

# CD74HC4067, CD74HCT4067

## High-Speed CMOS Logic 16-Channel Analog Multiplexer/Demultiplexer

### Features

- Wide Analog Input Voltage Range
- Low "ON" Resistance
  - $V_{CC} = 4.5V$  . . . . .  $70\Omega$  (Typ)
  - $V_{CC} = 6V$  . . . . .  $60\Omega$  (Typ)
- Fast Switching and Propagation Speeds
- "Break-Before-Make" Switching. . . . . 6ns (Typ) at 4.5V
- Available in Both Narrow and Wide-Body Plastic Packages
- Fanout (Over Temperature Range)
  - Standard Outputs . . . . . 10 LSTTL Loads
  - Bus Driver Outputs . . . . . 15 LSTTL Loads
- Wide Operating Temperature Range . . . -55°C to 125°C
- Balanced Propagation Delay and Transition Times
- Significant Power Reduction Compared to LSTTL Logic ICs
- HC Types
  - 2V to 6V Operation
  - High Noise Immunity:  $N_{IL} = 30\%$ ,  $N_{IH} = 30\%$  of  $V_{CC}$

at  $V_{CC} = 5V$

- HCT Types
  - 4.5V to 5.5V Operation
  - Direct LSTTL Input Logic Compatibility,  $V_{IL} = 0.8V$  (Max),  $V_{IH} = 2V$  (Min)
  - CMOS Input Compatibility,  $I_I \leq 1\mu A$  at  $V_{OL}$ ,  $V_{OH}$

### Description

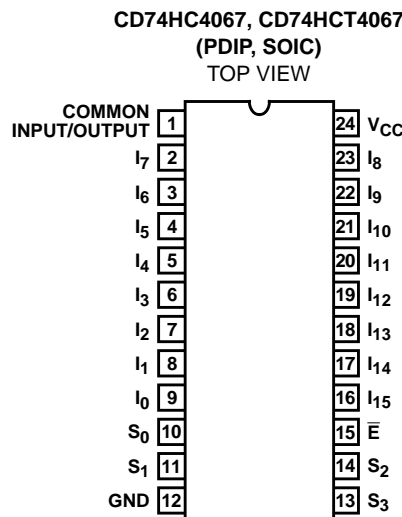
The Harris CD74HC4067 and CD74HCT4067 are digitally controlled analog switches which utilize silicon-gate CMOS technology to achieve operating speeds similar to LSTTL with the low power consumption of standard CMOS integrated circuits.

These analog multiplexers/demultiplexers control analog voltages that may vary across the voltage supply range. They are bidirectional switches thus allowing any analog input to be used as an output and visa-versa. The switches have low "on" resistance and low "off" leakages. In addition, these devices have an enable control which when high will disable all switches to their "off" state.

### Ordering Information

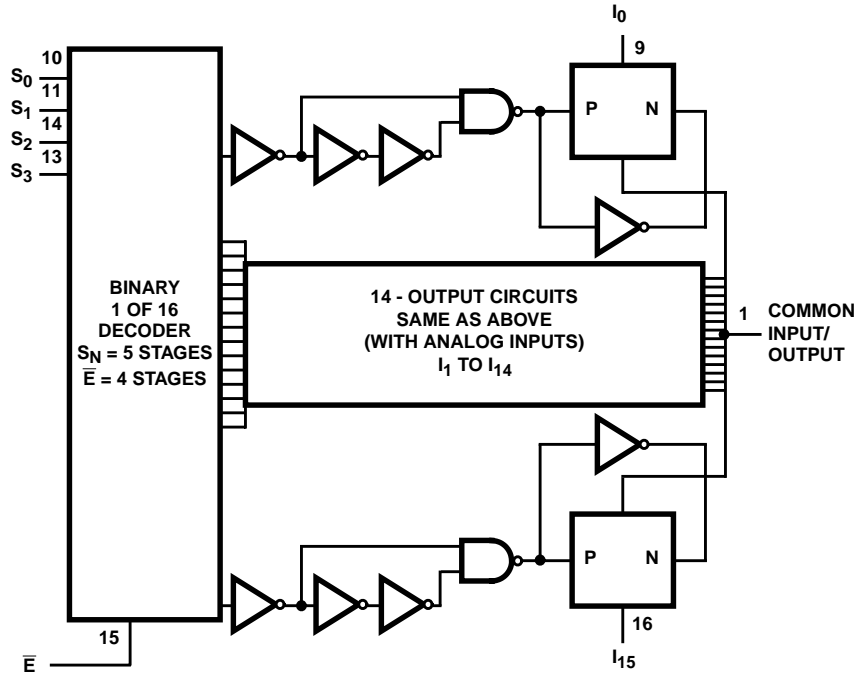
PART NUMBER	TEMP. RANGE (°C)	PACKAGE	PKG. NO.
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### Pinout



CD74HC4067, CD74HCT4067

Functional Diagram



TRUTH TABLE

S <sub>0</sub>	S <sub>1</sub>	S <sub>2</sub>	S <sub>3</sub>	E-bar	SELECTED CHANNEL
X	X	X	X	1	None
0	0	0	0	0	0
1	0	0	0	0	1
0	1	0	0	0	2
1	1	0	0	0	3
0	0	1	0	0	4
1	0	1	0	0	5
0	1	1	0	0	6
1	1	1	0	0	7
0	0	0	1	0	8
1	0	0	1	0	9
0	1	0	1	0	10
1	1	0	1	0	11
0	0	1	1	0	12
1	0	1	1	0	13
0	1	1	1	0	14
1	1	1	1	0	15

NOTE:

H = High Level

L = Low Level

X = Don't Care

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## Absolute Maximum Ratings

DC Supply Voltage, $V_{CC}$ (Voltages Referenced to Ground) .....	-0.5V to 7V
DC Input Diode Current, $I_{IK}$ For $V_I < -0.5V$ or $V_I > V_{CC} + 0.5V$ .....	$\pm 20mA$
DC Drain Current, $I_O$ For $-0.5V < V_O < V_{CC} + 0.5V$ .....	$\pm 25mA$
DC Output Diode Current, $I_{OK}$ For $V_O < -0.5V$ or $V_O > V_{CC} + 0.5V$ .....	$\pm 20mA$
DC Output Source or Sink Current per Output Pin, $I_O$ For $V_O > -0.5V$ or $V_O < V_{CC} + 0.5V$ .....	$\pm 25mA$
DC $V_{CC}$ or Ground Current, $I_{CC}$ .....	$\pm 50mA$

## Thermal Information

Thermal Resistance (Typical, Note 3)	$\theta_{JA}$ ( $^{\circ}C/W$ )
PDIP Package .....	60
SOIC Package .....	75
Maximum Junction Temperature (Hermetic Package or Die) . . .	$175^{\circ}C$
Maximum Junction Temperature (Plastic Package) .....	$150^{\circ}C$
Maximum Storage Temperature Range .....	$-65^{\circ}C$ to $150^{\circ}C$
Maximum Lead Temperature (Soldering 10s) .....	$300^{\circ}C$ (SOIC - Lead Tips Only)

## Operating Conditions

Temperature Range, $T_A$ .....	$-55^{\circ}C$ to $125^{\circ}C$
Supply Voltage Range, $V_{CC}$	
HC Types .....	$.2V$ to $6V$
HCT Types .....	$.4.5V$ to $5.5V$
DC Input or Output Voltage, $V_I, V_O$ .....	$0V$ to $V_{CC}$
Input Rise and Fall Time	
$2V$ .....	$1000ns$ (Max)
$4.5V$ .....	$500ns$ (Max)
$6V$ .....	$400ns$ (Max)

CAUTION: Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.

### NOTE:

- $\theta_{JA}$  is measured with the component mounted on an evaluation PC board in free air.

## DC Electrical Specifications

PARAMETER	SYMBOL	TEST CONDITIONS		$V_{CC}$ (V)	25°C			-40°C TO 85°C		-55°C TO 125°C		UNITS
		$V_I$ (V)	$V_{IS}$ (V)		MIN	TYP	MAX	MIN	MAX	MIN	MAX	
<b>HC TYPES</b>												
High Level Input Voltage	$V_{IH}$	-	-	2	1.5	-	-	1.5	-	1.5	-	V
				4.5	3.15	-	-	3.15	-	3.15	-	V
				6	4.2	-	-	4.2	-	4.2	-	V
Low Level Input Voltage	$V_{IL}$	-	-	2	-	-	0.5	-	0.5	-	0.5	V
				4.5	-	-	1.35	-	1.35	-	1.35	V
				6	-	-	1.8	-	1.8	-	1.8	V
Maximum "ON" Resistance $I_O = 1mA$	$R_{ON}$	$V_{CC}$ or GND	$V_{CC}$ or GND	4.5	-	70	160	-	200	-	240	$\Omega$
				6	-	60	140	-	175	-	210	$\Omega$
		$V_{CC}$ to GND	$V_{CC}$ to GND	4.5	-	90	180	-	225	-	270	$\Omega$
				6	-	80	160	-	200	-	240	$\Omega$
Maximum "ON" Resistance Between Any Two Switches	$\Delta R_{ON}$	-	-	4.5	-	10	-	-	-	-	-	$\Omega$
				6	-	8.5	-	-	-	-	-	$\Omega$
Switch "Off" Leakage Current 16 Channels	$I_{IZ}$	$\bar{E} = V_{CC}$	$V_{CC}$ or GND	6	-	-	$\pm 0.8$	-	$\pm 8$	-	$\pm 8$	$\mu A$
Logic Input Leakage Current	$I_I$	$V_{CC}$ or GND	-	6	-	-	$\pm 0.1$	-	$\pm 1$	-	$\pm 1$	$\mu A$
Quiescent Device Current $I_O = 0mA$	$I_{CC}$	$V_{CC}$ or GND	-	6	-	-	8	-	80	-	160	$\mu A$

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### DC Electrical Specifications (Continued)

PARAMETER	SYMBOL	TEST CONDITIONS		V <sub>CC</sub> (V)	25°C			-40°C TO 85°C		-55°C TO 125°C		UNITS
		V <sub>I</sub> (V)	V <sub>IS</sub> (V)		MIN	TYP	MAX	MIN	MAX	MIN	MAX	
<b>HCT TYPES</b>												
High Level Input Voltage	V <sub>IH</sub>	-	-	4.5	2	-	-	2	-	2	-	V
Low Level Input Voltage	V <sub>IL</sub>	-	-	4.5	-	-	0.8	-	0.8	-	0.8	V
Maximum "ON" Resistance I <sub>O</sub> = 1mA	R <sub>ON</sub>	V <sub>CC</sub> or GND	V <sub>CC</sub> or GND	4.5	-	70	160	-	200	-	240	Ω
		V <sub>CC</sub> to GND	V <sub>CC</sub> to GND	4.5	-	90	180	-	225	-	270	Ω
Maximum "ON" Resistance Between Any Two Switches	ΔR <sub>ON</sub>	-	-	4.5	-	10	-	-	-	-	-	Ω
Switch "Off" Leakage Current 16 Channels	I <sub>Iz</sub>	$\bar{E} = V_{CC}$	V <sub>CC</sub> or GND	6	-	-	±0.8	-	±8	-	±8	μA
Logic Input Leakage Current	I <sub>I</sub>	V <sub>CC</sub> or GND (Note 5)	-	6	-	-	±0.1	-	±1	-	±1	μA
Quiescent Device Current	I <sub>CC</sub>	V <sub>CC</sub> or GND	-	6	-	-	8	-	80	-	160	μA
Additional Quiescent Device Current Per Input Pin: 1 Unit Load	ΔI <sub>CC</sub> (Note 4)	V <sub>CC</sub> -2.1	-	-	-	100	360	-	450	-	490	μA

**NOTES:**

4. For dual-supply systems theoretical worst case (V<sub>I</sub> = 2.4V, V<sub>CC</sub> = 5.5V) specification is 1.8mA.
5. Any voltage between V<sub>CC</sub> and GND.

### HCT Input Loading Table

INPUT	UNIT LOADS
S <sub>0</sub> - S <sub>3</sub>	0.5
$\bar{E}$	0.3

NOTE: Unit Load is ΔI<sub>CC</sub> limit specified in DC Electrical Specifications table, e.g., 360μA max at 25°C.

### Switching Specifications Input t<sub>r</sub>, t<sub>f</sub> = 6ns

PARAMETER	SYMBOL	TEST CONDITIONS	V <sub>CC</sub> (V)	25°C			-40°C TO 85°C		-55°C TO 125°C		UNITS
				MIN	TYP	MAX	MIN	MAX	MIN	MAX	
<b>HC TYPES</b>											
Propagation Delay Time Switch In to Out	t <sub>PLH</sub> , t <sub>PHL</sub>	C <sub>L</sub> = 50pF	2	-	-	75	-	95	-	110	ns
			4.5	-	-	15	-	19	-	22	ns
			6	-	-	13	-	16	-	19	ns
		C <sub>L</sub> = 15pF	5	-	6	-	-	-	-	-	ns
Switch Turn On $\bar{E}$ to Out	t <sub>PZH</sub> , t <sub>PZL</sub>	C <sub>L</sub> = 50pF	2	-	-	275	-	345	-	415	ns
			4.5	-	-	55	-	69	-	83	ns
			6	-	-	47	-	59	-	71	ns
		C <sub>L</sub> = 15pF	5	-	23	-	-	-	-	-	ns

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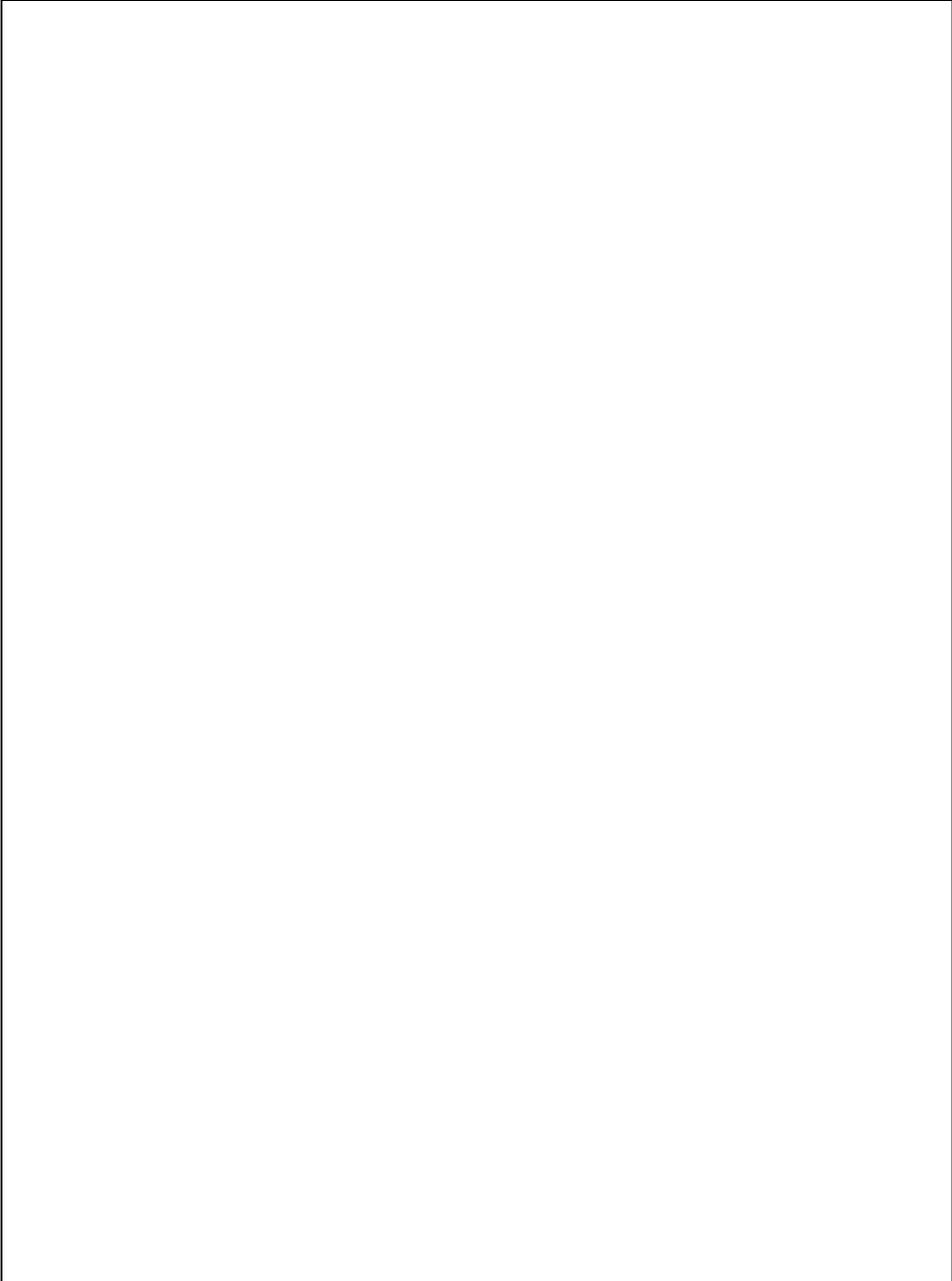
**Switching Specifications** Input  $t_r, t_f = 6\text{ns}$  (Continued)

PARAMETER	SYMBOL	TEST CONDITIONS	V <sub>CC</sub> (V)	25°C			-40°C TO 85°C		-55°C TO 125°C		UNITS
				MIN	TYP	MAX	MIN	MAX	MIN	MAX	
Switch Turn On Sn to Out	t <sub>PZH</sub> , t <sub>PZL</sub>	C <sub>L</sub> = 50pF	2	-	-	300	-	375	-	450	ns
			4.5	-	-	60	-	75	-	90	ns
			6	-	-	51	-	64	-	76	ns
		C <sub>L</sub> = 15pF	5	-	25	-	-	-	-	-	ns
Switch Turn Off Ē to Out	t <sub>PHZ</sub> , t <sub>PLZ</sub>	C <sub>L</sub> = 50pF	2	-	-	275	-	345	-	415	ns
			4.5	-	-	55	-	69	-	83	ns
			6	-	-	47	-	59	-	71	ns
		C <sub>L</sub> = 15pF	5	-	23	-	-	-	-	-	ns
Switch Turn Off Sn to Out	t <sub>PHZ</sub> , t <sub>PLZ</sub>	C <sub>L</sub> = 50pF	2	-	-	290	-	365	-	435	ns
			4.5	-	-	58	-	73	-	87	ns
			6	-	-	49	-	62	-	74	ns
		C <sub>L</sub> = 50pF	5	-	21	-	-	-	-	-	ns
Input (Control) Capacitance	C <sub>I</sub>	-	-	-	10	-	10	-	10	pF	
Power Dissipation Capacitance (Notes 6, 7)	C <sub>PD</sub>	-	5	-	93	-	-	-	-	pF	
<b>HCT TYPES</b>											
Propagation Delay Time Switch In to Out	t <sub>PLH</sub> , t <sub>PHL</sub>	C <sub>L</sub> = 50pF	4.5	-	-	15	-	19	-	22	ns
		C <sub>L</sub> = 15pF	5	-	6	-	-	-	-	-	ns
Switch Turn On Ē to Out	t <sub>PZH</sub> , t <sub>PZL</sub>	C <sub>L</sub> = 50pF	4.5	-	-	60	-	75	-	90	ns
		C <sub>L</sub> = 15pF	5	-	25	-	-	-	-	-	ns
Switch Turn On Sn to Out	t <sub>PZH</sub> , t <sub>PZL</sub>	C <sub>L</sub> = 50pF	4.5	-	-	60	-	75	-	90	ns
		C <sub>L</sub> = 15pF	5	-	25	-	-	-	-	-	ns
Switch Turn Off Ē to Out	t <sub>PHZ</sub> , t <sub>PLZ</sub>	C <sub>L</sub> = 50pF	4.5	-	-	55	-	69	-	83	ns
		C <sub>L</sub> = 15pF	5	-	23	-	-	-	-	-	ns
Switch Turn Off Sn to Out	t <sub>PHZ</sub> , t <sub>PLZ</sub>	C <sub>L</sub> = 50pF	4.5	-	-	58	-	73	-	87	ns
		C <sub>L</sub> = 15pF	5	-	21	-	-	-	-	-	ns
Input (Control) Capacitance	C <sub>I</sub>	-	-	-	10	-	10	-	10	pF	
Power Dissipation Capacitance (Notes 6, 7)	C <sub>PD</sub>	-	5	-	96	-	-	-	-	pF	

**NOTES:**

6. C<sub>PD</sub> is used to determine the dynamic power consumption, per package.

7.  $P_D = C_{PD} V_{CC}^2 f_i + \sum (C_L + C_S) V_{CC}^2 f_o$  where  $f_i$  = input frequency,  $f_o$  = output frequency,  $C_L$  = output load capacitance,  $C_S$  = switch capacitance,  $V_{CC}$  = supply voltage.



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## Analog Channel Specifications $T_A = 25^\circ\text{C}$

PARAMETER	TEST CONDITIONS	V <sub>CC</sub> (V)	HC/HCT	UNITS
Switch Frequency Response Bandwidth at -3dB (Figure 2)	Figure 4, Notes 8, 9	4.5	89	MHz
Sine Wave Distortion	Figure 5	4.5	0.051	%
Feedthrough Noise E to Switch	Figure 6, Notes 9, 10	4.5	TBE	mV
Feedthrough Noise S to Switch			TBE	mV
Switch "OFF" Signal Feedthrough (Figure 3)	Figure 7	4.5	-75	dB
Switch Input Capacitance, C <sub>S</sub>		-	5	pF
Common Capacitance, C <sub>COM</sub>		-	50	pF

**NOTES:**

8. Adjust input level for 0dBm at output,  $f = 1\text{MHz}$ .
9.  $V_{IS}$  is centered at  $V_{CC}/2$ .
10. Adjust input for 0dBm at  $V_{IS}$ .

## Typical Performance Curves

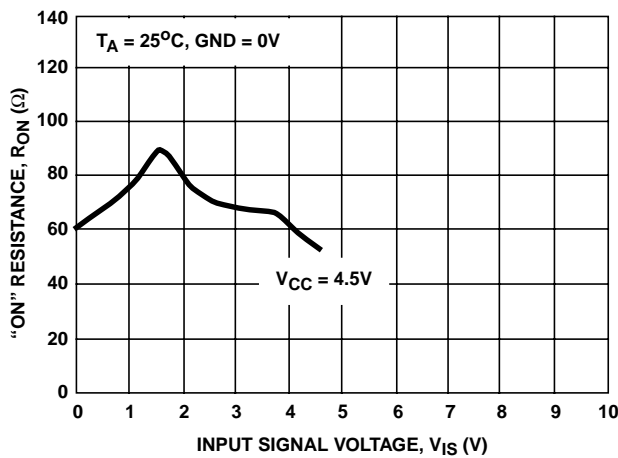


FIGURE 1. TYPICAL "ON" RESISTANCE vs INPUT SIGNAL VOLTAGE

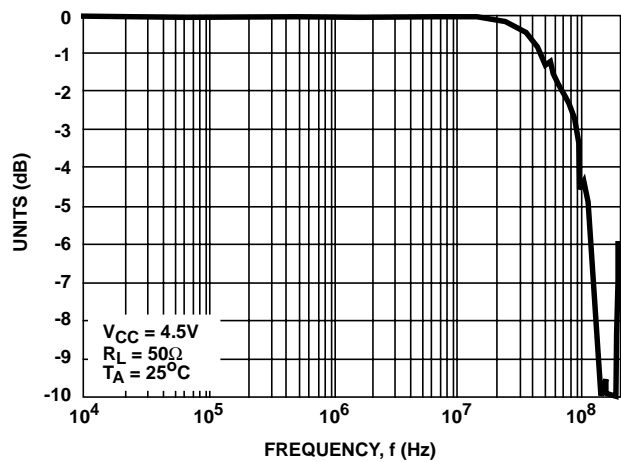


FIGURE 2. TYPICAL SWITCH FREQUENCY RESPONSE

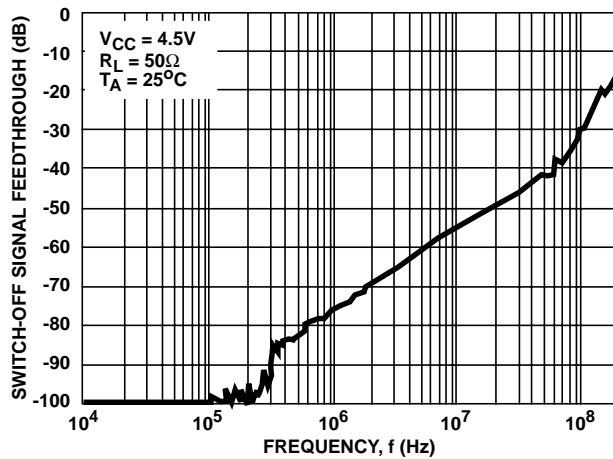


FIGURE 3. TYPICAL SWITCH-OFF SIGNAL FEEDTHROUGH vs FREQUENCY

## Analog Test Circuits

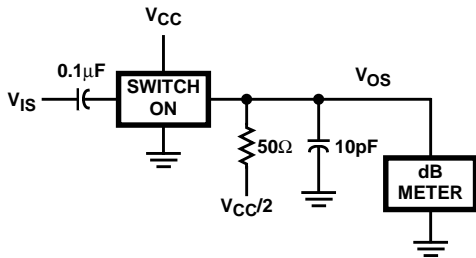
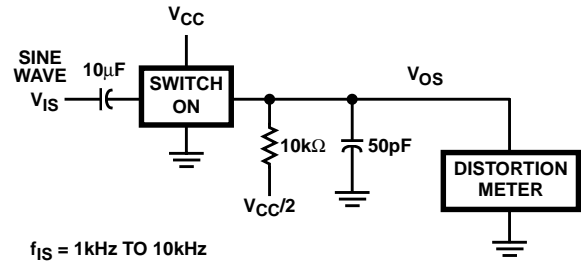


FIGURE 4. FREQUENCY RESPONSE TEST CIRCUIT



$f_{IS} = 1\text{kHz TO } 10\text{kHz}$

FIGURE 5. SINE WAVE DISTORTION TEST CIRCUIT

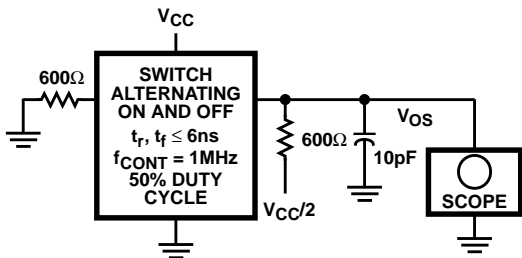


FIGURE 6. CONTROL-TO-SWITCH FEEDTHROUGH NOISE TEST CIRCUIT

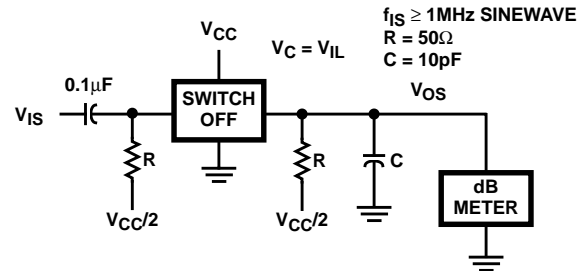


FIGURE 7. SWITCH OFF SIGNAL FEEDTHROUGH TEST CIRCUIT

## Test Circuits and Waveforms

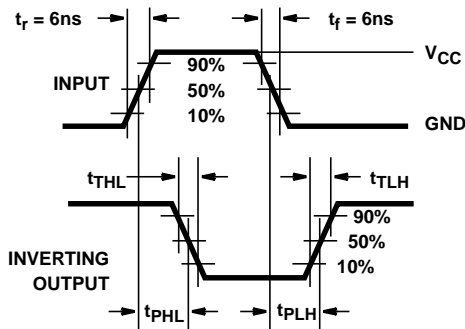


FIGURE 8. HC TRANSITION TIMES AND PROPAGATION DELAY TIMES, COMBINATION LOGIC

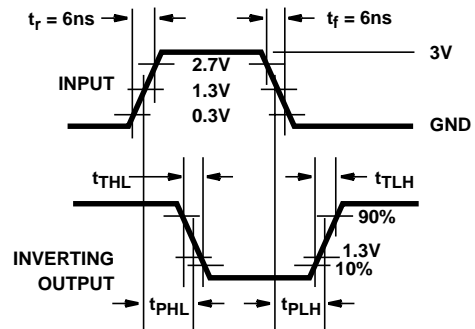


FIGURE 9. HCT TRANSITION TIMES AND PROPAGATION DELAY TIMES, COMBINATION LOGIC



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