DESIGN AND DEVELOPMENT OF AN INTEGRATED RF-FRONT END FOR GPS-IRNSS NAVIGATION SYSTEM

R. SINDHU RAJENDRAN, K. V. PRASAD, N. HEMANTH KUMAR REDDY

1, 2, 3 Department of Electronics and Communication Engineering, Bangalore Institute of Technology, Bangalore, India
E-mail: 1sindhurajendra31@gmail.com, 2drsvt@yahoo.com, 3hemanthr@isac.gov.in

Abstract: Today the use of GPS for both navigation and altitude determination functions on LEO spacecraft has become somewhat routine; however, it took years of research and development efforts by a variety of organizations to get to this point. With the apparition of several new civilian signals in the years to come, there will be great demand for multi-frequency receivers. The GPS satellite transmits a L1C/A signal and IRNSS satellites transmits a L5 civil signal. In this paper we realize an RF-Front end for a dual frequency GPS-IRNSS integrated receiver and propose a solution wherein the power consumption is comparable with that of a single frequency front end.

Keywords: GPS, IRNSS, SPS, C/A and PRN.

I. INTRODUCTION

The Global Positioning System (GPS) was conceived as a ranging system from known positions of satellites in space to unknown positions on land, sea, in air and Space. The GPS constellation consists of 24 satellites in 6 orbital planes with 4 satellites in each plane. The ascending nodes of the orbital planes are separated by 60 degrees and the planes are inclined 55 degrees. Each GPS satellite is in an approximately circular, semi-synchronous (20,200 km altitude) orbit. The orbits of the GPS satellites are available by broadcast - superimposed on the GPS pseudorandom noise codes (PRN), or after post-processing to get precise ephemerides, they are available from organizations such as the Jet Propulsion Lab (JPL) or the International Geodetic Service (IGS) among others. Each GPS satellite transmits data on frequency, L1 (1575.42 MHz).

Indian Regional Navigation Satellite System (IRNSS) is an independent, indigenously developed satellite navigation system fully planned, established and controlled by the Indian Space Research Organization (ISRO). The IRNSS would provide two services, with the standard positioning service open for civilian use and the restricted service for authorised users. The IRNSS SPS service is transmitted on L5 (1176.45MHz) and S (2492.028 MHz) bands. The frequency in L5 band has been selected in the allocated spectrum.

ORGANISATION OF THE PAPER

Session-I gives a brief introduction to the navigation system, namely GPS and IRNSS. Session-II gives an explanation of the system with the help of block diagrams, The Applications are explained in Session-III and the results are explained in Session-IV. Session V gives the conclusion.

II. BLOCK DIAGRAM

The receiving two signals located in different bands will add complexity in the receiver, particularly in the radio-frequency (RF) front-end. As a consequence, the first objective of this project is to design a low-power dual-frequency RF front-end architecture for the L1C/A and L5 signals that could be integrated using standard technologies and which would have a power consumption and performances comparable with that of single-frequency GPS RF front-ends. The signals transmitted of frequency L1 (1575.42MHz) and L5 (1176.45MHz) from the GPS satellite and IRNSS satellite are received from the antennas. Through the radio frequency (RF) chain the input signal is amplified to proper amplitude, the signals are down converted to two-level of intermediate frequencies and the frequency is converted to a desired output frequency. An analog-to-digital converter (ADC) is used to digitize the output signal. Further processing of signals is done using a baseband processor.

III. APPLICATIONS

The Global Positioning System (GPS) is revolutionizing and revitalizing the way nations operate in space, from guidance systems for crewed vehicles to the management, tracking, and control of communication satellite constellations, to monitoring the Earth from space. Applications of using GPS include:
- Navigation solutions -- providing high precision orbit determination, and minimum ground control crews, with existing space-qualified GPS units.
- Attitude solutions -- replacing high cost on-board attitude sensors with low-cost multiple GPS antennae and specialized algorithms.
- Timing solutions -- replacing expensive spacecraft atomic clocks with low-cost, precise time GPS receivers.
- Constellation control -- providing single point-of-contact to control for the orbit maintenance of large numbers of space vehicles such as telecommunication satellites.
- Formation flying -- allowing precision satellite formations with minimal intervention from ground crews.
- The IRNSS satellites observe the planet Earth from space and provide us periodically synoptic and systematic information pertaining to land, ocean and atmosphere and several aspects of environment. This information is a key ingredient towards ensuring food and water security, sustaining our environment and eco-system, understanding weather and climate, monitoring and management of natural resources, planning and monitoring of developmental activities, support to management and mitigation during disaster events, and information for better governance. Some of the applications of IRNSS are as follows:

  - Agriculture & Soils- Provides Crop production and Saline/sodic soils mapping, agro-Met services & disaster surveillance (pest, floods, and drought) and horticulture development.
  - Cartography- Large scale mapping of land area, satellite based topos-map update, digital Elevation Model (Carto-DEM) and cadastral level mapping is provided efficiently by IRNSS satellites.
  - Geology and Mineral Resources-Landslide hazard zonation, Mineral /oil exploration, mining areas, Seism-tectonic studies and engineering and geo-environmental studies like services are provided.
  - Ocean and Meteorology-Provides ocean primary productivity, Ocean status forecast, storm surge modelling, regional weather prediction, tropical cyclone and mesoscale studies, extended range monsoon prediction.

IV. RESULTS

The RF-Front end for a dual frequency GPS-IRNSS system is implemented using the two civilian signals L1C/A and L5 frequency. An experimental lab setup is developed and tested for the integrated GPS-IRNSS system such that the power consumption is comparable with that of a single frequency RF-Front end.

CONCLUSION

A low power dual frequency front end architecture based on the classical heterodyne architecture has been proposed. The two signals L1C/A from GPS and L5 civilian Signal from IRNSS was simultaneously down converted to baseband level. However, the accuracy provided by single-frequency GPS receiver will soon not be sufficient anymore to be compliant for the upcoming high resolution imaging satellites.

REFERENCES

[5] Zhai Lin; Gao Shuaihe; Li Pengfei; Han Xuechuan The design and validation of RF front-end platform for GPS receiver, 2010.

BIBLIOGRAPHY

1. Ms. R. Sindhu Rajendran is pursuing a Masters Degree in Digital Electronics and Communication Engineering from Bangalore Institute of technology.
2. Mr. K.V.Prasad is a professor, Head of the department in Electronics and Communication Engineering from Bangalore Institute of technology.
3. Mr.N.Hemanth kumar reddy, Head, Navigation Section ,Data Transmission and Navigation Division Communication Systems Group,ISRO Satellite Centre,