Circuit Note
CN-0237

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Devices Connected/Referenced	
ADA4940-1/ ADA4940-2	Single/Dual, Ultralow Power, Low Distortion Differential ADC Driver
AD7982	18-Bit, 1 MSPS PulSAR ADC
ADR435	Ultralow Noise XFET Voltage Reference with Current Sink and Source Capability

Ultralow Power, 18-Bit, Differential PulSAR ADC Driver

EVALUATION AND DESIGN SUPPORT

Design and Integration Files

Schematics, Layout Files, Bill of Materials

CIRCUIT FUNCTION AND BENEFITS

The circuit shown in Figure 1 uses the ultralow power AD7982 18-bit, 1 MSPS analog-to-digital converter (ADC) driven by the ADA4940-1, a low power fully differential amplifier. The ADR435 low noise precision 5.0 V voltage reference is used to supply the 5 V needed for the ADC. All the ICs shown in Figure 1 are available in small packages, either 3 mm × 3 mm LFCSP or 3 mm × 5 mm MSOP, which helps to reduce board cost and space.

Power dissipation of the ADA4940-1 in the circuit is typically 6.25 mW. The 18-bit, 1 MSPS AD7982 ADC consumes only 7 mW at 1 MSPS. This power also scales with the throughput. The ADR435 consumes only 4.7 mW, making the total power dissipated by the system less than 18 mW.

CIRCUIT DESCRIPTION

Modern high resolution SAR ADCs, such as the AD7982 18-bit, 1 MSPS PulSAR® ADC, require a differential driver for optimum performance. In such applications, the ADC driver takes either a differential or single-ended signal and performs the level shifting required to drive the input of the ADC at the right level.

Figure 1 shows the ADA4940-1 differential amplifier level shifting and driving the 18-bit AD7982 differential input successive approximation PulSAR ADC. Using four resistors, the ADA4940-1 can either buffer the signal with a gain of 1 or amplify the signal for more dynamic range. The ac and dc performances are compatible with those of the AD7982 18-bit, 1 MSPS PulSAR® ADC and other 16-bit and 18-bit members of the family, which have sampling rates of up to 2 MSPS. This circuit can also accept a single-ended input signal to generate the same fully differential output signal.

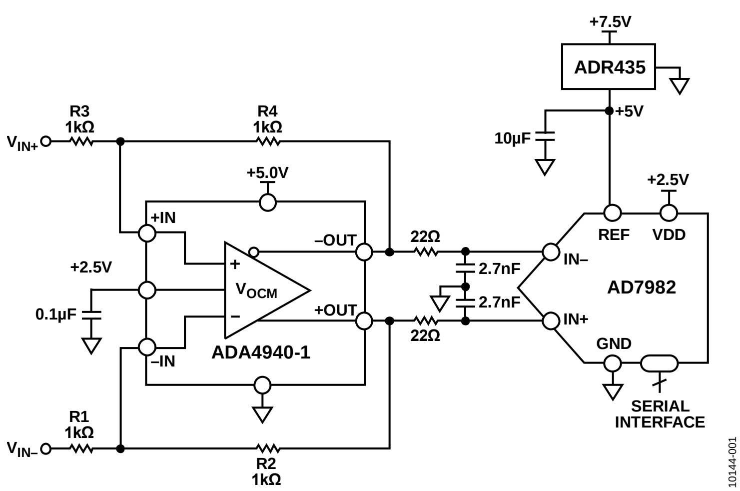

Figure 1. High Performance 18-Bit Differential ADC Driver (Simplified Schematic: All Connections and Decoupling Not Shown)

Rev. A

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

The AD7982 operates on a single VDD supply of 2.5 V. It contains a low power, high speed, 18-bit sampling ADC and a versatile serial interface port. The reference voltage (REF) is applied externally from the ADR435 precision low dropout (0.3 V) band gap reference, and can be set independently of the supply voltage.

The ADA4940-1 operates from a 5 V single supply and offers sufficient headroom on the outputs, which swing from 0 V to 5 V with a 2.5 V common-mode and accommodate a full-scale input to the ADC. The ADA4940-1 is dc-coupled on the input and the output, and its outputs drive the inputs of the AD7982. It also allows single-ended to differential conversion if needed.

The gain is set by the ratio of the feedback resistor (R2 = R4) to the gain resistor (R1 = R3). For R1 = R2 = R3 = R4 = 1 kΩ, the single-ended input impedance is approximately 1.33 kΩ. In addition, the circuit can be used to convert either single-ended or differential inputs to a differential output. If needed, a termination resistor in parallel with the input can be used. Whether the input is a single-ended input or differential input, the input impedance of the amplifier can be calculated as shown in the MT-076 Tutorial and in the DiffAmpCalc™ Differential Amplifier Calculator (www.analog.com/DiffAmpCalc).

A single-pole, 2.7 MHz, RC (22 Ω, 2.7 nF) noise filter is placed between the op amp output and the ADC input to help limit the noise at the ADC input and to reduce the effect of kickbacks coming from the capacitive DAC input of the SAR ADC.

For the tests on this circuit, the signal generator provided a 10 V p-p differential output. The V_{OCM} input is bypassed for noise reduction and set externally with 1% resistors to maximize the output dynamic range on the 5 V reference. With an output common-mode voltage of 2.5 V, each ADA4940-1 output swings between 0 V and 5 V, opposite in phase, providing a gain of 1 and a 10 V p-p differential signal to the ADC input.

The FFT performance is shown in Figure 3 and is summarized as follows:

- Dynamic range = 97.33 dB
- SNR = 96.67 dBFS
- SINAD = 96.52 dBFS
- THD = −111.03 dBFS

Figure 2 shows the typical INL and DNL performance of the AD7982.

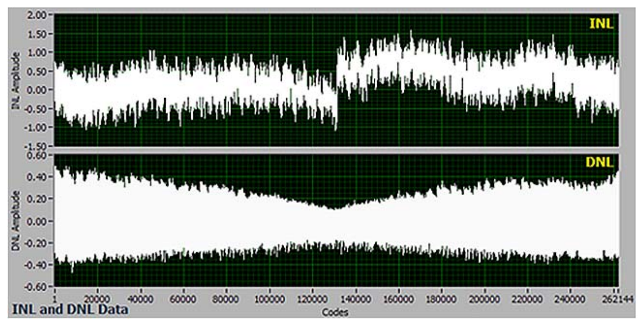

Figure 2. INL and DNL Plot for 20 kHz Signal, with Sampling Frequency of 1 MSPS (Min/Max INL = +1.6 LSB/−1.1 LSB and DNL = ±0.5 LSB)

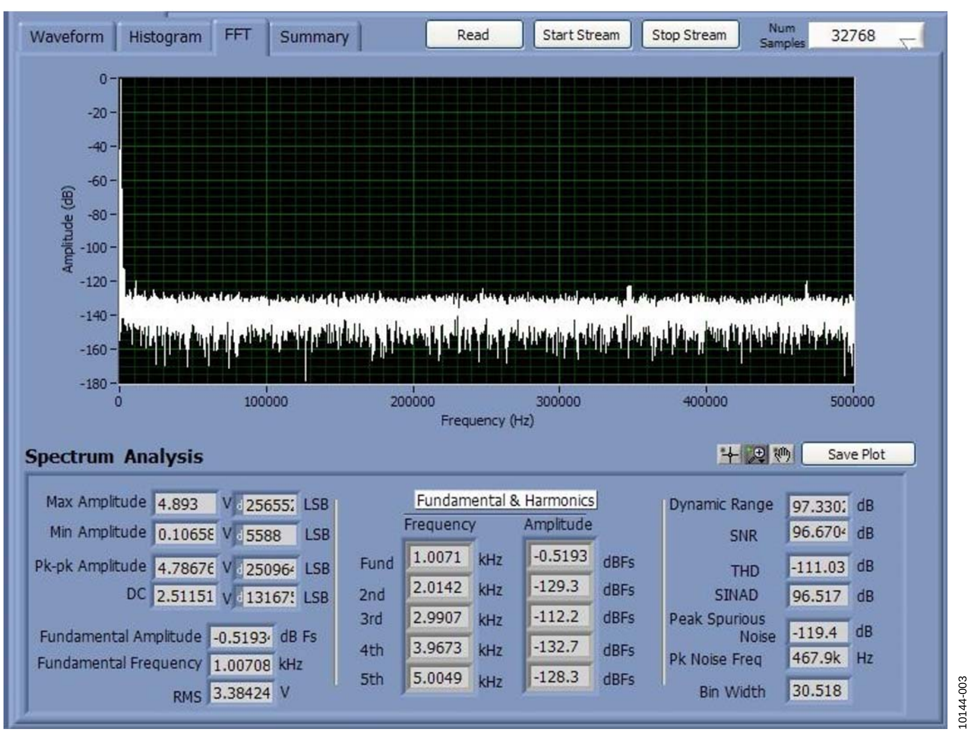

Figure 3. FFT Plot for 1 kHz Signal, 0.5 dB Below Full Scale, with Sampling Frequency of 1 MSPS

COMMON VARIATIONS

The circuit is proven to work with good stability and accuracy with the component values shown. Other ADCs can be used in place of the AD7982 to achieve the maximum desired performance. The ADA4940-1/ADA4940-2 are optimal for driving 16-bit and 18-bit ADCs with minimal degradation in performance. Faster sampling 18-bit ADCs include the AD7984 (1.33 MSPS) and AD7986 (2 MSPS). Differential 16-bit ADCs include the AD7688 (500 kSPS) and the AD7693 (500 kSPS).

The ADA4940-1/ADA4940-2 rail-to-rail outputs can be driven to within 0.5 V of each power rail without significant ac performance degradation. Other differential ADC drivers such as the AD8137 and ADA4941-1 can also be used to replace the ADA4940-1 for applications when speed, input impedance, or other factors dictate.

CIRCUIT EVALUATION AND TEST

This circuit was tested using a EVAL-AD7982SDZ PulSAR AD7982 evaluation board connected to the EVAL-SDP-CB1Z system demonstration platform.

The EVAL-AD7982SDZ is a user evaluation board intended to ease standalone testing of performance and functionality for the 18-bit AD7982 PulSAR ADC.

The EVAL-SDP-CB1Z board is a platform intended for use in evaluation, demonstration, and development of systems using Analog Devices, Inc. precision converters. It provides the necessary communications between the converter and the PC, programming or controlling the device, transmitting or receiving data over a USB link as shown in Figure 4 and Figure 5.

Equipment Needed

In addition to the two evaluation boards, external 5 V power supplies are required for the ADA4940-1. A wall wart supplies the 9 V dc voltage for the EVAL-SDP-CB1Z. Other appropriate voltages are supplied to the AD7982 evaluation board from the EVAL-SDP-CB1Z.

A low distortion signal source, the Audio Precision® SYS-2702, was used to achieve the required performance. A PC with Windows® XP or Windows 7 equipped with an USB port was used to run the PulSAR evaluation software.

Getting Started

Install the evaluation software as described at the EVAL-SDP-CB1Z and EVAL-AD7982SDZ product pages.

Connect the ADA49xx-1 EVAL-BRDZ, EVAL-AD7982SDZ, and EVAL-SDP-CB1Z boards together as shown in Figure 5. Connect a 9 V wall wart to the EVAL-AD7982SDZ, connect the USB cable to EVAL-SDP-CB1Z, and connect the external 5 V power supply to the ADA49xx-1 EVAL-BRDZ.

For more information on differential amplifier evaluation boards like the ADA49xx-1 EVAL-BRDZ, see the UG-132.

Setup and Test

An Audio Precision SYS-2702 source was used to provide the input signal to the EVAL-AD7982SDZ. The PulSAR evaluation software was used to monitor the ADC output results.

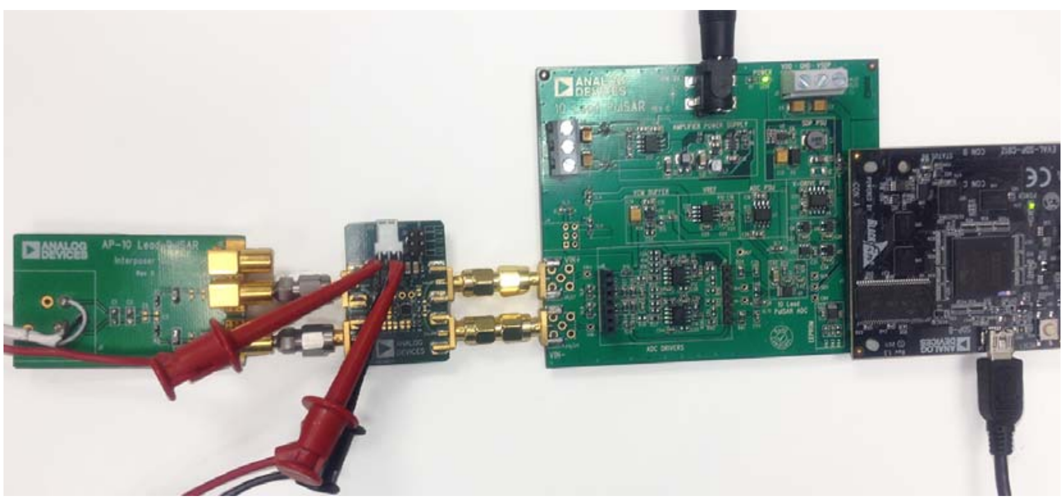

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Figure 4. PulSAR ADC Evaluation Platform

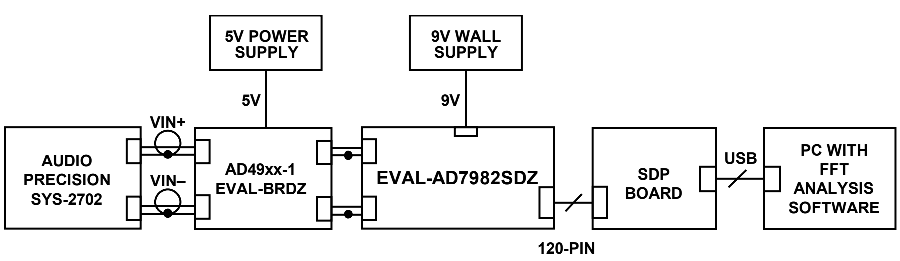

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Figure 5. Test Setup Functional Block Diagram

LEARN MORE

CN-0237 Design Support Package: www.analog.com/CN0237-DesignSupport

DiffAmpCalc™ Differential Amplifier Calculator

Ardizzoni, John. *A Practical Guide to High-Speed Printed-Circuit-Board Layout*, Analog Dialogue 39-09, September 2005.

MT-031 Tutorial. *Grounding Data Converters and Solving the Mystery of "AGND" and "DGND"*. 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.

Data Sheets and Evaluation Boards

ADA4940-1 Data Sheet

ADA4940-2 Data Sheet

ADA4940 Evaluation Board

AD7982 Data Sheet

AD7982 Evaluation Board

ADR435 Data Sheet

REVISION HISTORY

2/15—Rev. 0 to Rev. A

10/11—Revision 0: Initial Version

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