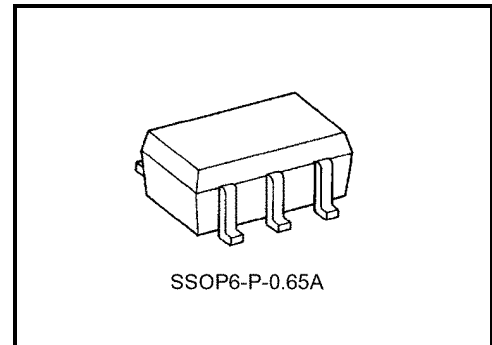


# TC7PA04FU

## 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 ( $T_a = 25^\circ\text{C}$ )

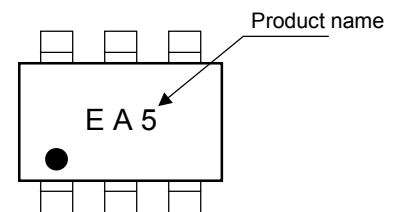
| Characteristics             | Symbol    | Value                         | Unit             |
|-----------------------------|-----------|-------------------------------|------------------|
| Power supply voltage        | $V_{CC}$  | -0.5~6                        | V                |
| DC input voltage            | $V_{IN}$  | -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                       | $^\circ\text{C}$ |

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

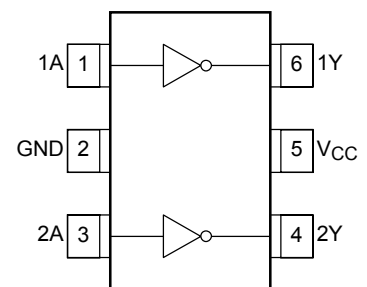
Note 2: High or Low state. The  $I_{OUT}$  maximum rating must be adhere to.

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               | °C   |
| Input rise and fall time | $d_t/d_v$       | 0~10 (Note 10)       | ns/V |

Note 4: Data retention only

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

Note 6: High or Low state

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

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

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

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

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

| Characteristics                       | Symbol           | Test Condition  |                           | VCC (V) | Min                   | Max   | Unit |
|---------------------------------------|------------------|---|---------------------------|---------|-----------------------|-------|------|
|                                       |                  |   |                           |         |                       |       |      |
| 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 | —                     | 0.8   |      |
| 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 | —                     | 0.2   | V    |
|                                       |                  |   | I <sub>OL</sub> = 12 mA   | 2.7     | —                     | 0.4   |      |
|                                       |                  |   | I <sub>OL</sub> = 18 mA   | 3.0     | —                     | 0.4   |      |
|                                       |                  |   | I <sub>OL</sub> = 24 mA   | 3.0     | —                     | 0.55  |      |
| 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 ≤ VCC ≤ 2.7 V)**

| Characteristics           | Symbol           | Test Condition  |                           | VCC (V) | Min                   | Max   | Unit |
|---------------------------|------------------|---|---------------------------|---------|-----------------------|-------|------|
|                           |                  |   |                           |         |                       |       |      |
| 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 | —                     | 0.7   |      |
| 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 | —                     | 0.2   | V    |
|                           |                  |   | I <sub>OL</sub> = 12 mA   | 2.3     | —                     | 0.4   |      |
|                           |                  |   | I <sub>OL</sub> = 18 mA   | 2.3     | —                     | 0.6   |      |
| 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><br>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<br>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<br>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<br>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)**

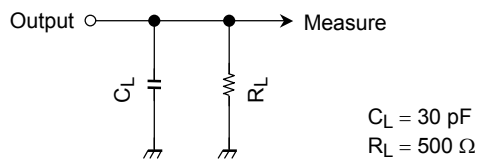
| Characteristics               | Symbol | Test Condition |           | TYP. | Unit |
|-------------------------------|--------|----------------|-----------|------|------|
|                               |        |                | VCC (V)   |      |      |
| Input Capacitance             | CIN    | —              |           | 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:

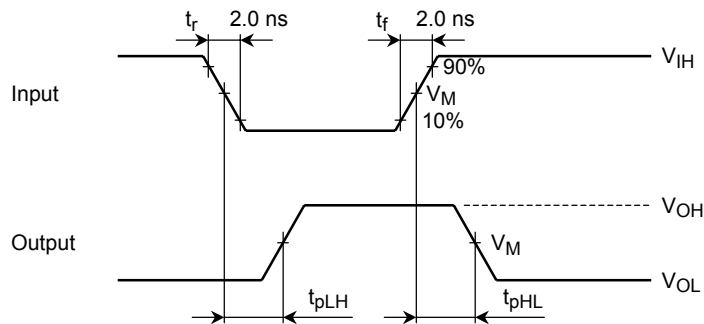
$$I_{CC} (opr.) = C_{PD} \cdot V_{CC} \cdot f_{IN} + I_{CC}/2$$

Figure 1 Test Circuit



**AC Waveforms**

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

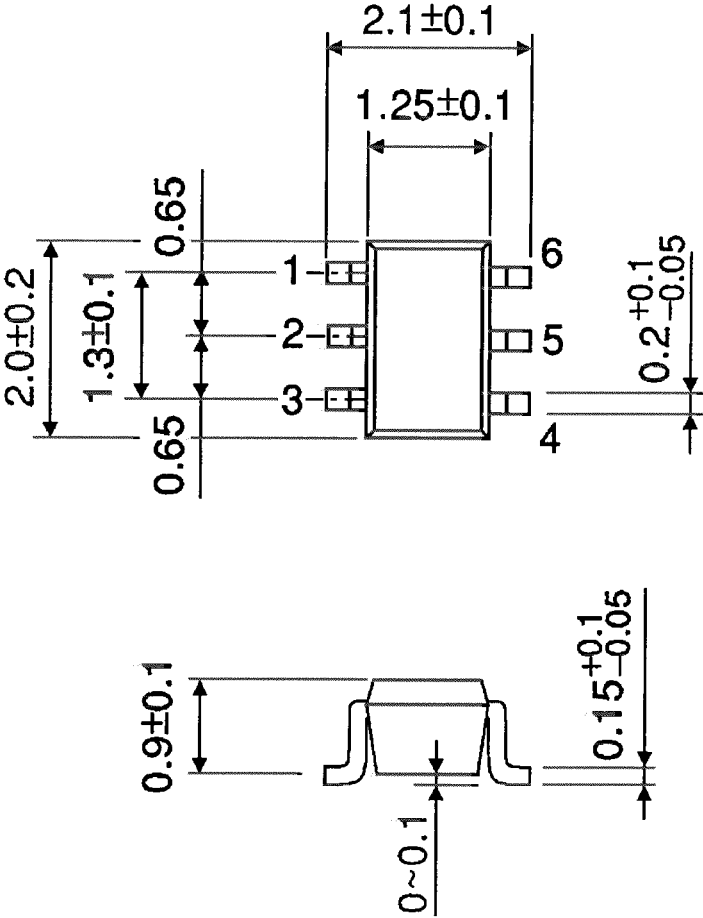


| Symbol   | $V_{CC}$                |                         |                 |
|----------|-------------------------|-------------------------|-----------------|
|          | $3.3 \pm 0.3 \text{ V}$ | $2.5 \pm 0.2 \text{ V}$ | $1.8 \text{ V}$ |
| $V_{IH}$ | $2.7 \text{ V}$         | $V_{CC}$    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

**Package Dimensions**

SSOP6-P-0.65A

Unit: mm



Weight: 0.0068 g (typ.)

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000707EBA

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