Document Title

1M x 16 bit Low Low Power 1T/1C Pseudo SRAM

Revision history

Revision No.	History	Draft Date	Remark
1.0	Initial	Dec. 3. '02	Preliminary

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1M x 16 bit Low Low Power 1T/1C SRAM

DESCRIPTION

The HY64UD16162B is a 16Mbit 1T/1C SRAM featured by high-speed operation and super low power consumption. The HY64UD16162B adopts one transistor memory cell and is organized as 1,048,576 words by 16bits. The HY64UD16162B operates in the extended range of temperature and supports a wide operating voltage range. The HY64UD16162B also supports the deep power down mode for a super low standby current. The HY64UD16162B delivers the high-density low power SRAM capability to the high-speed low power system.

FEATURES

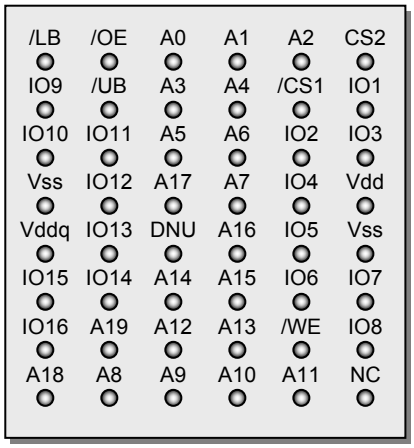
- CMOS Process Technology
- 1M x 16 bit Organization
- TTL compatible and Tri-state outputs
- Deep Power Down : Memory cell data hold invalid
- Standard pin configuration : 48-FBGA(6mmX8mm)
- Data mask function by /LB, /UB
- Separated I/O Power Supply : Vddq

PRODUCT FAMILY

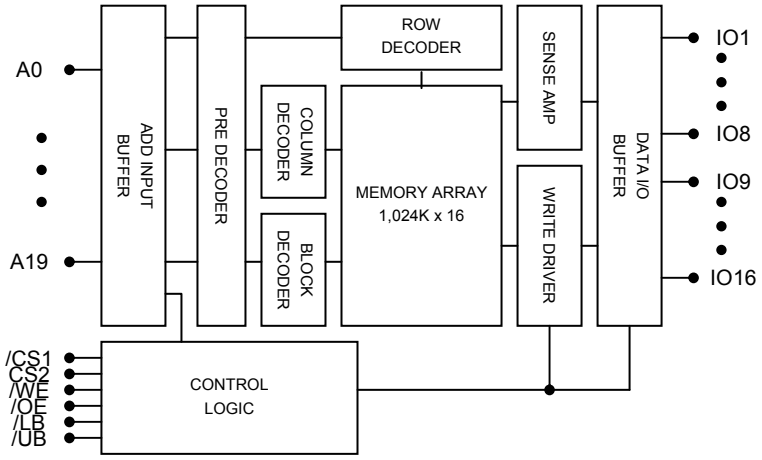
Product No.	Voltage [V] Vdd/Vddq	Mode	Power Dissipation			Speed tRC[ns]	Temp. [°C]
			(I_{SB1},Max)	(I_{DPD},Max)	(I_{CC2},Max)		
HY64UD16162B-DF60E	3.0/3.0	1CS with /UB,/LB:tCS[1]	TBD	2μA	25mA	TBD	-25~85
HY64UD16162B-DF60I	3.0/3.0	1CS with /UB,/LB:tCS[1]	TBD	2μA	25mA	TBD	-40~85
HY64UD16162B-DF70E	3.0/3.0	1CS with /UB,/LB:tCS[1]	85μA	2μA	25mA	70	-25~85
HY64UD16162B-DF70I	3.0/3.0	1CS with /UB,/LB:tCS[1]	85μA	2μA	25mA	70	-40~85

Note 1. tCS - /UB,/LB=High : Chip Deselect.

PIN CONNECTION (Top View)



BLOCK DIAGRAM



PIN DESCRIPTION

Pin Name	Pin Function	Pin Name	Pin Function
/CS1	Chip Select	/OE	Output Enable
CS2	Deep Power Down	IO1~IO8	Lower Data Inputs/Outputs
/WE	Write Enable	IO9~IO16	Upper Data Inputs/Outputs
/LB	Lower Byte(I/O1~I/O8)	A0~A19	Address Inputs
/UB	Upper Byte(I/O9~I/O16)	Vdd	Power Supply for Internal Circuit
DNU	Do Not Use	Vddq	Power Supply for I/O
NC	No Connection	Vss	Ground

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ORDERING INFORMATION

Part Number	Speed	Power	Temperature	Package
HY64UD16162B-E	60 / 70	LL-Part	E[1]	FBGA
HY64UD16162B-I	60 / 70	LL-Part	I[2*]	FBGA

Note

1. E : Extended Temp. (-25°C ~ 85°C)
2. I : Industrial Temp. (-40°C ~ 85°C)

ABSOLUTE MAXIMUM RATINGS [1]

Symbol	Parameter	Rating	Unit	Remark
VIN	Input Voltage	-0.3 to Vdd+0.3	V	
VOUT	Output Voltage	-0.3 to Vddq+0.3	V	
Vdd	Core Power Supply	-0.3 to 3.6	V	
Vddq	I/O Power Supply	-0.3 to 3.6	V	
TA	Ambient Temperature	-25 to 85	°C	HY64PD16162A-E
		-40 to 85	°C	HY64PD16162A-I
TSTG	Storage Temperature	-55 to 150	°C	
PD	Power Dissipation	1.0	W	
TSOLDER	Ball Soldering Temperature & Time	260•10	°C•sec	

Note

1. Stresses greater than those listed under ABSOLUTE MAXIMUM RATINGS may cause permanent damage to the device. This is stress rating only and the functional operation of the device under these or any other conditions above those indicated in the operation of this specification is not implied. Exposure to the absolute maximum rating conditions for extended period may affect reliability.

TRUTH TABLE

/CS1	CS2	/WE	/OE	/LB	/UB	Mode	I/O Pin		Power
							I/O1~I/O8	I/O9~I/O16	
H	H	X	X	X	X	Deselected	High-Z	High-Z	Standby
X	L	X	X	X	X	Deselected	High-Z	High-Z	Deep Power Down
X	H	X	X	H	H	Deselected	High-Z	High-Z	Standby
L	H	L	X	L	H	Write	DIN	High-Z	Active
L	H	H	L	L	H	Read	DOUT	High-Z	Active
L	H	H	H	L	H	Output Disabled	High-Z	High-Z	Active
L	H	L	X	H	L	Write	High-Z	DIN	Active
L	H	H	L	H	L	Read	High-Z	DOUT	Active
L	H	H	H	H	L	Output Disabled	High-Z	High-Z	Active
L	H	L	X	L	L	Write	DIN	DIN	Active
L	H	H	L	L	L	Read	DOUT	DOUT	Active
L	H	H	H	L	L	Output Disabled	High-Z	High-Z	Active

Note

1. H=VIH, L=VIL, X=don't care(VIL or VIH)
2. /UB, /LB(Upper, Lower Byte enable)
   These active LOW inputs allow individual bytes to be written or read.
   When /LB is LOW, data is written or read to the lower byte, I/O1 - I/O8.
   When /UB is LOW, data is written or read to the upper byte, I/O9 - I/O16.

RECOMMENDED DC OPERATING CONDITION

Symbol	Parameter	Min.	Typ.	Max.	Unit
Vdd	Core Supply Voltage	2.7	3.0	3.3	V
Vddq	I/O Supply Voltage	2.7	3.0	3.3	V
VSS	Ground	0	-	0	V
VIH	Input High Voltage	2.2	-	Vdd+0.3	V
VIL	Input Low Voltage	-0.3[1]	-	0.6	V

Note 1. VIL=-1.5V for pulse width less than 10ns

Undershoot is sampled, not 100% tested.

DC ELECTRICAL CHARACTERISTICS

Vdd=2.7V~3.3V, Vddq=2.7V~3.3V, TA= -25°C to 85°C(E) / -40°C to 85°C(I)

Sym.	Parameter	Test Condition		Min.	Max.	Unit
ILI	Input Leakage Current	VSS≤VIN≤Vdd		-1	1	μA
ILO	Output Leakage Current	VSS≤VOUT≤Vddq, /CS1=VIH, CS2=VIH, /OE=VIH or /WE=VIL		-1	1	μA
ICC	Operating Power Supply Current	/CS1=VIL, CS2=VIH, VIN=VIH or VIL, II/O=0mA		-	3	mA
ICC1	Average Operating Current	/CS1≤ 0.2V, CS2 ≥Vdd-0.2V, VIN ≤0.2V or VIN≥Vdd-0.2V, Cycle Time=1μs. 100% Duty, II/O=0mA		-	5	mA
ICC2		/CS1=VIL, CS2=VIH, VIN=VIH or VIL, Cycle Time=Min. 100% Duty, II/O=0mA	60ns	-	25	mA
			70ns		25	mA
ISB	TTL Standby Current	/CS1,CS2=VIH or /UB,/LB= VIH		-	0.5	mA
ISB1	Standby Current(CMOS Input)	/CS1,CS2≥Vdd-0.2V, /UB,/LB ≤0.2V or /UB,/LB ≥Vdd-0.2V, otherwise CS2,/UB,/LB≥Vdd-0.2V, /CS1≤0.2V or /CS1≥Vdd-0.2V	60ns	-	TBD	μA
			70ns	-	85	μA
IDPD	Deep Power Down	CS2≤VSS+0.2V		-	2	μA
VOH	Output High Voltage	IOH=-1.0mA		2.4	-	V
VOL	Output Low Voltage	IOL=2.1mA		-	0.4	V

CAPACITANCE

(Temp = 25°C, f=1.0MHz)

Symbol	Parameter	Condition	Max.	Unit
CIN	Input Capacitance(ADD, /CS1, CS2, /WE, /OE, /UB, /LB)	VIN=0V	8	pF
COUT	Output Capacitance(I/O)	VI/O=0V	10	pF

Note : These parameters are sampled and not 100% tested

AC CHARACTERISTICS

Vdd=2.7V~3.3V, Vddq=2.7V~3.3V, T_A = -25°C to 85°C(E) / -40°C to 85°C(I), unless otherwise specified

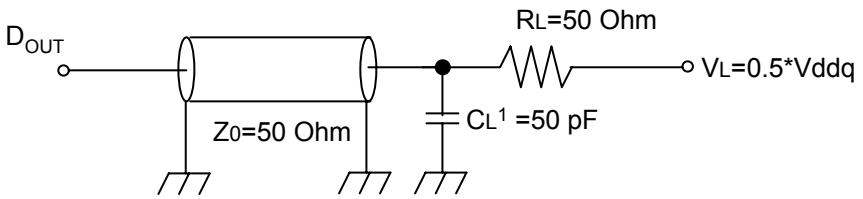
#	Symbol	Parameter	-60		-70		Unit
			Min.	Max.	Min.	Max.	
Read Cycle							
1	tRC	Read Cycle Time	60	-	70	-	ns
2	tAA	Address Access Time	-	60	-	70	ns
3	tACS	Chip Select Access Time	-	60	-	70	ns
4	tOE	Output Enable to Output Valid	-	20	-	20	ns
5	tBA	/LB, /UB Access Time	-	60	-	70	ns
6	tCLZ	Chip Select to Output in Low Z	10	-	10	-	ns
7	tOLZ	Output Enable to Output in Low Z	5	-	5	-	ns
8	tBLZ	/LB, /UB Enable to Output in Low Z	10	-	10	-	ns
9	tCHZ	Chip Disable to Output in High Z	0	10	0	10	ns
10	tOHZ	Out Disable to Output in High Z	0	10	0	10	ns
11	tBHZ	/LB, /UB Disable to Output in High Z	0	10	0	10	ns
12	tOH	Output Hold from Address Change	5	-	5	-	ns
Write Cycle							
13	tWC	Write Cycle Time	60	-	70	-	ns
14	tCW	Chip Selection to End of Write	55	-	60	-	ns
15	tAW	Address Valid to End of Write	55	-	60	-	ns
16	tBW	/LB, /UB Valid to End of Write	55	-	60	-	ns
17	tAS	Address Set-up Time	0	-	0	-	ns
18	tWP	Write Pulse Width	50	-	50	-	ns
19	tWR	Write Recovery Time	0	-	0	-	ns
20	tWHZ	Write to Output in High Z	0	15	0	20	ns
21	tDW	Data to Write Time Overlap	25	-	30	-	ns
22	tDH	Data Hold from Write Time	0	-	0	-	ns
23	tOW	Output Active from End of Write	5	-	5	-	ns

AC TEST CONDITIONS

T_A = -25°C to 85°C(E) / -40°C to 85°C(I), unless otherwise specified

Parameter	Value
Input Pulse Level	0.4V to 2.2V
Input Rising and Fall Time	5ns
Input Timing Reference Level	1.5V
Output Timing Reference Level	0.5*Vddq
Output Load	See Below

AC TEST LOADS



Note

1. Including jig and scope capacitance.

Power-Up Sequence

1. Supply power with CS2 high.
2. Maintain stable power for longer than 200μs.

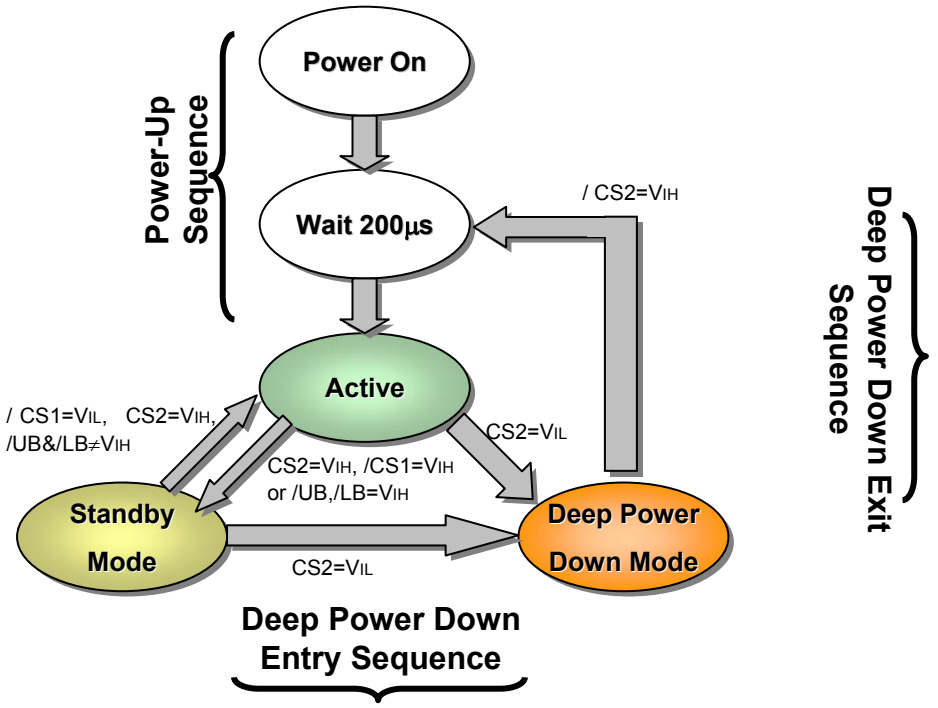
Deep Power Down Entry Sequence

1. Keep CS2 low state.
   Deep power down mode is maintained while CS2 is low state.

Deep Power Down Exit Sequence

1. Keep CS2 high state.
2. Maintain stable power for longer than 200μs.

STATE DIAGRAM

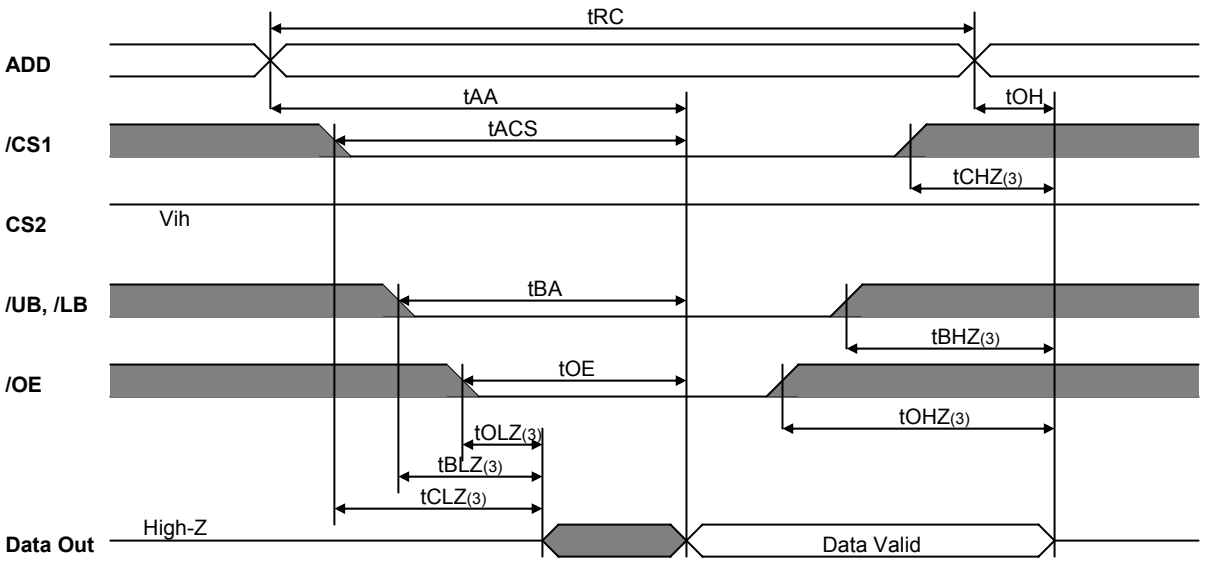


STANDBY MODE CHARACTERISTICS

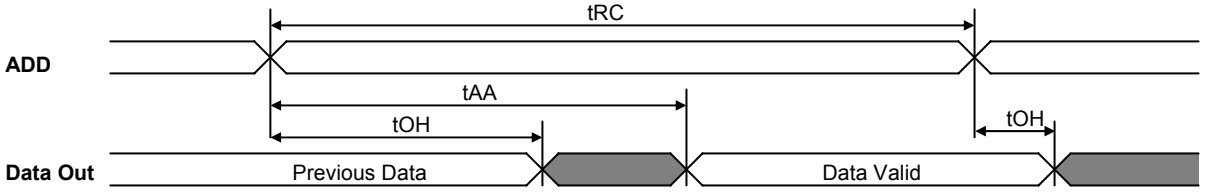
Mode	Memory Cell Data	Standby Current[μA]	Wait Time[μs]
Standby	Valid	TBD / 60ns 85 / 70ns	0
Deep Power Down	Invalid	2	200

TIMING DIAGRAM

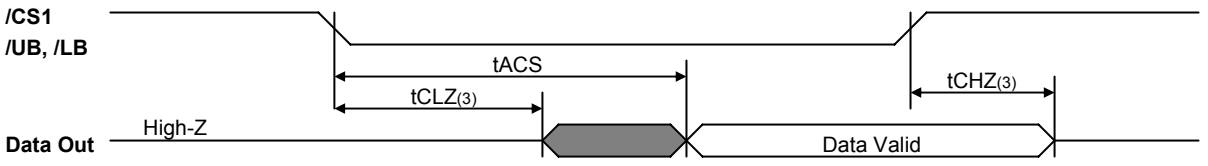
READ CYCLE 1 (Note 1, 4)



READ CYCLE 2 (Note 1, 2, 4)(CS2=Vih)



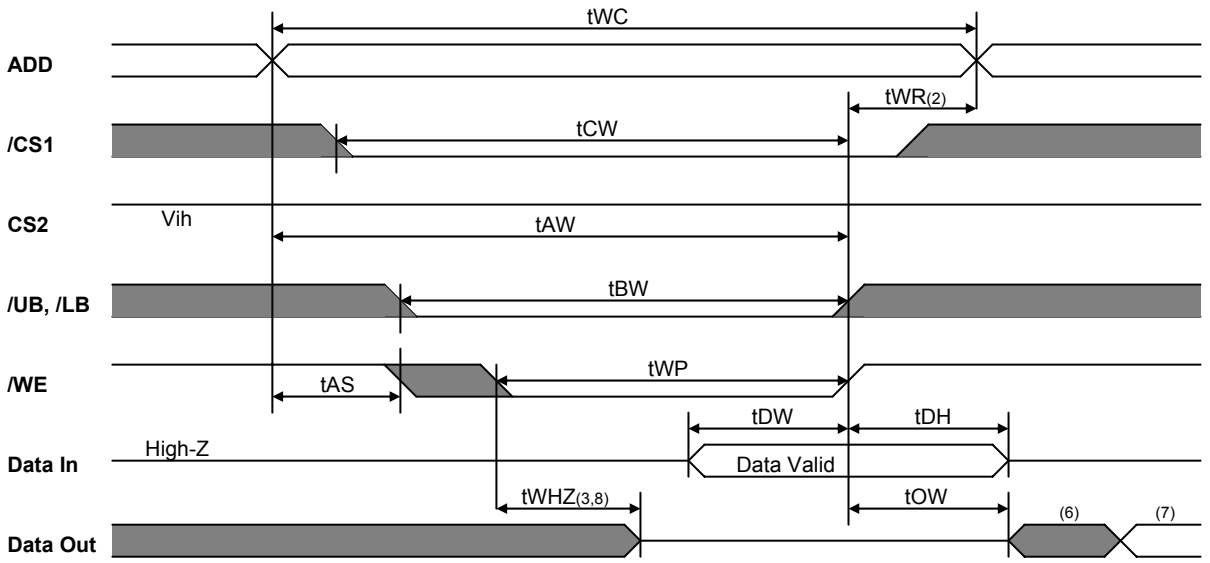
READ CYCLE 3 (Note 1, 2, 4)(CS2=Vih)



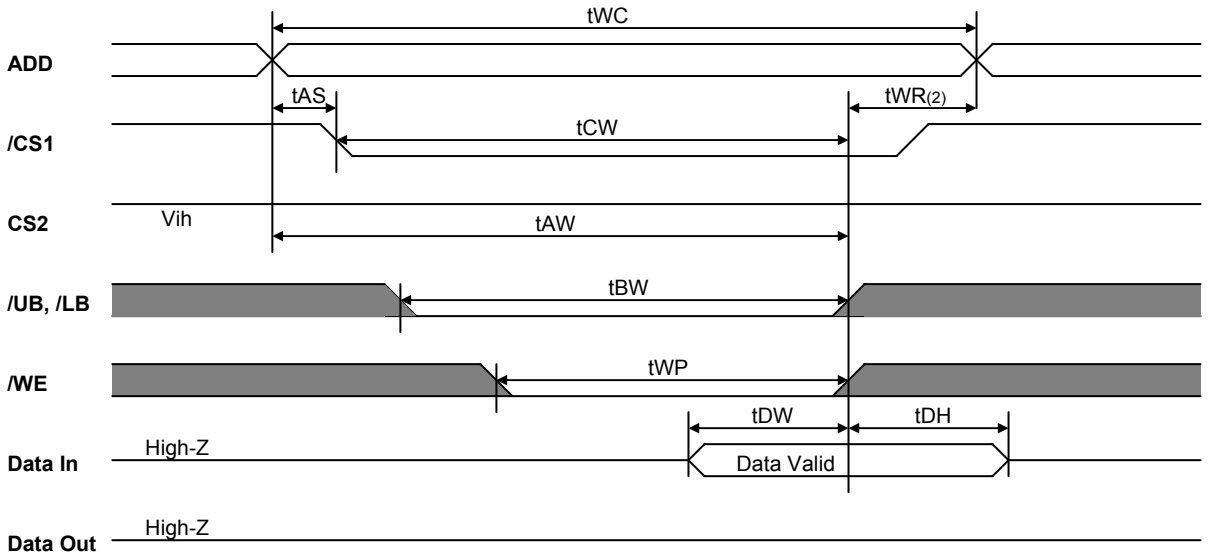
Notes :

1. Read Cycle occurs whenever a high on the /WE and /OE is low, while /UB and/or /LB and /CS1 and CS2 are in active status.
2. /OE = V_{IL}
3. tCHZ, tBHZ and tOHZ are defined as the time at which the outputs achieve the high impedance state and tOLZ,tBLZ and tCLZ are defined as the time at which the outputs achieve the low impedance state.
   These are not referenced to output voltage levels.
4. /CS1 in high for the standby, low for active.
   /UB and /LB in high for the standby, low for active.

WRITE CYCLE 1 (Note 1, 4, 5, 9, 10) (/WE Controlled)



WRITE CYCLE 2 (Note 1, 4, 5, 9, 10) (/CS1 Controlled)



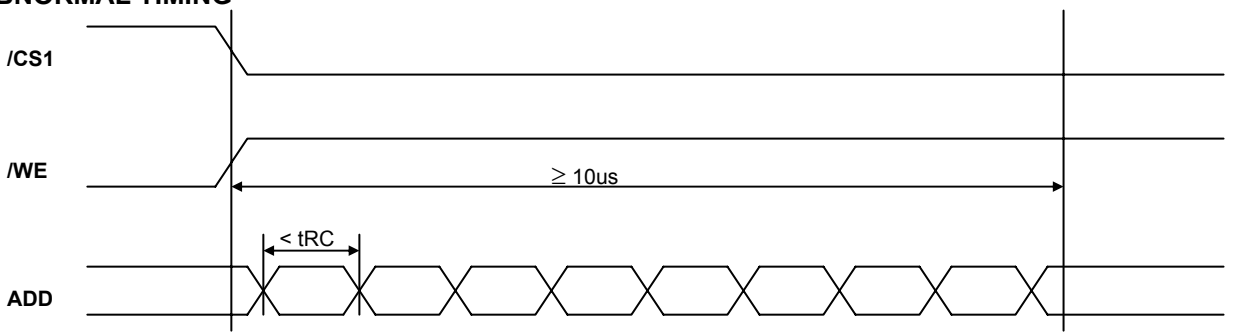
Notes :

1. A write occurs during the overlap of low /CS1, low /WE and low /UB and/or /LB.
2. tWR is measured from the earlier of /CS1, /LB, /UB, or /WE going high to the end of write cycle.
3. During this period, I/O pins are in the output state so that the input signals of opposite phase to the output must not be applied.
4. If the /CS1, /LB and /UB low transition occur simultaneously with the /WE low transition or after the /WE transition, outputs remain in a high impedance state.
5. /OE is continuously low (/OE=V_{IL})
6. Q(data out) is the invalid data.
7. Q(data out) is the read data of the next address.
8. tWHZ is defined as the time at which the outputs achieve the high impedance state. It is not referenced to output voltage levels.
9. /CS1 in high for the standby, low for active. /UB and /LB in high for the standby, low for active.
10. Do not input data to the I/O pins while they are in the output state.

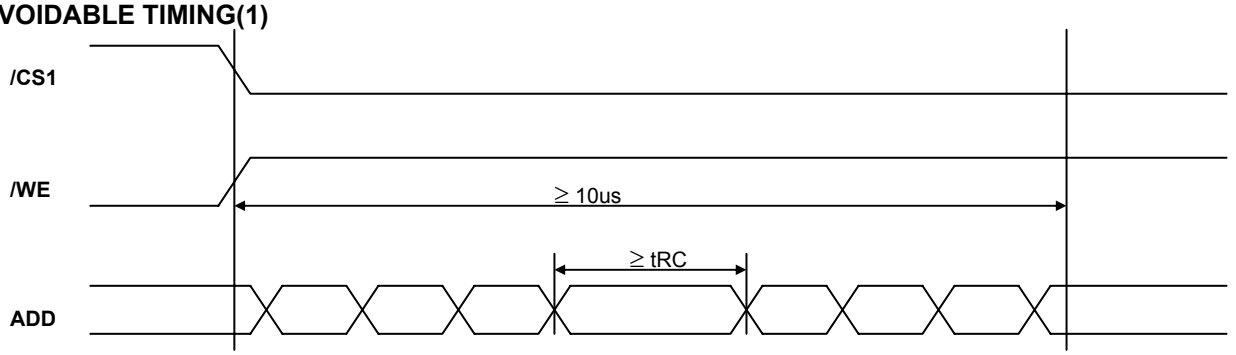
AVOID TIMING

Hynix 1T/1C SRAM has a timing which is not supported at read operation. If your system has multiple invalid address signal shorter than tRC during over 10us at read operation which showed in abnormal timing, Hynix 1T/1C SRAM needs a normal read timing at least during 10us which showed in avoidable timing(1) or toggle the /CS1 to high(≥tRC) one time at least which showed in avoidable timing(2)

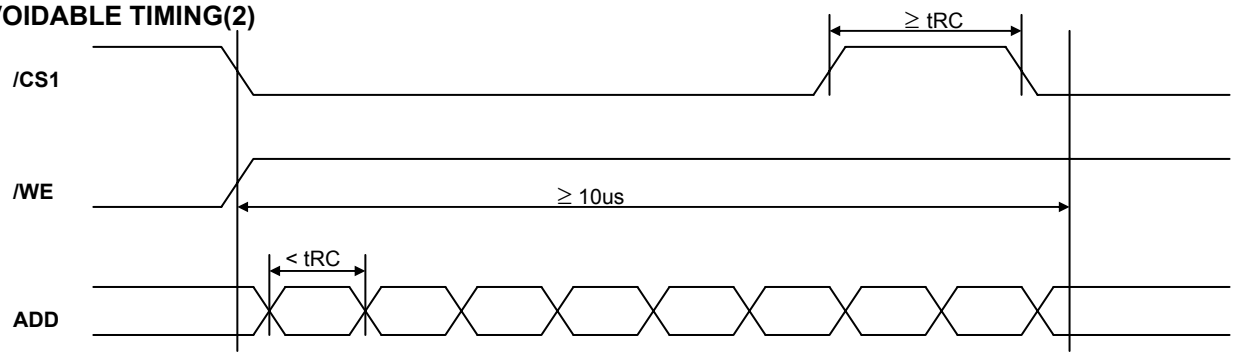
ABNORMAL TIMING



AVOIDABLE TIMING(1)

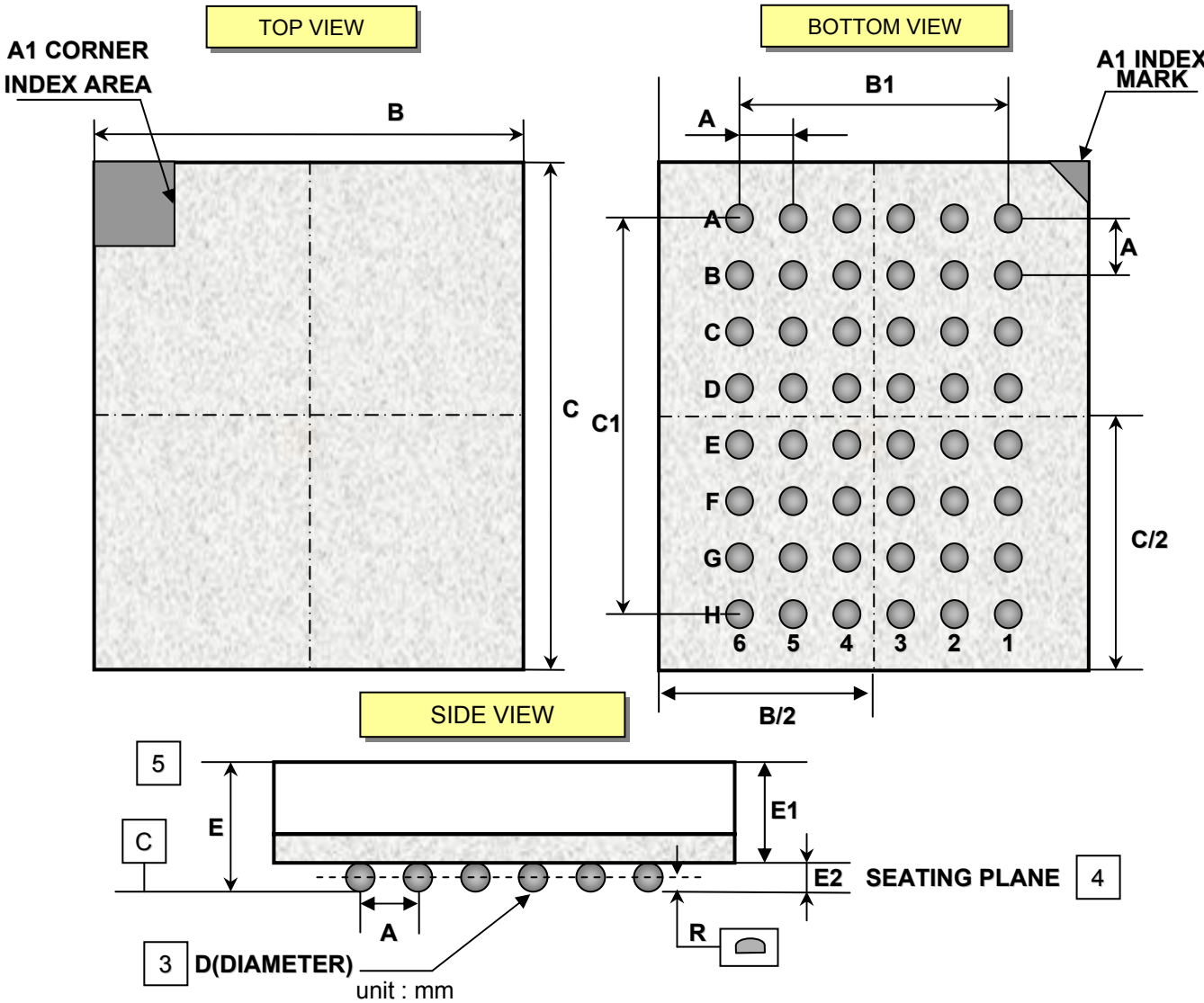


AVOIDABLE TIMING(2)



PACKAGE DIMENSION

48ball Fine Pitch Ball Grid Array Package(F)

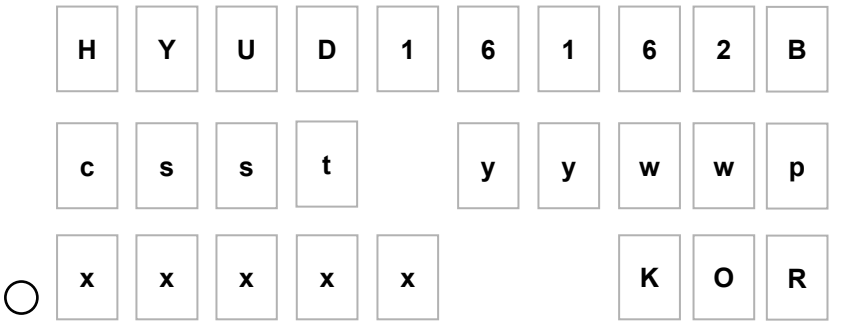


Symbol	Min.	Typ.	Max.
A	-	0.75	-
B	5.90	6.00	6.10
B1	-	3.75	-
C	7.90	8.00	8.10
C1	-	5.25	-
D	0.30	0.35	0.40
E	-	1.00	1.10
E1	-	0.75	-
E2	0.20	0.25	0.30
R	-	-	0.08

NOTE.

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M-1994
2. ALL DIMENSIONS ARE MILLIMETERS.
3. DIMENSION “D” IS MEASURED AT THE MAXIMUM SOLDER BALL DIAMETER IN A PLANE PARALLEL TO DATUM C.
4. PRIMARY DATUM C(SEATING PLANE) IS DEFINED BY THE CROWN OF THE SOLDER BALLS.
5. THIS IS A CONTROLLING DIMENSION.

MARKING INFORMATION

Package	Marking Example
FBGA	

Index

- **HYUD16162B** : Part Name
  - **HY** : HYNIX
  - **U** : Power Supply : Vdd=2.7V~3.3V/Vddq=2.7V~3.3V
  - **D** : Tech. + Classification : 1T+1C
  - **16** : Bit Organization : x16
  - **16** : Density : 16M
  - **2** : Mode : 1CS with /UB,/LB;tCS
  - **B** : Version : 3rd Generation

- **c** : Power Consumption : D – Low Low Power
- **ss** : Speed : 60 – 60ns, 70 – 70ns
- **t** : Temperature : E – Extended(-25 ~ 85°C), I – Industrial(-40 ~ 85°C)
- **yy** : Year (ex : 02 = year 2002, 03= year 2003)
- **ww** : Work Week (ex : 12 = work week 12)
- **p** : Process Code

- **xxxxx** : Lot No.
- **KOR** : Origin Country

Note

- Capital Letter : Fixed Item
- Small Letter : Non-fixed Item