Memory FeRAM

4 M (256 K × 16) Bit

MS85R4M2TA

■ DESCRIPTIONS

The MS85R4M2TA is an FeRAM (Ferroelectric Random Access Memory) chip consisting of 262,144 words × 16 bits of nonvolatile memory cells fabricated using ferroelectric process and silicon gate CMOS process technologies.

The MS85R4M2TA is able to retain data without using a back-up battery, as is needed for SRAM.

The memory cells used in the MS85R4M2TA can be used for 10^{14} read/write operations, which is a significant improvement over the number of read and write operations supported by Flash memory and E2PROM. The MS85R4M2TA uses a pseudo-SRAM interface.

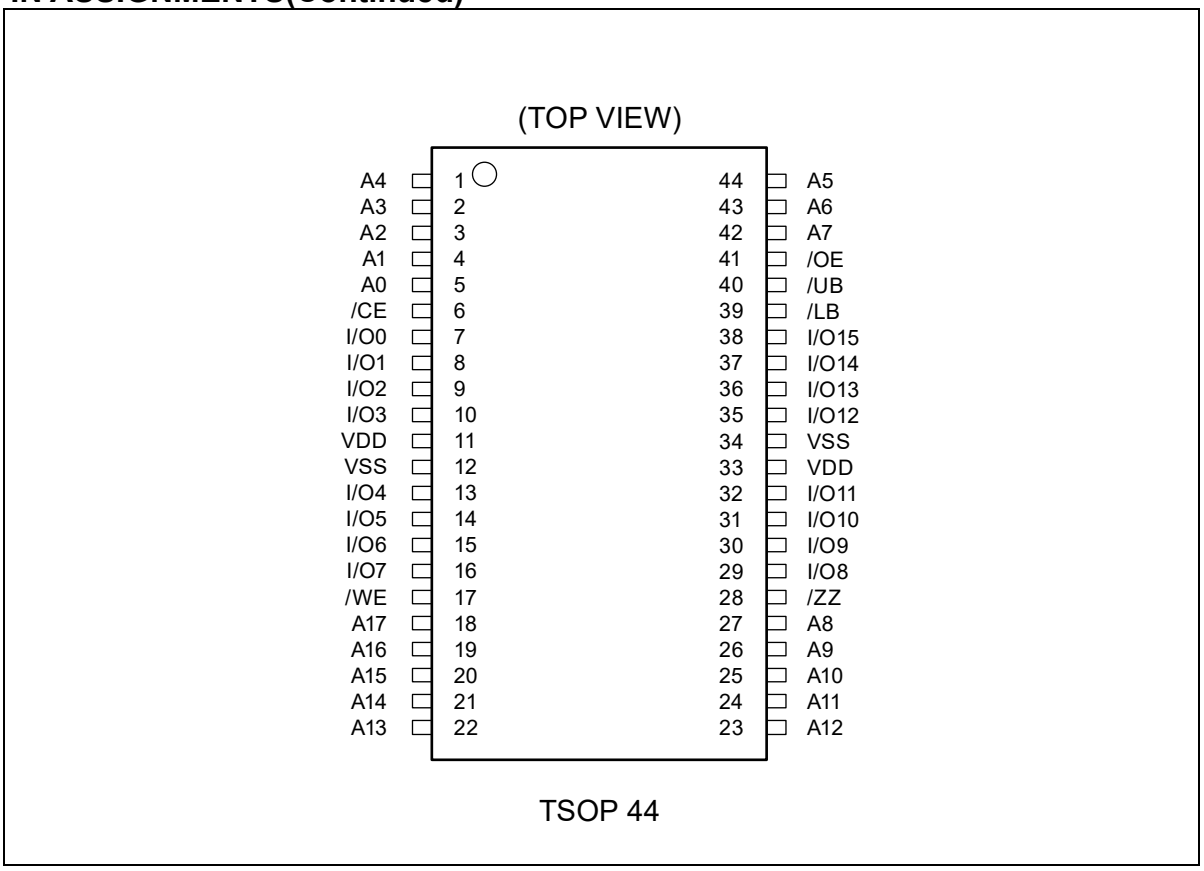
■ FEATURES

• Bit configuration	: 262,144 words × 16 bits
• LB and UB data byte control	: Available Configuration of 524,288 words × 8 bits
• Read/write endurance	: 10^{14} times (+ 85 °C), 10^{13} times (+ 105 °C),
• Data retention	: 10 years (+ 105 °C), 40 years (+ 85 °C), over 200 years (+ 35 °C)
• Operating power supply voltage	: 1.8 V to 3.6 V
• Low power operation	: Operating power supply current 16 mA (Max) Standby current 150 µA (Max) Sleep current 12 µA (Max)
• Operation ambient temperature range	: − 40 °C to + 105 °C
• Package	: 44-pin plastic TSOP RoHS compliant

Fujitsu Semiconductor Memory Solutions Limited has changed its name to RAMXEED Limited.
RAMXEED Limited will continue to offer and support existing products while maintaining Fujitsu's part number unchanged.

■ PIN ASSIGNMENTS

PIN ASSIGNMENTS(Continued)

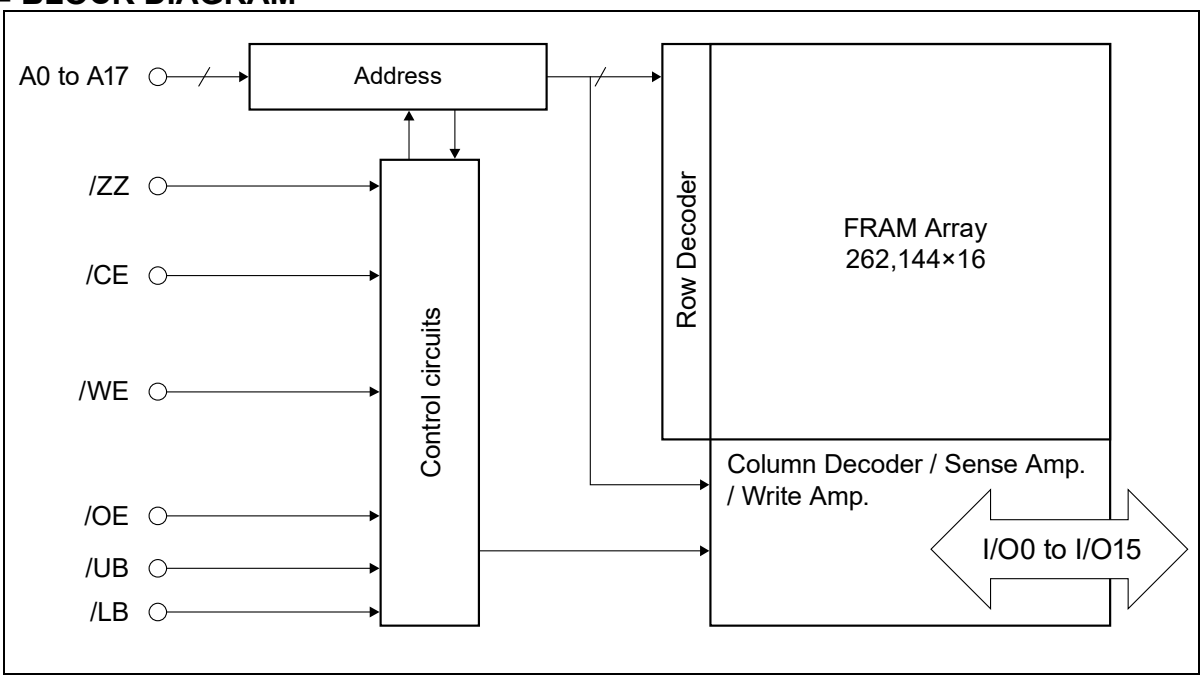


■ PIN DESCRIPTIONS

Pin Number(TSOP)	Pin Name	Functional Description
5 to 1, 44 to 42, 27 to 23, 22 to 18	A0 to A17	Address Input pins Select 262,144 words in FeRAM memory array by 18 Address Input pins. When these address inputs are changed during /CE equals to “L” level, reading operation of data selected in the address after transition will start.
7 to 10, 13 to 16, 29 to 32, 35 to 38	I/O0 to I/O15	Data Input/Output pins These are 16 bits bidirectional pins for reading and writing.
6	/CE	Chip Enable Input pin In case the /CE equals to “L” level and /ZZ equals to “H” level, device is activated and enables to start memory access. In writing operation, input data from I/O pins are latched at the rising edge of /CE and written to FeRAM memory array.
17	/WE	Write Enable Input pin Writing operation starts at the falling edge of /WE. Input data from I/O pins are latched at the rising edge of /WE and written to FeRAM memory array.
41	/OE	Output Enable Input pin When the /OE is “L” level, valid data are output to data bus. When the /OE is “H” level, all I/O pins become high impedance (High-Z) state.
28	/ZZ	Sleep Mode Input pin When the /ZZ becomes to “L” level, device transits to the Sleep Mode. During reading and writing operation, /ZZ pin shall be hold “H” level.
40, 39	/UB, /LB	Lower/Upper byte Control Input pins In case /LB or /UB equals to “L” level, it enables reading/writing operation of I/O0 to I/O7 or I/O8 to I/O15 respectively. In case /LB and /UB equal to “H” level, all I/O pins become High-Z state.
11, 33	VDD	Supply Voltage pins Connect all two pins to the power supply.
12, 34	VSS	Ground pins Connect all two pins to ground.

Note: Please refer to the timing diagram for functional description of each pin.

■ BLOCK DIAGRAM



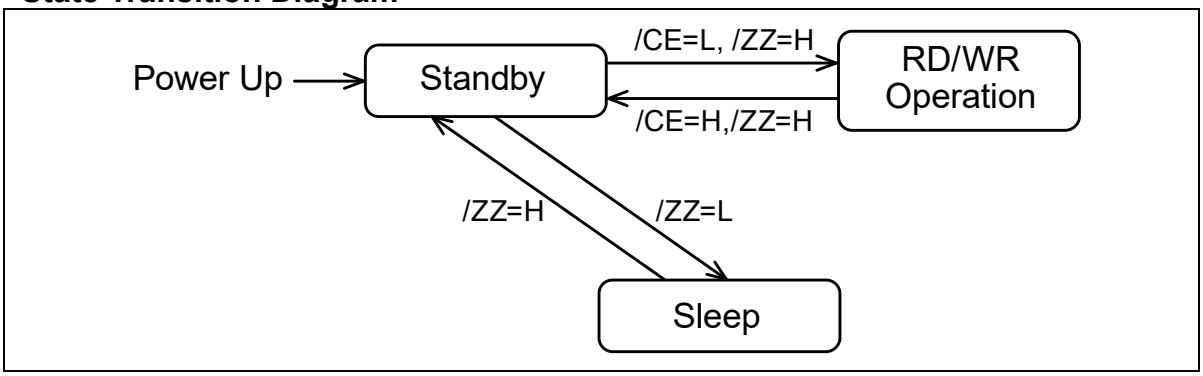
■ FUNCTIONAL TRUTH TABLE

Operation Mode	/CE	/WE	/OE	A0 to A1	A2 to A17	/ZZ	/UB,/LB
Sleep	×	×	×	×	×	L	×
Standby	H	×	×	×	×	H	×
Read(/CE Control)	↓	H	L	H or L	H or L	H	×
Address Access Read	L	H	L	H or L	↑ or ↓	H	×
Write(/CE Control)*1	↓	L	×	H or L	H or L	H	×
Write(/WE Control)*1*2	L	↓	×	H or L	H or L	H	×
Address Access Write*1*3	L	↓	×	H or L	↑ or ↓	H	×
Pre-charge	↑	×	×	×	×	H	×
Page Read	L	H	L	↑ or ↓	H or L	H	L
/UB,/LB Access Wright	L	L	H	H or L	H or L	H	↓
Page Address Write	L	↓	H	↑ or ↓	H or L	H	L

Note: H= “H” level, L= “L” level, ↑= Rising edge, ↓= Falling edge, ×= H, L, ↓ or ↑

*1: In writing cycle, input data is latched at early rising edge of /CE or /WE.
*2: In writing sequence of /WE control, there exists time with data output of reading cycle at the falling edge of /CE.
*3: In writing sequence of Address Access Write, there exists time with data output of reading cycle at the address transition.

■ State Transition Diagram



■ FUNCTIONAL TRUTH TABLE OF BYTE CONTROL

Operation Mode	/WE	/OE	/LB	/UB	I/O0 to I/O7	I/O8 to I/O15
Read(Without Output)	H	H	×	×	Hi-Z	Hi-Z
	H	×	H	H	Hi-Z	Hi-Z
Read(I/O8 to I/O15)	H	L	H	L	Hi-Z	Output
Read(I/O0 to I/O7)			L	H	Output	Hi-Z
Read(I/O0 to I/O15)			L	L	Output	Output
Write(I/O8 to I/O15)	↑	×	H	L	×	Input
Write(I/O0 to I/O7)			L	H	Input	×
Write(I/O0 to I/O15)			L	L	Input	Input

Note: H= “H” level, L= “L” level, ↑= Rising edge, ↓= Falling edge, ×= H, L, ↓ or ↑
Hi-Z= High Impedance

In case the byte reading or writing are not selected, /LB and /UB pins shall be connected to GND pin.
In case the byte writing, while /CE=L, please don’t switch /LB and /UB.

■ ABSOLUTE MAXIMUM RATINGS

Parameter	Symbol	Rating		Unit
		Min	Max	
Power Supply Voltage*	V_{DD}	− 0.5	+ 4.0	V
Input Pin Voltage*	V_{IN}	− 0.5	V_{DD} + 0.5 (≤ 4.0)	V
Output Pin Voltage*	V_{OUT}	− 0.5	V_{DD} + 0.5 (≤ 4.0)	V
Operation Ambient Temperature	T_A	− 40	+ 105	°C
Storage Temperature	Tstg	− 55	+ 125	°C

* : All voltages are referenced to VSS (ground 0 V).

WARNING: Semiconductor devices can be permanently damaged by application of stress (voltage, current, temperature, etc.) in excess of absolute maximum ratings. Do not exceed these ratings.

■ RECOMMENDED OPERATING CONDITIONS

Parameter	Symbol	Value			Unit
		Min	Typ	Max	
Power Supply Voltage*1	V_{DD}	1.8	3.3	3.6	V
Operation Ambient Temperature*2	T_A	− 40	—	+ 105	°C

*1: All voltages are referenced to VSS (ground 0 V).

*2: Ambient temperature when only this device is working. Please consider it to be the almost same as the package surface temperature.

WARNING: The recommended operating conditions are required in order to ensure the normal operation of the semiconductor device. All of the device's electrical characteristics are warranted when the device is operated within these ranges.
Always use semiconductor devices within their recommended operating condition ranges. Operation outside these ranges may adversely affect reliability and could result in device failure.
No warranty is made with respect to uses, operating conditions, or combinations not represented on the data sheet. Users considering application outside the listed conditions are advised to contact their representatives beforehand.

■ ELECTRICAL CHARACTERISTICS

1. DC Characteristics

(within recommended operating conditions)

Parameter	Sym-bol	Condition	Value				Unit
			Min	Typ	Max(TA ≤85°C)	Max(TA ≥ 85°C)	
Input Leakage Current	$\|I_{LI}\|$	V_{IN} = 0V to V_{DD}	—	—	5		µA
Output Leakage Current	$\|I_{LO}\|$	V_{OUT} = 0V to V_{DD} /CE = V_{IH} or /OE = V_{IH}	—	—	5		µA
Operating Power Supply Current*1	I_{DD}	/CE = 0.2 V, I_{out} = 0 mA	—	13.5	16	16	mA
Standby Current	I_{SB}	/ZZ ≥ V_{DD} − 0.2V /CE, /WE, /OE ≥ V_{DD} − 0.2V /LB, /UB ≥ V_{DD} − 0.2V Others ≥ V_{DD} − 0.2V or ≤ 0.2V	—	12	100	150	µA
Sleep Current	I_{ZZ}	/ZZ = V_{SS} /CE, /WE, /OE ≥ V_{DD} − 0.2V /LB, /UB ≥ V_{DD} − 0.2V Others ≥ V_{DD} − 0.2V or ≤ 0.2V	—	3.5	10	12	µA
High Level Input Voltage	V_{IH}	V_{DD} = 1.8V to 3.6V	V_{DD} × 0.8	—	V_{DD} + 0.3		V
Low Level Input Voltage	V_{IL}	V_{DD} = 1.8V to 3.6V	− 0.3	—	V_{DD} × 0.2		V
High Level Output Voltage	V_{OH1}	V_{DD} = 2.5V to 3.6V I_{OH} = − 1.0mA	V_{DD} × 0.8	—	—		V
	V_{OH2}	V_{DD} = 1.8V to 2.5V I_{OH} = − 100µA	V_{DD} − 0.2	—	—		
Low Level Output Voltage	V_{OL1}	V_{DD} = 2.5V to 3.6V I_{OL} = 2.0mA	—	—	0.4		V
	V_{OL2}	V_{DD} = 1.8V to 2.5V I_{OL} = 150µA	—	—	0.2		

*1: During the measurement of I_{DD}, all Address and I/O were taken to only change once per active cycle.
Iout : output current

2. AC Characteristics

▪ AC Test Conditions

Power Supply Voltage	: 1.8 V to 3.6 V
Operation Ambient Temperature	: − 40 °C to + 105 °C
Input Voltage Amplitude	: 0 V / V_{DD}
Input Rising Time	: 3 ns
Input Falling Time	: 3 ns
Input Evaluation Level	: V_{DD}/2
Output Evaluation Level	: V_{DD}/2
Output Load Capacitance	: 30 pF

(1) Read Cycle

Parameter	Symbol	TA≤+85°C				Unit
		Value (V_{DD}=1.8V to 2.5V)		Value (V_{DD}=2.5V to 3.6V)		
		Min	Max	Min	Max	
Read Cycle time(/CE control)	t_{RC}	120	—	120	—	ns
Read Cycle time(Address access)	t_{RCA}	135	—	120	—	ns
/CE Access Time	t_{CE}	—	65	—	65	ns
Address Access Time	t_{AA}	—	135	—	120	ns
/CE Output Data Hold time	t_{OH}	0	—	0	—	ns
Address Access Output Data Hold time	t_{OAH}	20	—	20	—	ns
/CE Active Time	t_{CA}	65	—	65	—	ns
Pre-charge Time	t_{PC}	55	—	55	—	ns
/LB, /UB Access Time	t_{BA}	—	35	—	20	ns
Address Setup Time	t_{AS}	0	—	0	—	ns
Address Hold Time	t_{AH}	65	—	65	—	ns
/CE↑ to Address Transition time*1	t_{CAH}	0	—	0	—	ns
/OE Access Time	t_{OE}	—	35	—	20	ns
/CE Output Floating Time*1	t_{HZ}	—	10	—	10	ns
/OE Output Floating Time	t_{OHZ}	—	10	—	10	ns
/LB, /UB Output Floating Time	t_{BHZ}	—	10	—	10	ns
Address Transition Time*1	t_{AX}	—	15	—	15	ns

*1: Same parameters with the Write cycle.

Parameter	Symbol	TA≥+85°C				Unit
		Value (V_{DD}=1.8V to 2.5V)		Value (V_{DD}=2.5V to 3.6V)		
		Min	Max	Min	Max	
Read Cycle time(/CE control)	t_{RC}	125	—	125	—	ns
Read Cycle time(Address access)	t_{RCA}	140	—	125	—	ns
/CE Access Time	t_{CE}	—	70	—	70	ns
Address Access Time	t_{AA}	—	140	—	125	ns
/CE Output Data Hold time	t_{OH}	0	—	0	—	ns
Address Access Output Data Hold time	t_{OAH}	20	—	20	—	ns
/CE Active Time	t_{CA}	70	—	70	—	ns
Pre-charge Time	t_{PC}	55	—	55	—	ns
/LB, /UB Access Time	t_{BA}	—	35	—	20	ns
Address Setup Time	t_{AS}	0	—	0	—	ns
Address Hold Time	t_{AH}	70	—	70	—	ns
/CE↑ to Address Transition time*1	t_{CAH}	0	—	0	—	ns
/OE Access Time	t_{OE}	—	35	—	20	ns
/CE Output Floating Time*1	t_{HZ}	—	10	—	10	ns
/OE Output Floating Time	t_{OHZ}	—	10	—	10	ns
/LB, /UB Output Floating Time	t_{BHZ}	—	10	—	10	ns
Address Transition Time*1	t_{AX}	—	15	—	15	ns

*1: Same parameters with the Write cycle.

(2) Write Cycle

Parameter	Symbol	TA≤+85°C				Unit
		Value (V_{DD}=1.8V to 2.5V)		Value (V_{DD}=2.5V to 3.6V)		
		Min	Max	Min	Max	
Write Cycle Time	t_{WC}	120	—	120	—	ns
/CE Active Time	t_{CA}	65	—	65	—	ns
/CE↓ to /WE↑ Time	t_{CW}	65	—	65	—	ns
Pre-charge Time	t_{PC}	55	—	55	—	ns
Write Pulse Width	t_{WP}	20	—	20	—	ns
Address Setup Time	t_{AS}	0	—	0	—	ns
Address Hold Time	t_{AH}	65	—	65	—	ns
/WE↓ to /CE↑ Time	t_{WLC}	20	—	20	—	ns
(/UB or /LB) ↓ to /CE ↑	t_{BLC}	20	—	20	—	ns
Address Transition to /WE↑ Time	t_{AWH}	135	—	120	—	ns
/WE↑ to Address Transition Time	t_{WHA}	0	—	0	—	ns
Data Setup Time	t_{DS}	10	—	10	—	ns
Data Hold Time	t_{DH}	0	—	0	—	ns
/WE Output Floating Time	t_{WZ}	—	10	—	10	ns
/WE Output Access Time*1	t_{WX}	10	—	10	—	ns
Write Setup Time*1	t_{WS}	0	—	0	—	ns
Write Hold Time*1	t_{WH}	0	—	0	—	ns
/CE Output Floating Time	t_{HZ}	—	10	—	10	ns
Address transition Time	t_{AX}	—	15	—	15	ns
/UB, /LB Write Pulse Width	t_{WP2}	20	—	20	—	ns
/WE=L to (/UB, /LB)=H period	t_{WP3}	20	—	20	—	ns

Parameter	Symbol	TA≥+85°C				Unit
		Value (V_{DD}=1.8V to 2.5V)		Value (V_{DD}=2.5V to 3.6V)		
		Min	Max	Min	Max	
Write Cycle Time	t_{WC}	125	—	125	—	ns
/CE Active Time	t_{CA}	70	—	70	—	ns
/CE↓ to /WE↑ Time	t_{CW}	70	—	70	—	ns
Pre-charge Time	t_{PC}	55	—	55	—	ns
Write Pulse Width	t_{WP}	20	—	20	—	ns
Address Setup Time	t_{AS}	0	—	0	—	ns
Address Hold Time	t_{AH}	70	—	70	—	ns
/WE↓ to /CE↑ Time	t_{WLC}	20	—	20	—	ns
(/UB or /LB) ↓ to /CE ↑	t_{BLC}	20	—	20	—	ns
Address Transition to /WE↑ Time	t_{AWH}	140	—	125	—	ns
/WE↑ to Address Transition Time	t_{WHA}	0	—	0	—	ns
Data Setup Time	t_{DS}	10	—	10	—	ns
Data Hold Time	t_{DH}	0	—	0	—	ns
/WE Output Floating Time	t_{WZ}	—	10	—	10	ns
/WE Output Access Time[*1]	t_{WX}	10	—	10	—	ns
Write Setup Time[*1]	t_{WS}	0	—	0	—	ns
Write Hold Time[*1]	t_{WH}	0	—	0	—	ns
/CE Output Floating Time	t_{HZ}	—	10	—	10	ns
Address transition Time	t_{AX}	—	15	—	15	ns
/UB, /LB Write Pulse Width	t_{WP2}	20	—	20	—	ns
/WE=L to (/UB, /LB)=H period	t_{WP3}	20	—	20	—	ns

(3) Page Mode Read/Write Cycle

Parameter	Symbol	Value (V_{DD}=1.8V to 2.5V)		Value (V_{DD}=2.5V to 3.6V)		Unit
		Min	Max	Min	Max	
Page Mode Write Cycle Time	t_{PWC}	25	—	25	—	ns
Page Mode Write Pulse Width	t_{WPP}	15	—	15	—	ns
Page Address Setup Time (/WE=L)	t_{ASP}	8	—	8	—	ns
Page Address Hold Time (/WE=L)	t_{AHP}	15	—	15	—	ns
Page Address Access Time	t_{AAP}	—	25	—	25	ns
Page Address Data Hold Time	t_{OHP}	3	—	3	—	ns
Page Mode Read Cycle Time	t_{PRCA}	25	—	25	—	ns
Page Mode Write Pre Charge Width	t_{WPHP}	7	—	7	—	ns

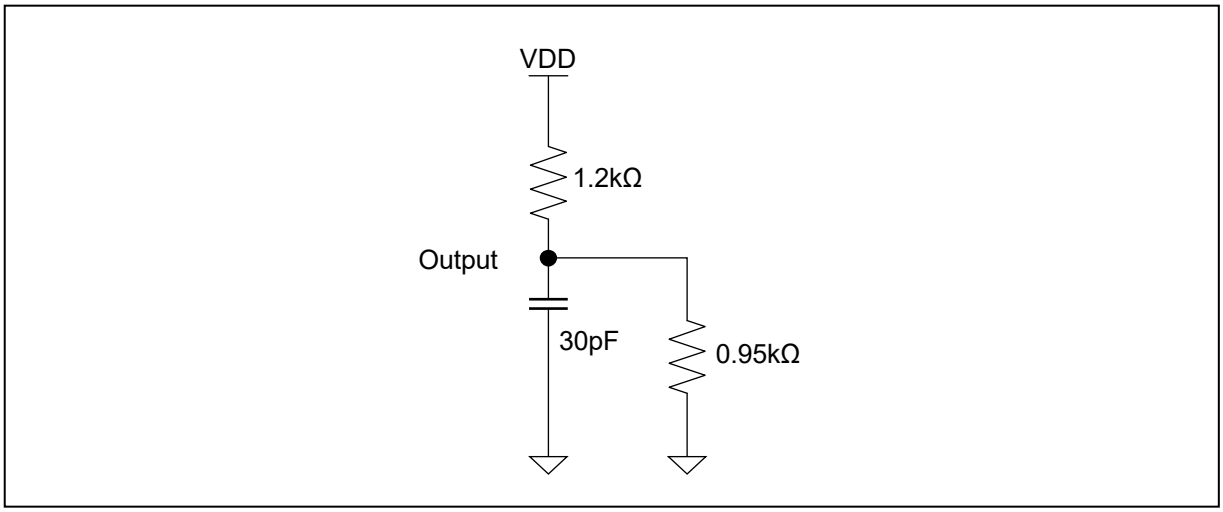
(4) Power ON/OFF Sequence and Sleep Mode Cycle

Parameter	Symbol	Value		Unit
		Min	Max	
/CE level hold time for Power ON	t_{PU}	450	—	µs
/CE level hold time for Power OFF	t_{PD}	85	—	ns
Power supply rising time	t_{VR}	50	—	µs/V
Power supply falling time	t_{VF}	100	—	µs/V
/ZZ active time	t_{ZZL}	1	—	µs
Sleep mode enable time	t_{ZZEN}	—	0	µs
/CE level hold time for Sleep mode release	t_{ZZEX}	450	—	µs

3. Pin Capacitance

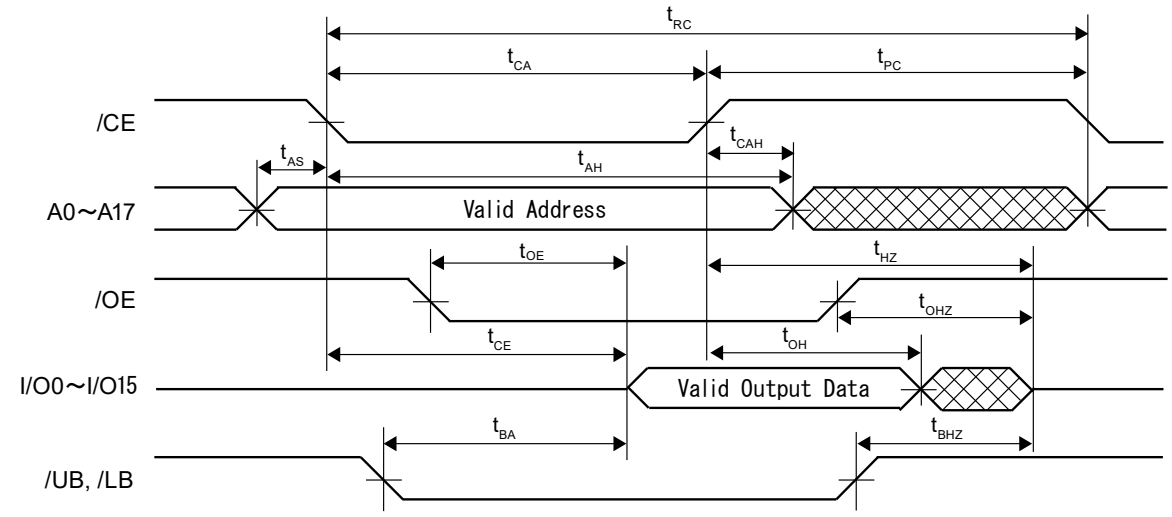
Parameter	Symbol	Condition	Value			Unit
			Min	Typ	Max	
Input Capacitance	C_{IN}	V_{DD} = 3.3 V, VIN = VOUT = 0V~VDD, f = 1 MHz, T_A = + 25 °C	—	—	6	pF
Input/Output Capacitance (I/O pin)	$C_{I/O}$		—	—	8	pF
/ZZ Pin Input Capacitance	C_{ZZ}		—	—	8	pF

■ AC Test Load Circuit



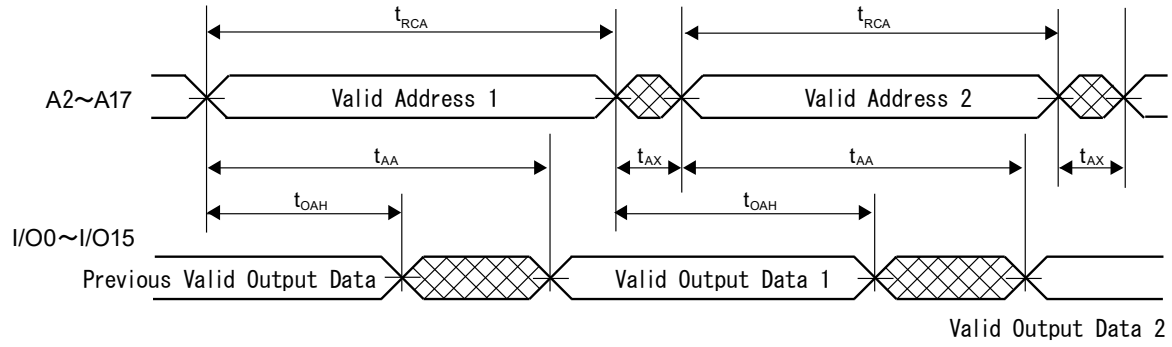
■ TIMING DIAGRAMS

1. Read Cycle Timing 1 (/CE, /OE, /UB, /LB Control)



XXX : H or L

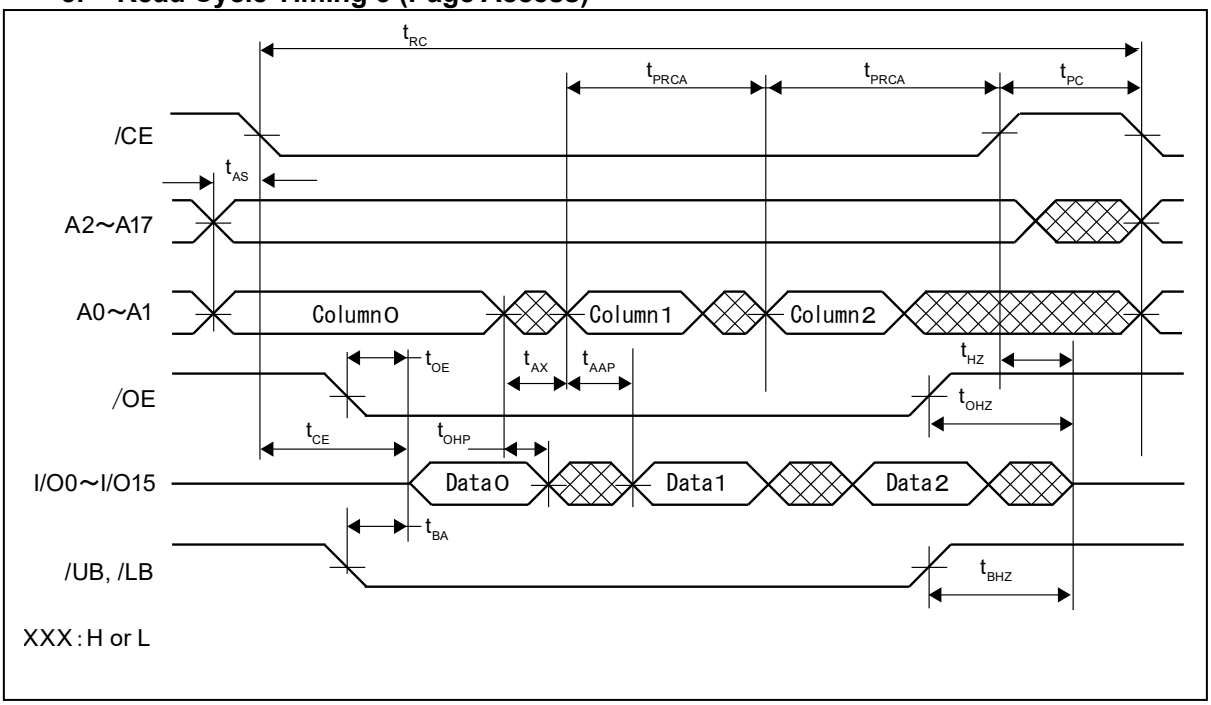
2. Read Cycle Timing 2 (Address Access)



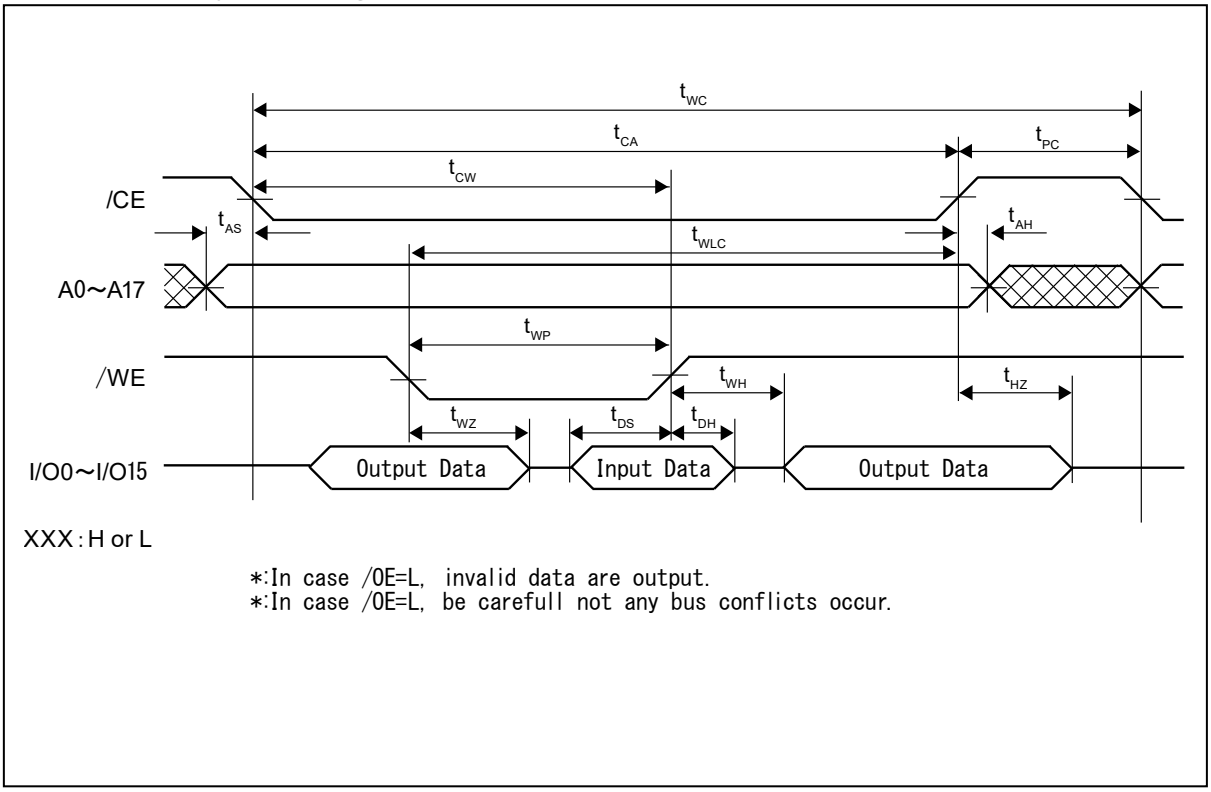
/CE = /OE = /UB = /LB = L, /WE = H

XXX : H or L

3. Read Cycle Timing 3 (Page Access)

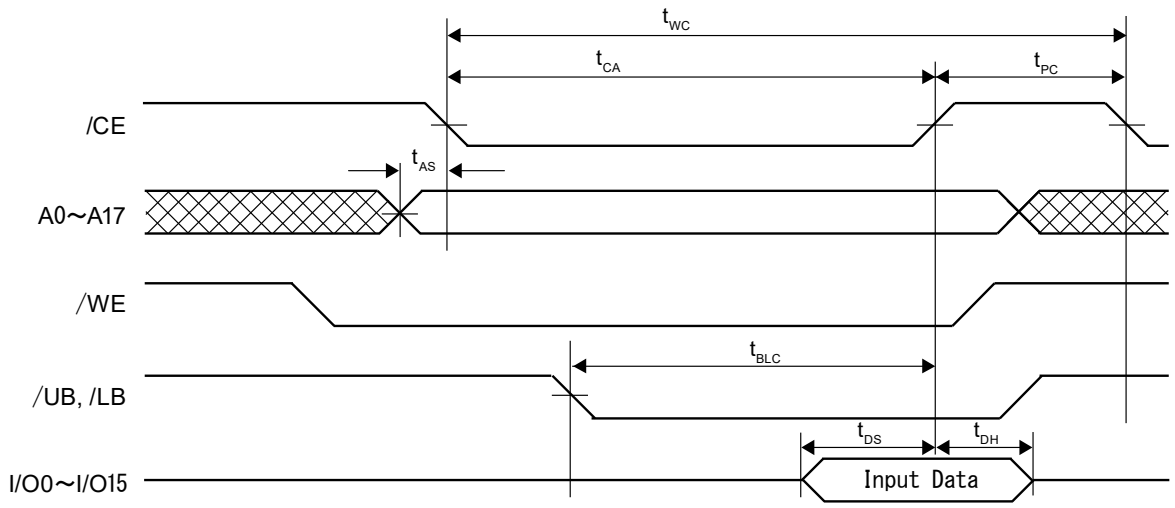


4. Write Cycle Timing 1 (/WE Control)



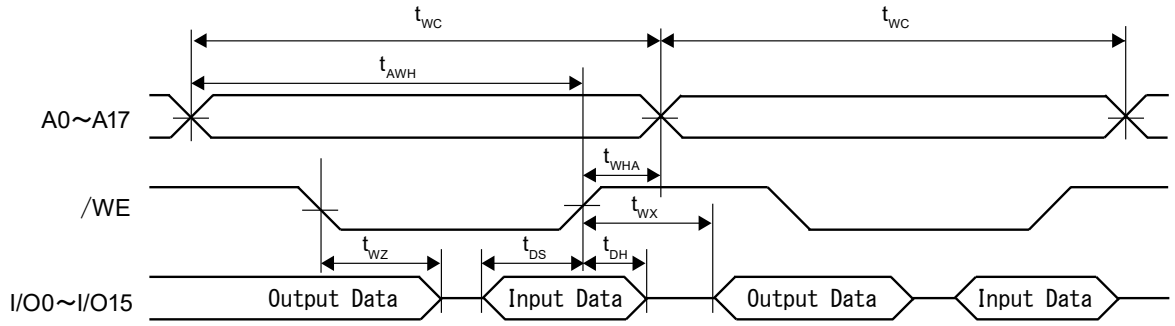
*:In case /OE=L, invalid data are output.
*:In case /OE=L, be carefull not any bus conflicts occur.

5. Write Cycle Timing 2 (/CE Control)



XXX : H or L

6. Write Cycle Timing 3 (Address Access and /WE Control)

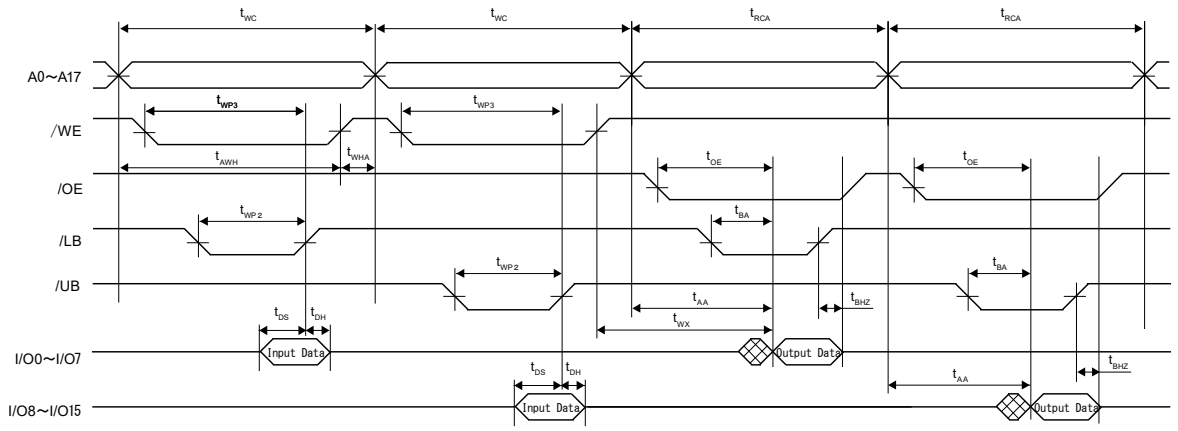


/CE = /OE = L

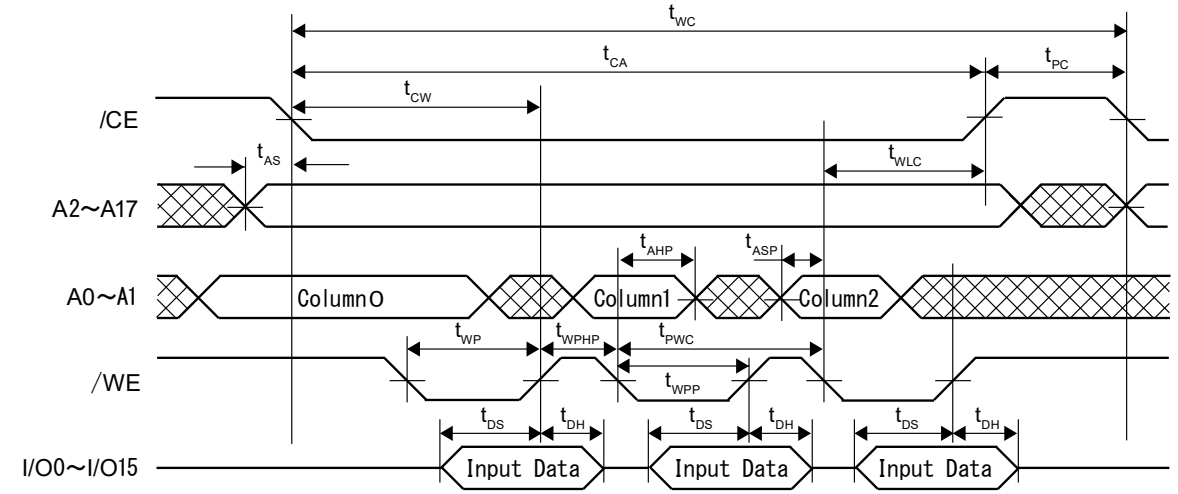
XXX : H or L

∗:In case /OE=L, invalid data are output.
∗:In case /OE=L, be carefull not any bus conflicts occur.

7. Write Cycle Timing 4 (/UB,/LB Access)

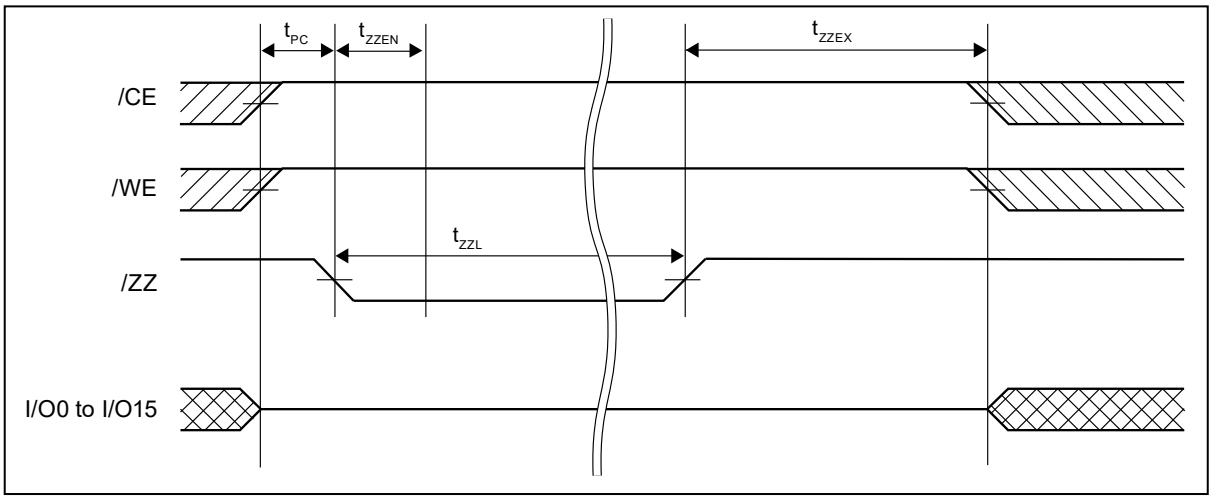


8. Write Cycle Timing 5 (Page Address Access)

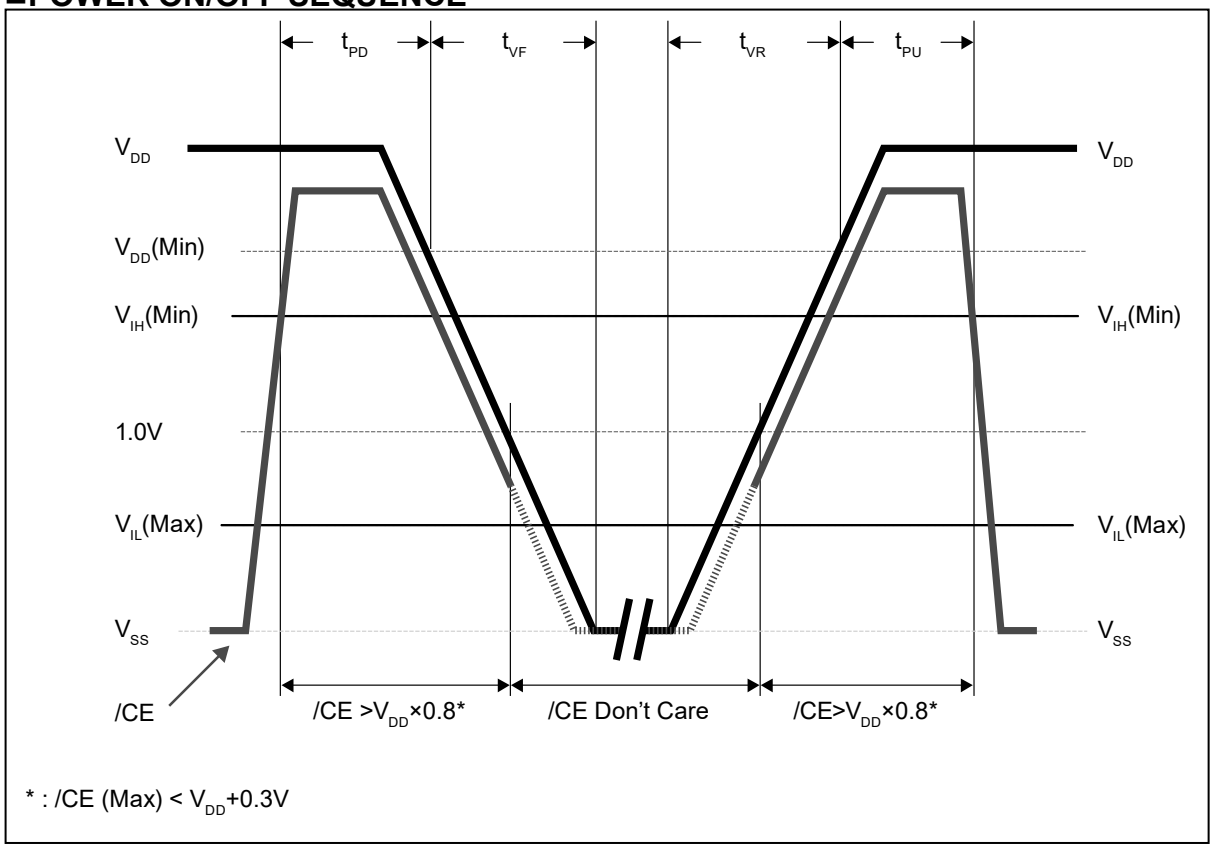


XXX : H or L

9. Sleep Mode Timing



■POWER ON/OFF SEQUENCE



When applying relatively short term VDD pulse whose peak is more than 1.7V, it is required to set falling time, t_{VF} more than 0.4ms/V. (In case VDD rises over 1.7V and falls just after that, if this term is short, device may lose its function.)

■ FeRAM CHARACTERISTICS

Item	Min	Max	Unit	Parameter
Read/Write Endurance*1	10^{13} *2	—	Times	Operation Ambient Temperature T_A = + 105 °C
	10^{14}	—		Operation Ambient Temperature T_A = + 85 °C
Data Retention*3	10	—	Years	Operation Ambient Temperature T_A = + 105 °C
	40			Operation Ambient Temperature T_A = + 85 °C
	95	—		Operation Ambient Temperature T_A = + 55 °C
	≥ 200	—		Operation Ambient Temperature T_A = + 35 °C

*1: The values for Read/Write Endurance apply to the total number of read and write operations per row in FeRAM. This is because FeRAM needs writing operation after each reading operations. When switching rows, the number of Read/Write operations is counted for each selected row. However, if only addresses A0 and A1 are switched, no row switching occurs. The memory consists of 64 internal outputs per row, and switching only A0 and A1 selects 16 of these outputs. Each row in the memory array has 64 internal outputs, and 16 outputs are selected by A0 and A1. Therefore, once a certain address is selected, switching only A0 and A1 does not change the selected row, and the Read/Write count is totaled as one operation. For other address switches, each corresponding row is counted once.

*2: Evaluating about minimum Read/Write Endurance at +105℃, over 10^{13} times.

*3: The minimum value of Date Retention refers to data retention term from first read/write after the device shipped. The value is estimated from qualification results.

■ NOTE ON USE

- We recommend programming of the device after reflow. Data written before reflow cannot be guaranteed.

■ ESD AND LATCH-UP

Test	DUT	Value
ESD HBM (Human Body Model) JESD22-A114 compliant	MS85R4M2TAFN-G-JAE2	≥ |2000 V|
ESD CDM (Charged Device Model) JESD22-C101 compliant		≥ |1000 V|
Latch-Up (C-V Method) Proprietary method		≥ |200 V|

■ REFLOW CONDITIONS AND FLOOR LIFE

[JEDEC MSL] : Moisture Sensitivity Level 3 (IPC/JEDEC J-STD-020E)

■ CURRENT STATUS ON CONTAINED RESTRICTED SUBSTANCES

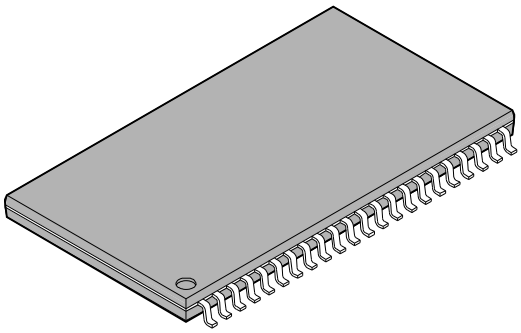
This product complies with the regulations of REACH Regulations, EU RoHS Directive and China RoHS.

■ ORDERING INFORMATION

Part Number	Package	Shipping form	Minimum shipping quantity
MS85R4M2TAFN-G-JAE2	44-pin plastic TSOP	Tray	—*

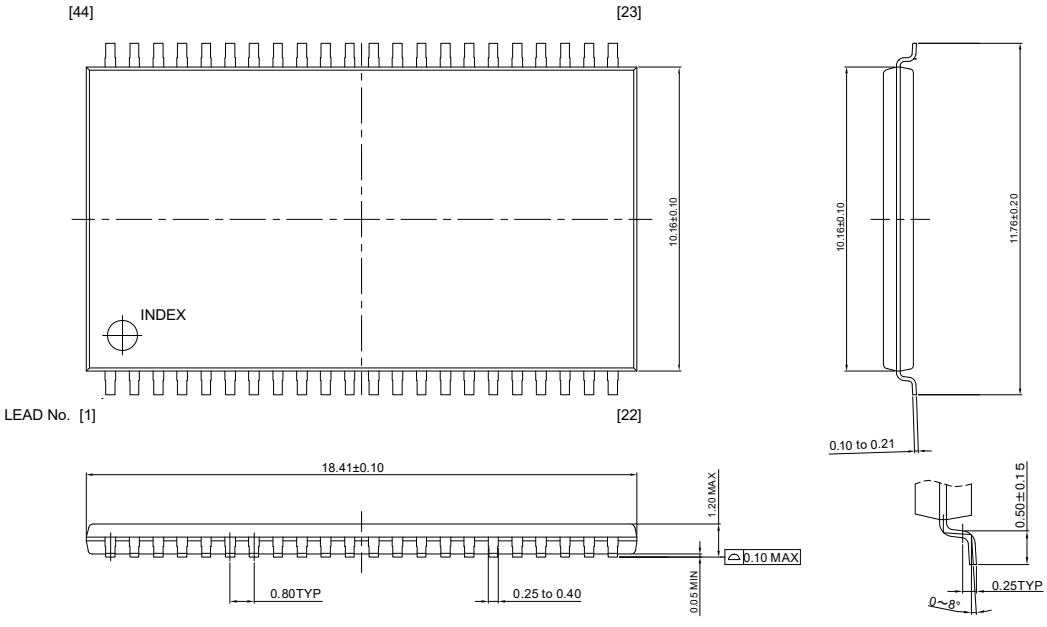
*: Please contact our sales office about minimum shipping quantity.

■ PACKAGE DIMENSIONS

44-pin plastic TSOP		
 MS85R4M2TAFN-G-JAE2	Lead pitch	0.8mm
	Package width × package length	10.16 × 18.41mm
	Lead shape	Gullwing
	Sealing method	Plastic mold
	Mounting height	1.2mm (max.)

44-pin plastic TSOP
MS85R4M2TAFN-G-JAE2

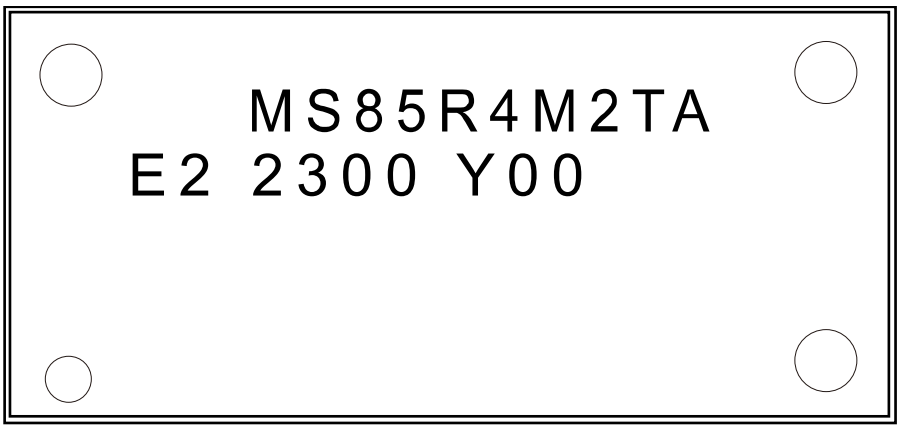
Note 1): These dimensions do not include resin protrusion.
Note 2): Pins width do not include tie bar cutting remainder.
Pins width and pins thickness include plating thickness.



Dimensions in mm.

■ MARKING(Examples)

[MS85R4M2TAFN-G-JAE2]



[44pin Plastic TSOP]

MS85R4M2TA: Product name

E2: (Lead free code)

2300 Y00:2300(Year and Week code)＋Y00（Trace code）

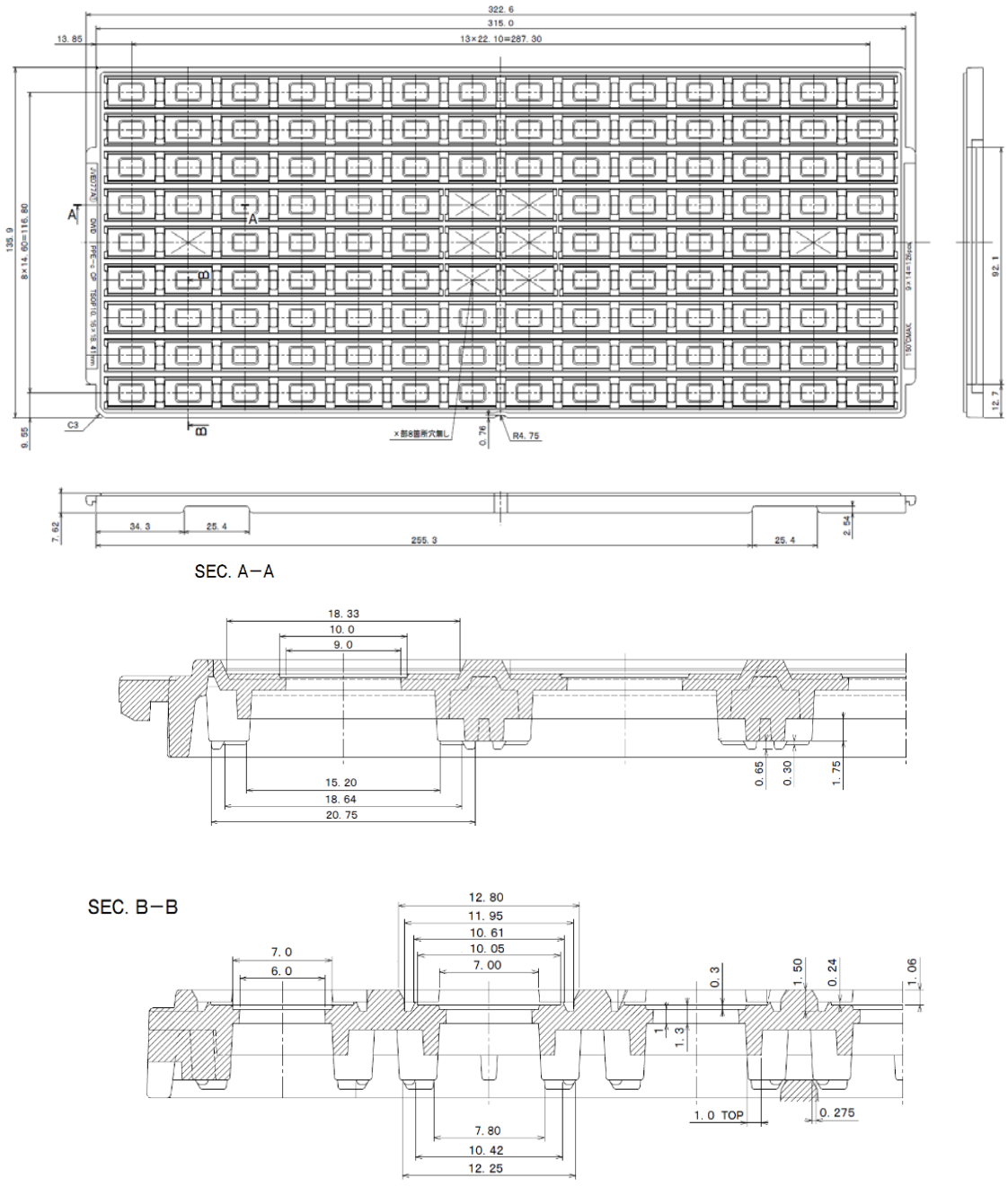
■ PACKING

MS85R4M2TAFN-G-JAE2

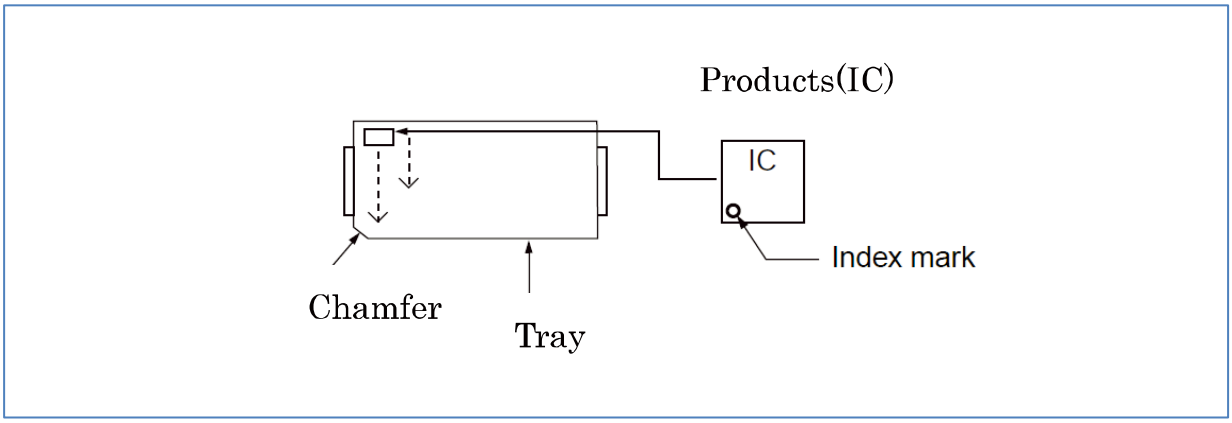
1.1 Tray dimensions

Maximum storage capacity		
pcs/tray	pcs/inner box	pcs/outer box
126	1260 (10trays)	5040 (4 inner boxes, Max)

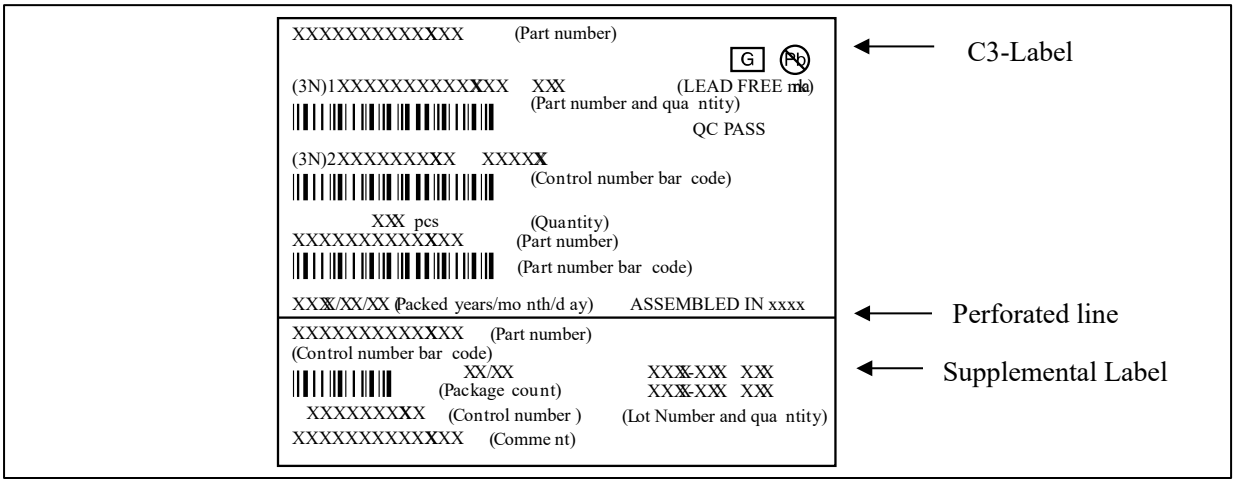
TSOP44



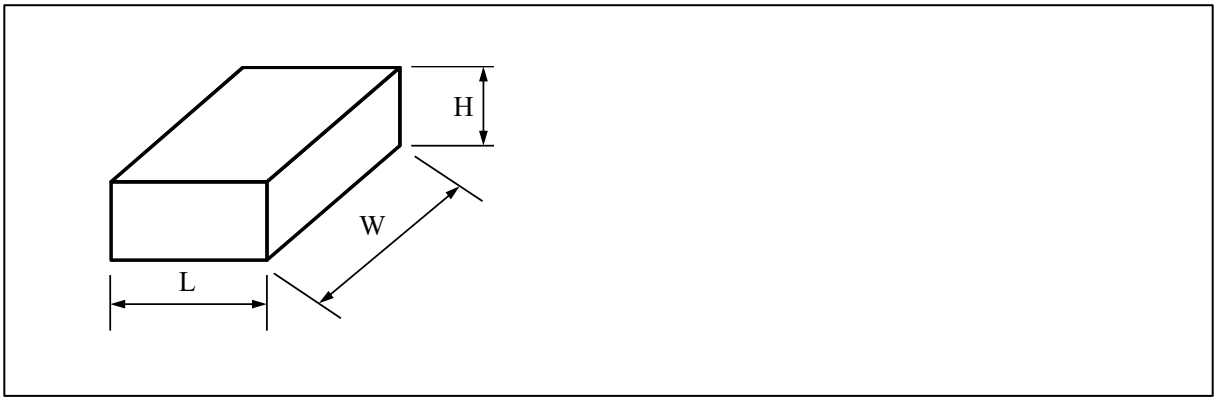
1.2 IC orientation



1.3 Product label indicators
Label I: Label on Inner box/Moisture Barrier Bag/ (It sticks it on the reel for the emboss taping)
[C-3 Label (50mm x 100mm) Supplemental Label (20mm x 100mm)]



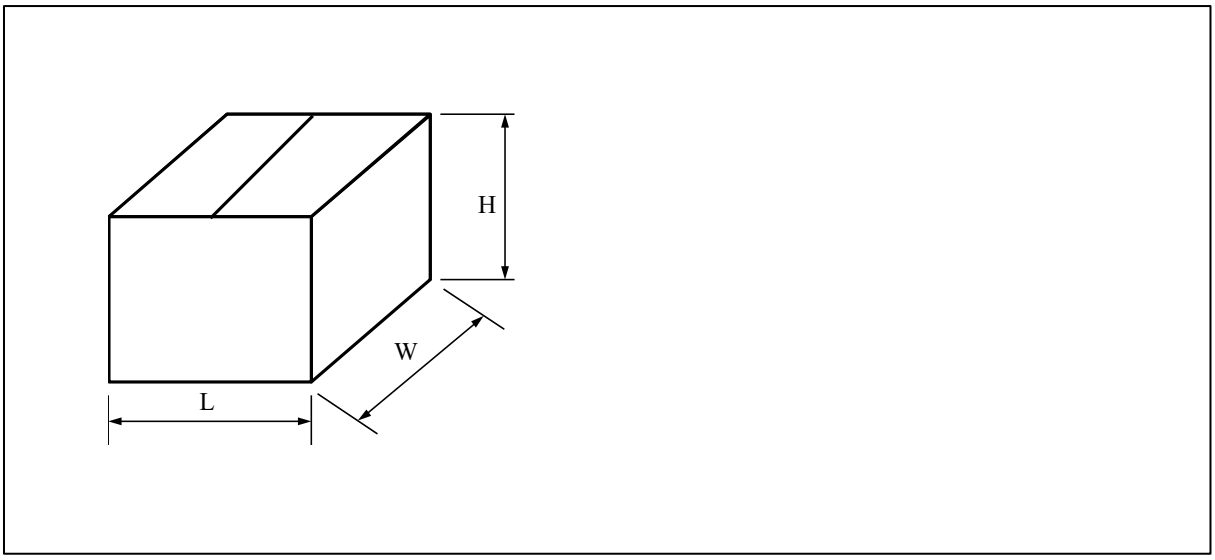
1.4 Dimensions for container
(1) Dimensions for inner box



L	W	H
162	360	90

(Dimensions in mm)

(2) Dimensions for outer box



L	W	H
410	375	225

(Dimensions in mm)

■ MAJOR CHANGES IN THIS EDITION

A change on a page is indicated by a vertical line drawn on the left side of that page.

Page	Section	Change Results
P.1,17	Read/write endurance	10^{14} times/64bits → 10^{14} times(+85℃)

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