Digital Potentiometers Vary Amplitude In DDS Devices

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Direct digital synthesis (DDS) devices are used in many applications to generate signals of different frequencies. The devices have frequency registers that enable users to alter the frequency of the signal, and phase registers to allow phase shifting. In addition to frequency and phase control, many applications require amplitude variation. In test equipment, signals of different amplitudes are required. In communications applications, amplitude variation is required to power down idle sections. Therefore, by using amplitude variation, the DDS output voltage could be ramped up or down. Most DDS devices don't perform amplitude variation digitally. However, this can be easily performed in the analog domain using digital potentiometers.

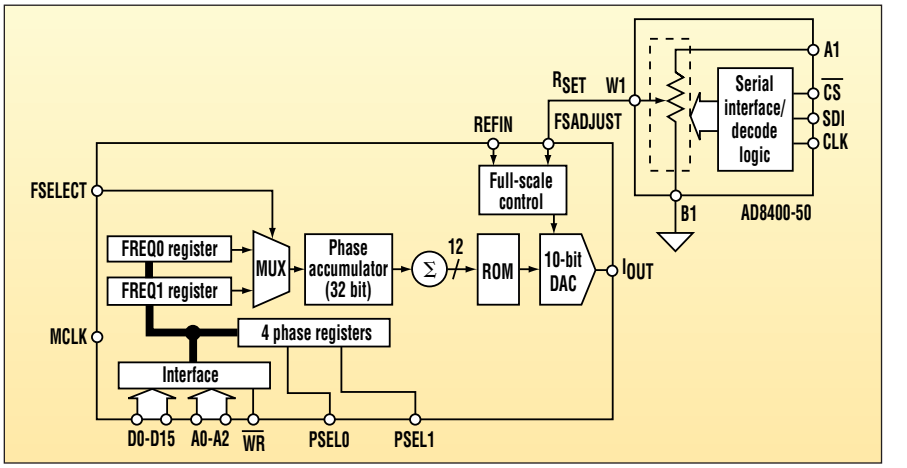
Amplitude modulation can be performed external to the DDS device through various methods. The analog output of the DDS device is given by:

$$V_{REF}/R_{SET} * N * R_L$$

where V_{REF} is the reference voltage; R_{SET} is the external resistor used to set up the reference current in the DAC; N is an integer amount by which the reference current in the DAC is scaled up; R_L is the load resistor that converts the current output from the DAC into a voltage.

The analog output can be varied by controlling the reference voltage. However, the reference voltage is buffered within the DDS device. The op amp used doesn't have significant "headroom," which means that the voltage can only be varied from 0.7 to 1.21 V.

The load resistance can be varied, but an easier solution would be to vary the R_{SET} resistor. Digital potentiometers are available with a maximum resistance of 1 kΩ, 10 kΩ, 50 kΩ, or 100 kΩ. These pots have 256 taps, allowing the resistance to be varied in steps of $R_{MAX}/256$, where R_{MAX} is the maximum resistance value of the potentiometer. The load resistance of a DDS device is quite low (300 Ω or 50 Ω for the DDS devices available from Analog Devices). Therefore, the digital pots available wouldn't provide enough resolution to vary the amplitude by using a digital pot as the load resistor.



By combining the AD9831 Direct Digital Synthesis IC and the AD8400 digital potentiometer, AM modulation capability can be added to a DDS waveform generator.

The figure shows the AD9831 being used for amplitude modulation along with the AD8400 (50-kΩ version), both parts from Analog Devices. The AD9831 typically uses an R_{SET} resistance of 3.9 kΩ. With a reference voltage of 1.21 V, the reference current in the DAC (V_{REF}/R_{SET}) usually equals 0.3 mA. Because N has a value of 12.5 for the AD9831, the full-scale current equals 3.88 mA. This gives a maximum analog output voltage of 1.16 V (R_L = 300 Ω).

The AD8400 has a three-wire serial interface, so it's easy to transfer data to the device. In addition, it's available in an 8-lead SOIC package, which is suitable for applications where board space is a concern. The AD9831 is a parallel device but, again, if board space is a concern, the AD9832 can be used. This device has a three-wire serial interface and comes in a 16-lead TSSOP package.

For higher-frequency applications, the AD9835 or AD9830 can be employed. These devices can operate with a master clock of 50 MHz. For applications such as portable equipment, where power consumption needs to be minimized, the AD9831, AD9832, and AD8400 are fully specified for operation with 3-V power supplies.