

MEMORY

**CMOS 1M × 16 BIT
FAST PAGE MODE DYNAMIC RAM****MB8118160A-60/-70****CMOS 1,048,576 × 16 BIT Fast Page Mode Dynamic RAM****DESCRIPTION**

The Fujitsu MB8118160A is a fully decoded CMOS Dynamic RAM (DRAM) that contains 16,777,216 memory cells accessible in 16-bit increments. The MB8118160A features a "fast page" mode of operation whereby high-speed random access of up to 1,024 × 16 bits of data within the same row can be selected. The MB8118160A DRAM is ideally suited for mainframe, buffers, hand-held computers video imaging equipment, and other memory applications where very low power dissipation and high bandwidth are basic requirements of the design. Since the standby current of the MB8118160A is very small, the device can be used as a non-volatile memory in equipment that uses batteries for primary and/or auxiliary power.

The MB8118160A is fabricated using silicon gate CMOS and Fujitsu's advanced four-layer polysilicon and two-layer aluminum process. This process, coupled with advanced stacked capacitor memory cells, reduces the possibility of soft errors and extends the time interval between memory refreshes. Clock timing requirements for the MB8118160A are not critical and all inputs are TTL compatible.

PRODUCT LINE & FEATURES

Parameter		MB8118160A-60	MB8118160A-70
R _{AS} Access Time		60 ns max.	70 ns max.
Random Cycle Time		110 ns min.	130 ns min.
Address Access Time		30 ns max.	35 ns max.
C _{AS} Access Time		15 ns max.	17 ns max.
Fast Page Mode Cycle Time		40 ns min.	45 ns min.
Low Power Dissipation	Operating current	880 mW max.	825 mW max.
	Standby current	11 mW max. (LTTL level)/5.5 mW max. (CMOS level)	

- 1,048,576 words × 16 bit organization
- Silicon gate, CMOS, Advanced Stacked Capacitor Cell
- All input and output are TTL compatible
- 1,024 refresh cycles every 16.4 ms
- Self refresh function
- Early write or \overline{OE} controlled write capability
- RAS-only, CAS-before-RAS, or Hidden Refresh
- Fast page mode, Read-Modify-Write capability
- On chip substrate bias generator for high performance

This device contains circuitry to protect the inputs against damage due to high static voltages or electric fields. However, it is advised that normal precautions be taken to avoid application of any voltage higher than maximum rated voltages to this high impedance circuit.

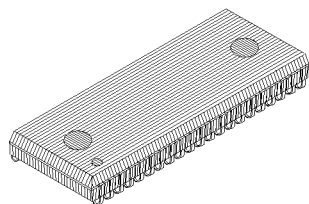
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■ ABSOLUTE MAXIMUM RATINGS (See WARNING)

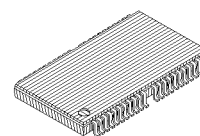
Parameter	Symbol	Value	Unit
Voltage at any pin relative to V_{SS}	V_{IN}, V_{OUT}	-0.5 to +7.0	V
Voltage of V_{CC} supply relative to V_{SS}	V_{CC}	-0.5 to +7.0	V
Power Dissipation	P_D	1.0	W
Short Circuit Output Current	—	50	mA
Operating Temperature	T_{OPE}	0 to 70	°C
Storage Temperature	T_{STG}	-55 to +125	°C

WARNING: Permanent device damage may occur if the above **Absolute Maximum Ratings** are exceeded. Functional operation should be restricted to the conditions as detailed in the operational sections of this data sheet. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

■ PACKAGE



Plastic SOJ Package
(LCC-42P-M01)



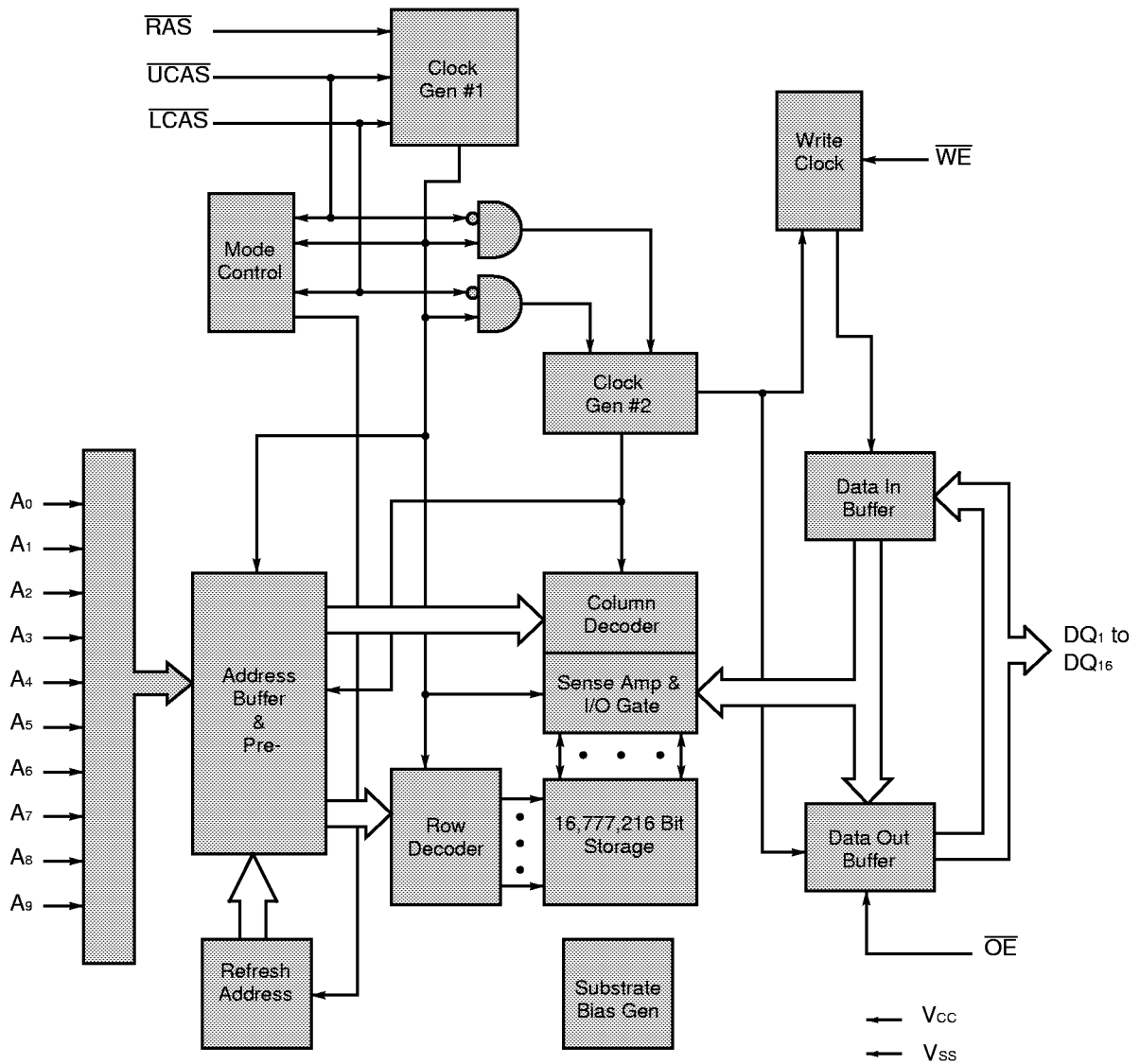
Plastic TSOP Package
(FPT-50P-M06)
(Normal Bend)

Package and Ordering Information

- 42-pin plastic (400 mil) SOJ, order as MB8118160A-xxPJ
- 50-pin plastic (400 mil) TSOP-II with normal bend leads, order as MB8118160A-xxPFTN

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Fig. 1 – MB8118160A DYNAMIC RAM - BLOCK DIAGRAM



■ CAPACITANCE

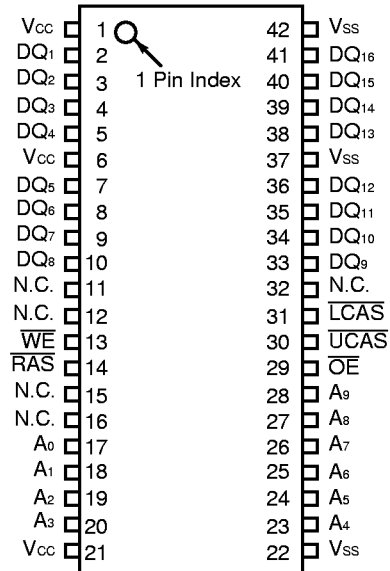
($T_A = 25^\circ\text{C}$, $f = 1\text{ MHz}$)

Parameter	Symbol	Max.	Unit
Input Capacitance, A_0 to A_9	C_{IN1}	5	pF
Input Capacitance, RAS, LCAS, UCAS, WE, \overline{OE}	C_{IN2}	5	pF
Input/Output Capacitance, DQ_1 to DQ_{16}	C_{DQ}	7	pF

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■ PIN ASSIGNMENTS AND DESCRIPTIONS

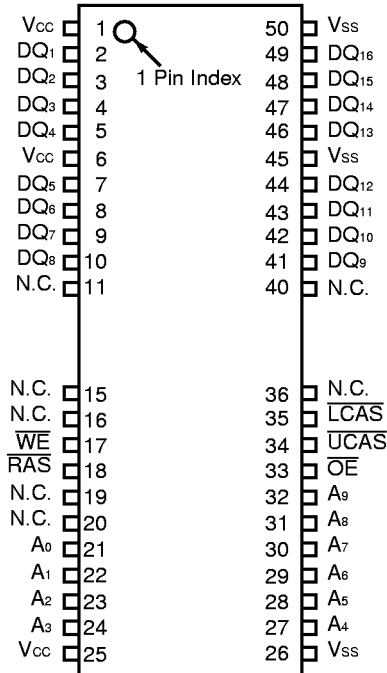
42-Pin SOJ
(TOP VIEW)



Designator	Function
A ₀ to A ₉	Address inputs row : A ₀ to A ₉ column : A ₀ to A ₉ refresh : A ₀ to A ₉
$\overline{\text{RAS}}$	Row address strobe
$\overline{\text{LCAS}}$	Lower column address strobe
$\overline{\text{UCAS}}$	Upper column address strobe
$\overline{\text{WE}}$	Write enable
$\overline{\text{OE}}$	Output enable
DQ ₁ to DQ ₁₆	Data Input/Output
V _{cc}	+5.0 volt power supply
V _{ss}	Circuit ground
N.C.	No connection

50-Pin TSOP
(TOP VIEW)

<Normal Bend>



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■ RECOMMENDED OPERATING CONDITIONS

Parameter	Notes	Symbol	Min.	Typ.	Max.	Unit	Ambient Operating Temp.
Supply Voltage	[1]	V _{CC}	4.5	5.0	5.5	V	0°C to +70°C
		V _{SS}	0.0	0.0	0.0		
Input High Voltage, all inputs	[1]	V _{IH}	2.4	—	6.5	V	
Input Low Voltage, all inputs*	[1]	V _{IL}	-0.3	—	0.8	V	

* : Undershoots of up to -2.0 volts with a pulse width not exceeding 20 ns are acceptable.

■ FUNCTIONAL OPERATION

ADDRESS INPUTS

Twenty input bits are required to decode any sixteen of 16,777,216 cell addresses in the memory matrix. Since only twelve address bits (A₀ to A₉) are available, the column and row inputs are separately strobed by $\overline{\text{LCAS}}$ or $\overline{\text{UCAS}}$ and $\overline{\text{RAS}}$ as shown in Figure 1. First, ten row address bits are input on pins A₀-through-A₉ and latched with the row address strobe ($\overline{\text{RAS}}$) then, ten column address bits are input and latched with the column address strobe ($\overline{\text{LCAS}}$ or $\overline{\text{UCAS}}$). Both row and column addresses must be stable on or before the falling edges of $\overline{\text{RAS}}$ and $\overline{\text{LCAS}}$ or $\overline{\text{UCAS}}$, respectively. The address latches are of the flow-through type; thus, address information appearing after t_{RAH} (min.) + t_t is automatically treated as the column address.

WRITE ENABLE

The read or write mode is determined by the logic state of $\overline{\text{WE}}$. When $\overline{\text{WE}}$ is active Low, a write cycle is initiated; when $\overline{\text{WE}}$ is High, a read cycle is selected. During the read mode, input data is ignored.

DATA INPUT

Input data is written into memory in either of three basic ways – an early write cycle, an $\overline{\text{OE}}$ (delayed) write cycle, and a read-modify-write cycle. The falling edge of $\overline{\text{WE}}$ or $\overline{\text{LCAS}}$ / $\overline{\text{UCAS}}$, whichever is later, serves as the input data-latch strobe. In an early write cycle, the input data of DQ₁-DQ₈ is strobed by $\overline{\text{LCAS}}$ and DQ₉-DQ₁₆ is strobed by $\overline{\text{UCAS}}$ and the setup/hold times are referenced to each $\overline{\text{LCAS}}$ and $\overline{\text{UCAS}}$ because $\overline{\text{WE}}$ goes Low before $\overline{\text{LCAS}}$ / $\overline{\text{UCAS}}$. In a delayed write or a read-modify-write cycle, $\overline{\text{WE}}$ goes Low after $\overline{\text{LCAS}}$ / $\overline{\text{UCAS}}$; thus, input data is strobed by $\overline{\text{WE}}$ and all setup/hold times are referenced to the write-enable signal.

DATA OUTPUT

The three-state buffers are TTL compatible with a fanout of two TTL loads. Polarity of the output data is identical to that of the input; the output buffers remain in the high-impedance state until the column address strobe goes Low. When a read or read-modify-write cycle is executed, valid outputs are obtained under the following conditions:

- t_{TRAC} : from the falling edge of $\overline{\text{RAS}}$ when t_{TRCD} (max.) is satisfied.
- t_{TCAC} : from the falling edge of $\overline{\text{LCAS}}$ (for DQ₁-DQ₈) $\overline{\text{UCAS}}$ (for DQ₉-DQ₁₆) when t_{TRCD} is greater than t_{TRCD} (max.).
- t_{TAA} : from column address input when t_{TRAD} is greater than t_{TRAD} (max.).
- t_{TOEA} : from the falling edge of $\overline{\text{OE}}$ when $\overline{\text{OE}}$ is brought Low after t_{TRAC}, t_{TCAC}, or t_{TAA}, and t_{TRCD} (max.) is satisfied.

The data remains valid until either $\overline{\text{LCAS}}$ / $\overline{\text{UCAS}}$ or $\overline{\text{OE}}$ returns to a High logic level. When an early write is executed, the output buffers remain in a high-impedance state during the entire cycle.

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FAST PAGE MODE OF OPERATION

The fast page mode of operation provides faster memory access and lower power dissipation. The fast page mode is implemented by keeping the same row address and strobing in successive column addresses. To satisfy these conditions, \overline{RAS} is held Low for all contiguous memory cycles in which row addresses are common. For each fast page of memory, any of 1,024×16-bits can be accessed and, when multiple MB8118160As are used, \overline{CAS} is decoded to select the desired memory fast page. Fast page mode operations need not be addressed sequentially and combinations of read, write, and/or read-modify-write cycles are permitted.

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■ DC CHARACTERISTICS

(Recommended operating conditions unless otherwise noted.)

Notes 3

Parameter	Notes	Symbol	Conditions	Value			Unit
				Min.	Typ.	Max.	
Output high voltage	[1]	V_{OH}	$I_{OH} = -5.0 \text{ mA}$	2.4	—	—	V
Output low voltage	[1]	V_{OL}	$I_{OL} = +4.2 \text{ mA}$	—	—	0.4	
Input leakage current (any input)		$I_{I(L)}$	$0 \text{ V} \leq V_{IN} \leq V_{CC}$; $4.5 \text{ V} \leq V_{CC} \leq 5.5 \text{ V}$; $V_{SS} = 0 \text{ V}$; All other pins not under test = 0 V	-10	—	10	μA
Output leakage current		$I_{DO(L)}$	$0 \text{ V} \leq V_{OUT} \leq V_{CC}$; Data out disabled	-10	—	10	
Operating current (Average power supply current) [2]	MB8118160A-60	I_{CC1}	\overline{RAS} & \overline{LCAS} , \overline{UCAS} cycling; $t_{RC} = \text{min.}$	—	—	160	mA
	MB8118160A-70					150	
Standby current (Power supply current) [2]	TTL level	I_{CC2}	$\overline{RAS} = \overline{LCAS}$, $\overline{UCAS} = V_{IH}$	—	—	2.0	mA
	CMOS level					$\overline{RAS} = \overline{LCAS}$, $\overline{UCAS} \geq V_{CC} - 0.2 \text{ V}$	
Refresh current#1 (Average power supply current) [2]	MB8118160A-60	I_{CC3}	\overline{LCAS} , $\overline{UCAS} = V_{IH}$, \overline{RAS} cycling; $t_{RC} = \text{min.}$	—	—	160	mA
	MB8118160A-70					150	
Fast Page Mode Current [2]	MB8118160A-60	I_{CC4}	$\overline{RAS} = V_{IL}$, $\overline{LCAS} = \overline{UCAS}$ cycling; $t_{PC} = \text{min.}$	—	—	100	mA
	MB8118160A-70					90	
Refresh current#2 (Average power supply current) [2]	MB8118160A-60	I_{CC5}	\overline{RAS} cycling; \overline{CAS} -before- \overline{RAS} ; $t_{RC} = \text{min.}$	—	—	160	mA
	MB8118160A-70					150	
Refresh current#3 (Average power supply current)	MB8118160A-60	I_{CC9}	$\overline{RAS} = V_{IL}$, $\overline{CAS} = V_{IL}$ Self refresh; $t_{RASS} = \text{min.}$	—	—	1000	μA
	MB8118160A-70						

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■ AC CHARACTERISTICS

(At recommended operating conditions unless otherwise noted.)

Notes 3, 4, 5

No.	Parameter	Notes	Symbol	MB8118160A-60		MB8118160A-70		Unit
				Min.	Max.	Min.	Max.	
1	Time Between Refresh		t _{REF}	—	16.4	—	16.4	ms
2	Random Read/Write Cycle Time		t _{RC}	110	—	130	—	ns
3	Read-Modify-Write Cycle Time		t _{RWC}	150	—	174	—	ns
4	Access Time from $\overline{\text{RAS}}$	6, 9	t _{RAC}	—	60	—	70	ns
5	Access Time from $\overline{\text{CAS}}$	7, 9	t _{CAC}	—	15	—	17	ns
6	Column Address Access Time	8, 9	t _{AA}	—	30	—	35	ns
7	Output Hold Time		t _{OH}	3	—	3	—	ns
8	Output Buffer Turn On Delay Time		t _{ON}	0	—	0	—	ns
9	Output Buffer Turn off Delay Time	10	t _{OFF}	—	15	—	17	ns
10	Transition Time		t _T	3	50	3	50	ns
11	$\overline{\text{RAS}}$ Precharge Time		t _{RP}	40	—	50	—	ns
12	$\overline{\text{RAS}}$ Pulse Width		t _{RAS}	60	100000	70	100000	ns
13	$\overline{\text{RAS}}$ Hold Time		t _{RSH}	15	—	17	—	ns
14	$\overline{\text{CAS}}$ to $\overline{\text{RAS}}$ Precharge Time		t _{CRP}	5	—	5	—	ns
15	$\overline{\text{RAS}}$ to $\overline{\text{CAS}}$ Delay Time	11, 12	t _{RCD}	20	45	20	53	ns
16	$\overline{\text{CAS}}$ Pulse Width		t _{CAS}	15	—	17	—	ns
17	$\overline{\text{CAS}}$ Hold Time		t _{CSH}	60	—	70	—	ns
18	$\overline{\text{CAS}}$ Precharge Time (Normal)	19	t _{CPN}	10	—	10	—	ns
19	Row Address Set Up Time		t _{ASR}	0	—	0	—	ns
20	Row Address Hold Time		t _{RAH}	10	—	10	—	ns
21	Column Address Set Up Time		t _{ASC}	0	—	0	—	ns
22	Column Address Hold Time		t _{CAH}	15	—	15	—	ns
23	Column Address Hold Time from $\overline{\text{RAS}}$		t _{AR}	35	—	35	—	ns
24	$\overline{\text{RAS}}$ to Column Address Delay Time	13	t _{RAD}	15	30	15	35	ns
25	Column Address to $\overline{\text{RAS}}$ Lead Time		t _{RAL}	30	—	35	—	ns
26	Column Address to $\overline{\text{CAS}}$ Lead Time		t _{CAL}	30	—	35	—	ns
27	Read Command Set Up Time		t _{RCS}	0	—	0	—	ns
28	Read Command Hold Time Referenced to $\overline{\text{RAS}}$	14	t _{RRH}	0	—	0	—	ns
29	Read Command Hold Time Referenced to $\overline{\text{CAS}}$	14	t _{RCH}	0	—	0	—	ns
30	Write Command Set Up Time	15, 20	t _{WCS}	0	—	0	—	ns
31	Write Command Hold Time		t _{WCH}	15	—	15	—	ns
32	Write Hold Time from $\overline{\text{RAS}}$		t _{WCR}	35	—	35	—	ns

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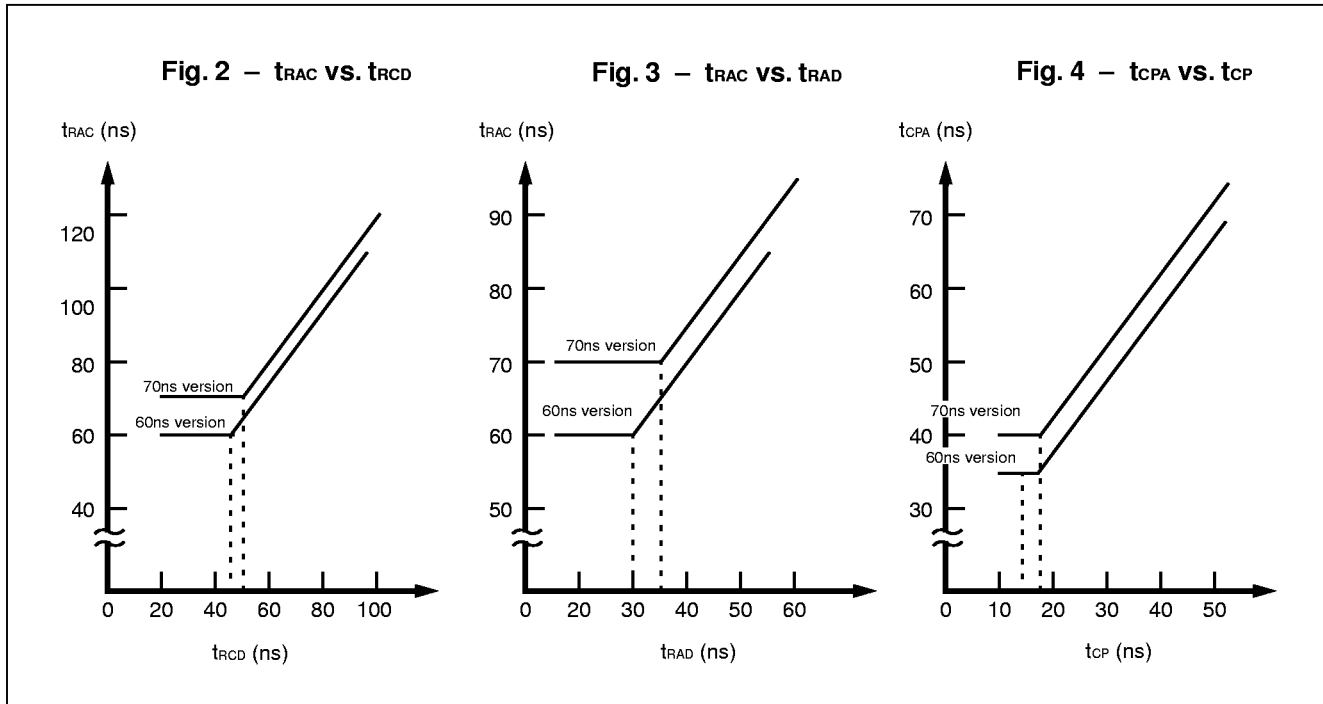
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No.	Parameter	Notes	Symbol	MB8118160A-60		MB8118160A-70		Unit
				Min.	Max.	Min.	Max.	
33	\overline{WE} Pulse Width		t _{WP}	15	—	15	—	ns
34	Write Command to \overline{RAS} Lead Time		t _{RWL}	15	—	17	—	ns
35	Write Command to \overline{CAS} Lead Time		t _{CWL}	15	—	17	—	ns
36	DIN Set Up Time		t _{DS}	0	—	0	—	ns
37	DIN Hold Time		t _{DH}	15	—	15	—	ns
38	Data Hold Time from \overline{RAS}		t _{DHR}	35	—	35	—	ns
39	\overline{RAS} to \overline{WE} Delay Time	20	t _{RWD}	80	—	92	—	ns
40	\overline{CAS} to \overline{WE} Delay Time	20	t _{CWD}	35	—	39	—	ns
41	Column Address to \overline{WE} Delay Time	20	t _{AWD}	50	—	57	—	ns
42	\overline{RAS} Precharge Time to \overline{CAS} Active Time (Refresh Cycles)		t _{RPC}	5	—	5	—	ns
43	\overline{CAS} Set Up Time for \overline{CAS} -before- \overline{RAS} Refresh		t _{CSR}	0	—	0	—	ns
44	\overline{CAS} Hold Time for \overline{CAS} -before- \overline{RAS} Refresh		t _{CHR}	10	—	12	—	ns
45	Access Time from \overline{OE}	9	t _{OEA}	—	15	—	17	ns
46	Output Buffer Turn Off Delay from \overline{OE}	10	t _{OEZ}	—	15	—	17	ns
47	\overline{OE} to \overline{RAS} Lead Time for Valid Data		t _{OEL}	10	—	10	—	ns
48	\overline{OE} Hold Time Referenced to \overline{WE}	16	t _{OEH}	5	—	5	—	ns
49	\overline{OE} to Data in Delay Time		t _{OED}	15	—	17	—	ns
50	\overline{CAS} to Data in Delay Time		t _{CDD}	15	—	17	—	ns
51	DIN to \overline{CAS} Delay Time	17	t _{DZC}	0	—	0	—	ns
52	DIN to \overline{OE} Delay Time	17	t _{DZO}	0	—	0	—	ns
60	Fast Page Mode \overline{RAS} Pulse Width		t _{RASP}	—	10000	—	10000	ns
61	Fast Page Mode Read/Write Cycle Time		t _{PC}	40	—	45	—	ns
62	Fast Page Mode Read-Modify-Write Cycle Time		t _{PRWC}	80	—	89	—	ns
63	Access Time from \overline{CAS} Precharge	9, 18	t _{CPA}	—	35	—	40	ns
64	Fast Page Mode \overline{CAS} Precharge Time		t _{CP}	10	—	10	—	ns
65	Fast Page Mode \overline{RAS} Hold Time from \overline{CAS} Precharge		t _{RHCP}	35	—	40	—	ns
66	Fast Page Mode \overline{CAS} Precharge to \overline{WE} Delay Time	20	t _{CPWD}	55	—	62	—	ns

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- Notes:
1. Referenced to V_{SS} .
 2. I_{CC} depends on the output load conditions and cycle rates; The specified values are obtained with the output open.
 I_{CC} depends on the number of address change as $\overline{RAS} = V_{IL}$, $\overline{UCAS} = V_{IH}$, $\overline{LCAS} = V_{IH}$ and $V_{IL} > -0.3V$.
 I_{CC1} , I_{CC3} , I_{CC4} and I_{CC5} are specified at one time of address change during $\overline{RAS} = V_{IL}$ and $\overline{UCAS} = V_{IH}$, $\overline{LCAS} = V_{IH}$. I_{CC2} is specified during $\overline{RAS} = V_{IH}$ and $V_{IL} > -0.3V$.
 3. An initial pause ($\overline{RAS} = \overline{CAS} = V_{IH}$) of $200\mu s$ is required after power-up followed by any eight \overline{RAS} -only cycles before proper device operation is achieved. In case of using internal refresh counter, a minimum of eight \overline{CAS} -before- \overline{RAS} initialization cycles instead of 8 \overline{RAS} cycles are required.
 4. AC characteristics assume $t_T = 5ns$.
 5. V_{IH} (min.) and V_{IL} (max.) are reference levels for measuring timing of input signals. Also transition times are measured between V_{IH} (min.) and V_{IL} (max.).
 6. Assumes that $t_{RCD} \leq t_{RCD} (max.)$, $t_{RAD} \leq t_{RAD} (max.)$. If t_{RCD} is greater than the maximum recommended value shown in this table, t_{RAC} will be increased by the amount that t_{RCD} exceeds the value shown. Refer to Fig.2 and 3.
 7. If $t_{RCD} \geq t_{RCD} (max.)$, $t_{RAD} \geq t_{RAD} (max.)$, and $t_{ASC} \geq t_{AA} - t_{CAC} - t_T$, access time is t_{CAC} .
 8. If $t_{RAD} \geq t_{RAD} (max.)$ and $t_{ASC} \leq t_{AA} - t_{CAC} - t_T$, access time is t_{AA} .
 9. Measured with a load equivalent to two TTL loads and $50pF$.
 10. t_{OFF} and t_{OEZ} are specified that output buffer change to high impedance state.
 11. Operation within the $t_{RCD} (max.)$ limit ensures that $t_{RAC} (max.)$ can be met. $t_{RCD} (max.)$ is specified as a reference point only; if t_{RCD} is greater than the specified $t_{RCD} (max.)$ limit, access time is controlled exclusively by t_{CAC} or t_{AA} .
 12. $t_{RCD} (min.) = t_{RAH} (min.) + 2t_T + t_{ASC} (min.)$.
 13. Operation within the $t_{RAD} (max.)$ limit ensures that $t_{RAC} (max.)$ can be met. $t_{RAD} (max.)$ is specified as a reference point only; if t_{RAD} is greater than the specified $t_{RAD} (max.)$ limit, access time is controlled exclusively by t_{CAC} or t_{AA} .
 14. Either t_{RRH} or t_{RCH} must be satisfied for a read cycle.
 15. t_{WCS} is specified as a reference point only. If $t_{WCS} \geq t_{WCS} (min.)$ the data output pin will remain High-Z state through entire cycle.
 16. Assumes that $t_{WCS} < t_{WCS} (min.)$.
 17. Either t_{DZC} or t_{DZO} must be satisfied.
 18. t_{CPA} is access time from the selection of a new column address (that is caused by changing both \overline{UCAS} and \overline{LCAS} from "L" to "H"). Therefore, if t_{CP} is long, t_{CPA} is longer than $t_{CPA} (max.)$.
 19. Assumes that \overline{CAS} -before- \overline{RAS} refresh.
 20. t_{WCS} , t_{CWD} , t_{RWD} , t_{AWD} and t_{CPWD} are not restrictive operating parameters. They are included in the data sheet as an electrical characteristic only. If $t_{WCS} \geq t_{WCS} (min.)$, the cycle is an early write cycle and D_{OUT} pin will maintain high impedance state throughout the entire cycle. If $t_{CWD} \geq t_{CWD} (min.)$, $t_{RWD} \geq t_{RWD} (min.)$, and $t_{AWD} \geq t_{AWD} (min.)$, $t_{CPWD} \geq t_{CPWD} (min.)$, the cycle is a read-modify-write cycle and data from the selected cell will appear at the D_{OUT} pin. If neither of the above conditions is satisfied, the cycle is a delayed write cycle and invalid data will appear the D_{OUT} pin, and write operation can be executed by satisfying t_{RWL} , t_{CWL} , and t_{RAL} specifications.

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FUNCTIONAL TRUTH TABLE

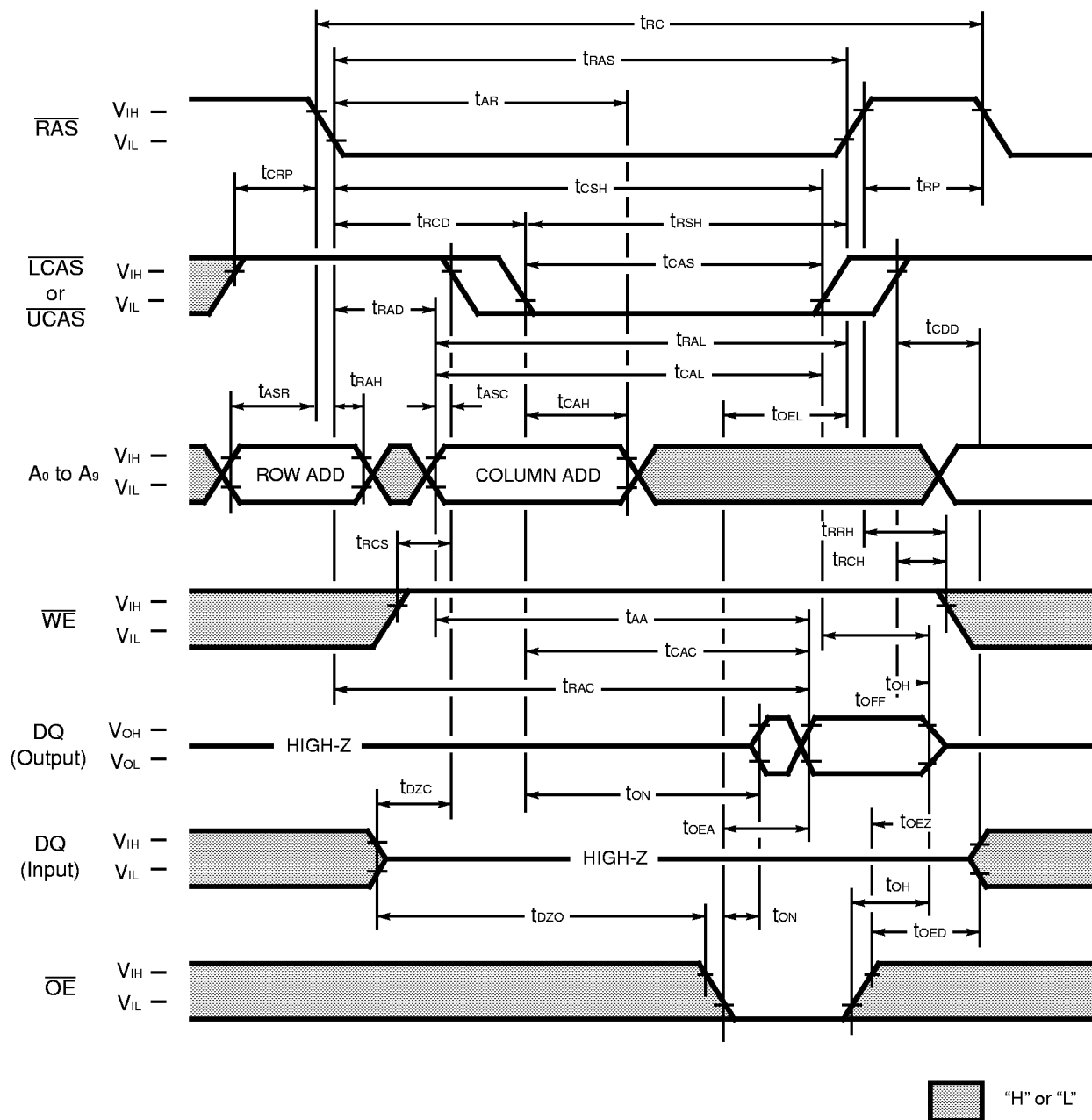
Operation Mode	Clock Input					Address		Input/Output Data				Refresh	Note	
	RAS	LCAS	UCAS	WE	OE	Row	Column	DQ ₁ to DQ ₈		DQ ₉ to DQ ₁₆				
								Input	Output	Input	Output			
Standby	H	H	H	X	X	—	—	—	High-Z	—	High-Z	—		
Read Cycle	L	L H L	H L L	H	L	Valid	Valid	—	Valid High-Z Valid	—	High-Z Valid Valid	Yes*	t _{RCS} ≥ t _{RCS} (min.)	
Write Cycle (Early Write)	L	L H L	H L L	L	X	Valid	Valid	Valid — Valid	High-Z	—	Valid Valid	High-Z	Yes*	t _{WCS} ≥ t _{WCS} (min.)
Read-Modify-Write Cycle	L	L H L	H L L	H→L	L→H	Valid	Valid	Valid — Valid	Valid High-Z Valid	—	Valid Valid Valid	High-Z Valid Valid	Yes*	
RAS-only Refresh Cycle	L	H	H	X	X	Valid	—	—	High-Z	—	High-Z	Yes		
CAS-before-RAS Refresh Cycle	L	L	L	X	X	—	—	—	High-Z	—	High-Z	Yes	t _{CSR} ≥ t _{CSR} (min.)	
Hidden Refresh Cycle	H→L	L H L	H L L	H→X	L	—	—	—	Valid High-Z Valid	—	High-Z Valid Valid	Yes	Previous data is kept	

Note: X ; "H" or "L"

* ; It is impossible in Hyper Page Mode.

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Fig. 5 – READ CYCLE



DESCRIPTION

To implement a read operation, a valid address is latched by the \overline{RAS} and \overline{LCAS} or \overline{UCAS} address strobes and with \overline{WE} set to a High level and \overline{OE} set to a low level, the output is valid once the memory access time has elapsed. \overline{LCAS} controls the input/output data on DQ₁ to DQ₈ pins, \overline{UCAS} controls one on DQ₉-DQ₁₆ pins. The access time is determined by $\overline{RAS}(t_{RC})$, $\overline{LCAS}/\overline{UCAS}(t_{CAC})$, $\overline{OE}(t_{OEA})$ or column addresses (t_{AA}) under the following conditions:

If $t_{RC} > t_{RC}(\max.)$, access time = t_{CAC} .

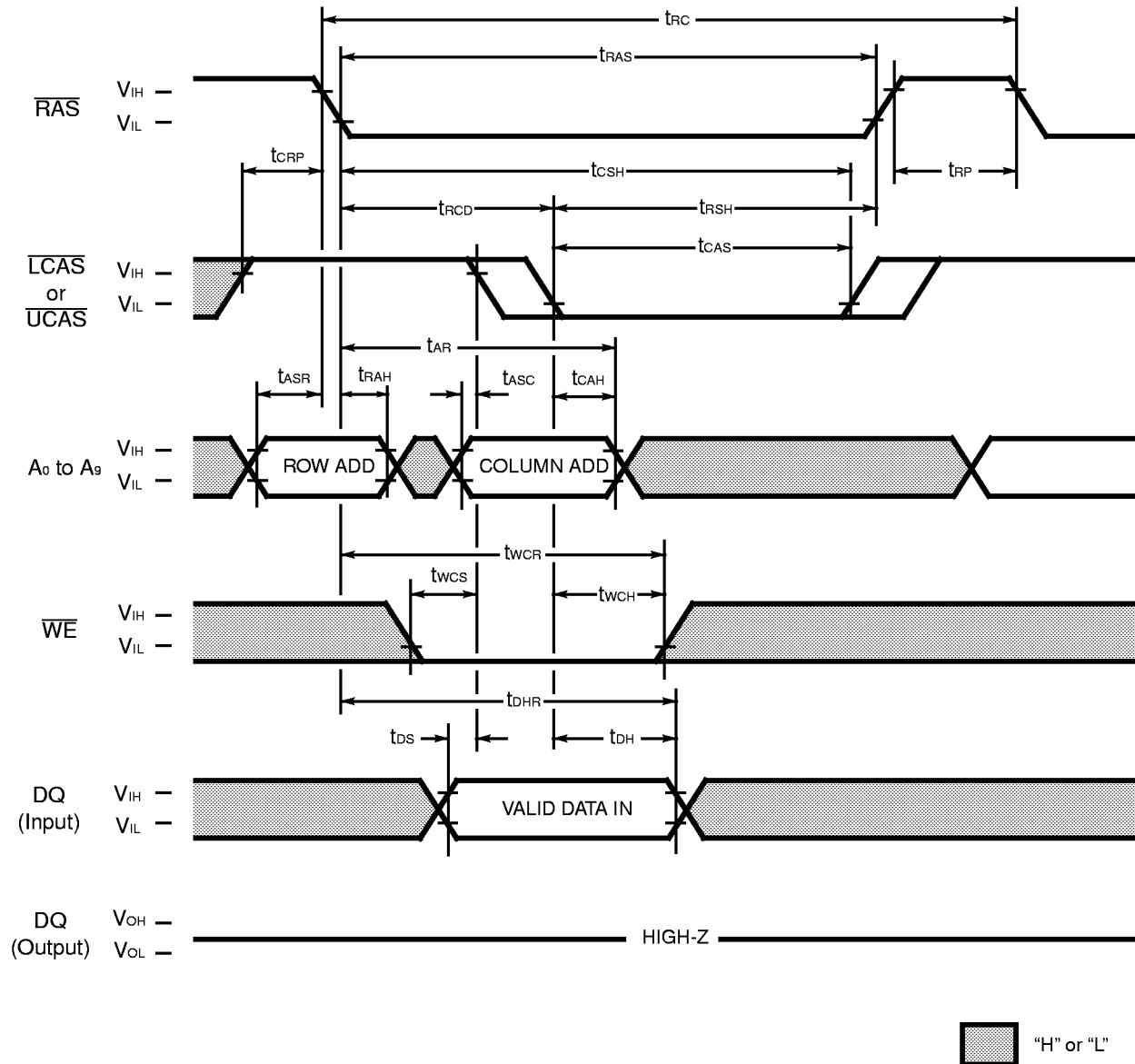
If $t_{RAD} > t_{RAD}(\max.)$, access time = t_{AA} .

If \overline{OE} is brought Low after t_{RC} , t_{CAC} , or t_{AA} (whichever occurs later), access time = t_{OEA} .

However, if either $\overline{LCAS}/\overline{UCAS}$ or \overline{OE} goes High, the output returns to a high-impedance state after t_{OH} is satisfied.

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Fig. 6 – EARLY WRITE CYCLE (\overline{OE} = “H” or “L”)

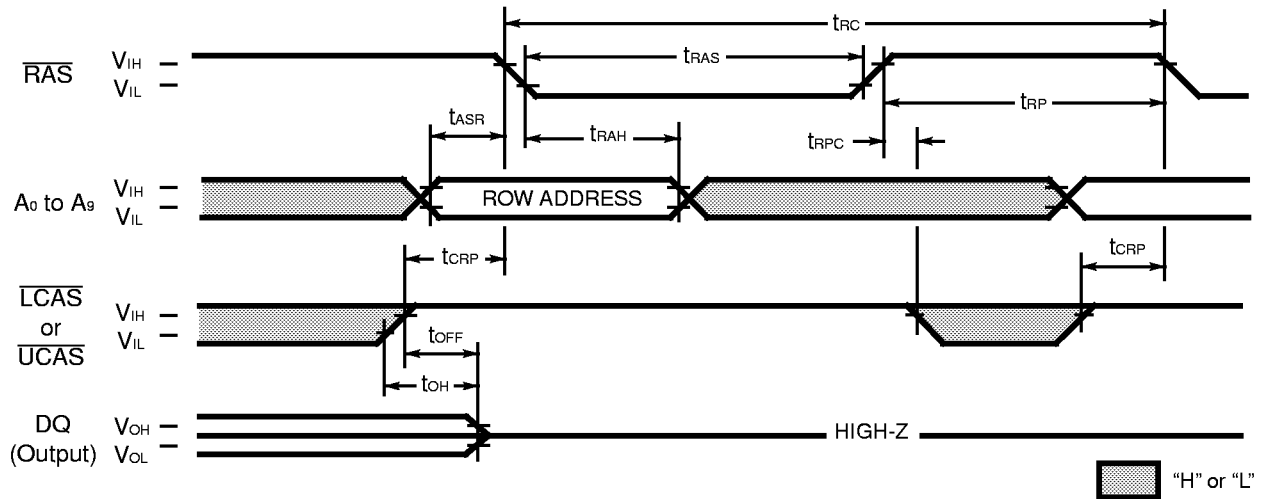


DESCRIPTION

A write cycle is similar to a read cycle except \overline{WE} is set to a Low state and \overline{OE} is an "H" or "L" signal. A write cycle can be implemented in either of three ways - early write, delayed write, or read-modify-write. During all write cycles, timing parameters t_{RWL} , t_{CWL} , t_{RAL} and t_{CAL} must be satisfied. In the early write cycle shown above t_{WCS} satisfied, data on the DQ pins are latched with the falling edge of LCAS or UCAS and written into memory.

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Fig. 13 – $\overline{\text{RAS}}$ -ONLY REFRESH ($\overline{\text{WE}} = \overline{\text{OE}} = \text{"H" or "L"}$)

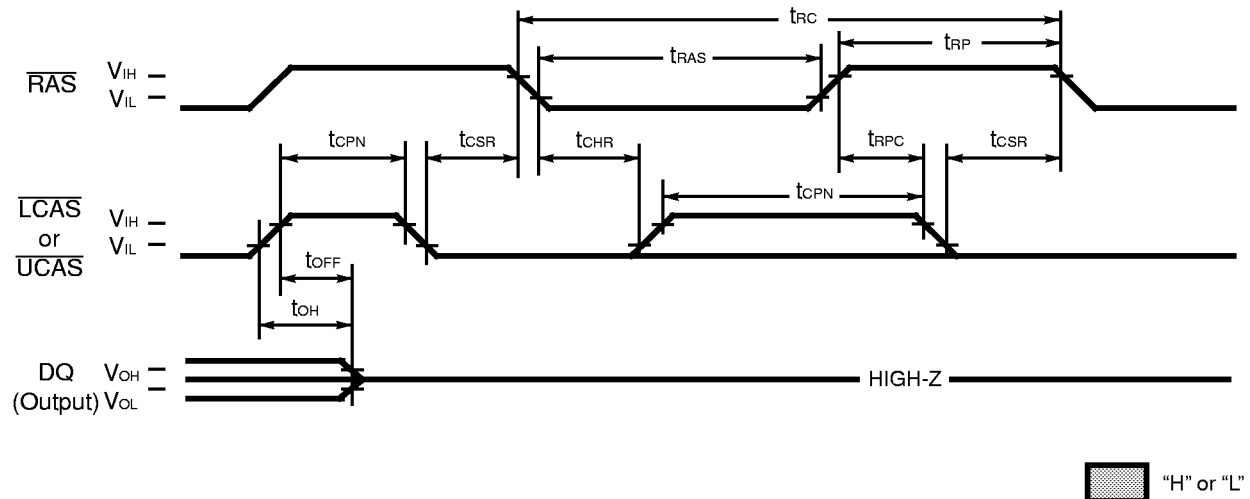


DESCRIPTION

Refresh of RAM memory cells is accomplished by performing a read, a write, or a read-modify-write cycle at each of 1,024 row addresses every 16.4-milliseconds. Three refresh modes are available: $\overline{\text{RAS}}$ -only refresh, $\overline{\text{CAS}}$ -before- $\overline{\text{RAS}}$ refresh, and hidden refresh.

$\overline{\text{RAS}}$ -only refresh is performed by keeping $\overline{\text{RAS}}$ Low and $\overline{\text{LCAS}}$ and $\overline{\text{UCAS}}$ High throughout the cycle; the row address to be refreshed is latched on the falling edge of $\overline{\text{RAS}}$. During $\overline{\text{RAS}}$ -only refresh, DQ pins are kept in a high-impedance state.

Fig. 14 – $\overline{\text{CAS}}$ -BEFORE- $\overline{\text{RAS}}$ REFRESH (ADDRESSES = $\overline{\text{WE}} = \overline{\text{OE}} = \text{"H" or "L"}$)

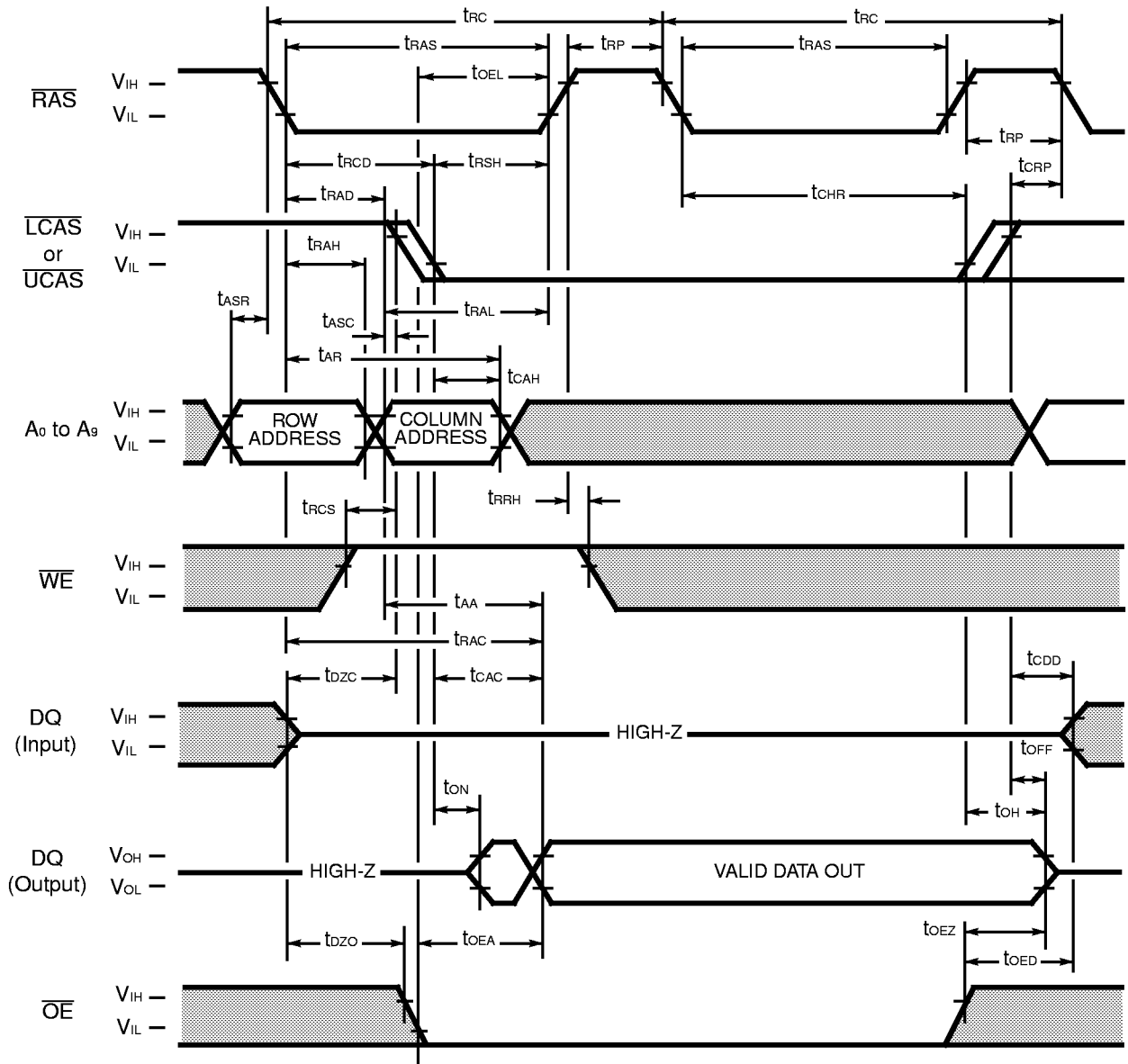


DESCRIPTION

$\overline{\text{CAS}}$ -before- $\overline{\text{RAS}}$ refresh is an on-chip refresh capability that eliminates the need for external refresh addresses. If $\overline{\text{LCAS}}$ or $\overline{\text{UCAS}}$ is held Low for the specified setup time (t_{CSR}) before $\overline{\text{RAS}}$ goes Low, the on-chip refresh control clock generators and refresh address counter are enabled. An internal refresh operation automatically occurs and the refresh address counter is internally incremented in preparation for the next $\overline{\text{CAS}}$ -before- $\overline{\text{RAS}}$ refresh operation.

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Fig. 15 – HIDDEN REFRESH CYCLE



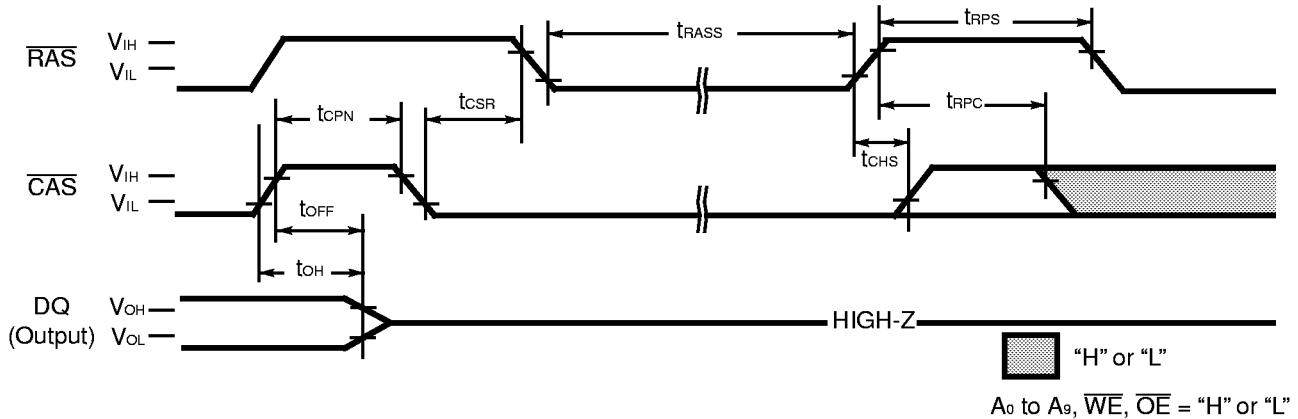
■ "H" or "L"

DESCRIPTION

A hidden refresh cycle may be performed while maintaining the latest valid data at the output by extending the active time of \overline{LCAS} or \overline{UCAS} and cycling \overline{RAS} . The refresh row address is provided by the on-chip refresh address counter. This eliminates the need for the external row address that is required by DRAMs that do not have \overline{CAS} -before- \overline{RAS} refresh capability.

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Fig. 17 – SELF REFRESH CYCLE ($A_0 - A_9 = \overline{WE} = \overline{OE} = \text{"H" or "L"}$)



(At recommended operating conditions unless otherwise noted.)

No.	Parameter	Symbol	MB8118160A-60		MB8118160A-70		Unit
			Min.	Max.	Min.	Max.	
100	\overline{RAS} Pulse Width	t_{RASS}	100	—	100	—	μs
101	\overline{RAS} Precharge Time	t_{RPS}	110	—	125	—	ns
102	\overline{CAS} Hold Time	t_{CHS}	-50	—	-50	—	ns

Note : Assumes self refresh cycle only.

DESCRIPTION

The self refresh cycle provides a refresh operation without external clock and external Address. Self refresh control circuit on chip is operated in the self refresh cycle and refresh operation can be automatically executed using internal refresh address counter and timing generator.

If \overline{CAS} goes to "L" before \overline{RAS} goes to "L" (CBR) and the condition of \overline{CAS} "L" and \overline{RAS} "L" is kept for term of t_{RASS} (more than 100 μs), the device can enter the self refresh cycle. Following that, refresh operation is automatically executed at fixed intervals using internal refresh address counter during " $\overline{RAS}=\text{L}$ " and " $\overline{CAS}=\text{L}$ ".

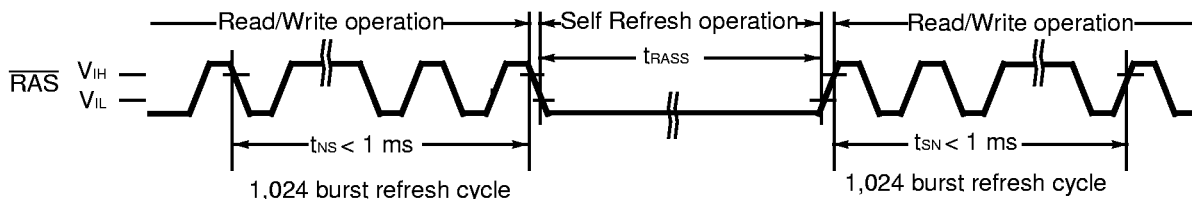
Exit from self refresh cycle is performed by toggling \overline{RAS} and \overline{CAS} to "H" with specified t_{CHS} min. In this time, \overline{RAS} must be kept "H" with specified t_{RPS} min.

Using self refresh mode, data can be retained without external \overline{CAS} signal during system is in standby.

Restriction for Self Refresh operation ;

For self refresh operation, the notice below must be considered.

- 1) In the case that distributed CBR refresh are operated between read/write cycles
Self refresh cycles can be executed without special rule if 1,024 cycles of distributed CBR refresh are executed within t_{REF} max.
- 2) In the case that burst CBR refresh or distributed/burst \overline{RAS} only refresh are operated between read/write cycles
1,024 times of burst CBR refresh or 1,024 times of burst \overline{RAS} only refresh must be executed before and after Self refresh cycles.

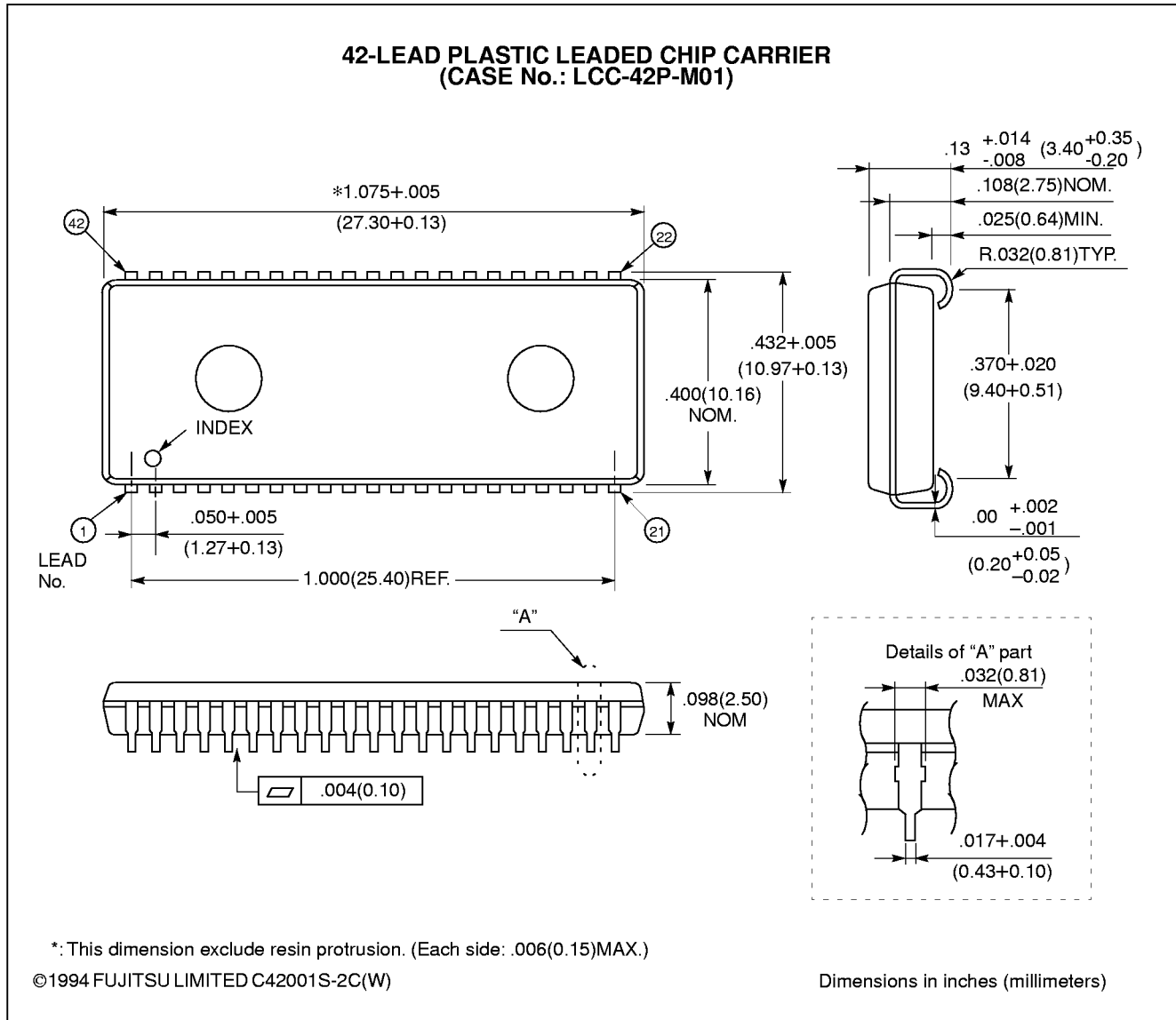


* Read/write operation can be performed non refresh time within t_{NS} or t_{SN} .

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■ PACKAGE DIMENSIONS

(Suffix: -PJ)

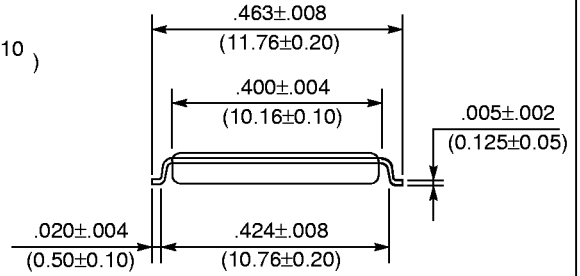
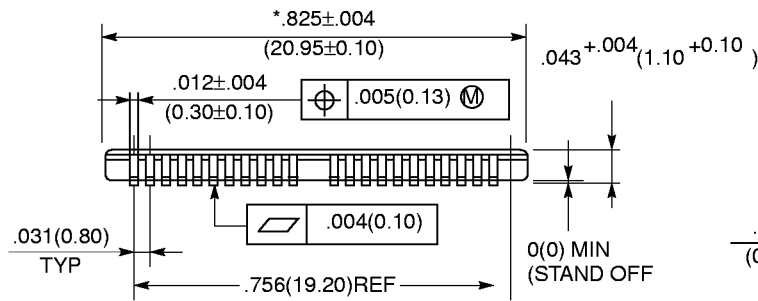
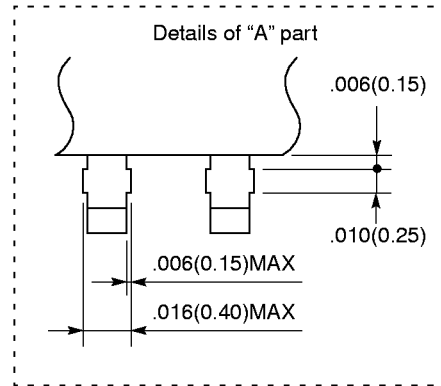
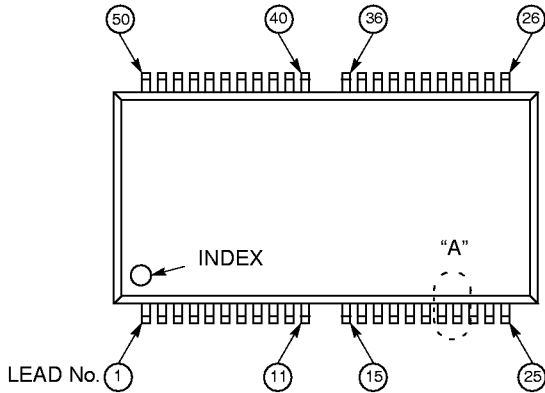


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(Continued)

(Suffix: -PFTN)

50-LEAD PLASTIC FLAT PACKAGE (CASE No.: FPT-50P-M06)



*: This dimension exclude resin protrusion. (Each side: .006(0.15) MAX)

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Dimensions in inches (millimeters)