

## 128K x 16 HIGH-SPEED CMOS STATIC RAM

FEBRUARY 2006

### FEATURES

- High-speed access time:  
12 ns: 3.3V  $\pm$  10%  
15 ns: 2.5V-3.6V
- Operating Current: 25mA (typ.)
- Stand by Current: 400 $\mu$ A(typ.)
- TTL and CMOS compatible interface levels
- Fully static operation: no clock or refresh required
- Three state outputs
- Data control for upper and lower bytes
- Industrial and Automotive temperatures available
- Lead-free available

### DESCRIPTION

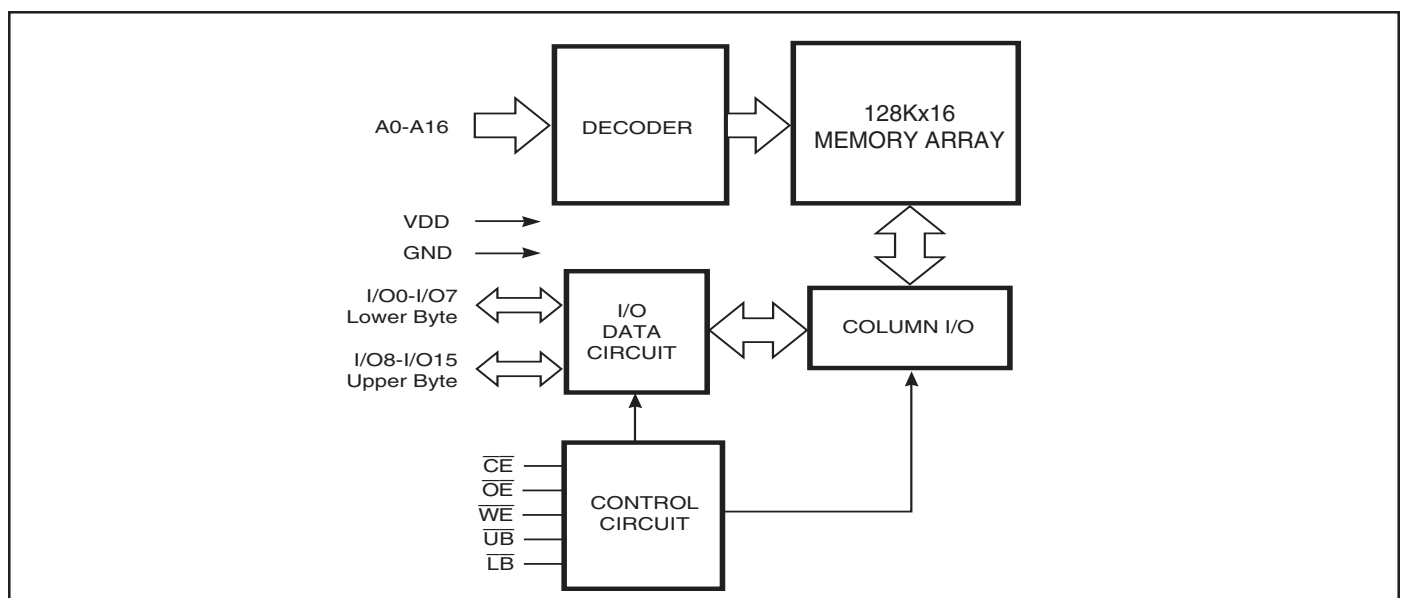
The *ISSI* IS61WV12816BLL and IS64WV12816BLL are high-speed, 2,097,152-bit static RAM organized as 131,072 words by 16 bits. They are fabricated using *ISSI*'s high-performance CMOS technology. This highly reliable process coupled with innovative circuit design techniques, yields access times as fast as 12 ns with low power consumption.

When  $\overline{CE}$  is HIGH (deselected), the device assumes a standby mode at which the power dissipation can be reduced down with CMOS input levels.

Easy memory expansion is provided by using Chip Enable and Output Enable inputs,  $\overline{CE}$  and  $\overline{OE}$ . The active LOW Write Enable ( $\overline{WE}$ ) controls both writing and reading of the memory. A data byte allows Upper Byte ( $\overline{UB}$ ) and Lower Byte ( $\overline{LB}$ ) access.

The IS61WV12816BLL and IS64WV12816BLL are packaged in the JEDEC standard 44-pin TSOP (Type II) and 48-pin mini BGA (6mm x 8mm).

### FUNCTIONAL BLOCK DIAGRAM

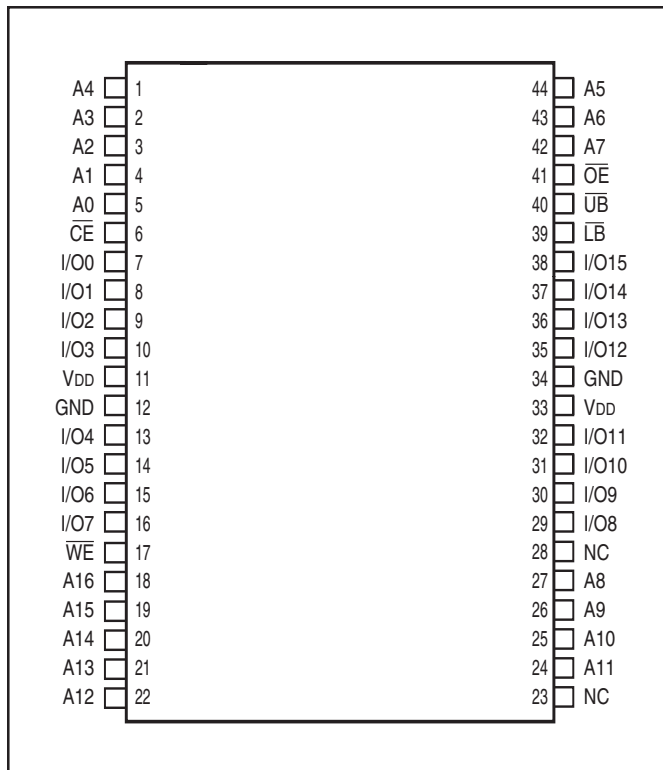


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TRUTH TABLE

| Mode            | I/O PIN         |                 |                 |                 |                 |           | V <sub>DD</sub> Current |                                     |
|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------|-------------------------|-------------------------------------|
|                 | $\overline{WE}$ | $\overline{CE}$ | $\overline{OE}$ | $\overline{LB}$ | $\overline{UB}$ | I/O0-I/O7 |                         | I/O8-I/O15                          |
| Not Selected    | X               | H               | X               | X               | X               | High-Z    | High-Z                  | I <sub>SB1</sub> , I <sub>SB2</sub> |
| Output Disabled | H               | L               | H               | X               | X               | High-Z    | High-Z                  | I <sub>CC</sub>                     |
|                 | X               | L               | X               | H               | H               | High-Z    | High-Z                  |                                     |
| Read            | H               | L               | L               | L               | H               | DOUT      | High-Z                  | I <sub>CC</sub>                     |
|                 | H               | L               | L               | H               | L               | High-Z    | DOUT                    |                                     |
|                 | H               | L               | L               | L               | L               | DOUT      | DOUT                    |                                     |
| Write           | L               | L               | X               | L               | H               | DIN       | High-Z                  | I <sub>CC</sub>                     |
|                 | L               | L               | X               | H               | L               | High-Z    | DIN                     |                                     |
|                 | L               | L               | X               | L               | L               | DIN       | DIN                     |                                     |

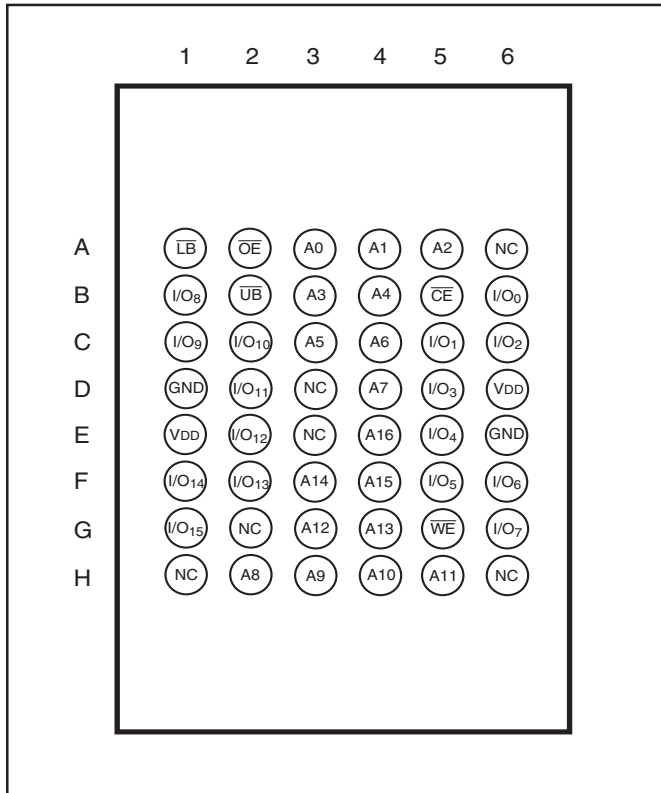
PIN CONFIGURATION  
44-Pin TSOP (Type II) (T)



PIN DESCRIPTIONS

|                 |                                 |
|-----------------|---------------------------------|
| A0-A16          | Address Inputs                  |
| I/O0-I/O15      | Data Inputs/Outputs             |
| $\overline{CE}$ | Chip Enable Input               |
| $\overline{OE}$ | Output Enable Input             |
| $\overline{WE}$ | Write Enable Input              |
| $\overline{LB}$ | Lower-byte Control (I/O0-I/O7)  |
| $\overline{UB}$ | Upper-byte Control (I/O8-I/O15) |
| NC              | No Connection                   |
| V <sub>DD</sub> | Power                           |
| GND             | Ground                          |

**PIN CONFIGURATION**  
48-Pin mini BGA (B)



**PIN DESCRIPTIONS**

|                 |                                 |
|-----------------|---------------------------------|
| A0-A16          | Address Inputs                  |
| I/O0-I/O15      | Data Inputs/Outputs             |
| $\overline{CE}$ | Chip Enable Input               |
| $\overline{OE}$ | Output Enable Input             |
| $\overline{WE}$ | Write Enable Input              |
| $\overline{LB}$ | Lower-byte Control (I/O0-I/O7)  |
| $\overline{UB}$ | Upper-byte Control (I/O8-I/O15) |
| NC              | No Connection                   |
| VDD             | Power                           |
| GND             | Ground                          |

**ABSOLUTE MAXIMUM RATINGS<sup>(1)</sup>**

| Symbol            | Parameter                            | Value                         | Unit |
|-------------------|--------------------------------------|-------------------------------|------|
| V <sub>DD</sub>   | Power Supply Voltage Relative to GND | -0.5 to 4.0V                  | V    |
| V <sub>TERM</sub> | Terminal Voltage with Respect to GND | -0.5 to V <sub>DD</sub> + 0.5 | V    |
| T <sub>STG</sub>  | Storage Temperature                  | -65 to + 150                  | °C   |
| P <sub>T</sub>    | Power Dissipation                    | 1.0                           | W    |

**Note:**

1. Stress 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.

**OPERATING RANGE (V<sub>DD</sub>)**

| Range      | Ambient Temperature | V <sub>DD</sub> (15 ns) | V <sub>DD</sub> (12 ns) |
|------------|---------------------|-------------------------|-------------------------|
| Industrial | -40°C to +85°C      | 2.5V-3.6V               | 3.3V ± 10%              |
| Automotive | -40°C to +125°C     | 2.5V-3.6V               |                         |

**DC ELECTRICAL CHARACTERISTICS (Over Operating Range)**

**V<sub>DD</sub> = 2.5V-3.6V**

| Symbol          | Parameter                        | Test Conditions   | Min. | Max.                  | Unit |
|-----------------|----------------------------------|---|------|-----------------------|------|
| V <sub>OH</sub> | Output HIGH Voltage              | V <sub>DD</sub> = Min., I <sub>OH</sub> = -1.0 mA           | 1.8  | —                     | V    |
| V <sub>OL</sub> | Output LOW Voltage               | V <sub>DD</sub> = Min., I <sub>OL</sub> = 1.0 mA            | —    | 0.4                   | V    |
| V <sub>IH</sub> | Input HIGH Voltage               |   | 2.0  | V <sub>DD</sub> + 0.3 | V    |
| V <sub>IL</sub> | Input LOW Voltage <sup>(1)</sup> |   | -0.3 | 0.4                   | V    |
| I <sub>LI</sub> | Input Leakage                    | GND ≤ V <sub>IN</sub> ≤ V <sub>DD</sub>                     | -1   | 1                     | μA   |
| I <sub>LO</sub> | Output Leakage                   | GND ≤ V <sub>OUT</sub> ≤ V <sub>DD</sub> , Outputs Disabled | -1   | 1                     | μA   |

**Note:**

1. V<sub>IL</sub> (min.) = -0.3V DC; V<sub>IL</sub> (min.) = -2.0V AC (pulse width - 2.0 ns). Not 100% tested.  
V<sub>IH</sub> (max.) = V<sub>DD</sub> + 0.3V DC; V<sub>IH</sub> (max.) = V<sub>DD</sub> + 2.0V AC (pulse width - 2.0 ns). Not 100% tested.

**DC ELECTRICAL CHARACTERISTICS (Over Operating Range)**

**V<sub>DD</sub> = 3.3V ± 10%**

| Symbol          | Parameter                        | Test Conditions   | Min. | Max.                  | Unit |
|-----------------|----------------------------------|---|------|-----------------------|------|
| V <sub>OH</sub> | Output HIGH Voltage              | V <sub>DD</sub> = Min., I <sub>OH</sub> = -4.0 mA           | 2.4  | —                     | V    |
| V <sub>OL</sub> | Output LOW Voltage               | V <sub>DD</sub> = Min., I <sub>OL</sub> = 8.0 mA            | —    | 0.4                   | V    |
| V <sub>IH</sub> | Input HIGH Voltage               |   | 2    | V <sub>DD</sub> + 0.3 | V    |
| V <sub>IL</sub> | Input LOW Voltage <sup>(1)</sup> |   | -0.3 | 0.8                   | V    |
| I <sub>LI</sub> | Input Leakage                    | GND ≤ V <sub>IN</sub> ≤ V <sub>DD</sub>                     | -1   | 1                     | μA   |
| I <sub>LO</sub> | Output Leakage                   | GND ≤ V <sub>OUT</sub> ≤ V <sub>DD</sub> , Outputs Disabled | -1   | 1                     | μA   |

**Note:**

1. V<sub>IL</sub> (min.) = -0.3V DC; V<sub>IL</sub> (min.) = -2.0V AC (pulse width - 2.0 ns). Not 100% tested.  
V<sub>IH</sub> (max.) = V<sub>DD</sub> + 0.3V DC; V<sub>IH</sub> (max.) = V<sub>DD</sub> + 2.0V AC (pulse width - 2.0 ns). Not 100% tested.

**POWER SUPPLY CHARACTERISTICS<sup>(1)</sup>** (Over Operating Range)

| Symbol           | Parameter                                | Test Conditions   |                     | -12ns |      | -15 ns |      | Unit    |
|------------------|--|---|---------------------|-------|------|--------|------|---------|
|                  |  |   |                     | Min.  | Max. | Min.   | Max. |         |
| I <sub>CC</sub>  | V <sub>DD</sub> Operating Supply Current | V <sub>DD</sub> = Max., $\overline{CE} = V_{IL}$<br>I <sub>OUT</sub> = 0 mA, f = Max.   | Com.                | —     | 35   | —      | 30   | mA      |
|                  |  |   | Ind.                | —     | 40   | —      | 35   |         |
|                  |  |   | Auto                | —     | —    | —      | 40   |         |
|                  |  |   | typ. <sup>(2)</sup> | —     | 25   | —      | 20   |         |
| I <sub>SB1</sub> | TTL Standby Current (TTL Inputs)         | V <sub>DD</sub> = Max.,<br>V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub><br>$\overline{CE} \geq V_{IH}$ , f = max                            | Com.                | —     | 20   | —      | 20   | mA      |
|                  |  |   | Ind.                | —     | 20   | —      | 20   |         |
|                  |  |   | Auto                | —     | —    | —      | 30   |         |
| I <sub>SB2</sub> | CMOS Standby Current (CMOS Inputs)       | V <sub>DD</sub> = Max.,<br>$\overline{CE} \geq V_{DD} - 0.2V$ ,<br>V <sub>IN</sub> $\geq V_{DD} - 0.2V$ , or<br>V <sub>IN</sub> $\leq 0.2V$ , f = 0 | Com.                | —     | 750  | —      | 750  | $\mu A$ |
|                  |  |   | Ind.                | —     | 900  | —      | 900  | $\mu A$ |
|                  |  |   | Auto                | —     | —    | —      | 6    | mA      |
|                  |  |   | typ. <sup>(2)</sup> | —     | 400  | —      | 400  | $\mu A$ |

**Note:**

- At f = f<sub>MAX</sub>, address and data inputs are cycling at the maximum frequency, f = 0 means no input lines change.
- Typical values are measured at V<sub>DD</sub>=3.3V, T<sub>A</sub>=25°C. Not 100% tested.

**CAPACITANCE<sup>(1)</sup>**

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

**Note:**

- Tested initially and after any design or process changes that may affect these parameters.

AC TEST CONDITIONS

| Parameter   | Unit<br>(2.5V-3.6V)           | Unit<br>(3.3V ± 10%)          |
|---|-------------------------------|-------------------------------|
| Input Pulse Level   | 0.4V to V <sub>DD</sub> -0.3V | 0.4V to V <sub>DD</sub> -0.3V |
| Input Rise and Fall Times                                       | 1.5ns                         | 1.5ns                         |
| Input and Output Timing and Reference Level (V <sub>Ref</sub> ) | V <sub>DD</sub> /2            | V <sub>DD</sub> /2 + 0.05     |
| Output Load   | See Figures 1 and 2           | See Figures 1 and 2           |

AC TEST LOADS

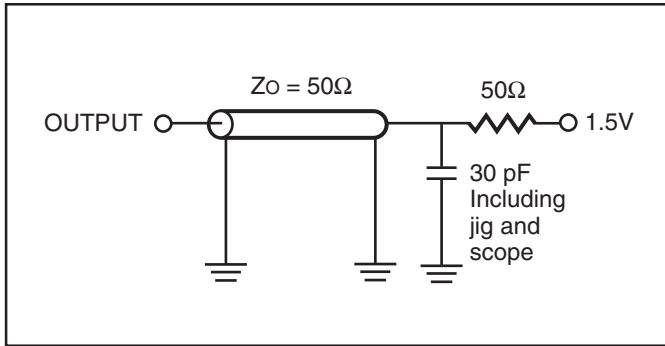


Figure 1.

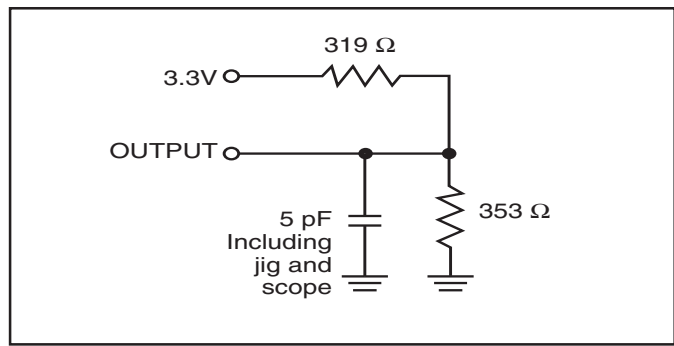


Figure 2.

READ CYCLE SWITCHING CHARACTERISTICS<sup>(1)</sup> (Over Operating Range)

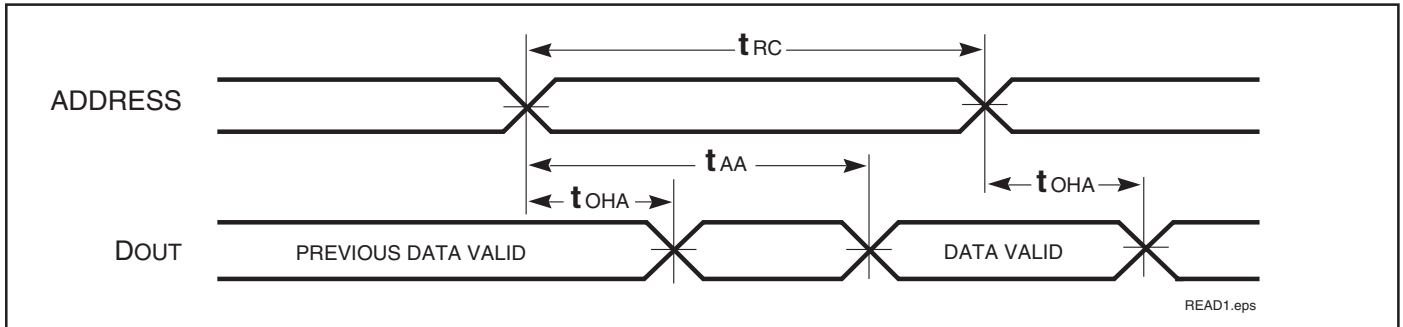
| Symbol                           | Parameter  | -12 ns |      | -15 ns |      | Unit |
|----------------------------------|--|--------|------|--------|------|------|
|                                  |  | Min.   | Max. | Min.   | Max. |      |
| t <sub>RC</sub>                  | Read Cycle Time                                    | 12     | —    | 15     | —    | ns   |
| t <sub>AA</sub>                  | Address Access Time                                | —      | 12   | —      | 15   | ns   |
| t <sub>OHA</sub>                 | Output Hold Time                                   | 3      | —    | 3      | —    | ns   |
| t <sub>ACE</sub>                 | $\overline{CE}$ Access Time                        | —      | 12   | —      | 15   | ns   |
| t <sub>DOE</sub>                 | $\overline{OE}$ Access Time                        | —      | 5    | —      | 7    | ns   |
| t <sub>HZOE</sub> <sup>(2)</sup> | $\overline{OE}$ to High-Z Output                   | —      | 5    | —      | 6    | ns   |
| t <sub>LZOE</sub> <sup>(2)</sup> | $\overline{OE}$ to Low-Z Output                    | 0      | —    | 0      | —    | ns   |
| t <sub>HZCE</sub> <sup>(2)</sup> | $\overline{CE}$ to High-Z Output                   | 0      | 5    | 0      | 6    | ns   |
| t <sub>LZCE</sub> <sup>(2)</sup> | $\overline{CE}$ to Low-Z Output                    | 3      | —    | 3      | —    | ns   |
| t <sub>BA</sub>                  | $\overline{LB}$ , $\overline{UB}$ Access Time      | —      | 5    | —      | 7    | ns   |
| t <sub>HZB</sub> <sup>(2)</sup>  | $\overline{LB}$ , $\overline{UB}$ to High-Z Output | 0      | 5    | 0      | 6    | ns   |
| t <sub>LZB</sub> <sup>(2)</sup>  | $\overline{LB}$ , $\overline{UB}$ to Low-Z Output  | 0      | —    | 0      | —    | ns   |

Notes:

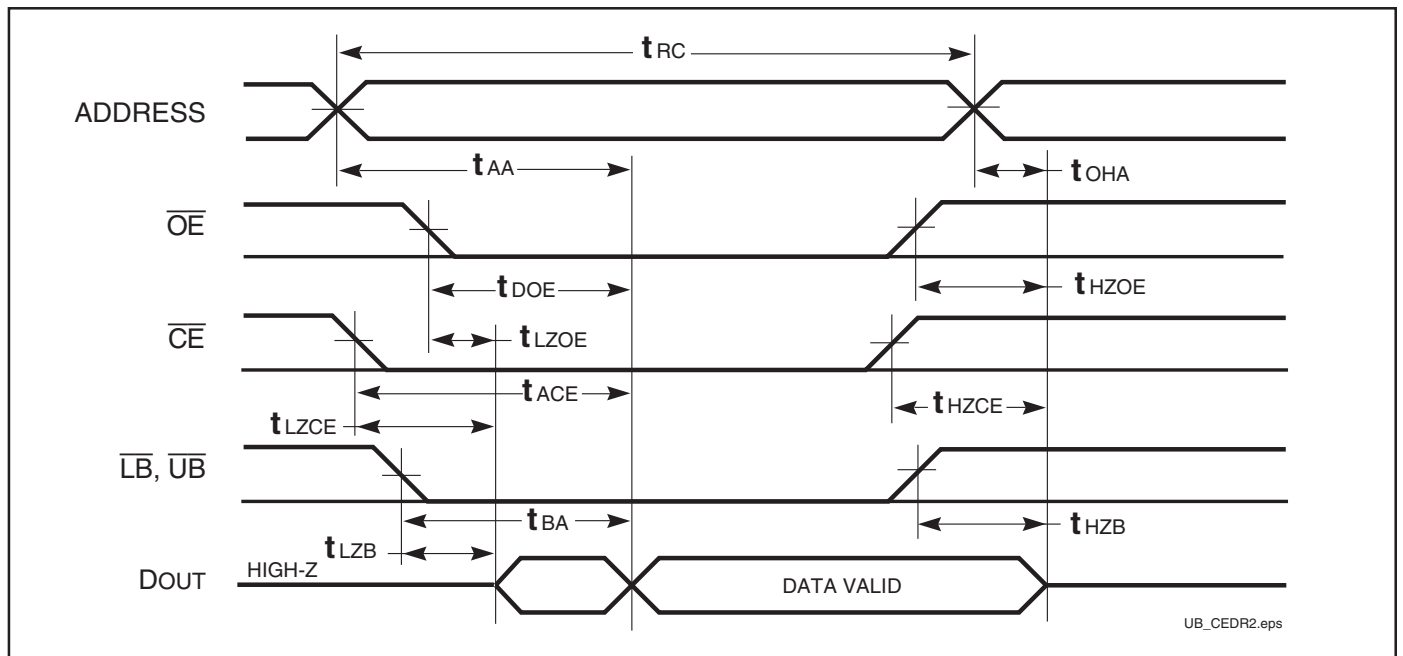
1. Test conditions assume signal transition times of 3 ns or less, timing reference levels of 1.5V, input pulse levels of 0V to 3.0V and output loading specified in Figure 1.
2. Tested with the load in Figure 2. Transition is measured ±500 mV from steady-state voltage. Not 100% tested.

AC WAVEFORMS

READ CYCLE NO. 1<sup>(1,2)</sup> (Address Controlled) ( $\overline{CE} = \overline{OE} = V_{IL}$ ,  $\overline{UB}$  or  $\overline{LB} = V_{IL}$ )



READ CYCLE NO. 2<sup>(1,3)</sup>



Notes:

1.  $\overline{WE}$  is HIGH for a Read Cycle.
2. The device is continuously selected.  $\overline{OE}$ ,  $\overline{CE}$ ,  $\overline{UB}$ , or  $\overline{LB} = V_{IL}$ .
3. Address is valid prior to or coincident with  $\overline{CE}$  LOW transition.

**WRITE CYCLE SWITCHING CHARACTERISTICS<sup>(1,3)</sup>** (Over Operating Range)

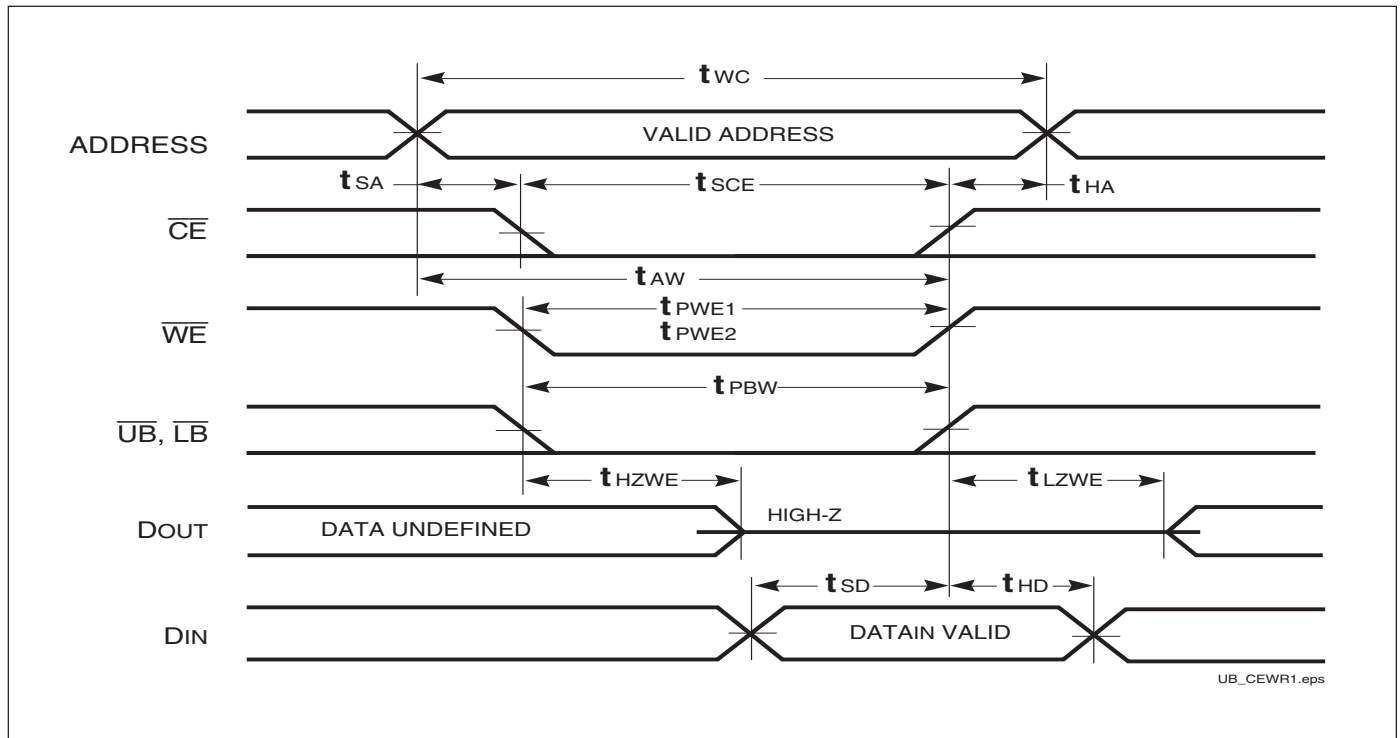
| Symbol                          | Parameter   | -12 ns |      | -15 ns |      | Unit |
|---------------------------------|---|--------|------|--------|------|------|
|                                 |   | Min.   | Max. | Min.   | Max. |      |
| t <sub>WC</sub>                 | Write Cycle Time  | 12     | —    | 15     | —    | ns   |
| t <sub>SCE</sub>                | $\overline{CE}$ to Write End                            | 8      | —    | 10     | —    | ns   |
| t <sub>AW</sub>                 | Address Setup Time to Write End                         | 8      | —    | 10     | —    | ns   |
| t <sub>HA</sub>                 | Address Hold from Write End                             | 0      | —    | 0      | —    | ns   |
| t <sub>SA</sub>                 | Address Setup Time                                      | 0      | —    | 0      | —    | ns   |
| t <sub>PBW</sub>                | $\overline{LB}$ , $\overline{UB}$ Valid to End of Write | 9      | —    | 10     | —    | ns   |
| t <sub>PWE1</sub>               | $\overline{WE}$ Pulse Width ( $\overline{OE}$ = HIGH)   | 8      | —    | 10     | —    | ns   |
| t <sub>PWE2</sub>               | $\overline{WE}$ Pulse Width ( $\overline{OE}$ = LOW)    | 10     | —    | 12     | —    | ns   |
| t <sub>SD</sub>                 | Data Setup to Write End                                 | 6      | —    | 7      | —    | ns   |
| t <sub>HD</sub>                 | Data Hold from Write End                                | 0      | —    | 0      | —    | ns   |
| t <sub>HZWE<sup>(3)</sup></sub> | $\overline{WE}$ LOW to High-Z Output                    | —      | 5    | —      | 7    | ns   |
| t <sub>LZWE<sup>(3)</sup></sub> | $\overline{WE}$ HIGH to Low-Z Output                    | 0      | —    | 0      | —    | ns   |

**Notes:**

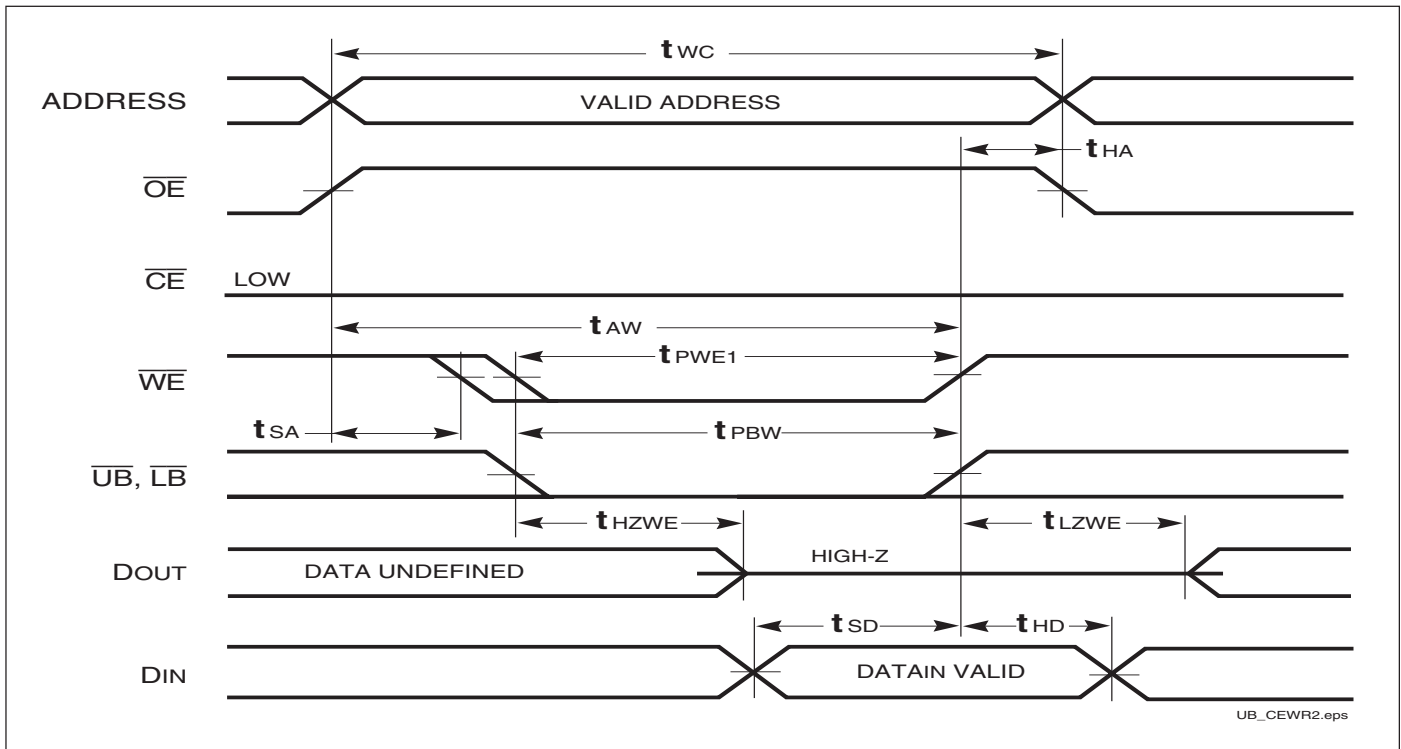
1. Test conditions assume signal transition times of 3 ns or less, timing reference levels of 1.5V, input pulse levels of 0V to 3.0V and output loading specified in Figure 1.
2. The internal write time is defined by the overlap of  $\overline{CE}$  LOW and  $\overline{UB}$  or  $\overline{LB}$ , and  $\overline{WE}$  LOW. All signals must be in valid states to initiate a Write, but any one can go inactive to terminate the Write. The Data Input Setup and Hold timing are referenced to the rising or falling edge of the signal that terminates the write.
3. Tested with the load in Figure 2. Transition is measured  $\pm 500$  mV from steady-state voltage. Not 100% tested.



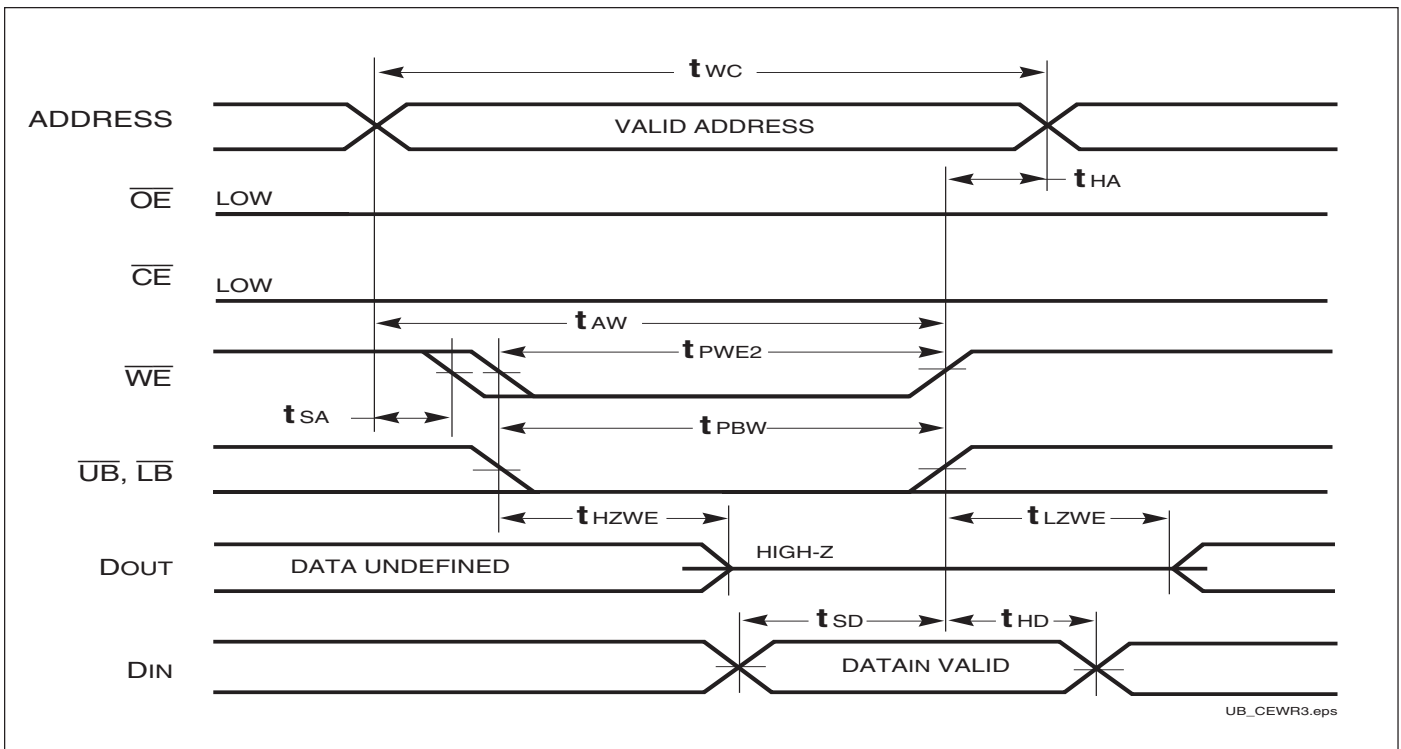
WRITE CYCLE NO. 1<sup>(1,2)</sup> ( $\overline{CE}$  Controlled,  $\overline{OE}$  = HIGH or LOW)



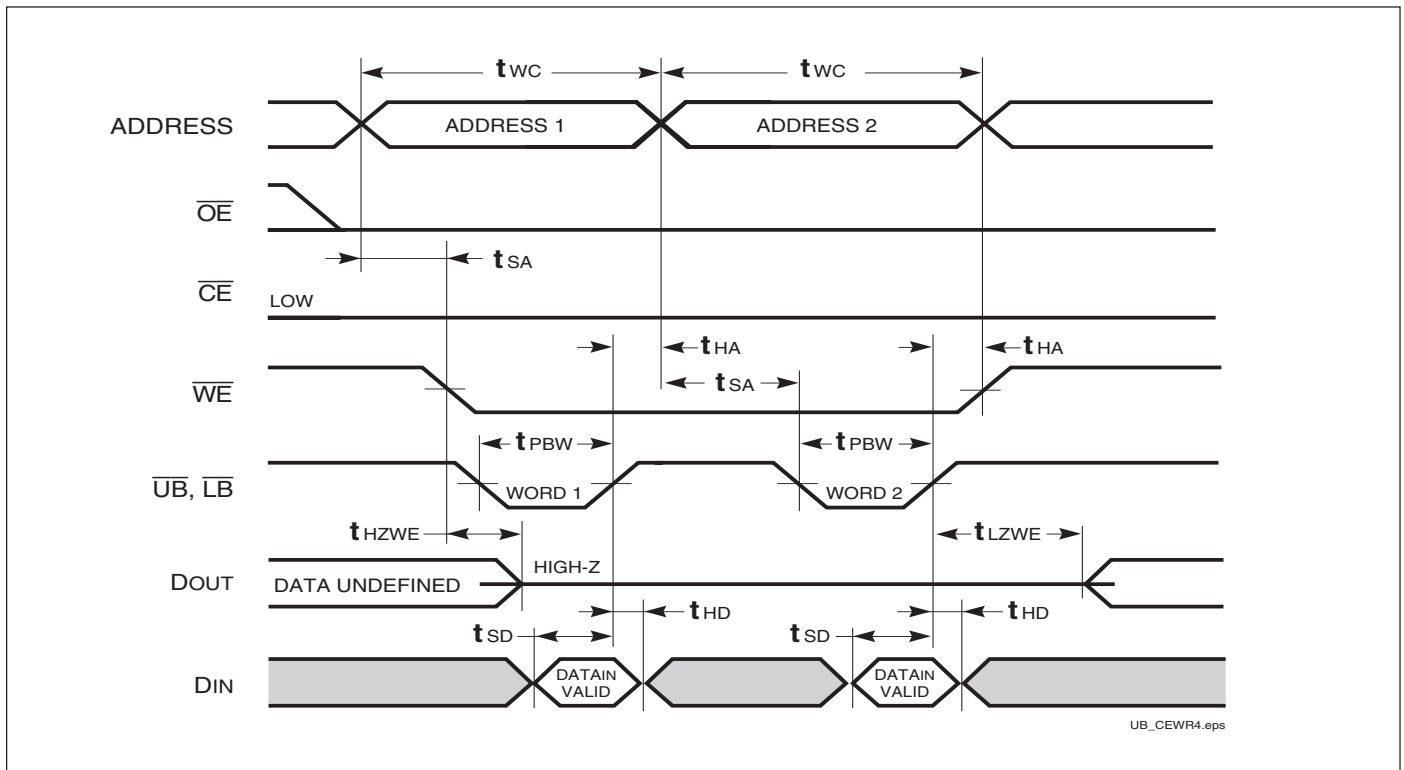
**WRITE CYCLE NO. 2**<sup>(1)</sup> ( $\overline{WE}$  Controlled,  $\overline{OE}$  = HIGH during Write Cycle)



**WRITE CYCLE NO. 3** ( $\overline{WE}$  Controlled:  $\overline{OE}$  is LOW During Write Cycle)



WRITE CYCLE NO. 4 ( $\overline{\text{LB}}$ ,  $\overline{\text{UB}}$  Controlled, Back-to-Back Write) (1,3)



Notes:

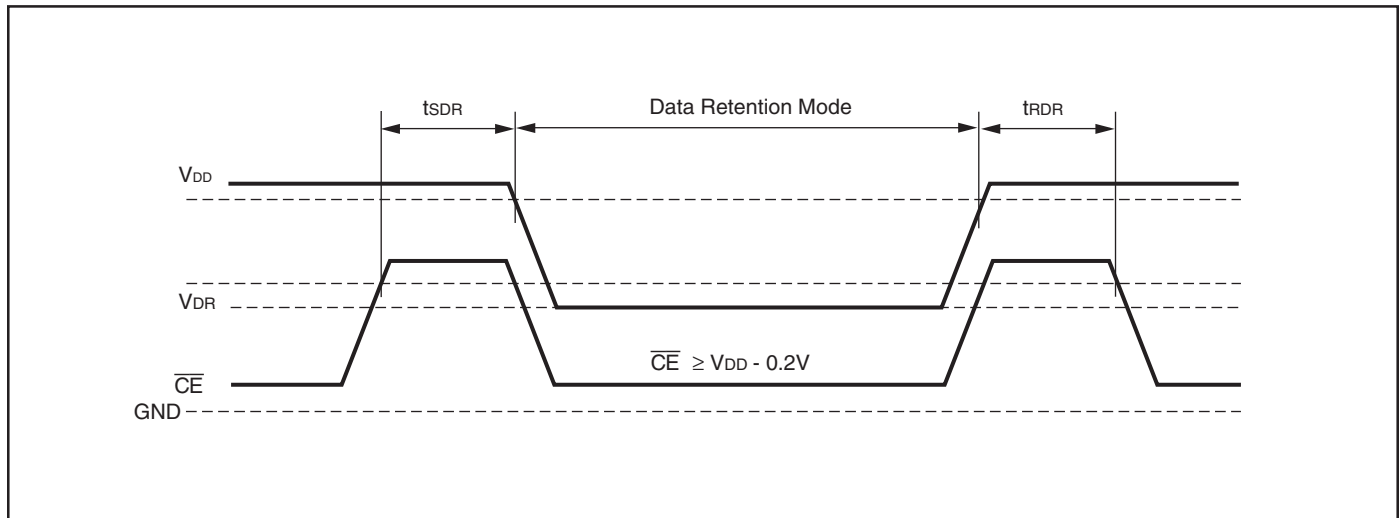
1. The internal Write time is defined by the overlap of  $\overline{\text{CE}} = \text{LOW}$ ,  $\overline{\text{UB}}$  and/or  $\overline{\text{LB}} = \text{LOW}$ , and  $\overline{\text{WE}} = \text{LOW}$ . All signals must be in valid states to initiate a Write, but any can be deasserted to terminate the Write. The  $t_{SA}$ ,  $t_{HA}$ ,  $t_{SD}$ , and  $t_{HD}$  timing is referenced to the rising or falling edge of the signal that terminates the Write.
2. Tested with OE HIGH for a minimum of 4 ns before  $\overline{\text{WE}} = \text{LOW}$  to place the I/O in a HIGH-Z state.
3. WE may be held LOW across many address cycles and the  $\overline{\text{LB}}$ ,  $\overline{\text{UB}}$  pins can be used to control the Write function.

**DATA RETENTION SWITCHING CHARACTERISTICS**

| Symbol           | Parameter                          | Test Condition   | Options      | Min.            | Typ. <sup>(1)</sup> | Max.     | Unit     |
|------------------|------------------------------------|--|--------------|-----------------|---------------------|----------|----------|
| V <sub>DR</sub>  | V <sub>DD</sub> for Data Retention | See Data Retention Waveform                                |              | 1.8             | —                   | 3.6      | V        |
| I <sub>DR</sub>  | Data Retention Current             | V <sub>DD</sub> = 2.0V, $\overline{CE} \geq V_{DD} - 0.2V$ | Ind.<br>Auto | —<br>—          | 0.4<br>0.4          | 0.9<br>6 | mA<br>mA |
| t <sub>SDR</sub> | Data Retention Setup Time          | See Data Retention Waveform                                |              | 0               | —                   | —        | ns       |
| t <sub>RDR</sub> | Recovery Time                      | See Data Retention Waveform                                |              | t <sub>RC</sub> | —                   | —        | ns       |

**Note 1:** Typical values are measured at V<sub>DD</sub> = 3.3V, T<sub>A</sub> = 25°C. Not 100% tested.

**DATA RETENTION WAVEFORM ( $\overline{CE}$  Controlled)**



**ORDERING INFORMATION:**

**Industrial Range: -40°C to +85°C**

| Speed (ns) | Order Part No.       | Package                           |
|------------|----------------------|-----------------------------------|
| 12 (15')   | IS61WV12816BLL-12BI  | mini BGA (6mm x 8mm)              |
|            | IS61WV12816BLL-12BLI | mini BGA (6mm x 8mm), Lead-free   |
|            | IS61WV12816BLL-12TI  | Plastic TSOP (Type II)            |
|            | IS61WV12816BLL-12TLI | Plastic TSOP (Type II), Lead-free |

**Note:**

1. Speed = 12ns for  $V_{DD} = 3.3V \pm 10\%$ . Speed = 15ns for  $V_{DD} = 2.5V-3.6V$

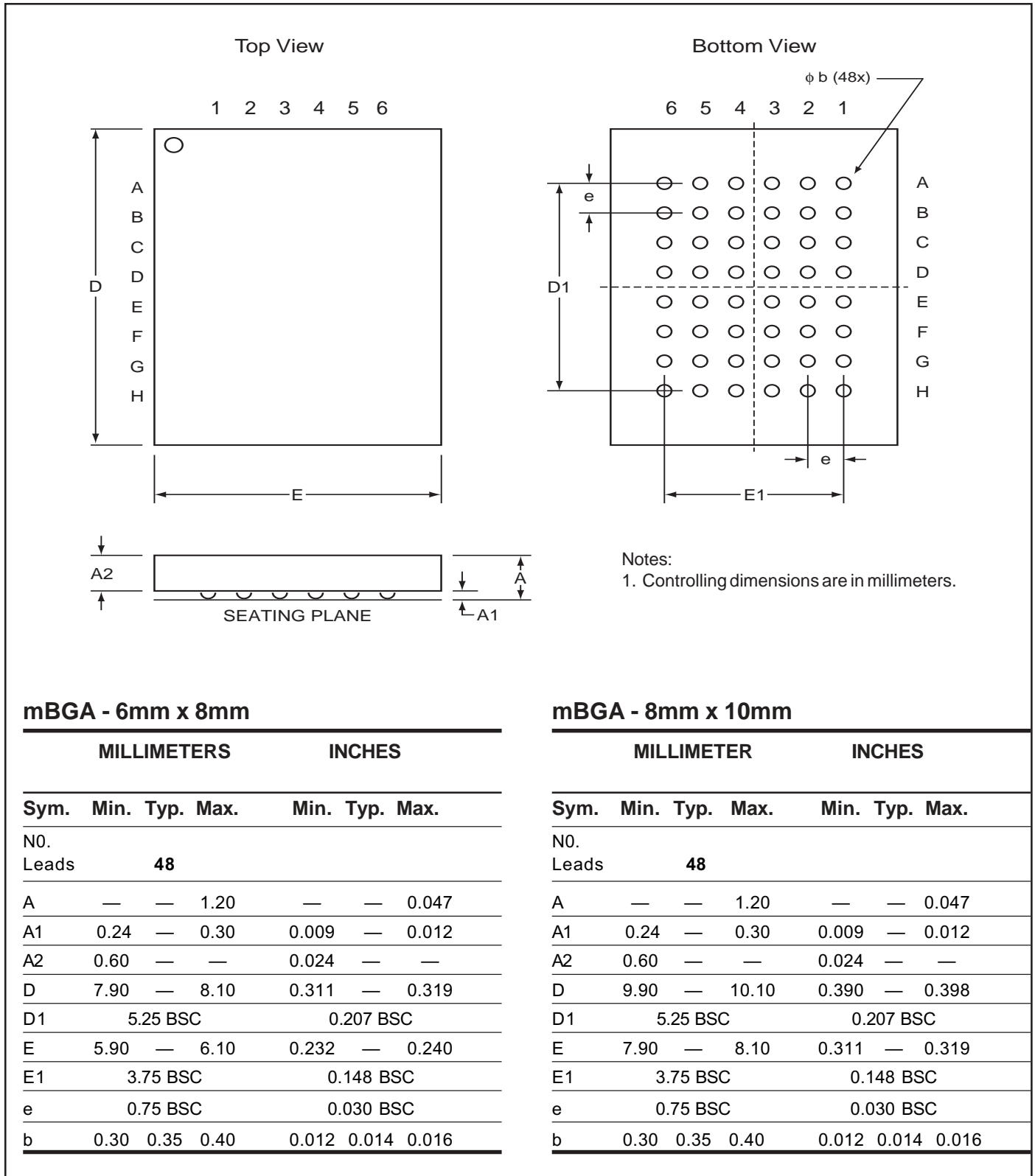
**Automotive Range: -40°C to +125°C**

| Speed (ns) | Order Part No.        | Package                           |
|------------|-----------------------|-----------------------------------|
| 15         | IS64WV12816BLL-15BA3  | mini BGA (6mm x 8mm)              |
|            | IS64WV12816BLL-15TA3  | Plastic TSOP (Type II)            |
|            | IS64WV12816BLL-15TLA3 | Plastic TSOP (Type II), Lead-free |

# PACKAGING INFORMATION



## Mini Ball Grid Array Package Code: B (48-pin)



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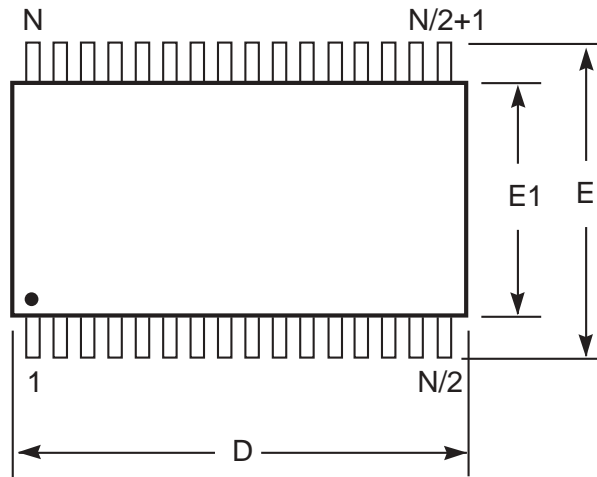
Integrated Silicon Solution, Inc. — [www.issi.com](http://www.issi.com) — 1-800-379-4774

Rev. D  
01/15/03

# PACKAGING INFORMATION

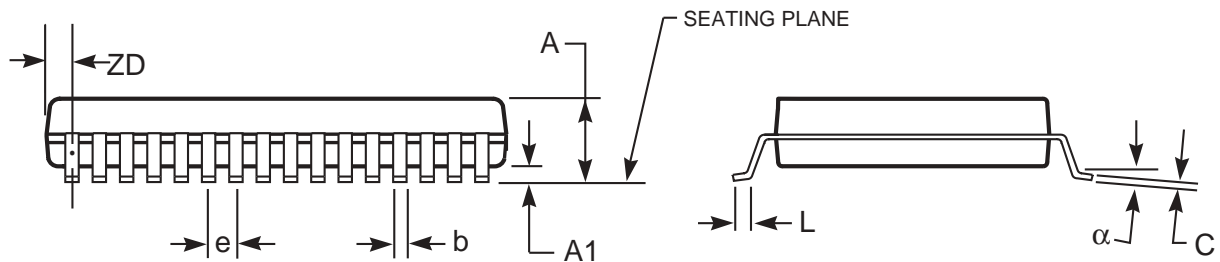


## Plastic TSOP Package Code: T (Type II)



### Notes:

1. Controlling dimension: millimeters, unless otherwise specified.
2. BSC = Basic lead spacing between centers.
3. Dimensions D and E1 do not include mold flash protrusions and should be measured from the bottom of the package.
4. Formed leads shall be planar with respect to one another within 0.004 inches at the seating plane.



Plastic TSOP (T - Type II)

| Symbol        | Millimeters |       | Inches    |       | Millimeters |       | Inches    |       | Millimeters |       | Inches    |       |
|---------------|-------------|-------|-----------|-------|-------------|-------|-----------|-------|-------------|-------|-----------|-------|
|               | Min         | Max   | Min       | Max   | Min         | Max   | Min       | Max   | Min         | Max   | Min       | Max   |
| Ref. Std.     |             |       |           |       |             |       |           |       |             |       |           |       |
| No. Leads (N) | 32          |       |           |       | 44          |       |           |       | 50          |       |           |       |
| A             | —           | 1.20  | —         | 0.047 | —           | 1.20  | —         | 0.047 | —           | 1.20  | —         | 0.047 |
| A1            | 0.05        | 0.15  | 0.002     | 0.006 | 0.05        | 0.15  | 0.002     | 0.006 | 0.05        | 0.15  | 0.002     | 0.006 |
| b             | 0.30        | 0.52  | 0.012     | 0.020 | 0.30        | 0.45  | 0.012     | 0.018 | 0.30        | 0.45  | 0.012     | 0.018 |
| C             | 0.12        | 0.21  | 0.005     | 0.008 | 0.12        | 0.21  | 0.005     | 0.008 | 0.12        | 0.21  | 0.005     | 0.008 |
| D             | 20.82       | 21.08 | 0.820     | 0.830 | 18.31       | 18.52 | 0.721     | 0.729 | 20.82       | 21.08 | 0.820     | 0.830 |
| E1            | 10.03       | 10.29 | 0.391     | 0.400 | 10.03       | 10.29 | 0.395     | 0.405 | 10.03       | 10.29 | 0.395     | 0.405 |
| E             | 11.56       | 11.96 | 0.451     | 0.466 | 11.56       | 11.96 | 0.455     | 0.471 | 11.56       | 11.96 | 0.455     | 0.471 |
| e             | 1.27 BSC    |       | 0.050 BSC |       | 0.80 BSC    |       | 0.032 BSC |       | 0.80 BSC    |       | 0.031 BSC |       |
| L             | 0.40        | 0.60  | 0.016     | 0.024 | 0.41        | 0.60  | 0.016     | 0.024 | 0.40        | 0.60  | 0.016     | 0.024 |
| ZD            | 0.95 REF    |       | 0.037 REF |       | 0.81 REF    |       | 0.032 REF |       | 0.88 REF    |       | 0.035 REF |       |
| α             | 0°          | 5°    | 0°        | 5°    | 0°          | 5°    | 0°        | 5°    | 0°          | 5°    | 0°        | 5°    |

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