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# HD74LVU04A

Hex Inverters

# HITACHI

ADE-205-248 (Z)

1st Edition

March 1999

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## Description

The HD74LVU04A has six inverters with unbuffered outputs in a 14-pin package. Low-voltage and high-speed operation is suitable for the battery-powered products (e.g., notebook computers), and the low-power consumption extends the battery life.

## Features

- $V_{CC} = 2.0\text{ V}$  to  $5.5\text{ V}$  operation
- All inputs  $V_{IH}$  (Max.) =  $5.5\text{ V}$  (@  $V_{CC} = 0\text{ V}$  to  $5.5\text{ V}$ )
- All outputs  $V_O$  (Max.) =  $5.5\text{ V}$  (@  $V_{CC} = 0\text{ V}$ )
- Typical  $V_{OL}$  ground bounce  $< 0.8\text{ V}$  (@  $V_{CC} = 3.3\text{ V}$ ,  $T_a = 25^\circ\text{C}$ )
- Typical  $V_{OH}$  undershoot  $> 2.3\text{ V}$  (@  $V_{CC} = 3.3\text{ V}$ ,  $T_a = 25^\circ\text{C}$ )
- Output current  $\pm 6\text{ mA}$  (@  $V_{CC} = 3.0\text{ V}$  to  $3.6\text{ V}$ ),  $\pm 12\text{ mA}$  (@  $V_{CC} = 4.5\text{ V}$  to  $5.5\text{ V}$ )

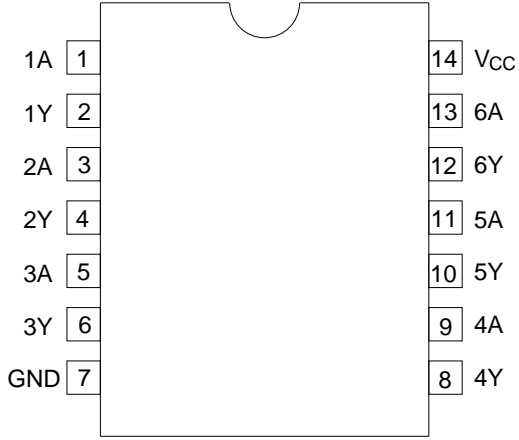
## Function Table

| Input A | Output Y |
|---------|----------|
| H       | L        |
| L       | H        |

Note: H: High level

L: Low level

## Pin Arrangement



(Top view)

**Absolute Maximum Ratings**

| Item   | Symbol                | Ratings                | Unit             | Conditions                  |
|--|-----------------------|------------------------|------------------|-----------------------------|
| Supply voltage range   | $V_{CC}$              | -0.5 to 7.0            | V                |                             |
| Input voltage range* <sup>1</sup>  | $V_I$                 | -0.5 to 7.0            | V                |                             |
| Output voltage range* <sup>1,2</sup>   | $V_O$                 | -0.5 to $V_{CC} + 0.5$ | V                | Output: H or L              |
| Input clamp current  | $I_{IK}$              | -20                    | mA               | $V_I < 0$                   |
| Output clamp current   | $I_{OK}$              | $\pm 50$               | mA               | $V_O < 0$ or $V_O > V_{CC}$ |
| Continuous output current  | $I_O$                 | $\pm 25$               | mA               | $V_O = 0$ to $V_{CC}$       |
| Continuous current through $V_{CC}$ or GND   | $I_{CC}$ or $I_{GND}$ | $\pm 50$               | mA               |                             |
| Maximum power dissipation at $T_a = 25^\circ\text{C}$ (in still air)* <sup>3</sup> | $P_T$                 | 785                    | mW               | SOP                         |
|  |                       | 500                    |                  | TSSOP                       |
| Storage temperature  | $T_{stg}$             | -65 to 150             | $^\circ\text{C}$ |                             |

Notes: The absolute maximum ratings are values which must not individually be exceeded, and furthermore, no two of which may be realized at the same time.

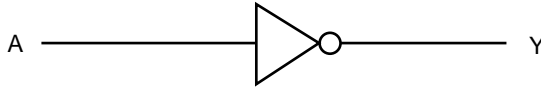
1. The input and output voltage ratings may be exceeded if the input and output clamp-current ratings are observed.
2. This value is limited to 5.5 V maximum.
3. The maximum package power dissipation was calculated using a junction temperature of  $150^\circ\text{C}$ .

## Recommended Operating Conditions

| Item                           | Symbol   | Min | Max      | Unit        | Conditions                       |
|--------------------------------|----------|-----|----------|-------------|----------------------------------|
| Supply voltage range           | $V_{CC}$ | 2.0 | 5.5      | V           |                                  |
| Input voltage range            | $V_I$    | 0   | 5.5      | V           |                                  |
| Output voltage range           | $V_O$    | 0   | $V_{CC}$ | V           |                                  |
| Output current                 | $I_{OH}$ | —   | -50      | $\mu A$     | $V_{CC} = 2.0 V$                 |
|                                |          | —   | -2       | mA          | $V_{CC} = 2.3 \text{ to } 2.7 V$ |
|                                |          | —   | -6       |             | $V_{CC} = 3.0 \text{ to } 3.6 V$ |
|                                |          | —   | -12      |             | $V_{CC} = 4.5 \text{ to } 5.5 V$ |
|                                | $I_{OL}$ | —   | 50       | $\mu A$     | $V_{CC} = 2.0 V$                 |
|                                |          | —   | 2        | mA          | $V_{CC} = 2.3 \text{ to } 2.7 V$ |
|                                |          | —   | 6        |             | $V_{CC} = 3.0 \text{ to } 3.6 V$ |
|                                |          | —   | 12       |             | $V_{CC} = 4.5 \text{ to } 5.5 V$ |
| Operating free-air temperature | $T_a$    | -40 | 85       | $^{\circ}C$ |                                  |

Note: Unused or floating inputs must be held high or low.

## Logic Diagram



**DC Electrical Characteristics**

- $T_a = -40$  to  $85^\circ\text{C}$

| Item                     | Symbol   | $V_{CC}$ (V)* | Min                 | Typ | Max                 | Unit          | Test Conditions            |                                     |
|--------------------------|----------|---------------|---------------------|-----|---------------------|---------------|----------------------------|-------------------------------------|
| Input voltage            | $V_{IH}$ | 2.0           | 1.7                 | —   | —                   | V             |                            |                                     |
|                          |          | 2.3 to 2.7    | $V_{CC} \times 0.8$ | —   | —                   |               |                            |                                     |
|                          |          | 3.0 to 3.6    | $V_{CC} \times 0.8$ | —   | —                   |               |                            |                                     |
|                          |          | 4.5 to 5.5    | $V_{CC} \times 0.8$ | —   | —                   |               |                            |                                     |
|                          | $V_{IL}$ | 2.0           | —                   | —   | 0.3                 |               |                            |                                     |
|                          |          | 2.3 to 2.7    | —                   | —   | $V_{CC} \times 0.2$ |               |                            |                                     |
|                          |          | 3.0 to 3.6    | —                   | —   | $V_{CC} \times 0.2$ |               |                            |                                     |
|                          |          | 4.5 to 5.5    | —                   | —   | $V_{CC} \times 0.2$ |               |                            |                                     |
| Output voltage           | $V_{OH}$ | Min to Max    | $V_{CC} - 0.1$      | —   | —                   | V             | $I_{OL} = -50 \mu\text{A}$ |                                     |
|                          |          | 2.3           | 2.0                 | —   | —                   |               | $I_{OL} = -2 \text{ mA}$   |                                     |
|                          |          | 3.0           | 2.48                | —   | —                   |               | $I_{OL} = -6 \text{ mA}$   |                                     |
|                          |          | 4.5           | 3.8                 | —   | —                   |               | $I_{OL} = -12 \text{ mA}$  |                                     |
|                          | $V_{OL}$ | Min to Max    | —                   | —   | 0.1                 |               | V                          | $I_{OL} = 50 \mu\text{A}$           |
|                          |          | 2.3           | —                   | —   | 0.4                 |               |                            | $I_{OL} = 2 \text{ mA}$             |
|                          |          | 3.0           | —                   | —   | 0.44                |               |                            | $I_{OL} = 6 \text{ mA}$             |
|                          |          | 4.5           | —                   | —   | 0.55                |               |                            | $I_{OL} = 12 \text{ mA}$            |
| Input current            | $I_{IN}$ | 0 to 5.5      | —                   | —   | $\pm 1$             | $\mu\text{A}$ |                            | $V_{IN} = 5.5 \text{ V or GND}$     |
| Quiescent supply current | $I_{CC}$ | 5.5           | —                   | —   | 20                  | $\mu\text{A}$ |                            | $V_{IN} = V_{CC}$ or GND, $I_O = 0$ |
| Input capacitance        | $C_{IN}$ | 3.3           | —                   | 4.0 | —                   | pF            |                            | $V_I = V_{CC}$ or GND               |

Note: For conditions shown as Min or Max, use the appropriate values under recommended operating conditions.

**Switching Characteristics**

- $V_{CC} = 2.5 \pm 0.2 \text{ V}$

$T_a = 25^\circ\text{C}$                        $T_a = -40 \text{ to } 85^\circ\text{C}$

| Item                              | Symbol    | $T_a = 25^\circ\text{C}$ |     |      | $T_a = -40 \text{ to } 85^\circ\text{C}$ |      | Unit | Test Conditions       | FROM<br>(Input) | TO<br>(Output) |
|-----------------------------------|-----------|--------------------------|-----|------|--|------|------|-----------------------|-----------------|----------------|
|                                   |           | Min                      | Typ | Max  | Min                                      | Max  |      |                       |                 |                |
| Propa-<br>gation<br>delay<br>time | $t_{PLH}$ | —                        | 3.2 | 10.9 | 1.0                                      | 14.0 | ns   | $C_L = 15 \text{ pF}$ | A               | Y              |
|                                   | $t_{PHL}$ | —                        | 6.6 | 13.4 | 1.0                                      | 16.0 |      | $C_L = 50 \text{ pF}$ |                 |                |

- $V_{CC} = 3.3 \pm 0.3 \text{ V}$

$T_a = 25^\circ\text{C}$                        $T_a = -40 \text{ to } 85^\circ\text{C}$

| Item                              | Symbol    | $T_a = 25^\circ\text{C}$ |     |      | $T_a = -40 \text{ to } 85^\circ\text{C}$ |      | Unit | Test Conditions       | FROM<br>(Input) | TO<br>(Output) |
|-----------------------------------|-----------|--------------------------|-----|------|--|------|------|-----------------------|-----------------|----------------|
|                                   |           | Min                      | Typ | Max  | Min                                      | Max  |      |                       |                 |                |
| Propa-<br>gation<br>delay<br>time | $t_{PLH}$ | —                        | 2.5 | 8.9  | 1.0                                      | 10.5 | ns   | $C_L = 15 \text{ pF}$ | A               | Y              |
|                                   | $t_{PHL}$ | —                        | 4.7 | 11.4 | 1.0                                      | 13.0 |      | $C_L = 50 \text{ pF}$ |                 |                |

- $V_{CC} = 5.0 \pm 0.5 \text{ V}$

$T_a = 25^\circ\text{C}$                        $T_a = -40 \text{ to } 85^\circ\text{C}$

| Item                              | Symbol    | $T_a = 25^\circ\text{C}$ |     |     | $T_a = -40 \text{ to } 85^\circ\text{C}$ |     | Unit | Test Conditions       | FROM<br>(Input) | TO<br>(Output) |
|-----------------------------------|-----------|--------------------------|-----|-----|--|-----|------|-----------------------|-----------------|----------------|
|                                   |           | Min                      | Typ | Max | Min                                      | Max |      |                       |                 |                |
| Propa-<br>gation<br>delay<br>time | $t_{PLH}$ | —                        | 2.2 | 5.5 | 1.0                                      | 6.5 | ns   | $C_L = 15 \text{ pF}$ | A               | Y              |
|                                   | $t_{PHL}$ | —                        | 3.9 | 7.0 | 1.0                                      | 8.0 |      | $C_L = 50 \text{ pF}$ |                 |                |

## Operating Characteristics

- $C_L = 50 \text{ pF}$

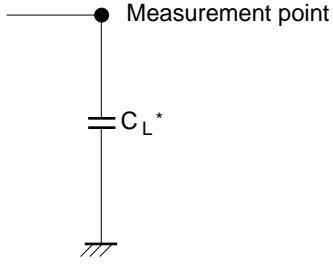
| Item                          | Symbol   | $V_{CC}$ (V) | $T_a = 25^\circ\text{C}$ |     |     | Unit | Test Conditions |
|-------------------------------|----------|--------------|--------------------------|-----|-----|------|-----------------|
|                               |          |              | Min                      | Typ | Max |      |                 |
| Power dissipation capacitance | $C_{PD}$ | 3.3          | —                        | 5.6 | —   | pF   | f = 10 MHz      |
|                               |          | 5.0          | —                        | 6.7 | —   |      |                 |

## Noise Characteristics

- $C_L = 50 \text{ pF}$

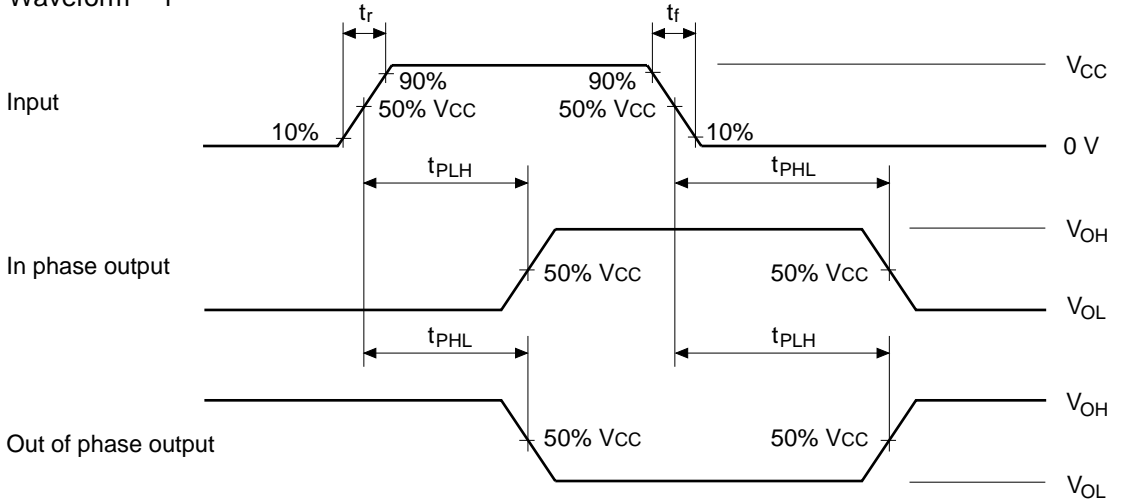
| Item                                   | Symbol      | $V_{CC}$ (V) | $T_a = 25^\circ\text{C}$ |      |      | Unit | Test Conditions |
|--|-------------|--------------|--------------------------|------|------|------|-----------------|
|  |             |              | Min                      | Typ  | Max  |      |                 |
| Quiet output, maximum dynamic $V_{OL}$ | $V_{OL(P)}$ | 3.3          | —                        | 0.5  | 0.8  | V    |                 |
| Quiet output, minimum dynamic $V_{OL}$ | $V_{OL(V)}$ | 3.3          | —                        | -0.1 | -0.8 |      |                 |
| Quiet output, minimum dynamic $V_{OH}$ | $V_{OH(V)}$ | 3.3          | —                        | 3.0  | —    |      |                 |
| High-level dynamic put voltage         | $V_{IH(D)}$ | 3.3          | 2.31                     | —    | —    | V    |                 |
| Low-level dynamic put voltage          | $V_{IL(D)}$ | 3.3          | —                        | —    | 0.99 |      |                 |

## Test Circuit



Note:  $C_L$  includes the probe and jig capacitance.

### • Waveform – 1

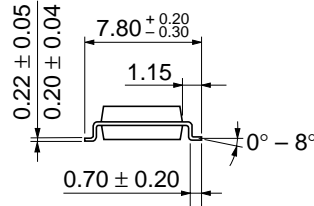
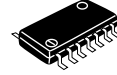
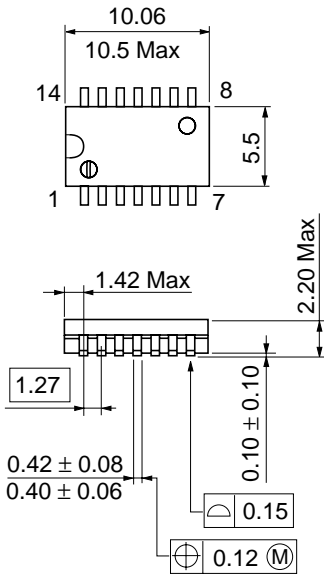


- Notes: 1. Input waveform:  $PRR \leq 1\text{ MHz}$ ,  $Z_o = 50\ \Omega$ ,  $t_r \leq 3\text{ ns}$ ,  $t_f \leq 3\text{ ns}$   
2. The output are measured one at a time with one transition per measurement.



Package Dimensions

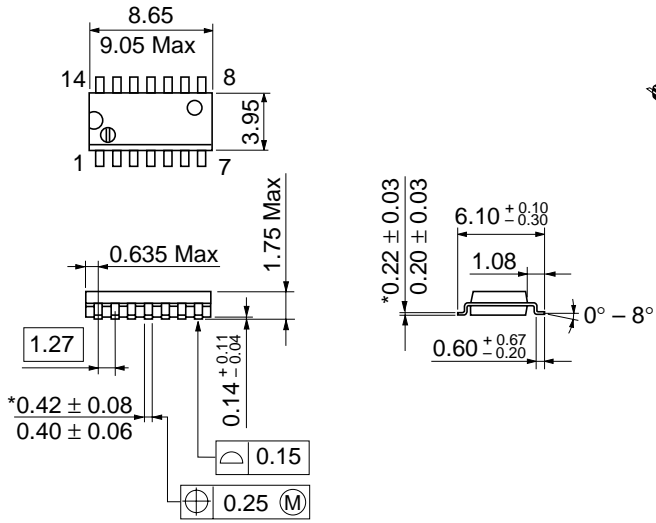
Unit: mm



Dimension including the plating thickness  
Base material dimension

|                          |          |
|--------------------------|----------|
| Hitachi Code             | FP-14DA  |
| JEDEC                    | —        |
| EIAJ                     | Conforms |
| Weight (reference value) | 0.23 g   |

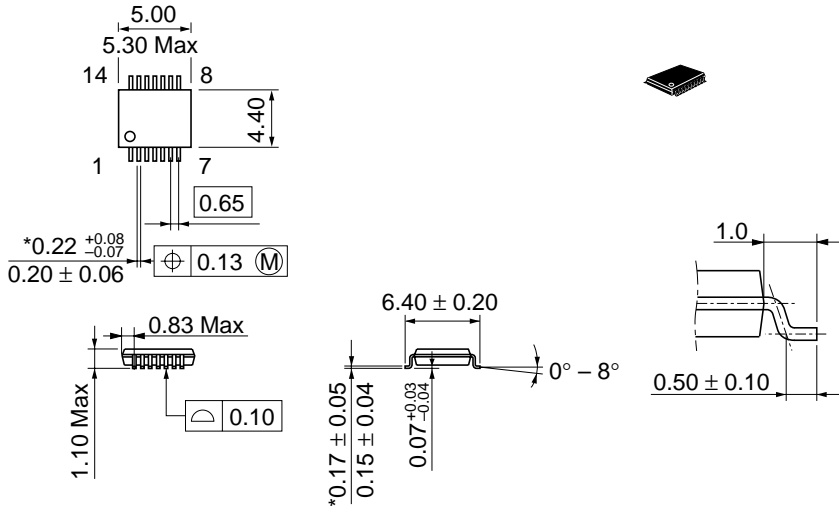
Unit: mm



\*Dimension including the plating thickness  
Base material dimension

|                          |          |
|--------------------------|----------|
| Hitachi Code             | FP-14DN  |
| JEDEC                    | Conforms |
| EIAJ                     | Conforms |
| Weight (reference value) | 0.13 g   |

Unit: mm



\*Dimension including the plating thickness  
Base material dimension

|                          |         |
|--------------------------|---------|
| Hitachi Code             | TTP-14D |
| JEDEC                    | —       |
| EIAJ                     | —       |
| Weight (reference value) | 0.05 g  |

## Cautions

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