![ANALOG DEVICES]

AN-1239
APPLICATION NOTE

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

High Accuracy, Bipolar Voltage Output Digital-to-Analog Conversion
Using the AD5763 DAC

CIRCUIT FUNCTION AND BENEFITS

This circuit provides high accuracy, bipolar data conversion using the AD5763, a dual, 16-bit, serial input, bipolar voltage output DAC. This circuit utilizes the ADR420 precision reference to achieve optimal DAC performance over a full operating temperature range. The only external components needed for this precision 16-bit DAC are a reference voltage source, decoupling capacitors on the supply pins and reference inputs, and an optional short-circuit current setting resistor. This implementation, therefore, leads to savings in cost and reduced board space. This circuit is well suited for both closed-loop servo control and open-loop control applications.

CIRCUIT DESCRIPTION

Table 1. Devices Connected/Referenced

Product	Description
AD5763	Complete quad, 16-bit, high accuracy DAC
ADR420	Precision 2.048 V voltage reference

The AD5763 is a high performance digital-to-analog converter that offers guaranteed monotonicity, integral nonlinearity (INL) of ±1 LSB (C-grade device), low noise, and a 10 μs settling time. Performance is guaranteed over the following supply voltage ranges: the AV_{DD} supply range is from +4.75 V to +5.25 V, and the AV_{SS} supply range is from −4.75 V to −5.25 V. The nominal full-scale output range is ±4.096 V from a reference voltage input of 2.048 V.

A precision voltage reference must be used in order for the DAC to achieve the optimum performance over its full operating temperature range. The AD5763 incorporates reference buffers, which eliminate the need for both a positive and negative external reference and associated buffers. This leads to further savings in both cost and board space. Because the voltages applied to the reference inputs (REFA, REFB) are used to generate the buffered positive and negative internal references for the DAC cores, any error in the external voltage reference is reflected in the outputs of the device.

Four possible sources of error to consider when choosing a voltage reference for high accuracy applications are initial accuracy, temperature coefficient of the output voltage, long term drift, and output voltage noise. Table 2 lists other 2.048 V precision reference candidates from Analog Devices, Inc., and their respective attributes.
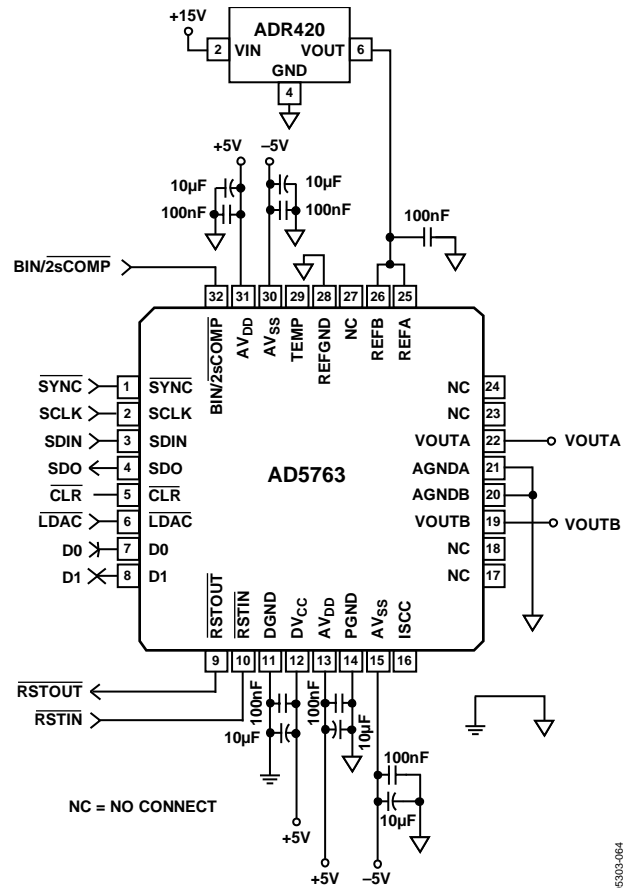

Figure 1. High Accuracy, Bipolar Configuration of the AD5763 DAC Using a Precision Reference

In any circuit where accuracy is important, careful consideration of the power supply and ground return layout helps to ensure the rated performance. The PCB on which the AD5763 is mounted must be designed so that the analog and digital sections are physically separated and confined to certain areas of the board. If the AD5763 is in a system where multiple devices require an AGND-to-DGND connection, the connection is to be made at one point only. The star ground point is established as close as possible to the device. The AD5763 must have ample supply bypassing of 10 μF in parallel with 0.1 μF on each supply, located as close to the package as possible, ideally right up against the device. The 10 μF capacitors are the tantalum bead type. The 0.1 μF capacitor must have low effective series resistance (ESR) and low effective series inductance (ESL), such as the common ceramic types, which provide a low impedance path to ground at high frequencies to handle transient currents due to internal logic switching.

Table 2. Precision 2.048 V References

Part Number	Initial Accuracy Max (mV)	Long-Term Drift Typ (ppm)	Temp Drift Max (ppm/°C)	0.1 Hz to 10 Hz Noise Typ (µV p-p)
ADR430	±1	40	3	3.5
ADR420	±1	50	3	1.75

The power supply traces of the AD5763 must be as wide as possible to provide low impedance paths and reduce the effects of glitches on the power supply line. Fast switching signals, such as clocks, must be shielded with digital ground to avoid radiating noise to other parts of the board and must never be run near the reference inputs. A ground line routed between the SDIN and SCLK lines helps reduce crosstalk between them (not required on a multilayer board, which has a separate ground plane; however, it is helpful to separate the lines). It is essential to minimize noise on the reference inputs because it couples through to the DAC output. Avoid crossover of digital and analog signals. Traces on opposite sides of the board must run at right angles to each other. This reduces the effects of feedthrough on the board. A microstrip technique is recommended but not always possible with a double-sided board. In this technique, the component side of the board is dedicated to the ground plane, and signal traces are placed on the solder side. Best layout and performance are achieved with at least a 4-layer multilayer board, where there are a ground plane layer, a power supply layer, and two signal layers.

LEARN MORE

Kester, Walt. 2005. The Data Conversion Handbook. Analog Devices. Chapters 3 and 7.

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

Voltage Reference Wizard Design Tool.

Data Sheets and Evaluation Boards

AD5763 Data Sheet.

AD5765 Evaluation Board (Compatible with AD5763).

ADR420 Data Sheet.

REVISION HISTORY

4/13—Rev. 0 to Rev. A
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6/09—Revision 0: Initial Version

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