LINEAR TECHNOLOGY

DESIGN NOTES

Micropower 4- and 8-Channel, 12-Bit ADCs Save Power and Space – Design Note 153

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Introduction

Data acquisition applications that require low power dissipation fall into two general areas: products that must use power very efficiently, such as battery-powered portable test equipment, and remotely located data logging equipment. To help meet these requirements, Linear Technology has introduced the LTC®1594 and LTC1598.

Micropower ADCs in Small Packages

The LTC1594/LTC1594L and LTC1598/LTC1598L are micropower 12-bit ADCs that feature a 4- and 8-channel multiplexer, respectively. To cover different system supply voltages, the LTC1594 and LTC1598 operate on 5V and the LTC1594L and LTC1598L operate on 3V. The LTC1594L and the LTC1598L are tested to operate on supplies as low as 2.7V and sample at a maximum of 10.5ksps. The LTC1594 and LTC1598 have a maximum sample rate of 16.8ksps. At full conversion rate, the LTC1594/LTC1598 and LTC1594L/LTC1598L typically draw 320µA and 160µA, respectively. At 1ksps these converters typically draw 20µA. The LTC1594/LTC1594L are available in a 16-pin SO package and the LTC1598/LTC1598L are available in a 24-pin SSOP package.

As shown in Figure 1, each converter includes a MUX with separate MUXOUT and ADCIN pins (useful for conditioning an analog input prior to conversion), S/H, 12-bit ADC and a simple, efficient, serial interface that reduces interconnects. Reduced interconnections also reduce board size and allow the use of processors having limited I/O, both of which help reduce system costs.

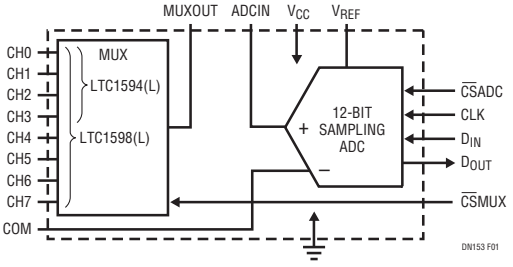

Figure 1. With a 4- or 8-Channel MUX, the LTC1594/LTC1594L and LTC1598/LTC1598L Feature Low Power Dissipation, MUXOUT/ADCIN Connections for External Signal Conditioning and Serial Interface

Conserve Power with Auto Shutdown Operation

The LTC1594/LTC1594L and LTC1598/LTC1598L include an auto shutdown feature that reduces power dissipation when the converter is inactive ($\overline{CS}$ = 1). Nominal power dissipation while either 5V converter is clocked at 320kHz is typically 1.6mW. The 3V converters dissipate 480µW when clocked at 200kHz. The curve in Figure 2 shows the amount of current drawn by this MUXed 12-bit ADC family vs sample rate.

Good DC Performance

The DC specs include excellent differential nonlinearity (DNL) of ±3/4LSB, an advantage in pen-screen and other monitoring applications. No missing codes are guaranteed over temperature.

Versatile, Flexible Serial I/O

The serial interface found on the LTC1594/LTC1594L and LTC1598/LTC1598L is designed for ease of use, flexibility, minimal interconnections and I/O compatibility with QSPI, SPI, MICROWIRE and other serial interfaces. The MUX and the ADC have separate chip select ($\overline{CS}$)

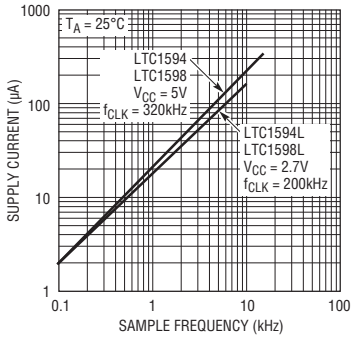

Figure 2. The Auto Shutdown Feature Automatically Reduces Supply Current as Sample Rate is Reduced. Supply Current Drops to 20µA at 1ksps

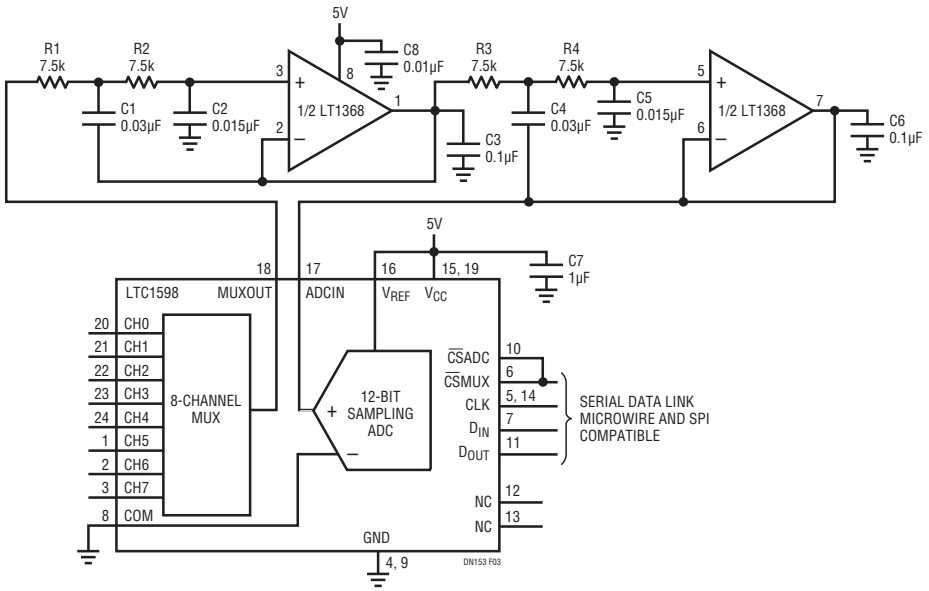

Figure 3. This Data Acquisition System Takes Advantage of the LTC1598's MUXOUT/ADCIN Pins to Filter All Eight Analog Signals with a Single Filter Prior to ADC Conversion

and serial clock inputs that can be tied together or used separately, adding versatility. The remaining serial interface signals are data input (D_{IN}) and data output (D_{OUT}). The maximum serial clock frequencies are 320kHz and 200kHz for the 5V and 3V parts, respectively.

Latchup Proof MUX Inputs

The LTC1594's and LTC1598's input MUXes are designed to handle input voltages that exceed the nominal input range, GND to the supply voltage, without latchup. Although an overdriven unselected channel may affect a selected, correctly driven channel, no latchup occurs and correct conversion results resume when the offending input voltage is removed. The MUX inputs remain latchup proof for input currents up to ±200mA over temperature.

Individual ADC and MUX Chip Selects Enhance Flexibility

The LTC1594/LTC1594L and LTC1598/LTC1598L feature separate chip selects for ADC and MUX. This allows the user to select a channel once for multiple conversions. This has the following benefits: first, it eliminates the overhead of sending a D_{IN} word for the same channel each time for each conversion; second, it avoids possible glitches that may occur if a slow-settling antialiasing filter is used following the MUX; and third, it sets the gain once for multiple conversions if the MUXOUT/ADCIN pins are used with an op amp to create a programmable gain amplifier (PGA).

MUXOUT/ADCIN Economizes Signal Conditioning

The MUXOUT and ADCIN pins allow the filtering, amplification or conditioning of analog input signals prior to conversion. These input/output connections are also a cost-effective way to perform the conditioning because only one circuit is needed instead of one for each channel. The circuit in Figure 3 uses these connections to insert an antialiasing filter into the signal path, filtering several analog inputs. The output signal of the selected MUX channel, present on the MUXOUT pin, is applied to R1 of the Sallen-Key filter. The filter band limits the analog signal and its output is applied to ADCIN. When lightly loaded, as in this application, the LT1368 rail-to-rail op amps used in the filter will swing to within 8mV of the positive supply voltage and 6mV of ground. Since only one circuit is used for all channels, each channel sees the same filter characteristics and channel-to-channel matching is ensured.

Conclusion

With their serial interfaces, small packages and auto shutdown, the LTC1594/LTC1594L and LTC1598/LTC1598L achieve very low power consumption while occupying very little circuit board area. Their outstanding DC specifications make them the choice for applications that benefit from low power, battery conserving operation, multichannel inputs and space and component saving signal conditioning.

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