

Document Title

512K x 16 bit Pseudo SRAM Specification

Revision History

Revision No.	History	Date	Remark
0.0	-. Initial Draft	Mar 12 2012	Preliminary

**512Kb x16 Pseudo Static RAM Specification**

**GENERAL DESCRIPTION**

The EM784SU16BxP is 8,388,608 bits of Pseudo SRAM which uses DRAM type memory cells, but this device has refresh-free operation and extreme low power consumption technology. Furthermore the interface is compatible to a low power Asynchronous type SRAM. The EM784SU16BxP is organized as 524,288 Words x 16 bit.

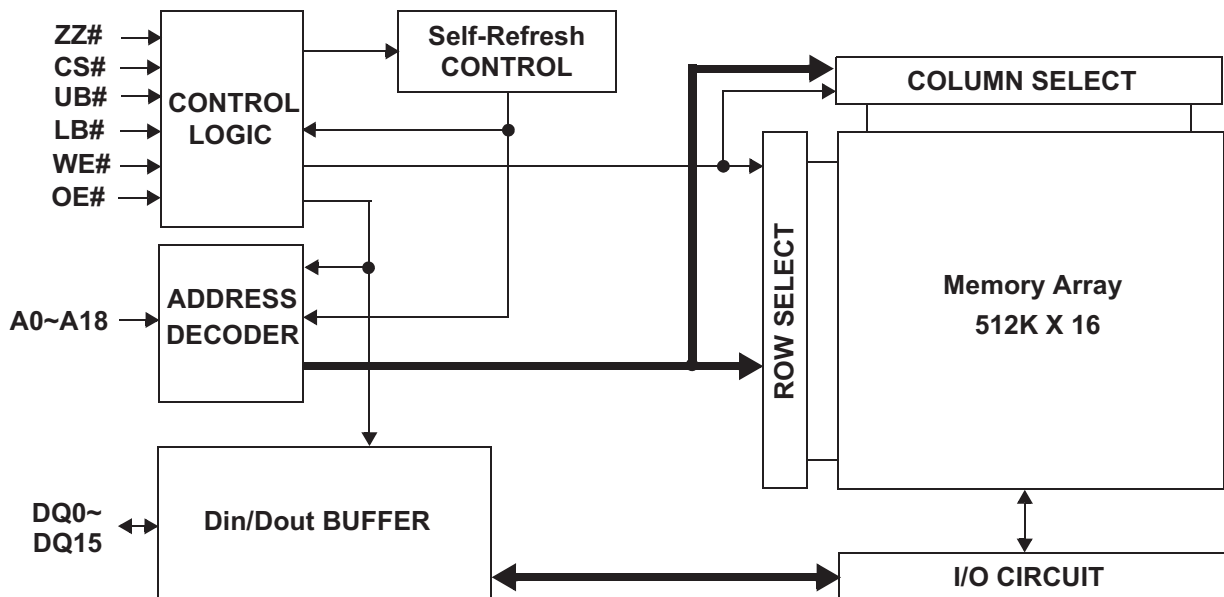
**FEATURES**

- Organization :512K x16
- Power Supply Voltage : 2.6 ~ 3.6V
- Separated I/O power(VccQ) & Core power(Vcc)
- Three state outputs
- Byte read/write control by UB# / LB#
- Auto-TCSR for power saving
- Package type : 48-FPBGA 6.0x7.0
- Operating Temperature
  - . Wireless : -30 °C~ 85 °C
  - . Industrial : -40 °C~ 85 °C
- EM784SU16BLP support 8 page mode & DPD
- EM784SU16BMP support 8 page mode & Non-DPD
- EM784SU16BNP support 16 page mode & DPD
- EM784SU16BPP support 16 page mode & Non-DPD
- EM784SU16BRP support Non-page mode & DPD
- EM784SU16BSP support Non-page mode & Non-DPD

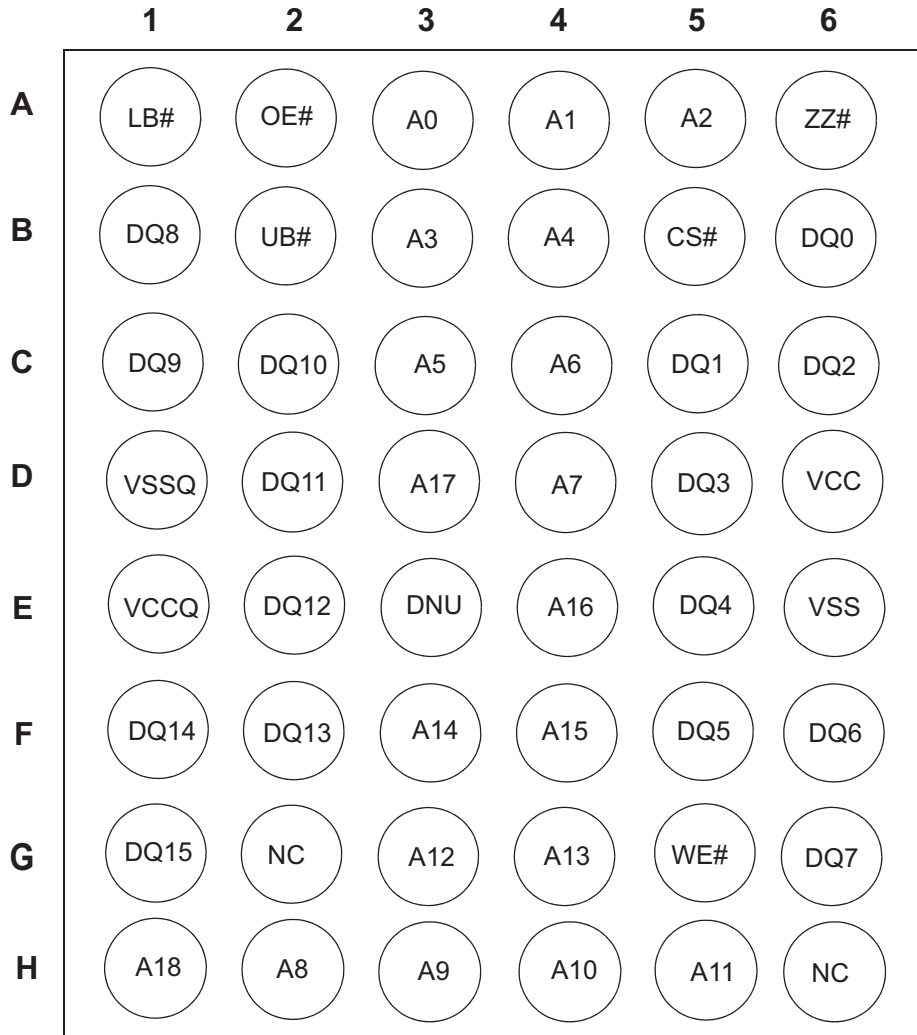
**PRODUCT FAMILY**

Part Number	Operating Temp.	Power Supply	Speed (t <sub>RC</sub> )	Power Dissipation		
				Standby (I <sub>SB</sub> , Max.)	Operating I <sub>CC</sub> ( Max.)	
					I <sub>CC1</sub> ( f = 1MHz)	I <sub>CC2</sub> ( f = f <sub>max</sub> )
EM784SU16BxP-70LF	-30 °C to 85 °C	2.6V to 3.6V	70ns	90uA	5mA	25mA
EM784SU16BxP-70LFI	-40 °C to 85 °C	2.6V to 3.6V	70ns	90uA	5mA	25mA

**FUNCTION BLOCK DIAGRAM**



**PIN DESCRIPTION ( 48-FBGA-6.00x7.00 )**



**TOP VIEW (Ball Down)**

Name	Function	Name	Function
CS#	Chip select input	LB#	Lower byte (DQ <sub>0~7</sub> )
OE#	Output enable input	UB#	Upper byte (DQ <sub>8~15</sub> )
WE#	Write enable input	VCC	Power supply
ZZ#	Low power control	VCCQ	I/O power supply
DQ <sub>0-15</sub>	Data in-out	VSS(Q)	Ground
A <sub>0-18</sub>	Address inputs	NC	No connection
DNU	Do not use		

Note : ZZ# pin is replaced to NC pin in EM784SU16BMP, EM784SU16BPP, EM784SU16BSP.

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

Parameter		Symbol	Ratings	Unit
Voltage on Any Pin Relative to Vss		$V_{IN}, V_{OUT}$	-0.2 to $V_{CCQ}+0.3$	V
Voltage on Vcc supply relative to Vss		$V_{CC}, V_{CCQ}$	-0.2 <sup>2)</sup> to 3.9	V
Power Dissipation		$P_D$	1.0	W
Storage Temperature		$T_{STG}$	-65 to 150	°C
Operating Temperature	Wireless	$T_A$	-30 to 85	°C
	Industrial		-40 to 85	°C

- Stresses greater than those listed above “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.
- Undershoot at power-off : -1.0V in case of pulse width  $\leq 20$ ns

## FUNCTIONAL DESCRIPTION

CS#	ZZ#	OE#	WE#	LB#	UB#	DQ <sub>0~7</sub>	DQ <sub>8~15</sub>	Mode	Power
H	H	X	X	X	X	High-Z	High-Z	Deselected	Stand by
X	L	X	X	X	X	High-Z	High-Z	Deselected	Low Power Mode <sup>*2)</sup>
L	H	H	H	L	X	High-Z	High-Z	Output Disabled	Active
L	H	H	H	X	L	High-Z	High-Z	Output Disabled	Active
L	H	L	H	L	H	Data Out	High-Z	Lower Byte Read	Active
L	H	L	H	H	L	High-Z	Data Out	Upper Byte Read	Active
L	H	L	H	L	L	Data Out	Data Out	Word Read	Active
L	H	X	L	L	H	Data In	High-Z	Lower Byte Write	Active
L	H	X	L	H	L	High-Z	Data In	Upper Byte Write	Active
L	H	X	L	L	L	Data In	Data In	Word Write	Active

Note:

- X means don't care. (Must be low or high state)
- This Low Power mode is supported in EM784SU16BLP, EM784SU16BNP & EM784SU16BRP.

## RECOMMENDED DC OPERATING CONDITIONS

Parameter	Symbol	Min	Typ	Max	Unit
Supply voltage	$V_{CC}$	2.6	3.0	3.6	V
	$V_{CCQ}$	2.6	3.0	3.6	V
Ground	$V_{SS}, V_{SSQ}$	0	0	0	V
Input high voltage	$V_{IH}$	$0.8 * V_{CCQ}$	-	$V_{CCQ} + 0.2^{1)}$	V
Input low voltage	$V_{IL}$	$-0.2^{2)}$	-	$0.2 * V_{CCQ}$	V

1. Overshoot:  $V_{CC} + 1.0$  V in case of pulse width  $\leq 20$ ns
2. Undershoot:  $-1.0$  V in case of pulse width  $\leq 20$ ns
3. Overshoot and undershoot are sampled, not 100% tested.

## CAPACITANCE<sup>1)</sup> ( $f=1$ MHz, $T_A=25^\circ$ C)

Item	Symbol	Test Condition	Min	Max	Unit
Input capacitance	$C_{IN}$	$V_{IN}=0V$	-	8	pF
Input/Output capacitance	$C_{IO}$	$V_{IO}=0V$	-	8	pF

1. Capacitance is sampled, not 100% tested

## DC AND OPERATING CHARACTERISTICS

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
Input leakage current	$I_{LI}$	$V_{IN}=V_{SS}$ to $V_{CCQ}$ , $V_{CC}=V_{CCmax}$	-1	-	1	$\mu$ A
Output leakage current	$I_{LO}$	$CS\#=V_{IH}$ , $ZZ\#=V_{IH}$ , $OE\#=V_{IH}$ or $WE\#=V_{IL}$ , $V_{IO}=V_{SS}$ to $V_{CCQ}$ , $V_{CC}=V_{CCmax}$	-1	-	1	$\mu$ A
Average operating current	$I_{CC1}$	Cycle time = 1 $\mu$ s, $I_{IO}=0$ mA, 100% duty, $CS\#\leq 0.2V$ , $ZZ\#\geq V_{CCQ}-0.2V$ , $V_{IN}\leq 0.2V$ or $V_{IN}\geq V_{CCQ}-0.2V$	-	-	5	mA
	$I_{CC2}$	Cycle time = Min, $I_{IO}=0$ mA, 100% duty, $CS\#=V_{IL}$ , $ZZ\#=V_{IH}$ , $V_{IN}=V_{IL}$ or $V_{IH}$	-	-	25	mA
Page access operating current	$I_{CCP}$	$t_{PC} = \text{Min}$ , $CS\#=V_{IL}$ , $ZZ\#=V_{IH}$ , $I_{IO}=0$ mA, Page add. cycling.	-	-	15	mA
Output low voltage	$V_{OL}$	$I_{OL} = 0.5$ mA, $V_{CC}=V_{CCmin}$	-	-	$0.2 * V_{CCQ}$	V
Output high voltage	$V_{OH}$	$I_{OH} = -0.5$ mA, $V_{CC}=V_{CCmin}$	$0.8 * V_{CCQ}$	-	-	V
Standby current (CMOS)	$I_{SB}$	$CS\#, ZZ\#\geq V_{CCQ}-0.2V$ , Other inputs = $0 \sim V_{CCQ}$ (Typ. condition : $V_{CC}=3.0V$ @ $25^\circ$ C) (Max. condition : $V_{CC}=3.6V$ @ $85^\circ$ C)	-	-	90	$\mu$ A

1. Maximum  $I_{CC}$  specifications are tested with  $V_{CC} = V_{CCmax}$ .

### AC OPERATING CONDITIONS

Test Conditions (Test Load and Test Input/Output Reference)

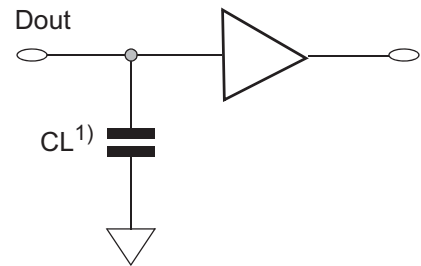
Input Pulse Level : 0.2V to  $V_{CCQ}-0.2V$

Input Rise and Fall Time : 5ns

Input and Output reference Voltage :  $V_{CCQ}/2$

Output Load (See right) :  $CL^1) = 30pF$

1. Including scope and Jig capacitance



### AC CHARACTERISTICS

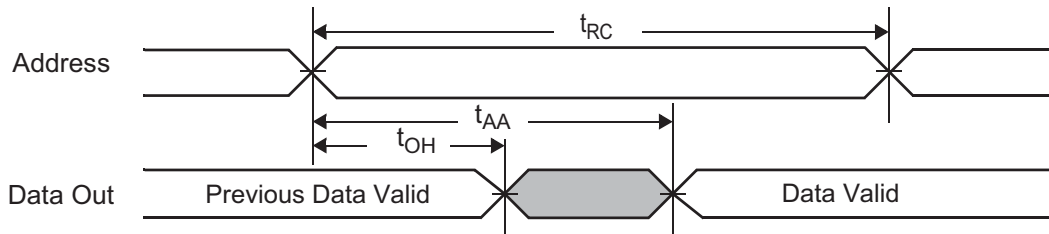
Parameter List		Symbol	Speed		Unit
			Min	Max	
Read	Read Cycle Time	$t_{RC}$	70	10k	ns
	Address access time	$t_{AA}$	-	70	ns
	Chip enable to data output	$t_{CO}$	-	70	ns
	Output enable to valid output	$t_{OE}$	-	25	ns
	UB#, LB# enable to data output	$t_{BA}$	-	25	ns
	Chip enable to low-Z output	$t_{LZ}$	10	-	ns
	UB#, LB# enable to low-Z output	$t_{BLZ}$	0	-	ns
	Output enable to low-Z output	$t_{OLZ}$	0	-	ns
	Chip disable to high-Z output	$t_{HZ}$	0	20	ns
	UB#, LB# disable to high-Z output	$t_{BHZ}$	0	20	ns
	Output disable to high-Z output	$t_{OHZ}$	0	20	ns
	Output hold from Address change	$t_{OH}$	5	-	ns
Write	Write Cycle Time	$t_{WC}$	70	10k	ns
	Chip enable to end of write	$t_{CW}$	60	-	ns
	Address setup time	$t_{AS}$	0	-	ns
	Address valid to end of write	$t_{AW}$	60	-	ns
	UB#, LB# valid to end of write	$t_{BW}$	60	-	ns
	Write pulse width	$t_{WP}$	50	-	ns
	Write recovery time	$t_{WR}$	0	-	ns
	Write to output high-Z	$t_{WHZ}$	0	20	ns
	Data to write time overlap	$t_{DW}$	20	-	ns
	Data hold from write time	$t_{DH}$	0	-	ns
	End write to output low-Z	$t_{OW}$	5	-	ns
Page	Maximum cycle time	$t_{MRC}^{*1)}$	-	10k	ns
	Page mode cycle time	$t_{PC}^{*1)}$	25	-	ns
	Page mode address access time	$t_{PAA}^{*1)}$	-	25	ns

#### NOTES

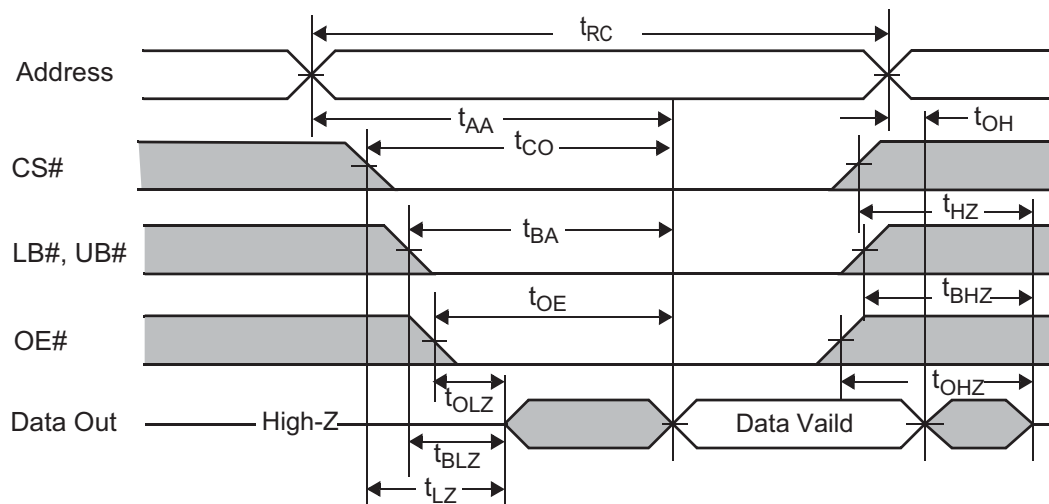
1. These parameters are not supported in EM784SU16BRP & EM784SU16BSP.

## TIMING DIAGRAMS

**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>)



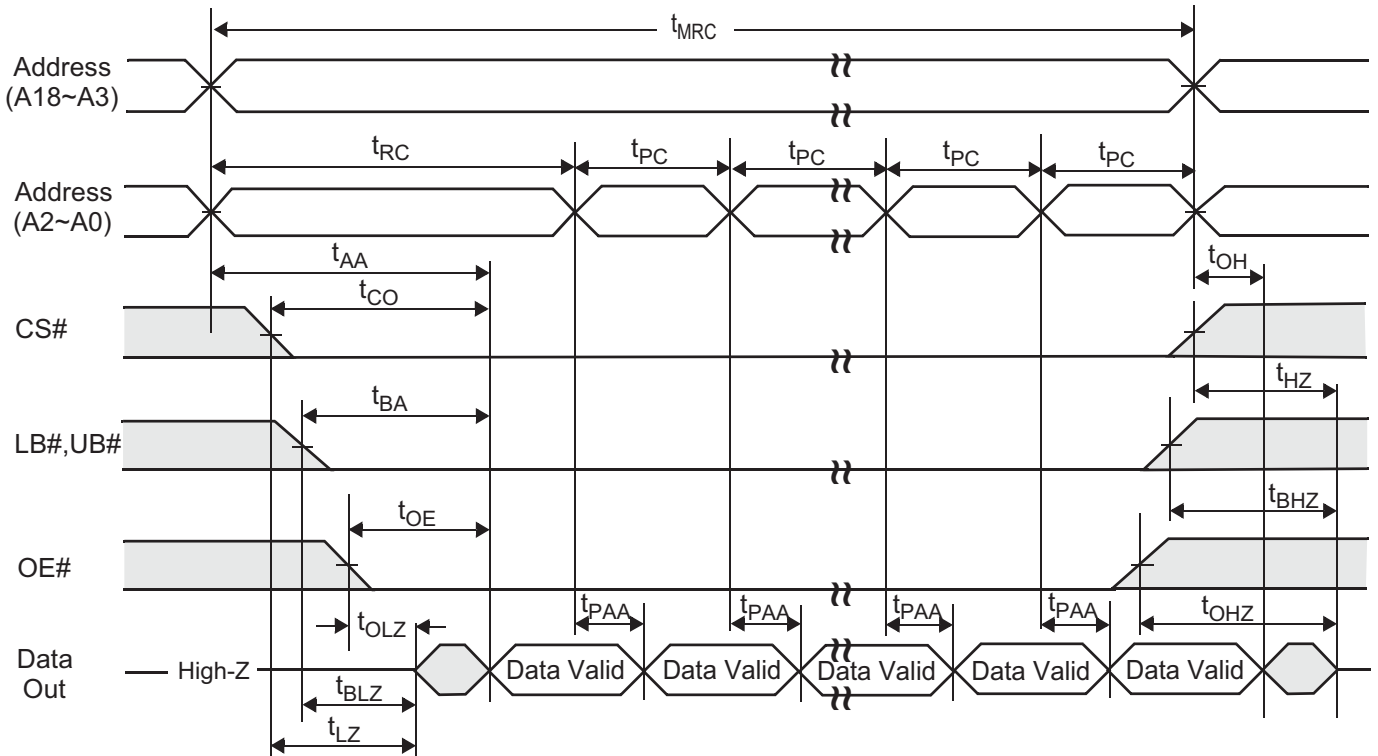
**READ CYCLE (2)** (ZZ#=WE#=V<sub>IH</sub>)



### NOTES (READ CYCLE)

- $t_{HZ}$ ,  $t_{BHZ}$  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.
- Do not Access device with cycle timing shorter than  $t_{RC}$  for continuous periods > 10 $\mu$ s.

**PAGE READ CYCLE (1) (ZZ#=WE#=V<sub>IH</sub>, 8 Words access)**

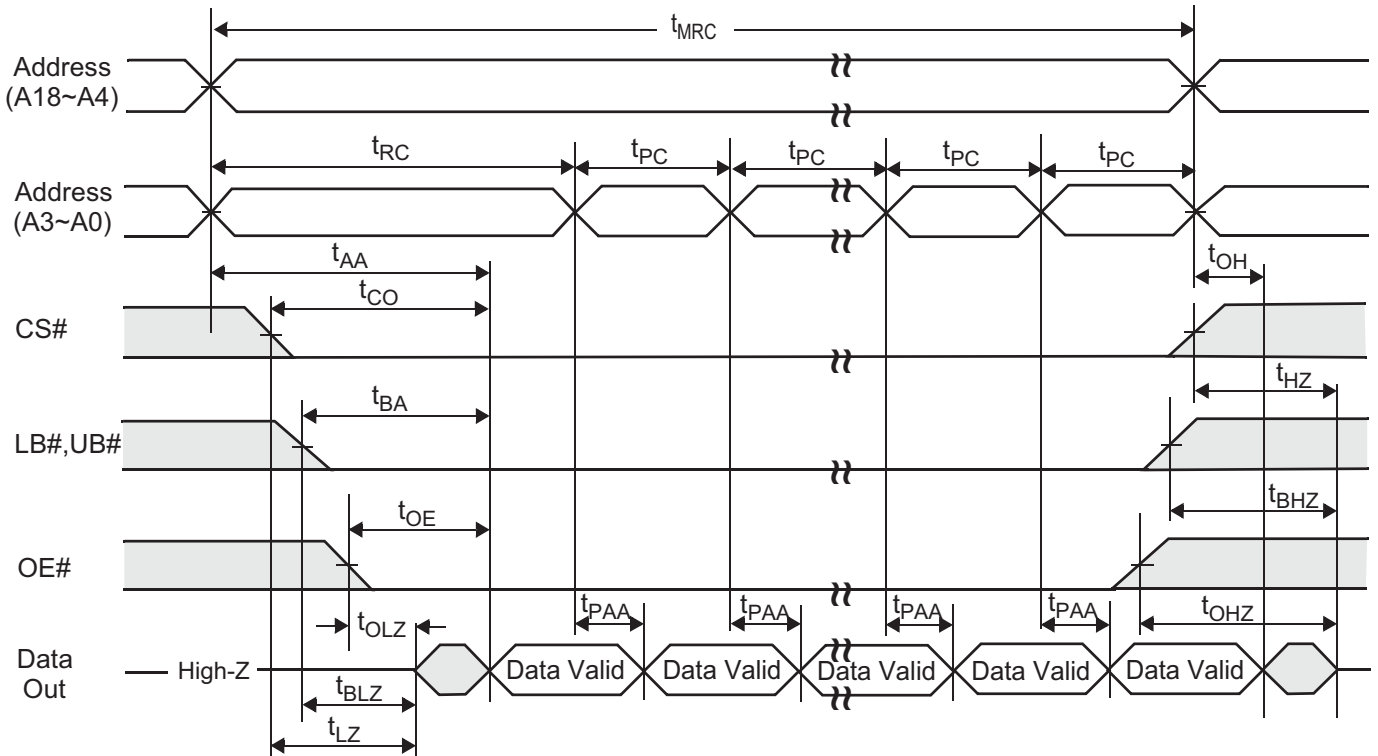


**NOTES (READ CYCLE)**

1.  $t_{HZ}$ ,  $t_{BHZ}$  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. Do not Access device with cycle timing shorter than  $t_{RC}$  for continuous periods > 10us.
3. This page read cycle(8 page mode) is supported in EM784SU16BLP & EM784SU16BMP.



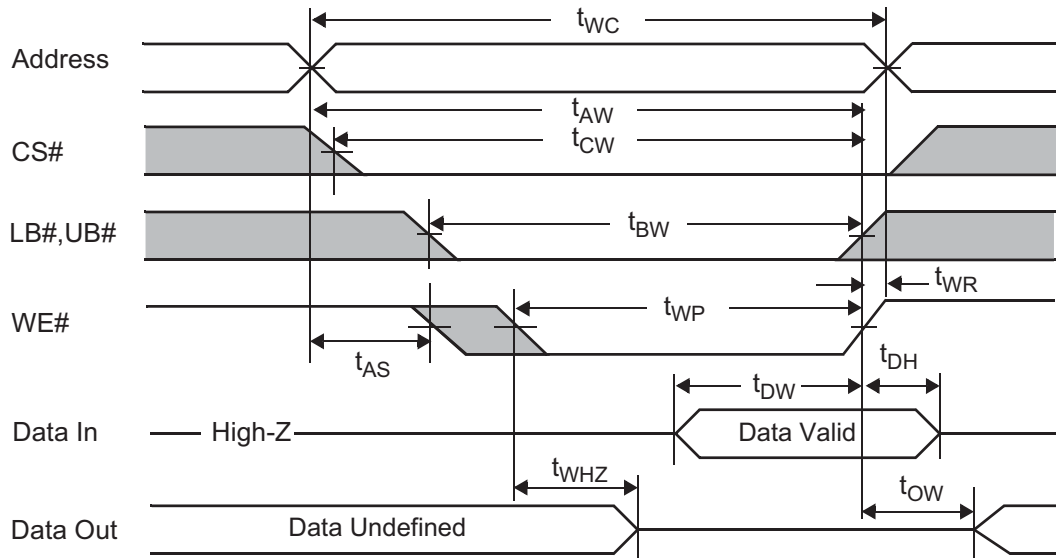
**PAGE READ CYCLE (2) (ZZ#=WE#=V<sub>IH</sub>, 16 Words access)**



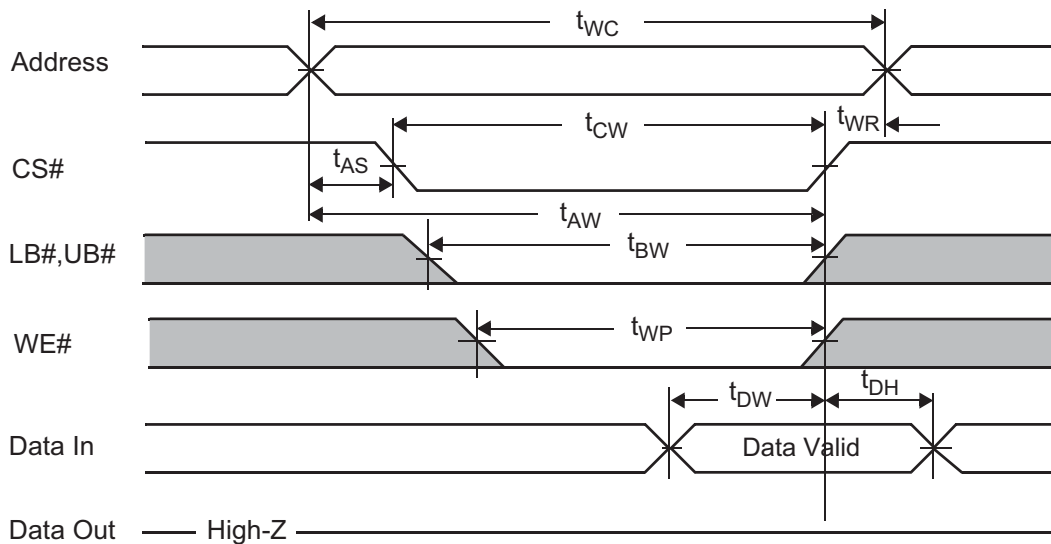
**NOTES (READ CYCLE)**

1. t<sub>HZ</sub>, t<sub>BHZ</sub> and t<sub>OHZ</sub> are defined as the time at which the outputs achieve the open circuit conditions and are not referenced to output voltage levels.
2. Do not Access device with cycle timing shorter than t<sub>RC</sub> for continuous periods > 10us.
3. This page read cycle(16 page mode) is supported in EM784SU16BNP & EM784SU16BPP.

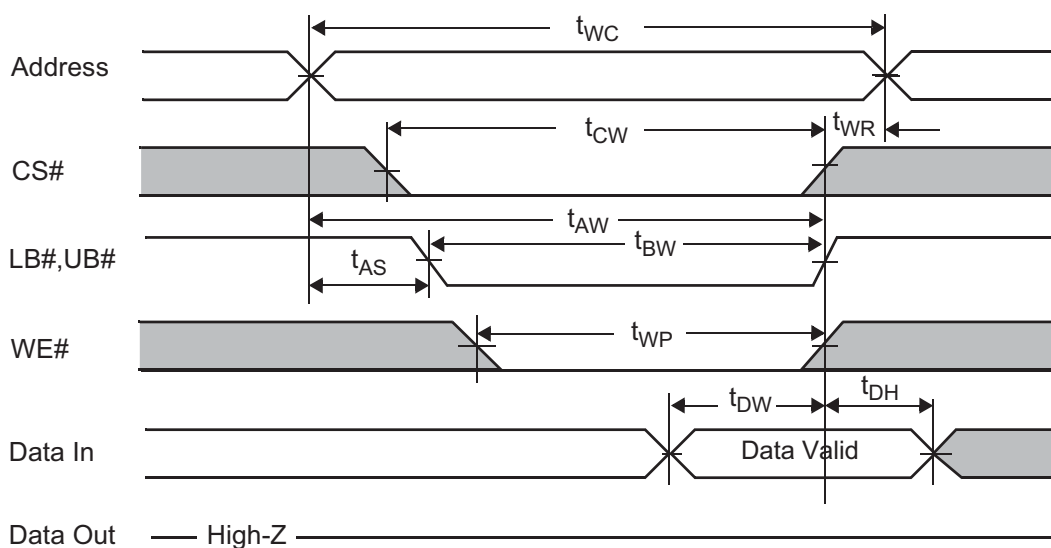
**WRITE CYCLE (1) (WE# controlled, ZZ#=V<sub>IH</sub>)**



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



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

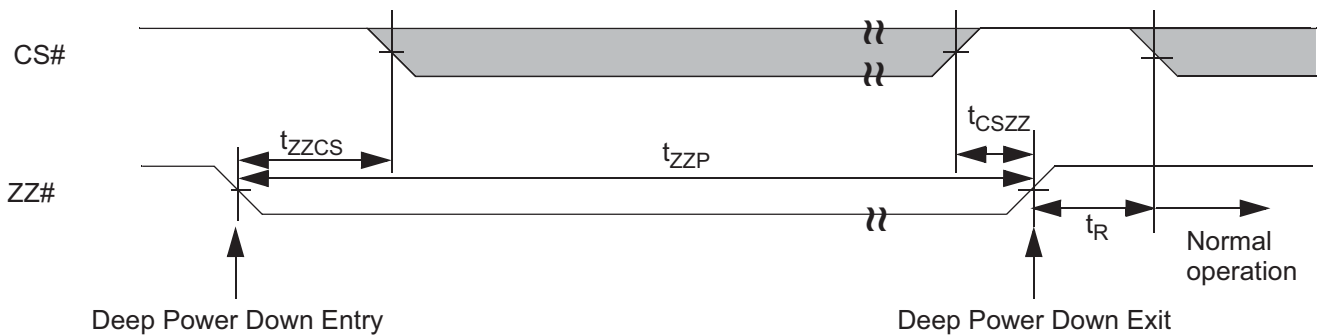


**NOTES (WRITE CYCLE)**

1. A write occurs during the overlap( $t_{WP}$ ) of low CS#, low WE# and low UB# or LB#. A write begins at the last transition among low CS# and low WE# with asserting UB# or LB# low for single byte operation or simultaneously asserting UB# and LB# low for word operation. A write ends at the earliest transition among high CS# and high WE#. The  $t_{WP}$  is measured from the beginning of write to the end of write.
2.  $t_{CW}$  is measured from 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  $t_{WC}$  for continuous periods > 10us.

**LOW POWER MODES**

**Deep Power Down Mode Entry/Exit**



**NOTES ( DEEP POWER DOWN )**

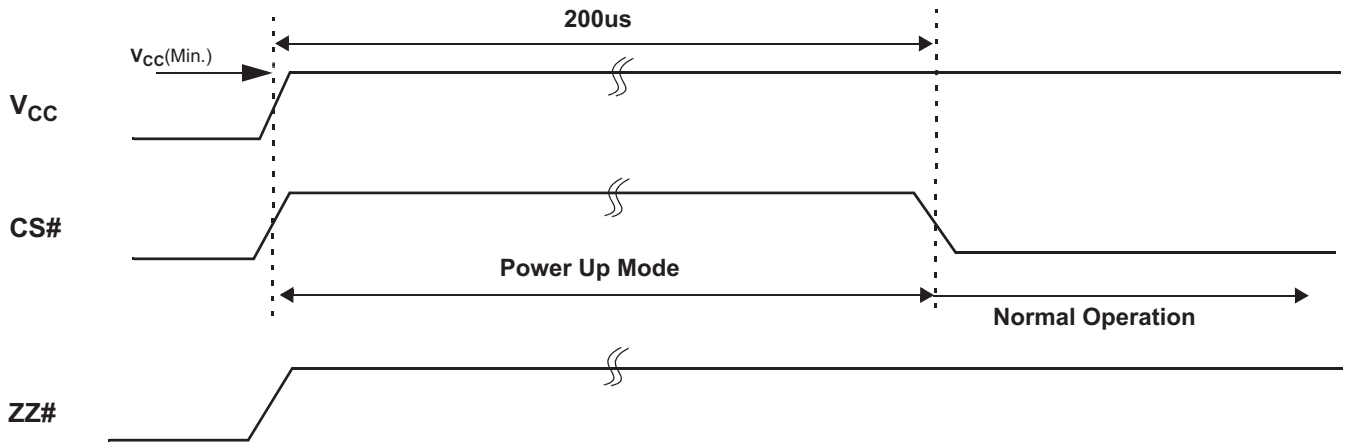
1. During Deep Power Down mode, all refresh related activity are disabled.
2. This DPD mode is supported in EM784SU16BLP, EM784SU16BNP & EM784SU16BRP.

Parameter	Description	Min.	Max.	Units
$t_{zzcs}$	ZZ# low to CS# low	0	-	ns
$t_{cszz}$	CS# high to ZZ# high	0	-	ns
$t_R$	Operation Recovery Time	200	-	us
$t_{zzp}$	ZZ# pulse width	20	-	ns

**Low Power Mode Characteristics**

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
Deep Power Down Current	$I_{ZZ}$	ZZ# $\leq 0.2V$ , Other inputs = 0 ~ $V_{CCQ}$ (Max. condition : $V_{CC}=3.6V @ 85^{\circ}C$ )	-	-	10	$\mu A$

## TIMING WAVEFORM OF POWER UP



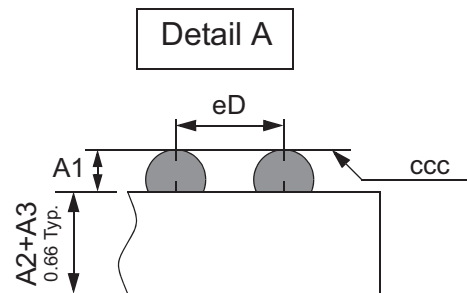
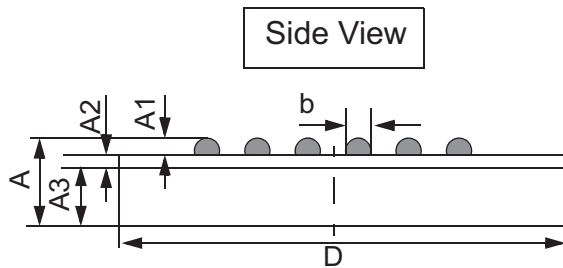
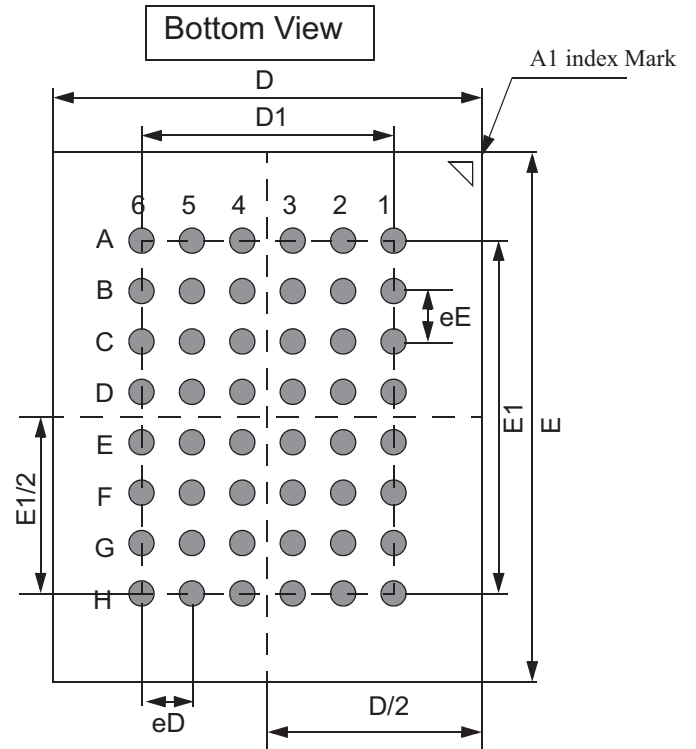
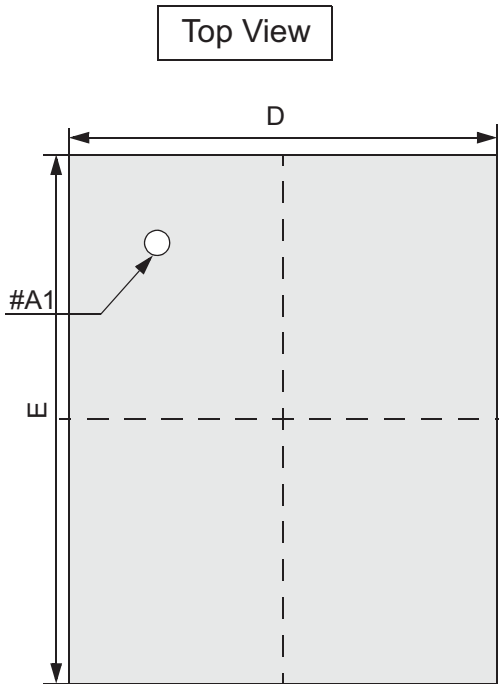
### NOTE ( POWER UP )

1. After V<sub>CC</sub> reaches V<sub>CC(Min.)</sub> , wait 200us with CS# high. Then you get into the normal operation.
2. ZZ# pin is replaced to NC pin in EM784SU16BMP, EM784SU16BPP, EM784SU16BSP.

Unit: millimeters

### PACKAGE DIMENSION

48 Ball Fine Pitch BGA (0.75mm ball pitch)

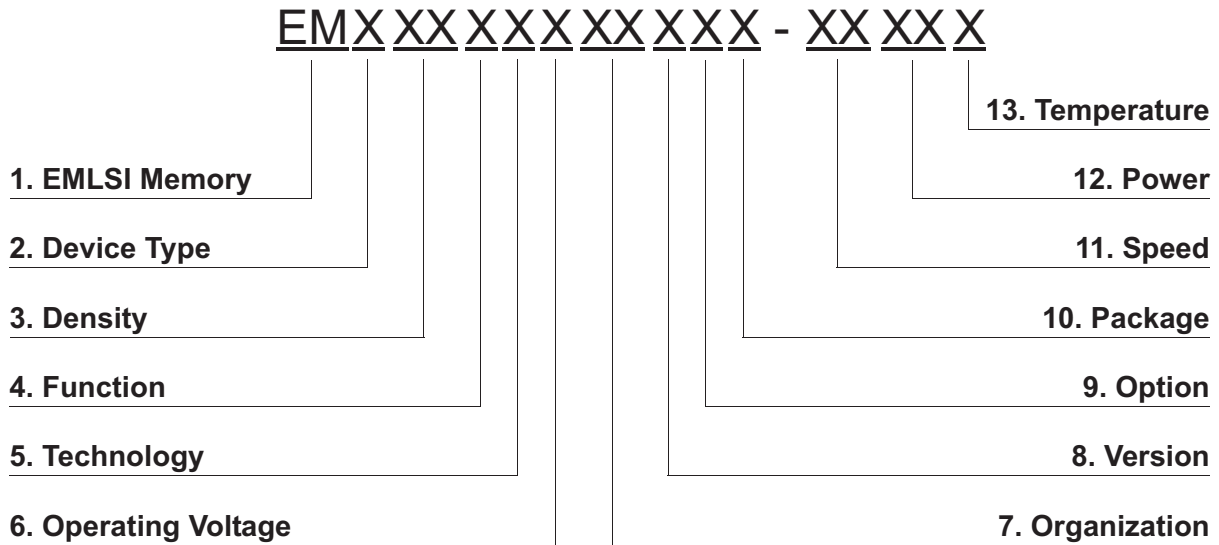


	Min	Typ	Max
A	-	-	1.00
A1	0.22	-	0.32
A2	-	0.21	-
A3	-	0.45	-
b	0.32	-	0.42
D	5.90	6.00	6.10
E	6.90	7.00	7.10
D1	-	3.75	-
E1	-	5.25	-
eE	-	0.75	-
eD	-	0.75	-
ccc	-	-	0.08

#### NOTES.

1. Bump counts : 48(8row x 6column)
2. Bump pitch : (x,y)=(0.75x0.75) (typ.)
3. All tolerance are +/-0.050 unless otherwise specified.
4. Typ : Typical
5. ccc is coplanarity : 0.08(Max)

**MEMORY FUNCTION GUIDE**



1. Memory Component
2. Device Type
  - 6 ----- Low Power SRAM
  - 7 ----- STRAM
  - C ----- CellularRAM
3. Density
  - 4 ----- 4M
  - 8 ----- 8M
  - 16 ----- 16M
  - 32 ----- 32M
  - 64 ----- 64M
  - 28 ----- 128M
4. Function
  - 2 ----- Multiplexed async.
  - 3 ----- Multiplexed sync.
  - 4 ----- Demultiplexed async.
  - 5 ----- Multiplexed sync.
  - 6 ----- Demultiplexed sync.
5. Technology
  - S ----- Single Transistor
6. Operating Voltage
  - U ----- 2.6V ~ 3.6V
  - P ----- 1.7V ~ 1.95V
7. Organization
  - 8 ----- X8 bit
  - 16 ----- X16 bit
  - 32 ----- X32 bit
8. Version
  - Blank----- Mother die
  - A ----- 2 nd generation
  - B ----- 3 rd generation
  - C ----- 4 th generation
  - D ----- 5 th generation

9. Option
  - Blank----- No optional mode
  - J ----- Non-RBC
  - K ----- RBC
  - L ----- 8 page mode / DPD
  - M ----- 8 page mode / Non-DPD
  - N ----- 16 page mode / DPD
  - P ----- 16 page mode / Non-DPD
  - R ----- Non-page mode / DPD
  - S ----- Non-page mode / Non-DPD
10. Package
  - Blank----- Wafer
  - S ----- 32 sTSOP1
  - T ----- 32 TSOP1
  - U ----- 44 TSOP2
  - P ----- 48 FPBGA
  - Z ----- 52 FPBGA
  - Y ----- 54 FPBGA
  - W ----- 60 FPBGA
  - V ----- 90 FPBGA
11. Speed(@async.)
  - 45 ----- 45ns
  - 55 ----- 55ns
  - 60 ----- 60ns
  - 70 ----- 70ns
  - 85 ----- 85ns
  - 90 ----- 90ns
  - 10 ----- 100ns
  - 12 ----- 120ns
12. Power
  - LL ----- Low Low Power
  - LF ----- Low Low Power(Pb-free & Green)
  - L ----- Low Power
  - S ----- Standard Power
13. Temperature
  - Blank----- Wireless (-30 ℃~ 85 ℃)
  - I ----- Industrial (-40 ℃~ 85 ℃)