HM514256A/AL Series

262,144-Word x 4-Bit CMOS Dynamic RAM

■ DESCRIPTION

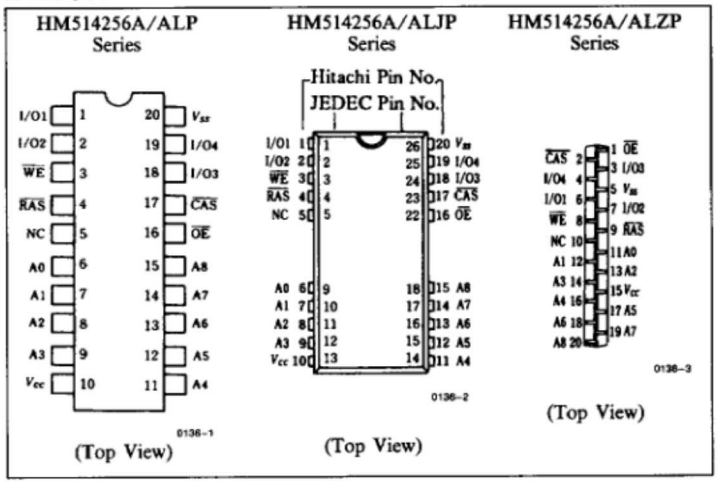
The Hitachi HM514256A/AL is a CMOS dynamic RAM organized 262,144-word x 4-bit. HM514256A/AL has realized higher density, higher performance and various functions by employing 1.3 μm CMOS technology and some new CMOS circuit design technologies. The HM514256A/AL offers Fast Page Mode as a high speed access mode.

Multiplexed address input permits the HM514256A/AL to be packaged in standard 20-pin plastic DIP, 20-pin plastic SOJ and 20-pin plastic ZIP.

■ FEATURES

- Single 5V (±10%)
- High Speed
  - Access Time .....60 ns/70 ns/80 ns/100 ns/120 ns (max)
- Low Power
  - Standby .....11 mW (max), 1.7 mW (max) (L Version)
  - Active .....495 mW/440 mW/363 mW/302.5 mW/258.5 mW (max)
- Fast Page Mode Capability
- 512 Refresh Cycles .....(8 ms), (64 ms) (L Version)
- 2 Variations of Refresh
  - $\overline{RAS}$ Only Refresh
  - $\overline{CAS}$ Before $\overline{RAS}$ Refresh

■ PIN OUT



HM514256A/ALP Series

3DDP20NA

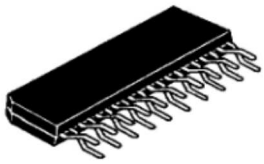
(DP-20NA)

HM514256A/ALJP Series

3DCP20D

(CP-20D)

HM514256A/ALZP Series



3DZP20

(ZP-20)

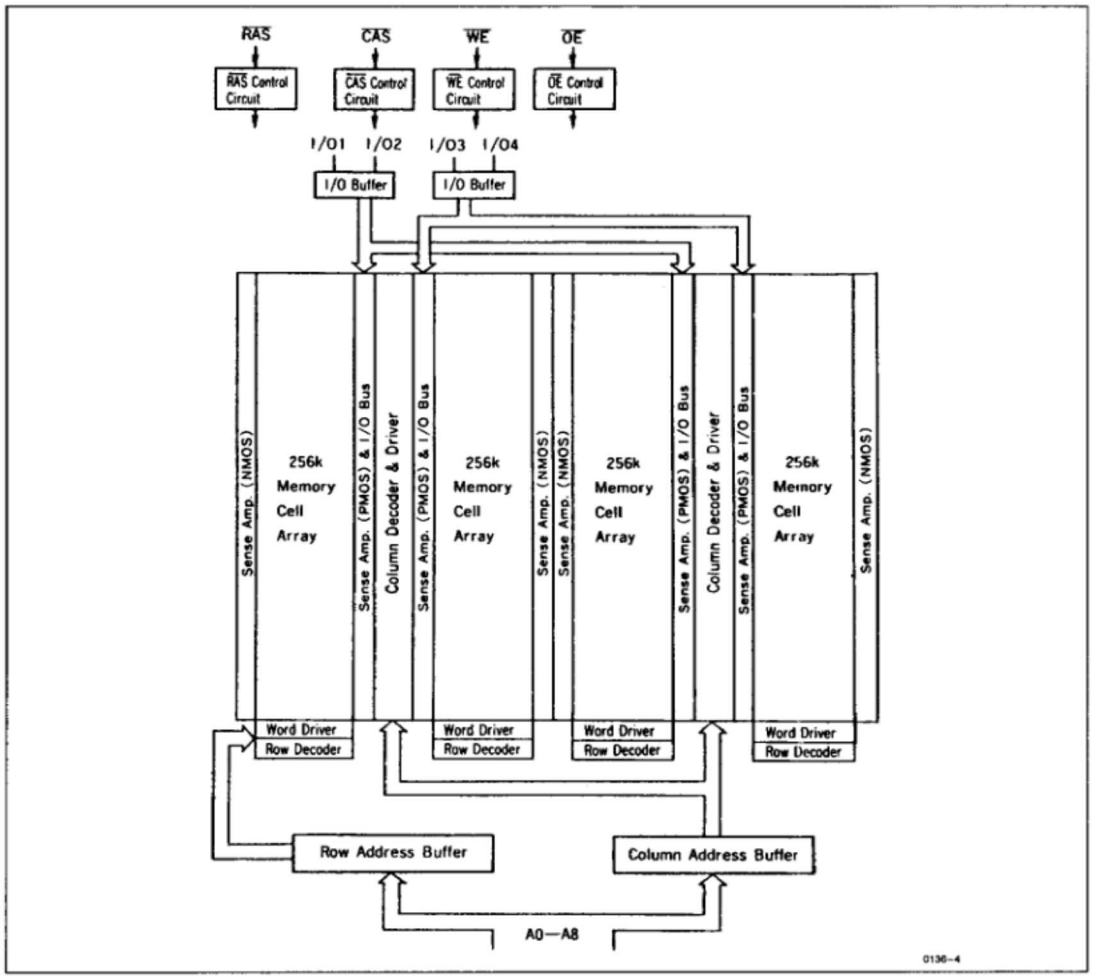
■ PIN DESCRIPTION

Pin Name	Function
A_0–A_8	Address Input
A_0–A_8	Refresh Address Input
I/O_1–I/O_4	Data Input/Data Output
$\overline{RAS}$	Row Address Strobe
$\overline{CAS}$	Column Address Strobe
$\overline{WE}$	Write Enable
$\overline{OE}$	Output Enable
V_{CC}	Power Supply (+5V)
V_{SS}	Ground

■ ORDERING INFORMATION

Part No.	Access Time	Package	Part No.	Access Time	Package
HM514256AP-6	60 ns		HM514256ALP-6	60 ns	
HM514256AP-7	70 ns	300-mil 20-pin	HM514256ALP-7	70 ns	300-mil 20-pin
HM514256AP-8	80 ns	Plastic DIP	HM514256ALP-8	80 ns	Plastic DIP
HM514256AP-10	100 ns	(DP-20NA)	HM514256ALP-10	100 ns	(DP-20NA)
HM514256AP-12	120 ns		HM514256ALP-12	120 ns	
HM514256AJP-6	60 ns		HM514256ALJP-6	60 ns	
HM514256AJP-7	70 ns	300-mil 20-pin	HM514256ALJP-7	70 ns	300-mil 20-pin
HM514256AJP-8	80 ns	Plastic SOJ	HM514256ALJP-8	80 ns	Plastic SOJ
HM514256AJP-10	100 ns	(CP-20D)	HM514256ALJP-10	100 ns	(CP-20D)
HM514256AJP-12	120 ns		HM514256ALJP-12	120 ns	
HM514256AZP-6	60 ns		HM514256ALZP-6	60 ns	
HM514256AZP-7	70 ns	400-mil 20-pin	HM514256ALZP-7	70 ns	400-mil 20-pin
HM514256AZP-8	80 ns	Plastic ZIP	HM514256ALZP-8	80 ns	Plastic ZIP
HM514256AZP-10	100 ns	(ZP-20)	HM514256ALZP-10	100 ns	(ZP-20)
HM514256AZP-12	120 ns		HM514256ALZP-12	120 ns	

■ BLOCK DIAGRAM



■ ABSOLUTE MAXIMUM RATINGS

Item	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 Temerature	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)

Item		Symbol	Min	Typ	Max	Unit	Note
Supply Voltage		V_{SS}	0	0	0	V	
		V_{CC}	4.5	5.0	5.5	V	1
Input High Voltage		V_{IH}	2.4	—	6.5	V	1
Input Low Voltage	I/O Pin	V_{IL}	− 1.0	—	0.8	V	1
	Others	V_{IL}	− 2.0	—	0.8	V	1

Note: 1. All voltage reference to V_{SS}.

• DC Characteristics (T_A = 0 to + 70°C, V_{CC} = 5V ± 10%, V_{SS} = 0V)

Item	Symbol	HM514256										Unit	Test Conditions	Note
		A/AL-6		A/AL-7		A/AL-8		A/AL-10		A/AL-12				
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max			
Operating Current	I_{CC1}	—	90	—	80	—	66	—	55	—	47	mA	$\overline{RAS}$, $\overline{CAS}$ Cycling, t_{RC} = Min	1, 2
Standby Current	I_{CC2}	—	2	—	2	—	2	—	2	—	2	mA	$\overline{RAS}$, $\overline{CAS}$ = V_{IH} D_{out} = High-Z TTL Interface	
		—	1	—	1	—	1	—	1	—	1		$\overline{RAS}$, $\overline{CAS}$ ≥ V_{CC} − 0.2V CMOS Interface	
		—	300	—	300	—	300	—	300	—	300	μA	D_{out} = High-Z CMOS Interface L-Version	
$\overline{RAS}$ Only Refresh Current	I_{CC3}	—	90	—	80	—	66	—	55	—	47	mA	t_{RC} = Min	2
Battery Backup Current (Only for L-Version)	I_{CC4}	—	300	—	300	—	300	—	300	—	300	μA	t_{RC} = 125 μs $\overline{CAS}$ Before $\overline{RAS}$ Cycling	4
Standby Current	I_{CC5}	—	5	—	5	—	5	—	5	—	5	mA	$\overline{RAS}$ = V_{IH} $\overline{CAS}$ = V_{IL} D_{out} = Enable	1
$\overline{CAS}$ Before $\overline{RAS}$ Refresh Current	I_{CC6}	—	80	—	70	—	66	—	55	—	47	mA	t_{RC} = Min	
Fast Page Mode Current	I_{CC7}	—	80	—	70	—	55	—	55	—	47	mA	t_{PC} = Min	1, 3
Input Leakage Current	I_{LI}	− 10	10	− 10	10	− 10	10	− 10	10	− 10	10	μA	0V ≤ V_{in} ≤ 7V	
Output Leakage Current	I_{LO}	− 10	10	− 10	10	− 10	10	− 10	10	− 10	10	μA	0V ≤ V_{out} ≤ 7V D_{out} = Disable	

• **DC Characteristics** (T_A = 0 to +70°C, V_{CC} = 5V ±10%, V_{SS} = 0V) (continued)

Item	Symbol	HM514256 A/AL-6 Min	A/AL-6 Max	A/AL-7 Min	A/AL-7 Max	A/AL-8 Min	A/AL-8 Max	A/AL-10 Min	A/AL-10 Max	A/AL-12 Min	A/AL-12 Max	Unit	Test Conditions	Note
Output High Voltage	V_{OH}	2.4	V_{CC}	2.4	V_{CC}	2.4	V_{CC}	2.4	V_{CC}	2.4	V_{CC}	V	High I_{out} = −5 mA	
Output Low Voltage	V_{OL}	0	0.4	0	0.4	0	0.4	0	0.4	0	0.4	V	Low I_{out} = 4.2 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 $\overline{RAS}$ = V_{IL}.
3. Address can be changed once or less while $\overline{CAS}$ = V_{IH}.
4. t_{RAS} = t_{RAS} (min) to 1 μs.
Input Voltage: I/O Pins: $V_{IH} \geq V_{CC} - 0.2V$, $V_{IL} \leq 0.2V$ or High-Z
The Other Pins: $V_{IH} \geq V_{CC} - 0.2V$, or $V_{IL} \leq 0.2V$

• **Capacitance** (T_A = 25°C, V_{CC} ±10%)

Item		Symbol	Typ	Max	Unit	Note
Input Capacitance	Address	C_{I1}	—	5	pF	1
	Clock	C_{I2}	—	7	pF	1
Input/Output Capacitance	Data Input/Data Output	$C_{I/O}$	—	10	pF	1, 2

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

• **AC Characteristics** (T_A = 0 to +70°C, V_{CC} = 5V ±10%, V_{SS} = 0V)[14]

Test Conditions

Input Rise and Fall Times	5 ns
Input Timing Reference Levels	0.8V, 2.4V
Output Load	2 TTL Gate + C_L (100 pF) (Including Scope and Jig)

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

Item	Symbol	HM514256 A/AL-6 Min	A/AL-6 Max	A/AL-7 Min	A/AL-7 Max	A/AL-8 Min	A/AL-8 Max	A/AL-10 Min	A/AL-10 Max	A/AL-12 Min	A/AL-12 Max	Unit	Note
Random Read or Write Cycle Time	t_{RC}	120	—	130	—	160	—	190	—	220	—	ns	
$\overline{RAS}$ Precharge Time	t_{RP}	50	—	50	—	70	—	80	—	90	—	ns	
$\overline{RAS}$ Pulse Width	t_{RAS}	60	10000	70	10000	80	10000	100	10000	120	10000	ns	
$\overline{CAS}$ 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	
$\overline{RAS}$ to $\overline{CAS}$ Delay Time	t_{RCD}	20	40	20	50	22	55	25	75	25	90	ns	8
$\overline{RAS}$ to Column Delay Time	t_{RAD}	15	30	15	35	17	40	20	55	20	65	ns	9
$\overline{RAS}$ Hold Time	t_{RSH}	20	—	20	—	25	—	25	—	30	—	ns	
$\overline{CAS}$ Hold Time	t_{CSH}	60	—	70	—	80	—	100	—	120	—	ns	
$\overline{CAS}$ to $\overline{RAS}$ Precharge Time	t_{CRP}	10	—	10	—	10	—	10	—	10	—	ns	

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

Item	Symbol	HM514256										Unit	Note
		A/AL-6		A/AL-7		A/AL-8		A/AL-10		A/AL-12			
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max		
$\overline{OE}$ to D_{in} Delay Time	t_{ODD}	20	—	20	—	20	—	25	—	30	—	ns	
$\overline{OE}$ Delay Time from D_{in}	t_{DZO}	0	—	0	—	0	—	0	—	0	—	ns	
$\overline{CAS}$ Delay Time from D_{in}	t_{DZC}	0	—	0	—	0	—	0	—	0	—	ns	
Transition Time (Rise and Fall)	t_T	3	50	3	50	3	50	3	50	3	50	ns	1, 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

Item	Symbol	HM514256										Unit	Note
		A/AL-6		A/AL-7		A/AL-8		A/AL-10		A/AL-12			
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max		
Access Time from $\overline{RAS}$	t_{RAC}	—	60	—	70	—	80	—	100	—	120	ns	2, 3
Access Time from $\overline{CAS}$	t_{CAC}	—	20	—	20	—	25	—	25	—	30	ns	3, 4
Access Time from Address	t_{AA}	—	30	—	35	—	40	—	45	—	55	ns	3, 5
Access Time from $\overline{OE}$	t_{OAC}	—	20	—	20	—	25	—	25	—	30	ns	
Read Command Setup Time	t_{RCS}	0	—	0	—	0	—	0	—	0	—	ns	
Read Command Hold Time to $\overline{CAS}$	t_{RCH}	0	—	0	—	0	—	0	—	0	—	ns	
Read Command Hold Time to $\overline{RAS}$	t_{RRH}	10	—	10	—	10	—	10	—	10	—	ns	
Column Address to $\overline{RAS}$ Lead Time	t_{RAL}	30	—	35	—	40	—	45	—	55	—	ns	
Output Buffer Turn-off Time	t_{OFF1}	—	20	—	20	—	20	—	25	—	30	ns	6
Output Buffer Turn-off to $\overline{OE}$	t_{OFF2}	—	20	—	20	—	20	—	25	—	30	ns	6
$\overline{CAS}$ to D_{in} Delay Time	t_{CDD}	20	—	20	—	20	—	25	—	30	—	ns	

Write Cycle

Item	Symbol	HM514256										Unit	Note
		A/AL-6		A/AL-7		A/AL-8		A/AL-10		A/AL-12			
		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 $\overline{RAS}$ Lead Time	t_{RWL}	20	—	20	—	25	—	25	—	30	—	ns	
Write Command to $\overline{CAS}$ 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	—	15	—	20	—	25	—	ns	11

Read-Modify-Write Cycle

Item	Symbol	HM514256										Unit	Note
		A/AL-6		A/AL-7		A/AL-8		A/AL-10		A/AL-12			
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max		
Read-Write Cycle Time	t_{RWC}	170	—	180	—	220	—	255	—	295	—	ns	
$\overline{RAS}$ to $\overline{WE}$ Delay Time	t_{RWD}	85	—	95	—	110	—	135	—	160	—	ns	10
$\overline{CAS}$ to $\overline{WE}$ Delay Time	t_{CWD}	45	—	45	—	55	—	60	—	70	—	ns	10
Column Address to $\overline{WE}$ Delay Time	t_{AWD}	55	—	60	—	70	—	80	—	95	—	ns	10
$\overline{OE}$ Hold Time from $\overline{WE}$	t_{OEH}	20	—	20	—	25	—	25	—	30	—	ns	

Refresh Cycle

Item	Symbol	HM514256										Unit	Note
		A/AL-6		A/AL-7		A/AL-8		A/AL-10		A/AL-12			
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max		
$\overline{CAS}$ Setup Time ($\overline{CAS}$ Before $\overline{RAS}$ Refresh Cycle)	t_{CSR}	10	—	10	—	10	—	10	—	10	—	ns	
$\overline{CAS}$ Hold Time ($\overline{CAS}$ Before $\overline{RAS}$ Refresh Cycle)	t_{CHR}	15	—	15	—	20	—	20	—	25	—	ns	
$\overline{RAS}$ Precharge to $\overline{CAS}$ Hold Time	t_{RPC}	10	—	10	—	10	—	10	—	10	—	ns	

Fast Page Mode Cycle

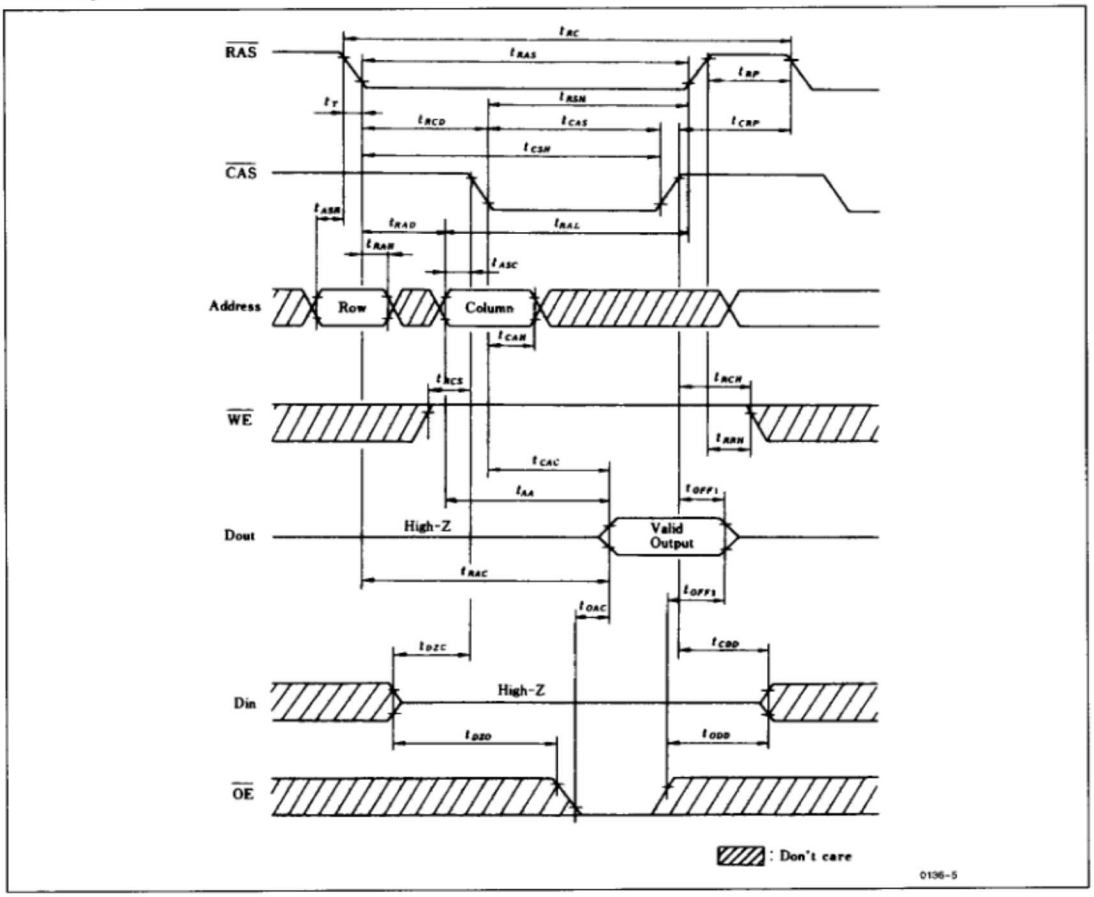
Item	Symbol	HM514256										Unit	Note
		A/AL-6		A/AL-7		A/AL-8		A/AL-10		A/AL-12			
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max		
Fast Page Mode Cycle Time	t_{PC}	45	—	50	—	55	—	55	—	65	—	ns	
Fast Page Mode $\overline{CAS}$ Precharge Time	t_{CP}	10	—	10	—	10	—	10	—	15	—	ns	
Fast Page Mode $\overline{RAS}$ Pulse Width	t_{RASC}	—	100000	—	100000	—	100000	—	1000000	—	100000	ns	12
Access Time from $\overline{CAS}$ Precharge	t_{ACP}	—	40	—	45	—	50	—	50	—	60	ns	13
$\overline{RAS}$ Hold Time from $\overline{CAS}$ Precharge	t_{RHCP}	40	—	45	—	50	—	50	—	60	—	ns	
Fast Page Mode Read-Write Cycle Time	t_{PCM}	95	—	100	—	110	—	115	—	135	—	ns	

Notes:
1. AC measurements assume $t_T = 5$ ns.
2. Assumes that $t_{RCD} \leq t_{RCD}$ (max) and $t_{RAD} \leq t_{RAD}$ (max). If t_{RCD} or t_{RAD} is greater than the maximum recommended value shown in this table, t_{RAC} exceeds the value shown.
3. Measured with a load circuit equivalent to 2 TTL loads and 100 pF.
4. Assumes that $t_{RCD} \geq t_{RCD}$ (max) and $t_{RAD} \leq t_{RAD}$ (max).
5. Assumes that $t_{RCD} \leq t_{RCD}$ (max) and $t_{RAD} \geq t_{RAD}$ (max).
6. t_{OFF} (max) is defined as the time at which the output achieves the open circuit condition and is not referenced to output voltage levels.
7. Transition times are measured between V_{IH} and V_{IL}.
8. Operation with the t_{RCD} (max) limit insures 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 exclusively by t_{CAC}.
9. Operation with the t_{RAD} (max) limit insures 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 exclusively by t_{AA}.

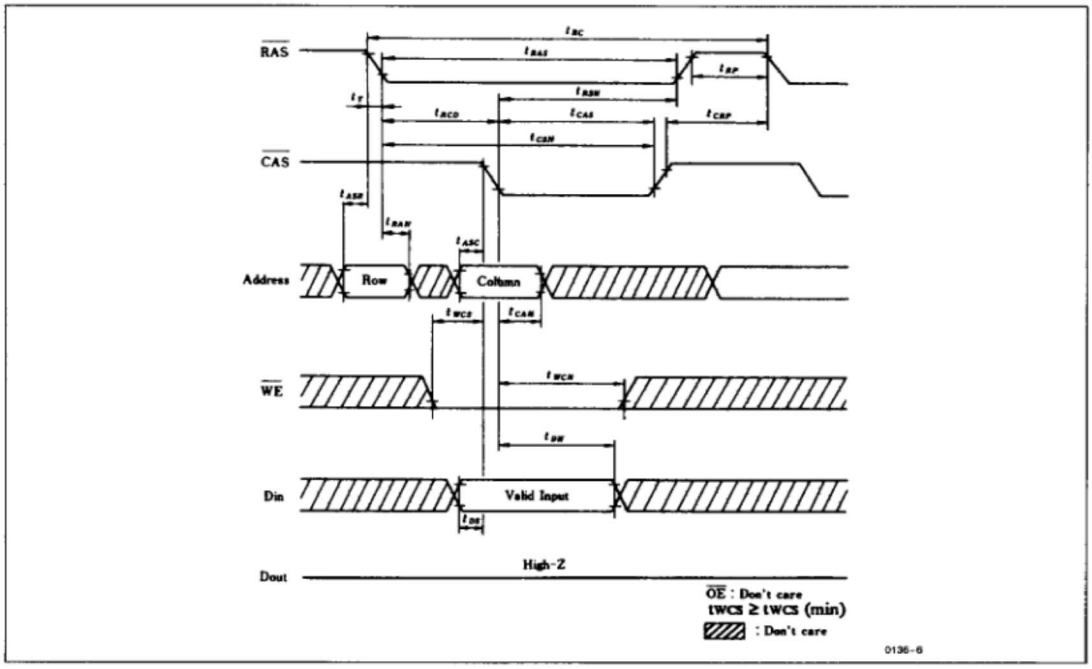
10. t_{WCS}, t_{RWD}, t_{CWD} and t_{AWD} are not restrictive operating parameters. They are included in the data sheet as electrical characteristics only: if $t_{WCS} \geq t_{WCS}$ (min), the cycle is an early write cycle and the data out pin will remain open circuit (high impedance) throughout the entire cycle; if $t_{RWD} \geq t_{RWD}$ (min), $t_{CWD} \geq t_{CWD}$ (min) and $t_{AWD} \geq t_{AWD}$ (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.
11. These parameters are referenced to $\overline{CAS}$ leading edge in early write cycles and to $\overline{WE}$ leading edge in delayed write or read-modify-write cycles.
12. t_{RASC} is determined by $\overline{RAS}$ pulse width in fast page mode cycles.
13. Access time is determined by the longer of t_{AA}, t_{CAC} or t_{ACP}.
14. An initial pause of 100 µs is required after power-up followed by eight or more initialization cycles (any combination of cycles containing $\overline{RAS}$ clock such as $\overline{RAS}$ only refresh). If the internal refresh counter is used, eight or more $\overline{CAS}$ before $\overline{RAS}$ refresh cycles are required.

■ TIMING WAVEFORMS

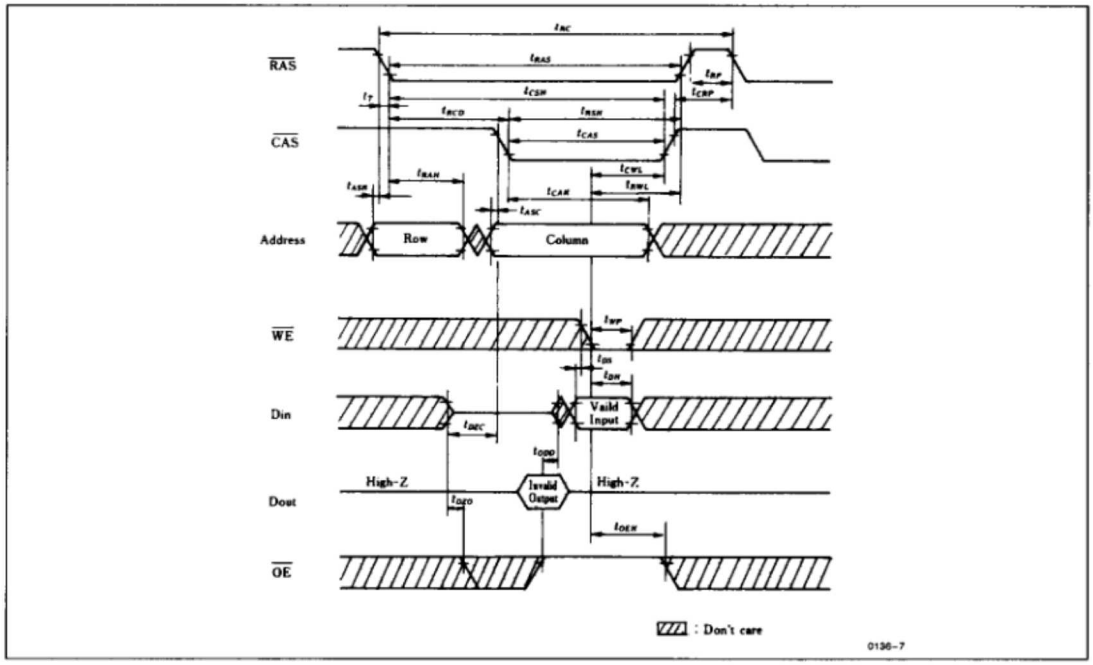
• Read Cycle



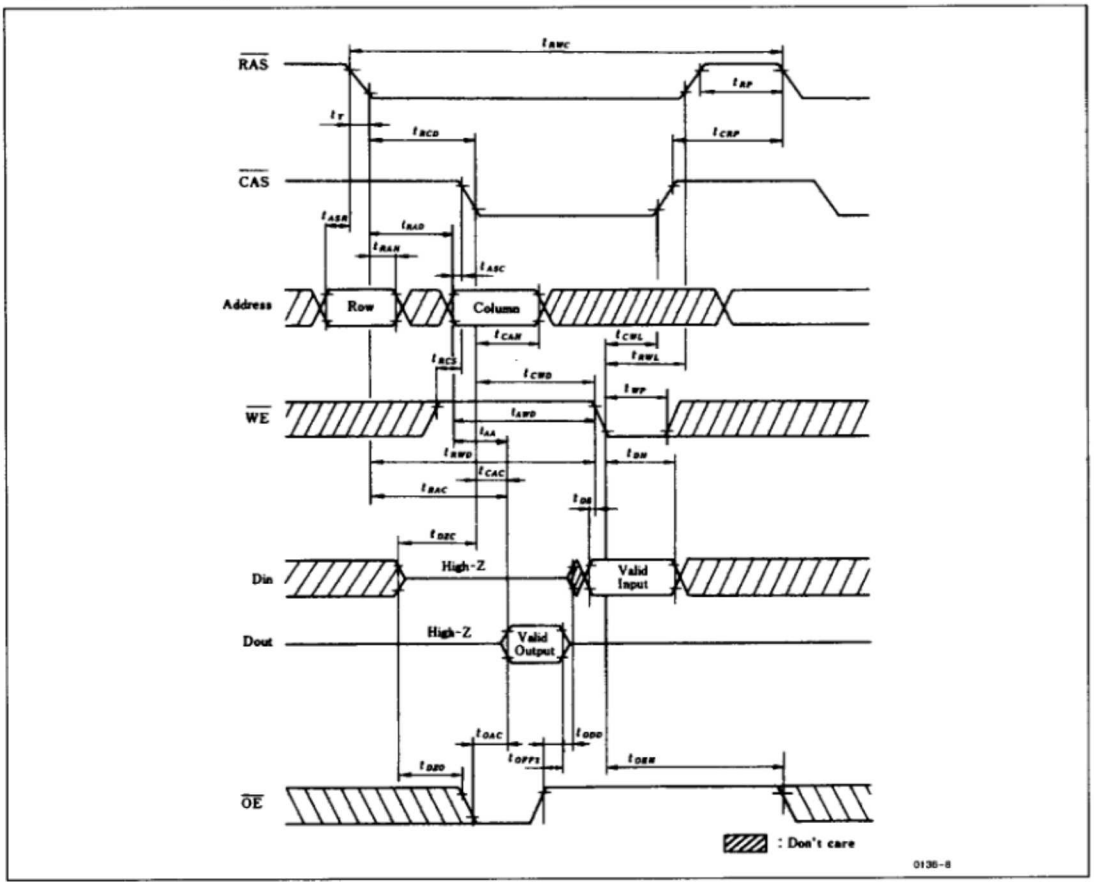
• **Early Write Cycle**



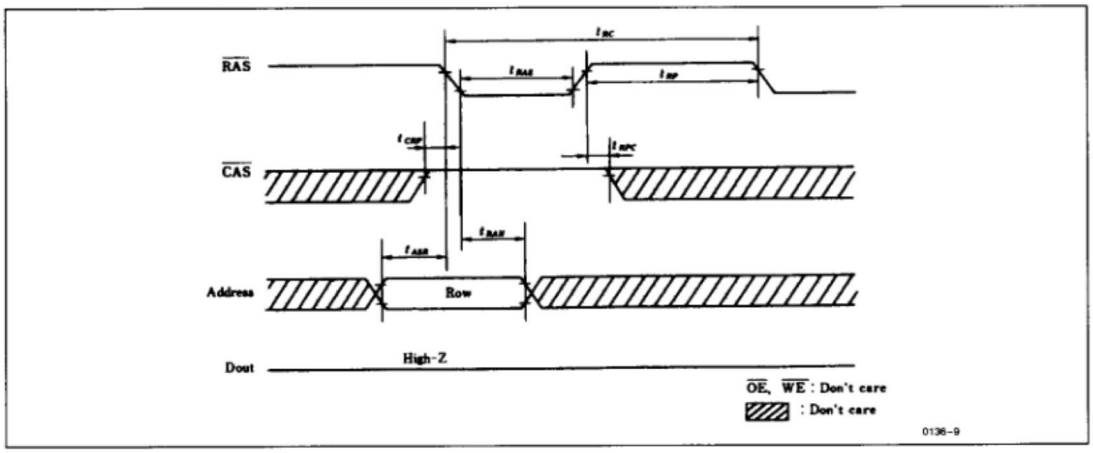
• **Delayed Write Cycle**



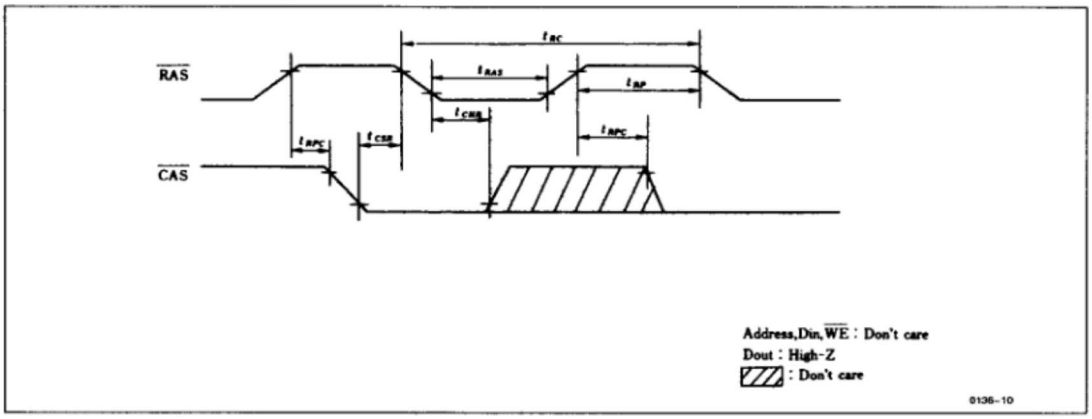
• **Read-Modify-Write Cycle**



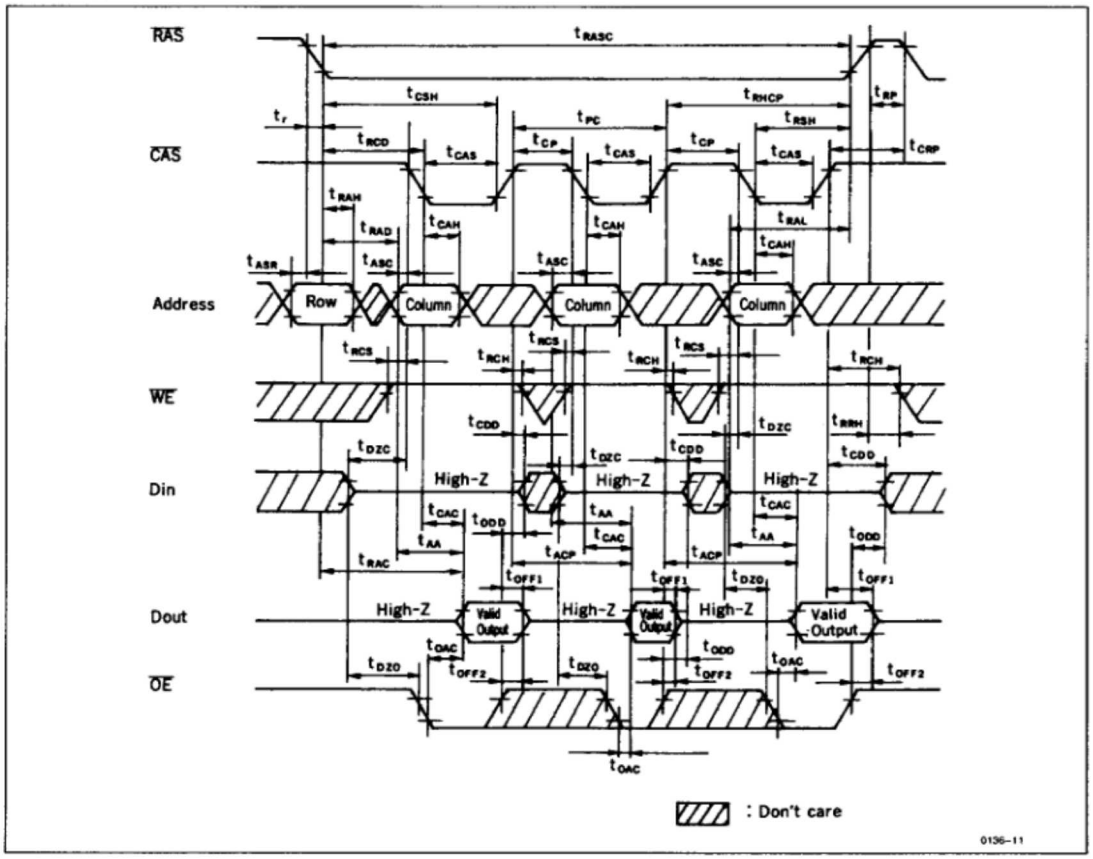
• **$\overline{RAS}$ Only Refresh Cycle**



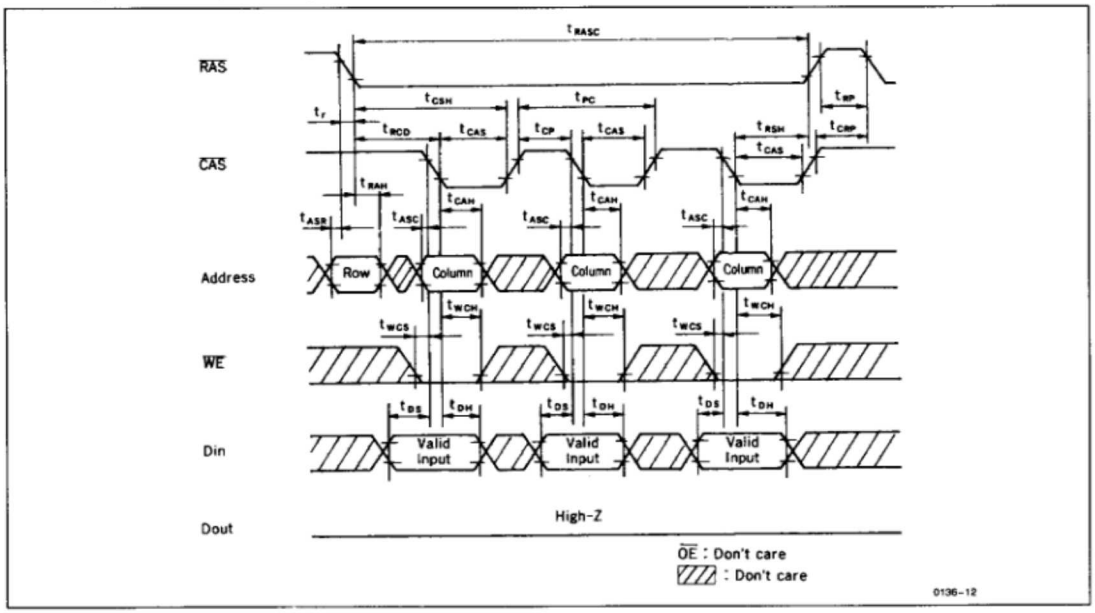
• $\overline{CAS}$ Before $\overline{RAS}$ Refresh Cycle



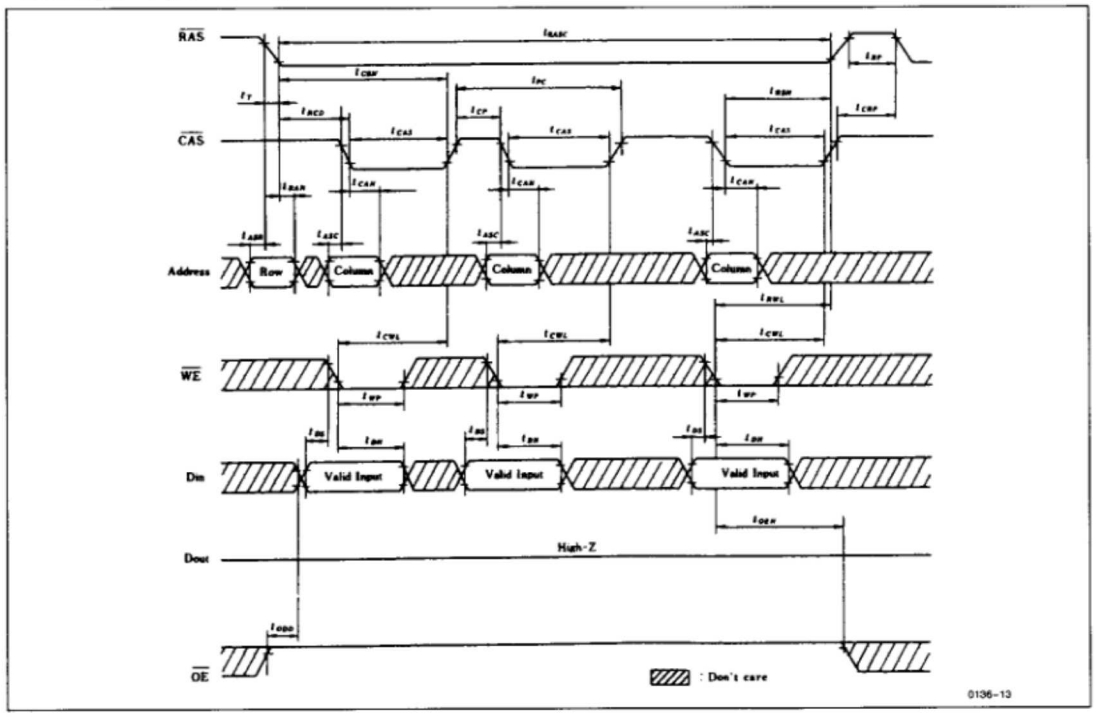
• Fast Page Mode Read Cycle



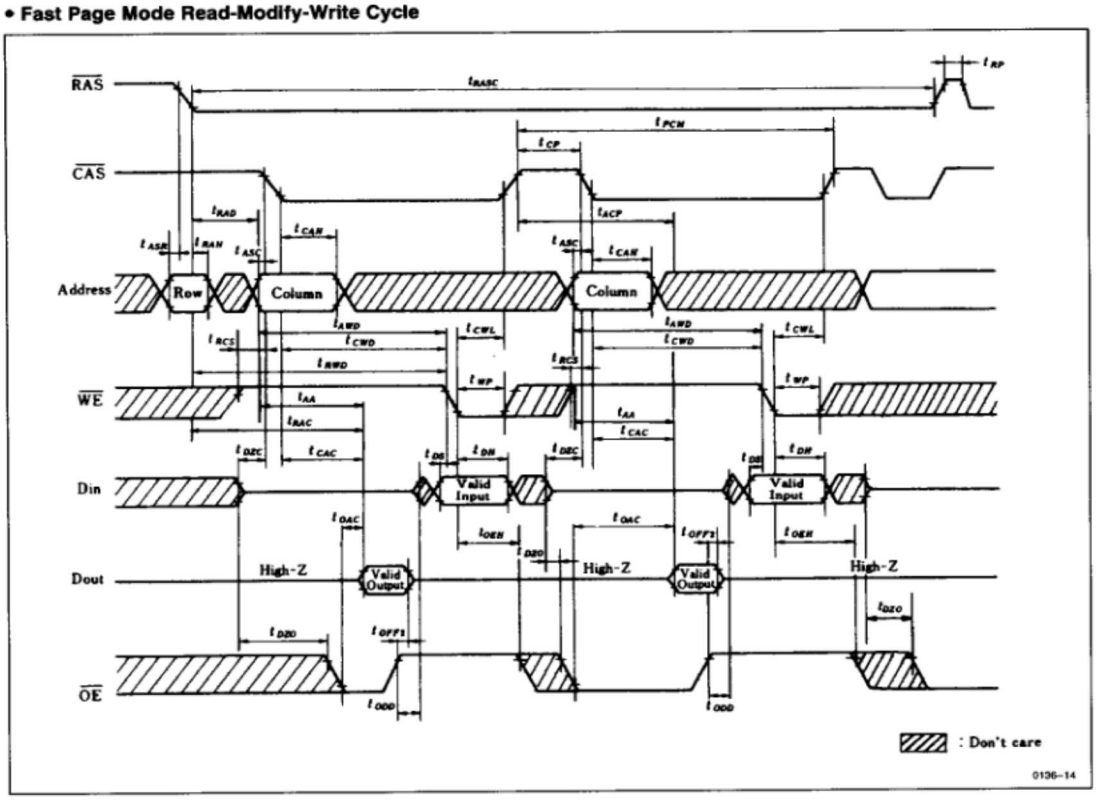
• **Fast Page Mode Early Write Cycle**



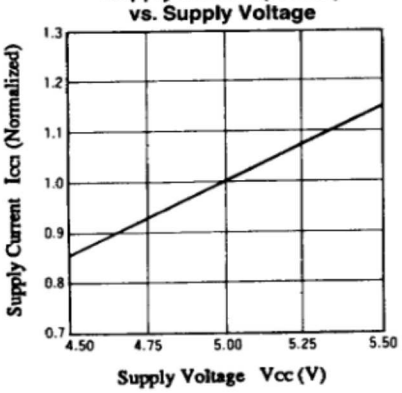
• **Fast Page Delayed Write Cycle**



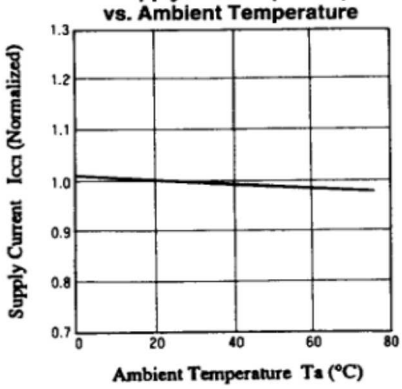
• Fast Page Mode Read-Modify-Write Cycle



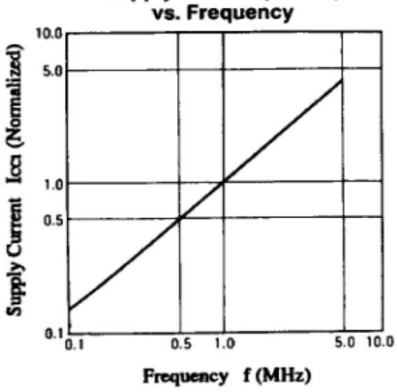
Supply Current (Active) vs. Supply Voltage



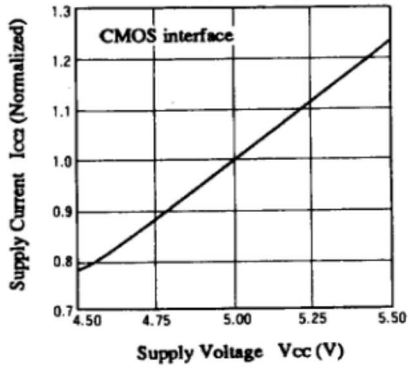
Supply Current (Active) vs. Ambient Temperature



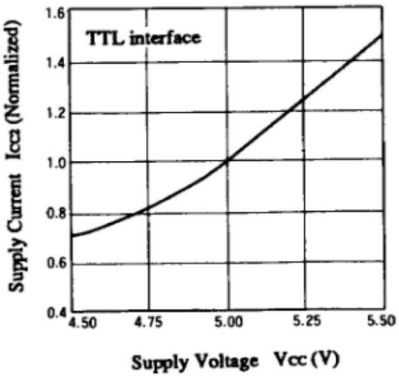
Supply Current (Active) vs. Frequency



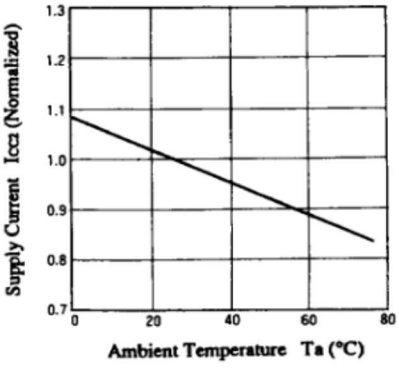
Supply Current (Standby) vs. Supply Voltage



Supply Current (Standby) vs. Supply Voltage

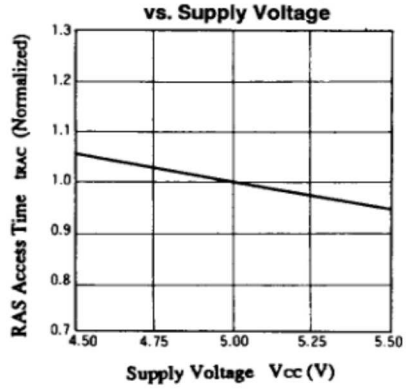


Supply Current (Standby) vs. Ambient Temperature

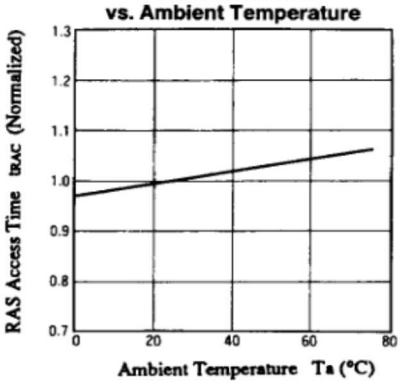


0136-15

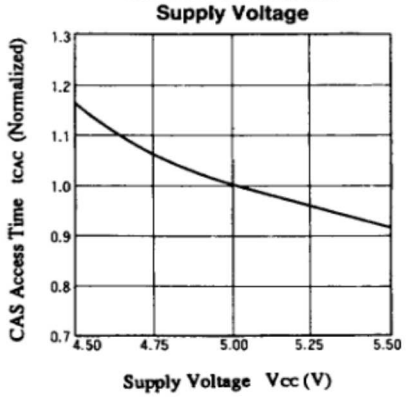
$\overline{RAS}$ Access Time vs. Supply Voltage



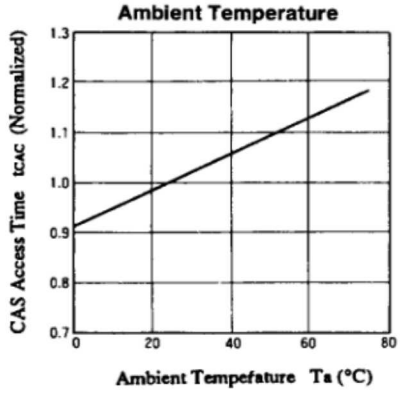
$\overline{RAS}$ Access Time vs. Ambient Temperature



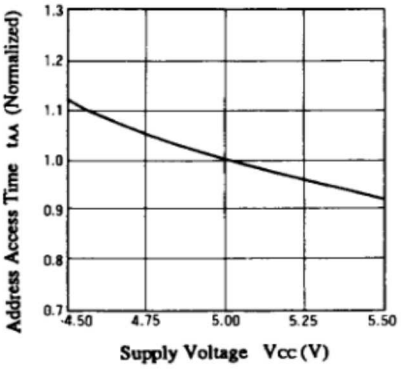
$\overline{CAS}$ Access Time vs. Supply Voltage



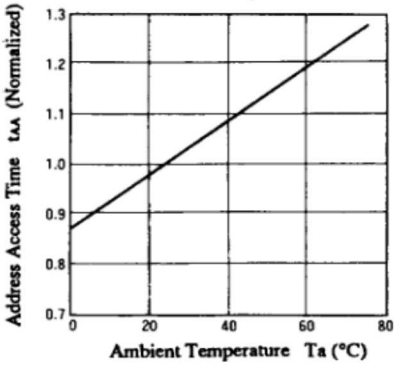
$\overline{CAS}$ Access Time vs. Ambient Temperature



Address Access Time vs. Supply Voltage



Address Access Time vs. Ambient Temperature



0136-16