

64K x 16 HIGH-SPEED CMOS STATIC RAM

OCTOBER 2006

FEATURES

- High-speed access time:
12 ns: 3.3V \pm 10%
15 ns: 2.5V-3.6V
- CMOS low power operation:
50 mW (typical) operating
25 μ W (typical) standby
- TTL compatible interface levels
- Fully static operation: no clock or refresh required
- Three state outputs
- Data control for upper and lower bytes
- Automotive Temperature Available
- Lead-free available

DESCRIPTION

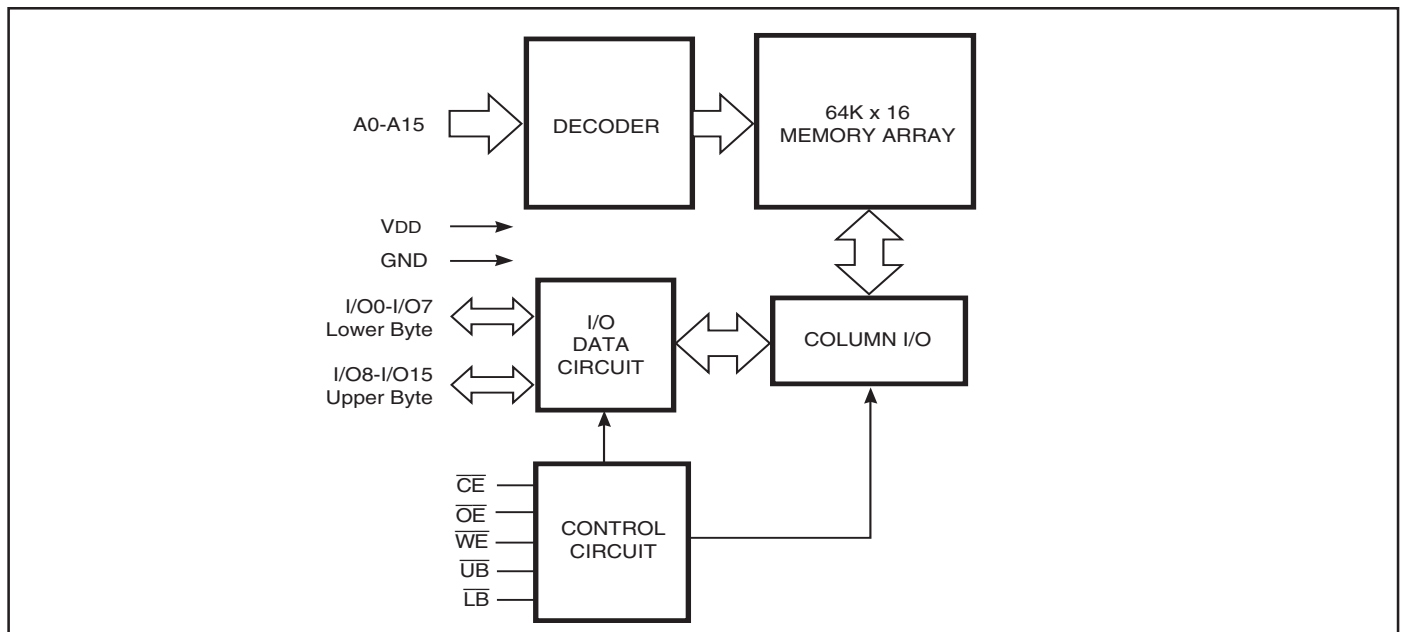
The *ISSI* IS61/64WV6416BLL is a high-speed, 1,048,576-bit static RAM organized as 65,536 words by 16 bits. It is fabricated using *ISSI*'s high-performance CMOS technology. This highly reliable process coupled with innovative circuit design techniques, yields access times as fast as 12ns (3.3V \pm 10%) and 15ns (2.5V-3.6V) 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 IS61/64WV6416BLL is packaged in the JEDEC standard 44-pin TSOP-II, 44-pin 400-mil SOJ, and 48-pin mini BGA (6mm x 8mm).

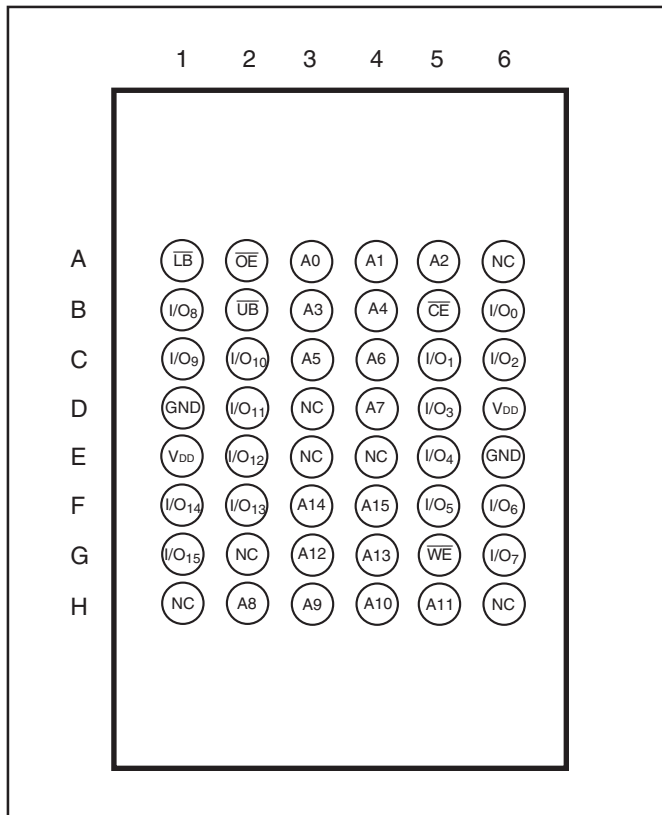
FUNCTIONAL BLOCK DIAGRAM



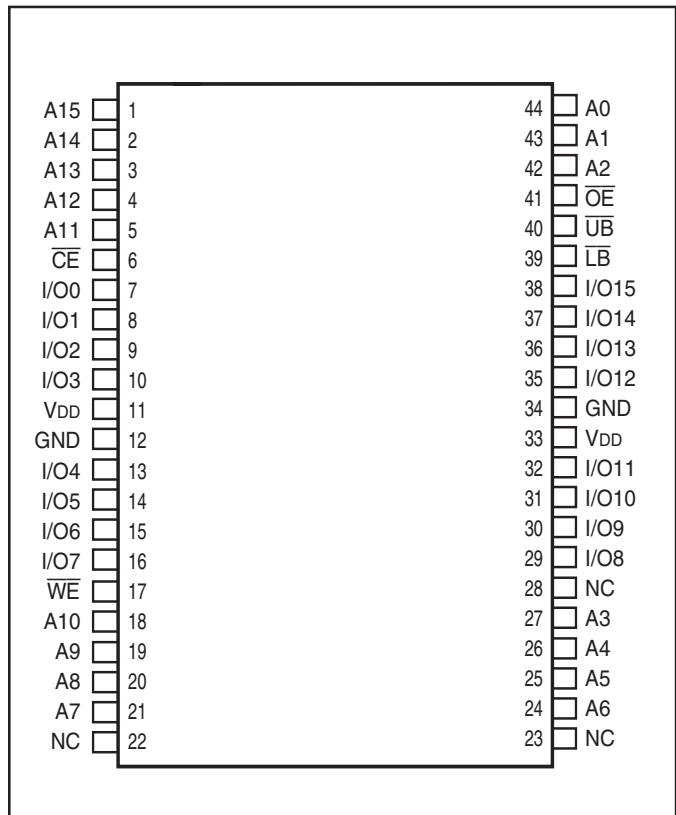
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PIN CONFIGURATIONS

48-Pin mini BGA (6mm x 8mm)



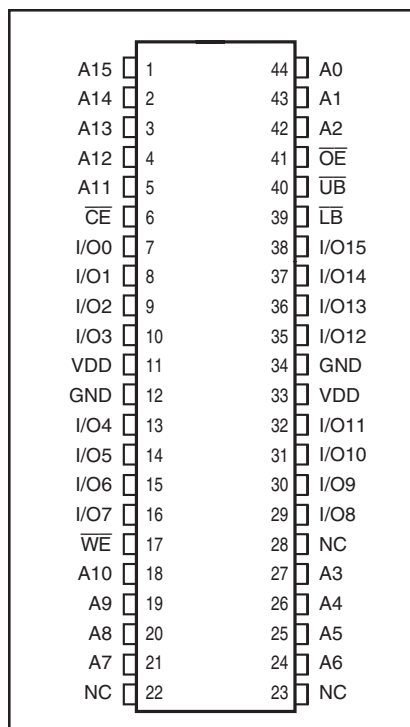
44-Pin TSOP-II



PIN DESCRIPTIONS

| | |
|-----------------|---------------------------------|
| A0-A15 | 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 _{DD} | Power |
| GND | Ground |

44-Pin SOJ (K)



TRUTH TABLE

| Mode | \overline{WE} | \overline{CE} | \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 | High-Z | High-Z | I _{SB1} , I _{SB2} |
| Output Disabled | H | L | H | X | X | High-Z | High-Z | I _{CC} |
| | X | L | X | H | H | High-Z | High-Z | |
| Read | H | L | L | L | H | Dout | High-Z | I _{CC} |
| | 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 _{CC} |
| | L | L | X | H | L | High-Z | Din | |
| | L | L | X | L | L | Din | Din | |

ABSOLUTE MAXIMUM RATINGS⁽¹⁾

| Symbol | Parameter | Value | Unit |
|-------------------|--------------------------------------|------------------------------|------|
| V _{TERM} | Terminal Voltage with Respect to GND | -0.5 to V _{DD} +0.5 | V |
| T _{STG} | Storage Temperature | -65 to +150 | °C |
| P _T | Power Dissipation | 1.5 | W |
| V _{DD} | V _{DD} Related to GND | -0.2 to +3.9 | V |

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})

| Range | Ambient Temperature | V _{DD} (15 ns) | V _{DD} (12 ns) |
|------------|---------------------|-------------------------|-------------------------|
| Commercial | 0°C to +70°C | 2.5V-3.6V | 3.3V ± 10% |
| Industrial | -40°C to +85°C | 2.5V-3.6V | 3.3V ± 10% |
| Automotive | -40°C to +125°C | 2.5V-3.6V | 3.3V ± 10% |

DC ELECTRICAL CHARACTERISTICS (Over Operating Range)

V_{DD} = 2.5V-3.6V

| Symbol | Parameter | Test Conditions | Min. | Max. | Unit |
|-----------------|----------------------------------|---|------|-----------------------|------|
| V _{OH} | Output HIGH Voltage | V _{DD} = Min., I _{OH} = -1.0 mA | 2.3 | — | V |
| V _{OL} | Output LOW Voltage | V _{DD} = Min., I _{OL} = 1.0 mA | — | 0.4 | V |
| V _{IH} | Input HIGH Voltage | | 2.0 | V _{DD} + 0.3 | V |
| V _{IL} | Input LOW Voltage ⁽¹⁾ | | -0.3 | 0.8 | V |
| I _{LI} | Input Leakage | GND ≤ V _{IN} ≤ V _{DD} | -2 | 2 | μA |
| I _{LO} | Output Leakage | GND ≤ V _{OUT} ≤ V _{DD} , Outputs Disabled | -2 | 2 | μA |

Note:

- V_{IL} (min.) = -0.3V DC; V_{IL} (min.) = -2.0V AC (pulse width - 2.0 ns). Not 100% tested.
V_{IH} (max.) = V_{DD} + 0.3V DC; V_{IH} (max.) = V_{DD} + 2.0V AC (pulse width - 2.0 ns). Not 100% tested.

DC ELECTRICAL CHARACTERISTICS (Over Operating Range)

V_{DD} = 3.3V ± 10%

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

Note:

- V_{IL} (min.) = -0.3V DC; V_{IL} (min.) = -2.0V AC (pulse width - 2.0 ns). Not 100% tested.
V_{IH} (max.) = V_{DD} + 0.3V DC; V_{IH} (max.) = V_{DD} + 2.0V AC (pulse width - 2.0 ns). Not 100% tested.

POWER SUPPLY CHARACTERISTICS⁽¹⁾ (Over Operating Range)

| Symbol | Parameter | Test Conditions | Options | -12 ns | | -15 ns | | Unit |
|------------------|--|--|---------------------|--------|------|--------|------|------|
| | | | | Min. | Max. | Min. | Max. | |
| I _{CC} | V _{DD} Dynamic Operating Supply Current | V _{DD} = Max., I _{OUT} = 0 mA, f = f _{MAX} | COM. | — | 35 | — | 30 | mA |
| | | | IND. | — | 45 | — | 40 | |
| | | | AUTO | — | 60 | — | 50 | |
| | | | typ. ⁽²⁾ | — | 20 | — | 20 | |
| I _{CC1} | Operating Supply Current | V _{DD} = Max., I _{OUT} = 0mA, f = 0 | COM. | — | 5 | — | 5 | mA |
| | | | IND. | — | 5 | — | 5 | |
| | | | AUTO | — | 5 | — | 5 | |
| I _{SB2} | CMOS Standby Current (CMOS Inputs) | V _{DD} = Max., $\overline{CE} \geq V_{DD} - 0.2V$, V _{IN} ≥ V _{DD} - 0.2V, or V _{IN} ≤ 0.2V, f = 0 | COM. | — | 20 | — | 20 | uA |
| | | | IND. | — | 50 | — | 50 | |
| | | | AUTO | — | 75 | — | 75 | |
| | | | typ. ⁽²⁾ | — | 6 | — | 6 | |

Note:

- At f = f_{MAX}, address and data inputs are cycling at the maximum frequency, f = 0 means no input lines change.
- Typical values are measured at V_{DD}=2.5V, T_A=25°C. Not 100% tested.

CAPACITANCE⁽¹⁾

| Symbol | Parameter | Conditions | Max. | Unit |
|------------------|--------------------------|-----------------------|------|------|
| C _{IN} | Input Capacitance | V _{IN} = 0V | 6 | pF |
| C _{OUT} | Input/Output Capacitance | V _{OUT} = 0V | 8 | pF |

Note:

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

AC TEST CONDITIONS

| Parameter | Unit (2.5V-3.6V) | Unit (3.3V ± 10%) |
|---|-------------------------|---------------------------|
| Input Pulse Level | 0V to V _{DD} V | 0V to V _{DD} V |
| Input Rise and Fall Times | 1.5ns | 1.5ns |
| Input and Output Timing and Reference Level (V _{Ref}) | V _{DD} /2 | V _{DD} /2 + 0.05 |
| Output Load | See Figures 1a and 1b | See Figures 1a and 1b |

AC TEST LOADS

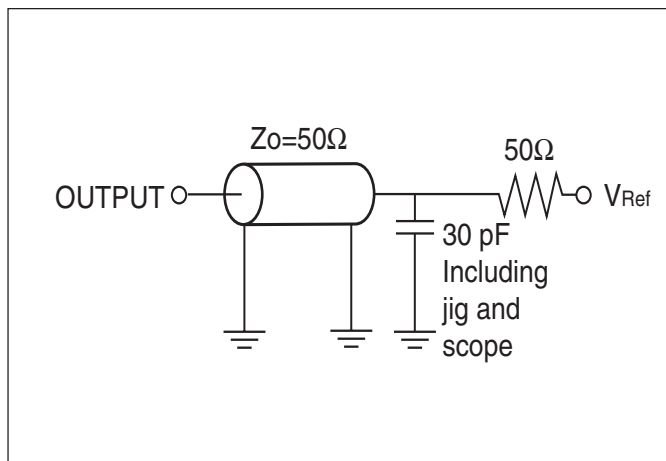


Figure 1a.

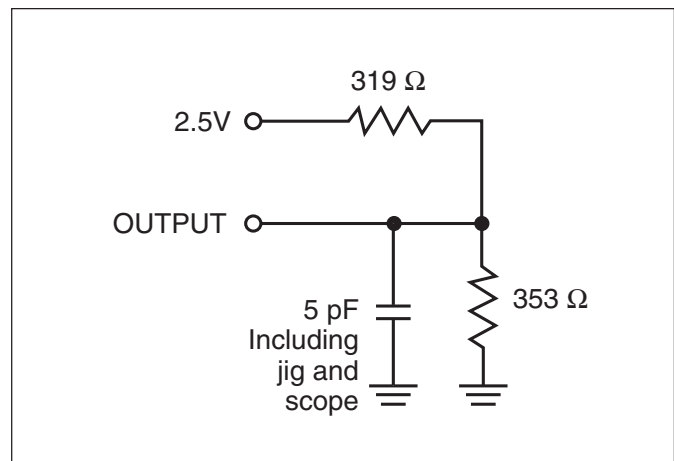


Figure 1b.

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

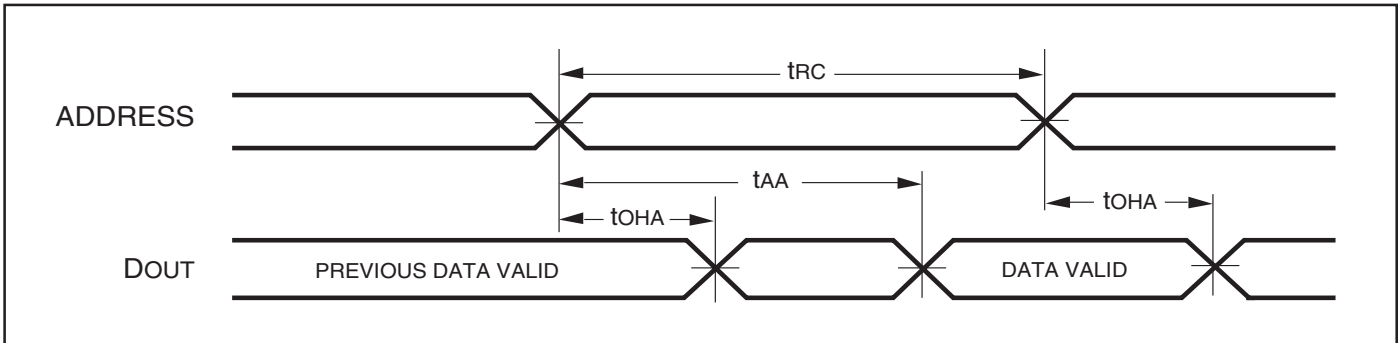
| Symbol | Parameter | -12 ns | | -15 ns | | Unit |
|----------------------------------|---|--------|------|--------|------|------|
| | | Min. | Max. | Min. | Max. | |
| t _{RC} | Read Cycle Time | 12 | — | 15 | — | ns |
| t _{AA} | Address Access Time | — | 12 | — | 15 | ns |
| t _{OHA} | Output Hold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

Notes:

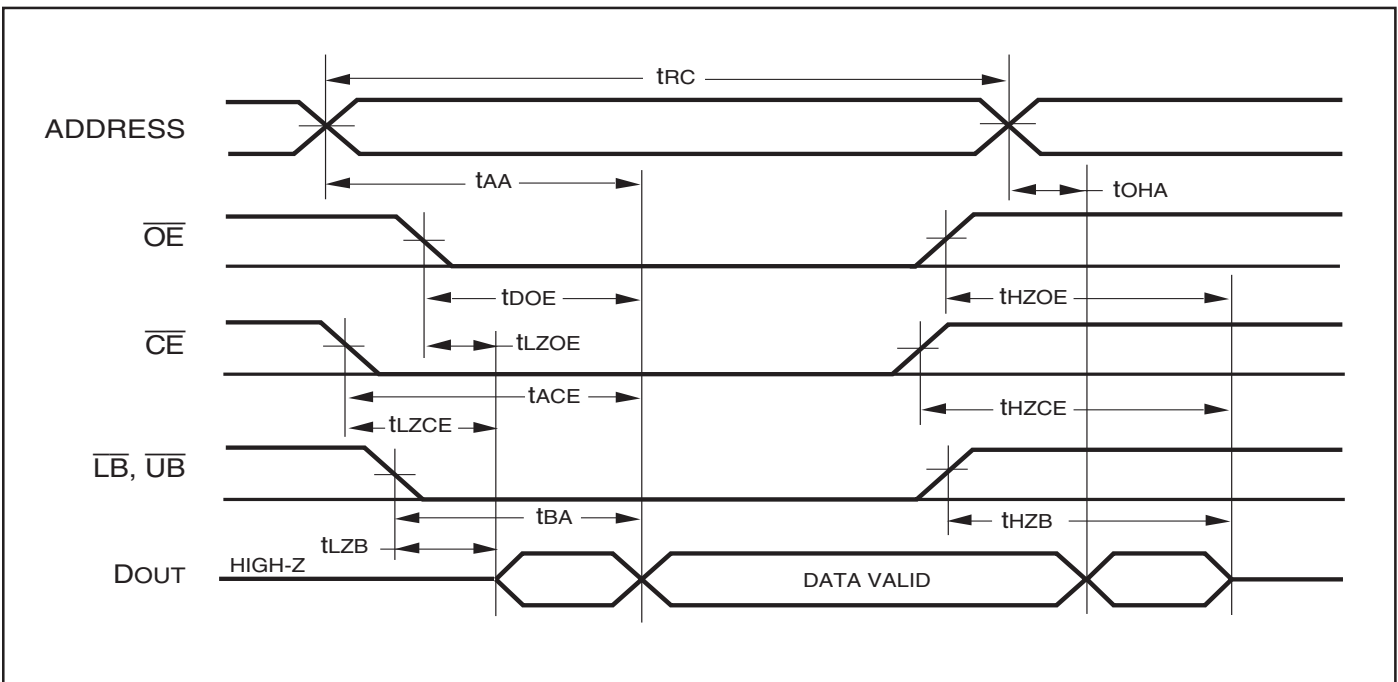
1. Test conditions assume signal transition times of 1.5 ns or less, timing reference levels of 1.25V, input pulse levels of 0V to V_{DD} V and output loading specified in Figure 1a.
2. Tested with the load in Figure 1b. Transition is measured ±500 mV from steady-state voltage. Not 100% tested.
3. Not 100% tested.

AC WAVEFORMS

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



READ CYCLE NO. 2^(1,3)



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.

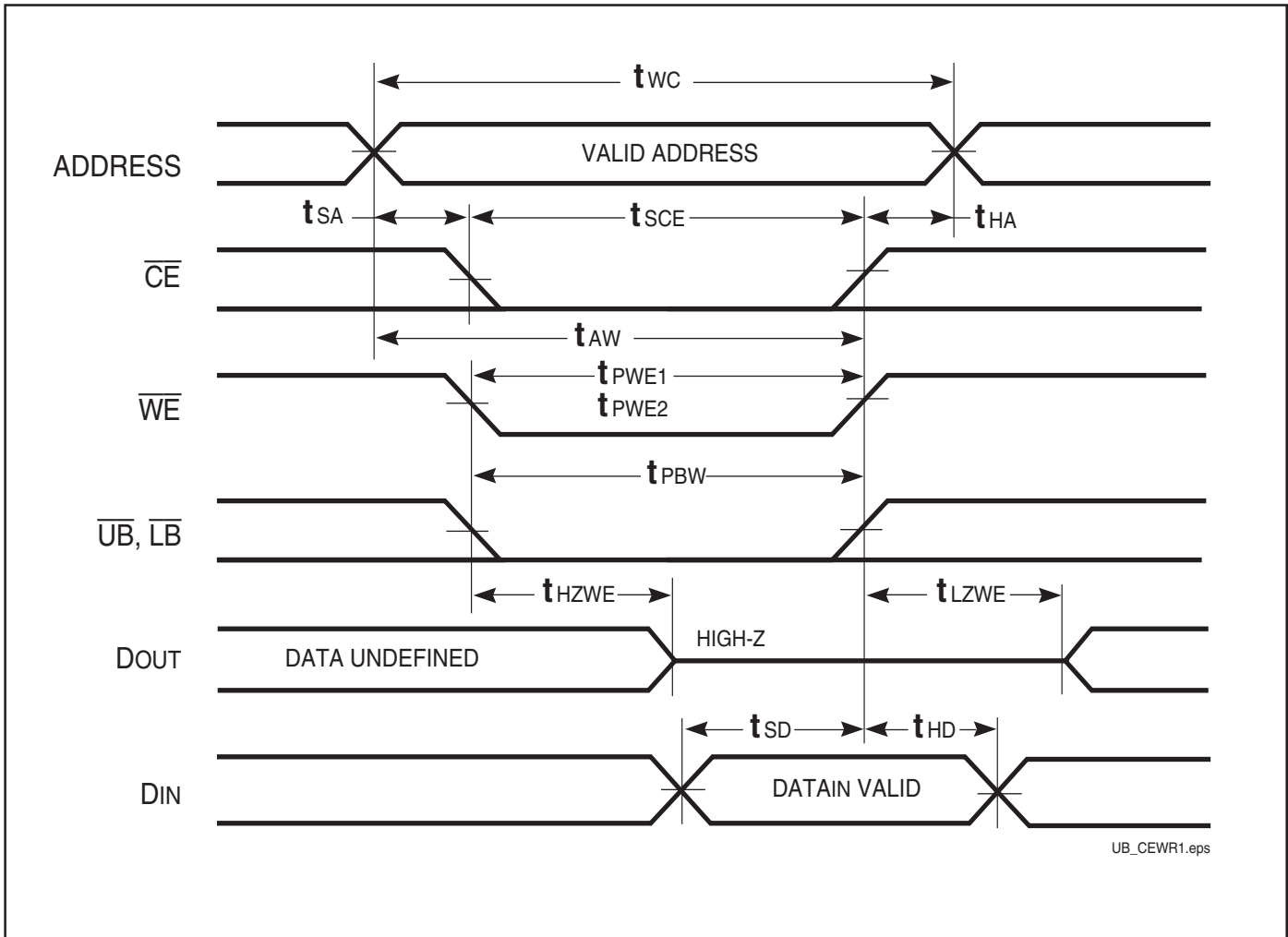
WRITE CYCLE SWITCHING CHARACTERISTICS^(1,2) (Over Operating Range)

| Symbol | Parameter | -12 ns | | -15 ns | | Unit |
|---------------------------------|---|--------|------|--------|------|------|
| | | Min. | Max. | Min. | Max. | |
| t _{WC} | Write Cycle Time | 12 | — | 15 | — | ns |
| t _{SCE} | $\overline{\text{CE}}$ to Write End | 9 | — | 10 | — | ns |
| t _{AW} | Address Setup Time to Write End | 9 | — | 10 | — | 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 | 9 | — | 10 | — | ns |
| t _{PWE1} | $\overline{\text{WE}}$ Pulse Width ($\overline{\text{OE}}$ = HIGH) | 9 | — | 10 | — | ns |
| t _{PWE2} | $\overline{\text{WE}}$ Pulse Width ($\overline{\text{OE}}$ = LOW) | 11 | — | 12 | — | ns |
| t _{SD} | Data Setup to Write End | 9 | — | 9 | — | ns |
| t _{HD} | Data Hold from Write End | 0 | — | 0 | — | ns |
| t _{HZWE⁽³⁾} | $\overline{\text{WE}}$ LOW to High-Z Output | — | 6 | — | 7 | ns |
| t _{LZWE⁽³⁾} | $\overline{\text{WE}}$ HIGH to Low-Z Output | 3 | — | 3 | — | ns |

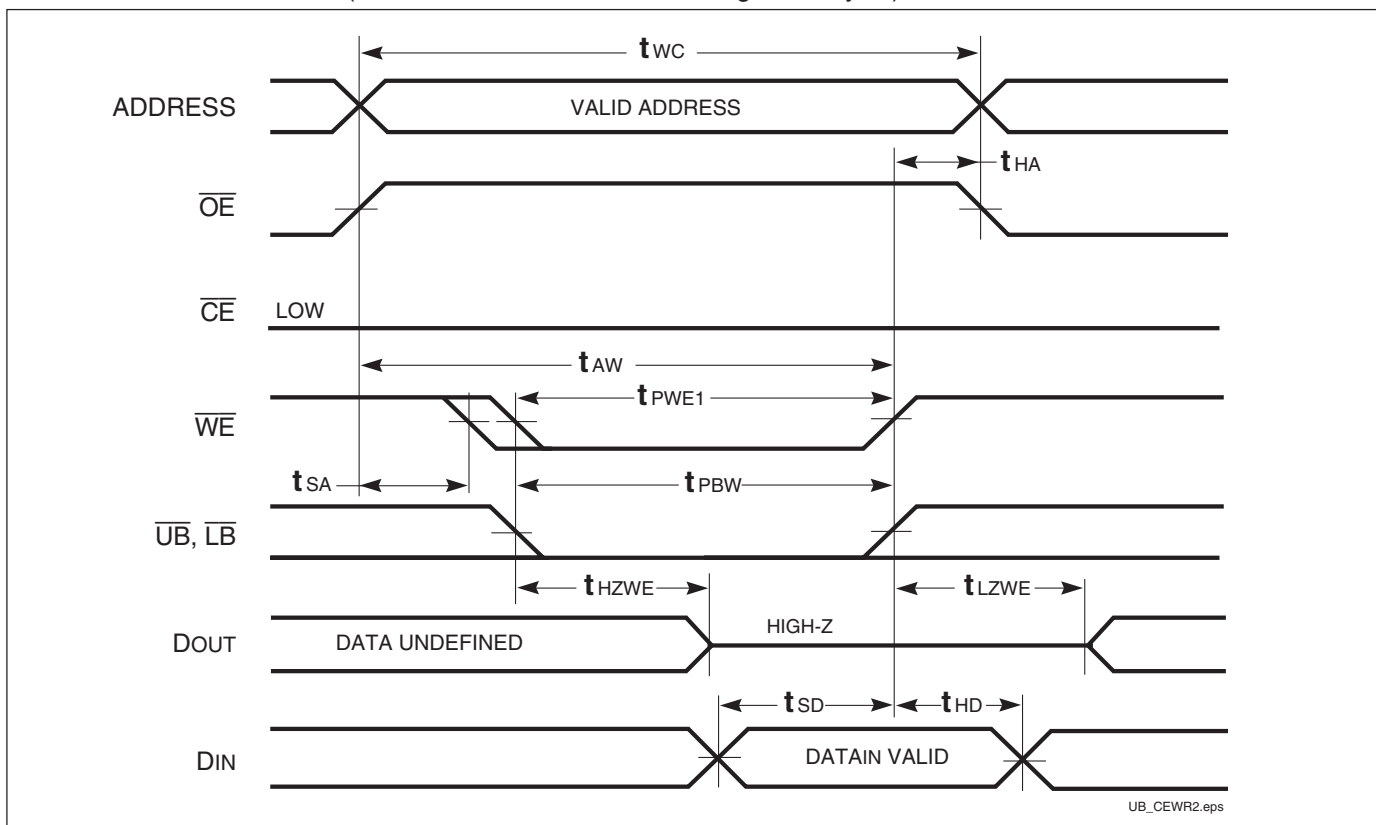
Notes:

1. Test conditions for IS61WV6416BLL assume signal transition times of 1.5ns or less, timing reference levels of 1.25V, input pulse levels of 0V to V_{DD} V and output loading specified in Figure 1a.
2. Tested with the load in Figure 1b. Transition is measured ±500 mV from steady-state voltage. Not 100% tested.
3. The internal write time is defined by the overlap of $\overline{\text{CE}}$ LOW 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.

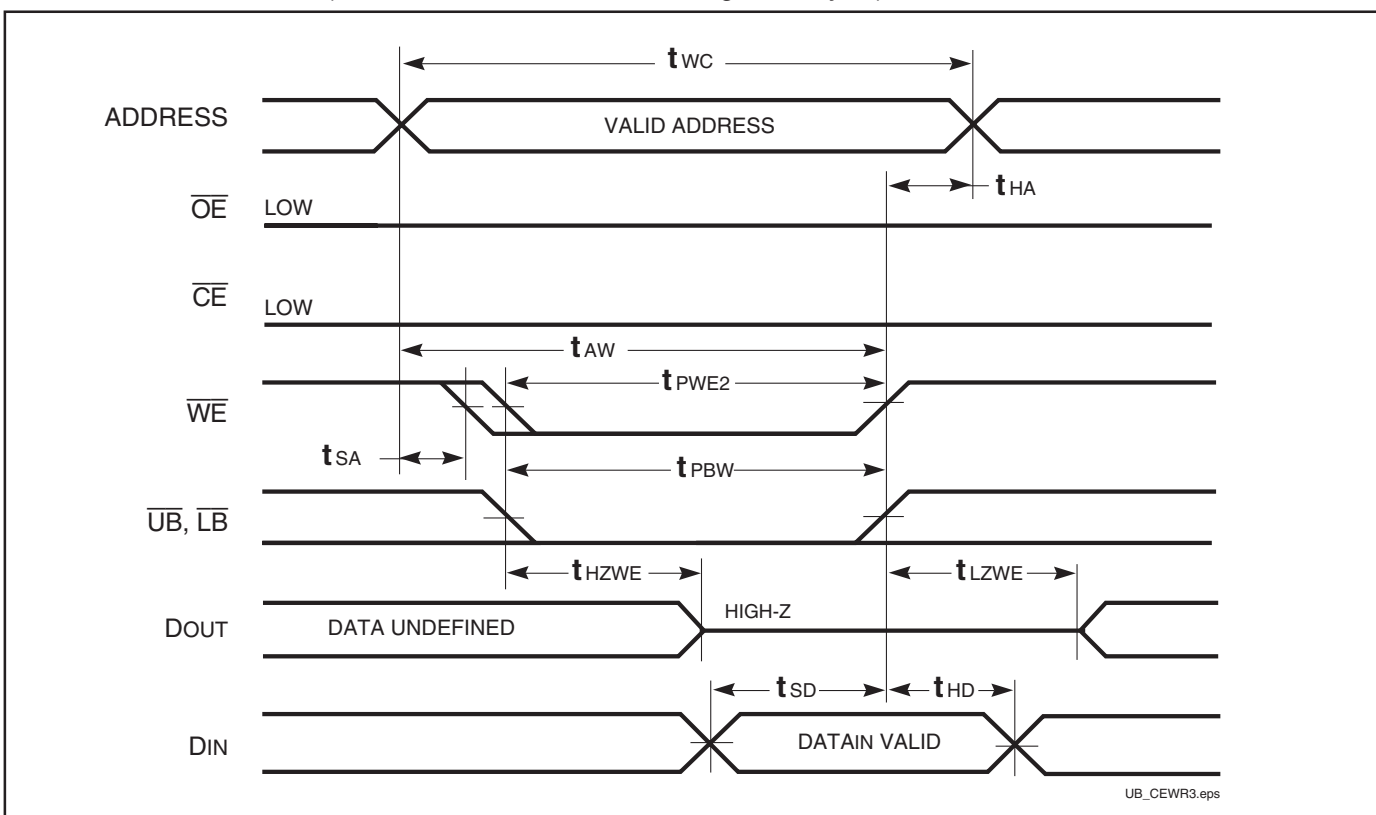
WRITE CYCLE NO. 1^(1,2) (\overline{CE} Controlled, \overline{OE} = HIGH or LOW)



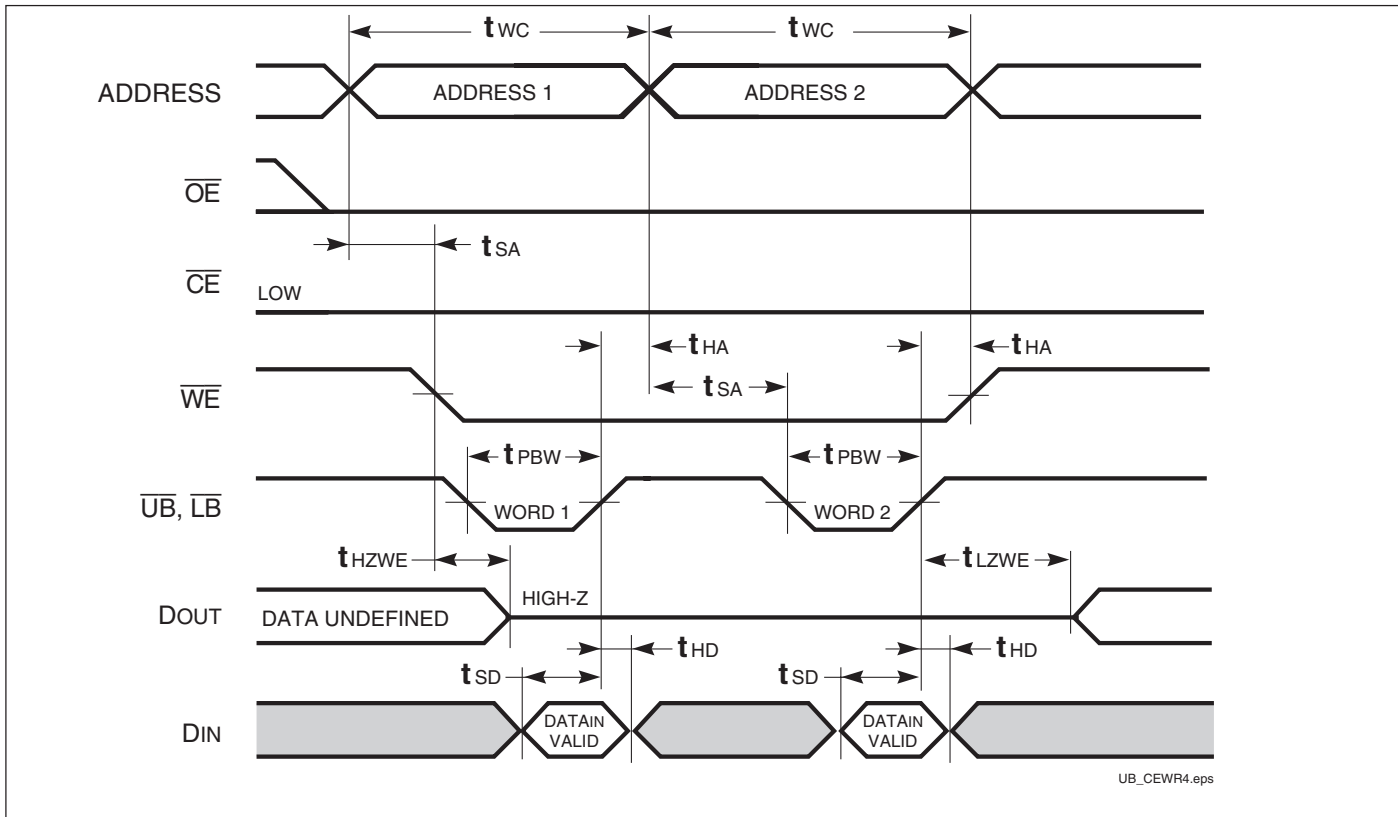
WRITE CYCLE NO. 2⁽¹⁾ (\overline{WE} Controlled, \overline{OE} = HIGH during Write Cycle)



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 $\overline{\text{OE}}$ HIGH for a minimum of 4 ns before $\overline{\text{WE}} = \text{LOW}$ to place the I/O in a HIGH-Z state.
3. $\overline{\text{WE}}$ 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.

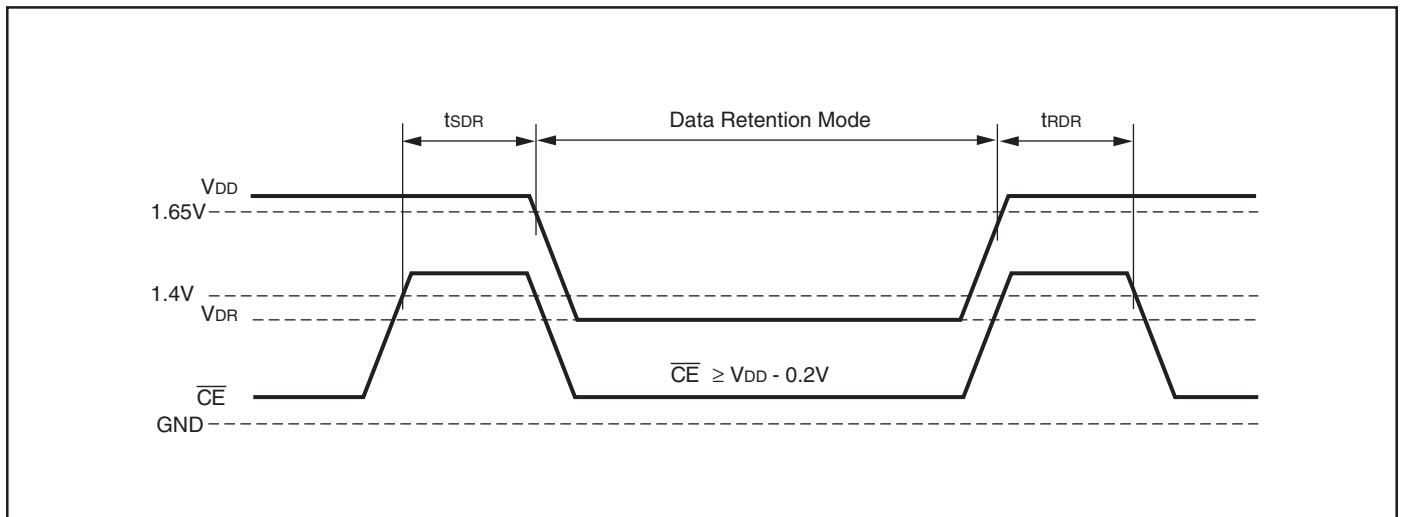
DATA RETENTION SWITCHING CHARACTERISTICS

| Symbol | Parameter | Test Condition | Operations | Min. | Typ. ⁽¹⁾ | Max. | Unit |
|------------------|------------------------------------|--|----------------------|-----------------|---------------------|----------------|------|
| V _{DR} | V _{DD} for Data Retention | See Data Retention Waveform | | 1.8 | — | 3.6 | V |
| I _{DR} | Data Retention Current | V _{DD} = 1.8V, $\overline{CE} \geq V_{DD} - 0.2V$ | COM. IND. AUTO | — — — | 6 6 6 | 20 50 75 | 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} = 2.5V, T_A = 25°C. Not 100% tested.

DATA RETENTION WAVEFORM (\overline{CE} Controlled)



ORDERING INFORMATION

Commercial Temperature Range: 0°C to +70°C

| Speed (ns) | Order Part No. | Package |
|------------|--------------------|--------------------------------|
| 12 | IS61WV6416BLL-12KL | 400-mil Plastic SOJ, Lead-free |

Industrial Temperature Range: -40°C to +85°C

| Speed (ns) | Order Part No. | Package |
|------------|---------------------|---------------------------------|
| 12 | IS61WV6416BLL-12TI | Plastic TSOP |
| 12 | IS61WV6416BLL-12TLI | Plastic TSOP, Lead-free |
| 12 | IS61WV6416BLL-12KLI | 400-mil Plastic SOJ, Lead-free |
| 12 | IS61WV6416BLL-12BI | mini BGA (6mm x 8mm) |
| 12 | IS61WV6416BLL-12BLI | mini BGA (6mm x 8mm), Lead-free |

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

| Speed (ns) | Order Part No. | Package |
|-----------------------|----------------------|---------------------------------|
| 15 (12 ¹) | IS64WV6416BLL-15TA3 | Plastic TSOP |
| 15 (12 ¹) | IS64WV6416BLL-15TLA3 | Plastic TSOP, Lead-free |
| 15 (12 ¹) | IS64WV6416BLL-15BA3 | mini BGA (6mm x 8mm) |
| 15 (12 ¹) | IS64WV6416BLL-15BLA3 | mini BGA (6mm x 8mm), Lead-free |

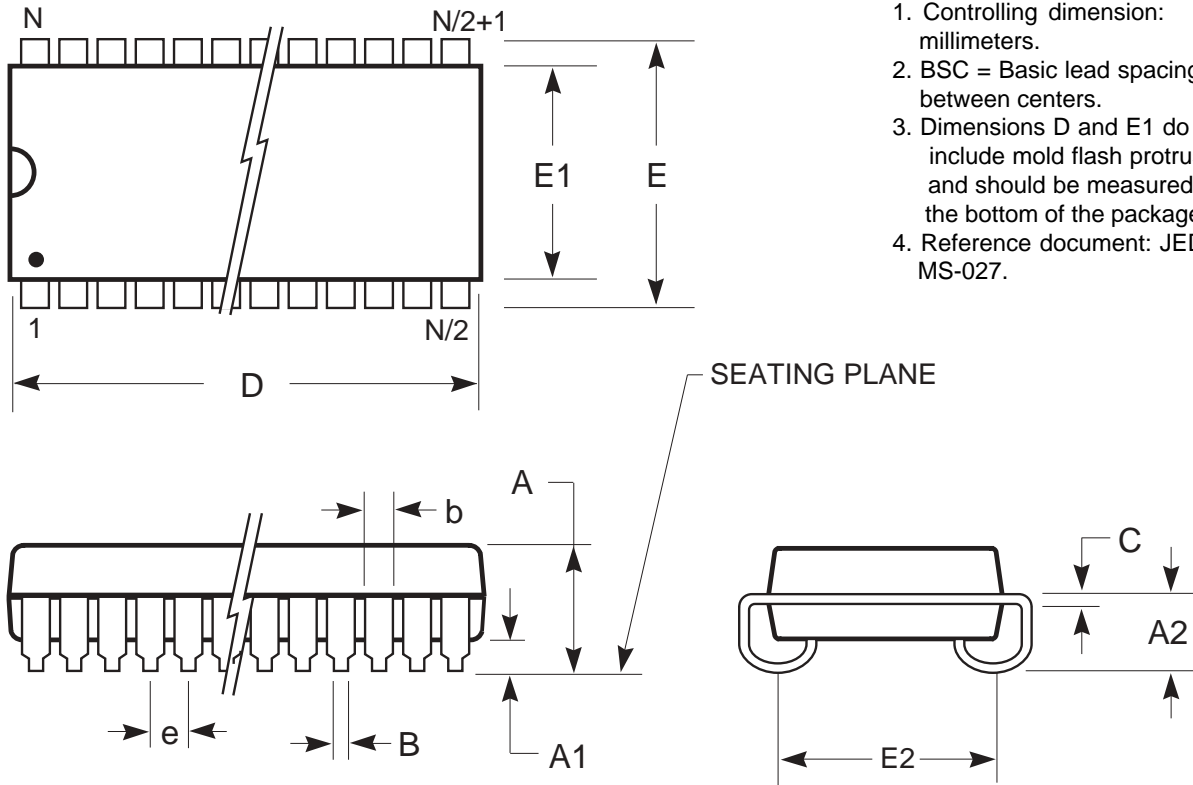
Note:

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

PACKAGING INFORMATION

400-mil Plastic SOJ

Package Code: K



Notes:

1. Controlling dimension: millimeters.
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. Reference document: JEDEC MS-027.

| Symbol | Millimeters | | Inches | | Millimeters | | Inches | | Millimeters | | Inches | |
|---------------|-------------|-------|-----------|-------|-------------|-------|-----------|-------|-------------|-------|-----------|-------|
| | Min | Max | Min | Max | Min | Max | Min | Max | Min | Max | Min | Max |
| No. Leads (N) | 28 | | | | 32 | | | | 36 | | | |
| A | 3.25 | 3.75 | 0.128 | 0.148 | 3.25 | 3.75 | 0.128 | 0.148 | 3.25 | 3.75 | 0.128 | 0.148 |
| A1 | 0.64 | — | 0.025 | — | 0.64 | — | 0.025 | — | 0.64 | — | 0.025 | — |
| A2 | 2.08 | — | 0.082 | — | 2.08 | — | 0.082 | — | 2.08 | — | 0.082 | — |
| B | 0.38 | 0.51 | 0.015 | 0.020 | 0.38 | 0.51 | 0.015 | 0.020 | 0.38 | 0.51 | 0.015 | 0.020 |
| b | 0.66 | 0.81 | 0.026 | 0.032 | 0.66 | 0.81 | 0.026 | 0.032 | 0.66 | 0.81 | 0.026 | 0.032 |
| C | 0.18 | 0.33 | 0.007 | 0.013 | 0.18 | 0.33 | 0.007 | 0.013 | 0.18 | 0.33 | 0.007 | 0.013 |
| D | 18.29 | 18.54 | 0.720 | 0.730 | 20.82 | 21.08 | 0.820 | 0.830 | 23.37 | 23.62 | 0.920 | 0.930 |
| E | 11.05 | 11.30 | 0.435 | 0.445 | 11.05 | 11.30 | 0.435 | 0.445 | 11.05 | 11.30 | 0.435 | 0.445 |
| E1 | 10.03 | 10.29 | 0.395 | 0.405 | 10.03 | 10.29 | 0.395 | 0.405 | 10.03 | 10.29 | 0.395 | 0.405 |
| E2 | 9.40 BSC | | 0.370 BSC | | 9.40 BSC | | 0.370 BSC | | 9.40 BSC | | 0.370 BSC | |
| e | 1.27 BSC | | 0.050 BSC | | 1.27 BSC | | 0.050 BSC | | 1.27 BSC | | 0.050 BSC | |

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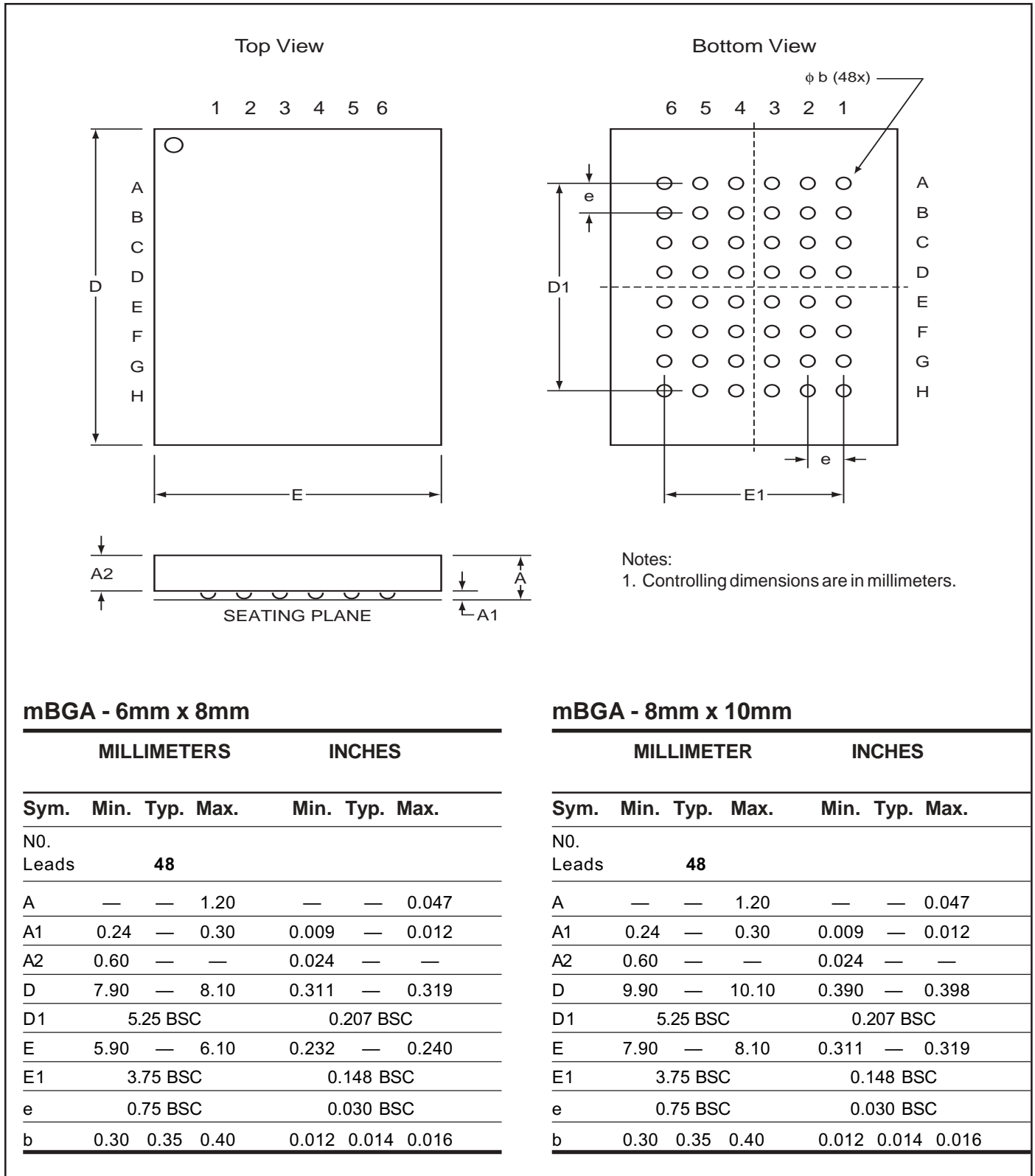
| Symbol | Millimeters | | Inches | | Millimeters | | Inches | | Millimeters | | Inches | |
|---------------|-------------|-------|-----------|-------|-------------|-------|-----------|-------|-------------|-------|-----------|-------|
| | Min | Max | Min | Max | Min | Max | Min | Max | Min | Max | Min | Max |
| No. Leads (N) | 40 | | | | 42 | | | | 44 | | | |
| A | 3.25 | 3.75 | 0.128 | 0.148 | 3.25 | 3.75 | 0.128 | 0.148 | 3.25 | 3.75 | 0.128 | 0.148 |
| A1 | 0.64 | — | 0.025 | — | 0.64 | — | 0.025 | — | 0.64 | — | 0.025 | — |
| A2 | 2.08 | — | 0.082 | — | 2.08 | — | 0.082 | — | 2.08 | — | 0.082 | — |
| B | 0.38 | 0.51 | 0.015 | 0.020 | 0.38 | 0.51 | 0.015 | 0.020 | 0.38 | 0.51 | 0.015 | 0.020 |
| b | 0.66 | 0.81 | 0.026 | 0.032 | 0.66 | 0.81 | 0.026 | 0.032 | 0.66 | 0.81 | 0.026 | 0.032 |
| C | 0.18 | 0.33 | 0.007 | 0.013 | 0.18 | 0.33 | 0.007 | 0.013 | 0.18 | 0.33 | 0.007 | 0.013 |
| D | 25.91 | 26.16 | 1.020 | 1.030 | 27.18 | 27.43 | 1.070 | 1.080 | 28.45 | 28.70 | 1.120 | 1.130 |
| E | 11.05 | 11.30 | 0.435 | 0.445 | 11.05 | 11.30 | 0.435 | 0.445 | 11.05 | 11.30 | 0.435 | 0.445 |
| E1 | 10.03 | 10.29 | 0.395 | 0.405 | 10.03 | 10.29 | 0.395 | 0.405 | 10.03 | 10.29 | 0.395 | 0.405 |
| E2 | 9.40 BSC | | 0.370 BSC | | 9.40 BSC | | 0.370 BSC | | 9.40 BSC | | 0.370 BSC | |
| e | 1.27 BSC | | 0.050 BSC | | 1.27 BSC | | 0.050 BSC | | 1.27 BSC | | 0.050 BSC | |

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PACKAGING INFORMATION



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



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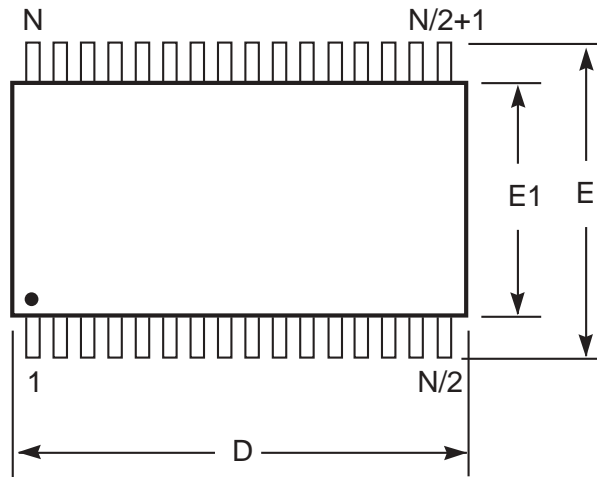
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Rev. D
01/15/03

PACKAGING INFORMATION

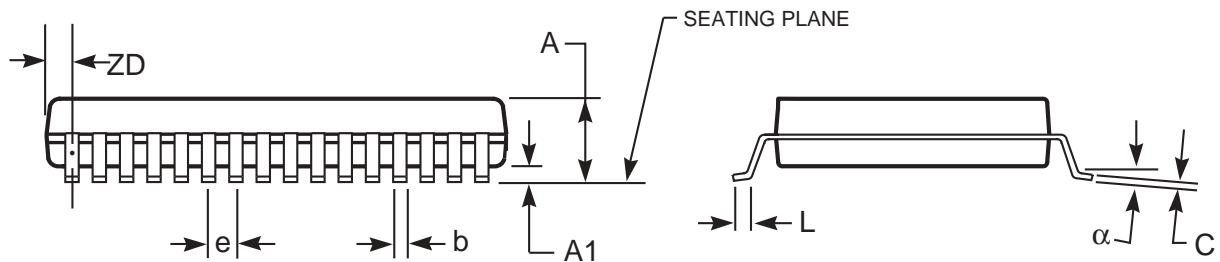


Plastic TSOP Package Code: T (Type II)



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 | |
| alpha | 0° | 5° | 0° | 5° | 0° | 5° | 0° | 5° | 0° | 5° | 0° | 5° |

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