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A 24-bit delta–sigma ADC with an ultra-low noise chopper-stabilized programmable gain instrumentation amplifier

J.E. Johnston *

Crystal Products Division, Cirrus Logic Inc., 4210 South Industrial Drive, Austin, TX 78744, USA

Abstract

A 24-bit delta–sigma analog-to-digital converter with a programmable gain amplifier is presented. The converter uses a dual amplifier input structure to optimize it for different measurement tasks. One of the amplifiers is a chopper-stabilized multipath feedforward architecture that achieves exceptionally high open loop gain with very low drift and ultra-low noise.
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Keywords: Analog-to-digital converter; Instrumentation amplifier; Chopper-stabilized; Low noise

1. Introduction

Common transducers used for the measurement of physical parameters (temperature, pressure, force, etc.) generate very low-level signals. Many applications require that these signals be amplified with a very low noise amplifier to allow them to be digitized with an analog-to-digital converter (ADC).

A 24-bit delta–sigma analog-to-digital converter is introduced, which includes an ultra-low noise chopper-stabilized programmable gain instrumentation amplifier. The combination of the world's lowest noise monolithic instrumentation amplifier in the band 0.1 to 10 Hz, and a very high dynamic range delta–sigma analog-to-digital converter results in a digitizer ideal for transducers, which output very low level signals with frequencies below 50 Hz.

2. The analog-to-digital converter

Fig. 1 illustrates the ADC. The converter is designed to operate from a single $+5$ V supply or from ± 3 V supplies. The ADC includes a chopper-stabilized Programmable Gain Instrumentation Amplifier (PGIA) with binary gain steps from $2\times$ to $64\times$. The output of the PGIA feeds a fourth order delta–sigma modulator. The modulator has an input range of ± 2.5 V. The span at the input of the PGIA is ± 2.5 V/[PGIA Gain]. At its highest gain ($64\times$), the amplifier range is approximately ± 40 mV. Input referred noise voltage density is 6 nV/$\sqrt{\text{Hz}}$ at 0.1 Hz. The chopper-stabilized amplifier exhibits no $1/f$ noise. The ADC achieves about 130 dB of dynamic range with an output word rate of 7.5 S/s on its most sensitive input range (± 40 mV).

* Tel.: +1-512-912-3256; fax: +1-512-445-2831.
E-mail address: jej@crystal.cirrus.com (J.E. Johnston).

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