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Next-generation spacebourne GPS receiver and its application for radio occultation measurement

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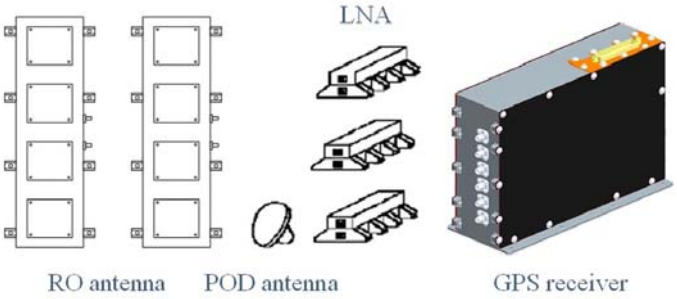
1. Introduction



The Japan Aerospace Exploration Agency (JAXA) has accumulated knowledge and experience on spaceborne global positioning system (GPS) receivers through various programs from the first OREX (1994) to the recent GOSAT (2009). Currently JAXA is developing new generation spaceborne GPS receiver system (Next-generation GPS Receiver: NGPSR). Since the NGPSR has dual-frequency and multi-antenna tracking capabilities, it can be modified for GPS radio occultation (GPS RO) mission. In this paper, the concept of possible NGPSR modification for GPS RO mission is presented.

2. Next-generation GPS receiver (NGPSR)

Currently JAXA is developing NGPSR, which will have more signal processing power, and will be light weight and low power consumption. Major characteristics of NGPSR are:
- Multi-frequency signal tracking capability
- Larger number of tracking channels
- Simultaneous signal tracking with multiple antennas
- Precise real-time navigation filter software
- Small size
- Space-borne quality

NGPSR has capability to track L1C/A, L2C(C/A), and L2P(Y) signals. It has 36 channels for L1C/A, 36 channels for L2C(C/A), and 16 channels for L2P(Y). These channels can be assigned flexibly to three dual-frequency antennas. Mass is 1.5kg and power consumption is planned to be 15W. The production of the first NGPSR can be completed by the end of 2012 and will be shipped for various types of space missions.

3. NGPSR modification for GPS radio occultation mission

Since NGPSR has dual-frequency and multi-antenna tracking capabilities, it can be utilized for GPS RO mission with small modifications. The necessary modifications includes only two major development items: the first is GPS RO antennas, and the second is dedicated onboard software for GPS RO measurement. Other parts can be utilized for GPS RO mission without any

modifications.

The figure shows the conceptual view of NGPSR system modified for GPS RO mission. It consists of a GPS receiver, three Low-Noise Amplifiers (LNAs), an antenna for Precise Orbit Determination (POD), two antennas for GPS RO measurement. The POD antenna will be put on the Zenith side of the spacecraft. Two GPS RO antennas should be put on the side of the spacecraft.

Some key parameters of NGPSR for GPS RO mission are shown as follows:
- Available signals: GPS L1 C/A, L2C(C/A), L2P(Y)
- No. of channels for RO: 4ch for each antenna
- No. of channels for POD: 12ch
- Target sensitivity: 26dBHz(L1C/A, L2C), 35dBHz (L2P(Y))
- Sampling rate of RO data: 50Hz
- Mass, Power: 1.5kg, 15W

The dedicated onboard software for GPS RO measurement has two additional functionalities. The first is automatic occultation event prediction and satellite selection. The second is data compression of 50Hz dense RO measurements (Carrier-phase and S/N data). Both functionalities can be implemented to NGPSR without any improvement of hardware configurations.

For a single LEO satellite with two occultation antennas pointing towards the fore and aft directions of the spacecraft, nearly 500 GPS occultation events are expected to occur per day. The amount of data produced by NGPSR for GPS RO mission is roughly estimated to be 17M bytes/ day for navigation data and 25M bytes/day for RO measurements.

Development of modified NGPSR for GPS RO mission can be completed until the end of 2012.

4. Conclusion

The concept of possible NGPSR modification for GPS RO mission is presented. GPS RO mission with the modified NGPSR is currently proposed for one of candidate missions of micro-STAR small satellite program, and the modifications of NGPSR for GPS RO mission is considered to be feasible in both technical and programmatic aspects.

Keywords: GPS receiver, GPS radio occultation measurement, navigation, orbit determination