CMOS Digital Integrated Circuits Silicon Monolithic

7UL1G14FU

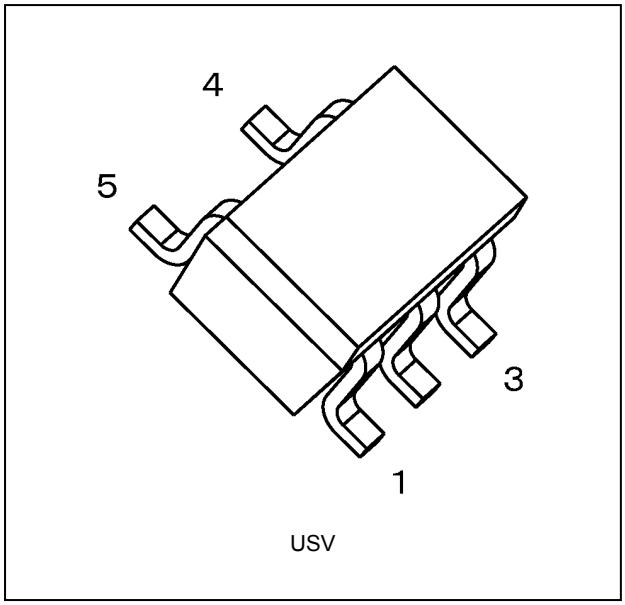
1. Functional Description

- Schmitt Inverter

2. Features

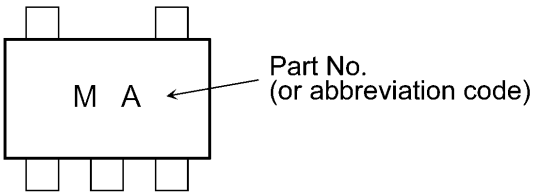
(1) Wide operating temperature range: T_{opr} = -40 to 125 °C
(2) High output current: ±8.0 mA (min) at V_{CC} = 3.0 V
(3) Super high speed operation: t_{pd} = 3.0 ns (typ.) at V_{CC} = 3.3 V, C_L = 15 pF
(4) Operating voltage range: V_{CC} = 0.9 to 3.6 V
(5) 3.6 V tolerant input
(6) 3.6 V power down protection output

3. Packaging

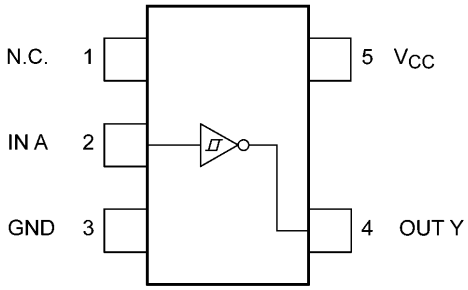


USV

4. Marking and Pin Assignment



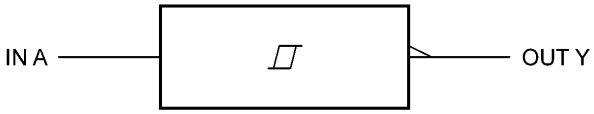
Marking



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 °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	°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}		—	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 125	°C

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
Positive threshold voltage	V_P	—		0.9	—	—	0.73	V
				1.1	—	—	0.86	
				1.4	—	—	1.07	
				1.65	—	—	1.23	
				2.3	—	—	1.66	
				3.0	—	—	2.14	
Negative threshold voltage	V_N	—		0.9	0.18	—	—	V
				1.1	0.26	—	—	
				1.4	0.36	—	—	
				1.65	0.45	—	—	
				2.3	0.69	—	—	
				3.0	0.96	—	—	
Hysteresis voltage	V_H	—		0.9	0.15	—	0.38	V
				1.1	0.18	—	0.41	
				1.4	0.20	—	0.48	
				1.65	0.22	—	0.60	
				2.3	0.35	—	0.76	
				3.0	0.45	—	0.93	
High-level output voltage	V_{OH}	V_{IN} = V_{IL}	I_{OH} = -0.02 mA	0.9	0.75	—	—	V
			I_{OH} = -0.3 mA	1.1 to 1.3	V_{CC} × 0.75	—	—	
			I_{OH} = -1.7 mA	1.4 to 1.6	V_{CC} × 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}	I_{OL} = 0.02 mA	0.9	—	—	0.1	V
			I_{OL} = 0.3 mA	1.1 to 1.3	—	—	V_{CC} × 0.25	
			I_{OL} = 1.7 mA	1.4 to 1.6	—	—	V_{CC} × 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	—	—	±0.1	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

9.2. DC Characteristics (Unless otherwise specified, T_a = -40 to 85 °C)

Characteristics	Symbol	Test Condition		V_{CC} (V)	Min	Max	Unit
Positive threshold voltage	V_P	—		0.9	—	0.73	V
				1.1	—	0.86	
				1.4	—	1.07	
				1.65	—	1.23	
				2.3	—	1.66	
				3.0	—	2.14	
Negative threshold voltage	V_N	—		0.9	0.18	—	V
				1.1	0.26	—	
				1.4	0.36	—	
				1.65	0.45	—	
				2.3	0.69	—	
				3.0	0.96	—	
Hysteresis voltage	V_H	—		0.9	0.15	0.38	V
				1.1	0.18	0.41	
				1.4	0.20	0.48	
				1.65	0.22	0.60	
				2.3	0.35	0.76	
				3.0	0.45	0.93	
High-level output voltage	V_{OH}	V_{IN} = V_{IL}	I_{OH} = -0.02 mA	0.9	0.75	—	V
			I_{OH} = -0.3 mA	1.1 to 1.3	V_{CC} × 0.75	—	
			I_{OH} = -1.7 mA	1.4 to 1.6	V_{CC} × 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}	I_{OL} = 0.02 mA	0.9	—	0.1	V
			I_{OL} = 0.3 mA	1.1 to 1.3	—	V_{CC} × 0.25	
			I_{OL} = 1.7 mA	1.4 to 1.6	—	V_{CC} × 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	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

9.3. DC Characteristics (Unless otherwise specified, T_a = -40 to 125 °C)

Characteristics	Symbol	Test Condition		V_{CC} (V)	Min	Max	Unit
Positive threshold voltage	V_P	—		0.9	—	0.73	V
				1.1	—	0.86	
				1.4	—	1.07	
				1.65	—	1.23	
				2.3	—	1.66	
				3.0	—	2.14	V
Negative threshold voltage	V_N	—		0.9	0.18	—	
				1.1	0.26	—	
				1.4	0.36	—	
				1.65	0.45	—	
				2.3	0.69	—	
				3.0	0.96	—	
Hysteresis voltage	V_H	—		0.9	0.15	0.38	V
				1.1	0.18	0.41	
				1.4	0.20	0.48	
				1.65	0.22	0.60	
				2.3	0.35	0.76	
				3.0	0.45	0.93	
High-level output voltage	V_{OH}	V_{IN} = V_{IL}	I_{OH} = -0.02 mA	0.9	0.75	—	V
			I_{OH} = -0.3 mA	1.1 to 1.3	V_{CC} × 0.73	—	
			I_{OH} = -1.7 mA	1.4 to 1.6	V_{CC} × 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}	I_{OL} = 0.02 mA	0.9	—	0.1	V
			I_{OL} = 0.3 mA	1.1 to 1.3	—	V_{CC} × 0.27	
			I_{OL} = 1.7 mA	1.4 to 1.6	—	V_{CC} × 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	—	±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

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)	C_L (pF)	Min	Typ.	Max	Unit
Propagation delay time	t_{PLH},t_{PHL}		R_L = 1 MΩ	0.9	10	—	22.0	—	ns
				1.1 to 1.3		—	11.1	22.6	
				1.4 to 1.6		—	6.7	10.5	
				1.65 to 1.95		—	5.0	7.8	
				2.3 to 2.7		—	3.3	5.4	
				3.0 to 3.6		—	2.7	4.4	
Propagation delay time	t_{PLH},t_{PHL}		R_L = 1 MΩ	0.9	15	—	24.2	—	ns
				1.1 to 1.3		—	12.1	25.1	
				1.4 to 1.6		—	7.3	11.5	
				1.65 to 1.95		—	5.5	8.4	
				2.3 to 2.7		—	3.7	5.7	
				3.0 to 3.6		—	3.0	4.6	
Propagation delay time	t_{PLH},t_{PHL}		R_L = 1 MΩ	0.9	30	—	31.0	—	ns
				1.1 to 1.3		—	15.7	35.7	
				1.4 to 1.6		—	9.1	15.8	
				1.65 to 1.95		—	7.1	10.7	
				2.3 to 2.7		—	4.7	6.9	
				3.0 to 3.6		—	3.9	5.2	
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.

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

9.5. 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)	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	35.9	
			1.4 to 1.6		1.0	11.3	
			1.65 to 1.95		1.0	8.2	
			2.3 to 2.7		1.0	5.8	
			3.0 to 3.6		1.0	4.6	
Propagation delay time	t_{PLH},t_{PHL}	R_L = 1 MΩ	0.9	15	—	—	ns
			1.1 to 1.3		1.0	41.8	
			1.4 to 1.6		1.0	12.6	
			1.65 to 1.95		1.0	8.7	
			2.3 to 2.7		1.0	6.1	
			3.0 to 3.6		1.0	5.0	
Propagation delay time	t_{PLH},t_{PHL}	R_L = 1 MΩ	0.9	30	—	—	ns
			1.1 to 1.3		1.0	58.1	
			1.4 to 1.6		1.0	17.6	
			1.65 to 1.95		1.0	11.7	
			2.3 to 2.7		1.0	8.1	
			3.0 to 3.6		1.0	6.1	

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)	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	44.8	
			1.4 to 1.6		1.0	11.9	
			1.65 to 1.95		1.0	8.5	
			2.3 to 2.7		1.0	6.1	
			3.0 to 3.6		1.0	4.8	
Propagation delay time	t_{PLH},t_{PHL}	R_L = 1 MΩ	0.9	15	—	—	ns
			1.1 to 1.3		1.0	53.0	
			1.4 to 1.6		1.0	13.4	
			1.65 to 1.95		1.0	8.9	
			2.3 to 2.7		1.0	6.4	
			3.0 to 3.6		1.0	5.3	
Propagation delay time	t_{PLH},t_{PHL}	R_L = 1 MΩ	0.9	30	—	—	ns
			1.1 to 1.3		1.0	73.1	
			1.4 to 1.6		1.0	18.8	
			1.65 to 1.95		1.0	12.4	
			2.3 to 2.7		1.0	8.9	
			3.0 to 3.6		1.0	6.7	

9.7. AC Waveform

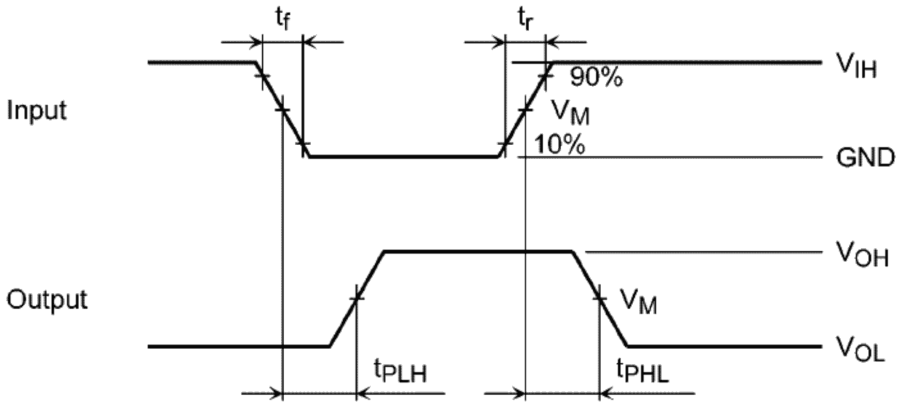


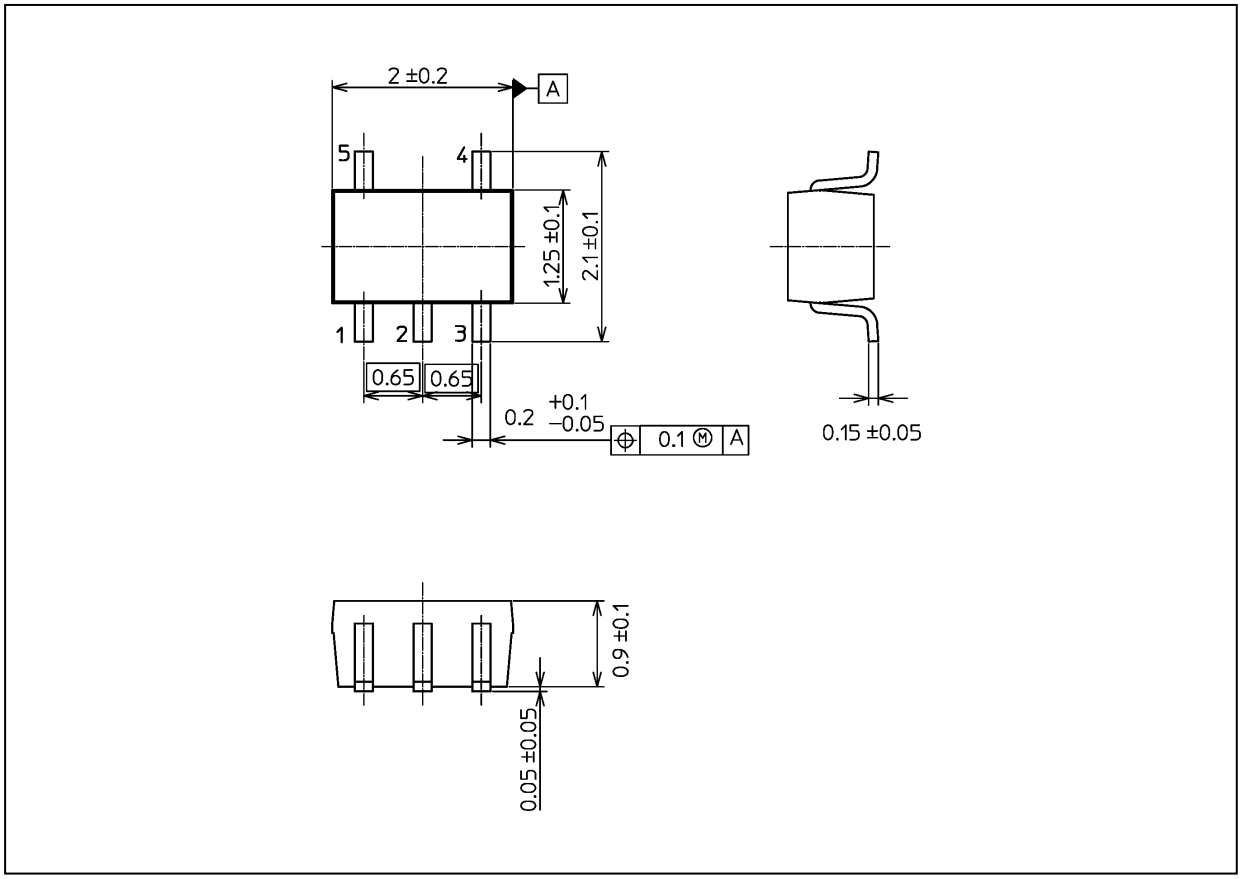
Fig. 9.7.1 t_{PLH}, t_{PHL}

Table 9.7.1 AC Waveform Symbols

	Symbol	V_{CC} = 3.3 ± 0.3 V	V_{CC} = 2.5 ± 0.2 V	V_{CC} = 1.8 ± 0.15 V	V_{CC} = 1.5 ± 0.1 V	V_{CC} = 1.2 ± 0.1 V	V_{CC} = 0.9 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

Package Dimensions

Unit: mm



Weight: 6.2 mg (typ.)

Package Name(s)
Nickname: USV

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