

# 7UL1G126FU

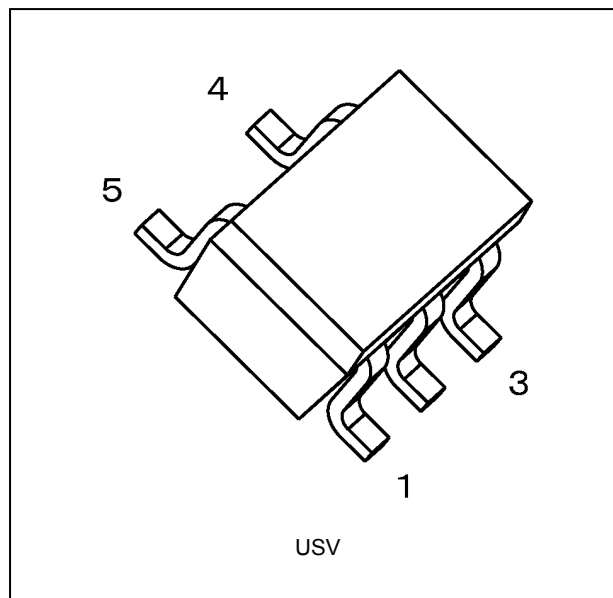
### 1. Functional Description

- Bus Buffer with 3-State Output

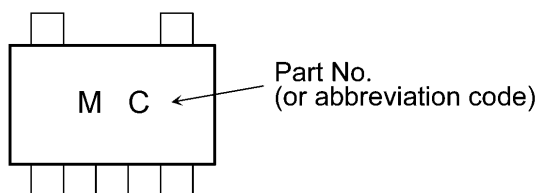
### 2. Features

- (1) Wide operating temperature range:  $T_{opr} = -40$  to  $125$  °C
- (2) High output current:  $\pm 8.0$  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 inputs
- (6) 3.6 V power down protection output

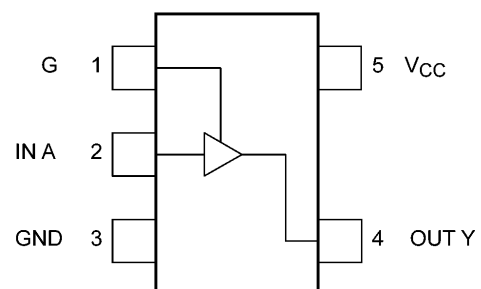
### 3. Packaging



### 4. Marking and Pin Assignment



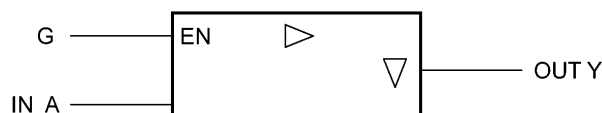
Marking



Pin Assignment (Top view)

Start of commercial production  
2020-12

### 5. IEC Logic Symbol



### 6. Truth Table

Input G	Input A	Output 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, $T_a = 25\text{ }^\circ\text{C}$ )

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	$I_{OUT}$		$\pm 25$	mA
$V_{CC}$ /ground current	$I_{CC}$		$\pm 50$	mA
Power dissipation	$P_D$		200	mW
Storage temperature	$T_{stg}$		-65 to 150	$^\circ\text{C}$

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:  $V_{CC} = 0\text{ V}$  or high impedance condition

Note 2: High (H) or Low (L) state.  $I_{OUT}$  absolute maximum rating must be observed.

Note 3:  $V_{OUT} < \text{GND}$

### 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	$\pm 8.0$	mA
			$V_{CC} = 2.3$ to $2.7$ V	$\pm 4.0$	
			$V_{CC} = 1.65$ to $1.95$ V	$\pm 3.0$	
			$V_{CC} = 1.4$ to $1.6$ V	$\pm 1.7$	
			$V_{CC} = 1.1$ to $1.3$ V	$\pm 0.3$	
			$V_{CC} = 0.9$ V	$\pm 0.02$	
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.

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, $T_a = 25\text{ }^\circ\text{C}$ )

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		
High-level output voltage	$V_{OH}$	$V_{IN} = V_{IH}$	$I_{OH} = -0.02\text{ mA}$	0.9	0.75	—	V	
			$I_{OH} = -0.3\text{ mA}$	1.1 to 1.3	$V_{CC} \times 0.75$	—		—
			$I_{OH} = -1.7\text{ mA}$	1.4 to 1.6	$V_{CC} \times 0.75$	—		—
			$I_{OH} = -3.0\text{ mA}$	1.65 to 1.95	$V_{CC} - 0.45$	—		—
			$I_{OH} = -4.0\text{ mA}$	2.3 to 2.7	2.0	—		—
			$I_{OH} = -8.0\text{ mA}$	3.0 to 3.6	2.48	—		—
Low-level output voltage	$V_{OL}$	$V_{IN} = V_{IH}$ or $V_{IL}$	$I_{OL} = 0.02\text{ mA}$	0.9	—	—	V	
			$I_{OL} = 0.3\text{ mA}$	1.1 to 1.3	—	—		$V_{CC} \times 0.25$
			$I_{OL} = 1.7\text{ mA}$	1.4 to 1.6	—	—		$V_{CC} \times 0.25$
			$I_{OL} = 3.0\text{ mA}$	1.65 to 1.95	—	—		0.45
			$I_{OL} = 4.0\text{ mA}$	2.3 to 2.7	—	—		0.4
			$I_{OL} = 8.0\text{ mA}$	3.0 to 3.6	—	—		0.4
Input leakage current	$I_{IN}$	$V_{IN} = 0$ to $3.6\text{ V}$	0 to 3.6	—	—	$\pm 0.1$	$\mu\text{A}$	
3-state output OFF-state leakage current	$I_{OZ}$	$V_{IN} = V_{IH}$ or $V_{IL}$ , $V_{OUT} = 0$ to $3.6\text{ V}$	0.9 to 3.6	—	—	$\pm 1.0$	$\mu\text{A}$	
Power-OFF leakage current	$I_{OFF}$	$V_{IN} = 0$ to $3.6\text{ V}$ , $V_{OUT} = 0$ to $3.6\text{ V}$	0	—	—	1.0	$\mu\text{A}$	
Quiescent supply current	$I_{CC}$	$V_{IN} = V_{CC}$ or GND	3.6	—	—	1.0	$\mu\text{A}$	

### 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		
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	$V_{CC} \times 0.75$	—	
			$I_{OH} = -1.7$ mA	1.4 to 1.6	$V_{CC} \times 0.75$	—	
			$I_{OH} = -3.0$ 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	—	$V_{CC} \times 0.25$	
			$I_{OL} = 1.7$ 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	—	$\pm 0.5$	$\mu$ A	
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	—	$\pm 10.0$	$\mu$ A	
Power-OFF leakage current	$I_{OFF}$	$V_{IN} = 0$ to $3.6$ V, $V_{OUT} = 0$ to $3.6$ V	0	—	10.0	$\mu$ A	
Quiescent supply current	$I_{CC}$	$V_{IN} = V_{CC}$ or GND	3.6	—	10.0	$\mu$ A	

### 9.3. DC Characteristics (Unless otherwise specified, $T_a = -40$ to $125$ °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		
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	$V_{CC} \times 0.73$	—	
			$I_{OH} = -1.7$ mA	1.4 to 1.6	$V_{CC} \times 0.73$	—	
			$I_{OH} = -3.0$ mA	1.65 to 1.95	$V_{CC} - 0.5$	—	
			$I_{OH} = -4.0$ mA	2.3 to 2.7	1.95	—	
			$I_{OH} = -8.0$ mA	3.0 to 3.6	2.4	—	
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	—	$V_{CC} \times 0.27$	
			$I_{OL} = 1.7$ mA	1.4 to 1.6	—	$V_{CC} \times 0.27$	
			$I_{OL} = 3.0$ 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	—	$\pm 2.0$	$\mu$ A	
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	—	$\pm 80.0$	$\mu$ A	
Power-OFF leakage current	$I_{OFF}$	$V_{IN} = 0$ to $3.6$ V, $V_{OUT} = 0$ to $3.6$ V	0	—	80.0	$\mu$ A	
Quiescent supply current	$I_{CC}$	$V_{IN} = V_{CC}$ or GND	3.6	—	80.0	$\mu$ A	

### 9.4. AC Characteristics

(Unless otherwise specified,  $T_a = 25\text{ }^\circ\text{C}$ , Input:  $t_r = t_f = 3\text{ ns}$ )

Characteristics	Symbol	Note	Test Condition	$V_{CC}$ (V)	$C_L$ (pF)	Min	Typ.	Max	Unit
Propagation delay time	$t_{PLH}, t_{PHL}$		$R_L = 1\text{ M}\Omega$ See Fig. 9.7.1, 9.8.1 Table 9.7.1, 9.8.1	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	
			$R_L = 1\text{ M}\Omega$ See Fig. 9.7.1, 9.8.1 Table 9.7.1, 9.8.1	0.9	15	—	22.9	—	ns
				1.1 to 1.3		—	11.5	21.5	
				1.4 to 1.6		—	6.7	9.3	
				1.65 to 1.95		—	4.9	6.9	
				2.3 to 2.7		—	3.2	4.4	
				3.0 to 3.6		—	2.5	3.4	
			$R_L = 1\text{ M}\Omega$ See Fig. 9.7.1, 9.8.1 Table 9.7.1, 9.8.1	0.9	30	—	30.6	—	ns
				1.1 to 1.3		—	14.8	29.6	
				1.4 to 1.6		—	8.5	13.1	
				1.65 to 1.95		—	6.3	9.2	
				2.3 to 2.7		—	4.3	5.7	
				3.0 to 3.6		—	3.3	4.4	
Output enable time	$t_{PZL}, t_{PZH}$		$R_L = 100\text{ k}\Omega$ See Fig. 9.7.1, 9.8.2 Table 9.7.1, 9.8.1	0.9	10	—	23.0	—	ns
				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	
			$R_L = 100\text{ k}\Omega$ See Fig. 9.7.1, 9.8.2 Table 9.7.1, 9.8.1	0.9	15	—	25.2	—	ns
				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	
			$R_L = 100\text{ k}\Omega$ See Fig. 9.7.1, 9.8.2 Table 9.7.1, 9.8.1	0.9	30	—	31.0	—	ns
				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	$t_{PLZ}, t_{PHZ}$		$R_L = 100\text{ k}\Omega$ See Fig. 9.7.1, 9.8.2 Table 9.7.1, 9.8.1	0.9	10	—	120.7	—	ns
				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	

Characteristics	Symbol	Note	Test Condition	V <sub>CC</sub> (V)	C <sub>L</sub> (pF)	Min	Typ.	Max	Unit		
Output disable time	t <sub>PLZ</sub> , t <sub>PHZ</sub>		R <sub>L</sub> = 100 kΩ See Fig. 9.7.1, 9.8.2 Table 9.7.1, 9.8.1	0.9	15	—	152.4	—	ns		
						R <sub>L</sub> = 5 kΩ See Fig. 9.7.1, 9.8.2 Table 9.7.1, 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 <sub>L</sub> = 100 kΩ See Fig. 9.7.1, 9.8.2 Table 9.7.1, 9.8.1	0.9	30	—	246.9	—	ns		
						R <sub>L</sub> = 5 kΩ See Fig. 9.7.1, 9.8.2 Table 9.7.1, 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 <sub>IN</sub>		—	3.6	—	—	3	—	pF		
Power dissipation capacitance	C <sub>PD</sub>	(Note 1)	—	0.9 to 3.6	—	—	9	—	pF		

Note 1: C<sub>PD</sub> 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.

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



Characteristics	Symbol	Test Condition	V <sub>CC</sub> (V)	C <sub>L</sub> (pF)	Min	Max	Unit	
Output disable time	t <sub>PLZ</sub> , t <sub>PHZ</sub>	R <sub>L</sub> = 100 kΩ See Fig. 9.7.1, 9.8.2 Table 9.7.1, 9.8.1	0.9	15	—	—	ns	
					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
		R <sub>L</sub> = 5 kΩ See Fig. 9.7.1, 9.8.2 Table 9.7.1, 9.8.1	0.9	30	—	—	ns	
					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
		R <sub>L</sub> = 100 kΩ See Fig. 9.7.1, 9.8.2 Table 9.7.1, 9.8.1	0.9	30	—	—	ns	
					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
R <sub>L</sub> = 5 kΩ See Fig. 9.7.1, 9.8.2 Table 9.7.1, 9.8.1	0.9	30	—	—	ns			
			1.1 to 1.3	1.0		31.9		
R <sub>L</sub> = 100 kΩ See Fig. 9.7.1, 9.8.2 Table 9.7.1, 9.8.1	0.9	30	—	—	ns			
			1.1 to 1.3	1.0		31.9		
R <sub>L</sub> = 5 kΩ See Fig. 9.7.1, 9.8.2 Table 9.7.1, 9.8.1	0.9	30	—	—	ns			
			1.1 to 1.3	1.0		31.9		



Characteristics	Symbol	Test Condition	V <sub>CC</sub> (V)	C <sub>L</sub> (pF)	Min	Max	Unit	
Output disable time	t <sub>PLZ</sub> , t <sub>PHZ</sub>	R <sub>L</sub> = 100 kΩ See Fig. 9.7.1, 9.8.2 Table 9.7.1, 9.8.1	0.9	15	—	—	ns	
					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
	t <sub>PLZ</sub> , t <sub>PHZ</sub>	R <sub>L</sub> = 5 kΩ See Fig. 9.7.1, 9.8.2 Table 9.7.1, 9.8.1	0.9	30	—	—	ns	
					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

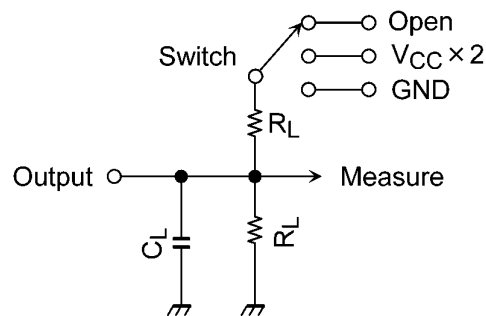
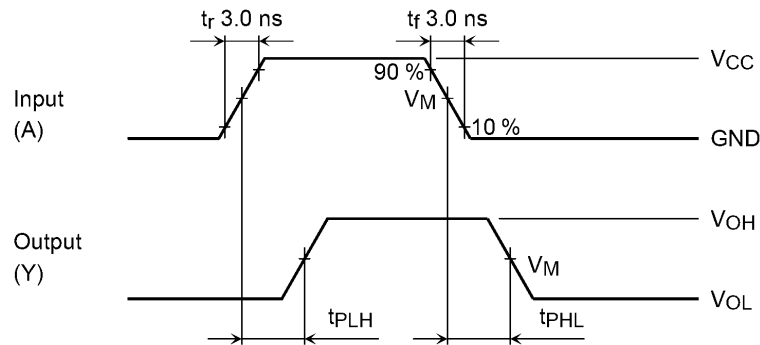


Fig. 9.7.1 AC Test Circuit

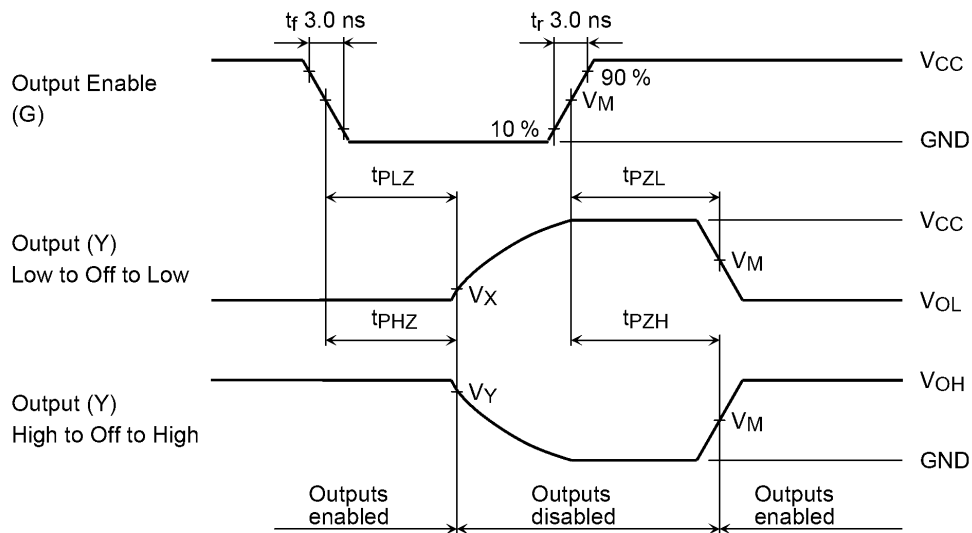
Table 9.7.1 Parameter for AC Test Circuit

Characteristics	Switch
t <sub>PLH</sub> , t <sub>PHL</sub>	Open
t <sub>PLZ</sub> , t <sub>PZL</sub>	V <sub>CC</sub> × 2
t <sub>PHZ</sub> , t <sub>PZH</sub>	GND

## 9.8. AC Waveform



**Fig. 9.8.1**  $t_{PLH}$ ,  $t_{PHL}$



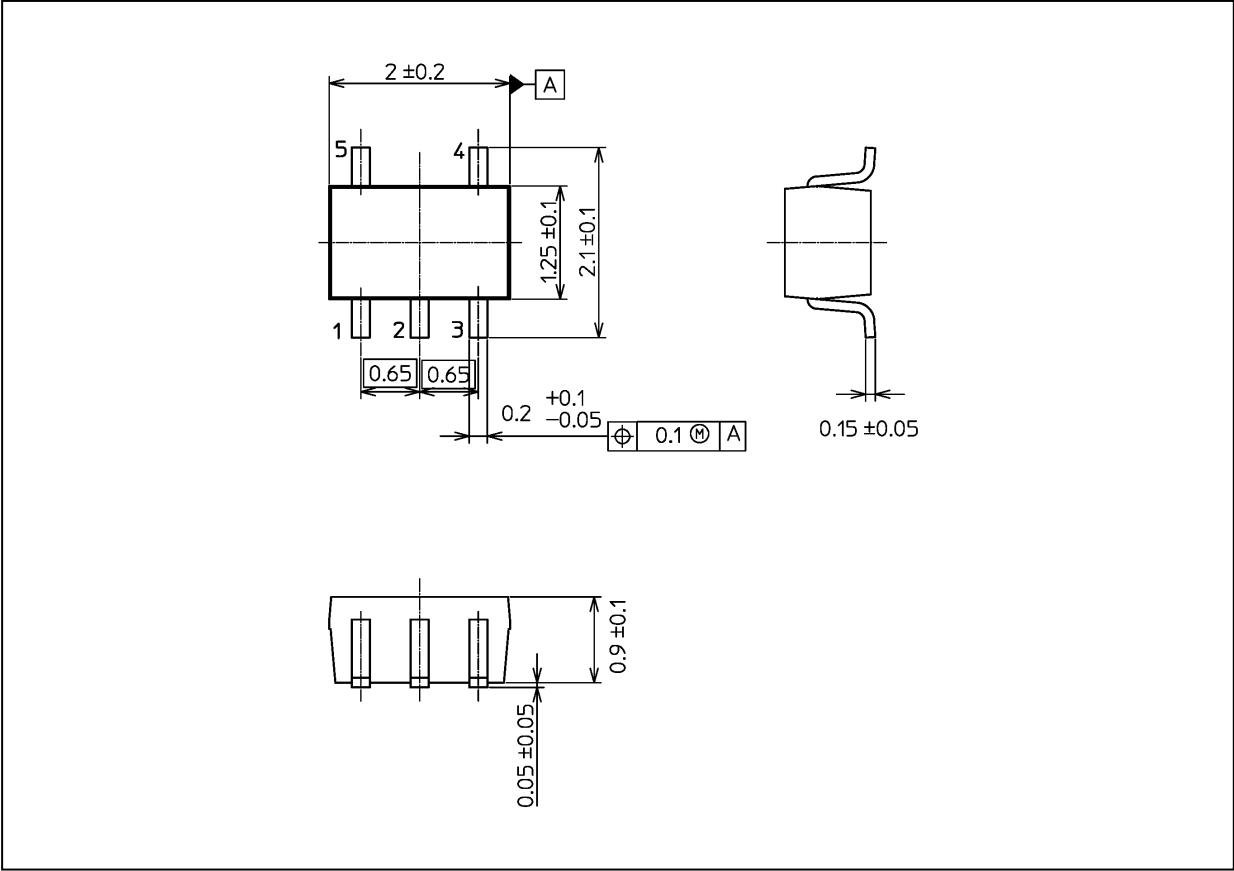
**Fig. 9.8.2**  $t_{PLZ}$ ,  $t_{PHZ}$ ,  $t_{PZL}$ ,  $t_{PZH}$

**Table 9.8.1** AC Waveform Symbols

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

Package Dimensions

Unit: mm



Weight: 6.2 mg (typ.)

Package Name(s)
Nickname: USV

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