DESCRIPTION

The NN514100 series is a high performance CMOS Dynamic Random Access Memory organized as 4,194,304 words by 1 bit. The NN514100 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 NN514100 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 $\overline{CAS}$ which, in essence, acts as an output enable independent of $\overline{RAS}$ with very fast CAS to output access time.

Refresh is accomplished by performing $\overline{RAS}$ only refresh cycles, hidden refresh cycles, $\overline{CAS}$ before $\overline{RAS}$ refresh cycles, or normal read or write cycles on the 1,024 address combinations of A0 to A9 during a 16 ms period.

Multiplexed address inputs permit The NN514100 series be packaged in a standard 26-pin plastic SOJ, 20-pin plastic ZIP and 26 pin TSOP TYPE II. The package sizes provide high system bit densities and are compatible with widely available automated testing and insertion equipment. System level features include single power supply of 5V ±10% tolerance and direct interface with high performance TTL logic families.

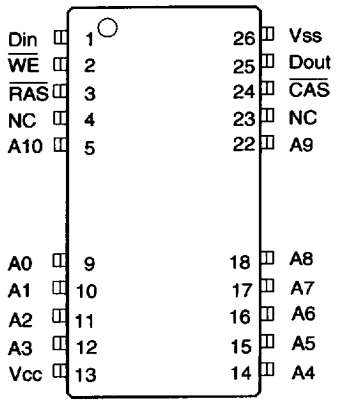
FEATURES

- 4,194,304 × 1 bit Organization
- Single 5V ±10% Power Supply
- Performance Ranges

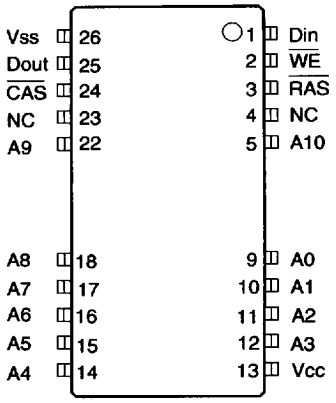
Parameter	-45	-50	-60	-70
Max. $\overline{RAS}$ Access Time (t_{RAC})	45ns	50ns	60ns	70ns
Max. $\overline{CAS}$ Access Time (t_{CAC})	15ns	15ns	15ns	20ns
Max. Column Address Access Time (t_{AA})	25ns	27ns	30ns	35ns
Min. Read/Write Cycle Time (t_{RC})	80ns	90ns	110ns	130ns

- Fast Page Mode Operation
- Low Power Operation
  Low Standby Current (CMOS level inputs)
  – Standard 1mA
  – L version 50µA
- 1,024 Refresh Cycles
  – Standard distributed across 16ms
  – L version distributed across 128ms
- Self Refresh Mode
  (L version)
- All inputs/Outputs and Clocks
  fully TTL and CMOS compatible
- Refresh Modes
  $\overline{RAS}$ only
  $\overline{CAS}$ before $\overline{RAS}$
  Hidden Refresh
- ×8 bit Test Mode
- High Reliability Package
  Plastic 20pin ZIP (P20ZP-2B0)
  Plastic 26pin SOJ (P26SJ-2A6)
  Plastic 26pin TSOP TYPE II (P26TP-2A6/R)

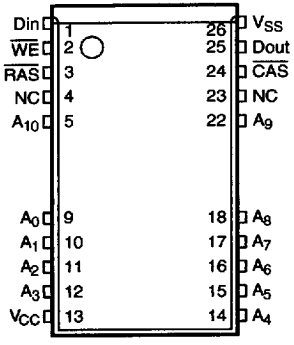
PIN CONFIGURATION (TOP VIEW)



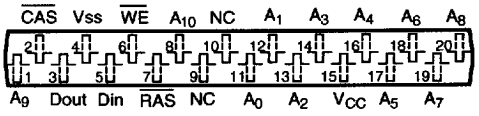
26/20-pin TSOP TYPE (II)
Normal Bend (300 mil)
P26TP-2A6



26/20-pin TSOP TYPE (II)
Reverse Bend (300 mil)
P26TP-2A6-R



26/20-pin SOJ (300mil)
P26SJ-2A6

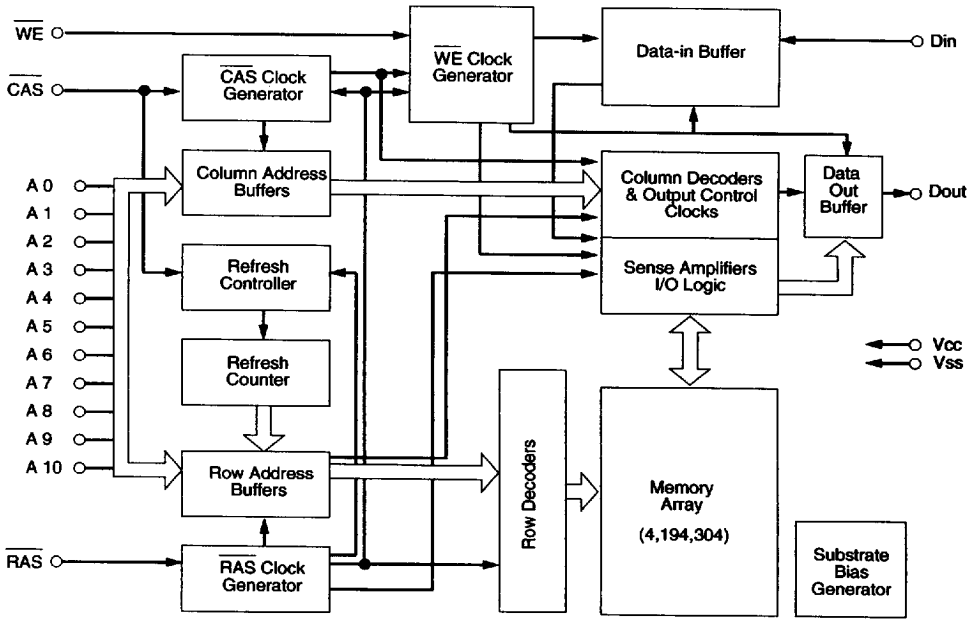


20-pin ZIP (400mil)
P20ZP-2B0

PIN NAMES

A0~A10	Address Inputs
$\overline{RAS}$	Row Address Strobe
$\overline{CAS}$	Column Address Strobe
Din	Data-in
Dout	Data-out
$\overline{WE}$	Write Enable
V_{CC}	+5V Supply
V_{SS}	Ground
NC	No Connection

FUNCTIONAL BLOCK DIAGRAM



ABSOLUTE MAXIMUM RATINGS

RATING	SYMBOL	VALUE	UNIT
Voltage on Any Pin Relative to V_{SS}	Vin,Vout	−1 to 7	V
Voltage on Vcc Relative to V_{SS}	V_{CC}	−1 to 7	V
Storage Temperature (Plastic)	Tstg	−55 to +125	°C
Power Dissipation	Pd	1.0	W
Ambient Operating Temperature	Ta	0 to + 70	°C
Short Circuit Output Current	Iout	50	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	4.5	5.0	5.5	V
V_{SS}	Supply Voltage	0	0	0	V
V_{IH}	Input High Voltage, All Inputs	2.4	—	6.5	V
V_{IL}	Input Low Voltage, All Inputs	−1.0	—	0.8	V

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

DC ELECTRICAL CHARACTERISTICS (0°C ≤ Ta ≤ 70°C, V_{CC} = 5.0V ±10%)

SYMBOL	PARAMETER	SPEED	MIN.	MAX.	UNIT	TEST CONDITIONS	NOTES
I_{CC1}	Operating Current	-45 -50 -60 -70		130 120 110 100	mA mA mA mA	t_{RC} = t_{RC} (min.) $\overline{RAS}$, $\overline{CAS}$, Address cycling	1, 2
I_{CC2}	Standby Current			1.0	mA	$\overline{RAS}$ = $\overline{CAS}$ ≥ (V_{CC} - 0.2V)	
				2.0	mA	$\overline{RAS}$ = $\overline{CAS}$ ≥ V_{IH}	
	Standby Current (L version)			50	µA	$\overline{RAS}$ = $\overline{CAS}$ ≥ (V_{CC} - 0.2V) All other inputs are stable at (V_{CC} - 0.2V) or (V_{SS} + 0.2V)	
I_{CC3}	Refresh Current ($\overline{RAS}$ only refresh)	-45 -50 -60 -70		130 120 110 100	mA mA mA mA	t_{RC} = t_{RC} (min.) $\overline{RAS}$ cycling, $\overline{CAS}$ = V_{IH}	1
I_{CC4}	Fast Page Mode Current	-45 -50 -60 -70		75 70 60 50	mA mA mA mA	t_{PC} = t_{PC} (min.) $\overline{RAS}$ = V_{IL} $\overline{CAS}$, Address cycling	1,2
I_{CC5}	Refresh Current ($\overline{CAS}$ before $\overline{RAS}$ refresh)	-45 -50 -60 -70		130 120 110 100	mA mA mA mA	t_{RC} = t_{RC} (min.) $\overline{RAS}$, $\overline{CAS}$ cycling	1
I_{CC6}	Refresh Current (L version : $\overline{CAS}$ before $\overline{RAS}$ refresh)			150	µA	1024 cycles / 128ms t_{RAS} ≤ 200ns, $\overline{WE}$ ≥ (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)			100	µA	$\overline{RAS}$ =$\overline{CAS}$ ≤ (V_{SS} + 0.2V) All other input high levels are (V_{CC} - 0.2V) or input low levels are (V_{SS} + 0.2V)	
$\|I_{LI}\|$	Input Leakage Current (Any input pin)		-10	10	µA	0V ≤ V_{IH} ≤ 5.5V, Others = 0V	
$\|I_{LO}\|$	Output Leakage Current (For high impedance state)		-10	10	µA	$\overline{RAS}$ ≥ V_{IH}(min.), $\overline{CAS}$ ≥ V_{IH}(min.) 0V ≤ V_{OUT} ≤ 5.5V	
V_{OH}	Output High Voltage		2.4		V	I_{OH} = –5.0 mA	
V_{OL}	Output Low Voltage			0.4	V	I_{OL} = 4.2 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} = 5.0V ±10%, f = 1MHz)

SYMBOL	PARAMETER	MIN.	MAX.	UNIT
C_{IN1}	Address(A0 ~ A10)	—	5	pF
C_{IN2}	$\overline{RAS}$, $\overline{CAS}$, $\overline{WE}$, Din	—	5	pF
C_{OUT}	Dout	—	7	pF

A.C. OPERATING CONDITIONS (0 °C≤Ta≤70°C, V_{CC} = 5 V ± 10%, V_{SS} = 0 V) (NOTES 3, 4, 5)

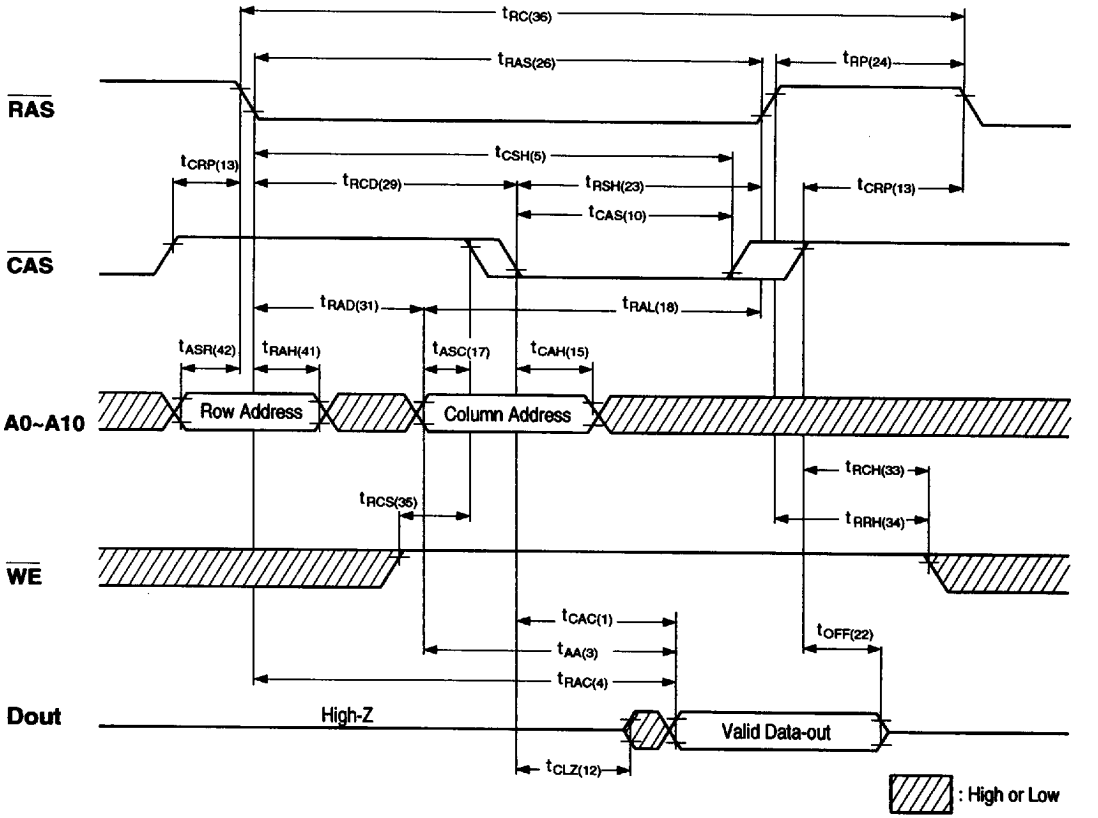
NO.	NOTES		PARAMETER	-45		-50		-60		-70		UNIT	NOTE
	JEDEC	STD.		MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.		
1	t_{CL1QV}	t_{CAC}	Access Time from $\overline{CAS}$	—	15	—	15	—	15	—	20	ns	6,13
2	t_{CH2QV}	t_{CPA}	Access Time from $\overline{CAS}$ Precharge	—	30	—	32	—	35	—	40	ns	13,14
3	t_{AVQV}	t_{AA}	Access Time from Column Address	—	25	—	27	—	30	—	35	ns	7,13
4	t_{RL1QV}	t_{RAC}	Access Time from $\overline{RAS}$	—	45	—	50	—	60	—	70	ns	6,7
5	t_{RL1CH1}	t_{CSH}	$\overline{CAS}$ Hold Time	45	—	50	—	60	—	70	—	ns	
6	t_{RL1CH1}	t_{CHR}	$\overline{CAS}$ Hold Time ($\overline{CAS}$ before $\overline{RAS}$ Refresh)	10	—	10	—	10	—	10	—	ns	
7	t_{RL1CX}	t_{CHS}	$\overline{CAS}$ Hold Time (Self Refresh Mode)	-50	—	-50	—	-50	—	-50	—	ns	
8	t_{CH2CL2}	t_{CPN}	$\overline{CAS}$ Precharge Time ($\overline{CAS}$ before $\overline{RAS}$ Refresh)	10	—	10	—	10	—	10	—	ns	
9	t_{CH2CL2}	t_{CP}	$\overline{CAS}$ Precharge Time (Fast Page Mode)	5	—	5	—	5	—	5	—	ns	14
10	t_{CL1CH1}	t_{CAS}	$\overline{CAS}$ Pulse Width	15	100K	15	100K	15	100K	20	100K	ns	
11	t_{CL1RL2}	t_{CSR}	$\overline{CAS}$ Setup Time ($\overline{CAS}$ before $\overline{RAS}$ Refresh)	5	—	5	—	5	—	5	—	ns	
12	t_{CL1QX}	t_{CLZ}	$\overline{CAS}$ to Output in Low-Z	0	—	0	—	0	—	0	—	ns	8
13	t_{CH2RL2}	t_{CRP}	$\overline{CAS}$ to $\overline{RAS}$ Precharge Time	5	—	5	—	5	—	5	—	ns	
14	t_{CL1WL2}	t_{CWD}	$\overline{CAS}$ to $\overline{WE}$ Delay Time	15	—	15	—	15	—	20	—	ns	11
15	t_{CL1AX}	t_{CAH}	Column Address Hold Time	10	—	10	—	15	—	15	—	ns	
16	t_{RL1AX}	t_{AR}	Column Address Hold Time Referenced to $\overline{RAS}$	30	—	35	—	40	—	40	—	ns	
17	t_{AVCL2}	t_{ASC}	Column Address Setup Time	0	—	0	—	0	—	0	—	ns	14
18	t_{AVRH1}	t_{RAL}	Column Address to $\overline{RAS}$ Lead Time	25	—	27	—	30	—	35	—	ns	
19	t_{AVWL2}	t_{AWD}	Column Address to $\overline{WE}$ Delay Time	25	—	27	—	30	—	35	—	ns	11
20	t_{CL1DX} t_{WL1DX}	t_{DH}	Data Hold Time	15	—	15	—	15	—	15	—	ns	12
21	t_{DVCL2} t_{DVWL2}	t_{DS}	Data Setup Time	0	—	0	—	0	—	0	—	ns	12
22	t_{CH2QZ}	t_{OFF}	Output Buffer Turn-off Delay Time	0	13	0	13	0	15	0	20	ns	10
23	t_{CL1RH1}	t_{RSH}	$\overline{RAS}$ Hold Time	15	—	15	—	15	—	20	—	ns	
24	t_{RH2RL2}	t_{RP}	$\overline{RAS}$ Precharge Time	25	—	25	—	30	—	40	—	ns	
25	t_{RH2RL2}	t_{RPS}	$\overline{RAS}$ Precharge Time(Self Refresh Mode)	80	—	90	—	110	—	130	—	ns	
26	t_{RL1RH1}	t_{RAS}	$\overline{RAS}$ Pulse Width	45	100K	50	100K	60	100K	70	100K	ns	
27	t_{RL1RH1}	t_{RASS}	$\overline{RAS}$ Pulse Width(Self Refresh Mode)	300	—	300	—	300	—	300	—	µs	
28	t_{RL1RH1}	t_{RASP}	$\overline{RAS}$ Pulse Width (Fast Page Mode)	45	100K	50	100K	60	100K	70	100K	ns	
29	t_{RL1CL1}	t_{RCD}	$\overline{RAS}$ to $\overline{CAS}$ Delay Time	13	30	13	35	13	45	13	50	ns	6
30	t_{RH2CL2}	t_{RPC}	$\overline{RAS}$ to $\overline{CAS}$ Precharge Time	10	—	10	—	10	—	10	—	ns	
31	t_{RL1AV}	t_{RAD}	$\overline{RAS}$ to Column Address Delay Time	11	20	11	23	11	30	11	35	ns	7
32	t_{RL1WL2}	t_{RWD}	$\overline{RAS}$ to $\overline{WE}$ Delay Time	45	—	50	—	60	—	70	—	ns	11
33	t_{CH2WL2}	t_{RCH}	Read Command Hold Time	0	—	0	—	0	—	0	—	ns	9
34	t_{RH2WL2}	t_{RRH}	Read Command Hold Time Referenced to $\overline{RAS}$	10	—	10	—	10	—	10	—	ns	9
35	t_{WH2CL2}	t_{RCS}	Read Command Setup Time	0	—	0	—	0	—	0	—	ns	

NO.	SYMBOL		PARAMETER	-45		-50		-60		-70		UNIT	NOTE
	JEDEC	STD.		MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.		
36	t_{RL2RL2}	t_{RC}	Random Read or Write Cycle Time	80	—	90	—	110	—	130	—	ns	
37	t_{CL2CL2}	t_{PC}	Read or Write Cycle Time (Fast Page Mode)	30	—	33	—	40	—	45	—	ns	13,14
38	t_{RL2RL2}	t_{RMW}	Read-Modify-Write Cycle Time	105	—	115	—	135	—	155	—	ns	
39	t_{CL2CL2}	t_{PRMW}	Read-Modify-Write Cycle Time (Fast Page Mode)	50	—	62	—	65	—	70	—	ns	13,14
40	t_{REF}	t_{REF}	Refresh Period	—	8	—	8	—	8	—	8	ms	15
41	t_{RL1AX}	t_{RAH}	Row Address Hold Time	8	—	8	—	8	—	8	—	ns	
42	t_{AVRL2}	t_{ASR}	Row Address Setup Time	0	—	0	—	0	—	0	—	ns	
43	t_T	t_T	Transition Time (Rise and Fall)	2	50	2	50	2	50	2	50	ns	4,5
44	t_{CL1WH1}	t_{WCH}	Write Command Hold Time	10	—	10	—	10	—	15	—	ns	
45	t_{WL1WH1}	t_{WP}	Write Command Pulse Width	10	—	10	—	10	—	15	—	ns	
46	t_{WL1CL2}	t_{WCS}	Write Command Setup Time	0	—	0	—	0	—	0	—	ns	11
47	t_{WL1CH1}	t_{CWL}	Write Command to $\overline{CAS}$ Lead Time	15	—	15	—	15	—	20	—	ns	
48	t_{WL1RH1}	t_{RWL}	Write Command to $\overline{RAS}$ Lead Time	15	—	15	—	15	—	20	—	ns	
49	t_{WL1RL2}	t_{WSR}	Write Command Setup Time (Test Mode)	10	—	10	—	10	—	10	—	ns	
50	t_{RL1WH1}	t_{WHR}	Write Command Hold Time (Test Mode)	10	—	10	—	10	—	10	—	ns	
51	t_{WH2RL2}	t_{WRP}	$\overline{WE}$ to $\overline{RAS}$ Precharge Time ($\overline{CAS}$ before $\overline{RAS}$)	10	—	10	—	10	—	10	—	ns	
52	t_{RL1WH2}	t_{WRH}	$\overline{WE}$ to $\overline{RAS}$ Precharge Time ($\overline{CAS}$ before $\overline{RAS}$)	10	—	10	—	10	—	10	—	ns	

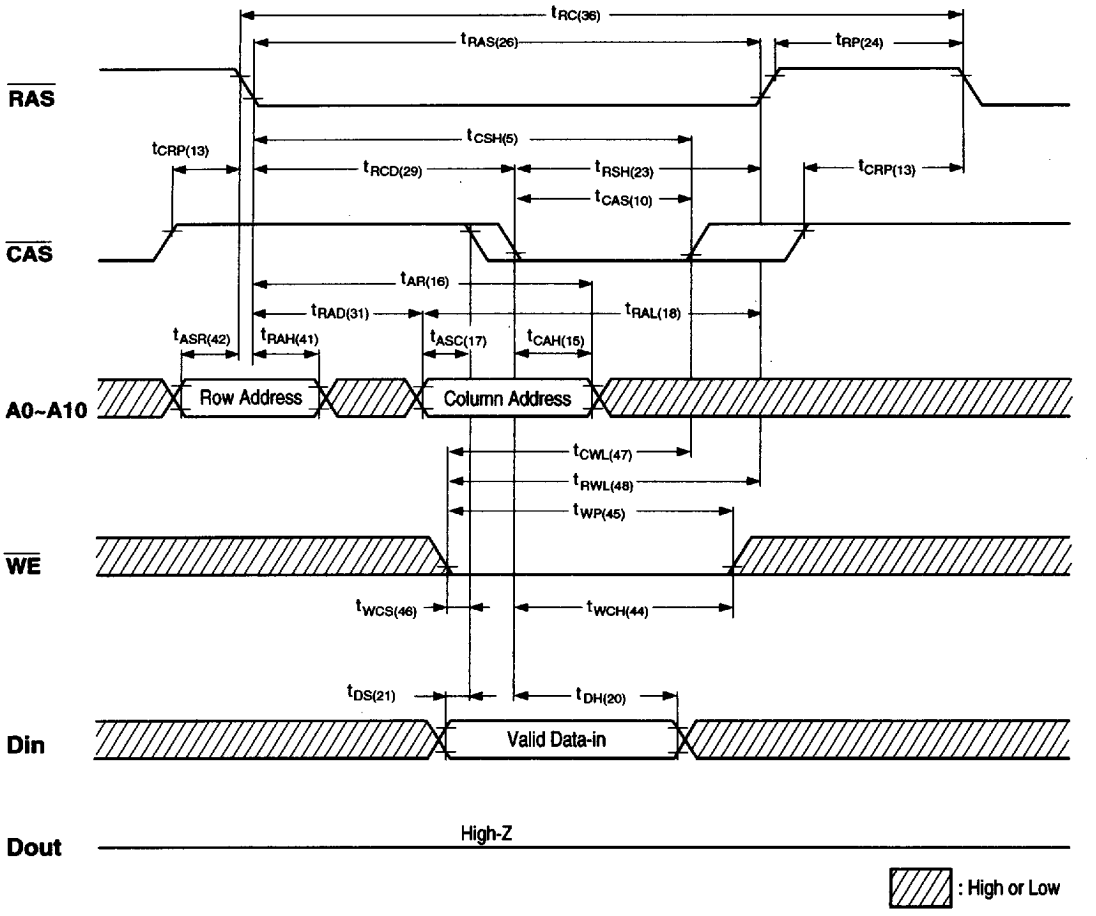
Notes:

3. Eight Initialization Cycles are required following a 200μs pause after Power Up. These Initialization Cycles may consist of one of the following : $\overline{RAS}$ only refresh Cycles, Read Cycles, Write Cycles, $\overline{CAS}$ before $\overline{RAS}$ refresh Cycles.
4. AC measurements assume t_T=3ns. All AC parameters are measured with V_{IL}(min.)≥V_{SS} and V_{IH}(max.)≤V_{CC} and with a load equivalent to two TTL loads and 100pF.
5. V_{IH}(min.) and V_{IL}(max.) are reference levels for measuring timing of input signals. Also, transition times are measured between V_{IH} and V_{IL}.
6. 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 access time is controlled by t_{CAC}.
7. 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 access time is controlled by t_{AA}.
8. Assumes three state test load (5pF and a 220 ohm to 1.3V Thevenin equivalent).
9. Either t_{RCH} or t_{RRH} must be satisfied for a read cycle.
10. t_{OFF}(max.) defines the time at which the output achieves an open circuit condition and is not referenced to output voltage levels.
11. 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}≥t_{WCS}(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}≥t_{RWD}(min.), t_{CWD}≥t_{CWD}(min.) and t_{AWD}≥t_{AWD}(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.
12. These parameters are referenced to $\overline{CAS}$ leading edge in early write cycles and to $\overline{WE}$ leading edge in read-modify-write cycles.
13. Access time is determined by the longer of t_{AA}, t_{CAC}, or t_{CPA}.
14. t_{ASC}≥t_{CP} to achieve t_{PC}(min.) and t_{CPA}(max.) values.
15. t_{REF}=128msec for Long Refresh version (L version).

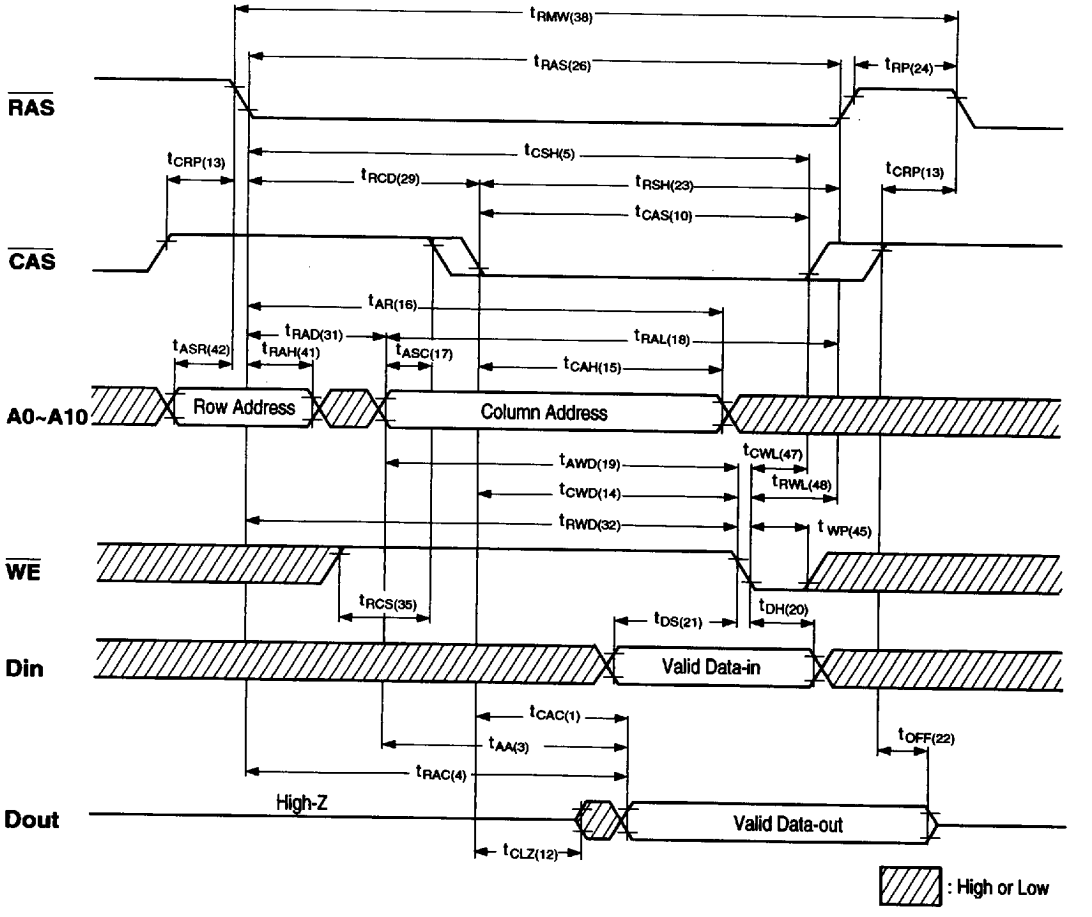
READ CYCLE



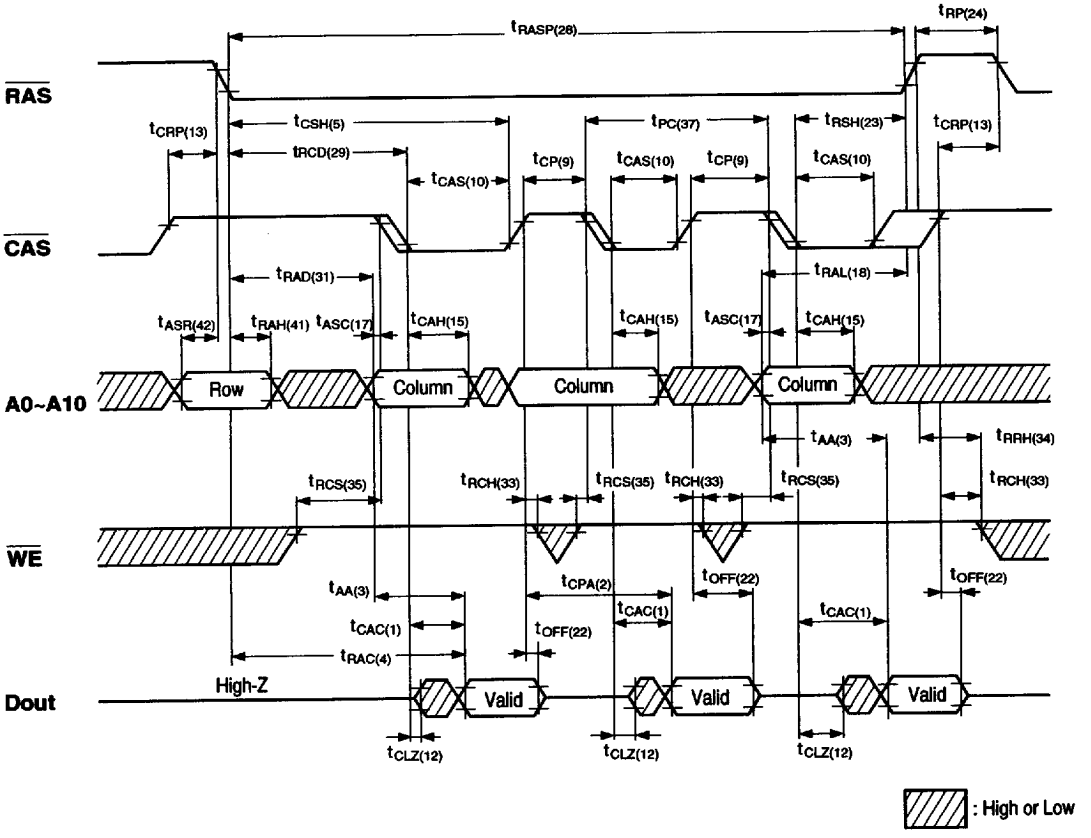
WRITE CYCLE (EARLY WRITE)



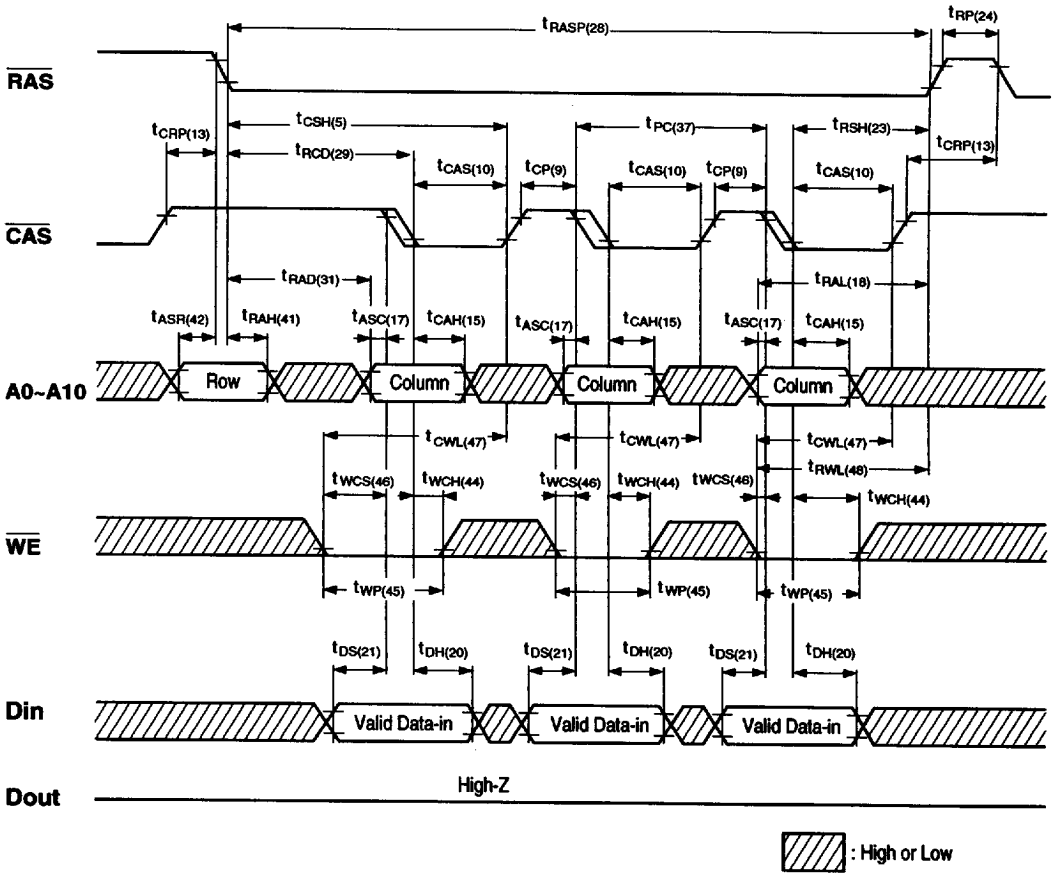
READ-MODIFY-WRITE CYCLE



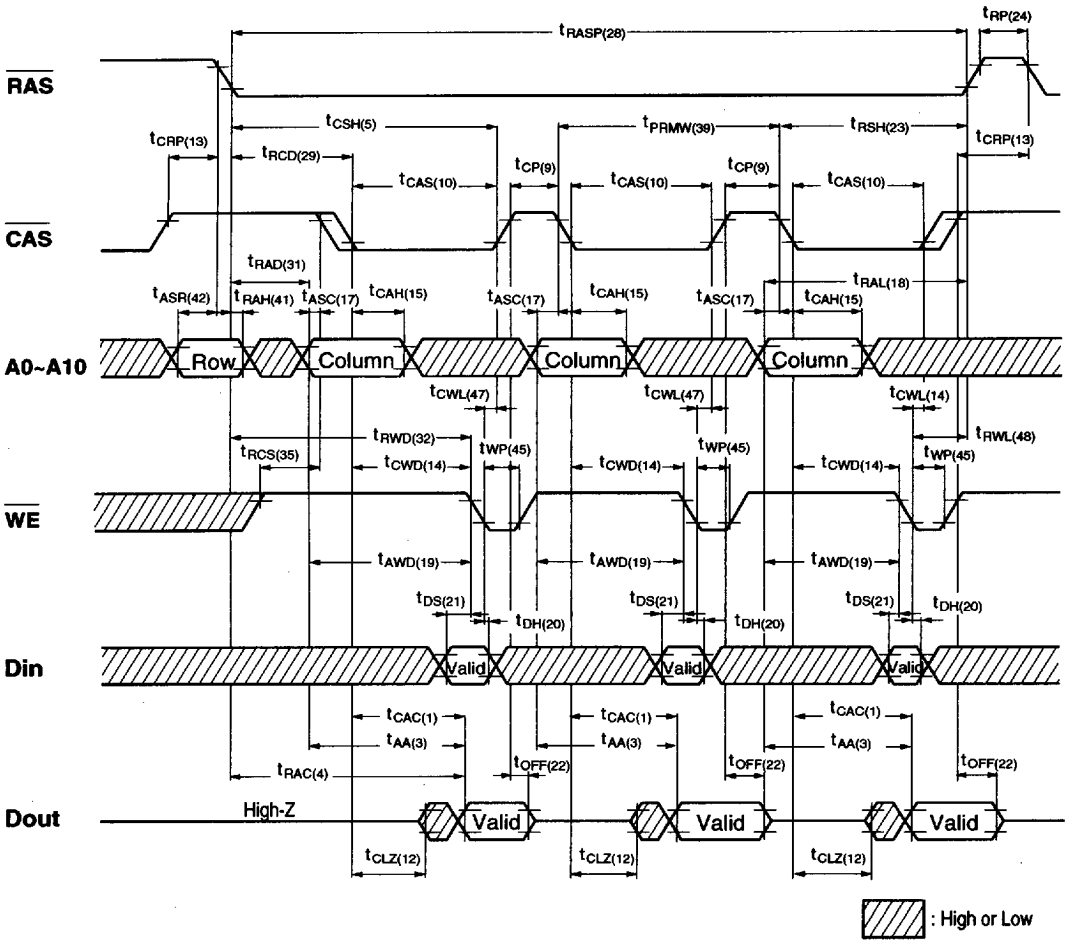
FAST PAGE MODE READ CYCLE



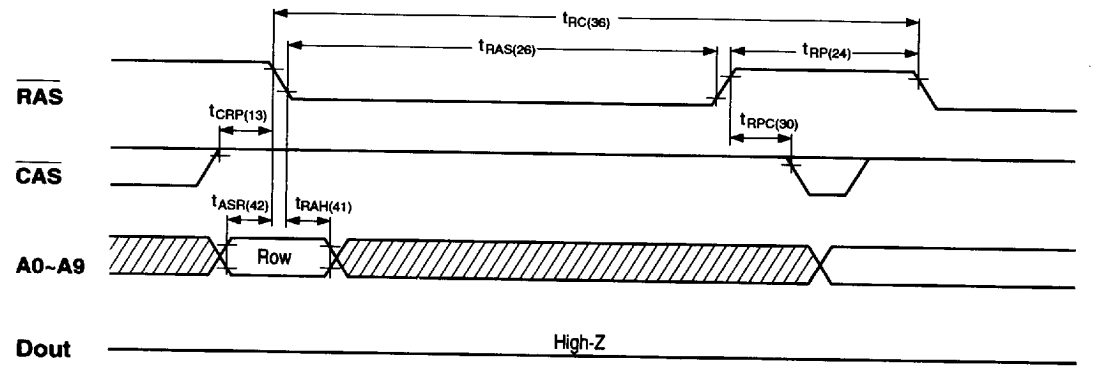
FAST PAGE MODE EARLY WRITE CYCLE



FAST PAGE MODE READ-MODIFY-WRITE CYCLE



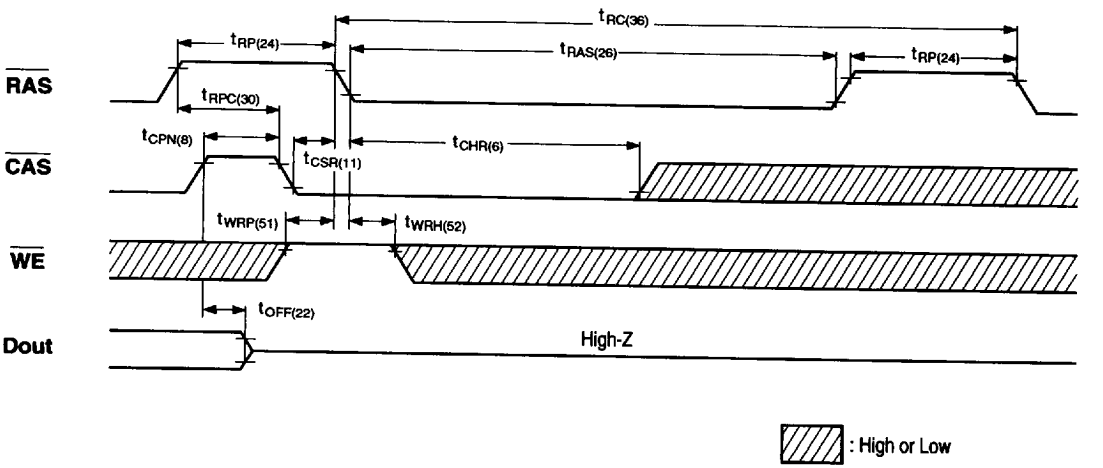
$\overline{RAS}$ ONLY REFRESH CYCLE



Note : $\overline{WE}$,A10 = Don't care.

: High or Low

$\overline{CAS}$ BEFORE $\overline{RAS}$ REFRESH CYCLE

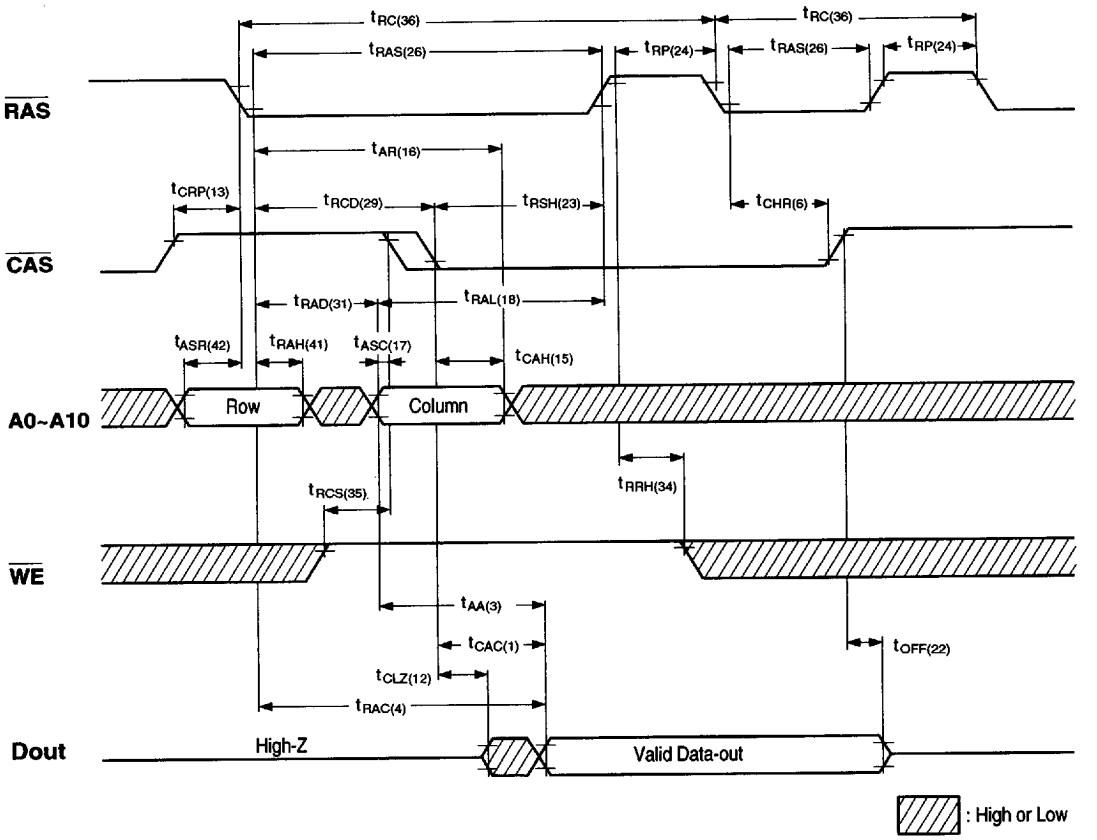


: High or Low

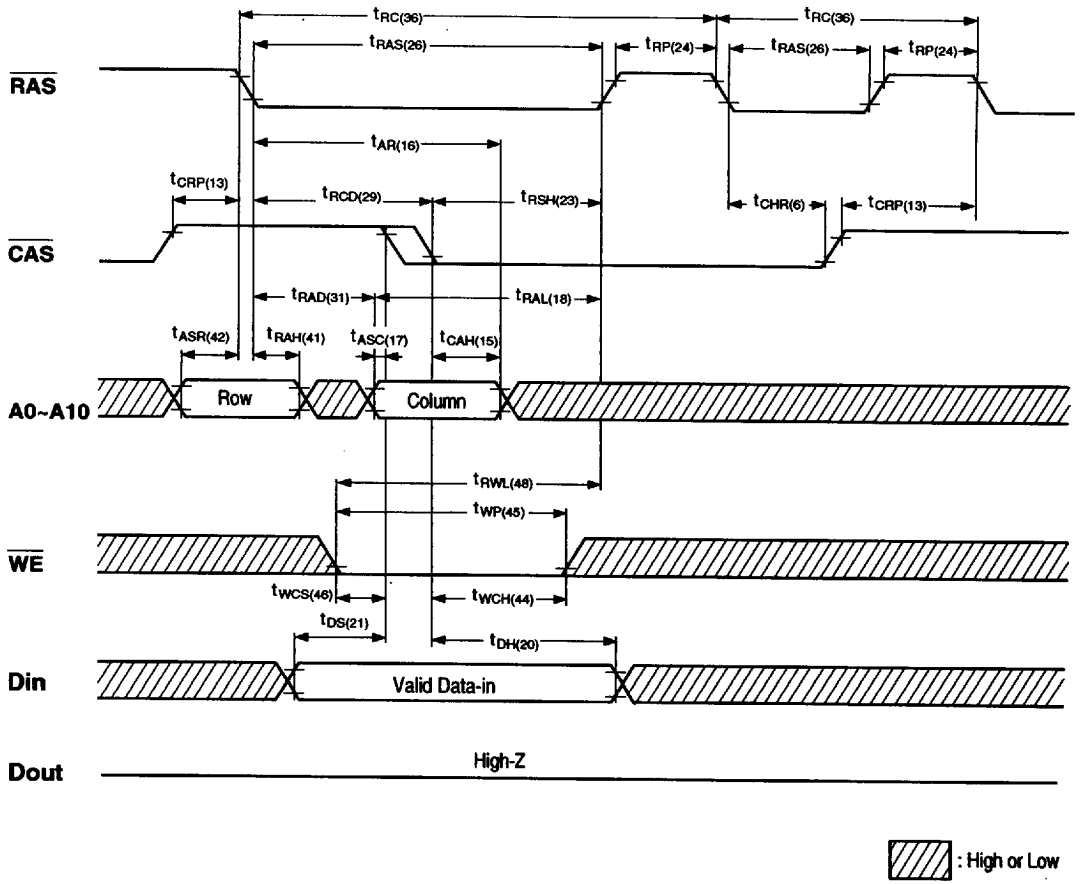
Note: $\overline{OE}$, A0~A10 = Don't care.

$\overline{WE}$ must be high at the falling edge of $\overline{RAS}$ in order to prevent entry into test mode.

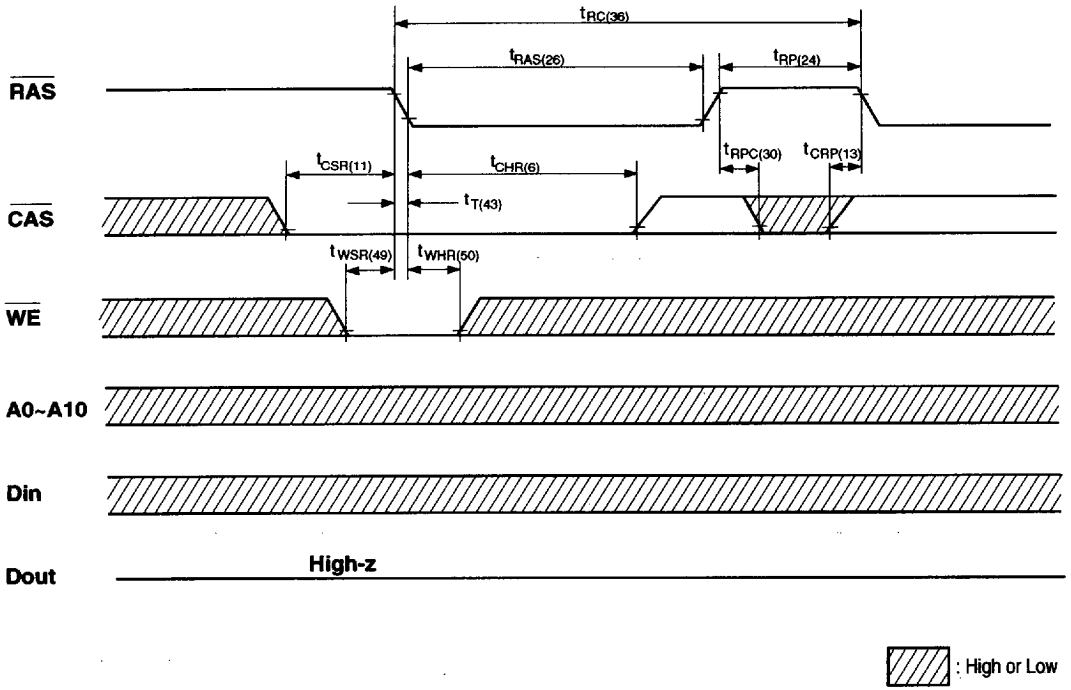
HIDDEN REFRESH CYCLE (READ)



HIDDEN REFRESH CYCLE (EARLY WRITE)



TEST MODE SET CYCLE ($\overline{WE}$, $\overline{CAS}$ BEFORE $\overline{RAS}$ REFRESH CYCLE)



■ The NN514100 has an 8 bits parallel Test Mode Function for reducing test time. In the Test Mode, memory configuration is 512K x 8 bits and the Row address A10, Column address A10, and Column address A0 is ignored.

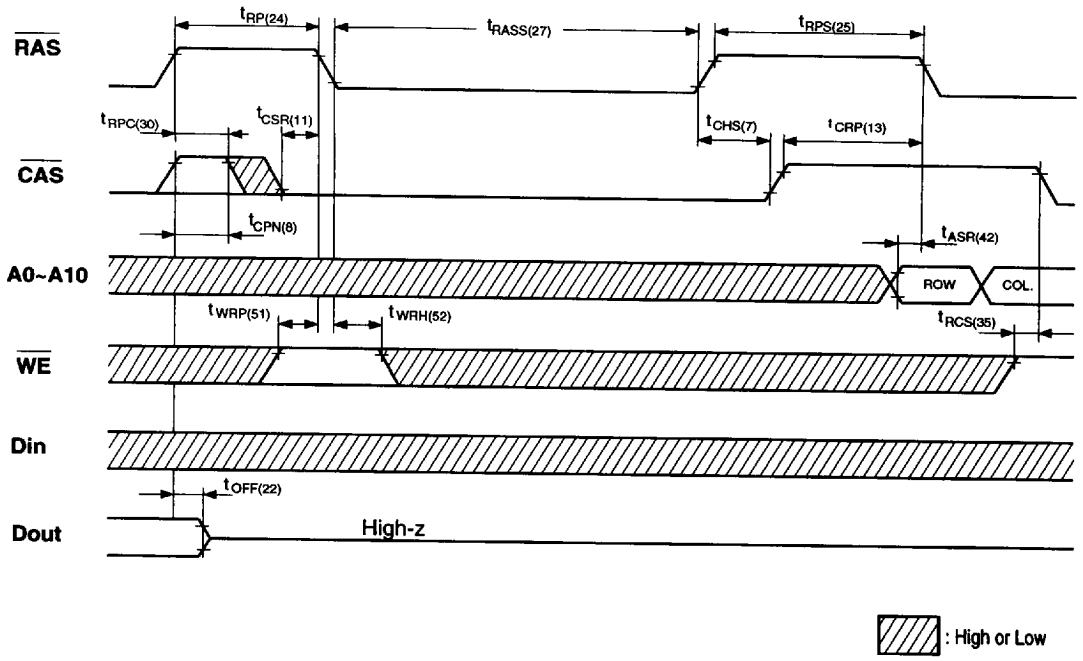
a. Entering the test mode:
The NN514100 test mode is entered by using the test mode set cycle ($\overline{WE}$,$\overline{CAS}$ before $\overline{RAS}$ cycle).

b. Read/Write operation in test mode:
For Write cycle, data input from Din is written to 8 parallel memory cells at the same time.
During the read cycle, if all read data is equivalent then a "1" is output from Dout.
If even one bit is not equal then a "0" will be output from Dout.

c. Exiting the test mode:
The NN514100 will exit the test mode by either a $\overline{RAS}$ only refresh cycle or a $\overline{CAS}$ before $\overline{RAS}$ refresh cycle width $\overline{WE}$ "high".

d. Refresh during test mode:
During test mode refresh must be executed by a normal Read cycle or a $\overline{WE}$, $\overline{CAS}$ before $\overline{RAS}$ refresh cycle.

SELF REFRESH MODE



■ The NN514100L version has a Self Refresh Mode.

a. Entering the Self Refresh Mode:
The NN514100L Self Refresh Mode is entered by using $\overline{CAS}$ before $\overline{RAS}$ refresh cycle with $\overline{WE}$ " high " and holding $\overline{RAS}$ and $\overline{CAS}$ signal " low " longer than 300μs.

b. Continuing the Self Refresh Mode:
The Self Refresh Mode is continued by holding $\overline{RAS}$ " low " after entering the Self Refresh Mode.
It is 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 NN514100L exits the Self Refresh Mode when the $\overline{RAS}$ signal is brought " high ".

ORDERING INFORMATION

NN514100XX(X) - XX

SPEED	45	:	45ns
	50	:	50ns
	60	:	60ns
	70	:	70ns
PACKAGE	J	:	Plastic SOJ
	Z	:	Plastic ZIP
	TT	:	Plastic TSOP TYPE II (Normal Bend)
	RR	:	Plastic TSOP TYPE II (Reverse Bend)
VERSION	BLANK	:	Standard Version
	L	:	Long Refresh Version 128ms Refresh
MODE	4100	:	Fast Page 4M x 1