

# OKI Semiconductor

## MSM514265E/ESL

Preliminary

**262,144-Word x 16-Bit DYNAMIC RAM : FAST PAGE MODE TYPE WITH EDO**

### DESCRIPTION

The MSM514265E/ESL is a 262,144-word × 16-bit dynamic RAM fabricated in Oki’s silicon-gate CMOS technology. The MSM514265E/ESL 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 MSM514265E/ESL is available in a 40-pin plastic SOJ or 44/40-pin plastic TSOP. The MSM514265ESL (the Self-refresh version) is specially designed for lower-power applications.

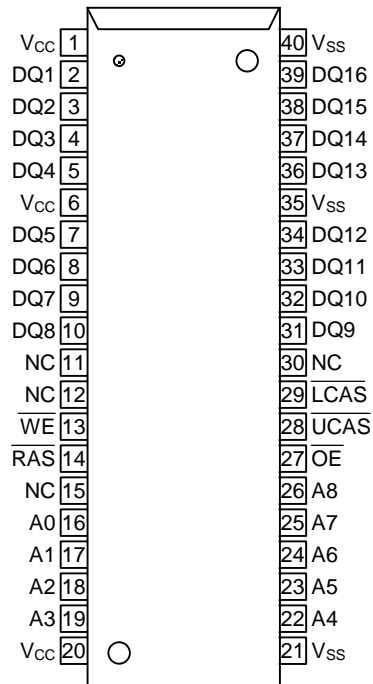
### FEATURES

- 262,144-word × 16-bit configuration
  - Single 5V power supply, ±10% tolerance
  - Input : TTL compatible, low input capacitance
  - Output : TTL compatible, 3-state
  - Refresh : 512 cycles/8ms, 512 cycles/128 ms (SL version)
  - Fast page mode with EDO, read modify write capability
  - $\overline{\text{CAS}}$  before  $\overline{\text{RAS}}$  refresh, hidden refresh,  $\overline{\text{RAS}}$ -only refresh capability
  - $\overline{\text{CAS}}$  before  $\overline{\text{RAS}}$  self-refresh capability (SL version)
  - Package options:
    - 40-pin 400mil plastic SOJ (SOJ40-P-400-1.27) (Product : MSM514265E/ESL-xxJS)
    - 44/40-pin 400mil plastic TSOP (TSOPII44/40-P-400-0.80-K) (Product : MSM514265E./ESL-xxTS-K)
- xx indicates speed rank.

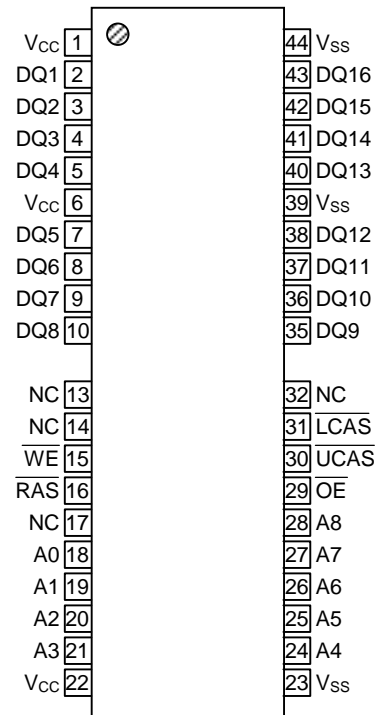
### PRODUCT FAMILY

Family	Access Time (Max.)				Cycle Time (Min.)	Power Dissipation	
	t <sub>RAC</sub>	t <sub>AA</sub>	t <sub>CAC</sub>	t <sub>OEA</sub>		Operating (Max.)	Standby (Max.)
MSM514265E/ESL	60ns	30ns	15ns	15ns	104ns	633mW	5.5mW/
	70ns	35ns	20ns	20ns	124ns	578mW	1.1mW (SL version)

### PIN CONFIGURATION (TOP VIEW)



40-Pin Plastic SOJ

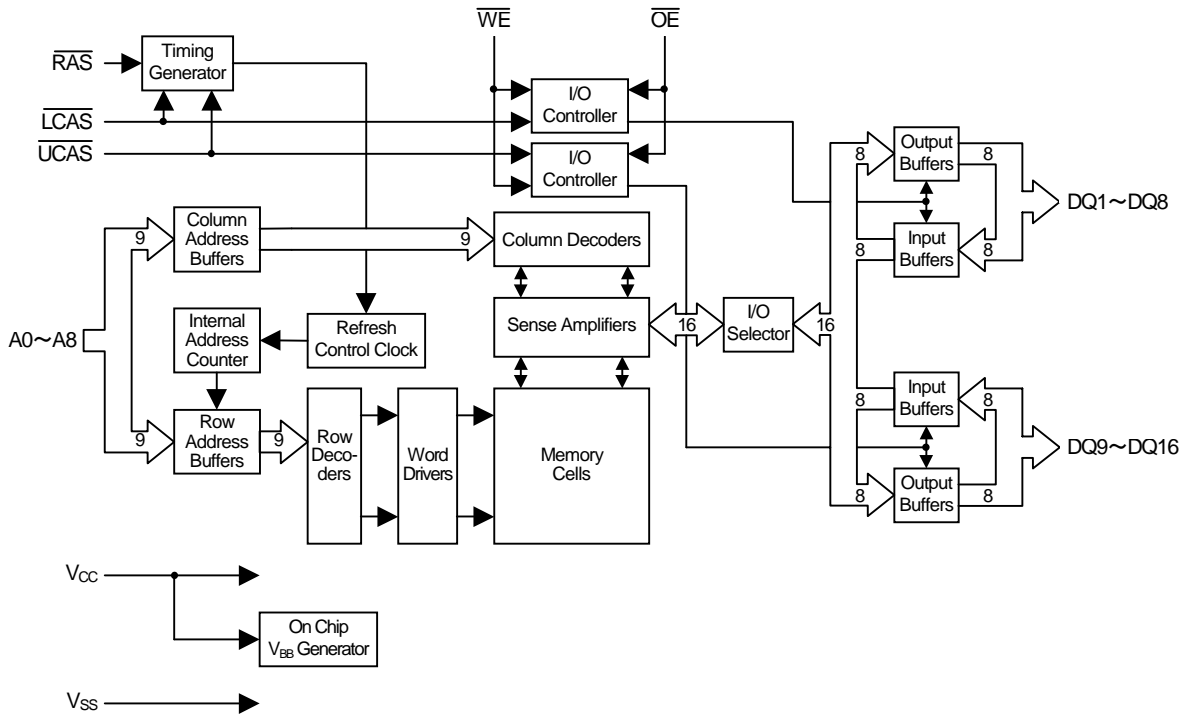


44/40-Pin Plastic TSOP (K Type)

Pin Name	Function
A0 – A8	Address Input
RAS	Row Address Strobe
LCAS	Lower Byte Column Address Strobe
UCAS	Upper Byte Column Address Strobe
DQ1–DQ16	Data Input/Data Output
OE	Output Enable
WE	Write Enable
V <sub>CC</sub>	Power Supply (5V)
V <sub>SS</sub>	Ground (0V)
NC	No Connection

Note : The same power supply voltage must be provided to every V<sub>CC</sub> pin, and the same GND voltage level must be provided to every V<sub>SS</sub> pin.

### BLOCK DIAGRAM



### FUNCTION TABLE

Input Pin					DQ Pin		Function Mode
RAS	LCAS	UCAS	WE	OE	DQ1-DQ8	DQ9-DQ16	
H	*	*	*	*	High-Z	High-Z	Standby
L	H	H	*	*	High-Z	High-Z	Refresh
L	L	H	H	L	D <sub>OUT</sub>	High-Z	Lower Byte Read
L	H	L	H	L	High-Z	D <sub>OUT</sub>	Upper Byte Read
L	L	L	H	L	D <sub>OUT</sub>	D <sub>OUT</sub>	Word Read
L	L	H	L	H	D <sub>IN</sub>	Don't Care	Lower Byte Write
L	H	L	L	H	Don't Care	D <sub>IN</sub>	Upper Byte Write
L	L	L	L	H	D <sub>IN</sub>	D <sub>IN</sub>	Word Write
L	L	L	H	H	High-Z	High-Z	—

\* : "H" or "L"

## ELECTRICAL CHARACTERISTICS

### Absolute Maximum Ratings

Parameter	Symbol	Rating	Unit
Voltage on Any Pin Relative to $V_{SS}$	$V_{IN}, V_{OUT}$	$-0.5$ to $V_{CC} + 0.5$	V
Voltage $V_{CC}$ supply Relative to $V_{SS}$	$V_{CC}$	$-0.5$ 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  $70^\circ\text{C}$ )

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

( $V_{CC} = 5\text{V} \pm 10\%$ ,  $T_a = 25^\circ\text{C}$ ,  $f=1\text{MHz}$ )

Parameter	Symbol	Typ.	Max.	Unit
Input Capacitance (A0 – A8)	$C_{IN1}$	—	5	pF
Input Capacitance ( $\overline{RAS}$ , $\overline{LCAS}$ , $\overline{UCAS}$ , $\overline{WE}$ , $\overline{OE}$ )	$C_{IN2}$	—	7	pF
Output Capacitance (DQ1 - DQ16)	$C_{I/O}$	—	7	pF

## DC Characteristics

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

Parameter	Symbol	Condition	MSM514265 E/ESL-60		MSM514265 E/ESL-70		Unit	Note
			Min.	Max.	Min.	Max.		
Output High Voltage	$V_{OH}$	$I_{OH} = -5.0\text{mA}$	2.4	$V_{CC}$	2.4	$V_{CC}$	V	
Output Low Voltage	$V_{OL}$	$I_{OL} = 4.2\text{mA}$	0	0.4	0	0.4	V	
Input Leakage Current	$I_{LI}$	$0V \leq V_I \leq V_{CC} + 0.5V$ ; All other pins not under test = $0V$	-10	10	-10	10	$\mu\text{A}$	
Output Leakage Current	$I_{LO}$	DQ disable $0V \leq V_O \leq V_{CC}$	-10	10	-10	10	$\mu\text{A}$	
Average Power Supply Current (Operating)	$I_{CC1}$	$\overline{\text{RAS}}$ , $\overline{\text{CAS}}$ cycling, $t_{RC} = \text{Min.}$	—	115	—	105	mA	1,2
Power Supply Current (Standby)	$I_{CC2}$	$\overline{\text{RAS}}$ , $\overline{\text{CAS}} = V_{IH}$	—	2	—	2	mA	1
		$\overline{\text{RAS}}$ , $\overline{\text{CAS}} \geq$ $V_{CC} - 0.2V$	—	1	—	1	$\mu\text{A}$	1,5
Average Power Supply Current ( $\overline{\text{RAS}}$ -only Refresh)	$I_{CC3}$	$\overline{\text{RAS}}$ cycling, $\overline{\text{CAS}} = V_{IH}$ , $t_{RC} = \text{Min.}$	—	115	—	105	mA	1,2
Power Supply Current (Standby)	$I_{CC5}$	$\overline{\text{RAS}} = V_{IH}$ , $\overline{\text{CAS}} = V_{IL}$ , DQ = enable	—	5	—	5	mA	1
Average Power Supply Current ( $\overline{\text{CAS}}$ before $\overline{\text{RAS}}$ Refresh)	$I_{CC6}$	$\overline{\text{RAS}} = \text{cycling}$ , $\overline{\text{CAS}}$ before $\overline{\text{RAS}}$	—	115	—	105	mA	1,2
Average Power Supply Current (Fast Page Mode)	$I_{CC7}$	$\overline{\text{RAS}} = V_{IL}$ , $\overline{\text{CAS}}$ cycling, $t_{HPC} = \text{Min.}$	—	115	—	105	mA	1,3
Average Power Supply Current (Battery Backup)	$I_{CC10}$	$t_{RC} = 125\mu\text{s}$ $\overline{\text{CAS}}$ before $\overline{\text{RAS}}$ $t_{RAS} = 1\mu\text{s}$	—	300	—	300	$\mu\text{A}$	1,4 ,5
Average Power Supply Current ( $\overline{\text{CAS}}$ before $\overline{\text{RAS}}$ Self-Refresh)	$I_{CCS}$	$\overline{\text{RAS}} \leq 0.2V$ , $\overline{\text{CAS}} \leq 0.2V$ ,	—	300	—	300	$\mu\text{A}$	1,5

- Notes: 1.  $I_{CC}$  Max. is specified as  $I_{CC}$  for output open condition.  
 2. The address can be changed once or less while  $\overline{\text{RAS}} = V_{IL}$ .  
 3. The address can be changed once or less while  $\overline{\text{CAS}} = V_{IH}$ .  
 4.  $V_{CC} - 0.2V \leq V_{IH} \leq V_{CC} + 0.5V$ ,  $-0.5V \leq V_{IL} \leq 0.2V$ .  
 5. SL version.

## AC Characteristic (1/2)

( $V_{CC} = 5V \pm 10\%$ ,  $T_a = 0^\circ\text{C}$  to  $70^\circ\text{C}$ ) Note1,2,3

Parameter	Symbol	MSM514265 E/ESL-60		MSM514265 E/ESL-70		Unit	Note
		Min.	Max.	Min.	Max.		
Random Read or Write Cycle Time	$t_{RC}$	104	—	124	—	ns	
Read Modify Write Cycle Time	$t_{RWC}$	135	—	160	—	ns	
Fast Page Mode Cycle Time	$t_{HPC}$	25	—	30	—	ns	
Fast Page Mode Read Modify Write Cycle Time	$t_{HPRWC}$	68	—	78	—	ns	
Access Time from $\overline{RAS}$	$t_{RAC}$	—	60	—	70	ns	4, 5, 6
Access Time from $\overline{CAS}$	$t_{CAC}$	—	15	—	20	ns	4,5
Access Time from Column Address	$t_{AA}$	—	30	—	35	ns	4,6
Access Time from $\overline{CAS}$ Precharge	$t_{CPA}$	—	35	—	40	ns	4,13
Access Time from $\overline{OE}$	$t_{OEA}$	—	15	—	20	ns	4
Output Low Impedance Time from $\overline{CAS}$	$t_{CLZ}$	0	—	0	—	ns	4
Data Output Hold After $\overline{CAS}$ Low	$t_{DOH}$	5	—	5	—	ns	
$\overline{CAS}$ to Data Output Buffer Turn-off Delay Time	$t_{CEZ}$	0	15	0	20	ns	7,8
$\overline{RAS}$ to Data Output Buffer Turn-off Delay Time	$t_{REZ}$	0	15	0	20	ns	7,8
$\overline{OE}$ to Data Output Buffer Turn-off Delay Time	$t_{OEZ}$	0	15	0	20	ns	7
$\overline{WE}$ to Data Output Buffer Turn-off Delay Time	$t_{WEZ}$	0	15	0	20	ns	7
Transition Time	$t_T$	1	50	1	50	ns	3
Refresh Period	$t_{REF}$	—	8	—	8	ms	
Refresh Period (SL version)	$t_{REF}$	—	128	—	128	ms	16
$\overline{RAS}$ Precharge Time	$t_{RP}$	40	—	50	—	ns	
$\overline{RAS}$ Pulse Width	$t_{RAS}$	60	10,000	70	10,000	ns	
$\overline{RAS}$ Pulse Width (Fast Page Mode with EDO)	$t_{RASP}$	60	100,000	70	100,000	ns	
$\overline{RAS}$ Hold Time	$t_{RSH}$	10	—	13	—	ns	
$\overline{RAS}$ Hold Time referenced to $\overline{OE}$	$t_{ROH}$	10	—	13	—	ns	
$\overline{CAS}$ Precharge Time (Fast Page Mode with EDO)	$t_{CP}$	10	—	10	—	ns	15
$\overline{CAS}$ Pulse Width	$t_{CAS}$	10	10,000	10	10,000	ns	
$\overline{CAS}$ Hold Time	$t_{CSH}$	40	—	45	—	ns	
$\overline{CAS}$ to $\overline{RAS}$ Precharge Time	$t_{CRP}$	5	—	5	—	ns	13
$\overline{RAS}$ Hold Time from $\overline{CAS}$ Precharge	$t_{RHCP}$	35	—	40	—	ns	13
$\overline{OE}$ Hold Time from $\overline{CAS}$ (DQ Disable)	$t_{CHO}$	5	—	5	—	ns	
$\overline{RAS}$ to $\overline{CAS}$ Delay Time	$t_{RCD}$	14	45	14	50	ns	5
$\overline{RAS}$ to Column Address Delay Time	$t_{RAD}$	12	30	12	35	ns	6
Row Address Set-up Time	$t_{ASR}$	0	—	0	—	ns	
Row Address Hold Time	$t_{RAH}$	10	—	10	—	ns	

**AC Characteristic (2/2)** $(V_{CC} = 5V \pm 10\%, T_a = 0^\circ C \text{ to } 70^\circ C)$  Note1,2,3

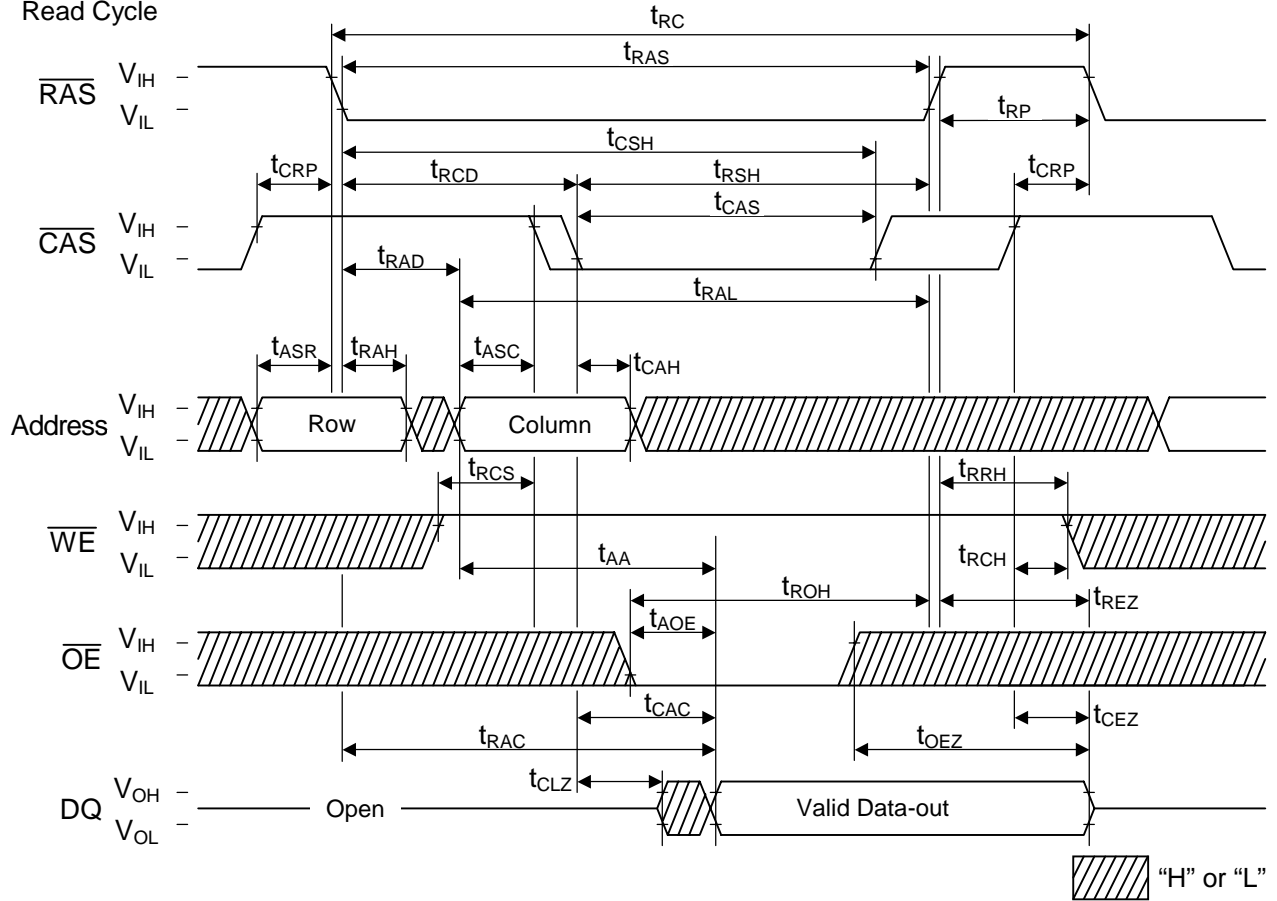
Parameter	Symbol	MSM514265 E-60		MSM514265 E-70		Unit	Note
		Min.	Max.	Min.	Max.		
Column Address Set-up Time	$t_{ASC}$	0	—	0	—	ns	12
Column Address Hold Time	$t_{CAH}$	10	—	13	—	ns	12
Column Address to $\overline{RAS}$ Lead Time	$t_{RAL}$	30	—	35	—	ns	
Read Command Set-up Time	$t_{RCS}$	0	—	0	—	ns	12
Read Command Hold Time	$t_{RCH}$	0	—	0	—	ns	9,12
Read Command Hold Time referenced to $\overline{RAS}$	$t_{RRH}$	0	—	0	—	ns	9
Write Command Set-up Time	$t_{WCS}$	0	—	0	—	ns	10,12
Write Command Hold Time	$t_{WCH}$	10	—	13	—	ns	12
Write Command Pulse Width	$t_{WP}$	10	—	10	—	ns	
$\overline{WE}$ Pulse Width (DQ Disable)	$t_{WPE}$	7	—	7	—	ns	
$\overline{OE}$ Command Hold Time	$t_{OEH}$	10	—	13	—	ns	
$\overline{OE}$ Precharge Time	$t_{OEP}$	10	—	10	—	ns	
$\overline{OE}$ Command Hold Time	$t_{OCH}$	10	—	10	—	ns	
Write Command to $\overline{RAS}$ Lead Time	$t_{RWL}$	10	—	13	—	ns	
Write Command to $\overline{CAS}$ Lead Time	$t_{CWL}$	10	—	13	—	ns	14
Data-in Set-up Time	$t_{DS}$	0	—	0	—	ns	11,12
Data-in Hold Time	$t_{DH}$	10	—	13	—	ns	11,12
$\overline{OE}$ to Data-in Delay Time	$t_{OED}$	15	—	20	—	ns	
$\overline{CAS}$ to $\overline{WE}$ Delay Time	$t_{CWD}$	35	—	45	—	ns	10
Column Address to $\overline{WE}$ Delay Time	$t_{AWD}$	50	—	60	—	ns	10
$\overline{RAS}$ to $\overline{WE}$ Delay Time	$t_{RWD}$	80	—	95	—	ns	10
$\overline{CAS}$ Precharge $\overline{WE}$ Delay Time	$t_{CPWD}$	55	—	65	—	ns	10
$\overline{CAS}$ Active Delay Time from $\overline{RAS}$ Precharge	$t_{RPC}$	5	—	5	—	ns	12
$\overline{RAS}$ to $\overline{CAS}$ Set-up Time ( $\overline{CAS}$ before $\overline{RAS}$ )	$t_{CSR}$	5	—	5	—	ns	12
$\overline{RAS}$ to $\overline{CAS}$ Hold Time ( $\overline{CAS}$ before $\overline{RAS}$ )	$t_{CHR}$	10	—	10	—	ns	13
$\overline{RAS}$ Pulse Width ( $\overline{CAS}$ before $\overline{RAS}$ Self-Refresh)	$t_{RASS}$	100	—	100	—	$\mu s$	16
$\overline{RAS}$ Precharge Time ( $\overline{CAS}$ before $\overline{RAS}$ Self-Refresh)	$t_{RPS}$	110	—	130	—	ns	16
$\overline{CAS}$ Hold Time ( $\overline{CAS}$ before $\overline{RAS}$ Self-Refresh)	$t_{CHS}$	-40	—	-50	—	ns	16

- Notes:
1. A start-up delay of 200 $\mu$ 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  $t_T = 2\text{ns}$ .
  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 1 TTL load and 50pF. The output timing reference levels are  $V_{OH} = 2.0\text{V}$  ( $I_{OH} = -2\text{mA}$ ) and  $V_{OL} = 0.8\text{V}$  ( $I_{OH} = 2\text{mA}$ ).
  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.  $t_{CEZ}$  (Max.),  $t_{REZ}$  (Max.),  $t_{WEZ}$  (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.  $t_{CEZ}$ , and  $t_{REZ}$  must be satisfied for open circuit condition.
  9.  $t_{RCH}$  or  $t_{RRH}$  must be satisfied for a read cycle.
  10.  $t_{WCS}$ ,  $t_{CWD}$ ,  $t_{RWD}$ ,  $t_{AWD}$  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.
  11. These parameters are referenced to the  $\overline{\text{UCAS}}$  and  $\overline{\text{LCAS}}$ , leading edges 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.
  12. These parameters are determined by the falling edge of either  $\overline{\text{UCAS}}$  or  $\overline{\text{LCAS}}$ , whichever is earlier.
  13. These parameters are determined by the rising edge of either  $\overline{\text{UCAS}}$  or  $\overline{\text{LCAS}}$ , whichever is later.
  14.  $t_{CWL}$  should be satisfied by both  $\overline{\text{UCAS}}$  and  $\overline{\text{LCAS}}$ .
  15.  $t_{CP}$  is determined by the time both  $\overline{\text{UCAS}}$  and  $\overline{\text{LCAS}}$  are high.
  16. Only SL version.

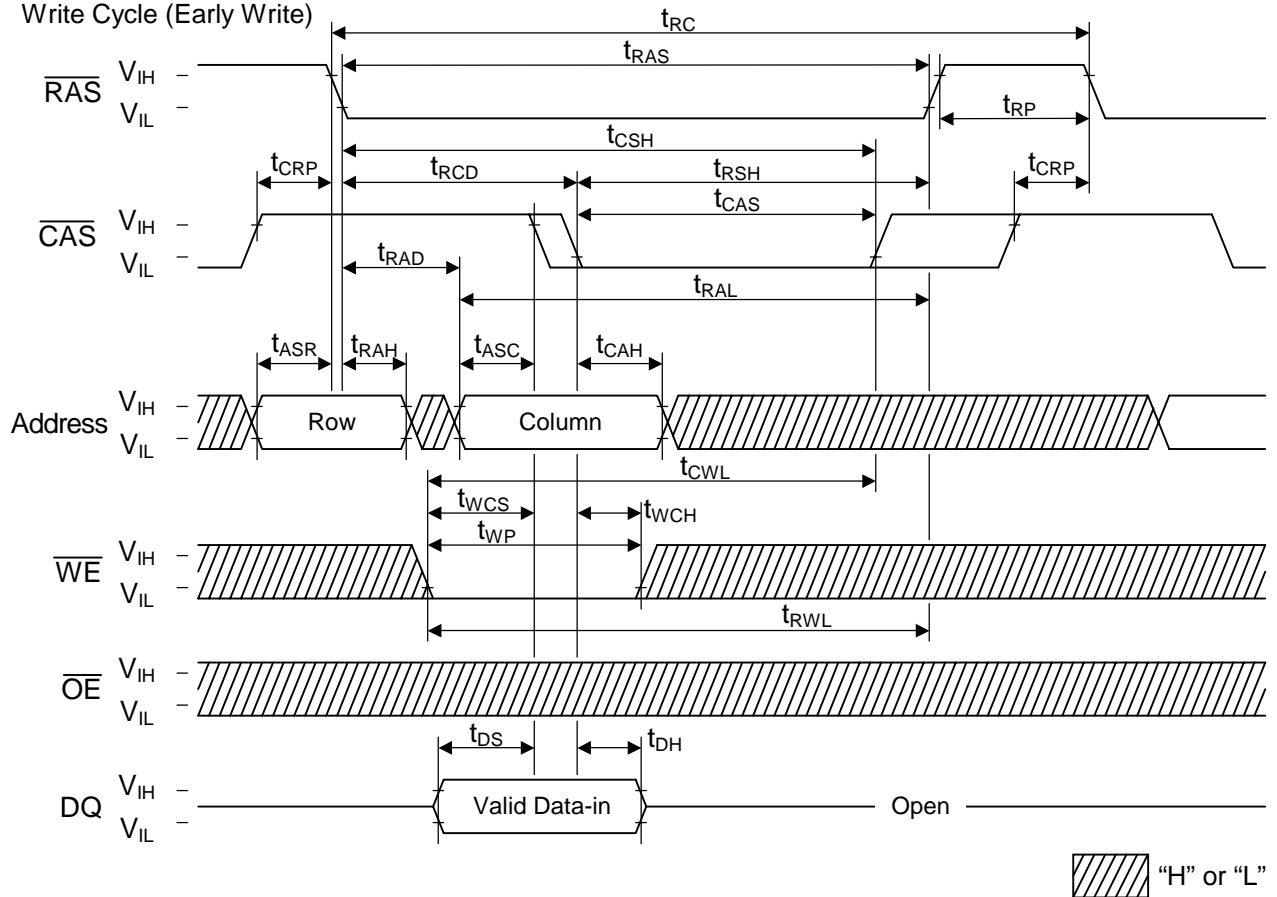


## Timing Chart

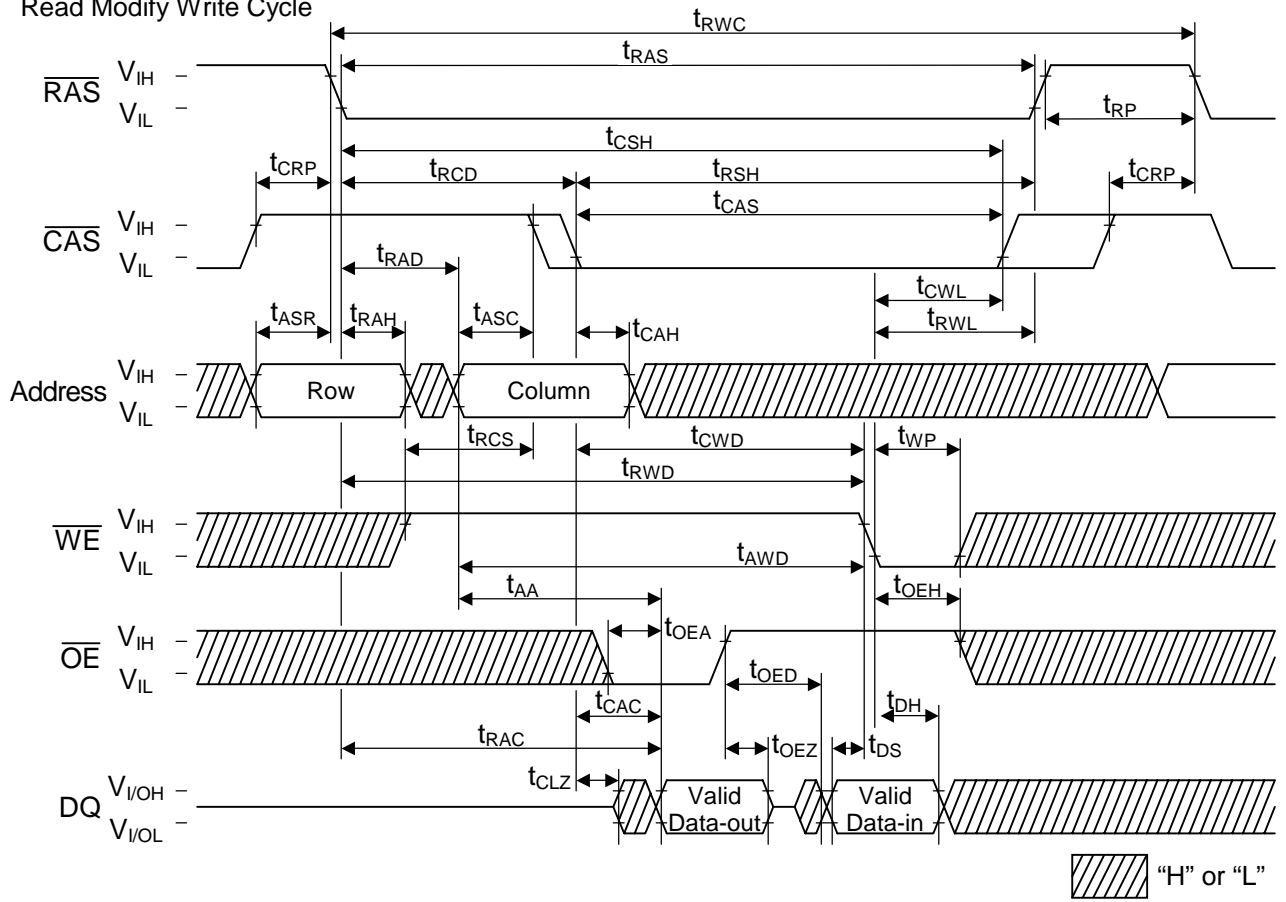
• Read Cycle



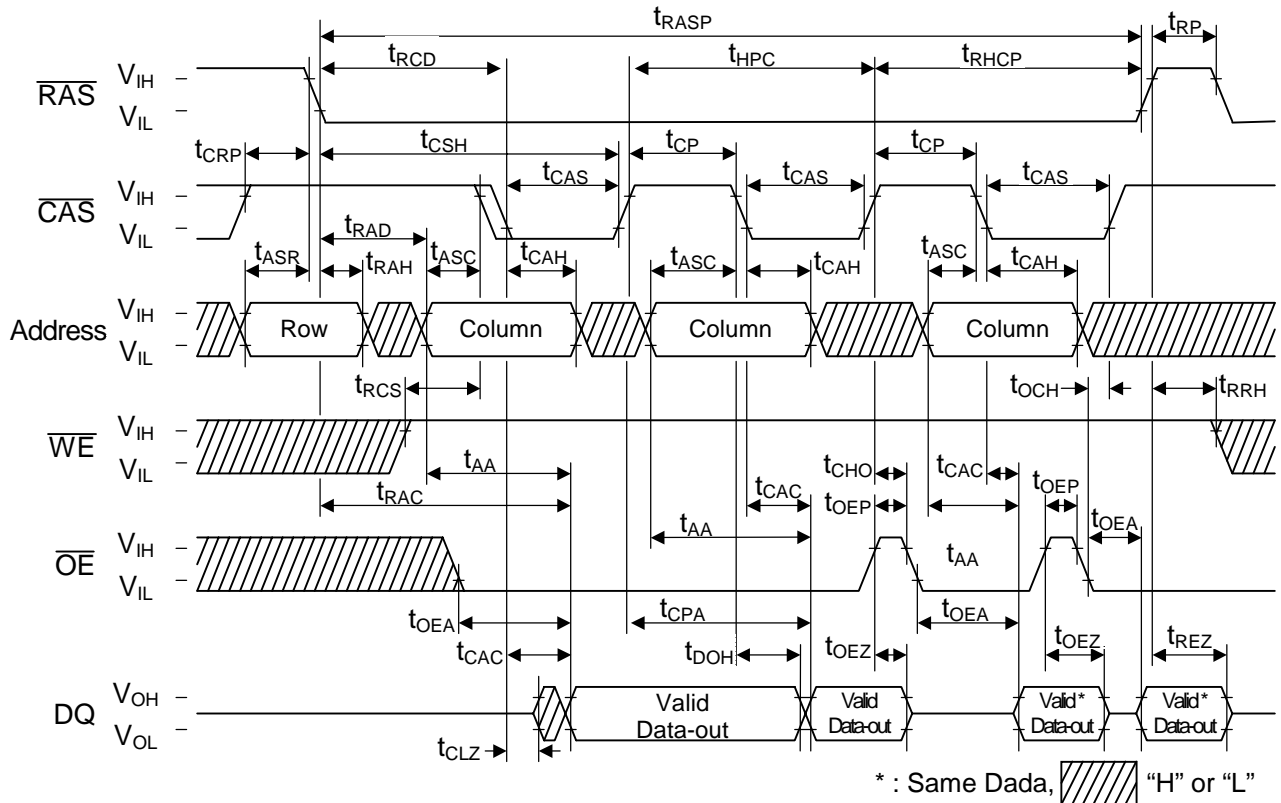
• Write Cycle (Early Write)



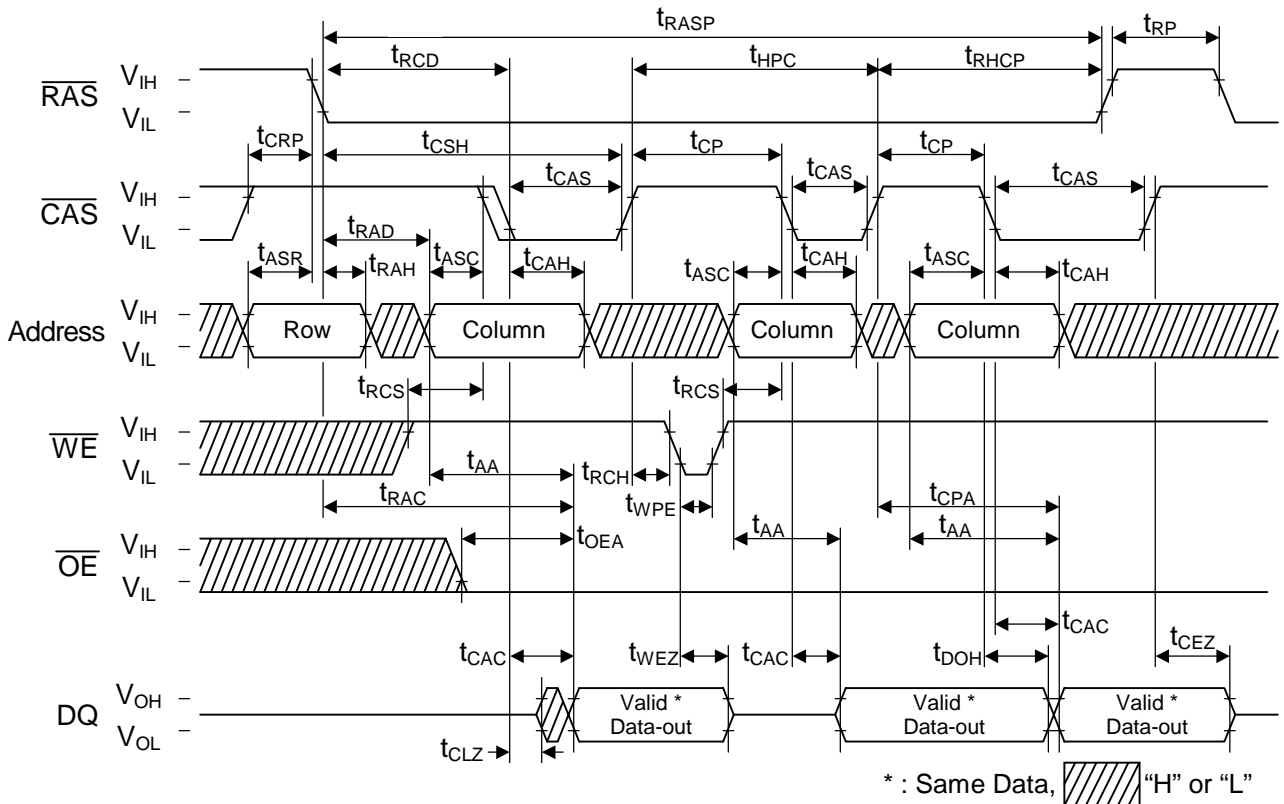
• Read Modify Write Cycle



• Fast Page Mode Read Cycle (Part-1)

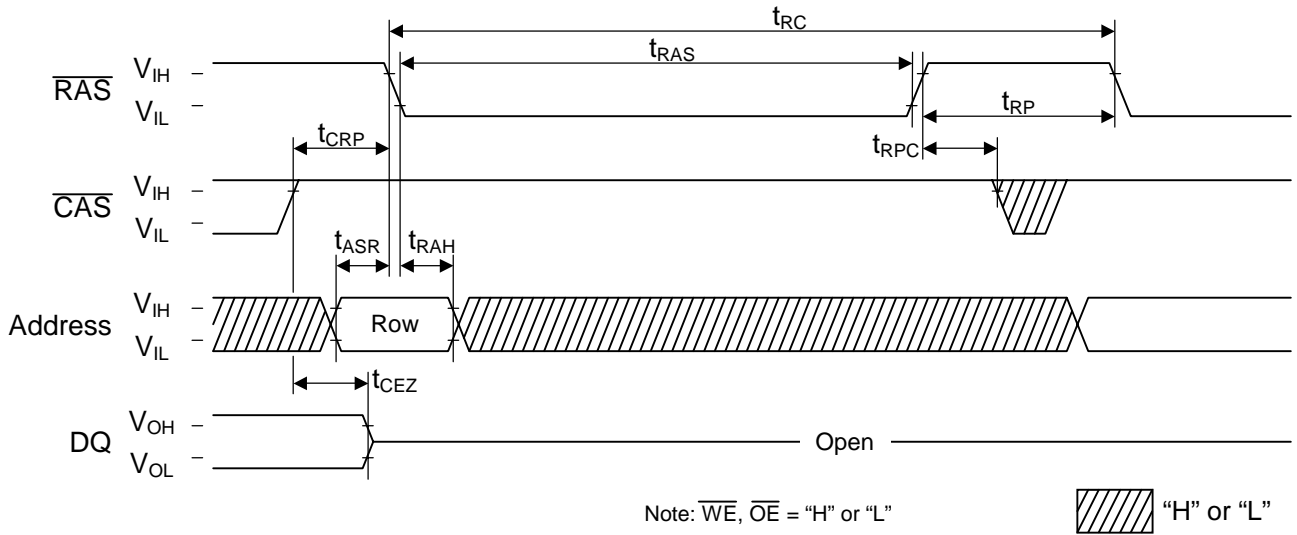


• Fast Page Mode Read Cycle (Part-2)

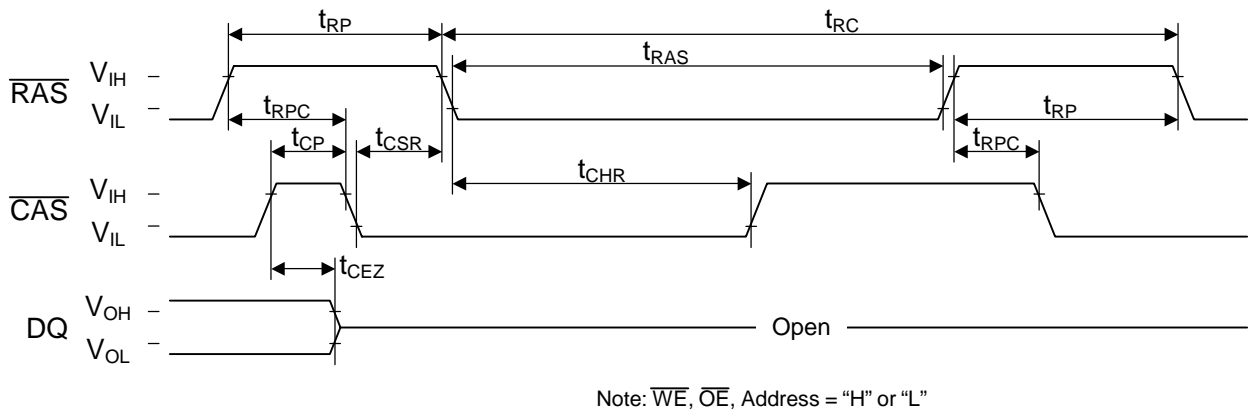




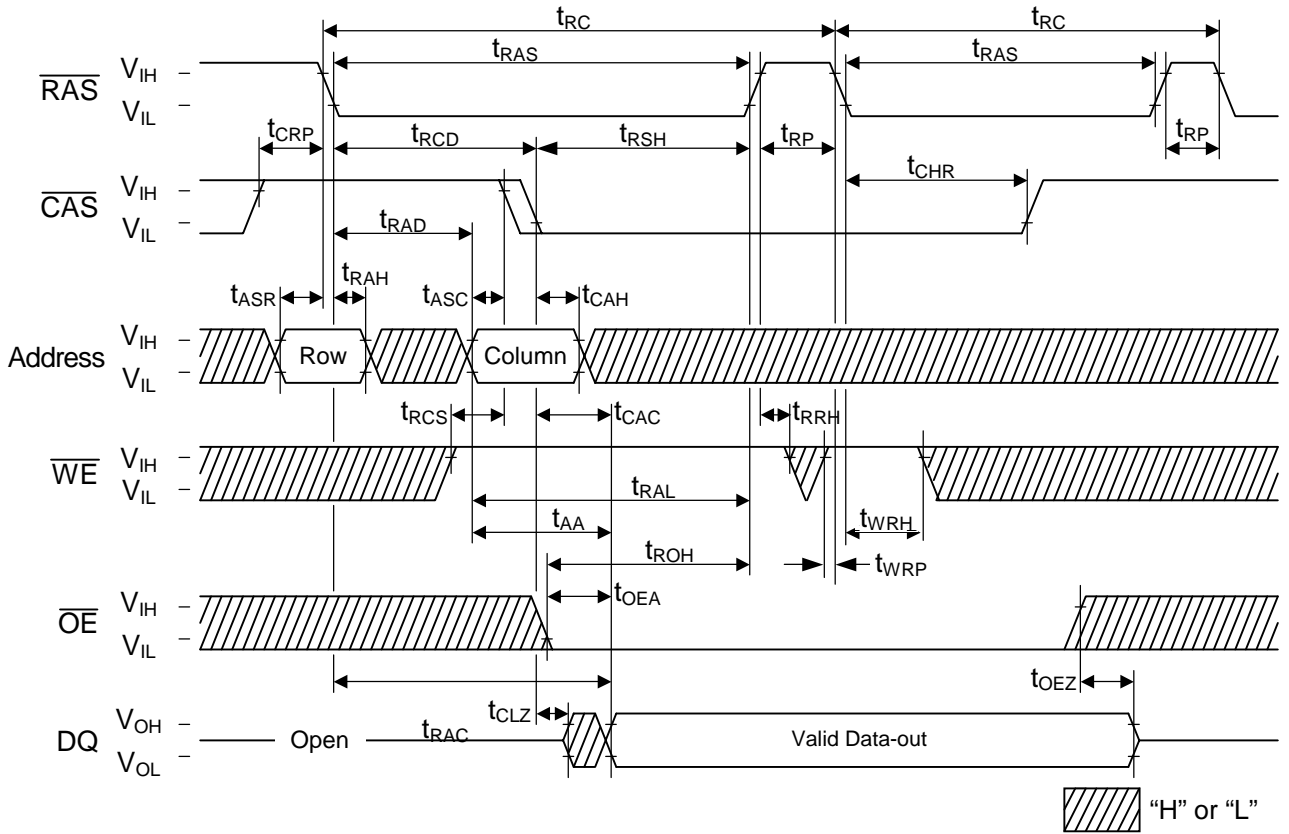
- $\overline{\text{RAS}}$ -Only Refresh Cycle



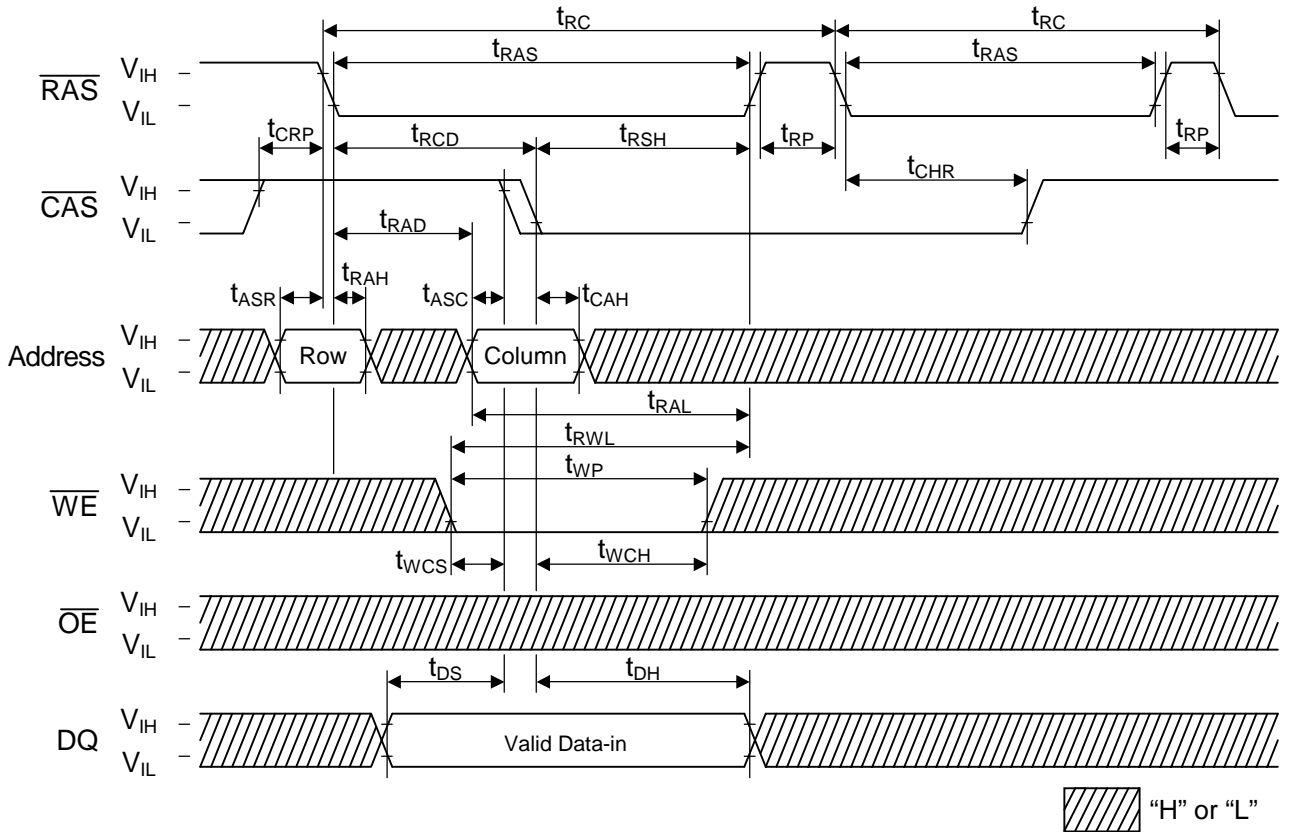
- $\overline{\text{CAS}}$  before  $\overline{\text{RAS}}$  Refresh Cycle



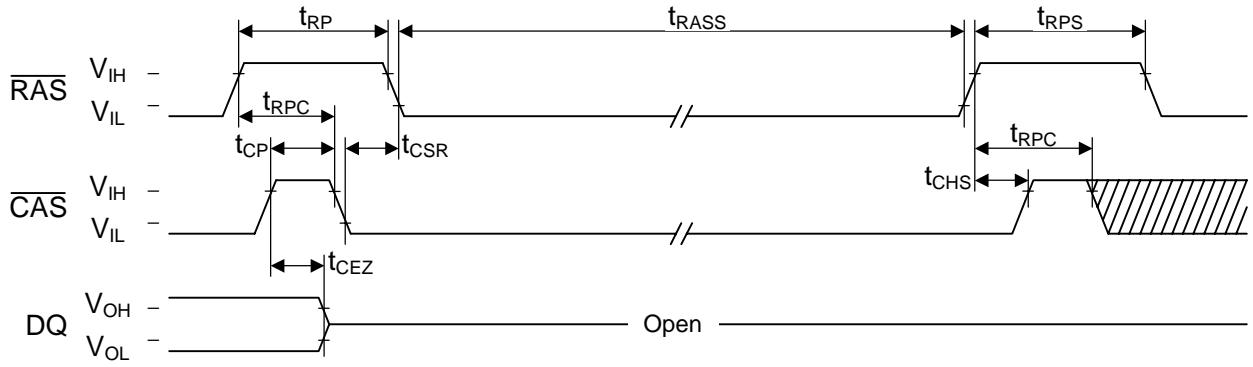
- Hidden Refresh Read Cycle




- Hidden Refresh Write Cycle



$\overline{\text{CAS}}$  before  $\overline{\text{RAS}}$  Self-Refresh Cycle



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