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GPS Transmitter and Receiver System for Navigation and location Based Services

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ABSTRACT

The proposed research is described to show design and implementation of the Global Positioning System (GPS) transmitter and receiver system for real time navigation, location based services and last but not least tracking applications. This GPS system measures the various satellite position located in space and some navigational parameters such as position of the object/satellite on world latitude or longitude, velocity, altitude and the most important, name of current location etc. This research system is used for providing information on the topic of the satellites that are view in provisions the number of satellites are being tracked, the satellite ID/PRN (Pseudo Random Noise) and parameters like Signal to Noise Ratio (SNR) of the capture satellite signal. Every model and information is described above on the Simulation and Graphical User Interface (GUI). To complete this research we are following the Matlab and Simulink with DSP, Xilinx Software.

Keywords: Global Positioning System; DSP; Graphical User Interface; Simulink; Xilinx Software.

I. INTRODUCTION

The Global Positioning System (GPS) [1] system is space based satellite navigation system. In space 32 satellite are there to provide acquire signal information to the GPS receiver but we have design our model using the 29 satellite which mean we have counted 29 satellite ID/PRN code in space. Whenever for operating a GPS receiver requires minimum four satellites to acquire the signal information. GPS receivers are used to determine the current location at real transmission time, velocity and signal speed depend on speed of light (3×10^8 meters/second) in all weather conditions [2, 14]. It is easily reached to anyone and freely accessible for tracking a location and calculates a real time user position. GPS Satellite signals are used for broadcasting on equivalent frequencies but it works on diverse ranging codes having low cross correlation. The satellites signal are having a CDMA (Code Division Multiple Access) for ranging codes to estimate the propagation as well as navigation time and to calculate the exact position of the satellite and real transmission time [11].

GPS receiver uses such type of ranging code like P(Y) code for military purpose and C/A codes (coarse acquisition code), these codes are used basically for satellite broadcasting. Every code has a unique value which is called the signal frequency such as C/A code is of 1.023 MHz and the carrier frequency of L1 signal is 1575.42 MHz. The coarse acquisition code was provided by GPS satellites system [3]. It is generated as a sequence of 1023 chips. It is repeated every milli second with chipping rate of 1.023 MHz and modulated only on L1 frequency. Here used a simulation environment such Simulink 8.1 to simulate and verify each phase of C/A code. A complete C/A code was built in simulation using received satellite ID/PRN code, initial code phase and loaded code phase, these all are required in the C/A code generation [4]. PRN code is abbreviated as pseudo random noise code which is determined for 29 satellites. This code determines the C/A code replica of different 1023 chips using a shift register. It is compared with the satellite code using a

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correlator [16]. A complete GPS system has main three section transmitter, receiver and channel. The simulation model and result of these three sections are given below.

II. LITERATURE REVIEW

Traditional methods of surveying and navigation resort to tedious field and astronomical observation for deriving positional and directional information [5, 6]. Diverse field conditions, seasonal variation and many unavoidable circumstances always bias the traditional field approach. However, due to rapid advancement in electronic systems, every aspect of human life is affected to a great deal. Field of surveying and navigation is tremendously benefited through electronic devices. Many of the critical situations in surveying/navigation are now easily and precisely solved in short time (Seeber, Gunter 2003) [12].

Although the speciûc requirements vary signiûcantly, the most fundamental aspects remain unchanged. Every GPS application ultimately involves the determination of platform position, velocity, and/or time [7, 8]. The exact algorithms and implementations differ depending upon the application but in each case the most basic measurements are the same: user-to-satellite Line-of-Sight (LoS) range and range-rate. Information describing the satellite position and velocity is also required. This is transmitted to the user in the form of binary data over the ranging signal via a spread-spectrum communication technique (R. Ziemer and R. Peterson, 1985) [13].

When the locally generated code is locked to the received code, the correlation effectively ampliûes the underlying BPSK data signal. The ampliûcation factor is given by, the length of the PRN sequence. The no encrypted portion of the GPS signal employs spreading codes known as Gold codes (R. Gold, 1967) [15]. The Gold codes are formed by combining two -sequences. The result is a family of PRN codes with low cross correlation between codes. This allows all satellites to transmit on the same carrier frequency without incurring signiûcantly mutual interference. The encrypted portion of the GPS signal also uses quasi orthogonal codes, but they are not Gold codes. Since each satellite is assigned a unique code, the system is referred to as code-division multiple access (CDMA) [9, 10].

III. PROPOSED METHODOLOGY

This Simulation stages and implementation of the GPS transmitter and receiver system having a functionality such as transmitter input, transmitter model, channel that connect transmitter signal output to direct or bypass to the receiver input and navigation of GPS receiver on a DSP/Xilinx system using the graphical programming language, C/C++ Programming. This Structural design makes every section of the GPS receiver very easy to understand, the DSP environment is used with approach simulation as well as implementation stages. The implementation stages are easy to understand the functionality as compared to the developing stages of most of the designer. It has a new look for designing, simulating, implementing and developing the most difficult parts of a representative GPS transmitter and receiver.

(A) Trasmitter of GPS System

GPS transmitter having a satellite ID/PRN code, in which we have entered satellite ID from 1 to 29.We have set a PRN code value (Tx PRN ID) is 3inside the transmitter and variable symbol rate error both are taken as an input. This transmitter generate two output 1) transmitter output (Tx out) which proceed toward the receiver through the channel functionality. 2) The chip clock. Chip generator shown in Fig. 1. This signal is converted into a continuous time signal, generally composed of RF chip which used to convert RF (Radio Frequency) signal to IF (Intermediate Frequency) signal. It have correlation between RF signal to IF signal which processes on the baseband signal and after that the baseband continuous time signal data passes through the buffer, and reaches to the channel input end.

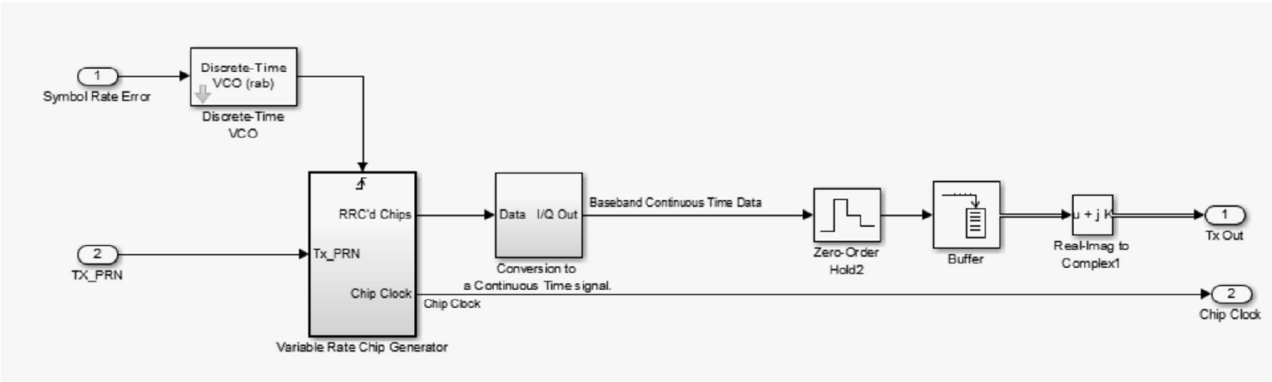

Figure 1: Simulink block diagrams of GPS transmitter with variable symbol timing

(B) Channel System

Here showing the system channel, it is inter-connectivity of the GPS transmitter output and the input of the receiver. In which we have designed two process which are, one is channel which pass the input signal from the channel and second is bypass in which the input signal directly pass to the receiver input end. The channel of transmitter and receiver of basic GPS receiver Simulink block is shown below, this block having transmitter or receiver gain, free space path loss and receiver thermal noise. By using a channel we can take input from the transmitter directly with passing all these block that is called bypass input as shown in fig. 2.

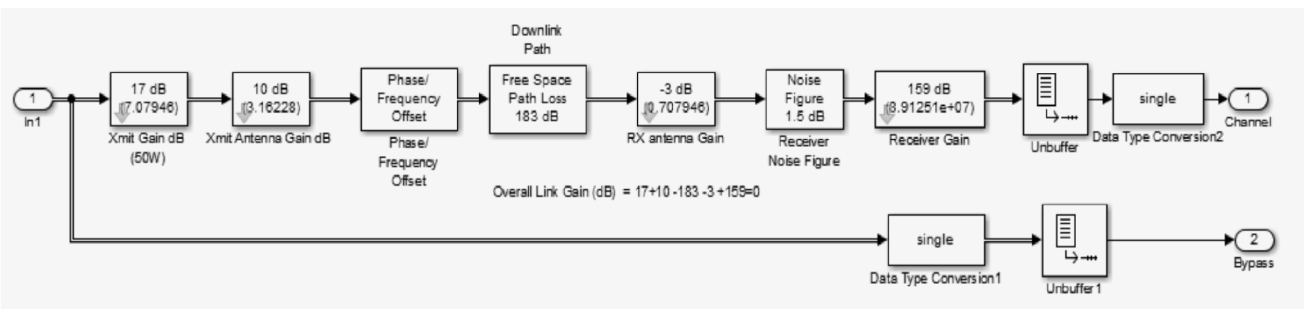

Figure 2: Transmitter and receiver channel of basic GPS receiver

(C) GPS Receiver System

The GPS receiver System describes the other functionality to the transmitter such as discrete time, carrier recovery, phase out & loop filter, farrow variable delay, C/A code generation and correlator, timing loop filter and timing control unit as shown in Fig. 3. The receiver system consider two inputs one is coming from the channel end and second is the satellite ID/PRN code which is same of the transmitter model.

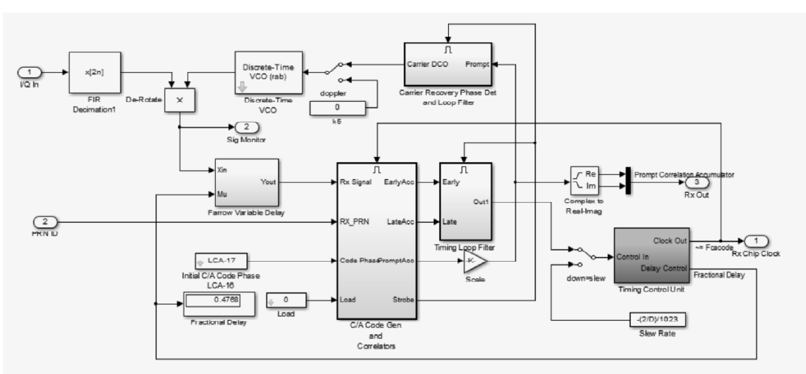

Figure 3: Simulink block diagrams of receiver system with timing control unit used in GPS transmitter and receiver model

The input signal of the GPS is passing through the farrow variable delay Simulink block and reaches to the C/A code generator. The correlator block correlated the input and output signal and generate a waveform that shows the behavior of the input and output. The block C/A code generator and correlator for the receiver signal are generate a C/A code chip size is 1.023. In this model we have add two new Simulink block one is timing loop filter and second is the timing control unit. The timing loop filter measures the receiver signal in account to time dependence and plot the early or late receiver signal. Timing control unit is used in GPS receiver signal model for controlling the clock time and maintained delay signal time.

IV. EXPERIMENTAL RESULT

The results of GPS transmitter and receiver system are showing the receiver spectrum, scatter plot, correlation and power estimation. These all block are taking the output from the receiver block. Here, the complete transmitter and receiver of the GPS as shown in Fig. 4. and receiver spectrum block, correlator block and power estimation is clearly mentioned in this block.

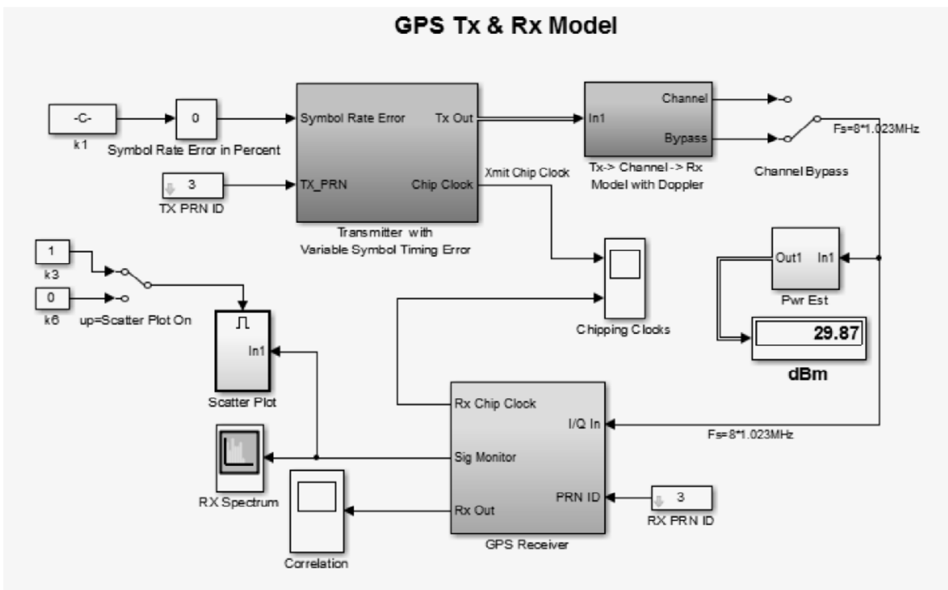

Figure 4: Simulink block diagrams of complete GPS transmitter and receiver system.

The receiver spectrum is monitor of the GPS receiver signal with is the combination of the transmitter passes signal and satellite ID/PRN code generated signal. The receiver spectrum signal has generated following parameters values given below:

- Resolution Bandwidth (RBW) = 11.99 KHz
- NFFT = 513
- Span = 4.09 MHz
- Carrier Frequency (CF) = 0 Hz

The received signal spectrum is showing the signal with respect to frequency and magnitude, the horizontal axis shows the frequency value of the signal and vertical axis shows the magnitude value of the received signal as shown in Fig. 5.

The Correlation between the Satellite ID/PRN received signal and input signal come through the channel which passes by the transmitter including sample frequency (Fs= 8*1.023 MHz or 8*C/A chip Size). In Fig. 6 two signals is showing: 1). Magenta color (input signal including sample frequency) and 2) yellow

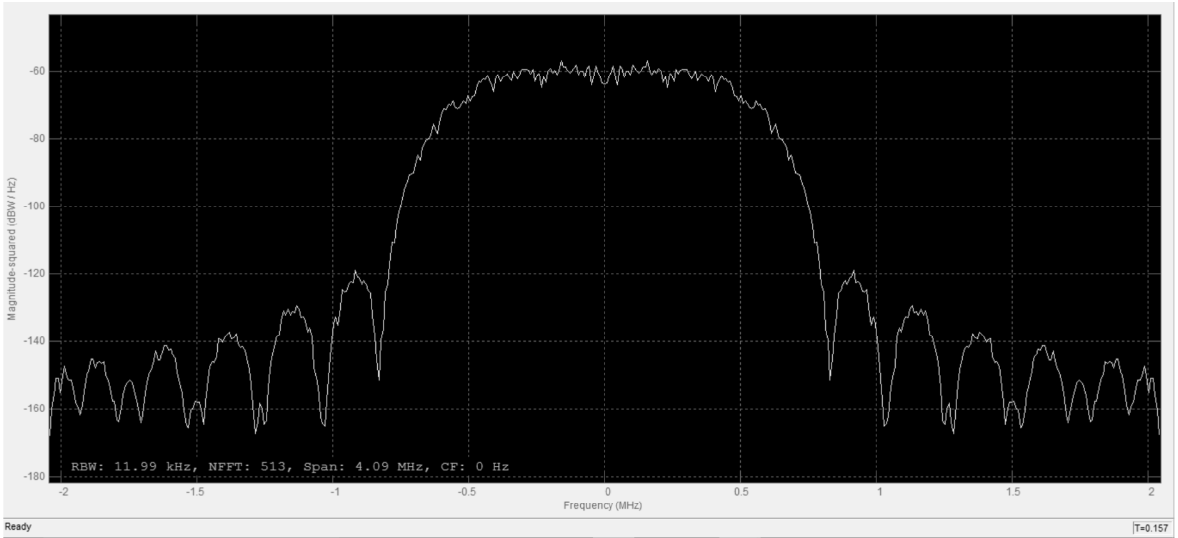

Figure 5: Received signal of complete GPS transmitter and receiver system

color (received signal from the satellite ID/PRN). The received signal having the amplitude -1 < 0 >1 with respect to the time sample, showing three image of the correlation.

1. Satellite ID/PRN signal and input signal in same phase +90 degree.
2. Satellite ID/PRN signal and input signal are changing the phase +90 degree to -90 degree.
3. Satellite ID/PRN signal and input signal are in opposite phase -90 degree.

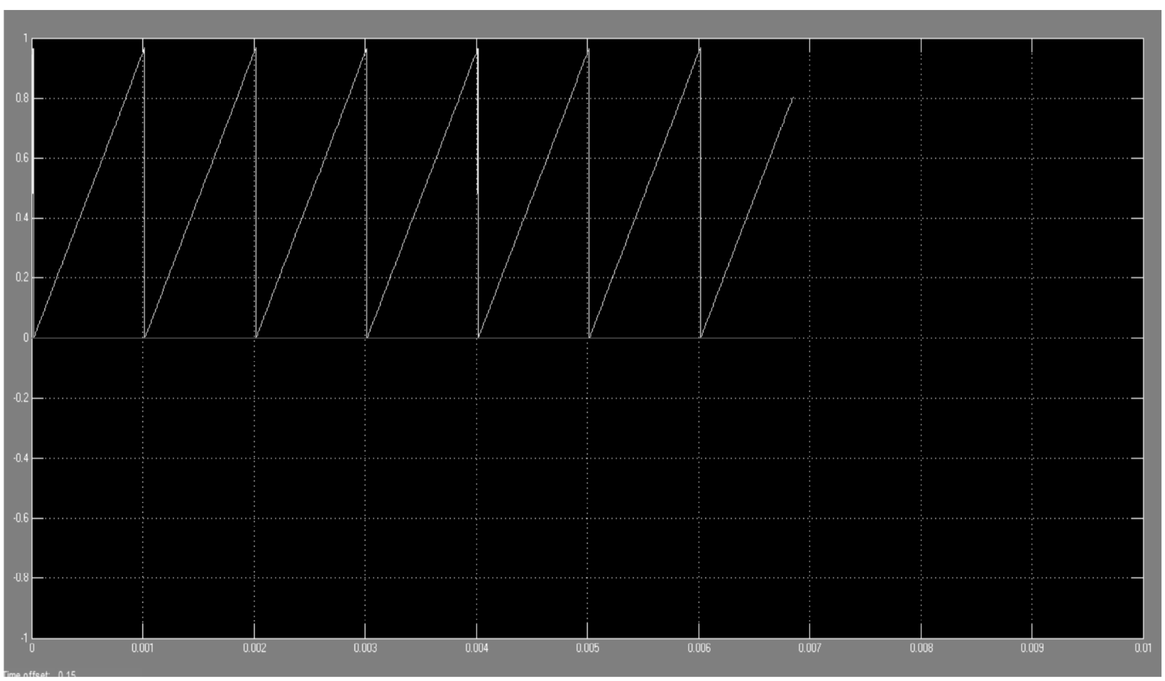

Figure 6: Correlation Signal of complete GPS transmitter and receiver system

In this proposed research the scatter plot shows the results of a long term GPS signal measurement of a fixed position, in this order to check the precision or, at least, the reproducibility of a GPS signal measurement. For GPS signal position of a fixed point was recorded in every 30 seconds intervals with in phase amplitude and Quadrature amplitude. This present work is showing precision of the long-term signal measurements and statistical distribution of the error under different conditions as shown in Fig. 7.

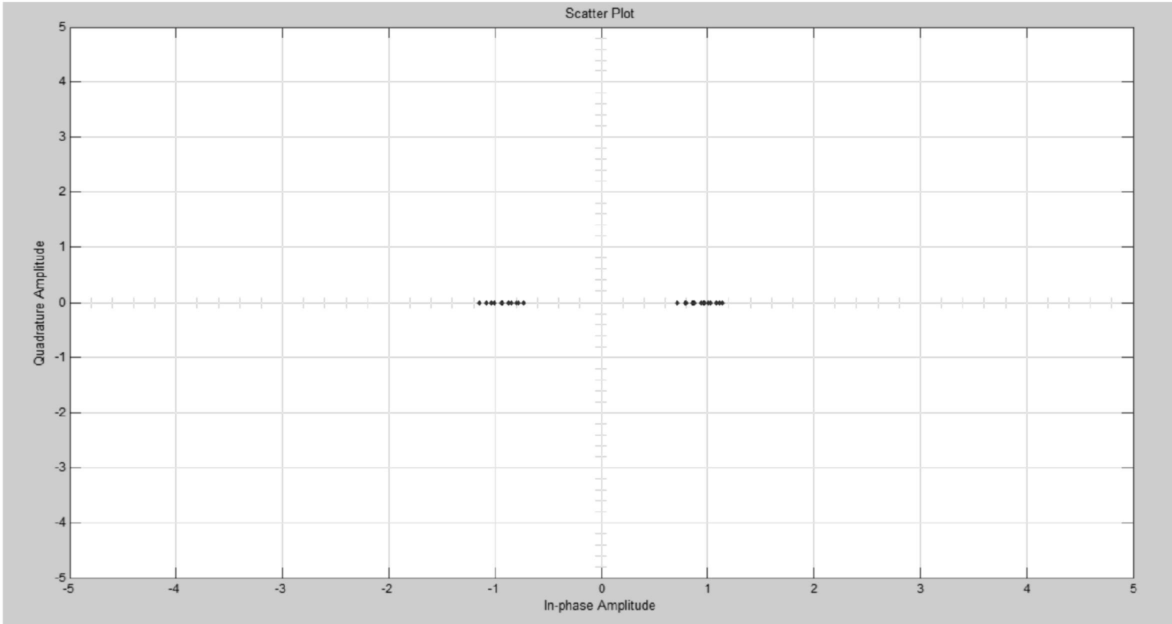

Figure 7: Scatter plot of complete GPS transmitter and receiver system

In the present GPS system we have calculated some error like phase error, integrator and carrier VCO. The graph of these error in Fig. 8 having zero amplitude with respect to time sample value at infinite run time.

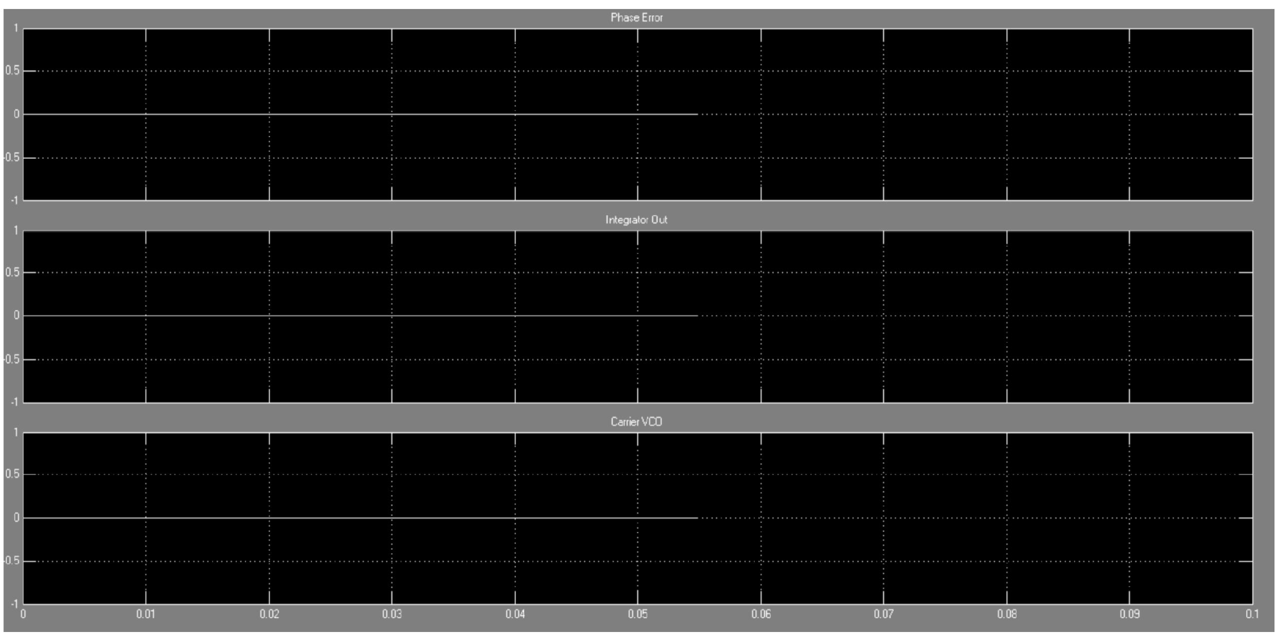

Figure 8: Errors measurement in the complete GPS transmitter and receiver system

V. CONCLUSION

In the proposed research we introduced the simulation and implementation of GPS transmitter and receiver on the DSP/Xilinx System through a graphical programming language (Simulink 8.1). Here we have completed an idea of modifying both the IF and Fs in input side of the GPS receiver and the subsequent results obtained from the PRN code at set value 3. GPS system is measures various satellite position located in the space and showing the exact position of the satellite with the help of the scatter plot. Here we have calculated the value of navigational parameters such as position of the satellite on the world latitude or longitude, velocity, altitude and error etc. This research system has used for collecting the information on for the satellites that are view in provisions the number of satellites are being tracked, the satellite ID/ PRN (Pseudo Random Noise) and parameters like SNR (Signal to Noise Ratio) of the capture satellite signal.

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