DESIGN NOTES

Highly Integrated Quad 16-Bit, SoftSpan™, Voltage Output DAC for Industrial and Control Applications

Design Note 431

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Introduction

Digital-to-analog converters (DACs) are prevalent in industrial control and automated test applications. General-purpose automated test equipment often requires many channels of precisely controlled voltages that span several voltage ranges. The LTC2704 is a highly integrated 16-bit, 4-channel DAC for high-end applications. It has a wide range of features designed to increase performance and simplify design.

Unprecedented Integration

The LTC2704 provides true 16-bit performance over six software selectable ranges: 0V to 5V, 0V to 10V, –2.5V to 2.5V, –5V to 5V, –10V to 10V and –2.5V to 7.5V. Four single-range voltage outputs would normally require four current-output DACs, two reference amplifiers and four output amplifiers—seven packages if dual amplifiers are used. Implementing multiple ranges discretely is prohibitive. Design Note 337 explains the difficulty in implementing multiple ranges, including the cost of precision-matched resistors and the performance limitations of analog switches. Control is also complicated, requiring extra digital lines for each DAC and for range control. The LTC2704 integrates all of these functions into a single package with no compromises, and all functions are controlled via an easy-to-use 4-wire SPI bus.

Ease of Use

The LTC2704 provides many features to aid system design. The voltage output and feedback are separated, allowing external current booster stages to be added with no loss in accuracy. The C1A, C1B, C1C and C1D pins allow external frequency compensation capacitors to be used, either to allow capacitive loads to be directly driven by the LTC2704's outputs, or to compensate slow booster stages. The V_{OS} pins provide a convenient way to add an offset to the output voltage. The gain from the V_{OS} pin to the output is –0.01, –0.02 or –0.04, depending on the selected range. While this seems like a simple function to perform externally, implementing it inside the LTC2704 eliminates concerns about matching the temperature coefficient of the external offsetting resistor to the internal resistors.

Example Circuits

Figure 1 shows several ways to use the LTC2704's features. The offset pin of DAC A is driven by an LTC2601 DAC through an LTC1991 amplifier. This provides ±50mV of "system offset" adjustment in the ±2.5V and 0V to 5V ranges, ±100mV of adjustment in the –2.5V to 7.5V, ±5V, and 0V to 10V ranges and ±200mV of adjustment in the ±10V range. The C1 pin is left open for fast settling. An LTC2604 quad DAC can be used to drive all four offset pins, and can share the same SPI bus as the LTC2704.

DAC B drives a 1μF capacitor through a 1Ω resistor, with 2200pF of additional compensation. This is useful for applications where the load has high frequency transients, such as driving the reference pin of an ADC.

DAC C drives an LT3080 low dropout regulator, providing up to 1A of output current. This can be used to power test circuitry directly. Global feedback removes the offset of the regulator, maintaining accuracy at the output.

DAC D is boosted by an LT1970 power op amp, providing 500mA of drive current, either sourcing or sinking. Once again, global feedback preserves DC accuracy.

Conclusion

The LTC2704 provides a highly integrated solution for generating multiple precision voltages. It saves design time, board space and cost compared to imple-mentations using separate DACs and amplifiers.

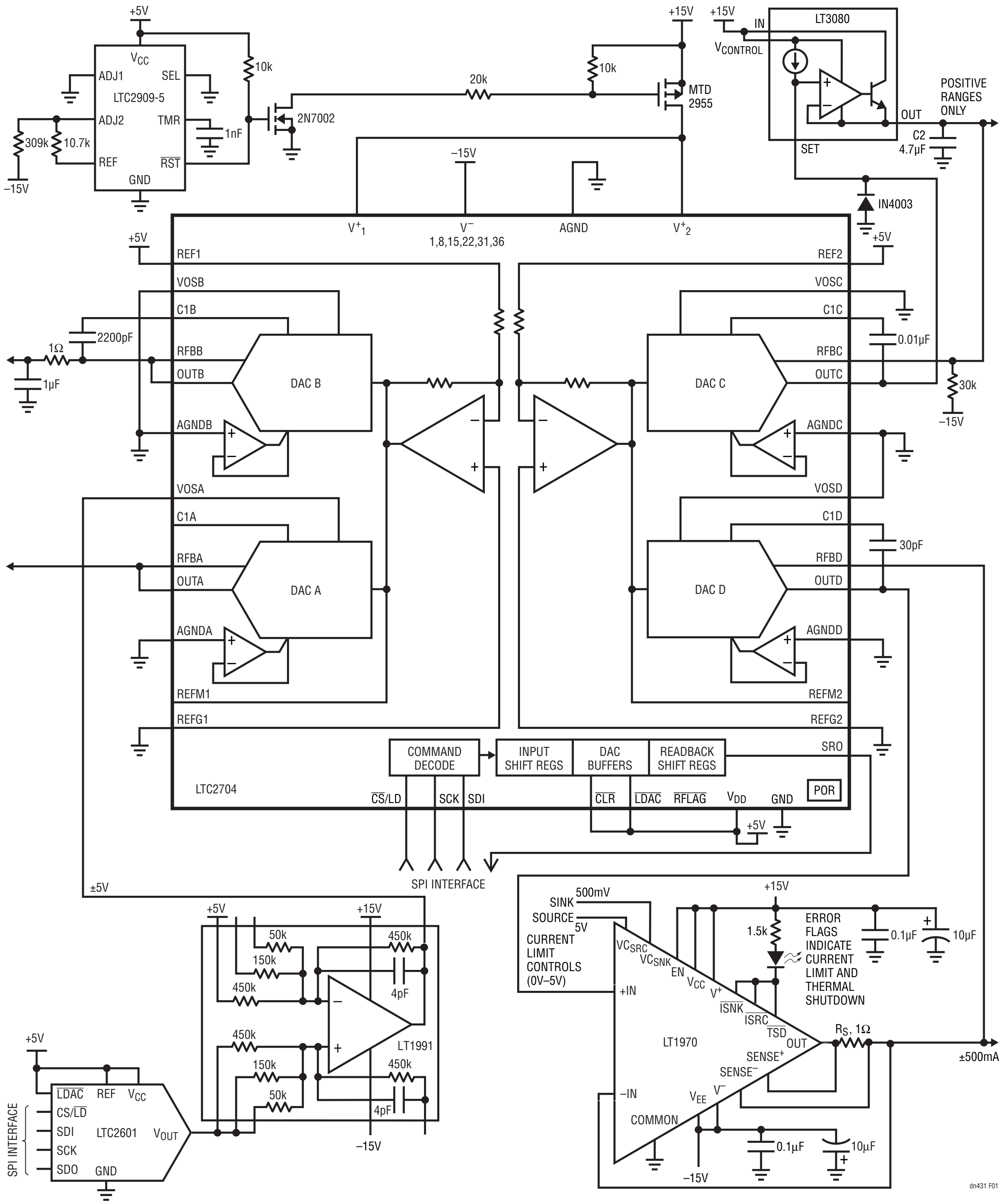

Figure 1. LTC2704 Application Examples

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