Bipolar Input 24-Bit A/D Converter Accepts ±2.5V Inputs

Differential Input 24-Bit A/D Converter Provides Half-Scale Zero for Bipolar Input Signals

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SPECIFICATIONS

$V_{CC} = V_{REF}$ = LT®1236-5; $V_{FS} = \pm 2.5V$;
$R_{SOURCE} = 175\Omega$ (Balanced)

PARAMETER	CIRCUIT (MEASURED)	LTC2400	TOTAL (UNITS)
Input Voltage Range	±2.8		V
Zero Error	70	1.5	µV
Input Current	See Text		
Nonlinearity	±35	4	ppm
Input-Referred Noise (without averaging)	10	1.5	μV_{RMS}
Input Referred Noise (averaged 64 readings)	1.5		μV_{RMS}
Resolution (with averaged readings)	21.7		Bits
Supply Voltage	5	5	V
Supply Current	0.5	0.2	mA
CMRR	118		dB
Common Mode Range	0 to 5		V

OPERATION

The circuit in Figure 1 is ideal for wide dynamic range differential signals in applications that have a 5V supply. The circuit uses one-half of an LTC®1043 to perform a differential to single-ended conversion over an input common mode range that includes the power supplies. This half of the LTC1043 samples a differential input voltage, holds it on C_{S1} and transfers it to capacitor C_{H1}. The voltage on C_{H1} is applied to the LTC2400's input and converted to a digital value.

A reference voltage is applied to the LTC2400's V_{REF} pin and the LTC1043's Pin 6. The remaining half of the LTC1043 divides the reference voltage by two with a high degree of accuracy. This $V_{REF}/2$ voltage is applied to the bottom of C_{H1}, centering the LTC1043's output voltage at midscale (2.5V). This allows the converter to accept bipolar input voltages that swing about a $V_{REF}/2$ point when operating on a single supply.

The LTC1043 achieves its best differential to single-ended conversion when its internal switching frequency operates at a nominal 300Hz, as set by the 0.01µF capacitor C1 and when 1µF capacitors are used for C_{S1}, C_{S2}, C_{H1} and C_{H2}. Each of the four capacitors should be a film type such as mylar or polypropylene. Conversion accuracy is enhanced by placing a guard shield around C_{S1} and connecting the shield to Pin 10 of the LTC1043. This minimizes nonlinearity that results from stray capacitance transfer errors associated with C_{S1}. Consult the LTC1043 data sheet for more information. As is good practice in all high precision circuits, keep all lead lengths as short as possible to minimize stray capacitance and noise pickup.

Like all delta-sigma converters, the LTC2400's input circuitry causes small current spikes on the input signal. These current spikes perturb the voltage on the LTC1043's C_{H1}, which results in an effective increase in offset voltage and gain error. These errors remain constant over a short time interval and can be removed through software. Without this end-point correction that reduces the effects of zero and full-scale error, the overall accuracy is degraded. The input dynamic range, however, is not compromised and the overall linearity remains at ±35ppm, or 14.5bits.

As stated above, the LTC1043 has the highest transfer accuracy when using 1µF capacitors. Using any other value will compromise the accuracy. For example, 0.1µF will typically increase the circuit's overall nonlinearity by a factor of 10.

The LTC1043's internal oscillator's frequency will vary with changes in supply voltage. This variation shows up as increased noise and/or gain error. For example, a 100mV change in the LTC1043's supply voltage causes 14ppm gain error in the LTC2400. If this variation is short term, this error appears as noise. The LTC1043 shows the largest gain error at a nominal 3V input. These errors can be reduced by using an external clock. As the LTC1043's V_{CC} increases from a nominal 5V, gain errors are most significant and below 5V, linearity errors become more significant.

The circuit's input current is dependent on the input signal's magnitude and the reference voltage. For a 5V reference, the input current is approximately –1µA at –2.5V, 1µA at 2.5V and 0µA at midscale (0V). The values may vary from part to part. Figure 1's input is analogous to a 2µF capacitor in parallel with a 2.5MΩ connected to ground. The LTC1043's nominal 800Ω switch resistance is between the source and the 2µF capacitance. This description applies to cases where a capacitor is connected in parallel to the LTC2400's input.

This topology is better suited to lower level signals and higher source impedances than a similar topology without the 1/2 reference point. Operation about the 1/2 reference point minimizes the input current passed from the LTC2400 and reduces the effect of the gain error variation that results from internal oscillator frequency change in the LTC1043.

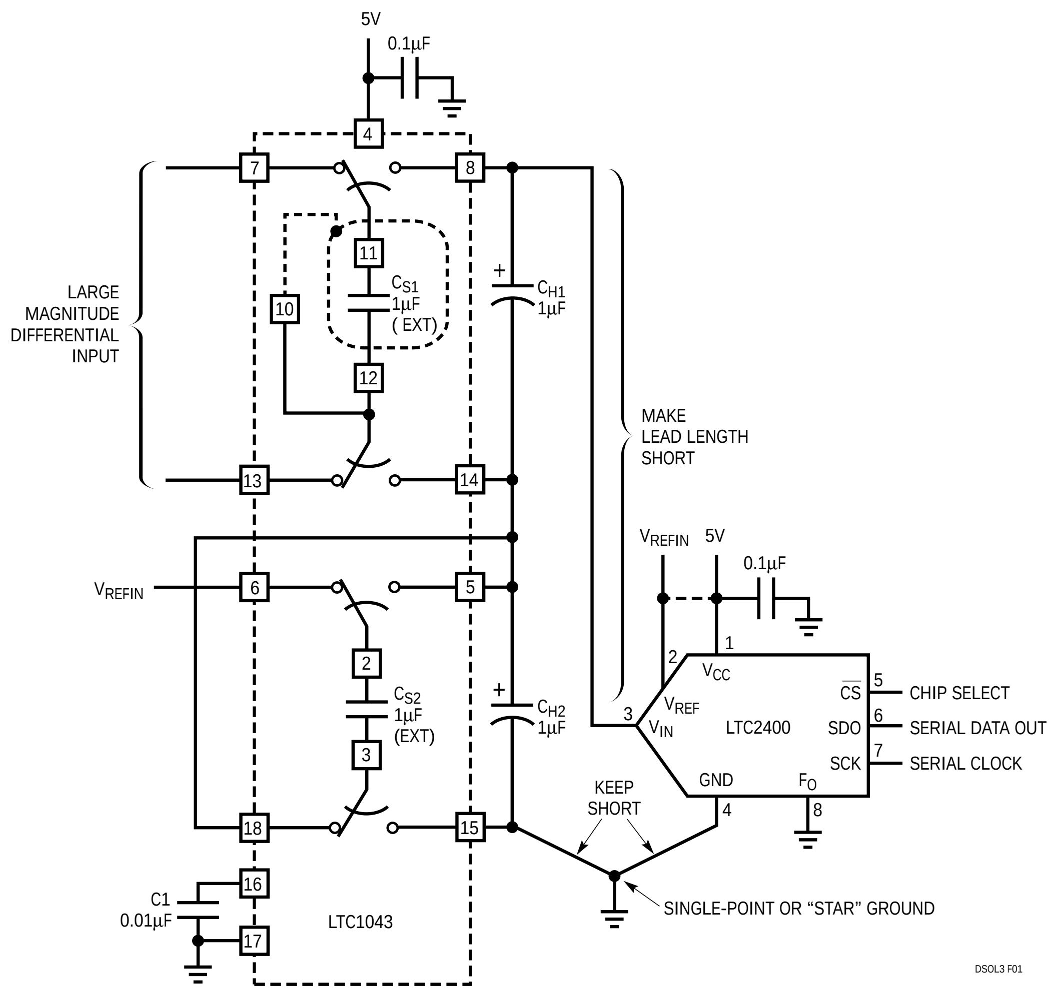

Figure 1. Differential Input 24-Bit A/D Converter with Half-Scale Zero for Bipolar Input Signals

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