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Document Title

1Mx16 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	December 12, 2003	Preliminary

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## 1M x 16 bit Page Mode Uni-Transistor CMOS RAM

### FEATURES

- Process Technology: CMOS
- Organization: 1M x16 bit
- Power Supply Voltage: 1.7~2.1V
- Three State Outputs
- Compatible with Low Power SRAM
- Support 4 page read mode
- Package Type: 48-FBGA-6.00x7.00

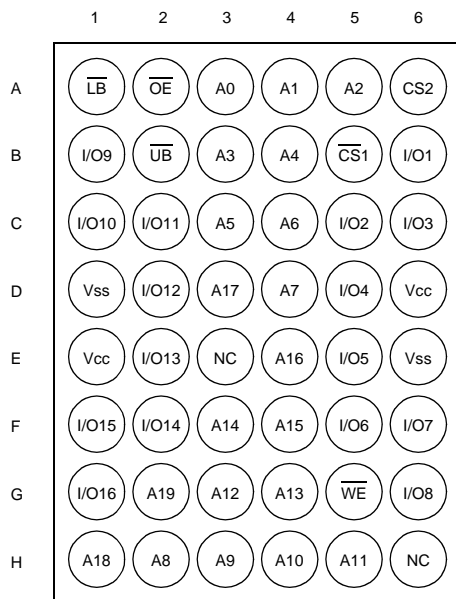
### GENERAL DESCRIPTION

The K1S1616BCA 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.)	
K1S1616BCA-I	Industrial(-40~85°C)	1.7~2.1V	70/85ns	80µA	30mA	48-FBGA-6.00x7.00

### PIN DESCRIPTION

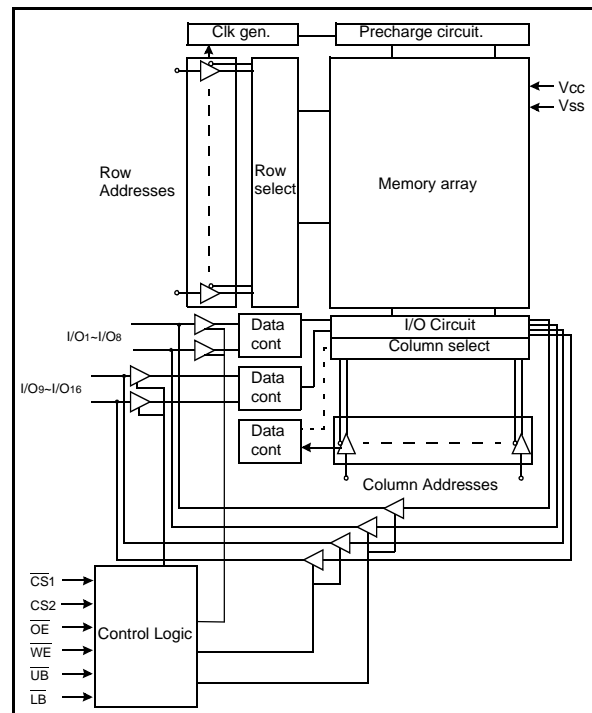


48-FBGA: Top View(Ball Down)

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/O9~16)
A0~A19	Address Inputs	LB	Lower Byte(I/O1~8)
I/O1~I/O16	Data Inputs/Outputs	NC	No Connection <sup>1)</sup>

1) Reserved for future use

### FUNCTIONAL BLOCK DIAGRAM

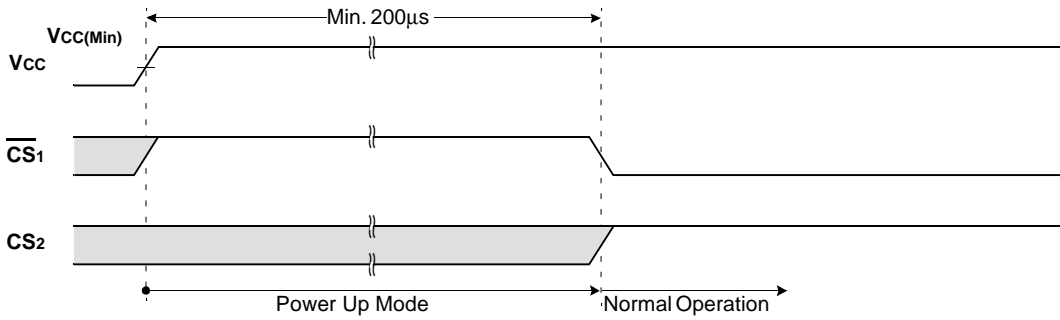


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## POWER UP SEQUENCE

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

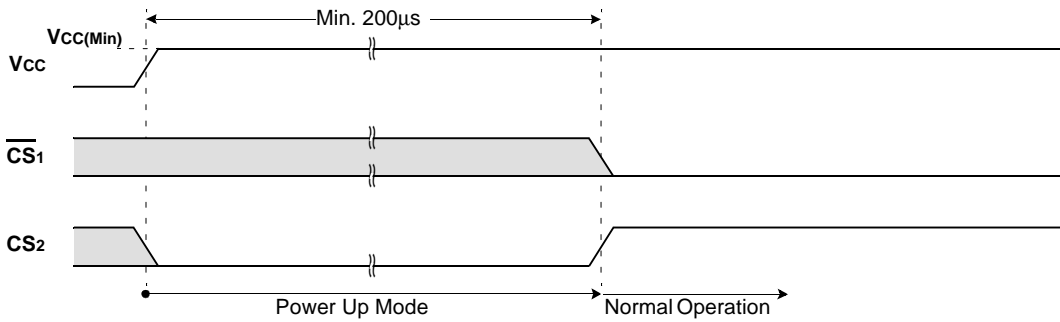
### TIMING WAVEFORM OF POWER UP(1) ( $\overline{CS1}$ controlled)



#### 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**

$\overline{CS1}$	$CS2$	$\overline{OE}$	$\overline{WE}$	$\overline{LB}$	$\overline{UB}$	I/O1-8	I/O9-16	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 low or high 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 Vcc+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
K1S1616BCA-FI70	48-FBGA-6.00x7.00, 70ns
K1S1616BCA-FI85	48-FBGA-6.00x7.00, 85ns
K1S1616BCA-BI70 <sup>1)</sup>	48-FBGA-6.00x7.00, 70ns
K1S1616BCA-BI85 <sup>1)</sup>	48-FBGA-6.00x7.00, 85ns

1. Lead Free Product

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

Item	Symbol	Min	Typ	Max	Unit
Supply voltage	V <sub>CC</sub>	1.7	1.8/2.0	2.1	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 ≤20ns.
3. Undershoot: -1.0V in case of pulse width ≤20ns.
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

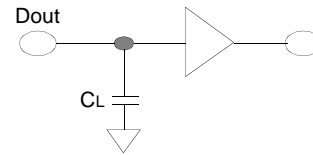
Item	Symbol	Test Conditions	Min	Typ <sup>1)</sup>	Max	Unit
Input leakage current	I <sub>LI</sub>	V <sub>IN</sub> =V <sub>SS</sub> to V <sub>CC</sub>	-1	-	1	μA
Output leakage current	I <sub>LO</sub>	$\overline{CS}=V_{IH}, \overline{ZZ}=V_{IH}, \overline{OE}=V_{IH}$ or $\overline{WE}=V_{IL}, V_{IO}=V_{SS}$ 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, $\overline{CS} \leq 0.2V$ , $\overline{ZZ} \geq V_{CC}-0.2V$ , 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=t <sub>RC</sub> +3t <sub>PC</sub> , I <sub>IO</sub> =0mA, 100% duty, $\overline{CS}=V_{IL}, \overline{ZZ}=V_{IH}$ , V <sub>IN</sub> =V <sub>IL</sub> or V <sub>IH</sub>	-	-	30	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>	$\overline{CS} \geq V_{CC}-0.2V, \overline{ZZ} \geq V_{CC}-0.2V$ , Other inputs=V <sub>SS</sub> to V <sub>CC</sub>	-	-	80	μA

1. Typical values are tested at V<sub>CC</sub>=1.8V, T<sub>A</sub>=25°C and not guaranteed.

## AC OPERATING CONDITIONS

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

Input pulse level: 0.2 to  $V_{CC}-0.2V$   
 Input rising and falling time: 5ns  
 Input and output reference voltage:  $0.5 \times V_{CC}$   
 Output load (See right):  $C_L=50pF$



1. Including scope and jig capacitance

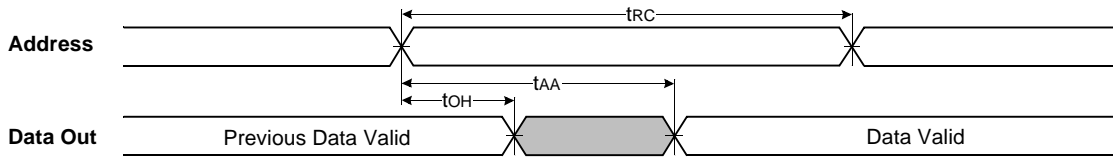
## AC CHARACTERISTICS ( $V_{CC}=1.7\sim 2.1V$ , $T_A=-40$ to $85^\circ C$ )

Parameter List		Symbol	Speed Bins				Units
			70ns		85ns		
			Min	Max	Min	Max	
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
	$\overline{UB}$ , $\overline{LB}$ Access Time	tBA	-	70	-	85	ns
	Chip Select to Low-Z Output	tLZ	10	-	10	-	ns
	$\overline{UB}$ , $\overline{LB}$ 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
	$\overline{UB}$ , $\overline{LB}$ 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	5	-	5	-	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
	$\overline{UB}$ , $\overline{LB}$ 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

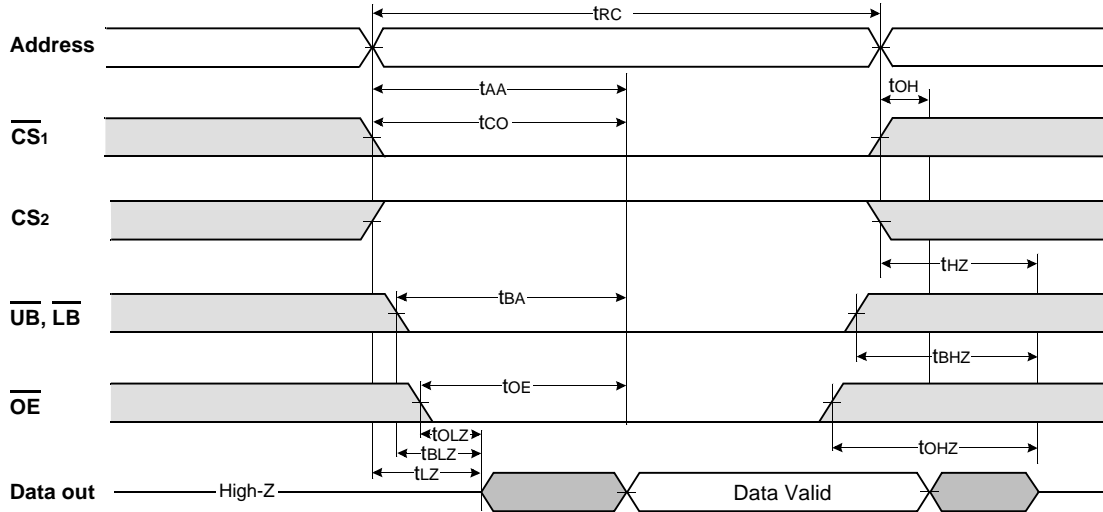
1. tWP(min)=70ns for continuous write operation over 50 times.

TIMING DIAGRAMS

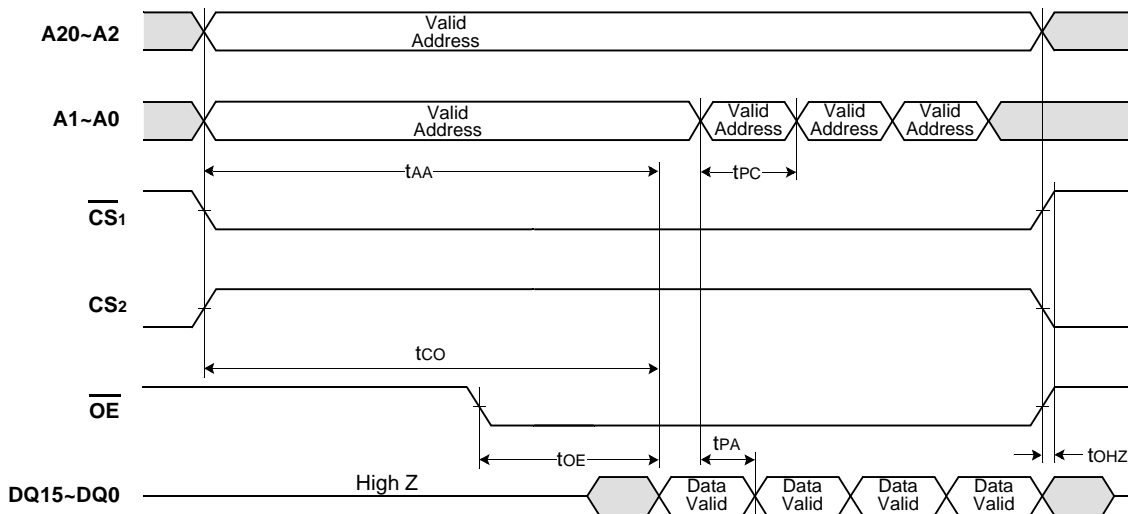
TIMING WAVEFORM OF READ CYCLE(1)(Address Controlled,  $\overline{CS}=\overline{OE}=V_{IL}$ ,  $\overline{WE}=V_{IH}$ ,  $\overline{UB}$  or/and  $\overline{LB}=V_{IL}$ )



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



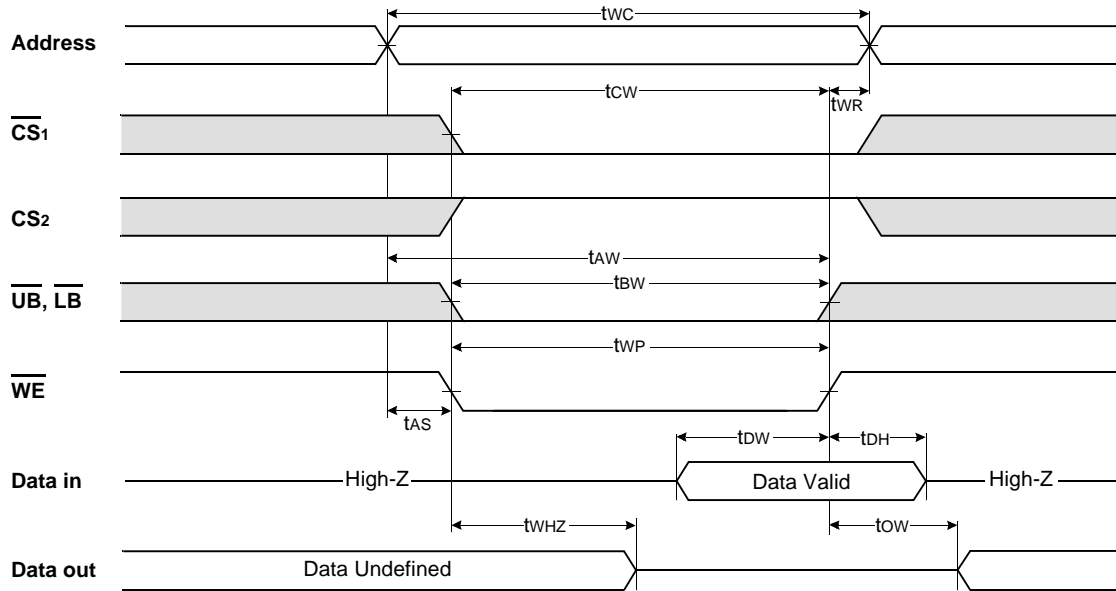
TIMING WAVEFORM OF PAGE CYCLE(READ ONLY)



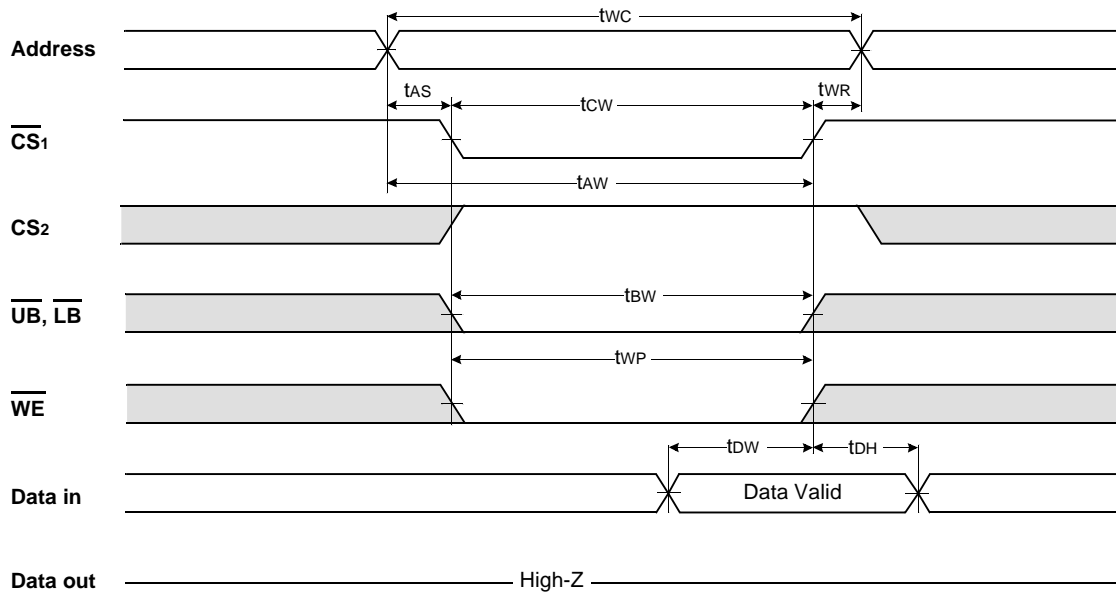
(READ CYCLE)

1.  $t_{HZ}$  and  $t_{OZH}$  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,  $t_{HZ}(\text{Max.})$  is less than  $t_{LZ}(\text{Min.})$  both for a given device and from device to device interconnection.
3.  $t_{OE}(\text{max})$  is met only when  $\overline{OE}$  becomes enabled after  $t_{AA}(\text{max})$ .
4. If invalid address signals shorter than min.  $t_{RC}$  are continuously repeated for over 4 $\mu\text{s}$ , the device needs a normal read timing( $t_{RC}$ ) or needs to sustain standby state for min.  $t_{RC}$  at least once in every 4 $\mu\text{s}$ .

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

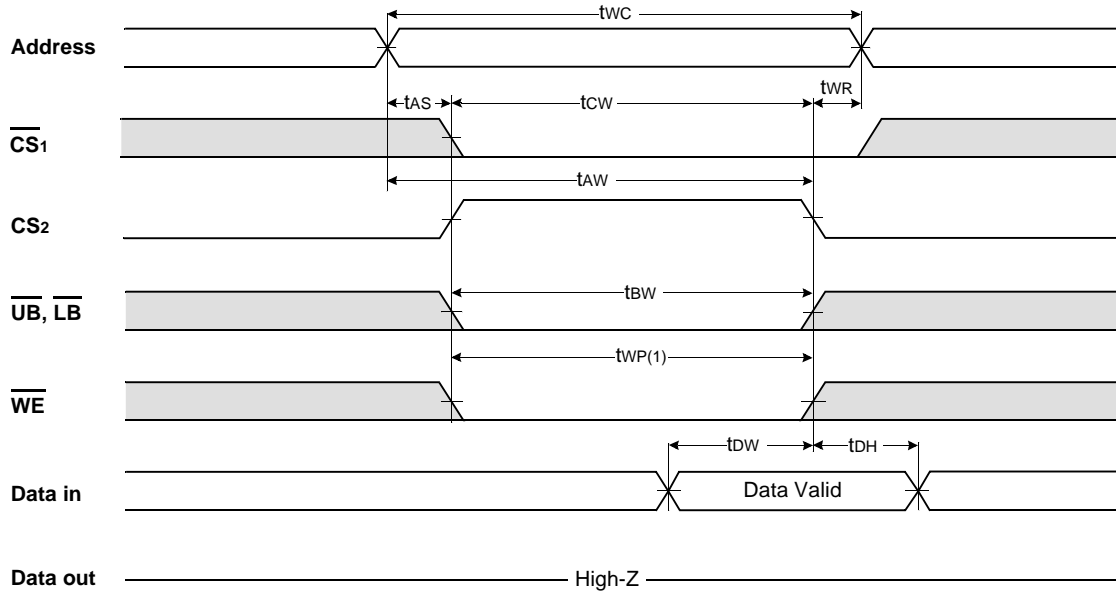


TIMING WAVEFORM OF WRITE CYCLE(2) ( $\overline{CS1}$  Controlled)

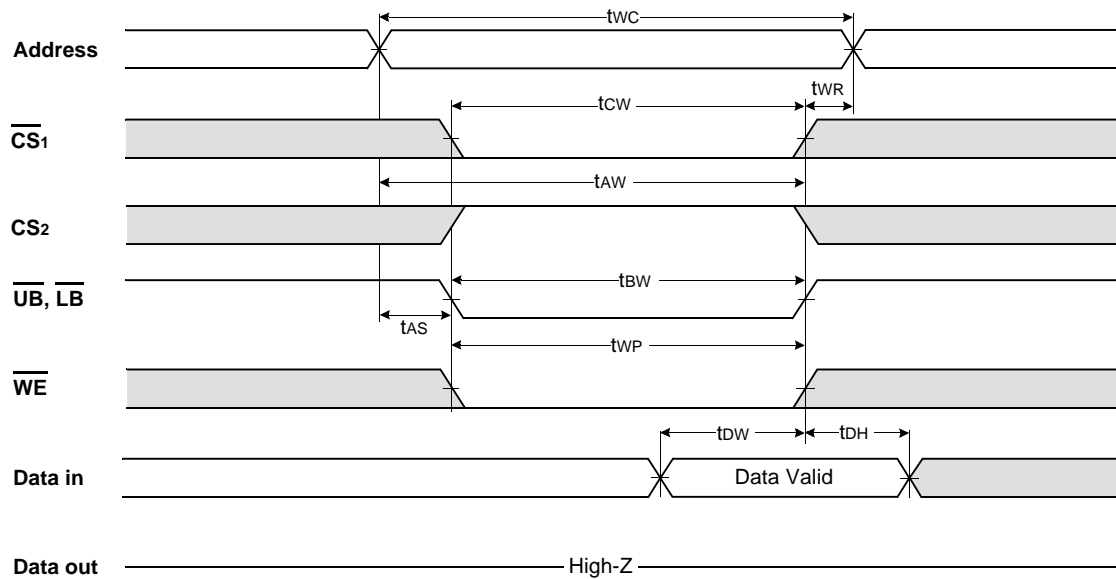




**TIMING WAVEFORM OF WRITE CYCLE(3) (CS2 Controlled)**



**TIMING WAVEFORM OF WRITE CYCLE(4) (UB, LB Controlled)**



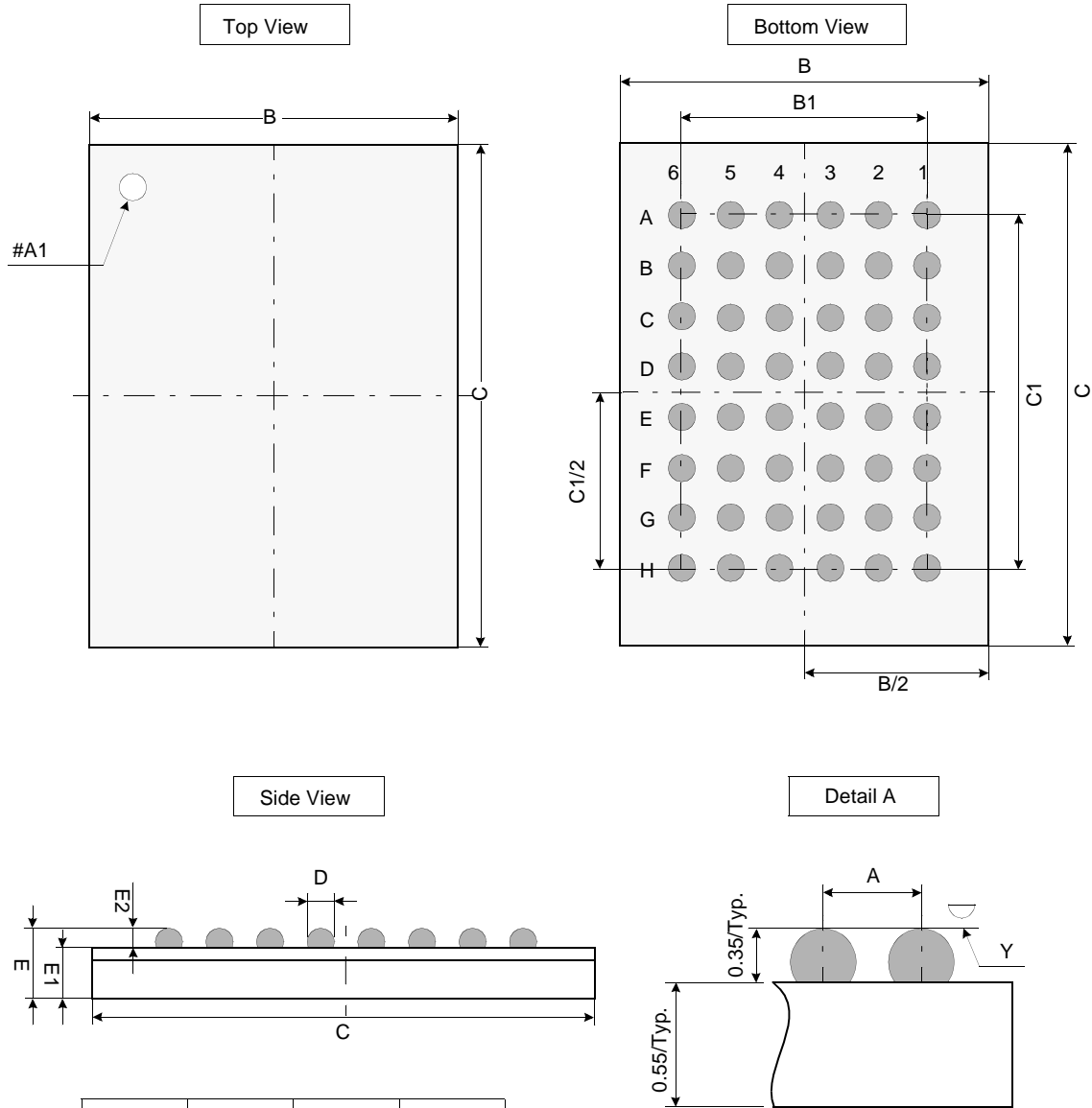
**NOTES (WRITE CYCLE)**

1. A write occurs during the overlap(tWP) of low CS1 and low WE. A write begins when CS1 goes low and WE goes low with asserting UB or LB for single byte operation or simultaneously asserting UB and LB for double byte operation. A write ends at the earliest transition when CS1 goes high and WE goes high. The tWP is measured from the beginning of write to the end of write.
2. tcw is measured from the 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 CS1 or 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	-	0.90	1.00
E1	-	0.55	-
E2	0.30	0.35	0.40
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: 0.10(Max)