

7UL2T126FK

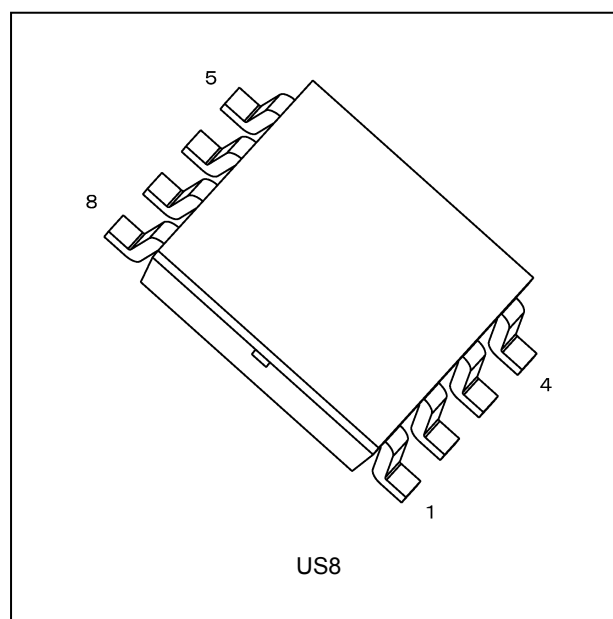
1. Functional Description

- Dual 3-State Bus Buffer with Level Shifting

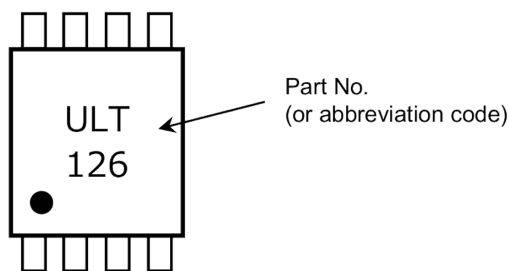
2. Features

- (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.

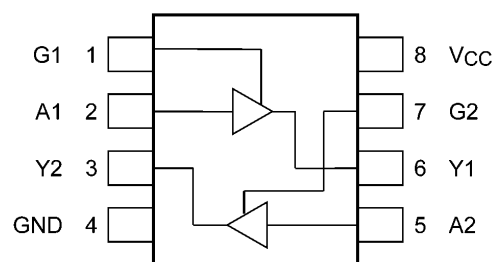
3. Packaging



4. Marking and Pin Assignment



Marking

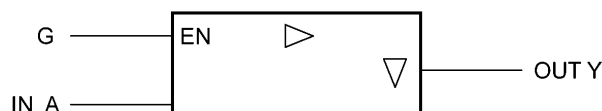


Pin Assignment (Top view)

Start of commercial production

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

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}		± 25	mA
V_{CC} /ground current	I_{CC}		± 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}		$V_{CC} = 3.0$ to 3.6 V	± 8.0	mA
			$V_{CC} = 2.3$ to 2.7 V	± 4.0	
Operating temperature	T_{opr}		—	-40 to 85	°C
Input rise and fall time	dt/dv		$V_{CC} = 2.3$ to 3.6 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

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}	$V_{IN} = V_{IH}$	$I_{OH} = -0.02\text{ mA}$	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}	$V_{IN} = V_{IL}$	$I_{OL} = 0.02\text{ mA}$	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	—	—	± 0.1	μA
3-state output OFF-state leakage current	I_{OZ}	$V_{IN} = V_{IL}\text{ or }V_{IH}$ $V_{OUT} = 0\text{ to }3.6\text{ V}$	2.3 to 3.6	—	—	± 1.0	μA
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	μA
Quiescent supply current	I_{CC}	$V_{IN} = V_{CC}\text{ or GND}$	3.6	—	—	1.0	μA
Quiescent supply current	I_{CCT}	$V_{IN} = 1.5\text{ V}$	3.6	—	—	35	μA

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}	$V_{IN} = V_{IH}$	$I_{OH} = -0.02\text{ mA}$	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}	$V_{IN} = V_{IL}$	$I_{OL} = 0.02\text{ mA}$	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	—	± 0.5	μA	
3-state output OFF-state leakage current	I_{OZ}	$V_{IN} = V_{IL}\text{ or }V_{IH}$ $V_{OUT} = 0\text{ to }3.6\text{ V}$	2.3 to 3.6	—	± 10.0	μA	
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	μA	
Quiescent supply current	I_{CC}	$V_{IN} = V_{CC}\text{ or GND}$	3.6	—	10.0	μA	
Quiescent supply current	I_{CCT}	$V_{IN} = 1.5\text{ V}$	3.6	—	40	μA	

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	—	4.3	6.0	ns
					2.3 to 2.7	—	3.5	5.5	
					3.0 to 3.6	—	3.0	5.1	
				3.0 to 3.6	1.65 to 1.95	—	4.3	5.7	
					2.3 to 2.7	—	3.3	4.9	
					3.0 to 3.6	—	2.8	4.3	
	t_{PHL}		$C_L = 15\text{ pF}$ $R_L = 1\text{ M}\Omega$	2.3 to 2.7	1.65 to 1.95	—	3.7	5.8	ns
					2.3 to 2.7	—	4.1	6.2	
					3.0 to 3.6	—	4.4	6.5	
				3.0 to 3.6	1.65 to 1.95	—	3.1	4.1	
2.3 to 2.7					—	3.2	4.4		
3.0 to 3.6					—	3.4	4.7		
3-state output enable time	t_{PZH}		$C_L = 15\text{ pF}$ $R_L = 5\text{ k}\Omega$	2.3 to 2.7	1.65 to 1.95	—	4.4	6.2	ns
					2.3 to 2.7	—	3.6	5.6	
					3.0 to 3.6	—	3.2	4.9	
				3.0 to 3.6	1.65 to 1.95	—	4.3	6.0	
					2.3 to 2.7	—	3.4	4.8	
					3.0 to 3.6	—	2.8	4.0	
	t_{PZL}		$C_L = 15\text{ pF}$ $R_L = 5\text{ k}\Omega$	2.3 to 2.7	1.65 to 1.95	—	4.4	6.2	ns
					2.3 to 2.7	—	3.6	5.6	
					3.0 to 3.6	—	3.2	4.9	
				3.0 to 3.6	1.65 to 1.95	—	4.3	6.0	
2.3 to 2.7					—	3.4	4.8		
3.0 to 3.6					—	2.8	4.0		
3-state output disable time	t_{PLZ}		$C_L = 15\text{ pF}$ $R_L = 5\text{ k}\Omega$	2.3 to 2.7	1.65 to 1.95	—	4.8	7.4	ns
					2.3 to 2.7	—	5.0	7.8	
					3.0 to 3.6	—	5.2	8.4	
				3.0 to 3.6	1.65 to 1.95	—	6.4	8.1	
					2.3 to 2.7	—	6.5	9.4	
					3.0 to 3.6	—	6.6	9.7	
	t_{PHZ}		$C_L = 15\text{ pF}$ $R_L = 5\text{ k}\Omega$	2.3 to 2.7	1.65 to 1.95	—	4.8	7.4	ns
					2.3 to 2.7	—	5.0	7.8	
					3.0 to 3.6	—	5.2	8.4	
				3.0 to 3.6	1.65 to 1.95	—	6.4	8.1	
2.3 to 2.7					—	6.5	9.4		
3.0 to 3.6					—	6.6	9.7		
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, $T_a = -40$ to 85 °C, Input: $t_r = t_f = 3$ ns)

Characteristics	Symbol	Test Condition	V_{CC} (V)	V_{IN} (V)	Min	Max	Unit
Propagation delay time	t_{PLH}	$C_L = 15$ pF $R_L = 1$ M Ω	2.3 to 2.7	1.65 to 1.95	1.0	6.9	ns
				2.3 to 2.7	1.0	6.5	
				3.0 to 3.6	1.0	6.1	
			3.0 to 3.6	1.65 to 1.95	1.0	7.5	
				2.3 to 2.7	1.0	6.0	
				3.0 to 3.6	1.0	5.3	
	t_{PHL}	$C_L = 15$ pF $R_L = 1$ M Ω	2.3 to 2.7	1.65 to 1.95	1.0	6.8	ns
				2.3 to 2.7	1.0	7.2	
				3.0 to 3.6	1.0	7.6	
			3.0 to 3.6	1.65 to 1.95	1.0	5.2	
				2.3 to 2.7	1.0	5.4	
				3.0 to 3.6	1.0	5.6	
3-state output enable time	t_{PZH}	$C_L = 15$ pF $R_L = 5$ k Ω	2.3 to 2.7	1.65 to 1.95	1.0	7.0	ns
				2.3 to 2.7	1.0	6.6	
				3.0 to 3.6	1.0	5.9	
			3.0 to 3.6	1.65 to 1.95	1.0	7.7	
				2.3 to 2.7	1.0	5.9	
				3.0 to 3.6	1.0	5.2	
	t_{PZL}	$C_L = 15$ pF $R_L = 5$ k Ω	2.3 to 2.7	1.65 to 1.95	1.0	7.0	ns
				2.3 to 2.7	1.0	6.6	
				3.0 to 3.6	1.0	5.9	
			3.0 to 3.6	1.65 to 1.95	1.0	7.7	
				2.3 to 2.7	1.0	5.9	
				3.0 to 3.6	1.0	5.2	
3-state output disable time	t_{PLZ}	$C_L = 15$ pF $R_L = 5$ k Ω	2.3 to 2.7	1.65 to 1.95	1.0	7.9	ns
				2.3 to 2.7	1.0	8.7	
				3.0 to 3.6	1.0	8.9	
			3.0 to 3.6	1.65 to 1.95	1.0	9.0	
				2.3 to 2.7	1.0	9.8	
				3.0 to 3.6	1.0	10.2	
	t_{PHZ}	$C_L = 15$ pF $R_L = 5$ k Ω	2.3 to 2.7	1.65 to 1.95	1.0	7.9	ns
				2.3 to 2.7	1.0	8.7	
				3.0 to 3.6	1.0	8.9	
			3.0 to 3.6	1.65 to 1.95	1.0	9.0	
				2.3 to 2.7	1.0	9.8	
				3.0 to 3.6	1.0	10.2	

9.5. AC Test Circuit

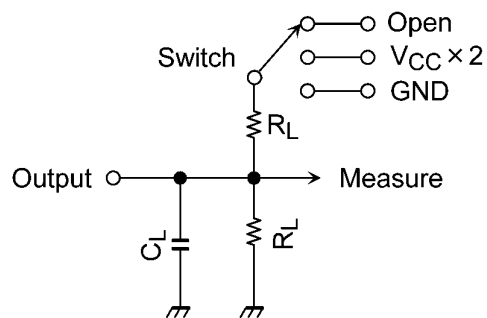


Table 9.5.1 Parameter for AC Test Circuit

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

9.6. AC Waveform

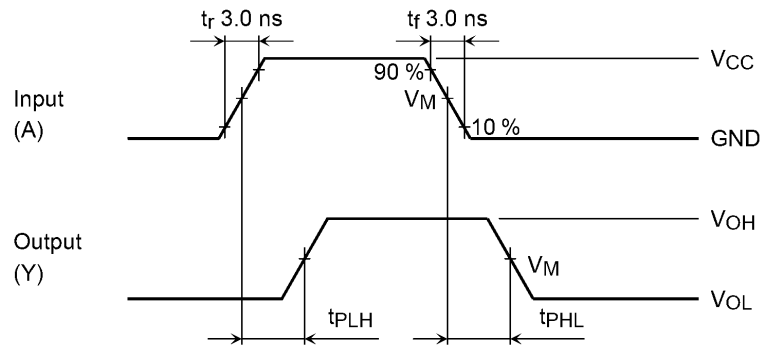


Fig. 9.6.1 t_{PLH} , t_{PHL}

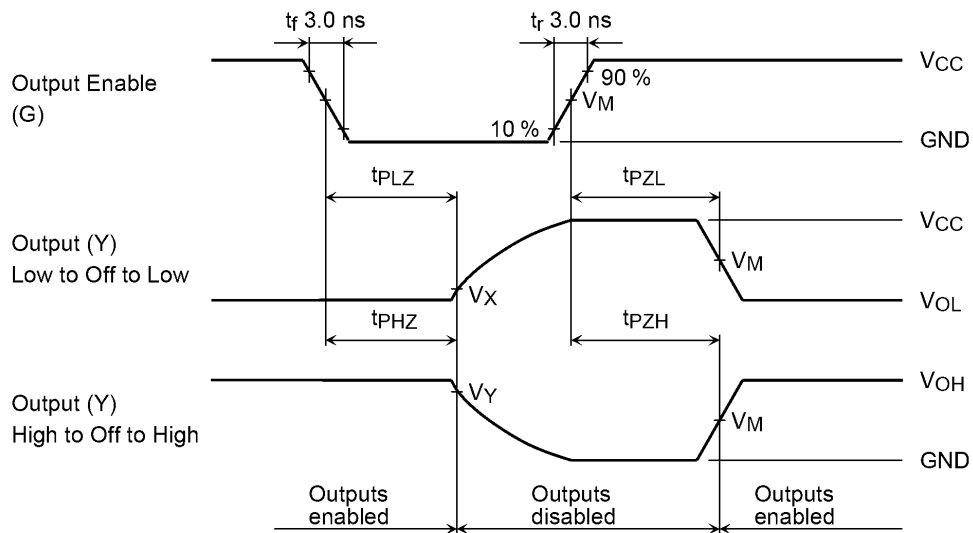


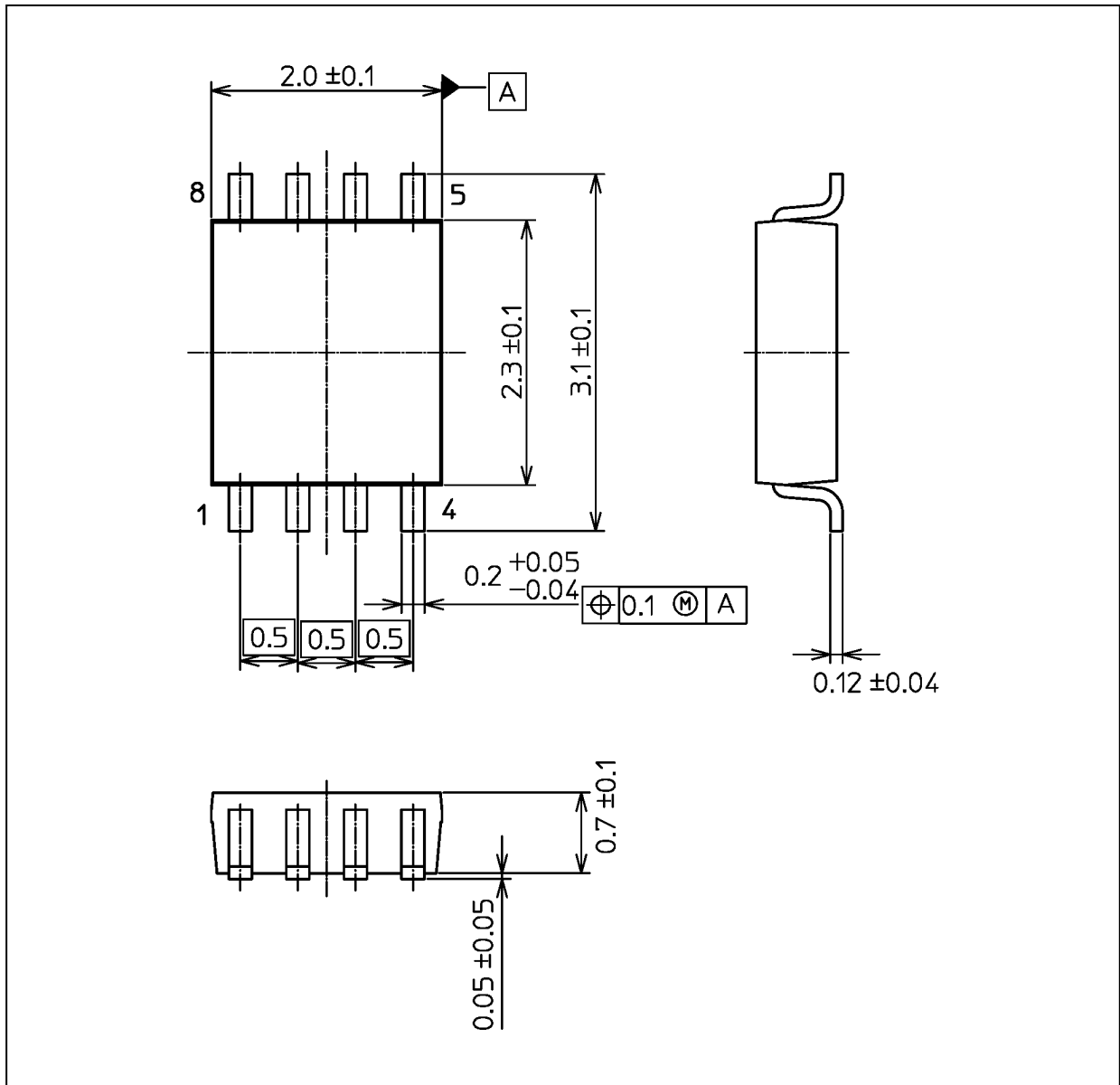
Fig. 9.6.2 t_{PLZ} , t_{PHZ} , t_{PZL} , t_{PZH}

Table 9.6.1 AC Waveform Symbols

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

Package Dimensions

Unit: mm



Weight: 0.01 g (typ.)

Package Name(s)
Nickname: US8

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