

**Document Title**

**1Mx16 bit Uni-Transistor Random Access Memory**

**Revision History**

<b><u>Revision No.</u></b>	<b><u>History</u></b>	<b><u>Draft Date</u></b>	<b><u>Remark</u></b>
0.0	Initial Draft	October 6, 2003	Preliminary
0.1	Revised - Added Lead Free 48-FBGA-6.00x7.00 Product	November 25, 2003	Preliminary

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# K1S161611A

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

### FEATURES

- Process Technology: CMOS
- Organization: 1M x16 bit
- Power Supply Voltage: 2.7V~3.1V
- Three State Outputs
- Compatible with Low Power SRAM
- Dual Chip selection support
- Package Type: 48-FBGA-6.00x7.00

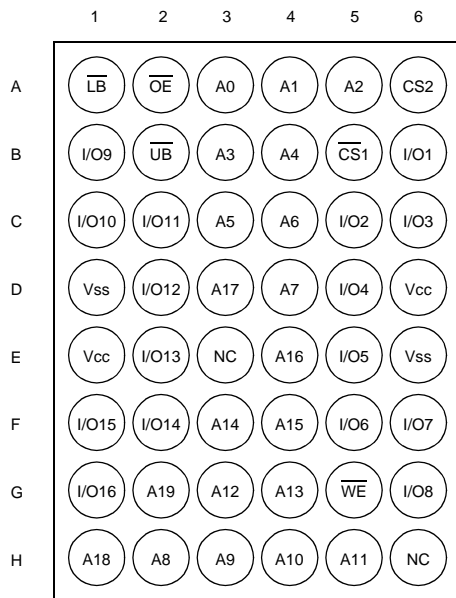
### GENERAL DESCRIPTION

The K1S161611A is fabricated by SAMSUNG's advanced CMOS technology using one transistor memory cell. The device supports Industrial temperature range and 48 ball Chip Scale Package for user flexibility of system design. The device also supports dual chip selection for user interface.

### PRODUCT FAMILY

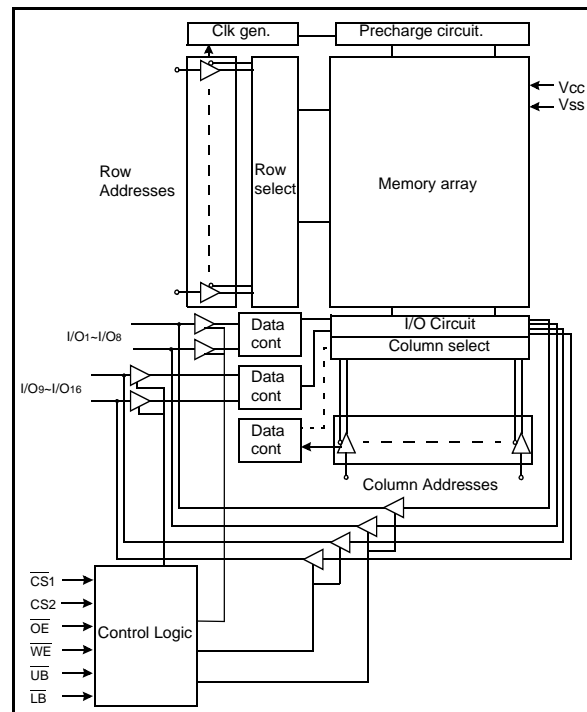
Product Family	Operating Temp.	Vcc Range	Speed	Power Dissipation		PKG Type
				Standby (I <sub>SB1</sub> , Max.)	Operating (I <sub>CC2</sub> , Max.)	
K1S161611A-I	Industrial(-40~85°C)	2.7V~3.1V	70ns	80μA	30mA	48-FBGA-6.00x7.00

### PIN DESCRIPTION



48-FBGA: Top View(Ball Down)

### FUNCTIONAL BLOCK DIAGRAM



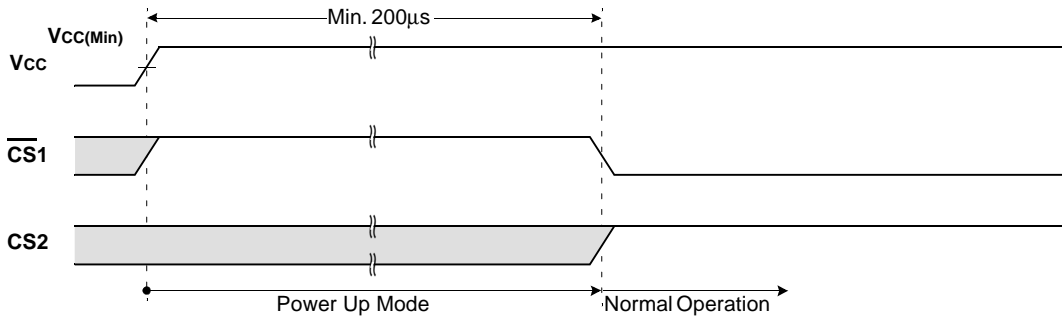
Name	Function	Name	Function
$\overline{CS1}, \overline{CS2}$	Chip Select Inputs	Vcc	Power
$\overline{OE}$	Output Enable Input	Vss	Ground
$\overline{WE}$	Write Enable Input	$\overline{UB}$	Upper Byte(I/O9~16)
A0~A19	Address Inputs	$\overline{LB}$	Lower Byte(I/O1~8)
I/O1~I/O16	Data Inputs/Outputs	NC	No Connection

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## POWER UP SEQUENCE

1. Apply power.
2. Maintain stable power ( $V_{cc} \text{ min.} = 2.7V$ ) for a minimum  $200\mu s$  with  $\overline{CS1} = \text{high}$  or  $CS2 = \text{low}$ .

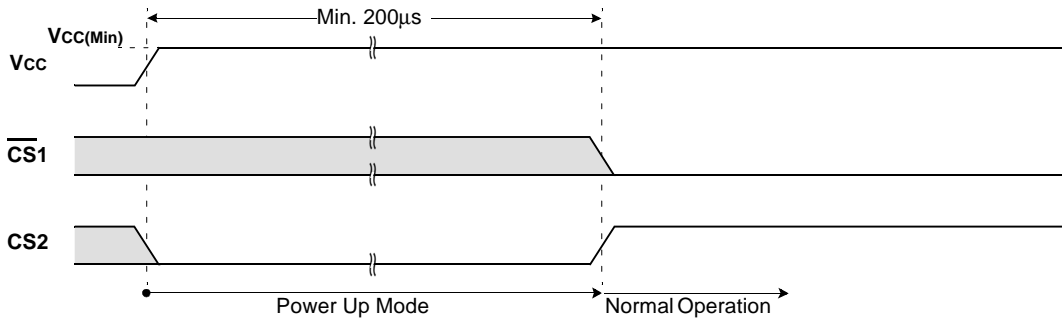
### TIMING WAVEFORM OF POWER UP(1) ( $\overline{CS1}$ controlled)



#### 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 V <sub>CC</sub> +0.3V	V
Voltage on Vcc supply relative to Vss	V <sub>CC</sub>	-0.2 to 3.6V	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 Products(-40~85°C)	
Part Name	Function
K1S161611A-FI70 K1S161611A-BI70 <sup>1)</sup>	48-FBGA-6.00x7.00, 70ns 48-FBGA-6.00x7.00, 70ns

1. Lead Free Product

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

Item	Symbol	Min	Typ	Max	Unit
Supply voltage	V <sub>CC</sub>	2.7	2.9	3.1	V
Ground	V <sub>SS</sub>	0	0	0	V
Input high voltage	V <sub>IH</sub>	2.2	-	V <sub>CC</sub> +0.3 <sup>2)</sup>	V
Input low voltage	V <sub>IL</sub>	-0.3 <sup>3)</sup>	-	0.6	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.

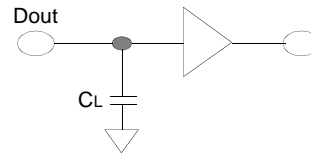
## DC AND OPERATING CHARACTERISTICS

Item	Symbol	Test Conditions	Min	Typ	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>	$\overline{CS1}=V_{IH}$ or $\overline{CS2}=V_{IL}$ 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, $\overline{CS1} \leq 0.2V$ , $\overline{LB} \leq 0.2V$ or/and $\overline{UB} \leq 0.2V$ , $\overline{CS2} \geq V_{CC}-0.2V$ , V <sub>IN</sub> ≤0.2V or V <sub>IN</sub> ≥V <sub>CC</sub> -0.2V	-	-	7	mA
	I <sub>CC2</sub>	Cycle time=Min, I <sub>IO</sub> =0mA, 100% duty, $\overline{CS1}=V_{IL}$ , $\overline{CS2}=V_{IH}$ , $\overline{LB}=V_{IL}$ or/and $\overline{UB}=V_{IL}$ , V <sub>IN</sub> =V <sub>IH</sub> or V <sub>IL</sub>	-	-	30	mA
Output low voltage	V <sub>OL</sub>	I <sub>OL</sub> = 2.1mA	-	-	0.4	V
Output high voltage	V <sub>OH</sub>	I <sub>OH</sub> = -0.1mA	2.4	-	-	V
Standby Current(CMOS)	I <sub>SB1</sub>	Other inputs=0~V <sub>CC</sub> 1) $\overline{CS1} \geq V_{CC}-0.2V$ , $\overline{CS2} \geq V_{CC}-0.2V$ ( $\overline{CS1}$ controlled) or 2) $0V \leq \overline{CS2} \leq 0.2V$ ( $\overline{CS2}$ controlled)	-	-	80	μA

**AC OPERATING CONDITIONS**

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

Input pulse level: 0.4 to 2.2V  
 Input rising and falling time: 5ns  
 Input and output reference voltage: 1.5V  
 Output load (See right): CL=50pF



1. Including scope and jig capacitance

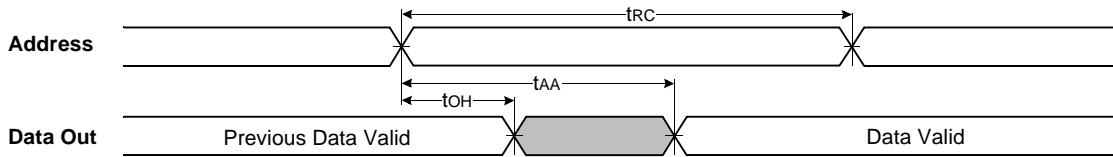
**AC CHARACTERISTICS**(VCC=2.7~3.1V, TA=-40 to 85°C)

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

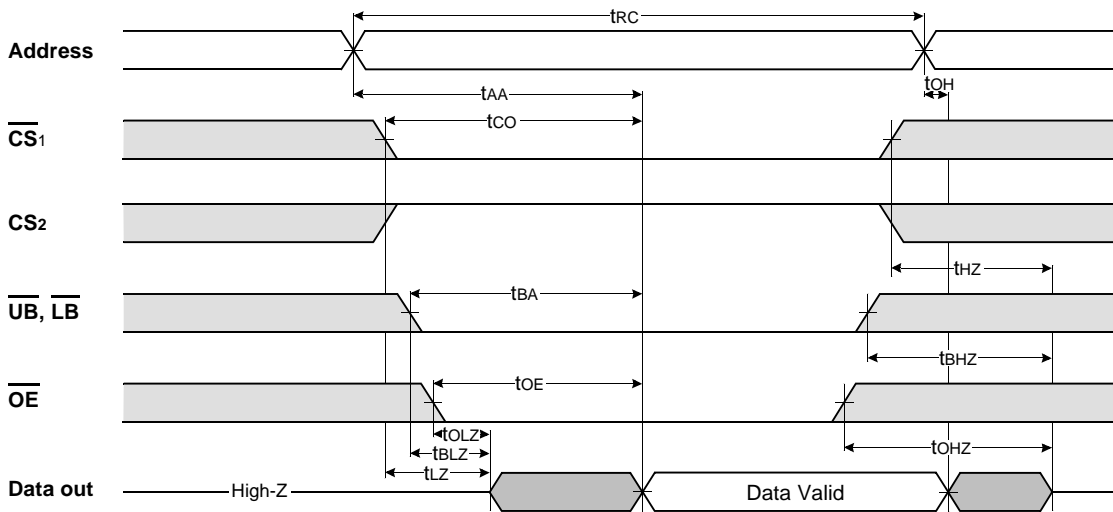
1. tWP(min)=70ns for continuous write operation over 50 times.

TIMING DIAGRAMS

TIMING WAVEFORM OF READ CYCLE(1) (Address Controlled,  $\overline{CS1}=\overline{OE}=V_{IL}$ ,  $CS2=\overline{WE}=V_{IH}$ ,  $\overline{UB}$  or/and  $\overline{LB}=V_{IL}$ )



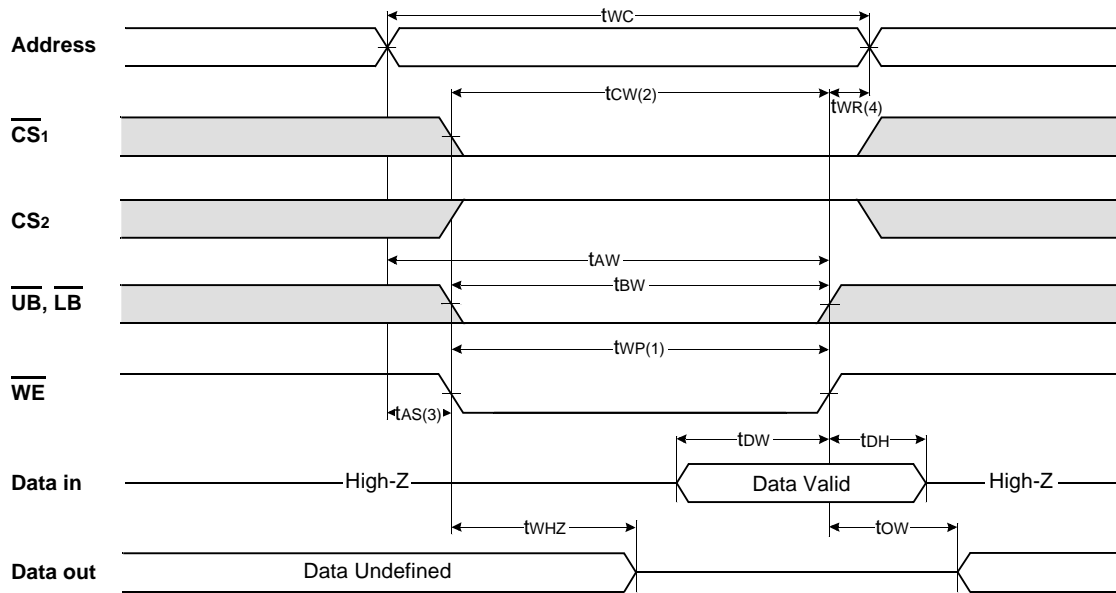
TIMING WAVEFORM OF READ CYCLE(2) ( $\overline{WE}=V_{IH}$ )



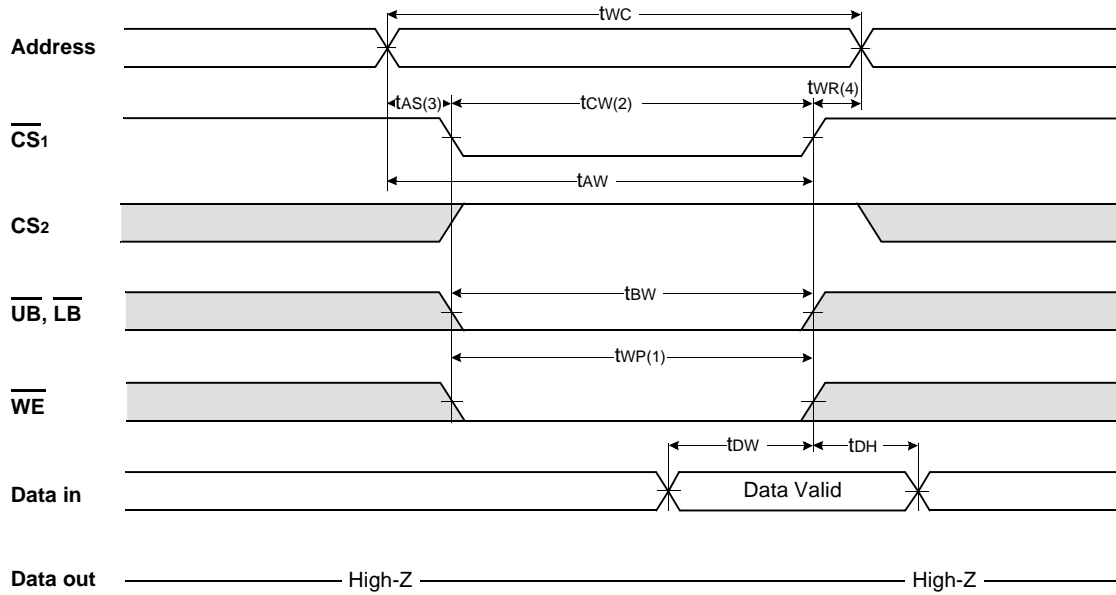
NOTES (READ CYCLE)

1.  $t_{HZ}$  and  $t_{OHZ}$  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 $\mu$ 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 $\mu$ s.

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

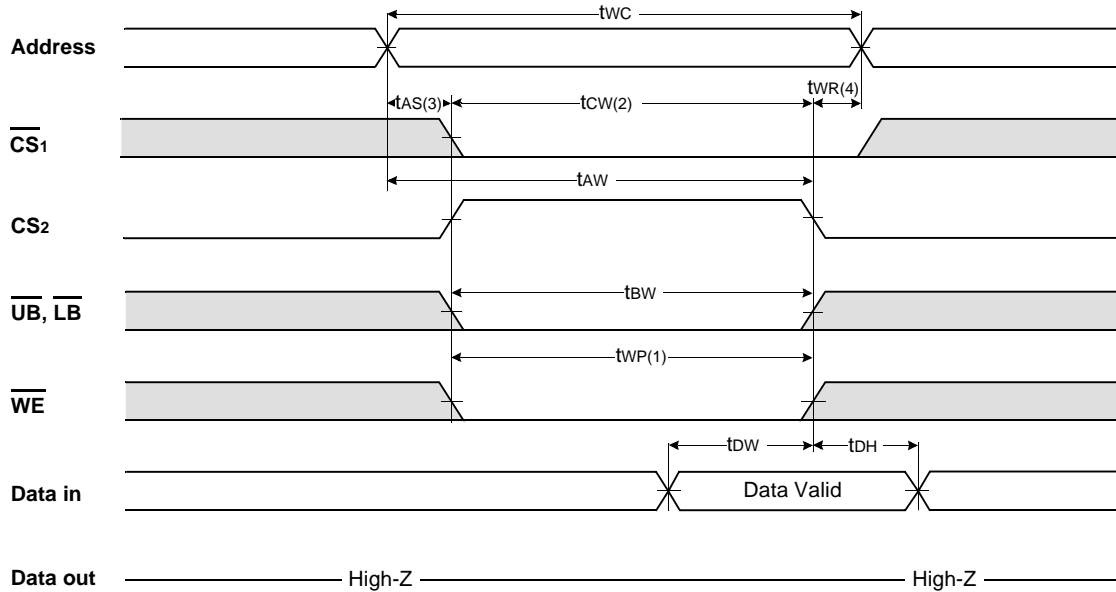


TIMING WAVEFORM OF WRITE CYCLE(2) ( $\overline{CS1}$  Controlled)

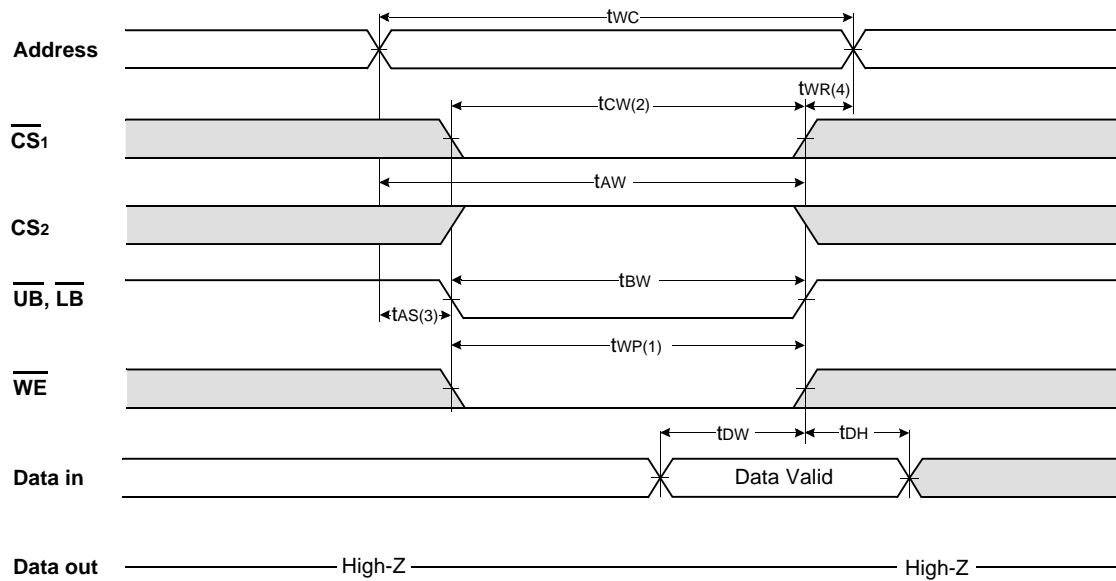




**TIMING WAVEFORM OF WRITE CYCLE(3) (CS2 Controlled)**



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



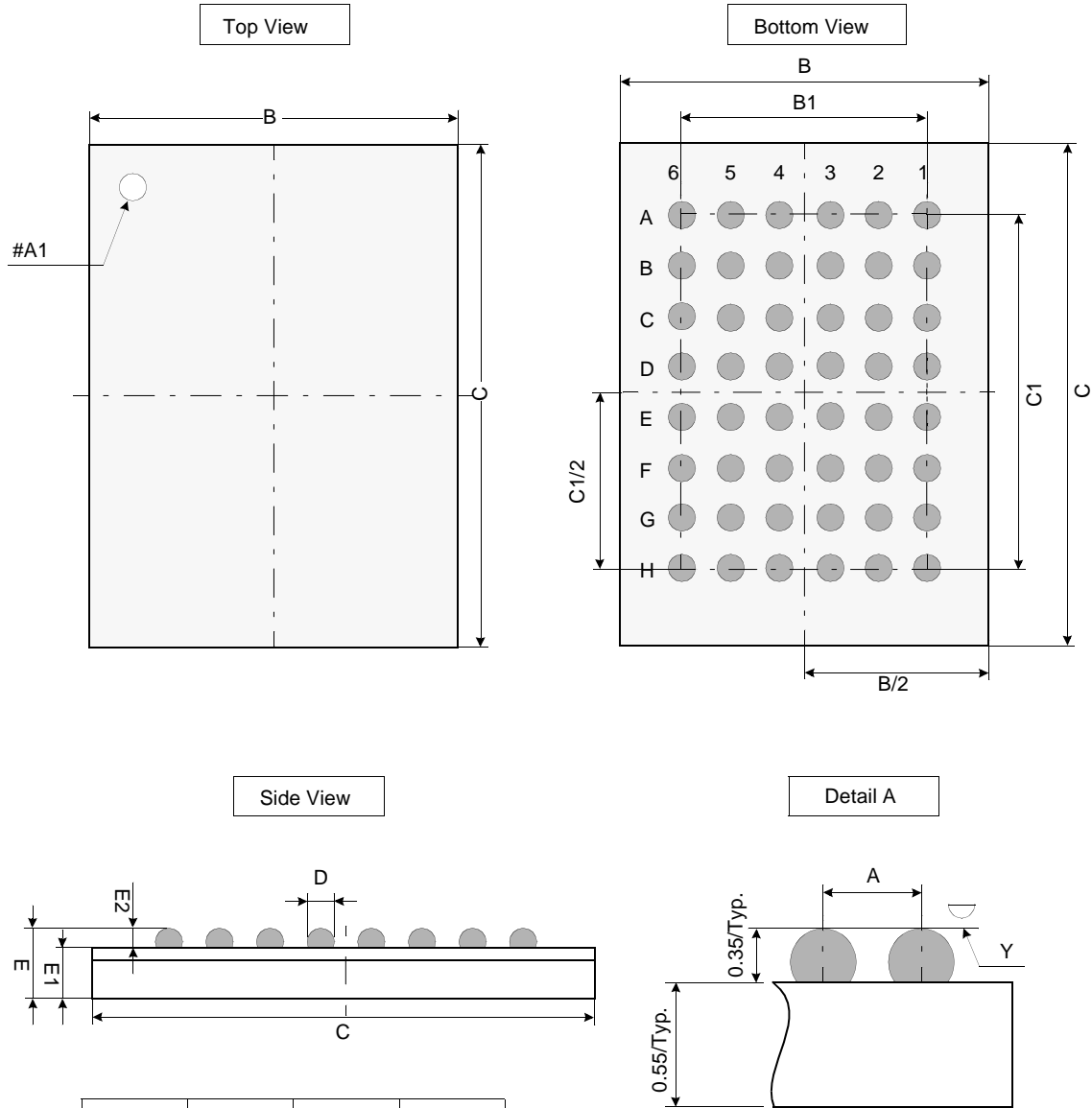
**NOTES (WRITE CYCLE)**

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 TAPE BALL GRID ARRAY(0.75mm ball pitch)



	Min	Typ	Max
A	-	0.75	-
B	5.90	6.00	6.10
B1	-	3.75	-
C	6.90	7.00	7.10
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)