

# TC7SZ14FU

## 1. Functional Description

- Schmitt Inverter

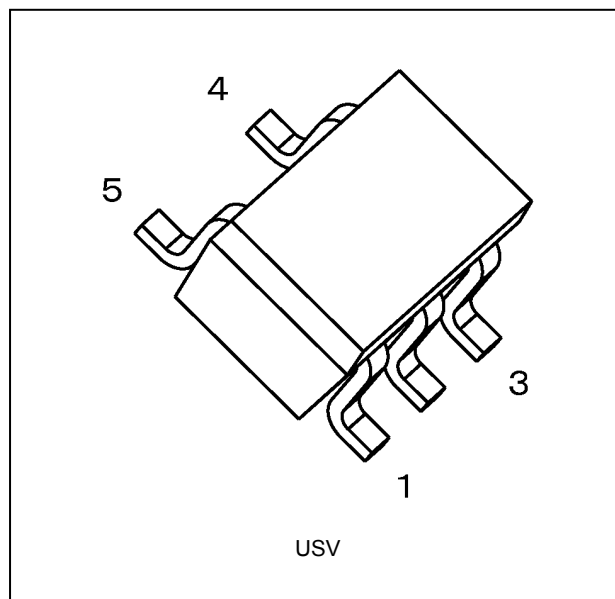
## 2. Features

- (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:  $t_{pd} = 3.7$  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 TC7SZ14FU,LJ(CT).  $T_{opr} = -40$  to  $85$  °C for the other devices.

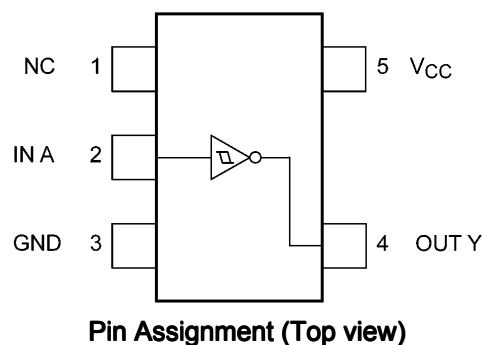
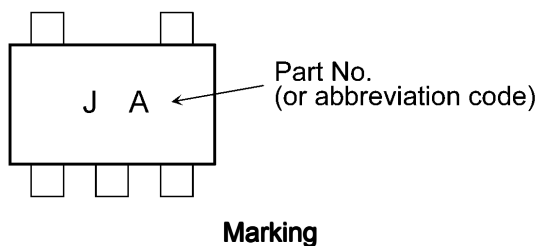
## 3. Packaging



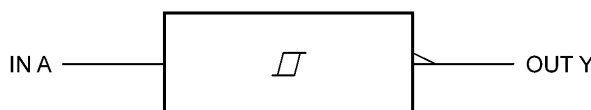
Start of commercial production

2002-06

**4. Marking and Pin Assignment**



**5. IEC Logic Symbol**



**6. Truth Table**

A	Y
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	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	

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:  $V_{CC} = 0$  V

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

Note 4: For devices with the ordering part number TC7SZ14FU,LJ(CT).

Note 5: For devices except those with the ordering part number TC7SZ14FU,LJ(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			
Positive threshold voltage	$V_P$	—		1.65	0.6	1.0	1.4	V			
				1.8	0.7	1.1	1.5				
				2.3	1.0	1.4	1.8				
				3.0	1.3	1.75	2.2				
				4.5	1.9	2.45	3.1				
				5.5	2.2	2.9	3.6				
Negative threshold voltage	$V_N$	—		1.65	0.2	0.5	0.8	V			
				1.8	0.25	0.55	0.9				
				2.3	0.4	0.75	1.15				
				3.0	0.6	1.0	1.5				
				4.5	1.0	1.43	2.0				
				5.5	1.2	1.7	2.4				
Hysteresis voltage	$V_H$	—		1.65	0.1	0.48	0.9	V			
				1.8	0.15	0.54	1.0				
				2.3	0.25	0.65	1.1				
				3.0	0.4	0.77	1.2				
				4.5	0.6	1.01	1.5				
				5.5	0.7	1.18	1.7				
High-level output voltage	$V_{OH}$	$V_{IN} = V_N$	$I_{OH} = -100\text{ }\mu\text{A}$	1.65	1.55	1.65	—	V			
				1.8	1.7	1.8	—				
				2.3	2.2	2.3	—				
				3.0	2.9	3.0	—				
				4.5	4.4	4.5	—				
						$I_{OH} = -4\text{ mA}$	1.65		1.29	1.52	—
						$I_{OH} = -8\text{ mA}$	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	—
						$I_{OH} = -32\text{ mA}$	4.5		3.8	4.2	—
Low-level output voltage	$V_{OL}$	$V_{IN} = V_P$	$I_{OL} = 100\text{ }\mu\text{A}$	1.65	—	0.0	0.1	V			
				1.8	—	0.0	0.1				
				2.3	—	0.0	0.1				
				3.0	—	0.0	0.1				
				4.5	—	0.0	0.1				
						$I_{OL} = 4\text{ mA}$	1.65		—	0.08	0.24
						$I_{OL} = 8\text{ mA}$	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
						$I_{OL} = 32\text{ mA}$	4.5		—	0.22	0.55
Input leakage current	$I_{IN}$	$V_{IN} = 5.5\text{ V or GND}$		0 to 5.5	—	—	$\pm 1$	$\mu\text{A}$			
Power-OFF leakage current	$I_{OFF}$	$V_{IN}$ or $V_{OUT} = 5.5\text{ V}$		0	—	—	1	$\mu\text{A}$			
Quiescent supply current	$I_{CC}$	$V_{IN} = 5.5\text{ V or GND}$		1.65 to 5.5	—	—	1	$\mu\text{A}$			

**9.2. DC Characteristics (Unless otherwise specified,  $T_a = -40$  to  $85$  °C)**

Characteristics	Symbol	Test Condition		$V_{CC}$ (V)	Min	Max	Unit
Positive threshold voltage	$V_P$	—		1.65	0.65	1.4	V
				1.8	0.7	1.5	
				2.3	1.0	1.8	
				3.0	1.3	2.2	
				4.5	1.9	3.1	
				5.5	2.2	3.6	
Negative threshold voltage	$V_N$	—		1.65	0.2	0.8	V
				1.8	0.25	0.9	
				2.3	0.4	1.15	
				3.0	0.6	1.5	
				4.5	1.0	2.0	
				5.5	1.2	2.4	
Hysteresis voltage	$V_H$	—		1.65	0.1	1.0	V
				1.8	0.15	1.0	
				2.3	0.25	1.1	
				3.0	0.4	1.2	
				4.5	0.6	1.5	
				5.5	0.7	1.7	
High-level output voltage	$V_{OH}$	$V_{IN} = V_N$	$I_{OH} = -100 \mu A$	1.65	1.55	—	V
				1.8	1.7	—	
				2.3	2.2	—	
				3.0	2.9	—	
				4.5	4.4	—	
			$I_{OH} = -4$ mA	1.65	1.29	—	
			$I_{OH} = -8$ mA	2.3	1.9	—	
			$I_{OH} = -16$ mA	3.0	2.4	—	
			$I_{OH} = -24$ mA	3.0	2.3	—	
			$I_{OH} = -32$ mA	4.5	3.8	—	
Low-level output voltage	$V_{OL}$	$V_{IN} = V_P$	$I_{OL} = 100 \mu A$	1.65	—	0.1	V
				1.8	—	0.1	
				2.3	—	0.1	
				3.0	—	0.1	
				4.5	—	0.1	
			$I_{OL} = 4$ mA	1.65	—	0.24	
			$I_{OL} = 8$ mA	2.3	—	0.3	
			$I_{OL} = 16$ mA	3.0	—	0.4	
			$I_{OL} = 24$ mA	3.0	—	0.55	
			$I_{OL} = 32$ mA	4.5	—	0.55	
Input leakage current	$I_{IN}$	$V_{IN} = 5.5$ V or GND		0 to 5.5	—	$\pm 10$	$\mu A$
Power-OFF leakage current	$I_{OFF}$	$V_{IN}$ or $V_{OUT} = 5.5$ V		0	—	10	$\mu A$
Quiescent supply current	$I_{CC}$	$V_{IN} = 5.5$ V or GND		1.65 to 5.5	—	10	$\mu A$

**9.3. DC Characteristics (Note) (Unless otherwise specified,  $T_a = -40$  to  $125$  °C)**

Characteristics	Symbol	Test Condition		$V_{CC}$ (V)	Min	Max	Unit
Positive threshold voltage	$V_P$	—		1.65	0.65	1.4	V
				1.8	0.7	1.5	
				2.3	1.0	1.8	
				3.0	1.3	2.2	
				4.5	1.9	3.1	
				5.5	2.2	3.6	
Negative threshold voltage	$V_N$	—		1.65	0.2	0.8	V
				1.8	0.25	0.9	
				2.3	0.4	1.15	
				3.0	0.6	1.5	
				4.5	1.0	2.0	
				5.5	1.2	2.4	
Hysteresis voltage	$V_H$	—		1.65	0.1	1.0	V
				1.8	0.15	1.0	
				2.3	0.25	1.1	
				3.0	0.4	1.2	
				4.5	0.6	1.5	
				5.5	0.7	1.7	
High-level output voltage	$V_{OH}$	$V_{IN} = V_N$	$I_{OH} = -100 \mu A$	1.65	1.55	—	V
				1.8	1.7	—	
				2.3	2.2	—	
				3.0	2.9	—	
				4.5	4.4	—	
			$I_{OH} = -4$ mA	1.65	0.95	—	
			$I_{OH} = -8$ mA	2.3	1.7	—	
			$I_{OH} = -16$ mA	3.0	2.2	—	
			$I_{OH} = -24$ mA	3.0	2.0	—	
			$I_{OH} = -32$ mA	4.5	3.4	—	
Low-level output voltage	$V_{OL}$	$V_{IN} = V_P$	$I_{OL} = 100 \mu A$	1.65	—	0.1	V
				1.8	—	0.1	
				2.3	—	0.1	
				3.0	—	0.1	
				4.5	—	0.1	
			$I_{OL} = 4$ mA	1.65	—	0.7	
			$I_{OL} = 8$ mA	2.3	—	0.45	
			$I_{OL} = 16$ mA	3.0	—	0.6	
			$I_{OL} = 24$ mA	3.0	—	0.8	
			$I_{OL} = 32$ mA	4.5	—	0.8	
Input leakage current	$I_{IN}$	$V_{IN} = 5.5$ V or GND		0 to 5.5	—	$\pm 20.0$	$\mu A$
Power-OFF leakage current	$I_{OFF}$	$V_{IN}$ or $V_{OUT} = 5.5$ V		0	—	100	$\mu A$
Quiescent supply current	$I_{CC}$	$V_{IN} = 5.5$ V or GND		1.65 to 5.5	—	100	$\mu A$

Note: For devices with the ordering part number TC7SZ14FU,LJ(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	9.1	15.0	ns
				$2.5 \pm 0.2$		1.0	5.0	9.0	
				$3.3 \pm 0.3$		1.0	3.7	6.3	
				$5.0 \pm 0.5$		0.5	3.1	5.2	
			$R_L = 500\ \Omega$	$3.3 \pm 0.3$	50	1.5	4.4	7.2	ns
				$5.0 \pm 0.5$		0.5	3.7	5.9	
Input capacitance	$C_{IN}$		—	0 to 5.5	—	—	4	—	pF
Power dissipation capacitance	$C_{PD}$	(Note 1)	—	3.3	—	—	24	—	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	15.6	ns
			$2.5 \pm 0.2$		1.0	9.5	
			$3.3 \pm 0.3$		1.0	6.5	
			$5.0 \pm 0.5$		0.5	5.5	
		$R_L = 500\ \Omega$	$3.3 \pm 0.3$	50	1.5	7.5	ns
			$5.0 \pm 0.5$		0.8	6.2	

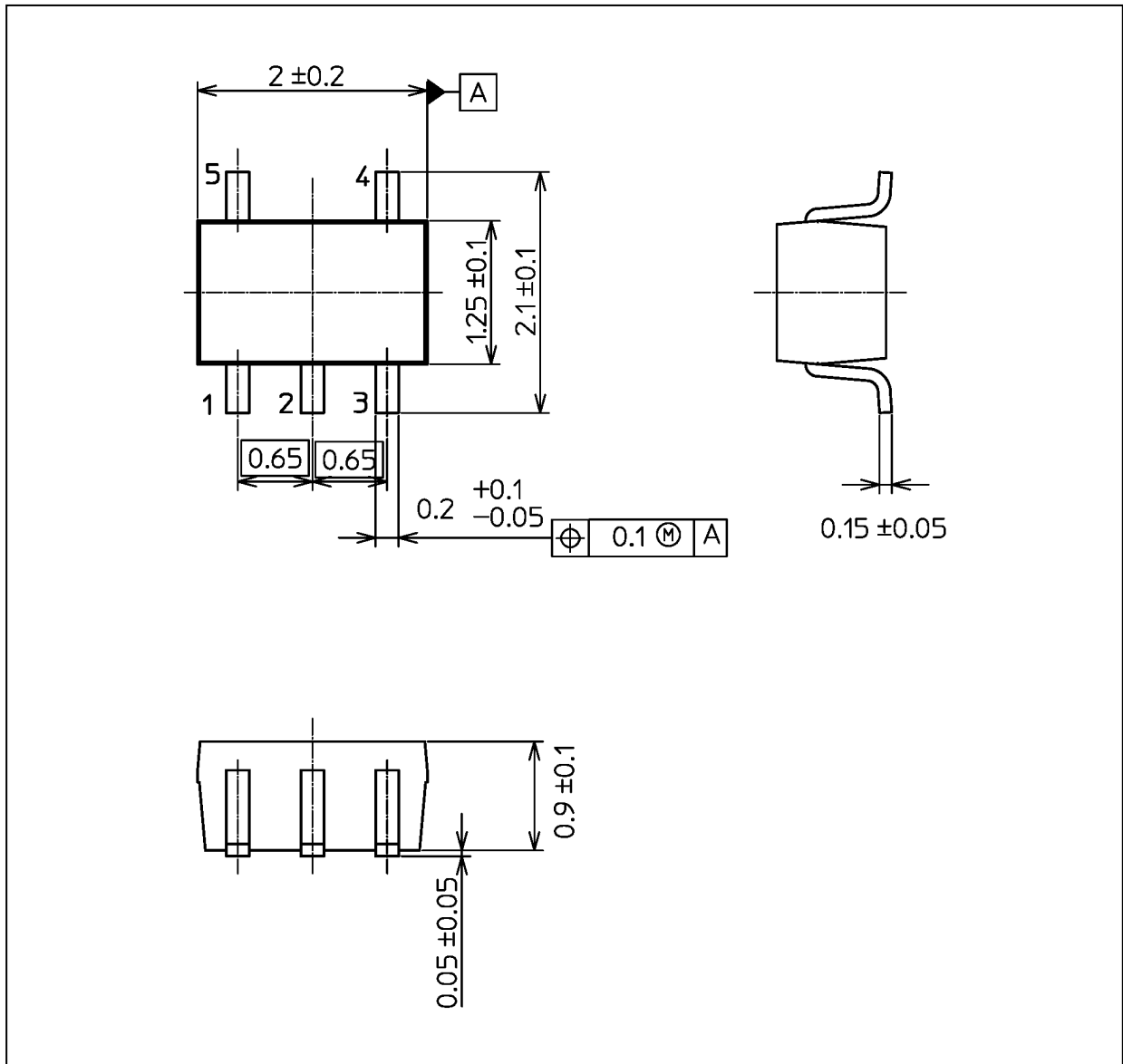
**9.6. AC Characteristics (Note) (Unless otherwise specified,  $T_a = -40\text{ to }125\text{ }^\circ\text{C}$ , Input:  $t_r = t_f = 3\text{ ns}$ )**

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	17.5	ns
			$2.5 \pm 0.2$		1.0	10.5	
			$3.3 \pm 0.3$		1.0	7.5	
			$5.0 \pm 0.5$		0.5	6.5	
		$R_L = 500\ \Omega$	$3.3 \pm 0.3$	50	1.5	8.5	ns
			$5.0 \pm 0.5$		0.8	7.0	

Note: For devices with the ordering part number TC7SZ14FU,LJ(CT).

Package Dimensions

Unit: mm



Weight: 0.006 g (typ.)

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



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