

<b>SANYO</b>	No 4699A	<b>LC32464P, M-80</b>
		<b>256 K (65536 words × 4 bits) DRAM Fast Page Mode</b>

## Overview

The LC32464P, M is a CMOS dynamic RAM operating on a single 5 V power source and having a 65536 words × 4 bits configuration. Equipped with high speed and low power dissipation, the LC32464P, M is suited for a wide variety of applications ranging from computer main memory and expansion memory to commercial equipment. Address inputs utilizes a multiplexed address bus which permits it to be enclosed in a compact plastic package. The LC32464P, M supports  $\overline{\text{CAS}}$ -before  $\overline{\text{RAS}}$  refresh and  $\overline{\text{RAS}}$ -only refresh within 4 ms with 256 row address (A0 to A7) selection.

## Features

- 65536 words × 4 bits configuration.
- $\overline{\text{RAS}}$  access time/cycle time/power dissipation

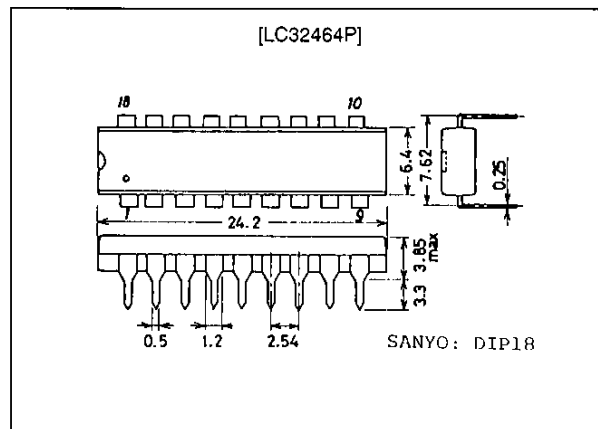
Parameter		LC32464P, M-80
RAS access time		80 ns
Cycle time		160 ns
Power dissipation (max.)	Operating	385 mW
	Standby	5.5 mW (CMOS level)/ 11 mW (TTL level)

- Single 5 V ± 10% power supply.
- All input and output (I/O) TTL compatible.
- Supports fast page mode and read-modify-write.
- Supports output caching control using early write and Output Enable (OE) control.
- 4 ms refresh using 256 refresh cycles.
- Supports  $\overline{\text{RAS}}$ -only refresh,  $\overline{\text{CAS}}$ -before- $\overline{\text{RAS}}$  refresh and hidden refresh.
- Packages
  - DIP 18-pin plastic package: LC32464P
  - MFP 24-pin plastic package: LC32464M

## Package Dimensions

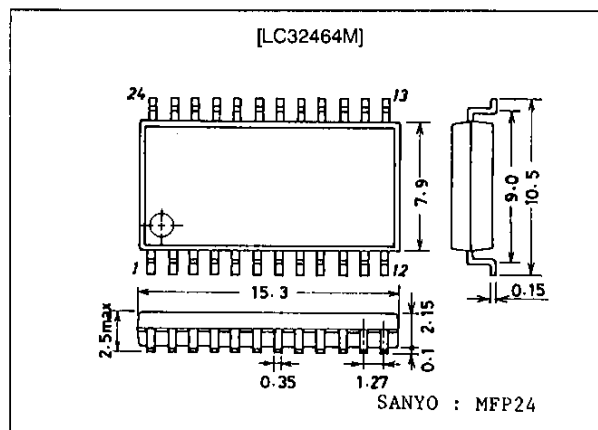
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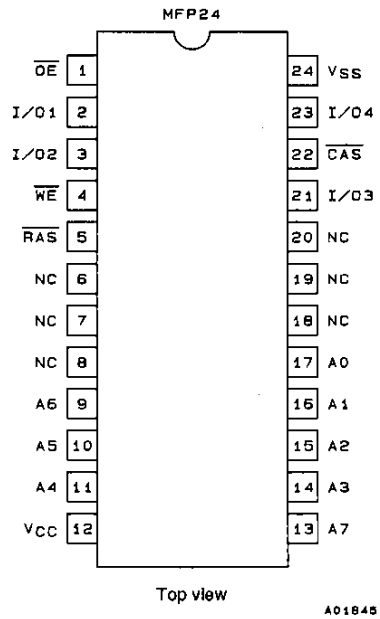
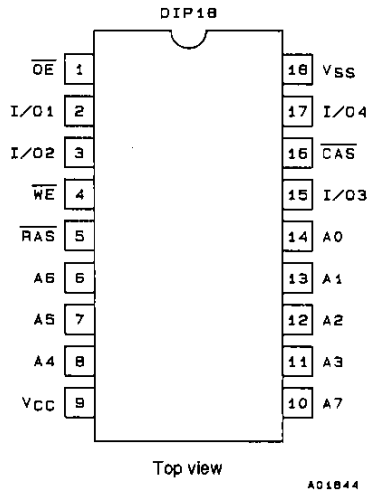


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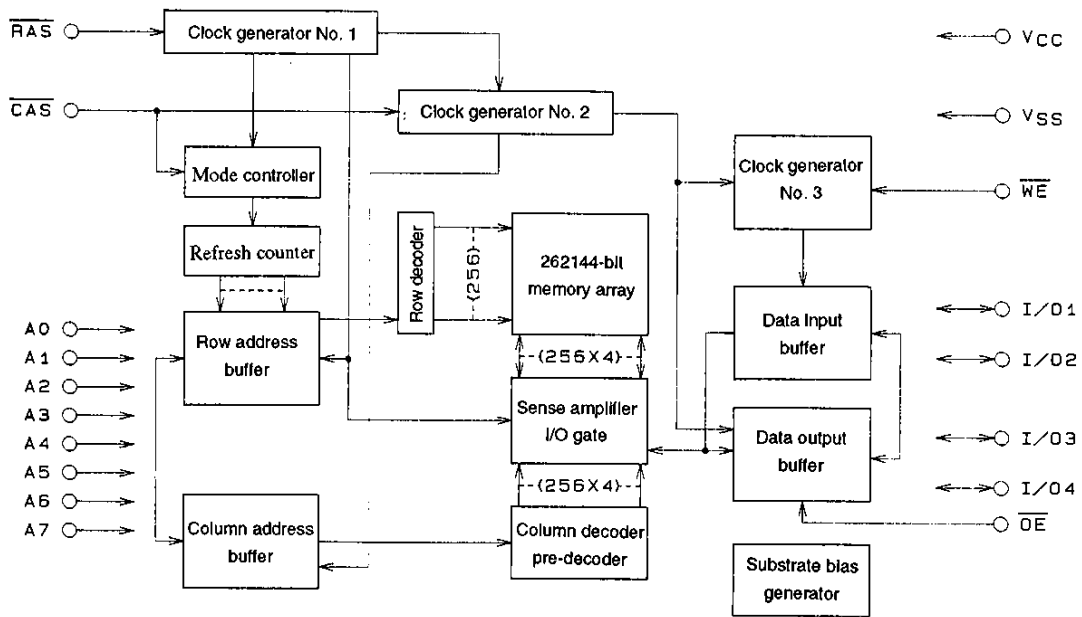
### 3045B-MFP24



Pin Assignment



Block Diagram



A05712

## Specifications

### Absolute Maximum Ratings

Parameter	Symbol	Ratings	Unit	Note
Maximum supply voltage	$V_{CC}$ max	-1.0 to +7.0	V	1
Input voltage	$V_{IN}$	-1.0 to +7.0	V	1
Output voltage	$V_{OUT}$	-1.0 to +7.0	V	1
Allowable power dissipation	$P_d$ max	600	mW	1
Output short-circuit current	$I_{OUT}$	50	mA	1
Operating temperature range	$T_{opr}$	0 to +70	°C	1
Storage temperature range	$T_{stg}$	-55 to +150	°C	1

Note: 1) Stresses greater than the above listed maximum values may result in damage to the device.

### DC Recommended Operating Ranges at $T_a = 0$ to +70°C

Parameter	Symbol	min	typ	max	Unit	Note
Power supply voltage	$V_{CC}$	4.5	5.0	5.5	V	2
Input high level voltage	$V_{IH}$	2.4		6.5	V	2
Input low level voltage	$V_{IL}$	-1.0		+0.8	V	2

Note: 2) All voltages are referenced to  $V_{SS}$ . A bypass capacitor of about 0.1  $\mu$ F should be connected between the device  $V_{CC}$  and  $V_{SS}$  pins.

### DC Electrical Characteristics at $T_a = 0$ to +70°C, $V_{CC} = 5\text{ V} \pm 10\%$

Parameter	Symbol	Conditions	min	max	Unit	Note
Operating current (Average current during operation)	$I_{CC1}$	$\overline{RAS}$ , $\overline{CAS}$ , address cycling: $t_{RC} = t_{RC\ min}$		70	mA	3, 4
Standby current	$I_{CC2}$	$\overline{RAS} = \overline{CAS} = V_{IH}$		2	mA	
$\overline{RAS}$ -only refresh current	$I_{CC3}$	$\overline{RAS}$ cycling: $\overline{CAS} = V_{IH}$ ; $t_{RC} = t_{RC\ min}$		70	mA	3
Fast page mode current	$I_{CC4}$	$\overline{RAS} = V_{IL}$ , $\overline{CAS}$ , address cycling: $t_{PC} = t_{PC\ min}$		55	mA	3, 4
Standby current	$I_{CC5}$	$\overline{RAS} = \overline{CAS} = V_{CC} - 0.2\text{ V}$		1	mA	
$\overline{CAS}$ -before- $\overline{RAS}$ refresh current	$I_{CC6}$	$\overline{RAS}$ , $\overline{CAS}$ cycling: $t_{RC} = t_{RC\ min}$		70	mA	3
Input leakage current	$I_{IL}$	$0\text{ V} \leq V_{IN} \leq 6.5\text{ V}$ , pins other than measuring pin = 0 V	-10	+10	$\mu$ A	
Output leakage current	$I_{OL}$	$D_{OUT}$ disable, $0\text{ V} \leq V_{OUT} \leq 5.5\text{ V}$	-10	+10	$\mu$ A	
Output high level voltage	$V_{OH}$	$I_{OUT} = -5.0\text{ mA}$	2.4		V	
Output low level voltage	$V_{OL}$	$I_{OUT} = 4.2\text{ mA}$		0.4	V	

Note: 3) All current values are measured at minimal cycle rate. Since current flows immoderately, if cycle time is longer than shown here, current value becomes smaller.

4)  $I_{CC1}$  and  $I_{CC4}$  are dependent on output loads. Maximum values for  $I_{CC1}$  and  $I_{CC4}$  represent values with output open.

AC Electrical Characteristics at  $T_a = 0$  to  $+70^\circ\text{C}$ ,  $V_{CC} = 5\text{ V} \pm 10\%$  (note 5, 6, 7)

Parameter	Symbol	min	max	Unit	Note
Random read or write cycle time	$t_{RC}$	160		ns	
Read-write/read-modify-write cycle time	$t_{RWC}$	215		ns	
Fast page mode cycle time	$t_{PC}$	55		ns	
Fast page mode read-write/read-modify-write cycle time	$t_{PRWC}$	100		ns	
$\overline{\text{RAS}}$ access time	$t_{RAC}$		80	ns	8, 13
$\overline{\text{CAS}}$ access time	$t_{CAC}$		20	ns	8, 13
Column address access time	$t_{AA}$		40	ns	8, 14
$\overline{\text{CAS}}$ precharge access time	$t_{CPA}$		45	ns	8
Output low-impedance time from $\overline{\text{CAS}}$ low	$t_{CLZ}$	5		ns	8
Output buffer turn-off delay time	$t_{OFF}$	0	20	ns	9
Rise or fall time	$t_T$	3	50	ns	7
$\overline{\text{RAS}}$ precharge time	$t_{RP}$	70		ns	
$\overline{\text{RAS}}$ pulse width	$t_{RAS}$	80	10000	ns	
$\overline{\text{RAS}}$ pulse width for fast page mode only	$t_{RASP}$	80	100000	ns	
$\overline{\text{RAS}}$ hold time	$t_{RSH}$	20		ns	
$\overline{\text{CAS}}$ hold time	$t_{CSH}$	80		ns	
$\overline{\text{CAS}}$ pulse width	$t_{CAS}$	20	10000	ns	
$\overline{\text{RAS}}$ to $\overline{\text{CAS}}$ delay time	$t_{RCD}$	25	60	ns	13
$\overline{\text{RAS}}$ column address delay time	$t_{RAD}$	17	40	ns	14
$\overline{\text{CAS}}$ to $\overline{\text{RAS}}$ precharge time	$t_{CRP}$	10		ns	
$\overline{\text{CAS}}$ precharge time for fast page mode only	$t_{CP}$	10		ns	
Row address setup time	$t_{ASR}$	0		ns	
Row address hold time	$t_{RAH}$	12		ns	
Column address setup time	$t_{ASC}$	0		ns	
Column address hold time	$t_{CAH}$	20		ns	
Column address hold time referenced to $\overline{\text{RAS}}$	$t_{AR}$	60		ns	
Column address to $\overline{\text{RAS}}$ lead time	$t_{RAL}$	40		ns	
Read command setup time	$t_{RCS}$	0		ns	
Read command hold time referenced to $\overline{\text{CAS}}$	$t_{RCH}$	0		ns	10
Read command hold time referenced to $\overline{\text{RAS}}$	$t_{RRH}$	0		ns	10
Write command hold time	$t_{WCH}$	15		ns	
Write command hold time referenced to $\overline{\text{RAS}}$	$t_{WCR}$	60		ns	
Write command pulse width	$t_{WP}$	15		ns	

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Parameter	Symbol	min	max	Unit	Note
Write command to $\overline{\text{RAS}}$ lead time	$t_{\text{RWL}}$	25		ns	
Write command to $\overline{\text{CAS}}$ lead time	$t_{\text{CWL}}$	20		ns	
Data input setup time	$t_{\text{DS}}$	0		ns	11
Data input hold time	$t_{\text{DH}}$	20		ns	11
Data input hold time referenced to $\overline{\text{RAS}}$	$t_{\text{DHR}}$	60		ns	
Refresh period	$t_{\text{REF}}$		4	ms	
Write command setup time	$t_{\text{WCS}}$	0		ns	12
$\overline{\text{CAS}}$ to $\overline{\text{WE}}$ delay time	$t_{\text{CWD}}$	50		ns	12
$\overline{\text{RAS}}$ to $\overline{\text{WE}}$ delay time	$t_{\text{RWD}}$	105		ns	12
Column address to $\overline{\text{WE}}$ delay time	$t_{\text{AWD}}$	65		ns	12
$\overline{\text{CAS}}$ setup time for $\overline{\text{CAS}}$ -before- $\overline{\text{RAS}}$ refresh	$t_{\text{CSR}}$	10		ns	
$\overline{\text{CAS}}$ hold time for $\overline{\text{CAS}}$ -before- $\overline{\text{RAS}}$ refresh	$t_{\text{CHR}}$	20		ns	
$\overline{\text{RAS}}$ precharge time to $\overline{\text{CAS}}$ active time	$t_{\text{RPC}}$	10		ns	
$\overline{\text{CAS}}$ precharge time for $\overline{\text{CAS}}$ -before- $\overline{\text{RAS}}$ counter test	$t_{\text{CPT}}$	40		ns	
$\overline{\text{CAS}}$ precharge time for $\overline{\text{CAS}}$ -before- $\overline{\text{RAS}}$ refresh	$t_{\text{CPN}}$	15		ns	
$\overline{\text{RAS}}$ hold time referenced to $\overline{\text{OE}}$	$t_{\text{ROH}}$	20		ns	
$\overline{\text{OE}}$ access time	$t_{\text{OEA}}$		20	ns	
$\overline{\text{OE}}$ delay time	$t_{\text{OED}}$	20		ns	
$\overline{\text{OE}}$ output buffer turn-off delay time	$t_{\text{O EZ}}$	0	20	ns	
$\overline{\text{OE}}$ command hold time	$t_{\text{OEH}}$	20		ns	
Data input to $\overline{\text{CAS}}$ delay time	$t_{\text{DZC}}$	0		ns	15
Data input to $\overline{\text{OE}}$ delay time	$t_{\text{DZO}}$	0		ns	15

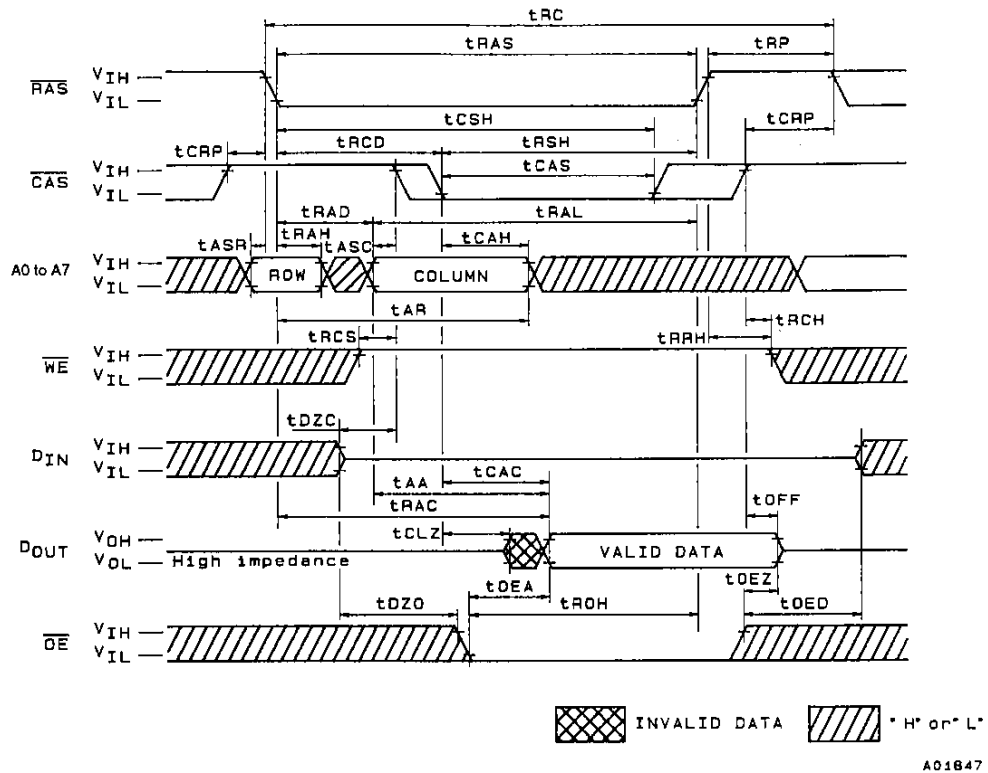
Input/Output Capacitance at  $T_a = 25^\circ\text{C}$ ,  $f = 1\text{ MHz}$ ,  $V_{\text{CC}} = 5\text{ V} \pm 10\%$ 

Parameter	Symbol	min	max	Unit
Input capacitance ( $A_0$ to $A_7$ )	$C_{\text{IN1}}$		5	pF
Input capacitance ( $\overline{\text{RAS}}$ , $\overline{\text{CAS}}$ , $\overline{\text{WE}}$ , $\overline{\text{OE}}$ )	$C_{\text{IN2}}$		7	pF
I/O capacitance ( $I/O_1$ to $I/O_4$ )	$C_{\text{I/O}}$		7	pF

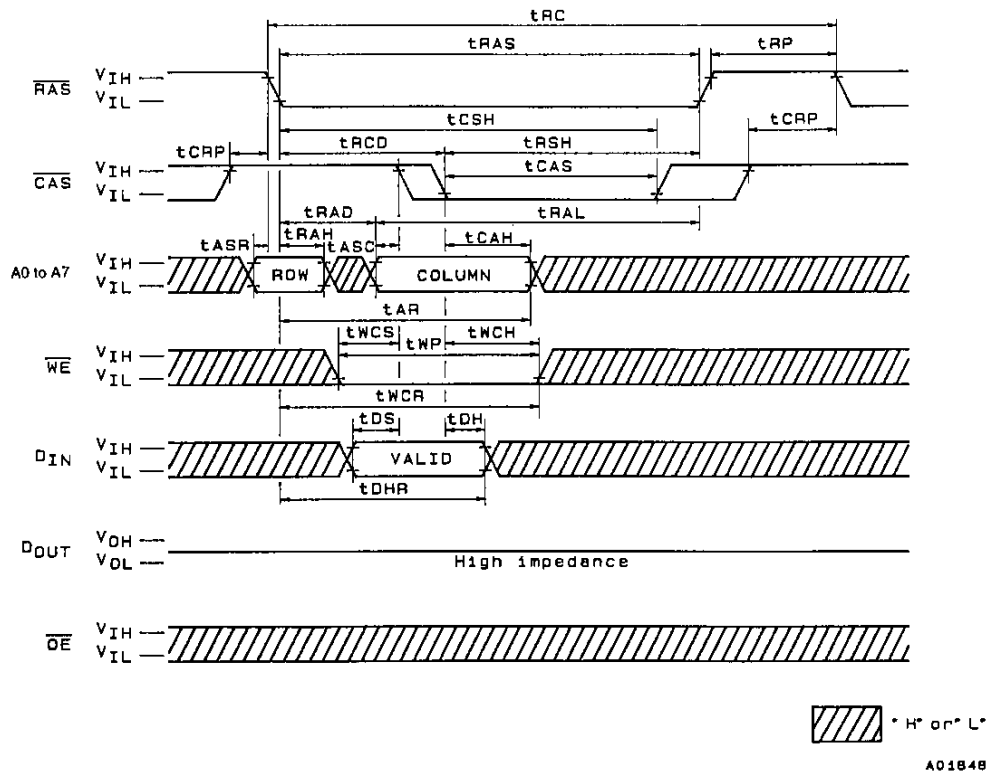
- Notes:
- 5) After the power is turned on, 200  $\mu\text{s}$  are required after the arrival of  $V_{CC}$  stabilized current before memory is initialized and begins operation. In addition, before memory operation initializes, approximately 8 cycles worth of  $\overline{\text{RAS}}$  dummy cycles are required. When the on-chip refresh counter is applied, approximately 8 cycles worth of  $\overline{\text{CAS}}$ -before- $\overline{\text{RAS}}$  dummy cycles are required instead of the  $\overline{\text{RAS}}$  dummy cycles.
  - 6) Measured at  $t_T = 5 \text{ ns}$ .
  - 7) When measuring input signal timing,  $V_{IH}$  (min) and  $V_{IL}$  (max) are used for reference points. In addition, rise and fall time are defined between  $V_{IH}$  and  $V_{IL}$ .
  - 8) Measured using an equivalent of 100 pF and two standard TTL loads.
  - 9)  $t_{OFF}$  (max) is defined as the time until output voltage can no longer be measured when output switches to a high impedance condition.
  - 10) Operation is guaranteed if either  $t_{RRH}$  or  $t_{RCH}$  is satisfied.
  - 11) These parameters are measured from the falling edge of  $\overline{\text{CAS}}$  for an early-write cycle, and from the falling edge of  $\overline{\text{WE}}$  for a read-write/read-modify-write cycle.
  - 12)  $t_{WCS}$ ,  $t_{CWD}$ ,  $t_{RWD}$  and  $t_{AWD}$  are not restrictive operating parameters for memory in that they specify the operating mode. If  $t_{WCS} \geq t_{WCS}(\text{min})$ , the cycle switches to an early-write cycle and output pins switch to high impedance throughout the cycle. If  $t_{CWD} \geq t_{CWD}(\text{min})$ ,  $t_{RWD} \geq t_{RWD}(\text{min})$  and  $t_{AWD} \geq t_{AWD}(\text{min})$ , the cycle switches to a read-write/read-modify-write cycle and data outputs equal information in the selected cells. If neither of the above conditions are satisfied, output pins are in an undefined state.
  - 13)  $t_{RCD}$  (max) does not indicate a restrictive operating parameter but instead represents the point at which the access time  $t_{RAC}$  (max) is guaranteed. If  $t_{RCD} \geq t_{RCD}(\text{max})$ , access time is determined according to  $t_{CAC}$ .
  - 14)  $t_{RAD}$  (max) does not indicate a restrictive operating parameter but instead represents the point at which the access time  $t_{RAC}$  (max) is guaranteed. If  $t_{RAD} \geq t_{RAD}(\text{max})$ , access time is determined according to  $t_{AA}$ .
  - 15) Operation is guaranteed if either  $t_{DZC}$  or  $t_{DZO}$  is satisfied.

Timing Chart

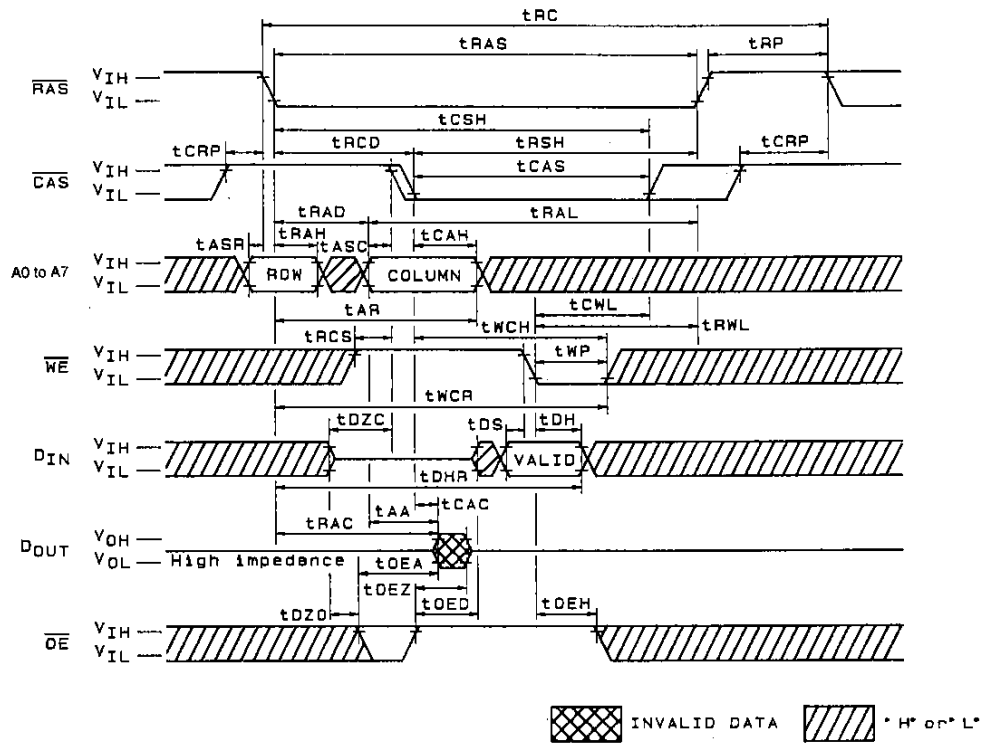
Read Cycle



Write Cycle (Early-write)

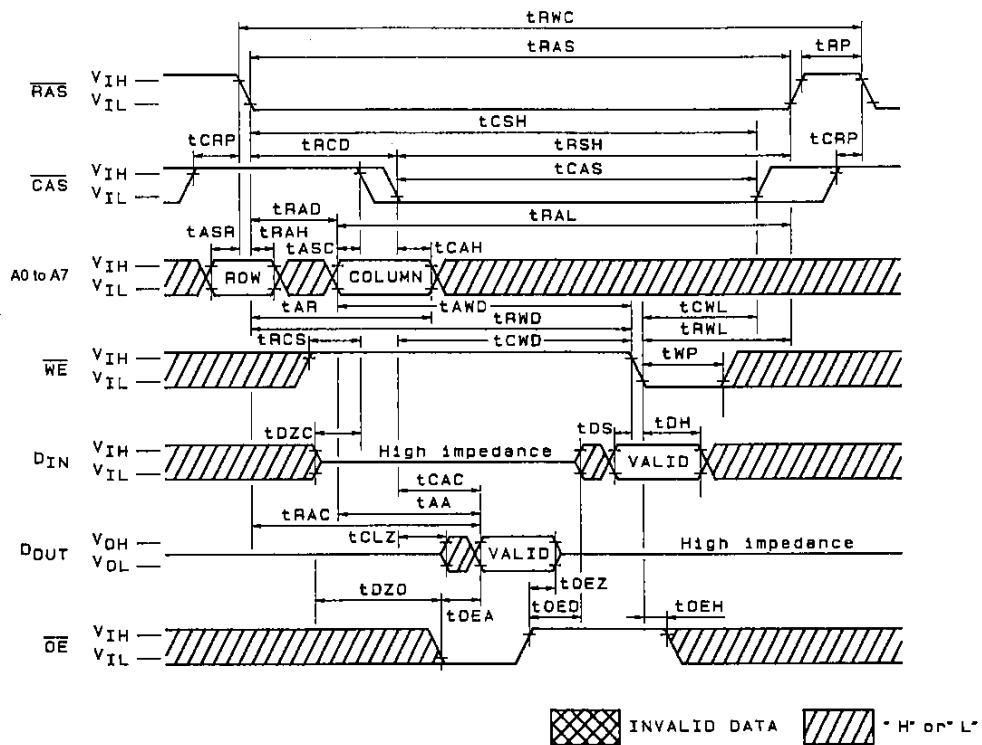


Write Cycle ( $\overline{OE}$  Control)



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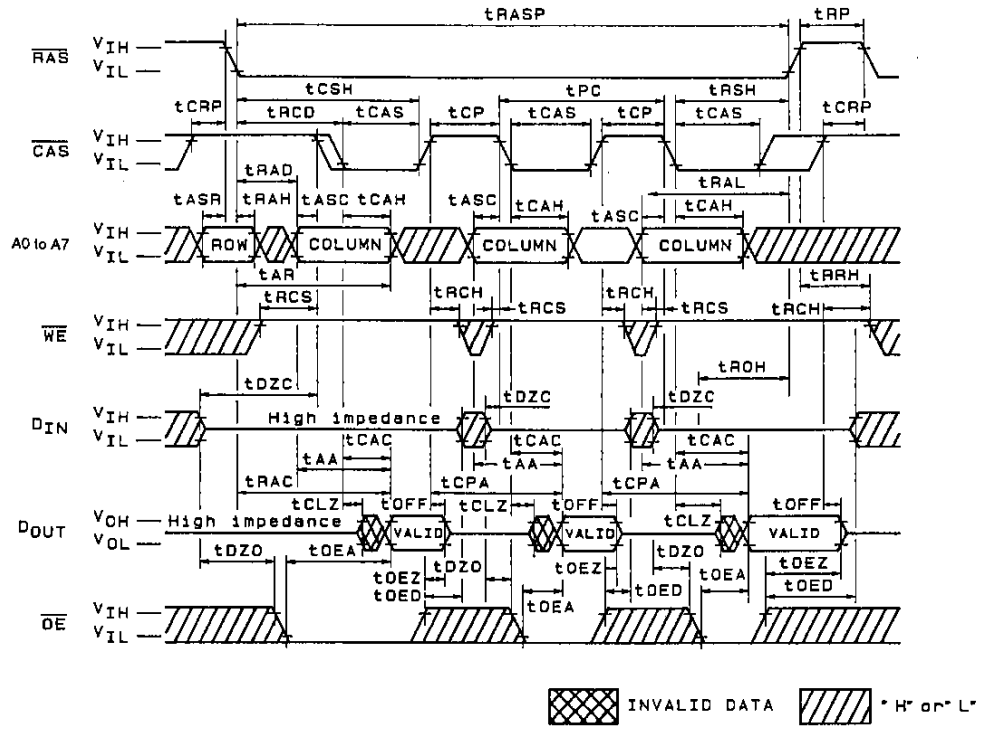
Read-Write/Read-Modify-Write Cycle



A01850

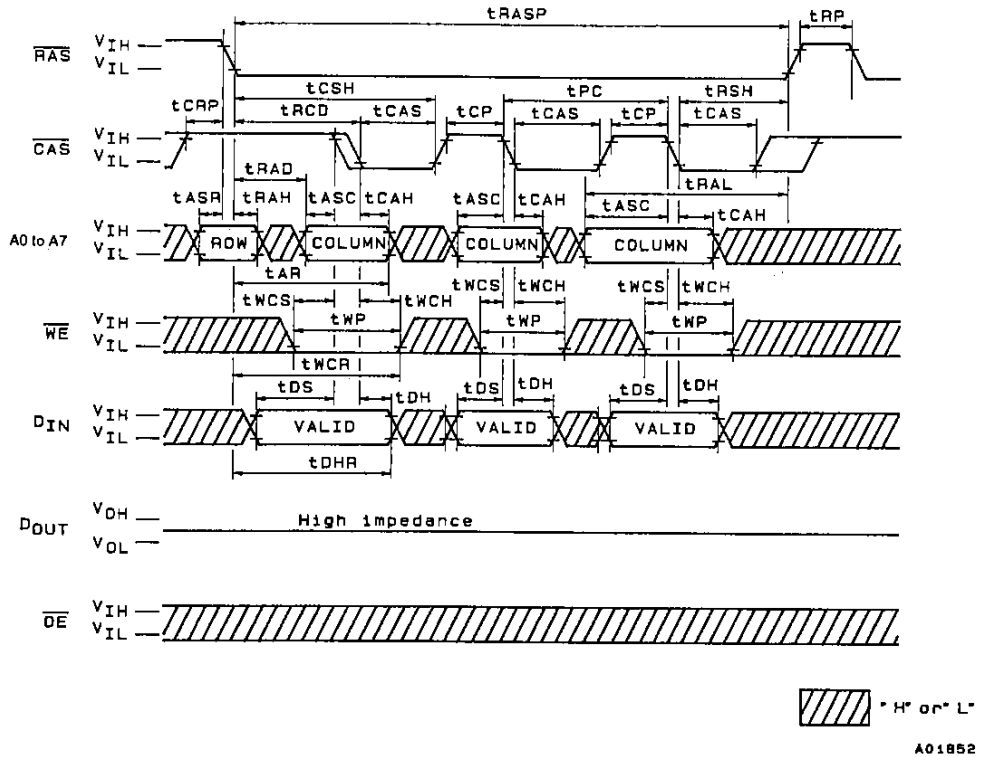


Fast Page Mode Read Cycle



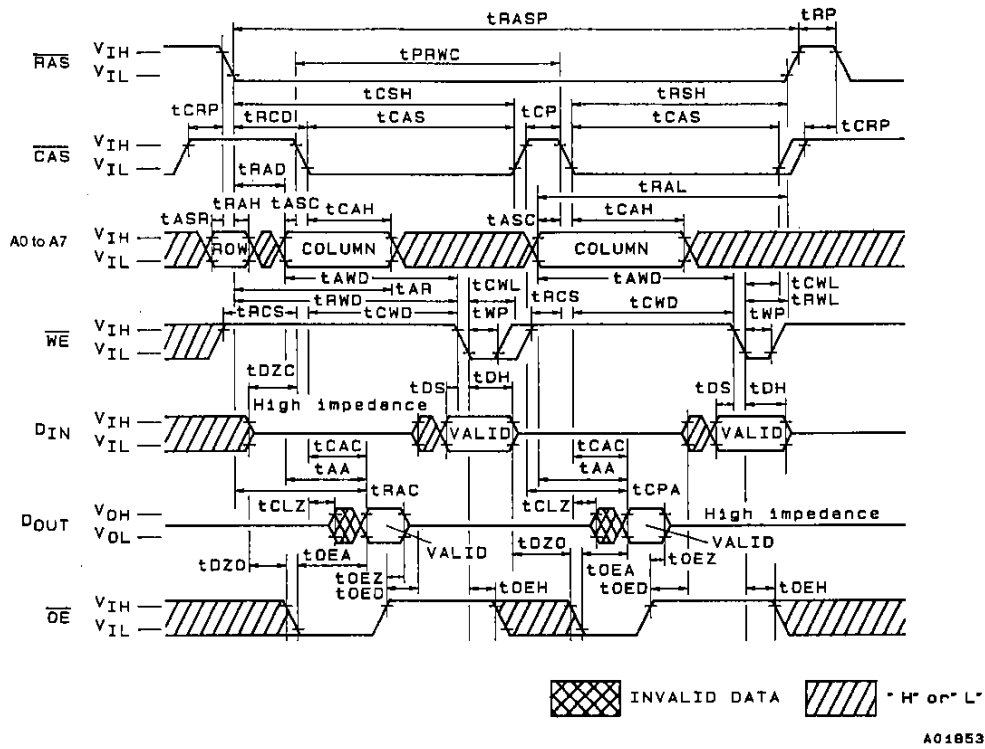
A01851

Fast Page Mode Write Cycle

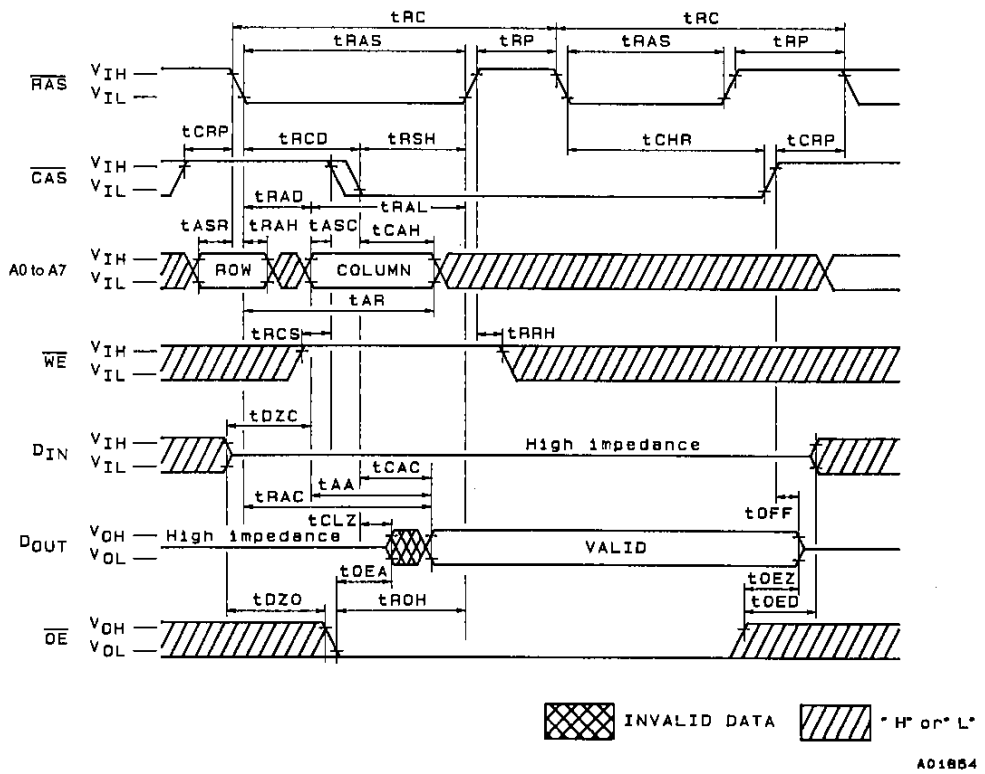


A01852

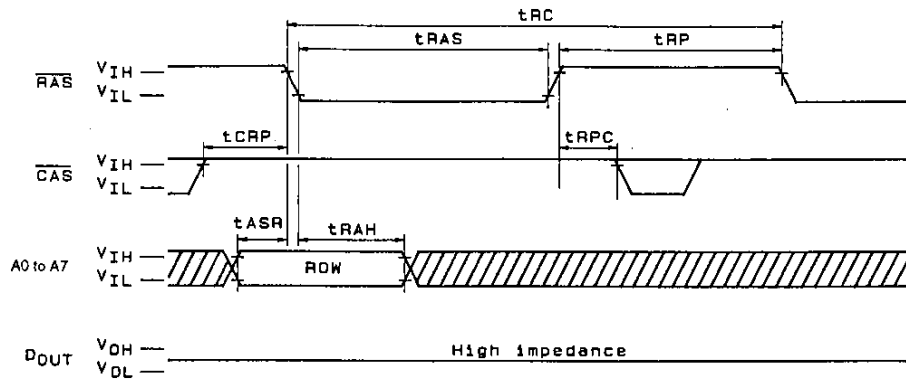
Fast Page Mode Read-Write/Read-Modify-Write Cycle




Hidden Refresh Cycle



**RAS-Only Refresh Cycle**

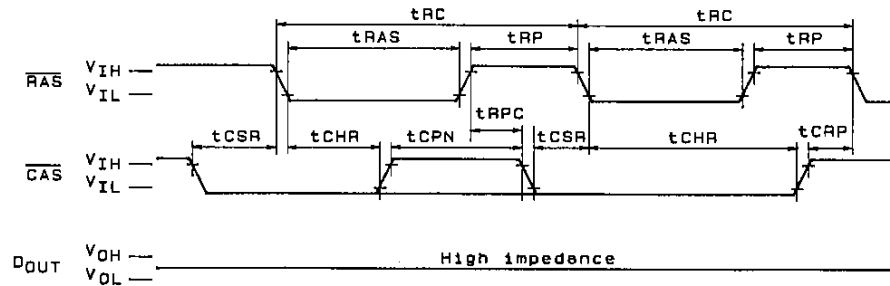


$\overline{WE}$ ,  $D_{IN}$ ,  $\overline{OE}$ : "H" or "L"

 "H" or "L"

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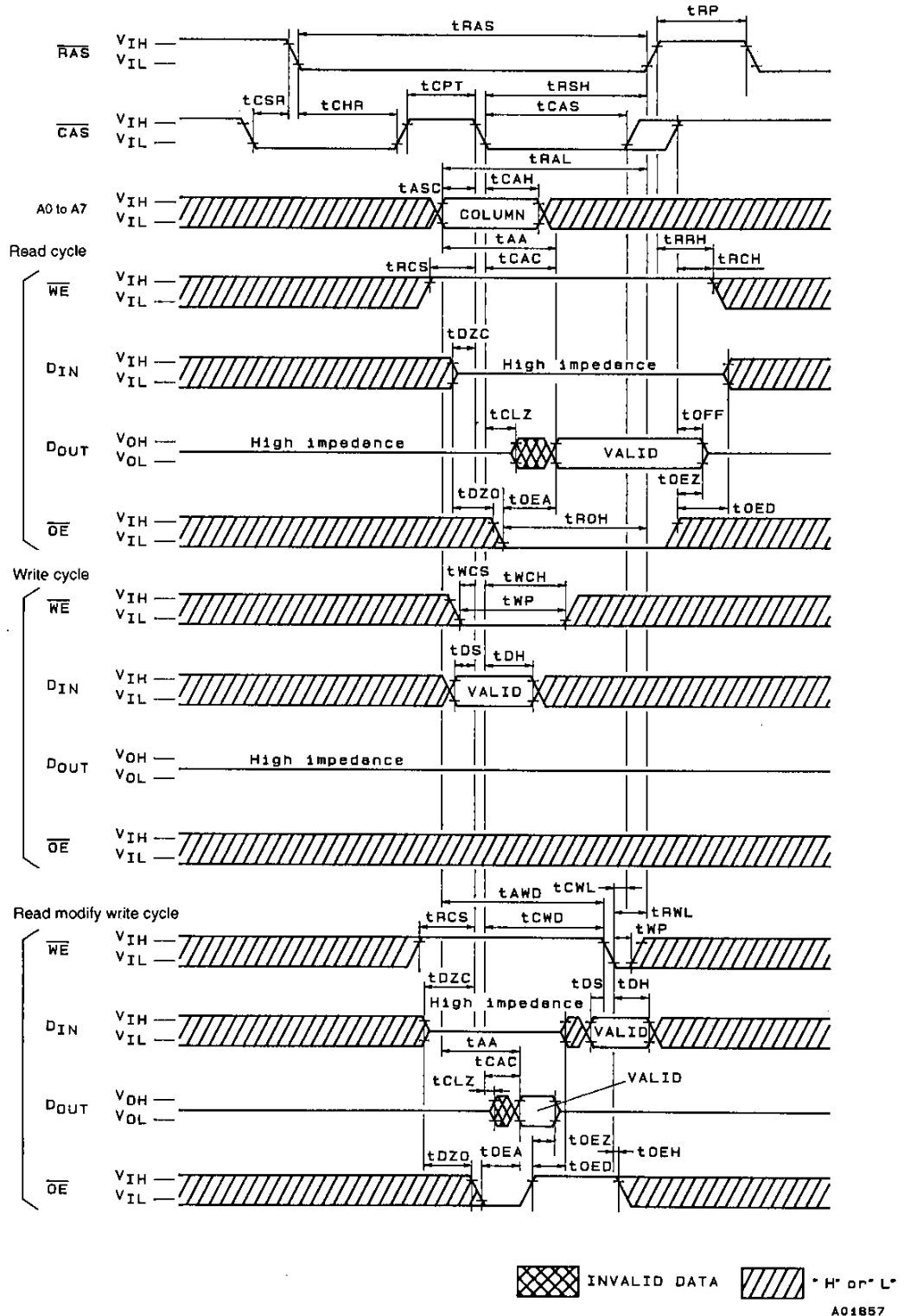
**CAS-Before-RAS Refresh Cycle**



A0 to A7,  $\overline{WE}$ ,  $D_{IN}$ ,  $\overline{OE}$ : "H" or "L"

A01856

CAS-Before-RAS Refresh Counter Test Cycle



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