FACULTY OF SCIENCE

DEPARTMENT OF ASTRONOMY

MASTER THESIS:

WIDEBAND DIGITAL SPECTROMETERS ON THE ROACH FIELD PROGRAMMABLE GATE ARRAY

A Thesis submitted by Katherine Cortés for the degree of Master of Science with mention in physics at the University of Concepción

Supervised by:
Neil Mark Nagar.

CONCEPCIÓN-CHILE
JULIO 2014

Abstract

An optimized wideband spectrometer was developed by the CASPER (Collaboration for Astronomy Signal Processing and Electronics Research) group for the ROACH (Reconfigurable Open Architecture Computing Hardware) board. Here we installed, and set up a ROACH board. We also characterize the parameter space of this spectrometer design within the capacities of a single ROACH 1.0 board. We test for the maximum spectral resolution, maximum bandwidth achievable, and the number of such spectrometers. Which can be run concurrently on a single board. We also experimented with different types of FFT blocks.
For a ROACH clocked at 250 MHz (the typical) a single 500 MHz bandwidth spectrometer (1 GSps, 8 bits resolution), the maximum number of channels is 2^{14}. A maximum of five parallel 500 MHz (1 GSps), 8 bit, 2048 channels spectrometers can be fit on a single ROACH 1.0. This number can be increased to 8 if the number of channels per spectrometers is reduced to 32. We also tested the feasibility of using an interleaved sampling mode between two independent ADCs attached to the ROACH board. For a single 1 GHz bandwidth spectrometer a maximum of 3 parallel spectrometers for 3-GHz 32-channels or 2 parallel spectrometers for 2-GHz 2048-channels can be fit onto a single ROACH 1.0. Developing a single wideband, or multi-parallel, digital spectrometer(s) is useful in a wide range of spectral analyzer products. Specifically, we were interested in two applications for the ROACH: as a wideband spectrometer 'back-end' in atmospheric sensing radiometers by to determine the water vapor and oxygen lines in the atmosphere in the valley of Chajnantor this cause interference on radio signals , and as a flexible general-purpose laboratory spectrometer.