

# 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

# 16-channel analog multiplexer/demultiplexer

## 74HC/HCT4067

### FEATURES

- Low "ON" resistance:  
80  $\Omega$  (typ.) at  $V_{CC} = 4.5$  V  
70  $\Omega$  (typ.) at  $V_{CC} = 6.0$  V  
60  $\Omega$  (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 ( $\bar{E}$ ), 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  $\bar{E}$  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  $\bar{E}$  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 $\bar{E}$ to $V_{OS}$ $S_n$ to $V_{OS}$	$C_L = 15$ pF; $R_L = 1$ k $\Omega$ ; $V_{CC} = 5$ V	26	32	ns
			29	33	ns
$t_{PLZ}/t_{PHZ}$	turn-off time $\bar{E}$ to $V_{OS}$ $S_n$ to $V_{OS}$		27	26	ns
			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) common (Z)		5	5	pF
			45	45	pF

### Notes

1.  $C_{PD}$  is used to determine the dynamic power dissipation ( $P_D$  in  $\mu$ W):

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

$f_i$  = 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  $V_I = \text{GND to } V_{CC}$   
For HCT the condition is  $V_I = \text{GND to } V_{CC} - 1.5$  V

# 16-channel analog multiplexer/demultiplexer

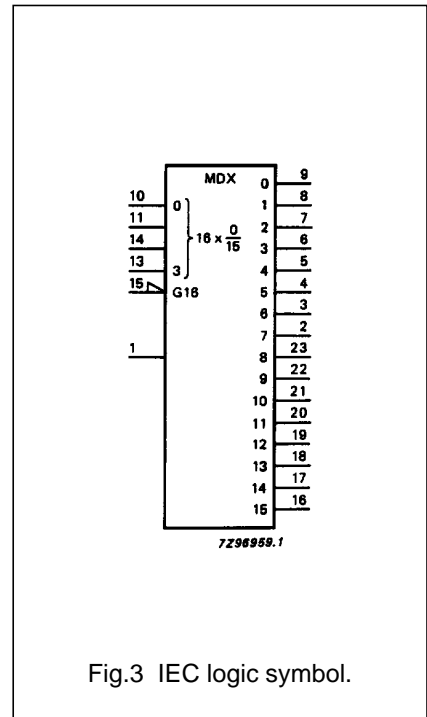
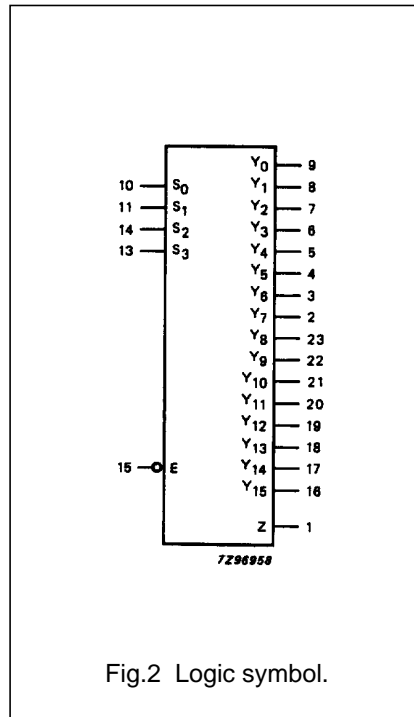
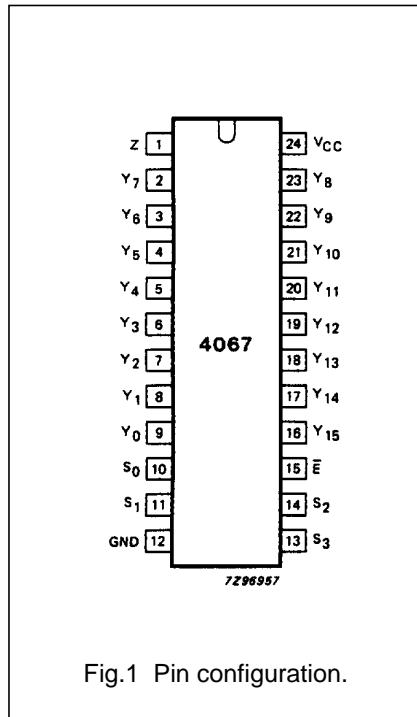
74HC/HCT4067

## 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 <sub>0</sub> to Y <sub>15</sub>	independent inputs/outputs
10, 11, 14, 13	S <sub>0</sub> to S <sub>3</sub>	address inputs
12	GND	ground (0 V)
15	$\bar{E}$	enable input (active LOW)
24	V <sub>CC</sub>	positive supply voltage

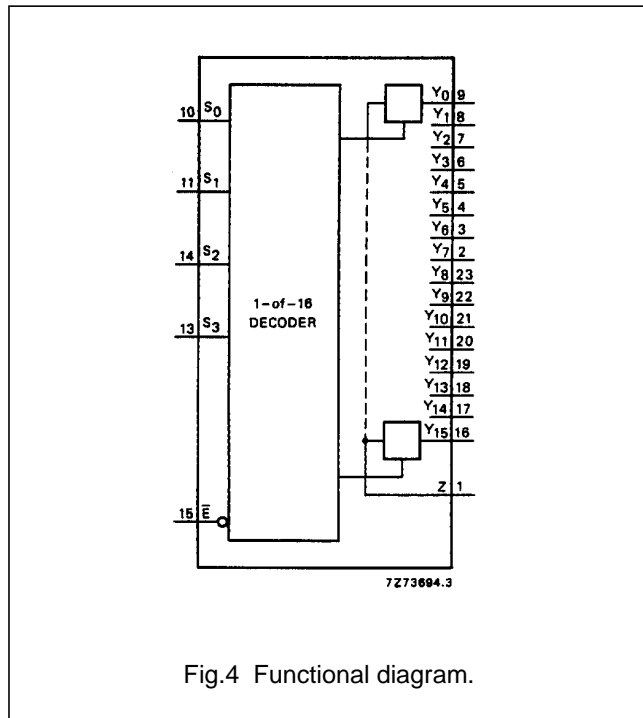


# 16-channel analog multiplexer/demultiplexer

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## APPLICATIONS

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

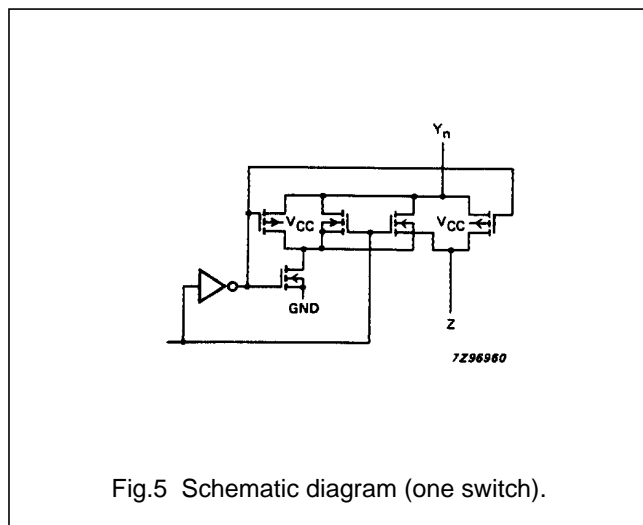


## FUNCTION TABLE

INPUTS					CHANNEL ON
$\bar{E}$	$S_3$	$S_2$	$S_1$	$S_0$	
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



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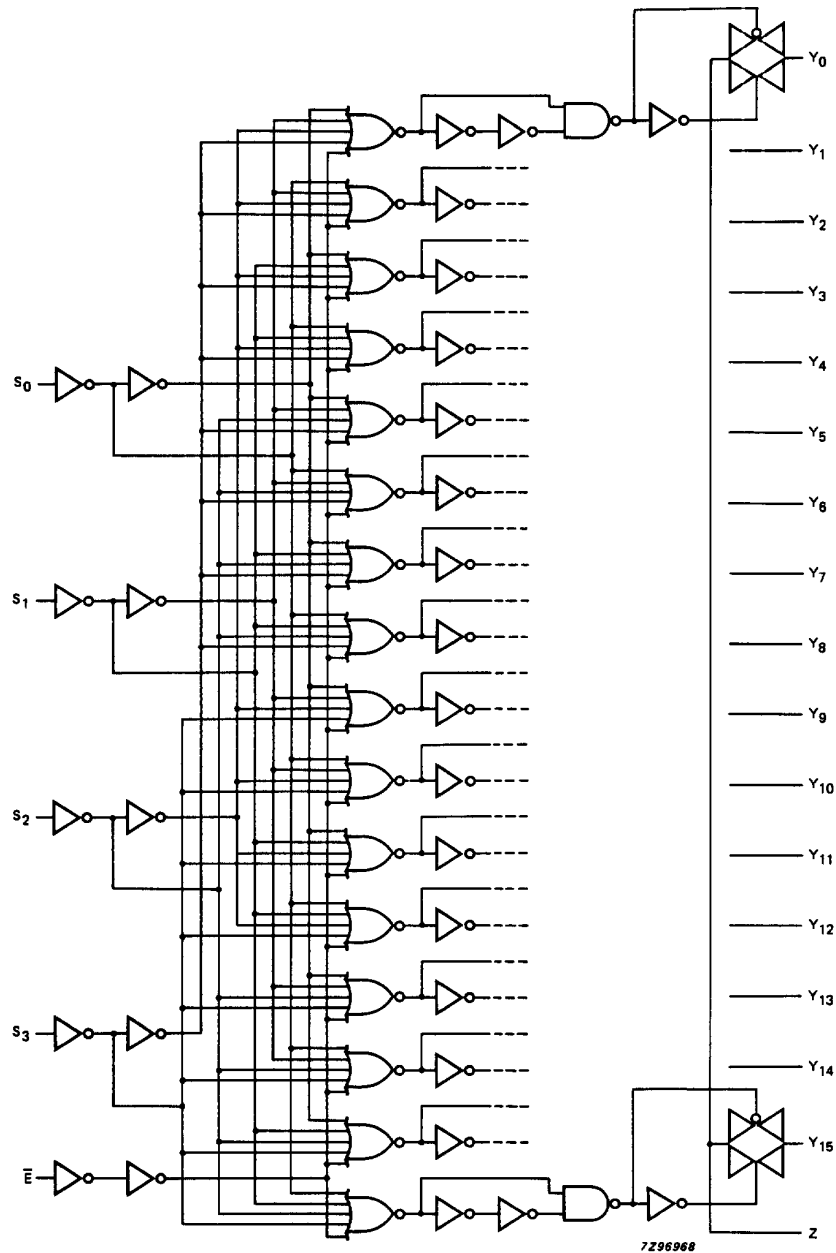


Fig.6 Logic diagram.

# 16-channel analog multiplexer/demultiplexer

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## 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

- 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

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## 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	$T_{amb} (°C)$						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)		-	-		-		-	$\Omega$	2.0	100	$V_{CC}$	$V_{IH}$
			110	180		225		270	$\Omega$	4.5	1000	to	or
			95	160		200		240	$\Omega$	6.0	1000	GND	$V_{IL}$
			75	130		165		195	$\Omega$	9.0	1000		
$R_{ON}$	ON-resistance (rail)		150	-		-		-	$\Omega$	2.0	100	GND	$V_{IH}$
			90	160		200		240	$\Omega$	4.5	1000	or	or
			80	140		175		210	$\Omega$	6.0	1000	$V_{CC}$	$V_{IL}$
			70	120		150		180	$\Omega$	9.0	1000		
$\Delta R_{ON}$	maximum variation of ON-resistance between any two channels		-						$\Omega$	2.0		$V_{CC}$	$V_{IH}$
			9						$\Omega$	4.5		to	or
			8						$\Omega$	6.0		GND	$V_{IL}$
			6						$\Omega$	9.0			

### Notes

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

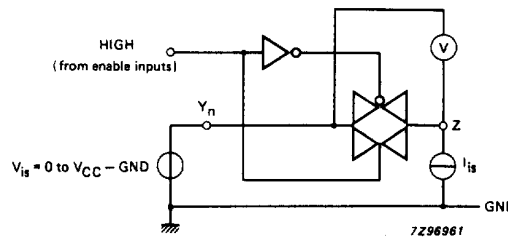


Fig.7 Test circuit for measuring ON-resistance ( $R_{ON}$ ).

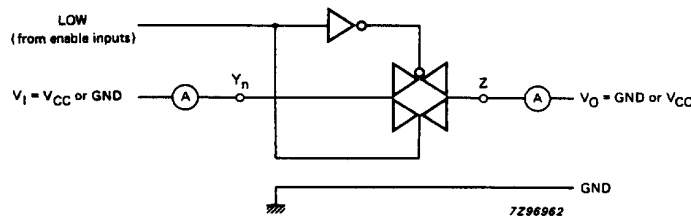
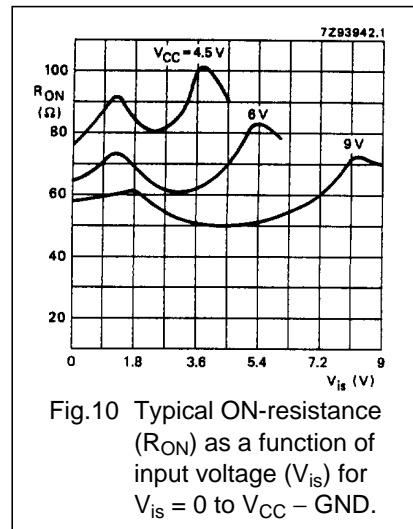
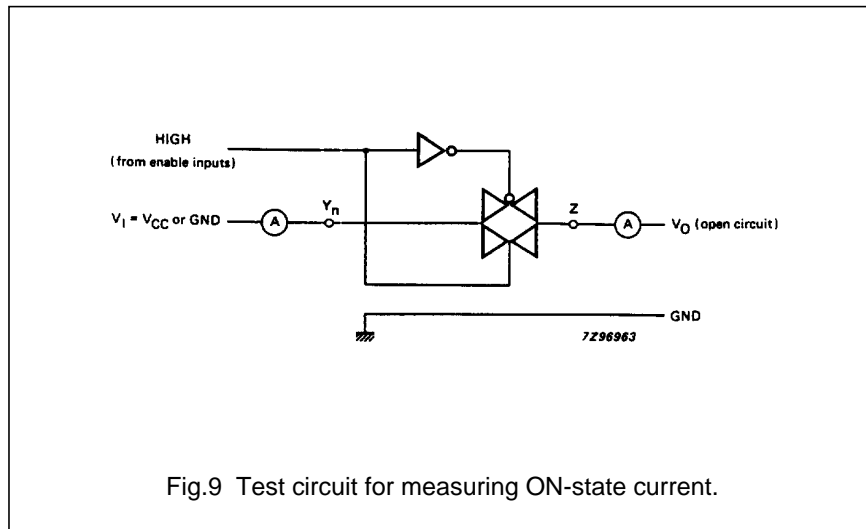


Fig.8 Test circuit for measuring OFF-state current.

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### DC CHARACTERISTICS FOR 74HC

Voltages are referenced to GND (ground = 0 V)

SYMBOL	PARAMETER	$T_{amb} (^{\circ}C)$							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	1.2		1.5		1.5		V	2.0		
		3.15	2.4		3.15		3.15			4.5		
		4.2	3.2		4.2		4.2			6.0		
		6.3	4.7		6.3		6.3			9.0		
$V_{IL}$	LOW level input voltage		0.8	0.50		0.50		0.50	V	2.0		
			2.1	1.35		1.35		1.35		4.5		
			2.8	1.80		1.80		1.80		6.0		
			4.3	2.70		2.70		2.70		9.0		
$\pm I_i$	input leakage current			0.1		1.0		1.0	$\mu A$	6.0	$V_{CC}$ or GND	
				0.2		2.0		2.0		10.0		
$\pm I_S$	analog switch OFF-state current per channel			0.1		1.0		1.0	$\mu A$	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	$\mu A$	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	$\mu A$	10.0	$V_{IH}$ or $V_{IL}$	$ V_S  = V_{CC} - GND$ (see Fig.9)
$I_{CC}$	quiescent supply current			8.0		80.0		160	$\mu A$	6.0	$V_{CC}$ or GND	$V_{is} = GND$ or $V_{CC}$ ; $V_{os} = V_{CC}$ or GND
				16.0		160		320		10.0		



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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)	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> ; Y <sub>n</sub> to Z		25	75		95		110	ns	2.0 4.5 6.0 9.0	R <sub>L</sub> = ∞; C <sub>L</sub> = 50 pF (see Fig.16)
			9	15		19		22			
			7	13		16		19			
			5	9		11		14			
t <sub>PHL</sub> / t <sub>PLH</sub>	propagation delay V <sub>is</sub> to V <sub>os</sub> ; Z to Y <sub>n</sub>		18	60		75		90	ns	2.0 4.5 6.0 9.0	
			6	12		15		18			
			5	10		13		15			
			4	8		10		12			
t <sub>PHZ</sub> / t <sub>PLZ</sub>	turn-off time Ē to Y <sub>n</sub>		74	250		315		375	ns	2.0 4.5 6.0 9.0	
			27	50		63		75			
			22	43		54		64			
			20	38		48		57			
t <sub>PHZ</sub> / t <sub>PLZ</sub>	turn-off time S <sub>n</sub> to Y <sub>n</sub>		83	250		315		375	ns	2.0 4.5 6.0 9.0	
			30	50		63		75			
			24	43		54		64			
			21	38		48		57			
t <sub>PHZ</sub> / t <sub>PLZ</sub>	turn-off time Ē to Z		85	275		345		415	ns	2.0 4.5 6.0 9.0	
			31	55		69		83			
			25	47		59		71			
			24	42		53		63			
t <sub>PHZ</sub> / t <sub>PLZ</sub>	turn-off time S <sub>n</sub> to Z		94	290		365		435	ns	2.0 4.5 6.0 9.0	
			34	58		73		87			
			27	47		62		74			
			25	45		56		68			
t <sub>PZH</sub> / t <sub>PZL</sub>	turn-on time Ē to Y <sub>n</sub>		80	275		345		415	ns	2.0 4.5 6.0 9.0	
			29	55		69		83			
			23	47		59		71			
			17	42		53		63			
t <sub>PZH</sub> / t <sub>PZL</sub>	turn-on time S <sub>n</sub> to Y <sub>n</sub>		88	300		375		450	ns	2.0 4.5 6.0 9.0	
			32	60		75		90			
			26	51		64		77			
			18	45		56		68			
t <sub>PZH</sub> / t <sub>PZL</sub>	turn-on time Ē to Z		85	275		345		415	ns	2.0 4.5 6.0 9.0	
			31	55		69		83			
			25	47		59		71			
			18	42		53		63			
t <sub>PZH</sub> / t <sub>PZL</sub>	turn-on time S <sub>n</sub> to Z		94	300		375		450	ns	2.0 4.5 6.0 9.0	
			34	60		75		90			
			27	51		64		77			
			19	45		56		68			

# 16-channel analog multiplexer/demultiplexer

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**Note to AC CHARACTERISTICS FOR 74HC**

- 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)							UNIT	TEST CONDITIONS		
		74HCY								$V_{CC}$ (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	$\mu A$	5.5	$V_{CC}$ or GND	
$\pm I_S$	analog switch OFF-state current per channel			0.1		1.0		1.0	$\mu A$	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	$\mu A$	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	$\mu A$	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	$\mu A$	4.5 to 5.5	$V_{CC}$ or GND	$V_{is} = GND$ or $V_{CC}$ ; $V_{os} = V_{CC}$ or GND
$\Delta I_{CC}$	additional quiescent supply current per input pin for unit load coefficient is 1 (note 1)		100	360		450		490	$\mu A$	4.5 to 5.5	$V_{CC}$ -2.1 V	other inputs at $V_{CC}$ or GND

**Note**

- 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
$\bar{E}$	0.6
$S_n$	0.5

# 16-channel analog multiplexer/demultiplexer

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**AC CHARACTERISTICS FOR 74HCT**GND = 0 V;  $t_r = t_f = 6$  ns

SYMBOL	PARAMETER	T <sub>amb</sub> (°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> ; Y <sub>n</sub> to Z		9	15		19		22	ns	4.5	R <sub>L</sub> = ∞; C <sub>L</sub> = 50 pF (see Fig.16)
t <sub>PHL</sub> / t <sub>PLH</sub>	propagation delay V <sub>is</sub> to V <sub>os</sub> ; Z to Y <sub>n</sub>		6	12		15		18	ns	4.5	
t <sub>PHZ</sub> / t <sub>PLZ</sub>	turn-off time Ē to Y <sub>n</sub>		26	55		69		83	ns	4.5	R <sub>L</sub> = 1 kΩ; C <sub>L</sub> = 50 pF (see Fig.17)
t <sub>PHZ</sub> / t <sub>PLZ</sub>	turn-off time S <sub>n</sub> to Y <sub>n</sub>		31	55		69		83	ns	4.5	
t <sub>PHZ</sub> / t <sub>PLZ</sub>	turn-off time Ē to Z		30	60		75		90	ns	4.5	
t <sub>PHZ</sub> / t <sub>PLZ</sub>	turn-off time S <sub>n</sub> to Z		35	60		75		90	ns	4.5	
t <sub>PZH</sub> / t <sub>PZL</sub>	turn-on time Ē to Y <sub>n</sub>		32	60		75		90	ns	4.5	
t <sub>PZH</sub> / t <sub>PZL</sub>	turn-on time S <sub>n</sub> to Y <sub>n</sub>		35	60		75		90	ns	4.5	
t <sub>PZH</sub> / t <sub>PZL</sub>	turn-on time Ē to Z		38	65		81		98	ns	4.5	
t <sub>PZH</sub> / t <sub>PZL</sub>	turn-on time S <sub>n</sub> 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.

# 16-channel analog multiplexer/demultiplexer

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## ADDITIONAL AC CHARACTERISTICS FOR 74HC/HCT

Recommended conditions and typical values

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

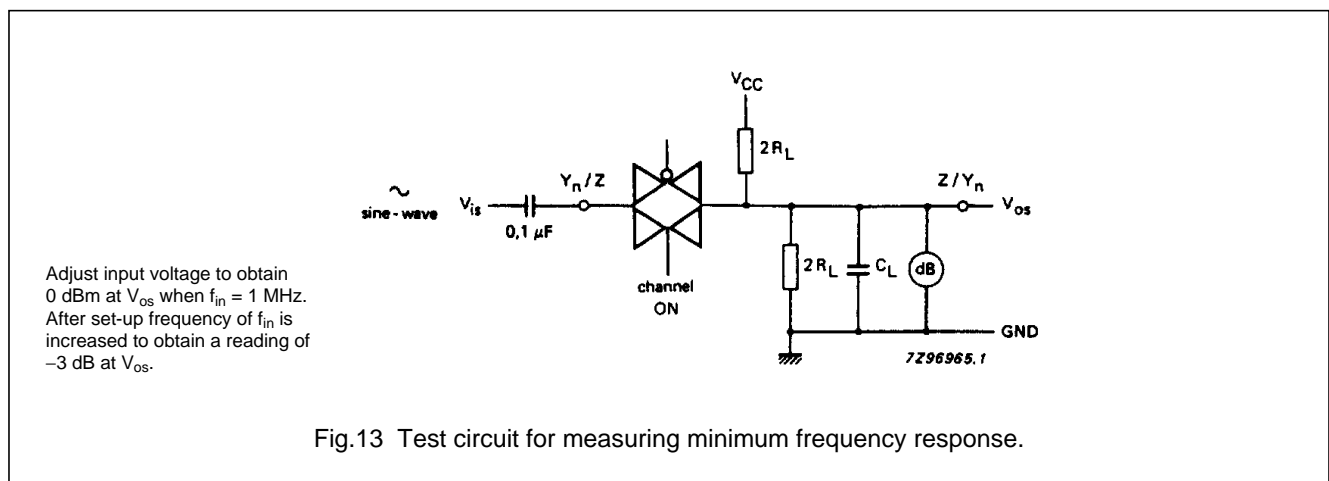
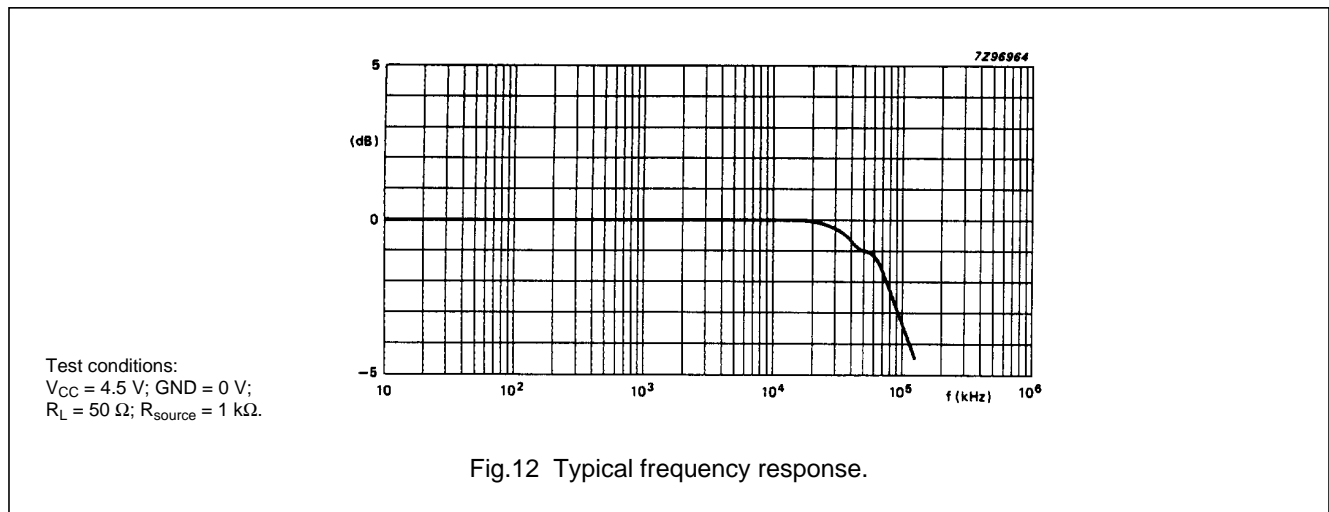
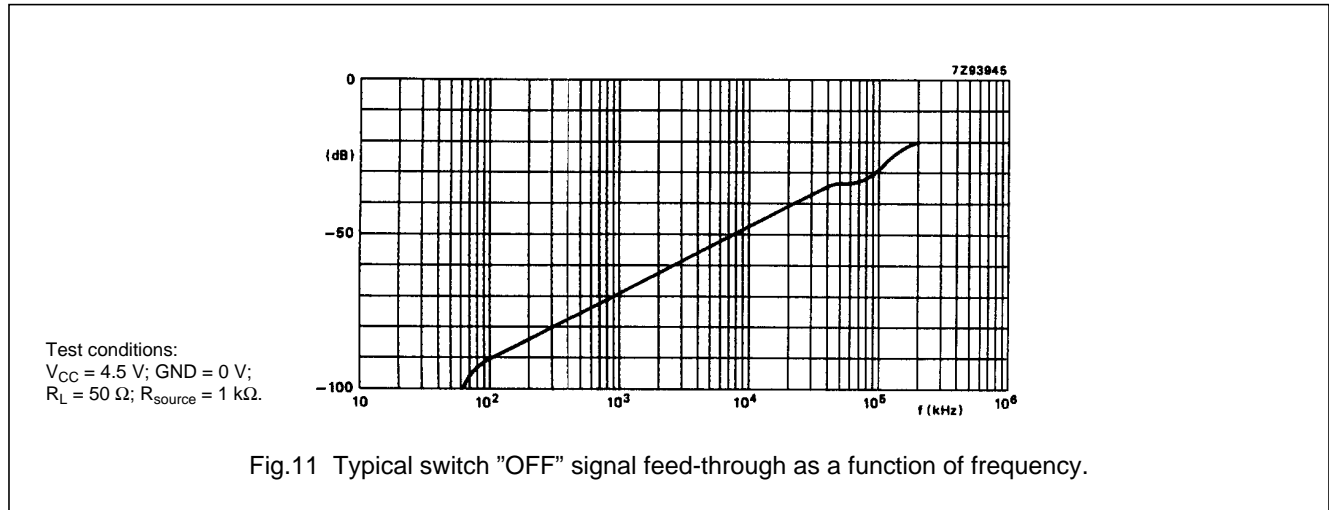
SYMBOL	PARAMETER	TYP.	UNIT	V <sub>CC</sub> (V)	V <sub>is(p-p)</sub> (V)	CONDITIONS
	sine-wave distortion f = 1 kHz	0.04 0.02	% %	4.5 9.0	4.0 8.0	R <sub>L</sub> = 10 kΩ; C <sub>L</sub> = 50 pF (see Fig.14)
	sine-wave distortion f = 10 kHz	0.12 0.06	% %	4.5 9.0	4.0 8.0	R <sub>L</sub> = 10 kΩ; C <sub>L</sub> = 50 pF (see Fig.14)
	switch "OFF" signal feed-through	-50 -50	dB dB	4.5 9.0	note 3	R <sub>L</sub> = 600 Ω; C <sub>L</sub> = 50 pF f = 1 MHz (see Figs 11 and 15)
f <sub>max</sub>	minimum frequency response (-3 dB)	90 100	MHz MHz	4.5 9.0	note 4	R <sub>L</sub> = 50 Ω; C <sub>L</sub> = 10 pF (see Figs 12 and 13)
C <sub>S</sub>	maximum switch capacitance independent (Y) common (Z)	5 45	pF pF			

### Notes

1. V<sub>is</sub> is the input voltage at Y<sub>n</sub> or Z terminal, whichever is assigned as an input.
2. V<sub>os</sub> is the output voltage at Y<sub>n</sub> or Z terminal, whichever is assigned as an output.
3. Adjust input voltage V<sub>is</sub> is 0 dBm level (0 dBm = 1 mW into 600 Ω).
4. 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).

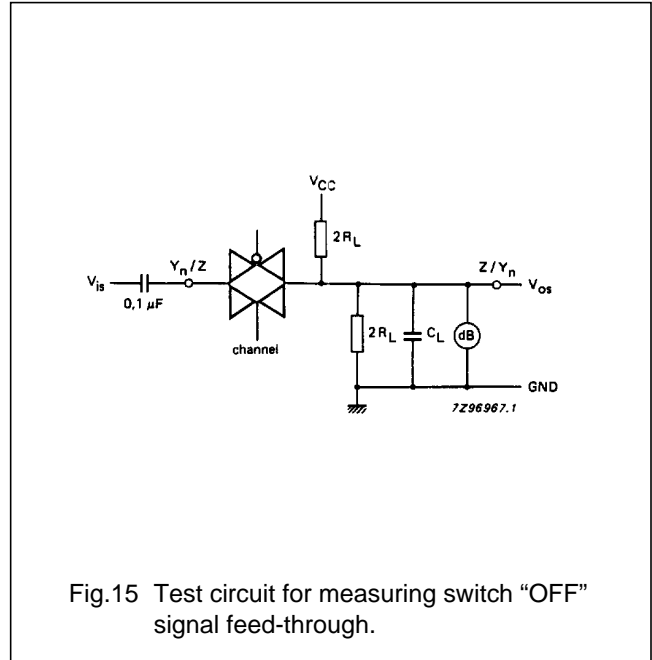
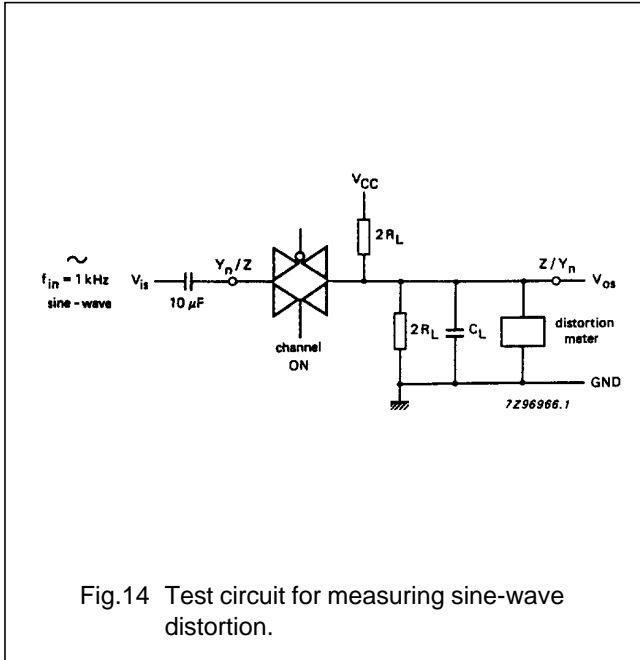
# 16-channel analog multiplexer/demultiplexer

74HC/HCT4067

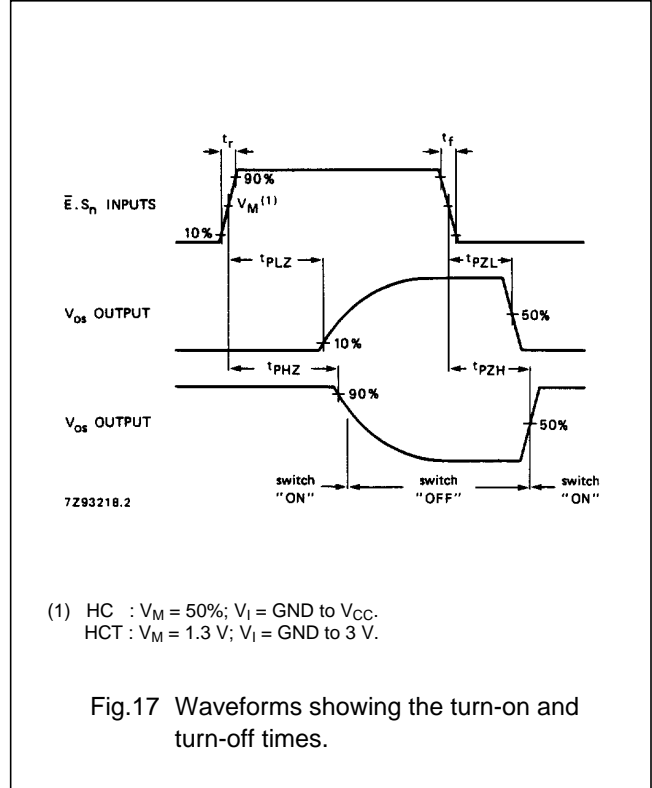
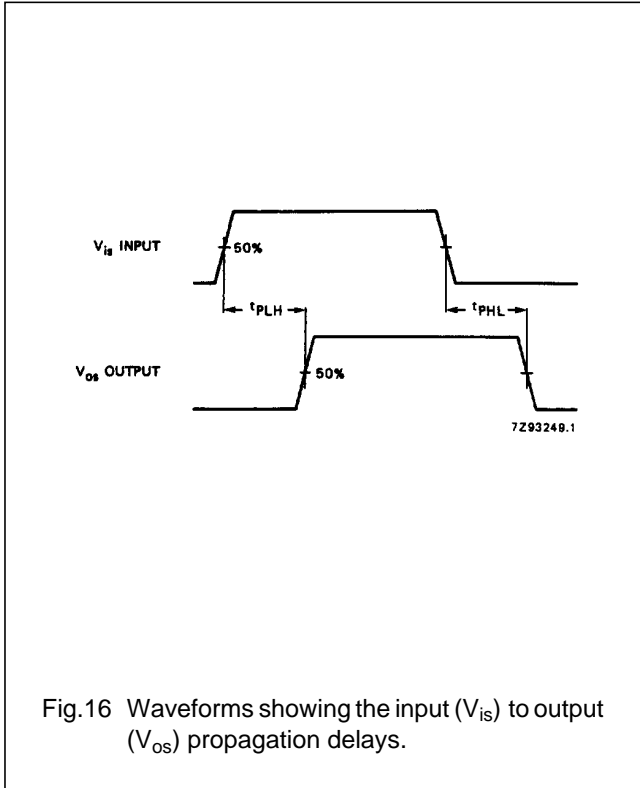


# 16-channel analog multiplexer/demultiplexer

74HC/HCT4067



## AC WAVEFORMS



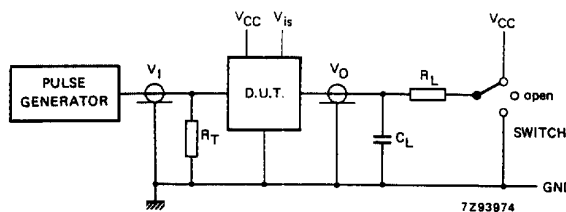
# 16-channel analog multiplexer/demultiplexer

74HC/HCT4067

## TEST CIRCUIT AND WAVEFORMS

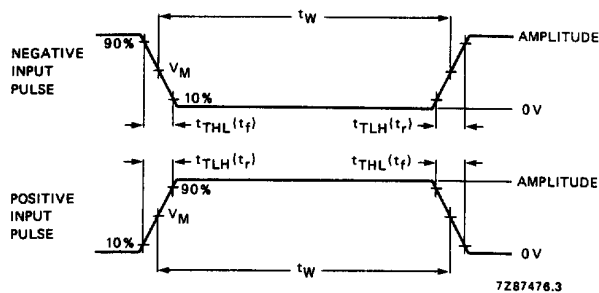
### Conditions

TEST	SWITCH	V <sub>is</sub>
t <sub>PZH</sub>	GND	V <sub>CC</sub>
t <sub>PZL</sub>	V <sub>CC</sub>	GND
t <sub>PHZ</sub>	GND	V <sub>CC</sub>
t <sub>PLZ</sub>	V <sub>CC</sub>	GND
others	open	pulse



- 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.18 Test circuit for measuring AC performance.



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

Fig.19 Input pulse definitions.

## PACKAGE OUTLINES

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