![ANALOG DEVICES]

Circuits from the Lab™ Reference Circuits

Circuits from the Lab™ reference circuits are engineered and tested for quick and easy system integration to help solve today's analog, mixed-signal, and RF design challenges. For more information and/or support, visit www.analog.com/CN0202.

Devices Connected/Referenced	
AD5750	Industrial Current/Voltage Output Driver with Programmable Ranges
AD5662	16-Bit nanoDAC® Digital-to-Analog Converter in SOT-23
ADR444	Ultralow Noise, 4.096V LDO XFET Voltage Reference with Current Sink and Source

Flexible, High Accuracy, Low Drift, PLC/DCS Analog Output Module

EVALUATION AND DESIGN SUPPORT

Circuit Evaluation Boards
   CN-0202 Circuit Evaluation Board (EVAL-CN0202-SDPZ)
   System Demonstration Platform (EVAL-SDP-CB1Z)
Design and Integration Files
   Schematics, Layout Files, Bill of Materials

CIRCUIT FUNCTION AND BENEFITS

The circuit shown in Figure 1 provides a full function, flexible, programmable analog output solution that meets most requirements for programmable logic controller (PLC) and distributed control system (DCS) applications. The AD5662 low power (0.75 mW @ 5 V), rail-to-rail output, 16-bit nanoDAC® converter and the AD5750 industrial current/voltage output driver are well matched with respect to input and output voltage ranges, as well as reference voltage requirements. The ADR444

low drift (3 ppm/°C maximum for B-grade), high initial accuracy (0.04% maximum for B-grade), and low noise (1.8 µV p-p typical, 0.1 Hz to 10 Hz) provides the reference voltage for both the AD5750 and AD5662 and guarantees ultralow noise, high accuracy, and low temperature drift for the circuit. This circuit provides all the typical voltage and current output ranges with 16-bit resolution and no missing codes, 0.05% linearity, and less than 0.2% total output error.

The circuit also contains key features for industrial applications, such as on-chip output fault detection and protection (short circuit, undervoltage output, open circuit current output, and overtemperature), CRC checking to prevent packet error (PEC), and flexible power-up options, making it an ideal choice for robust industrial control systems. No external precision resistors or calibration routines

Figure 1. Basic Analog Output Circuit for Single Channel (Simplified Schematic, All Connections and Protection Circuits Not Shown)

Rev.0

are needed to maintain consistent performance in mass production, thereby making it ideal for PLC or DCS modules.

CIRCUIT DESCRIPTION

The AD5750/AD5750-1 are both single-channel, low cost, precision voltage/current output drivers developed to meet the requirements of industrial process control applications. The voltage output range can be programmed for the standard output ranges for PLC and DCS applications: 0 V to 5 V, 0 V to 10 V, −5 V to +5 V, and −10 V to +10 V. A 20% overrange setting is also provided for the standard ranges, giving the following options: 0 V to 6 V, 0 V to 12 V, −6 V to +6 V, and −12 V to +12 V.

The current output, which is provided on a separate pin, can be programmed for the ranges of 4 mA to 20 mA, 0 mA to 20 mA, −20 mA to +20 mA, 0 mA to 24 mA, and −24 mA to +24 mA. The unipolar ranges have a 2% overrange setting. Because the AD5750/AD5750-1 current output can either source or sink current, it can interface to a wide variety of sensors or actuators. The voltage and current output pins can be tied together to configure the end system as a single-channel output if desired.

The AD5662 is a single channel, low cost, low power, rail-to-rail voltage buffered output nanoDAC® device. The AD5662 guarantees ±1 LSB DNL under a wide range of reference voltages that can vary from 0.75 V to the V_{DD} supply so that the AD5750 and the AD5662 can operate from a common reference source of 4.096 V, provided by the ADR444. The whole system will benefit from the ultralow noise and low temperature coefficient of ADR444. The ADR44x family of references are ideal for driving either the reference or the power input of converters because they can source and sink current. The AD5662 also incorporates a power-on reset circuit to ensure that the DAC output powers up to either midscale or zero and remains there until a valid write takes place.

Devices for PLC and DCS applications generally need ESD protection and overvoltage protection much higher than the formal recommend specifications. The AD5750 has integrated ESD protection diodes internal to each pin that can prevent damage from a 3 kV transient (Human Body Model). However, the industrial control environment can subject I/O circuits to much higher transients. External 30 V, 600 W transient voltage suppressors (TVS), a 50 mA, 30 V PolySwitch, and power Schottky diodes are built into the EVAL-CN0202-SDPZ circuit board to provide higher voltage ESD protection, 50 mA overcurrent, and 30 V overvoltage protection. The optional external protection circuits are not shown in the simplified schematic of Figure 1 but can be found in the detailed schematic (EVAL-CN0202-SDPZ-SCH pdf file) in the CN0202 Design Support package: www.analog.com/CN0202-DesignSupport.

The circuit must be constructed on a multilayer PC board with a large area ground plane. Proper layout, grounding, and decoupling techniques must be used to achieve optimum performance (see Tutorial MT-031, *Grounding Data Converters and Solving the Mystery of "AGND" and "DGND,"* and Tutorial MT-101, *Decoupling Techniques*).

Measurements

Integral nonlinearity (INL), differential nonlinearity (DNL), and output error are the most important specifications for PLC, DCS, and other process control systems. The AD5750 has highly flexible and configurable output ranges that can be tailored to meet the needs of the application. Measurements of INL, DNL, and output error for the circuit are shown in Figure 2, Figure 3, and Figure 4, respectively. This data was taken at 25°C in the 0 V to 5 V voltage output mode. The test results for all the other ranges are listed in Table 1.
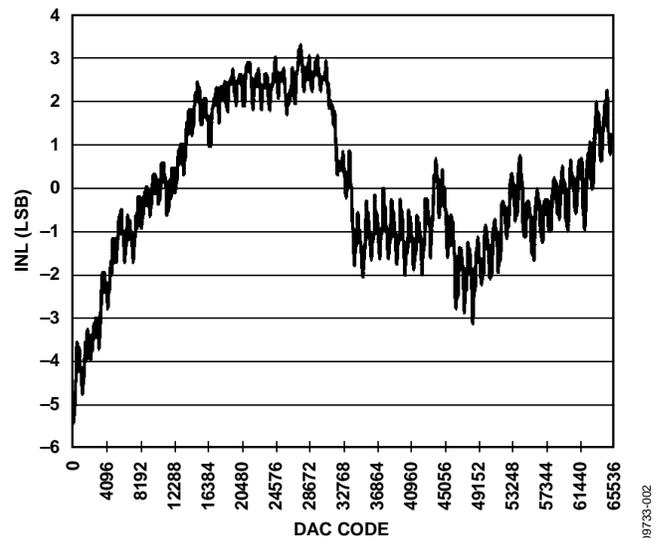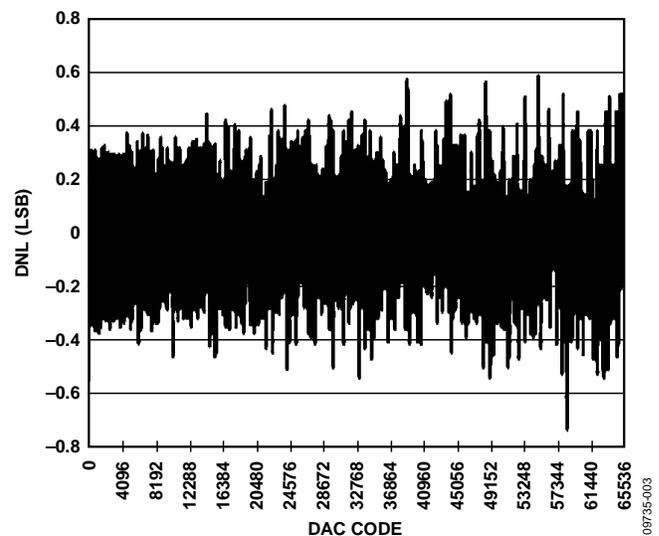

Figure 2. INL for 0 V to 5 V Output Range

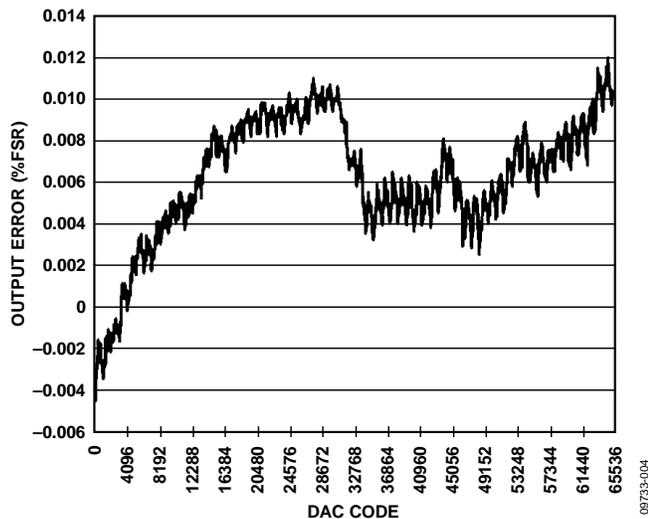*Figure 3. DNL for 0 V to 5 V Output Range*

Figure 4. Output Error for 0 V to 5 V Output Range

The test results shown in Table 1 were made at 25°C using the EVAL-CN0202-SDPZ board powered by an Agilent E3631A dc supply and measured with an Agilent 34401A digital multimeter.

Note that the output ranges 0 mA to 20.4 mA and 0 mA to 24.5 mA are both designed to be trimmed by the customer to precisely match the 0 mA to 20 mA and 0 mA to 24 mA ranges. The 1.54% FSR output error measurement in the 0 mA to 20.4 mA range includes the gain error, which should be removed by customer calibration.

Table 1. Test Results for All Output Ranges

Range	Current Sense Resistor	INL (LSB)	Linearity (%FSR)	Ouptut Error (%FSR)
0 V to 5 V	Don't care	3.5	0.009	0.02
0 V to 10 V	Don't care	3.3	0.007	0.03
−5 V to +5 V	Don't care	3.6	0.008	0.13
−10 V to +10 V	Don't care	3.5	0.008	0.12
0 V to 6 V	Don't care	3.6	0.008	0.03
0 V to 12 V	Don't care	5.3	0.008	0.09
−6 V to +6 V	Don't care	3.3	0.008	0.15
−12 V to +12 V	Don't care	3.3	0.008	0.15
−2.5 V to +2.5 V	Don't care	3.6	0.008	0.13
4 mA to 20 mA	Internal	4.1	0.008	0.10
4 mA to 20 mA	External	4.1	0.010	0.08
0 mA to 20 mA	Internal	3.7	0.008	0.05
0 mA to 20 mA	External	4.9	0.011	0.03
0 mA to 24 mA	Internal	3.7	0.009	0.04
0 mA to 24 mA	External	4.7	0.012	0.03
−20 mA to +20 mA	Internal	4.1	0.006	0.14
−20 mA to +20 mA	External	3.7	0.006	0.12
−24 mA to +24 mA	Internal	3.9	0.006	0.14
−24 mA to +24 mA	External	3.3	0.005	0.12
3.92 mA to +20.4 mA	Internal	4.4	0.010	0.20
0 mA to +20.4 mA	Internal	3.6	0.008	1.54
0 mA to +24.5 mA	Internal	5.1	0.008	1.43

COMMON VARIATIONS

This circuit describes one implementation of a family of driver and DAC products, from which various devices can be selected to achieve desired performance. 12-bit to 16-bit resolution is the regular requirement for PLC and DCS applications. For applications not requiring 16-bit resolution, the AD5620 (12-bit), and AD5640 (14-bit) are available, but have internal references.

For multichannel applications, the AD5623R (12-bit), AD5643R (14-bit), and AD5663R (16-bit) are dual nanoDAC devices, and the AD5624R (12-bit), AD5644R (14-bit), and AD5664R (16-bit) are quad nanoDAC devices.

The AD5750-1 driver is pin-compatible with the AD5750 and can accept a 0 V to 2.5 V input range when used with a 1.25 V reference. The AD5751 is a unipolar analog output driver and can supply a 40 V output using a 50 V AVDD supply.

CIRCUIT EVALUATION AND TEST

Equipment Needed (Equivalents Can Be Substituted)

- System Demonstration Platform (EVAL-SDP-CB1Z)

- CN-0202 Circuit Evaluation Board (EVAL-CN0202-SDPZ)

- CN-0202 Evaluation Software

- Software for controlling external test measurement equipment (not included on CD)

- Agilent 34401A, 6.5 Digit Digital Multimeter

- Agilent E3631A 0 V to 6 V/5 A; ±25 V/1 A Triple Output DC Power Supply

- PC (Windows® 2000 or Windows XP) with USB interface

- National Instruments GPIB to USB-B interface and cable

Getting Started

Load the evaluation software by placing the CN0202 Evaluation Software disc in the CD drive of the PC. Using My Computer, locate the drive that contains the evaluation software disc and open the Readme file. Follow the instructions contained in the Readme file for installing and using the evaluation software.

Functional Block Diagram

Figure 5 shows a functional block diagram of the test setup. The pdf file "EVAL-CN0202-SDPZ-SCH" contains the detailed circuit schematics for the CN-0202 evaluation board. This file is contained in the CN-0202 Design Support Package: www.analog.com/CN0202-DesignSupport.

Setup

Connect the 120-pin connector on the EVAL-CN0202-SDPZ circuit board to the connector marked "CON A" or "CON B" on the EVAL-SDP-CB1Z evaluation (SDP) board. Nylon hardware should be used to firmly secure the two boards, using the holes provided at the ends of the 120-pin connectors. After successfully setting the dc output supply to +15 V, −15 V and +6 V output, turn the power supply off.

With power to the supply off, connect a +15 V power supply to pin of CN1 marked "+15 V," a −15 V power supply to the pin of CN1 marked "−15 V", and "GND" to the pin of CN1 marked "GND". Connect +6 V to CN2 the same way. Turn on the power supply and then connect the USB cable with the SDP board to the USB port on the PC. Note: Do not connect the USB cable to the mini USB connector on the SDP board before turning on the dc power supply for the EVAL-CN0202-SDPZ.
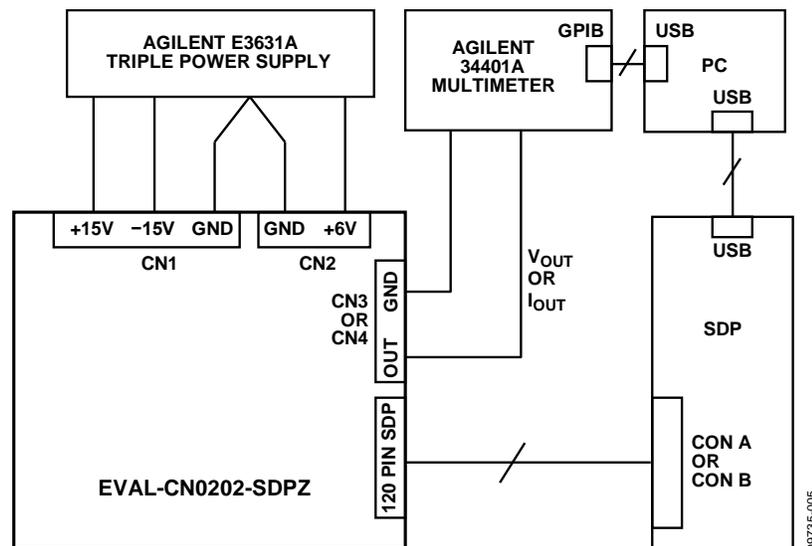

Figure 5. Test Setup Functional Block Diagram

Table 2. Jumper Settings for EVAL-CN0202-SDPZ (Bolded Values Are Default Settings)

Jumper	Descriptions	Setting	Function
JP1	Sets the address of AD5750	Shorting Pin1 with Pin2	Address of AD5750 : b'001
		Shorting Pin3 with Pin2	**Address of AD5750 : b'000**
JP2	Sets the external compensation capacitor	Shorting	Adding 1 nF Compensation Capacitor
		Opening	**Removing 1 nF Compensation Capacitor**
JP3	VSENSE+ Setting	**Shorting**	**Shorting VSENSE+ with VOUT internally**
		Opening	VSENSE+ has no connection with VOUT internally
JP4	VSENSE− Setting	**Shorting**	**Shorting VSENSE− with GND internally**
		Opening	VSENSE− has no connection with GND internally
JP5	Shorts the VOUT and IOUT pins	Shorting	Shorts VOUT and IOUT together.
		Opening	**VOUT and IOUT have no connection internally**
JP6	Sets the CLEAR Mode for AD5750	Shorting	Clears to midscale
		Opening	**Clears to zero scale**

Test

After setting up the test equipment, connect the pin of CN3 marked "VOUT" or the pin of CN4 marked "IOUT" to the input of the Agilent 34401A. Make sure that the cable connection on the front panel of the Agilent 34401A is correct, depending on the different input signal type (current or voltage). Testing the INL, DNL, and total error will take a considerable amount of time because all of the AD5660-1 16-bit DAC levels must be set and measured by the 34401A.

The software provided on the CD allows the DAC codes to be set by the PC. An automatic test program is necessary to step through the codes and analyze the data. This is not provided on the CD but must be implemented by the customer to correspond to the requirements of the particular multimeter used in the test setup.

In the test configuration shown in Figure 5, the GPIB output of the 34401A multimeter interfaces to a second USB port on the PC using the National Instruments GPIB to USB-B interface and cable. This allows the multimeter readings corresponding to each code to be loaded into an Excel spreadsheet on the PC. The data is then analyzed for INL, DNL, and total error using industry-standard definitions.

For more details on the definitions and how to calculate the INL, DNL, and total error from the measured data, see the "TERMINOLOGY" section of the AD5662 data sheet and also the following reference: *Data Conversion Handbook*, "Testing Data Converters," Chapter 5, Analog Devices.

LEARN MORE

CN-0202 Design Support Package:
http://www.analog.com/CN0202-DesignSupport

Slattery, Colm, Derrick Hartmann, and Li Ke, "PLC Evaluation Board Simplifies Design of Industrial Process Control Systems." *Analog Dialogue* (April 2009).

CN-0063 Circuit Note, *16-Bit Fully Isolated Voltage Output Module Using the AD5662 DAC, ADuM1401 Digital Isolator, and External Amplifiers*, Analog Devices.

CN-0064 Circuit Note, *16-Bit Fully Isolated 4 mA to 20 mA Output Module Using the AD5662 DAC, ADuM1401 Digital Isolator, and External Amplifiers*, Analog Devices.

CN-0065 Circuit Note, *16-Bit Fully Isolated Output Module Using the AD5422 Single Chip Voltage and Current Output DAC and the ADuM1401 Digital Isolator*, Analog Devices.

CN-0066 Circuit Note, *Fully Isolated Input Module Based on the AD7793 24-Bit Σ-Δ ADC and the ADuM5401 Digital Isolator*, Analog Devices.

CN-0067 Circuit Note, *Fully Isolated Input Module Based on the AD7793 24-Bit Σ-Δ ADC, the ADuM5401 Digital Isolator, and a High Performance In-Amp*, Analog Devices.

CN-0097 Circuit Note, *Simplified 12-Bit Voltage and 4 mA-to-20 mA Output Solution Using the AD5412*, Analog Devices.

CN-0209 Circuit Note, *Fully Programmable Universal Analog Front End for Process Control Applications*, Analog Devices.

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

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

Kester, Walt. *Practical Design Techniques for Sensor Signal Conditioning, Analog Devices*, 1999, ISBN 0-916550-20-6

Kester, Walt. *Data Conversion Handbook*, Chapter 5, Analog Devices.

Data Sheets and Evaluation Boards

CN-0202 Circuit Evaluation Board (EVAL-CN0202-SDPZ)

System Demonstration Platform (EVAL-SDP-CB1Z)

AD5750 Data Sheet

AD5750 Evaluation Board

AD5662 Data Sheet

AD5662 Evaluation Board

REVISION HISTORY

9/11—Revision 0: Initial Version

www.analog.com

MOSCHIP.RU
ВМЕСТЕ МЫ СОЗДАЕМ БУДУЩЕЕ

ПОСТАВКА
ЭЛЕКТРОННЫХ КОМПОНЕНТОВ

многоканальный
📞 +7 495 668 12 70
✉ info@moschip.ru

Общество с ограниченной ответственностью «МосЧип» ИНН 7719860671 / КПП 771901001
Адрес: 105318, г.Москва, ул.Щербаковская д.3, офис 1107

Данный компонент на территории Российской Федерации

Вы можете приобрести в компании MosChip.

Для оперативного оформления запроса Вам необходимо перейти по данной ссылке:

http://moschip.ru/get-element

Вы можете разместить у нас заказ для любого Вашего проекта, будь то серийное   производство или разработка единичного прибора.

В нашем ассортименте представлены ведущие мировые производители активных и пассивных электронных компонентов.

Нашей специализацией является поставка электронной компонентной базы двойного назначения, продукции таких производителей как XILINX, Intel (ex.ALTERA), Vicor, Microchip, Texas Instruments, Analog Devices, Mini-Circuits, Amphenol, Glenair.

Сотрудничество с глобальными дистрибьюторами электронных компонентов, предоставляет возможность заказывать и получать с международных складов практически любой перечень компонентов в оптимальные для Вас сроки.

На всех этапах разработки и производства наши партнеры могут получить квалифицированную поддержку опытных инженеров.

Система менеджмента качества компании отвечает требованиям в соответствии с ГОСТ Р ИСО 9001, ГОСТ РВ 0015-002 и ЭС РД 009

Офис по работе с юридическими лицами:

105318, г.Москва, ул.Щербаковская д.3, офис 1107, 1118, ДЦ «Щербаковский»

Телефон: +7 495 668-12-70 (многоканальный)

Факс: +7 495 668-12-70 (доб.304)

E-mail: info@moschip.ru

Skype отдела продаж:
moschip.ru	moschip.ru_6
moschip.ru_4	moschip.ru_9