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SMALL SPACECRAFT FOR GLOBAL GREENHOUSE GAS EMISSION MONITORING

Abstract

Currently, an urgent task is to create a carbon calculator that allows assessing the ecological footprint of technologies. Anthropogenic greenhouse gas emissions come from a very large number of point sources, including oil and gas facilities, coal mines, landfills, sewage treatment plants and animal husbandry. Ground detection technologies currently in use are capable of capturing gases at low detection thresholds, but they are limited in terms of application time and territorial coverage. Satellite monitoring can contribute to the rapid and fairly accurate identification of problematic greenhouse gas emissions. Restrictions on the observation time from satellites can be resolved by launching more satellites in a constellation (by creating a grouping). This work is devoted to the analysis of the capabilities of constellation and small spacecraft developed using CubeSat technology to solve promising problems of the Earth remote sensing in the area of greenhouse gas emissions.

The team has developed a project of a small spacecraft based on the 16U CubeSat platform (226x226x454 mm, 23 kg). The satellite is divided into two parts: The Fourier Transform Infrared Spectroradiometer (FTIR) unit and the service systems unit, created and assembled independently. The satellite and the scientific equipment installed on it provide an image ground target and spectroscopic information about the content of the target gas (oxygen and carbon dioxide - the wavelength range of 0.75-0.80 m and 2.0-2.2 m). A distinctive feature compared to other greenhouse gas remote sensing missions is the combination of high spatial resolution (5-6 km at the orbit altitude 500-600 km) and high spectral resolution (2 cm-1) in a compact volume. The developed optical scheme was implemented in the FTIR spectrometer ground-based mock-up sample. The service systems were developed taking into account the flight tests of the Yareelo 1 and 2 spacecraft. Due to the requirements orientation of the photodetector in nadir, the satellite has active three-axis altitude control system: flywheels with unloading by magnetic coils. The orientation error on all axes is less than 0.1 degree. Three electric propulsion engines are used for satellite's orbit correction. For transferring the target information to the ground control center the radio communication systems in UHF, S and X bands are used.

A spacecraft mock-up was created.