

# DATA SHEET

For a complete data sheet, please also download:

- The IC06 74HC/HCT/HCU/HCMOS Logic Family Specifications
- The IC06 74HC/HCT/HCU/HCMOS Logic Package Information
- The IC06 74HC/HCT/HCU/HCMOS Logic Package Outlines

## **74HC/HCT14** Hex inverting Schmitt trigger

Product specification  
File under Integrated Circuits, IC06

September 1993

## Hex inverting Schmitt trigger

## 74HC/HCT14

## FEATURES

- Output capability: standard
- $I_{CC}$  category: SSI

## GENERAL DESCRIPTION

The 74HC/HCT14 are high-speed Si-gate CMOS devices and are pin compatible with low power Schottky TTL (LSTTL). They are specified in compliance with JEDEC standard no. 7A.

The 74HC/HCT14 provide six inverting buffers with Schmitt-trigger action. They are capable of transforming slowly changing input signals into sharply defined, jitter-free output signals.

## QUICK REFERENCE DATA

GND = 0 V;  $T_{amb} = 25\text{ }^{\circ}\text{C}$ ;  $t_r = t_f = 6\text{ ns}$

| SYMBOL            | PARAMETER                              | CONDITIONS                                   | TYPICAL |     | UNIT |
|-------------------|----------------------------------------|----------------------------------------------|---------|-----|------|
|                   |                                        |                                              | HC      | HCT |      |
| $t_{PHL}/t_{PLH}$ | propagation delay nA to nY             | $C_L = 15\text{ pF}$ ; $V_{CC} = 5\text{ V}$ | 12      | 17  | ns   |
| $C_I$             | input capacitance                      |                                              | 3.5     | 3.5 | pF   |
| $C_{PD}$          | power dissipation capacitance per gate | notes 1 and 2                                | 7       | 8   | pF   |

## Notes

1.  $C_{PD}$  is used to determine the dynamic power dissipation ( $P_D$  in  $\mu\text{W}$ ):

$$P_D = C_{PD} \times V_{CC}^2 \times f_i + \sum (C_L \times V_{CC}^2 \times f_o) \text{ where:}$$

$f_i$  = input frequency in MHz

$f_o$  = output frequency in MHz

$C_L$  = output load capacitance in pF

$V_{CC}$  = supply voltage in V

$\sum (C_L \times V_{CC}^2 \times f_o)$  = sum of outputs

2. For HC the condition is  $V_I = \text{GND to } V_{CC}$   
For HCT the condition is  $V_I = \text{GND to } V_{CC} - 1.5\text{ V}$

## ORDERING INFORMATION

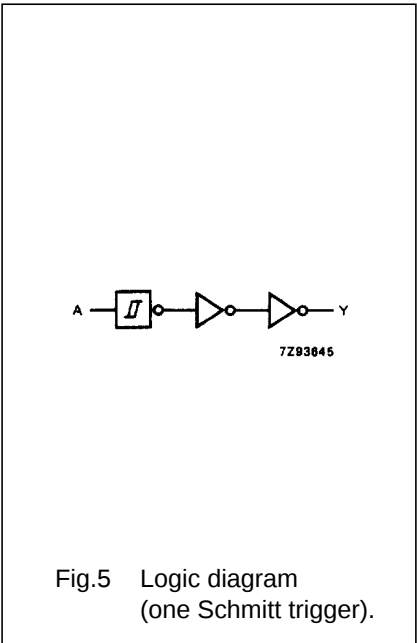
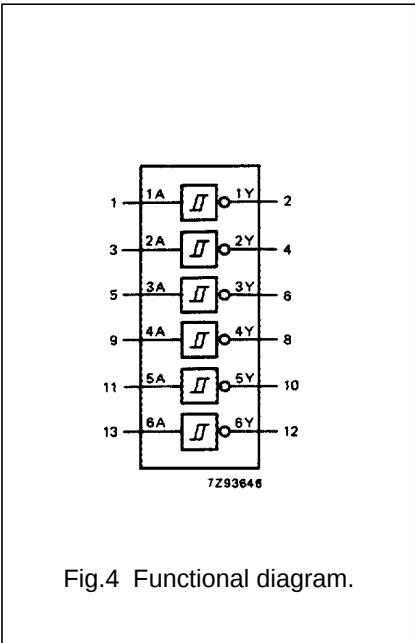
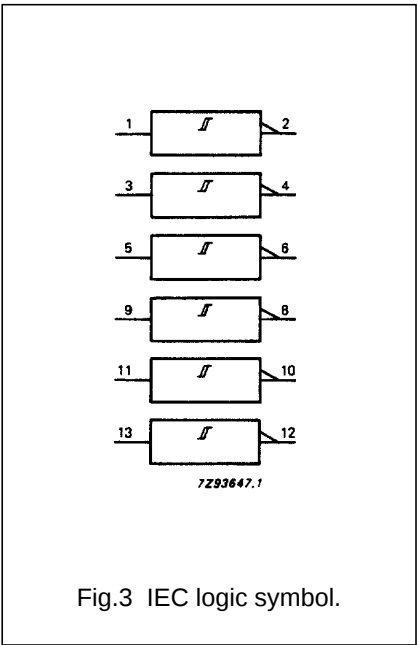
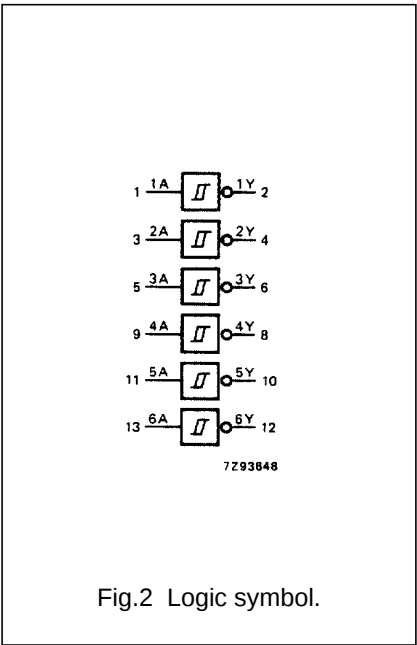
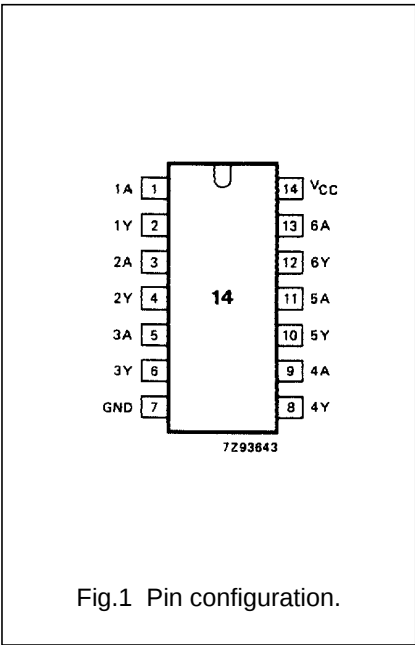
See "74HC/HCT/HCU/HCMOS Logic Package Information".

Hex inverting Schmitt trigger

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PIN DESCRIPTION

| PIN NO.            | SYMBOL          | NAME AND FUNCTION       |
|--------------------|-----------------|-------------------------|
| 1, 3, 5, 9, 11, 13 | 1A to 6A        | data inputs             |
| 2, 4, 6, 8, 10, 12 | 1Y to 6Y        | data outputs            |
| 7                  | GND             | ground (0 V)            |
| 14                 | V <sub>CC</sub> | positive supply voltage |



| FUNCTION TABLE |        |
|----------------|--------|
| INPUT          | OUTPUT |
| nA             | nY     |
| L              | H      |
| H              | L      |

- Notes
1. H = HIGH voltage level  
L = LOW voltage level

- APPLICATIONS
- Wave and pulse shapers
  - Astable multivibrators
  - Monostable multivibrators

## Hex inverting Schmitt trigger

## 74HC/HCT14

**DC CHARACTERISTICS FOR 74HC**

For the DC characteristics see *"74HC/HCT/HCU/HCMOS Logic Family Specifications"*. Transfer characteristics are given below.

Output capability: standard

I<sub>CC</sub> category: SSI

**Transfer characteristics for 74HC**

Voltages are referenced to GND (ground = 0 V)

| SYMBOL          | PARAMETER                                          | T <sub>amb</sub> (°C) |                      |                      |                     |                      |                     |                      | UNIT | TEST CONDITIONS        |              |
|-----------------|----------------------------------------------------|-----------------------|----------------------|----------------------|---------------------|----------------------|---------------------|----------------------|------|------------------------|--------------|
|                 |                                                    | 74HC                  |                      |                      |                     |                      |                     |                      |      | V <sub>CC</sub><br>(V) | WAVEFORMS    |
|                 |                                                    | +25                   |                      |                      | −40 to +85          |                      | −40 to +125         |                      |      |                        |              |
|                 |                                                    | min.                  | typ.                 | max.                 | min.                | max.                 | min.                | max.                 |      |                        |              |
| V <sub>T+</sub> | positive-going threshold                           | 0.7<br>1.7<br>2.1     | 1.18<br>2.38<br>3.14 | 1.5<br>3.15<br>4.2   | 0.7<br>1.7<br>2.1   | 1.5<br>3.15<br>4.2   | 0.7<br>1.7<br>2.1   | 1.5<br>3.15<br>4.2   | V    | 2.0<br>4.5<br>6.0      | Figs 6 and 7 |
| V <sub>T−</sub> | negative-going threshold                           | 0.3<br>0.9<br>1.2     | 0.52<br>1.40<br>1.89 | 0.90<br>2.00<br>2.60 | 0.3<br>0.90<br>1.20 | 0.90<br>2.00<br>2.60 | 0.30<br>0.90<br>1.2 | 0.90<br>2.00<br>2.60 | V    | 2.0<br>4.5<br>6.0      | Figs 6 and 7 |
| V <sub>H</sub>  | hysteresis<br>(V <sub>T+</sub> − V <sub>T−</sub> ) | 0.2<br>0.4<br>0.6     | 0.66<br>0.98<br>1.25 | 1.0<br>1.4<br>1.6    | 0.2<br>0.4<br>0.6   | 1.0<br>1.4<br>1.6    | 0.2<br>0.4<br>0.6   | 1.0<br>1.4<br>1.6    | V    | 2.0<br>4.5<br>6.0      | Figs 6 and 7 |

**AC CHARACTERISTICS FOR 74HC**

GND = 0 V; t<sub>f</sub> = t<sub>r</sub> = 6 ns; C<sub>L</sub> = 50 pF

| SYMBOL                              | PARAMETER                     | T <sub>amb</sub> (°C) |                |                 |            |                 |             |                 | UNIT | TEST CONDITIONS        |           |
|-------------------------------------|-------------------------------|-----------------------|----------------|-----------------|------------|-----------------|-------------|-----------------|------|------------------------|-----------|
|                                     |                               | 74HC                  |                |                 |            |                 |             |                 |      | V <sub>CC</sub><br>(V) | WAVEFORMS |
|                                     |                               | +25                   |                |                 | −40 to +85 |                 | −40 to +125 |                 |      |                        |           |
|                                     |                               | min.                  | typ.           | max.            | min.       | max.            | min.        | max.            |      |                        |           |
| t <sub>PHL</sub> / t <sub>PLH</sub> | propagation delay<br>nA to nY |                       | 41<br>15<br>12 | 125<br>25<br>21 |            | 155<br>31<br>26 |             | 190<br>38<br>32 | ns   | 2.0<br>4.5<br>6.0      | Fig.8     |
| t <sub>THL</sub> / t <sub>TLH</sub> | output transition<br>time     |                       | 19<br>7<br>6   | 75<br>15<br>13  |            | 95<br>19<br>15  |             | 110<br>22<br>19 | ns   | 2.0<br>4.5<br>6.0      | Fig.8     |

## Hex inverting Schmitt trigger

## 74HC/HCT14

**DC CHARACTERISTICS FOR 74HCT**

For the DC characteristics see *"74HC/HCT/HCU/HCMOS Logic Family Specifications"*. Transfer characteristics are given below.

Output capability: standard

$I_{CC}$  category: SSI

**Note to HCT types**

The value of additional quiescent supply current ( $\Delta I_{CC}$ ) for a unit load of 1 is given in the family specifications.

To determine  $\Delta I_{CC}$  per input, multiply this value by the unit load coefficient shown in the table below.

| INPUT | UNIT LOAD COEFFICIENT |
|-------|-----------------------|
| nA    | 0.3                   |

**Transfer characteristics for 74HCT**

Voltages are referenced to GND (ground = 0 V)

| SYMBOL          | PARAMETER                                      | T <sub>amb</sub> (°C) |              |            |            |            |             |            |   | UNIT       | TEST CONDITIONS        |           |
|-----------------|------------------------------------------------|-----------------------|--------------|------------|------------|------------|-------------|------------|---|------------|------------------------|-----------|
|                 |                                                | 74HCT                 |              |            |            |            |             |            |   |            | V <sub>CC</sub><br>(V) | WAVEFORMS |
|                 |                                                | +25                   |              |            | −40 to +85 |            | −40 to +125 |            |   |            |                        |           |
|                 |                                                | min.                  | typ.         | max.       | min.       | max.       | min.        | max.       |   |            |                        |           |
| V <sub>T+</sub> | positive-going threshold                       | 1.2<br>1.4            | 1.41<br>1.59 | 1.9<br>2.1 | 1.2<br>1.4 | 1.9<br>2.1 | 1.2<br>1.4  | 1.9<br>2.1 | V | 4.5<br>5.5 | Figs 6 and 7           |           |
| V <sub>T−</sub> | negative-going threshold                       | 0.5<br>0.6            | 0.85<br>0.99 | 1.2<br>1.4 | 0.5<br>0.6 | 1.2<br>1.4 | 0.5<br>0.6  | 1.2<br>1.4 | V | 4.5<br>5.5 | Figs 6 and 7           |           |
| V <sub>H</sub>  | hysteresis (V <sub>T+</sub> −V <sub>T−</sub> ) | 0.4<br>0.4            | 0.56<br>0.60 | —<br>—     | 0.4<br>0.4 | —<br>—     | 0.4<br>0.4  | —<br>—     | V | 4.5<br>5.5 | Figs 6 and 7           |           |

**AC CHARACTERISTICS FOR 74HCT**

GND = 0 V;  $t_r = t_f = 6$  ns;  $C_L = 50$  pF

| SYMBOL                              | PARAMETER                      | T <sub>amb</sub> (°C) |      |      |            |      |             |      | UNIT | TEST CONDITIONS        |           |
|-------------------------------------|--------------------------------|-----------------------|------|------|------------|------|-------------|------|------|------------------------|-----------|
|                                     |                                | 74HCT                 |      |      |            |      |             |      |      | V <sub>CC</sub><br>(V) | WAVEFORMS |
|                                     |                                | +25                   |      |      | −40 to +85 |      | −40 to +125 |      |      |                        |           |
|                                     |                                | min.                  | typ. | max. | min.       | max. | min.        | max. |      |                        |           |
| t <sub>PHL</sub> / t <sub>PLH</sub> | propagation delay<br>nA, to nY |                       | 20   | 34   |            | 43   |             | 51   | ns   | 4.5                    | Fig.8     |
| t <sub>THL</sub> / t <sub>TLH</sub> | output transition<br>time      |                       | 7    | 15   |            | 19   |             | 22   | ns   | 4.5                    | Fig.8     |

## Hex inverting Schmitt trigger

## 74HC/HCT14

## TRANSFER CHARACTERISTIC WAVEFORMS

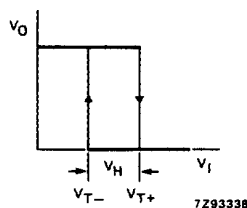
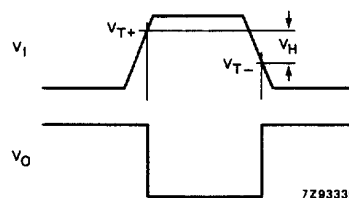
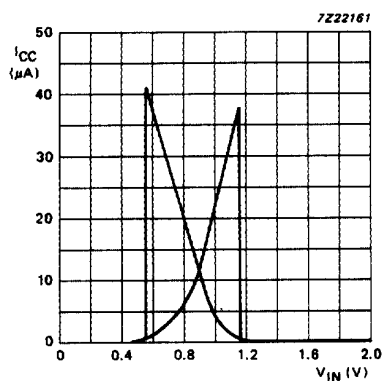
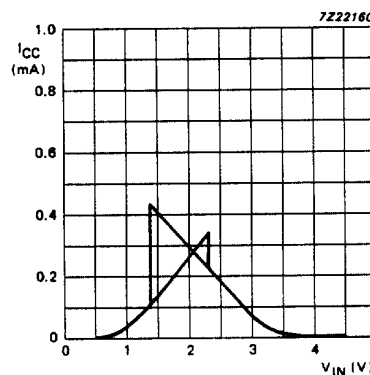
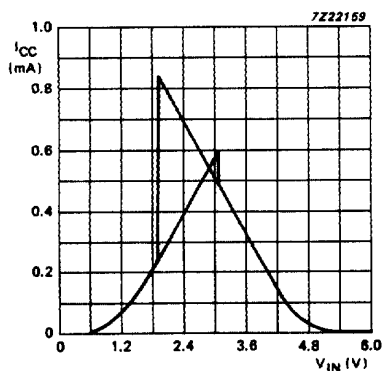
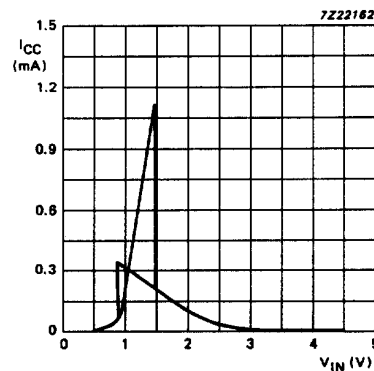
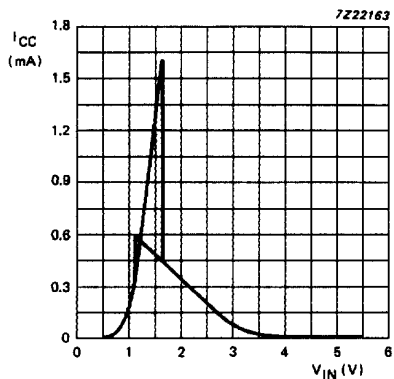


Fig.6 Transfer characteristic.

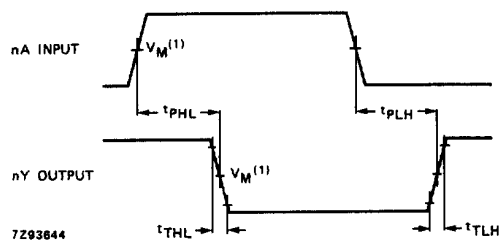
Fig.7 Waveforms showing the definition of  $V_{T+}$ ,  $V_{T-}$  and  $V_H$ ; where  $V_{T+}$  and  $V_{T-}$  are between limits of 20% and 70%.Fig.8 Typical HC transfer characteristics;  $V_{CC} = 2$  V.Fig.9 Typical HC transfer characteristics;  $V_{CC} = 4.5$  V.Fig.10 Typical HC transfer characteristics;  $V_{CC} = 6$  V.Fig.11 Typical HCT transfer characteristics;  $V_{CC} = 4.5$  V.

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Fig.12 Typical HCT transfer characteristics;  $V_{CC} = 5.5$  V.

## AC WAVEFORMS



- (1) HC :  $V_M = 50\%$ ;  $V_L = \text{GND to } V_{CC}$ .  
 HCT:  $V_M = 1.3$  V;  $V_L = \text{GND to } 3$  V.

Fig.13 Waveforms showing the input (nA) to output (nY) propagation delays and output transitions times.

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## APPLICATION INFORMATION

The slow input rise and fall times cause additional power dissipation, this can be calculated using the following formula:

$$P_{ad} = f_i \times (t_r \times I_{CCa} + t_f \times I_{CCa}) \times V_{CC}$$

Where:

- $P_{ad}$  = additional power dissipation ( $\mu W$ )
- $f_i$  = input frequency (MHz)
- $t_r$  = input rise time ( $\mu s$ ); 10% – 90%
- $t_f$  = input fall time ( $\mu s$ ); 10% – 90%
- $I_{CCa}$  = average additional supply current ( $\mu A$ )

Average  $I_{CCa}$  differs with positive or negative input transitions, as shown in Figs 14 and 15.

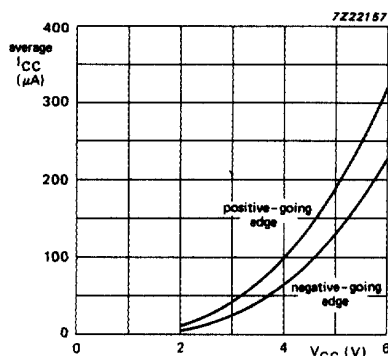


Fig.14 Average  $I_{CC}$  for HC Schmitt trigger devices; linear change of  $V_i$  between  $0.1 V_{CC}$  to  $0.9 V_{CC}$

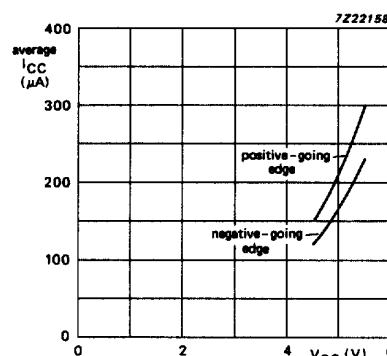


Fig.15 Average  $I_{CC}$  for HCT Schmitt trigger devices; linear change of  $V_i$  between  $0.1 V_{CC}$  to  $0.9 V_{CC}$ .

HC/HCT14 used in a relaxation oscillator circuit, see Fig.16.

$$HC: f = \frac{1}{T} = \frac{1}{0.8 RC}$$

$$HCT: f = \frac{1}{T} = \frac{1}{0.67 RC}$$

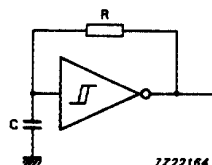


Fig.16 Relaxation oscillator using HC/HCT14.

## Note to Application information

All values given are typical unless otherwise specified.

## PACKAGE OUTLINES

See "74HC/HCT/HCU/HCMOS Logic Package Outlines".