QUAD BILATERAL SWITCHES

FEATURES

- Very low "ON" resistance:
  50 Ω (typ.) at V_{CC} = 4.5 V
  45 Ω (typ.) at V_{CC} = 6.0 V
  35 Ω (typ.) at V_{CC} = 9.0 V
- Output capability: non-standard
- I_{CC} category: SSI

GENERAL DESCRIPTION

The 74HC/HCT4066 are high-speed Si-gate CMOS devices and are pin compatible with the "4066" of the "4000B" series. They are specified in compliance with JEDEC standard no. 7A.

The 74HC/HCT4066 have four independent analog switches. Each switch has two input/output terminals (nY, nZ) and an active HIGH enable input (nE). When nE is LOW the belonging analog switch is turned off.

The "4066" is pin compatible with the "4016" but exhibits a much lower "ON" resistance. In addition, the "ON" resistance is relatively constant over the full input signal range.

SYMBOL	PARAMETER	CONDITIONS	TYPICAL		UNIT
			HC	HCT	
t_{PZH}/ t_{PZL}	turn-on time nE to V_{os}	C_L = 15 pF, R_L = 1 kΩ, V_{CC} = 5 V	11	12	ns
t_{PHZ}/ t_{PLZ}	turn-off time nE to V_{os}		13	16	ns
C_I	input capacitance		3.5	3.5	pF
C_{PD}	power dissipation capacitance per switch	notes 1 and 2	11	12	pF
C_S	max. switch capacitance		8	8	pF

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

Notes

1. C_{PD} is used to determine the dynamic power dissipation (P_D in μW):
   $P_D = C_{PD} \times V_{CC}^2 \times f_i + \Sigma \{ (C_L + C_S) \times V_{CC}^2 \times f_o \}$ where:
   f_i = input frequency in MHz
   f_o = output frequency in MHz
   $\Sigma \{ (C_L + C_S) \times V_{CC}^2 \times f_o \}$ = 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

PACKAGE OUTLINES

14-lead DIL; plastic (SOT27).
14-lead mini-pack; plastic (SO14; SOT108A).

PIN DESCRIPTION

PIN NO.	SYMBOL	NAME AND FUNCTION
1, 4, 8, 11	1Y to 4Y	independent inputs/outputs
2, 3, 9, 10	1Z to 4Z	independent inputs/outputs
7	GND	ground (0 V)
13, 5, 6, 12	1E to 4E	enable inputs (active HIGH)
14	V_{CC}	positive supply voltage

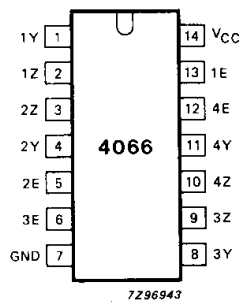


Fig. 1 Pin configuration.

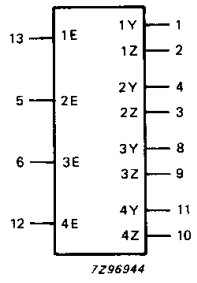


Fig. 2 Logic symbol.

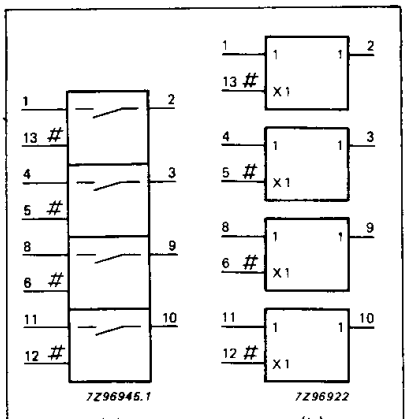


Fig. 3 IEC logic symbol.

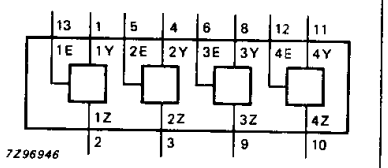


Fig. 4 Functional diagram.

FUNCTION TABLE

INPUT nE	SWITCH
L	off
H	on

H = HIGH voltage level
L = LOW voltage level

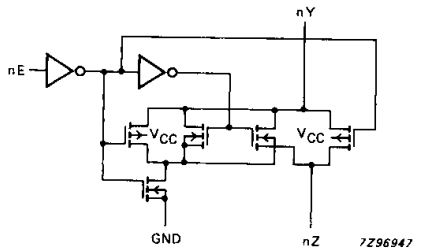


Fig. 5 Schematic diagram (one switch).

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	+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
$\pm I_{CC}$; $\pm I_{GND}$	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 the Ratings

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

RECOMMENDED OPERATING CONDITIONS

SYMBOL	PARAMETER	74HC			74HCT			UNIT	CONDITIONS
		min.	typ.	max.	min.	typ.	max.		
V_{CC}	DC supply voltage	2.0	5.0	10.0	4.5	5.0	5.5	V	
V_I	DC input voltage range	GND		V_{CC}	GND		V_{CC}	V	
V_S	DC switch voltage range	GND		V_{CC}	GND		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

DC CHARACTERISTICS FOR 74HC/HCT

For 74HC: V_{CC} = 2.0, 4.5, 6.0 and 9.0 V
For 74HCT: V_{CC} = 4.5 V

SYMBOL	PARAMETER	T_{amb} (°C)							UNIT	TEST CONDITIONS			
		74HC/HCT											
		+25			−40 to +85		−40 to +125			V_{CC} V	I_S μA	V_{is}	V_I
		min.	typ.	max.	min.	max.	min.	max.					
R_{ON}	ON-resistance (peak)		– 54 42 32	– 95 84 70		– 118 105 88		– 142 126 105	Ω Ω Ω Ω	2.0 4.5 6.0 9.0	100 1000 1000 1000	V_{CC} to GND	V_{IH} or V_{IL}
R_{ON}	ON-resistance (rail)		80 35 27 20	– 75 65 55		– 95 82 70		– 115 100 85	Ω Ω Ω Ω	2.0 4.5 6.0 9.0	100 1000 1000 1000	GND	V_{IH} or V_{IL}
R_{ON}	ON-resistance (rail)		100 42 35 27	– 80 75 60		– 106 94 78		– 128 113 95	Ω Ω Ω Ω	2.0 4.5 6.0 9.0	100 1000 1000 1000	V_{CC}	V_{IH} or V_{IL}
ΔR_{ON}	maximum variation of ON-resistance between any two channels		– 5 4 3						Ω Ω Ω Ω	2.0 4.5 6.0 9.0		V_{CC} to GND	V_{IH} or V_{IL}

Note to DC characteristics

1. At supply voltages approaching 2 V, the analog switch ON-resistance becomes extremely non-linear. Therefore it is recommended that these devices be used to transmit digital signals only, when using these supply voltages.

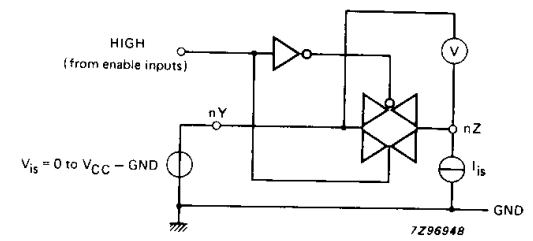


Fig. 6 Test circuit for measuring ON-resistance (R_{ON}).

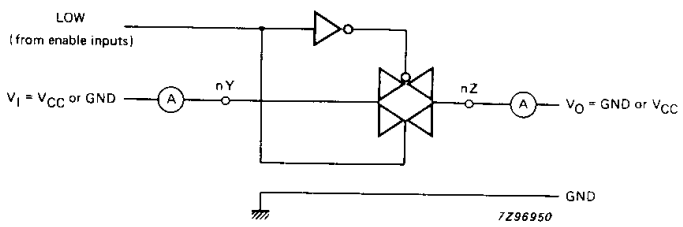


Fig. 7 Test circuit for measuring OFF-state current.

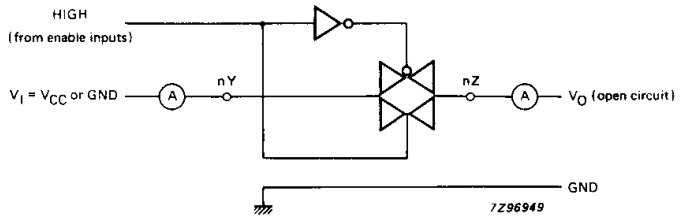


Fig. 8 Test circuit for measuring ON-state current.

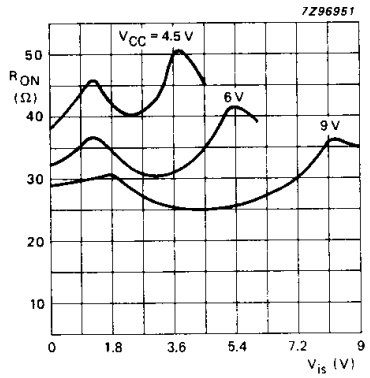


Fig. 9 Typical ON-resistance (R_{ON}) as a function of input voltage (V_{is}) for V_{is} = 0 to V_{CC}.

DC CHARACTERISTICS FOR 74HC

Voltage are referenced to GND (ground = 0 V)

SYMBOL	PARAMETER	T_{amb} (°C)							UNIT	TEST CONDITIONS		
		74HC								V_{CC} 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 4.7		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	0.50 1.35 1.80 2.70		0.50 1.35 1.80 2.70		0.50 1.35 1.80 2.70	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	V_{CC} or GND	
$\pm I_S$	analog switch OFF-state current per channel			0.1		1.0		1.0	μA	10.0	V_{IH} or V_{IL}	$\lvert V_S \rvert = V_{CC} - GND$ (see Fig. 7)
$\pm I_S$	analog switch ON-state current			0.1		1.0		1.0	μA	10.0	V_{IH} or V_{IL}	$\lvert V_S \rvert = V_{CC} - GND$ (see Fig. 8)
I_{CC}	quiescent supply current			2.0 4.0		20.0 40.0		40.0 80.0	μA	6.0 10.0	V_{CC} or GND	V_{is} = GND or V_{CC}; V_{os} = V_{CC} or GND

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								V_{CC} 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}		8 3 2 2	60 12 10 8		75 15 13 10		90 18 15 12	ns	2.0 4.5 6.0 9.0	$R_L = \infty$; C_L = 50 pF (see Fig. 17)
t_{PZH}/ t_{PZL}	turn-on time nE to V_{os}		36 13 10 8	100 20 17 13		125 25 21 16		150 30 26 20	ns	2.0 4.5 6.0 9.0	R_L = 1 kΩ; C_L = 50 pF (see Figs 18 and 19)
t_{PHZ}/ t_{PLZ}	turn-off time nE to V_{os}		44 16 13 16	150 30 26 24		190 38 33 16		225 45 38 20	ns	2.0 4.5 6.0 9.0	R_L = 1 kΩ; C_L = 50 pF (see Figs 18 and 19)

DC CHARACTERISTICS FOR 74HCT

Voltages are referenced to GND (ground = 0 V)

SYMBOL	PARAMETER	T_{amb} (°C)							UNIT	TEST CONDITIONS		
		74HCT								V_{CC} 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	V_{CC} or GND	
$\pm I_S$	analog switch OFF-state current per channel			0.1		1.0		1.0	μA	5.5	V_{IH} or V_{IL}	$\lvert V_S \rvert = V_{CC} - GND$ (see Fig. 7)
$\pm I_S$	analog switch ON-state current			0.1		1.0		1.0	μA	5.5	V_{IH} or V_{IL}	$\lvert V_S \rvert = V_{CC} - GND$ (see Fig. 8)
I_{CC}	quiescent supply current			2.0		20.0		40.0	μA	4.5 to 5.5	V_{CC} or GND	V_{is} = GND or V_{CC}; V_{os} = V_{CC} or GND
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	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
nE	1.00

AC CHARACTERISTICS FOR 74HCT

GND = 0 V; $t_r = t_f$ = 6 ns

SYMBOL	PARAMETER	T_{amb} (°C)							UNIT	TEST CONDITIONS	
		74HCT								V_{CC} 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}		3	12		15		18	ns	4.5	$R_L = \infty$; C_L = 50 pF (see Fig. 17)
t_{PZH}/t_{PZL}	turn-on time nE to V_{os}		12	24		30		36	ns	4.5	R_L = 1 kΩ; C_L = 50 pF (see Figs 18 and 19)
t_{PHZ}/t_{PLZ}	turn-off time nE to V_{os}		20	35		44		53	ns	4.5	R_L = 1 kΩ; C_L = 50 pF (see Figs 18 and 19)

ADDITIONAL AC CHARACTERISTICS FOR 74HC/HCT

Recommended conditions and typical values

GND = 0 V; $t_r = t_f$ = 6 ns

SYMBOL	PARAMETER	TYP.	UNIT	V_{CC} V	$V_{is(p-p)}$ V	CONDITIONS
	sine-wave distortion f = 1 kHz	0.04 0.02	% %	4.5 9.0	4.0 8.0	R_L = 10 kΩ; C_L = 50 pF (see Fig. 15)
	sine-wave distortion f =10 kHz	0.12 0.06	% %	4.5 9.0	4.0 8.0	R_L = 10 kΩ; C_L = 50 pF (see Fig. 15)
	switch "OFF" signal feed-through	−50 −50	dB dB	4.5 9.0	note 1	R_L = 600 Ω; C_L = 50 pF; f = 1 MHz (see Figs 10 and 16)
	crosstalk between any two switches	−60 −60	dB dB	4.5 9.0	note 1	R_L = 600 Ω; C_L = 50 pF; f = 1 MHz (see Fig. 12)
$V_{(p-p)}$	crosstalk voltage between enable or address input to any switch (peak-to-peak value)	110 220	mV mV	4.5 9.0		R_L = 600 Ω; C_L = 50 pF; f =1 MHz (nE, square wave between V_{CC} and GND, $t_r = t_f$ = 6 ns) (see Fig. 13)
f_{max}	minimum frequency response (−3 dB)	180 200	MHz MHz	4.5 9.0	note 2	R_L = 50 Ω; C_L = 10 pF (see Figs 11 and 14)
C_S	maximum switch capacitance	8	pF			

Notes to the AC characteristics

General note

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

Notes

1. Adjust input voltage V_{is} is 0 dBm level (0 dBm = 1 mW into 600 Ω).
2. Adjust input voltage V_{is} is 0 dBm level at V_{os} for 1 MHz (0 dBm = 1 mW into 50 Ω).

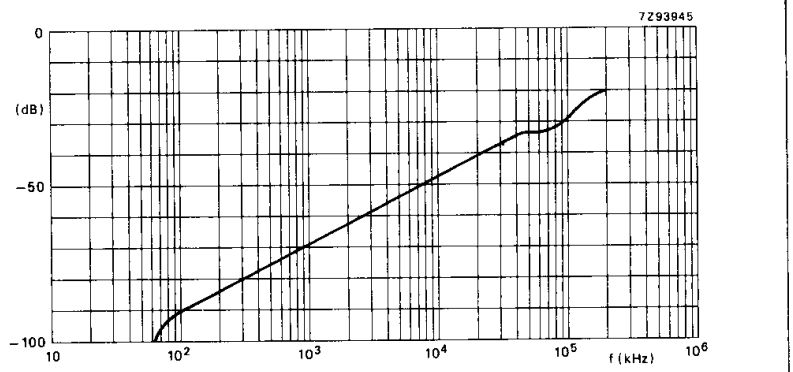


Fig. 10 Typical switch "OFF" signal feed-through as a function of frequency.

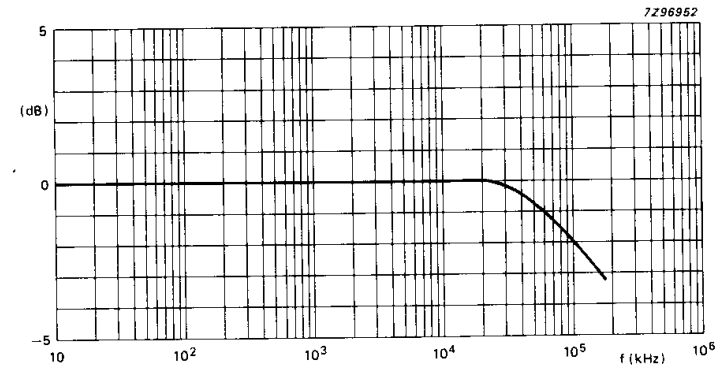


Fig. 11 Typical frequency response.

Note to Figs 10 and 11

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

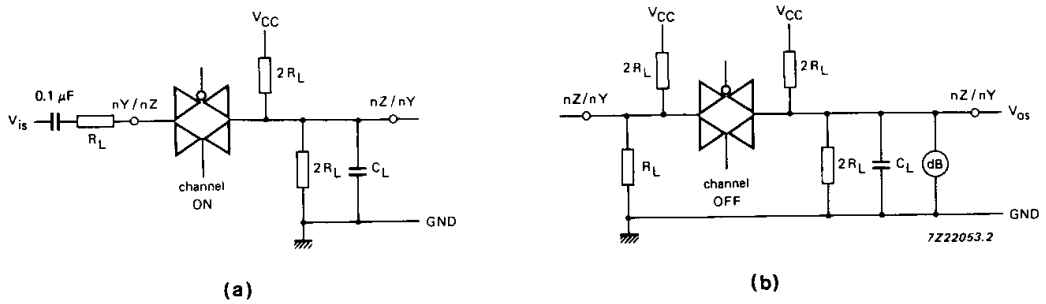


Fig. 12 Test circuit for measuring crosstalk between any two switches.
(a) channel ON condition; (b) channel OFF condition.

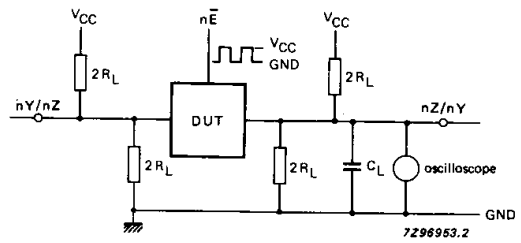
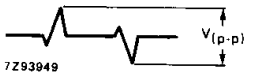


Fig. 13 Test circuit for measuring crosstalk between control and any switch.

Note to Fig. 13

The crosstalk is defined as follows (oscilloscope output):



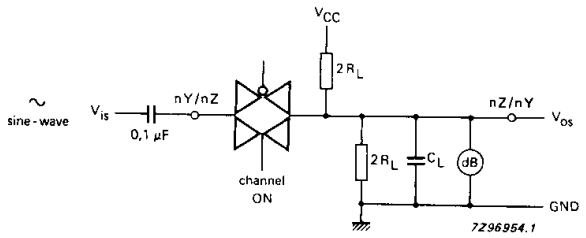


Fig. 14 Test circuit for measuring minimum frequency response.

Note to Fig. 14

Adjust input voltage to obtain 0 dBm at V_{os} when f_{in} = 1 MHz. After set-up frequency of f_{in} is increased to obtain a reading of −3 dB at V_{os}.

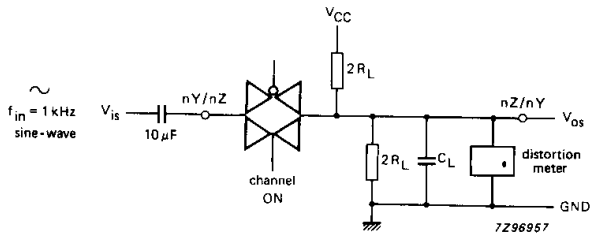


Fig. 15 Test circuit for measuring sine-wave distortion.

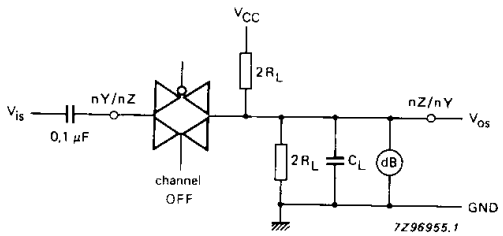


Fig. 16 Test circuit for measuring switch "OFF" signal feed-through.

AC WAVEFORMS

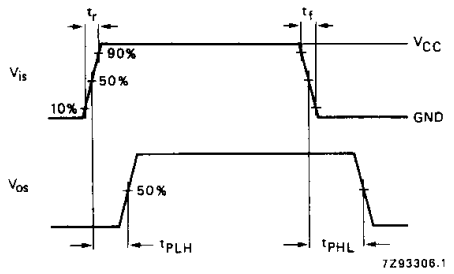


Fig. 17 Waveforms showing the input (V_{is}) to output (V_{os}) propagation delays.

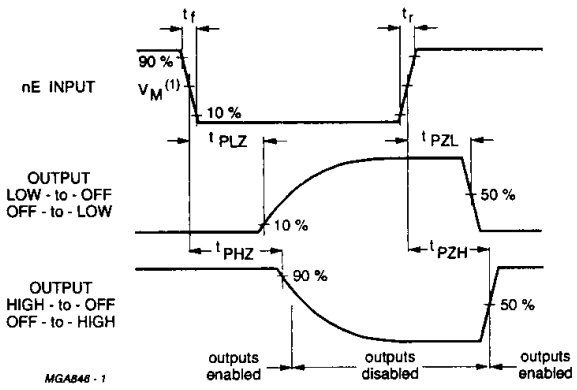
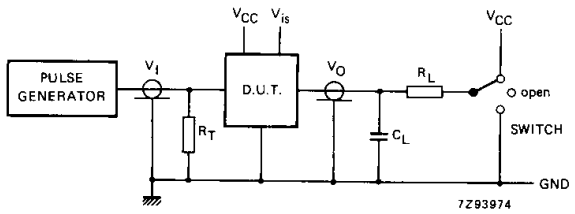


Fig. 18 Waveforms showing the turn-on and turn-off times.

Note to AC waveforms

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

TEST CIRCUIT AND WAVEFORMS



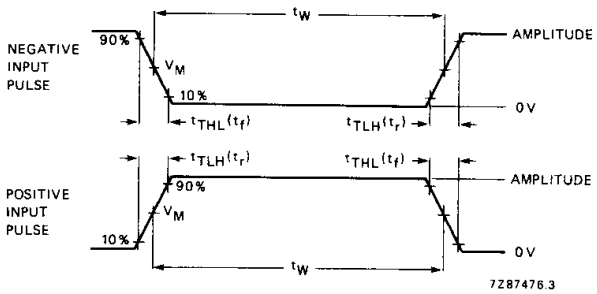


Fig. 20 Input pulse definitions.

Conditions

TEST	SWITCH	V_{is}
t_{PZH}	GND	V_{CC}
t_{PZL}	V_{CC}	GND
t_{PHZ}	GND	V_{CC}
t_{PLZ}	V_{CC}	GND
others	open	pulse

Fig. 19 Test circuit for measuring AC performance.

Definitions for Figs 19 and 20:

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 on t_r, t_f with 50% duty factor.

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