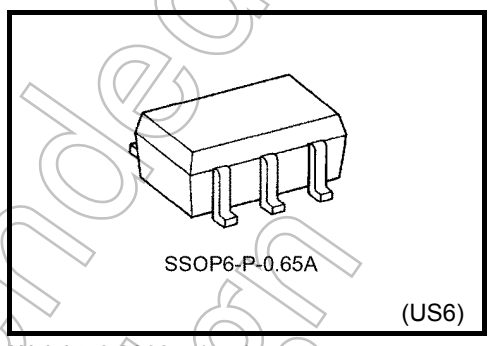
TOSHIBA CMOS Digital Integrated Circuit Silicon Monolithic

TC7PA04FU

Inverter with 3.6 V Tolerant Input and Output

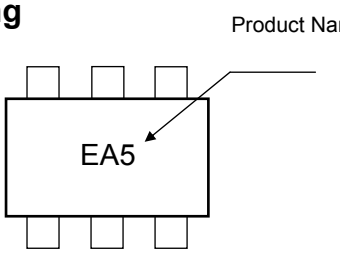
Features

- Low voltage operation : V_{CC} = 1.8 to 3.6 V
- High speed operation : t_{pd} = 2.8 ns (max) (V_{CC} = 3.0 to 3.6 V)
  : t_{pd} = 3.7 ns (max) (V_{CC} = 2.3 to2.7 V)
  : t_{pd} = 7.4 ns (max) (V_{CC} = 1.8 V)
- High Output current : I_{OH}/I_{OL} = ±24 mA (min) (V_{CC} = 3.0 V)
  : I_{OH}/I_{OL} = ±18 mA (min) (V_{CC} = 2.3 V)
  : I_{OH}/I_{OL} = ±6 mA (min) (V_{CC} = 1.8 V)
- 3.6-V Tolerant input.
- Power down protection is provided on output.



Weight: 0.0068 g (typ.)

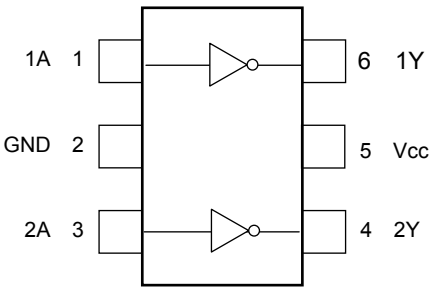
Marking



Absolute Maximum Ratings (Ta = 25°C)

Characteristics	Symbol	Rating	Unit
Power supply voltage	V_{CC}	−0.5 to 4.6	V
DC input voltage	V_{IN}	−0.5 to 4.6	V
DC output voltage	V_{OUT}	−0.5 to 4.6 (Note 1) −0.5 to V_{CC} + 0.5 (Note 2)	V
Input diode current	I_{IK}	−50	mA
Output diode current	I_{OK}	−50 (Note 3)	mA
DC output current	I_{OUT}	±50	mA
Power dissipation	P_D	200	mW
DC V_{CC}/ground current	I_{CC}	±100	mA
Storage temperature range	T_{stg}	−65 to 150	°C

Pin Assignment (top view)



Note: 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 or low state. I_{OUT} absolute maximum rating be observed.

Note 3: V_{OUT} < GND

Start of commercial production
2001-10

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IEC Logic Symbol

Truth Table

A	Y
L	H
H	L

Operating Ranges

Characteristics	Symbol	Rating	Unit
Power supply voltage	V_{CC}	1.8 to 3.6	V
		1.2 to 3.6 (Note 4)	
Input voltage	V_{IN}	−0.3 to 3.6	V
Output voltage	V_{OUT}	0 to 3.6 (Note 5)	V
		0 to V_{CC} (Note 6)	
Output current	I_{OH}/I_{OL}	±24 (Note 7)	mA
		±18 (Note 8)	
		±6 (Note 9)	
Operating temperature range	T_{opr}	−40 to 85	°C
Input rise and fall time	dt/dv	0 to 10 (Note 10)	ns/V

Note 4: Data retention only

Note 5: V_{CC} = 0 V

Note 6: High or low state

Note 7: V_{CC} = 3.0 to 3.6 V

Note 8: V_{CC} = 2.3 to 2.7 V

Note 9: V_{CC} = 1.8 V

Note 10: V_{IN} = 0.8 to 2.0 V, V_{CC} = 3.0 V

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Electrical Characteristics

DC Characteristics (Ta = –40 to 85°C, 2.7 V < V_{CC} ≤ 3.6 V)

Characteristics		Symbol	Test Condition		V_{CC} (V)	Min	Max	Unit
Input voltage	High level	V_{IH}	—		2.7 to 3.6	2.0	—	V
	Low level	V_{IL}	—		2.7 to 3.6	—	0.8	
Output voltage	High level	V_{OH}	V_{IN} = V_{IL}	I_{OH} = –100 μA	2.7 to 3.6	V_{CC} – 0.2	—	V
				I_{OH} = –12 mA	2.7	2.2	—	
				I_{OH} = –18 mA	3.0	2.4	—	
				I_{OH} = –24 mA	3.0	2.2	—	
	Low level	V_{OL}	V_{IN} = V_{IH}	I_{OL} = 100 μA	2.7 to 3.6	—	0.2	
				I_{OL} = 12 mA	2.7	—	0.4	
				I_{OL} = 18 mA	3.0	—	0.4	
				I_{OL} = 24 mA	3.0	—	0.55	
Input leakage current		I_{IN}	V_{IN} = 0 to 3.6 V		2.7 to 3.6	—	±5.0	μA
Power off leakage current		I_{OFF}	V_{IN}, V_{OUT} = 0 to 3.6 V		0	—	10.0	μA
Quiescent supply current		I_{CC}	V_{IN} = V_{CC} or GND		2.7 to 3.6	—	20.0	μA
			V_{CC} ≤ (V_{IN}, V_{OUT}) ≤ 3.6 V		2.7 to 3.6	—	±20.0	
Increase in I_{CC} per input		ΔI_{CC}	V_{IH} = V_{CC} – 0.6 V		2.7 to 3.6	—	750	

DC Characteristics (Ta = –40 to 85°C, 2.3 V ≤ V_{CC} ≤ 2.7 V)

Characteristics		Symbol	Test Condition		V_{CC} (V)	Min	Max	Unit
Input voltage	High level	V_{IH}	—		2.3 to 2.7	1.6	—	V
	Low level	V_{IL}	—		2.3 to 2.7	—	0.7	
Output voltage	High level	V_{OH}	V_{IN} = V_{IL}	I_{OH} = –100 μA	2.3 to 2.7	V_{CC} – 0.2	—	V
				I_{OH} = –6 mA	2.3	2.0	—	
				I_{OH} = –12 mA	2.3	1.8	—	
				I_{OH} = –18 mA	2.3	1.7	—	
	Low level	V_{OL}	V_{IN} = V_{IH}	I_{OL} = 100 μA	2.3 to 2.7	—	0.2	
				I_{OL} = 12 mA	2.3	—	0.4	
				I_{OL} = 18 mA	2.3	—	0.6	
Input leakage current		I_{IN}	V_{IN} = 0 to 3.6 V		2.3 to 2.7	—	±5.0	μA
Power off leakage current		I_{OFF}	V_{IN}, V_{OUT} = 0 to 3.6 V		0	—	10.0	μA
Quiescent supply current		I_{CC}	V_{IN} = V_{CC} or GND		2.3 to 2.7	—	20.0	μA
			V_{CC} ≤ (V_{IN}, V_{OUT}) ≤ 3.6 V		2.3 to 2.7	—	±20.0	

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DC Characteristics (Ta = –40 to 85°C, 1.8 V ≤ V_{CC} < 2.3 V)

Characteristics		Symbol	Test Condition		V_{CC} (V)	Min	Max	Unit
Input voltage	High level	V_{IH}	—		1.8 to 2.3	V_{CC} ×0.7	—	V
	Low level	V_{IL}	—		1.8 to 2.3	—	V_{CC} ×0.2	
Output voltage	High level	V_{OH}	V_{IN} = V_{IL}	I_{OH} = –100 μA	1.8	V_{CC} – 0.2	—	V
				I_{OH} = –6 mA	1.8	1.4	—	
	Low level	V_{OL}	V_{IN} = V_{IH}	I_{OL} = 100 μA	1.8	—	0.2	
				I_{OL} = 6 mA	1.8	—	0.3	
Input leakage current		I_{IN}	V_{IN} = 0 to 3.6 V		1.8	—	±5.0	μA
Power off leakage current		I_{OFF}	V_{IN}, V_{OUT} = 0 to 3.6 V		0	—	10.0	μA
Quiescent supply current		I_{CC}	V_{IN} = V_{CC} or GND		1.8	—	20.0	μA
			V_{CC} ≤ (V_{IN}, V_{OUT}) ≤ 3.6 V		1.8	—	±20.0	

AC Characteristics (Ta = –40 to 85°C, input: t_r = t_f = 2.0 ns, C_L = 30 pF, R_L = 500 Ω)

Characteristics	Symbol	Test Condition	V_{CC} (V)	Min	Max	Unit
Propagation delay time	t_{pLH} t_{pHL}	Figure 1, Figure 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_L = 50 pF, add approximately 300 ps to the AC maximum specification.

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Dynamic Switching Characteristics (Ta = 25°C, input $t_r = t_f = 2.0$ ns, $C_L = 30$ pF)

項　　目		記　号	測　定　条　件		V_{CC} (V)	標準	単位
Quiet output maximum dynamic	V_{OL}	V_{OLP}	V_{IH} = 1.8V, V_{IL} = 0V	(Note 11)	1.8	0.25	V
			V_{IH} = 2.5V, V_{IL} = 0V	(Note 11)	2.5	0.6	
			V_{IH} = 3.3V, V_{IL} = 0V	(Note 11)	3.3	0.8	
Quiet output minimum dynamic	V_{OL}	V_{OLV}	V_{IH} = 1.8V, V_{IL} = 0V	(Note 11)	1.8	-0.25	V
			V_{IH} = 2.5V, V_{IL} = 0V	(Note 11)	2.5	-0.6	
			V_{IH} = 3.3V, V_{IL} = 0V	(Note 11)	3.3	-0.8	
Quiet output minimum dynamic	V_{OH}	V_{OHV}	V_{IH} = 1.8V, V_{IL} = 0V	(Note 11)	1.8	1.5	V
			V_{IH} = 2.5V, V_{IL} = 0V	(Note 11)	2.5	1.9	
			V_{IH} = 3.3V, V_{IL} = 0V	(Note 11)	3.3	2.2	

Note 11: Parameter guaranteed by design

Capacitive Characteristics (Ta = 25°C)

Characteristics	Symbol	Test Condition		V_{CC} (V)	Typ.	Unit
Input capacitance	C_{IN}	—		1.8, 2.5, 3.3	5	pF
Power dissipation capacitance	C_{PD}	f_{IN} = 10 MHz	(Note 12)	1.8, 2.5, 3.3	18	pF

Note 12: 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.
$I_{CC\ (opr)} = C_{PD} \cdot V_{CC} \cdot f_{IN} + I_{CC}$

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AC Test Circuit

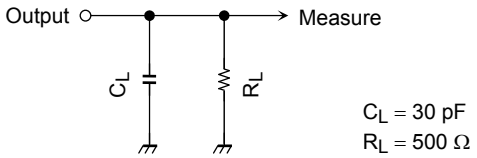
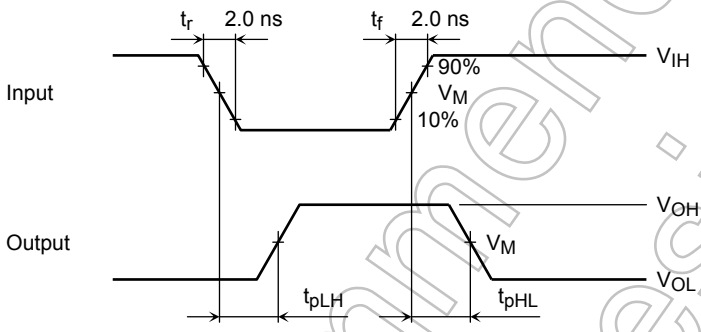


Figure 1

AC Wareform



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

Figure 2 t_{pLH}, t_{pHL}

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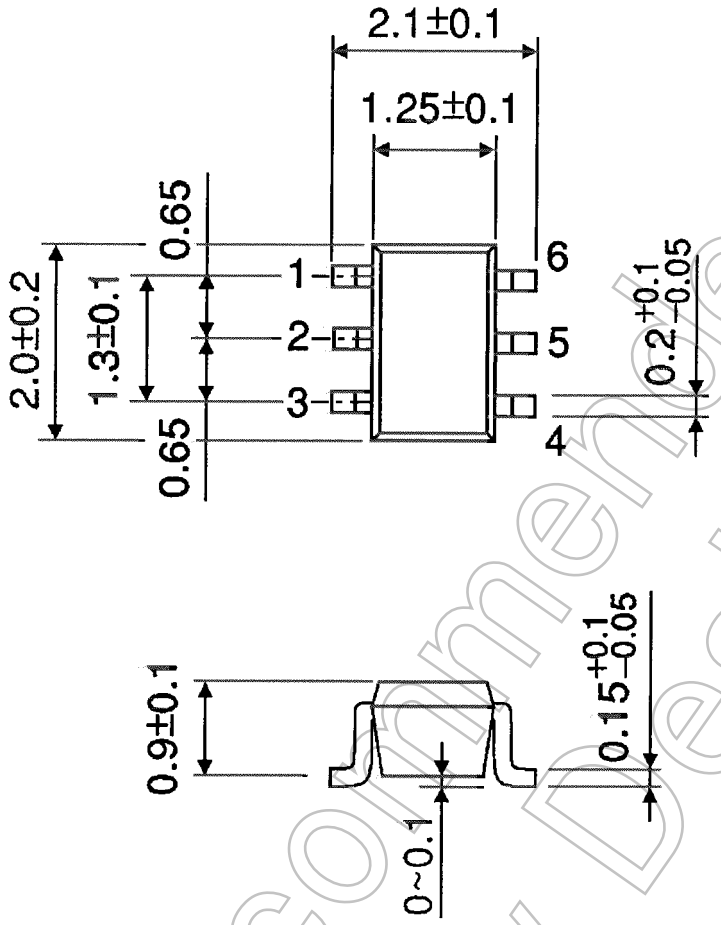
Package Dimensions

SSOP6-P-0.65A

Unit: mm



Weight: 0.0068 g (typ.)

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