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/HCT4067

16-channel analog multiplexer/demultiplexer

Product specification

File under Integrated Circuits, IC06

September 1993

Philips
Semiconductors

PHILIPS

16-channel analog multiplexer/demultiplexer

74HC/HCT4067

FEATURES

- Low "ON" resistance:
  80 Ω (typ.) at V_{CC} = 4.5 V
  70 Ω (typ.) at V_{CC} = 6.0 V
  60 Ω (typ.) at V_{CC} = 9.0 V
  typical "break before make" built-in

- Output capability: non-standard

- I_{CC} category: MSI

GENERAL DESCRIPTION

The 74HC/HCT4067 are high-speed Si-gate CMOS devices and are pin compatible with the "4067" of the "4000B" series. They are specified in compliance with JEDEC standard no. 7A.

The 74HC/HCT4067 are 16-channel analog multiplexers/demultiplexers with four address inputs (S_0 to S_3) , an active LOW enable input ($\overline{E}$), sixteen independent inputs/outputs (Y_0 to Y_{15}) and a common input/output (Z). The "4067" contains sixteen bidirectional analog switches, each with one side connected to an independent input/output (Y_0 to Y_{15}) and the other side connected to a common input/output (Z).

With $\overline{E}$ LOW, one of the sixteen switches is selected (low impedance ON-state) by S_0 to S_3. All unselected switches are in the high impedance OFF-state. With $\overline{E}$ HIGH, all switches are in the high impedance OFF-state, independent of S_0 to S_3.

The analog inputs/outputs (Y_0 to Y_{15}, and Z) can swing between V_{CC} as a positive limit and GND as a negative limit. V_{CC} to GND may not exceed 10 V.

QUICK REFERENCE DATA

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

SYMBOL	PARAMETER	CONDITIONS	TYPICAL		UNIT
			HC	HCT	
t_{PZL}/ t_{PZH}	turn-on time	C_L = 15 pF; R_L = 1 kΩ; V_{CC} = 5 V			
	$\overline{E}$ to V_{os}		26	32	ns
	S_n to V_{os}		29	33	ns
t_{PLZ}/ t_{PHZ}	turn-off time				
	$\overline{E}$ to V_{os}		27	26	ns
	S_n to V_{os}		29	30	ns
C_I	input capacitance		3.5	3.5	pF
C_{PD}	power dissipation capacitance per switch	notes 1 and 2	29	29	pF
C_S	max. switch capacitance				
	independent (Y)		5	5	pF
	common (Z)		45	45	pF

Notes

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

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

16-channel analog
multiplexer/demultiplexer

74HC/HCT4067

ORDERING INFORMATION

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

PIN DESCRIPTION

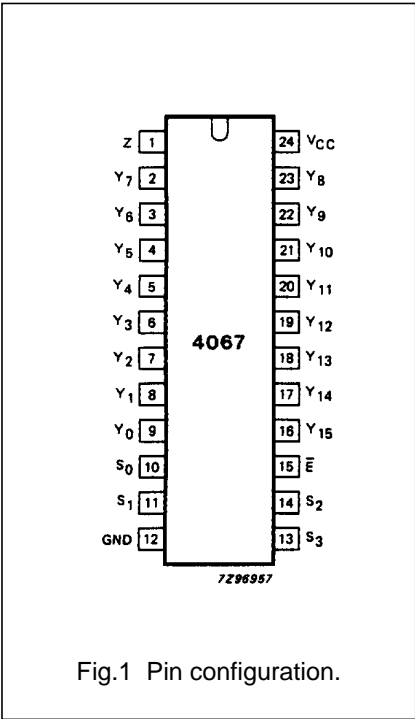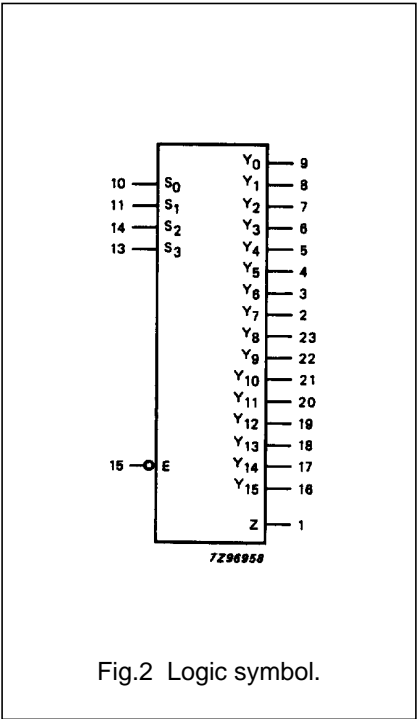| PIN NO.	SYMBOL	NAME AND FUNCTION
1	Z	common input/output
9, 8, 7, 6, 5, 4, 3, 2, 23, 22, 21, 20, 19, 18, 17, 16	Y_0 to Y_{15}	independent inputs/outputs
10, 11, 14, 13	S_0 to S_3	address inputs
12	GND	ground (0 V)
15	$\overline{E}$	enable input (active LOW)
24	V_{CC}	positive supply voltage

Fig.1 Pin configuration.

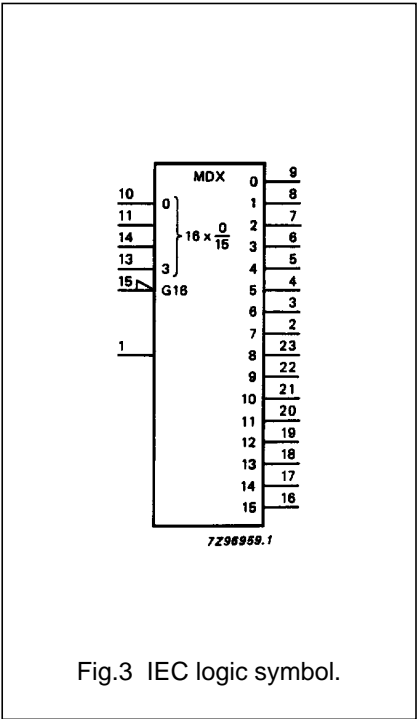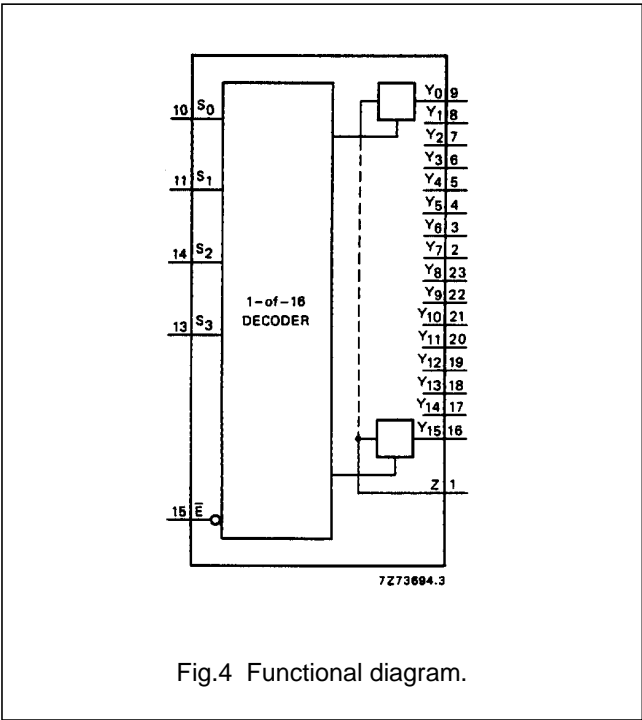

Fig.2 Logic symbol.

Fig.3 IEC logic symbol.

16-channel analog multiplexer/demultiplexer

74HC/HCT4067

APPLICATIONS

- Analog multiplexing and demultiplexing
- Digital multiplexing and demultiplexing
- Signal gating

Fig.4 Functional diagram.

FUNCTION TABLE

INPUTS					CHANNEL ON
$\overline{E}$	S_3	S_2	S_1	S_0	
L	L	L	L	L	$Y_0 - Z$
L	L	L	L	H	$Y_1 - Z$
L	L	L	H	L	$Y_2 - Z$
L	L	L	H	H	$Y_3 - Z$
L	L	H	L	L	$Y_4 - Z$
L	L	H	L	H	$Y_5 - Z$
L	L	H	H	L	$Y_6 - Z$
L	L	H	H	H	$Y_7 - Z$
L	H	L	L	L	$Y_8 - Z$
L	H	L	L	H	$Y_9 - Z$
L	H	L	H	L	$Y_{10} - Z$
L	H	L	H	H	$Y_{11} - Z$
L	H	H	L	L	$Y_{12} - Z$
L	H	H	L	H	$Y_{13} - Z$
L	H	H	H	L	$Y_{14} - Z$
L	H	H	H	H	$Y_{15} - Z$
H	X	X	X	X	none

Notes

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

Fig.5 Schematic diagram (one switch).
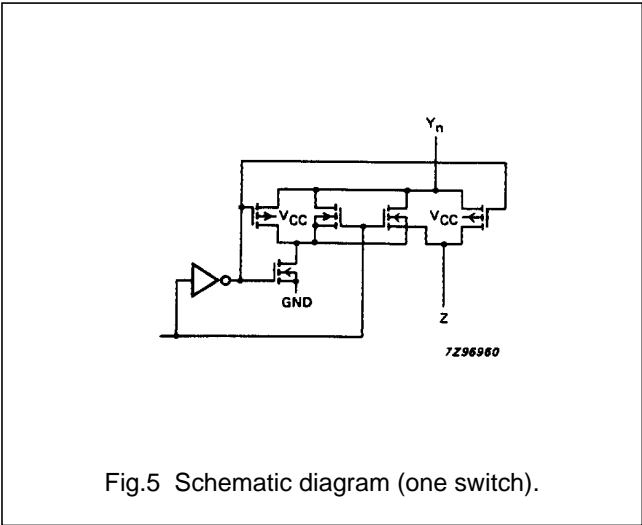
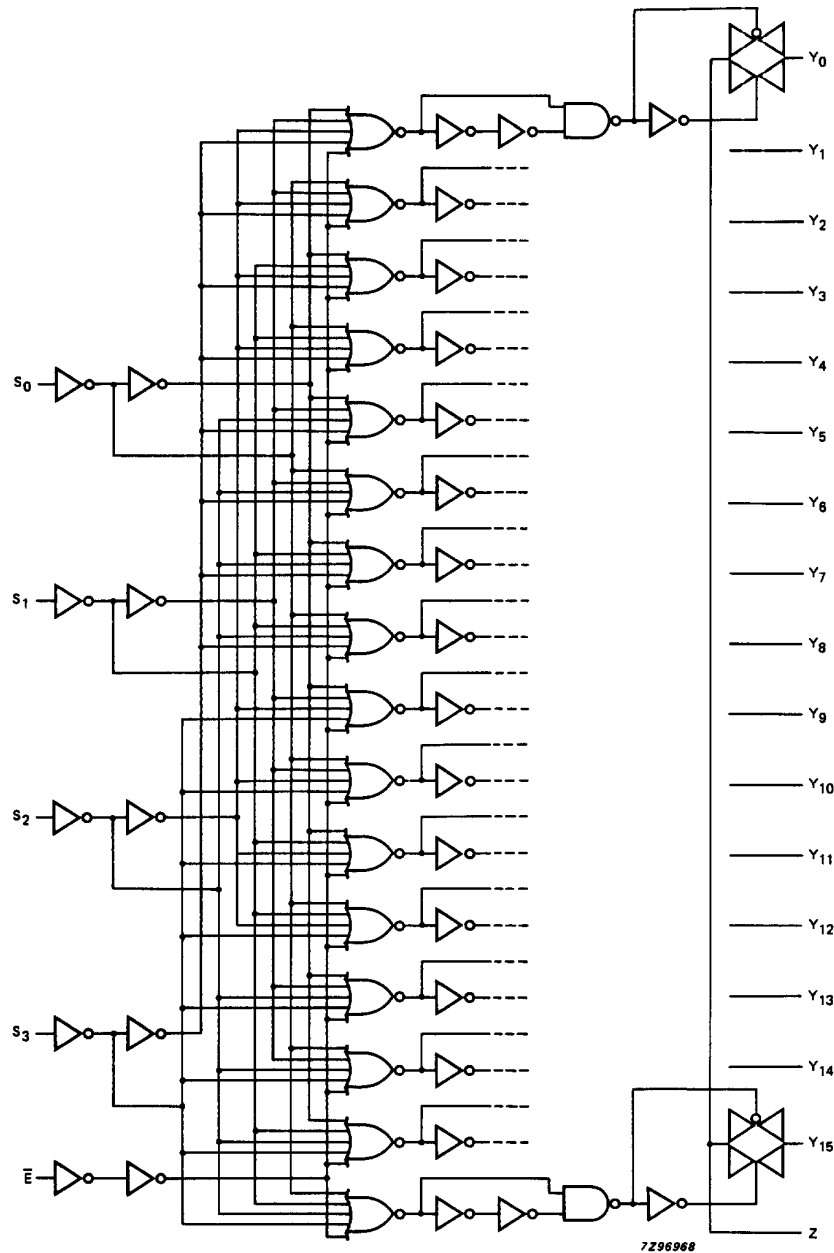16-channel analog
multiplexer/demultiplexer

74HC/HCT4067

Fig.6 Logic diagram.

16-channel analog
multiplexer/demultiplexer

74HC/HCT4067

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 $V_I < −0.5$ or $V_I > V_{CC} + 0.5$ V
$\pm I_{SK}$	DC switch diode current		20	mA	for $V_S < −0.5$ 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

1. 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 terminal Z, no V_{CC} current will flow out of terminals 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 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 CHARACTER-ISTICS
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

16-channel analog
multiplexer/demultiplexer

74HC/HCT4067

DC CHARACTERISTICS FOR 74HC/HCT

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

For 74HCT: V_{CC} − GND = 4.5 V

SYMBOL	PARAMETER	T_{amb} (°C) 74HC/HCT						UNIT	V_{CC} (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)		− 110 95 75	− 180 160 130		− 225 200 165		− 270 240 195	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)	150 90 80 70		− 160 140 120		− 200 175 150		− 240 210 180	Ω Ω Ω Ω	2.0 4.5 6.0 9.0	100 1000 1000 1000	GND or V_{CC}	V_{IH} or V_{IL}
ΔR_{ON}	maximum variation of ON-resistance between any two channels		− 9 8 6						Ω Ω Ω Ω	2.0 4.5 6.0 9.0		V_{CC} to GND	V_{IH} or V_{IL}

Notes

1. At supply voltages (V_{CC} − GND) 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.

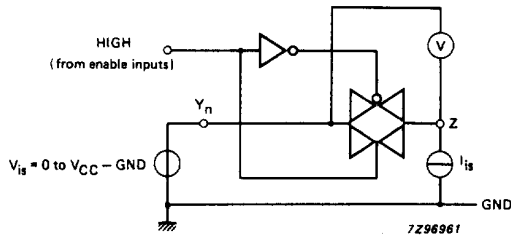2. For test circuit measuring R_{ON} see Fig.7.

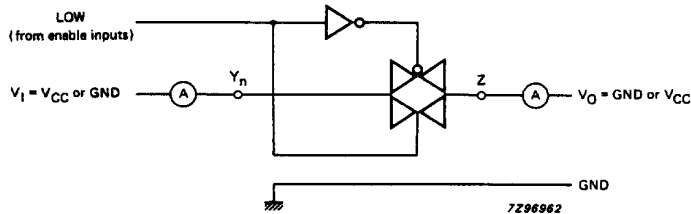Fig.7 Test circuit for measuring ON-resistance (R_{ON}).

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

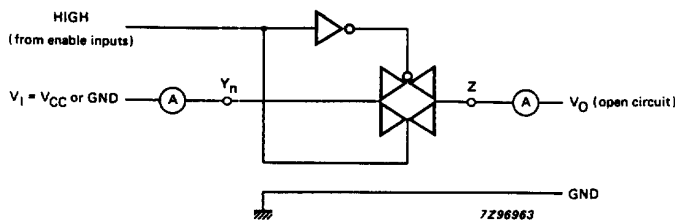## 16-channel analog multiplexer/demultiplexer

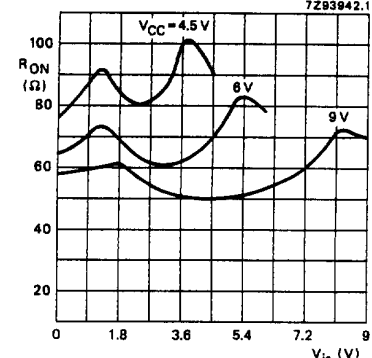## 74HC/HCT4067

Fig.9 Test circuit for measuring ON-state current.

Fig.10 Typical ON-resistance (R_{ON}) as a function of input voltage (V_{is}) for V_{is} = 0 to V_{CC} − GND.

DC CHARACTERISTICS FOR 74HC

Voltages are referenced to GND (ground = 0 V)

SYMBOL	PARAMETER	T_{amb} (°C)							UNIT	V_{CC} (V)	V_I	OTHER
		74HC										
		+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}	$|V_S|$ = V_{CC} − GND (see Fig.8)
$\pm I_S$	analog switch OFF-state current all channels			0.8		8.0		8.0	µA	10.0	V_{IH} or V_{IL}	$|V_S|$ = V_{CC} − GND (see Fig.9)
$\pm I_S$	analog switch ON-state current			0.8		8.0		8.0	µA	10.0	V_{IH} or V_{IL}	$|V_S|$ = V_{CC} − GND (see Fig.9)
I_{CC}	quiescent supply current			8.0 16.0		80.0 160		160 320	µA	6.0 10.0	V_{CC} or GND	V_{is} = GND or V_{CC}; V_{os} = V_{CC} or GND

16-channel analog multiplexer/demultiplexer

74HC/HCT4067

AC CHARACTERISTICS FOR 74HC

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

SYMBOL	PARAMETER	+25 min.	+25 typ.	+25 max.	−40 to +85 min.	−40 to +85 max.	−40 to +125 min.	−40 to +125 max.	UNIT	V_{CC} (V)	OTHER
t_{PHL}/t_{PLH}	propagation delay V_{is} to V_{os}; Y_n to Z		25 9 7 5	75 15 13 9		95 19 16 11		110 22 19 14	ns	2.0 4.5 6.0 9.0	R_L = ∞; C_L = 50 pF (see Fig.16)
t_{PHL}/t_{PLH}	propagation delay V_{is} to V_{os}; Z to Y_n		18 6 5 4	60 12 10 8		75 15 13 10		90 18 15 12	ns	2.0 4.5 6.0 9.0	
t_{PHZ}/t_{PLZ}	turn-off time $\overline{E}$ to Y_n		74 27 22 20	250 50 43 38		315 63 54 48		375 75 64 57	ns	2.0 4.5 6.0 9.0	
t_{PHZ}/t_{PLZ}	turn-off time S_n to Y_n		83 30 24 21	250 50 43 38		315 63 54 48		375 75 64 57	ns	2.0 4.5 6.0 9.0	
t_{PHZ}/t_{PLZ}	turn-off time $\overline{E}$ to Z		85 31 25 24	275 55 47 42		345 69 59 53		415 83 71 63	ns	2.0 4.5 6.0 9.0	
t_{PHZ}/t_{PLZ}	turn-off time S_n to Z		94 34 27 25	290 58 47 45		365 73 62 56		435 87 74 68	ns	2.0 4.5 6.0 9.0	R_L = 1 kΩ; C_L = 50 pF (see Fig.17)
t_{PZH}/t_{PZL}	turn-on time $\overline{E}$ to Y_n		80 29 23 17	275 55 47 42		345 69 59 53		415 83 71 63	ns	2.0 4.5 6.0 9.0	
t_{PZH}/t_{PZL}	turn-on time S_n to Y_n		88 32 26 18	300 60 51 45		375 75 64 56		450 90 77 68	ns	2.0 4.5 6.0 9.0	
t_{PZH}/t_{PZL}	turn-on time $\overline{E}$ to Z		85 31 25 18	275 55 47 42		345 69 59 53		415 83 71 63	ns	2.0 4.5 6.0 9.0	
t_{PZH}/t_{PZL}	turn-on time S_n to Z		94 34 27 19	300 60 51 45		375 75 64 56		450 90 77 68	ns	2.0 4.5 6.0 9.0	

Note to AC CHARACTERISTICS FOR 74HC

1. Due to higher Z terminal capacitance (16 switches versus 1) the delay figures to the Z terminal are higher than those to the Y terminal.

DC CHARACTERISTICS FOR 74HCT

Voltages are referenced to GND (ground = 0 V)

| SYMBOL | PARAMETER | T_{amb} (°C) 74HCY | | | | | | UNIT | TEST CONDITIONS | | |
| | | +25 | | | −40 to +85 | | −40 to +125 | | | V_{CC} (V) | V_I | OTHER |
		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}	$\|V_S\|$ = V_{CC} − GND (see Fig.8)
$\pm I_S$	analog switch OFF-state current all channels			0.8		8.0		8.0	µA	5.5	V_{IH} or V_{IL}	$\|V_S\|$ = V_{CC} − GND (see Fig.9)
$\pm I_S$	analog switch ON-state current			0.8		8.0		8.0	µA	5.5	V_{IH} or V_{IL}	$\|V_S\|$ = V_{CC} − GND (see Fig.9)
I_{CC}	quiescent supply current			8.0		80.0		160	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
$\overline{E}$	0.6
S_n	0.5

16-channel analog multiplexer/demultiplexer

74HC/HCT4067

AC CHARACTERISTICS FOR 74HCT

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

SYMBOL	PARAMETER	T_{amb} (°C) 74HCT +25			−40 to +85		−40 to +125		UNIT	V_{CC} (V)	TEST CONDITIONS OTHER
		min.	typ.	max.	min.	max.	min.	max.			
t_{PHL}/ t_{PLH}	propagation delay V_{is} to V_{os}; Y_n to Z		9	15		19		22	ns	4.5	$R_L = \infty$; $C_L = 50$ pF (see Fig.16)
t_{PHL}/ t_{PLH}	propagation delay V_{is} to V_{os}; Z to Y_n		6	12		15		18	ns	4.5	
t_{PHZ}/ t_{PLZ}	turn-off time $\overline{E}$ to Y_n		26	55		69		83	ns	4.5	$R_L = 1$ kΩ; $C_L = 50$ pF (see Fig.17)
t_{PHZ}/ t_{PLZ}	turn-off time S_n to Y_n		31	55		69		83	ns	4.5	
t_{PHZ}/ t_{PLZ}	turn-off time $\overline{E}$ to Z		30	60		75		90	ns	4.5	
t_{PHZ}/ t_{PLZ}	turn-off time S_n to Z		35	60		75		90	ns	4.5	
t_{PZH}/ t_{PZL}	turn-on time $\overline{E}$ to Y_n		32	60		75		90	ns	4.5	
t_{PZH}/ t_{PZL}	turn-on time S_n to Y_n		35	60		75		90	ns	4.5	
t_{PZH}/ t_{PZL}	turn-on time $\overline{E}$ to Z		38	65		81		98	ns	4.5	
t_{PZH}/ t_{PZL}	turn-on time S_n to Z		38	65		81		98	ns	4.5	

Note

1. Due to higher Z terminal capacitance (16 switches versus 1) the delay figures to the Z terminal are higher than those to the Y terminal.

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.14)
	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.14)
	switch "OFF" signal feed-through	−50 −50	dB dB	4.5 9.0	note 3	R_L = 600 Ω; C_L = 50 pF f = 1 MHz (see Figs 11 and 15)
f_{max}	minimum frequency response (−3 dB)	90 100	MHz MHz	4.5 9.0	note 4	R_L = 50 Ω; C_L = 10 pF (see Figs 12 and 13)
C_S	maximum switch capacitance independent (Y) common (Z)	5 45	pF pF			

Notes

1. V_{is} is the input voltage at Y_n or Z terminal, whichever is assigned as an input.

2. V_{os} is the output voltage at Y_n or Z terminal, whichever is assigned as an output.

3. Adjust input voltage V_{is} is 0 dBm level (0 dBm = 1 mW into 600 Ω).

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

Test conditions:
$V_{CC} = 4.5$ V; GND = 0 V;
$R_L = 50$ Ω; $R_{source} = 1$ kΩ.
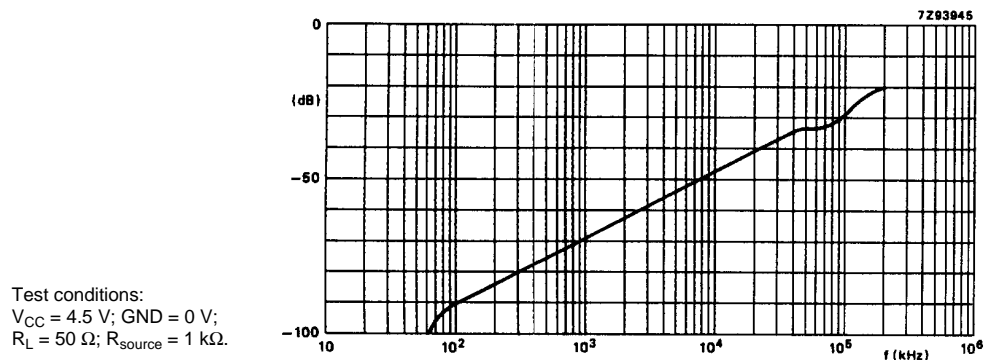
Fig.11 Typical switch "OFF" signal feed-through as a function of frequency.

Test conditions:
$V_{CC} = 4.5$ V; GND = 0 V;
$R_L = 50$ Ω; $R_{source} = 1$ kΩ.
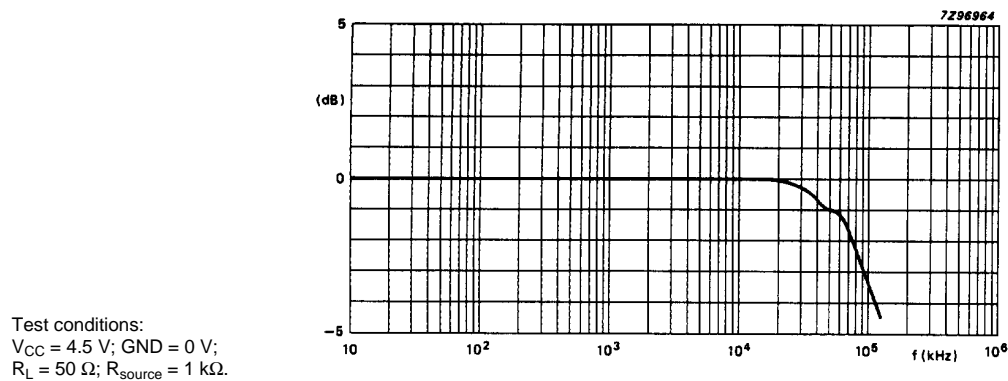
Fig.12 Typical frequency response.

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}.
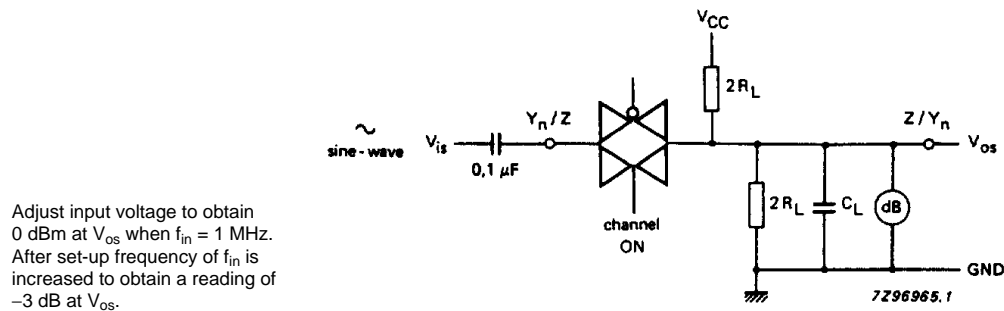
Fig.13 Test circuit for measuring minimum frequency response.
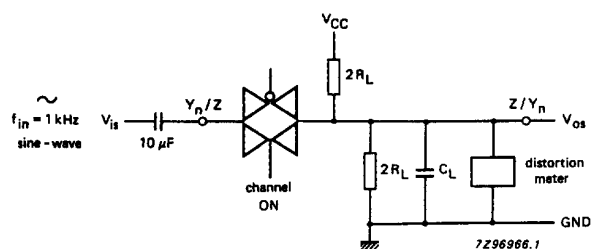
Fig.14 Test circuit for measuring sine-wave
distortion.
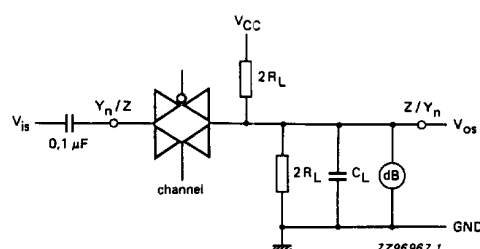
Fig.15 Test circuit for measuring switch "OFF"
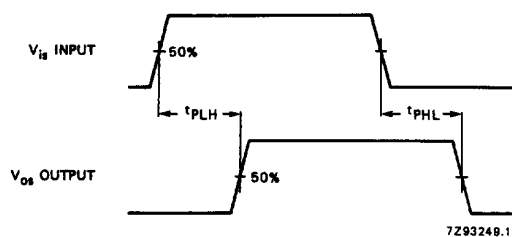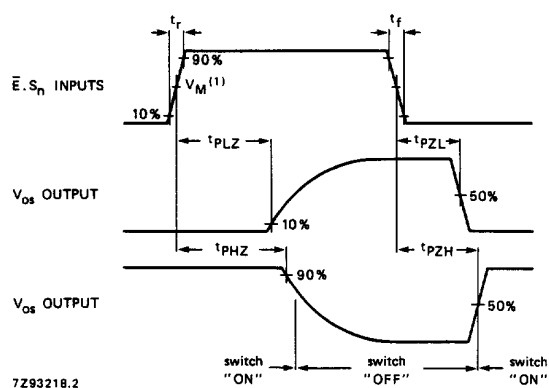signal feed-through.

AC WAVEFORMS

Fig.16 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.17 Waveforms showing the turn-on and
turn-off times.

16-channel analog
multiplexer/demultiplexer   74HC/HCT4067

TEST CIRCUIT AND WAVEFORMS

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
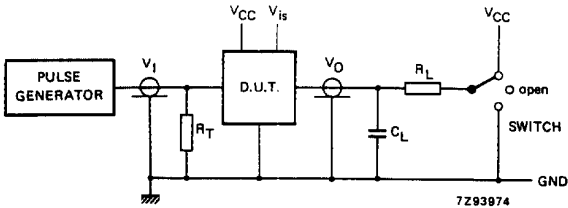
C_L = load capacitance including jig and probe capacitance (see AC CHARACTERISTICS for values).
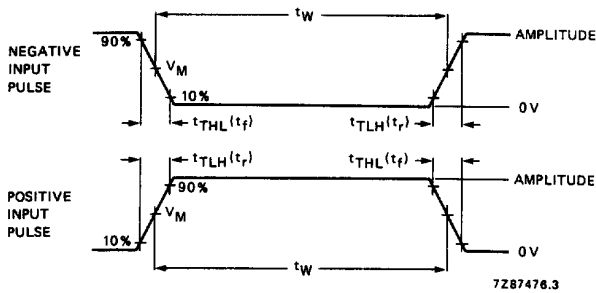
R_T = termination resistance should be equal to the output impedance Z_O of the pulse generator.

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

Fig.18 Test circuit for measuring AC performance.

Fig.19 Input pulse definitions.

FAMILY	AMPLI-TUDE	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

PACKAGE OUTLINES

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