

# 7UL1T04FU

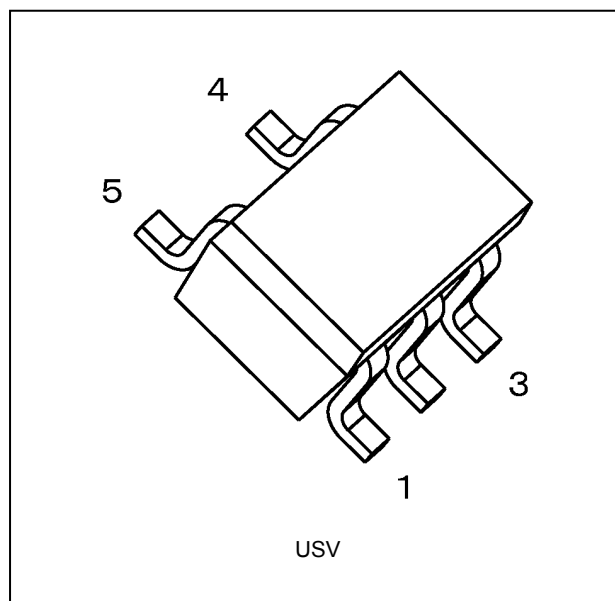
### 1. Functional Description

- Inverter with Level Shifting

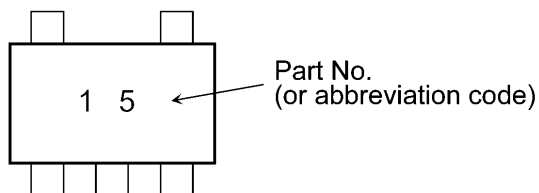
### 2. Features

- (1) Operating supply voltage range:  $V_{CC} = 2.3\text{ V to }3.6\text{ V}$
- (2) The high-level input voltage is up translation to the power supply voltage.
- (3) The high-level input voltage is down translation to the power supply voltage.
- (4) 3.6 V tolerant input
- (5) 3.6 V power-down protection is provided on output.

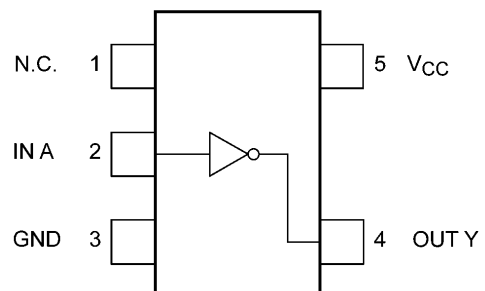
### 3. Packaging



### 4. Marking and Pin Assignment



Marking



Pin Assignment (Top view)

Start of commercial production

2021-04

## 5. IEC Logic Symbol



## 6. Truth Table

Input A	Output Y
L	H
H	L

## 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:  $V_{CC} = 0\text{ V}$

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	$V_{CC}$		—	2.3 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	$I_{OH}, I_{OL}$		$V_{CC} = 3.0\text{ to }3.6\text{ V}$	$\pm 8.0$	mA
			$V_{CC} = 2.3\text{ to }2.7\text{ V}$	$\pm 4.0$	
Operating temperature	$T_{opr}$		—	-40 to 85	$^\circ\text{C}$
Input rise and fall time	$dt/dv$		$V_{CC} = 2.3\text{ to }3.6\text{ V}$	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:  $V_{CC} = 0\text{ V}$

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	$V_{IH}$	—	2.3 to 2.7	1.1	—	—	V
			3.0 to 3.6	1.2	—	—	
Low-level input voltage	$V_{IL}$	—	2.3 to 2.7	—	—	0.35	V
			3.0 to 3.6	—	—	0.5	
High-level output voltage	$V_{OH}$	$V_{IN} = V_{IL}$	$I_{OH} = -0.02\text{ mA}$	2.3 to 3.6	$V_{CC} - 0.1$	—	V
			$I_{OH} = -4.0\text{ mA}$	2.3 to 2.7	2.0	—	
			$I_{OH} = -8.0\text{ mA}$	3.0 to 3.6	2.48	—	
Low-level output voltage	$V_{OL}$	$V_{IN} = V_{IH}$	$I_{OL} = 0.02\text{ mA}$	2.3 to 3.6	—	0.1	V
			$I_{OL} = 4.0\text{ mA}$	2.3 to 2.7	—	0.4	
			$I_{OL} = 8.0\text{ mA}$	3.0 to 3.6	—	0.4	
Input leakage current	$I_{IN}$	$V_{IN} = 0\text{ to }3.6\text{ V}$	0 to 3.6	—	—	$\pm 0.1$	$\mu\text{A}$
Power-OFF leakage current	$I_{OFF}$	$V_{IN} = 0\text{ to }3.6\text{ V}$ , $V_{OUT} = 0\text{ to }3.6\text{ V}$	0	—	—	1.0	$\mu\text{A}$
Quiescent supply current	$I_{CC}$	$V_{IN} = V_{CC}\text{ or GND}$	3.6	—	—	1.0	$\mu\text{A}$
	$I_{CCT}$	$V_{IN} = 1.5\text{ V}$ (per input)	3.6	—	—	35	

#### 9.2. DC Characteristics (Unless otherwise specified, $T_a = -40\text{ to }85\text{ }^\circ\text{C}$ )

Characteristics	Symbol	Test Condition	$V_{CC}$ (V)	Min	Max	Unit	
High-level input voltage	$V_{IH}$	—	2.3 to 2.7	1.1	—	V	
			3.0 to 3.6	1.2	—		
Low-level input voltage	$V_{IL}$	—	2.3 to 2.7	—	0.35	V	
			3.0 to 3.6	—	0.5		
High-level output voltage	$V_{OH}$	$V_{IN} = V_{IL}$	$I_{OH} = -0.02\text{ mA}$	2.3 to 3.6	$V_{CC} - 0.1$	—	V
			$I_{OH} = -4.0\text{ mA}$	2.3 to 2.7	2.0	—	
			$I_{OH} = -8.0\text{ mA}$	3.0 to 3.6	2.48	—	
Low-level output voltage	$V_{OL}$	$V_{IN} = V_{IH}$	$I_{OL} = 0.02\text{ mA}$	2.3 to 3.6	—	0.1	V
			$I_{OL} = 4.0\text{ mA}$	2.3 to 2.7	—	0.4	
			$I_{OL} = 8.0\text{ mA}$	3.0 to 3.6	—	0.4	
Input leakage current	$I_{IN}$	$V_{IN} = 0\text{ to }3.6\text{ V}$	0 to 3.6	—	$\pm 0.5$	$\mu\text{A}$	
Power-OFF leakage current	$I_{OFF}$	$V_{IN} = 0\text{ to }3.6\text{ V}$ , $V_{OUT} = 0\text{ to }3.6\text{ V}$	0	—	10.0	$\mu\text{A}$	
Quiescent supply current	$I_{CC}$	$V_{IN} = V_{CC}\text{ or GND}$	3.6	—	10.0	$\mu\text{A}$	
	$I_{CCT}$	$V_{IN} = 1.5\text{ V}$ (per input)	3.6	—	40		

### 9.3. 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)	$V_{IN}$ (V)	Min	Typ.	Max	Unit
Propagation delay time	$t_{PLH}$		$C_L = 15\text{ pF}$ $R_L = 1\text{ M}\Omega$	2.3 to 2.7	1.65 to 1.95	—	3.5	5.1	ns
					2.3 to 2.7	—	3.9	5.5	
					3.0 to 3.6	—	4.2	5.9	
				3.0 to 3.6	1.65 to 1.95	—	2.9	3.8	
					2.3 to 2.7	—	3.0	4.1	
					3.0 to 3.6	—	3.2	4.4	
	$t_{PHL}$		$C_L = 15\text{ pF}$ $R_L = 1\text{ M}\Omega$	2.3 to 2.7	1.65 to 1.95	—	3.6	5.6	ns
					2.3 to 2.7	—	2.9	4.7	
					3.0 to 3.6	—	2.5	4.1	
				3.0 to 3.6	1.65 to 1.95	—	3.6	4.7	
2.3 to 2.7					—	2.7	3.8		
3.0 to 3.6					—	2.2	3.3		
Input capacitance	$C_{IN}$		—	3.6	—	—	3	—	pF
Power dissipation capacitance	$C_{PD}$	(Note 1)	—	2.3 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, $T_a = -40\text{ to }85\text{ }^\circ\text{C}$ , Input: $t_r = t_f = 3\text{ ns}$ )

Characteristics	Symbol	Test Condition	$V_{CC}$ (V)	$V_{IN}$ (V)	Min	Max	Unit
Propagation delay time	$t_{PLH}$	$C_L = 15\text{ pF}$ $R_L = 1\text{ M}\Omega$	2.3 to 2.7	1.65 to 1.95	1.0	6.0	ns
				2.3 to 2.7	1.0	6.4	
				3.0 to 3.6	1.0	6.9	
			3.0 to 3.6	1.65 to 1.95	1.0	4.8	
				2.3 to 2.7	1.0	5.0	
				3.0 to 3.6	1.0	5.3	
	$t_{PHL}$	$C_L = 15\text{ pF}$ $R_L = 1\text{ M}\Omega$	2.3 to 2.7	1.65 to 1.95	1.0	5.9	ns
				2.3 to 2.7	1.0	5.1	
				3.0 to 3.6	1.0	4.6	
			3.0 to 3.6	1.65 to 1.95	1.0	5.6	
2.3 to 2.7				1.0	4.7		
3.0 to 3.6				1.0	4.1		

## 9.5. AC Waveform

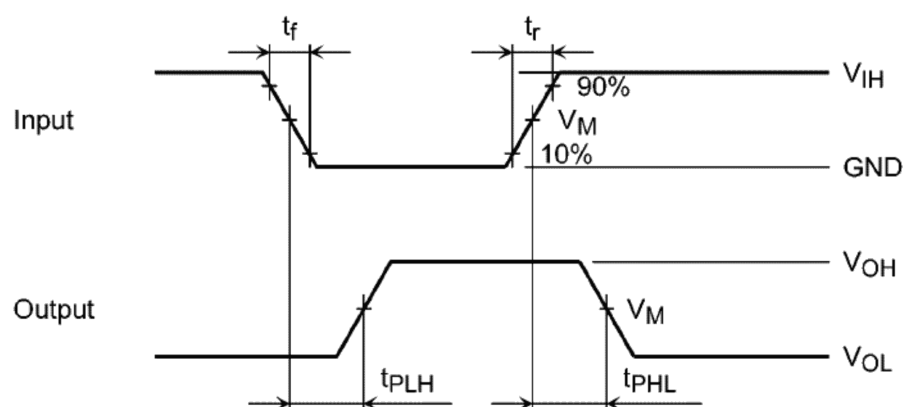


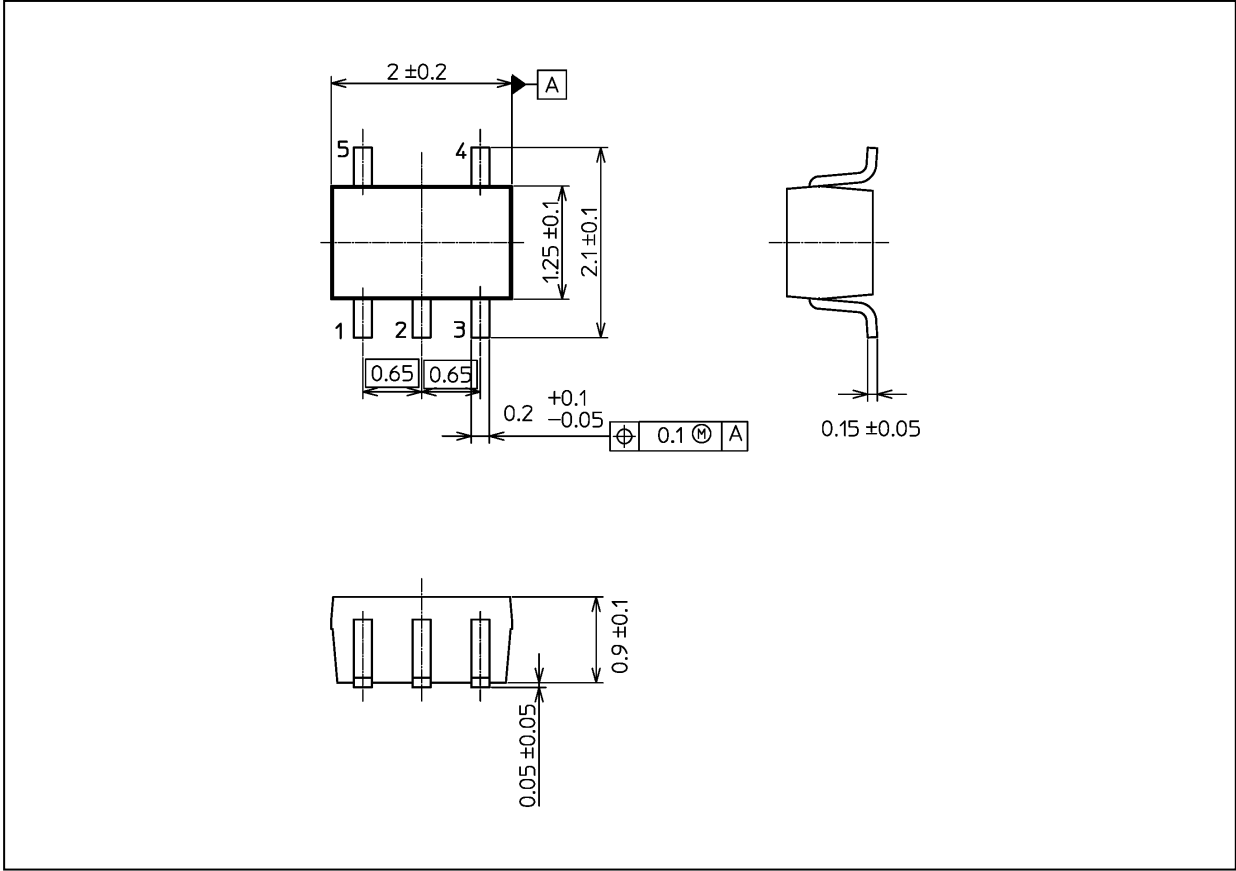
Fig. 9.5.1  $t_{PLH}$ ,  $t_{PHL}$

Table 9.5.1 AC Waveform Symbols

	Symbol	$V_{CC} = 3.3 \pm 0.3 \text{ V}$	$V_{CC} = 2.5 \pm 0.2 \text{ V}$
Input	$V_{IH}$	$V_{IN}$	$V_{IN}$
	$V_M$	$V_{IN}/2$	$V_{IN}/2$
Output	$V_M$	$V_{CC}/2$	$V_{CC}/2$

Package Dimensions

Unit: mm



Weight: 6.2 mg (typ.)

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

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