CMOS Digital Integrated Circuits Silicon Monolithic

7UL1T00FS

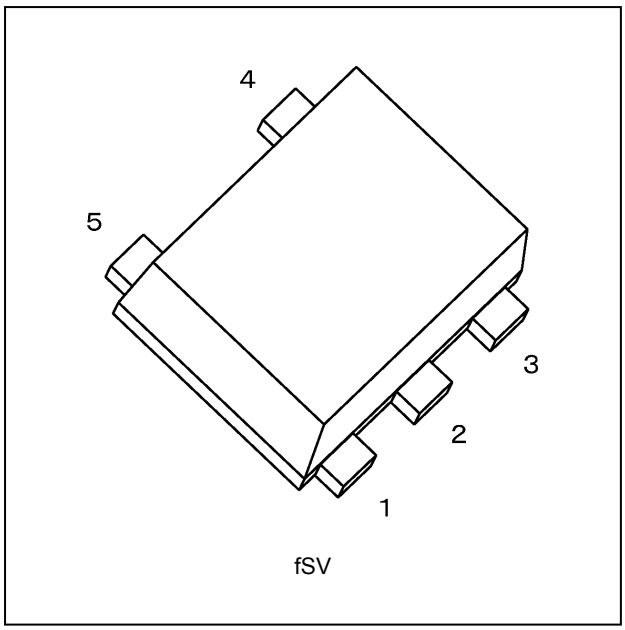
1. Functional Description

- 2-Input NAND Gate with Level Shifting

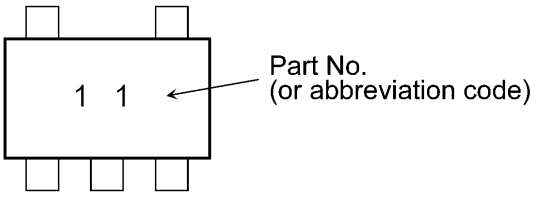
2. Features

(1) Wide operating temperature range: T_{opr} = -40 to 125 °C
(2) Operating supply voltage range: V_{CC} = 2.3 V to 3.6 V
(3) The high-level input voltage is up translation to the power supply voltage.
(4) The high-level input voltage is down translation to the power supply voltage.
(5) 3.6 V tolerant inputs
(6) 3.6 V power-down protection is provided on output.

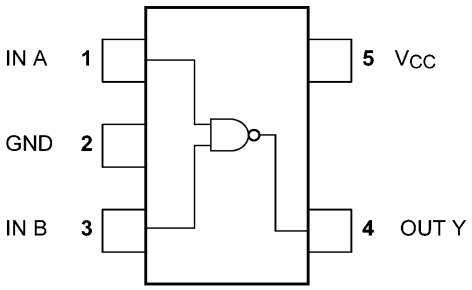
3. Packaging



4. Marking and Pin Assignment



Marking



Pin Assignment (Top view)

Start of commercial production
2021-12

5. IEC Logic Symbol

6. Truth Table

Input A	Input B	Output Y
L	L	H
L	H	H
H	L	H
H	H	L

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
		(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	°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 V

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

Note 3: V_{OUT} < 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 125	°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 °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} or V_{IL}	I_{OH} = -0.02 mA	2.3 to 3.6	V_{CC} -0.1	—	—	V
			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}	I_{OL} = 0.02 mA	2.3 to 3.6	—	—	0.1	V
			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
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
	I_{CCT}	V_{IN} = 1.5 V (per input)		3.6	—	—	35	

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}	—		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} or V_{IL}	I_{OH} = -0.02 mA	2.3 to 3.6	V_{CC} -0.1	—	V
			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}	I_{OL} = 0.02 mA	2.3 to 3.6	—	0.1	V
			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
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
	I_{CCT}	V_{IN} = 1.5 V (per input)		3.6	—	40	

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}	—		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 mA	2.3 to 3.6	V_{CC} -0.1	—	V
			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	2.3 to 3.6	—	0.1	V
			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
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
Quiescent supply current	I_{CCT}	V_{IN} = 1.5 V (per input)		3.6	—	55	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)	V_{IN} (V)	Min	Typ.	Max	Unit
Propagation delay time	t_{PLH}		C_L = 15 pF R_L = 1 MΩ	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 pF R_L = 1 MΩ	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.

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

9.5. 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)	V_{IN} (V)	Min	Max	Unit
Propagation delay time	t_{PLH}	C_L = 15 pF R_L = 1 MΩ	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 pF R_L = 1 MΩ	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	

9.6. AC Characteristics
(Unless otherwise specified, T_a = -40 to 125 °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 MΩ	2.3 to 2.7	1.65 to 1.95	1.0	6.6	ns
				2.3 to 2.7	1.0	7.0	
				3.0 to 3.6	1.0	7.6	
			3.0 to 3.6	1.65 to 1.95	1.0	5.5	
				2.3 to 2.7	1.0	5.6	
				3.0 to 3.6	1.0	5.9	
	t_{PHL}	C_L = 15 pF R_L = 1 MΩ	2.3 to 2.7	1.65 to 1.95	1.0	6.5	ns
				2.3 to 2.7	1.0	5.7	
				3.0 to 3.6	1.0	5.2	
			3.0 to 3.6	1.65 to 1.95	1.0	6.2	
				2.3 to 2.7	1.0	5.3	
				3.0 to 3.6	1.0	4.7	

9.7. AC Waveform

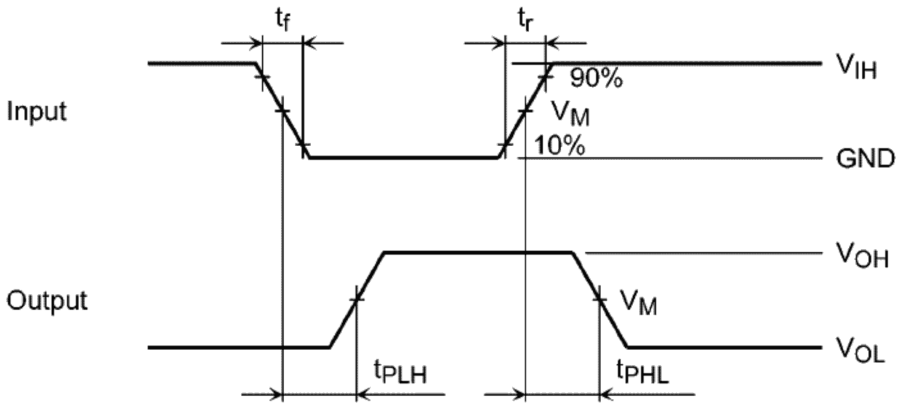


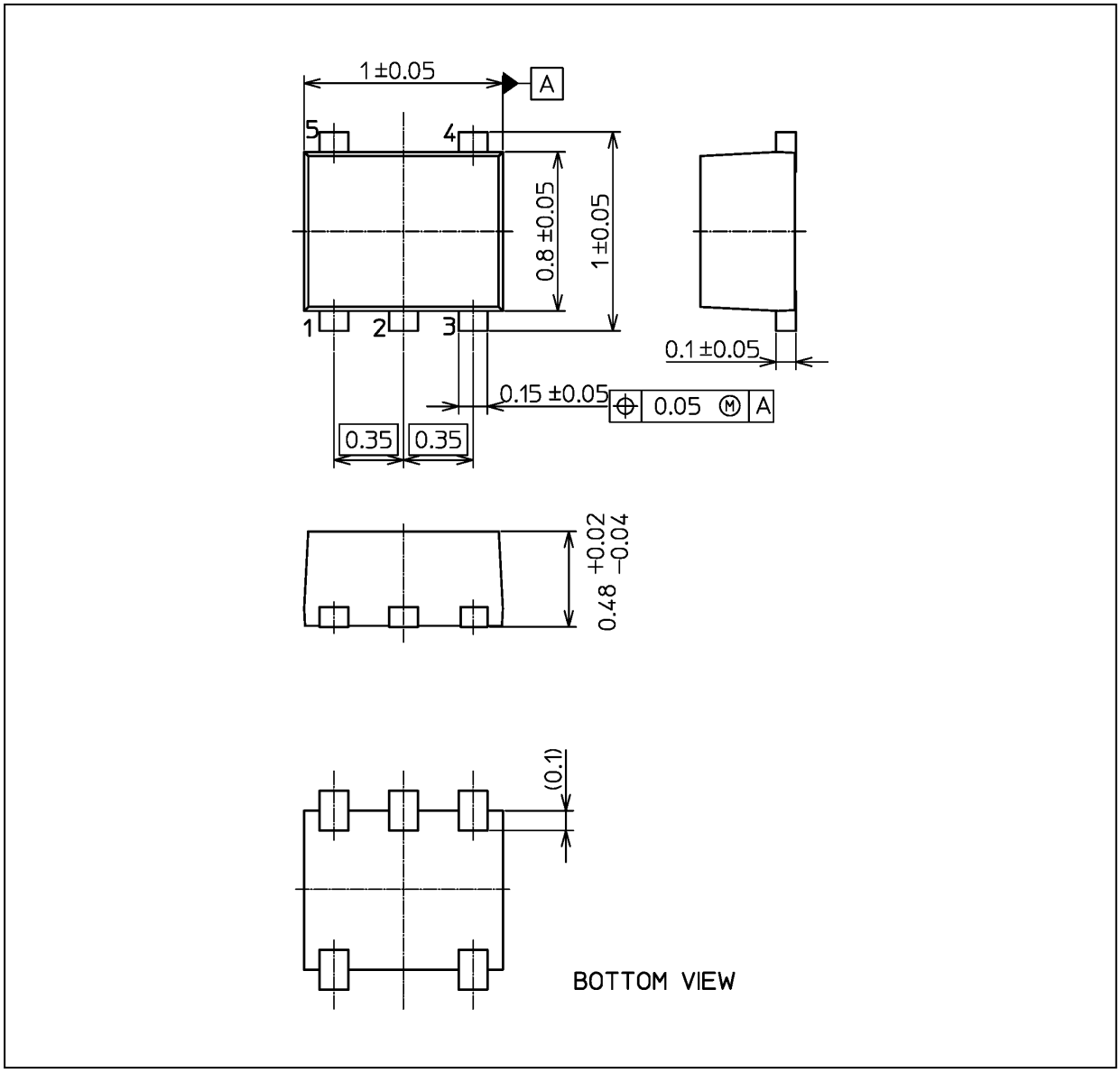
Fig. 9.7.1 t_{PLH}, t_{PHL}

Table 9.7.1 AC Waveform Symbols

	Symbol	V_{CC} = 3.3 ± 0.3 V	V_{CC} = 2.5 ± 0.2 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: 1.0 mg (typ.)

Package Name(s)
JEDEC: SOT-953
Nickname: fSV

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