

**QUAD BILATERAL SWITCHES**

**FEATURES**

- Very low "ON" resistance:  
50 Ω (typ.) at VCC = 4.5 V  
45 Ω (typ.) at VCC = 6.0 V  
35 Ω (typ.) at VCC = 9.0 V
- Output capability: non-standard
- ICC 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 <sub>PZH</sub> / t <sub>PZL</sub>	turn-on time nE to V <sub>OS</sub>	C <sub>L</sub> = 15 pF R <sub>L</sub> = 1 kΩ V <sub>CC</sub> = 5 V	11	12	ns
t <sub>PHZ</sub> / t <sub>PLZ</sub>	turn-off time nE to V <sub>OS</sub>		13	16	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	11	12	pF
C <sub>S</sub>	max. switch capacitance		8	8	pF

GND = 0 V; T<sub>amb</sub> = 25 °C; t<sub>r</sub> = t<sub>f</sub> = 6 ns

**Notes**

1. C<sub>PD</sub> is used to determine the dynamic power dissipation (P<sub>D</sub> 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<sub>i</sub> = input frequency in MHz  
 f<sub>o</sub> = output frequency in MHz  
 $\sum \{ (C_L + C_S) \times V_{CC}^2 \times f_o \}$  = sum of outputs  
 C<sub>L</sub> = output load capacitance in pF  
 C<sub>S</sub> = max. switch capacitance in pF  
 V<sub>CC</sub> = supply voltage in V
2. For HC the condition is V<sub>I</sub> = GND to V<sub>CC</sub>  
 For HCT the condition is V<sub>I</sub> = GND to V<sub>CC</sub> - 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 <sub>CC</sub>	positive supply voltage

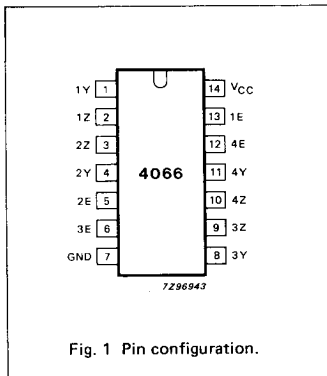


Fig. 1 Pin configuration.

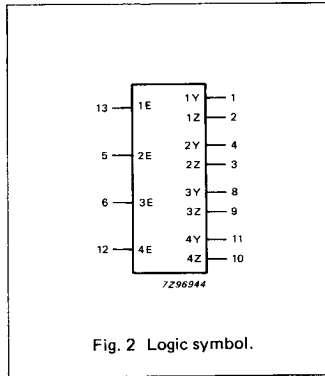


Fig. 2 Logic symbol.

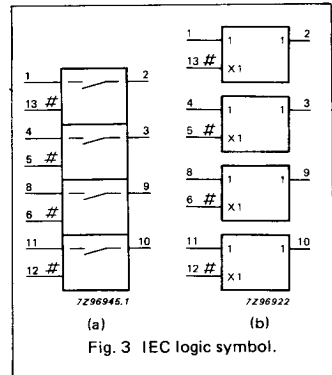


Fig. 3 IEC logic symbol.

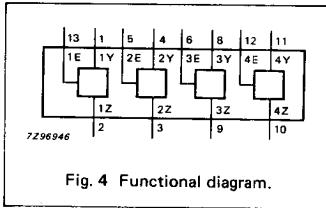


Fig. 4 Functional diagram.

FUNCTION TABLE

INPUT nE	SWITCH
L	off
H	on

H = HIGH voltage level  
L = LOW voltage level

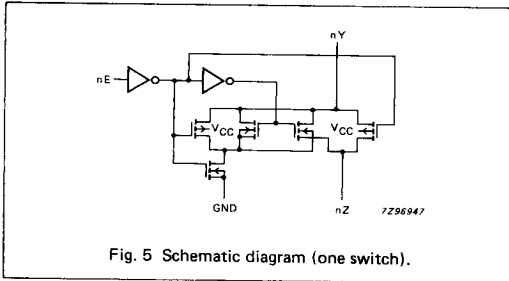


Fig. 5 Schematic diagram (one switch).

## 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

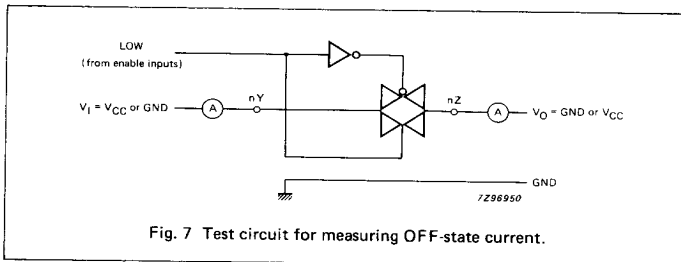
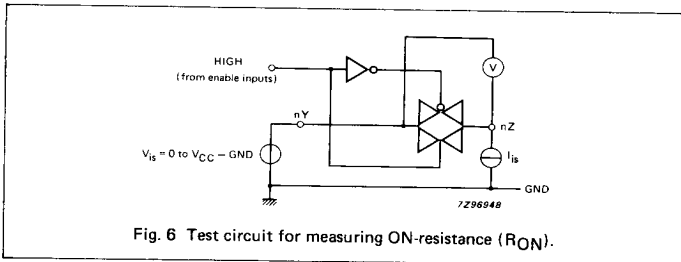
**DC CHARACTERISTICS FOR 74HC/HCT**

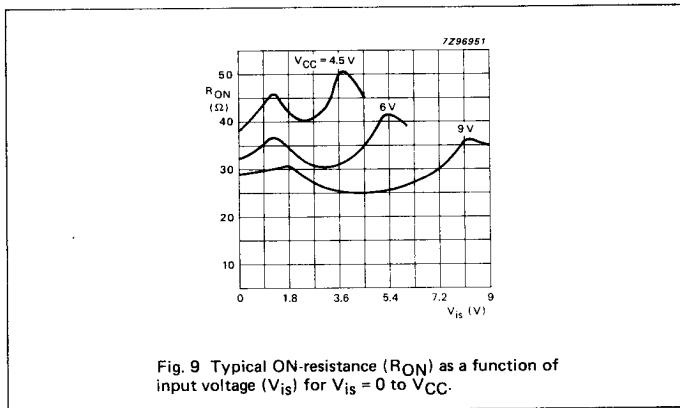
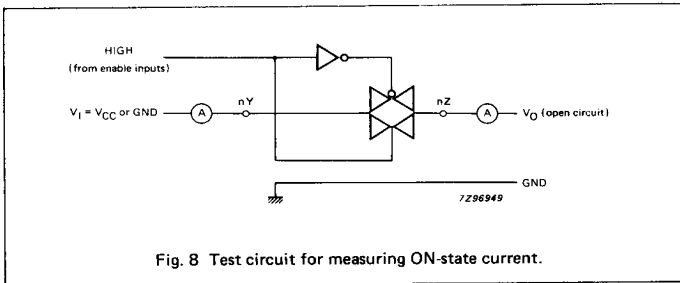
For 74HC:  $V_{CC} = 2.0, 4.5, 6.0$  and  $9.0$  V  
For 74HCT:  $V_{CC} = 4.5$  V

SYMBOL	PARAMETER	$T_{amb}$ (°C)						UNIT	TEST CONDITIONS				
		74HC/HCT							$V_{CC}$ V	$I_S$ $\mu A$	$V_{IS}$	$V_I$	
		+25			-40 to +85		-40 to +125						
		min.	typ.	max.	min.	max.	min.						max.
$R_{ON}$	ON-resistance (peak)		— 54 42 32	— 95 84 70		— 118 105 88		— 142 126 105	$\Omega$ $\Omega$ $\Omega$ $\Omega$	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	$\Omega$ $\Omega$ $\Omega$ $\Omega$	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	$\Omega$ $\Omega$ $\Omega$ $\Omega$	2.0 4.5 6.0 9.0	100 1000 1000 1000	$V_{CC}$	$V_{IH}$ or $V_{IL}$
$\Delta R_{ON}$	maximum variation of ON-resistance between any two channels		— 5 4 3						$\Omega$ $\Omega$ $\Omega$ $\Omega$	2.0 4.5 6.0 9.0		$V_{CC}$ to GND	$V_{IH}$ or $V_{IL}$

**Note to DC characteristics**

- 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.





## DC CHARACTERISTICS FOR 74HC

Voltage 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>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 4.7		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 <sub>IL</sub>	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			
±I <sub>I</sub>	input leakage current			0.1 0.2		1.0 2.0		1.0 2.0	μA	6.0 10.0	V <sub>CC</sub> or GND		
±I <sub>S</sub>	analog switch OFF-state current per channel			0.1		1.0		1.0	μA	10.0	V <sub>IH</sub> or V <sub>IL</sub>	V <sub>S</sub>   = V <sub>CC</sub> - GND (see Fig. 7)	
±I <sub>S</sub>	analog switch ON-state current			0.1		1.0		1.0	μA	10.0	V <sub>IH</sub> or V <sub>IL</sub>	V <sub>S</sub>   = V <sub>CC</sub> - GND (see Fig. 8)	
I <sub>CC</sub>	quiescent supply current			2.0 4.0		20.0 40.0		40.0 80.0	μA	6.0 10.0	V <sub>CC</sub> or GND	V <sub>is</sub> = GND or V <sub>CC</sub> ; V <sub>os</sub> = V <sub>CC</sub> or GND	

## AC CHARACTERISTICS FOR 74HC

GND = 0 V; t<sub>r</sub> = t<sub>f</sub> = 6 ns; C<sub>L</sub> = 50 pF

SYMBOL	PARAMETER	T <sub>amb</sub> (°C)						UNIT	TEST CONDITIONS			
		74HC							V <sub>CC</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>		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 <sub>L</sub> = ∞; C <sub>L</sub> = 50 pF (see Fig. 17)	
t <sub>PZH</sub> / t <sub>PZL</sub>	turn-on time nE to V <sub>os</sub>		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 <sub>L</sub> = 1 kΩ; C <sub>L</sub> = 50 pF (see Figs 18 and 19)	
t <sub>pHZ</sub> / t <sub>pLZ</sub>	turn-off time nE to V <sub>os</sub>		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 <sub>L</sub> = 1 kΩ; C <sub>L</sub> = 50 pF (see Figs 18 and 19)	

## DC CHARACTERISTICS FOR 74HCT

Voltages are referenced to GND (ground = 0 V)

SYMBOL	PARAMETER	T <sub>amb</sub> (°C)						UNIT	TEST CONDITIONS			
		74HCT							V <sub>CC</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	V <sub>CC</sub> or GND	
±I <sub>S</sub>	analog switch OFF-state current per channel			0.1		1.0		1.0	μA	5.5	V <sub>IH</sub> or V <sub>IL</sub>	V <sub>S</sub>   = V <sub>CC</sub> - GND (see Fig. 7)
±I <sub>S</sub>	analog switch ON-state current			0.1		1.0		1.0	μA	5.5	V <sub>IH</sub> or V <sub>IL</sub>	V <sub>S</sub>   = V <sub>CC</sub> - GND (see Fig. 8)
I <sub>CC</sub>	quiescent supply current			2.0		20.0		40.0	μA	4.5 to 5.5	V <sub>CC</sub> or GND	V <sub>IS</sub> = GND or V <sub>CC</sub> ; V <sub>OS</sub> = V <sub>CC</sub> or GND
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	V <sub>CC</sub> -2.1V	other inputs at V <sub>CC</sub> or GND

## Note

1. The value of additional quiescent supply current (ΔI<sub>CC</sub>) for a unit load of 1 is given here.To determine ΔI<sub>CC</sub> 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	Tamb (°C)						UNIT	TEST CONDITIONS		
		74HCT							V <sub>CC</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>		3	12		15		18	ns	4.5	R <sub>L</sub> = ∞; C <sub>L</sub> = 50 pF (see Fig. 17)
t <sub>PZH</sub> / t <sub>PZL</sub>	turn-on time nE to V <sub>OS</sub>		12	24		30		36	ns	4.5	R <sub>L</sub> = 1 kΩ; C <sub>L</sub> = 50 pF (see Figs 18 and 19)
t <sub>PHZ</sub> / t <sub>PLZ</sub>	turn-off time nE to V <sub>OS</sub>		20	35		44		53	ns	4.5	R <sub>L</sub> = 1 kΩ; C <sub>L</sub> = 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 <sub>CC</sub> V	V <sub>is(p-p)</sub> V	CONDITIONS
	sine-wave distortion f = 1 kHz	0.04 0.02	% %	4.5 9.0	4.0 8.0	R <sub>L</sub> = 10 kΩ; C <sub>L</sub> = 50 pF (see Fig. 15)
	sine-wave distortion f = 10 kHz	0.12 0.06	% %	4.5 9.0	4.0 8.0	R <sub>L</sub> = 10 kΩ; C <sub>L</sub> = 50 pF (see Fig. 15)
	switch "OFF" signal feed-through	-50 -50	dB dB	4.5 9.0	note 1	R <sub>L</sub> = 600 Ω; C <sub>L</sub> = 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 <sub>L</sub> = 600 Ω; C <sub>L</sub> = 50 pF; f = 1 MHz (see Fig. 12)
V <sub>(p-p)</sub>	crosstalk voltage between enable or address input to any switch (peak-to-peak value)	110 220	mV mV	4.5 9.0		R <sub>L</sub> = 600 Ω; C <sub>L</sub> = 50 pF; f = 1 MHz (nE, square wave between V <sub>CC</sub> and GND, t <sub>r</sub> = t <sub>f</sub> = 6 ns) (see Fig. 13)
f <sub>max</sub>	minimum frequency response (-3 dB)	180 200	MHz MHz	4.5 9.0	note 2	R <sub>L</sub> = 50 Ω; C <sub>L</sub> = 10 pF (see Figs 11 and 14)
C <sub>S</sub>	maximum switch capacitance	8	pF			

## Notes to the AC characteristics

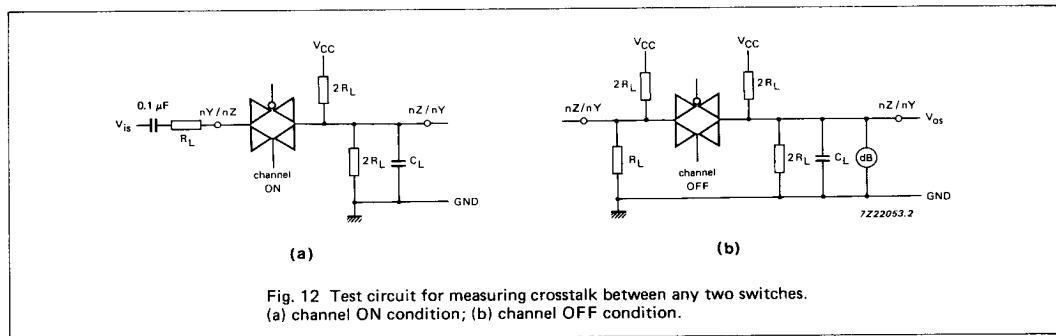
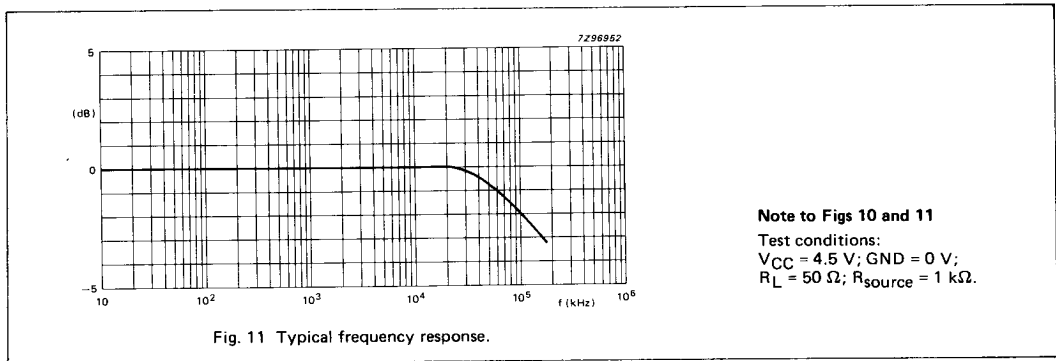
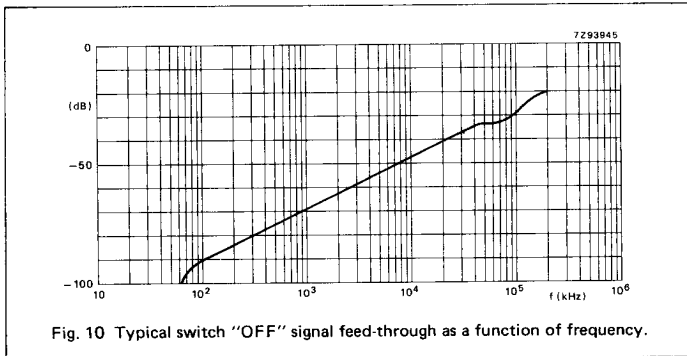
## General note

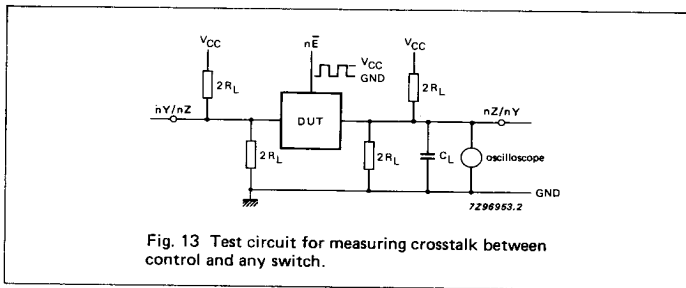
V<sub>IS</sub> is the input voltage at nY or nZ terminal, whichever is assigned as an input.V<sub>OS</sub> is the output voltage at nY or nZ terminal, whichever is assigned as an output.

## Notes

- Adjust input voltage V<sub>IS</sub> is 0 dBm level (0 dBm = 1 mW into 600 Ω).
- Adjust input voltage V<sub>IS</sub> is 0 dBm level at V<sub>OS</sub> for 1 MHz (0 dBm = 1 mW into 50 Ω).

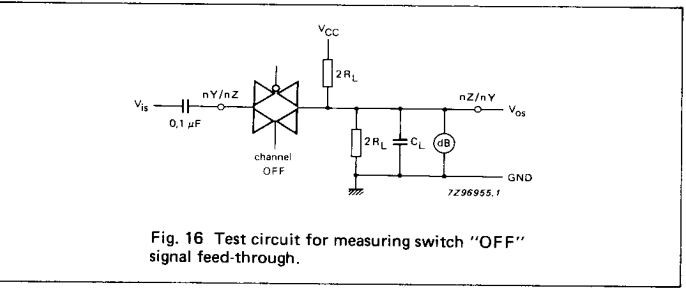
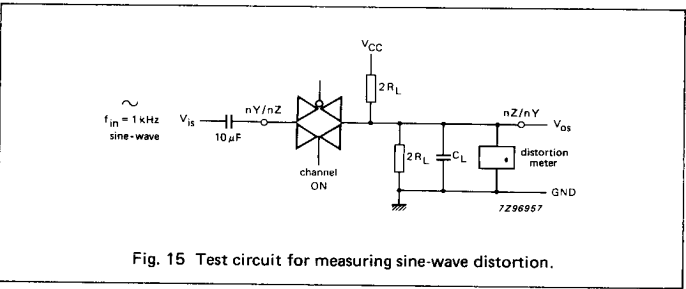
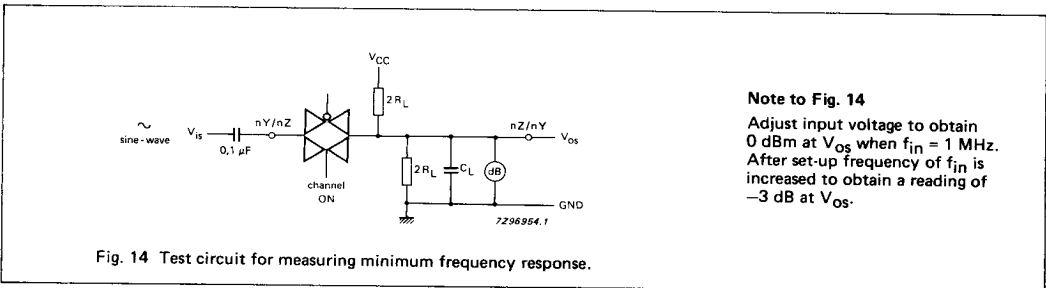




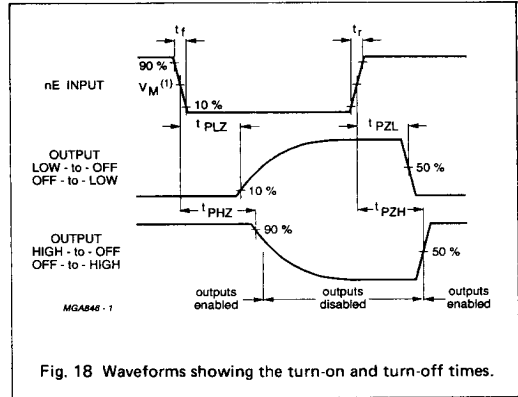
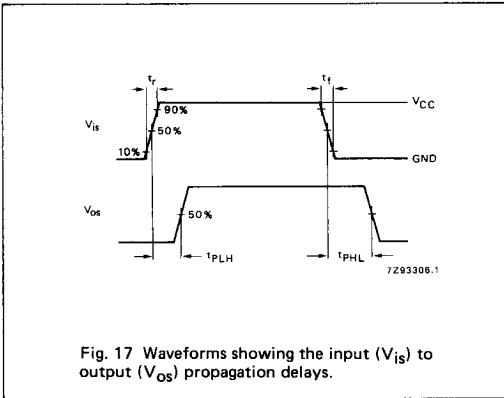


**Note to Fig. 13**  
The crosstalk is defined as follows (oscilloscope output):

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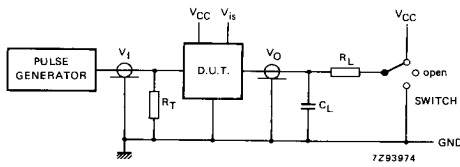
AC WAVEFORMS



Note to AC waveforms

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

TEST CIRCUIT AND WAVEFORMS



Conditions

TEST	SWITCH	V <sub>is</sub>
tpZH	GND	V <sub>CC</sub>
tpZL	V <sub>CC</sub>	GND
tpHZ	GND	V <sub>CC</sub>
tpLZ	V <sub>CC</sub>	GND
others	open	pulse

Fig. 19 Test circuit for measuring AC performance.

Definitions for Figs 19 and 20:

C<sub>L</sub> = load capacitance including jig and probe capacitance (see AC CHARACTERISTICS for values).

R<sub>T</sub> = termination resistance should be equal to the output impedance Z<sub>O</sub> of the pulse generator.

t<sub>r</sub> = t<sub>f</sub> = 6 ns, when measuring f<sub>max</sub>, there is no constraint on t<sub>r</sub>, t<sub>f</sub> with 50% duty factor.

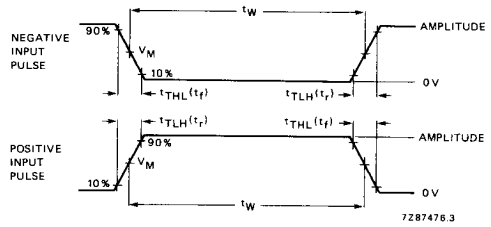


Fig. 20 Input pulse definitions.

FAMILY	AMPLITUDE	V <sub>M</sub>	t <sub>r</sub> , t <sub>f</sub>	
			f <sub>max</sub> , PULSE WIDTH	OTHER
74HC	V <sub>CC</sub>	50%	< 2 ns	6 ns
74HCT	3.0 V	1.3 V	< 2 ns	6 ns