CMOS Digital Integrated Circuits Silicon Monolithic

TC7SH09FU

1. Functional Description

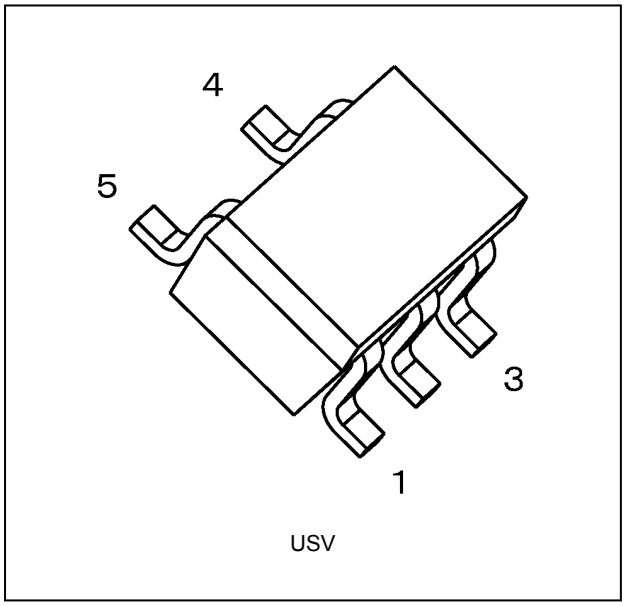
- 2-Input AND Gate (Open Drain)

2. Features

(1) AEC-Q100 (Rev. H) (Note 1)
(2) Wide operating temperature : T_{opr} =-40 to 125 °C (Note 2)
(3) High speed operation: t_{pZL} = 3.2 ns (typ.) (V_{CC} = 5.0 V, C_L = 15 pF)
(4) Low power dissipation: I_{CC} = 2.0 μA (max) (T_a = 25 °C)
(5) Wide operating voltage range: V_{CC} = 2.0 to 5.5 V
(6) 5.5 V tolerant inputs
(7) 5.5 V power down protection output

Note 1: This device is compliant with the reliability requirements of AEC-Q100. For details, contact your Toshiba sales representative.
Note 2: For devices with the ordering part number ending in J(CT. T_{opr} = -40 to 85 °C for the other devices.

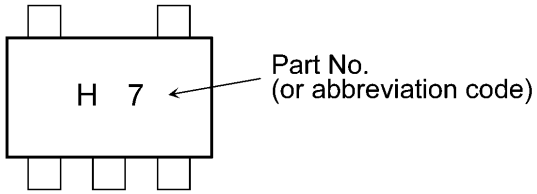
3. Packaging



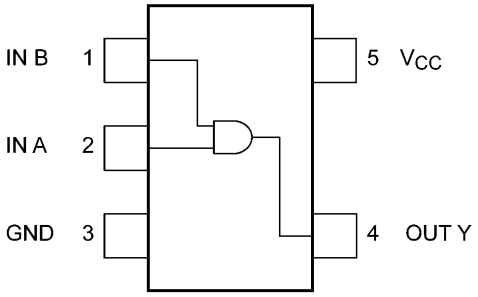
USV

Start of commercial production
2011-08

4. Marking and Pin Assignment



Marking



Pin Assignment (Top view)

5. IEC Logic Symbol

6. Truth Table

A	B	Y
L	L	L
L	H	L
H	L	L
H	H	Z

Z: High impedance

7. Absolute Maximum Ratings (Note) (Unless otherwise specified, T_a = 25 °C)

Characteristics	Symbol	Note	Rating	Unit
Supply voltage	V_{CC}		-0.5 to 7.0	V
Input voltage	V_{IN}		-0.5 to 7.0	
DC output voltage	V_{OUT}	(Note 1)	-0.5 to 7.0	
Input diode current	I_{IK}		-20	mA
Output diode current	I_{OK}	(Note 2)	-20	
DC output current	I_{OUT}		+25	
V_{CC}/ground current	I_{CC}		±50	
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: Do not exceed I_{OUT} of absolute maximum ratings.

Note 2: V_{OUT} < GND

8. Operating Ranges (Note)

Characteristics	Symbol	Note	Test Condition	Rating	Unit
Supply voltage	V_{CC}		—	2.0 to 5.5	V
Input voltage	V_{IN}		—	0 to 5.5	V
Output voltage	V_{OUT}	(Note 1)	—	0 to 5.5	V
		(Note 2)	—	0 to V_{CC}	
Operating temperature	T_{opr}	(Note 3)	—	-40 to 125	°C
		(Note 4)	—	-40 to 85	
Input rise and fall time	dt/dv		V_{CC} = 3.3 ± 0.3 V	0 to 100	ns/V
			V_{CC} = 5.0 ± 0.5 V	0 to 20	

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: High impedance state.

Note 2: Low state.

Note 3: For devices with the ordering part number ending in J(CT.

Note 4: For devices except those with the ordering part number ending in J(CT.

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}	—		2.0	1.5	—	—	V
				3.0 to 5.5	V_{CC} × 0.7	—	—	
Low-level input voltage	V_{IL}	—		2.0	—	—	0.5	V
				3.0 to 5.5	—	—	V_{CC} × 0.3	
Low-level output voltage	V_{OL}	V_{IN} = V_{IL}	I_{OL} = 50 μA	2.0	—	0.0	0.1	V
				3.0	—	0.0	0.1	
				4.5	—	0.0	0.1	
			I_{OL} = 4 mA	3.0	—	—	0.36	
			I_{OL} = 8 mA	4.5	—	—	0.36	
Input leakage current	I_{IN}	V_{IN} = 5.5 V or GND		0 to 5.5	—	—	±0.1	μA
3-state output OFF-state leakage current	I_{OZ}	V_{IN} = V_{IH} V_{OUT} = V_{CC} or GND		0 to 5.5	—	—	±0.25	μA
Power-OFF leakage current	I_{OFF}	V_{IN} = 5.5 V or V_{OUT} = 0 to 5.5 V		0.0	—	—	1.0	μA
Quiescent supply current	I_{CC}	V_{IN} = V_{CC} or GND		5.5	—	—	2.0	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}	—		2.0	1.5	—	V
				3.0 to 5.5	V_{CC} × 0.7	—	
Low-level input voltage	V_{IL}	—		2.0	—	0.5	V
				3.0 to 5.5	—	V_{CC} × 0.3	
Low-level output voltage	V_{OL}	V_{IN} = V_{IL}	I_{OL} = 50 μA	2.0	—	0.1	V
				3.0	—	0.1	
				4.5	—	0.1	
			I_{OL} = 4 mA	3.0	—	0.44	
			I_{OL} = 8 mA	4.5	—	0.44	
Input leakage current	I_{IN}	V_{IN} = 5.5 V or GND		0 to 5.5	—	±1.0	μA
3-state output OFF-state leakage current	I_{OZ}	V_{IN} = V_{IH} V_{OUT} = V_{CC} or GND		0 to 5.5	—	±2.5	μA
Power-OFF leakage current	I_{OFF}	V_{IN} = 5.5 V or V_{OUT} = 0 to 5.5 V		0.0	—	10.0	μA
Quiescent supply current	I_{CC}	V_{IN} = V_{CC} or GND		5.5	—	20.0	μA

9.3. DC Characteristics (Note) (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}	—		2.0	1.5	—	V
				3.0 to 5.5	V_{CC} × 0.7	—	
Low-level input voltage	V_{IL}	—		2.0	—	0.5	V
				3.0 to 5.5	—	V_{CC} × 0.3	
Low-level output voltage	V_{OL}	V_{IN} = V_{IL}	I_{OL} = 50 μA	2.0	—	0.1	V
				3.0	—	0.1	
				4.5	—	0.1	
			I_{OL} = 4 mA	3.0	—	0.55	
			I_{OL} = 8 mA	4.5	—	0.55	
Input leakage current	I_{IN}	V_{IN} = 5.5 V or GND		0 to 5.5	—	±2.0	μA
3-state output OFF-state leakage current	I_{OZ}	V_{IN} = V_{IH} V_{OUT} = V_{CC} or GND		0 to 5.5	—	±10.0	μA
Power-OFF leakage current	I_{OFF}	V_{IN} = 5.5 V or V_{OUT} = 0 to 5.5 V		0.0	—	20.0	μA
Quiescent supply current	I_{CC}	V_{IN} = V_{CC} or GND		5.5	—	40.0	μA

Note: For devices with the ordering part number ending in J(CT.

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_{PZL}		R_L = 1 kΩ	3.3 ± 0.3	15	—	4.6	7.5	ns
					50	—	6.5	11.0	
				5.0 ± 0.5	15	—	3.2	5.5	
					50	—	4.6	7.5	
Propagation delay time	t_{PLZ}		R_L = 1 kΩ	3.3 ± 0.3	15	—	4.6	7.5	ns
					50	—	6.5	11.0	
				5.0 ± 0.5	15	—	3.2	5.5	
					50	—	4.6	7.5	
Input capacitance	C_{IN}		—			—	1.5	10	pF
Power dissipation capacitance	C_{PD}	(Note 1)	—			—	5	—	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_{PZL}	R_L = 1 kΩ	3.3 ± 0.3	15	1.0	8.5	ns
				50	1.5	12.0	
			5.0 ± 0.5	15	1.0	6.5	
				50	1.5	8.0	
Propagation delay time	t_{PLZ}	R_L = 1 kΩ	3.3 ± 0.3	15	1.0	8.5	ns
				50	1.5	12.0	
			5.0 ± 0.5	15	1.0	6.5	
				50	1.5	8.0	
Input capacitance	C_{IN}	—			—	10	pF

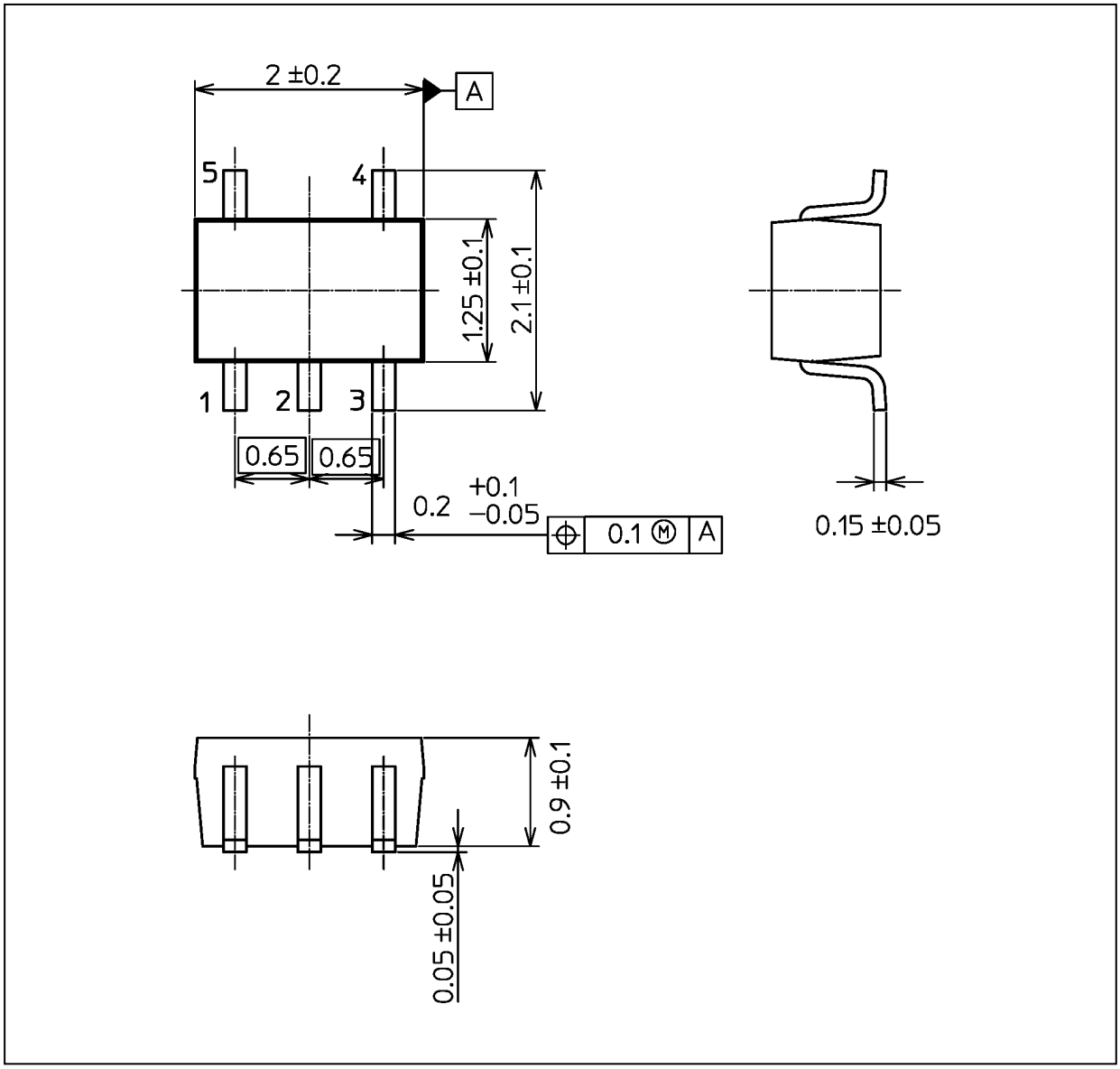
9.6. AC Characteristics (Note) (Unless otherwise specified, T_a = -40 to 125 °C, Input: $t_r = t_f$ = 3 ns)

Characteristics	Symbol	Test Condition	V_{CC} (V)	C_L (pF)	Min	Max	Unit
Propagation delay time	t_{PZL}	R_L = 1 kΩ	3.3 ± 0.3	15	1.0	10.5	ns
				50	1.5	14.0	
			5.0 ± 0.5	15	1.0	7.5	
				50	1.5	9.5	
Propagation delay time	t_{PLZ}	R_L = 1 kΩ	3.3 ± 0.3	15	1.0	10.5	ns
				50	1.5	14.0	
			5.0 ± 0.5	15	1.0	7.5	
				50	1.5	9.5	
Input capacitance	C_{IN}	—			—	10	pF

Note: For devices with the ordering part number ending in J(CT.

Package Dimensions

Unit: mm



Weight: 0.006 g (typ.)

Package Name(s)
JEDEC: SOT-353
Nickname: USV

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