PRELIMINARY

CY81U032X16A9A
MoBL3™

32M (2M x 16) SRAM

Features

- **Very high speed: 70 ns**
- **Advanced low-power MoBL® architecture**
- **Wide voltage range:**
  - **— V_{CC} range: 2.3V – 3.1V**
  - **— V_{CCQ} (I/O) range: 1.7V – V_{CC}**
- **Ultra-low active, standby power**
- **Easy memory expansion with $\overline{CE}$ and $\overline{OE}$ features**
- **1T SRAM memory cell**
- **Automatic power-down when deselected**
- **CMOS for optimum speed/power**

Functional Description[1]

The MoBL3 is a high-performance CMOS static RAM organized as 2M words by 16 bits. This device features advanced circuit design to provide ultra-low active current. This is ideal for providing More Battery Life™ (MoBL) in portable applications such as cellular telephones. The device can be put into standby mode when deselected ($\overline{CE}$ HIGH, or both $\overline{BLE}$ and $\overline{BHE}$ HIGH). The input/output pins (I/O_0 through I/O_{15}) are placed in a high-impedance state when: deselected ($\overline{CE}$ HIGH, or both $\overline{BLE}$ and $\overline{BHE}$ HIGH), outputs are disabled ($\overline{OE}$ HIGH), or during a write operation ($\overline{CE}$ LOW and $\overline{WE}$ LOW).

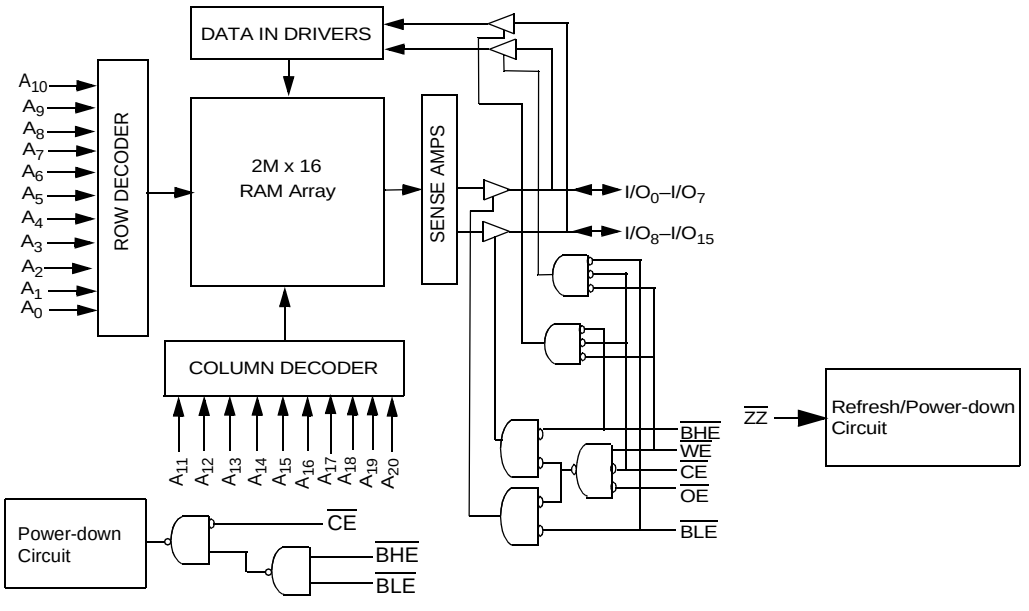
Writing to the device is accomplished by taking Chip Enable ($\overline{CE}$) LOW and Write Enable ($\overline{WE}$) input LOW. If Byte Low Enable ($\overline{BLE}$) is LOW, then data from I/O pins (I/O_0 through I/O_7), is written into the location specified on the address pins (A_0 through A_{20}). If Byte High Enable ($\overline{BHE}$) is LOW, then data from I/O pins (I/O_8 through I/O_{15}) is written into the location specified on the address pins (A_0 through A_{20}).

Reading from the device is accomplished by taking Chip Enable ($\overline{CE}$) LOW and Output Enable ($\overline{OE}$) LOW while forcing the Write Enable ($\overline{WE}$) HIGH. If Byte Low Enable ($\overline{BLE}$) is LOW, then data from the memory location specified by the address pins will appear on I/O_0 to I/O_7. If Byte High Enable ($\overline{BHE}$) is LOW, then data from memory will appear on I/O_8 to I/O_{15}. See the truth table at the back of this datasheet for a complete description of read and write modes.

This SRAM has multiple power down functions. The $\overline{ZZ}$ pin will put the SRAM into a deep sleep mode, where the data is not retained in the SRAM. The Variable Address Mode allows the user to retain data in a section of the SRAM and reduce the standby current. The CY81U032X16A9A has the deep sleep mode disabled on power-up. The VAR register can be used to enable the deep sleep mode.

The MoBL3 is available in a 48-ball FBGA package.

Logic Block Diagram



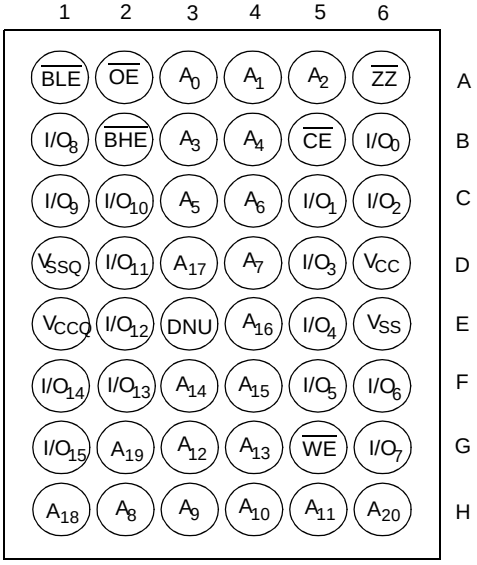
Note:

1. For best practice recommendations, please refer to the CY application note “System Design Guidelines” on http://www.cypress.com.

Pin Configuration[2, 3]

FBGA

Top View



Notes:
2. DNU pins are to be connected to V_{SS} or left open.
3. V_{SSQ} is the Ground pin for the I/O drivers. It should be connected to V_{SS}.

Maximum Ratings

(Above which the useful life may be impaired. For user guidelines, not tested.)

Storage Temperature .....–65°C to +150°C

Ambient Temperature with Power Applied.....–55°C to +125°C

Supply Voltage to Ground Potential-V25 ..... –0.2V to +3.3V

DC Voltage Applied to Outputs in High-Z State[4, 5, 6].....–0.2V to Vcc + 0.3V

DC Input Voltage[4, 5, 6] .....–0.2V to Vcc + 0.3V

Output Current into Outputs (LOW)..... 20 mA

Static Discharge Voltage..... > 2001V (per MIL-STD-883, Method 3015)

Latch-up Current..... > 200 mA

Operating Range

Ambient Temperature	V_{CC}	V_{CCQ}
–25°C to +85°C	2.3 to 3.1V	1.7V to V_{CC}

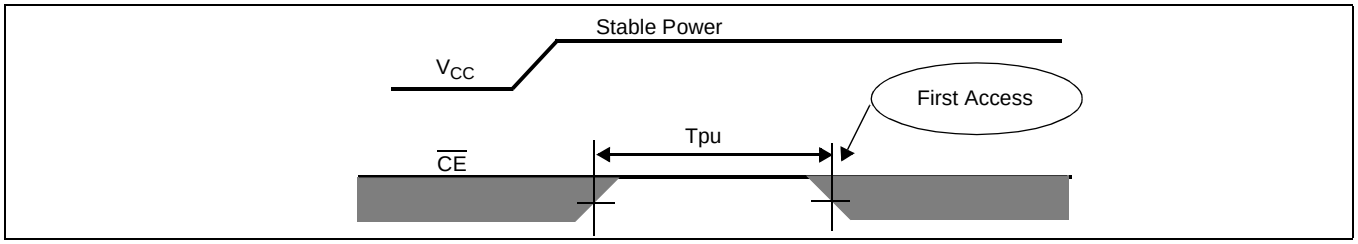
Product Portfolio

Product	V_{CC} Range			Cycle Time	t_{AA}	Power Dissipation					
						Operating (Icc)				Standby (I_{SB2})	
						f = 1MHz		f = f_{MAX}			
	Min.	Typ.	Max.			Typ.[7]	Max.	Typ[7]	Max.	Typ.[7]	Max.
CY81U032X16A9A-85	2.3V	2.5V	3.1V	85 ns	85 ns		2 mA		18 mA		100µA
CY81U032X16A9A-70				70 ns	70 ns				21 mA		

Power-up Characteristics

The 32M needs to have a initialization time before accesses can be started on the device.

The initialization sequence is shown in the figure below. Chip Select (CE) should be HIGH for at least 200 us after V_{CC} has reached a stable value. No access must be attempted during this period of 200 us.



Parameter	Description	Min	Typ	Max	Units
Tpu	Chip Enable Low After Stable Vcc	200			µs

Notes:

4. Overshoot: V_{CC} + 0.2V, pulse width < 20 ns.
5. Undershoot: –0.2V, pulse width < 20 ns.
6. Overshoot and undershoot specifications are characterized and are not 100% tested.
7. Typical values are included for reference only and are not guaranteed or tested. Typical values are measured at V_{CC} = $V_{CC(typ.)}$, T_A = 25°C.

Variable Address Refresh

Description

The variable address mode allows customers to turn off sections of the die to save standby current. The 32M MoBL3 is divided into four 8M sections allowing certain sections to be active (i.e., refreshed). The variable address mode also allows a customer to go into a low-power mode with $\overline{ZZ}$ tied low and keep the data in a certain section of memory.

Function

At power up, all four sections of the die are activated and the SRAM enters into its default state of full memory size and refresh space.

MoBL3 provides three distinct operation modes for reducing standby power:

a. Reduced Memory Size Operation

b. Partial Array Refresh

c. Deep Sleep Mode.

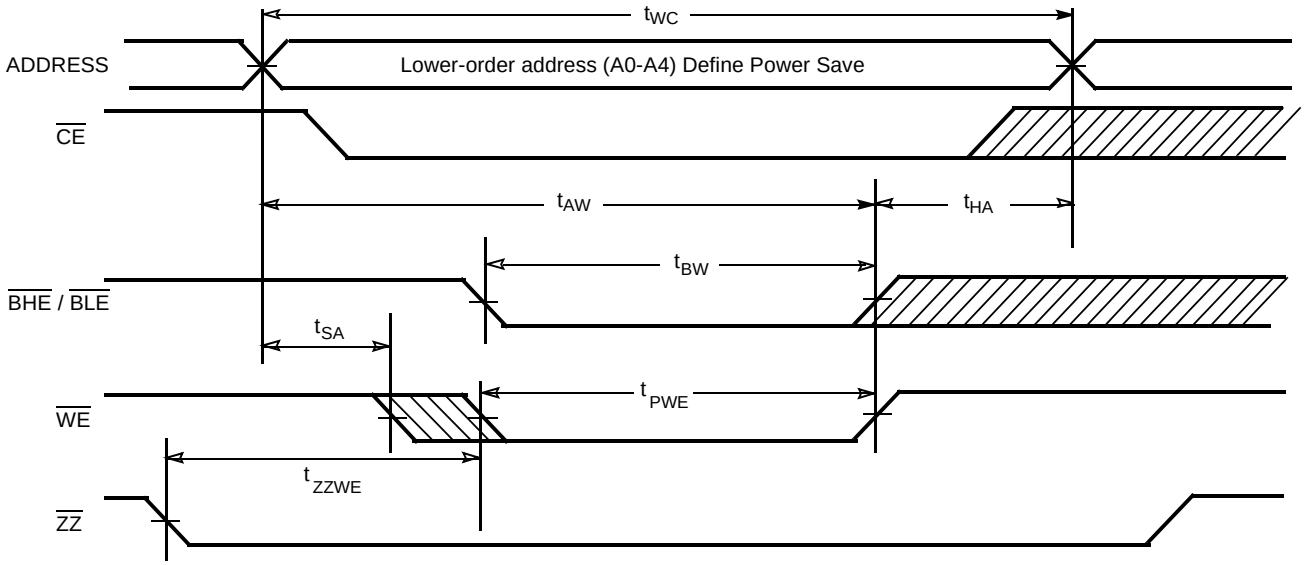
In the Reduced Memory Size (RMS) operation, the SRAM can be operated as a reduced size SRAM. For example, one could operate the 32M SRAM as an 8M, 16M, or a 32M memory block. The protocol to turn on/off the sections of the memory is given in the following pages. The RMS mode is enabled after $\overline{ZZ}$ goes high and remains in RMS mode after $\overline{ZZ}$ goes high. To revert back to a complete 32M SRAM, the protocol outlined on the next page will have to be followed, along with the bit pattern definitions shown on page 6.

In the Partial Array Refresh (PAR), the SRAM will only refresh certain portions of the memory, as configured by the user. This mode is only for standby and is applicable as long as $\overline{ZZ}$ remains low. Once $\overline{ZZ}$ returns high in this mode, the SRAM goes back to operating in full address refresh. The protocol shown on the next page will have to be followed to turn on/off this mode of operation. Once the Variable Address (VA) register is updated, all future PAR accesses will use the contents of the VA register when $\overline{ZZ}$ returns low. If the customer wants to change the PAR space, the VA register must be updated per next figure.

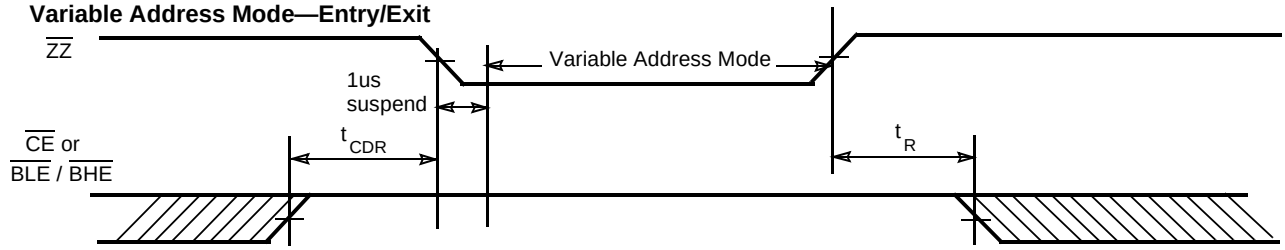
If the Variable Address (VA) register is not updated after power up, the SRAM will be in its default state. In the default state the whole memory array will be refreshed and driving $\overline{ZZ}$ low will not place the SRAM into a deep sleep mode. To enable the deep sleep mode, the customer must update the VA register, then address bit 4 (A4) must be set to 0, indicating to the SRAM that the deep sleep mode is enabled. Once the deep sleep mode is enabled, driving $\overline{ZZ}$ low places the SRAM into a deep sleep mode after 1us. Once in the deep sleep mode, data integrity in the SRAM is not guaranteed and the contents of the VA register is destroyed. The SRAM will remain in deep sleep mode until $\overline{ZZ}$ is driven high. At any point of time, one could drive $\overline{ZZ}$ low and change the VA register's A4 bit back to 1 and the SRAM returns to its default state.

Variable Address Refresh Switching Diagrams

Variable Address Mode—Register Update[8]



Variable Address Mode—Entry/Exit



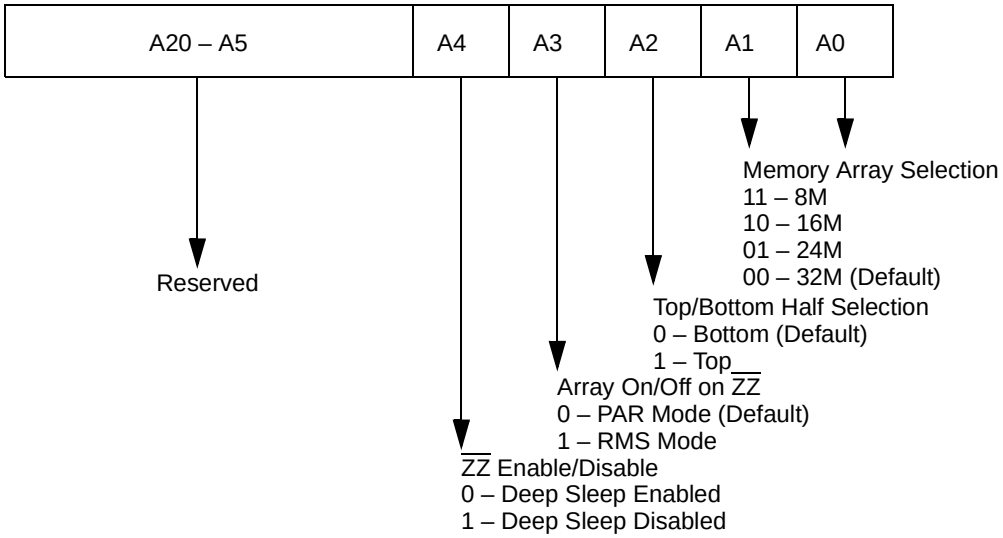
Note:

8. $\overline{OE}$ and the data pins are in a don't care state while the device is in variable address mode.

Variable Address Space Timings[9]

Parameter	Description	Min.	Max.	Unit
t_{ZZWE}	$\overline{ZZ}$ LOW to $\overline{WE}$ LOW		1000	ns
t_{CDR}	Chip deselect to $\overline{ZZ}$ LOW	0		ns
t_R[10]	Operation Recovery Time (Deep Sleep Mode only)	200		µs
t_{ZZMIN}	Deep Sleep Mode Time	10		µs

Variable Address Space–Register



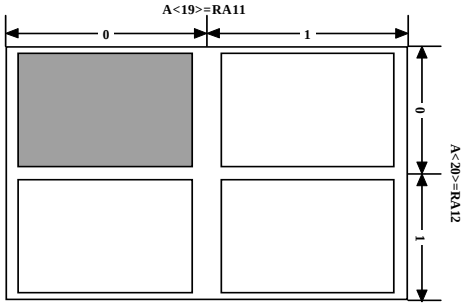
Variable Address Space—Address Patterns

Partial Array Refresh Mode (A3=0, A4=1)					
A2	**A1, A0**	**Refresh Section**	**Address**	**Size**	**Density**
0	11	One-fourth of the Die	00000h – 07FFFFh (A20=A19=0)	512K x 16	8M
0	10	Half of the Die	00000h – 0FFFFFh (A20=0, A19=0 or 1)	1M x 16	16M
0	01	Three-fourths of the Die	00000h – 17FFFFh (A20:A19 != 11)	1.5M x 16	24M
1	11	One-fourth of the Die	180000h – 1FFFFFh (A20=A19=1)	512K x 16	8M
1	10	Half of the Die	100000h – 1FFFFFh (A20=1, A19=0 or 1)	1M x 16	16M
1	01	Three-fourths of the Die	080000h – 1FFFFFh (A20:A19 != 00)	1.5M x 16	24M
Reduced Memory Size Mode (A3=1, A4=1)					
0	11	One-fourth of the Die	00000h – 07FFFFh (A20=A19=0)	512K x 16	8M
0	10	Half of the Die	00000h – 0FFFFFh (A20=0, A19=0 or 1)	1M x 16	16M
0	01	Three-fourths of the Die	00000h – 17FFFFh (A20:A19 != 11)	1.5M x 16	24M
0	00	Full Die	00000h – 1FFFFFh	2M x 16	32M
1	11	One-fourth of the Die	180000h – 07FFFFh (A20=A19=0)	512K x 16	8M
1	10	Half of the Die	100000h – 0FFFFFh (A20=0, A19=0 or 1)	1M x 16	16M
1	01	Three-fourths of the Die	080000h – 17FFFFh (A20:A19 != 00)	1.5M x 16	24M
1	00	Full Die	000000h – 1FFFFFh	2M x 16	32M

Notes:
9. All other timing parameters are as shown in the data sheets.
10. t_R applies only in the deep sleep mode.

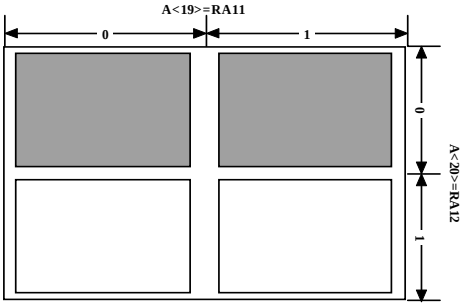
Memory Block Split

Bottom Address Range



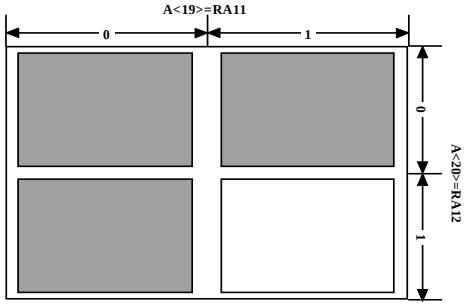
1/4 Address Space Refresh

Active Address Space:
A0-A18
A<19,20> = <0,0>



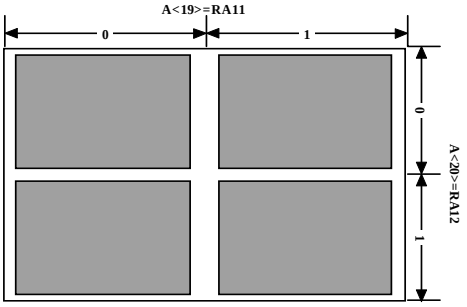
1/2 Address Space Refresh

Active Address Space:
A0-A19
A<20>=<0>



3/4 Address Space Refresh

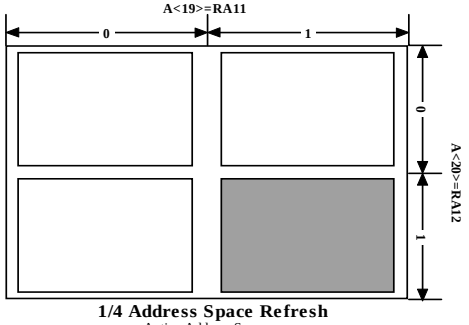
Active Address Space:
A0-A20
A<19,20> = <0,0>,<1,0>,<0,1>



Full Address Space Refresh

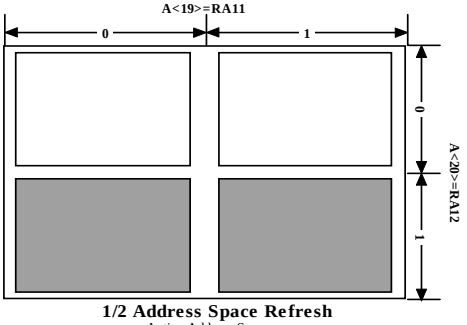
Active Address Space:
A0-A20
A<19,20> = <X,X>

Top Address Range



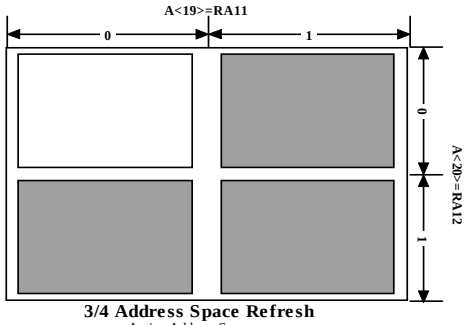
1/4 Address Space Refresh

Active Address Space:
A0-A18
A<19,20> = <1,1>



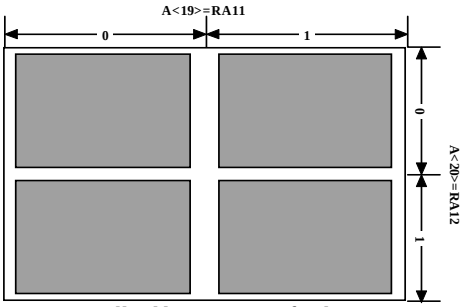
1/2 Address Space Refresh

Active Address Space:
A0-A19
A<20>=<1>



3/4 Address Space Refresh

Active Address Space:
A0-A20
A<19,20> = <1,0>,<0,1>,<1,1>



Full Address Space Refresh

Active Address Space:
A0-A20
A<19,20> = <X,X>

Electrical Characteristics Over the Operating Range[4, 5, 6]

Parameter	Description	Test Conditions		CY81U032X16A9A Min.	Typ.[7]	Max.	Unit
V_{OH}[11]	Output HIGH Voltage	I_{OH} = –0.1 mA		V_{CCQ} – 0.2			V
V_{OL}[11]	Output LOW Voltage	I_{OL} = 0.1 mA				0.2	V
V_{IH}[12]	Input HIGH Voltage			1.4		V_{CC} +0.2V	V
V_{IL}[12]	Input LOW Voltage			–0.2		0.4	V
I_{IX}	Input Leakage Current	GND ≤ V_I ≤ V_{CC}		–1		+1	µA
I_{OZ}	Output Leakage Current	GND ≤ V_O ≤ V_{CC}, Output Disabled		–1		+1	µA
I_{CC}	V_{CC} Operating Supply Current	I_{OUT} = 0 mA, f = f_{MAX} = 1/t_{RC}, V_{CC} = Max CMOS Levels	t_{AA} = 85 ns			18	mA
			t_{AA} = 70 ns			21	mA
		I_{OUT} = 0 mA, f=1MHz, CMOS Levels, V_{CC} = Max				2	mA
I_{SB1}	Automatic CE Power-down Current—CMOS Inputs	$\overline{CE}$ ≥ V_{CC} – 0.3V or CE ≤ 0.3V V_{IN} ≥ V_{CC} – 0.3V or V_{IN} ≤ 0.3V, f = f_{MAX} (Address and Data Only), f=0 ($\overline{OE}$, $\overline{WE}$, $\overline{BHE}$, $\overline{BLE}$) V_{CC} = Max				100	µA
I_{SB2}	Automatic CE Power-down Current—CMOS Inputs	$\overline{CE}$ ≥ V_{CC} – 0.3V or CE ≤ 0.3V, V_{IN} ≥ V_{CC} – 0.3V or V_{IN} ≤ 0.3V, f=0, V_{CC} = Max				100	µA

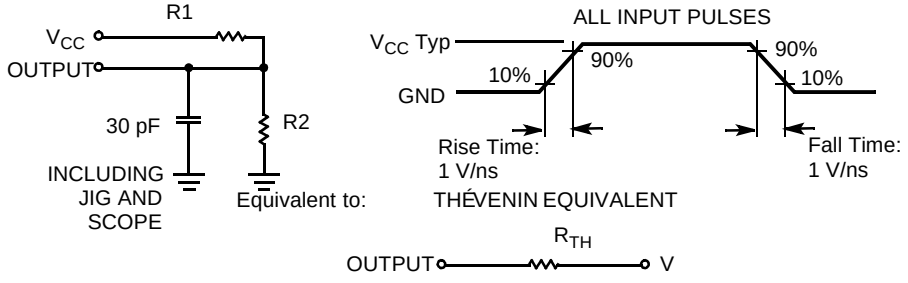
Capacitance[13]

Parameter	Description	Test Conditions	Max.	Unit
C_{IN}	Input Capacitance	T_A = 25°C, f = 1 MHz, $V_{CC(typ)}$	6	pF
C_{OUT}	Output Capacitance		8	pF

Thermal Resistance

Parameter	Description	Test Conditions	BGA	Units
Θ_{JA}	Thermal Resistance (Junction to Ambient)[13]	Still Air, soldered on a 4.25 x 1.125 inch, 4-layer printed circuit board	55	°C/W
Θ_{JC}	Thermal Resistance (Junction to Case)[13]		16	°C/W

AC Test Loads and Waveforms



Notes:
11. For I_{OH} = –0.4 mA, V_{OH} = 0.8 x V_{CCQ}; for I_{OL} = 0.4 mA, V_{OL} = 0.2 x V_{CCQ}.
12. For V_{CCQ} = 1.7 – 2.25V: V_{IH} = higher of (1.4V, 0.8 x V_{CCQ}); V_{IL} = lower of (0.4V, 0.2 x V_{CCQ}).
13. Tested initially and after any design or process changes that may affect these parameters.

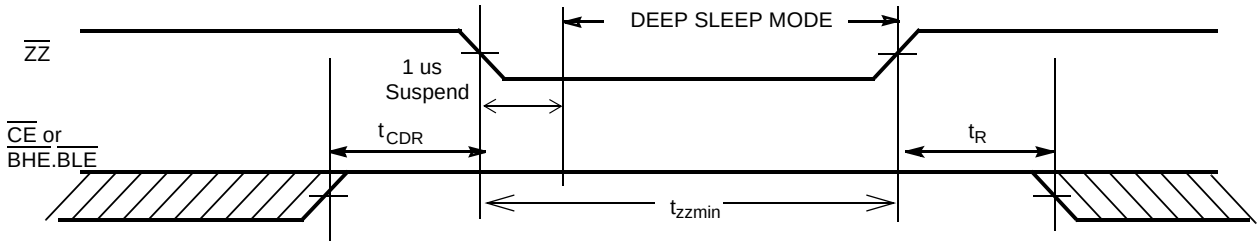
Parameters	2.5V I/O	1.8V I/O	Unit
R1	21000	14000	Ohms
R2	21000	14000	Ohms

Parameters	2.5V I/O	1.8V I/O	Unit
R_{TH}	10500	7000	Ohms
V_{TH}	1.25	0.9	Volts

Deep Sleep Mode[14]

Parameter	Description	Conditions	Min.	Typ.[7]	Max.	Unit
I_{CCDS}	Deep Sleep Current	$\overline{CE} \geq V_{CC} - 0.2V, \overline{ZZ} \leq V_{IL}, V_{IN} \geq V_{CC} - 0.2V$ or $V_{IN} \leq 0.2V$; No input may exceed $V_{CC} + 0.2V$		7	10	µA
t_{CDR}[14]	Chip Deselect to Data Retention Time		0			ns
t_R	Operation Recovery Time		200			µs
t_{zzmin}	Deep Sleep mode Time		10			µs

Deep Sleep Waveform[15]



Switching Characteristics Over the Operating Range[16]

Parameter	Description	85 ns		70 ns		Unit
		Min.	Max.	Min.	Max.	
Read Cycle						
t_{RC}	Read Cycle Time	85		70		ns
t_{AA}	Address to Data Valid		85		70	ns
t_{OHA}	Data Hold from Address Change	10		10		ns
t_{ACE}	$\overline{CE}$ LOW to Data Valid		85		70	ns
t_{DOE}	$\overline{OE}$ LOW to Data Valid		35		35	ns
t_{LZOE}[20]	$\overline{OE}$ LOW to Low-Z[17]	5		5		ns
t_{HZOE}[20]	$\overline{OE}$ HIGH to High-Z[17, 18]		25		25	ns
t_{LZCE}[20]	$\overline{CE}$ LOW to Low-Z[17]	10		10		ns
t_{HZCE}[20]	$\overline{CE}$ HIGH to High-Z[17, 18]		25		25	ns
t_{PU}	$\overline{CE}$ LOW to Power-up	0		0		ns
t_{PD}	$\overline{CE}$ HIGH to Power-down		85		70	ns
t_{DBE}	$\overline{BLE}$ / $\overline{BHE}$ LOW to Data Valid		85		70	ns
t_{LZBE}[20]	$\overline{BLE}$ / $\overline{BHE}$ LOW to Low-Z[17]	5		5		ns
t_{HZBE}[20]	$\overline{BLE}$ / $\overline{BHE}$ HIGH to High-Z[17,18]		25		25	ns

Notes:

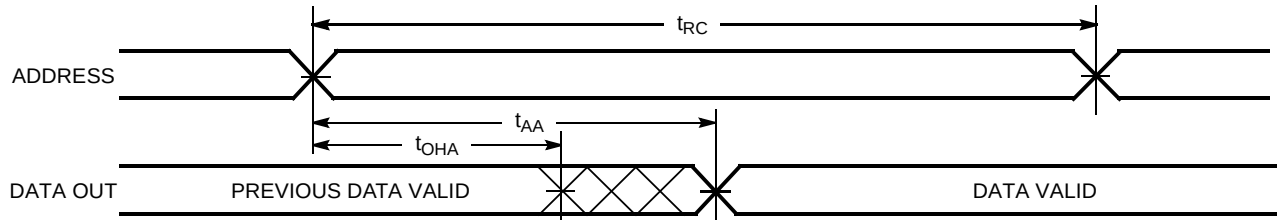
14. This mode does not retain the data in the SRAM. All data will be lost in the mode of operation. This is the default mode of operation on the CY81U032X16A9A device.
15. BHE.BLE is the AND of both $\overline{BHE}$ and $\overline{BLE}$. Chip can be deselected by either disabling the chip enable signal ($\overline{CE}$ HIGH) or by disabling both $\overline{BHE}$ and $\overline{BLE}$ (both HIGH).
16. Test conditions assume signal transition time of 3ns or less, timing reference levels of $V_{CC(typ)}/2$, input pulse levels of 0 to $V_{CC(typ)}$, and output loading of the specified I_{OL}/I_{OH} and 30-pF load capacitance
17. At any given temperature and voltage condition, t_{HZCE} is less than t_{LZCE}, t_{HZOE} is less than t_{LZOE}, t_{HZBE} is less than t_{LZBE} and t_{HZWE} is less than t_{LZWE} for any given device.
18. t_{HZOE}, t_{HZCE}, t_{HZBE} and t_{HZWE} transitions are measured when the output enters a high impedance state.
19. The internal write time of the memory is defined by the overlap of $\overline{WE}$, $\overline{CE}$ = V_{IL}, $\overline{BHE}$ and/or $\overline{BLE}$ = V_{IL}. All signals must be ACTIVE to initiate a write and any of these signals can terminate a write by going INACTIVE. The data input set-up and hold timing should be referenced to the edge of the signal that terminates the write.
20. High-Z and Low-Z parameters are guaranteed by design and are not tested.

Switching Characteristics Over the Operating Range[16] (continued)

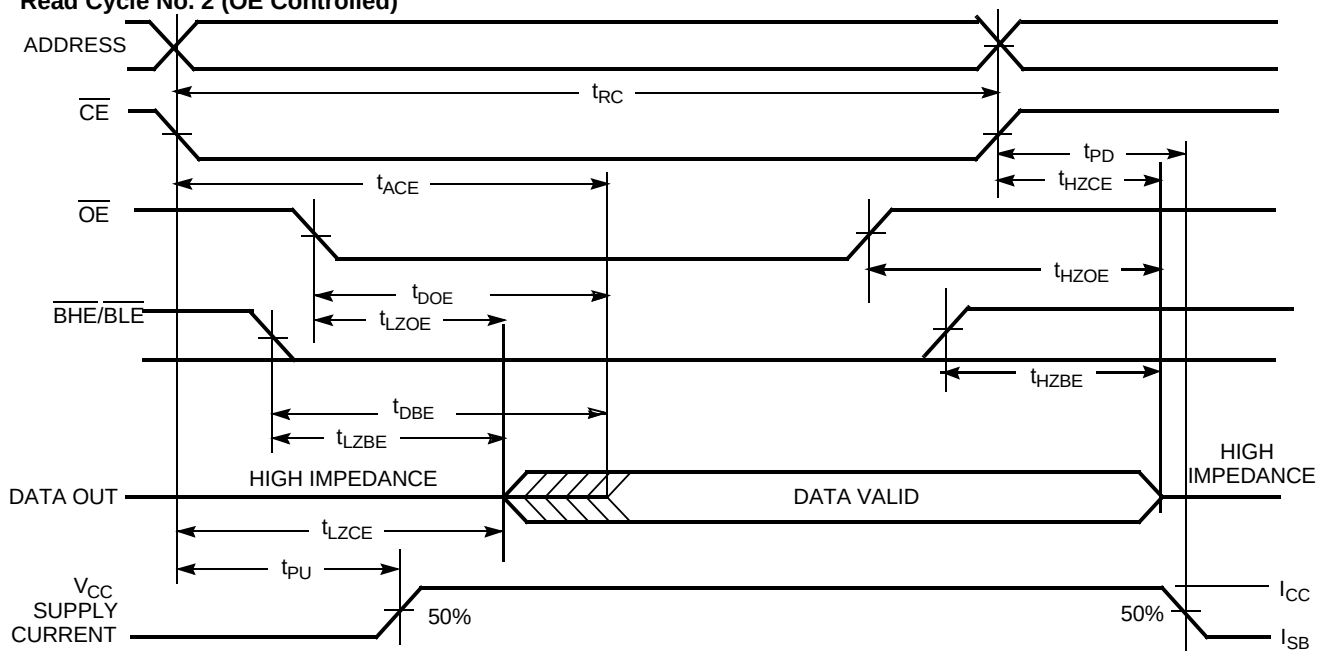
Parameter	Description	85 ns		70 ns		Unit
		Min.	Max.	Min.	Max.	
Write Cycle[19]						
t_{WC}	Write Cycle Time	85		70		ns
t_{SCE}	$\overline{CE}$ LOW to Write End	75		60		ns
t_{AW}	Address Set-up to Write End	75		60		ns
t_{HA}	Address Hold from Write End	0		0		ns
t_{SA}	Address Set-up to Write Start	0		0		ns
t_{PWE}	$\overline{WE}$ Pulse Width	65	1000	50	1000	ns
t_{BW}	$\overline{BLE}$ / $\overline{BHE}$ LOW to Write End	75		60		ns
t_{SD}	Data Set-up to Write End	30		30		ns
t_{HD}	Data Hold from Write End	0		0		ns
t_{HZWE}[20]	$\overline{WE}$ LOW to High-Z[17, 18]		25		25	ns
t_{LZWE}[20]	$\overline{WE}$ HIGH to Low-Z[17]	10		10		ns

Switching Waveforms

Read Cycle No. 1(Address Transition controlled) [21, 22]



Read Cycle No. 2 ($\overline{OE}$ Controlled) [22, 23]

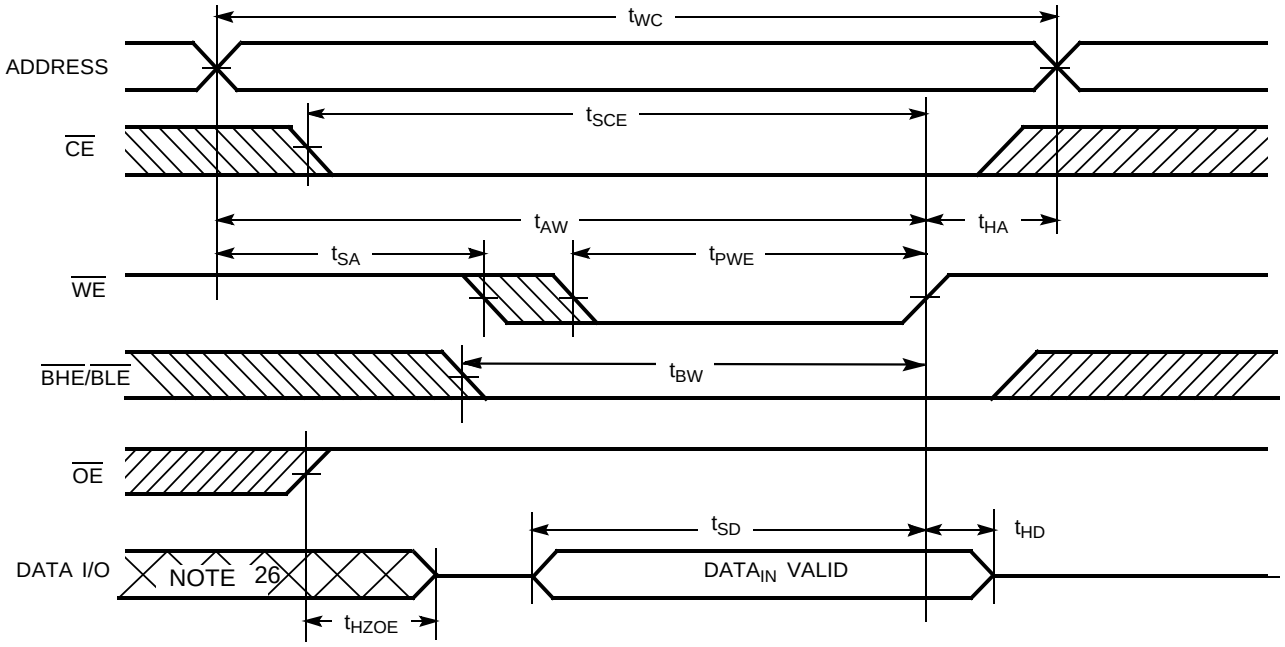


Notes:

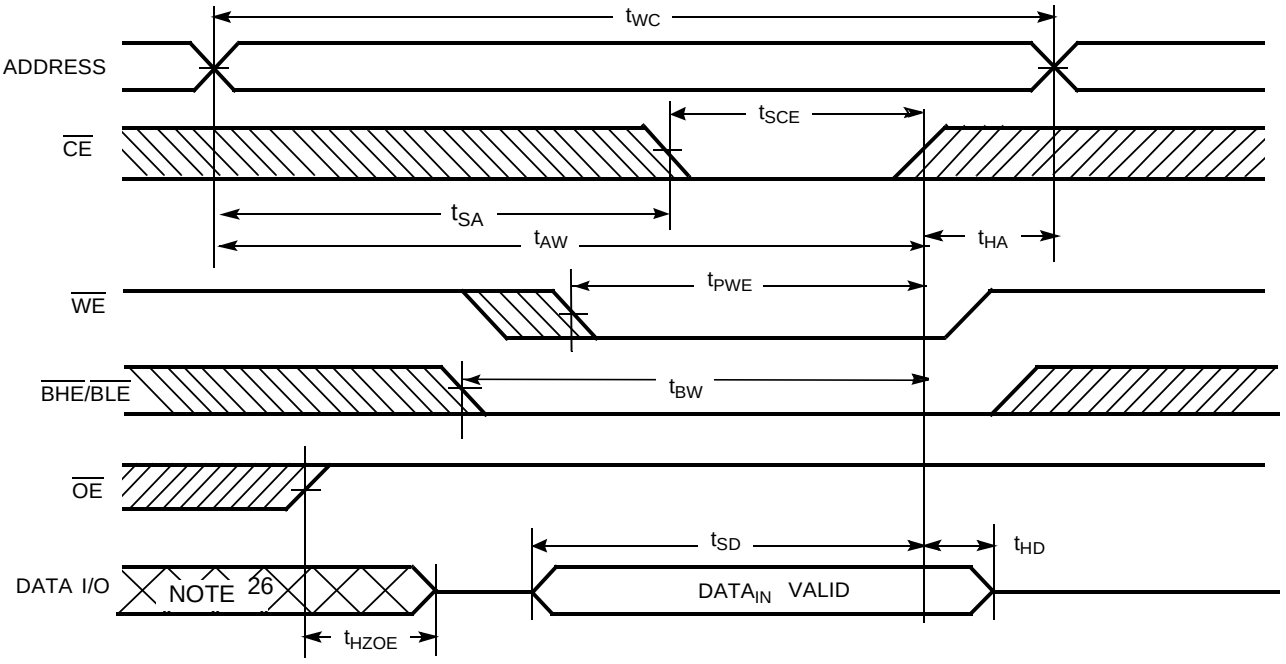
21. Device is continuously selected. $\overline{OE}$, $\overline{CE}$ = V_{IL} , $\overline{BHE}$ and/or $\overline{BLE}$ = V_{IL}.
22. $\overline{WE}$ is HIGH for read cycle.
23. Address valid prior to or coincident with $\overline{CE}$ transition LOW.
24. Data I/O is high impedance if $\overline{OE}$ = V_{IH}.

Switching Waveforms (continued)

Write Cycle No. 1(WE Controlled) [19, 24, 25]



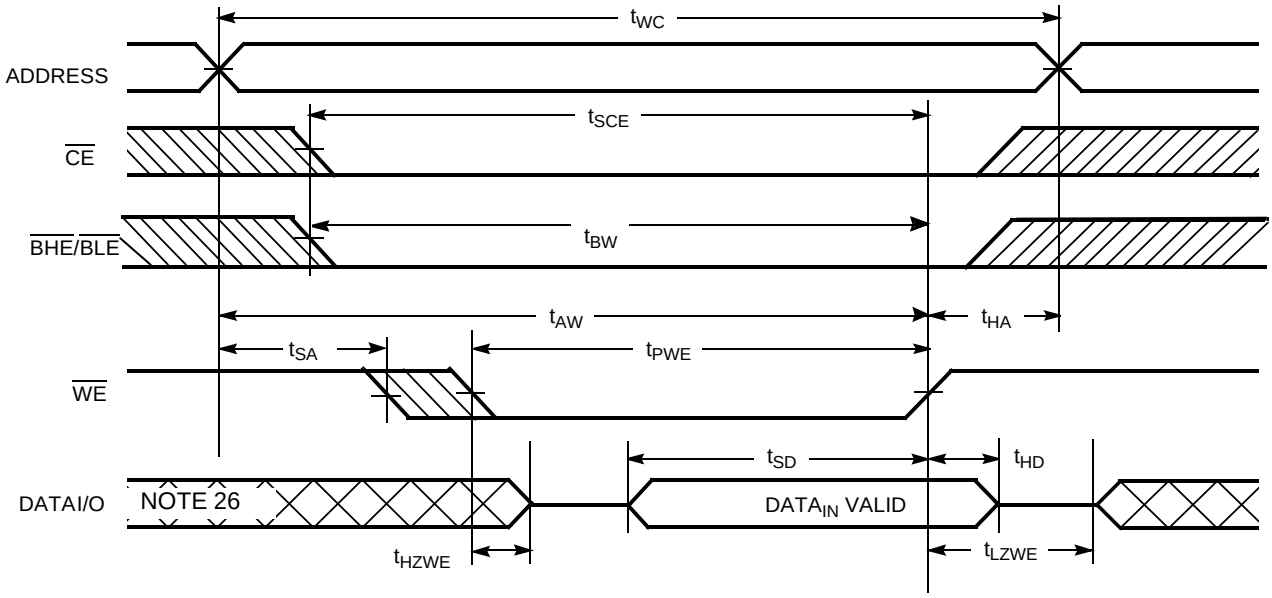
Write Cycle No. 2 (CE Controlled) [19, 24, 25]



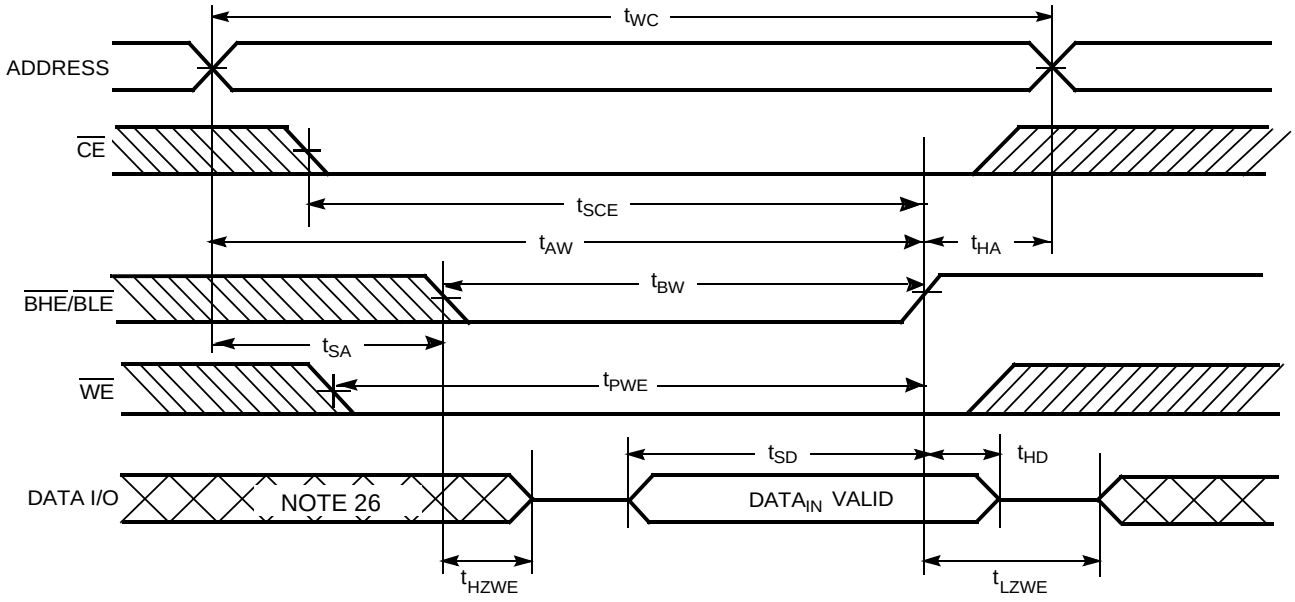
Notes:
25. If CE goes LOW simultaneously with WE HIGH, the output remains in a high-impedance state.
26. During this period, the I/Os are in output state and input signals should not be applied.

Switching Waveforms (continued)

Write Cycle No. 3 (WE Controlled, OE LOW) [25]



Write Cycle No. 4 (BHE/BLE Controlled, OE LOW) [25]



Truth Table

$\overline{CE}$	$\overline{ZZ}$	$\overline{WE}$	$\overline{OE}$	$\overline{BHE}$	$\overline{BLE}$	Inputs/Outputs	Mode	Power
X	H	X	X	H	H	High-Z	Deselect/Power-down	Standby (I_{SB})
H	H	X	X	X	X	High-Z	Deselect/Power-down	Standby (I_{SB})
X	L	X	X	X	X	High-Z	Deep Sleep Mode	Deep Sleep Current (Iccds)[27]
L	H	H	L	L	L	Data Out (I/O0–I/O15)	Read	Active (I_{CC})
L	H	H	L	H	L	Data Out (I/O0–I/O7); High-Z (I/O8–I/O15)	Read	Active (I_{CC})
L	H	H	L	L	H	Data Out (I/O8–I/O15); High-Z (I/O0–I/O7)	Read	Active (I_{CC})
L	H	X	H	L	L	High-Z	Output Disabled	Active (I_{CC})
L	H	L	X	L	L	Data In (I/O0–I/O15)	Write	Active (I_{CC})
L	H	L	X	H	L	Data In (I/O0–I/O7); High-Z (I/O8–I/O15)	Write	Active (I_{CC})
L	H	L	X	L	H	Data In (I/O8–I/O15); High-Z (I/O0–I/O7)	Write	Active (I_{CC})

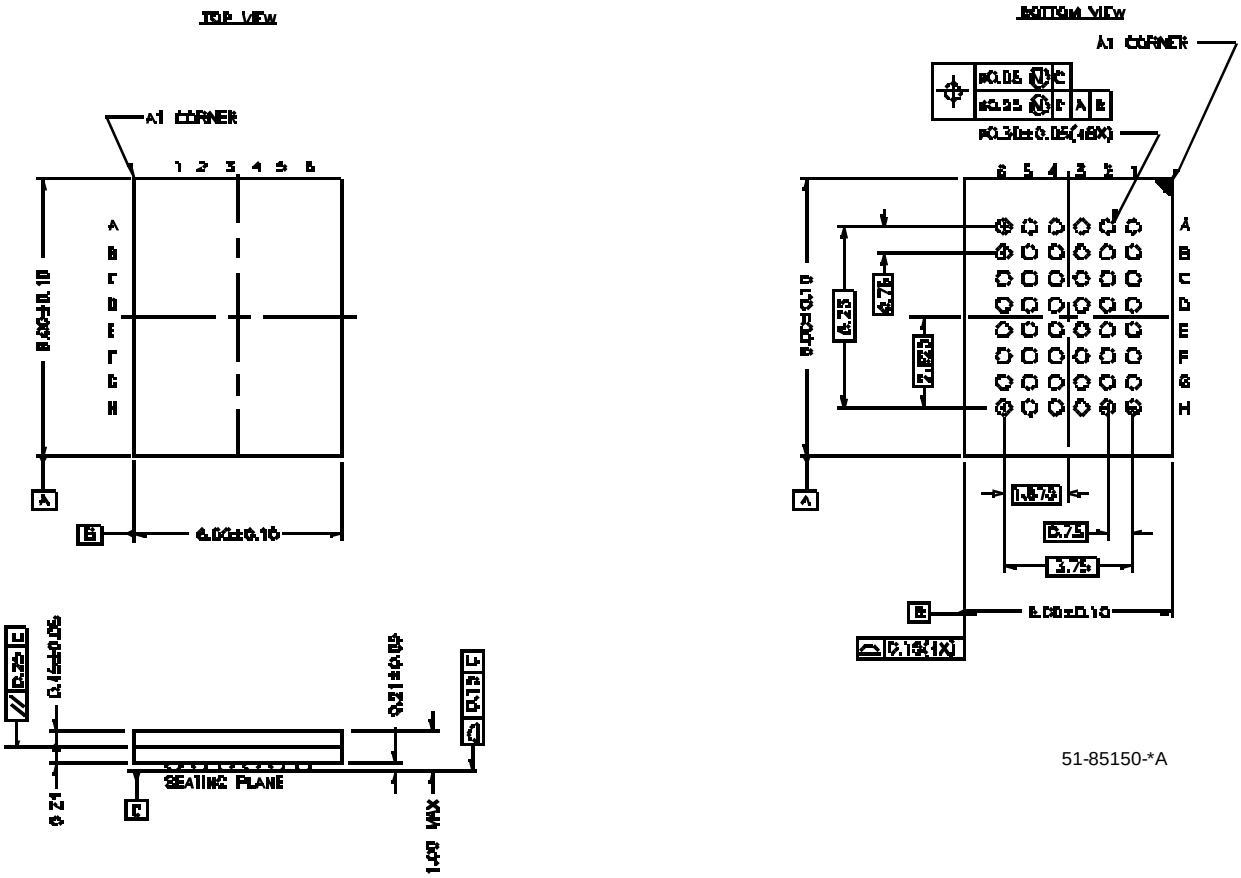
Ordering Information

Speed (ns)	Ordering Code	Package Name	Package Type	Operating Range
70	CY81U032X16A9A-7N4FI	BV48A	6 x 8 x 1 48-ball Fine Pitch BGA	Industrial
85	CY81U032X16A9A-8N4FI			

Note:
27. This assures that the deep sleep mode is enabled in the VAR register.

Package Diagrams

48-Lead VFBGA (6 x 8 x 1 mm) BV48A



Document History Page

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REV.	**ECN NO.**	**Issue Date**	**Orig. of Change**	**Description of Change**
**	117424	09/12/02	HRT	New Data Sheet