DIGITAL BEAMFORMING ANALYSIS AND PERFORMANCE OF A DIGITAL L-BAND PSEUDO-CORRELATION RADIOMETER

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1. INTRODUCTION

The Passive Advanced Unit (PAU) for ocean monitoring (Fig. 1) is a new instrument that combines in a single receiver and without time multiplexing a microwave radiometer at L-band (PAU-RAD) and a GPS-reflectometer (PAU-GNSS/R), which, in conjunction with an infra-red radiometer (PAU-IR), will simultaneously provide the sea surface temperature and –more important– the sea state information needed to accurately retrieve the sea surface salinity. In [1] a general overview of the PAU system was analyzed. Moreover, in [2] the first results on the calibration performance using a single receiver were provided.

2. BEAMFORMING ANALYSIS AND PERFORMANCE

PAU-RAD is a digital radiometer with digital beamforming and polarization synthesis capabilities. To avoid the mechanical scan of the antenna, a digital beamformer with the 4x4 element array has been designed so that the beam can be steered up to ±20º from the array boresight (45º nominal incidence angle) in 5º steps (incidence angle from 25º to 65º). Each element has a dual-polarization antenna (horizontal and vertical) and each polarization is thereafter divided in two using a Wilkinson power splitter. The receiver topology is described in detail in [3]: The input signals are demodulated at an intermediate frequency (IF) of 4.309 MHz and have a 2.2 MHz bandwidth. The analog signals are then digitalized at 8 bits at a sampling frequency of 5.745 MHz. This digital signals feed an FPGA where are then processed in real time.

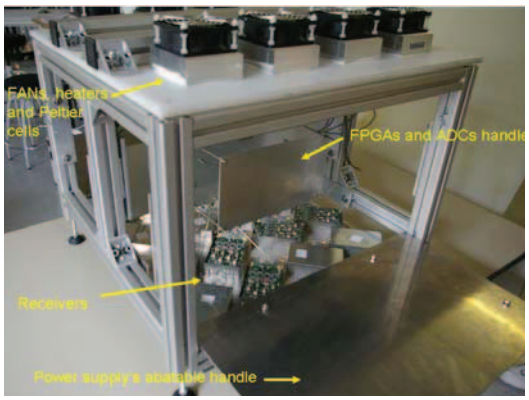

FIGURE 1. PAU OVERVIEW (GENERAL PRESPECTIVE)

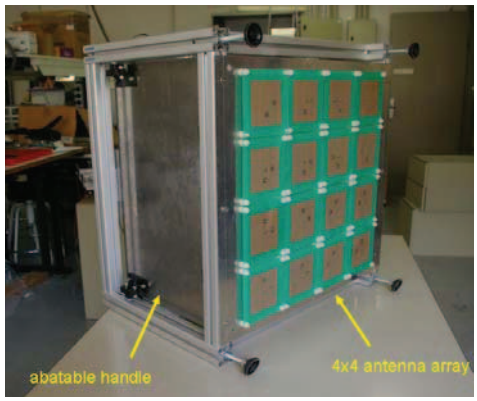

FIGURE 2. PAU OVERVIEW (ANTENNA ARRAY PRESPECTIVE)

Different procedures are implemented inside the FPGA such as the signal phase, amplitude and offset calibration, the beamforming and the algorithms to compute the Stokes elements (radiometer output). The beamforming is achieved giving the necessary complex weight to each digital signal to steer the beam to the right position. This process is achieved

simultaneously with the calibration complex weights as described in [2]. The beamformed signals (one per each branch of Wilkinson power splitters) are the input of the pseudo-correlation radiometer which obtains the first two Stokes parameters. In order to ensure that PAU-RAD will fulfill radiometric requirements (Maim Beam Efficiency > 95% or $\Delta T_B / T_B$) it is essential to measure and analyze the performance of the beamformer. This paper will focus on the characterization of the PAU-RAD's digital beamforming, taking into account all the signal calibration procedures, and will present its measured performance in the anechoic chamber.

4. CONCLUSIONS

In order to characterize the performance of the beamformer PAU-RAD's antenna pattern will be measured in an anechoic chamber for all possible predetermined beams. Finally, conclusions will be extracted and discussed.

5. REFERENCES

[1] Camps, A., X. Bosch-Lluis, I. Ramos-Perez, J. F. Marchan-Hernandez, B. Izquierdo and N. Rodríguez, "New Instrument Concepts for Ocean Sensing: Analysis of the PAU-Radiometer", *IEEE Transactions on Geosceince and Remote Sensing*, vol. 45, n.10, pp: 3180 – 3192, Oct. 2007.

[2] Bosch-Lluis, X., A. Camps, I. Ramos-Perez, J. F. Marchan-Hernandez, N. Rodriguez-Alvarez, E. Valencia, "PAU/RAD: Design and Preliminary Calibration Results of a New L-Band Pseudo-Correlation Radiometer Concept", *Sensors Journal*, ISSN: 1424-8220.

[3] Ramos-Perez, I., X. Bosch-Lluis, A. Camps, J. F. Marchan-Hernandez, R. Prehn, "Design of a compact dual-polarization receiver for pseudo-correlation radiometers at L-band", *Proceedings of the International Geoscience and Remote Sensing Symposium*, pp: 1172-1175, IGARSS06, July 31-August 4, 2006, Denver, Colorado, USA,.