
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

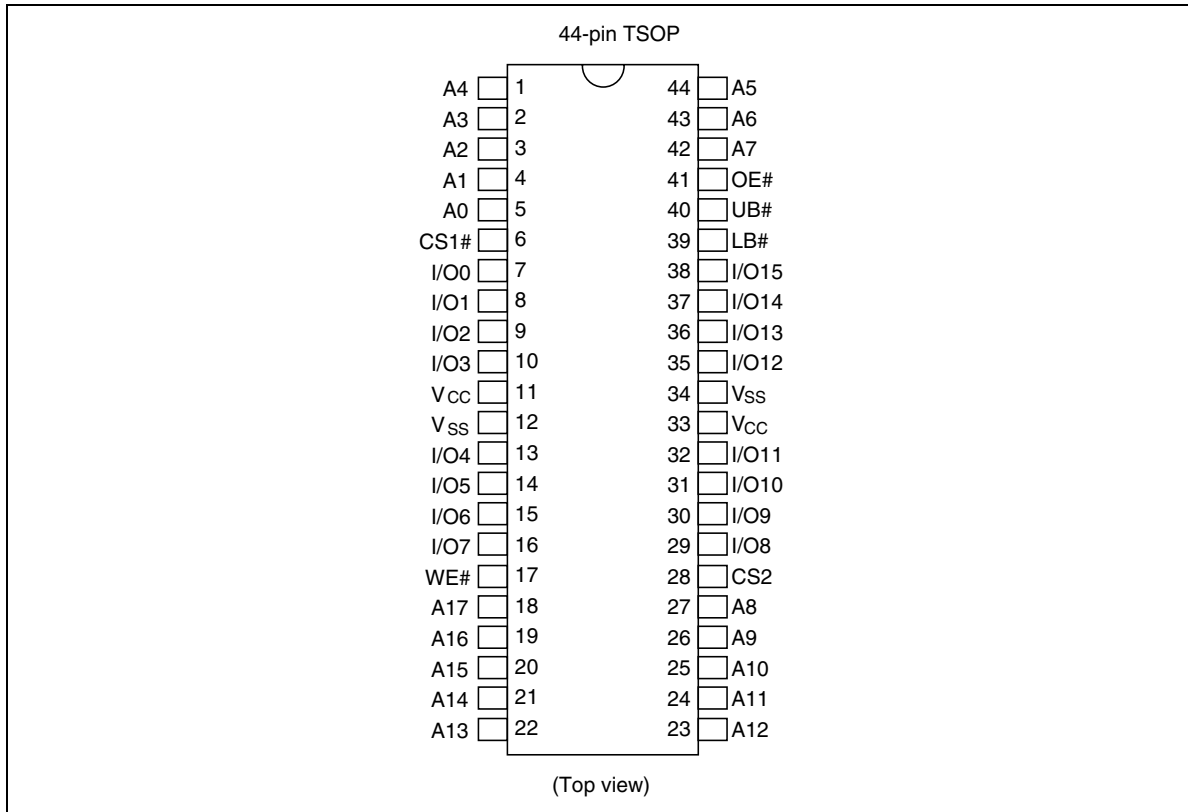
- Single 2.5 V and 3.0 V supply: 2.2 V to 3.6 V
- Fast access time: 55/70 ns (max)
- Power dissipation:
 - Active: 5.0 mW/MHz (typ)(V_{CC} = 2.5 V)
: 6.0 mW/MHz (typ) (V_{CC} = 3.0 V)
 - Standby: 1.25 μW (typ) (V_{CC} = 2.5 V)
: 1.5 μW (typ) (V_{CC} = 3.0 V)
- Completely static memory.
 - No clock or 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

Ordering Information

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

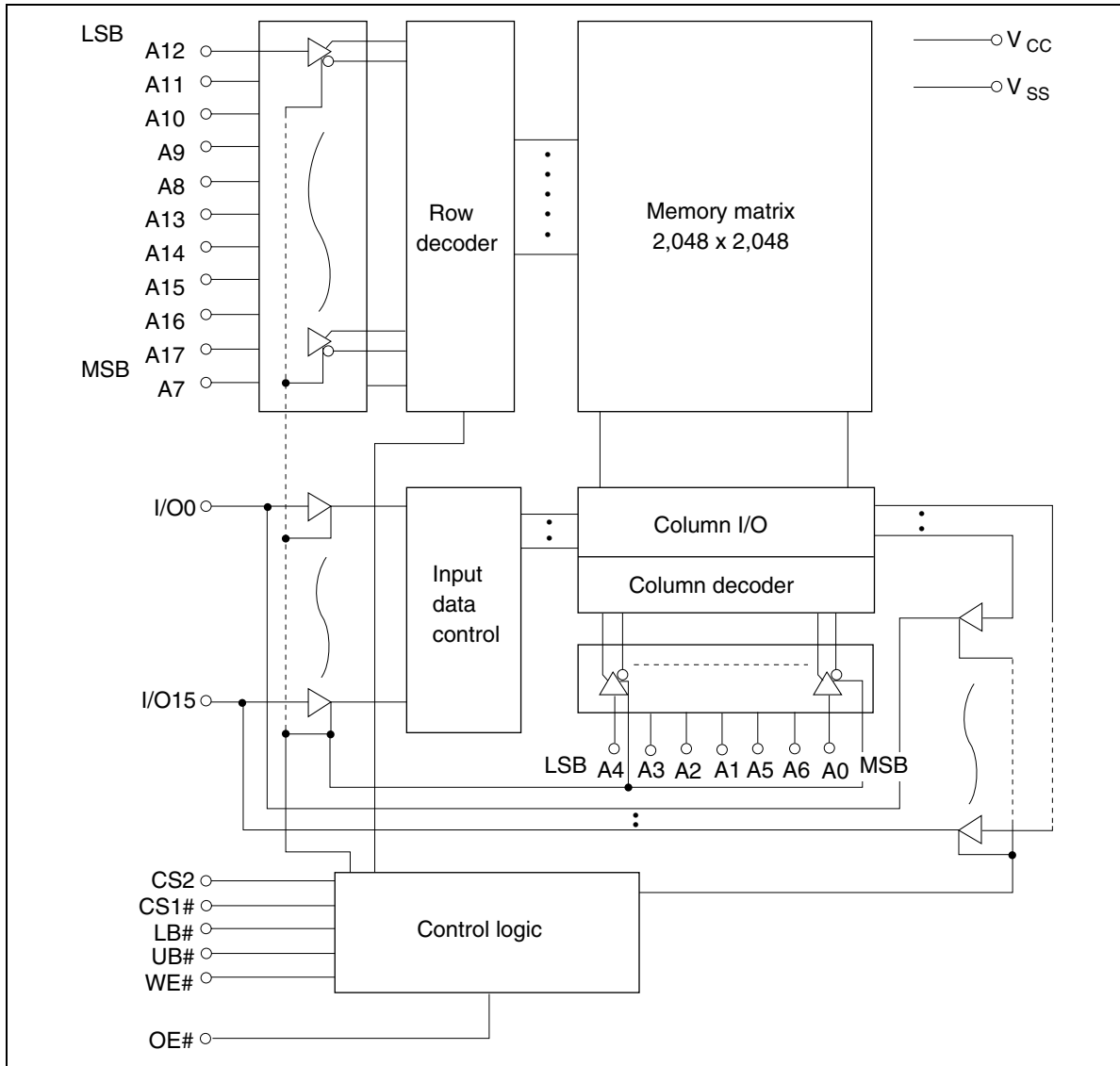
Pin Arrangement



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 _{CC}	Power supply
V _{SS}	Ground

Block Diagram



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°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	$V_{CC} = 2.2$ V to 2.7 V V_{IH}	2.0	—	$V_{CC} + 0.3$	V	
	$V_{CC} = 2.7$ V to 3.6 V V_{IH}	2.2	—	$V_{CC} + 0.3$	V	
Input low voltage	$V_{CC} = 2.2$ V to 2.7 V V_{IL}	-0.2	—	0.4	V	1
	$V_{CC} = 2.7$ V to 3.6 V V_{IL}	-0.3	—	0.6	V	1

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

DC Characteristics

Parameter	Symbol	Min	Typ	Max	Unit	Test conditions		
Input leakage current	$ I_{LI} $	—	—	1	μA	$V_{in} = V_{SS}$ to V_{CC}		
Output leakage current	$ I_{LO} $	—	—	1	μA	CS1# = V_{IH} or CS2 = V_{IL} or OE# = V_{IH} or WE# = V_{IL} or LB# = UB# = V_{IH} , $V_{I/O} = V_{SS}$ 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 μs , 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	μA	$V_{in} \geq 0 \text{ V}$
		to +70°C	I_{SB1}	—	—	8	μA	(1) $0 \text{ V} \leq \text{CS2} \leq 0.2 \text{ V}$ or
		to +40°C	I_{SB1}	—	0.7^{*2}	3	μA	(2) CS1# $\geq V_{CC} - 0.2 \text{ V}$,
		to +25°C	I_{SB1}	—	0.5^{*1}	3	μA	CS2 $\geq V_{CC} - 0.2 \text{ V}$ or
	-7LI	to +85°C	I_{SB1}	—	—	20	μA	(3) LB# = UB# $\geq V_{CC} - 0.2 \text{ V}$,
		to +70°C	I_{SB1}	—	—	16	μA	CS2 $\geq V_{CC} - 0.2 \text{ V}$,
		to +40°C	I_{SB1}	—	0.7^{*2}	10	μA	CS1# $\leq 0.2 \text{ V}$
		to +25°C	I_{SB1}	—	0.5^{*1}	10	μA	
Output high voltage	$V_{CC} = 2.2 \text{ V}$ to 2.7 V	V_{OH}	2.0	—	—	V	$I_{OH} = -0.5 \text{ mA}$	
	$V_{CC} = 2.7 \text{ V}$ to 3.6 V	V_{OH}	2.4	—	—	V	$I_{OH} = -1 \text{ mA}$	
	$V_{CC} = 2.2 \text{ V}$ to 3.6 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 V	V_{OL}	—	—	0.4	V	$I_{OL} = 0.5 \text{ mA}$	
	$V_{CC} = 2.7 \text{ V}$ to 3.6 V	V_{OL}	—	—	0.4	V	$I_{OL} = 2 \text{ mA}$	
	$V_{CC} = 2.2 \text{ V}$ to 3.6 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

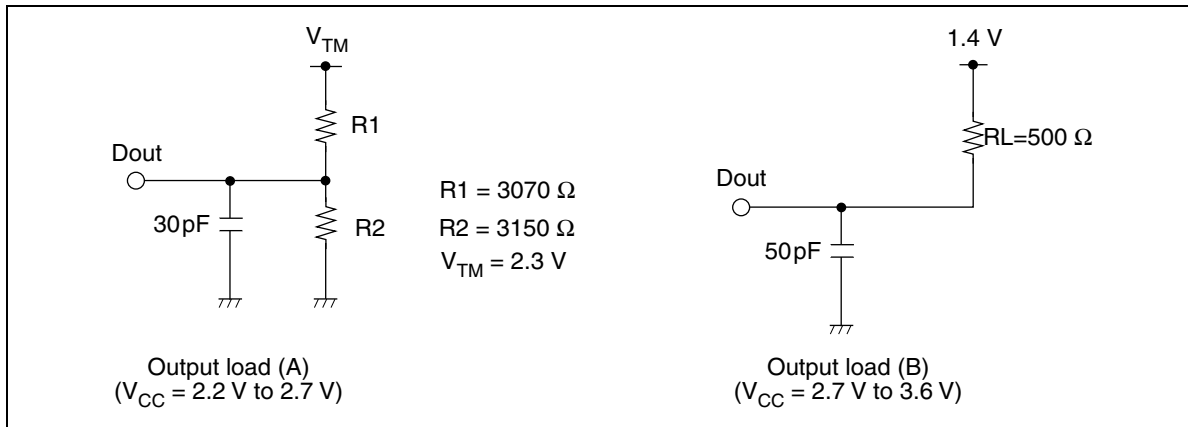
Note: 1. This parameter is sampled and not 100% tested.

AC Characteristics

($T_a = -40$ to $+85^\circ\text{C}$, $V_{CC} = 2.2\text{ V}$ to 3.6 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 V)
: $V_{IL} = 0.4\text{ V}$, $V_{IH} = 2.4\text{ V}$ ($V_{CC} = 2.7\text{ V}$ to 3.6 V)
- Input rise and fall time: 5 ns
- Input/output timing reference levels: 1.1 V ($V_{CC} = 2.2\text{ V}$ to 2.7 V)
: 1.4 V ($V_{CC} = 2.7\text{ V}$ to 3.6 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_{RC}	55	—	70	—	ns	
Address access time	t_{AA}	—	55	—	70	ns	
Chip select access time	t_{ACS1}	—	55	—	70	ns	
	t_{ACS2}	—	55	—	70	ns	
Output enable to output valid	t_{OE}	—	35	—	40	ns	
Output hold from address change	t_{OH}	10	—	10	—	ns	
LB#, UB# access time	t_{BA}	—	55	—	70	ns	
Chip select to output in low-Z	t_{CLZ1}	10	—	10	—	ns	2, 3
	t_{CLZ2}	10	—	10	—	ns	2, 3
LB#, UB# disable to low-Z	t_{BLZ}	5	—	5	—	ns	2, 3
Output enable to output in low-Z	t_{OLZ}	5	—	5	—	ns	2, 3
Chip deselect to output in high-Z	t_{CHZ1}	0	20	0	25	ns	1, 2, 3
	t_{CHZ2}	0	20	0	25	ns	1, 2, 3
LB#, UB# disable to high-Z	t_{BHZ}	0	20	0	25	ns	1, 2, 3
Output disable to output in high-Z	t_{OHZ}	0	20	0	25	ns	1, 2, 3

R1LV0416C-I Series

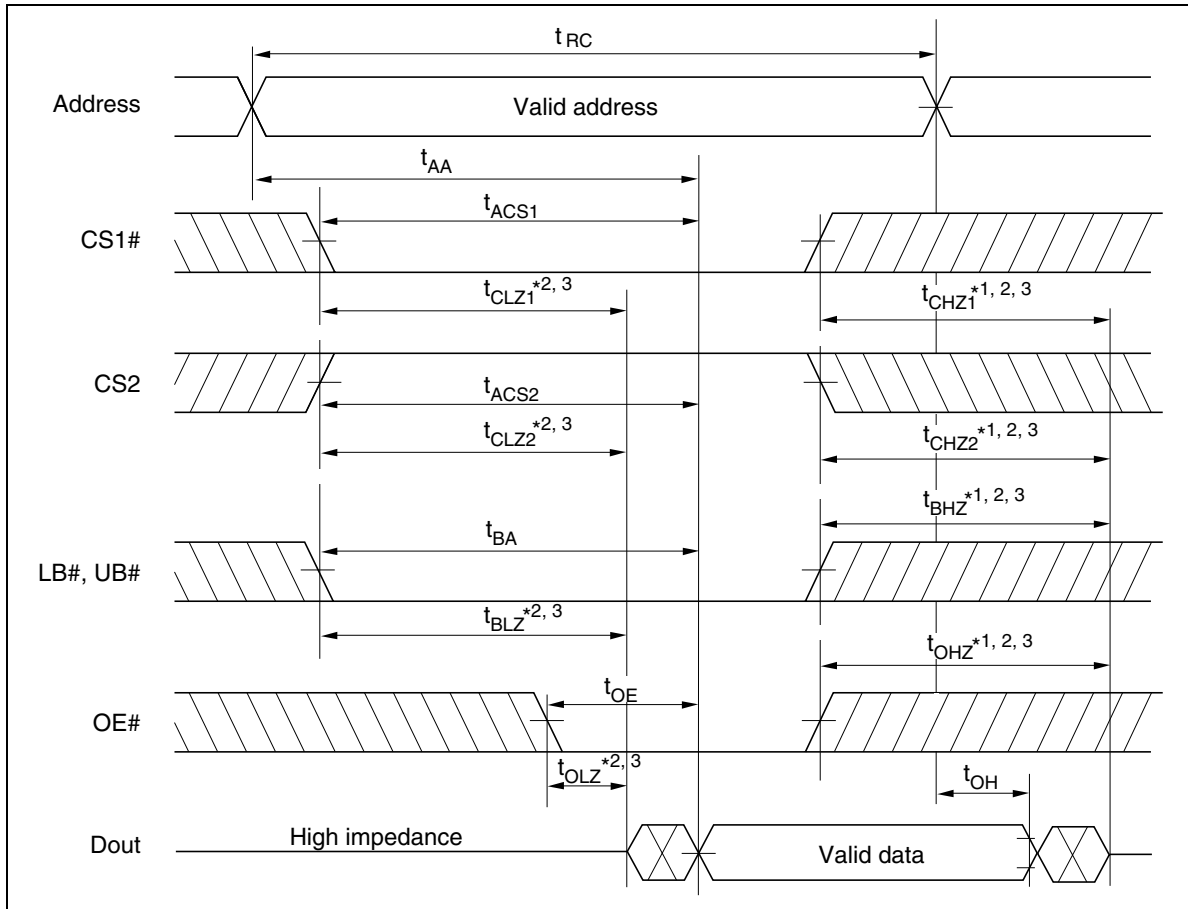
Write Cycle

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

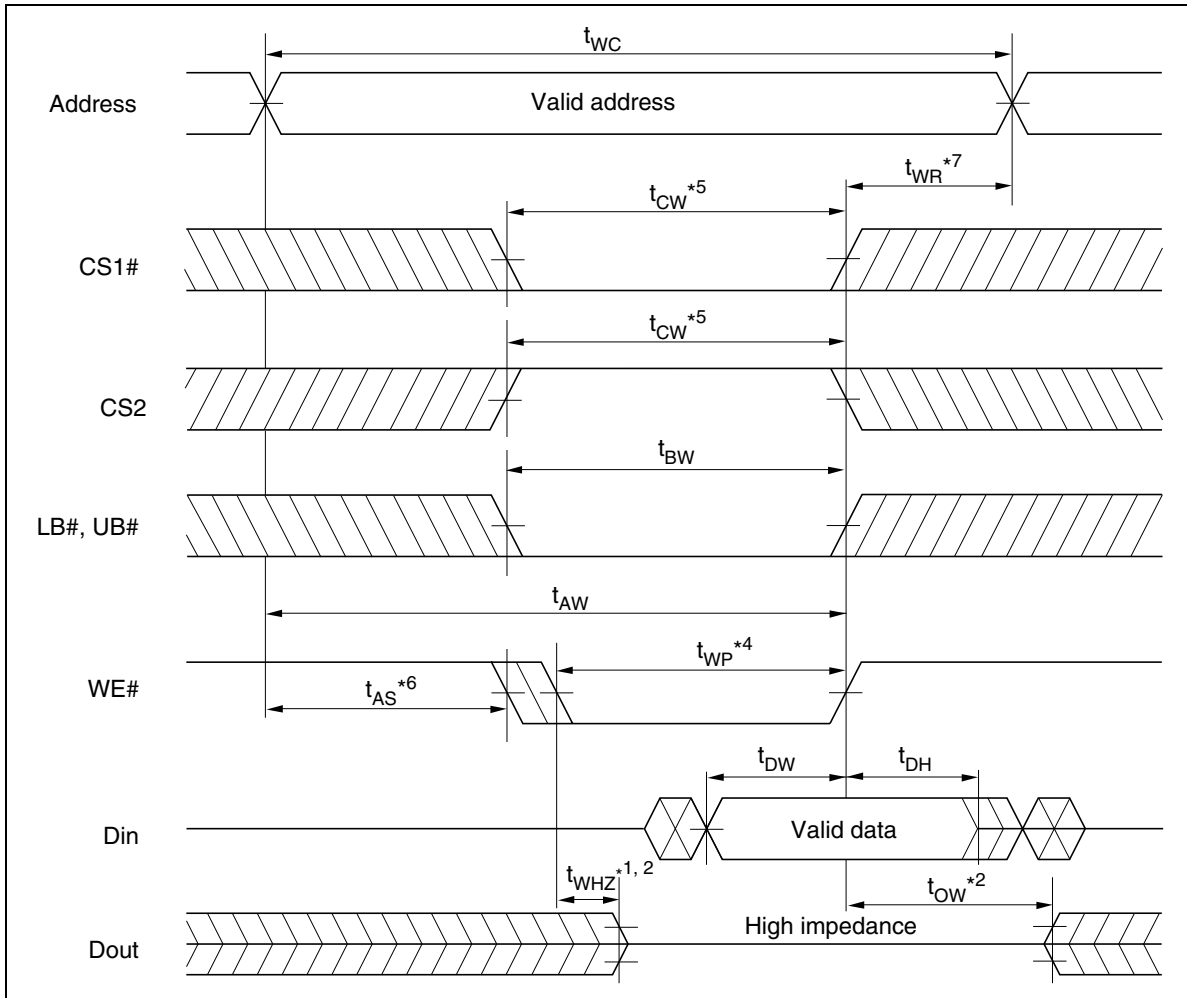
- Notes:
1. t_{CHZ} , t_{OHZ} , t_{WHZ} and t_{BHZ} are defined as the time at which the outputs achieve the open circuit conditions and are not referred to output voltage levels.
 2. This parameter is sampled and not 100% tested.
 3. At any given temperature and voltage condition, t_{HZ} max is less than t_{LZ} min both for a given device and from device to device.
 4. 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.
 5. t_{CW} is measured from the later of CS1# going low or CS2 going high to the end of write.
 6. t_{AS} is measured from the address valid to the beginning of write.
 7. t_{WR} is measured from the earliest of CS1# or WE# going high or CS2 going low to the end of write cycle.

Timing Waveform

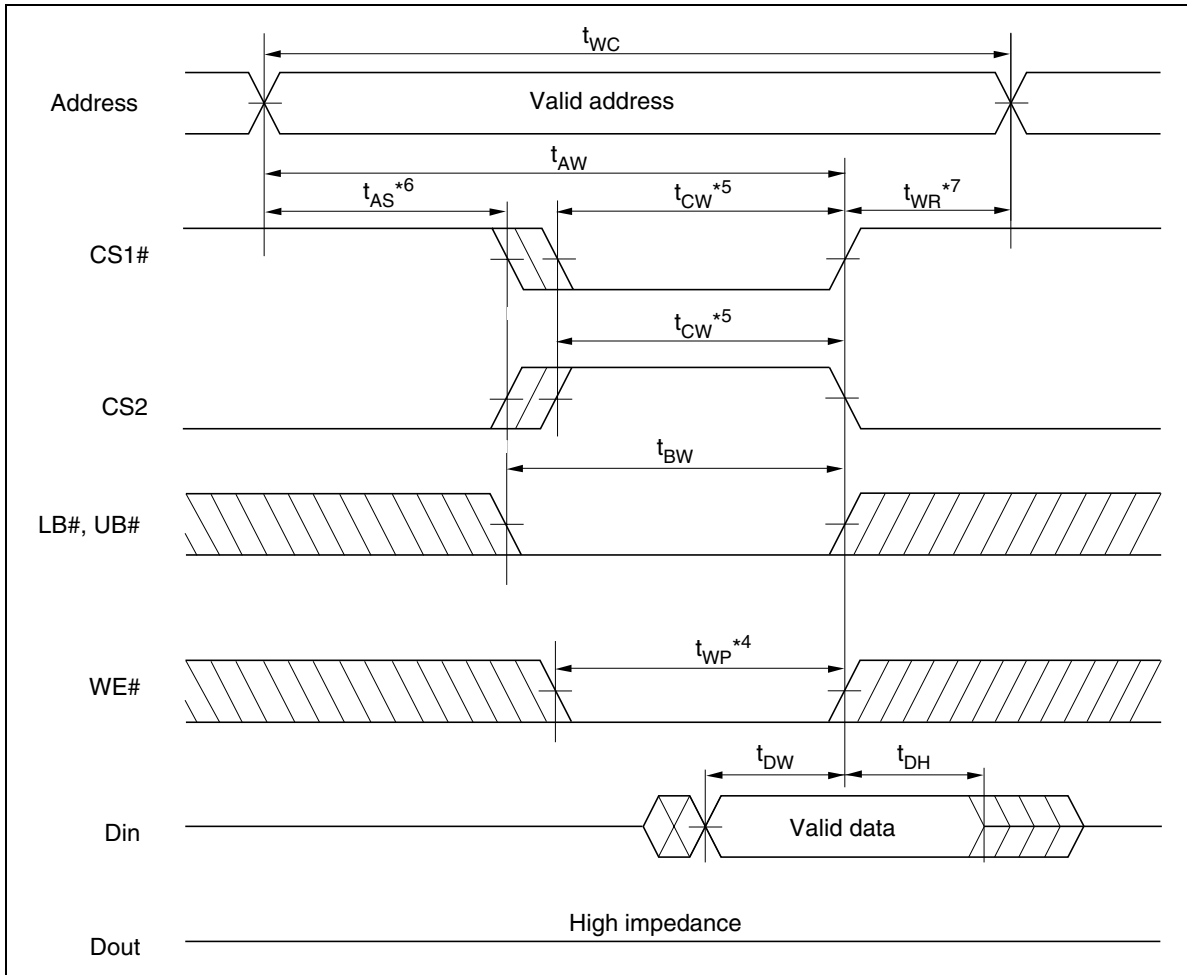
Read Timing Waveform ($WE\# = V_{IH}$)



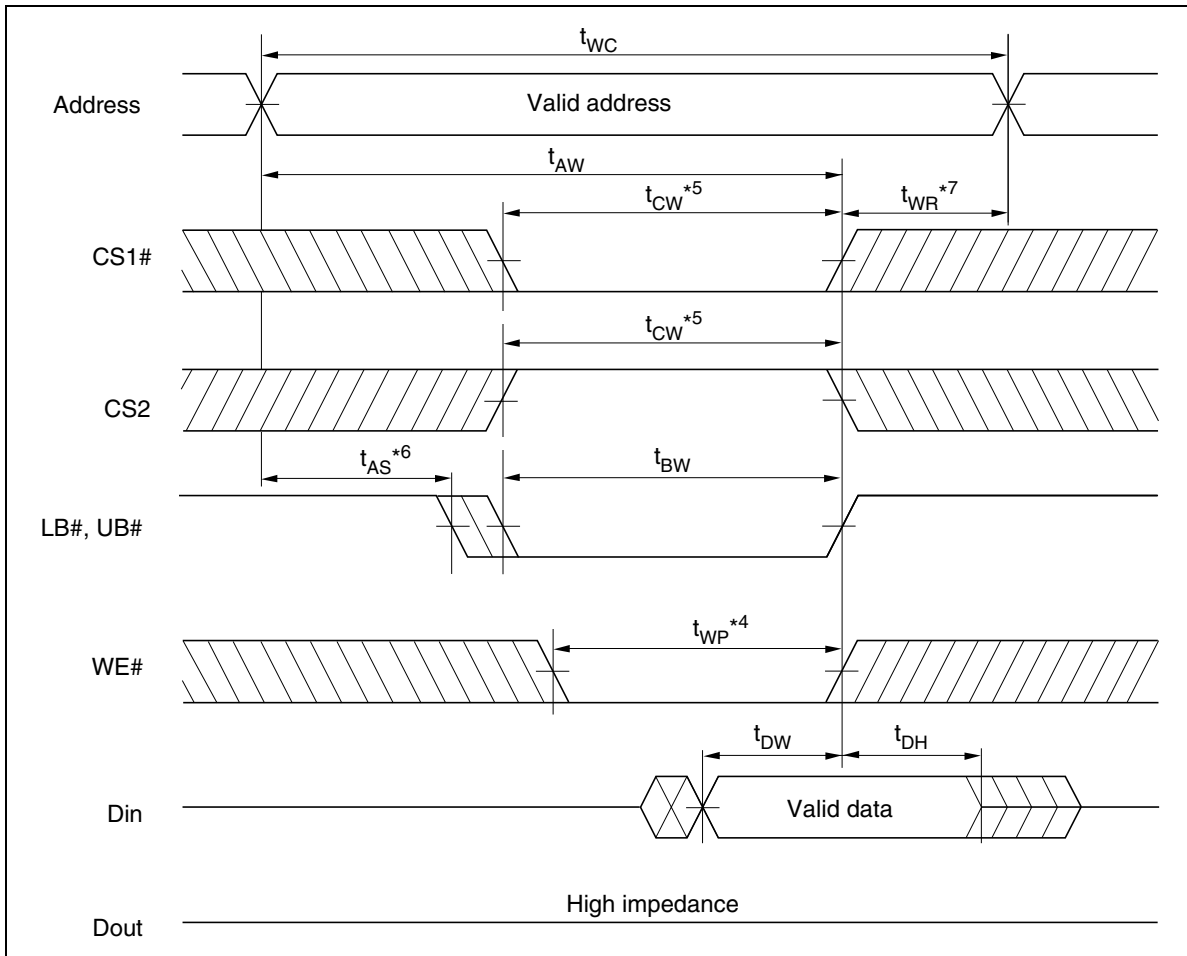
Write Timing Waveform (1) (WE# Clock)



Write Timing Waveform (2) (CS# Clock, OE# = V_{IH})



Write Timing Waveform (3) (LB#, UB# Clock, OE# = V_{IH})



Low V_{CC} Data Retention Characteristics

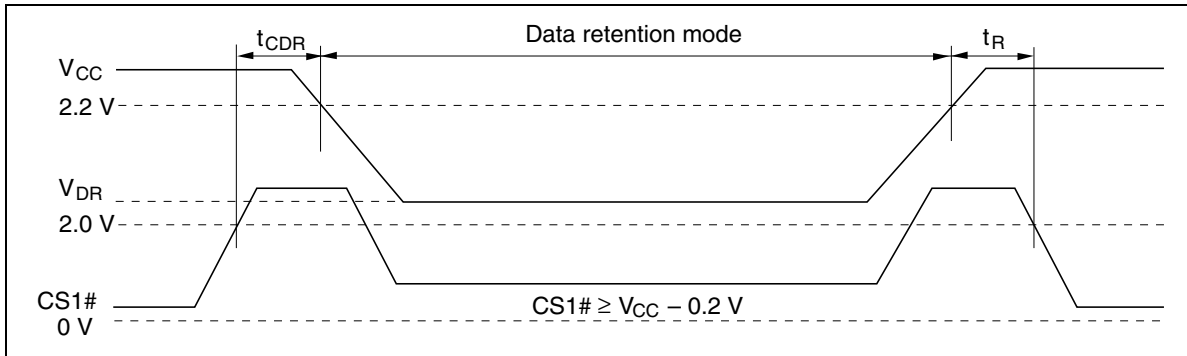
($T_a = -40$ to $+85^\circ\text{C}$)

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 μA	$V_{CC} = 3.0V$, $V_{in} \geq 0V$ (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 μA	
		to $+40^\circ\text{C}$	I_{CCDR}	—	0.7^{*2}	3 μA	
		to $+25^\circ\text{C}$	I_{CCDR}	—	0.5^{*1}	3 μA	
	-7LI	to $+85^\circ\text{C}$	I_{CCDR}	—	—	20 μA	
		to $+70^\circ\text{C}$	I_{CCDR}	—	—	16 μA	
		to $+40^\circ\text{C}$	I_{CCDR}	—	0.7^{*2}	10 μA	
		to $+25^\circ\text{C}$	I_{CCDR}	—	0.5^{*1}	10 μA	
Chip deselect to data retention time	t_{CDR}	0	—	—	ns	See retention waveform	
Operation recovery time	t_R	t_{RC}^{*4}	—	—	ns		

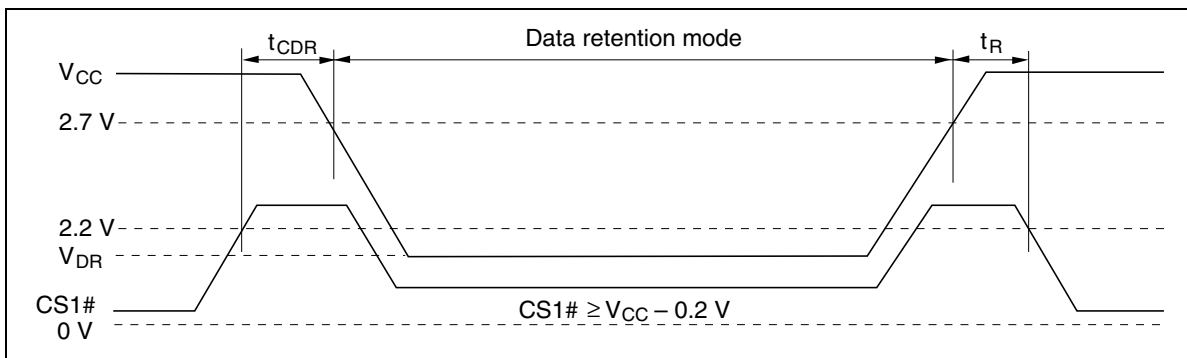
- Notes:
1. Typical values are at $V_{CC} = 3.0V$, $T_a = +25^\circ\text{C}$ and specified loading, and not guaranteed.
 2. Typical values are at $V_{CC} = 3.0V$, $T_a = +40^\circ\text{C}$ and specified loading, and not guaranteed.
 3. CS2 controls address buffer, WE# buffer, CS1# buffer, OE# buffer, 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.
 4. t_{RC} = read cycle time.

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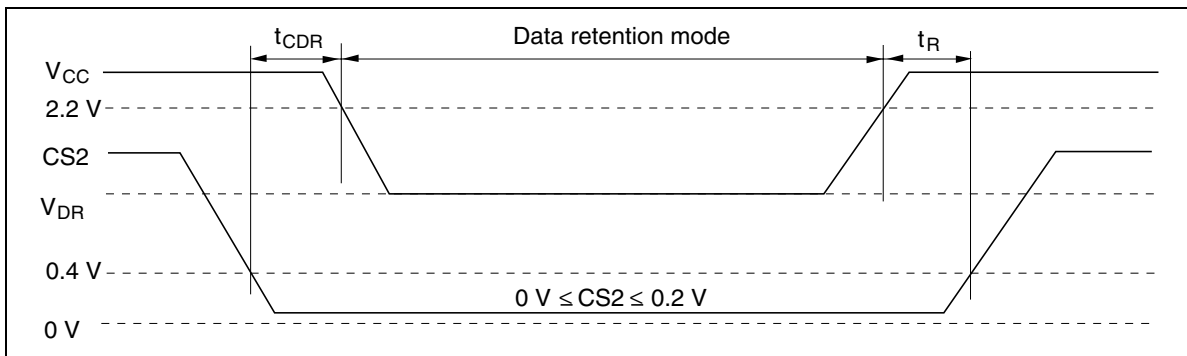
Low V_{CC} Data Retention Timing Waveform (1) (CS1# Controlled) ($V_{CC} = 2.2\text{ V to } 2.7\text{ V}$)



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

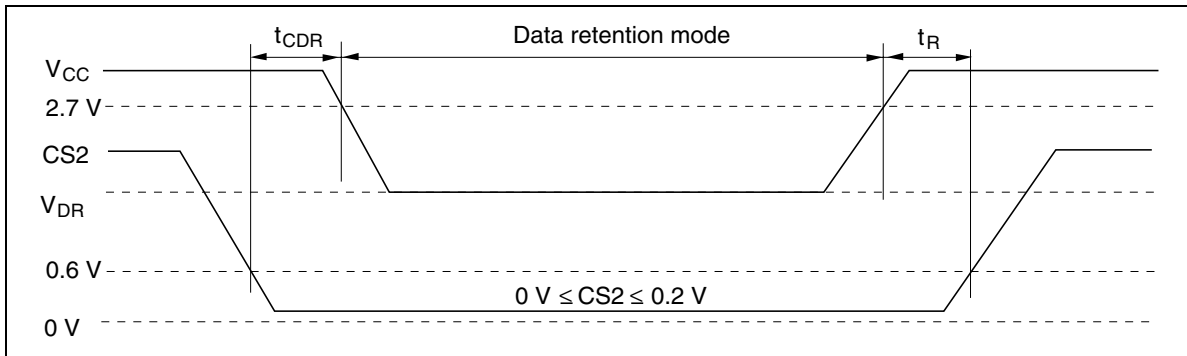


Low V_{CC} Data Retention Timing Waveform (3) (CS2 Controlled) ($V_{CC} = 2.2\text{ V to } 2.7\text{ V}$)

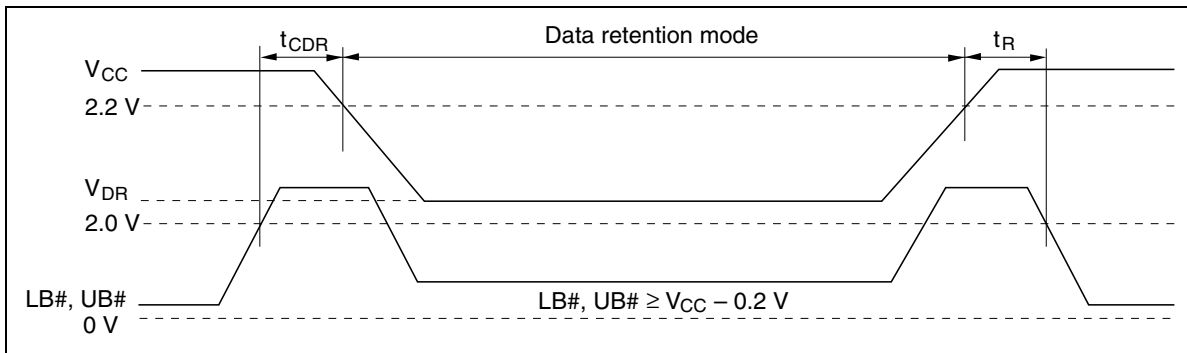


R1LV0416C-I Series

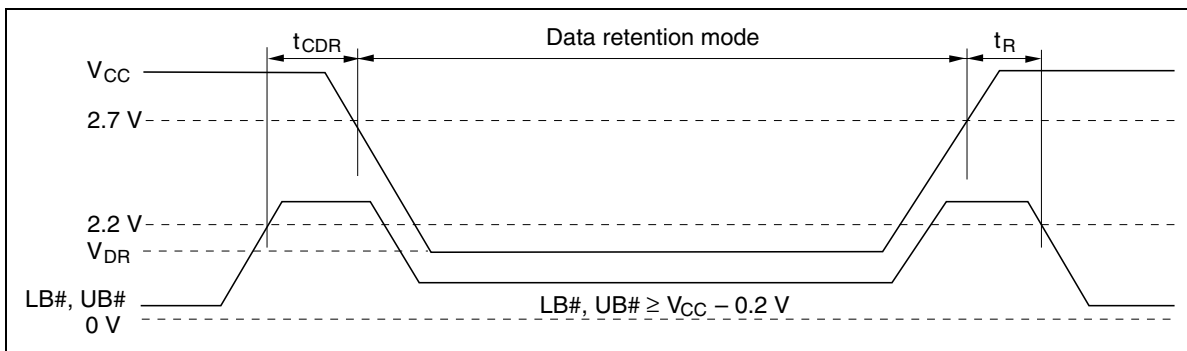
Low V_{CC} Data Retention Timing Waveform (4) (CS2 Controlled) ($V_{CC} = 2.7\text{ V}$ to 3.6 V)



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



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



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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