Circuit Note
CN-0156

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Devices Connected/Referenced	
AD9834	75 MHz Complete Low Power DDS
AD5620	12-Bit Voltage Output *nano*DAC®

Amplitude Control Circuit for AD9834 Waveform Generator (DDS)

CIRCUIT FUNCTION AND BENEFITS

The circuit shown in Figure 1 provides a simple approach for controlling the amplitude of the output waveform of an AD9834 75 MHz low power (20 mW) waveform generator (DDS).

DDS (direct digital synthesis) devices are capable of producing sine wave, square wave, and triangular output waveforms and, therefore, serve as waveform generators.

Capability for phase modulation and frequency modulation is provided internally in the AD9834. However, in order to modulate the amplitude of the output signal, a low power DAC or digital potentiometer is required to set the full-scale current. A voltage output DAC can be used to drive the FS ADJUST pin of the AD9834 through a series resistor. This determines the magnitude of the full-scale DAC current.

The DAC used in this example is the 12-bit AD5620, a member of the *nano*DAC family. The AD5620 contains an on-chip 5 ppm/°C reference, has an SPI interface, and is available in an 8-lead SOT-23 or MSOP package. The low power (2.2 mW @ 3.3 V) and small size of the AD5620 (8-lead SOT-23) provide an attractive solution for generating an amplitude modulated output from the AD9834.

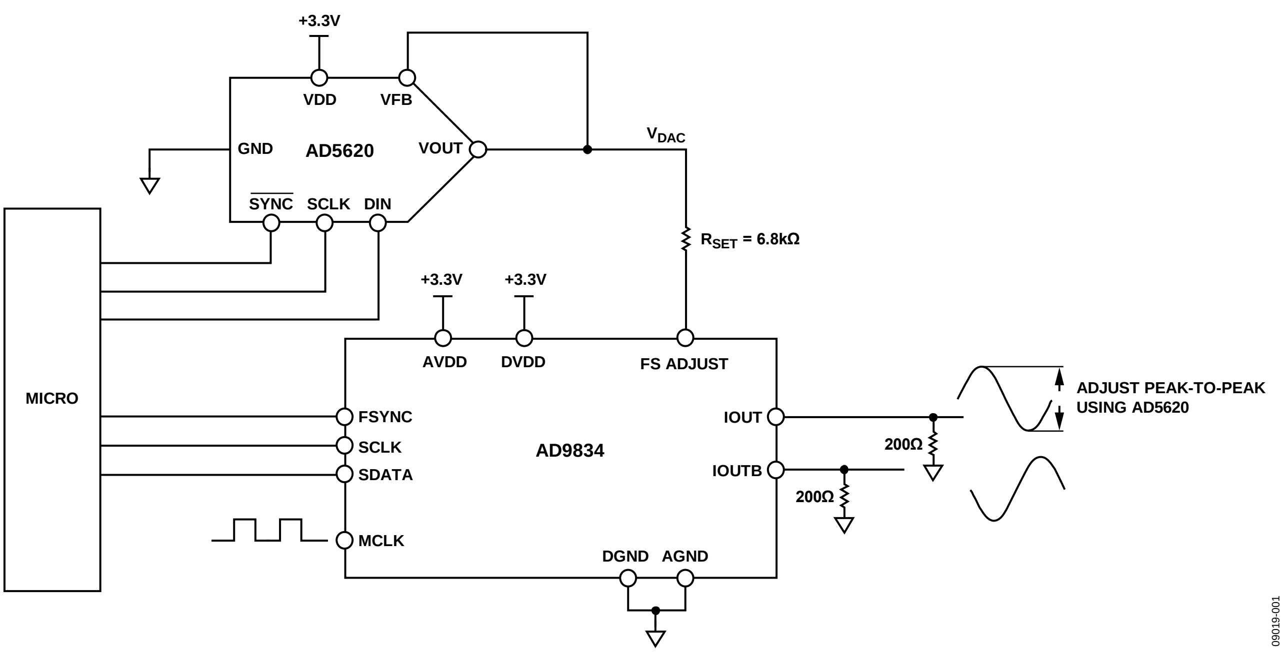

Figure 1. Low Power Amplitude Control Circuit for AD9834 DDS (Simplified Schematic: All Connections and Decoupling Not Shown)

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CIRCUIT DESCRIPTION

The circuit operates on a 3 V to 5 V single supply. Both the DAC and DDS operate with an SPI interface. The on-chip DAC for many DDS devices provides a complementary current output, IOUT and IOUTB, for the AD9834 DDS.

The reference current to the DAC is a function of the internal reference voltage, V_{REF}, and an external resistor, R_{SET}, which normally connects from the DAC FS ADJUST pin to ground. The reference current is equal to V_{REF}/R_{SET} where V_{REF} is the internal reference of the AD9834 and has a typical value of 1.20 V. The R_{SET} resistor has a typical value of 6.8 kΩ.

The full-scale current from the DAC is a multiple of the reference current. For example, the full-scale current of the AD9834 is

$$I_{FULLSCALE} = 18 \times (V_{REF} / R_{SET})$$

If FS ADJUST is connected to a varying voltage, V_{DAC}, the full-scale current is

$$I_{FULLSCALE} = 18 \times (V_{REF} - V_{DAC}) / R_{SET}$$

Varying V_{DAC} varies the full-scale current and, therefore, the voltage output from the DDS device. You can provide this varying voltage by using a voltage-output DAC.

The AD5620 is a low power, small, price effective solution here. A member of the *nano*DAC family, it contains an on-chip 5 ppm/°C reference and is available in an 8-lead SOT-23 or MSOP package. The output voltage of the AD5620 is 0 V to +2.5 V.

The maximum full-scale output current is reached when V_{DAC} = 0 V (zero-scale) and the current from the AD9834 swings between approximately 0.16 mA and 3.12 mA. With the 200 Ω load resistor, the AD9834 output voltage swings between approximately 0.032 V and 0.624 V. The output voltage on the IOUT pin of the AD9834 is shown in Figure 2, where the DDS output frequency is set for 1 MHz.

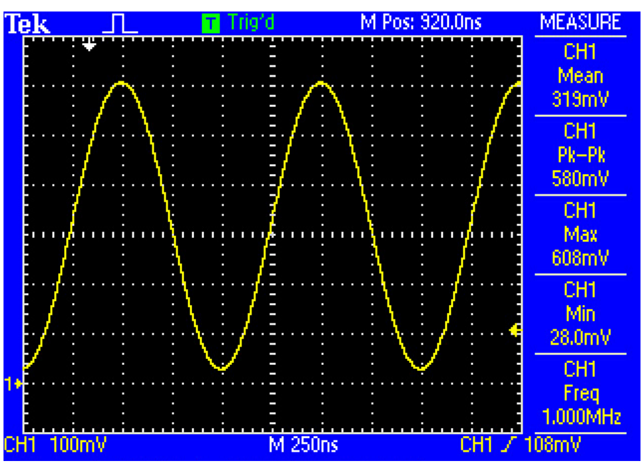

Figure 2. DDS Output When Amplitude Control DAC Is Set to 0 V (This Produces Maximum DDS Full-Scale Output)

Increasing the voltage output from the AD5620 reduces the full-scale output current of the AD9834. The minimum full-scale current will be reached when the voltage from the AD5620 is equal to V_{REF}, or 1.20 V.

Figure 3 shows the AD9834 output voltage for a half-scale output current, where $V_{DAC} = 0.5 \times V_{REF}$, or 0.6 V.

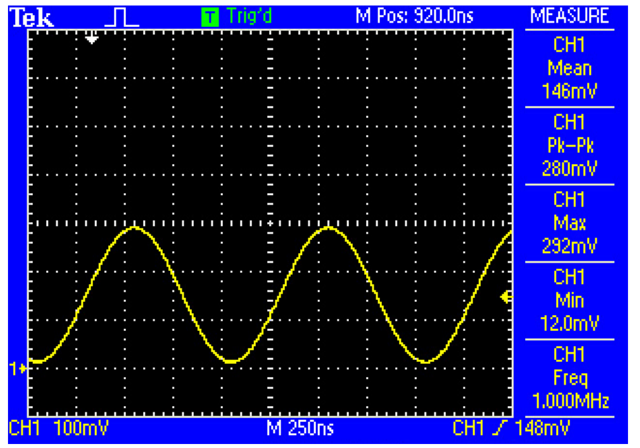

Figure 3. DDS Output When Amplitude Control DAC Is Set to 0.6 V (This Produces One-Half Scale DDS Output)

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 MT-031 Tutorial and MT-101 Tutorial).

COMMON VARIATIONS

The AD5640 and AD5660 are 14-bit and 16-bit versions, respectively, of the AD5620 that are suitable where higher resolutions are required. The AD9833 offers the same functionality of the AD9834 without the amplitude modulation capability.

LEARN MORE

ADIsimDDS Design and Evaluation Tool.

Kester, Walt. *The Data Conversion Handbook*. 2005. Chapters 3, 7, and 8. Analog Devices.

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-085 Tutorial, *Fundamentals of Direct Digital Synthesis (DDS)*. Analog Devices.

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

Riordan, Liam. AN-1070 Application Note, *Programming the AD9833/AD9834*. Analog Devices.

Data Sheets and Evaluation Boards

AD9834 Data Sheet

AD9834 Evaluation Board

AD5620 Data Sheet

AD5620 Evaluation Board

REVISION HISTORY

7/13—Rev. 0 to Rev. A

Changes to Circuit Description Section and Figure 3 Caption 2

6/10—Revision 0: Initial Version