

**Document Title****128K x16 bit Super Low Power and Low Voltage Full CMOS Static RAM****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	May 20, 1998	Advance
1.0	Finalize - IDR test condition change : Vcc=1.5V to Vcc=1.2V - 48-CSP package dimension change Die thickness : 0.32mm → 0.45mm E : 0.80mm → 0.93mm E1 : 0.55mm → 0.68mm	November 17, 1998	Final
2.0	Revise - Change VDR 1.0V to 1.5V - Change IDR test condition ; Vcc=1.2V to 1.5V - Change Icc2 45mA to 35mA	May 12, 1999	Final

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## 128K x 16 bit Super Low Power and Low Voltage Full CMOS Static RAM

### FEATURES

- Process Technology: Full CMOS
- Organization: 128K x16 bit
- Power Supply Voltage: 2.7 ~ 3.3V
- Low Data Retention Voltage: 1.5V(Min)
- Three state output status and TTL Compatible
- Package Type: 48-μBGA-6.00x8.00

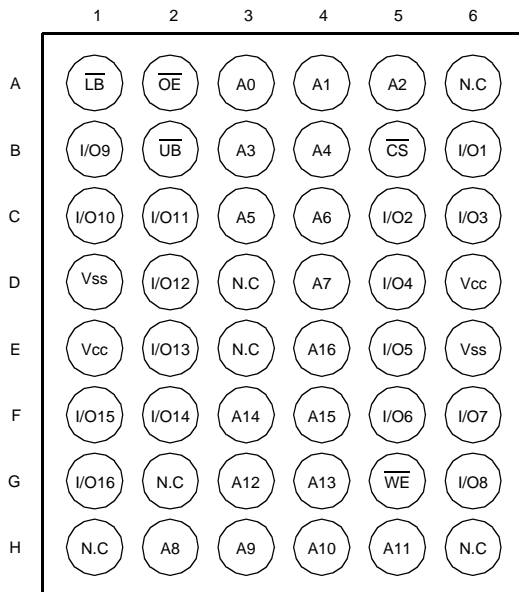
### GENERAL DESCRIPTION

The K6F2016U4A families are fabricated by SAMSUNG's advanced full CMOS process technology. The families support industrial temperature range and 48 ball Chip Scale Package for user flexibility of system design. The families also support low data retention voltage for battery back-up operation with low data retention current.

### PRODUCT FAMILY

Product Family	Operating Temperature	Vcc Range	Speed(ns)	Power Dissipation		PKG Type
				Standby (I <sub>SB1</sub> , Typ.)	Operating (I <sub>CC1</sub> , Max)	
K6F2016U4A-I	Industrial(-40~85°C)	2.7~3.3V	70/100	0.5μA	5mA	48-μBGA

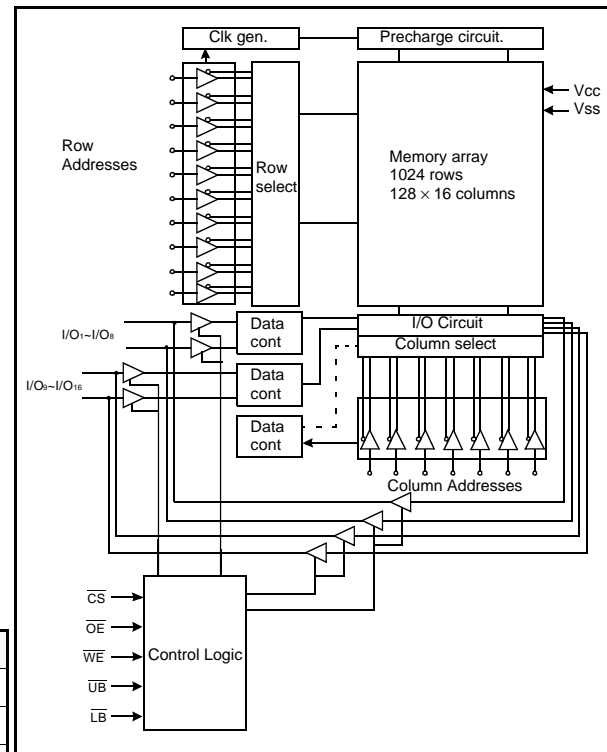
### PIN DESCRIPTION



48-ball CSP - Top View (Ball Down)

Name	Function	Name	Function
$\overline{CS}$	Chip Select Input	Vcc	Power
$\overline{OE}$	Output Enable Input	Vss	Ground
$\overline{WE}$	Write Enable Input	$\overline{UB}$	Upper Byte(I/O <sub>9~16</sub> )
A <sub>0</sub> -A <sub>16</sub>	Address Inputs	$\overline{LB}$	Lower Byte(I/O <sub>1~8</sub> )
I/O <sub>1</sub> -I/O <sub>16</sub>	Data Inputs/Outputs	N.C.	No Connection

### FUNCTIONAL BLOCK DIAGRAM



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## PRODUCT LIST

Industrial Temperature Products(-40~85°C)	
Part Name	Function
K6F2016U4A-ZI70 K6F2016U4A-ZI10	48-μBGA, 70ns, 3.0V 48-μBGA, 100ns, 3.0V

## FUNCTIONAL DESCRIPTION

$\overline{CS}$	$\overline{OE}$	$\overline{WE}$	$\overline{LB}$	$\overline{UB}$	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>	High-Z	High-Z	Deselected	Standby
X <sup>1)</sup>	X <sup>1)</sup>	X <sup>1)</sup>	H	H	High-Z	High-Z	Deselected	Standby
L	H	H	L	X <sup>1)</sup>	High-Z	High-Z	Output Disabled	Active
L	H	H	X <sup>1)</sup>	L	High-Z	High-Z	Output Disabled	Active
L	L	H	L	H	Dout	High-Z	Lower Byte Read	Active
L	L	H	H	L	High-Z	Dout	Upper Byte Read	Active
L	L	H	L	L	Dout	Dout	Word Read	Active
L	X <sup>1)</sup>	L	L	H	Din	High-Z	Lower Byte Write	Active
L	X <sup>1)</sup>	L	H	L	High-Z	Din	Upper Byte Write	Active
L	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 V <sub>ss</sub>	V <sub>IN</sub> , V <sub>OUT</sub>	-0.2 to 3.6V	V
Voltage on V <sub>cc</sub> supply relative to V <sub>ss</sub>	V <sub>CC</sub>	-0.2 to 4.0V	V
Power Dissipation	P <sub>D</sub>	1.0	W
Storage temperature	T <sub>STG</sub>	-55 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 recommended operating condition. Exposure to absolute maximum rating conditions for extended periods may affect reliability.

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

Item	Symbol	Min	Typ	Max	Unit
Supply voltage	V <sub>CC</sub>	2.7	3.0	3.3	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>	-0.2 <sup>3)</sup>	-	0.6	V

Note :

1. T<sub>A</sub>=-40 to 85°C, otherwise specified
2. Overshoot : V<sub>CC</sub> +1.0 V 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**

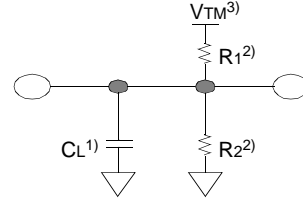
Item	Symbol	Test Conditions	Min	Typ	Max	Unit
Input leakage current	I <sub>LI</sub>	V <sub>IN</sub> =V <sub>SS</sub> to V <sub>CC</sub>	-1	-	1	μA
Output leakage current	I <sub>LO</sub>	$\overline{CS}=V_{IH}$ or $\overline{OE}=V_{IH}$ or $\overline{WE}=V_{IL}$ , V <sub>IO</sub> =V <sub>SS</sub> to V <sub>CC</sub>	-1	-	1	μA
Operating power supply current	I <sub>CC</sub>	I <sub>IO</sub> =0mA, $\overline{CS}=V_{IL}$ , V <sub>IN</sub> =V <sub>IH</sub> or V <sub>IL</sub>	-	-	3	mA
Average operating current	I <sub>CC1</sub>	Cycle time=1μs, 100% duty, I <sub>IO</sub> =0mA, $\overline{CS} \leq 0.2V$ , 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, $\overline{CS}=V_{IL}$ , V <sub>IN</sub> =V <sub>IH</sub> or V <sub>IL</sub>	-	-	35	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>OL</sub> = -1.0mA	2.2	-	-	V
Standby Current(TTL)	I <sub>SB</sub>	$\overline{CS}=V_{IH}$ or $\overline{LB}=\overline{UB}=V_{IH}$ , Other inputs=V <sub>IH</sub> or V <sub>IL</sub>	-	-	0.3	mA
Standby Current (CMOS)	I <sub>SB1</sub>	$\overline{CS} \geq V_{CC}-0.2V$ or $\overline{LB}=\overline{UB} \geq V_{CC}-0.2V$ , $\overline{CS} \leq 0.2V$ , Other inputs=0~V <sub>CC</sub>	-	0.5	10 <sup>1)</sup>	μA

1. Super low power product=2μA with special handling

## 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) :  $C_L = 100\text{pF} + 1\text{TTL}$



1. Including scope and jig capacitance
2.  $R_1 = 3070\Omega$ ,  $R_2 = 3150\Omega$
3.  $V_{TM} = 2.8\text{V}$

## AC CHARACTERISTICS ( $V_{CC} = 2.7 \sim 3.3\text{V}$ , $T_A = -40$ to $85^\circ\text{C}$ )

Parameter List		Symbol	Speed Bins				Units
			70ns		100ns		
			Min	Max	Min	Max	
Read	Read cycle time	tRC	70	-	100	-	ns
	Address access time	tAA	-	70	-	100	ns
	Chip select to output	tCO	-	70	-	100	ns
	Output enable to valid output	tOE	-	35	-	50	ns
	$\overline{\text{UB}}, \overline{\text{LB}}$ Access Time	tBA	-	70	-	100	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	30	ns
	$\overline{\text{UB}}, \overline{\text{LB}}$ disable to high-Z output	tBHZ	0	25	0	30	ns
	Output disable to high-Z output	tOHZ	0	25	0	30	ns
Output hold from address change	tOH	10	-	15	-	ns	
Write	Write cycle time	tWC	70	-	100	-	ns
	Chip select to end of write	tCW	60	-	80	-	ns
	Address set-up time	tAS	0	-	0	-	ns
	Address valid to end of write	tAW	60	-	80	-	ns
	$\overline{\text{UB}}, \overline{\text{LB}}$ Valid to End of Write	tBW	60	-	80	-	ns
	Write pulse width	tWP	55	-	70	-	ns
	Write recovery time	tWR	0	-	0	-	ns
	Write to output high-Z	tWHZ	0	25	0	30	ns
	Data to write time overlap	tDW	30	-	40	-	ns
	Data hold from write time	tDH	0	-	0	-	ns
	End write to output low-Z	tOW	5	-	5	-	ns

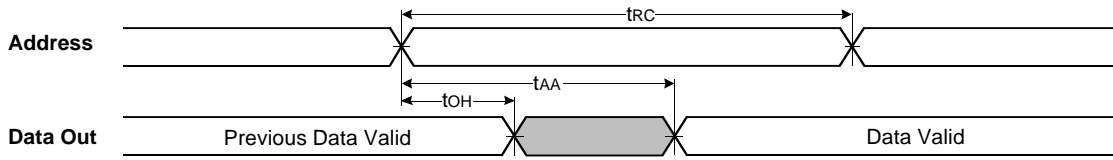
## DATA RETENTION CHARACTERISTICS

Item	Symbol	Test Condition	Min	Typ	Max	Unit
Vcc for data retention	VDR	$\overline{\text{CS}} \geq V_{CC} - 0.2\text{V}^{(1)}$	1.5	-	3.3	V
Data retention current	IDR	$V_{CC} = 1.5\text{V}$ , $\overline{\text{CS}} \geq V_{CC} - 0.2\text{V}^{(1)}$	-	1	3 <sup>(2)</sup>	$\mu\text{A}$
Data retention set-up time	tSDR	See data retention waveform	0	-	-	ns
Recovery time	tRDR		tRC	-	-	

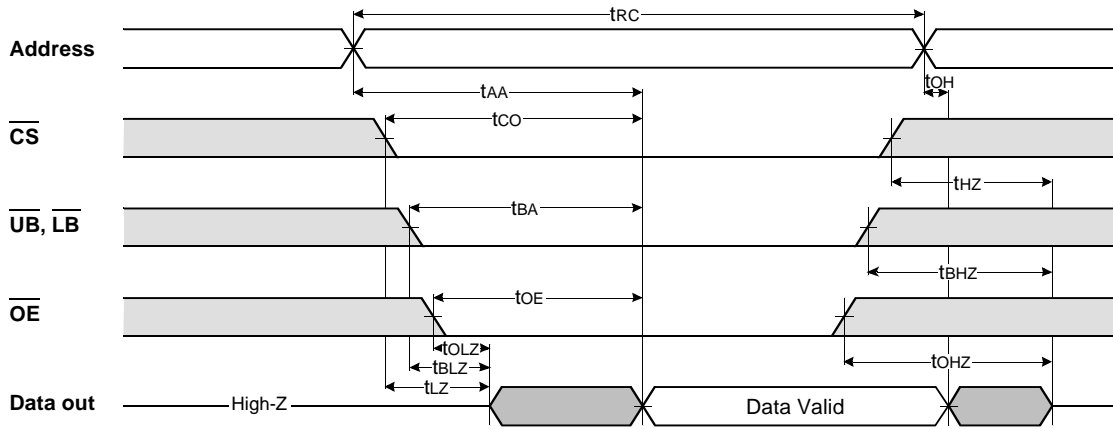
1.  $\overline{\text{CS}} \geq V_{CC} - 0.2\text{V}$  ( $\overline{\text{CS}}$  controlled) or  $\overline{\text{LB}} = \overline{\text{UB}} \geq V_{CC} - 0.2\text{V}$ ,  $\overline{\text{CS}} \leq 0.2\text{V}$  ( $\overline{\text{LB}}, \overline{\text{UB}}$  controlled)
2. Super low power product =  $1\mu\text{A}$  with special handling.

TIMMING DIAGRAMS

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



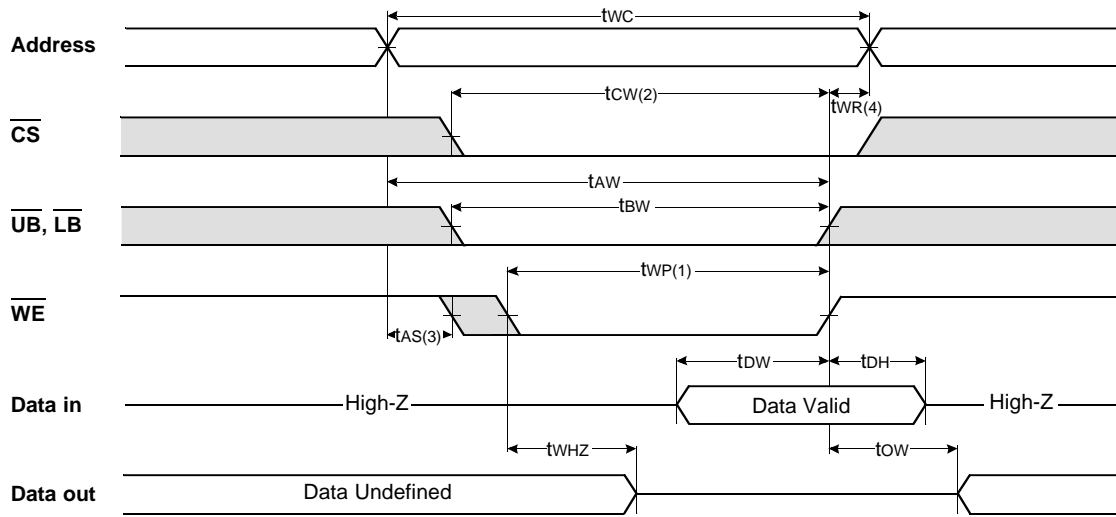
TIMING WAVEFORM OF READ CYCLE(2) ( $\overline{WE}=V_{IH}$ )



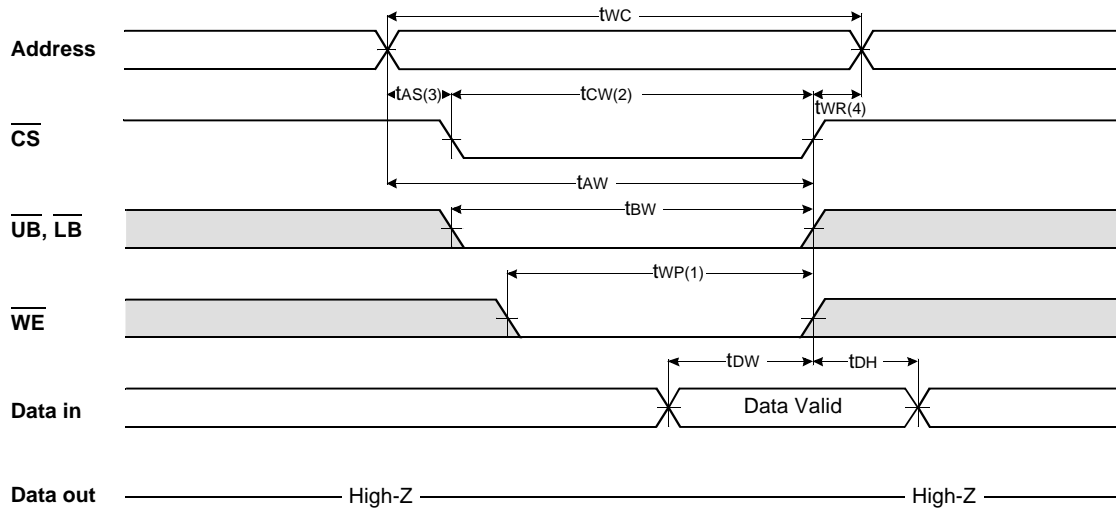
NOTES (READ CYCLE)

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.

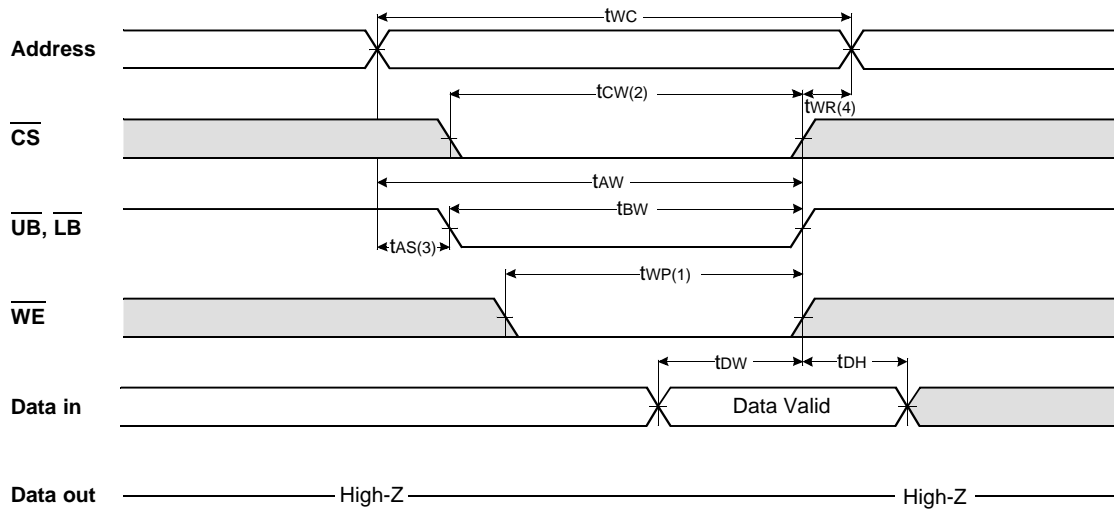
TIMING WAVEFORM OF WRITE CYCLE(1) ( $\overline{WE}$  Controlled)



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



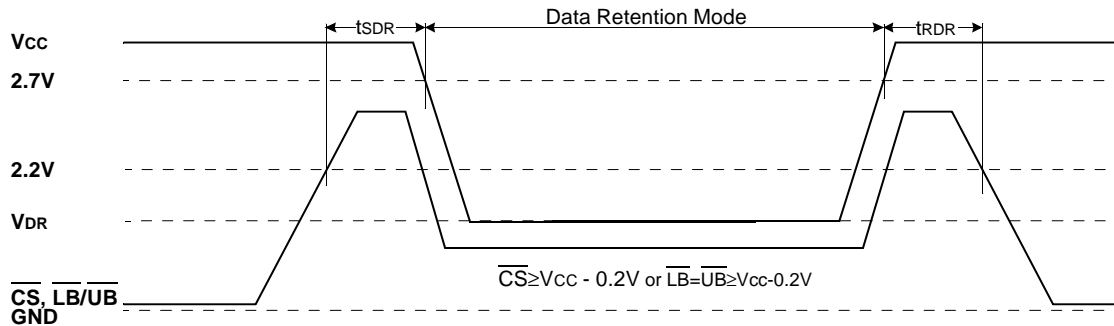
TIMING WAVEFORM OF WRITE CYCLE(3) ( $\overline{UB}$ ,  $\overline{LB}$  Controlled)



NOTES (WRITE CYCLE)

1. A write occurs during the overlap( $t_{WP}$ ) of low  $\overline{CS}$  and low  $\overline{WE}$ . A write begins when  $\overline{CS}$  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  $\overline{CS}$  goes high and  $\overline{WE}$  goes high. The  $t_{WP}$  is measured from the beginning of write to the end of write.
2.  $t_{CW}$  is measured from the  $\overline{CS}$  going low to end of write.
3.  $t_{AS}$  is measured from the address valid to the beginning of write.
4.  $t_{WR}$  is measured from the end of write to the address change.  $t_{WR}$  applied in case a write ends as  $\overline{CS}$  or  $\overline{WE}$  going high.

DATA RETENTION WAVE FORM

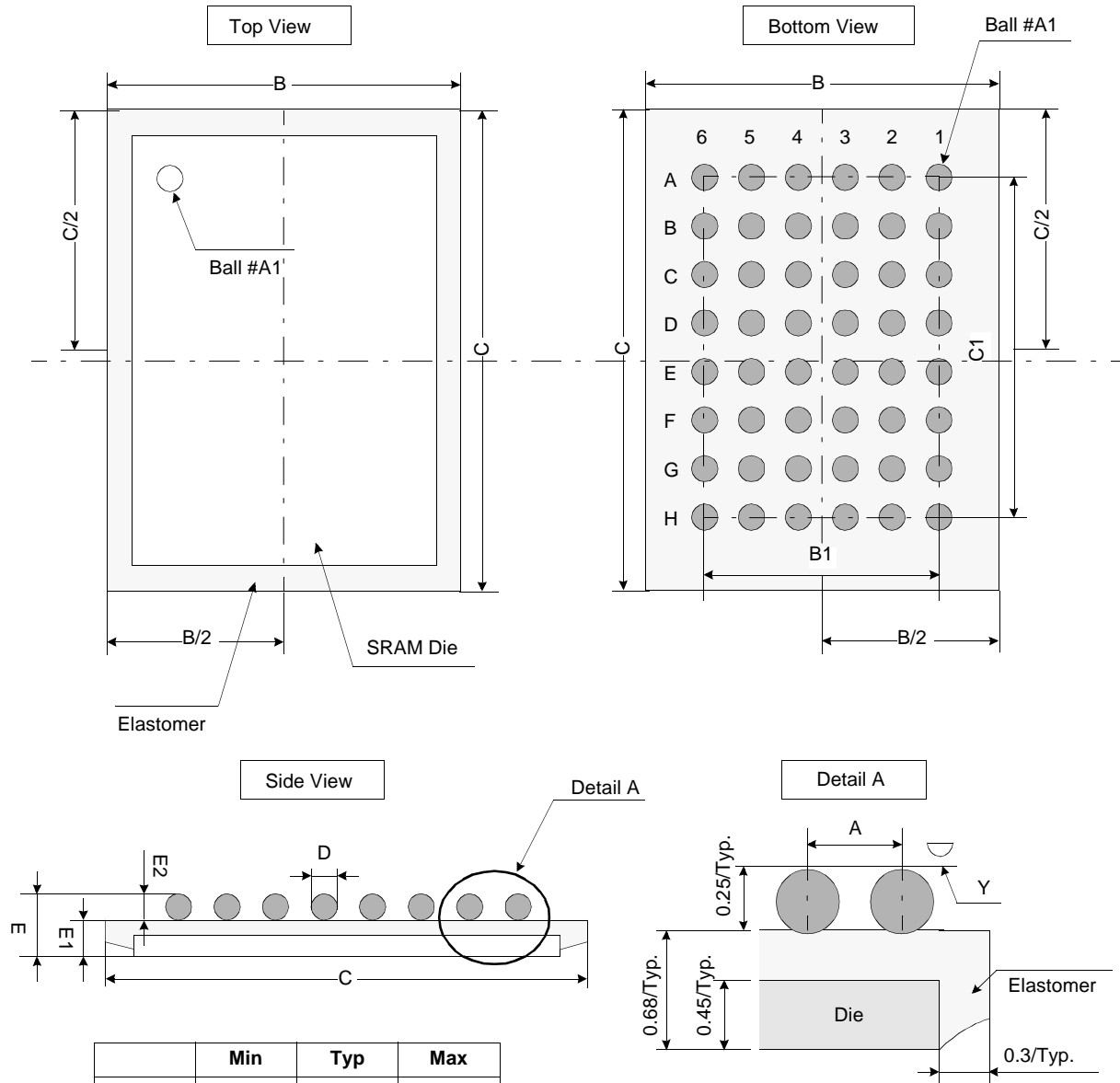




PACKAGE DIMENSIONS

Unit : millimeter(inch)

48 BALL MICRO BALL GRID ARRAY - 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	0.30	0.35	0.40
E	-	0.93	0.94
E1	-	0.68	-
E2	-	0.25	-
Y	-	-	0.08

Notes.

1. Bump counts : 48(row x 6column)
2. Bump pitch : (x,y)=(0.75 x 0.75)(typ.)
3. All tolerance are +/-0.050 unless otherwise specified.
4. Typ : Typical
5. Y is coplanarity : 0.08(Max)