CMOS Digital Integrated Circuits Silicon Monolithic

7UL1G07FU

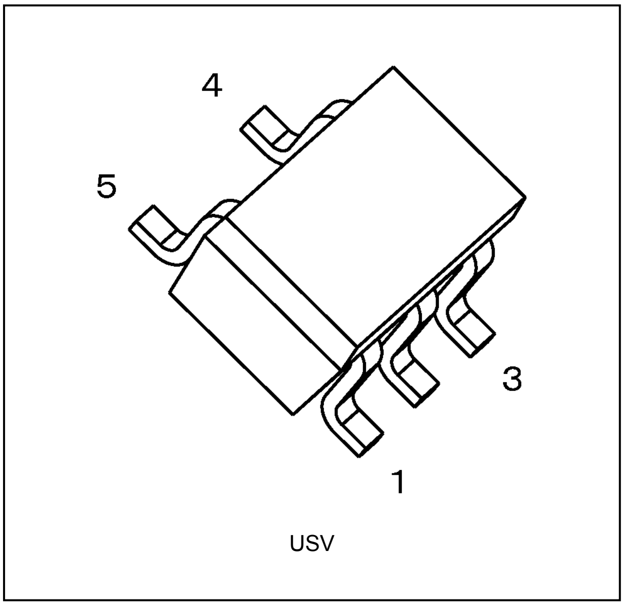
1. Functional Description

- Non-Inverter (Open Drain)

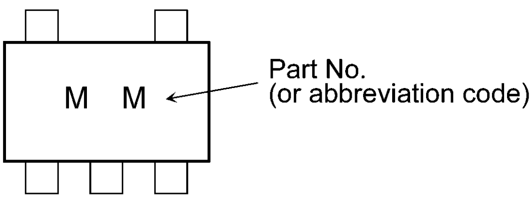
2. Features

(1) Wide operating temperature range: T_{opr} = -40 to 125 °C
(2) High output current: 8.0 mA (min) at V_{CC} = 3.0 V
(3) Super high speed operation: t_{pd} = 2.5 ns (typ.) at V_{CC} = 3.3 V, C_L = 15 pF
(4) Operating voltage range: V_{CC} = 0.9 to 3.6 V
(5) 3.6 V tolerant input
(6) 3.6 V power down protection output

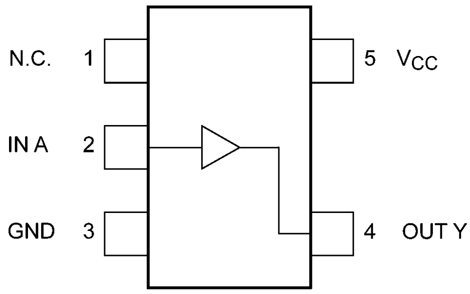
3. Packaging



4. Marking and Pin Assignment



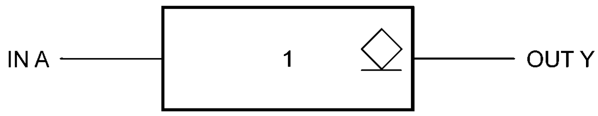
Marking



Pin Assignment (Top view)

Start of commercial production
2020-03

5. IEC Logic Symbol



6. Truth Table

Input A	Input Y
L	L
H	Z

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
Input diode current	I_{IK}		-20	mA
Output diode current	I_{OK}	(Note 2)	-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: When V_{CC} = 0 V or when the output is in the high-impedance state

Note 2: V_{OUT} < GND

8. Operating Ranges (Note)

Characteristics	Symbol	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}	—	0 to 3.6	V
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 125	°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.

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	$V_{CC} \times 0.70$	—	—	
				1.4 to 1.6	$V_{CC} \times 0.65$	—	—	
				1.65 to 1.95	$V_{CC} \times 0.65$	—	—	
				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	—	—	$V_{CC} \times 0.30$	
				1.4 to 1.6	—	—	$V_{CC} \times 0.35$	
				1.65 to 1.95	—	—	$V_{CC} \times 0.35$	
				2.3 to 2.7	—	—	0.7	
				3.0 to 3.6	—	—	0.8	
Low-level output voltage	V_{OL}	$V_{IN} = V_{IL}$	I_{OL} = 0.02 mA	0.9	—	—	0.1	V
			I_{OL} = 0.3 mA	1.1 to 1.3	—	—	$V_{CC} \times 0.25$	
			I_{OL} = 1.7 mA	1.4 to 1.6	—	—	$V_{CC} \times 0.25$	
			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}	$V_{IN} = V_{IH}$, 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	$V_{CC} \times 0.70$	—	
				1.4 to 1.6	$V_{CC} \times 0.65$	—	
				1.65 to 1.95	$V_{CC} \times 0.65$	—	
				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	—	$V_{CC} \times 0.30$	
				1.4 to 1.6	—	$V_{CC} \times 0.35$	
				1.65 to 1.95	—	$V_{CC} \times 0.35$	
				2.3 to 2.7	—	0.7	
				3.0 to 3.6	—	0.8	
Low-level output voltage	V_{OL}	$V_{IN} = V_{IL}$	I_{OL} = 0.02 mA	0.9	—	0.1	V
			I_{OL} = 0.3 mA	1.1 to 1.3	—	$V_{CC} \times 0.25$	
			I_{OL} = 1.7 mA	1.4 to 1.6	—	$V_{CC} \times 0.25$	
			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}	$V_{IN} = V_{IH}$, 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. DC Characteristics (Unless otherwise specified, T_a = -40 to 125 ℃)

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	
Low-level output voltage	V_{OL}	V_{IN} = V_{IL}	I_{OL} = 0.02 mA	0.9	—	0.1	V
			I_{OL} = 0.3 mA	1.1 to 1.3	—	V_{CC} × 0.27	
			I_{OL} = 1.7 mA	1.4 to 1.6	—	V_{CC} × 0.27	
			I_{OL} = 3.0 mA	1.65 to 1.95	—	0.5	
			I_{OL} = 4.0 mA	2.3 to 2.7	—	0.45	
			I_{OL} = 8.0 mA	3.0 to 3.6	—	0.45	
Input leakage current	I_{IN}	V_{IN} = 0 to 3.6 V		0 to 3.6	—	±2.0	μA
3-state output OFF-state leakage current	I_{OZ}	V_{IN} = V_{IH} V_{OUT} = 0 to 3.6 V		0.9 to 3.6	—	±80.0	μA
Power-OFF leakage current	I_{OFF}	V_{IN} = 0 to 3.6 V V_{OUT} = 0 to 3.6 V		0	—	80.0	μA
Quiescent supply current	I_{CC}	V_{IN} = V_{CC} or GND		3.6	—	80.0	μA

9.4. 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
Output enable time	t_{PZL}		R_L = 100 kΩ See Fig. 9.7.1, 9.8.1, Table 9.8.1	0.9	10	—	23.0	—	ns
			R_L = 5 kΩ See Fig. 9.7.1, 9.8.1, Table 9.8.1	1.1 to 1.3		—	10.8	18.7	
				1.4 to 1.6		—	6.2	9.5	
				1.65 to 1.95		—	4.5	7.0	
				2.3 to 2.7		—	3.1	4.6	
				3.0 to 3.6		—	2.5	3.6	
			R_L = 100 kΩ See Fig. 9.7.1, 9.8.1, Table 9.8.1	0.9	15	—	25.2	—	ns
			R_L = 5 kΩ See Fig. 9.7.1, 9.8.1, Table 9.8.1	1.1 to 1.3		—	11.8	20.7	
				1.4 to 1.6		—	6.9	10.0	
				1.65 to 1.95		—	5.1	7.3	
				2.3 to 2.7		—	3.4	4.8	
				3.0 to 3.6		—	2.8	3.7	
			R_L = 100 kΩ See Fig. 9.7.1, 9.8.1, Table 9.8.1	0.9	30	—	31.0	—	ns
			R_L = 5 kΩ See Fig. 9.7.1, 9.8.1, Table 9.8.1	1.1 to 1.3		—	15.7	30.7	
				1.4 to 1.6		—	8.6	13.1	
				1.65 to 1.95		—	6.6	9.2	
				2.3 to 2.7		—	4.5	5.8	
				3.0 to 3.6		—	3.7	4.5	
Output disable time	t_{PLZ}		R_L = 100 kΩ See Fig. 9.7.1, 9.8.1, Table 9.8.1	0.9	10	—	120.7	—	ns
			R_L = 5 kΩ See Fig. 9.7.1, 9.8.1, Table 9.8.1	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	8.6	
				2.3 to 2.7		—	5.1	6.4	
				3.0 to 3.6		—	5.8	7.9	
			R_L = 100 kΩ See Fig. 9.7.1, 9.8.1, Table 9.8.1	0.9	15	—	152.4	—	ns
			R_L = 5 kΩ See Fig. 9.7.1, 9.8.1, Table 9.8.1	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	9.6	
				2.3 to 2.7		—	6.0	9.4	
				3.0 to 3.6		—	7.1	9.5	
			R_L = 100 kΩ See Fig. 9.7.1, 9.8.1, Table 9.8.1	0.9	30	—	246.9	—	ns
			R_L = 5 kΩ See Fig. 9.7.1, 9.8.1, Table 9.8.1	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.

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

9.5. 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
Output enable time	t_{PZL}	R_L = 100 kΩ See Fig. 9.7.1, 9.8.1, Table 9.8.1	0.9	10	—	—	ns
		R_L = 5 kΩ See Fig. 9.7.1, 9.8.1, Table 9.8.1	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	7.5	
			2.3 to 2.7		1.0	5.2	
			3.0 to 3.6		1.0	4.2	
		R_L = 100 kΩ See Fig. 9.7.1, 9.8.1, Table 9.8.1	0.9	15	—	—	ns
		R_L = 5 kΩ See Fig. 9.7.1, 9.8.1, Table 9.8.1	1.1 to 1.3		1.0	34.7	
			1.4 to 1.6		1.0	11.1	
			1.65 to 1.95		1.0	8.5	
			2.3 to 2.7		1.0	5.7	
			3.0 to 3.6		1.0	4.9	
		R_L = 100 kΩ See Fig. 9.7.1, 9.8.1, Table 9.8.1	0.9	30	—	—	ns
		R_L = 5 kΩ See Fig. 9.7.1, 9.8.1, Table 9.8.1	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	11.9	
			2.3 to 2.7		1.0	7.6	
			3.0 to 3.6		1.0	6.1	
Output disable time	t_{PLZ}	R_L = 100 kΩ See Fig. 9.7.1, 9.8.1, Table 9.8.1	0.9	10	—	—	ns
		R_L = 5 kΩ See Fig. 9.7.1, 9.8.1, Table 9.8.1	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 See Fig. 9.7.1, 9.8.1, Table 9.8.1	0.9	15	—	—	ns
		R_L = 5 kΩ See Fig. 9.7.1, 9.8.1, Table 9.8.1	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 See Fig. 9.7.1, 9.8.1, Table 9.8.1	0.9	30	—	—	ns
		R_L = 5 kΩ See Fig. 9.7.1, 9.8.1, Table 9.8.1	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	

9.6. AC Characteristics (Unless otherwise specified, T_a = -40 to 125 ℃, Input: $t_r = t_f$ = 3 ns)

Characteristics	Symbol	Test Condition	V_{CC} (V)	C_L (pF)	Min	Max	Unit
Output enable time	t_{PZL}	R_L = 100 kΩ See Fig. 9.7.1, 9.8.1, Table 9.8.1	0.9	10	—	—	ns
		R_L = 5 kΩ See Fig. 9.7.1, 9.8.1, Table 9.8.1	1.1 to 1.3		1.0	37.2	
			1.4 to 1.6		1.0	12.5	
			1.65 to 1.95		1.0	8.2	
			2.3 to 2.7		1.0	5.8	
			3.0 to 3.6		1.0	4.8	
		R_L = 100 kΩ See Fig. 9.7.1, 9.8.1, Table 9.8.1	0.9	15	—	—	ns
		R_L = 5 kΩ See Fig. 9.7.1, 9.8.1, Table 9.8.1	1.1 to 1.3		1.0	44.1	
			1.4 to 1.6		1.0	11.9	
			1.65 to 1.95		1.0	9.3	
			2.3 to 2.7		1.0	6.3	
			3.0 to 3.6		1.0	5.7	
		R_L = 100 kΩ See Fig. 9.7.1, 9.8.1, Table 9.8.1	0.9	30	—	—	ns
		R_L = 5 kΩ See Fig. 9.7.1, 9.8.1, Table 9.8.1	1.1 to 1.3		1.0	63.7	
			1.4 to 1.6		1.0	16.5	
			1.65 to 1.95		1.0	13.7	
			2.3 to 2.7		1.0	8.8	
			3.0 to 3.6		1.0	7.2	
Output disable time	t_{PLZ}	R_L = 100 kΩ See Fig. 9.7.1, 9.8.1, Table 9.8.1	0.9	10	—	—	ns
		R_L = 5 kΩ See Fig. 9.7.1, 9.8.1, Table 9.8.1	1.1 to 1.3		1.0	26.7	
			1.4 to 1.6		1.0	11.7	
			1.65 to 1.95		1.0	10.8	
			2.3 to 2.7		1.0	9.5	
			3.0 to 3.6		1.0	11.3	
		R_L = 100 kΩ See Fig. 9.7.1, 9.8.1, Table 9.8.1	0.9	15	—	—	ns
		R_L = 5 kΩ See Fig. 9.7.1, 9.8.1, Table 9.8.1	1.1 to 1.3		1.0	30.6	
			1.4 to 1.6		1.0	12.3	
			1.65 to 1.95		1.0	12.1	
			2.3 to 2.7		1.0	14.4	
			3.0 to 3.6		1.0	15.7	
		R_L = 100 kΩ See Fig. 9.7.1, 9.8.1, Table 9.8.1	0.9	30	—	—	ns
		R_L = 5 kΩ See Fig. 9.7.1, 9.8.1, Table 9.8.1	1.1 to 1.3		1.0	39.3	
			1.4 to 1.6		1.0	16.1	
			1.65 to 1.95		1.0	18.0	
			2.3 to 2.7		1.0	13.2	
			3.0 to 3.6		1.0	17.8	

9.7. AC Test Circuit

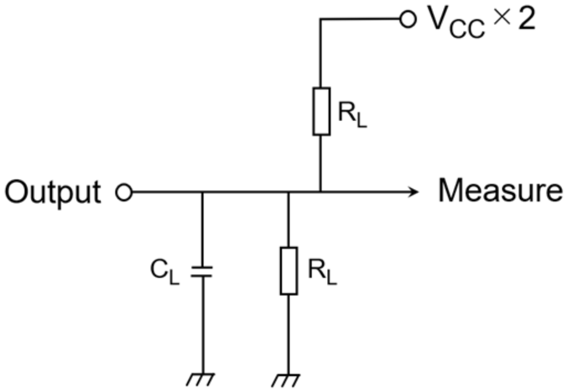


Fig. 9.7.1 AC Test Circuit

9.8. AC Waveform

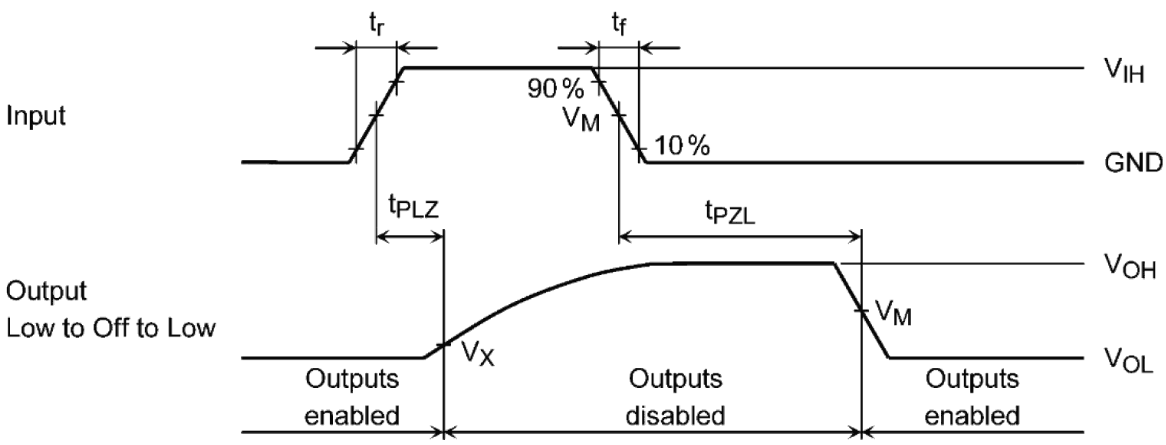


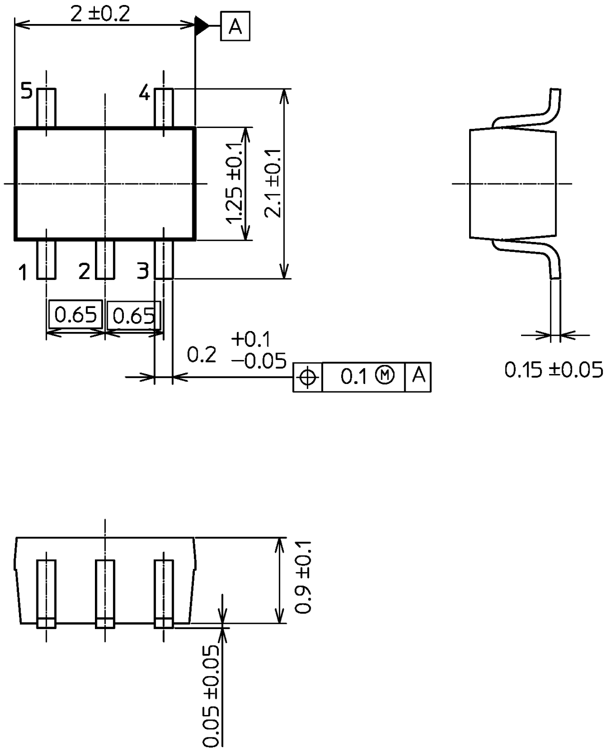
Fig. 9.8.1 t_{PLZ}, t_{PZL}

Table 9.8.1 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
Input	V_{IH}	V_{CC}	V_{CC}	V_{CC}	V_{CC}	V_{CC}	V_{CC}
	V_M	$V_{CC}/2$	$V_{CC}/2$	$V_{CC}/2$	$V_{CC}/2$	$V_{CC}/2$	$V_{CC}/2$
Output	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

Package Dimensions

Unit: mm



Weight: 6.2 mg (typ.)

Package Name(s)
JEDEC: SOT-353
Nickname: USV

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