GPS Solut
DOI 10.1007/s10291-013-0351-7

GNSS IN PROGRESS

IRNSS-1A: signal and clock characterization of the Indian regional navigation system

Steffen Thoelert · Oliver Montenbruck · Michael Meurer

Received: 14 October 2013 / Accepted: 24 October 2013

Abstract An initial characterization of the L5 and S-Band navigation signals transmitted by the first satellite of the Indian regional navigation satellite system (IRNSS) is presented. In the absence of a public signal specification, a 30 m high-gain antenna has been used to record the signal spectrum and the modulated chip sequences. For the IRNSS standard positioning service, use of a Gold ranging code is confirmed and relevant shift register parameters for the two frequencies are identified. Based on a prototype receiver, L5 single-frequency code and phase observations of IRNSS-1A have also been collected. The tracking performance is described, and the measurements are used to characterize the short-term clock stability of IRNSS-1A.

Keywords IRNSS · Signal monitoring · Rubidium clock · IGSO · BPSK-modulation · Gold codes

Introduction

Following Japan and China, India is the third nation aiming to build a regional satellite navigation service. Following Majithiya et al. (2011) and Ganeshan (2012), the Indian regional navigation satellite system (IRNSS) will comprise 3 satellites in geosynchronous orbit (GEO) and two pairs of satellites in inclined geosynchronous orbits (IGSOs). IRNSS will transmit navigation signals in both the L5-band and the lower S-band. A binary phase shift key [BPSK(1)] modulation will be employed for the open standard positioning service (SPS), while a binary offset carrier [BOC(5,2)] modulation will be used for the restricted/authorized service (RS). The latter offers both a pilot and a data channel (Sekar et al. 2012).

A first satellite of the new constellation, IRNSS-1A, was successfully launched on July 1, 2013 and reached its final orbit about 2 weeks later. At a 24 h orbital period and an inclination of 27°, the satellite ground track describes a distinct figure-of-eight over the Indian Ocean with a center longitude of 55° East (Fig. 1). Even though navigation signals were soon transmitted, no public signal specification has been released so far and IRNSS cannot yet be tracked by common GNSS receivers. An effort has therefore been made to analyze the IRNSS navigation signals using the signal monitoring facility of the German Aerospace Center (DLR) at Weilheim, Germany. It makes use of a 30 m deep space antenna and a spectrum vector analyzer to record high-rate inphase (I) and quadrature (Q) samples of the received signals. The facility has earlier been used for signal studies of GPS, GIOVE/Galileo and BeiDou satellites (Montenbruck et al. 2006, Hauschild et al. 2012, Thölert et al. 2012). It provides fully calibrated measurements (Thölert et al. 2009) over the full range of L-band frequencies, but can also be used for signals in the S-band frequency but without an exact power calibration.

The measurements discussed in this report have been collected in August 2013. They are representative of the signal transmission during the commissioning of IRNSS-1A but do not necessarily reflect the signals transmitted

S. Thoelert (✉) · M. Meurer
Institute of Communications and Navigation,
Deutsches Zentrum für Luft- und Raumfahrt e.V.,
82230 Wessling, Germany
e-mail: steffen.thoelert@dlr.de

O. Montenbruck
German Space Operations Center, Deutsches Zentrum
für Luft- und Raumfahrt e.V., 82230 Wessling, Germany

M. Meurer
Institute of Navigation, RWTH Aachen University,
52062 Aachen, Germany

Published online: 05 December 2013