CMOS Digital Integrated Circuits Silicon Monolithic

7UL3GU04FK

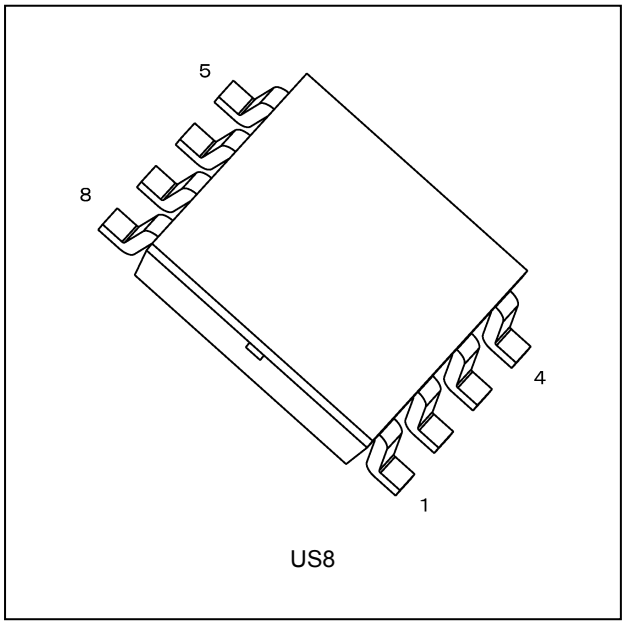
1. Functional Description

- Inverter (Unbuffer)

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} = 2.3 ns (typ.) at V_{CC} = 3.3 V, C_L = 15 pF
(4) Operating voltage range: V_{CC} = 0.9 V to 3.6 V
(5) 3.6 V tolerant input

3. Packaging



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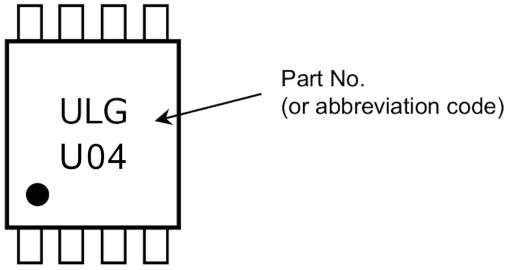
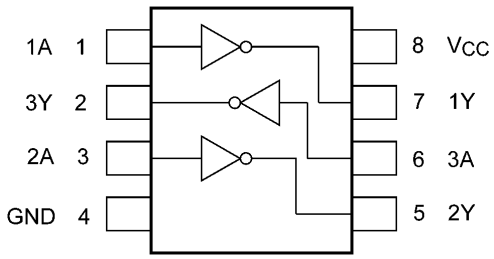
4. Marking and Pin Assignment



Marking



Pin Assignment (Top view)

Start of commercial production
2023-03

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}		-0.5 to V_{CC} + 0.5	V
Input diode current	I_{IK}		-20	mA
Output diode current	I_{OK}	(Note 1)	±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_{OUT} < GND, V_{OUT} > V_{CC}

8. Operating Ranges (Note)

Characteristics	Symbol	Test Condition	Rating	Unit
Supply voltage	V_{CC}	—	0.9 to 3.6	V
Output voltage	V_{OUT}	—	0 to V_{CC}	V
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.

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}	—		0.9	V_{CC}	—	—	V
				1.1 to 1.3	V_{CC} × 0.8	—	—	
				1.4 to 1.6	V_{CC} × 0.8	—	—	
				1.65 to 1.95	V_{CC} × 0.8	—	—	
				2.3 to 2.7	V_{CC} × 0.8	—	—	
				3.0 to 3.6	V_{CC} × 0.8	—	—	
Low-level input voltage	V_{IL}	—		0.9	—	—	GND	V
				1.1 to 1.3	—	—	V_{CC} × 0.2	
				1.4 to 1.6	—	—	V_{CC} × 0.2	
				1.65 to 1.95	—	—	V_{CC} × 0.2	
				2.3 to 2.7	—	—	V_{CC} × 0.2	
				3.0 to 3.6	—	—	V_{CC} × 0.2	
High-level output voltage	V_{OH}	V_{IN} = GND	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_{CC}	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
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} × 0.8	—	
				1.4 to 1.6	V_{CC} × 0.8	—	
				1.65 to 1.95	V_{CC} × 0.8	—	
				2.3 to 2.7	V_{CC} × 0.8	—	
				3.0 to 3.6	V_{CC} × 0.8	—	
Low-level input voltage	V_{IL}	—		0.9	—	GND	V
				1.1 to 1.3	—	V_{CC} × 0.2	
				1.4 to 1.6	—	V_{CC} × 0.2	
				1.65 to 1.95	—	V_{CC} × 0.2	
				2.3 to 2.7	—	V_{CC} × 0.2	
				3.0 to 3.6	—	V_{CC} × 0.2	
High-level output voltage	V_{OH}	V_{IN} = GND	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_{CC}	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
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
High-level input voltage	V_{IH}	—		0.9	V_{CC}	—	V
				1.1 to 1.3	V_{CC} × 0.8	—	
				1.4 to 1.6	V_{CC} × 0.8	—	
				1.65 to 1.95	V_{CC} × 0.8	—	
				2.3 to 2.7	V_{CC} × 0.8	—	
				3.0 to 3.6	V_{CC} × 0.8	—	
Low-level input voltage	V_{IL}	—		0.9	—	GND	V
				1.1 to 1.3	—	V_{CC} × 0.2	
				1.4 to 1.6	—	V_{CC} × 0.2	
				1.65 to 1.95	—	V_{CC} × 0.2	
				2.3 to 2.7	—	V_{CC} × 0.2	
				3.0 to 3.6	—	V_{CC} × 0.2	
High-level output voltage	V_{OH}	V_{IN} = GND	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_{CC}	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
Quiescent supply current	I_{CC}	V_{IN} = V_{CC} or GND		3.6	—	80	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 See Fig. 9.7.1, Table 9.7.1	0.9	10	—	9.6	—	ns
				1.1 to 1.3		—	5.9	18.4	
				1.4 to 1.6		—	4.0	8.5	
				1.65 to 1.95		—	3.2	6.2	
				2.3 to 2.7		—	2.3	3.9	
				3.0 to 3.6		—	1.9	3.1	
Propagation delay time	t_{PLH},t_{PHL}		R_L = 1 MΩ See Fig. 9.7.1, Table 9.7.1	0.9	15	—	11.8	—	ns
				1.1 to 1.3		—	7.1	21.5	
				1.4 to 1.6		—	4.7	9.3	
				1.65 to 1.95		—	3.8	6.9	
				2.3 to 2.7		—	2.7	4.4	
				3.0 to 3.6		—	2.3	3.5	
Propagation delay time	t_{PLH},t_{PHL}		R_L = 1 MΩ See Fig. 9.7.1, Table 9.7.1	0.9	30	—	18.6	—	ns
				1.1 to 1.3		—	10.2	29.6	
				1.4 to 1.6		—	6.5	13.1	
				1.65 to 1.95		—	5.2	9.2	
				2.3 to 2.7		—	3.7	5.7	
				3.0 to 3.6		—	3.1	4.6	
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 See Fig. 9.7.1, Table 9.7.1	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	
Propagation delay time	t_{PLH},t_{PHL}	R_L = 1 MΩ See Fig. 9.7.1, Table 9.7.1	0.9	15	—	—	ns
			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	4.0	
Propagation delay time	t_{PLH},t_{PHL}	R_L = 1 MΩ See Fig. 9.7.1, Table 9.7.1	0.9	30	—	—	ns
			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	5.0	

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 See Fig. 9.7.1, Table 9.7.1	0.9	10	—	—	ns
			1.1 to 1.3		1.0	44.8	
			1.4 to 1.6		1.0	11.0	
			1.65 to 1.95		1.0	7.1	
			2.3 to 2.7		1.0	4.8	
			3.0 to 3.6		1.0	4.1	
Propagation delay time	t_{PLH},t_{PHL}	R_L = 1 MΩ See Fig. 9.7.1, Table 9.7.1	0.9	15	—	—	ns
			1.1 to 1.3		1.0	47.7	
			1.4 to 1.6		1.0	12.5	
			1.65 to 1.95		1.0	7.3	
			2.3 to 2.7		1.0	5.4	
			3.0 to 3.6		1.0	4.4	
Propagation delay time	t_{PLH},t_{PHL}	R_L = 1 MΩ See Fig. 9.7.1, Table 9.7.1	0.9	30	—	—	ns
			1.1 to 1.3		1.0	73.6	
			1.4 to 1.6		1.0	17.8	
			1.65 to 1.95		1.0	9.9	
			2.3 to 2.7		1.0	6.4	
			3.0 to 3.6		1.0	5.3	

9.7. AC Waveform

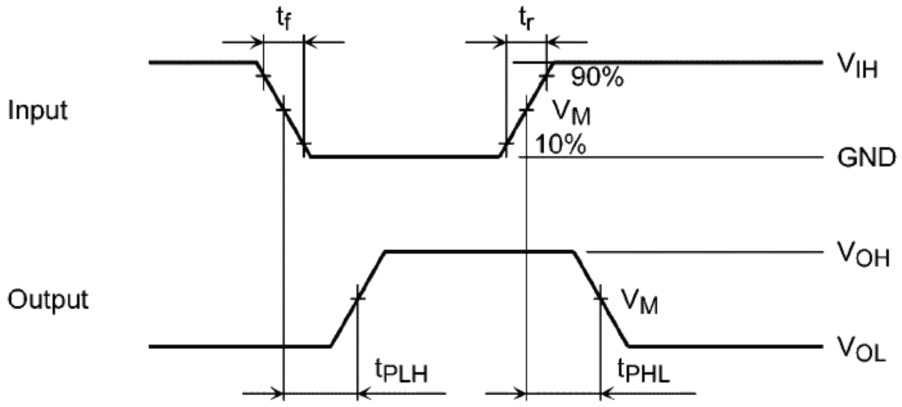


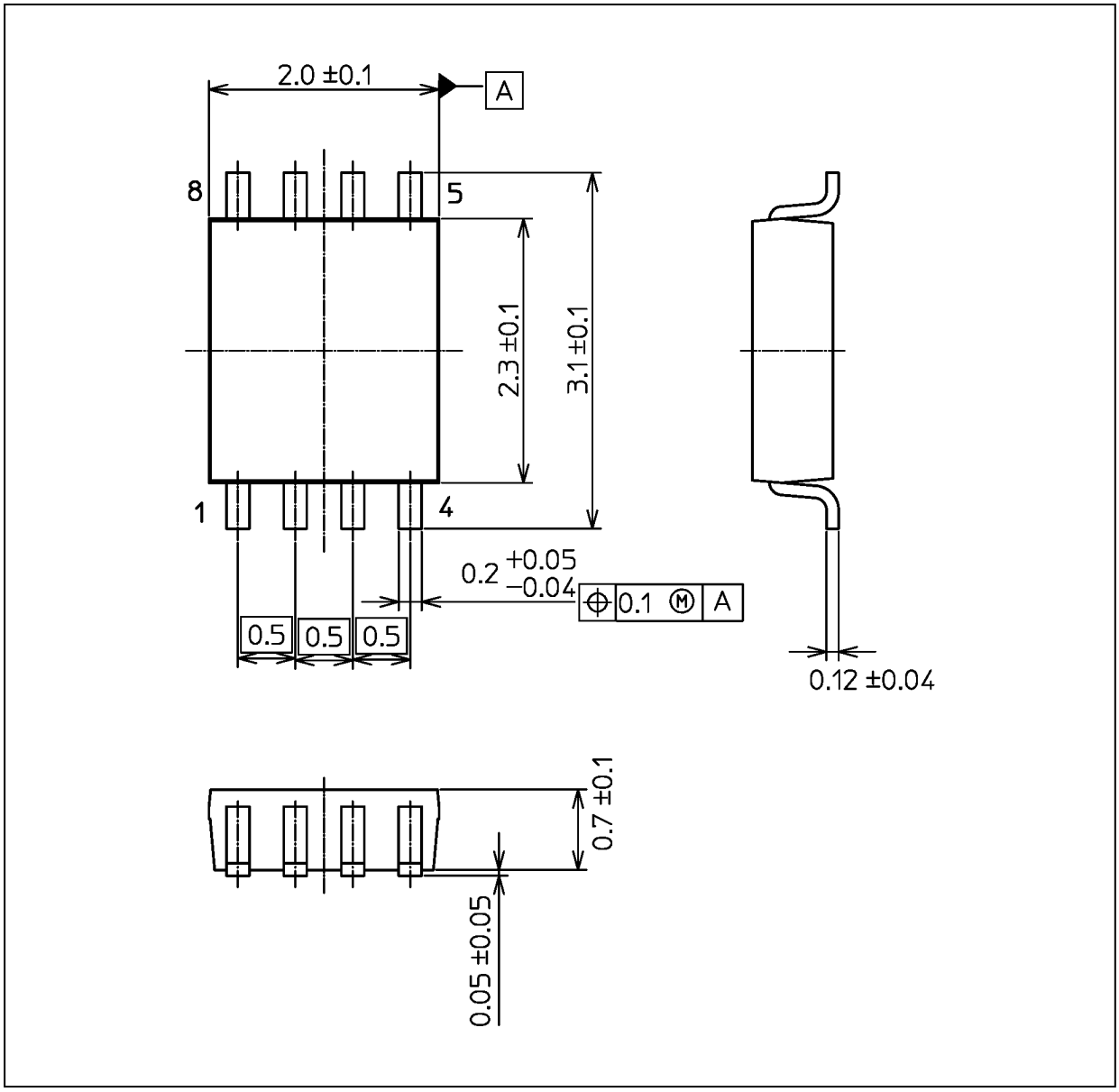
Fig. 9.7.1 t_{PLH}, t_{PHL}

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: 0.01 g (typ.)

Package Name(s)
Nickname: US8

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