

## TC518512PL/FL/FTL/TRL-70LV/80LV/10LV

### SILICON GATE CMOS

### 524,288 WORD x 8 BIT CMOS PSEUDO STATIC RAM

#### Description

The TC518512PL is a 4M bit high speed CMOS pseudo static RAM organized as 524,288 words by 8 bits. The TC518512PL utilizes a one transistor dynamic memory cell with CMOS peripheral circuitry to provide high capacity, high speed and low power storage. The TC518512PL-LV operates from a single 3.0V ~ 5.5V power supply. Refreshing is supported by a refresh ( $\overline{OE}/RFSH$ ) input which enables two types of refreshing - auto refresh and self refresh. The TC518512PL features a static RAM-like interface with a write cycle in which the input data is written into the memory cell at the rising edge of R/W thus simplifying the microprocessor interface.

The TC518512PL is available in a 32-pin, 0.6 inch width plastic DIP, a small outline plastic flat package, and a thin small outline package (forward type, reverse type).

#### Features

- Organization: 524,288 words x 8 bits
- Low voltage operation: 3.0V ~ 5.5V
- Data retention supply voltage: 3.0V ~ 5.5V
- Fast access time

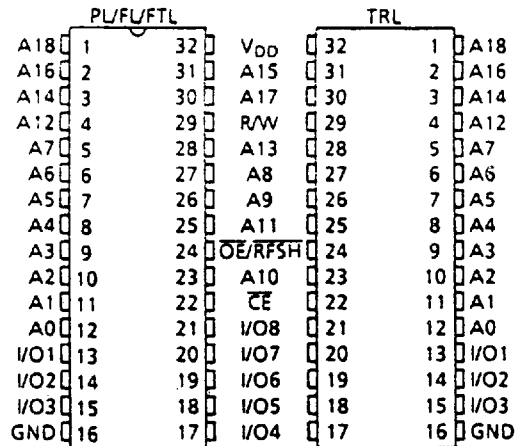
	TC518512PL-LV Family		
	-70	-80	-10
$t_{CEA}$ $\overline{OE}$ Access Time	70ns	80ns	100ns
$t_{OEA}$ $\overline{OE}$ Access Time	30ns	30ns	40ns
$t_{RC}$ Cycle Time	115ns	130ns	160ns
Power Dissipation	385mW	330mW	275mW
Self Refresh Current	5.5V	200 $\mu$ A	
Self Refresh Current	3.0V	100 $\mu$ A	

- Auto refresh is supported by an internal refresh address counter
- Self refresh is supported by an internal timer
- Inputs and outputs TTL compatible
- Refresh: 2048 refresh cycles/32ms
- Package
  - TC518512PL: DIP32-P-600
  - TC518512FL: SOP32-P-525
  - TC518512FTL: TSOP32-P-400
  - TC518512TRL: TSOP32-P-400A

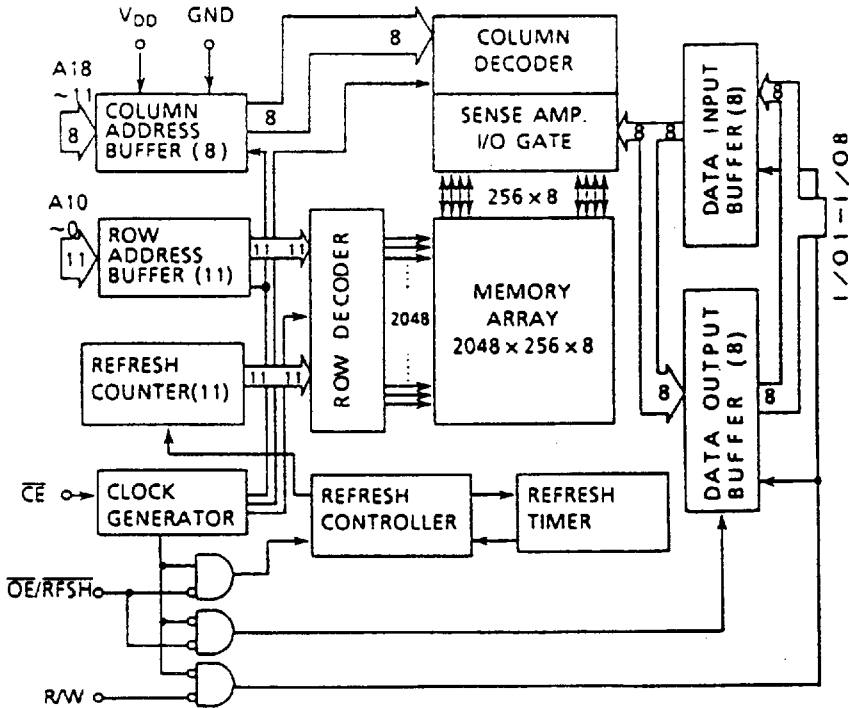
#### Pin Names

A0 ~ A18	Address Inputs
R/W	Read/Write Control Input
$\overline{OE}/RFSH$	Output Enable Input Refresh Input
$\overline{CE}$	Chip Enable Input
I/O1 ~ I/O8	Data Inputs/Outputs
$V_{DD}$	Power
GND	Ground

#### Pin Connection (Top View)



Block Diagram



Operating Mode

MODE \ PIN	CE	OE/RFSH	R/W	A0 ~ A18	I/O1 ~ 8
Read	L	L	H	V*	OUT
Write	L	*	L	V*	IN
CE only Refresh	L	H	H	V*	HZ
Auto/Self Refresh	H	L	*	*	HZ
Standby	H	H	*	*	HZ

H = High level input (V<sub>IH</sub>)

L = Low level input (V<sub>IL</sub>)

\* = V<sub>IH</sub> or V<sub>IL</sub>

V\* = At the falling edge of CE, all address inputs are latched. At all other times, the address inputs are \*\*\*.

HZ = High impedance

Maximum Ratings

SYMBOL	ITEM	RATING	UNIT	NOTES
V <sub>IN</sub>	Input Voltage	-1.0 ~ 7.0	V	1
V <sub>OUT</sub>	Output Voltage	-1.0 ~ 7.0	V	
V <sub>DD</sub>	Power Supply Voltage	-1.0 ~ 7.0	V	
T <sub>OPR</sub>	Operating Temperature	0 ~ 70	°C	
T <sub>STRG</sub>	Storage Temperature	-55 ~ 150	°C	
T <sub>SOLDER</sub>	Soldering Temperature • Time	260 • 10	°C • sec	
P <sub>D</sub>	Power Dissipation	600	mW	
I <sub>OUT</sub>	Short Circuit Output Current	50	mA	

## DC Recommended Operating Conditions

SYMBOL	PARAMETER	MIN.	TYP.	MAX.	UNIT	NOTES
$V_{DD}$	Power Supply Voltage	4.5	5.0	5.5	V	2
$V_{IH}$	Input High Voltage	2.4	-	$V_{DD} + 1.0$	V	
$V_{IL}$	Input Low Voltage	-1.0	-	0.8	V	

DC Characteristics ( $T_a = 0 \sim 70^\circ\text{C}$ ,  $V_{DD} = 5V \pm 10\%$ )

SYMBOL	PARAMETER	MIN.	TYP.	MAX.	UNIT	NOTES	
$I_{DDO}$	Operating Current (Average) CE, Address cycling: $t_{RC} = t_{RC}$ min.	70ns version	-	50	70	mA	3,4
		80ns version	-	45	60		
		100ns version	-	35	50		
$I_{DDs1}$	Standby Current CE = $V_{IH}$ , OE/RFSH = $V_{IH}$	-	-	1	mA		
$I_{DDs2}$	Standby Current CE = $V_{DD} - 0.2V$ , OE/RFSH = $V_{DD} - 0.2V$	-	-	200	$\mu\text{A}$		
$I_{DDF1}$	Self Refresh Current (Average) CE = $V_{IH}$ , OE/RFSH = $V_{IL}$	-	-	1	mA		
$I_{DDF2}$	Self Refresh Current (Average) CE = $V_{DD} - 0.2V$ , OE/RFSH = $0.2V$	-	-	200	$\mu\text{A}$		
$I_{DDF3}$	Auto Refresh Current (Average) OE/RFSH cycling: $t_{FC} = t_{FC}$ min.	70ns version	-	-	70	mA	3
		80ns version	-	-	60		
		100ns version	-	-	50		
$I_{DDF4}$	CE only Refresh Current (Average) CE, Address cycling: $t_{RC} = t_{RC}$ min.	70ns version	-	-	70	mA	3
		80ns version	-	-	60		
		100ns version	-	-	50		
$I_{I(L)}$	Input Leakage Current $0V \leq V_{IN} \leq V_{DD}$ , All other Inputs not under test = $0V$	-	-	$\pm 10$	$\mu\text{A}$		
$I_{O(L)}$	Output Leakage Current Output Disabled (CE = $V_{IH}$ or OE/RFSH = $V_{IH}$ or R/W = $V_{IL}$ ) $0V \leq V_{OUT} \leq V_{DD}$	-	-	$\pm 10$	$\mu\text{A}$		
$V_{OH}$	Output High Level $I_{OH} = -1.0\text{mA}$	2.4	-	-	V		
$V_{OL}$	Output Low Level $I_{OL} = 2.1\text{mA}$	-	-	0.4	V		

Capacitance\* ( $V_{DD} = 5V$ ,  $T_a = 25^\circ\text{C}$ ,  $f = 1\text{MHz}$ )

SYMBOL	PARAMETER	MIN.	MAX.	UNIT
$C_{I1}$	Input Capacitance (A0 ~ A18)	-	5	pF
$C_{I2}$	Input Capacitance (CE, OE/RFSH, R/W)	-	7	
$C_{IO}$	Input/Output Capacitance	-	7	

\*This parameter is periodically sampled and is not 100% tested.

AC Characteristics (Ta = 0 ~ 70°C, V<sub>DD</sub> = 5V±10%) (Notes: 5, 6, 7, 8)

SYMBOL	PARAMETER	-70		-80		-10		UNIT	NOTES
		MIN.	MAX.	MIN.	MAX.	MIN.	MAX.		
t <sub>RC</sub>	Random Read, Write Cycle Time	115	–	130	–	160	–		
t <sub>RMW</sub>	Read Modify Write Cycle Time	165	–	180	–	220	–		
t <sub>CE</sub>	$\overline{CE}$ Pulse Width	70	10,000	80	10,000	100	10,000		
t <sub>p</sub>	$\overline{CE}$ Precharge Time	35	–	40	–	50	–		
t <sub>CEA</sub>	$\overline{CE}$ Access Time	–	70	–	80	–	100		
t <sub>OEA</sub>	$\overline{OE}$ Access Time	–	30	–	30	–	40		
t <sub>CLZ</sub>	$\overline{CE}$ to Output in Low -Z	20	–	20	–	20	–		
t <sub>OLZ</sub>	$\overline{OE}$ to Output in Low -Z	0	–	0	–	0	–		
t <sub>WLZ</sub>	Output Active from End of Write	0	–	0	–	0	–		
t <sub>CHZ</sub>	Chip Disable to Output in High-Z	0	20	0	20	0	25		9
t <sub>OHZ</sub>	$\overline{OE}$ Disable to Output in High-Z	0	20	0	20	0	25		9
t <sub>WHZ</sub>	Write Enable to Output in High-Z	0	20	0	20	0	25		9
t <sub>OSC</sub>	$\overline{OE}$ Setup Time Referenced to $\overline{CE}$	10	–	10	–	10	–		9
t <sub>OHC</sub>	$\overline{OE}$ Hold Time Referenced to $\overline{CE}$	0	–	0	–	0	–		9
t <sub>RCS</sub>	Read Command Setup Time	0	–	0	–	0	–		
t <sub>RCH</sub>	Read Command Hold Time	0	–	0	–	0	–	ns	
t <sub>WP</sub>	Write Pulse Width	25	–	25	–	30	–		
t <sub>WCH</sub>	Write Command Hold Time	40	–	40	–	50	–		
t <sub>CWL</sub>	Write Command to $\overline{CE}$ Lead Time	25	–	25	–	30	–		
t <sub>DSW</sub>	Data Setup Time from R/W	20	–	20	–	25	–		10
t <sub>DSC</sub>	Data Setup Time from $\overline{CE}$	20	–	20	–	25	–		10
t <sub>DHW</sub>	Data Hold Time from R/W	0	–	0	–	0	–		10
t <sub>DHC</sub>	Data Hold Time from $\overline{CE}$	0	–	0	–	0	–		10
t <sub>ASC</sub>	Address Setup Time	0	–	0	–	0	–		11
t <sub>AHC</sub>	Address Hold Time	15	–	20	–	25	–		11
t <sub>FC</sub>	Auto Refresh Cycle Time	130	–	130	–	160	–		
t <sub>RFD</sub>	RFSH Delay Time from $\overline{CE}$	40	–	40	–	50	–		
t <sub>FAP</sub>	RFSH Pulse Width (Auto Refresh)	30	8,000	30	8,000	30	8,000		12
t <sub>FP</sub>	RFSH Precharge Time	30	–	30	–	30	–		12
t <sub>FAS</sub>	RFSH Pulse Width (Self Refresh)	8,000	–	8,000	–	8,000	–		12
t <sub>FRS</sub>	$\overline{CE}$ Delay Time from RFSH (Self Refresh)	160	–	160	–	190	–		12
t <sub>REF</sub>	Refresh Period (2048 cycles, A0 ~ A10)	–	32	–	32	–	32	ms	
t <sub>T</sub>	Transition Time (Rise and Fall)	3	50	3	50	3	50	ns	

## 3.3V Operation

## DC Recommended Operating Conditions

SYMBOL	PARAMETER	MIN.	TYP.	MAX.	UNIT	NOTES
$V_{DD}$	Power Supply Voltage	3.0	3.3	3.6	V	2
$V_{IH}$	Input High Voltage	$V_{DD} - 0.2V$	-	$V_{DD} + 1.0$	V	
$V_{IL}$	Input Low Voltage	-0.5	-	0.2	V	

DC Characteristics ( $T_a = 0 \sim 70^\circ\text{C}$ ,  $V_{DD} = 3.3V \pm 0.3V$ )

SYMBOL	PARAMETER	MIN.	TYP.	MAX.	UNIT	NOTES
$I_{DDO}$	Operating Current (Average) $\overline{CE}$ , Address cycling: $t_{RC} = t_{RC}$ min.	-	15	20	mA	3,4
$I_{DDs2}$	Standby Current	-	-	100	$\mu\text{A}$	
$I_{DDF2}$	Self Refresh Current (Average)	-	50	100	$\mu\text{A}$	
$I_{DDF3}$	Auto Refresh Current (Average) RFSH cycling: $t_{FC} = t_{FC}$ min.	-	-	20	mA	3
$I_{DDF4}$	$\overline{CE}$ only Refresh Current (Average) $\overline{CE}$ , Address cycling: $t_{RC} = t_{RC}$ min.	-	-	20	mA	3
$I_{I(L)}$	Input Leakage Current $0V \leq V_{IN} \leq V_{DD}$ , All other Inputs not under test = $0V$	-	-	$\pm 10$	$\mu\text{A}$	
$I_{O(L)}$	Output Leakage Current Output Disabled, $0V \leq V_{OUT} \leq V_{DD}$	-	-	$\pm 10$	$\mu\text{A}$	
$V_{OH}$	Output High Level, $I_{OH} = -100\mu\text{A}$	$V_{DD} - 0.2V$	-	-	V	
$V_{OL}$	Output Low Level, $I_{OL} = 100\mu\text{A}$	-	-	0.2	V	

AC Characteristics (Ta = 0 ~ 70°C, V<sub>DD</sub> = 3.3V±0.3V) (Notes: 5, 6, 8)

SYMBOL	PARAMETER	MIN.	MAX.	UNIT	NOTES
t <sub>RC</sub>	Random Read, Write Cycle Time	230	—	ns	
t <sub>RMW</sub>	Read Modify Write Cycle Time	305	—		
t <sub>CE</sub>	$\overline{\text{CE}}$ Pulse Width	150	10,000		
t <sub>p</sub>	$\overline{\text{CE}}$ Precharge Time	80	—		
t <sub>CEA</sub>	$\overline{\text{CE}}$ Access Time	—	150		
t <sub>OEa</sub>	$\overline{\text{OE}}$ Access Time	—	80		
t <sub>CLZ</sub>	$\overline{\text{CE}}$ to Output in Low -Z	20	—		
t <sub>OLZ</sub>	$\overline{\text{OE}}$ to Output in Low -Z	5	—		
t <sub>WLZ</sub>	Output Active from End of Write	5	—		
t <sub>CHZ</sub>	Chip Disable to Output in High-Z	0	30		9
t <sub>OHZ</sub>	$\overline{\text{OE}}$ Disable to Output in High-Z	0	30		9
t <sub>WHZ</sub>	Write Enable to Output in High-Z	0	30		9
t <sub>OSC</sub>	$\overline{\text{OE}}$ Setup Time Referenced to $\overline{\text{CE}}$	10	—		9
t <sub>OHC</sub>	$\overline{\text{OE}}$ Hold Time Referenced to $\overline{\text{CE}}$	15	—		9
t <sub>RCS</sub>	Read Command Setup Time	0	—		
t <sub>RCH</sub>	Read Command Hold Time	0	—		
t <sub>WP</sub>	Write Pulse Width	35	—		
t <sub>WCH</sub>	Write Command Hold Time	70	—		
t <sub>CWL</sub>	Write Command to $\overline{\text{CE}}$ Lead Time	35	—		
t <sub>DSW</sub>	Data Setup Time from R/W	30	—		10
t <sub>DSC</sub>	Data Setup Time from $\overline{\text{CE}}$	30	—		10
t <sub>DHW</sub>	Data Hold Time from R/W	0	—		10
t <sub>DHC</sub>	Data Hold Time from $\overline{\text{CE}}$	0	—		10
t <sub>ASC</sub>	Address Setup Time	0	—		11
t <sub>AHC</sub>	Address Hold Time	30	—		11
t <sub>FC</sub>	Auto Refresh Cycle Time	230	—		
t <sub>RFD</sub>	RFSH Delay Time from $\overline{\text{CE}}$	80	—		
t <sub>FAP</sub>	RFSH Pulse Width (Auto Refresh)	80	8,000	12	
t <sub>FP</sub>	RFSH Precharge Time	50	—	12	
t <sub>FAS</sub>	RFSH Pulse Width (Self Refresh)	8,000	—	12	
t <sub>FRS</sub>	$\overline{\text{CE}}$ Delay Time from RFSH (Self Refresh)	300	—	12	
t <sub>REF</sub>	Refresh Period (2048 cycles, A0 ~ A10)	—	32	ms	
t <sub>T</sub>	Transition Time (Rise and Fall)	3	50	ns	

## Timing Reference Levels:

Input Reference Levels: 1.5V/1.5V

Output Reference Levels: 1.5V/1.5V

## Notes:

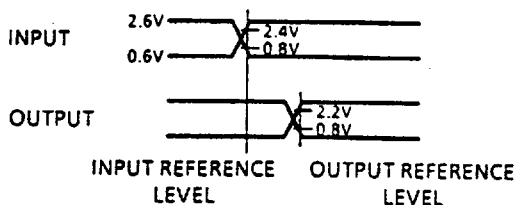
- 1) Stress greater than those listed under "Maximum Ratings" may cause permanent damage to the device.
- 2) All voltages are referenced to GND.
- 3)  $I_{DD0}$ ,  $I_{DDF3}$ , and  $I_{DDF4}$  depend on the cycle time.
- 4)  $I_{DD0}$  depends on the output loading. Specified values are obtained with the outputs open.
- 5) An initial pause of 100 $\mu$ s with high  $\overline{CE}$  is required after power-up before proper device operation is achieved.
- 6) AC measurements assume  $t_T = 5$ ns.

## 7) Timing reference levels

Input Levels :  $V_{IH} = 2.6V$   
 $V_{IL} = 0.6V$

Input Reference Levels :  $V_{IH} = 2.4V$   
 $V_{IL} = 0.8V$

Output Reference Levels :  $V_{OH} = 2.2V$   
 $V_{OL} = 0.8V$



- 8) Measured with a load equivalent to 1 TTL load and 100pF.
- 9)  $t_{CHZ}$ ,  $t_{OHZ}$ ,  $t_{WHZ}$  define the time at which the output achieves the open circuit condition and is not referenced to output voltage levels.
- 10) For write cycles, the input data is latched at the earlier of  $R/W$  or  $\overline{CE}$  rising edge. Therefore, the input data must be valid during the setup time ( $t_{DSW}$  or  $t_{DSC}$ ) and hold time ( $t_{DHW}$  or  $t_{DHC}$ ).
- 11) All address inputs are latched at the falling edge of  $\overline{CE}$ . Therefore, all the address inputs must be valid during  $t_{ASC}$  and  $t_{AHC}$ .
- 12) The two refresh operations, auto refresh and self refresh, are defined by the  $\overline{RFSH}$  pulse width under the condition  $\overline{CE} = V_{IH}$ .  
 Auto refresh :  $\overline{RFSH}$  pulse width  $\leq t_{FAP}$  (max.)  
 Self refresh :  $\overline{RFSH}$  pulse width  $\geq t_{FAS}$  (min.)

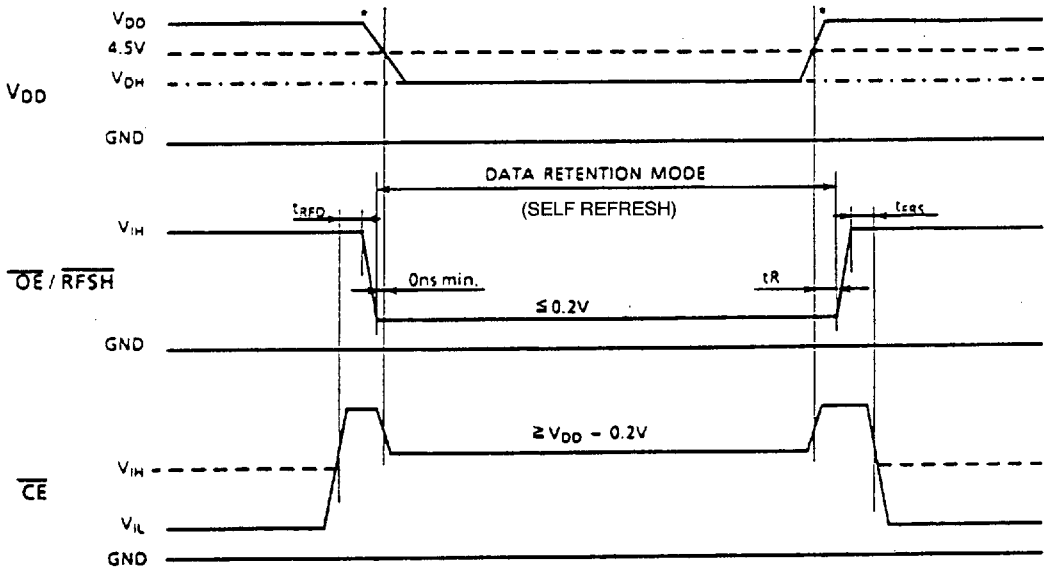
The timing parameter  $t_{FRS}$  must be met for proper device operation under the following conditions:

- after self refresh
- if  $\overline{OE}/\overline{RFSH} = "L"$  after power-up

Data Retention Characteristics (Ta = 0 ~ 70°C)

SYMBOL	PARAMETER	MIN.	TYP.	MAX.	UNIT
V <sub>DH</sub>	Data Retention Supply Voltage	3.0	-	5.5	V
I <sub>DDF2</sub>	Self Refresh Current	V <sub>DH</sub> = 3.0V	-	50	μA
		V <sub>DH</sub> = 5.5V	-	100	
t <sub>R</sub>	Recovery Time	5	-	-	ms

\*The rising and falling slope of V<sub>DD</sub> must be more than 50ms for proper device operation (20ms/V).

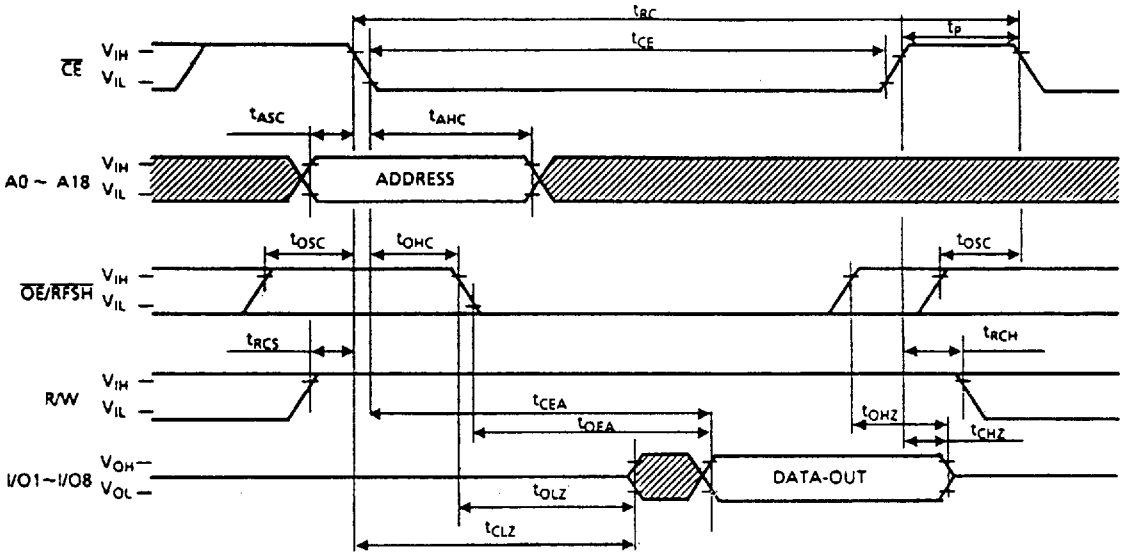


Notes: R/W, A0 ~ A18 = V<sub>IH</sub> or V<sub>IL</sub>  
 I<sub>DDF1</sub> is applicable when OE/RFSH = V<sub>IL</sub> (max.), CE = V<sub>IH</sub> (min.).

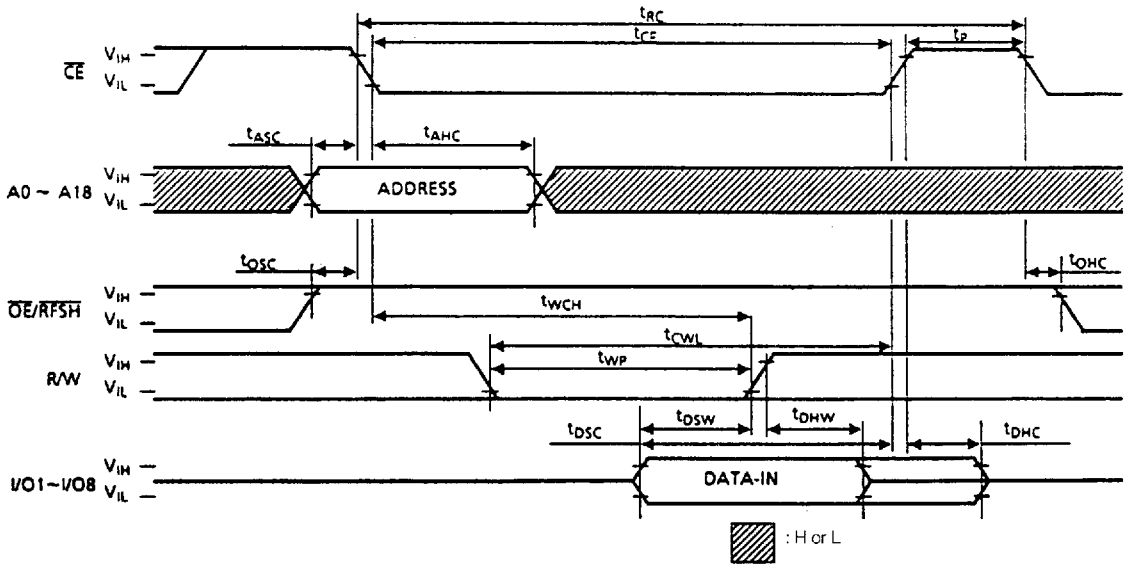


### Timing Waveforms

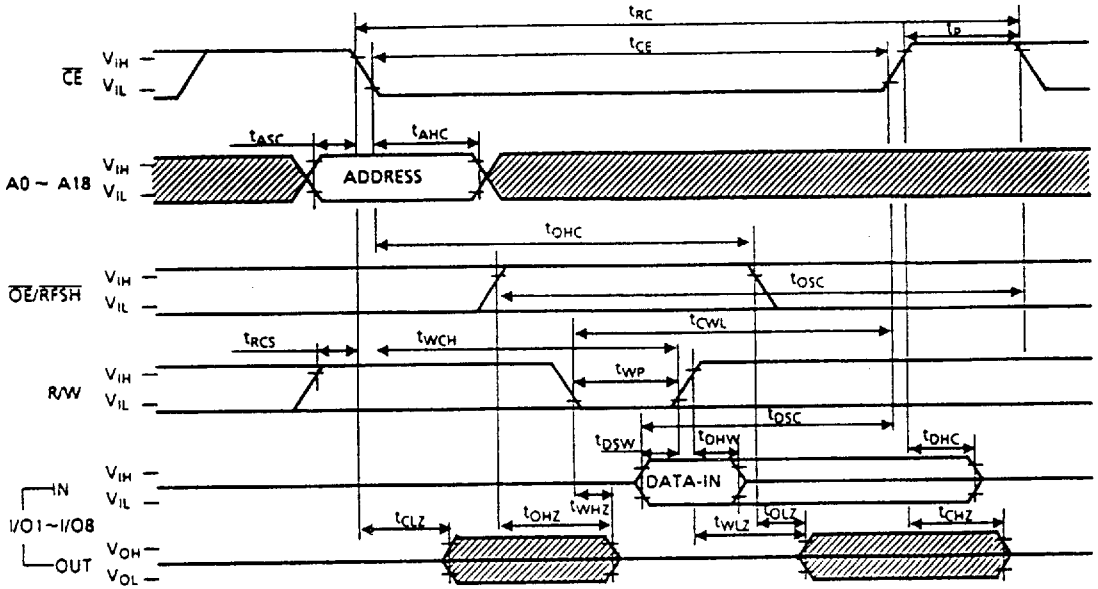
#### Read Cycle



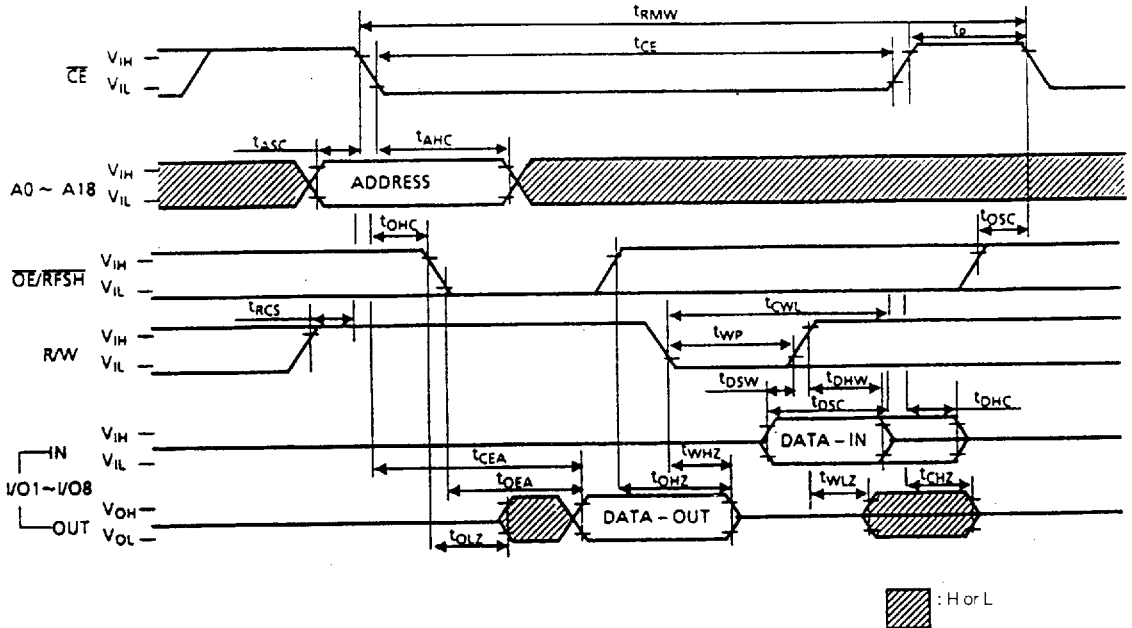
#### Write Cycle 1 (OE Fixed High)



Write Cycle 2 ( $\overline{OE}$  Clocked or Fixed Low)

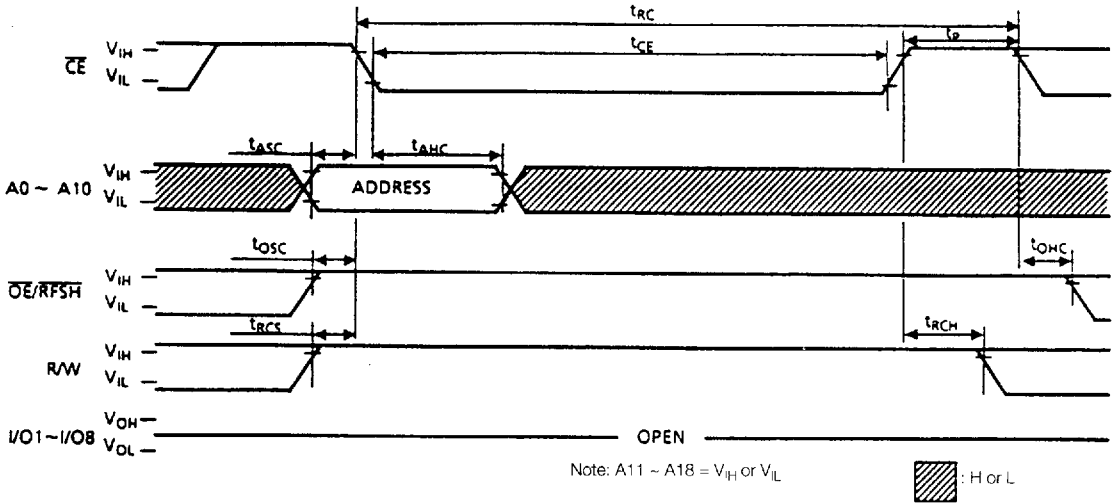


Read Modify Write Cycle

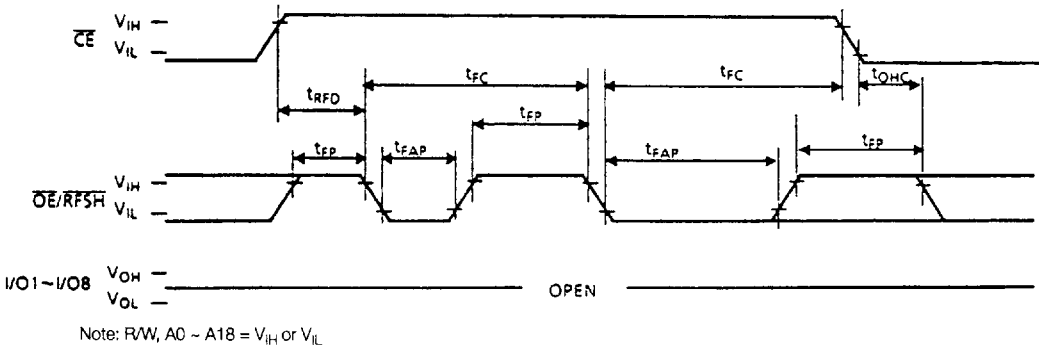


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**CE Only Refresh**



**Auto Refresh**



**Self Refresh**

