

## KM416C256A/AL/ALL

## CMOS DRAM

*256K x 16 Bit CMOS Dynamic RAM with Fast Page Mode*

## FEATURES

## • Performance range:

	t <sub>RAC</sub>	t <sub>CAC</sub>	t <sub>RC</sub>
KM416C256A/AL/ALL-6	60ns	15ns	110ns
KM416C256A/AL/ALL-7	70ns	20ns	130ns
KM416C256A/AL/ALL-8	80ns	20ns	150ns

- Fast Page Mode operation
- 2  $\overline{\text{CAS}}$  Byte/Word Read/Write operation
- $\overline{\text{CAS}}$ -before- $\overline{\text{RAS}}$  refresh capability
- $\overline{\text{RAS}}$ -only and Hidden Refresh capability
- Self Refresh operation (LL-version)
- TTL compatible inputs and outputs
- Early Write or output enable controlled write
- Triple +5V  $\pm$  10% power supply
- Refresh Cycle
  - 512 cycle/8ms (Normal)
  - 512 cycle/64ms (L-version)
  - 512 cycle/128ms (LL-version)
- Power Dissipation
  - Standby: 5.5mW (Normal)
  - 1.1mW (L-version)
  - 0.83mW (LL-version)
  - Active (60/70/80): 660/605/550 mW
- JEDEC Standard pinout
- Available in Plastic SOJ, ZIP and TSOP II

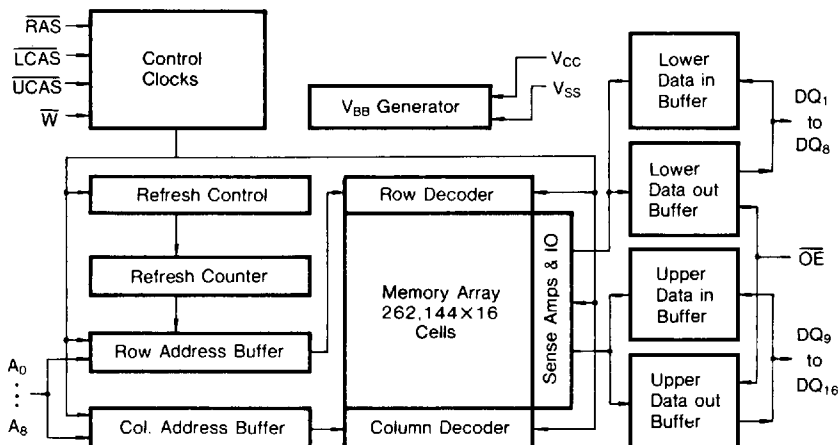
## GENERAL DESCRIPTION

The Samsung KM416C256A/AL/ALL is a CMOS high speed 262,144 bit x 16 Dynamic Random Access Memory. Its design is optimized for high performance applications such as personal computer, graphics and high performance portable computers.

The KM416C256A/AL/ALL features Fast Page Mode operation which allows high speed random access of memory cells within the same row.  $\overline{\text{CAS}}$ -before- $\overline{\text{RAS}}$  refresh capability provides on-chip auto refresh as an alternative to  $\overline{\text{RAS}}$ -only refresh. All inputs and outputs are fully TTL compatible.

The KM416C256A/AL/ALL is fabricated using Samsung's advanced CMOS process.

## FUNCTIONAL BLOCK DIAGRAM

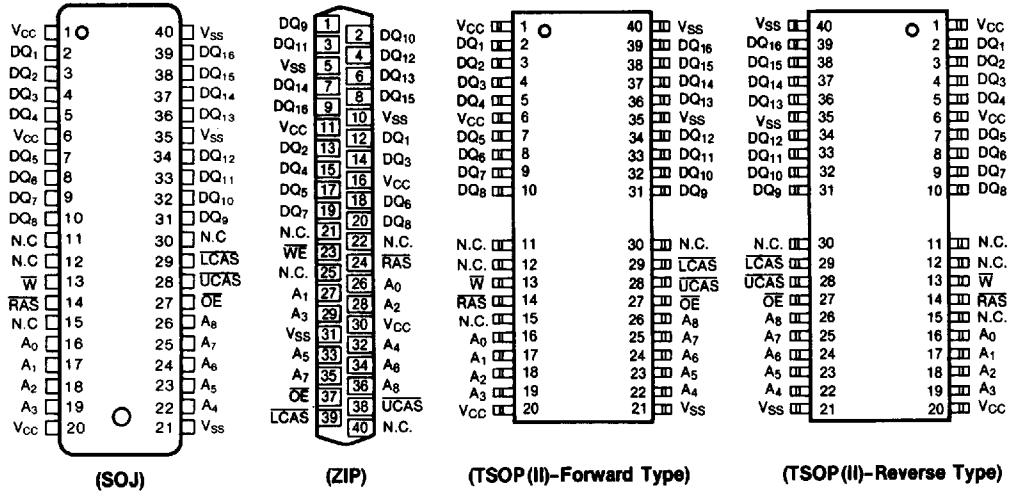


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**PIN CONFIGURATION (Top Views)**

• KM416C256AJ/ALJ/ALLJ • KM416C256AZ/ALZ/ALLZ • KM416C256AT/ALT/ALLT • KM416C256ATR/ALTR/ALLTR



Pin Name	Pin Function	Pin Name	Pin Function
A <sub>0</sub> -A <sub>8</sub>	Address Inputs	LCAS	Lower Column Address Strobe
DQ <sub>1-16</sub>	Data In/Out	$\overline{W}$	Read/Write Input
V <sub>SS</sub>	Ground	$\overline{OE}$	Data Output Enable
$\overline{RAS}$	Row Address Strobe	V <sub>CC</sub>	Power (+ 5V)
$\overline{UCAS}$	Upper Column Address Strobe	N.C.	No Connection

**ABSOLUTE MAXIMUM RATINGS\***

Parameter	Symbol	Rating	Units
Voltage on Any Pin Relative to V <sub>SS</sub>	V <sub>IN</sub> , V <sub>OUT</sub>	-1 to +7.0	V
Voltage on V <sub>CC</sub> Supply Relative to V <sub>SS</sub>	V <sub>CC</sub>	-1 to +7.0	V
Storage Temperature	T <sub>stg</sub>	-55 to +150	°C
Power Dissipation	P <sub>D</sub>	700	mW
Short Circuit Output Current	I <sub>OS</sub>	50	mA

\* Permanent device damage may occur if "ABSOLUTE MAXIMUM RATINGS" are exceeded. Functional Operation should be restricted to the conditions as detailed in the operational sections of this data sheet. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

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RECOMMENDED OPERATING CONDITIONS (Voltage reference to  $V_{SS}$ ,  $T_A=0$  to  $70^\circ\text{C}$ )

Parameter	Symbol	Min	Typ	Max	Unit
Supply Voltage	$V_{CC}$	4.5	5.0	5.5	V
Ground	$V_{SS}$	0	0	0	V
Input High Voltage	$V_{IH}$	2.4	—	$V_{CC}+1$	V
Input Low Voltage	$V_{IL}$	-1.0	—	0.8	V

## DC AND OPERATING CHARACTERISTICS

(Recommended operating conditions unless otherwise noted)

Parameter	Symbol	Min	Max	Units
Operating Current* (RAS, UCAS, or LCAS, Address Cycling @ $t_{RC} = \text{min.}$ )	KM416C256A/AL/ALL-6 KM416C256A/AL/ALL-7 KM416C256A/AL/ALL-8 $I_{CC1}$	— — —	120 110 100	mA mA mA
Standby Current (RAS = UCAS = LCAS = $V_{IH}$ )	$I_{CC2}$	—	2	mA
RAS-Only Refresh Current* (UCAS = LCAS, RAS, Address Cycling @ $t_{RC} = \text{min.}$ )	KM416C256A/AL/ALL-6 KM416C256A/AL/ALL-7 KM416C256A/AL/ALL-9 $I_{CC3}$	— — —	120 110 100	mA mA mA
Fast Page Mode Current* (RAS = $V_{IL}$ , UCAS or LCAS, Address Cycling @ $t_{RC} = \text{min.}$ )	KM416C256A/AL/ALL-6 KM416C256A/AL/ALL-7 KM416C256A/AL/ALL-8 $I_{CC4}$	— — —	95 85 80	mA mA mA
Standby Current (RAS = UCAS = LCAS $\geq V_{CC} - 0.2V$ )	KM416C256A KM416C256AL KM416C256ALL $I_{CC5}$	— — —	1 200 150	mA $\mu\text{A}$ $\mu\text{A}$
CAS-Before-RAS Refresh Current* (RAS, UCAS or LCAS Cycling @ $t_{RC} = \text{min.}$ )	KM416C256A/AL/ALL-6 KM416C256A/AL/ALL-7 KM416C256A/AL/ALL-8 $I_{CC6}$	— — —	120 110 100	mA mA mA
Battery Back Up Current Average Power Supply Current, Battery Back Up Mode Input High Voltage ( $V_{IH}$ ) = $V_{CC} - 0.2V$ Input Low Voltage ( $V_{IL}$ ) = 0.2V CAS = $V_{IL}$ D <sub>IN</sub> = Don't Care $T_{RC} = 125\mu\text{S}$ , $T_{RAS} = t_{RAS} \text{ min.} - 1\mu\text{S}$	KM416C256AL $I_{CC7}$	—	300	$\mu\text{A}$
Self Refresh Current RAS = CAS = 0.2V W = OE = A0 ~ A8 = $V_{CC} - 0.2V$ or 0.2V DQ1 ~ 16 = $V_{CC} - 0.2V$ , 0.2V or OPEN	KM416C256ALL $I_{CC8}$	—	200	$\mu\text{A}$
Input Leakage Current (Any input $0 \leq V_{IN} \leq 6.5V$ , all other pins not under test = 0V)	$I_{IL}$	-10	10	$\mu\text{A}$
Output Leakage Current (Data out is disabled, $0V \leq V_{OUT} \leq 5.5V$ )	$I_{OL}$	-10	10	$\mu\text{A}$
Output High Voltage Level ( $I_{OH} = -5\text{mA}$ )	$V_{OH}$	2.4	—	V
Output Low Voltage Level ( $I_{OL} = 4.2\text{mA}$ )	$V_{OL}$	—	0.4	V

\* NOTE:  $I_{CC1}$ ,  $I_{CC3}$ ,  $I_{CC4}$  and  $I_{CC6}$  are dependent on output loading and cycle rates. Specified values are obtained with the output open.  $I_{CC}$  is specified as an average current. In  $I_{CC1}$  and  $I_{CC3}$ , Address can be changed maximum two times while RAS =  $V_{IL}$ . In  $I_{CC4}$ , Address can be changed maximum once while UCAS and LCAS =  $V_{IH}$ .

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CAPACITANCE ( $T_A=25^\circ\text{C}$ )

Parameter	Symbol	Min	Max	Unit
Input Capacitance ( $A_0-A_8$ )	$C_{IN1}$	—	5	pF
Input Capacitance ( $\overline{RAS}$ , $\overline{LCAS}$ , $\overline{UCAS}$ , $\overline{W}$ , $\overline{OE}$ )	$C_{IN2}$	—	7	pF
Output Capacitance ( $DQ_1-DQ_{16}$ )	$C_{DQ}$	—	7	pF

AC CHARACTERISTICS ( $0^\circ\text{C} \leq T_A \leq 70^\circ\text{C}$ ,  $V_{CC} = 5.0\text{V} \pm 10\%$ , See notes 1, 2)

Parameter	Symbol	KM416C256A/AL/ALL-6		KM416C256A/AL/ALL-7		KM416C256A/AL/ALL-8		Units	Notes
		Min	Max	Min	Max	Min	Max		
Random read or write cycle time	$t_{RC}$	110		130		150		ns	
Read-modify-write cycle time	$t_{RWC}$	155		185		205		ns	
Access time from $\overline{RAS}$	$t_{RAC}$		60		70		80	ns	3,4,11
Access time from $\overline{CAS}$	$t_{CAC}$		15		20		20	ns	3,4,5
Access time from column address	$t_{AA}$		30		35		40	ns	3,11
$\overline{CAS}$ to output in Low-Z	$t_{CLZ}$	0		0		0		ns	3
Output buffer turn-off delay	$t_{OFF}$	0	15	0	20	0	20	ns	7
Transition time (rise and fall)	$t_T$	3	50	3	50	3	50	ns	2
$\overline{RAS}$ precharge time	$t_{RP}$	40		50		60		ns	
$\overline{RAS}$ pulse width	$t_{RAS}$	60	10,000	70	10,000	80	10,000	ns	
$\overline{RAS}$ hold time	$t_{RSH}$	15		20		20		ns	
$\overline{CAS}$ hold time	$t_{CSH}$	60		70		80		ns	
$\overline{CAS}$ pulse width	$t_{CAS}$	15	10,000	20	10,000	20	10,000	ns	
$\overline{RAS}$ to $\overline{CAS}$ delay time	$t_{RCD}$	20	45	20	50	20	60	ns	4
$\overline{RAS}$ to column address delay time	$t_{RAD}$	15	30	15	35	15	40	ns	11
$\overline{CAS}$ to $\overline{RAS}$ precharge time	$t_{CRP}$	5		5		5		ns	
Row address set-up time	$t_{ASR}$	0		0		0		ns	
Row address hold time	$t_{RAH}$	10		10		10		ns	
Column address set-up time	$t_{ASC}$	0		0		0		ns	
Column address hold time	$t_{CAH}$	15		15		15		ns	
Column address hold time referenced to $\overline{RAS}$	$t_{AR}$	50		55		60		ns	6
Column address to $\overline{RAS}$ lead time	$t_{RAL}$	30		35		40		ns	
Read command set-up time	$t_{RCS}$	0		0		0		ns	
Read command hold time referenced to $\overline{CAS}$	$t_{RCH}$	0		0		0		ns	9
Read command hold time referenced to $\overline{RAS}$	$t_{RRH}$	0		0		0		ns	9
Write command set-up time	$t_{WCS}$	0		0		0		ns	8
Write command hold time	$t_{WCH}$	10		15		15		ns	
Write command hold time referenced to $\overline{RAS}$	$t_{WCR}$	45		55		60		ns	6
Write command pulse width	$t_{Wp}$	10		15		15		ns	
Write command to $\overline{RAS}$ lead time	$t_{RWL}$	15		20		20		ns	
Write command to $\overline{CAS}$ lead time	$t_{CWL}$	15		20		20		ns	

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## AC CHARACTERISTICS (Continued)

Parameter	Symbol	KM416C256A/AL/ALL-6		KM416C256A/AL/ALL-7		KM416C256A/AL/ALL-8		Units	Notes
		Min	Max	Min	Max	Min	Max		
Data-in set-up time	t <sub>DS</sub>	0		0		0		ns	10
Data-in hold time	t <sub>DH</sub>	15		15		15		ns	10
Data-in hold time referenced to $\overline{\text{RAS}}$	t <sub>DHR</sub>	50		55		60		ns	6
Refresh period (512 cycles)	t <sub>REF</sub>		8		8		8	ms	
Refresh period (L-version)	t <sub>REF</sub>		64		64		64	ms	
Refresh period (LL-version)	t <sub>REF</sub>		128		128		128	ms	
$\overline{\text{CAS}}$ to $\overline{\text{W}}$ delay time	t <sub>CWD</sub>	40		45		45		ns	8
$\overline{\text{RAS}}$ to $\overline{\text{W}}$ delay time	t <sub>RWD</sub>	85		95		105		ns	8
Column address to $\overline{\text{W}}$ delay time	t <sub>AWD</sub>	55		60		65		ns	8
$\overline{\text{CAS}}$ setup time ( $\overline{\text{CAS}}$ -before- $\overline{\text{RAS}}$ cycle)	t <sub>CSR</sub>	10		10		10		ns	
$\overline{\text{CAS}}$ hold time ( $\overline{\text{CAS}}$ -before- $\overline{\text{RAS}}$ refresh)	t <sub>CHR</sub>	10		10		10		ns	
$\overline{\text{RAS}}$ precharge to $\overline{\text{CAS}}$ hold time	t <sub>RPC</sub>	5		5		5		ns	
$\overline{\text{CAS}}$ precharge time ( $\overline{\text{C-B-R}}$ counter test cycle)	t <sub>CPT</sub>	20		25		30		ns	
Access time from $\overline{\text{CAS}}$ precharge	t <sub>CPA</sub>		35		40		45	ns	3
Fast page mode cycle time	t <sub>PC</sub>	40		45		50		ns	
Fast page mode read-modify-write cycle time	t <sub>PRWC</sub>	80		95		100		ns	
$\overline{\text{RAS}}$ pulse width (fast page mode)	t <sub>RASP</sub>	60	100K	70	100K	80	100K	ns	
$\overline{\text{RAS}}$ hold time from $\overline{\text{CAS}}$ precharge	t <sub>RHCP</sub>	35		40		45		ns	
$\overline{\text{CAS}}$ precharge time (fast page mode)	t <sub>CP</sub>	10		10		10		ns	
$\overline{\text{RAS}}$ hold time referenced to $\overline{\text{OE}}$	t <sub>ROH</sub>	15		20		20		ns	
Access time from $\overline{\text{OE}}$	t <sub>OEA</sub>		15		20		20	ns	
$\overline{\text{OE}}$ to data-in delay time	t <sub>OED</sub>	15		20		20		ns	
Output buffer turn off delay time from $\overline{\text{OE}}$	t <sub>OEZ</sub>	0	15	0	20	0	20	ns	
$\overline{\text{OE}}$ command hold time	t <sub>OEH</sub>	15		20		20		ns	
$\overline{\text{RAS}}$ pulse width ( $\overline{\text{C-B-R}}$ self refresh)	t <sub>RASS</sub>	100		100		100		$\mu\text{S}$	19
$\overline{\text{RAS}}$ precharge time ( $\overline{\text{C-B-R}}$ self refresh)	t <sub>RPS</sub>	110		130		150		ns	19
$\overline{\text{CAS}}$ hold time ( $\overline{\text{C-B-R}}$ self refresh)	t <sub>CHS</sub>	0		0		0		ns	19

## KM416C256 Truth Table

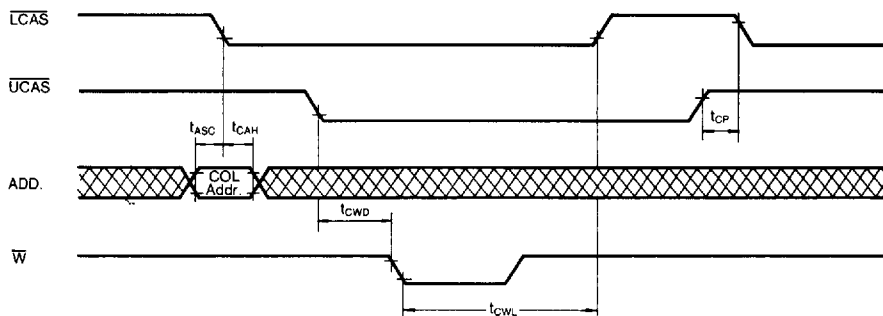
RAS	LCAS	UCAS	W	OE	DQ <sub>1~8</sub>	DQ <sub>9~16</sub>	State
H	H	H	H	H	Hi-Z	Hi-Z	Standby
L	H	H	H	H	Hi-Z	Hi-Z	Refresh
L	L	H	H	L	DQ-OUT	Hi-Z	Lower Byte Read
L	H	L	H	L	Hi-Z	DQ-OUT	Upper Byte Read
L	L	L	H	L	DQ-OUT	DQ-OUT	Word Read
L	L	H	L	H	DQ-IN	Don't Care	Lower Byte Write
L	H	L	L	H	Don't Care	DQ-IN	Upper Byte Write
L	L	L	L	H	DQ-IN	DQ-IN	Word Write
L	L	L	H	H	Hi-Z	Hi-Z	—

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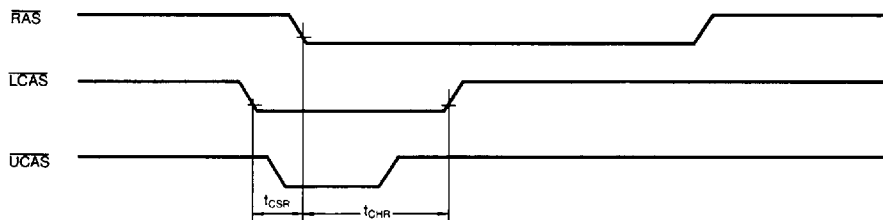
## CMOS DRAM

## NOTES

1. An initial pause of 200 $\mu$ s is required after power-up followed by any 8  $\overline{\text{RAS}}$ -only or  $\overline{\text{CAS}}$ -before- $\overline{\text{RAS}}$  refresh cycles before proper device operation is achieved.
2.  $V_{IH(\min)}$  and  $V_{IL(\max)}$  are reference levels for measuring timing of input signals. Transition times are measured between  $V_{IH(\min)}$  and  $V_{IL(\max)}$  and are assumed to be 5ns for all inputs.
3. Measured with a load equivalent to 2 TTL loads and 100pF.
4. Operation within the  $t_{\text{RCD}(\max)}$  limit insures that  $t_{\text{RAC}(\max)}$  can be met.  $t_{\text{RCD}(\max)}$  is specified as a reference point only. If  $t_{\text{RCD}}$  is greater than the specified  $t_{\text{RCD}(\max)}$  limit, then access time is controlled exclusively by  $t_{\text{CAC}}$ .
5. Assumes that  $t_{\text{RCD}} \geq t_{\text{RCD}(\max)}$ .
6.  $t_{\text{AR}}$ ,  $t_{\text{WCR}}$ ,  $t_{\text{DHR}}$  are referenced to  $t_{\text{RAD}(\max)}$ .
7.  $t_{\text{OFF}(\max)}$  defines the time at which the output achieves the open circuit condition and is not referenced to  $V_{OH}$  or  $V_{OL}$ .
8.  $t_{\text{WCS}}$ ,  $t_{\text{RWD}}$ ,  $t_{\text{CWD}}$  and  $t_{\text{AWD}}$  are non restrictive operating aparameters. They are included in the data sheet as electrical characteristics only. If  $t_{\text{WCS}} \geq t_{\text{WCS}(\min)}$  the cycle is an early write cycle and the data output will remain high impedance for the duration of the cycle. If  $t_{\text{CWD}} \geq t_{\text{CWD}(\min)}$ ,  $t_{\text{RWD}} \geq t_{\text{RWD}(\min)}$ ,  $t_{\text{AWD}} \geq t_{\text{AWD}(\min)}$  then the cycle is a read-write cycle and the data output will contain the data read from the selected address. If neither of the above conditions are satisfied, the condition of the data out is indeterminate.
9. Either  $t_{\text{RCH}}$  or  $t_{\text{RRH}}$  must be satisfied for a read cycle.
10. These parameters are referenced to the  $\overline{\text{CAS}}$  leading edge in early write cycles and to the  $\overline{\text{W}}$  leading edge in read-write cycles.
11. Operation within the  $t_{\text{RAD}(\max)}$  limit insures that  $t_{\text{RAC}(\max)}$  can be met.  $t_{\text{RAD}(\max)}$  is specified as a reference point only. If  $t_{\text{RAD}}$  is greater than the specified  $t_{\text{RAD}(\max)}$  limit, then access time is controlled by  $t_{\text{AA}}$ .
12.  $t_{\text{ASC}}$ ,  $t_{\text{CAH}}$  are referenced to the earlier  $\overline{\text{CAS}}$  falling edge.
13.  $t_{\text{CP}}$  is specified from the last  $\overline{\text{CAS}}$  rising edge in the previous cycle to the first  $\overline{\text{CAS}}$  falling edge in the next cycle.
14.  $t_{\text{CWD}}$  is referenced to the later  $\overline{\text{CAS}}$  falling edge at word read-modify-write cycle.
15.  $t_{\text{CWL}}$  is specified from  $\overline{\text{W}}$  falling edge to the earlier  $\overline{\text{CAS}}$  rising edge.



16.  $t_{\text{CSR}}$  is referenced to earlier  $\overline{\text{CAS}}$  falling low before  $\overline{\text{RAS}}$  transition low.
17.  $t_{\text{CHR}}$  is referenced to the later  $\overline{\text{CAS}}$  rising high after  $\overline{\text{RAS}}$  transition low.





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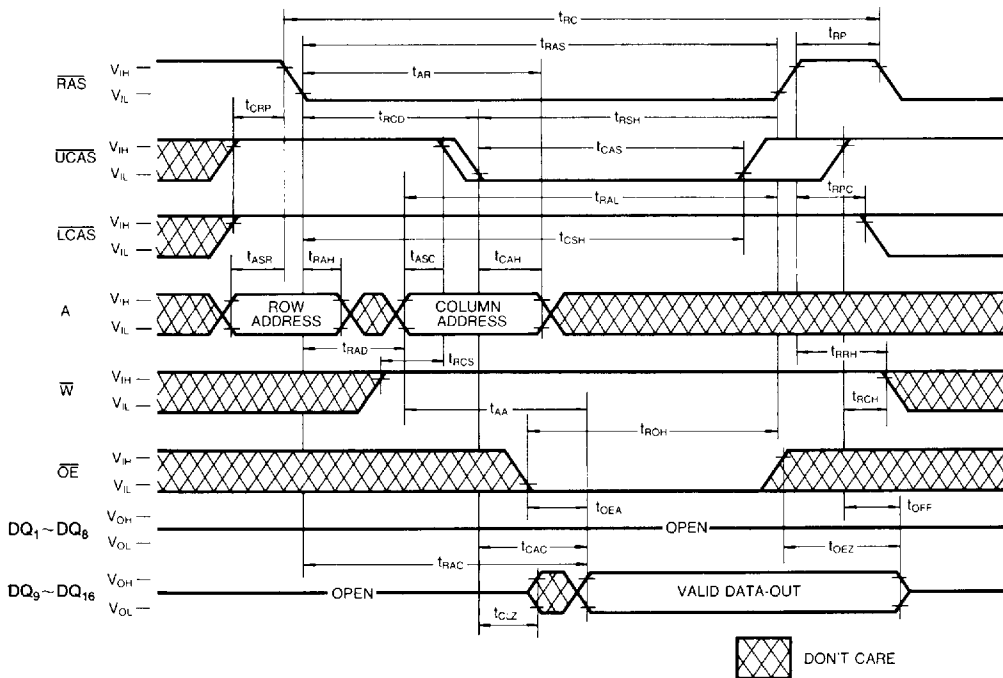
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**TIMING DIAGRAMS (Continued)**

**LOWER BYTE READ CYCLE**



**UPPER BYTE READ CYCLE**



 DON'T CARE

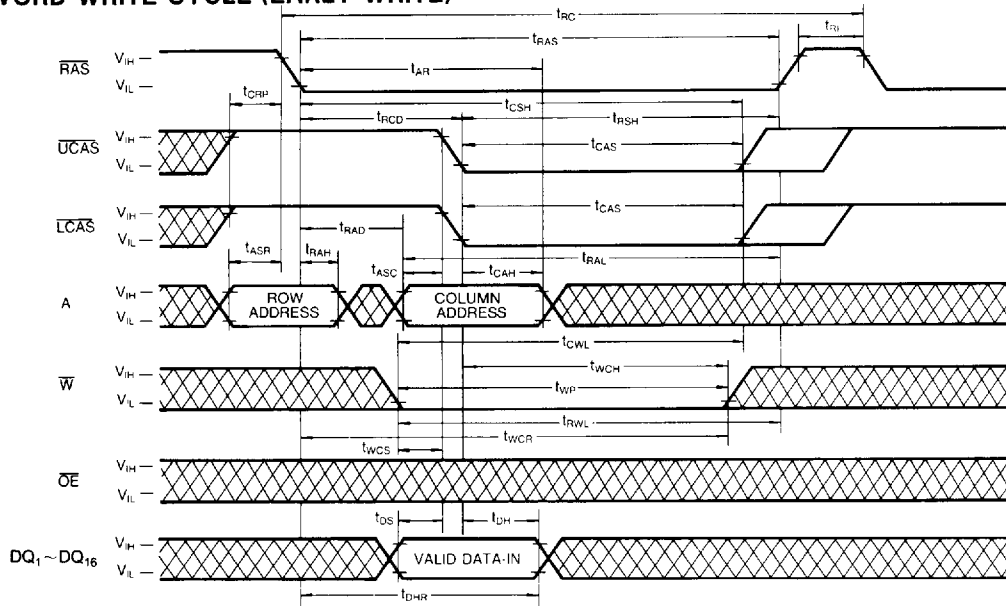
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**KM416C256A/AL/ALL**

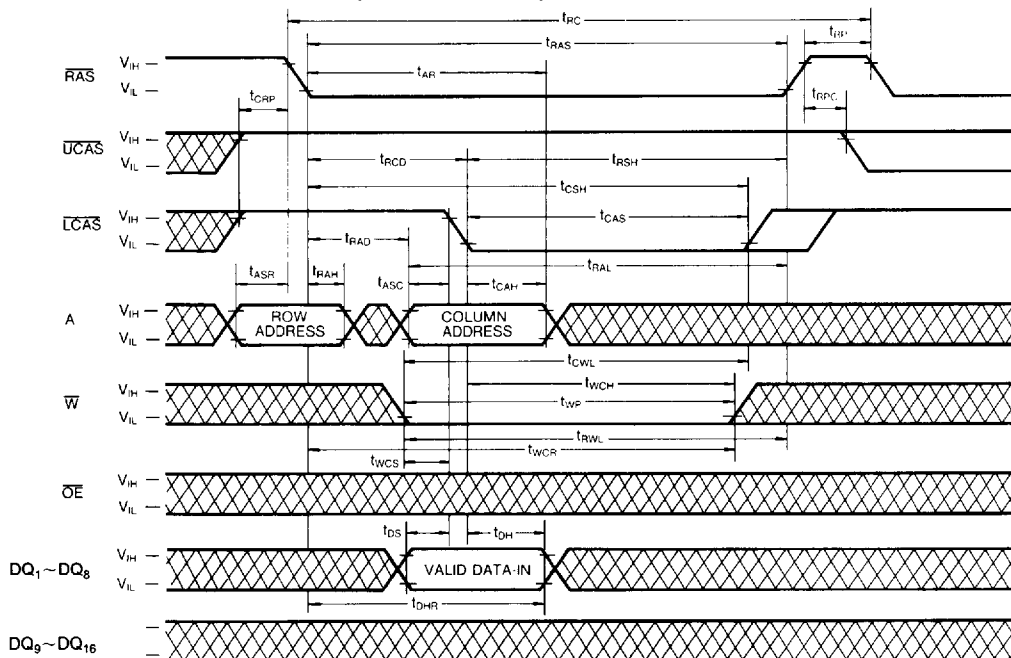
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**TIMING DIAGRAMS (Continued)**

**WORD WRITE CYCLE (EARLY WRITE)**



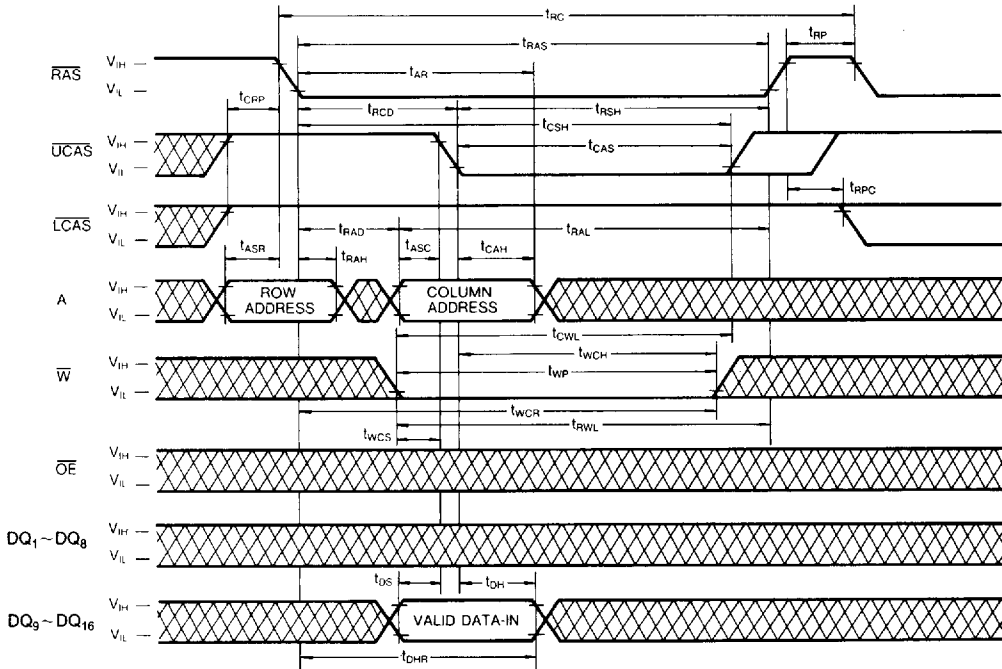
**LOWER BYTE WRITE CYCLE (EARLY WRITE)**



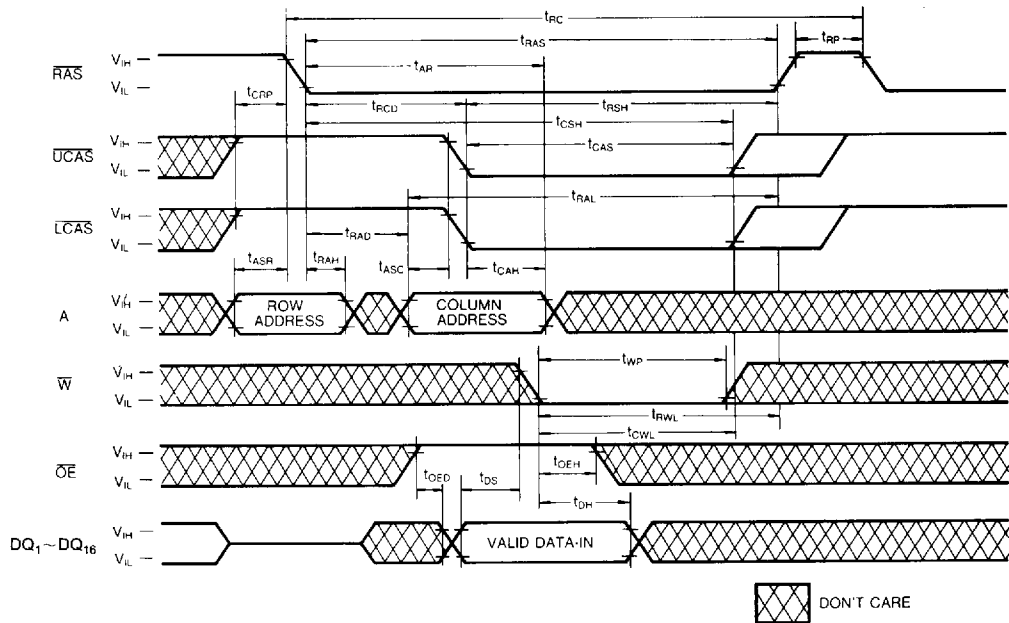
 DON'T CARE

**TIMING DIAGRAMS** (Continued)

**UPPER BYTE WRITE CYCLE (EARLY WRITE)**



**WORD WRITE CYCLE (OE CONTROLLED WRITE)**



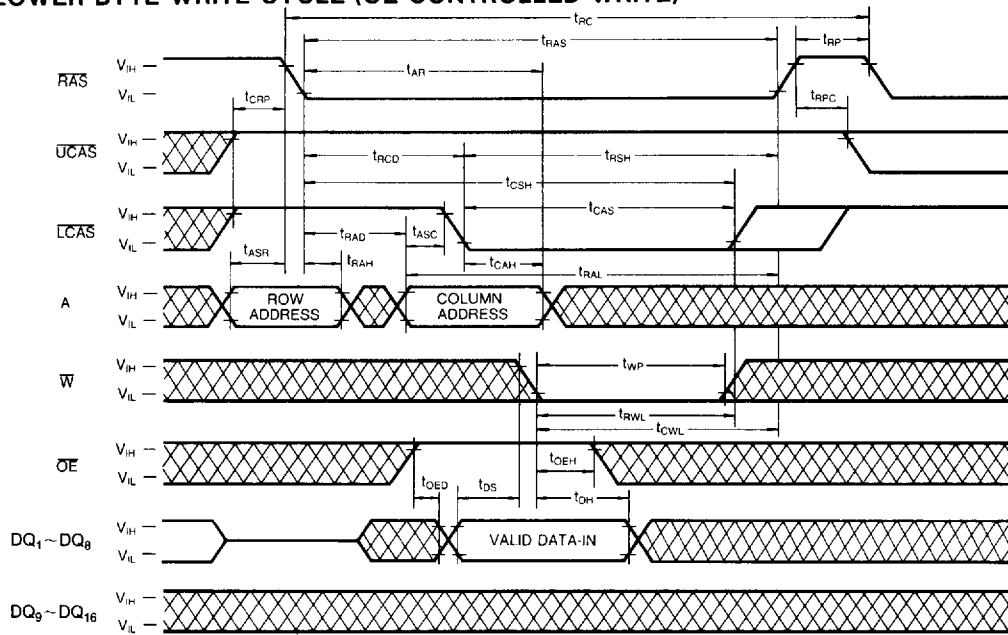
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**KM416C256A/AL/ALL**

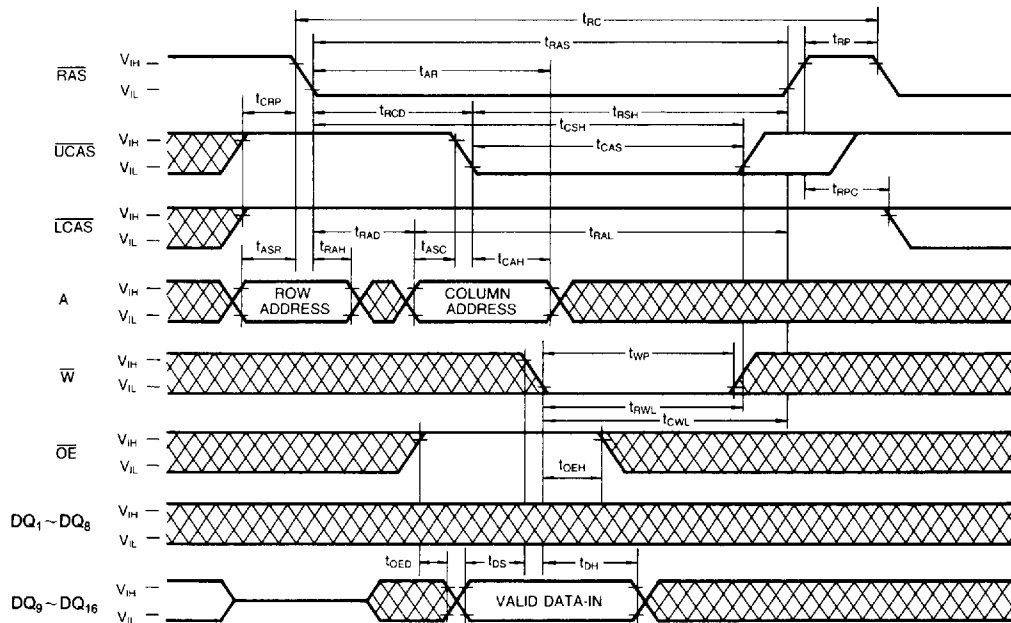
**CMOS DRAM**

**TIMING DIAGRAMS** (Continued)

**LOWER BYTE WRITE CYCLE ( $\overline{OE}$  CONTROLLED WRITE)**



**UPPER BYTE WRITE CYCLE ( $\overline{OE}$  CONTROLLED WRITE)**



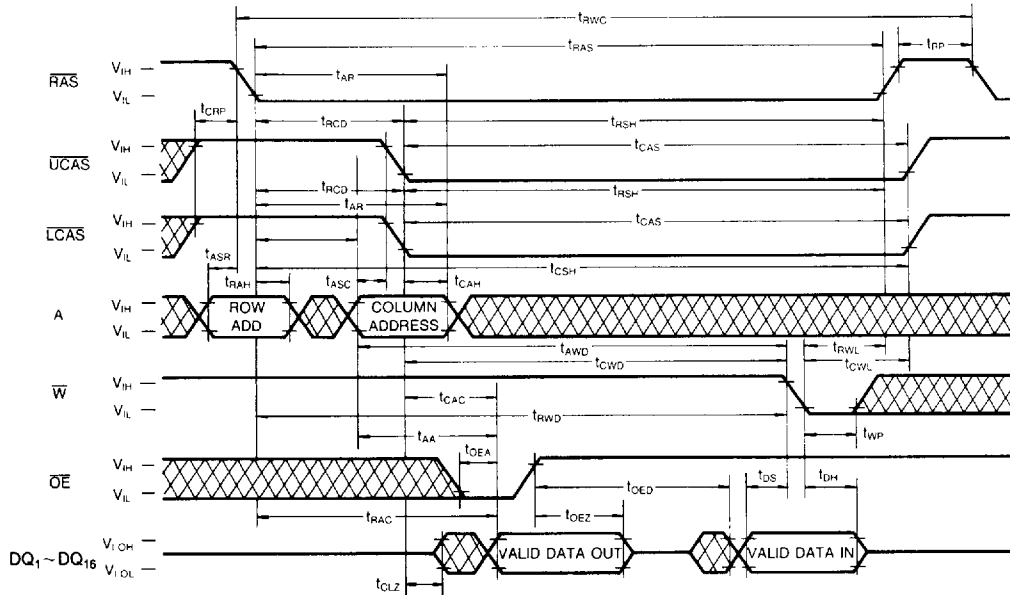
 DON'T CARE

**KM416C256A/AL/ALL**

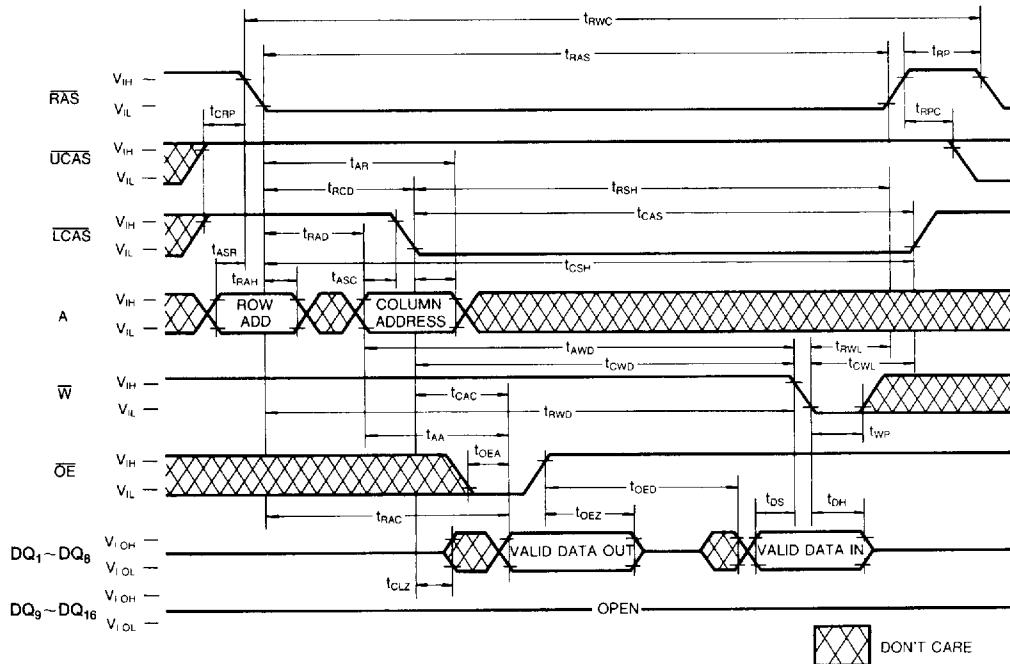
**CMOS DRAM**

**TIMING DIAGRAMS (Continued)**

**WORD READ-MODIFY-WRITE CYCLE**



**LOWER-BYTE READ-MODIFY-WRITE CYCLE**



DONT CARE

2









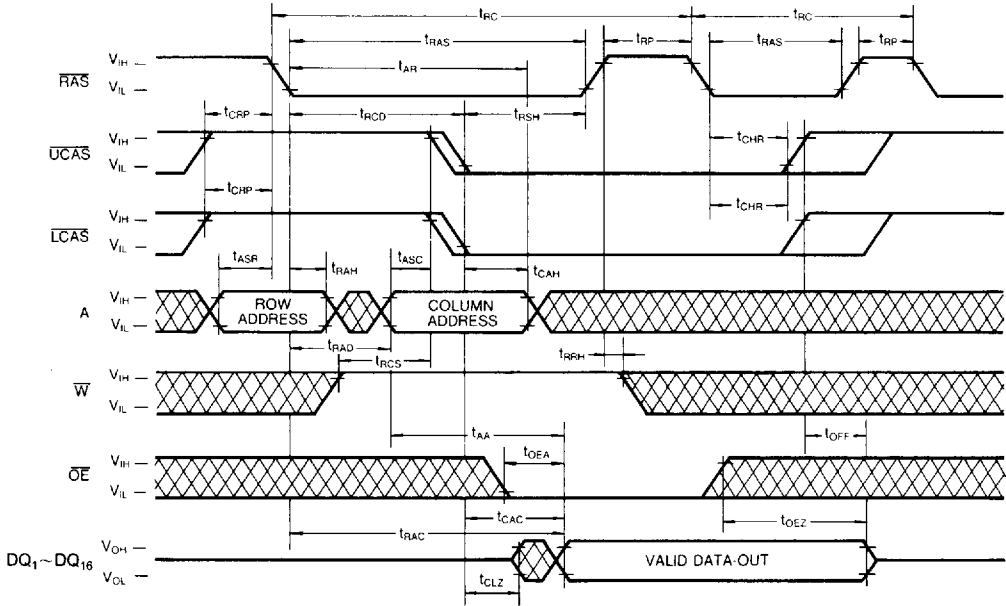


**KM416C256A/AL/ALL**

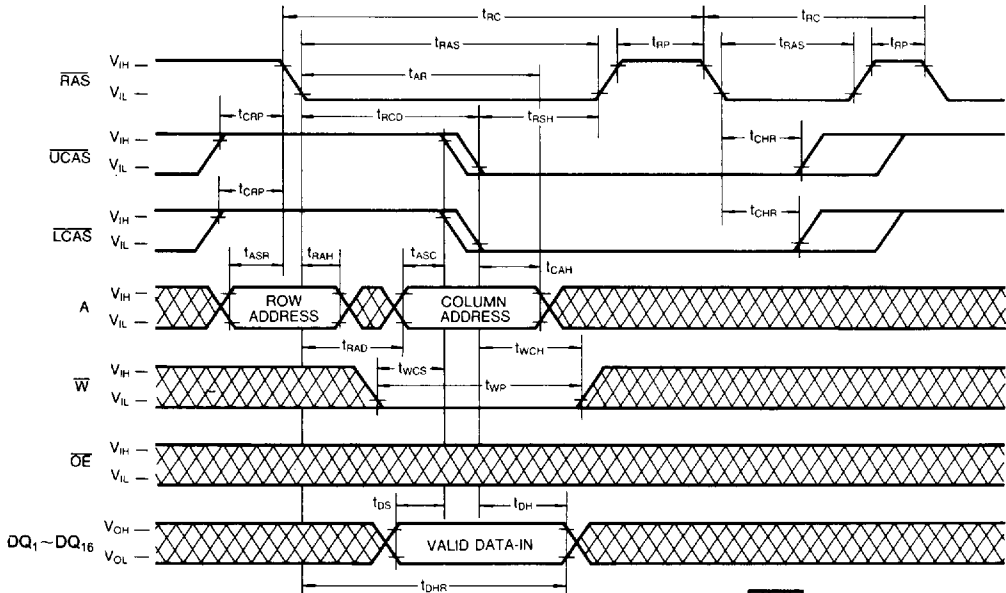
**CMOS DRAM**

**TIMING DIAGRAMS (Continued)**

**HIDDEN REFRESH CYCLE (READ)**



**HIDDEN REFRESH CYCLE (WRITE)**



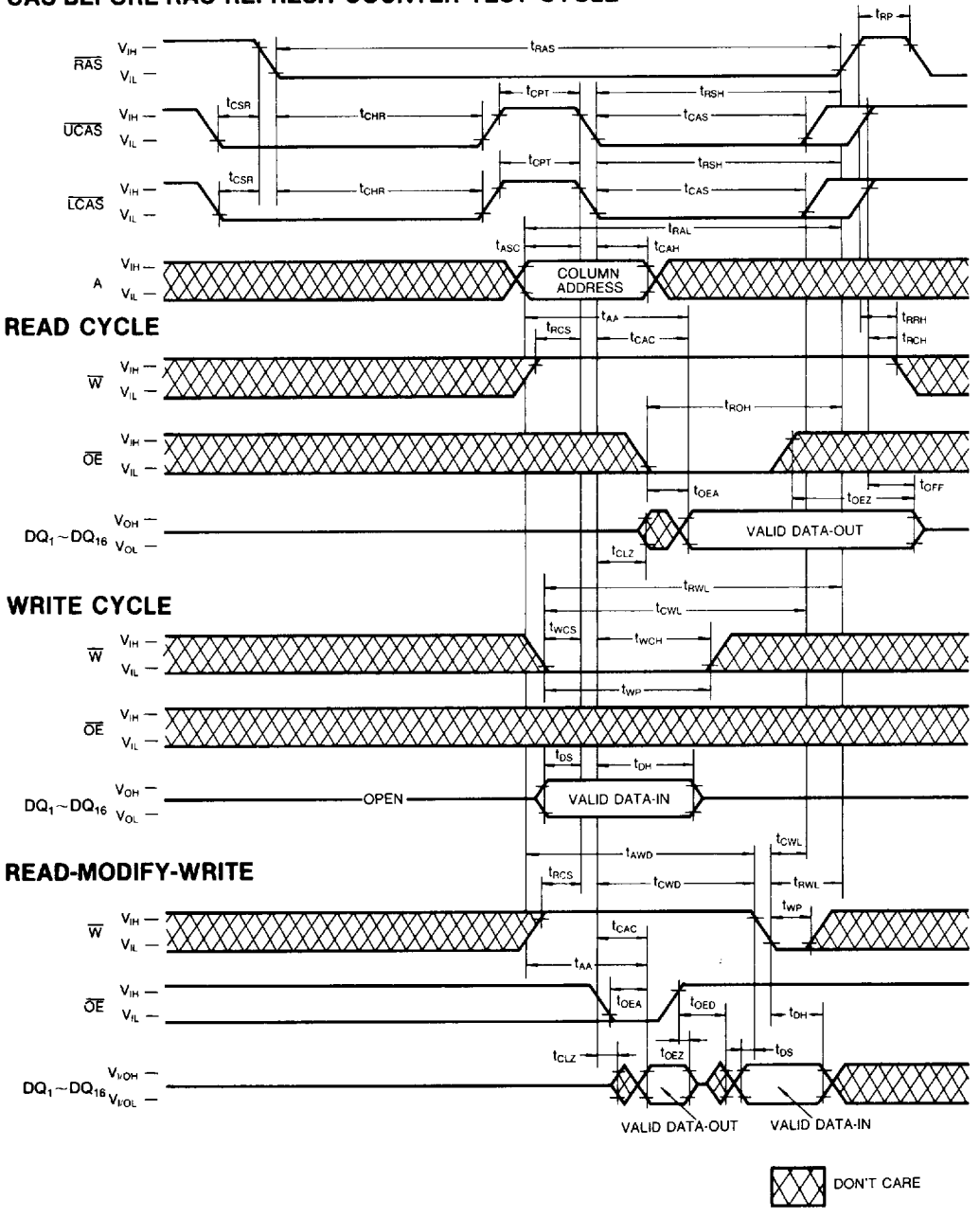
 DONT CARE

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**TIMING DIAGRAMS** (Continued)

**CAS-BEFORE-RAS REFRESH CYCLE TEST CYCLE**



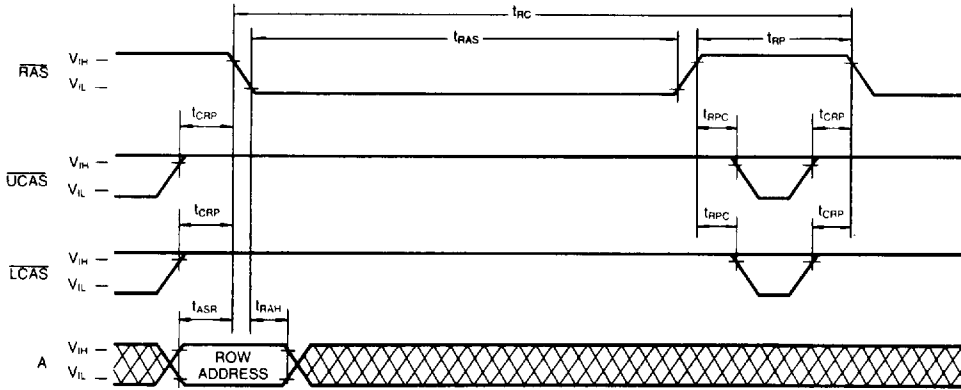
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**TIMING DIAGRAMS (Continued)**

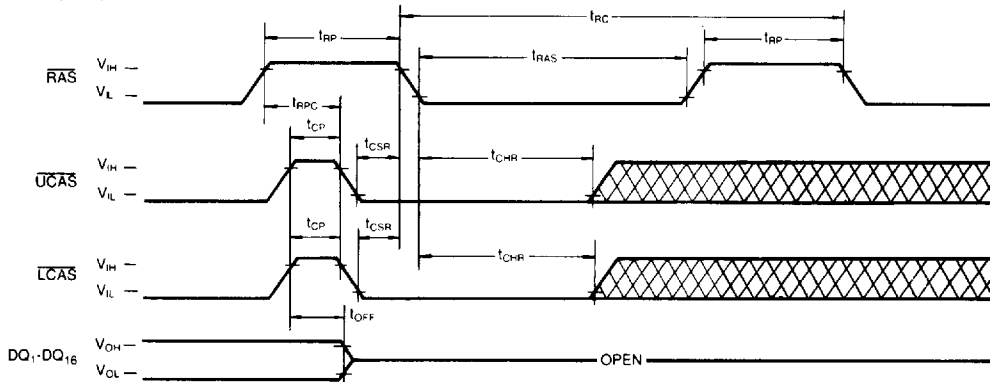
**RAS ONLY REFRESH CYCLE**

NOTE:  $\bar{W}$ ,  $\bar{OE}$  = Don't Care



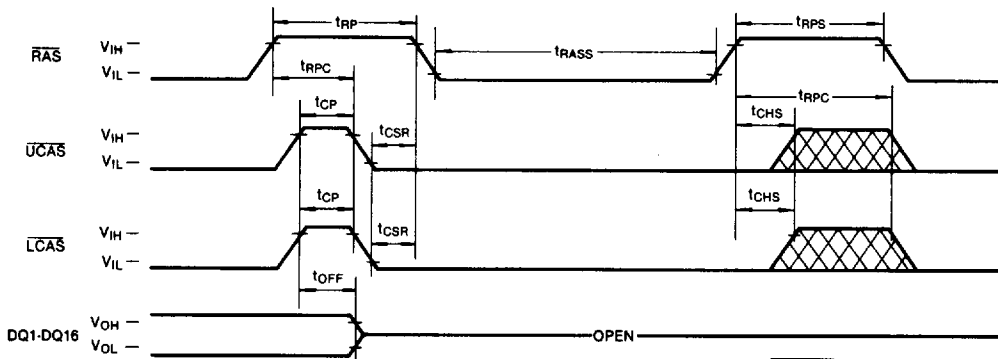
**CAS-BEFORE-RAS REFRESH CYCLE**

NOTE:  $\bar{W}$ ,  $\bar{OE}$ , A = Don't Care



**CAS-BEFORE-RAS SELF REFRESH CYCLE (LL-version)**

NOTE:  $\bar{W}$ ,  $\bar{OE}$ , A = Don't Care



 DON'T CARE

**KM416C256A/AL/ALL****CMOS DRAM****DEVICE OPERATION****Device Operation**

The KM416C256A/AL/ALL contains 4,194,304 memory locations arranged in 16 groups of  $262,144 \times 1$  bit each. Eighteen address bits are required to address a particular memory location. Since the KM416C256A/AL/ALL has only 9 address input pins, time multiplexed addressing is used to input 9 row and 9 column addresses. The multiplexing is controlled by the timing relationship between the row address strobe ( $\overline{RAS}$ ), the column address strobe ( $\overline{LCAS}$ ,  $\overline{UCAS}$ ) and the valid row and column address inputs.

Operation of the KM416C256A/AL/ALL begins by strobing in a valid row address with  $\overline{RAS}$  while  $\overline{LCAS}$  ( $\overline{UCAS}$ ) remains high. Then the address on the 9 address input pins is changed from a row address to a column address and is strobed in by  $\overline{LCAS}$  ( $\overline{UCAS}$ ). This is the beginning of any KM416C256A/AL/ALL cycle in which a memory location is accessed. The specific type of cycle is determined by the state of the write enable pin and various timing relationships. The cycle is terminated when both  $\overline{RAS}$  and  $\overline{LCAS}$  ( $\overline{UCAS}$ ) have returned to the high state. Another cycle can be initiated after  $\overline{RAS}$  remains high long enough to satisfy the  $\overline{RAS}$  precharge time ( $t_{RP}$ ) requirement.

 **$\overline{RAS}$  and  $\overline{CAS}$  Timing**

The minimum  $\overline{RAS}$  and  $\overline{CAS}$  pulse widths are specified by  $t_{RAS(min)}$  and  $t_{CAS(min)}$  respectively. These minimum pulse widths must be satisfied for proper device operation and data integrity. Once a cycle is initiated by bringing  $\overline{RAS}$  low, it must not be aborted prior to satisfying the minimum  $\overline{RAS}$  and  $\overline{CAS}$  pulse widths. In addition, a new cycle must not begin until the minimum  $\overline{RAS}$  precharge time,  $t_{RP}$ , has been satisfied. Once a cycle begins, internal clocks and other circuits within the KM416C256A/AL/ALL begin a complex sequence of events. If the sequence is broken by violating minimum timing requirements, loss of data integrity can occur.

**Read**

A read cycle is achieved by maintaining the write enable input ( $\overline{W}$ ) high during a  $\overline{RAS}/\overline{CAS}$  cycle. The access time is normally specified with respect to the falling edge of  $\overline{RAS}$ . But the access time also depends on the falling edge of  $\overline{CAS}$  and on the valid column address transition. If  $\overline{xCAS}$  goes low before  $t_{RCD(max)}$  and if the column address is valid before  $t_{RAD(max)}$  then the access time to valid data is specified by  $t_{RAC(min)}$ . However, if  $\overline{xCAS}$  goes low after  $t_{RCD(max)}$  or if the column address becomes valid after  $t_{RAD(max)}$ , access is specified by  $t_{CAC}$  or  $t_{AA}$ . In order to achieve the minimum access time,  $t_{RAC(min)}$ , it is necessary to meet both  $t_{RCD(max)}$  and  $t_{RAD(max)}$ .

**Write**

The KM416C256A/AL/ALL can perform early write, late write and read-modify-write cycles. The difference between these cycles is in the state of data-out and is determined by the timing relationship between  $\overline{W}$ ,  $\overline{OE}$ ,  $\overline{LCAS}$  and  $\overline{UCAS}$ . In any type of write cycle, Data-in must be valid at or before the falling edge of  $\overline{W}$  or  $\overline{xCAS}$ , whichever is later.

*Early Write:* An early write cycle is performed by bringing  $\overline{W}$  low before  $\overline{xCAS}$ . The 8-bit wide data at the data I/O pins is written into the addressed memory cells. Throughout the early write cycle the output remains in the Hi-Z state. In the early write cycle the output buffers remain in the Hi-Z state regardless of the state of the  $\overline{OE}$  input.

*Read-Modify-Write:* In this cycle, valid data from the addressed cell appears at the output before and during the time that data is being written into the same cells. This cycle is achieved by bringing  $\overline{W}$  low after  $\overline{CAS}$  and meeting the data sheet read-modify-write timing requirements. The  $\overline{OE}$  input must be low during the time defined by  $t_{OEA}$  for data to appear at the outputs. If  $t_{CWD}$  and  $t_{RWD}$  are not met output may contain invalid data. Conforming to the  $\overline{OE}$  timing requirements prevents bus contention on the KM416C256A/AL/ALL DQ pins.

**Data Output**

The KM416C256A/AL/ALL has a three-state output buffers which are controlled by  $\overline{CAS}$  and  $\overline{OE}$ . Whenever either  $\overline{CAS}$  or  $\overline{OE}$  is high ( $V_{IH}$ ), the outputs are in the high impedance (Hi-Z) state. In any cycle in which valid data appears at the outputs, the outputs enter into the low impedance state in the time specified by  $t_{CLZ}$  after the falling edge of  $\overline{CAS}$ . Invalid data may be present at the output during the time after  $t_{CLZ}$  and before the valid data appears at the output. The timing parameters  $t_{CAC}$ ,  $t_{RAC}$  and  $t_{AA}$  specify when the valid data will be present at the output. This is true even if a new  $\overline{RAS}$  cycle occurs (as in hidden refresh). Each of the KM416C256/L/SL operating cycles is listed below after the corresponding output state produced by the cycle.

*Valid Output Data:* Read, Read-Modify-Write, Hidden Refresh, Fast Page Mode Read, Fast Page Mode Read-Modify-Write.

*Hi-Z Output State:* Early Write,  $\overline{RAS}$ -only Refresh, Fast Page Mode Write,  $\overline{CAS}$ -before- $\overline{RAS}$  Refresh,  $\overline{OE}$  controlled write,  $\overline{CAS}$ -only cycle.

*Indeterminate Output State:* Delayed Write ( $t_{CWD}$  or  $t_{RWD}$  times are not met)

## KM416C256A/AL/ALL

## CMOS DRAM

**DEVICE OPERATION** (Continued)**Refresh**

The data in the KM416C256A/AL/ALL is stored as a charge on microscopic capacitor within each memory cell. The stored charge tends to dissipate over time and will affect data integrity if the charge is not periodically refreshed. Refresh of the individual storage cells is accomplished by accessing all rows within the refresh period ( $t_{REF}$ ) off within 8ms. (L: 64ms, LL: 128ms) There are several ways to accomplish this.

**$\overline{RAS}$ -Only Refresh:** This is the most common method for performing refresh. It is performed by strobing in a row address with  $\overline{RAS}$  while  $\overline{CAS}$  remains high. This cycle must be repeated for each of the 512 row address (A0-A8).

**$\overline{CAS}$ -before- $\overline{RAS}$  Refresh:** The KM416C256A/AL/ALL has  $\overline{CAS}$ -before- $\overline{RAS}$  on-chip refresh capability that eliminates the need for external refresh addresses. If either  $\overline{LCAS}$  or  $\overline{UCAS}$  input is held low for the specified set up time ( $t_{CSR}$ ) before  $\overline{RAS}$  transitions low, the on-chip refresh circuitry is enabled. An internal refresh operation automatically occurs. The refresh address is supplied by the on-chip refresh address counter which is then internally incremented in preparation for the next  $\overline{CAS}$ -before- $\overline{RAS}$  refresh cycle.

**Hidden Refresh:** A hidden refresh cycle may be performed while maintaining the latest valid data at the output by extending either  $\overline{LCAS}$  or  $\overline{UCAS}$  input active time and cycling  $\overline{RAS}$ . The hidden refresh cycle is actually a  $\overline{CAS}$ -before- $\overline{RAS}$  refresh cycle within an extended read cycle. The refresh row address is provided by the on-chip refresh address counter.

**Self Refresh:** The self refresh is  $\overline{CAS}$ -before- $\overline{RAS}$  refresh to be used for long periods of standby, such as a battery back-up. In normal  $\overline{CAS}$ -before- $\overline{RAS}$  condition, when  $\overline{RAS}$  is held low above 100 $\mu$ s an internal timer activates an refresh operation of consecutive row addresses in DRAM. The self refresh mode is exited when either  $\overline{RAS}$  or  $\overline{CAS}$  goes high ( $V_{IH}$ ).

**Other Refresh Methods:** It is also possible to refresh the KM416C256A/AL/ALL by using read, write or read-modify-write cycles. Whenever a row is accessed, all the cells in the row are automatically refreshed. There are certain applications in which it might be advantageous to perform refresh in this manner but in general  $\overline{RAS}$ -only or  $\overline{CAS}$ -before- $\overline{RAS}$  refresh is the preferred method.

**Fast Page Mode**

The KM416C256A/AL/ALL has Fast page mode capability provides high speed read, write or read-modify-write access to all memory locations within a selected row. These cycles may be mixed in any order. A fast page mode cycle begins with a normal cycle. Then, while  $\overline{RAS}$  is held low to maintain the row address,  $\overline{CAS}$  is cycled to strobe in additional column addresses. This eliminates the time required to set up and strobe sequential row addresses for the same page.

 **$\overline{CAS}$ -before- $\overline{RAS}$  Refresh Counter Test Cycle**

A special timing sequence using the  $\overline{CAS}$ -before- $\overline{RAS}$  counter test cycle provides a convenient method of verifying the functionality of the  $\overline{CAS}$ -before- $\overline{RAS}$  refresh activated circuitry. The cycle begins as a  $\overline{CAS}$ -before- $\overline{RAS}$  refresh operation. Then, if  $\overline{CAS}$  is asserted high and then low again while  $\overline{RAS}$  is asserted low, the read and write operations are enabled. In this method, the row address bits A0 through A8 are supplied by on chip refresh counter.

**Power-up**

If  $\overline{RAS} = V_{SS}$  during power-up, the KM416C256A/AL/ALL could begin an active cycle. This condition results in higher than necessary current demands from the power supply during power-up. It is recommended that  $\overline{RAS}$  and  $\overline{CAS}$  track with  $V_{CC}$  during power-up or be held a valid  $V_{IH}$  in order to minimize the power-up current.

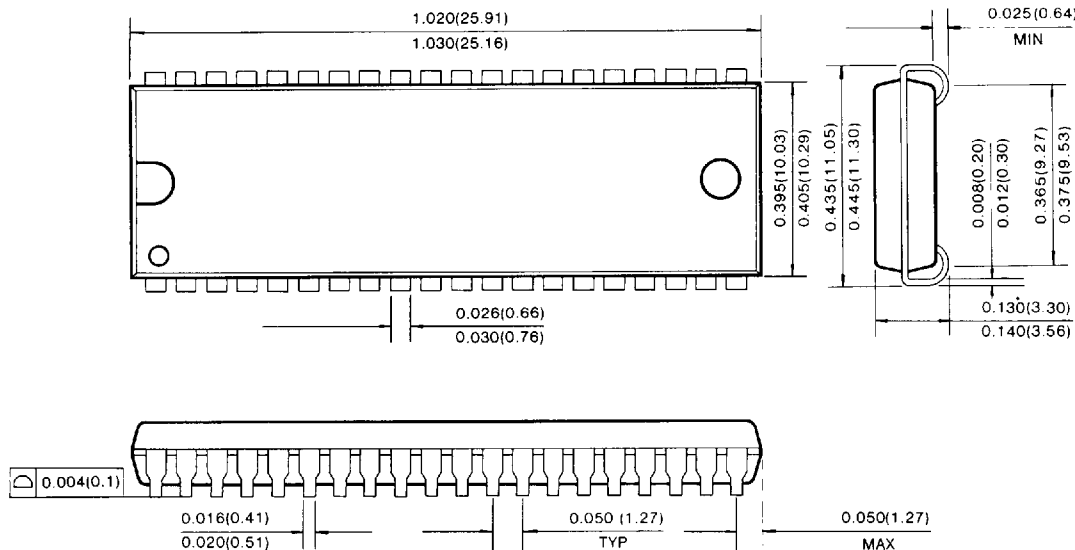
**KM416C256A/AL/ALL**

**CMOS DRAM**

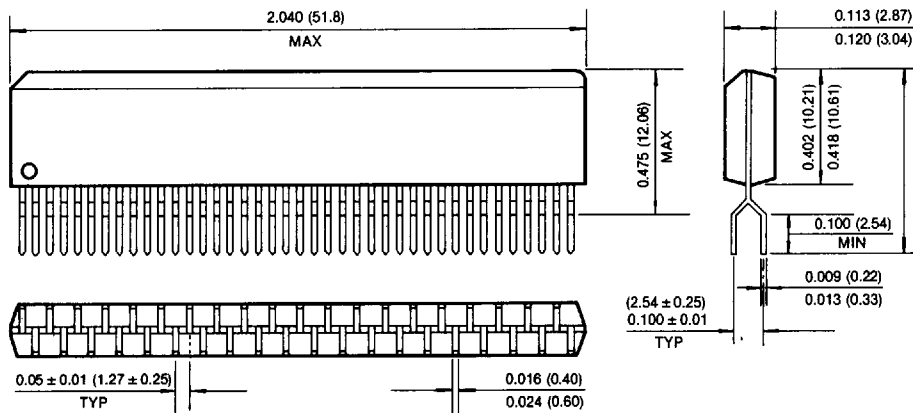
**PACKAGE DIMENSION**

**40-LEAD PLASTIC SMALL OUT-LINE J-LEAD**

Units: Inches (millimeters)



**40-LEAD PLASTIC ZIGZAG-IN-LINE PACKAGE**

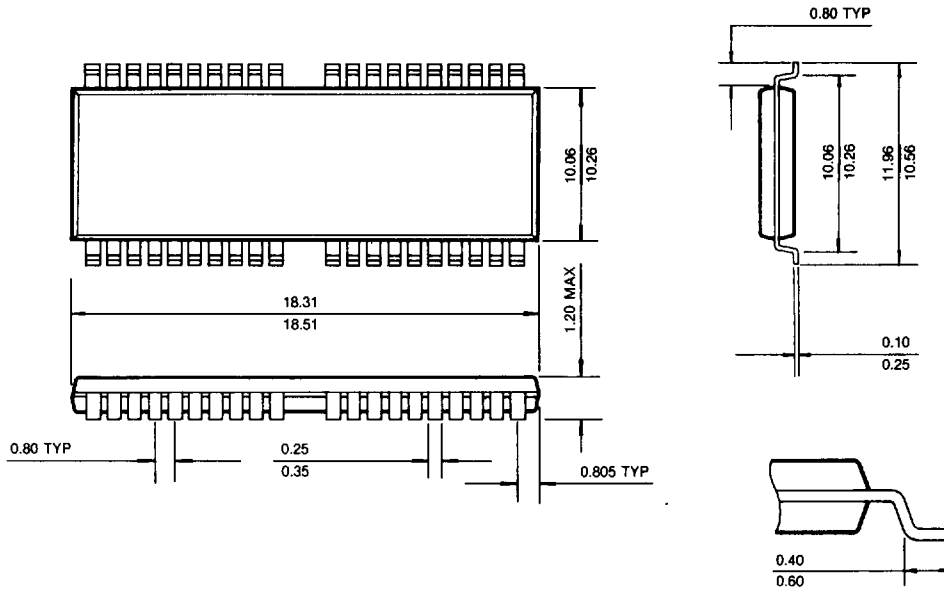


# KM416C256A/AL/ALL

# CMOS DRAM

40 LEAD PLASTIC THIN SMALL OUT-LINE PACKAGE TYPE (II)  
(Forward and Reverse Type)

Units: Inches (millimeters)



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