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Implementation of Signal generation and modulation of IRNSS L5 band signal in MATLAB Simulink

Vijeshree Kadiya[1], Prof Viral Mehta[2], Prof Virendra Patel[3]
Communication system engineering, Shankersinh Vaghela Bapu Institute of Technology[1]
Electronics and communication, Shankersinh Vaghela Bapu Institute of Technology[2]
Electronics, Bhagwan Mahavir College of Engineering and Technology[3]

Abstract- *Indian Regional Navigation Satellite System (IRNSS) is an indigenous system established, run and fully controlled by ISRO. Till now the constellation of the IRNSS is design for seven satellite and can be increased further, the series named to this satellites are 1A, 1B, 1C, 1D, 1E, 1F and 1G out of which five satellite are present in the space and two of them are planned to deployed by the end of year 2016 so full system will be in operation by the end of this year. This paper present the signal generated in MATLAB using simulink model and modulation of the same signal for IRNSS system. The C/A code of L5 signal of IRNSS is generated and used for modulation. This can be further carried for determination of the signal delay due to ionosphere effect. Also this signal can further carried for acquisition and tracking purpose. This paper includes five section Introduction, signal specification, C/A code simulink, modulation model and conclusion.*

Keywords- *IRNSS, C/A code, BPSK, Navigation data.*

I. INTRODUCTION

IRNSS is latest system involve in the satellite based navigation family. This system will provide services in India and 1500 km surrounding region of India for positioning. The proposed architecture is of seven satellite constellation out of which five are deployed and remaining two are planned by the end of this year. The full constellation will be operational after the deployment of the remaining two of the satellite by end of 2016. Two services are provided by the IRNSS i.e. Standard Positioning Service (SPS) which is available without encrypted for civilian purposes and Restricted service (RS) which is encrypted one only for authorised users, this services are provided using L5 and S band signal at centred frequency of 1176.45 MHz and 2492.028 MHz respectively. The communication uses the spread spectrum technique like GPS using Code Division Multiple Access (CDMA) modulation. The IRNSS signals include ranging signals, which is used to measure the distance to the satellite, and navigation messages that include ephemeris data, used to calculate the position of each satellite in orbit, and information about the time and status of the entire satellite constellation, called the almanac. The signal generated in MATLAB simulink which is a graphical programming language, this makes architecture very clear and easier to understand, follow, modify and debug. Using the same environment in both the simulation and implementation stages makes the designer's mind dedicated most of the time in developing and enhancing the algorithm through rapid prototyping and experimentation and less time on the coding. So this simulation can be carried for designing of the IRNSS software based receiver like GPS one. A unique pseudo-random noise (PRN) code is assigned to each satellite. This distinguishes itself from the other satellites. There are two codes used they are precision (P) code, used when a high accuracy is desired on the measured position, such codes are used for RS services and this code is transmitted at a rate of 10.23 MHz Another code Coarse/Acquisition (C/A) code is intended for civilian use and is transmitted at a rate of 1.023 MHz this are used in SPS services.

II. IRNSS SIGNAL SPECIFICATION

The signal transmit ranging code and navigation data which is BPSK(1) modulated on L5 and S bands for SPS signals and for RS signal it is BOC(5,2) modulated. The navigation data are transmitted at data rate of 50 sps (1/2 rate FEC encoded) which is modulo 2 added to PRN code chipped at 1.023 Mcps identified for SPS service. The CDMA modulated code, modulates the L5 and S carriers at 1176.45MHz and 2492.028 MHz respectively. IRNSS PRN code utilizes Gold codes for the SPS signal. The codes are selected based on the auto-correlation and cross-correlation properties. The codes are generated using 10 Linear Feedback Shift Registers [1].

2.1 PRN codes for SPS

PRN Codes selected for Standard Positioning System are similar to GPS C/A Gold codes. The length of each code is 1023 chips. The code is chipped at 1.023 Mcps.

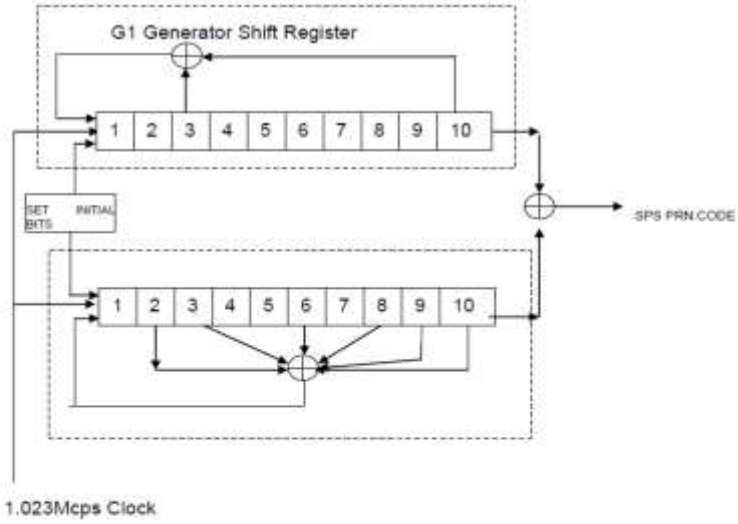

Figure 1.PRN code gnerator

2.2 SPS code generation

For SPS code generation, the two polynomials G1 and G2 are as defined below:

G1: $X^{10} + X^3 + 1$ (1)

G2: $X^{10} + X^9 + X^8 + X^6 + X^3 + X^2 + 1$ (2)

Polynomial G1 and G2 are similar to the ones used by GPS C/A signal. The G1 and G2 generators are realized by using 10 bits Maximum Length Feedback Shift Registers (MLFSR). The initial state of G2 provides the chip delay. G1 and G2 are XOR'ed for the generation of the final 1023 chip long PRN sequence. The time period of the PRN sequence is 1 millisecond [1].

III. MATLAB Simulink of IRNSS C/A code

The IRNSS signal simulation is constructed on Matlab Simulink. The major used tool boxes and module libraries are Simulink sources, communication block set and DSP block set. C/A code are combined with a navigation message using exclusive or and the resulting bit stream is used for modulation. These codes only match up, or strongly auto correlate when they are almost exactly aligned. Those module libraries offered the familiar communication modules, and it provides effective help to the FPGA design of signals simulation. The L5 code generator is shown in Fig. 2. The L5 code generator used the module of the unit delay as the linear shift register, connected 10 unit delay as tapped feedback shift register based on the code polynomials [4].

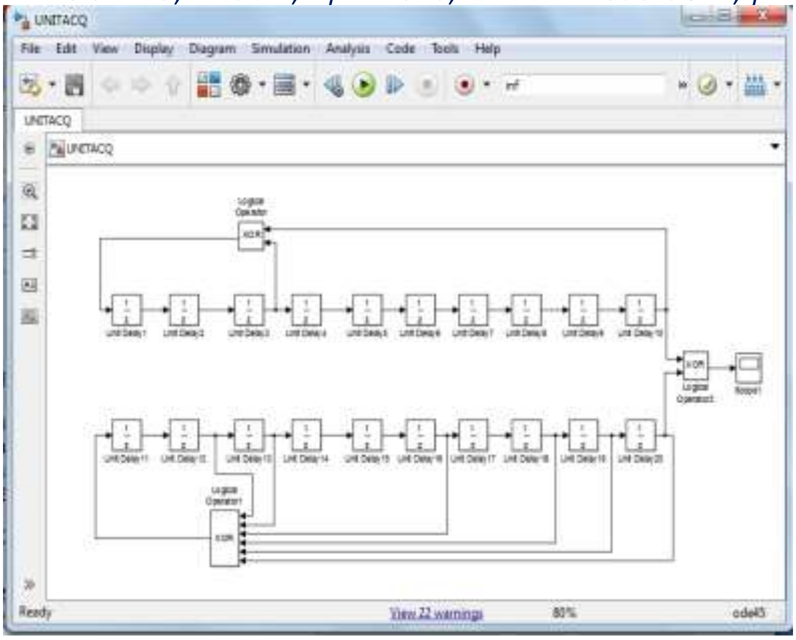

Figure 2.C/A code simulink

Fig. 3 shows the C/A code of the signal according to the condition specified in the generator polynominal of the two linear feedback shift register. Each satellite uses a unique PRN code, which does not correlate well with any other satellite's PRN code. In other words, the PRN codes are highly orthogonal to one another. The output of the first LFSR whose generator initial state is 1111111111.

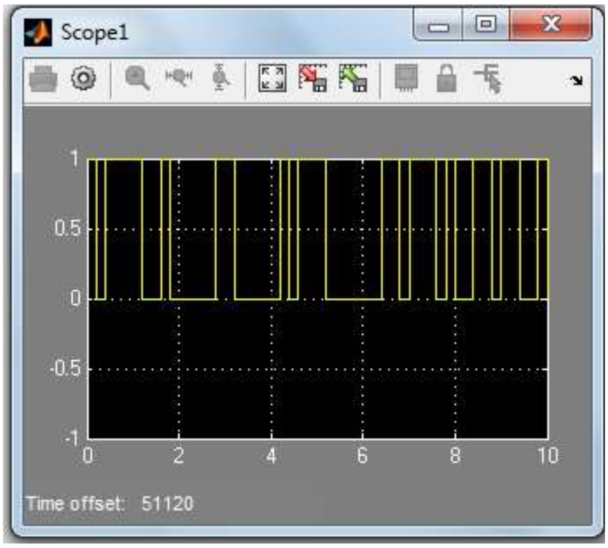

Figure 3.C/Acode

IV. MODULATION MODEL

IRNSS use BPSK and BOC modulation technique for SPS and RS services respectively. Here BPSK modulation is shown in matlab simulink for C/A code signal generated. BPSK is most efficient modulation method and used for high bit rate. In this modulation the phase of the carrier is changed according to the data bit to be transmitted. The BPSK signal in time domain can be represented as

$V(t) = b(t)*\sqrt{(2E_b/T_b)} \cos(2\pi fct)$ (3)
For b (t) = +1/-1 corresponding to logic 1 or 0.
$V_1(t) = \sqrt{(2E_b/T_b)} \cos(2\pi fct)$ (4)
$V_0(t) = -\sqrt{(2E_b/T_b)} \cos(2\pi fct)$ (5)
Where
E_b is energy of the signal
T_b is time period

Fig.4 shows the design of the satellite signal BPSK modulation model using MATLAB Simulink.

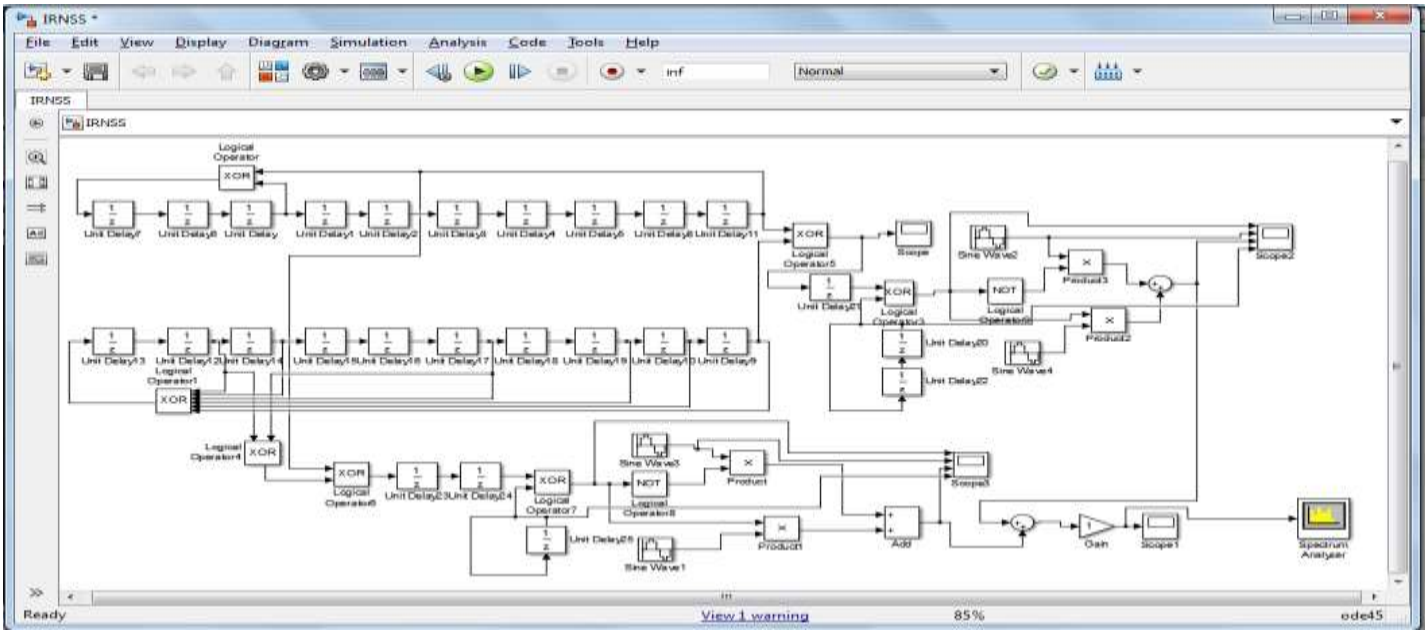

Figure 4.Modulation of signal

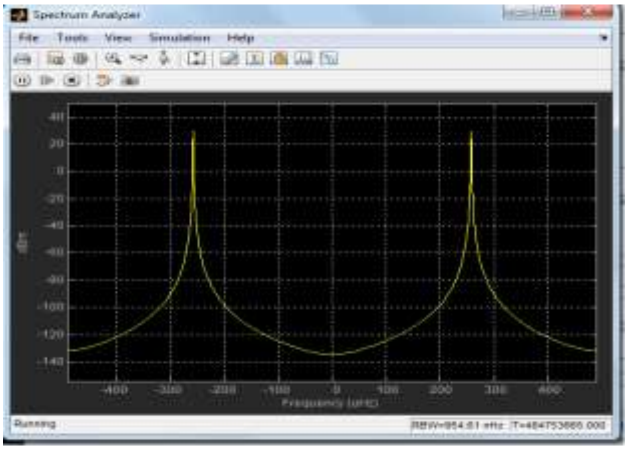

Figure 5.Frequency spectrum

Fig.5 shows the spectrum analyser of the modulated signal using spectrum analyser tool from simulink. Demodulation consists of satellite acquisition and tracking. During the acquisition phase, a local replica of the incoming signal is generated. The replica consists of two parts, the carrier replica and the C/A-code replica. Modulation function is to provide the 2-bit digitized IF signal for the baseband processor. The model consists of five main components. A C/A-code generator is composed of two linear feedback shift registers, G1 and G2. The C/A-code is then passed to a code phase delay block which delays the generated code by an integer number of chips in order to model signal propagation delays. The delayed code is XOR added with the navigation data, so that the latter is superimposed on the C/A-code. The resulting signal is then fed to the BPSK modulator, which modulates the L 5 carrier. The BPSK modulator consists of two identical carrier sine waves but one has a phase shift of 0° and the other has a phase shift of 180° When the modulating digital data is ‘0’, the non-shifted sine wave is enabled and the other sine wave is multiplied by zero. Similarly, when the modulating data is ‘1’ the phase-shifted sine wave is enabled and the non-shifted sine wave is multiplied by zero. This program quantizes the samples to 2-bit sign and magnitude digitized IF samples and these are written to another text file in VHDL test bench format. The model also includes an Automatic Gain Control (AGC) block which mainly caters for fading propagation. This maintains a constant signal level at the output, regardless of the input signal’s variations, to ensure that the amplitude is spread amongst all quantization levels of the ADC. Finally, a normally distributed (Gaussian) random noise source can be inserted in the model in order to analyze the noise performance of the baseband processor. The noise generator generates a series of random numbers that are added to the useful BPSK signal [4].

IV. CONCLUSION

In this paper the structure of the IRNSS signals can be observed intuitionally from the Simulink simulation platform, which provides effective help to the design of simulation as well as various simulation algorithms. This model can be extended to simulate for Doppler shifts, atmospheric delays and weather conditions. Besides, using Simulink to simulate IRNSS signals is simple and reliable.

REFERENCE

[1] IRNSS Signal-In-Space ICD For SPS Version 1.0, pp. 10-11.
[2] Kai Borre "A Software-Defined GPS and Galileo Receiver A Single-Frequency Approach" Birkh¨auser.
[3] Virendra Patel "Implementation of GPS L5 Signal using Model based design tool", IEEE, pp. 1-4, March 2014.
[4] Terence Zarb "Verification of a VHDL GPS baseband processor using a simulink based test bench generator", IEEE, pp. 327-330, 2010.
[5] M.N.Venkatesh Babu.S "Implementation Of the Modernized GPS Signals L2C, L5 And their Tracking Strategies", Vol. 2, Issue4, IJERA, pp.2148-2152, July-august 2012.