Document Title

1M x 16 bit Super Low Power and Low Voltage Full CMOS RAM

Revision History

Revision No.	History	Draft date	Remark
0.0	Initial Draft	Dec,08th, 2008	Preliminary
0.1	Revised Load Condition Revised I/O power (1.7V to VCC → 2.7V to VCC) Revised VIH (VCC-0.4 → 0.8VCCQ) Revised VIL (0.4 → 0.2VCCQ)	Jul. 3rd, 2009	Preliminary
0.2	Revised ISB1 (110uA → 100uA) Revised ISB0c (110uA → 100uA) Revised ISB0b (100uA → 80uA) Revised ISB0a (90uA → 70uA)	Nov. 25th, 2009	Preliminary
0.3	Correct typo in Array Refresh Area of Mode Register Set	Feb. 3rd, 2010	Preliminary
0.4	Removed Page Write Operation	Jul. 21st, 2010	Final

1M x 16 bit Super Low Power and Low Voltage Full CMOS RAM

FEATURES

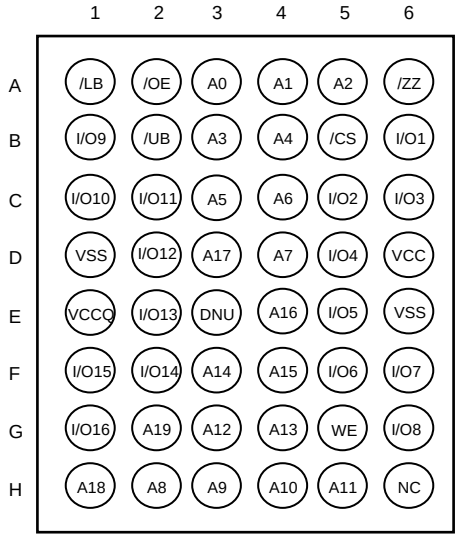
- Process Technology : Full CMOS
- Organization : 1M x 16
- Power Supply Voltage : 2.7~3.3V
- Three state output and TTL Compatible
- Separated I/O power(VCCQ) & Core power(VCC)
- Operating Temperature Ranges:
  - Special (-10'C to +60'C)
  - Commercial (0'C to +70'C)
  - Extended (-25'C to +85'C)
  - Industrial (-40'C to +85'C)
- Package Type : 48-FBGA-6.00x8.00 mm²
  - FMP1617DAx-HxxX : Pb-Free & Halogen Free
- Low Power & Page Modes
  - FMP1617DA1 : support the PASR/DPD function
  - FMP1617DA2 : support the Direct DPD function
  - FMP1617DA4 : support the PASR/DPD/PAGE function
  - FMP1617DA5 : support the Direct DPD/PAGE function
- Page read/write operation by 16 words
  - (FMP1617DA4, FMP1617DA5)
- DPD mode by using MRS only
  - (FMP1617DA1, FMP1617DA4)
- Direct DPD mode when /ZZ goes low
  - (FMP1617DA2, FMP1617DA5)

PRODUCT FAMILY

Product Family	Operating Voltage (V)			Speed	Power Dissipation					
					ICC1		ICC2		ISB1 (CMOS Standby Current)	
					f = 1MHz		f = fmax			
	Min.	Typ.	Max.		Typ.	Max.	Typ.	Max.	Typ.	Max.
FMP1617DAx-H60E FMP1617DAx-H70E	2.7	3.0	3.3	60ns 70ns	1.5mA	3mA	15mA 12mA	20mA	**70uA**	**100uA**

1. Typical values are included for reference only and are not guaranteed or tested. Typical values are measured at Vcc = Vcc (typ) and T_A = 25C.
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)

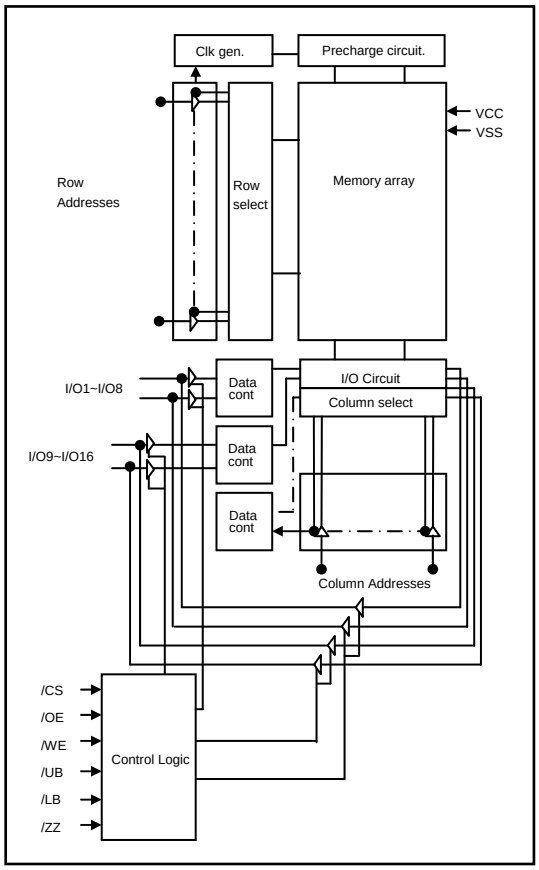
PIN DESCRIPTION



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(I/O9~16)
A0~A19	Address Inputs	/LB	Lower Byte(I/O 1~8)
I/O1~I/O16	Data Inputs/Outputs	DNU	Do Not Use

FUNCTIONAL BLOCK DIAGRAM



PRODUCT LIST

Part Name	Function
FMP1617DAx-H60E	60ns, VCC=3.0V, VCCQ=3.0V
FMP1617DAx-H70E	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[1]	X[1]	X[1]	X[1]	High-Z	High-Z	Deselected	Standby
X[1]	L	X[1]	X[1]	X[1]	X[1]	High-Z	High-Z	Deselected	Direct DPD[2]
H	L	X[1]	X[1]	X[1]	X[1]	High-Z	High-Z	Deselected	Low Power Modes[3]
X[1]	H	X[1]	X[1]	H	H	High-Z	High-Z	Deselected	Standby
L	H	H	H	L	X[1]	High-Z	High-Z	Output Disabled	Active
	H	H	H	X[1]	L	High-Z	High-Z	Output Disabled	Active
L	H	L	H	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[1]	L	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 FMP1617DA2 & FMP1617DA5 product
3. In case of FMP1617DA1 & FMP1617DA4 product

ABSOLUTE MAXIMUM RATINGS[1]

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	FMP1617DAx			Unit
		Min	Typ	Max	
Supply voltage	VCC	2.7	3.0V	3.3	V
I/O operating voltage (VCCQ ≤ VCC)	VCCQ	2.7	3.0V	3.3	V
Ground	VSS	0	0	0	V
Input high voltage	VIH	0.8VCCQ	VCCQ	VCC+0.2[1]	V
Input low voltage	VIL	-0.2[2]	0	0.2VCCQ	V

Note :
1. Overshoot : Vcc+1.0V in case of pulse width≤20ns.
2. Undershoot : -1.0V in case of pulse width≤20ns.
3. Overshoot and undershoot are sampled, not 100% tested.

CAPACITANCE[1)] (f=1MHz , T_A=25'C)

Item	Symbol	Test Condition	Min	Max	Unit
Input capacitance	CIN	VIN=0V	-	8	pF
Input/Output capacitance	CIO	VIO=0V	-	8	pF

1. Capacitance is sampled, not 100% tested.

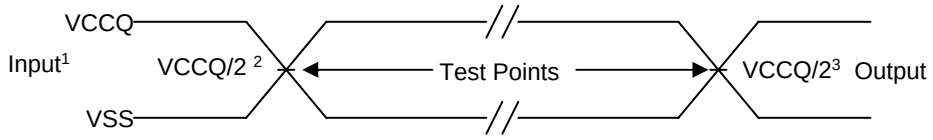
DC AND OPERATING CHARACTERISTICS

Item	Symbol	Test Conditions	Min	Max	Unit
Input leakage current	ILI	VIN=VSS to VCC	-1	1	uA
Output leakage current	ILO	/CS=VIH, /ZZ=VIH, /OE=VIH or /WE=VIL, VIO=VSS to VCC	-1	1	uA
Average operating current	ICC1	Cycle time=1us, 100%duty, IIO=0mA, /CS≤0.2V, /ZZ=VIH, VIN≤0.2V or VIN≥VCC-0.2V	-	3	mA
	ICC2	Cycle time=Min, IIO=0mA, 100% duty, /CS=VIL, /ZZ=VIH, VIN=VIL or VIH	-	20	mA
Output low voltage	VOL	IOL=0.5mA		0.2VCCQ	V
Output high voltage	VOH	IOH=-0.5mA	0.8VCCQ		V
Standby Current(TTL)	ISB	/CS=VIH, /ZZ=VIH, Other inputs=VIH or VIL	-	0.3	mA
Standby Current(CMOS)	ISB1	/CS≥VCC-0.2V, /ZZ≥VCC-0.2V, Other inputs=0~VCC	-	100	uA
Low Power Modes	ISB0	/ZZ≤0.2V, Other inputs=0~VCC, No refresh(DPD)	-	10	uA
	ISB0a	/ZZ≤0.2V, Other inputs=0~VCC, ¼ refresh area selection	-	70	uA
	ISB0b	/ZZ≤0.2V, Other inputs=0~VCC, ½ refresh area selection	-	80	uA
	ISB0c	/ZZ≤0.2V, Other inputs=0~VCC, All refresh area selection	-	100	uA

Operating Range

Device	Range	Ambient Temperature	VCC	VCCQ
FMP1617DAx-XxxS	Special	-10℃ to +60℃	2.7V to 3.3V	2.7V to VCC
FMP1617DAx-XxxC	Commercial	0℃ to +70℃		
FMP1617DAx-XxxE	Extended	-25℃ to +85℃		
FMP1617DAx-XxxI	Industrial	-40℃ to +85℃		

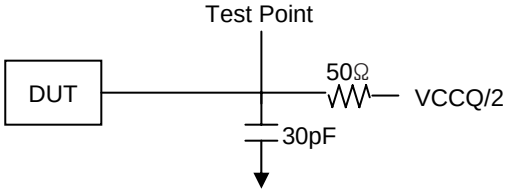
AC Input/Output Reference Waveform



NOTE:

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

AC Output Load Circuit



AC CHARACTERISTICS(VCC=2.7V~3.3V)

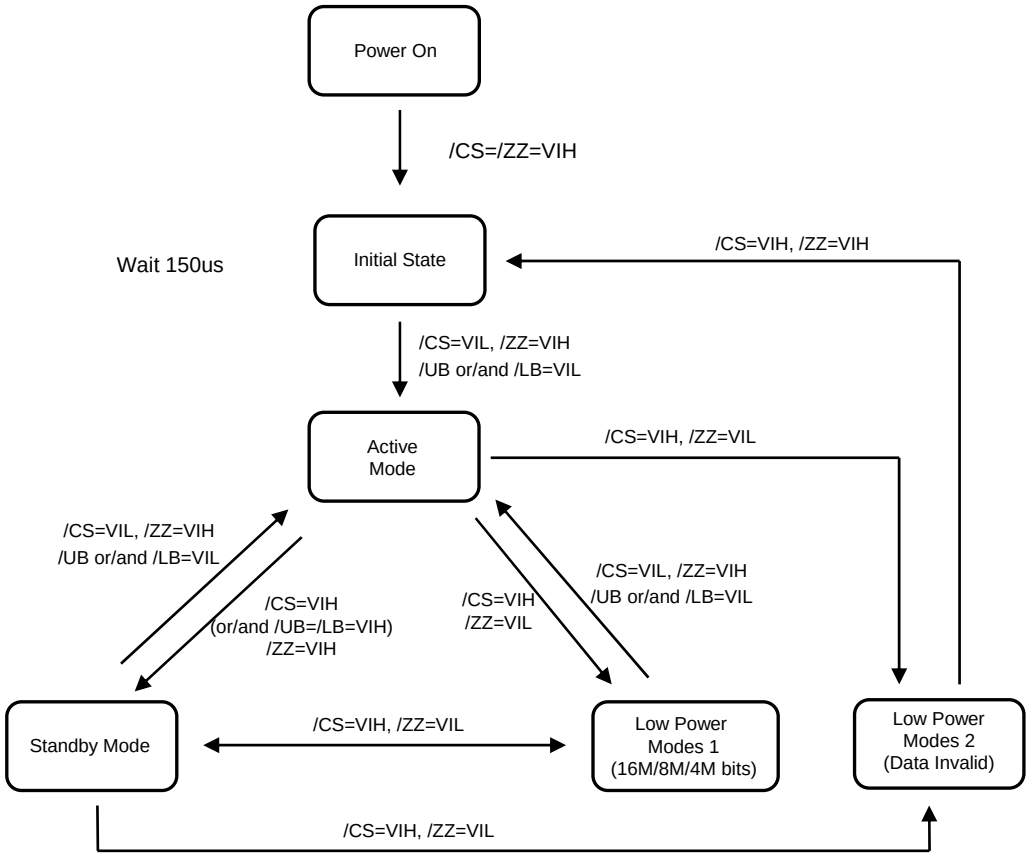
Parameter List		Symbol	Speed Bins				Units
			60ns		70ns		
			Min	Max	Min	Max	
Read	Read Cycle Time	tRC	60	20k	70	20k	ns
	Address Access Time	tAA	-	60	-	70	ns
	Chip Select to Output	tCO	-	60	-	70	ns
	Output Enable to Valid Output	tOE	-	25	-	25	ns
	/UB, /LB Access Time	tBA	-	60	-	70	ns
	Chip Select to 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 or (/UB and /LB) because /UB & /LB can make standby mode when /UB=High and /LB=High.

Power Up Sequence

1. Apply Power
2. Maintain stable power for a minimum of 150us with /CS=/ZZ=VIH

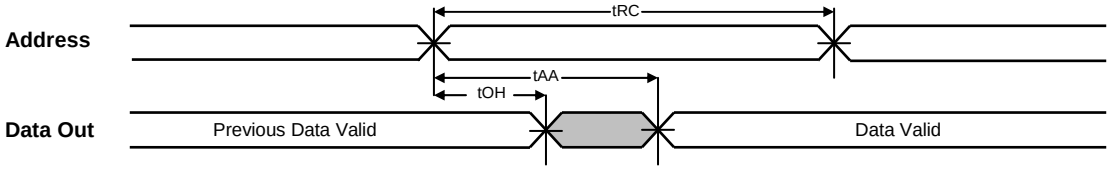
Standby Mode State machines



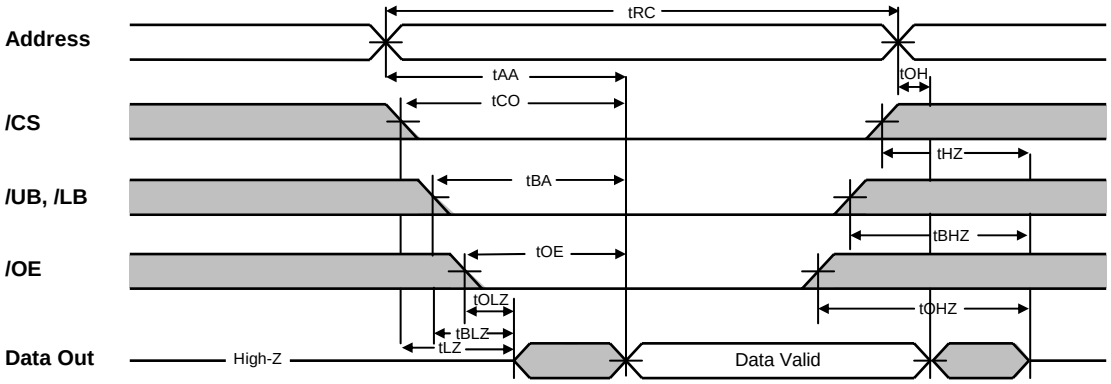
Standby Mode Characteristics

Mode	Memory Cell Data	Standby Current(uA)	Wait Time(us)
Standby	Valid	100 (ISB1)	0
Low Power Modes	Invalid	10 (ISB0)	150
	¼ valid	70 (ISB0a)	0
	½ valid	80 (ISB0b)	0
	valid	100 (ISB0c)	0

READ CYCLE (1) (Address controlled,/CS=/OE=VIL, /ZZ=/WE=VIH, /UB or/and /LB=VIL)

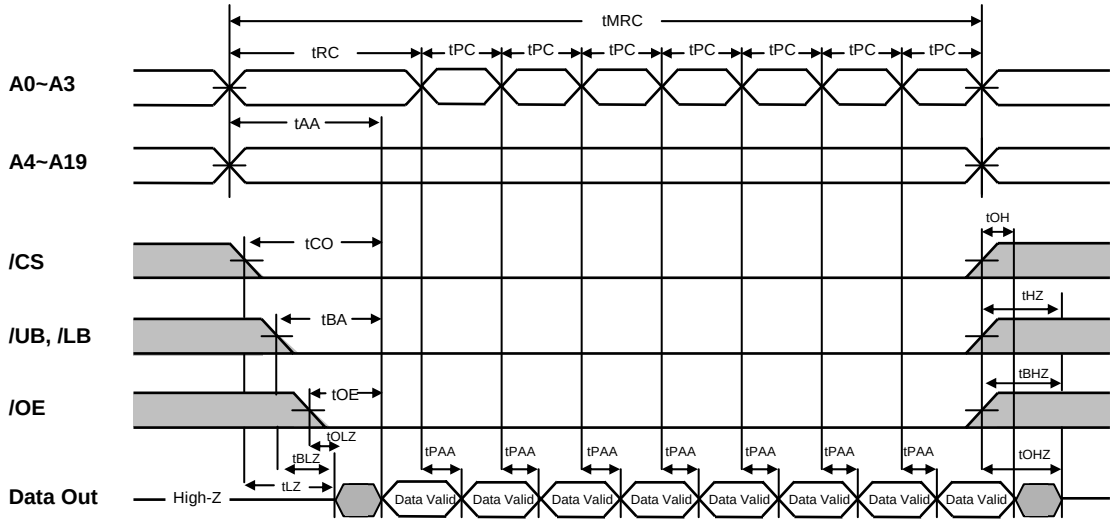


READ CYCLE (2) (/ZZ=/WE=VIH)



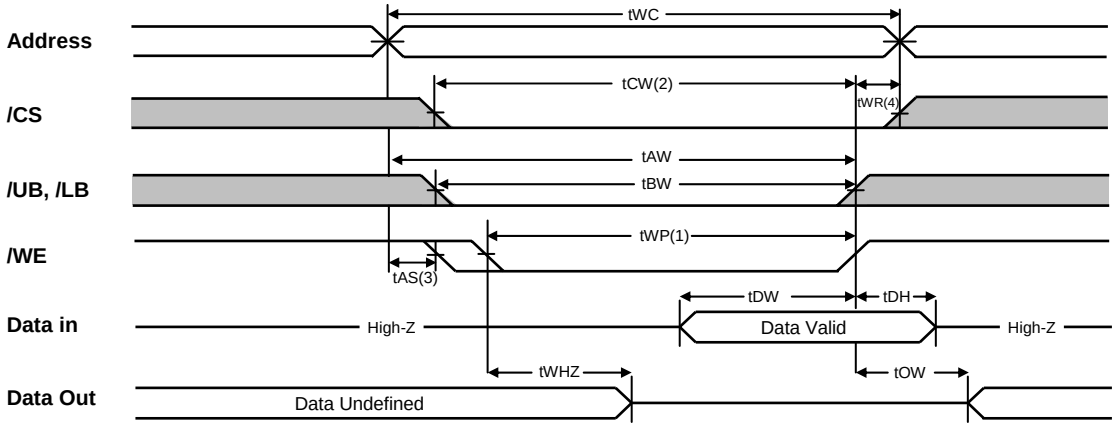
1. tHZ and tOHZ are defined as the time at which the outputs achieve the open circuit conditions and are not referenced to output voltage levels.
2. At any given temperature and voltage condition, tHZ(Max.) is less than tLZ(Min.) both for a given device and from device to device interconnection.
3. Do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

PAGE READ CYCLE (/ZZ=/WE=VIH, 16 words access)

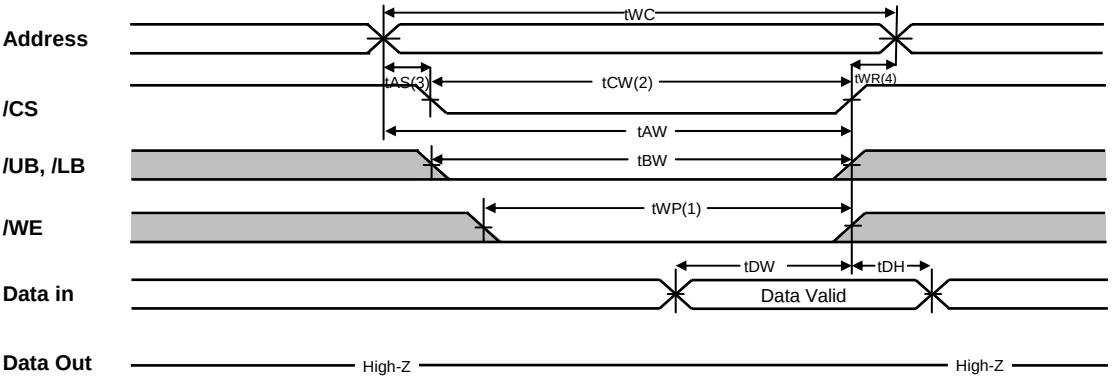


1. tHZ and tOHZ are defined as the time at which the outputs achieve the open circuit conditions and are not referenced to output voltage levels.
2. At any given temperature and voltage condition, tHZ(Max.) is less than tLZ(Min.) both for a given device and from device to device interconnection.
3. Do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

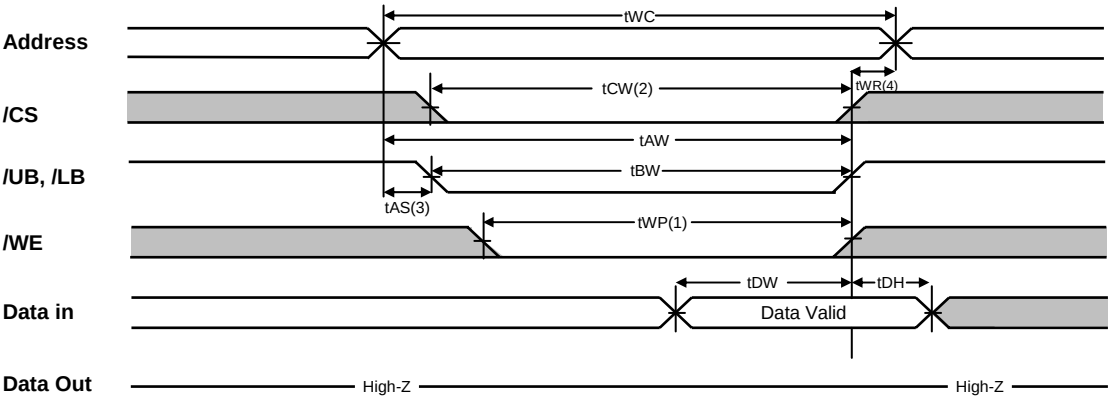
WRITE CYCLE (1) (/WE controlled, /ZZ=VIH)



WRITE CYCLE (2) (/CS controlled, /ZZ=/WE=VIH)



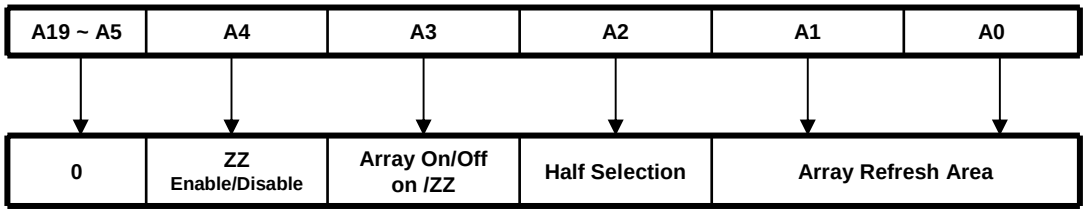
WRITE CYCLE (3) (/UB, /LB controlled, /ZZ=VIH)



1. A write occurs during the overlap (tWP) 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 tWP is measured from the beginning of write to the end of write.
2. tCW is measured from the /CS going low to 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 applied in case a write ends as /CS or /WE going high.
5. Do not access device with cycle timing shorter than tRC(tWC) for continuous periods > 20us.

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.

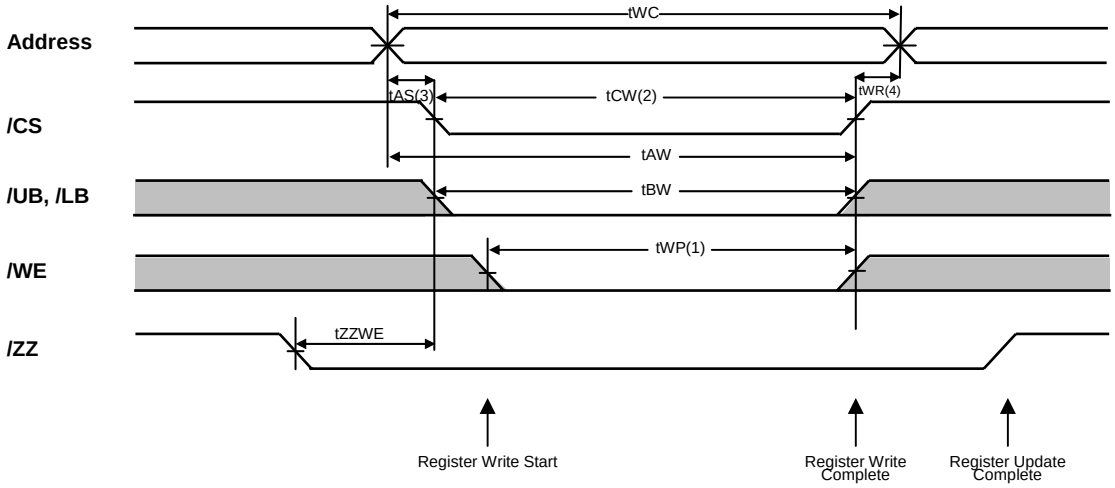
Half Selection (Top / Bottom)

A2	Type
0	Bottom (Default)
1	Top

Array Refresh Area

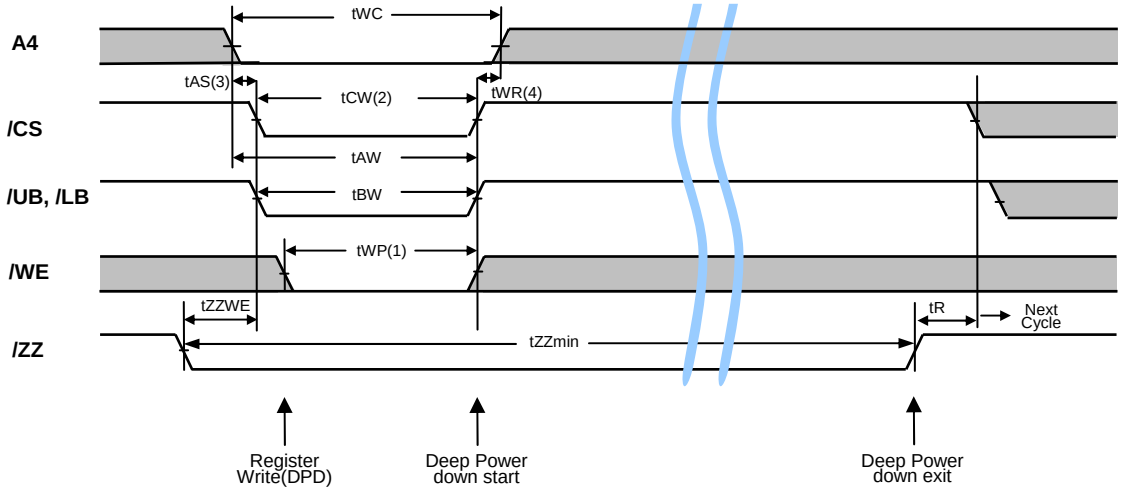
A1	A0	Type
0	0	Full Array (Default)
0	1	RFU
1	0	½ Array
1	1	¼ Array

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	00000h-3FFFFh	256Kbx16	4Mb
0	10	1/2	00000h-7FFFFh	512Kbx16	8Mb
X	00	Full	00000h-FFFFFh	1Mbx16	16Mb
1	11	1/4	C0000h-FFFFFh	256Kbx16	4Mb
1	10	1/2	80000h-FFFFFh	512Kbx16	8Mb

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

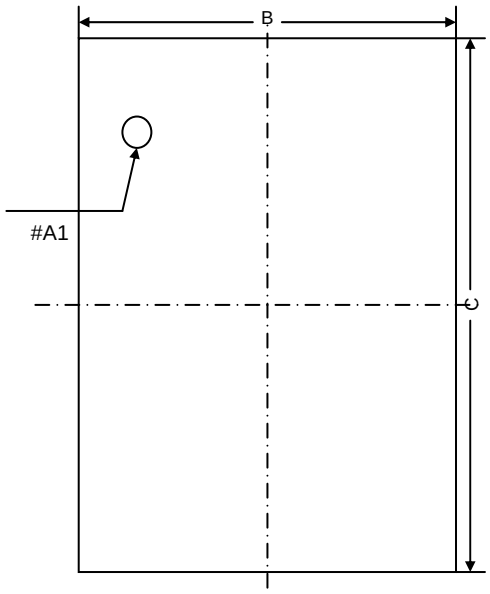
A2	A1,A0	Refresh Section	Address	Size	Density
0	11	1/4	00000h-3FFFFh	256Kbx16	4Mb
0	10	1/2	00000h-7FFFFh	512Kbx16	8Mb
1	11	1/4	C0000h-FFFFFh	256Kbx16	4Mb
1	10	1/2	80000h-FFFFFh	512Kbx16	8Mb

PACKAGE DIMENSION

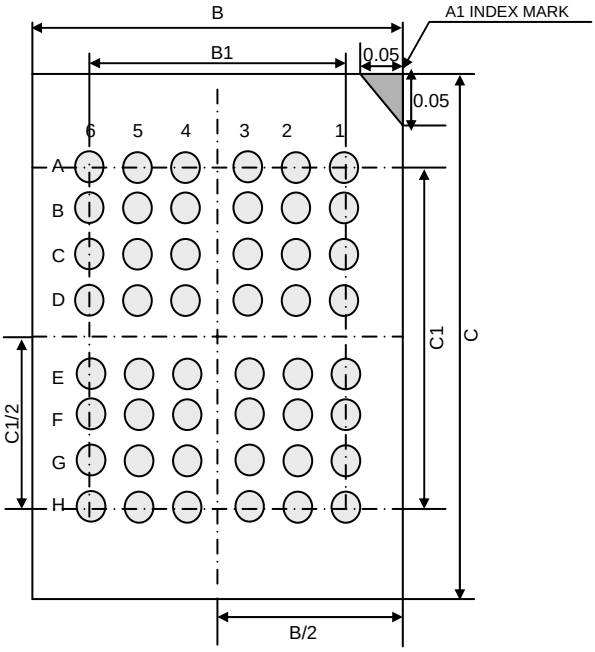
Unit : millimeters

48 BALL FINE PITCH BGA(0.75mm ball pitch)

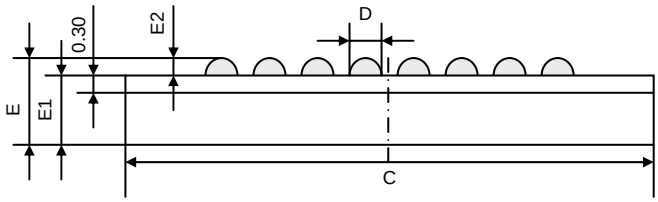
Top View



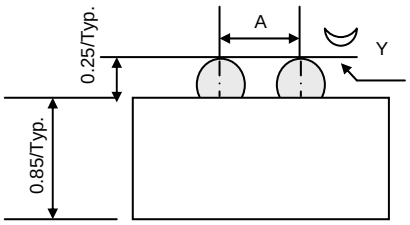
Bottom View



Side View



Detail A



-	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)