NEC

MOS INTEGRATED CIRCUIT
μPD444012L-X

4M-BIT CMOS STATIC RAM
256K-WORD BY 16-BIT
EXTENDED TEMPERATURE OPERATION

Description

The μPD444012L-X is a high speed, low power, 4,194,304 bits (262,144 words by 16 bits) CMOS static RAM.

The μPD444012L-X has two chip enable pins (/CE1, CE2) to extend the capacity.

★ The μPD444012L-X is packed in 48-pin plastic TSOP (I) (Normal bent).

Features

- 262,144 words by 16 bits organization
- Fast access time: 70, 85, 100, 120, 150, 200 ns (MAX.)
- Byte data control: /LB (I/O1 - I/O8), /UB (I/O9 - I/O16)
- Low voltage operation
  (B version: V_{CC} = 2.7 to 3.6 V, C version: V_{CC} = 2.2 to 3.6 V, D version: V_{CC} = 1.8 to 3.6 V)
- Low V_{CC} data retention
  (B version: 2.0 V (MIN.), C version: 1.5 V (MIN.), D version: 1.5 V (MIN.))
- Operating ambient temperature: T_A = –25 to +85 °C
- Output Enable input for easy application
- Two Chip Enable inputs: /CE1, CE2

Part number	Access time ns (MAX.)	Operating supply voltage V	Operating ambient temperature °C	Supply current		
				At operating mA (MAX.)	At standby μA (MAX.)	At data retention μA (MAX.)
μPD444012L-BxxX	70, 85	2.7 to 3.6	–25 to +85	40	7	7
μPD444012L-CxxX	100, 120	2.2 to 3.6				
μPD444012L-DxxX Note	150, 200	1.8 to 3.6				

Note Under development

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Printed in Japan

The mark ★ shows major revised points.

★ Ordering Information

Part number	Package	Access time ns (MAX.)	Operating supply voltage V	Operating temperature °C	Remark
μPD444012LGY-B70X-MJH	48-PIN PLASTIC TSOP (I) (12×18) (Normal bent)	70	2.7 to 3.6	–25 to +85	B version
μPD444012LGY-B85X-MJH		85			
μPD444012LGY-C10X-MJH		100	2.2 to 3.6		C version
μPD444012LGY-C12X-MJH		120			
μPD444012LGY-D15X-MJH Note		150	1.8 to 3.6		D version
μPD444012LGY-D20X-MJH Note		200			

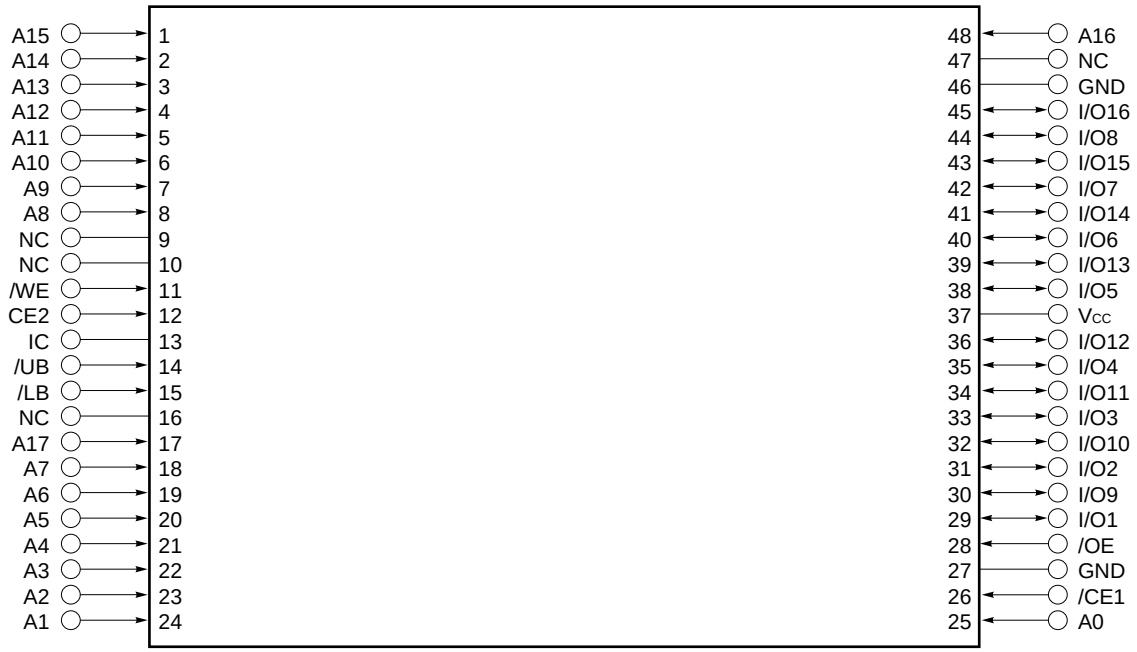
Note Under development

★ Pin Configuration (Marking Side)

/xxx indicates active low signal.

48-PIN PLASTIC TSOP (I) (12×18) (Normal bent)

[μPD444012LGY-BxxX-MJH]
[μPD444012LGY-CxxX-MJH]
[μPD444012LGY-DxxX-MJH]

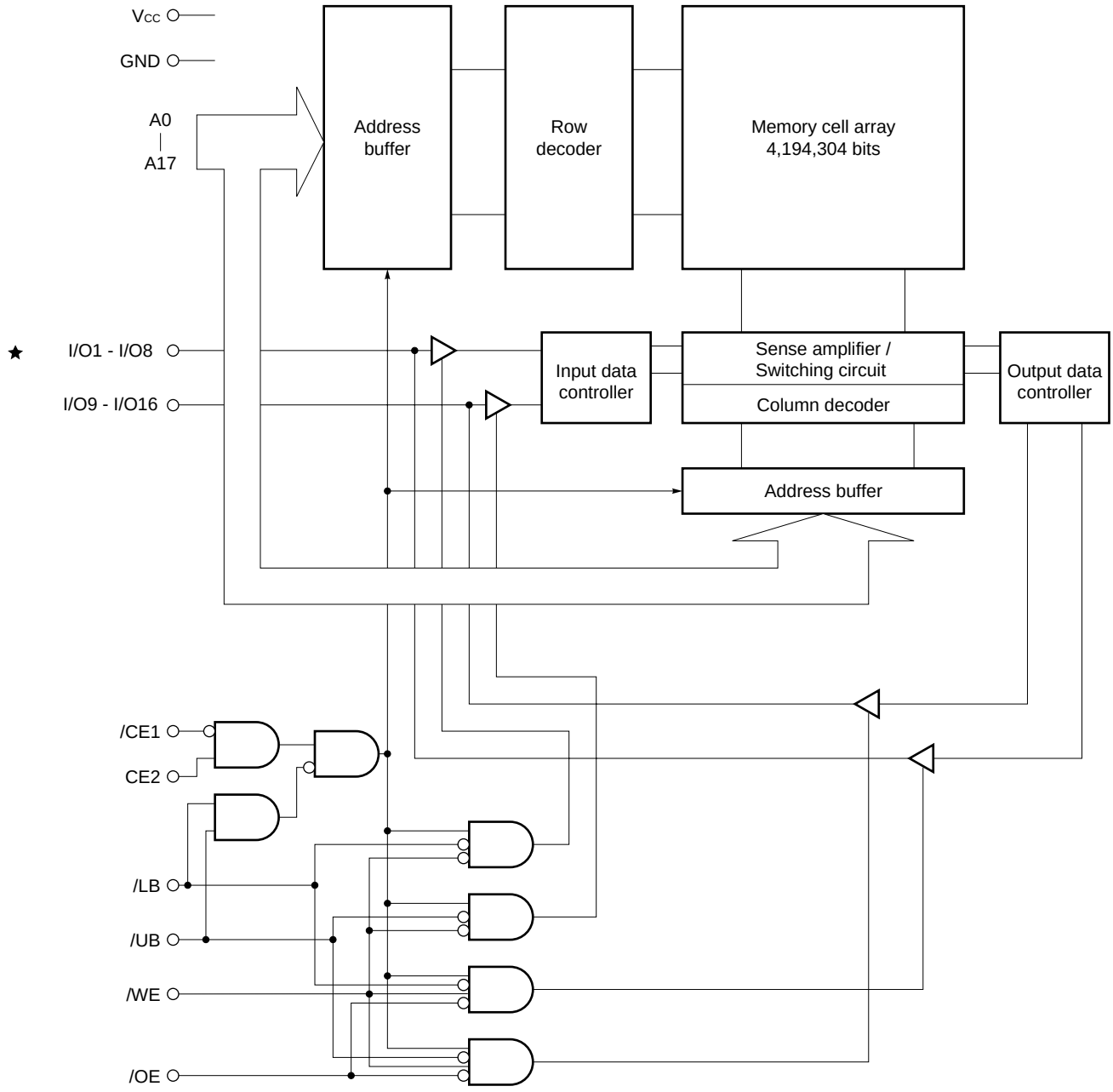


A0 - A17	:	Address inputs
I/O1 - I/O16	:	Data inputs / outputs
/CE1, CE2	:	Chip Enable 1, 2
/WE	:	Write Enable
/OE	:	Output Enable
/LB, /UB	:	Byte data select
V_{CC}	:	Power supply
GND	:	Ground
NC	:	No Connection
IC [Note]	:	Internal Connection

Note Leave this pin unconnected or connect to GND.

Remark Refer to **Package Drawing** for the 1-pin index mark.

Block Diagram



Truth Table

/CE1	CE2	/OE	/WE	/LB	/UB	Mode	I/O		Supply current
							I/O1 - I/O8	I/O9 - I/O16	
H	×	×	×	×	×	Not selected	High impedance	High impedance	I_{SB}
×	L	×	×	×	×				
L	H	H	H	×	×	Output disable	High impedance	High impedance	I_{CCA}
		L	H	L	L	Word read	D_{OUT}	D_{OUT}	
				L	H	Lower byte read	D_{OUT}	High impedance	
				H	L	Upper byte read	High impedance	D_{OUT}	
		×	L	L	L	Word write	D_{IN}	D_{IN}	
				L	H	Lower byte write	D_{IN}	High impedance	
				H	L	Upper byte write	High impedance	D_{IN}	
★ ×	×	×	×	H	H	Not selected	High impedance	High impedance	I_{SB}

Remark × : V_{IH} or V_{IL}

Electrical Specifications

Absolute Maximum Ratings

Parameter	Symbol	Product	Rating	Unit
Supply voltage	V_{CC}		–0.5 Note to +4.0	V
Input / Output voltage	V_T		–0.5 Note to V_{CC} + 0.4 (4.0 V MAX.)	V
Operating ambient temperature	T_A		–25 to +85	°C
Storage temperature	T_{stg}		–55 to +125	°C

Note –3.0 V (MIN.) (Pulse width : 30 ns)

Caution Exposing the device to stress above those listed in Absolute Maximum Rating could cause permanent damage. The device is not meant to be operated under conditions outside the limits described in the operational section of this specification. Exposure to Absolute Maximum Rating conditions for extended periods may affect device reliability.

Recommended Operating Conditions

Parameter	Symbol	Condition	μPD444012L-BxxX		μPD444012L-CxxX		μPD444012L-DxxX		Unit
			MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	
Supply voltage	V_{CC}		2.7	3.6	2.2	3.6	1.8	3.6	V
High level input voltage	V_{IH}	2.7 V ≤ V_{CC} ≤ 3.6 V	2.4	V_{CC} + 0.4	2.4	V_{CC} + 0.4	2.4	V_{CC} + 0.4	V
		2.2 V ≤ V_{CC} < 2.7 V	–	–	2.0	V_{CC} + 0.3	2.0	V_{CC} + 0.3	
		1.8 V ≤ V_{CC} < 2.2 V	–	–	–	–	1.6	V_{CC} + 0.2	
Low level input voltage	V_{IL}		–0.3 Note	+0.5	–0.3 Note	+0.3	–0.3 Note	+0.2	V
Operating ambient temperature	T_A		–25	+85	–25	+85	–25	+85	°C

Note –1.5 V (MIN.) (Pulse width: 30 ns)

Capacitance (T_A = 25 °C, f = 1 MHz)

Parameter	Symbol	Test condition	MIN.	TYP.	MAX.	Unit
Input capacitance	C_{IN}	V_{IN} = 0 V			8	pF
Input / Output capacitance	$C_{I/O}$	$V_{I/O}$ = 0 V			10	pF

Remarks 1. V_{IN} : Input voltage

$V_{I/O}$: Input / Output voltage

2. These parameters are periodically sampled and not 100% tested.

DC Characteristics (Recommended Operating Conditions Unless Otherwise Noted)

Parameter	Symbol	Test condition		$V_{CC} \geq 2.7$ V			$V_{CC} \geq 2.2$ V			$V_{CC} \geq 1.8$ V			Unit
				μPD444012L-BxxX			μPD444012L-CxxX			μPD444012L-DxxX			
				MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	
Input leakage current	I_{LI}	V_{IN} = 0 V to V_{CC}		–1.0		+1.0	–1.0		+1.0	–1.0		+1.0	μA
I/O leakage current	I_{LO}	$V_{I/O}$ = 0 V to V_{CC}, /CE1 = V_{IH} or CE2 = V_{IL} or /WE = V_{IL} or /OE = V_{IH}		–1.0		+1.0	–1.0		+1.0	–1.0		+1.0	μA
Operating supply current	I_{CCA1}	/CE1 = V_{IL}, CE2 = V_{IH},			–	40		–	40		–	40	mA
		Minimum cycle time, $I_{I/O}$ = 0 mA	$V_{CC} \leq 2.7$ V		–	–		–	38		–	38	
			$V_{CC} \leq 2.2$ V		–	–		–	–		–	35	
	I_{CCA2}	/CE1 = V_{IL}, CE2 = V_{IH},			–	10		–	10		–	10	
		$I_{I/O}$ = 0 mA	$V_{CC} \leq 2.7$ V		–	–		–	8		–	8	
			$V_{CC} \leq 2.2$ V		–	–		–	–		–	6	
	I_{CCA3}	/CE1 ≤ 0.2 V, CE2 ≥ V_{CC} – 0.2 V, Cycle = 1 MHz, $I_{I/O}$ = 0 mA,			–	8		–	8		–	8	
		$V_{IL} \leq 0.2$ V,	$V_{CC} \leq 2.7$ V		–	–		–	6		–	6	
		$V_{IH} \geq V_{CC}$ – 0.2 V	$V_{CC} \leq 2.2$ V		–	–		–	–		–	6	
Standby supply current	I_{SB}	/CE1 = V_{IH} or CE2 = V_{IL} or			–	0.6		–	0.6		–	0.6	mA
		/LB = /UB = V_{IH},	$V_{CC} \leq 2.7$ V		–	–		–	0.6		–	0.6	
		/CE1, CE2 = V_{IH} or V_{IL}	$V_{CC} \leq 2.2$ V		–	–		–	–		–	0.6	
	I_{SB1}	/CE1 ≥ V_{CC} – 0.2 V,			0.5	7		0.5	7		0.5	7	μA
		CE2 ≥ V_{CC} – 0.2 V	$V_{CC} \leq 2.7$ V		–	–		0.4	6		0.4	6	
			$V_{CC} \leq 2.2$ V		–	–		–	–		0.3	5	
	I_{SB2}	CE2 ≤ 0.2 V			0.5	7		0.5	7		0.5	7	
			$V_{CC} \leq 2.7$ V		–	–		0.4	6		0.4	6	
			$V_{CC} \leq 2.2$ V		–	–		–	–		0.3	5	
	I_{SB3}	/LB = /UB ≥ V_{CC} – 0.2 V,			0.5	7		0.5	7		0.5	7	
		/CE1 ≤ 0.2 V,	$V_{CC} \leq 2.7$ V		–	–		0.4	6		0.4	6	
		CE2 ≥ V_{CC} – 0.2 V	$V_{CC} \leq 2.2$ V		–	–		–	–		0.3	5	
High level output voltage	V_{OH}	I_{OH} = –0.5 mA		2.4			2.4			2.4			V
			$V_{CC} \leq 2.7$ V	–			1.8			1.8			
			$V_{CC} \leq 2.2$ V	–			–			1.5			
Low level output voltage	V_{OL}	I_{OL} = 1.0 mA				0.4			0.4			0.4	V

Remarks 1. V_{IN} : Input voltage

$V_{I/O}$: Input / Output voltage

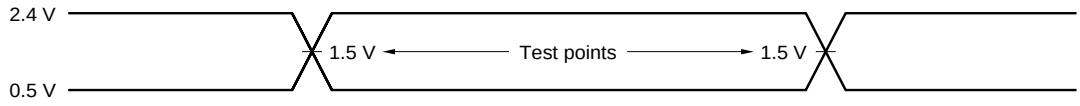
2. These DC characteristics are in common regardless of access time.

AC Characteristics (Recommended Operating Conditions Unless Otherwise Noted)

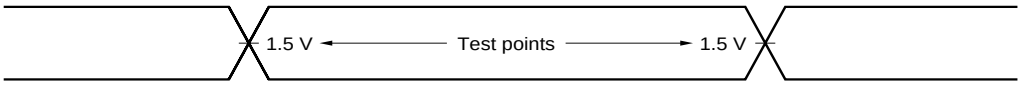
AC Test Conditions

[μPD444012L-B70X, μPD444012L-B85X]

Input Waveform (Rise and Fall Time ≤ 5 ns)



Output Waveform

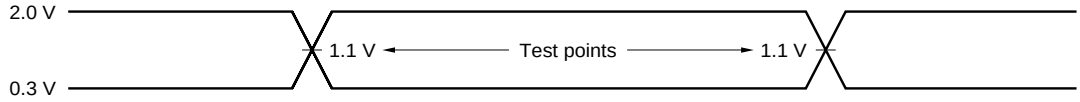


Output Load

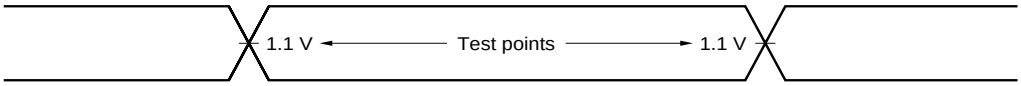
1TTL + 50 pF

[μPD444012L-C10X, μPD444012L-C12X]

Input Waveform (Rise and Fall Time ≤ 5 ns)



Output Waveform

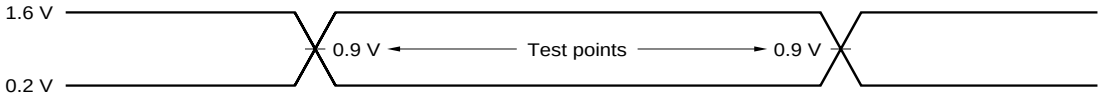


Output Load

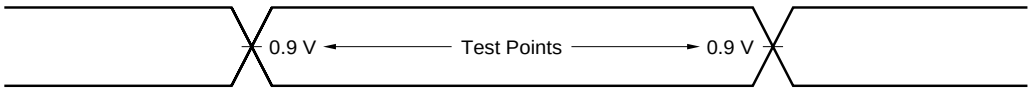
1TTL + 30 pF

[μPD444012L-D15X, μPD444012L-D20X]

Input Waveform (Rise and Fall Time ≤ 5 ns)



Output Waveform



Output Load

1TTL + 30 pF

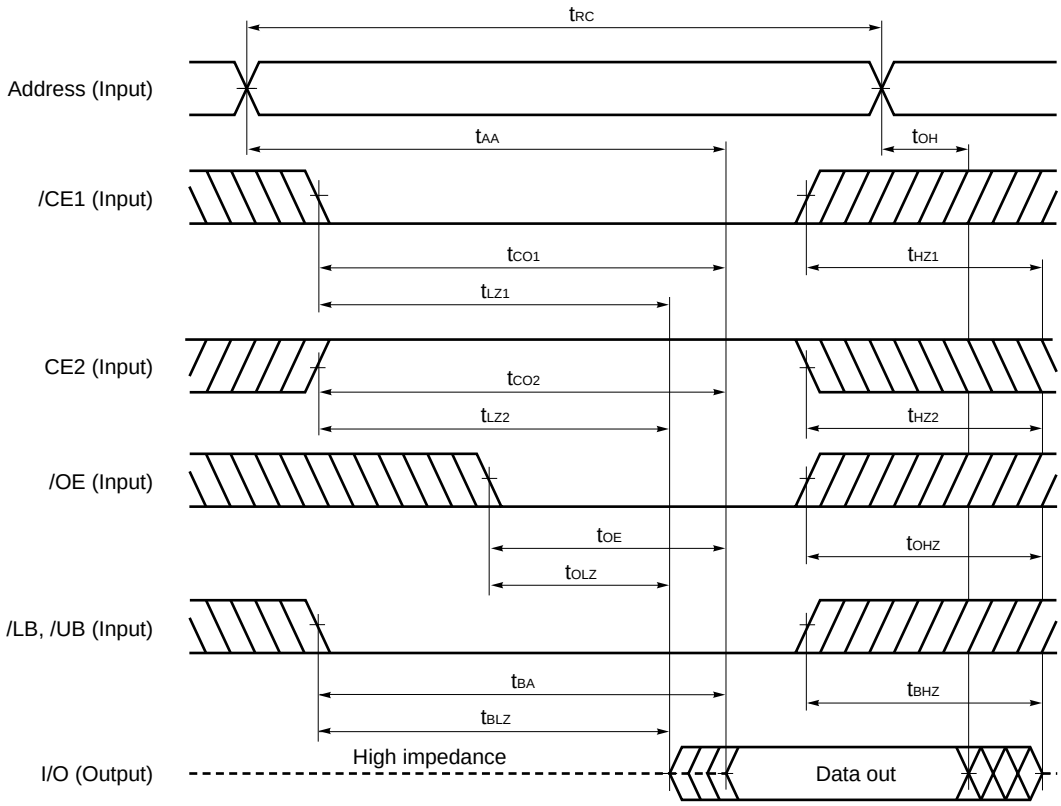
Read Cycle

Parameter	Symbol	$V_{CC} \geq 2.7$ V				$V_{CC} \geq 2.2$ V				$V_{CC} \geq 1.8$ V				Unit	Condition
		μPD444012L-B70X		μPD444012L-B85X		μPD444012L-C10X		μPD444012L-C12X		μPD444012L-D15X		μPD444012L-D20X			
		MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.		
Read cycle time	t_{RC}	70		85		100		120		150		200		ns	
Address access time	t_{AA}		70		85		100		120		150		200	ns	**Note 1**
/CE1 access time	t_{CO1}		70		85		100		120		150		200	ns	
CE2 access time	t_{CO2}		70		85		100		120		150		200	ns	
/OE to output valid	t_{OE}		35		40		50		60		70		100	ns	
/LB, /UB to output valid	t_{BA}		70		85		100		120		150		200	ns	
Output hold from address change	t_{OH}	10		10		10		10		10		10		ns	
/CE1 to output in low impedance	t_{LZ1}	10		10		10		10		10		10		ns	**Note 2**
CE2 to output in low impedance	t_{LZ2}	10		10		10		10		10		10		ns	
/OE to output in low impedance	t_{OLZ}	5		5		5		5		5		5		ns	
/LB, /UB to output in low impedance	t_{BLZ}	10		10		10		10		10		10		ns	
/CE1 to output in high impedance	t_{HZ1}		25		30		35		40		50		70	ns	
CE2 to output in high impedance	t_{HZ2}		25		30		35		40		50		70	ns	
/OE to output in high impedance	t_{OHZ}		25		30		35		40		50		70	ns	
/LB, /UB to output in high impedance	t_{BHZ}		25		30		35		40		50		70	ns	

Notes 1. The output load is 1TTL + 50 pF (μPD444012L-BxxX) or 1TTL + 30 pF (μPD444012L-CxxX, -DxxX).

2. The output load is 1TTL + 5 pF.

Read Cycle Timing Chart



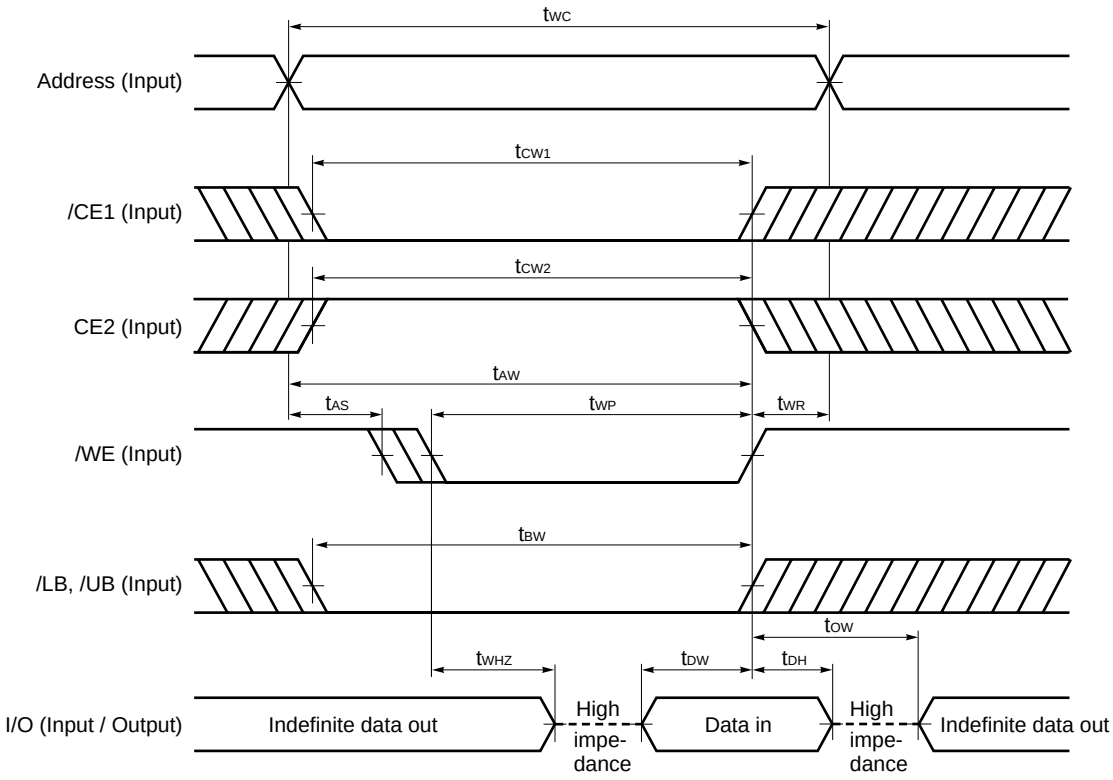
Remark In read cycle, /WE should be fixed to high level.

Write Cycle

Parameter	Symbol	$V_{CC} \geq 2.7$ V				$V_{CC} \geq 2.2$ V				$V_{CC} \geq 1.8$ V				Unit	Condition
		μPD444012L-B70X		μPD444012L-B85X		μPD444012L-C10X		μPD444012L-C12X		μPD444012L-D15X		μPD444012L-D20X			
		MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.		
Write cycle time	t_{WC}	70		85		100		120		150		200		ns	
/CE1 to end of write	t_{CW1}	55		70		80		100		120		160		ns	
CE2 to end of write	t_{CW2}	55		70		80		100		120		160		ns	
/LB, /UB to end of write	t_{BW}	55		70		80		100		120		160		ns	
Address valid to end of write	t_{AW}	55		70		80		100		120		160		ns	
Address setup time	t_{AS}	0		0		0		0		0		0		ns	
Write pulse width	t_{WP}	50		55		60		85		100		140		ns	
Write recovery time	t_{WR}	0		0		0		0		0		0		ns	
Data valid to end of write	t_{DW}	30		35		40		60		80		100		ns	
Data hold time	t_{DH}	0		0		0		0		0		0		ns	
/WE to output in high impedance	t_{WHZ}		25		30		35		40		50		70	ns	**Note**
Output active from end of write	t_{OW}	5		5		5		5		5		5		ns	

Note The output load is 1TTL + 5 pF.

Write Cycle Timing Chart 1 (/WE Controlled)



Cautions 1. During address transition, at least one of pins /CE1, CE2, /WE should be inactivated.

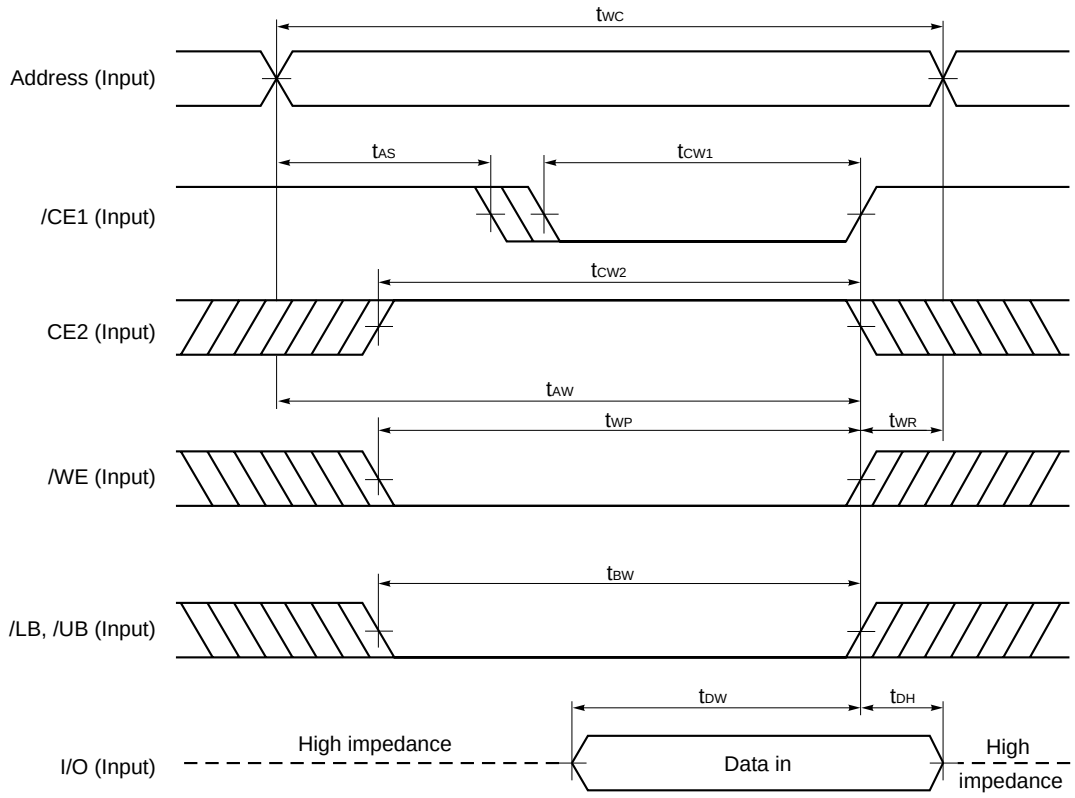
★ **2. Do not input data to the I/O pins while they are in the output state.**

Remarks 1. Write operation is done during the overlap time of a low level /CE1, /WE, /LB and/or /UB, and a high level CE2.

2. If /CE1 changes to low level at the same time or after the change of /WE to low level, or if CE2 changes to high level at the same time or after the change of /WE to low level, the I/O pins will remain high impedance state.

3. When /WE is at low level, the I/O pins are always high impedance. When /WE is at high level, read operation is executed. Therefore /OE should be at high level to make the I/O pins high impedance.

Write Cycle Timing Chart 2 (/CE1 Controlled)

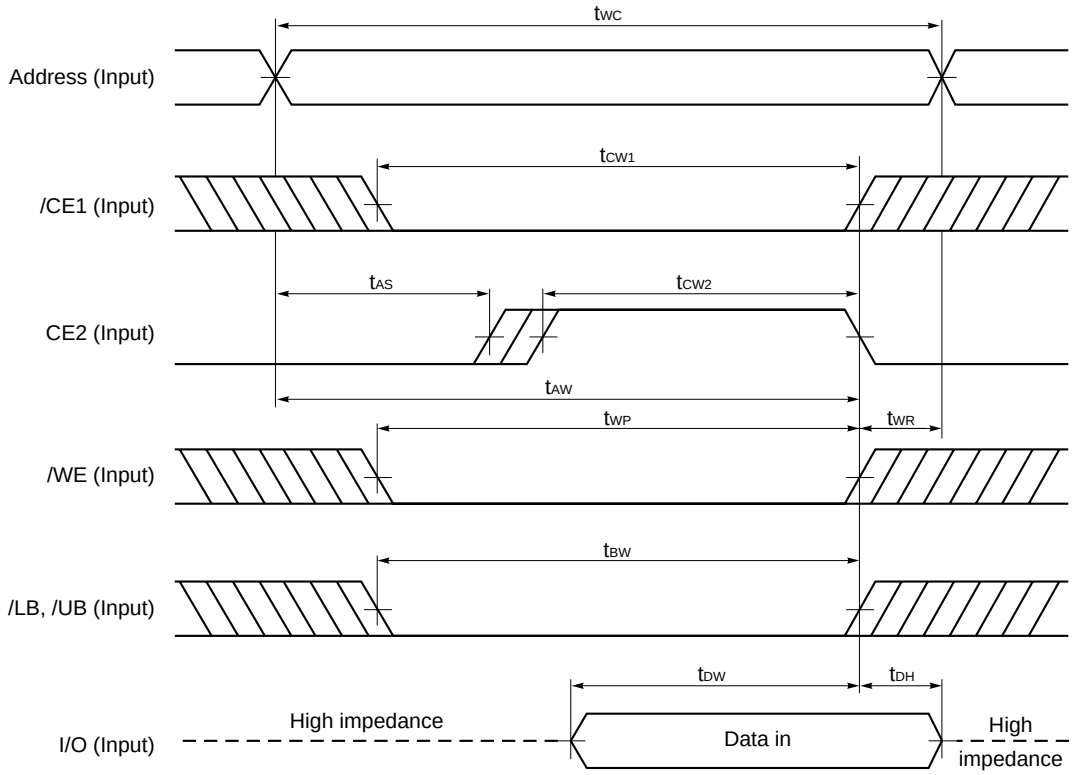


Cautions 1. During address transition, at least one of pins /CE1, CE2, /WE should be inactivated.

★ **2. Do not input data to the I/O pins while they are in the output state.**

Remark Write operation is done during the overlap time of a low level /CE1, /WE, /LB and/or /UB, and a high level CE2.

Write Cycle Timing Chart 3 (CE2 Controlled)

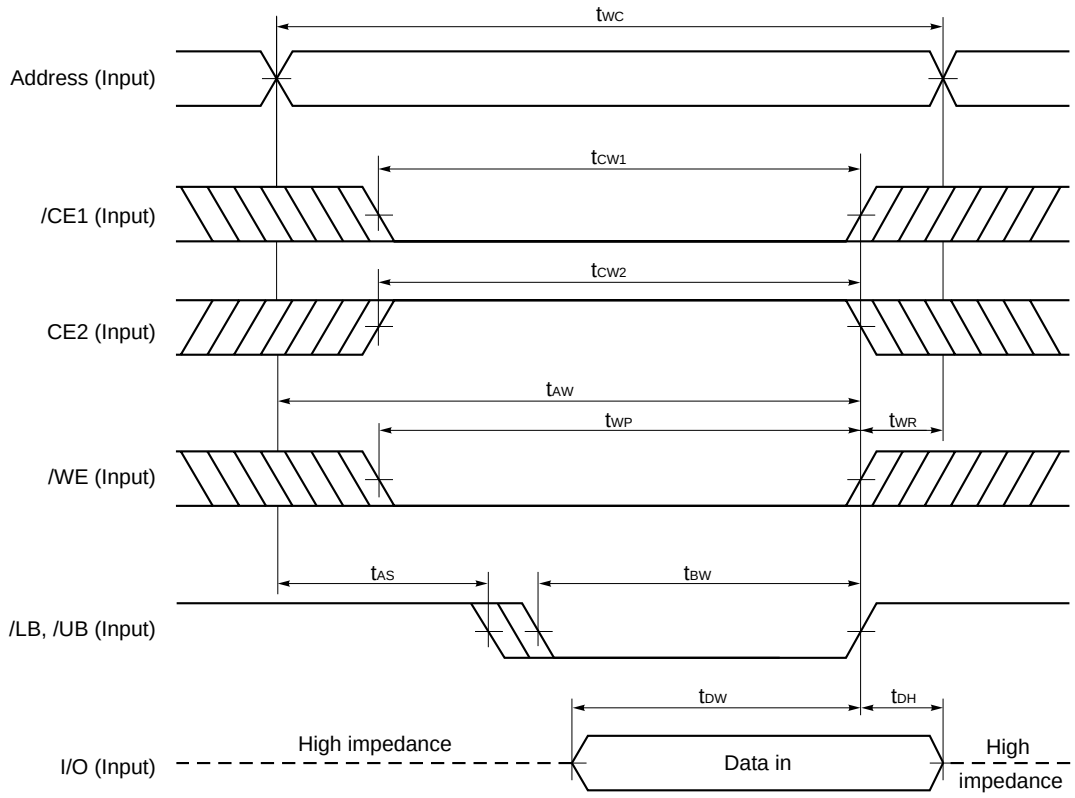


Cautions 1. During address transition, at least one of pins /CE1, CE2, /WE should be inactivated.

★ **2. Do not input data to the I/O pins while they are in the output state.**

Remark Write operation is done during the overlap time of a low level /CE1, /WE, /LB and/or /UB, and a high level CE2.

Write Cycle Timing Chart 4 (/LB, /UB Controlled)



Cautions 1. During address transition, at least one of pins /CE1, CE2, /WE should be inactivated.

★ **2. Do not input data to the I/O pins while they are in the output state.**

Remark Write operation is done during the overlap time of a low level /CE1, /WE, /LB and/or /UB, and a high level CE2.

Low V_{CC} Data Retention Characteristics (T_A = –25 to +85 °C)

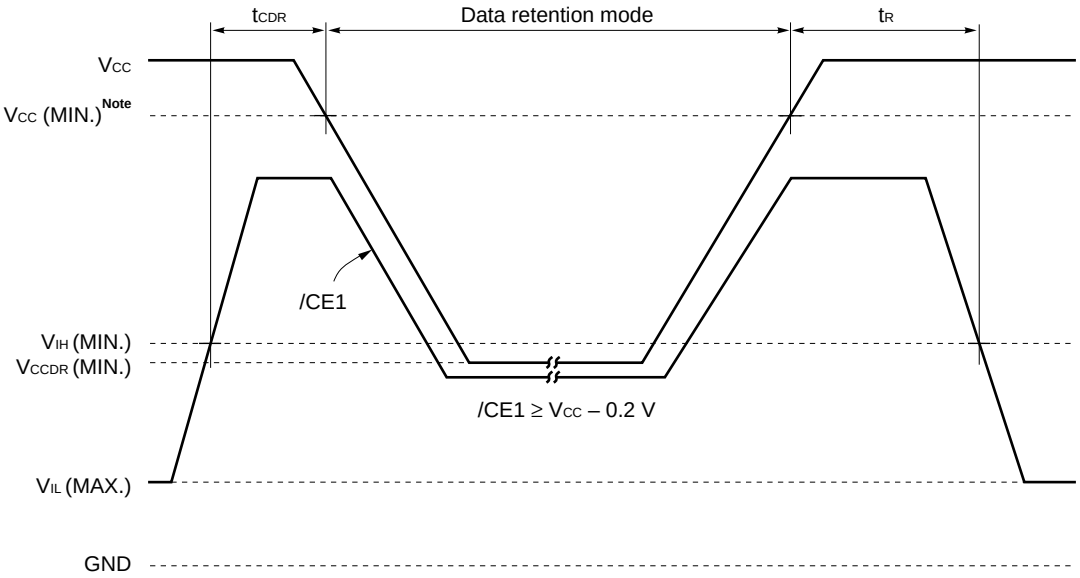
Parameter	Symbol	Test Condition	V_{CC} ≥ 2.7 V			V_{CC} ≥ 2.2 V			V_{CC} ≥ 1.8 V			Unit
			μPD444012L -B××X			μPD444012L -C××X			μPD444012L -D××X			
			MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	
Data retention supply voltage	V_{CCDR1}	/CE1 ≥ V_{CC} – 0.2 V, CE2 ≥ V_{CC} – 0.2 V	2.0		3.6	1.5		3.6	1.5		3.6	V
	V_{CCDR2}	CE2 ≤ 0.2 V	2.0		3.6	1.5		3.6	1.5		3.6	
	V_{CCDR3}	/LB = /UB ≥ V_{CC} – 0.2 V, /CE1 ≤ 0.2 V, CE2 ≥ V_{CC} – 0.2 V	2.0		3.6	1.5		3.6	1.5		3.6	
Data retention supply current	I_{CCDR1}	V_{CC} = 3.0 V, /CE1 ≥ V_{CC} – 0.2 V, CE2 ≥ V_{CC} – 0.2 V or CE2 ≤ 0.2 V		0.5	7		0.5	7		0.5	7	μA
	I_{CCDR2}	V_{CC} = 3.0 V, CE2 ≤ 0.2 V		0.5	7		0.5	7		0.5	7	
	I_{CCDR3}	V_{CC} = 3.0 V, /LB = /UB ≥ V_{CC} – 0.2 V, /CE1 ≤ 0.2 V, CE2 ≥ V_{CC} – 0.2 V		0.5	7		0.5	7		0.5	7	
Chip deselection to data retention mode	t_{CDR}		0			0			0			ns
Operation recovery time	t_R		t_{RC} Note			t_{RC} Note			t_{RC} Note			ns

Note t_{RC} : Read cycle time

Data Retention Timing Chart

(1) /CE1 Controlled

★

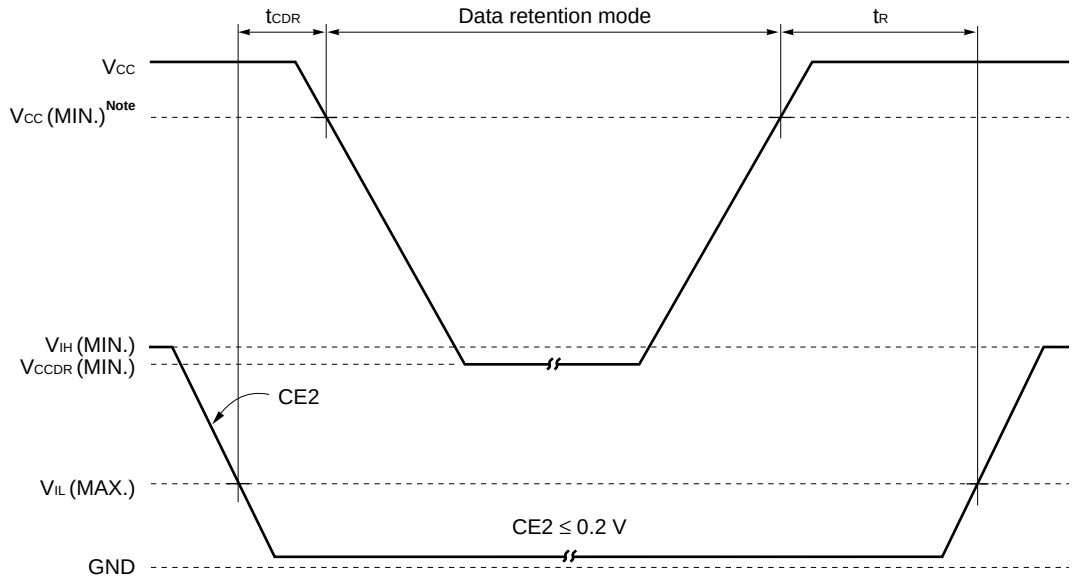


Note B version : 2.7 V, C version : 2.2 V, D version : 1.8 V

Remark On the data retention mode by controlling /CE1, the input level of CE2 must be ≥ V_{CC} – 0.2 V or ≤ 0.2 V. The other pins (Address, I/O, /WE, /OE, /LB, /UB) can be in high impedance state.

(2) CE2 Controlled

★

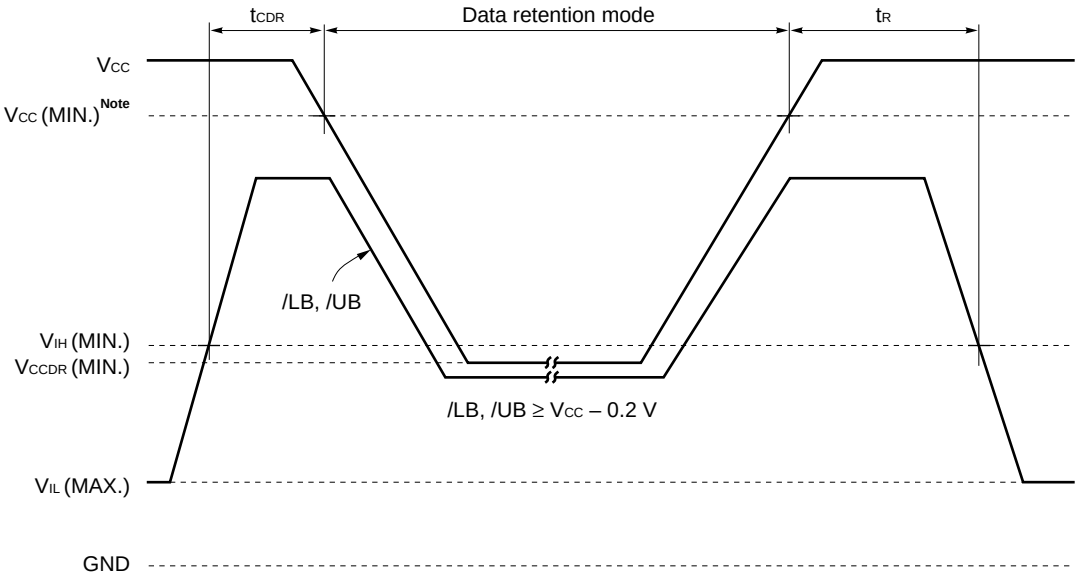


Note B version : 2.7 V, C version : 2.2 V, D version : 1.8 V

Remark On the data retention mode by controlling CE2, the other pins (/CE1, Address, I/O, /WE, /OE, /LB, /UB) can be in high impedance state.

(3) /LB, /UB Controlled

★

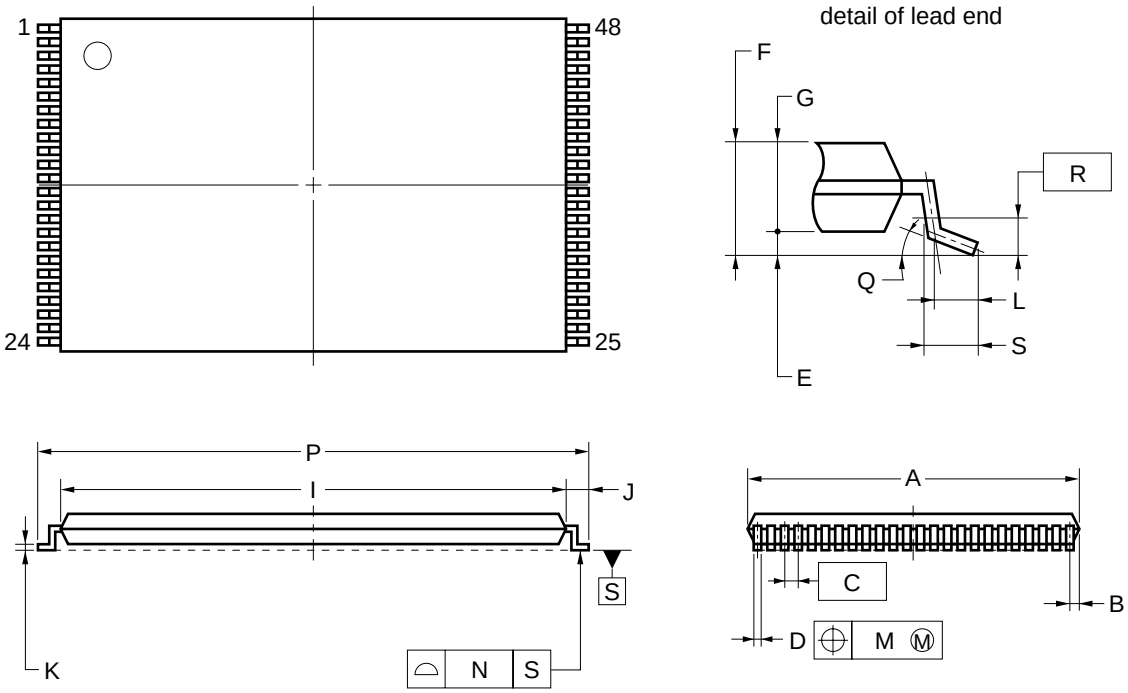


Note B version : 2.7 V, C version : 2.2 V, D version : 1.8 V

Remark On the data retention mode by controlling /LB and /UB, the input level of /CE1 and CE2 must be ≥ V_{CC} – 0.2 V or ≤ 0.2 V. The other pins (Address, I/O, /WE, /OE) can be in high impedance state.

★ **Package Drawing**

48-PIN PLASTIC TSOP(I) (12x18)



NOTES

1. Each lead centerline is located within 0.10 mm of its true position (T.P.) at maximum material condition.
2. "A" excludes mold flash. (Includes mold flash : 12.4 mm MAX.)

ITEM	MILLIMETERS
A	12.0±0.1
B	0.45 MAX.
C	0.5 (T.P.)
D	0.22±0.05
E	0.1±0.05
F	1.2 MAX.
G	1.0±0.05
I	16.4±0.1
J	0.8±0.2
K	0.145±0.05
L	0.5
M	0.10
N	0.10
P	18.0±0.2
Q	$3^{\circ}{}^{+5^{\circ}}_{-3^{\circ}}$
R	0.25
S	0.60±0.15

S48GY-50-MJH1-1

Recommended Soldering Conditions

Please consult with our sales offices for soldering conditions of the μPD444012L-X.

★ Types of Surface Mount Device

μPD444012LGY-BxxX-MJH: 48-PIN PLASTIC TSOP (I) (12×18) (Normal bent)
μPD444012LGY-CxxX-MJH: 48-PIN PLASTIC TSOP (I) (12×18) (Normal bent)
μPD444012LGY-DxxX-MJH: 48-PIN PLASTIC TSOP (I) (12×18) (Normal bent)

[MEMO]

[MEMO]

NOTES FOR CMOS DEVICES

① PRECAUTION AGAINST ESD FOR SEMICONDUCTORS

Note:

Strong electric field, when exposed to a MOS device, can cause destruction of the gate oxide and ultimately degrade the device operation. Steps must be taken to stop generation of static electricity as much as possible, and quickly dissipate it once, when it has occurred. Environmental control must be adequate. When it is dry, humidifier should be used. It is recommended to avoid using insulators that easily build static electricity. Semiconductor devices must be stored and transported in an anti-static container, static shielding bag or conductive material. All test and measurement tools including work bench and floor should be grounded. The operator should be grounded using wrist strap. Semiconductor devices must not be touched with bare hands. Similar precautions need to be taken for PW boards with semiconductor devices on it.

② HANDLING OF UNUSED INPUT PINS FOR CMOS

Note:

No connection for CMOS device inputs can be cause of malfunction. If no connection is provided to the input pins, it is possible that an internal input level may be generated due to noise, etc., hence causing malfunction. CMOS devices behave differently than Bipolar or NMOS devices. Input levels of CMOS devices must be fixed high or low by using a pull-up or pull-down circuitry. Each unused pin should be connected to V_{DD} or GND with a resistor, if it is considered to have a possibility of being an output pin. All handling related to the unused pins must be judged device by device and related specifications governing the devices.

③ STATUS BEFORE INITIALIZATION OF MOS DEVICES

Note:

Power-on does not necessarily define initial status of MOS device. Production process of MOS does not define the initial operation status of the device. Immediately after the power source is turned ON, the devices with reset function have not yet been initialized. Hence, power-on does not guarantee out-pin levels, I/O settings or contents of registers. Device is not initialized until the reset signal is received. Reset operation must be executed immediately after power-on for devices having reset function.

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  "Special": Transportation equipment (automobiles, trains, ships, etc.), traffic control systems, anti-disaster systems, anti-crime systems, safety equipment and medical equipment (not specifically designed for life support)

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