

# 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 E̅ to V <sub>OS</sub> nS to V <sub>OS</sub>	C <sub>L</sub> = 15 pF; R <sub>L</sub> = 1 kΩ; V <sub>CC</sub> = 5 V	19	19	ns
			16	17	ns
t <sub>PZL</sub>	turn “ON” time E̅ to V <sub>OS</sub> nS to V <sub>OS</sub>		19	24	ns
			16	21	ns
t <sub>PHZ</sub> / t <sub>PLZ</sub>	turn “OFF” time E̅ to V <sub>OS</sub> nS to V <sub>OS</sub>		20	21	ns
			16	19	ns
C <sub>I</sub>	input capacitance		3.5	3.5	pF
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

Quad bilateral switches

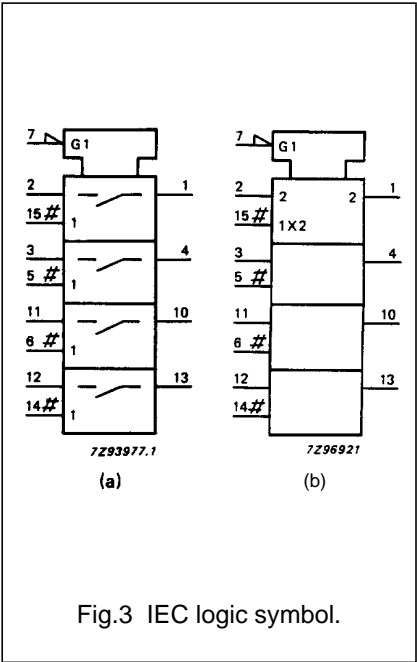
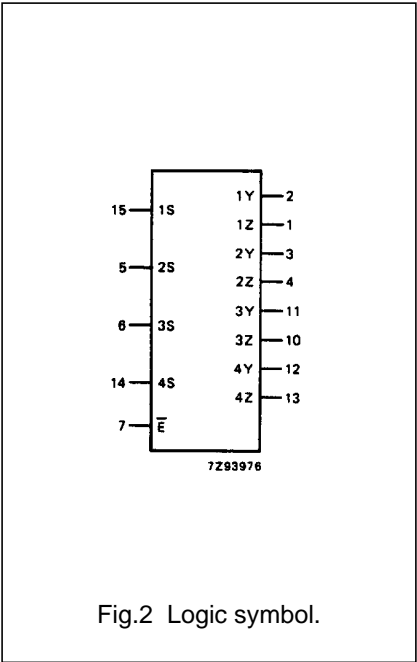
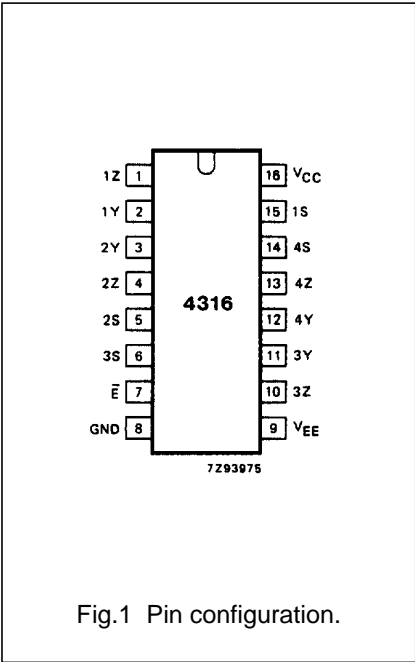
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ORDERING INFORMATION

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

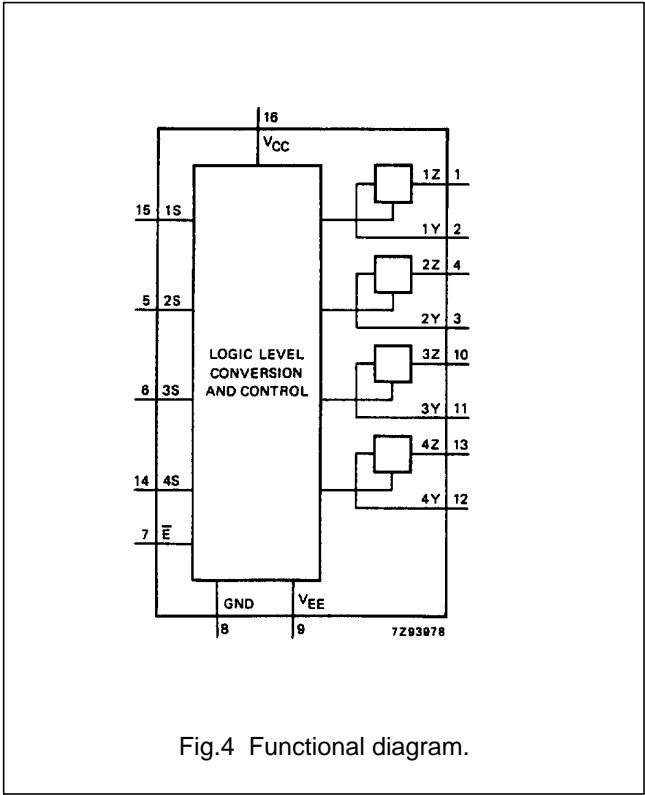


Fig.4 Functional diagram.

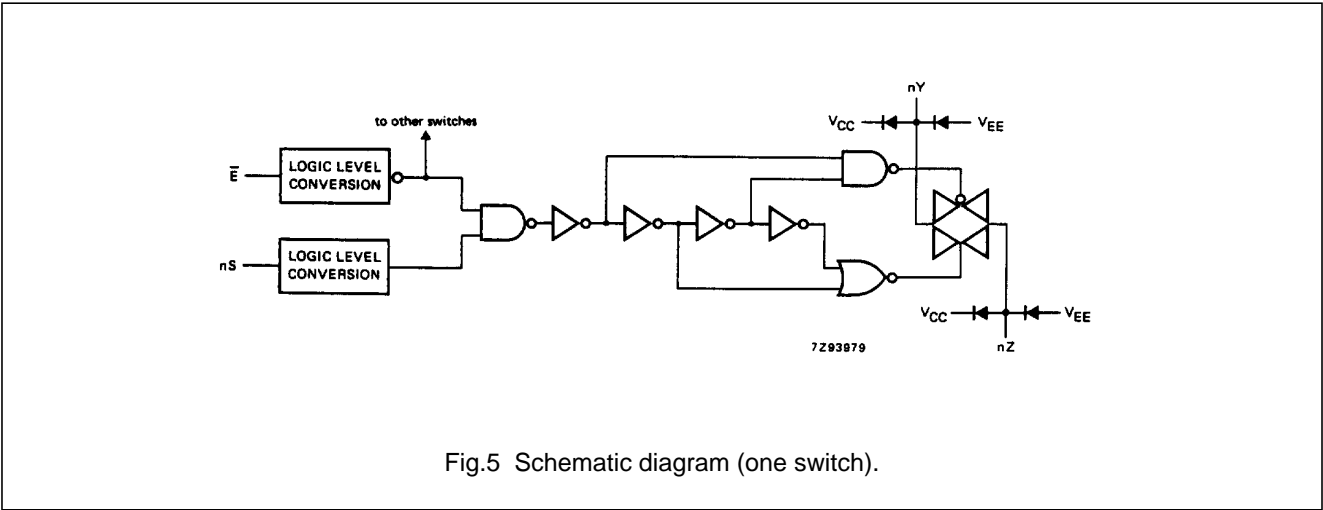


Fig.5 Schematic diagram (one switch).

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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	
$\pm I_{CC}$ ; $\pm I_{GND}$	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 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 CHARACTERISTICS
$T_{amb}$	operating ambient temperature range	-40		+125	-40		+125	°C	
$t_r, t_f$	input rise and fall times		6.0	1000 500 400 250		6.0	500	ns	$V_{CC} = 2.0 \text{ V}$ $V_{CC} = 4.5 \text{ V}$ $V_{CC} = 6.0 \text{ V}$ $V_{CC} = 10.0 \text{ V}$

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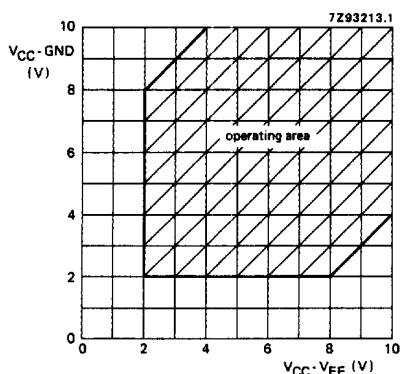


Fig.6 Guaranteed operating area as a function of the supply voltages for 74HC4316.

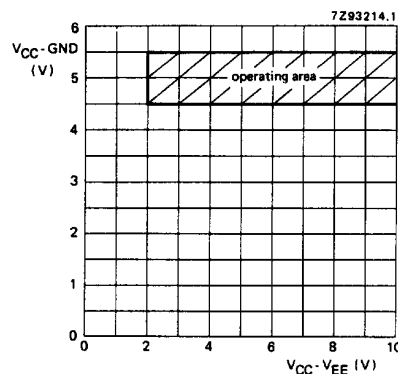


Fig.7 Guaranteed operating area as a function of the supply voltages for 74HCT4316.

## 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> (V)	V <sub>EE</sub> (V)	I <sub>S</sub> (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 (peak)		—	—		—		—	Ω	2.0	0	100	V <sub>CC</sub> to V <sub>EE</sub>	V <sub>IH</sub> or 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 (rail)		160	—		—		—	Ω	2.0	0	100	V <sub>EE</sub>	V <sub>IH</sub> or 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 (rail)		170	—		—		—	Ω	2.0	0	100	V <sub>CC</sub>	V <sub>IH</sub> or 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 resistance between any two channels		—						Ω	2.0	0		V <sub>CC</sub> to V <sub>EE</sub>	V <sub>H</sub> or 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.

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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> (V)	V <sub>EE</sub> (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 3.15 4.2 6.3	1.2 2.4 3.2 4.3		1.5 3.15 4.2 6.3		1.5 3.15 4.2 6.3		V	2.0 4.5 6.0 9.0			
V <sub>IL</sub>	LOW level input voltage		0.8 2.1 2.8 4.3	0.5 1.35 1.8 2.7		0.5 1.35 1.8 2.7		0.5 1.35 1.8 2.7	V	2.0 4.5 6.0 9.0			
±I <sub>I</sub>	input leakage current			0.1 0.2		1.0 2.0		1.0 2.0	μA	6.0 10.0	0 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>	V <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>	V <sub>S</sub>   = V <sub>CC</sub> − V <sub>EE</sub> (see Fig.11)
I <sub>CC</sub>	quiescent supply current			8.0 16.0		80.0 160.0		160.0 320.0	μA	6.0 10.0	0 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>

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



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**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> (V)	V <sub>EE</sub> (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 16.0		80.0 160.0		160.0 320.0	μA	5.5 5.0	0 −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

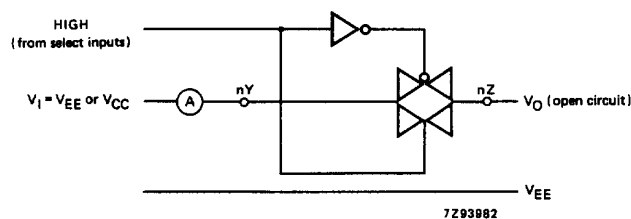
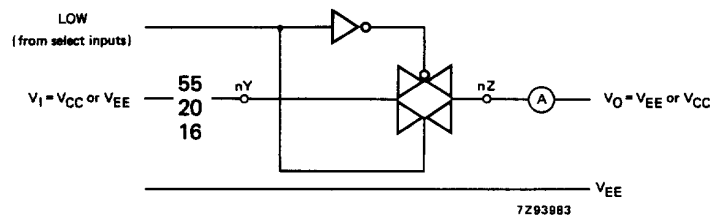
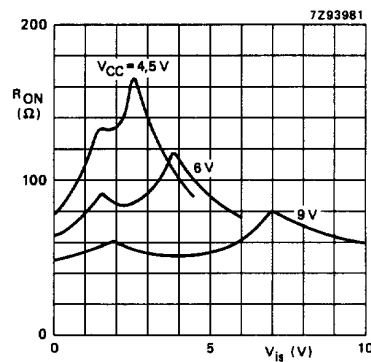
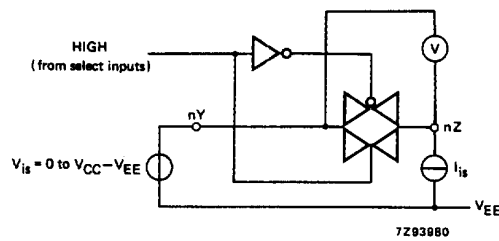
**Note**

1. 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

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

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

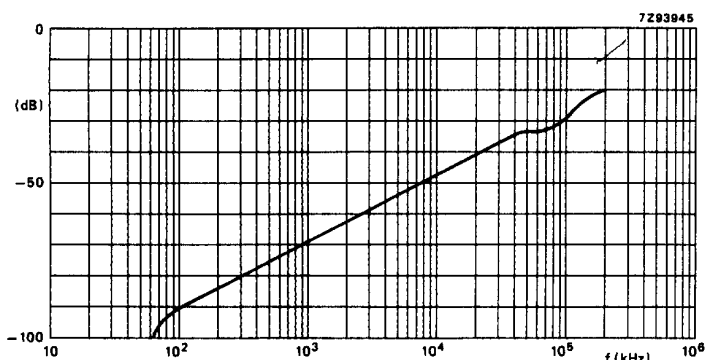
 $V_{is}$  is the input voltage at an nY or nZ terminal, whichever is assigned as an input. $V_{OS}$  is the output voltage at an nY or nZ terminal, whichever is assigned as an output.

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

## Quad bilateral switches

## 74HC/HCT4316

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

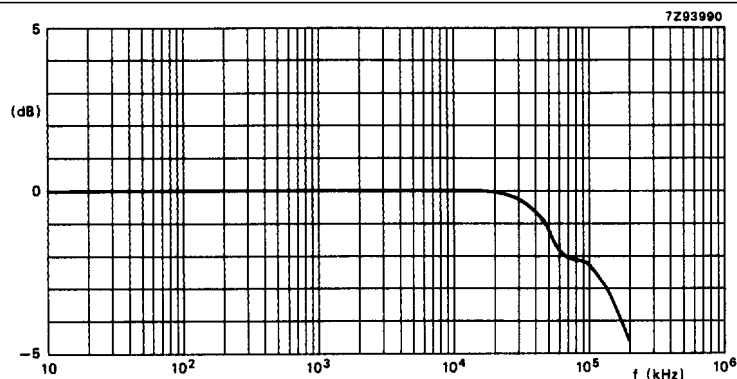


Fig.13 Typical frequency response.

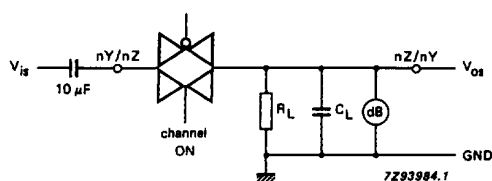


Fig.14 Test circuit for measuring sine-wave distortion and minimum frequency response.

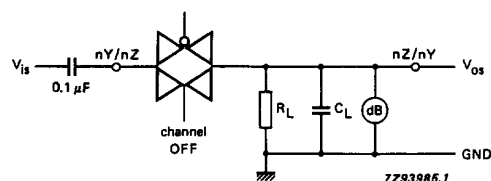


Fig.15 Test circuit for measuring switch "OFF" signal feed-through.

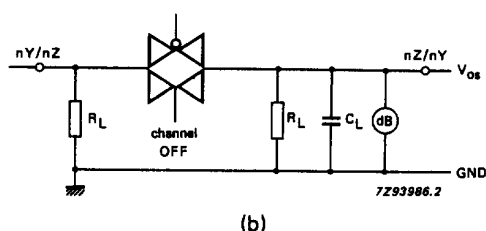
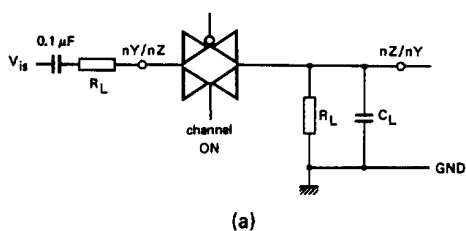
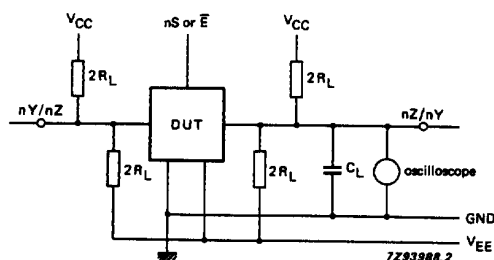
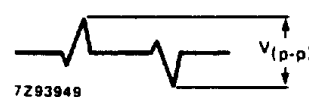
Fig.16 Test circuit for measuring crosstalk between any two switches.  
(a) channel ON condition; (b) channel OFF condition.

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

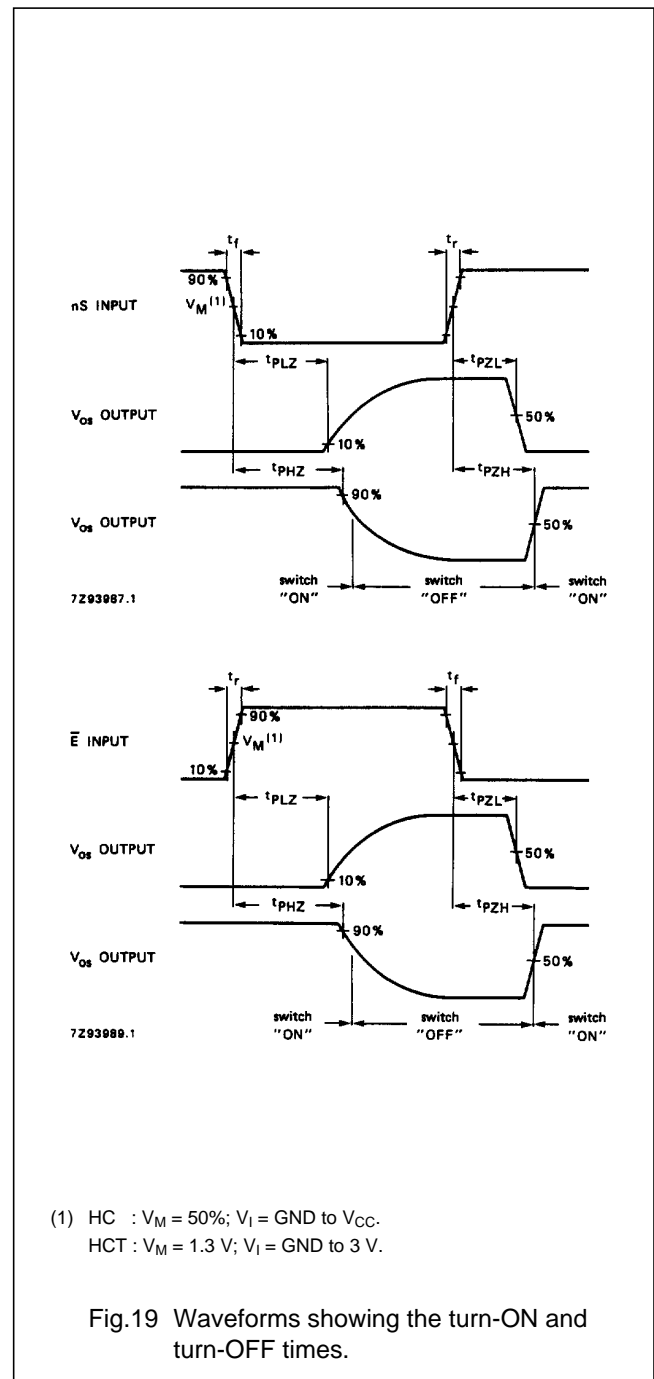
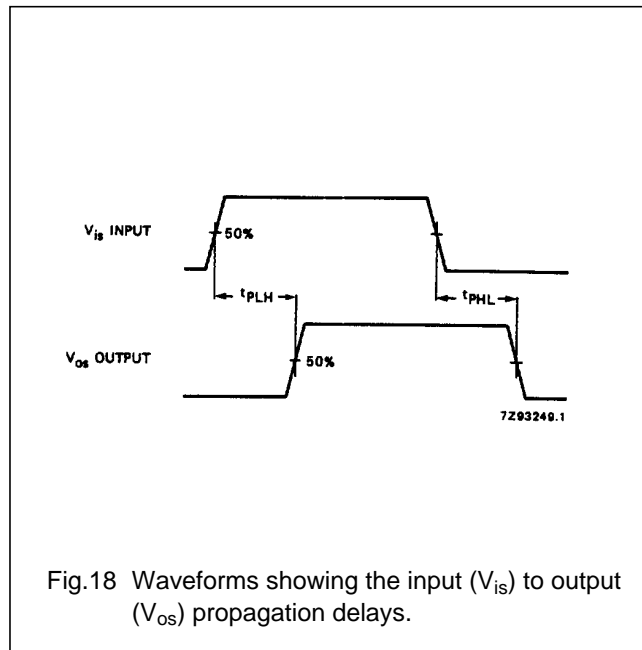
The crosstalk is defined as follows  
 (oscilloscope output):



## Quad bilateral switches

## 74HC/HCT4316

## AC WAVEFORMS



## Quad bilateral switches

## 74HC/HCT4316

## TEST CIRCUIT AND WAVEFORMS

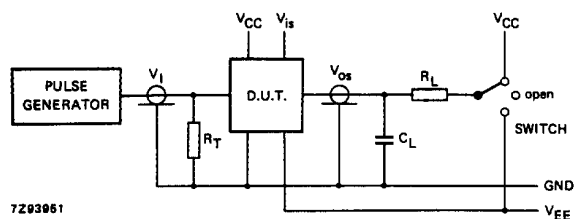


Fig.20 Test circuit for measuring AC performance.

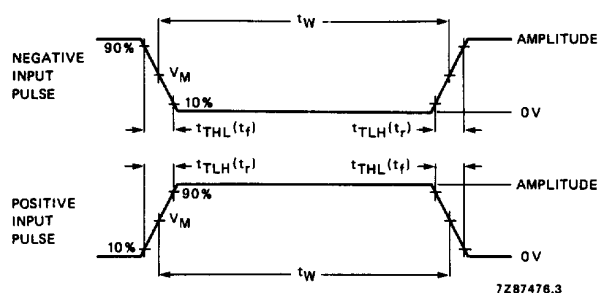


Fig.21 Input pulse definitions.

## 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	$V_M$	$t_r; t_f$	
			$f_{max};$ 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".