One Technology Way • P.O. Box 9106 • Norwood, MA 02062-9106, U.S.A. • Tel: 781.329.4700 • Fax: 781.461.3113 • www.analog.com

AD7265 12-Bit, 3-Channel SAR ADC in Differential and Single-Ended Configurations Using the AD8022 High Speed Op Amp

CIRCUIT FUNCTION AND BENEFITS

The AD8022 is optimized for dc-coupled applications requiring low distortion and low noise performance. They ensure that the maximum AD7265 performance is achieved by providing adequate settling time, low distortion, and low output impedance.

CIRCUIT DESCRIPTION

In applications where the signal source has high impedance, it is recommended to buffer the analog input signal before applying the signal to the switched capacitor inputs of the AD7265. This isolates the source from the transient currents that appear at the input of the analog-to-digital converter (ADC). A dual op amp pair can be used to directly couple a differential signal to one of the analog input pairs of the AD7265.

The AD8022 is an ideal choice for the dual op amp and has low power (4.0 mA/A), low noise (2.5 nV/√Hz at 100 kHz), and low distortion (110 dB SFDR at 200 kHz). The AD7265 has a specified minimum acquisition time of 90 ns with a voltage power rail (VDD) of 5 V. This is the time from when the device enters track mode until the next conversion is initiated. The op amp selected must have adequate settling time to meet the acquisition time requirements of the AD7265 and achieve the specified performance.

The circuit configurations illustrated in Figure 1 shows how an AD8022 op amp can convert a bipolar single-ended signal into a unipolar differential signal that can be applied directly to the AD7265 analog inputs. The circuit not only performs the single-ended to differential conversion but also level shifts the output signal to match the ADC input range. The voltage applied to Point A sets up the common-mode voltage for each half of the AD8022. The 10 kΩ/20 kΩ divider generates this voltage (1.67 V) from the AD7265 2.5 V internal reference. If the on-chip 2.5 V reference on the AD7265 is used elsewhere in a system (as illustrated in Figure 1 and Figure 2), the output from the decoupling capacitor pins ($D_{CAP}A$ and $D_{CAP}B$) must first be buffered. The OP177 features the highest precision performance of any op amp currently available and is recommended for a reference buffer.

The primary negative feedback path is provided by the AD8022 R2 to R1 resistors, and the gain from the AD8022 VIN input signal to the AD7265 V_{A2} pin is set by the ratio of R2 to R1. In this case, the ratio is 0.5. The common-mode voltage of 1.67 V at the input of the upper half of the AD8022 produces an output common-mode voltage at the V_{A2} pin of (1 + R2/R1) × 1.67 V = 2.5 V. Localized feedback supplied by the R3 and R4 resistors produces a signal at V_{A1} that is 180° out of phase with the signal at V_{A2}.

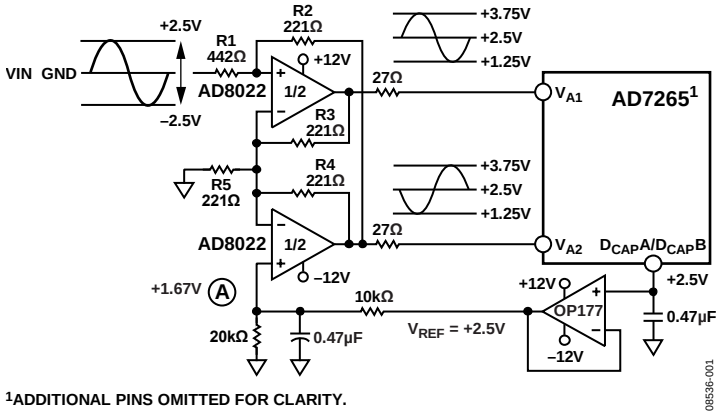


Figure 1. AD8022 DC-Coupled Circuit to Convert a Bipolar Single-Ended Signal into a Unipolar Differential Signal (Simplified Schematic—Decoupling and All Connections Not Shown)

TABLE OF CONTENTS

Circuit Function and Benefits 1
Circuit Description 1
Revision History 2
Common Variations 3
References 3

REVISION HISTORY

1/2018—Rev. A to Rev. B

Document Title Changed from CN0048 to AN-1506 ..... Universal
Changes to Circuit Description Section 1
Changes to Common Variations Section 3

5/2010—Rev. 0 to Rev. A

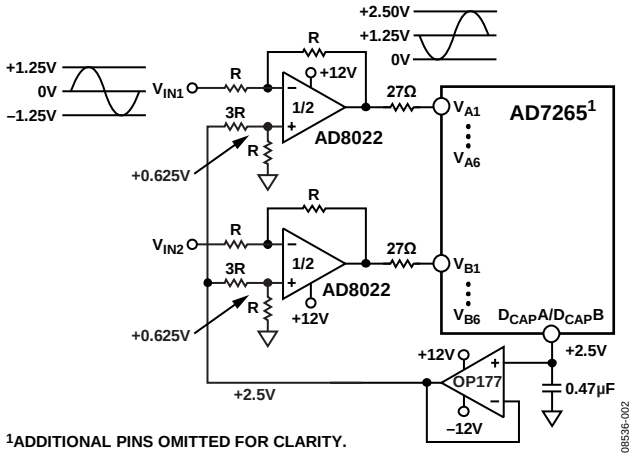
Updated Format ..... Universal

10/2008—Revision 0: Initial Version

When the input voltage is 0 V, both V_{A1} and V_{A2} must be 2.5 V. This condition requires a current in both R3 and R4 of (2.5 V – 1.67 V)/ 221 Ω = 3.76 mA. The current through R5 is therefore 2 × 3.76 mA =7.52 mA. Therefore, R5 must be equal to R3 and R4 to force the common-mode voltage at V_{A1} to be 2.5 V.

The AD7265 can have a total of 12 single-ended analog input channels. The analog input range can be programmed to be either 0 V to the reference voltage (V_{REF}) or 0 V to 2 × V_{REF}. Figure 2 shows a typical connection diagram when operating the ADC in single-ended mode, where an AD8022 drives a differential input pair per channel. The AD8021 is a high performance single op amp that can be used as an alternative to a dual device in very high performance systems. The absolute value of the resistor network (R) is flexible, but it must be chosen to achieve the desired bandwidth of the op amp.

In both Figure 1 and Figure 2, the AD8022 operates on dual 12 V supplies and the AD7265 is specified for power supply voltages of 2.7 V to 5.25 V. Ensure that the maximum input voltage limits of the AD7265 are not exceeded during transient or power-on conditions (see the MT-036 Tutorial). The circuit must also be constructed on a multilayer PC board with a large area ground plane. Use proper layout, grounding, and decoupling techniques must to achieve optimum performance (see the MT-031 Tutorial, the MT-101 Tutorial, and EVAL-AD7265).



[1]ADDITIONAL PINS OMITTED FOR CLARITY.

Figure 2. AD8022 DC-Coupled Circuit for Single-Ended Input Mode of Operation (Simplified Schematic—Decoupling and All Connections Not Shown)

COMMON VARIATIONS

The OP07D, an ultralow offset voltage op amp, is a lower cost alternative to the OP177. It offers similar performance with the exception of the voltage offset (V_{OS}) specification.

REFERENCES

Kester, Walt, Bryant, James, and Byrne, Mike. MT-031 Tutorial, *Grounding Data Converters and Solving the Mystery of "AGND" and "DGND."* Analog Devices.

MT-036 Tutorial, *Op Amp Output Phase-Reversal and Input Over-Voltage Protection.* Analog Devices.

MT-074 Tutorial, *Differential Drivers for Precision ADCs.* Analog Devices.

MT-075 Tutorial, *Differential Drivers for High Speed ADCs Overview.* Analog Devices.

MT-076 Tutorial, *Differential Driver Analysis*. Analog Devices.

MT-101 Tutorial, *Decoupling Techniques*. Analog Devices.

AN08536-0-1/18(B)