μPD424101
4,194,304 x 1-Bit
Dynamic CMOS RAM

Description

The μPD424101 is a nibble-mode dynamic RAM organized as 4,194,304 words by 1 bit and designed to operate from a single +5-volt power supply. Advanced polycide technology using trench capacitors minimizes silicon area and provides high storage cell capacity, high performance, and high reliability. A single-transistor dynamic storage cell and advanced CMOS circuitry throughout ensure minimum power dissipation, while an on-chip circuit internally generates the negative-voltage substrate bias—automatically and transparently.

The three-state output is controlled by $\overline{CAS}$ independent of $\overline{RAS}$. After a valid read or read-modify-write cycle, data is held on the output by holding $\overline{CAS}$ low. The data output is returned to high impedance by returning $\overline{CAS}$ high. Nibble-mode read and write cycles can be executed by cycling $\overline{CAS}$.

Refreshing may be accomplished by a $\overline{CAS}$ before $\overline{RAS}$ cycle that internally generates the refresh address. Refreshing can also be accomplished by $\overline{RAS}$-only refresh cycles or by normal read or write cycles on the 1024 address combinations of A_0 - A_9 during a 16-ms refresh period.

Features

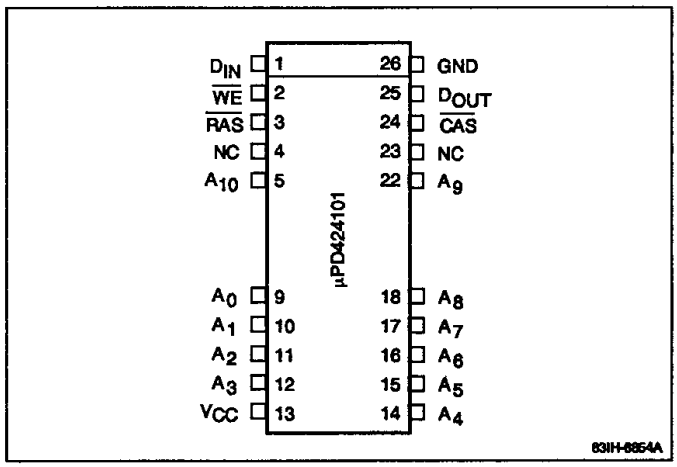
- 4,194,304-word by 1-bit organization
- Single +5-volt power supply
- Nibble-mode option
- Low power dissipation
- $\overline{CAS}$ before $\overline{RAS}$ refresh cycles
- Multiplexed address inputs
- On-chip substrate bias generator
- Nonlatched, three-state outputs
- Low input capacitance
- TTL-compatible inputs and outputs
- 1024 refresh cycles every 16 ms
- 26/20-pin SOJ, 20-pin ZIP, or 26/20-pin TSOP plastic packaging

Pin Identification

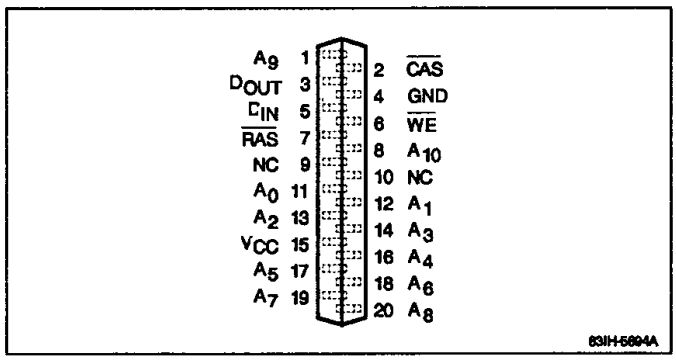
Name	Function
A_0 - A_{10}	Address inputs
$\overline{CAS}$	Chip select
D_{IN}	Data input
D_{OUT}	Data output
$\overline{RAS}$	Row address strobe
$\overline{WE}$	Write enable
GND	Ground
V_{CC}	+5-volt power supply
NC	No connection

Pin Configurations

26/20-Pin Plastic SOJ



20-Pin Plastic ZIP



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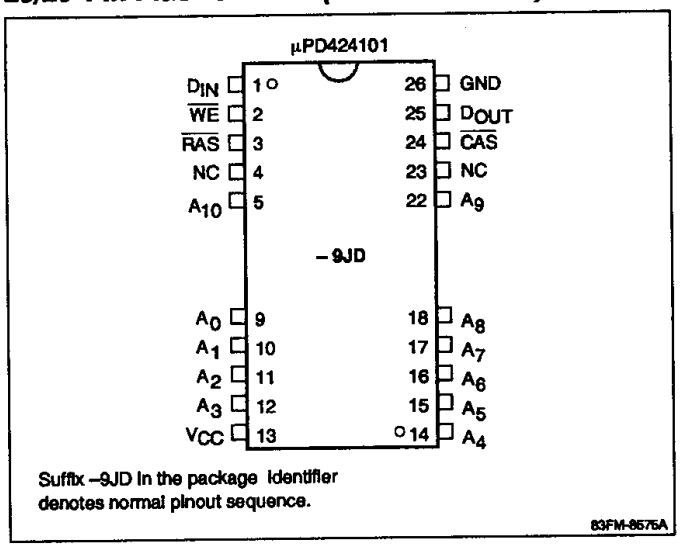
Pin Configurations (cont)

26/20-Pin Plastic TSOP (Normal Pinouts)



Suffix –9JD in the package identifier denotes normal pinout sequence.

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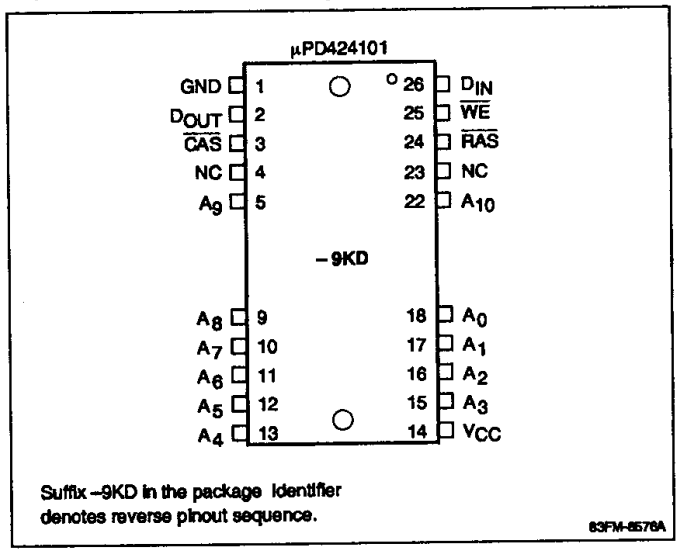
26/20-Pin Plastic TSOP (Reverse Pinouts)



Suffix –9KD in the package identifier denotes reverse pinout sequence.

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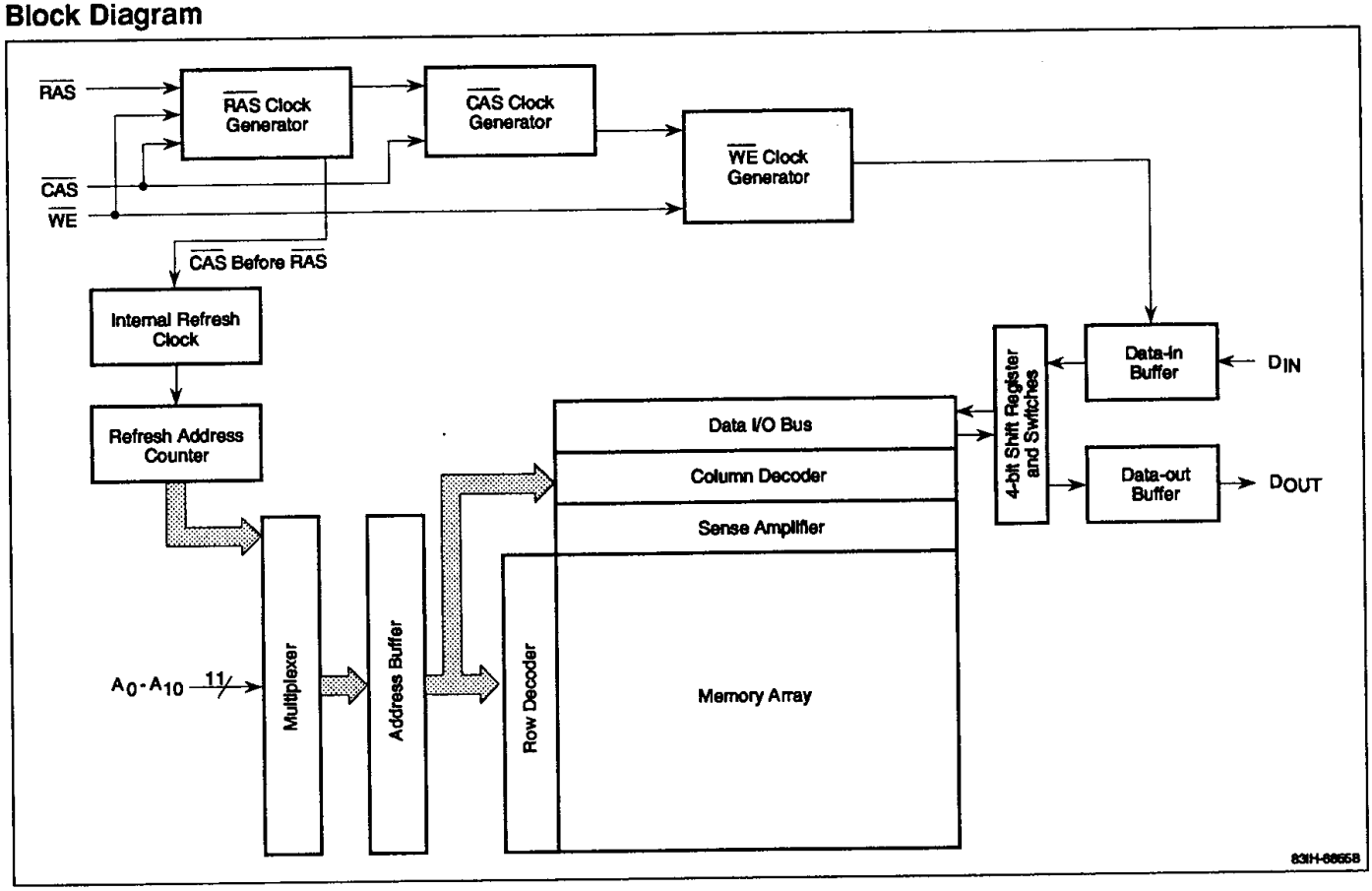
Block Diagram



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Ordering Information

Part Number	RAS Access Time	R/W Cycle Time	Nibble Cycle Time	Refresh Period	Standby Current	Package
μPD424101LA-60	60 ns	120 ns	40 ns	16 ms	1 mA	26/20-pin plastic SOJ (300-mil)
LA-70	70 ns	140 ns	40 ns			
LA-80	80 ns	160 ns	40 ns			
LA-10	100 ns	190 ns	45 ns			
μPD424101LA-60L	60 ns	120 ns	40 ns	128 ms	300 μA	
LA-70L	70 ns	140 ns	40 ns			
LA-80L	80 ns	160 ns	40 ns			
LA-10L	100 ns	190 ns	45 ns			
μPD424101V-60	60 ns	120 ns	40 ns	16 ms	1 mA	20-pin plastic ZIP
V-70	70 ns	140 ns	40 ns			
V-80	80 ns	160 ns	40 ns			
V-10	100 ns	190 ns	45 ns			
μPD424101V-60L	60 ns	120 ns	40 ns	128 ms	300 μA	
V-70L	70 ns	140 ns	40 ns			
V-80L	80 ns	160 ns	40 ns			
V-10L	100 ns	190 ns	45 ns			
μPD424101GS-60	60 ns	120 ns	40 ns	16 ms	1 mA	26/20-pin plastic TSOP (normal pinouts)
GS-70	70 ns	140 ns	40 ns			
GS-80	80 ns	160 ns	40 ns			
GS-10	100 ns	190 ns	45 ns			
μPD424101GS-60L	60 ns	120 ns	40 ns	128 ms	300 μA	
GS-70L	70 ns	140 ns	40 ns			
GS-80L	80 ns	160 ns	40 ns			
GS-10L	100 ns	190 ns	45 ns			
μPD424101GSM-60	60 ns	120 ns	40 ns	16 ms	1 mA	26/20-pin plastic TSOP (reverse pinouts)
GSM-70	70 ns	140 ns	40 ns			
GSM-80	80 ns	160 ns	40 ns			
GSM-10	100 ns	190 ns	45 ns			
μPD424101GSM-60L	60 ns	120 ns	40 ns	128 ms	300 μA	
GSM-70L	70 ns	140 ns	40 ns			
GSM-80L	80 ns	160 ns	40 ns			
GSM-10L	100 ns	190 ns	45 ns			

Absolute Maximum Ratings

Voltage on any pin relative to GND	−1.0 to +7.0 V
Operating temperature, T_{OPR}	0 to +70°C
Storage temperature, T_{STG}	−55 to +125°C
Short-circuit output current, I_{OS}	50 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.

Recommended Operating Conditions

Parameter	Symbol	Min	Typ	Max	Unit
Input voltage, high	V_{IH}	2.4		V_{CC} + 1.0	V
Input voltage, low	V_{IL}	−1.0		0.8	V
Supply voltage	V_{CC}	4.5	5.0	5.5	V
Ambient temperature	T_A	0		70	°C

Capacitance

T_A = 25°C; f = 1 MHz

Parameter	Symbol	Max	Unit	Pins Under Test
Input capacitance	C_{I1}	5	pF	Address, D_{IN}
	C_{I2}	7	pF	$\overline{RAS}$, $\overline{CAS}$, $\overline{WE}$
Output capacitance	C_O	7	pF	D_{OUT}

DC Characteristics

T_A = 0 to +70°C; V_{CC} = +5.0 V ±10%

Parameter	Symbol	Min	Max	Unit	Test Conditions
Standby current	I_{CC2}		2.0	mA	$\overline{RAS}$ = $\overline{CAS}$ ≥ V_{IH} (min)
			1.0	mA	$\overline{RAS}$ = $\overline{CAS}$ ≥ V_{CC} − 0.2 V
Input leakage current	$I_{I(L)}$	−10	10	μA	V_{IN} = 0 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 V to V_{CC}
Output voltage, low	V_{OL}		0.4	V	I_{OL} = 4.2 mA
Output voltage, high	V_{OH}	2.4		V	I_{OH} = −5 mA

Low-Power Battery Backup (-L Versions Only)

Symbol	Max	Unit	t_{RAS}	$\overline{CAS}$ Before $\overline{RAS}$ Refresh Cycle	Standby Conditions
I_{CC6}	500	μA	≤ 1 μs	1024 refresh cycles (min) every 128 ms; $\overline{RAS}$ = $\overline{CAS}$ ≥ V_{CC} − 0.2 V or ≤ 0.2 V, as appropriate; D_{OUT} open; all other inputs ≥ V_{CC} − 0.2 V or ≤ 0.2 V	$\overline{RAS}$ = $\overline{CAS}$ ≥ V_{CC} − 0.2 V; D_{IN}, $\overline{WE}$, Addresses ≥ V_{CC} − 0.2 V or ≤ 0.2 V; D_{OUT} open
	300	μA	≤ 200 μs		
t_{REF}	128	ms			

AC Characteristics

T_A = 0 to +70°C; V_{CC} = +5.0 V ±10%

Parameter	Symbol	μPD424101-60		μPD424101-70		μPD424101-80		μPD424101-10		Unit	Test Conditions
		Min	Max	Min	Max	Min	Max	Min	Max		
Operating current, average	I_{CC1}		120		100		90		80	mA	$\overline{RAS}$ and $\overline{CAS}$ cycling; t_{RC} = t_{RC} min; I_O = 0 mA (Note 5)
Operating current, $\overline{RAS}$-only refresh cycle, average	I_{CC3}		120		100		90		80	mA	$\overline{RAS}$ cycling; $\overline{CAS}$ ≥ V_{IH}; t_{RC} = t_{RC} min; I_O = 0 mA (Note 5)
Operating current, nibble mode, average	I_{CC4}		80		80		70		60	mA	$\overline{RAS}$ ≤ V_{IL}; $\overline{CAS}$ cycling; t_{NC} = t_{NC} min; I_O = 0 mA (Note 5)
Operating current, $\overline{CAS}$ before $\overline{RAS}$ refresh cycle, average	I_{CC5}		120		100		90		80	mA	$\overline{RAS}$ cycling; $\overline{CAS}$ before $\overline{RAS}$; t_{RC} = t_{RC} min; I_O = 0 mA (Note 5)
Access time from column address	t_{AA}		30		35		40		50	ns	(Notes 7, 9)
Column address setup time	t_{ASC}	0		0		0		0		ns	
Row address setup time	t_{ASR}	0		0		0		0		ns	
Column address to $\overline{WE}$ delay time	t_{AWD}	30		35		40		50		ns	(Note 16)
Access time from $\overline{CAS}$ (falling edge)	t_{CAC}		20		20		20		25	ns	(Notes 7, 9)
Column address hold time	t_{CAH}	15		15		15		20		ns	
$\overline{CAS}$ pulse width	t_{CAS}	20	10,000	20	10,000	20	10,000	25	10,000	ns	
$\overline{CAS}$ hold time for $\overline{CAS}$ before $\overline{RAS}$ refresh cycle	t_{CHR}	15		15		15		20		ns	
$\overline{CAS}$ precharge time, non-nibble cycle	t_{CPN}	10		10		10		10		ns	
$\overline{CAS}$ to $\overline{RAS}$ precharge time	t_{CRP}	10		10		10		10		ns	(Note 12)
$\overline{CAS}$ hold time	t_{CSH}	60		70		80		100		ns	
$\overline{CAS}$ setup time for $\overline{CAS}$ before $\overline{RAS}$ refresh cycle	t_{CSR}	10		10		10		10		ns	
$\overline{CAS}$ to $\overline{WE}$ delay	t_{CWD}	20		20		20		25		ns	(Note 16)
Write command to $\overline{CAS}$ lead time	t_{CWL}	15		15		15		20		ns	
Data-in hold time	t_{DH}	15		15		15		20		ns	(Note 15)
Data-in setup time	t_{DS}	0		0		0		0		ns	(Note 15)
Nibble mode access time	t_{NAC}		20		20		20		25	ns	

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AC Characteristics (cont)

Parameter	Symbol	μPD424101-60		μPD424101-70		μPD424101-80		μPD424101-10		Unit	Test Conditions
		Min	Max	Min	Max	Min	Max	Min	Max		
$\overline{CAS}$ pulse width in nibble mode	t_{NAS}	20		20		20		25		ns	
Nibble mode cycle time	t_{NC}	40		40		40		45		ns	
$\overline{CAS}$ to $\overline{WE}$ delay in nibble mode	t_{NCWD}	20		20		20		25		ns	
Write command to $\overline{CAS}$ lead time in nibble mode	t_{NCWL}	15		15		20		25		ns	
$\overline{CAS}$ precharge time in nibble mode	t_{NP}	10		10		10		10		ns	
$\overline{RAS}$ hold time for nibble read cycle	t_{NRRSH}	20		20		20		25		ns	
$\overline{RAS}$ hold time for nibble write cycle	t_{NWRSH}	20		20		20		25		ns	
Output buffer turnoff delay	t_{OFF}	0	15	0	15	0	20	0	25	ns	(Note 10)
Access time from $\overline{RAS}$	t_{RAC}		60		70		80		100	ns	(Notes 7, 8)
$\overline{RAS}$ to column address delay time	t_{RAD}	15	30	15	35	17	40	17	50	ns	(Note 9)
Row address hold time	t_{RAH}	10		10		12		12		ns	
Column address lead time referenced to $\overline{RAS}$ (rising edge)	t_{RAL}	30		35		40		50		ns	
$\overline{RAS}$ pulse width	t_{RAS}	60	10,000	70	10,000	80	10,000	100	10,000	ns	
$\overline{RAS}$ pulse width in nibble mode	t_{RASP}	60	125,000	70	125,000	80	125,000	100	125,000	ns	
Random read or write cycle time	t_{RC}	120		140		160		190		ns	(Note 6)
$\overline{RAS}$ to $\overline{CAS}$ delay time	t_{RCD}	20	40	20	50	25	60	25	75	ns	(Note 11)
Read command hold time referenced to $\overline{CAS}$	t_{RCH}	0		0		0		0		ns	(Note 13)
Read command setup time	t_{RCS}	0		0		0		0		ns	
Refresh period	t_{REF}		16		16		16		16	ms	Addresses A_0 - A_9
$\overline{RAS}$ precharge time	t_{RP}	50		60		70		80		ns	
$\overline{RAS}$ precharge $\overline{CAS}$ hold time	t_{RPC}	10		10		10		10		ns	
Read command hold time referenced to $\overline{RAS}$	t_{RRH}	10		10		10		10		ns	(Note 13)
$\overline{RAS}$ hold time	t_{RSH}	20		20		20		25		ns	

AC Characteristics (cont)

Parameter	Symbol	μPD424101-60 Min	μPD424101-60 Max	μPD424101-70 Min	μPD424101-70 Max	μPD424101-80 Min	μPD424101-80 Max	μPD424101-10 Min	μPD424101-10 Max	Unit	Test Conditions
Read-write cycle time	t_{RWC}	145		165		185		220		ns	(Note 6)
$\overline{RAS}$ to $\overline{WE}$ delay	t_{RWD}	60		70		80		100		ns	(Note 16)
Write command to $\overline{RAS}$ lead time	t_{RWL}	20		20		20		25		ns	
Rise and fall transition time	t_T	3	50	3	50	3	50	3	50	ns	(Note 3)
Write command hold time	t_{WCH}	15		15		15		20		ns	
Write command setup time	t_{WCS}	0		0		0		0		ns	(Note 16)
$\overline{WE}$ hold time	t_{WHR}	15		15		15		20		ns	
Write command pulse width	t_{WP}	15		15		15		20		ns	(Note 14)
$\overline{WE}$ setup time	t_{WSR}	10		10		10		10		ns	

Notes:

(1) All voltages are referenced to GND.

(2) An initial pause of 100 μs is required after power-up, followed by any eight $\overline{RAS}$ cycles, before proper device operation is achieved. At the end of the initial power-up sequence, it is recommended that either a $\overline{RAS}$-only refresh or a $\overline{CAS}$ before $\overline{RAS}$ refresh cycle be executed while $\overline{WE} \geq V_{IH}$ to ensure normal operation.

(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 $\overline{RAS}$-only refresh cycles. I_{CC4} is measured assuming that all column address inputs are switched only once during each nibble 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°C) is assured.

(7) Load = 2 TTL (−1 mA, +4 mA) loads and 100 pF.

(8) Assumes that $t_{RCD} \leq t_{RCD}$ (max) and $t_{RAD} \leq t_{RAD}$ (max). If t_{RCD} or t_{RAD} is greater than the maximum recommended value in this table, t_{RAC} increases by the amount that t_{RCD} or t_{RAD} exceeds the value shown.

(9) If $t_{RAD} \geq t_{RAD}$ (max), then the access time is defined by t_{AA}.

(10) t_{OFF} (max) defines the time at which the output achieves the open-circuit condition an is not referenced to V_{OH} or V_{OL}.

(11) Operation within the t_{RCD} (max) limit assures that t_{RAC} (max) can be met. t_{RCD} (max) is specified as a reference point only; if t_{RCD} is greater than t_{RCD} (max), then access time is controlled exclusively by t_{CAC}.

(12) The t_{CRP} requirement should be applicable for $\overline{RAS}$/$\overline{CAS}$ cycles preceded by any cycle.

(13) Either t_{RRH} or t_{RCH} must be satisfied for a read cycle.

(14) Parameter t_{WP} is applicable for a delayed write cycle such as a read-write/read-modify-write cycle. For early write operation, both t_{WCS} and t_{WCH} must be met.

(15) These parameters are referenced to the falling edge of $\overline{CAS}$ for early write cycles and to the falling edge of $\overline{WE}$ for delayed write or read-modify-write cycles.

(16) t_{WCS}, t_{RWD}, t_{CWD}, and t_{AWD} are restrictive operating parameters in read-write/read-modify-write cycles only. If $t_{WCS} \geq t_{WCS}$ (min), the cycle is an early write cycle and the data output will remain open-circuit throughout the entire cycle. If $t_{CWD} \geq t_{CWD}$ (min), $t_{RWD} \geq t_{RWD}$ (min), and $t_{AWD} \geq t_{AWD}$ (min), the cycle is a read-write cycle and the data output will contain data read from the selected cell. If neither of the above conditions is met, the condition of the data output pin (at access time and until $\overline{CAS}$ returns to V_{IH}) is indeterminate.

(17) A test mode may be initiated by executing a $\overline{CAS}$ before $\overline{RAS}$ refresh cycle with $\overline{WE}$ held at V_{IL}. This mode also may inadvertently be initiated during power-up because external control of the signal lines is very difficult during this period. It is therefore recommended that while $\overline{WE}$ is held at V_{IH}, either a $\overline{RAS}$-only or $\overline{CAS}$ before $\overline{RAS}$ refresh cycle should be executed at any time after the end of the initial power-up sequence to ensure normal device operation.

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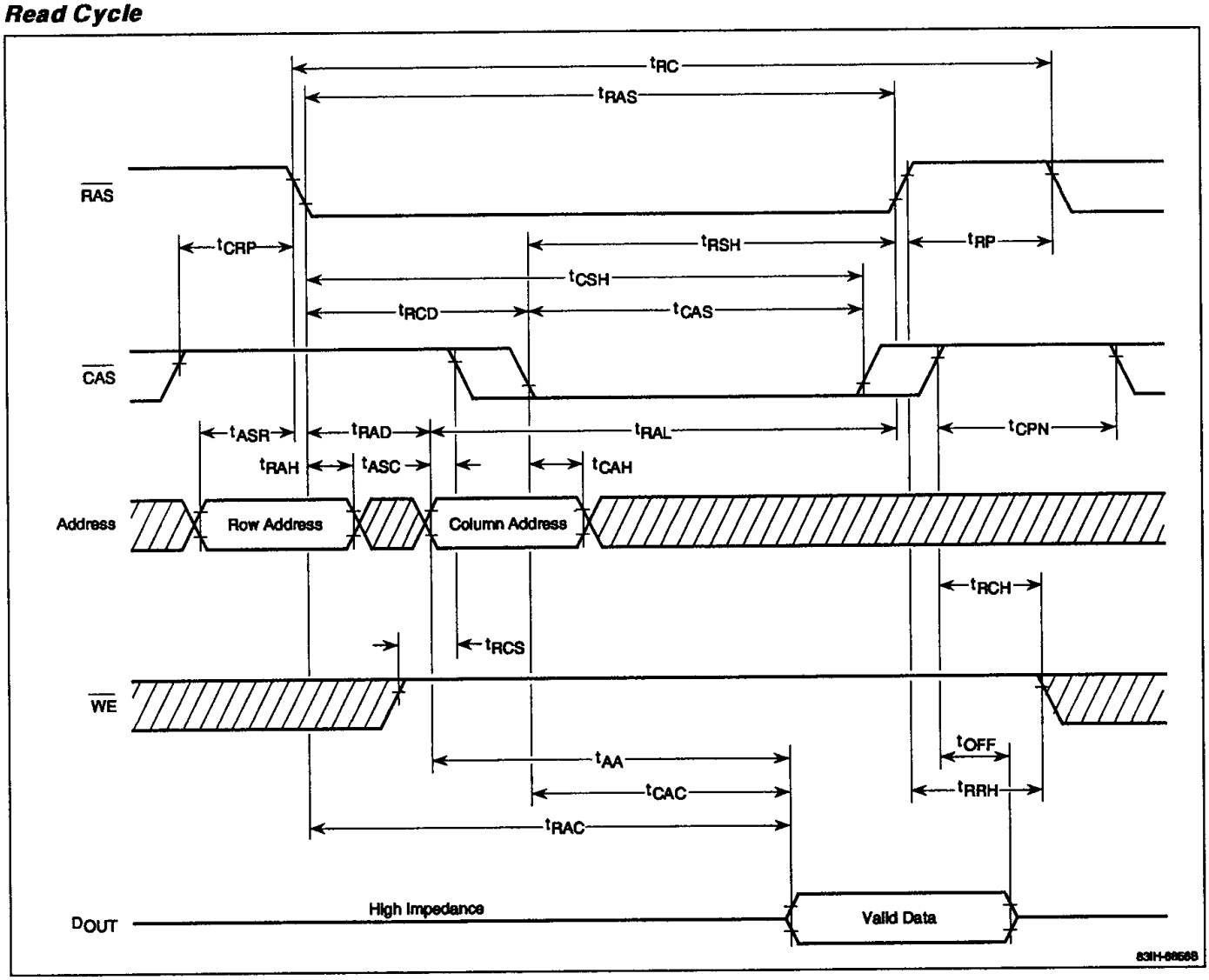
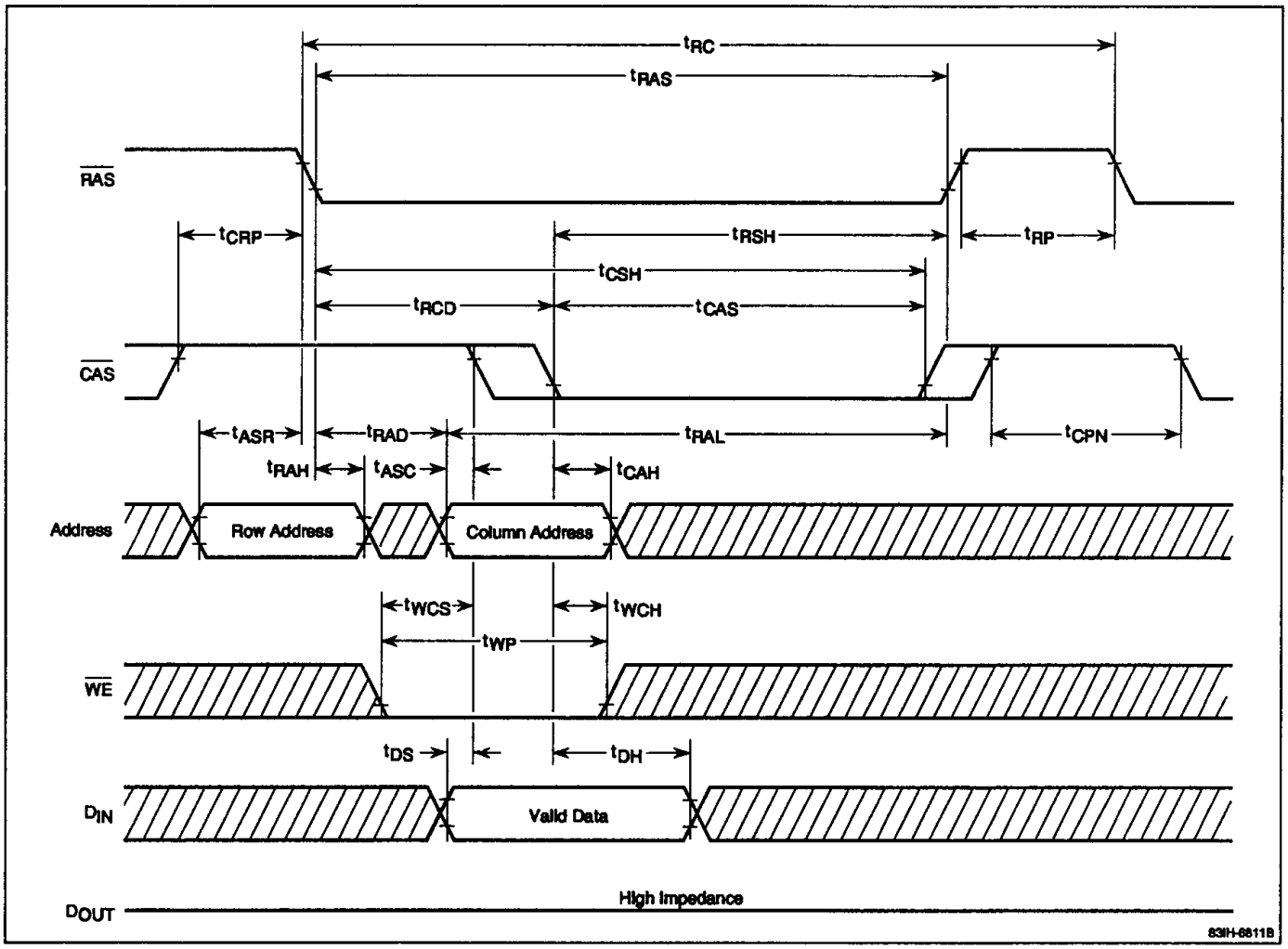
Timing Waveforms

Read Cycle



Timing Waveforms (cont)

Early Write Cycle



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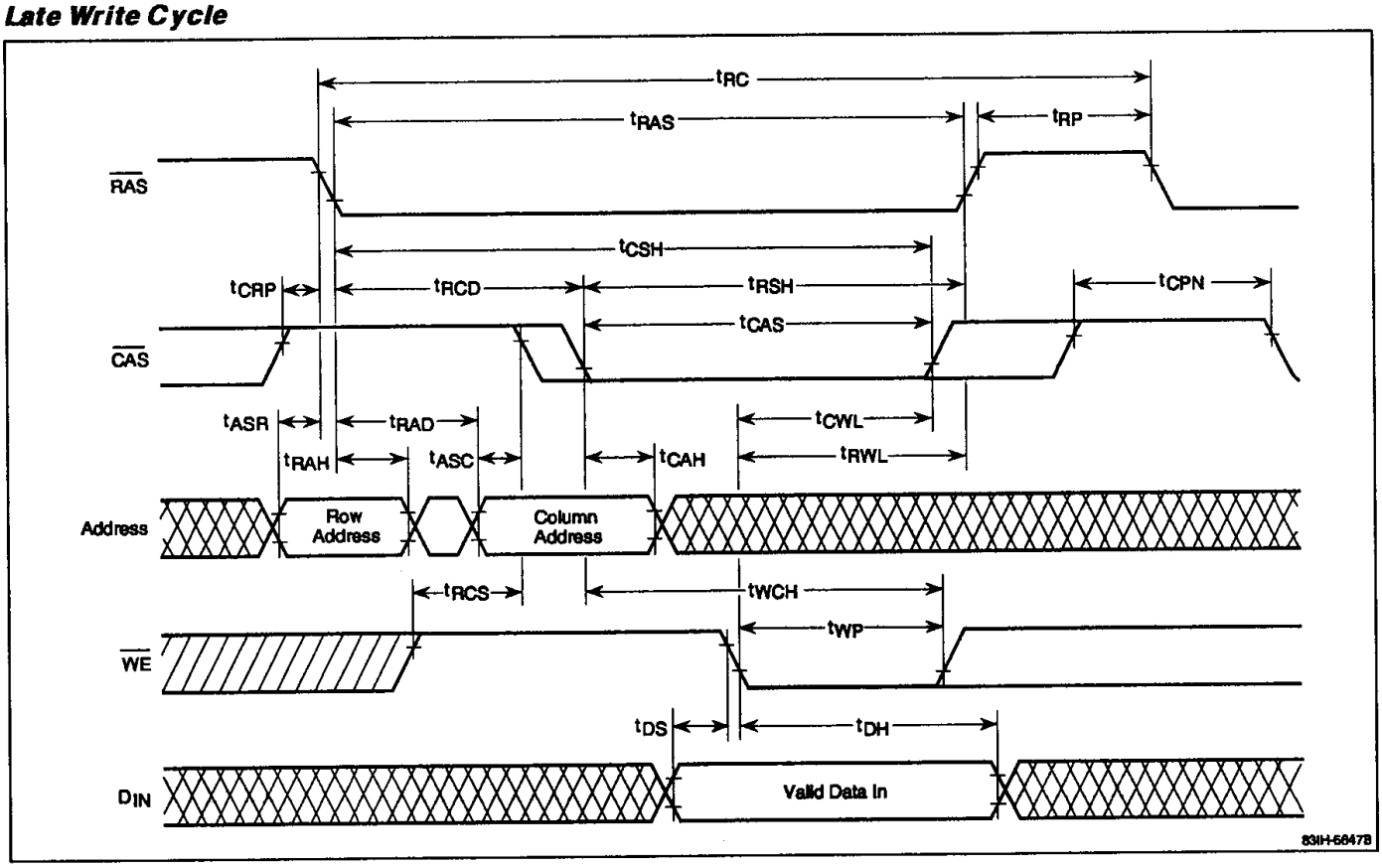
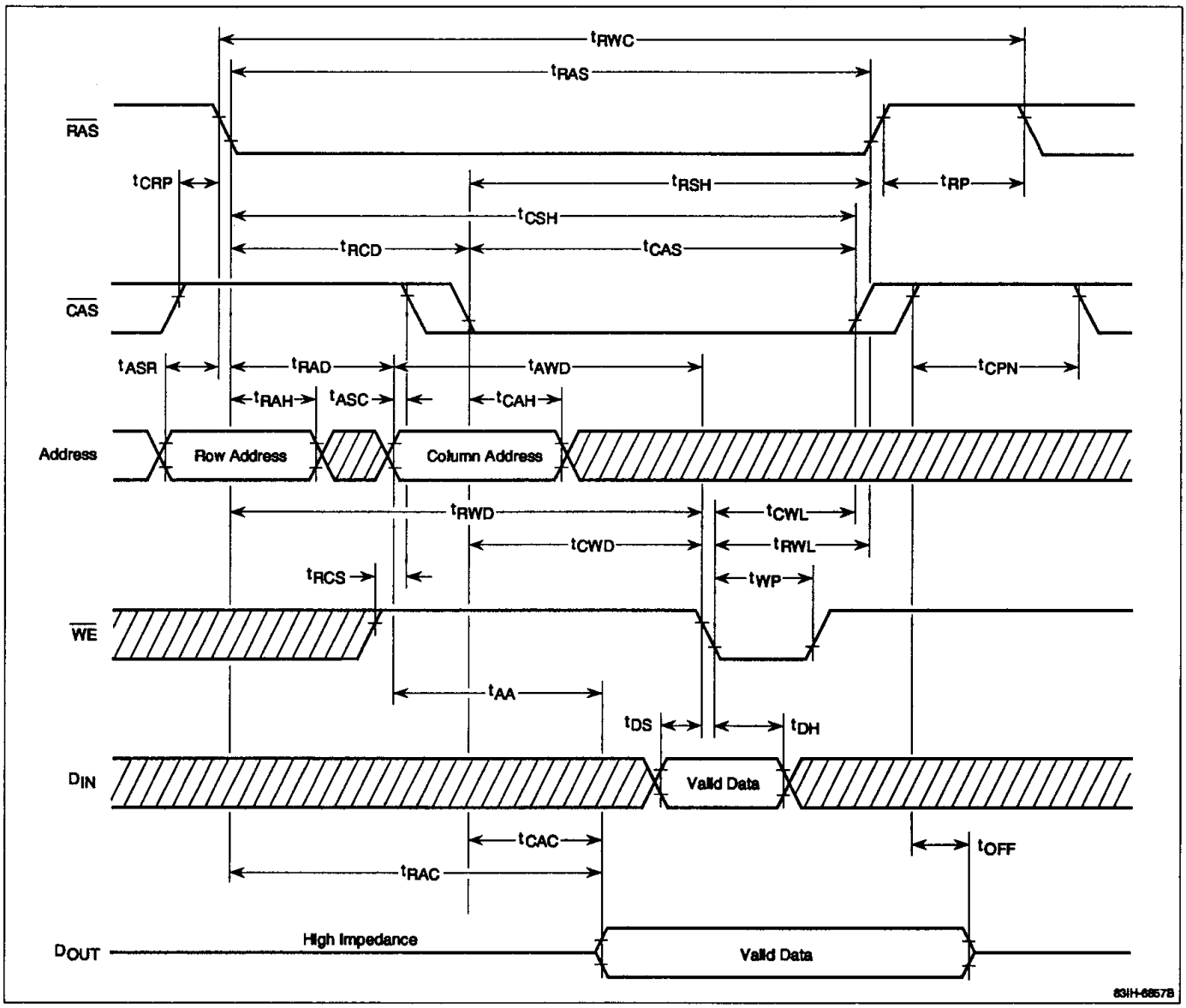
Timing Waveforms (cont)

Late Write Cycle



Timing Waveforms (cont)

Read-Write/Read-Modify-Write Cycle



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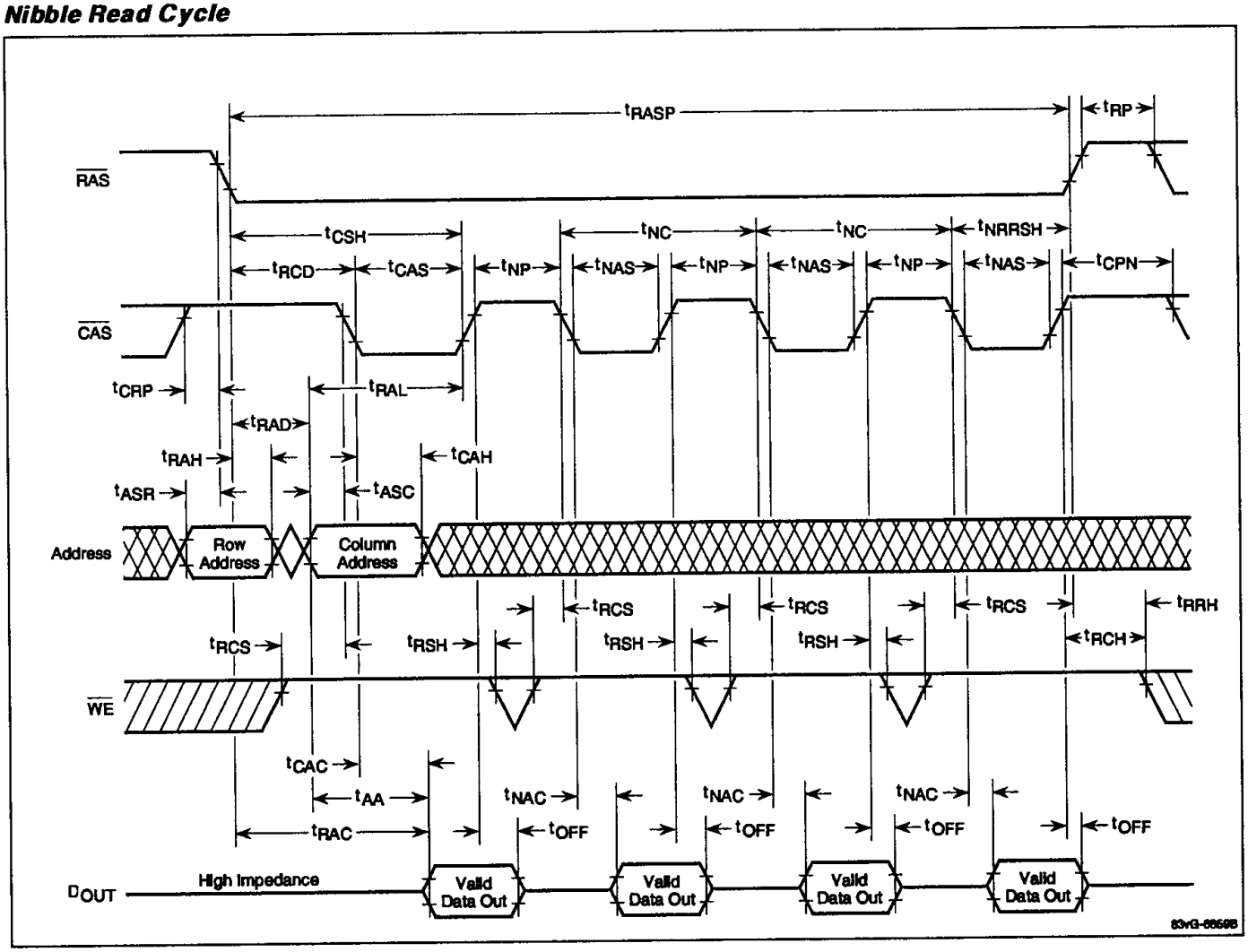
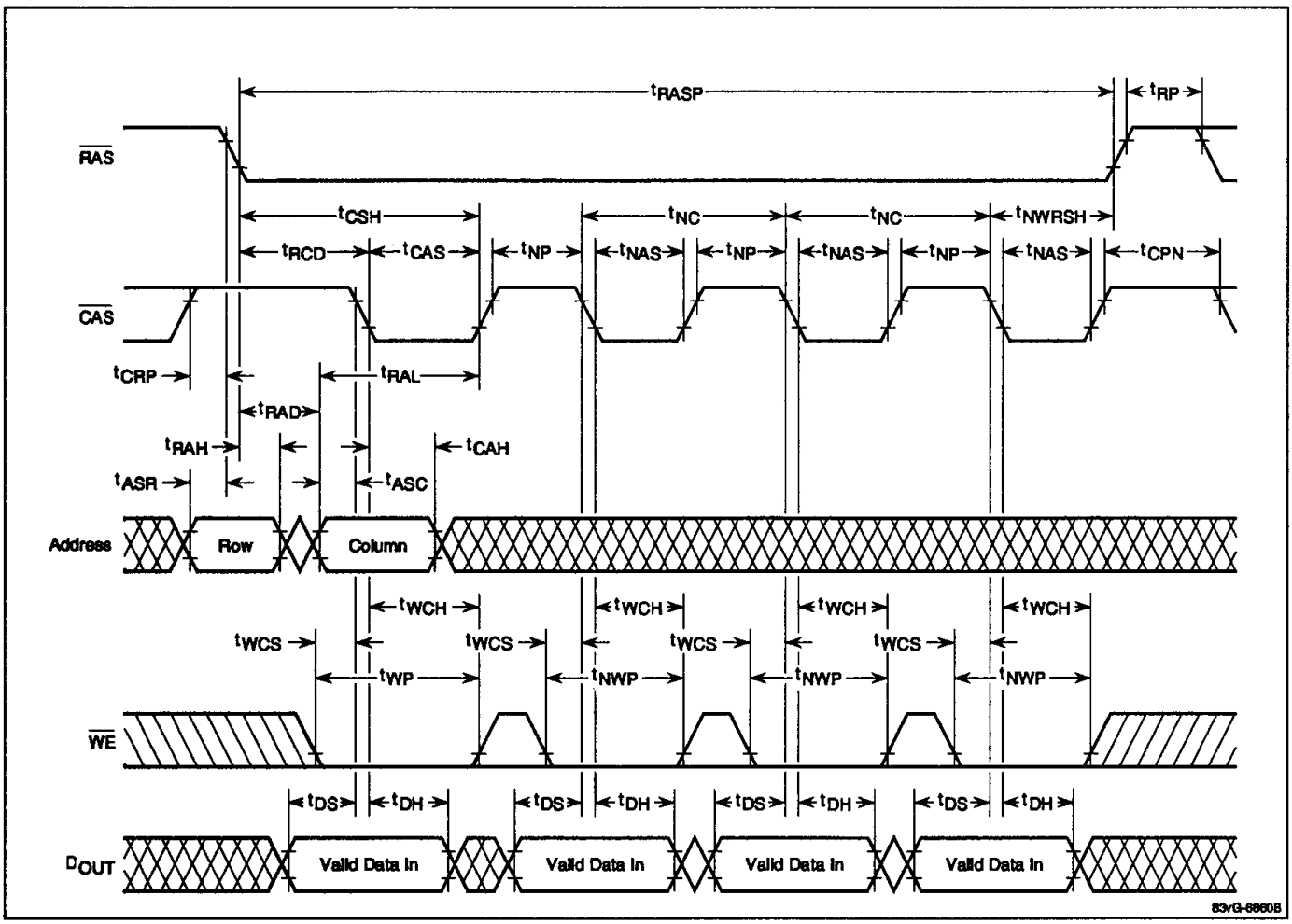
Timing Waveforms (cont)

Nibble Read Cycle



Timing Waveforms (cont)

Nibble Early Write Cycle



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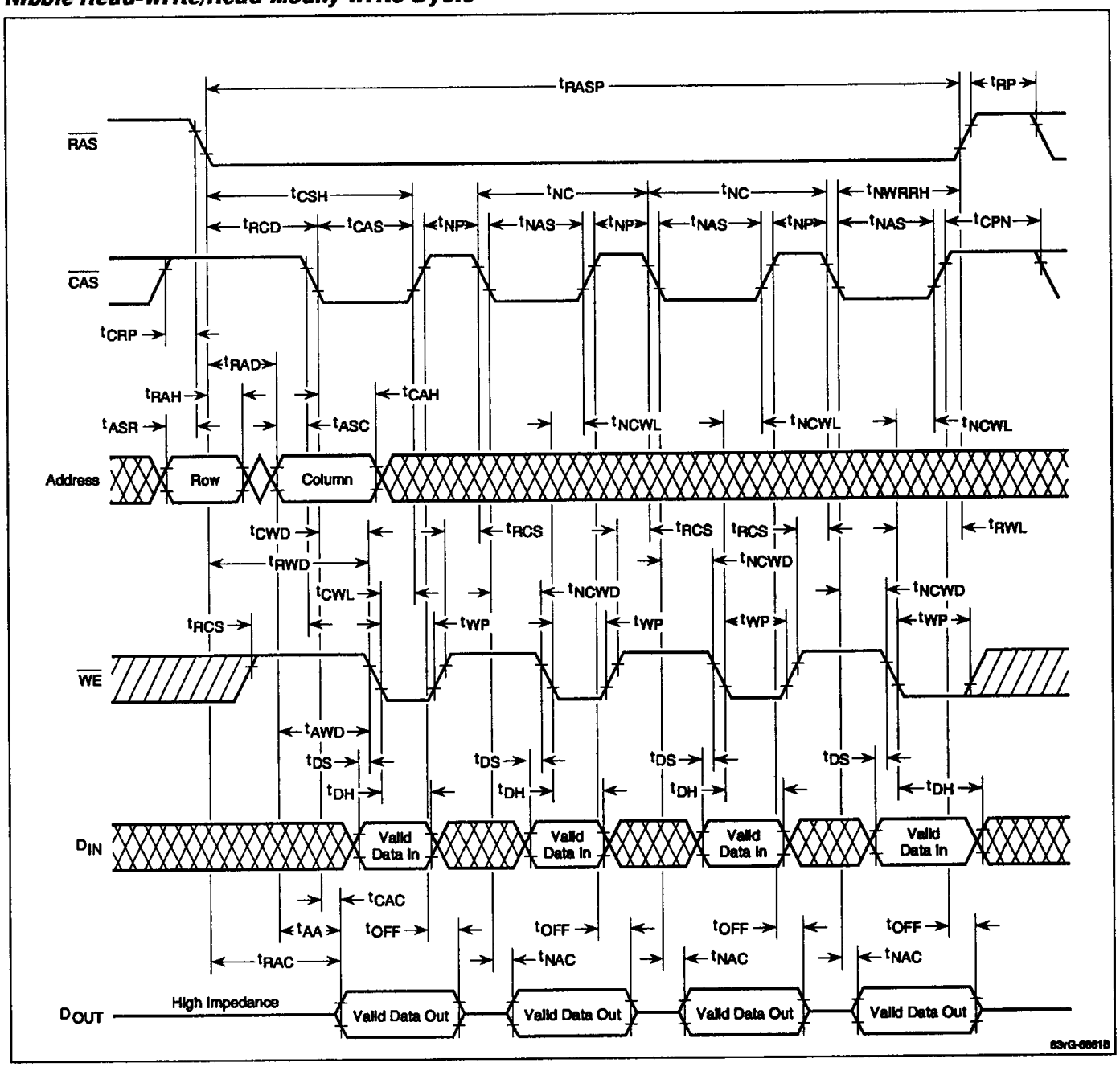
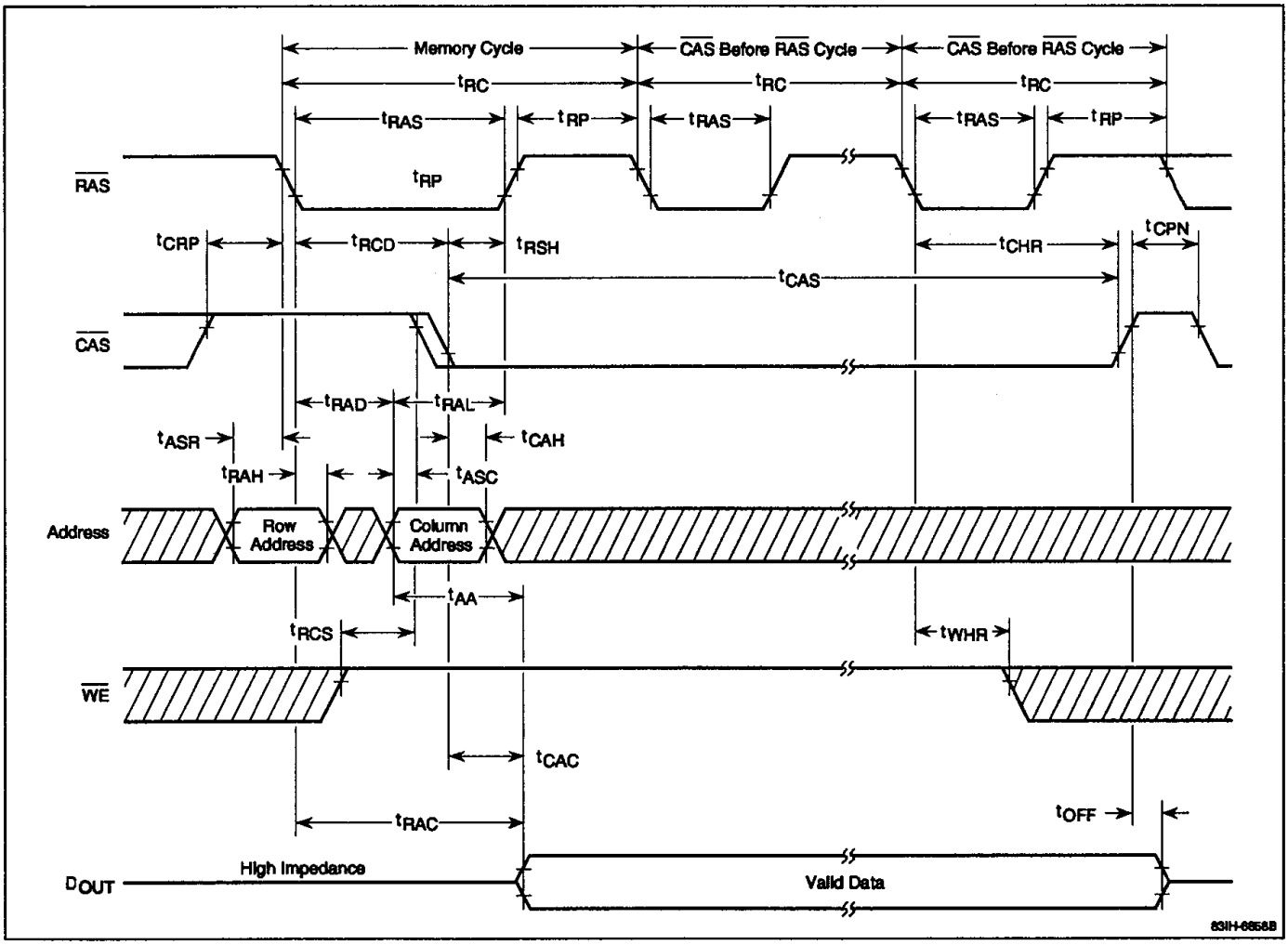
Timing Waveforms (cont)

Nibble Read-Write/Read-Modify-Write Cycle



Timing Waveforms (cont)

Hidden Refresh Cycle



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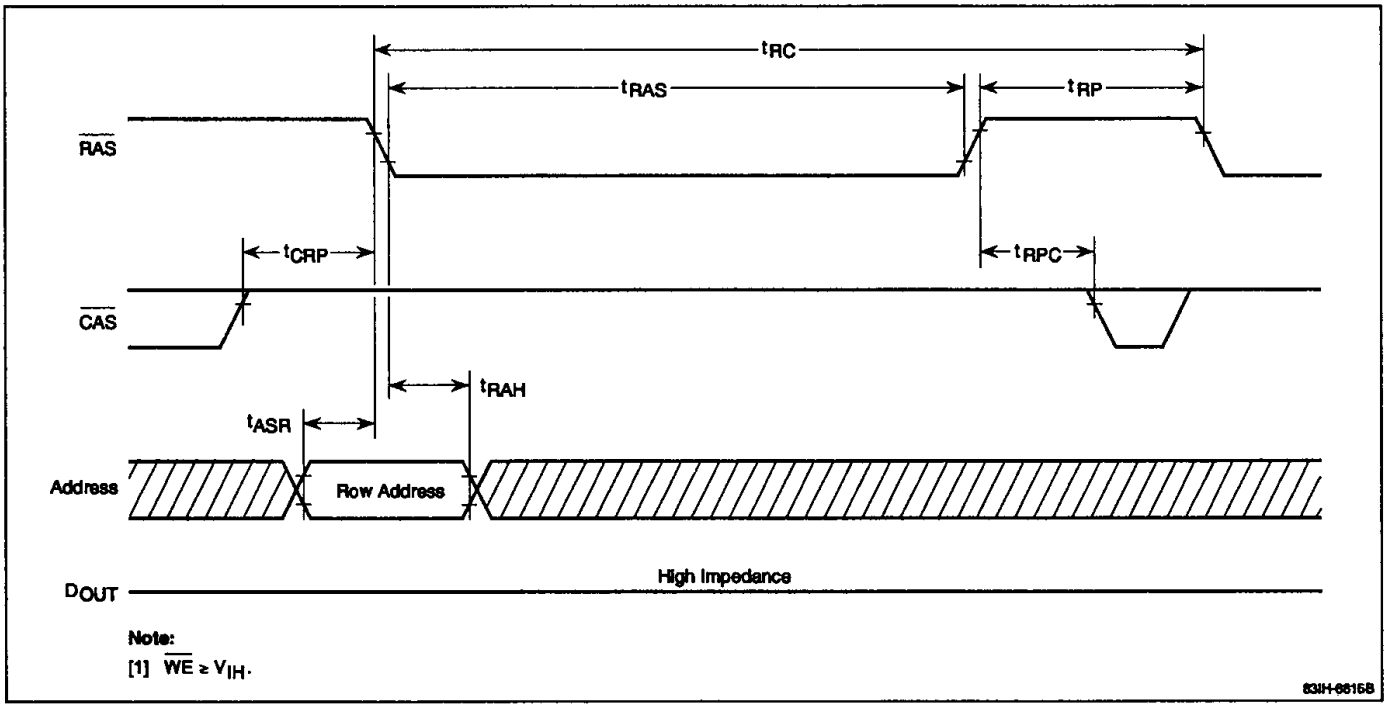
Timing Waveforms (cont)

$\overline{RAS}$-Only Refresh Cycle



Note:
[1] $\overline{WE} \geq V_{IH}$.

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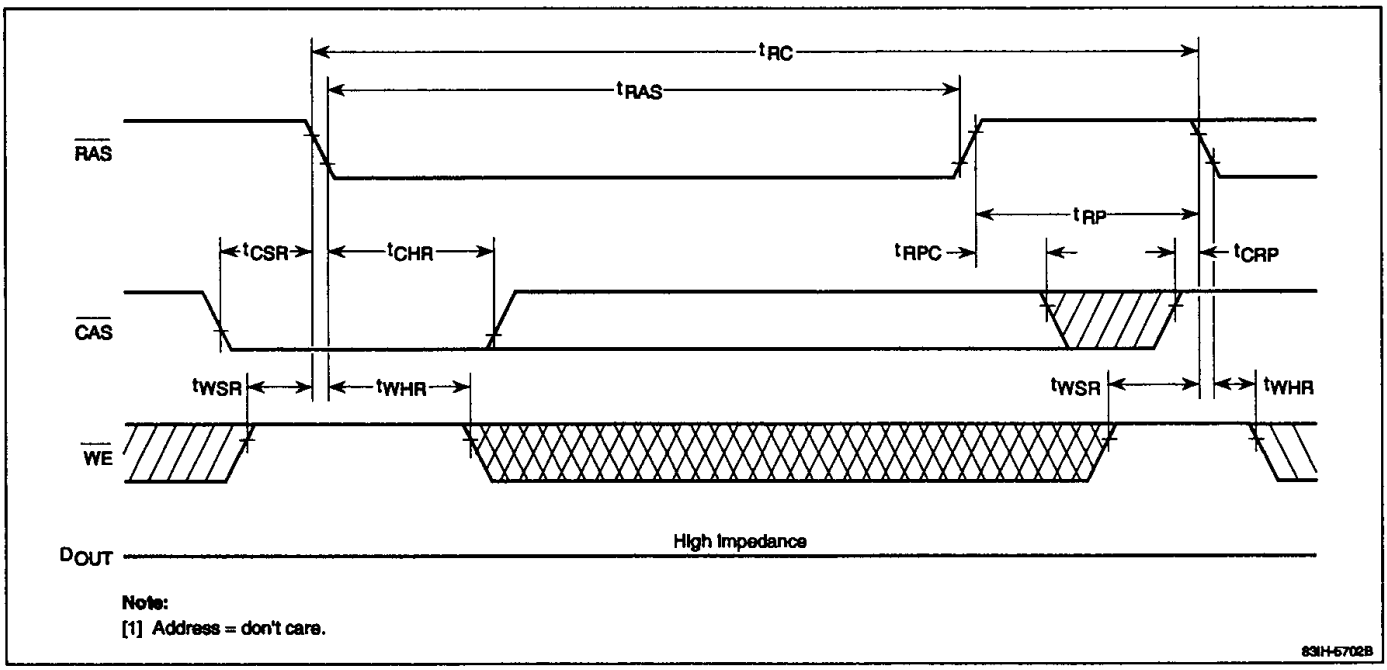
$\overline{CAS}$ Before $\overline{RAS}$ Refresh Cycle



Note:
[1] Address = don't care.

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