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#### Devices Connected/Referenced

<a href="#">AD5662</a>	16-Bit $V_{OUT}/I_{OUT}$ DAC
<a href="#">ADR02</a>	Precision 5 V Reference
<a href="#">OP2177</a>	Dual, Precision 36 V FET Amplifier
<a href="#">ADuM1401</a>	Quad-Channel Digital Isolator

## 16-Bit Fully Isolated Voltage Output Module Using the AD5662 DAC, ADuM1401 Digital Isolator, and External Amplifiers

### CIRCUIT FUNCTION AND BENEFITS

This circuit provides a complete solution for an industrial control output module. This design is suitable for process control programmable logic controllers (PLCs) and distributed control systems (DCSes) that require bipolar output voltage ranges. The AD5662 *nanoDAC*® is a 5 V, 16-bit DAC in a SOT-23 package. The ADuM1401 four-channel digital isolator provides all the necessary signal isolation between the microcontroller and the DAC.

### CIRCUIT DESCRIPTION

For industrial control modules, analog output voltage ranges are typically  $\pm 5$  V,  $\pm 10$  V, 0 V to 5 V, or 0 V to 10 V. The AD5662 provides a 0 V to 5 V output, which goes through two gain and offset stages to provide 16-bit resolution in each of the above ranges. Jumpers (shown here as switches) are used to switch between output ranges. The OP2177 was chosen for this design, primarily due to low noise and offset performance, as well as bipolar voltage capability.

The ADR02 was chosen as the reference for this circuit. The ADR02 has excellent ppm drift specs at 9 ppm/°C max. It is also often used in industrial applications due to its high input range to 36 V.

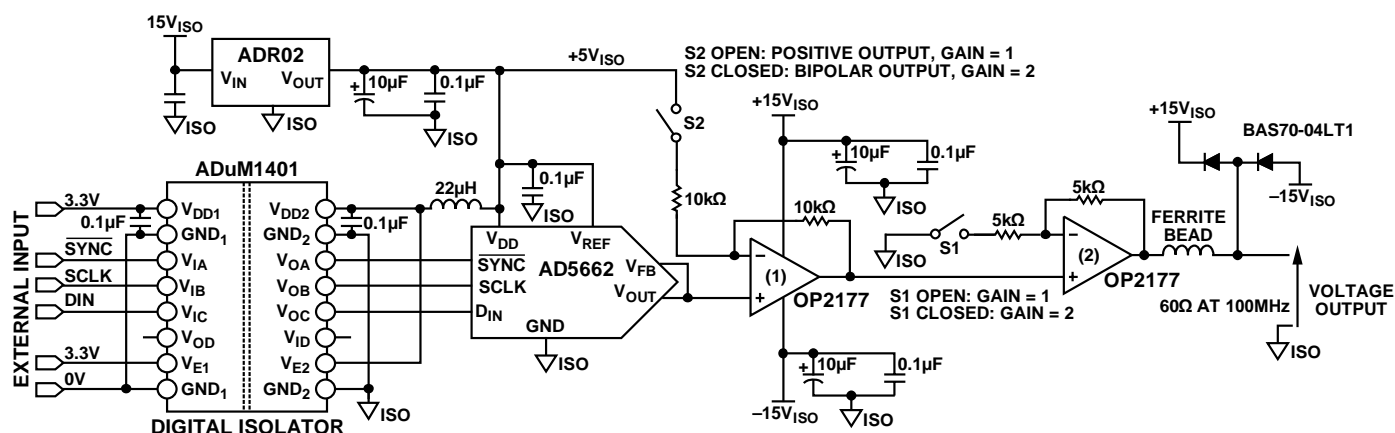


Figure 1. 16-Bit Isolated Industrial Control Voltage Output Module (Simplified Schematic)

#### Rev. A

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The ADuM1401 is a four-channel digital isolator based on Analog Devices *iCoupler*® technology. It is used to provide isolation between the AD5662 and the system microcontroller, with an isolation rating of 2.5 kV rms. Three wires are used to connect the standard SPI interface connections to the AD5662: SYNC, SCLK, and DIN.

Figure 2 shows an output error plot (integral nonlinearity) of the output of the circuit when the AD5662 is used with the ADR02 external reference. Results are shown in %FSR (full-scale range) as a function of input code.

See Colm Slattery, Derrick Hartmann, and Li Ke, "PLC Evaluation Board Simplifies Design of Industrial Process Control Systems," *Analog Dialogue*, April 2009, for more discussion of external protection techniques.

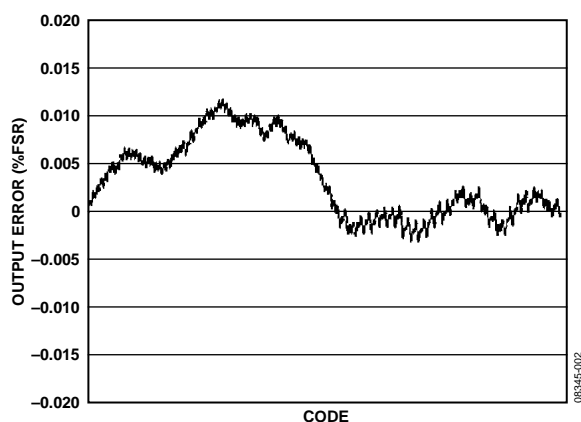


Figure 2. INL Accuracy Plot 0 V to +10 V Output Range

## LEARN MORE

Chen, Baoxing. 2006. *iCoupler® Products with isoPower™ Technology: Signal and Power Transfer Across Isolation Barrier Using Microtransformers*. Analog Devices.

MT-014 Tutorial, *Basic DAC Architectures I: String DACs and Thermometer (Fully Decoded) DACs*, Analog Devices.

MT-015 Tutorial, *Basic DAC Architectures II: Binary DACs*, Analog Devices.

MT-016 Tutorial, *Basic DAC Architectures III: Segmented DACs*, Analog Devices.

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

Wayne, Scott. "iCoupler® Digital Isolators Protect RS-232, RS-485, and CAN Buses in Industrial, Instrumentation, and Computer Applications." *Analog Dialogue* (October 2005).

## Data Sheets and Evaluation Boards

[AD5662 Data Sheet](#).

[ADR02 Data Sheet](#).

[ADuM1401 Data Sheet](#).

[ADuM1401 Evaluation Board](#).

[OP2177 Data Sheet](#).

[PLC Demo System](#).

## REVISION HISTORY

3/11—Rev. 0 to Rev. A

Changes to Circuit Function and Benefits.....1

Changes to Circuit Description.....2

7/09—Revision 0: Initial Version

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