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AN-1573
APPLICATION NOTE

High Accuracy, Bipolar Voltage Output Digital-to-Analog Conversion Using the AD5765 DAC

CIRCUIT FUNCTION AND BENEFITS

This circuit provides high accuracy, bipolar data conversion using the AD5765, a quad, 16-bit, serial input, bipolar voltage output digital-to-analog converter (DAC). This circuit utilizes the ADR420 precision voltage reference to achieve optimal DAC performance over the full operating temperature range. The only external components necessary 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. Use this implementation to save costs and reduce board space. The circuit is well suited for both closed-loop servo control and open-loop control applications.

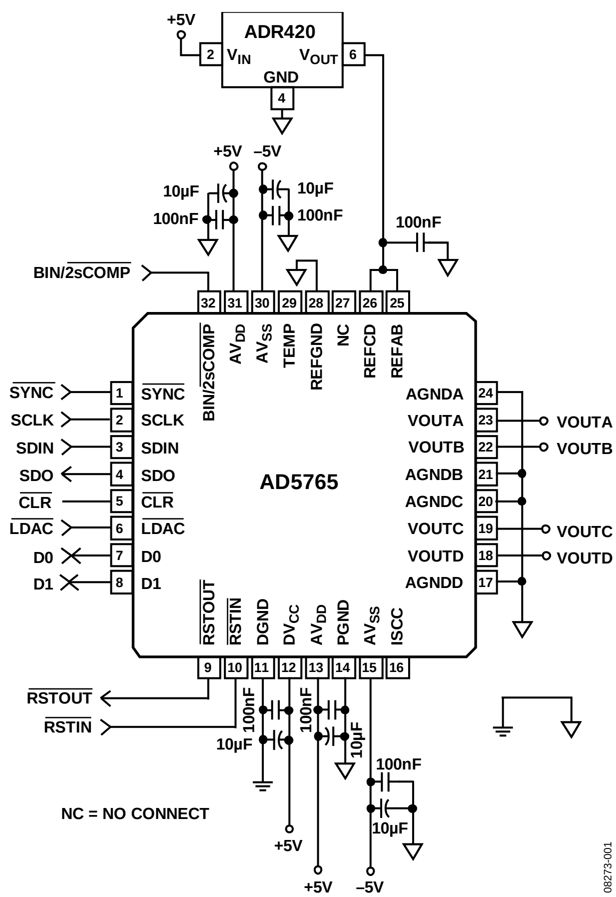

Figure 1. High Accuracy, Bipolar Configuration of the AD5765 DAC Using a Precision Reference

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REVISION HISTORY

8/2018—Rev. 0 to Rev. A

Document Title Changed from CN-0073 to AN-1573 .... Universal
Changes to Circuit Function and Benefits Section 1
Deleted Data Sheets and Evaluation Board Section 2
Changes to Circuit Description Section 3
Changed Learn More Section to References Section 3

6/2009—Revision 0: Initial Version

CIRCUIT DESCRIPTION

The AD5765 is a high performance DAC that offers guaranteed monotonicity, integral nonlinearity (INL) of ±1 least significant bit (LSB) for the 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.
- The AV_{SS} supply range is from −4.75 V to −5.25 V. The nominal full-scale output voltage range is ±4.096 V.

Use a precision voltage reference for the DAC to achieve optimum performance over its full operating temperature range. The AD5765 incorporates reference buffers that eliminate the need for both a positive and negative external reference and associated buffers, and that lead to further savings in both cost and board space. Because the voltages applied to the reference inputs (REFAB and REFCD) are used to generate the buffered positive and negative internal references for the DAC cores, any error in the external voltage reference reflects in the outputs of the device.

When choosing a voltage reference for high accuracy applications, consider the following four possible sources of error: initial accuracy, temperature coefficient of the output voltage, long term drift, and output voltage noise. Table 1 lists other 2.048 V precision reference candidates from Analog Devices, Inc., and their respective attributes.

In any circuit where accuracy is important, careful consideration of the power supply and ground return layout helps to ensure the rated performance. The printed circuit board (PCB) on which the AD5765 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 AD5765 is in a system where multiple devices require an AGND to DGND connection, the connection can be made at one point only. Establish the star ground point as close as possible to the device. The AD5765 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 directly 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 that provide a low impedance path to ground at high frequencies to handle transient currents due to internal logic switching.

The power supply traces of the AD5765 must be as wide as possible to provide low impedance paths and to reduce the effects of glitches on the power supply line. Shield fast switching signals, such as clocks, with digital grounds to avoid radiating noise to other parts of the board, and never run these signals near the reference inputs. A ground line routed between the SDIN and the SCLK lines helps reduce crosstalk between the pins (not required on a multilayer board that has a separate ground plane; however, it is helpful to separate the lines). Minimizing noise on the reference inputs is essential because the reference 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 reducing the effects of feedthrough on the board. A microstrip technique is recommended but is not always possible with a double-sided board. With the microstrip technique, the component side of the board is dedicated to the ground plane, and signal traces are placed on the solder side. To achieve the best layout and performance, use at least a 4-layer multilayer board where there is a ground plane layer, a power supply layer, and two signal layers.

REFERENCES

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.

Table 1. Precision 2.048 V References

Part Number	Initial Accuracy, Maximum (mV)	Long-Term Stability, Typical (ppm)	Temperature Coefficient, Maximum (ppm/°C)	0.1 Hz to 10 Hz Voltage Noise, Typical (μV p-p)
ADR430	±1	40	3	3.5
ADR420	±1	50	3	1.75