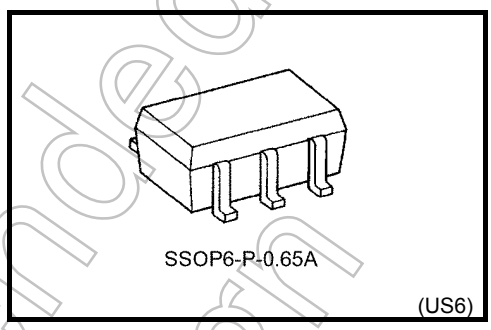
TOSHIBA CMOS Digital Integrated Circuit Silicon Monolithic

# TC7PA14FU

Dual Schmitt Inverter

## Features

- Operating voltage range: $V_{CC}$ = 1.8 to 3.6 V
- High-speed operation: $t_{pd}$ = 4.0 ns (max) at $V_{CC}$ = 3.0 to 3.6 V
  $t_{pd}$ = 4.3 ns (max) at $V_{CC}$ = 2.3 to 2.7 V
  $t_{pd}$ = 8.6 ns (max) at $V_{CC}$ = 1.8 V
- High-level output current:
  $I_{OH}/I_{OL}$ = ±24 mA (min) at $V_{CC}$ = 3.0 V
  $I_{OH}/I_{OL}$ = ±18 mA (min) at $V_{CC}$ = 2.3 V
  $I_{OH}/I_{OL}$ = ±6 mA (min) at $V_{CC}$ = 1.8 V
- 3.6-V tolerant inputs.
- 3.6-V power down protection outputs




Weight: 0.0068 g (typ.)



## Absolute Maximum Ratings (Ta = 25°C)

| Characteristics | Symbol | Rating | Unit |
|---|---|---|---|
| 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)<br>−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 | $T_{stg}$ | −65 to 150 | °C |

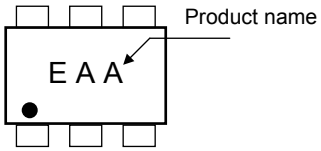
Note: Using continuously under heavy loads (e.g. the application of high temperature/current/voltage and the significant change in temperature, etc.) may cause this product to decrease in the reliability significantly even if the operating conditions (i.e. operating temperature/ current/voltage, etc.) 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

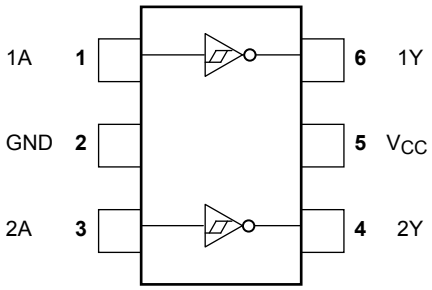
Note 2: High or Low State. $I_{OUT}$ absolute maximum rating must be observed.

Note 3: $V_{OUT}$ < GND

## Marking

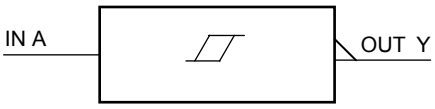



## Pin Assignment (top view)




Start of commercial production
2002-12

## IEC Logic Symbol




## Truth Table

| A | Y |
|---|---|
| L | H |
| H | L |

## Operating Ranges

| Characteristics | Symbol | Rating | | Unit |
|---|---|---|---|---|
| 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 | $T_{opr}$ | −40 to 85 | | °C |

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

## Electrical Characteristics

### DC Characteristics (2.7 V < $V_{CC}$ ≤ 3.6 V)

| Characteristics | | Symbol | Test Condition | | $V_{CC}$ (V) | Ta = 40 to 85°C Min | Ta = 40 to 85°C Max | Unit |
|---|---|---|---|---|---|---|---|---|
| Threshold Voltage | High level | $V_P$ | — | | 3.6 | — | 2.2 | V |
| | | | | | 3.0 | — | 2.0 | |
| | Low level | $V_N$ | — | | 3.6 | 0.8 | — | |
| | | | | | 3.0 | 0.7 | — | |
| Hysteresis Voltage | | $V_H$ | — | | 3.6 | 0.3 | 1.2 | V |
| | | | | | 3.0 | 0.3 | 1.2 | |
| 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 | | $\Delta I_{CC}$ | $V_{IH}$ = $V_{CC}$ − 0.6 V | | 2.7 to 3.6 | — | 750 | |

### DC Characteristics (2.3 V ≤ $V_{CC}$ ≤ 2.7 V)

| Characteristics | | Symbol | Test Condition | | $V_{CC}$ (V) | Ta = 40 to 85°C Min | Ta = 40 to 85°C Max | Unit |
|---|---|---|---|---|---|---|---|---|
| Threshold Voltage | High level | $V_P$ | — | | 2.3 | — | 1.8 | V |
| | Low level | $V_N$ | — | | 2.3 | 0.5 | — | |
| Hysteresis Voltage | | $V_H$ | — | | 2.3 | 0.3 | 1.0 | V |
| 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 | |

## DC Characteristics ($1.8\ V \leq V_{CC} < 2.3\ V$)

| Characteristics | | Symbol | Test Condition | | Ta = 40 to 85°C | | | Unit |
|---|---|---|---|---|---|---|---|---|
| | | | | | $V_{CC}$ (V) | Min | Max | |
| Threshold Voltage | High level | $V_P$ | — | | 1.8 | — | 1.4 | V |
| | Low level | $V_N$ | — | | 1.8 | 0.25 | — | |
| Hysteresis Voltage | | $V_H$ | — | | 1.8 | 0.2 | 0.95 | V |
| Output Voltage | High level | $V_{OH}$ | $V_{IN} = V_{IL}$ | $I_{OH} = -100\ \mu A$ | 1.8 | $V_{CC} - 0.2$ | — | V |
| | | | | $I_{OH} = -6\ mA$ | 1.8 | 1.4 | — | |
| | Low level | $V_{OL}$ | $V_{IN} = V_{IH}$ | $I_{OL} = 100\ \mu A$ | 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 |
| | | | $V_{CC} \leq (V_{IN}, V_{OUT}) \leq 3.6$ V | | 1.8 | — | ±20.0 | |

## AC Characteristics (Input $t_r = t_f = 2.0$ ns, $C_L = 30$ pF, $R_L = 500\ \Omega$)

| Characteristics | Symbol | Test Condition | Ta = 40 to 85°C | | | Unit |
|---|---|---|---|---|---|---|
| | | | $V_{CC}$ (V) | Min | Max | |
| Propagation delay time | $t_{pLH}$ $t_{pHL}$ | (Figure 1 and 2) | 1.8 | 1.0 | 8.6 | ns |
| | | | 2.5 ± 0.2 | 0.8 | 4.3 | |
| | | | 3.3 ± 0.3 | 0.6 | 4.0 | |

For $C_L = 50$ pF, add approximately 300 ps to the AC maximum specification.

## Dynamic Switching Characteristics (Input $t_r = t_f = 2.0$ ns, $C_L = 30$ pF)

| Characteristics | Symbol | Test Condition | | Ta = 25°C | Unit |
|---|---|---|---|---|---|
| | | | $V_{CC}$ (V) | Typ | |
| Quiet Output Maximum Dynamic $V_{OL}$ | $V_{OLP}$ | $V_{IN}$ = 1.8 V, $V_{IL}$ = 0 V (Note 10) | 1.8 | 0.25 | ns |
| | | $V_{IN}$ = 2.5 V, $V_{IL}$ = 0 V (Note 10) | 2.5 | 0.6 | |
| | | $V_{IN}$ = 3.3 V, $V_{IL}$ = 0 V (Note 10) | 3.3 | 0.8 | |
| Quiet Output Minimum Dynamic $V_{OL}$ | $V_{OLV}$ | $V_{IN}$ = 1.8 V, $V_{IL}$ = 0 V (Note 10) | 1.8 | −0.25 | ns |
| | | $V_{IN}$ = 2.5 V, $V_{IL}$ = 0 V (Note 10) | 2.5 | −0.6 | |
| | | $V_{IN}$ = 3.3 V, $V_{IL}$ = 0 V (Note 10) | 3.3 | −0.8 | |
| Quiet Output Minimum Dynamic $V_{OH}$ | $V_{OLP}$ | $V_{IN}$ = 1.8 V, $V_{IL}$ = 0 V (Note 10) | 1.8 | 1.5 | ns |
| | | $V_{IN}$ = 2.5 V, $V_{IL}$ = 0 V (Note 10) | 2.5 | 1.9 | |
| | | $V_{IN}$ = 3.3 V, $V_{IL}$ = 0 V (Note 10) | 3.3 | 2.2 | |

Note 10: Characteristics guaranteed by design.

## Capacitive Characteristics

| Characteristics | Symbol | Test Condition | | Ta = 25°C | Unit |
|---|---|---|---|---|---|
| | | | $V_{CC}$ (V) | Typ | |
| Input Capacitance | $C_{IN}$ | — | 1.8, 2.5, 3.3 | 4 | pF |
| Power Dissipation Capacitance | $C_{PD}$ | $f_{IN}$ = 10 MHz (Note 11) | 1.8, 2.5, 3.3 | 27 | pF |

Note 11: $C_{PD}$ 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:
$I_{CC\ (opr.)} = C_{PD} \cdot V_{CC} \cdot f_{IN} + I_{CC}/2$

## AC Test Circuit

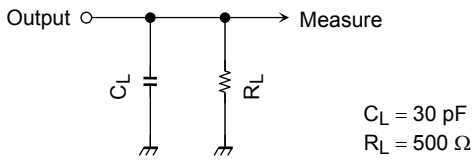
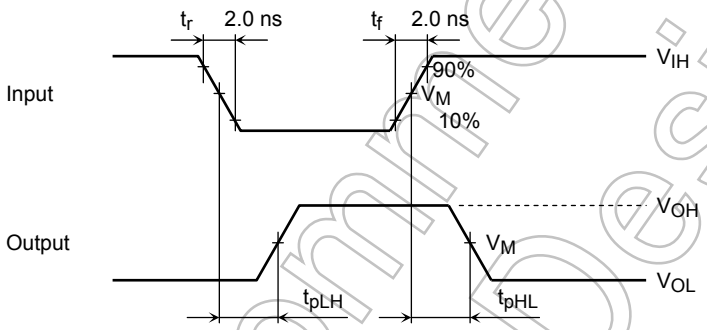



**Figure 1**

## AC Waveforms



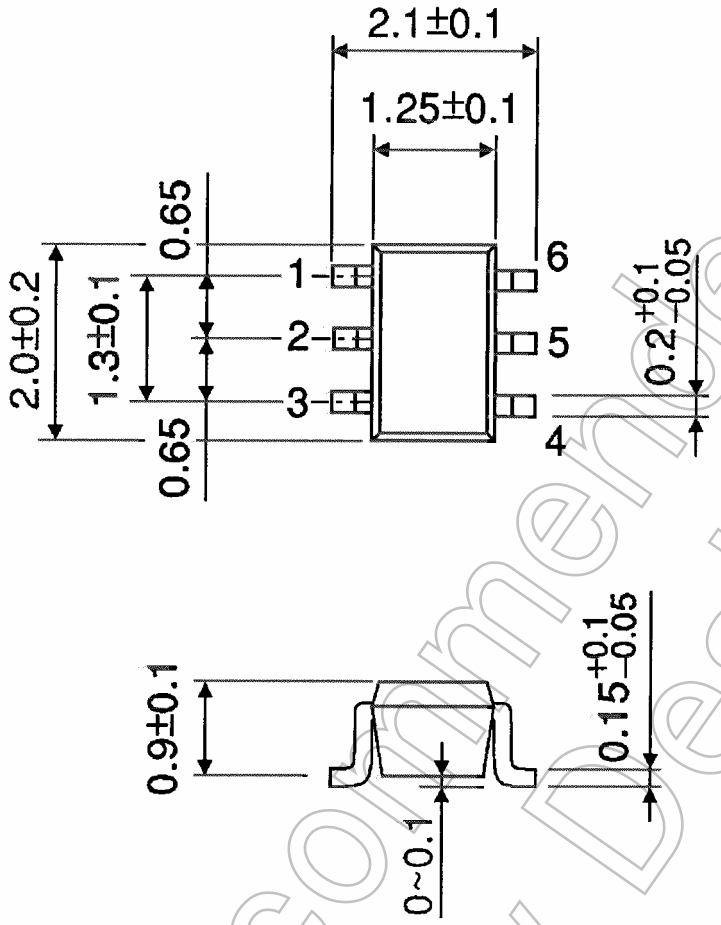

| Symbol | $V_{CC}$ | | |
|---|---|---|---|
| | 3.3 ± 0.3 V | 2.5 ± 0.2 V | 1.8 V |
| $V_{IH}$ | 2.7 V | $V_{CC}$ | $V_{CC}$ |
| $V_M$ | 1.5 V | $V_{CC}/2$ | $V_{CC}/2$ |

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

## Package Dimensions

SSOP6-P-0.65A

Unit: mm




Weight: 0.0068 g (typ.)

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