

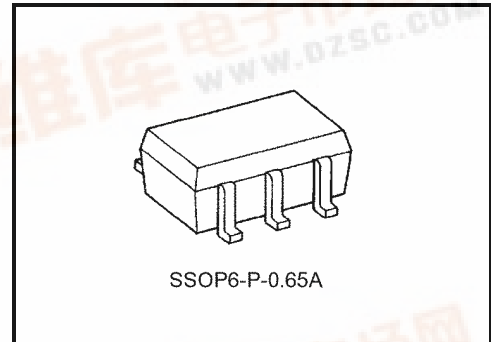
TOSHIBA CMOS Digital Integrated Circuit Silicon Monolithic

# TC7PA04FU

Dual Inverter with 3.6 V Tolerant Input and Output

## Features

- Operating voltage range:  $V_{CC} = 1.8\sim 3.6\text{ V}$
- High-speed operation:  $t_{pd} = 2.8\text{ ns (max) at } V_{CC} = 3.0\sim 3.6\text{ V}$   
 $t_{pd} = 3.7\text{ ns (max) at } V_{CC} = 2.3\sim 2.7\text{ V}$   
 $t_{pd} = 7.4\text{ ns (max) at } V_{CC} = 1.8\text{ V}$
- High-level output current:  
 $I_{OH}/I_{OL} = \pm 24\text{ mA (min) at } V_{CC} = 3.0\text{ V}$   
 $I_{OH}/I_{OL} = \pm 18\text{ mA (min) at } V_{CC} = 2.3\text{ V}$   
 $I_{OH}/I_{OL} = \pm 6\text{ mA (min) at } V_{CC} = 1.8\text{ V}$
- High latch-up immunity:  $\pm 300\text{ mA}$
- High ESD: Higher than or equal to  $\pm 200\text{ V (JEITA)}$   
 Higher than or equal to  $\pm 2000\text{ V (MIL)}$
- 3.6-V tolerant function and power-down protection provided on all inputs and outputs



Weight: 0.0068 g (typ.)

## Maximum Ratings (Ta = 25°C)

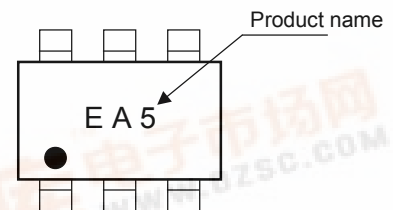
Characteristics	Symbol	Value	Unit
Power supply voltage	$V_{CC}$	-0.5~6	V
DC input voltage	$V_{IN}$	-0.5~6	V
DC output voltage	$V_{OUT}$	-0.5~6 (Note 1)	V
		-0.5~ $V_{CC} + 0.5$ (Note 2)	
Input diode current	$I_{IK}$	-50	mA
Output diode current	$I_{OK}$	$\pm 50$ (Note 3)	mA
DC output current	$I_{OUT}$	$\pm 50$	mA
Power dissipation	$P_D$	200	mW
DC $V_{CC}$ /ground current	$I_{CC}$	$\pm 100$	mA
Storage temperature	$T_{stg}$	-65~150	°C

Note 1:  $V_{CC} = 0\text{ V}$

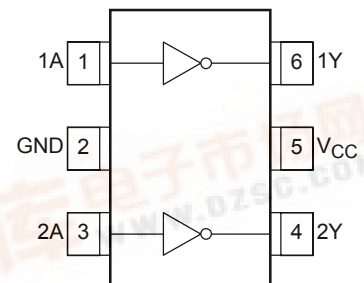
Note 2: High or Low state. The  $I_{OUT}$  maximum rating must be adhere to.

Note 3:  $V_{OUT} < \text{GND}$ ,  $V_{OUT} > V_{CC}$

## Marking



## Pin Assignment (top view)



**Truth Table**

A	Y
L	H
H	L

**IEC Logic Symbol**



**Recommended Operating Conditions**

Characteristics	Symbol	Value	Unit
Power supply voltage	$V_{CC}$	1.8~3.6	V
		1.2~3.6 (Note 4)	
Input voltage	$V_{IN}$	-0.3~3.6	V
Output voltage	$V_{OUT}$	0~3.6 (Note 5)	V
		0~ $V_{CC}$ (Note 6)	
Output Current	$I_{OH}/I_{OL}$	$\pm 24$ (Note 7)	mA
		$\pm 18$ (Note 8)	
		$\pm 6$ (Note 9)	
Operating temperature	$T_{opr}$	-40~85	$^{\circ}C$
Input rise and fall time	$d_t/d_v$	0~10 (Note 10)	ns/V

Note 4: Data retention only

Note 5:  $V_{CC} = 0\text{ V}$

Note 6: High or Low state

Note 7:  $V_{CC} = 3.0\sim 3.6\text{ V}$

Note 8:  $V_{CC} = 2.3\sim 2.7\text{ V}$

Note 9:  $V_{CC} = 1.8\text{ V}$

Note 10:  $V_{IN} = 0.8\sim 2.0\text{ V}$ ,  $V_{CC} = 3.0\text{ V}$

**DC Electrical Characteristics (Ta = -40~85°C, 2.7 V < V<sub>CC</sub> ≤ 3.6 V)**

Characteristics	Symbol	Test Condition		Min	Max	Unit	
			V <sub>CC</sub> (V)				
High-Level Input Voltage	V <sub>IH</sub>	—		2.7~3.6	2.0	V	
Low-Level Input Voltage	V <sub>IL</sub>	—		2.7~3.6	—		
High-Level Output Voltage	V <sub>OH</sub>	V <sub>IN</sub> = V <sub>IL</sub>	I <sub>OH</sub> = -100 μA	2.7~3.6	V <sub>CC</sub> - 0.2	V	
			I <sub>OH</sub> = -12 mA	2.7	2.2		
			I <sub>OH</sub> = -18 mA	3.0	2.4		
			I <sub>OH</sub> = -24 mA	3.0	2.2		
Low-Level Output Voltage	V <sub>OL</sub>	V <sub>IN</sub> = V <sub>IH</sub>	I <sub>OL</sub> = 100 μA	2.7~3.6	—	V	
			I <sub>OL</sub> = 12 mA	2.7	—		
			I <sub>OL</sub> = 18 mA	3.0	—		
			I <sub>OL</sub> = 24 mA	3.0	—		
Input Leakage Current	I <sub>IN</sub>	V <sub>IN</sub> = 0~3.6 V		2.7~3.6	—	±5.0	μA
Power-off Leakage Current	I <sub>OFF</sub>	V <sub>IN</sub> , V <sub>OUT</sub> = 0~3.6 V		0	—	10.0	μA
Quiescent Supply Current	I <sub>CC</sub>	V <sub>IN</sub> = V <sub>CC</sub> or GND		2.7~3.6	—	20.0	μA
		V <sub>CC</sub> ≤ (V <sub>IN</sub> , V <sub>OUT</sub> ) ≤ 3.6 V		2.7~3.6	—	±20.0	
Increase in I <sub>CC</sub> per Input	ΔI <sub>CC</sub>	V <sub>IH</sub> = V <sub>CC</sub> - 0.6 V		2.7~3.6	—	750	

**DC Characteristics (Ta = -40~85°C, 2.3 V ≤ V<sub>CC</sub> ≤ 2.7 V)**

Characteristics	Symbol	Test Condition		Min	Max	Unit	
			V <sub>CC</sub> (V)				
High-Level Input Voltage	V <sub>IH</sub>	—		2.3~2.7	1.6	V	
Low-Level Input Voltage	V <sub>IL</sub>	—		2.3~2.7	—		
High-Level Output Voltage	V <sub>OH</sub>	V <sub>IN</sub> = V <sub>IL</sub>	I <sub>OH</sub> = -100 μA	2.3~2.7	V <sub>CC</sub> - 0.2	V	
			I <sub>OH</sub> = -6 mA	2.3	2.0		
			I <sub>OH</sub> = -12 mA	2.3	1.8		
			I <sub>OH</sub> = -18 mA	2.3	1.7		
Low-Level Output Voltage	V <sub>OL</sub>	V <sub>IN</sub> = V <sub>IH</sub>	I <sub>OL</sub> = 100 μA	2.3~2.7	—	V	
			I <sub>OL</sub> = 12 mA	2.3	—		
			I <sub>OL</sub> = 18 mA	2.3	—		
Input Leakage Current	I <sub>IN</sub>	V <sub>IN</sub> = 0~3.6 V		2.3~2.7	—	±5.0	μA
Power-off Leakage Current	I <sub>OFF</sub>	V <sub>IN</sub> , V <sub>OUT</sub> = 0~3.6 V		0	—	10.0	μA
Quiescent Supply Current	I <sub>CC</sub>	V <sub>IN</sub> = V <sub>CC</sub> or GND		2.3~2.7	—	20.0	μA
		V <sub>CC</sub> ≤ (V <sub>IN</sub> , V <sub>OUT</sub> ) ≤ 3.6 V		2.3~2.7	—	±20.0	

## DC Characteristics (Ta = -40~85°C, 1.8 V ≤ VCC < 2.3 V)

Characteristics	Symbol	Test Condition		VCC (V)	Min	Max	Unit
High-Level Input Voltage	V <sub>IH</sub>	—		1.8~2.3	0.7 × V <sub>CC</sub>	—	V
Low-Level Input Voltage	V <sub>IL</sub>	—		1.8~2.3	—	0.2 × V <sub>CC</sub>	
High-Level Output Voltage	V <sub>OH</sub>	V <sub>IN</sub> = V <sub>IL</sub>	I <sub>OH</sub> = -100 μA	1.8	V <sub>CC</sub> - 0.2	—	V
			I <sub>OH</sub> = -6 mA	1.8	1.4	—	
Low-Level Output Voltage	V <sub>OL</sub>	V <sub>IN</sub> = V <sub>IH</sub>	I <sub>OL</sub> = 100 μA	1.8	—	0.2	
			I <sub>OL</sub> = 6 mA	1.8	—	0.3	
Input Leakage Current	I <sub>IN</sub>	V <sub>IN</sub> = 0~3.6 V		1.8	—	±5.0	μA
Power-off Leakage Current	I <sub>OFF</sub>	V <sub>IN</sub> , V <sub>OUT</sub> = 0~3.6 V		0	—	10.0	μA
Quiescent Supply Current	I <sub>CC</sub>	V <sub>IN</sub> = V <sub>CC</sub> or GND		1.8	—	20.0	μA
		V <sub>CC</sub> ≤ (V <sub>IN</sub> , V <sub>OUT</sub> ) ≤ 3.6 V		1.8	—	±20.0	

## AC Electrical Characteristics (Ta = -40~85°C, input t<sub>r</sub> = t<sub>f</sub> = 2.0 ns, C<sub>L</sub> = 30 pF, R<sub>L</sub> = 500 Ω)

Characteristics	Symbol	Test Condition		VCC (V)	Min	Max	Unit
Propagation delay time	t <sub>pLH</sub> t <sub>pHL</sub>	(Figure 1 and 2)		1.8	1.0	7.4	ns
				2.5 ± 0.2	0.8	3.7	
				3.3 ± 0.3	0.6	2.8	

For C<sub>L</sub> = 50 pF, add approximately 300 ps to the AC maximum specification.

**Dynamic Switching Characteristics (Ta = 25°C, input tr = tf = 2.0 ns, CL = 30 pF)**

Characteristics	Symbol	Test Condition		TYP.	Unit	
			VCC (V)			
Quiet Output Maximum Dynamic VOL	VOLP	VIN = 1.8 V, VIL = 0 V	(Note 11)	1.8	0.25	ns
		VIN = 2.5 V, VIL = 0 V	(Note 11)	2.5	0.6	
		VIN = 3.3 V, VIL = 0 V	(Note 11)	3.3	0.8	
Quiet Output Minimum Dynamic VOL	VOLV	VIN = 1.8 V, VIL = 0 V	(Note 11)	1.8	-0.25	ns
		VIN = 2.5 V, VIL = 0 V	(Note 11)	2.5	-0.6	
		VIN = 3.3 V, VIL = 0 V	(Note 11)	3.3	-0.8	
Quiet Output Minimum Dynamic VOH	VOLP	VIN = 1.8 V, VIL = 0 V	(Note 11)	1.8	1.5	ns
		VIN = 2.5 V, VIL = 0 V	(Note 11)	2.5	1.9	
		VIN = 3.3 V, VIL = 0 V	(Note 11)	3.3	2.2	

Note 11: Characteristics guaranteed by design.

**Capacitive Characteristics (Ta = 25°C)**

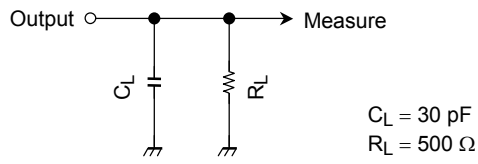
Characteristics	Symbol	Test Condition		TYP.	Unit
			VCC (V)		
Input Capacitance	CIN	—		5	pF
Power Dissipation Capacitance	CPD	fIN = 10 MHz	(Note 12)	18	pF

Note 12: CPD 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:

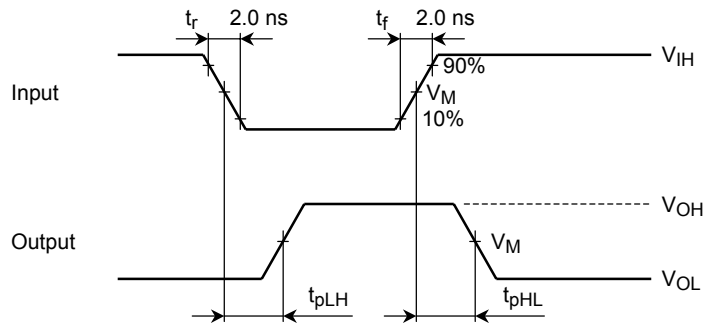
$$I_{CC}(\text{opr.}) = C_{PD} \cdot V_{CC} \cdot f_{IN} + I_{CC}/2$$

**Figure 1 Test Circuit**



**AC Waveforms**

**Figure 2  $t_{pLH}$ ,  $t_{pHL}$**

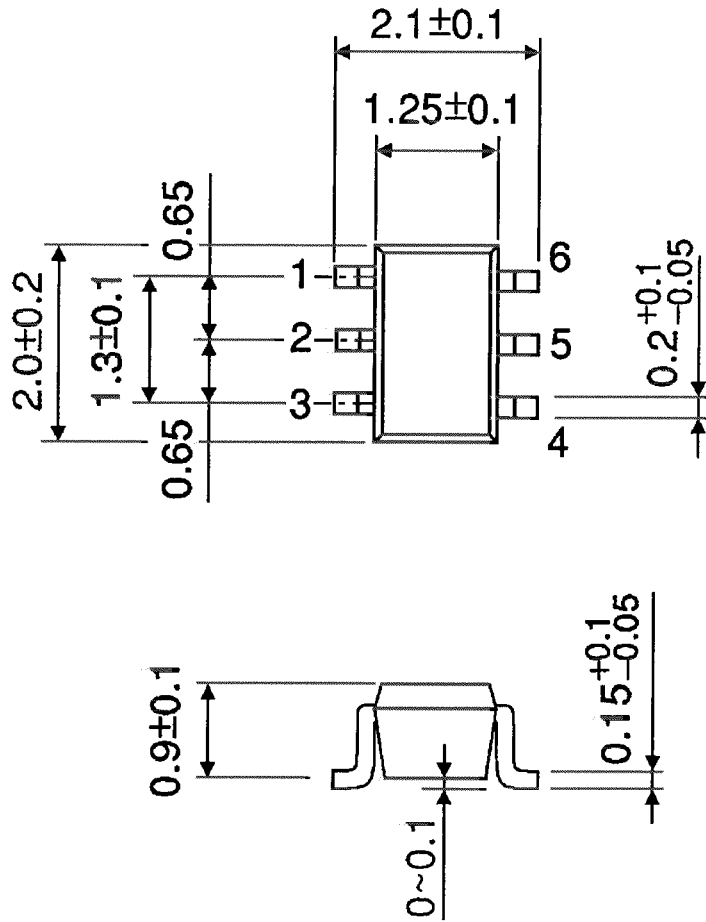


Symbol	$V_{CC}$		
	$3.3 \pm 0.3 \text{ V}$	$2.5 \pm 0.2 \text{ V}$	1.8 V
$V_{IH}$	2.7 V	$V_{CC}$	$V_{CC}$
$V_M$	1.5 V	$V_{CC}/2$	$V_{CC}/2$

**Package Dimensions**

SSOP6-P-0.65A

Unit: mm



Weight: 0.0068 g (typ.)

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