MC74LVX4066

Quad Analog Switch/ Multiplexer/Demultiplexer

High−Performance Silicon−Gate CMOS

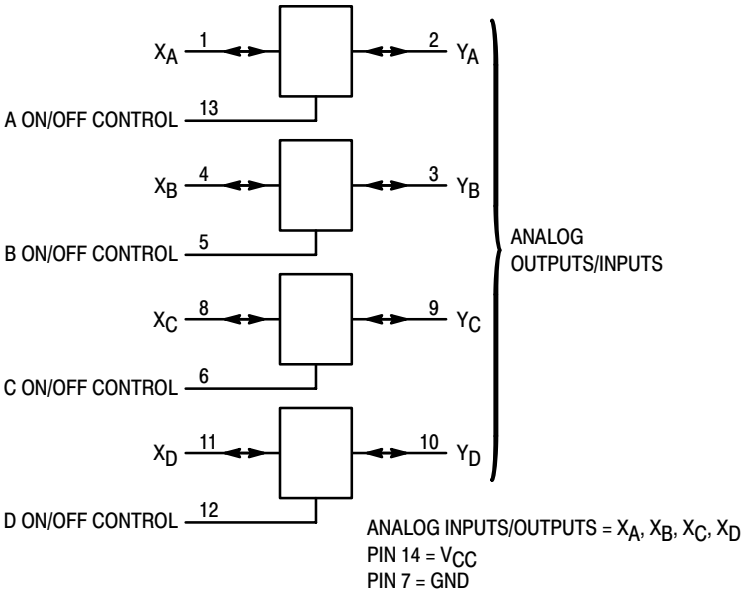
The MC74LVX4066 utilizes silicon−gate CMOS technology to achieve fast propagation delays, low ON resistances, and low OFF−channel leakage current. This bilateral switch/multiplexer/ demultiplexer controls analog and digital voltages that may vary across the full power−supply range (from V_{CC} to GND).

The LVX4066 is identical in pinout to the metal−gate CMOS MC14066 and the high−speed CMOS HC4066A. Each device has four independent switches. The device has been designed so that the ON resistances (R_{ON}) are much more linear over input voltage than R_{ON} of metal−gate CMOS analog switches.

The ON/OFF control inputs are compatible with standard CMOS outputs; with pull−up resistors, they are compatible with LSTTL outputs.

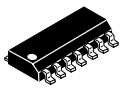
- Fast Switching and Propagation Speeds
- High ON/OFF Output Voltage Ratio
- Low Crosstalk Between Switches
- Diode Protection on All Inputs/Outputs
- Wide Power−Supply Voltage Range (V_{CC} − GND) = 2.0 to 6.0 Volts
- Analog Input Voltage Range (V_{CC} − GND) = 2.0 to 6.0 Volts
- Improved Linearity and Lower ON Resistance over Input Voltage than the MC14016 or MC14066
- Low Noise
- Chip Complexity: 44 FETs or 11 Equivalent Gates

LOGIC DIAGRAM



ON Semiconductor

http://onsemi.com



14−LEAD SOIC
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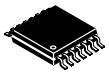
CASE 751A



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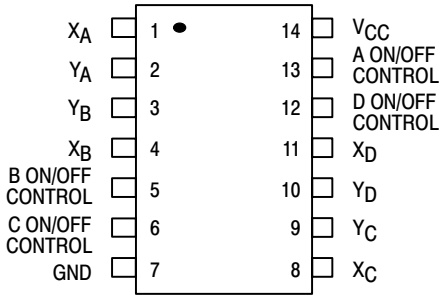
CASE 948G

PIN CONNECTION AND MARKING DIAGRAM (Top View)



For detailed package marking information, see the Marking Diagram section on page 139 of this data sheet.

FUNCTION TABLE

On/Off Control Input	State of Analog Switch
L	Off
H	On

ORDERING INFORMATION

Device	Package	Shipping
MC74LVX4066D	SOIC	55 Units/Rail
MC74LVX4066DR2	SOIC	2500 Units/Reel
MC74LVX4066DT	TSSOP	96 Units/Rail
MC74LVX4066DTR2	TSSOP	2500 Units/Reel

MAXIMUM RATINGS*

Symbol	Parameter	Value	Unit
V_{CC}	Positive DC Supply Voltage (Referenced to GND)	– 0.5 to + 7.0	V
V_{IS}	Analog Input Voltage (Referenced to GND)	– 0.5 to V_{CC} + 0.5	V
V_{in}	Digital Input Voltage (Referenced to GND)	– 0.5 to V_{CC} + 0.5	V
I_{in}	DC Current Into or Out of ON/OFF Control Pins	± 20	mA
I_S	DC Current Into or Out of Switch Pins	± 20	mA
P_D	Power Dissipation in Still Air, SOIC Package†	500	mW
	TSSOP Package†	450	
T_{stg}	Storage Temperature	– 65 to + 150	°C
T_L	Lead Temperature, 1 mm from Case for 10 Seconds	260	°C

*Maximum Ratings are those values beyond which damage to the device may occur. Functional operation should be restricted to the Recommended Operating Conditions.
†Derating — SOIC Package: – 7 mW/°C from 65° to 125°C
TSSOP Package: − 6.1 mW/°C from 65° to 125°C

This device contains protection circuitry to guard against damage due to high static voltages or electric fields. However, precautions must be taken to avoid applications of any voltage higher than maximum rated voltages to this high−impedance circuit. For proper operation, V_{in} and V_{out} should be constrained to the range GND ≤ (V_{in} or V_{out}) ≤ V_{CC}.

Unused inputs must always be tied to an appropriate logic voltage level (e.g., either GND or V_{CC}). Unused outputs must be left open. I/O pins must be connected to a properly terminated line or bus.

RECOMMENDED OPERATING CONDITIONS

Symbol	Parameter	Min	Max	Unit
V_{CC}	Positive DC Supply Voltage (Referenced to GND)	2.0	6.0	V
V_{IS}	Analog Input Voltage (Referenced to GND)	GND	V_{CC}	V
V_{in}	Digital Input Voltage (Referenced to GND)	GND	V_{CC}	V
V_{IO}*	Static or Dynamic Voltage Across Switch	—	1.2	V
T_A	Operating Temperature, All Package Types	– 55	+ 85	°C
t_r, t_f	Input Rise and Fall Time, ON/OFF Control			ns/V
	Inputs (Figure 10) V_{CC} = 3.3 V ± 0.3 V	0	100	
	V_{CC} = 5.0 V ± 0.5 V	0	20	

*For voltage drops across the switch greater than 1.2 V (switch on), excessive V_{CC} current may be drawn; i.e., the current out of the switch may contain both V_{CC} and switch input components. The reliability of the device will be unaffected unless the Maximum Ratings are exceeded.

DC ELECTRICAL CHARACTERISTIC Digital Section (Voltages Referenced to GND)

Symbol	Parameter	Test Conditions	V_{CC} V	Guaranteed Limit			Unit
				– 55 to 25°C	≤ 85°C	≤ 125°C	
V_{IH}	Minimum High−Level Voltage ON/OFF Control Inputs (Note 1)	R_{on} = Per Spec	2.0	1.5	1.5	1.5	V
			3.0	2.1	2.1	2.1	
			4.5	3.15	3.15	3.15	
			5.5	3.85	3.85	3.85	
V_{IL}	Maximum Low−Level Voltage ON/OFF Control Inputs (Note 1)	R_{on} = Per Spec	2.0	0.5	0.5	0.5	V
			3.0	0.9	0.9	0.9	
			4.5	1.35	1.35	1.35	
			5.5	1.65	1.65	1.65	
I_{in}	Maximum Input Leakage Current ON/OFF Control Inputs	V_{in} = V_{CC} or GND	5.5V	± 0.1	± 1.0	± 1.0	μA
I_{CC}	Maximum Quiescent Supply Current (per Package)	V_{in} = V_{CC} or GND V_{IO} = 0 V	5.5	4.0	40	160	μA

7. Specifications are for design target only. Not final specification limits.

DC ELECTRICAL CHARACTERISTICS Analog Section (Voltages Referenced to GND)

Symbol	Parameter	Test Conditions	V_{CC} V	Guaranteed Limit			Unit
				− 55 to 25°C	≤ 85°C	≤ 125°C	
R_{on}	Maximum "ON" Resistance	$V_{in} = V_{IH}$ $V_{IS} = V_{CC}$ to GND $\|I_S\| \leq 10$ mA (Figures 1, 2)	2.0† 3.0 4.5 5.5	— 40 25 20	— 45 30 25	— 50 35 30	Ω
		$V_{in} = V_{IH}$ $V_{IS} = V_{CC}$ or GND (Endpoints) $\|I_S\| \leq 10$ mA (Figures 1, 2)	2.0 3.0 4.5 5.5	— 30 25 20	— 35 30 25	— 40 35 30	
ΔR_{on}	Maximum Difference in "ON" Resistance Between Any Two Channels in the Same Package	$V_{in} = V_{IH}$ V_{IS} = 1/2 (V_{CC} − GND) $I_S \leq 2.0$ mA	3.0 4.5 5.5	15 10 10	20 12 12	25 15 15	Ω
I_{off}	Maximum Off−Channel Leakage Current, Any One Channel	$V_{in} = V_{IL}$ $V_{IO} = V_{CC}$ or GND Switch Off (Figure 3)	5.5	0.1	0.5	1.0	μA
I_{on}	Maximum On−Channel Leakage Current, Any One Channel	$V_{in} = V_{IH}$ $V_{IS} = V_{CC}$ or GND (Figure 4)	5.5	0.1	0.5	1.0	μA

†At supply voltage (V_{CC}) approaching 2 V the analog switch−on resistance becomes extremely non−linear. Therefore, for low−voltage operation, it is recommended that these devices only be used to control digital signals (See Figure 1a).

AC ELECTRICAL CHARACTERISTICS (C_L = 50 pF, ON/OFF Control Inputs: $t_r = t_f$ = 6 ns)

Symbol	Parameter	V_{CC} V	Guaranteed Limit			Unit
			− 55 to 25°C	≤ 85°C	≤ 125°C	
t_{PLH}, t_{PHL}	Maximum Propagation Delay, Analog Input to Analog Output (Figures 8 and 9)	2.0 3.0 4.5 5.5	4.0 3.0 1.0 1.0	6.0 5.0 2.0 2.0	8.0 6.0 2.0 2.0	ns
t_{PLZ}, t_{PHZ}	Maximum Propagation Delay, ON/OFF Control to Analog Output (Figures 10 and 11)	2.0 3.0 4.5 5.5	30 20 15 15	35 25 18 18	40 30 22 20	ns
t_{PZL}, t_{PZH}	Maximum Propagation Delay, ON/OFF Control to Analog Output (Figures 10 and 1 1)	2.0 3.0 4.5 5.5	20 12 8.0 8.0	25 14 10 10	30 15 12 12	ns
C	Maximum Capacitance — ON/OFF Control Input	—	10	10	10	pF
	Control Input = GND Analog I/O Feedthrough	 — —	 35 1.0	 35 1.0	 35 1.0	

		Typical @ 25°C, V_{CC} = 5.0 V	
C_{PD}	Power Dissipation Capacitance (Per Switch) (Figure 13)*	15	pF

* Used to determine the no−load dynamic power consumption: $P_D = C_{PD} V_{CC}^2 f + I_{CC} V_{CC}$.

ADDITIONAL APPLICATION CHARACTERISTICS (Voltages Referenced to GND Unless Noted)

Symbol	Parameter	Test Conditions	V_{CC} V	Limit* 25°C	Unit
BW	Maximum On−Channel Bandwidth or Minimum Frequency Response (Figure 5)	f_{in} = 1 MHz Sine Wave Adjust f_{in} Voltage to Obtain 0 dBm at V_{OS} Increase f_{in} Frequency Until dB Meter Reads – 3 dB R_L = 50 Ω, C_L = 10 pF	4.5 5.5	150 160	MHz
—	Off−Channel Feedthrough Isolation (Figure 6)	$f_{in} \equiv$ Sine Wave Adjust f_{in} Voltage to Obtain 0 dBm at V_{IS} f_{in} = 10 kHz, R_L = 600 Ω, C_L = 50 pF	4.5 5.5	− 50 − 50	dB
		f_{in} = 1.0 MHz, R_L = 50 Ω, C_L = 10 pF	4.5 5.5	− 37 − 37	
—	Feedthrough Noise, Control to Switch (Figure 7)	$V_{in} \leq$ 1 MHz Square Wave ($t_r = t_f$ = 6 ns) Adjust R_L at Setup so that I_S = 0 A R_L = 600 Ω, C_L = 50 pF	4.5 5.5	100 200	mV_{PP}
		R_L = 10 kΩ, C_L = 10 pF	4.5 5.5	50 100	
—	Crosstalk Between Any Two Switches (Figure 12)	$f_{in} \equiv$ Sine Wave Adjust f_{in} Voltage to Obtain 0 dBm at V_{IS} f_{in} = 10 kHz, R_L = 600 Ω, C_L = 50 pF	4.5 5.5	– 70 – 70	dB
		f_{in} = 1.0 MHz, R_L = 50 Ω, C_L = 10 pF	4.5 5.5	– 80 – 80	
THD	Total Harmonic Distortion (Figure 14)	f_{in} = 1 kHz, R_L = 10 kΩ, C_L = 50 pF $THD = THD_{Measured} - THD_{Source}$ V_{IS} = 4.0 V_{PP} sine wave V_{IS} = 5.0 V_{PP} sine wave	 4.5 5.5	 0.10 0.06	%

*Guaranteed limits not tested. Determined by design and verified by qualification.

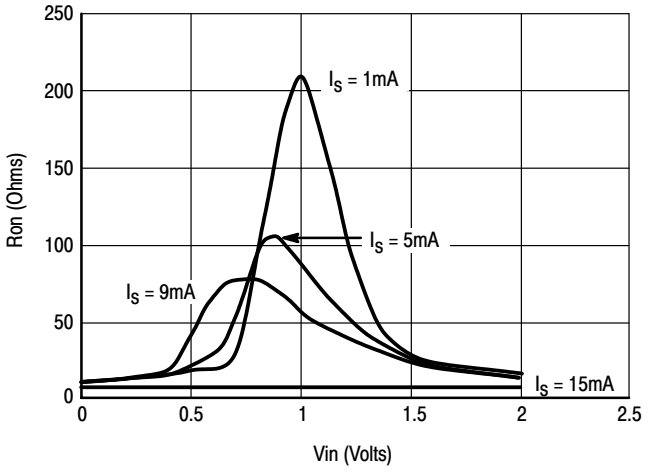


Figure 1a. Typical On Resistance, V_{CC} = 2.0 V, T = 25°C

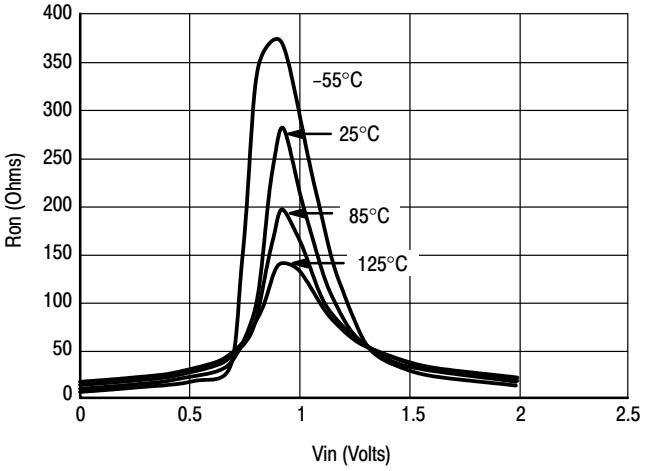


Figure 1b. Typical On Resistance, V_{CC} = 2.0 V

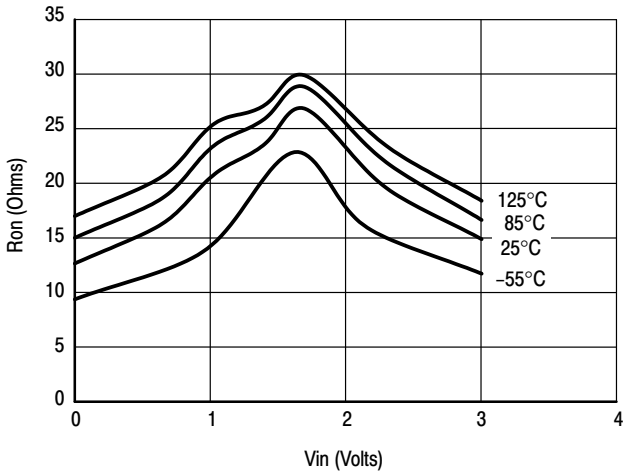


Figure 1c. Typical On Resistance, V_{CC} = 3.0 V

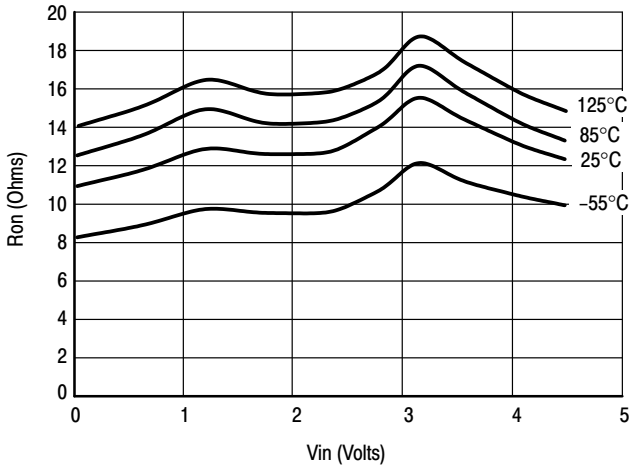


Figure 1d. Typical On Resistance, V_{CC} = 4.5 V

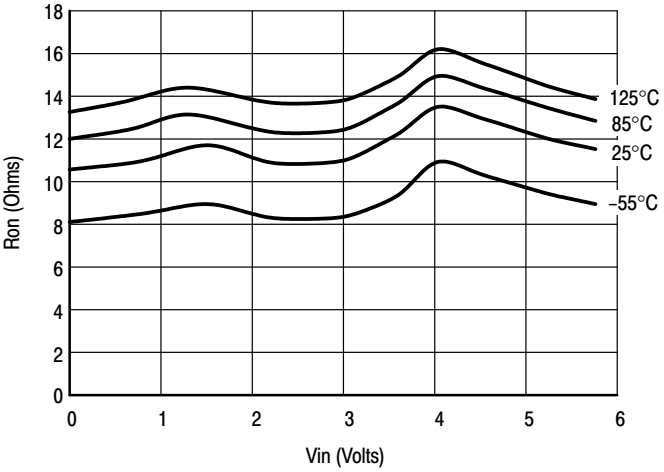


Figure 1e. Typical On Resistance, V_{CC} = 5.5 V

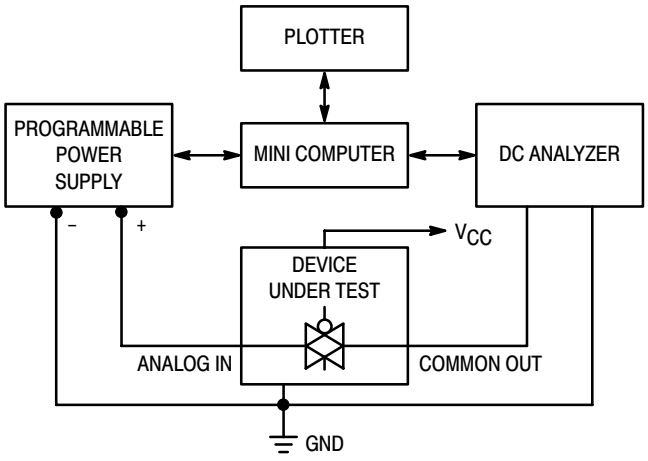


Figure 2. On Resistance Test Set−Up

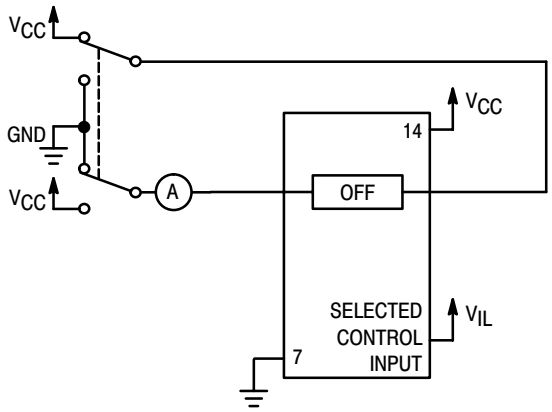


Figure 3. Maximum Off Channel Leakage Current, Any One Channel, Test Set−Up

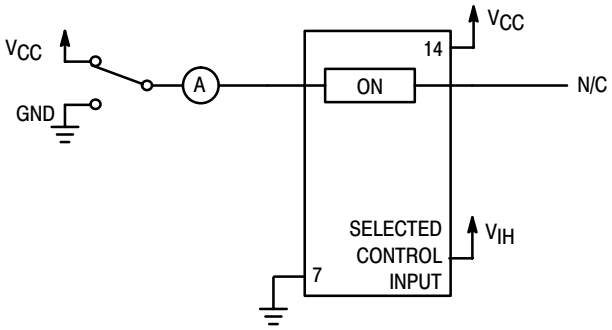
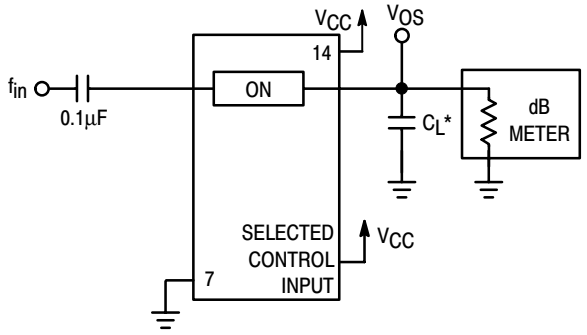
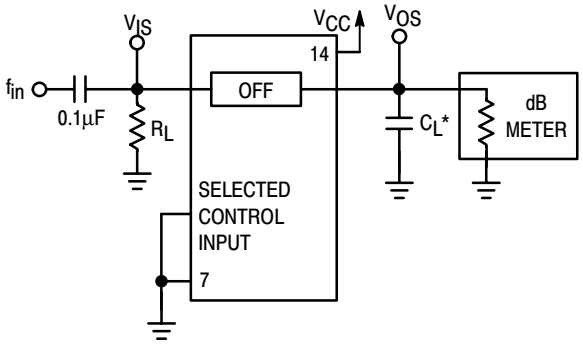


Figure 4. Maximum On Channel Leakage Current, Test Set−Up



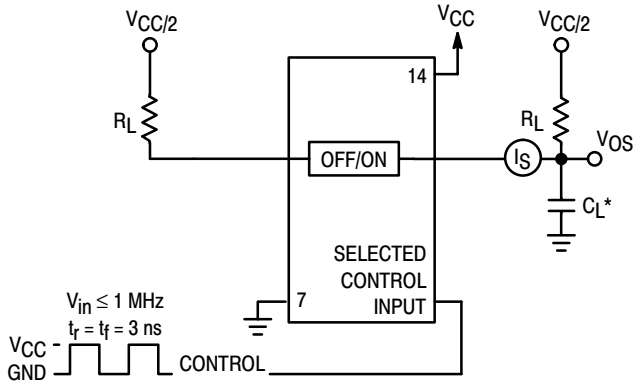
*Includes all probe and jig capacitance.

Figure 5. Maximum On−Channel Bandwidth Test Set−Up



*Includes all probe and jig capacitance.

Figure 6. Off−Channel Feedthrough Isolation, Test Set−Up



*Includes all probe and jig capacitance.

Figure 7. Feedthrough Noise, ON/OFF Control to Analog Out, Test Set−Up

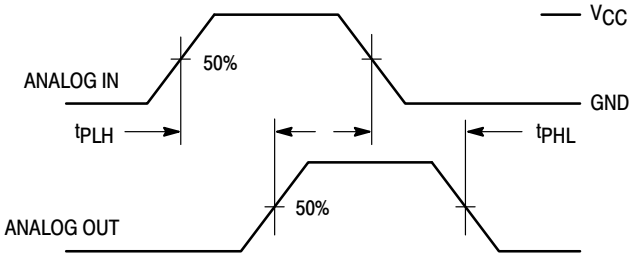
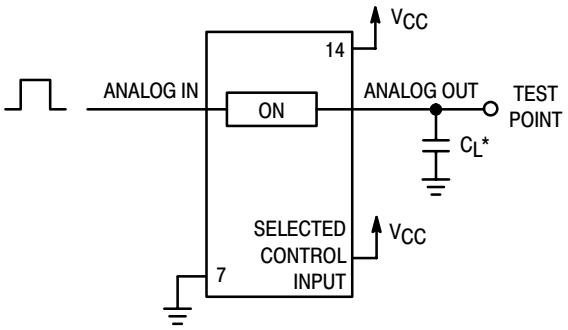


Figure 8. Propagation Delays, Analog In to Analog Out



*Includes all probe and jig capacitance.

Figure 9. Propagation Delay Test Set−Up

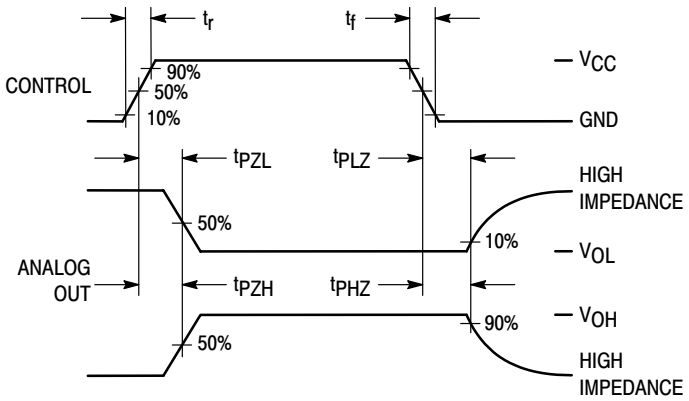
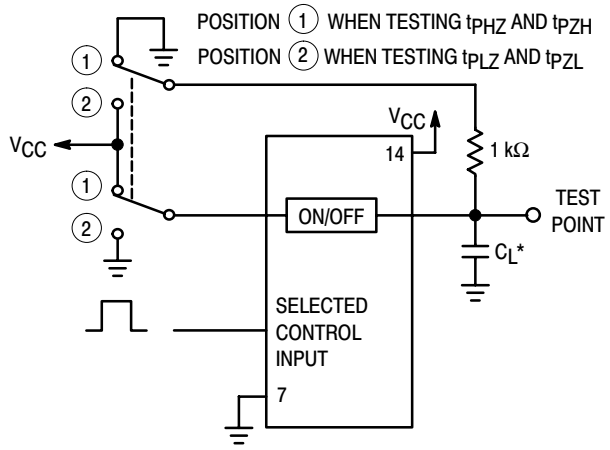
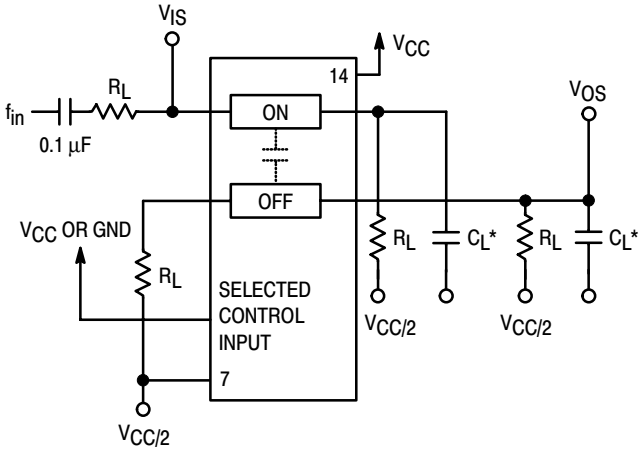


Figure 10. Propagation Delay, ON/OFF Control to Analog Out



*Includes all probe and jig capacitance.

Figure 11. Propagation Delay Test Set−Up



*Includes all probe and jig capacitance.

Figure 12. Crosstalk Between Any Two Switches, Test Set−Up

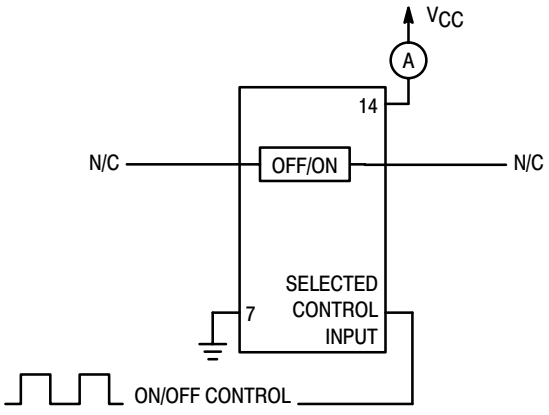
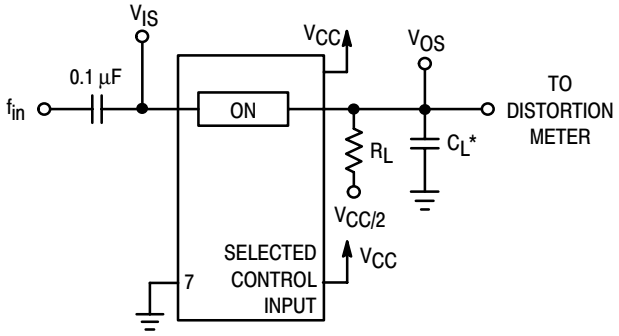


Figure 13. Power Dissipation Capacitance Test Set−Up



*Includes all probe and jig capacitance.

Figure 14. Total Harmonic Distortion, Test Set−Up

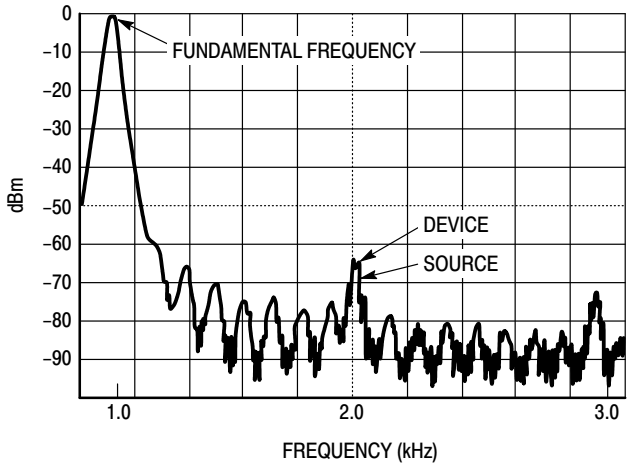


Figure 15. Plot, Harmonic Distortion

APPLICATION INFORMATION

The ON/OFF Control pins should be at V_{CC} or GND logic levels, V_{CC} being recognized as logic high and GND being recognized as a logic low. Unused analog inputs/outputs may be left floating (not connected). However, it is advisable to tie unused analog inputs and outputs to V_{CC} or GND through a low value resistor. This minimizes crosstalk and feedthrough noise that may be picked−up by the unused I/O pins.

The maximum analog voltage swings are determined by the supply voltages V_{CC} and GND. The positive peak analog voltage should not exceed V_{CC}. Similarly, the negative peak analog voltage should not go below GND. In the example below, the difference between V_{CC} and GND is six volts. Therefore, using the configuration in Figure 16, a maximum analog signal of six volts peak−to−peak can be controlled.

When voltage transients above V_{CC} and/or below GND are anticipated on the analog channels, external diodes (Dx) are recommended as shown in Figure 17. These diodes should be small signal, fast turn−on types able to absorb the maximum anticipated current surges during clipping. An alternate method would be to replace the Dx diodes with Mosorbs (Mosorb™ is an acronym for high current surge protectors). Mosorbs are fast turn−on devices ideally suited for precise DC protection with no inherent wear out mechanism.

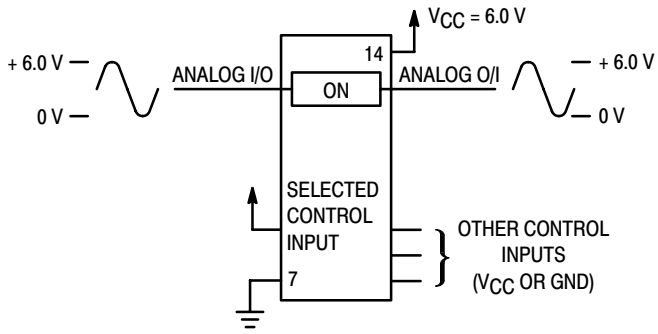


Figure 16. 6.0 V Application

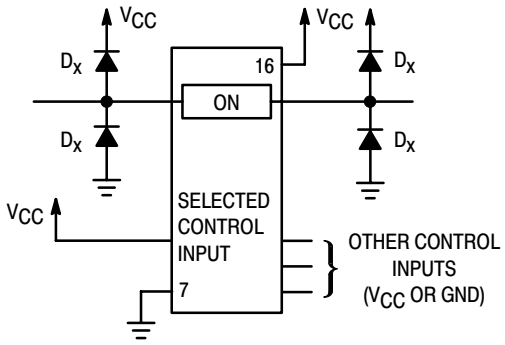
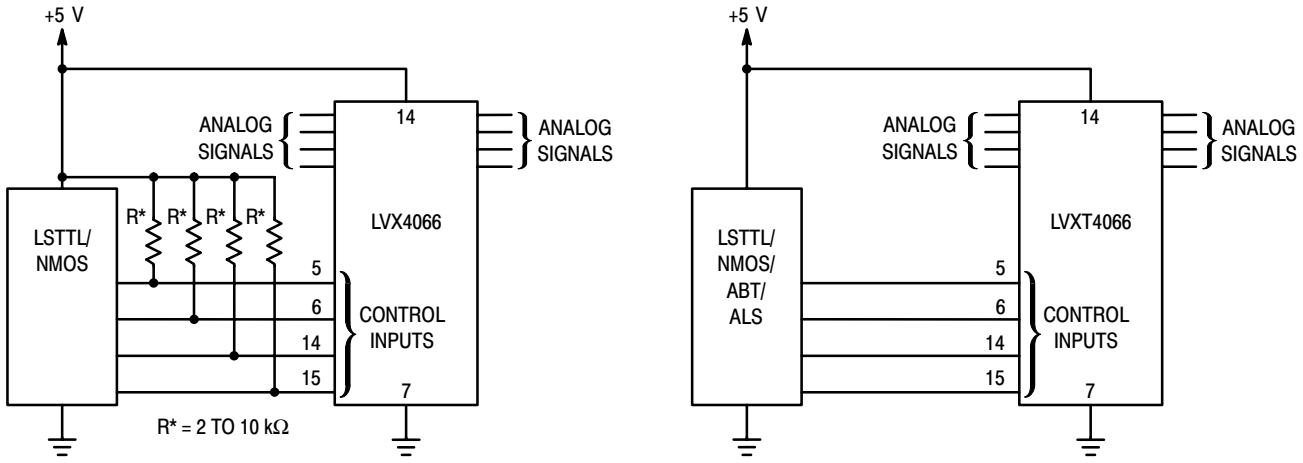


Figure 17. Transient Suppressor Application



a. Using Pull-Up Resistors **b. Using LVXT4066**

Figure 18. LSTTL/NMOS to CMOS Interface

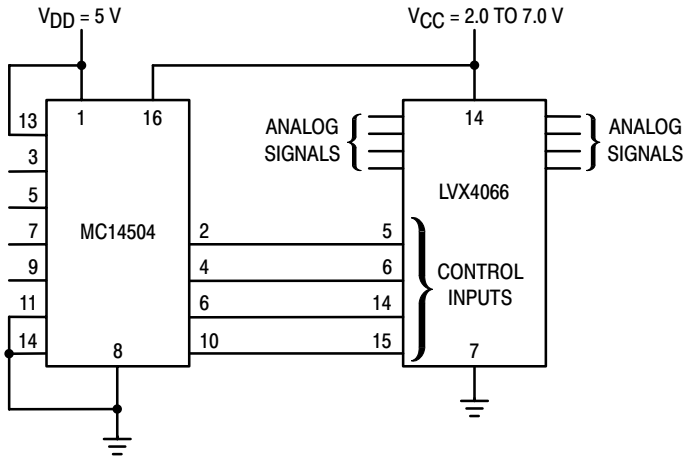


Figure 19. TTL/NMOS−to−CMOS Level Converter Analog Signal Peak−to−Peak Greater than 5 V

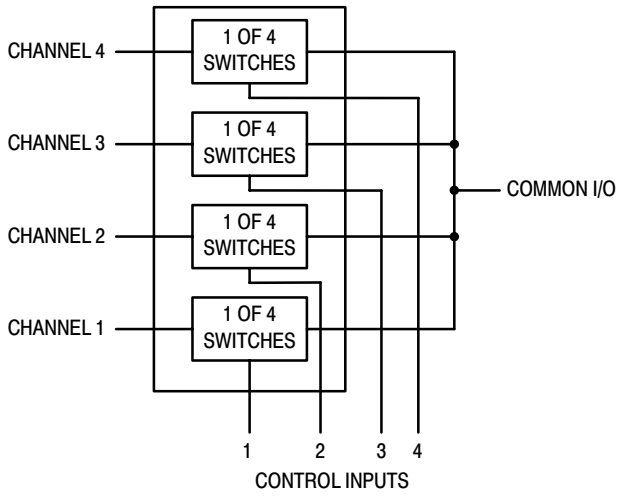


Figure 20. 4−Input Multiplexer

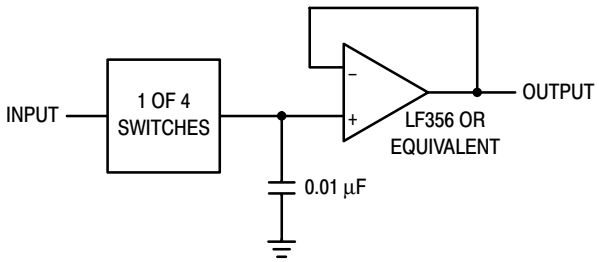
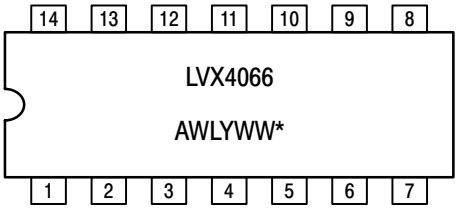


Figure 21. Sample/Hold Amplifier

MARKING DIAGRAMS
(Top View)



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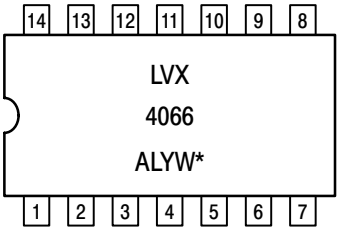
D SUFFIX
CASE 751A



14−LEAD TSSOP
DT SUFFIX
CASE 948G

*See Applications Note #AND8004/D for date code and traceability information.