CMOS Digital Integrated Circuits Silicon Monolithic

7UL2G126FK

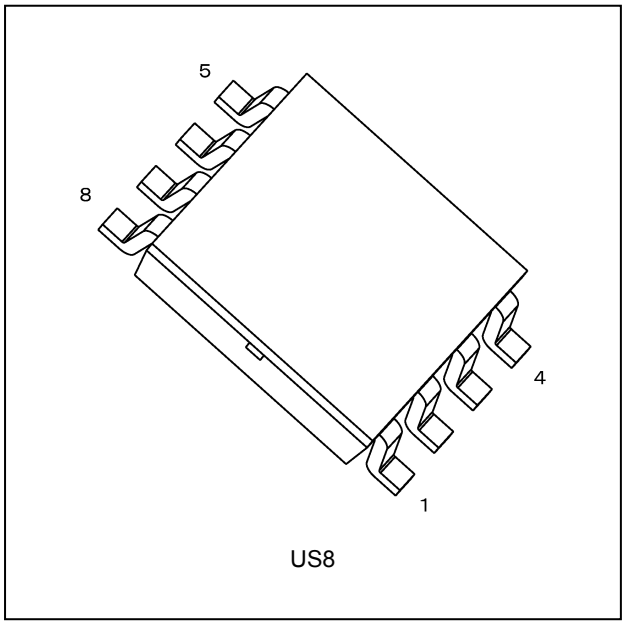
1. Functional Description

- Dual Bus Buffer with 3-State Output

2. Features

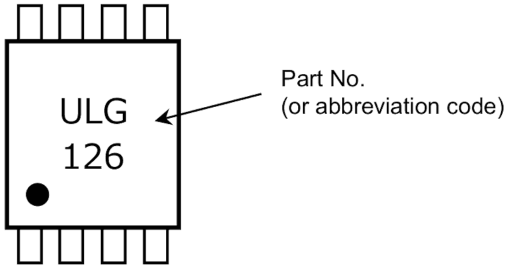
(1) High output current: ±8.0 mA (min) at V_{CC} = 3.0 V
(2) Super high speed operation: t_{pd} = 2.9 ns (typ.) at V_{CC} = 3.3 V, C_L = 15 pF
(3) Operation voltage range: V_{CC} = 0.9 to 3.6 V
(4) 3.6 V tolerant inputs
(5) 3.6 V power down protection output

3. Packaging

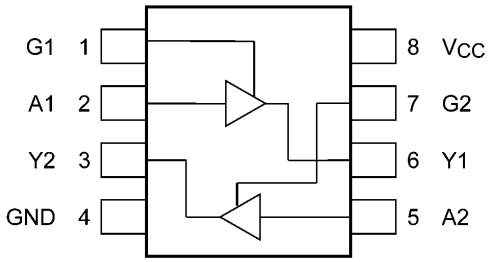


US8

4. Marking and Pin Assignment



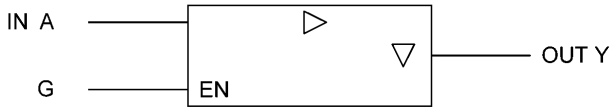
Marking



Pin Assignment (Top view)

Start of commercial production
2020-04

5. IEC Logic Symbol



6. Truth Table

G	A	Y
L	X	Z
H	L	L
H	H	H

X: Don't care
Z: High impedance

7. Absolute Maximum Ratings (Note) (Unless otherwise specified, T_a = 25 °C)

Characteristics	Symbol	Note	Rating	Unit
Supply voltage	V_{CC}		-0.5 to 4.6	V
Input voltage	V_{IN}		-0.5 to 4.6	V
DC output voltage	V_{OUT}	(Note 1)	-0.5 to 4.6	V
		(Note 2)	-0.5 to V_{CC} + 0.5	
Input diode current	I_{IK}		-20	mA
Output diode current	I_{OK}	(Note 3)	-20	mA
DC output current	I_{OUT}		±25	mA
V_{CC}/ground current	I_{CC}		±50	mA
Power dissipation	P_D		200	mW
Storage temperature	T_{stg}		-65 to 150	°C

Note: Exceeding any of the absolute maximum ratings, even briefly, lead to deterioration in IC performance or even destruction.
Using continuously under heavy loads (e.g. the application of high temperature/current/voltage and the significant change in temperature, etc.) may cause this product to decrease in the reliability significantly even if the operating conditions (i.e. operating temperature/current/voltage, etc.) are within the absolute maximum ratings and the operating ranges.
Please design the appropriate reliability upon reviewing the Toshiba Semiconductor Reliability Handbook (“Handling Precautions”/“Derating Concept and Methods”) and individual reliability data (i.e. reliability test report and estimated failure rate, etc).

Note 1: V_{CC} = 0 V or high impedance condition
Note 2: High (H) or Low (L) state. I_{OUT} absolute maximum rating must be observed.
Note 3: V_{OUT} < GND

8. Operating Ranges (Note)

Characteristics	Symbol	Note	Test Condition	Rating	Unit
Supply voltage	V_{CC}		—	0.9 to 3.6	V
Input voltage	V_{IN}		—	0 to 3.6	V
Output voltage	V_{OUT}	(Note 1)	—	0 to 3.6	V
		(Note 2)	—	0 to V_{CC}	
Output current	I_{OH},I_{OL}		V_{CC} = 3.0 to 3.6 V	±8.0	mA
			V_{CC} = 2.3 to 2.7 V	±4.0	
			V_{CC} = 1.65 to 1.95 V	±3.0	
			V_{CC} = 1.4 to 1.6 V	±1.7	
			V_{CC} = 1.1 to 1.3 V	±0.3	
			V_{CC} = 0.9 V	±0.02	
Operating temperature	T_{opr}		—	-40 to 85	°C
Input rise and fall time	dt/dv		V_{IN} = 0.8 to 2.0 V, V_{CC} = 3.0 V	0 to 10	ns/V

Note: The operating ranges must be maintained to ensure the normal operation of the device.
Unused inputs must be tied to either V_{CC} or GND.

Note 1: V_{CC} = 0 V or high impedance condition

Note 2: High (H) or Low (L) state.

9. Electrical Characteristics

9.1. DC Characteristics (Unless otherwise specified, T_a = 25 °C)

Characteristics	Symbol	Test Condition		V_{CC} (V)	Min	Typ.	Max	Unit
High-level input voltage	V_{IH}	—		0.9	V_{CC}	—	—	V
				1.1 to 1.3	V_{CC} × 0.70	—	—	
				1.4 to 1.6	V_{CC} × 0.65	—	—	
				1.65 to 1.95	V_{CC} × 0.65	—	—	
				2.3 to 2.7	1.7	—	—	
				3.0 to 3.6	2.0	—	—	
Low-level input voltage	V_{IL}	—		0.9	—	—	GND	V
				1.1 to 1.3	—	—	V_{CC} × 0.30	
				1.4 to 1.6	—	—	V_{CC} × 0.35	
				1.65 to 1.95	—	—	V_{CC} × 0.35	
				2.3 to 2.7	—	—	0.7	
				3.0 to 3.6	—	—	0.8	
High-level output voltage	V_{OH}	V_{IN} = V_{IH}	I_{OH} = -0.02 mA	0.9	0.75	—	—	V
			I_{OH} = -0.3 mA	1.1 to 1.3	V_{CC} × 0.75	—	—	
			I_{OH} = -1.7 mA	1.4 to 1.6	V_{CC} × 0.75	—	—	
			I_{OH} = -3.0 mA	1.65 to 1.95	V_{CC} -0.45	—	—	
			I_{OH} = -4.0 mA	2.3 to 2.7	2.0	—	—	
			I_{OH} = -8.0 mA	3.0 to 3.6	2.48	—	—	
Low-level output voltage	V_{OL}	V_{IN} = V_{IH} or V_{IL}	I_{OL} = 0.02 mA	0.9	—	—	0.1	V
			I_{OL} = 0.3 mA	1.1 to 1.3	—	—	V_{CC} × 0.25	
			I_{OL} = 1.7 mA	1.4 to 1.6	—	—	V_{CC} × 0.25	
			I_{OL} = 3.0 mA	1.65 to 1.95	—	—	0.45	
			I_{OL} = 4.0 mA	2.3 to 2.7	—	—	0.4	
			I_{OL} = 8.0 mA	3.0 to 3.6	—	—	0.4	
Input leakage current	I_{IN}	V_{IN} = 0 to 3.6 V		0 to 3.6	—	—	±0.1	μA
3-state output OFF-state leakage current	I_{OZ}	V_{IN} = V_{IH} or V_{IL}, V_{OUT} = 0 to 3.6 V		0.9 to 3.6	—	—	±1.0	μA
Power-OFF leakage current	I_{OFF}	V_{IN} = 0 to 3.6 V, V_{OUT} = 0 to 3.6 V		0	—	—	1.0	μA
Quiescent supply current	I_{CC}	V_{IN} = V_{CC} or GND		3.6	—	—	1.0	μA

9.2. DC Characteristics (Unless otherwise specified, T_a = -40 to 85 °C)

Characteristics	Symbol	Test Condition		V_{CC} (V)	Min	Max	Unit
High-level input voltage	V_{IH}	—		0.9	V_{CC}	—	V
				1.1 to 1.3	V_{CC} × 0.70	—	
				1.4 to 1.6	V_{CC} × 0.65	—	
				1.65 to 1.95	V_{CC} × 0.65	—	
				2.3 to 2.7	1.7	—	
				3.0 to 3.6	2.0	—	
Low-level input voltage	V_{IL}	—		0.9	—	GND	V
				1.1 to 1.3	—	V_{CC} × 0.30	
				1.4 to 1.6	—	V_{CC} × 0.35	
				1.65 to 1.95	—	V_{CC} × 0.35	
				2.3 to 2.7	—	0.7	
				3.0 to 3.6	—	0.8	
High-level output voltage	V_{OH}	V_{IN} = V_{IH}	I_{OH} = -0.02 mA	0.9	0.75	—	V
			I_{OH} = -0.3 mA	1.1 to 1.3	V_{CC} × 0.75	—	
			I_{OH} = -1.7 mA	1.4 to 1.6	V_{CC} × 0.75	—	
			I_{OH} = -3.0 mA	1.65 to 1.95	V_{CC} -0.45	—	
			I_{OH} = -4.0 mA	2.3 to 2.7	2.0	—	
			I_{OH} = -8.0 mA	3.0 to 3.6	2.48	—	
Low-level output voltage	V_{OL}	V_{IN} = V_{IH} or V_{IL}	I_{OL} = 0.02 mA	0.9	—	0.1	V
			I_{OL} = 0.3 mA	1.1 to 1.3	—	V_{CC} × 0.25	
			I_{OL} = 1.7 mA	1.4 to 1.6	—	V_{CC} × 0.25	
			I_{OL} = 3.0 mA	1.65 to 1.95	—	0.45	
			I_{OL} = 4.0 mA	2.3 to 2.7	—	0.4	
			I_{OL} = 8.0 mA	3.0 to 3.6	—	0.4	
Input leakage current	I_{IN}	V_{IN} = 0 to 3.6 V		0 to 3.6	—	±0.5	μA
3-state output OFF-state leakage current	I_{OZ}	V_{IN} = V_{IH} or V_{IL}, V_{OUT} = 0 to 3.6 V		0.9 to 3.6	—	±10.0	μA
Power-OFF leakage current	I_{OFF}	V_{IN} = 0 to 3.6 V, V_{OUT} = 0 to 3.6 V		0	—	10.0	μA
Quiescent supply current	I_{CC}	V_{IN} = V_{CC} or GND		3.6	—	10.0	μA

9.3. AC Characteristics (Unless otherwise specified, T_a = 25 °C, Input: $t_r = t_f$ = 3 ns)

Characteristics	Symbol	Note	Test Condition	V_{CC} (V)	C_L (pF)	Min	Typ.	Max	Unit
Propagation delay time	t_{PLH},t_{PHL}		R_L = 1 MΩ	0.9	10	—	20.7	—	ns
				1.1 to 1.3		—	10.5	18.4	
				1.4 to 1.6		—	6.1	8.5	
				1.65 to 1.95		—	4.5	6.2	
				2.3 to 2.7		—	3.0	3.9	
				3.0 to 3.6		—	2.3	3.1	
			R_L = 1 MΩ	0.9	15	—	24.5	—	
				1.1 to 1.3		—	12.7	21.5	
				1.4 to 1.6		—	7.3	10.1	
				1.65 to 1.95		—	5.4	7.3	
				2.3 to 2.7		—	3.5	4.5	
				3.0 to 3.6		—	2.9	3.6	
			R_L = 1 MΩ	0.9	30	—	31.8	—	
				1.1 to 1.3		—	16.3	29.6	
				1.4 to 1.6		—	9.2	13.1	
				1.65 to 1.95		—	6.9	9.3	
				2.3 to 2.7		—	4.7	6.4	
				3.0 to 3.6		—	3.8	4.9	
Output enable time	t_{PZL},t_{PZH}		R_L = 100 kΩ	0.9	10	—	23.9	—	ns
			R_L = 5 kΩ	1.1 to 1.3		—	11.5	20.3	
				1.4 to 1.6		—	6.2	9.5	
				1.65 to 1.95		—	5.1	7.3	
				2.3 to 2.7		—	3.4	4.6	
				3.0 to 3.6		—	2.9	4.0	
			R_L = 100 kΩ	0.9	15	—	25.2	—	
			R_L = 5 kΩ	1.1 to 1.3		—	12.6	21.3	
				1.4 to 1.6		—	7.3	10.5	
				1.65 to 1.95		—	5.5	7.7	
				2.3 to 2.7		—	4.1	5.1	
				3.0 to 3.6		—	3.1	3.9	
			R_L = 100 kΩ	0.9	30	—	31.0	—	
			R_L = 5 kΩ	1.1 to 1.3		—	16.1	30.7	
				1.4 to 1.6		—	9.2	13.1	
				1.65 to 1.95		—	8.7	11.6	
				2.3 to 2.7		—	4.8	6.0	
				3.0 to 3.6		—	3.9	4.7	
Output disable time	t_{PLZ},t_{PHZ}		R_L = 100 kΩ	0.9	10	—	123.5	—	ns
			R_L = 5 kΩ	1.1 to 1.3		—	10.6	16.0	
				1.4 to 1.6		—	6.3	9.1	
				1.65 to 1.95		—	7.3	8.8	
				2.3 to 2.7		—	5.1	6.4	
				3.0 to 3.6		—	5.8	7.9	
			R_L = 100 kΩ	0.9	15	—	172.0	—	
			R_L = 5 kΩ	1.1 to 1.3		—	12.2	16.9	
				1.4 to 1.6		—	7.5	9.8	
				1.65 to 1.95		—	8.3	9.9	
				2.3 to 2.7		—	6.0	9.4	
				3.0 to 3.6		—	7.1	9.5	

Characteristics	Symbol	Note	Test Condition	V_{CC} (V)	C_L (pF)	Min	Typ.	Max	Unit
Output disable time	t_{PLZ},t_{PHZ}		R_L = 100 kΩ	0.9	30	—	266.7	—	ns
			R_L = 5 kΩ	1.1 to 1.3		—	16.9	20.8	
				1.4 to 1.6		—	10.1	13.2	
				1.65 to 1.95		—	12.7	14.6	
				2.3 to 2.7		—	8.6	10.8	
				3.0 to 3.6		—	12.2	14.4	
Input capacitance	C_{IN}		—	3.6	—	—	3	—	pF
Power dissipation capacitance	C_{PD}	(Note 1)	—	0.9 to 3.6	—	—	9	—	pF

Note 1: C_{PD} is defined as the value of the internal equivalent capacitance which is calculated from the operating current consumption without load. Average operating current can be obtained by the equation.

$I_{CC(opr)} = C_{PD} \cdot V_{CC} \cdot f_{IN} + I_{CC}$

9.4. AC Characteristics (Unless otherwise specified, T_a = -40 to 85 °C, Input: $t_r = t_f$ = 3 ns)

Characteristics	Symbol	Test Condition	V_{CC} (V)	C_L (pF)	Min	Max	Unit
Propagation delay time	t_{PLH},t_{PHL}	R_L = 1 MΩ	0.9	10	—	—	ns
			1.1 to 1.3		1.0	34.2	
			1.4 to 1.6		1.0	10.0	
			1.65 to 1.95		1.0	6.8	
			2.3 to 2.7		1.0	4.7	
			3.0 to 3.6		1.0	3.9	
		R_L = 1 MΩ	0.9	15	—	—	
			1.1 to 1.3		1.0	37.2	
			1.4 to 1.6		1.0	11.2	
			1.65 to 1.95		1.0	8.6	
			2.3 to 2.7		1.0	5.8	
			3.0 to 3.6		1.0	4.8	
		R_L = 1 MΩ	0.9	30	—	—	
			1.1 to 1.3		1.0	56.0	
			1.4 to 1.6		1.0	15.9	
			1.65 to 1.95		1.0	10.6	
			2.3 to 2.7		1.0	7.3	
			3.0 to 3.6		1.0	5.9	
Output enable time	t_{PZL},t_{PZH}	R_L = 100 kΩ	0.9	10	—	—	ns
		R_L = 5 kΩ	1.1 to 1.3		1.0	29.8	
			1.4 to 1.6		1.0	11.3	
			1.65 to 1.95		1.0	8.3	
			2.3 to 2.7		1.0	5.6	
			3.0 to 3.6		1.0	4.7	
		R_L = 100 kΩ	0.9	15	—	—	
		R_L = 5 kΩ	1.1 to 1.3		1.0	34.7	
			1.4 to 1.6		1.0	11.4	
			1.65 to 1.95		1.0	8.9	
			2.3 to 2.7		1.0	6.8	
			3.0 to 3.6		1.0	4.9	
		R_L = 100 kΩ	0.9	30	—	—	
		R_L = 5 kΩ	1.1 to 1.3		1.0	50.5	
			1.4 to 1.6		1.0	15.1	
			1.65 to 1.95		1.0	13.8	

Characteristics	Symbol	Test Condition	V_{CC} (V)	C_L (pF)	Min	Max	Unit
Output enable time	t_{PZL},t_{PZH}	R_L = 5 kΩ	2.3 to 2.7	30	1.0	7.6	ns
			3.0 to 3.6		1.0	6.1	
Output disable time	t_{PLZ},t_{PHZ}	R_L = 100 kΩ	0.9	10	—	—	ns
		R_L = 5 kΩ	1.1 to 1.3		1.0	22.4	
			1.4 to 1.6		1.0	10.4	
			1.65 to 1.95		1.0	9.8	
			2.3 to 2.7		1.0	7.2	
			3.0 to 3.6		1.0	9.3	
		R_L = 100 kΩ	0.9	15	—	—	
		R_L = 5 kΩ	1.1 to 1.3		1.0	25.1	
			1.4 to 1.6		1.0	11.3	
			1.65 to 1.95		1.0	11.1	
			2.3 to 2.7		1.0	12.4	
			3.0 to 3.6		1.0	13.2	
		R_L = 100 kΩ	0.9	30	—	—	
		R_L = 5 kΩ	1.1 to 1.3		1.0	31.9	
			1.4 to 1.6		1.0	14.9	
			1.65 to 1.95		1.0	16.6	
			2.3 to 2.7		1.0	12.2	
			3.0 to 3.6		1.0	16.4	

9.5. AC Test Circuit

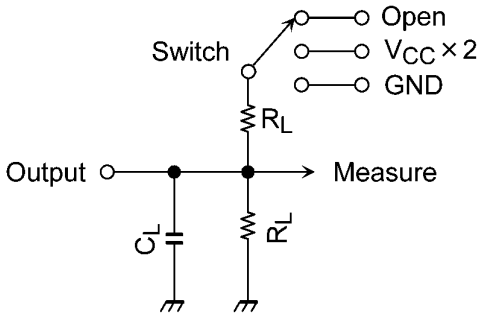


Table 9.5.1 Parameter for AC Test Circuit

Characteristics	Switch
t_{PLH}, t_{PHL}	Open
t_{PLZ}, t_{PZL}	V_{CC} × 2
t_{PHZ}, t_{PZH}	GND

9.6. AC Waveform

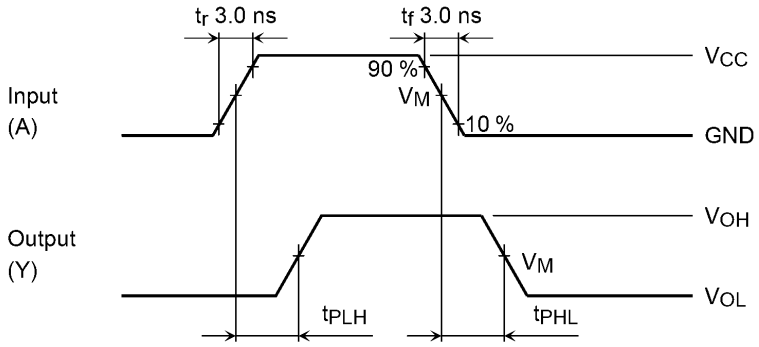


Fig. 9.6.1 t_{PLH}, t_{PHL}

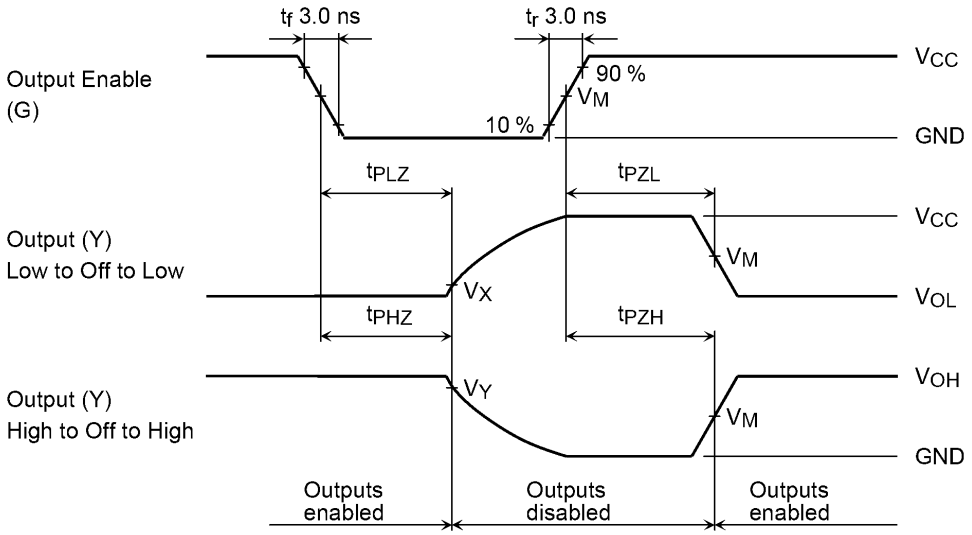


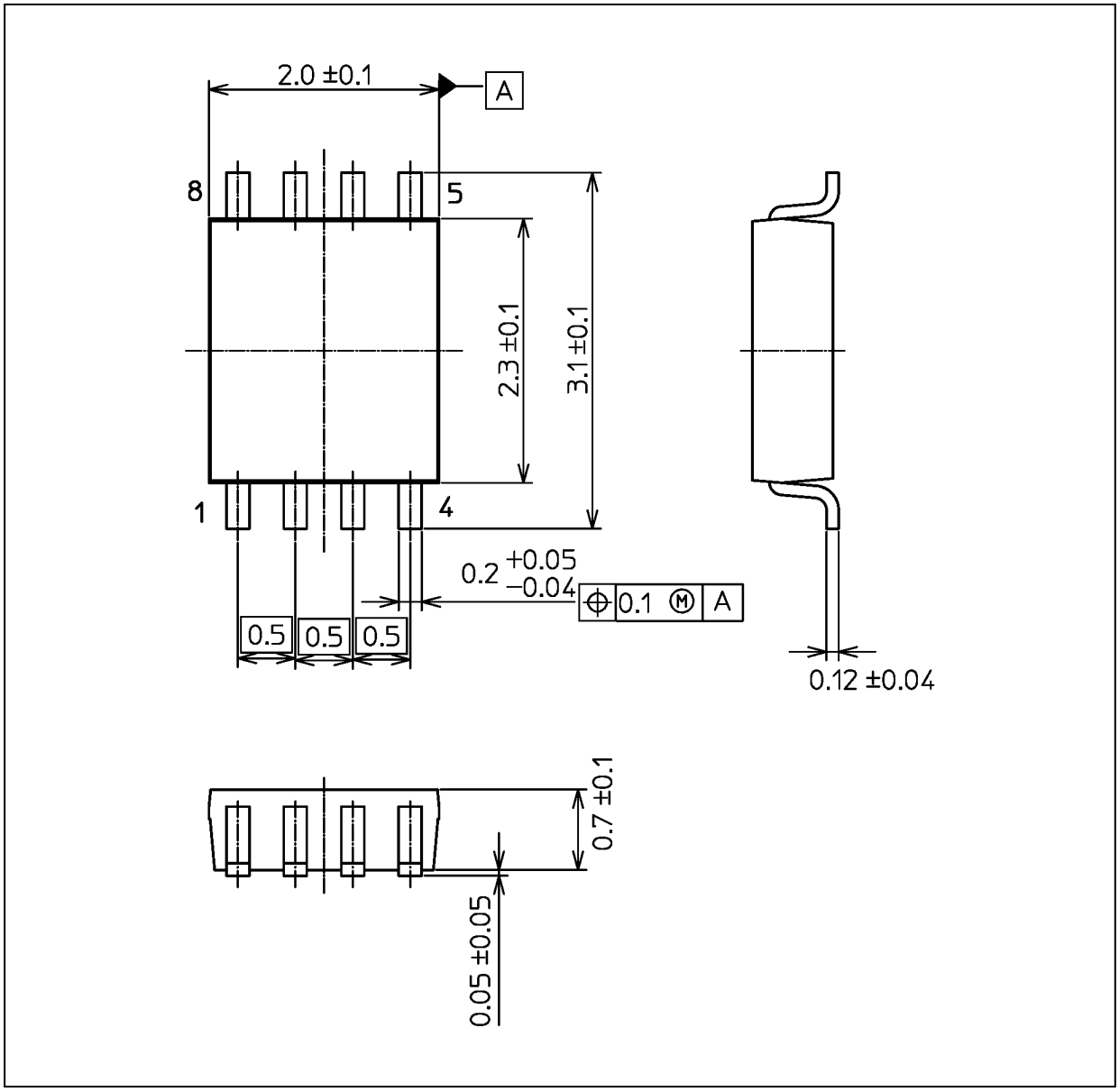
Fig. 9.6.2 t_{PLZ}, t_{PHZ}, t_{PZL}, t_{PZH}

Table 9.6.1 AC Waveform Symbols

Symbol	V_{CC} = 3.3 ± 0.3 V	V_{CC} = 2.5 ± 0.2 V	V_{CC} = 1.8 ± 0.15 V	V_{CC} = 1.5 ± 0.1 V	V_{CC} = 1.2 ± 0.1 V	V_{CC} = 0.9 V
V_M	$V_{CC}/2$	$V_{CC}/2$	$V_{CC}/2$	$V_{CC}/2$	$V_{CC}/2$	$V_{CC}/2$
V_X	V_{OL} + 0.3 V	V_{OL} + 0.15 V	V_{OL} + 0.15 V	V_{OL} + 0.1 V	V_{OL} + 0.1 V	V_{OL} + 0.1 V
V_Y	V_{OH} - 0.3 V	V_{OH} - 0.15 V	V_{OH} - 0.15 V	V_{OH} - 0.1 V	V_{OH} - 0.1 V	V_{OH} - 0.1 V

Package Dimensions

Unit: mm



Weight: 0.01 g (typ.)

Package Name(s)
Nickname: US8

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