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# MODULAR SOFTWARE DEFINED RADIO FOR ADVANCED CUBESAT COMMUNICATIONS

**Abstract**

University CubeSat programs are growing in popularity as the technology becomes cheaper and more advanced in small packages. They provide a hands on learning opportunity for students to gain experience with the design cycles for real space missions. The communications system is one part of this puzzle that Universities spend significant time in the design cycle testing and fine-tuning. A primary objective of this work is to reduce the design time by providing a fully modular system that can be programmed to fit a variety of needs.

The University of Alaska Fairbanks has previously developed CubeSats using all-in-one communications systems such as the CC1101 chip. These combine basic baseband processing with the RF front end to provide a simple solution suitable for projects requiring fast design cycles. The problem with this solution is the lack of flexibility to implement modulation schemes and being locked into certain frequencies for a specific design, thus requiring a new system to be interfaced with and a new design cycle started.

The solution to requiring the new software design is to move base-band processing from the RF front end (included in CC1101) into an FPGA programmed to generate I and Q waveforms to drive various IQ transceivers. The system proposed is based on software defined radios to fit the CubeSat form factor. The system consists of an FPGA programmed with modules to facilitate data rates in excess of 1 Mbps, supports various modulation schemes including BPSK, QPSK, 8-PSK, 16 QAM and FSK, FEC codes, 16 bit CRC and built in option to implement the amateur AX.25 packet scheme. Multiple communication standards are supported to interface with the external microcontroller and transceiver chips including SPI, UART, I2S and certain proprietary standards for specific IQ transceivers.

The motivation for such a flexible system is to have a cheap baseband standard system capable of meeting the needs of both current systems and future communications that is capable of implementing adaptive protocols. All the modules are selectable in the FPGA, but the activation of which is controlled by a microcontroller. This provides a balance of flexibility and simplicity of implementation that requires very few components. This system provides the base for communication systems in the UHF, S, X and Ka bands as new RF front ends are designed.