C- and Ku-Band (at 5.6GHz and 13.6GHz), Dual-Frequency, Multi-Polarization, Short Pulse, Combined Scatterometer-Radiometer System for Low Altitude Platform, Vessel and Aircraft Applications

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1. INTRODUCTION

The retrieval of surface parameters from microwave remote-sensing data requires accurate models for the relationship between the desired geophysical parameters of a target and the observed quantities. As natural surfaces generally are described as random functions, the modeling should involve both electromagnetic and stochastic aspects. Therefore, for an unambiguous and accurate retrieval of land snow cover and soil moistures and classification of soil vegetation a wider set of independent measurements and a synergy of various sensors are welcomed. Since, microwave signals backscattered from and emitted by the soil surface are partially decorrelated from each other and in practice may be considered as independent variables, the synergetic application of microwave radar and radiometer observations represents special interests. For it successful implementation it is important and suitable to develop multi-band complex of polarimetric, combined radar-radiometer systems and to perform multi-frequency, polarimetric, microwave, active-passive combined measurements of snow, bare and vegetated soils under well controlled conditions. On the basis of the acquired data, it will be possible to validate and to improve reflective (scattering) and radiative transfer models, and to develop new methods and algorithms providing the possibility to reach high precision in snow and soil moistures retrieval. At present time, only single frequency (S, C, Ku, K and Ka-band), polarimetric, combined radar-radiometer systems for various platform applications are developed and are used for soil, snow, vegetation and water surface microwave active passive characteristics preliminary measurements[1-5].

In this paper C-, and Ku-band, dual frequency, multi-polarization, combined, short-pulse scatterometer-radiometer system is described, for short (from low altitude platform), middle (from vessel) and long (from aircraft) distance remote sensing applications for water surface, soil and land snow cover's microwave reflective and emissive characteristics simultaneous and spatially coincident measurements [6,7].

2. C- AND Ka-BAND, COMBINED SCATTEROMETER-RADIOMETER SYSTEM

The principal requirements for a development of the system were:

- Functional and constructive combining all dual-channel radiometers at 5.6GHz, dual-channel radiometers at 13.6GHz, dual channel scatterometes at 5.6GHz and dual channel scatterometes at 13.6GHz as a single microwave device providing simultaneous operational capability from 4m up to 1500m.
- Coherent-pulse construction of the scatterometers' functional scheme and high level decoupling between transmitters and receivers to realize short range operational potential beginning from 4m.
- Series (periodical) or regular transmission of signals of two various frequencies at specified (vertical or horizontal) polarization and simultaneous receiving all co- and cross-polarized components of the backscattered scatterometer signals at 5.6GHz and 13.6GHz.
- A possibility for application developed principles and methods of signal forming and processing in space-aerial based prototype of the system.

In comparison with earlier developed scatterometer-radiometer systems of S (~3GHz), C (5.6GHz), Ku (15GHz), K (~20GHz) and Ka (~37GHz) band of frequencies the described system has one antenna, two transmitters, four receiving channels for simultaneous reception all co- and cross polarized components of the backscattered signals at 5,6GHz and 13.6GHz and vertical and horizontal polarized components of the observed surface proper radiothermal emissions at 5,6GHz and 13.6GHz. The system may work in the following operational modes, the mode for short distance application (the operational range from 4m up to 50m), the mode for middle distance application (the operational range from 30m up to 250m) and the mode for long distance application (the operational range from 150m up to 1500m).

Time-division channeling of scatterometers and radiometers functioning was used for the system functional scheme development for all three range operational modes, to provide their interference free cooperation.

Independently of the frequency band and of the operation modes the work while of the system is divided by 1ms time periods, in which 10% of the period is used for probing signals transmitting at 5,6GHz and 13.6GHz, for reception of co- and cross polarized components of the backscattered scatterometeric signals at 5,6GHz and 13.6GHz and for protection inputs of the radiometric receivers form the residual influence of transmitters. The remain of the time period (0.9ms) is used for reception the observed surface proper radio thermal signals at 5,6GHz and 13.6GHz at vertical and horizontal polarizations.

The transmitted signals' polarizations may be changed either periodically (periodically changing operating mode) or stepwise by issuing the outside command (polarization stability operating mode). Such a construction allows improve relative accuracy of the measurements by cross polarized signals, simplify calibration procedures, and reduce complicity and value of the system by using microwave and intermediate frequency modules of any frequency band of the system as a common modules for theirl scatterometric and radiometric channels.

The principal peculiarities of the developed device are its originality in spatio-temporally combining of functionality microwave active-passive channels of observation from various frequency bands, under the

condition of short range sensing application of the system. The minimum operational range of the system's scatterometers is 4m, at a far zone condition of sensing.

In the paper will be represented the systems' Block Diagram, the main technical characteristics and the results of its preliminary field trial.

3. REFERENCES

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