

MOTOROLA SEMICONDUCTOR TECHNICAL DATA

512K x 32 Bit Dynamic Random Access Memory Module

The MCM32512 is a 16M dynamic random access memory (DRAM) module organized as 524,288 x 32 bits. The module is a 72-lead double-sided single-in-line memory module (SIMM) consisting of sixteen MCM514256A DRAMs housed in 20/26 J-lead small outline packages (SOJ) mounted on a substrate along with a 0.22 μ F (min) decoupling capacitor mounted under each DRAM. The MCM514256A is a 1.0 μ CMOS high-speed dynamic random access memory organized as 262,144 four-bit words and fabricated with CMOS silicon-gate process technology.

- Three-State Data Output
- Early-Write Common I/O Capability
- Fast Page Mode Capability
- TTL-Compatible Inputs and Outputs
- $\overline{\text{RAS}}$ -Only Refresh
- $\overline{\text{CAS}}$ Before $\overline{\text{RAS}}$ Refresh
- Hidden Refresh
- 512 Cycle Refresh:
 - MCM32512 = 8 ms (Max)
 - MCM32L512 = 64 ms (Max)
- Consists of Sixteen 256K x 4 DRAMs and Sixteen 0.22 μ F (Min) Decoupling Capacitors
- Unlatched Data Out at Cycle End Allows Two Dimensional Chip Selection
- Fast Access Time (t_{RAC}): MCM32512-70 = 70 ns (Max)
MCM32512-80 = 80 ns (Max)
- Low Active Power Dissipation: MCM32512-70 = 3.608 W (Max)
MCM32512-80 = 3.168 W (Max)
- Low Standby Power Dissipation: TTL Levels = 176 mW (Max)
CMOS Levels = 88 mW (Max, MCM32512)
= 18 mW (Max, MCM32L512)
- Available in 60 ns Access Time (t_{RAC}): MCM32B512AS60

PIN NAMES

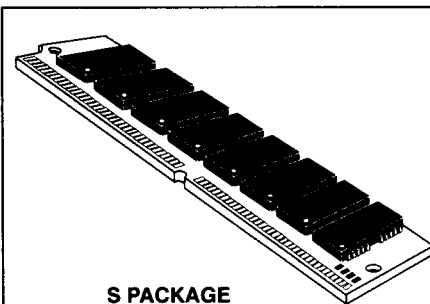
A0 – A8 Address Inputs	DQ0 – DQ31 Data Input/Output
CAS0 – CAS3 Column Address Strobe	PD1 – PD4 Presence Detect
RAS0 – RAS3 Row Address Strobe	W Read/Write Input
VCC Power (+ 5 V)	VSS Ground
NC No Connection	

All power supply and ground pins must be connected for proper operation of the device.

PIN OUT

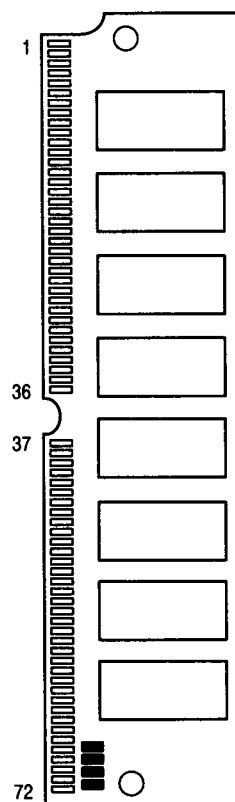
Pin	Name	Pin	Name	Pin	Name	Pin	Name	Pin	Name	Pin	Name
1	VSS	13	A1	25	DQ22	37	NC	49	DQ8	61	DQ13
2	DQ0	14	A2	26	DQ7	38	NC	50	DQ24	62	DQ30
3	DQ16	15	A3	27	DQ23	39	VSS	51	DQ9	63	DQ14
4	DQ1	16	A4	28	A7	40	CAS0	52	DQ25	64	DQ31
5	DQ17	17	A5	29	NC	41	CAS2	53	DQ10	65	DQ15
6	DQ2	18	A6	30	VCC	42	CAS3	54	DQ26	66	NC
7	DQ18	19	NC	31	A8	43	CAS1	55	DQ11	67	PD1
8	DQ3	20	DQ4	32	NC	44	RAS0	56	DQ27	68	PD2
9	DQ19	21	DQ20	33	$\overline{\text{RAS3}}$	45	RAS1	57	DQ12	69	PD3
10	VCC	22	DQ5	34	$\overline{\text{RAS2}}$	46	NC	58	DQ28	70	PD4
11	NC	23	DQ21	35	NC	47	W	59	VCC	71	NC
12	A0	24	DQ6	36	NC	48	NC	60	DQ29	72	VSS

MCM32512 MCM32L512



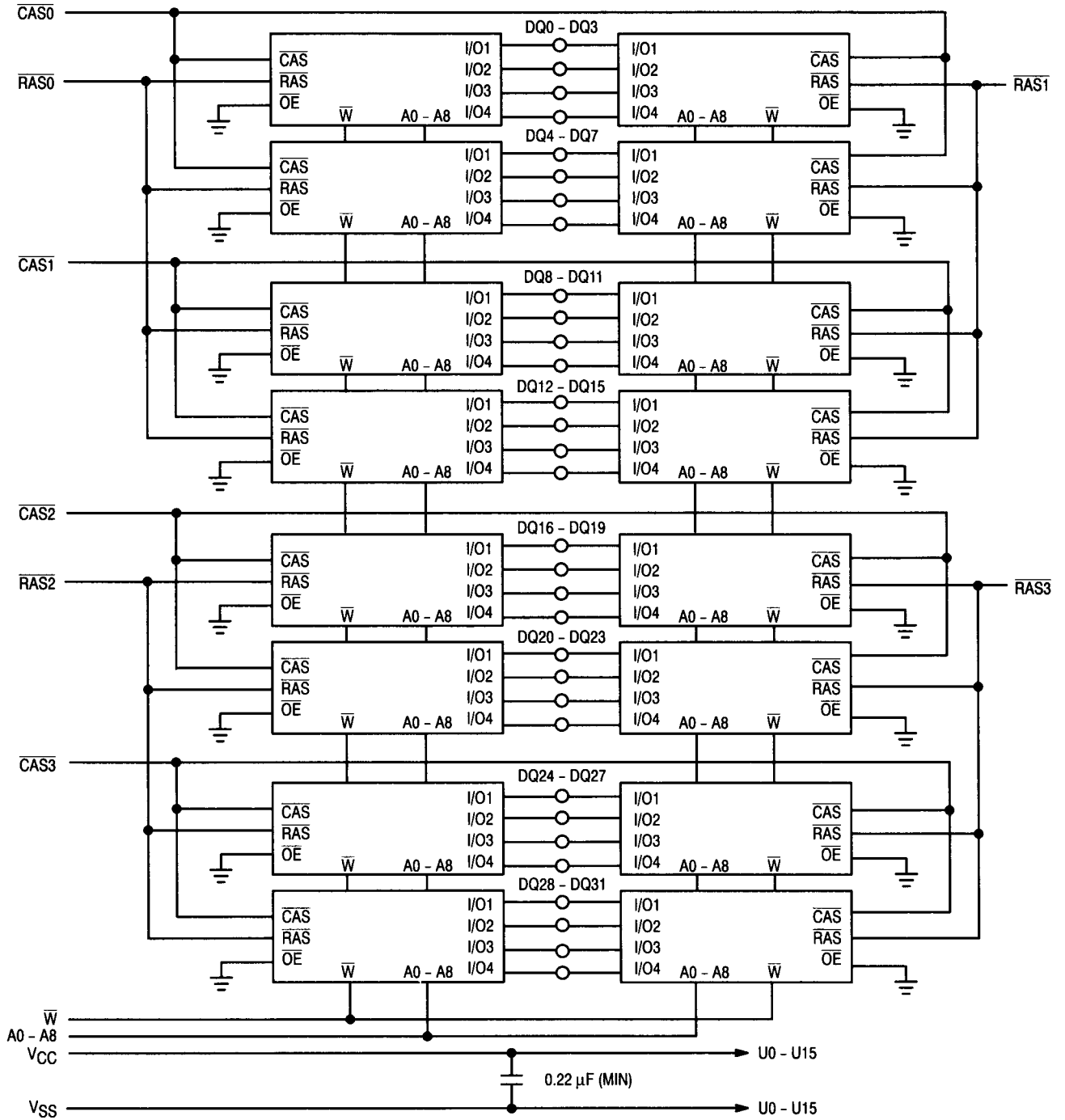
S PACKAGE
SIMM MODULE
CASE 866-02

TOP VIEW



MOTOROLA

BLOCK DIAGRAM



PRESENCE DETECT PIN OUT

Pin Name	70 ns	80 ns
PD1	NC	NC
PD2	VSS	VSS
PD3	VSS	NC
PD4	NC	VSS

ABSOLUTE MAXIMUM RATINGS (See Note)

Rating	Symbol	Value	Unit
Power Supply Voltage	V_{CC}	- 1 to + 7	V
Voltage Relative to V_{SS} (For Any Pin Except V_{CC})	V_{in}, V_{out}	- 1 to + 7	V
Data Output Current per DQ Pin	I_{out}	50	mA
Power Dissipation	P_D	4.92	W
Operating Temperature Range	T_A	0 to + 70	°C
Storage Temperature Range	T_{stg}	- 55 to + 125	°C

NOTE: Permanent device damage may occur if ABSOLUTE MAXIMUM RATINGS are exceeded. Functional operation should be restricted to RECOMMENDED OPERATING CONDITIONS. Exposure to higher than recommended voltages for extended periods of time could affect device reliability.

This device contains circuitry to protect the inputs against damage due to high static voltages or electric fields; however, it is advised that normal precautions be taken to avoid application of any voltage higher than maximum rated voltages to these high-impedance circuits.

DC OPERATING CONDITIONS AND CHARACTERISTICS

($V_{CC} = 5.0 \text{ V} \pm 10\%$, $T_A = 0 \text{ to } 70^\circ\text{C}$, Unless Otherwise Noted)

RECOMMENDED OPERATING CONDITIONS (All voltages referenced to V_{SS})

Parameter	Symbol	Min	Typ	Max	Unit
Supply Voltage (Operating Voltage Range)	V_{CC}	4.5	5.0	5.5	V
	V_{SS}	0	0	0	
Logic High Voltage, All Inputs	V_{IH}	2.4	—	6.5	V
Logic Low Voltage, All Inputs	V_{IL}	- 1.0	—	0.8	V

DC CHARACTERISTICS AND SUPPLY CURRENTS

Characteristic	Symbol	Min	Max	Unit	Notes
V_{CC} Power Supply Current MCM32512-70, $t_{RC} = 130 \text{ ns}$ MCM32512-80, $t_{RC} = 150 \text{ ns}$	I_{CC1}	—	656 576	mA	1
V_{CC} Power Supply Current (Standby) ($\overline{RAS} = \overline{CAS} = V_{IH}$)	I_{CC2}	—	32	mA	
V_{CC} Power Supply Current During \overline{RAS} -Only Refresh Cycles MCM32512-70, $t_{RC} = 130 \text{ ns}$ MCM32512-80, $t_{RC} = 150 \text{ ns}$	I_{CC3}	—	656 576	mA	1
V_{CC} Power Supply Current During Fast Page Mode Cycle MCM32512-70, $t_{PC} = 40 \text{ ns}$ MCM32512-80, $t_{PC} = 45 \text{ ns}$	I_{CC4}	—	496 416	mA	1, 2
V_{CC} Power Supply Current (Standby) ($\overline{RAS} = \overline{CAS} = V_{CC} - 0.2 \text{ V}$) MCM32512 MCM32L512	I_{CC5}	—	16 3.2	mA	
V_{CC} Power Supply Current During \overline{CAS} Before \overline{RAS} Refresh Cycle MCM32512-70, $t_{RC} = 130 \text{ ns}$ MCM32512-80, $t_{RC} = 150 \text{ ns}$	I_{CC6}	—	656 576	mA	1
V_{CC} Power Supply Current Battery Backup Mode ($t_{RC} = 125 \mu\text{s}$; $\overline{CAS} = \overline{CAS}$ before \overline{RAS} Cycling or 0.2 V; $\overline{W}, DQ, A0 - A8 = V_{CC} - 0.2 \text{ V}$ or 0.2 V) $t_{RAS} = 1 \mu\text{s}$ MCM32L512 only	I_{CC7}	—	4.8	mA	3
Input Leakage Current ($V_{SS} \leq V_{in} \leq V_{CC}$)	$I_{kg(I)}$	- 160	160	μA	
Output Leakage Current (\overline{CAS} at Logic 1, $V_{SS} \leq V_{out} \leq V_{CC}$)	$I_{kg(O)}$	- 20	20	μA	
Output High Voltage ($I_{OH} = - 5 \text{ mA}$)	V_{OH}	2.4	—	V	
Output Low Voltage ($I_{OL} = 4.2 \text{ mA}$)	V_{OL}	—	0.4	V	

NOTES:

- Current is a function of cycle rate and output loading; maximum current is measured at the fastest cycle rate with the output open.
- Measured with one address transition per page mode cycle.
- $t_{RAS}(\text{max}) = 1 \mu\text{s}$ is applied to refresh of battery backup. $t_{RAS}(\text{max}) = 10 \mu\text{s}$ is applied to functional operating.

CAPACITANCE ($f = 1.0 \text{ MHz}$, $T_A = 25^\circ\text{C}$, $V_{CC} = 5 \text{ V}$, Periodically Sampled Rather Than 100% Tested)

Characteristic	Symbol	Min	Max	Unit
Input Capacitance (A0 – A8)	C_{I1}	—	90	pF
Input Capacitance (\overline{W})	C_{I2}	—	122	pF
Input Capacitance (RAS0 – RAS3)	C_{I3}	—	38	pF
Input Capacitance (CAS0 – CAS3)	C_{I4}	—	38	pF
I/O Capacitance (DQ0 – DQ31)	C_{DQ}	—	24	pF

NOTE: Capacitance measured with a Boonton Meter or effective capacitance calculated from the equation: $C = I \Delta t / \Delta V$.

AC OPERATING CONDITIONS AND CHARACTERISTICS

($V_{CC} = 5.0 \text{ V} \pm 10\%$, $T_A = 0 \text{ to } 70^\circ\text{C}$, Unless Otherwise Noted)

READ AND WRITE CYCLES (See Notes 1, 2, 3, and 4)

Parameter	Symbol		MCM32512-70 MCM32L512-70		MCM32512-80 MCM32L512-80		Unit	Notes
	Standard	Alternate	Min	Max	Min	Max		
Random Read or Write Cycle Time	t_{RELREL}	t_{RC}	130	—	150	—	ns	5
Page Mode Cycle Time	t_{CELCEL}	t_{PC}	40	—	45	—	ns	
Access Time from \overline{RAS}	t_{RELQV}	t_{RAC}	—	70	—	80	ns	6, 7
Access Time from \overline{CAS}	t_{CELQV}	t_{CAC}	—	20	—	20	ns	6, 8
Access Time from Column Address	t_{AVQV}	t_{AA}	—	35	—	40	ns	6, 9
Access Time from Precharge \overline{CAS}	t_{CEHQV}	t_{CPA}	—	35	—	40	ns	6
\overline{CAS} to Output in Low-Z	t_{CELQX}	t_{CLZ}	0	—	0	—	ns	6
Output Buffer and Turn-Off Delay	t_{CEHQZ}	t_{OFF}	0	20	0	20	ns	10
Transition Time (Rise and Fall)	t_T	t_T	3	50	3	50	ns	
\overline{RAS} Precharge Time	t_{REHREL}	t_{RP}	50	—	60	—	ns	
\overline{RAS} Pulse Width	t_{RELREH}	t_{RAS}	70	10,000	80	10,000	ns	
\overline{RAS} Pulse Width (Fast Page Mode)	t_{RELREH}	t_{RASP}	70	100,000	80	100,000	ns	
\overline{RAS} Hold Time	t_{CELREH}	t_{RSH}	20	—	20	—	ns	
\overline{CAS} Hold Time	t_{RELCEH}	t_{CSH}	70	—	80	—	ns	
\overline{CAS} Pulse Width	t_{CELCEH}	t_{CAS}	20	10,000	20	10,000	ns	
\overline{RAS} to \overline{CAS} Delay Time	t_{RELCEL}	t_{RCD}	20	50	20	60	ns	11
\overline{RAS} to Column Address Delay Time	t_{RELAV}	t_{RAD}	15	35	15	40	ns	12

NOTES:

(continued)

- V_{IH} (min) and V_{IL} (max) are reference levels for measuring timing of input signals. Transition times are measured between V_{IH} and V_{IL} .
- An initial pause of 200 μs is required after power-up followed by 8 \overline{RAS} cycles before proper device operation is guaranteed.
- The transition time specification applies for all input signals. In addition to meeting the transition rate specification, all input signals must transition between V_{IH} and V_{IL} (or between V_{IL} and V_{IH}) in a monotonic manner.
- AC measurements $t_T = 5.0 \text{ ns}$.
- The specification for t_{RC} (min) is used only to indicate cycle time at which proper operation over the full temperature range ($0^\circ\text{C} \leq T_A \leq 70^\circ\text{C}$) is ensured.
- Measured with a current load equivalent to 2 TTL ($-200 \mu\text{A}$, $+4 \text{ mA}$) loads and 100 pF with the data output trip points set at $V_{OH} = 2.0 \text{ V}$ and $V_{OL} = 0.8 \text{ V}$.
- Assumes that $t_{RCD} \leq t_{RCD}(\text{max})$.
- Assumes that $t_{RCD} \geq t_{RCD}(\text{max})$.
- Assumes that $t_{RAD} \geq t_{RAD}(\text{max})$.
- $t_{OFF}(\text{max})$ defines the time at which the output achieves the open circuit condition and is not referenced to output voltage levels.
- Operation within the $t_{RCD}(\text{max})$ limit ensures 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 within the $t_{RAD}(\text{max})$ limit ensures 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 $t_{RAD}(\text{max})$, then access time is controlled exclusively by t_{AA} .

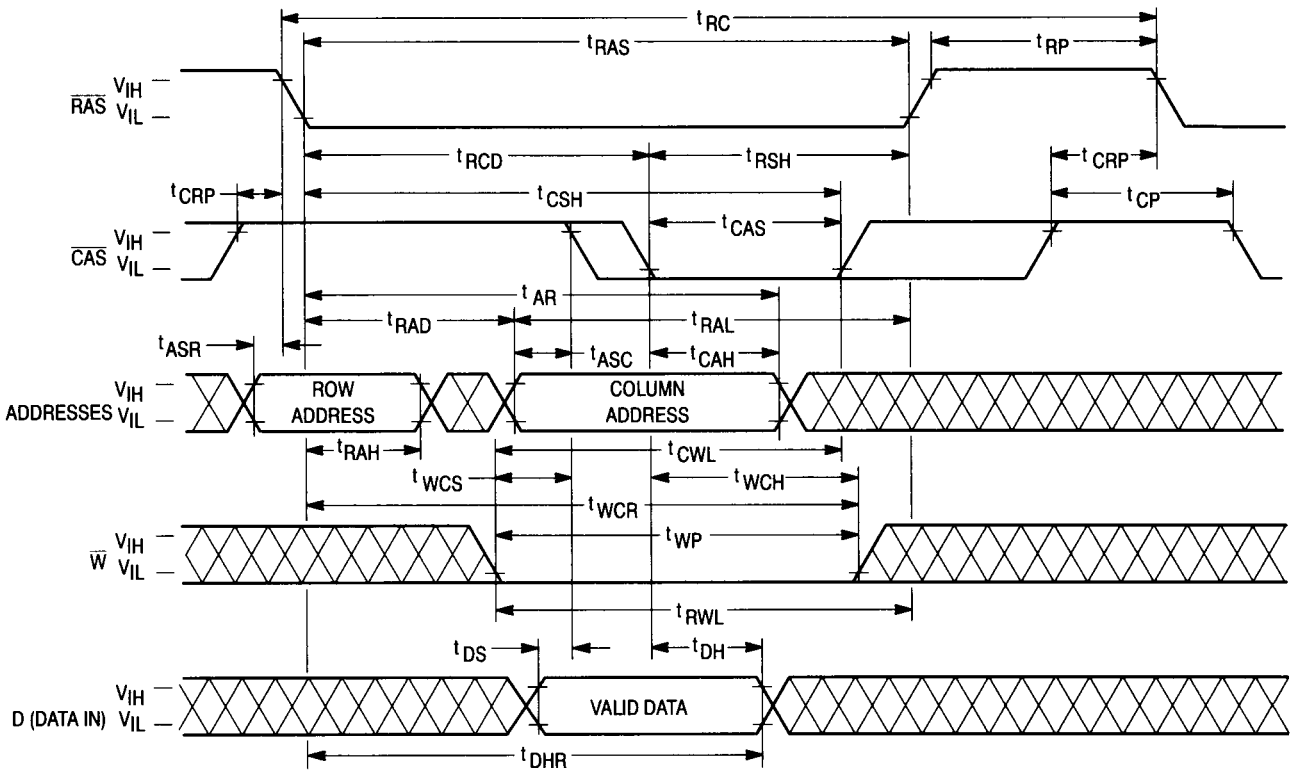
READ AND WRITE CYCLES (Continued)

Parameter	Symbol		MCM32512-70 MCM32L512-70		MCM32512-80 MCM32L512-80		Unit	Notes
	Standard	Alternate	Min	Max	Min	Max		
CAS to $\overline{\text{RAS}}$ Precharge Time	t_{CEHREL}	t_{CRP}	5	—	5	—	ns	
$\overline{\text{CAS}}$ Precharge Time (Page Mode Cycle Only)	t_{CEHCEL}	t_{CP}	10	—	10	—	ns	
Row Address Setup Time	t_{AVREL}	t_{ASR}	0	—	0	—	ns	
Row Address Hold Time	t_{RELAX}	t_{RAH}	10	—	10	—	ns	
Column Address Setup Time	t_{AVCEL}	t_{ASC}	0	—	0	—	ns	
Column Address Hold Time	t_{CELAX}	t_{CAH}	15	—	15	—	ns	
Column Address Hold Time Referenced to $\overline{\text{RAS}}$	t_{RELAX}	t_{AR}	55	—	60	—	ns	
Column Address to $\overline{\text{RAS}}$ Lead Time	t_{AVREH}	t_{RAL}	35	—	40	—	ns	
Read Command Setup Time	t_{WHCEL}	t_{RCS}	0	—	0	—	ns	
Read Command Hold Time Referenced to $\overline{\text{CAS}}$	t_{CEHWX}	t_{RCH}	0	—	0	—	ns	13
Read Command Hold Time Referenced to $\overline{\text{RAS}}$	t_{REHWX}	t_{RRH}	0	—	0	—	ns	13
Write Command Hold Time Referenced to $\overline{\text{CAS}}$	t_{CELWH}	t_{WCH}	15	—	15	—	ns	
Write Command Hold Time Referenced to $\overline{\text{RAS}}$	t_{RELWH}	t_{WCR}	55	—	60	—	ns	
Write Command Pulse Width	t_{WLWH}	t_{WP}	15	—	15	—	ns	
Write Command to $\overline{\text{RAS}}$ Lead Time	t_{WLREH}	t_{RWL}	20	—	20	—	ns	
Write Command to $\overline{\text{CAS}}$ Lead Time	t_{WLCEH}	t_{CWL}	20	—	20	—	ns	
Data in Setup Time	t_{DVCEL}	t_{DS}	0	—	0	—	ns	14
Data in Hold Time	t_{CELDX}	t_{DH}	15	—	15	—	ns	14
Data in Hold Time Referenced to $\overline{\text{RAS}}$	t_{RELDX}	t_{DHR}	55	—	60	—	ns	
Refresh Period	MCM32512 MCM32L512	t_{RVRV}	t_{RFSH}	— 8 64	— 8 64	— 8 64	ms	
Write Command Setup Time	t_{WLCEL}	t_{WCS}	0	—	0	—	ns	15
$\overline{\text{CAS}}$ Setup Time for $\overline{\text{CAS}}$ Before $\overline{\text{RAS}}$ Refresh	t_{RELCEL}	t_{CSR}	10	—	10	—	ns	
$\overline{\text{CAS}}$ Hold Time for $\overline{\text{CAS}}$ Before $\overline{\text{RAS}}$ Refresh	t_{RELCEH}	t_{CHR}	30	—	30	—	ns	
$\overline{\text{CAS}}$ Precharge to $\overline{\text{CAS}}$ Active Time	t_{REHCEL}	t_{RPC}	0	—	0	—	ns	
$\overline{\text{CAS}}$ Precharge Time for $\overline{\text{CAS}}$ Before $\overline{\text{RAS}}$ Counter Test	t_{CEHCEL}	t_{CPT}	40	—	40	—	ns	
$\overline{\text{CAS}}$ Precharge Time	t_{CEHCEL}	t_{CPN}	10	—	10	—	ns	

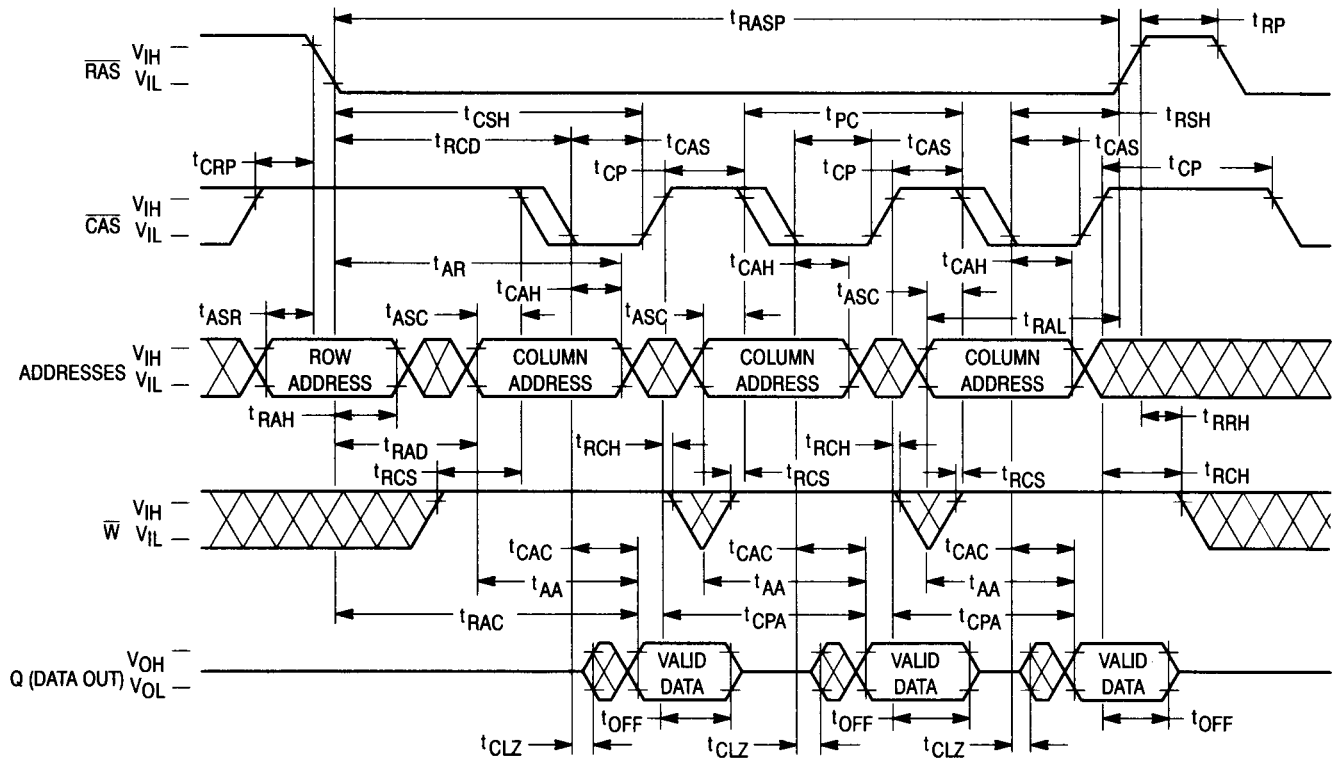
NOTES:

13. Either t_{RRH} or t_{RCH} must be satisfied for a read cycle.
14. These parameters are referenced to $\overline{\text{CAS}}$ leading edge in random write cycles.
15. t_{WCS} is not a restrictive operating parameter. It is included in the data sheet as an electrical characteristic only; if $t_{\text{WCS}} \geq t_{\text{WCS}}(\text{min})$, the cycle is an early write cycle and the data out pin will remain open circuit (high impedance) throughout the entire cycle. If this condition is not satisfied, the condition of the data out (at access time) is indeterminate.
16. To avoid bus contention and potential damage to the module, $\overline{\text{RAS0}}$ and $\overline{\text{RAS1}}$ may not be active low simultaneously. Similarly, $\overline{\text{RAS2}}$ and $\overline{\text{RAS3}}$ may not be simultaneously active low.

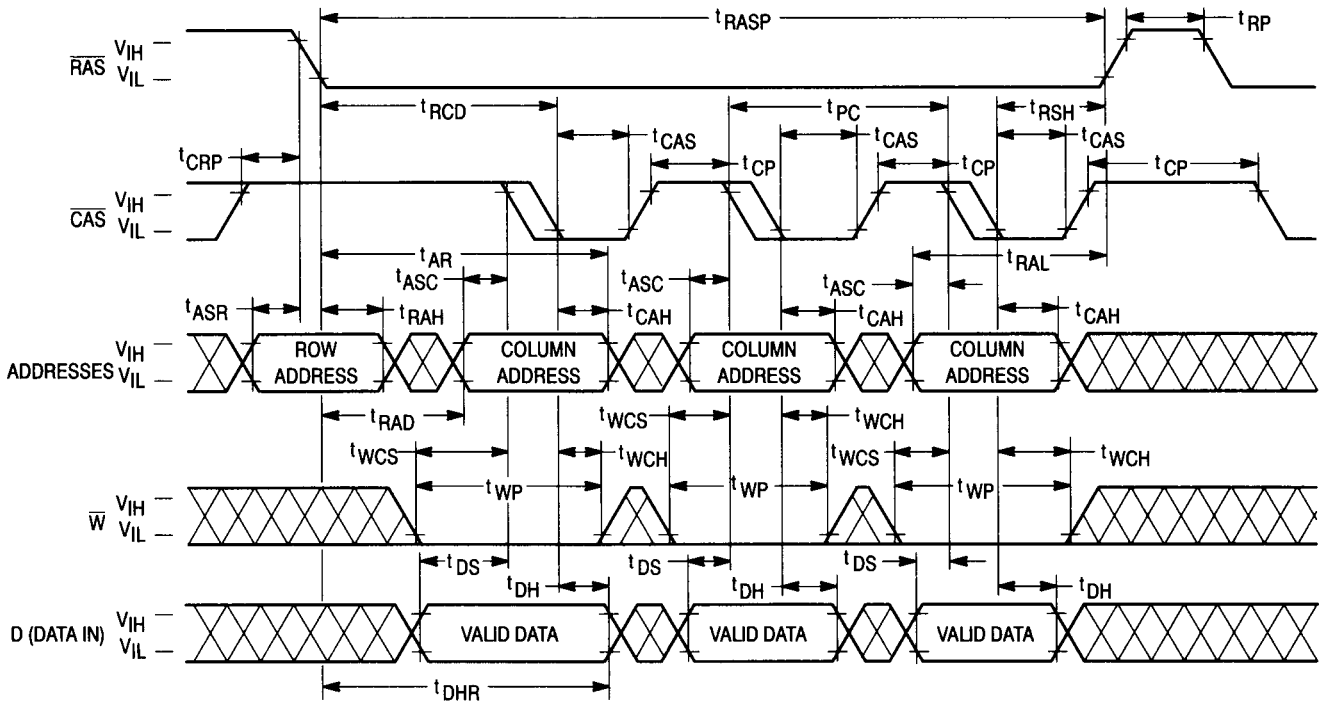
EARLY WRITE CYCLE



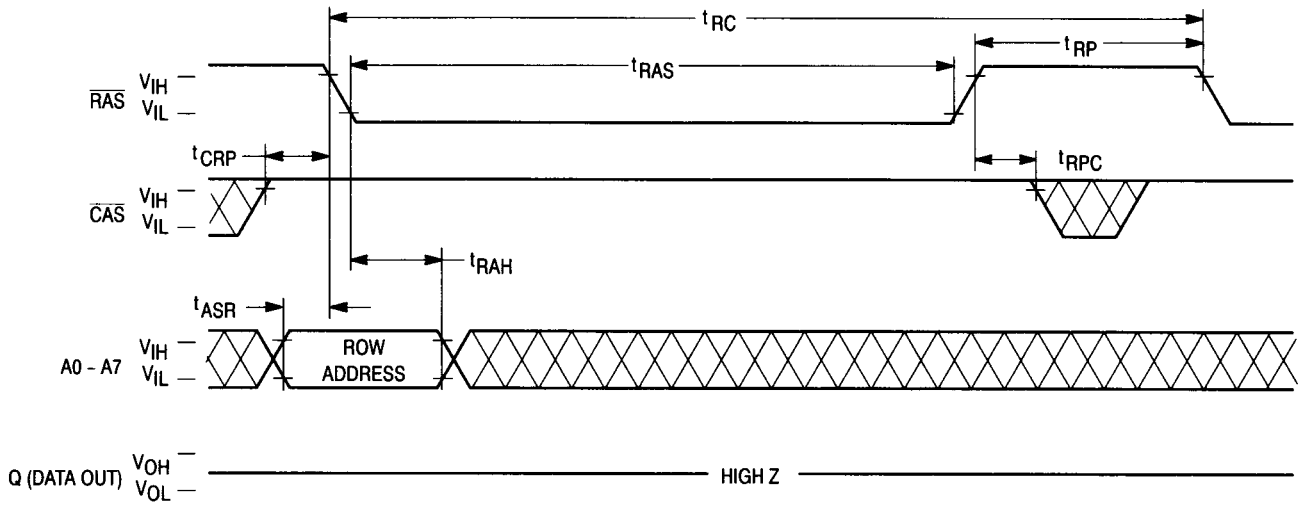
FAST PAGE MODE READ CYCLE



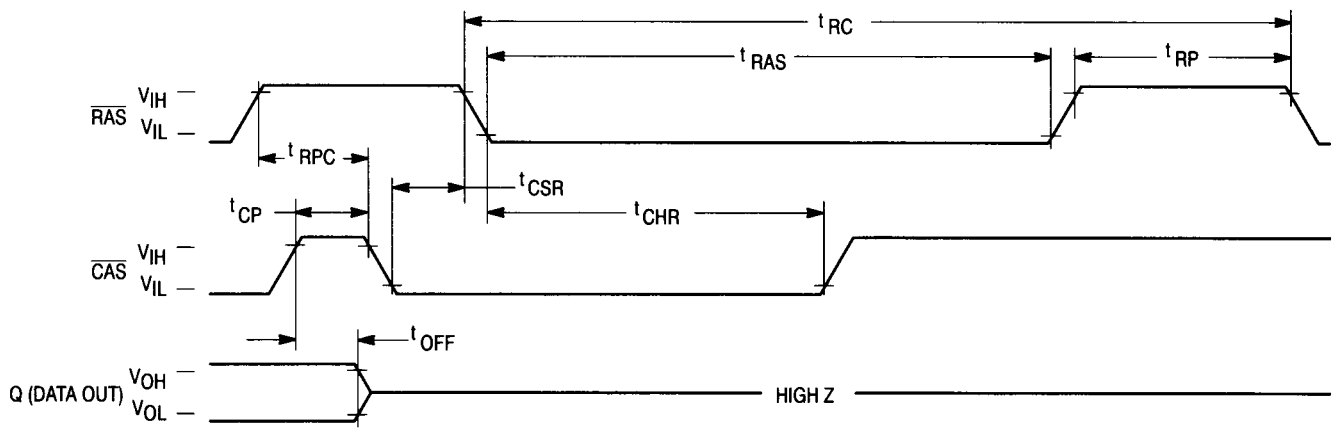
FAST PAGE MODE WRITE CYCLE (EARLY WRITE)



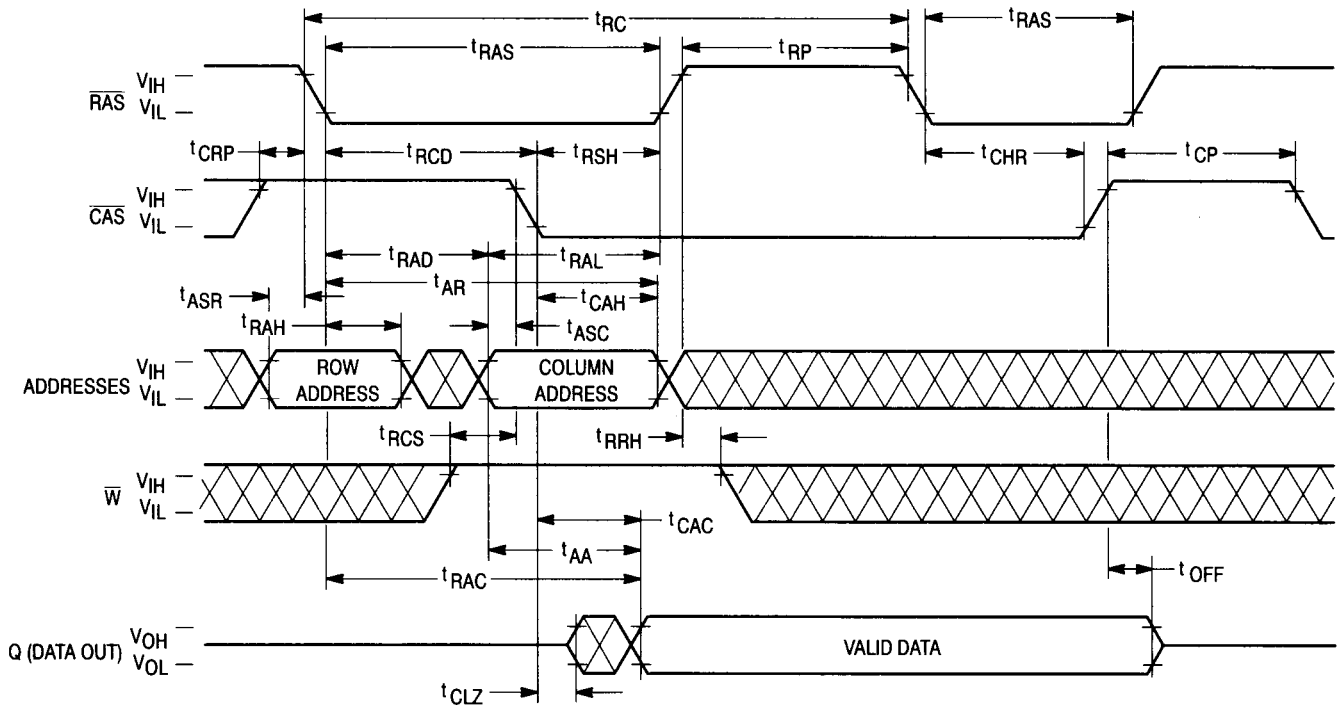
RAS-ONLY REFRESH CYCLE
(\overline{W} and A8 are Don't Care)



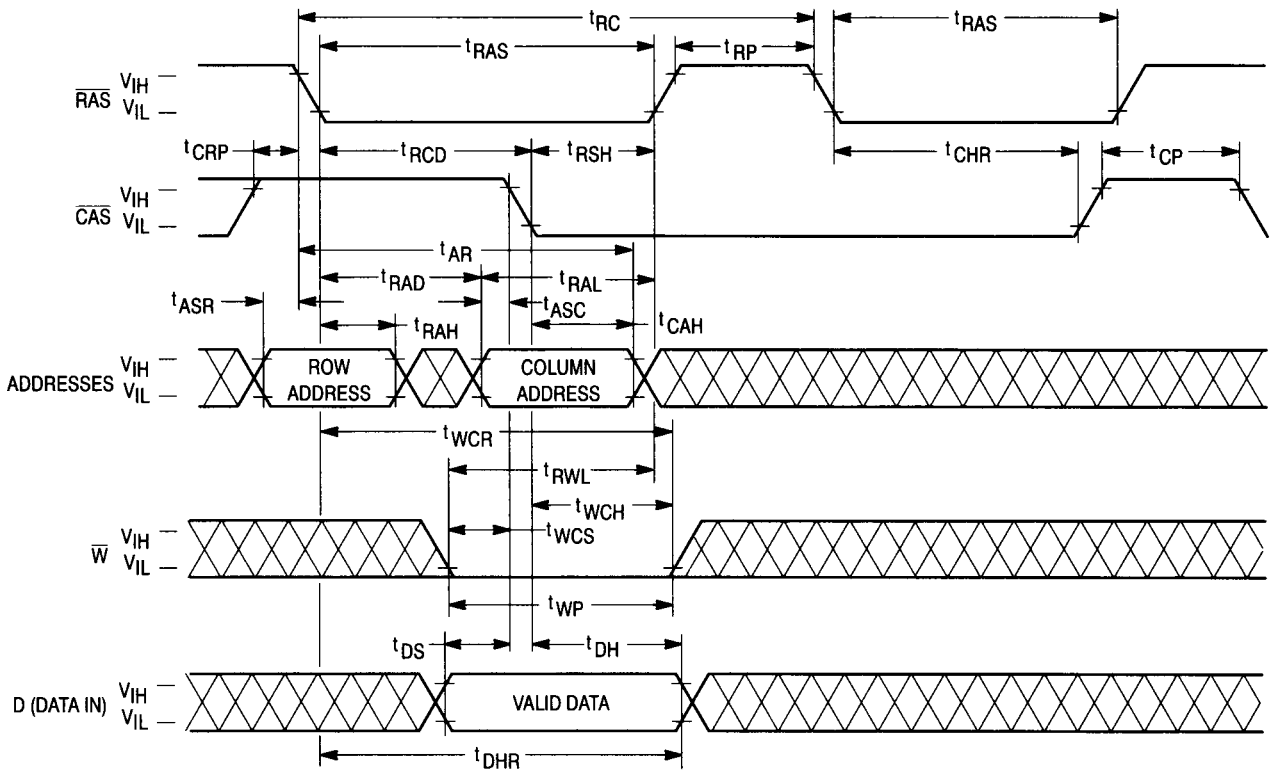
CAS BEFORE RAS REFRESH CYCLE
(\overline{W} and A0 - A8 are Don't Care)



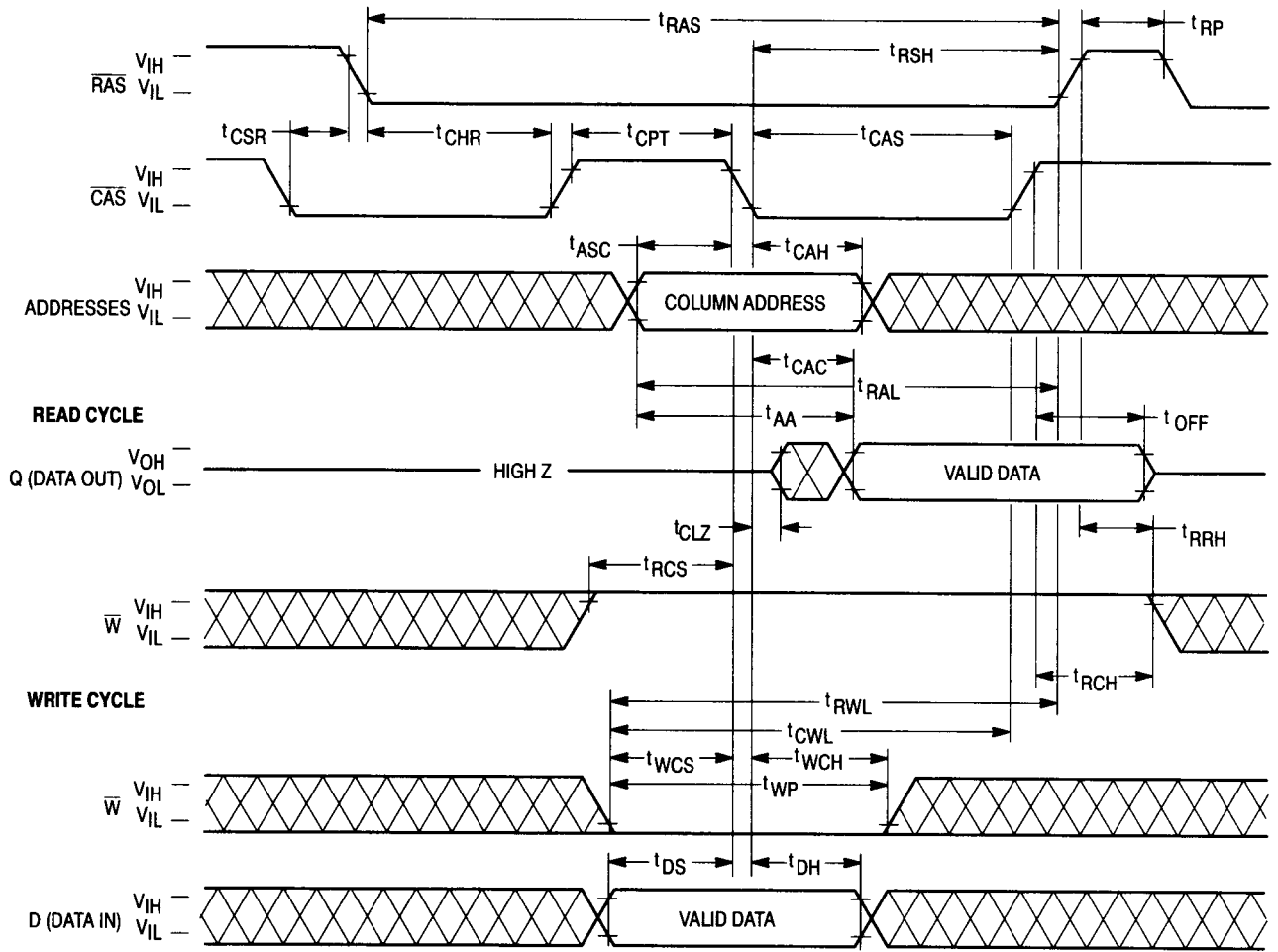
HIDDEN REFRESH CYCLE (READ)



HIDDEN REFRESH CYCLE (WRITE)



CAS BEFORE RAS REFRESH COUNTER TEST CYCLE



DEVICE INITIALIZATION

On power-up, an initial pause of 200 microseconds is required for the internal substate generator pump to establish the correct bias voltage. This is to be followed by a minimum of eight active cycles of the row address strobe (clock) to initialize the various dynamic nodes internal to the module. During an extended inactive state of the module (greater than 4 milliseconds with device powered up), the wake up sequence (8 active cycles) will be necessary to ensure proper device operation.

ADDRESSING THE RAM

The nine address bus pins on the device are time multiplexed with two separate 9-bit address fields that are strobed at the beginning of the memory cycle by two clocks (active negative) called the row address strobe (\overline{RAS}) and the column address strobe (CAS). A total of eighteen address bits will decode one of the 524,288 word locations in the device. The column address strobe follows the row address strobe by a specified minimum and maximum time called t_{RCD} , which is the row to column strobe delay. This time interval is also referred to as the multiplex window, which gives flexibility to a system designer to set up the external addresses into the RAM. These conditions have to be met for normal read or write cycles. This initial portion of the cycle accomplishes the normal addressing of the device. There are, however, other variations in addressing the module: the refresh modes (\overline{RAS} -only refresh, CAS before \overline{RAS} refresh, hidden refresh), and another mode called page mode which allows the user to column access all words within a selected row. The refresh mode and page mode operations are described in more detail in later sections.

READ CYCLE

A read cycle is referred to as a normal read cycle to differentiate it from a page mode read cycle, which is covered in a later section.

The memory read cycle begins with the row addresses valid and the \overline{RAS} clock transitioning from V_{IH} to the V_{IL} level. The \overline{CAS} clock must also make a transition from V_{IH} to the V_{IL} level at the specified t_{RCD} timing limits when the column addresses are latched. Both the \overline{RAS} and \overline{CAS} clocks trigger a sequence of events that are controlled by several delayed internal clocks. Also, these clocks are linked in such a manner that the access time of the device is independent of the address multiplex window. The only stipulation is that the \overline{CAS} clock must be active before or at the t_{RCD} maximum specification for an access (data valid) from the \overline{RAS} clock edge to be guaranteed (t_{RAC}). If the t_{RCD} maximum condition is not met, the access (t_{CAC}) from the \overline{CAS} clock active transition will determine read access time. The external \overline{CAS} signal is ignored until an internal \overline{RAS} signal is available. This gating feature on the \overline{CAS} clock will allow the external CAS signal to become active as soon as the row address hold time (t_{RAH}) specification has been met and defines the t_{RCD} minimum specification. The time difference between t_{RCD} minimum and t_{RCD} maximum can be used to absorb skew delays in switching the address bus from the row to column addresses and in generating the \overline{CAS} clock.

Once the clocks have become active, they must stay active for the minimum (t_{RAS}) period for the \overline{RAS} clock and the

minimum (t_{CAS}) period for the \overline{CAS} clock. The \overline{RAS} clock must stay inactive for the minimum (t_{RP}) time. The former is for the completion of the cycle in progress, and the latter is for the device internal circuitry to be precharged for the next active cycle.

Data out is not latched and is valid as long as the \overline{CAS} clock is active; the output will switch to the three-state mode when the \overline{CAS} clock goes inactive. To perform a read cycle, the write (\overline{W}) input must be held at the V_{IH} level from the time the \overline{CAS} clock makes its active transition (t_{RCS}) to the time when it transitions into the inactive (t_{RCH}) mode.

WRITE CYCLE

A write cycle is similar to a read cycle except that the write (\overline{W}) clock must go active (V_{IL} level) at or before the \overline{CAS} clock goes active at a minimum t_{WCS} time. If the above condition is met, then the cycle in progress is referred to as an early write cycle. In an early write cycle, the write clock and the data in are referenced to the active transition of the \overline{CAS} clock edge. There are two important parameters with respect to the write cycle: the column strobe to write lead time (t_{CWL}) and the row strobe to write lead time (t_{RWL}). These define the minimum time that \overline{RAS} and \overline{CAS} clocks need to be active after the write operation has started (\overline{W} clock at V_{IL} level).

PAGE-MODE CYCLES

Page mode operation allows fast successive data operations at all 512 column locations on a selected row. Page access (t_{CAC}) is typically half the regular \overline{RAS} clock access (t_{RAC}) on the Motorola 1M dynamic RAM. Page mode operation consists of holding the \overline{RAS} clock active while cycling the \overline{CAS} clock to access the column locations determined by the 10-bit column address field.

The page cycle is always initiated with a row address being provided and latched by the \overline{RAS} clock, followed by the column address and \overline{CAS} clock. From the timing illustrated, the initial cycle is a normal read or write cycle (previously described), followed by the shorter \overline{CAS} cycles (t_{PC}). The \overline{CAS} cycle time (t_{PC}) consists of the \overline{CAS} clock active time (t_{CAS}), and \overline{CAS} clock precharge time (t_{CP}) and two transitions. In practice, any combination of read and write cycles can be performed to suit a particular application.

REFRESH CYCLES

The dynamic RAM design is based on capacitor charge storage for each bit in the array. This charge will tend to degrade with time and temperature. Therefore, to retain the correct information, the module needs to be refreshed at least once every 8 milliseconds. This is accomplished by sequentially cycling through the 512 row address locations every 8 milliseconds (i.e., at least one row every 15.6 microseconds). A normal read or write operation to the module will also refresh all the words associated with the particular row(s) decoded.

\overline{RAS} -Only Refresh

In this refresh method, the system must perform a \overline{RAS} -only cycle on 512 row addresses every 8 milliseconds. The row addresses are latched in with the \overline{RAS} clock, and the associated internal row locations are refreshed. As the heading implies, the \overline{CAS} clock is not required and must be inactive or at a V_{IH} level.

CAS Before RAS Refresh

This refresh cycle is initiated when $\overline{\text{RAS}}$ falls, after $\overline{\text{CAS}}$ has been low (by t_{CSR}). This activates the internal refresh counter, which generates the row address to be refreshed. Externally applied addresses are ignored during the automatic refresh cycle. If the output buffer was off before the automatic refresh cycle, the output will stay in the high impedance state. If the output was enabled by $\overline{\text{CAS}}$ in the previous cycle, the data out will be maintained during the automatic refresh cycle as long as $\overline{\text{CAS}}$ is held active (hidden refresh).

Hidden Refresh

The hidden refresh method allows refresh cycles to be performed while maintaining valid data at the output pin. Hidden refresh is performed by holding $\overline{\text{CAS}}$ at V_{IL} and taking $\overline{\text{RAS}}$ high and after a specified precharge period (t_{RP}), executing a $\overline{\text{CAS}}$ before $\overline{\text{RAS}}$ refresh cycle. (See Figure 1.)

CAS BEFORE RAS REFRESH COUNTER TEST

The internal refresh counter of the device can be tested with

a **CAS before RAS refresh counter test**. This refresh counter test is performed with read and write operations. During this test, the internal refresh counter generates the row address, while the external address input supplies the column address. The entire array is refreshed after 512 test cycles, as indicated by the check data written in each row. See **CAS before RAS refresh counter test cycle** timing diagram.

The test can be performed only after a minimum of **8 CAS before RAS** initialization cycles. The test procedure is as follows:

1. Write "0"s into all memory cells (normal write mode).
2. Select a column address, and read "0" out of the cell by performing **CAS before RAS refresh counter test, read cycle**. Repeat this operation 512 times.
3. Select a column address, and write "1" into the cell by performing **CAS before RAS refresh counter test, write cycle**. Repeat this operation 512 times.
4. Read "1"s (normal read mode), which were written at step 3.
5. Repeat steps 1 to 4 using complement data.

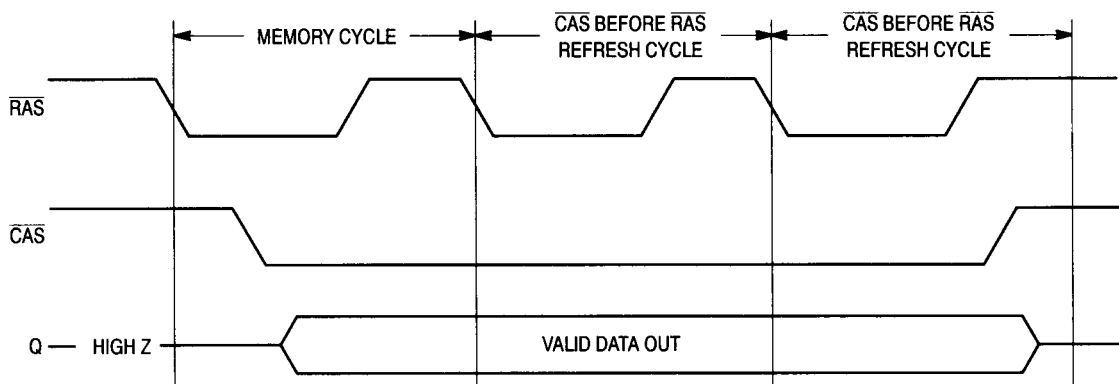
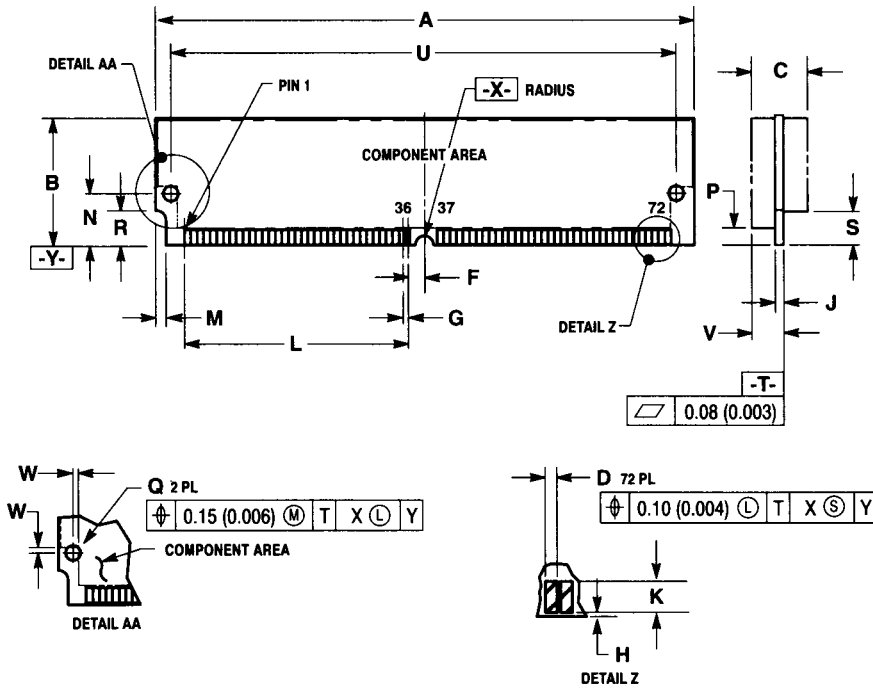


Figure 1. Hidden Refresh Cycle

PACKAGE DIMENSIONS

S PACKAGE SIMM MODULE CASE 866-02



NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. CARD THICKNESS APPLIES ACROSS TABS AND INCLUDES PLATING AND/OR METALIZATION.
4. 866-01 IS OBSOLETE, NEW STANDARD 866-02.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	107.82	108.08	4.245	4.255
B	25.27	25.53	0.995	1.005
C	—	9.14	—	0.360
D	1.02	1.07	0.040	0.042
F	3.18 BSC	—	0.125 BSC	—
G	1.27 BSC	—	0.050 BSC	—
H	—	0.25	—	0.010
J	1.19	1.37	0.047	0.054
K	0.25	—	0.100	—
L	44.45 REF	—	1.750 REF	—
M	1.90	2.16	0.075	0.085
N	10.16 BSC	—	0.400 BSC	—
P	3.18	—	0.125	—
Q	3.12	3.22	0.123	0.127
R	6.22	6.48	0.245	0.255
S	5.72	—	0.225	—
U	101.19 BSC	—	3.984 BSC	—
V	—	5.28	—	0.208
W	1.12	—	0.044	—
X	1.52	1.63	0.060	0.064

ORDERING INFORMATION (Order by Full Part Number)

Motorola Memory Prefix **MCM** **32512 or 32L512** **X** **XX**
 Part Number _____
 _____ Speed (70 = 70 ns, 80 = 80 ns, 10 = 100 ns)
 _____ Package (AS = SIMM, ASG = Gold Pad SIMM)

Full Part Numbers — MCM32512AS70 MCM32512ASG70
 MCM32512AS80 MCM32512ASG80
 MCM32L512AS70 MCM32L512ASG70
 MCM32L512AS80 MCM32L512ASG80

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