

**DESCRIPTION**

The HYM591600 is a 16M x 9-bit Fast page mode CMOS DRAM module consisting of nine HY5116100 in 24/28 pin SOJ or TSOP-II on a 30 pin glass-epoxy printed circuit board. 0.22 $\mu$ F decoupling capacitor is mounted for each DRAM.

The HYM591600M/LM/TM/LTM are Tin-Lead plated socket type Single In-line Memory Modules suitable for easy interchange and addition of 16M byte memory.

**FEATURES**

- Low power dissipation

Max. battery back-up 29.7mW (L-part)

Max. CMOS standby 19.8mW (L-part)

49.5mW

Max. TTL standby 99.0mW

Max. operating

Speed	Power
60	4.46W
70	3.96W
80	3.47W

- Single power supply of 5V  $\pm$  10%

- TTL compatible inputs and outputs

- Fast access time

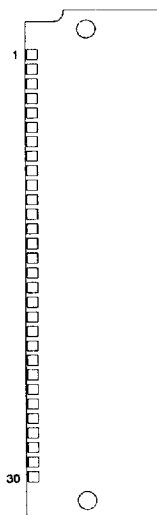
Speed	tRAC	tCAC	tPC
60	60ns	15ns	40ns
70	70ns	18ns	45ns
80	80ns	20ns	50ns

- Fast page mode operation

- CAS-before-RAS, RAS-only, Hidden refresh

- 4096 refresh cycles / 256ms (L-part)

4096 refresh cycles / 64ms

**PIN CONNECTION****PIN DESCRIPTION**

RAS	Row Address Strobe
CAS	Column Address Strobe
PCAS	CAS for Parity
WE	Write Enable
A0-A11	Address Input
DQ0-DQ7	Data Input/Output
PD	Data In for Parity
PQ	Data Out for Parity
VCC	Power (+5V)
VSS	Ground

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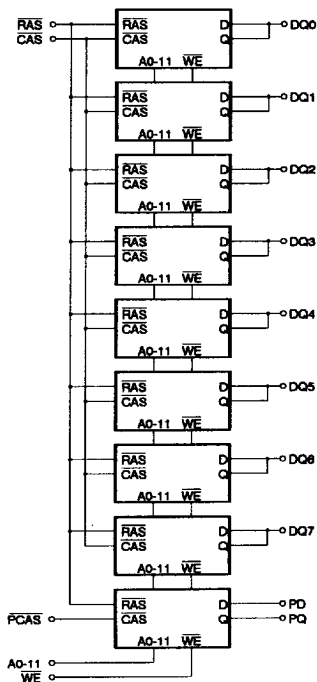
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**PIN NAME**

#	NAME
1	VCC
2	CAS
3	DQ0
4	A0
5	A1
6	DQ1
7	A2
8	A3
9	VSS
10	DQ2
11	A4
12	A5
13	DQ3
14	A6
15	A7
16	DQ4
17	A8
18	A9
19	A10
20	DQ5
21	WE
22	VSS
23	DQ6
24	A11
25	DQ7
26	PQ
27	RAS
28	PCAS
29	PD
30	VCC

**BLOCK DIAGRAM**



**ABSOLUTE MAXIMUM RATINGS**

SYMBOL	PARAMETER	RATING	UNIT
TA	Ambient Temperature	0 to 70	°C
TSTG	Storage Temperature	-55 to 150	°C
VIN, VOUT	Voltage on Any Pin Relative to Vss	-1.0 to 7.0	V
VCC	Voltage on VCC Relative to Vss	-1.0 to 7.0	V
Ios	Short Circuit Output Current	50	mA
Pd	Power Dissipation	6.3	W

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	Supply Voltage	4.5	5.0	5.5	V
VIH	Input High Voltage	2.4	-	VCC + 1.0	V
VIL	Input Low Voltage	-1.0	-	0.8	V

NOTE : All voltages are referenced to Vss.

**DC CHARACTERISTICS**

(TA = 0°C to 70°C, VCC = 5V ± 10%, VSS = 0V, unless otherwise noted.)

SYMBOL	PARAMETER	TEST CONDITIONS	SPEED/ POWER	MIN.	MAX.	UNIT	NOTE	
ILI	Input Leakage Current (Any Input Pin)	VSS ≤ VIN ≤ VCC + 1.0, All other pins not under test = VSS		-90	90	μA		
ILO	Output Leakage Current (High Impedance State)	VSS ≤ VOUT ≤ VCC, RAS & CAS at VIH		-10	10	μA		
ICC1	VCC Supply Current, Operating	trc = trc (min.)	60	-	810	mA	1,2,3	
			70	-	720			
			80	-	630			
ICC2	VCC Supply Current, TTL Standby	RAS & CAS at VIH, other inputs ≥ VSS		-	18	mA		
ICC3	VCC Supply Current, RAS-only refresh	trc = trc (min.)	60	-	810	mA	1,3	
			70	-	720			
			80	-	630			
ICC4	VCC Supply Current, Fast Page mode	tpc = tpc (min.)	60	-	630	mA	1,2,3	
			70	-	540			
			80	-	450			
ICC5	VCC Supply Current, CMOS Standby	RAS & CAS ≥ VCC-0.2V	L-part	-	9	mA	5	
				-	3.6			
ICC6	VCC Supply Current, CAS-before-RAS refresh	trc = trc (min.)	60	-	810	mA	1,3	
			70	-	720			
			80	-	630			
ICC7	VCC Supply Current, Battery Back Up (L-part only)	trc = 62.5μs, CAS = CBR cycling or 0.2V WE = VCC-0.2V A0-A11 = VCC-0.2V or 0.2V DQ0-DQ7 = VCC-0.2V, 0.2V, or open		trās ≤ 300ns	-	3.2	mA	1,4,5
				trās ≤ 1μs	-	5.4		
VOL	Output Low Voltage	IOL = 4.2mA		-	0.4	V		
VOH	Output High Voltage	IOH = -5mA		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 = VIH and CAS = VIH.
4. Only trās(max.) = 1μs is applied to refresh of battery backup but trās(max.) = 10μs is applied to normal functional operation.
5. ICC5(max.) = 3.6mA and ICC7 are applied to L-part only (HYM591600LM and HYM591600LTM).

**AC CHARACTERISTICS**

(TA = 0°C to 70°C, VCC = 5V ± 10%, VSS = 0V, unless otherwise noted.) NOTE : 1, 2, 3

#	SYMBOL	PARAMETER	HYM591600M/LM/TM/LTM						UNIT	NOTE
			-60		-70		-80			
			MIN.	MAX.	MIN.	MAX.	MIN.	MAX.		
1	tRC	Random Read or Write Cycle Time	110	-	130	-	150	-	ns	
2	tRPC	RAS to CAS Precharge Time	0	-	0	-	0	-	ns	
3	tPC	Fast Page Mode Cycle Time	40	-	45	-	50	-	ns	
4	tRHCP	RAS Hold Time from CAS Precharge	35	-	40	-	45	-	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	-	30	-	35	-	40	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	15	0	18	0	20	ns	5
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	400K	70	400K	80	400K	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	15	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	-	10	-	ns	
24	tASC	Column Address Set-up Time	0	-	0	-	0	-	ns	
25	tCAH	Column Address Hold Time	10	-	15	-	15	-	ns	
26	tAR	Column Address Hold Time from RAS	50	-	55	-	60	-	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	-	15	-	15	-	ns	
32	tWCR	Write Command Hold Time from RAS	50	-	55	-	60	-	ns	
33	tWP	Write Command Pulse Width	10	-	15	-	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	-	15	-	15	-	ns	7
38	tDHR	Data-In Hold Time Referenced to RAS	50	-	55	-	60	-	ns	
39	tREF	Refresh Period (4096 cycles)	-	64	-	64	-	64	ms	
		L-part	-	256	-	256	-	256		11
40	tWCS	Write Command Set-up Time	0	-	0	-	0	-	ns	8

**AC CHARACTERISTICS**

(continued)

#	SYMBOL	PARAMETER	HYM591600M/LM/TM/LTM						UNIT	NOTE
			-60		-70		-80			
			MIN.	MAX.	MIN.	MAX.	MIN.	MAX.		
41	tCSR	CAS Set-up Time (CBR Cycle)	10	-	10	-	10	-	ns	
42	tCHR	CAS Hold Time (CBR Cycle)	10	-	15	-	15	-	ns	
43	tCPT	CAS Precharge Time (CBR Counter Test)	20	-	25	-	25	-	ns	
44	tWRP	WE to RAS Precharge Time (CBR Cycle)	10	-	10	-	10	-	ns	
45	tWRH	WE to RAS Hold Time (CBR Cycle)	10	-	10	-	10	-	ns	

**NOTE :**

1. An initial pause of 200 $\mu$ s is required after power-up followed by 8  $\overline{\text{RAS}}$  cycles before proper device operation is achieved. In case of using internal refresh counter, a minimum of 8  $\overline{\text{CAS}}$ -before- $\overline{\text{RAS}}$  initialization cycles instead of 8  $\overline{\text{RAS}}$ -only refresh cycles are required. The device should be carefully initialized to be prevented from being entered into multi bit test mode.
2.  $V_{IH}(\text{min.})$  and  $V_{IL}(\text{max.})$  are reference levels for measuring timing of input signals. Transition time is measured between  $V_{IH}$  and  $V_{IL}$  and assumed to be 5ns for all inputs.
3. Refer to the HY5116100 data sheet for detailed information.
4. Measured with a load equivalent to 2 TTL loads and 100pF.
5.  $t_{OFF}(\text{max.})$  defines the time at which the output achieves the open circuit condition and is not referenced to output voltage levels.
6. Either  $t_{RCH}$  or  $t_{RRH}$  must be satisfied for a read cycle.
7. These parameters are referenced to  $\overline{\text{CAS}}$  leading edge in early write cycles.
8.  $t_{WCS}$  is not a restrictive operating parameter. It is included in the data sheet as electrical characteristics only. If  $t_{WCS} \geq t_{WCS}(\text{min.})$ , the cycle is an early write cycle and data out pin will remain open circuit (high impedance) through the entire cycle.
9. Operation within the  $t_{RCD}(\text{max.})$  limit insures that  $t_{RAC}(\text{max.})$  can be met.  $t_{RCD}(\text{max.})$  is specified as a reference point only. If  $t_{RCD}$  is greater than the specified  $t_{RCD}(\text{max.})$  limit, then access time is controlled by  $t_{CAC}$ .
10. Operation within the  $t_{RAD}(\text{max.})$  limit insures that  $t_{RAC}(\text{max.})$  can be met.  $t_{RAD}(\text{max.})$  is specified as a reference point only. If  $t_{RAD}$  is greater than the specified  $t_{RAD}(\text{max.})$  limit, then access time is controlled by  $t_{AA}$ .
11.  $t_{REF}(\text{max.}) = 256\text{ms}$  is applied to L-part only (HYM591600LM and HYM591600LTM).

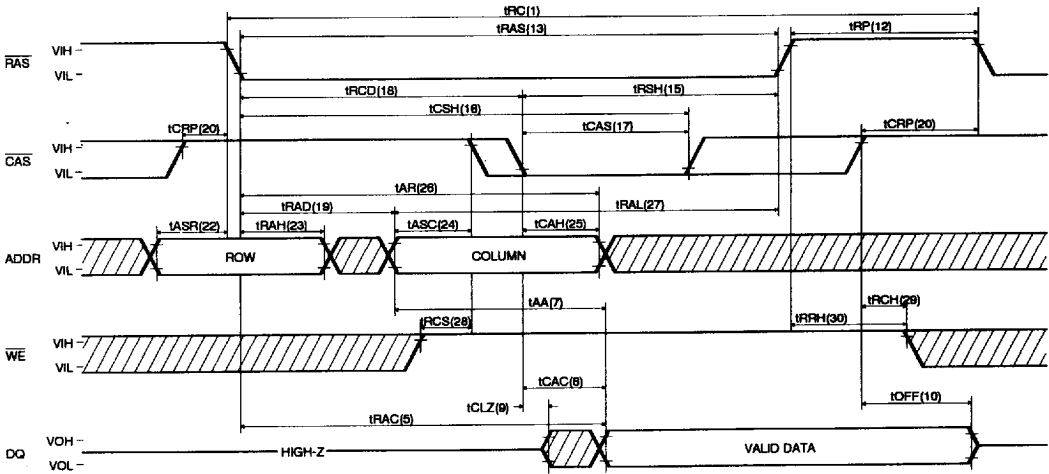
**CAPACITANCE**

( $T_A = 25^\circ\text{C}$ ,  $V_{CC} = 5V \pm 10\%$ ,  $V_{SS} = 0V$ ,  $f = 1\text{MHz}$ , unless otherwise noted.)

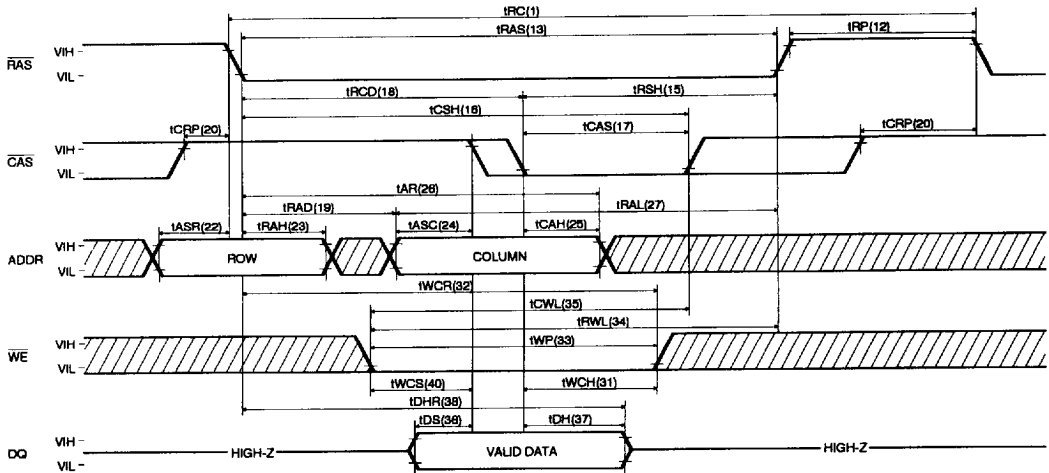
SYMBOL	PARAMETER	TYP.	MAX.	UNIT
CIN1	Input Capacitance (A0-A11)	-	55	pF
CIN2	Input Capacitance ( $\overline{\text{RAS}}$ , $\overline{\text{CAS}}$ , $\overline{\text{WE}}$ )	-	65	pF
CIN3	Input Capacitance (PD, PCAS)	-	10	pF
CDQ	Data Input/Output Capacitance (DQ0-DQ7)	-	15	pF
CPQ	Output Capacitance (PQ)	-	10	pF

TIMING DIAGRAM

READ CYCLE

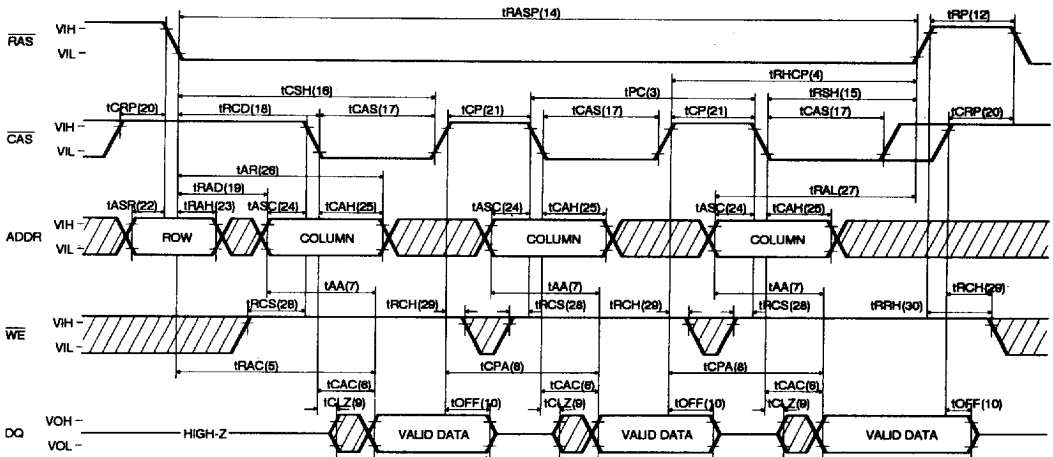


EARLY WRITE CYCLE

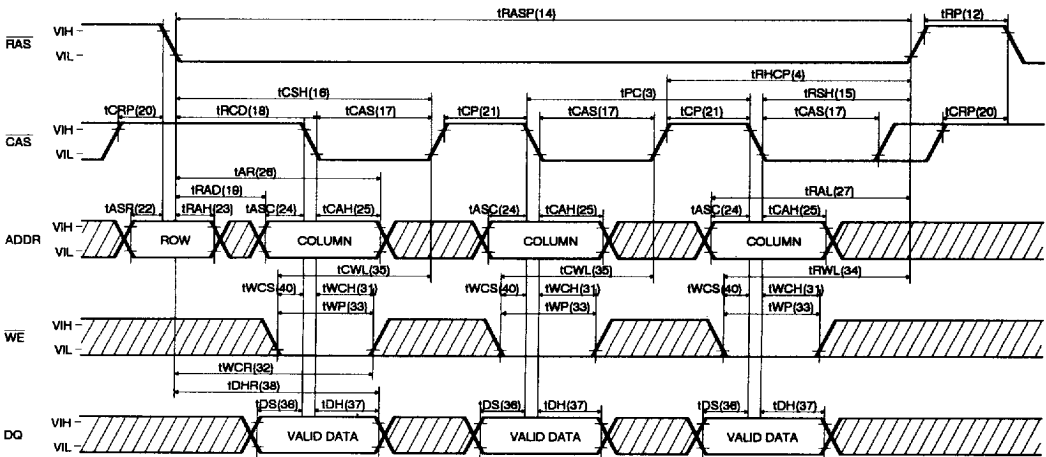




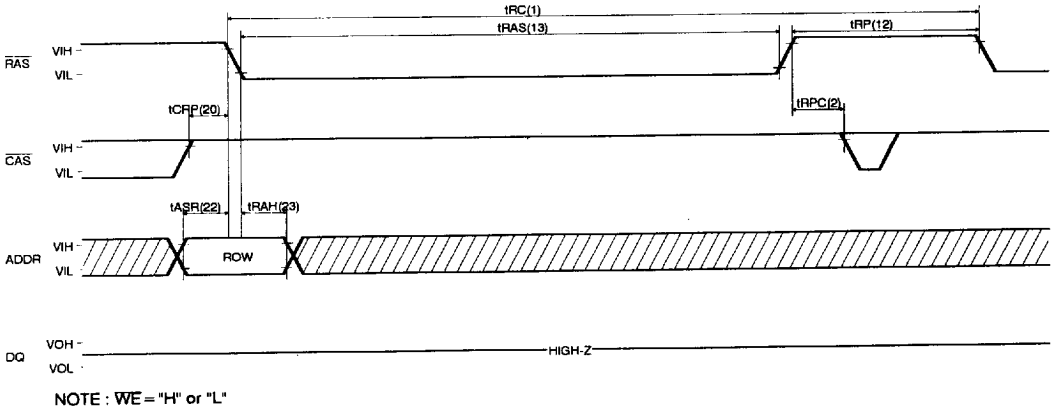
FAST PAGE MODE READ CYCLE



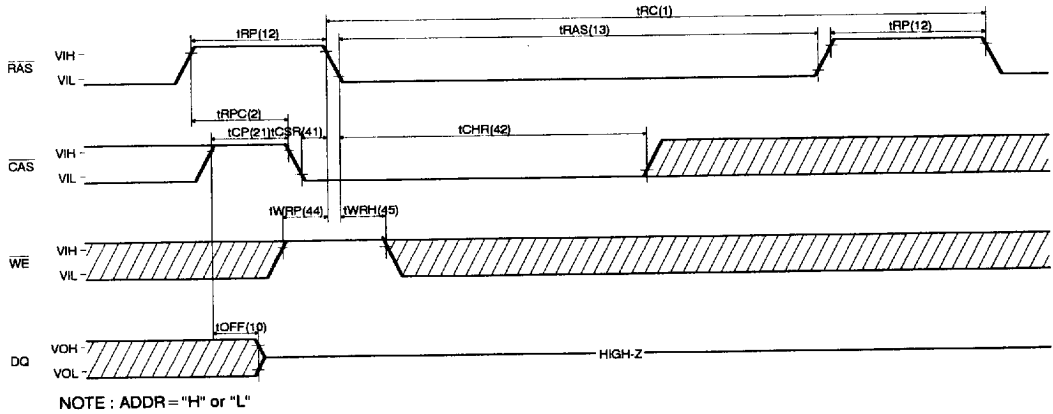
FAST PAGE MODE EARLY WRITE CYCLE



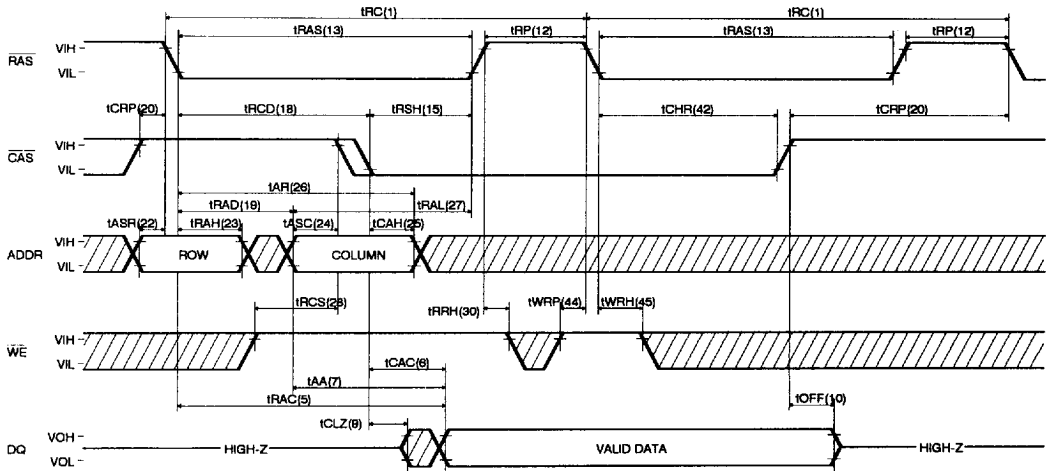
**RAS-ONLY REFRESH CYCLE**



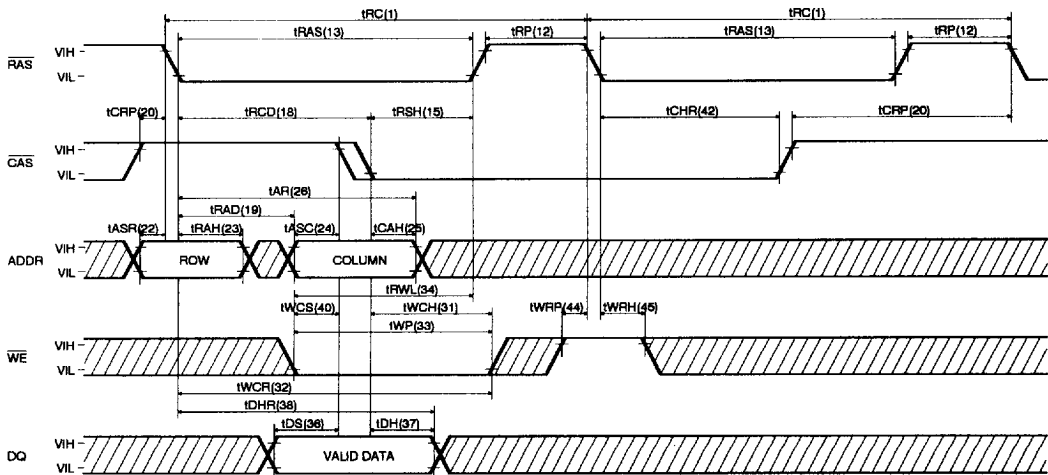
**CAS-BEFORE-RAS REFRESH CYCLE**



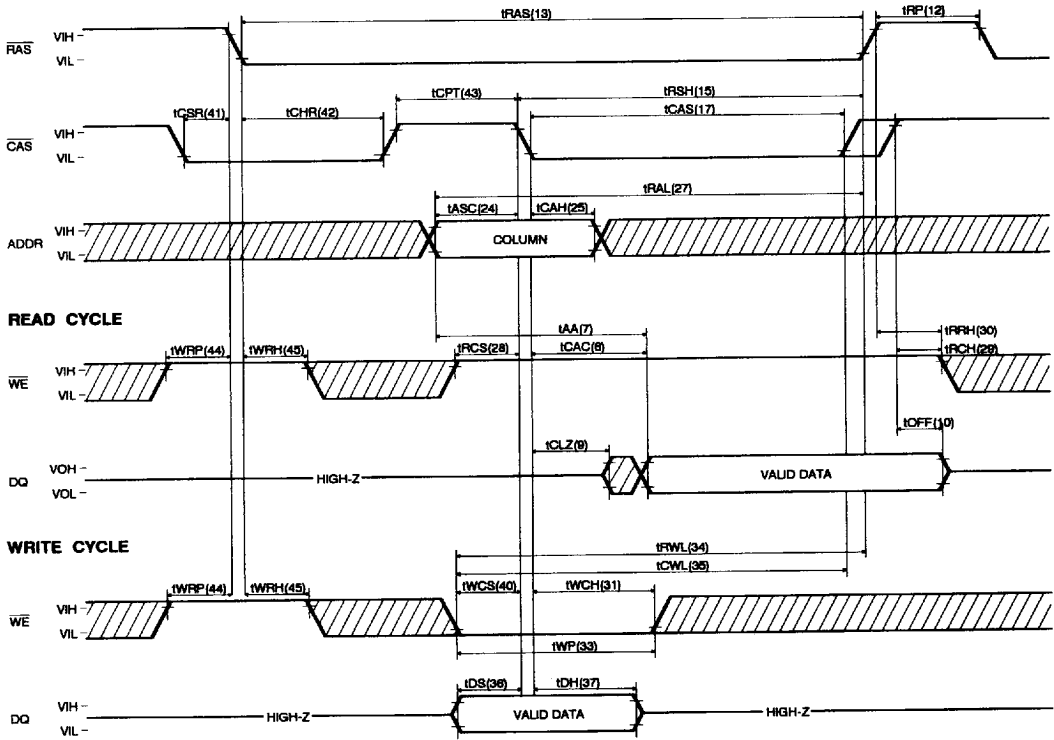
**HIDDEN REFRESH CYCLE (READ)**



**HIDDEN REFRESH CYCLE (WRITE)**



CAS-BEFORE-RAS REFRESH COUNTER TEST CYCLE

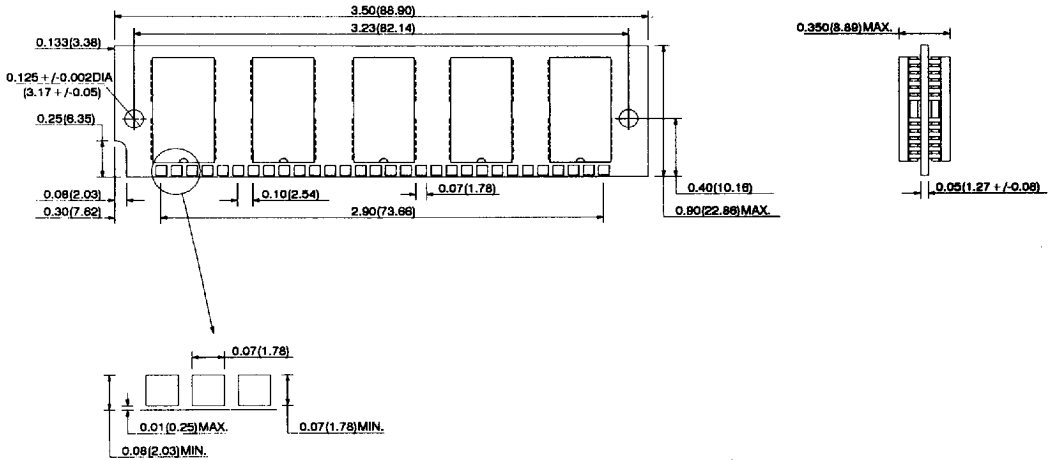


**PACKAGE INFORMATION**

**30 pin Single In-line Memory Module (M; Tin-Lead plated)**

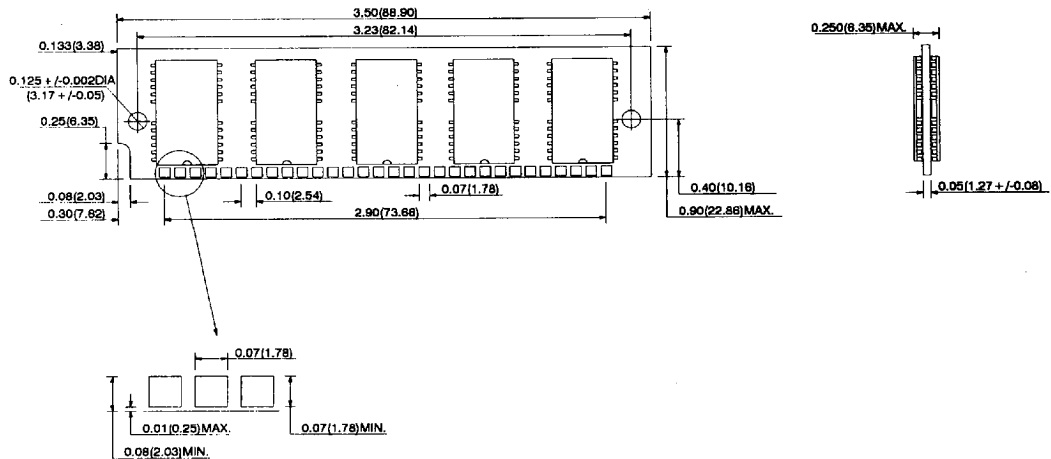
**HYM591600M/LM**

UNIT : INCH(mm)  
TOLERANCE : +/-0.005(0.13)



**HYM591600TM/LTM**

UNIT : INCH(mm)  
TOLERANCE : +/-0.005(0.13)



**ORDERING INFORMATION**

PART NUMBER	SPEED	POWER	PACKAGE	PLATING
HYM591600M	60/70/80		SIMM	Tin-Lead
HYM591600LM	60/70/80	L-part	SIMM	Tin-Lead
HYM591600TM	60/70/80		SIMM	Tin-Lead
HYM591600LTM	60/70/80	L-part	SIMM	Tin-Lead