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DESIGN OF AN ELECTRIC POWER SYSTEM WITH INCORPORATION OF A PHASED ARRAY ANTENNA FOR OLFAR

Abstract

The Orbiting Low Frequency Antennas for Radio Astronomy (OLFAR) project is investigating the feasibility of an orbiting low frequency radio telescope. The radio telescope is formed using a swarm of nano-satellites equipped with astronomical antennas, conceivably orbiting the Moon or the second Lagrange-point of the Earth-Moon system. In these orbits, at the far-side of the Moon as seen from the Earth, the low frequency radio signals originating from Earth are blocked by the Moon, reducing the amount of interference considerably. Such a telescope, with its unique vantage point, will open up a new field in astronomical research; yet the power demands, as well as the data rates involved are quite challenging. This paper details the design of the highly integrated Electric Power System (EPS) of an OLFAR satellite.

The most demanding power mode of the mission is during exchange and pre-processing of science data. In this mode, each individual satellite has an average power consumption of 30W. Similar power demand is expected during the orbit transfer phases, in which the main electric thruster has a duty cycle close to unity, and places additional constraints on the attitude control of the satellite. Such power levels, for extended periods of time, have rarely been shown in such a small form factor.

A phased array antenna is used for the downlink, and is constructed from an array of small-patch antennas, in order to achieve sufficient data rates. In an OLFAR satellite, the collection surface of the solar array is shared with this antenna. The tracking mechanism of solar array and antenna uses electric motors, to allow tracking the Sun or the ground station in a three-axes controlled attitude mode. The phased array antenna in turn allows fine pointing when required.

The design of the Electric Power System is based on a Maximum Power Point Tracker-fed battery bank, using deployable panels. Care is taken to reduce the number of charge-discharge cycles encountered by the batteries, allowing for an increase in the expected system lifetime. Also the thermal aspects of the power levels involved both in the solar cells, as well as the phased array have been addressed.