |
|            |   | Ind.  | L              | —                   | —    | 5     |         |
|            |   |       | LL             | —                   | —    | 4     |         |
| $t_{CDR}$  | Chip Deselect to Data Retention Time  |       | 0              | —                   | —    | ns    |         |
| $t_R$      | Operation Recovery Time (see Retention Waveform)  |       | $t_{RC}^{(1)}$ | —                   | —    | ns    |         |

**NOTES:**

1.  $t_{RC}$  = Read Cycle Time
2.  $T_A = +25^\circ C$ .

**Low  $V_{CC}$  Data Retention Waveform ( $\overline{CE}$  Controlled)**



**AC Electrical Characteristics**

(over all temperature ranges)

**Read Cycle**

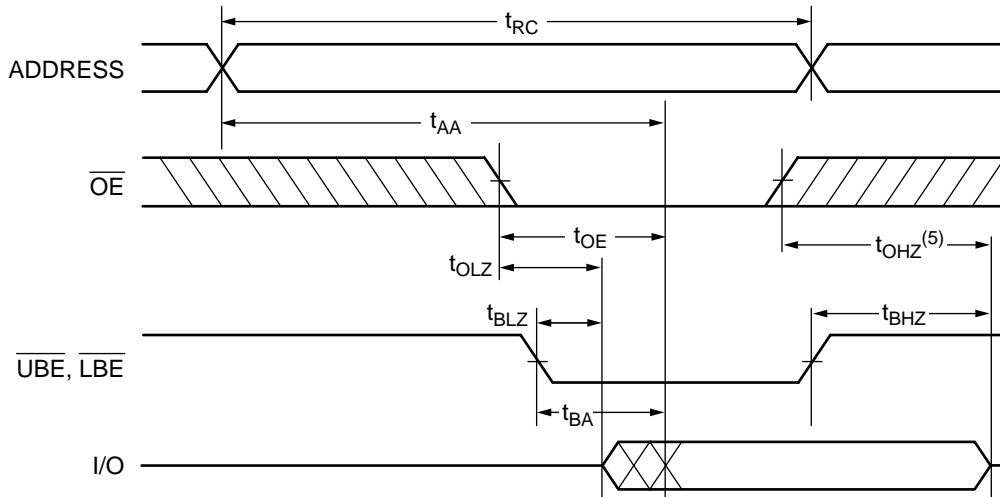
| Parameter Name   | Parameter   | 70   |      | 85   |      | Unit |
|------------------|---|------|------|------|------|------|
|                  |   | Min. | Max. | Min. | Max. |      |
| t <sub>RC</sub>  | Read Cycle Time   | 70   | —    | 85   | —    | ns   |
| t <sub>AA</sub>  | Address Access Time                                     | —    | 70   | —    | 85   | ns   |
| t <sub>ACS</sub> | Chip Enable Access Time                                 | —    | 70   | —    | 85   | ns   |
| t <sub>BA</sub>  | $\overline{UBE}$ , $\overline{LBE}$ Access Time         | —    | 70   | —    | 85   | ns   |
| t <sub>OE</sub>  | Output Enable to Output Valid                           | —    | 35   | —    | 35   | ns   |
| t <sub>CLZ</sub> | Chip Enable to Output in Low Z                          | 10   | —    | 10   | —    | ns   |
| t <sub>BLZ</sub> | $\overline{UBE}$ , $\overline{LBE}$ to Output in Low Z  | 10   | —    | 10   | —    | ns   |
| t <sub>OLZ</sub> | Output Enable to Output in Low Z                        | 5    | —    | 10   | —    | ns   |
| t <sub>CHZ</sub> | Chip Disable to Output in High Z                        | 0    | 25   | 0    | 30   | ns   |
| t <sub>OHZ</sub> | Output Disable to Output in High Z                      | 0    | 25   | 0    | 30   | ns   |
| t <sub>BHZ</sub> | $\overline{UBE}$ , $\overline{LBE}$ to Output in High Z | 0    | 25   | 0    | 30   | ns   |
| t <sub>OH</sub>  | Output Hold from Address Change                         | 5    | —    | 10   | —    | ns   |

**Write Cycle**

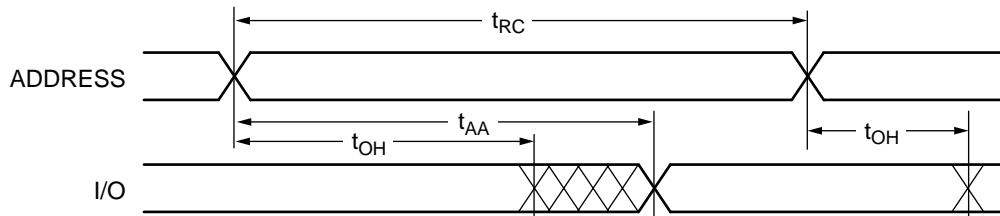
| Parameter Name   | Parameter   | 70   |      | 85   |      | Unit |
|------------------|---|------|------|------|------|------|
|                  |   | Min. | Max. | Min. | Max. |      |
| t <sub>WC</sub>  | Write Cycle Time                                    | 70   | —    | 85   | —    | ns   |
| t <sub>CW</sub>  | Chip Enable to End of Write                         | 60   | —    | 70   | —    | ns   |
| t <sub>AS</sub>  | Address Setup Time                                  | 0    | —    | 0    | —    | ns   |
| t <sub>AW</sub>  | Address Valid to End of Write                       | 60   | —    | 70   | —    | ns   |
| t <sub>WP</sub>  | Write Pulse Width                                   | 50   | —    | 60   | —    | ns   |
| t <sub>WR</sub>  | Write Recovery Time                                 | 0    | —    | 0    | —    | ns   |
| t <sub>WHZ</sub> | Write to Output High-Z                              | 0    | 20   | 0    | 25   | ns   |
| t <sub>DW</sub>  | Data Setup to End of Write                          | 35   | —    | 40   | —    | ns   |
| t <sub>DH</sub>  | Data Hold from End of Write                         | 0    | —    | 0    | —    | ns   |
| t <sub>BW</sub>  | $\overline{UBE}$ , $\overline{LBE}$ to End of Write | 60   | —    | 70   | —    | ns   |

Switching Waveforms (Read Cycle)

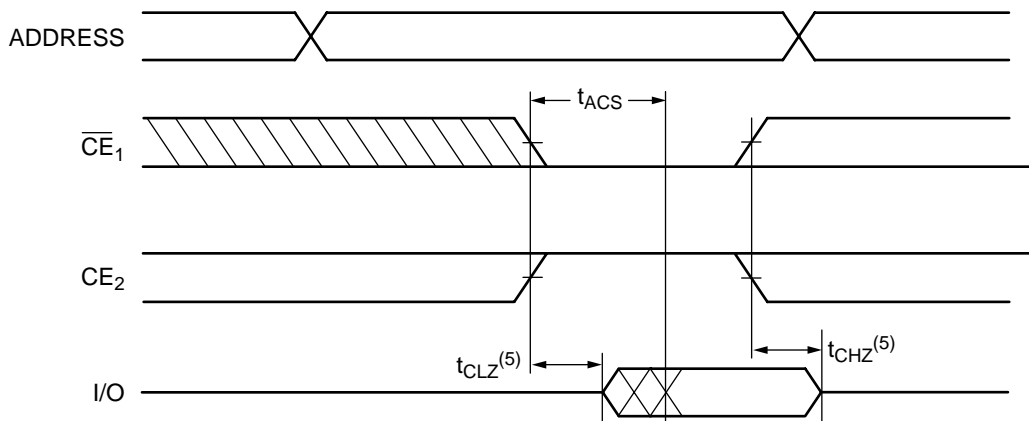
Read Cycle 1<sup>(1, 2, 7)</sup>



Read Cycle 2<sup>(1, 2, 4, 6, 7)</sup>



Read Cycle 3<sup>(1, 3, 4, 6, 7)</sup>

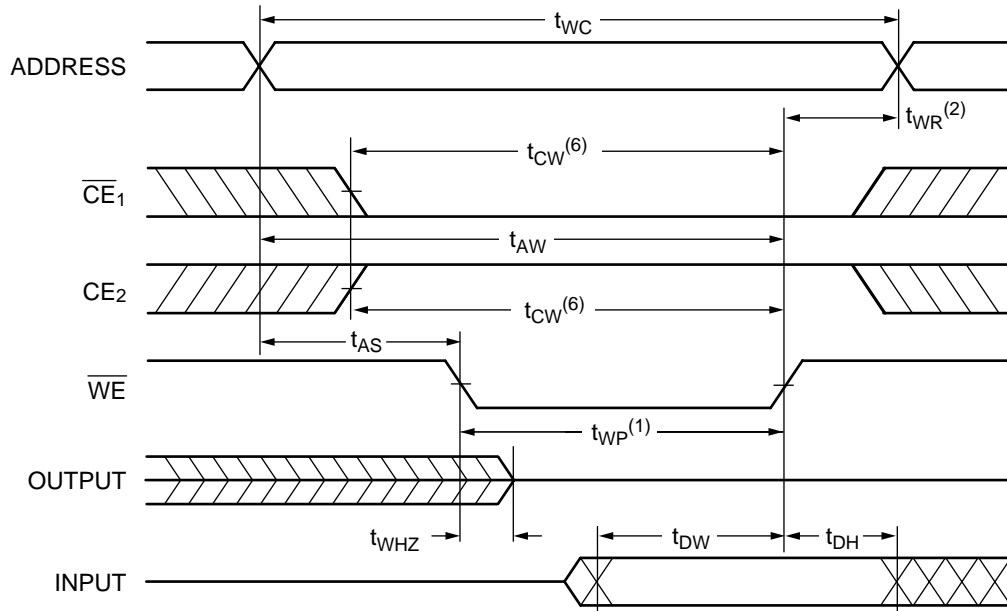


NOTES:

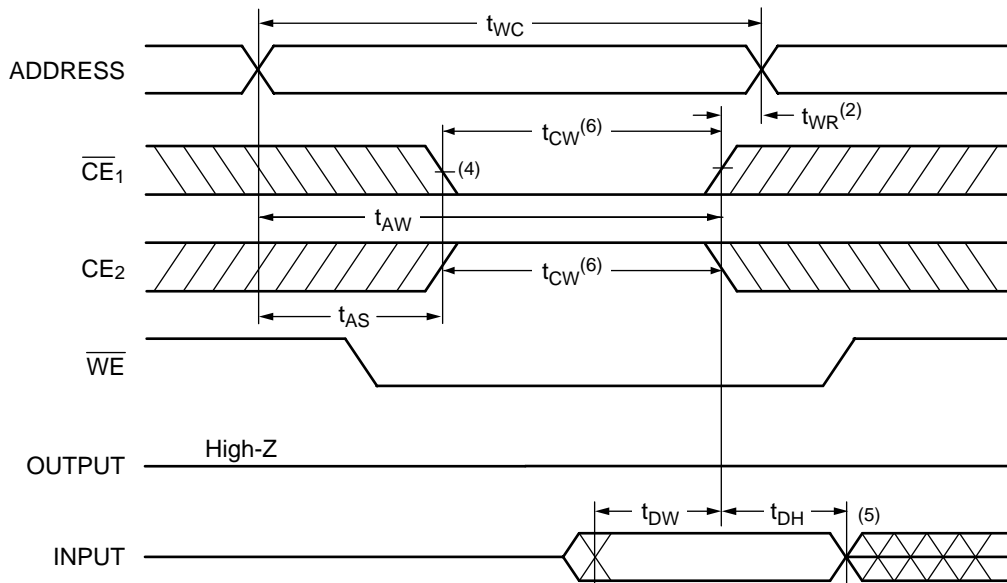
1.  $\overline{WE} = V_{IH}$ .
2.  $\overline{CE}_1 = V_{IL}$ ,  $CE_2 = V_{IH}$ .
3. Address valid prior to or coincident with  $\overline{CE}$  transition LOW.
4.  $\overline{OE} = V_{IL}$ .
5. Transition is measured  $\pm 500mV$  from steady state with  $C_L = 5pF$ . This parameter is guaranteed and not 100% tested.
6.  $\overline{UBE} = V_{IL}$ ,  $\overline{LBE} = V_{IL}$ .
7.  $CE_2$  is offered on BGA package only.

Switching Waveforms (Write Cycle)

Write Cycle 1 ( $\overline{WE}$  Controlled)<sup>(4, 7)</sup>



Write Cycle 2 (CE Controlled)<sup>(4, 7)</sup>



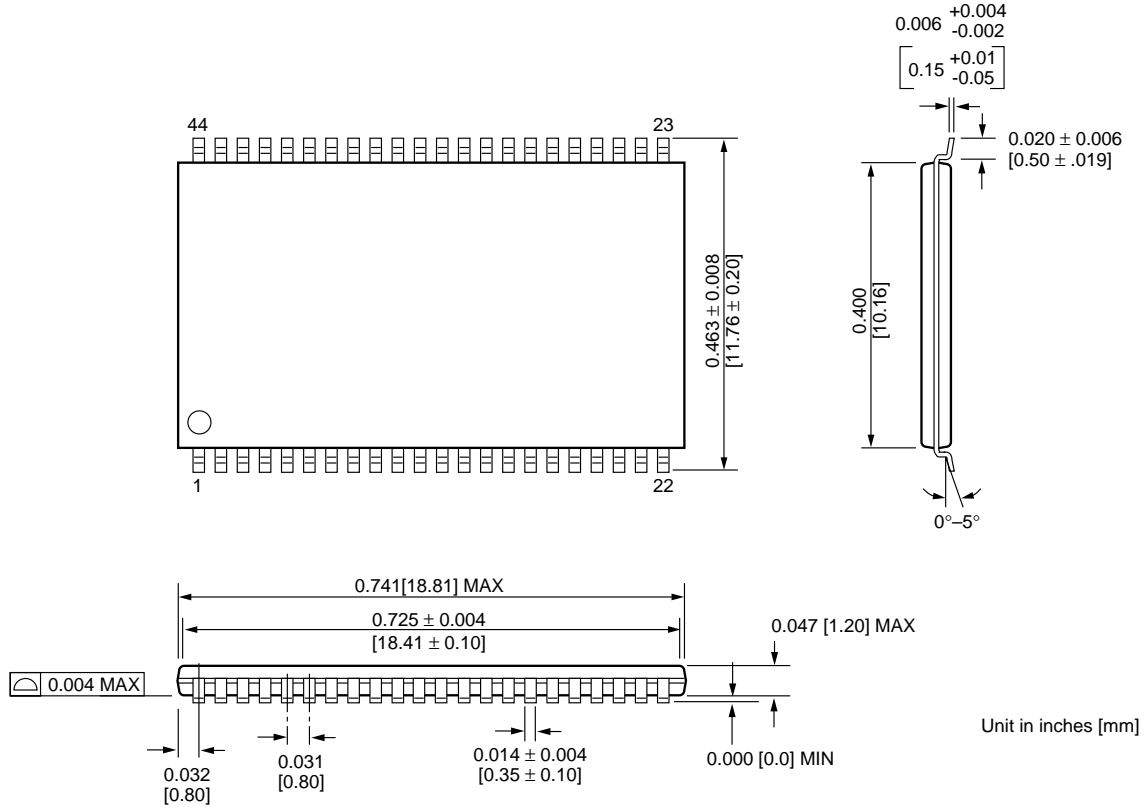
NOTES:

1. The internal write time of the memory is defined by the overlap of  $\overline{CE}_1$  and  $CE_2$  active and  $\overline{WE}$  low. All signals must be active to initiate and any one signal can terminate a write by going inactive. The data input setup and hold timing should be referenced to the second transition edge of the signal that terminates the write.
2.  $t_{WR}^{(2)}$  is measured from the earlier of  $\overline{CE}_1$  or  $\overline{WE}$  going high, or  $CE_2$  going LOW at the end of the write cycle.
3. During this period, I/O pins are in the output state so that the input signals of opposite phase to the outputs must not be applied.
4.  $\overline{OE} = V_{IL}$  or  $V_{IH}$ . However it is recommended to keep  $\overline{OE}$  at  $V_{IH}$  during write cycle to avoid bus contention.
5. If  $\overline{CE}_1$  is LOW and  $CE_2$  is HIGH during this period, I/O pins are in the output state. Then the data input signals of opposite phase to the outputs must not be applied to them.
6.  $t_{CW}^{(6)}$  is measured from  $\overline{CE}_1$  going low or  $CE_2$  going HIGH to the end of write.
7.  $CE_2$  is available on BGA package only.

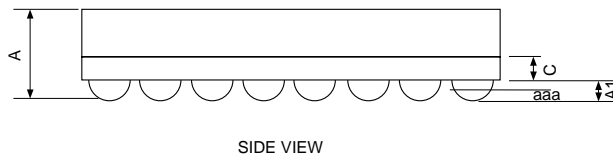
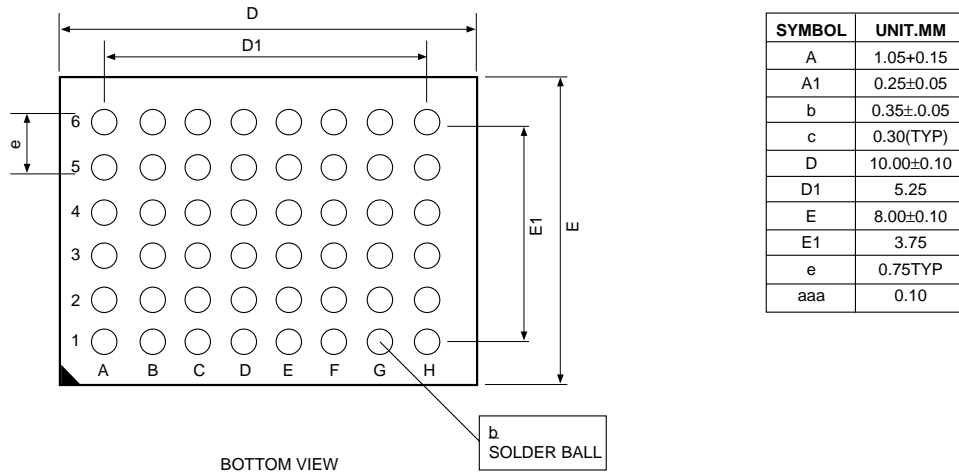


**Package Diagrams**

**44-pin 400 mil TSOP-II**



**48 Ball—8x10 BGA**



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