New TxDAC® Generation

125-MSPS 10-, 12-, and 14-bit high-performance DACs for wideband multitone communication Transmit channels

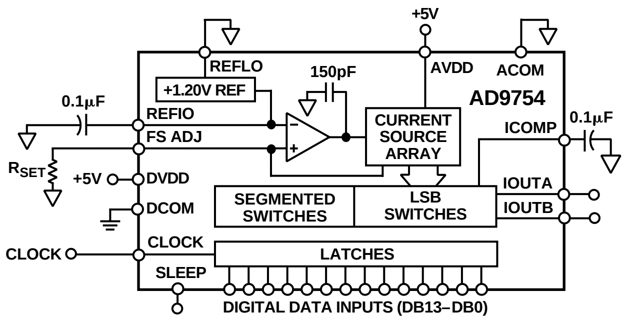

Figure 1. AD9754 functional block diagram.

The *AD9754*, *AD9752*, and *AD9750* are 14-, 12-, and 10-bit wideband, high-performance, low-power CMOS digital-to-analog converters that operate from +5 V supplies. They offer exceptional ac and dc performance, while supporting update rates up to 125 MSPS. All three share the same interface options, 28-lead TSSOP or 0.3" small-outline package, and pinout as the first generation, the *AD976x* series [*Analog Dialogue 30-3, 1996*, pp. 3-5]. This allows a highly flexible upward or downward selection path, based on performance, resolution, and cost.

These DACs are current-output; they have a nominal 20-mA full-scale output with a 100-kΩ source impedance and 1.25-V compliance range. The outputs are differential to support either differential or single-ended applications. The devices include an internal 1.20-V reference and a control amplifier which can set output full-scale values from 2 mA for power conservation to 20 mA, providing 20 dB of output flexibility. They have low dissipation of 190 mW, which can be reduced to 65 mW at the 2-mA end of the output scale, and just 20 mW in power-down mode. They are equipped with edge-triggered latches, and the digital interface is CMOS compatible (+2.7 to 5.5 V)

Emerging wireless/wireline communications standards (Wideband, Multicarrier) are demanding lower distortion and noise to improve system capacity and signal quality. The D/A converter in a modem/transceiver transmitting chain (TxDAC) is the basic analog signal generator; it defines the ultimate performance available in a communications system. Everything after it—power amplifier, antenna, transmission medium, and receiver front end—can only contribute to the degradation of a digitally defined signal, and the end result can never be better than what is at first available from the TxDAC.

*Prices indicated here are recommended resale prices (U.S. Dollars) FOB U.S.A. Prices are subject to change without notice. For specific price quotations, get in touch with our *sales offices or distributors*.

The AD975x family is specifically designed for applications such as wideband CDMA, software/multi-carrier base stations, wireless local-loop RIUs, wireless LAN, broadband set-top boxes, and xDSL modems that utilize wide signal bandwidths to transmit high volumes of data over a desired medium. Key specifications over a 25-MHz band, such as 68-dBc SFDR (spurious-free dynamic range) and –65-dBc THD (total harmonic distortion), are improved over those of the AD976x family by 8 to 10 dB, accompanied by a 9-dB lower integrated noise floor at –109 dB.

The AD975x DACs operate over the industrial temperature range from –40 to +85°C. Evaluation boards are available. Prices* (1000s) for 14/12/10 bits are $21.09/$16.70/$9.45.

What's special about DACs for multitone?

The frequency-domain performance of high-speed DACs has traditionally been characterized by analyzing the spectral output of a reconstructed full-scale (i.e., 0 dB FS) single-tone sine wave at a particular output frequency and update rate. Although this characterization data is useful, it is often insufficient to reflect a DAC's performance for a reconstructed multitone or spread-spectrum waveform. In fact, evaluating a DAC's spectral performance using a full-scale single-tone at the highest specified frequency (i.e., f_H) of a bandlimited waveform is typically indicative of a DAC's "worst-case" performance for that given waveform. In the time domain, the full-scale sine wave represents the lowest peak-to-rms crest factor (i.e., V_{PEAK}/V_{RMS}) that the bandlimited signal will encounter.

However, the inherent nature of a multitone, spread-spectrum, or QAM waveform, in which the spectral energy of the waveform is spread over a designated bandwidth, will result in a higher peak-to-rms ratio when compared to the case of a simple sine wave. As the reconstructed waveform's peak-to-average ratio increases, an increasing amount of the signal energy is concentrated around the DAC's midscale value. Figure 2 is just one example of a bandlimited multitone vector (i.e., eight tones) centered on one-half the Nyquist bandwidth (i.e., $f_{CLOCK}/4$).

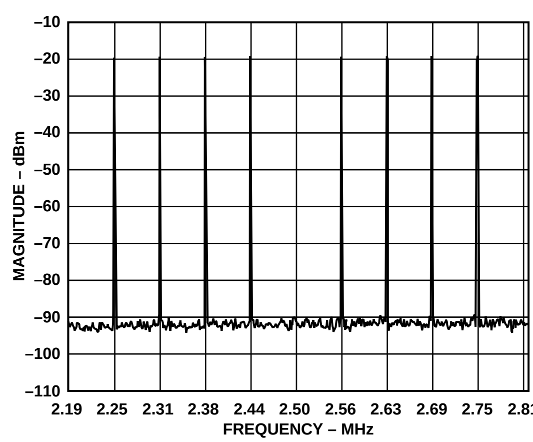

Figure 2. Multitone spectral plot.

This particular multitone vector has a peak-to-rms ratio of 13.5 dB, as compared to a sine wave's peak-to-rms ratio of 3 dB. This means that the DAC must be able to handle a waveform where most of the information is carried at low levels in order to be able to handle large instantaneous peaks without clipping. A "snapshot" of this reconstructed multitone vector in the time domain as shown in Figure 3 reveals the dense signal content around the midscale value. As a result, a DAC's "small-scale" dynamic and static linearity become increasingly critical to obtaining low intermodulation distortion and maintaining sufficient carrier-to-noise ratios for a given modulation scheme.

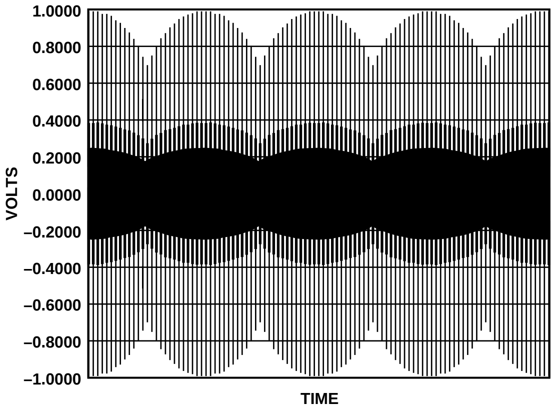

Figure 3. Time-domain "snapshot" of the multitone waveform.

A DAC's small-scale linearity performance is also an important consideration in applications where additive dynamic range is required for gain-control purposes or "predistortion" signal conditioning. For instance, a DAC with sufficient dynamic range can be used to provide additional digitally controlled variation of its reconstructed signal. In fact, the gain can be controlled in 6-dB increments by simply performing a shift-left or -right on the DAC's digital input word. An application might be to predistort the DAC's input signal intentionally to compensate for nonlinearities associated with subsequent analog components in the signal chain. For example, the signal compression associated with a power amplifier can be compensated for by predistorting the DAC's digital input with the inverse nonlinear transfer function of the power amplifier. Since the DAC must accommodate increased gains at higher output levels, the DAC's performance at reduced signal levels should be carefully evaluated.

A full-scale single tone will induce all of the dynamic and static nonlinearities present in a DAC that contribute to its distortion; the distortion components will reduce its SFDR (Spurious-free dynamic range). Thus, in Figure 4 as the frequency of the digitally generated single-tone waveform increases, the dynamic linearities of a DAC (here the AD9754) tend to dominate, thus contributing to the substantial reduction in SFDR with increased frequency.

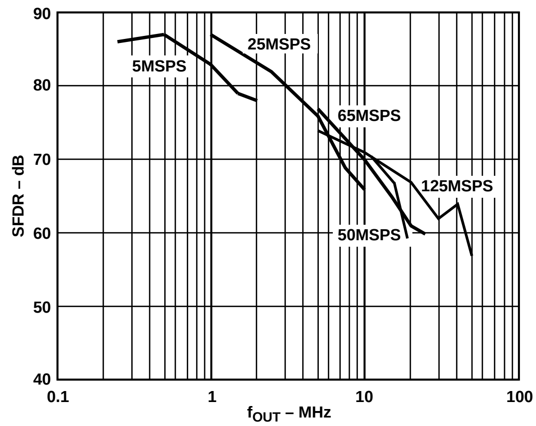

Figure 4. AD9754 SFDR vs. f_{OUT} @ 0 dB FS.

However, unlike the vast majority of DACs, which employ an R-2R ladder for the lower-bit current segmentation, the AD9754 (and the other TxDACs) actually exhibit an improvement in distortion performance as the amplitude of a single tone is reduced from its full-scale level. This reduction of distortion at reduced signal levels is evident in the SFDR plot of Figure 5, which shows typical SFDR vs. frequency at 0, -6, and -12 dB levels for a 65-MSPS sampling rate. Maintaining such decent "small-scale" linearity across the full span of a DAC transfer function is critical in maintaining excellent multitone performance. ▶

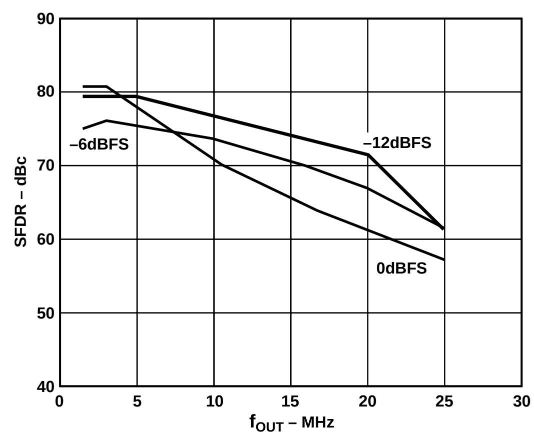

Figure 5. AD9754 SFDR vs. f_{OUT} at 65 MSPS.