TEXAS INSTRUMENTS

Data sheet acquired from Harris Semiconductor
SCHS209

February 1998

CD74HC4067, CD74HCT4067

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

Features

- Wide Analog Input Voltage Range
- Low "ON" Resistance
  - V_{CC} = 4.5V. . . . . 70Ω (Typ)
  - V_{CC} = 6V . . . . . 60Ω (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.

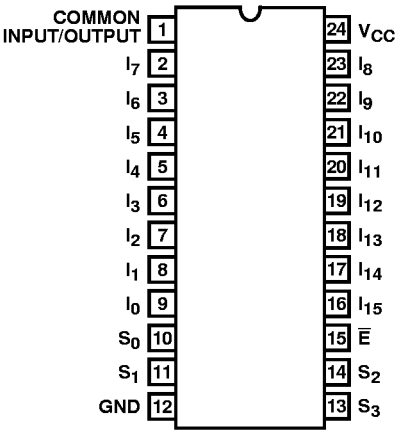
These analog multiplexers/demultiplexers control analog voltages that may vary across the voltage supply range. They are bidirectional switches thus allowing any analog input to be used as an output and visa-versa. The switches have low "on" resistance and low "off" leakages. In addition, these devices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

Pinout

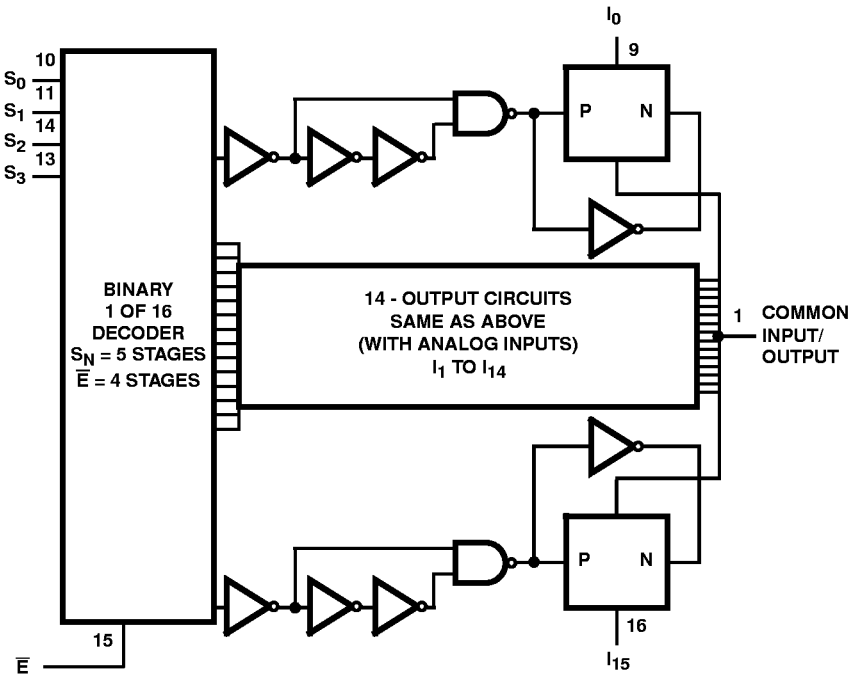
CD74HC4067, CD74HCT4067
(PDIP, SOIC)
TOP VIEW



CAUTION: These devices are sensitive to electrostatic discharge. Users should follow proper IC Handling Procedures.

File Number 1783.1

Functional Diagram



TRUTH TABLE

S0	S1	S2	S3	$\overline{E}$	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

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 . . . . . ±20mA
DC Drain Current, I_O
For -0.5V < V_O < V_{CC} + 0.5V . . . . . ±25mA
DC Output Diode Current, I_{OK}
For V_O < -0.5V or V_O > V_{CC} + 0.5V . . . . . ±20mA
DC Output Source or Sink Current per Output Pin, I_O
For V_O > -0.5V or V_O < V_{CC} + 0.5V . . . . . ±25mA
DC V_{CC} or Ground Current, I_{CC} . . . . . ±50mA

Operating Conditions

Temperature Range, T_A . . . . . -55°C to 125°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)

Thermal Information

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

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:

3. θ_{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	
HC TYPES												
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	Ω
				6	-	60	140	-	175	-	210	Ω
		V_{CC} to GND	V_{CC} to GND	4.5	-	90	180	-	225	-	270	Ω
				6	-	80	160	-	200	-	240	Ω
Maximum "ON" Resistance Between Any Two Switches	ΔR_{ON}	-	-	4.5	-	10	-	-	-	-	-	Ω
				6	-	8.5	-	-	-	-	-	Ω
Switch "Off" Leakage Current 16 Channels	I_{IZ}	$\overline{E}$ = V_{CC}	V_{CC} or GND	6	-	-	±0.8	-	±8	-	±8	µA
Logic Input Leakage Current	I_I	V_{CC} or GND	-	6	-	-	±0.1	-	±1	-	±1	µA
Quiescent Device Current I_O = 0mA	I_{CC}	V_{CC} or GND	-	6	-	-	8	-	80	-	160	µA

DC Electrical Specifications (Continued)

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	
HCT TYPES												
High Level Input Voltage	V_{IH}	-	-	4.5	2	-	-	2	-	2	-	V
Low Level Input Voltage	V_{IL}	-	-	4.5	-	-	0.8	-	0.8	-	0.8	V
Maximum "ON" Resistance I_O = 1mA	R_{ON}	V_{CC} or GND	V_{CC} or GND	4.5	-	70	160	-	200	-	240	Ω
		V_{CC} to GND	V_{CC} to GND	4.5	-	90	180	-	225	-	270	Ω
Maximum "ON" Resistance Between Any Two Switches	ΔR_{ON}	-	-	4.5	-	10	-	-	-	-	-	Ω
Switch "Off" Leakage Current 16 Channels	I_{IZ}	$\overline{E} = V_{CC}$	V_{CC} or GND	6	-	-	±0.8	-	±8	-	±8	µA
Logic Input Leakage Current	I_I	V_{CC} or GND (Note 5)	-	6	-	-	±0.1	-	±1	-	±1	µA
Quiescent Device Current	I_{CC}	V_{CC} or GND	-	6	-	-	8	-	80	-	160	µA
Additional Quiescent Device Current Per Input Pin: 1 Unit Load	ΔI_{CC} (Note 4)	V_{CC} -2.1	-	-	-	100	360	-	450	-	490	µA

NOTES:

4. For dual-supply systems theoretical worst case (V_I = 2.4V, V_{CC} = 5.5V) specification is 1.8mA.
5. Any voltage between V_{CC} and GND.

HCT Input Loading Table

INPUT	UNIT LOADS
S_0 - S_3	0.5
$\overline{E}$	0.3

NOTE: Unit Load is ΔI_{CC} limit specified in DC Electrical Specifications table, e.g., 360µA max at 25°C.

Switching Specifications Input t_r, t_f = 6ns

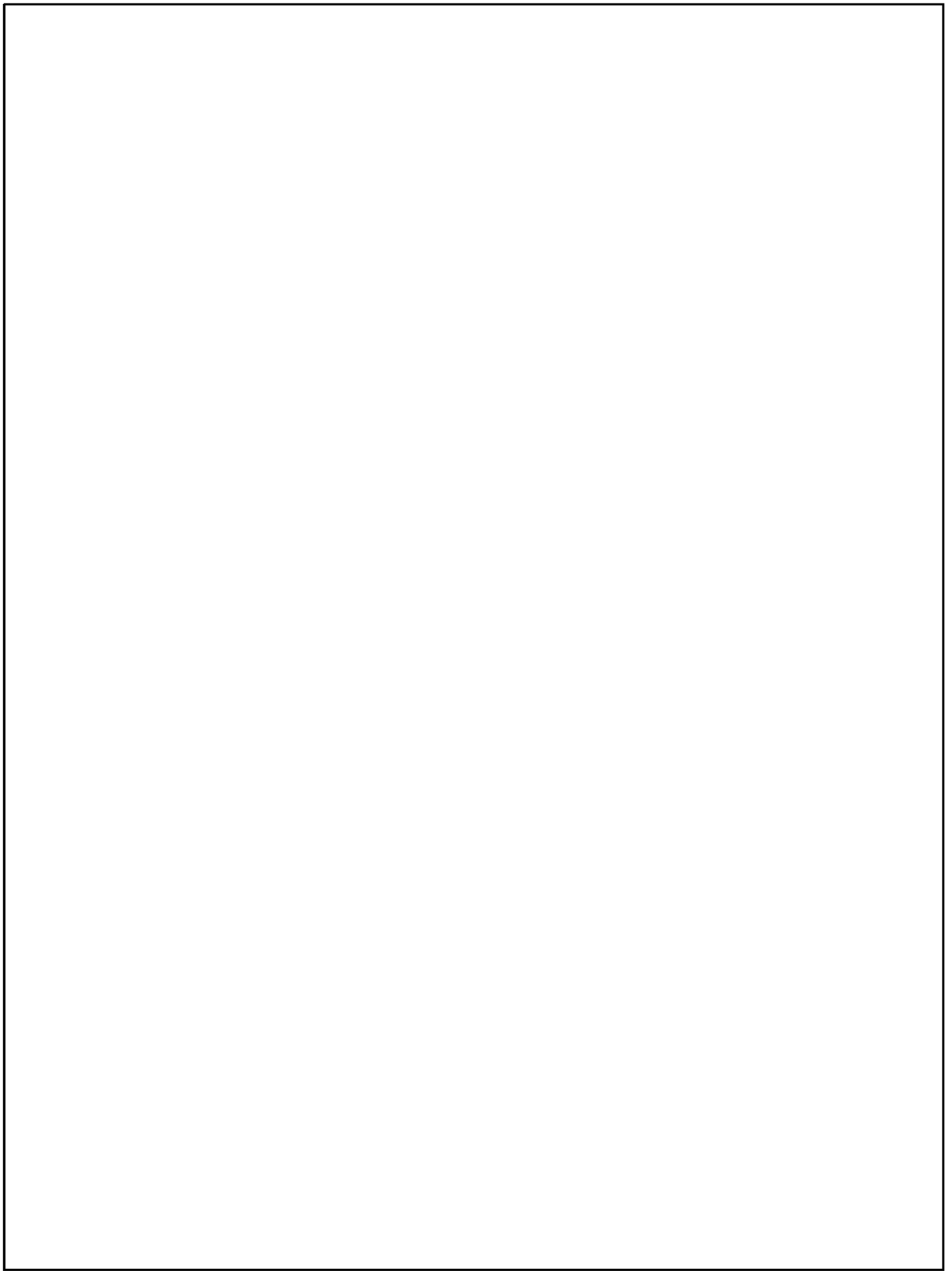
PARAMETER	SYMBOL	TEST CONDITIONS	V_{CC} (V)	25°C			-40°C TO 85°C		-55°C TO 125°C		UNITS
				MIN	TYP	MAX	MIN	MAX	MIN	MAX	
HC TYPES											
Propagation Delay Time Switch In to Out	t_{PLH}, t_{PHL}	C_L = 50pF	2	-	-	75	-	95	-	110	ns
			4.5	-	-	15	-	19	-	22	ns
			6	-	-	13	-	16	-	19	ns
		C_L = 15pF	5	-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

Switching Specifications Input t_r, t_f = 6ns **(Continued)**

PARAMETER	SYMBOL	TEST CONDITIONS	V_{CC} (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_{PZH}, t_{PZL}	C_L = 50pF	2	-	-	300	-	375	-	450	ns
			4.5	-	-	60	-	75	-	90	ns
			6	-	-	51	-	64	-	76	ns
		C_L = 15pF	5	-	25	-	-	-	-	-	ns
Switch Turn Off $\overline{E}$ to Out	t_{PHZ}, t_{PLZ}	C_L = 50pF	2	-	-	275	-	345	-	415	ns
			4.5	-	-	55	-	69	-	83	ns
			6	-	-	47	-	59	-	71	ns
		C_L = 15pF	5	-	23	-	-	-	-	-	ns
Switch Turn Off Sn to Out	t_{PHZ}, t_{PLZ}	C_L = 50pF	2	-	-	290	-	365	-	435	ns
			4.5	-	-	58	-	73	-	87	ns
			6	-	-	49	-	62	-	74	ns
		C_L = 50pF	5	-	21	-	-	-	-	-	ns
Input (Control) Capacitance	C_I	-	-	-	-	10	-	10	-	10	pF
Power Dissipation Capacitance (Notes 6, 7)	C_{PD}	-	5	-	93	-	-	-	-	-	pF
HCT TYPES											
Propagation Delay Time Switch In to Out	t_{PLH}, t_{PHL}	C_L = 50pF	4.5	-	-	15	-	19	-	22	ns
		C_L = 15pF	5	-	6	-	-	-	-	-	ns
Switch Turn On $\overline{E}$ to Out	t_{PZH}, t_{PZL}	C_L = 50pF	4.5	-	-	60	-	75	-	90	ns
		C_L = 15pF	5	-	25	-	-	-	-	-	ns
Switch Turn On Sn to Out	t_{PZH}, t_{PZL}	C_L = 50pF	4.5	-	-	60	-	75	-	90	ns
		C_L = 15pF	5	-	25	-	-	-	-	-	ns
Switch Turn Off $\overline{E}$ to Out	t_{PHZ}, t_{PLZ}	C_L = 50pF	4.5	-	-	55	-	69	-	83	ns
		C_L = 15pF	5	-	23	-	-	-	-	-	ns
Switch Turn Off Sn to Out	t_{PHZ}, t_{PLZ}	C_L = 50pF	4.5	-	-	58	-	73	-	87	ns
		C_L = 15pF	5	-	21	-	-	-	-	-	ns
Input (Control) Capacitance	C_I	-	-	-	-	10	-	10	-	10	pF
Power Dissipation Capacitance (Notes 6, 7)	C_{PD}	-	5	-	96	-	-	-	-	-	pF

NOTES:

6. C_{PD} is used to determine the dynamic power consumption, per package.
7. $P_D = C_{PD} V_{CC}^2 f_i + \Sigma (C_L + C_S) V_{CC}^2 f_o$ where f_i = input frequency, f_o = output frequency, C_L = output load capacitance, C_S = switch capacitance, V_{CC} = supply voltage.



Analog Channel Specifications $T_A = 25^oC$

PARAMETER	TEST CONDITIONS	V_{CC} (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 $\overline{E}$ 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_S		-	5	pF
Common Capacitance, C_{COM}		-	50	pF

NOTES:

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

Typical Performance Curves

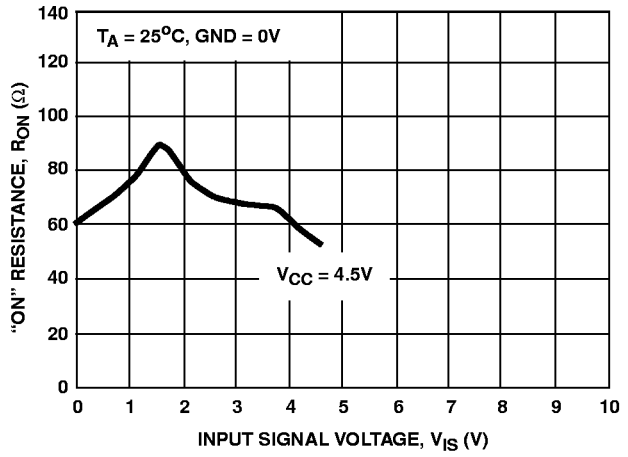


FIGURE 1. TYPICAL "ON" RESISTANCE vs INPUT SIGNAL VOLTAGE

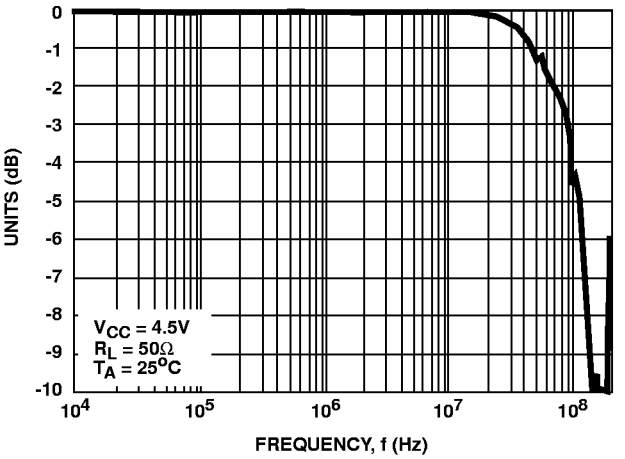


FIGURE 2. TYPICAL SWITCH FREQUENCY RESPONSE

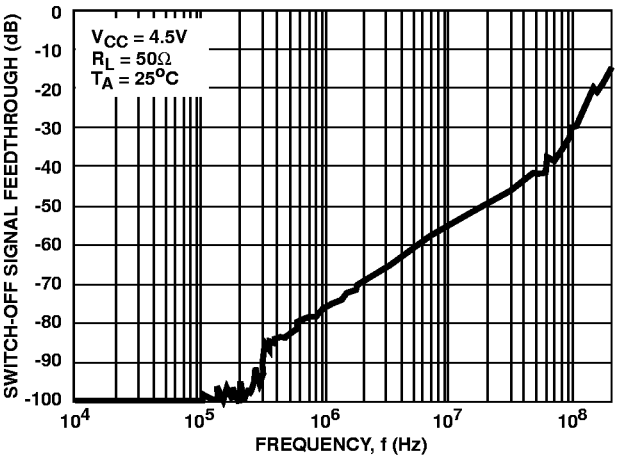


FIGURE 3. TYPICAL SWITCH-OFF SIGNAL FEEDTHROUGH vs FREQUENCY

Analog Test Circuits

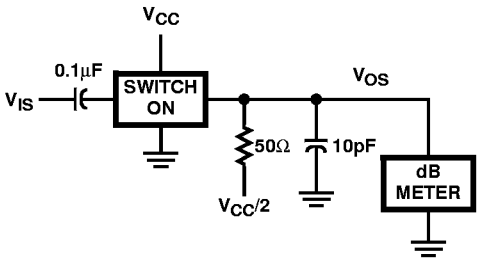


FIGURE 4. FREQUENCY RESPONSE TEST CIRCUIT

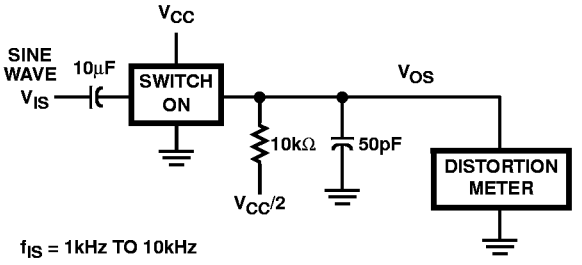


FIGURE 5. SINE WAVE DISTORTION TEST CIRCUIT

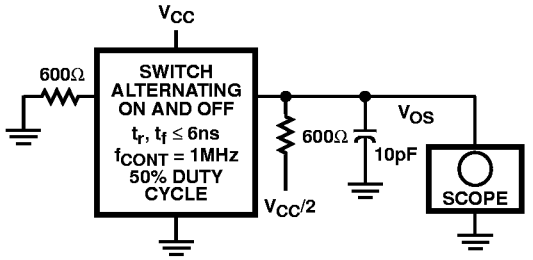


FIGURE 6. CONTROL-TO-SWITCH FEEDTHROUGH NOISE TEST CIRCUIT

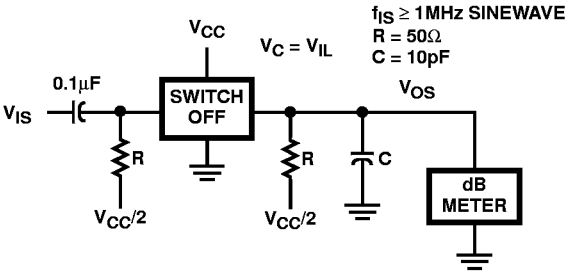


FIGURE 7. SWITCH OFF SIGNAL FEEDTHROUGH TEST CIRCUIT

Test Circuits and Waveforms

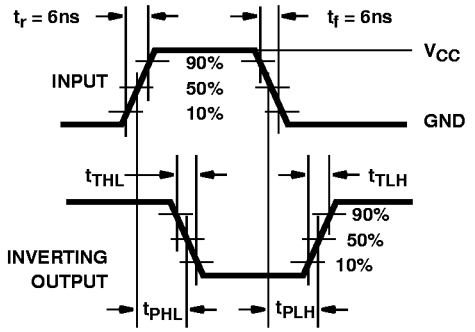


FIGURE 8. HC TRANSITION TIMES AND PROPAGATION DELAY TIMES, COMBINATION LOGIC

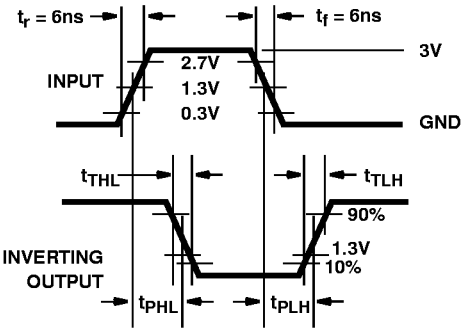


FIGURE 9. HCT TRANSITION TIMES AND PROPAGATION DELAY TIMES, COMBINATION LOGIC