

IS65WV12816ALL IS65WV12816BLL



128K x 16 LOW VOLTAGE, ULTRA LOW POWER CMOS STATIC RAM

NOVEMBER 2007

FEATURES

- High-speed access time: 55ns, 70ns
- CMOS low power operation:
 - 36 mW (typical) operating
 - 9 μ W (typical) CMOS standby
- TTL compatible interface levels
- Single power supply:
 - 1.65V to 2.2V V_{DD} (65WV12816ALL)
 - 2.5V to 3.6V V_{DD} (65WV12816BLL)
- Fully static operation: no clock or refresh required
- Three state outputs
- Data control for upper and lower bytes
- 2CS Option Available
- Temperature Offerings:
 - Option A: 0 to 70°C
 - Option A1: -40 to +85°C
 - Option A2: -40 to +105°C
 - Option A3: -40 to +125°C
- Lead-free available

DESCRIPTION

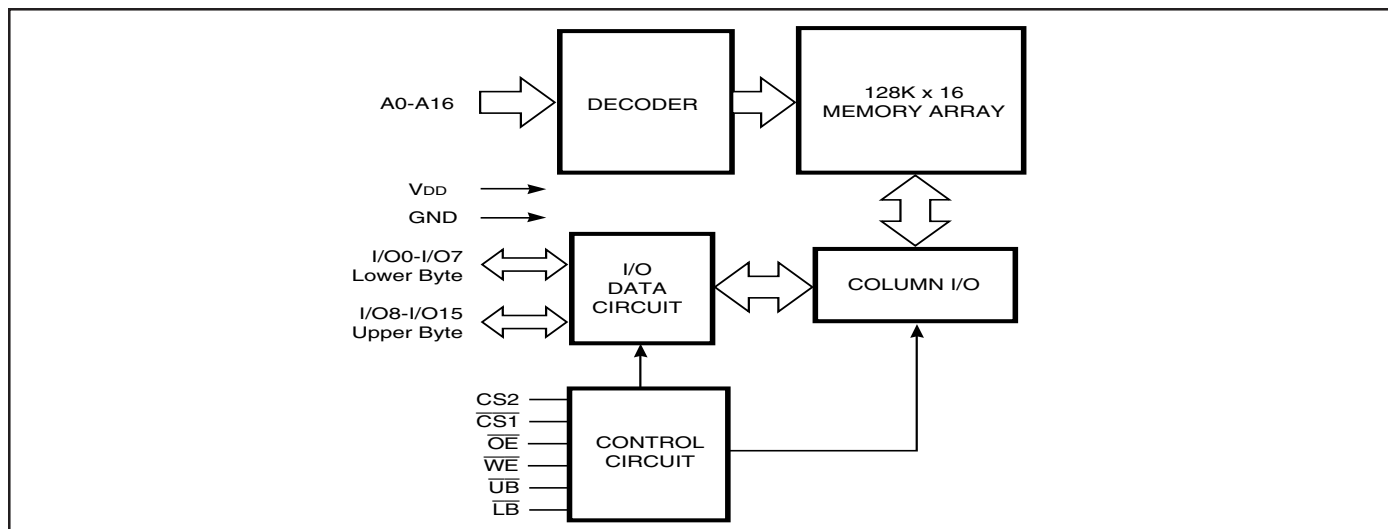
The *ISSI* IS65WV12816ALL/IS65WV12816BLL are high-speed, 2M bit static RAMs organized as 128K words by 16 bits. It is fabricated using *ISSI*'s high-performance CMOS technology. This highly reliable process coupled with innovative circuit design techniques, yields high-performance and low power consumption devices.

When $\overline{CS1}$ is HIGH (deselected) or when CS2 is LOW (deselected) or when $\overline{CS1}$ is LOW, CS2 is HIGH and both \overline{LB} and \overline{UB} are HIGH, 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. 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 IS65WV12816ALL and IS65WV12816BLL are packaged in the JEDEC standard 48-pin mini BGA (6mm x 8mm) and 44-Pin TSOP (TYPE II).

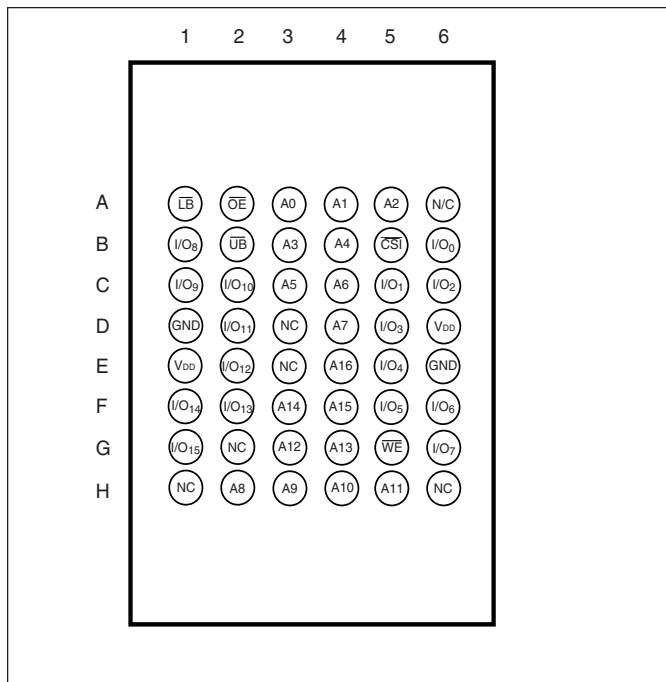
FUNCTIONAL BLOCK DIAGRAM



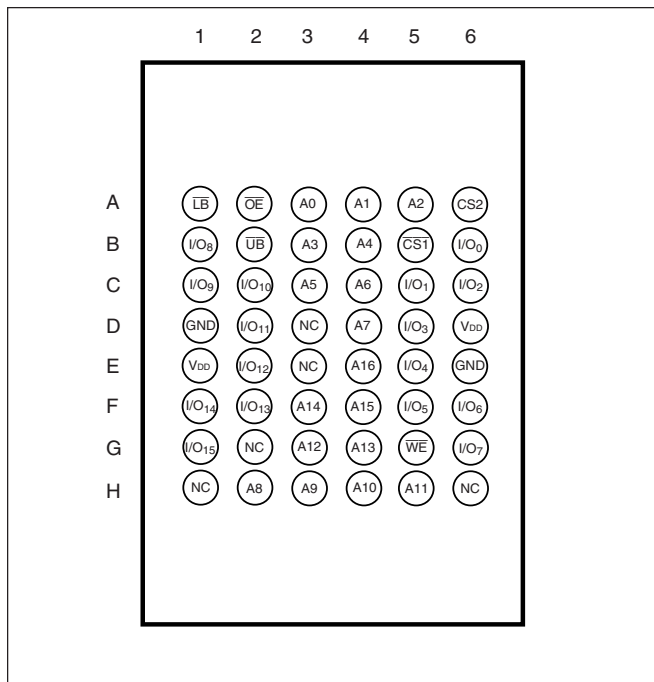
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PIN CONFIGURATIONS

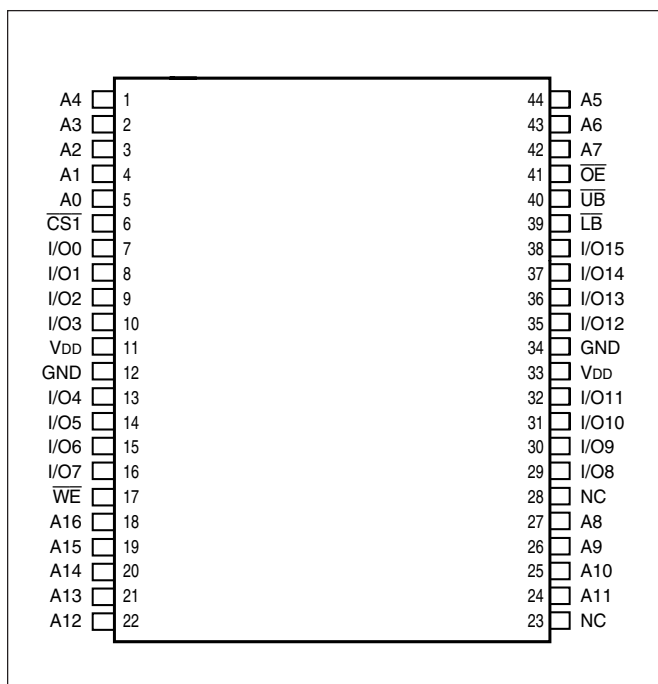
**48-Pin mini BGA (6mm x 8mm)
(Package Code B)**



**48-Pin mini BGA (6mm x 8mm)
2 CS Option (Package Code B2)**



**44-Pin mini TSOP (Type II)
(Package Code T)**



PIN DESCRIPTIONS

| | |
|------------|---------------------------------|
| A0-A16 | Address Inputs |
| I/O0-I/O15 | Data Inputs/Outputs |
| CS1, CS2 | Chip Enable Input |
| OE | Output Enable Input |
| WE | Write Enable Input |
| LB | Lower-byte Control (I/O0-I/O7) |
| UB | Upper-byte Control (I/O8-I/O15) |
| NC | No Connection |
| VDD | Power |
| GND | Ground |

TRUTH TABLE

| Mode | \overline{WE} | $\overline{CS1}$ | CS2 | \overline{OE} | \overline{LB} | \overline{UB} | I/O PIN | | V _{DD} Current |
|-----------------|-----------------|------------------|-----|-----------------|-----------------|-----------------|------------------|------------------|-------------------------------------|
| | | | | | | | I/O0-I/O7 | I/O8-I/O15 | |
| Not Selected | X | H | X | X | X | X | High-Z | High-Z | I _{SB1} , I _{SB2} |
| | X | X | L | X | X | X | High-Z | High-Z | I _{SB1} , I _{SB2} |
| | X | X | X | X | H | H | High-Z | High-Z | I _{SB1} , I _{SB2} |
| Output Disabled | H | L | H | H | L | X | High-Z | High-Z | I _{CC} |
| | H | L | H | H | X | L | High-Z | High-Z | I _{CC} |
| Read | H | L | H | L | L | H | D _{OUT} | High-Z | I _{CC} |
| | H | L | H | L | H | L | High-Z | D _{OUT} | |
| | H | L | H | L | L | L | D _{OUT} | D _{OUT} | |
| Write | L | L | H | X | L | H | D _{IN} | High-Z | I _{CC} |
| | L | L | H | X | H | L | High-Z | D _{IN} | |
| | L | L | H | X | L | L | D _{IN} | D _{IN} | |

ABSOLUTE MAXIMUM RATINGS⁽¹⁾

| Symbol | Parameter | Value | Unit |
|-------------------|--------------------------------------|------------------------------|------|
| V _{TERM} | Terminal Voltage with Respect to GND | -0.2 to V _{DD} +0.3 | V |
| T _{STG} | Storage Temperature | -65 to +150 | °C |
| P _T | 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_{DD})

| Option | Ambient Temperature | IS65WV12816ALL | IS65WV12816BLL |
|--------|---------------------|----------------|----------------|
| A | 0°C to +70°C | 1.65V - 2.2V | 2.5V - 3.6V |
| A1 | -40°C to +85°C | 1.65V - 2.2V | 2.5V - 3.6V |
| A2 | -40°C to +105°C | 1.65V - 2.2V | 2.5V - 3.6V |
| A3 | -40°C to +125°C | 1.65V - 2.2V | 2.5V - 3.6V |

DC ELECTRICAL CHARACTERISTICS (Over Operating Range)

| Symbol | Parameter | Test Conditions | Vdd | Min. | Max. | Unit |
|--------------------------------|---------------------|---|-----------|------|-----------------------|------|
| V _{OH} | Output HIGH Voltage | I _{OH} = -0.1 mA I _{OH} = -1 mA | 1.65-2.2V | 1.4 | — | V |
| | | | 2.5-3.6V | 2.2 | — | V |
| V _{OL} | Output LOW Voltage | I _{OL} = 0.1 mA I _{OL} = 2.1 mA | 1.65-2.2V | — | 0.2 | V |
| | | | 2.5-3.6V | — | 0.4 | V |
| V _{IH} | Input HIGH Voltage | | 1.65-2.2V | 1.4 | V _{DD} + 0.2 | V |
| | | | 2.5-3.6V | 2.2 | V _{DD} + 0.3 | V |
| V _{IL} ⁽¹⁾ | Input LOW Voltage | | 1.65-2.2V | -0.2 | 0.4 | V |
| | | | 2.5-3.6V | -0.2 | 0.6 | V |
| I _{LI} | Input Leakage | GND ≤ V _{IN} ≤ V _{DD} | | -1 | 1 | μA |
| I _{LO} | Output Leakage | GND ≤ V _{OUT} ≤ V _{DD} , Outputs Disabled | | -1 | 1 | μA |

Notes:

- V_{IL} (min.) = -1.0V for pulse width less than 10 ns.

CAPACITANCE⁽¹⁾

| Symbol | Parameter | Conditions | Max. | Unit |
|------------------|--------------------------|-----------------------|------|------|
| C _{IN} | Input Capacitance | V _{IN} = 0V | 8 | pF |
| C _{OUT} | Input/Output Capacitance | V _{OUT} = 0V | 10 | pF |

Note:

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

IS65WV12816ALL, POWER SUPPLY CHARACTERISTICS⁽¹⁾ (Over Operating Range)

| Symbol | Parameter | Test Conditions | Options | Max. -70 ns | Unit |
|--------|--------------------------------------|--|-------------------|----------------|------|
| loc | Vdd Dynamic Operating Supply Current | VDD=Max., IOUT=0 mA, f=fMAX | A, A1 A2, A3 | 15 20 | mA |
| loc1 | Operating Supply Current | VDD=Max., IOUT=0 mA, f=0 | A, A1 A2, A3 | 7 7 | mA |
| ISB1 | TTL Standby Current (TTL Inputs) | VDD=Max., VIN=VIH or VIL $\overline{CS1}$ =VIH, CS2=VIL, f=1 MHz OR | A, A1 A2, A3 | 0.6 0.6 | mA |
| | ULB Control | VDD=Max., VIN=VIH or VIL $\overline{CS1}$ =VIL, f=0, \overline{UB} =VIH, \overline{LB} =VIH | | | |
| ISB2 | CMOS Standby Current (CMOS Inputs) | VDD=Max., $\overline{CS1}$ ≥VDD-0.2V, CS2≤0.2V, VIN≥VDD-0.2V, or VIN≤0.2V, f=0 OR | A, A1 A2 A3 | 15 20 50 | μA |
| | ULB Control | VDD=Max., $\overline{CS1}$ =VIL, CS2=VIH VIN≤0.2V, f=0; $\overline{UB}/\overline{LB}$ =VDD-0.2V | | | |

IS65WV12816BLL, POWER SUPPLY CHARACTERISTICS⁽¹⁾ (Over Operating Range)

| Symbol | Parameter | Test Conditions | Options | Max. -55 ns | Max. -70 ns | Unit |
|--------|--------------------------------------|--|-------------------|----------------|----------------|------|
| loc | Vdd Dynamic Operating Supply Current | VDD=Max., IOUT=0 mA, f=fMAX | A, A1 A2, A3 | 25 30 | 20 25 | mA |
| loc1 | Operating Supply Current | VDD=Max., IOUT=0 mA, f=0 | A, A1 A2, A3 | 7 7 | 7 7 | mA |
| ISB1 | TTL Standby Current (TTL Inputs) | VDD=Max., VIN=VIH or VIL $\overline{CS1}$ =VIH, CS2=VIL, f=1 MHz OR | A, A1 A2, A3 | 0.6 0.6 | 0.6 0.6 | mA |
| | ULB Control | VDD=Max., VIN=VIH or VIL $\overline{CS1}$ =VIL, f=0, \overline{UB} =VIH, \overline{LB} =VIH | | | | |
| ISB2 | CMOS Standby Current (CMOS Inputs) | VDD=Max., $\overline{CS1}$ ≥VDD-0.2V, CS2≤0.2V, VIN≥VDD-0.2V, or VIN≤0.2V, f=0 OR | A, A1 A2 A3 | 15 25 65 | 15 25 65 | μA |
| | ULB Control | VDD=Max., $\overline{CS1}$ =VIL, CS2=VIH VIN≤0.2V, f=0; $\overline{UB}/\overline{LB}$ =VDD-0.2V | | | | |

Note:

1. At f = fMAX, address and data inputs are cycling at the maximum frequency, f = 0 means no input lines change.

AC TEST CONDITIONS

| Parameter | 65WV12816ALL (Unit) | 65WV12816BLL (Unit) |
|---|------------------------|------------------------|
| Input Pulse Level | 0.4V to $V_{DD}-0.2V$ | 0.4V to $V_{DD}-0.3V$ |
| Input Rise and Fall Times | 5 ns | 5ns |
| Input and Output Timing and Reference Level | V_{REF} | V_{REF} |
| Output Load | See Figures 1 and 2 | See Figures 1 and 2 |

| | 65WV12816ALL (1.65V-2.2V) | 65WV12816BLL (2.5V - 3.6V) |
|--------------------------------|------------------------------|-------------------------------|
| R1(Ω) | 3070 | 3070 |
| R2(Ω) | 3150 | 3150 |
| V_{REF} | 0.9V | 1.5V |
| V_{TM} | 1.8V | 2.8V |

AC TEST LOADS

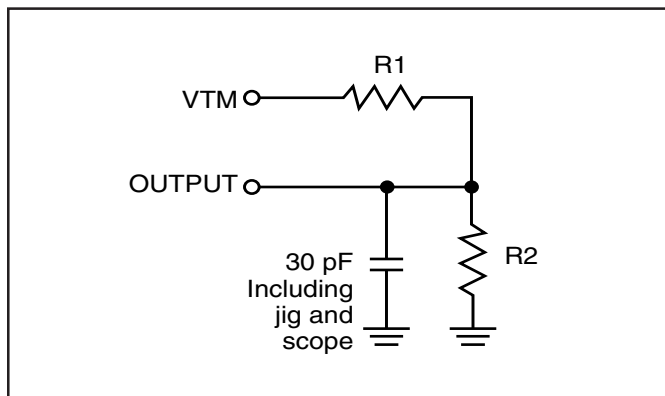


Figure 1

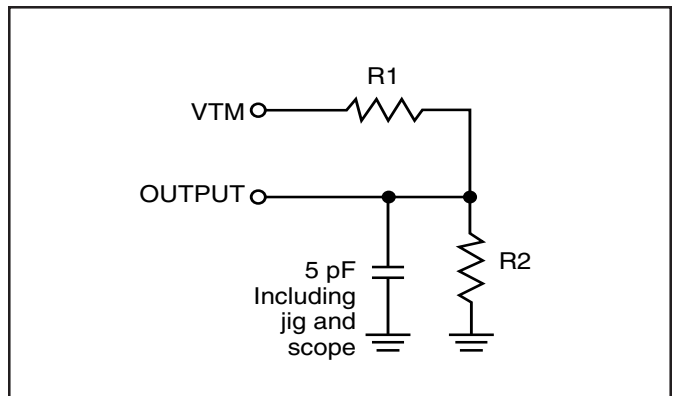


Figure 2

READ CYCLE SWITCHING CHARACTERISTICS⁽¹⁾ (Over Operating Range)

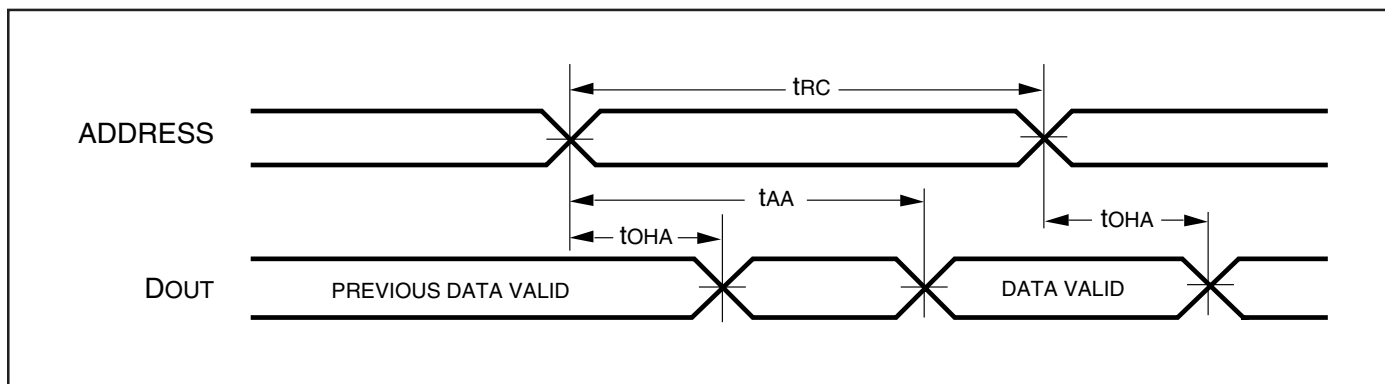
| Symbol | Parameter | -55 ns | | -70 ns | | Unit |
|---|--|--------|------|--------|------|------|
| | | Min. | Max. | Min. | Max. | |
| t _{RC} | Read Cycle Time | 55 | — | 70 | — | ns |
| t _{AA} | Address Access Time | — | 55 | — | 70 | ns |
| t _{OHA} | Output Hold Time | 10 | — | 10 | — | ns |
| t _{ACS1} /t _{ACS2} | $\overline{\text{CS1}}/\overline{\text{CS2}}$ Access Time | — | 55 | — | 70 | ns |
| t _{DOE} | $\overline{\text{OE}}$ Access Time | — | 25 | — | 35 | ns |
| t _{HZOE} ⁽²⁾ | $\overline{\text{OE}}$ to High-Z Output | — | 20 | — | 25 | ns |
| t _{LZOE} ⁽²⁾ | $\overline{\text{OE}}$ to Low-Z Output | 5 | — | 5 | — | ns |
| t _{HZCS1} /t _{HZCS2} ⁽²⁾ | $\overline{\text{CS1}}/\overline{\text{CS2}}$ to High-Z Output | 0 | 20 | 0 | 25 | ns |
| t _{LZCS1} /t _{LZCS2} ⁽²⁾ | $\overline{\text{CS1}}/\overline{\text{CS2}}$ to Low-Z Output | 10 | — | 10 | — | ns |
| t _{BA} | $\overline{\text{LB}}, \overline{\text{UB}}$ Access Time | — | 55 | — | 70 | ns |
| t _{HZB} | $\overline{\text{LB}}, \overline{\text{UB}}$ to High-Z Output | 0 | 20 | 0 | 25 | ns |
| t _{LZB} | $\overline{\text{LB}}, \overline{\text{UB}}$ to Low-Z Output | 0 | — | 0 | — | ns |

Notes:

1. Test conditions assume signal transition times of 5 ns or less, timing reference levels of 0.9V, input pulse levels of 0.4 to 1.4V 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.

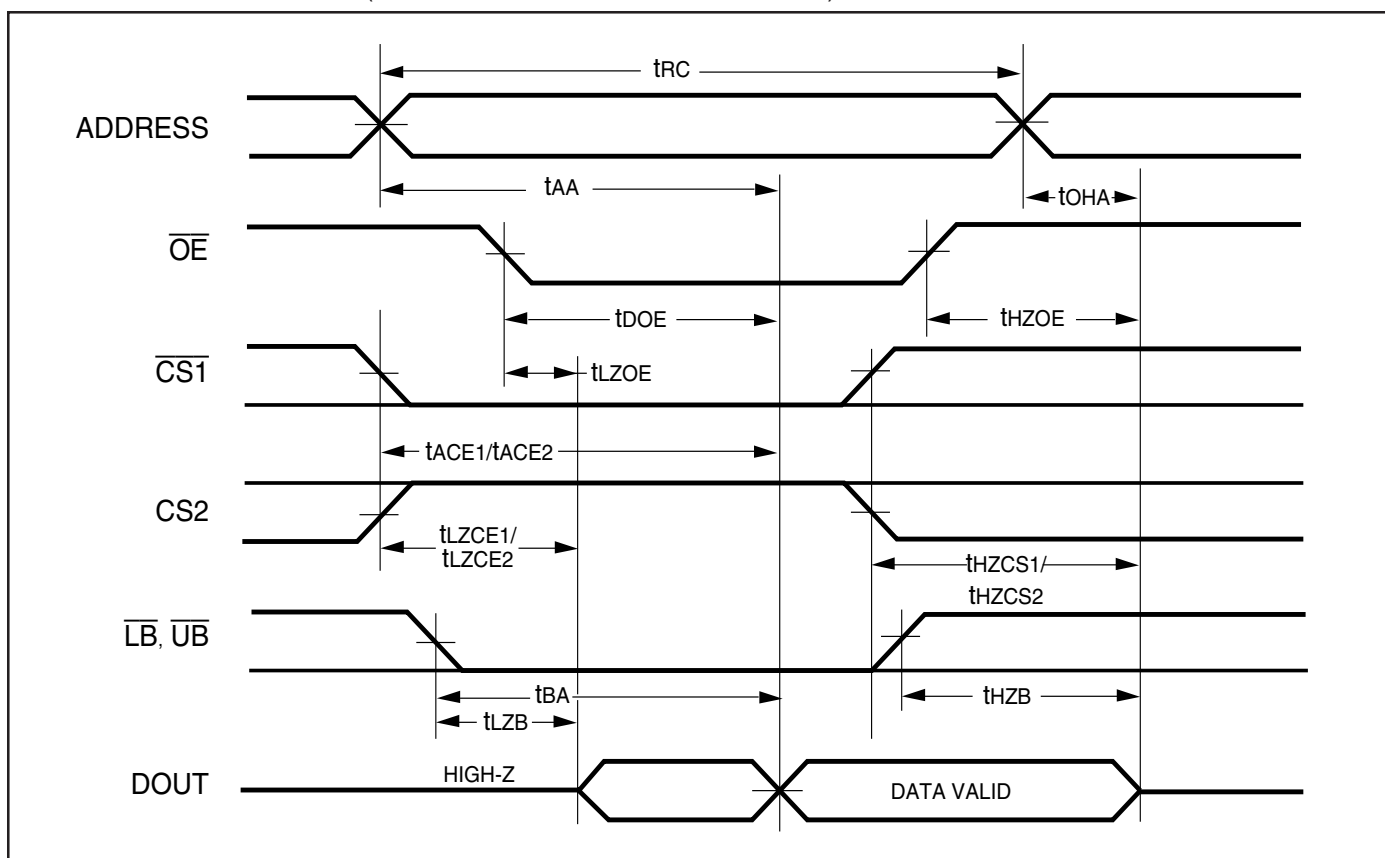
AC WAVEFORMS

READ CYCLE NO. 1^(1,2) (Address Controlled) ($\overline{CS1} = \overline{OE} = V_{IL}$, $\overline{CS2} = \overline{WE} = V_{IH}$, \overline{UB} or $\overline{LB} = V_{IL}$)



AC WAVEFORMS

READ CYCLE NO. 2^(1,3) ($\overline{CS1}$, $\overline{CS2}$, \overline{OE} , AND $\overline{UB/LB}$ Controlled)



Notes:

1. \overline{WE} is HIGH for a Read Cycle.
2. The device is continuously selected. \overline{OE} , $\overline{CS1}$, \overline{UB} , or $\overline{LB} = V_{IL}$. $CS2 = \overline{WE} = V_{IH}$.
3. Address is valid prior to or coincident with $\overline{CS1}$ LOW transition.

WRITE CYCLE SWITCHING CHARACTERISTICS^(1,2) (Over Operating Range)

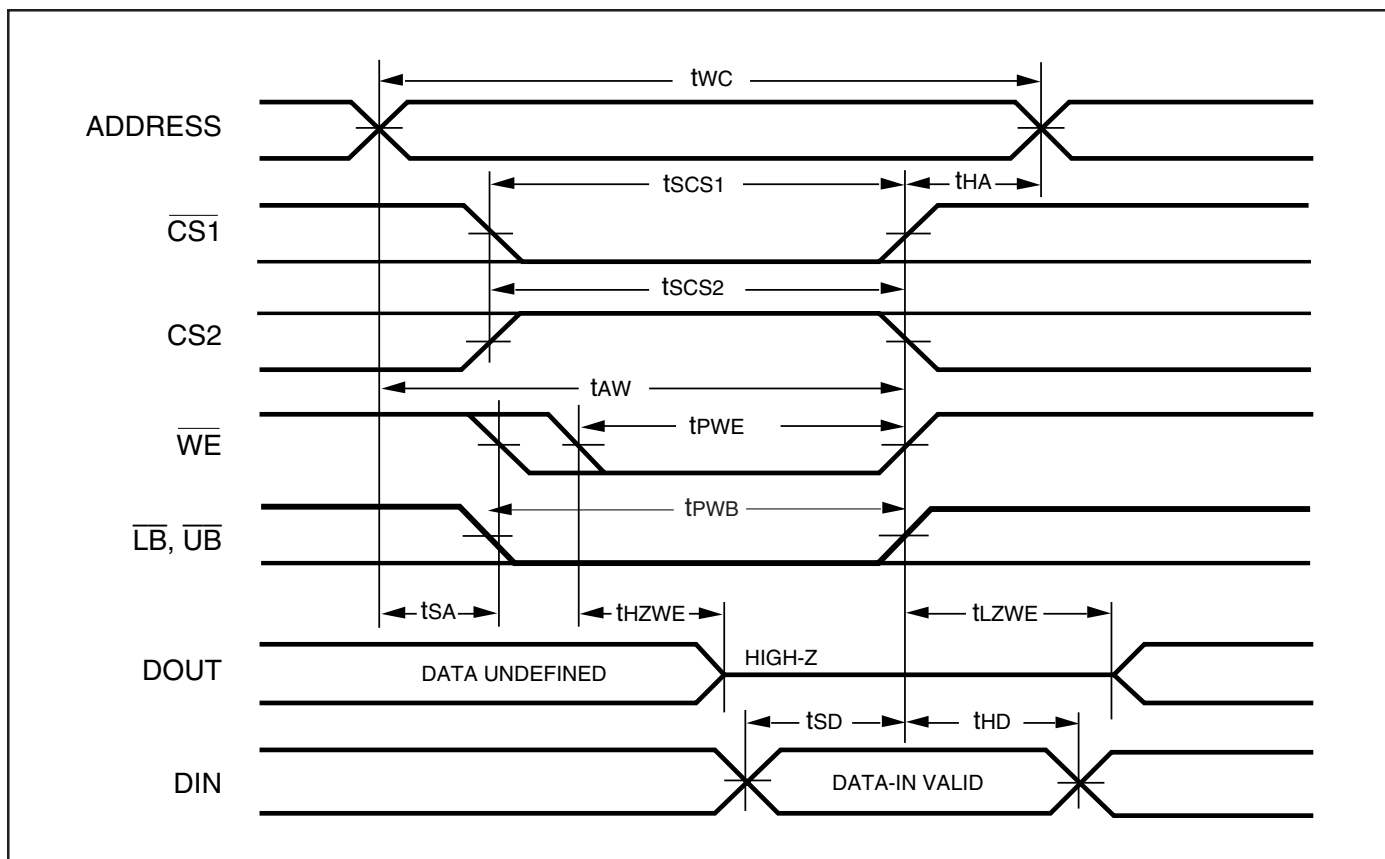
| Symbol | Parameter | -55 ns | | -70 ns | | Unit |
|--------------------------------------|---|--------|------|--------|------|------|
| | | Min. | Max. | Min. | Max. | |
| t _{WC} | Write Cycle Time | 55 | — | 70 | — | ns |
| t _{SCS1} /t _{SCS2} | $\overline{\text{CS1}}$ / $\overline{\text{CS2}}$ to Write End | 45 | — | 60 | — | ns |
| t _{AW} | Address Setup Time to Write End | 45 | — | 60 | — | ns |
| t _{HA} | Address Hold from Write End | 0 | — | 0 | — | ns |
| t _{SA} | Address Setup Time | 0 | — | 0 | — | ns |
| t _{PWB} | $\overline{\text{LB}}$, $\overline{\text{UB}}$ Valid to End of Write | 45 | — | 60 | — | ns |
| t _{PWE} | $\overline{\text{WE}}$ Pulse Width | 40 | — | 50 | — | ns |
| t _{SD} | Data Setup to Write End | 25 | — | 30 | — | ns |
| t _{HD} | Data Hold from Write End | 0 | — | 0 | — | ns |
| t _{HZWE} ⁽³⁾ | $\overline{\text{WE}}$ LOW to High-Z Output | — | 20 | — | 20 | ns |
| t _{LZWE} ⁽³⁾ | $\overline{\text{WE}}$ HIGH to Low-Z Output | 5 | — | 5 | — | ns |

Notes:

1. Test conditions assume signal transition times of 5 ns or less, timing reference levels of 0.9V, input pulse levels of 0.4V to 1.4V and output loading specified in Figure 1.
2. The internal write time is defined by the overlap of $\overline{\text{CS1}}$ LOW, CS2 HIGH and $\overline{\text{UB}}$ or $\overline{\text{LB}}$, and $\overline{\text{WE}}$ 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 ± 500 mV from steady-state voltage. Not 100% tested.

AC WAVEFORMS

WRITE CYCLE NO. 1^(1,2) ($\overline{CS1}$ Controlled, \overline{OE} = HIGH or LOW)

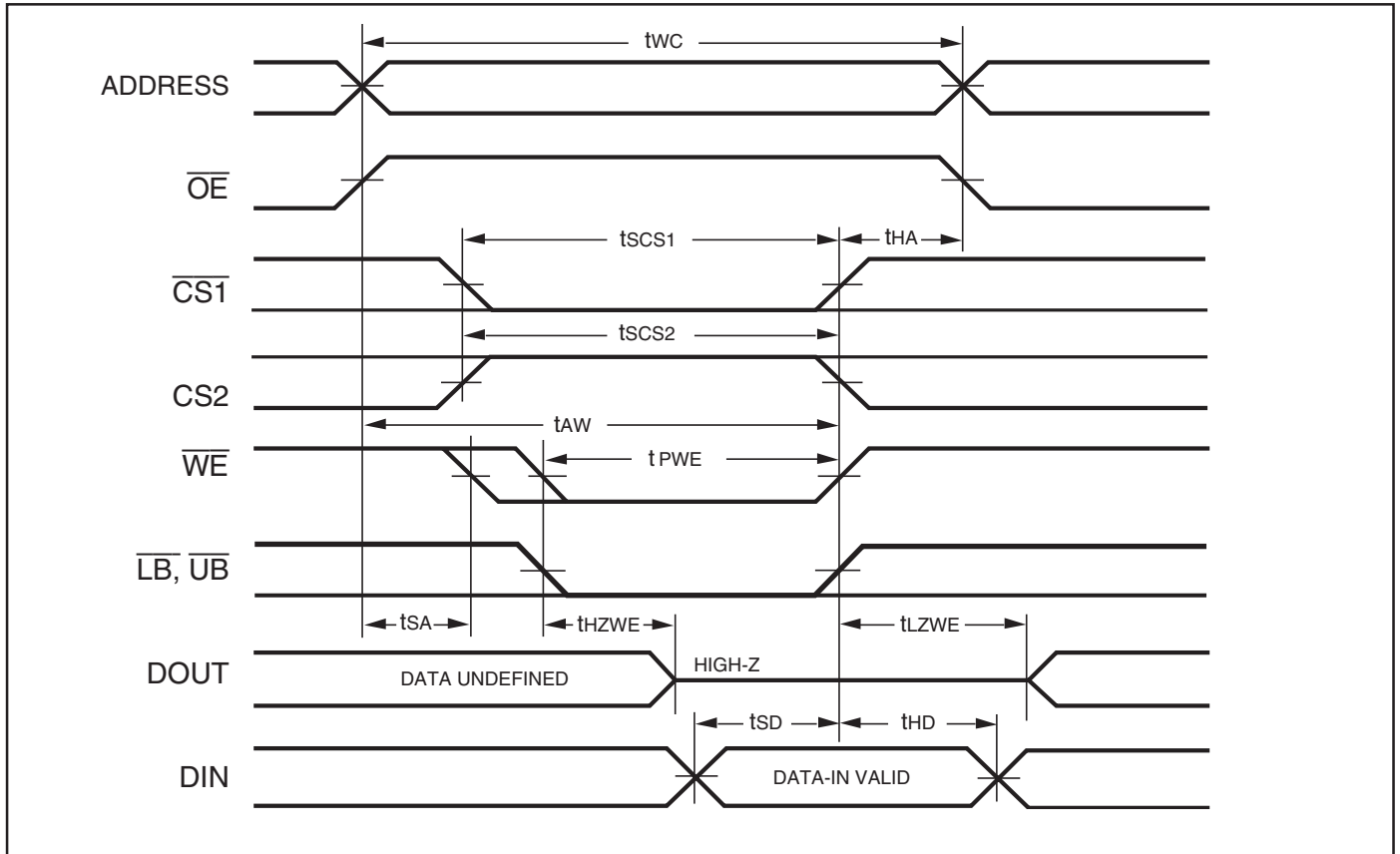


Notes:

1. WRITE is an internally generated signal asserted during an overlap of the LOW states on the $\overline{CS1}$, CS2 and \overline{WE} inputs and at least one of the \overline{LB} and \overline{UB} inputs being in the LOW state.
2. WRITE = ($\overline{CS1}$) [(\overline{LB}) = (\overline{UB})] (\overline{WE}).

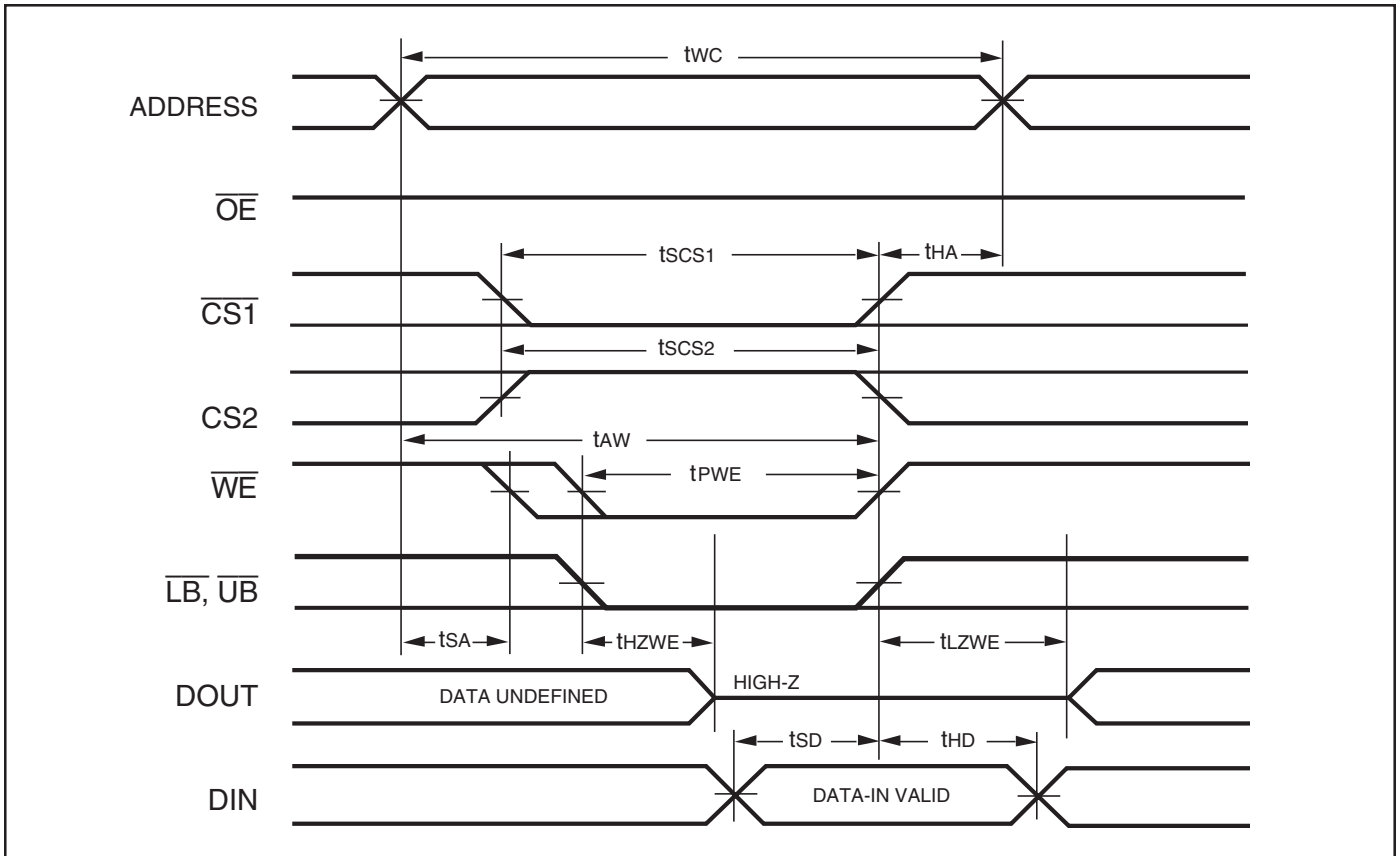
AC WAVEFORMS

WRITE CYCLE NO. 2 (\overline{WE} Controlled: \overline{OE} is HIGH During Write Cycle)



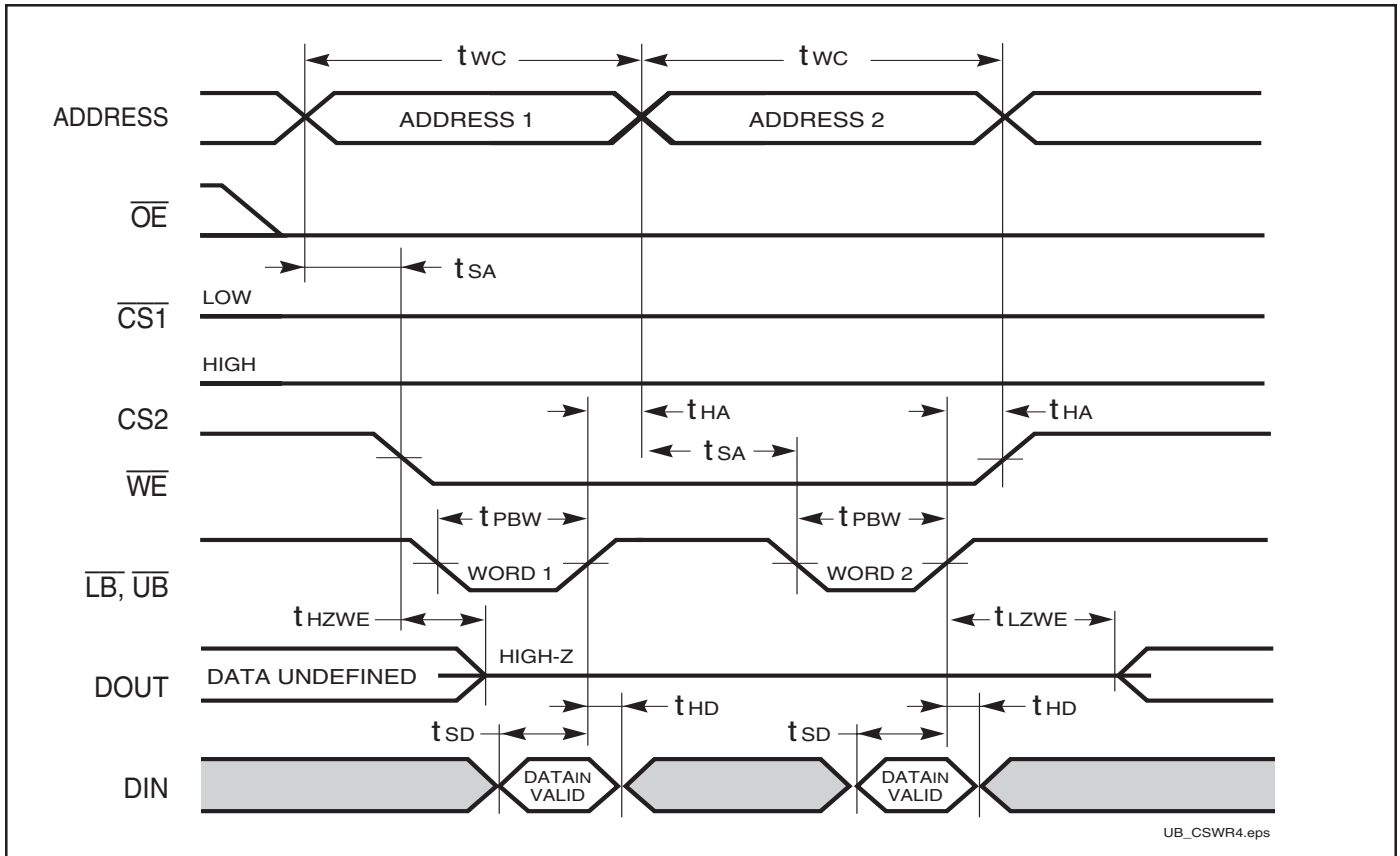
AC WAVEFORMS

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



AC WAVEFORMS

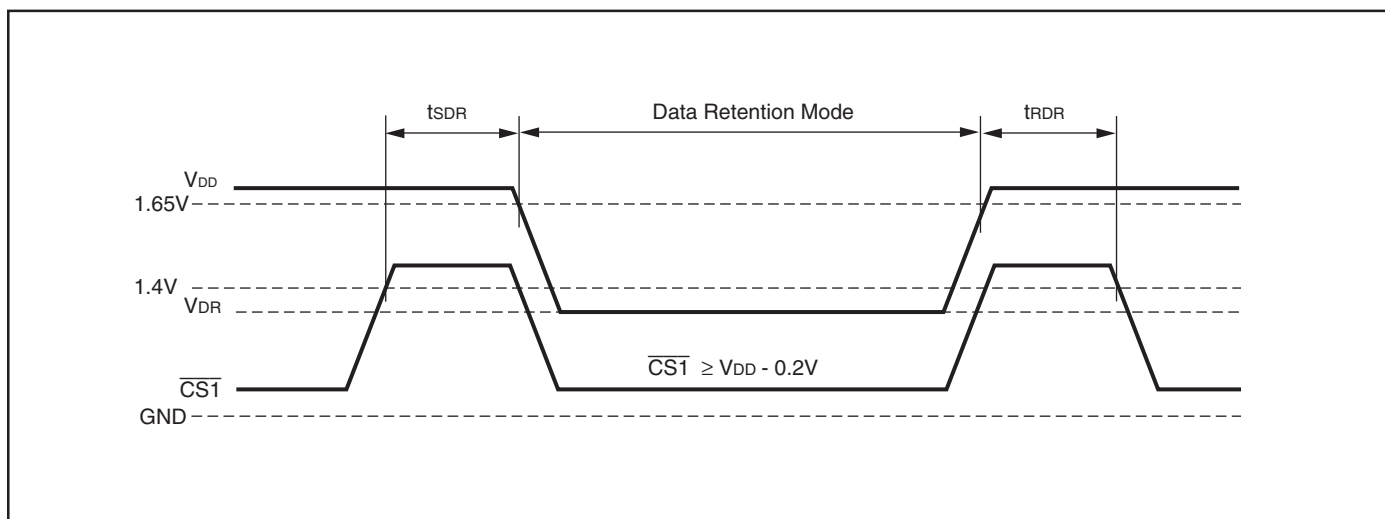
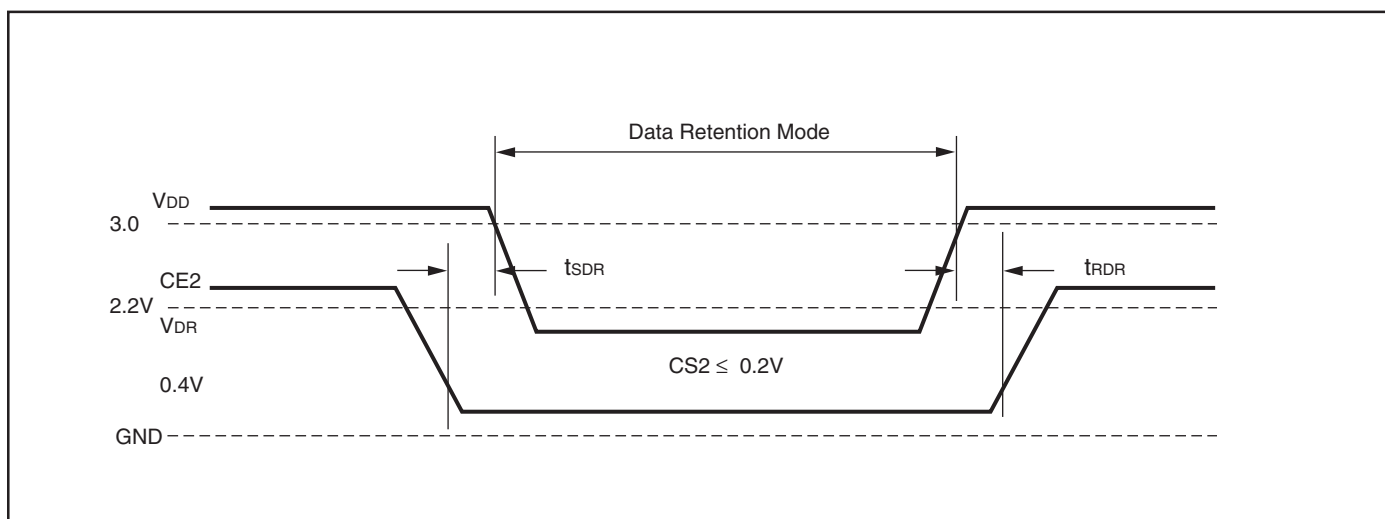
WRITE CYCLE NO. 4 ($\overline{UB}/\overline{LB}$ Controlled)



DATA RETENTION SWITCHING CHARACTERISTICS (LL)

| Symbol | Parameter | Test Condition | Options | Min. | Typ. ⁽¹⁾ | Max. | Unit |
|-----------|-----------------------------|--|-------------------|----------|---------------------|----------------|---------|
| V_{DR} | V_{DD} for Data Retention | See Data Retention Waveform | | 1.2 | — | 3.6 | V |
| I_{DR} | Data Retention Current | $V_{DD} = 1.2V, \overline{CS1} \geq V_{DD} - 0.2V$ | A, A1 A2 A3 | — | 5 — — | 15 25 65 | μA |
| t_{SDR} | Data Retention Setup Time | See Data Retention Waveform | | 0 | — | — | ns |
| t_{RDR} | Recovery Time | See Data Retention Waveform | | t_{RC} | — | — | ns |

Note 1: Typical values are measured at $V_{DD} = 3.0V$, $T_A = 25^\circ C$ and not 100% tested.

DATA RETENTION WAVEFORM ($\overline{CS1}$ Controlled)

DATA RETENTION WAVEFORM ($CS2$ Controlled)


ORDERING INFORMATION
IS65WV12816ALL (1.65V - 2.2V)
Temperature Range (A): 0°C to +70°C

| Speed (ns) | Order Part No. | Package |
|------------|----------------------|-----------------------------------|
| 70 | IS65WV12816ALL-70TA | TSOP |
| | IS65WV12816ALL-70BA | mini BGA (6mm x 8mm) |
| | IS65WV12816ALL-70B2A | mini BGA (6mm x 8mm), 2 CS Option |

Temperature Range (A1): -40°C to +85°C

| Speed (ns) | Order Part No. | Package |
|------------|-----------------------|-----------------------------------|
| 70 | IS65WV12816ALL-70TA1 | TSOP |
| | IS65WV12816ALL-70BA1 | mini BGA (6mm x 8mm) |
| | IS65WV12816ALL-70B2A1 | mini BGA (6mm x 8mm), 2 CS Option |

Temperature Range (A2): -40°C to +105°C

| Speed (ns) | Order Part No. | Package |
|------------|-----------------------|-----------------------------------|
| 70 | IS65WV12816ALL-70TA2 | TSOP |
| | IS65WV12816ALL-70BA2 | mini BGA (6mm x 8mm) |
| | IS65WV12816ALL-70B2A2 | mini BGA (6mm x 8mm), 2 CS Option |

Temperature Range (A3): -40°C to +125°C

| Speed (ns) | Order Part No. | Package |
|------------|-----------------------|-----------------------------------|
| 70 | IS65WV12816ALL-70TA3 | TSOP |
| | IS65WV12816ALL-70BA3 | mini BGA (6mm x 8mm) |
| | IS65WV12816ALL-70B2A3 | mini BGA (6mm x 8mm), 2 CS Option |

ORDERING INFORMATION

IS65WV12816BLL (2.5V - 3.6V)

Temperature Range (A): 0°C to +70°C

| Speed (ns) | Order Part No. | Package |
|------------|----------------------|-----------------------------------|
| 55 | IS65WV12816BLL-55TA | TSOP |
| | IS65WV12816BLL-55BA | mini BGA (6mm x 8mm) |
| | IS65WV12816BLL-55B2A | mini BGA (6mm x 8mm), 2 CS Option |
| 70 | IS65WV12816BLL-70TA | TSOP |
| | IS65WV12816BLL-70BA | mini BGA (6mm x 8mm) |
| | IS65WV12816BLL-70B2A | mini BGA (6mm x 8mm), 2 CS Option |

Temperature Range (A1): -40°C to +85°C

| Speed (ns) | Order Part No. | Package |
|------------|-----------------------|-----------------------------------|
| 55 | IS65WV12816BLL-55TA1 | TSOP |
| | IS65WV12816BLL-55BA1 | mini BGA (6mm x 8mm) |
| | IS65WV12816BLL-55B2A1 | mini BGA (6mm x 8mm), 2 CS Option |
| 70 | IS65WV12816BLL-70TA1 | TSOP |
| | IS65WV12816BLL-70BA1 | mini BGA (6mm x 8mm) |
| | IS65WV12816BLL-70B2A1 | mini BGA (6mm x 8mm), 2 CS Option |

ORDERING INFORMATION (continual)

IS65WV12816BLL (2.5V - 3.6V)

TEMPERATURE RANGE (A2): -40°C TO +105°C

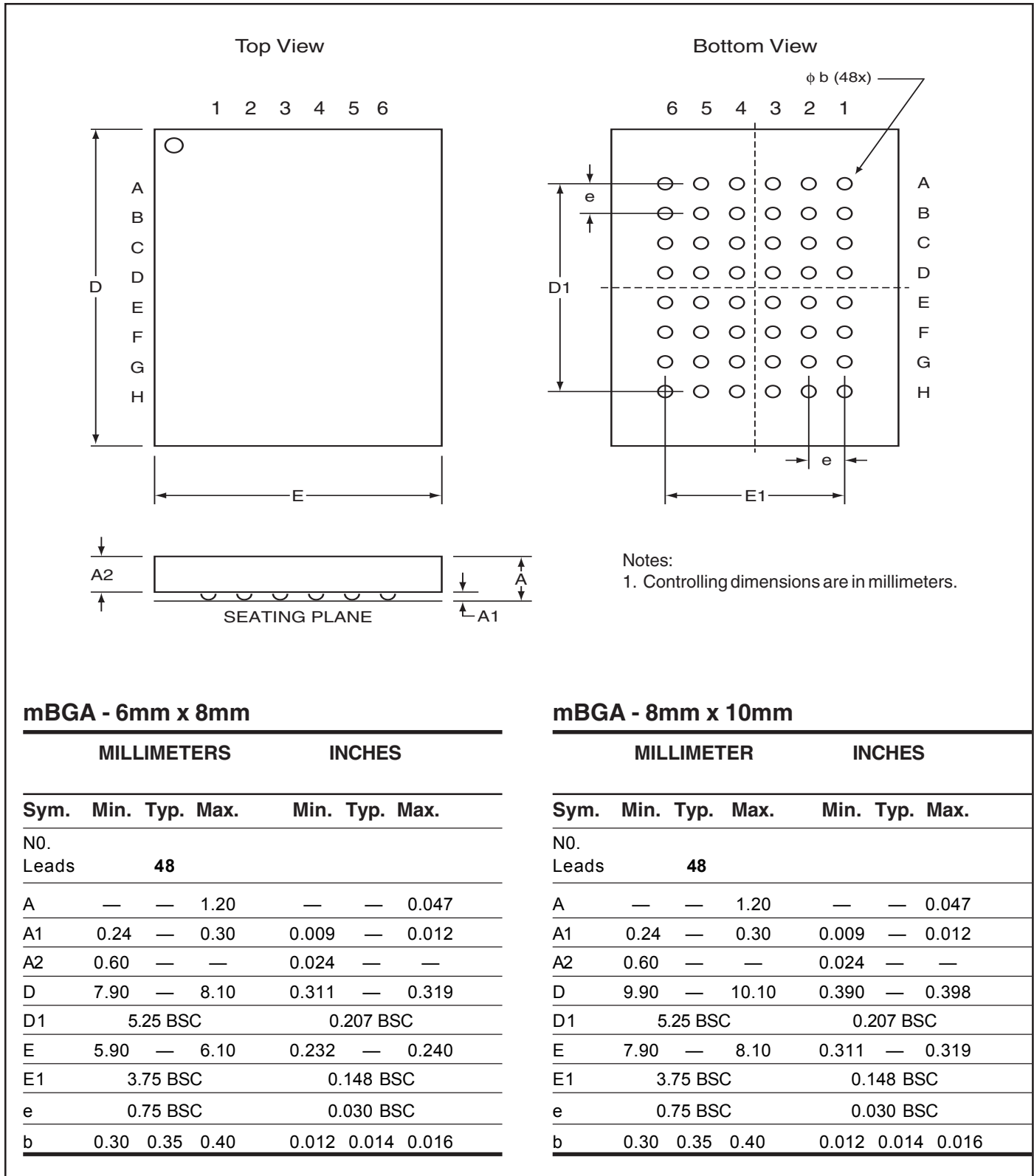
| Speed (ns) | Order Part No. | Package |
|------------|-----------------------|-----------------------------------|
| 55 | IS65WV12816BLL-55TA2 | TSOP |
| | IS65WV12816BLL-55BA2 | mini BGA (6mm x 8mm) |
| | IS65WV12816BLL-55B2A2 | mini BGA (6mm x 8mm), 2 CS Option |
| 70 | IS65WV12816BLL-70TA2 | TSOP |
| | IS65WV12816BLL-70BA2 | mini BGA (6mm x 8mm) |
| | IS65WV12816BLL-70B2A2 | mini BGA (6mm x 8mm), 2 CS Option |

Temperature Range (A3): -40°C to +125°C

| Speed (ns) | Order Part No. | Package |
|------------|-----------------------|-----------------------------------|
| 55 | IS65WV12816BLL-55TA3 | TSOP |
| | IS65WV12816BLL-55TLA3 | TSOP, Lead-free |
| | IS65WV12816BLL-55BA3 | mini BGA (6mm x 8mm) |
| | IS65WV12816BLL-55BLA3 | mini BGA (6mm x 8mm), Lead-free |
| | IS65WV12816BLL-55B2A3 | mini BGA (6mm x 8mm), 2 CS Option |
| 70 | IS65WV12816BLL-70TA3 | TSOP |
| | IS65WV12816BLL-70BA3 | mini BGA (6mm x 8mm) |
| | IS65WV12816BLL-70B2A3 | mini BGA (6mm x 8mm), 2 CS Option |

PACKAGING INFORMATION

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



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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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- При необходимости вся продукция военного и аэрокосмического назначения проходит испытания и сертификацию в лаборатории (по согласованию с заказчиком);
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JONHON

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