

TC7SH09FU

1. Functional Description

- 2-Input AND Gate (Open Drain)

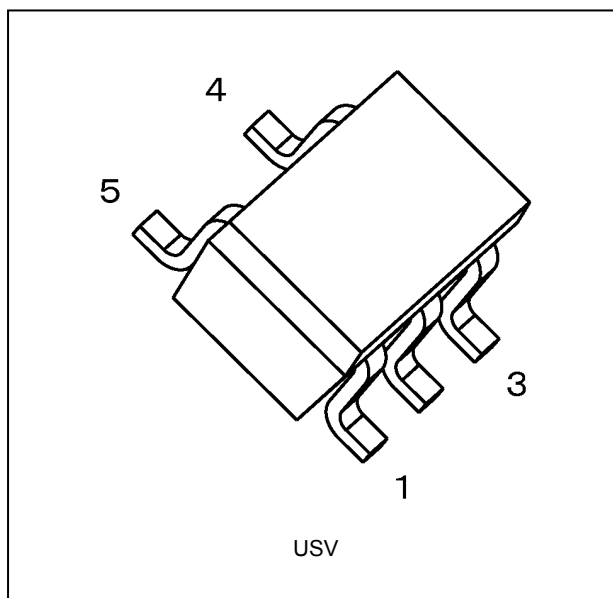
2. Features

- (1) AEC-Q100 (Rev. H) (Note 1)
- (2) Wide operating temperature : $T_{opr} = -40$ to $125\text{ }^{\circ}\text{C}$ (Note 2)
- (3) High speed operation: $t_{pZL} = 3.2\text{ ns}$ (typ.) ($V_{CC} = 5.0\text{ V}$, $C_L = 15\text{ pF}$)
- (4) Low power dissipation: $I_{CC} = 2.0\text{ }\mu\text{A}$ (max) ($T_a = 25\text{ }^{\circ}\text{C}$)
- (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 $85\text{ }^{\circ}\text{C}$ for the other devices.

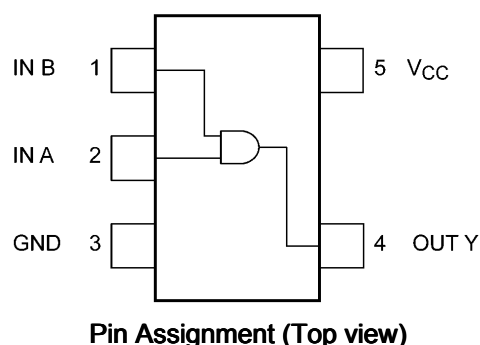
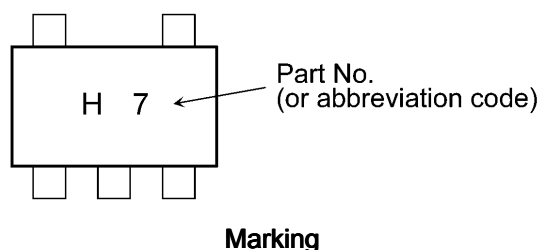
3. Packaging



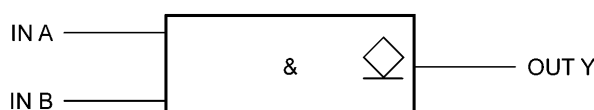
Start of commercial production

2011-08

4. Marking and Pin Assignment



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

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	$^{\circ}\text{C}$

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: 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		$V_{CC} = 3.3 \pm 0.3$ V	0 to 100	ns/V
			$V_{CC} = 5.0 \pm 0.5$ 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	$V_{CC} \times 0.7$	—	—	
Low-level input voltage	V_{IL}	—		2.0	—	—	0.5	V
				3.0 to 5.5	—	—	$V_{CC} \times 0.3$	
Low-level output voltage	V_{OL}	$V_{IN} = V_{IL}$	$I_{OL} = 50$ μ A	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	μ A
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	μ A
Power-OFF leakage current	I_{OFF}	$V_{IN} = 5.5$ V or $V_{OUT} = 0$ to 5.5 V		0.0	—	—	1.0	μ A
Quiescent supply current	I_{CC}	$V_{IN} = V_{CC}$ or GND		5.5	—	—	2.0	μ A

9.2. DC Characteristics (Unless otherwise specified, $T_a = -40$ to $85\text{ }^{\circ}\text{C}$)

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	$V_{CC} \times 0.7$	—	
Low-level input voltage	V_{IL}	—		2.0	—	0.5	V
				3.0 to 5.5	—	$V_{CC} \times 0.3$	
Low-level output voltage	V_{OL}	$V_{IN} = V_{IL}$	$I_{OL} = 50\text{ }\mu\text{A}$	2.0	—	0.1	V
				3.0	—	0.1	
				4.5	—	0.1	
			$I_{OL} = 4\text{ mA}$	3.0	—	0.44	
			$I_{OL} = 8\text{ mA}$	4.5	—	0.44	
Input leakage current	I_{IN}	$V_{IN} = 5.5\text{ V}$ 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}	$V_{IN} = 5.5\text{ V}$ 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 $125\text{ }^{\circ}\text{C}$)

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	$V_{CC} \times 0.7$	—	
Low-level input voltage	V_{IL}	—		2.0	—	0.5	V
				3.0 to 5.5	—	$V_{CC} \times 0.3$	
Low-level output voltage	V_{OL}	$V_{IN} = V_{IL}$	$I_{OL} = 50\text{ }\mu\text{A}$	2.0	—	0.1	V
				3.0	—	0.1	
				4.5	—	0.1	
			$I_{OL} = 4\text{ mA}$	3.0	—	0.55	
			$I_{OL} = 8\text{ mA}$	4.5	—	0.55	
Input leakage current	I_{IN}	$V_{IN} = 5.5\text{ V}$ 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}	$V_{IN} = 5.5\text{ V}$ 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, $T_a = 25\text{ }^\circ\text{C}$, 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_{PZL}		$R_L = 1\text{ k}\Omega$	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}		$R_L = 1\text{ k}\Omega$	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, $T_a = -40\text{ to }85\text{ }^\circ\text{C}$, Input: $t_r = t_f = 3\text{ ns}$)

Characteristics	Symbol	Test Condition	V_{CC} (V)	C_L (pF)	Min	Max	Unit
Propagation delay time	t_{PZL}	$R_L = 1\text{ k}\Omega$	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}	$R_L = 1\text{ k}\Omega$	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, $T_a = -40\text{ to }125\text{ }^\circ\text{C}$, Input: $t_r = t_f = 3\text{ ns}$)

Characteristics	Symbol	Test Condition	V_{CC} (V)	C_L (pF)	Min	Max	Unit
Propagation delay time	t_{PZL}	$R_L = 1\text{ k}\Omega$	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}	$R_L = 1\text{ k}\Omega$	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).

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