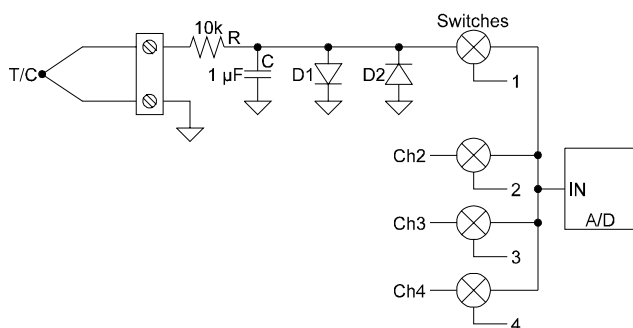


## Application Note

### Using the CS5525/CS5526 in Multiplexed Applications

By Jerome Johnston

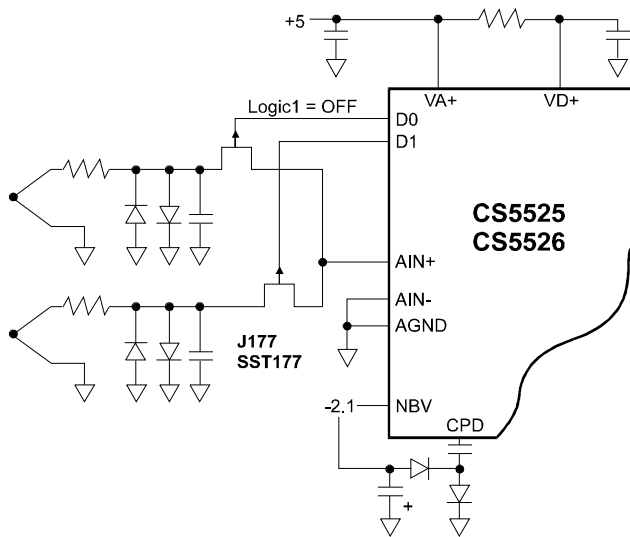
The CS5525/CS5526 A/D converter is optimized for the measurement of thermocouples. It is designed with a single analog input, but includes four digital output pins to control analog switches and multiplexers. The performance characteristics of an analog switch or multiplexer in a thermocouple digitizer application are important because of the typical protection circuitry which is included in the signal path. Figure 1 illustrates a multiplexed thermocouple circuit which includes input protection. Resistor R, capacitor C, and diodes D1 and D2 provide input protection for the analog switch and the A/D converter. Input protection guards against ESD (Electro-Static Discharge), high voltage glitches which can get coupled into long thermocouple leads in an industrial environment, and incorrect connections which can cause +24 volts to become directly connected to the digitizer input terminals.



**Figure 1. Typical Thermocouple Digitizer Input Circuitry**

To achieve sufficient protection, the input protection resistor is usually 10 K $\Omega$  or greater. This resistance can introduce measurement errors if leakage currents in the circuitry are large. Even small changes in leakage currents can affect accuracy since thermocouple output voltages change very little for each degree of temperature change (typically between 6  $\mu$ V/ $^{\circ}$ C and 80  $\mu$ V/ $^{\circ}$ C). Therefore, leakage current from the analog switch or from the input of the amplifier used to amplify the thermocouple signal can introduce significant errors if a large protection resistor is used. A large value for the protection resistor is desirable because the combination of R and C also act as a low pass filter to help reject 50/60 Hz. A large resistor value helps to achieve a low frequency cutoff for the filter while using a small capacitor value (many applications use surface mounted components in which the availability of surface mounted capacitors is limited to low values). The capacitor is usually a low leakage device with a quality dielectric to achieve low dielectric absorption.

Figure 2 illustrates the CS5525/CS5526 using the p-channel J177 (or SST177 for surface mount) JFET as an analog switch. The J177 has a maximum  $V_{GS(off)}$  of 2.25 V, therefore a +5 V drive signal from one of the digital outputs from the CS5525/CS5526 can turn it off (Driving the gate of the JFET with only +3.0 volts will shut the J177 off but it can exhibit more leakage current). When the logic drive to the gate of the JFET is 0 V, the FET will be turned on. It can safely handle input signals of  $\pm$ 250 mV without forward biasing the channel to



**Figure 2. CS5525/CS5526 Controls P-Channel JFETs as analog switches.**

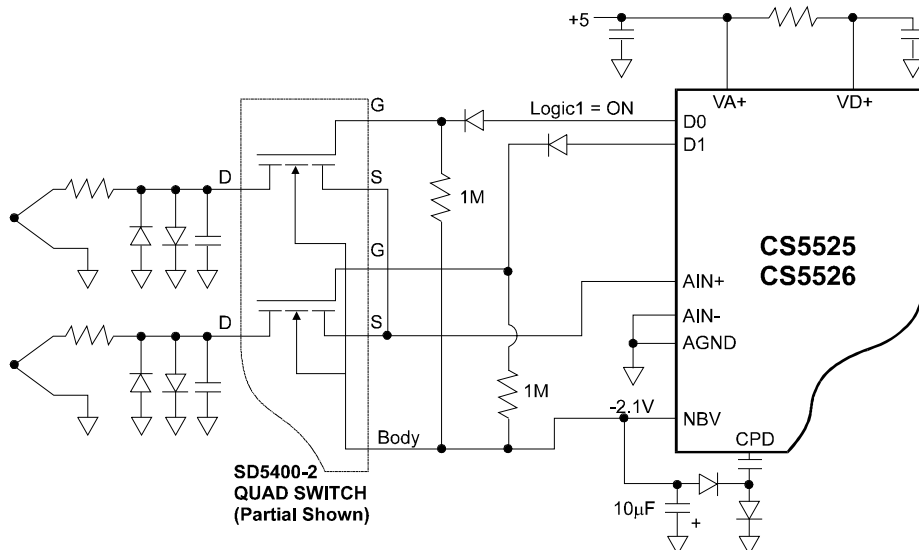
gate junction. When ON, the J177 (SST177) exhibits a resistance of 300 ohms maximum. If used to switch signals less than  $\pm 250$  mV, the leakage current (25 °C) will be sub-picoamps.

Figure 3 illustrates an example of using an enhancement mode transistor switch as an analog switch. The SD5400-2 quad DMOS switch is illustrated (the SD5000-2, SD5200-2, and SD5300-2 series are similar). The diode-resistor drive combination on the gate of the SD5400-2 allows the gate to go to -0.6 V when the DO-D3 logic drive from

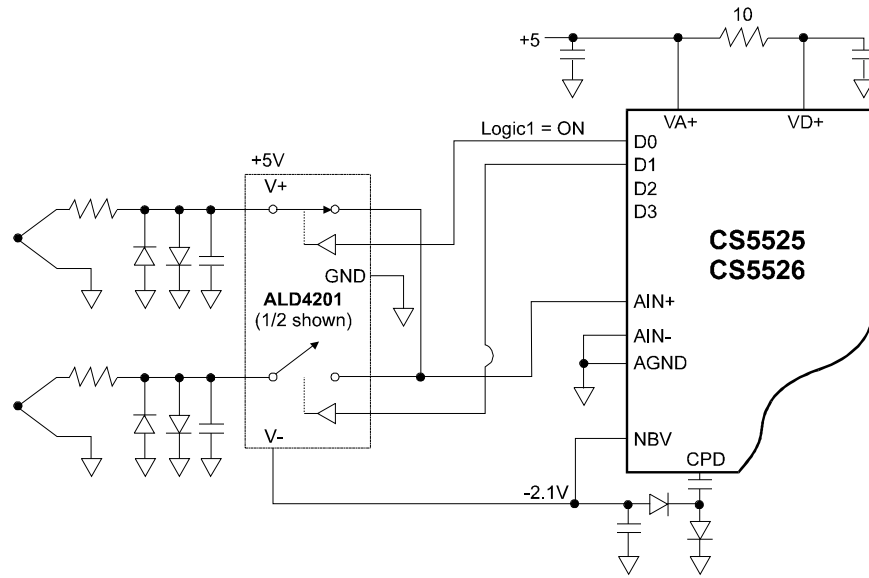
the CS5525/CS5526 is low. The -0.6V gate drive shuts off the transistor with adequate gate drive to ensure very high off resistance. When the D0-D3 output drive is high, the transistor is on with a resistance less than 100  $\Omega$ . Signals of  $\pm 1$  V can readily be passed by the switch.

Some analog switches are available which are designed to function with supply voltages of  $\pm 5$  V or less. The Advanced Linear Devices ALD4201 quad switch is used in Figure 4 (1/2 of device is shown) for switching thermocouple signals. The switch is operated from a +5 V supply and from the NBV voltage (-2.1) used for the CS5525/CS5526. This is acceptable as the supply current requirement of the ALD4201 is only a microampere. Leakage currents for the ALD4201 are stated to remain below 500 pA over the industrial temperature range. On resistance over the industrial temperature range with a total supply of +5V or more is less than 300  $\Omega$ .

This application note illustrates the flexibility of using the CS5525/CS5526 digital output pins to control analog switches and multiplexers. While all the circuits introduced have illustrated the CS5525/CS5526 being used in thermocouple applications, the device can be used for bridge transducers as well.



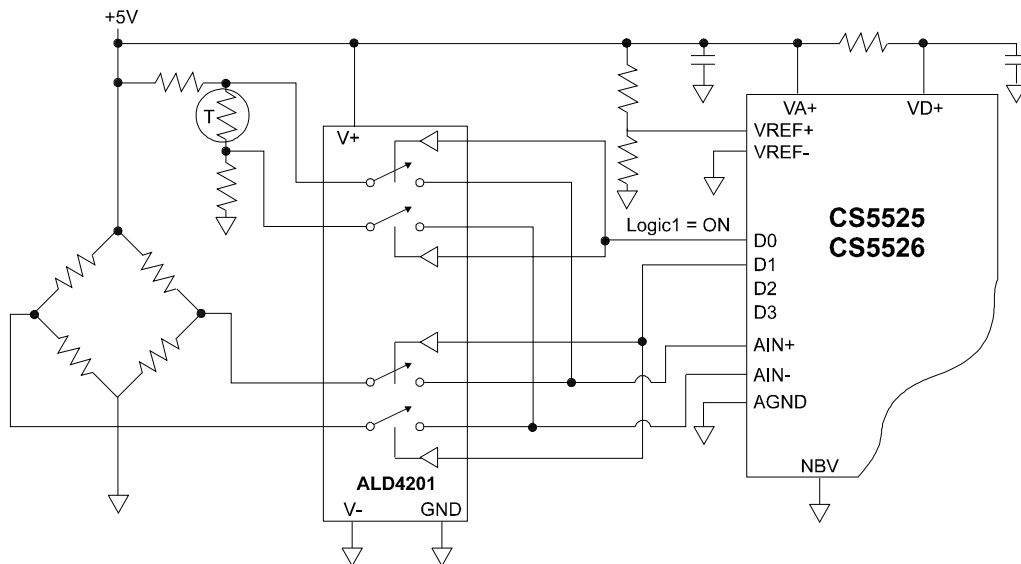
**Figure 3. CS5525/CS5526 Controls N-Channel DMOS transistors as analog switches.**



**Figure 4. CS5525/CS5526 Controls the low-voltage ALD4201 analog switch.**

Figure 5 illustrates the CS5525/CS5526 configured to interface to a bridge transducer. The bridge is excited with +5 V. The voltage reference for the A/D is derived from the +5 V which excites the bridge to set up a ratiometric measurement configuration. A ALD4201 quad analog switch is used to select between the differential bridge signal and a thermistor temperature sensor which is being used to measure the bridge temperature.

The CS5525/CS5526 has four digital outputs that can be used to control as many as 16 analog switches with the use of either the 74HC137 or 74HC237 1-of-8 Decoder/Multiplexers. The main difference between the two chips is that the 74HC137 has active low outputs; the 74HC237 has active high outputs. Figure 6 illustrates how the CS5525/CS5526 digital outputs (D0-D3) can be used to derive 16 separate control lines using a pair of 74HC237s.



**Figure 5. CS5525/CS5526 Controls the low-voltage ALD4201 analog switch.**

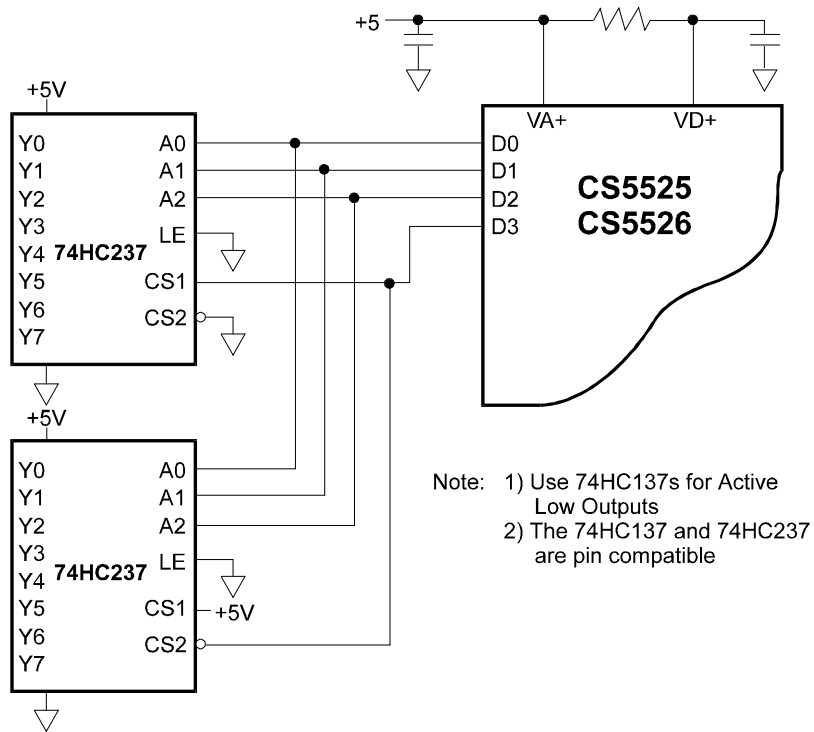


Figure 6. Use external logic to generate 16 separate analog switch control lines.

## APPENDIX

### J177/SST177 Suppliers

Calogic, Fremont, California  
 Siliconix, Santa Clara, California  
 Interfet, Garland, Texas  
 Philips, Eindhoven, The Netherlands

### SD5000-2 Series Supplier

Calogic, Fremont, California

### ALD4201 Supplier

Advanced Linear Devices, Sunnyvale, California