

# MEMORY

## DRAM CARD

JEIDA \* [DRAM Card Guide Line Ver. 2.0] conformable

### MB98B7515/7516/7517/7518

#### DYNAMIC RANDOM ACCESS MEMORY CARD 16 M/32 M - BYTE

#### ■ DESCRIPTION

The MB98B7515 is a DRAM Card (4,194,304 words × 32 bits) with eight MB8117400A's mounted.

The MB98B7516 is a DRAM Card (4,194,304 words × 36 bits) with eight MB8117400A's and four MB814100A mounted.

The MB98B7517 is a DRAM Card (8,388,608 words × 32 bits) with sixteen MB8117400A's mounted.

The MB98B7518 is a DRAM Card (8,388,608 words × 36 bits) with sixteen MB8117400A's and eight MB814100A mounted.

The connector used for these series is a 88-pin, two-piece connector.

This card complies with JEIDA [DRAM Card Guide Line Ver. 2.0]

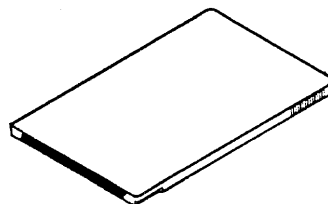
\*: Japanese Electronic Industry Development Association (JEIDA).

#### ■ FEATURES

- Outside dimensions: 85.6 mm × 54.0 mm × 3.3 mm
- Supply voltage: +5 V ±5 %
- Input/output level TTL compatible
- 2,048 refresh cycles / 128 ms (dispersion refresh)
- $\overline{\text{CAS}}$  before  $\overline{\text{RAS}}$  Refresh,  $\overline{\text{RAS}}$  Only Refresh, and Hidden Refresh are possible.
- High-speed Page Mode is available.
- DRAM with Substrate Bias Generator is mounted.
- 88-pin two-piece connector

#### ■ PACKAGE

88-pin DRAM Card



(CRD-88P-M01)

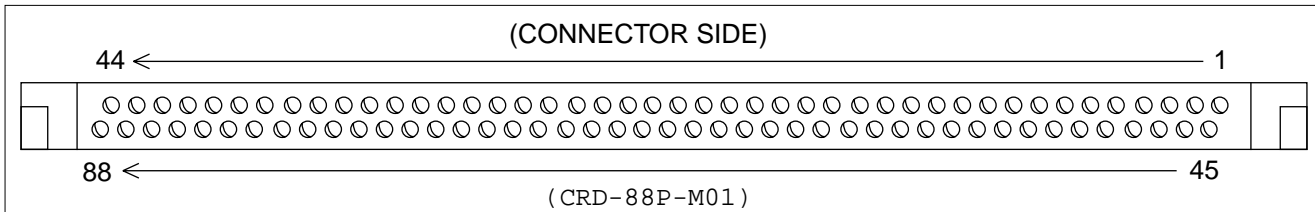
# MB98B7515/7516/7517/7518

## ■ PRODUCT CLASS

Part Number	Memory Device	Memory configuration	Access time (max.) ns		Cycle time (min.) ns		Power dissipation (max.) mW		
			Normal Mode	High-speed page mode	Normal Mode	High-speed page mode	Operating	Stand-by	
								TTL	CMOS
MB98B7515-70	MB8117400 A-60 × 8 pcs	4 M × 32	70	45	130	50	4,988	137	47.3
MB98B7516-70	MB8117400 A-60 × 8 pcs MB814100 A-60L × 4 pcs	4 M × 36					7,298	168	52.5
MB98B7517-70	MB8117400 A-60 × 16 pcs	8 M × 32					5,093	221	89.3
MB98B7518-70	MB8117400 A-60 × 16 pcs MB814100 A-60L × 8 pcs	8 M × 36					7,455	284	99.8
MB98B7515-80	MB8117400 A-70 × 8 pcs	4 M × 32	80	50	150	55	4,305	137	47.3
MB98B7516-80	MB8117400 A-70 × 8 pcs MB814100 A-70L × 4 pcs	4 M × 36					6,405	168	52.5
MB98B7517-80	MB8117400 A-70 × 16 pcs	8 M × 32					4,410	221	89.3
MB98B7518-80	MB8117400 A-70 × 16 pcs MB814100 A-70L × 8 pcs	8 M × 36					6,563	284	99.8

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## ■ PIN ASSIGNMENTS



Pin symbol	Pin name
A <sub>0</sub> to A <sub>10</sub>	Address
$\overline{\text{RAS}}_0$ to $\overline{\text{RAS}}_3$	Load address strobe
$\overline{\text{CAS}}_0$ to $\overline{\text{CAS}}_3$	Column address strobe
$\overline{\text{WE}}$	Write enable
DQ <sub>0</sub> to DQ <sub>35</sub>	Input/output data
PD <sub>1</sub> to PD <sub>8</sub>	Presence detect pin
N.C.	No connection
V <sub>CC</sub>	Power supply (+ 5 V)
GND	Ground

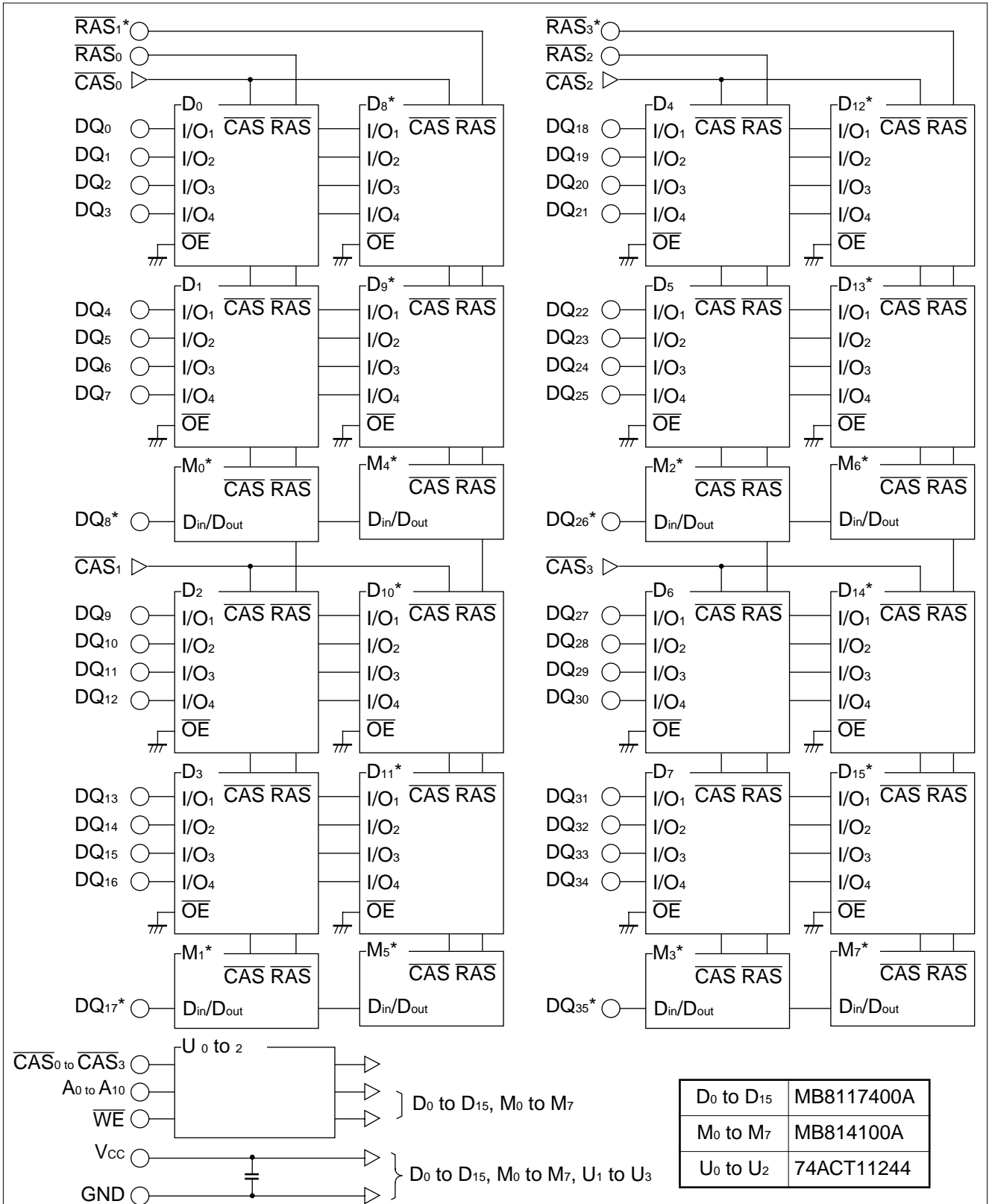
Pin No	Pin symbol	Pin No	Pin symbol	Pin No	Pin symbol	Pin No	Pin symbol
1	GND	23	$\overline{\text{CAS}}_0$	45	GND	67	GND
2	DQ <sub>0</sub>	24	$\overline{\text{CAS}}_1$	46	DQ <sub>18</sub>	68	$\overline{\text{CAS}}_3$
3	DQ <sub>1</sub>	25	N.C.	47	DQ <sub>19</sub>	69	$\overline{\text{RAS}}_3^{*1}$
4	DQ <sub>2</sub>	26	$\overline{\text{RAS}}_2$	48	DQ <sub>20</sub>	70	$\overline{\text{WE}}$
5	DQ <sub>3</sub>	27	V <sub>CC</sub>	49	DQ <sub>21</sub>	71	PD <sub>1</sub> <sup>*2</sup>
6	DQ <sub>4</sub>	28	PD <sub>2</sub> <sup>*2</sup>	50	DQ <sub>22</sub>	72	PD <sub>3</sub> <sup>*2</sup>
7	DQ <sub>5</sub>	29	PD <sub>4</sub> <sup>*2</sup>	51	DQ <sub>23</sub>	73	GND
8	DQ <sub>6</sub>	30	PD <sub>6</sub> <sup>*2</sup>	52	DQ <sub>24</sub>	74	PD <sub>5</sub> <sup>*2</sup>
9	V <sub>CC</sub>	31	N.C.	53	DQ <sub>25</sub>	75	PD <sub>7</sub> <sup>*2</sup>
10	DQ <sub>7</sub>	32	N.C.	54	DQ <sub>26</sub> <sup>*1</sup>	76	PD <sub>8</sub> <sup>*2</sup>
11	N.C.	33	DQ <sub>17</sub> <sup>*1</sup>	55	N.C.	77	N.C.
12	DQ <sub>8</sub> <sup>*1</sup>	34	DQ <sub>9</sub>	56	GND	78	N.C.
13	A <sub>0</sub>	35	N.C.	57	A <sub>1</sub>	79	DQ <sub>35</sub> <sup>*1</sup>
14	A <sub>2</sub>	36	DQ <sub>10</sub>	58	A <sub>3</sub>	80	DQ <sub>27</sub>
15	V <sub>CC</sub>	37	V <sub>CC</sub>	59	A <sub>5</sub>	81	DQ <sub>28</sub>
16	A <sub>4</sub>	38	DQ <sub>11</sub>	60	A <sub>7</sub>	82	DQ <sub>29</sub>
17	N.C.	39	DQ <sub>12</sub>	61	A <sub>9</sub>	83	DQ <sub>30</sub>
18	A <sub>6</sub>	40	DQ <sub>13</sub>	62	N.C.	84	DQ <sub>31</sub>
19	A <sub>8</sub>	41	DQ <sub>14</sub>	63	GND	85	DQ <sub>32</sub>
20	A <sub>10</sub>	42	DQ <sub>15</sub>	64	N.C.	86	DQ <sub>33</sub>
21	N.C.	43	DQ <sub>16</sub>	65	$\overline{\text{RAS}}_1^{*1}$	87	DQ <sub>34</sub>
22	$\overline{\text{RAS}}_0$	44	GND	66	$\overline{\text{CAS}}_2$	88	GND

\*1: The descriptions of  $\overline{\text{RAS}}$  pin/DQ pin depend on the series. Refer to "■ Differences among the Series" for details.

\*2: The description of PD pin depends on the series. Refer to "■ About PD pin" for details.

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## ■ BLOCK DIAGRAM



D <sub>0</sub> to D <sub>15</sub>	MB8117400A
M <sub>0</sub> to M <sub>7</sub>	MB814100A
U <sub>0</sub> to U <sub>2</sub>	74ACT11244

\* : The descriptions of  $\overline{\text{RAS}}$  pin/DQ pin and the class and number of the mounted Device depend on the series. Refer to "■ Differences among the Series" for details.

# MB98B7515/7516/7517/7518

## ■ DIFFERENCES AMONG THE SERIES

### 1. List of Pins and Mounted Devices

Series \ Part Number		MB98B7515	MB98B7516	MB98B7517	MB98B7518
Pin	$\overline{RAS}_0$	○	○		
	$RAS_1$	—	—		
	$\overline{RAS}_2$	○	○	○	○
	$\overline{RAS}_3$	—	—		
	DQ <sub>0</sub> to DQ <sub>7</sub>	○		○	
	DQ <sub>8</sub>	—		—	
	DQ <sub>9</sub> to DQ <sub>16</sub>	○		○	
	DQ <sub>17</sub>	—		—	
	DQ <sub>18</sub> to DQ <sub>25</sub>	○	○	○	○
	DQ <sub>26</sub>	—		—	
	DQ <sub>27</sub> to DQ <sub>34</sub>	○		○	
	DQ <sub>35</sub>	—		—	
Device	D <sub>0</sub> to D <sub>1</sub>	○	○	○	○
	D <sub>8</sub> to D <sub>15</sub>	—	—		
	M <sub>0</sub> to M <sub>3</sub>	—	○	—	○
	M <sub>4</sub> to M <sub>7</sub>		—		

○ : Mounted    — : Not mounted

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## ■ FUNCTIONAL TRUTH TABLE

### 1. Read/Write Modes

$\overline{RAS}_0$	$\overline{RAS}_1$	$\overline{RAS}_2$	$\overline{RAS}_3$	$\overline{CAS}_{0,1}$	$\overline{CAS}_{2,3}$	Active memory	DQ <sub>0</sub> to DQ <sub>17</sub>	DQ <sub>18</sub> to DQ <sub>35</sub>
H	H	H	H	H	H	—	High-Z	High-Z
L	H	H	H	L	H	D <sub>0</sub> to D <sub>3</sub> , M <sub>0,1</sub>	I/O data	High-Z
H	L	H	H	L	H	D <sub>8</sub> to D <sub>11</sub> , M <sub>4,5</sub>	I/O data	High-Z
H	H	L	H	H	L	D <sub>4</sub> to D <sub>7</sub> , M <sub>2,3</sub>	High-Z	I/O data
H	H	H	L	H	L	D <sub>12</sub> to D <sub>15</sub> , M <sub>6,7</sub>	High-Z	I/O data
L	H	L	H	L	L	D <sub>0</sub> to D <sub>7</sub> , M <sub>0</sub> to M <sub>3</sub>	I/O data	
L	L	X	X	X	X	Prohibited operation		
H	L	H	L	L	L	D <sub>0</sub> to D <sub>7</sub> , M <sub>0</sub> to M <sub>3</sub>	I/O data	
X	X	L	L	X	X	Prohibited operation		

### 2. $\overline{RAS}$ Only Refresh Mode

$\overline{RAS}_0$	$\overline{RAS}_1$	$\overline{RAS}_2$	$\overline{RAS}_3$	$\overline{CAS}_{0,1}$	$\overline{CAS}_{2,3}$	Active memory	DQ <sub>0</sub> to DQ <sub>17</sub>	DQ <sub>18</sub> to DQ <sub>35</sub>
L	H	H	H	H	H	D <sub>0</sub> to D <sub>3</sub> , M <sub>0,1</sub>	High-Z	
H	L	H	H	H	H	D <sub>8</sub> to D <sub>11</sub> , M <sub>4,5</sub>	High-Z	
H	H	L	H	H	H	D <sub>4</sub> to D <sub>7</sub> , M <sub>2,3</sub>	High-Z	
H	H	H	L	H	H	D <sub>12</sub> to D <sub>15</sub> , M <sub>6,7</sub>	High-Z	
L	H	L	H	H	H	D <sub>0</sub> to D <sub>7</sub> , M <sub>0</sub> to M <sub>3</sub>	High-Z	
L	L	X	X	X	X	Prohibited operation		
H	L	H	L	H	H	D <sub>8</sub> to D <sub>15</sub> , M <sub>4</sub> to M <sub>7</sub>	High-Z	
X	X	L	L	X	X	Prohibited operation		

### 3. $\overline{CAS}$ before $\overline{RAS}$ Refresh Mode

$\overline{RAS}_0$	$\overline{RAS}_1$	$\overline{RAS}_2$	$\overline{RAS}_3$	$\overline{CAS}_{0,1}$	$\overline{CAS}_{2,3}$	Active memory	DQ <sub>0</sub> to DQ <sub>17</sub>	DQ <sub>18</sub> to DQ <sub>35</sub>
L	H	H	H	L	H	D <sub>0</sub> to D <sub>3</sub> , M <sub>0,1</sub>	High-Z	
H	L	H	H	L	H	D <sub>8</sub> to D <sub>11</sub> , M <sub>4,5</sub>	High-Z	
H	H	L	H	H	L	D <sub>4</sub> to D <sub>7</sub> , M <sub>2,3</sub>	High-Z	
H	H	H	L	H	L	D <sub>12</sub> to D <sub>15</sub> , M <sub>6,7</sub>	High-Z	
L	H	L	H	L	L	D <sub>0</sub> to D <sub>7</sub> , M <sub>0</sub> to M <sub>3</sub>	High-Z	
L	L	X	X	X	X	Prohibited operation		
H	L	H	L	L	L	D <sub>8</sub> to D <sub>15</sub> , M <sub>4</sub> to M <sub>7</sub>	High-Z	
X	X	L	L	X	X	Prohibited operation		

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## 4. Hidden Refresh Mode

RAS <sub>0</sub>	RAS <sub>1</sub>	RAS <sub>2</sub>	RAS <sub>3</sub>	CAS <sub>0,1</sub>	CAS <sub>2,3</sub>	Active memory	DQ <sub>0</sub> to DQ <sub>17</sub>	DQ <sub>18</sub> to DQ <sub>35</sub>
H→L	H	H	H	L	H	D <sub>0</sub> to D <sub>3</sub> , M <sub>0,1</sub>	I/O data	High-Z
H	H→L	H	H	L	H	D <sub>8</sub> to D <sub>11</sub> , M <sub>4,5</sub>	I/O data	High-Z
H	H	H→L	H	H	L	D <sub>4</sub> to D <sub>7</sub> , M <sub>2,3</sub>	High-Z	I/O data
H	H	H	H→L	H	L	D <sub>12</sub> to D <sub>15</sub> , M <sub>6,7</sub>	High-Z	I/O data
H→L	H	H→L	H	L	L	D <sub>0</sub> to D <sub>7</sub> , M <sub>0</sub> to M <sub>3</sub>	I/O data	
H→L	H→L	X	X	X	X	Prohibited operation		
H	H→L	H	H→L	L	L	D <sub>8</sub> to D <sub>15</sub> , M <sub>4</sub> to M <sub>7</sub>	I/O data	
X	X	H→L	H→L	X	X	Prohibited operation		

X: "H" or "L".

## ■ ABSOLUTE MAXIMUM RATINGS (See WARNING)

(Voltage is with reference to the GND (ground))

Parameter	Symbol	Value				Unit
		MB98B7515	MB98B7516	MB98B7517	MB98B7518	
Supply Voltage	V <sub>CC</sub>	-0.5 to +6.0				V
Input Voltage	V <sub>IN</sub>	0 to V <sub>CC</sub>				V
Output Voltage	V <sub>OUT</sub>	0 to V <sub>CC</sub>				V
Storage Temperature	T <sub>stg</sub>	-30 to +70				°C
Power Dissipation	P <sub>D</sub>	8	12	16	24	W
Output Current (D.C.)	I <sub>OUT</sub>	50				mA

**WARNING:** Semiconductor devices can be permanently damaged by application of stress (voltage, current, temperature, etc.) in excess of absolute maximum ratings. Do not exceed these ratings.

## ■ RECOMMENDED OPERATING CONDITIONS

(Voltage is with reference to the GND (ground))

Parameter	Symbol	Min.	Typ.	Max.	Unit	Ambient Operating Temperature
Supply Voltage	V <sub>CC</sub>	4.75	5.0	5.25	V	0°C to +55°C
	V <sub>SS</sub>	0	0	0		
"High" Level Input Voltage (All Input Pins)	V <sub>IH</sub>	2.4	—	V <sub>CC</sub>	V	
"Low" Level Input Voltage (All Input Pins)	V <sub>IL</sub>	0	—	0.8	V	

**WARNING:** Recommended operating conditions are normal operating ranges for the semiconductor device. All the device's electrical characteristics are warranted when operated within these ranges.

Always use semiconductor devices within the recommended operating conditions. Operation outside these ranges may adversely affect reliability and could result in device failure.

No warranty is made with respect to uses, operating conditions, or combinations not represented on the data sheet. Users considering application outside the listed conditions are advised to contact their FUJITSU representative beforehand.

# MB98B7515/7516/7517/7518

## ■ ELECTRICAL CHARACTERISTICS

### 1. DC Characteristics

#### (1) MB98B7515 NOTE 3

(On the recommended operating conditions)

Parameter	Notes	Symbol	Min.	Max.	Unit	Measuring conditions
Supply Current (When Normally Operating)	*2	$I_{CC1}$	—	660	mA	Average supply current $t_{RC} = \text{min.}$ $\overline{RAS}, \overline{CAS}$ cycling
Supply Current (When Stand-by)	TTL	$I_{CC2}$	—	20	mA	$\overline{RAS} = \overline{CAS} = V_{IH}$
	CMOS		—	9		$\overline{RAS} = \overline{CAS} \geq V_{CC} - 0.2 \text{ V}$
Supply Current (On $\overline{RAS}$ Only Refresh)	*2	$I_{CC3}$	—	660	mA	Average supply current $t_{RC} = \text{min.}$ $\overline{RAS}$ cycling, $\overline{CAS} = V_{IH}$
Supply Current (In High-speed Page Mode)	*2	$I_{CC4}$	—	660	mA	Average supply current $t_{PC} = \text{min.}$ $\overline{RAS} = V_{IL}, \overline{CAS}$ cycling
Supply Current (On $\overline{CAS}$ Before $\overline{RAS}$ Refresh)	*2	$I_{CC5}$	—	660	mA	Average supply current $t_{RC} = \text{min.}$ $\overline{RAS}$ cycling, $\overline{CAS}$ before $\overline{RAS}$
Input Leakage Current	$\overline{CAS}_0$ to $\overline{CAS}_3$ $A_0$ to $A_{10}, \overline{WE}$	$I_{I(L)}$	-10	10	$\mu\text{A}$	(0 V $\leq V_{IN} \leq 5.25$ V) (0 V except the measured pin, 4.75 V $\leq V_{CC} \leq 5.25$ V)
	$\overline{RAS}_0, \overline{RAS}_2$		-30	30		
Output Leakage Current	DQ <sub>0</sub> to DQ <sub>7</sub> , DQ <sub>9</sub> to DQ <sub>16</sub> DQ <sub>18</sub> to DQ <sub>25</sub> , DQ <sub>27</sub> to DQ <sub>34</sub>	$I_{O(L)}$	-10	10	$\mu\text{A}$	(With output impedance high 0 V $\leq V_{OUT} \leq 5.25$ V)
	—		—	—		
“High” Level Output Voltage	*1	$V_{OH}$	2.4	—	V	( $I_{OH} = -5$ mA)
“Low” Level Output Voltage	*1	$V_{OL}$	—	0.4	V	( $I_{OL} = 4.2$ mA)



## MB98B7515/7516/7517/7518

## (2) MB98B7516 NOTE 3

(On the recommended operating conditions)

Parameter	Notes	Symbol	Min.	Max.	Unit	Measuring conditions
Supply Current (When Normally Operating)	*2	I <sub>CC1</sub>	—	1060	mA	Average supply current t <sub>RC</sub> = min. RAS, CAS cycling
Supply Current (When Stand-by)	TTL	I <sub>CC2</sub>	—	25	mA	RAS = CAS = V <sub>IH</sub>
	CMOS		—	10		RAS = CAS ≥ V <sub>CC</sub> - 0.2 V
Supply Current (On RAS Only Refresh)	*2	I <sub>CC3</sub>	—	1060	mA	Average supply current t <sub>RC</sub> = min. RAS cycling, CAS = V <sub>IH</sub>
Supply Current (In High-speed Page Mode)	*2	I <sub>CC4</sub>	—	860	mA	Average supply current t <sub>PC</sub> = min. RAS = V <sub>IL</sub> , CAS cycling
Supply Current (On CAS Before RAS Refresh)	*2	I <sub>CC5</sub>	—	980	mA	Average supply current t <sub>RC</sub> = min. RAS cycling, CAS before RAS
Input Leakage Current	CAS <sub>0</sub> to CAS <sub>3</sub> , A <sub>0</sub> to A <sub>10</sub> , WE	I <sub>I(L)</sub>	-10	10	μA	(0 V ≤ V <sub>IN</sub> ≤ 5.25 V) (0 V except the measured pin, 4.75 V ≤ V <sub>CC</sub> ≤ 5.25 V)
	RAS <sub>0</sub> , RAS <sub>2</sub>		-40	40		
Output Leakage Current	DQ <sub>0</sub> to DQ <sub>7</sub> , DQ <sub>9</sub> to DQ <sub>16</sub> , DQ <sub>18</sub> to DQ <sub>25</sub> , DQ <sub>27</sub> to DQ <sub>34</sub>	I <sub>O(L)</sub>	-10	10	μA	(With output impedance high 0 V ≤ V <sub>OUT</sub> ≤ 5.25 V)
	DQ <sub>8</sub> , DQ <sub>17</sub> , DQ <sub>26</sub> , DQ <sub>35</sub>		-20	20		
"High" Level Output Voltage	*1	V <sub>OH</sub>	2.4	—	V	(I <sub>OH</sub> = -5 mA)
"Low" Level Output Voltage	*1	V <sub>OL</sub>	—	0.4	V	(I <sub>OL</sub> = 4.2 mA)

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## (3) MB98B7517 NOTES 3, 19

(On the recommended operating conditions)

Parameter	Notes	Symbol	Min.	Max.	Unit	Measuring conditions
Supply Current (When Normally Operating)	*2	$I_{CC1}$	—	680	mA	Average supply current $t_{RC} = \text{min.}$ $\overline{RAS}, \overline{CAS}$ cycling
Supply Current (When Stand-by)	TTL	$I_{CC2}$	—	35	mA	$\overline{RAS} = \overline{CAS} = V_{IH}$
	CMOS		—	17		$\overline{RAS} = \overline{CAS} \geq V_{CC} - 0.2 \text{ V}$
Supply Current (On $\overline{RAS}$ Only Refresh)	*2	$I_{CC3}$	—	680	mA	Average supply current $t_{RC} = \text{min.}$ $\overline{RAS}$ cycling, $\overline{CAS} = V_{IH}$
Supply Current (In High-speed Page Mode)	*2	$I_{CC4}$	—	680	mA	Average supply current $t_{PC} = \text{min.}$ $\overline{RAS} = V_{IL}, \overline{CAS}$ cycling
Supply Current (On $\overline{CAS}$ Before $\overline{RAS}$ Refresh)	*2	$I_{CC5}$	—	680	mA	Average supply current $t_{RC} = \text{min.}$ $\overline{RAS}$ cycling, $\overline{CAS}$ before $\overline{RAS}$
Input Leakage Current	$\overline{CAS}_0$ to $\overline{CAS}_3$ $A_0$ to $A_{10}, \overline{WE}$	$I_{(L)}$	-10	10	$\mu\text{A}$	(0 V $\leq V_{IN} \leq 5.25$ V) (0 V except the measured pin, 4.75 V $\leq V_{CC} \leq 5.25$ V)
	$\overline{RAS}_0$ to $\overline{RAS}_3$		-30	30		
Output Leakage Current	DQ <sub>0</sub> to DQ <sub>7</sub> , DQ <sub>9</sub> to DQ <sub>16</sub> DQ <sub>18</sub> to DQ <sub>25</sub> , DQ <sub>27</sub> to DQ <sub>34</sub>	$I_{O(L)}$	-20	20	$\mu\text{A}$	(With output impedance high 0 V $\leq V_{OUT} \leq 5.25$ V)
	—		—	—		
“High” Level Output Voltage	*1	$V_{OH}$	2.4	—	V	( $I_{OH} = -5$ mA)
“Low” Level Output Voltage	*1	$V_{OL}$	—	0.4	V	( $I_{OL} = 4.2$ mA)

## MB98B7515/7516/7517/7518

## (4) MB98B7518 NOTES 3, 19

(On the recommended operating conditions)

Parameter	Notes	Symbol	Min.	Max.	Unit	Measuring conditions
Supply Current (When Normally Operating)	*2	$I_{CC1}$	—	1080	mA	Average supply current $t_{RC} = \text{min.}$ $\overline{RAS}, \overline{CAS}$ cycling
Supply Current (When Stand-by)	TTL	$I_{CC2}$	—	45	mA	$\overline{RAS} = \overline{CAS} = V_{IH}$
	CMOS		—	19		$\overline{RAS} = \overline{CAS} \geq V_{CC} - 0.2 \text{ V}$
Supply Current (On $\overline{RAS}$ Only Refresh)	*2	$I_{CC3}$	—	1080	mA	Average supply current $t_{RC} = \text{min.}$ $\overline{RAS}$ cycling, $\overline{CAS} = V_{IH}$
Supply Current (In High-speed Page Mode)	*2	$I_{CC4}$	—	880	mA	Average supply current $t_{PC} = \text{min.}$ $\overline{RAS} = V_{IL}, \overline{CAS}$ cycling
Supply Current (On $\overline{CAS}$ Before $\overline{RAS}$ Refresh)	*2	$I_{CC5}$	—	1000	mA	Average supply current $t_{RC} = \text{min.}$ $\overline{RAS}$ cycling, $\overline{CAS}$ before $\overline{RAS}$
Input Leakage Current	$\overline{CAS}_0$ to $\overline{CAS}_3$ $A_0$ to $A_{10}, \overline{WE}$	$I_{(L)}$	-10	10	$\mu\text{A}$	(0 V $\leq V_{IN} \leq 5.25$ V) (0 V except the measured pin, 4.75 V $\leq V_{CC} \leq 5.25$ V)
	$\overline{RAS}_0$ to $\overline{RAS}_3$		-40	40		
Output Leakage Current	DQ <sub>0</sub> to DQ <sub>7</sub> , DQ <sub>9</sub> to DQ <sub>16</sub> DQ <sub>18</sub> to DQ <sub>25</sub> , DQ <sub>27</sub> to DQ <sub>34</sub>	$I_{O(L)}$	-20	20	$\mu\text{A}$	(With output impedance high 0 V $\leq V_{OUT} \leq 5.25$ V)
	DQ <sub>8</sub> , DQ <sub>17</sub> , DQ <sub>26</sub> , DQ <sub>35</sub>		-30	30		
“High” Level Output Voltage	*1	$V_{OH}$	2.4	—	V	( $I_{OH} = -5$ mA)
“Low” Level Output Voltage	*1	$V_{OL}$	—	0.4	V	( $I_{OL} = 4.2$ mA)

# MB98B7515/7516/7517/7518

## 2. AC Characteristics NOTES 3, 4, 5

### (1) MB98B7515/6/7/8-70

(On the recommended operating conditions)

No.	Parameter	Notes	Symbol	Min.	Max.	Unit
1	Refresh Interval		$t_{REF}$	—	128	ms
2	Random Read/write Cycle Time		$t_{RC}$	130	—	ns
3	Access Time from $\overline{RAS}$	*6,9	$t_{RAC}$	—	70	ns
4	Access Time from $\overline{CAS}$	*7,9	$t_{CAC}$	—	25	ns
5	Column Address Access Time	*8,9	$t_{AA}$	—	40	ns
6	Output Data Hold Time		$t_{OH}$	2	—	ns
7	Output Turn On Delay Time		$t_{ON}$	2	—	ns
8	Output Turn Off Delay Time	*10	$t_{OFF}$	—	25	ns
9	Turn On/turn Off Periods		$t_r$	5	50	ns
10	$\overline{RAS}$ Precharge Time		$t_{RP}$	50	—	ns
11	$\overline{RAS}$ Pulse Width		$t_{RAS}$	70	100000	ns
12	$\overline{RAS}$ Hold Time		$t_{RSH}$	25	—	ns
13	$\overline{RAS} \cdot \overline{CAS}$ Precharge Time		$t_{CRP}$	15	—	ns
14	$\overline{RAS} \cdot \overline{CAS}$ Delay Time	*11,12	$t_{RCD}$	20	45	ns
15	$\overline{CAS}$ Pulse Width		$t_{CAS}$	25	—	ns
16	$\overline{CAS}$ Hold Time		$t_{CSH}$	70	—	ns
17	$\overline{CAS}$ Precharge Time	*17	$t_{CPN}$	10	—	ns
18	Low Address Setup Time		$t_{ASR}$	10	—	ns
19	Low Address Hold Time		$t_{RAH}$	10	—	ns
20	Column Address Setup Time		$t_{ASC}$	2	—	ns
21	Column Address Hold Time		$t_{CAH}$	15	—	ns
22	$\overline{RAS}$ Column Address Delay Time	*13	$t_{RAD}$	15	30	ns
23	Column Address $\overline{RAS}$ Read Time		$t_{RAL}$	40	—	ns
24	Column Address $\overline{CAS}$ Read Time		$t_{CAL}$	40	—	ns
25	Read Instruction Setup Time		$t_{RCS}$	0	—	ns
26	Read Instruction Hold Time from $\overline{RAS}$	*14	$t_{RRH}$	0	—	ns
27	Read Instruction Hold Time	*14	$t_{RCH}$	0	—	ns
28	Write Instruction Setup Time	*15	$t_{WCS}$	2	—	ns
29	Write Instruction Hold Time		$t_{WCH}$	15	—	ns
30	Write Instruction Pulse Width		$t_{WP}$	15	—	ns

(Continued)

## MB98B7515/7516/7517/7518

(Continued)

No.	Parameter	Notes	Symbol	Min.	Max.	Unit
31	Write Instruction · $\overline{\text{RAS}}$ Read Time		$t_{\text{RWL}}$	25	—	ns
32	Write Instruction · $\overline{\text{CAS}}$ Read Time		$t_{\text{CWL}}$	25	—	ns
33	Data Input Setup Time		$t_{\text{DS}}$	0	—	ns
34	Data Input Hold Time		$t_{\text{DH}}$	25	—	ns
35	$\overline{\text{CAS}}$ Active Display from $\overline{\text{RAS}}$ Precharge		$t_{\text{RPC}}$	5	—	ns
36	$\overline{\text{RAS}}$ · $\overline{\text{CAS}}$ Setup Time ( $\overline{\text{CAS}}$ Before $\overline{\text{RAS}}$ )		$t_{\text{CSR}}$	10	—	ns
37	$\overline{\text{RAS}}$ · $\overline{\text{CAS}}$ Hold Time ( $\overline{\text{CAS}}$ Before $\overline{\text{RAS}}$ )		$t_{\text{CHR}}$	10	—	ns
38	$\overline{\text{WE}}$ Setup Time from $\overline{\text{RAS}}$	*18	$t_{\text{WSR}}$	10	—	ns
39	$\overline{\text{WE}}$ Hold Time from $\overline{\text{RAS}}$	*18	$t_{\text{WHR}}$	10	—	ns
40	Data Input $\overline{\text{CAS}}$ Delay Time		$t_{\text{DZC}}$	0	—	ns
41	High-speed Page Mode Read/write Cycle Time		$t_{\text{PC}}$	50	—	ns
42	Access Time from High-speed Page Mode $\overline{\text{CAS}}$ Precharge	*9,16	$t_{\text{CPA}}$	—	45	ns
43	High-speed Page Mode $\overline{\text{CAS}}$ Precharge Time		$t_{\text{CP}}$	10	—	ns
44	$\overline{\text{RAS}}$ Hold Time From High-speed Page Mode $\overline{\text{CAS}}$ Precharge		$t_{\text{RHCP}}$	40	—	ns

# MB98B7515/7516/7517/7518

## (2) MB98B7515/6/7/8-80

(On the recommended operating conditions)

No.	Parameter	Notes	Symbol	Min.	Max.	Unit
1	Refresh Interval		$t_{REF}$	—	128	ms
2	Random Read/Write Cycle Time		$t_{RC}$	150	—	ns
3	Access Time from $\overline{RAS}$	*6,9	$t_{RAC}$	—	80	ns
4	Access Time from $\overline{CAS}$	*7,9	$t_{CAC}$	—	30	ns
5	Column Address Access Time	*8,9	$t_{AA}$	—	45	ns
6	Output Data Hold Time		$t_{OH}$	2	—	ns
7	Output Turn On Delay Time		$t_{ON}$	2	—	ns
8	Output Turn Off Delay Time	*10	$t_{OFF}$	—	30	ns
9	Turn On/turn Off Periods		$t_r$	5	50	ns
10	$\overline{RAS}$ Precharge Time		$t_{RP}$	60	—	ns
11	$\overline{RAS}$ Pulse Width		$t_{RAS}$	80	100000	ns
12	$\overline{RAS}$ Hold Time		$t_{RSH}$	30	—	ns
13	$\overline{RAS} \cdot \overline{CAS}$ Precharge Time		$t_{CRP}$	15	—	ns
14	$\overline{RAS} \cdot \overline{CAS}$ Delay Time	*11,12	$t_{RCD}$	20	50	ns
15	$\overline{CAS}$ Pulse Width		$t_{CAS}$	30	—	ns
16	$\overline{CAS}$ Hold Time		$t_{CSH}$	80	—	ns
17	$\overline{CAS}$ Precharge Time	*17	$t_{CPN}$	10	—	ns
18	Low Address Setup Time		$t_{ASR}$	10	—	ns
19	Low Address Hold Time		$t_{RAH}$	10	—	ns
20	Column Address Setup Time		$t_{ASC}$	2	—	ns
21	Column Address Hold Time		$t_{CAH}$	15	—	ns
22	$\overline{RAS}$ Column Address Delay Time	*13	$t_{RAD}$	15	35	ns
23	Column Address $\overline{RAS}$ Read Time		$t_{RAL}$	45	—	ns
24	Column Address $\overline{CAS}$ Read Time		$t_{CAL}$	45	—	ns
25	Read Instruction Setup Time		$t_{RCS}$	0	—	ns
26	Read Instruction Hold Time from $\overline{RAS}$	*14	$t_{RRH}$	0	—	ns
27	Read Instruction Hold Time	*14	$t_{RCH}$	0	—	ns
28	Write Instruction Setup Time	*15	$t_{WCS}$	2	—	ns
29	Write Instruction Hold Time		$t_{WCH}$	15	—	ns
30	Write Instruction Pulse Width		$t_{WP}$	15	—	ns

(Continued)

## MB98B7515/7516/7517/7518

(Continued)

No.	Parameter	Notes	Symbol	Min.	Max.	Unit
31	Write Instruction · $\overline{\text{RAS}}$ Read Time		$t_{\text{RWL}}$	30	—	ns
32	Write Instruction · $\overline{\text{CAS}}$ Read Time		$t_{\text{CWL}}$	30	—	ns
33	Data Input Setup Time		$t_{\text{DS}}$	0	—	ns
34	Data Input Hold Time		$t_{\text{DH}}$	25	—	ns
35	$\overline{\text{CAS}}$ Active Display from $\overline{\text{RAS}}$ Precharge		$t_{\text{RPC}}$	5	—	ns
36	$\overline{\text{RAS}}$ · $\overline{\text{CAS}}$ Setup Time ( $\overline{\text{CAS}}$ Before $\overline{\text{RAS}}$ )		$t_{\text{CSR}}$	10	—	ns
37	$\overline{\text{RAS}}$ · $\overline{\text{CAS}}$ Hold Time ( $\overline{\text{CAS}}$ Before $\overline{\text{RAS}}$ )		$t_{\text{CHR}}$	12	—	ns
38	$\overline{\text{WE}}$ Setup Time from $\overline{\text{RAS}}$	*18	$t_{\text{WSR}}$	10	—	ns
39	$\overline{\text{WE}}$ Hold Time from $\overline{\text{RAS}}$	*18	$t_{\text{WHR}}$	10	—	ns
40	Data Input $\overline{\text{CAS}}$ Delay Time		$t_{\text{DZC}}$	0	—	ns
41	High-speed Page Mode Read/write Cycle Time		$t_{\text{PC}}$	55	—	ns
42	Access Time from High-speed Page Mode $\overline{\text{Cas}}$ Precharge	*9,16	$t_{\text{CPA}}$	—	50	ns
43	High-speed Page Mode $\overline{\text{CAS}}$ Precharge Time		$t_{\text{CP}}$	10	—	ns
44	$\overline{\text{RAS}}$ Hold Time From High-speed Page Mode $\overline{\text{CAS}}$ Precharge		$t_{\text{RHCP}}$	50	—	ns

# MB98B7515/7516/7517/7518

- Notes:**
- \*1. Voltage reference is  $V_{SS}$ .
  - \*2. Output pin is open. Supply current depends on cycle time and output load. If  $V_{IL} > -0.5\text{ V}$ ,  $\overline{RAS} = V_{IL}$  and  $\overline{CAS} = V_{IH}$ , supply current depends on the number of address changes. If  $\overline{RAS} = V_{IL}$  and  $\overline{CAS} = V_{IH}$ , the value of either  $I_{CC1}$ ,  $I_{CC3}$ ,  $I_{CC4}$  or  $I_{CC5}$  indicates that the address change has occurred only one time.
  - \*3. A time delay of  $200\ \mu\text{s}$  (called the pause time) plus the dummy cycles (shown below) is necessary for these elements to function after power on. The dummy cycles are one of the following: eight  $\overline{RAS}$  Only Refresh cycles, or eight  $\overline{CAS}$  before  $\overline{RAS}$  Refresh cycles ( $\overline{WE} = \text{“H”}$ ). If using the internal refresh counter, equal to or more than eight  $\overline{CAS}$  before  $\overline{RAS}$  Refresh cycles must be used for the dummy cycles.
  - \*4. AC characteristics must be measured by using  $t_T = 5\ \text{ns}$ .
  - \*5. Input reference levels for specifying the timing are the  $V_{IH}$  (min.) and  $V_{IL}$  (max.). The transition time ( $t_T$ ) is the time for a output voltage to switch from  $V_{IH}$  to  $V_{IL}$ .
  - \*6. The  $t_{RAC}$  (max.) is guaranteed on the condition that  $t_{RCD} \leq t_{RCD}(\text{max.})$  and  $t_{RAD} \leq t_{RAD}(\text{max.})$ . Therefore, if  $t_{RCD} > t_{RCD}(\text{max.})$  and  $t_{RAD} > t_{RAD}(\text{max.})$ ,  $t_{RAC}$  will appear after the delay time equivalent to the difference between  $t_{RCD}$  and  $t_{RCD}(\text{max.})$  or  $t_{RAD}$  and  $t_{RAD}(\text{max.})$ .
  - \*7. If  $t_{ASC} \geq t_{AA} - t_{CAC} - (t_T)$  with  $t_{RCD} \geq t_{RCD}(\text{max.})$  and  $t_{RAD} \geq t_{RAD}(\text{max.})$ , the access time is dependent of the  $\overline{CAS}$ .
  - \*8. If  $t_{ASC} \leq t_{AA} - t_{CAC} - (t_T)$  with  $t_{RAD} \geq t_{RAD}(\text{max.})$ , the access time is dependent of the column address.
  - \*9. 2TTL + 100PF load.
  - \*10. The  $t_{OFF}$  is defined while the internal output buffer is in high impedance.
  - \*11. The  $t_{RCD}(\text{max.})$  is not a critical operating point, but a max.  $t_{RCD}$  value that guarantees  $t_{RAC}(\text{max.})$ . In case  $t_{RCD} > t_{RCD}(\text{max.})$ , the access time depends on the  $t_{CAC}$  or  $t_{AA}$ .
  - \*12. The  $t_{RCD}(\text{min.}) = t_{RAH}(\text{min.}) + 2t_T + t_{ASC}(\text{min.})$ .
  - \*13. The  $t_{RAD}(\text{max.})$  is not a critical operating point, but a max.  $t_{RAD}$  value that guarantees  $t_{RAC}(\text{max.})$ . In case  $t_{RAD} > t_{RAD}(\text{max.})$ , the access time depends on the  $t_{CAC}$  or  $t_{AA}$ .
  - \*14. Operation is guaranteed if one of the  $t_{RCH}$  or  $t_{RRH}$  is met.
  - \*15. If  $t_{WCS} \geq t_{WCS}(\text{min.})$ , the DQ(output) pin shows open (high impedance) during this cycle.
  - \*16. The  $t_{CPA}$  regulates the access time if the  $\overline{CAS}$  releases the column address latch, and this release consequently permits a new column address to be selected. Therefore, the  $t_{CPA}$  gets longer than  $t_{CPA}(\text{max.})$  if the  $t_{CP}$  is long.
  - \*17. Only  $\overline{CAS}$  before  $\overline{RAS}$  Refresh cycle is defined.
  - \*18. The test mode is defined.
  - \*19. On reading, the Bank 1 (controlled by  $\overline{RAS}_0$  and  $\overline{RAS}_2$ ) and Bank 2 (controlled by  $\overline{RAS}_1$  and  $\overline{RAS}_3$ ) must not work at the same time because the DQ pin is common to both the Bank 1 and Bank 2 (the other must be in stand-by).

## 3. Capacity between Pins

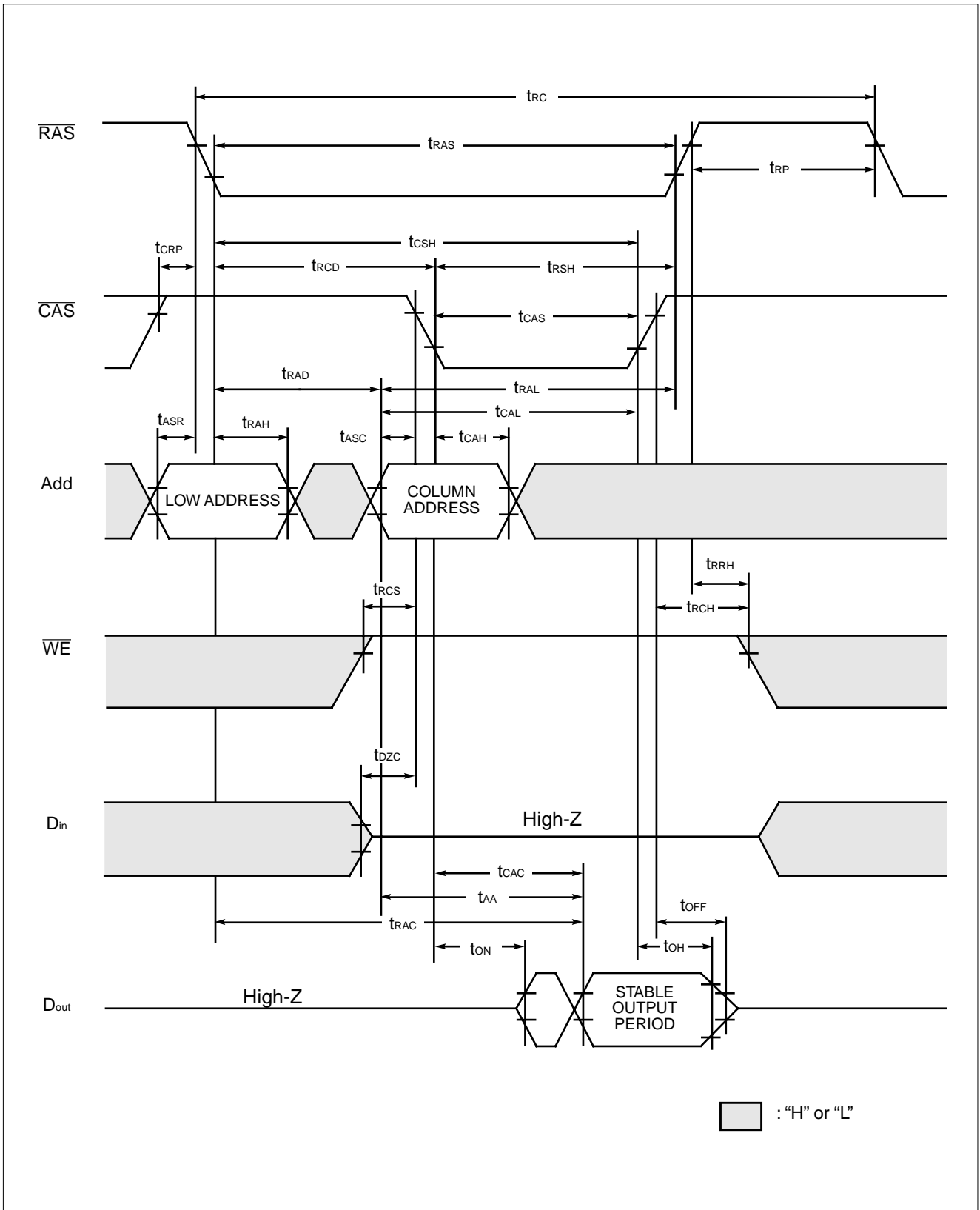
Parameter	Symbol	Series	Min.	Max.	Units
Input Capacity ( $A_0$ to $A_9$ , $\overline{WE}$ , $\overline{CAS}_0$ to $\overline{CAS}_3$ )	$C_{IN1}$	Common to series	—	20	pF
Input Capacity ( $\overline{RAS}_0$ to $\overline{RAS}_3$ )	$C_{IN2}$	MB98B7515,7517	—	45	pF
		MB98B7516,7518		55	pF
Input/Output Capacity ( $DQ_0$ to $DQ_7$ , $DQ_9$ to $DQ_{16}$ , $DQ_{18}$ to $DQ_{25}$ , $DQ_{27}$ to $DQ_{34}$ )	$C_{DQ1}$	MB98B7515,7517	—	30	pF
		MB98B7516,7518		35	pF
Input/Output Capacity ( $DQ_8$ , $DQ_{17}$ , $DQ_{26}$ , $DQ_{35}$ )	$C_{DQ2}$	MB98B7516	—	30	pF
		MB98B7518		35	pF



# MB98B7515/7516/7517/7518

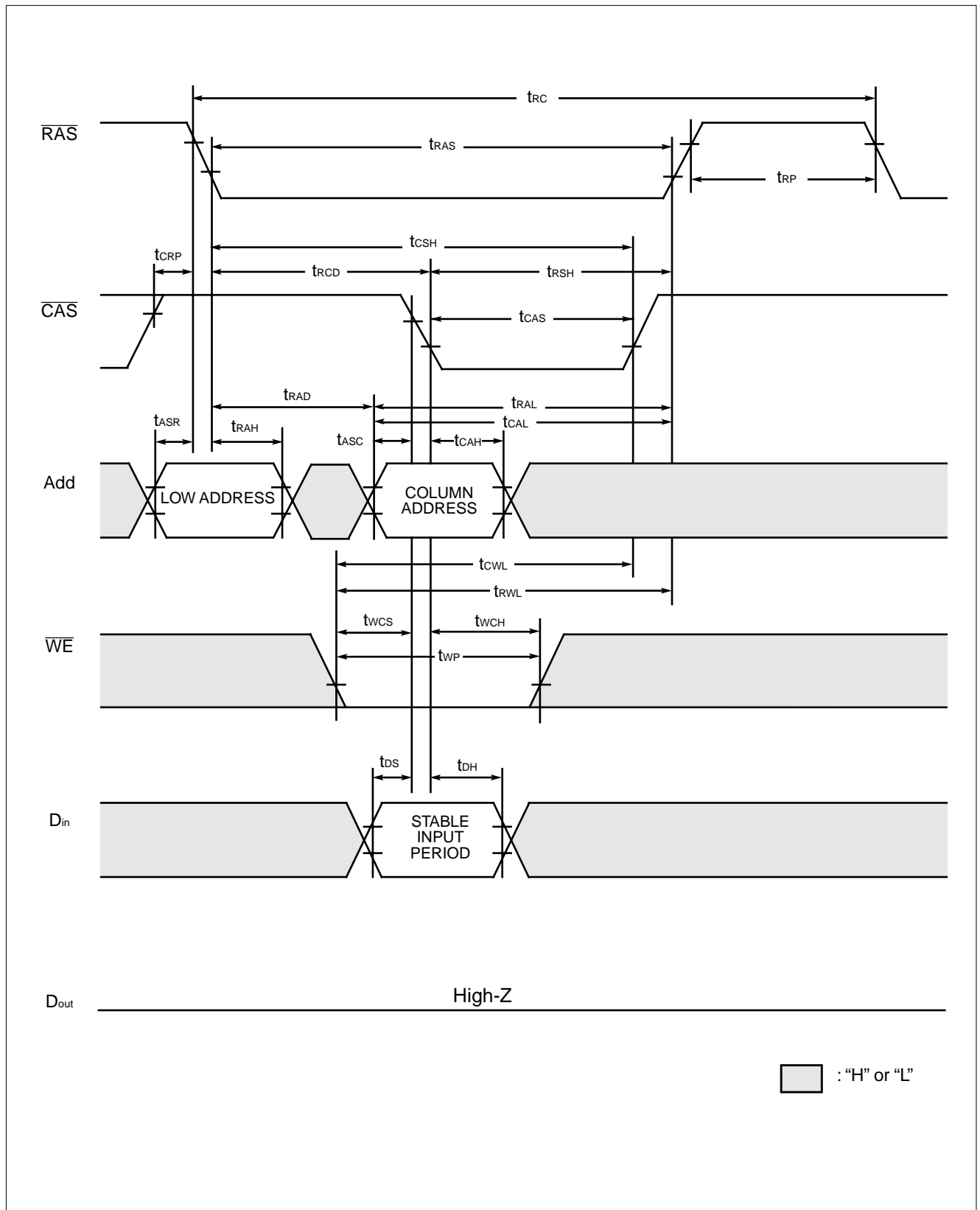
## ■ TIMING DIAGRAM

### 1. Read Cycle



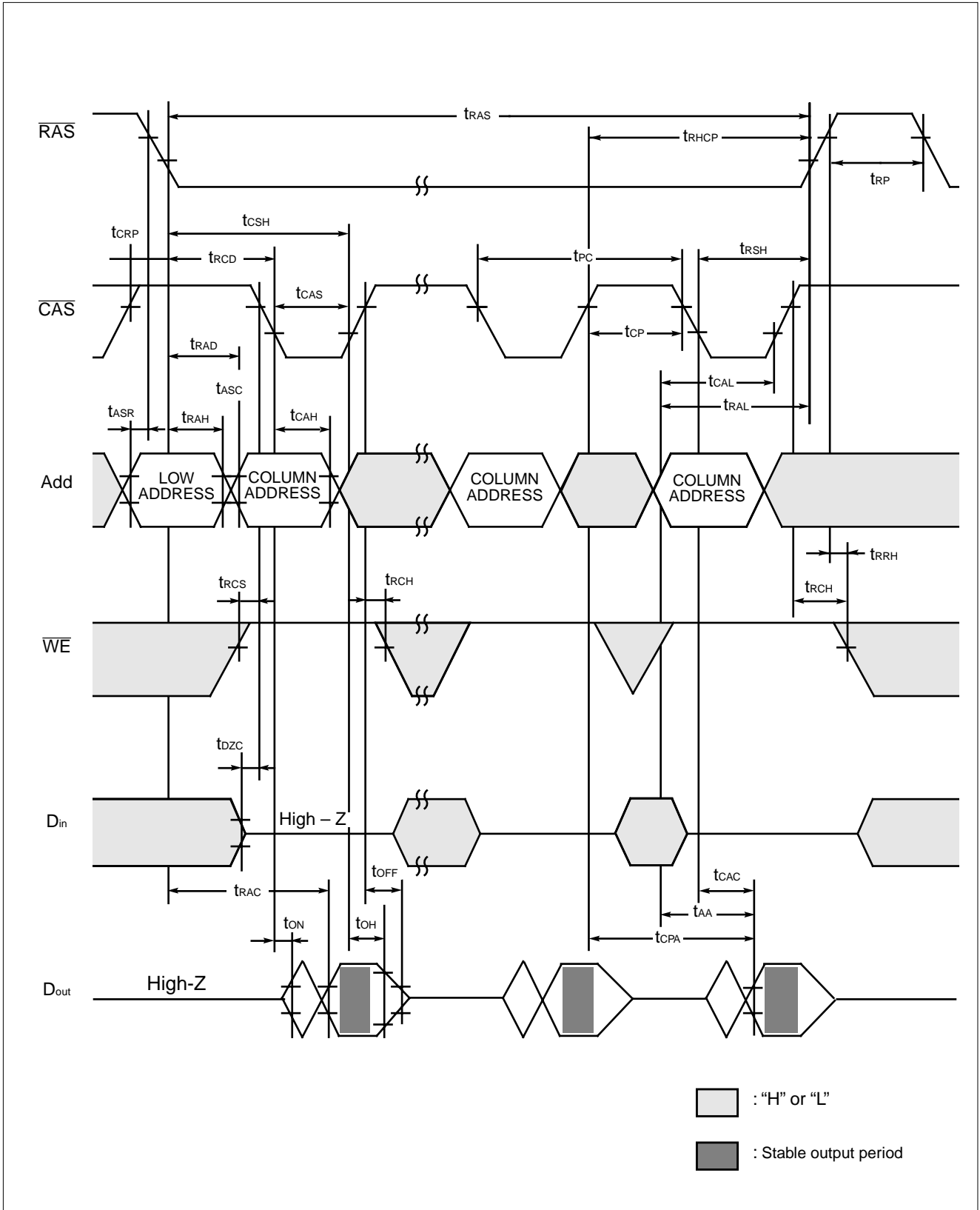
# MB98B7515/7516/7517/7518

## 2. Write Cycle



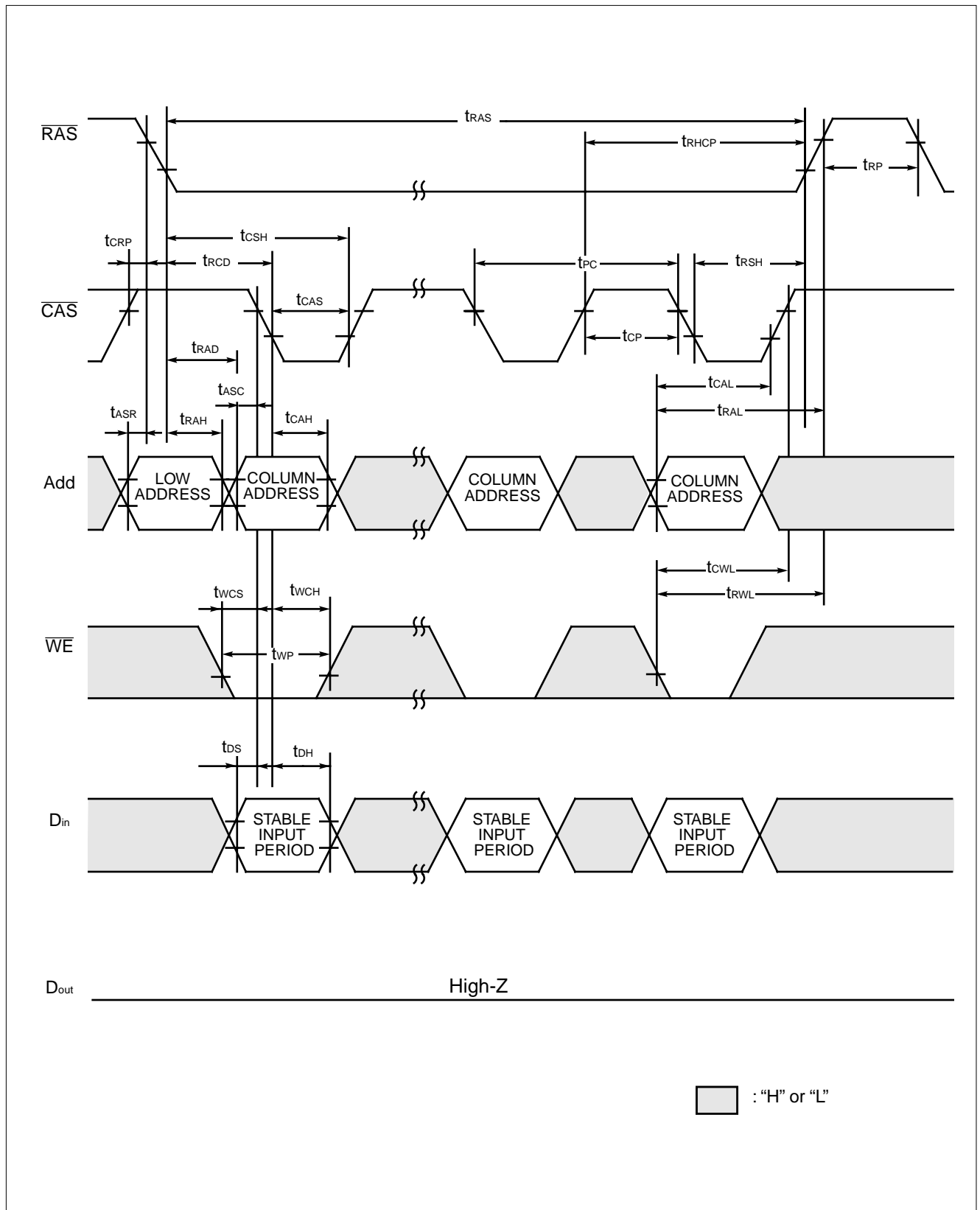
# MB98B7515/7516/7517/7518

## 3. High-speed Page Mode Read Cycle

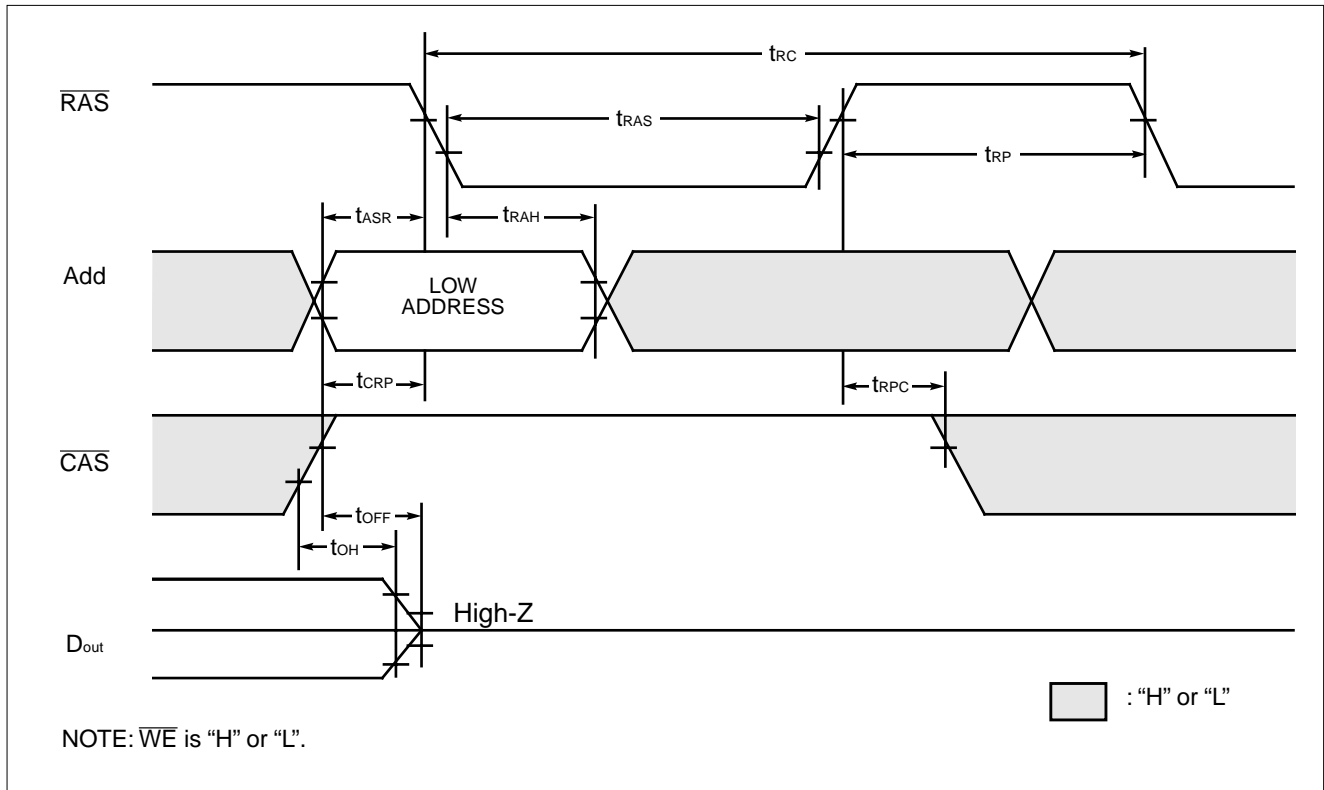
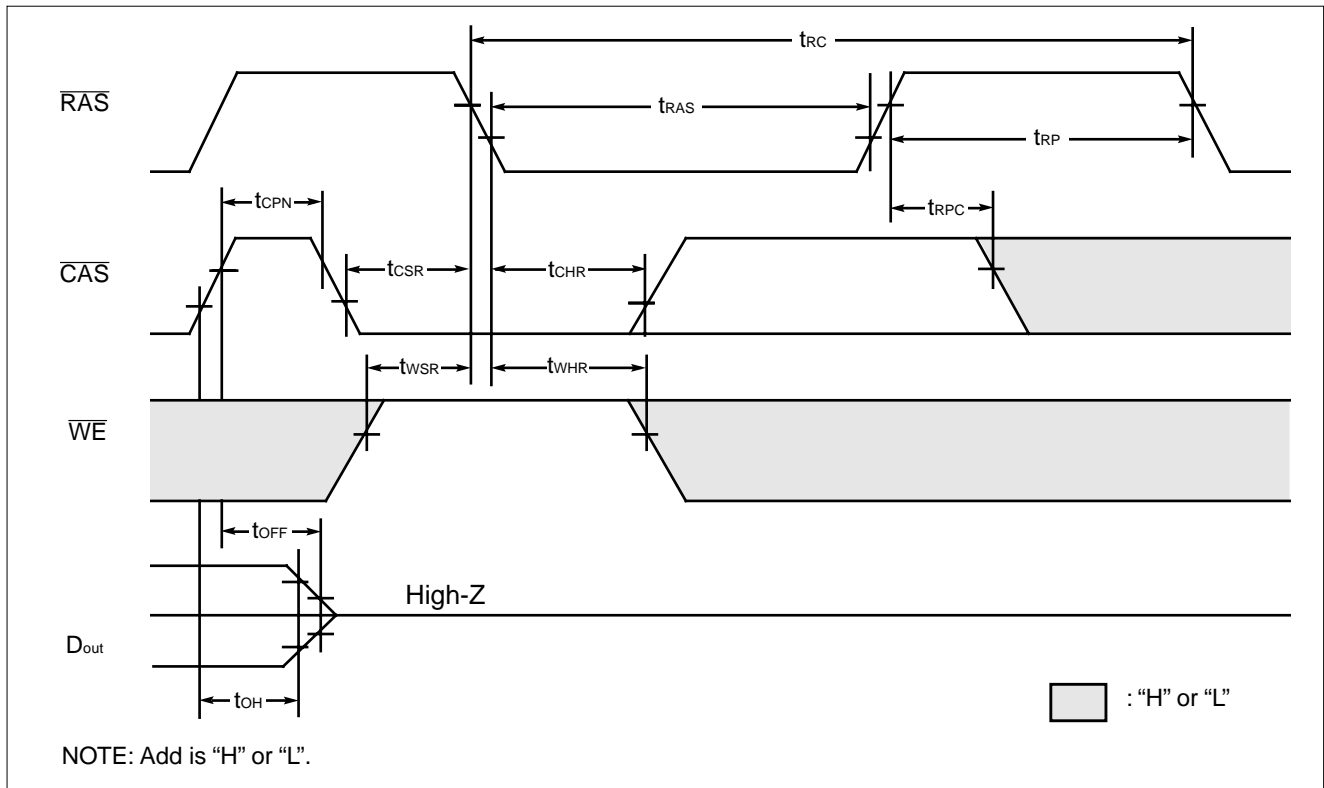


# MB98B7515/7516/7517/7518

## 4. High-speed Page Mode Write Cycle

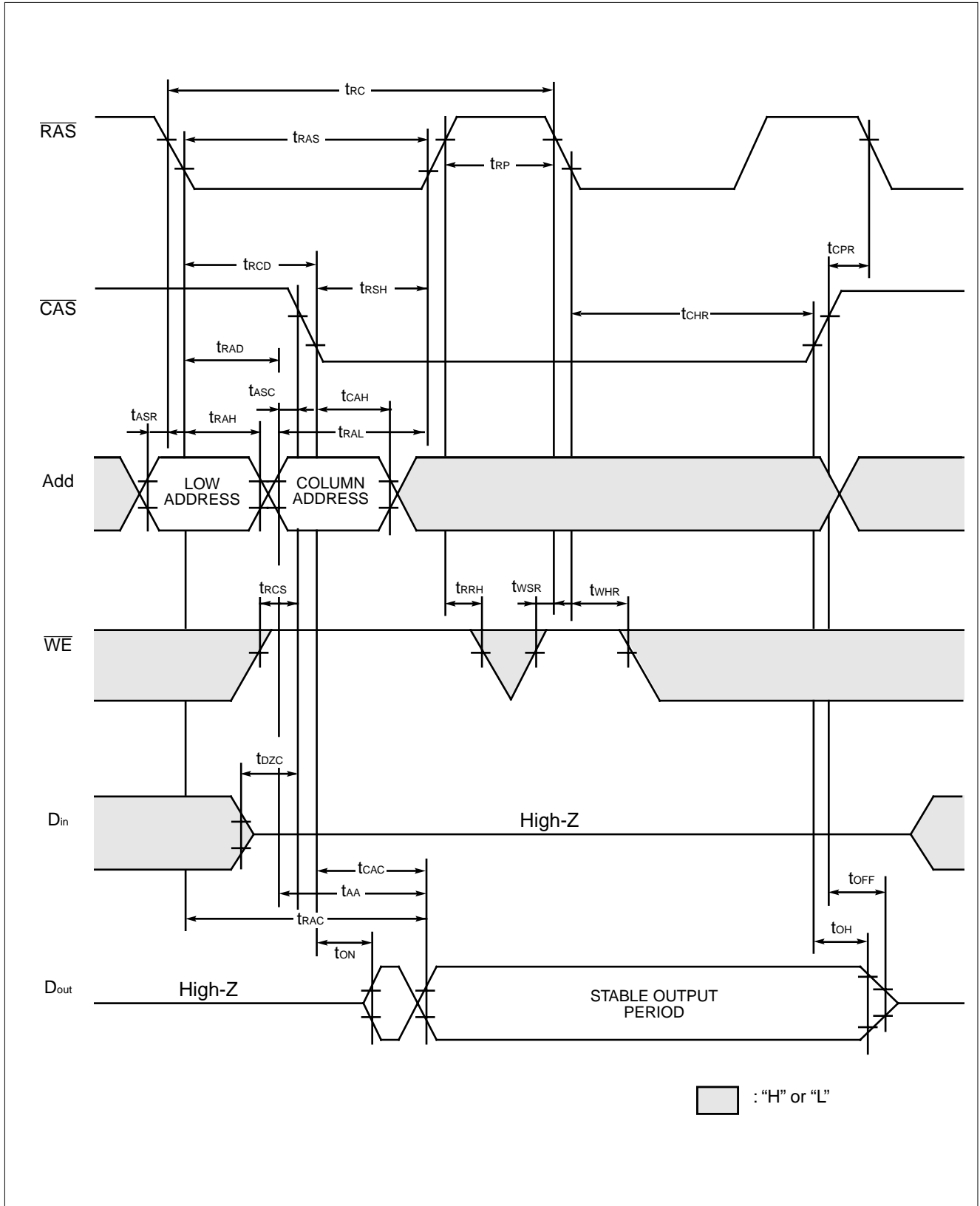


## MB98B7515/7516/7517/7518

5.  $\overline{\text{RAS}}$  Only Refresh Cycle6.  $\overline{\text{CAS}}$  Before  $\overline{\text{RAS}}$  Refresh Cycle

# MB98B7515/7516/7517/7518

## 7. Hidden Refresh Cycle



# MB98B7515/7516/7517/7518

## ■ PD PIN

### 1. List of Pins

Part Number \ PD pin	PD <sub>1</sub>	PD <sub>2</sub>	PD <sub>3</sub>	PD <sub>4</sub>	PD <sub>5</sub>	PD <sub>6</sub>	PD <sub>7</sub>	PD <sub>8</sub>
MB98B7515-70	GND	GND	N.C.	GND	N.C.	GND	N.C.	N.C.
MB98B7516-70					GND			
MB98B7517-70						GND		
MB98B7518-70					GND			
MB98B7515-80						N.C.	N.C.	
MB98B7516-80					GND			
MB98B7517-80						GND		
MB98B7518-80					GND			

### 2. Functional Table

Part Number		MB98B7515	MB98B7516	MB98B7517	MB98B7518	
Device Class	Data	4 M × 4	4 M × 4	4 M × 4	4 M × 4	PD <sub>1</sub> PD <sub>2</sub> PD <sub>3</sub> PD <sub>4</sub>
	Parity	—	4 M × 1	—	4 M × 1	
Address (quantity)	Data	11/11 Low/Column				PD <sub>5</sub>
	Parity	11/11 Low/Column				
Number of Banks		1		2		PD <sub>6</sub> PD <sub>7</sub>
Access Time		70/80 ns				PD <sub>8</sub>
Refresh		Slow Refresh				

\* : Refer to the “DRAM Card Guide Line Ver 2.0” by the JEIDA for details of PD pins.

# MB98B7515/7516/7517/7518

## ■ LABEL INDICATION (FOR REFERENCE)

The label indication is as follows by the JEIDA specifications:

### 1. Label Specifications

No.	Parameter	MB98B7515	MB98B7516	MB98B7517	MB98B7518
1	Connector Type	Type A (5 V, 3.3 V)			
2	Address Area	4 M words		8 M words	
3	Bit Width	32 bits	36 bits	32 bits	36 bits
4	Circuit Configuration	RAS/CAS = 2/4		RAS/CAS = 4/4	
5	Address Composition	ROW/COL = 11/11			
6	Access Time	$t_{RAC} = 80 \text{ ns}$			
7	Refresh Type	Slow Refresh			
8	Operation Mode	High-speed Page Mode			
9	Supply Voltage	$V_{CC} = 5 \text{ V}$			
10	Expansion PD Pin	Not Applicable			

### 2. Label Format

MB98B7515 ●●●  016M32R2C4A0 – 08 F0 P 5   
 MB98B7516 ●●●  016M36R2C4A0 – 08 F0 P 5   
 MB98B7517 ●●●  032M32R4C4A0 – 08 F0 P 5   
 MB98B7518 ●●●  032M36R4C4A0 – 08 F0 P 5  \*:  \* is blank.

(1) (2) (3) (4) (5) (6) (7) (8)(9)(10)

\* : Refer to the “DRAM Card Guide Line Ver 2.0” by the JEIDA for details Label Specifications.

## ■ DEVICE HANDLING PRECAUTIONS

This device is composed of fine electronic parts, so take care in handling or keeping it as below.

- The card is made fine, so do not keep it in the high temperature nor high humidity, place line in the direct sunshine nor near the heater.
- The card should not be bent, scratched, dropped nor be shocked violently.
- This device should never be taken a part. It could destroy the card or your personal computer hardware.
- To help you handle this device safely, request us the device specifications when purchasing this device.

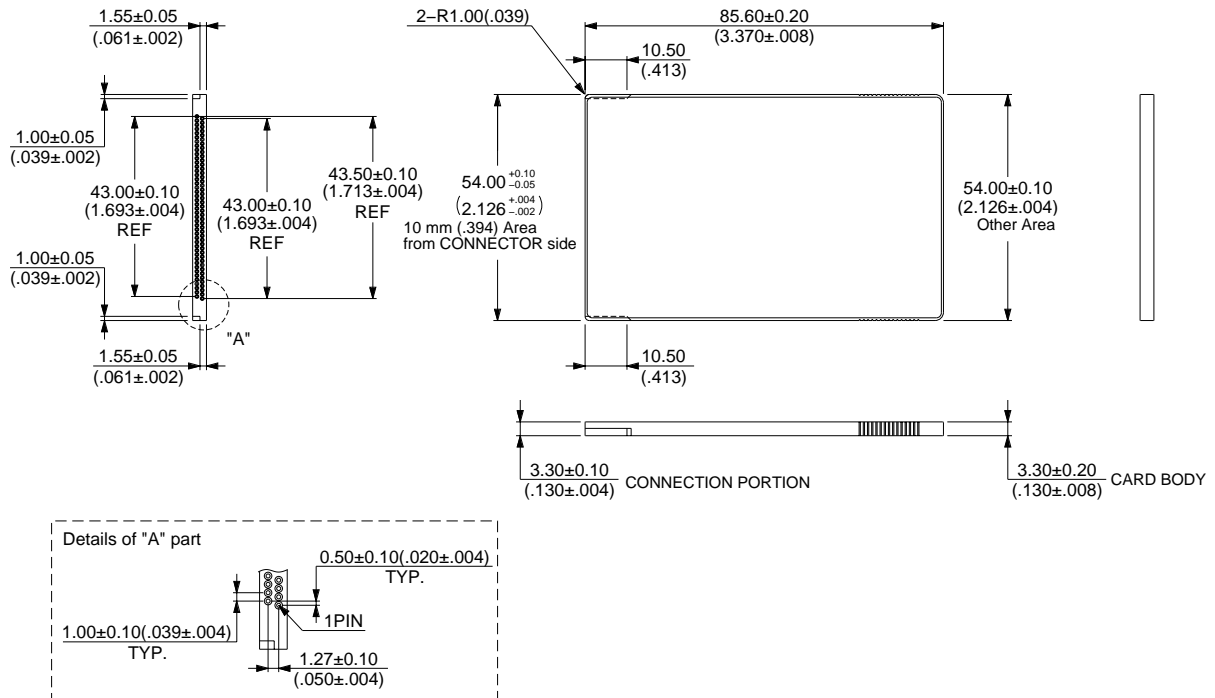


# MB98B7515/7516/7517/7518

## ■ PACKAGE DIMENSIONS

### 88-pin DRAM Card (CRD-88P-M01)

Note: Dimensions conform with JEIDA DRAM CARD Ver.2.0.



# MB98B7515/7516/7517/7518

## FUJITSU LIMITED

*For further information please contact:*

### **Japan**

FUJITSU LIMITED  
Corporate Global Business Support Division  
Electronic Devices  
KAWASAKI PLANT, 4-1-1, Kamikodanaka  
Nakahara-ku, Kawasaki-shi  
Kanagawa 211-88, Japan  
Tel: (044) 754-3763  
Fax: (044) 754-3329

### **North and South America**

FUJITSU MICROELECTRONICS, INC.  
Semiconductor Division  
3545 North First Street  
San Jose, CA 95134-1804, U.S.A.  
Tel: (408) 922-9000  
Fax: (408) 432-9044/9045

### **Europe**

FUJITSU MIKROELEKTRONIK GmbH  
Am Siebenstein 6-10  
63303 Dreieich-Buchsschlag  
Germany  
Tel: (06103) 690-0  
Fax: (06103) 690-122

### **Asia Pacific**

FUJITSU MICROELECTRONICS ASIA PTE. LIMITED  
#05-08, 151 Lorong Chuan  
New Tech Park  
Singapore 556741  
Tel: (65) 281-0770  
Fax: (65) 281-0220

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