

<b>SANYO</b>	No.4794B	<b>LC3564S, SS, SM, ST-70/85/10</b>
		<b>64K (8192words×8 bits)SRAM</b>

### Overview

The LC3564S, LC3564SS, LC3564SM, and LC3564ST are asynchronous silicon gate CMOS static RAMs with an 8192-word X 8-bit organization. These SRAMs are full CMOS type SRAMs with a six-transistor memory cell and feature high-speed access, a low operating current, and an ultra-low standby current. Control signal inputs include an  $\overline{OE}$  input for high-speed memory access and two chip enable inputs,  $\overline{CE1}$  and  $\overline{CE2}$ , for power-down and device selection. Thus these products are optimal for systems that require low power and/or battery backup and they support easy expansion of memory capacities. The ultra-low standby mode current drain allows capacitors to be used for backup and 3V operation makes these devices an excellent choice for use in battery operated portable equipment.

### Features

- Supply voltage : 2.7 to 5.5V
  - 5V operation :  $5.0V \pm 10\%$
  - 3V operation :  $3.0V \pm 10\%$
- Address access time ( $t_{AA}$ )
  - 5V operation
    - LC3564S, SS, SM, ST-70 : 70ns (max.)
    - LC3564S, SS, SM, ST-85 : 85ns (max.)
    - LC3564S, SS, SM, ST-10 : 100ns (max.)
  - 3V operation
    - LC3564S, SS, SM, SS-70 : 200ns (max.)
    - LC3564S, SS, SM, SS-85 : 250ns (max.)
    - LC3564S, SS, SM, SS-10 : 500ns (max.)
- Ultra-low standby current
  - 5V operation :  $1.0\mu A$  ( $T_a \leq 70^\circ C$ )  
 $3.0\mu A$  ( $T_a \leq 85^\circ C$ )
  - 3V operation :  $0.8\mu A$  ( $T_a \leq 70^\circ C$ )  
 $2.5\mu A$  ( $T_a \leq 85^\circ C$ )
- Operating temperature
  - 3V operation :  $-40^\circ C$  to  $+85^\circ C$
  - 5V operation :  $-40^\circ C$  to  $+85^\circ C$
- Data retention voltage : 2.0 to 5.5V
- All I/O levels
  - 5V operation : TTL compatible
  - 3V operation :  $V_{CC} - 0.2V/0.2V$
- Three control inputs ( $\overline{OE}$ ,  $\overline{CE1}$ ,  $\overline{CE2}$ )
- Common input/output pins, three-state outputs
- No clock or timing signals required

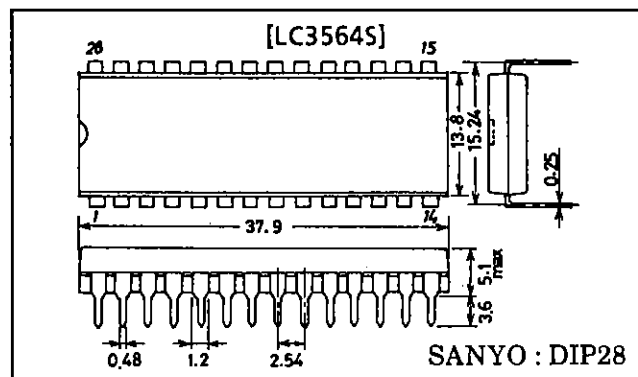
### Package :

- 28-pin DIP (600mil)plastic package : LC3564S
- 28-pin DIP (300mil)plastic package : LC3564SS
- 28-pin SOP (450mil)plastic package : LC3564SM
- 28-pin TSOP ( $8 \times 13.4$ mm)plastic package : LC3564ST

### Package Dimensions

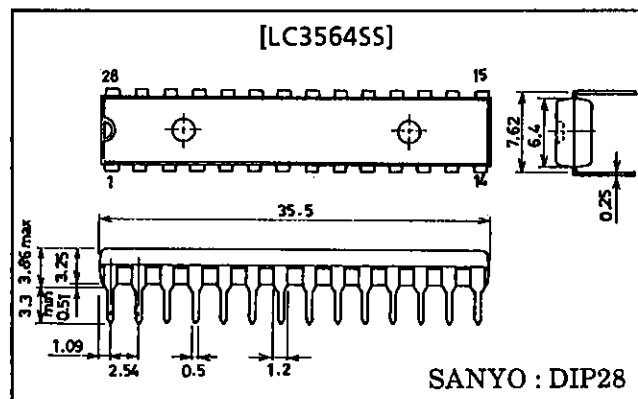
unit : mm

#### 3012A-DIP28

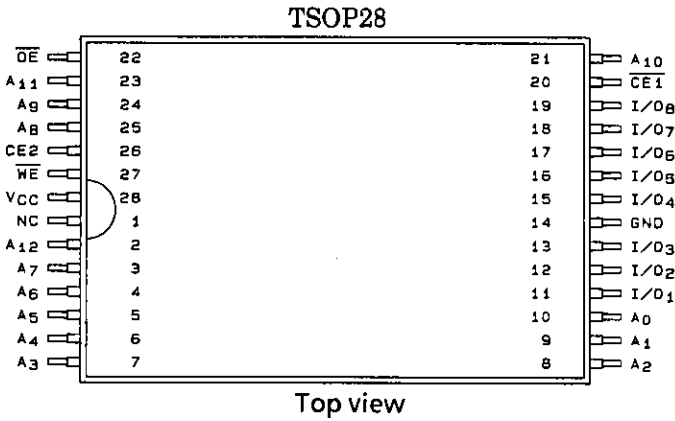
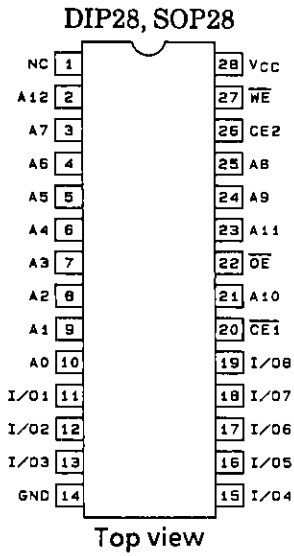


unit : mm

#### 3133-DIP28

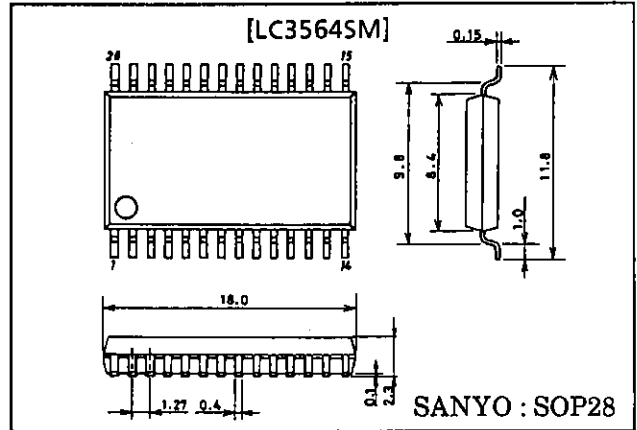


Pin Assignments

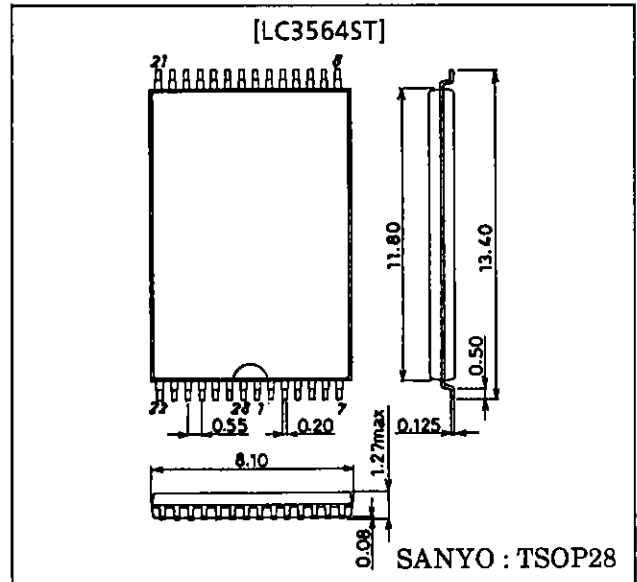


Package Dimensions

unit : mm  
3187-SOP28

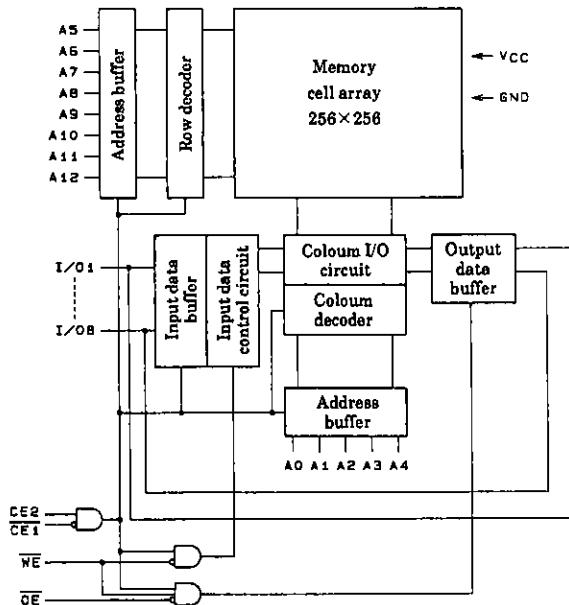


unit : mm  
3221-TSOP28



A0 to A12	Address input
$\overline{WE}$	Write enable
$\overline{OE}$	Output enable
$\overline{CE1}, \overline{CE2}$	Chip enable
I/O <sub>1</sub> to I/O <sub>8</sub>	Data input/output
VCC, GND	Power, ground

Block Diagram



**Pin Functions**

Mode	$\overline{CE1}$	CE2	$\overline{OE}$	$\overline{WE}$	I/O	Current
Read Cycle	L	H	L	H	Data output	$I_{CCA}$
Write Cycle	L	H	×	L	Data input	$I_{CCA}$
Output Disable	L	H	H	H	High impedance	$I_{CCA}$
Unselected	H	×	×	×	High impedance	$I_{CCS}$
	×	L	×	×	High impedance	$I_{CCS}$

× : Arbitrary H or L

**Specifications**

**Absolute Maximum Ratings at  $T_a = 25^\circ\text{C}$**

Parameter	Symbol	Conditions	Ratings	Unit
Max supply voltage	$V_{CC\ max}$		7.0	V
Input voltage	$V_{IN}$		-0.3* to $V_{CC} + 0.3$	V
I/O voltage	$V_{I/O}$		-0.3 to $V_{CC} + 0.3$	V
Operating temperature range	$T_{opr}$		-40 to +85	°C
Storage temperature range	$T_{stg}$		-55 to +125	°C

\*) The inputs may undershoot to -3.0V (min.) for periods less than 30ns.

**I/O Capacitance at  $T_a = 25^\circ\text{C}$ ,  $f = 1\text{MHz}$**

Parameter	Symbol	Conditions	min	typ	max	Unit
Input/output capacitance	$C_{I/O}$	$V_{I/O} = 0\text{V}$		6	10	pF
Input capacitance	$C_I$	$V_{IN} = 0\text{V}$		6	10	pF

(Note) This parameter is sampled and not 100% tested.

5V Operation

DC Recommended Operating Ranges at  $T_a = -40$  to  $+85^\circ\text{C}$ ,  $V_{CC} = 4.5$  to  $5.5\text{V}$

Parameter	Symbol	min	typ	max	Unit
Supply voltage	$V_{CC}$	4.5	5.0	5.5	V
Input voltage	$V_{IH}$	2.2		$V_{CC} + 0.3$	V
	$V_{IL}$	-0.3*		+0.8	V

\*) The inputs may undershoot to  $-3.0\text{V}$  (min.) for periods less than 30ns.

DC Electrical Characteristics at  $T_a = -40$  to  $+85^\circ\text{C}$ ,  $V_{CC} = 4.5$  to  $5.5\text{V}$

Parameter	Symbol	Conditions	min	typ*	max	Unit		
Input leakage current	$I_{LI}$	$V_{IN} = 0$ to $V_{CC}$	-1.0		+1.0	$\mu\text{A}$		
I/O leakage current	$I_{LO}$	$V_{\overline{CE1}} = V_{IH}$ or $V_{CE2} = V_{IL}$ or $V_{\overline{OE}} = V_{IH}$ or $V_{\overline{WE}} = V_{IL}$ , $V_{I/O} = 0$ to $V_{CC}$	-1.0		+1.0	$\mu\text{A}$		
Output high level voltage	$V_{OH}$	$I_{OH} = -1.0\text{mA}$	2.4			V		
Output low level voltage	$V_{OL}$	$I_{OL} = 2.0\text{mA}$			0.4	V		
Operating current	$V_{CC} - 0.2\text{V}/$ $0.2\text{V}$ input	$I_{CCA1}$	$V_{\overline{CE1}} \cong 0.2\text{V}$ , $V_{CE2} \cong V_{CC} - 0.2\text{V}$ , $I_{I/O} = 0\text{mA}$ , $V_{IN} \cong 0.2\text{V}$ or $V_{IN} \cong V_{CC} - 0.2\text{V}$		$T_a \leq 70^\circ\text{C}$	0.01	1.0	$\mu\text{A}$
			$T_a \leq 85^\circ\text{C}$		3.0			
		$I_{CCA4}$	$V_{\overline{CE1}} \cong 0.2\text{V}$ , $V_{CE2} \cong V_{CC} - 0.2\text{V}$ , $I_{I/O} = 0\text{mA}$ , DUTY 100%	min cycle	LC3564S, SS, SM, ST-70		35	mA
					LC3564S, SS, SM, ST-85		35	
	LC3564S, SS, SM, ST-10					30		
			1 $\mu\text{s}$ cycle			4		mA
	TTL input	$I_{CCA2}$	$V_{\overline{CE1}} = V_{IL}$ , $V_{CE2} = V_{IH}$ , $I_{I/O} = 0\text{mA}$ , $V_{IN} = V_{IH}$ or $V_{IL}$				7	mA
			$I_{CCA3}$	$V_{\overline{CE1}} = V_{IL}$ , $V_{CE2} = V_{IH}$ , $I_{I/O} = 0\text{mA}$ , DUTY 100%	min cycle	LC3564S, SS, SM, SS-70		
		LC3564S, SS, SM, SS-85					40	
		LC3564S, SS, SM, SS-10					35	
		1 $\mu\text{s}$ cycle			7		mA	
Standby current	$V_{CC} - 0.2\text{V}/$ $0.2\text{V}$ input	$I_{CCS1}$	$V_{CE2} \cong 0.2\text{V}$ or $V_{\overline{CE1}} \cong V_{CC} - 0.2\text{V}$ $V_{CE2} \cong V_{CC} - 0.2\text{V}$		$T_a \leq 70^\circ\text{C}$	0.01	1.0	$\mu\text{A}$
			$T_a \leq 85^\circ\text{C}$		3.0			
	TTL input	$I_{CCS2}$	$V_{CE2} = V_{IL}$ or $V_{\overline{CE1}} = V_{IH}$ , $V_{IN} = 0$ to $V_{CC}$				2.0	mA

\*) Reference value at  $V_{CC} = 5\text{V}$ ,  $T_a = 25^\circ\text{C}$

**LC3564S, SS, SM, ST-70/85/10**

**AC Electrical Characteristics at Ta = -40 to +85°C, V<sub>CC</sub> = 4.5 to 5.5V**

AC test conditions

Input pulse levels : V<sub>IH</sub> = 2.4V, V<sub>IL</sub> = 0.6V  
 Input rise and fall time : 5ns  
 Input and output timing reference levels : 1.5V  
 Output load LC3564S, SS, SM, ST-70 : 30pF + 1TTL gate  
 (including jig capacitance)  
 LC3564S, SS, SM, ST-85/10 : 100pF + 1TTL gate  
 (including jig capacitance)

**Read Cycle**

Parameter	Symbol	LC3564S, SS, SM, ST						Unit
		-70		-85		-10		
		min	max	min	max	min	max	
Read cycle time	t <sub>RC</sub>	70		85		100		ns
Address access time	t <sub>AA</sub>		70		85		100	ns
$\overline{\text{CE1}}$ access time	t <sub>CA1</sub>		70		85		100	ns
CE2 access time	t <sub>CA2</sub>		70		85		100	ns
$\overline{\text{OE}}$ access time	t <sub>OA</sub>		35		45		50	ns
Output hold time	t <sub>OH</sub>	10		10		10		ns
$\overline{\text{CE1}}$ - output enable time	t <sub>COE1</sub>	10		10		10		ns
CE2 - output enable time	t <sub>COE2</sub>	10		10		10		ns
$\overline{\text{OE}}$ - output enable time	t <sub>OOE</sub>	5		5		5		ns
$\overline{\text{CE1}}$ - output disable time	t <sub>COD1</sub>		30		35		35	ns
CE2 - output disable time	t <sub>COD2</sub>		30		35		35	ns
$\overline{\text{OE}}$ - output disable time	t <sub>OOD</sub>		25		25		25	ns

**Write Cycle**

Parameter	Symbol	LC3564S, SS, SM, ST						Unit
		-70		-85		-10		
		min	max	min	max	min	max	
Write cycle time	t <sub>WC</sub>	70		85		100		ns
Address setup time	t <sub>AS</sub>	0		0		0		ns
Write pulse width	t <sub>WP</sub>	50		55		55		ns
$\overline{\text{CE1}}$ setup time	t <sub>CW1</sub>	60		65		65		ns
CE2 setup time	t <sub>CW2</sub>	60		65		65		ns
Write recovery time	t <sub>WR</sub>	0		0		0		ns
$\overline{\text{CE1}}$ write recovery time	t <sub>WR1</sub>	0		0		0		ns
CE2 write recovery time	t <sub>WR2</sub>	0		0		0		ns
Data setup time	t <sub>DS</sub>	35		40		40		ns
Data hold time	t <sub>DH</sub>	0		0		0		ns
$\overline{\text{CE1}}$ data hold time	t <sub>DH1</sub>	0		0		0		ns
CE2 data hold time	t <sub>DH2</sub>	0		0		0		ns
$\overline{\text{WE}}$ - output enable time	t <sub>WOE</sub>	5		5		5		ns
$\overline{\text{WE}}$ - output disable time	t <sub>WOD</sub>		30		35		35	ns

**3V Operation**

**DC Recommended Operating Ranges** at  $T_a = -40$  to  $+85^\circ\text{C}$ ,  $V_{CC} = 2.7$  to  $3.3\text{V}$

Parameter	Symbol	min	typ	max	Unit
Supply voltage	$V_{CC}$	2.7	3.0	3.3	V
Input voltage	$V_{IH}$	$V_{CC} - 0.2$		$V_{CC}$	V
	$V_{IL}$	0		0.2	V

**DC Electrical Characteristics** at  $T_a = -40$  to  $+85^\circ\text{C}$ ,  $V_{CC} = 2.7$  to  $3.3\text{V}$

Parameter		Symbol	Conditions		min	typ*	max	Unit	
Input leakage current		$I_{LI}$	$V_{IN} = 0$ to $V_{CC}$		-1.0		+1.0	$\mu\text{A}$	
I/O leakage current		$I_{LO}$	$V_{CE1} = V_{IH}$ or $V_{CE2} = V_{IL}$ or $V_{OE} = V_{IH}$ or $V_{WE} = V_{IL}$ , $V_{I/O} = 0$ to $V_{CC}$		-1.0		+1.0	$\mu\text{A}$	
Output high level voltage		$V_{OH}$	$I_{OH} = -0.5\text{mA}$		$V_{CC} - 0.2\text{V}$			V	
Output low level voltage		$V_{OL}$	$I_{OL} = 1.0\text{mA}$				0.2	V	
Operating current	$V_{CC} - 0.2\text{V}/0.2\text{V}$ input	$I_{CCA1}$	$V_{CE1} \leq V_{IL}$ , $V_{CE2} \geq V_{IH}$ , $I_{I/O} = 0\text{mA}$ , $V_{IN} \geq V_{IL}$ , $V_{IN} \geq V_{IH}$		$T_a \leq 70^\circ\text{C}$	0.01	0.8	$\mu\text{A}$	
					$T_a \leq 85^\circ\text{C}$		2.5		
		$I_{CCA4}$	$V_{CE1} \leq V_{IL}$ , $V_{CE2} \geq V_{IH}$ , $I_{I/O} = 0\text{mA}$ , DUTY = 100%	min cycle	LC3564S, SS, SM, ST-70			20	mA
					LC3564S, SS, SM, ST-85			20	
			LC3564S, SS, SM, ST-10			10			
			1 $\mu\text{s}$ cycle			3		mA	
Standby current	$V_{CC} - 0.2\text{V}/0.2\text{V}$ input	$I_{CCS1}$	$V_{CE2} \leq V_{IL}$ or $V_{CE1} \geq V_{IH}$ $V_{CE2} \geq V_{IH}$		$T_a \leq 70^\circ\text{C}$	0.01	0.8	$\mu\text{A}$	
					$T_a \leq 85^\circ\text{C}$		2.5		

\*) Reference value at  $V_{CC} = 3\text{V}$ ,  $T_a = 25^\circ\text{C}$

**LC3564S, SS, SM, ST-70/85/10**

**AC Electrical Characteristics** at  $T_a = -40$  to  $+85^\circ\text{C}$ ,  $V_{CC} = 2.7$  to  $3.3\text{V}$

AC test conditions

Input pulse levels		: $V_{IH} = V_{CC} - 0.2\text{V}$ , $V_{IL} = 0.2\text{V}$
Input rise and fall time		: 10ns
Input and output timing reference levels		: 1.5V
Output load	LC3564S, SS, SM, ST-70	: 30pF (including scope and jig)
	LC3564S, SS, SM, ST-85/10	: 100pF (including scope and jig)

**Read Cycle**

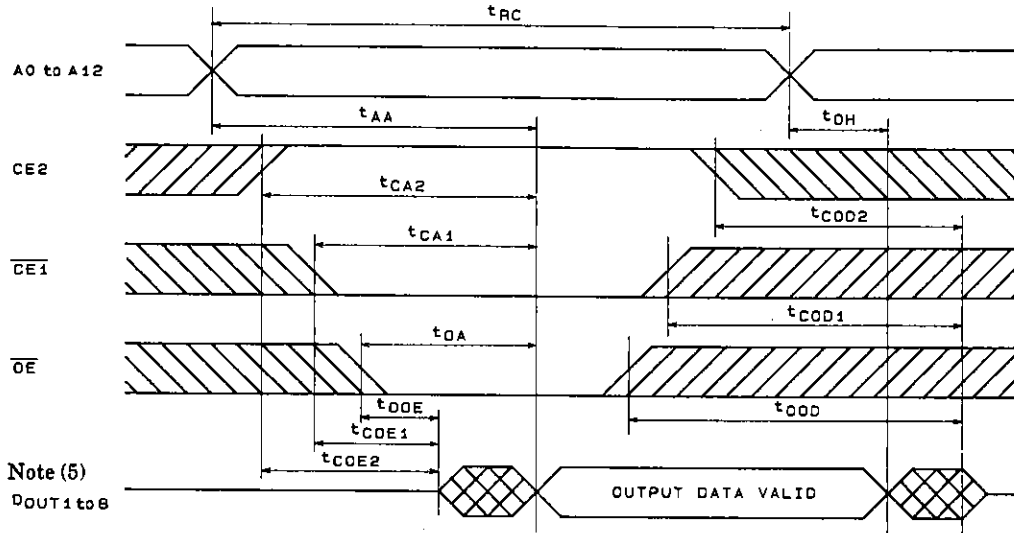
Parameter	Symbol	LC3564S, SS, SM, ST						Unit
		-70		-85		-10		
		min	max	min	max	min	max	
Read cycle time	$t_{RC}$	200		250		500		ns
Address access time	$t_{AA}$		200		250		500	ns
$\overline{CE1}$ access time	$t_{CA1}$		200		250		500	ns
CE2 access time	$t_{CA2}$		200		250		500	ns
$\overline{OE}$ access time	$t_{OA}$		100		130		250	ns
Output hold time	$t_{OH}$	20		20		20		ns
$\overline{CE1}$ - output enable time	$t_{COE1}$	20		20		20		ns
CE2 - output enable time	$t_{COE2}$	20		20		20		ns
$\overline{OE}$ - output enable time	$t_{OOE}$	10		10		10		ns
$\overline{CE1}$ - output disable time	$t_{COD1}$		60		80		120	ns
CE2 - output disable time	$t_{COD2}$		60		80		120	ns
$\overline{OE}$ - output disable time	$t_{OOD}$		50		70		100	ns

**Write Cycle**

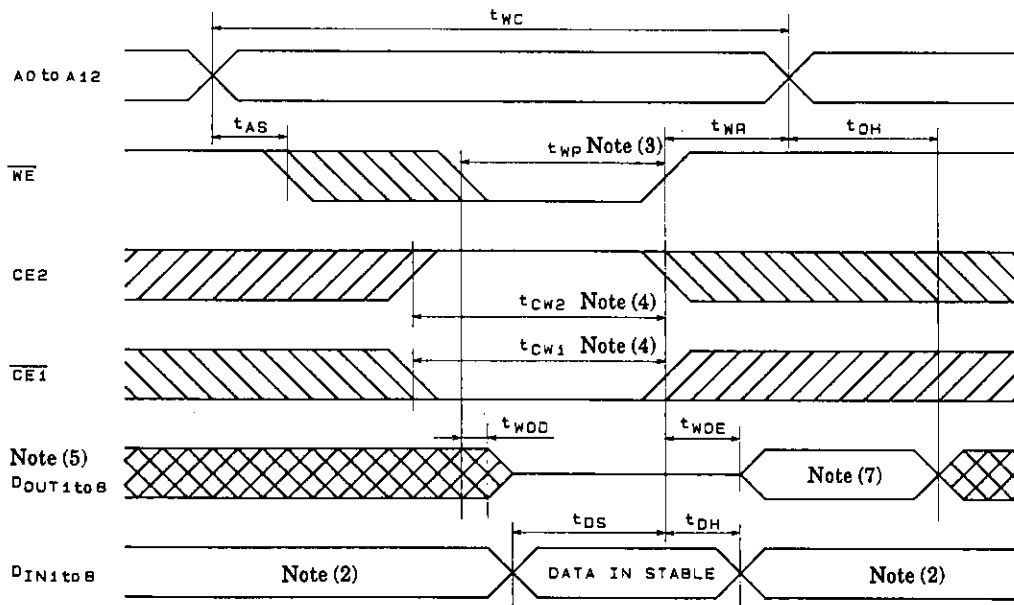
Parameter	Symbol	LC3564S, SS, SM, ST						Unit
		-70		-85		-10		
		min	max	min	max	min	max	
Write cycle time	$t_{WC}$	200		250		500		ns
Address setup time	$t_{AS}$	0		0		0		ns
Write pulse width	$t_{WP}$	140		160		200		ns
$\overline{CE1}$ setup time	$t_{CW1}$	150		180		250		ns
CE2 setup time	$t_{CW2}$	150		180		250		ns
Write recovery time	$t_{WR}$	0		0		0		ns
$\overline{CE1}$ write recovery time	$t_{WR1}$	0		0		0		ns
CE2 write recovery time	$t_{WR2}$	0		0		0		ns
Data setup time	$t_{DS}$	130		150		180		ns
Data hold time	$t_{DH}$	0		0		0		ns
$\overline{CE1}$ data hold time	$t_{DH1}$	0		0		0		ns
CE2 data hold time	$t_{DH2}$	0		0		0		ns
$\overline{WE}$ - output enable time	$t_{WOE}$	10		10		10		ns
$\overline{WE}$ - output disable time	$t_{WOD}$		60		80		120	ns

Timing Waveform

Read Cycle Note (1)

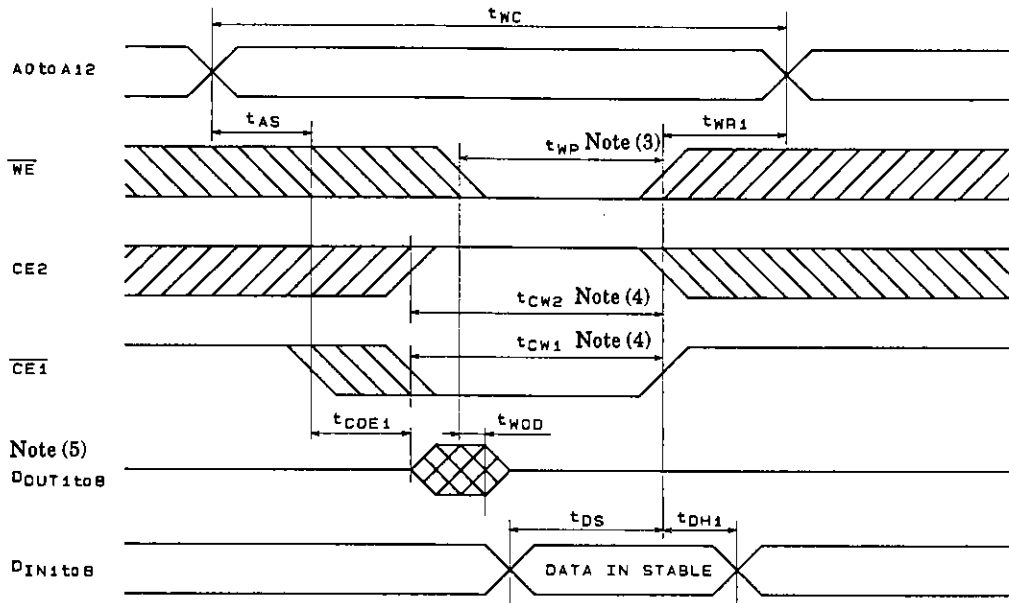


Write Cycle 1 ( $\overline{WE}$  Write) Note (6)

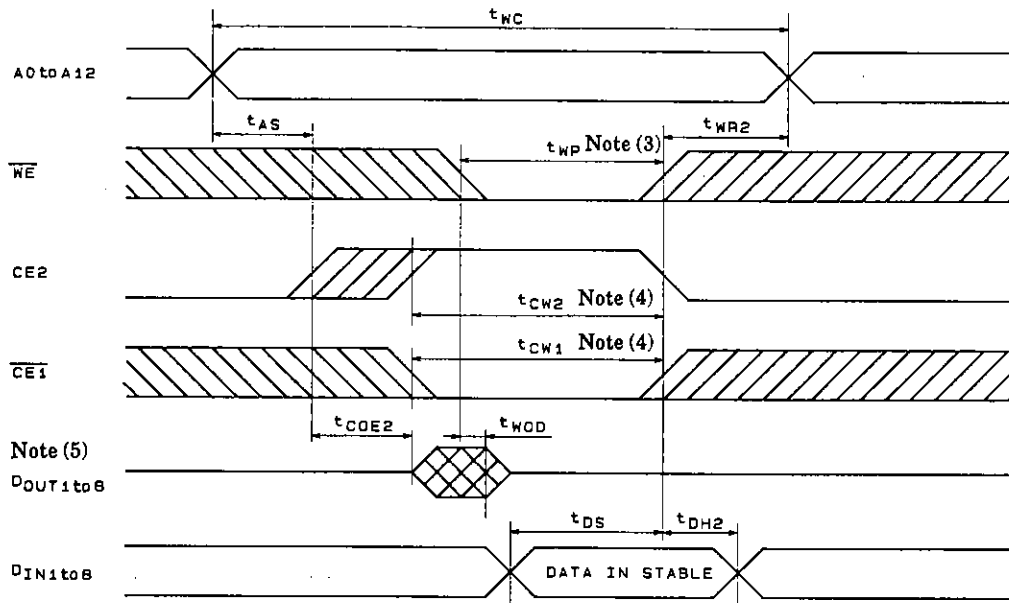




Write Cycle 2 ( $\overline{CE1}$  Write) Note (6)



Write Cycle 3 (CE2 Write) Note (6)



Notes : (1) In Read Cycle,  $\overline{WE}$  should be high.

(2) During this period, I/O pins are in the output state, therefore the input signals of opposite phase to the outputs must not be applied.

(3) A write occurs during the overlap of a low  $\overline{CE1}$ , a high CE2 and a low  $\overline{WE}$ .  
 A write begins at the latest transition among  $\overline{CE1}$  going low, CE2 going high and  $\overline{WE}$  going low.  
 A write ends at the earliest transition among  $\overline{CE1}$  going high, CE2 going low and  $\overline{WE}$  going high.

$t_{WP}$  is measured from the beginning of write to the end of write.

(4)  $t_{COW1}$ ,  $t_{COW2}$  are measured from the later of  $\overline{CE1}$  going low or CE2 going high to the end of write.

(5) If one of these conditions ( $\overline{OE}$  is high,  $\overline{CE1}$  is high, CE2 is low,  $\overline{WE}$  is low) at least is satisfied,  $D_{OUT}$  goes to high impedance state.

(6) In Write Cycle,  $\overline{OE} = V_{IH}$  or  $V_{IL}$ .

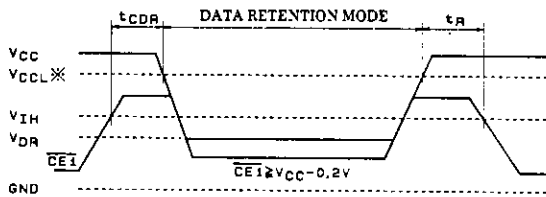
(7)  $D_{OUT}$  is in the same phase of written data of this cycle.

Data Retention Characteristics at  $T_a = -40$  to  $+85^\circ\text{C}$

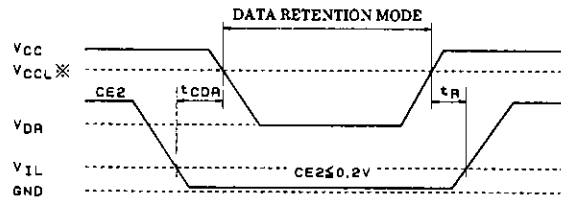
Parameter	Symbol	Conditions	min	typ	max	Unit
Date retention supply voltage	$V_{DR}$	$V_{CE2} \leq 0.2\text{V}$ , or $V_{CE1} \geq V_{CC} - 0.2\text{V}$ or $V_{CE2} \geq V_{CC} - 0.2\text{V}$	2.0		5.5	V
Data retention current	$I_{CCDR}$	$V_{CC} = 3\text{V}$ , $V_{CE2} \leq 0.2\text{V}$ , or $V_{CE1} \geq V_{CC} - 0.2\text{V}$ or $V_{CE2} \geq V_{CC} - 0.2\text{V}$	$T_a \leq 70^\circ\text{C}$		0.8	$\mu\text{A}$
			$T_a \leq 85^\circ\text{C}$		2.5	
Chip enable setup time	$t_{CDR}$		0			ns
Chip enable hold time	$t_R$		$t_{RC}^*$			ns

\*)  $t_{RC}$  = Read Cycle Time

Data Retention Waveform (1) ( $\overline{CE1}$  CONTROL)



Data Retention Waveform (2) (CE2 CONTROL)



\*)  $V_{CCL}$  —  $\begin{cases} 5\text{V operation} : 4.5\text{V} \\ 3\text{V operation} : 2.7\text{V} \end{cases}$

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