

7UL1G126FS

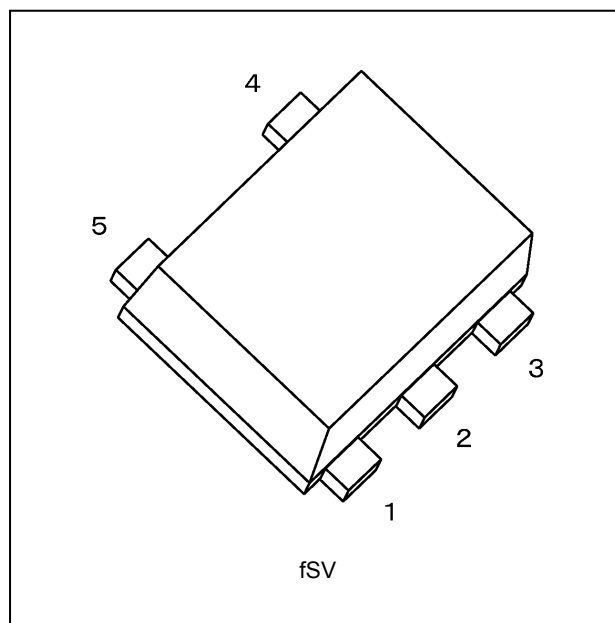
1. Functional Description

- Bus Buffer with 3-State Output

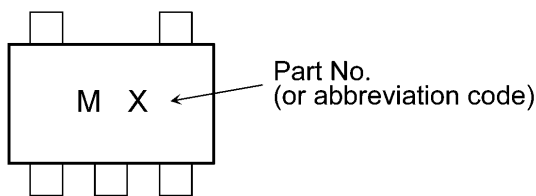
2. Features

- (1) High output current: ± 8.0 mA (min) at $V_{CC} = 3.0$ V
- (2) Super high speed operation: $t_{pd} = 2.5$ 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

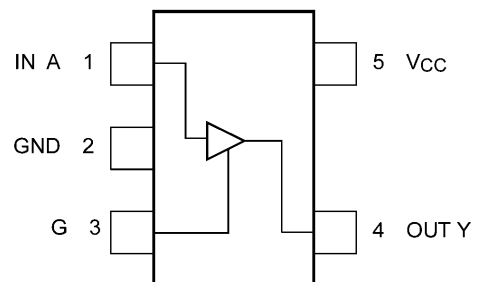
3. Packaging



4. Marking and Pin Assignment



Marking

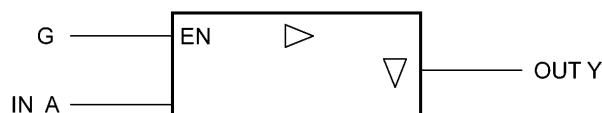


Pin Assignment (Top view)

Start of commercial production

2018-10

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

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 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	$V_{CC} \times 0.70$	—		
			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	—	± 0.5	μ 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	—	± 10.0	μ A	
Power-OFF leakage current	I_{OFF}	$V_{IN} = 0$ to 3.6 V, $V_{OUT} = 0$ to 3.6 V	0	—	10.0	μ A	
Quiescent supply current	I_{CC}	$V_{IN} = V_{CC}$ or GND	3.6	—	10.0	μ A	

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)	C_L (pF)	Min	Typ.	Max	Unit			
Propagation delay time	t_{PLH}, t_{PHL}		$R_L = 1\text{ M}\Omega$	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				
			$R_L = 1\text{ M}\Omega$	0.9	15	—	22.9	—				
				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				
			$R_L = 1\text{ M}\Omega$	0.9	30	—	30.6	—				
				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}		$R_L = 100\text{ k}\Omega$	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					
$R_L = 100\text{ k}\Omega$	0.9	15				—	25.2	—				
	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				
$R_L = 100\text{ k}\Omega$	0.9	30				—	31.0	—				
	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}					$R_L = 100\text{ k}\Omega$	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					
			$R_L = 100\text{ k}\Omega$	0.9	15	—	152.4	—				
				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				

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	—	246.9	—	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	6.7		
			2.3 to 2.7		1.0	4.4		
			3.0 to 3.6		1.0	3.7		
		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	7.1		
			2.3 to 2.7		1.0	5.0		
			3.0 to 3.6		1.0	3.9		
		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	9.6		
			2.3 to 2.7		1.0	6.1		
			3.0 to 3.6		1.0	4.8		
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		7.5
					2.3 to 2.7	1.0		5.2
		3.0 to 3.6	1.0	4.2				
		R _L = 100 kΩ	R _L = 5 kΩ	0.9	15	—		—
				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	R _L = 5 kΩ	0.9	30	—		—
				1.1 to 1.3		1.0		50.5
				1.4 to 1.6		1.0		15.1

Characteristics	Symbol	Test Condition	V _{CC} (V)	C _L (pF)	Min	Max	Unit
Output enable time	t _{PZL} , t _{PZH}	R _L = 5 kΩ	1.65 to 1.95	30	1.0	11.9	ns
			2.3 to 2.7		1.0	7.6	
			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

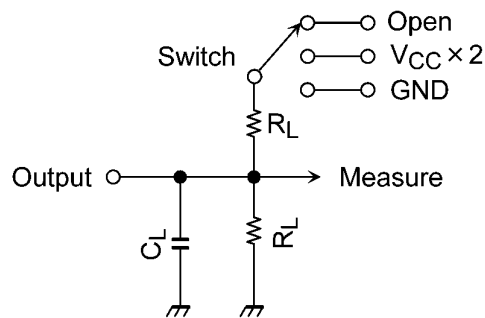


Table 9.5.1 Parameter for AC Test Circuit

Characteristics	Switch
t _{PLH} , t _{PHL}	Open
t _{PLZ} , t _{PZL}	V _{CC} × 2
t _{PHZ} , t _{PZH}	GND

9.6. AC Waveform

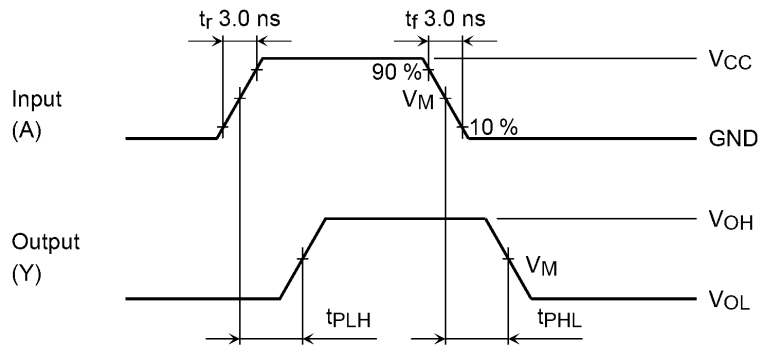


Fig. 9.6.1 t_{PLH} , t_{PHL}

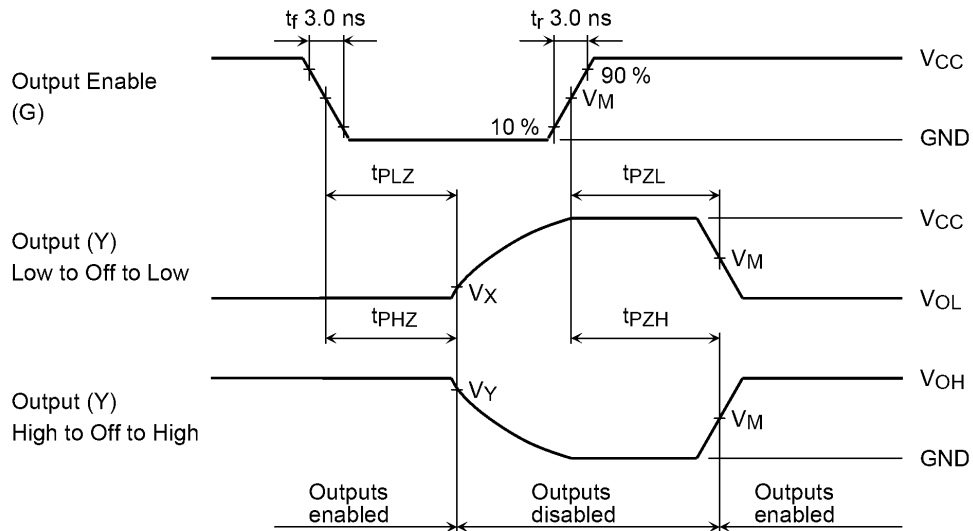


Fig. 9.6.2 t_{PLZ} , t_{PHZ} , t_{PZL} , t_{PZH}

Table 9.6.1 AC Waveform Symbols

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

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