

LH2464

NMOS 256K (64K × 4) Dynamic RAM

FEATURES

- 65,536 × 4 bit organization
- Access times: 100/120/150 ns (MAX.)
- Cycle times: 200/220/260 ns (MIN.)
- Page mode, Read-Modify-Write operation
- Power supply: +5 V ± 10%
- Power consumption (MAX.):
Operating: 523/457/413 mW (MAX.)
Standby: 27.5 mW
- TTL compatible I/O
- Built-in gated $\overline{\text{CAS}}$ function
- Early-write or $\overline{\text{OE}}$ control allows bus management of the data-out buffer
- $\overline{\text{RAS}}$ only refresh, Hidden refresh, $\overline{\text{CAS}}$ before $\overline{\text{RAS}}$ refresh capability
- 256 refresh cycle (refreshing time 4 ms)
- Built-in high output substrate bias generator circuit
- Package:
18-pin, 300-mil DIP

DESCRIPTION

The LH2464 is a 65,536 × 4 bit dynamic RAM fabricated using N-channel 2-layer polysilicon gate process technology. With multiplexed address inputs and a standard 18-pin DIP package, it is easy to comprise memory systems with high speed, low power consumption and large memory capacity. The LH2464 operates on a single +5 V power supply. The built-in high output substrate bias generator circuit eliminates sensitivity to undershoot on the input signals.

PIN CONNECTIONS

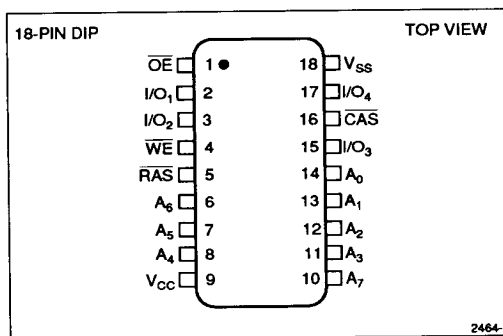


Figure 1. Pin Connections for DIP Package

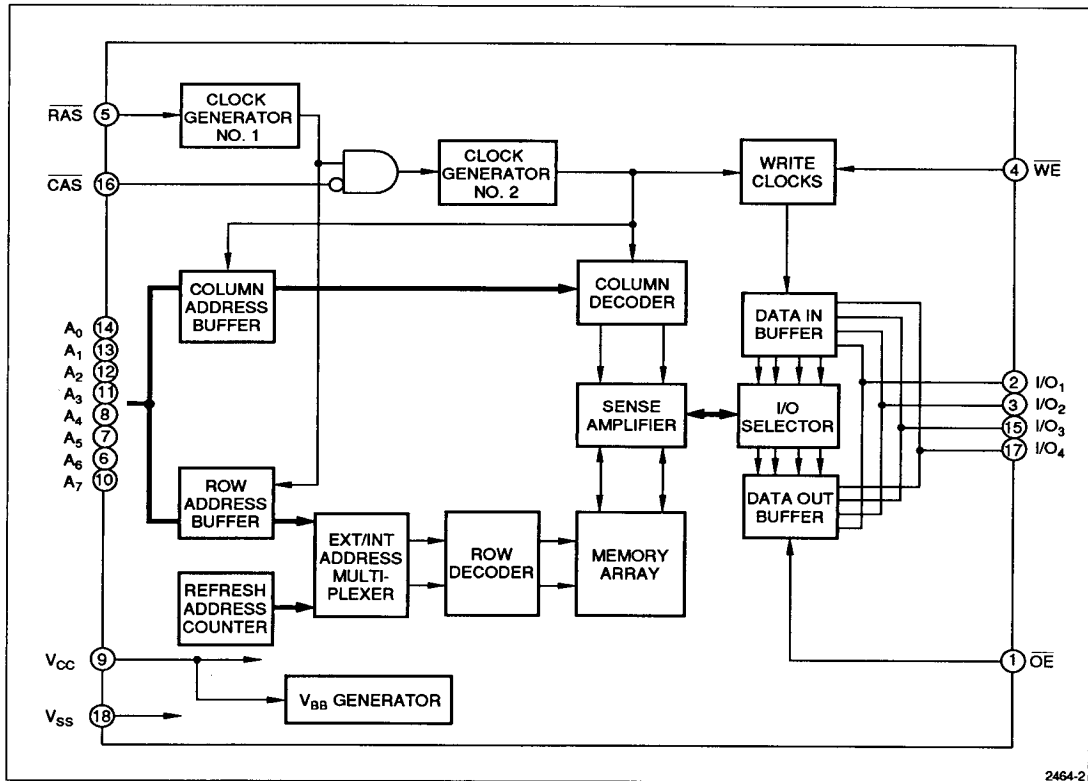


Figure 2. LH2464 Block Diagram

PIN DESCRIPTION

SIGNAL	PIN NAME
A ₀ - A ₇	Address input
$\overline{\text{RAS}}$	Row address strobe
$\overline{\text{CAS}}$	Column address strobe
$\overline{\text{WE}}$	Write enable

SIGNAL	PIN NAME
$\overline{\text{OE}}$	Output enable
I/O ₁ - I/O ₄	Data input/output
V _{cc}	Power supply (+5 V)
V _{ss}	Power supply (0 V)

ABSOLUTE MAXIMUM RATINGS

PARAMETER	SYMBOL	RATING	UNIT	NOTE
Supply voltage	V _T	-1.0 to +7.0	V	1
Output short-circuit current	I _O	50	mA	
Power consumption	P _D	1.0	W	
Operating temperature	T _{opr}	0 to +70	°C	
Storage temperature	T _{stg}	-55 to +150	°C	

NOTE:

1. Referenced to V_{ss}

RECOMMENDED OPERATING CONDITIONS (TA = 0 to +70°C)

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNIT	NOTE
Supply voltage	V _{CC}	4.5	5.0	5.5	V	1
	V _{SS}	0	0	0		
Input voltage	V _{IH}	2.4		6.5	V	1
	V _{IL}	-1.0		0.8		

NOTE:

1. Referenced to V_{SS}

CAPACITANCE (V_{CC} = 5 V ± 10%, TA = 0 to 70°C, f = 1MHz)

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNIT
Input capacitance	A ₀ - A ₇	C _{IN1}		5	pF
	$\overline{\text{OE}}, \overline{\text{WE}}$	C _{IN2}		7	
	$\overline{\text{RAS}}, \overline{\text{CAS}}$	C _{IN2}		10	
Input/Output capacitance	I/O ₁ - I/O ₄	C _{IO}		8	pF

DC CHARACTERISTICS (V_{CC} = 5 V ± 10%, TA = 0 to +70°C)

PARAMETER		SYMBOL	MIN.	MAX.	UNIT	NOTE
Average supply current in normal operation	LH2464-10	I _{CC1}	—	95	mA	1, 2
	LH2464-12		—	83		
	LH2464-15		—	75		
Average supply current in the standby mode		I _{CC2}	—	5.0	mA	1
Average supply current in RAS only refresh time	LH2464-10	I _{CC3}	—	85	mA	1, 2
	LH2464-12		—	63		
	LH2464-15		—	65		
Average supply current in page mode	LH2464-10	I _{CC4}	—	70	mA	1
	LH2464-12		—	60		
	LH2464-15		—	50		
CAS before RAS average supply current in refresh cycle	LH2464-10	I _{CC5}	—	85	mA	1, 2
	LH2464-12		—	70		
	LH2464-15		—	65		
Input leakage current	0 V ≤ V _{IN} ≤ 6.5 V 0 V on all other pins	I _{L1}	-10	10	μA	
Output leakage current	0 V ≤ V _{OUT} ≤ 6.5 V Output in high-impedance state	I _{LO}	-10	10	μA	
Output "High" voltage	I _{OUT} = -2 mA	V _{OH}	2.4	—	V	
Output "Low" voltage	I _{OUT} = 4.2 mA	V _{OL}	—	0.4	V	

NOTES:

1. The output pins are in high-impedance state.
2. I_{CC1}, I_{CC3}, I_{CC4}, and I_{CC5} depend on the cycle time.

AC CHARACTERISTICS ^{1, 2, 3} ($V_{CC} = 5\text{ V} \pm 10\%$, $T_A = 0\text{ to } +70^\circ\text{C}$)

PARAMETER	SYMBOL	LH2464-10		LH2464-12		LH2464-15		UNIT	NOTE
		MIN.	MAX.	MIN.	MAX.	MIN.	MAX.		
Random read/write cycle time	t_{RC}	200	—	220	—	260	—	ns	
Read write cycle time	t_{RWC}	280	—	305	—	360	—	ns	
Page mode cycle time	t_{PC}	100	—	120	—	145	—	ns	
Access time from $\overline{\text{RAS}}$	t_{RAC}	—	100	—	120	—	150	ns	4, 6
Access time from $\overline{\text{CAS}}$	t_{CAC}	—	50	—	60	—	75	ns	5, 6
Output turn off delay time	t_{OFF}	0	30	0	30	0	40	ns	
Rise and fall time	t_T	3	35	3	35	3	35	ns	3
RAS precharge time	t_{RP}	90	—	90	—	100	—	ns	
RAS pulse width	t_{RAS}	100	10,000	120	10,000	150	10,000	ns	
RAS hold time	t_{RSH}	50	—	60	—	75	—	ns	
Refresh counter test cycle time	t_{RTC}	385	—	445	—	520	—	ns	12
Refresh counter test RAS pulse width	t_{TRAS}	285	—	335	—	410	—	ns	12
CAS precharge time	t_{CP}	40	—	50	—	60	—	ns	
CAS pulse width	t_{CAS}	50	10,000	60	10,000	75	10,000	ns	
CAS hold time	t_{CSH}	100	—	120	—	150	—	ns	
CAS hold time (CAS before RAS)	t_{FCH}	100	—	120	—	150	—	ns	
CAS setup time (CAS before RAS)	t_{FCS}	10	—	10	—	30	—	ns	
RAS/CAS delay time	t_{RCD}	20	50	25	60	30	75	ns	7, 8
CAS/RAS precharge time	t_{CRP}	10	—	10	—	30	—	ns	
Row address setup time	t_{ASR}	0	—	0	—	0	—	ns	
Row address hold time	t_{RAH}	10	—	15	—	20	—	ns	
Column address setup time	t_{ASC}	0	—	0	—	0	—	ns	
Column address hold time	t_{CAH}	20	—	20	—	45	—	ns	
Column address hold time from RAS	t_{AR}	75	—	80	—	120	—	ns	
Read command setup time	t_{RCS}	0	—	0	—	0	—	ns	
Read command hold time	t_{RCH}	0	—	0	—	0	—	ns	10
Read command hold time from RAS	t_{RRH}	10	—	10	—	20	—	ns	10
Write command setup time	t_{WCS}	0	—	0	—	0	—	ns	9
Write command hold time	t_{WCH}	35	—	40	—	45	—	ns	
Write command hold time from RAS	t_{WCR}	85	—	100	—	120	—	ns	
Write command pulse width	t_{WP}	35	—	40	—	45	—	ns	
Write command RAS lead time	t_{RWL}	35	—	40	—	45	—	ns	
Write command $\overline{\text{CAS}}$ lead time	t_{CWL}	35	—	40	—	45	—	ns	
RAS write command delay time	t_{RWD}	140	—	160	—	200	—	ns	
CAS write command delay time	t_{CWD}	90	—	100	—	125	—	ns	
Data input setup time	t_{DS}	0	—	0	—	0	—	ns	
Data input hold time from $\overline{\text{CAS}}$	t_{DHC}	35	—	40	—	45	—	ns	
Data input hold time from RAS	t_{DHR}	85	—	100	—	120	—	ns	
Refresh interval	t_{REF}	—	4	—	4	—	4	ns	
$\overline{\text{RAS}}$ precharge CAS hold time	t_{RPC}	0	—	0	—	0	—	ns	
OE command hold time	t_{OEH}	25	—	25	—	40	—	ns	11
$\overline{\text{OE}}$ access time	t_{OEA}	—	25	—	30	—	40	ns	
OE to data delay	t_{OED}	30	—	30	—	40	—	ns	
Output buffer turn-off delay time from OE	t_{OEZ}	0	30	0	30	0	40	ns	
Data input hold time from WE	t_{DHW}	35	—	40	—	45	—	ns	

NOTES:

- For proper operation, at least 500 μs of pause time after power-on followed by several initialization cycles (usually 8 ordinary refresh cycles) should be given.
- AC characteristic assume $t_T = 5\text{ ns}$. (t_T refers to the transition time between V_{IH} and V_{IL} .)
- Timing measurements are referenced to V_{IH} (MIN.) and V_{IL} (MAX.).
- Only when $t_{RCD} \leq t_{RCD}(\text{MAX.})$. If $t_{RCD} > t_{RCD}(\text{MAX.})$, t_{RAC} will increase by $(t_{RCD} - t_{RCD}(\text{MAX.}))$.
- When $t_{RCD} \geq t_{RCD}(\text{MAX.})$.
- Load condition for 2TTL + 100 pF.
- $t_{RCD}(\text{MAX.})$ is the max. point for t_{RCD} where $t_{RAC}(\text{MAX.})$ is ensured, and doesn't represent a limit of operation. If $t_{RCD}(\text{MAX.}) \leq t_{RCD}$, the access time will come under the control of t_{CAC} .
- $t_{RCD}(\text{MIN.}) = t_{RAH}(\text{MIN.}) + 2t_T + t_{ASC}(\text{MIN.})$.
- When $t_{WCS} \geq t_{WCS}(\text{MIN.})$, it comes into early write cycle.
- The operation is ensured when either t_{RCH} or t_{RRH} is satisfied.
- Only when $t_{WCS} < t_{WCS}(\text{MIN.})$, it must be satisfied.
- Only when in CAS-before-RAS refresh counter test cycle.

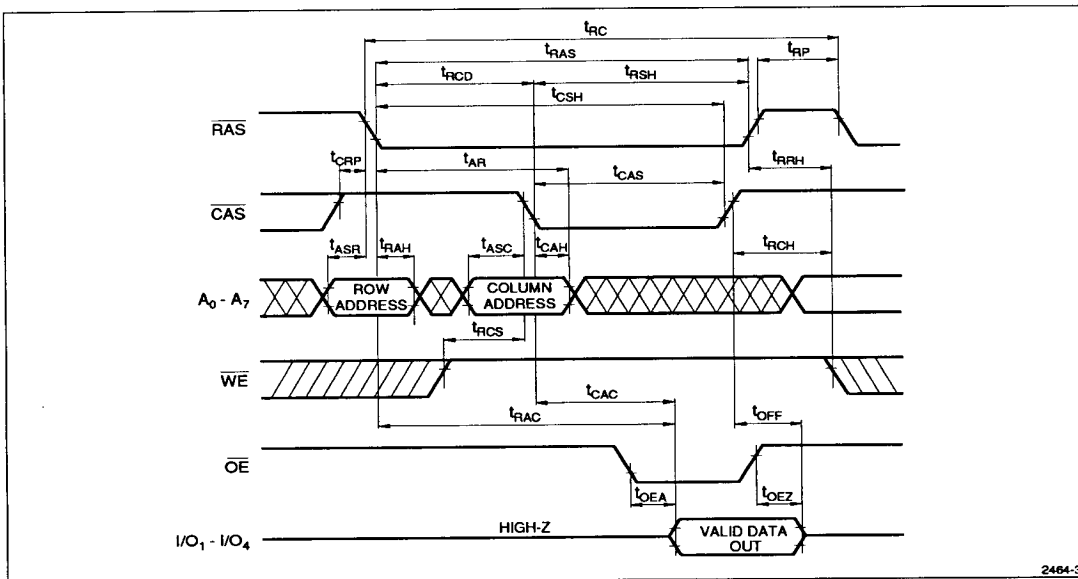


Figure 3. Read Cycle

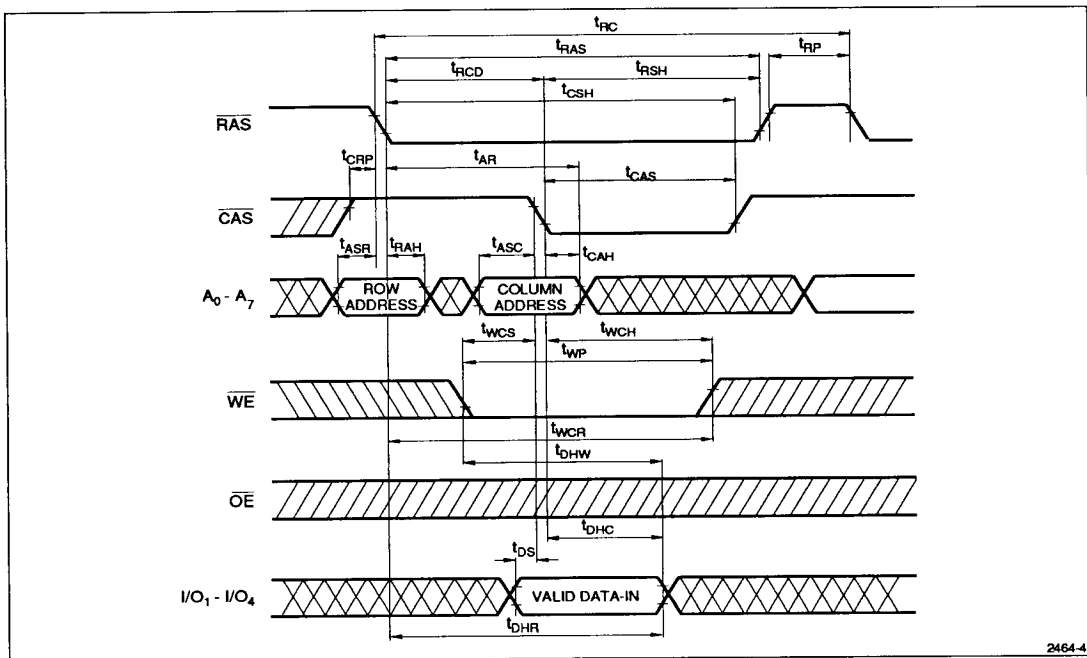
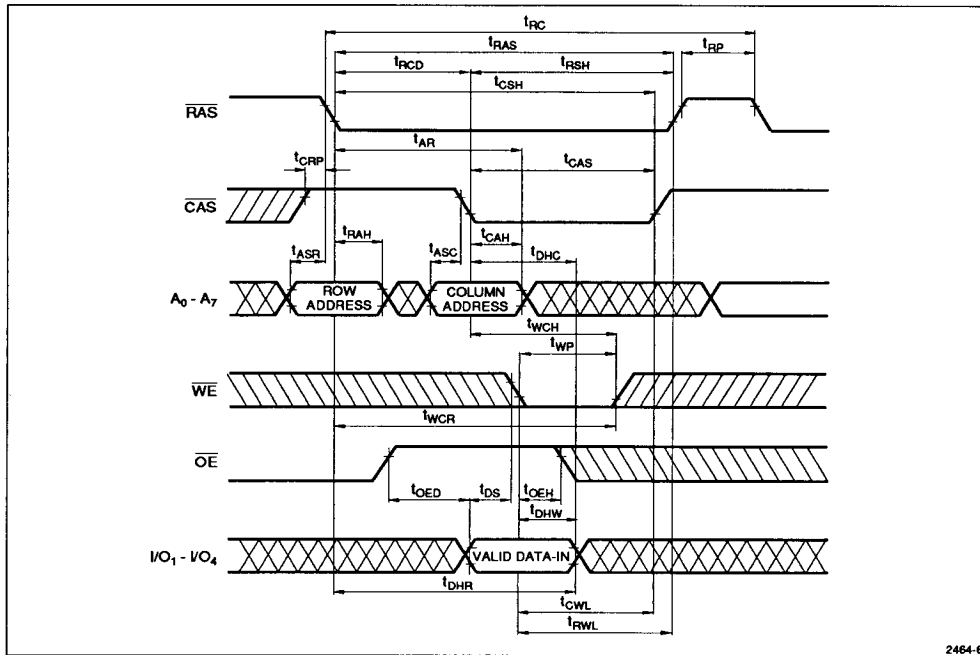
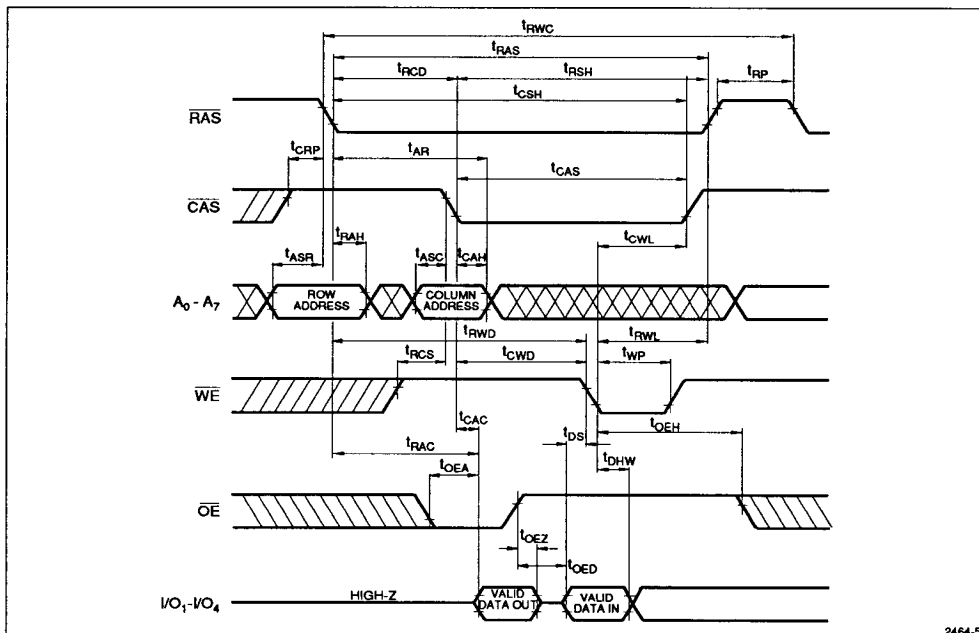


Figure 4. Write Cycle (Early Write)



2464-6

Figure 5. Write Cycle ($\overline{OE}$ Controlled Write)

2464-5

Figure 6. Read-Write/Read-Modify-Write Cycle

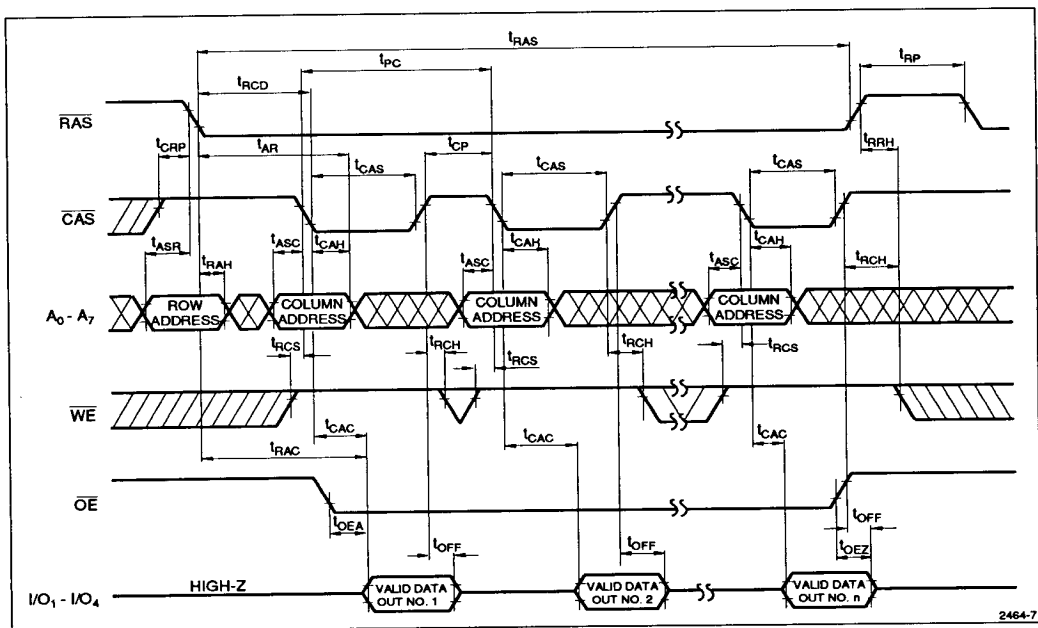


Figure 7. Page Mode Read Cycle

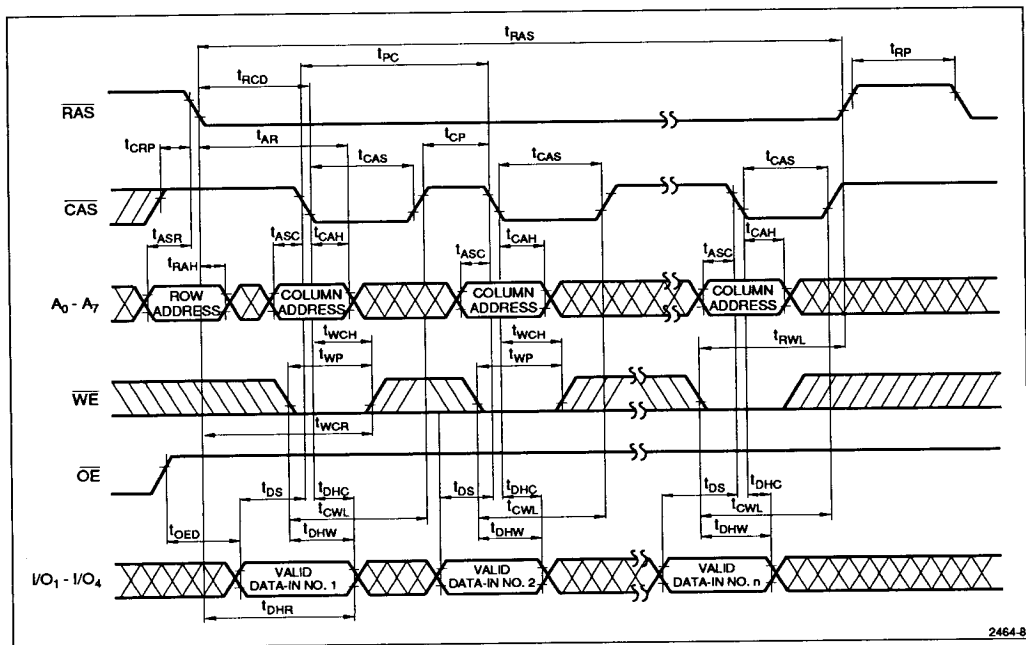
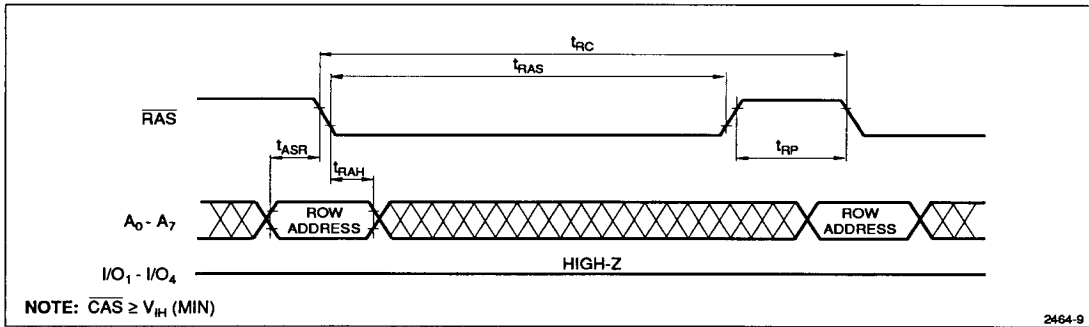
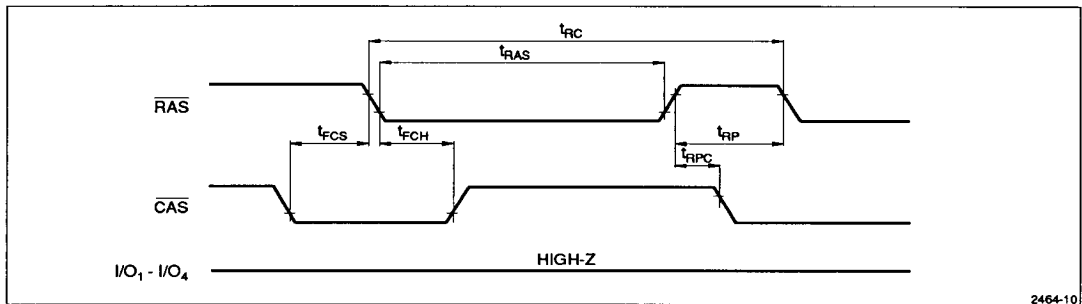


Figure 8. Page Mode Write Cycle

Figure 9. $\overline{RAS}$ Only Refresh CycleFigure 10. $\overline{CAS}$ Before $\overline{RAS}$ Refresh Cycle

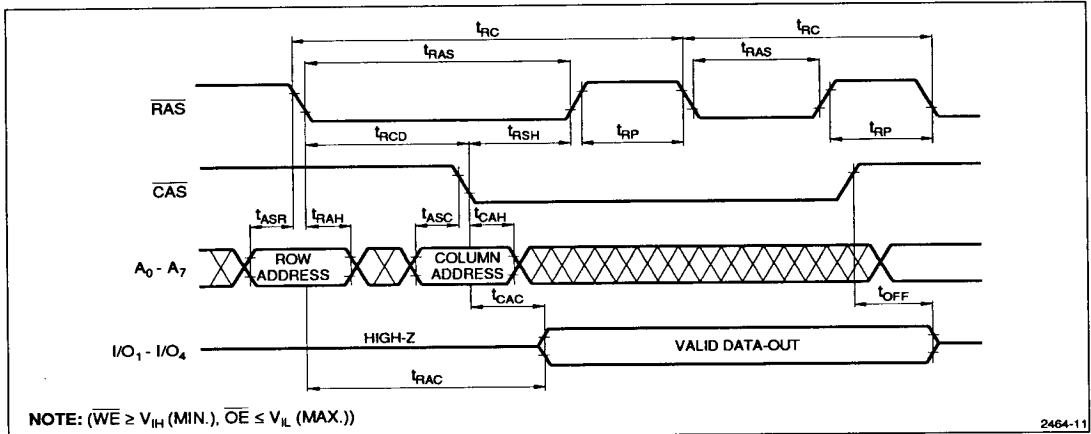


Figure 11. Hidden Refresh Cycle

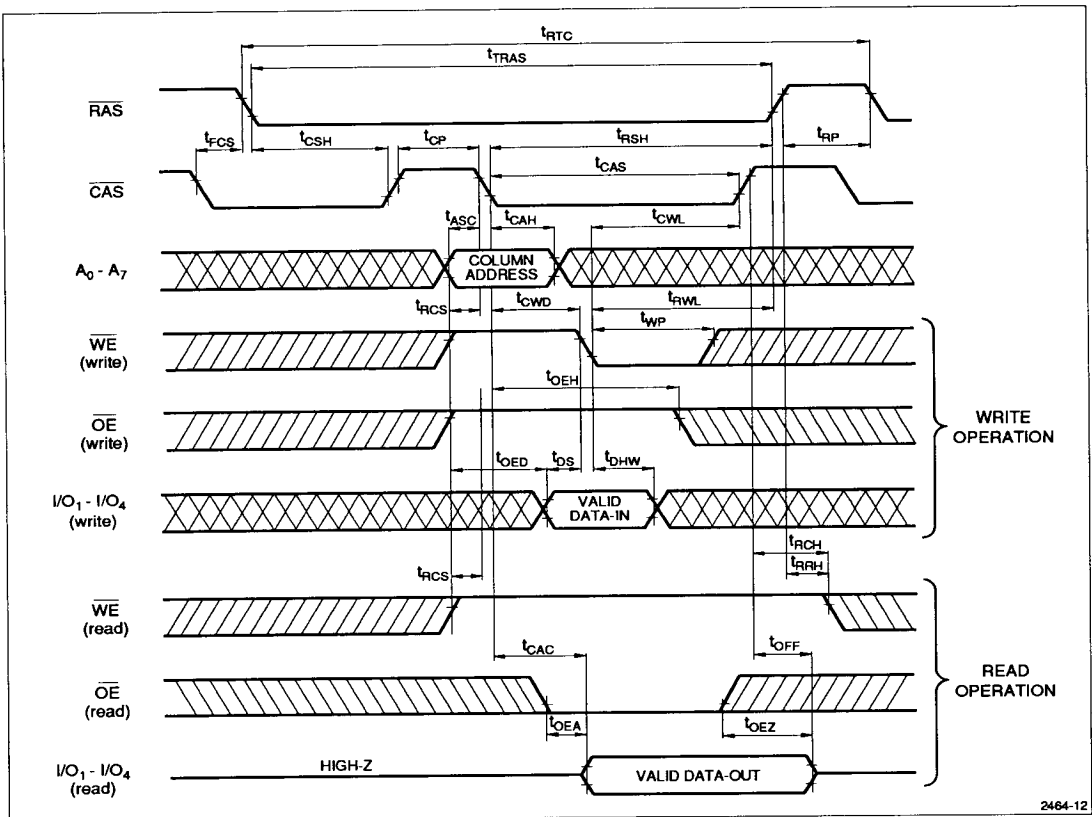


Figure 12. $\overline{CAS}$ Before $\overline{RAS}$ Refresh Counter Test Cycle

CAS-before-RAS Refresh Counter Test Cycle

The $\overline{\text{CAS}}$ -before- $\overline{\text{RAS}}$ refresh counter test cycle is used to verify the operation of the internal refresh counter. The verification can be done by following the steps as described below.

1. Write "0" into 256 row addresses on a particular column address, which are selected by the internal refresh counter, by the write operation of the $\overline{\text{CAS}}$ -before- $\overline{\text{RAS}}$ refresh counter test cycle mode with any given column address.

2. Read and verify "0" of the 256 row addresses on the same column in regular read mode by externally supplying address signals.

Then, write "1" into the above 256 row addresses in regular write mode.

3. Read and verify "1" of the 256 row addresses in the $\overline{\text{CAS}}$ -before- $\overline{\text{RAS}}$ refresh counter test cycle mode.

Refer to timing chart (12) of the $\overline{\text{CAS}}$ -before- $\overline{\text{RAS}}$ refresh counter test cycle.

ORDERING INFORMATION

LH2464 Device Type	X Package	- ## Speed	
		10 100 12 120 15 150	Access Time (ns)
			Blank 18-pin, 300-mil DIP (DIP18-P-300)
			NMOS 64K x 4 Dynamic RAM

Example: LH2464-10 (NMOS 256K (64K x 4) Dynamic RAM, 100 ns, 18-pin, 300-mil DIP)

2464-13