

128K x 16 Static RAM

Features

- **Low voltage range:**
— 1.65V–1.95V
- **Ultra-low active power**
— Typical Active Current: 0.5 mA @ f = 1 MHz
— Typical Active Current: 1.5 mA @ f = f_{max}
- **Low standby power**
- **Easy memory expansion with $\overline{CE}$ and $\overline{OE}$ features**
- **Automatic power-down when deselected**
- **CMOS for optimum speed/power**

Functional Description

The WCMB2016R4X is a high-performance CMOS static RAM organized as 128K words by 16 bits. This device features advanced circuit design to provide ultra-low active current. This device is ideal for portable applications such as cellular telephones. The device also has an automatic power-down feature that significantly reduces power consumption by 99% when addresses are not toggling. The device can also be put into standby mode when deselected ($\overline{CE}$ HIGH or both BLE

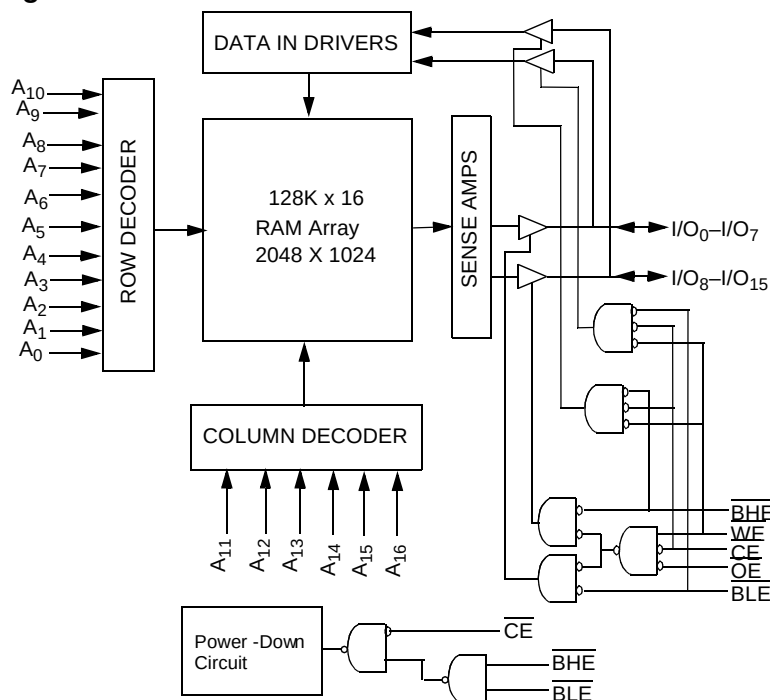
and $\overline{BHE}$ are HIGH). The input/output pins (I/O₀ through I/O₁₅) are placed in a high-impedance state when: deselected ($\overline{CE}$ HIGH), outputs are disabled ($\overline{OE}$ HIGH), both Byte High Enable and Byte Low Enable are disabled ($\overline{BHE}$, BLE HIGH), or during a write operation ($\overline{CE}$ LOW, and $\overline{WE}$ LOW).

Writing to the device is accomplished by taking Chip Enable ($\overline{CE}$) and Write Enable ($\overline{WE}$) inputs LOW. If Byte Low Enable (BLE) is LOW, then data from I/O pins (I/O₀ through I/O₇), is written into the location specified on the address pins (A₀ through A₁₆). If Byte High Enable ($\overline{BHE}$) is LOW, then data from I/O pins (I/O₈ through I/O₁₅) is written into the location specified on the address pins (A₀ through A₁₆).

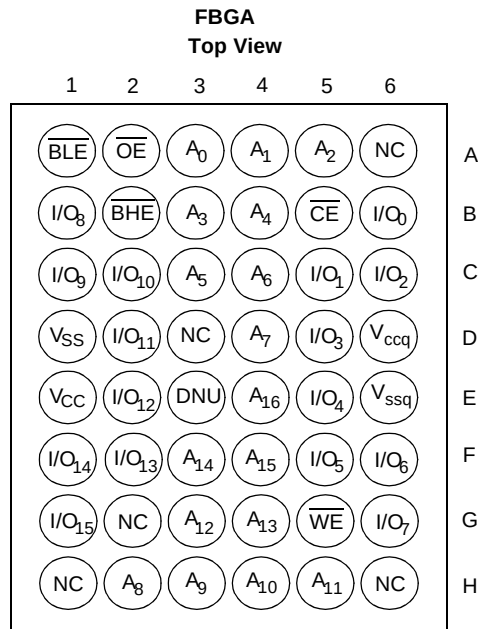
Reading from the device is accomplished by taking Chip Enable ($\overline{CE}$) and Output Enable ($\overline{OE}$) LOW while forcing the Write Enable ($\overline{WE}$) HIGH. If Byte Low Enable (BLE) is LOW, then data from the memory location specified by the address pins will appear on I/O₀ to I/O₇. If Byte High Enable ($\overline{BHE}$) is LOW, then data from memory will appear on I/O₈ to I/O₁₅. See the Truth Table at the back of this data sheet for a complete description of read and write modes.

The WCMB2016R4X is available in a 48-ball FBGA package.

Logic Block Diagram



Pin Configuration^[1, 2]



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 -0.2V to +2.4V

DC Voltage Applied to Outputs

in High Z State^[3]..... -0.2V to V_{CC} + 0.2V

DC Input Voltage^[3]..... -0.2V to V_{CC} + 0.2V

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

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

Latch-Up Current..... >200 mA

Operating Range

Device	Range	Ambient Temperature	V _{CC}
WCMB2016R4X	Industrial	-40°C to +85°C	1.65V to 1.95V

Product Portfolio

Product	V _{CC} Range			Speed	Power Dissipation (Industrial)					
					Operating (I _{CC})				Standby (I _{SB2})	
					f = 1MHz		f = f _{max}			
	V _{CC(min.)}	V _{CC(typ.)} ^[4]	V _{CC(max.)}		Typ. ^[4]	Max.	Typ. ^[4]	Max.	Typ. ^[4]	Max.
WCMB2016R4X	1.65V	1.80V	1.95V	70 ns	0.5 mA	2 mA	1.5 mA	6 mA	1 μA	8 μA

Notes:

- NC pins are not connected to the die.
- E3 (DNU) can be left as NC or V_{SS} to ensure proper application.
- V_{IL}(min) = -2.0V for pulse durations less than 20 ns.
- 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.

Electrical Characteristics Over the Operating Range

Param- eter	Description	Test Conditions	WCMB2016R4X			Unit
			Min.	Typ. ^[4]	Max.	
V _{OH}	Output HIGH Voltage	I _{OH} = -0.1 mA V _{CC} = 1.65V	1.4			V
V _{OL}	Output LOW Voltage	I _{OL} = 0.1 mA V _{CC} = 1.65V			0.2	V
V _{IH}	Input HIGH Voltage		1.4		V _{CC} + 0.2V	V
V _{IL}	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	f = f _{MAX} = 1/t _{RC} V _{CC} = 1.95V		1.5	6	mA
		f = 1 MHz I _{OUT} = 0 mA CMOS levels		0.5	2	mA
I _{SB1}	Automatic CE Power-Down Current—CMOS Inputs	$\overline{CE} \geq V_{CC}-0.2V$, V _{IN} ≥ V _{CC} -0.2V, V _{IN} ≤ 0.2V f = f _{MAX} (Address and Data Only), f=0 (OE, WE, BHE and BLE)		1	8	μA
I _{SB2}	Automatic CE Power-Down Current—CMOS Inputs	$\overline{CE} \geq V_{CC}-0.2V$ V _{IN} ≥ V _{CC} -0.2V or V _{IN} ≤ 0.2V, f = 0, V _{CC} =1.95V				

Capacitance^[5]

Parameter	Description	Test Conditions	Max.	Unit
C _{IN}	Input Capacitance	T _A = 25°C, f = 1 MHz, V _{CC} = V _{CC(typ)}	6	pF
C _{OUT}	Output Capacitance		8	pF

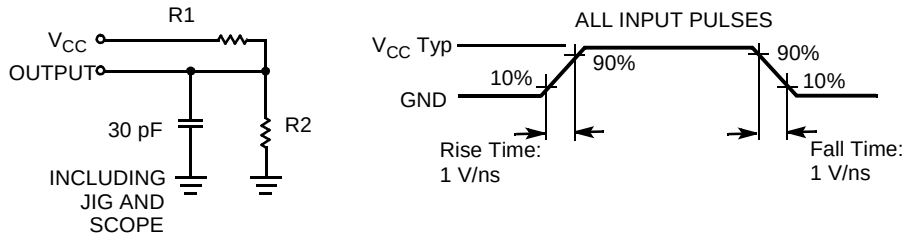
Thermal Resistance

Description	Test Conditions	Symbol	BGA	Units
Thermal Resistance (Junction to Ambient) ^[5]	Still Air, soldered on a 4.25 x 1.125 inch, 4-layer printed circuit board	θ _{JA}	55	°C/W
Thermal Resistance (Junction to Case) ^[5]		θ _{JC}	16	°C/W

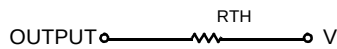
Note:

5. Tested initially and after any design or process changes that may affect these parameters.

AC Test Loads and Waveforms



Equivalent to: THÉVENIN EQUIVALENT

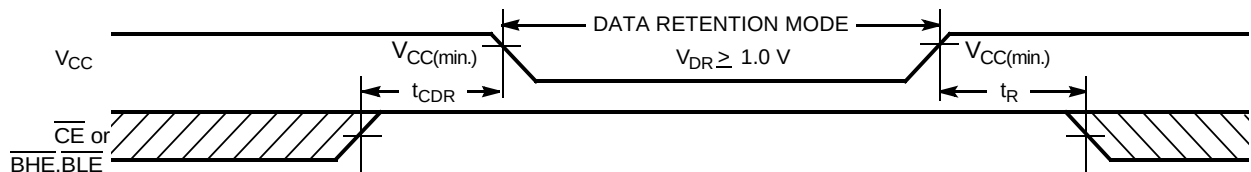


Parameters	1.8V	UNIT
R1	13500	Ohms
R2	10800	Ohms
R_{TH}	6000	Ohms
V_{TH}	0.80	Volts

Data Retention Characteristics (Over the Operating Range)

Parameter	Description	Conditions	Min.	Typ. ^[4]	Max.	Unit
V_{DR}	V_{CC} for Data Retention		1.0		1.95	V
I_{CCDR}	Data Retention Current	$V_{CC} = 1.0V$ $CE \geq V_{CC} - 0.2V$, $V_{IN} \geq V_{CC} - 0.2V$ or $V_{IN} \leq 0.2V$		0.5	5	μA
$t_{CDR}^{[5]}$	Chip Deselect to Data Retention Time		0			ns
$t_R^{[6]}$	Operation Recovery Time		t_{RC}			ns

Data Retention Waveform^[7]



Notes:

- Full device operation requires linear V_{CC} ramp from V_{DR} to $V_{CC(min.)} \geq 100 \mu s$ or stable at $V_{CC(min.)} \geq 100 \mu s$.
- $\overline{BHE.BLE}$ is the AND of both $\overline{BHE}$ and $\overline{BLE}$. Chip can be deselected by either disabling the chip enable signals or by disabling both $\overline{BHE}$ and $\overline{BLE}$.

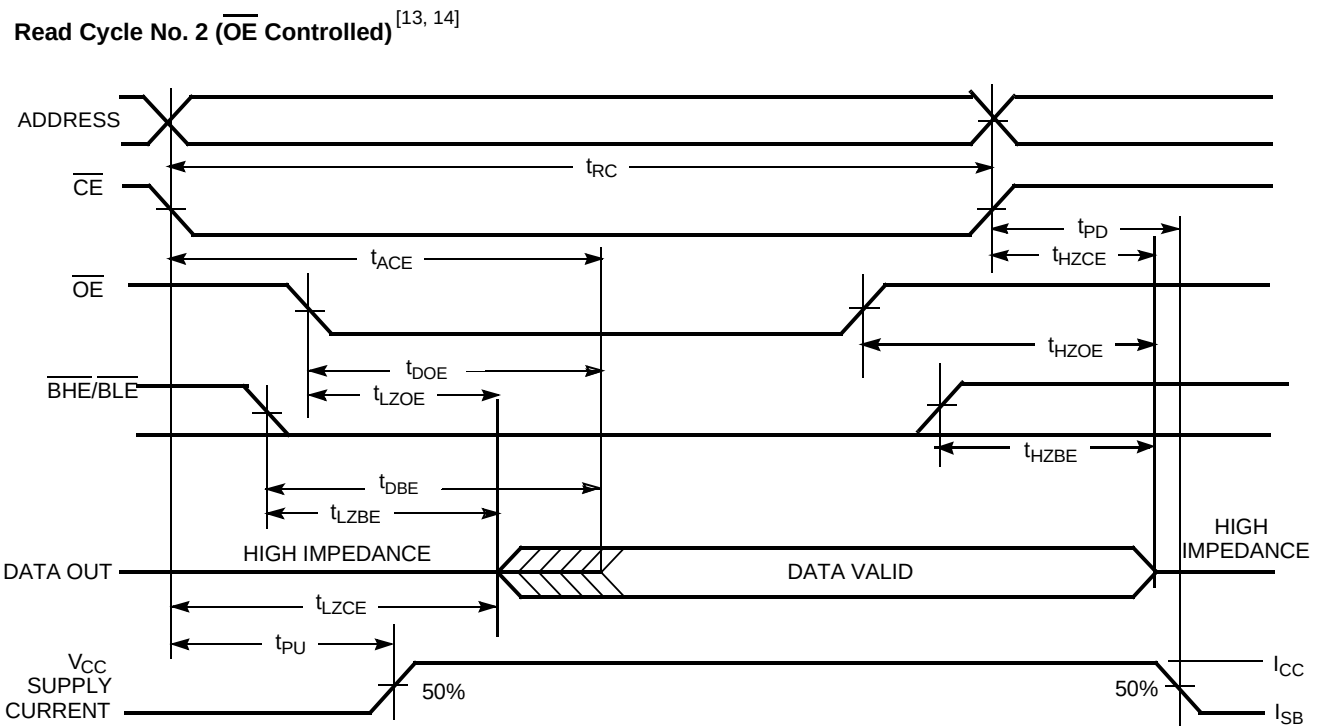
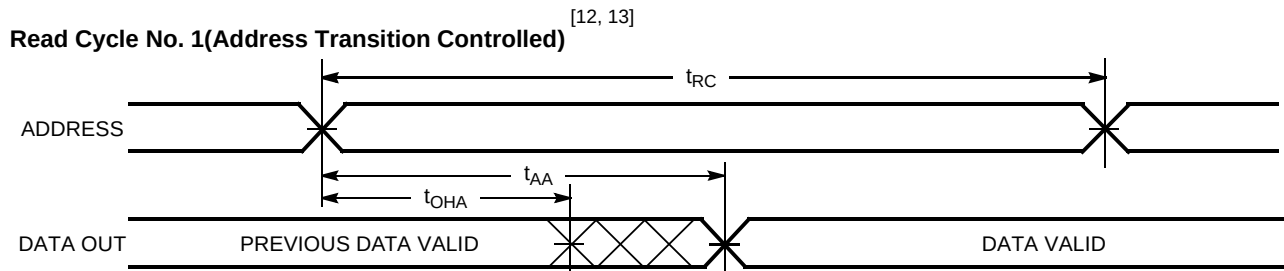
Switching Characteristics Over the Operating Range^[8]

Parameter	Description	WCMB2016R4X		Unit
		Min.	Max.	
READ CYCLE				
t _{RC}	Read Cycle Time	70		ns
t _{AA}	Address to Data Valid		70	ns
t _{OHA}	Data Hold from Address Change	10		ns
t _{ACE}	$\overline{\text{CE}}$ LOW to Data Valid		70	ns
t _{DOE}	$\overline{\text{OE}}$ LOW to Data Valid		35	ns
t _{LZOE}	$\overline{\text{OE}}$ LOW to Low Z ^[9]	5		ns
t _{HZOE}	$\overline{\text{OE}}$ HIGH to High Z ^[9, 10]		25	ns
t _{LZCE}	$\overline{\text{CE}}$ LOW to Low Z ^[9]	10		ns
t _{HZCE}	$\overline{\text{CE}}$ HIGH to High Z ^[9, 10]		25	ns
t _{PU}	$\overline{\text{CE}}$ LOW to Power-Up	0		ns
t _{PD}	$\overline{\text{CE}}$ HIGH to Power-Down		70	ns
t _{DBE}	$\overline{\text{BLE}}$ / $\overline{\text{BHE}}$ LOW to Data Valid		70	ns
t _{LZBE}	$\overline{\text{BLE}}$ / $\overline{\text{BHE}}$ LOW to Low Z ^[9]	5		ns
t _{HZBE}	$\overline{\text{BLE}}$ / $\overline{\text{BHE}}$ HIGH to High Z ^[9, 10]		25	ns
WRITE CYCLE ^[11]				
t _{WC}	Write Cycle Time	70		ns
t _{SCE}	$\overline{\text{CE}}$ LOW to Write End	60		ns
t _{AW}	Address Set-Up to Write End	60		ns
t _{HA}	Address Hold from Write End	0		ns
t _{SA}	Address Set-Up to Write Start	0		ns
t _{PWE}	$\overline{\text{WE}}$ Pulse Width	50		ns
t _{BW}	$\overline{\text{BLE}}$ / $\overline{\text{BHE}}$ LOW to Write End	60		ns
t _{SD}	Data Set-Up to Write End	30		ns
t _{HD}	Data Hold from Write End	0		ns
t _{HZWE}	$\overline{\text{WE}}$ LOW to High Z ^[9, 10]		25	ns
t _{LZWE}	$\overline{\text{WE}}$ HIGH to Low Z ^[9]	10		ns

Note:

8. Test conditions assume signal transition time of 5 ns 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.
9. At any given temperature and voltage condition, t_{HZCE} is less than t_{LZCE} , t_{HZBE} is less than t_{LZBE} , t_{HZOE} is less than t_{LZOE} , and t_{HZWE} is less than t_{LZWE} for any given device.
10. t_{HZOE} , t_{HZCE} , t_{HZBE} and t_{HZWE} transitions are measured when the outputs enter a high impedance state.
11. 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.

Switching Waveforms

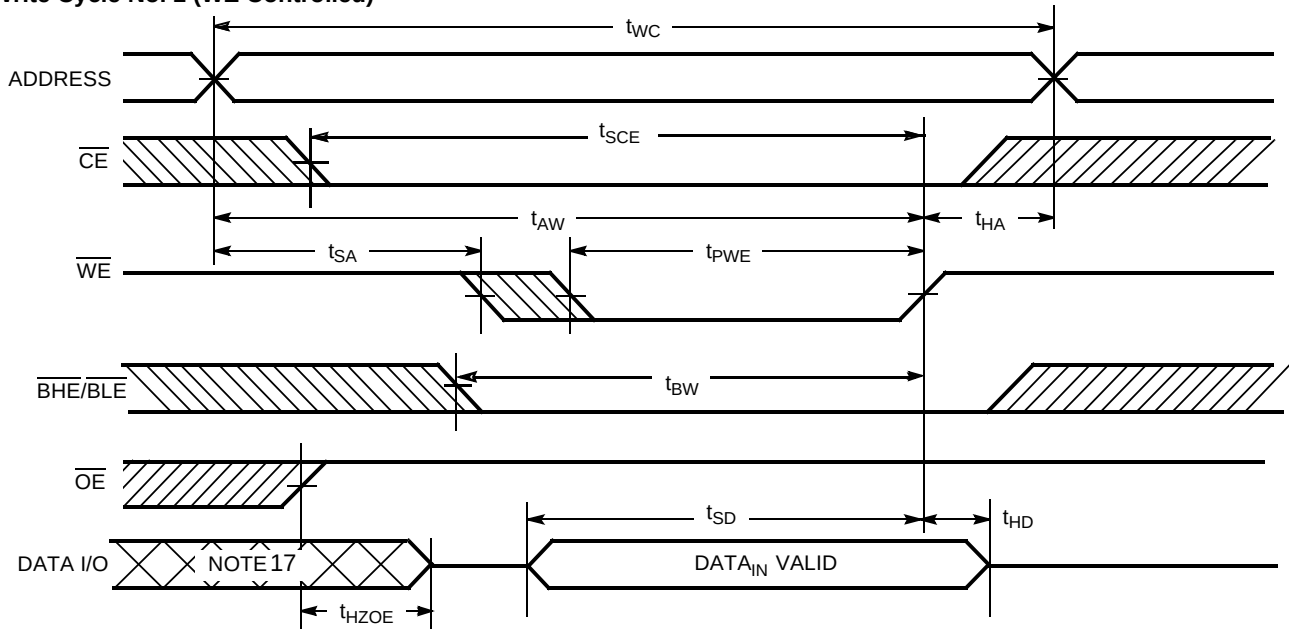


Notes:

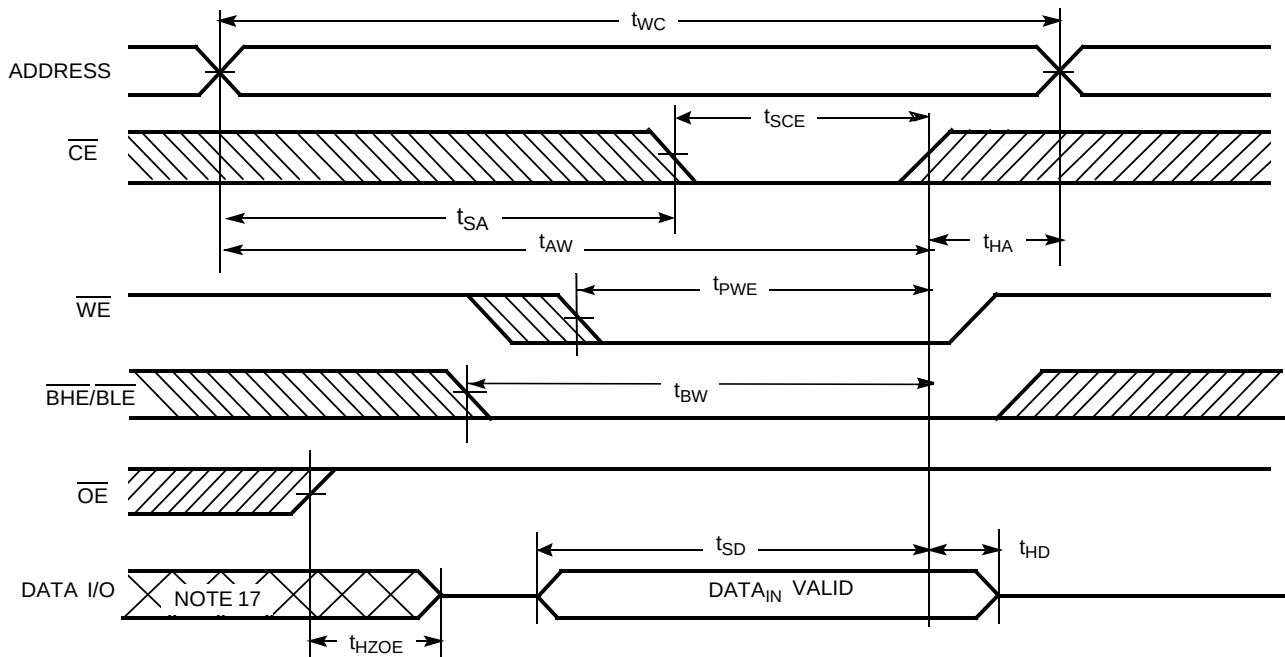
12. Device is continuously selected. $\overline{OE}$, $\overline{CE} = V_{IL}$, $\overline{BHE}$ and/or $\overline{BLE} = V_{IL}$.
13. $\overline{WE}$ is HIGH for read cycle.
14. Address valid prior to or coincident with $\overline{CE}$, $\overline{BHE}$, $\overline{BLE}$, transition LOW.

Switching Waveforms

Write Cycle No. 1 ($\overline{\text{WE}}$ Controlled) [11, 15, 16]



Write Cycle No. 2 ($\overline{\text{CE}}$ Controlled) [11, 15, 16]

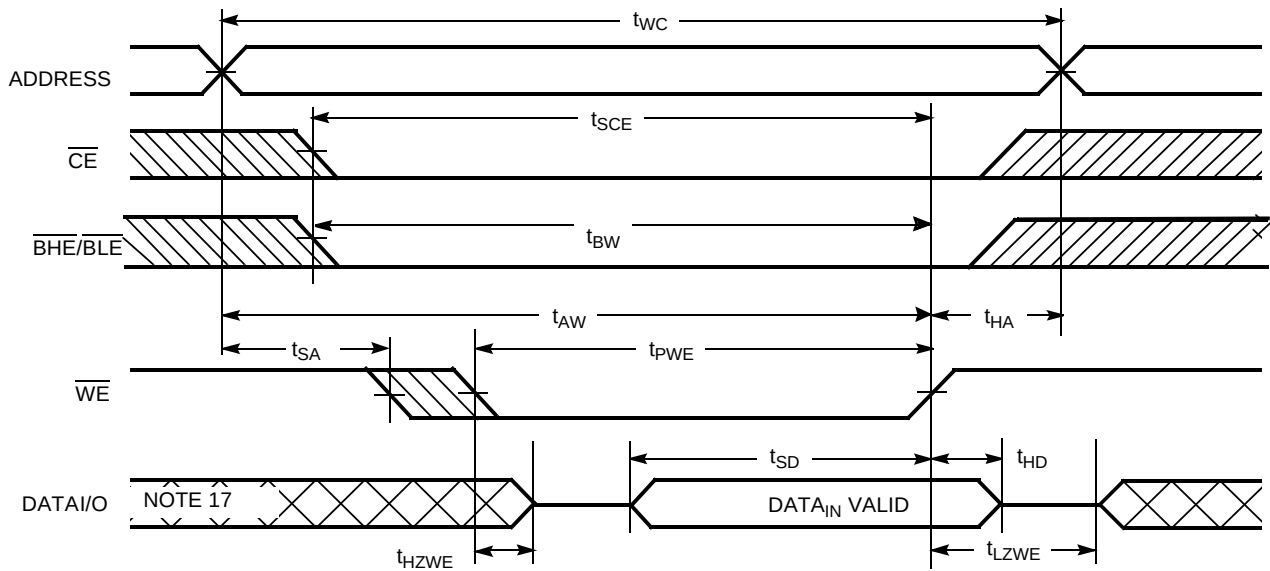


Note:

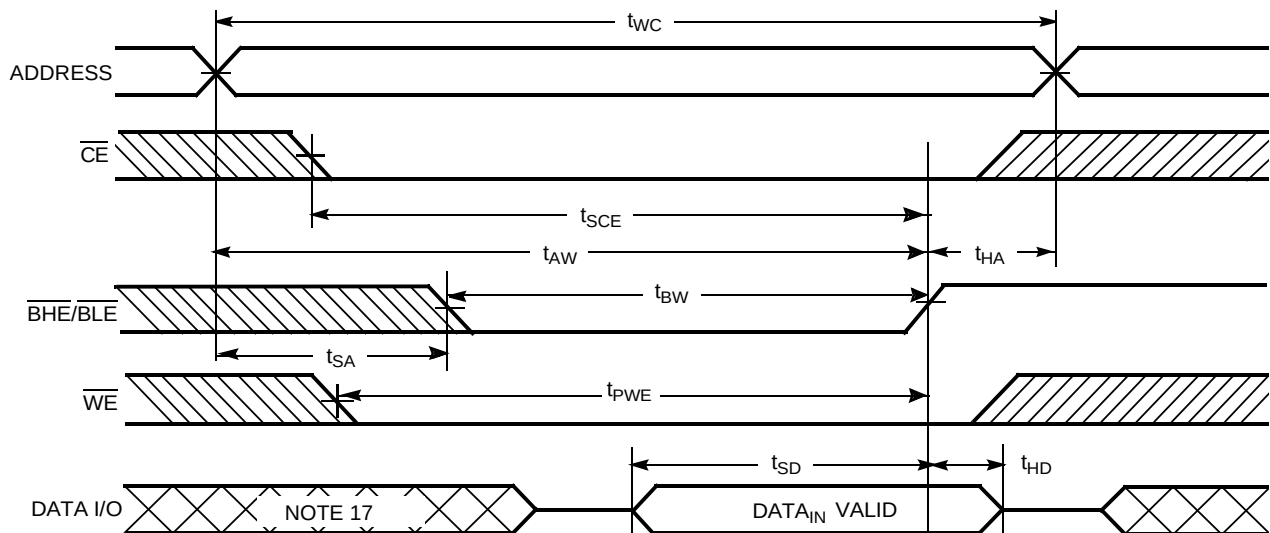
- 15. Data I/O is high impedance if $\overline{\text{OE}} = V_{IH}$.
- 16. If CE goes HIGH simultaneously with WE HIGH, the output remains in a high-impedance state.
- 17. During this period, the I/Os are in output state and input signals should not be applied.

Switching Waveforms

Write Cycle No. 3 ($\overline{\text{WE}}$ Controlled, $\overline{\text{OE}}$ LOW) ^[16]

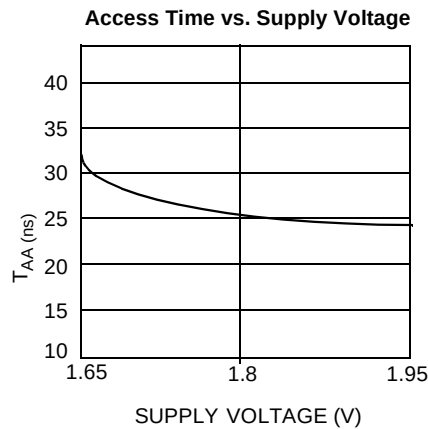
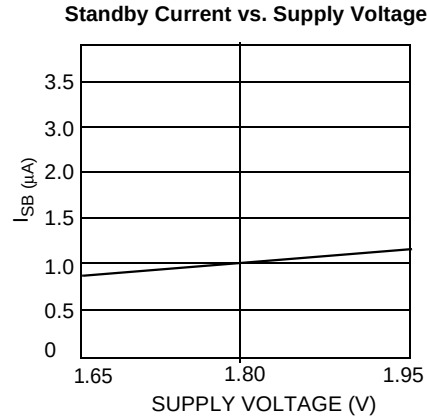
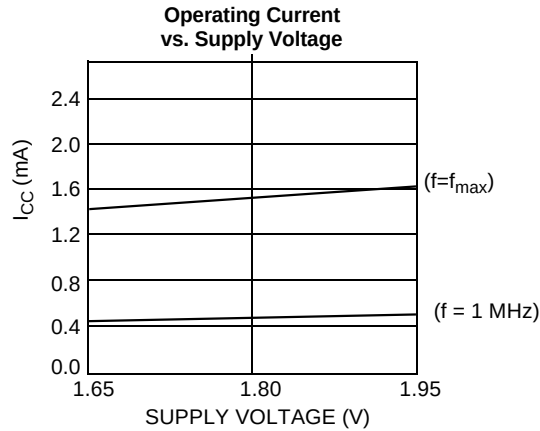


Write Cycle No. 4 ($\overline{\text{BHE/BLE}}$ Controlled, $\overline{\text{OE}}$ LOW) ^[16]



Typical DC and AC Characteristics

(Typical values are included for reference only and are not guaranteed or tested. Typical values are measured at $V_{CC} = V_{CC(typ)}$ Typ, $T_A = 25^\circ\text{C}$.)



Truth Table

CE	WE	OE	BHE	BLE	Inputs/Outputs	Mode	Power
H	X	X	X	X	High Z	Deselect/Power-Down	Standby (I_{SB})
X	X	X	H	H	High Z	Deselect/Power-Down	Standby (I_{SB})
L	H	L	L	L	Data Out (I/O_0 – I/O_{15})	Read	Active (I_{CC})
L	H	L	H	L	Data Out (I/O_0 – I/O_7); I/O_8 – I/O_{15} in High Z	Read	Active (I_{CC})
L	H	L	L	H	Data Out (I/O_8 – I/O_{15}); I/O_0 – I/O_7 in High Z	Read	Active (I_{CC})
L	H	H	L	L	High Z	Output Disabled	Active (I_{CC})
L	H	H	H	L	High Z	Output Disabled	Active (I_{CC})
L	H	H	L	H	High Z	Output Disabled	Active (I_{CC})
L	L	X	L	L	Data In (I/O_0 – I/O_{15})	Write	Active (I_{CC})
L	L	X	H	L	Data In (I/O_0 – I/O_7); I/O_8 – I/O_{15} in High Z	Write	Active (I_{CC})
L	L	X	L	H	Data In (I/O_8 – I/O_{15}); I/O_0 – I/O_7 in High Z	Write	Active (I_{CC})

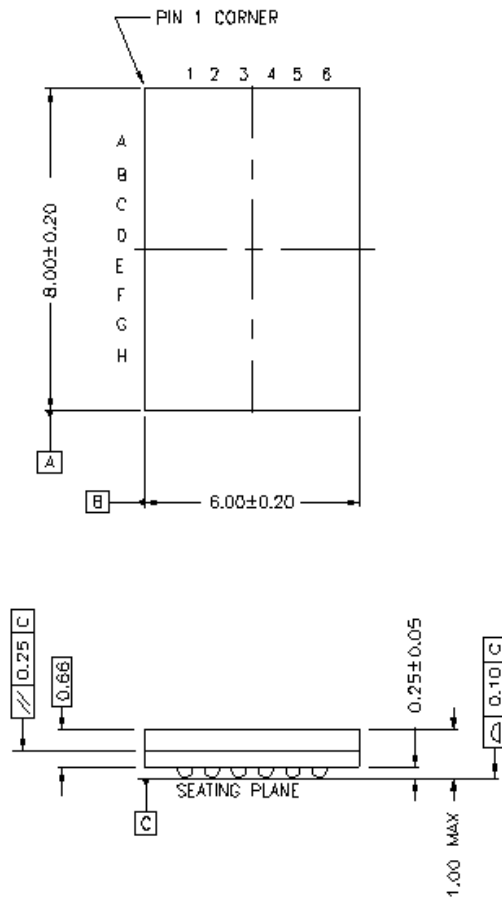
Ordering Information

Speed (ns)	Ordering Code	Package Name	Package Type	Operating Range
70	WCMB2016R4X-FF70	FB48A	48-Ball Fine Pitch BGA	Industrial

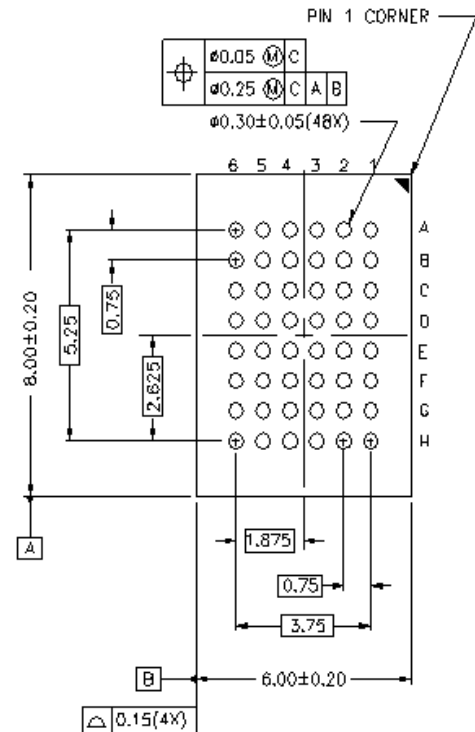
Package Diagrams

48-Ball (6.0 mm x 8.0 mm x 1.0 mm) Fine Pitch BGA, FB48A

Top View



Bottom View





Document Title: WCMB2016R4X, 128K x 16 Static RAM					
REV.	Spec #	ECN #	Issue Date	Orig. of Change	Description of Change
**	38-14011	115226	4/24/2002	MGN	New Data Sheet



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