

R1LV1616HBG-I Series

Wide Temperature Range Version
16 M SRAM (1-Mword × 16-bit)

REJ03C0263-0102

Rev. 1.02

Feb.20.2020

Description

The R1LV1616HBG-I Series is 16-Mbit static RAM organized 1-Mword × 16-bit with embedded ECC. R1LV1616HBG-I Series has realized higher density, higher performance and low power consumption by employing CMOS process technology (6-transistor memory cell). It offers low power standby power dissipation; therefore, it is suitable for battery backup systems. It is packaged in 48-ball plastic FBGA for high density surface mounting.

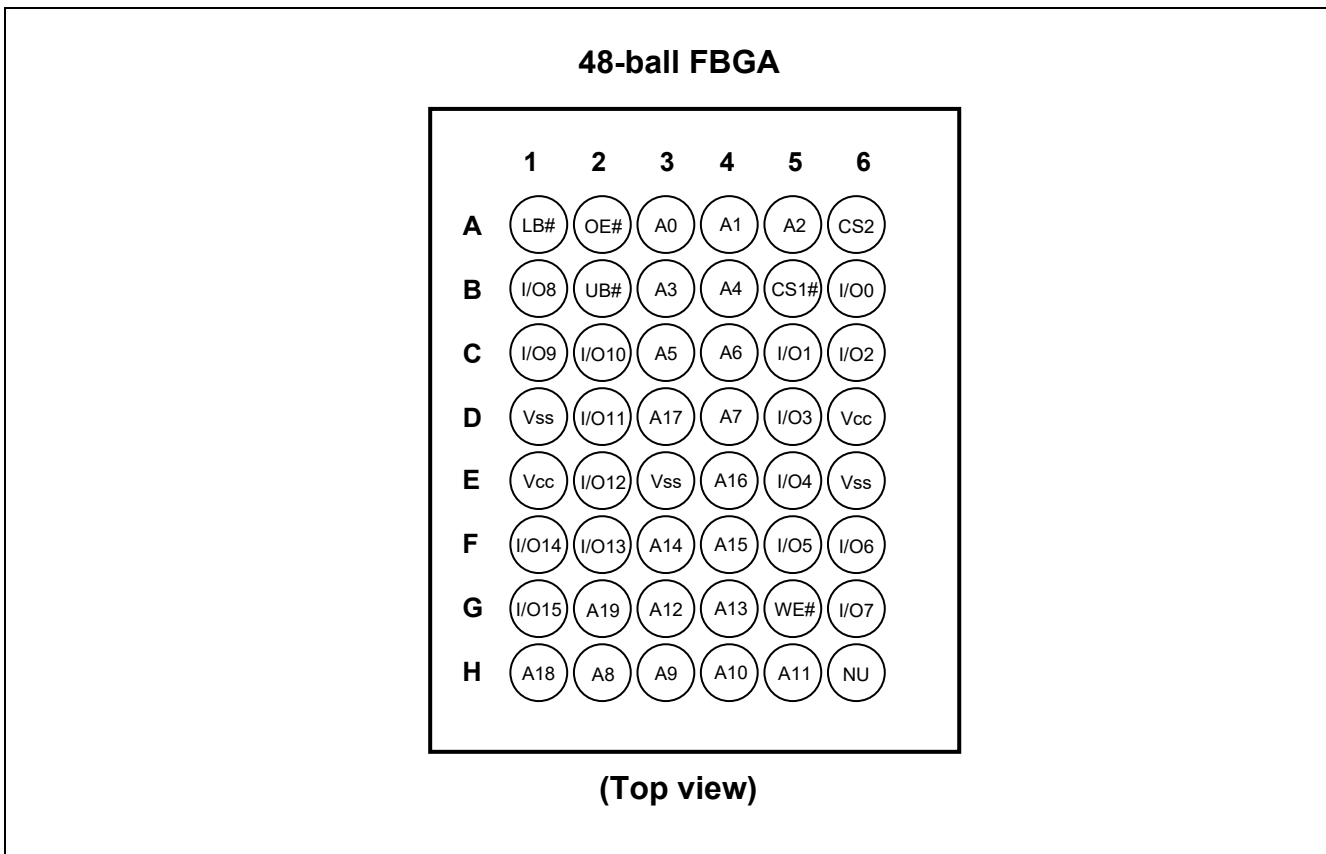
Features

- Single 3.0 V supply: 2.7 V to 3.6 V
- Fast access time: 45/55 ns (max)
- Power dissipation:
 - Active: 9 mW/MHz (typ)
 - Standby: 1.5 μW (typ)
- 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
- Embedded ECC (error checking and correction) for single-bit error correction

Ordering Information

Type No.	Access time	Package
R1LV1616HBG-4SI	45 ns	48-ball plastic FBGA with 0.75 mm ball pitch
R1LV1616HBG-5SI	55 ns	PTBG0048HF (48FHJ)

Pin Arrangement

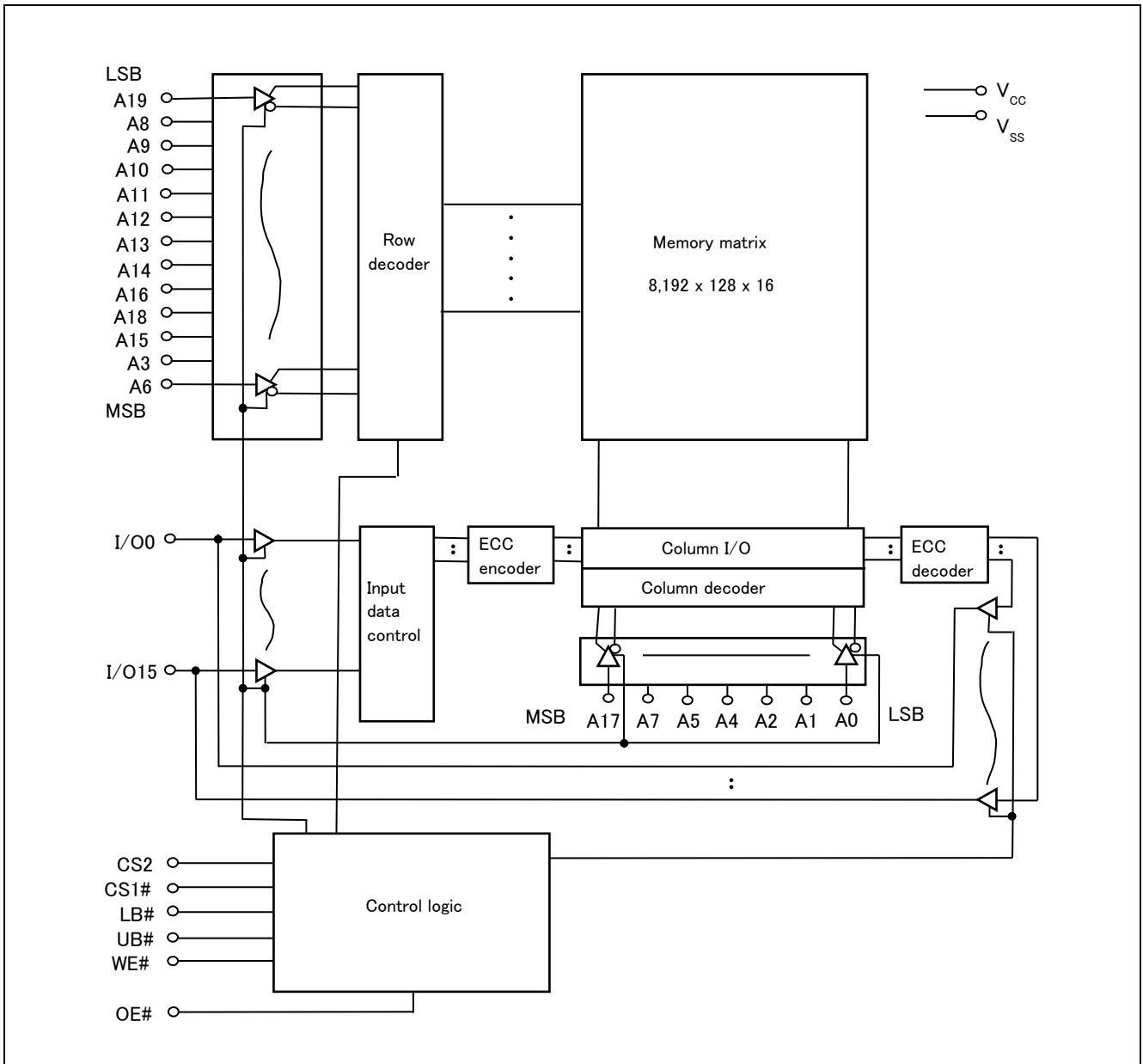


Pin Description

Pin name	Function
A0 to A19	Address input
I/O0 to I/O15	Data input/output
CS1# ($\overline{CS1}$)	Chip select 1
CS2	Chip select 2
WE# (\overline{WE})	Write enable
OE# (\overline{OE})	Output enable
LB# (\overline{LB})	Lower byte select
UB# (\overline{UB})	Upper byte select
Vcc	Power supply
Vss	Ground
NU*1	Not used (test mode pin)

Note: 1. This pin should be connected to a ground (Vss), or not be connected (open).

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	1.0	W
Storage temperature range	T_{stg}	-55 to +125	°C
Storage temperature range under bias	T_{bias}	-40 to +85	°C

Notes: 1. V_T min: -2.0 V for pulse half-width ≤ 10 ns.

2. Maximum voltage is +4.6 V.

DC Operating Conditions

Parameter	Symbol	Min	Typ	Max	Unit	Note
Supply voltage	V_{CC}	2.7	3.0	3.6	V	
	V_{SS}	0	0	0	V	
Input high voltage	V_{IH}	2.2	—	$V_{CC} + 0.3$	V	
Input low voltage	V_{IL}	-0.3	—	0.6	V	1
Ambient temperature range	T_a	-40	—	+85	°C	

Note: 1. V_{IL} min: -2.0 V for pulse half-width ≤ 10 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}	—	—	20	mA	CS1# = V_{IL} , CS2 = V_{IH} , Others = V_{IH}/V_{IL} , $I_{I/O} = 0$ mA
Average operating current	I_{CC1} (READ)	—	22*1	35	mA	Min. cycle, duty = 100%, $I_{I/O} = 0$ mA, CS1# = V_{IL} , CS2 = V_{IH} , WE# = V_{IH} , Others = V_{IH}/V_{IL}
	I_{CC1}	—	30*1	50	mA	Min. cycle, duty = 100%, $I_{I/O} = 0$ mA, CS1# = V_{IL} , CS2 = V_{IH} , Others = V_{IH}/V_{IL}
	I_{CC2} (READ)	—	3*1	8	mA	Cycle time = 70 ns, duty = 100%, $I_{I/O} = 0$ mA, CS1# = V_{IL} , CS2 = V_{IH} , WE# = V_{IH} , Others = V_{IH}/V_{IL} Address increment scan or decrement scan
	I_{CC2}	—	20*1	30	mA	Cycle time = 70 ns, duty = 100%, $I_{I/O} = 0$ mA, CS1# = V_{IL} , CS2 = V_{IH} , Others = V_{IH}/V_{IL} Address increment scan or decrement scan
	I_{CC3}	—	3*1	8	mA	Cycle time = 1 μs , duty = 100%, $I_{I/O} = 0$ mA, CS1# ≤ 0.2 V, CS2 $\geq V_{CC} - 0.2$ V $V_{IH} \geq V_{CC} - 0.2$ V, $V_{IL} \leq 0.2$ V
Standby current	I_{SB}	—	0.1*1	0.5	mA	CS2 = V_{IL}
	I_{SB1}	—	0.5*1	8	μA	$0 \text{ V} \leq V_{in}$ (1) $0 \text{ V} \leq \text{CS2} \leq 0.2 \text{ V}$ or (2) CS1# $\geq V_{CC} - 0.2 \text{ V}$, CS2 $\geq V_{CC} - 0.2 \text{ V}$ or (3) LB# = UB# $\geq V_{CC} - 0.2 \text{ V}$, CS2 $\geq V_{CC} - 0.2 \text{ V}$, CS1# $\leq 0.2 \text{ V}$ Average value
Output high voltage	V_{OH}	2.4	—	—	V	$I_{OH} = -1$ mA
	V_{OH}	$V_{CC} - 0.2$	—	—	V	$I_{OH} = -100$ μA
Output low voltage	V_{OL}	—	—	0.4	V	$I_{OL} = 2$ mA
	V_{OL}	—	—	0.2	V	$I_{OL} = 100$ μA

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

Capacitance

(Ta = +25°C, f = 1.0 MHz)

Parameter	Symbol	Min	Typ	Max	Unit	Test conditions	Note
Input capacitance	C _{in}	—	—	8	pF	V _{in} = 0 V	1
Input/output capacitance	C _{I/O}	—	—	10	pF	V _{I/O} = 0 V	1

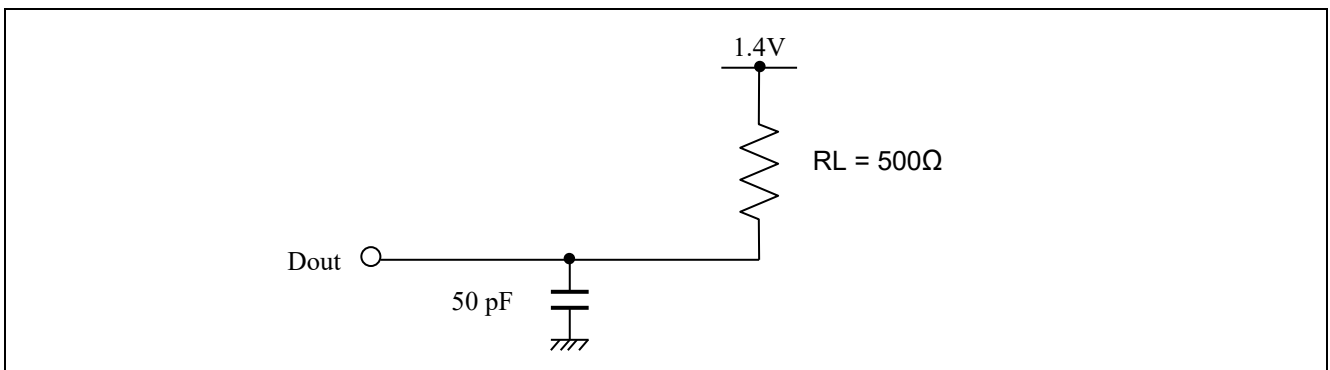
Note: 1. This parameter is sampled and not 100% tested.

AC Characteristics

(Ta = -40 to +85°C, V_{CC} = 2.7 V to 3.6 V)

Test Conditions

- Input pulse levels: V_{IL} = 0.4 V, V_{IH} = 2.4 V
- Input rise and fall time: 5 ns
- Input and output timing reference levels: 1.4 V
- Output load: See figures (Including scope and jig)



Read Cycle

Parameter	Symbol	R1LV1616HBG-I				Unit	Notes
		-4SI		-5SI			
		Min	Max	Min	Max		
Read cycle time	t _{RC}	45	—	55	—	ns	
Address access time	t _{AA}	—	45	—	55	ns	
Chip select access time	t _{ACS1}	—	45	—	55	ns	
	t _{ACS2}	—	45	—	55	ns	
Output enable to output valid	t _{OE}	—	30	—	35	ns	
Output hold from address change	t _{OH}	10	—	10	—	ns	
LB#, UB# access time	t _{BA}	—	45	—	55	ns	
Chip select to output in low-Z	t _{CLZ1}	10	—	10	—	ns	2, 3
	t _{CLZ2}	10	—	10	—	ns	2, 3
LB#, UB# enable 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	20	ns	1, 2, 3
	t _{CHZ2}	0	20	0	20	ns	1, 2, 3
LB#, UB# disable to high-Z	t _{BHZ}	0	15	0	20	ns	1, 2, 3
Output disable to output in high-Z	t _{OHZ}	0	15	0	20	ns	1, 2, 3

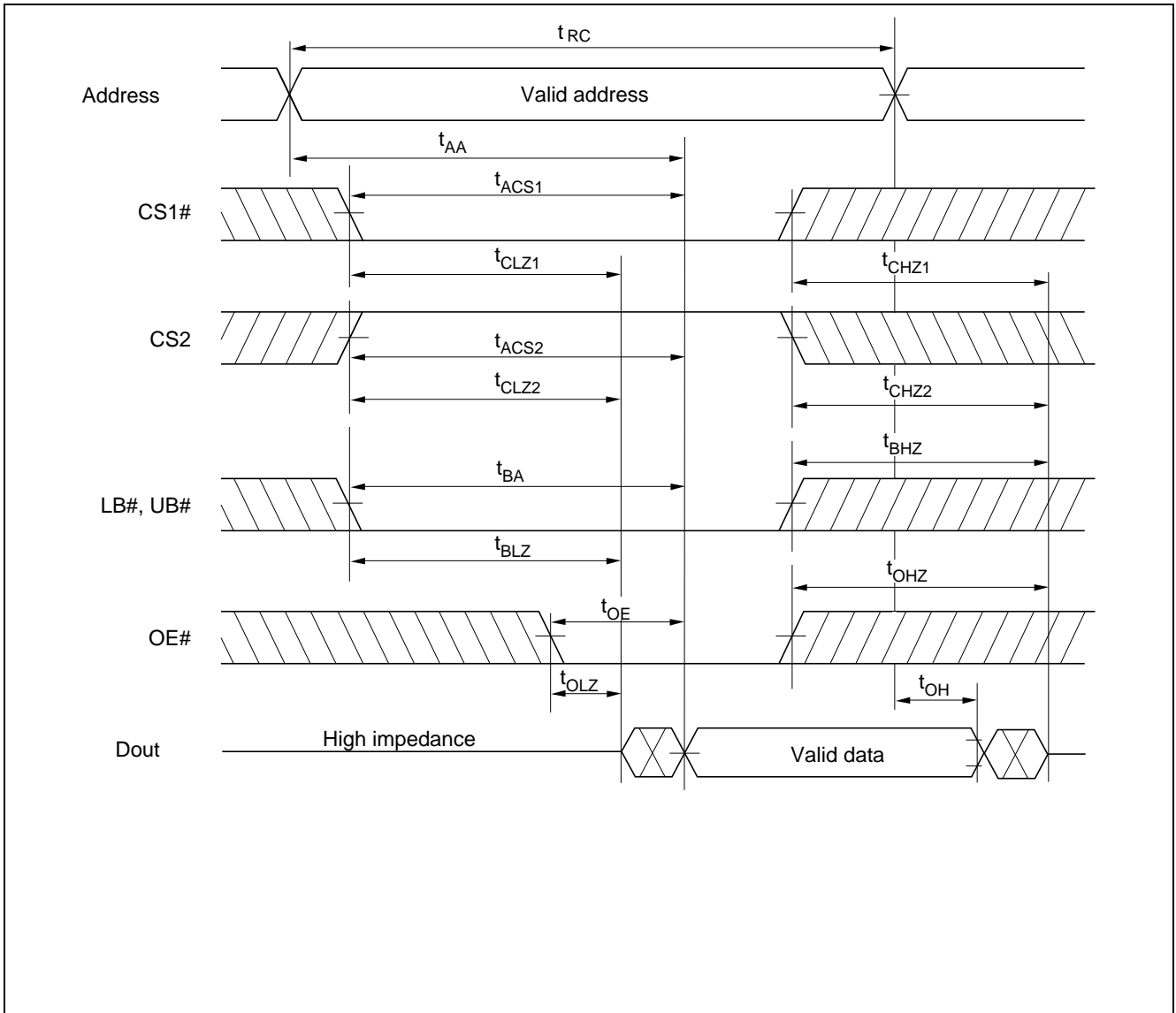
Write Cycle

Parameter	Symbol	R1LV1616HBG-I				Unit	Notes
		-4SI		-5SI			
		Min	Max	Min	Max		
Write cycle time	t _{WC}	45	—	55	—	ns	
Address valid to end of write	t _{AW}	45	—	50	—	ns	
Chip selection to end of write	t _{CW}	45	—	50	—	ns	5
Write pulse width	t _{WP}	35	—	40	—	ns	4
LB#, UB# valid to end of write	t _{BW}	45	—	50	—	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	—	25	—	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	15	0	20	ns	1, 2
Write to output in high-Z	t _{WHZ}	0	15	0	20	ns	1, 2

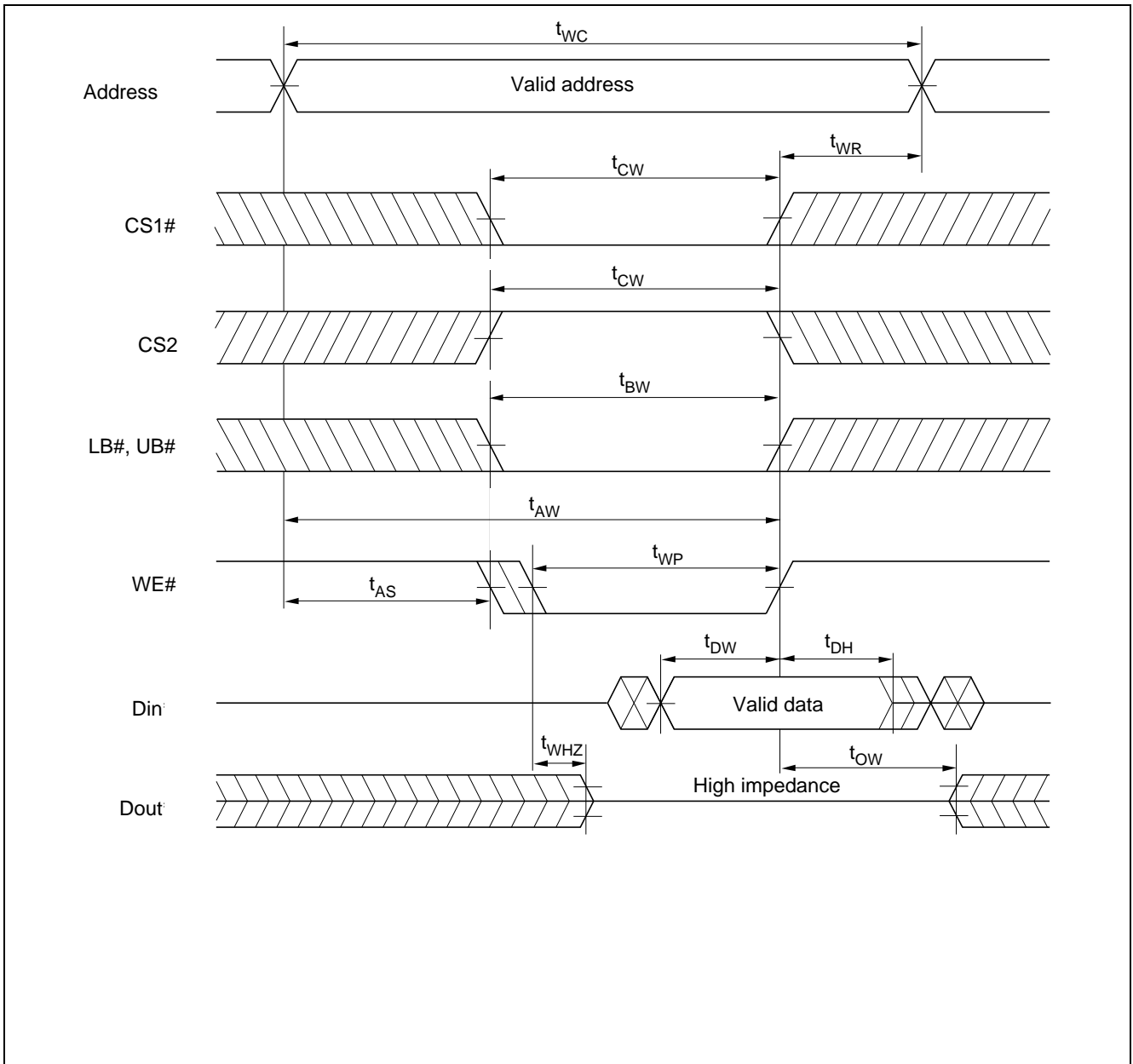
- Notes:
1. t_{CHZ}, t_{OHZ}, t_{WHZ} and t_{BHZ} are defined as the time at which the outputs achieve the open circuit conditions and are not referred to output voltage levels.
 2. This parameter is sampled and not 100% tested.
 3. At any given temperature and voltage condition, t_{HZ} max is less than 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

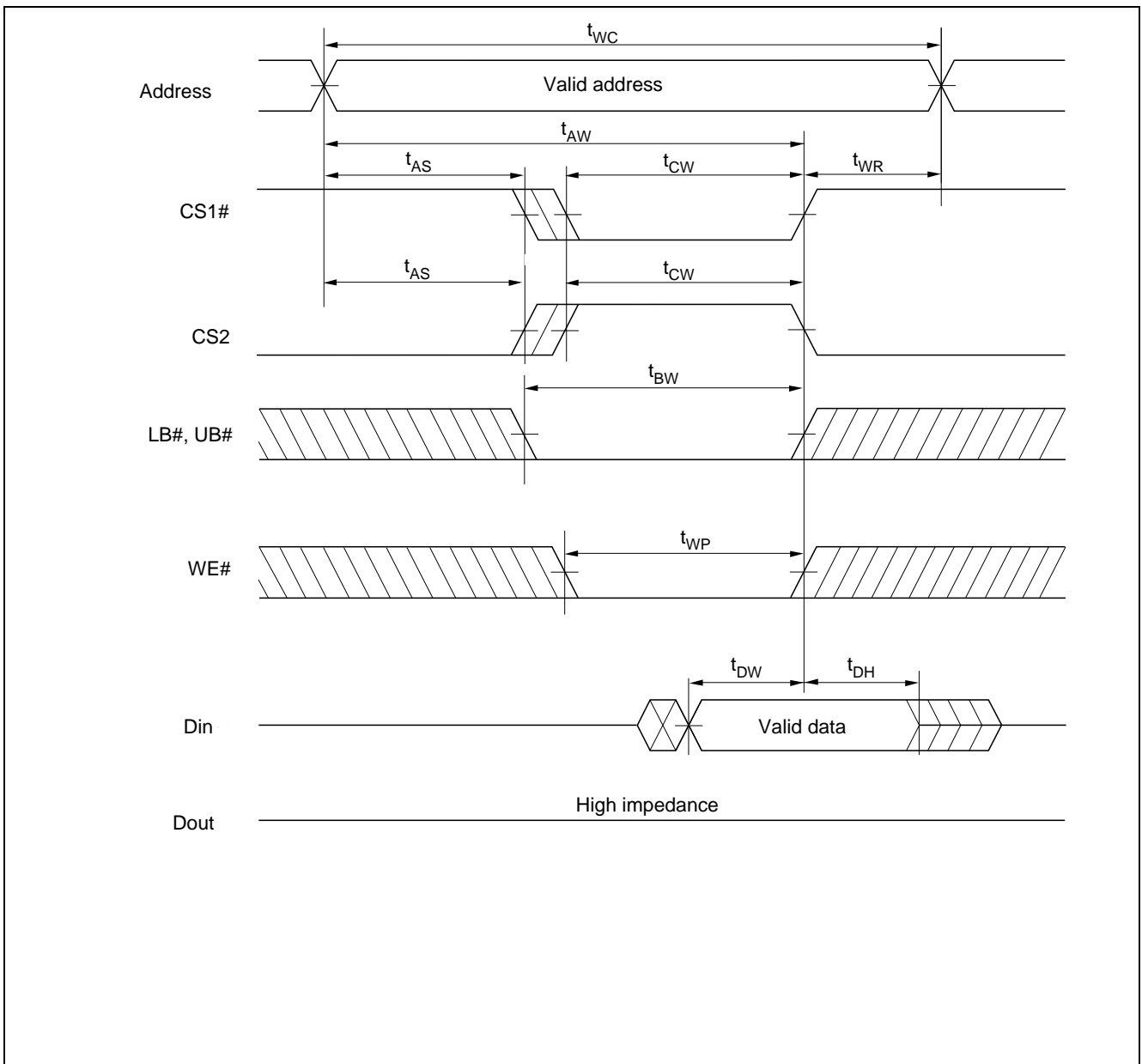
Read Cycle



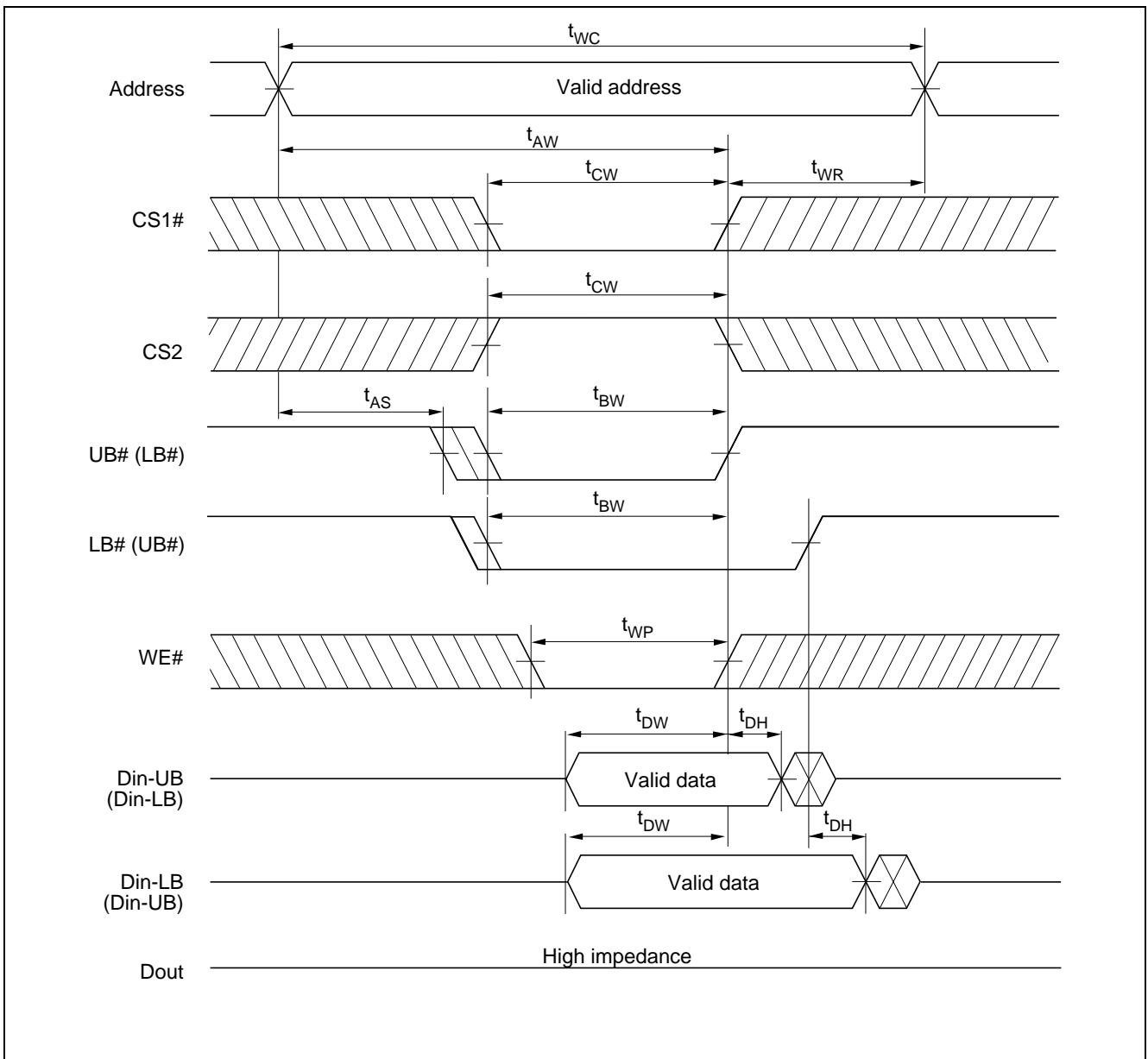
Write Cycle (1) (WE# Clock)



Write Cycle (2) (CS1#, CS2 Clock, OE# = V_{IH})



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



Low V_{CC} Data Retention Characteristics

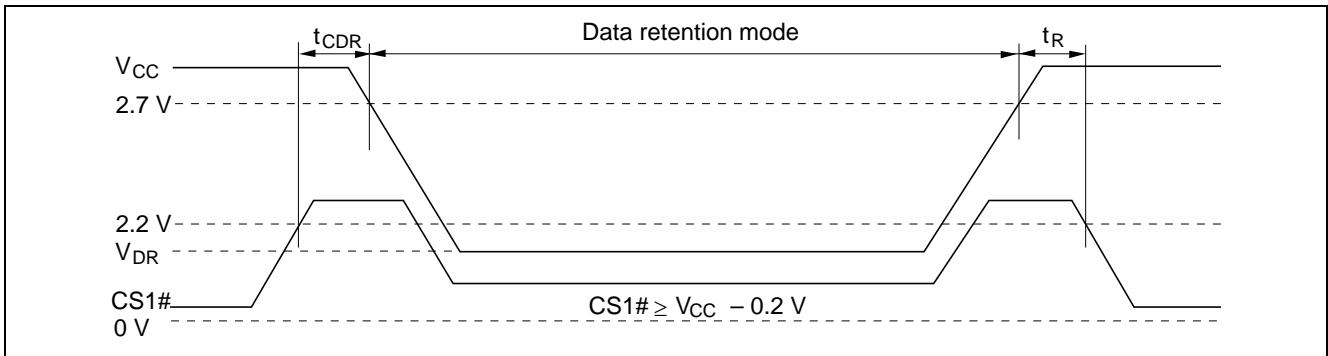
(Ta = -40 to +85°C)

Parameter	Symbol	Min	Typ	Max	Unit	Test conditions*2
V_{CC} for data retention	V_{DR}	1.5	—	3.6	V	$V_{in} \geq 0$ V (1) 0 V \leq CS2 \leq 0.2 V or (2) CS2 \geq $V_{CC} - 0.2$ V, CS1# \geq $V_{CC} - 0.2$ V or (3) LB# = UB# \geq $V_{CC} - 0.2$ V, CS2 \geq $V_{CC} - 0.2$ V, CS1# \leq 0.2 V
Data retention current	I_{CCDR}	—	0.5*1	8	μ A	$V_{CC} = 3.0$ V, $V_{in} \geq 0$ V (1) 0 V \leq CS2 \leq 0.2 V or (2) CS2 \geq $V_{CC} - 0.2$ V, CS1# \geq $V_{CC} - 0.2$ V or (3) LB# = UB# \geq $V_{CC} - 0.2$ V, CS2 \geq $V_{CC} - 0.2$ V, CS1# \leq 0.2 V Average value
Chip deselect to data retention time	t_{CDR}	0	—	—	ns	See retention waveforms
Operation recovery time	t_R	5	—	—	ms	

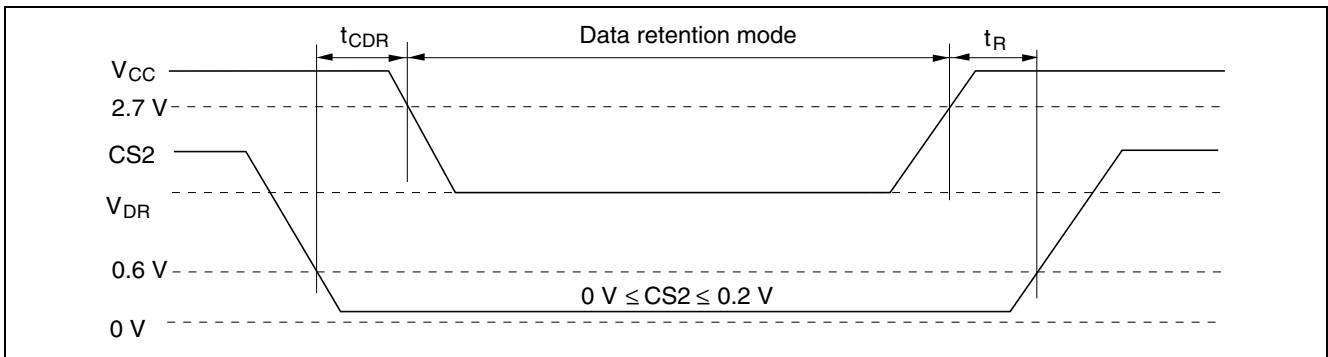
Notes: 1. Typical values are at $V_{CC} = 3.0$ V, Ta = +25°C and not guaranteed.

2. 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 $V_{CC} - 0.2$ V or 0 V \leq CS2 \leq 0.2 V. The other input levels (address, WE#, OE#, LB#, UB#, I/O) can be in the high impedance state.

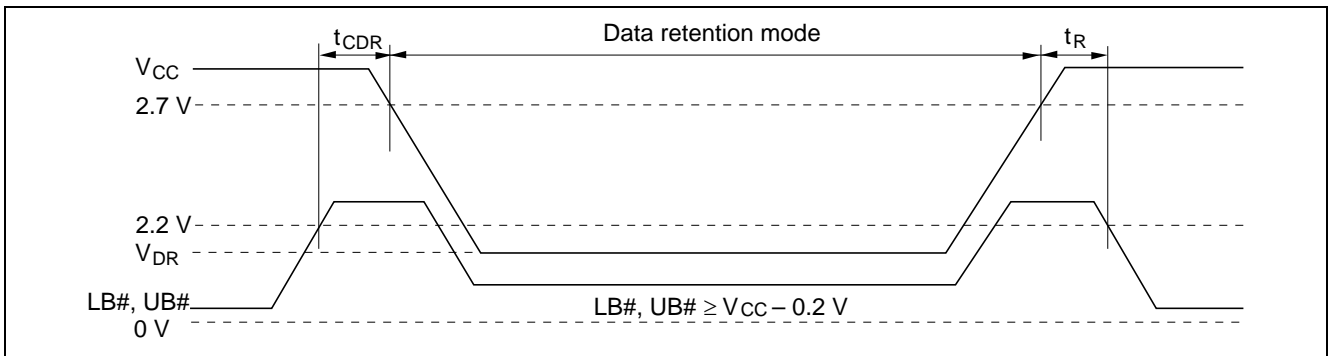
Low V_{CC} Data Retention Timing Waveform (1) (CS1# Controlled)



Low V_{CC} Data Retention Timing Waveform (2) (CS2 Controlled)



Low V_{CC} Data Retention Timing Waveform (3) (LB#, UB# Controlled)



Revision History

R1LV1616HBG-I Series Data Sheet

Rev.	Date	Contents of Modification	
		Page	Description
0.01	Apr.29.2005	—	Initial issue
1.00	Sep.21.2005	—	Deletion of Preliminary
1.01	Feb.23.2017	p.1,p.3	Disclosed embedded ECC features
1.02	Feb.20.2020	Last page	Updated the Notice to the latest version

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