

ABSOLUTE MAXIMUM RATINGS

SYMBOL	PARAMETER	RATING	UNIT
TA	Ambient Temperature	0 to 70	°C
TSTG	Storage Temperature	-55 to 125	°C
VIN, VOUT	Voltage on Any Pin Relative to VSS	-0.5 to 4.6	V
VCC	Voltage on Vcc Relative to Vss	-0.5 to 4.6	V
Ios	Short Circuit Output Current	20	mA
Pd	Power Dissipation	0.41	W
TSOLDER	Soldering Temperature• Time	260• 10	°C•sec

NOTE : Operation at or above Absolute Maximum Ratings can adversely affect device reliability.

RECOMMENDED DC OPERATING CONDITIONS

(TA= 0°C to 70°C)

SYMBOL	PARAMETER	MIN.	TYP.	MAX.	UNIT
Vcc	Power Supply Voltage	3.0	3.3	3.6	V
VIH	Input High Voltage	2.0	-	Vcc+ 0.3	V
VIL	Input Low Voltage	-0.3	-	0.8	V

NOTE : All voltages are referenced to Vss.

DC CHARACTERISTICS

(TA= 0°C to 70°C, VCC= 3.3V± 10%, VSS= 0V, unless otherwise noted.)

SYMBOL	PARAMETER	TEST CONDITIONS	SPEED /POWER	MIN.	MAX.	UNIT	NOTE
ILI	Input Leakage Current (Any Input Pins)	$V_{SS} \leq V_{IN} \leq V_{CC} + 1.0$, All other pins not under test= V_{SS}		-10	10	μA	
ILO	Output Leakage Current (High Impedance State)	$V_{SS} \leq V_{OUT} \leq V_{CC}$, RAS & CAS at V_{IH}		-10	10	μA	
ICC1	Vcc Supply Current, Operating	trC= trC (min.)	60	-	90	mA	1,2,3
			70	-	80		
			80	-	70		
ICC2	Vcc Supply Current, TTL Standby	RAS & CAS at V_{IH} , other inputs $\geq V_{SS}$		-	1	mA	
ICC3	Vcc Supply Current, RAS-only refresh	trC= trC (min.)	60	-	90	mA	1,3
			70	-	80		
			80	-	70		
ICC4	Vcc Supply Current, Fast Page mode	tPC= tPC (min.)	60	-	70	mA	1,2,3
			70	-	60		
			80	-	50		
ICC5	Vcc Supply Current, CMOS Standby	RAS & CAS $\geq V_{CC} - 0.2V$	SL-part	-	1	mA	5
				-	0.5		
ICC6	Vcc Supply Current, CAS-before-RAS refresh	trC= trC (min.)	60	-	90	mA	1,3
			70	-	80		
			80	-	70		
ICC7	Vcc Supply Current, Battery Back Up (SL-part only)	trC= 62.5 μs , CAS= CBR cycling or 0.2V, OE & WB/WE= $V_{CC} - 0.2V$, A0-A11= $V_{CC} - 0.2V$ or 0.2V, W/DQ0-W/DQ3= 0.2V, $V_{CC} - 0.2V$, or open	trAS \leq 300ns	-	350	μA	1,4,5
			trAS \leq 1 μs	-	600		
ICC8	Vcc Supply Current, Self refresh (SL-part only)	RAS & CAS $\leq 0.2V$ OE & WB/WE & A0-A11= $V_{CC} - 0.2V$ or 0.2V W/DQ0-W/DQ3= 0.2V, $V_{CC} - 0.2V$ or open			300	μA	5
VOL	Output Low Voltage	IOL= 2mA		-	0.4	V	
VOH	Output High Voltage	IOH= -2mA		2.4	-	V	

NOTE :

1. ICC1, ICC3, ICC4, ICC6 and ICC7 depend on cycle rate.
2. ICC1 and ICC4 depend on output loading. Specified values are obtained with the output open.
3. It depends on user whether column address is changed or not at least once while RAS= V_{IL} and CAS= V_{IH} .
4. trAS(max.)= 1 μs is only applied to refresh of battery backup but trAS(max.)= 10 μs is applied to normal functional operating.
5. ICC8(max.)= 0.2mA and ICC7 are applied to SL-part only (HY51V16410ASLJ, HY51V16410ASLT and HY51V16410ASLR).

AC CHARACTERISTICS

(TA= 0°C to 70°C, VCC= 3.3V± 10%, VSS = 0V, unless otherwise noted.) NOTE : 1, 2, 3

#	SYMBOL	PARAMETER	HY51V16410AJ/T/R/SLJ/SLT/SLR						UNIT	NOTE
			-60		-70		-80			
			MIN.	MAX.	MIN.	MAX.	MIN.	MAX.		
1	tRC	Random Read or Write Cycle Time	100	-	130	-	150	-	ns	
2	tRWC	Read-Modify-Write Cycle Time	160	-	180	-	200	-	ns	
3	tPC	Fast Page Mode Cycle Time	40	-	45	-	50	-	ns	
4	tPRWC	Fast Page Mode Read-Modify-Write Cycle Time	85	-	90	-	100	-	ns	
5	tRAC	Access Time from RAS	-	60	-	70	-	80	ns	4,9,10
6	tCAC	Access Time from CAS	-	15	-	18	-	20	ns	4,9
7	tAA	Access Time from Column Address	-	25	-	30	-	35	ns	4,10
8	tCPA	Access Time from CAS Precharge	-	35	-	40	-	45	ns	4
9	tCLZ	CAS to Output Low Impedance	0	-	0	-	0	-	ns	4
10	tOFF	Output Buffer Turn-off Delay	0	13	0	15	0	15	ns	
11	tT	Transition Time (Rise and Fall)	3	50	3	50	3	50	ns	3
12	tRP	RAS Precharge Time	40	-	50	-	60	-	ns	
13	tRAS	RAS Pulse Width	60	10K	70	10K	80	10K	ns	
14	tRASp	RAS Pulse Width (Fast Page Mode)	60	200K	70	200K	80	200K	ns	
15	tRSH	RAS Hold Time	15	-	18	-	20	-	ns	
16	tCSH	CAS Hold Time	60	-	70	-	80	-	ns	
17	tCAS	CAS Pulse Width	15	10K	18	10K	20	10K	ns	
18	tRCD	RAS to CAS Delay	20	45	20	52	20	60	ns	9
19	tRAD	RAS to Column Address Delay Time	15	30	15	35	17	40	ns	10
20	tCRP	CAS to RAS Precharge Time	5	-	5	-	5	-	ns	
21	tCP	CAS Precharge Time	10	-	10	-	10	-	ns	
22	tASR	Row Address Set-up Time	0	-	0	-	0	-	ns	
23	tRAH	Row Address Hold Time	10	-	10	-	12	-	ns	
24	tASC	Column Address Set-up Time	0	-	0	-	0	-	ns	
25	tCAH	Column Address Hold Time	10	-	10	-	15	-	ns	
26	tAR	Column Address Hold Time from RAS	50	-	50	-	55	-	ns	
27	tRAL	Column Address to RAS Lead Time	30	-	35	-	40	-	ns	
28	tRCS	Read Command Set-up Time	0	-	0	-	0	-	ns	
29	tRCH	Read Command Hold Time Referenced to CAS	0	-	0	-	0	-	ns	6
30	tRRH	Read Command Hold Time Referenced to RAS	0	-	0	-	0	-	ns	6
31	tWCH	Write Command Hold Time	10	-	10	-	15	-	ns	
32	tWCR	Write Command Hold Time from RAS	45	-	55	-	60	-	ns	
33	tWP	Write Command Pulse Width	10	-	10	-	15	-	ns	
34	tRWL	Write Command to RAS Lead Time	15	-	18	-	20	-	ns	
35	tCWL	Write Command to CAS Lead Time	15	-	18	-	20	-	ns	
36	tDS	Data-In Set-up Time	0	-	0	-	0	-	ns	7
37	tDH	Data-In Hold Time	10	-	10	-	10	-	ns	7
38	tDHR	Data-In Hold Time Referenced to RAS	50	-	50	-	55	-	ns	
39	tREF	Refresh Period (2048 cycles)	-	64	-	64	-	64	ms	12
		SL-part	-	256	-	256	-	256		11
40	tWCS	Write Command Set-up Time	0	-	0	-	0	-	ns	8

AC CHARACTERISTICS

(continued)

#	SYMBOL	PARAMETER	HY51V16410AJ/T/R/SLJ/SLT/SLR						UNIT	NOTE
			-60		-70		-80			
			MIN.	MAX.	MIN.	MAX.	MIN.	MAX.		
41	tCWD	CAS to WE Delay Time	38	-	43	-	45	-	ns	8
42	tRWD	RAS to WE Delay Time	83	-	95	-	105	-	ns	8
43	tAWD	Column Address to WE Delay Time	53	-	60	-	65	-	ns	8
44	tCSR	CAS Set-up Time (CBR Cycle)	5	-	5	-	5	-	ns	
45	tCHR	CAS Hold Time (CBR Cycle)	10	-	10	-	10	-	ns	
46	tRPC	RAS to CAS Precharge Time	0	-	0	-	0	-	ns	
47	tCPT	CAS Precharge Time (CBR Counter Test)	20	-	25	-	25	-	ns	
48	tROH	RAS Hold Time Reference to OE	0	-	0	-	0	-	ns	
49	tOEA	OE Access Time	-	15	-	18	-	20	ns	
50	tOED	OE to Data Delay	15	-	15	-	15	-	ns	
51	tOEZ	Output Buffer Turn Off Delay Time	0	13	0	15	0	15	ns	
52	tOEH	OE Command Hold Time	10	-	10	-	10	-	ns	
53	tCPWD	WE Delay Time from CAS Precharge	35	-	40	-	45	-	ns	8
54	tRHCP	RAS Hold Time from CAS Precharge	35	-	40	-	45	-	ns	
55	tWRP	WE to RAS Precharge Time (CBR Cycle)	10	-	10	-	10	-	ns	
56	tWRH	WE to RAS Hold Time (CBR Cycle)	10	-	10	-	10	-	ns	
57	tWTS	Write Command Set-up Time (Test Mode In)	10	-	10	-	10	-	ns	
58	tWTH	Write Command Hold Time (Test Mode In)	10	-	10	-	10	-	ns	
59	twBS	Write-Per-Bit Set-up Time (Test Mode In)	0		0		0		ns	
60	twBH	Write-Per-Bit Hold Time (Test Mode In)	10		10		10		ns	
61	twDS	Write-Per-Bit Selection Set-up Time (Test Mode In)	0		0		0		ns	
62	twDH	Write-Per-Bit Selection Hold Time (Test Mode In)	10		10		10		ns	
63	tRASS	RAS Pulse Width (Self Refresh Cycle)	100	-	100	-	100	-	μs	
64	tRPS	RAS Precharge Time (Self Refresh Cycle)	90	-	110	-	130	-	ns	
65	tCHS	CAS Hold Time (Self Refresh Cycle)	-50	-	-50	-	-50	-	ns	

AC CHARACTERISTICS IN TEST MODE NOTE 13

#	SYMBOL	PARAMETER	HY51V16410AJ/T/R/SLJ/SLT/SLR						UNIT	NOTE
			-80		-70		-80			
			MIN.	MAX.	MIN.	MAX.	MIN.	MAX.		
1	tRC	Random Read or Write Cycle Time	105	-	135	-	155	-	ns	
2	tRWC	Read-Modify-Write Cycle Time	165	-	185	-	205	-	ns	
3	tPC	Fast Page Mode Cycle Time	45	-	50	-	55	-	ns	
4	tPRWC	Fast Page Mode Read-Modify-Write Cycle Time	90	-	95	-	105	-	ns	
5	tRAC	Access Time from RAS	-	65	-	75	-	85	ns	4,9,10
6	tCAC	Access Time from CAS	-	20	-	23	-	25	ns	4,9
7	tAA	Access Time from Column Address	-	30	-	35	-	40	ns	4,10
8	tCPA	Access Time from CAS Precharge	-	40	-	45	-	50	ns	4
13	tRAS	RAS Pulse Width	65	10K	75	10K	85	10K	ns	
14	tRASP	RAS Pulse Width (Fast Page Mode)	65	200K	75	200K	85	200K	ns	
15	tRSH	RAS Hold Time	20	-	23	-	25	-	ns	
16	tCSH	CAS Hold Time	65	-	75	-	85	-	ns	
17	tCAS	CAS Pulse Width	20	10K	23	10K	25	10K	ns	
27	tRAL	Column Address to RAS Lead Time	35	-	40	-	45	-	ns	
41	tCWD	CAS to WE Delay Time	43	-	48	-	50	-	ns	8
42	tRWD	RAS to WE Delay Time	88	-	100	-	110	-	ns	8
43	tAWD	Column Address to WE Delay Time	58	-	65	-	70	-	ns	8
49	tOEA	OE Access Time	-	20	-	23	-	25	ns	
50	tOED	OE to Data Delay	20	-	20	-	20	-	ns	
52	tOEH	OE Command Hold Time	15	-	15	-	15	-	ns	

NOTE :

1. An initial pause of 200 μ s is required after power-up followed by any 8 $\overline{\text{RAS}}$ only or $\overline{\text{CAS}}$ -before- $\overline{\text{RAS}}$ refresh cycle before proper device operation is achieved.
2. If $\overline{\text{RAS}}=\text{Vss}$ during power-up, the HY51V16410A could begin an active cycle. These condition results in higher current than necessary which is demanded from the power supply during power-up. It is recommended that $\overline{\text{RAS}}$ and $\overline{\text{CAS}}$ track with Vcc during power-up or be held at a valid Vih in order to minimize the power-up current
3. $\text{Vih}(\text{min.})$ and $\text{Vil}(\text{max.})$ are reference levels for measuring timing of input signals. Also, transition times are measured between $\text{Vih}(\text{min.})$ and $\text{Vil}(\text{max.})$, and are assumed to be 5ns for all inputs.
4. Measured at $\text{Voh}=2.0\text{V}$ and $\text{Vol}=0.8\text{V}$ with a load equivalent to 2 TTL loads and 100pF.
5. $\text{toff}(\text{max.})$ and toez define the time at which the output achieves the open circuit condition and is not referenced to output voltage levels.
6. Either trch or trrh must be satisfied for a read cycle.
7. These parameters are referenced to $\overline{\text{CAS}}$ leading edge in early write cycles and to $\overline{\text{WB/WE}}$ leading edge in Read-Modify-Write cycles.
8. twcs , trwd , tcwd , tawd and tcpwd are not restrictive operating parameters. They are included in the data sheet as electrical characteristics only. If $\text{twcstwcs}(\text{min.})$, the cycle is an early write cycle and data out pin will remain open circuit (high impedance) through the entire cycle. If $\text{trwdtrwd}(\text{min.})$, $\text{tcwdtcwd}(\text{min.})$, $\text{tawdtawd}(\text{min.})$, and $\text{tcpwdtcpwd}(\text{min.})$, the cycle is a Read-Modify-Write cycle and data out 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 indetermined.
9. Operation within the $\text{trcd}(\text{max.})$ limit insures that $\text{trac}(\text{max.})$ can be met. $\text{trcd}(\text{max.})$ is specified as a reference point only. If trcd is greater than the specified $\text{trcd}(\text{max.})$ limit, then access time is controlled by tcac .
10. Operation within the $\text{trad}(\text{max.})$ limit insures that $\text{trac}(\text{max.})$ can be met. $\text{trad}(\text{max.})$ is specified as a reference point only. If trad is greater than the specified $\text{trad}(\text{max.})$ limit, then access time is controlled by taa .
11. $\text{tref}(\text{max.})=256\text{ms}$ is applied to SL-Parts (HY51V16410ASLJ, HY51V16410ASLT and HY51V16410ASLR).
12. A burst of 4096 $\overline{\text{CAS}}$ -before- $\overline{\text{RAS}}$ refresh cycles must be executed within 64ms(256ms for SL-part) after exiting self refresh.
13. These specifications are applied to the Test Mode.

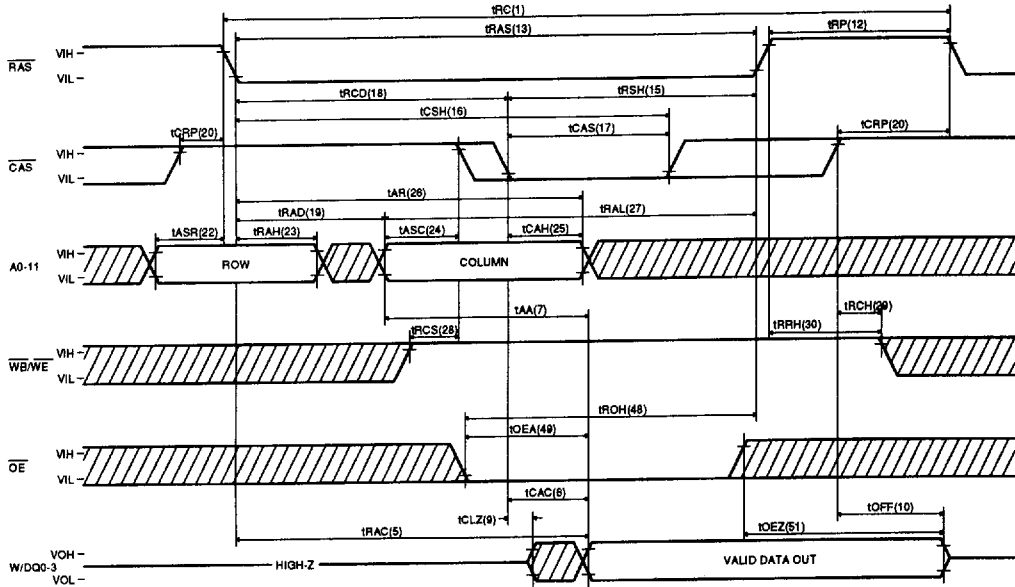
CAPACITANCE

($\text{Ta}=25^\circ\text{C}$, $\text{Vcc}=5\text{V}$ 10%, $\text{Vss}=0\text{V}$, $f=1\text{MHz}$, unless otherwise noted.)

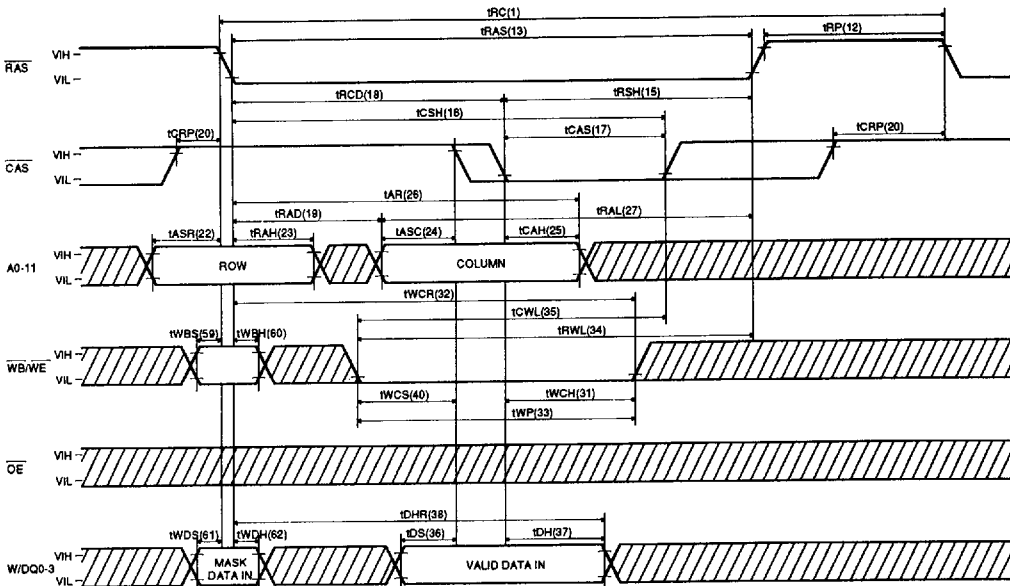
SYMBOL	PARAMETER	TYP.	MAX.	UNIT
CIN1	Input Capacitance (A0-A11)	-	5	pF
CIN2	Input Capacitance ($\overline{\text{RAS}}$, $\overline{\text{CAS}}$, $\overline{\text{WB/WE}}$, $\overline{\text{OE}}$)	-	7	pF
CDQ	Write Mask / Data I/O Capacitance (W/DQ0-W/DQ3)	-	7	pF

TIMING DIAGRAM

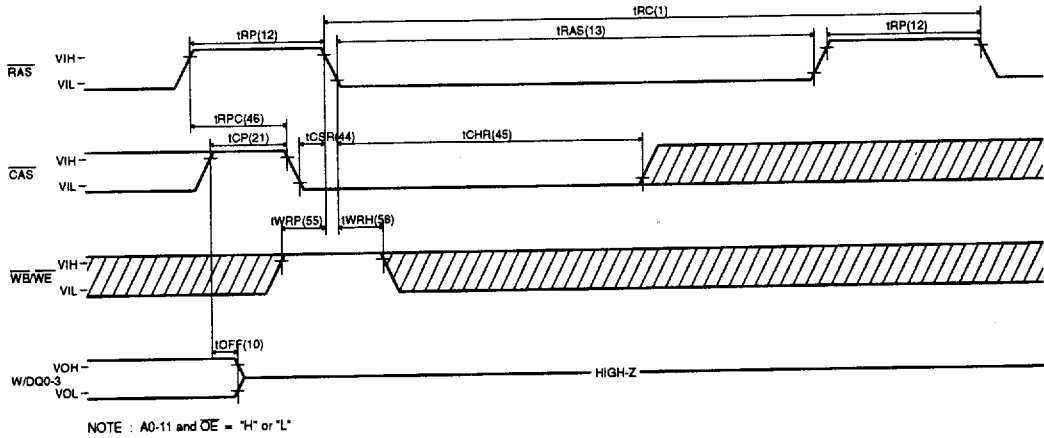
READ CYCLE



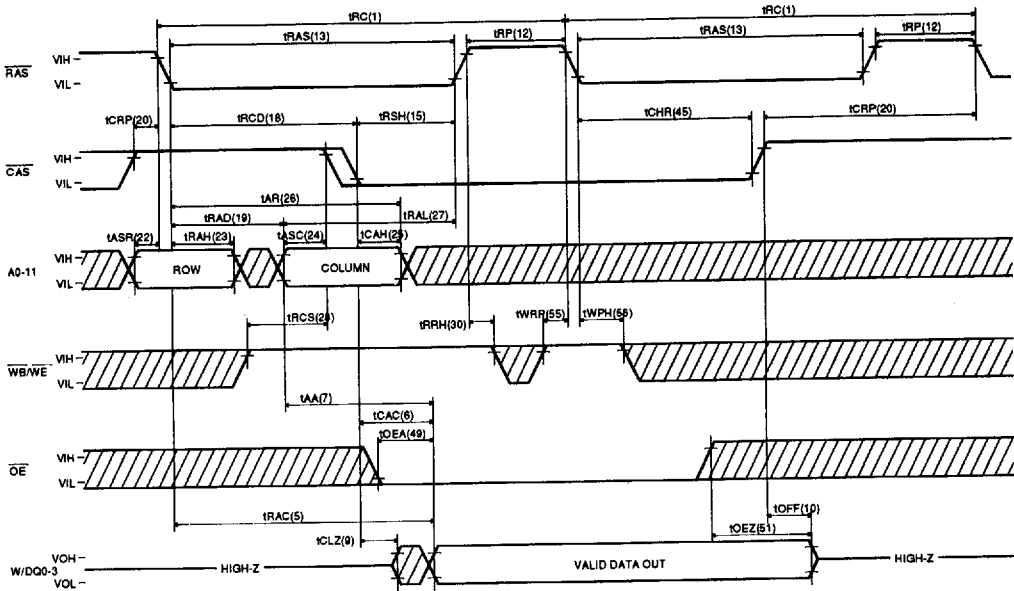
EARLY WRITE CYCLE



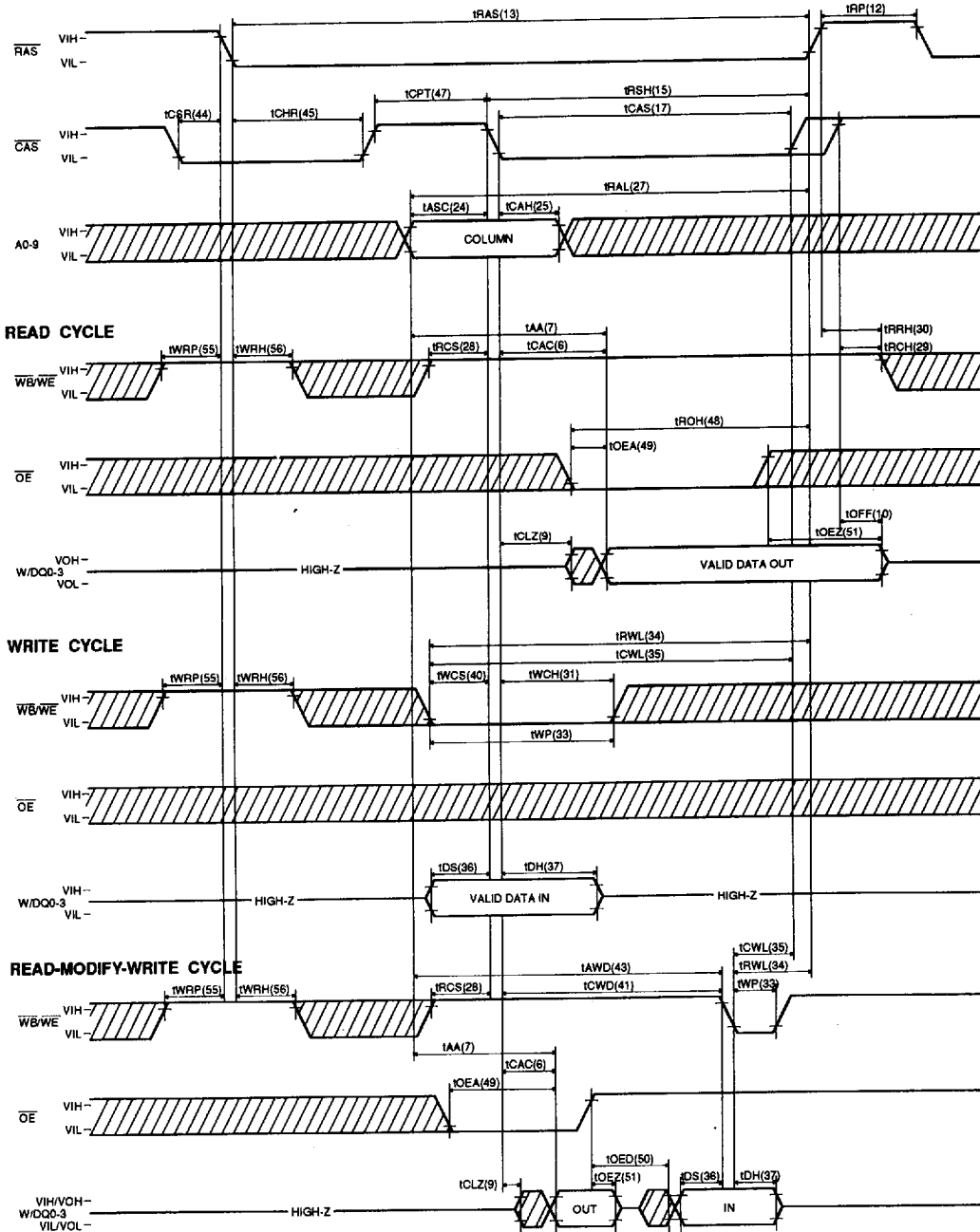
CAS-BEFORE-RAS REFRESH CYCLE



HIDDEN REFRESH CYCLE (READ)



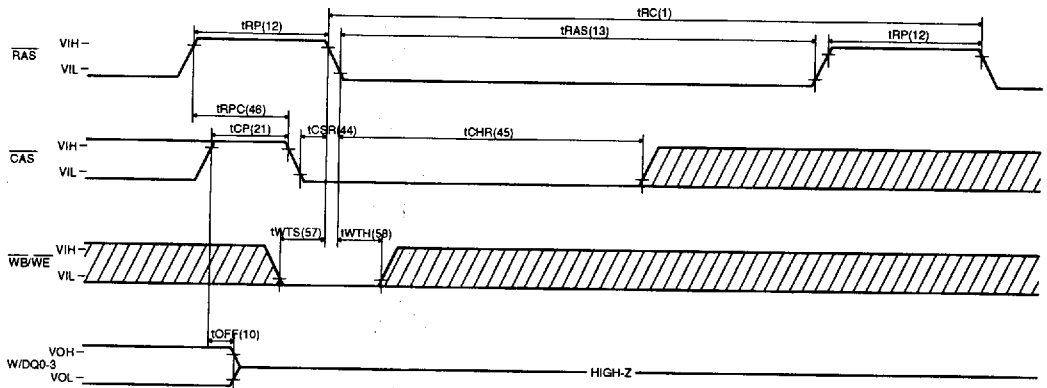
CAS-BEFORE-RAS REFRESH COUNTER TEST CYCLE



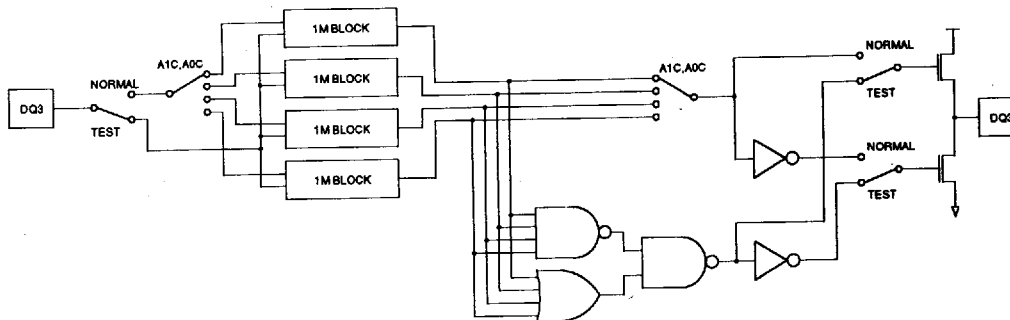
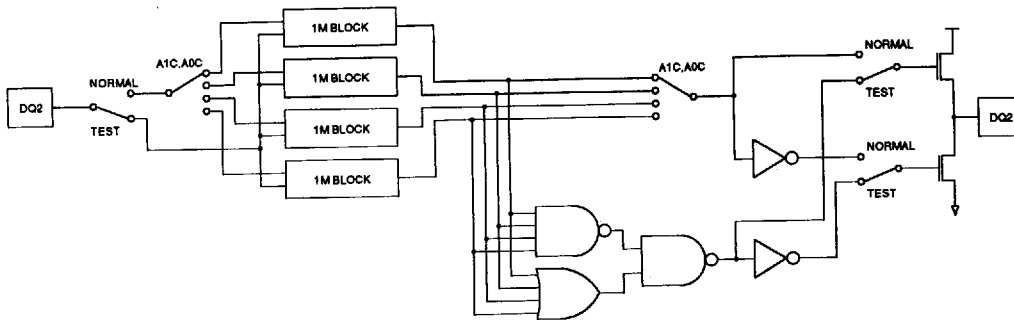
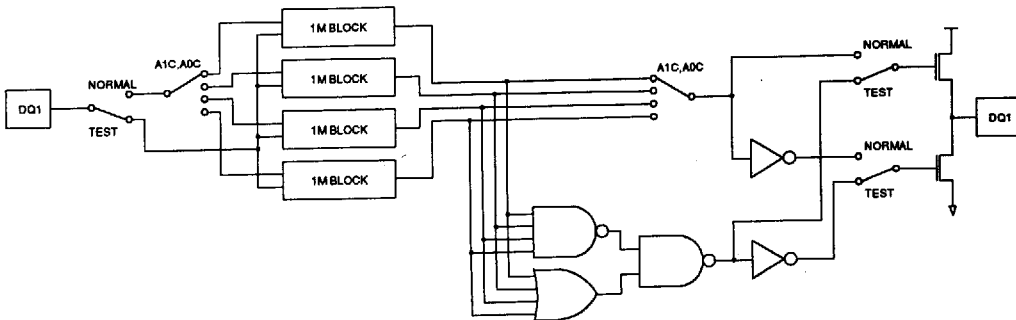
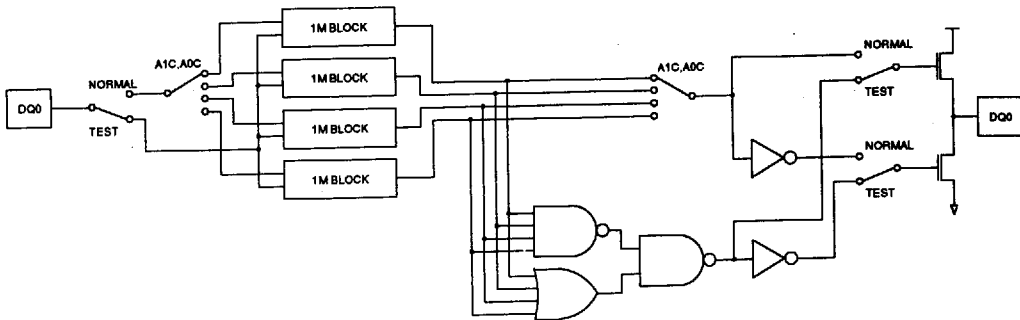
TEST MODE

The HY51V16400A is a DRAM organized 4,194,304 x 4-bit. It is internally organized 1,048,576 x 16-bit. In Test Mode, data are written into 16 sectors (Each is composed of 1M bits) in parallel and retrieved the same way. Column address A0 and A1 are not used. If, upon reading, 4-bit data from 4 sectors connected to one DQ pin are equal (all "1"s or "0"s), the DQ pin indicates a "1". If they are not equal, the DQ pin indicates a "0". Belowing shows the timing diagram of the HY51V16400A to enter Test Mode. In Test Mode, the 4Mx4 DRAM can be tested as if it were a 1Mx4 DRAM. WE, CAS-before-RAS cycle (Test Mode In Cycle) puts the HY51V16400A into Test Mode and CAS-before-RAS or RAS-only refresh cycle puts it back into Normal Mode. In Test Mode, WE, CAS-before-RAS cycle shall be used for the refresh operation. The Test Mode function reduces test time (1/4 in case of N test pattern).

TEST MODE IN CYCLE

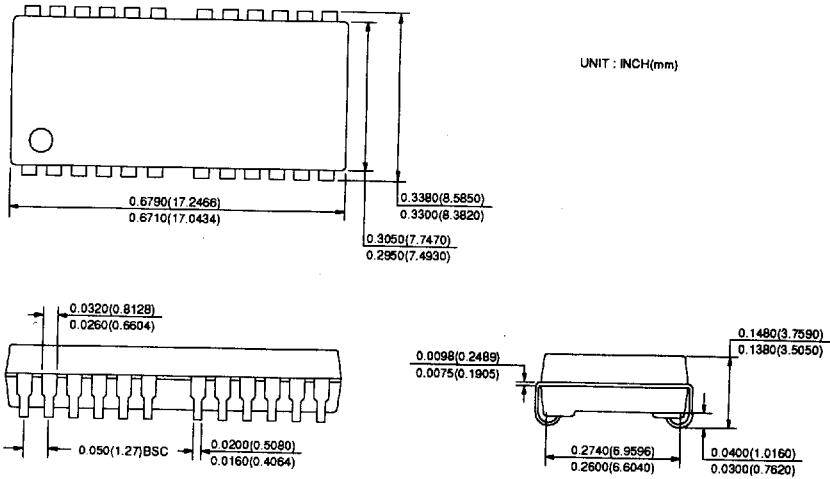


BLOCK DIAGRAM IN TEST MODE

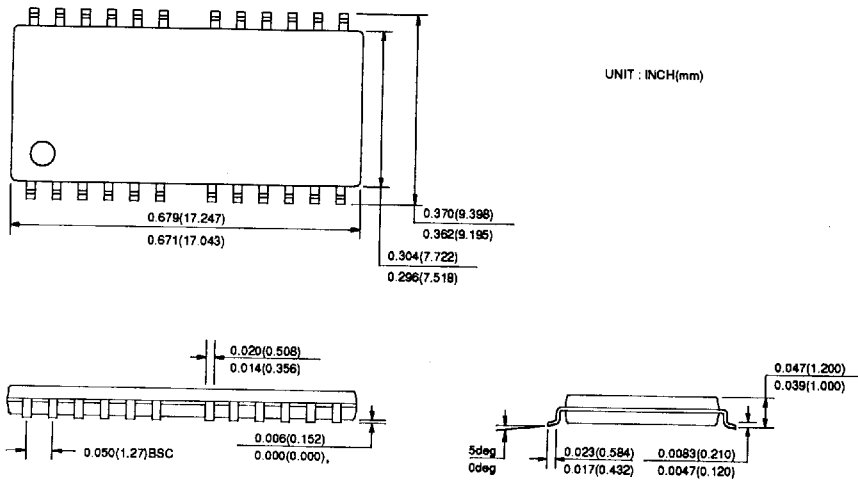


PACKAGE INFORMATION

300 mil 24/28 pin Small Outline J-form Package (J)



300 mil 24/28 pin Thin Small Outline Package (T) (R)



ORDERING INFORMATION

PART NO	SPEED	POWER	PACKAGE
HY51V16410AJC	60/70/80		SOJ
HY51V16410ASLJC	60/70/80	SL-part	SOJ
HY51V16410ATC	60/70/80		TSOP-II
HY51V16410ASLTC	60/70/80	SL-part	TSOP-II
HY51V16410ARC	60/70/80		TSOP-II(R)
HY51V16410ASLRC	60/70/80	SL-part	TSOP-II(R)