ANALOG DEVICES

AN-32
APPLICATION NOTE

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Single Supply Operation of JFET Multiplexers

INTRODUCTION

In addition to normal operation (+/- supplies), the ADI family of JFET multiplexers (MUX-08/88, MUX-24, MUX-16, and MUX-28) performs quite well in single supply systems. This Application Note explains single supply operation as it applies to JFET and CMOS multiplexers. Common requirements are in battery-operated systems and in microprocessor-based, single supply data acquisition systems. JFET and CMOS devices are compared for R_{ON} variation versus power supply voltage (V_S), then settling times.

CONNECTIONS FOR SINGLE SUPPLY OPERATION

Figure 1 shows single supply connections for the entire ADI JFET multiplexer family. Each multiplexer handles 0 to +10V signals with a +15V supply. The signal range is conservatively rated to be (V_S − 4V) as a maximum, and zero volt as a minimum.

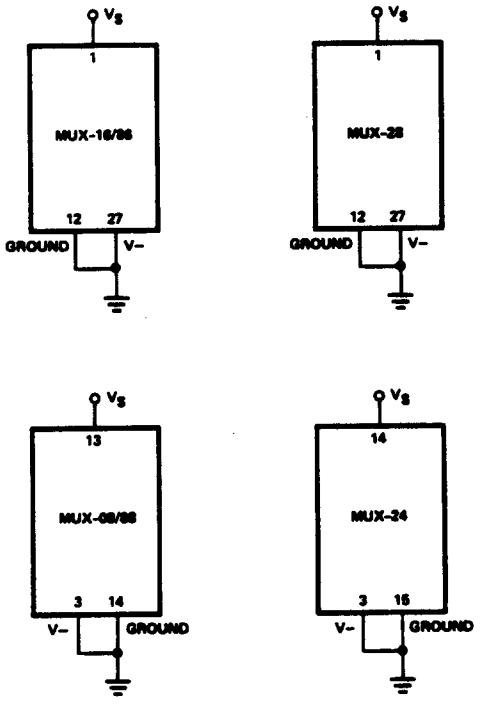

Figure 1. JFET Multiplexer Single Supply Connections

JFET VARIATION OF R_{ON} WITH V_S (MUX-08)

Figure 2 shows the test circuit and defines the test conditions (MUX-08). Figure 3 shows the performance of a MUX-08 driving a 1kΩ load. The positive voltage should be 1.10V and the negative voltage should be −0.4V. The reason for the output voltages being less (magnitude) than the above is due to the R_{ON} of the multiplexer switches. Curves 1 and 2 show that R_{ON} does not vary as V_S varies from +5V to +15V.

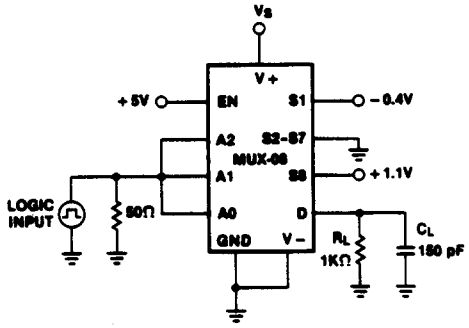

Figure 2. Test Circuit

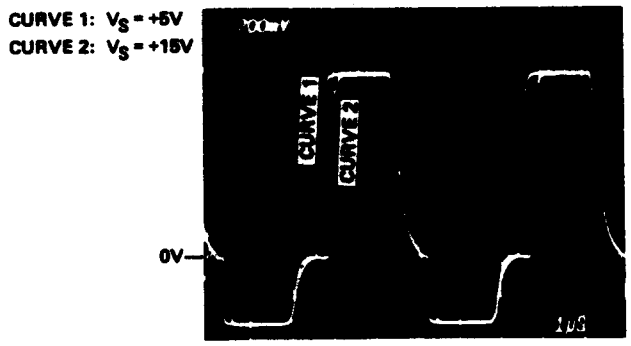

Figure 3. JFET Variation of R_{ON} with V_S

CMOS VARIATION OF R_{ON} WITH V_S (508 Pin-Compatible Device)

The CMOS multiplexer (connected as shown in Figure 4) **does** show a variation in R_{ON} as V_S is varied from +6V to 15V. This is evidenced by the curves shown in Figure 5. Note .at while the positive peak voltages in Figure 3 are the same for both curves, the peaks differ in Figure 5.

One very important consideration when choosing a multiplexer is the nonlinearity (or distortion) introduced by the switch when it is ON. What is important is the **change** in R_{ON} which occurs because of external variations such as power supplies. In particular, the variation in R_{ON} shown in Figure 3 is 148 ohms. The R_{ON} at $V_S = +6V$ is 1000 ohms, while its value at $V_S = +15V$ is only 852 ohms. A change of 148 ohms represents a 1.48% error if the load resistor is 10,000 ohms. In battery-operated systems (which is what a lot of single supply applications are), distortion due to power supply variations is generally not acceptable.

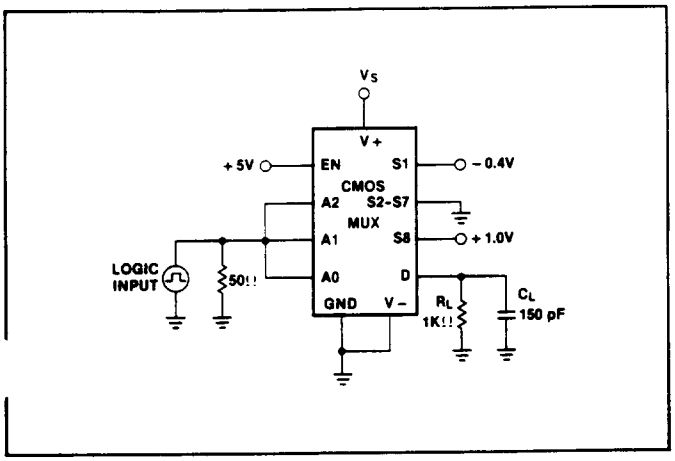

Figure 4. Test Circuit

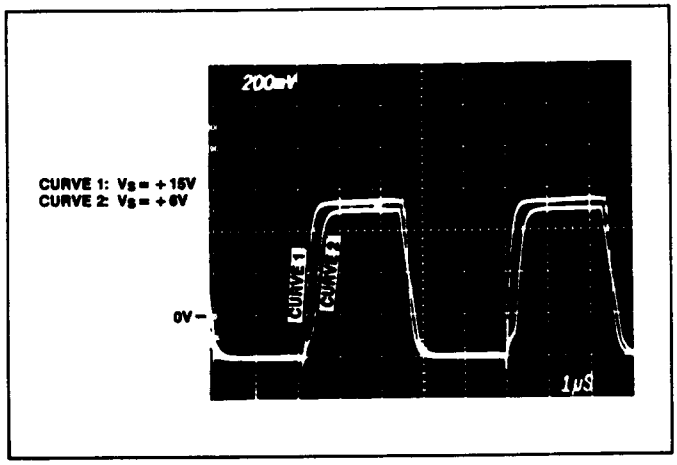

Figure 5. CMOS Variation of R_{ON} with V_S

CMOS vs JFET — EFFECT OF R_{ON} ON SETTLING TIME

Figure 6 defines the test conditions used for the JFET and CMOS multiplexer curves shown in Figure 7. In this case, R_L is large enough so that the output voltages will reach the input voltage levels. Note that MUX-08 does just that, while the CMOS multiplexer does not reach the final value.

The problem is settling time, and occurs because the R_{ON} of the CMOS device is considerably larger than the MUX-08 (852 ohms as opposed to 250 ohms). A final note concerns the fact that the multiplexers are switching signals at 400mV more negative than the negative supply voltage without appreciable distortion. In no circumstances should the input exceed one diode voltage below the negative supply voltage.

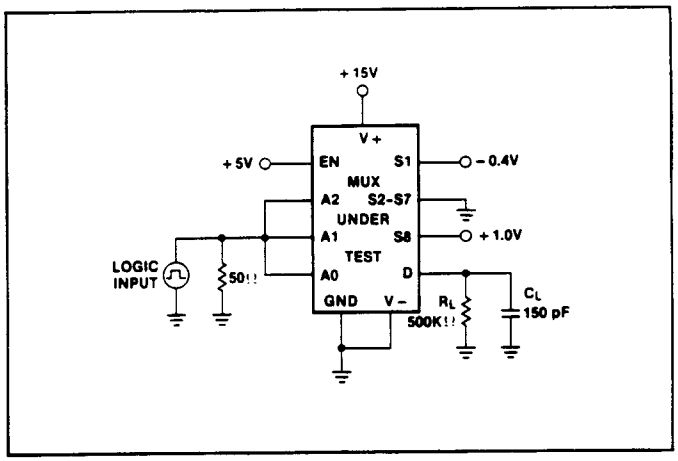

Figure 6. Test Circuit

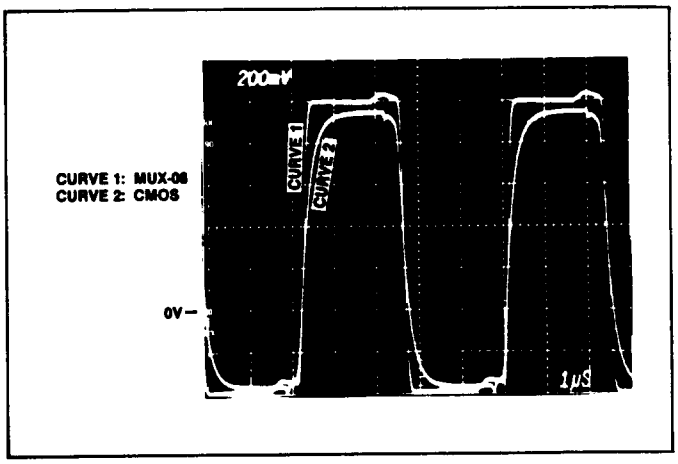

Figure 7. CMOS vs JFET Settling Time (Unloaded Output Voltage)

CONCLUSION

The information presented has shown how JFET multiplexers handle analog inputs in single supply systems, with R_{ON} independent of power supply variations, and with fast settling time.