

Revision History :

Revision 1.0 (Jul. 4, 2007)
- Original

PSRAM

16-Mbit (1M x 16)

Pseudo Static RAM

Features

- Wide voltage range: 2.2V–3.6V
- 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
- Offered in a 48-ball BGA Package
- Operating Temperature: –40°C to +85°C

Functional Description[1]

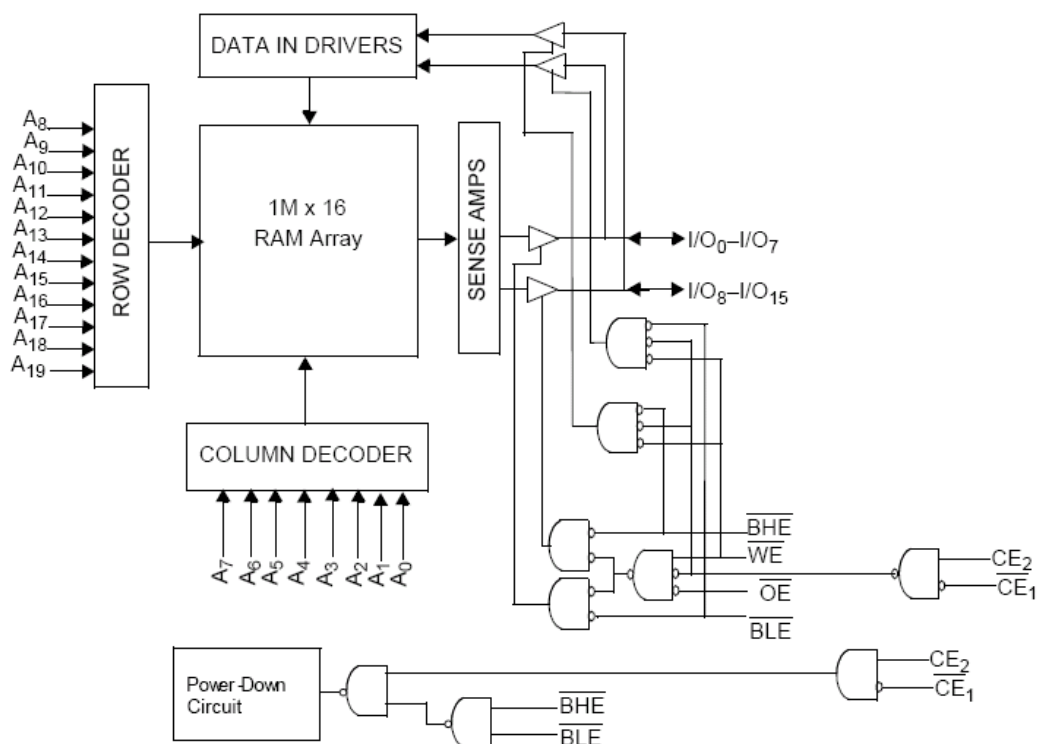
The M24L16161DA is a high-performance CMOS Pseudo Static RAM organized as 1M words by 16 bits that supports an asynchronous memory interface. This device features advanced circuit design to provide ultra-low active current. This is ideal for portable applications such as cellular telephones. The device can be put into standby mode when deselected ($\overline{CE1}$ 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 ($\overline{CE1}$

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 ($\overline{CE1}$ LOW and $CE2$ HIGH and $\overline{WE}$ LOW).

To write to the device, take Chip Enable ($\overline{CE1}$ LOW and $CE2$ HIGH) 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_{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 ($\overline{CE1}$ 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/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.

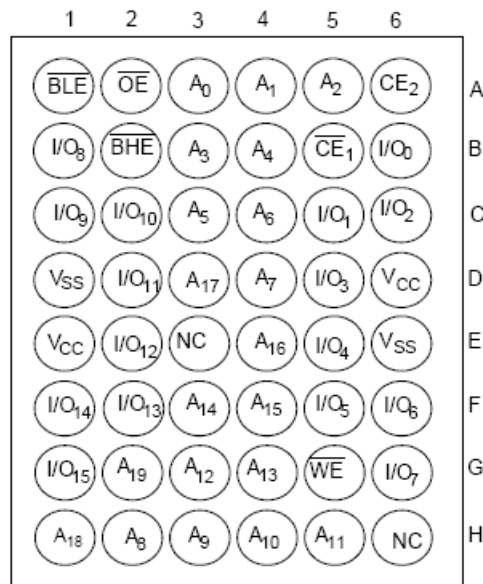
Logic Block Diagram



Pin Configuration[2, 3]

48-ball VFBGA

Top View

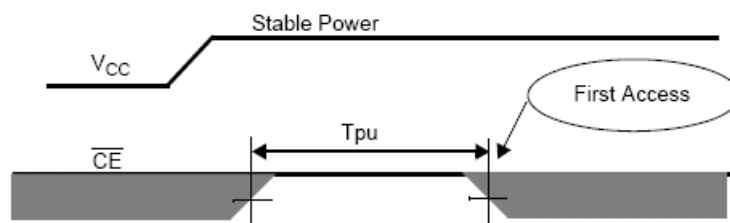


Product Portfolio[4]

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	70	Typ.[4]	Max.	Typ.[4]	Max	Typ. [4]	Max
M24L16161DA	2.2	3.0	3.6		3	5	18	25	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.	Typ.	Max.	Unit
T _{PU}	Chip Enable Low After Stable V _{CC}	200			μs

Notes:

- Ball H6 and E3 can be used to upgrade to a 32-Mbit and a 64-Mbit density, respectively.
- NC "no connect"-not connected internally to the die.
- 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.-0.3V to $V_{CCMAX} + 0.3V$

DC Voltage Applied to Outputs

in High Z State[5, 6, 7].....-0.3V to $V_{CCMAX} + 0.3V$

DC Input Voltage[5, 6, 7].....-0.3V 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	2.2V to 3.6V

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

Parameter	Description	Test Conditions	-70			Unit
			Min.	Typ.[4]	Max.	
V_{CC}	Supply Voltage		2.2	3.0	3.6	V
V_{OH}	Output HIGH Voltage	$I_{OH} = -0.1\text{ mA}$ $V_{CC} = 2.2V\text{ to }3.6V$	$V_{CC}-0.2$			V
V_{OL}	Output LOW Voltage	$I_{OL} = 0.1\text{ mA}$, $V_{CC} = 2.2V\text{ to }3.6$			0.2	V
V_{IH}	Input HIGH Voltage	$V_{CC} = 1.7V\text{ to }1.95V$	$0.8 \cdot V_{CC}$		$V_{CC}+0.3V$	V
V_{IL}	Input LOW Voltage	2.2V to 3.6	-0.3		$0.2 \cdot V_{CC}$	V
I_{IX}	Input Leakage Current	$GND \leq V_{IN} \leq V_{CC}$	-1		+1	μA
I_{OZ}	Output Leakage Current	$GND \leq V_{OUT} \leq V_{CC}$	-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
		$f = 1\text{ MHz}$		3	5	mA
I_{SB1}	Automatic CE Power-Down Current —CMOS Inputs	$\overline{CE1} \geq V_{CC} - 0.2V$, $CE2 \leq 0.2V$, $V_{IN} > V_{CC} - 0.2V$, $V_{IN} < 0.2V$, $f = f_{MAX}$ (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	$\overline{CE1} \geq V_{CC}-0.2V$, $CE2 \leq 0.2V$, $V_{IN} \geq V_{CC} - 0.2V$ or $V_{IN} \leq 0.2V$, $f = 0$, $V_{CC} = V_{CCMAX}$,		55	70	μA

Capacitance[8]

Parameter	Description	Test Conditions	Max.	Unit
C_{IN}	Input Capacitance	$T_A = 25^\circ C$, $f = 1\text{ MHz}$,	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 impedance, per EIA/JESD51.	56	$^\circ C/W$
Θ_{JC}	Thermal Resistance (Junction to Case)		11	$^\circ C/W$

Notes:

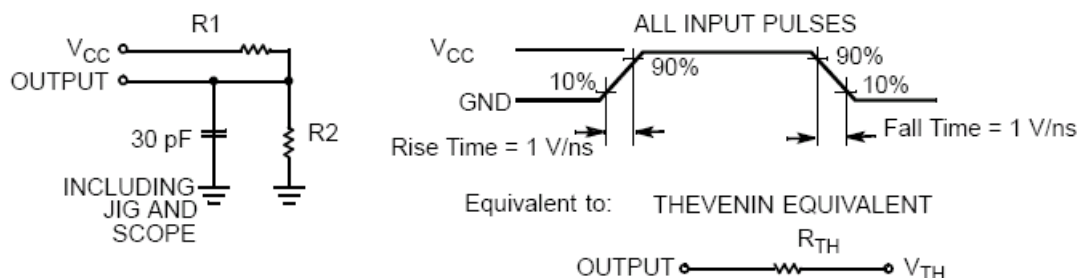
5. $V_{IL(MIN)}$ = -0.5V for pulse durations less than 20 ns.

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	3.0V V _{CC}	Unit
R1	26000	Ω
R2	26000	Ω
R _{TH}	13000	Ω
V _{TH}	1.50	V

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

Parameter	Description	-70		Unit
		Min.	Max.	
Read Cycle				
t _{RC} [13]	Read Cycle Time	70	40000	ns
t _{CD}	Chip Deselect Time $\overline{CE1}$ =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}	$\overline{CE}$ 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}	$\overline{CE}$ LOW to Low Z[10, 11, 12]	10		ns
t _{HZCE}	$\overline{CE}$ HIGH 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:

- 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.
- 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).
- 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.
- 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.
- In order to achieve 70-ns performance, the read access must be Chip Enable ($\overline{CE1}$ 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)

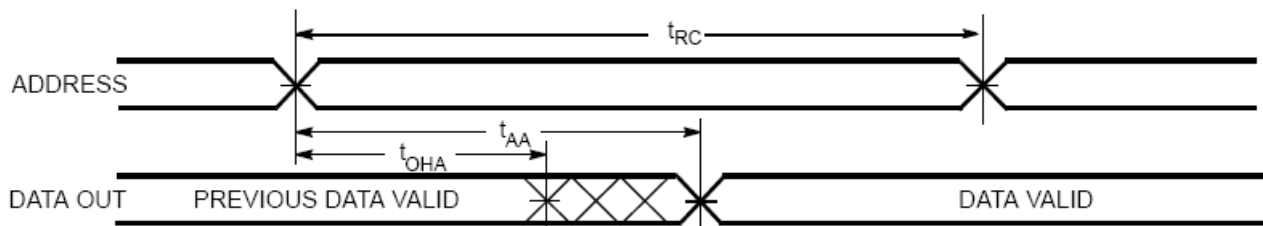
Parameter	Description	-70		Unit
		Min.	Max.	
Write Cycle[15]				
t _{WC}	Write Cycle Time	70	40000	ns
t _{SCE}	$\overline{CE}$ LOW to Write End	60		ns
t _{AW}	Address Set-Up to Write End	60		ns
t _{CD}	Chip Deselect Time $\overline{CE1}$ = HIGH or $CE2$ = LOW, $\overline{BLE}$ / $\overline{BHE}$ High 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:

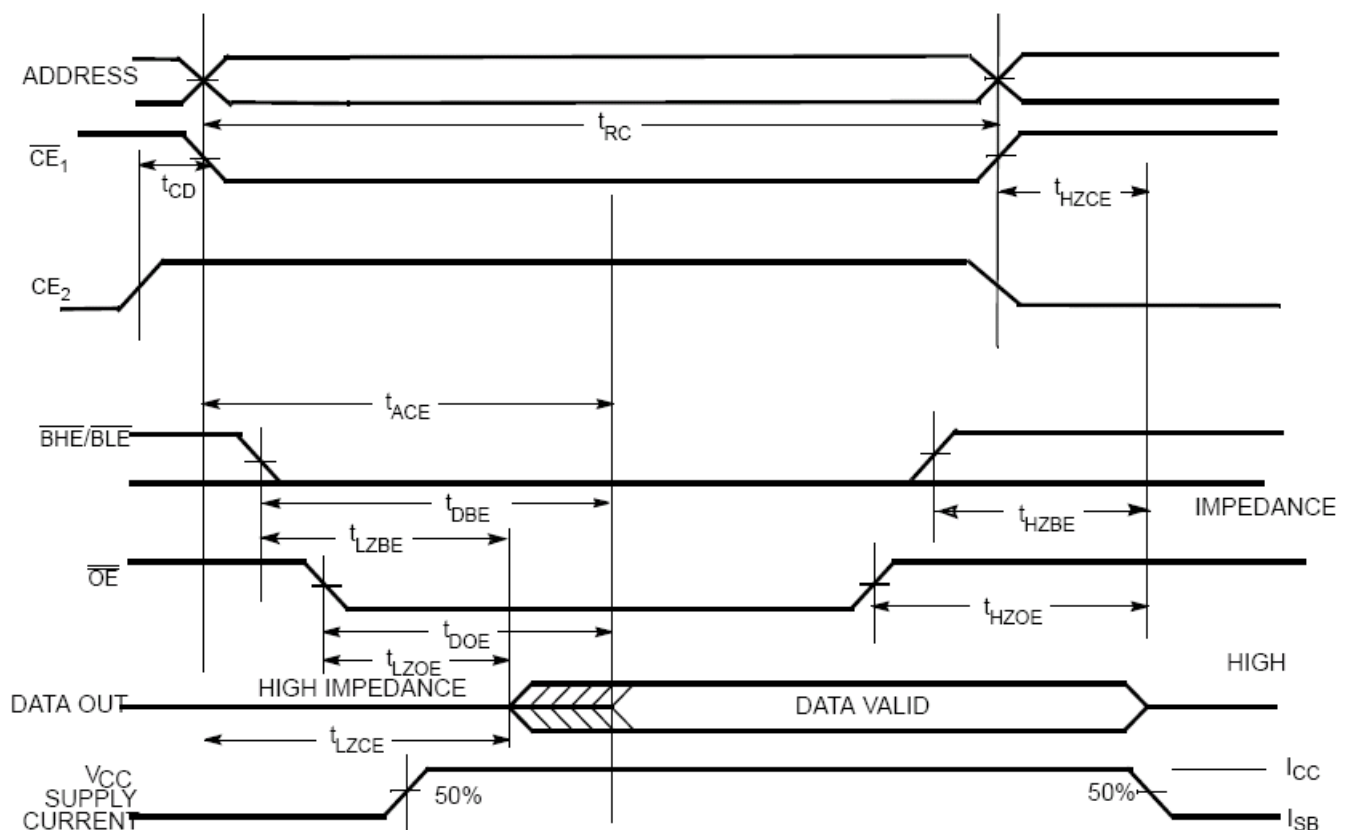
15. The internal Write time of the memory is defined by the overlap of $\overline{WE}$, $\overline{CE1} = V_{IL}$ or $\overline{CE2} = V_{IH}$, $\overline{BHE}$ and/or $\overline{BLE} = V_{IL}$. All signals must be ACTIVE to initiate a write and any of these signals can terminate a write by going INACTIVE. 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]

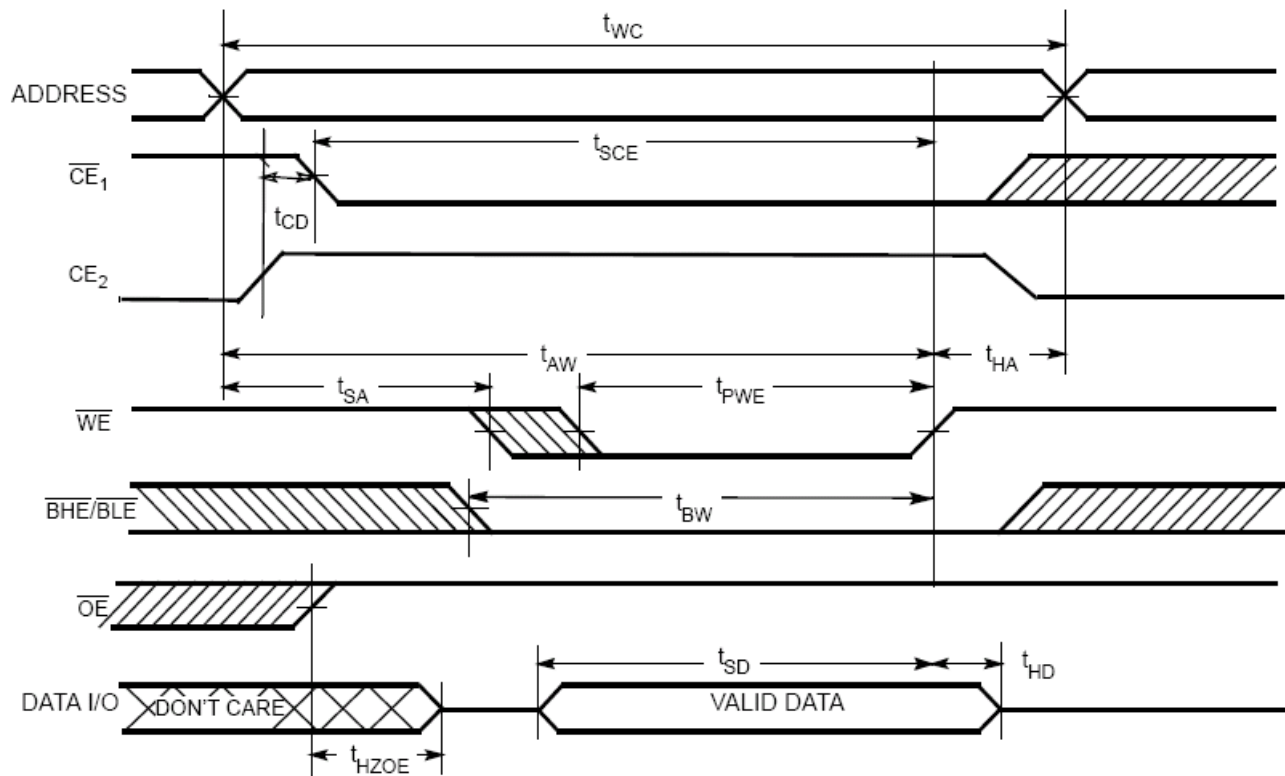


Notes:

16. Whenever $\overline{CE}_1 = \text{HIGH}$ or $CE_2 = \text{LOW}$, $\overline{BHE}/\overline{BLE}$ are taken inactive, they must remain inactive for a minimum of 5 ns.
17. Device is continuously selected. $\overline{OE} = \overline{CE}_1 = V_{IL}$ and $CE_2 = V_{IH}$.
18. $\overline{WE}$ is HIGH for Read Cycle.
19. $\overline{CE}$ is the Logical AND of $\overline{CE}_1$ and CE_2 .

Switching Waveforms (continued)

Write Cycle 1 ($\overline{\text{WE}}$ Controlled)[15, 12, 16, 19, 20, 21]



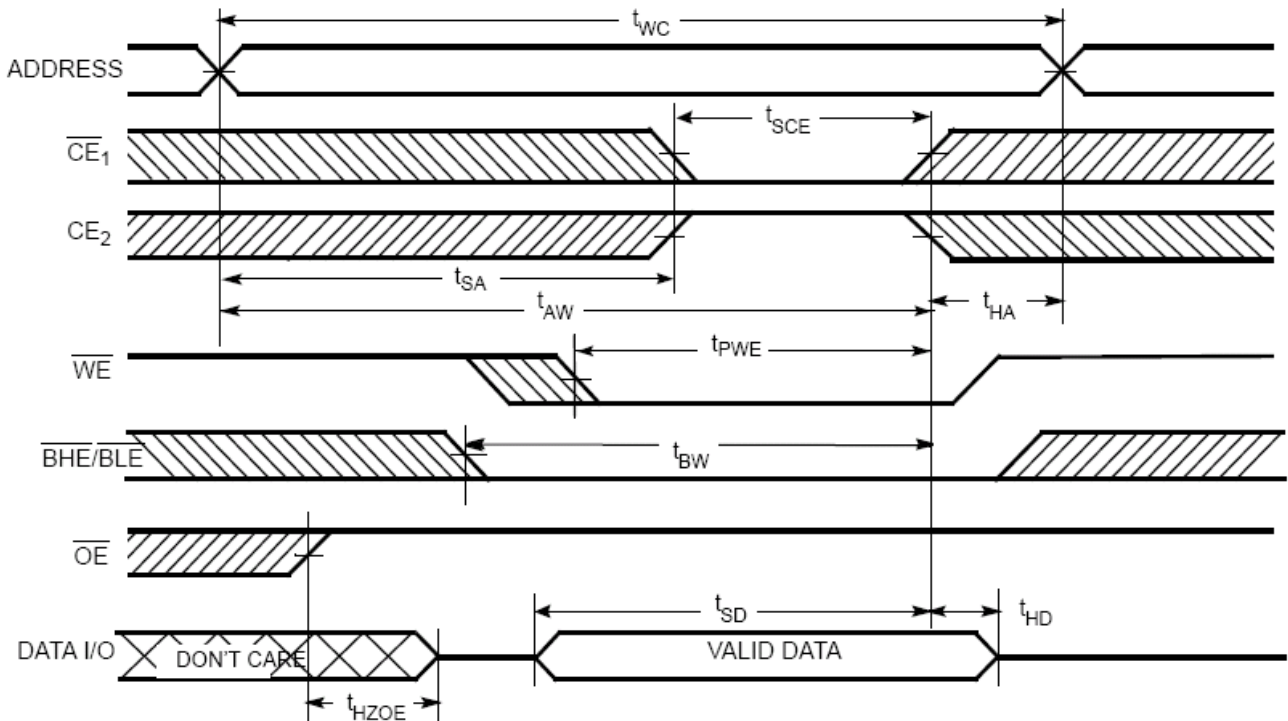
Notes:

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

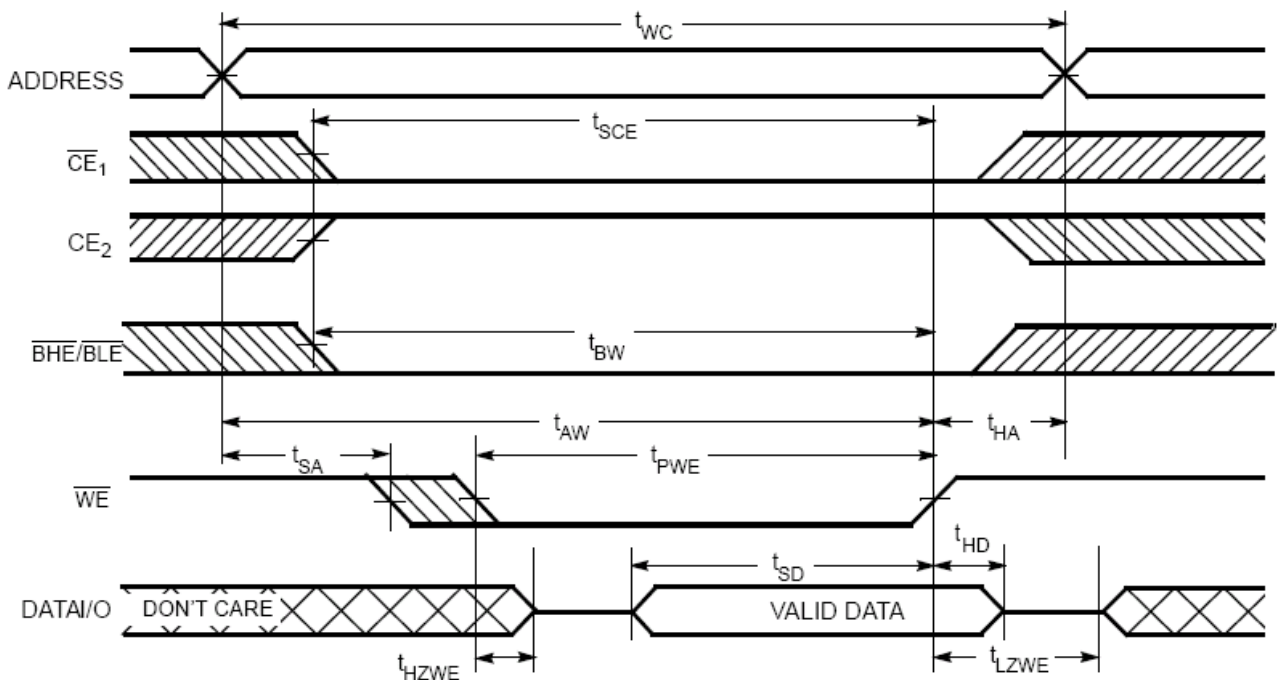
21.During the DON'T CARE period in the DATA I/O waveform, the I/Os are in output state and input signals should not be applied.

Switching Waveforms (continued)

Write Cycle 2 ($\overline{\text{CE}}_1$ or CE_2 Controlled)[15, 12, 16, 20, 21]

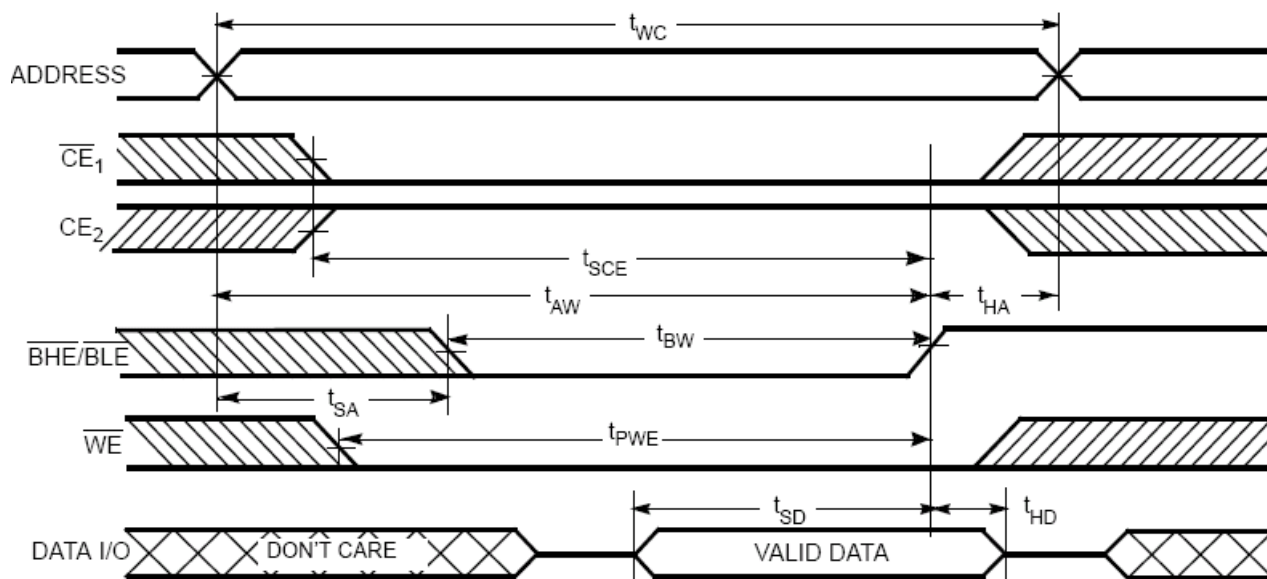


Write Cycle 3 ($\overline{\text{WE}}$ Controlled, $\overline{\text{OE}}$ LOW)[16, 21]



Switching Waveforms (continued)

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



Truth Table[22]

$\overline{\text{CE}}_1$	CE_2	$\overline{\text{WE}}$	$\overline{\text{OE}}$	BHE	BL $\overline{\text{E}}$	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:

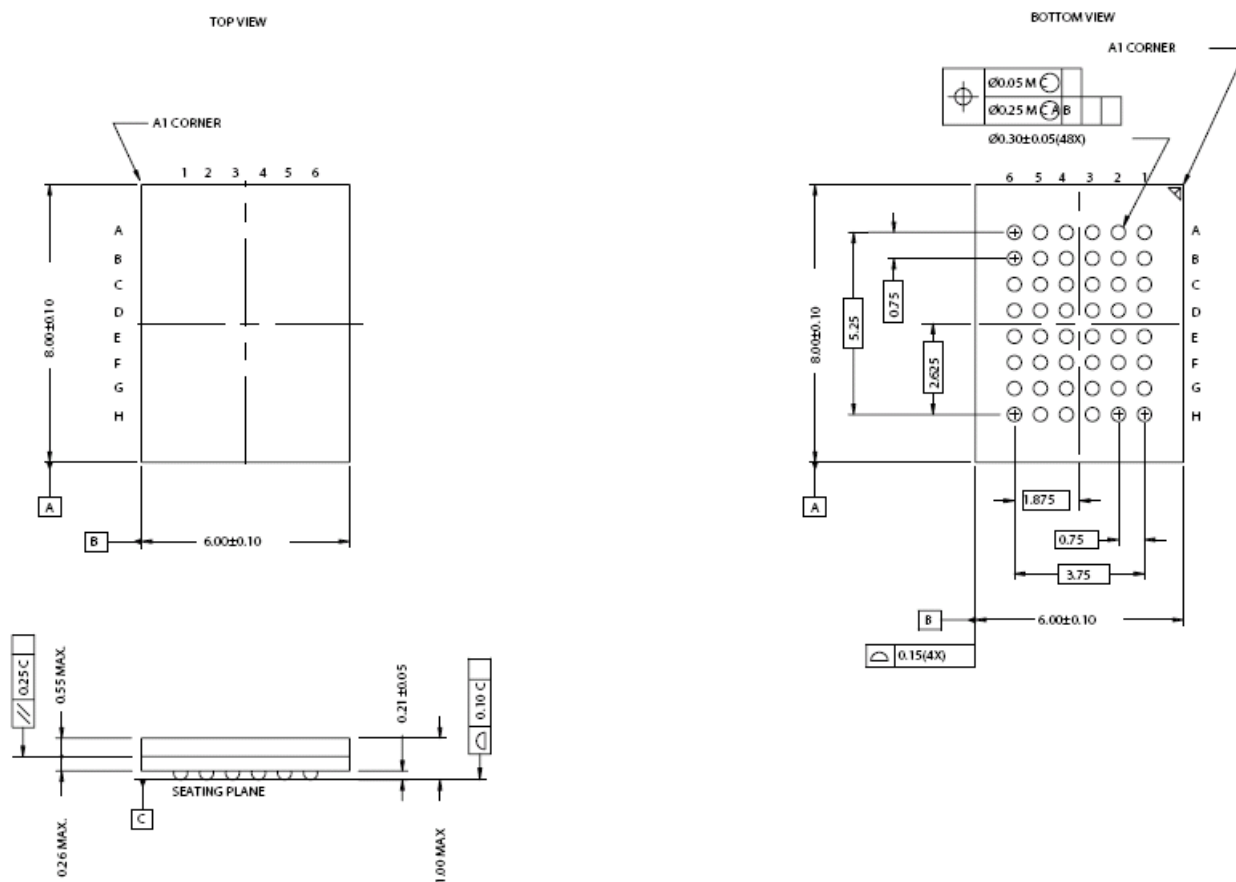
22.H = Logic HIGH, L = Logic LOW, X = Don't Care.

Ordering Information

Speed (ns)	Ordering Code	Package Type	Operating Range
70	M24L16161DA -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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