

DRAM

256K x 4 DRAM

STANDARD OR LOW POWER,
EXTENDED REFRESH

DRAM

FEATURES

- 512-cycle refresh in 8ms (MT4C4256) or 64ms (MT4C4256 L)
- Industry-standard x4 pinout, timing, functions and packages
- High-performance CMOS silicon-gate process
- Single +5V ±10% power supply
- Low power, 0.8mW standby; 175mW active, typical
- All inputs, outputs and clocks are TTL-compatible
- FAST PAGE MODE access cycle
- Refresh modes: \overline{RAS} ONLY, \overline{CAS} -BEFORE- \overline{RAS} (CBR), HIDDEN and Extended (MT4C4256 L only)
- Low CMOS Standby Current, 200µA maximum (MT4C4256 L)

OPTIONS

- Timing

60ns access	-6
70ns access	-7
80ns access	-8
- Packages

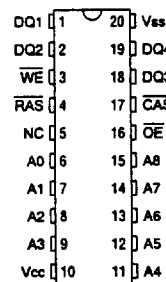
Plastic DIP (300 mil)	None
Plastic SOJ (300 mil)	DJ
Plastic ZIP (350 mil)	Z
- Version

512-cycle refresh in 8 ms	None
512-cycle refresh in 64 ms	L
- Part Number Example: MT4C4256DJ-7 L

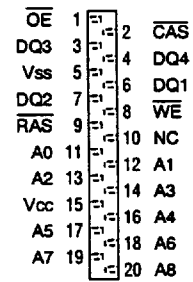
MARKING

PIN ASSIGNMENT (Top View)

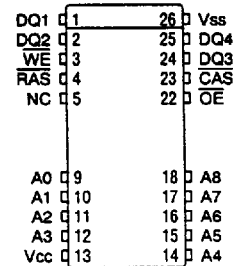
20-Pin DIP (DA-2)



20-Pin ZIP (DB-1)



20/26-Pin SOJ (DC-1)



GENERAL DESCRIPTION

The MT4C4256(L) is a randomly accessed solid-state memory containing 1,048,576 bits organized in a x4 configuration. During READ or WRITE cycles, each bit is uniquely addressed through the 18 address bits, which are entered 9 bits (A0-A8) at a time. \overline{RAS} is used to latch the first 9 bits and \overline{CAS} the latter 9 bits. READ and WRITE cycles are selected with the \overline{WE} input. A logic HIGH on \overline{WE} dictates READ mode while a logic LOW on \overline{WE} dictates WRITE mode. During a WRITE cycle, data-in (D) is latched by the falling edge of \overline{WE} or \overline{CAS} , whichever occurs last. If \overline{WE} goes LOW

prior to \overline{CAS} going LOW, the output pin(s) remain open (High-Z) until the next \overline{CAS} cycle. If \overline{WE} goes LOW after data reaches the output pin, data-out (Q) is activated and retains the selected cell data as long as \overline{CAS} remains LOW (regardless of \overline{WE} or \overline{RAS}). This late \overline{WE} pulse results in a READ WRITE cycle. The four data inputs and four data outputs are routed through four pins using common I/O and pin direction is controlled by \overline{WE} and \overline{OE} .

FAST PAGE MODE operations allow faster data operations (READ, WRITE or READ-MODIFY-WRITE) within a row-address-defined (A0-A8) page boundary. The FAST PAGE MODE cycle is always initiated with a row-address strobed-in by \overline{RAS} followed by a column-address strobed-

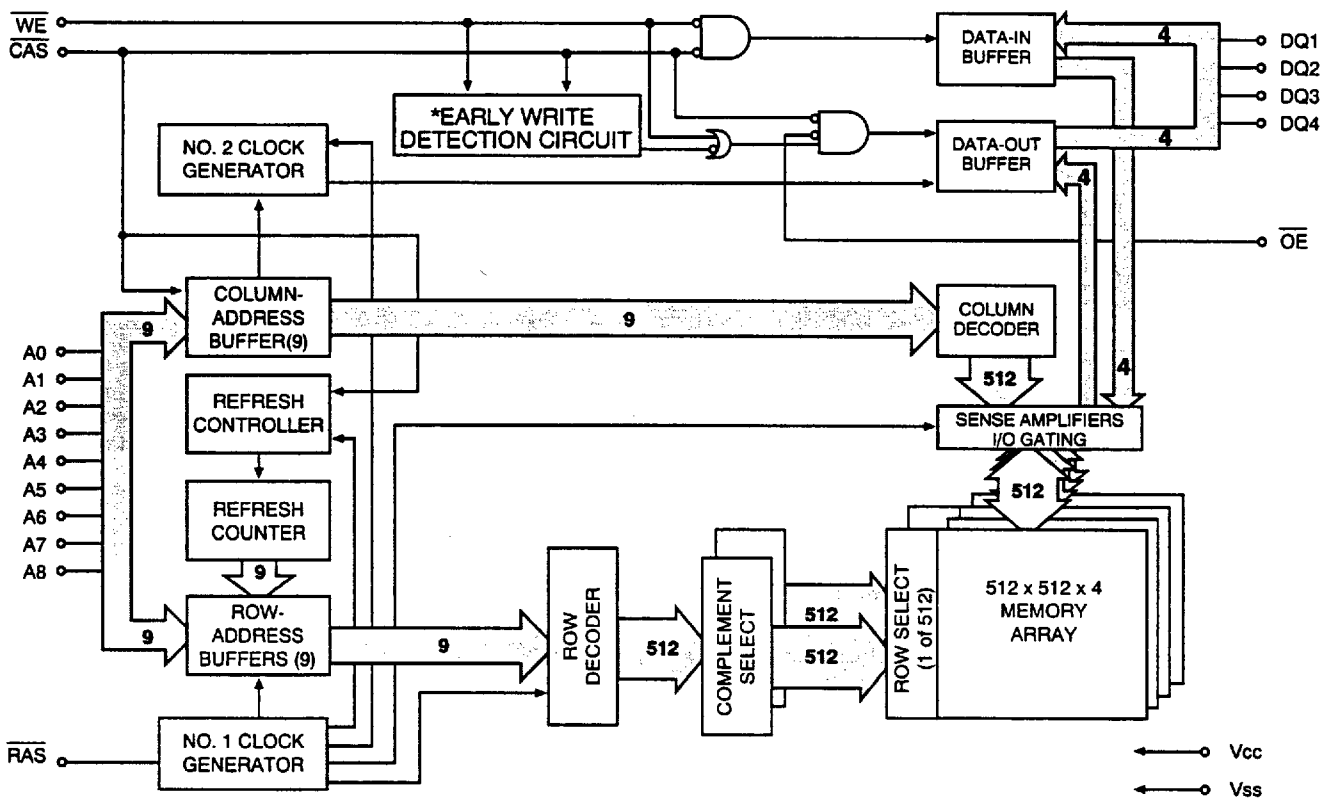
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in by \overline{CAS} . \overline{CAS} may be toggled-in by holding \overline{RAS} LOW and strobing-in different column-addresses, thus executing faster memory cycles. Returning \overline{RAS} HIGH terminates the FAST PAGE MODE cycle.

Returning \overline{RAS} and \overline{CAS} HIGH terminates a memory cycle and decreases chip current to a reduced standby level. Also, the chip is preconditioned for the next cycle during the \overline{RAS} HIGH time. Memory cell data is retained in its correct

state by maintaining power and executing any \overline{RAS} cycle (READ, WRITE) or \overline{RAS} REFRESH cycle (\overline{RAS} ONLY, CBR, or HIDDEN) so that all 512 combinations of \overline{RAS} addresses (A0-A8) are executed at least every 8ms for the MT4C4256 and every 64ms for the MT4C4256L, regardless of sequence. The CBR REFRESH cycle will invoke the internal refresh counter for automatic \overline{RAS} addressing.

FUNCTIONAL BLOCK DIAGRAM
FAST PAGE MODE



***NOTE:** 1. If \overline{WE} goes LOW prior to \overline{CAS} going LOW, EW detection circuit output is a HIGH (EARLY WRITE).
2. If \overline{CAS} goes LOW prior to \overline{WE} going LOW, EW detection circuit output is a LOW (LATE WRITE).

TRUTH TABLE

FUNCTION		RAS	CAS	WE	OE	ADDRESSES		DATA-IN/OUT
						'R	'C	DQ1-DQ4
Standby		H	H→X	X	X	X	X	High-Z
READ		L	L	H	L	ROW	COL	Data-Out
EARLY WRITE		L	L	L	X	ROW	COL	Data-In
READ WRITE		L	L	H→L	L→H	ROW	COL	Data-Out, Data-In
FAST-PAGE-MODE READ	1st Cycle	L	H→L	H	L	ROW	COL	Data-Out
	2nd Cycle	L	H→L	H	L	n/a	COL	Data-Out
FAST-PAGE-MODE EARLY-WRITE	1st Cycle	L	H→L	L	X	ROW	COL	Data-In
	2nd Cycle	L	H→L	L	X	n/a	COL	Data-In
FAST-PAGE-MODE READ-WRITE	1st Cycle	L	H→L	H→L	L→H	ROW	COL	Data-Out, Data-In
	2nd Cycle	L	H→L	H→L	L→H	n/a	COL	Data-Out, Data-In
RAS ONLY REFRESH		L	H	X	X	ROW	n/a	High-Z
HIDDEN REFRESH	READ	L→H→L	L	H	L	ROW	COL	Data-Out
	WRITE	L→H→L	L	L	X	ROW	COL	Data-In
CBR REFRESH		H→L	L	X	X	X	X	High-Z
Extended Refresh (MT4C4256 L only)		H→L	L	X	X	X	X	High-Z

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ABSOLUTE MAXIMUM RATINGS*

Voltage on Any Pin Relative to V_{SS} -1V to +7V
 Operating Temperature, T_A (ambient) 0°C to +70°C
 Storage Temperature (plastic) -55°C to +150°C
 Power Dissipation 1W
 Short Circuit Output Current 50mA

*Stresses greater than those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect reliability.

DC ELECTRICAL CHARACTERISTICS AND RECOMMENDED DC OPERATING CONDITIONS

(Notes: 1, 6, 7) (V_{CC} = +5V ±10%)

PARAMETER/CONDITION	SYMBOL	MIN	MAX	UNITS	NOTES
Supply Voltage	V _{CC}	4.5	5.5	V	
Input High (Logic 1) Voltage, all inputs	V _{IH}	2.4	V _{CC} +1	V	
Input Low (Logic 0) Voltage, all inputs	V _{IL}	-1.0	0.8	V	
INPUT LEAKAGE CURRENT Any input 0V ≤ V _{IN} ≤ 6.5V (All other pins not under test = 0V)	I _I	-2	2	μA	
OUTPUT LEAKAGE CURRENT: (Q is disabled; 0V ≤ V _{OUT} ≤ 5.5V)	I _{OZ}	-10	10	μA	
OUTPUT LEVELS	V _{OH}	2.4		V	
Output High Voltage (I _{OUT} = -5mA)					
Output Low Voltage (I _{OUT} = 4.2mA)	V _{OL}		0.4	V	

PARAMETER/CONDITION	VERSION	SYMBOL	MAX			UNITS	NOTES
			-6	-7	-8		
STANDBY CURRENT: (TTL) ($\overline{RAS} = \overline{CAS} = V_{IH}$)		I _{CC1}	2	2	2	mA	
STANDBY CURRENT: (CMOS) ($\overline{RAS} = \overline{CAS} = V_{CC} - 0.2V$)	MT4C4256	I _{CC2}	1	1	1	mA	
	MT4C4256 L	I _{CC2}	200	200	200	μA	
OPERATING CURRENT: Random READ/WRITE Average power supply current (\overline{RAS} , \overline{CAS} , Single Address Cycling: $t_{RC} = t_{RC} [MIN]$)		I _{CC3}	90	80	70	mA	3, 4, 29
OPERATING CURRENT: FAST PAGE MODE Average power supply current ($\overline{RAS} = V_{IL}$, \overline{CAS} , Address Cycling: $t_{PC} = t_{PC} [MIN]$)		I _{CC4}	70	60	50	mA	3, 4, 29
REFRESH CURRENT: \overline{RAS} ONLY Average power supply current (\overline{RAS} Cycling, $\overline{CAS} = V_{IH}$: $t_{RC} = t_{RC} [MIN]$)		I _{CC5}	90	80	70	mA	3, 29
REFRESH CURRENT: CBR Average power supply current (\overline{RAS} , \overline{CAS} , Address Cycling: $t_{RC} = t_{RC} [MIN]$)		I _{CC6}	90	80	70	mA	3, 5
REFRESH CURRENT: Extended Average power supply current during Extended Refresh: $\overline{CAS} = 0.2V$ or CBR cycling; $\overline{RAS} = t_{RAS} (MIN)$ to 1μs; \overline{WE} , A0-A8 and D _{IN} = V _{CC} - 0.2V or 0.2V (D _{IN} may be left open); $t_{RC} = 125\mu s$ (512 rows at 125μs = 64ms)	MT4C4256 L	I _{CC7}	200	200	200	μA	3, 5, 27

CAPACITANCE

PARAMETER	SYMBOL	MIN	MAX	UNITS	NOTES
Input Capacitance: A0-A8	C _{I1}		5	pF	2
Input Capacitance: $\overline{\text{RAS}}$, $\overline{\text{CAS}}$, $\overline{\text{WE}}$, $\overline{\text{OE}}$	C _{I2}		7	pF	2
Input/Output Capacitance: DQ	C _{I0}		7	pF	2

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ELECTRICAL CHARACTERISTICS AND RECOMMENDED AC OPERATING CONDITIONS

(Notes: 6, 7, 8, 9, 10, 11, 12, 13, 23) (V_{CC} = +5V ±10%)

AC CHARACTERISTICS		-6		-7		-8			
PARAMETER	SYM	MIN	MAX	MIN	MAX	MIN	MAX	UNITS	NOTES
Random READ or WRITE cycle time	^t RC	110		130		150		ns	
READ WRITE cycle time	^t RWC	165		185		205		ns	
FAST-PAGE-MODE READ or WRITE cycle time	^t PC	35		40		45		ns	
FAST-PAGE-MODE READ-WRITE cycle time	^t PRWC	90		95		100		ns	
Access time from $\overline{\text{RAS}}$	^t RAC		60		70		80	ns	14
Access time from $\overline{\text{CAS}}$	^t CAC		20		20		20	ns	15
Output Enable	^t OE		20		20		20	ns	
Access time from column-address	^t AA		30		35		40	ns	
Access time from $\overline{\text{CAS}}$ precharge	^t CPA		35		40		45	ns	
$\overline{\text{RAS}}$ pulse width	^t RAS	60	100,000	70	100,000	80	100,000	ns	
$\overline{\text{RAS}}$ pulse width (FAST PAGE MODE)	^t RASP	60	100,000	70	100,000	80	100,000	ns	
$\overline{\text{RAS}}$ hold time	^t RSH	20		20		20		ns	
$\overline{\text{RAS}}$ precharge time	^t RP	40		50		60		ns	
$\overline{\text{CAS}}$ pulse width	^t CAS	20	100,000	20	100,000	20	100,000	ns	
$\overline{\text{CAS}}$ hold time	^t CSH	60		70		80		ns	
$\overline{\text{CAS}}$ precharge time	^t CPN	10		10		10		ns	16
$\overline{\text{CAS}}$ precharge time (FAST PAGE MODE)	^t CP	10		10		10		ns	
$\overline{\text{RAS}}$ to $\overline{\text{CAS}}$ delay time	^t RCD	20	40	20	50	20	60	ns	17
$\overline{\text{CAS}}$ to $\overline{\text{RAS}}$ precharge time	^t CRP	5		5		5		ns	
Row-address setup time	^t ASR	0		0		0		ns	
Row-address hold time	^t RAH	10		10		10		ns	
$\overline{\text{RAS}}$ to column-address delay time	^t RAD	15	30	15	35	15	40	ns	18
Column-address setup time	^t ASC	0		0		0		ns	
Column-address hold time	^t CAH	15		15		15		ns	
Column-address hold time (referenced to $\overline{\text{RAS}}$)	^t AR	45		55		60		ns	
Column-address to $\overline{\text{RAS}}$ lead time	^t RAL	30		35		40		ns	
Read command setup time	^t RCS	0		0		0		ns	
Read command hold time (referenced to $\overline{\text{CAS}}$)	^t RCH	0		0		0		ns	19
Read command hold time (referenced to $\overline{\text{RAS}}$)	^t RRH	0		0		0		ns	19
$\overline{\text{CAS}}$ to output in Low-Z	^t CLZ	0		0		0		ns	

ELECTRICAL CHARACTERISTICS AND RECOMMENDED AC OPERATING CONDITIONS

(Notes: 6, 7, 8, 9, 10, 11, 12, 13, 23) (V_{CC} = +5V ±10%)

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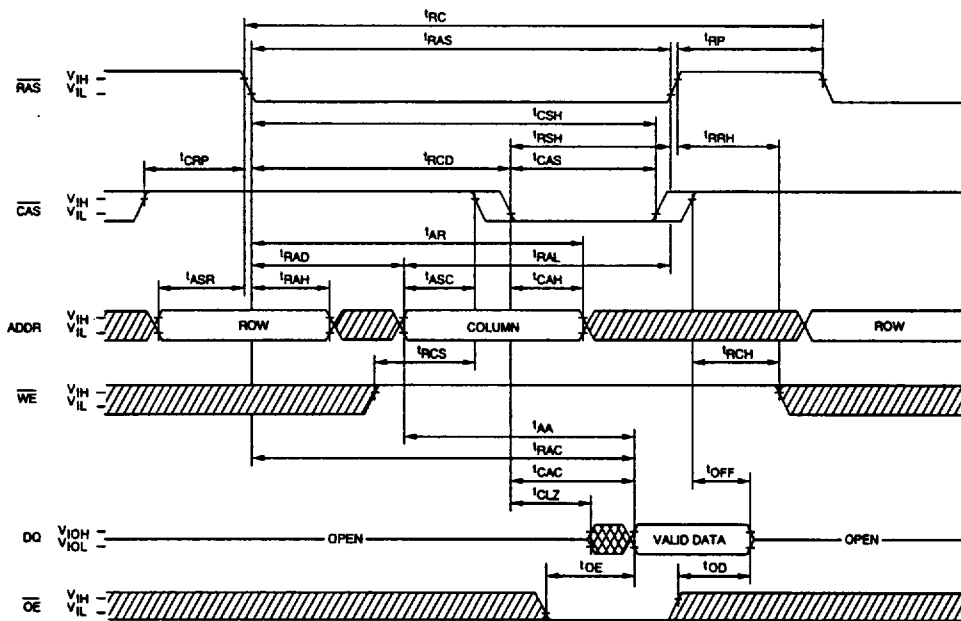
AC CHARACTERISTICS		-6		-7		-8			
PARAMETER	SYM	MIN	MAX	MIN	MAX	MIN	MAX	UNITS	NOTES
Output buffer turn-off delay	t _{OFF}	3	20	3	20	3	20	ns	20, 26, 28
Output disable	t _{OD}		15		20		20	ns	26
WE command setup time	t _{WCS}	0		0		0		ns	21
Write command hold time	t _{WCH}	10		15		15		ns	
Write command hold time (referenced to RAS)	t _{WCR}	45		55		60		ns	
Write command pulse width	t _{WP}	10		15		15		ns	
Write command to RAS lead time	t _{RWL}	20		20		20		ns	
Write command to CAS lead time	t _{CWL}	20		20		20		ns	
Data-in setup time	t _{DS}	0		0		0		ns	22
Data-in hold time	t _{DH}	15		15		15		ns	22
Data-in hold time (referenced to RAS)	t _{DHR}	45		55		60		ns	
RAS to WE delay time	t _{RWD}	85		100		110		ns	21
Column-address to WE delay time	t _{AWD}	60		65		70		ns	21
CAS to WE delay time	t _{CWD}	40		50		55		ns	21
Transition time (rise or fall)	t _T	3	50	3	50	3	50	ns	9, 10
Refresh period (512 cycles) MT4C4256 / MT4C4256 L	t _{REF}		8 / 64		8 / 64		8 / 64	ms	
RAS to CAS precharge time	t _{RPC}	0		0		0		ns	
CAS setup time (CBR REFRESH)	t _{CSR}	10		10		10		ns	5
CAS hold time (CBR REFRESH)	t _{CHR}	10		15		15		ns	5
OE hold time from WE during READ-MODIFY-WRITE cycle	t _{OEH}	15		20		20		ns	25
OE setup prior to RAS during HIDDEN REFRESH cycle	t _{ORD}	0		0		0		ns	24

NOTES

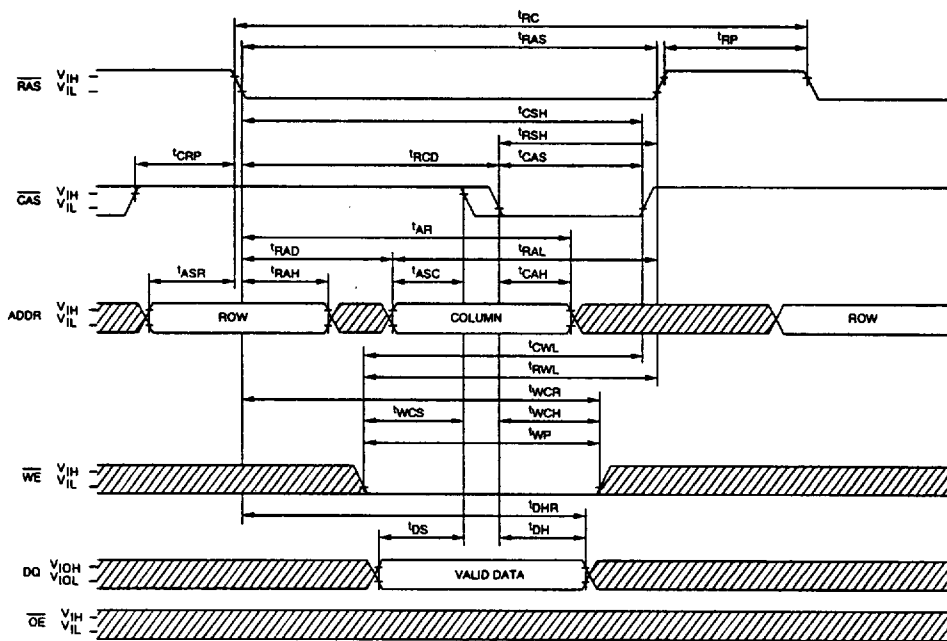
1. All voltages referenced to V_{SS}.
2. This parameter is sampled. V_{CC} = 5V ±10%; f = 1 MHz.
3. I_{CC} is dependent on cycle rates.
4. I_{CC} is dependent on output loading and cycle rates. Specified values are obtained with minimum cycle time and the outputs open.
5. Enables on-chip refresh and address counters.
6. The minimum specifications are used only to indicate cycle time at which proper operation over the full temperature range is assured.
7. An initial pause of 100µs is required after power-up followed by any eight $\overline{\text{RAS}}$ cycles before proper device operation is assured. The eight $\overline{\text{RAS}}$ cycle wake-ups should be repeated any time the $\overline{\text{REF}}$ refresh requirement is exceeded.
8. AC characteristics assume T = 5ns.
9. 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} (or between V_{IL} and V_{IH}).
10. In addition to meeting the transition rate specification, all input signals must transit between V_{IH} and V_{IL} (or between V_{IL} and V_{IH}) in a monotonic manner.
11. If $\overline{\text{CAS}} = \text{V}_{\text{IH}}$, data output is High-Z.
12. If $\overline{\text{CAS}} = \text{V}_{\text{IL}}$, data output may contain data from the last valid READ cycle.
13. Measured with a load equivalent to two TTL gates and 100pF.
14. Assumes that t_{RCD} < t_{RCD} (MAX). If t_{RCD} is greater than the maximum recommended value shown in this table, t_{RAC} will increase by the amount that t_{RCD} exceeds the value shown.
15. Assumes that t_{RCD} ≥ t_{RCD} (MAX).
16. If $\overline{\text{CAS}}$ is LOW at the falling edge of $\overline{\text{RAS}}$, Q will be maintained from the previous cycle. To initiate a new cycle and clear the data-out buffer, $\overline{\text{CAS}}$ must be pulsed HIGH for t_{CPN}.
17. Operation within the t_{RCD} (MAX) limit ensures 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}.
18. Operation within the t_{RAD} (MAX) limit ensures that t_{RAC} (MIN) and t_{CAC} (MIN) 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}.
19. Either t_{RCH} or t_{RRH} must be satisfied for a READ cycle.
20. t_{OFF} (MAX) defines the time at which the output achieves the open circuit condition and is not referenced to V_{OH} or V_{OL}.
21. t_{WCS}, t_{RWD}, t_{AWD} and t_{CWD} are not restrictive operating parameters. t_{WCS} applies to EARLY WRITE cycles. t_{RWD}, t_{AWD} and t_{CWD} apply to READ-MODIFY-WRITE cycles. If t_{WCS} ≥ t_{WCS} (MIN), the cycle is an EARLY WRITE cycle, and the data output will remain an open circuit throughout the entire cycle. If t_{RWD} ≥ t_{RWD} (MIN), t_{AWD} ≥ t_{AWD} (MIN) and t_{CWD} ≥ t_{CWD} (MIN), the cycle is a READ-MODIFY-WRITE cycle, and the data output will contain data read from the selected cell. If neither of the above conditions is met, the state of data-out is indeterminate. $\overline{\text{OE}}$ held HIGH and $\overline{\text{WE}}$ taken LOW after $\overline{\text{CAS}}$ goes LOW results in a LATE WRITE ($\overline{\text{OE}}$ -controlled) cycle. t_{WCS}, t_{RWD}, t_{CWD} and t_{AWD} are not applicable in a LATE WRITE cycle.
22. These parameters are referenced to $\overline{\text{CAS}}$ leading edge in EARLY WRITE cycles and $\overline{\text{WE}}$ leading edge in LATE WRITE or READ-MODIFY-WRITE cycles.
23. If $\overline{\text{OE}}$ is tied permanently LOW, LATE WRITE or READ-MODIFY-WRITE operations are not possible.
24. A HIDDEN REFRESH may also be performed after a WRITE cycle. In this case, $\overline{\text{WE}} = \text{LOW}$ and $\overline{\text{OE}} = \text{HIGH}$.
25. LATE WRITE and READ-MODIFY-WRITE cycles must have both t_{OD} and t_{OE}H met ($\overline{\text{OE}}$ HIGH during WRITE cycle) in order to ensure that the output buffers will be open during the WRITE cycle. If $\overline{\text{OE}}$ is taken back LOW while $\overline{\text{CAS}}$ remains LOW, the DQs will remain open.
26. The DQs open during READ cycles once t_{OD} or t_{OFF} occur. If $\overline{\text{CAS}}$ goes HIGH before $\overline{\text{OE}}$, the DQs will open regardless of the state of $\overline{\text{OE}}$. If $\overline{\text{CAS}}$ stays LOW while $\overline{\text{OE}}$ is brought HIGH, the DQs will open. If $\overline{\text{OE}}$ is brought back LOW ($\overline{\text{CAS}}$ still LOW), the DQs will provide the previously read data.
27. Extended refresh current is reduced as t_{RAS} is reduced from its maximum specification during the extended refresh cycle.
28. The 3ns minimum is a parameter guaranteed by design.
29. Column-address changed once each cycle.

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READ CYCLE

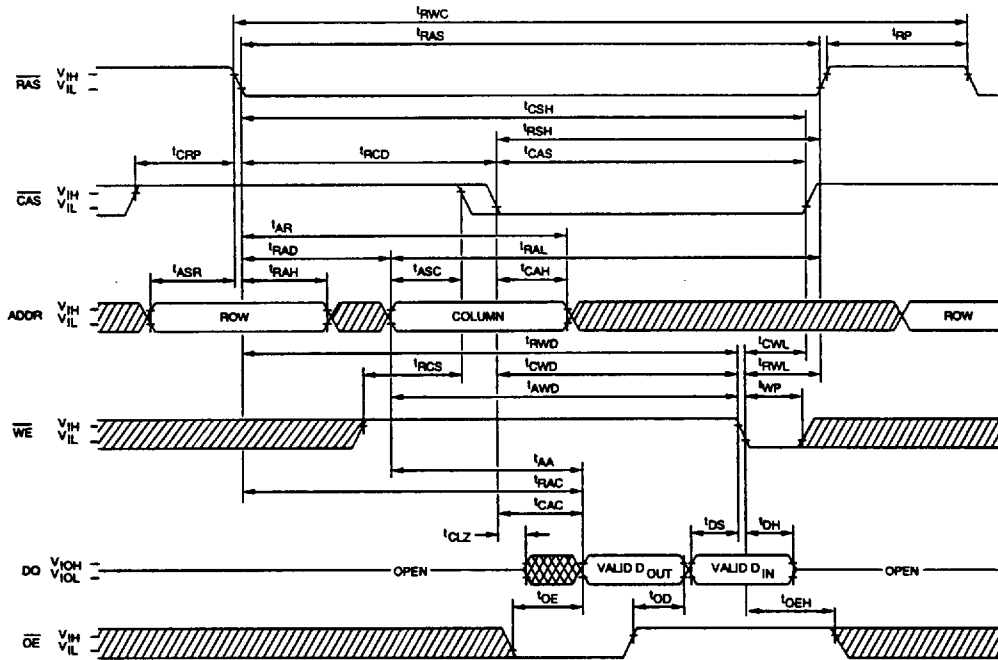


EARLY WRITE CYCLE



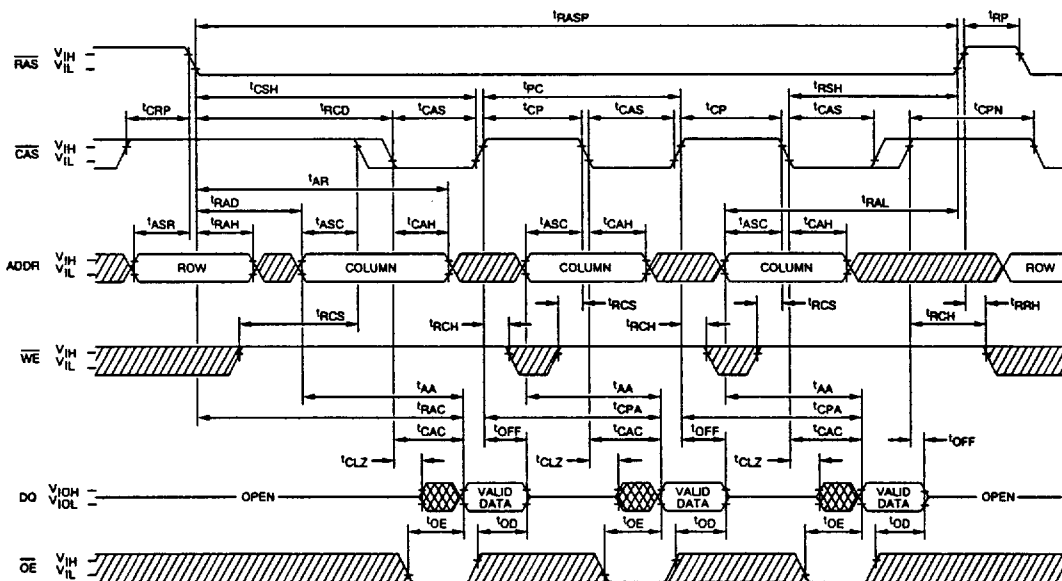
▨ DONT CARE
▩ UNDEFINED

READ WRITE CYCLE
(LATE WRITE and READ-MODIFY-WRITE CYCLES)



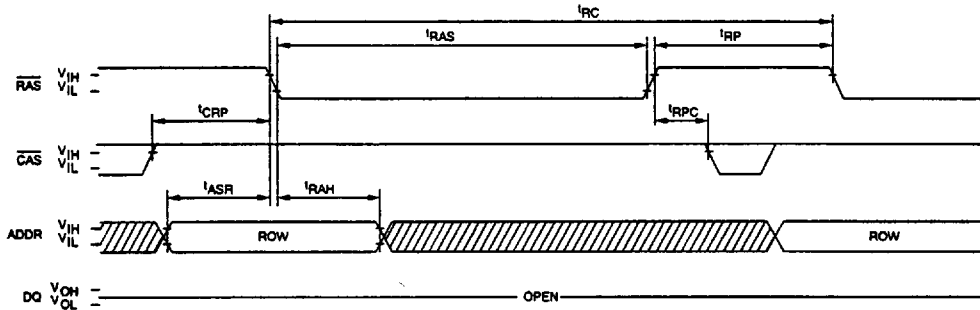
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FAST-PAGE-MODE READ CYCLE

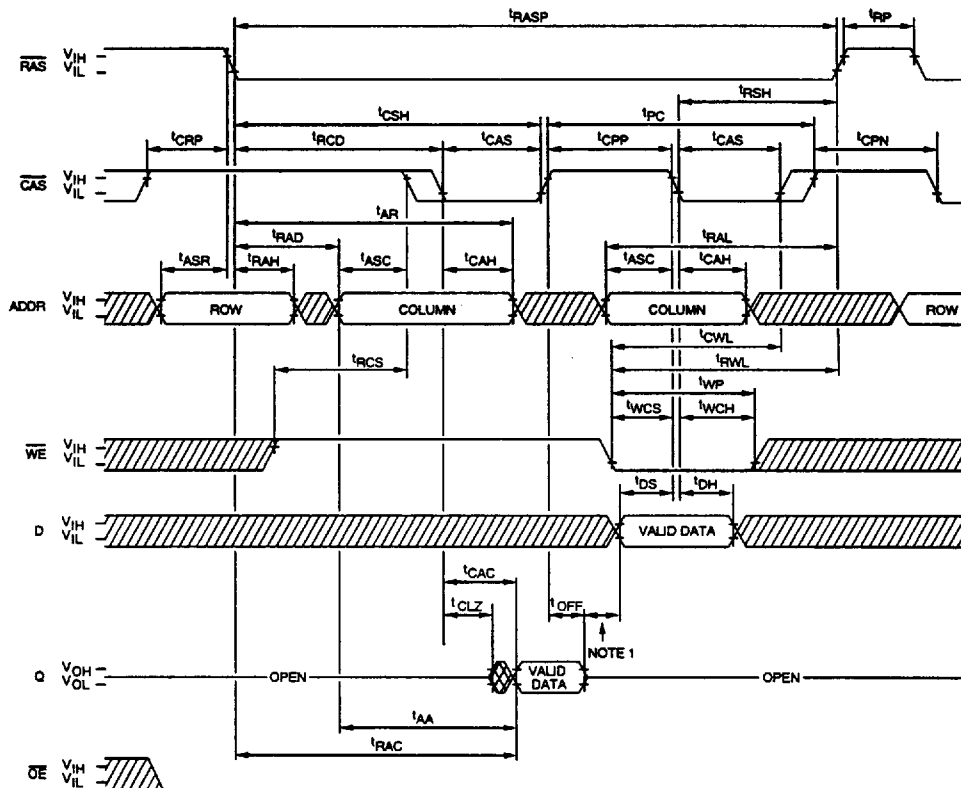


DONT CARE
 UNDEFINED

RAS ONLY REFRESH CYCLE
(ADDR = A0-A8; \overline{WE} = DON'T CARE)



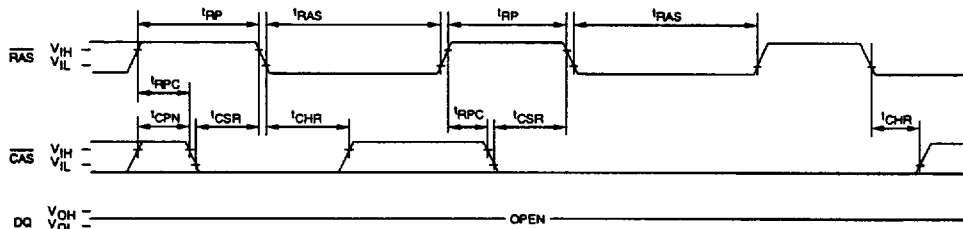
FAST-PAGE-MODE READ-EARLY-WRITE CYCLE
(Pseudo READ-MODIFY-WRITE)



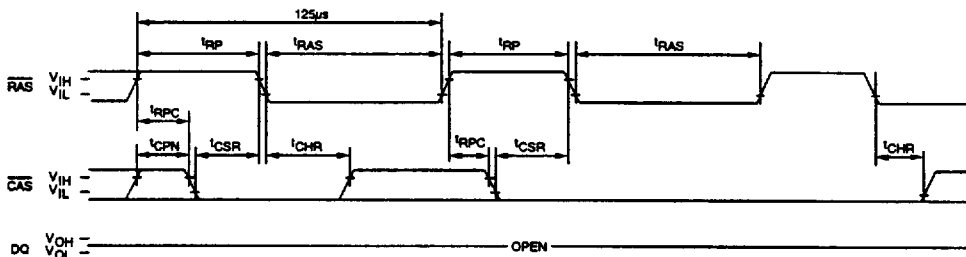
▨ DON'T CARE
▩ UNDEFINED

NOTE: 1. Do not drive data prior to tristate: $t_{CPP}(\text{MIN})$ or t_{CP} (whichever is greater) + $t_{DS}(\text{MIN})$ + any guardband between data-out and driving the bus with the new data-in.

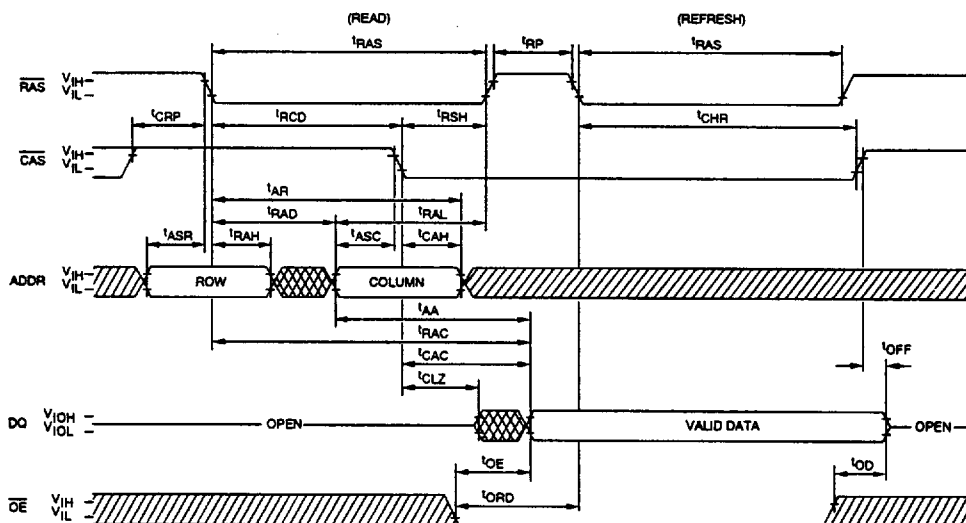
CBR REFRESH CYCLE
(A0-A8, \overline{WE} and \overline{OE} = DON'T CARE)



EXTENDED REFRESH CYCLE (MT4C4256 L ONLY)
(A0-A8, \overline{WE} and \overline{OE} = DON'T CARE)



HIDDEN REFRESH CYCLE ²⁴
(\overline{WE} = HIGH; \overline{OE} = LOW)



▨ DON'T CARE
▩ UNDEFINED