

PSRAM

4-Mbit (256K x 16) Pseudo Static RAM

Features

- Wide voltage range: 2.7V–3.6V
- Access time: 55 ns, 60 ns and 70 ns
- Ultra-low active power
 - Typical active current: 1 mA @ $f = 1$ MHz
 - Typical active current: 8 mA @ $f = f_{\max}$ (70-ns speed)
- Ultra low standby power
- Automatic power-down when deselected
- CMOS for optimum speed/power

Functional Description

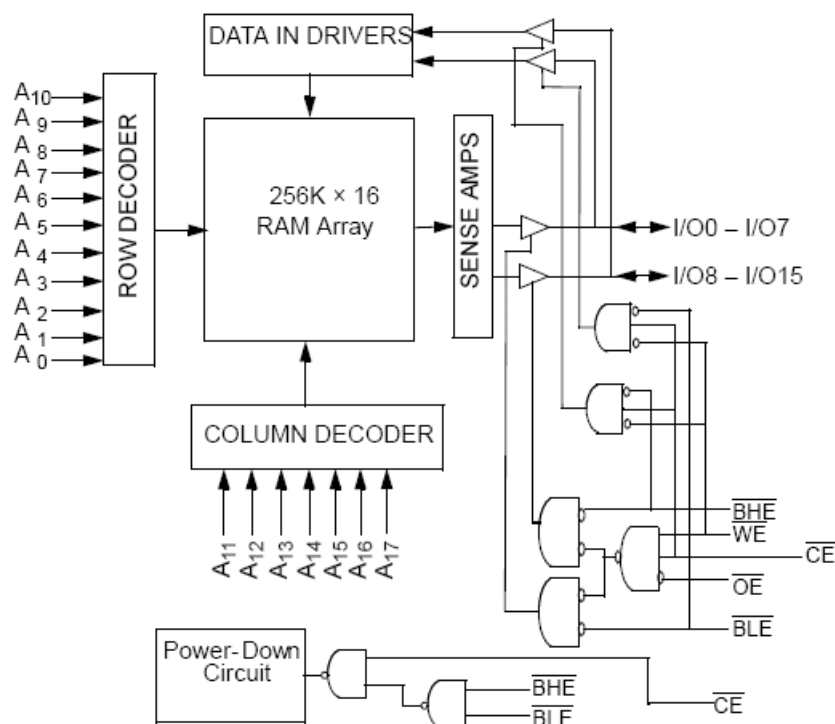
The M24L416256SA is a high-performance CMOS Pseudo static RAM organized as 256K words by 16 bits that supports an asynchronous memory interface. This device features advanced circuit design to provide ultra-low active current. This is ideal for portable applications such as cellular telephones. The device can be put into standby mode when deselected (\overline{CE} HIGH or both \overline{BHE} and \overline{BLE} are HIGH).

The input/output pins (I/O_0 through I/O_{15}) 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} , \overline{BLE} HIGH), or during a write operation (\overline{CE} LOW and \overline{WE} LOW).

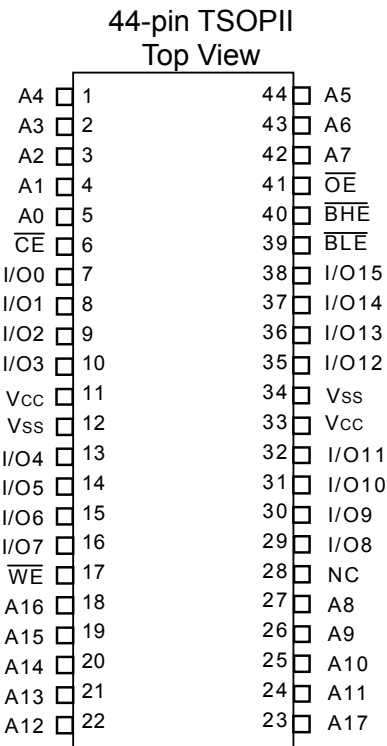
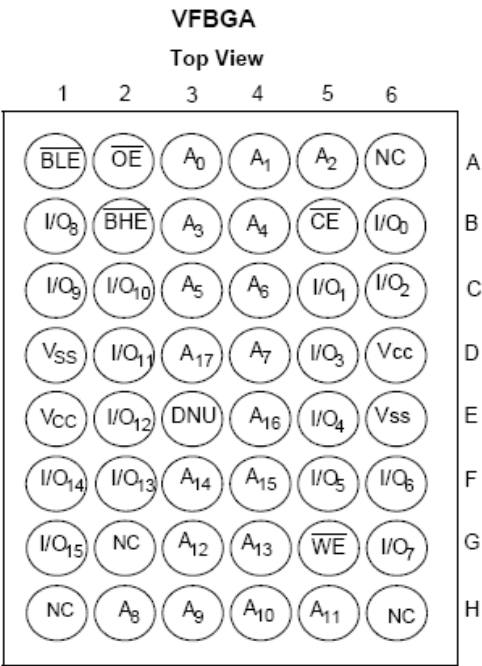
Writing to the device is accomplished by taking Chip Enable (\overline{CE} LOW) and Write Enable (\overline{WE}) input LOW. If Byte Low Enable (\overline{BLE}) is LOW, then data from I/O pins (I/O_0 through I/O_7) is written into the location specified on the address pins (A_0 through A_{17}). If Byte 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_{17}).

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} . Refer to the truth table for a complete description of read and write modes.

Logic Block Diagram



Pin Configuration[2, 3, 4]



Product Portfolio

Product	V _{CC} Range(V)			Speed (ns)	Power Dissipation					
					Operating, I _{CC} (mA)				Standby, I _{SB2} (μA)	
					f = 1 MHz		f = fmax			
	Min.	Typ.[5]	Max.		Typ.[5]	Max.	Typ.[5]	Max.	Typ.[5]	Max.
M24L416256SA	2.7	3.0	3.6	55	1	5	14	22	17	40
				60						
				70			8	15		

Notes:

2. Ball H1, G2 and ball H6 for the VFBGA package can be used to upgrade to an 8-Mbit, 16-Mbit and 32-Mbit density, respectively.
3. NC "no connect" – not connected internally to the die.
4. DNU (Do Not Use) pins have to be left floating or tied to V_{SS} to ensure proper application.
5. 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.

Maximum Ratings

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

Storage Temperature-65°C to +150°C

Ambient Temperature with

Power Applied-55°C to +125°C

Supply Voltage to Ground Potential-0.4V to 4.6V

DC Voltage Applied to Outputs

in High-Z State[6, 7, 8]-0.4V to 3.7V

DC Input Voltage[6, 7, 8]-0.4V to 3.7V

Output Current into Outputs (LOW)20 mA

Static Discharge Voltage > 2001V

(per MIL-STD-883, Method 3015)

Latch-up Current> 200 mA

Operating Range

Range	Ambient Temperature (T _A)	V _{CC}
Extended	-25°C to +85°C	2.7V to 3.6V
Industrial	-40°C to +85°C	2.7V to 3.6V

DC Electrical Characteristics (Over the Operating Range)

Parameter	Description	Test Conditions	-55, 60, 70			Unit
			Min.	Typ.[5]	Max.	
V _{CC}	Supply Voltage		2.7	3.0	3.6	V
V _{OH}	Output HIGH Voltage	I _{OH} = -0.1 mA, V _{CC} = 2.7V	V _{CC} - 0.4			V
V _{OL}	Output LOW Voltage	I _{OL} = 0.1 mA, V _{CC} = 2.7V			0.4	V
V _{IH}	Input HIGH Voltage		0.8 * V _{CC}		V _{CC} + 0.4	V
V _{IL}	Input LOW Voltage		-0.4		0.6	V
I _{IX}	Input Leakage Current	GND ≤ V _{IN} ≤ V _{CC}	-1		+1	μA
I _{OZ}	Output Leakage Current	GND ≤ V _{OUT} ≤ V _{CC} , Output Disabled	-1		+1	μA
I _{CC}	V _{CC} Operating Supply Current	f = f _{MAX} = 1/t _{RC}		14 for -55 14 for -60 8 for -70	22 for -55 22 for -60 15 for -70	mA
		f = 1 MHz		1 for all speeds	5 for all speeds	
I _{SB1}	Automatic \overline{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 (\overline{OE} , \overline{WE} , \overline{BHE} and \overline{BLE}), V _{CC} = 3.6V		150	250	μA
I _{SB2}	Automatic \overline{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} = 3.6V		17	40	μA

Thermal Resistance[9]

Parameter	Description	Test Conditions	VFBGA	Unit
θ _{JA}	Thermal Resistance (Junction to Ambient)	Test conditions follow standard test methods and procedures for measuring thermal impedance, per EIA/JESD51.	55	°C/W
θ _{JC}	Thermal Resistance (Junction to Case)		17	°C/W

Capacitance[9]

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

Notes:

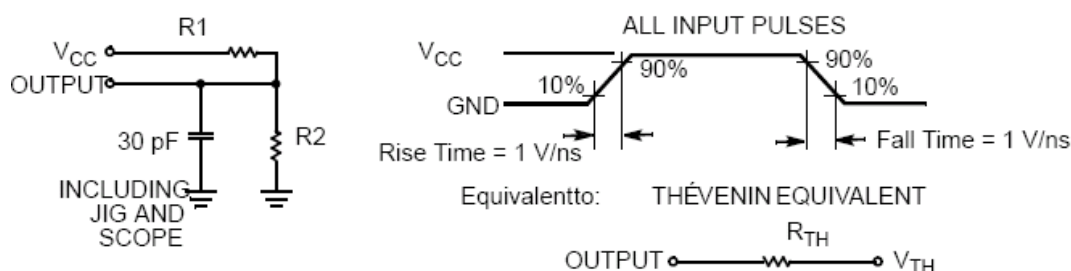
6. V_{IL(MIN)} = -0.5V for pulse durations less than 20 ns.

7. V_{IH(Max)} = V_{CC} + 0.5V for pulse durations less than 20 ns.

8. Overshoot and undershoot specifications are characterized and are not 100% tested.

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

AC Test Loads and Waveforms



Parameters	3.0V V _{CC}	Unit
R1	22000	Ω
R2	22000	Ω
R _{TH}	11000	Ω
V _{TH}	1.50	V

Switching Characteristics (Over the Operating Range)[10]

Prameter	Description	-55		-60		-70		Unit
		Min.	Max.	Min.	Max.	Min.	Max.	
Read Cycle								
t _{RC}	Read Cycle Time	55		60		70		ns
t _{AA}	Address to Data Valid		55		60		70	ns
t _{OHA}	Data Hold from Address Change	5		8		10		ns
t _{ACE}	\overline{CE} LOW to Data Valid		55		60		70	ns
t _{DOE}	\overline{OE} LOW to Data Valid		25		25		35	ns
t _{LZOE}	\overline{OE} LOW to Low Z[11, 13]	5		5		5		ns
t _{HZOE}	\overline{OE} HIGH to High Z[11, 13]		25		25		25	ns
t _{LZCE}	\overline{CE} LOW to Low Z[11, 13]	2		2		5		ns
t _{HZCE}	\overline{CE} HIGH to High Z[11, 13]		25		25		25	ns
t _{DBE}	BLE / BHE LOW to Data Valid		55		60		70	ns
t _{LZBE}	$\overline{BLE} / \overline{BHE}$ LOW to Low Z[11, 13]	5		5		5		ns
t _{HZBE}	$\overline{BLE} / \overline{BHE}$ HIGH to High-Z[11, 13]		10		10		25	ns
t _{SK} ^[14]	Address Skew		0		5		10	ns
Write Cycle[12]								
t _{WC}	Write Cycle Time	55		60		70		ns
t _{SCE}	\overline{CE} LOW to Write End	45		45		60		ns
t _{AW}	Address Set-up to Write End	45		45		55		ns
t _{HA}	Address Hold from Write End	0		0		0		ns
t _{SA}	Address Set-up to Write Start	0		0		0		ns
t _{PWE}	\overline{WE} Pulse Width	40		40		45		ns

Notes:

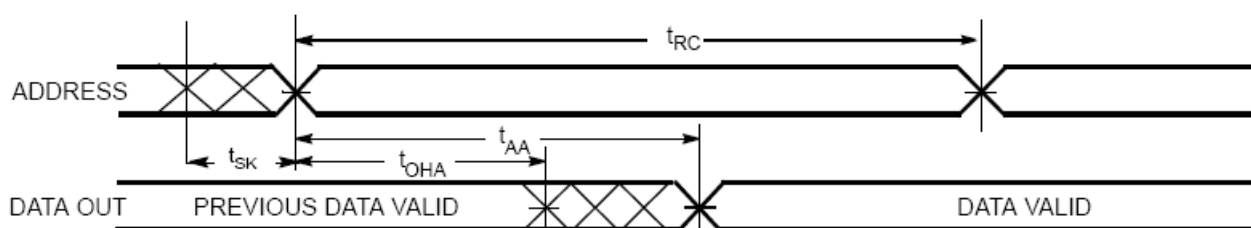
- Test conditions for all parameters other than tri-state parameters assume signal transition time of 1 ns/V, timing reference levels of $V_{CC(typ)}/2$, input pulse levels of 0V to $V_{CC(typ)}$, and output loading of the specified I_{OL}/I_{OH} as shown in the "AC Test Loads and Waveforms" section.
- t_{HZOE} , t_{HZCE} , t_{HZBE} , and t_{HZWE} transitions are measured when the outputs enter a high impedance state.
- 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.
- High-Z and Low-Z parameters are characterized and are not 100% tested.
- To achieve 55-ns performance, the read access should be \overline{CE} controlled. In this case t_{ACE} is the critical parameter and t_{SK} is satisfied when the addresses are stable prior to chip enable going active. For the 70-ns cycle, the addresses must be stable within 10 ns after the start of the read cycle.

Switching Characteristics (Over the Operating Range)[10] (continued)

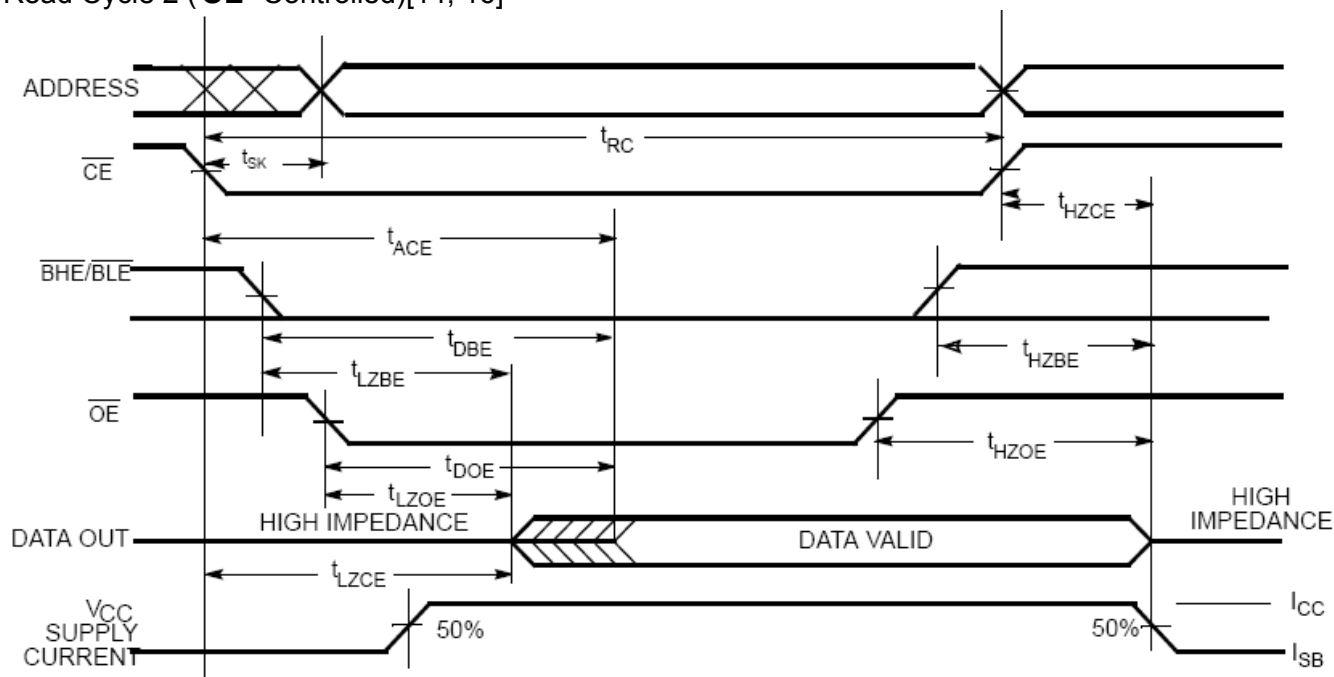
Parameter	Description	-55		-60		-70		Unit
		Min.	Max.	Min.	Max.	Min.	Max.	
t_{BW}	$\overline{BLE}/\overline{BHE}$ LOW to Write End	50		50		55		ns
t_{SD}	Data Set-up to Write End	25		25		25		ns
t_{HD}	Data Hold from Write End	0		0		0		ns
t_{HZWE}	\overline{WE} LOW to High Z[11, 13]		25		25		25	ns
t_{LZWE}	\overline{WE} HIGH to Low Z[11, 13]	5		5		5		ns

Switching Waveforms

Read Cycle 1 (Address Transition Controlled)[14, 15, 16]



Read Cycle 2 (\overline{OE} Controlled)[14, 16]



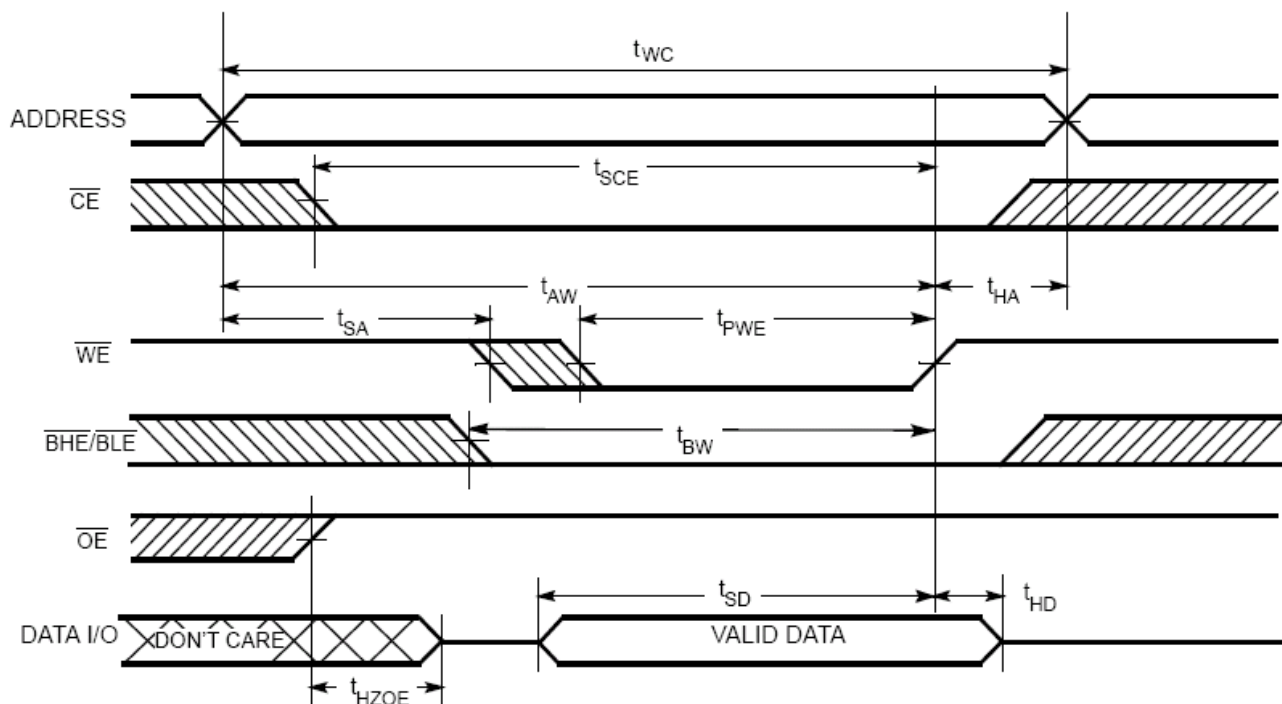
Notes:

15. Device is continuously selected. \overline{OE} , \overline{CE} = V_{IL} .

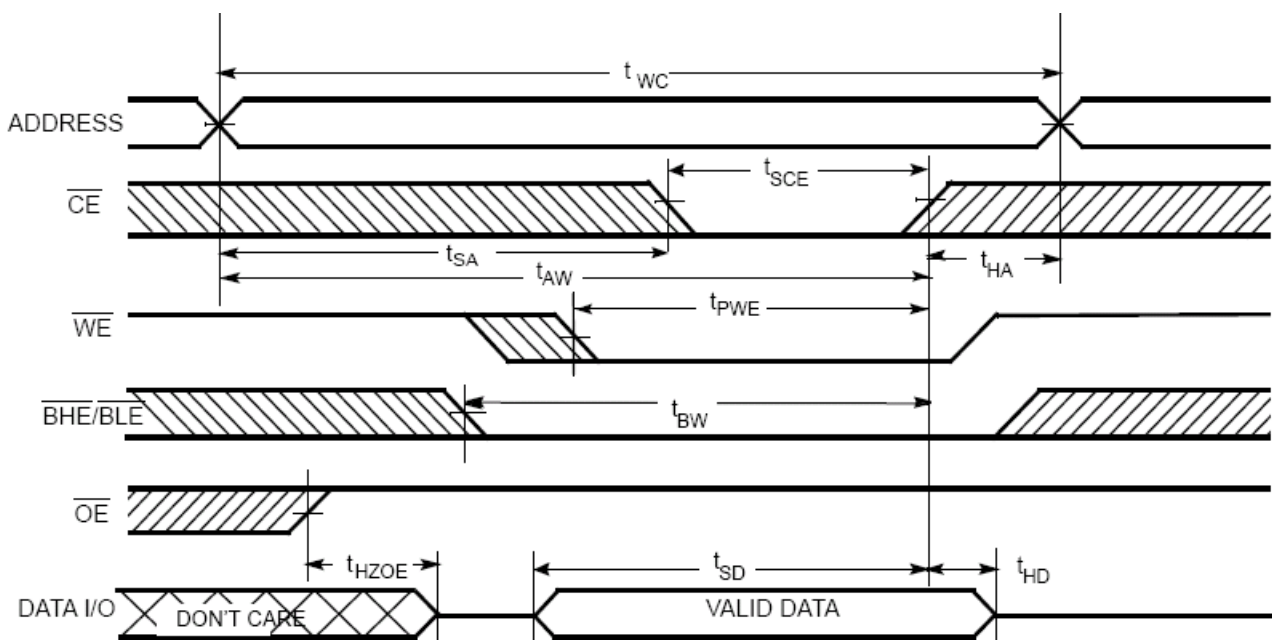
16. \overline{WE} is HIGH for Read Cycle.

Switching Waveforms (continued)

Write Cycle 1 (\overline{WE} Controlled)[12, 13, 17, 18, 19]



Write Cycle 2 (\overline{CE} Controlled)[12, 13, 17, 18, 19]



Notes:

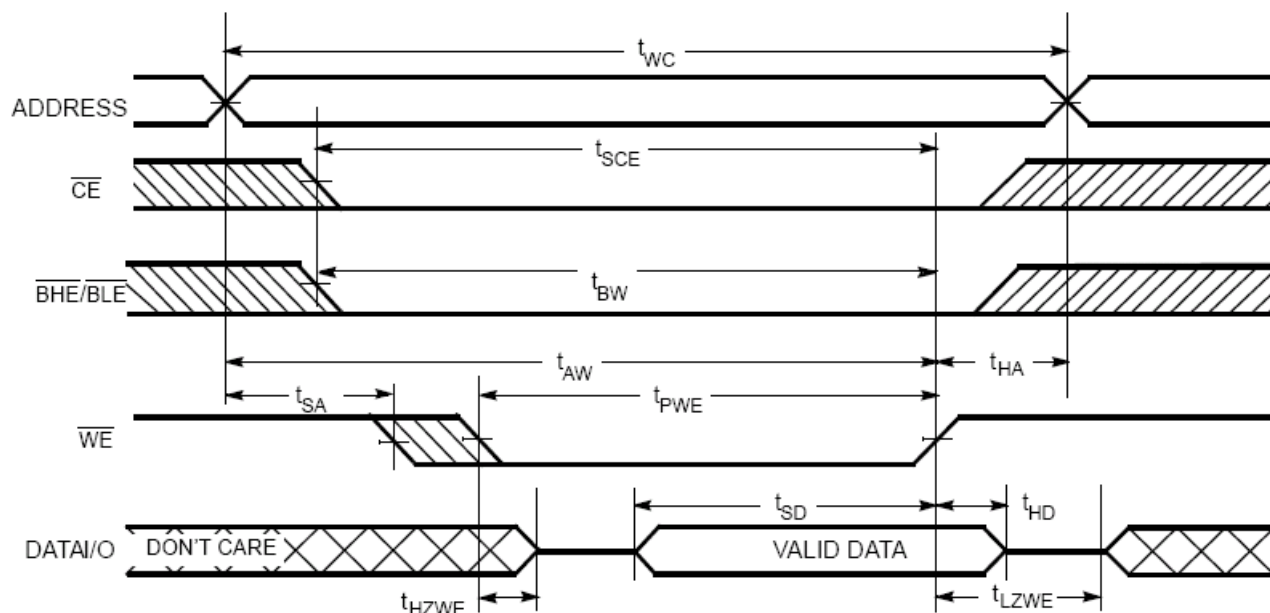
17.Data I/O is high-impedance if $\overline{OE} \geq V_{IH}$.

18.If Chip Enable goes INACTIVE with $\overline{WE} = V_{IH}$, the output remains in a high-impedance state.

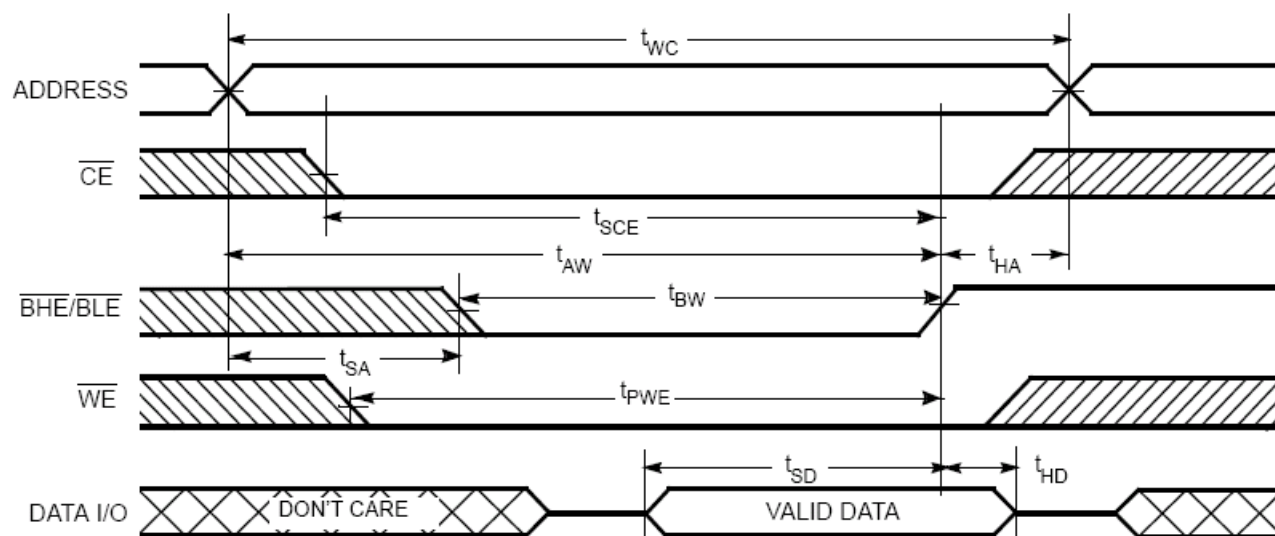
19.During this period in the DATA I/O waveform, the I/Os could be in the output state and input signals should not be applied.

Switching Waveforms (continued)

Write Cycle 3 ($\overline{\text{WE}}$ Controlled, $\overline{\text{OE}}$ LOW)[18, 19]



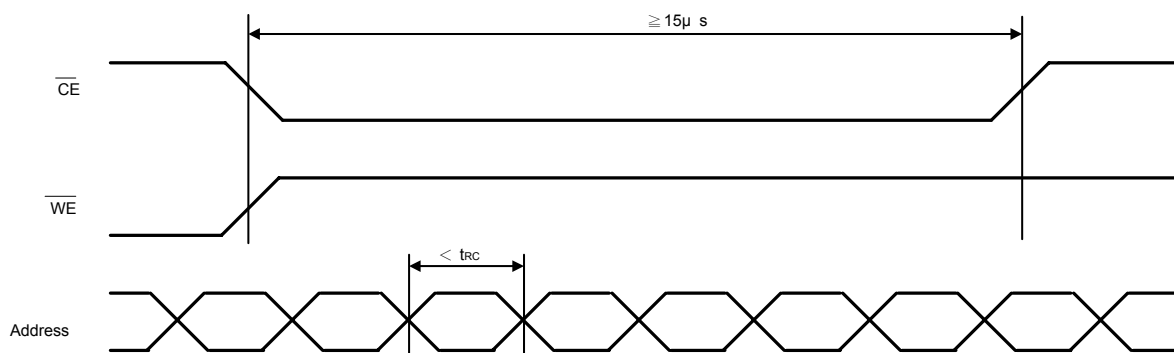
Write Cycle 4 ($\overline{\text{BHE/BLE}}$ Controlled, $\overline{\text{OE}}$ LOW)[18, 19]



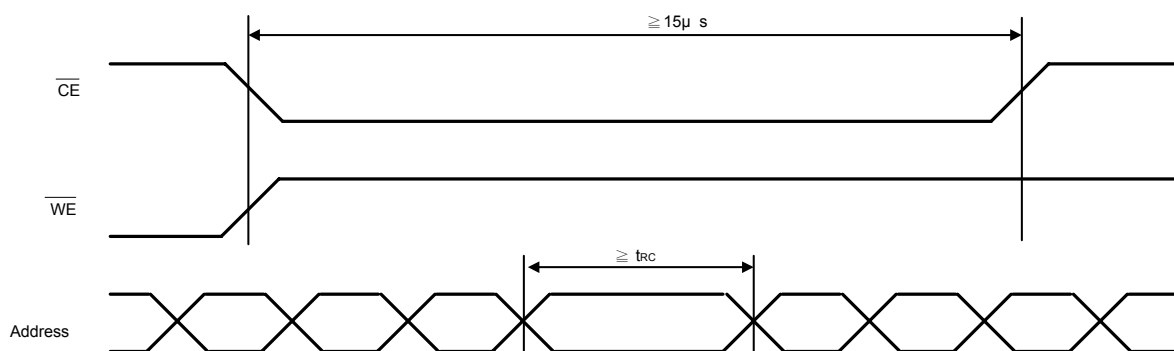
Avoid Timing

ESMT Pseudo SRAM has a timing which is not supported at read operation, If your system has multiple invalid address signal shorter than t_{rc} during over $15\mu s$ at read operation shown as in Abnormal Timing, it requires a normal read timing at least during $15\mu s$ shown as in Avoidable timing 1 or toggle \overline{CE} to high ($\geq t_{rc}$) one time at least shown as in Avoidable Timing 2.

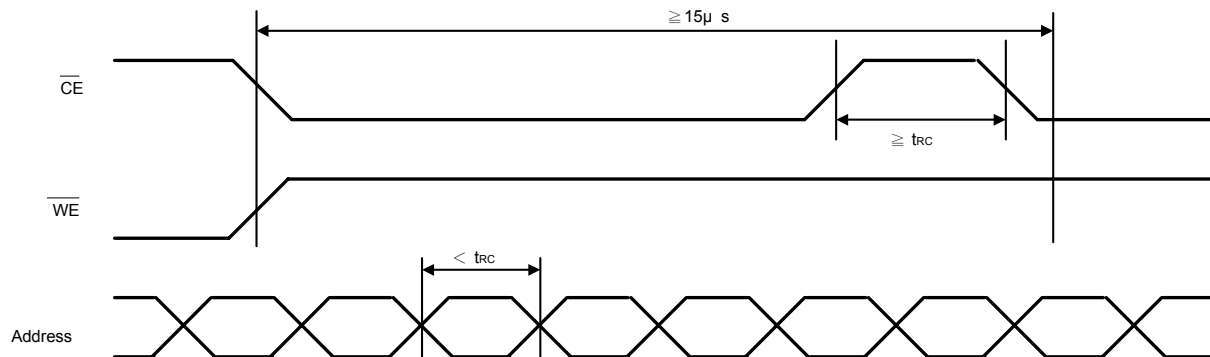
Abnormal Timing



Avoidable Timing 1



Avoidable Timing 2



Truth Table[20]

CE1	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); High Z I/O ₈ –I/O ₁₅	Read	Active (I _{CC})
L	H	L	L	H	High Z I/O ₀ –I/O ₇ ; Data Out (I/O ₈ –I/O ₁₅)	Read	Active (I _{CC})
L	H	H	L	H	High Z	Output Disabled	Active (I _{CC})
L	H	H	H	L	High Z	Output Disabled	Active (I _{CC})
L	H	H	L	L	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); High Z I/O ₈ –I/O ₁₅	Write	Active (I _{CC})
L	L	X	L	H	High Z I/O ₀ –I/O ₇ ; Data In (I/O ₈ –I/O ₁₅)	Write	Active (I _{CC})

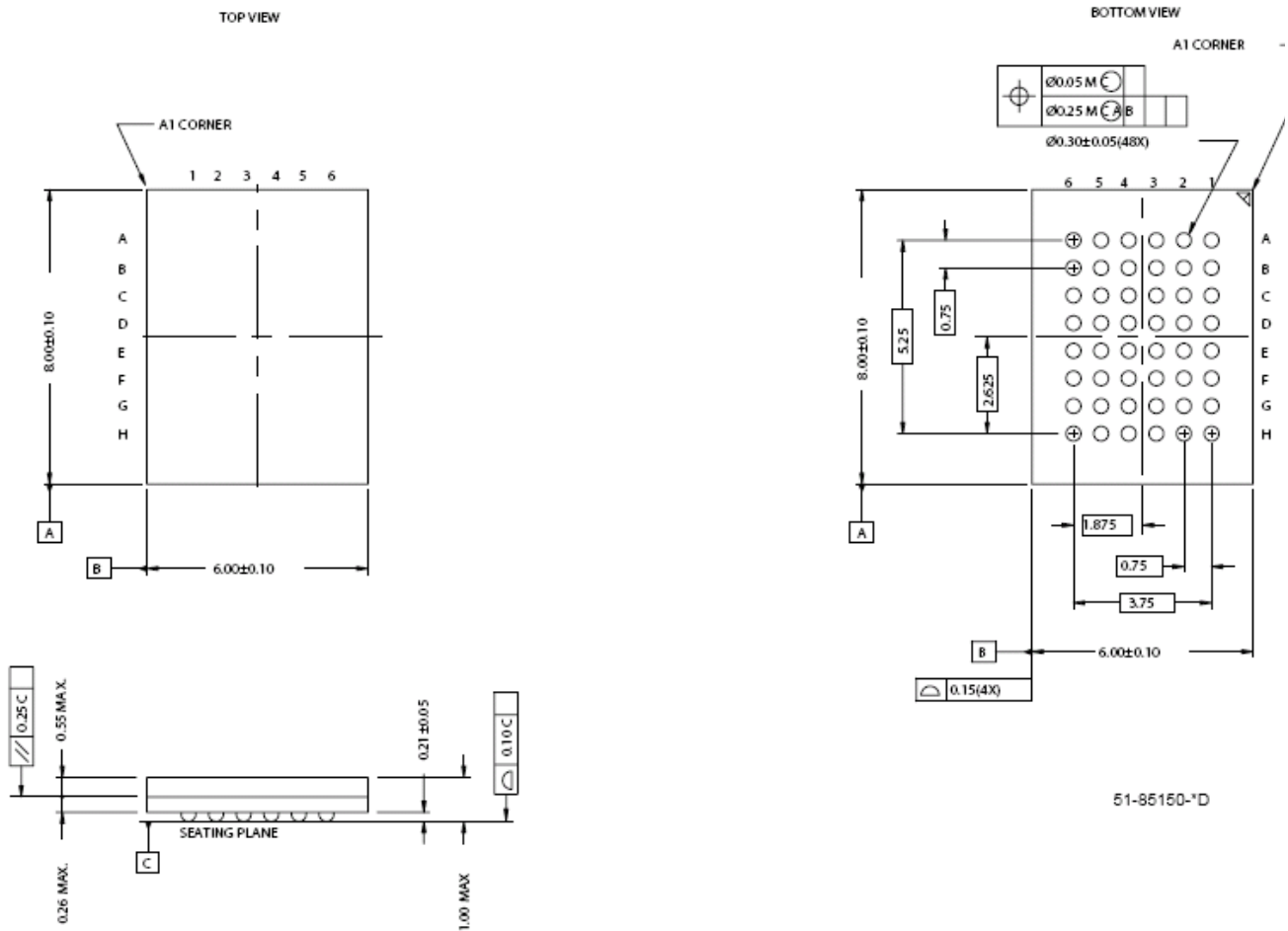
Ordering Information

Speed (ns)	Ordering Code	Package Type	Operating Range
55	M24L416256SA-55BEG	48-ball Very Fine Pitch BGA (6.0 x 8.0 x 1.0 mm) (Pb-Free)	Extended
60	M24L416256SA-60BEG	48-ball Very Fine Pitch BGA (6.0 x 8.0 x 1.0 mm) (Pb-Free)	Extended
70	M24L416256SA-70BEG	48-ball Very Fine Pitch BGA (6.0 x 8.0 x 1.0 mm) (Pb-Free)	Extended
55	M24L416256SA-55TEG	44-pin TSOPII (Pb-Free)	Extended
60	M24L416256SA-60TEG	44-pin TSOPII (Pb-Free)	Extended
70	M24L416256SA-70TEG	44-pin TSOPII (Pb-Free)	Extended
55	M24L416256SA-55BIG	48-ball Very Fine Pitch BGA (6.0 x 8.0 x 1.0 mm) (Pb-Free)	Industrial
60	M24L416256SA-60BIG	48-ball Very Fine Pitch BGA (6.0 x 8.0 x 1.0 mm) (Pb-Free)	Industrial
70	M24L416256SA-70BIG	48-ball Very Fine Pitch BGA (6.0 x 8.0 x 1.0 mm) (Pb-Free)	Industrial
55	M24L416256SA-55TIG	44-pin TSOPII (Pb-Free)	Industrial
60	M24L416256SA-60TIG	44-pin TSOPII (Pb-Free)	Industrial
70	M24L416256SA-70TIG	44-pin TSOPII (Pb-Free)	Industrial

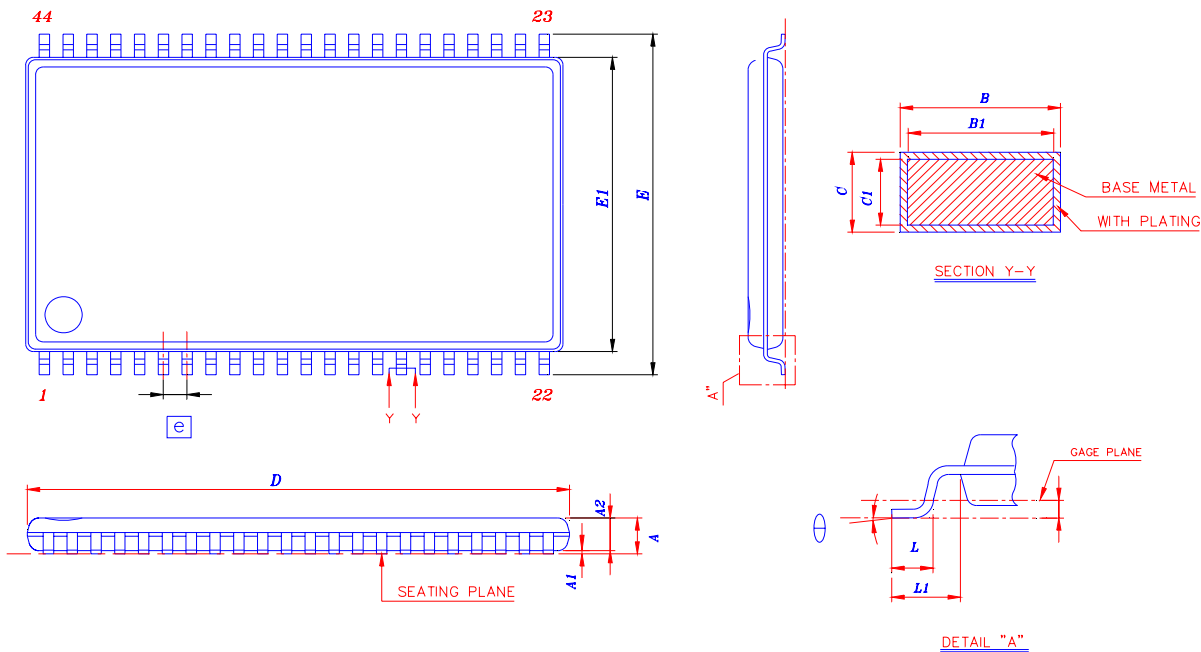
Note :

20. H = Logic HIGH, L = Logic LOW, X = Don't Care.

Package Diagram
48-ball VFBGA (6 x 8 x 1 mm)



44-LEAD TSOP(II) PSRAM(400mil)



Symbol	Dimension in mm			Dimension in inch		
	Min	Norm	Max	Min	Norm	Max
A	—	—	1.20	—	—	0.047
A1	0.05	—	0.15	0.002	—	0.006
A2	0.95	1.00	1.05	0.037	0.039	0.042
B	0.30	—	0.45	0.012	—	0.018
B1	0.30	0.35	0.40	0.012	0.014	0.016
C	0.12	—	0.21	0.005	—	0.008
C1	0.10	—	0.16	0.004	—	0.006
D	18.28	18.41	18.54	0.720	0.725	0.730
ZD	0.805 REF			0.0317 REF		
E	11.56	11.76	11.96	0.455	0.463	0.471
E1	10.03	10.16	10.29	0.395	0.400	0.4
L	0.40	0.59	0.69	0.016	0.023	0.027
L1	0.80 REF			0.031 REF		
e	0.80 BSC			0.0315 BSC		
θ	0°	—	8°	0°	—	8°

Revision History

Revision	Date	Description
1.0	2007.07.04	Original
1.1	2007.09.10	Modify Vcc (max) =3.3V to 3.6V
1.2	2008.02.27	1. Add 44-pin TSOPII package 2. Add Avoid timing
1.3	2008.03.24	Add I-grade for TSOPII package
1.4	2008.07.04	1. Move Revision History to the last 2. Add Industrial grade for BGA package

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