

HM511000A Series

HM511000AL Series

1048576-Word x 1-Bit CMOS Dynamic RAM

DESCRIPTION

The Hitachi HM511000A/AL series is a CMOS dynamic RAM organized 1048576-word x 1-bit. HM511000A/AL has realized higher density, higher performance and various functions by employing 1.3 μ m CMOS process technology and some new CMOS circuit design technologies.

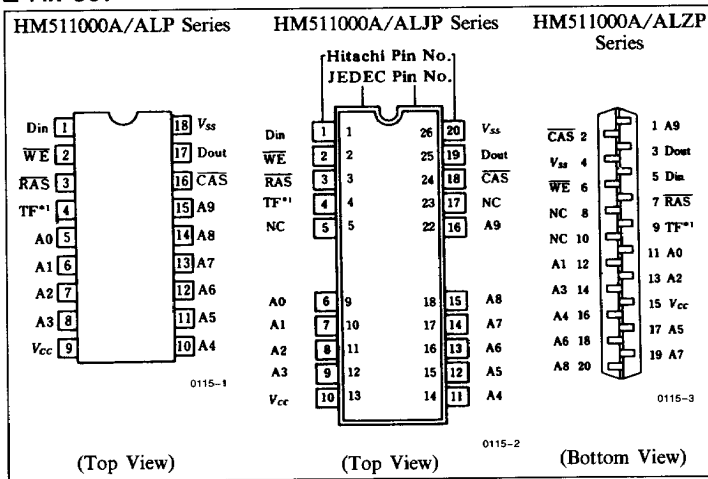
The HM511000A/AL offers Fast Page Mode as a high speed access mode.

Multiplexed address input permits the HM511000A/AL to be packaged in standard 18-pin plastic DIP, 20-pin plastic ZIP and 20-pin plastic SOJ.

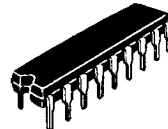
FEATURES

- High Speed
 - Access Time 60 ns/70 ns/80 ns/100 ns/120 ns (max)
- Low Power Dissipation
 - Active Mode 495 mW/440 mW/385 mW/330 mW/275 mW (max)
 - Standby Mode 11 mW (max)
- Single 5V Supply ($\pm 10\%$)
- Fast Page Mode Capability
- 512 Refresh Cycles (8 ms)
- 2 Variations of Refresh
 - RAS Only Refresh
 - CAS Before RAS Refresh

PIN OUT



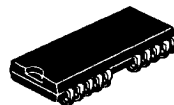
HM511000A/ALP Series



(DP-18C)

3DCP18C

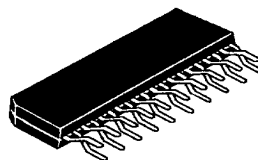
HM511000A/ALJP Series



(CP-20D)

3DCP20D

HM511000A/ALZP Series



(ZP-20)

3DZP20

PIN DESCRIPTION

Pin Name	Function
A ₀ -A ₉	Address Input
A ₀ -A ₈	Refresh Address Input
D _{in}	Data-in
D _{out}	Data-out
RAS	Row Address Strobe
CAS	Column Address Strobe
WE	Read/Write Input
TF ¹	Test Function
V _{CC}	Power (+ 5V)
V _{SS}	Ground

Note: 1. TF pin can be connected with any line or unconnected provided the voltage level of TF pin must be kept lower than V_{CC} + 0.5V.

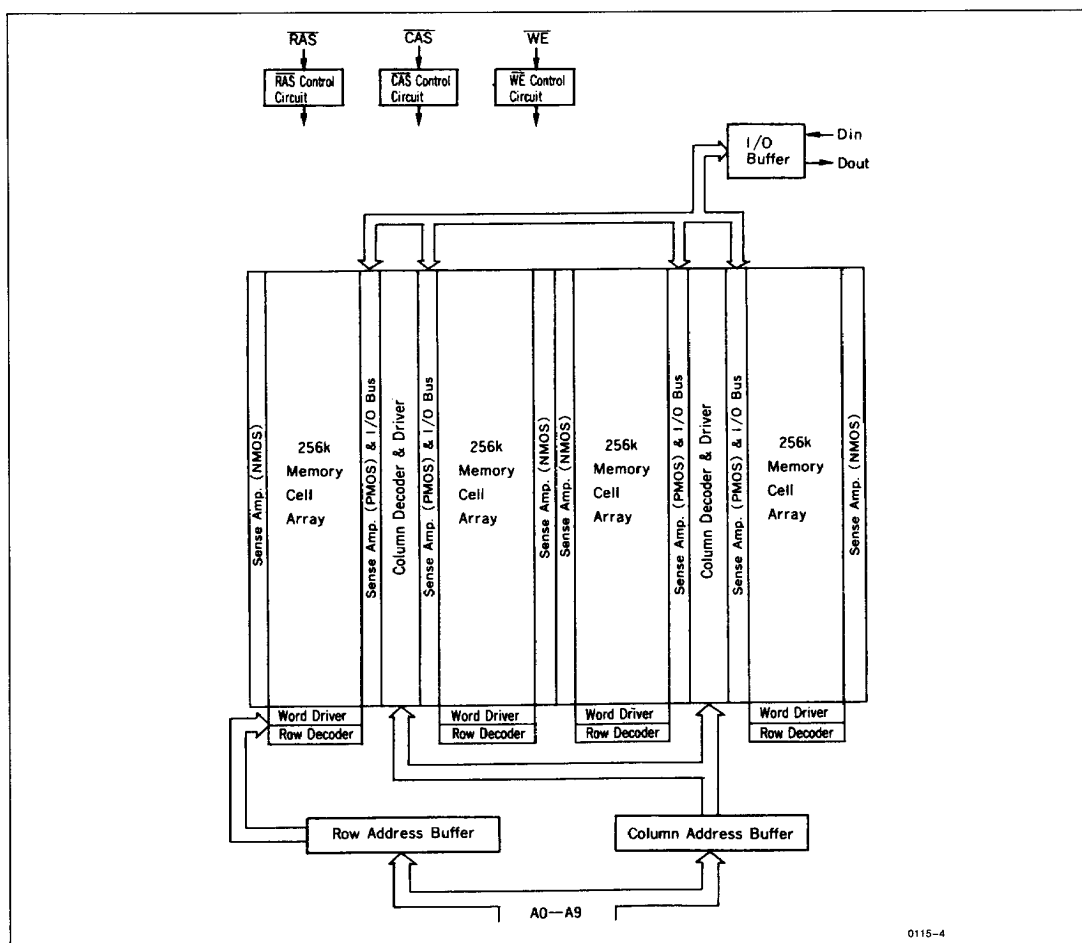


■ ORDERING INFORMATION

Part No.	Access Time	Package
HM511000AP-6	60 ns	300 mil 18-pin Plastic DIP (DP-18C)
HM511000AP-7	70 ns	
HM511000AP-8	80 ns	
HM511000AP-10	100 ns	
HM511000AP-12	120 ns	
HM511000AJP-6	60 ns	300 mil 20-pin Plastic SOJ (CP-20D)
HM511000AJP-7	70 ns	
HM511000AJP-8	80 ns	
HM511000AJP-10	100 ns	
HM511000AJP-12	120 ns	
HM511000AZP-6	60 ns	400 mil 20-pin Plastic ZIP (ZP-20)
HM511000AZP-7	70 ns	
HM511000AZP-8	80 ns	
HM511000AZP-10	100 ns	
HM511000AZP-12	120 ns	

Part No.	Access Time	Package
HM511000ALP-6	60 ns	300 mil 18-pin Plastic DIP (DP-18C)
HM511000ALP-7	70 ns	
HM511000ALP-8	80 ns	
HM511000ALP-10	100 ns	
HM511000ALP-12	120 ns	
HM511000ALJP-6	60 ns	300 mil 20-pin Plastic SOJ (CP-20D)
HM511000ALJP-7	70 ns	
HM511000ALJP-8	80 ns	
HM511000ALJP-10	100 ns	
HM511000ALJP-12	120 ns	
HM511000ALZP-6	60 ns	400 mil 20-pin Plastic ZIP (ZP-20)
HM511000ALZP-7	70 ns	
HM511000ALZP-8	80 ns	
HM511000ALZP-10	100 ns	
HM511000ALZP-12	120 ns	

■ BLOCK DIAGRAM



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87

■ ABSOLUTE MAXIMUM RATINGS

Parameter	Symbol	Value	Unit
Voltage on Any Pin Relative to V_{SS}	V_T	-1.0 to +7.0	V
Supply Voltage Relative to V_{SS}	V_{CC}	-1.0 to +7.0	V
Short Circuit Output Current	I_{out}	50	mA
Power Dissipation	P_T	1.0	W
Operating Temperature	T_{opr}	0 to +70	°C
Storage Temperature	T_{stg}	-55 to +125	°C

■ ELECTRICAL CHARACTERISTICS

• Recommended DC Operating Conditions ($T_A = 0$ to +70°C)

Parameter	Symbol	Min	Typ	Max	Unit
Supply Voltage	V_{CC}	4.5	5.0	5.5	V
Input High Voltage	V_{IH}	2.4	—	6.5	V
Input Low Voltage	V_{IL}	-2.0	—	0.8	V

Note: All voltages referenced to V_{SS} .• DC Electrical Characteristics ($V_{CC} = 5V \pm 10\%$, $V_{SS} = 0V$, $T_A = 0$ to +70°C)

Parameter	Symbol	HM511000A /AL-6		HM511000A /AL-7		HM511000 /A-8		HM511000 /A-10		HM511000 /A-12		Unit	Test Conditions	Note
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max			
Operating Current	I_{CC1}	—	90	—	80	—	70	—	60	—	50	mA	RAS, CAS Cycling, $t_{RC} = \text{Min}$	1, 2
Standby Current	I_{CC2}	—	2	—	2	—	2	—	2	—	2	mA	TTL Interface RAS, CAS = V_{IH} , $D_{out} = \text{High-Z}$	
		—	1	—	1	—	1	—	1	—	1	mA	CMOS Interface RAS, CAS $\geq V_{CC} - 0.2V$ $D_{out} = \text{High-Z}$	
		—	300	—	300	—	300	—	300	—	300	μA	CMOS Interface L-Version	
Refresh Current	I_{CC3}	—	90	—	80	—	60	—	50	—	45	mA	RAS Only Refresh, $t_{RC} = \text{Min}$	2
Battery Back Up Current (Only for L-Version)	I_{CC4}	—	300	—	300	—	300	—	300	—	300	μA	$t_{RC} = 125 \mu s$, CAS Before RAS Cycling	4
Standby Current	I_{CC5}	—	5	—	5	—	5	—	5	—	5	mA	RAS = V_{IH} , CAS = V_{IL} , $D_{out} = \text{Enable}$	1
Refresh Current	I_{CC6}	—	80	—	70	—	60	—	50	—	40	mA	CAS Before RAS Refresh $t_{RC} = \text{Min}$	
Fast Page Mode Current	I_{CC7}	—	80	—	70	—	50	—	50	—	40	mA	RAS = V_{IL} , CAS Cycling, $t_{PC} = \text{Min}$	1, 3



• DC Electrical Characteristics ($V_{CC} = 5V \pm 10\%$, $V_{SS} = 0V$, $T_A = 0$ to $+70^\circ C$) (continued)

Parameter	Symbol	HM511000A /AL-6		HM511000A /AL-7		HM511000 /A-8		HM511000 /A-10		HM511000 /A-12		Unit	Test Conditions	Note
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max			
Input Leakage	I_{L1}	-10	10	-10	10	-10	10	-10	10	-10	10	μA	$V_{in} = 0$ to $+7V$	
Output Leakage	I_{LO}	-10	10	-10	10	-10	10	-10	10	-10	10	μA	$V_{out} = 0$ to $+7V$, $D_{out} = \text{Disable}$	
Output Levels	V_{OH}	2.4	V_{CC}	2.4	V_{CC}	2.4	V_{CC}	2.4	V_{CC}	2.4	V_{CC}	V	$I_{out} = -5 \text{ mA}$	
	V_{OL}	0	0.4	0	0.4	0	0.4	0	0.4	0	0.4	V	$I_{out} = 4.2 \text{ mA}$	

Notes: 1. I_{CC} depends on output loading condition when the device is selected. I_{CC} max is specified at the output open condition.
 2. Address can be changed less than three times while $RAS = V_{IL}$.
 3. Address can be changed once while $CAS = V_{IH}$.
 4. $t_{RAS} = t_{RAS}(\text{min})$ to $1 \mu s$
 Input voltage: All pins: $V_{IH} \geq V_{CC} - 0.2V$ or $V_{IL} \leq 0.2V$.

• Capacitance ($V_{CC} = 5V \pm 10\%$, $T_A = 25^\circ C$)

Parameter	Symbol	Typ	Max	Unit	Note
Input Capacitance	Address, Data Input	C_{I1}	—	5	pF
	Clocks	C_{I2}	—	7	pF
Output Capacitance	Data Output	C_O	—	7	pF

Notes: 1. Capacitance measured with Boonton Meter or effective capacitance measuring method.
 2. $CAS = V_{IH}$ to disable D_{out} .

• AC Characteristics ($T_A = 0$ to $+70^\circ C$, $V_{SS} = 0V$, $V_{CC} = 5V \pm 10\%$)

Test Conditions

Input rise and fall times: 5 ns
 Input timing reference levels: 0.8V, 2.4V (Including scope and jig)
 Output load: 2 TTL Gate + C_L (100 pF)

Read, Write, Read-Modify-Write and Refresh Cycles (Common Parameters)

Parameter	Symbol	HM511000A /AL-6		HM511000A /AL-7		HM511000A /AL-8		HM511000A /AL-10		HM511000A /AL-12		Unit	Note
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max		
Random Read or Write Cycle Time	t_{RC}	120	—	130	—	160	—	190	—	220	—	ns	
RAS Precharge Time	t_{RP}	50	—	50	—	70	—	80	—	90	—	ns	
RAS Pulse Width	t_{RAS}	60	10000	70	10000	80	10000	100	10000	120	10000	ns	
CAS Pulse Width	t_{CAS}	20	10000	20	10000	25	10000	25	10000	30	10000	ns	
Row Address Setup Time	t_{ASR}	0	—	0	—	0	—	0	—	0	—	ns	
Row Address Hold Time	t_{RAH}	10	—	10	—	12	—	15	—	15	—	ns	
Column Address Setup Time	t_{ASC}	0	—	0	—	0	—	0	—	0	—	ns	
Column Address Hold Time	t_{CAH}	15	—	15	—	20	—	20	—	25	—	ns	
RAS to CAS Delay Time	t_{RCD}	20	40	20	50	22	55	25	75	25	90	ns	8
RAS to Column Address Delay Time	t_{RAD}	15	30	15	35	17	40	20	55	20	65	ns	9
RAS Hold Time	t_{RSH}	20	—	20	—	25	—	25	—	30	—	ns	
CAS Hold Time	t_{CSH}	60	—	70	—	80	—	100	—	120	—	ns	
CAS to RAS Precharge Time	t_{CRP}	10	—	10	—	10	—	10	—	10	—	ns	
Transition Time (Rise and Fall)	t_T	3	50	3	50	3	50	3	50	3	50	ns	7
Refresh Period	t_{REF}	—	8	—	8	—	8	—	8	—	8	ms	
Refresh Period (Only for L-Version)	t_{REF}	—	64	—	64	—	64	—	64	—	64	ms	



Read Cycle

Parameter	Symbol	HM511000A /AL-6		HM511000A /AL-7		HM511000A /AL-8		HM511000A /AL-10		HM511000A /AL-12		Unit	Note
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max		
Access Time from $\overline{\text{RAS}}$	t_{RAC}	—	60	—	70	—	80	—	100	—	120	ns	2, 3
Access Time from $\overline{\text{CAS}}$	t_{CAC}	—	20	—	20	—	25	—	25	—	30	ns	3, 4
Access Time from Address	t_{AA}	—	30	—	35	—	40	—	45	—	55	ns	3, 5
Read Command Setup Time	t_{RCS}	0	—	0	—	0	—	0	—	0	—	ns	
Read Command Hold Time to $\overline{\text{CAS}}$	t_{RCH}	0	—	0	—	0	—	0	—	0	—	ns	
Read Command Hold Time to $\overline{\text{RAS}}$	t_{RRH}	10	—	10	—	10	—	10	—	10	—	ns	10
Column Address to $\overline{\text{RAS}}$ Lead Time	t_{RAL}	30	—	35	—	40	—	45	—	55	—	ns	
Output Buffer Turn-off Time	t_{OFF}	—	20	—	20	—	20	—	25	—	30	ns	6

Write Cycle

Parameter	Symbol	HM511000A /AL-6		HM511000A /AL-7		HM511000A /AL-8		HM511000A /AL-10		HM511000A /AL-12		Unit	Note
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max		
Write Command Setup Time	t_{WCS}	0	—	0	—	0	—	0	—	0	—	ns	10
Write Command Hold Time	t_{WCH}	15	—	15	—	20	—	20	—	25	—	ns	
Write Command Pulse Width	t_{WP}	10	—	10	—	15	—	15	—	20	—	ns	
Write Command to $\overline{\text{RAS}}$ Lead Time	t_{RWL}	20	—	20	—	25	—	25	—	30	—	ns	
Write Command to $\overline{\text{CAS}}$ Lead Time	t_{CWL}	20	—	20	—	25	—	25	—	30	—	ns	
Data-in Setup Time	t_{DS}	0	—	0	—	0	—	0	—	0	—	ns	11
Data-in Hold Time	t_{DH}	15	—	15	—	20	—	20	—	25	—	ns	11

Read-Modify-Write Cycle

Parameter	Symbol	HM511000A /AL-6		HM511000A /AL-7		HM511000A /AL-8		HM511000A /AL-10		HM511000A /AL-12		Unit	Note
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max		
Read-Write Cycle Time	t_{RWC}	145	—	155	—	190	—	220	—	255	—	ns	
$\overline{\text{RAS}}$ to $\overline{\text{WE}}$ Delay Time	t_{RWD}	60	—	70	—	80	—	100	—	120	—	ns	10
$\overline{\text{CAS}}$ to $\overline{\text{WE}}$ Delay Time	t_{CWD}	20	—	20	—	25	—	25	—	30	—	ns	10
Column Address to $\overline{\text{WE}}$ Delay Time	t_{AWD}	30	—	35	—	40	—	45	—	55	—	ns	10

Refresh Cycle

Parameter	Symbol	HM511000A /AL-6		HM511000A /AL-7		HM511000A /AL-8		HM511000A /AL-10		HM511000A /AL-12		Unit	Note
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max		
$\overline{\text{CAS}}$ Setup Time (CAS Before $\overline{\text{RAS}}$ Refresh)	t_{CSR}	10	—	10	—	10	—	10	—	10	—	ns	
$\overline{\text{CAS}}$ Hold Time (CAS Before $\overline{\text{RAS}}$ Refresh)	t_{CHR}	15	—	15	—	20	—	20	—	25	—	ns	
$\overline{\text{RAS}}$ Precharge to $\overline{\text{CAS}}$ Hold Time	t_{RPC}	10	—	10	—	10	—	0	—	0	—	ns	



Fast Page Mode Cycle

Parameter	Symbol	HM511000A /AL-6		HM511000A /AL-7		HM511000A /AL-8		HM511000A /AL-10		HM511000A /AL-12		Unit	Note
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max		
Fast Page Mode Cycle Time	t_{PC}	45	—	50	—	55	—	55	—	65	—	ns	
CAS Precharge Time	t_{CP}	10	—	10	—	10	—	10	—	15	—	ns	
Fast Page Mode RAS Pulse Width	t_{RASC}	—	100000	—	100000	—	100000	—	100000	—	100000	ns	13
Access Time from CAS Precharge	t_{ACP}	—	40	—	45	—	50	—	50	—	60	ns	14
RAS Hold Time from CAS Precharge	t_{RHCP}	40	—	45	—	50	—	50	—	60	—	ns	

Fast Page Mode Read-Modify-Write Cycle

Parameter	Symbol	HM511000A /AL-6		HM511000A /AL-7		HM511000A /AL-8		HM511000A /AL-10		HM511000A /AL-12		Unit	Note
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max		
Fast Page Mode Read-Modify-Write Cycle Time	t_{PCM}	70	—	75	—	85	—	85	—	100	—	ns	

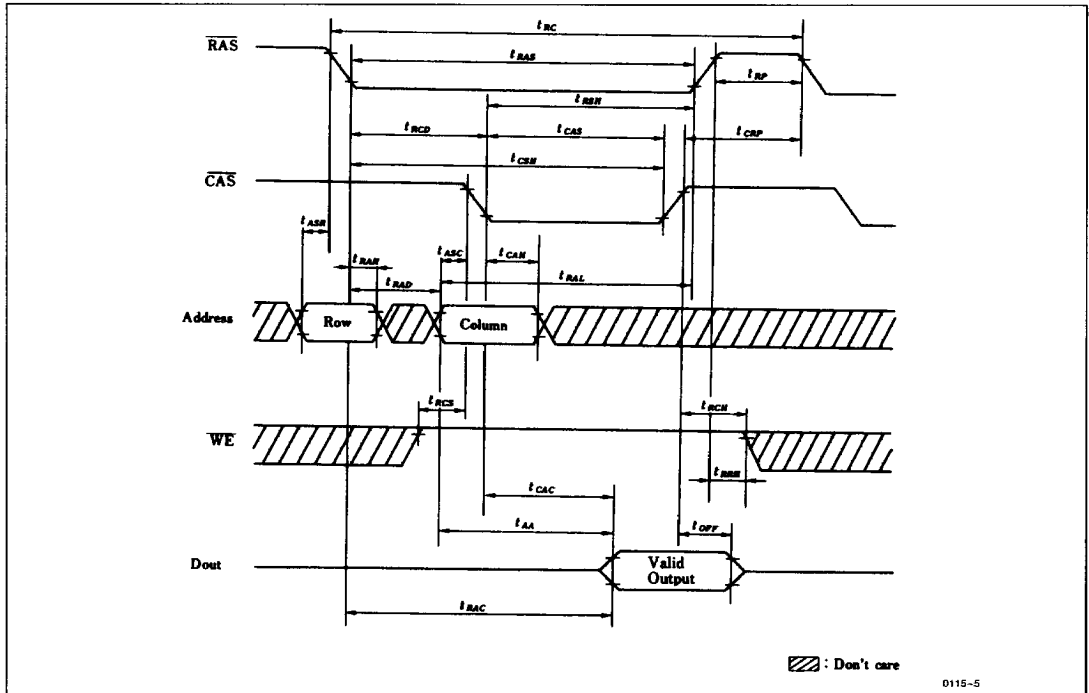
Notes: 1. AC measurements assume $t_T = 5$ ns.

- Assumes that $t_{RCD} \leq t_{RCD}(\text{max})$ and $t_{RAD} \leq t_{RAD}(\text{max})$. If t_{RCD} or t_{RAD} is greater than the maximum recommended value shown in this table, t_{RAC} exceeds the value shown.
- Measured with a load circuit equivalent to 2 TTL loads and 100 pF.
- Assumes that $t_{RCD} \geq t_{RCD}(\text{max})$, $t_{RAD} \leq t_{RAD}(\text{max})$.
- Assumes that $t_{RCD} \leq t_{RCD}(\text{max})$, and $t_{RAD} \geq t_{RAD}(\text{max})$.
- $t_{OFF}(\text{max})$ is defined as the time at which the output achieves the open circuit condition and is not referenced to output voltage levels.
- Transition times are measured between V_{IH} and V_{IL} .
- Operation with 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 exclusively by t_{CAC} .
- Operation with 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 exclusively by t_{AA} .
- t_{WCS} , t_{RWD} , t_{CWD} and t_{AWD} are not restrictive operating parameters. They are 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 the data out pin will remain open circuit (high impedance) throughout the entire cycle; if $t_{RWD} \geq t_{RWD}(\text{min})$, $t_{CWD} \geq t_{CWD}(\text{min})$ and $t_{AWD} \geq t_{AWD}(\text{min})$, the cycle is a read/write and the data output 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 indeterminate.
- These parameters are referenced to $\overline{\text{CAS}}$ leading edge in early write cycles and to $\overline{\text{WE}}$ leading edge in delayed write or read-modify-write cycles.
- An initial pause of 100 μs is required after power-up followed by eight or more initialization cycles (any combination of cycles containing RAS clock such as $\overline{\text{RAS}}$ only refresh). If internal refresh counter is used, eight or more CAS before RAS refresh cycles are required.
- t_{RASC} is determined by $\overline{\text{RAS}}$ pulse width in fast page mode cycle.
- Access time is determined by the longer of t_{AA} , t_{CAC} or t_{ACP} .

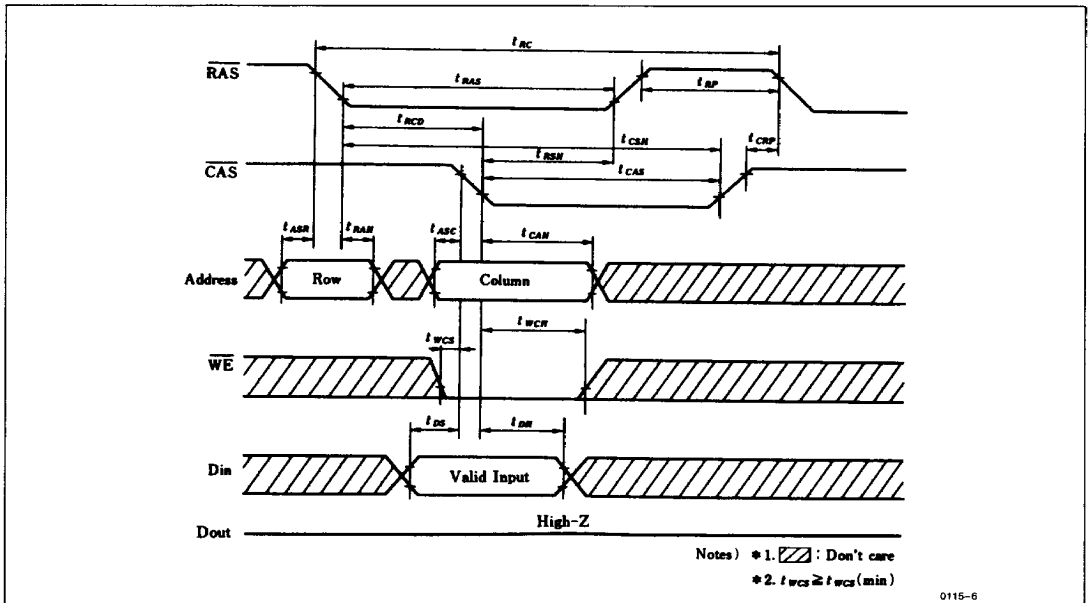


■ TIMING WAVEFORMS

• Read Cycle



• Early Write Cycle





0115-8





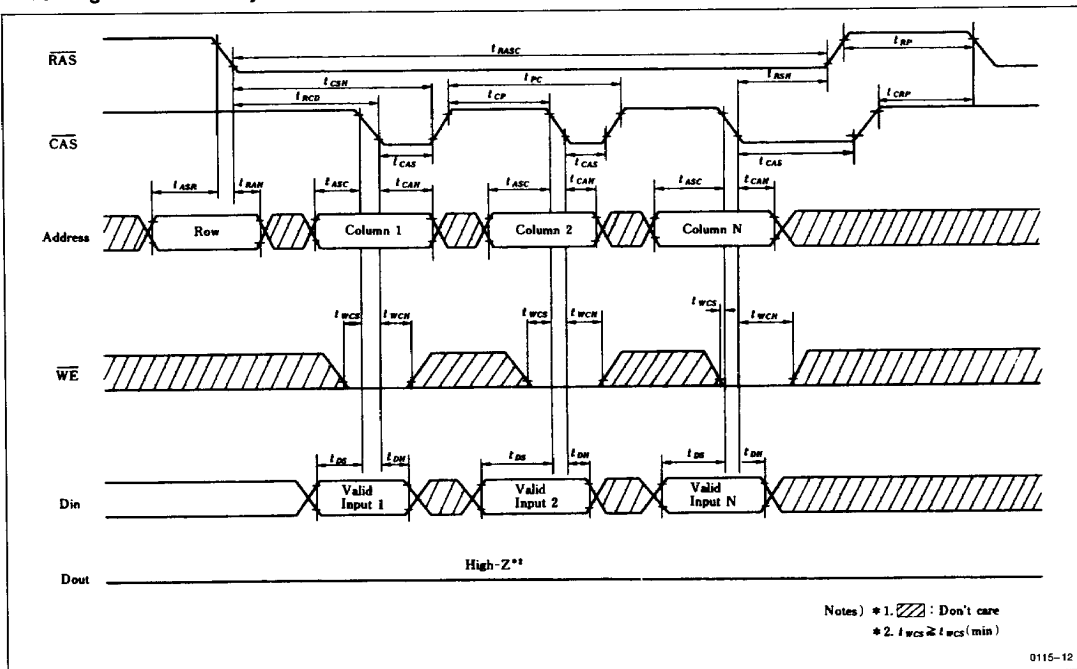
- **CAS Before RAS Refresh Cycle**



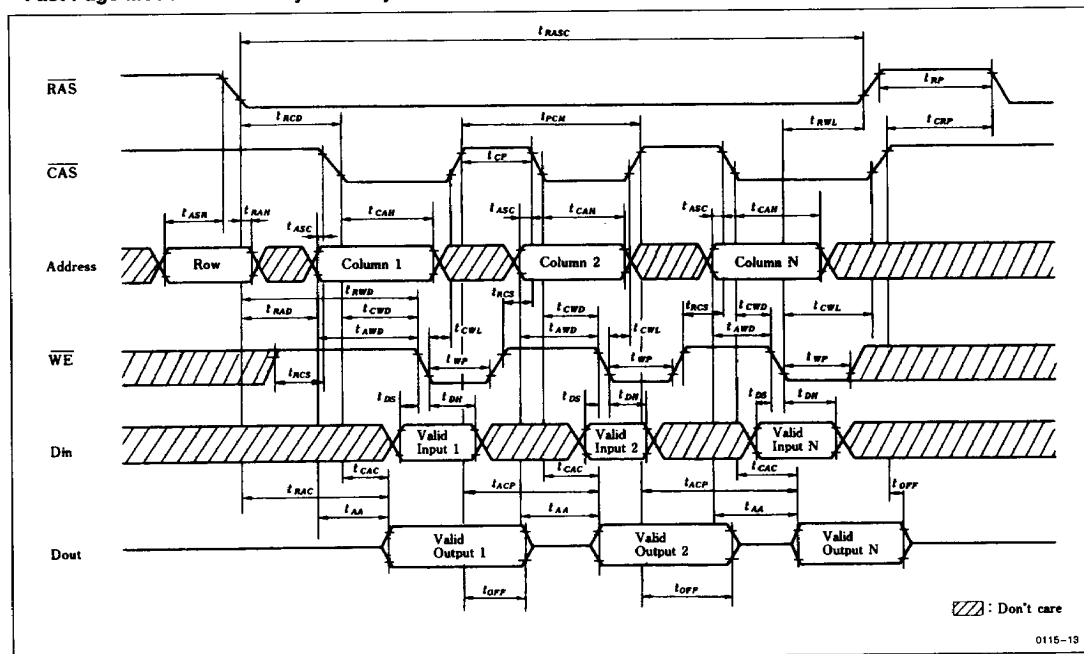
- **Fast Page Mode Read Cycle**



• Fast Page Mode Write Cycle

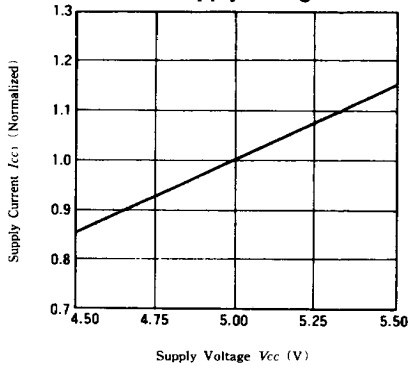


• Fast Page Mode Read Modify Write Cycle

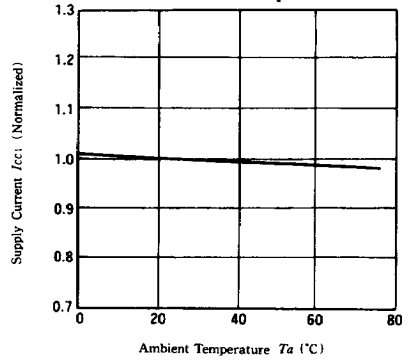


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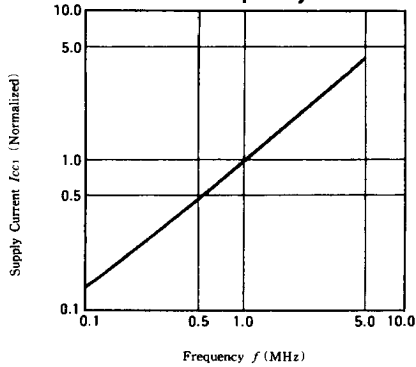
**Supply Current (Active)
vs Supply Voltage**



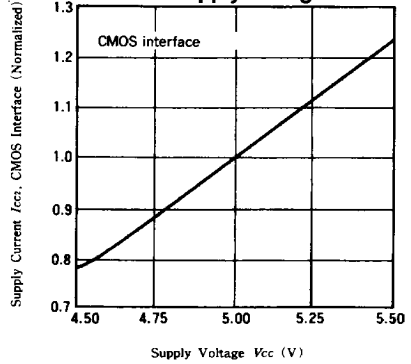
**Supply Current (Active)
vs Ambient Temperature**



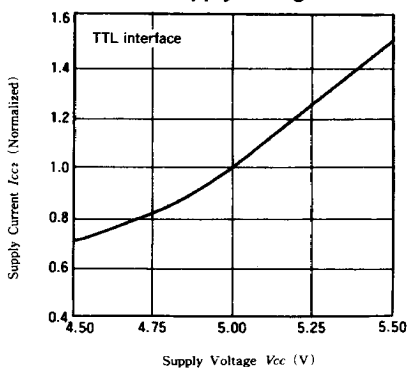
**Supply Current (Active)
vs Frequency**



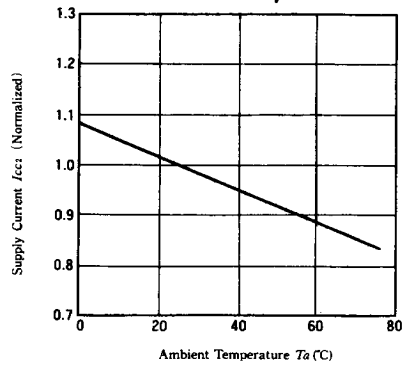
**Supply Current (Standby)
vs Supply Voltage**



**Supply Current (Standby)
vs Supply Voltage**

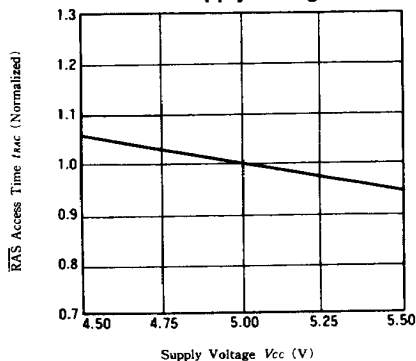
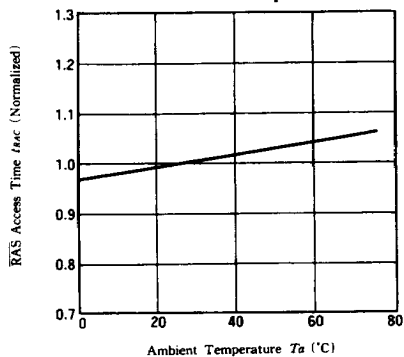
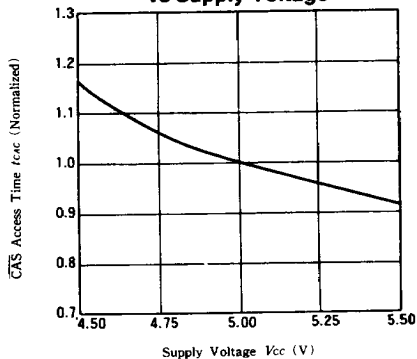
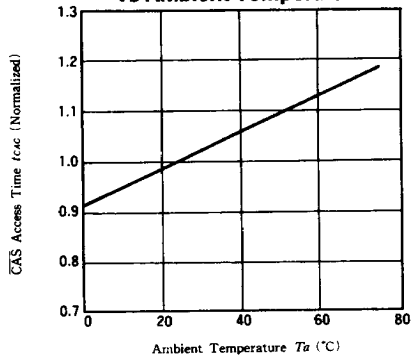
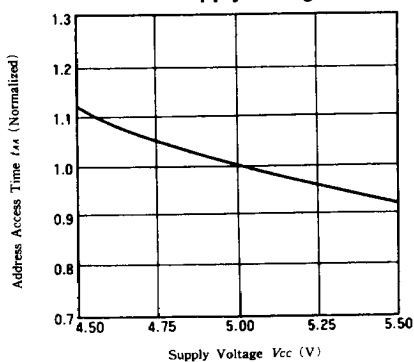
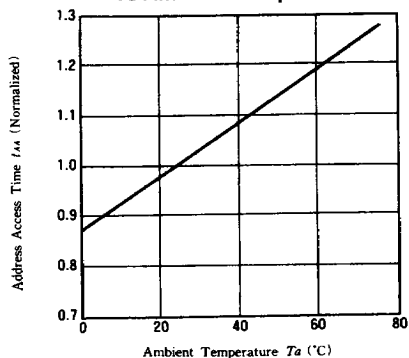


**Supply Current (Standby)
vs Ambient Temperature**



0115-14



**RAS Access Time
vs Supply Voltage****RAS Access Time
vs Ambient Temperature****CAS Access Time
vs Supply Voltage****CS Access Time
vs Ambient Temperature****Address Access Time
vs Supply Voltage****Address Access Time
vs Ambient Temperature**

0115-15



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97