

# 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/HCT4316** Quad bilateral switches

Product specification  
File under Integrated Circuits, IC06

September 1993

## Quad bilateral switches

## 74HC/HCT4316

## FEATURES

- Low “ON” resistance:  
160  $\Omega$  (typ.) at  $V_{CC} - V_{EE} = 4.5$  V  
120  $\Omega$  (typ.) at  $V_{CC} - V_{EE} = 6.0$  V  
80  $\Omega$  (typ.) at  $V_{CC} - V_{EE} = 9.0$  V
- Logic level translation:  
to enable 5 V logic to communicate  
with  $\pm 5$  V analog signals
- Typical “break before make” built in
- Output capability: non-standard
- $I_{CC}$  category: MSI

## GENERAL DESCRIPTION

The 74HC/HCT4316 are high-speed Si-gate CMOS devices. They are specified in compliance with JEDEC standard no. 7A.

The 74HC/HCT4316 have four independent analog switches. Each switch has two input/output terminals (nY, nZ) and an active HIGH select input (nS). When the enable input ( $\bar{E}$ ) is HIGH, all four analog switches are turned off.

Current through a switch will not cause additional  $V_{CC}$  current provided the voltage at the terminals of the switch is maintained within the supply voltage range;  $V_{CC} \gg (V_Y, V_Z) \gg V_{EE}$ . Inputs nY and nZ are electrically equivalent terminals.

$V_{CC}$  and GND are the supply voltage pins for the digital control inputs ( $\bar{E}$  and nS). The  $V_{CC}$  to GND ranges are 2.0 to 10.0 V for HC and 4.5 to 5.5 V for HCT.

The analog inputs/outputs (nY and nZ) can swing between  $V_{CC}$  as a positive limit and  $V_{EE}$  as a negative limit.

$V_{CC} - V_{EE}$  may not exceed 10.0 V.

See the “4016” for the version without logic level translation.

## QUICK REFERENCE DATA

$V_{EE} = \text{GND} = 0$  V;  $T_{\text{amb}} = 25$  °C;  $t_r = t_f = 6$  ns

| SYMBOL                              | PARAMETER                                                         | CONDITIONS                                                              | TYPICAL |     | UNIT |
|-------------------------------------|-------------------------------------------------------------------|-------------------------------------------------------------------------|---------|-----|------|
|                                     |                                                                   |                                                                         | HC      | HCT |      |
| t <sub>PZH</sub>                    | turn “ON” time<br>E̅ to V <sub>OS</sub><br>nS to V <sub>OS</sub>  | C <sub>L</sub> = 15 pF; R <sub>L</sub> = 1 kΩ;<br>V <sub>CC</sub> = 5 V | 19      | 19  | ns   |
|                                     |                                                                   |                                                                         | 16      | 17  | ns   |
| t <sub>PZL</sub>                    | turn “ON” time<br>E̅ to V <sub>OS</sub><br>nS to V <sub>OS</sub>  |                                                                         | 19      | 24  | ns   |
|                                     |                                                                   |                                                                         | 16      | 21  | ns   |
| t <sub>PHZ</sub> / t <sub>PLZ</sub> | turn “OFF” time<br>E̅ to V <sub>OS</sub><br>nS to V <sub>OS</sub> |                                                                         | 20      | 21  | ns   |
|                                     |                                                                   |                                                                         | 16      | 19  | ns   |
| C <sub>I</sub>                      | input capacitance                                                 |                                                                         |         | 3.5 | 3.5  |
| C <sub>PD</sub>                     | power dissipation capacitance per switch                          | notes 1 and 2                                                           | 13      | 14  | pF   |
| C <sub>S</sub>                      | max. switch capacitance                                           |                                                                         | 5       | 5   | pF   |

## Notes

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

$$P_D = C_{PD} \times V_{CC}^2 \times f_i + \sum \{ (C_L + C_S) \times V_{CC}^2 \times f_o \}$$
 where:  
 $f_i$  = input frequency in MHz  
 $f_o$  = output frequency in MHz  
 $\sum \{ (C_L + C_S) \times V_{CC}^2 \times f_o \}$  = sum of outputs

$C_L$  = output load capacitance in pF

$C_S$  = max. switch capacitance in pF

$V_{CC}$  = supply voltage in V

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

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ORDERING INFORMATION

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

PIN DESCRIPTION

| PIN NO.      | SYMBOL         | NAME AND FUNCTION           |
|--------------|----------------|-----------------------------|
| 1, 4, 10, 13 | 1Z to 4Z       | independent inputs/outputs  |
| 2, 3, 11, 12 | 1Y to 4Y       | independent inputs/outputs  |
| 7            | $\overline{E}$ | enable input (active LOW)   |
| 8            | GND            | ground (0 V)                |
| 9            | $V_{EE}$       | negative supply voltage     |
| 15, 5, 6, 14 | 1S to 4S       | select inputs (active HIGH) |
| 16           | $V_{CC}$       | positive supply voltage     |



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FUNCTION TABLE

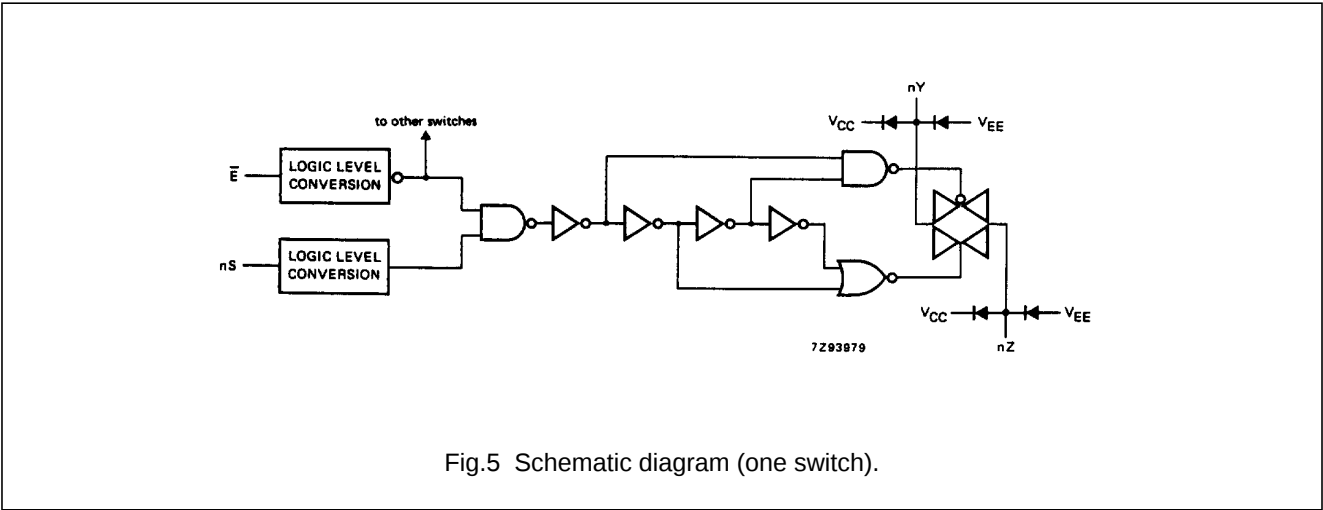
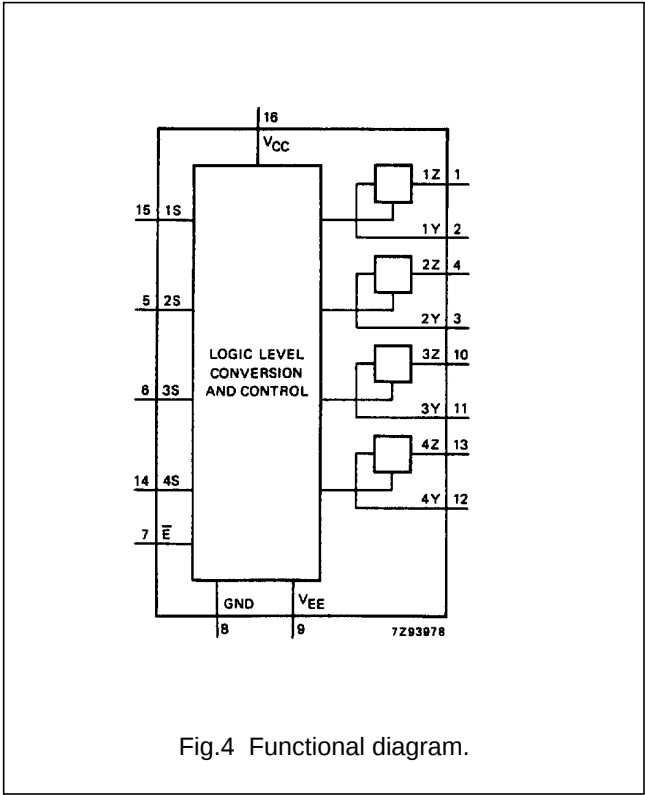
| INPUTS         |    | SWITCH |
|----------------|----|--------|
| $\overline{E}$ | nS |        |
| L              | L  | off    |
| L              | H  | on     |
| H              | X  | off    |

Note

1. H = HIGH voltage level
- L = LOW voltage level
- X = don't care

APPLICATIONS

- Signal gating
- Modulation
- Demodulation
- Chopper



## Quad bilateral switches

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## RATINGS

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

Voltages are referenced to  $V_{EE} = \text{GND}$  (ground = 0 V)

| SYMBOL                          | PARAMETER                      | MIN. | MAX.  | UNIT | CONDITIONS                                                   |
|---------------------------------|--------------------------------|------|-------|------|--------------------------------------------------------------|
| $V_{CC}$                        | DC supply voltage              | -0.5 | +11.0 | V    |                                                              |
| $\pm I_{IK}$                    | DC digital input diode current |      | 20    | mA   | for $V_I < -0.5 \text{ V}$ or $V_I > V_{CC} + 0.5 \text{ V}$ |
| $\pm I_{SK}$                    | DC switch diode current        |      | 20    | mA   | for $V_S < -0.5 \text{ V}$ or $V_S > V_{CC} + 0.5 \text{ V}$ |
| $\pm I_S$                       | DC switch current              |      | 25    | mA   | for $-0.5 \text{ V} < V_S < V_{CC} + 0.5 \text{ V}$          |
| $\pm I_{EE}$                    | DC $V_{EE}$ current            |      | 20    | mA   |                                                              |
| $\pm I_{CC}$ ;<br>$\pm I_{GND}$ | DC $V_{CC}$ or GND current     |      | 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/HCT            |
|                                 | 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                    |
| $P_S$                           | power dissipation per switch   |      | 100   | mW   |                                                              |

## Note to ratings

To avoid drawing  $V_{CC}$  current out of terminal Z, when switch current flows in terminals  $Y_n$ , the voltage drop across the bidirectional switch must not exceed 0.4 V. If the switch current flows into terminals Z, no  $V_{CC}$  current will flow out of terminal  $Y_n$ . In this case there is no limit for the voltage drop across the switch, but the voltages at  $Y_n$  and Z may not exceed  $V_{CC}$  or  $V_{EE}$ .

## RECOMMENDED OPERATING CONDITIONS

| SYMBOL     | PARAMETER                             | 74HC     |      |                           | 74HCT    |      |          | UNIT | CONDITIONS                                                                                                    |
|------------|---------------------------------------|----------|------|---------------------------|----------|------|----------|------|---------------------------------------------------------------------------------------------------------------|
|            |                                       | min.     | typ. | max.                      | min.     | typ. | max.     |      |                                                                                                               |
| $V_{CC}$   | DC supply voltage $V_{CC}-\text{GND}$ | 2.0      | 5.0  | 10.0                      | 4.5      | 5.0  | 5.5      | V    | see Figs 6 and 7                                                                                              |
| $V_{CC}$   | DC supply voltage $V_{CC}-V_{EE}$     | 2.0      | 5.0  | 10.0                      | 2.0      | 5.0  | 10.0     | V    | see Figs 6 and 7                                                                                              |
| $V_I$      | DC input voltage range                | GND      |      | $V_{CC}$                  | GND      |      | $V_{CC}$ | V    |                                                                                                               |
| $V_S$      | DC switch voltage range               | $V_{EE}$ |      | $V_{CC}$                  | $V_{EE}$ |      | $V_{CC}$ | V    |                                                                                                               |
| $T_{amb}$  | operating ambient temperature range   | -40      |      | +85                       | -40      |      | +85      | °C   | see DC and AC<br>CHARACTERISTICS                                                                              |
| $T_{amb}$  | operating ambient temperature range   | -40      |      | +125                      | -40      |      | +125     | °C   |                                                                                                               |
| $t_r, t_f$ | input rise and fall times             |          | 6.0  | 1000<br>500<br>400<br>250 |          | 6.0  | 500      | ns   | $V_{CC} = 2.0 \text{ V}$<br>$V_{CC} = 4.5 \text{ V}$<br>$V_{CC} = 6.0 \text{ V}$<br>$V_{CC} = 10.0 \text{ V}$ |

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Fig.6 Guaranteed operating area as a function of the supply voltages for 74HC4316.



Fig.7 Guaranteed operating area as a function of the supply voltages for 74HCT4316.

## DC CHARACTERISTICS FOR 74HC/HCT

For 74HC:  $V_{CC} - GND$  or  $V_{CC} - V_{EE} = 2.0, 4.5, 6.0$  and  $9.0$  V

For 74HCT:  $V_{CC} - GND = 4.5$  and  $5.5$  V;  $V_{CC} - V_{EE} = 2.0, 4.5, 6.0$  and  $9.0$  V

| SYMBOL           | PARAMETER                                                | T <sub>amb</sub> (°C) |      |      |            |      |             |      | UNIT | TEST CONDITIONS        |                        |                        |                                          |                                          |
|------------------|----------------------------------------------------------|-----------------------|------|------|------------|------|-------------|------|------|------------------------|------------------------|------------------------|------------------------------------------|------------------------------------------|
|                  |                                                          | 74HC/HCT              |      |      |            |      |             |      |      | V <sub>CC</sub><br>(V) | V <sub>EE</sub><br>(V) | I <sub>S</sub><br>(μA) | V <sub>is</sub>                          | V <sub>I</sub>                           |
|                  |                                                          | +25                   |      |      | −40 to +85 |      | −40 to +125 |      |      |                        |                        |                        |                                          |                                          |
|                  |                                                          | min.                  | typ. | max. | min.       | max. | min.        | max. |      |                        |                        |                        |                                          |                                          |
| R <sub>ON</sub>  | ON resistance<br>(peak)                                  |                       | —    | —    |            | —    |             | —    | Ω    | 2.0                    | 0                      | 100                    | V <sub>CC</sub><br>to<br>V <sub>EE</sub> | V <sub>IH</sub><br>or<br>V <sub>IL</sub> |
|                  |                                                          |                       | 160  | 320  |            | 400  |             | 480  | Ω    | 4.5                    | 0                      | 1000                   |                                          |                                          |
|                  |                                                          |                       | 120  | 240  |            | 300  |             | 360  | Ω    | 6.0                    | 0                      | 1000                   |                                          |                                          |
|                  |                                                          |                       | 85   | 170  |            | 215  |             | 255  | Ω    | 4.5                    | −4.5                   | 1000                   |                                          |                                          |
| R <sub>ON</sub>  | ON resistance<br>(rail)                                  |                       | 160  | —    |            | —    |             | —    | Ω    | 2.0                    | 0                      | 100                    | V <sub>EE</sub>                          | V <sub>IH</sub><br>or<br>V <sub>IL</sub> |
|                  |                                                          |                       | 80   | 160  |            | 200  |             | 240  | Ω    | 4.5                    | 0                      | 1000                   |                                          |                                          |
|                  |                                                          |                       | 70   | 140  |            | 175  |             | 210  | Ω    | 6.0                    | 0                      | 1000                   |                                          |                                          |
|                  |                                                          |                       | 60   | 120  |            | 150  |             | 180  | Ω    | 4.5                    | −4.5                   | 1000                   |                                          |                                          |
| R <sub>ON</sub>  | ON resistance<br>(rail)                                  |                       | 170  | —    |            | —    |             | —    | Ω    | 2.0                    | 0                      | 100                    | V <sub>CC</sub>                          | V <sub>IH</sub><br>or<br>V <sub>IL</sub> |
|                  |                                                          |                       | 90   | 180  |            | 225  |             | 270  | Ω    | 4.5                    | 0                      | 1000                   |                                          |                                          |
|                  |                                                          |                       | 80   | 160  |            | 200  |             | 240  | Ω    | 6.0                    | 0                      | 1000                   |                                          |                                          |
|                  |                                                          |                       | 65   | 135  |            | 170  |             | 205  | Ω    | 4.5                    | −4.5                   | 1000                   |                                          |                                          |
| ΔR <sub>ON</sub> | maximum ΔON<br>resistance<br>between any<br>two channels |                       | —    |      |            |      |             |      | Ω    | 2.0                    | 0                      |                        | V <sub>CC</sub><br>to<br>V <sub>EE</sub> | V <sub>H</sub><br>or<br>V <sub>IL</sub>  |
|                  |                                                          |                       | 16   |      |            |      |             |      | Ω    | 4.5                    | 0                      |                        |                                          |                                          |
|                  |                                                          |                       | 9    |      |            |      |             |      | Ω    | 6.0                    | 0                      |                        |                                          |                                          |
|                  |                                                          |                       | 6    |      |            |      |             |      | Ω    | 4.5                    | −4.5                   |                        |                                          |                                          |

## Notes

- At supply voltages ( $V_{CC} - V_{EE}$ ) approaching 2.0 V the analog switch ON-resistance becomes extremely non-linear. Therefore it is recommended that these devices are used to transmit digital signals only, when using these supply voltages.
- For test circuit measuring  $R_{ON}$  see Fig.8.

## Quad bilateral switches

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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>EE</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<br>6.3 | 1.2<br>2.4<br>3.2<br>4.3 |                           | 1.5<br>3.15<br>4.2<br>6.3 |                           | 1.5<br>3.15<br>4.2<br>6.3 |                           | V    | 2.0<br>4.5<br>6.0<br>9.0 |                        |                                          |                                                                                                                      |
| V <sub>IL</sub> | LOW level input voltage         |                           | 0.8<br>2.1<br>2.8<br>4.3 | 0.5<br>1.35<br>1.8<br>2.7 |                           | 0.5<br>1.35<br>1.8<br>2.7 |                           | 0.5<br>1.35<br>1.8<br>2.7 | V    | 2.0<br>4.5<br>6.0<br>9.0 |                        |                                          |                                                                                                                      |
| ±I <sub>I</sub> | input leakage current           |                           |                          | 0.1<br>0.2                |                           | 1.0<br>2.0                |                           | 1.0<br>2.0                | μA   | 6.0<br>10.0              | 0<br>0                 | V <sub>CC</sub><br>or<br>GND             |                                                                                                                      |
| ±I <sub>S</sub> | analog switch OFF-state current |                           |                          | 0.1                       |                           | 1.0                       |                           | 1.0                       | μA   | 10.0                     | 0                      | V <sub>IH</sub><br>or<br>V <sub>IL</sub> | V <sub>S</sub>   =<br>V <sub>CC</sub> − V <sub>EE</sub><br>(see Fig.10)                                              |
| ±I <sub>S</sub> | analog switch ON-state current  |                           |                          | 0.1                       |                           | 1.0                       |                           | 1.0                       | μA   | 10.0                     | 0                      | V <sub>IH</sub><br>or<br>V <sub>IL</sub> | V <sub>S</sub>   =<br>V <sub>CC</sub> − V <sub>EE</sub><br>(see Fig.11)                                              |
| I <sub>CC</sub> | quiescent supply current        |                           |                          | 8.0<br>16.0               |                           | 80.0<br>160.0             |                           | 160.0<br>320.0            | μA   | 6.0<br>10.0              | 0<br>0                 | V <sub>CC</sub><br>or<br>GND             | V <sub>is</sub> = V <sub>EE</sub><br>or V <sub>CC</sub> ;<br>V <sub>OS</sub> = V <sub>CC</sub><br>or V <sub>EE</sub> |

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## AC CHARACTERISTICS FOR 74HC

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

| SYMBOL                              | PARAMETER                                               | T <sub>amb</sub> (°C) |                      |                       |            |                       |             |                       |    | UNIT                     | TEST CONDITIONS        |                                                                              |       |
|-------------------------------------|---------------------------------------------------------|-----------------------|----------------------|-----------------------|------------|-----------------------|-------------|-----------------------|----|--------------------------|------------------------|------------------------------------------------------------------------------|-------|
|                                     |                                                         | 74HC                  |                      |                       |            |                       |             |                       |    |                          | V <sub>CC</sub><br>(V) | V <sub>EE</sub><br>(V)                                                       | OTHER |
|                                     |                                                         | +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>V <sub>is</sub> to V <sub>os</sub> |                       | 17<br>6<br>5<br>4    | 60<br>12<br>10<br>8   |            | 75<br>15<br>13<br>10  |             | 90<br>18<br>15<br>12  | ns | 2.0<br>4.5<br>6.0<br>4.5 | 0<br>0<br>0<br>−4.5    | R <sub>L</sub> = ∞; C <sub>L</sub> = 50 pF<br>(see Fig.18)                   |       |
| t <sub>PZH</sub> / t <sub>PZL</sub> | turn “ON” time<br>E̅ to V <sub>os</sub>                 |                       | 61<br>22<br>18<br>19 | 205<br>41<br>35<br>37 |            | 255<br>51<br>43<br>47 |             | 310<br>62<br>53<br>56 | ns | 2.0<br>4.5<br>6.0<br>4.5 | 0<br>0<br>0<br>−4.5    | R <sub>L</sub> = 1 kΩ;<br>C <sub>L</sub> = 50 pF<br>(see Figs 19, 20 and 21) |       |
| t <sub>PZH</sub> / t <sub>PZL</sub> | turn “ON” time<br>nS to V <sub>os</sub>                 |                       | 52<br>19<br>15<br>17 | 175<br>35<br>30<br>34 |            | 220<br>44<br>37<br>43 |             | 265<br>53<br>45<br>51 | ns | 2.0<br>4.5<br>6.0<br>4.5 | 0<br>0<br>0<br>−4.5    | R <sub>L</sub> = 1 kΩ;<br>C <sub>L</sub> = 50 pF<br>(see Figs 19, 20 and 21) |       |
| t <sub>PHZ</sub> / t <sub>PLZ</sub> | turn “OFF”<br>time<br>E̅ to V <sub>os</sub>             |                       | 63<br>23<br>18<br>21 | 220<br>44<br>37<br>39 |            | 275<br>55<br>47<br>49 |             | 330<br>66<br>56<br>59 | ns | 2.0<br>4.5<br>6.0<br>4.5 | 0<br>0<br>0<br>−4.5    | R <sub>L</sub> = 1 kΩ;<br>C <sub>L</sub> = 50 pF<br>(see Figs 19, 20 and 21) |       |
| t <sub>PHZ</sub> / t <sub>PLZ</sub> | turn “OFF”<br>time<br>nS to V <sub>os</sub>             |                       | 55<br>20<br>16<br>18 | 175<br>35<br>30<br>36 |            | 220<br>44<br>37<br>45 |             | 265<br>53<br>45<br>54 | ns | 2.0<br>4.5<br>6.0<br>4.5 | 0<br>0<br>0<br>−4.5    | R <sub>L</sub> = 1 kΩ;<br>C <sub>L</sub> = 50 pF<br>(see Figs 19, 20 and 21) |       |

## Quad bilateral switches

## 74HC/HCT4316

**DC CHARACTERISTICS FOR 74HCT**

Voltages are referenced to GND (ground = 0)

| SYMBOL           | PARAMETER                                                                                 | T <sub>amb</sub> (°C) |      |             |            |               |             |                | UNIT | TEST CONDITIONS        |                        |                                    |                                                                                                             |
|------------------|-------------------------------------------------------------------------------------------|-----------------------|------|-------------|------------|---------------|-------------|----------------|------|------------------------|------------------------|------------------------------------|-------------------------------------------------------------------------------------------------------------|
|                  |                                                                                           | 74HCT                 |      |             |            |               |             |                |      | V <sub>CC</sub><br>(V) | V <sub>EE</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                                                                  | 2.0                   | 1.6  |             | 2.0        |               | 2.0         |                | V    | 4.5 to 5.5             |                        |                                    |                                                                                                             |
| V <sub>IL</sub>  | LOW level input voltage                                                                   |                       | 1.2  | 0.8         |            | 0.8           |             | 0.8            | V    | 4.5 to 5.5             |                        |                                    |                                                                                                             |
| ±I <sub>I</sub>  | input leakage current                                                                     |                       |      | 0.1         |            | 1.0           |             | 1.0            | μA   | 5.5                    | 0                      | V <sub>CC</sub> or GND             |                                                                                                             |
| ±I <sub>S</sub>  | analog switch OFF-state current                                                           |                       |      | 0.1         |            | 1.0           |             | 1.0            | μA   | 10.0                   | 0                      | V <sub>IH</sub> or V <sub>IL</sub> | M <sub>S</sub>   = V <sub>CC</sub> − V <sub>EE</sub> (see Fig.10)                                           |
| ±I <sub>S</sub>  | analog switch ON-state current                                                            |                       |      | 0.1         |            | 1.0           |             | 1.0            | μA   | 10.0                   | 0                      | V <sub>IH</sub> or V <sub>IL</sub> | M <sub>S</sub>   = V <sub>CC</sub> − V <sub>EE</sub> (see Fig.11)                                           |
| I <sub>CC</sub>  | quiescent supply current                                                                  |                       |      | 8.0<br>16.0 |            | 80.0<br>160.0 |             | 160.0<br>320.0 | μA   | 5.5<br>5.0             | 0<br>−5.0              | V <sub>CC</sub> or GND             | V <sub>IS</sub> = V <sub>EE</sub> or V <sub>CC</sub> ; V <sub>OS</sub> = V <sub>CC</sub> or V <sub>EE</sub> |
| ΔI <sub>CC</sub> | additional quiescent supply current per input pin for unit load coefficient is 1 (note 1) |                       | 100  | 360         |            | 450           |             | 490            | μA   | 4.5 to 5.5             | 0                      | V <sub>CC</sub> −2.1 V             | other inputs at V <sub>CC</sub> or GND                                                                      |

**Note**

- The value of additional quiescent supply current ( $\Delta I_{CC}$ ) for a unit load of 1 is given here.  
To determine  $\Delta I_{CC}$  per input, multiply this value by the unit load coefficient shown in the table below.

| INPUT     | UNIT LOAD COEFFICIENT |
|-----------|-----------------------|
| nS        | 0.50                  |
| $\bar{E}$ | 0.50                  |

## Quad bilateral switches

## 74HC/HCT4316

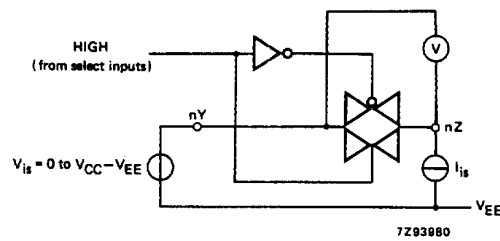
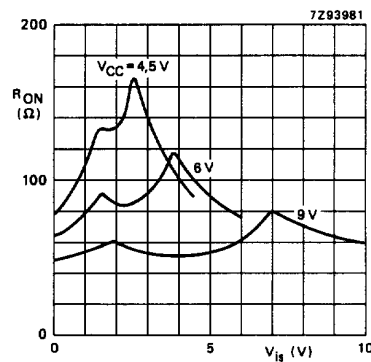
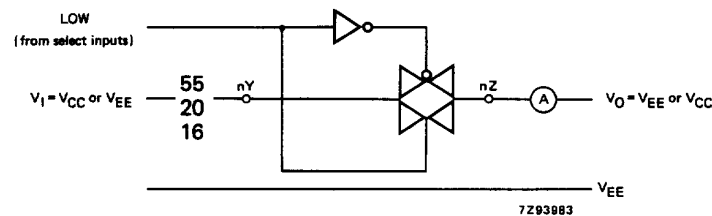
Fig.8 Test circuit for measuring  $R_{ON}$ .Fig.9 Typical  $R_{ON}$  as a function of input voltage  $V_{is}$  for  $V_{is} = 0$  to  $V_{CC} - V_{EE}$ .

Fig.10 Test circuit for measuring OFF-state current.

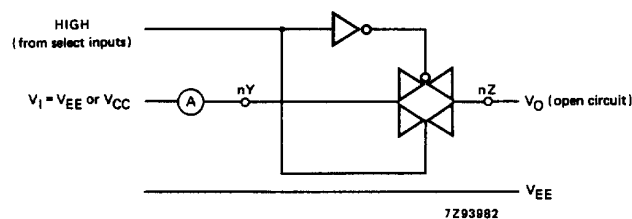


Fig.11 Test circuit for measuring ON-state current.

## Quad bilateral switches

## 74HC/HCT4316

## 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) | V <sub>EE</sub><br>(V) | OTHER                                                                           |
|                                     |                                                         | +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>V <sub>IS</sub> to V <sub>OS</sub> |                       | 6<br>4   | 12<br>8  |            | 15<br>10 |             | 18<br>12 | ns   | 4.5<br>4.5             | 0<br>−4.5              | R <sub>L</sub> = ∞;<br>C <sub>L</sub> = 50 pF<br>(see Fig.18)                   |
| t <sub>PZH</sub>                    | turn “ON” time<br>E̅ to V <sub>OS</sub>                 |                       | 22<br>21 | 44<br>42 |            | 55<br>53 |             | 66<br>63 | ns   | 4.5<br>4.5             | 0<br>−4.5              | R <sub>L</sub> = 1 kΩ;<br>C <sub>L</sub> = 50 pF<br>(see Figs 19,<br>20 and 21) |
| t <sub>PZL</sub>                    | turn “ON” time<br>E̅ to V <sub>OS</sub>                 |                       | 28<br>21 | 56<br>42 |            | 70<br>53 |             | 84<br>63 | ns   | 4.5<br>4.5             | 0<br>−4.5              |                                                                                 |
| t <sub>PZH</sub>                    | turn “ON” time<br>nS to V <sub>OS</sub>                 |                       | 20<br>17 | 40<br>34 |            | 53<br>43 |             | 60<br>51 | ns   | 4.5<br>4.5             | 0<br>−4.5              |                                                                                 |
| t <sub>PZL</sub>                    | turn “ON” time<br>nS to V <sub>OS</sub>                 |                       | 25<br>17 | 50<br>34 |            | 63<br>43 |             | 75<br>51 | ns   | 4.5<br>4.5             | 0<br>−4.5              | (see Figs 19,<br>20 and 21)                                                     |
| t <sub>PHZ</sub> / t <sub>PLZ</sub> | turn “OFF” time<br>E̅ to V <sub>OS</sub>                |                       | 25<br>23 | 50<br>46 |            | 63<br>58 |             | 75<br>69 | ns   | 4.5<br>4.5             | 0<br>−4.5              | R <sub>L</sub> = 1 kΩ;<br>C <sub>L</sub> = 50 pF<br>(see Figs 19,<br>20 and 21) |
| t <sub>PHZ</sub> / t <sub>PLZ</sub> | turn “OFF” time<br>nS to V <sub>OS</sub>                |                       | 22<br>20 | 44<br>40 |            | 55<br>50 |             | 66<br>60 | ns   | 4.5<br>4.5             | 0<br>−4.5              | R <sub>L</sub> = 1 kΩ;<br>C <sub>L</sub> = 50 pF<br>(see Figs 19,<br>20 and 21) |

## Quad bilateral switches

## 74HC/HCT4316

## ADDITIONAL AC CHARACTERISTICS FOR 74HC/HCT

## Recommended conditions and typical values

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

| SYMBOL      | PARAMETER                                                                   | typ.         | UNIT       | $V_{CC}$<br>(V) | $V_{EE}$<br>(V) | $V_{is(p-p)}$<br>(V) | CONDITIONS                                                                                                                                                                           |
|-------------|-----------------------------------------------------------------------------|--------------|------------|-----------------|-----------------|----------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|             | sine-wave distortion<br>$f = 1\text{ kHz}$                                  | 0.80<br>0.40 | %<br>%     | 2.25<br>4.5     | -2.25<br>-4.5   | 4.0<br>8.0           | $R_L = 10\text{ k}\Omega$ ; $C_L = 50\text{ pF}$<br>(see Fig.14)                                                                                                                     |
|             | sine-wave distortion<br>$f = 10\text{ kHz}$                                 | 2.40<br>1.20 | %<br>%     | 2.25<br>4.5     | -2.25<br>-4.5   | 4.0<br>8.0           | $R_L = 10\text{ k}\Omega$ ; $C_L = 50\text{ pF}$<br>(see Fig.14)                                                                                                                     |
|             | switch "OFF" signal<br>feed-through                                         | -50<br>-50   | dB<br>dB   | 2.25<br>4.5     | -2.25<br>-4.5   | note 1               | $R_L = 600\text{ }\Omega$ ; $C_L = 50\text{ pF}$<br>$f = 1\text{ MHz}$ (see Figs 12 and 15)                                                                                          |
|             | crosstalk between<br>any two switches                                       | -60<br>-60   | dB<br>dB   | 2.25<br>4.5     | -2.25<br>-4.5   | note 1               | $R_L = 600\text{ }\Omega$ ; $C_L = 50\text{ pF}$ ;<br>$f = 1\text{ MHz}$ ; (see Fig.16)                                                                                              |
| $V_{(p-p)}$ | crosstalk voltage between<br>control and any switch<br>(peak-to-peak value) | 110<br>220   | mV<br>mV   | 4.5<br>4.5      | 0<br>-4.5       |                      | $R_L = 600\text{ k}\Omega$ ; $C_L = 50\text{ pF}$ ;<br>$f = 1\text{ MHz}$ ( $\bar{E}$ or nS,<br>square-wave between $V_{CC}$<br>and GND, $t_r = t_f = 6\text{ ns}$ )<br>(see Fig.17) |
| $f_{max}$   | minimum frequency response<br>(-3 dB)                                       | 150<br>160   | MHz<br>MHz | 2.25<br>4.5     | -2.25<br>-4.5   | note 2               | $R_L = 50\text{ }\Omega$ ; $C_L = 10\text{ pF}$<br>(see Figs 13 and 14)                                                                                                              |
| $C_S$       | maximum switch capacitance                                                  | 5            | pF         |                 |                 |                      |                                                                                                                                                                                      |

## Notes

1. Adjust input voltage  $V_{is}$  to 0 dBm level (0 dBm = 1 mW into 600  $\Omega$ ).
2. Adjust input voltage  $V_{is}$  to 0 dBm level at  $V_{OS}$  for 1 MHz (0 dBm = 1 mW into 50  $\Omega$ ).

## General note

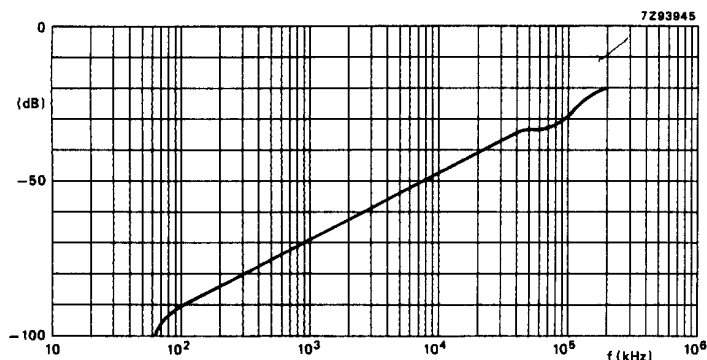
 $V_{is}$  is the input voltage at an nY or nZ terminal, whichever is assigned as an input. $V_{OS}$  is the output voltage at an nY or nZ terminal, whichever is assigned as an output.

Fig.12 Typical switch "OFF" signal feed-through as a function of frequency.

## Quad bilateral switches

## 74HC/HCT4316

Test conditions:  
 $V_{CC} = 4.5\text{ V}$ ;  $GND = 0\text{ V}$ ;  $V_{EE} = -4.5\text{ V}$ ;  
 $R_L = 50\ \Omega$ ;  $R_{source} = 1\text{ k}\Omega$ .



Fig.13 Typical frequency response.



Fig.14 Test circuit for measuring sine-wave distortion and minimum frequency response.



Fig.15 Test circuit for measuring switch "OFF" signal feed-through.

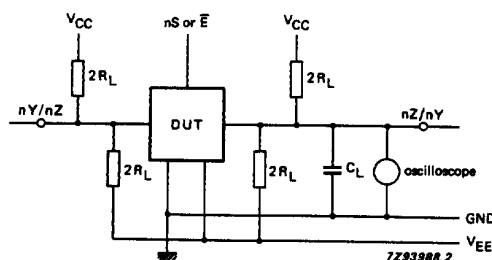
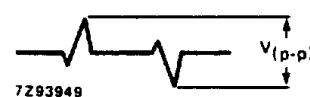
Fig.16 Test circuit for measuring crosstalk between two switches.  
(a) channel ON condition; (b) channel OFF condition.

Fig.17 Test circuit for measuring crosstalk between control and any switch.

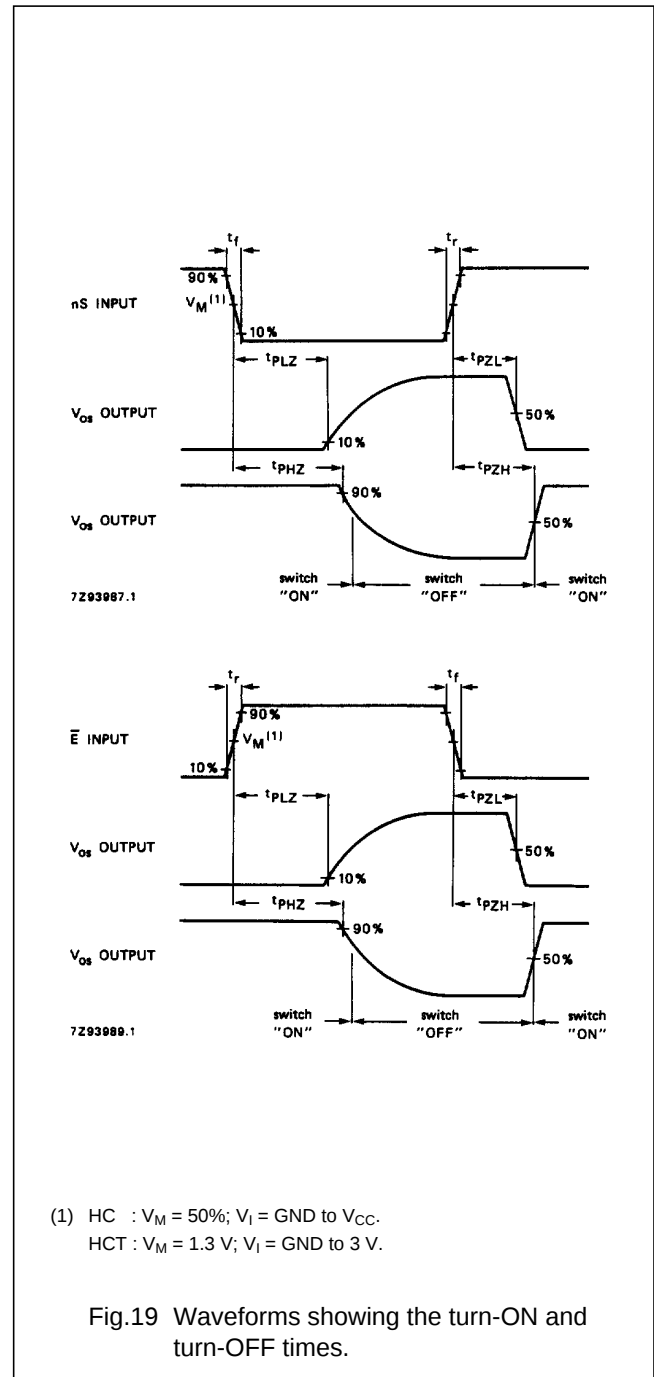
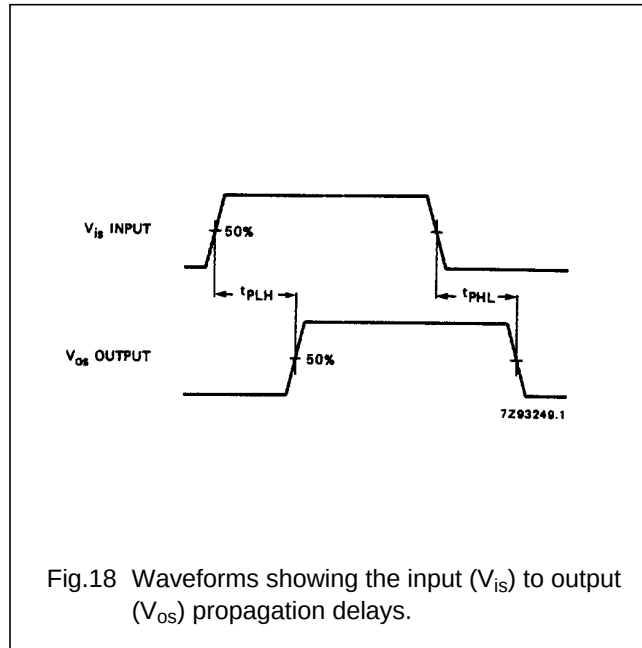
The crosstalk is defined as follows  
(oscilloscope output):



## Quad bilateral switches

## 74HC/HCT4316

## AC WAVEFORMS



## Quad bilateral switches

## 74HC/HCT4316

## TEST CIRCUIT AND WAVEFORMS



Fig.20 Test circuit for measuring AC performance.



Fig.21 Input pulse definitions.

## Conditions

| TEST      | SWITCH   | $V_{is}$ |
|-----------|----------|----------|
| $t_{PZH}$ | $V_{EE}$ | $V_{CC}$ |
| $t_{PZL}$ | $V_{CC}$ | $V_{EE}$ |
| $t_{PHZ}$ | $V_{EE}$ | $V_{CC}$ |
| $t_{PLZ}$ | $V_{CC}$ | $V_{EE}$ |
| others    | open     | pulse    |

| FAMILY | AMPLITUDE | $V_M$ | $t_r; t_f$                |       |
|--------|-----------|-------|---------------------------|-------|
|        |           |       | $f_{max};$<br>PULSE WIDTH | OTHER |
| 74HC   | $V_{CC}$  | 50%   | < 2 ns                    | 6 ns  |
| 74HCT  | 3.0 V     | 1.3 V | < 2 ns                    | 6 ns  |

Definitions for Figs 20 and 21:

$C_L$  = load capacitance including jig and probe capacitance (see AC CHARACTERISTICS for values).

$R_T$  = termination resistance should be equal to the output impedance  $Z_O$  of the pulse generator.

$t_r = t_f = 6$  ns; when measuring  $f_{max}$ , there is no constraint to  $t_r, t_f$  with 50% duty factor.

## PACKAGE OUTLINES

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

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