

MSM5116400D

4,194,304-Word × 4-Bit DYNAMIC RAM : FAST PAGE MODE TYPE

DESCRIPTION

The MSM5116400D is a 4,194,304-word × 4-bit dynamic RAM fabricated in Oki's silicon-gate CMOS technology. The MSM5116400D achieves high integration, high-speed operation, and low-power consumption because Oki manufactures the device in a quadruple-layer polysilicon/double-layer metal CMOS process. The MSM5116400D is available in a 26/24-pin plastic SOJ, 26/24-pin plastic TSOP.

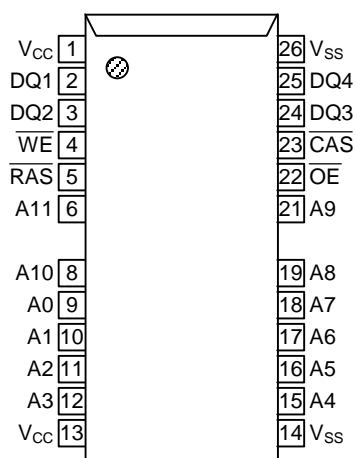
FEATURES

- 4,194,304-word × 4-bit configuration
 - Single 5V power supply, ±10% tolerance
 - Input : TTL compatible, low input capacitance
 - Output : TTL compatible, 3-state
 - Refresh : 4096 cycles/64 ms
 - Fast page mode, read modify write capability
 - $\overline{\text{CAS}}$ before $\overline{\text{RAS}}$ refresh, hidden refresh, $\overline{\text{RAS}}$ -only refresh capability
 - Multi-bit test mode capability
 - Package options:
 - 26/24-pin 300mil plastic SOJ (SOJ26/24-P-300-1.27) (Product : MSM5116400D-xxSJ)
 - 26/24-pin 300mil plastic TSOP (TSOPII26/24-P-300-1.27-K) (Product : MSM5116400D-xxTS-K)
- xx : indicates speed rank.

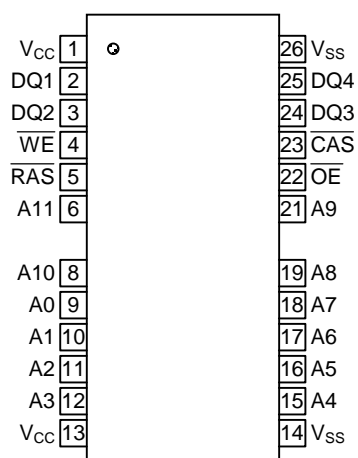
PRODUCT FAMILY

Family	Access Time (Max.)				Cycle Time (Min.)	Power Dissipation	
	t _{RAC}	t _{AA}	t _{CAC}	t _{OEA}		Operating (Max.)	Standby (Max.)
MSM5116400D-50	50ns	25ns	13ns	13ns	90ns	413mW	5.5mW
MSM5116400D-60	60ns	30ns	15ns	15ns	110ns	385mW	
MSM5116400D-70	70ns	35ns	20ns	20ns	130ns	358mW	

PIN CONFIGURATION (TOP VIEW)

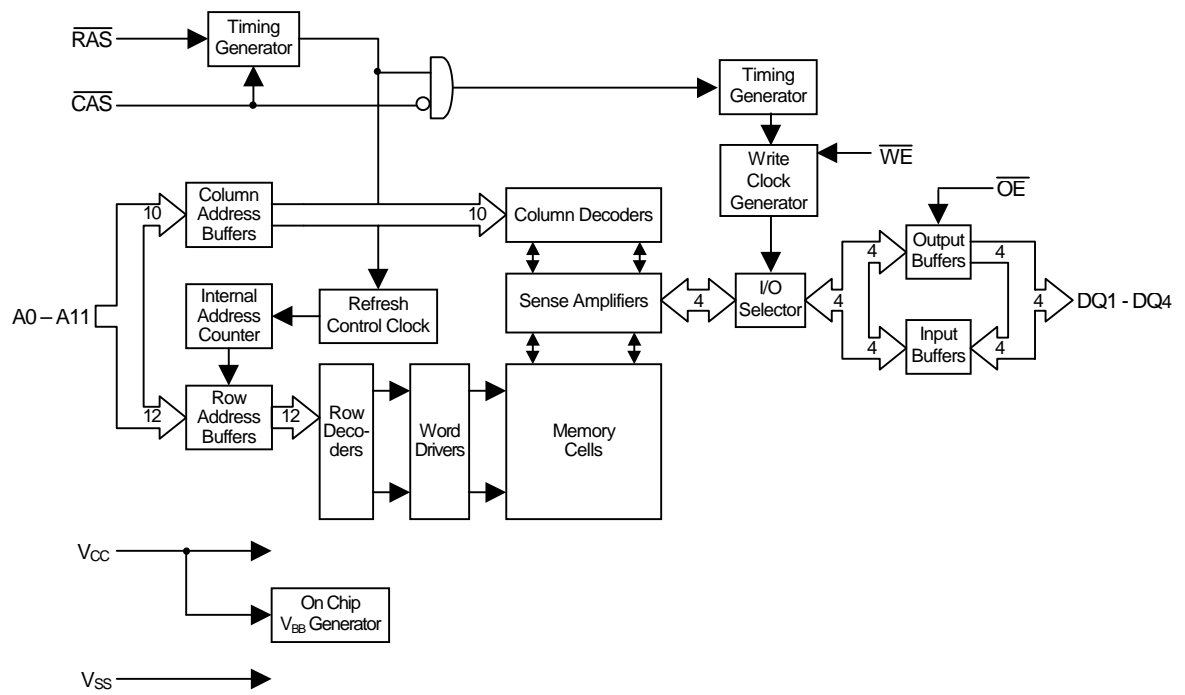


26/24-Pin Plastic SOJ

26/24-Pin Plastic TSOP
(K Type)

Pin Name	Function
A0–A11	Address Input
$\overline{\text{RAS}}$	Row Address Strobe
$\overline{\text{CAS}}$	Column Address Strobe
DQ1–DQ4	Data Input/Data Output
$\overline{\text{OE}}$	Output Enable
$\overline{\text{WE}}$	Write Enable
V _{CC}	Power Supply (5V)
V _{SS}	Ground (0V)
NC	No Connection

BLOCK DIAGRAM



ELECTRICAL CHARACTERISTICS

Absolute Maximum Ratings

Parameter	Symbol	Rating	Unit
Voltage on Any Pin Relative to V_{SS}	V_T	-0.5 to 7.0	V
Short Circuit Output Current	I_{OS}	50	mA
Power Dissipation	P_D^*	1	W
Operating Temperature	T_{opr}	0 to 70	°C
Storage Temperature	T_{stg}	-55 to 150	°C

*: $T_a = 25^\circ\text{C}$

Recommended Operating Conditions

($T_a = 0^\circ\text{C}$ to 70°C)

Parameter	Symbol	Min.	Typ.	Max.	Unit
Power Supply Voltage	V_{CC}	4.5	5.0	5.5	V
	V_{SS}	0	0	0	V
Input High Voltage	V_{IH}	2.4	—	$V_{CC} + 0.5^{*1}$	V
Input Low Voltage	V_{IL}	-0.5^{*2}	—	0.8	V

Notes: *1. The input voltage is $V_{CC} + 2.0\text{V}$ when the pulse width is less than 20ns (the pulse width is with respect to the point at which V_{CC} is applied).

*2. The input voltage is $V_{SS} - 2.0\text{V}$ when the pulse width is less than 20ns (the pulse width respect to the point at which V_{SS} is applied).

Capacitance

($V_{CC} = 5.0\text{V} \pm 10\%$, $T_a = 25^\circ\text{C}$, $f=1\text{MHz}$)

Parameter	Symbol	Typ.	Max.	Unit
Input Capacitance (A0 – A11)	C_{IN1}	—	5	pF
Input Capacitance ($\overline{\text{RAS}}$, $\overline{\text{CAS}}$, $\overline{\text{WE}}$, $\overline{\text{OE}}$)	C_{IN2}	—	7	pF
Output Capacitance (DQ1 – DQ4)	$C_{I/O}$	—	7	pF

DC Characteristics

 $(V_{CC} = 5V \pm 10\%, T_a = 0^\circ C \text{ to } 70^\circ C)$

Parameter	Symbol	Condition	MSM5116400 D-50		MSM5116400 D-60		MSM5116400 D-70		Unit	Note
			Min.	Max	Min.	Max	Min.	Max		
Output High Voltage	V_{OH}	$I_{OH} = -5.0mA$	2.4	V_{CC}	2.4	V_{CC}	2.4	V_{CC}	V	
Output Low Voltage	V_{OL}	$I_{OL} = 4.2mA$	0	0.4	0	0.4	0	0.4	V	
Input Leakage Current	I_{LI}	$0V \leq V_I \leq 6.5V$; All other pins not under test = 0V	-10	10	-10	10	-10	10	μA	
Output Leakage Current	I_{LO}	DQ disable $0V \leq V_O \leq V_{CC}$	-10	10	-10	10	-10	10	μA	
Average Power Supply Current (Operating)	I_{CC1}	\overline{RAS} , \overline{CAS} cycling, $t_{RC} = \text{Min.}$	—	75	—	70	—	65	mA	1,2
Power Supply Current (Standby)	I_{CC2}	\overline{RAS} , $\overline{CAS} = V_{IH}$	—	2	—	2	—	2	mA	1
		\overline{RAS} , $\overline{CAS} \geq V_{CC} - 0.2V$	—	0.5	—	0.5	—	0.5		
Average Power Supply Current (\overline{RAS} -only Refresh)	I_{CC3}	\overline{RAS} cycling, $\overline{CAS} = V_{IH}$, $t_{RC} = \text{Min.}$	—	75	—	70	—	65	mA	1,2
Power Supply Current (Standby)	I_{CC5}	$\overline{RAS} = V_{IH}$, $\overline{CAS} = V_{IL}$, DQ = enable	—	2	—	2	—	2	mA	1
Average Power Supply Current (\overline{CAS} before \overline{RAS} Refresh)	I_{CC6}	$\overline{RAS} = \text{cycling}$, \overline{CAS} before \overline{RAS}	—	75	—	70	—	65	mA	1,2
Average Power Supply Current (Fast Page Mode)	I_{CC7}	$\overline{RAS} = V_{IL}$, \overline{CAS} cycling, $t_{PC} = \text{Min.}$	—	70	—	65	—	60	mA	1,3

- Notes: 1. I_{CC} Max. is specified as I_{CC} for output open condition.
 2. The address can be changed once or less while $\overline{RAS} = V_{IL}$.
 3. The address can be changed once or less while $\overline{CAS} = V_{IH}$.

AC Characteristic (1/2)

(V_{CC} = 5V ± 10%, Ta = 0°C to 70°C) Note1,2,3

Parameter	Symbol	MSM5116400 D-50		MSM5116400 D-60		MSM5116400 D-70		Unit	Note
		Min.	Max.	Min.	Max.	Min.	Max.		
Random Read or Write Cycle Time	t _{RC}	90	—	110	—	130	—	ns	
Read Modify Write Cycle Time	t _{RWC}	131	—	155	—	185	—	ns	
Fast Page Mode Cycle Time	t _{PC}	35	—	40	—	45	—	ns	
Fast Page Mode Read Modify Write Cycle Time	t _{PRWC}	76	—	85	—	100	—	ns	
Access Time from $\overline{\text{RAS}}$	t _{RAC}	—	50	—	60	—	70	ns	4,5,6
Access Time from $\overline{\text{CAS}}$	t _{CAC}	—	13	—	15	—	20	ns	4,5
Access Time from Column Address	t _{AA}	—	25	—	30	—	35	ns	4,6
Access Time from $\overline{\text{CAS}}$ Precharge	t _{CPA}	—	30	—	35	—	40	ns	4
Access Time from $\overline{\text{OE}}$	t _{OEA}	—	13	—	15	—	20	ns	4
Output Low Impedance Time from $\overline{\text{CAS}}$	t _{CLZ}	0	—	0	—	0	—	ns	4
$\overline{\text{CAS}}$ to Data Output Buffer Turn-off Delay Time	t _{OFF}	0	13	0	15	0	20	ns	7
$\overline{\text{OE}}$ to Data Output Buffer Turn-off Delay Time	t _{OEZ}	0	13	0	15	0	20	ns	7
Transition Time	t _T	3	50	3	50	3	50	ns	3
Refresh Period	t _{REF}	—	64	—	64	—	64	m	
$\overline{\text{RAS}}$ Precharge Time	t _{RP}	30	—	40	—	50	—	ns	
$\overline{\text{RAS}}$ Pulse Width	t _{RAS}	50	10,000	60	10,000	70	10,000	ns	
$\overline{\text{RAS}}$ Pulse Width (Fast Page Mode)	t _{RASP}	50	100,000	60	100,000	70	100,000	ns	
$\overline{\text{RAS}}$ Hold Time	t _{RSH}	13	—	15	—	20	—	ns	
$\overline{\text{RAS}}$ Hold Time referenced to $\overline{\text{OE}}$	t _{ROH}	13	—	15	—	20	—	ns	
$\overline{\text{CAS}}$ Precharge Time (Fast Page Mode)	t _{CP}	7	—	10	—	10	—	ns	
$\overline{\text{CAS}}$ Pulse Width	t _{CAS}	13	10,000	15	10,000	20	10,000	ns	
$\overline{\text{CAS}}$ Hold Time	t _{CSH}	50	—	60	—	70	—	ns	
$\overline{\text{CAS}}$ to $\overline{\text{RAS}}$ Precharge Time	t _{CRP}	5	—	5	—	5	—	ns	
$\overline{\text{RAS}}$ Hold Time from $\overline{\text{CAS}}$ Precharge	t _{RHCP}	30	—	35	—	40	—	ns	
$\overline{\text{RAS}}$ to $\overline{\text{CAS}}$ Delay Time	t _{RCD}	17	37	20	45	20	50	ns	5
$\overline{\text{RAS}}$ to Column Address Delay Time	t _{RAD}	12	25	15	30	15	35	ns	
Row Address Set-up Time	t _{ASR}	0	—	0	—	0	—	ns	
Row Address Hold Time	t _{RAH}	7	—	10	—	10	—	ns	
Column Address Set-up Time	t _{ASC}	0	—	0	—	0	—	ns	

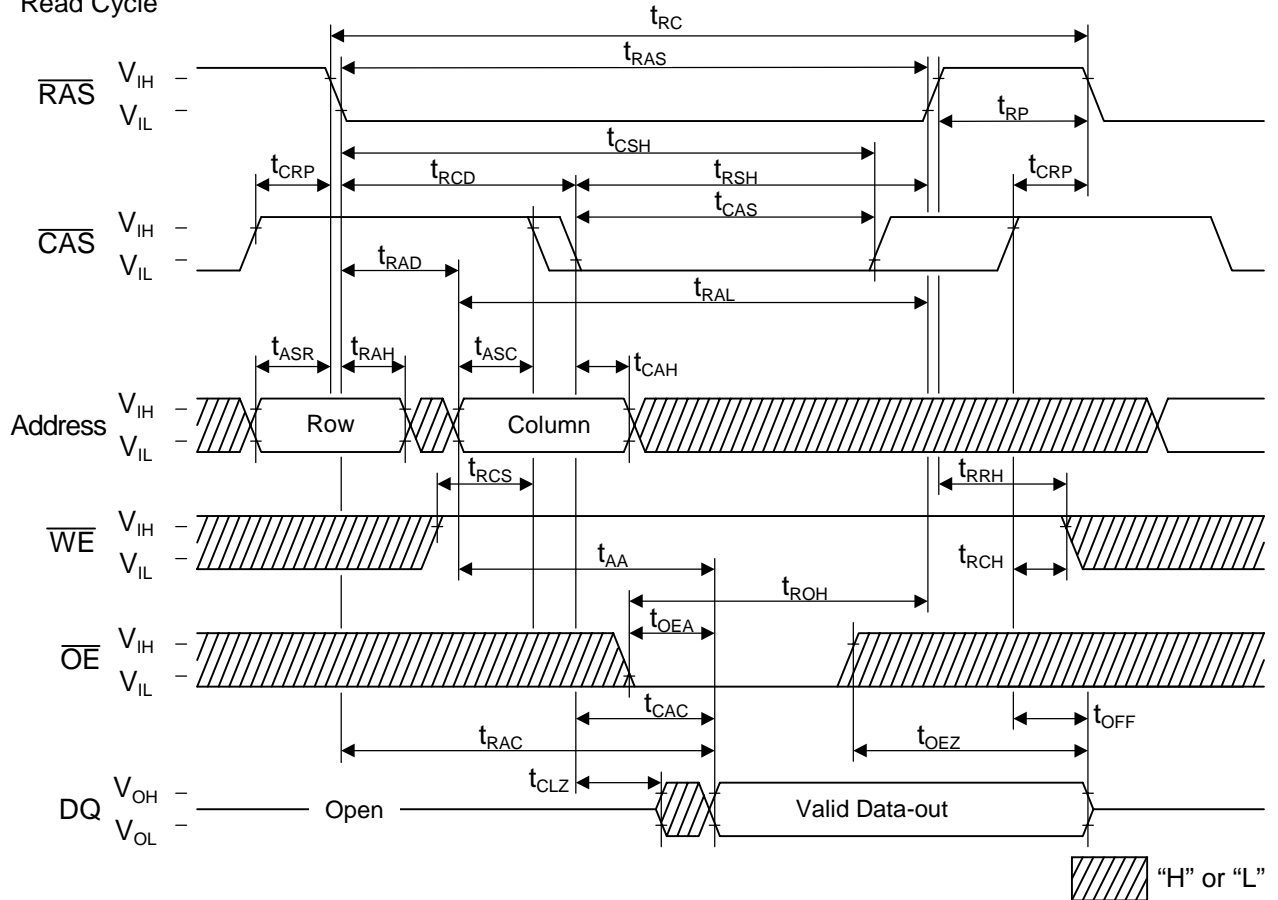
AC Characteristic (2/2)(V_{CC} = 5V ± 10%, T_a = 0°C to 70°C) Note1,2,3

Parameter	Symbol	MSM5116400 D-50		MSM5116400 D-60		MSM5116400 D-70		Unit	Note
		Min.	Max.	Min.	Max.	Min.	Max.		
Column Address Hold Time	t _{CAH}	7	—	15	—	15	—	ns	
Column Address to $\overline{\text{RAS}}$ Lead Time	t _{RAL}	25	—	30	—	35	—	ns	
Read Command Set-up Time	t _{RCS}	0	—	0	—	0	—	ns	
Read Command Hold Time	t _{RCH}	0	—	0	—	0	—	ns	8
Read Command Hold Time referenced to $\overline{\text{RAS}}$	t _{RRH}	0	—	0	—	0	—	ns	8
Write Command Set-up Time	t _{WCS}	0	—	0	—	0	—	ns	9
Write Command Hold Time	t _{WCH}	7	—	10	—	15	—	ns	
Write Command Pulse Width	t _{WP}	7	—	10	—	10	—	ns	
$\overline{\text{OE}}$ Command Hold Time	t _{OEH}	13	—	15	—	20	—	ns	
Write Command to $\overline{\text{RAS}}$ Lead Time	t _{RWL}	13	—	15	—	20	—	ns	
Write Command to $\overline{\text{CAS}}$ Lead Time	t _{CWL}	13	—	15	—	20	—	ns	
Data-in Set-up Time	t _{DS}	0	—	0	—	0	—	ns	10
Data-in Hold Time	t _{DH}	7	—	10	—	15	—	ns	10
$\overline{\text{OE}}$ to Data-in Delay Time	t _{OED}	13	—	15	—	20	—	ns	
$\overline{\text{CAS}}$ to $\overline{\text{WE}}$ Delay Time	t _{CWD}	36	—	40	—	50	—	ns	9
Column Address to $\overline{\text{WE}}$ Delay Time	t _{AWD}	48	—	55	—	65	—	ns	9
$\overline{\text{RAS}}$ to $\overline{\text{WE}}$ Delay Time	t _{RWD}	73	—	85	—	100	—	ns	9
$\overline{\text{CAS}}$ Precharge $\overline{\text{WE}}$ Delay Time	t _{CPWD}	53	—	60	—	70	—	ns	9
$\overline{\text{CAS}}$ Active Delay Time from $\overline{\text{RAS}}$ Precharge	t _{RPC}	5	—	5	—	5	—	ns	
$\overline{\text{RAS}}$ to $\overline{\text{CAS}}$ Set-up Time ($\overline{\text{CAS}}$ before $\overline{\text{RAS}}$)	t _{CSR}	10	—	10	—	10	—	ns	
$\overline{\text{RAS}}$ to $\overline{\text{CAS}}$ Hold Time ($\overline{\text{CAS}}$ before $\overline{\text{RAS}}$)	t _{CHR}	10	—	10	—	10	—	ns	

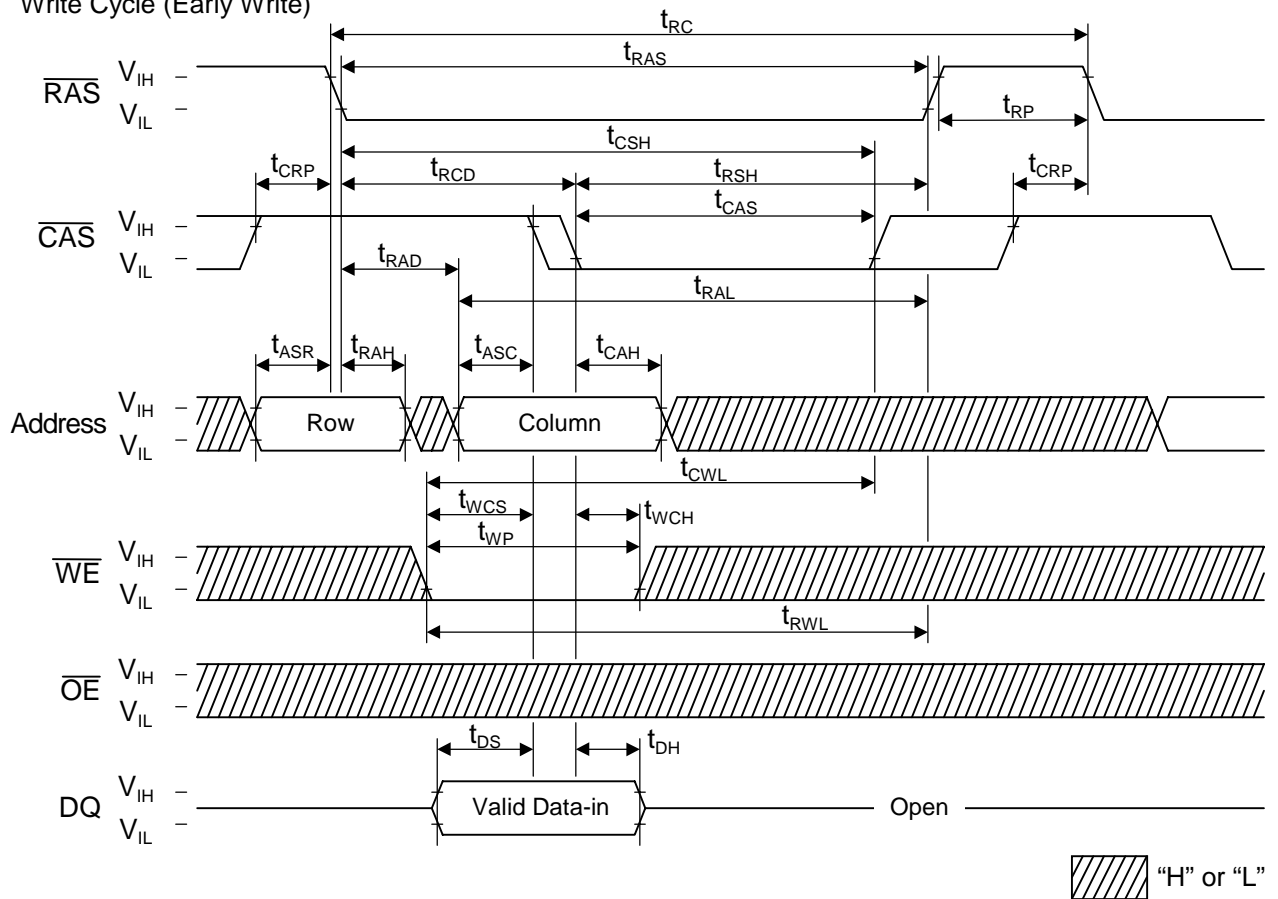
- Notes:
1. A start-up delay of 200 μ s is required after power-up, followed by a minimum of eight initialization cycles ($\overline{\text{RAS}}$ -only refresh or $\overline{\text{CAS}}$ before $\overline{\text{RAS}}$ refresh) before proper device operation is achieved.
 2. The AC characteristics assume $t_T = 5\text{ns}$.
 3. V_{IH} (Min.) and V_{IL} (Max.) are reference levels for measuring input timing signals. Transition times (t_T) are measured between V_{IH} and V_{IL} .
 4. This parameter is measured with a load circuit equivalent to 2 TTL load and 100pF.
 5. 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 the access time is controlled by t_{CAC} .
 6. Operation within the t_{RAD} (Max.) limit ensures 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 the access time is controlled by t_{AA} .
 7. t_{OFF} (Max.) and t_{OEZ} (Max.) define the time at which the output achieved the open circuit condition and are not referenced to output voltage levels.
 8. t_{RCH} or t_{RRH} must be satisfied for a read cycle.
 9. t_{WCS} , t_{CWD} , t_{RWD} , t_{AWD} and t_{CPWD} are not restrictive operating parameters. They are included in the data sheet as electrical characteristics only. If $t_{WCS} \geq t_{WCS}$ (Min.), then the cycle is an early write cycle and the data out will remain open circuit (high impedance) throughout the entire cycle. If $t_{CWD} \geq t_{CWD}$ (Min.), $t_{RWD} \geq t_{RWD}$ (Min.), $t_{AWD} \geq t_{AWD}$ (Min.) and $t_{CPWD} \geq t_{CPWD}$ (Min.), then the cycle is a read modify write cycle and data out will contain data read from the selected cell; if neither of the above sets of conditions is satisfied, then the condition of the data out (at access time) is indeterminate.
 10. These parameters are referenced to the $\overline{\text{CAS}}$ leading edge in an early write cycle, and to the $\overline{\text{WE}}$ leading edge in an $\overline{\text{OE}}$ control write cycle, or a read modify write cycle.

Timing Chart

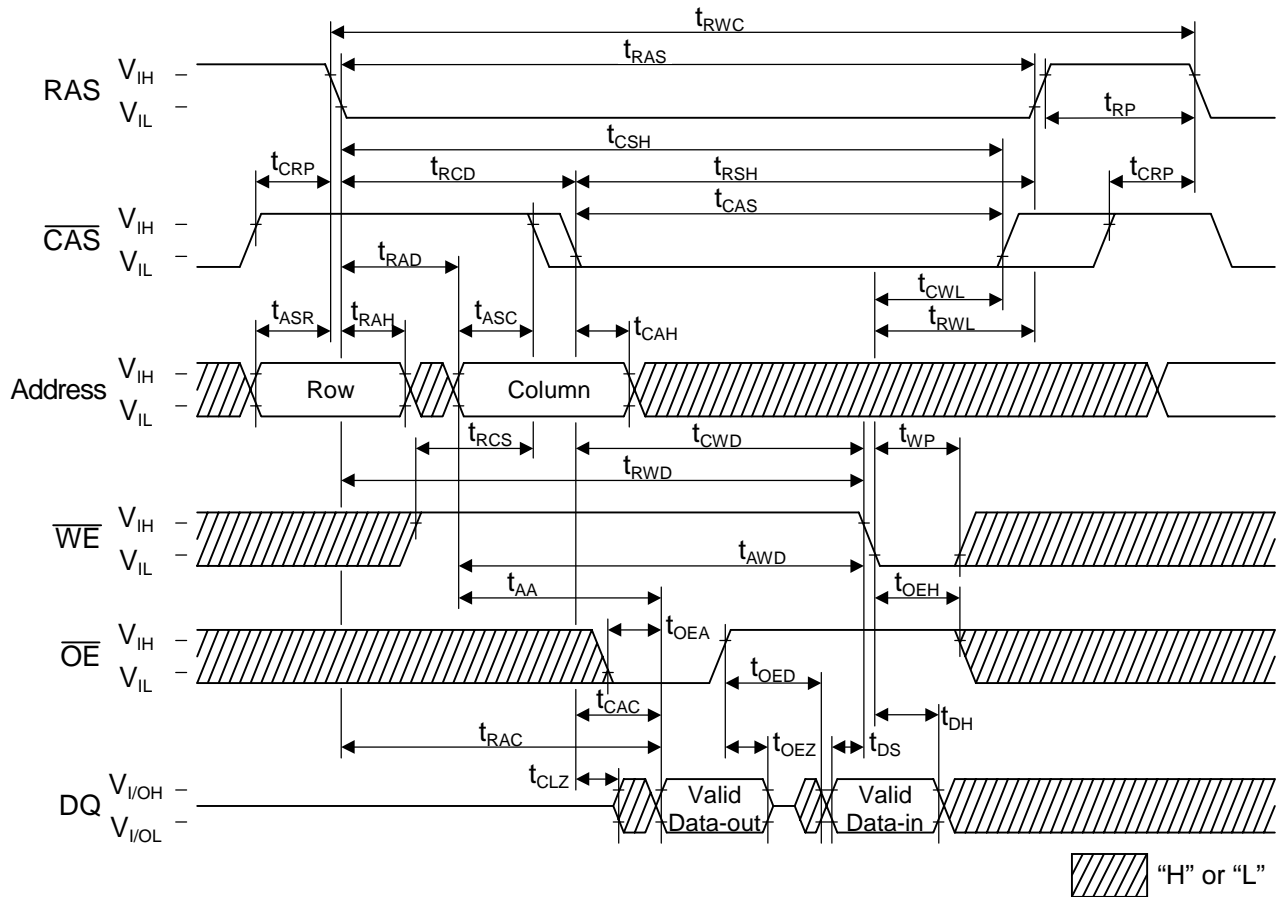
- Read Cycle



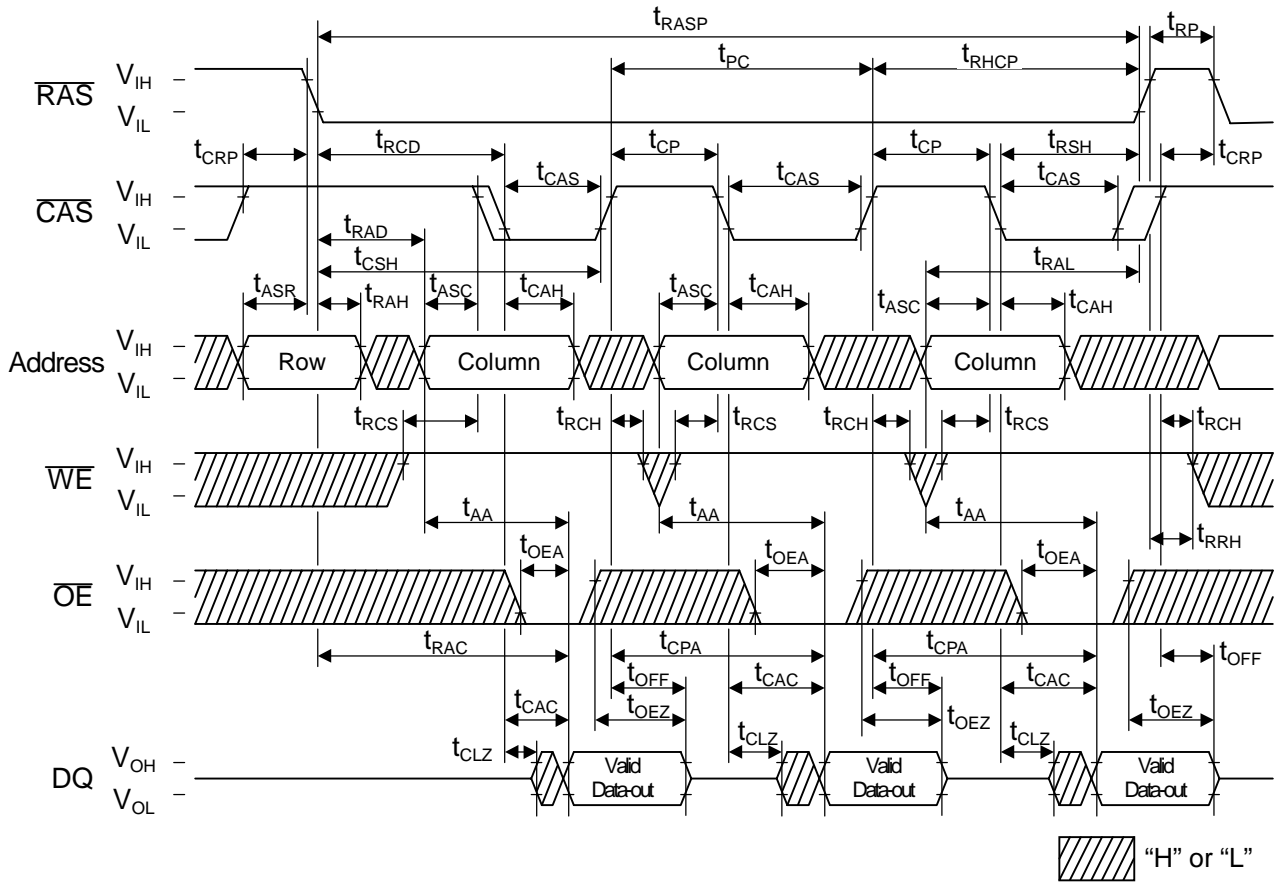
- Write Cycle (Early Write)



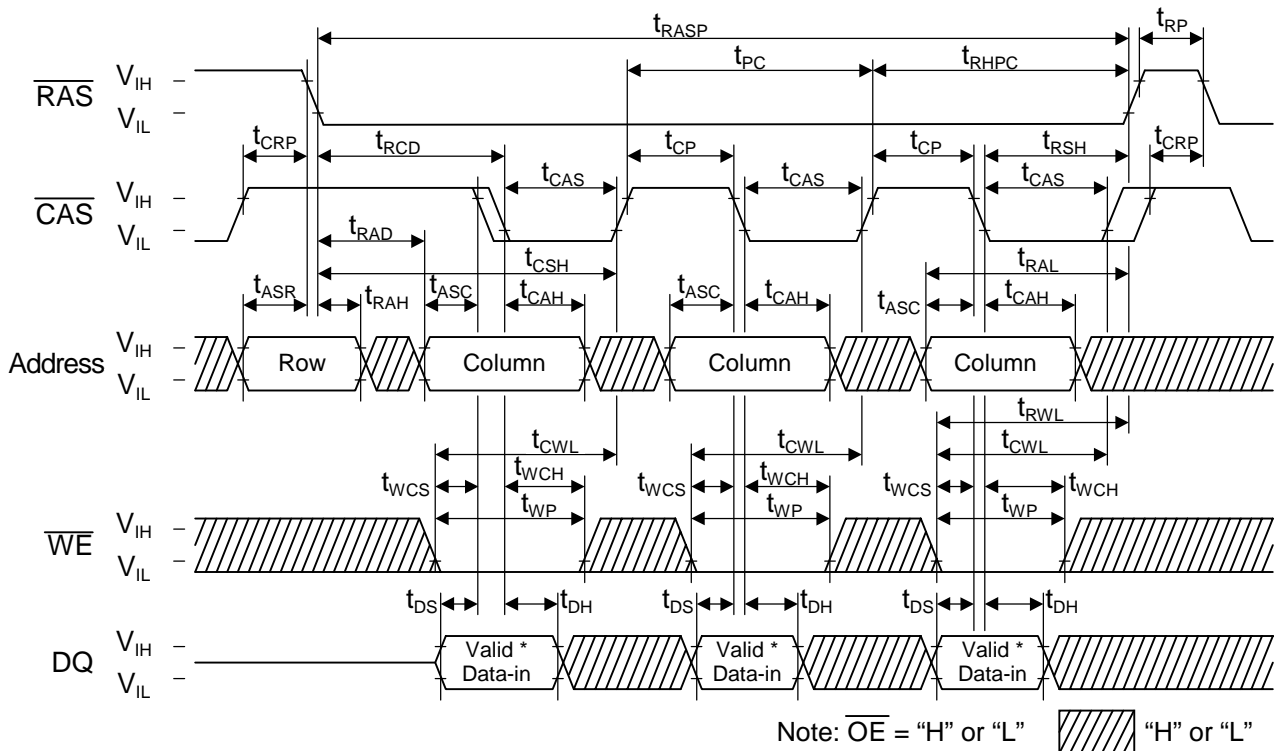
• Read Modify Write Cycle



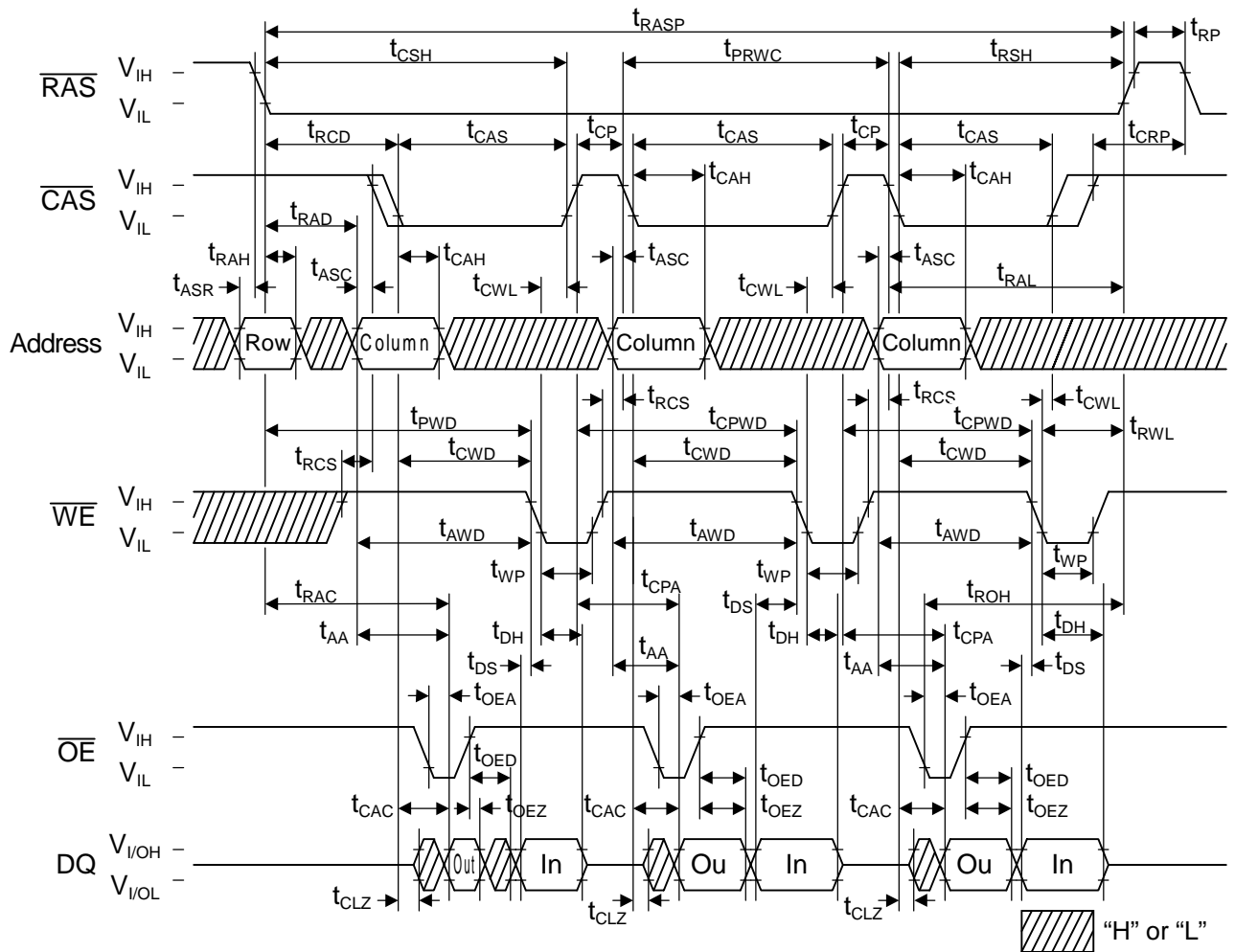
• Fast Page Mode Cycle



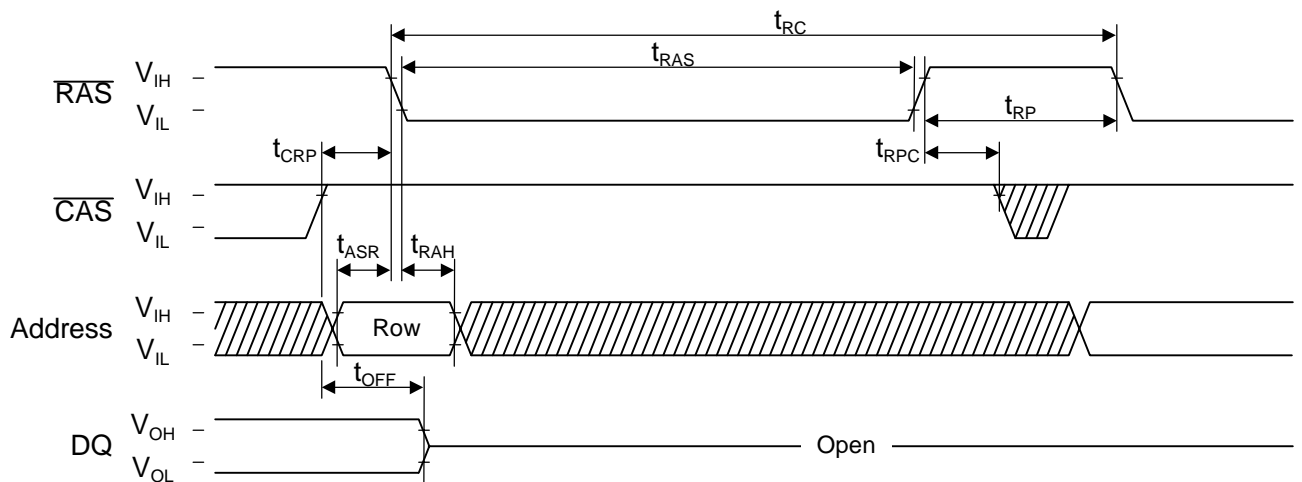
• Fast Page Mode Write Cycle (Early Write)



- Fast Page Mode Read Modify Write Cycle

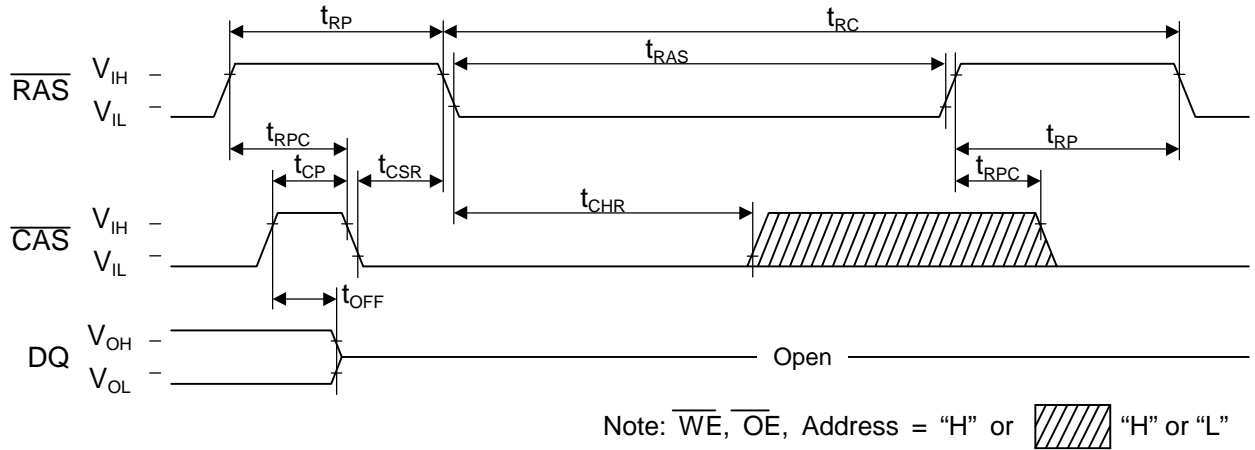


- $\overline{\text{RAS}}$ -only Refresh Cycle

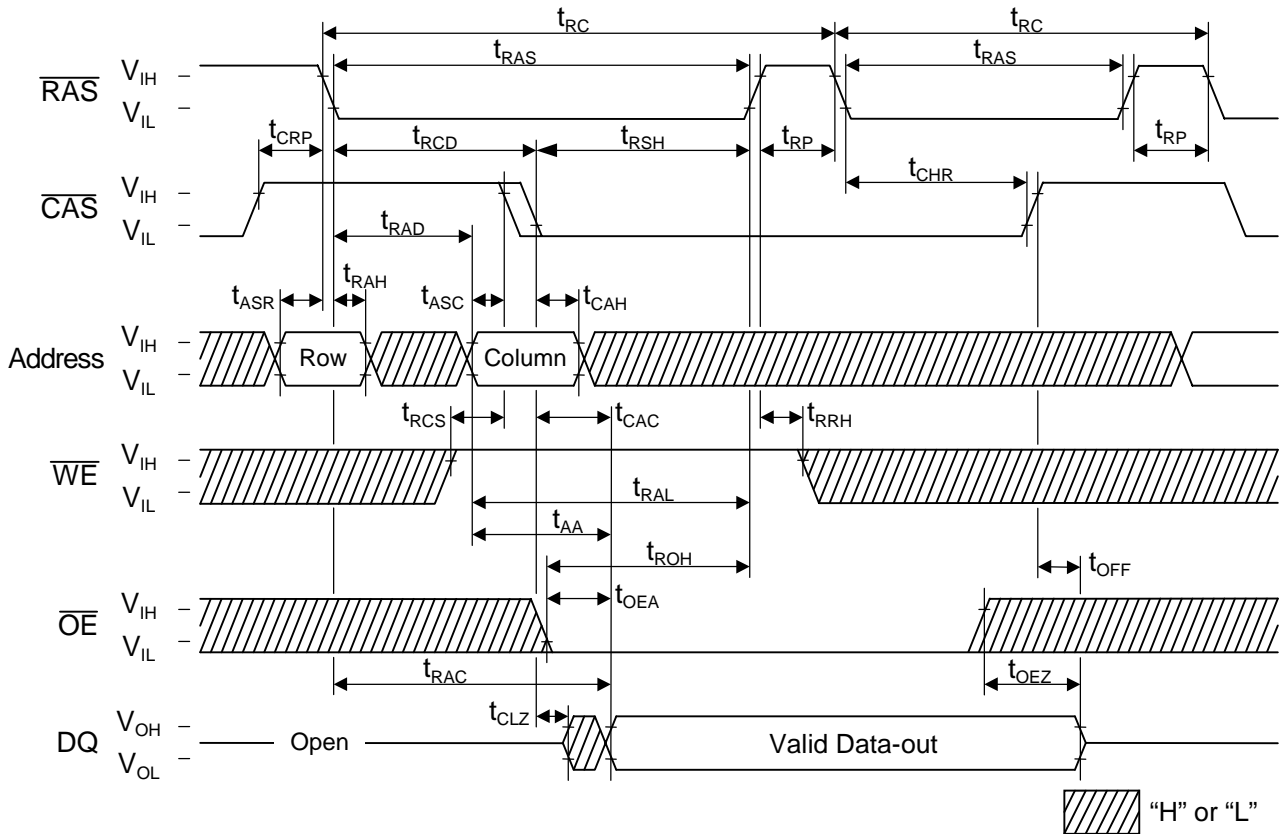


Note: $\overline{\text{WE}}, \overline{\text{OE}}$ = "H" or "H" or "L"

• $\overline{\text{CAS}}$ before $\overline{\text{RAS}}$ Refresh Cycle



• Hidden Refresh Read Cycle



Hidden Refresh Write Cycle

