

# TC7SH09FU

## 1. Functional Description

- 2-Input AND Gate (Open Drain)

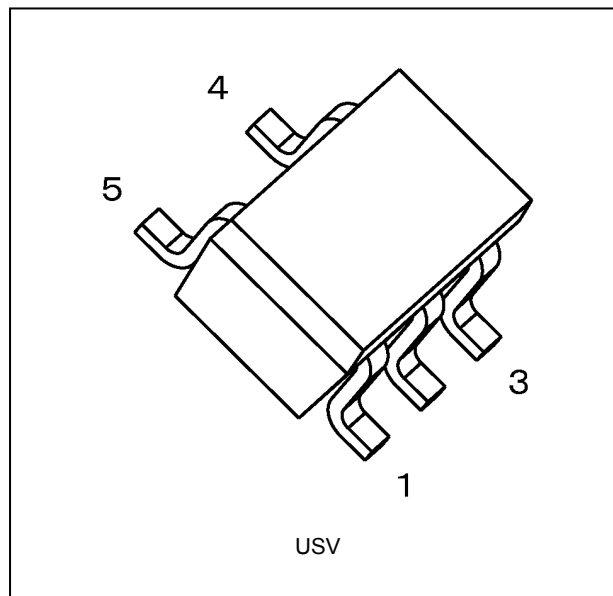
## 2. Features

- (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:  $I_{CC} = 2.0$   $\mu$ A (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.

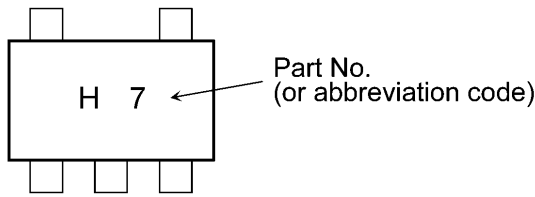
## 3. Packaging



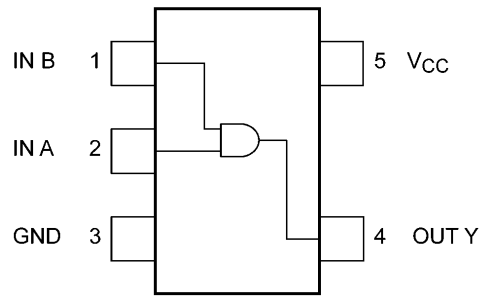
Start of commercial production

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<sub>a</sub> = 25 °C)**

Characteristics	Symbol	Note	Rating	Unit
Supply voltage	V <sub>CC</sub>		-0.5 to 7.0	V
Input voltage	V <sub>IN</sub>		-0.5 to 7.0	
DC output voltage	V <sub>OUT</sub>	(Note 1)	-0.5 to 7.0	
Input diode current	I <sub>IK</sub>		-20	mA
Output diode current	I <sub>OK</sub>	(Note 2)	-20	
DC output current	I <sub>OUT</sub>		+25	
V <sub>CC</sub> /ground current	I <sub>CC</sub>		±50	
Power dissipation	P <sub>D</sub>		200	mW
Storage temperature	T <sub>stg</sub>		-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<sub>OUT</sub> of absolute maximum ratings.

Note 2: V<sub>OUT</sub> < 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	$V_{OL}$	$V_{IN} = V_{IL}$	$I_{OL} = 50$ $\mu$ 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	—	—	$\pm 0.1$	$\mu$ A	
3-state output OFF-state leakage current	$I_{OZ}$	$V_{IN} = V_{IH}$ $V_{OUT} = V_{CC}$ or GND		0 to 5.5	—	—	$\pm 0.25$	$\mu$ A	
Power-OFF leakage current	$I_{OFF}$	$V_{IN} = 5.5$ V or $V_{OUT} = 0$ to 5.5 V		0.0	—	—	1.0	$\mu$ A	
Quiescent supply current	$I_{CC}$	$V_{IN} = V_{CC}$ or GND		5.5	—	—	2.0	$\mu$ A	

**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	$V_{CC} \times 0.7$	—		
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	$V_{OL}$	$V_{IN} = V_{IL}$	$I_{OL} = 50 \mu A$	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	—	$\pm 1.0$	$\mu A$	
3-state output OFF-state leakage current	$I_{OZ}$	$V_{IN} = V_{IH}$ $V_{OUT} = V_{CC}$ or GND		0 to 5.5	—	$\pm 2.5$	$\mu A$	
Power-OFF leakage current	$I_{OFF}$	$V_{IN} = 5.5 \text{ V}$ or $V_{OUT} = 0$ to $5.5 \text{ V}$		0.0	—	10.0	$\mu A$	
Quiescent supply current	$I_{CC}$	$V_{IN} = V_{CC}$ or GND		5.5	—	20.0	$\mu A$	

**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	$V_{CC} \times 0.7$	—		
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	$V_{OL}$	$V_{IN} = V_{IL}$	$I_{OL} = 50 \mu A$	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	—	$\pm 2.0$	$\mu A$	
3-state output OFF-state leakage current	$I_{OZ}$	$V_{IN} = V_{IH}$ $V_{OUT} = V_{CC}$ or GND		0 to 5.5	—	$\pm 10.0$	$\mu A$	
Power-OFF leakage current	$I_{OFF}$	$V_{IN} = 5.5 \text{ V}$ or $V_{OUT} = 0$ to $5.5 \text{ V}$		0.0	—	20.0	$\mu A$	
Quiescent supply current	$I_{CC}$	$V_{IN} = V_{CC}$ or GND		5.5	—	40.0	$\mu A$	

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	$t_{PZL}$		$R_L = 1\text{ k}\Omega$	$3.3 \pm 0.3$	15	—	4.6	7.5	ns
					50	—	6.5	11.0	
				$5.0 \pm 0.5$	15	—	3.2	5.5	
					50	—	4.6	7.5	
Propagation delay time	$t_{PLZ}$		$R_L = 1\text{ k}\Omega$	$3.3 \pm 0.3$	15	—	4.6	7.5	ns
					50	—	6.5	11.0	
				$5.0 \pm 0.5$	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	$t_{PZL}$	$R_L = 1\text{ k}\Omega$	$3.3 \pm 0.3$	15	1.0	8.5	ns
				50	1.5	12.0	
			$5.0 \pm 0.5$	15	1.0	6.5	
				50	1.5	8.0	
Propagation delay time	$t_{PLZ}$	$R_L = 1\text{ k}\Omega$	$3.3 \pm 0.3$	15	1.0	8.5	ns
				50	1.5	12.0	
			$5.0 \pm 0.5$	15	1.0	6.5	
				50	1.5	8.0	
Input capacitance	$C_{IN}$	—			—	10	pF

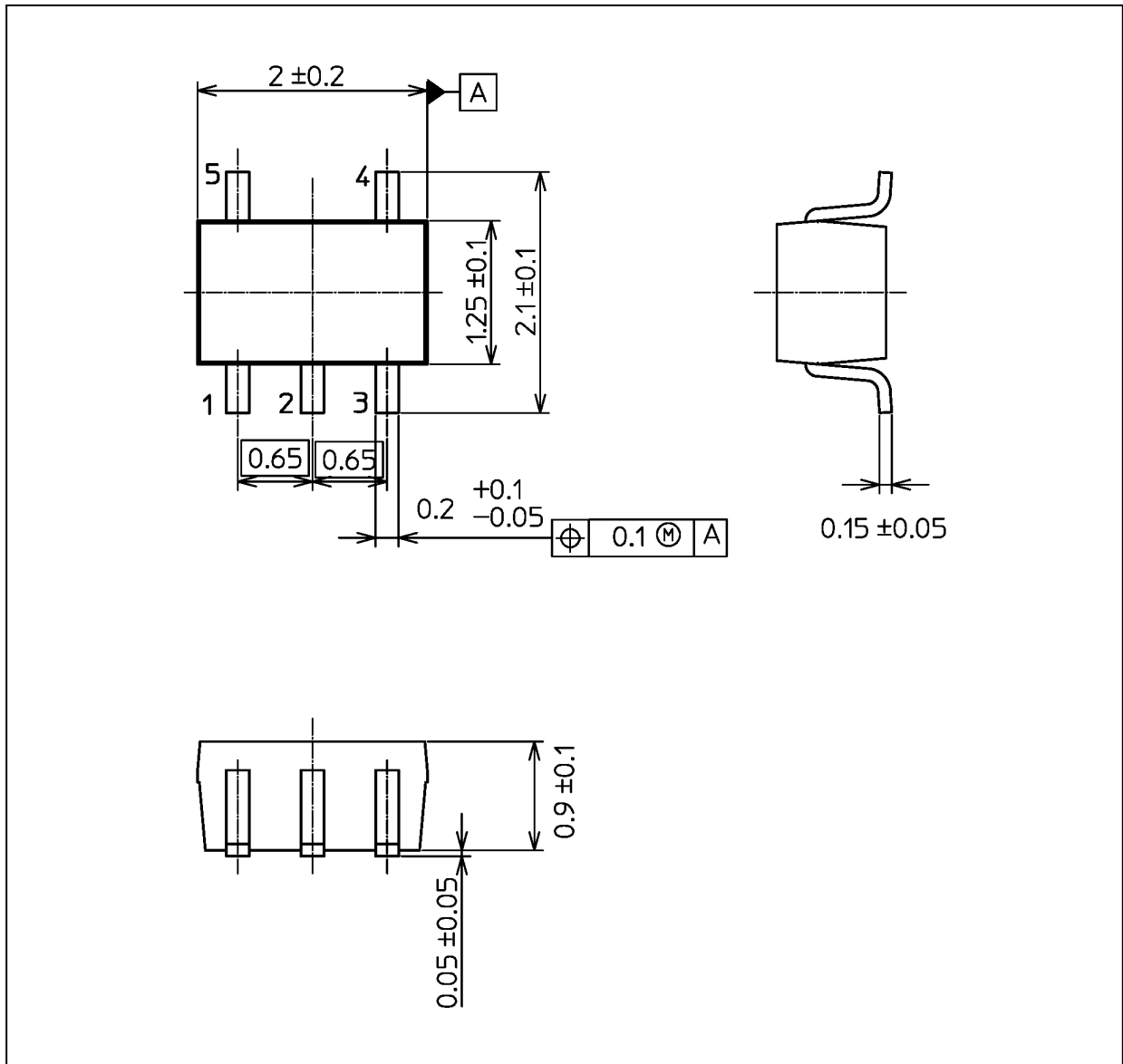
**9.6. AC Characteristics (Note) (Unless otherwise specified,  $T_a = -40\text{ to }125\text{ }^\circ\text{C}$ , Input:  $t_r = t_f = 3\text{ ns}$ )**

Characteristics	Symbol	Test Condition	$V_{CC}$ (V)	$C_L$ (pF)	Min	Max	Unit
Propagation delay time	$t_{PZL}$	$R_L = 1\text{ k}\Omega$	$3.3 \pm 0.3$	15	1.0	10.5	ns
				50	1.5	14.0	
			$5.0 \pm 0.5$	15	1.0	7.5	
				50	1.5	9.5	
Propagation delay time	$t_{PLZ}$	$R_L = 1\text{ k}\Omega$	$3.3 \pm 0.3$	15	1.0	10.5	ns
				50	1.5	14.0	
			$5.0 \pm 0.5$	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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