

4 M x 4-Bit Dynamic RAM

HYB 5116400AJ-50/-60/-70/-80
HYB 5116400ASJ-50/-60/-70/-80

Advanced Information

- 4 194 304 words by 4-bit organization
- 0 to 70 °C operating temperature
- Fast access and cycle time
 - RAS access time:
 - 50 ns (-50 version)
 - 60 ns (-60 version)
 - 70 ns (-70 version)
 - 80 ns (-80 version)
 - Cycle time:
 - 95 ns (-50 version)
 - 110 ns (-60 version)
 - 130 ns (-70 version)
 - 150 ns (-80 version)
 - CAS access time:
 - 15 ns (-50,-60 version)
 - 20 ns (-70,-80 version)
- Fast page mode cycle time
 - 35 ns (-50 version)
 - 40 ns (-60 version)
 - 45 ns (-70 version)
 - 50 ns (-80 version)
- Single + 5 V ($\pm 10\%$) supply
- Low power dissipation
 - max. 550 active mW (-50 version)
 - max. 495 active mW (-60 version)
 - max. 440 active mW (-70 version)
 - max. 385 active mW (-80 version)
 - 11 mW standby (TTL)
 - 5.5. mW standby (MOS)
- Output unlatched at cycle end allows two-dimensional chip selection
- Read, write, read-modify-write, CAS-before-RAS refresh, RAS-only refresh, hidden refresh, test mode
- Fast page mode capability
- All inputs, outputs and clocks fully TTL-compatible
- 4096 refresh cycles / 64 ms
- Plastic Package:
 - P-SOJ-28/24-1 400 mil
 - P-SOJ-26/24-1 300 mil

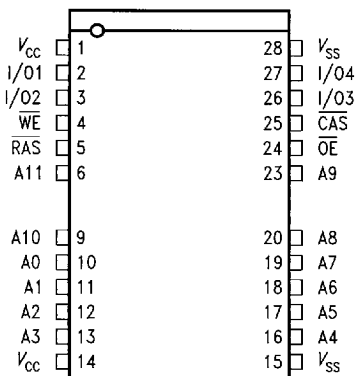
The HYB 5116400AS/ASJ is the new generation dynamic RAM organized as 4194304 words by 4-bits. The HYB 5116400AS/ASJ utilizes a submicron CMOS silicon gate process technology, as well as advanced circuit techniques to provide wide operating margins, both internally and for the system user. Multiplexed address inputs permit the HYB 5116400AS/ASJ to be packaged in a standard SOJ 28/24 400 mil or SOJ 26/24 300 mil wide plastic package. These packages provide high system bit densities and are compatible with commonly used automatic testing and insertion equipment. System-oriented features include single + 5 V ($\pm 10\%$) power supply, direct interfacing with high-performance logic device families such as Schottky TTL.

Ordering Information

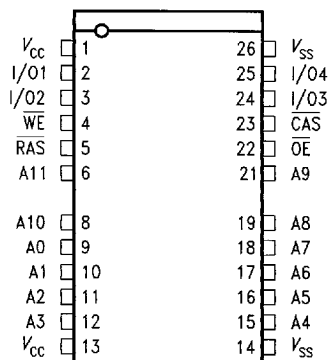
Type	Ordering Code	Package	Descriptions
HYB 5116400ASJ-50	Q67100-Q838	P-SOJ-28/24-1 400 mil	DRAM (access time 50 ns)
HYB 5116400ASJ-60	Q67100-Q839	P-SOJ-28/24-1 400 mil	DRAM (access time 60 ns)
HYB 5116400ASJ-70	Q67100-Q840	P-SOJ-28/24-1 400 mil	DRAM (access time 70 ns)
HYB 5116400ASJ-80	Q67100-Q841	P-SOJ-28/24-1 400 mil	DRAM (access time 80 ns)
HYB 5116400AJ-50	Q67100-Q830	P-SOJ-26/24-1 300 mil	DRAM (access time 50 ns)
HYB 5116400AJ-60	Q67100-Q831	P-SOJ-26/24-1 300 mil	DRAM (access time 60 ns)
HYB 5116400AJ-70	Q67100-Q832	P-SOJ-26/24-1 300 mil	DRAM (access time 70 ns)
HYB 5116400AJ-80	Q67100-Q833	P-SOJ-26/24-1 300 mil	DRAM (access time 80 ns)

Pin Names

A0-A11	Address Inputs
RAS	Row Address Strobe
OE	Output Enable
I/O1-I/O4	Data Input/Output
CAS	Column Address Strobe
WRITE	Read/Write Input
V _{CC}	Power Supply (+ 5 V)
V _{SS}	Ground (0 V)



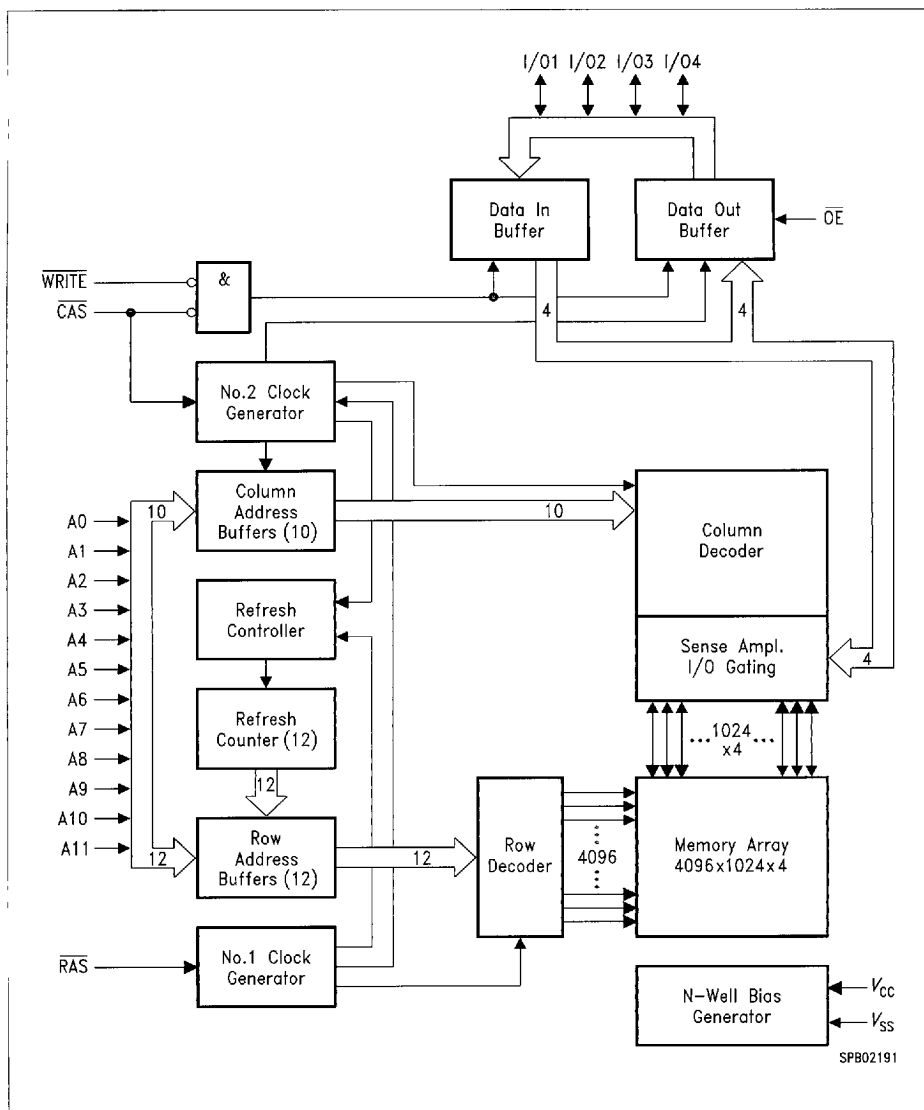
P-SOJ-28/24-1 (400 mil)



SPP02190

P-SOJ-26/24-1 (300 mil)

Pin Configuration



Block Diagram

Absolute Maximum Ratings

Operating temperature range	0 to 70 °C
Storage temperature range.....	– 55 to 150 °C
Soldering temperature	260 °C
Soldering time.....	10 s
Input/output voltage	– 0.5 to min ($V_{CC}+0.5, 7.0$) V
Power supply voltage.....	– 1.0V to 7.0 V
Power dissipation.....	1.0 W
Data out current (short circuit)	50 mA

Note:

Stresses above those listed under "Absolute Maximum Ratings" may cause permanent damage of the device. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

DC Characteristics

$T_A = 0$ to 70 °C, $V_{SS} = 0$ V, $V_{CC} = 5$ V $\pm 10\%$; $t_T = 5$ ns

Parameter	Symbol	Limit Values		Unit	Test Condition
		min.	max.		
Input high voltage	V_{IH}	2.4	$V_{CC}+0.5$	V	1)
Input low voltage	V_{IL}	– 0.5	0.8	V	1)
Output high voltage ($I_{OUT} = -5$ mA)	V_{OH}	2.4	–	V	1)
Output low voltage ($I_{OUT} = 4.2$ mA)	V_{OL}	–	0.4	V	1)
Input leakage current ($0 \text{ V} \leq V_{IH} \leq V_{CC} + 0.3 \text{ V}$, all other pins = 0 V)	$I_{I(L)}$	– 10	10	μA	1)
Output leakage current (DO is disabled, $0 \text{ V} \leq V_{OUT} \leq V_{CC} + 0.3 \text{ V}$)	$I_{O(L)}$	– 10	10	μA	1)
Average V_{CC} supply current: –50 ns version –60 ns version –70 ns version –80 ns version ($\overline{\text{RAS}}$, $\overline{\text{CAS}}$, address cycling: $t_{RC} = t_{RC \text{ min.}}$)	I_{CC1}	– – – –	100 90 80 70	mA mA mA mA	2) 3) 4) 2) 3) 4) 2) 3) 4) 2) 3) 4)
Standby V_{CC} supply current ($\overline{\text{RAS}} = \overline{\text{CAS}} = V_{IH}$)	I_{CC2}	–	2	mA	–
Average V_{CC} supply current, during $\overline{\text{RAS}}$ -only refresh cycles: –50 ns version –60 ns version –70 ns version –80 ns version ($\overline{\text{RAS}}$ cycling: $\overline{\text{CAS}} = V_{IH}$; $t_{RC} = t_{RC \text{ min.}}$)	I_{CC3}	– – – –	100 90 80 70	mA mA mA mA	2) 4) 2) 4) 2) 4) 2) 4)

Notes see page 205.

DC Characteristics (cont'd) $T_A = 0$ to $70\text{ }^{\circ}\text{C}$, $V_{SS} = 0\text{ V}$, $V_{CC} = 5\text{ V} \pm 10\%$; $t_T = 5\text{ ns}$

Parameter	Symbol	Limit Values		Unit	Test Condition
		min.	max.		
Average V_{CC} supply current, during fast page mode: -50 ns version -60 ns version -70 ns version -80 ns version ($\overline{\text{RAS}} = V_{IL}$, $\overline{\text{CAS}}$, address cycling: $t_{PC} = t_{PC\text{ min.}}$)	I_{CC4}	— — — —	85 75 65 55	mA mA mA mA	2) 3) 4) 2) 3) 4) 2) 3) 4) 2) 3) 4)
Standby V_{CC} supply current ($\text{RAS} = \text{CAS} = V_{CC} - 0.2\text{ V}$)	I_{CC5}	—	1	mA	1)
Average V_{CC} supply current, during $\overline{\text{CAS}}$ -before-RAS refresh mode: -50 ns version -60 ns version -70 ns version -80 ns version ($\overline{\text{RAS}}$, $\overline{\text{CAS}}$ cycling: $t_{RC} = t_{RC\text{ min.}}$)	I_{CC6}	— — — —	100 90 80 70	mA mA mA mA	2) 4) 2) 4) 2) 4) 2) 4)

Notes see page 205.

AC Characteristics ⁵⁾ $T_A = 0 \text{ to } 70^\circ\text{C}$, $V_{CC} = 5 \text{ V} \pm 10\%$, $t_T = 5 \text{ ns}$

Parameter	Symbol	Limit Values								Unit
		-50		-60		-70		-80		
		min.	max.	min.	max.	min.	max.	min.	max.	
Random read or write cycle time	t_{RC}	95	—	110	—	130	—	150	—	ns
Read-write cycle time	t_{RWC}	135	—	150	—	180	—	200	—	ns
Fast page mode cycle time	t_{PC}	35	—	40	—	45	—	50	—	ns
Fast page mode read-write cycle time	t_{PRWC}	75	—	80	—	95	—	100	—	ns
Access time from RAS ^{7) 12)}	t_{RAC}	—	50	—	60	—	70	—	80	ns
Access time from CAS ^{7) 12)}	t_{CAC}	—	15	—	15	—	20	—	20	ns
Access time from column address ^{7) 13)}	t_{AA}	—	25	—	30	—	35	—	40	ns
Access time from CAS precharge ⁷⁾	t_{CPA}	—	30	—	35	—	40	—	45	ns
CAS to output in low-Z ⁷⁾	t_{CLZ}	0	—	0	—	0	—	0	—	ns
Output buffer turn-off delay ⁸⁾	t_{OFF}	0	15	0	15	0	20	0	20	ns
Transition time (rise and fall) ⁶⁾	t_T	3	50	3	50	3	50	3	50	ns
RAS precharge time	t_{RP}	35	—	40	—	50	—	60	—	ns
RAS pulse width	t_{RAS}	50	10k	60	10k	70	10k	80	10k	ns
RAS pulse width (fast page mode)	t_{RASp}	50	200k	60	200k	70	200k	80	200k	ns
CAS precharge to RAS Delay	t_{RHCP}	30	—	35	—	40	—	45	—	ns
CAS precharge to WE (FPMR RMW)	t_{CPWD}	50	—	55	—	65	—	70	—	ns
RAS hold time	t_{RSH}	15	—	15	—	20	—	20	—	ns
CAS hold time	t_{CSH}	50	—	60	—	70	—	80	—	ns

Notes see page 205.

AC Characteristics (cont'd) ⁵⁾ $T_A = 0 \text{ to } 70^\circ\text{C}$, $V_{CC} = 5 \text{ V} \pm 10\%$, $t_T = 5 \text{ ns}$

Parameter	Symbol	Limit Values								Unit
		-50		-60		-70		-80		
		min.	max.	min.	max.	min.	max.	min.	max.	
CAS pulse width	t_{CAS}	15	10k	15	10k	20	10k	20	10k	ns
RAS to CAS delay time ¹²⁾	t_{RCD}	20	35	20	45	20	50	20	60	
RAS to column address delay time ¹³⁾	t_{RAD}	15	25	15	30	15	35	15	40	ns
CAS to RAS precharge time	t_{CRP}	5	—	5	—	5	—	5	—	ns
CAS precharge time	t_{CPN}	10	—	10	—	10	—	10	—	ns
CAS precharge time (fast page mode)	t_{CP}	10	—	10	—	10	—	10	—	ns
Row address setup time	t_{ASR}	0	—	0	—	0	—	0	—	ns
Row address hold time	t_{RAH}	10	—	10	—	10	—	10	—	ns
Column address setup time	t_{ASC}	0	—	0	—	0	—	0	—	ns
Column address hold time	t_{CAH}	10	—	15	—	15	—	15	—	ns
Column address to RAS lead time	t_{RAL}	25	—	30	—	35	—	40	—	ns
Read command setup time	t_{RCS}	0	—	0	—	0	—	0	—	ns
Read command hold time ⁹⁾	t_{RCH}	0	—	0	—	0	—	0	—	ns
Read command hold time referenced to RAS ⁹⁾	t_{RRH}	0	—	0	—	0	—	0	—	ns
Write command hold time	t_{WCH}	10	—	15	—	15	—	15	—	ns
Write command pulse width	t_{WP}	10	—	15	—	15	—	15	—	ns

Notes see page 205.

AC Characteristics (cont'd) ⁵⁾ $T_A = 0 \text{ to } 70^\circ\text{C}$, $V_{CC} = 5 \text{ V} \pm 10\%$, $t_T = 5 \text{ ns}$

Parameter	Symbol	Limit Values								Unit
		-50		-60		-70		-80		
		min.	max.	min.	max.	min.	max.	min.	max.	
Write command to RAS lead time	t_{RWL}	15	—	15	—	20	—	20	—	ns
Write command to CAS lead time	t_{CWL}	15	—	15	—	20	—	20	—	ns
Data setup time ¹⁰⁾	t_{DS}	0	—	0	—	0	—	0	—	ns
Data hold time ¹⁰⁾	t_{DH}	10	—	15	—	15	—	15	—	ns
Refresh period	t_{REF}	—	64	—	64	—	64	—	64	ms
Write command setup time ¹¹⁾	t_{WCS}	0	—	0	—	0	—	0	—	ns
CAS to <u>WRITE</u> delay time ¹¹⁾	t_{CWD}	35	—	35	—	45	—	45	—	ns
RAS to <u>WRITE</u> delay time ¹¹⁾	t_{RWD}	70	—	80	—	95	—	105	—	ns
Column address to <u>WRITE</u> delay time ¹¹⁾	t_{AWD}	45	—	50	—	60	—	65	—	ns
CAS setup time (CAS-before-RAS cycle)	t_{CSR}	10	—	10	—	10	—	10	—	ns
CAS hold time (CAS-before-RAS cycle)	t_{CHR}	30	—	30	—	30	—	30	—	ns
RAS to CAS precharge time	t_{RPC}	0	—	0	—	0	—	0	—	ns
CAS precharge time (CAS-before-RAS counter test cycle)	t_{CPT}	35	—	40	—	40	—	40	—	ns
Write command setup time (in test mode entry cycle)	t_{WTS}	10	—	10	—	10	—	10	—	ns
Write command hold time (in test mode entry cycle)	t_{WTH}	10	—	10	—	10	—	10	—	ns

Notes see page 205.

AC Characteristics (cont'd) ⁵⁾ $T_A = 0$ to 70°C , $V_{CC} = 5\text{ V} \pm 10\%$, $t_T = 5\text{ ns}$

Parameter	Symbol	Limit Values								Unit
		-50		-60		-70		-80		
		min.	max.	min.	max.	min.	max.	min.	max.	
Write to $\overline{\text{RAS}}$ precharge time ($\overline{\text{CAS}}$ -before-RAS cycle)	t_{WRP}	10	—	10	—	10	—	10	—	ns
Write hold time referenced to $\overline{\text{RAS}}$ ($\overline{\text{CAS}}$ -before-RAS cycle)	t_{WRH}	10	—	10	—	10	—	10	—	ns
$\overline{\text{OE}}$ command hold time	t_{OEH}	15	—	15	—	20	—	20	—	ns
$\overline{\text{OE}}$ access time	t_{OEA}	—	15	—	15	—	20	—	20	ns
Output buffer turn-off delay from $\overline{\text{OE}}$	t_{OEZ}	0	15	0	15	0	20	0	20	ns
Data to $\overline{\text{CAS}}$ low delay ¹⁵⁾	t_{DZC}	0	—	0	—	0	—	0	—	ns
Data to $\overline{\text{OE}}$ low delay ¹⁵⁾	t_{DZO}	0	—	0	—	0	—	0	—	ns
$\overline{\text{CAS}}$ high to data delay ¹⁶⁾	t_{CDD}	15	—	15	—	20	—	20	—	ns
$\overline{\text{OE}}$ high to data delay ¹⁶⁾	t_{ODD}	15	—	15	—	20	—	20	—	ns

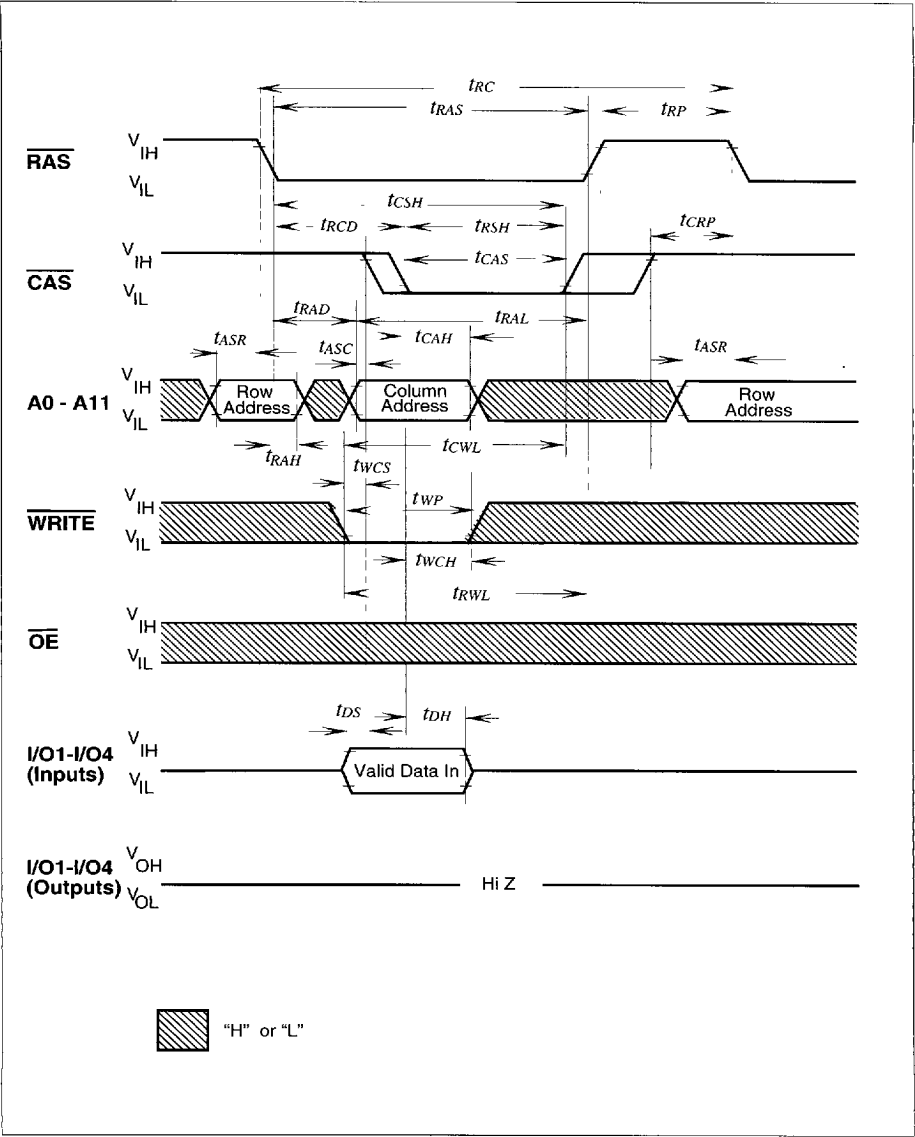
Notes see page 205.

Capacitance $T_A = 0$ to 25°C , $V_{CC} = 5\text{ V} \pm 10\%$, $f = 1\text{ MHz}$

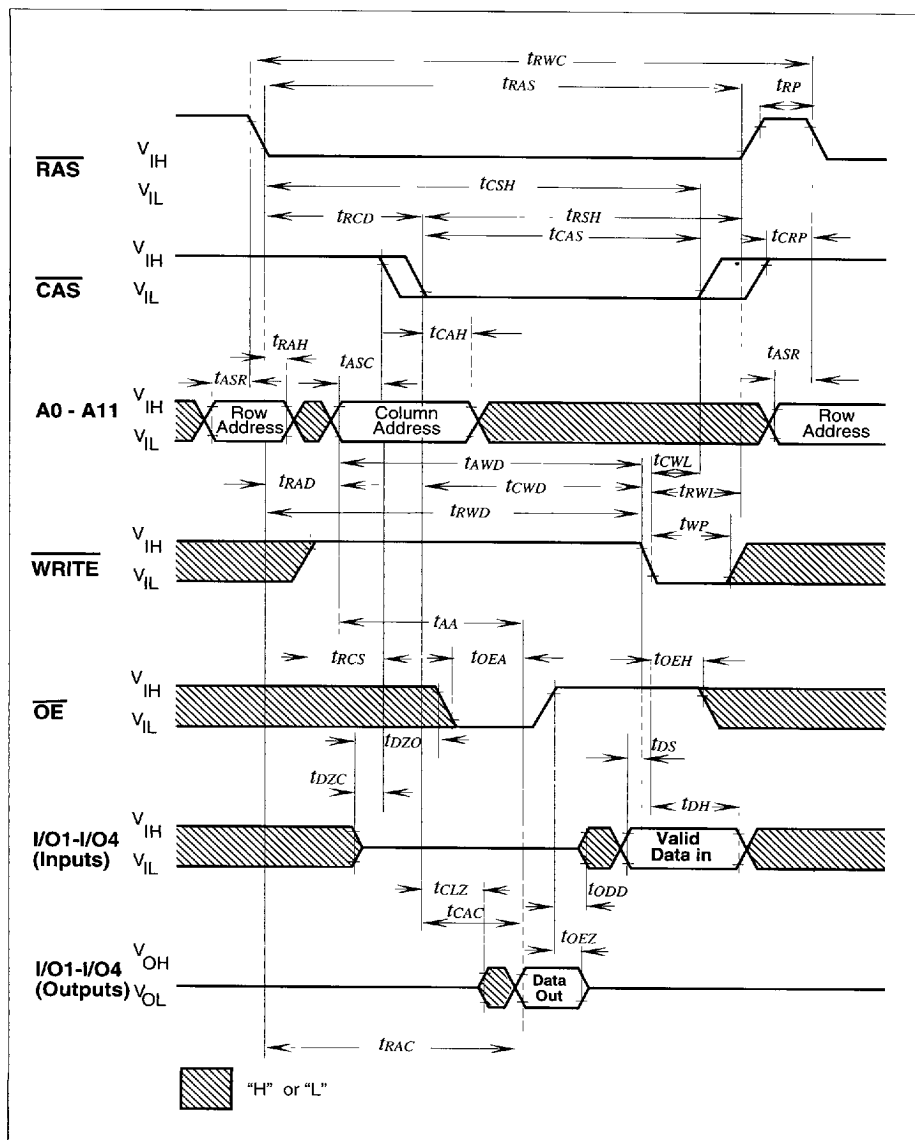
Parameter	Symbol	Limit Values		Unit
		min.	max.	
Input capacitance (A0 to A11)	C_{I1}	—	5	pF
Input capacitance ($\overline{\text{RAS}}$, $\overline{\text{CAS}}$, $\overline{\text{WRITE}}$, $\overline{\text{OE}}$)	C_{I2}	—	7	pF
I/O capacitance (I/O1-I/O4)	C_{I0}	—	7	pF

Notes for pages 199 to 204:

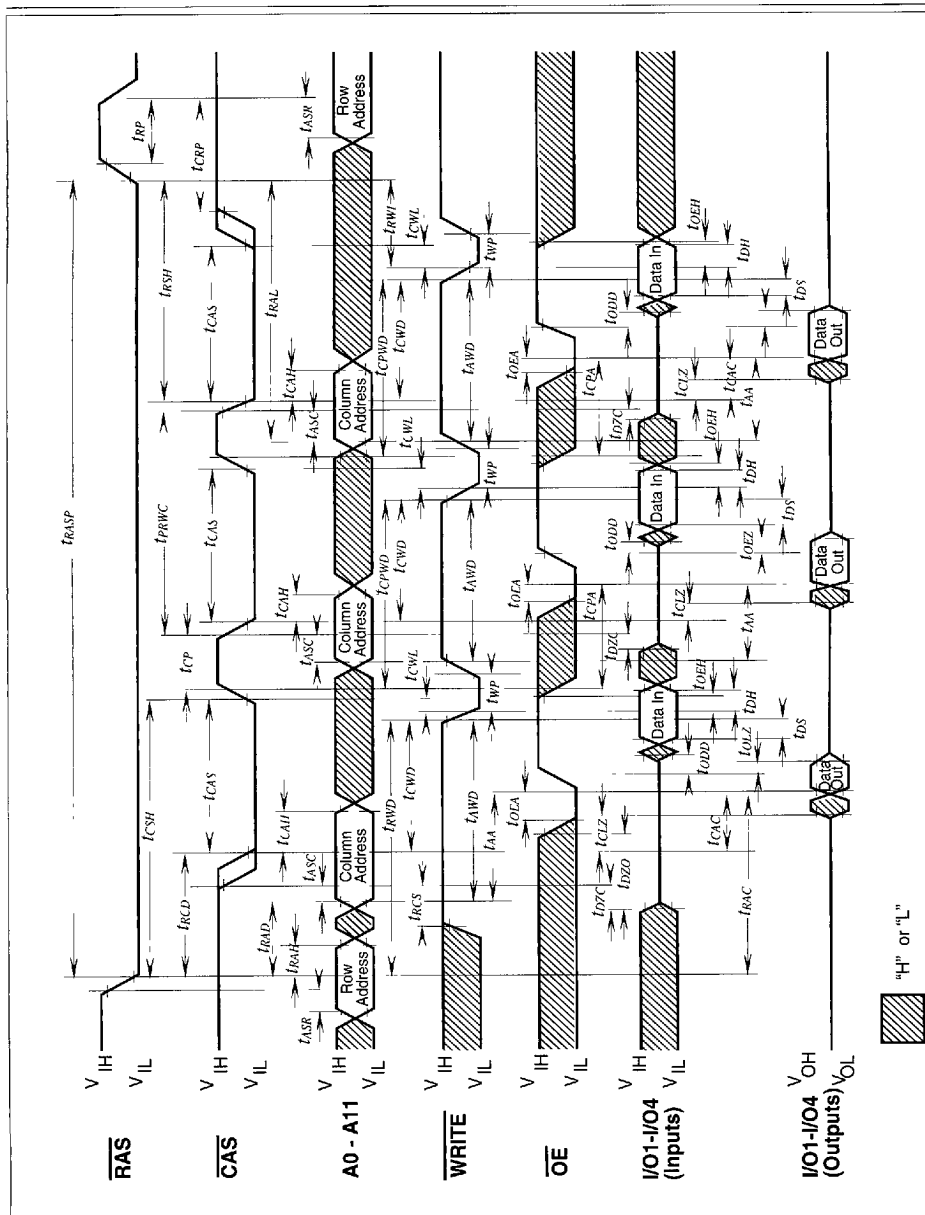
- 1) All voltages are referenced to V_{SS} .
- 2) I_{CC1} , I_{CC3} , I_{CC4} and I_{CC6} depend on cycle rate.
- 3) I_{CC1} and I_{CC4} depend on output loading. Specified values are measured with the output open.
- 4) Address can be changed once or less while $\overline{RAS} = V_{IL}$. In the case of I_{CC4} it can be changed once or less during a fast page mode cycle (t_{PC}).
- 5) An initial pause of 200 μs is required after power-up followed by 8 $\overline{RAS}$ cycles of which at least one cycle has to be a refresh cycle, before proper device operation is achieved. In case of using internal refresh counter, a minimum of 8 CAS-before- $\overline{RAS}$ initialization cycles instead of 8 $\overline{RAS}$ cycles are required.
- 6) $V_{IH} (min.)$ and $V_{IL} (max.)$ are reference levels for measuring timing of input signals. Transition times are also measured between V_{IH} and V_{IL} .
- 7) Measured with a load equivalent to 2 TTL loads and 100 pF.
- 8) $t_{OFF} (max.)$ and $t_{OEZ} (max.)$ define the time at which the outputs achieve the open-circuit condition and are not referenced to output voltage levels.
- 9) Either t_{RCH} or t_{RRH} must be satisfied for a read cycle.
- 10) These parameters are referenced to the $\overline{CAS}$ leading edge in early write cycles and to the $\overline{WRITE}$ leading edge in read-write cycles.
- 11) t_{WCS} , t_{RWD} , t_{CWD} , t_{AWD} and t_{CPWD} 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 I/O pin will remain open-circuit (high impedance) through the entire cycle; if $t_{RWD} \geq t_{RWD} (min.)$, $t_{CWD} \geq t_{CWD} (min.)$, $t_{AWD} \geq t_{AWD} (min.)$ and $t_{CPWD} \geq t_{CPWD} (min.)$, the cycle is a read-write cycle and I/O pins will contain data read from the selected cells. If neither of the above sets of conditions is satisfied, the condition of the I/O pins (at access time) is indeterminate.
- 12) Operation within the $t_{RCD} (max.)$ limit ensures 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 by t_{CAC} .
- 13) Operation within the $t_{RAD} (max.)$ limit ensures 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 by t_{AA} .
- 14) AC measurements assume $t_T = 5$ ns.
- 15) Either t_{DZC} or t_{DZO} must be satisfied.
- 16) Either t_{CDD} or t_{ODD} must be satisfied.



Write Cycle (Early Write)



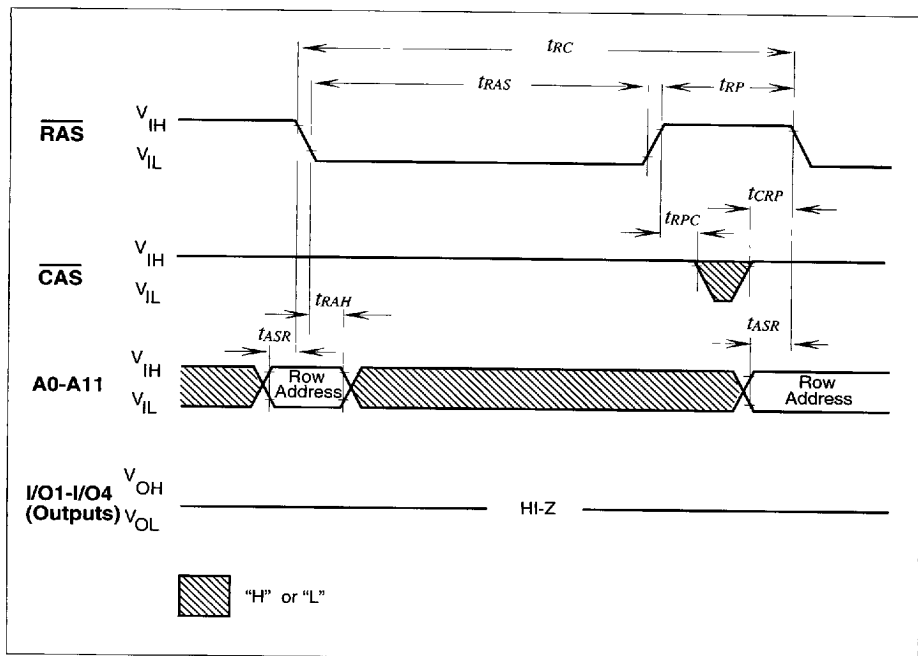
Read-Write (Read-Modify-Write) Cycle



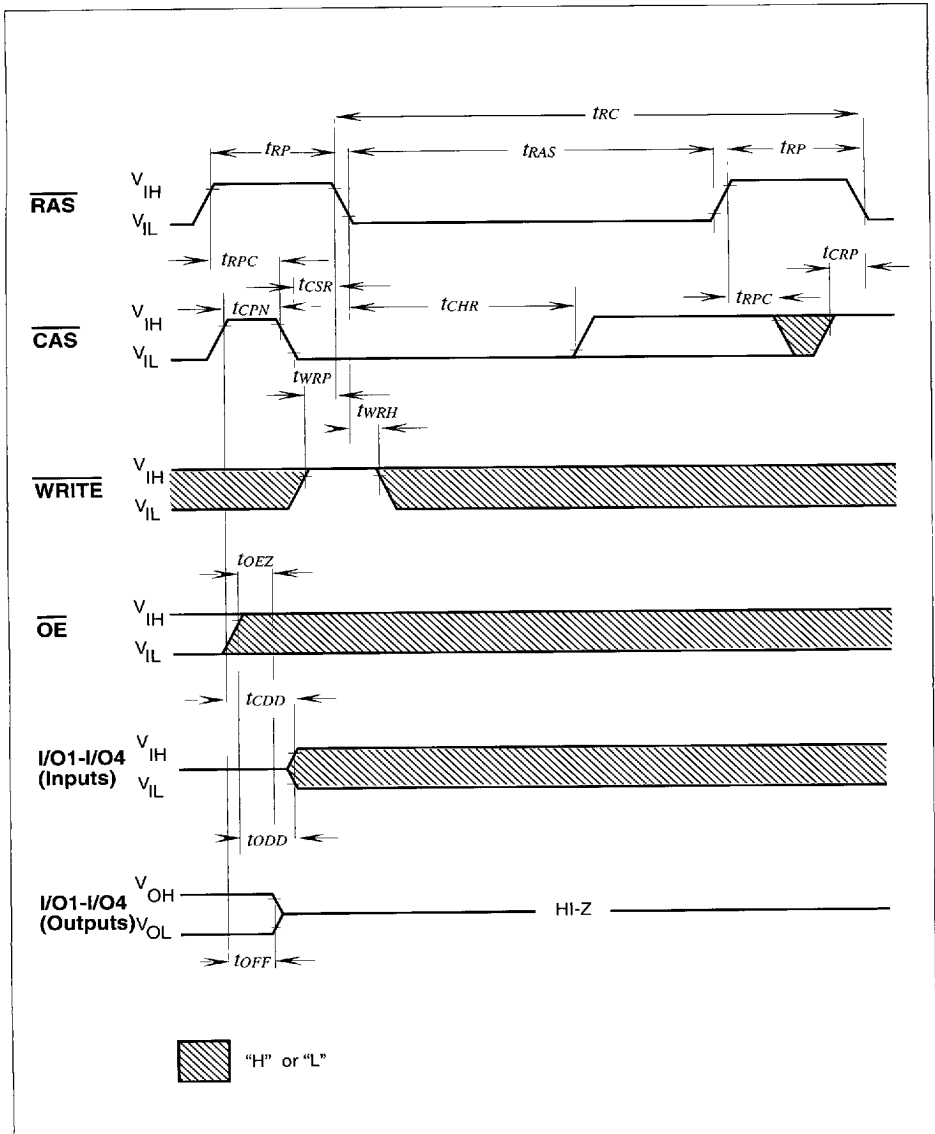
Fast Page Mode Read-Modify-Write Cycle



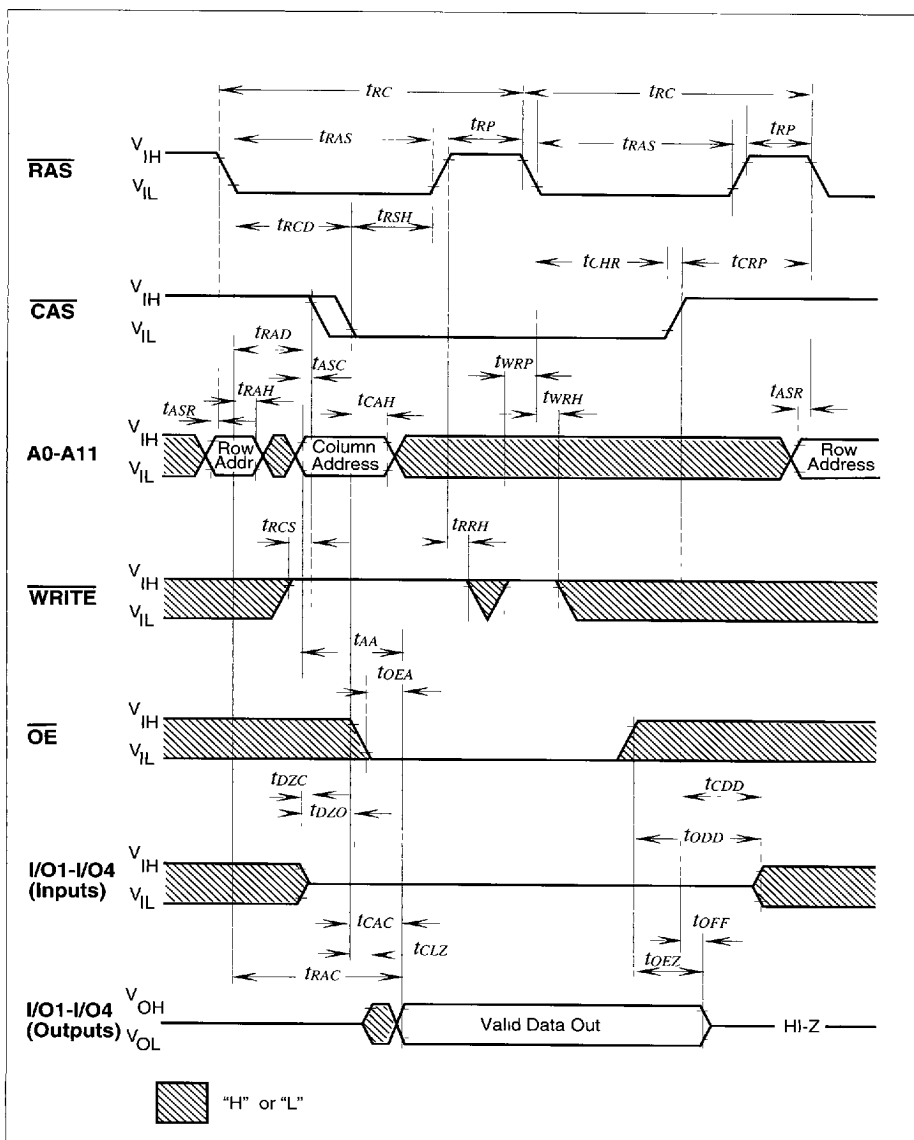




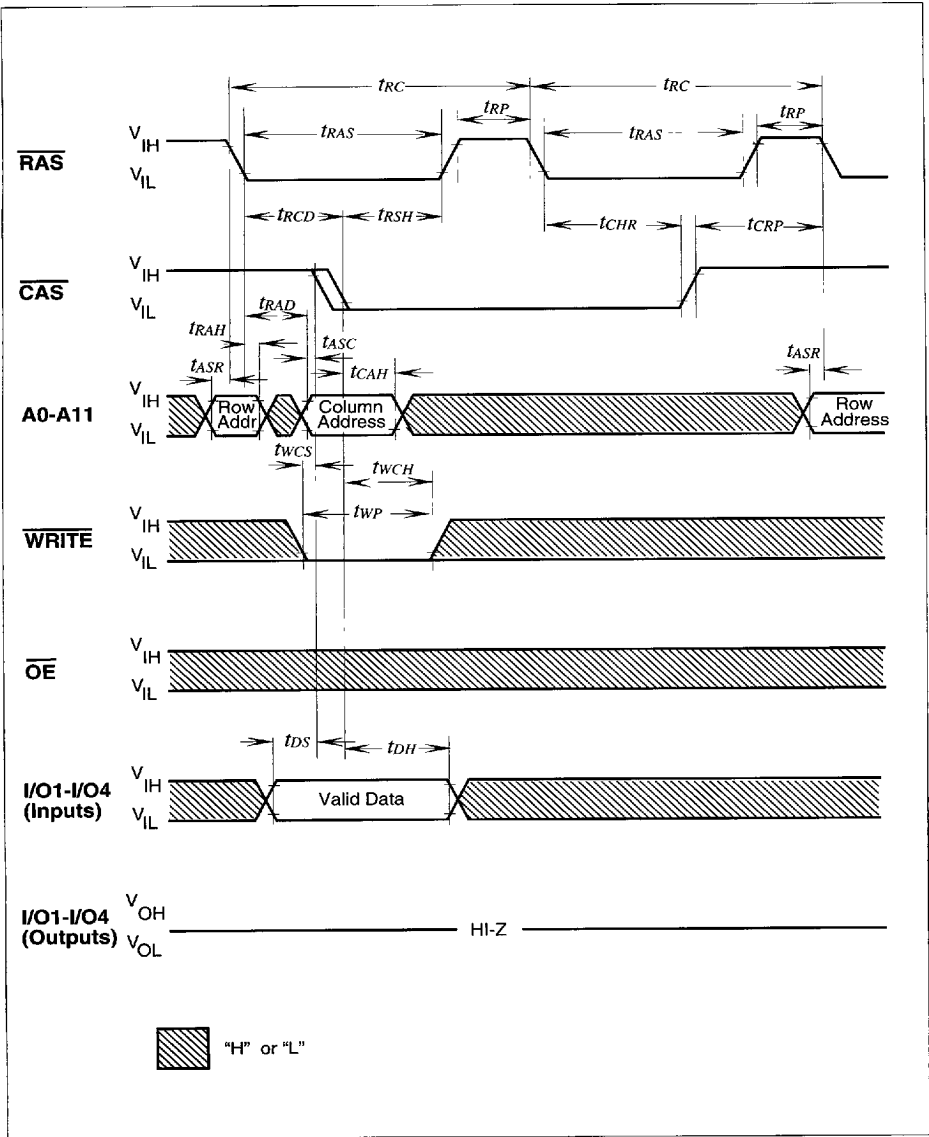
RAS-Only Refresh Cycle



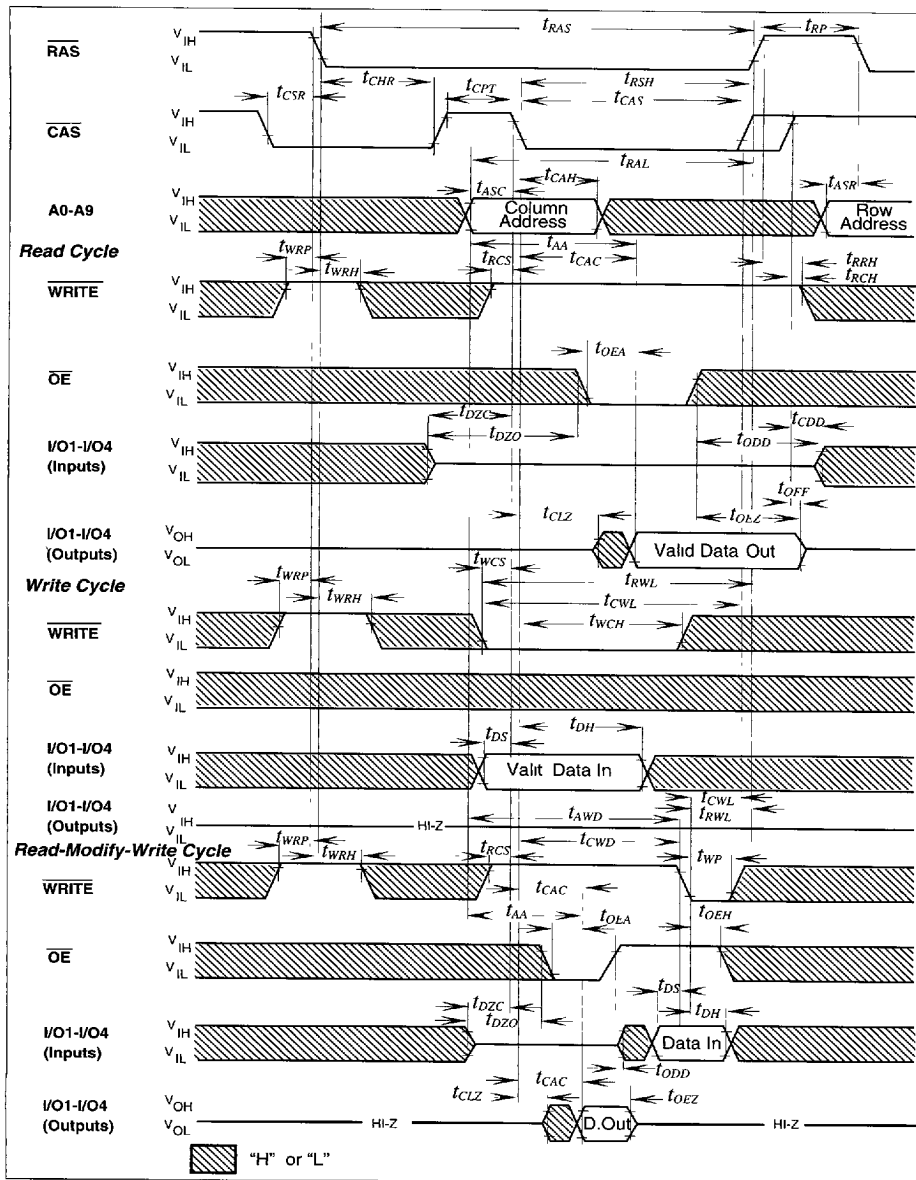
CAS-Before-RAS Refresh Cycle



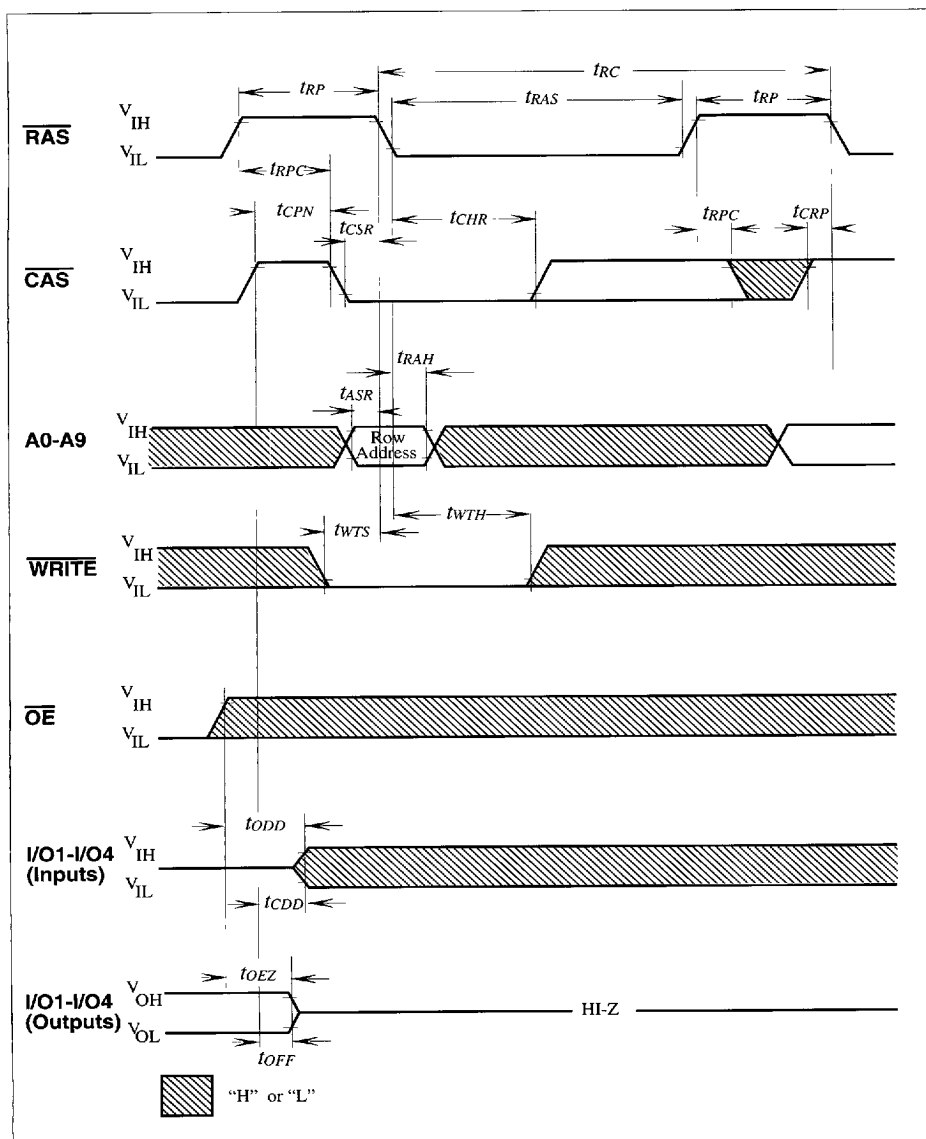
Hidden Refresh Cycle (Read)



Hidden Refresh Cycle (Early Write)



CAS-Before-RAS Refresh Counter Test Cycle



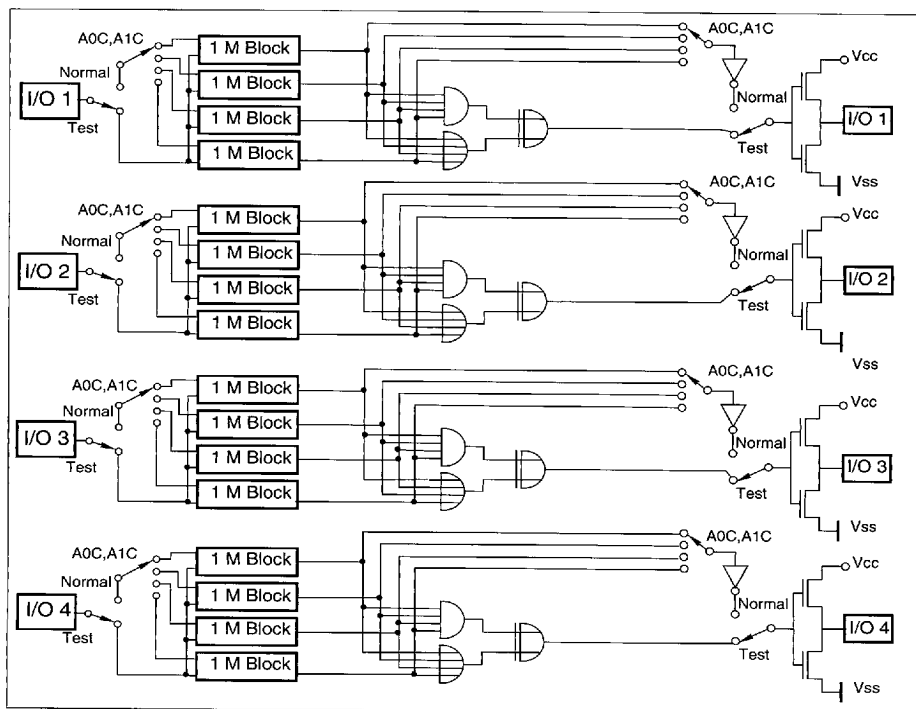
Test Mode Entry

Test Mode

As the HYB 5116400AJ/ASJ is organized internally as 1M x 16-bits, a test mode cycle using 4:1 compression can be used to improve test time. Note that in the 4M x 4 version the test time is reduced by 1/4 for a N test pattern.

In a test mode "write" the data from each I/O pin is written into four 1M blocks simultaneously (all "1" s or all "0" s). In test mode "read" each I/O output is used for indicating the test mode result. If the internal four bits are equal, the I/O would indicate a "1". If they were not equal, the I/O would indicate a "0". The WCBR cycle (WRITE, CAS before RAS) puts the device into test mode. To exit from test mode, a "CAS before RAS refresh", "RAS only refresh" or "Hidden refresh" can be used. Refresh during test mode operation can be performed by normal read cycles or by WCBR refresh cycles.

Row addresses A0 through A9 have to be kept high to perform a testmode entry cycle. All other addresses are don't care.



Block Diagram in Test Mode