64K x 4 Bit CMOS Dynamic RAM with Static Column Mode

FEATURES

- **Performance range:**

	t_{RAC}	t_{CAC}	t_{RC}
KM41C466-7	70ns	20ns	130ns
KM41C466-8	80ns	20ns	150ns
KM41C466-10	100ns	25ns	180ns

- **Static Column Mode operation**
- **$\overline{CS}$-before-$\overline{RAS}$ refresh capability**
- **$\overline{RAS}$-only and Hidden refresh capability**
- **TTL compatible inputs and output**
- **Early write or Output Enable Controlled Write**
- **Single +5V ± 10% power supply**
- **256 cycles/4ms refresh**
- **JEDEC standard pinout**
- **A vailable in Plastic DIP, PLCC or ZIP**

GENERAL DESCRIPTION

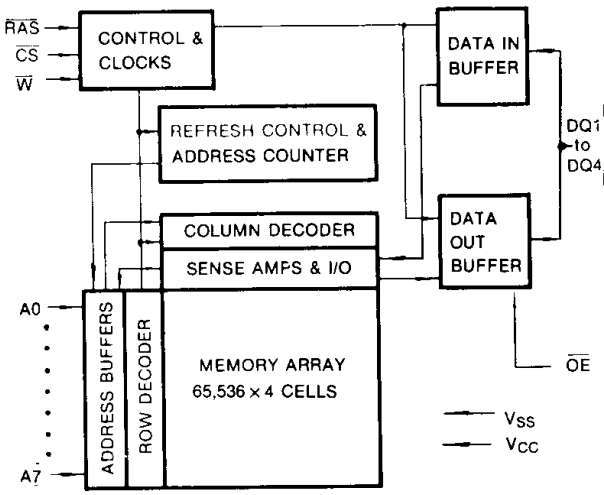
The Samsung KM41C466 is a CMOS high speed 65,536 bit x 4 Dynamic Random Access Memory. Its design is optimized for high performance applications such as mainframes and mini computers, graphics and high performance microprocessor systems.

The KM41C466 features Static Column Mode operation which allows high speed random or sequential access within a row. Static Column Mode operation offers high performance while relaxing many critical system timing requirements for fast usable speed.

$\overline{CS}$-before-$\overline{RAS}$ refresh capability provides on-chip auto refresh as an alternative to $\overline{RAS}$-only refresh. All inputs and outputs are fully TTL compatible.

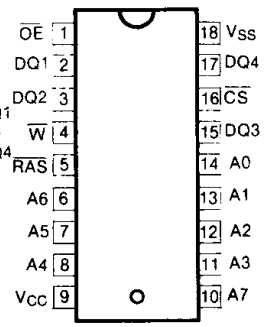
The KM41C466 is fabricated using Samsung's advanced CMOS process.

FUNCTIONAL BLOCK DIAGRAM

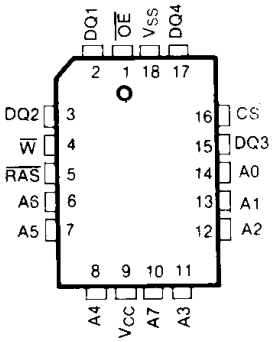


PIN CONFIGURATION (Top Views)

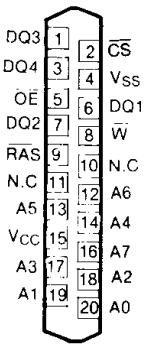
- **KM41C466P**



- **KM41C466J**



- **KM41C466Z**



Pin Name	Pin Function
A_0-A_7	Address Inputs
DQ_1-DQ_4	Data In/Data Output
$\overline{W}$	Read/Write Input
$\overline{OE}$	Data Output Enable
$\overline{RAS}$	Row Address Strobe
$\overline{CS}$	Chip Select Input
V_{CC}	Power (+5V)
V_{SS}	Ground
N.C.	No Connection

ABSOLUTE MAXIMUM RATINGS*

Item	Symbol	Rating	Units
Voltage on Any Pin Relative to V_{SS}	V_{IN}, V_{OUT}	−1 to +7.0	V
Voltage on V_{CC} Supply Relative to V_{SS}	V_{CC}	−1 to +7.0	V
Storage Temperature	T_{stg}	−55 to +150	°C
Power Dissipation	P_D	600	mW
Short Circuit Output Current	I_{OS}	50	mA

*Note: Permanent device damage may occur of "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.

RECOMMENDED OPERATING CONDITIONS (Voltage reference to V_{SS}, T_A = 0 to 70°C)

Item	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* ($\overline{RAS}$, $\overline{CS}$, Address Cycling @ t_{RC} = min.)	KM41C466-7	I_{CC1}	—	65	mA
	KM41C466-8		—	55	mA
	KM41C466-10		—	45	mA
Standby Current ($\overline{RAS}$ = $\overline{CS}$ = V_{IH})		I_{CC2}	—	2	mA
$\overline{RAS}$-Only Refresh Current* ($\overline{CS}$=V_{IH}, $\overline{RAS}$, Cycling @t_{RC}=min.)	KM41C466-7	I_{CC3}	—	65	mA
	KM41C466-8		—	55	mA
	KM41C466-10		—	45	mA
Static Column Mode Current* ($\overline{RAS}$ = $\overline{CS}$ = V_{IL}, Address Cycling: t_{SC}=min.)	KM41C466-7	I_{CC4}	—	40	mA
	KM41C466-8		—	35	mA
	KM41C466-10		—	30	mA
Standby Current ($\overline{RAS}$ = $\overline{CS}$ = V_{CC} − 0.2V)		I_{CC5}	—	1	mA
$\overline{CS}$-Before-$\overline{RAS}$ Refresh Current* ($\overline{RAS}$ and $\overline{CS}$ Cycling @t_{RC} = min.)	KM41C466-7	I_{CC6}	—	65	mA
	KM41C466-8		—	55	mA
	KM41C466-10		—	45	mA
Input Leakage Current (Any input 0V ≤ V_{IN} ≤ 6.5V, all other pins not under test = 0 volts.)		I_{IL}	−10	10	μA
Output Leakage Current (Data out is disabled, 0 ≤ V_{OUT} ≤ 5.5V)		I_{OL}	−10	10	μA
Output High Voltage Level (I_{OH} = −5mA)		V_{OH}	2.4	—	V
Output Low Voltage Level (I_{OL} = 4.2mA)		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 average current.

CAPACITANCE ($T_A = 25°C$)

Item	Symbol	Min	Max	Unit
Input capacitance (A_0-A_7)	C_{IN1}	—	6	pF
Input capacitance ($\overline{RAS}$, $\overline{CS}$, $\overline{W}$, $\overline{OE}$)	C_{IN2}	—	7	pF
Output Capacitance (DQ_1-DQ_4)	C_{OUT}	—	7	pF

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

Standard Operation	Symbol	KM41C466-7		KM41C466-8		KM41C466-10		Unit	Notes
		Min	Max	Min	Max	Min	Max		
Random read or write cycle time	t_{RC}	130		150		180		ns	
Read-modify-write cycle time	t_{RWC}	185		205		245		ns	
Static column Mode Cycle Time	t_{SC}	40		45		55		ns	
Static column Mode Read-Write Cycle Time	t_{SRWC}	100		110		135		ns	
Access time from $\overline{RAS}$	t_{RAC}		70		80		100	ns	3,4,11
Access time from $\overline{CS}$	t_{CAC}		20		20		25	ns	3,4,5
Access time from column address	t_{AA}		35		40		50	ns	3,11
Access time from last write	t_{ALW}		65		75		95	ns	3,12
$\overline{CS}$ to output in Low-Z	t_{CLZ}	5		5		5		ns	3
Output buffer turn-off delay time	t_{OFF}	0	25	0	25	0	30	ns	7
Output data hold time from column address	t_{AOH}	5		5		5		ns	
Output data enable time from $\overline{W}$	t_{OW}		45		50		70	ns	
Transition time (rise and fall)	t_T	3	50	3	50	3	50	ns	2
$\overline{RAS}$ precharge time	t_{RP}	50		60		70		ns	
$\overline{RAS}$ pulse width	t_{RAS}	70	10,000	80	10,000	100	10,000	ns	
$\overline{RAS}$ pulse width (static column mode)	t_{RASC}	70	100,000	80	100,000	100	100,000	ns	
$\overline{CS}$ to $\overline{RAS}$ hold time	t_{RSH}	20		20		25		ns	
$\overline{RAS}$ to $\overline{CS}$ hold time	t_{CSH}	70		80		100		ns	
$\overline{CS}$ pulse width	t_{CS}	20	10,000	20	10,000	25	20,000	ns	
$\overline{CS}$ pulse width (static column mode)	t_{CSC}	20	100,000	20	100,000	25	100,000	ns	
$\overline{RAS}$ to $\overline{CS}$ delay time	t_{RCD}	20	50	25	60	25	75	ns	4
$\overline{RAS}$ to column address delay time	t_{RAD}	15	35	20	40	20	50	ns	11
$\overline{CS}$ to $\overline{RAS}$ precharge time	t_{CRP}	5		5		5		ns	
$\overline{CS}$ precharge time (static column mode)	t_{CP}	10		10		10		ns	
Row address set-up time	t_{ASR}	0		0		0		ns	
Row address hold time	t_{RAH}	10		15		15		ns	
Column address set-up time	t_{ASC}	0		0		0		ns	
Column address hold time	t_{CAH}	15		20		20		ns	
Write address hold time referenced to $\overline{RAS}$	t_{AWR}	55		65		75		ns	6
Column Address hold time referenced to $\overline{RAS}$	t_{AR}	85		95		115		ns	

AC CHARACTERISTICS (Continued)

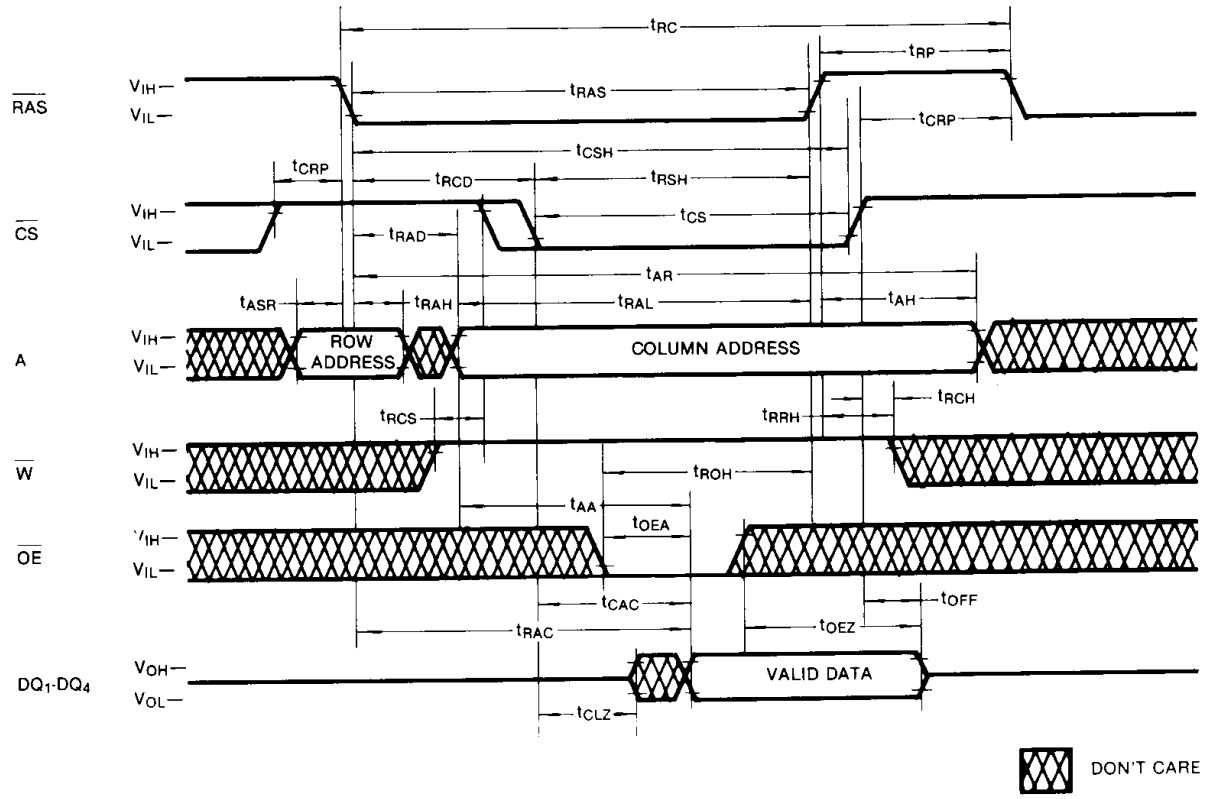
Standard Operation	Symbol	KM41C466-7		KM41C466-8		KM41C466-10		Unit	Notes
		Min	Max	Min	Max	Min	Max		
Column Address to $\overline{RAS}$ lead time	t_{RAL}	35		40		50		ns	
Column Address hold time referenced to $\overline{RAS}$ rise	t_{AH}	10		10		10		ns	
Last write to column address delay time	t_{LWAD}	20	30	25	35	25	45	ns	
Last write to column address hold time	t_{AHLW}	65		75		95		ns	
Read command set-up time	t_{RCS}	0		0		0		ns	
Read command hold time referenced to $\overline{CS}$	t_{RCH}	0		0		0		ns	9
Read command hold time referenced to $\overline{RAS}$	t_{RRH}	0		0		0		ns	9
Write command hold time	t_{WCH}	15		20		20		ns	
Write command hold time referenced to $\overline{RAS}$	t_{WCR}	55		65		75		ns	6
Write command pulse width	t_{WP}	15		20		20		ns	
Write command inactive time	t_{WI}	10		10		10		ns	
Write command to $\overline{RAS}$ lead time	t_{RWL}	20		20		25		ns	
Write command to $\overline{CS}$ lead time	t_{CWL}	20		20		25		ns	
Data-in set-up time	t_{DS}	0		0		0		ns	10
Data-in hold time	t_{DH}	15		20		20		ns	10
Data-in hold time referenced to $\overline{RAS}$	t_{DHR}	55		65		75		ns	6
Refresh period (256 cycles)	t_{REF}		4		4		4	ms	
Write command set-up time	t_{WCS}	0		0		0		ns	8
$\overline{CS}$ to $\overline{W}$ delay time (read modify write cycle)	t_{CWD}	50		50		60		ns	8
$\overline{RAS}$ to $\overline{W}$ delay time (read modify write cycle)	t_{RWD}	100		110		135		ns	8
Column address to $\overline{W}$ delay time	t_{AWD}	65		70		85		ns	8
$\overline{CS}$ setup time ($\overline{CS}$-before-$\overline{RAS}$ refresh)	t_{CSR}	10		10		10		ns	
$\overline{CS}$ hold time ($\overline{CS}$-before-$\overline{RAS}$ refresh)	t_{CHR}	20		30		30		ns	
$\overline{RAS}$ to $\overline{CS}$ precharge time	t_{RPC}	10		10		10		ns	
$\overline{CS}$ precharge time	t_{CPT}	35		40		50		ns	
$\overline{RAS}$ hold time referenced to $\overline{OE}$	t_{ROH}	20		20		20		ns	
$\overline{OE}$ access time	t_{OEA}		20		20		25	ns	
$\overline{OE}$ to data delay	t_{OED}	20		20		25		ns	
Output buffer turn off delay time from $\overline{OE}$	t_{OEZ}	0	20	0	20	0	25	ns	
$\overline{OE}$ command hold time	t_{OEH}	20		20		25		ns	

NOTES

1. An initial pause of 200μs is required after power-up followed by any 8 $\overline{RAS}$ 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_{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}.
5. Assumes that $t_{RCD} \geq t_{RCD}$(max).
6. t_{AWR}, t_{WCR}, t_{DHR} are referenced to t_{RAD}(max).
7. This parameter defineds the time at which the output achieves the open circuit condition and is not referenced to V_{OH} or V_{OL}.
8. t_{WCS}, t_{RWD}, t_{CWD} and t_{AWD} are non 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 throughout the entire cycle. If $t_{CWD} \geq t_{CWD}$(min) and $t_{RWD} \geq t_{RWD}$(min) and $t_{AWD} \geq t_{AWD}$(min), then the cycle is a read-write cycle and the data out will contain the data read from the selected address. If neither of the above conditions are satisfied, the condition of the data out is in indeterminate.
9. Either t_{RCH} or t_{RRH} must be satisfied for a read cycle.
10. These parameters are referenced to the $\overline{CS}$ leading edge in early write cycles and to the $\overline{W}$ leading edge in read-write cycles.
11. Operation within 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 by t_{AA}.
12. Operation within the t_{LWAD}(max) limit insures that t_{ALW}(max) can be met. t_{LWAD}(max) is specified as a reference point only. If t_{LWAD} is greater than the specified t_{LWAD}(max) limit, then access time is controlled by t_{AA}.

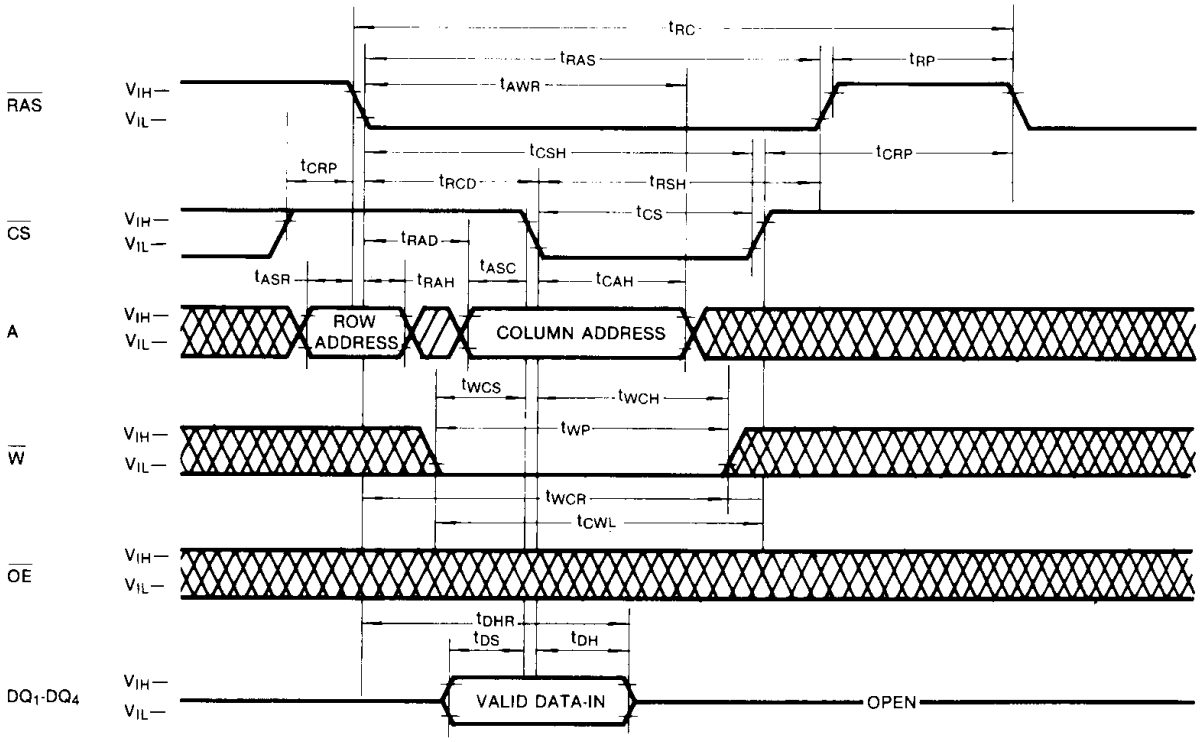
TIMING DIAGRAMS (Continued)

READ CYCLE

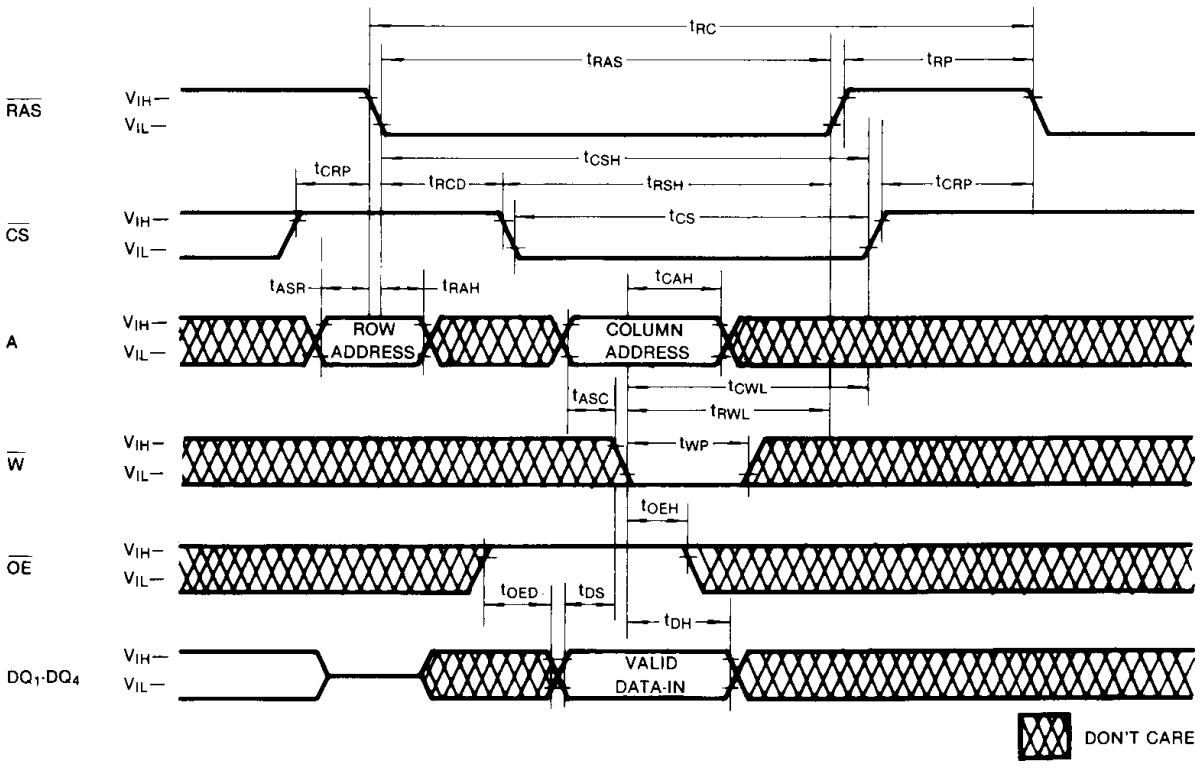


TIMING DIAGRAMS (Continued)

WRITE CYCLE (EARLY WRITE)

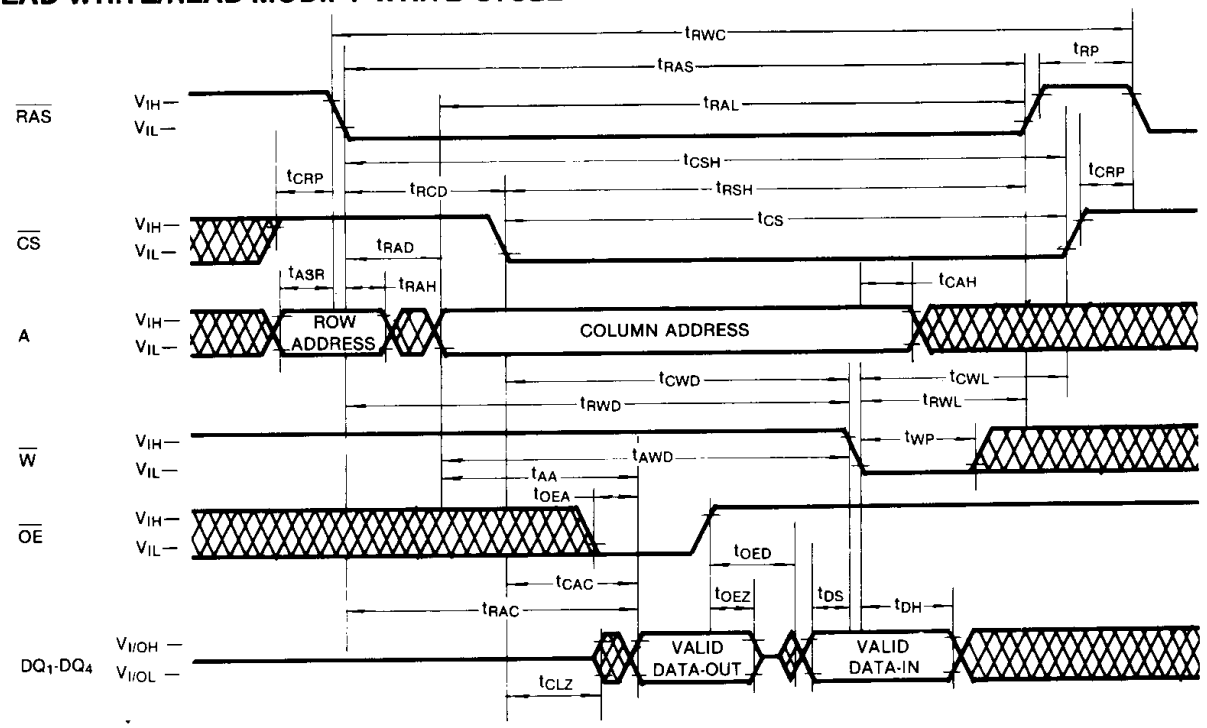


WRITE CYCLE (OE CONTROLLED WRITE)

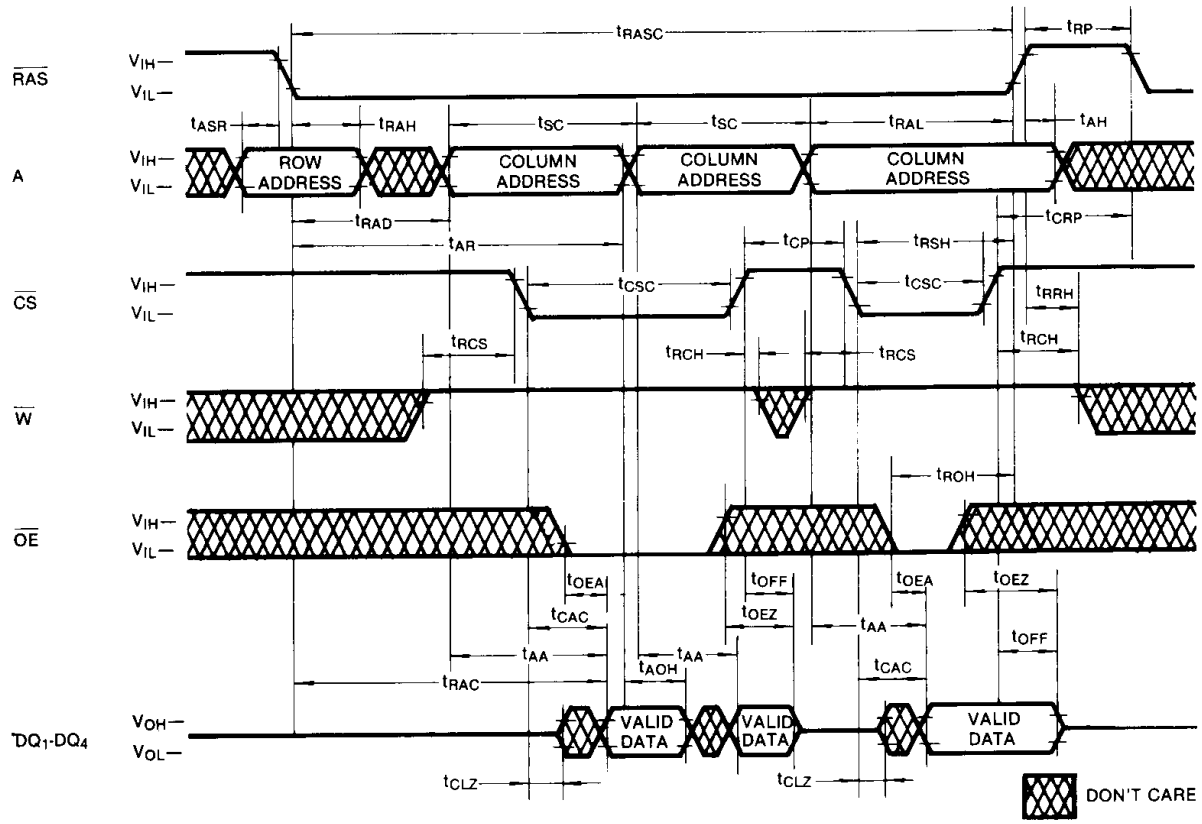


TIMING DIAGRAMS (Continued)

READ-WRITE/READ-MODIFY-WRITE CYCLE

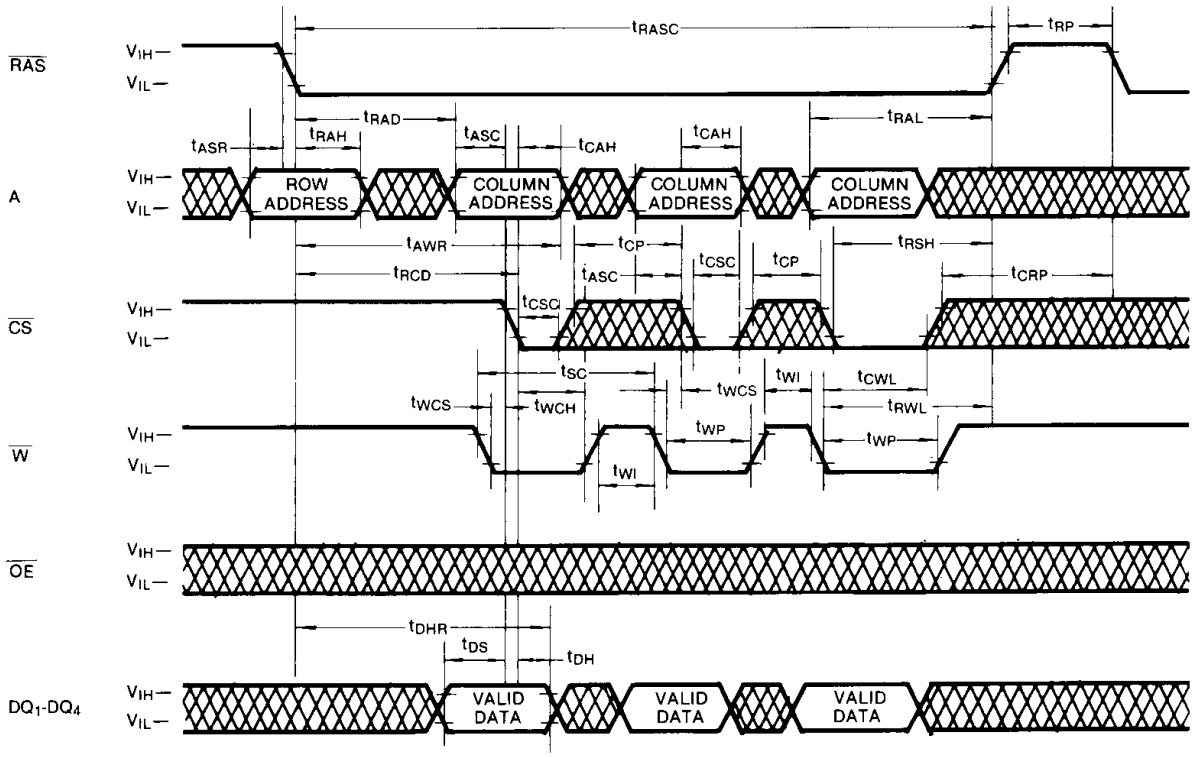


STATIC COLUMN MODE READ CYCLE

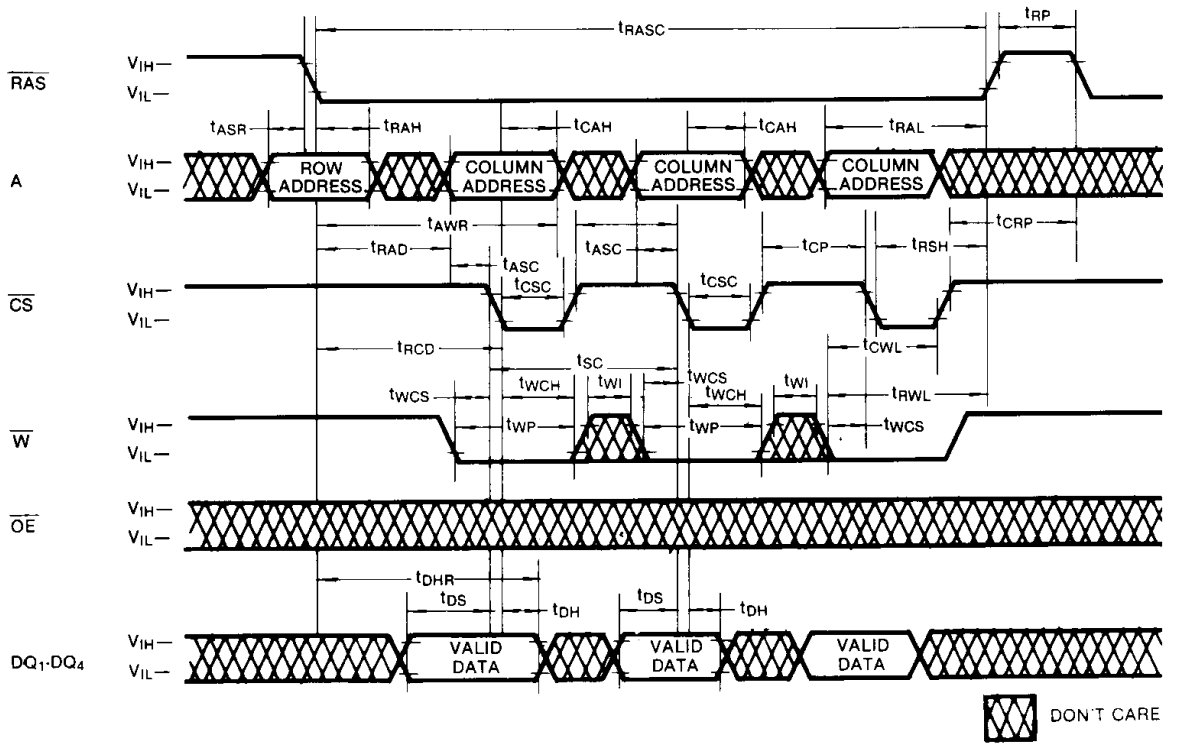


TIMING DIAGRAMS (Continued)

STATIC COLUMN MODE WRITE CYCLE ($\overline{W}$ controlled early write)

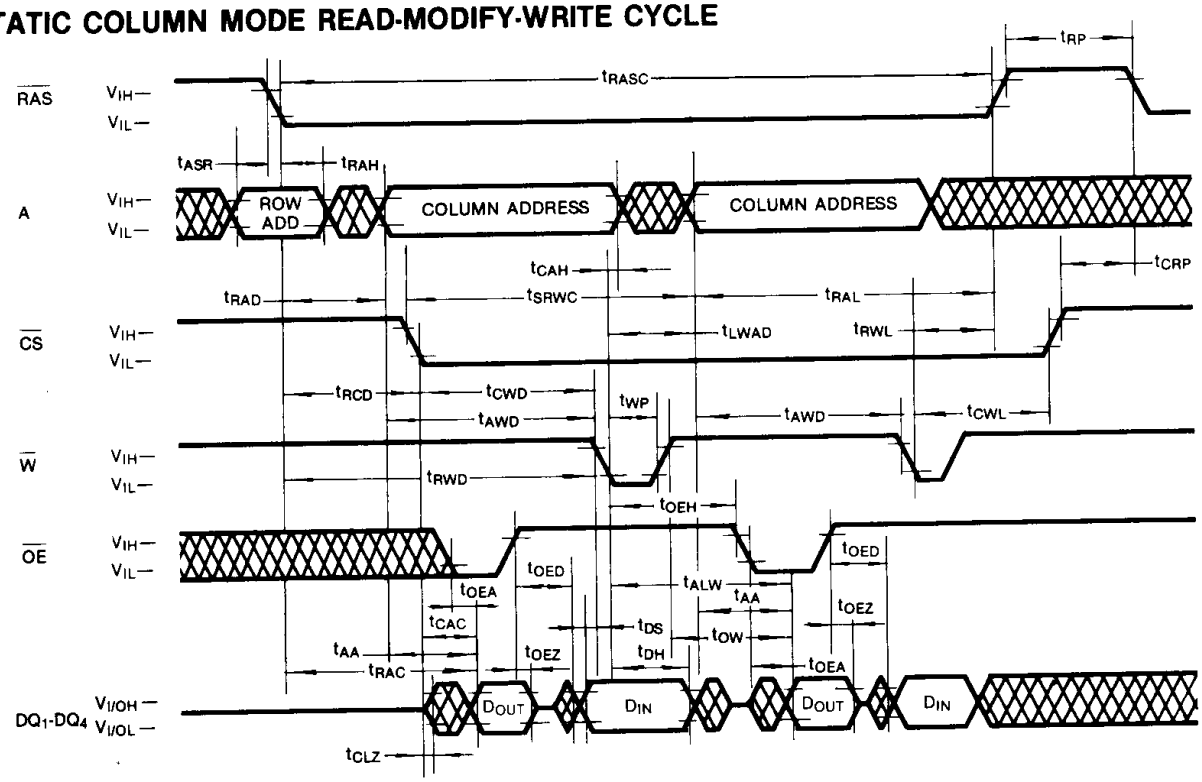


STATIC COLUMN MODE WRITE CYCLE ($\overline{CS}$ controlled early write)

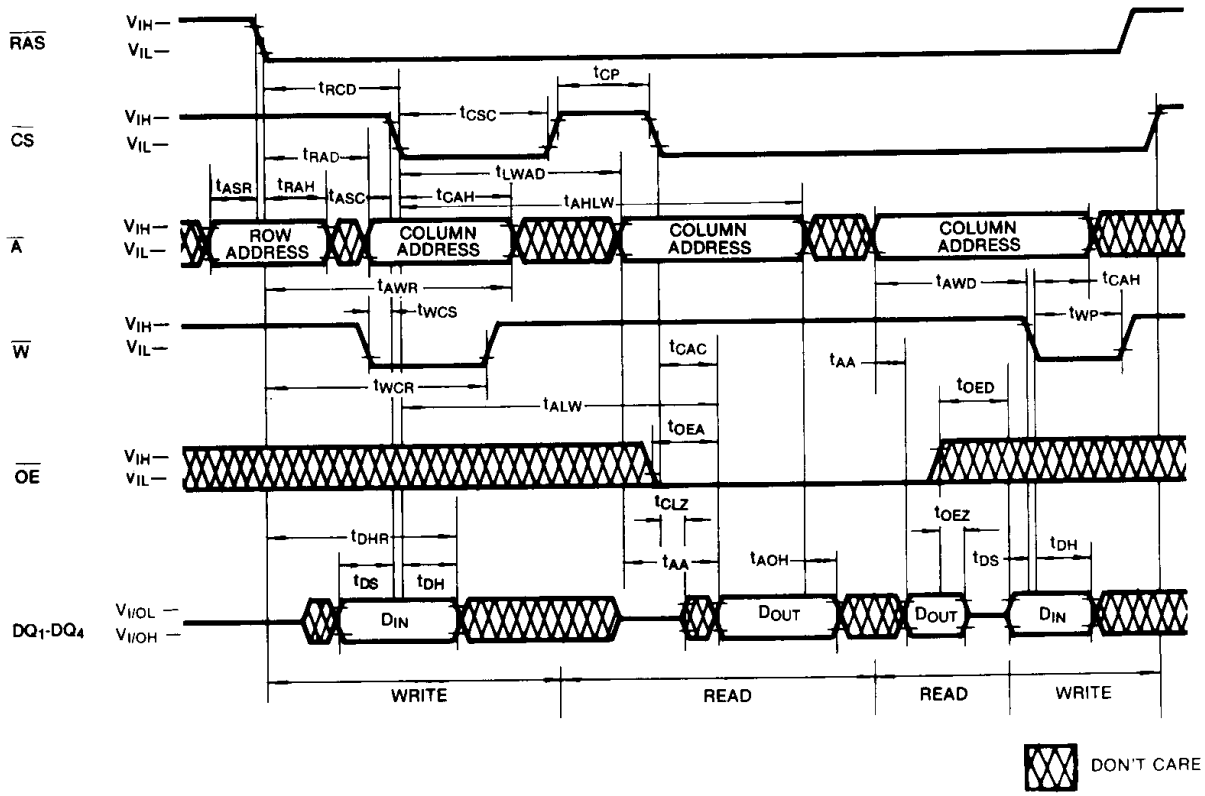


TIMING DIAGRAMS (Continued)

STATIC COLUMN MODE READ-MODIFY-WRITE CYCLE



STATIC COLUMN MODE MIXED CYCLE

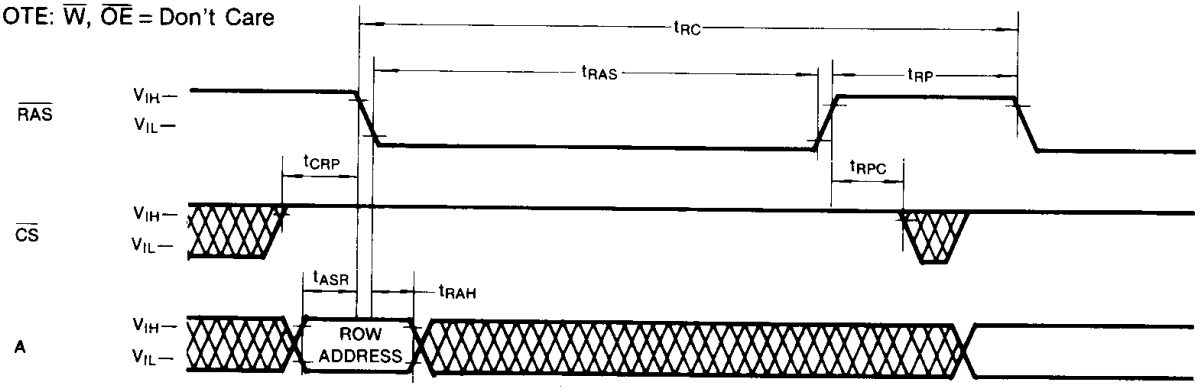


DON'T CARE

TIMING DIAGRAMS (Continued)

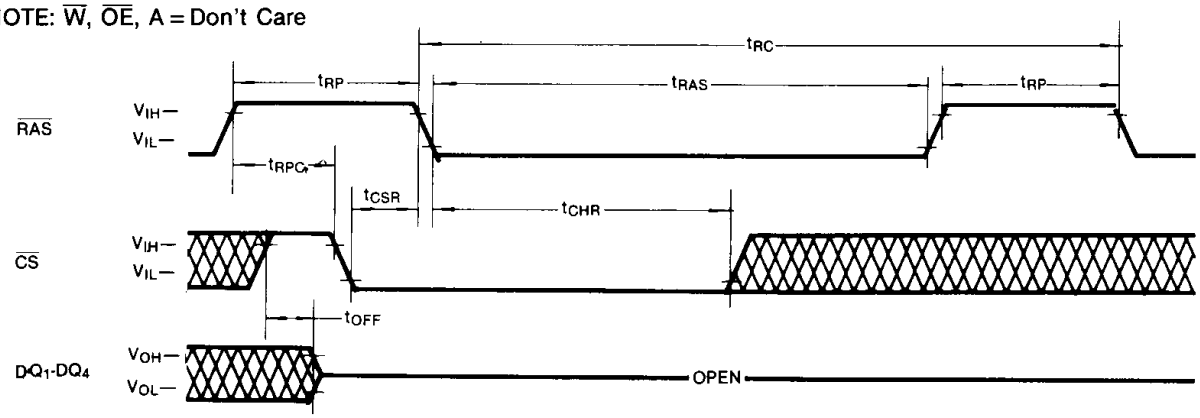
$\overline{RAS}$-ONLY REFRESH CYCLE

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



$\overline{CS}$-BEFORE-$\overline{RAS}$ REFRESH CYCLE

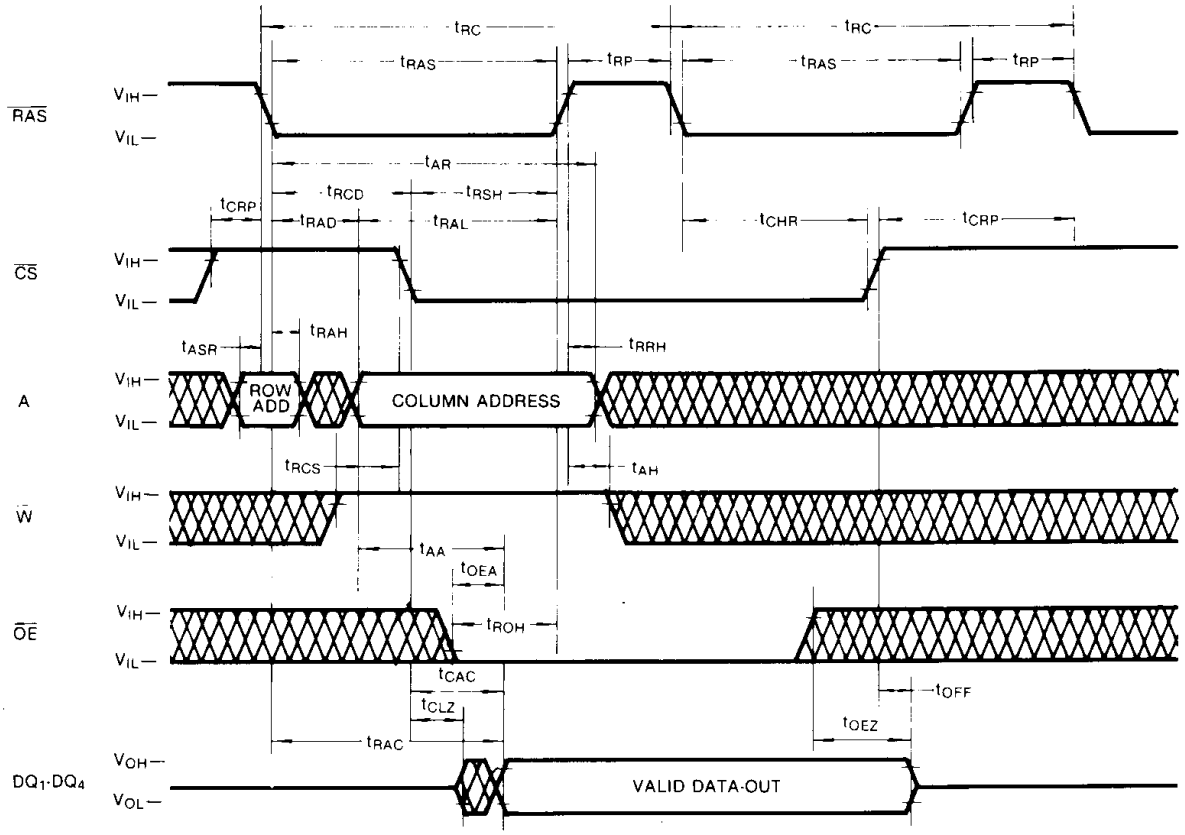
NOTE: $\overline{W}$, $\overline{OE}$, A = Don't Care



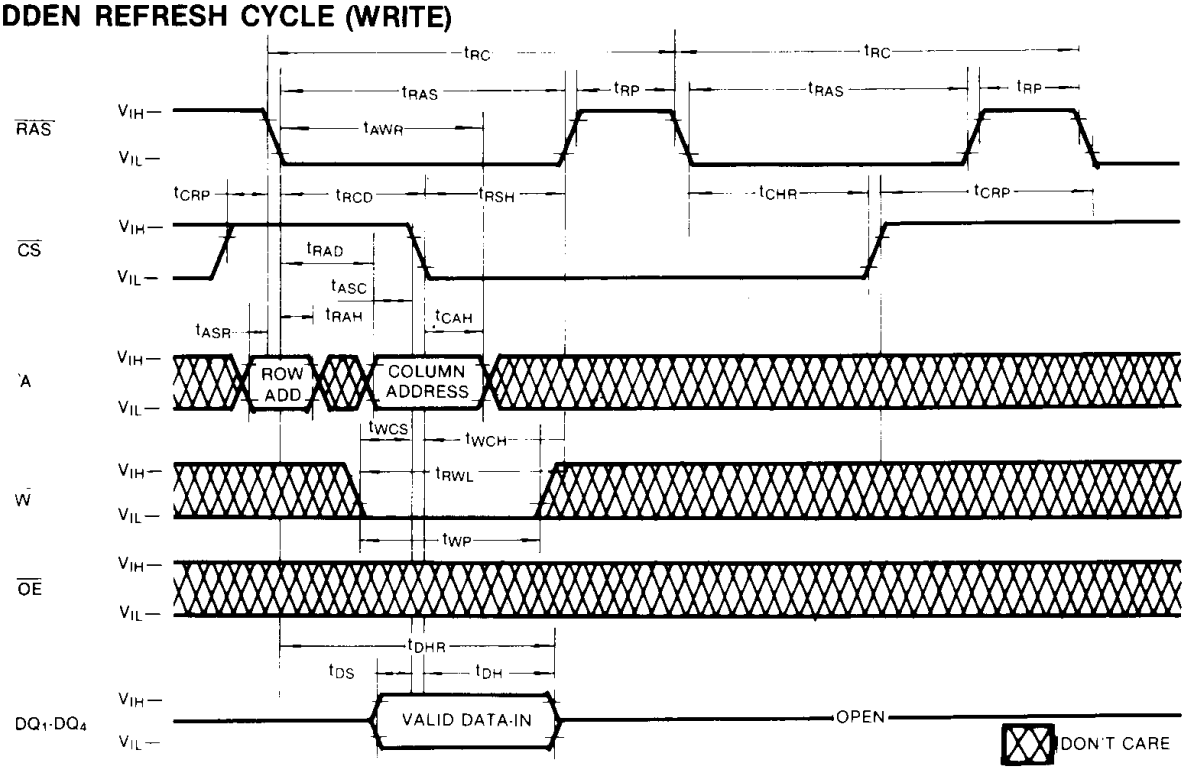
DON'T CARE

TIMING DIAGRAMS (Continued)

HIDDEN REFRESH CYCLE (READ)

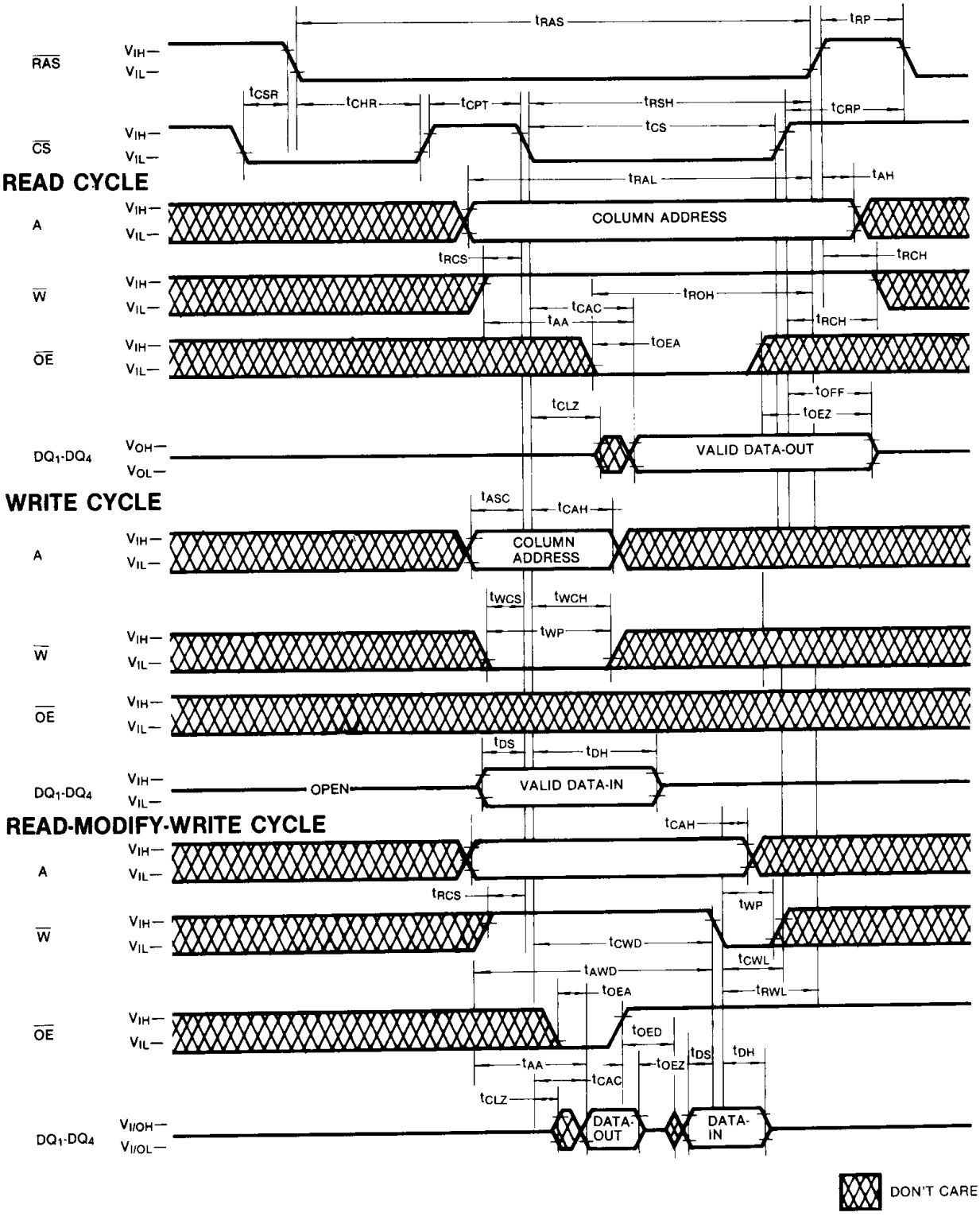


HIDDEN REFRESH CYCLE (WRITE)



TIMING DIAGRAMS (Continued)

$\overline{CS}$-BEFORE-$\overline{RAS}$ REFRESH COUNTER TEST CYCLE



DEVICE OPERATION

Device Operation

The KM41C466 contains 262,114 memory locations. Sixteen address bits are required to address a particular memory location. Since the KM41C466 has only 8 address input pins, time multiplexed addressing is used to input 8 row and 8 column addresses. The multiplexing is controlled by the timing relationship between the row address strobe ($\overline{RAS}$), the chip select input ($\overline{CS}$) and the valid row and column address inputs.

Operation of the KM41C466 begins by strobing in a valid row address with $\overline{RAS}$ while $\overline{CS}$ remains high. Then the address on the 8 address input pins is changed from a row address to a column address and is strobed in by $\overline{CS}$. This is the beginning of any KM41C466 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 $\overline{CS}$ 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 $\overline{CS}$ Timing

The minimum $\overline{RAS}$ and $\overline{CS}$ pulse widths are specified by t_{RAS}(min) and t_{CS}(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 $\overline{CS}$ 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 KM41C466 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 $\overline{RAS}$/$\overline{CS}$ cycle. The access time is nomally specified with respect to the falling edge $\overline{RAS}$. But the access time also depends on the falling edge of $\overline{CS}$ and on the vallid column address transition.

If $\overline{CS}$ 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 $\overline{CS}$ 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 KM41C466 can perform early 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 $\overline{W}$, $\overline{OE}$ and $\overline{CS}$. In any type of write cycle Data-in must be valid at or before the falling edge of $\overline{W}$ or $\overline{CS}$, whichever is later.

Early Write: An early write cycle is performed by bringing $\overline{W}$ low before $\overline{CS}$. The 4-bit wide data at the data input pins is written into the addressed memory cells. Throughout the early write cycle the outputs remain 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 cells appears at the outputs before and during the time that data is being written into the same cell locations. This cycle is achieved by bringing $\overline{W}$ low after $\overline{CS}$ and meeting the data sheet read-modify-write cycle timing requirements. The output enable input $\overline{OE}$ must be low during the time defined by t_{OEA} and t_{OEZ} for data to appear at the outputs. If t_{CWD} and t_{RWD} are not met the output may contain invalid data. Conforming to the $\overline{OE}$ timing requirements prevents bus contention on the KM41C466's DQ pins

Data Output

The KM41C466 has a three-state output buffers which are controlled by $\overline{CS}$ and $\overline{OE}$. When either $\overline{CS}$ or $\overline{OE}$ is high (V_{IH}) the output is in the high impedance (Hi-Z) state. In any cycle in which valid data appears at the output, the output goes into the low impedance state in a time specified by t_{CLZ} after the falling edge of $\overline{CS}$. 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 KM41C466 operating cycles is listed below after the corresponding output state produced by the cycle.

Valid Output Data: Read, Read-Modify-Write, Hidden Refresh, Static Column Mode Read, Static Column Mode Read-Modify-Write.

Hi-Z Output State: Early Write, $\overline{RAS}$-only Refresh, Static Column Mode Write, $\overline{CS}$-before-$\overline{RAS}$ Refresh, $\overline{CS}$-only cycle.

Indeterminate Output State: Delayed Write

DEVICE OPERATION (Continued)

Refresh

The data in the KM41C466 is stored on a tiny capacitor within each memory cell. Due to leakage the data may leak off after a period of time. To maintain data integrity it is necessary to refresh each of the rows every 4 ms. Either a burst refresh or distributed refresh may be used. 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 $\overline{CS}$ remains high. This cycle must be repeated for each of the 256 row addresses, (A_0-A_7).

$\overline{CS}$-before-RAS Refresh: The KM41C466 has $\overline{CS}$-before-$\overline{RAS}$ on-chip refresh capability that eliminates the need for external refresh addresses. If $\overline{CS}$ is held low for the specified set up time (t_{CSR}) before $\overline{RAS}$ goes 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 $\overline{CS}$-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 the $\overline{CS}$ active time and cycling $\overline{RAS}$. The KM41C466 hidden refresh cycle is actually a $\overline{CS}$-before-$\overline{RAS}$ refresh cycle within an extended read cycle. The refresh row address is provided by the on-chip refresh address counter.

Other Refresh Methods: It is also possible to refresh the KM41C466 by using read, write or read-modify-write cycles. Whenever a row is accessed, all the cells in that 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 $\overline{CS}$-before-$\overline{RAS}$ refresh is the preferred method.

Static Column Mode

Static Column mode allows high speed read, write or read-modify-write access to all the memory cells within a selected row. Operation within a selected row is similar to a static RAM. The read, write or read-modify-write cycles may be mixed in any order.

A Static Column mode read cycle starts as a normal cycle. Additional cells within the selected row are written by applying a new column address while $\overline{W} = V_{IH}$ and $\overline{RAS} = V_{IL}$.

A Static Column mode write cycle starts as a normal cycle. Additional cells within the selected row are written by applying a new column address while $\overline{RAS} = V_{IL}$ and toggling either $\overline{W}$ or $\overline{CS}$. The data is written into the cell triggered by the latter falling edge to $\overline{W}$ or $\overline{CS}$.

$\overline{CS}$-Before-$\overline{RAS}$ Refresh Counter Test Cycle

A special timing sequence using the $\overline{CS}$-before-$\overline{RAS}$ counter test cycle provides a convenient method of verifying the functionality of the $\overline{CS}$-before-$\overline{RAS}$ refresh activated circuitry.

After the $\overline{CS}$-before-$\overline{RAS}$ refresh operation, if $\overline{CS}$ goes high and then low again while $\overline{RAS}$ is held low, the read and write operations are enabled.

This is shown in the $\overline{CS}$-before-$\overline{RAS}$ counter test cycle timing diagram. A memory cell can be addressed with 8 row address bits and 8 column address bits defined as follows:

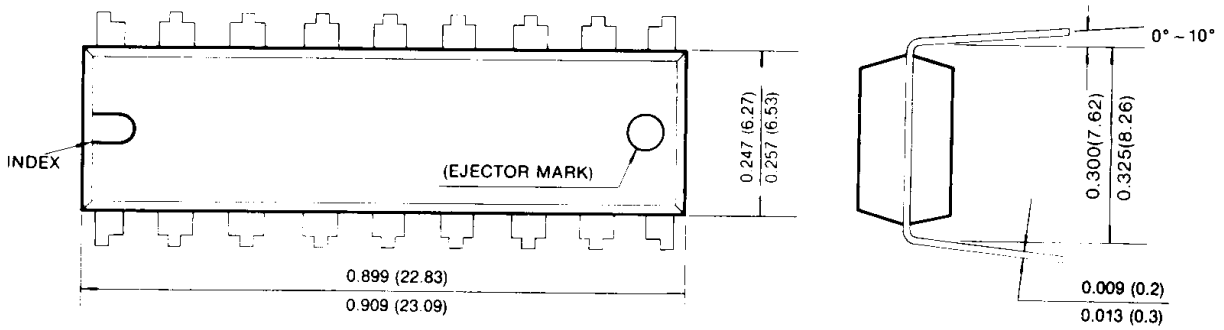
Row Address—Bits A_0 through A_7 are supplied by the on-chip refresh counter.

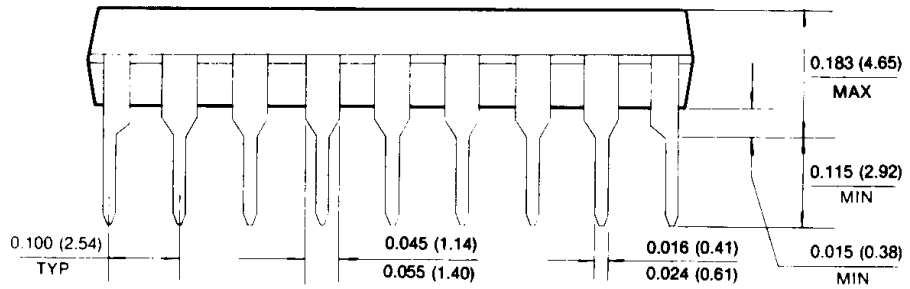
Column Address—Bits A_0 through A_7 are strobed-in by the falling edge of $\overline{CS}$ as in a normal memory cycle.

PACKAGE DIMENSIONS

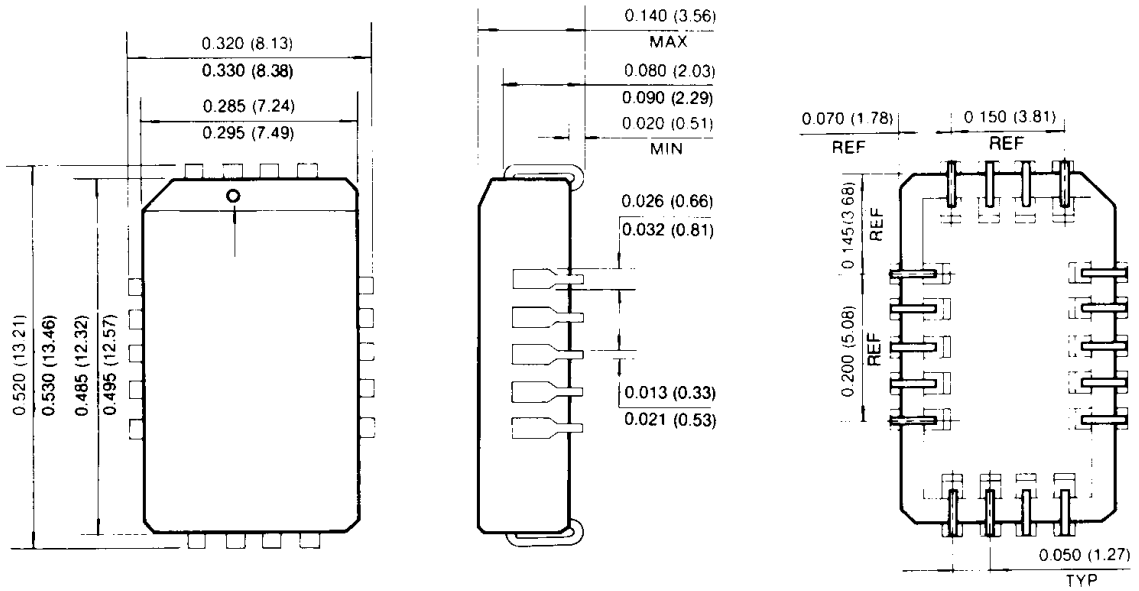
18-LEAD PLASTIC DUAL IN-LINE PACKAGE

Units: Inches (millimeters)





18- LEAD PLASTIC CHIP CARRIER



PACKAGE DIMENSIONS (Continued)

20-PIN PLASTIC ZIGZAG-IN-LINE PACKAGE

Units: Inches (millimeters)