

# TC7SZ02FU

## 1. Functional Description

- 2-Input NOR Gate

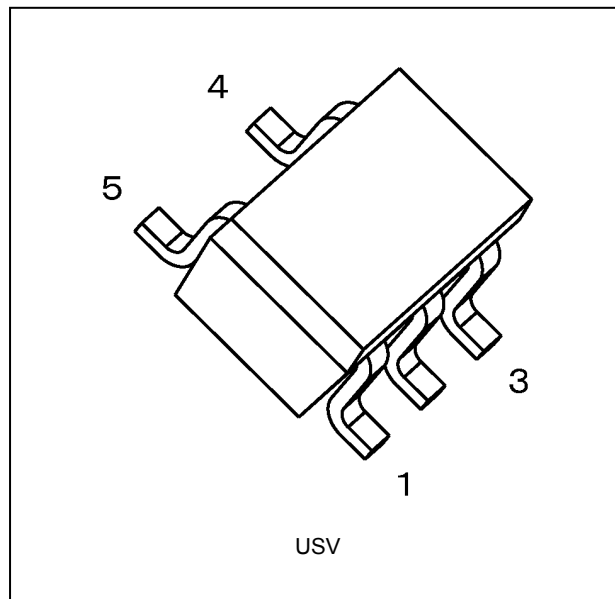
## 2. Features

- (1) AEC-Q100 (Rev. H) (Note 1)
- (2) Wide operating temperature range:  $T_{opr} = -40$  to  $125$  °C (Note 2)
- (3) High output current:  $\pm 24$  mA (min) at  $V_{CC} = 3.0$  V
- (4) Super high speed operation:  $t_{pd} = 2.4$  ns (typ.) at  $V_{CC} = 5.0$  V,  $C_L = 50$  pF
- (5) Operation voltage range:  $V_{CC} = 1.65$  to  $5.5$  V
- (6) 5.5 V tolerant inputs
- (7) 5.5 V power down protection output
- (8) Matches the performance of TC74LCX series when operated at  $3.3$  V  $V_{CC}$

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.

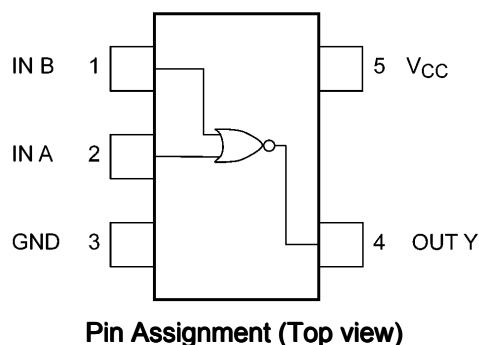
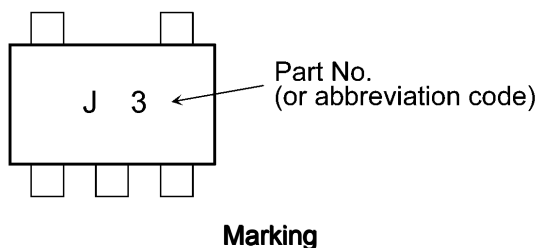
## 3. Packaging



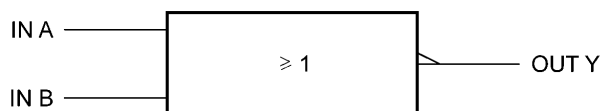
Start of commercial production

1998-08

**4. Marking and Pin Assignment**



**5. IEC Logic Symbol**



**6. Truth Table**

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

**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 6.0	V
Input voltage	V <sub>IN</sub>		-0.5 to 6.0	V
DC output voltage	V <sub>OUT</sub>	(Note 1)	-0.5 to 6.0	V
		(Note 2)	-0.5 to V <sub>CC</sub> + 0.5	
Input diode current	I <sub>IK</sub>		-20	mA
Output diode current	I <sub>OK</sub>	(Note 3)	-20	mA
DC output current	I <sub>OUT</sub>		±50	mA
V <sub>CC</sub> /ground current	I <sub>CC</sub>		±50	mA
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: V<sub>CC</sub> = 0 V

Note 2: High (H) or Low (L) state. I<sub>OUT</sub> absolute maximum rating must be observed.

Note 3: V<sub>OUT</sub> < GND

**8. Operating Ranges (Note)**

Characteristics	Symbol	Note	Test Condition	Rating	Unit
Supply voltage	$V_{CC}$		—	1.65 to 5.5	V
		(Note 1)	—	1.5 to 5.5	
Input voltage	$V_{IN}$		—	0 to 5.5	V
Output voltage	$V_{OUT}$	(Note 2)	—	0 to 5.5	V
		(Note 3)	—	0 to $V_{CC}$	
Operating temperature	$T_{opr}$	(Note 4)	—	-40 to 125	°C
		(Note 5)	—	-40 to 85	
Input rise and fall time	dt/dv		$V_{CC} = 1.8 \pm 0.15 \text{ V}, 2.5 \pm 0.2 \text{ V}$	0 to 20	ns/V
			$V_{CC} = 3.3 \pm 0.3 \text{ V}$	0 to 10	
			$V_{CC} = 5.0 \pm 0.5 \text{ V}$	0 to 5	

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: Data retention only

Note 2:  $V_{CC} = 0 \text{ V}$

Note 3: High (H) or Low (L) state.

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

Note 5: For devices except those with the ordering part number ending in J(CT).

**9. Electrical Characteristics**

**9.1. DC Characteristics (Unless otherwise specified,  $T_a = 25 \text{ }^\circ\text{C}$ )**

Characteristics	Symbol	Test Condition		$V_{CC}$ (V)	Min	Typ.	Max	Unit	
High-level input voltage	$V_{IH}$	—		1.65 to 1.95	$V_{CC} \times 0.88$	—	—	V	
				2.3 to 5.5	$V_{CC} \times 0.75$	—	—		
Low-level input voltage	$V_{IL}$	—		1.65 to 1.95	—	—	$V_{CC} \times 0.12$	V	
				2.3 to 5.5	—	—	$V_{CC} \times 0.25$		
High-level output voltage	$V_{OH}$	$V_{IN} = V_{IL}$	$I_{OH} = -100 \mu\text{A}$	1.65	1.55	1.65	—	V	
				2.3	2.2	2.3	—		
				3.0	2.9	3.0	—		
				4.5	4.4	4.5	—		
				$I_{OH} = -8 \text{ mA}$	2.3	1.9	2.15		—
				$I_{OH} = -16 \text{ mA}$	3.0	2.4	2.8		—
				$I_{OH} = -24 \text{ mA}$	3.0	2.3	2.68		—
Low-level output voltage	$V_{OL}$	$V_{IN} = V_{IH}$ or $V_{IL}$	$I_{OL} = 100 \mu\text{A}$	1.65	—	0.0	0.1	V	
				2.3	—	0.0	0.1		
				3.0	—	0.0	0.1		
				4.5	—	0.0	0.1		
				$I_{OL} = 8 \text{ mA}$	2.3	—	0.1		0.3
				$I_{OL} = 16 \text{ mA}$	3.0	—	0.15		0.4
				$I_{OL} = 24 \text{ mA}$	3.0	—	0.22		0.55
Input leakage current	$I_{IN}$	$V_{IN} = 5.5 \text{ V}$ or GND		0 to 5.5	—	—	$\pm 1.0$	$\mu\text{A}$	
Power-OFF leakage current	$I_{OFF}$	$V_{IN}$ or $V_{OUT} = 5.5 \text{ V}$		0	—	—	1	$\mu\text{A}$	
Quiescent supply current	$I_{CC}$	$V_{IN} = V_{CC}$ or GND		5.5	—	—	2	$\mu\text{A}$	

**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	$V_{IH}$	—		1.65 to 1.95	$V_{CC} \times 0.88$	—	V
				2.3 to 5.5	$V_{CC} \times 0.75$	—	
Low-level input voltage	$V_{IL}$	—		1.65 to 1.95	—	$V_{CC} \times 0.12$	V
				2.3 to 5.5	—	$V_{CC} \times 0.25$	
High-level output voltage	$V_{OH}$	$V_{IN} = V_{IL}$	$I_{OH} = -100 \mu A$	1.65	1.55	—	V
				2.3	2.2	—	
				3.0	2.9	—	
				4.5	4.4	—	
			$I_{OH} = -8 \text{ mA}$	2.3	1.9	—	
			$I_{OH} = -16 \text{ mA}$	3.0	2.4	—	
			$I_{OH} = -24 \text{ mA}$	3.0	2.3	—	
			$I_{OH} = -32 \text{ mA}$	4.5	3.8	—	
Low-level output voltage	$V_{OL}$	$V_{IN} = V_{IH}$ or $V_{IL}$	$I_{OL} = 100 \mu A$	1.65	—	0.1	V
				2.3	—	0.1	
				3.0	—	0.1	
				4.5	—	0.1	
			$I_{OL} = 8 \text{ mA}$	2.3	—	0.3	
			$I_{OL} = 16 \text{ mA}$	3.0	—	0.4	
			$I_{OL} = 24 \text{ mA}$	3.0	—	0.55	
			$I_{OL} = 32 \text{ mA}$	4.5	—	0.55	
Input leakage current	$I_{IN}$	$V_{IN} = 5.5 \text{ V}$ or GND		0 to 5.5	—	$\pm 10.0$	$\mu A$
Power-OFF leakage current	$I_{OFF}$	$V_{IN}$ or $V_{OUT} = 5.5 \text{ V}$		0	—	10	$\mu A$
Quiescent supply current	$I_{CC}$	$V_{IN} = V_{CC}$ or GND		5.5	—	20	$\mu A$

**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	$V_{IH}$	—		1.65 to 1.95	$V_{CC} \times 0.88$	—	V
				2.3 to 5.5	$V_{CC} \times 0.75$	—	
Low-level input voltage	$V_{IL}$	—		1.65 to 1.95	—	$V_{CC} \times 0.12$	V
				2.3 to 5.5	—	$V_{CC} \times 0.25$	
High-level output voltage	$V_{OH}$	$V_{IN} = V_{IL}$	$I_{OH} = -100 \mu A$	1.65	1.55	—	V
				2.3	2.2	—	
				3.0	2.9	—	
				4.5	4.4	—	
			$I_{OH} = -8 \text{ mA}$	2.3	1.7	—	
			$I_{OH} = -16 \text{ mA}$	3.0	2.2	—	
			$I_{OH} = -24 \text{ mA}$	3.0	2.0	—	
			$I_{OH} = -32 \text{ mA}$	4.5	3.4	—	
Low-level output voltage	$V_{OL}$	$V_{IN} = V_{IH}$ or $V_{IL}$	$I_{OL} = 100 \mu A$	1.65	—	0.1	V
				2.3	—	0.1	
				3.0	—	0.1	
				4.5	—	0.1	
			$I_{OL} = 8 \text{ mA}$	2.3	—	0.45	
			$I_{OL} = 16 \text{ mA}$	3.0	—	0.6	
			$I_{OL} = 24 \text{ mA}$	3.0	—	0.8	
			$I_{OL} = 32 \text{ mA}$	4.5	—	0.8	
Input leakage current	$I_{IN}$	$V_{IN} = 5.5 \text{ V}$ or GND		0 to 5.5	—	$\pm 20.0$	$\mu A$
Power-OFF leakage current	$I_{OFF}$	$V_{IN}$ or $V_{OUT} = 5.5 \text{ V}$		0	—	100	$\mu A$
Quiescent supply current	$I_{CC}$	$V_{IN} = V_{CC}$ or GND		5.5	—	200	$\mu A$

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	$t_{PLH}, t_{PHL}$		$R_L = 1\text{ M}\Omega$	$1.8 \pm 0.15$	15	2.0	4.4	9.5	ns
				$2.5 \pm 0.2$		0.8	2.9	6.5	
				$3.3 \pm 0.3$		0.5	2.3	4.5	
				$5.0 \pm 0.5$		0.5	1.9	3.9	
			$R_L = 500\ \Omega$	$3.3 \pm 0.3$	50	1.5	2.9	5.0	ns
				$5.0 \pm 0.5$		0.8	2.4	4.3	
Input capacitance	$C_{IN}$		—	0 to 5.5	—	—	4	—	pF
Power dissipation capacitance	$C_{PD}$	(Note 1)	—	3.3	—	—	23	—	pF
				5.5		—	30	—	

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	$t_{PLH}, t_{PHL}$	$R_L = 1\text{ M}\Omega$	$1.8 \pm 0.15$	15	2.0	10.0	ns
			$2.5 \pm 0.2$		0.8	7.0	
			$3.3 \pm 0.3$		0.5	4.7	
			$5.0 \pm 0.5$		0.5	4.1	
		$R_L = 500\ \Omega$	$3.3 \pm 0.3$	50	1.5	5.2	ns
			$5.0 \pm 0.5$		0.8	4.5	

**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	$t_{PLH}, t_{PHL}$	$R_L = 1\text{ M}\Omega$	$1.8 \pm 0.15$	15	2.0	11.0	ns
			$2.5 \pm 0.2$		0.8	8.0	
			$3.3 \pm 0.3$		0.5	5.5	
			$5.0 \pm 0.5$		0.5	5.0	
		$R_L = 500\ \Omega$	$3.3 \pm 0.3$	50	1.5	6.0	ns
			$5.0 \pm 0.5$		0.8	5.0	

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



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