Application Briefs

WAYS OF USING THE AD7520

SOME DESIGN IDEAS FOR A 10 BIT MULTIPLYING DAC

by Jerry Whitmore

The AD7520*, introduced in the last issue of *Dialogue*, is a monolithic 10-bit thin-film-on-CMOS digital-to-current converter, available in a 16-bit dual in-line package at low cost. Its equivalent circuit is, in effect, a digitally-controlled attenuator (Figure 1). Its ability to accept a wide range of positive or negative reference voltage, with linear response and wide bandwidth, makes it useful as a 4-quadrant multiplying d/a converter, as well as in more-conventional conversion applications. In the earlier article, we showed configurations for using it as a unipolar and as a bipolar d/a converter, the latter for both sign-magnitude and offset-binary/2's-complement coding.

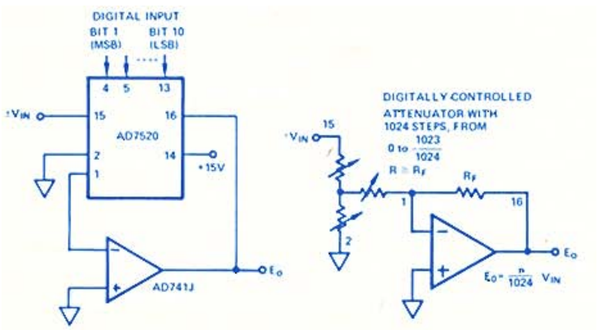

Figure 1. Connection of the AD7520 for unipolar binary input, and an equivalent circuit

Here, we shall mention a few more of its potential applications, with the thought that we may stimulate the reader to dig deeper into the many uses of DAC's, especially those having the promise of economy associated with monolithic integrated-circuit devices, and of power-conservation associated with CMOS devices. Beyond the circuits illustrated here, the interested reader should also consult Chapter I-4, "Analog Functions with Digital Components," in the *Analog-Digital Conversion Handbook* (see footnote 2 on the opposite page).

PROGRAMMABLE POWER SUPPLY

Since a d/a converter, with an op amp, can supply voltage in accordance with a digital code, and the op-amp output can be boosted in voltage or current capability to any reasonable degree by external circuitry, a programmable power supply should be a realistic possibility. One such circuit is shown in Figure 2.

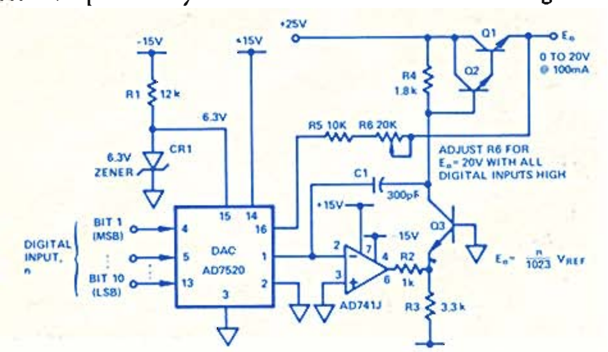

Figure 2. A digitally-programmable power-supply

Other circuitry could be used to provide a bipolar output range, so that one set of digital inputs could command a large positive-and-negative range of voltage and/or current. The supply shown in Figure 2 is designed for programmable voltage, but programmed-current supplies are equally possible, using conventional op-amp current-output circuitry.

If the reference voltage is variable, the converter and its boosted output circuit becomes a power amplifier with programmable gain, with frequency response from dc to well-beyond the audio range. The digital input can be furnished from any digital source, such as a computer or digital communications link (e.g., SERDEX). It can also be furnished manually, using switches to route control voltage to the appropriate digital code inputs. Note that the CMOS switching provides the benefits both of large logic-signal capability (hence high noise-immunity), and very low power drain on the source of the logic signals.

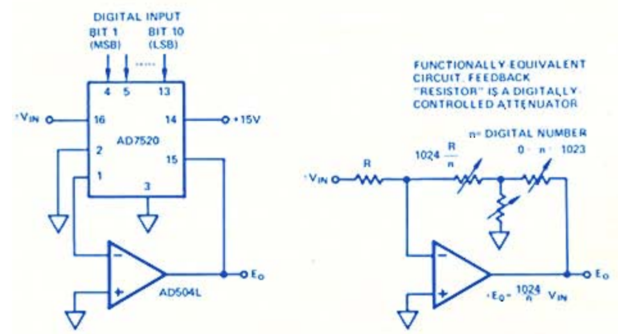

Figure 3. An analog-digital divider

ANALOG DIVIDER

Since one form of analog division circuit is a multiplier in a feedback loop, one might consider the divider circuit shown in Figure 3. In this circuit, the feedback current from the converter's "reference" input to the summing point of the op amp is proportional to (i.e., multiplied by) the digital number; but it must also be equal to the current developed through the input resistor. Therefore the op-amp output is constrained to depend on the ratio of the input signal to the gain value of the digital number. Note that the AD7520 in such an application is inherently a *2-quadrant* divider, since the input signal (and the inverted output) can be either positive or negative. Connected as shown, the gain magnitude varies from a minimum of 1024/1023 to (theoretically) 1024/0, the open-loop gain of the op amp; the largest controlled gain is 1024/1. At the higher gains, accuracy is lost because the feedback attenuation for small numbers may only be accurate to within ½LSB; for example, at a gain of 1024, if the LSB has an error of 10%, the gain will be in error by that amount. Naturally, accuracy rapidly improves with increasing denominator magnitude, and the error be less than 0.05% at full-scale denominator, after adjustment.

*For technical data on the AD7520, request M21.