CMOS Digital Integrated Circuits Silicon Monolithic

# TC7SZ04FU

#### 1. Functional Description

• Inverter

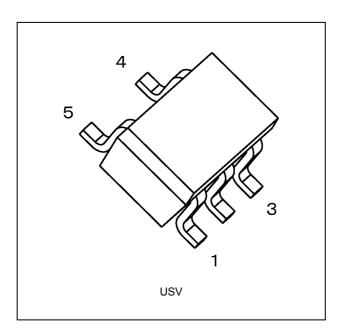
#### 2. Features

- (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:  $t_{pd} = 2.4 \text{ ns}$  (typ.) at  $V_{CC} = 5.0 \text{ V}$ ,  $C_L = 50 \text{ pF}$
- (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.

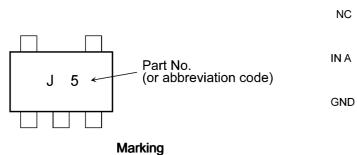
#### 3. Packaging

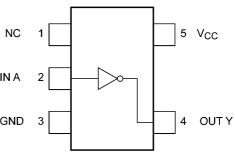


Rev.3.0



#### 4. Marking and Pin Assignment





Pin Assignment (Top view)

### 5. IEC Logic Symbol



#### 6. Truth Table

А	Y
L	Н
Н	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	٧
		(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	Icc		±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:  $V_{CC} = 0 V$ 

Note 2: High (H) or Low (L) state. IOUT 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 <sub>CC</sub>		_	1.65 to 5.5	V
		(Note 1)	_	1.5 to 5.5	
Input voltage	V <sub>IN</sub>		_	0 to 5.5	V
Output voltage	V <sub>OUT</sub>	(Note 2)	_	0 to 5.5	V
		(Note 3)	_	0 to V <sub>CC</sub>	
Operating temperature	T <sub>opr</sub>	(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 V, 2.5 $\pm$ 0.2 V	0 to 20	ns/V
			V <sub>CC</sub> = 3.3 ± 0.3 V	0 to 10	
			V <sub>CC</sub> = 5.0 ± 0.5 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:  $V_{CC} = 0 V$ 

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<sub>a</sub> = 25 °C)

Characteristics	Symbol	Test Condition		V <sub>CC</sub> (V)	Min	Тур.	Max	Unit
High-level input voltage	V <sub>IH</sub>	_		1.65 to 1.95	$V_{CC} \times 0.88$	_	_	V
				2.3 to 5.5	V <sub>CC</sub> × 0.75	_	_	
Low-level input voltage	V <sub>IL</sub>	_		1.65 to 1.95	_	_	V <sub>CC</sub> × 0.12	V
				2.3 to 5.5	_	_	$V_{CC} \times 0.25$	
High-level output voltage	V <sub>OH</sub>	V <sub>IN</sub> = V <sub>IL</sub>	I <sub>OH</sub> = -100 μA	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 <sub>OH</sub> = -8 mA	2.3	1.9	2.15	_	
			I <sub>OH</sub> = -16 mA	3.0	2.4	2.8	_	
			I <sub>OH</sub> = -24 mA	3.0	2.3	2.68	_	
			I <sub>OH</sub> = -32 mA	4.5	3.8	4.2	_	
Low-level output voltage	V <sub>OL</sub>	V <sub>IN</sub> = V <sub>IH</sub>	I <sub>OL</sub> = 100 μA	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 <sub>OL</sub> = 8 mA	2.3	_	0.1	0.3	
			I <sub>OL</sub> = 16 mA	3.0	_	0.15	0.4	
			I <sub>OL</sub> = 24 mA	3.0	_	0.22	0.55	
			I <sub>OL</sub> = 32 mA	4.5	_	0.22	0.55	
Input leakage current	I <sub>IN</sub>	V <sub>IN</sub> = 5.5 V or GND		0 to 5.5	_	_	±1.0	μА
Power-OFF leakage current	I <sub>OFF</sub>	V <sub>IN</sub> or V <sub>OUT</sub> = 5.5 V		0	_	_	1	μА
Quiescent supply current	I <sub>CC</sub>	V <sub>IN</sub> = V <sub>CC</sub> or GND		5.5	_	_	2	μА



# 9.2. DC Characteristics (Unless otherwise specified, T<sub>a</sub> = -40 to 85 °C)

Characteristics	Symbol	Test Conditio	n	V <sub>CC</sub> (V)	Min	Max	Unit
High-level input voltage	V <sub>IH</sub>	_		1.65 to 1.95	$V_{CC} \times 0.88$	_	V
				2.3 to 5.5	V <sub>CC</sub> × 0.75	_	
Low-level input voltage	V <sub>IL</sub>	_		1.65 to 1.95	_	V <sub>CC</sub> × 0.12	V
				2.3 to 5.5	_	V <sub>CC</sub> × 0.25	
High-level output voltage	V <sub>OH</sub>	$V_{IN} = V_{IL}$	I <sub>OH</sub> = -100 μA	1.65	1.55	_	V
				2.3	2.2		
				3.0	2.9	_	
				4.5	4.4	_	
			$I_{OH}$ = -8 mA	2.3	1.9	_	
			I <sub>OH</sub> = -16 mA	3.0	2.4	_	
			I <sub>OH</sub> = -24 mA	3.0	2.3	_	
			I <sub>OH</sub> = -32 mA	4.5	3.8	_	
Low-level output voltage	V <sub>OL</sub>	V <sub>IN</sub> = V <sub>IH</sub>	I <sub>OL</sub> = 100 μA	1.65	_	0.1	V
				2.3	_	0.1	
				3.0	_	0.1	
				4.5	_	0.1	
			$I_{OL}$ = 8 mA	2.3	_	0.3	
			I <sub>OL</sub> = 16 mA	3.0	_	0.4	
			I <sub>OL</sub> = 24 mA	3.0	_	0.55	
			I <sub>OL</sub> = 32 mA	4.5	_	0.55	
Input leakage current	I <sub>IN</sub>	V <sub>IN</sub> = 5.5 V or GND		0 to 5.5		±10.0	μΑ
Power-OFF leakage current	I <sub>OFF</sub>	V <sub>IN</sub> or V <sub>OUT</sub> = 5.5 V		0	_	10	μΑ
Quiescent supply current	I <sub>CC</sub>	$V_{IN} = V_{CC}$ or GND		5.5	_	20	μΑ



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

Characteristics	Symbol	Test Condition		V <sub>CC</sub> (V)	Min	Max	Unit
High-level input voltage	V <sub>IH</sub>	_		1.65 to 1.95	$V_{CC} \times 0.88$	_	V
				2.3 to 5.5	V <sub>CC</sub> × 0.75	_	
Low-level input voltage	V <sub>IL</sub>	_		1.65 to 1.95	_	V <sub>CC</sub> × 0.12	V
				2.3 to 5.5	_	V <sub>CC</sub> × 0.25	
High-level output voltage	V <sub>OH</sub>	$V_{IN} = V_{IL}$	I <sub>OH</sub> = -100 μA	1.65	1.55	_	V
				2.3	2.2	_	
				3.0	2.9	_	
				4.5	4.4	_	
			$I_{OH}$ = -8 mA	2.3	1.7		
			I <sub>OH</sub> = -16 mA	3.0	2.2	_	
			I <sub>OH</sub> = -24 mA	3.0	2.0	_	
			I <sub>OH</sub> = -32 mA	4.5	3.4	_	
Low-level output voltage	V <sub>OL</sub>	$V_{IN} = V_{IH}$	I <sub>OL</sub> = 100 μA	1.65	_	0.1	٧
				2.3	_	0.1	
				3.0	_	0.1	
				4.5	_	0.1	
			$I_{OL}$ = 8 mA	2.3	_	0.45	
			I <sub>OL</sub> = 16 mA	3.0	_	0.6	
			I <sub>OL</sub> = 24 mA	3.0	_	0.8	
			I <sub>OL</sub> = 32 mA	4.5	_	0.8	
Input leakage current	I <sub>IN</sub>	V <sub>IN</sub> = 5.5 V or GND		0 to 5.5	_	±20.0	μΑ
Power-OFF leakage current	I <sub>OFF</sub>	V <sub>IN</sub> or V <sub>OUT</sub> = 5.5 V		0	_	100	μΑ
Quiescent supply current	I <sub>CC</sub>	$V_{IN} = V_{CC}$ or GND		5.5	_	200	μΑ

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



## 9.4. AC Characteristics (Unless otherwise specified, $T_a = 25$ °C, Input: $t_f = t_f = 3$ ns)

Characteristics	Symbol	Note	Test Condition	V <sub>CC</sub> (V)	C <sub>L</sub> (pF)	Min	Тур.	Max	Unit
Propagation delay time	t <sub>PLH</sub> ,t <sub>PHL</sub>		$R_L = 1 M\Omega$	$1.8 \pm 0.15$	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	2.1	4.5	
				$5.0 \pm 0.5$		0.5	1.8	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 <sub>IN</sub>		_	0 to 5.5	_	_	4	_	pF
Power dissipation	C <sub>PD</sub>	(Note 1)	_	3.3	_		20	_	pF
capacitance				5.5			26	_	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 <sub>CC</sub> (V)	C <sub>L</sub> (pF)	Min	Max	Unit
Propagation delay time	t <sub>PLH</sub> ,t <sub>PHL</sub>	$R_L = 1 M\Omega$	$1.8 \pm 0.15$	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 to 125 °C, Input: $t_r$ = $t_f$ = 3 ns)

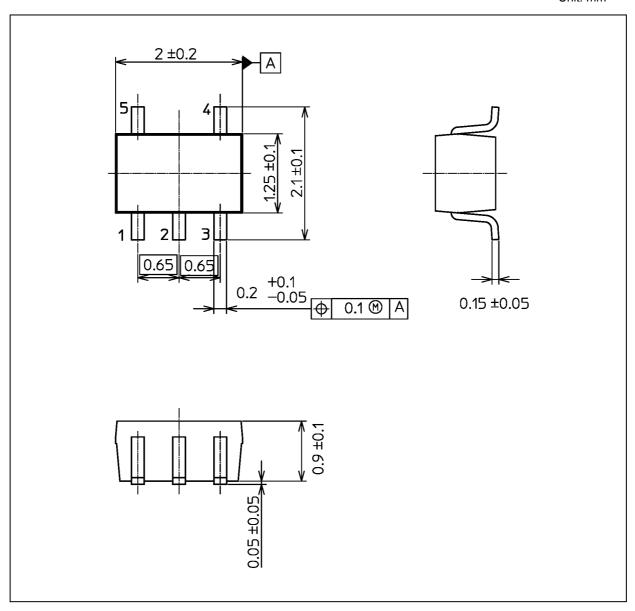
Characteristics	Symbol	Test Condition	V <sub>CC</sub> (V)	C <sub>L</sub> (pF)	Min	Max	Unit
Propagation delay time	t <sub>PLH</sub> ,t <sub>PHL</sub>	$R_L = 1 M\Omega$	$1.8 \pm 0.15$	15	2.0	11.0	ns
			$2.5\pm0.2$		0.8	8.0	
			$3.3 \pm 0.3$		0.5	5.5	
			$5.0 \pm 0.5$		0.5	5.0	
		R <sub>L</sub> = 500 Ω	$3.3 \pm 0.3$	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.



# **Package Dimensions**

Unit: mm



Weight: 0.006 g (typ.)

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



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