

# R1LV0416C-I Series

Wide Temperature Range Version  
4M SRAM (256-kword × 16-bit)

REJ03C0105-0200Z

Rev. 2.00

May.26.2004

## Description

The R1LV0416C-I is a 4-Mbit static RAM organized 256-kword × 16-bit. R1LV0416C-I Series has realized higher density, higher performance and low power consumption by employing CMOS process technology (6-transistor memory cell). The R1LV0416C-I Series offers low power standby power dissipation; therefore, it is suitable for battery backup systems. It has packaged in 44-pin TSOP II.

## Features

- Single 2.5 V and 3.0 V supply: 2.2 V to 3.6 V
- Fast access time: 55/70 ns (max)
- Power dissipation:
  - Active: 5.0 mW/MHz (typ)(V<sub>CC</sub> = 2.5 V)  
: 6.0 mW/MHz (typ) (V<sub>CC</sub> = 3.0 V)
  - Standby: 1.25 μW (typ) (V<sub>CC</sub> = 2.5 V)  
: 1.5 μW (typ) (V<sub>CC</sub> = 3.0 V)
- Completely static memory.
  - No clock or timing strobe required
- Equal access and cycle times
- Common data input and output.
  - Three state output
- Battery backup operation.
  - 2 chip selection for battery backup
- Temperature range: -40 to +85°C

## R1LV0416C-I Series

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### Ordering Information

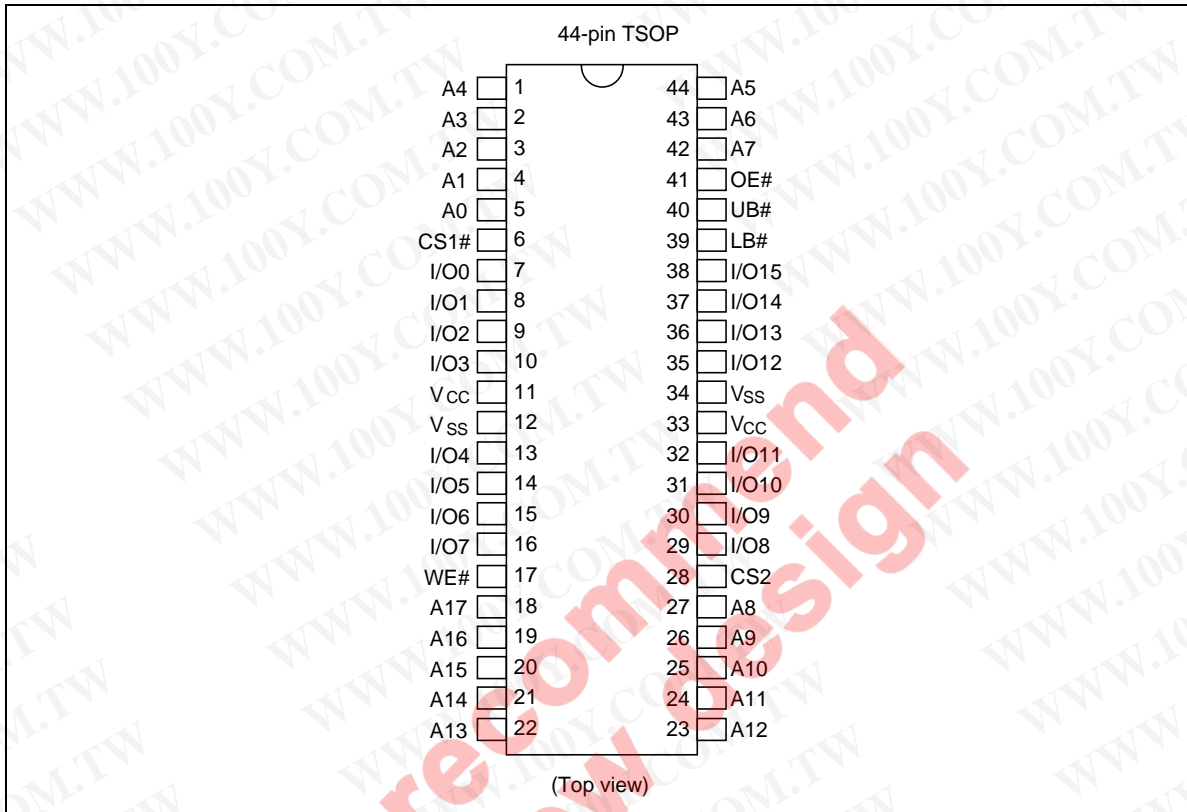
Type No.	Access time	Package
R1LV0416CSB-5SI	55 ns	400-mil 44-pin plastic TSOP II (44P3W-H)
R1LV0416CSB-7LI	70 ns	

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**Not recommend  
for new design**

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### Pin Arrangement



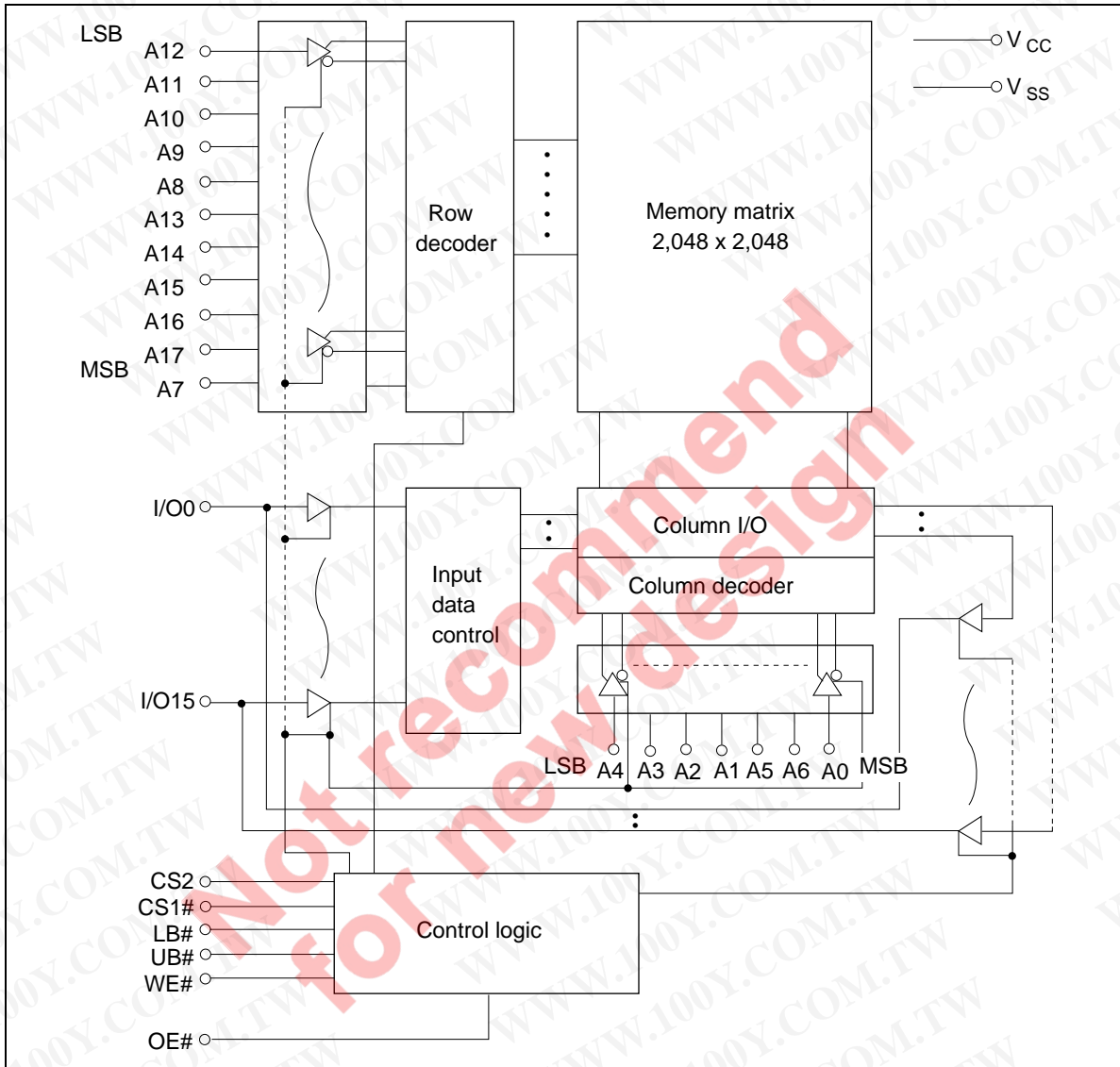
### Pin Description

Pin name	Function
A0 to A17	Address input
I/O0 to I/O15	Data input/output
CS1# ( $\overline{\text{CS1}}$ )	Chip select 1
CS2	Chip select 2
OE# ( $\overline{\text{OE}}$ )	Output enable
WE# ( $\overline{\text{WE}}$ )	Write enable
LB# ( $\overline{\text{LB}}$ )	Lower byte select
UB# ( $\overline{\text{UB}}$ )	Upper byte select
V <sub>cc</sub>	Power supply
V <sub>ss</sub>	Ground

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**Block Diagram**



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### Operation Table

CS1#	CS2	WE#	OE#	UB#	LB#	I/O0 to I/O7	I/O8 to I/O15	Operation
H	×	×	×	×	×	High-Z	High-Z	Standby
×	L	×	×	×	×	High-Z	High-Z	Standby
×	×	×	×	H	H	High-Z	High-Z	Standby
L	H	H	L	L	L	Dout	Dout	Read
L	H	H	L	H	L	Dout	High-Z	Lower byte read
L	H	H	L	L	H	High-Z	Dout	Upper byte read
L	H	L	×	L	L	Din	Din	Write
L	H	L	×	H	L	Din	High-Z	Lower byte write
L	H	L	×	L	H	High-Z	Din	Upper byte write
L	H	H	H	×	×	High-Z	High-Z	Output disable

Note: H:  $V_{IH}$ , L:  $V_{IL}$ , ×:  $V_{IH}$  or  $V_{IL}$

### Absolute Maximum Ratings

Parameter	Symbol	Value	Unit
Power supply voltage relative to $V_{SS}$	$V_{CC}$	-0.5 to +4.6	V
Terminal voltage on any pin relative to $V_{SS}$	$V_T$	$-0.5^{*1}$ to $V_{CC} + 0.3^{*2}$	V
Power dissipation	$P_T$	0.7	W
Operating temperature	$T_{opr}$	-40 to +85	°C
Storage temperature range	$T_{stg}$	-65 to +150	°C
Storage temperature range under bias	$T_{bias}$	-40 to +85	°C

Notes: 1.  $V_T$  min: -3.0 V for pulse half-width  $\leq$  30 ns.  
 2. Maximum voltage is +4.6 V.

### DC Operating Conditions

( $T_a = -40$  to  $+85^\circ\text{C}$ )

Parameter	Symbol	Min	Typ	Max	Unit	Note
Supply voltage	$V_{CC}$	2.2	2.5/3.0	3.6	V	
	$V_{SS}$	0	0	0	V	
Input high voltage	$V_{CC} = 2.2\text{ V to }2.7\text{ V}$	$V_{IH}$	2.0	—	$V_{CC} + 0.3$	V
	$V_{CC} = 2.7\text{ V to }3.6\text{ V}$	$V_{IH}$	2.2	—	$V_{CC} + 0.3$	V
Input low voltage	$V_{CC} = 2.2\text{ V to }2.7\text{ V}$	$V_{IL}$	-0.2	—	0.4	V 1
	$V_{CC} = 2.7\text{ V to }3.6\text{ V}$	$V_{IL}$	-0.3	—	0.6	V 1

Note: 1.  $V_{IL}$  min: -3.0 V for pulse half-width  $\leq$  30 ns.

**R1LV0416C-I Series**

**DC Characteristics**

Parameter	Symbol	Min	Typ	Max	Unit	Test conditions	
Input leakage current	$ I_{LI} $	—	—	1	$\mu\text{A}$	$V_{in} = V_{SS} \text{ to } V_{CC}$	
Output leakage current	$ I_{LO} $	—	—	1	$\mu\text{A}$	CS1# = $V_{IH}$ or CS2 = $V_{IL}$ or OE# = $V_{IH}$ or WE# = $V_{IL}$ or LB# = UB# = $V_{IH}$ , $V_{I/O} = V_{SS} \text{ to } V_{CC}$	
Operating current	$I_{CC}$	—	$5^{*1}$	20	mA	CS1# = $V_{IL}$ , CS2 = $V_{IH}$ , Others = $V_{IH}/V_{IL}$ , $I_{I/O} = 0 \text{ mA}$	
Average operating current	$I_{CC1}$	—	$8^{*1}$	25	mA	Min. cycle, duty = 100%, $I_{I/O} = 0 \text{ mA}$ , CS1# = $V_{IL}$ , CS2 = $V_{IH}$ , Others = $V_{IH}/V_{IL}$	
	$I_{CC2}$	—	$2^{*1}$	5	mA	Cycle time = 1 $\mu\text{s}$ , duty = 100%, $I_{I/O} = 0 \text{ mA}$ , CS1# $\leq 0.2 \text{ V}$ , CS2 $\geq V_{CC} - 0.2 \text{ V}$ $V_{IH} \geq V_{CC} - 0.2 \text{ V}$ , $V_{IL} \leq 0.2 \text{ V}$	
Standby current	$I_{SB}$	—	$0.1^{*1}$	0.3	mA	CS2 = $V_{IL}$	
Standby current	-5SI	to +85°C	$I_{SB1}$	—	—	10 $\mu\text{A}$	$V_{in} \geq 0 \text{ V}$
		to +70°C	$I_{SB1}$	—	—	8 $\mu\text{A}$	(1) $0 \text{ V} \leq \text{CS2} \leq 0.2 \text{ V}$ or
		to +40°C	$I_{SB1}$	—	$0.7^{*2}$	3 $\mu\text{A}$	(2) CS1# $\geq V_{CC} - 0.2 \text{ V}$ ,
		to +25°C	$I_{SB1}$	—	$0.5^{*1}$	3 $\mu\text{A}$	CS2 $\geq V_{CC} - 0.2 \text{ V}$ or
	-7LI	to +85°C	$I_{SB1}$	—	—	20 $\mu\text{A}$	(3) LB# = UB# $\geq V_{CC} - 0.2 \text{ V}$ ,
		to +70°C	$I_{SB1}$	—	—	16 $\mu\text{A}$	CS2 $\geq V_{CC} - 0.2 \text{ V}$ ,
		to +40°C	$I_{SB1}$	—	$0.7^{*2}$	10 $\mu\text{A}$	CS1# $\leq 0.2 \text{ V}$
		to +25°C	$I_{SB1}$	—	$0.5^{*1}$	10 $\mu\text{A}$	
Output high voltage	$V_{CC} = 2.2 \text{ V to } 2.7 \text{ V}$	$V_{OH}$	2.0	—	—	V $I_{OH} = -0.5 \text{ mA}$	
	$V_{CC} = 2.7 \text{ V to } 3.6 \text{ V}$	$V_{OH}$	2.4	—	—	V $I_{OH} = -1 \text{ mA}$	
	$V_{CC} = 2.2 \text{ V to } 3.6 \text{ V}$	$V_{OH2}$	$V_{CC} - 0.2$	—	—	V $I_{OH} = -100 \mu\text{A}$	
Output low voltage	$V_{CC} = 2.2 \text{ V to } 2.7 \text{ V}$	$V_{OL}$	—	—	0.4	V $I_{OL} = 0.5 \text{ mA}$	
	$V_{CC} = 2.7 \text{ V to } 3.6 \text{ V}$	$V_{OL}$	—	—	0.4	V $I_{OL} = 2 \text{ mA}$	
	$V_{CC} = 2.2 \text{ V to } 3.6 \text{ V}$	$V_{OL2}$	—	—	0.2	V $I_{OL} = 100 \mu\text{A}$	

Notes: 1. Typical values are at  $V_{CC} = 3.0 \text{ V}$ ,  $T_a = +25^\circ\text{C}$  and specified loading, and not guaranteed.  
 2. Typical values are at  $V_{CC} = 3.0 \text{ V}$ ,  $T_a = +40^\circ\text{C}$  and specified loading, and not guaranteed.

## R1LV0416C-I Series

### Capacitance

( $T_a = +25^\circ\text{C}$ ,  $f = 1.0\text{ MHz}$ )

Parameter	Symbol	Min	Typ	Max	Unit	Test conditions	Note
Input capacitance	$C_{in}$	—	—	8	pF	$V_{in} = 0\text{ V}$	1
Input/output capacitance	$C_{I/O}$	—	—	10	pF	$V_{I/O} = 0\text{ V}$	1

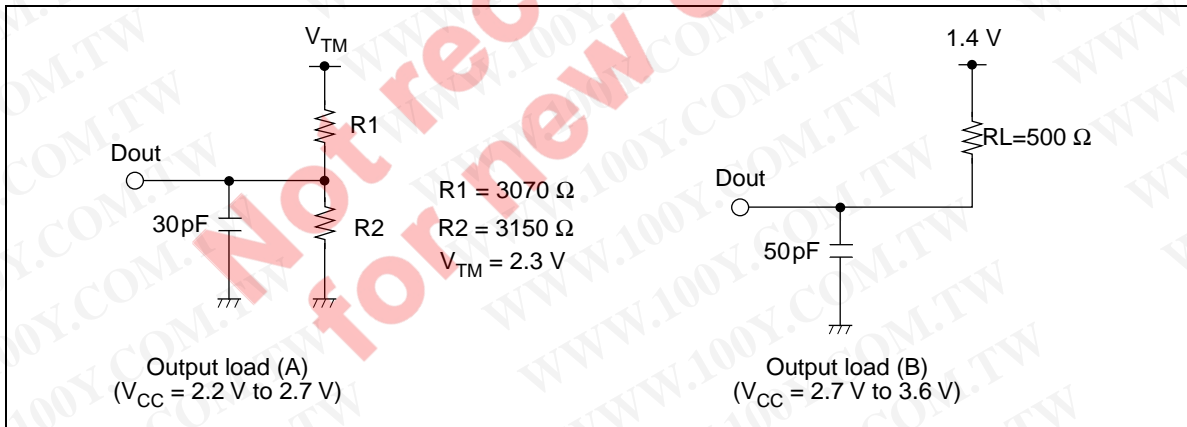
Note: 1. This parameter is sampled and not 100% tested.

### AC Characteristics

( $T_a = -40$  to  $+85^\circ\text{C}$ ,  $V_{CC} = 2.2\text{ V}$  to  $3.6\text{ V}$ , unless otherwise noted.)

#### Test Conditions

- Input pulse levels:  $V_{IL} = 0.4\text{ V}$ ,  $V_{IH} = 2.2\text{ V}$  ( $V_{CC} = 2.2\text{ V}$  to  $2.7\text{ V}$ )  
 :  $V_{IL} = 0.4\text{ V}$ ,  $V_{IH} = 2.4\text{ V}$  ( $V_{CC} = 2.7\text{ V}$  to  $3.6\text{ V}$ )
- Input rise and fall time:  $5\text{ ns}$
- Input/output timing reference levels:  $1.1\text{ V}$  ( $V_{CC} = 2.2\text{ V}$  to  $2.7\text{ V}$ )  
 :  $1.4\text{ V}$  ( $V_{CC} = 2.7\text{ V}$  to  $3.6\text{ V}$ )
- Output load: See figures (Including scope and jig)



## R1LV0416C-I Series

### Read Cycle

Parameter	Symbol	R1LV0416C-I				Unit	Notes
		-5SI		-7LI			
		Min	Max	Min	Max		
Read cycle time	t <sub>RC</sub>	55	—	70	—	ns	
Address access time	t <sub>AA</sub>	—	55	—	70	ns	
Chip select access time	t <sub>ACS1</sub>	—	55	—	70	ns	
	t <sub>ACS2</sub>	—	55	—	70	ns	
Output enable to output valid	t <sub>OE</sub>	—	35	—	40	ns	
Output hold from address change	t <sub>OH</sub>	10	—	10	—	ns	
LB#, UB# access time	t <sub>BA</sub>	—	55	—	70	ns	
Chip select to output in low-Z	t <sub>CLZ1</sub>	10	—	10	—	ns	2, 3
	t <sub>CLZ2</sub>	10	—	10	—	ns	2, 3
LB#, UB# disable to low-Z	t <sub>BLZ</sub>	5	—	5	—	ns	2, 3
Output enable to output in low-Z	t <sub>OLZ</sub>	5	—	5	—	ns	2, 3
Chip deselect to output in high-Z	t <sub>CHZ1</sub>	0	20	0	25	ns	1, 2, 3
	t <sub>CHZ2</sub>	0	20	0	25	ns	1, 2, 3
LB#, UB# disable to high-Z	t <sub>BHZ</sub>	0	20	0	25	ns	1, 2, 3
Output disable to output in high-Z	t <sub>OHZ</sub>	0	20	0	25	ns	1, 2, 3

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## R1LV0416C-I Series

### Write Cycle

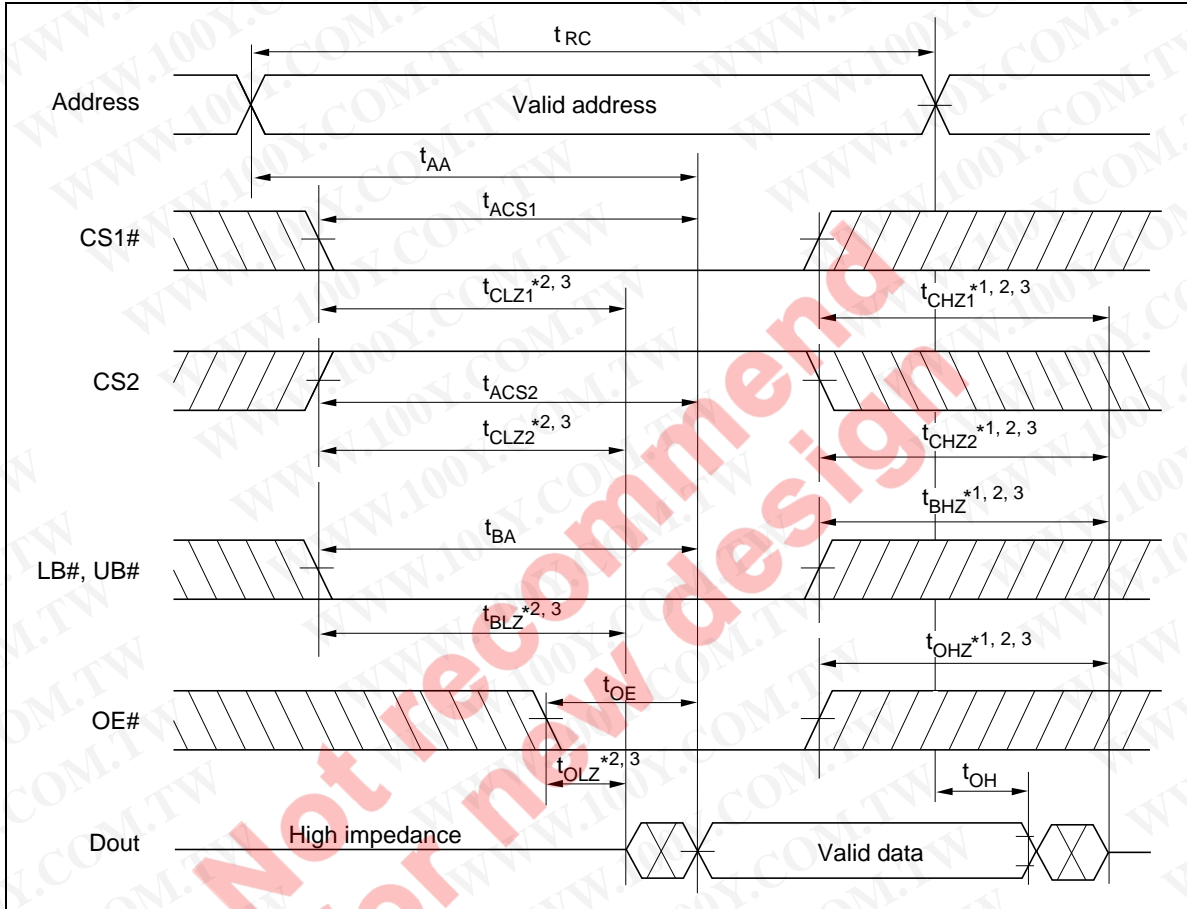
Parameter	Symbol	R1LV0416C-I				Unit	Notes
		-5SI		-7LI			
		Min	Max	Min	Max		
Write cycle time	$t_{WC}$	55	—	70	—	ns	
Address valid to end of write	$t_{AW}$	50	—	60	—	ns	
Chip selection to end of write	$t_{CW}$	50	—	60	—	ns	5
Write pulse width	$t_{WP}$	40	—	50	—	ns	4
LB#, UB# valid to end of write	$t_{BW}$	50	—	55	—	ns	
Address setup time	$t_{AS}$	0	—	0	—	ns	6
Write recovery time	$t_{WR}$	0	—	0	—	ns	7
Data to write time overlap	$t_{DW}$	25	—	30	—	ns	
Data hold from write time	$t_{DH}$	0	—	0	—	ns	
Output active from end of write	$t_{OW}$	5	—	5	—	ns	2
Output disable to output in high-Z	$t_{OHZ}$	0	20	0	25	ns	1, 2, 3
Write to output in high-Z	$t_{WHZ}$	0	20	0	25	ns	1, 2

- Notes:
- $t_{CHZ}$ ,  $t_{OHZ}$ ,  $t_{WHZ}$  and  $t_{BHZ}$  are defined as the time at which the outputs achieve the open circuit conditions and are not referred to output voltage levels.
  - This parameter is sampled and not 100% tested.
  - At any given temperature and voltage condition,  $t_{HZ}$  max is less than  $t_{LZ}$  min both for a given device and from device to device.
  - A write occurs during the overlap of a low CS1#, a high CS2, a low WE# and a low LB# or a low UB#. A write begins at the latest transition among CS1# going low, CS2 going high, WE# going low and LB# going low or UB# going low. A write ends at the earliest transition among CS1# going high, CS2 going low, WE# going high and LB# going high or UB# going high.  $t_{WP}$  is measured from the beginning of write to the end of write.
  - $t_{CW}$  is measured from the later of CS1# going low or CS2 going high to the end of write.
  - $t_{AS}$  is measured from the address valid to the beginning of write.
  - $t_{WR}$  is measured from the earliest of CS1# or WE# going high or CS2 going low to the end of write cycle.

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Timing Waveform

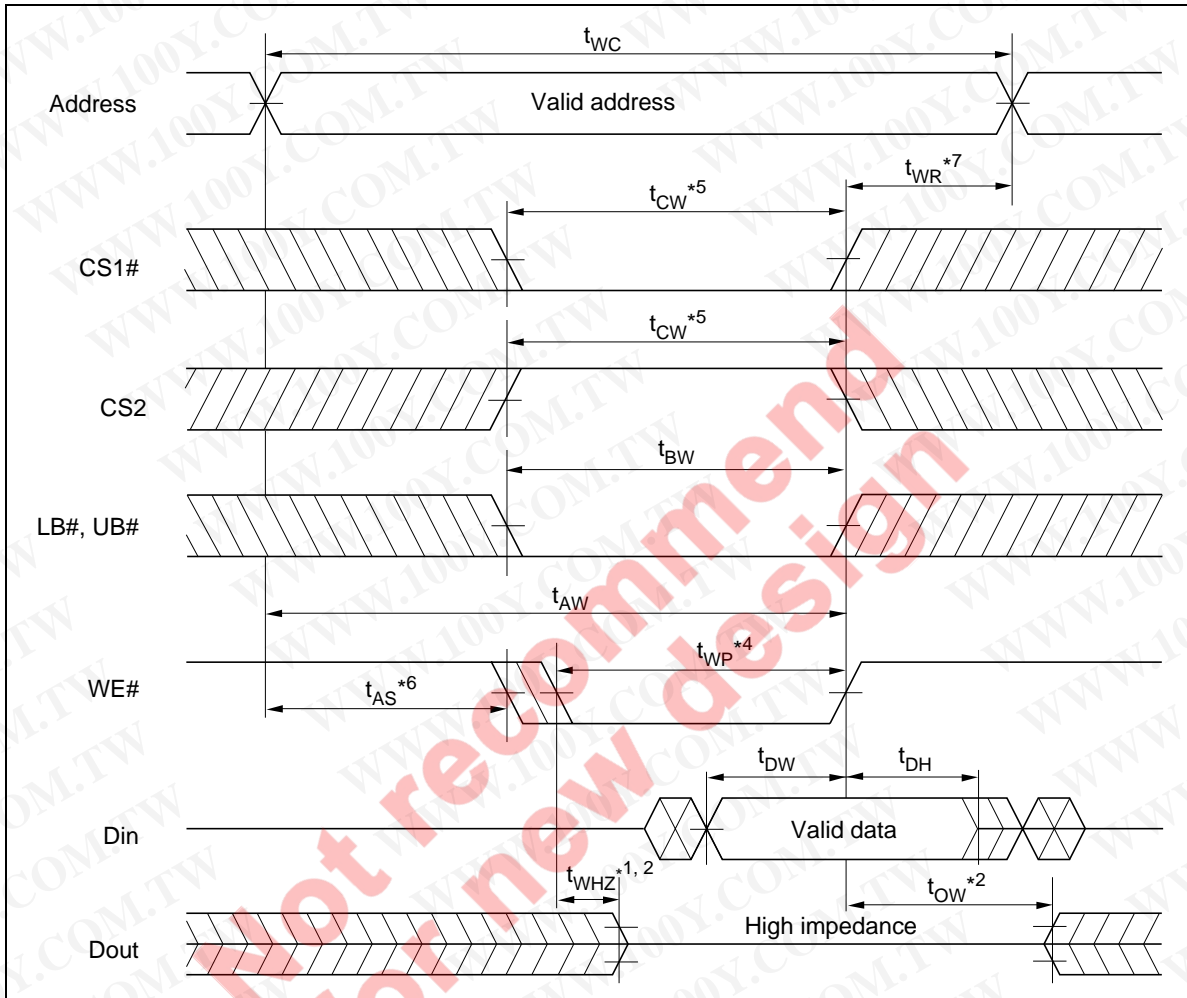
Read Timing Waveform (WE# = V<sub>IH</sub>)



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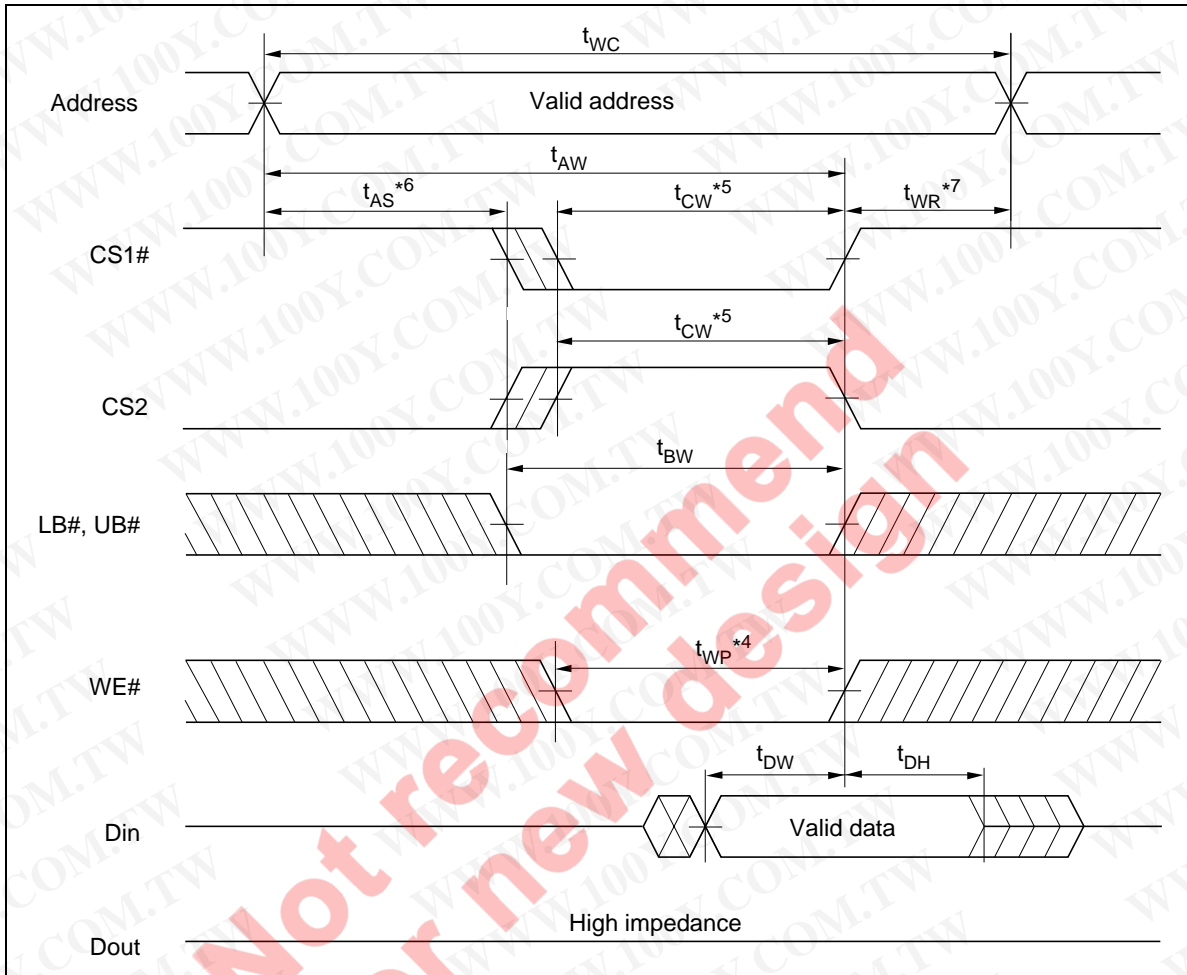
**Write Timing Waveform (1) (WE# Clock)**



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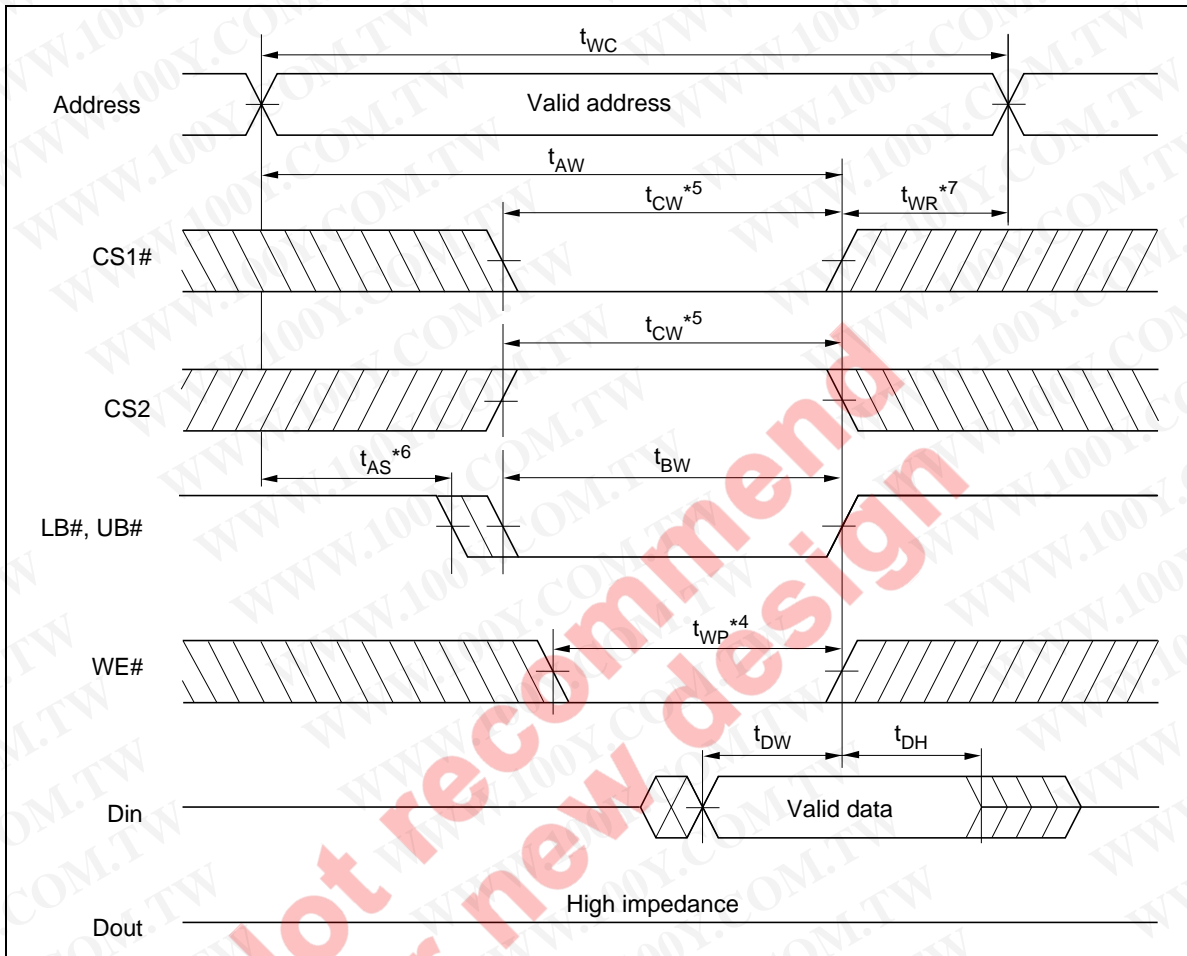
### Write Timing Waveform (2) (CS# Clock, OE# = V<sub>IH</sub>)



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**Write Timing Waveform (3) (LB#, UB# Clock, OE# = V<sub>IH</sub>)**



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## R1LV0416C-I Series

### Low $V_{CC}$ Data Retention Characteristics

( $T_a = -40$  to  $+85^\circ\text{C}$ )

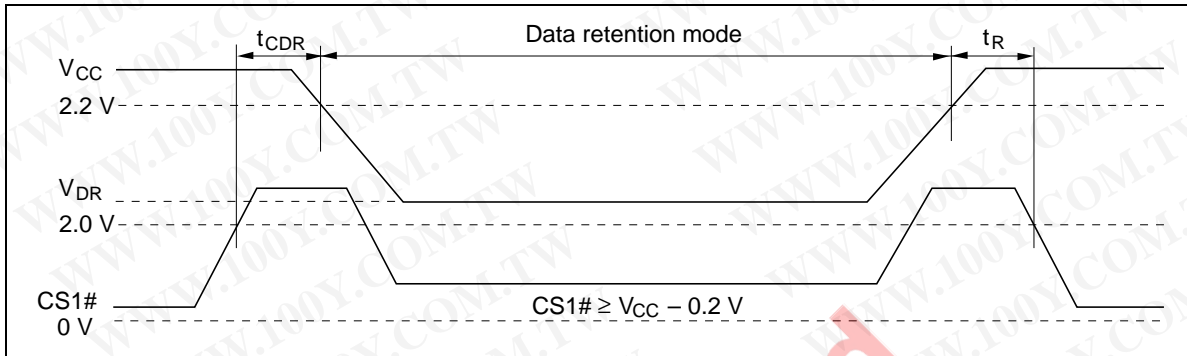
Parameter	Symbol	Min	Typ	Max	Unit	Test conditions*3	
$V_{CC}$ for data retention	$V_{DR}$	2.0	—	—	V	$V_{in} \geq 0V$ (1) $0V \leq CS2 \leq 0.2V$ or (2) $CS2 \geq V_{CC} - 0.2V$ , $CS1\# \geq V_{CC} - 0.2V$ or (3) $LB\# = UB\# \geq V_{CC} - 0.2V$ , $CS2 \geq V_{CC} - 0.2V$ , $CS1\# \leq 0.2V$	
Data retention current	-5SI	to $+85^\circ\text{C}$	$I_{CCDR}$	—	—	10 $\mu\text{A}$	$V_{CC} = 3.0V$ , $V_{in} \geq 0V$ (1) $0V \leq CS2 \leq 0.2V$ or (2) $CS2 \geq V_{CC} - 0.2V$ , $CS1\# \geq V_{CC} - 0.2V$ or (3) $LB\# = UB\# \geq V_{CC} - 0.2V$ , $CS2 \geq V_{CC} - 0.2V$ , $CS1\# \leq 0.2V$
		to $+70^\circ\text{C}$	$I_{CCDR}$	—	—	8 $\mu\text{A}$	
		to $+40^\circ\text{C}$	$I_{CCDR}$	—	$0.7^{*2}$	3 $\mu\text{A}$	
		to $+25^\circ\text{C}$	$I_{CCDR}$	—	$0.5^{*1}$	3 $\mu\text{A}$	
	-7LI	to $+85^\circ\text{C}$	$I_{CCDR}$	—	—	20 $\mu\text{A}$	
		to $+70^\circ\text{C}$	$I_{CCDR}$	—	—	16 $\mu\text{A}$	
		to $+40^\circ\text{C}$	$I_{CCDR}$	—	$0.7^{*2}$	10 $\mu\text{A}$	
		to $+25^\circ\text{C}$	$I_{CCDR}$	—	$0.5^{*1}$	10 $\mu\text{A}$	
Chip deselect to data retention time	$t_{CDR}$	0	—	—	ns	See retention waveform	
Operation recovery time	$t_R$	$t_{RC}^{*4}$	—	—	ns		

- Notes:
- Typical values are at  $V_{CC} = 3.0V$ ,  $T_a = +25^\circ\text{C}$  and specified loading, and not guaranteed.
  - Typical values are at  $V_{CC} = 3.0V$ ,  $T_a = +40^\circ\text{C}$  and specified loading, and not guaranteed.
  - CS2 controls address buffer, WE# buffer, CS1# buffer, OE# buffer, LB#, UB# buffer and Din buffer. If CS2 controls data retention mode,  $V_{in}$  levels (address, WE#, OE#, CS1#, LB#, UB#, I/O) can be in the high impedance state. If CS1# controls data retention mode, CS2 must be  $CS2 \geq V_{CC} - 0.2V$  or  $0V \leq CS2 \leq 0.2V$ . The other input levels (address, WE#, OE#, LB#, UB#, I/O) can be in the high impedance state.
  - $t_{RC}$  = read cycle time.

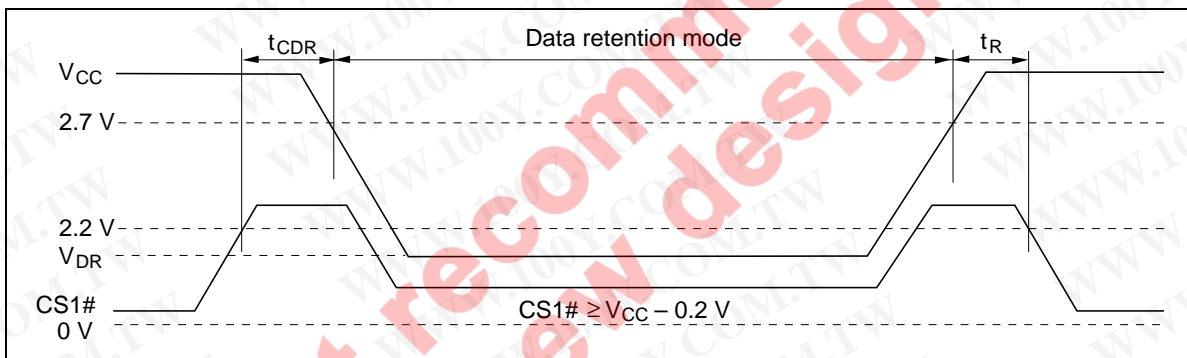
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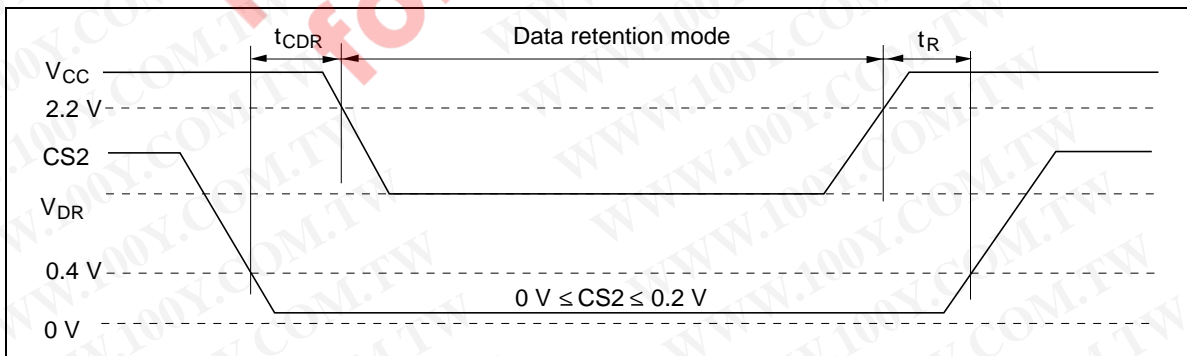
Low  $V_{CC}$  Data Retention Timing Waveform (1) (CS1# Controlled) ( $V_{CC} = 2.2\text{ V to } 2.7\text{ V}$ )



Low  $V_{CC}$  Data Retention Timing Waveform (2) (CS1# Controlled) ( $V_{CC} = 2.7\text{ V to } 3.6\text{ V}$ )



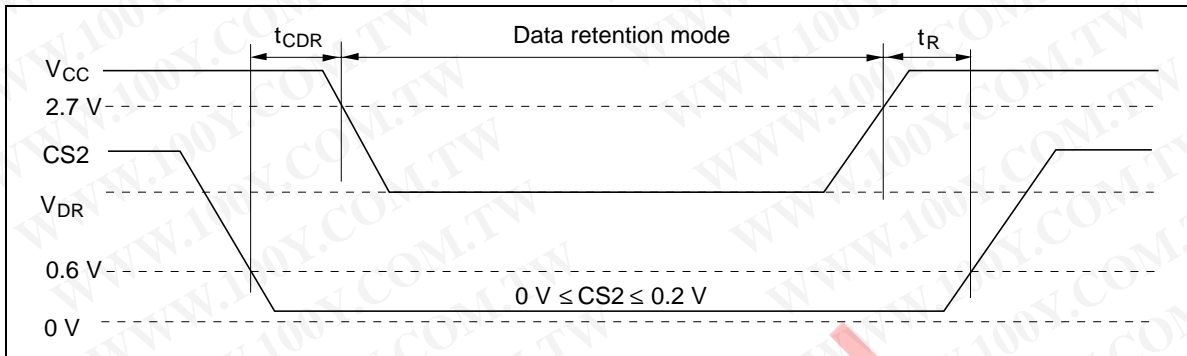
Low  $V_{CC}$  Data Retention Timing Waveform (3) (CS2 Controlled) ( $V_{CC} = 2.2\text{ V to } 2.7\text{ V}$ )



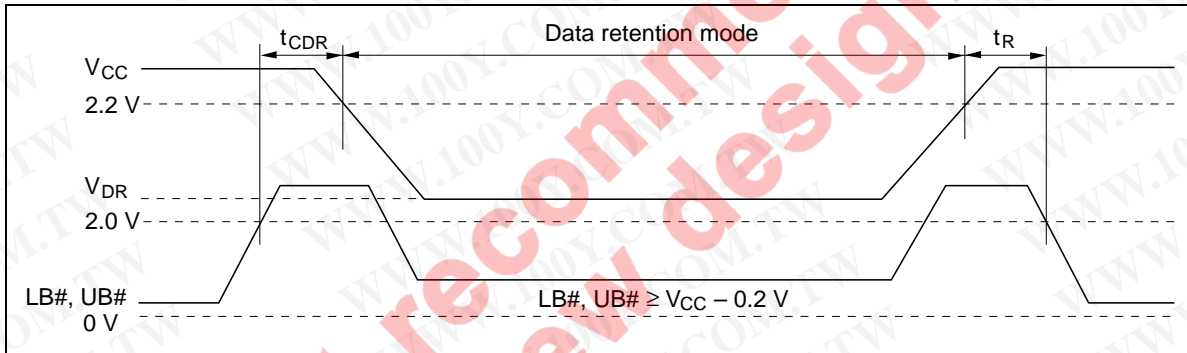
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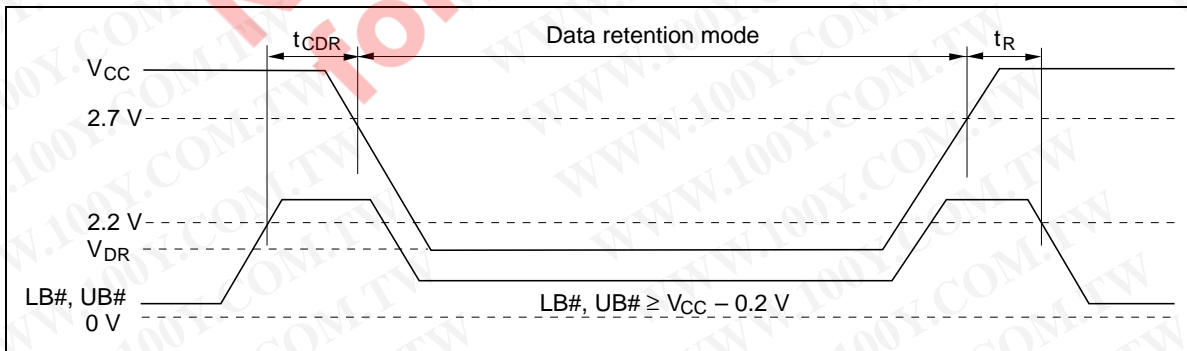
Low  $V_{CC}$  Data Retention Timing Waveform (4) (CS2 Controlled) ( $V_{CC} = 2.7\text{ V to }3.6\text{ V}$ )



Low  $V_{CC}$  Data Retention Timing Waveform (5) (LB#, UB# Controlled) ( $V_{CC} = 2.2\text{ V to }2.7\text{ V}$ )



Low  $V_{CC}$  Data Retention Timing Waveform (6) (LB#, UB# Controlled) ( $V_{CC} = 2.7\text{ V to }3.6\text{ V}$ )



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## Revision History

## R1LV0416C-I Series Data Sheet

Rev.	Date	Contents of Modification	
		Page	Description
1.00	Aug.05.2003	—	Initial issue
2.00	May.26.2004	5	Absolute Maximum Ratings Notes 2 : +7.0 V to +4.6 V
		6	DC characteristics –5SI and –7LI items' description are divided.
		7	AC characteristics
		8	Read Cycle/Notes: $t_{CLZ1}/t_{CLZ2}/t_{BLZ}/t_{OLZ}$ : Addition of [2, 3] $t_{CHZ1}/t_{CHZ2}/t_{BHZ}/t_{OHZ}$ : Addition of [1, 2, 3]
		9	Write Cycle/Notes: $t_{OHZ}$ : Addition of [1, 2, 3]
		14	Low $V_{CC}$ Data Retention Characteristics –5SI and –7LI items' description are divided.

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