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Summary

The main objective of the thesis is the full investigation, implementation and test of a electronically beam steerable antenna which is able to be used under space conditions. The project is part of the framework of ISHS-II project, which aims at transferring in-situ data from agricultural fields to a ground station via a satellite. Due to the use of a LEO satellite, a beam steering solution is preferable.

Considering the advantages of baseband beam forming such as price and steering speed, the work is mainly focused on this method. Based on the idea of analogue baseband beam forming (ABBF) [1] a 1x2 prototype of the method was implemented and compared with a digital counterpart, namely digital baseband beam forming (DBBF) [2] for LEO space applications. Antenna elements, working at 2.45 GHz, receive the waves and the RF boards right after the antennas filter, amplify and downconvert the signals to baseband.

The baseband phase shifters are implemented in a different way. A simple analogue circuit using four multipliers and two opamps have been used to change the phase of the I and Q signals in ABBF. The phase shifter signals are finally added using an opamp circuit. On the other hand, in DBBF, baseband I and Q signals are converted to digital and transferred to an FPGA board. The required phase shift is then applied in the FPGA and the summed output is sent to a digital to analogue converter for demonstration.

Although the analogue design is potentially faster, digital beam forming has proven to be more flexible than the analogue beam forming. For example, it can easily add a multiple beam capability. Therefore, the digital method has been selected for the final 4x4 prototype array. Recently, a first operational digital 1x2 prototype is being modified and is planned to be tested on the ground and on an aircraft in May 2010 in South Africa. The aircraft is able to simulate the satellite conditions Although the design is not fully space qualified. Space-grade components were primarily selected but not used due to their high price. At this moment some COTS (commercial of the shelf) components have been used. They will have to be tested in space environment simulation chambers. The final selection will be made after the aircraft test.

References

[1] W. Aerts, P. Delmotte, G. A. E. Vandenberg, "Conceptual Study of Analog Baseband Beam Forming: Design and Measurement of an Eight-by-Eight Phased Array", *Transactions on Antenna Propagation*, vol. 57, No. 5, 2009.
 [2] H. Aliakbarian, V. Volski, E. van der Westhuizen, R. Wolluter, G. A. E. Vandenberg, "Analog versus Digital for Baseband Beam Steerable Array used for LEO Satellite Applications, accepted in 4th European conference on antenna and propagation, 12-16 April 2010.