

# RMLV0816BGSD - 4S2

8Mb Advanced LPSRAM (512k word × 16bit / 1024k word × 8bit)

R10DS0253EJ0201  
Rev.2.01  
2020.02.20

## Description

The RMLV0816BGSD is a family of 8-Mbit static RAMs organized 524,288-word × 16-bit, fabricated by Renesas's high-performance Advanced LPSRAM technologies. The RMLV0816BGSD has realized higher density, higher performance and low power consumption. The RMLV0816BGSD offers low power standby power dissipation; therefore, it is suitable for battery backup systems. It is offered in 52pin  $\mu$ TSOP (II).

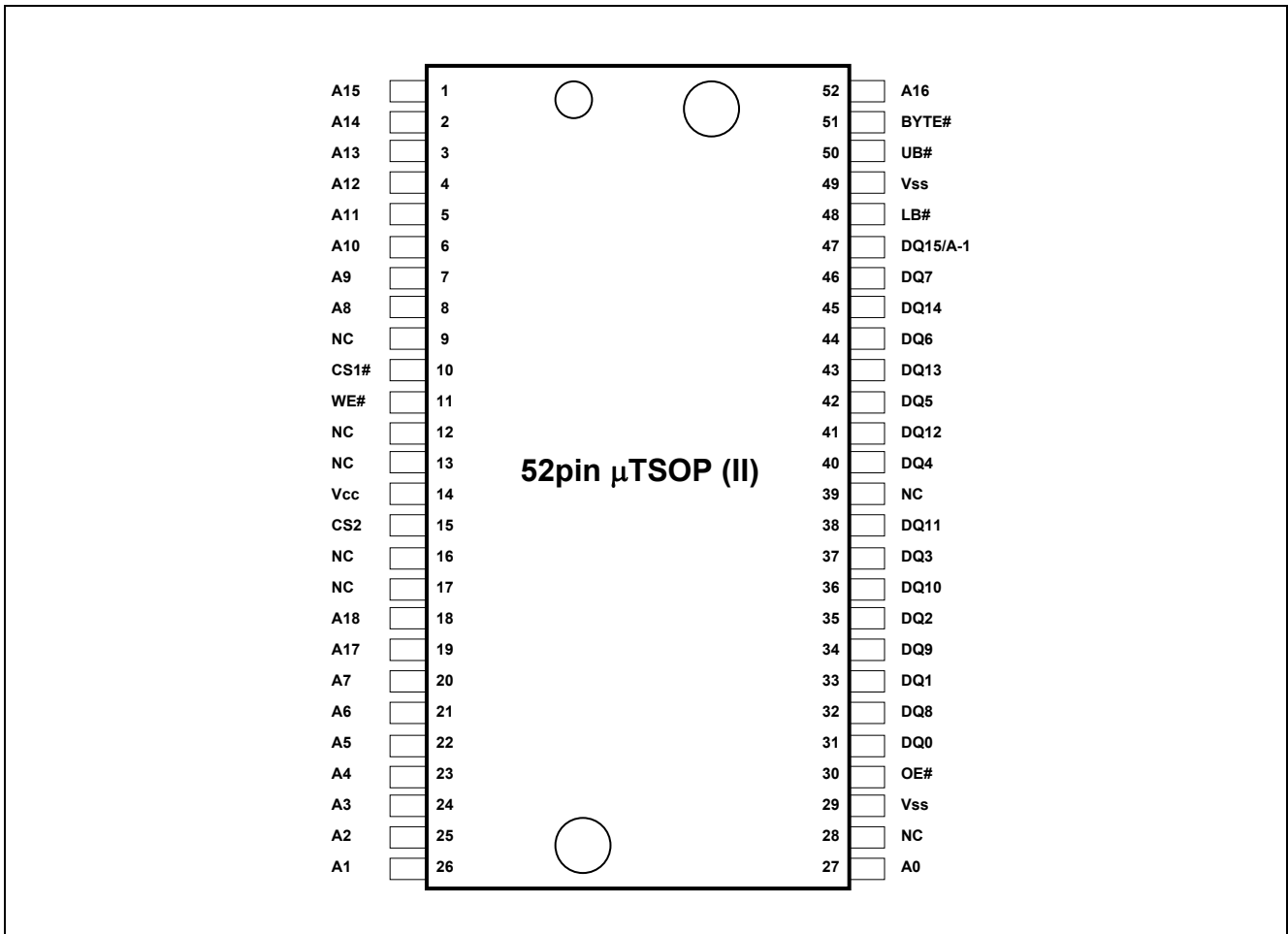
## Features

- Single 3V supply: 2.4V to 3.6V
- Access time:
  - Power supply voltage from 2.7V to 3.6V: 45ns (max.)
  - Power supply voltage from 2.4V to 2.7V: 55ns (max.)
- Current consumption:
  - Standby: 0.45 $\mu$ A (typ.)
- Equal access and cycle times
- Common data input and output
  - Three state output
- Directly TTL compatible
  - All inputs and outputs
- Battery backup operation

## Part Name Information

Part Name	Power supply	Access time	Temperature Range	Package
RMLV0816BGSD-4S2	2.7V to 3.6V	45 ns	-40 ~ +85°C	10.79mm × 10.49mm 52pin plastic $\mu$ TSOP (II)
	2.4V to 2.7V	55 ns		

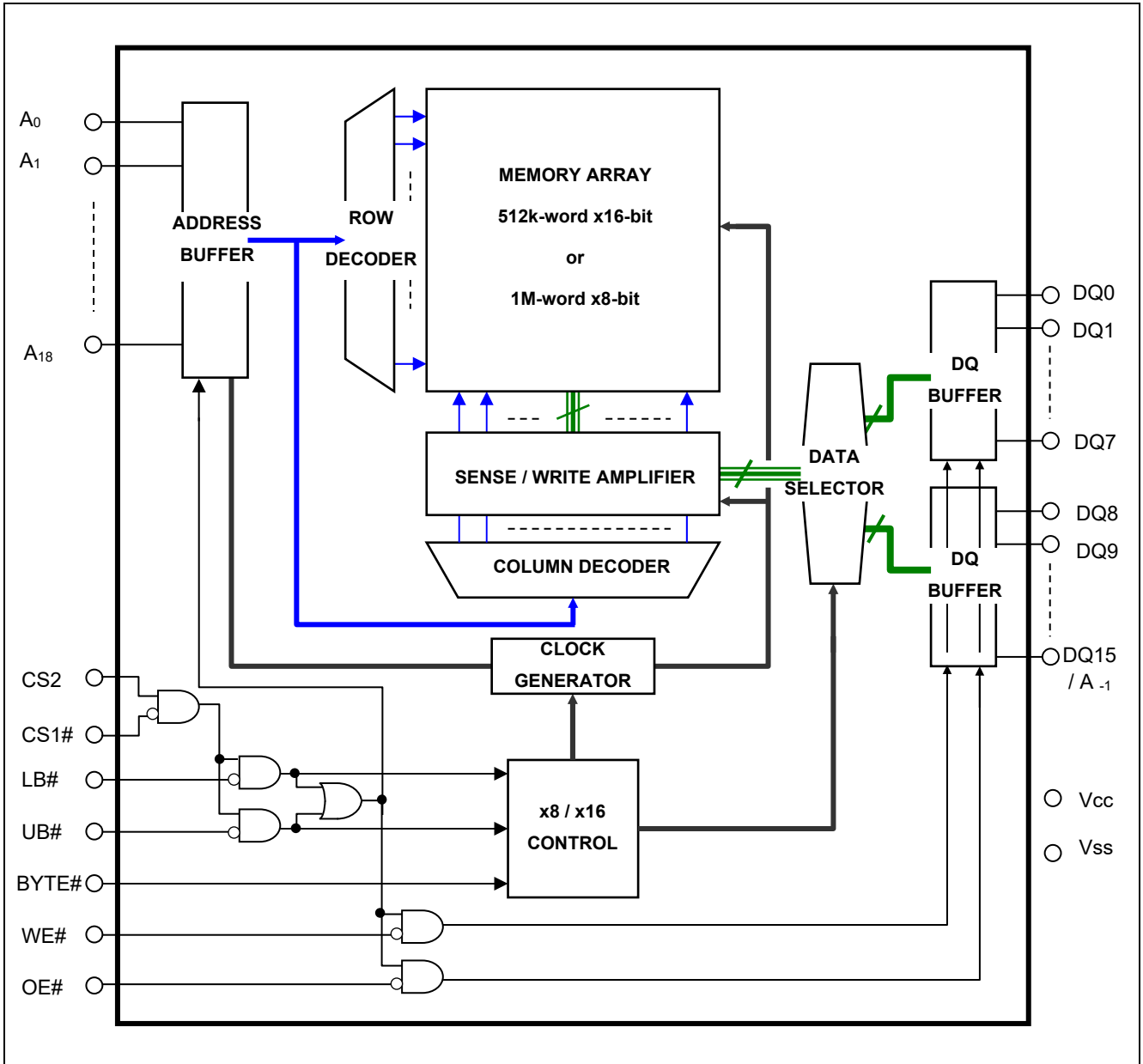
## Pin Arrangement



## Pin Description

Pin name	Function
Vcc	Power supply
Vss	Ground
A0 to A18	Address input (word mode)
A-1 to A18	Address input (byte mode)
DQ0 to DQ15	Data input/output
CS1#	Chip select 1
CS2	Chip select 2
OE#	Output enable
WE#	Write enable
LB#	Lower byte select
UB#	Upper byte select
BYTE#	Byte control mode enable
NC	No connection

### Block Diagram



## Operation Table

CS1#	CS2	BYTE#	UB#	LB#	WE#	OE#	DQ0~7	DQ8~14	DQ15	Operation
H	X	X	X	X	X	X	High-Z	High-Z	High-Z	Stand-by
X	L	X	X	X	X	X	High-Z	High-Z	High-Z	Stand-by
X	X	H	H	H	X	X	High-Z	High-Z	High-Z	Stand-by
L	H	H	H	L	L	X	Din	High-Z	High-Z	Write in lower byte
L	H	H	H	L	H	L	Dout	High-Z	High-Z	Read in lower byte
L	H	H	H	L	H	H	High-Z	High-Z	High-Z	Output disable
L	H	H	L	H	L	X	High-Z	Din	Din	Write in upper byte
L	H	H	L	H	H	L	High-Z	Dout	Dout	Read in upper byte
L	H	H	L	H	H	H	High-Z	High-Z	High-Z	Output disable
L	H	H	L	L	L	X	Din	Din	Din	Word write
L	H	H	L	L	H	L	Dout	Dout	Dout	Word read
L	H	H	L	L	H	H	High-Z	High-Z	High-Z	Output disable
L	H	L	X	X	L	X	Din	High-Z	A-1	Byte write
L	H	L	X	X	H	L	Dout	High-Z	A-1	Byte read
L	H	L	X	X	H	H	High-Z	High-Z	A-1	Output disable

Note 1. H:  $V_{IH}$  L:  $V_{IL}$  X:  $V_{IH}$  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 $V_{SS}$	$V_T$	$-0.5^2$ to $V_{CC}+0.3^3$	V
Power dissipation	$P_T$	0.7	W
Operation 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

Note 2. -3.0V for pulse  $\leq$  30ns (full width at half maximum)

3. Maximum voltage is +4.6V.

## DC Operating Conditions

Parameter	Symbol	Min.	Typ.	Max.	Unit	Test conditions	Note
Supply voltage	$V_{CC}$	2.4	3.0	3.6	V		
	$V_{SS}$	0	0	0	V		
Input high voltage	$V_{IH}$	2.0	—	$V_{CC}+0.2$	V	$V_{CC}=2.4V$ to $2.7V$	
		2.2	—	$V_{CC}+0.2$	V	$V_{CC}=2.7V$ to $3.6V$	
Input low voltage	$V_{IL}$	-0.2	—	0.4	V	$V_{CC}=2.4V$ to $2.7V$	4
		-0.2	—	0.6	V	$V_{CC}=2.7V$ to $3.6V$	4
Ambient temperature range	$T_a$	-40	—	+85	°C		

Note 4. -3.0V for pulse  $\leq$  30ns (full width at half maximum)

## DC Characteristics

Parameter	Symbol	Min.	Typ.	Max.	Unit	Test conditions	
Input leakage current	$ I_{LI} $	—	—	1	$\mu\text{A}$	$V_{in} = V_{SS}$ to $V_{CC}$	
Output leakage current	$ I_{LO} $	—	—	1	$\mu\text{A}$	BYTE# $\geq V_{CC} - 0.2\text{V}$ or BYTE# $\leq 0.2\text{V}$ 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 $V_{CC}$	
Average operating current	$I_{CC1}$	—	$20^{*5}$	25	$\text{mA}$	Cycle = 55ns, duty = 100%, $I_{I/O} = 0\text{mA}$ , BYTE# $\geq V_{CC} - 0.2\text{V}$ or BYTE# $\leq 0.2\text{V}$ CS1# = $V_{IL}$ , CS2 = $V_{IH}$ , Others = $V_{IH}/V_{IL}$	
		—	$25^{*5}$	30	$\text{mA}$	Cycle = 45ns, duty = 100%, $I_{I/O} = 0\text{mA}$ , BYTE# $\geq V_{CC} - 0.2\text{V}$ or BYTE# $\leq 0.2\text{V}$ CS1# = $V_{IL}$ , CS2 = $V_{IH}$ , Others = $V_{IH}/V_{IL}$	
	$I_{CC2}$	—	$1.5^{*5}$	3	$\text{mA}$	Cycle = 1 $\mu\text{s}$ , duty = 100%, $I_{I/O} = 0\text{mA}$ , BYTE# $\geq V_{CC} - 0.2\text{V}$ or BYTE# $\leq 0.2\text{V}$ 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	$I_{SB}$	—	—	0.3	$\text{mA}$	BYTE# $\geq V_{CC} - 0.2\text{V}$ or BYTE# $\leq 0.2\text{V}$ CS2 = $V_{IL}$ , Others = $V_{SS}$ to $V_{CC}$	
Standby current	$I_{SB1}$	—	$0.45^{*5}$	2	$\mu\text{A}$	$\sim +25^{\circ}\text{C}$	$V_{in} = V_{SS}$ to $V_{CC}$ , BYTE# $\geq V_{CC} - 0.2\text{V}$ or
		—	$0.6^{*6}$	4	$\mu\text{A}$	$\sim +40^{\circ}\text{C}$	BYTE# $\leq 0.2\text{V}$
		—	—	7	$\mu\text{A}$	$\sim +70^{\circ}\text{C}$	(1) CS2 $\leq 0.2\text{V}$ or
		—	—	10	$\mu\text{A}$	$\sim +85^{\circ}\text{C}$	(2) CS1# $\geq V_{CC} - 0.2\text{V}$ , CS2 $\geq V_{CC} - 0.2\text{V}$ or (3) LB# = UB# $\geq V_{CC} - 0.2\text{V}$ , CS1# $\leq 0.2\text{V}$ , CS2 $\geq V_{CC} - 0.2\text{V}$
Output high voltage	$V_{OH}$	2.4	—	—	$\text{V}$	BYTE# $\geq V_{CC} - 0.2\text{V}$ or BYTE# $\leq 0.2\text{V}$ $I_{OH} = -1\text{mA}$ $V_{CC} \geq 2.7\text{V}$	
	$V_{OH2}$	2.0	—	—	$\text{V}$	BYTE# $\geq V_{CC} - 0.2\text{V}$ or BYTE# $\leq 0.2\text{V}$ $I_{OH} = -0.1\text{mA}$	
Output low voltage	$V_{OL}$	—	—	0.4	$\text{V}$	BYTE# $\geq V_{CC} - 0.2\text{V}$ or BYTE# $\leq 0.2\text{V}$ $I_{OL} = 2\text{mA}$ $V_{CC} \geq 2.7\text{V}$	
	$V_{OL2}$	—	—	0.4	$\text{V}$	BYTE# $\geq V_{CC} - 0.2\text{V}$ or BYTE# $\leq 0.2\text{V}$ $I_{OL} = 0.1\text{mA}$	

Note 5. Typical parameter indicates the value for the center of distribution at 3.0V ( $T_a = 25^{\circ}\text{C}$ ), and not 100% tested.

Note 6. Typical parameter indicates the value for the center of distribution at 3.0V ( $T_a = 40^{\circ}\text{C}$ ), and not 100% tested.

## Capacitance

( $T_a = 25^{\circ}\text{C}$ ,  $f = 1\text{MHz}$ )

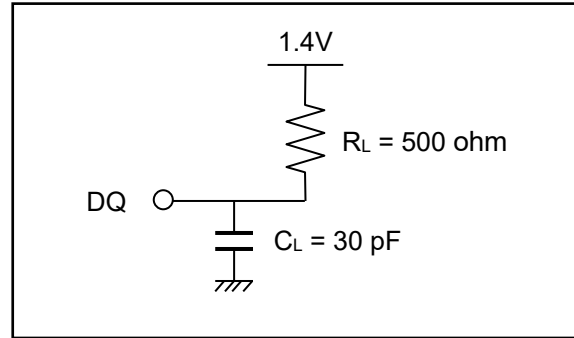
Parameter	Symbol	Min.	Typ.	Max.	Unit	Test conditions	Note
Input capacitance	$C_{in}$	—	—	8	$\text{pF}$	$V_{in} = 0\text{V}$	7
Input / output capacitance	$C_{I/O}$	—	—	10	$\text{pF}$	$V_{I/O} = 0\text{V}$	7

Note 7. This parameter is sampled and not 100% tested.

## AC Characteristics

Test Conditions ( $V_{CC} = 2.4V \sim 3.6V$ ,  $T_a = -40 \sim +85^{\circ}C$ )

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



## Read Cycle

Parameter	Symbol	$V_{CC}=2.7V$ to $3.6V$		$V_{CC}=2.4V$ to $2.7V$		Unit	Note
		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	$t_{OE}$	—	22	—	30	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	8,9
	$t_{CLZ2}$	10	—	10	—	ns	8,9
LB#, UB# enable to low-Z	$t_{BLZ}$	5	—	5	—	ns	8,9
Output enable to output in low-Z	$t_{OLZ}$	5	—	5	—	ns	8,9
Chip deselect to output in high-Z	$t_{CHZ1}$	0	18	0	20	ns	8,9,10
	$t_{CHZ2}$	0	18	0	20	ns	8,9,10
LB#, UB# disable to high-Z	$t_{BHZ}$	0	18	0	20	ns	8,9,10
Output disable to output in high-Z	$t_{OHZ}$	0	18	0	20	ns	8,9,10

Note 8. This parameter is sampled and not 100% tested.

9. At any given temperature and voltage condition,  $t_{CHZ1}$  max is less than  $t_{CLZ1}$  min,  $t_{CHZ2}$  max is less than  $t_{CLZ2}$  min,  $t_{BHZ}$  max is less than  $t_{BLZ}$  min, and  $t_{OHZ}$  max is less than  $t_{OLZ}$  min, for any device.

10.  $t_{CHZ1}$ ,  $t_{CHZ2}$ ,  $t_{BHZ}$  and  $t_{OHZ}$  are defined as the time when the DQ pins enter a high-impedance state and are not referred to the DQ levels.

**Write Cycle**

Parameter	Symbol	Vcc=2.7V to 3.6V		Vcc=2.4V to 2.7V		Unit	Note
		Min.	Max.	Min.	Max.		
Write cycle time	t <sub>WC</sub>	45	—	55	—	ns	
Address valid to write end	t <sub>AW</sub>	35	—	50	—	ns	
Chip select to write end	t <sub>CW</sub>	35	—	50	—	ns	
Write pulse width	t <sub>WP</sub>	35	—	40	—	ns	11
LB#,UB# valid to write end	t <sub>BW</sub>	35	—	50	—	ns	
Address setup time to write start	t <sub>AS</sub>	0	—	0	—	ns	
Write recovery time from write end	t <sub>WR</sub>	0	—	0	—	ns	
Data to write time overlap	t <sub>DW</sub>	25	—	25	—	ns	
Data hold from write end	t <sub>DH</sub>	0	—	0	—	ns	
Output enable from write end	t <sub>OW</sub>	5	—	5	—	ns	12
Output disable to output in high-Z	t <sub>OHZ</sub>	0	18	0	20	ns	12,13
Write to output in high-Z	t <sub>WHZ</sub>	0	18	0	20	ns	12,13

Note 11. t<sub>WP</sub> is the interval between write start and write end.

A write starts when all of (CS1#), (CS2), (WE#) and (one or both of LB# and UB#) become active.

A write is performed during the overlap of a low CS1#, a high CS2, a low WE# and a low LB# or a low UB#.

A write ends when any of (CS1#), (CS2), (WE#) or (one or both of LB# and UB#) becomes inactive.

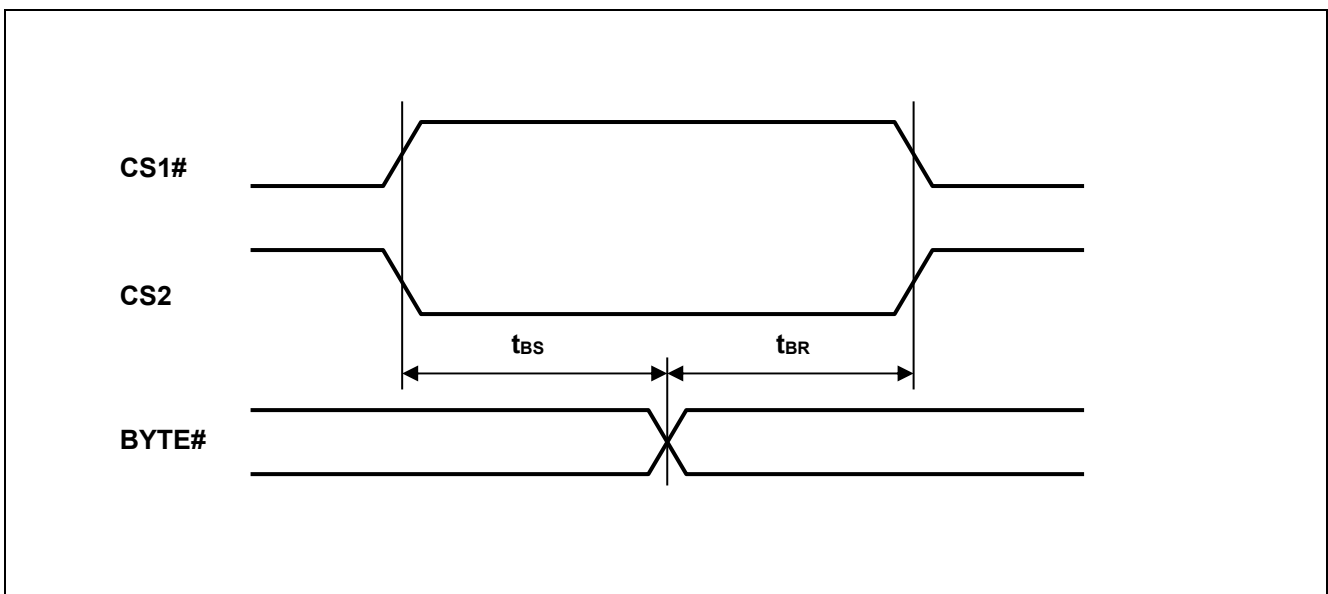
12. This parameter is sampled and not 100% tested.

13. t<sub>OHZ</sub> and t<sub>WHZ</sub> are defined as the time when the DQ pins enter a high-impedance state and are not referred to the DQ levels.

**BYTE# Timing Conditions**

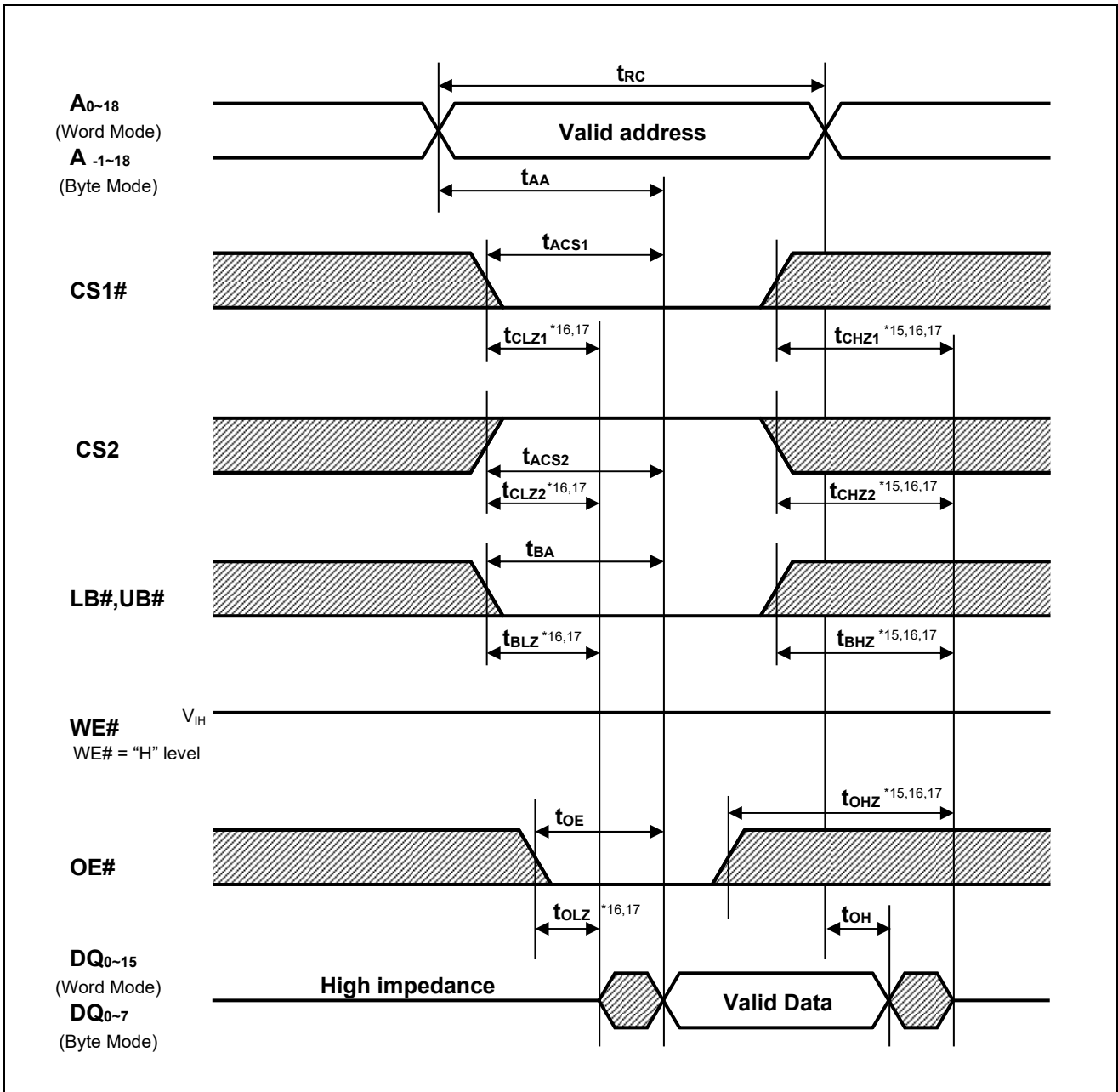
Parameter	Symbol	Vcc=2.7V to 3.6V		Vcc=2.4V to 2.7V		Unit	Note
		Min.	Max.	Min.	Max.		
Byte setup time	t <sub>BS</sub>	5	—	5	—	ms	
Byte recovery time	t <sub>BR</sub>	5	—	5	—	ms	

**BYTE# Timing Waveforms**



## Timing Waveforms

### Read Cycle<sup>\*14</sup>



Note 14.  $BYTE\# \geq V_{CC} - 0.2V$  or  $BYTE\# \leq 0.2V$

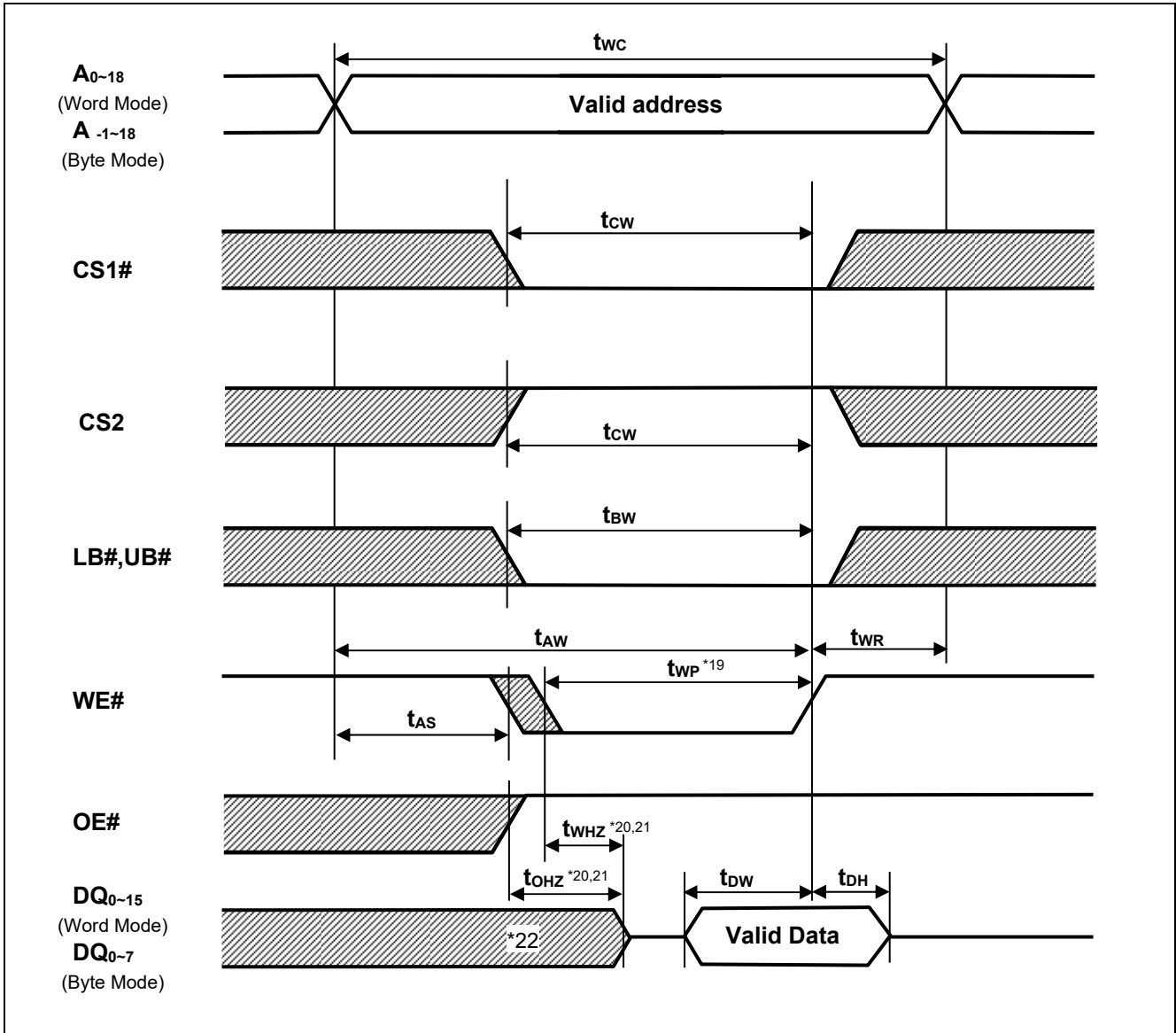
15.  $t_{CHZ1}$ ,  $t_{CHZ2}$ ,  $t_{BHZ}$  and  $t_{OHZ}$  are defined as the time when the DQ pins enter a high-impedance state and are not referred to the DQ levels.

16. This parameter is sampled and not 100% tested

17. At any given temperature and voltage condition,  $t_{CHZ1}$  max is less than  $t_{CLZ1}$  min,  $t_{CHZ2}$  max is less than  $t_{CLZ2}$  min,  $t_{BHZ}$  max is less than  $t_{BLZ}$  min, and  $t_{OHZ}$  max is less than  $t_{OLZ}$  min, for any device.



Write Cycle (1)<sup>\*18</sup> (WE# CLOCK, OE#="H" while writing)



Note 18.  $BYTE\# \geq V_{CC} - 0.2V$  or  $BYTE\# \leq 0.2V$

19.  $t_{WP}$  is the interval between write start and write end.

A write starts when all of (CS1#), (CS2), (WE#) and (one or both of LB# and UB#) become active.

A write is performed during the overlap of a low CS1#, a high CS2, a low WE# and a low LB# or a low UB#.

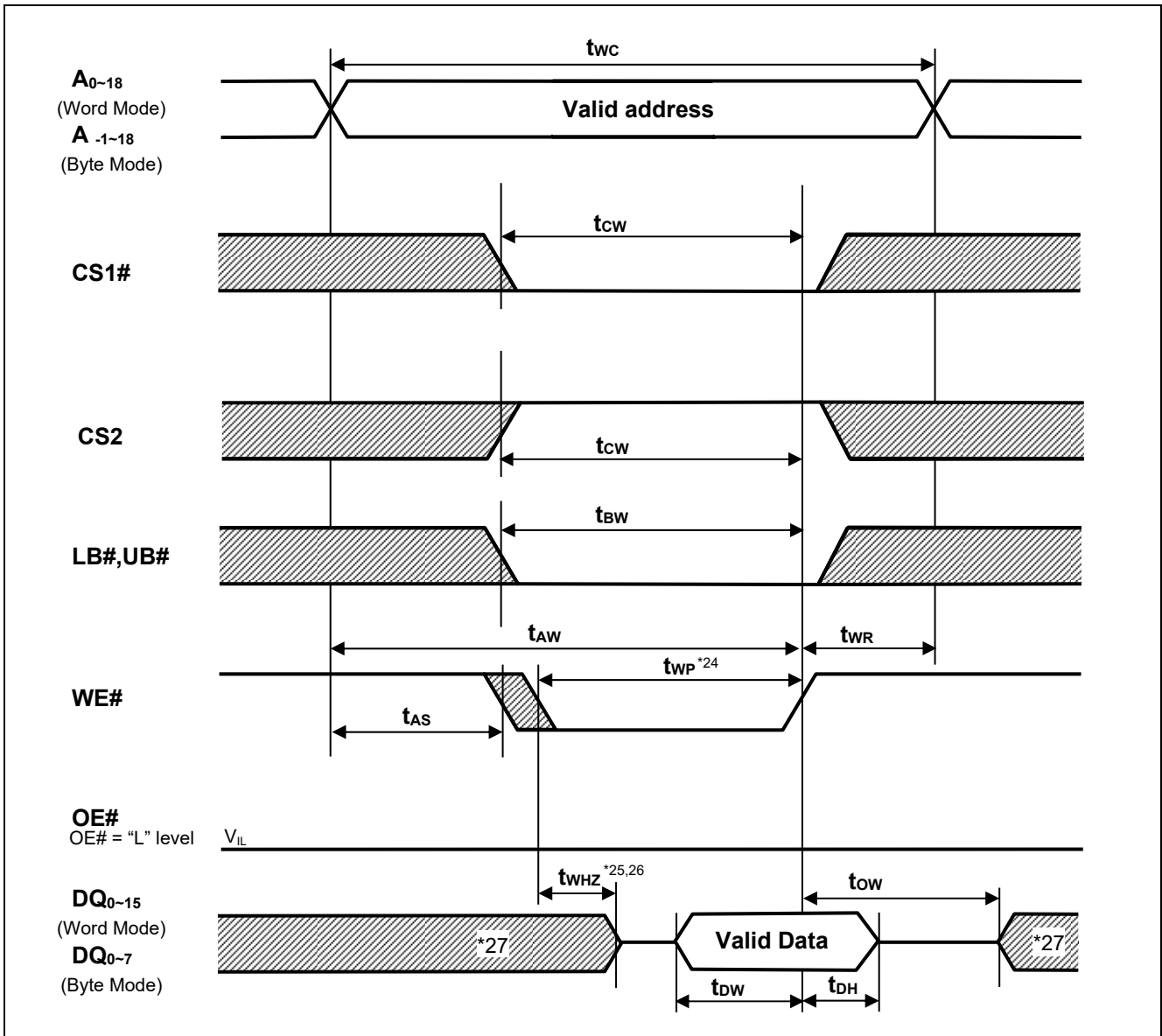
A write ends when any of (CS1#), (CS2), (WE#) or (one or both of LB# and UB#) becomes inactive.

20.  $t_{OHZ}$  and  $t_{WHZ}$  are defined as the time when the DQ pins enter a high-impedance state and are not referred to the DQ levels.

21. This parameter is sampled and not 100% tested

22. During this period, DQ pins are in the output state so input signals must not be applied to the DQ pins.

Write Cycle (2)<sup>\*23</sup> (WE# CLOCK, OE# Low Fixed)



Note 23.  $BYTE\# \geq V_{CC} - 0.2V$  or  $BYTE\# \leq 0.2V$

24.  $t_{WP}$  is the interval between write start and write end.

A write starts when all of (CS1#), (CS2), (WE#) and (one or both of LB# and UB#) become active.

A write is performed during the overlap of a low CS1#, a high CS2, a low WE# and a low LB# or a low UB#.

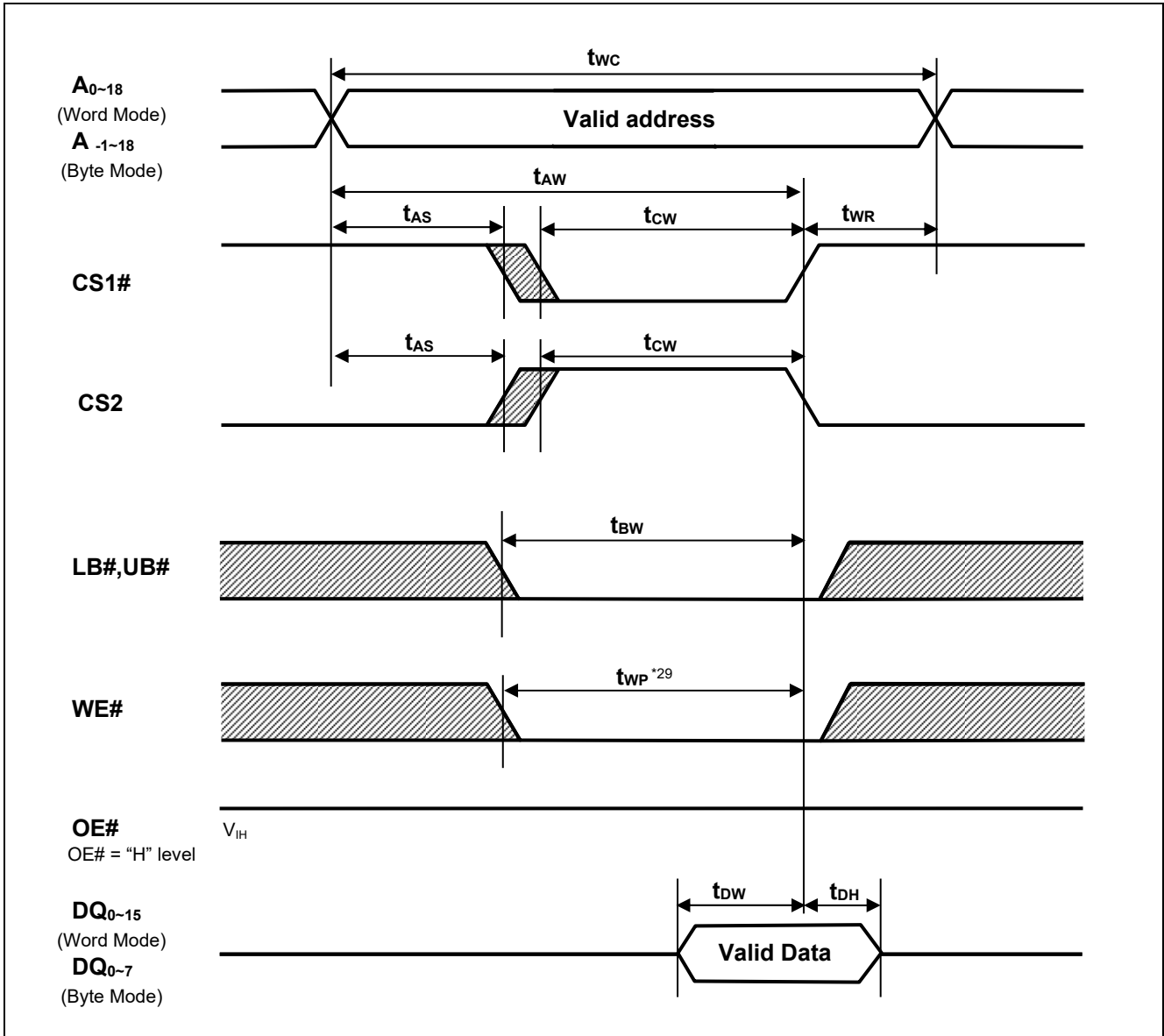
A write ends when any of (CS1#), (CS2), (WE#) or (one or both of LB# and UB#) becomes inactive.

25.  $t_{WHZ}$  is defined as the time when the DQ pins enter a high-impedance state and are not referred to the DQ levels.

26. This parameter is sampled and not 100% tested.

27. During this period, DQ pins are in the output state so input signals must not be applied to the DQ pins.

Write Cycle (3)<sup>\*28</sup> (CS1#, CS2 CLOCK)



Note 28. BYTE# ≥ V<sub>CC</sub> - 0.2V or BYTE# ≤ 0.2V

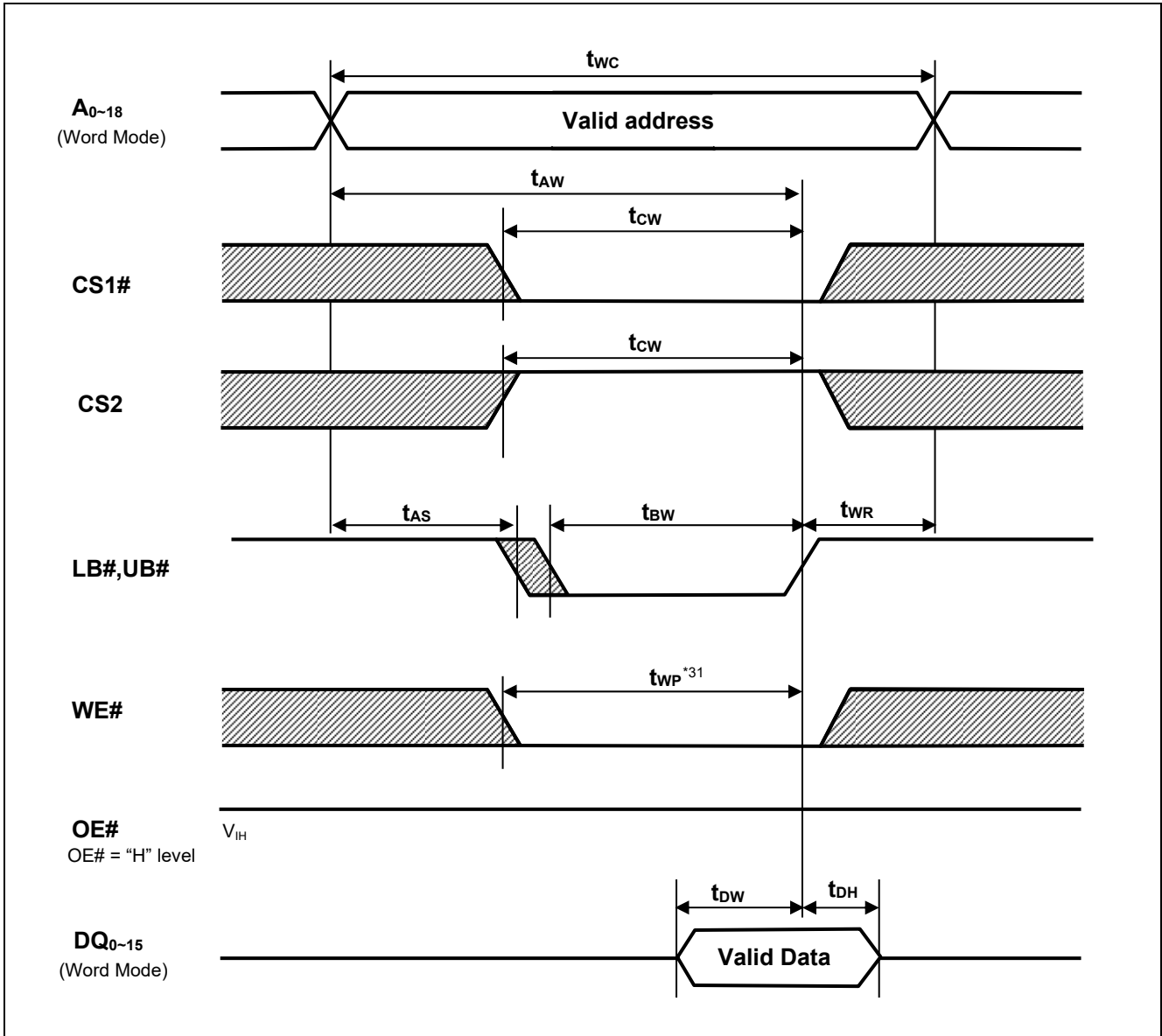
29. t<sub>WP</sub> is the interval between write start and write end.

A write starts when all of (CS1#), (CS2), (WE#) and (one or both of LB# and UB#) become active.

A write is performed during the overlap of a low CS1#, a high CS2, a low WE# and a low LB# or a low UB#.

A write ends when any of (CS1#), (CS2), (WE#) or (one or both of LB# and UB#) becomes inactive.

Write Cycle (4)<sup>\*30</sup> (LB#, UB# CLOCK, Word Mode)



Note 30. BYTE#  $\geq V_{CC} - 0.2V$

31.  $t_{WP}$  is the interval between write start and write end.

A write starts when all of (CS1#), (CS2), (WE#) and (one or both of LB# and UB#) become active.

A write is performed during the overlap of a low CS1#, a high CS2, a low WE# and a low LB# or a low UB#.

A write ends when any of (CS1#), (CS2), (WE#) or (one or both of LB# and UB#) becomes inactive.

Low  $V_{CC}$  Data Retention Characteristics

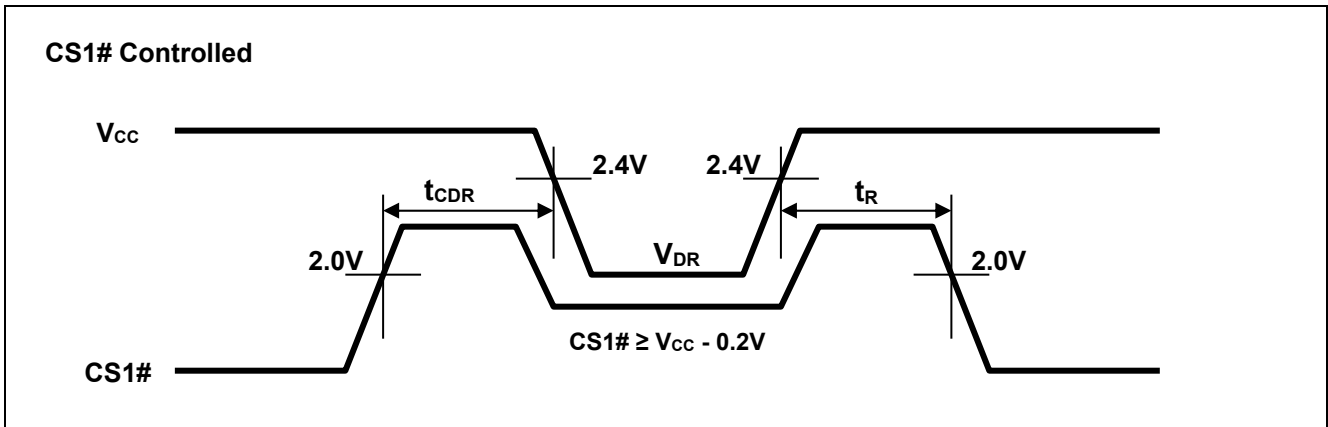
Parameter	Symbol	Min.	Typ.	Max.	Unit	Test conditions <sup>*34</sup>	
$V_{CC}$ for data retention	$V_{DR}$	1.5	—	3.6	V	$V_{in} \geq 0V$ , $BYTE\# \geq V_{CC} - 0.2V$ or $BYTE\# \leq 0.2V$ (1) $CS2 \leq 0.2V$ or (2) $CS1\# \geq V_{CC} - 0.2V$ , $CS2 \geq V_{CC} - 0.2V$ or (3) $LB\# = UB\# \geq V_{CC} - 0.2V$ , $CS1\# \leq 0.2V$ , $CS2 \geq V_{CC} - 0.2V$	
Data retention current	$I_{CCDR}$	—	0.45 <sup>*32</sup>	2	$\mu A$	$\sim +25^{\circ}C$	$V_{CC} = 3.0V$ , $V_{in} \geq 0V$ , $BYTE\# \geq V_{CC} - 0.2V$ or $BYTE\# \leq 0.2V$ (1) $CS2 \leq 0.2V$ or (2) $CS1\# \geq V_{CC} - 0.2V$ , $CS2 \geq V_{CC} - 0.2V$ or (3) $LB\# = UB\# \geq V_{CC} - 0.2V$ , $CS1\# \leq 0.2V$ , $CS2 \geq V_{CC} - 0.2V$
		—	0.6 <sup>*33</sup>	4	$\mu A$	$\sim +40^{\circ}C$	
		—	—	7	$\mu A$	$\sim +70^{\circ}C$	
		—	—	10	$\mu A$	$\sim +85^{\circ}C$	
Chip deselect time to data retention	$t_{CDR}$	0	—	—	ns	See retention waveform.	
Operation recovery time	$t_R$	5	—	—	ms		

Note 32. Typical parameter indicates the value for the center of distribution at 3.0V ( $T_a = 25^{\circ}C$ ), and not 100% tested.

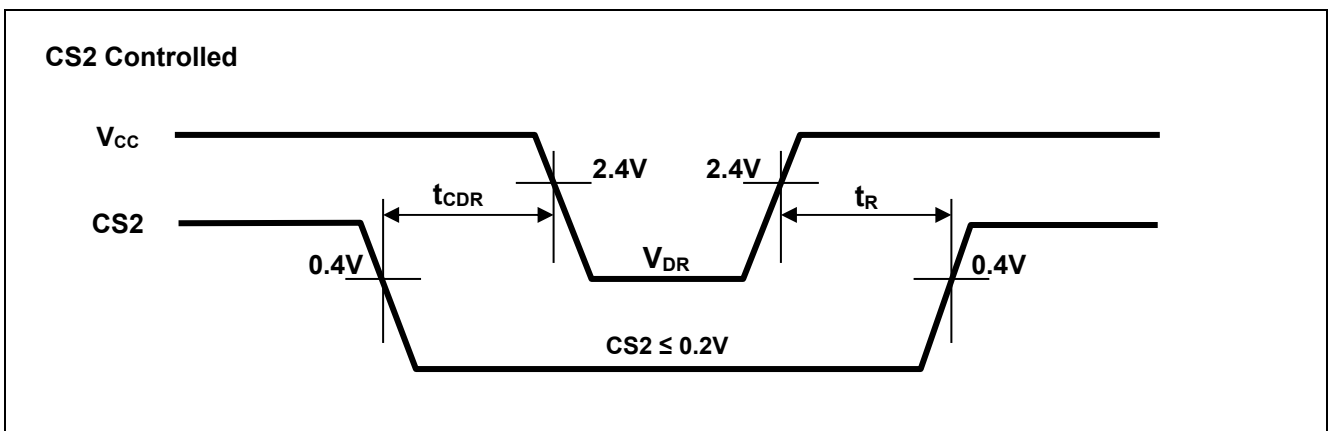
33. Typical parameter indicates the value for the center of distribution at 3.0V ( $T_a = 40^{\circ}C$ ), and not 100% tested.

34. CS2 controls address buffer, WE# buffer, CS1# buffer, OE# buffer, LB# buffer, UB# buffer and DQ buffer. If CS2 controls data retention mode,  $V_{in}$  levels (address, WE#, CS1#, OE#, LB#, UB#, DQ) can be in the high impedance state. If CS1# controls data retention mode, CS2 must be  $CS2 \geq V_{CC} - 0.2V$  or  $CS2 \leq 0.2V$ . The other inputs levels (address, WE#, OE#, LB#, UB#, DQ) can be in the high-impedance state.

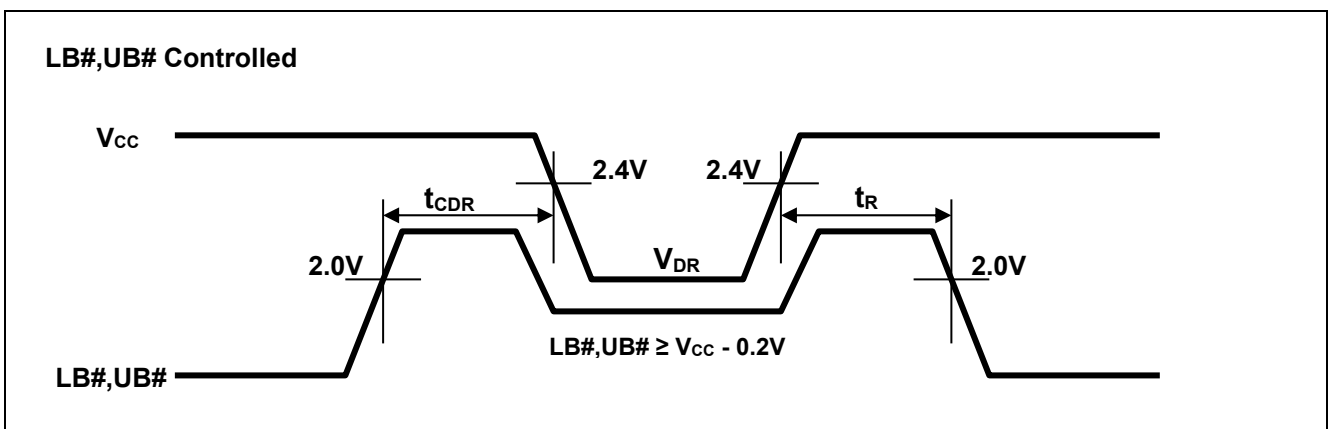
Low Vcc Data Retention Timing Waveforms (CS1# controlled)<sup>\*35</sup>



Low Vcc Data Retention Timing Waveforms (CS2 controlled)<sup>\*35</sup>



Low Vcc Data Retention Timing Waveforms (LB#,UB# controlled, Word Mode)<sup>\*36</sup>



Note 35. BYTE# ≥ V<sub>CC</sub> - 0.2V or BYTE# ≤ 0.2V

36. BYTE# ≥ V<sub>CC</sub> - 0.2V

Revision History	RMLV0816BGSD Data Sheet
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Rev.	Date	Description	
		Page	Summary
1.00	2014.11.28	—	First Edition issued
2.00	2015.06.26	P.1, 5 P.5 P.13	Standby current $I_{SB1}$ : 25°C 0.6μA ->0.45μA (typ.), 40°C 2μA ->0.6μA (typ.) Average operating current $I_{CC2}$ : 25°C 2mA ->1.5mA (typ.) Data retention current $I_{CCDR}$ : 25°C 0.6μA ->0.45μA (typ.), 40°C 2μA ->0.6μA (typ.)
2.01	2020.02.20	Last page	Updated the Notice to the latest version

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### Corporate Headquarters

TOYOSU FORESIA, 3-2-24 Toyosu,  
Koto-ku, Tokyo 135-0061, Japan  
[www.renesas.com](http://www.renesas.com)

### Contact Information

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