

DESCRIPTION

The NN51V18160B series is a high performance CMOS Dynamic Random Access Memory organized as 1,048,576 words by 16 bits. The NN51V18160B series is fabricated with advanced CMOS technology and designed with innovative design techniques resulting in high speed, extremely low power and wide operating margins at both component and system levels.

The NN51V18160B series features a high speed page mode operation in which a high speed read, write or read-write is performed on any column address along a row address.

An extremely short row address capture time and an asynchronous column address decoder relax the timing constraints associated with address multiplexing.

The outputs are tri-stated by $\overline{\text{CAS}}$ which, in essence, acts as an output enable independent of $\overline{\text{RAS}}$ with very fast $\overline{\text{CAS}}$ to output access time.

Refresh is accomplished by performing $\overline{\text{RAS}}$ only refresh cycles, hidden refresh cycles, $\overline{\text{CAS}}$ before $\overline{\text{RAS}}$ refresh cycles, or normal read or write cycles on the 1024 address combinations of A0 to A9 during a 16 ms period.

Multiplexed address inputs permit the NN51V18160B series to be packaged in a standard 42-pin plastic SOJ, 50-pin plastic TSOP TYPE II. The package sizes provide high system bit densities. System level features include single power supply of 3.3V $\pm 10\%$ tolerance and direct interface with high performance TTL logic families.

FEATURES

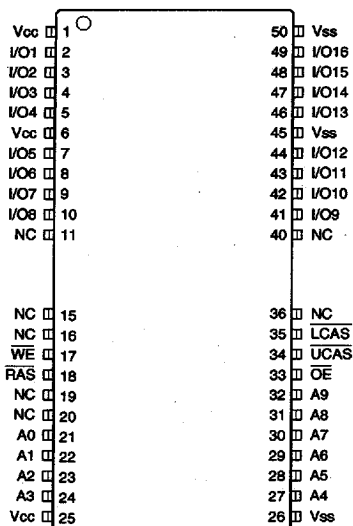
- 1,048,576 × 16 bit Organization
- Single 3.3V $\pm 10\%$ Power Supply
- Performance Ranges

Parameter	-50	-60	-70
Max. $\overline{\text{RAS}}$ Access Time (t_{RAC})	50ns	60ns	70ns
Max. $\overline{\text{CAS}}$ Access Time (t_{CAC})	15ns	17ns	20ns
Max. Column Address Access Time (t_{AA})	25ns	30ns	40ns
Min. Read/Write Cycle Time (t_{RC})	90ns	110ns	130ns

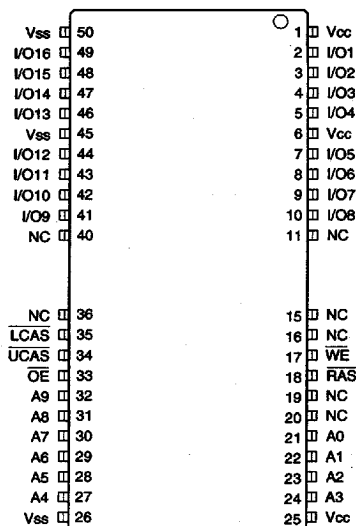
- Fast Page Mode Operation
- Separate $\overline{\text{CAS}}$ ($\overline{\text{UCAS}}$, $\overline{\text{LCAS}}$) for Byte Selection
- Byte Read/Write Mode Operation
- Low Power Operation
 - Low Standby Current (CMOS level input)
 - Standard 1mA
 - L version 150 μ A
- 1024 Refresh Cycles
 - Standard 16ms
 - L version 128ms
- Self Refresh Mode (L version)
- All inputs/Outputs and Clocks fully TTL and CMOS compatible
- Refresh Modes
 - $\overline{\text{RAS}}$ only
 - $\overline{\text{CAS}}$ before $\overline{\text{RAS}}$
 - Hidden Refresh
- High Reliability Package
 - Plastic 42pin SOJ (P42SJ-2B-L)
 - Plastic 50pin TSOP TYPE II (P50/44TP-3B-L)

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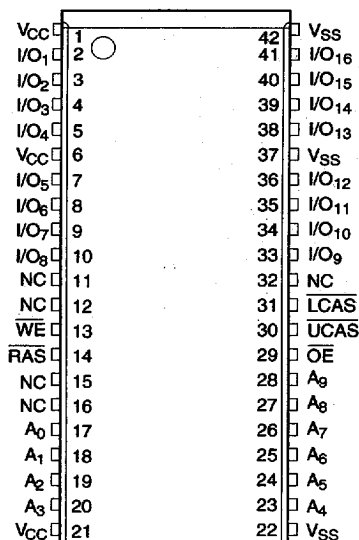
PIN CONFIGURATION



50/44-pin TSOP TYPE (II)
Normal Bend (400mil)
P50/44TP-3B-L



50/44-pin TSOP TYPE (II)
Reverse Bend (400mil)
P50/44TP-3B-L

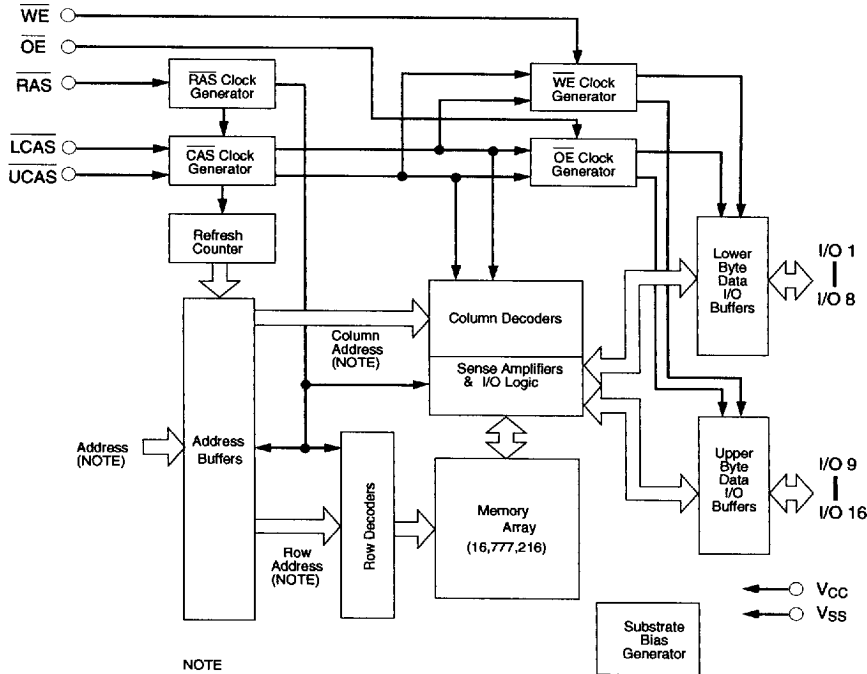


42-pin SOJ (400mil)
P42SJ-2B-L

PIN NAMES

A0~A9	Address Inputs
RAS	Row Address Strobe
UCAS	Column Address Strobe Upper Byte Control
LCAS	Column Address Strobe Lower Byte Control
OE	Output Enable
I/O1~I/O16	Data-in / Data-out
WE	Write Enable
Vcc	+3.3V Supply
Vss	Ground
NC	No Connection

FUNCTIONAL BLOCK DIAGRAM



NOTE

Address / Row Address	Column Address
A0 - A9	A0 - A9

ABSOLUTE MAXIMUM RATINGS

RATING	SYMBOL	VALUE	UNIT
Voltage on Any Pin Relative to V_{SS}	V_{in}, V_{out}	-0.5 to 4.6	V
Voltage on V_{CC} Relative to V_{SS}	V_{CC}	-0.5 to 4.6	V
Storage Temperature (Plastic)	T_{stg}	-55 to +125	°C
Power Dissipation	P_d	1.0	W
Ambient Operating Temperature	T_a	0 to +70	°C
Short Circuit Output Current	I_{out}	20	mA

Permanent device damage can occur if absolute maximum ratings are exceeded. Functional operation should be restricted to the conditions as detailed in the operational sections of this data sheet. Exposure to absolute maximum rating conditions for extended periods can affect device reliability.

DC OPERATING CONDITIONS

SYMBOL	PARAMETER	MIN.	TYP.	MAX.	UNIT
V_{CC}	Supply Voltage	3.0	3.3	3.6	V
V_{SS}	Supply Voltage	0	0	0	V
V_{IH}	Input High Voltage, All Inputs	2.0	—	$V_{CC} + 0.3$	V
V_{IL}	Input Low Voltage, All Inputs	-0.3	—	0.8	V

Note: All voltage values in this data sheet are with respect to V_{SS} unless otherwise specified.

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TRUTH TABLE

INPUTS					I/O		OPERATION	NOTES
RAS	LCAS	UCAS	WE	OE	I/O1~I/O8	I/O9~I/O16		
H	H	H	H	H	High-Z	High-Z	Standby	1,3
L	H	H	H	H	High-Z	High-Z	Refresh	1,3
L	L	H	H	L	Dout	High-Z	Lower byte read	1,3
L	H	L	H	L	High-Z	Dout	Upper byte read	1,3
L	L	L	H	L	Dout	Dout	Word read	1,3
L	L	H	L	H	Din	Don't care	Lower byte write	1,2,3
L	H	L	L	H	Don't care	Din	Upper byte write	1,2,3
L	L	L	L	H	Din	Din	Word write	1,2,3
L	L	L	H	H	High-Z	High-Z		1,3
H→L	L	H	H	—	High-Z	High-Z	CBR refresh or Self refresh	1,3
H→L	H	L	H	—	High-Z	High-Z		
H→L	L	L	H	—	High-Z	High-Z		

Notes: 1. H:high (inactive) , L:low (active) , —:unconcerned with H or L.

2. $t_{wcs} \geq 0ns$: early write mode.

$t_{wcs} < 0ns$: OE controlled write mode.

3. Operation mode is set by the earliest of $\overline{LCAS}$ and $\overline{UCAS}$ active edge and reset by the latest of $\overline{LCAS}$ and $\overline{UCAS}$ inactive edge.

However write operation and High-Z control are done independently by each $\overline{LCAS}$, $\overline{UCAS}$.

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DC ELECTRICAL CHARACTERISTICS (0°C ≤ Ta ≤ 70°C, V_{CC} = 3.3V ±10%)

SYMBOL	PARAMETER	SPEED	MIN.	MAX.	UNIT	TEST CONDITIONS	NOTES
I _{CC1}	Operating Current	-50 -60 -70		170 150 130	mA mA mA	t _{RC} = t _{RC} (min.) RAS, CAS, Address cycling	1, 2
I _{CC2}	Standby Current			1.0	mA	RAS = CAS ≥ (V _{CC} - 0.2V)	
				2.0	mA	RAS = CAS ≥ V _{IH}	
I _{CC3}	Refresh Current (RAS only refresh)			150	μA	RAS = CAS ≥ (V _{CC} - 0.2V)	
				130	μA	All other inputs are stable at (V _{CC} - 0.2V) or (V _{SS} + 0.2V)	
I _{CC3}	Refresh Current (RAS only refresh)	-50 -60 -70		170 150 130	mA mA mA	t _{RC} = t _{RC} (min.) RAS cycling, CAS = V _{IH}	1
I _{CC4}	Fast Page Mode Current	-50		100	mA	t _{PC} = t _{PC} (min.)	1,2
		-60		90	mA	RAS = V _{IL}	
		-70		80	mA	CAS, Address cycling	
I _{CC5}	Refresh Current (CAS before RAS refresh)	-50		170	mA	t _{RC} = t _{RC} (min.)	
		-60		150	mA	RAS, CAS cycling	1
		-70		130	mA		
I _{CC6}	Refresh Current (L version : CAS before RAS refresh)			500	μA	1,024 cycles / 128ms t _{RAS} ≤ 200ns, WE ≥ (V _{CC} - 0.2V) All other inputs are stable at (V _{CC} - 0.2V) or (V _{SS} + 0.2V)	
I _{CC7}	Self Refresh Mode Current (L version)			300	μA	RAS = CAS ≥ (V _{CC} - 0.2V) All other input high levels are (V _{CC} - 0.2V) input low levels are (V _{SS} + 0.2V)	
I _{L1}	Input Leakage Current (Any input pin)		-10	10	μA	0V ≤ V _{IH} ≤ 3.6V, Others = 0V	
I _{L0}	Output Leakage Current (For high impedance state)		-10	10	μA	RAS ≥ V _{IH} (min.), CAS ≥ V _{IH} (min.) 0V ≤ V _{OUT} ≤ 3.6V	
V _{OH}	Output High Voltage		2.4		V	I _{OH} = -2.0 mA	
V _{OL}	Output Low Voltage			0.4	V	I _{OL} = 2.0 mA	

Notes: 1. I_{CC1}, I_{CC3}, I_{CC4} and I_{CC5} depend on cycle rate.

2. I_{CC1} and I_{CC4} depend on output loading. Specified values are obtained with the outputs open.

CAPACITANCE (0°C ≤ Ta ≤ 70°C, V_{CC} = 3.3V ±10%, f = 1MHz)

SYMBOL	PARAMETER	MIN.	MAX.	UNIT
C _{IN1}	Address(A0 ~ A9)	—	5	pF
C _{IN2}	RAS, LCAS, UCAS, WE, OE	—	5	pF
C _{OUT}	I/O1 ~ I/O16	—	7	pF

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AC ELECTRICAL CHARACTERISTICS

Test conditions : $V_{IH}/V_{IL} = 2.4V/0.8V$ $V_{OH}/V_{OL} = 2.0V/0.8V$ output loading $C_L = 100pF + 1TTL$
 Operating conditions : ($0^\circ C \leq T_{as} \leq 70^\circ C$, $V_{CC} = 3.3V \pm 10\%$, $V_{SS} = 0V$) (NOTES 3, 4, 5)

NO.	SYMBOL		PARAMETER	-50		-60		-70		UNIT	NOTE
	JEDEC	STD		MIN.	MAX.	MIN.	MAX.	MIN.	MAX.		
1	t_{CL1QV}	t_{CAC}	Access Time from CAS	—	15	—	17	—	20	ns	6,13
2	t_{CH2QV}	t_{CPA}	Access Time from CAS Precharge	—	30	—	35	—	40	ns	13,14
3	t_{AVQV}	t_{AA}	Access Time from Column Address	—	25	—	30	—	40	ns	7,13
4	t_{RL1QV}	t_{RAC}	Access Time from RAS	—	50	—	60	—	70	ns	6,7
5	t_{RL1CH1}	t_{CSH}	CAS Hold Time	50	—	60	—	70	—	ns	
6	t_{RL1CH1}	t_{CHR}	CAS Hold Time (CAS before RAS Refresh)	10	—	10	—	10	—	ns	
7	t_{RL1CX}	t_{CHS}	CAS Precharge Time (Self Refresh Mode)	-50	—	-50	—	-50	—	ns	
8	t_{CH2CL2}	t_{CPN}	CAS Precharge Time (CAS before RAS Refresh)	7	—	10	—	10	—	ns	
9	t_{CH2CL2}	t_{CP}	CAS Precharge Time (Fast Page Mode)	5	—	5	—	5	—	ns	14
10	t_{CL1CH1}	t_{CAS}	CAS Pulse Width	15	100K	15	100K	20	100K	ns	
11	t_{CL1RL2}	t_{CSR}	CAS Setup Time (CAS before RAS Refresh)	5	—	5	—	5	—	ns	
12	t_{CL1QX}	t_{CLZ}	CAS to Output in Low-Z	0	—	0	—	0	—	ns	8
13	t_{CH2RL2}	t_{CRP}	CAS to RAS Precharge Time	5	—	5	—	5	—	ns	
14	t_{CL1WL2}	t_{CWD}	CAS to WE Delay Time	32	—	37	—	42	—	ns	11
15	t_{CL1AX}	t_{CAH}	Column Address Hold Time	7	—	10	—	12	—	ns	
16	t_{RL1AX}	t_{AR}	Column Address Hold Time Referenced to RAS	35	—	40	—	40	—	ns	
17	t_{AVCL2}	t_{ASC}	Column Address Setup Time	0	—	0	—	0	—	ns	14
18	t_{AVRH1}	t_{RAL}	Column Address to RAS Lead Time	25	—	30	—	35	—	ns	
19	t_{AVWL2}	t_{AWD}	Column Address to WE Delay Time	39	—	47	—	54	—	ns	11
20	t_{CL1DX} t_{WL1DX}	t_{DH}	Data Hold Time	7	—	10	—	10	—	ns	12
21	t_{DVCL2} t_{DWWL2}	t_{DS}	Data Setup Time	0	—	0	—	0	—	ns	12
22	t_{OL1QV}	t_{OEA}	OE Access Time	—	15	—	17	—	20	ns	
23	t_{WL1OL2}	t_{OEH}	OE Command Hold Time	13	—	15	—	20	—	ns	
24	t_{CH2QV}	t_{OED}	OE to Data Delay Time	13	—	15	—	20	—	ns	
25	t_{CH2QZ}	t_{OFF}	Output Buffer Turn-off Delay Time	0	13	0	15	0	20	ns	10
26	t_{CH2QX}	t_{OEZ}	Output Buffer Turn-off Delay Time Referenced to OE	0	13	0	15	0	20	ns	
27	t_{CL1RH1}	t_{RSH}	RAS Hold Time	13	—	15	—	18	—	ns	
28	t_{CL1RH1}	t_{ROH}	RAS Hold Time Referenced to OE	10	—	10	—	10	—	ns	
29	t_{RH2RL2}	t_{RP}	RAS Precharge Time	25	—	30	—	40	—	ns	
30	t_{RH2RL2}	t_{RPS}	RAS Precharge Time (Self Refresh Mode)	90	—	110	—	130	—	ns	
31	t_{RL1RH1}	t_{RAS}	RAS Pulse Width	50	100K	60	100K	70	100K	ns	
32	t_{RL1RH1}	t_{RASP}	RAS Pulse Width (Fast Page Mode)	50	100K	60	100K	70	100K	ns	
33	t_{RL1RH1}	t_{RASS}	RAS Pulse Width (Self Refresh Mode)	300	—	300	—	300	—	μs	
34	t_{RL1CL1}	t_{RCD}	RAS to CAS Delay Time	13	35	13	45	13	50	ns	6
35	t_{RH2CL2}	t_{RPC}	RAS to CAS Precharge Time	5	—	5	—	5	—	ns	
36	t_{RL1AV}	t_{RAD}	RAS to Column Address Delay Time	11	25	11	30	11	35	ns	7

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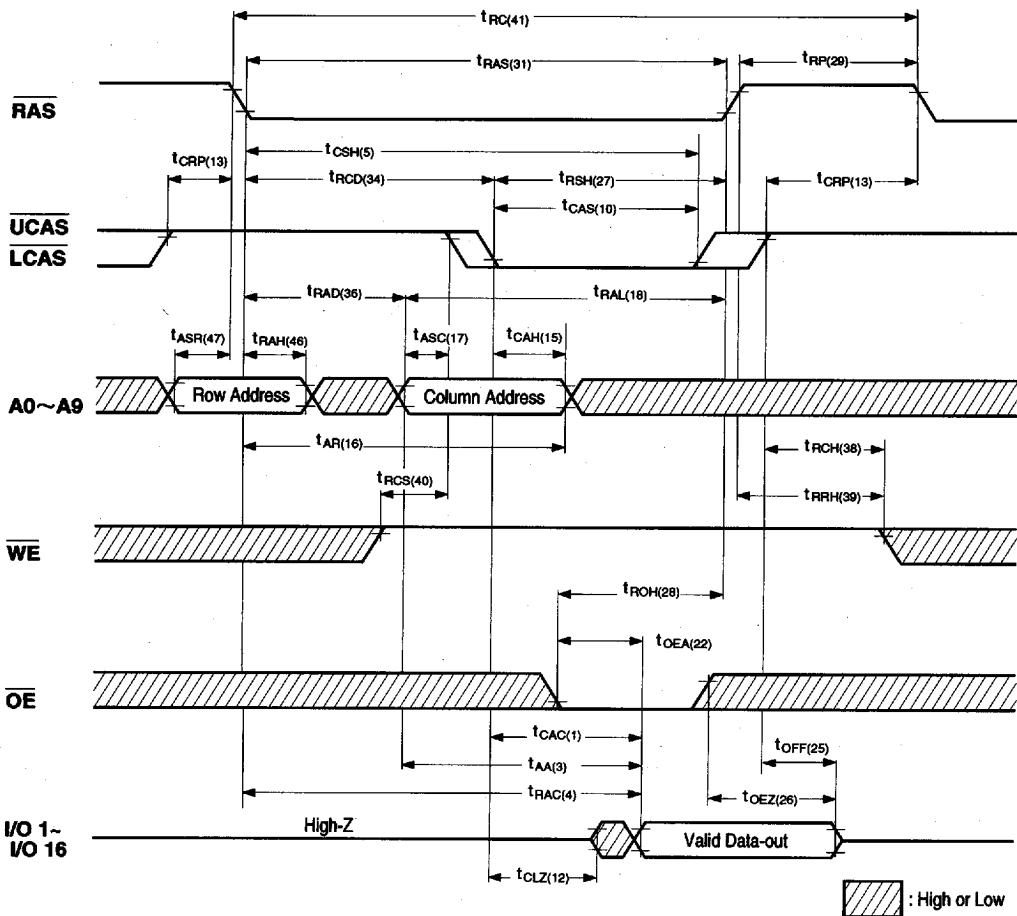
NO.	SYMBOL		PARAMETER	-50		-60		-70		UNIT	NOTE
	JEDEC	STD		MIN.	MAX.	MIN.	MAX.	MIN.	MAX.		
37	t_{RL1WL2}	t_{RWD}	RAS to WE Delay Time	64	—	77	—	89	—	ns	11
38	t_{CH2WL2}	t_{RCH}	Read Command Hold Time	0	—	0	—	0	—	ns	9
39	t_{RH2WL2}	t_{RRH}	Read Command Hold Time Referenced to RAS	0	—	0	—	0	—	ns	9
40	t_{WH2CL2}	t_{RCS}	Read Command Setup Time	0	—	0	—	0	—	ns	
41	t_{RL2RL2}	t_{RC}	Random Read or Write Cycle Time	90	—	110	—	130	—	ns	
42	t_{CL2CL2}	t_{PC}	Read or Write Cycle Time (Fast Page Mode)	35	—	40	—	45	—	ns	13,14
43	t_{RL2RL2}	t_{RMW}	Read-Modify-Write Cycle Time	120	—	140	—	160	—	ns	
44	t_{CL2CL2}	t_{PRMW}	Read-Modify-Write Cycle Time (Fast Page Mode)	80	—	85	—	95	—	ns	13,14
45	t_{REF}	t_{REF}	Refresh Period	—	16	—	16	—	16	ms	
46	t_{RL1AX}	t_{RAH}	Row Address Hold Time	8	—	8	—	8	—	ns	
47	t_{AVRL2}	t_{ASR}	Row Address Setup Time	0	—	0	—	0	—	ns	
48	t_T	t_T	Transition Time (Rise and Fall)	1	50	1	50	1	50	ns	4,5
49	t_{CL1WH1}	t_{WCH}	Write Command Hold Time	10	—	10	—	15	—	ns	
50	t_{WL1WH1}	t_{WP}	Write Command Pulse Width	10	—	10	—	15	—	ns	
51	t_{WL1CL2}	t_{WCS}	Write Command Setup Time	0	—	0	—	0	—	ns	11
52	t_{WL1CH1}	t_{CWL}	Write Command to CAS Lead Time	7	—	10	—	13	—	ns	
53	t_{WL1RH1}	t_{RWL}	Write Command to RAS Lead Time	7	—	10	—	13	—	ns	
54	t_{WH2RL2}	t_{WRP}	WE to RAS Precharge Time	10	—	10	—	10	—	ns	
55	t_{RL1WH2}	t_{WRH}	WE to RAS Hold Time	10	—	10	—	10	—	ns	

Notes:

- Eight Initialization Cycles are required following a 200 μ s pause after Power Up. These Initialization Cycles may consist of one of the following : RAS only refresh Cycles, Read Cycles, Write Cycles,CAS before RAS refresh Cycles.
- AC measurements assume $t_T=2$ ns.
- $V_{IH}(\text{min.})$ and $V_{IL}(\text{max.})$ are reference levels for measuring timing of input signals. Also, transition times are measured between V_{IH} and V_{IL} .
- Operation within the $t_{RCD}(\text{max.})$ limit ensures that $t_{RAC}(\text{max.})$ can be met. $t_{RCD}(\text{max.})$ is specified as a reference point only. If t_{RCD} is greater than the specified $t_{RCD}(\text{max.})$ limit, then access time is controlled by t_{CAC} .
- Operation within the $t_{RAD}(\text{max.})$ limit ensures that $t_{RAC}(\text{max.})$ can be met. $t_{RAD}(\text{max.})$ is specified as a reference point only. If t_{RAD} is greater than the specified $t_{RAD}(\text{max.})$ limit, then access time is controlled by t_{AA} .
- Assumes three state test load (500 ohm to 1.4V Thevenin equivalent).
- Either t_{RCH} or t_{RRH} must be satisfied for a read cycle.
- $t_{OFF}(\text{max.})$ defines the time at which the output achieves an open circuit condition and is not referenced to output voltage levels.
- t_{WCS} , t_{RWD} , t_{CWD} and t_{AWD} are not restrictive operating parameters. They are included in the data sheet as electrical characteristics only. If $t_{WCS} \geq t_{WCS}(\text{min.})$, the cycle is an early write cycle and data-out pins will remain open circuit (high impedance) throughout the entire cycle. If $t_{RWD} \geq t_{RWD}(\text{min.})$, $t_{CWD} \geq t_{CWD}(\text{min.})$ and $t_{AWD} \geq t_{AWD}(\text{min.})$, the cycle is a read-modify-write cycle and the data-out will contain data read from the selected cell. If neither of the above conditions is satisfied, the condition of the data-out (at access time) is indeterminate.
- These parameters are referenced to CAS leading edge in early write cycles and to WE leading edge in read-modify-write cycles.
- Access time is determined by the longer of t_{AA} , t_{CAC} , or t_{CPA} .
- $t_{ASC} \geq t_{CP}$ to achieve $t_{PC}(\text{min.})$ and $t_{CPA}(\text{max.})$ values.
- $t_{REF}=128$ msec for Long Refresh version (L version).

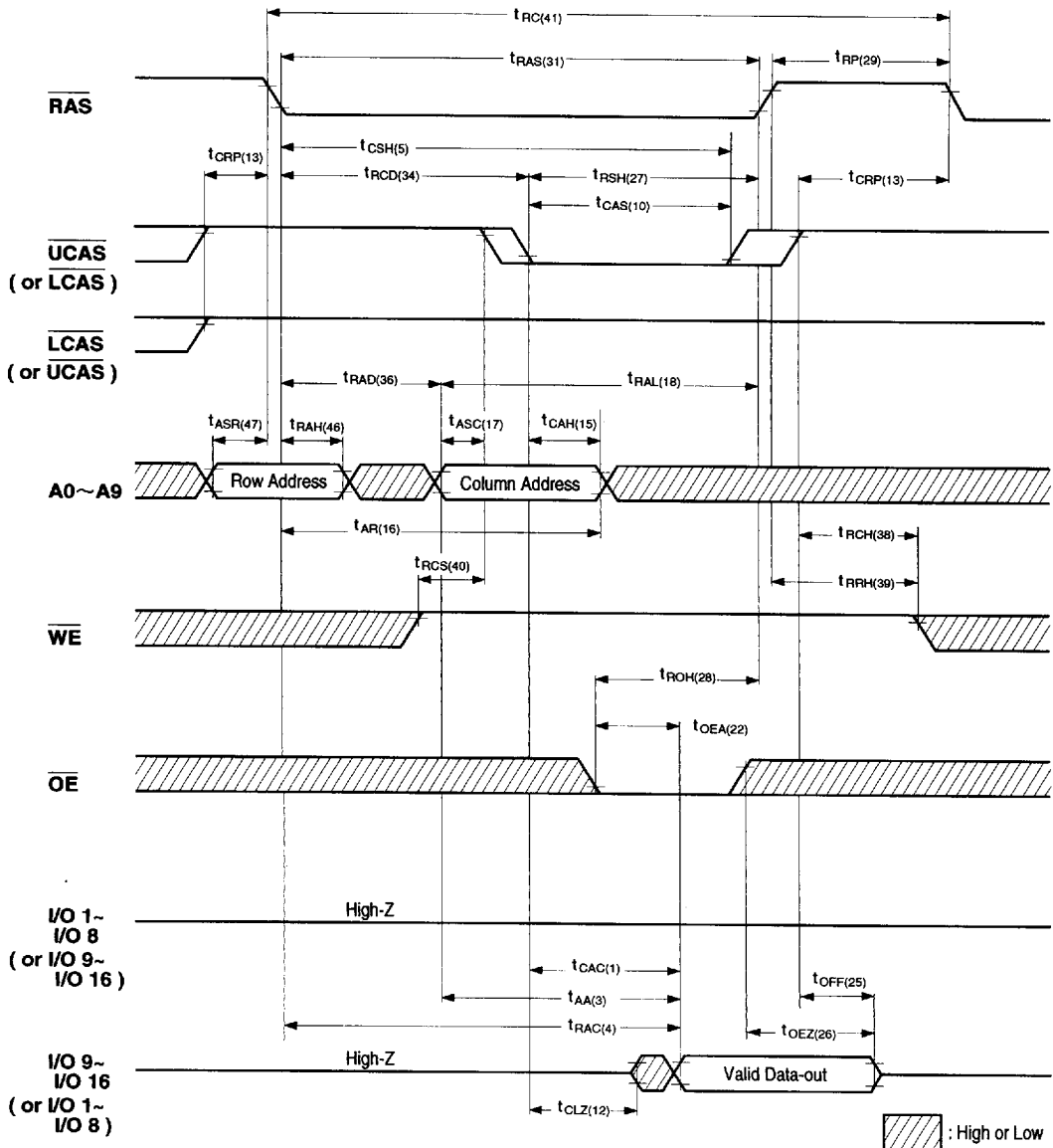
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WORD READ CYCLE



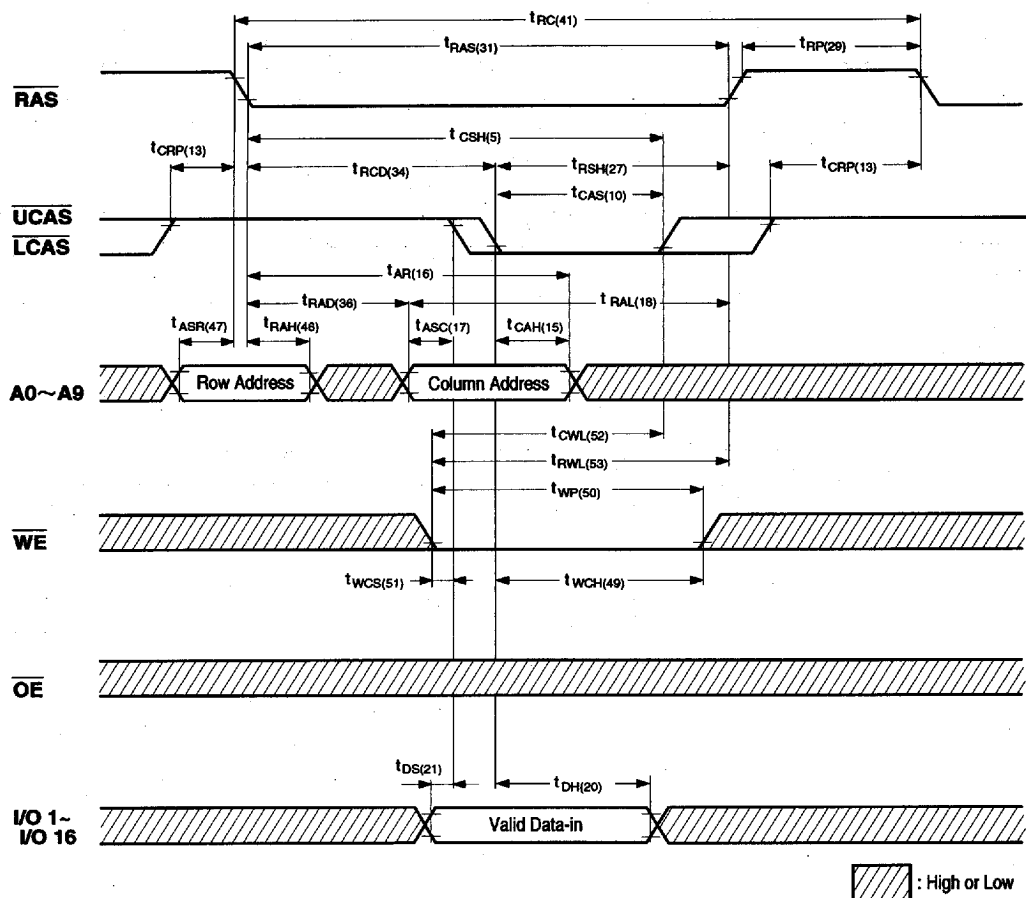
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BYTE READ CYCLE



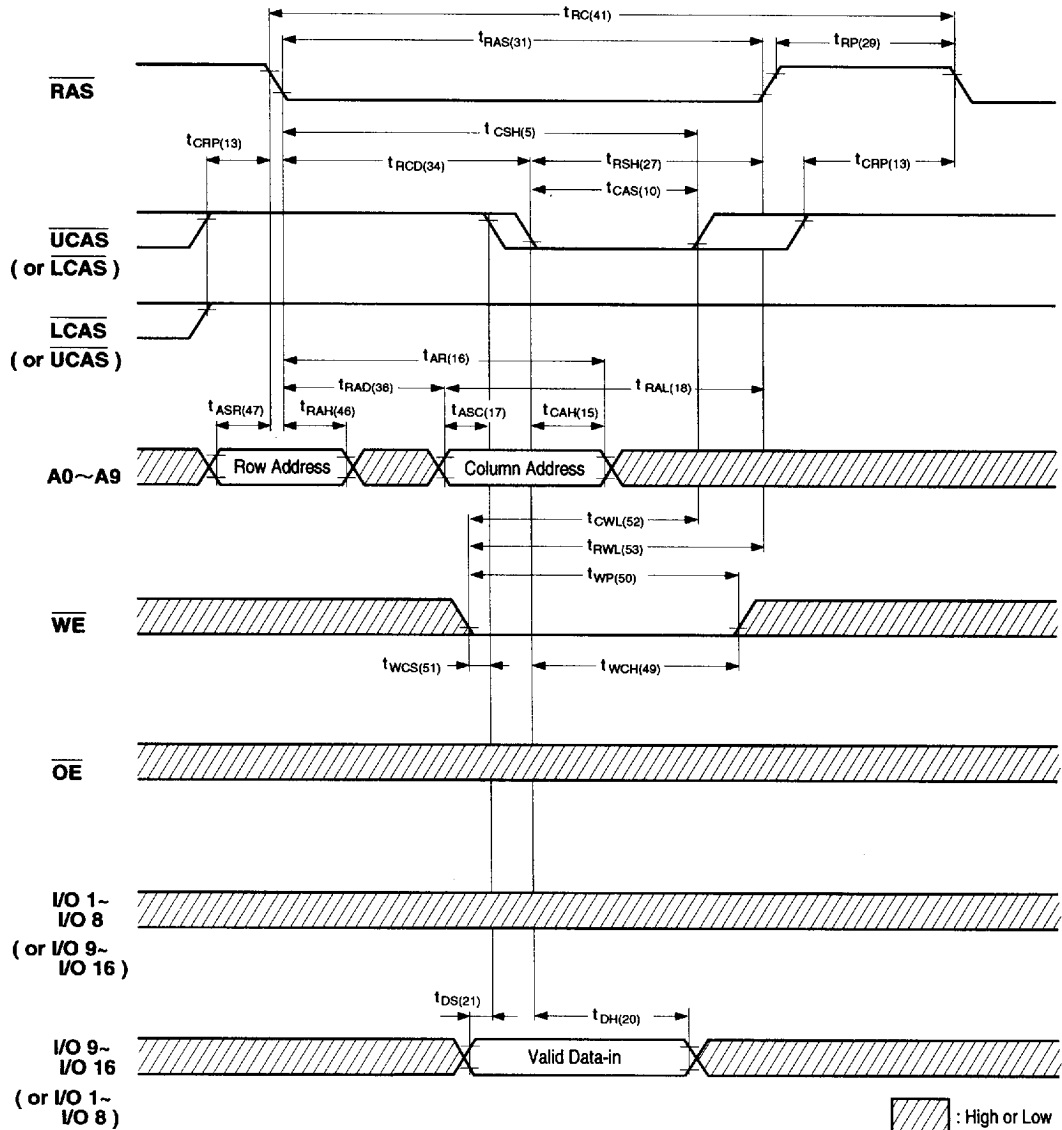
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WORD WRITE CYCLE (EARLY WRITE)



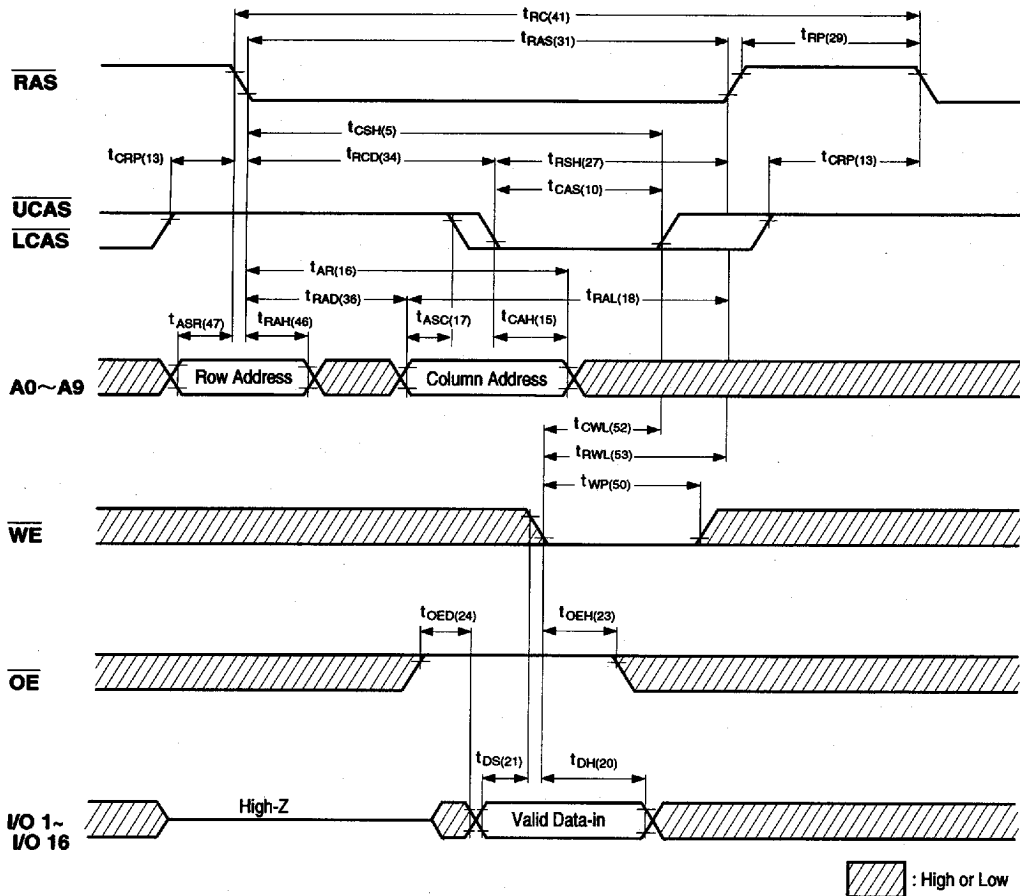
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BYTE WRITE CYCLE (EARLY WRITE)



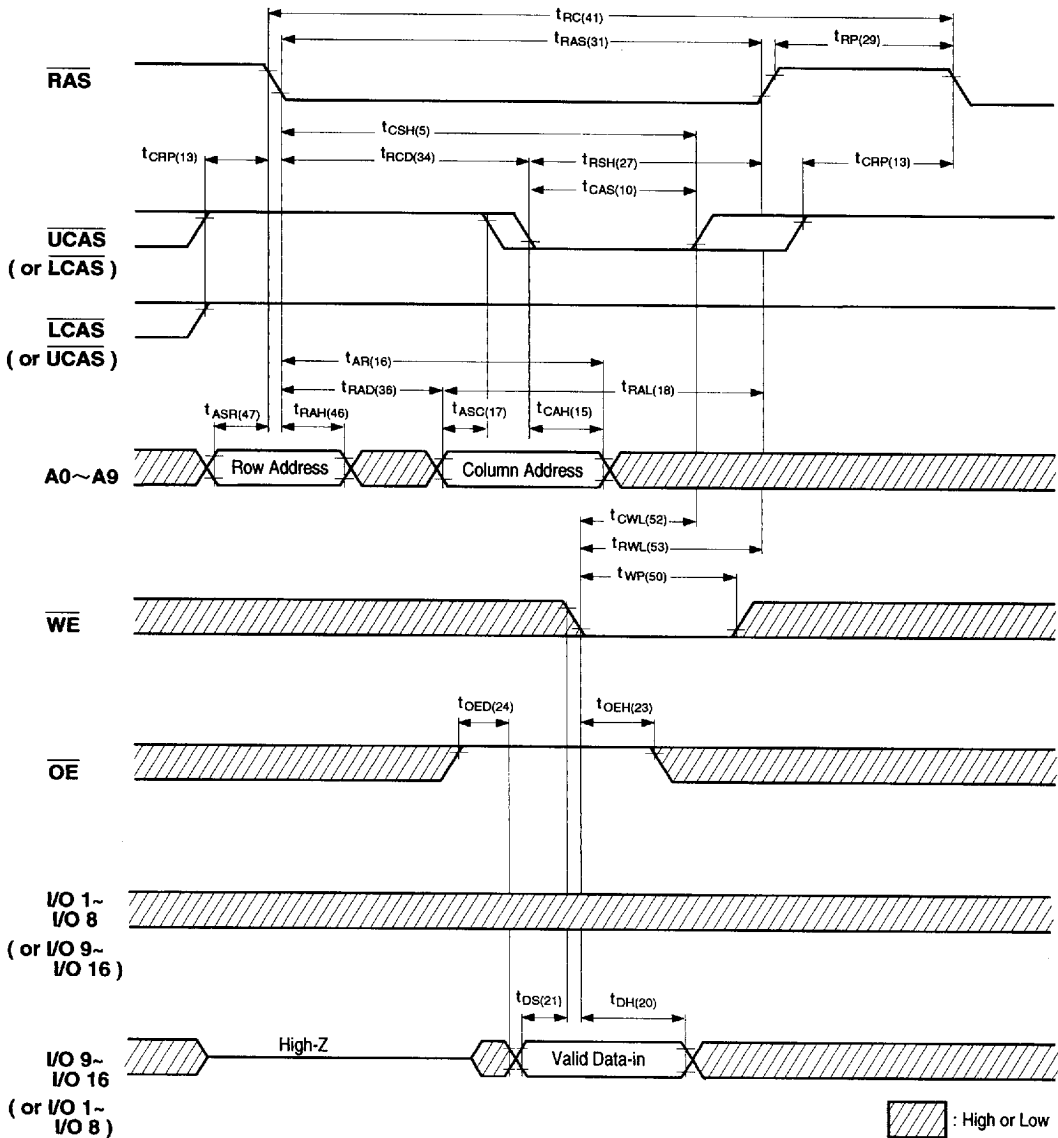
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WORD WRITE CYCLE ($\overline{OE}$ -CONTROLLED WRITE)



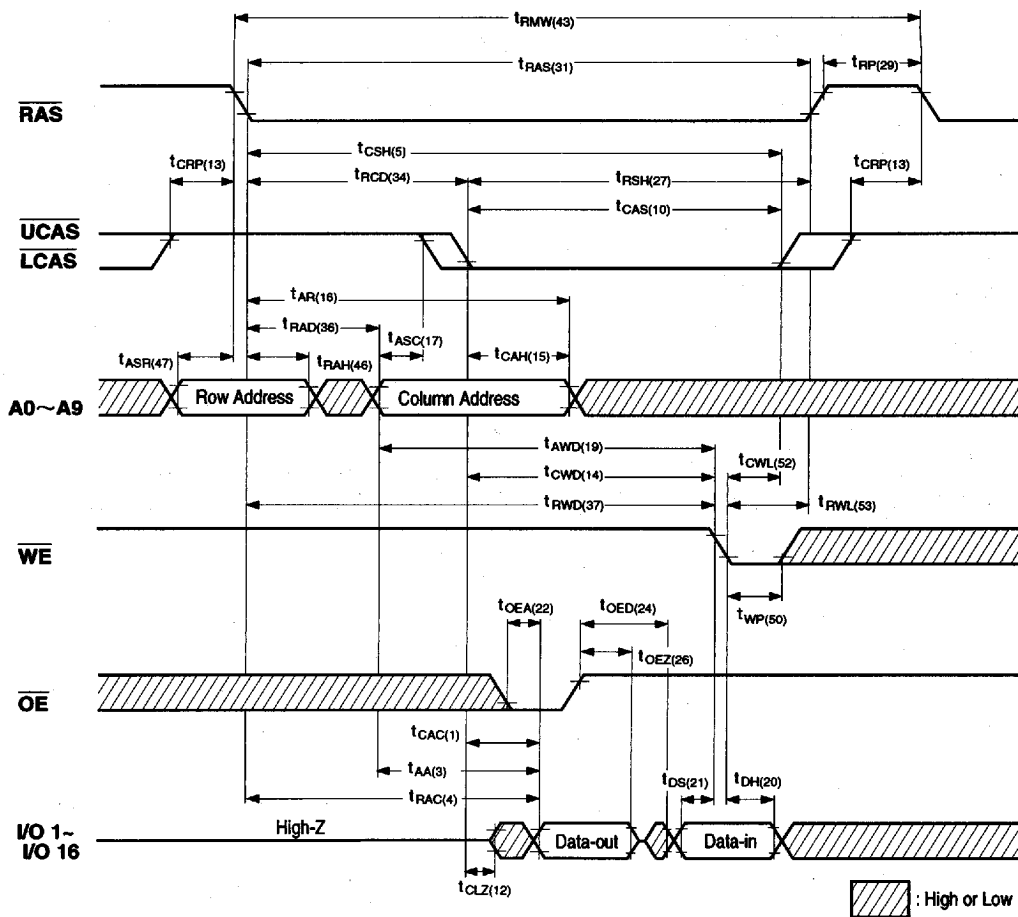
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BYTE WRITE CYCLE ($\overline{OE}$ -CONTROLLED WRITE)



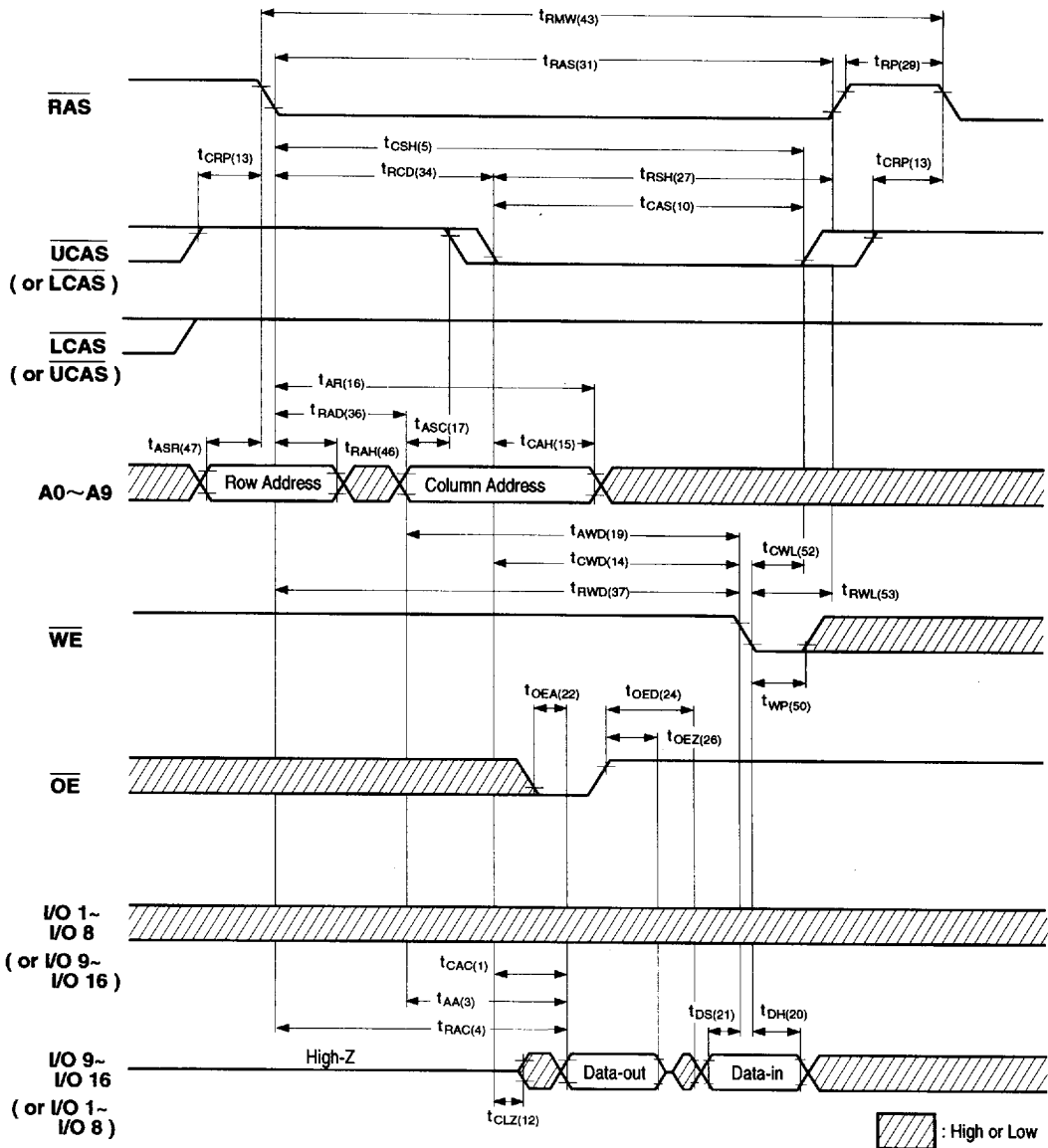
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WORD READ-MODIFY-WRITE CYCLE



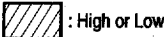
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BYTE READ-MODIFY-WRITE CYCLE



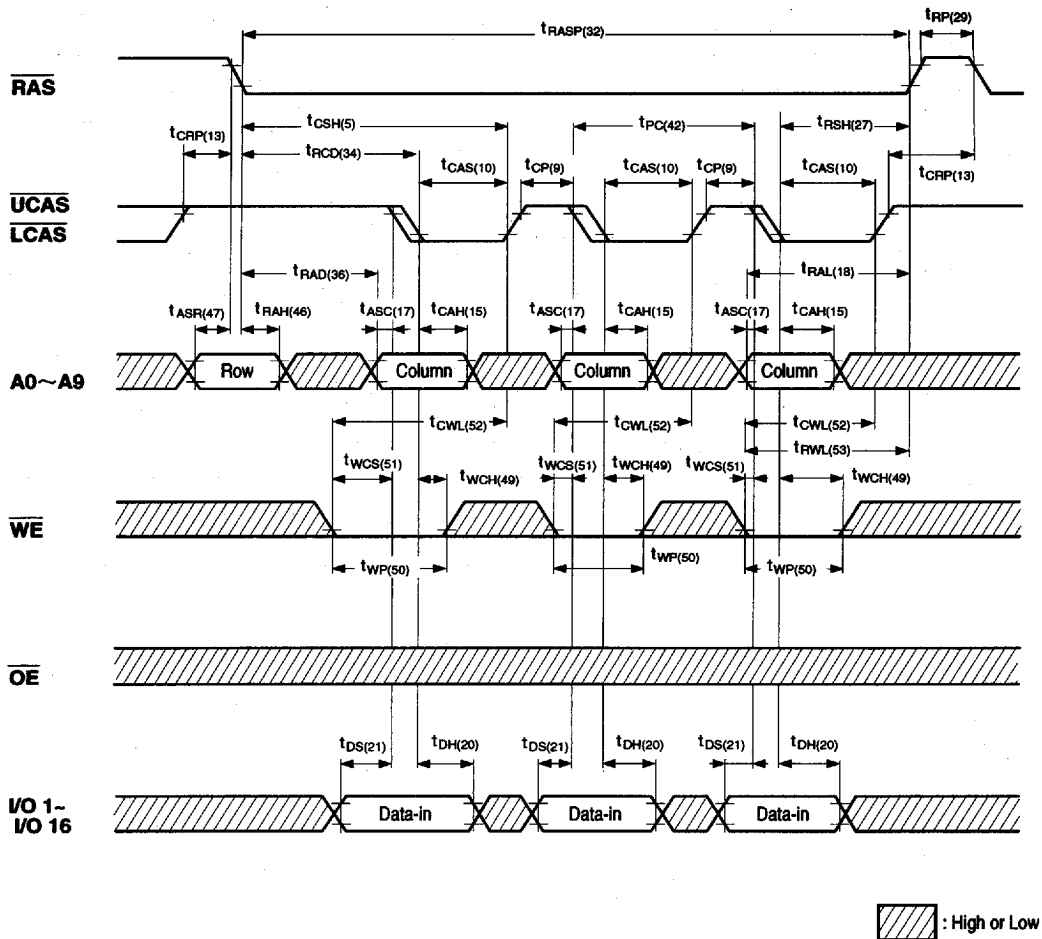
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FAST PAGE MODE WORD READ CYCLE



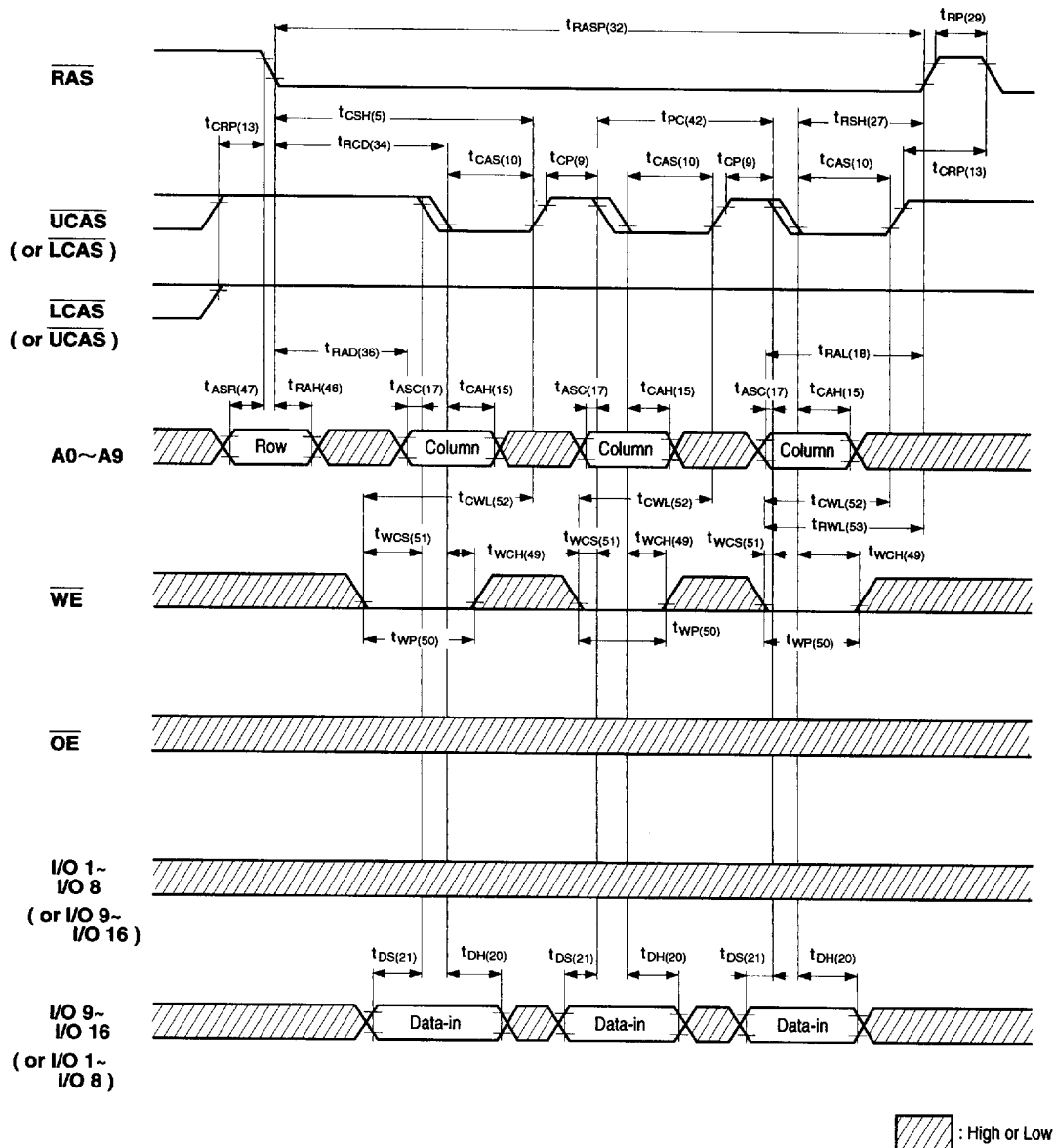


FAST PAGE MODE EARLY WORD WRITE CYCLE



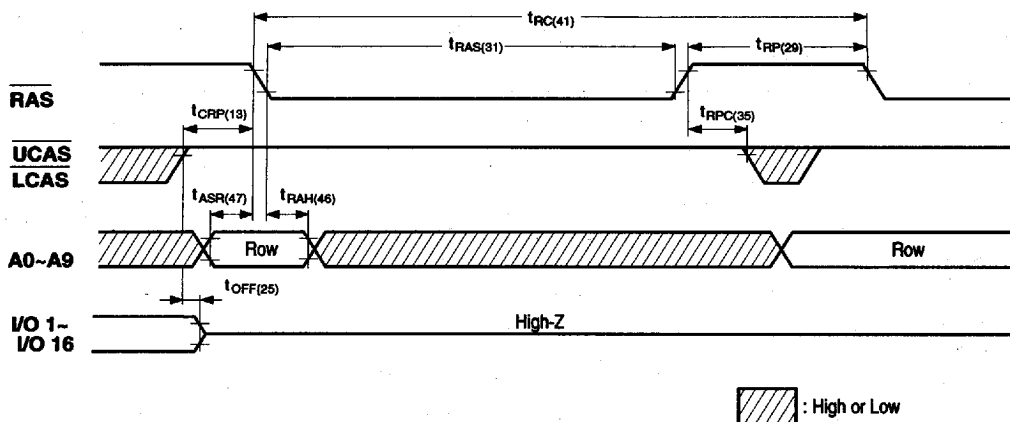
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FAST PAGE MODE EARLY BYTE WRITE CYCLE



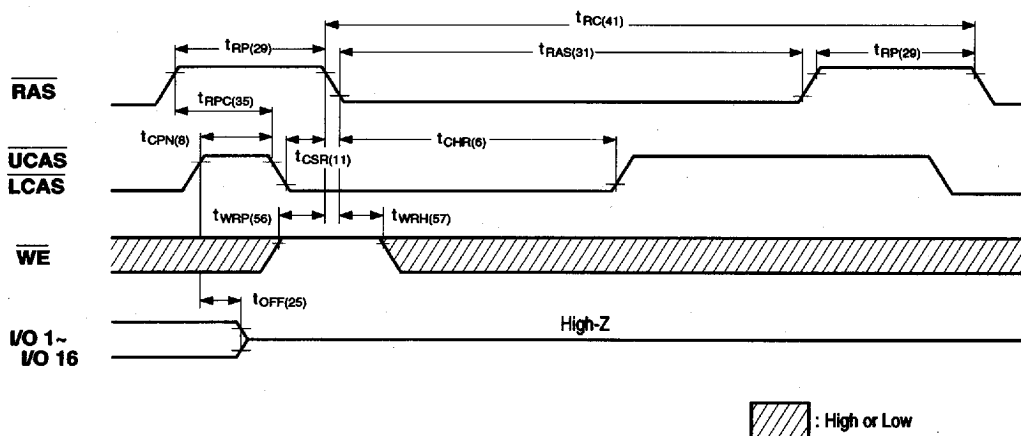
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RAS ONLY REFRESH CYCLE



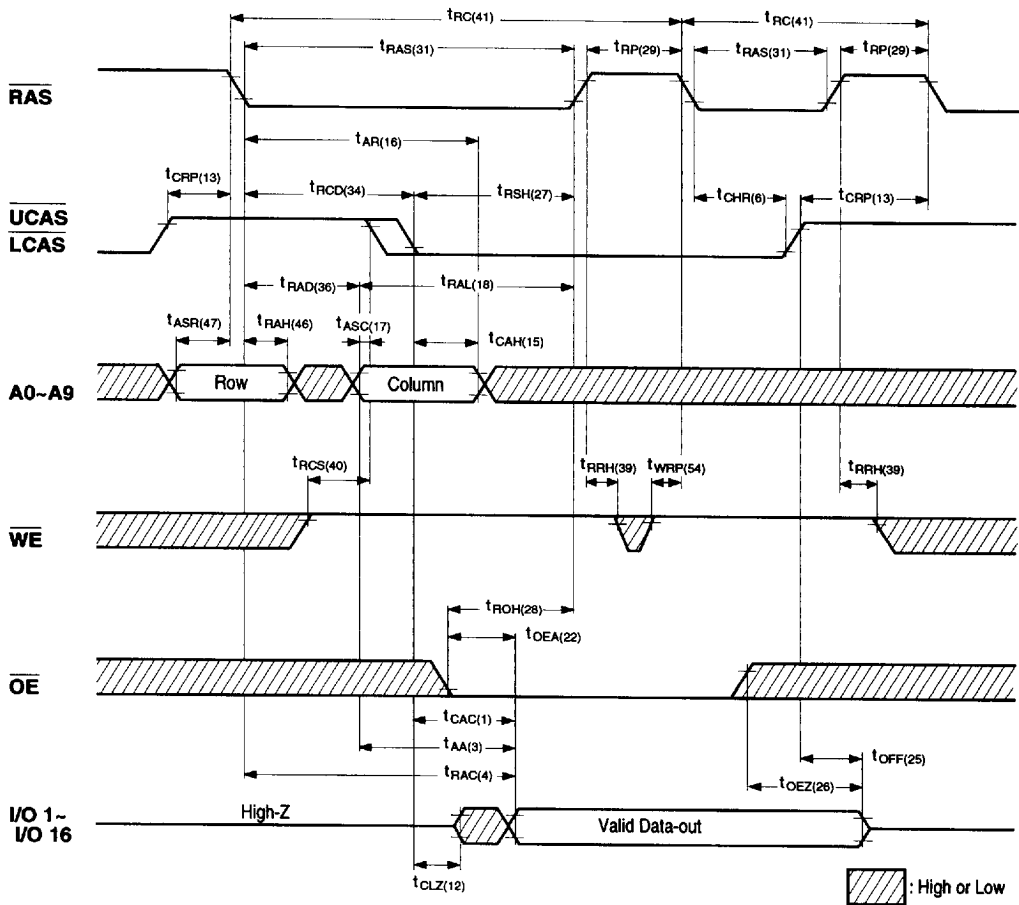
Note: $\overline{WE}$, $\overline{OE}$ = Don't care.

CAS BEFORE RAS REFRESH CYCLE



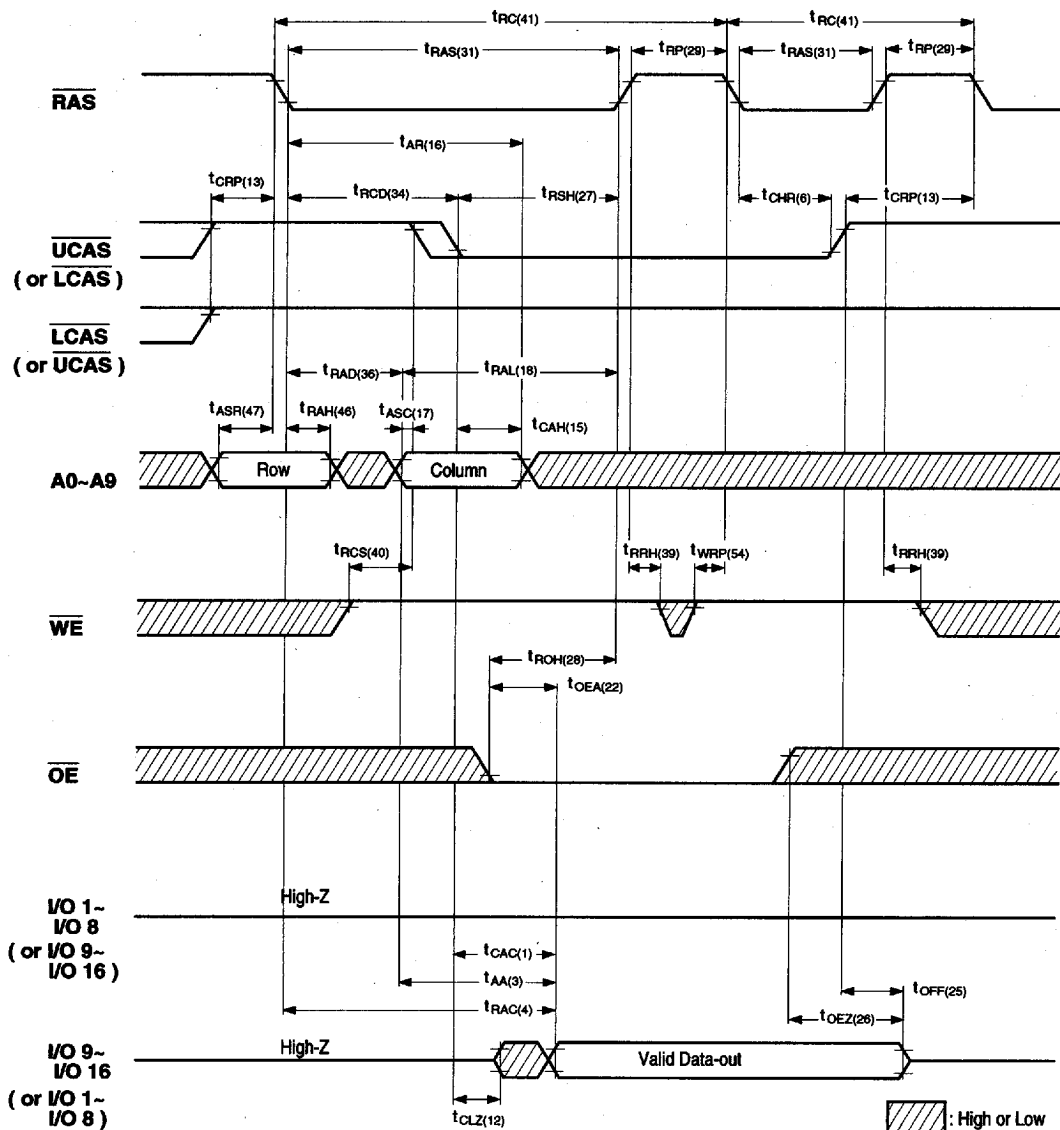
Note: $\overline{OE}$, A0~A9 = Don't care.

HIDDEN REFRESH CYCLE (WORD READ)



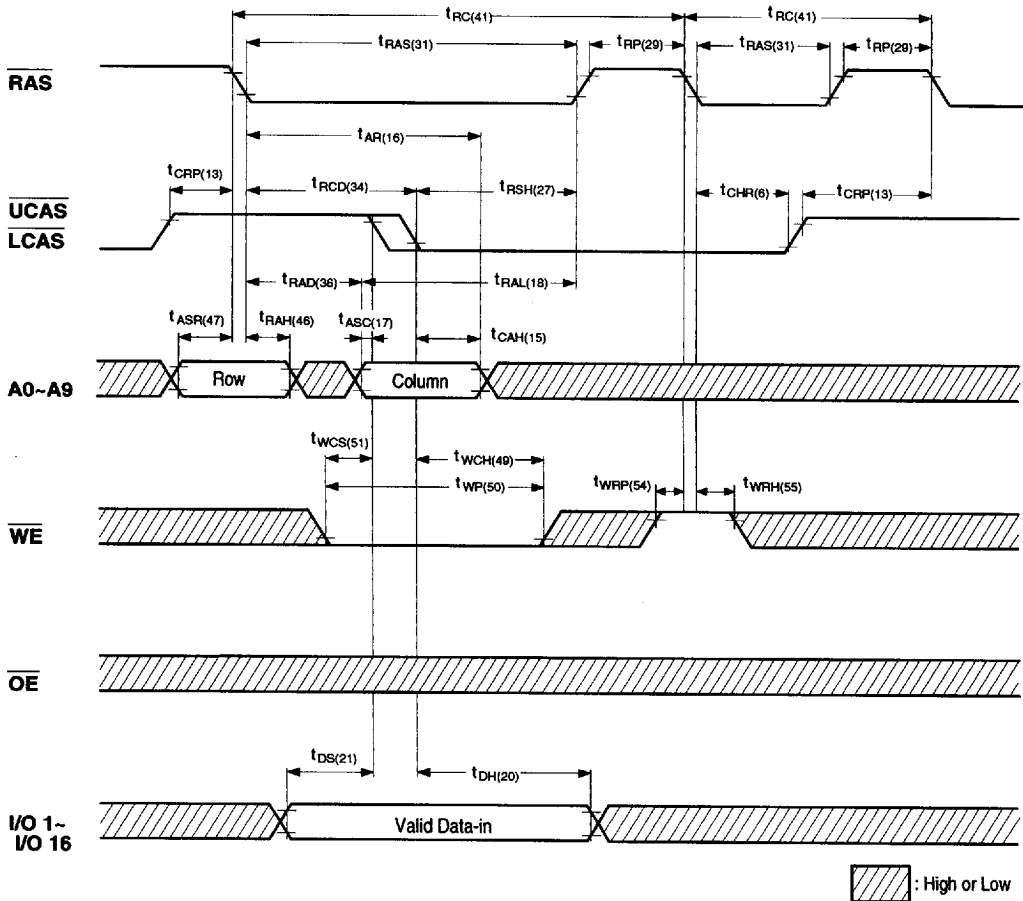
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HIDDEN REFRESH CYCLE (BYTE READ)



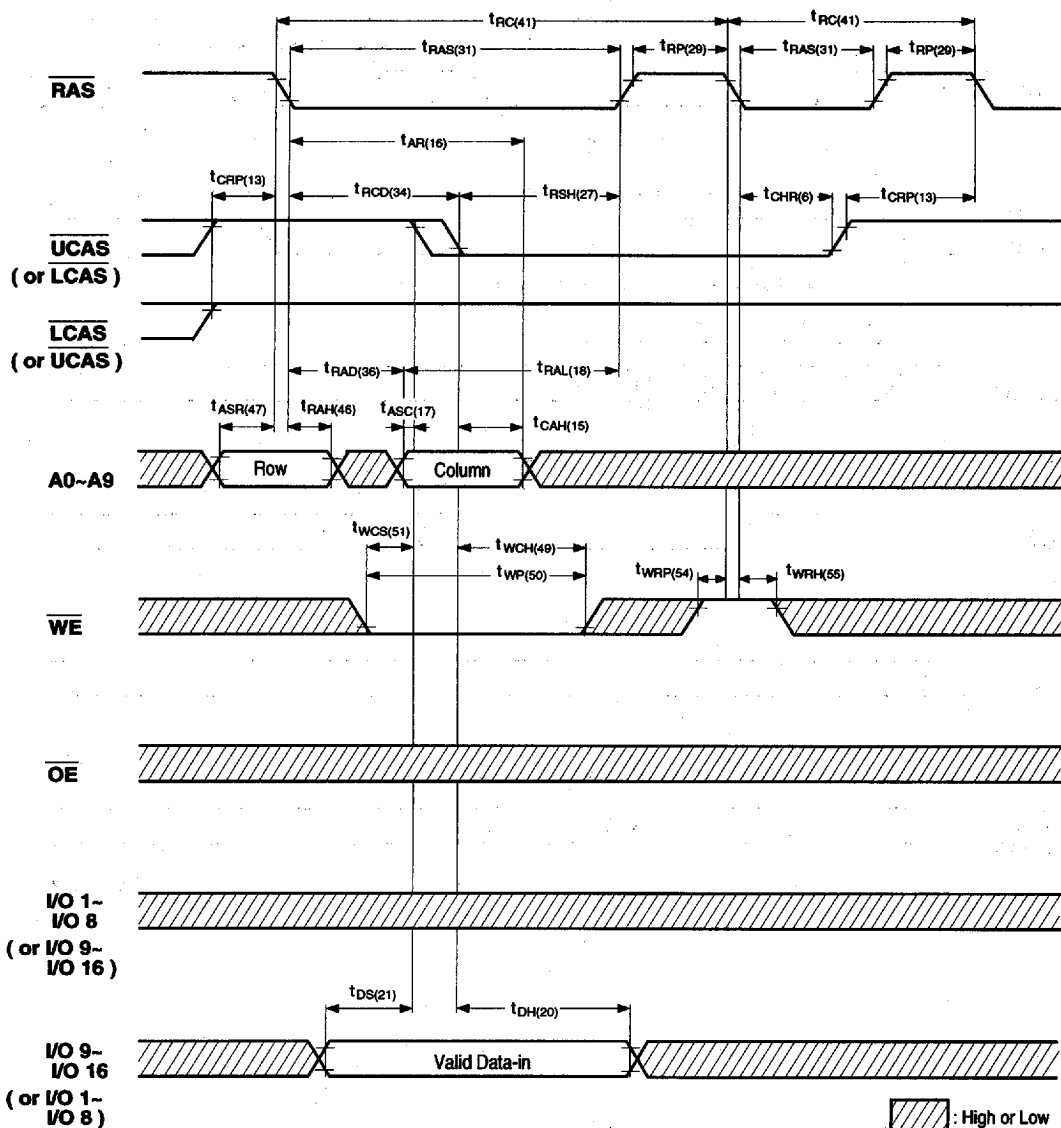
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HIDDEN REFRESH CYCLE (EARLY WORD WRITE)



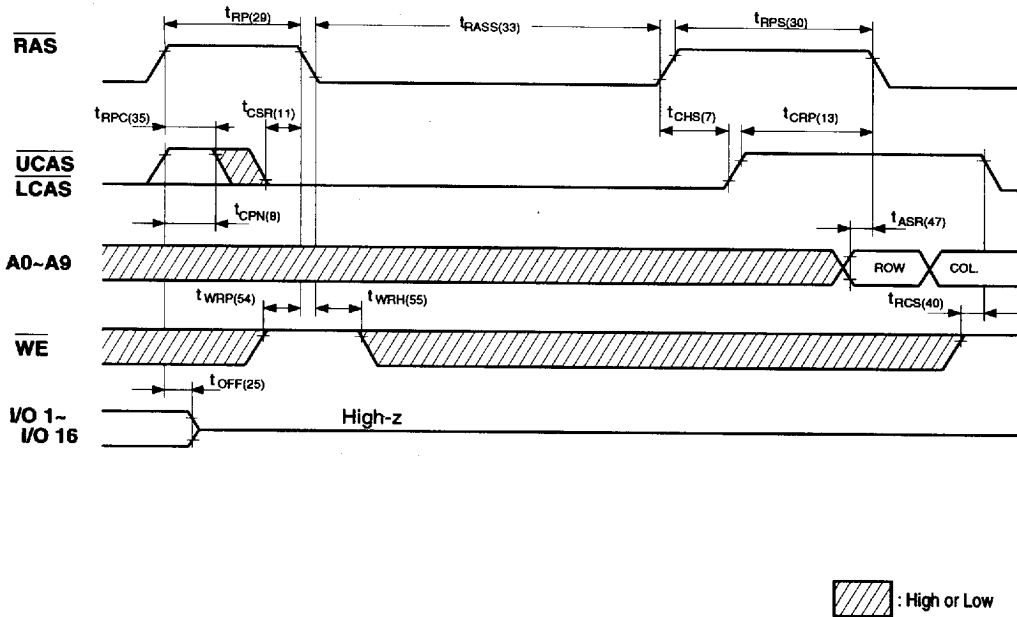
9005650 0001107 T67

HIDDEN REFRESH CYCLE (EARLY BYTE WRITE)



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SELF REFRESH MODE



■ The NN51V18160B (L version) has a Self Refresh Mode.

a. Entering the Self Refresh Mode:

The NN51V18160BL Self Refresh Mode is entered by using $\overline{CAS}$ before $\overline{RAS}$ cycle and holding $\overline{RAS}$ and $\overline{CAS}$ signal "low" longer than 300 μ s.

b. Continuing the Self Refresh Mode:

The Self Refresh Mode is continuing by holding $\overline{RAS}$ "low" after entering the Self Refresh Mode. It does not depend on $\overline{CAS}$ being "high" or "low" after entering the Self Refresh Mode to continue the Self Refresh Mode.

c. Exiting the Self Refresh Mode:

The NN51V18160BL exits will exit the Self Refresh Mode when the $\overline{RAS}$ signal is brought "high".

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ORDERING INFORMATION

NN51V18160BXX(X) - XX

	SPEED	50 : 50ns 60 : 60ns 70 : 70ns
	PACKAGE	J : Plastic SOJ TT : Plastic TSOP TYPE II (Normal Bend) RR : Plastic TSOP TYPE II (Reverse Bend)
	VERSION	BLANK: Standard Version L : Long Refresh Version 128ms Refresh
	DESIGN CODE	B
	MODE	18160 : Fast Page Mode 1M x 16,1024 Refresh Cycle
	POWER SUPPLY	V : 3.3V Version

■ 9005650 0001110 551 ■