

**Document Title**

**2Mx16 bit Page Mode Uni-Transistor Random Access Memory**

**Revision History**

<u>Revision No.</u>	<u>History</u>	<u>Draft Date</u>	<u>Remark</u>
0.0	Initial Draft	November 02, 2004	Preliminary
1.0	Finalize	Apri 06, 2005	Final

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## 2M x 16 bit Page Mode Uni-Transistor CMOS RAM

### FEATURES

- Process Technology: CMOS
- Organization: 2M x16 bit
- Power Supply Voltage: 1.7~2.0V
- Three State Outputs
- Compatible with Low Power SRAM
- Support 4 page read mode
- Package Type: 48-FBGA-6.00x8.00

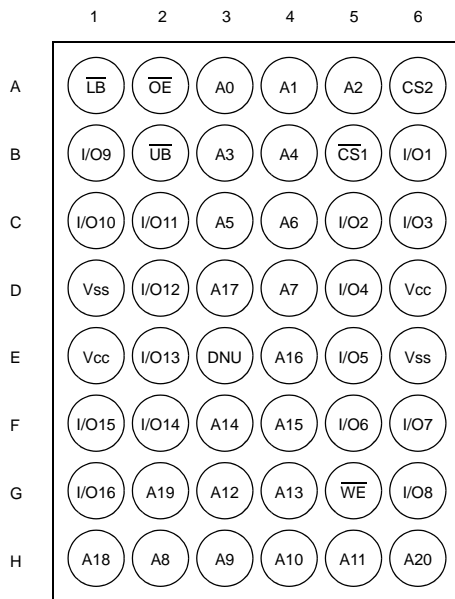
### GENERAL DESCRIPTION

The K1S3216BCD is fabricated by SAMSUNG's advanced CMOS technology using one transistor memory cell. The device support 4 page mode operation, Industrial temperature range and 48 ball Chip Scale Package for user flexibility of system design. The device also supports deep power down mode for low standby current.

### PRODUCT FAMILY

Product Family	Operating Temp.	Vcc Range	Speed (trc)	Power Dissipation		PKG Type
				Standby (I <sub>SB1</sub> , Max.)	Operating (I <sub>CC2</sub> , Max.)	
K1S3216BCD-I	Industrial(-40~85°C)	1.7~2.0V	70/85ns	100µA	35mA	48-FBGA-6.00x8.00

### PIN DESCRIPTION

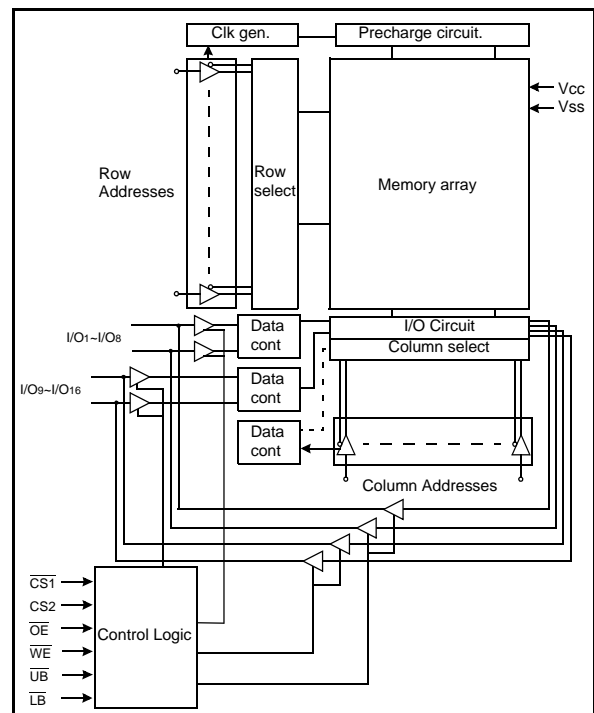


48-FBGA: Top View(Ball Down)

Name	Function	Name	Function
CS1, CS2	Chip Select Inputs	Vcc	Power
OE	Output Enable Input	Vss	Ground
WE	Write Enable Input	UB	Upper Byte(I/O <sub>9~16</sub> )
A0~A20	Address Inputs	LB	Lower Byte(I/O <sub>1~8</sub> )
I/O <sub>1~16</sub>	Data Inputs/Outputs	DNU	Do Not Use <sup>1)</sup>

1) Reserved for future use

### FUNCTIONAL BLOCK DIAGRAM

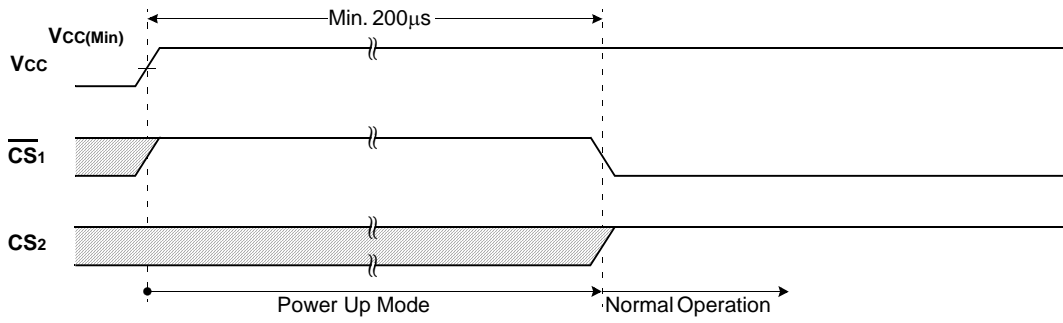


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**POWER UP SEQUENCE**

1. Apply power.
2. Maintain stable power ( $V_{cc}$  min.=1.7V) for a minimum 200 $\mu$ s with  $\overline{CS1}$ =high.or CS2=low.

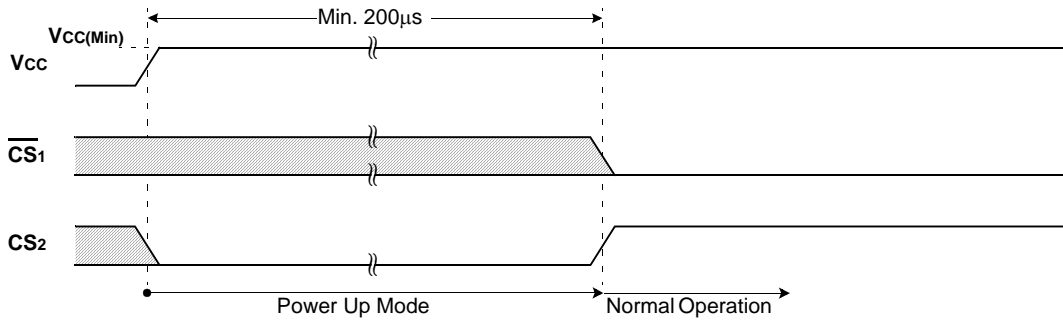
**TIMING WAVEFORM OF POWER UP(1) ( $\overline{CS1}$  controlled)**



**POWER UP(1)**

1. After  $V_{cc}$  reaches  $V_{cc}(\text{Min.})$ , wait 200 $\mu$ s with  $\overline{CS1}$  high. Then the device gets into the normal operation.

**TIMING WAVEFORM OF POWER UP(2) (CS2 controlled)**



**POWER UP(2)**

1. After  $V_{cc}$  reaches  $V_{cc}(\text{Min.})$ , wait 200 $\mu$ s with CS2 low. Then the device gets into the normal operation.

**FUNCTIONAL DESCRIPTION**

$\overline{\text{CS1}}$	$\text{CS2}$	$\overline{\text{OE}}$	$\overline{\text{WE}}$	$\overline{\text{LB}}$	$\overline{\text{UB}}$	I/O <sub>1-8</sub>	I/O <sub>9-16</sub>	Mode	Power
H	X <sup>1)</sup>	X <sup>1)</sup>	X <sup>1)</sup>	X <sup>1)</sup>	X <sup>1)</sup>	High-Z	High-Z	Deselected	Standby
X <sup>1)</sup>	L	X <sup>1)</sup>	X <sup>1)</sup>	X <sup>1)</sup>	X <sup>1)</sup>	High-Z	High-Z	Deselected	Standby
X <sup>1)</sup>	X <sup>1)</sup>	X <sup>1)</sup>	X <sup>1)</sup>	H	H	High-Z	High-Z	Deselected	Standby
L	H	H	H	L	X <sup>1)</sup>	High-Z	High-Z	Output Disabled	Active
L	H	H	H	X <sup>1)</sup>	L	High-Z	High-Z	Output Disabled	Active
L	H	L	H	L	H	Dout	High-Z	Lower Byte Read	Active
L	H	L	H	H	L	High-Z	Dout	Upper Byte Read	Active
L	H	L	H	L	L	Dout	Dout	Word Read	Active
L	H	X <sup>1)</sup>	L	L	H	Din	High-Z	Lower Byte Write	Active
L	H	X <sup>1)</sup>	L	H	L	High-Z	Din	Upper Byte Write	Active
L	H	X <sup>1)</sup>	L	L	L	Din	Din	Word Write	Active

1. X means don't care. (Must be VIL or VIH state)

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

Item	Symbol	Ratings	Unit
Voltage on any pin relative to Vss	V <sub>IN</sub> , V <sub>OUT</sub>	-0.2 to V <sub>CC</sub> +0.3V	V
Voltage on Vcc supply relative to Vss	V <sub>CC</sub>	-0.2 to 2.5V	V
Power Dissipation	P <sub>D</sub>	1.0	W
Storage temperature	T <sub>STG</sub>	-65 to 150	°C
Operating Temperature	T <sub>A</sub>	-40 to 85	°C

1. Stresses greater than those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. Functional operation should be restricted to be used under recommended operating condition. Exposure to absolute maximum rating conditions longer than 1 second may affect reliability.

## PRODUCT LIST

Industrial Temperature Product(-40~85°C)	
Part Name	Function
K1S3216BCD-FI70	48-FBGA, 70ns, 1.8V
K1S3216BCD-FI85	48-FBGA, 85ns, 1.8V

RECOMMENDED DC OPERATING CONDITIONS<sup>1)</sup>

Item	Symbol	Min	Typ	Max	Unit
Supply voltage	V <sub>CC</sub>	1.7	1.85	2.0	V
Ground	V <sub>SS</sub>	0	0	0	V
Input high voltage	V <sub>IH</sub>	1.4	-	V <sub>CC</sub> +0.3 <sup>2)</sup>	V
Input low voltage	V <sub>IL</sub>	-0.2 <sup>3)</sup>	-	0.4	V

1. T<sub>A</sub>=-40 to 85°C, otherwise specified.
2. Overshoot: V<sub>CC</sub>+1.0V in case of pulse width ≤3ns.
3. Undershoot: -1.0V in case of pulse width ≤3ns.
4. Overshoot and undershoot are sampled, not 100% tested.

CAPACITANCE<sup>1)</sup>(f=1MHz, T<sub>A</sub>=25°C)

Item	Symbol	Test Condition	Min	Max	Unit
Input capacitance	C <sub>IN</sub>	V <sub>IN</sub> =0V	-	8	pF
Input/Output capacitance	C <sub>IO</sub>	V <sub>IO</sub> =0V	-	10	pF

1. Capacitance is sampled, not 100% tested.

## DC AND OPERATING CHARACTERISTICS

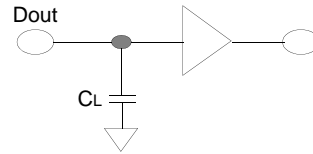
Item	Symbol	Test Conditions	Min	Typ <sup>1)</sup>	Max	Unit
Input leakage current	I <sub>LI</sub>	V <sub>IN</sub> =V <sub>SS</sub> to V <sub>CC</sub>	-1	-	1	μA
Output leakage current	I <sub>LO</sub>	$\overline{CS}_1=V_{IH}$ or CS <sub>2</sub> =V <sub>IL</sub> or $\overline{OE}=V_{IH}$ or $\overline{WE}=V_{IL}$ or $\overline{LB}=\overline{UB}=V_{IH}$ , V <sub>IO</sub> =V <sub>SS</sub> to V <sub>CC</sub>	-1	-	1	μA
Average operating current	I <sub>CC1</sub>	Cycle time=1μs, 100% duty, I <sub>IO</sub> =0mA, $\overline{CS}_1 \leq 0.2V$ , $\overline{LB} \leq 0.2V$ or/and $\overline{UB} \leq 0.2V$ , CS <sub>2</sub> ≥V <sub>CC</sub> -0.2V, V <sub>IN</sub> ≤0.2V or V <sub>IN</sub> ≥V <sub>CC</sub> -0.2V	-	-	5	mA
	I <sub>CC2</sub>	Cycle time=Min, I <sub>IO</sub> =0mA, 100% duty, $\overline{CS}_1=V_{IL}$ , CS <sub>2</sub> =V <sub>IH</sub> , $\overline{LB}=V_{IL}$ or/and $\overline{UB}=V_{IL}$ , V <sub>IN</sub> =V <sub>IL</sub> or V <sub>IH</sub>	-	-	35	mA
Output low voltage	V <sub>OL</sub>	I <sub>OL</sub> =0.1mA	-	-	0.2	V
Output high voltage	V <sub>OH</sub>	I <sub>OH</sub> =-0.1mA	1.4	-	-	V
Standby Current(CMOS)	I <sub>SB1</sub> <sup>2)</sup>	Other inputs = 0~V <sub>CC</sub> 1) $\overline{CS}_1 \geq V_{CC}-0.2V$ , CS <sub>2</sub> ≤V <sub>CC</sub> -0.2V ( $\overline{CS}_1$ controlled) or 2) 0V≤CS <sub>2</sub> ≤0.2V (CS <sub>2</sub> controlled)	-	-	100	μA

1. Typical values are tested at V<sub>CC</sub>=1.8V, T<sub>A</sub>=25°C and not guaranteed.
2. I<sub>SB1</sub> is measured after 60ms from the time when standby mode is set up.

**AC OPERATING CONDITIONS**

**TEST CONDITIONS**(Test Load and Test Input/Output Reference)

Input pulse level: 0.2 to V<sub>cc</sub>-0.2V  
 Input rising and falling time: 5ns  
 Input and output reference voltage: 0.5 x V<sub>cc</sub>  
 Output load (See right): C<sub>L</sub>=50pF



1. Including scope and jig capacitance

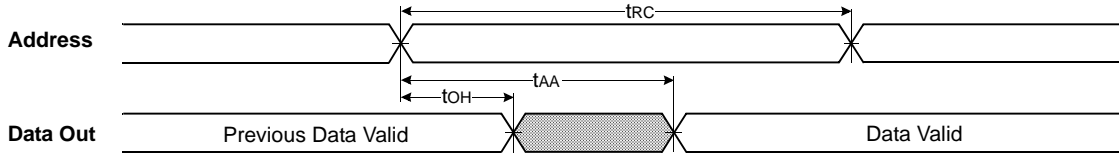
**AC CHARACTERISTICS** (V<sub>cc</sub>=1.7~2.0V, T<sub>A</sub>=-40 to 85°C)

	Parameter List	Symbol	Speed Bins				Units
			70ns		85ns		
			Min	Max	Min	Max	
Common	$\overline{\text{CS}}$ High Pulse Width	tCSHP	10	-	10	-	ns
Read	Read Cycle Time	tRC	70	-	85	-	ns
	Address Access Time	tAA	-	70	-	85	ns
	Chip Select to Output	tCO	-	70	-	85	ns
	Output Enable to Valid Output	tOE	-	35	-	40	ns
	$\overline{\text{UB}}$ , $\overline{\text{LB}}$ Access Time	tBA	-	70	-	85	ns
	Chip Select to Low-Z Output	tLZ	10	-	10	-	ns
	$\overline{\text{UB}}$ , $\overline{\text{LB}}$ Enable to Low-Z Output	tBLZ	10	-	10	-	ns
	Output Enable to Low-Z Output	tOLZ	5	-	5	-	ns
	Chip Disable to High-Z Output	tHZ	0	25	0	25	ns
	$\overline{\text{UB}}$ , $\overline{\text{LB}}$ Disable to High-Z Output	tBHZ	0	25	0	25	ns
	Output Disable to High-Z Output	tOHZ	0	25	0	25	ns
	Output Hold from Address Change	tOH	3	-	3	-	ns
	Page Cycle	tPC	25	-	25	-	ns
	Page Access Time	tPA	-	20	-	20	ns
Write	Write Cycle Time	tWC	70	-	85	-	ns
	Chip Select to End of Write	tCW	60	-	70	-	ns
	Address Set-up Time	tAS	0	-	0	-	ns
	Address Valid to End of Write	tAW	60	-	70	-	ns
	$\overline{\text{UB}}$ , $\overline{\text{LB}}$ Valid to End of Write	tBW	60	-	70	-	ns
	Write Pulse Width	tWP	55 <sup>1)</sup>	-	60 <sup>1)</sup>	-	ns
	Write Recovery Time	tWR	0	-	0	-	ns
	Write to Output High-Z	tWHZ	0	25	0	25	ns
	Data to Write Time Overlap	tDW	30	-	35	-	ns
	Data Hold from Write Time	tDH	0	-	0	-	ns
	End Write to Output Low-Z	tOW	5	-	5	-	ns

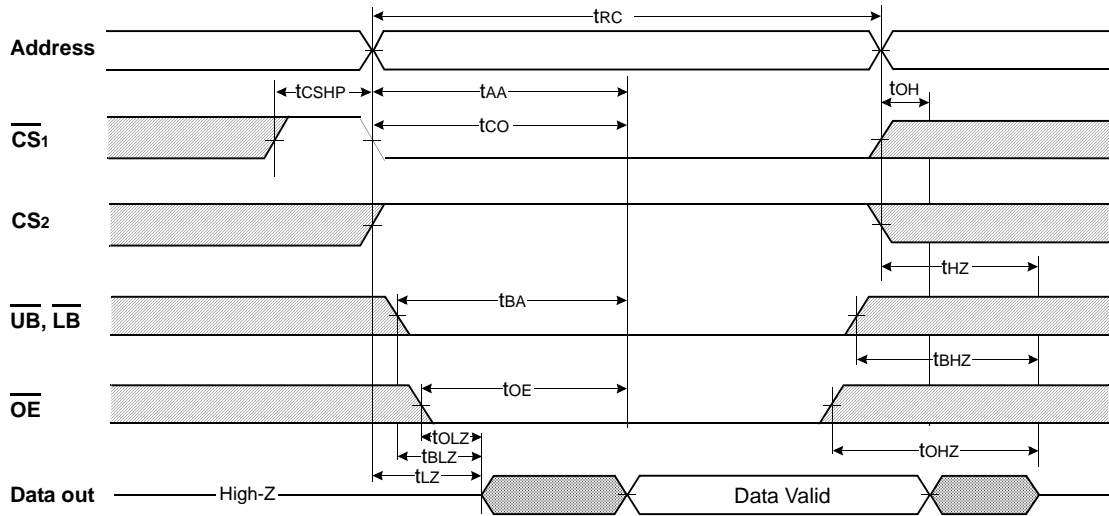
1. tWP(min)=70ns or tWC(min)=90ns for continuous write operation over 50 times.

TIMING DIAGRAMS

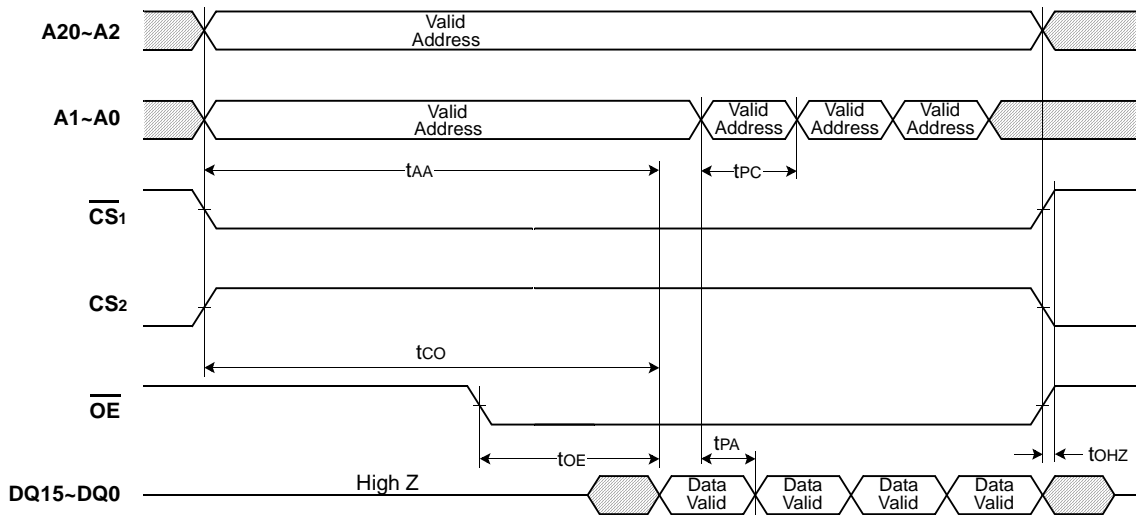
TIMING WAVEFORM OF READ CYCLE(1)(Address Controlled,  $\overline{CS}=\overline{OE}=V_{IL}$ ,  $\overline{WE}=V_{IH}$ ,  $\overline{UB}$  or/and  $\overline{LB}=V_{IL}$ )



TIMING WAVEFORM OF READ CYCLE(2)( $\overline{WE}=V_{IH}$ )



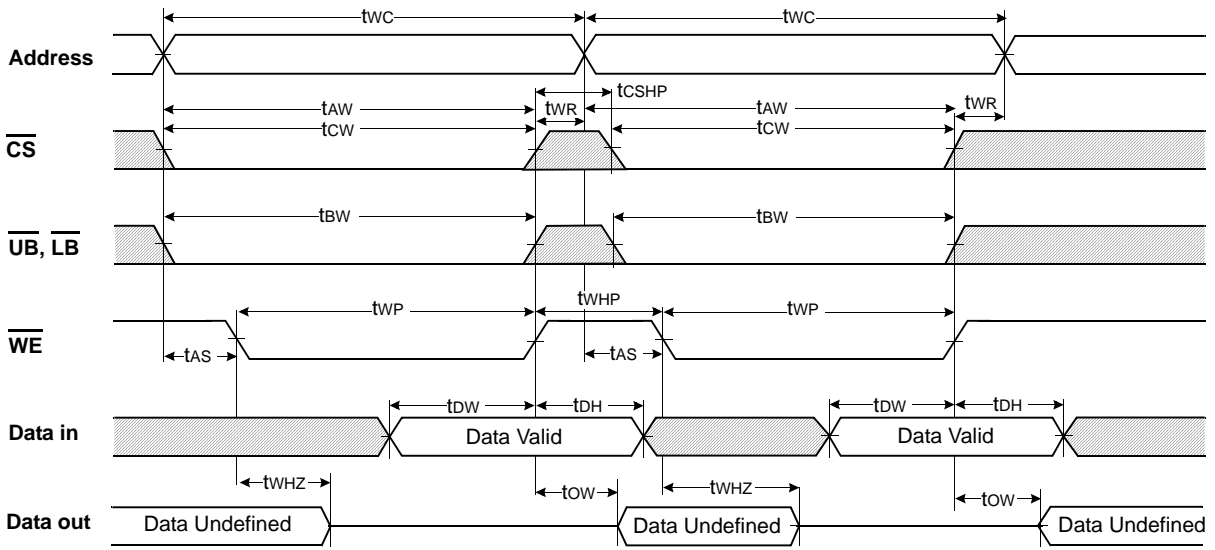
TIMING WAVEFORM OF PAGE CYCLE(READ ONLY)



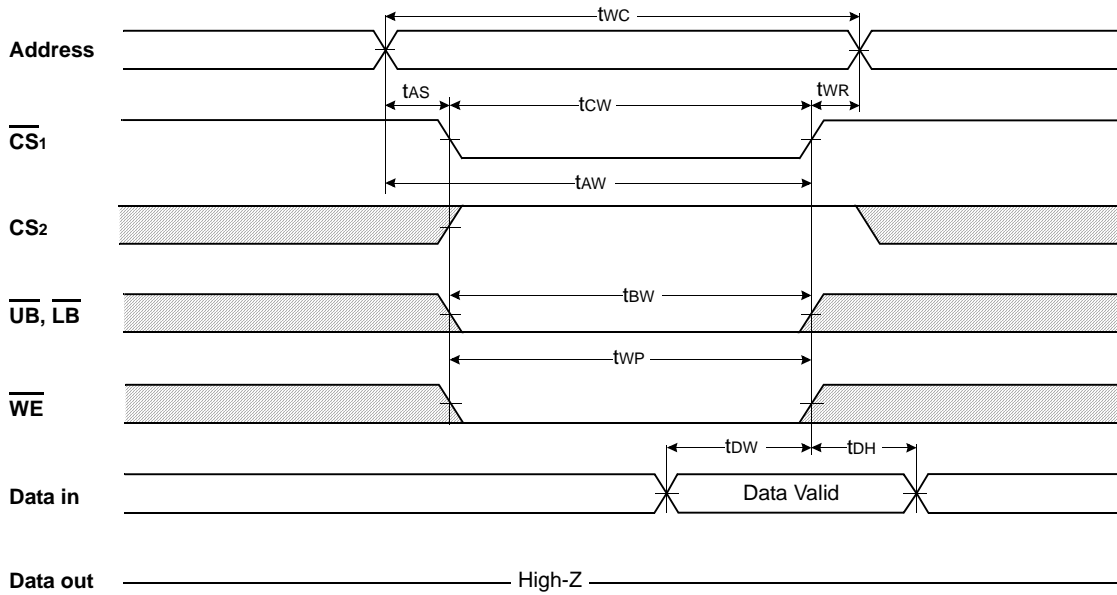
(READ CYCLE)

1. tHZ and tOHZ are defined as the time at which the outputs achieve the open circuit conditions and are not referenced to output voltage levels.
2. At any given temperature and voltage condition, tHZ(Max.) is less than tLZ(Min.) both for a given device and from device to device interconnection.
3. tOE(max) is met only when  $\overline{OE}$  becomes enabled after tAA(max).
4. If invalid address signals shorter than min. tRC are continuously repeated for over 4 $\mu$ s, the device needs a normal read timing(tRC) or needs to sustain standby state for min. tRC at least once in every 4 $\mu$ s.

TIMING WAVEFORM OF WRITE CYCLE(1) ( $\overline{WE}$  Controlled)

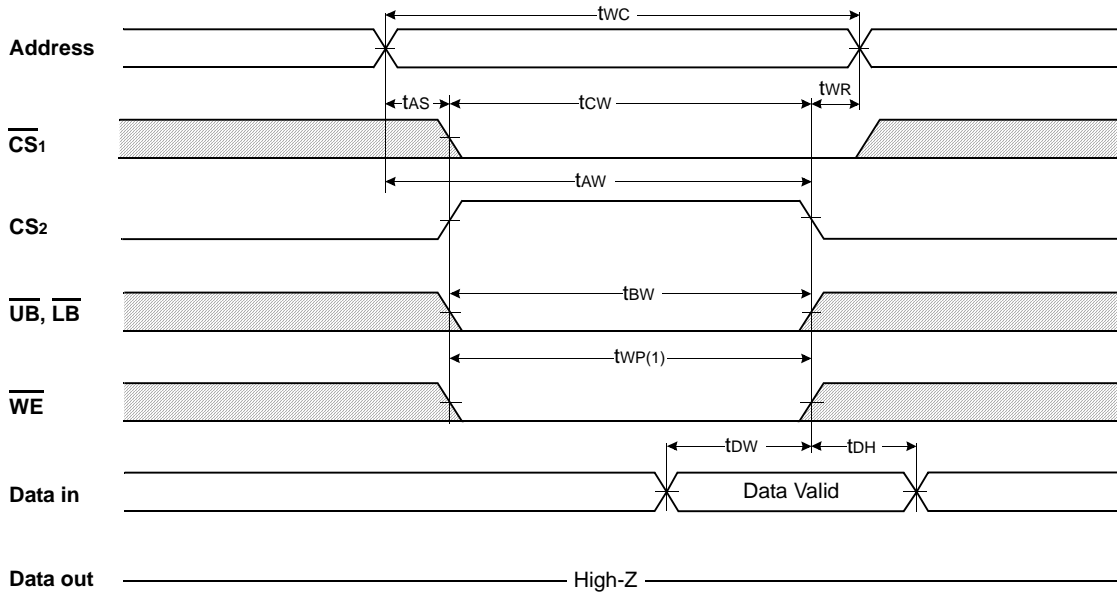


TIMING WAVEFORM OF WRITE CYCLE(2) ( $\overline{CS}_1$  Controlled)

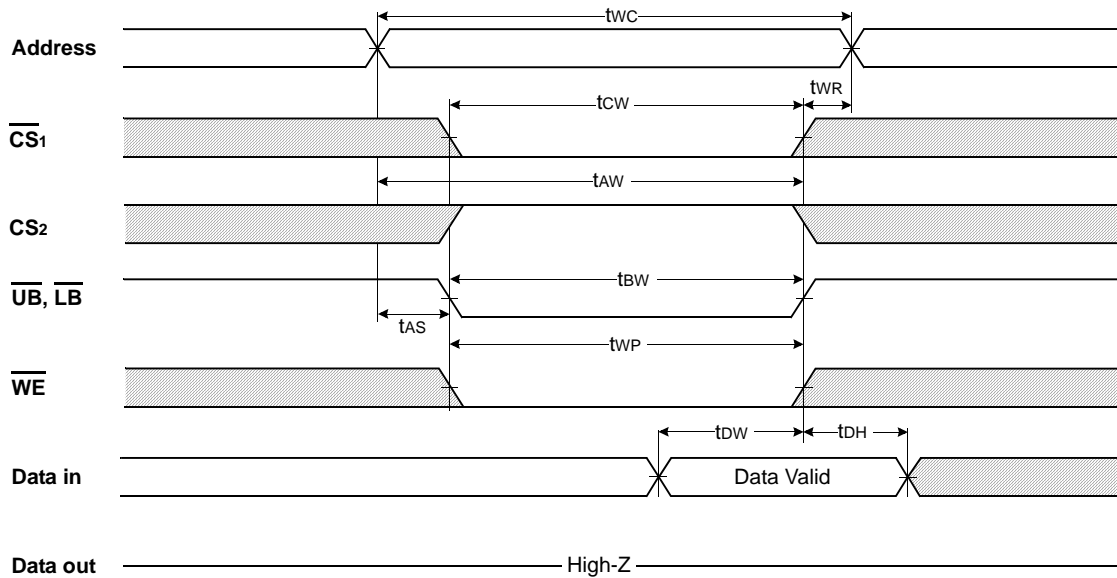




**TIMING WAVEFORM OF WRITE CYCLE(3) (CS2 Controlled)**



**TIMING WAVEFORM OF WRITE CYCLE(4) ( $\overline{UB}$ ,  $\overline{LB}$  Controlled)**



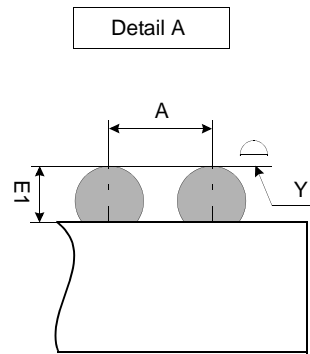
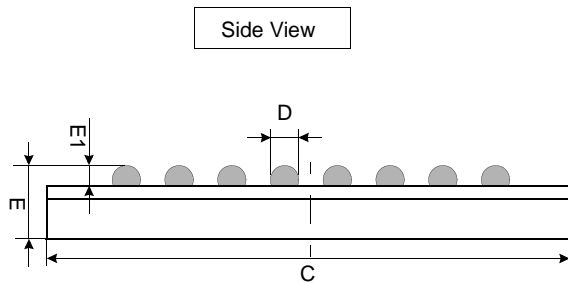
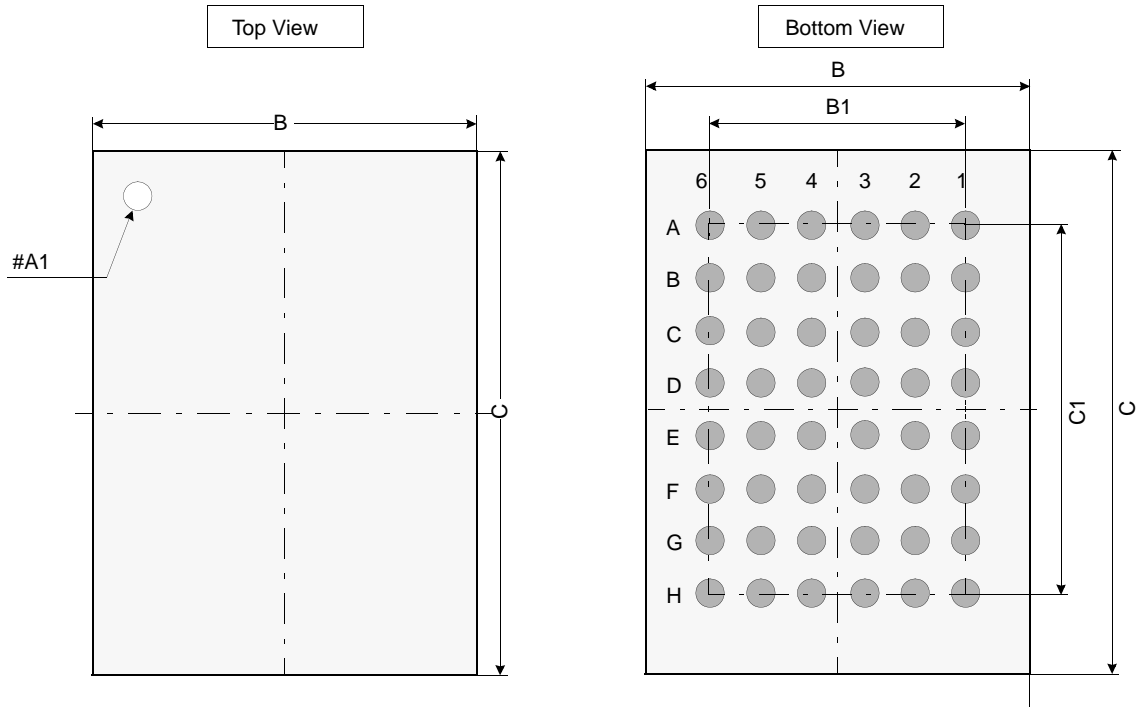
**NOTES (WRITE CYCLE)**

1. A write occurs during the overlap(tWP) of low  $\overline{CS1}$  and low  $\overline{WE}$ . A write begins when  $\overline{CS1}$  goes low and  $\overline{WE}$  goes low with asserting  $\overline{UB}$  or  $\overline{LB}$  for single byte operation or simultaneously asserting  $\overline{UB}$  and  $\overline{LB}$  for double byte operation. A write ends at the earliest transition when  $\overline{CS1}$  goes high and  $\overline{WE}$  goes high. The tWP is measured from the beginning of write to the end of write.
2. tCW is measured from the  $\overline{CS1}$  going low to the end of write.
3. tAS is measured from the address valid to the beginning of write.
4. tWR is measured from the end of write to the address change. tWR is applied in case a write ends with  $\overline{CS1}$  or  $\overline{WE}$  going high.

## PACKAGE DIMENSION

Unit: millimeters

48 BALL FINE PITCH BGA(0.75mm ball pitch)



	Min	Typ	Max
A	-	0.75	-
B	5.90	6.00	6.10
B1	-	3.75	-
C	7.90	8.00	8.10
C1	-	5.25	-
D	0.40	0.45	0.50
E	-		1.00
E1	0.25		
Y	-	-	0.10

**Notes.**

1. Bump counts: 48(8 row x 6 column)
2. Bump pitch : (x,y)=(0.75 x 0.75)(typ.)
3. All tolerance are  $\pm 0.050$  unless specified beside figures.
4. Typ : Typical
5. Y is coplanarity