

**Document Title****8M x 16 bit Super Low Power and Low Voltage Full CMOS RAM****Revision History**

Revision No.	History	Draft date	Remark
0.0	Initial Draft	Oct. 15 <sup>th</sup> , 2009	Preliminary
0.1	Change Deep Power Down Current Spec : 10uA → 20uA Revise MRS Code for Array Refresh Area	Oct. 12 <sup>th</sup> , 2010	Preliminary

**8M x 16 bit Super Low Power and Low Voltage Full CMOS RAM**

**FEATURES**

- Process Technology : Full CMOS
- Organization : 8M x 16
- Power Supply Voltage : 2.7~3.3V
- Three state output and TTL Compatible
- Separated I/O power(VCCQ) & Core power(VCC)
- Operating Temperature Ranges:
  - Special (-10°C to +60°C)
  - Commercial (0°C to +70°C)
  - Extended (-25°C to +85°C)
  - Industrial (-40°C to +85°C)

- Package Type : 54-FBGA-6.00x8.00 mm<sup>2</sup>  
FMP1216AAx-HxxX : Pb-Free & Halogen Free
- Low Power & Page Modes
  - FMP1216AA1 : support the PASR/DPD function
  - FMP1216AA2 : support the Direct DPD function
  - FMP1216AA4 : support the PASR/DPD/PAGE function
  - FMP1216AA5 : support the Direct DPD/PAGE function
- Page read/write operation by 16 words  
(FMP1216AA4, FMP1216AA5)
- DPD mode by using MRS only  
(FMP1216AA1, FMP1216AA4)
- Direct DPD mode when /ZZ goes low  
(FMP1216AA2, FMP1216AA5)

**PRODUCT FAMILY**

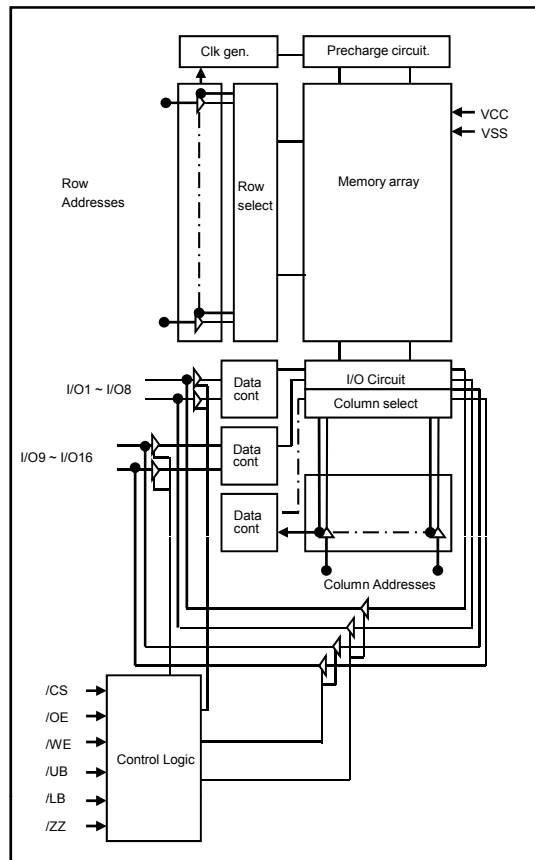
Product Family	Operating Voltage (V)			Speed	Power Dissipation					
	Min.	Typ.	Max.		ICC1		ICC2		ISB1 (CMOS Standby Current)	
					f = 1MHz		f = fmax			
					Typ.	Max.	Typ.	Max.	Typ.	Max.
FMP1216AAx-H60E FMP1216AAx-H70E	2.7	3.0	3.3	60ns 70ns	1.5mA	3mA	15mA 12mA	25mA	180uA	250uA

1. Typical values are included for reference only and are not guaranteed or tested. Typical values are measured at Vcc = Vcc (typ) and T<sub>A</sub> = 25°C.  
 2. H=FBGA(Pb-Free & Halogen Free), W=WAFER  
 3. Operating Temperature Range: S (-10°C~60°C), C(0°C~70°C), E(-25°C~85°C), I (-40°C~85°C)

**PIN DESCRIPTION**

Name	Function	Name	Function
/ZZ	Low Power Modes	VCC	Core Power
/CS	Chip Select Input	VCCQ	I/O Power
/OE	Output Enable Input	VSS	Ground
/WE	Write Enable Input	/UB	Upper Byte(I/O9~16)
A0~A22	Address Inputs	/LB	Lower Byte(I/O1~8)
I/O1~I/O16	Data Inputs/Outputs	NC	No Connect

**FUNCTIONAL BLOCK DIAGRAM**



**PRODUCT LIST**

Part Name	Function
FMP1216AAx-H60E FMP1216AAx-H70E	54-FBGA, 60ns, VCC=3.0V, VCCQ=3.0V 54-FBGA, 70ns, VCC=3.0V, VCCQ=3.0V

- 1. H=FBGA(Pb-Free & Halogen Free), W=WAFER
- 2. Operating Temperature Range: S (-10°C~60°C), C(0°C~70°C), E(-25°C~85°C), I (-40°C~85°C)

**FUNCTIONAL DESCRIPTION**

/CS	/ZZ	/OE	/WE	/LB	/UB	I/O1-8	I/O9-16	Mode	Power
H	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>	L	X <sup>1)</sup>	X <sup>1)</sup>	X <sup>1)</sup>	X <sup>1)</sup>	High-Z	High-Z	Deselected	Direct DPD <sup>2)</sup>
H	L	X <sup>1)</sup>	X <sup>1)</sup>	X <sup>1)</sup>	X <sup>1)</sup>	High-Z	High-Z	Deselected	Low Power Modes <sup>3)</sup>
L	H	H	H	X <sup>1)</sup>	X <sup>1)</sup>	High-Z	High-Z	Output Disabled	Active
L	H	L	H	H	H	High-Z	High-Z	Output Disabled	Active
				L	H	Dout	High-Z	Lower Byte Read	Active
				H	L	High-Z	Dout	Upper Byte Read	Active
				L	L	Dout	Dout	Word Read	Active
		X <sup>1)</sup>	L	H	H	High-Z	High-Z	Write-abort <sup>4)</sup>	Active
				L	H	Din	High-Z	Lower Byte Write	Active
				H	L	High-Z	Din	Upper Byte Write	Active
				L	L	Din	Din	Word Write	Active

- 1. X means don't care.(Must be low or high state)
- 2. In case of FMP1216AA2 & FMP1216AA5 product
- 3. In case of FMP1216AA1 & FMP1216AA4 product

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

Item	Symbol	Ratings	Unit
Voltage on any pin relative to Vss	VIN, VOUT	-0.2 to Vcc+0.3V	V
Voltage on Vcc supply relative to Vss	Vcc	-0.2 to 3.6	V
Power Dissipation	PD	1.0	W
Storage temperature	TSTG	-65 to 150	°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**

Item	Symbol	FMP1216AAx		Unit
		Min	Max	
Supply voltage	VCC	2.7	3.3	V
I/O operating voltage (VCCQ ≤ VCC)	VCCQ	2.7	3.3	V
Ground	VSS	0	0	V
Input high voltage	VIH	0.8VCCQ	VCC+0.2 <sup>1)</sup>	V
Input low voltage	VIL	-0.2 <sup>2)</sup>	0.2VCCQ	V

- Note :
- 1. Overshoot : Vcc+1.0V in case of pulse widths≤20ns.
  - 2. Undershoot : -1.0V in case of pulse widths≤20ns.
  - 3. 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	-	8	pF

1. Capacitance is sampled, not 100% tested.

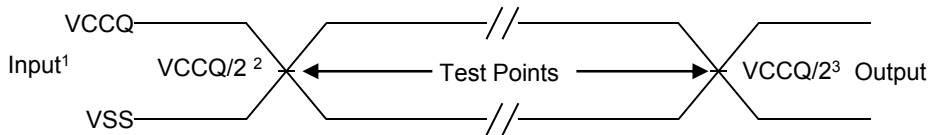
**DC AND OPERATING CHARACTERISTICS**

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	uA
Output leakage current	I <sub>LO</sub>	/CS=V <sub>IH</sub> , /ZZ=V <sub>IH</sub> , /OE=V <sub>IH</sub> or /WE=V <sub>IL</sub> , V <sub>IO</sub> =V <sub>SS</sub> to V <sub>CC</sub>	-1	-	1	uA
Average operating current	ICC1	Cycle time=1us, 100% duty, I <sub>IO</sub> =0mA, /CS≤0.2V, /ZZ=V <sub>IH</sub> , V <sub>IN</sub> ≤0.2V or V <sub>IN</sub> ≥V <sub>CC</sub> -0.2V	-	-	3	mA
	ICC2	Cycle time=Min, I <sub>IO</sub> =0mA, 100% duty, /CS=V <sub>IL</sub> , /ZZ=V <sub>IH</sub> , V <sub>IN</sub> =V <sub>IL</sub> or V <sub>IH</sub>	-	-	25	mA
Output low voltage	V <sub>OL</sub>	I <sub>OL</sub> =0.5mA			0.2V <sub>CCQ</sub>	V
Output high voltage	V <sub>OH</sub>	I <sub>OH</sub> =-0.5mA	0.8V <sub>CCQ</sub>			V
Standby Current(TTL)	ISB	/CS=V <sub>IH</sub> , /ZZ=V <sub>IH</sub> , Other inputs=V <sub>IH</sub> or V <sub>IL</sub>	-	-	0.3	mA
Standby Current(CMOS)	ISB1	/CS≥V <sub>CC</sub> -0.2V, /ZZ≥V <sub>CC</sub> -0.2V, Other inputs=0~V <sub>CC</sub>	-	-	250	uA
Low Power Modes	ISB0	/ZZ≤0.2V, Other inputs=0~V <sub>CC</sub> , No refresh(DPD)	-	-	20	uA
	ISB0a	/ZZ≤0.2V, Other inputs=0~V <sub>CC</sub> , ¼ refresh area selection	-	-	205	uA
	ISB0b	/ZZ≤0.2V, Other inputs=0~V <sub>CC</sub> , ½ refresh area selection	-	-	220	uA
	ISB0c	/ZZ≤0.2V, Other inputs=0~V <sub>CC</sub> , All refresh area selection	-	-	250	uA

**Operating Range**

Device	Range	Ambient Temperature	V <sub>CC</sub>	V <sub>CCQ</sub>
FMP1216AAx-XxxS	Special	-10°C to +60°C	2.7V to 3.3V	2.7V to V <sub>CC</sub>
FMP1216AAx-XxxC	Commercial	0°C to +70°C		
FMP1216AAx-XxxE	Extended	-25°C to +85°C		
FMP1216AAx-XxxI	Industrial	-40°C to +85°C		

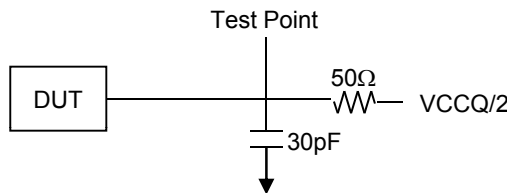
**AC Input/Output Reference Waveform**



NOTE:

1. AC test inputs are driven at V<sub>CCQ</sub> for a logic 1 and V<sub>SS</sub> for a logic 0. Input rise and fall times (10% to 90%) < 1.6ns.
2. Input timing begins at V<sub>CCQ</sub>/2.
3. Output timing ends at V<sub>CCQ</sub>/2.

**AC Output Load Circuit**



AC CHARACTERISTICS(VCC=2.7V~3.3V)

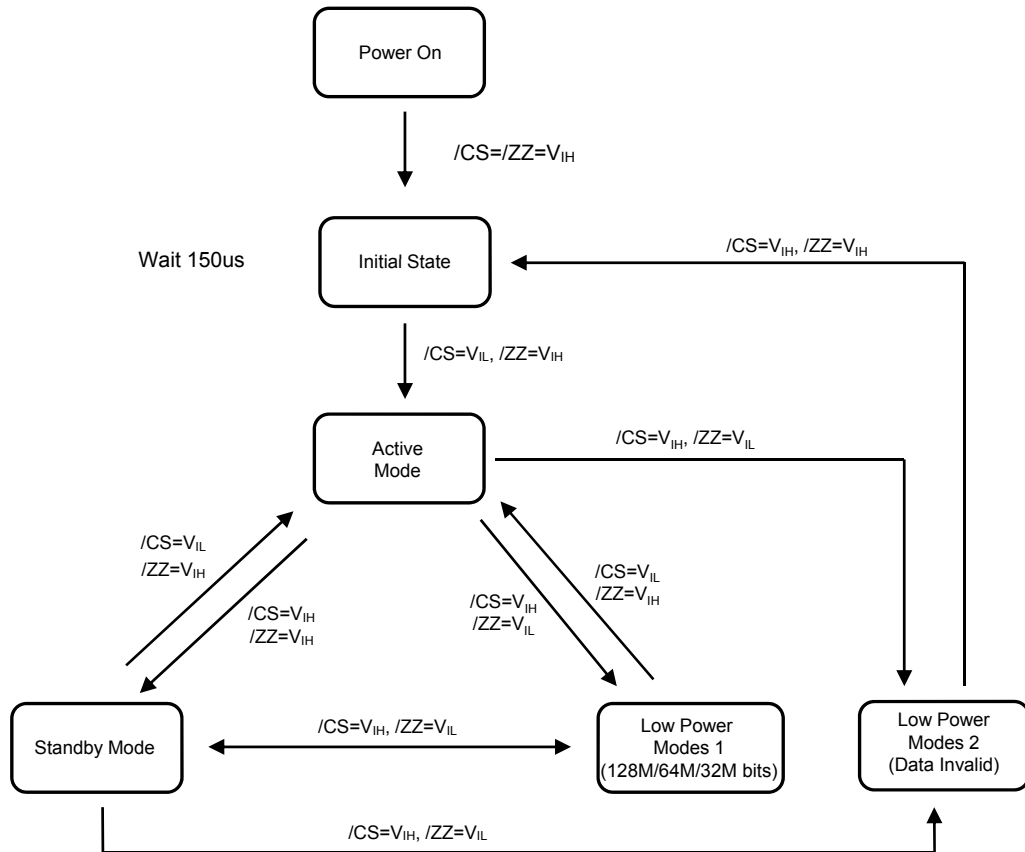
Parameter List		Symbol	Speed Bins				Units
			60ns		70ns		
			Min	Max	Min	Max	
Read	Read Cycle Time	tRC	60	20k	70	20k	ns
	Address Access Time	tAA	-	60	-	70	ns
	Chip Select to Output	tCO	-	60	-	70	ns
	Output Enable to Valid Output	tOE	-	25	-	25	ns
	/UB, /LB Access Time	tBA	-	25	-	25	ns
	Chip Select to Low-Z Output	tLZ	10	-	10	-	ns
	/UB, /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	5	0	5	ns
	/UB, /LB Disable to High- Z Output	tBHZ	0	5	0	5	ns
	Output Disable to High- Z Output	tOHZ	0	5	0	5	ns
	Output Hold from Address Change	tOH	5	-	5	-	ns
Write	Write Cycle Time	tWC	60	20k	70	20k	ns
	Chip Select to End of Write	tCW	50	-	60	-	ns
	Address Set-up Time	tAS	0	-	0	-	ns
	Address Valid to End of Write	tAW	50	-	60	-	ns
	/UB, /LB Valid to End of Write	tBW	50	-	60	-	ns
	Write Pulse Width	tWP	50	-	50	-	ns
	Write Recovery Time	tWR	0	-	0	-	ns
	Write to Output High-Z	tWHZ	0	5	0	5	ns
	Data to Write Time Overlap	tDW	20	-	20	-	ns
	Data Hold from Write Time	tDH	0	-	0	-	ns
	End Write to Output Low-Z	tOW	5	-	5	-	ns
Page	Page Mode Cycle Time	tPC	20	-	25	-	ns
	Page Mode Address Access Time	tPAA	-	20	-	25	ns
	Maximum Cycle Time	tMRC	-	20k	-	20k	ns
/CS High Pulse Width		tCP	10	-	10	-	ns

1. /CS High Pulse Width is defined by /CS.

**Power Up Sequence**

1. Apply Power
2. Maintain stable power for a minimum of 150us with /CS=/ZZ=V<sub>IH</sub>

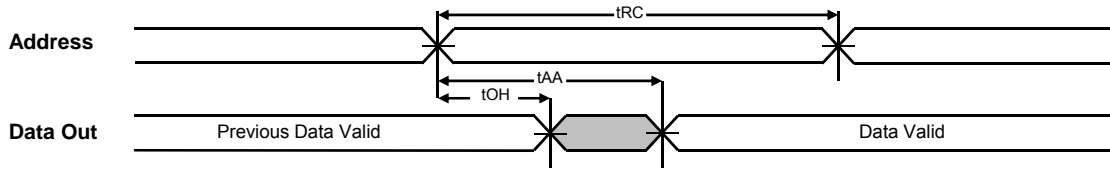
**Standby Mode State machines**



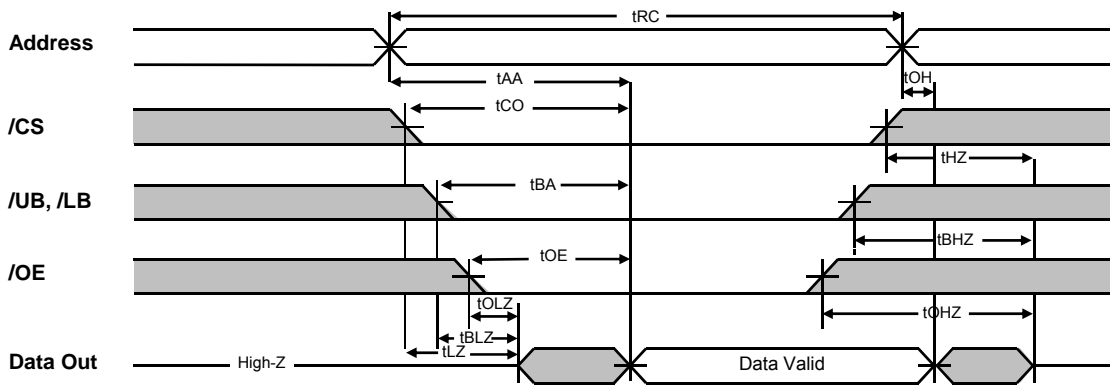
**Standby Mode Characteristics**

Mode	Memory Cell Data	Standby Current(uA)	Wait Time(us)
Standby	Valid	250 (ISB1)	0
Low Power Modes	Invalid	20 (ISB0)	150
	¼ valid	205 (ISB0a)	0
	½ valid	220 (ISB0b)	0
	valid	250 (ISB0c)	0

**READ CYCLE (1)** (Address controlled, /CS=/OE=V<sub>IL</sub>, /ZZ=/WE=V<sub>IH</sub>, /UB or/and /LB=V<sub>IL</sub>)

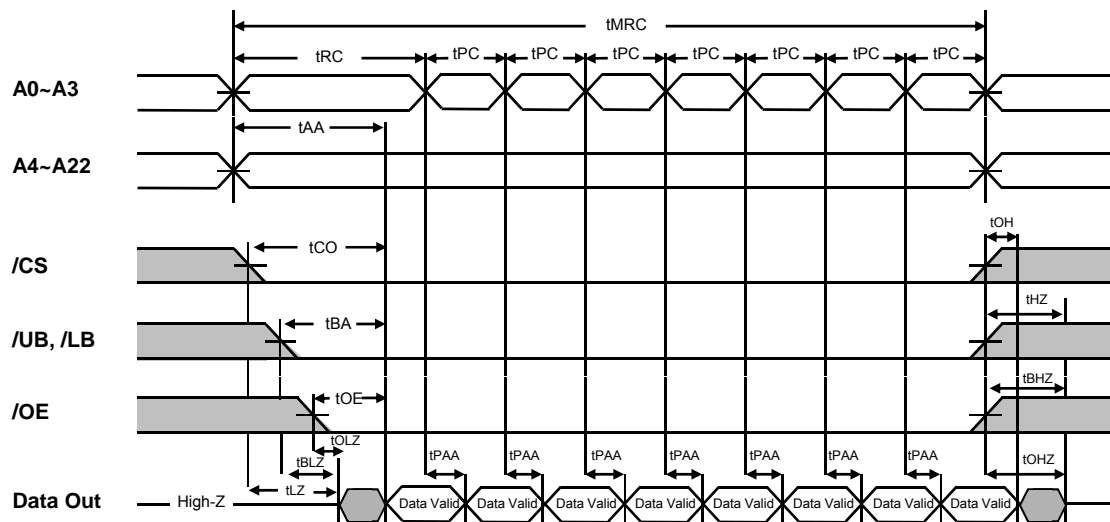


**READ CYCLE (2)** (/ZZ=/WE=V<sub>IH</sub>)



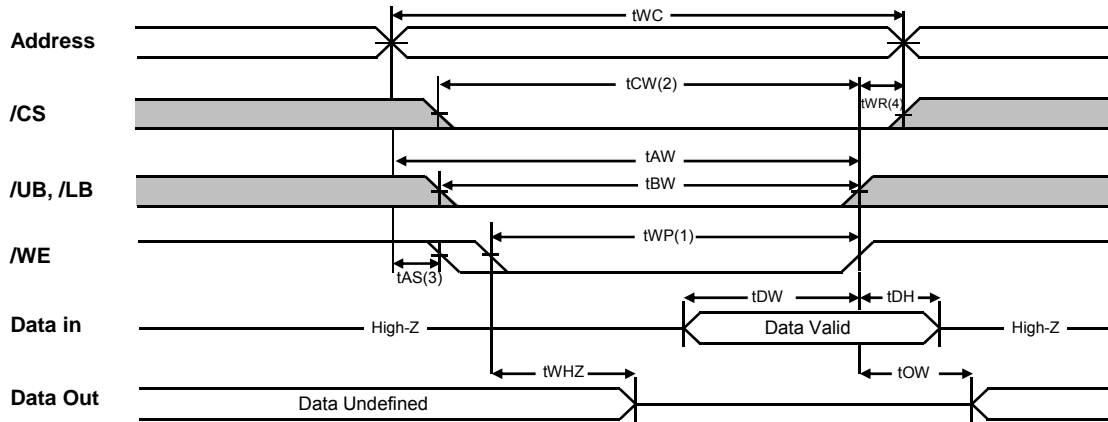
1. tHZ and tOHZ are defined as the time at which the outputs achieve the open circuit conditions and are not referenced to output voltage levels.
2. At any given temperature and voltage condition, tHZ(Max.) is less than tLZ(Min.) both for a given device and from device to device interconnection.
3. Do not access device with cycle timing shorter than tRC(tWC) for continuous periods > 20us.

**PAGE READ CYCLE** (/ZZ=/WE=V<sub>IH</sub>, 16 words access)

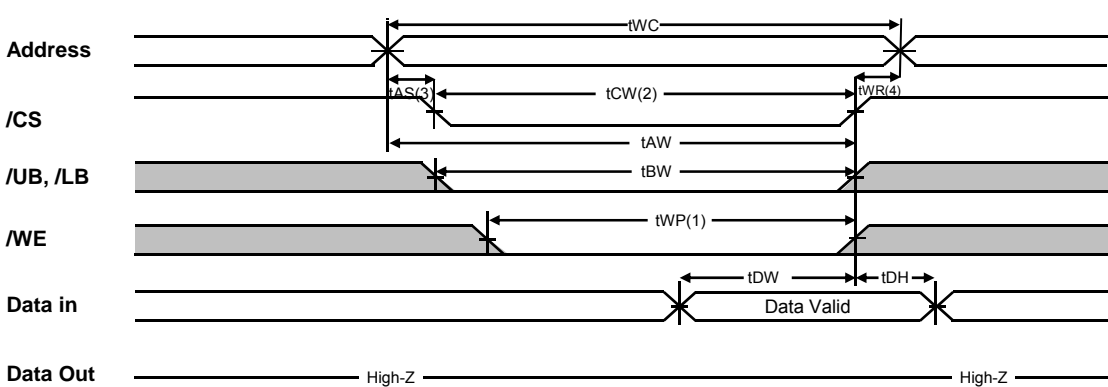


1. tHZ and tOHZ are defined as the time at which the outputs achieve the open circuit conditions and are not referenced to output voltage levels.
2. At any given temperature and voltage condition, tHZ(Max.) is less than tLZ(Min.) both for a given device and from device to device interconnection.
3. Do not access device with cycle timing shorter than tRC(tWC) for continuous periods > 20us.
4. In case page address skew is over 3ns, tPAA will be out of spec.

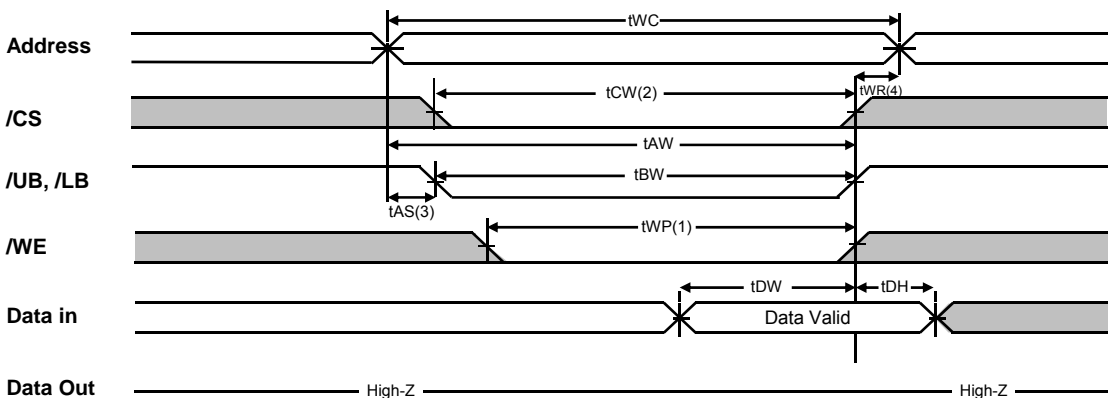
**WRITE CYCLE (1)** (*/WE controlled, /ZZ=V<sub>IH</sub>*)



**WRITE CYCLE (2)** (*/CS controlled, /ZZ=/WE=V<sub>IH</sub>*)



**WRITE CYCLE (3)** (*/UB, /LB controlled, /ZZ=V<sub>IH</sub>*)

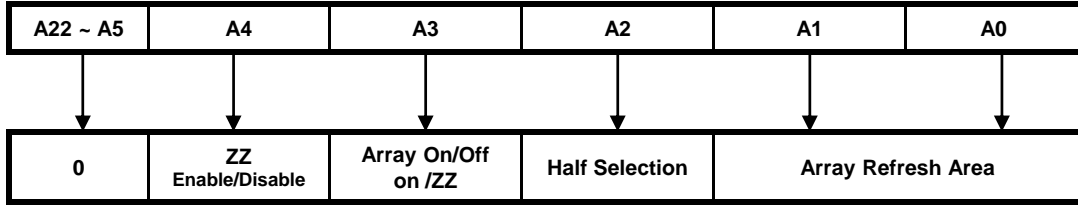


1. A write occurs during the overlap ( $t_{WP}$ ) of low  $/CS$  and  $/WE$ . A write begins when  $/CS$  goes low and  $/WE$  goes low with asserting  $/UB$  or  $/LB$  for single byte operation or simultaneously asserting  $/UB$  and  $/LB$  for double byte operation. A write ends at the earliest transition when  $/CS$  goes high and  $WE$  goes high. The  $t_{WP}$  is measured from the beginning of write to the end of write.
2.  $t_{CW}$  is measured from the  $/CS$  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  $/CS$  or  $/WE$  going high.
5. Do not access device with cycle timing shorter than  $t_{RC}(t_{WC})$  for continuous periods  $> 20\mu s$ .



LOW POWER MODES

1. Mode Register Set



**/ZZ Enable/Disable**

A4	Type
0	Deep Power Down Enable
1	DPD Disable (Default)

Note: If the register is written to enable the Deep Power Down, the part will go into Deep Power Down during the following time that /ZZ is driven low and there is no MRS update. When /ZZ is driven high, all of the register settings will return to default state for the part (i.e. full array refresh, Deep Power Down Disabled).

**Array On/Off on /ZZ**

A3	Type
0	Partial Array Refresh Mode (Default)
1	Reduced Memory Size Mode

Note: The RMS(Reduced Memory Size) mode is enabled after /ZZ goes high and remains enabled after /ZZ goes high. To change to a different mode, the mode register will have to be rewritten.

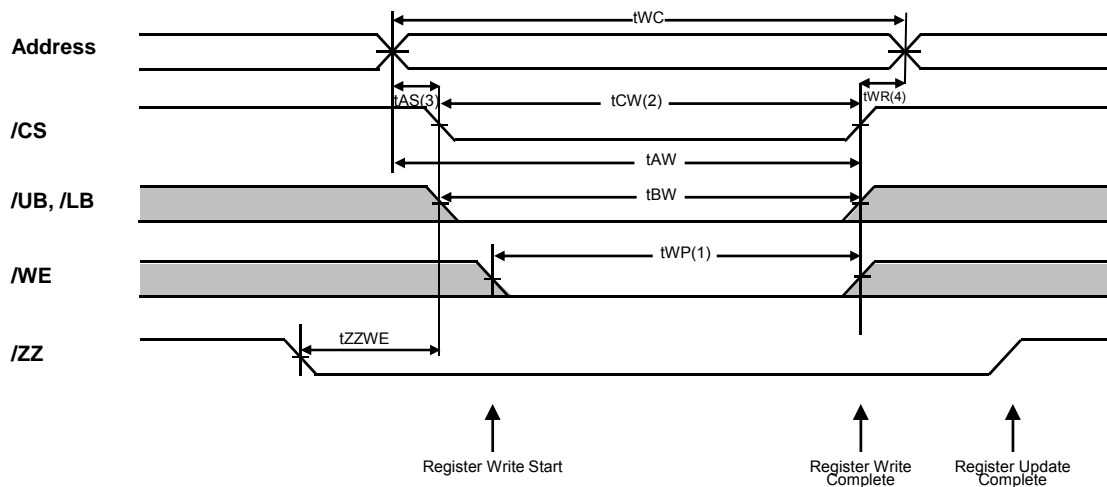
**Half Selection (Top / Bottom)**

A2	Type
0	Bottom (Default)
1	Top

**Array Refresh Area**

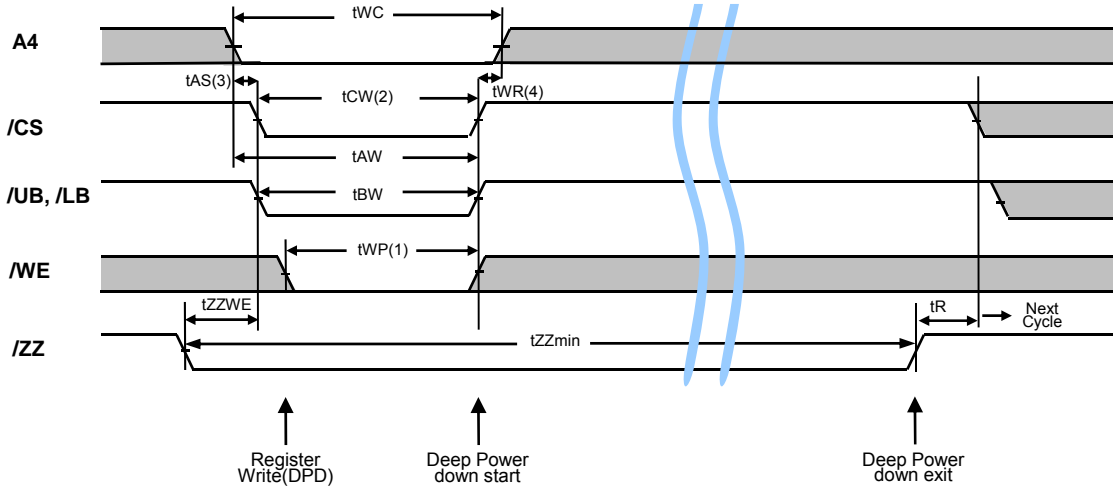
A1	A0	Type
0	0	Full Array (Default)
0	1	RFU
1	0	½ Array
1	1	¼ Array

2. MRS Update



The register update take place on the rising edge of /ZZ. Once the register is updated, the next time /ZZ goes low, without any updates to the register starting within the tZZWE max time of 1us, the part will refresh the array selected. The data bus is a don't care When /ZZ is low during the register updates.

3. Deep Power Down Mode Entry/Exit



Parameter	Description	Min	Max	Units
tZZWE	ZZ low to Write Enable Low	0	1	us
tR(Deep Power Down Mode only)	Operation Recovery Time	150	-	us
tZZmin	Low Power Mode Time	10	-	us

4. Address Information

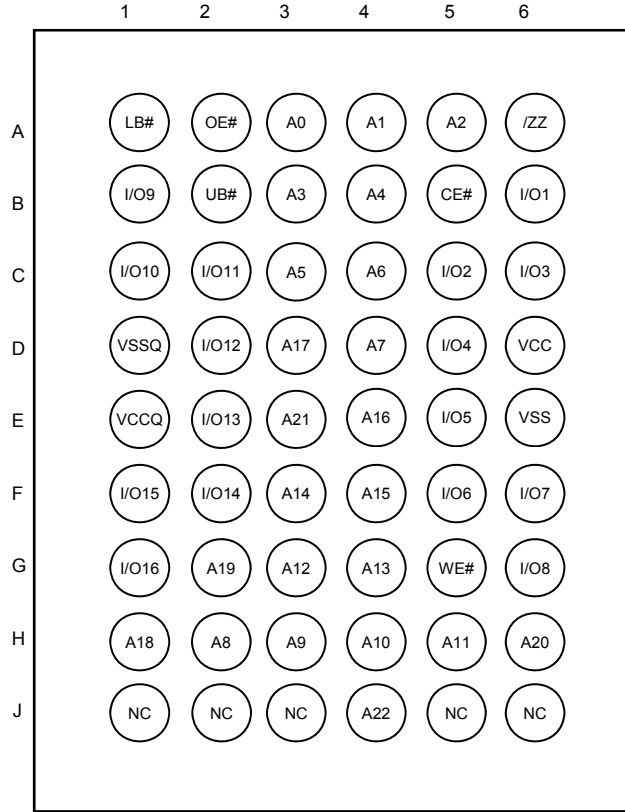
Partial Array Refresh Mode (A3=0, A4=1)

A2	A1,A0	Refresh Section	Address	Size	Density
0	11	1/4	000000h-1FFFFFFh	2Mbx16	32Mb
0	10	1/2	000000h-3FFFFFFh	4Mbx16	64Mb
X	00	Full	000000h-7FFFFFFh	8Mbx16	128Mb
1	11	1/4	600000h-7FFFFFFh	2Mbx16	32Mb
1	10	1/2	400000h-7FFFFFFh	4Mbx16	64Mb

Reduced Memory Size Mode (A3=1, A4=1)

A2	A1,A0	Refresh Section	Address	Size	Density
0	11	1/4	000000h-1FFFFFFh	2Mbx16	32Mb
0	10	1/2	000000h-3FFFFFFh	4Mbx16	64Mb
1	11	1/4	600000h-7FFFFFFh	2Mbx16	32Mb
1	10	1/2	400000h-7FFFFFFh	4Mbx16	64Mb

54Ball FBGA Ball Assignment



54-FBGA : Top View(Ball Down)

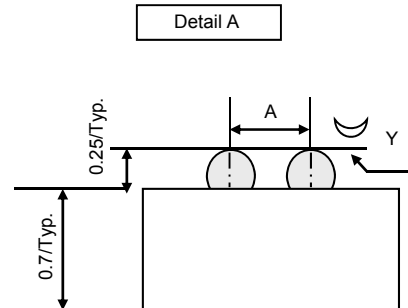
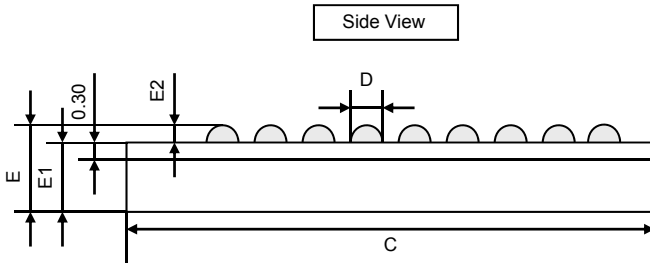
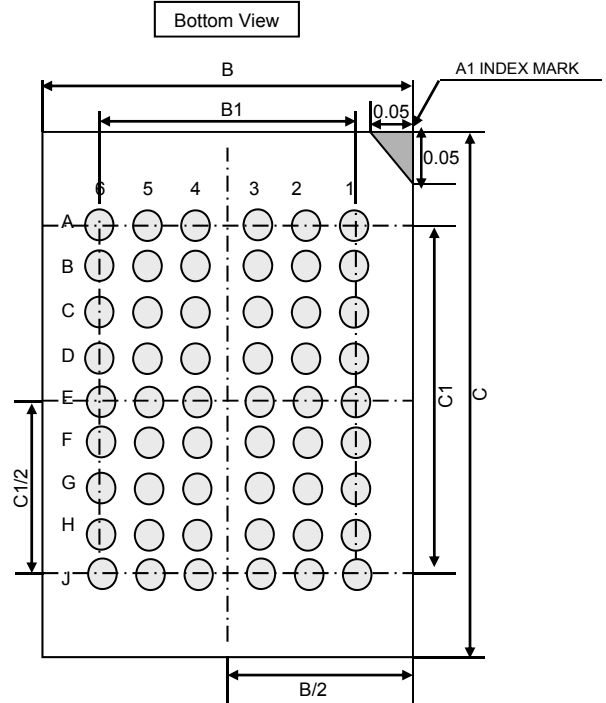
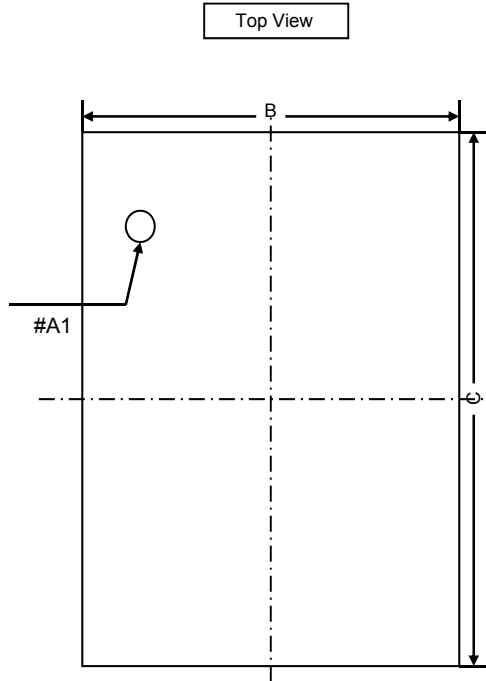
# FMP1216AAx

# CMOS LPRAM

## PACKAGE DIMENSION

Unit : millimeters

54 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	-	6.00	-
D	0.30	0.35	0.40
E	-	0.8	1.00
E1	-	0.7	-
E2	0.20	0.25	0.30
Y	-	-	0.08

### NOTES.

1. Bump counts : 54(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)