

# 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

## 74HC4050

### Hex high-to-low level shifter

Product specification  
File under Integrated Circuits, IC06

December 1990

## Hex high-to-low level shifter

## 74HC4050

## FEATURES

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

## GENERAL DESCRIPTION

The 74HC4050 is a high-speed Si-gate CMOS device and is pin compatible with the "4050" of the "4000B" series. It is specified in compliance with JEDEC standard no. 7A.

The 74HC4050 provides six non-inverting buffers with a modified input protection structure, which has no diode connected to  $V_{CC}$ . Input voltages of up to 15 V may

therefore be used. This feature enables the non-inverting buffers to be used as logic level translators, which will convert high level logic to low level logic, while operating from a low voltage power supply. For example 15 V logic ("4000B series") can be converted down to 2 V logic.

The actual input switch level remains related to the  $V_{CC}$  and is the same as mentioned in the family characteristics.

## APPLICATIONS

- Converting 15 V logic ("4000B" series) down to 2 V logic.

## 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      |      |
| $t_{PHL} / t_{PLH}$ | propagation delay nA to nY               | $C_L = 15\text{ pF}$ ; $V_{CC} = 5\text{ V}$ | 7       | ns   |
| $C_I$               | input capacitance                        |                                              | 3.5     | pF   |
| $C_{PD}$            | power dissipation capacitance per buffer | note 1                                       | 14      | 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

## ORDERING INFORMATION

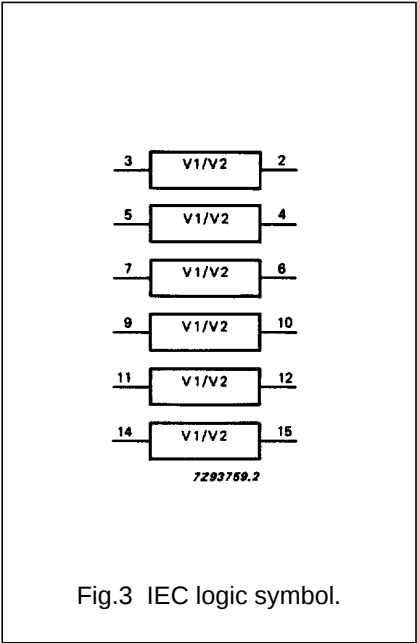
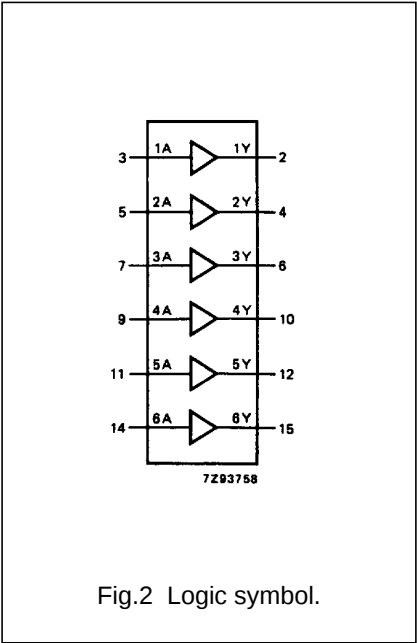
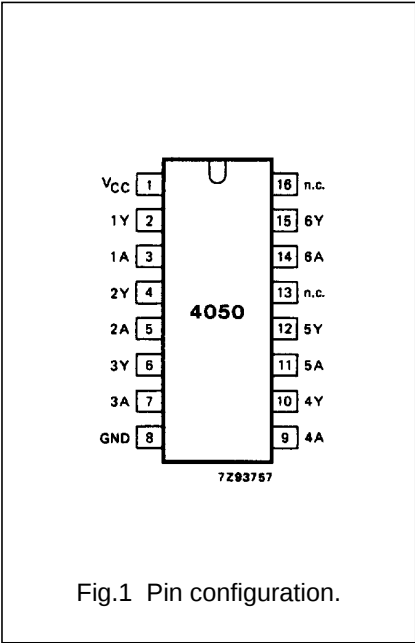
See "74HC/HCT/HCU/HCMOS Logic Package Information".

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PIN DESCRIPTION

| PIN NO.             | SYMBOL          | NAME AND FUNCTION       |
|---------------------|-----------------|-------------------------|
| 1                   | V <sub>CC</sub> | positive supply voltage |
| 2, 4, 6, 10, 12, 15 | 1Y to 6Y        | data outputs            |
| 3, 5, 7, 9, 11, 14  | 1A to 6A        | data inputs             |
| 8                   | GND             | ground (0 V)            |
| 13, 16              | n.c.            | not connected           |



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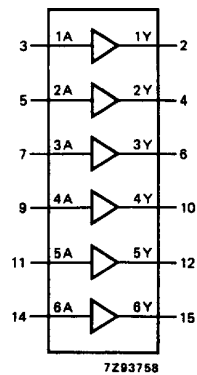


Fig.4 Functional diagram.

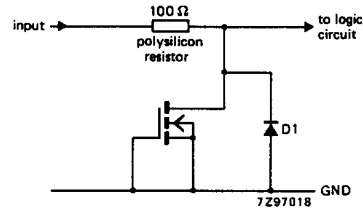


Fig.5 Input protection for HC4050. Single sided thick oxide field effect metal gate transistor as input protection.

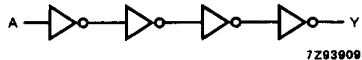


Fig.6 Logic diagram (one level shifter).

FUNCTION TABLE <sup>(1)</sup>

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

Note

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

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**RATINGS**

Limiting values in accordance with the Absolute Maximum System (IEC 134)

Voltages are referenced to GND (ground = 0 V)

| SYMBOL                          | PARAMETER                                                           | MIN. | MAX. | UNIT | CONDITIONS                                    |
|---------------------------------|---------------------------------------------------------------------|------|------|------|-----------------------------------------------|
| $V_{CC}$                        | DC supply voltage                                                   | -0.5 | +7   | V    |                                               |
| $V_{IK}$                        | DC input voltage range                                              | -0.5 | +16  | V    |                                               |
| $-I_{IK}$                       | DC input diode current                                              |      | 20   | mA   | for $V_I < -0.5$ V                            |
| $\pm I_{OK}$                    | DC output diode current                                             |      | 20   | mA   | for $V_O < -0.5$ V or $V_O > V_{CC} + 0.5$ V  |
| $\pm I_O$                       | DC output source or sink current<br>- standard outputs              |      | 25   | mA   | for $-0.5$ V $< V_O < V_{CC} + 0.5$ V         |
| $\pm I_{CC}$ ;<br>$\pm I_{GND}$ | DC $V_{CC}$ or GND current for types<br>with:<br>- standard outputs |      | 50   | mA   |                                               |
| $T_{stg}$                       | storage temperature range                                           | -65  | +150 | °C   |                                               |
| $P_{tot}$                       | power dissipation per package                                       |      |      |      | for temperature range: -40 to +125 °C<br>74HC |
|                                 | plastic DIL                                                         |      | 750  | mW   | above +70 °C: derate linearly with 12 mW/K    |
|                                 | plastic mini-pack (SO)                                              |      | 500  | mW   | above +70 °C: derate linearly with 8 mW/K     |

**RECOMMENDED OPERATING CONDITIONS**

| SYMBOL     | PARAMETER                           | 74HC |      |                                   | UNIT | CONDITIONS                                                                                                                                                                                   |
|------------|-------------------------------------|------|------|-----------------------------------|------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|            |                                     | min. | typ. | max.                              |      |                                                                                                                                                                                              |
| $V_{CC}$   | DC supply voltage                   | 2.0  | 5.0  | 6.0                               | V    |                                                                                                                                                                                              |
| $V_I$      | DC input voltage range              | GND  | –    | 15                                | V    |                                                                                                                                                                                              |
| $T_{amb}$  | operating ambient temperature range | -40  |      | +85                               | °C   | see DC and AC characteristics                                                                                                                                                                |
| $T_{amb}$  | operating ambient temperature range | -40  |      | +125                              | °C   |                                                                                                                                                                                              |
| $t_r, t_f$ | input rise and fall times           |      | 6.0  | 1000<br>500<br>400<br>650<br>1000 | ns   | $V_{CC} = 2.0$ V; $V_{IN} = 2.0$ V<br>$V_{CC} = 4.5$ V; $V_{IN} = 4.5$ V<br>$V_{CC} = 6.0$ V; $V_{IN} = 6.0$ V<br>$V_{CC} = 6.0$ V; $V_{IN} = 10.0$ V<br>$V_{CC} = 6.0$ V; $V_{IN} = 15.0$ V |

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**DC 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) | V <sub>I</sub>                           | OTHER                                                                         |
|                  |                                              | +25                   |                   |                    | −40 to +85         |                    | −40 to +125        |                    |      |                        |                                          |                                                                               |
|                  |                                              | min.                  | typ.              | max.               | min.               | max.               | min.               | max.               |      |                        |                                          |                                                                               |
| V <sub>IH</sub>  | HIGH level input voltage                     | 1.5<br>3.15<br>4.2    | 1.3<br>2.4<br>3.1 |                    | 1.5<br>3.15<br>4.2 |                    | 1.5<br>3.15<br>4.2 |                    | V    | 2.0<br>4.5<br>6.0      |                                          |                                                                               |
| V <sub>IL</sub>  | LOW level input voltage                      |                       | 0.7<br>1.8<br>2.3 | 0.5<br>1.35<br>1.8 |                    | 0.5<br>1.35<br>1.8 |                    | 0.5<br>1.35<br>1.8 | V    | 2.0<br>4.5<br>6.0      |                                          |                                                                               |
| V <sub>OH</sub>  | HIGH level output voltage - all outputs      | 1.9<br>4.4<br>5.9     | 2.0<br>4.5<br>6.0 |                    | 1.9<br>4.4<br>5.9  |                    | 1.9<br>4.4<br>5.9  |                    | V    | 2.0<br>4.5<br>6.0      | V <sub>IH</sub><br>or<br>V <sub>IL</sub> | −I <sub>O</sub> = 20 μA<br>−I <sub>O</sub> = 20 μA<br>−I <sub>O</sub> = 20 μA |
| V <sub>OH</sub>  | HIGH level output voltage - standard outputs | 3.98<br>5.48          |                   |                    | 3.84<br>5.34       |                    | 3.7<br>5.2         |                    | V    | 4.5<br>6.0             | V <sub>IH</sub><br>or<br>V <sub>IL</sub> | −I <sub>O</sub> = 4.0 mA<br>−I <sub>O</sub> = 5.2 mA                          |
| V <sub>OL</sub>  | LOW level output voltage - all outputs       |                       |                   | 0.1<br>0.1<br>0.1  |                    | 0.1<br>0.1<br>0.1  |                    | 0.1<br>0.1<br>0.1  | V    | 2.0<br>4.5<br>6.0      | V <sub>IH</sub><br>or<br>V <sub>IL</sub> | I <sub>O</sub> = 20 μA<br>I <sub>O</sub> = 20 μA<br>I <sub>O</sub> = 20 μA    |
| V <sub>OL</sub>  | LOW level output voltage - standard outputs  |                       |                   | 0.26<br>0.26       |                    | 0.33<br>0.33       |                    | 0.4<br>0.4         | V    | 4.5<br>6.0             | V <sub>IH</sub><br>or<br>V <sub>IL</sub> | I <sub>O</sub> = 4.0 mA<br>I <sub>O</sub> = 5.2 mA                            |
| ± I <sub>I</sub> | input leakage current                        |                       |                   | 0.1                |                    | 1.0                |                    | 1.0                | μA   | 6.0                    | V <sub>CC</sub><br>or<br>GND             |                                                                               |
|                  |                                              |                       |                   | 0.5                |                    | 5.0                |                    | 5.0                | μA   | 2.0<br>to<br>6.0       | 15 V                                     |                                                                               |
| I <sub>CC</sub>  | quiescent supply current                     |                       |                   | 2.0                |                    | 20.0               |                    | 40.0               | μA   | 6.0                    | 15 V<br>or<br>GND                        |                                                                               |

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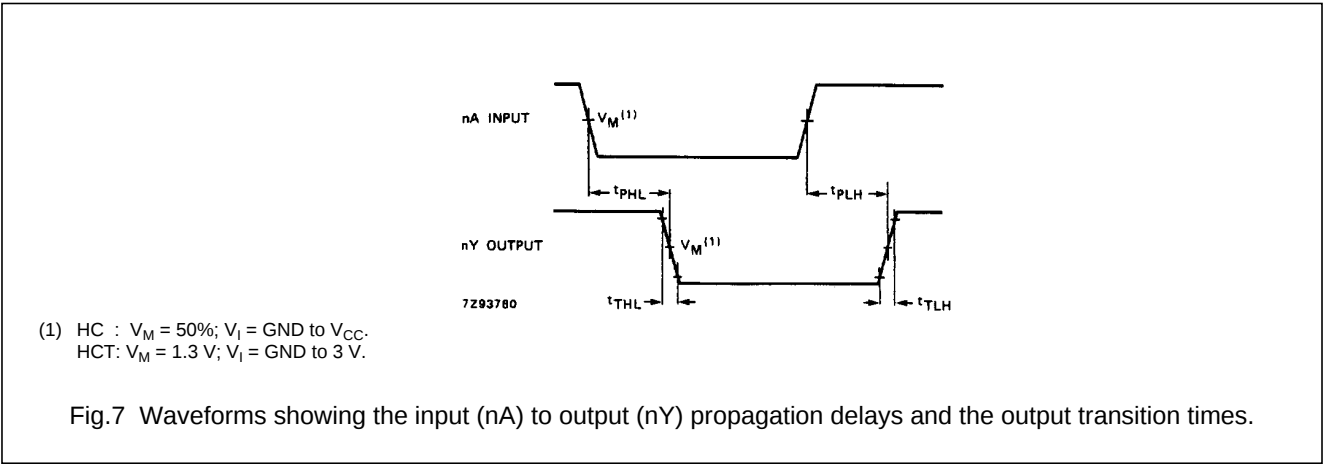
74HC4050

AC CHARACTERISTICS FOR 74HC

GND = 0 V;  $t_r = t_f = 6\text{ ns}$ ;  $C_L = 50\text{ pF}$

| 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 |                       | 25<br>9<br>7 | 85<br>17<br>14 |            | 105<br>21<br>18 |             | 130<br>26<br>22 | ns   | 2.0<br>4.5<br>6.0      | Fig.7     |
| t <sub>THL</sub> / t <sub>TLH</sub> | output transition time        |                       | 19<br>7<br>6 | 75<br>15<br>13 |            | 95<br>19<br>16  |             | 110<br>22<br>19 | ns   | 2.0<br>4.5<br>6.0      | Fig.7     |

AC WAVEFORMS



PACKAGE OUTLINES

See *“74HC/HCT/HCU/HCMOS Logic Package Outlines”*.