

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

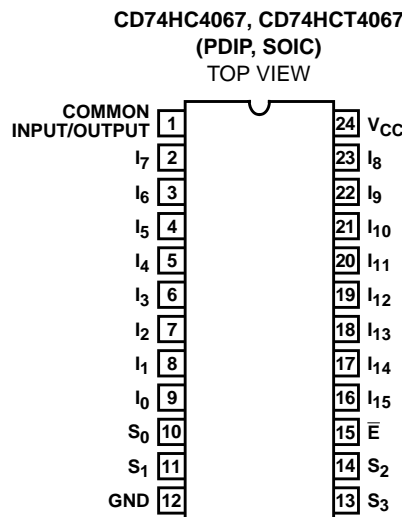
The Harris CD74HC4067 and CD74HCT4067 are digitally controlled analog switches which utilize silicon-gate CMOS technology to achieve operating speeds similar to LSTTL with the low power consumption of standard CMOS integrated circuits.

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.

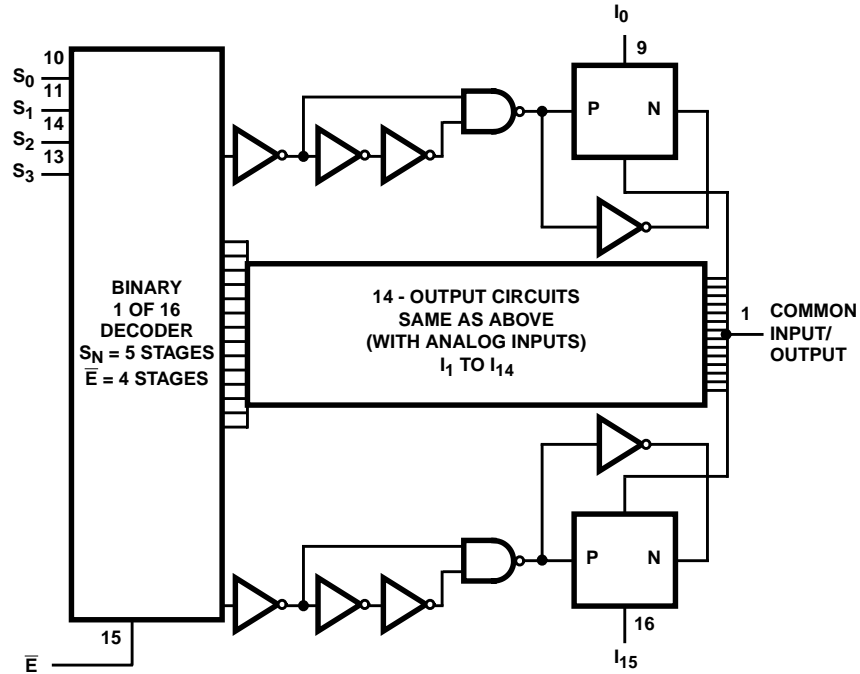
Ordering Information

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



Functional Diagram



TRUTH TABLE

S0	S1	S2	S3	\bar{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

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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)	θ_{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 Types2V 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:

- 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 $^{\circ}C$			-40 $^{\circ}C$ TO 85 $^{\circ}C$		-55 $^{\circ}C$ TO 125 $^{\circ}C$		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}	$\bar{E} = V_{CC}$	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

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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}	$\bar{E} = V_{CC}$	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
\bar{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 \bar{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

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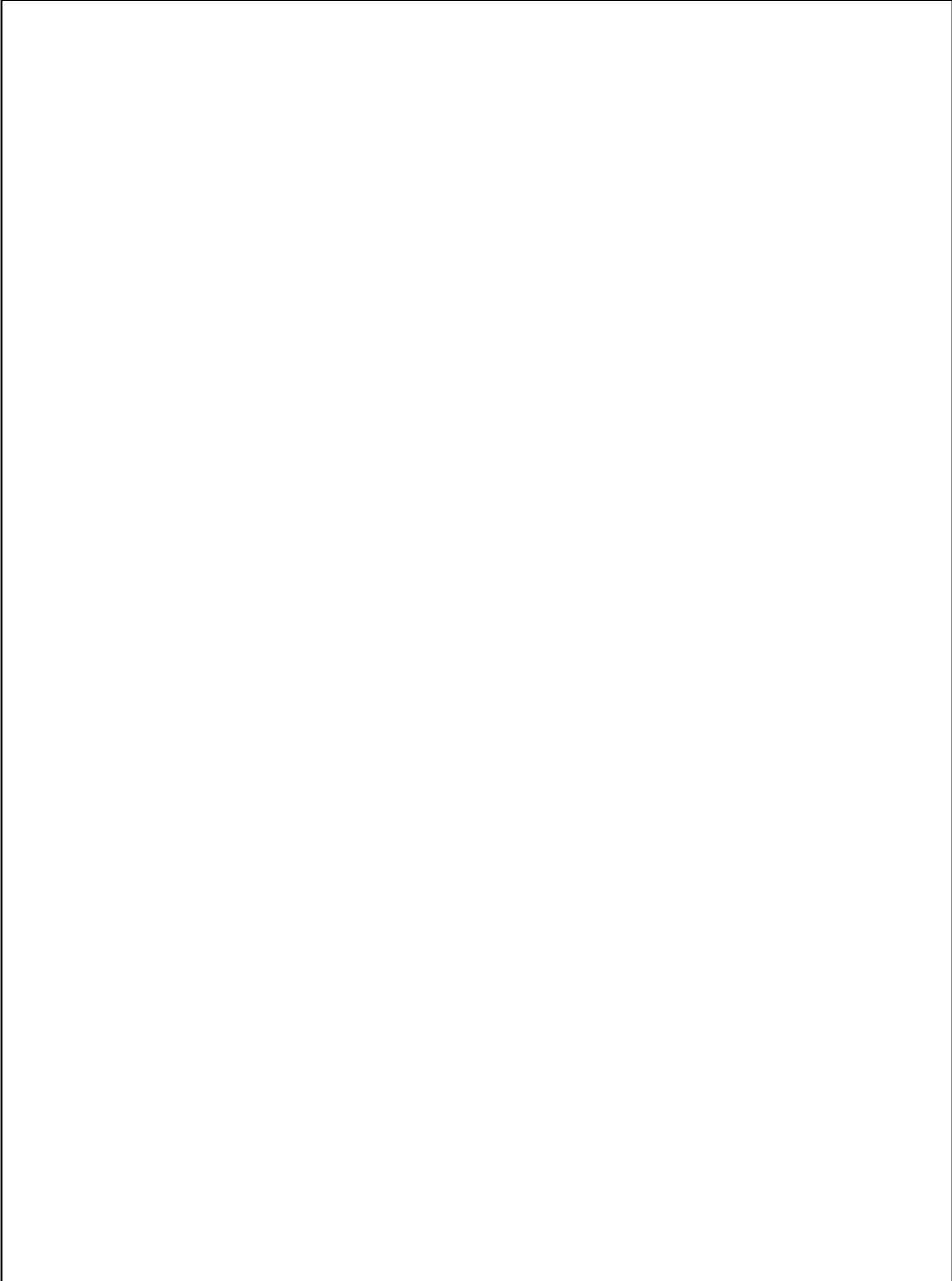
Switching Specifications Input $t_r, t_f = 6\text{ns}$ (Continued)

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 Ē 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 Ē 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 Ē 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. $P_D = C_{PD} V_{CC}^2 f_i + \sum (C_L + C_S) V_{CC}^2 f_o$ 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_{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 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, $f = 1\text{MHz}$.
9. V_{IS} is centered at $V_{CC}/2$.
10. Adjust input for 0dBm at V_{IS} .

Typical Performance Curves

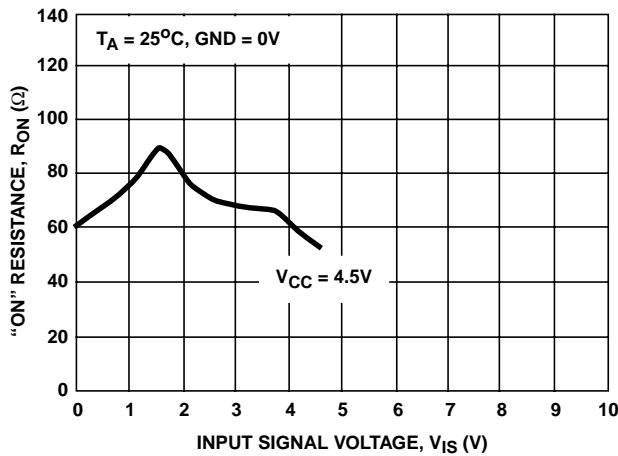


FIGURE 1. TYPICAL "ON" RESISTANCE vs INPUT SIGNAL VOLTAGE

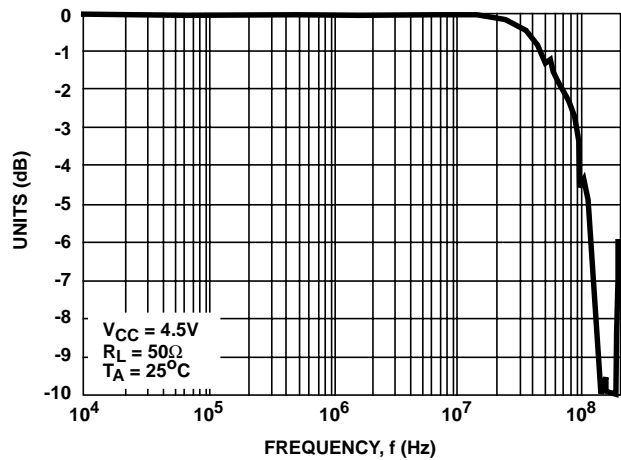


FIGURE 2. TYPICAL SWITCH FREQUENCY RESPONSE

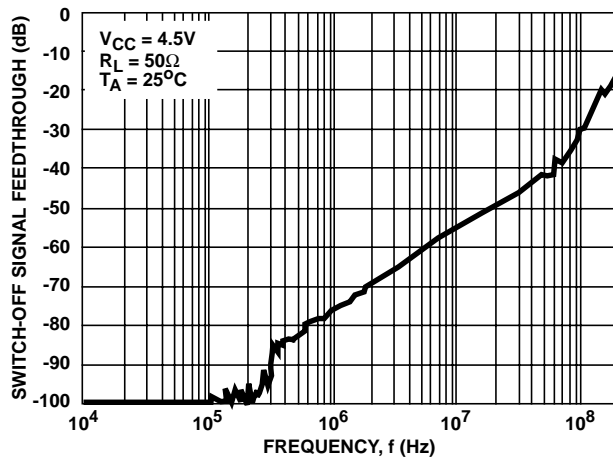


FIGURE 3. TYPICAL SWITCH-OFF SIGNAL FEEDTHROUGH vs FREQUENCY

Analog Test Circuits

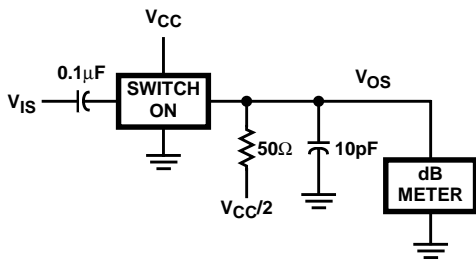
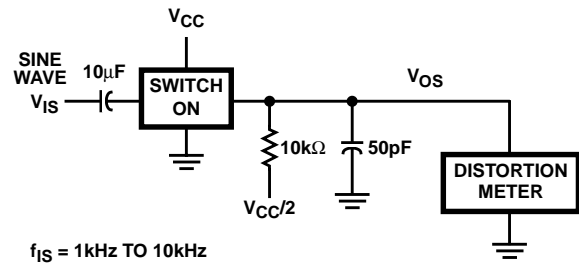


FIGURE 4. FREQUENCY RESPONSE TEST CIRCUIT



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

FIGURE 5. SINE WAVE DISTORTION TEST CIRCUIT

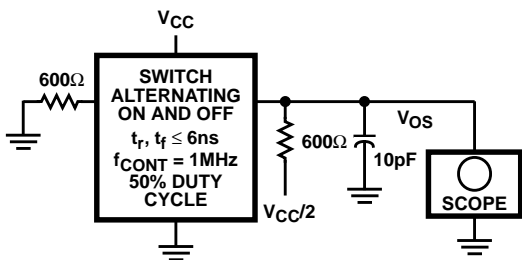


FIGURE 6. CONTROL-TO-SWITCH FEEDTHROUGH NOISE TEST CIRCUIT

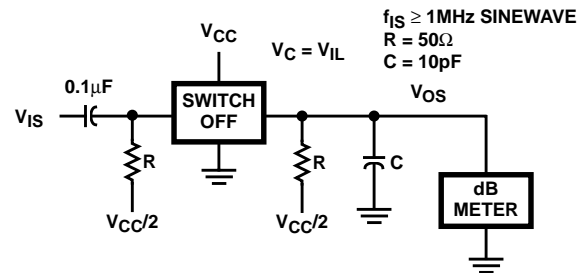


FIGURE 7. SWITCH OFF SIGNAL FEEDTHROUGH TEST CIRCUIT

Test Circuits and Waveforms

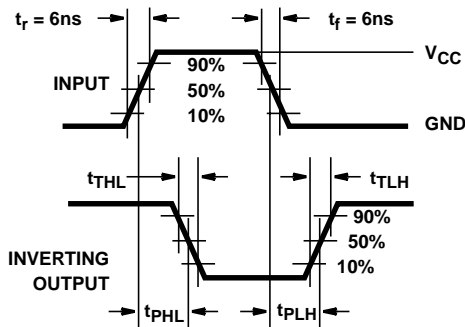


FIGURE 8. HC TRANSITION TIMES AND PROPAGATION DELAY TIMES, COMBINATION LOGIC

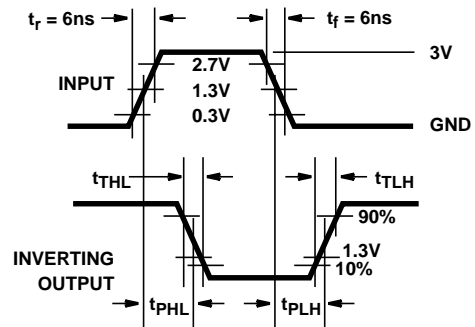


FIGURE 9. HCT TRANSITION TIMES AND PROPAGATION DELAY TIMES, COMBINATION LOGIC

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