BISTATIC P-BAND SAR FOR SPACECRAFT AIST-2

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Currently, we are witnessing the rapid development of space radar systems of remote sensing (RS). Areas of use of space radar data today is cartography, GIS, surveying, monitoring the effects of natural disasters and catastrophes, monitoring and mapping of the surface (oil) contamination of the water surface, providing navigation in high latitudes (small wires), control of the state forests, the measurement of soil moisture agriculture, crop forecast, status monitoring, oil and gas pipelines, environmental monitoring, archeology, and the dynamics of the Earth's surface control, military applications.

In recent years, interest in the use of space synthetic aperture radar (SAR) VHF or P bands for the observation of subsurface, hidden or camouflaged by vegetation objects, geological mapping, measuring vegetation biomass and other applications are increased.

It is known that the implementation of these systems, developers are faced with the problem of the destructive effect of the ionosphere [1, 2], the limitations of the WARC, the need to deploy a large space antenna system [3, 4], the use of high-speed radio and mass storage devices, powerful concentrated transmitter necessary use in polarimetric radar full basis and ultimately very expensive spacecraft and / or systems of spacecraft.

Several studies [5] showed that the development of multi-radar sensing technologies in recent years, opens opportunities for the development of a new class of radar sensing apparatus in P or VHF frequency bands without requiring the above costs.

In view of the above, it seems appropriate to consider implementing a multi-system radar remote sensing of the Earth and near-Earth space in the VHF frequency bands or P on the basis of micro and small satellites (MPRLK). According to preliminary estimates MPRLK may include several MCA providing radar surveillance Earth surface "television mode" (a quasi-continuous monitoring with a high frequency) at a spatial resolution of 5-30 m in the band up to a length of 6 km to 10 km (using 1st SC), the accuracy of the height up to 5 m, depth of penetration below the surface to 100 m (depending on soil moisture). If you receive a system of collection points MPRLK allows for tomography of the ionosphere over the controlled area.

Pulse signals received onboard transmitter surface equipment (stationary or mobile version) in two ways: "direct" and "reflection". Such a regimen can compensate distortion in the ionosphere and ensure coherent signal processing.

Justification of the basic parameters of the project can be conveniently represented in the form of answers to frequently asked questions:

1. Why selected VHF frequency bands or P? When using this range is significantly reduced weight and size requirements for on-board equipment MPRLK, you can use the simple transmission antennas from SC does not require high-precision systems software-based flight that actually allows you to use cheap microsatellite. In [5] it is also shown that the region of the focus area of radar images is maximal in the VHF and P-band wavelengths. Within these ranges the maximum penetrating power of radio waves, which makes it possible to observe the subsurface, sheltered and camouflaged targets of artificial origin.

2. What are the advantages of using a ground receiving equipment for imaging MPRLK? Only in this way it is possible to compensate for the degradation of VHF radio wave in the atmosphere and have a relatively high spatial resolution. In addition, binary scheme of obtaining the radio allows you to remove from the board the spacecraft high-speed radio link, memory, ie reduce the

cost and simplify the space segment. In such a scheme MPRLK just realized interferometric mode shooting two receive antennas in a location with a base 1-2 m, which gives a high potential accuracy of determining the height of the object. When using a fixed ground equipment becomes available mode "TV" surveillance when receiving the next shot the same surface of the spent minimal time. Finally, the implementation of the system is possible to obtain local permits for the use of SCR bands up to 50 MHz, which allows you to obtain resolution of 3-5 m.

3. How many satellites to be placed in orbit? The proposed system is fully operational in the presence of an orbit of the 1st SC. By increasing the number of satellites is achieved by a corresponding increase in the frequency capture objects from 12 hours to 5 minutes.

4. What are the advantages of the system in comparison with the existing? The answer to this question illustrates the proposed table.

Table 1 - Comparative characteristics of MPRLK.

Feature	M PRLK (SC 1-50)	Radar remote sensing system (SC 1-4)	Optoelectronic remote sensing system (SC 1-4)
All-weather, day and night shooting	yes	Yes	no
Restoring relief	yes	Yes	yes
Control microdeformations relief	yes	Yes	no
Selection of moving targets	yes	Yes	no
High frequency of shooting	up to 5 minutes	1-3 days	1-3 days
The possibility of observing under the surface, foliage-covered objects in the UHF band, and P	yes	No	no
Tomography of the Earth's ionosphere	yes	No	no
Surveillance of air targets	yes	No	no

As part of the creation of the SC "AIST-2" entails a key technology in the form of deployment MPRLK bistatic radar system with synthetic aperture P band (BiRLK). Onboard equipment BiRLK is multimode pulse transmitter that provides a wide range of highly stable signal at the carrier frequency 435 MHz in the band 1-30 MHz. The types of probing signals: a rectangular pulse, the sequence of chirped pulse sequence of phase-shifted signals encoded by the M-sequence. Pulse power of the emitted signal at the antenna is less than 200 watts. Board antenna is an antenna Uda-Yagi antenna polarization of radiation - the linear, the gain of 5 dB. Terrestrial stationary equipment is a dual straight receiver with digital registration and subsequent processing of signals in the 400 MHz band. Terrestrial aerial "Reflections" is a channel antenna array antennas 2×2 Uda-Yagi antenna to receive polarization - circular, the gain of 18 dB. At the given parameters of the system at a distance of 10 km from the receiving position is provided sensitivity Beers (σ_0) is not worse than 20 dB.

References

1. *Ishimaru A., Kuga Y., Liu J., Kim Y., Free-man T. Ionospheric effects on synthetic aperture radar at 100 MHz to 2 GHz. //Radio Science (USA) – 1999 – vol. 34 – num.1 – p. 257-268.*
2. *Goriachkin O.V. Azimuth Resolution of Spaceborne P,VHF-Band SAR // IEEE Geoscience and Remote Sensing Letters. – 2004. – Vol.1. - №4. – P.251-254.*
3. *Akhmetov R.N., Belokonov I.V., Goriachkin O.V., Kovalenko A.I., Riemann V.V., Stratilatov N.R., Tkachenko S.I. Space-based juxtaposition Earth and Circumterrestrial radar monitoring system based on micro-satellites technologies // in Book of abstracts of the First Specialized In-*

ternational Symposium, Limassol, Cyprus, November 2-7, 2009, M., A.A.Maximov Space Systems Research Institute (NIIKS), 2009. – 62 p.

4. *Ramongassie S., Valle P., Orlando G., Arpesi P.G., Hélière F., Arcioni M. P-band SAR instrument for BIOMASS// EUSAR 2014 – p.1156-1159.*
5. *Akhmetov R., Goriachkin O., Ivachenko E., Kovalenko A., Riemann V., Stratilatov N., Tkachenko S. Multi - Positional VHF - Band SAR System for Earth Observation on the Basis of Microsatellites // Program and Book of Abstracts for 12th URSI Commission - F Triennial Open Symposium on Radio Wave Propagation and Remote Sensing 8th – 11th March 2011 and URSI - F Training Workshops 7th March 2011 in Garmisch - Partenkirchen, Alpine - Bavaria, Germany, 2011, P.78-80.*