National Aeronautics and Space Administration

Design and Validation of High Date Rate Ka-Band Software Defined Radio for Small Satellite

Ka-band Transceiver Design

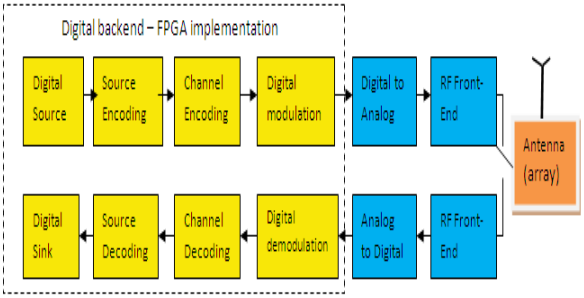
The Design and Validation of High Date Rate Ka-Band Software Defined Radio for Small Satellite project will develop a novel Ka-band software defined radio (SDR) that is capable of establishing high data rate inter-satellite links with a throughput of 500 megabits per second (Mb/s) and providing millimeter ranging precision. The system will be designed to operate with high performance and reliability that is robust against various interference effects and network anomalies. The Ka-band radio resulting from this work will improve upon state of the art Ka-band radios in terms of dimensional size, mass and power dissipation, which limit their use in small satellites.

Considered a distributed autonomous system, formation flying satellites (FFS) are a coordinated cluster of small satellites leveraged for their remote communication and sensing capabilities. Nearly all existing FFSs are single mission systems, where the satellite electronic circuitry has fixed functional operation, and the satellite network geometry has low flexibility to change the relative spatial position and attitude of the element satellite. Such single function single geometry formation design approach has the following drawbacks:

- Inflexibility to off-nominal conditions
- Increased space orbit congestion that leads to collision risk
- Network performance and reliability degradation

These elements highlight the need for a flexible, reconfigurable communication system based on the concept of SDR. This project will address the challenges put forth by precision formation flying small satellites.

The main goal of this project is to design a Ka-band radio that can accomplish high data rate with a compact design and low weight. The research scope focuses on Ka-band SDR transceiver design and validation. The scope of the project



Transceiver architecture, including digital backend and RF front end

includes the investigation of reconfigurable radio architecture and development of a transceiver test platform, including radio frequency (RF) front end, reconfigurable digital backend, and efficient coding algorithms to leverage small satellite functional reliability and accuracy. For the transceiver design, the digital backend and encoding/decoding algorithms will be implemented in a field-programmable gate array (FPGA) while the analog and RF front end will be designed with commercial-off-the-shelf (COTS) circuit components that will be extended to system on chip (SoC) design.

This project will accomplish a Ka-band SDR with high-order modulations, advanced error correction coding, and optimal receiver architecture at Ka-band with fading mitigation, and significantly higher data rates so as to leverage small satellite communication, ranging and navigation functional performance. As a result, it will advance FFS technology to the point where advanced scientific discoveries can be made.

This project is being performed at the University of Vermont in Burlington, Worchester Polytechnic Institute in Worcester, Massachusetts, in collaboration with NASA Goddard Space Flight Center in Greenbelt, Maryland.

NASAfacts

This project is funded through the SmallSat Technology Partnerships, a program within the Small Spacecraft Technology Program (SSTP). The SSTP is chartered to develop and mature technologies to enhance and expand the capabilities of small spacecraft with a particular focus on communications, propulsion, pointing, power, and autonomous operations. The SSTP is one of nine programs within NASA's Space Technology Mission Directorate.

For more information about the SSTP, visit:
http://www.nasa.gov/smallsats

For more information about this project, contact:

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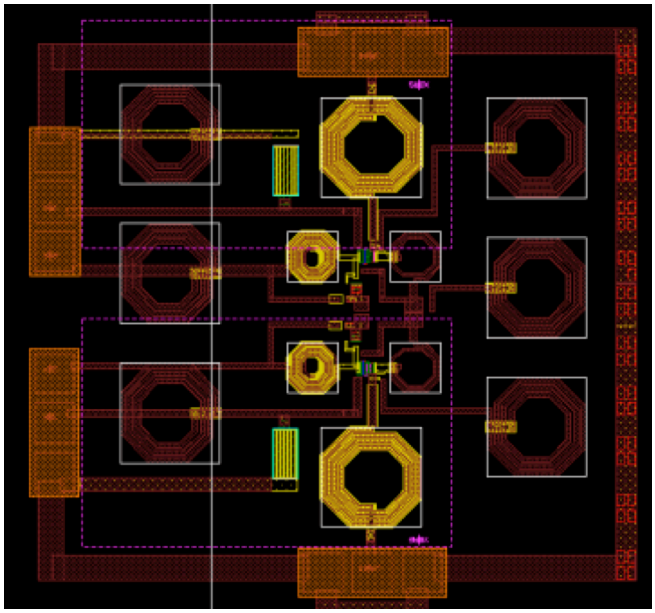
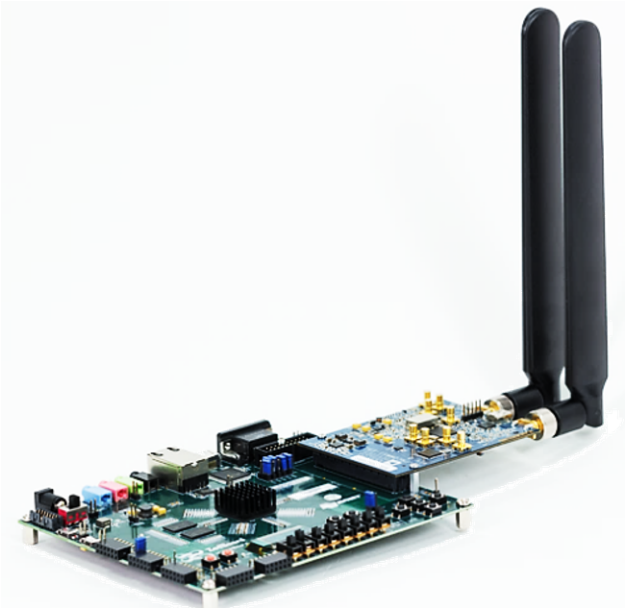


Low noise amplifier integrated circuit layout



AD9361 FPGA-based SDR prototyping platform for base band development

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