DDS device provides amplitude modulation

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Many applications require an analog output to assume different amplitudes, but many direct-digital-synthesis (DDS) devices do not accommodate amplitude variations. Test equipment uses DDS devices to generate signals of different frequencies. However, the amplitude of these signals often must be variable, too. In communication systems, such as base stations, it is essential that the system does not deliver signals until data is ready to transmit. Between transmissions, the amplitude of the DDS-device output must decrease to near zero. In addition, many applications require AM. Some DDS devices have onboard amplitude registers that allow you to vary the magnitude of the analog output. However, you can also use DDS devices that do not have AM registers (Figure 1). The method involves varying the onboard DAC's current.

The onboard DAC for many DDS devices is a current-source type. The reference current to the DAC is a function of the reference voltage, \( V_{\text{REF}} \), and an external resistor, which you normally tie from the DAC to ground. The reference current is \( V_{\text{REF}}/R_{\text{SET}} \). The full-scale current from the DAC is a multiple of the reference current; the multiple is a function of the size of the transistors in the DAC. For example, the full-scale current of an AD9830 is \( 16XV_{\text{REF}}/R_{\text{SET}} \). If you do not tie \( R_{\text{SET}} \) to ground but tie it instead to some varying voltage, \( V \), the full-scale current is \( 16X(V_{\text{REF}}-V)/R_{\text{SET}} \). Varying \( V \) varies the full-scale current and, therefore, the voltage output from the DDS device. You can provide the varying voltage by using a voltage-output DAC.

In Figure 1, an AD5310 provides a variable voltage to the AD9830. With the DAC output at 0V, the DDS device has maximum full-scale current. Increasing the voltage output from the AD5310 reduces the full-scale current of the AD-9830. The AD9830 uses a 1-kW \( R_{\text{SET}} \) and a nominal \( V_{\text{REF}} \) of 1.21V, yielding a 19.36-mA full-scale current. Figure 2 shows the output spectrum of the DDS device with this full-scale current. The master clock to the DDS device runs at 50 MHz, and the DDS device produces a 1-MHz output signal. The spurious-free dynamic range (SFDR) is typically 60 dB. Loading code 223 into the DAC generates a 1.089V output voltage. This voltage results in 1.936-mA full-scale current (reduced by a factor of 10) from the AD9830. With this full-scale current and the same clock and frequency conditions as above, the SFDR remains unchanged.

The AD5310 is a 10-bit DAC with integral nonlinearity of ±2 LSB. It is suitable for use with the AD9830 in test equipment or for amplitude-ramping applications. If you need high-resolution amplitude modulation of the DDS device's output, you need a more accurate DAC. The AD8300, for example, is a 12-bit DAC with integral nonlinearity of ±2 LSB, representing a fourfold improvement over the AD5310. The increased accuracy makes this DAC more suitable for systems in which you need finer control over the amplitude variations. Both DACs have a serial interface, so you need only three connections to talk to the DAC. (DI #2396).