
HM5164400A Series

HM5165400A Series

16777216-word $\times$ 4-bit Dynamic Random Access Memory

HITACHI

ADE-203-490 (Z)
Preliminary
Rev. 0.2
Jan. 22, 1997

Description

The Hitachi HM5164400A Series, HM5165400A Series are CMOS dynamic RAMs organized as 16,777,216-word $\times$ 4-bit. They employ the most advanced CMOS technology for high performance and low power. The HM5164400A Series, HM5165400A Series offer Fast Page Mode as a high speed access mode. They have the package variations of standard 400-mil 32-pin plastic SOJ and standard 400-mil 32-pin plastic TSOPII.

Features

- Single 3.3 V (± 0.3 V)
- High speed
 - Access time: 50 ns/60 ns/70 ns (max)
- Low power dissipation
 - Active mode : TBD/378 mW/324 mW (max) (HM5164400A Series)
: TBD/558 mW/486 mW (max) (HM5165400A Series)
 - Standby mode : 7.2 mW (max)
: TBD (L-version)
- Fast page mode capability
- Long refresh period
 - 8192 $\overline{\text{RAS}}$ only refresh cycles : 64 ms (HM5164400A Series)
4096 CBR/Hidden refresh cycles : 64 ms
: 128 ms (L-version)
 - 4096 $\overline{\text{RAS}}$ only refresh cycles : 64 ms (HM5165400A Series)
4096 CBR/Hidden refresh cycles : 64 ms
: 128 ms (L-version)

Preliminary: This document contains information on a new product. Specifications and information contained herein are subject to change without notice.

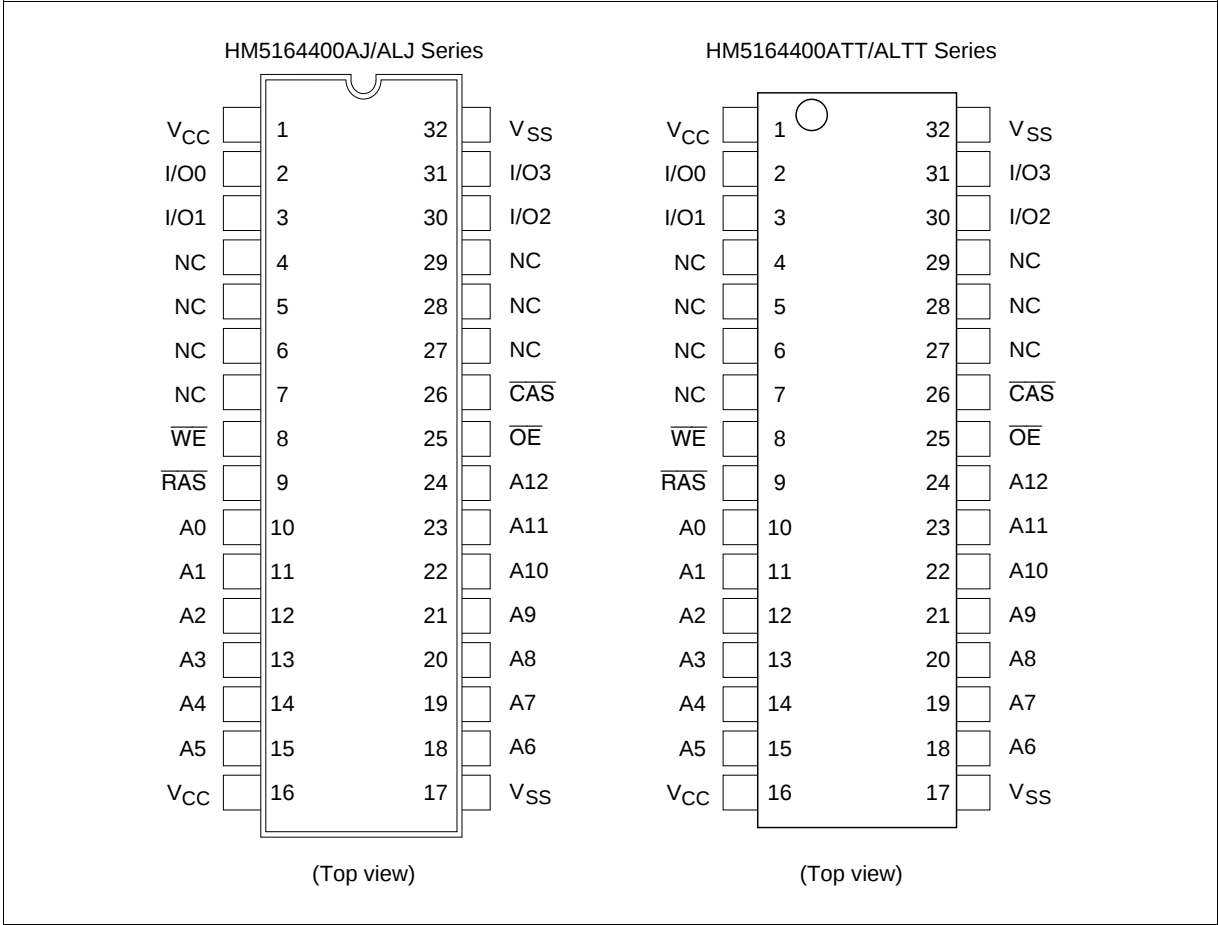
HM5164400A Series, HM5165400A Series

- 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)

Ordering Information

Type No.	Access time	Package
HM5164400AJ-5	50 ns	400-mil 32-pin plastic SOJ (CP-32DC)
HM5164400AJ-6	60 ns	
HM5164400AJ-7	70 ns	
HM5164400ALJ-5	50 ns	
HM5164400ALJ-6	60 ns	
HM5164400ALJ-7	70 ns	
HM5165400AJ-5	50 ns	
HM5165400AJ-6	60 ns	
HM5165400AJ-7	70 ns	
HM5165400ALJ-5	50 ns	
HM5165400ALJ-6	60 ns	
HM5165400ALJ-7	70 ns	
HM5164400ATT-5	50 ns	400-mil 32-pin plastic TSOP II (TTP-32DC)
HM5164400ATT-6	60 ns	
HM5164400ATT-7	70 ns	
HM5164400ALTT-5	50 ns	
HM5164400ALTT-6	60 ns	
HM5164400ALTT-7	70 ns	
HM5165400ATT-5	50 ns	
HM5165400ATT-6	60 ns	
HM5165400ATT-7	70 ns	
HM5165400ALTT-5	50 ns	
HM5165400ALTT-6	60 ns	
HM5165400ALTT-7	70 ns	

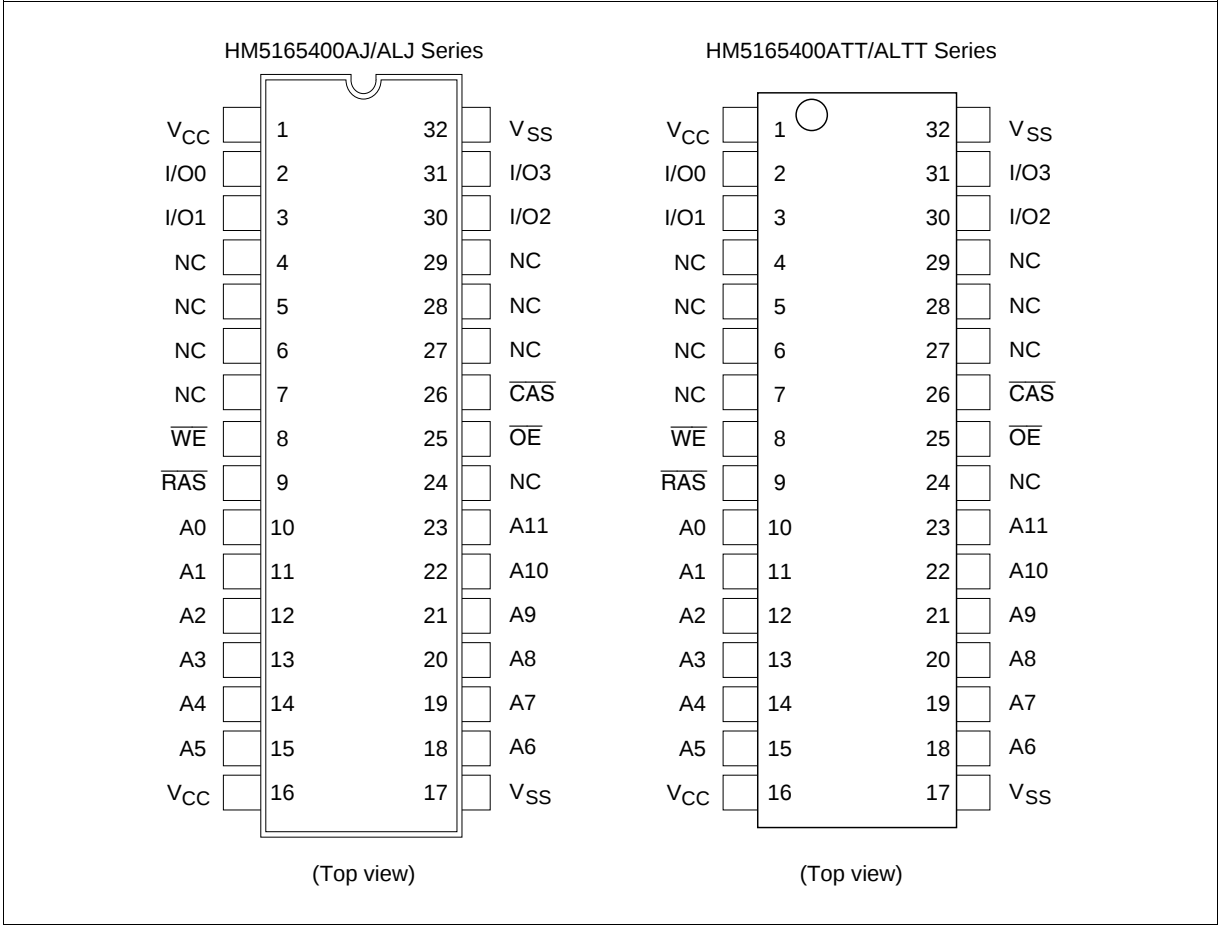
Pin Arrangement



Pin Description

Pin name	Function
A0 to A12	Address input — Row/Refresh address A0 to A12 — Column address A0 to A10
I/O0 to I/O3	Data input/Data output
RAS	Row address strobe
CAS	Column address strobe
WE	Read/Write enable
OE	Output enable
V _{cc}	Power supply
V _{ss}	Ground
NC	No connection

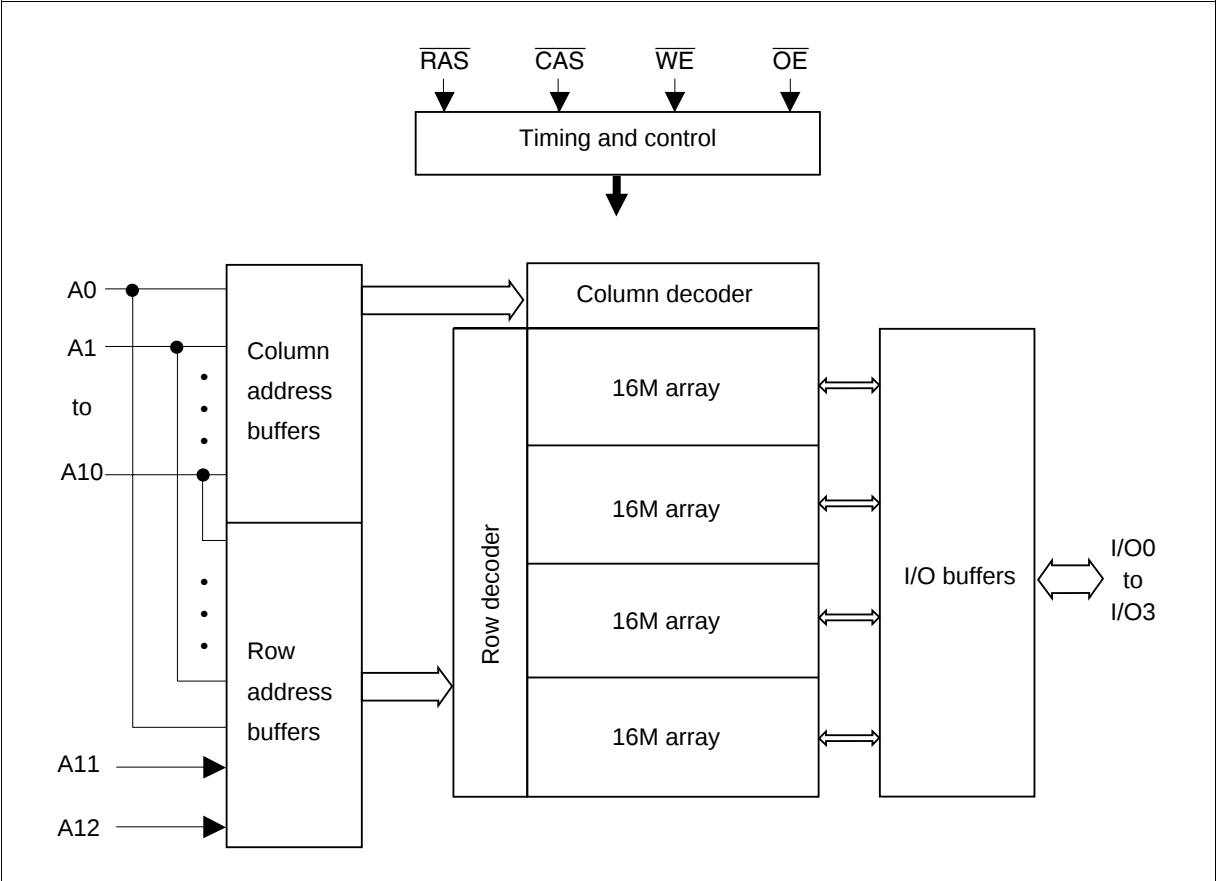
Pin Arrangement



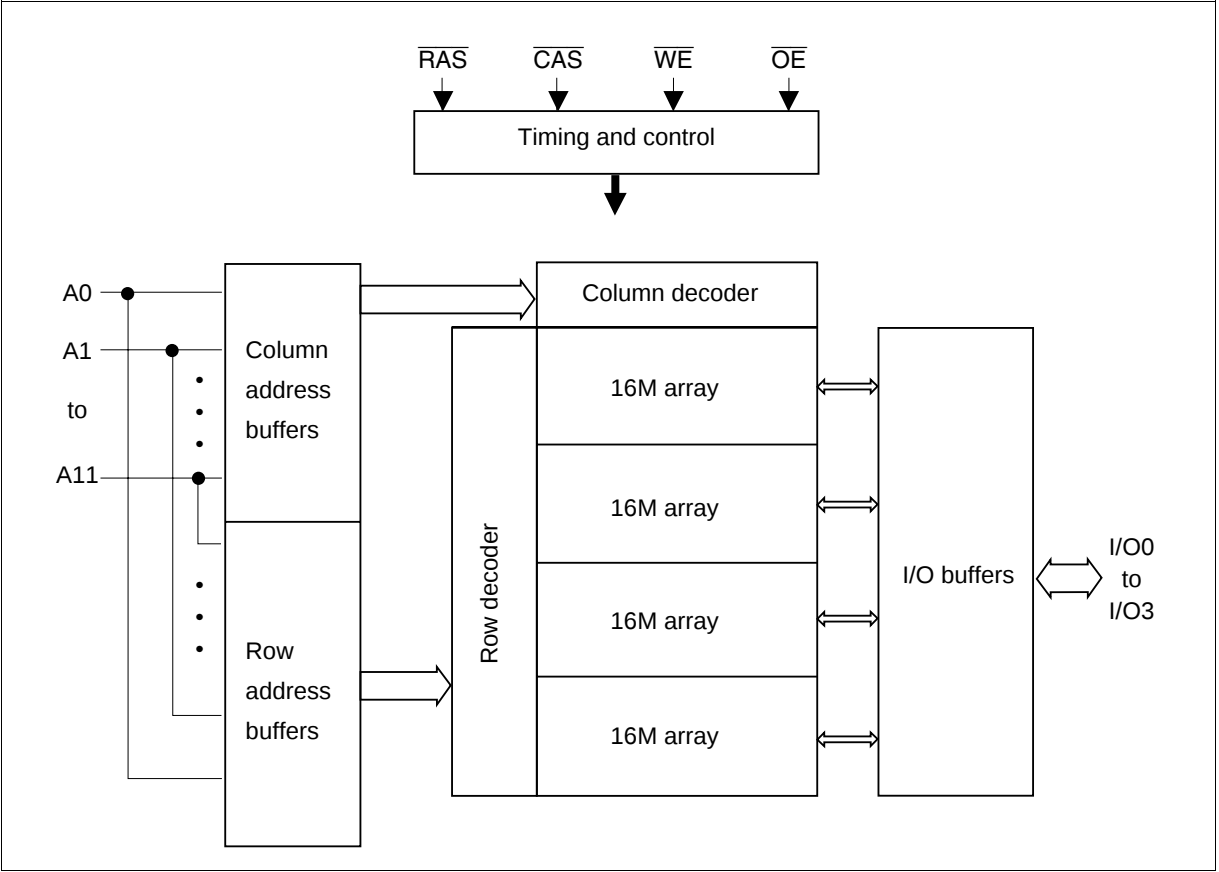
Pin Description

Pin name	Function
A0 to A11	Address input — Row/Refresh address A0 to A11 — Column address A0 to A11
I/O0 to I/O3	Data input/Data output
RAS	Row address strobe
CAS	Column address strobe
WE	Read/Write enable
OE	Output enable
V _{cc}	Power supply
V _{ss}	Ground
NC	No connection

Block Diagram (HM5164400A Series)



Block Diagram (HM5165400A Series)



Absolute Maximum Ratings

Parameter	Symbol	Value	Unit
Voltage on any pin relative to V_{SS}	V_T	-0.5 to $V_{CC} + 0.5$ (≤ 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 $+70$	$^{\circ}\text{C}$
Storage temperature	T_{stg}	-55 to $+125$	$^{\circ}\text{C}$

Recommended DC Operating Conditions ($T_a = 0$ to $+70^{\circ}\text{C}$)

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

Notes: 1. All voltage referred to V_{SS}
 2. The supply voltage with all V_{CC} pins must be on the same level. The supply voltage with all V_{SS} pins must be on the same level.

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DC Characteristics

(Ta = 0 to +70°C, V_{CC} = 3.3 V ± 0.3 V, V_{SS} = 0 V) (HM5164400A Series)

		HM5164400A							
		-5		-6		-7			
Parameter	Symbol	Min	Max	Min	Max	Min	Max	Unit	Test conditions
Operating current* ¹ , * ²	I _{CC1}	—	TBD	—	105	—	90	mA	t _{RC} = min
Standby current	I _{CC2}	—	TBD	—	2	—	2	mA	TTL interface R _{AS} , C _{AS} = V _{IH} Dout = High-Z
		—	TBD	—	1	—	1	mA	CMOS interface R _{AS} , C _{AS} ≥ V _{CC} − 0.2 V Dout = High-Z
Standby current (L-version)	I _{CC2}	—	TBD	—	TBD	—	TBD	μA	CMOS interface R _{AS} , C _{AS} ≥ V _{CC} − 0.2 V Dout = High-Z
R _{AS} -only refresh current* ²	I _{CC3}	—	TBD	—	105	—	90	mA	t _{RC} = min
Standby current* ¹	I _{CC5}	—	TBD	—	5	—	5	mA	R _{AS} = V _{IH} , C _{AS} = V _{IL} Dout = enable
C _{AS} -before-R _{AS} refresh current	I _{CC6}	—	TBD	—	140	—	120	mA	t _{RC} = min
Fast page mode current* ¹ , * ³	I _{CC7}	—	TBD	—	80	—	70	mA	t _{PC} = min
Battery backup current* ⁴ (Standby with CBR refresh) (L-version)	I _{CC10}	—	TBD	—	TBD	—	TBD	μA	CMOS interface Dout = High-Z, CBR refresh: t _{RC} = 31.3 μs t _{RAS} ≤ 0.3 μs
Self refresh mode current (L-version)	I _{CC11}	—	TBD	—	TBD	—	TBD	μA	CMOS interface R _{AS} , C _{AS} ≤ 0.2 V Dout = High-Z
Input leakage current	I _{LI}	TBD	TBD	−10	10	−10	10	μA	0 V ≤ Vin ≤ V _{CC} + 0.3 V
Output leakage current	I _{LO}	TBD	TBD	−10	10	−10	10	μA	0 V ≤ Vin ≤ V _{CC} Dout = disable
Output high voltage	V _{OH}	TBD	TBD	2.4	V _{CC}	2.4	V _{CC}	V	High Iout = −2 mA
Output low voltage	V _{OL}	TBD	TBD	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 R_{AS} = V_{IL}.
3. Address can be changed once or less within one page mode cycle t_{PC}.
4. V_{IH} ≥ V_{CC} − 0.2 V, 0 V ≤ V_{IL} ≤ 0.2 V.

DC Characteristics

(Ta = 0 to +70°C, V_{CC} = 3.3 V ± 0.3 V, V_{SS} = 0 V) (HM5165400A Series)

		HM5165400A							
		-5		-6		-7			
Parameter	Symbol	Min	Max	Min	Max	Min	Max	Unit	Test conditions
Operating current ^{*1, *2}	I _{CC1}	—	TBD	—	155	—	135	mA	t _{RC} = min
Standby current	I _{CC2}	—	TBD	—	2	—	2	mA	TTL interface RAS, CAS = V _{IH} Dout = High-Z
		—	TBD	—	1	—	1	mA	CMOS interface RAS, CAS ≥ V _{CC} − 0.2 V Dout = High-Z
Standby current (L-version)	I _{CC2}	—	TBD	—	TBD	—	TBD	μA	CMOS interface RAS, CAS ≥ V _{CC} − 0.2 V Dout = High-Z
RAS-only refresh current ^{*2}	I _{CC3}	—	TBD	—	155	—	135	mA	t _{RC} = min
Standby current ^{*1}	I _{CC5}	—	TBD	—	5	—	5	mA	RAS = V _{IH} , CAS = V _{IL} Dout = enable
CAS-before-RAS refresh current	I _{CC6}	—	TBD	—	140	—	120	mA	t _{RC} = min
Fast page mode current ^{*1, *3}	I _{CC7}	—	TBD	—	95	—	85	mA	t _{PC} = min
Battery backup current ^{*4} (Standby with CBR refresh) (L-version)	I _{CC10}	—	TBD	—	TBD	—	TBD	μA	CMOS interface Dout = High-Z, CBR refresh: t _{RC} = 31.3 μs t _{RAS} ≤ 0.3 μs
Self refresh mode current (L-version)	I _{CC11}	—	TBD	—	TBD	—	TBD	μA	CMOS interface RAS, CAS ≤ 0.2 V Dout = High-Z
Input leakage current	I _{LI}	TBD	TBD	−10	10	−10	10	μA	0 V ≤ Vin ≤ V _{CC} + 0.3 V
Output leakage current	I _{LO}	TBD	TBD	−10	10	−10	10	μA	0 V ≤ Vin ≤ V _{CC} Dout = disable
Output high voltage	V _{OH}	TBD	TBD	2.4	V _{CC}	2.4	V _{CC}	V	High Iout = −2 mA
Output low voltage	V _{OL}	TBD	TBD	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 RAS = V_{IL}.

3. Address can be changed once or less within one page mode cycle t_{PC}.

4. V_{IH} ≥ V_{CC} - 0.2 V, 0 V ≤ V_{IL} ≤ 0.2 V.

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Capacitance (Ta = 25°C, V_{CC} = 3.3 V ± 0.3 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. $\overline{\text{RAS}}$, $\overline{\text{CAS}}$ = V_{IH} to disable Dout.

AC Characteristics ($T_a = 0$ to $+70^{\circ}\text{C}$, $V_{CC} = 3.3\text{ V} \pm 0.3\text{ V}$, $V_{SS} = 0\text{ V}$) *¹, *², *¹⁷

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)

		HM5164400A/HM5165400A							
		-5		-6		-7			
Parameter	Symbol	Min	Max	Min	Max	Min	Max	Unit	Notes
Random read or write cycle time	t_{RC}	TBD	—	110	—	130	—	ns	
$\overline{\text{RAS}}$ precharge time	t_{RP}	TBD	—	40	—	50	—	ns	
$\overline{\text{CAS}}$ precharge time	t_{CP}	TBD	—	10	—	10	—	ns	
$\overline{\text{RAS}}$ pulse width	t_{RAS}	TBD	TBD	60	10000	70	10000	ns	
$\overline{\text{CAS}}$ pulse width	t_{CAS}	TBD	TBD	15	10000	18	10000	ns	
Row address setup time	t_{ASR}	TBD	—	0	—	0	—	ns	
Row address hold time	t_{RAH}	TBD	—	10	—	10	—	ns	
Column address setup time	t_{ASC}	TBD	—	0	—	0	—	ns	
Column address hold time	t_{CAH}	TBD	—	10	—	15	—	ns	
$\overline{\text{RAS}}$ to $\overline{\text{CAS}}$ delay time	t_{RCD}	TBD	TBD	20	45	20	52	ns	3
$\overline{\text{RAS}}$ to column address delay time	t_{RAD}	TBD	TBD	15	30	15	35	ns	4
$\overline{\text{RAS}}$ hold time	t_{RSH}	TBD	—	15	—	18	—	ns	
$\overline{\text{CAS}}$ hold time	t_{CSH}	TBD	—	60	—	70	—	ns	
$\overline{\text{CAS}}$ to $\overline{\text{RAS}}$ precharge time	t_{CRP}	TBD	—	5	—	5	—	ns	
$\overline{\text{OE}}$ to Din delay time	t_{OED}	TBD	—	15	—	18	—	ns	5
$\overline{\text{OE}}$ delay time from Din	t_{DZO}	TBD	—	0	—	0	—	ns	6
$\overline{\text{CAS}}$ delay time from Din	t_{DZC}	TBD	—	0	—	0	—	ns	6
Transition time (rise and fall)	t_T	TBD	TBD	3	50	3	50	ns	7

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Read Cycle

		HM5164400A/HM5165400A							
		-5		-6		-7			
Parameter	Symbol	Min	Max	Min	Max	Min	Max	Unit	Notes
Access time from $\overline{\text{RAS}}$	t_{RAC}	—	TBD	—	60	—	70	ns	8, 9
Access time from $\overline{\text{CAS}}$	t_{CAC}	—	TBD	—	15	—	18	ns	9, 10, 16
Access time from address	t_{AA}	—	TBD	—	30	—	35	ns	9, 11, 16
Access time from $\overline{\text{OE}}$	t_{OEA}	—	TBD	—	15	—	18	ns	9, 19
Read command setup time	t_{RCS}	TBD	—	0	—	0	—	ns	
Read command hold time to $\overline{\text{CAS}}$	t_{RCH}	TBD	—	0	—	0	—	ns	12
Read command hold time to $\overline{\text{RAS}}$	t_{RRH}	TBD	—	5	—	5	—	ns	12
Column address to $\overline{\text{RAS}}$ lead time	t_{RAL}	TBD	—	30	—	35	—	ns	
Column address to $\overline{\text{CAS}}$ lead time	t_{CAL}	TBD	—	30	—	35	—	ns	
$\overline{\text{CAS}}$ to output in low-Z	t_{CLZ}	TBD	—	0	—	0	—	ns	
Output data hold time	t_{OH}	TBD	—	3	—	3	—	ns	
Output data hold time from $\overline{\text{OE}}$	t_{OHO}	TBD	—	3	—	3	—	ns	
Output buffer turn-off time	t_{OFF}	—	TBD	—	15	—	15	ns	13
Output buffer turn-off to $\overline{\text{OE}}$	t_{OEZ}	—	TBD	—	15	—	15	ns	13
$\overline{\text{CAS}}$ to Din delay time	t_{CDD}	TBD	—	15	—	18	—	ns	5

Write Cycle

		HM5164400A/HM5165400A							
		-5		-6		-7			
Parameter	Symbol	Min	Max	Min	Max	Min	Max	Unit	Notes
Write command setup time	t_{WCS}	TBD	—	0	—	0	—	ns	14
Write command hold time	t_{WCH}	TBD	—	10	—	15	—	ns	
Write command pulse width	t_{WP}	TBD	—	10	—	10	—	ns	
Write command to $\overline{\text{RAS}}$ lead time	t_{RWL}	TBD	—	15	—	18	—	ns	
Write command to $\overline{\text{CAS}}$ lead time	t_{CWL}	TBD	—	15	—	18	—	ns	
Data-in setup time	t_{DS}	TBD	—	0	—	0	—	ns	
Data-in hold time	t_{DH}	TBD	—	10	—	15	—	ns	

Read-Modify-Write Cycle

		HM5164400A/HM5165400A							
		-5		-6		-7			
Parameter	Symbol	Min	Max	Min	Max	Min	Max	Unit	Notes
Read-modify-write cycle time	t _{RWC}	TBD	—	155	—	181	—	ns	
RAS to WE delay time	t _{RWD}	TBD	—	85	—	98	—	ns	14
CAS to WE delay time	t _{CWD}	TBD	—	40	—	46	—	ns	14
Column address to WE delay time	t _{AWD}	TBD	—	55	—	63	—	ns	14
OE hold time from WE	t _{OEH}	TBD	—	15	—	18	—	ns	

Refresh Cycle

		HM5164400A/HM5165400A							
		-5		-6		-7			
Parameter	Symbol	Min	Max	Min	Max	Min	Max	Unit	Notes
CAS setup time (CBR refresh cycle)	t _{CSR}	TBD	—	5	—	5	—	ns	
CAS hold time (CBR refresh cycle)	t _{CHR}	TBD	—	10	—	10	—	ns	
WE setup time (CBR refresh cycle)	t _{WRP}	TBD	—	0	—	0	—	ns	
WE hold time (CBR refresh cycle)	t _{WRH}	TBD	—	10	—	10	—	ns	
RAS precharge to CAS hold time	t _{RPC}	TBD	—	0	—	0	—	ns	

Fast Page Mode Cycle

		HM5164400A/HM5165400A							
		-5		-6		-7			
Parameter	Symbol	Min	Max	Min	Max	Min	Max	Unit	Notes
Fast page mode cycle time	t _{PC}	TBD	—	40	—	45	—	ns	
Fast page mode RAS pulse width	t _{RASP}	—	TBD	—	100000	—	100000	ns	15
Access time from CAS precharge	t _{CPA}	—	TBD	—	35	—	40	ns	9, 16
RAS hold time from CAS precharge	t _{CPRH}	TBD	—	35	—	40	—	ns	

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Fast Page Mode Read-Modify-Write Cycle

		HM5164400A/HM5165400A							
		-5		-6		-7			
Parameter	Symbol	Min	Max	Min	Max	Min	Max	Unit	Notes
Fast page mode read-modify-write cycle time	t _{PRWC}	TBD	—	85	—	96	—	ns	
$\overline{\text{WE}}$ delay time from $\overline{\text{CAS}}$ precharge	t _{CPW}	TBD	—	60	—	68	—	ns	14

Refresh (HM5164400A Series)

Parameter	Symbol	Max	Unit	Note
Refresh period	t _{REF}	64	ms	8192 cycles
Refresh period (L-version)	t _{REF}	128	ms	4096 cycles

Refresh (HM5165400A Series)

Parameter	Symbol	Max	Unit	Note
Refresh period	t _{REF}	64	ms	4096 cycles
Refresh period (L-version)	t _{REF}	128	ms	4096 cycles

Self Refresh Mode (L-version)

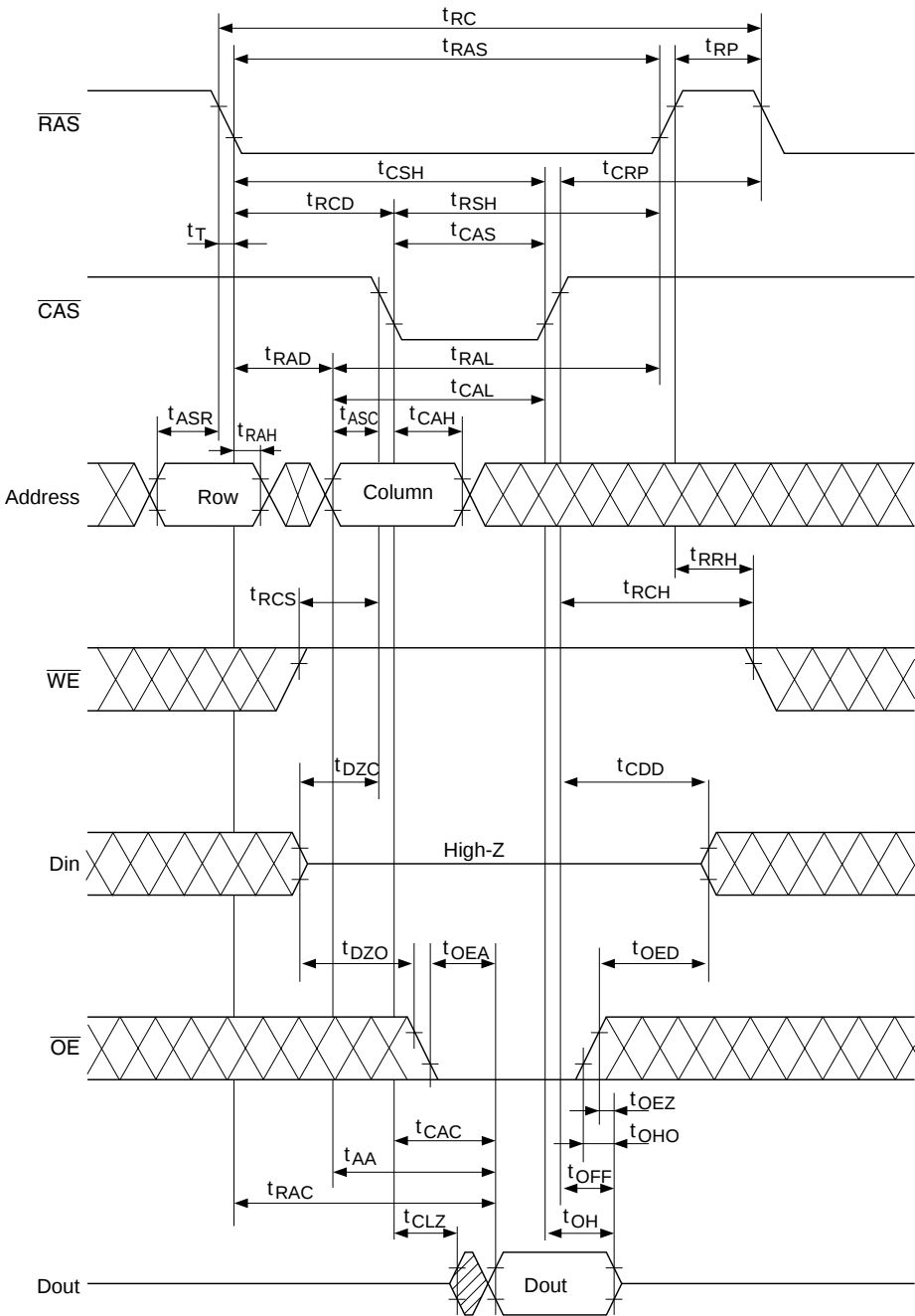
		HM5164400AL/HM5165400AL							
		-5		-6		-7			
Parameter	Symbol	Min	Max	Min	Max	Min	Max	Unit	Notes
$\overline{\text{RAS}}$ pulse width (Self refresh)	t _{RASS}	TBD	—	100	—	100	—	μs	20
$\overline{\text{RAS}}$ precharge time (Self refresh)	t _{RPS}	TBD	—	110	—	130	—	ns	
$\overline{\text{CAS}}$ hold time (Self refresh)	t _{CHS}	TBD	—	−50	—	−50	—	ns	

- Notes: 1. AC measurements assume t_T = 5 ns.
2. An initial pause of 200 μs is required after power up followed by a minimum of eight initialization cycles (any combination of cycles containing RAS-only refresh or $\overline{\text{CAS}}$ -before-RAS refresh).
3. 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}.
4. 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}.

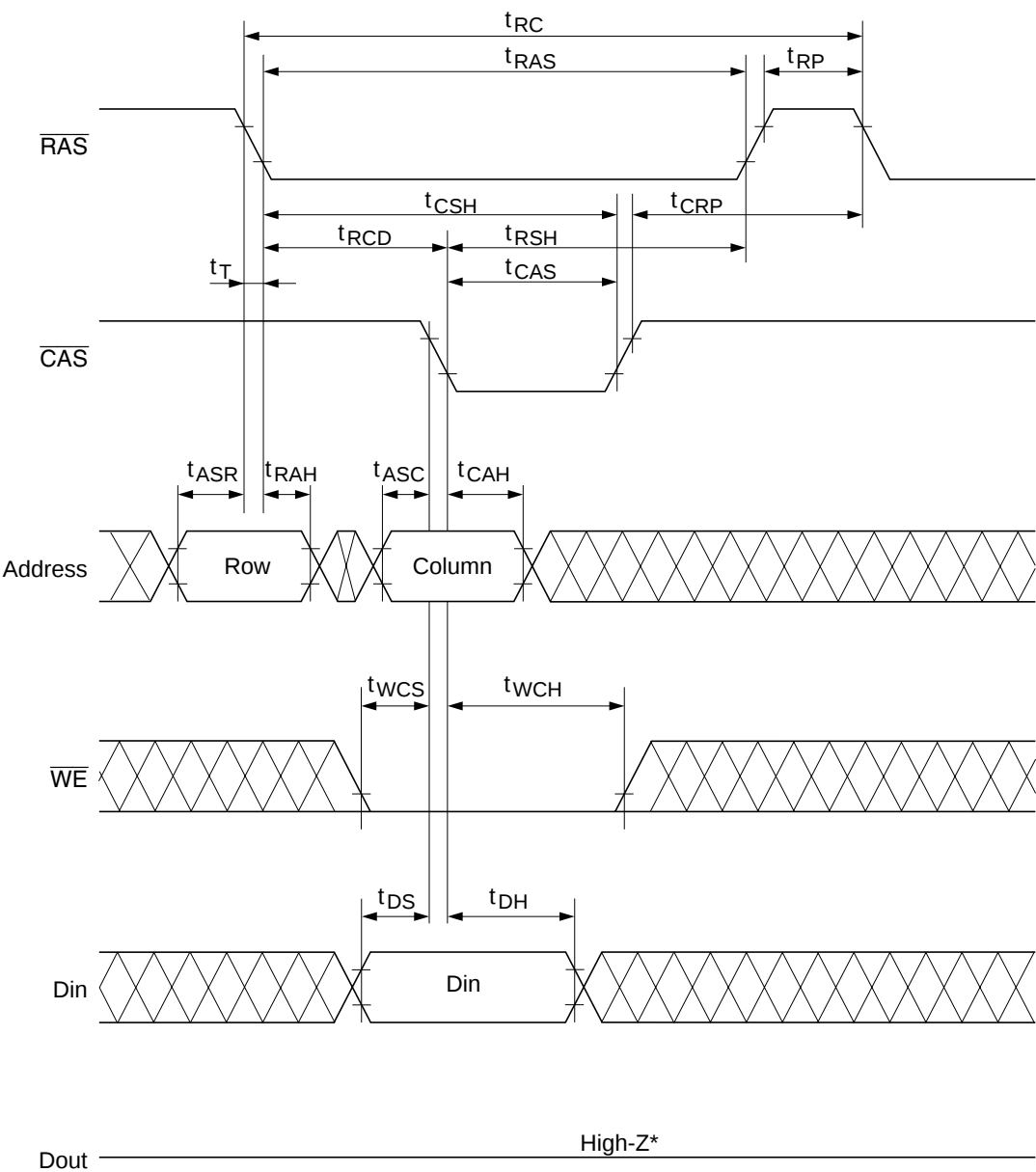
5. Either t_{OED} or t_{CDD} must be satisfied.
6. Either t_{DZO} or t_{DZC} must be satisfied.
7. V_{IH} (min) and V_{IL} (max) are reference levels for measuring timing of input signals. Also, transition times are measured between V_{IH} (min) and V_{IL} (max).
8. Assumes that $t_{\text{RCD}} \leq t_{\text{RCD}} (\text{max})$ and $t_{\text{RAD}} \leq t_{\text{RAD}} (\text{max})$. If t_{RCD} or t_{RAD} is greater than the maximum recommended value shown in this table, t_{RAC} exceeds the value shown.
9. Measured with a load circuit equivalent to 1 TTL loads and 100 pF.
10. Assumes that $t_{\text{RCD}} \geq t_{\text{RCD}} (\text{max})$ and $t_{\text{RCD}} + t_{\text{CAC}} (\text{max}) \geq t_{\text{RAD}} + t_{\text{AA}} (\text{max})$.
11. Assumes that $t_{\text{RAD}} \geq t_{\text{RAD}} (\text{max})$ and $t_{\text{RCD}} + t_{\text{CAC}} (\text{max}) \leq t_{\text{RAD}} + t_{\text{AA}} (\text{max})$.
12. Either t_{RCH} or t_{RRH} must be satisfied for a read cycles.
13. 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.
14. 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 $t_{\text{WCS}} \geq t_{\text{WCS}} (\text{min})$, the cycle is an early write cycle and the data out pin will remain open circuit (high impedance) throughout the entire cycle; if $t_{\text{RWD}} \geq t_{\text{RWD}} (\text{min})$, $t_{\text{CWD}} \geq t_{\text{CWD}} (\text{min})$, and $t_{\text{AWD}} \geq t_{\text{AWD}} (\text{min})$, or $t_{\text{CWD}} \geq t_{\text{CWD}} (\text{min})$, $t_{\text{AWD}} \geq t_{\text{AWD}} (\text{min})$ and $t_{\text{CPW}} \geq t_{\text{CPW}} (\text{min})$, 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.
15. t_{RASP} defines $\overline{\text{RAS}}$ pulse width in fast page mode cycles.
16. Access time is determined by the longest among t_{AA} , t_{CAC} and t_{CPA} .
17. All the V_{CC} and V_{SS} pins shall be supplied with the same voltages.
18. In delayed write or read-modify-write cycles, $\overline{\text{OE}}$ must disable output buffer prior to applying data to the device.
19. When output buffers are enabled once, sustain the low impedance state until valid data is obtained. When output buffer is turned on and off within a very short time, generally it causes large $V_{\text{CC}}/V_{\text{SS}}$ line noise, which causes to degrade $V_{\text{IH min}}/V_{\text{IL max}}$ level.
20. Please do not use t_{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 $t_{\text{RASS}} \geq 100 \mu\text{s}$, then $\overline{\text{RAS}}$ precharge time should use t_{RPS} instead of t_{RP} .
21. CBR burst refresh or 4096 cycles of distributed CBR refresh with $15.6 \mu\text{s}$ interval should be executed within 64 ms immediately after exiting from and before entering into the self refresh mode.
22. Repetitive self refresh mode without refreshing all memory is not allowed. Once you exit from self refresh mode, all memory cells need to be refreshed before re-entering the self refresh mode again.
23. XXX: H or L (H: $V_{\text{IH}} (\text{min}) \leq V_{\text{IN}} \leq V_{\text{IH}} (\text{max})$, 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_{IH} or V_{IL} .

Timing Waveforms*23

Read Cycle

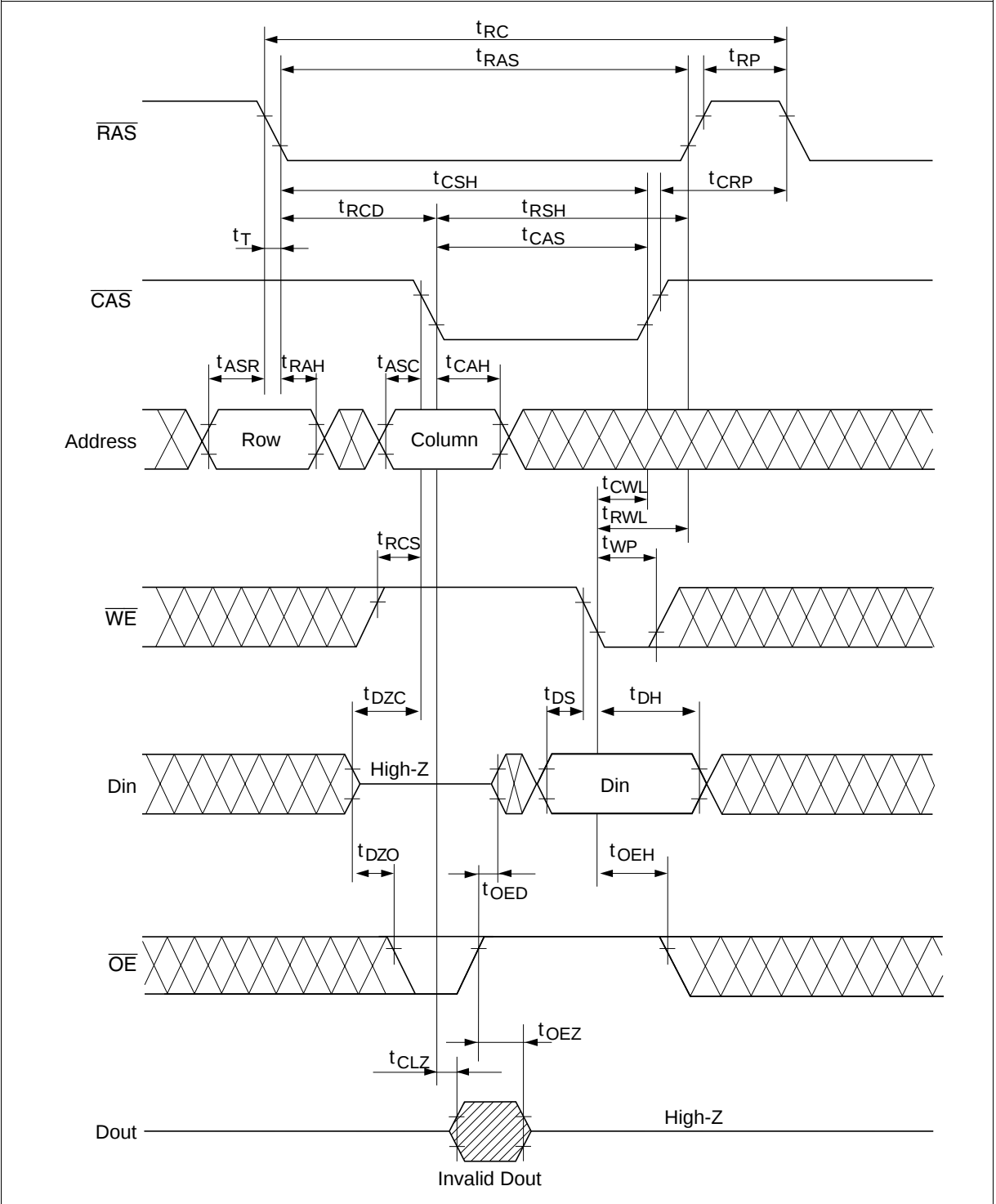


Early Write Cycle

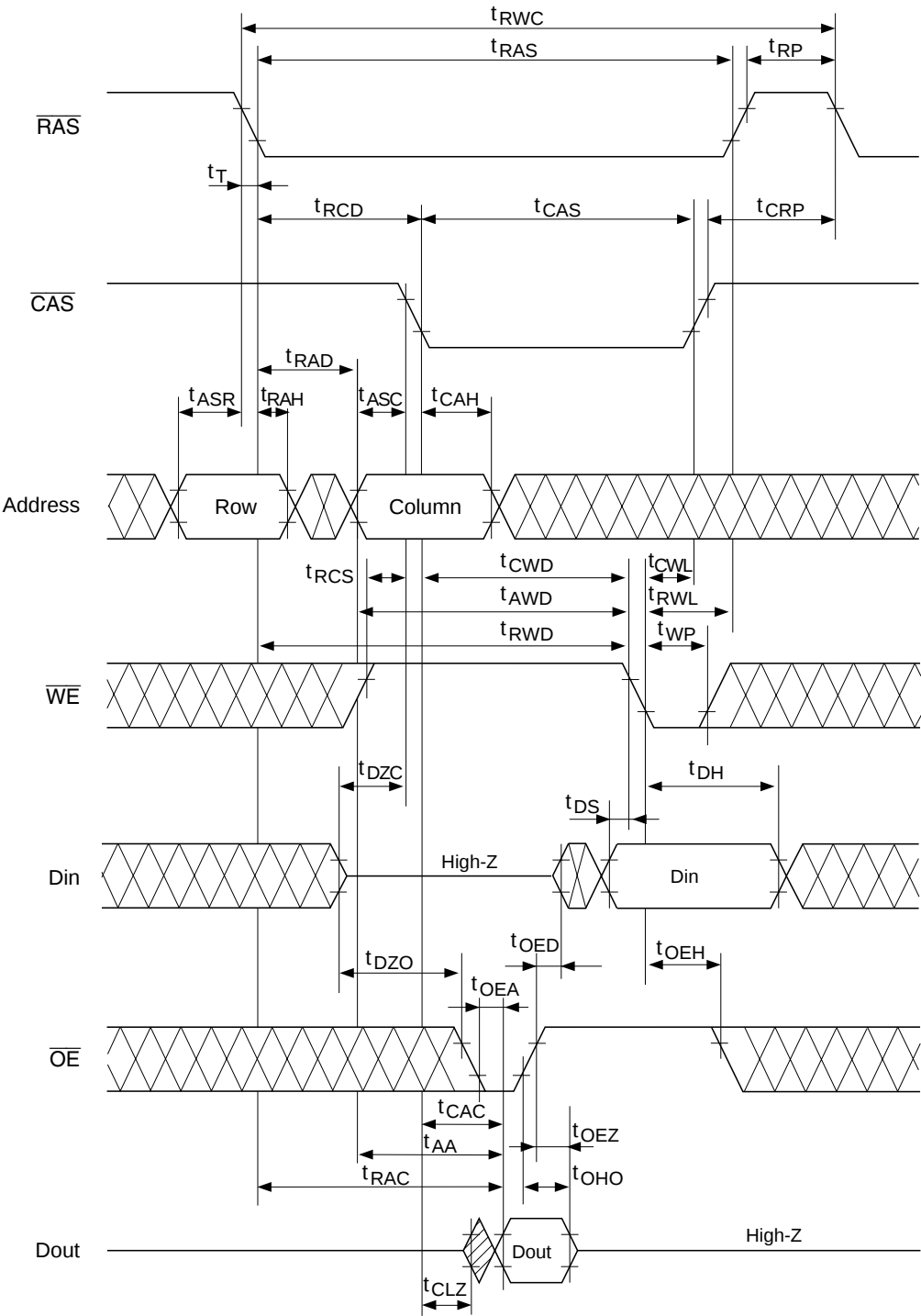


* $t_{WCS} \geq t_{WCS}(\text{min})$

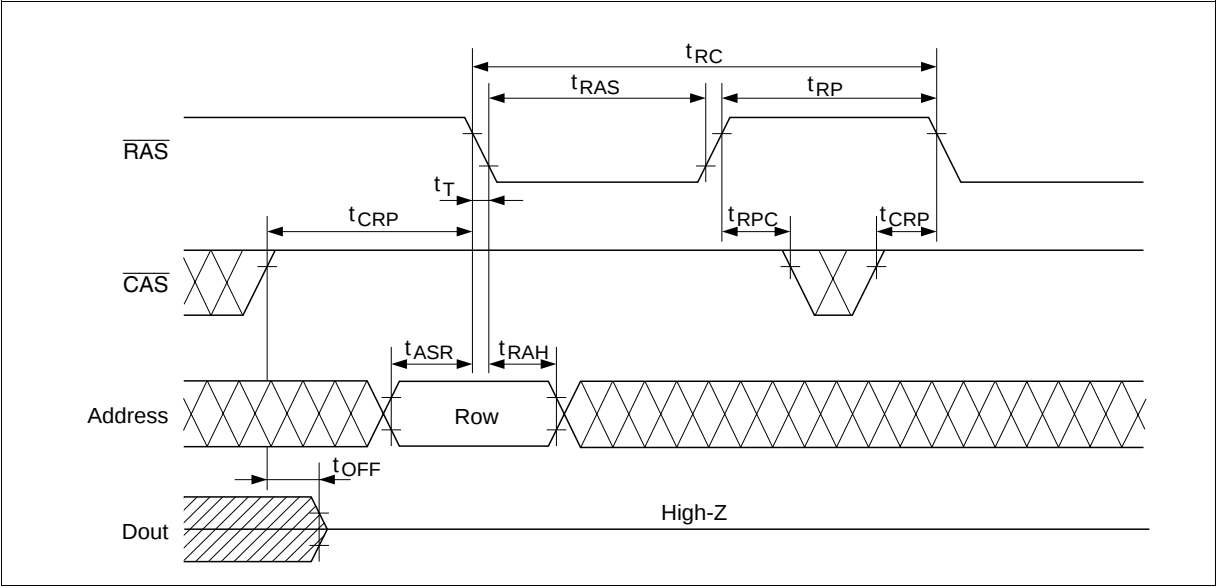
Delayed Write Cycle*18



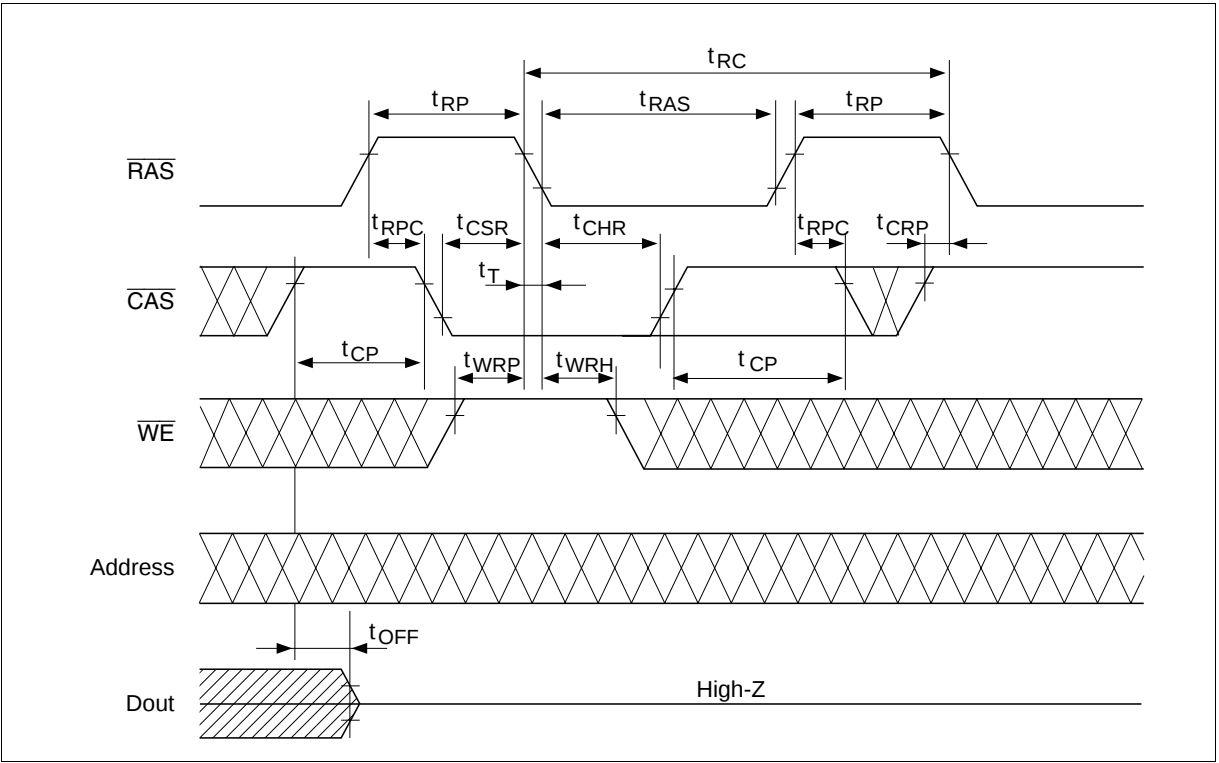
Read-Modify-Write Cycle*18



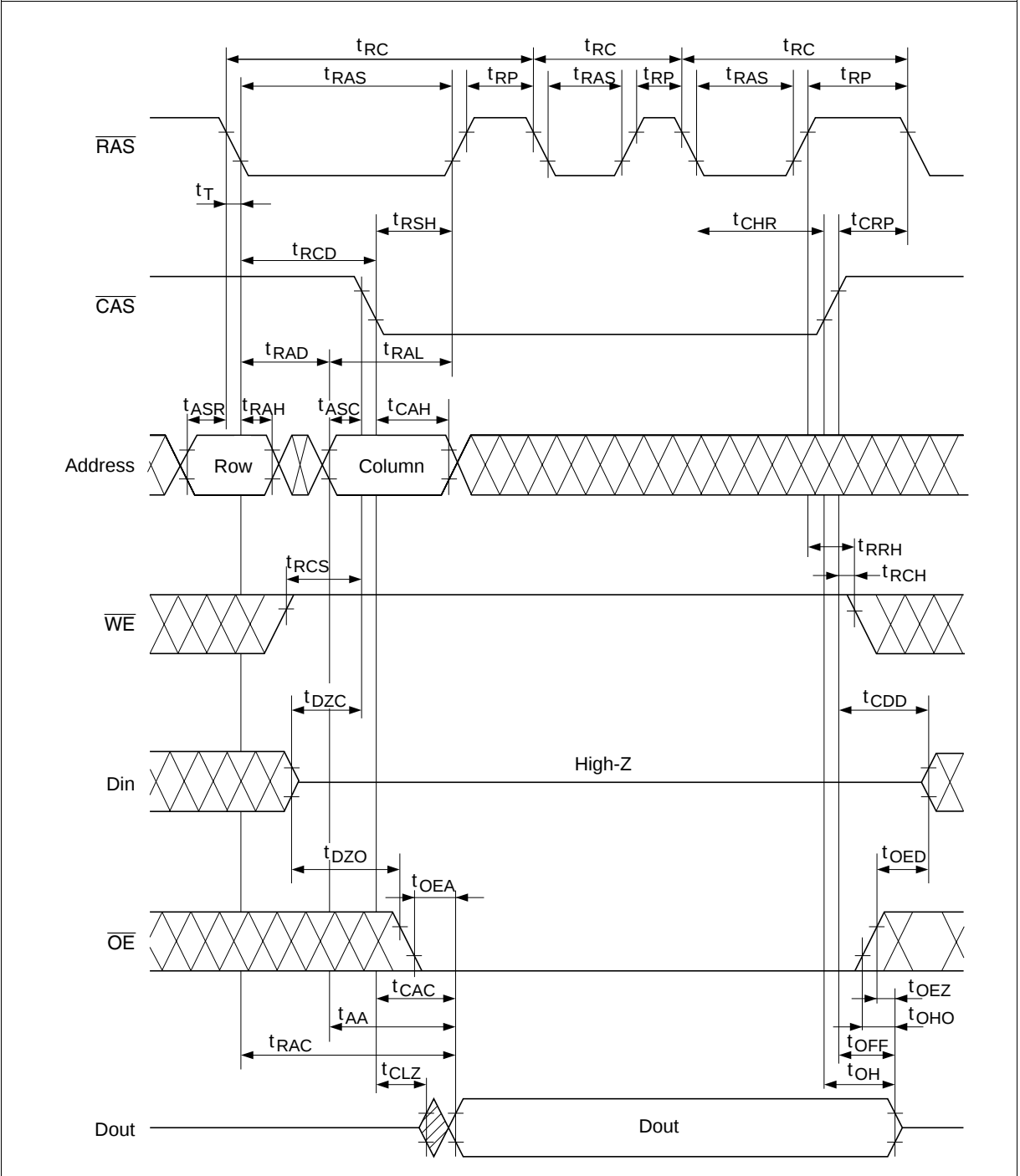
RAS-Only Refresh Cycle

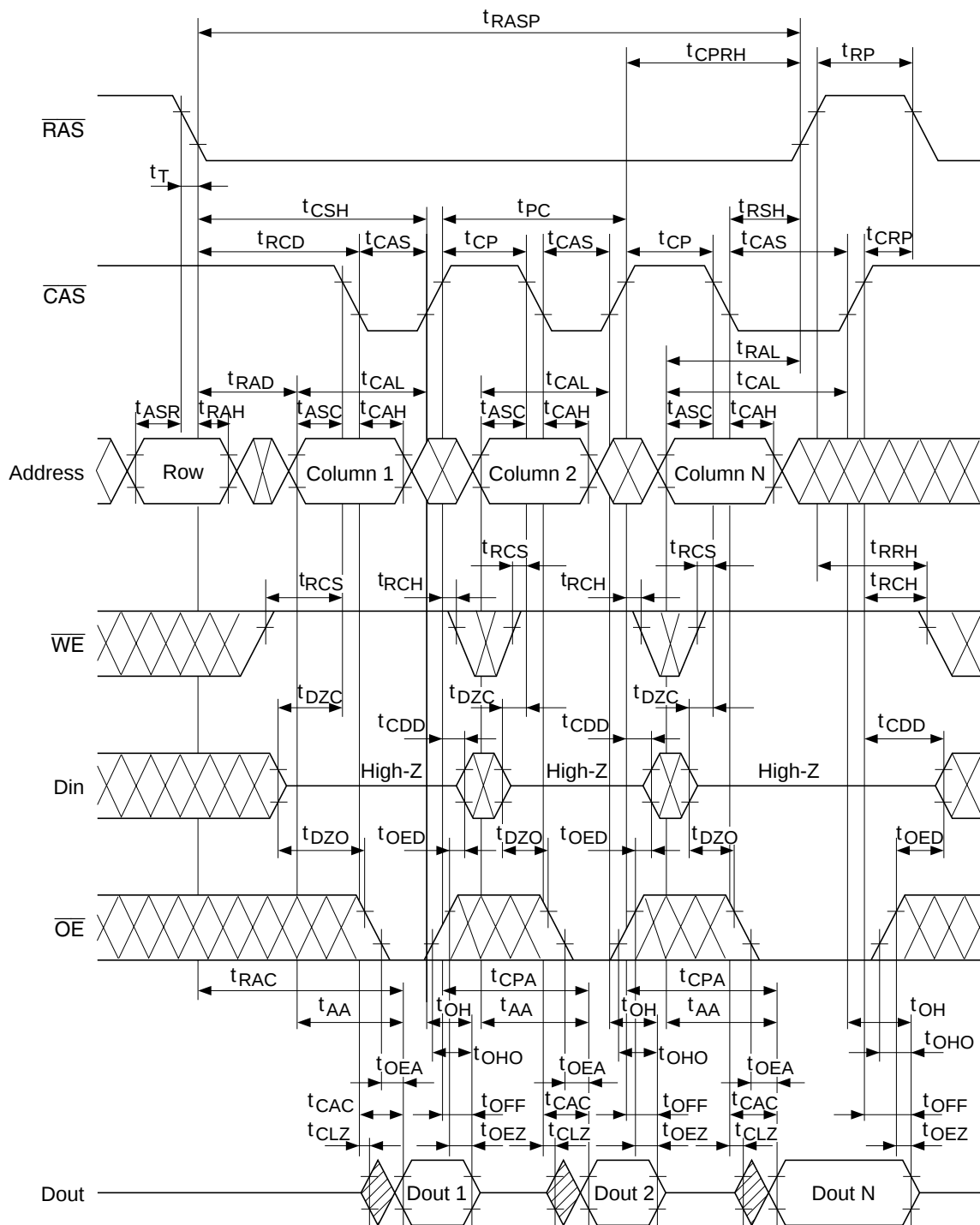


CAS-Before-RAS Refresh Cycle

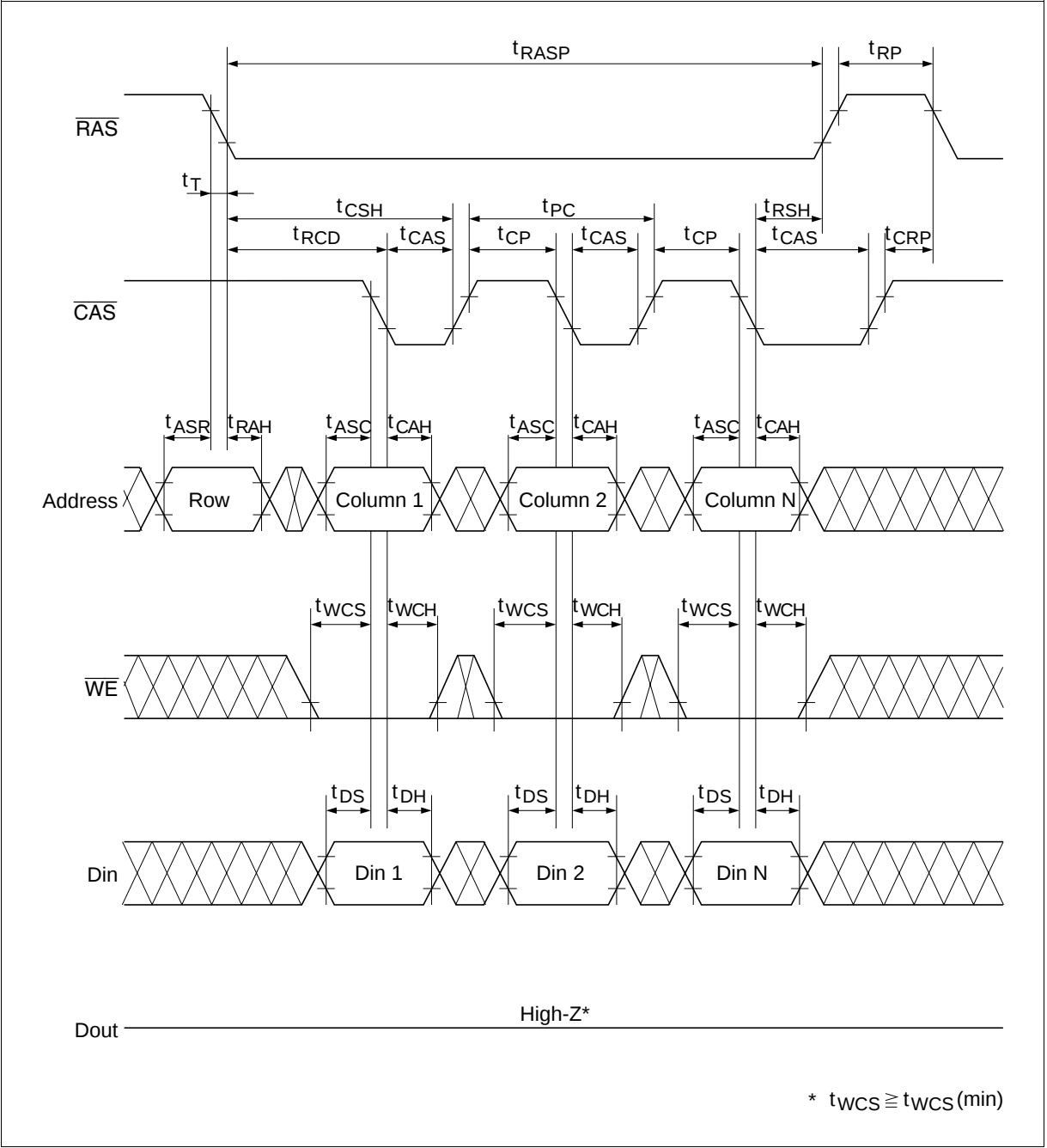


Hidden Refresh Cycle

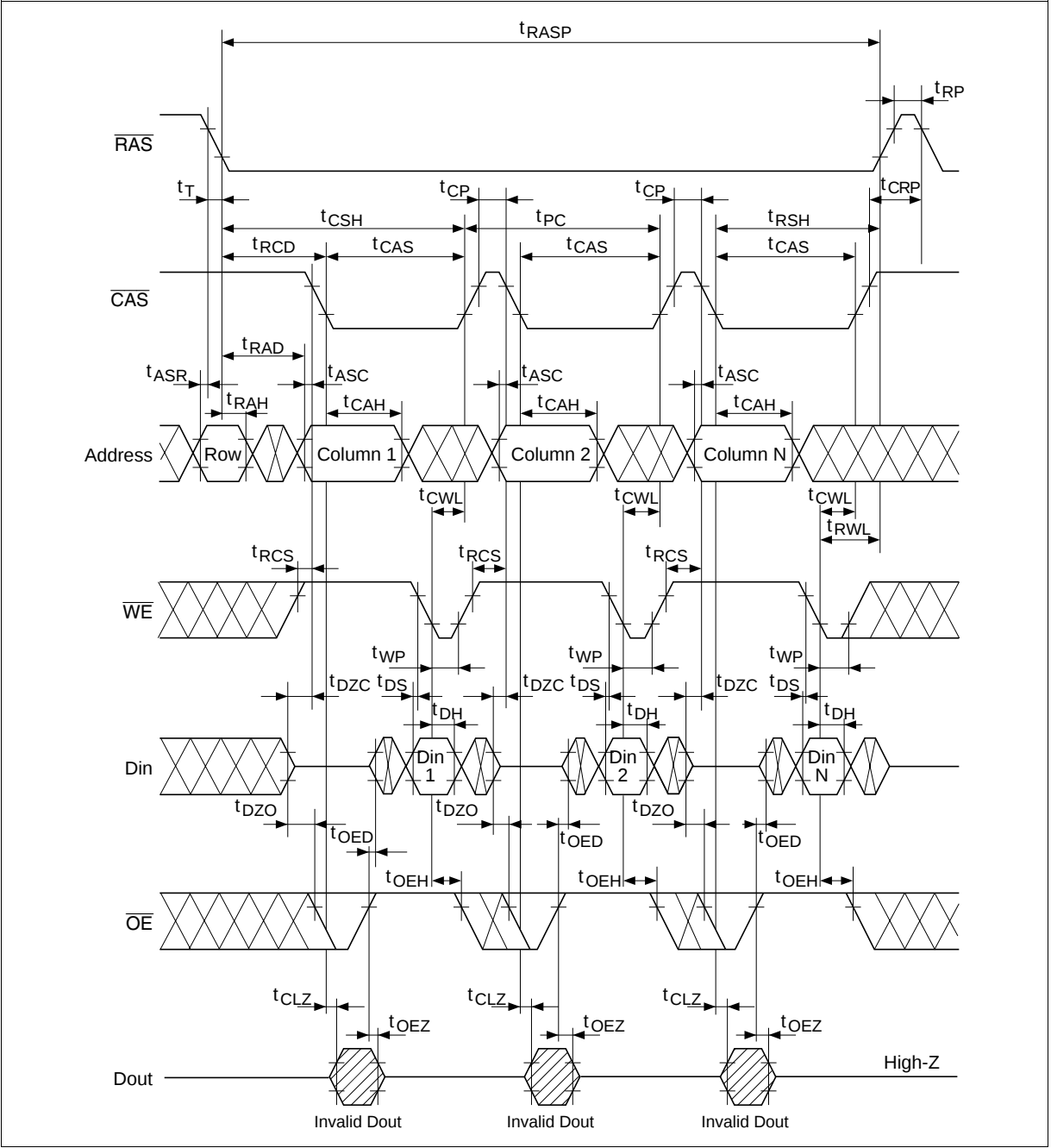




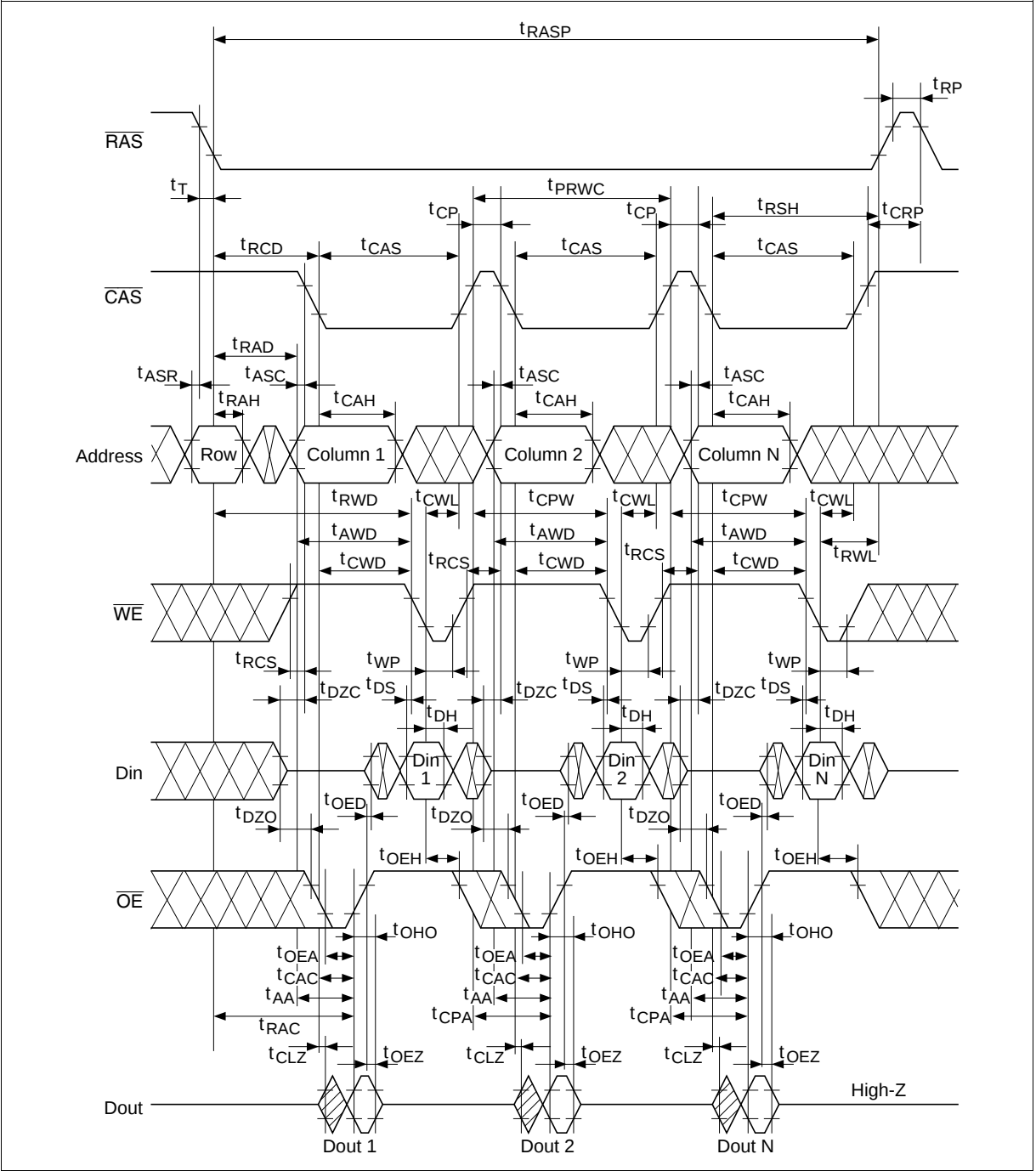
Fast Page Mode Early Write Cycle



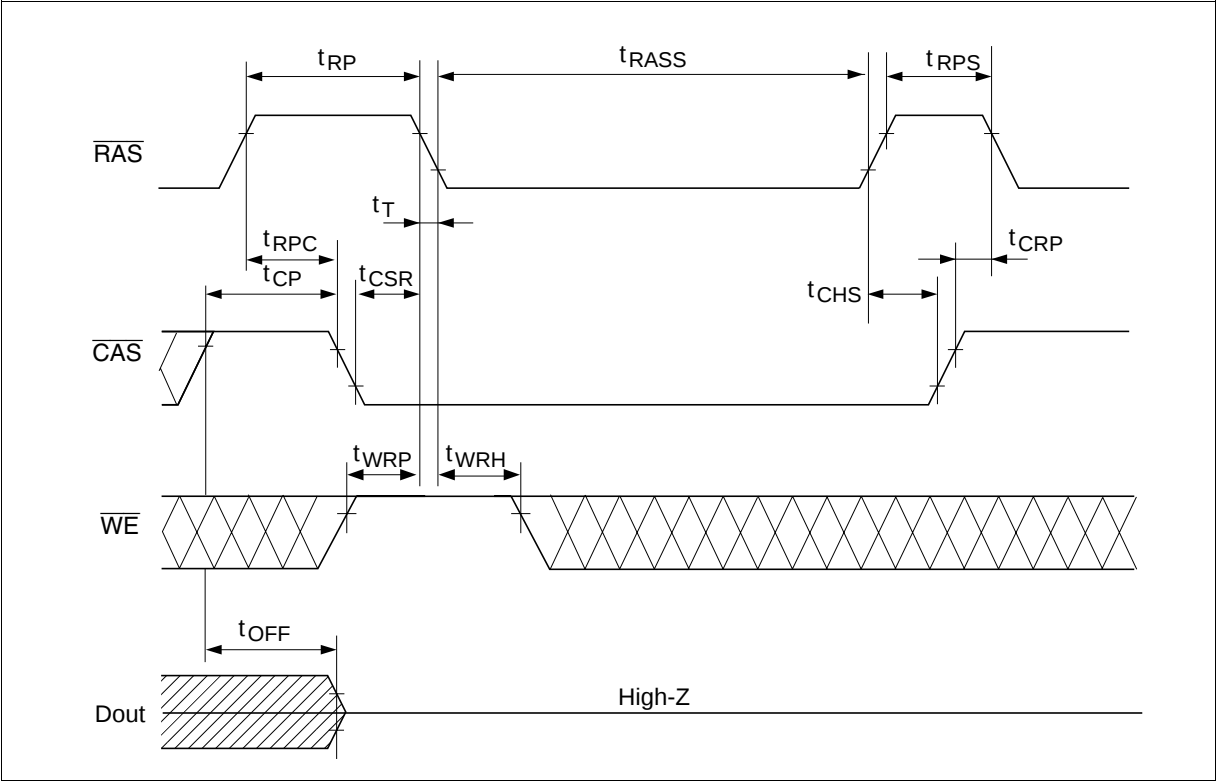
Fast Page Mode Delayed Write Cycle*18



Fast Page Mode Read-Modify-Write Cycle*18



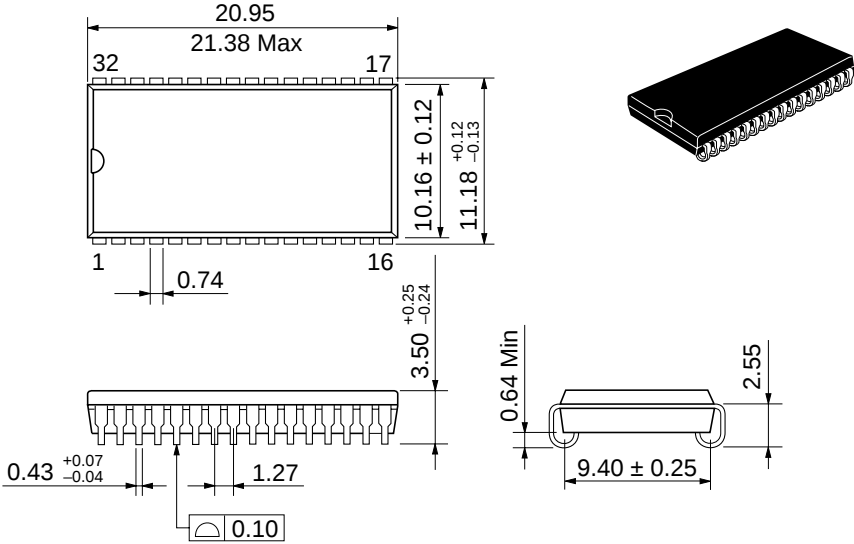
Self Refresh Cycle (L-version)*20, 21, 22



Package Dimensions

HM5164400AJ/ALJ Series
HM5165400AJ/ALJ Series (CP-32DC)

Unit: mm

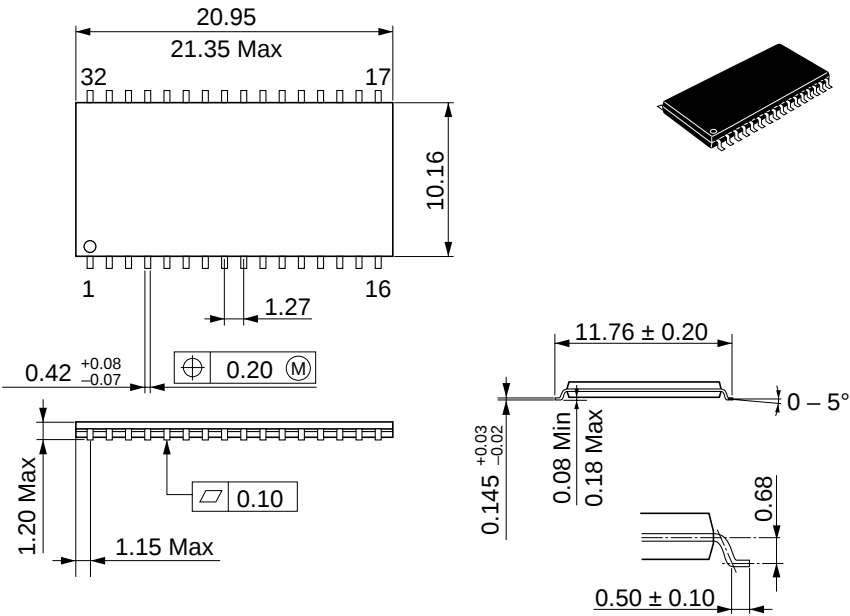


HM5164400A Series, HM5165400A Series

HM5164400ATT/ALTT Series

HM5165400ATT/ALTT Series (TTP-32DC)

Unit: mm



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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 America, Ltd.
Semiconductor & IC Div.
2000 Sierra Point Parkway
Brisbane, CA. 94005-1835
U S A
Tel: 415-589-8300
Fax: 415-583-4207

Hitachi Europe GmbH
Electronic Components Group
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: 0628-585000
Fax: 0628-778322

Hitachi Asia Pte. Ltd.
16 Collyer Quay #20-00
Hitachi Tower
Singapore 0104
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

Revision Record

Rev.	Date	Contents of Modification	Drawn by	Approved by
0.0	Jan. 22, 1996	Initial issue	S. Ikenaga	J. Kitano
0.1	Jun. 3, 1996	Change format Unification of HM5164400A Series and HM5165400A Series Addition of HM5164400A/HM5165400A-5 Series Addition of HM5164400AJ/ALJ Series, HM5165400AJ/ALJ Series (CP-32DC) HM5165400AT/ALTT Series (TTP-32DC) Pin Descriptions Addition of Row/Refresh address and Column address to address input Addition of Block Diagrams DC Characteristics (HM5164400A) I _{CC1} max: 100/90 mA to TBD/130/110 mA I _{CC3} max: 120/105 mA to TBD/130/110 mA I _{CC6} max: 120/105 mA to TBD/150/130 mA I _{CC7} max: 100/90 mA to TBD/130/110 mA Addition of note 4 AC Characteristics t _{RCD} max: 38/45 ns to TBD/45/52 ns Addition of notes 20 to 23 Change of notes 3 Change of notes 18 Timing waveforms Deletion of note: t _{OEH} ≥ t _{CWL} Deletion of notes about undefined pins		