



NEC Electronics Inc.

μPD424190A/L, 42S4190A/L
262,144 x 18-Bit
Dynamic CMOS RAM

T-46-23-17

Description

The μPD424190A/L and μPD42S4190A/L are fast-page dynamic RAMs organized as 262,144 words by 18 bits and designed to operate from a single power supply.

Optional features are power supply voltage (+5 V or +3.3 V) and a new refresh mode called "self-refresh."

μPD	Options
424190A	+5 V
424190L	+3.3 V
42S4190A	+5 V; self-refresh mode
42S4190L	+3.3 V; self-refresh mode

Advanced polycide technology using stacked capacitors minimizes silicon area and provides high storage cell capacity, high performance, and high reliability. A single-transistor dynamic storage cell and CMOS circuitry throughout ensure minimum power dissipation, while an on-chip circuit internally generates the negative-voltage substrate bias—automatically and transparently.

Word writing (I/O₁ - I/O₁₈), upper byte writing (I/O₁₀ - I/O₁₈), and lower byte writing (I/O₁ - I/O₉) are all possible using \overline{UWE} and \overline{LWE} . If \overline{UWE} or \overline{LWE} goes low during an early write cycle, all data outputs remain in high impedance. Either going low causes a byte write cycle, while bringing both low at the same time results in a word write cycle. \overline{UWE} and \overline{LWE} cannot be staggered within the same write cycle.

Refreshing may be accomplished by a \overline{CAS} before \overline{RAS} refresh cycle (CBR) that internally generates the refresh address. \overline{RAS} -only refresh cycles will also refresh all memory locations.

The self-refresh mode is entered by holding \overline{RAS} low for longer than 100 μs during a CBR cycle. Detection of this long \overline{RAS} time starts an internal oscillator that maintains data integrity without external clocking. The slow refresh reduces the data hold current to less than 200 microamperes. Self-refresh mode is used with microprocessors that have a "sleep mode" for low-power applications such as notebook PCs.

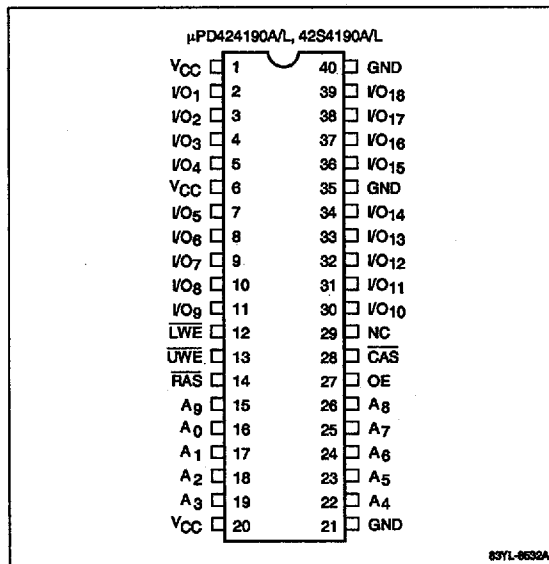
Features

- 262,144 by 18-bit organization
- Single power supply (+5-volt or +3.3-volt)
- Self-refresh option (slow internal automatic refresh)
- Fast-page option

- Byte write control with \overline{UWE} and \overline{LWE}
- Low power dissipation
- CAS before RAS refreshing
- On-chip substrate bias generator
- TTL-compatible inputs and outputs
- Nonlatched, three-state outputs
- Low input capacitance
- Multiplexed row and column addresses
- 1024 refresh cycles every 16 ms
- 40-pin SOJ, 40-pin ZIP, and 44/40-pin TSOP plastic packaging

Pin Configurations

40-Pin Plastic SOJ

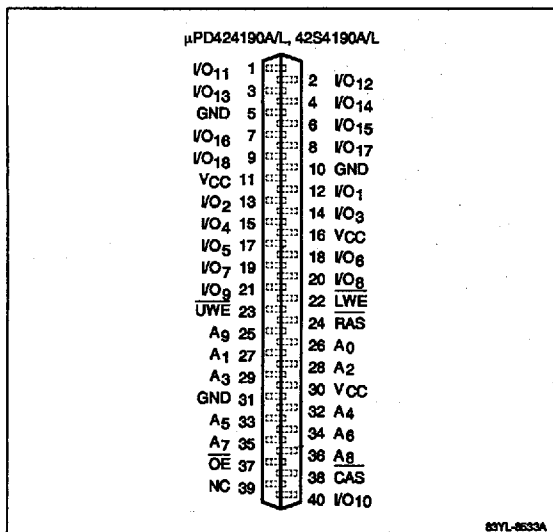


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μPD424190A/L, 42S4190A/L

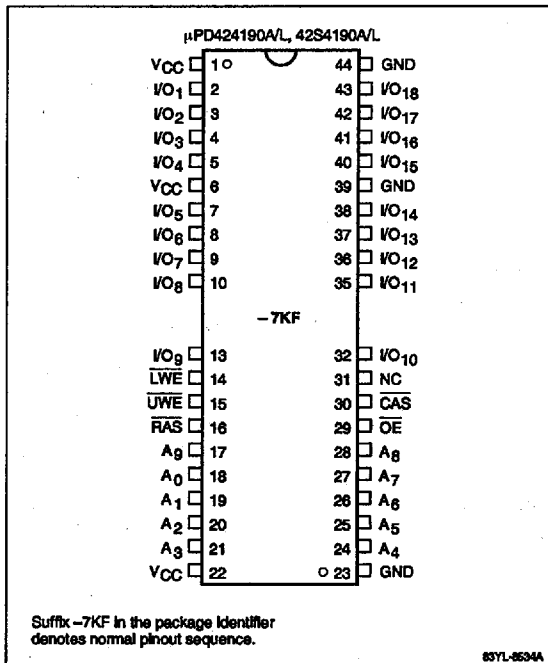
Pin Configurations (cont)

40-Pin Plastic ZIP



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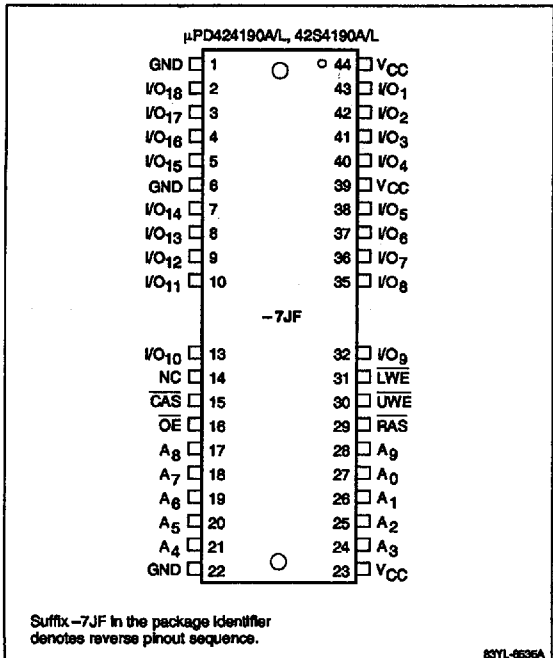
44/40-Pin Plastic TSOP (Normal Pinouts)



Suffix -7KF in the package identifier denotes normal pinout sequence.

83YL-8534A

44/40-Pin Plastic TSOP (Reverse Pinouts)



Suffix -7JF in the package identifier denotes reverse pinout sequence.

83YL-8536A

Pin Identification

Name	Function
A ₀ - A ₉	Address inputs
CAS	Column address strobe
I/O ₁ - I/O ₁₈	Data inputs and outputs
OE	Output enable
RAS	Row address strobe
LWE and LWE	Byte write enable
GND	Ground
V _{CC}	+5-volt or +3.3-volt power supply
NC	No connection



μ PD424190A/L, 42S4190A/L

Ordering Information, μ PD424190A (+ 5-volt power)

Part Number	RAS Access Time (max)	Fast-Page Cycle Time (max)	CAS Access Time (max)	Package
μ PD424190ALE-60	60 ns	40 ns	20 ns	40-pin plastic SOJ
LE-70	70 ns	45 ns		
LE-80	80 ns	50 ns		
μ PD424190AV-60	60 ns	40 ns	20 ns	40-pin plastic ZIP
V-70	70 ns	45 ns		
V-80	80 ns	50 ns		
μ PD424190AG5-60	60 ns	40 ns	20 ns	44/40-pin plastic TSOP (normal pinouts)
G5-70	70 ns	45 ns		
G5-80	80 ns	50 ns		
μ PD424190AG5M-60	60 ns	40 ns	20 ns	44/40-pin plastic TSOP (reverse pinouts)
G5M-70	70 ns	45 ns		
G5M-80	80 ns	50 ns		

Ordering Information, μ PD424190L (+ 3.3-volt power)

Part Number	RAS Access Time (max)	Fast-Page Cycle Time (max)	CAS Access Time (max)	Package
μ PD424190LLE-A60	60 ns	40 ns	20 ns	40-pin plastic SOJ
LE-A70	70 ns	45 ns		
LE-A80	80 ns	50 ns		
μ PD424190LV-A60	60 ns	40 ns	20 ns	40-pin plastic ZIP
V-A70	70 ns	45 ns		
V-A80	80 ns	50 ns		
μ PD424190LG5-A60	60 ns	40 ns	20 ns	44/40-pin plastic TSOP (normal pinouts)
G5-A70	70 ns	45 ns		
G5-A80	80 ns	50 ns		
μ PD424190LG5M-A60	60 ns	40 ns	20 ns	44/40-pin plastic TSOP (reverse pinouts)
G5M-A70	70 ns	45 ns		
G5M-A80	80 ns	50 ns		


μPD424190A/L, 42S4190A/L
Ordering Information, μPD42S4190A (+ 5-volt power; self-refresh mode)

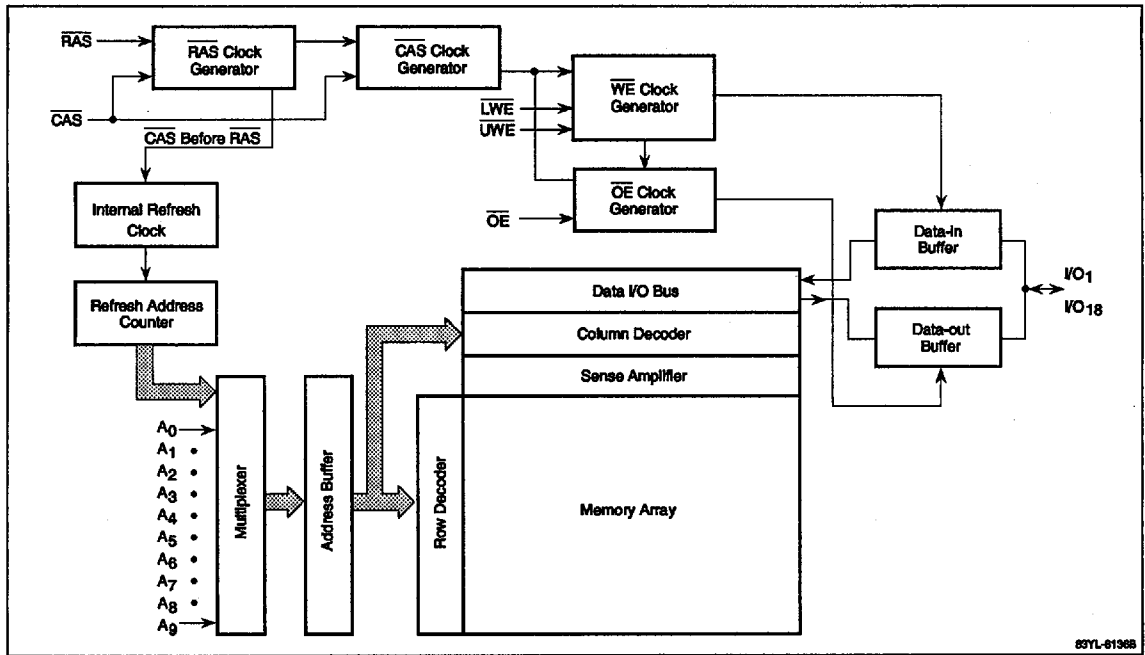
Part Number	RAS Access Time (max)	Fast-Page Cycle Time (max)	CAS Access Time (max)	Self-Refresh Current (max)	Package
μPD42S4190ALE-60	60 ns	40 ns	20 ns	300 μA	40-pin plastic SOJ
LE-70	70 ns	45 ns			
LE-80	80 ns	50 ns			
μPD42S4190AV-60	60 ns	40 ns	20 ns	300 μA	40-pin plastic ZIP
V-70	70 ns	45 ns			
V-80	80 ns	50 ns			
μPD42S4190AG5-60	60 ns	40 ns	20 ns	300 μA	44/40-pin plastic TSOP (normal pinouts)
G5-70	70 ns	45 ns			
G5-80	80 ns	50 ns			
μPD42S4190AG5M-60	60 ns	40 ns	20 ns	300 μA	44/40-pin plastic TSOP (reverse pinouts)
G5M-70	70 ns	45 ns			
G5M-80	80 ns	50 ns			

Ordering Information, μPD42S4190L (+ 3.3-volt power; self-refresh mode)

Part Number	RAS Access Time (max)	Fast-Page Cycle Time (max)	CAS Access Time (max)	Self-Refresh Current (max)	Package
μPD42S4190LLE-A60	60 ns	40 ns	20 ns	300 μA	40-pin plastic SOJ
LE-A70	70 ns	45 ns			
LE-A80	80 ns	50 ns			
μPD42S4190LV-A60	60 ns	40 ns	20 ns	300 μA	40-pin plastic ZIP
V-A70	70 ns	45 ns			
V-A80	80 ns	50 ns			
μPD42S4190LG5-A60	60 ns	40 ns	20 ns	300 μA	44/40-pin plastic TSOP (normal pinouts)
G5-A70	70 ns	45 ns			
G5-A80	80 ns	50 ns			
μPD42S4190LG5M-A60	60 ns	40 ns	20 ns	300 μA	44/40-pin plastic TSOP (reverse pinouts)
G5M-A70	70 ns	45 ns			
G5M-A80	80 ns	50 ns			



Block Diagram



Truth Table

Function	RAS	LWE	UWE	CAS	OE	I/O ₁ - I/O ₉	I/O ₁₀ - I/O ₁₈
Standby	V _{IH}	X	X	X	X	High-Z	High-Z
Refresh cycle	V _{IL}	X	X	V _{IH}	X	High-Z	High-Z
Byte write cycle	V _{IL}	V _{IL}	V _{IH}	V _{IL}	V _{IH}	Data input	High-Z
	V _{IL}	V _{IH}	V _{IL}	V _{IL}	V _{IH}	High-Z	Data input
Word read cycle	V _{IL}	V _{IH}	V _{IH}	V _{IL}	V _{IL}	Data output	Data output
Word write cycle	V _{IL}	V _{IL}	V _{IL}	V _{IL}	V _{IH}	Data input	Data input
	V _{IL}	V _{IL}	V _{IL}	V _{IH}	V _{IH}	High-Z	High-Z

X = don't care.

μPD424190A/L, 42S4190A/L**NEC****Absolute Maximum Ratings**

Voltage on any pin relative to GND	
5-volt devices	-1.0 to +7.0 V
3.3-volt devices	-0.5 to +4.6 V
Operating temperature, T_{OPR}	0 to +70°C
Storage temperature, T_{STG}	-55 to +125°C
Short-circuit output current, I_{OS}	
5-volt devices	50 mA
3.3-volt devices	20 mA
Power dissipation, P_D	1.0 W

Exposure to Absolute Maximum Ratings for extended periods may affect device reliability; exceeding the ratings could cause permanent damage. The device should be operated within the limits specified under DC and AC Characteristics.

Capacitance $T_A = 25^\circ\text{C}; f = 1\text{ MHz}$

Parameter	Symbol	Max	Unit	Pins Under Test
Input capacitance	C_{I1}	5	pF	Addresses
	C_{I2}	7	pF	LWE, UWE, OE, RAS
Input/output capacitance	C_O	7	pF	$I/O_1 - I/O_{18}$

Recommended Operating Conditions

Parameter	Symbol	5-Volt Devices			3.3-Volt Devices			Unit
		Min	Typ	Max	Min	Typ	Max	
Input voltage, high	V_{IH}	2.4		$V_{CC} + 1.0$	2.0		$V_{CC} + 0.3$	V
Input voltage, low	V_{IL}	-1.0		0.8	-0.5		0.8	V
Supply voltage	V_{CC}	4.5	5.0	5.5	3.0	3.3	3.6	V
Ambient temperature	T_A	0		+70	0		+70	°C

Self-Refresh Current $T_A = 0\text{ to }+70^\circ\text{C}; V_{CC} = +5\text{ V} \pm 10\% (42S4190A) \text{ or } +3.3\text{ V} \pm 0.3\text{ V} (42S4190L)$

Symbol	42S4190A	42S4190L	Conditions
I_{CC7}	300 μA max	100 μA max	I/O pins: $V_{IH} \geq V_{CC} - 0.2\text{ V}; V_{IL} \leq 0.2\text{ V}$ or open. Other input pins: $V_{IH} \geq V_{CC} - 0.2\text{ V}; V_{IL} \leq 0.2\text{ V}$ or open. $t_{RAS} \geq 100\ \mu\text{s}$

DC Characteristics; 5-Volt Devices $T_A = 0\text{ to }+70^\circ\text{C}; V_{CC} = +5.0\text{ V} \pm 10\%$

Parameter	Symbol	Min	Typ	Max	Unit	Test Conditions
Standby current	I_{CC2}			2.0	mA	$\overline{RAS} = \overline{CAS} \geq V_{IH}(\text{min}); I_O = 0\text{ mA}$
				300	μA	$\overline{RAS} = \overline{CAS} \geq V_{CC} - 0.2\text{ V}; I_O = 0\text{ mA}$
Input leakage current	$I_{I(L)}$	-10		10	μA	$V_{IN} = 0\text{ V to }V_{CC}$; all other pins not under test = 0 V
Output leakage current	$I_{O(L)}$	-10		10	μA	D_{OUT} disabled; $V_{OUT} = 0\text{ V to }V_{CC}$
Output voltage, low	V_{OL}			0.4	V	$I_{OL} = 4.2\text{ mA}$
Output voltage, high	V_{OH}	2.4			V	$I_{OH} = -5\text{ mA}$

DC Characteristics; 3.3-Volt Devices

T_A = 0 to +70°C; V_{CC} = +3.3 V ±0.3 V

Parameter	Symbol	Min	Typ	Max	Unit	Test Conditions
Standby current	I _{CC2}			500	μA	$\overline{RAS} = \overline{CAS} \geq V_{IH} \text{ (min)}; I_O = 0 \text{ mA}$
				100	μA	$\overline{RAS} = \overline{CAS} \geq V_{CC} - 0.2 \text{ V}; I_O = 0 \text{ mA}$
Input leakage current	I _{I(L)}	-5		5	μA	V _{IN} = 0 V to V _{CC} ; all other pins not under test = 0 V
Output leakage current	I _{O(L)}	-5		5	μA	D _{OUT} disabled; V _{OUT} = 0 V to V _{CC}
Output voltage, low	V _{OL}			0.4	V	I _{OL} = -2.0 mA
Output voltage, high	V _{OH}	2.4			V	I _{OH} = -2.0 mA

AC Characteristics

T_A = 0 to +70°C

μPD424190A, 42S4190A: V_{CC} = +5.0 V ±10%

μPD424190L, 42S4190L: V_{CC} = +3.3 V ±0.3 V

Parameter	Symbol	-60		-70		-80		Unit	Test Conditions
		Min	Max	Min	Max	Min	Max		
Operating current, average	I _{CC1} (+5)		130		120		110	mA	$\overline{RAS}, \overline{CAS}$ cycling; t _{RC} = t _{RC} min (Note 5)
	I _{CC1} (+3.3)		120		110		100		
Operating current, RAS-only refresh cycle, average	I _{CC3} (+5)		130		120		110	mA	\overline{RAS} cycling; $\overline{CAS} \geq V_{IH}$ min; t _{RC} = t _{RC} min (Note 5)
	I _{CC3} (+3.3)		120		110		100		
Operating current, fast-page cycle, average	I _{CC4} (+5)		110		100		90	mA	$\overline{RAS} \leq V_{IL}$; \overline{CAS} cycling; t _{PC} = t _{PC} min (Note 5)
	I _{CC4} (+3.3)		110		100		90		
Operating current, CAS before RAS refresh cycle, average	I _{CC5} (+5)		140		130		120	mA	\overline{RAS} cycling; $\overline{CAS} \leq V_{IL}$ max; t _{RC} = t _{RC} min (Note 5)
	I _{CC5} (+3.3)		130		120		110		
Access time from column address	t _{AA}		30		35		40	ns	(Notes 3, 4, 7, 8)
Access time from CAS precharge (rising edge)	t _{ACP}		35		40		45	ns	(Notes 3, 4, 7, 8)
Column address setup time	t _{ASC}	0		0		0		ns	
Row address setup time	t _{ASR}	0		0		0		ns	
Column address to WE delay time	t _{AWD}	50		55		70		ns	(Note 14)
Access time from CAS (falling edge)	t _{CAC}		20		20		20	ns	(Notes 3, 4, 7, 8)
Column address hold time	t _{CAH}	15		15		15		ns	
CAS pulse width	t _{CAS}	20	10,000	20	10,000	20	10,000	ns	
CAS hold time for CAS before RAS refreshing	t _{CHR}	15		15		15		ns	(Note 15)
CAS hold time (CBR self-refresh mode)	t _{CHS}	-35		-40		-50		ns	For 42S4190A/L only

μ PD424190A/L, 42S4190A/L

AC Characteristics (cont)

Parameter	Symbol	-60		-70		-80		Unit	Test Conditions
		Min	Max	Min	Max	Min	Max		
CAS to output in low-Z	t_{CLZ}	0		0		0		ns	(Notes 4, 7)
Fast-page CAS precharge time	t_{CP}	10		10		10		ns	
CAS precharge time	t_{CPN}	10		10		10		ns	
Fast-page CAS precharge to \overline{WE} delay time	t_{CPWD}	55		60		75		ns	(Note 14)
CAS to RAS precharge time	t_{CRP}	10		10		10		ns	(Note 10)
CAS hold time	t_{CSH}	60		70		80		ns	
CAS setup time for CAS before RAS refresh cycle	t_{CSR}	5		5		5		ns	(Note 15)
CAS to \overline{WE} delay	t_{CWD}	40		40		50		ns	(Note 14)
Write command referenced to CAS lead time	t_{CWL}	15		15		15		ns	
Data-in hold time	t_{DH}	15		15		15		ns	(Notes 13, 16)
Data-in setup time	t_{DS}	0		0		0		ns	(Notes 13, 16)
Masked write hold time referenced to CAS	t_{MCH}	0		0		0		ns	
Masked write setup time	t_{MCS}	0		0		0		ns	
Masked write hold time referenced to RAS	t_{MRH}	0		0		0		ns	
Access time from OE	t_{OEA}		20		20		20	ns	(Notes 3, 4, 7, 8)
OE data delay time	t_{OED}	15		15		15		ns	
OE command hold time	t_{OEH}	0		0		0		ns	
OE to RAS inactive setup time	t_{OES}	0		0		0		ns	
Output turnoff delay from OE	t_{OEZ}	0	15	0	15	0	15	ns	(Note 9)
Output disable from CAS high	t_{OFF}	0	15	0	15	0	20	ns	(Note 9)
OE to output in low-Z	t_{OLZ}	0		0		0		ns	(Notes 5, 7)
Fast-page read or write cycle time	t_{PC}	40		45		50		ns	(Note 6)
Fast-page read-modify-write cycle time with extended data output	t_{PRWC}	85		90		100		ns	(Note 6)



AC Characteristics (cont)

Parameter	Symbol	-60		-70		-80		Unit	Test Conditions
		Min	Max	Min	Max	Min	Max		
Access time from $\overline{\text{RAS}}$	t_{RAC}		60		70		80	ns	(Notes 3, 4, 7, 8)
$\overline{\text{RAS}}$ to column address delay time	t_{RAD}	15	30	15	35	15	40	ns	(Note 8)
Row address hold time	t_{RAH}	10		10		10		ns	
Column address lead time referenced to $\overline{\text{RAS}}$ (rising edge)	t_{RAL}	30		35		40		ns	
$\overline{\text{RAS}}$ pulse width	t_{RAS}	60	10,000	70	10,000	80	10,000	ns	
Fast-page $\overline{\text{RAS}}$ pulse width	t_{RASP}	60	125,000	70	125,000	80	125,000	ns	
$\overline{\text{RAS}}$ pulse width (CBR self-refresh mode)	t_{RASS}	100		100		100		μs	For 42S4190A/L
Random read or write cycle time	t_{RC}	120		130		150		ns	(Note 6)
$\overline{\text{RAS}}$ to $\overline{\text{CAS}}$ delay time	t_{RCD}	20	40	20	50	20	60	ns	(Note 8)
Read command hold time referenced to $\overline{\text{CAS}}$	t_{RCH}	0		0		0		ns	(Note 11)
Read command setup time	t_{RCS}	0		0		0		ns	
Refresh period	t_{REF}		16		16		16	ms	Addresses $A_0 - A_9$
$\overline{\text{RAS}}$ hold time referenced to $\overline{\text{CAS}}$ precharge	t_{RHCP}	35		40		45		ns	
$\overline{\text{RAS}}$ precharge time	t_{RP}	50		50		60		ns	
$\overline{\text{RAS}}$ precharge $\overline{\text{CAS}}$ hold time	t_{RPC}	0		0		0		ns	
$\overline{\text{RAS}}$ precharge time (CBR self-refresh mode)	t_{RPS}	120		130		150		ns	For 42S4190A/L
Read command hold time referenced to $\overline{\text{RAS}}$	t_{RRH}	0		0		0		ns	(Note 11)
$\overline{\text{RAS}}$ hold time	t_{RSH}	20		20		25		ns	
Read-modify-write cycle time	t_{RWC}	185		175		200		ns	(Note 6)
$\overline{\text{RAS}}$ to $\overline{\text{WE}}$ delay	t_{RWD}	80		90		105		ns	(Note 14)
Write command referenced to $\overline{\text{RAS}}$ lead time	t_{RWL}	20		20		20		ns	
Rise and fall times	t_{T}	3	50	3	50	3	50	ns	(Note 4)
Write command hold time	t_{WCH}	15		15		15		ns	(Note 12)



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AC Characteristics (cont)

Parameter	Symbol	-60		-70		-80		Unit	Test Conditions
		Min	Max	Min	Max	Min	Max		
Write command setup time	t_{WCS}	0		0		0		ns	(Note 14)
Write command pulse width	t_{WP}	15		15		15		ns	(Note 12)

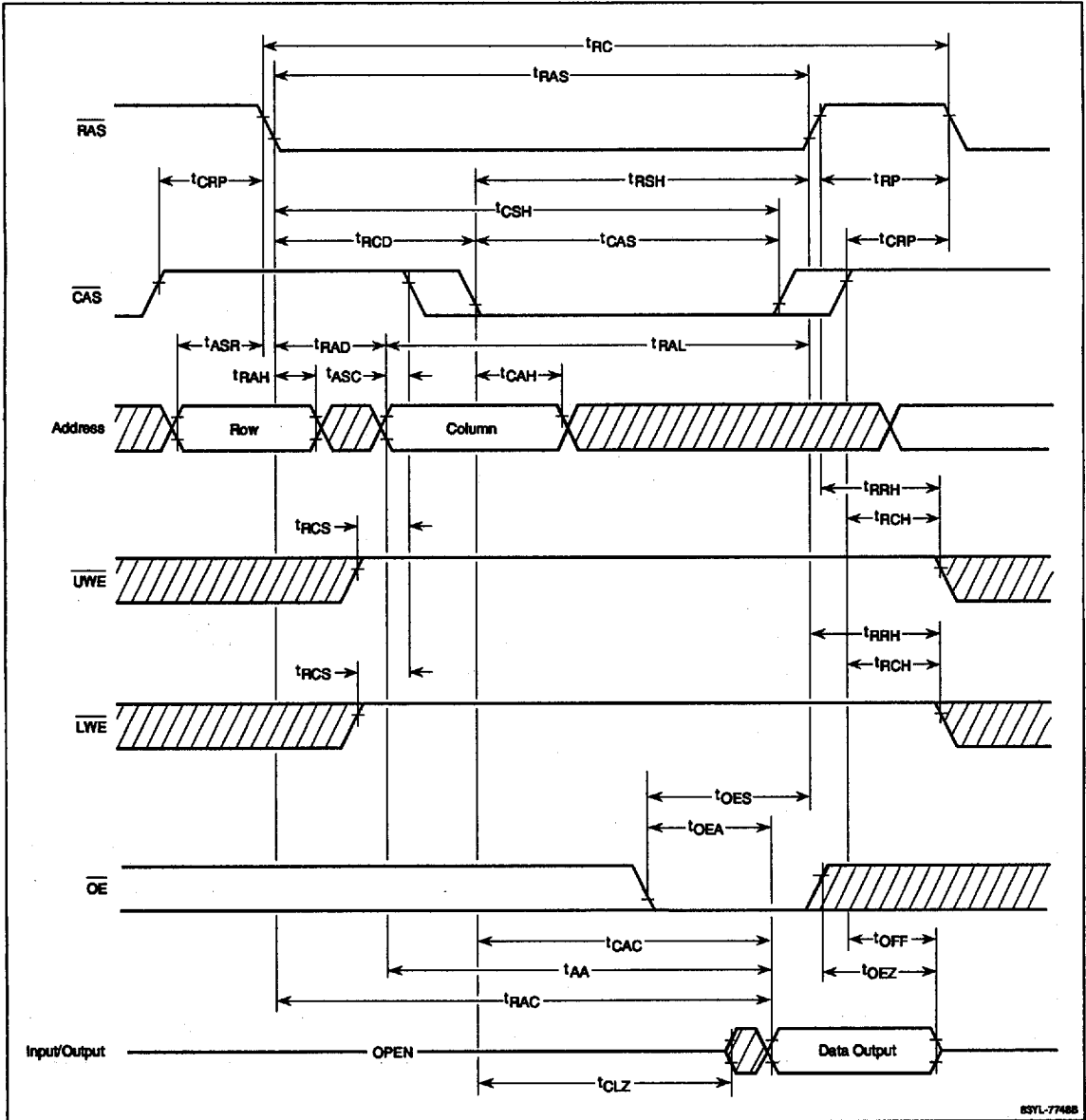
Notes:

- (1) All voltages are referenced to GND.
- (2) An initial pause of 100 μ s is required after power-up, followed by any eight RAS cycles, before proper device operation is achieved.
- (3) Ac measurements assume $t_T = 5$ ns.
- (4) V_{IH} (min) and V_{IL} (max) are reference levels for measuring the timing of input signals. Transition times are measured between V_{IH} and V_{IL} .
- (5) I_{CC1} , I_{CC3} , I_{CC4} , and I_{CC5} depend on output loading and cycle rates. Specified values are obtained with the output open. I_{CC3} is measured assuming that all column address inputs are held at either a high level or a low level during RAS-only refresh cycles. I_{CC4} is measured assuming that all column address inputs are switched only once during each fast-page cycle.
- (6) The minimum specifications are used only to indicate the cycle time at which proper operation over the full temperature range ($T_A = 0$ to $+70^\circ\text{C}$) is assured.
- (7) Load = 2 TTL (-1 mA, $+4$ mA) loads and 100 pF. For 3.3-volt devices, $V_{OH} = 2.0$ V and $V_{OL} = 0.8$ V (ac reference levels).
- (8) If $t_{RCD} \leq t_{RCD}(\text{max})$ and $t_{RAD} \leq t_{RAD}(\text{max})$, access time is defined by $t_{RAC}(\text{max})$.
If $t_{RCD} \geq t_{RCD}(\text{max})$, access time is defined by $t_{CAC}(\text{max})$.
If $t_{RAD} \geq t_{RAD}(\text{max})$, access time is defined by $t_{AA}(\text{max})$.
- (9) $t_{OFF}(\text{max})$ and $t_{OEZ}(\text{max})$ define the time at which the outputs become open-circuit and are not referenced to V_{OH} or V_{OL} .
- (10) The t_{CWP} requirement should be applicable for $\overline{\text{RAS}}/\overline{\text{CAS}}$ cycles preceded by any cycle.
- (11) Either t_{RRH} or t_{RCH} must be satisfied for a read cycle.
- (12) Parameter t_{WP} is applicable for a delayed write cycle such as a read-write/read-modify-write cycle. For early write cycles, both t_{WCS} and t_{WCH} must be met.
- (13) These parameters are referenced to the falling edge of $\overline{\text{CAS}}$ for early write cycles and to the falling edge of $\overline{\text{WE}}$ for delayed write or read-modify-write cycles.
- (14) t_{WCS} , t_{RWD} , t_{CWD} , t_{CPWD} and t_{AWD} are restrictive operating parameters in read-write/read-modify-write cycles only. If $t_{WCS} \geq t_{WCS}(\text{min})$, the cycle is an early write cycle and the data I/O pins will remain open-circuit throughout the entire cycle. If $t_{CWD} \geq t_{CWD}(\text{min})$, $t_{RWD} \geq t_{RWD}(\text{min})$, and $t_{AWD} \geq t_{AWD}(\text{min})$, then the cycle is a read-write cycle and the data I/O pins will contain data read from the selected cells. If neither of the above conditions is met, the condition of the data I/O pins (at access time and until CAS returns to V_{IH}) is indeterminate.
- (15) Holding $\overline{\text{CAS}}$ low prior to $\overline{\text{RAS}}$ going negative will initiate a $\overline{\text{CAS}}$ before RAS refresh cycle (t_{CSR} and t_{CHR} must be satisfied).
- (16) The first $\overline{\text{WE}}$ falling edge is used as a reference for the setup and hold requirements of t_{DS} and t_{DH} (late write cycle).



Timing Waveforms

Word Read Cycle



7b

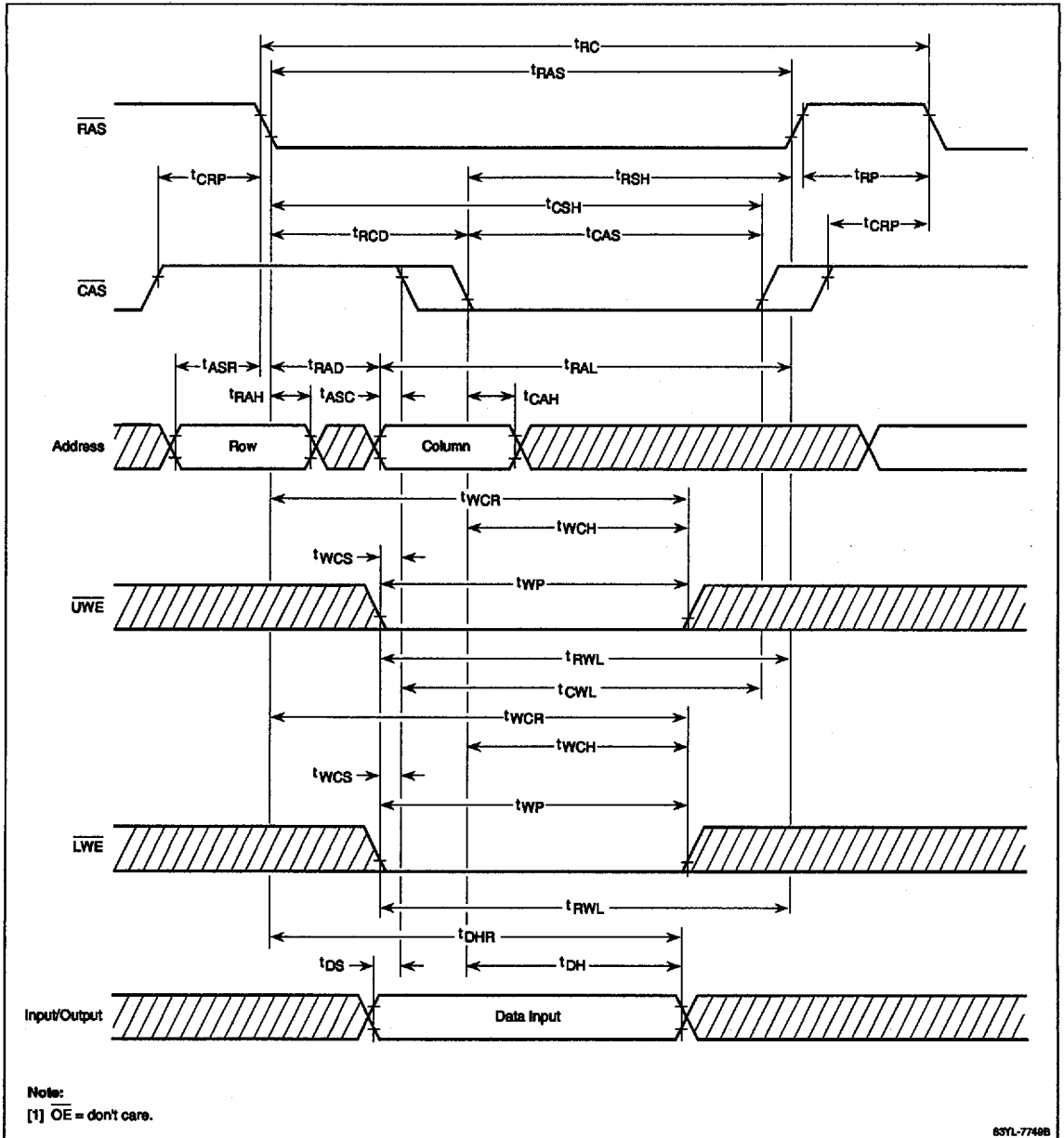
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Timing Waveforms (cont)

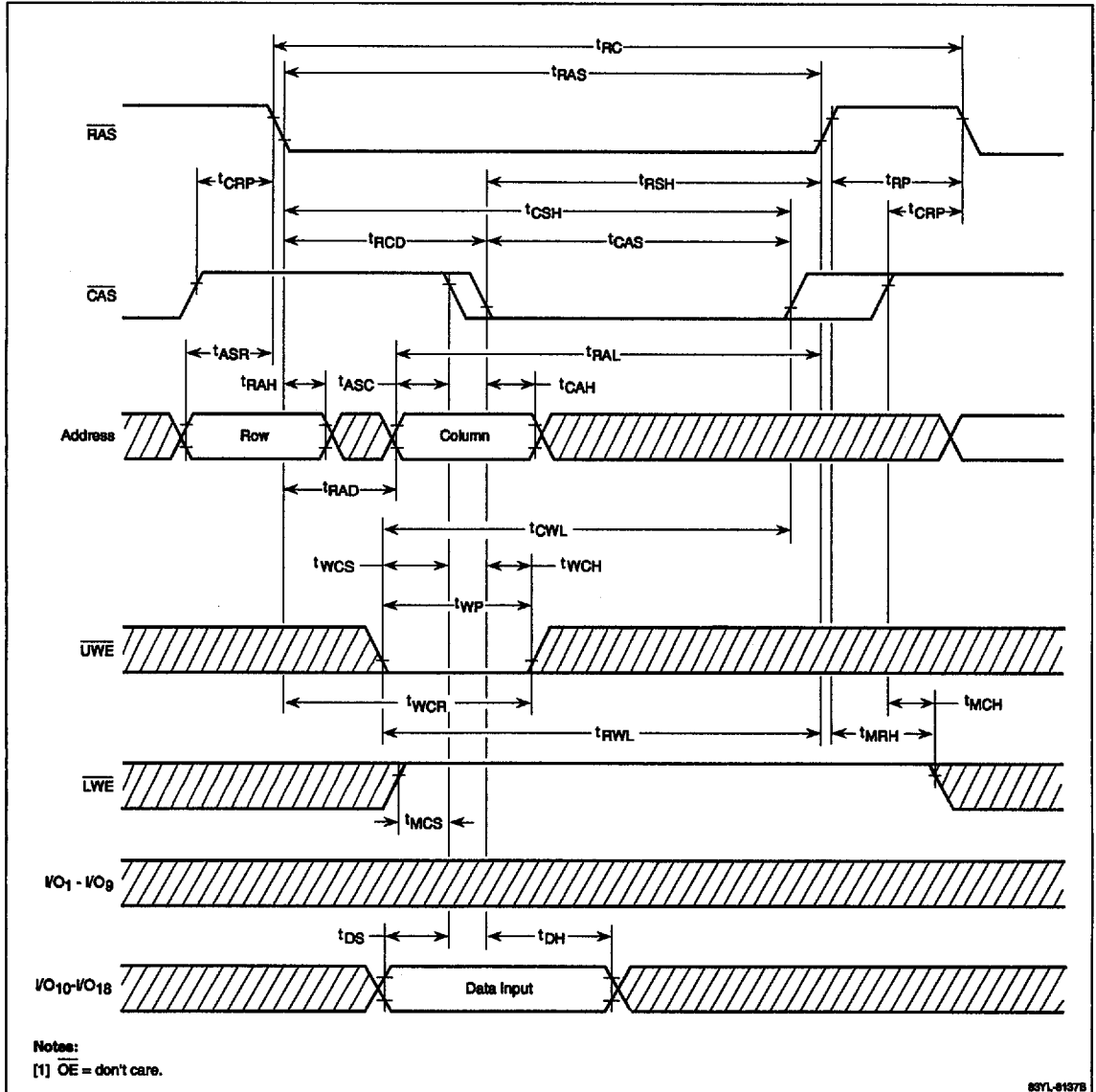
Word Early-Write Cycle



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Timing Waveforms (cont)

Byte Early-Write Cycle



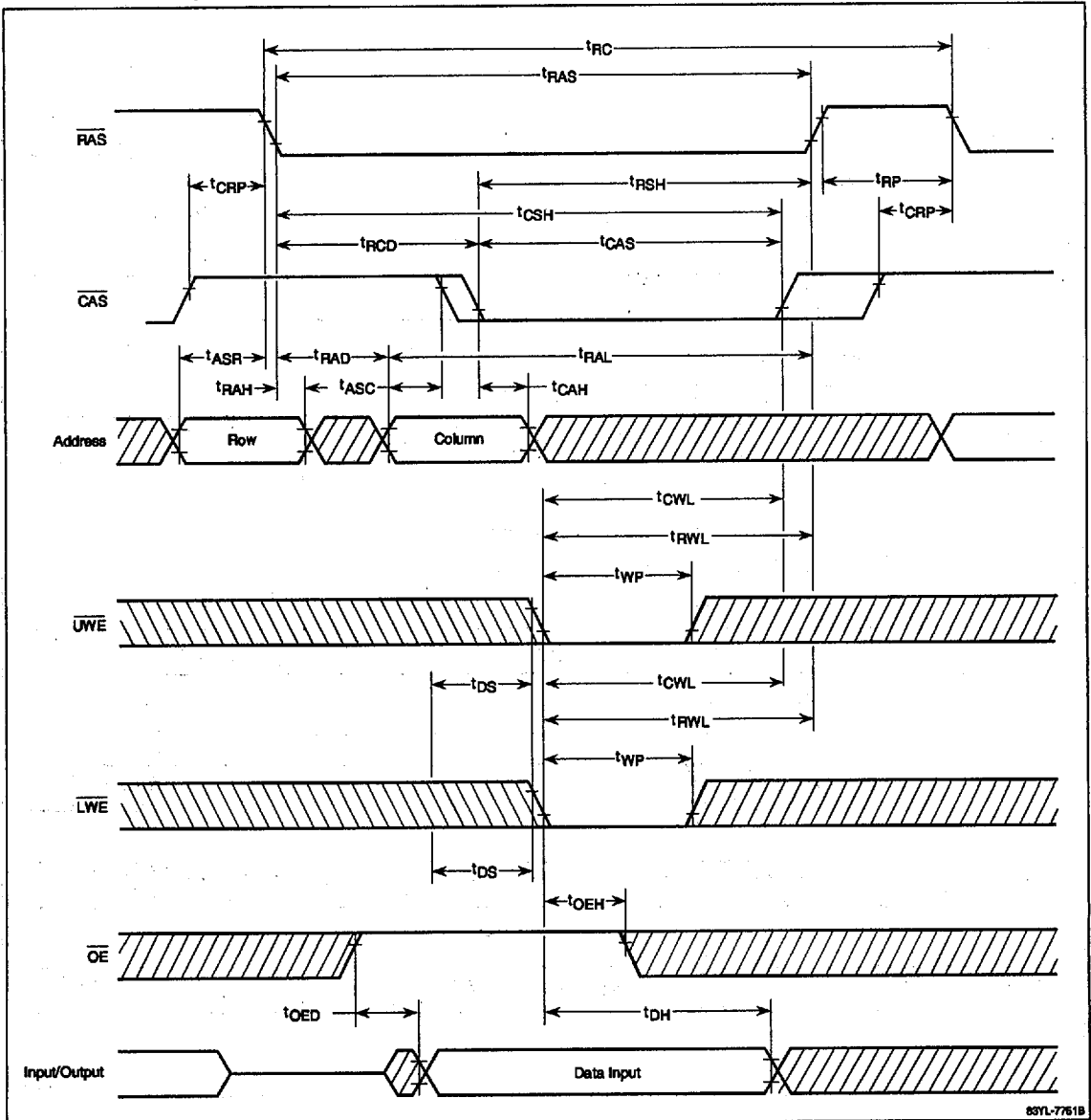
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μPD424190A/L, 42S4190A/L



Timing Waveforms (cont)

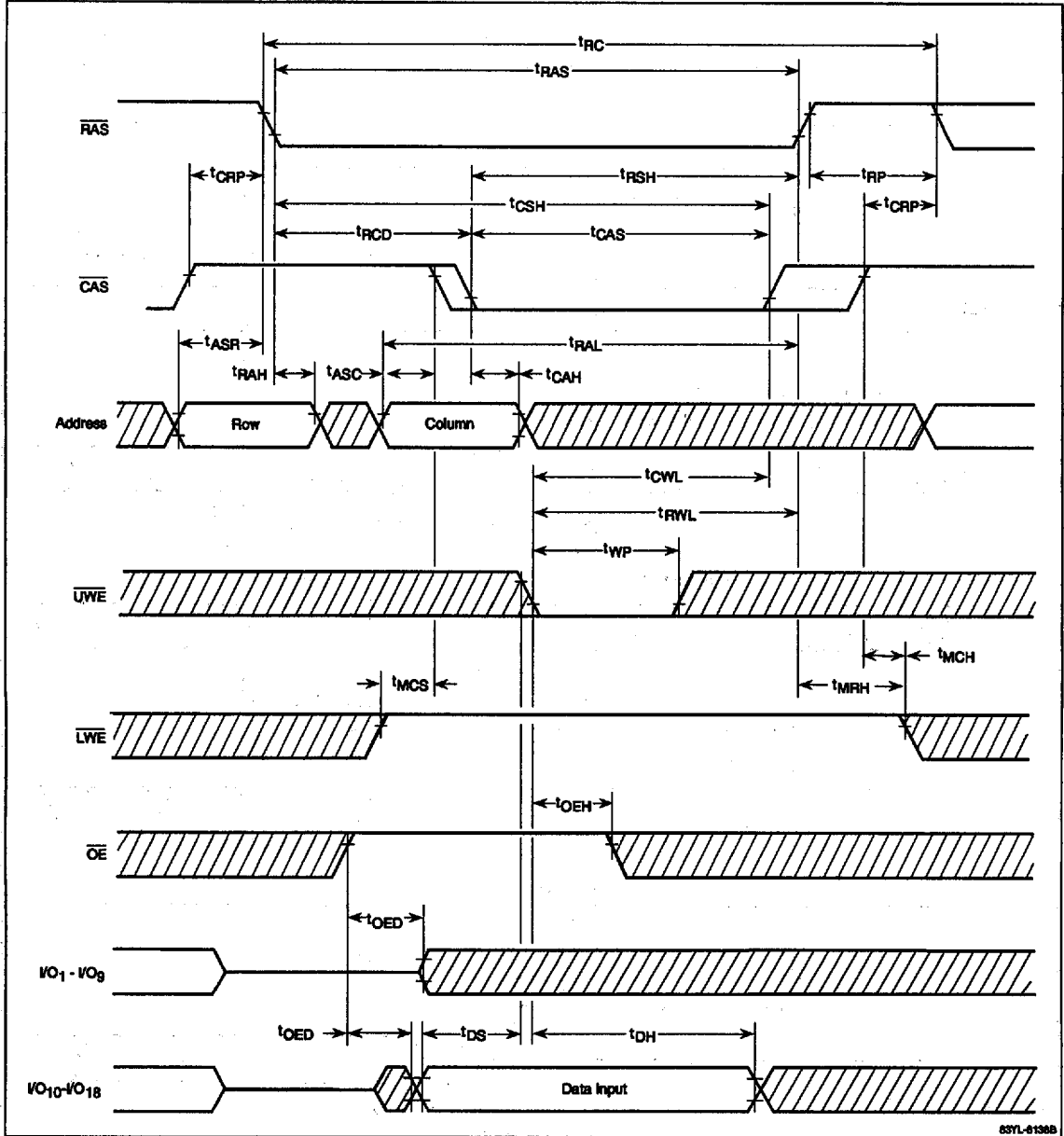
Word Late-Write Cycle



85YL-7761B

Timing Waveforms (cont)

Byte Late-Write Cycle



7b

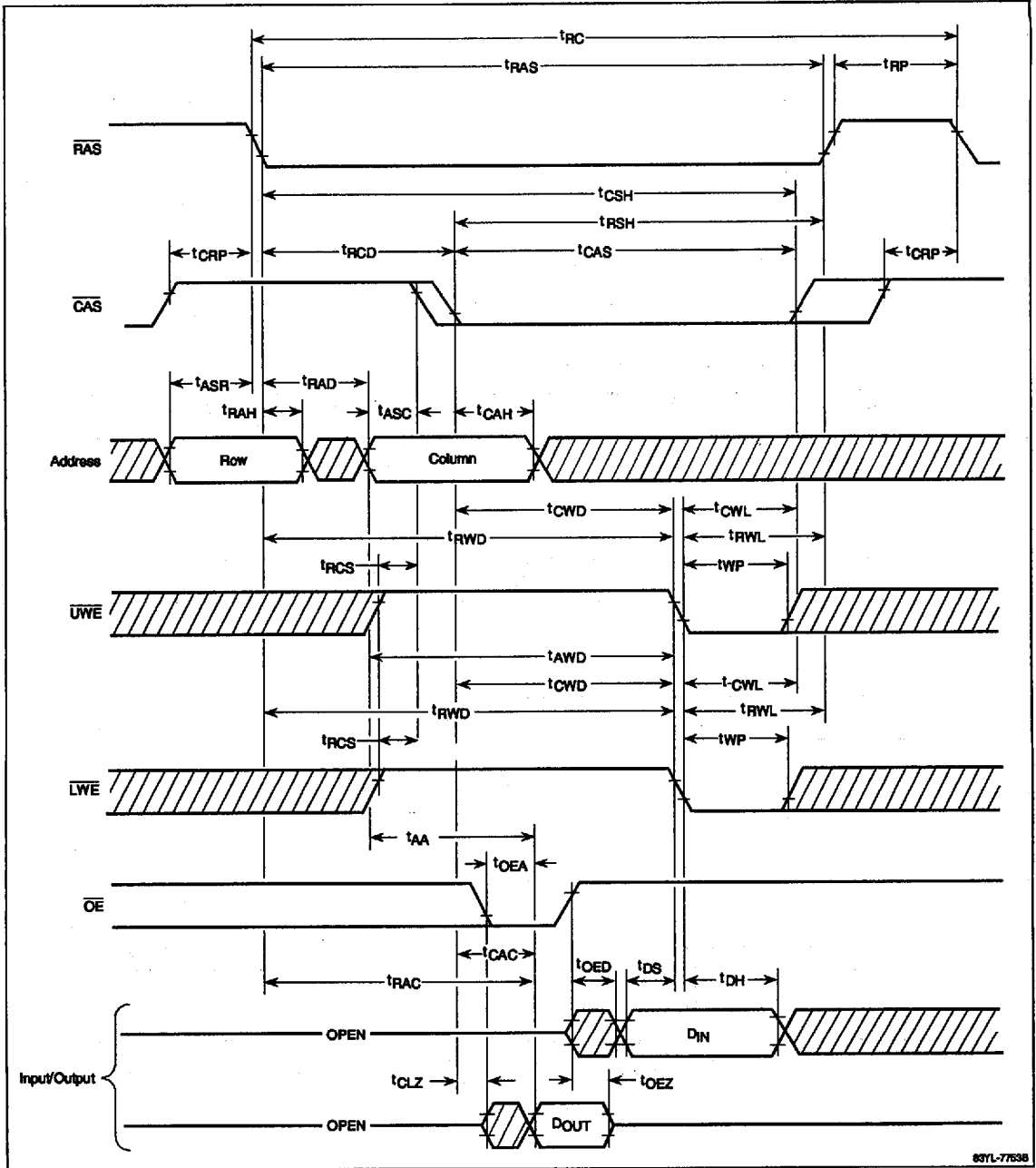
63YL-6136B



μPD424190A/L, 42S4190A/L

Timing Waveforms (cont)

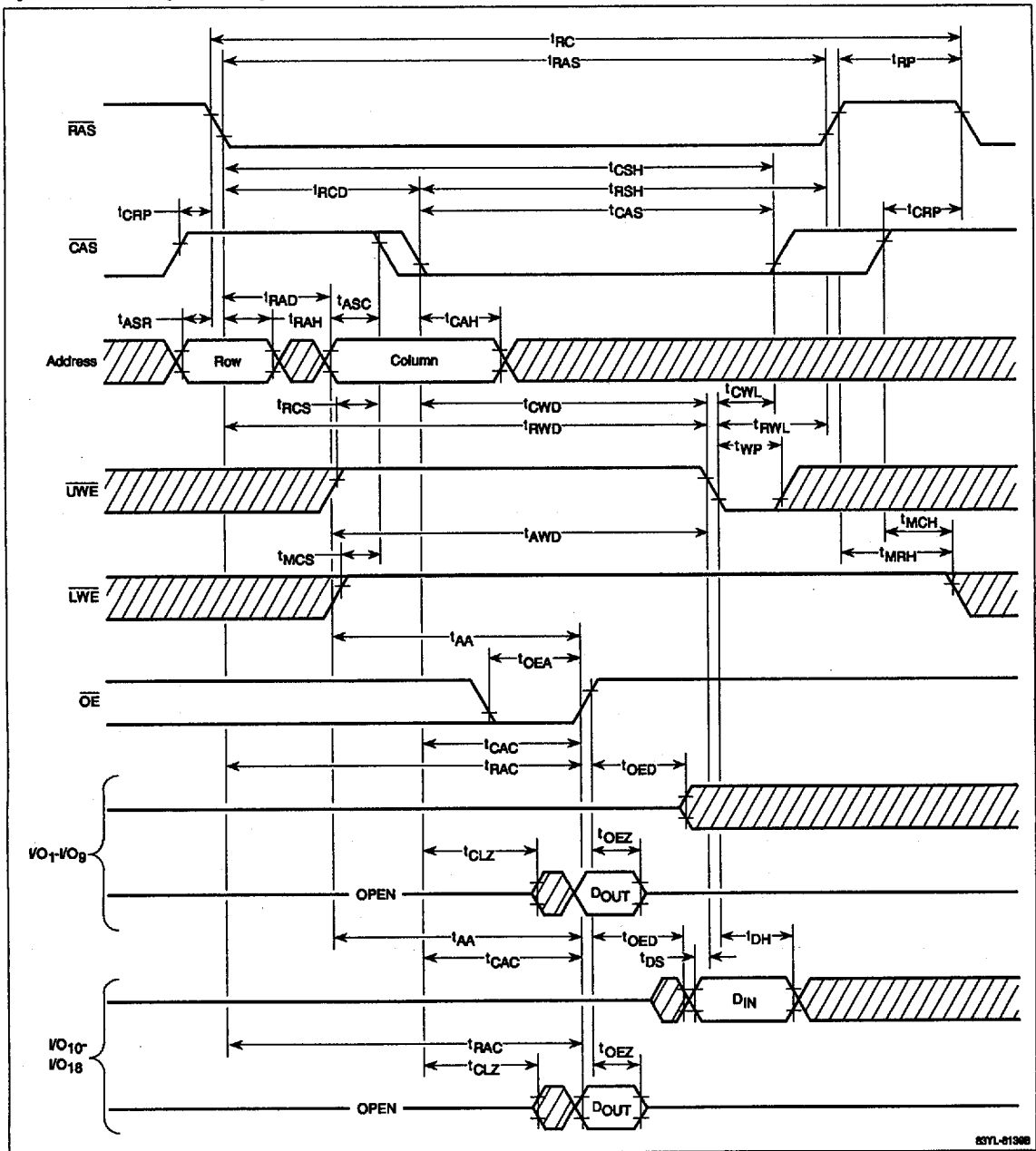
Word Read-Modify-Write Cycle



83YL-77538

Timing Waveforms (cont)

Byte Read-Modify-Write Cycle



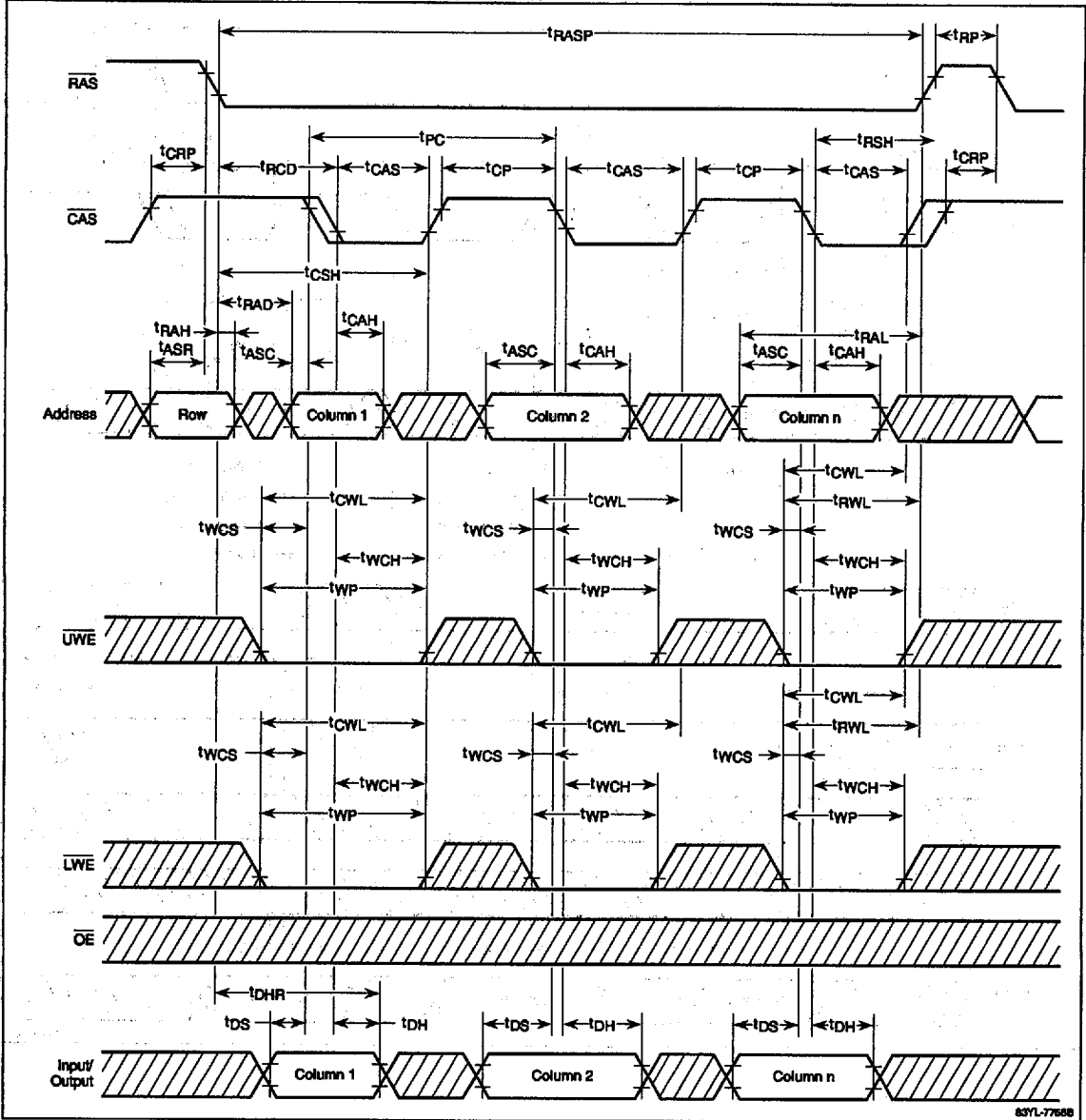
7b

837L-61368



Timing Waveforms (cont)

Word Fast-Page-Write Cycle

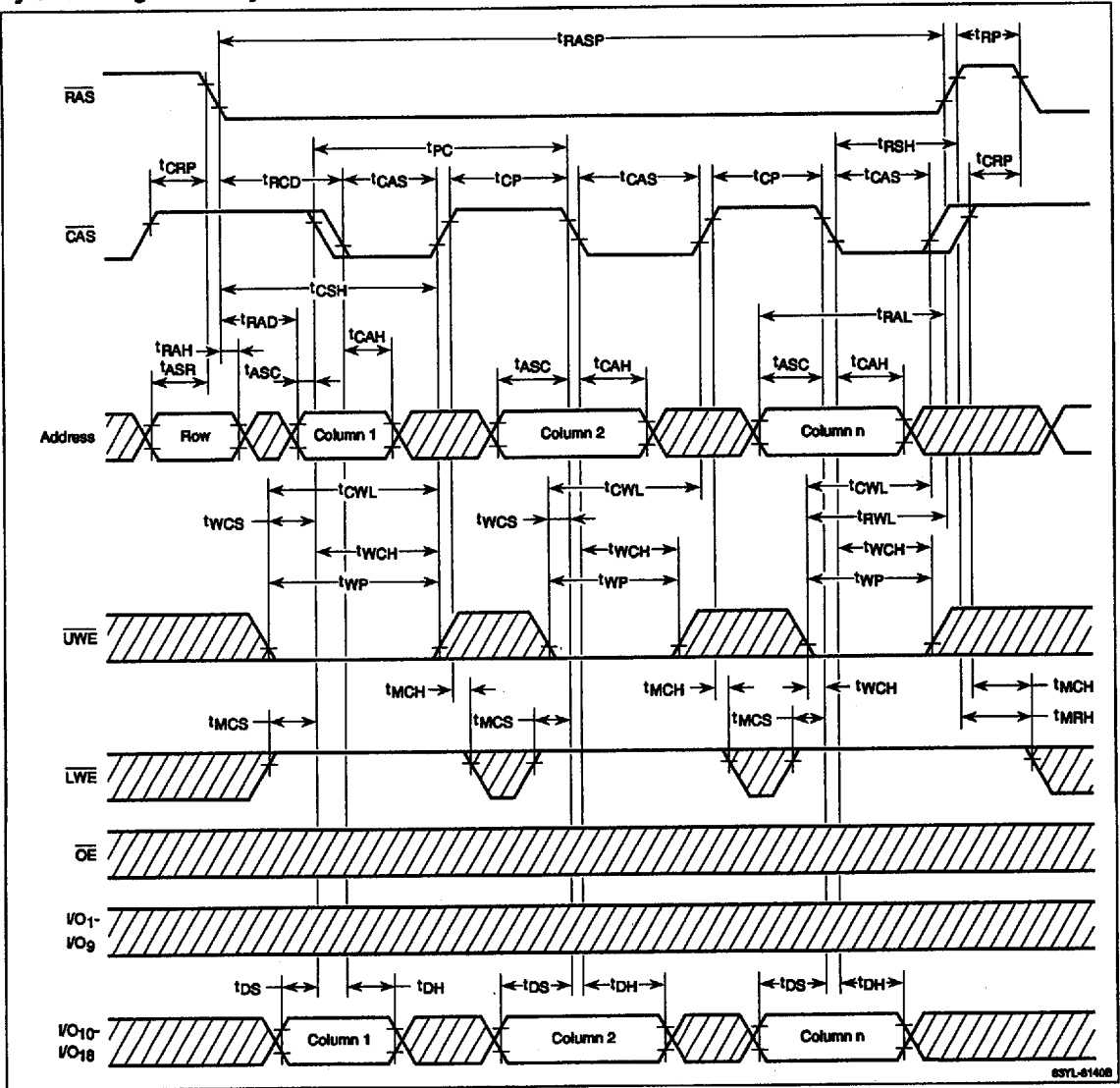


7b

μPD424190A/L, 42S4190A/L

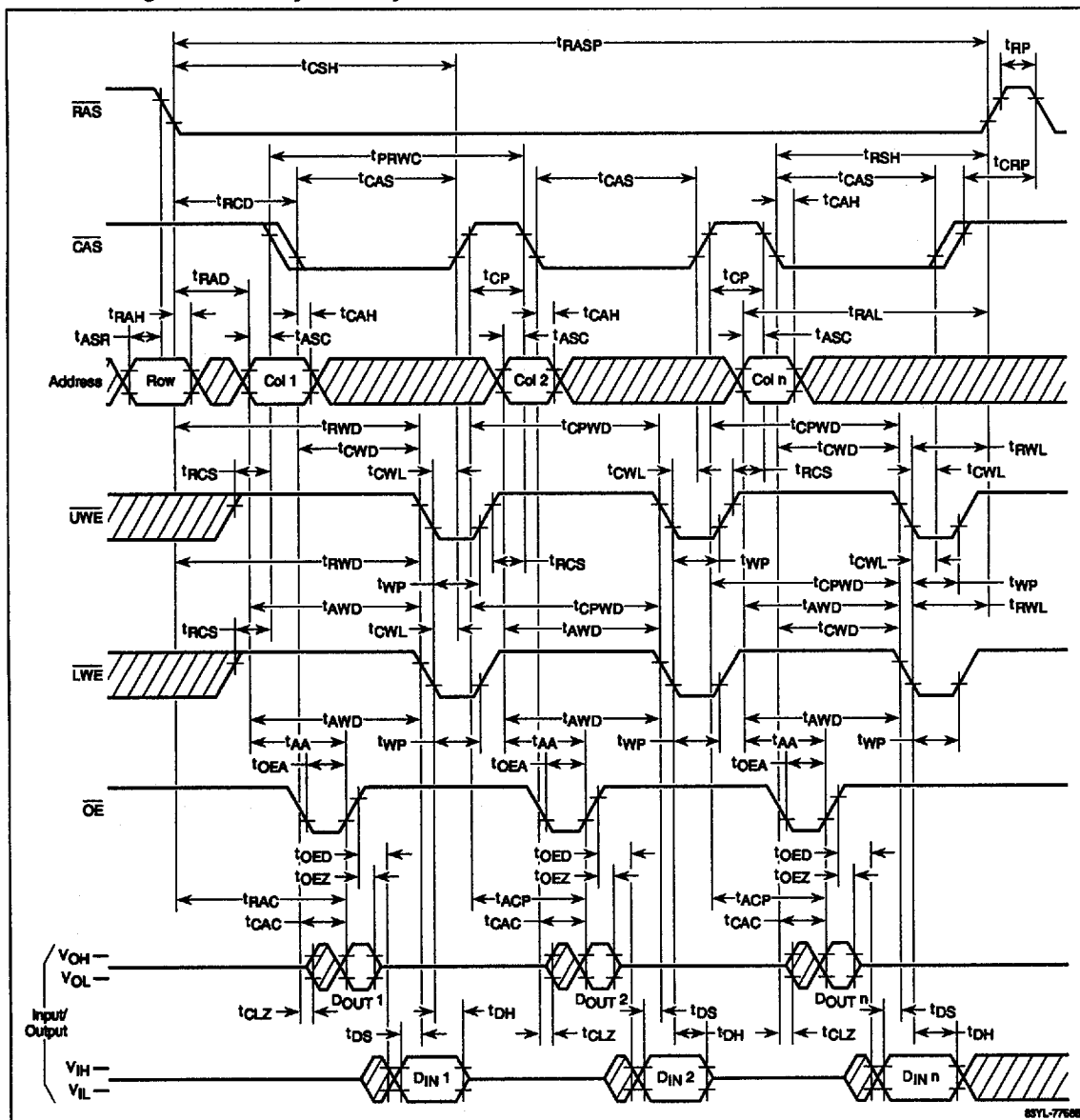
Timing Waveforms (cont)

Byte Fast-Page Write Cycle



Timing Waveforms (cont)

Word Fast-Page Read-Modify-Write Cycle

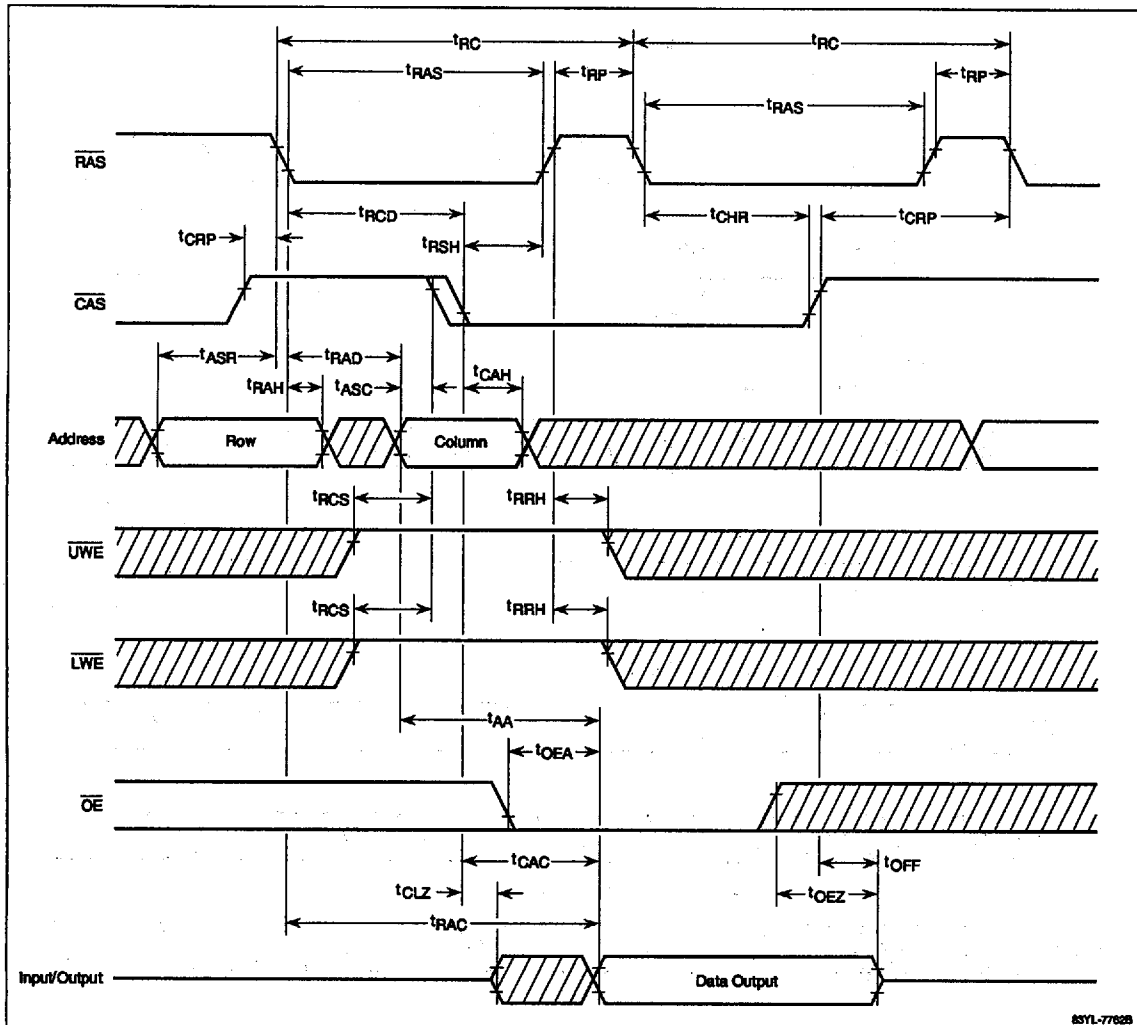


7b

85YL-7768

Timing Waveforms (cont)

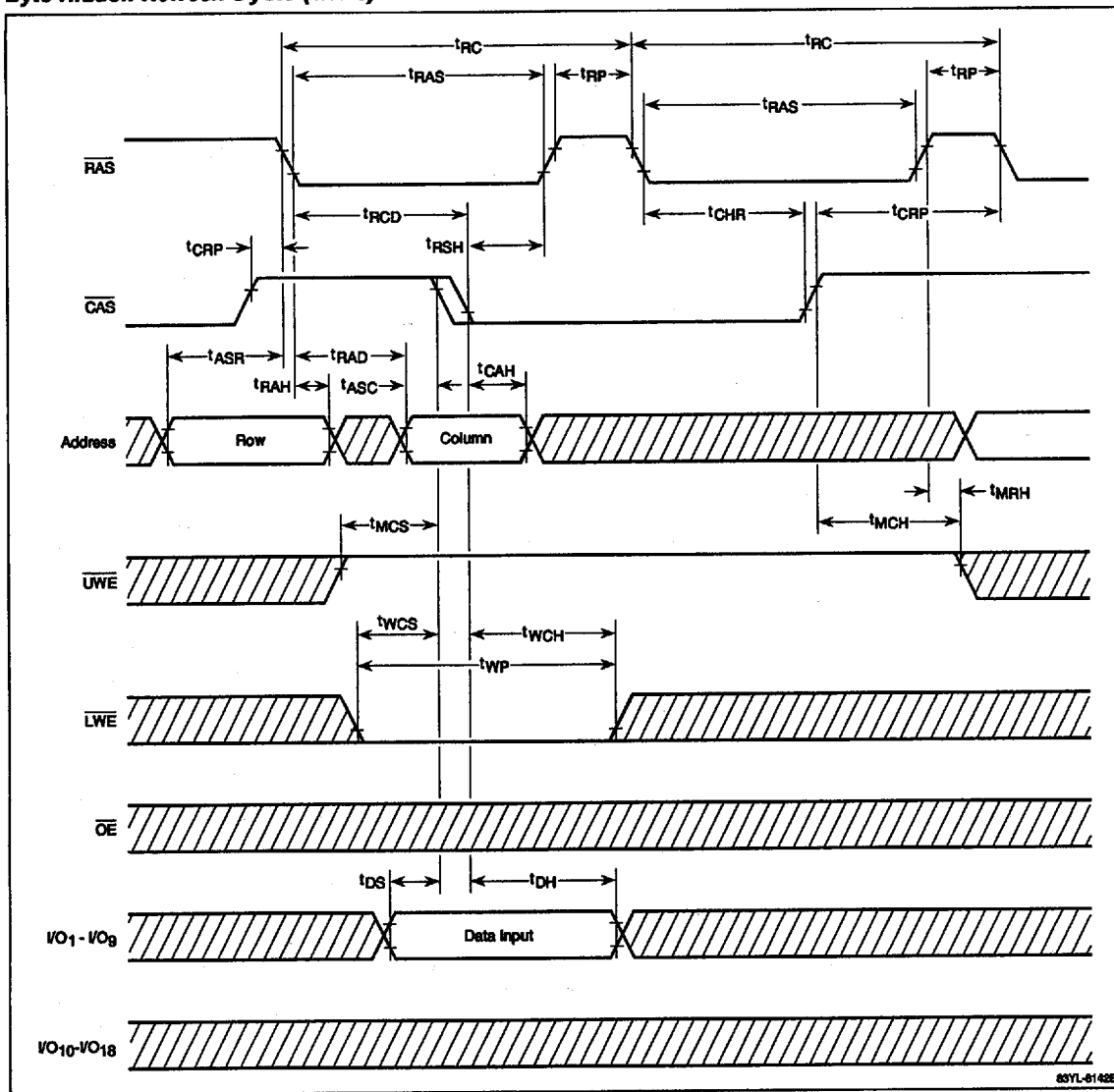
Hidden Refresh Cycle (Read Cycle)



85YL-77628

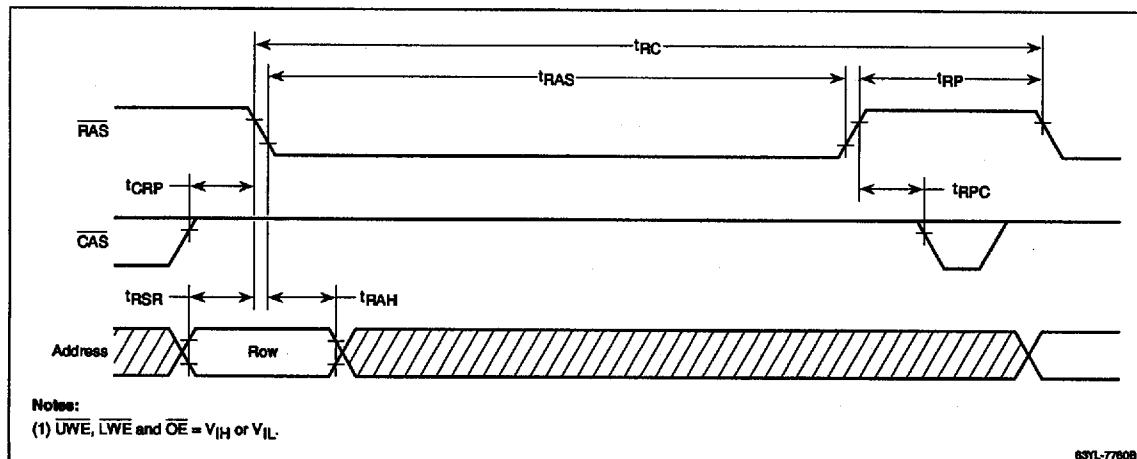
Timing Waveforms (cont)

Byte Hidden-Refresh Cycle (Write)

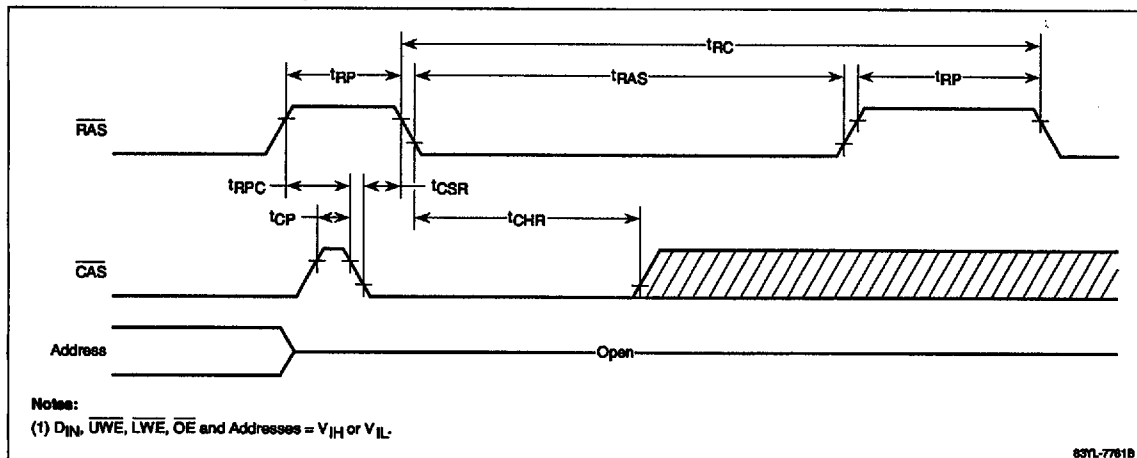


Timing Waveforms (cont)

RAS Refresh Cycle



CAS Before RAS Refresh Cycle



μ PD424190A/L, 42S4190A/L

Timing Waveforms (cont)

CBR Self-Refresh Cycle

