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# HM51W16400 Series

# HM51W17400 Series

16 M FP DRAM (4-Mword × 4-bit)  
4 k Refresh/2 k Refresh

# HITACHI

ADE-203-649E (Z)  
Rev. 5.0  
Nov. 1997

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## Description

The Hitachi HM51W16400 Series, HM51W17400 Series are CMOS dynamic RAMs organized 4,194,304-word × 4-bit. They employ the most advanced 0.5 μm CMOS technology for high performance and low power. The HM51W16400 Series, HM51W17400 Series offer Fast Page Mode as a high speed access mode. They have package variations of standard 300-mil 26-pin plastic SOJ and standard 300-mil 26-pin plastic TSOP.

## Features

- Single 3.3 V (±0.3 V)
- Access time: 60 ns/70 ns (max)
- Power dissipation
  - Active mode : 288mW/252 mW (max) (HM51W16400 Series)  
: 324 mW/288 mW (max) (HM51W17400 Series)
  - Standby mode : 7.2 mW (max)  
: 0.36 mW (max) (L-version)
- Fast page mode capability
- Long refresh period
  - 4096 refresh cycles : 64 ms (HM51W16400 Series)  
: 128 ms (L-version)
  - 2048 refresh cycles : 32 ms (HM51W17400 Series)  
: 128 ms (L-version)
- 4 variations of refresh
  - $\overline{\text{RAS}}$ -only refresh
  - $\overline{\text{CAS}}$ -before- $\overline{\text{RAS}}$  refresh
  - Hidden refresh
  - Self refresh (L-version)
- Battery backup operation (L-version)
- Test function

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## HM51W16400 Series, HM51W17400

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— 16-bit parallel test mode

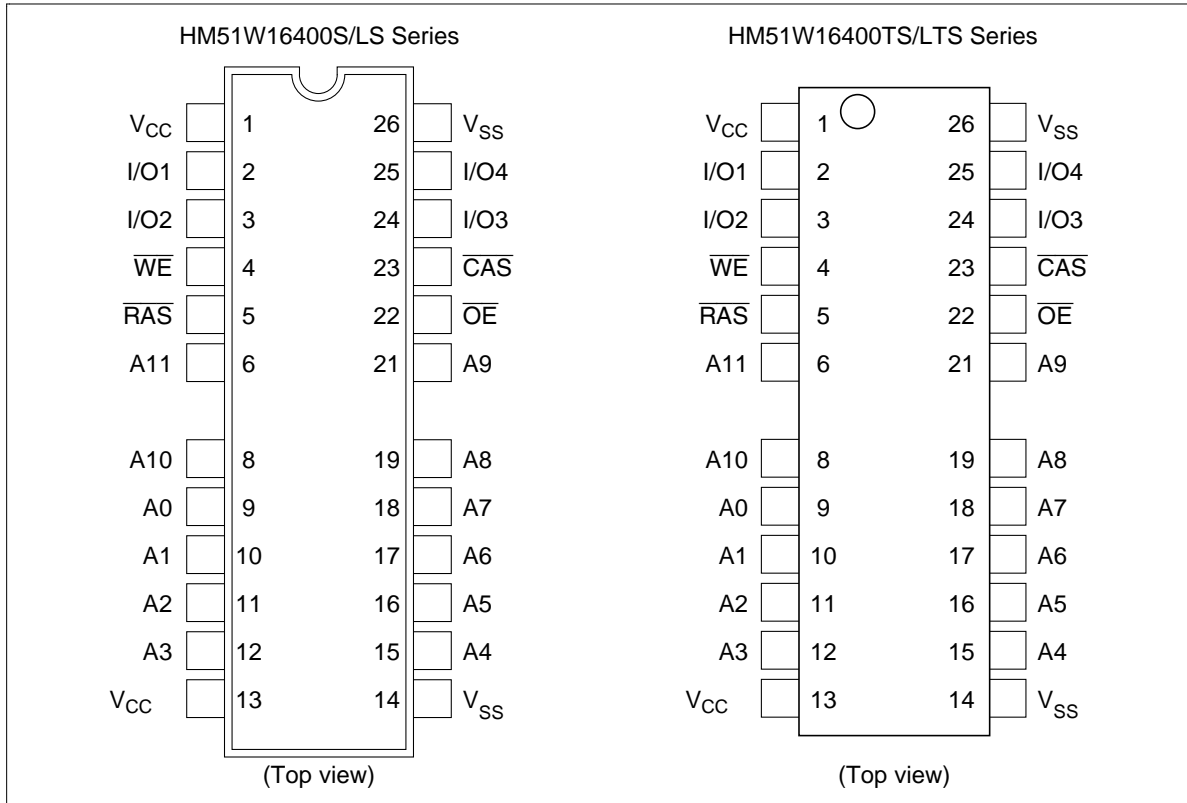
### Ordering Information

Type No.	Access time	Package
HM51W16400S-6	60 ns	300-mil 26-pin plastic SOJ (CP-26/24DB)
HM51W16400S-7	70 ns	
HM51W16400LS-6	60 ns	
HM51W16400LS-7	70 ns	
HM51W17400S-6	60 ns	
HM51W17400S-7	70 ns	
HM51W17400LS-6	60 ns	
HM51W17400LS-7	70 ns	
HM51W16400TS-6	60 ns	300-mil 26-pin plastic TSOP II (TTP-26/24DA)
HM51W16400TS-7	70 ns	
HM51W16400LTS-6	60 ns	
HM51W16400LTS-7	70 ns	
HM51W17400TS-6	60 ns	
HM51W17400TS-7	70 ns	
HM51W17400LTS-6	60 ns	
HM51W17400LTS-7	70 ns	

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## HM51W16400 Series, HM51W17400

### Pin Arrangement

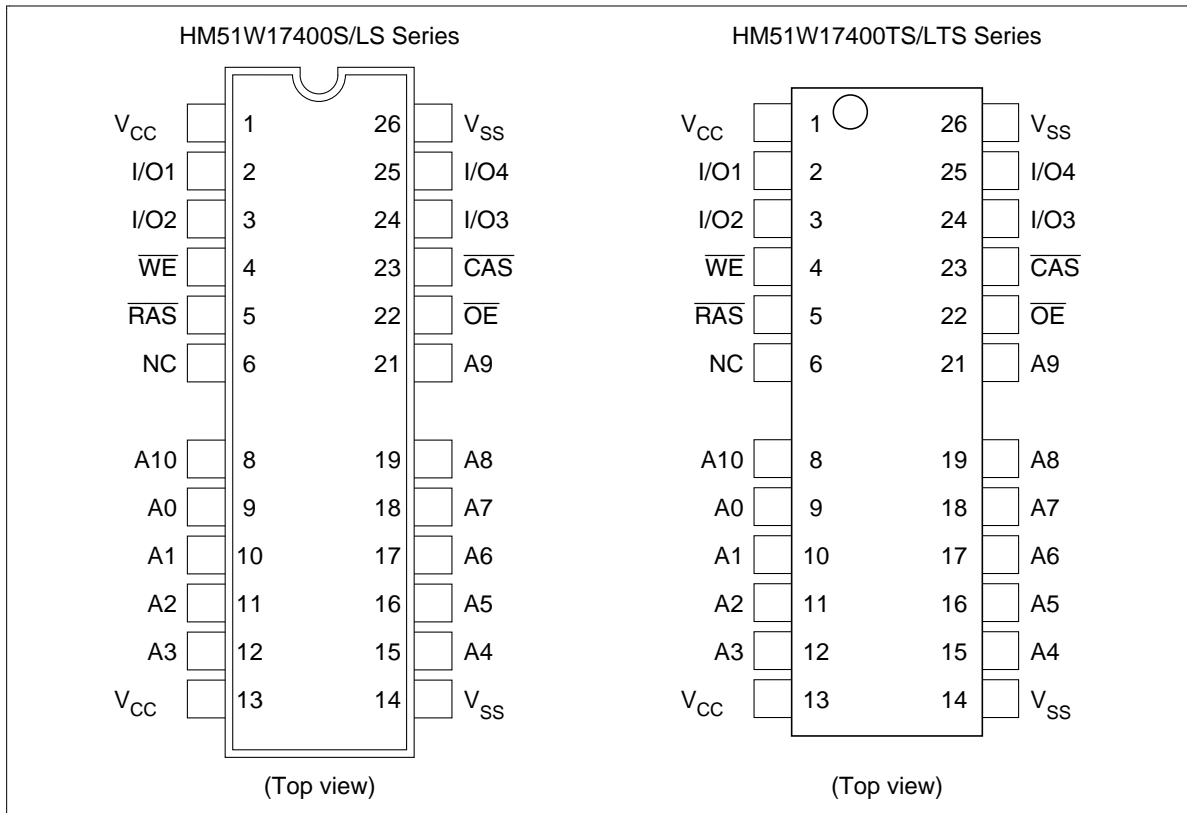


### Pin Description

Pin name	Function
A0 to A11	Address input <ul style="list-style-type: none"> <li>• Row/Refresh address A0 to A11</li> <li>• Column address A0 to A9</li> </ul>
I/O1 to I/O4	Data input/Data output
$\overline{\text{RAS}}$	Row address strobe
$\overline{\text{CAS}}$	Column address strobe
$\overline{\text{WE}}$	Read/Write enable
$\overline{\text{OE}}$	Output enable
$V_{\text{CC}}$	Power supply
$V_{\text{SS}}$	Ground

# HM51W16400 Series, HM51W17400

## Pin Arrangement

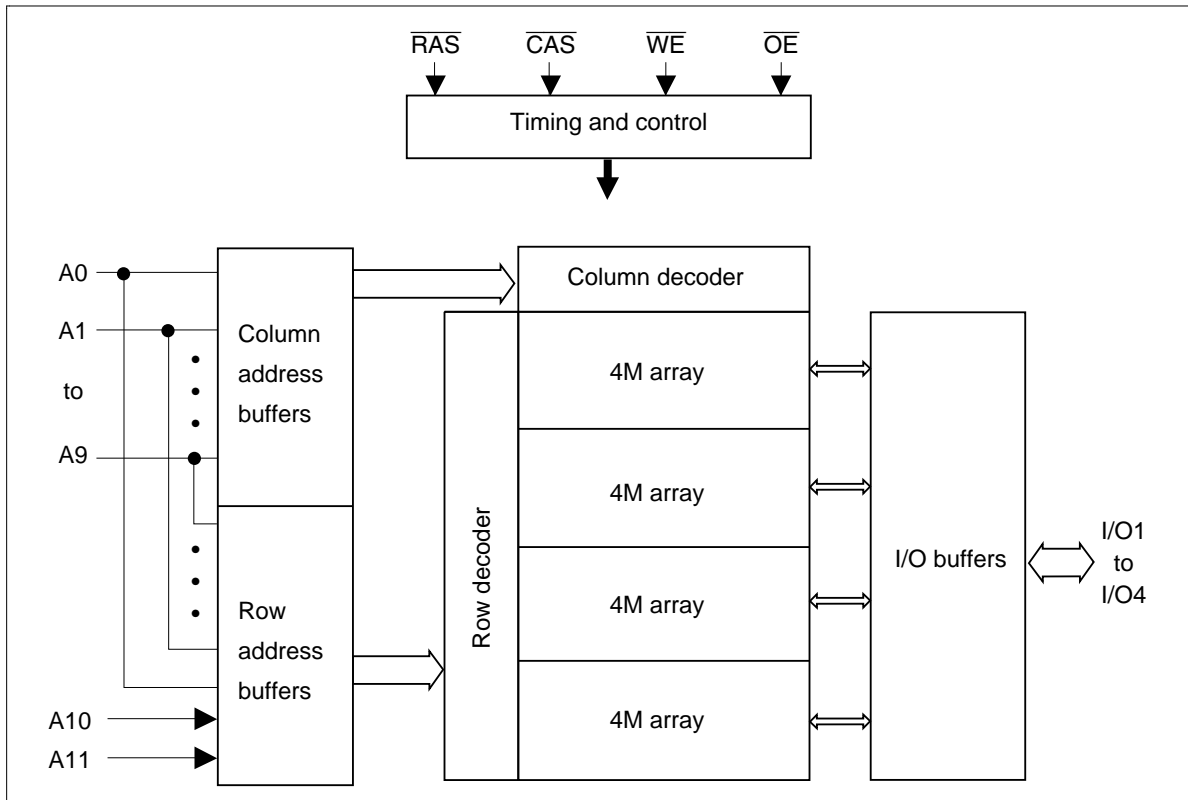


## Pin Description

Pin name	Function
A0 to A10	Address input <ul style="list-style-type: none"> <li>• Row/Refresh address A0 to A10</li> <li>• Column address A0 to A10</li> </ul>
I/O1 to I/O4	Data input/Data output
$\overline{\text{RAS}}$	Row address strobe
$\overline{\text{CAS}}$	Column address strobe
$\overline{\text{WE}}$	Read/Write enable
$\overline{\text{OE}}$	Output enable
$V_{\text{CC}}$	Power supply
$V_{\text{SS}}$	Ground
NC	No connection

# HM51W16400 Series, HM51W17400

## Block Diagram (HM51W16400 Series)

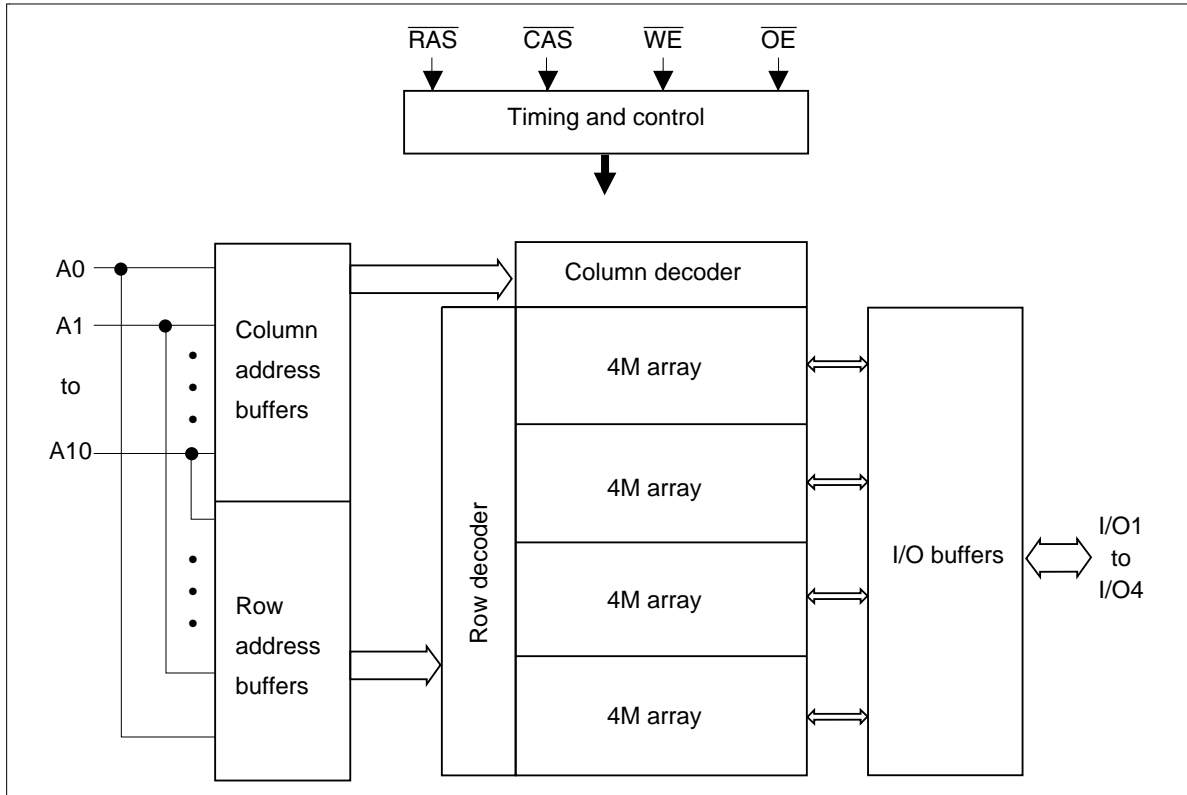


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## HM51W16400 Series, HM51W17400

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### Block Diagram (HM51W17400 Series)



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## HM51W16400 Series, HM51W17400

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### Absolute Maximum Ratings

Parameter	Symbol	Value	Unit
Voltage on any pin relative to $V_{SS}$	$V_T$	-0.5 to $V_{CC} + 0.5$ ( $\leq +4.6$ V (max))	V
Supply voltage relative to $V_{SS}$	$V_{CC}$	-0.5 to +4.6	V
Short circuit output current	$I_{out}$	50	mA
Power dissipation	$P_T$	1.0	W
Operating temperature	$T_{opr}$	0 to +70	°C
Storage temperature	$T_{stg}$	-55 to +125	°C

### Recommended DC Operating Conditions ( $T_a = 0$ to +70°C)

Parameter	Symbol	Min	Typ	Max	Unit	Notes
Supply voltage	$V_{CC}$	3.0	3.3	3.6	V	1, 2
Input high voltage	$V_{IH}$	2.0	—	$V_{CC} + 0.3$	V	1
Input low voltage	$V_{IL}$	-0.3	—	0.8	V	1

Note: 1. All voltage referred to  $V_{SS}$ .

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### DC Characteristics

( $T_a = 0$  to  $+70^\circ\text{C}$ ,  $V_{CC} = 3.3 \text{ V} \pm 0.3 \text{ V}$ ,  $V_{SS} = 0 \text{ V}$ ) (HM51W16400 Series)

Parameter	Symbol	HM51W16400				Unit	Test conditions
		-6		-7			
		Min	Max	Min	Max		
Operating current <sup>*1, *2</sup>	$I_{CC1}$	—	80	—	70	mA	$t_{RC} = \text{min}$
Standby current	$I_{CC2}$	—	2	—	2	mA	TTL interface $\overline{\text{RAS}}, \overline{\text{CAS}} = V_{IH}$ Dout = High-Z
		—	1	—	1	mA	CMOS interface $\overline{\text{RAS}}, \overline{\text{CAS}} \geq V_{CC} - 0.2 \text{ V}$ Dout = High-Z
Standby current (L-version)	$I_{CC2}$	—	100	—	100	$\mu\text{A}$	CMOS interface $\overline{\text{RAS}}, \overline{\text{CAS}} \geq V_{CC} - 0.2 \text{ V}$ Dout = High-Z
$\overline{\text{RAS}}$ -only refresh current <sup>*2</sup>	$I_{CC3}$	—	80	—	70	mA	$t_{RC} = \text{min}$
Standby current <sup>*1</sup>	$I_{CC5}$	—	5	—	5	mA	$\overline{\text{RAS}} = V_{IH}$ $\overline{\text{CAS}} = V_{IL}$ Dout = enable
$\overline{\text{CAS}}$ -before- $\overline{\text{RAS}}$ refresh current	$I_{CC6}$	—	80	—	70	mA	$t_{RC} = \text{min}$
Fast page mode current <sup>*1, *3</sup>	$I_{CC7}$	—	70	—	60	mA	$t_{PC} = \text{min}$
Battery backup current (Standby with CBR refresh) (L-version)	$I_{CC10}$	—	300	—	300	$\mu\text{A}$	CMOS interface Dout = High-Z, CBR refresh: $t_{RC} = 31.3 \mu\text{s}$ $t_{RAS} \leq 0.3 \mu\text{s}$
Self refresh mode current (L-version)	$I_{CC11}$	—	200	—	200	$\mu\text{A}$	CMOS interface $\overline{\text{RAS}}, \overline{\text{CAS}} \leq 0.2 \text{ V}$ Dout = High-Z
Input leakage current	$I_{LI}$	-10	10	-10	10	$\mu\text{A}$	$0 \text{ V} \leq V_{in} \leq 4.6 \text{ V}$
Output leakage current	$I_{LO}$	-10	10	-10	10	$\mu\text{A}$	$0 \text{ V} \leq V_{in} \leq 4.6 \text{ V}$ Dout = disable
Output high voltage	$V_{OH}$	2.4	$V_{CC}$	2.4	$V_{CC}$	V	High Iout = -2 mA
Output low voltage	$V_{OL}$	0	0.4	0	0.4	V	Low Iout = 2 mA

Notes : 1.  $I_{CC}$  depends on output load condition when the device is selected.  $I_{CC}$  max is specified at the output open condition.

2. Address can be changed once or less while  $\overline{\text{RAS}} = V_{IL}$ .

3. Address can be changed once or less while  $\overline{\text{CAS}} = V_{IH}$ .

## HM51W16400 Series, HM51W17400

### DC Characteristics

( $T_a = 0$  to  $+70^\circ\text{C}$ ,  $V_{CC} = 3.3 \text{ V} \pm 0.3 \text{ V}$ ,  $V_{SS} = 0 \text{ V}$ ) (HM51W17400 Series)

Parameter	Symbol	HM51W17400				Unit	Test conditions
		-6		-7			
		Min	Max	Min	Max		
Operating current <sup>*1, *2</sup>	$I_{CC1}$	—	90	—	80	mA	$t_{RC} = \text{min}$
Standby current	$I_{CC2}$	—	2	—	2	mA	TTL interface $\overline{\text{RAS}}, \overline{\text{CAS}} = V_{IH}$ Dout = High-Z
		—	1	—	1	mA	CMOS interface $\overline{\text{RAS}}, \overline{\text{CAS}} \geq V_{CC} - 0.2 \text{ V}$ Dout = High-Z
Standby current (L-version)	$I_{CC2}$	—	100	—	100	$\mu\text{A}$	CMOS interface $\overline{\text{RAS}}, \overline{\text{CAS}} \geq V_{CC} - 0.2 \text{ V}$ Dout = High-Z
$\overline{\text{RAS}}$ -only refresh current <sup>*2</sup>	$I_{CC3}$	—	90	—	80	mA	$t_{RC} = \text{min}$
Standby current <sup>*1</sup>	$I_{CC5}$	—	5	—	5	mA	$\overline{\text{RAS}} = V_{IH}$ $\overline{\text{CAS}} = V_{IL}$ Dout = enable
$\overline{\text{CAS}}$ -before- $\overline{\text{RAS}}$ refresh current	$I_{CC6}$	—	90	—	80	mA	$t_{RC} = \text{min}$
Fast page mode current <sup>*1, *3</sup>	$I_{CC7}$	—	80	—	70	mA	$t_{PC} = \text{min}$
Battery backup current (Standby with CBR refresh) (L-version)	$I_{CC10}$	—	300	—	300	$\mu\text{A}$	CMOS interface Dout = High-Z, CBR refresh: $t_{RC} = 62.5 \mu\text{s}$ $t_{RAS} \leq 0.3 \mu\text{s}$
Self refresh mode current (L-version)	$I_{CC11}$	—	200	—	200	$\mu\text{A}$	CMOS interface $\overline{\text{RAS}}, \overline{\text{CAS}} \leq 0.2 \text{ V}$ Dout = High-Z
Input leakage current	$I_{LI}$	-10	10	-10	10	$\mu\text{A}$	$0 \text{ V} \leq V_{in} \leq 4.6 \text{ V}$
Output leakage current	$I_{LO}$	-10	10	-10	10	$\mu\text{A}$	$0 \text{ V} \leq V_{in} \leq 4.6 \text{ V}$ Dout = disable
Output high voltage	$V_{OH}$	2.4	$V_{CC}$	2.4	$V_{CC}$	V	High Iout = -2 mA
Output low voltage	$V_{OL}$	0	0.4	0	0.4	V	Low Iout = 2 mA

Notes : 1.  $I_{CC}$  depends on output load condition when the device is selected.  $I_{CC}$  max is specified at the output open condition.

2. Address can be changed once or less while  $\overline{\text{RAS}} = V_{IL}$ .
3. Address can be changed once or less while  $\overline{\text{CAS}} = V_{IH}$ .

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Capacitance ( $T_a = 25^\circ\text{C}$ ,  $V_{CC} = 3.3\text{ V} \pm 0.3\text{ V}$ )

Parameter	Symbol	Typ	Max	Unit	Notes
Input capacitance (Address)	$C_{I1}$	—	5	pF	1
Input capacitance (Clocks)	$C_{I2}$	—	7	pF	1
Output capacitance (Data-in, Data-out)	$C_{I/O}$	—	7	pF	1, 2

Notes : 1. Capacitance measured with Boonton Meter or effective capacitance measuring method.  
2.  $\overline{CAS} = V_{IH}$  to disable Dout.

## HM51W16400 Series, HM51W17400

**AC Characteristics** ( $T_a = 0$  to  $+70^\circ\text{C}$ ,  $V_{CC} = 3.3\text{ V} \pm 0.3\text{ V}$ ,  $V_{SS} = 0\text{ V}$ ) \*<sup>1</sup>, \*<sup>2</sup>, \*<sup>18</sup>, \*<sup>19</sup>

### Test Conditions

- Input rise and fall time: 5 ns
- Input timing reference levels: 0.8 V, 2.0 V
- Output timing reference levels: 0.8 V, 2.0 V
- Output load: 1 TTL gate +  $C_L$  (100 pF) (Including scope and jig)

### Read, Write, Read-Modify-Write and Refresh Cycles (Common parameters)

Parameter	Symbol	HM51W16400/HM51W17400				Unit	Notes
		-6		-7			
		Min	Max	Min	Max		
Random read or write cycle time	$t_{RC}$	110	—	130	—	ns	
$\overline{\text{RAS}}$ precharge time	$t_{RP}$	40	—	50	—	ns	
$\overline{\text{CAS}}$ precharge time	$t_{CP}$	10	—	10	—	ns	
$\overline{\text{RAS}}$ pulse width	$t_{RAS}$	60	10000	70	10000	ns	
$\overline{\text{CAS}}$ pulse width	$t_{CAS}$	15	10000	18	10000	ns	
Row address setup time	$t_{ASR}$	0	—	0	—	ns	
Row address hold time	$t_{RAH}$	10	—	10	—	ns	
Column address setup time	$t_{ASC}$	0	—	0	—	ns	
Column address hold time	$t_{CAH}$	10	—	15	—	ns	
$\overline{\text{RAS}}$ to $\overline{\text{CAS}}$ delay time	$t_{RCD}$	20	45	20	52	ns	3
$\overline{\text{RAS}}$ to column address delay time	$t_{RAD}$	15	30	15	35	ns	4
$\overline{\text{RAS}}$ hold time	$t_{RSH}$	15	—	18	—	ns	
$\overline{\text{CAS}}$ hold time	$t_{CSH}$	60	—	70	—	ns	
$\overline{\text{CAS}}$ to $\overline{\text{RAS}}$ precharge time	$t_{CRP}$	5	—	5	—	ns	
$\overline{\text{OE}}$ to Din delay time	$t_{OED}$	15	—	18	—	ns	5
$\overline{\text{OE}}$ delay time from Din	$t_{DZO}$	0	—	0	—	ns	6
$\overline{\text{CAS}}$ delay time from Din	$t_{DZC}$	0	—	0	—	ns	6
Transition time (rise and fall)	$t_T$	3	50	3	50	ns	7

## HM51W16400 Series, HM51W17400

### Read Cycle

Parameter	Symbol	HM51W16400/HM51W17400				Unit	Notes
		-6		-7			
		Min	Max	Min	Max		
Access time from $\overline{\text{RAS}}$	$t_{\text{RAC}}$	—	60	—	70	ns	8, 9, 20
Access time from $\overline{\text{CAS}}$	$t_{\text{CAC}}$	—	15	—	18	ns	9, 10, 17, 20
Access time from address	$t_{\text{AA}}$	—	30	—	35	ns	9, 11, 17, 20
Access time from $\overline{\text{OE}}$	$t_{\text{OEA}}$	—	15	—	18	ns	9, 20
Read command setup time	$t_{\text{RCS}}$	0	—	0	—	ns	
Read command hold time to $\overline{\text{CAS}}$	$t_{\text{RCH}}$	0	—	0	—	ns	12
Read command hold time to $\overline{\text{RAS}}$	$t_{\text{RRH}}$	0	—	0	—	ns	12
Column address to $\overline{\text{RAS}}$ lead time	$t_{\text{RAL}}$	30	—	35	—	ns	
Column address to $\overline{\text{CAS}}$ lead time	$t_{\text{CAL}}$	30	—	35	—	ns	
$\overline{\text{CAS}}$ to output in low-Z	$t_{\text{CLZ}}$	0	—	0	—	ns	
Output data hold time	$t_{\text{OH}}$	3	—	3	—	ns	
Output data hold time from $\overline{\text{OE}}$	$t_{\text{OHO}}$	3	—	3	—	ns	
Output buffer turn-off time	$t_{\text{OFF}}$	—	15	—	15	ns	13
Output buffer turn-off to $\overline{\text{OE}}$	$t_{\text{OEZ}}$	—	15	—	15	ns	13
$\overline{\text{CAS}}$ to Din delay time	$t_{\text{CDD}}$	15	—	18	—	ns	5

### Write Cycle

Parameter	Symbol	HM51W16400/HM51W17400				Unit	Notes
		-6		-7			
		Min	Max	Min	Max		
Write command setup time	$t_{\text{WCS}}$	0	—	0	—	ns	14
Write command hold time	$t_{\text{WCH}}$	10	—	15	—	ns	
Write command pulse width	$t_{\text{WP}}$	10	—	10	—	ns	
Write command to $\overline{\text{RAS}}$ lead time	$t_{\text{RWL}}$	15	—	18	—	ns	
Write command to $\overline{\text{CAS}}$ lead time	$t_{\text{CWL}}$	15	—	18	—	ns	
Data-in setup time	$t_{\text{DS}}$	0	—	0	—	ns	15
Data-in hold time	$t_{\text{DH}}$	10	—	15	—	ns	15

## HM51W16400 Series, HM51W17400

### Read-Modify-Write Cycle

Parameter	Symbol	HM51W16400/HM51W17400				Unit	Notes
		-6		-7			
		Min	Max	Min	Max		
Read-modify-write cycle time	$t_{RWC}$	155	—	181	—	ns	
RAS to $\overline{WE}$ delay time	$t_{RWD}$	85	—	98	—	ns	14
CAS to $\overline{WE}$ delay time	$t_{CWD}$	40	—	46	—	ns	14
Column address to $\overline{WE}$ delay time	$t_{AWD}$	55	—	63	—	ns	14
$\overline{OE}$ hold time from $\overline{WE}$	$t_{OEH}$	15	—	18	—	ns	

### Refresh Cycle

Parameter	Symbol	HM51W16400/HM51W17400				Unit	Notes
		-6		-7			
		Min	Max	Min	Max		
CAS setup time (CBR refresh cycle)	$t_{CSR}$	5	—	5	—	ns	
CAS hold time (CBR refresh cycle)	$t_{CHR}$	10	—	10	—	ns	
$\overline{WE}$ setup time (CBR refresh cycle)	$t_{WRP}$	0	—	0	—	ns	
$\overline{WE}$ hold time (CBR refresh cycle)	$t_{WRH}$	10	—	10	—	ns	
RAS precharge to $\overline{CAS}$ hold time	$t_{RPC}$	5	—	5	—	ns	

### Fast Page Mode Cycle

Parameter	Symbol	HM51W16400/HM51W17400				Unit	Notes
		-6		-7			
		Min	Max	Min	Max		
Fast page mode cycle time	$t_{PC}$	40	—	45	—	ns	
Fast page mode $\overline{RAS}$ pulse width	$t_{RASP}$	—	100000	—	100000	ns	16
Access time from $\overline{CAS}$ precharge	$t_{CPA}$	—	35	—	40	ns	9, 17, 20
$\overline{RAS}$ hold time from $\overline{CAS}$ precharge	$t_{CPRH}$	35	—	40	—	ns	

## HM51W16400 Series, HM51W17400

### Fast Page Mode Read-Modify-Write Cycle

Parameter	Symbol	HM51W16400/HM51W17400				Unit	Notes
		-6		-7			
		Min	Max	Min	Max		
Fast page mode read-modify-write cycle time	$t_{PRWC}$	85	—	96	—	ns	
$\overline{WE}$ delay time from $\overline{CAS}$ precharge	$t_{CPW}$	60	—	68	—	ns	14

### Test Mode Cycle \*19

Parameter	Symbol	HM51W16400/HM51W17400				Unit	Notes
		-6		-7			
		Min	Max	Min	Max		
Test mode $\overline{WE}$ setup time	$t_{WTS}$	0	—	0	—	ns	
Test mode $\overline{WE}$ hold time	$t_{WTH}$	10	—	10	—	ns	

### Refresh (HM51W16400 Series)

Parameter	Symbol	Max	Unit	Notes
Refresh	$t_{REF}$	64	ms	4096 cycles
Refresh (L-version)	$t_{REF}$	128	ms	4096 cycles

### Refresh (HM51W17400 Series)

Parameter	Symbol	Max	Unit	Notes
Refresh period	$t_{REF}$	32	ms	2048 cycles
Refresh period (L-version)	$t_{REF}$	128	ms	2048 cycles

## HM51W16400 Series, HM51W17400

### Self Refresh Mode (L-version)

Parameter	Symbol	HM51W16400L/HM51W17400L				Unit	Notes
		-6		-7			
		Min	Max	Min	Max		
RAS pulse width (self refresh)	$t_{RASS}$	100	—	100	—	$\mu\text{s}$	21, 22, 23, 24
RAS precharge time (self refresh)	$t_{RPS}$	110	—	130	—	ns	
CAS hold time (self refresh)	$t_{CHS}$	-50	—	-50	—	ns	

- Notes:
- AC measurements assume  $t_r = 5$  ns.
  - An initial pause of 200  $\mu\text{s}$  is required after power up followed by a minimum of eight initialization cycles (any combination of cycles containing  $\overline{\text{RAS}}$ -only refresh or  $\overline{\text{CAS}}$ -before- $\overline{\text{RAS}}$  refresh). If the internal refresh counter is used, a minimum of eight  $\overline{\text{CAS}}$ -before- $\overline{\text{RAS}}$  refresh cycles are required.
  - Operation with the  $t_{RCD}$  (max) limit insures 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, then access time is controlled exclusively by  $t_{CAC}$ .
  - Operation with the  $t_{RAD}$  (max) limit insures 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, then access time is controlled exclusively by  $t_{AA}$ .
  - Either  $t_{OED}$  or  $t_{CDD}$  must be satisfied.
  - Either  $t_{DZO}$  or  $t_{DZC}$  must be satisfied.
  - $V_{IH}$  (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).
  - Assumes that  $t_{RCD} \leq t_{RCD}$  (max) and  $t_{RAD} \leq t_{RAD}$  (max). If  $t_{RCD}$  or  $t_{RAD}$  is greater than the maximum recommended value shown in this table,  $t_{RAC}$  exceeds the value shown.
  - Measured with a load circuit equivalent to 1 TTL loads and 100 pF. ( $V_{OH} = 2.0$  V,  $V_{OL} = 0.8$  V)
  - Assumes that  $t_{RCD} \geq t_{RCD}$  (max) and  $t_{RCD} + t_{CAC}$  (max)  $\geq t_{RAD} + t_{AA}$  (max).
  - Assumes that  $t_{RAD} \geq t_{RAD}$  (max) and  $t_{RCD} + t_{CAC}$  (max)  $\leq t_{RAD} + t_{AA}$  (max).
  - Either  $t_{RCH}$  or  $t_{RRH}$  must be satisfied for a read cycles.
  - $t_{OFF}$  (max) and  $t_{OEZ}$  (max) define the time at which the outputs achieve the open circuit condition and are not referred to output voltage levels.
  - $t_{WCS}$ ,  $t_{RWD}$ ,  $t_{CWD}$ ,  $t_{AWD}$  and  $t_{CPW}$  are not restrictive operating parameters. They are included in the data sheet as electrical characteristics only; if  $t_{WCS} \geq t_{WCS}$  (min), the cycle is an early write cycle and the data out pin will remain open circuit (high impedance) throughout the entire cycle; if  $t_{RWD} \geq t_{RWD}$  (min),  $t_{CWD} \geq t_{CWD}$  (min), and  $t_{AWD} \geq t_{AWD}$  (min), or  $t_{CWD} \geq t_{CWD}$  (min),  $t_{AWD} \geq t_{AWD}$  (min) and  $t_{CPW} \geq t_{CPW}$  (min), the cycle is a read-modify-write and the data output will contain data read from the selected cell; if neither of the above sets of conditions is satisfied, the condition of the data out (at access time) is indeterminate.
  - These parameters are referred to  $\overline{\text{CAS}}$  leading edge in early write cycles and to  $\overline{\text{WE}}$  leading edge in delayed write or read-modify-write cycles.
  - $t_{RASP}$  defines  $\overline{\text{RAS}}$  pulse width in Fast page mode cycles.
  - Access time is determined by the longest among  $t_{AA}$ ,  $t_{CAC}$  and  $t_{CPA}$ .
  - In delayed write or read-modify-write cycles,  $\overline{\text{OE}}$  must disable output buffer prior to applying data to the device.
  - The 16M DRAM offers a 16-bit time saving parallel test mode. Address CA0 and CA1 for the 4M  $\times$  4 are don't care during test mode. Test mode is set by performing a  $\overline{\text{WE}}$ -and- $\overline{\text{CAS}}$ -before- $\overline{\text{RAS}}$  (WCBR) cycle. In 16-bit parallel test mode, data is written into 4 bits in parallel at each I/O (I/O1 to I/O4) and read out from each I/O.

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## HM51W16400 Series, HM51W17400

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If 4 bits of each I/O are equal (all 1s or 0s), data output pin is a high state during test mode read cycle, then the device has passed. If they are not equal, data output pin is a low state, then the device has failed.

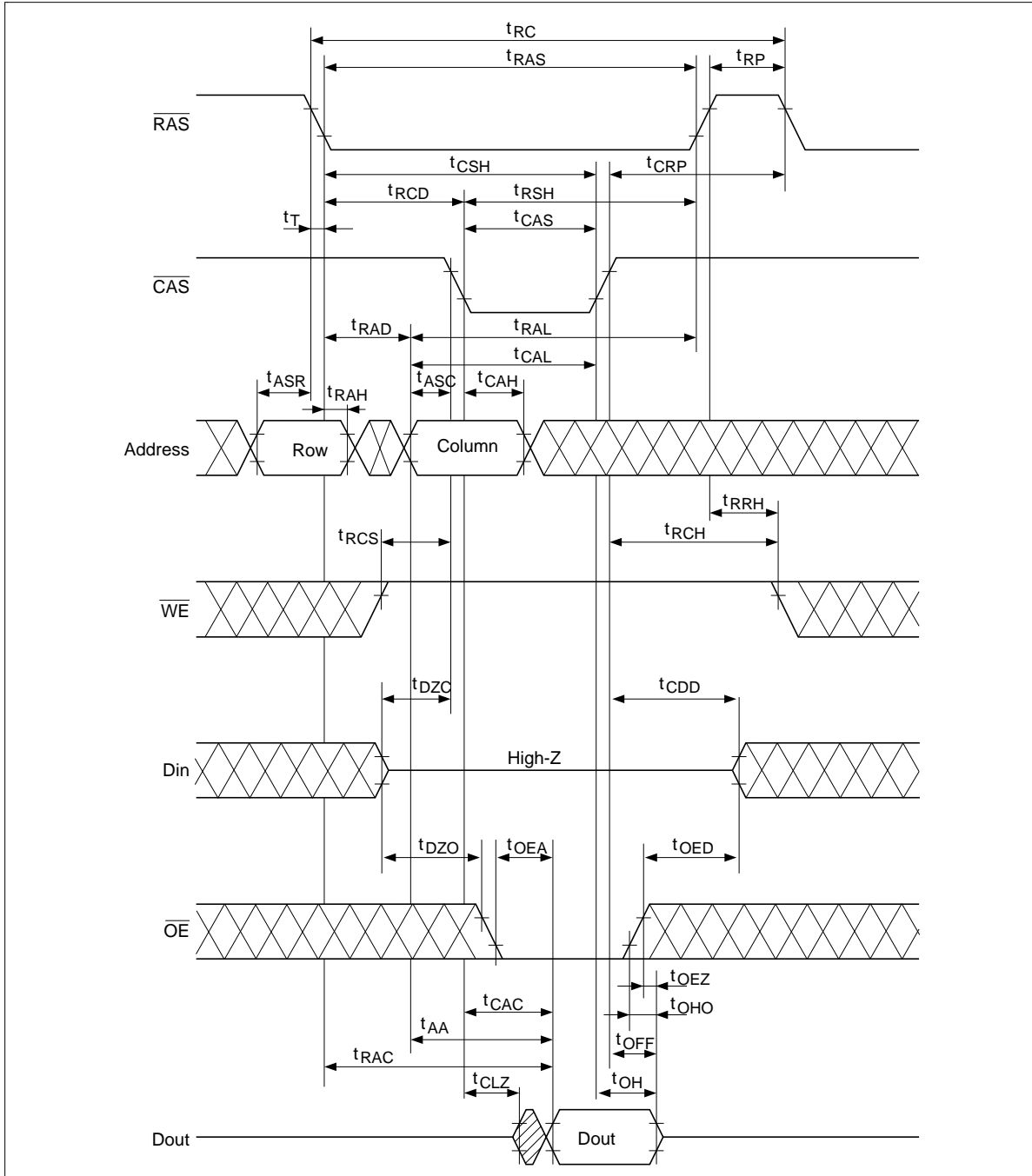
Refresh during test mode operation can be performed by normal read cycles or by WCBR refresh cycles.

To get out of test mode and enter a normal operation mode, perform either a regular  $\overline{\text{CAS}}$ -before- $\overline{\text{RAS}}$  refresh cycle or  $\overline{\text{RAS}}$ -only refresh cycle.

20. In a test mode read cycle, the value of  $t_{\text{RAC}}$ ,  $t_{\text{AA}}$ ,  $t_{\text{CAC}}$  and  $t_{\text{CPA}}$  is delayed by 2 ns to 5 ns for the specified value. These parameters should be specified in test mode cycles by adding the above value to the specified value in this data sheet.
21. Please do not use  $t_{\text{RASS}}$  timing,  $10 \mu\text{s} \leq t_{\text{RASS}} \leq 100 \mu\text{s}$ . During this period, the device is in transition state from normal operation mode to self refresh mode. If  $t_{\text{RASS}} > 100 \mu\text{s}$ , then  $\overline{\text{RAS}}$  precharge time should use  $t_{\text{RPS}}$  instead of  $t_{\text{RP}}$ .
22. If you use distributed CBR refresh mode with 15.6  $\mu\text{s}$  interval in normal read/write cycle, CBR refresh should be executed with in 15.6  $\mu\text{s}$  immediately after exiting from and before entering into self refresh mode.
23. If you use  $\overline{\text{RAS}}$  only refresh or CBR burst refresh mode in normal read/write cycle, 4096 or 2048 cycles (4096 cycles: HM51W16400 Series, 2048 cycles: HM51W 17400 Series) of distributed CBR refresh with 15.6  $\mu\text{s}$  interval should be executed with in 64 or 32 ms (64 ms: HM51W16400 Series, 32 ms: HM51W17400 Series) immediately after exiting from and before entering into the self refresh mode.
24. Repetitive self refresh mode without refreshing all memory is not allowed. Once you exit from self fresh mode, all memory cells need to be refreshed before re-entering the self refresh mode again.
25. XXX: H or L ( $V_{\text{IH}}(\text{min}) \leq V_{\text{IN}} \leq V_{\text{IH}}(\text{max})$ , L:  $V_{\text{IL}}(\text{min}) \leq V_{\text{IN}} \leq V_{\text{IL}}(\text{max})$ )  
/////: Invalid Dout  
When the address, clock and input pins are not described on timing waveforms, their pins must be applied  $V_{\text{IH}}$  or  $V_{\text{IL}}$ .

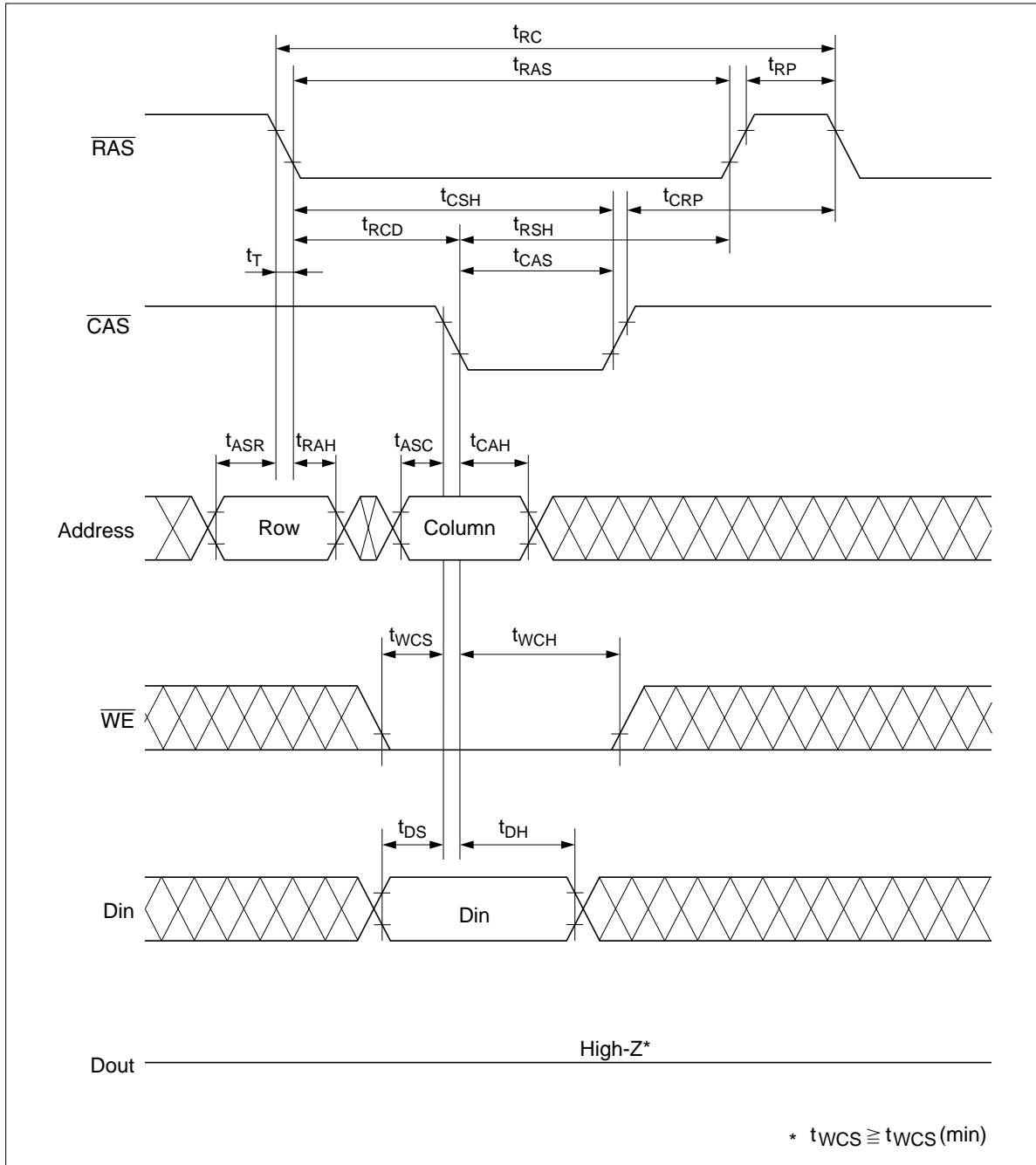
Timing Waveforms\*25

Read Cycle

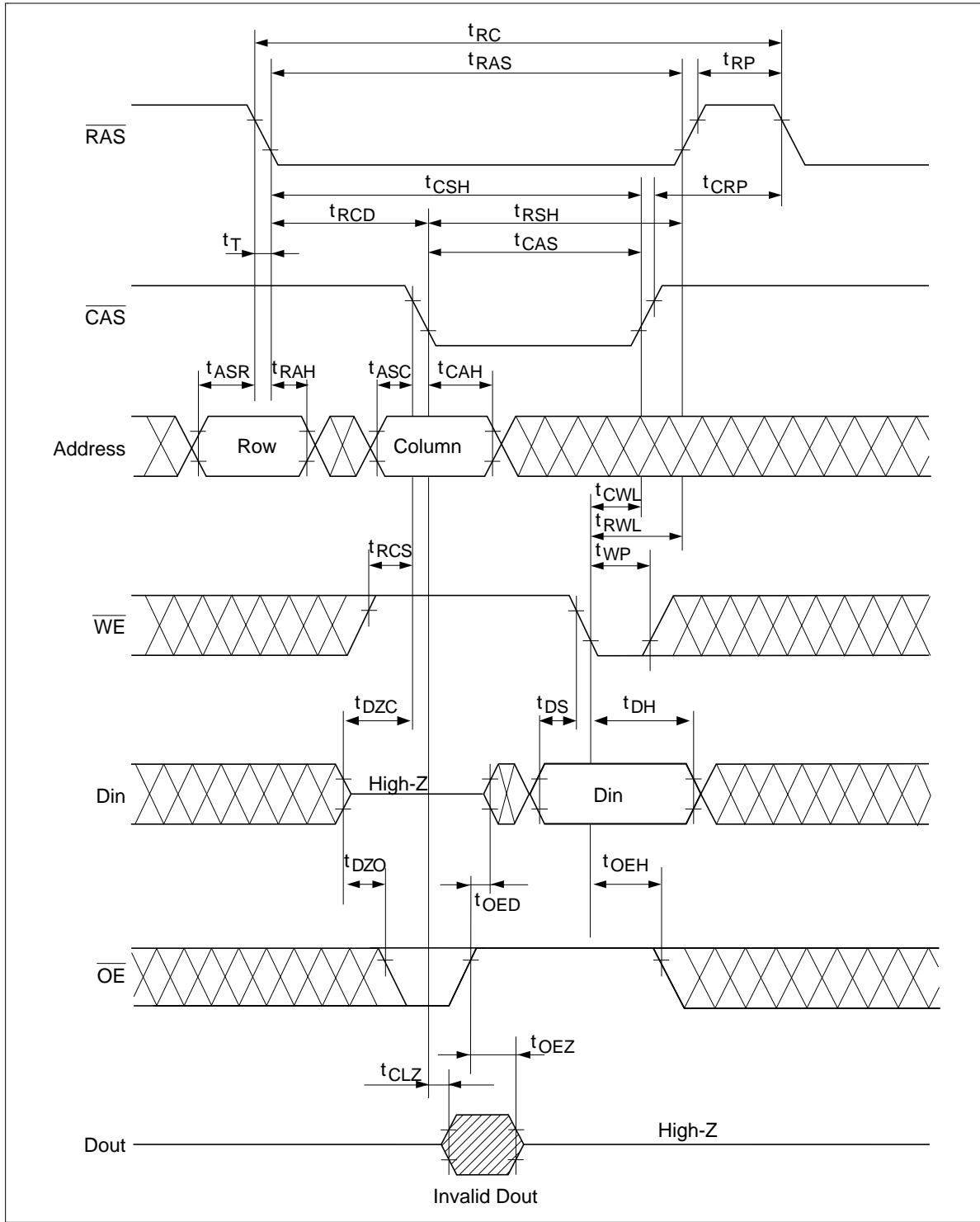


# HM51W16400 Series, HM51W17400

## Early Write Cycle

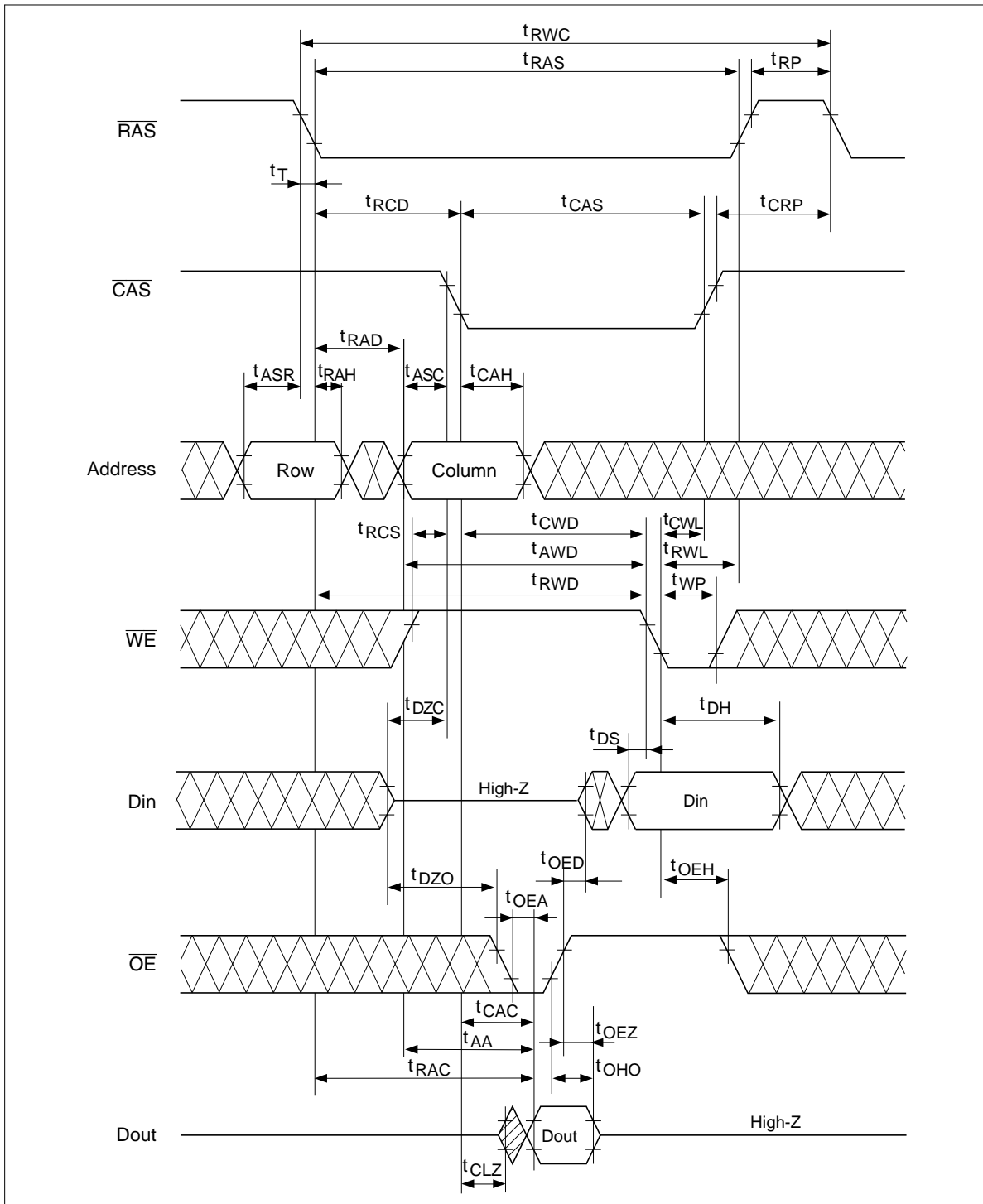


Delayed Write Cycle \*18



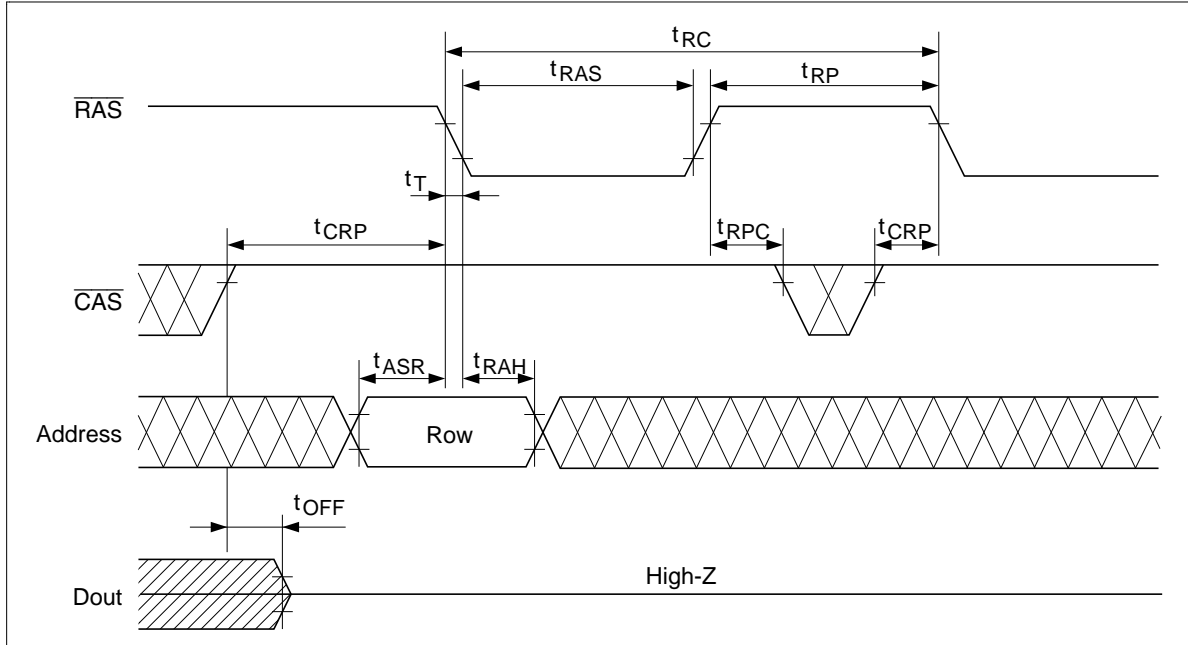
Read-Modify-Write Cycle \*18

# HM51W16400 Series, HM51W17400



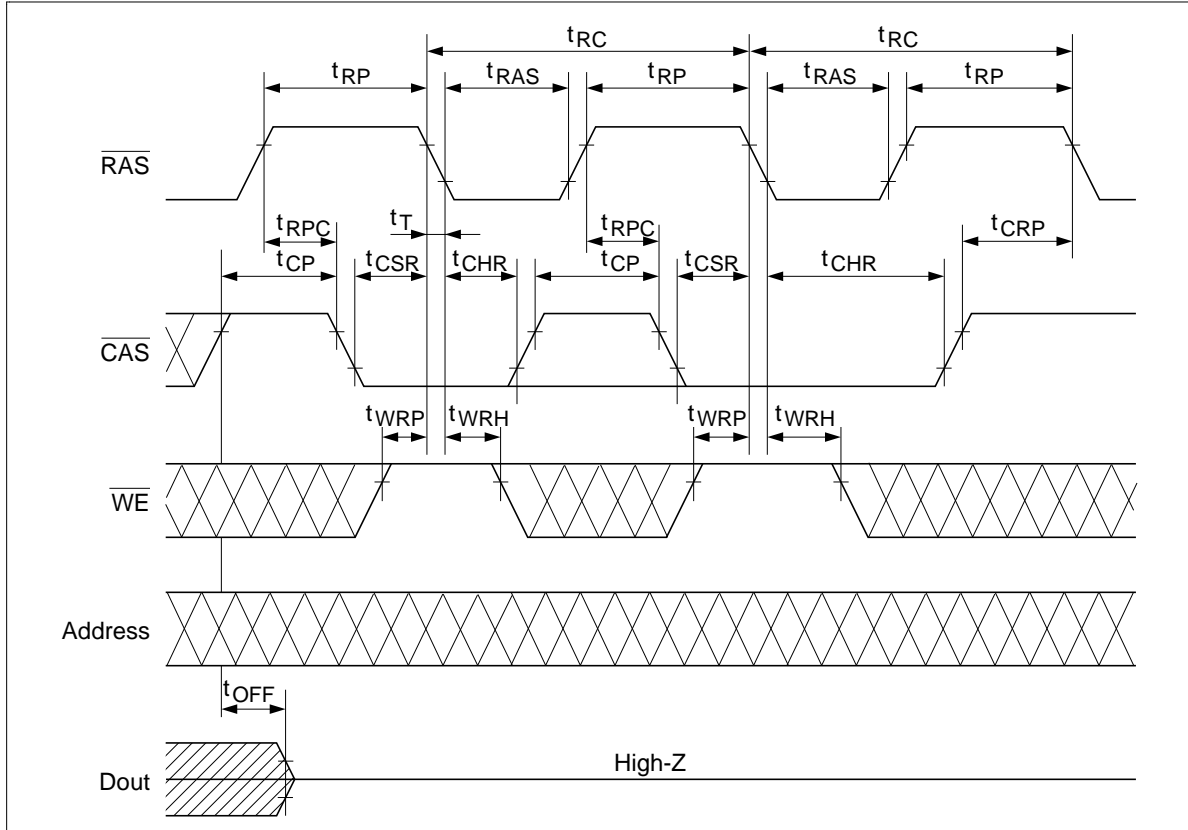
# HM51W16400 Series, HM51W17400

## $\overline{\text{RAS}}$ -Only Refresh Cycle



# HM51W16400 Series, HM51W17400

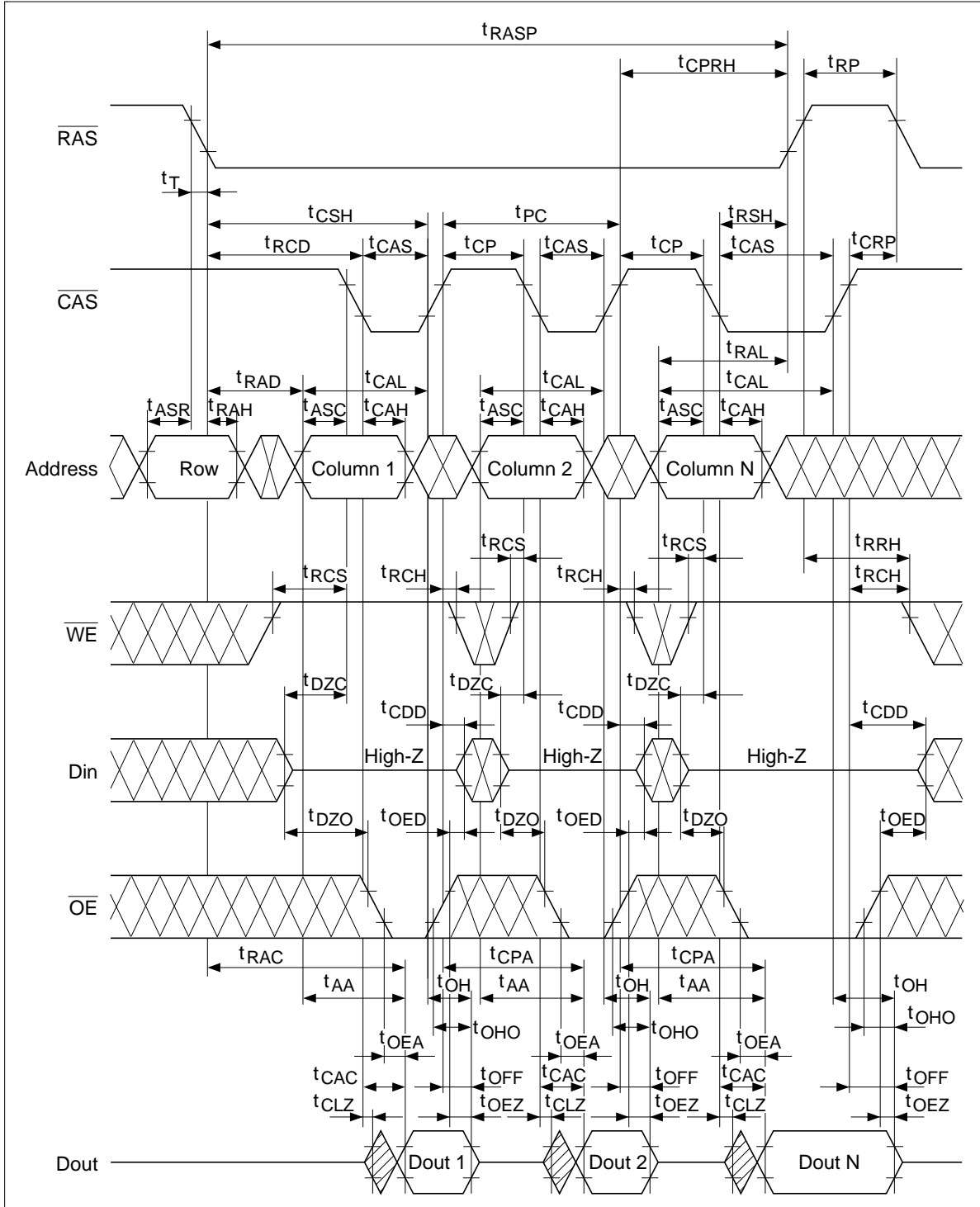
## $\overline{\text{CAS}}$ -Before- $\overline{\text{RAS}}$ Refresh Cycle



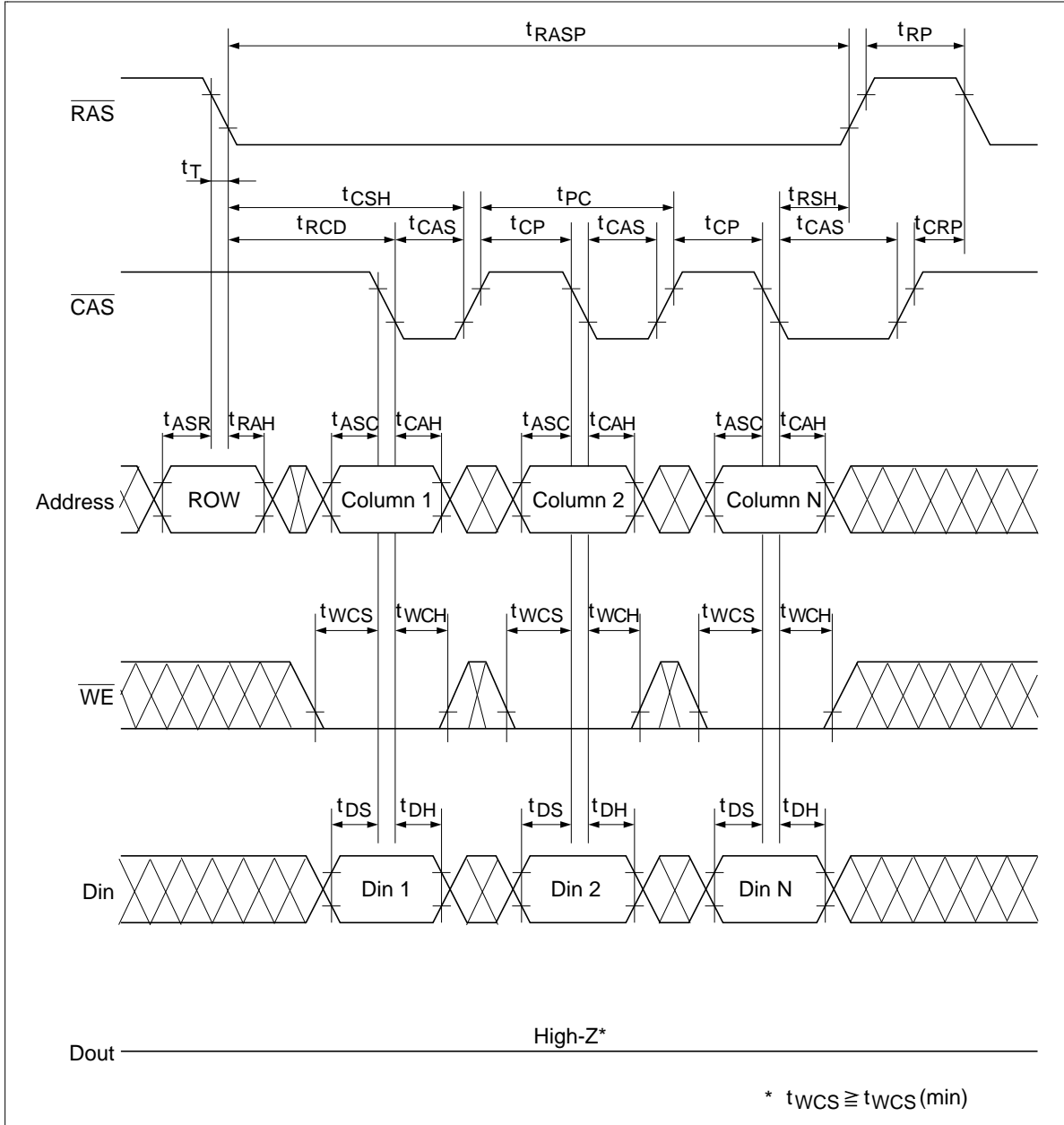


# HM51W16400 Series, HM51W17400

## Fast Page Mode Read Cycle

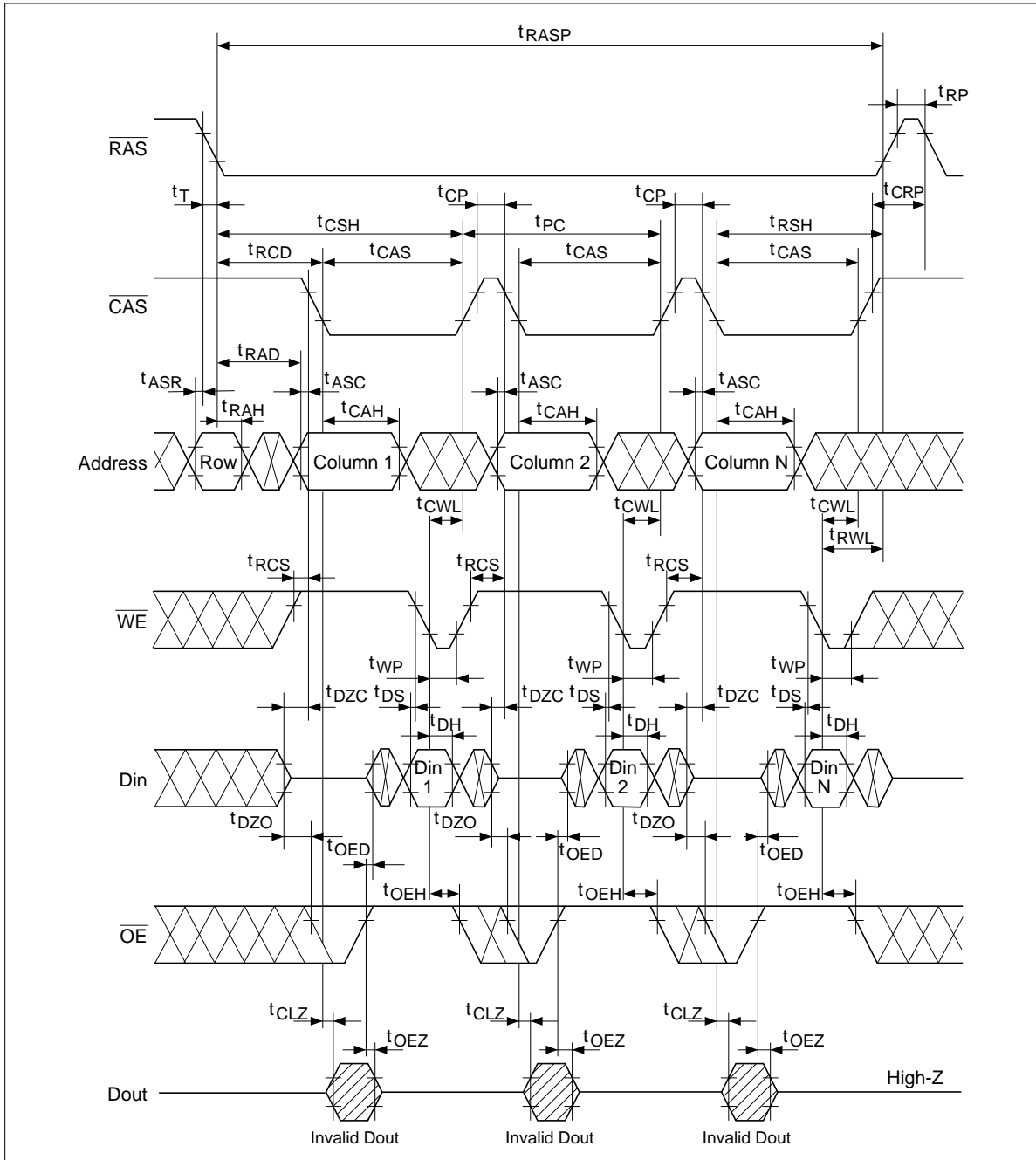


Fast Page Mode Early Write Cycle



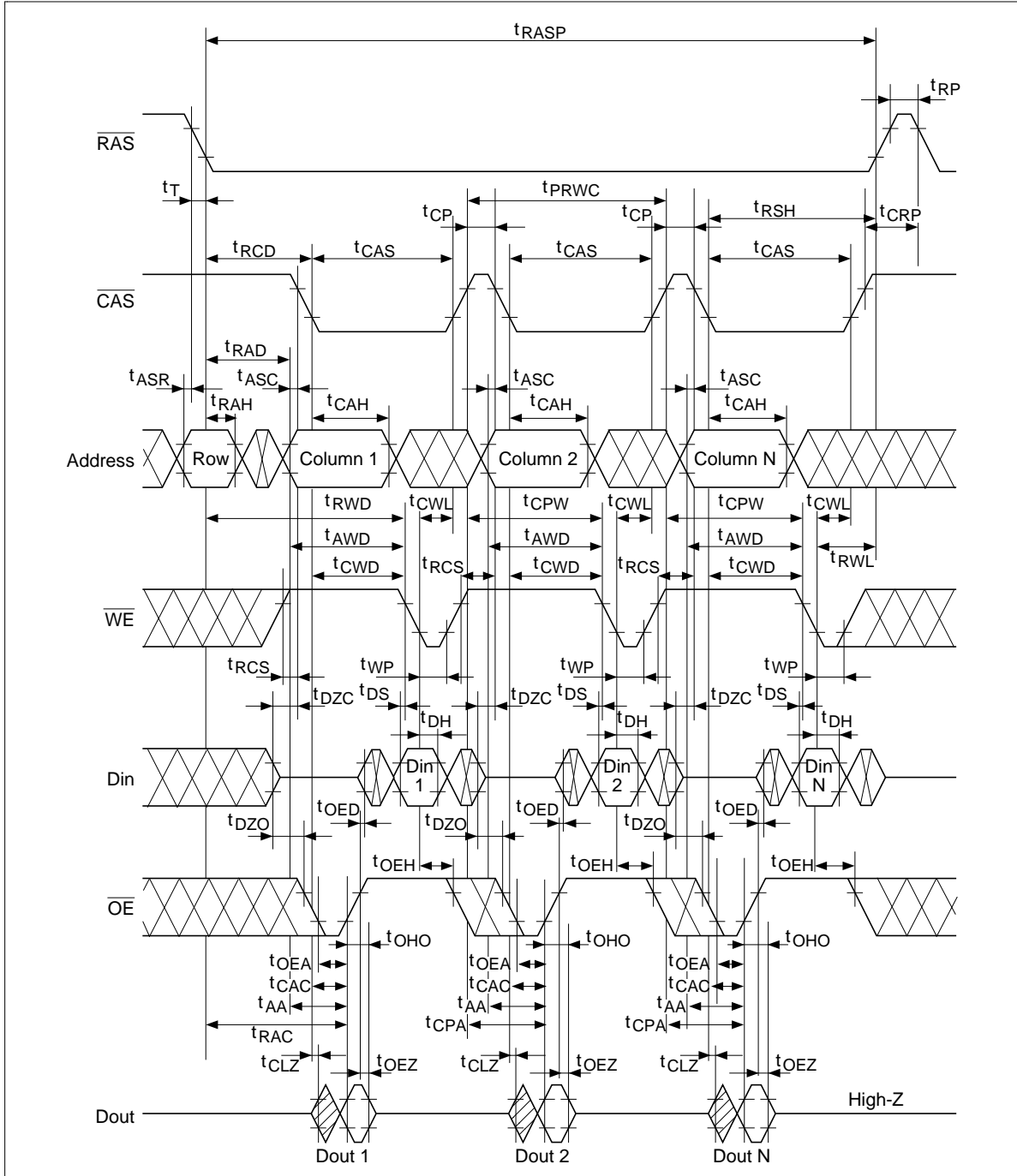
# HM51W16400 Series, HM51W17400

## Fast Page Mode Delayed Write Cycle \*18



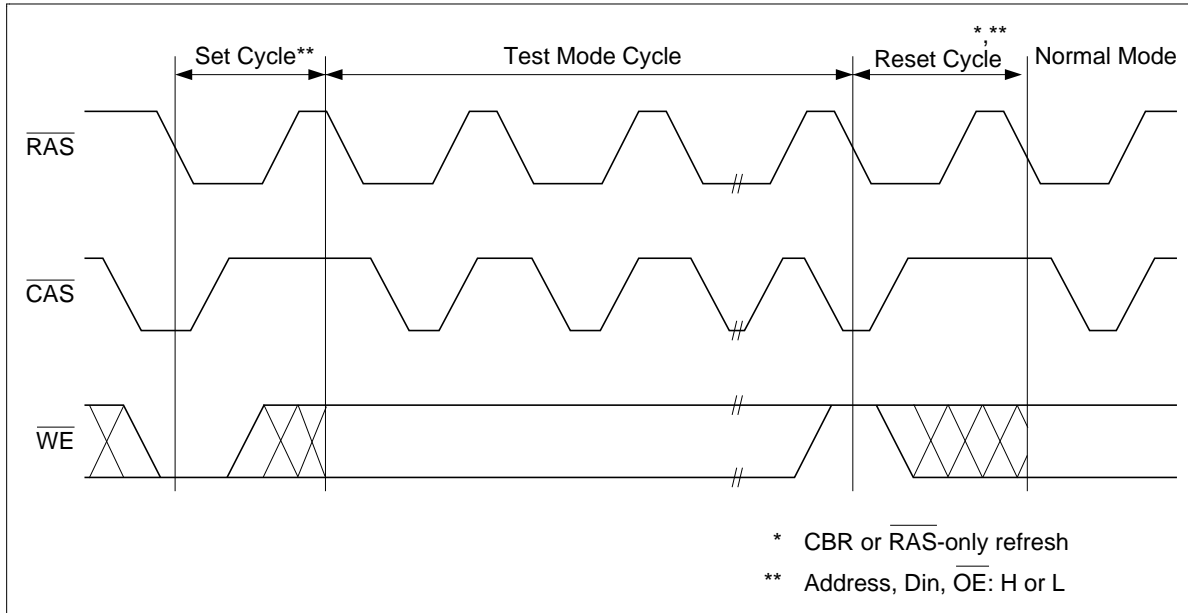
# HM51W16400 Series, HM51W17400

## Fast Page Mode Read-Modify-Write Cycle\*18

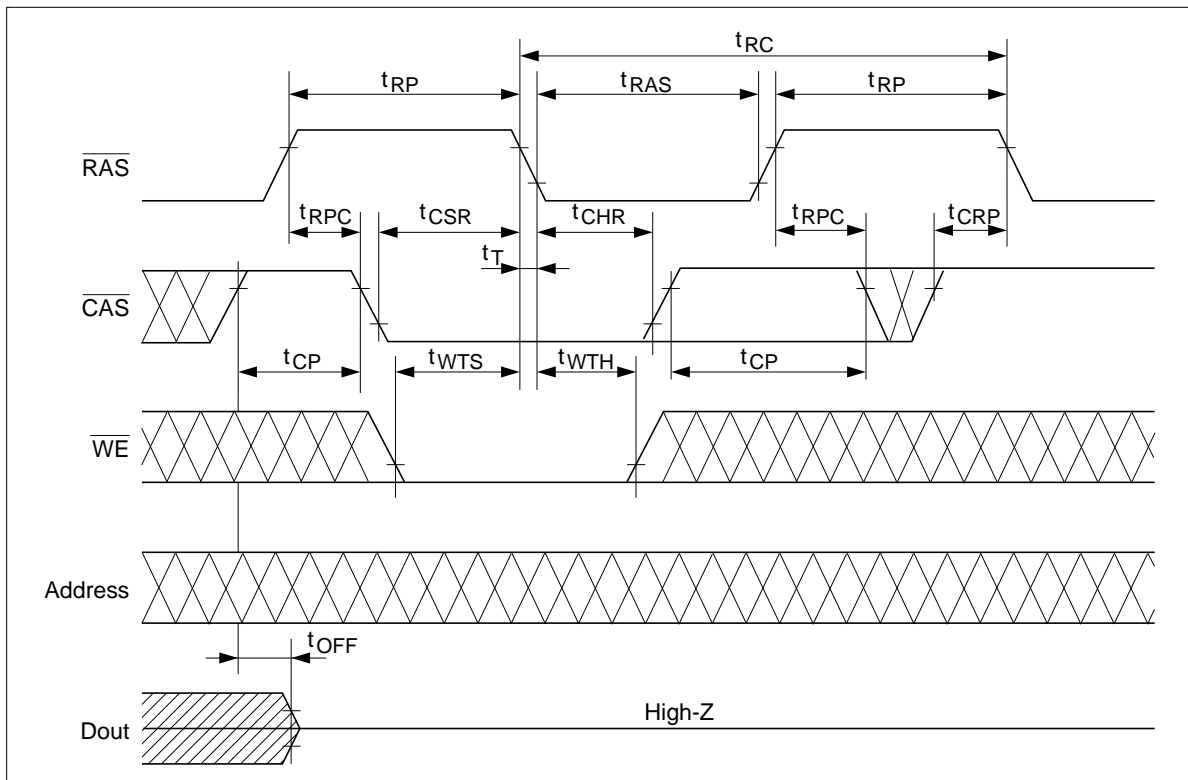


# HM51W16400 Series, HM51W17400

## Test Mode Cycle \*<sup>19</sup>

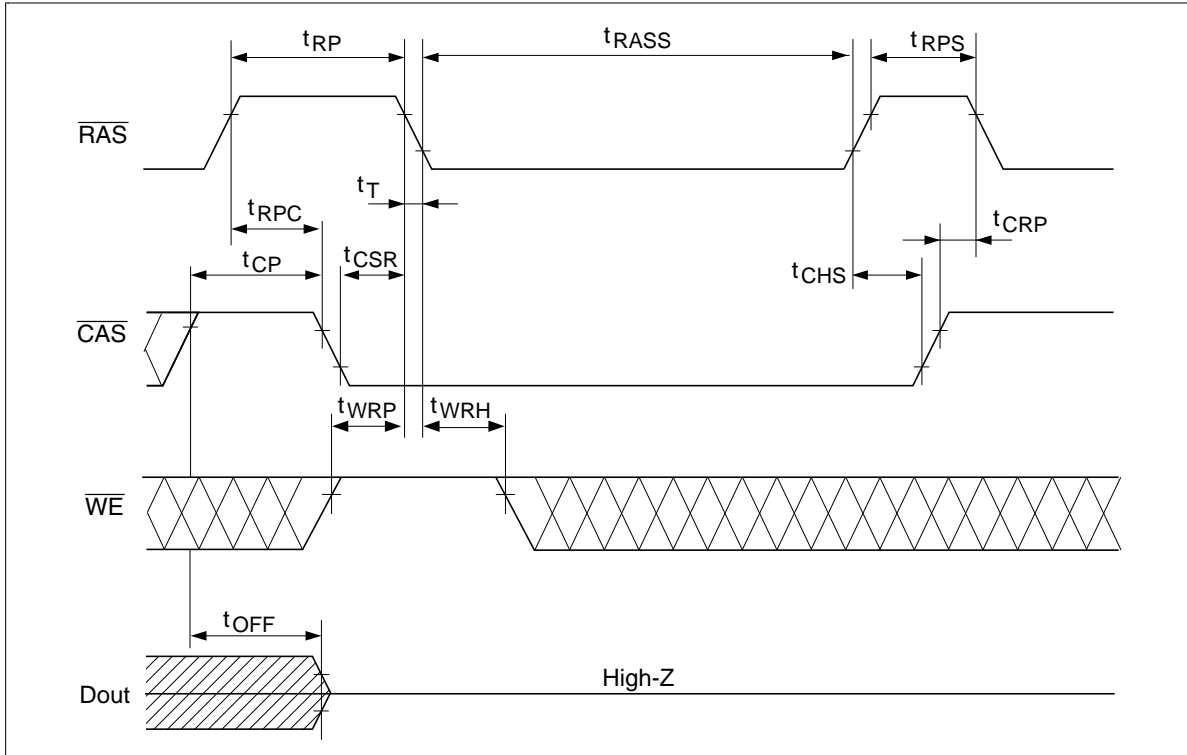


## Test Mode Set Cycle



# HM51W16400 Series, HM51W17400

Self Refresh Cycle (L-version)\*21,\*22,\*23,\*24



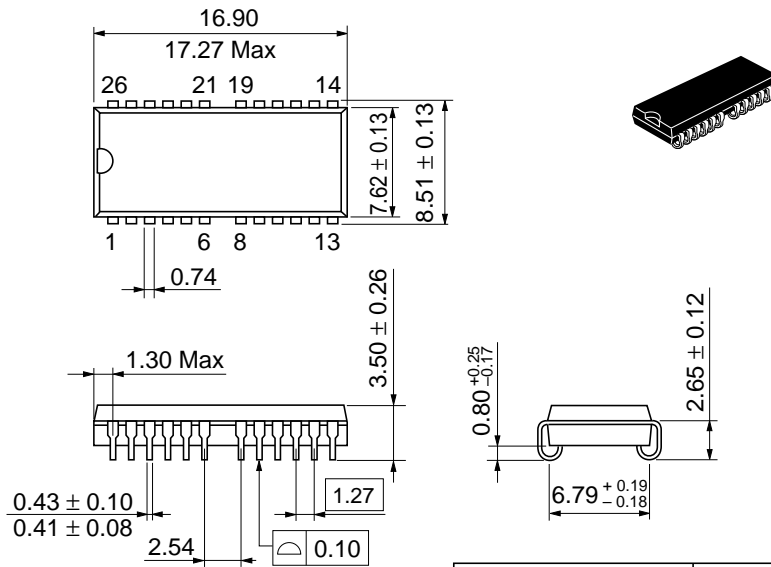
# HM51W16400 Series, HM51W17400

## Package Dimensions

HM51W16400S/LS Series

HM51W17400S/LS Series (CP-26/24DB)

Unit: mm



Dimension including the plating thickness  
Base material dimension

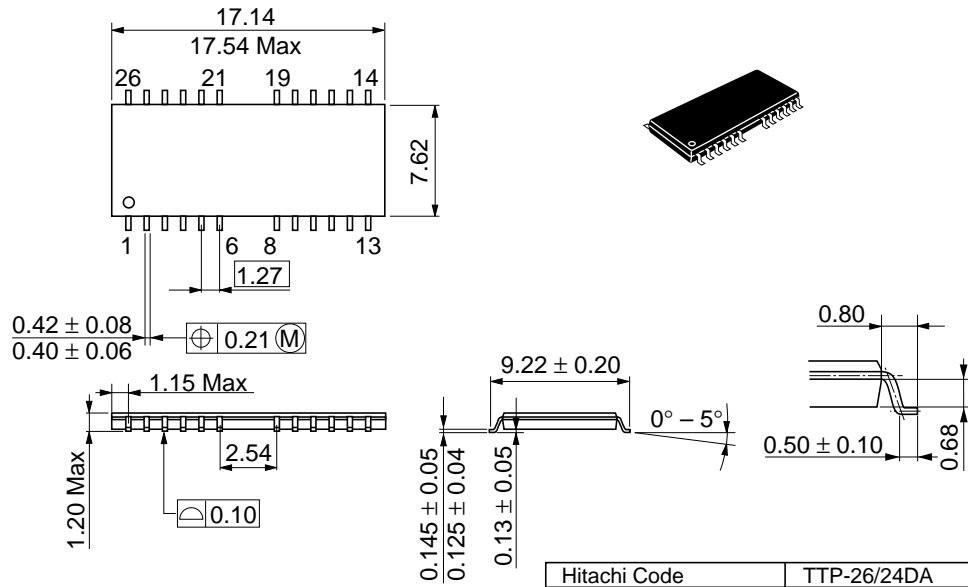
Hitachi Code	CP-26/24DB
JEDEC	Conforms
EIAJ	Conforms
Weight (reference value)	0.8 g

# HM51W16400 Series, HM51W17400

HM51W16400TS/LTS Series

HM51W17400TS/LTS Series (TTP-26/24DA)

Unit: mm



Dimension including the plating thickness  
Base material dimension

Hitachi Code	TTP-26/24DA
JEDEC	Conforms
EIAJ	—
Weight (reference value)	0.30 g

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## HM51W16400 Series, HM51W17400

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# HITACHI

## Hitachi, Ltd.

Semiconductor & IC Div.  
Nippon Bldg., 2-6-2, Ohte-machi, Chiyoda-ku, Tokyo 100, Japan  
Tel: Tokyo (03) 3270-2111  
Fax: (03) 3270-5109

### For further information write to:

Hitachi Semiconductor  
(America) Inc.  
2000 Sierra Point Parkway  
Brisbane, CA. 94005-1897  
U S A  
Tel: 800-285-1601  
Fax: 303-297-0447

Hitachi Europe GmbH  
Continental Europe  
Dornacher Straße 3  
D-85622 Feldkirchen  
München  
Tel: 089-9 91 80-0  
Fax: 089-9 29 30-00

Hitachi Europe Ltd.  
Electronic Components Div.  
Northern Europe Headquarters  
Whitebrook Park  
Lower Cookham Road  
Maidenhead  
Berkshire SL6 8YA  
United Kingdom  
Tel: 01628-585000  
Fax: 01628-585160

Hitachi Asia Pte. Ltd.  
16 Collyer Quay #20-00  
Hitachi Tower  
Singapore 049318  
Tel: 535-2100  
Fax: 535-1533

Hitachi Asia (Hong Kong) Ltd.  
Unit 706, North Tower,  
World Finance Centre,  
Harbour City, Canton Road  
Tsim Sha Tsui, Kowloon  
Hong Kong  
Tel: 27359218  
Fax: 27306071

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## HM51W16400 Series, HM51W17400

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### Revision Record

Rev.	Date	Contents of Modification	Drawn by	Approved by
1.0	Oct. 14, 1996	Initial issue	Y. Kasama	M. Mishima
2.0	Nov. 14, 1996	Addition of HM51W16400-5 Series Addition of HM51W17400-5 Series Power dissipation (active) 396/360 mW(max) to 360/324/288 mW (max) (HM51W17400 Series) DC Characteristics (HM51W17400 Series) $I_{CC1}$ max: 110/100 mA to 100/90/80 mA $I_{CC3}$ max: 110/100 mA to 100/90/80 mA $I_{CC6}$ max: 110/100 mA to 100/90/80 mA	Y. Kasama	Y. Matsuno
3.0	Feb. 27, 1997	AC Characteristics $t_{RRH}$ min: 5/5/5 ns to 0/0/0 ns	Y. Kasama	Y. Matsuno
4.0	Jun. 12, 1997	Deletion of HM51W16400/HM51W17400-5 Series	Y. Kasama	Y. Matsuno
5.0	Nov. 1997	Change of Subtitle		

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