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Improvement of the noise level of the Split Langmuir Probe – a spatial current density meter

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One of the main tasks at the experimental investigations of the wave processes in space plasma is the determination of the dispersion relations between their wave vector and frequency. The frequency analysis of the magnetic field fluctuations and the electric current density in plasma is very efficient in this case. It had been shown that the simultaneous measurements of the magnetic field orthogonal components and the spatial current density fluctuations can give the wave vector k values for the plane wave spectra, by which a wave field in a plasma reference frame can be represented.
The measurements of the magnetic field fluctuations usually are made by a variety of magnetometers using well developed methods.
Unfortunately, up to the moment the methods and instruments for the reliable measurements of the space current density are not so good developed as the magnetic ones. There are three independent techniques to study the spatial current density in plasma: the contactless Rogovsky coil, the Faraday cap and the Split Langmuir Probe (SLP).
The attempt to compare the different approaches and instruments was carried out during the experiment “Variant” onboard Ukrainian remote sensing satellite SICH-1M launched 2004. The clear advantages of the SLP over other instruments were revealed and proved. Using whistler as a test signal the very good consistency between the magnetic and electric fields and the spatial electric current density was obtained. However, the signal-to-noise ratio of the current density meters has to be further improved.
In this report we analyze the sources of the SLP noises and propose the ways to decrease it. The computer simulation of the improved current density meter reveals that the introduced changes have almost no influence on the sensor matching with the space plasma and, as a result, the minor changes of the transformation factor in operation frequency band are expected. The modernized version of the SLP was successfully tested in the laboratory test bench as well as in the plasma-dynamic vacuum chamber. These test show that the sensor noise level is decreased approximately 3-5 times.

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