

**Document Title****2M x 16 bit Super Low Power and Low Voltage Full CMOS RAM****Revision History**

Revision No.	History	Draft date	Remark
0.0	Initial Draft	Apr. 10, 2010	Preliminary
0.1	Removed Page Write Operation	Jul. 14, 2010	

2M x 16 bit Super Low Power and Low Voltage Full CMOS RAM

FEATURES

- Process Technology : Full CMOS
- Organization : 2M x 16
- Power Supply Voltage 2.7V ~ 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)

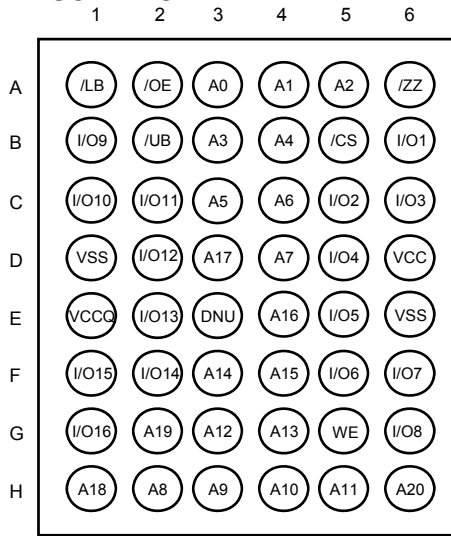
- Package Type : 48-FBGA-6.00x8.00 mm<sup>2</sup>  
FMP3216DAx-HxxX : Pb-Free & Halogen Free
- Low Power & Page Modes
  - FMP3216DA1 : support the PASR/DPD function
  - FMP3216DA2 : support the Direct DPD function
  - FMP3216DA4 : support the PASR/DPD/PAGE function
  - FMP3216DA5 : support the Direct DPD/PAGE function
- Page read operation by 16 words (FMP3216DA4, FMP3216DA5)
- DPD mode by using MRS only (FMP3216DA1, FMP3216DA4)
- Direct DPD mode when /ZZ goes low (FMP3216DA2, FMP3216DA5)

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.
FMP3216DAx-H60E FMP3216DAx-H70E	2.7	3.0	3.3	60ns 70ns	1.5mA	3mA	15mA 12mA	20mA	90uA	120uA

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)

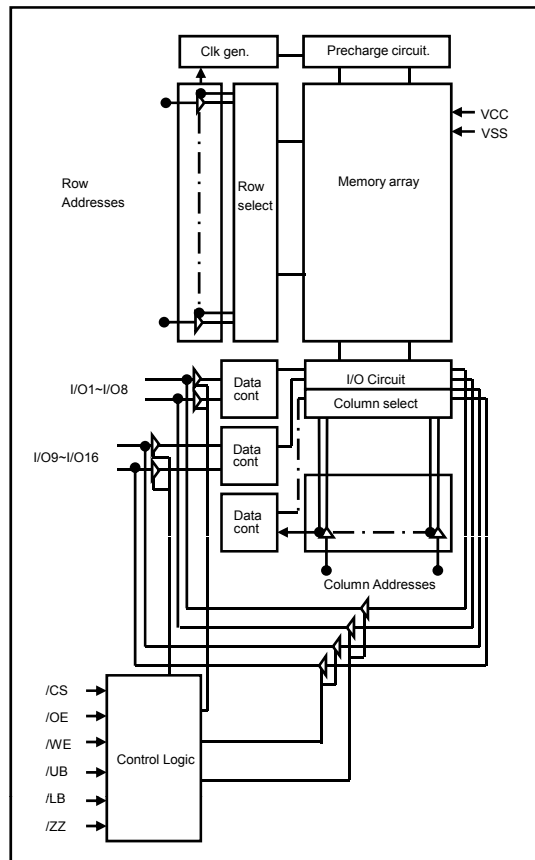
PIN DESCRIPTION



48-FBGA : Top View(Ball Down)

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(/O9~16)
A0~A20	Address Inputs	/LB	Lower Byte(/O 1~8)
/O1~/O16	Data Inputs/Outputs	DNU	Do Not Use

FUNCTIONAL BLOCK DIAGRAM



## PRODUCT LIST

Part Name	Function
FMP3216DAx-H60E FMP3216DAx-H70E	60ns, VCC=3.0V, VCCQ=3.0V 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 FMP3216DA2 & FMP3216DA5 product

3. In case of FMP3216DA1 & FMP3216DA4 product

4. Write data can't be written to the memory cell.

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

Item	Symbol	Ratings	Unit
Voltage on any pin relative to VSS	VIN, VOUT	-0.5 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	FMP3216DAx			Unit
		Min	Typ	Max	
Supply voltage	VCC	2.7	3.0	3.3	V
I/O operating voltage (VCCQ ≤ VCC)	VCCQ	2.7	3.0	3.3	V
Ground	VSS	0	0	0	V
Input high voltage	VIH	0.8VCCQ	VCCQ	VCC+0.2 <sup>1)</sup>	V
Input low voltage	VIL	-0.2 <sup>2)</sup>	0	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.

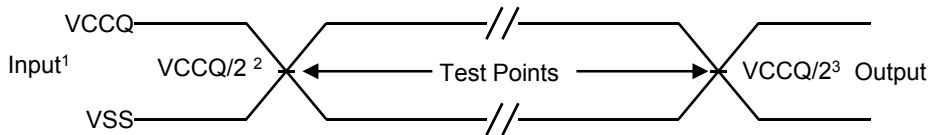
**DC AND OPERATING CHARACTERISTICS**

Item	Symbol	Test Conditions	Min	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>L</sub> , V <sub>IO</sub> =V <sub>SS</sub> to V <sub>CC</sub>	-1	1	uA
Average operating current	I <sub>CC1</sub>	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
	I <sub>CC2</sub>	Cycle time=Min, I <sub>IO</sub> =0mA, 100% duty, /CS=V <sub>L</sub> , /ZZ=V <sub>IH</sub> , V <sub>IN</sub> =V <sub>L</sub> or V <sub>IH</sub>	-	20	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)	I <sub>SB</sub>	/CS=V <sub>IH</sub> , /ZZ=V <sub>IH</sub> , Other inputs=V <sub>IH</sub> or V <sub>L</sub>	-	0.3	mA
Standby Current(CMOS)	I <sub>SB1</sub>	/CS≥V <sub>CC</sub> -0.2V, /ZZ≥V <sub>CC</sub> -0.2V, Other inputs=0~V <sub>CC</sub>	-	120	uA
Low Power Modes	I <sub>SB0</sub>	/ZZ≤0.2V, Other inputs=0~V <sub>CC</sub> , No refresh(DPD)	-	10	uA
	I <sub>SB0a</sub>	/ZZ≤0.2V, Other inputs=0~V <sub>CC</sub> , ¼ refresh area selection	-	90	uA
	I <sub>SB0b</sub>	/ZZ≤0.2V, Other inputs=0~V <sub>CC</sub> , ½ refresh area selection	-	100	uA
	I <sub>SB0c</sub>	/ZZ≤0.2V, Other inputs=0~V <sub>CC</sub> , All refresh area selection	-	120	uA

**Operating Range**

Device	Range	Ambient Temperature	V <sub>CC</sub>	V <sub>CCQ</sub>
FMP3216DAx-XxxS	Special	-10°C to +60°C	2.7V to 3.3V	2.7V to V <sub>CC</sub>
FMP3216DAx-XxxC	Commercial	0°C to +70°C		
FMP3216DAx-XxxE	Extended	-25°C to +85°C		
FMP3216DAx-XxxI	Industrial	-40°C to +85°C		

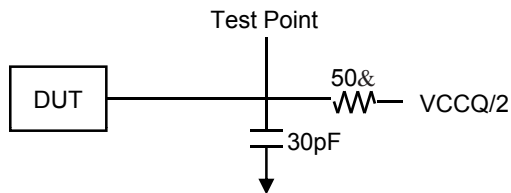
**AC Input/Output Reference Waveform**



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)

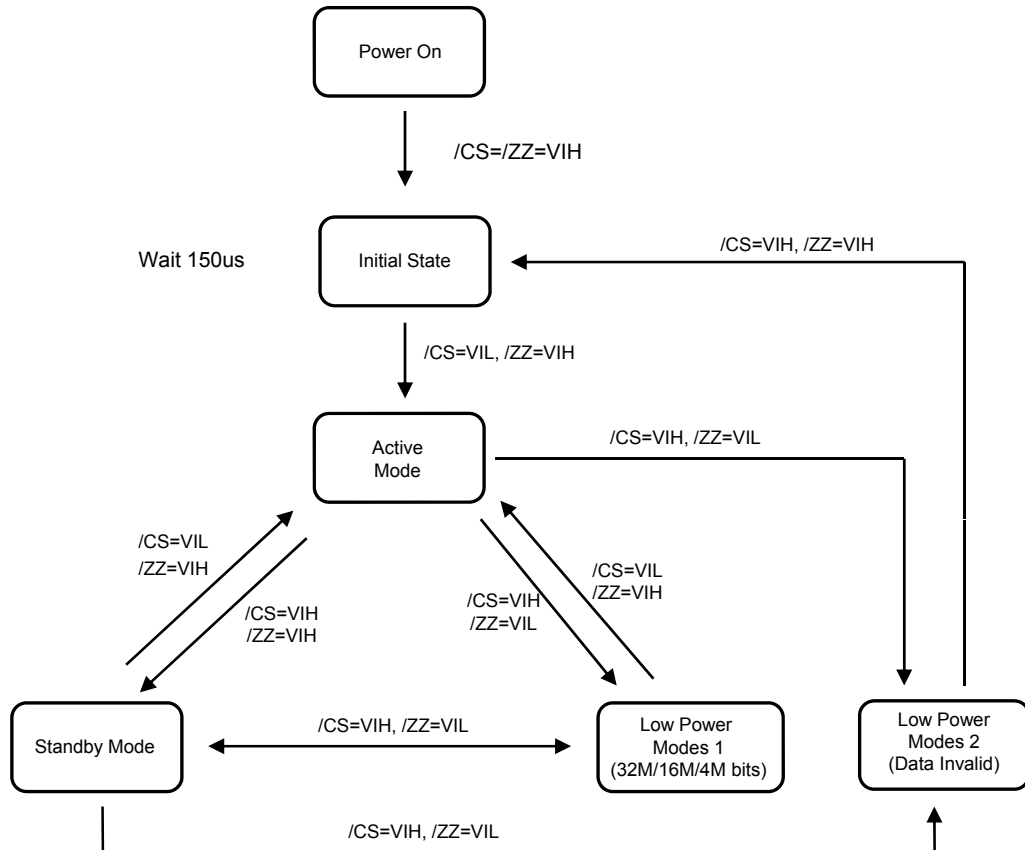
Parameter List		Symbol	Speed Bins				Units
			60ns		70ns		
			Min	Max	Min	Max	
Read	Read Cycle Time	tRC	60	20k	70	20k	ns
	Address Access Time	tAA	-	60	-	70	ns
	Chip Select to Output	tCO	-	60	-	70	ns
	Output Enable to Valid Output	tOE	-	25	-	25	ns
	/UB, /LB Access Time	tBA	-	25	-	25	ns
	Chip Select to 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	15	-	15	-	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=VIH

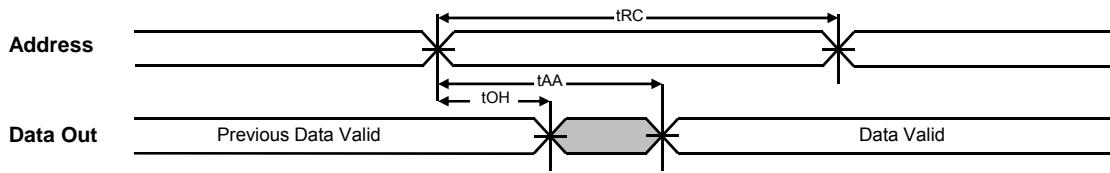
**Standby Mode State machines**



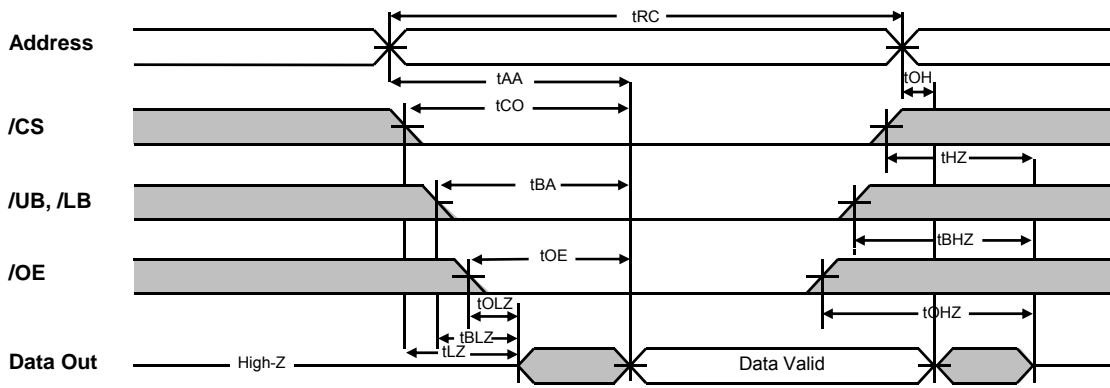
**Standby Mode Characteristics**

Mode	Memory Cell Data	Standby Current(uA)	Wait Time(us)
Standby	Valid	120 (ISB1)	0
Low Power Modes	Invalid	10 (ISB0)	150
	¼ valid	90 (ISB0a)	0
	½ valid	100 (ISB0b)	0
	valid	120 (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>)

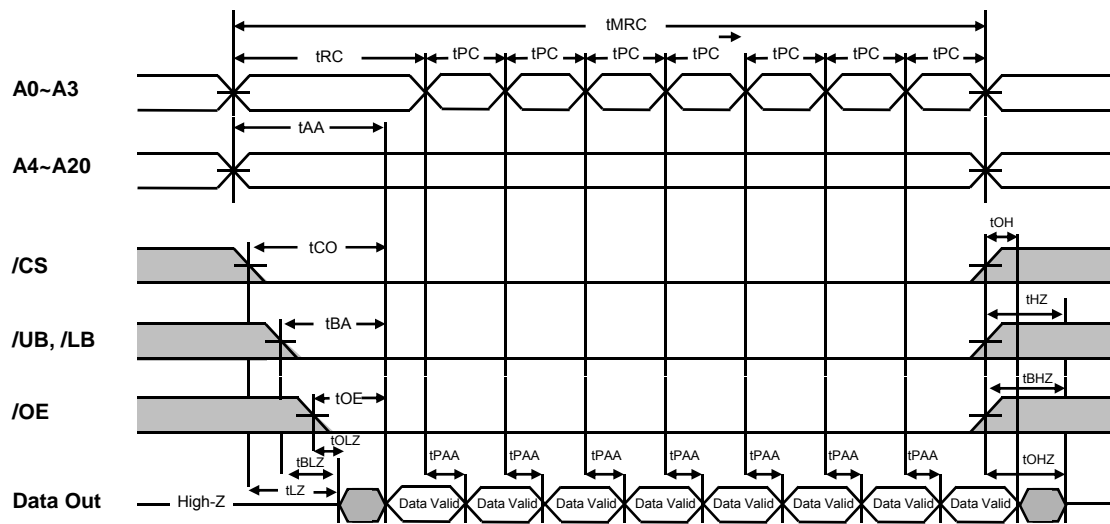


**READ CYCLE (2)** (/ZZ=/WE=V<sub>IH</sub>)



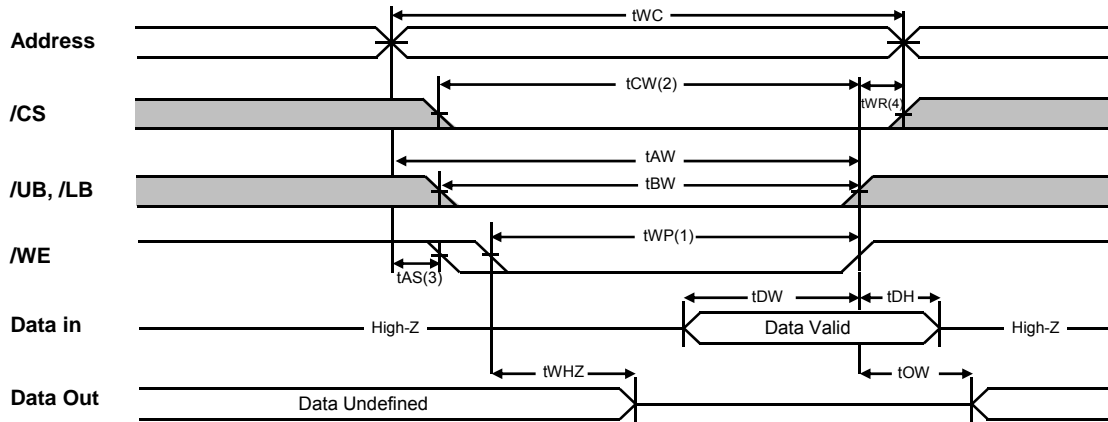
1. tHZ and tOZH are defined as the time at which the outputs achieve the open circuit conditions and are not referenced to output voltage levels.
2. At any given temperature and voltage condition, tHZ(Max.) is less than tLZ(Min.) both for a given device and from device to device interconnection.
3. Do 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)

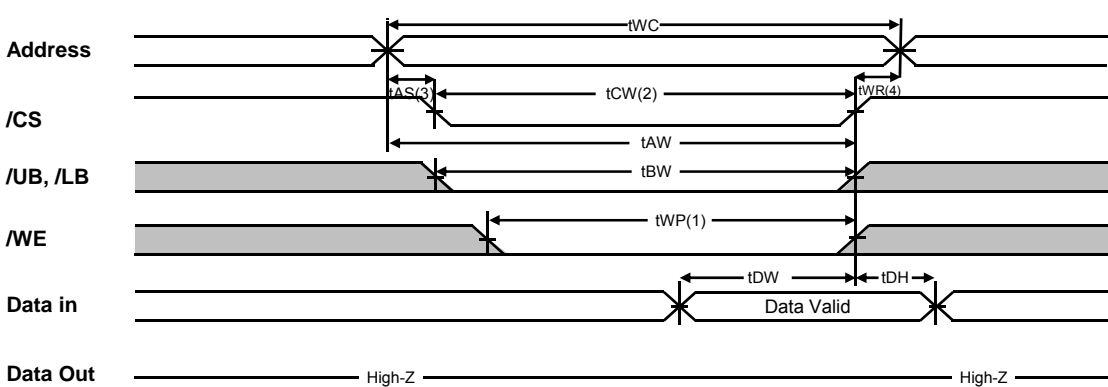


1. tHZ and tOZH are defined as the time at which the outputs achieve the open circuit conditions and are not referenced to output voltage levels.
2. At any given temperature and voltage condition, tHZ(Max.) is less than tLZ(Min.) both for a given device and from device to device interconnection.
3. Do 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.

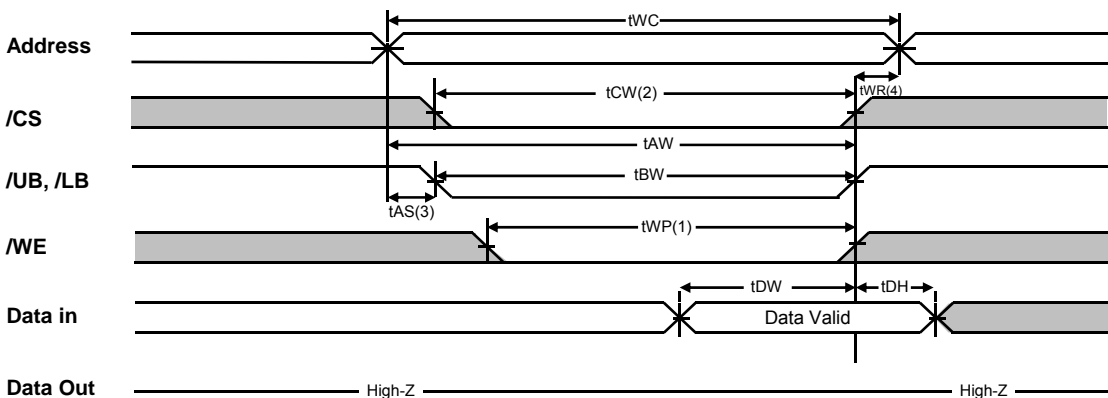
**WRITE CYCLE (1)** (*/WE controlled, /ZZ=V<sub>IH</sub>*)



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



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

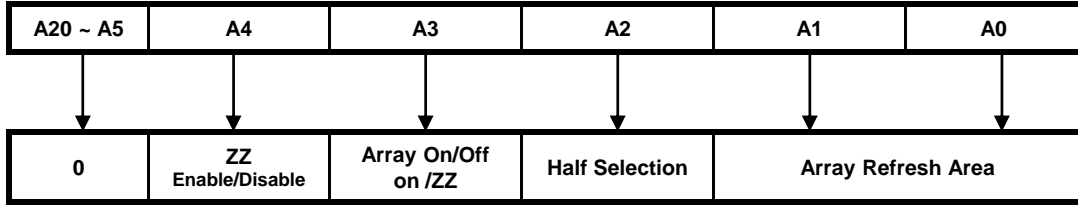


1. A write occurs during the overlap ( $t_{WP}$ ) of low  $/CS$  and  $/WE$ . A write begins when  $/CS$  goes low and  $/WE$  goes low with asserting  $/UB$  or  $/LB$  for single byte operation or simultaneously asserting  $/UB$  and  $/LB$  for double byte operation. A write ends at the earliest transition 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.

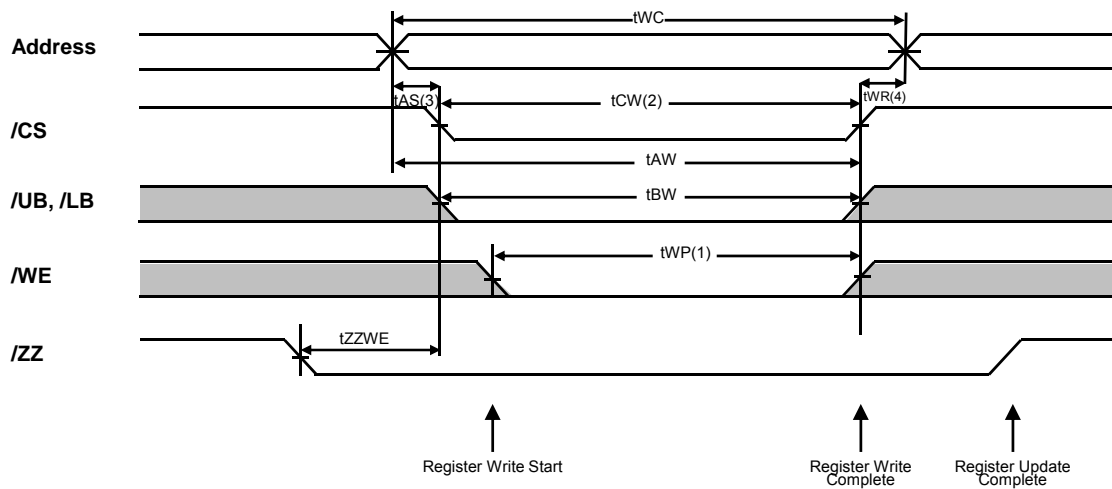
Half Selection (Top / Bottom)

A2	Type
0	Bottom (Default)
1	Top

Array Refresh Area

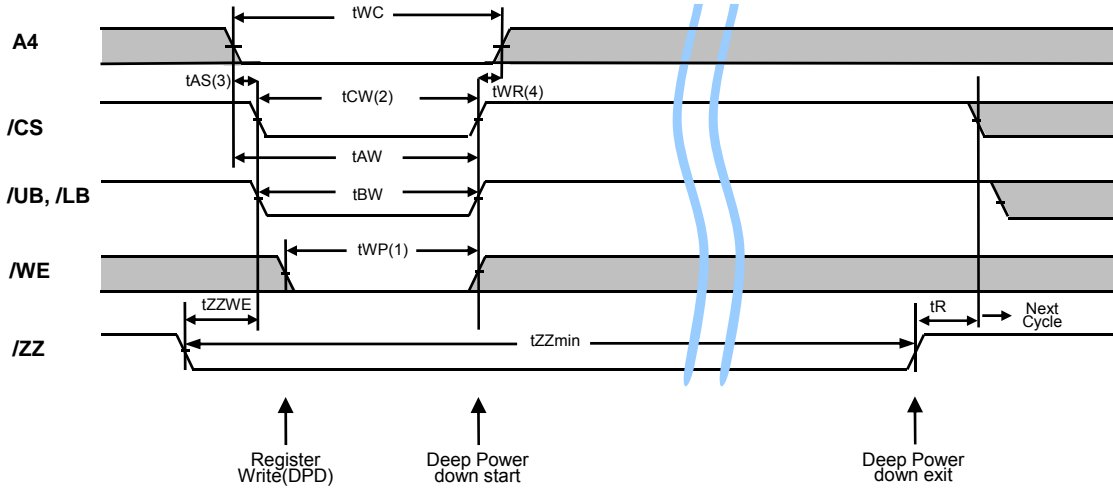
A1	A0	Type
0	0	Full Array (Default)
0	1	RFU
1	0	½ Array
1	1	¼ Array

2. MRS Update



The register update take place on the rising eDAe 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-7FFFFh	512Kbx16	8Mb
0	10	1/2	000000h-FFFFFFh	1Mbx16	16Mb
X	00	Full	000000h-1FFFFFFh	2Mbx16	32Mb
1	11	1/4	180000h-1FFFFFFh	512Kbx16	8Mb
1	10	1/2	100000h-1FFFFFFh	1Mbx16	16Mb

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

A2	A1,A0	Refresh Section	Address	Size	Density
0	11	1/4	000000h-7FFFFh	512Kbx16	8Mb
0	10	1/2	000000h-FFFFFFh	1Mbx16	16Mb
1	11	1/4	180000h-1FFFFFFh	512Kbx16	8Mb
1	10	1/2	100000h-1FFFFFFh	1Mbx16	16Mb

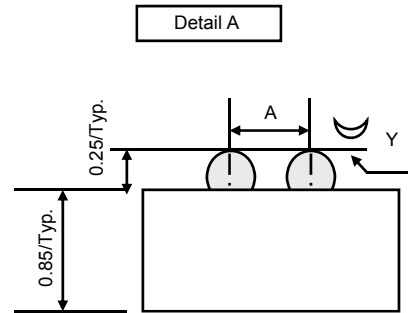
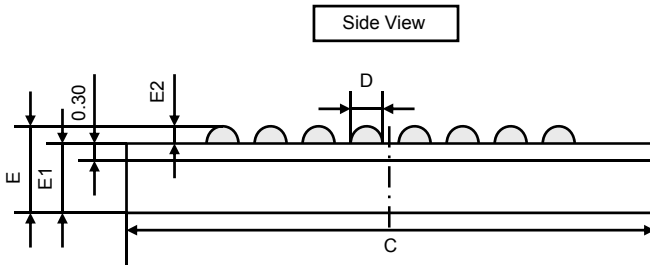
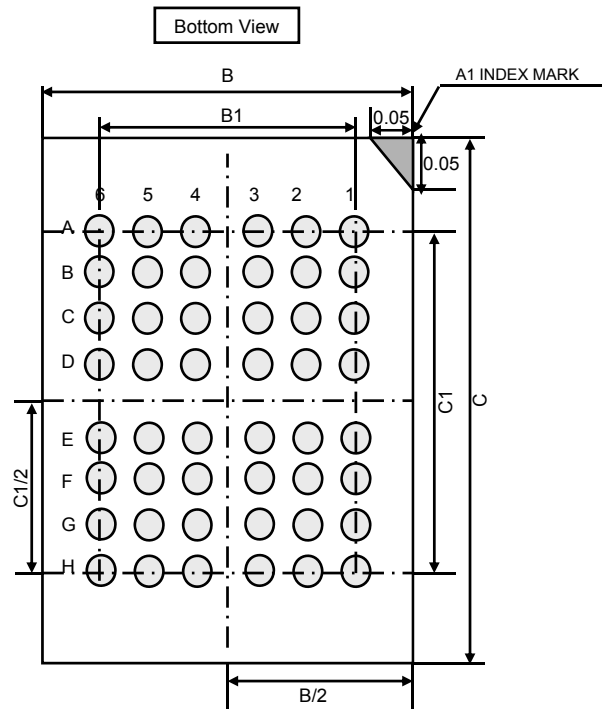
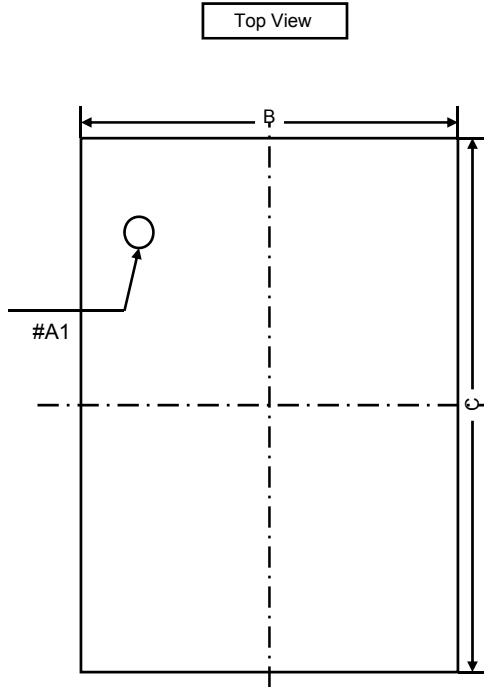
# FMP3216DAx

# CMOS LPRAM

## 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	0.30	0.35	0.40
E	-	1.10	1.20
E1	-	0.85	-
E2	0.20	0.25	0.30
Y	-	-	0.08

### NOTES.

1. Bump counts : 48(8row 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)