Multiple Output Range 16-Bit DAC Design Made Simple

Design Note 337

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Introduction

Precision 16-bit analog outputs with software-con-figurable output ranges are often needed in industrial process control equipment, analytical and scientific instruments and automatic test equipment. In the past, designing a universal output module was a daunting task and the cost and PCB real estate associated with this function were problematic, if not prohibitive. Figure 1 shows an example of the circuitry formerly required to produce a programmable 16-bit DAC with a variety of output ranges. However, with the new LTC®1592 multiple output range DAC, all of this complexity is unnecessary. Figure 2 shows the compact simplicity of an implementation based on the new LTC1592. All the standard industrial ranges (0V to 5V, 0V to 10V, ±5V, ±10V, ±2.5V and –2.5V to 7.5V) are provided, accurately and under software control.
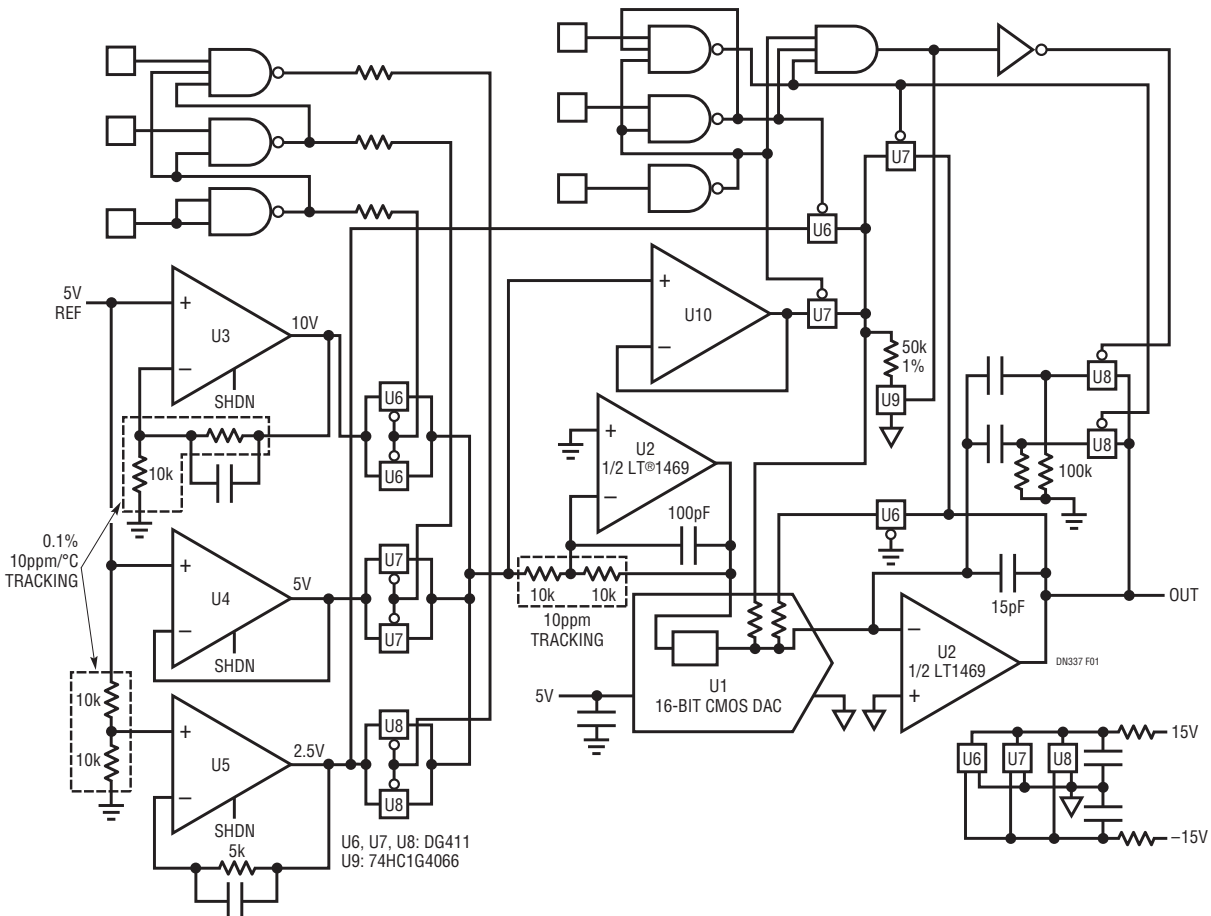
Figure 1. How NOT to Build a Universal 16-Bit Analog Output

The Old Way

Figure 1 shows a pre-LTC1592 implementation of a multiple output range DAC. The circuit can be made to work, but only with costly components and a lot of PCB real estate. The range switching capability requires the addition of analog switches and precision resistors to the basic DAC. Some of these analog switches are required to compensate for the resistance of switches at other points in the circuit. The circuit as shown, even with its considerable complexity, is a compromise as some of these analog switches are not paired with counterparts in the same package. The analog switches are expensive. They also require PCB real estate, bypassing and decoupling to compensate for poor PSRR to mitigate digital noise. In addition, since they are not switching at virtual ground, the analog switches exhibit on-resistance variation with voltage which will degrade linearity. Leakage can be an issue at high temperature.

Precision matched resistor pairs are shown, as they are available from a number of sources. But unless very expensive devices are used, they will degrade accuracy.

The New, Easy Way

In contrast is Figure 2 where the LTC1592 contains all of the circuitry required to perform these functions—all under processor control. All the ranges are accurate with low drift, fast settling and low glitch operation right out of the box. The LTC1592 incorporates all the switches and precision resistors. A full implementation takes less than 0.5in × 0.5in including the dual operational amplifier, bypass and compensation. This analog output subsystem can be reconfigured in real time and the serial interface makes optoisolation easy.

Conclusion

Building a precision, multiple output range, software-configurable 16-bit DAC is no longer a complicated, expensive design effort. Now a clean, simple design yields smaller size, lower cost and much better accuracy. The LTC1592 can also be used for embedded or fixed range applications, where its 4-quadrant operation with serial interface make it compelling even if range changing may not be required.
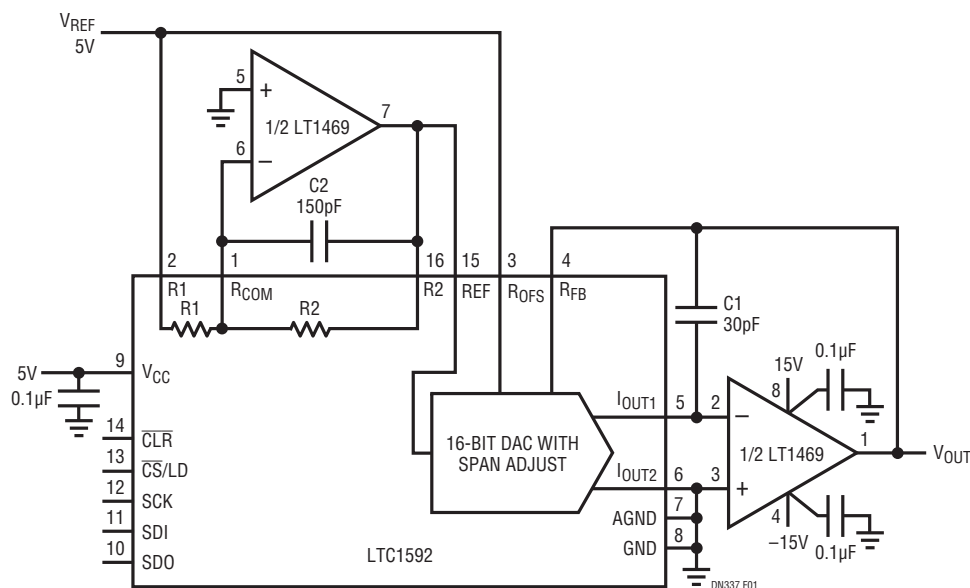
Figure 2. Programmable Output Range 16-Bit SoftSpan™ DAC