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Title

Radiation Test for the Evaluation of the Static Non-Linearity Parameters of the COTS 16-bit SAR ADC LTC2387 from Linear Technology

Summary

This paper presents the performance evaluation of the 16-bit LTC2387IUH ADC from Linear Technology under the Total Ionization Dose (TID) and Single Event Effects (SEE) test. The DUT (Device Under Test) is a SAR ADC with a 15MHz of maximum throughput rate and it supports a high-speed application using a serial LVDS digital interface with a one-lane or two-lane output modes. The paper is focus on the measurements of the two main static parameters of the ADC, the Integral Non-Linearity (INL) and the Differential Non-Linearity (DNL). The dynamic characterization was carried out by the Signal-to-Noise (SNR) evaluation.

Content

The Space Industry is strongly increasing its commitment to the use of Commercial Off-The Shelf (COTS) components to face and cover the massive production of satellites. Currently, many of the requirements of space applications can only be met by using commercial components. Designing systems with them has the advantage of reducing costs, as they are usually cheap devices that give flexibility to the design and are quick to achieve. On the other hand, the main drawback is the adaptation of these components into the hard conditions of space, such as the extreme temperatures or the radiation environment: knowing the performance under these conditions is critical for establishing the viability of the components [1].

Analog to Digital Converters (ADC) are key elements of any mixed-signal system, connecting the analog world to the digital world. They are always- present devices and their custom design for specific space applications is expensive and time consuming. This has led the use of commercial converters expanding in recent years [2], especially those that have a serial IO interface that facilitates a pin compatibility between different components representing a cost saving for future re-engineering solutions.

This paper presents the work carried out for the performance evaluation of the 16-bit LTC2387IUH (5mmx5mm QFN package) ADC from Linear Technology [3] under the Total Ionization Dose (TID) test [4]. The component was irradiated using a Cobalt60 source, with a dose rate of 210 rad(Si)/h and up to 50krad cumulative dose. Five samples were all pin grounded and five samples were biasing in a static configuration. The paper is focused on the measurements of the two main static parameters of the ADC, the Integral Non-Linearity (INL) and the Differential Non-Linearity (DNL), using the Histogram Method [6]. The dynamic characterization was carried out by the Signal-to-Noise (SNR) evaluation. The paper also gives an overview of the SEE test [5] and its results, where SET (Transient) and SEL (Latch-up) tests were done over four samples.

The LTC2387-16 is a Successive Approximation Register (SAR) ADC with a 15MHz of maximum throughput rate and no-latency operation. It supports a high-speed application using a serial LVDS digital interface with a one-lane or two-lane output modes, depending on the data rate. The converter operates from 5V and 2.5V supplies and has a fully differential ±4.096V input range. No missing codes at 16-bits with a maximum DNL = ±0.8 LSB (typical DNL = ±0.06 LSB).

The maximum INL = ±0.8 LSB (typical INL = ±0.15 LSB) and the minimum SNR = 91.2dB. The LTC2387 has an output test pattern that allows to check the digital interface configuration, forcing the ADC data outputs to a known code. This pattern has been used to perform a robust synchronization between the output data and our capture system, seeking to avoid influences on the measured performance due to synchronization errors during the TID test.

Concerning to setup key features, it stands out the manufacture of a custom-made socket integrating the critical capacitors for the SAR typology, the choice of a powerful capture system as the XEM7350 FPGA integration module and the use of an external 1ps phase- jitter clock for the ADC sampling clock. The test instrumentation included the Applicos ATX7006 Automatic Test Equipment (ATE) as the input signal generator: its AWG22 module is a 22-bit 2MHz Arbitrary Waveform Generator with a 50Ohms or <1Ohm output impedance, signal-path filtering possibility, and non-linearity of maximum ±3ppm of range. The input signal generation is fully synchronized to the ADC sampling frequency through the external low-jitter clock.

The paper will include an introduction, a first section describing the setup, the PCB-Capture system, and the evaluation of the electrical parameters, a second section focused on the radiation test and finally the conclusions and future work.

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