

PSRAM

2-Mbit (128K x 16)

Pseudo Static RAM

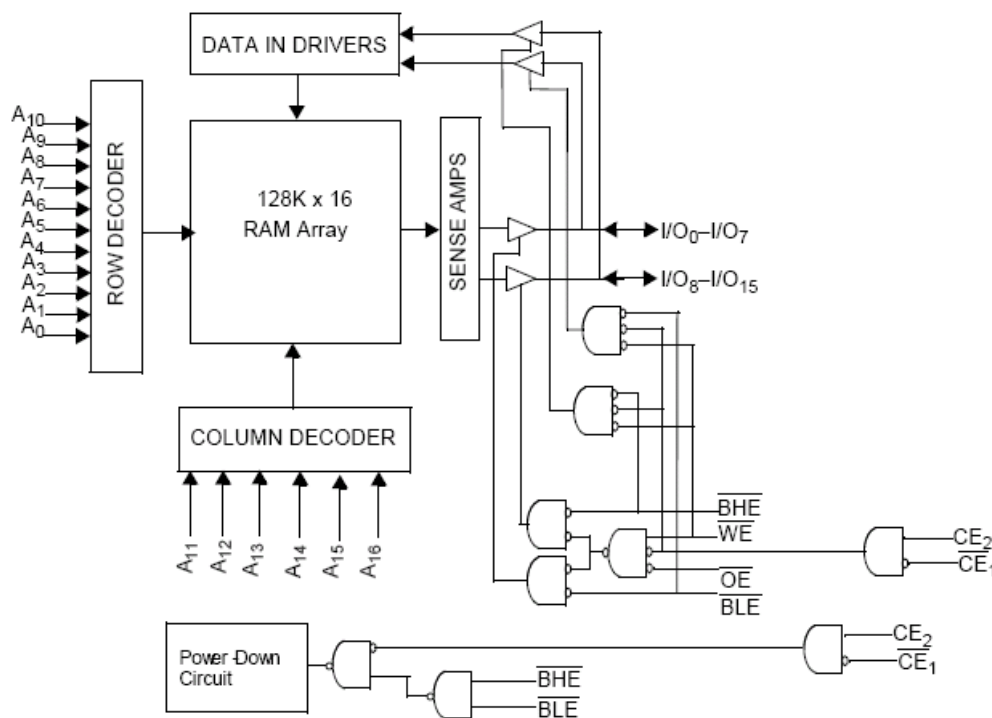
Features

- Advanced low-power architecture
- High speed: 55 ns, 70 ns
- Wide voltage range: 2.7V to 3.6V
- Typical active current: 1 mA @ f = 1 MHz
- Low standby power
- Automatic power-down when deselected

Functional Description

The M24L216128DA is a high-performance CMOS pseudo static RAM (PSRAM) organized as 128K 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, reducing power consumption dramatically when deselected ($\overline{CE1}$ HIGH, $CE2$ LOW 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 the chip is deselected ($\overline{CE1}$ HIGH, $CE2$ LOW) or \overline{OE} is deasserted HIGH), or during a write operation (Chip Enabled and Write Enable \overline{WE} LOW). Reading from the device is accomplished by asserting the Chip Enables ($\overline{CE1}$ LOW and $CE2$ HIGH) and Output Enable (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 for a complete description of read and write modes.

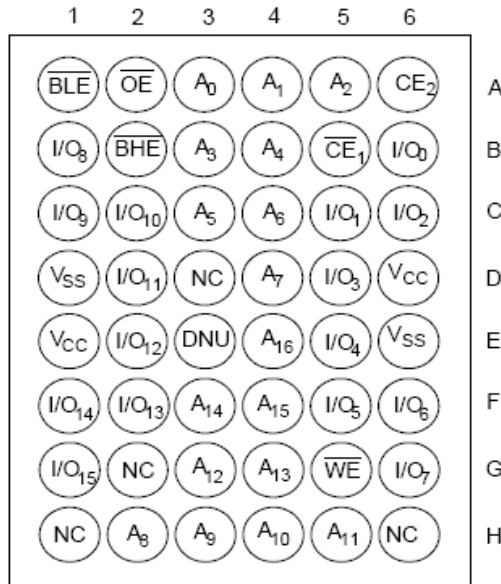
Logic Block Diagram



Pin Configuration[2, 3, 4]

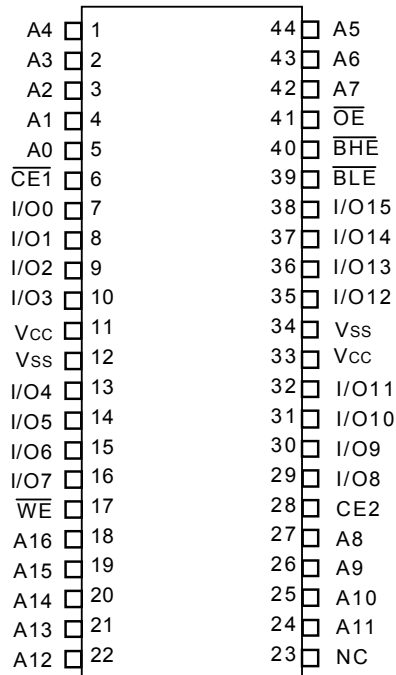
48-ball VFBGA

Top View



44-pin TSOPII

Top View



Product Portfolio Product

Product	V _{CC} Range (V)			Speed(ns)	Power Dissipation					
					Operating I _{CC} (mA)				Standby I _{SB2} (μA)	
	f = 1MHz		f = f _{MAX}							
	Min.	Typ.	Max		Typ.[5]	Max.	Typ.[5]	Max.	Typ. [5]	Max.
M24L216128DA	2.7	3.0	3.6	55	1	5	14	22	9	40
				70			8	15		

Note:

2. Ball D3, H1, G2, H6 are the address expansion pins for the 4-Mb, 8-Mb, 16-Mb, and 32-Mb densities 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) and 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			-70			Unit
			Min.	Typ [5]	Max.	Min.	Typ [5]	Max.	
V _{CC}	Supply Voltage		2.7	3.0	3.6	2.7	3.0	3.6	V
V _{OH}	Output HIGH Voltage	I _{OH} = -0.1 mA	V _{CC} -0.4			V _{CC} -0.4			V
V _{OL}	Output LOW Voltage	I _{OL} = 0.1 mA			0.4			0.4	V
V _{IH}	Input HIGH Voltage		0.8* V _{CC}		V _{CC} +0.4V	0.8* V _{CC}		V _{CC} +0.4V	V
V _{IL}	Input LOW Voltage	f = 0	-0.4		0.4	-0.4		0.4	V
I _{IX}	Input Leakage Current	GND ≤ V _{IN} ≤ V _{CC}	-1		+1	-1		+1	μA
I _{OZ}	Output Leakage Current	GND ≤ V _{OUT} ≤ V _{CC} , Output Disabled	-1		+1	-1		+1	μA
I _{CC}	V _{CC} Operating Supply Current	f = f _{MAX} = 1/t _{RC}		14	22		8	15	mA
		f = 1 MHz		1	5		1	5	
I _{SB1}	Automatic $\overline{CE1}$ Power-Down Current —CMOS Inputs	$\overline{CE1} \geq V_{CC} - 0.2V$, $CE2 \leq 0.2V$, $V_{IN} \geq V_{CC} - 0.2V$, $V_{IN} \leq 0.2V$, $f = f_{MAX}$ (Address and Data Only), $f = 0$ (\overline{OE} , \overline{WE} , \overline{BHE} and \overline{BLE}), $V_{CC}=3.6V$		40	250		40	250	μA
I _{SB2}	Automatic $\overline{CE1}$ Power-Down Current —CMOS Inputs	$\overline{CE1} \geq V_{CC}-0.2V$, $CE2 \leq 0.2V$, $V_{IN} \geq V_{CC} - 0.2V$ or $V_{IN} \leq 0.2V$, $f = 0$, $V_{CC} = 3.6V$		9	40		9	40	μA

Capacitance[9]

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

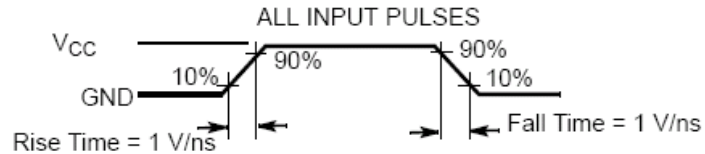
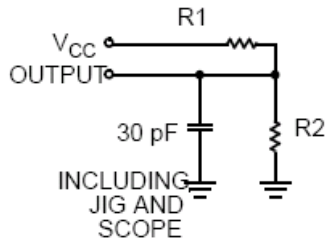
Thermal Resistance[9]

Parameter	Description	Test Conditions	BGA	Unit
θJA	Thermal Resistance(Junction to Ambient)	Test conditions follow standard test methods and procedures for measuring thermal impedance, per EIA/ JESD51.	55	°C/W
θJC	Thermal Resistance (Junction to Case)		17	°C/W

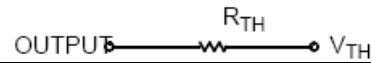
Notes:

- V_{IH(MAX)} = V_{CC} + 0.5V for pulse durations less than 20 ns.
- V_{IL(MIN)} = -0.5V for pulse durations less than 20 ns.
- Overshoot and undershoot specifications are characterized and are not 100% tested.
- Tested initially and after any design or process changes that may affect these parameters.

AC Test Loads and Waveforms



Equivalent to: THEVENIN EQUIVALENT



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]

Parameter	Description	-55 [14]		-70		Unit
		Min.	Max.	Min.	Max.	
Read Cycle						
t _{RC}	Read Cycle Time	55[14]		70		ns
t _{AA}	Address to Data Valid		55		70	ns
t _{OHA}	Data Hold from Address Change	5		10		ns
t _{ACE}	$\overline{CE1}$ LOW and CE2 HIGH to Data Valid		55		70	ns
t _{DOE}	\overline{OE} LOW to Data Valid		25		35	ns
t _{LZOE}	\overline{OE} LOW to LOW Z[11, 12]	5		5		ns
t _{HZOE}	\overline{OE} HIGH to High Z[11, 12]		25		25	ns
t _{LZCE}	$\overline{CE1}$ LOW and CE2 HIGH to Low Z[11, 12]	2		5		ns
t _{HZCE}	$\overline{CE1}$ HIGH and CE2 LOW to High Z[11, 12]		25		25	ns
t _{DBE}	$\overline{BLE}/\overline{BHE}$ LOW to Data Valid		55		70	ns
t _{LZBE}	$\overline{BLE}/\overline{BHE}$ LOW to Low Z[11, 12]	5		5		ns
t _{HZBE}	$\overline{BLE}/\overline{BHE}$ HIGH to High Z[11, 12]		10		25	ns
t _{SK} [14]	Address Skew		0		10	ns
Write Cycle[12]						
t _{WC}	Write Cycle Time	55		70		ns
t _{SCE}	$\overline{CE1}$ LOW and CE2 HIGH to Write End	45		55		ns
t _{AW}	Address Set-Up to Write End	45		55		ns
t _{HA}	Address Hold from Write End	0		0		ns
t _{SA}	Address Set-Up to Write Start	0		0		ns

Notes:

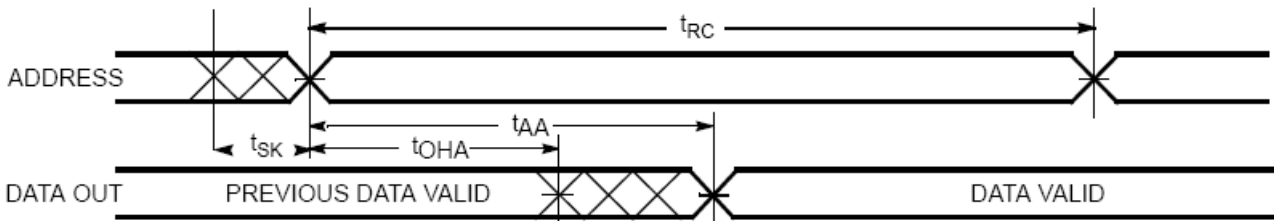
- Test conditions assume signal transition time of 1 V/ns or higher, timing reference levels of $V_{CC(typ)}/2$, input pulse levels of 0V to $V_{CC(typ)}$, and output loading of the specified I_{OL}/I_{OH} and 30-pF load capacitance.
- t_{HZOE} , t_{HZCE} , t_{HZBE} , and t_{HZWE} transitions are measured when the outputs enter a high-impedance state.
- High-Z and Low-Z parameters are characterized and are not 100% tested.
- The internal write time of the memory is defined by the overlap of \overline{WE} , $\overline{CE1} = V_{IL}$, $CE2 = V_{IH}$, \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 write.
- To achieve 55-ns performance, the read access should be Chip-enable 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 (continued)[10]

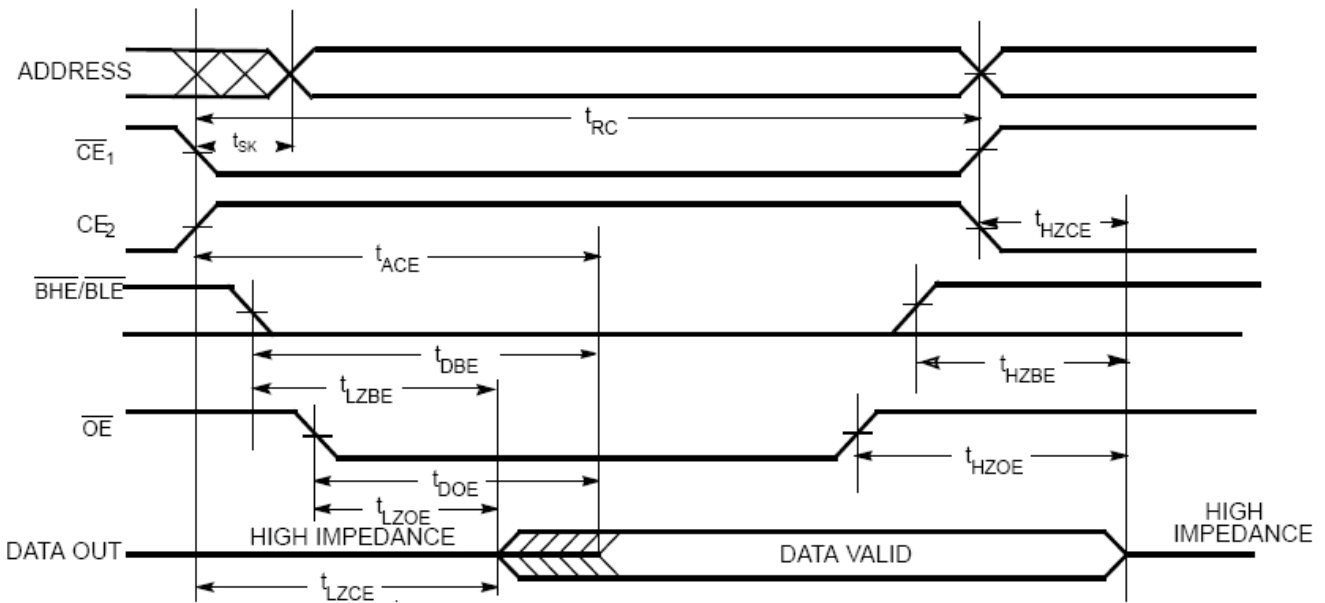
Parameter	Description	-55		-70		Unit
		Min.	Max.	Min.	Max.	
t_{PWE}	\overline{WE} Pulse Width	40		55		ns
t_{BW}	$\overline{BLE}/\overline{BHE}$ LOW to Write End	50		55		ns
t_{SD}	Data Set-Up to Write End	25		25		ns
t_{HD}	Data Hold from Write End	0		0		ns
t_{HZWE}	\overline{WE} LOW to High-Z[11, 12]		25		25	ns
t_{LZWE}	\overline{WE} HIGH to Low-Z[11, 12]	5		5		ns

Switching Waveforms

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



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



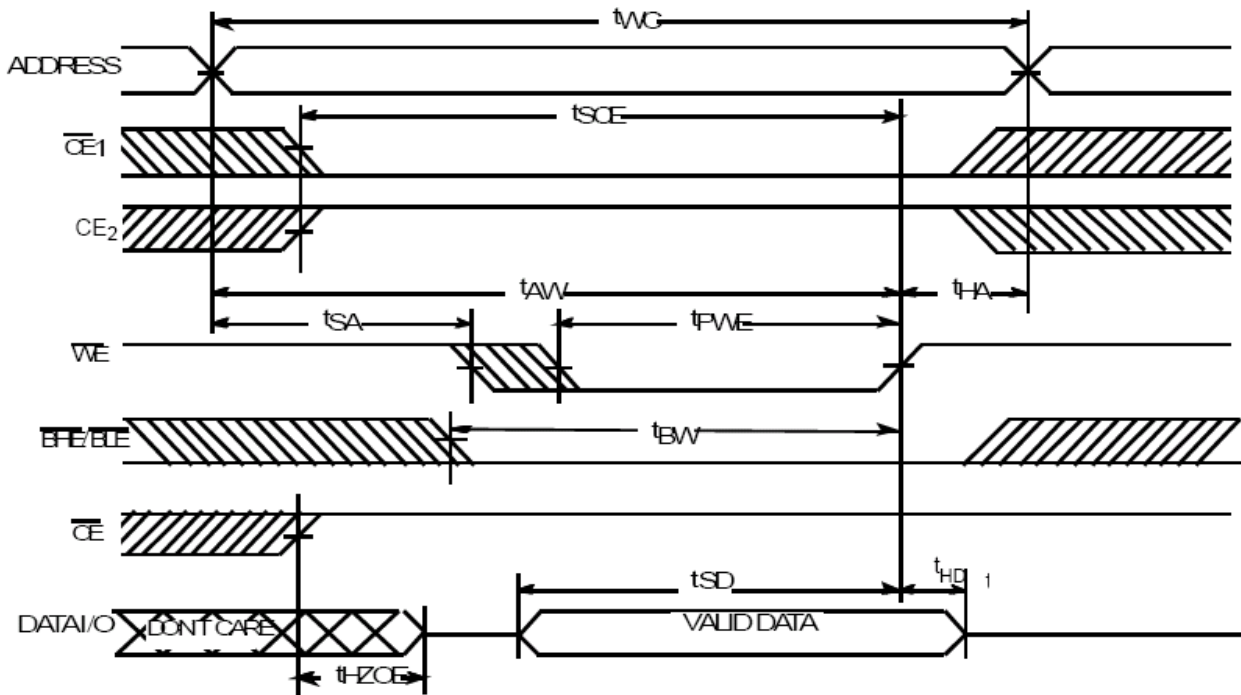
Notes:

15. Device is continuously selected. \overline{OE} , $\overline{CE1} = V_{IL}$ and $CE2 = V_{IH}$.

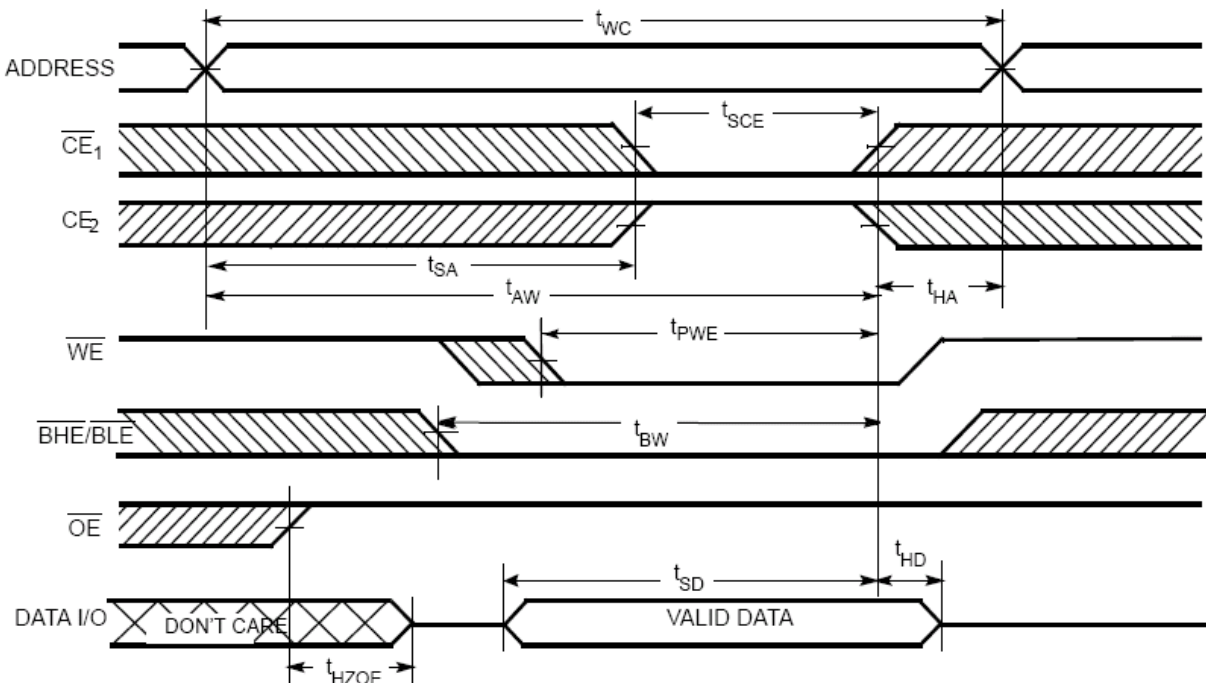
16. \overline{WE} is HIGH for Read Cycle.

Switching Waveforms (continued)

Write Cycle 1 (\overline{WE} Controlled)[13, 14, 17, 18, 19]



Write Cycle 2 ($\overline{CE1}$ or $\overline{CE2}$ Controlled)[13, 14, 17, 18, 19]



Notes:

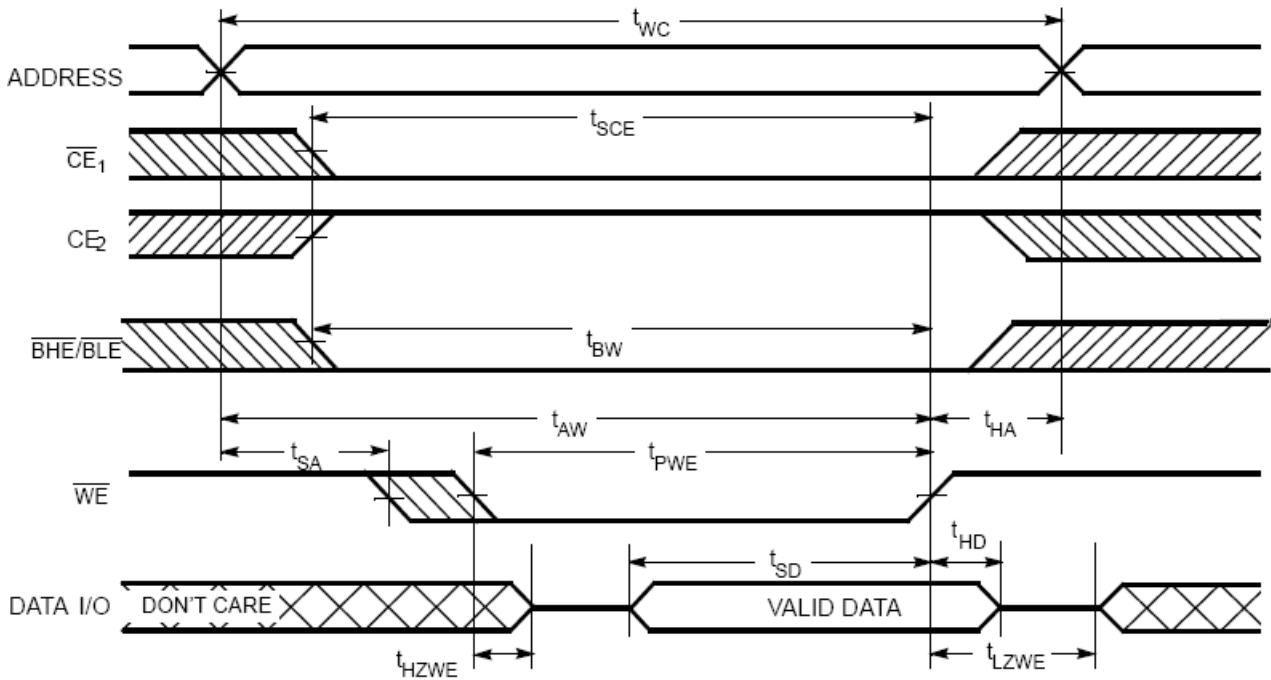
17.Data I/O is high impedance if $\overline{OE} \geq V_{IH}$.

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

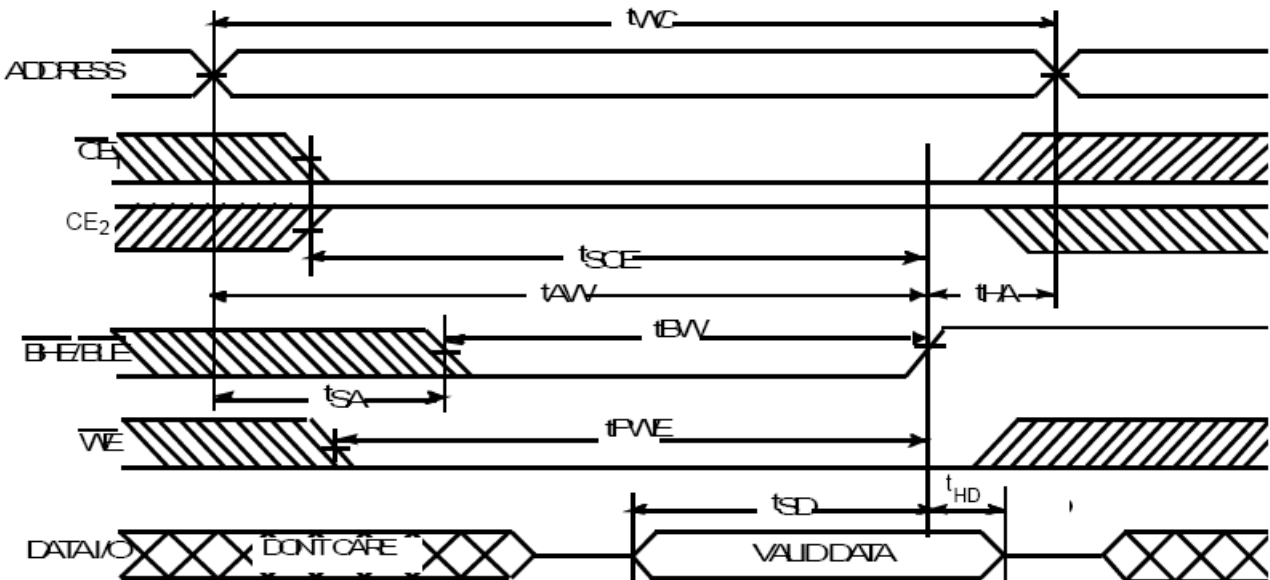
19.During the DON'T CARE period in the DATA I/O waveform, the I/Os are in output state and input signals should not be applied.

Switching Waveforms (continued)

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



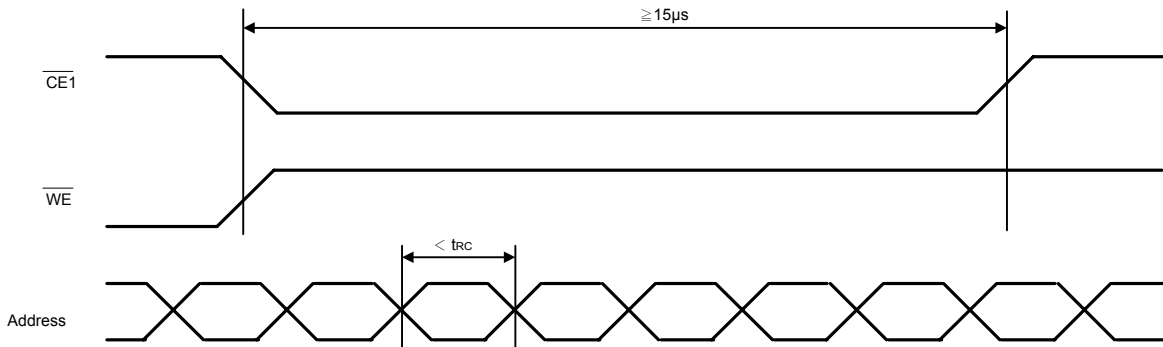
Write Cycle 4 ($\overline{BHE}/\overline{BLE}$ Controlled, \overline{OE} LOW)[18, 19]



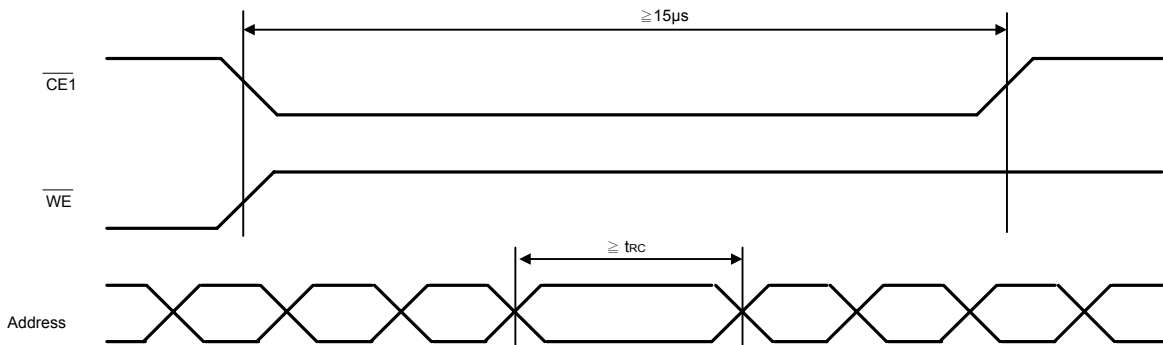
Avoid Timing

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 $\overline{CE1}$ to high ($\geq t_{RC}$) one time at least shown as in Avoidable Timing 2.

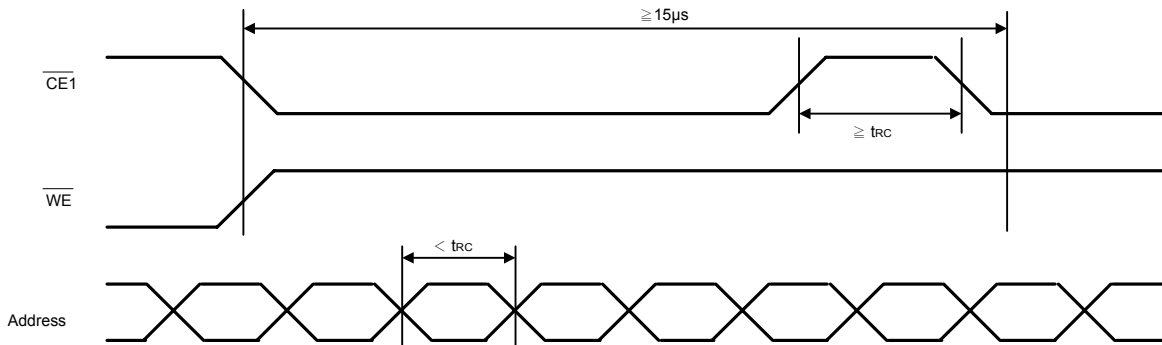
Abnormal Timing



Avoidable Timing 1



Avoidable Timing 2



Truth Table[20]

$\overline{CE1}$	CE2	\overline{WE}	\overline{OE}	\overline{BHE}	\overline{BLE}	Inputs/Outputs	Mode	Power
H	X	X	X	X	X	High Z	Deselect/Power-Down	Standby (I_{SB})
X	L	X	X	X	X	High Z	Deselect/Power-Down	Standby (I_{SB})
X	X	X	X	H	H	High Z	Deselect/Power-Down	Standby (I_{SB})
L	H	H	L	L	L	Data Out (I/O_0 – I/O_{15})	Read	Active (I_{CC})
L	H	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	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	H	L	L	High Z	Output Disabled	Active (I_{CC})
L	H	H	H	H	L	High Z	Output Disabled	Active (I_{CC})
L	H	H	H	L	H	High Z	Output Disabled	Active (I_{CC})
L	H	L	X	L	L	Data In (I/O_0 – I/O_{15})	Write (Upper Byte and Lower Byte)	Active (I_{CC})
L	H	L	X	H	L	Data In (I/O_0 – I/O_7); (I/O_8 – I/O_{15}) in High Z	Write (Lower Byte Only)	Active (I_{CC})
L	H	L	X	L	H	Data Out (I/O_8 – I/O_{15}); (I/O_0 – I/O_7) in High Z	Write (Upper Byte Only)	Active (I_{CC})

Ordering Information

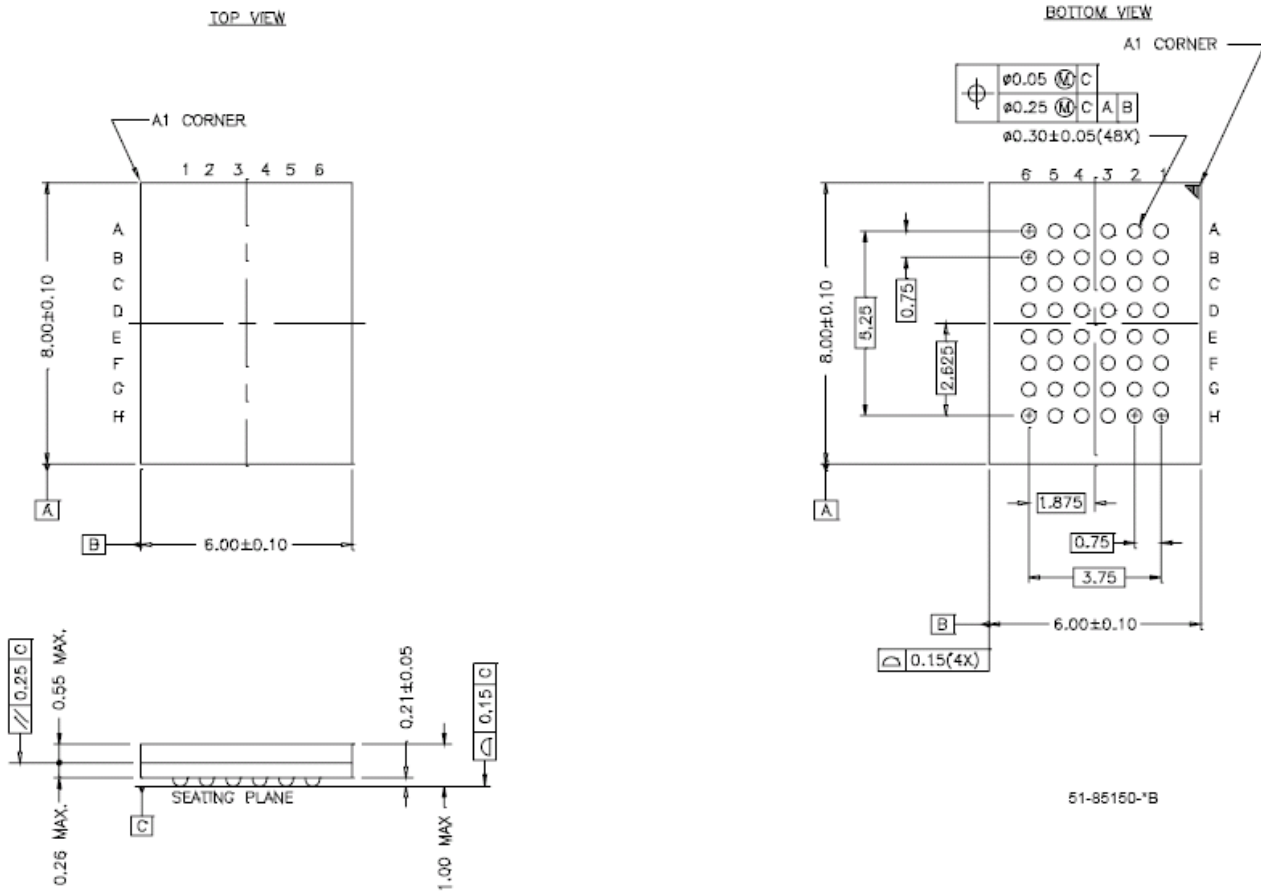
Speed (ns)	Ordering Code	Package Type	Operating Range
55	M24L216128DA-55BEG	48-ball Very Fine Pitch BGA (6.0 x 8.0 x 1.0 mm) (Pb-Free)	Extended
70	M24L216128DA-70BEG	48-ball Very Fine Pitch BGA (6.0 x 8.0 x 1.0 mm) (Pb-Free)	Extended
55	M24L216128DA-55TEG	44-pin TSOPII (Pb-Free)	Extended
70	M24L216128DA-70TEG	44-pin TSOPII (Pb-Free)	Extended
55	M24L216128DA-55BIG	48-ball Very Fine Pitch BGA (6.0 x 8.0 x 1.0 mm) (Pb-Free)	Industrial
70	M24L216128DA-70BIG	48-ball Very Fine Pitch BGA (6.0 x 8.0 x 1.0 mm) (Pb-Free)	Industrial
55	M24L216128DA-55TIG	44-pin TSOPII (Pb-Free)	Industrial
70	M24L216128DA-70TIG	44-pin TSOPII (Pb-Free)	Industrial

Note:

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

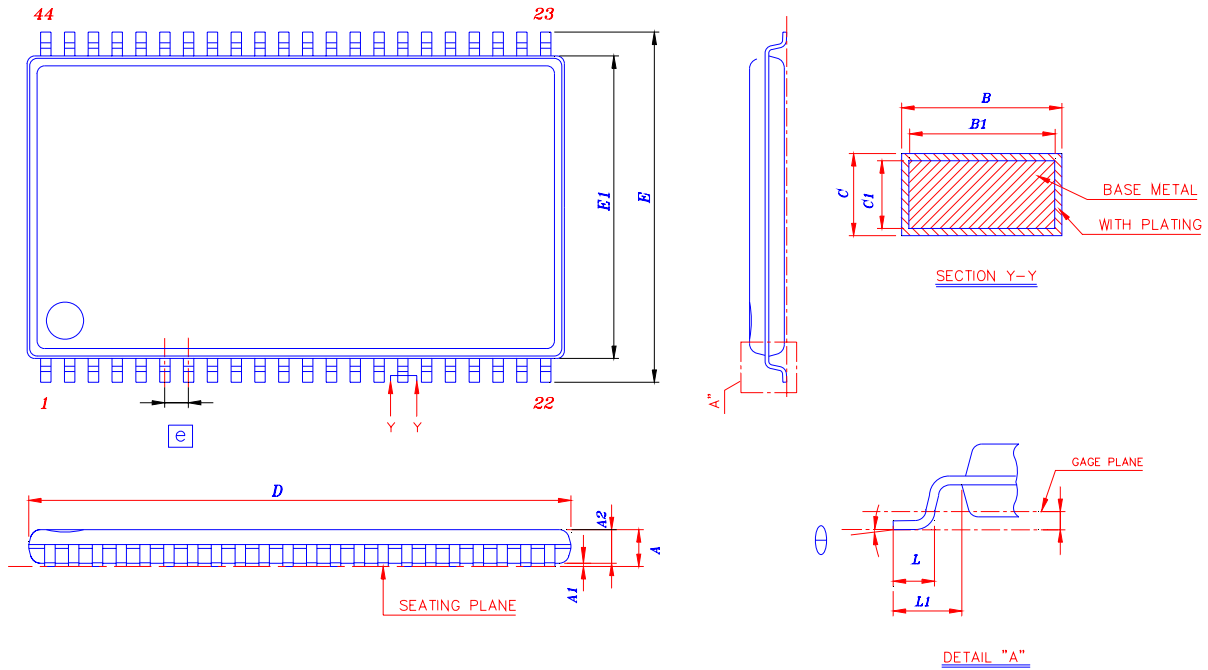
Package Diagrams

48-Lead 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	2007.07.06	Original
1.1	2008.02.27	1. Add 44-pin TSOPII package 2. Add Avoid timing 3. Modify type error of function description (standby mode : $\overline{CE1}$ LOW, CE2 HIGH => $\overline{CE1}$ HIGH, CE2 LOW)
1.2	2008.07.04	1. Move Revision History to the last 2. Modify voltage range 2.7V~3.3V to 2.7V~3.6V 3. Add Industrial grade

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