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

Philips Semiconductors

PHILIPS

Quad bilateral switches 74HC/HCT4316

FEATURES

- Low "ON" resistance:
  160 Ω (typ.) at $V_{CC} - V_{EE}$ = 4.5 V
  120 Ω (typ.) at $V_{CC} - V_{EE}$ = 6.0 V
  80 Ω (typ.) at $V_{CC} - V_{EE}$ = 9.0 V
- Logic level translation:
  to enable 5 V logic to communicate with ± 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 ($\overline{E}$) 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; $V_{CC} >> (V_Y, V_Z) >> V_{EE}$. Inputs nY and nZ are electrically equivalent terminals.

V_{CC} and GND are the supply voltage pins for the digital control inputs ($\overline{E}$ 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} = GND = 0 V; T_{amb} = 25 °C; $t_r = t_f$ = 6 ns

SYMBOL	PARAMETER	CONDITIONS	TYPICAL		UNIT
			HC	HCT	
t_{PZH}	turn "ON" time	C_L = 15 pF; R_L = 1 kΩ; V_{CC} = 5 V			
	$\overline{E}$ to V_{OS}		19	19	ns
	nS to V_{OS}		16	17	ns
t_{PZL}	turn "ON" time				
	$\overline{E}$ to V_{OS}		19	24	ns
	nS to V_{OS}		16	21	ns
t_{PHZ}/ t_{PLZ}	turn "OFF" time				
	$\overline{E}$ to V_{OS}		20	21	ns
	nS to V_{OS}		16	19	ns
C_I	input capacitance		3.5	3.5	pF
C_{PD}	power dissipation capacitance per switch	notes 1 and 2	13	14	pF
C_S	max. switch capacitance		5	5	pF

Notes

1. C_{PD} is used to determine the dynamic power dissipation (P_D in μW):

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

   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

2. For HC the condition is V_I = GND to V_{CC}
   For HCT the condition is V_I = GND to V_{CC} – 1.5 V

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

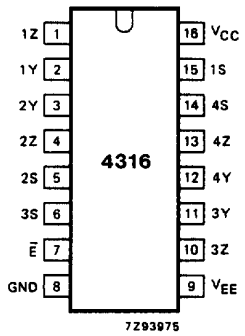


Fig.1 Pin configuration.

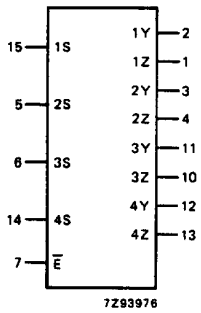


Fig.2 Logic symbol.

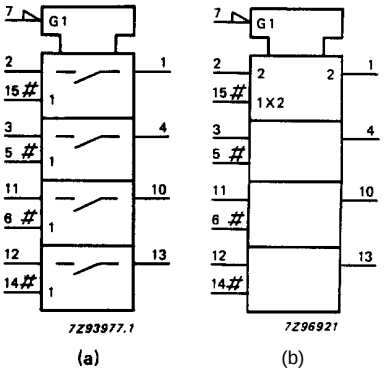


Fig.3 IEC logic symbol.

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

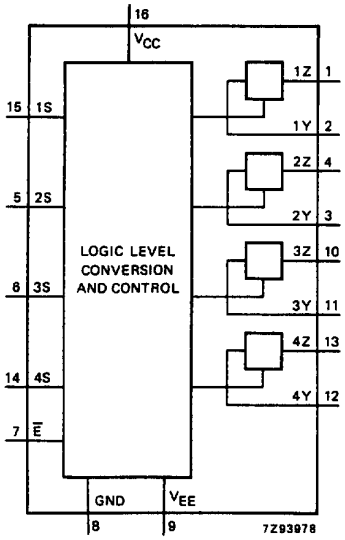


Fig.4 Functional diagram.

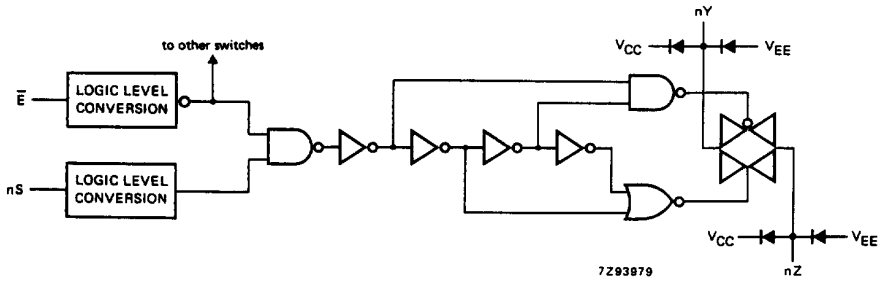


Fig.5 Schematic diagram (one switch).

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)
Voltages are referenced to V_{EE} = 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 $V_I < -0.5$ V or $V_I > V_{CC} + 0.5$ V
$\pm I_{SK}$	DC switch diode current		20	mA	for $V_S < -0.5$ V or $V_S > V_{CC} + 0.5$ V
$\pm I_S$	DC switch current		25	mA	for -0.5 V $< V_S < V_{CC} + 0.5$ 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}–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 V V_{CC} = 4.5 V V_{CC} = 6.0 V V_{CC} = 10.0 V

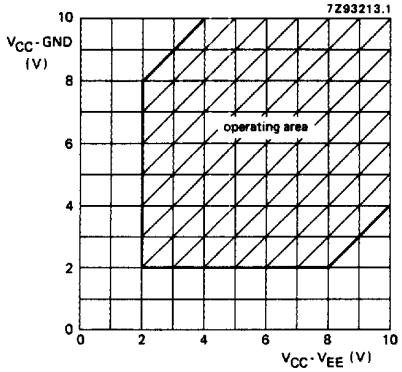


Fig.6 Guaranteed operating area as a function of the supply voltages for 74HC4316.

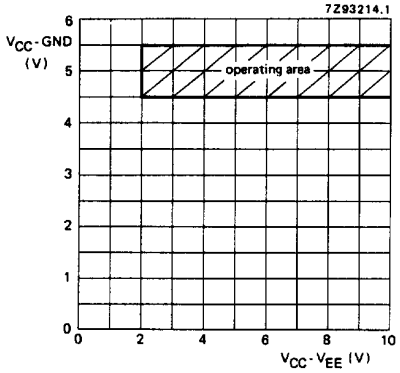


Fig.7 Guaranteed operating area as a function of the supply voltages for 74HCT4316.

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_{amb} (°C)							UNIT	TEST CONDITIONS				
		74HC/HCT								V_{CC} (V)	V_{EE} (V)	I_S (μA)	V_{is}	V_I
		+25			–40 to +85		–40 to +125							
		min.	typ.	max.	min.	max.	min.	max.						
R_{ON}	ON resistance (peak)		– 160 120 85	– 320 240 170		– 400 300 215		– 480 360 255	Ω Ω Ω Ω	2.0 4.5 6.0 4.5	0 0 0 –4.5	100 1000 1000 1000	V_{CC} to V_{EE}	V_{IH} or V_{IL}
R_{ON}	ON resistance (rail)		160 80 70 60	– 160 140 120		– 200 175 150		– 240 210 180	Ω Ω Ω Ω	2.0 4.5 6.0 4.5	0 0 0 –4.5	100 1000 1000 1000	V_{EE}	V_{IH} or V_{IL}
R_{ON}	ON resistance (rail)		170 90 80 65	– 180 160 135		– 225 200 170		– 270 240 205	Ω Ω Ω Ω	2.0 4.5 6.0 4.5	0 0 0 –4.5	100 1000 1000 1000	V_{CC}	V_{IH} or V_{IL}
ΔR_{ON}	maximum ΔON resistance between any two channels		– 16 9 6						Ω Ω Ω Ω	2.0 4.5 6.0 4.5	0 0 0 –4.5		V_{CC} to V_{EE}	V_H or V_{IL}

Notes

1. 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.
2. For test circuit measuring R_{ON} see Fig.8.

DC CHARACTERISTICS FOR 74HC

Voltages are referenced to GND (ground = 0 V)

SYMBOL	PARAMETER	T_{amb} (°C)							UNIT	TEST CONDITIONS			
		74HC								V_{CC} (V)	V_{EE} (V)	V_I	OTHER
		+25			−40 to +85		−40 to +125						
		min.	typ.	max.	min.	max.	min.	max.					
V_{IH}	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_{IL}	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			
$\pm I_I$	input leakage current			0.1 0.2		1.0 2.0		1.0 2.0	µA	6.0 10.0	0 0	V_{CC} or GND	
$\pm I_S$	analog switch OFF-state current			0.1		1.0		1.0	µA	10.0	0	V_{IH} or V_{IL}	$\lvert V_S \rvert$ = $V_{CC} - V_{EE}$ (see Fig.10)
$\pm I_S$	analog switch ON-state current			0.1		1.0		1.0	µA	10.0	0	V_{IH} or V_{IL}	$\lvert V_S \rvert$ = $V_{CC} - V_{EE}$ (see Fig.11)
I_{CC}	quiescent supply current			8.0 16.0		80.0 160.0		160.0 320.0	µA	6.0 10.0	0 0	V_{CC} or GND	$V_{is} = V_{EE}$ or V_{CC}; $V_{OS} = V_{CC}$ or V_{EE}

AC CHARACTERISTICS FOR 74HC

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

SYMBOL	PARAMETER	T_{amb} (°C)							UNIT	TEST CONDITIONS		
		74HC										
		+25			−40 to +85		−40 to +125			V_{CC} (V)	V_{EE} (V)	OTHER
		min.	typ.	max.	min.	max.	min.	max.				
t_{PHL}/ t_{PLH}	propagation delay V_{is} to V_{os}		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	$R_L = \infty$; C_L = 50 pF (see Fig.18)
t_{PZH}/ t_{PZL}	turn “ON” time $\overline{E}$ to V_{os}		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_L = 1 kΩ; C_L = 50 pF (see Figs 19, 20 and 21)
t_{PZH}/ t_{PZL}	turn “ON” time nS to V_{os}		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_L = 1 kΩ; C_L = 50 pF (see Figs 19, 20 and 21)
t_{PHZ}/ t_{PLZ}	turn “OFF” time $\overline{E}$ to V_{os}		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_L = 1 kΩ; C_L = 50 pF (see Figs 19, 20 and 21)
t_{PHZ}/ t_{PLZ}	turn “OFF” time nS to V_{os}		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_L = 1 kΩ; C_L = 50 pF (see Figs 19, 20 and 21)

DC CHARACTERISTICS FOR 74HCT

Voltages are referenced to GND (ground = 0)

SYMBOL	PARAMETER	T_{amb} (°C)							UNIT	TEST CONDITIONS			
		74HCT								V_{CC} (V)	V_{EE} (V)	V_I	OTHER
		+25			−40 to +85		−40 to +125						
		min.	typ.	max.	min.	max.	min.	max.					
V_{IH}	HIGH level input voltage	2.0	1.6		2.0		2.0		V	4.5 to 5.5			
V_{IL}	LOW level input voltage		1.2	0.8		0.8		0.8	V	4.5 to 5.5			
$\pm I_I$	input leakage current			0.1		1.0		1.0	µA	5.5	0	V_{CC} or GND	
$\pm I_S$	analog switch OFF-state current			0.1		1.0		1.0	µA	10.0	0	V_{IH} or V_{IL}	$\lvert V_S \rvert$ = $V_{CC} - V_{EE}$ (see Fig.10)
$\pm I_S$	analog switch ON-state current			0.1		1.0		1.0	µA	10.0	0	V_{IH} or V_{IL}	$\lvert V_S \rvert$ = $V_{CC} - V_{EE}$ (see Fig.11)
I_{CC}	quiescent supply current			8.0 16.0		80.0 160.0		160.0 320.0	µA	5.5 5.0	0 –5.0	V_{CC} or GND	$V_{is} = V_{EE}$ or V_{CC}; $V_{OS} = V_{CC}$ or V_{EE}
ΔI_{CC}	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_{CC} –2.1 V	other inputs at V_{CC} or GND

Note

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

INPUT	UNIT LOAD COEFFICIENT
nS	0.50
$\overline{E}$	0.50

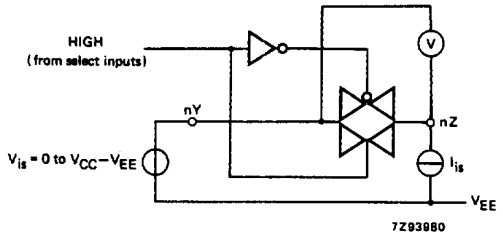


Fig.8 Test circuit for measuring R_{ON}.

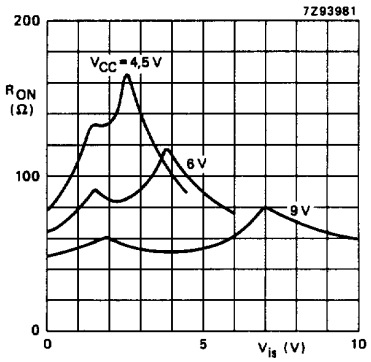


Fig.9 Typical R_{ON} as a function of input voltage V_{is} for V_{is} = 0 to $V_{CC} - V_{EE}$.

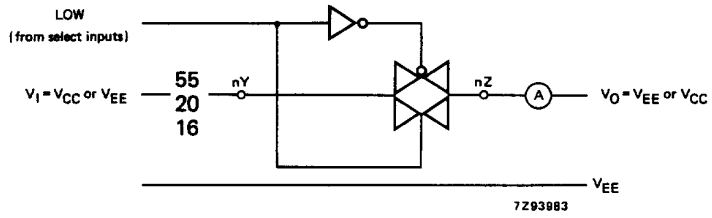


Fig.10 Test circuit for measuring OFF-state current.

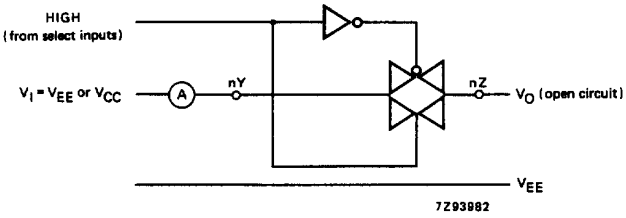


Fig.11 Test circuit for measuring ON-state current.

AC CHARACTERISTICS FOR 74HCT

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

SYMBOL	PARAMETER	T_{amb} (°C)							UNIT	TEST CONDITIONS		
		74HCT								V_{CC} (V)	V_{EE} (V)	OTHER
		+25			−40 TO +85		−40 to +125					
		min.	typ.	max.	min.	max.	min.	max.				
t_{PHL}/ t_{PLH}	propagation delay V_{is} to V_{os}		6 4	12 8		15 10		18 12	ns	4.5 4.5	0 –4.5	R_L = ∞; C_L = 50 pF (see Fig.18)
t_{PZH}	turn “ON” time $\overline{E}$ to V_{os}		22 21	44 42		55 53		66 63	ns	4.5 4.5	0 –4.5	R_L = 1 kΩ; C_L = 50 pF (see Figs 19, 20 and 21)
t_{PZL}	turn “ON” time $\overline{E}$ to V_{os}		28 21	56 42		70 53		84 63	ns	4.5 4.5	0 –4.5	
t_{PZH}	turn “ON” time nS to V_{os}		20 17	40 34		53 43		60 51	ns	4.5 4.5	0 –4.5	R_L = 1 kΩ; C_L = 50 pF (see Figs 19, 20 and 21)
t_{PZL}	turn “ON” time nS to V_{os}		25 17	50 34		63 43		75 51	ns	4.5 4.5	0 –4.5	
t_{PHZ}/ t_{PLZ}	turn “OFF” time $\overline{E}$ to V_{os}		25 23	50 46		63 58		75 69	ns	4.5 4.5	0 –4.5	R_L = 1 kΩ; C_L = 50 pF (see Figs 19, 20 and 21)
t_{PHZ}/ t_{PLZ}	turn “OFF” time nS to V_{os}		22 20	44 40		55 50		66 60	ns	4.5 4.5	0 –4.5	R_L = 1 kΩ; C_L = 50 pF (see Figs 19, 20 and 21)

ADDITIONAL AC CHARACTERISTICS FOR 74HC/HCT

Recommended conditions and typical values

GND = 0 V; T_{amb} = 25 °C

SYMBOL	PARAMETER	typ.	UNIT	V_{CC} (V)	V_{EE} (V)	$V_{is(p-p)}$ (V)	CONDITIONS
	sine-wave distortion f = 1 kHz	0.80 0.40	% %	2.25 4.5	–2.25 –4.5	4.0 8.0	R_L = 10 kΩ; C_L = 50 pF (see Fig.14)
	sine-wave distortion f = 10 kHz	2.40 1.20	% %	2.25 4.5	–2.25 –4.5	4.0 8.0	R_L = 10 kΩ; C_L = 50 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 Ω; C_L = 50 pF f = 1 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 Ω; C_L = 50 pF; f = 1 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 kΩ; C_L = 50 pF; f = 1 MHz ($\overline{E}$ or nS, square-wave between V_{CC} and GND, $t_r = t_f$ = 6 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 Ω ; C_L = 10 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 Ω).
2. Adjust input voltage V_{is} to 0 dBm level at V_{OS} for 1 MHz (0 dBm = 1 mW into 50 Ω).

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.

Test conditions:
V_{CC} = 4.5 V; GND = 0 V; V_{EE} = –4.5 V;
R_L = 50 Ω; R_{source} = 1 kΩ.

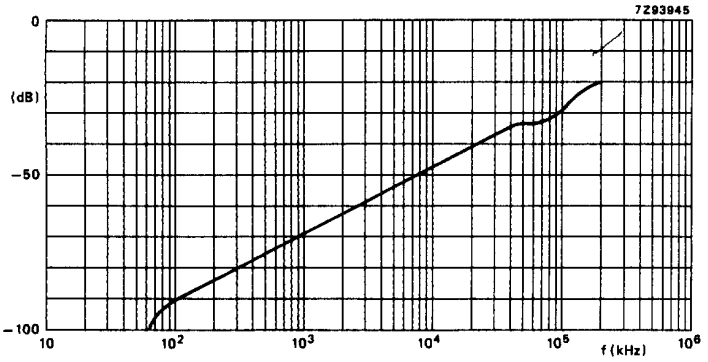


Fig.12 Typical switch “OFF” signal feed-through as a function of frequency.

Test conditions:
V_{CC} = 4.5 V; GND = 0 V; V_{EE} = −4.5 V;
R_L = 50 Ω; R_{source} = 1 kΩ.

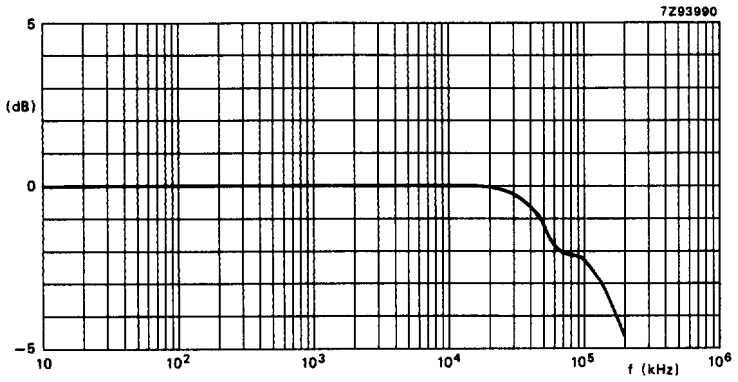


Fig.13 Typical frequency response.

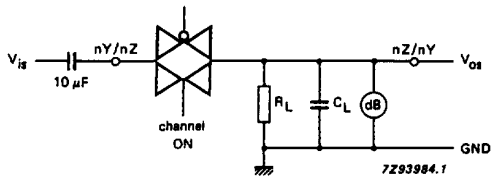


Fig.14 Test circuit for measuring sine-wave distortion and minimum frequency response.

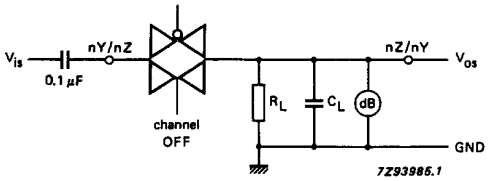


Fig.15 Test circuit for measuring switch “OFF” signal feed-through.

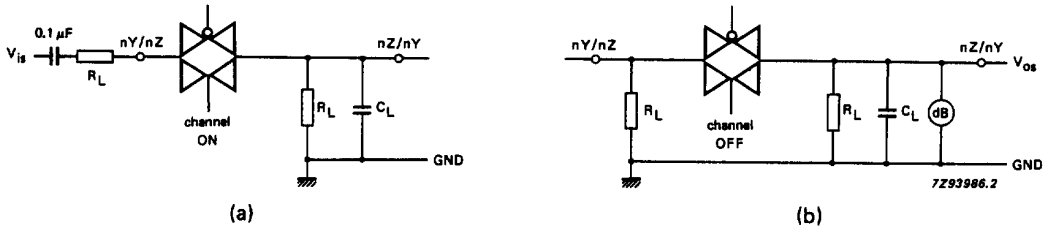
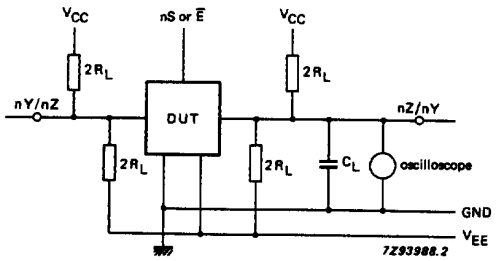


Fig.16 Test circuit for measuring crosstalk between any two switches.
(a) channel ON condition; (b) channel OFF condition.



The crosstalk is defined as follows (oscilloscope output):

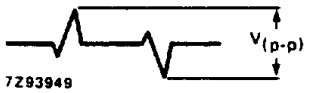


Fig.17 Test circuit for measuring crosstalk between control and any switch.

AC WAVEFORMS

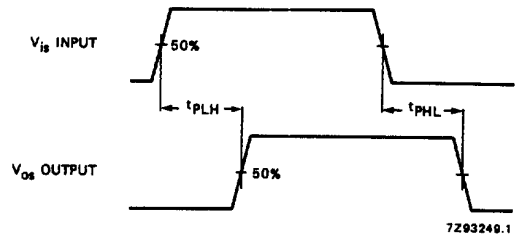
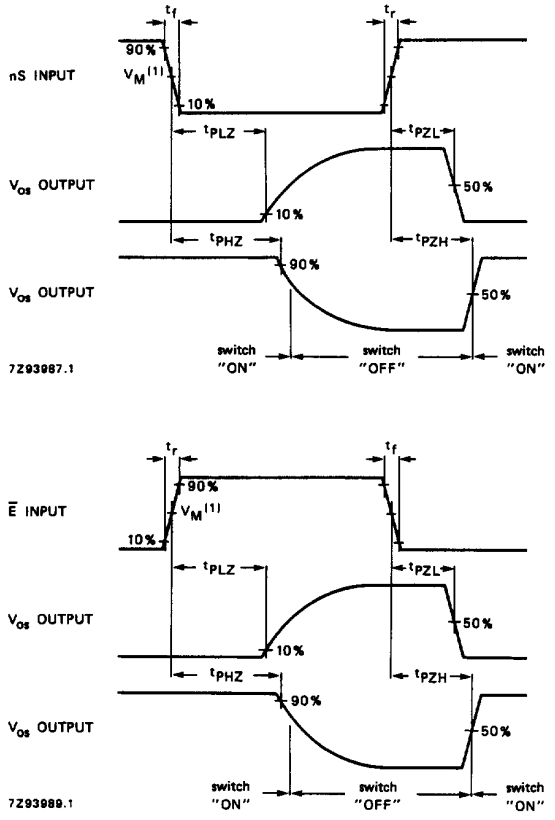


Fig.18 Waveforms showing the input (V_{is}) to output (V_{os}) propagation delays.



(1) HC : V_M = 50%; V_I = GND to V_{CC}.
HCT : V_M = 1.3 V; V_I = GND to 3 V.

Fig.19 Waveforms showing the turn-ON and turn-OFF times.

TEST CIRCUIT AND WAVEFORMS

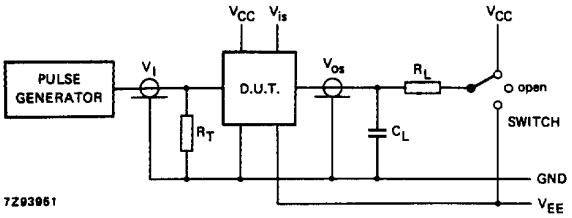


Fig.20 Test circuit for measuring AC performance.

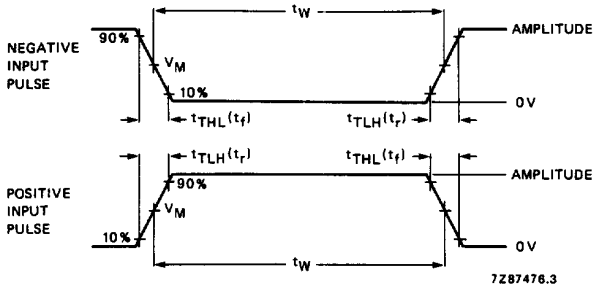


Fig.21 Input pulse definitions.

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).

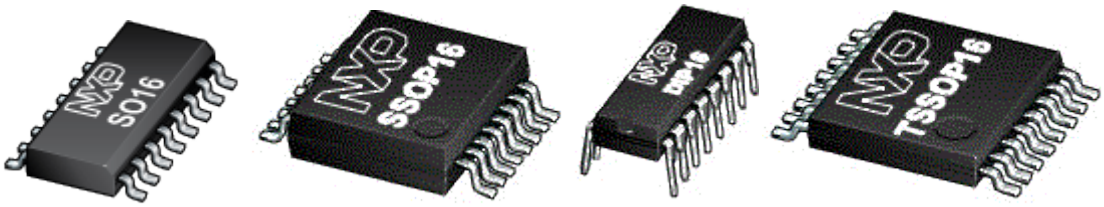
R_T = termination resistance should be equal to the output impedance Z_O of the pulse generator.

$t_r = t_f$ = 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"*.

74HC/HCT4316 Packaging Information



Type Number	Orderable Part Number	Package Name
74HC4316D	74HC4316D,653	SO16
74HC4316D	74HC4316D,652	SO16
74HC4316DB	74HC4316DB,118	SSOP16
74HC4316DB	74HC4316DB,112	SSOP16
74HC4316N	74HC4316N,652	DIP16
74HC4316PW	74HC4316PW,118	TSSOP16
74HC4316PW	74HC4316PW,112	TSSOP16
74HCT4316D	74HCT4316D,118	SO16
74HCT4316D	74HCT4316D,112	SO16
74HCT4316DB	74HCT4316DB,118	SSOP16
74HCT4316DB	74HCT4316DB,112	SSOP16
74HCT4316N	74HCT4316N,112	DIP16
74HCT4316PW	74HCT4316PW,118	TSSOP16
74HCT4316PW	74HCT4316PW,112	TSSOP16