Revision History :

Revision 1.0 (Jul. 6, 2007)
- Original

PSRAM 16-Mbit (1M x 16)

Pseudo Static RAM

Features

- Wide voltage range: 1.7V–1.95V
- Access Time: 70 ns
- Ultra-low active power
  - Typical active current: 3 mA @ f = 1 MHz
  - Typical active current: 18 mA @ f = fmax
- Ultra low standby power
- Automatic power-down when deselected
- CMOS for optimum speed/power
- Available in 48-ball BGA package
- Operating Temperature: –40°C to +85°C

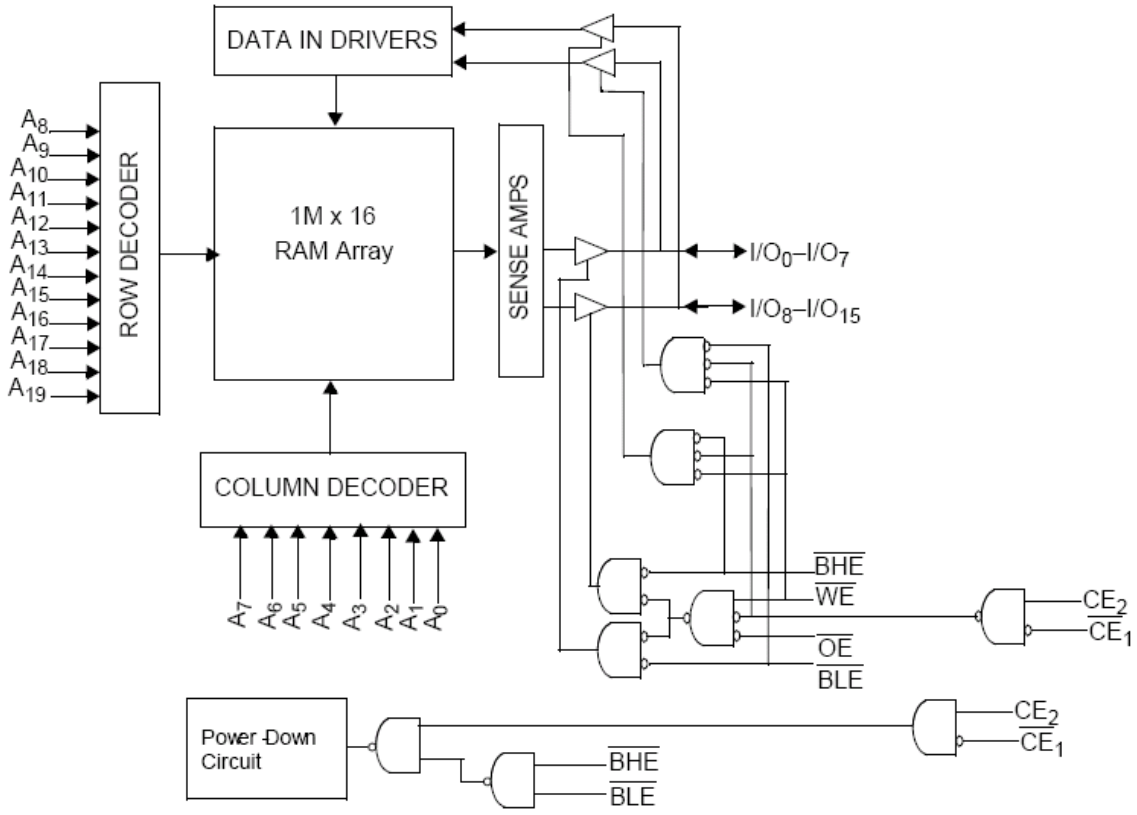
Functional Description[1]

The M24D16161DA is a high-performance CMOS Pseudo Static RAM organized as 1M 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 portable applications such as cellular telephones. The device can be put into standby mode when deselected ($\overline{CE}$1 HIGH or 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 : deselected ($\overline{CE}$1 HIGH or CE2 LOW), outputs are disabled ($\overline{OE}$ HIGH), both Byte High Enable and Byte Low Enable are disabled ($\overline{BHE}$, $\overline{BLE}$ HIGH), or during a write operation ($\overline{OE}$1 LOW and CE2 HIGH and $\overline{WE}$ LOW).

To write to the device, take Chip Enable ($\overline{CE}$1 LOW and CE2HIGH) and Write Enable ($\overline{WE}$) input LOW. If Byte Low Enable($\overline{BLE}$) is LOW, then data from I/O pins (I/O_0 through I/O_7), is written into the location specified on the address pins (A0through A_{19}). If Byte High Enable ($\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_{19}).

To read from the device, take Chip Enables ($\overline{CE}$1 LOW and CE2 HIGH) and Output Enable ($\overline{OE}$) LOW while forcing the Write Enable ($\overline{WE}$) HIGH. If Byte Low Enable ($\overline{BLE}$) is LOW, then data from the memory location specified by the address pins will appear on I/O0 to I/O7. If Byte High Enable ($\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.

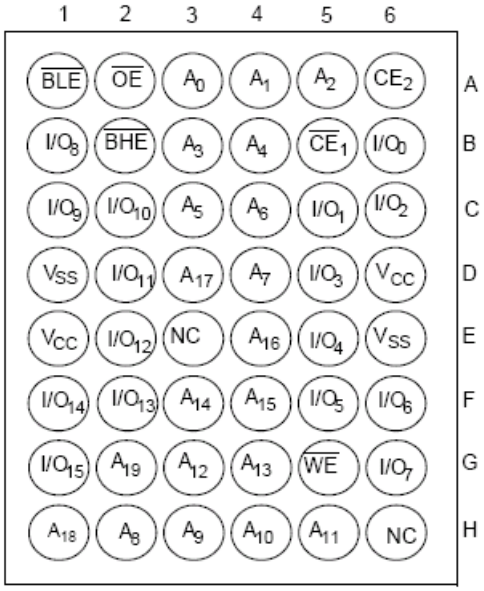
Logic Block Diagram



Pin Configuration[2, 3]

48-ball VFBGA

Top View

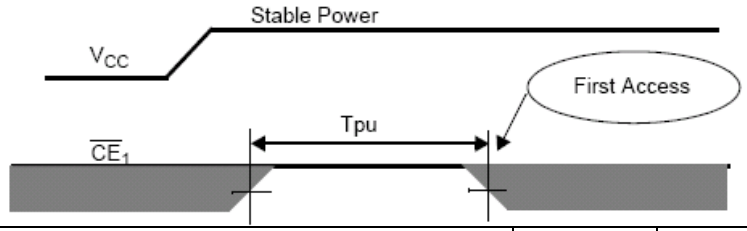


Product Portfolio[4]

Product	V_{CC} Range (V)			Speed(ns)	Power Dissipation					
					Operating I_{CC}(mA)				Standby I_{SB2}(μA)	
					f = 1MHz		f = fmax			
	Min.	Typ.[4]	Max		.Typ.[4]	Max.	.Typ.[4]	Max	.Typ. [4]	Max
M24D16161DA	1.7	1.8	1.95	70	3	5	18	20	55	70

Power-up Characteristics

The initialization sequence is shown in the figure below. Chip Select should be $\overline{OE}1$ HIGH or CE2 LOW for at least 200 μs after V_{CC} has reached a stable value. No access must be attempted during this period of 200 μs.



Parameter	Description	Min.	Max.	Unit
T_{PU}	Chip Enable Low After Stable V_{CC}	200		μs

Notes:
2.Ball H6 and E3 can be used to upgrade to a 32-Mbit and a 64-Mbit density, respectively.
3.NC "no connect"-not connected internally to the die.
4.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. Tested initially and after design changes that may affect the parameters.

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.–0.2V to V_{CCMAX} + 0.3V
DC Voltage Applied to Outputs
in High Z State[5, 6, 7].....–0.2V to V_{CCMAX} + 0.3V
DC Input Voltage[5, 6, 7].....–0.2V to V_{CCMAX} + 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

Range	Ambient Temperature (T_A)	V_{CC}
Industrial	−40°C to +85°C	1.7V to 1.95V

DC Electrical Characteristics (Over the Operating Range) [5, 6, 7]

Parameter	Description	Test Conditions		-70			Unit
				Min.	Typ.[4]	Max.	
V_{CC}	Supply Voltage			1.7	1.8	1.95	V
V_{OH}	Output HIGH Voltage	I_{OH} = −0.1 mA V_{CC} = 1.7V to 1.95V		V_{CC}-0.2			V
V_{OL}	Output LOW Voltage	I_{OL} = 0.1 mA, V_{CC} = 1.7V to 1.95V				0.2	V
V_{IH}	Input HIGH Voltage	V_{CC} = 1.7V to 1.95V		0.8* V_{CC}		V_{CC}+0.3V	V
V_{IL}	Input LOW Voltage	V_{CC} = 1.7V to 1.95V		-0.2		0.2* V_{CC}	V
I_{IX}	Input Leakage Current	GND ≤ V_{IN} ≤ V_{CC}		-1		+1	μA
I_{OZ}	Output Leakage Current	GND ≤ V_{OUT} ≤ V_{CC}		-1		+1	μA
I_{CC}	V_{CC} Operating Supply Current	f = f_{MAX} = 1/t_{RC}	V_{CC}= V_{CCmax} I_{OUT} = 0mA CMOS levels		18	25	mA
		f = 1 MHz			3	5	mA
I_{SB1}	Automatic CE Power-Down Current —CMOS Inputs	$\overline{CE}$ ≥ V_{CC} − 0.2V, CE2 ≤ 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}=3.60V			55	70	μA
I_{SB2}	Automatic CE Power-Down Current —CMOS Inputs	$\overline{CE}$1 ≥ V_{CC}−0.2V, CE2 ≤ 0.2V, V_{IN} ≥ V_{CC} − 0.2V or V_{IN} ≤ 0.2V, f = 0, V_{CC} = V_{CCMAX},			55	70	μA

Capacitance[8]

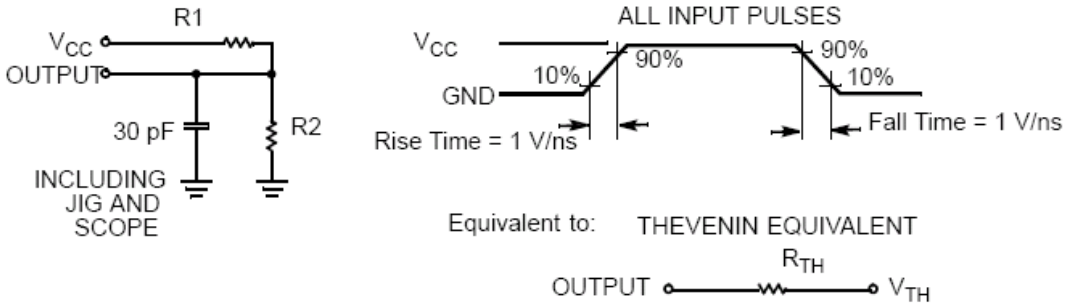
Parameter	Description	Test Conditions	Max.	Unit
C_{IN}	Input Capacitance	T_A = 25°C, f = 1 MHz,	8	pF
C_{OUT}	Output Capacitance	V_{CC} = $V_{CC(typ)}$	8	pF

Thermal Resistance[8]

Parameter	Description	Test Conditions	VFBGA	Unit
Θ_{JA}	Thermal Resistance (Junction to Ambient)	Test conditions follow standard test methods and procedures for measuring thermal impedence, per EIA/JESD51.	56	˚C/W
Θ_{JC}	Thermal Resistance (Junction to Case)		11	˚C/W

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

AC Test Loads and Waveforms



Parameters	1.8V V_{CC}	Unit
R1	14000	Ω
R2	14000	Ω
R_{TH}	7000	Ω
V_{TH}	1.90	V

Switching Characteristics Over the Operating Range[9, 10, 11, 15, 14]

Parameter	Description	-70		Unit
		Min.	Max.	
Read Cycle				
t_{RC}[13]	Read Cycle Time	70	40000	ns
t_{CD}	Chip Deselect Time $\overline{CE}1$ =HIGH or CE2=LOW, $\overline{BLE}$ / $\overline{BHE}$ High Pulse Time	15		ns
t_{AA}	Address to Data Valid		70	ns
t_{OHA}	Data Hold from Address Change	5		ns
t_{ACE}	$\overline{CE}1$ LOW to Data Valid		70	ns
t_{DOE}	$\overline{OE}$ LOW to Data Valid		35	ns
t_{LZOE}	$\overline{OE}$ LOW to Low Z[10, 11, 12]	5		ns
t_{HZOE}	$\overline{OE}$ HIGH to High Z[10, 11, 12]		25	ns
t_{LZCE}	$\overline{CE}1$ LOW and CE2 HIGH to Low Z[10, 11, 12]	10		ns
t_{HZCE}	$\overline{CE}1$ HIGH and CE2 LOW to High Z[10, 11, 12]		25	ns
t_{DBE}	$\overline{BLE}$ / $\overline{BHE}$ LOW to Data Valid		70	ns
t_{LZBE}	$\overline{BLE}$ / $\overline{BHE}$ LOW to Low Z[10, 11, 12]	5		ns
t_{HZBE}	$\overline{BLE}$ / $\overline{BHE}$ HIGH to High Z[10, 11, 12]		25	ns

Notes:
9. 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}, and output loading of the specified I_{OL}/I_{OH} as shown in the "AC Test Loads and Waveforms" section.
10. At any given temperature and voltage conditions 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. All low-Z parameters will be measured with a load capacitance of 30 pF (3V).
11. t_{HZOE}, t_{HZCE}, t_{HZBE}, and t_{HZWE} transitions are measured when the outputs enter a high-impedance state.
12. High-Z and Low-Z parameters are characterized and are not 100% tested.
13 .If invalid address signals shorter than min. t_{RC} are continuously repeated for 40 μs, the device needs a normal read timing (t_{RC}) or needs to enter standby state at least once in every 40 μs.
14. In order to achieve 70-ns performance, the read access must be Chip Enable ($\overline{CE}1$ or CE2) controlled. That is, the addresses must be stable prior to Chip Enable going active.

Switching Characteristics Over the Operating Range[9, 10, 11, 15, 14] (continued)

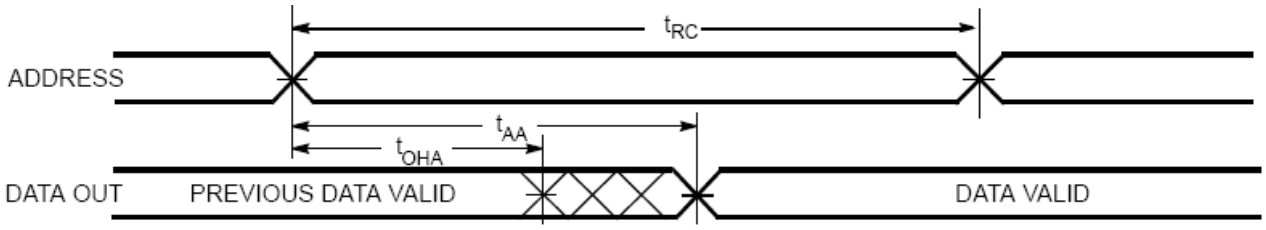
Parameter	Description	-70		Unit
		Min.	Max.	
Write Cycle[15]				
t_{WC}	Write Cycle Time	70	40000	ns
t_{SCE}	$\overline{CE1}$ LOW and CE2 HIGH to Write End	60		ns
t_{AW}	Address Set-Up to Write End	60		ns
t_{CD}	Chip Deselect Time $\overline{CE1}$ = HIGH or CE2 = LOW, $\overline{BLE}$ / $\overline{BHE}$ High Pulse Time	15		ns
t_{HA}	Address Hold from Write End	0		ns
t_{SA}	Address Set-Up to Write Start	0		ns
t_{PWE}	$\overline{WE}$ Pulse Width	50		ns
t_{BW}	$\overline{BLE}$ / $\overline{BHE}$ LOW to Write End	60		ns
t_{SD}	Data Set-Up to Write End	25		ns
t_{HD}	Data Hold from Write End	0		ns
t_{HZWE}	$\overline{WE}$ LOW to High-Z[10, 11, 12]		25	ns
t_{LZWE}	$\overline{WE}$ HIGH to Low-Z[10, 11, 12]	10		ns

Note:

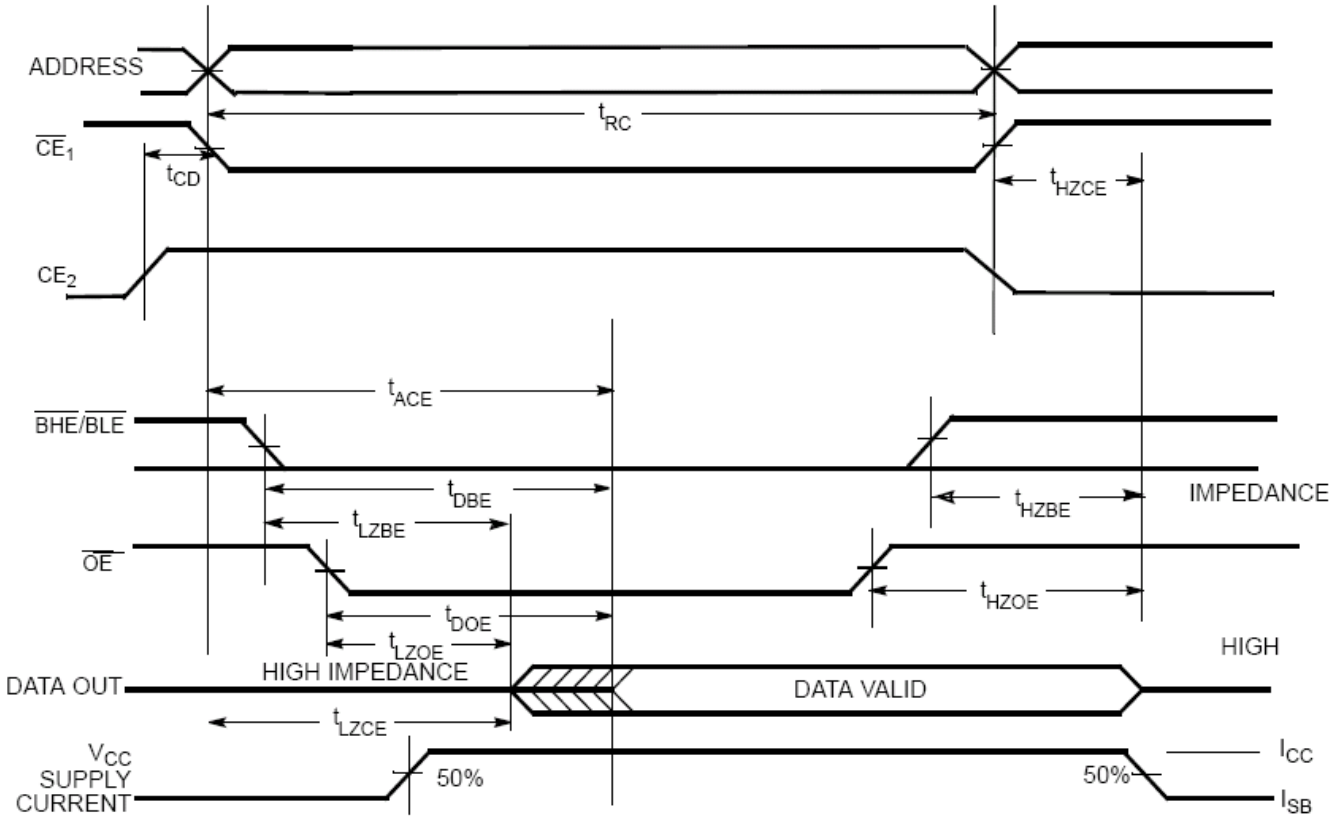
15. The internal Write time of the memory is defined by the overlap of $\overline{WE}$, $\overline{CE1}$ = V_{IL} or CE2 = V_{IH}, $\overline{BHE}$ and/or $\overline{BLE}$ = V_{IL}. All signals must be ACTIVE to initiate a write and any of these signals can terminate a write by going INACTIVE. The data input set-up and hold timing should be referenced to the edge of the signal that terminates the write.

Switching Wave forms

Read Cycle 1 (Address Transition Controlled)[17, 18]



Read Cycle 2 ($\overline{OE}$ Controlled)[16, 18,19]



Notes:

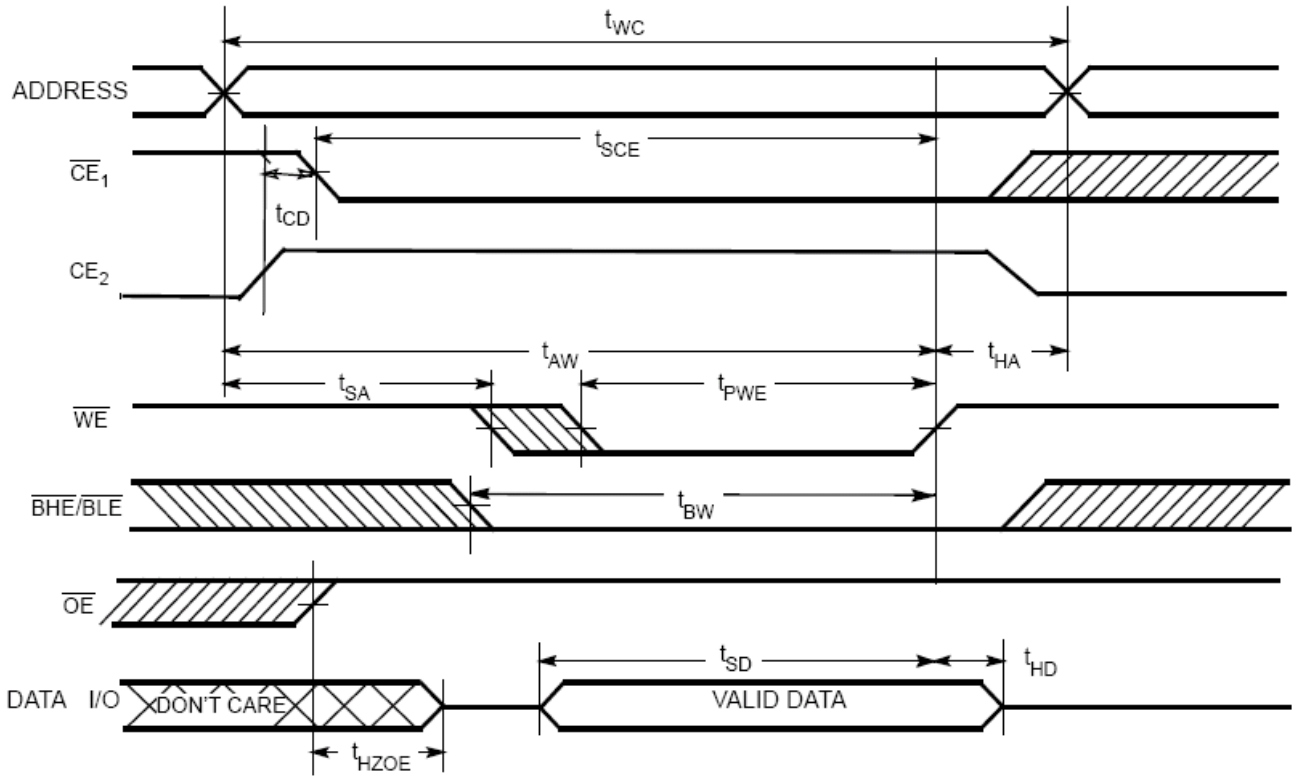
16.Whenever $\overline{CE1}$ = HIGH or CE2 = LOW, $\overline{BHE}$ / $\overline{BLE}$ are taken inactive, they must remain inactive for a minimum of 5 ns.

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

18. $\overline{WE}$ is HIGH for Read Cycle.

19. $\overline{CE}$ is the Logical AND of $\overline{CE1}$ and CE2.

Switching Waveforms (continued)



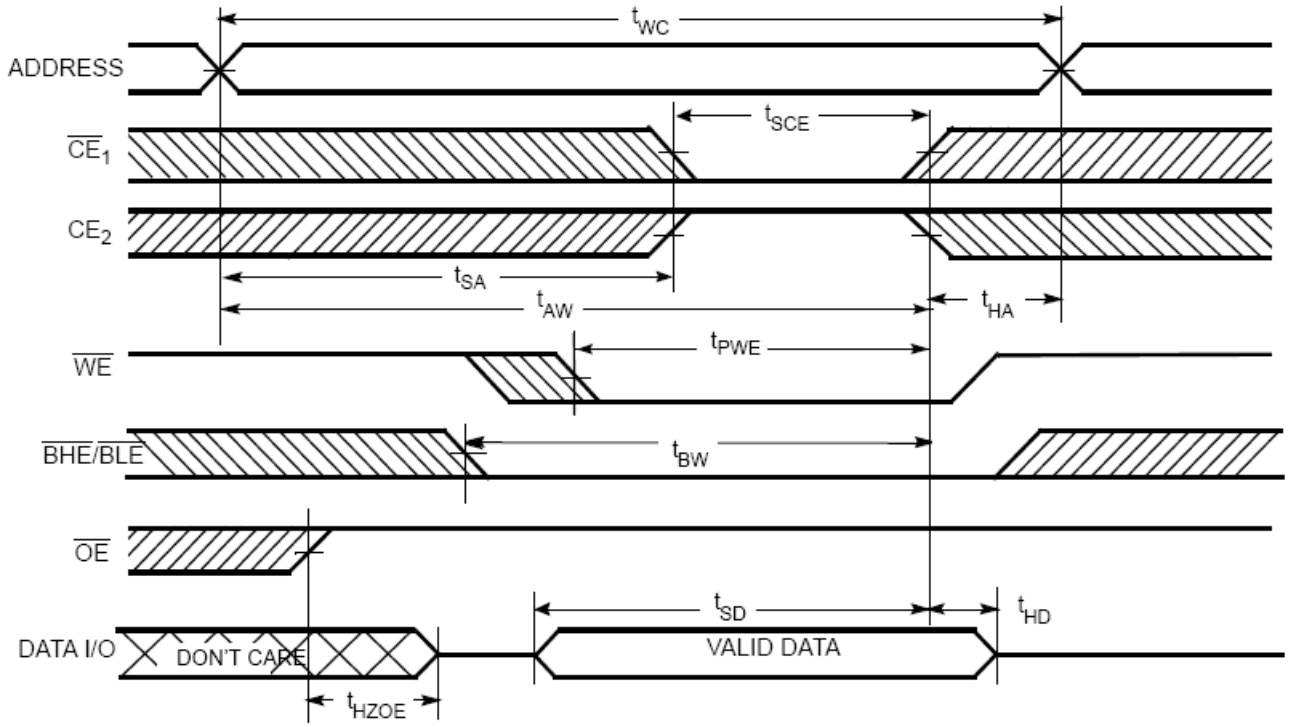
Notes:

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

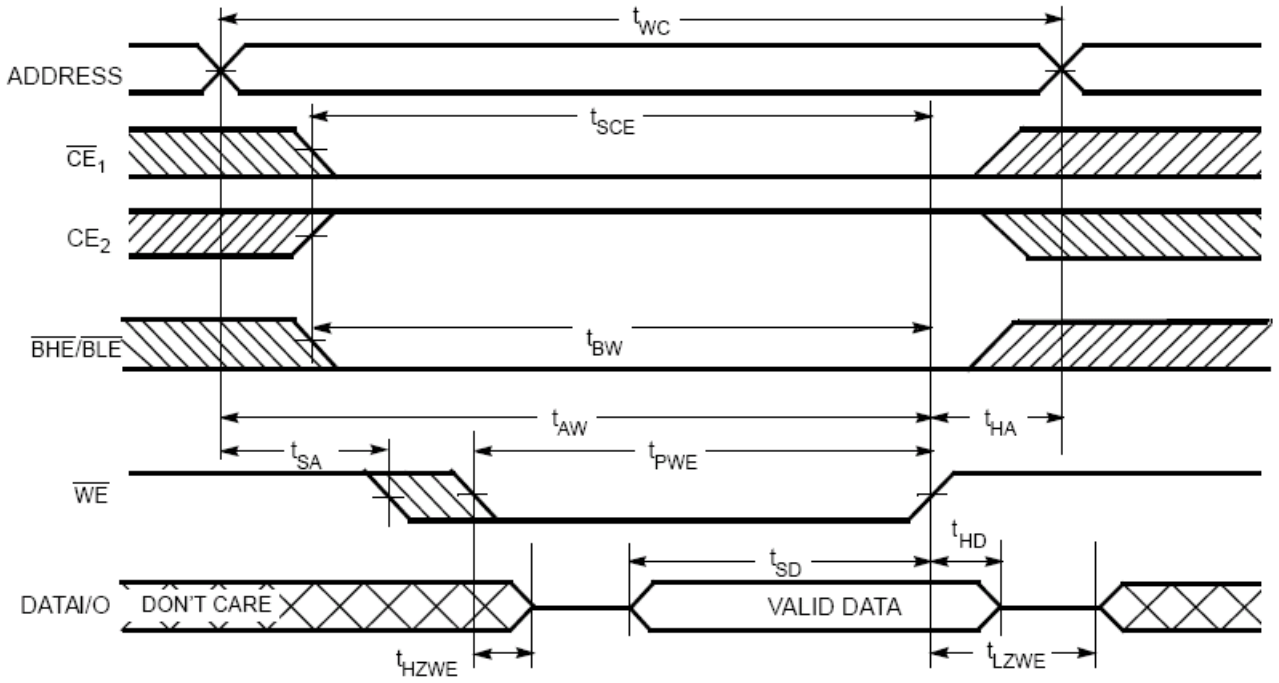
21.During the DON'T CARE period in the DATA I/O waveform, the I/Os are in output state and input signals should not be applied.

Switching Waveforms (continued)

Write Cycle 2 ($\overline{CE}_1$ or CE2 Controlled)[15, 12, 16, 20, 21]

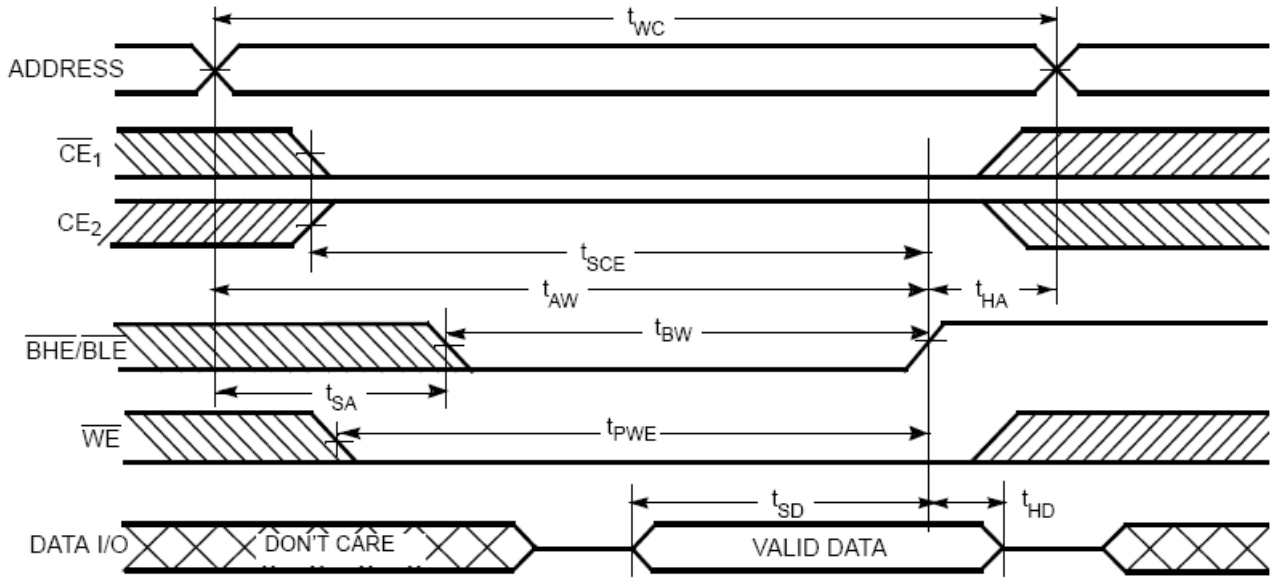


Write Cycle 3 ($\overline{WE}$ Controlled, $\overline{OE}$ LOW)[16, 21]



Switching Waveforms (continued)

Write Cycle 4 ($\overline{BHE}$/$\overline{BLE}$ Controlled, $\overline{OE}$ LOW)[15, 16, 20, 21]



Truth Table[22]

$\overline{CE1}$	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})

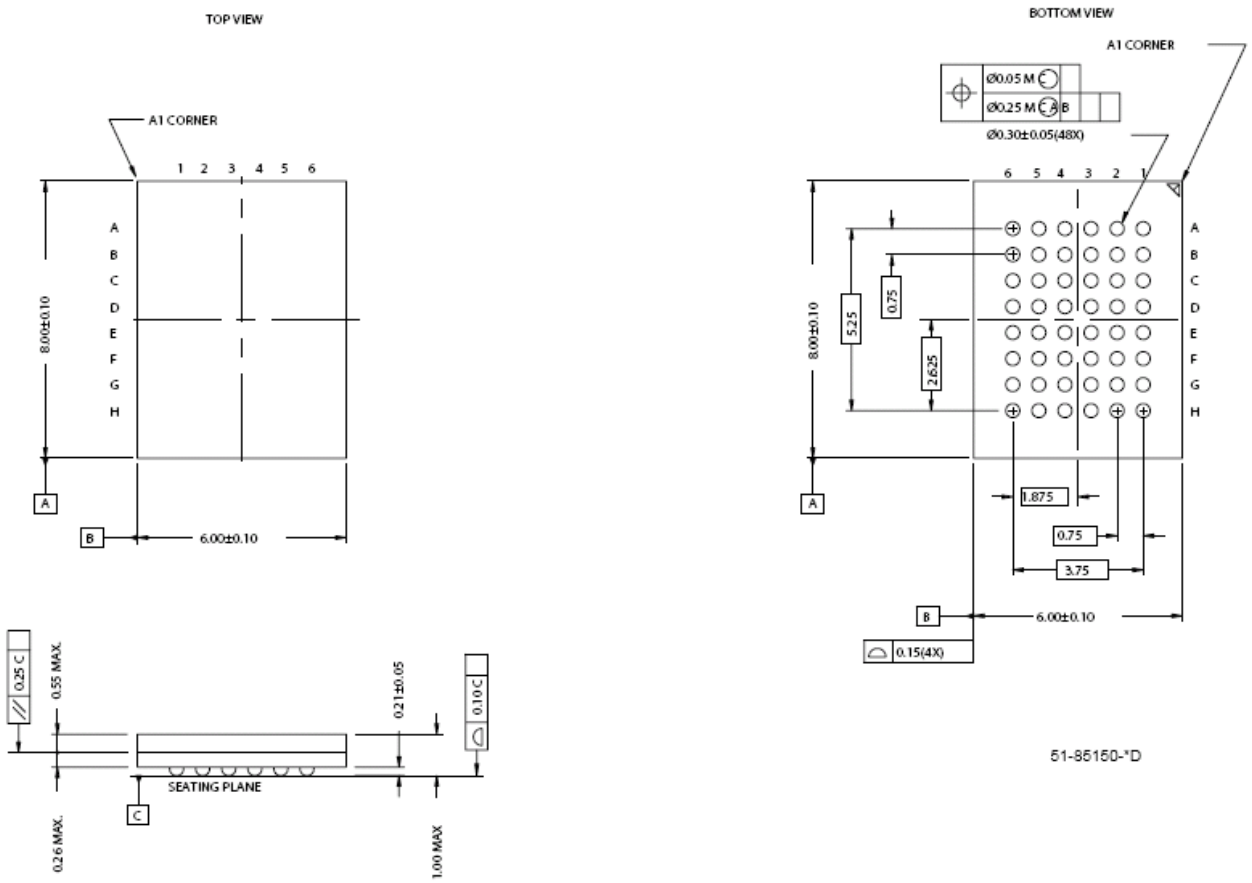
Notes:
22.H = Logic HIGH, L = Logic LOW, X = Don't Care.

Ordering Information

Speed (ns)	Ordering Code	Package Type	Operating Range
70	M24D16161DA -70BIG	48-ball Very Fine Pitch BGA (6 x 8 x 1 mm) (Pb-Free)	Industrial

Package Diagrams

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



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