Preface

If one examines the current literature on GPS receiver design, most of it is quite a bit above the level of the novice. It is taken for granted that the reader is already at a fairly high level of understanding and proceeds from there. This text will be an attempt to take the reader through the concepts and circuits needed to be able to understand how a GPS receiver works from the antenna to the solution of user position.

To write such a text is not trivial. It is easy to get distracted in the GPS receiver. Many papers and articles deal with the minutiae of extracting the last little bit of accuracy from the system. That is not the goal of this text. The primary goal of this text is to understand a GPS receiver that solves for the "first-order" user position. What is meant mean by "first-order solution"? The best way to answer that question is another question and that is, "What do we have to do to build the minimum GPS receiver system to give user Position accurate to approximately 300 m?" The reader should know that as desired accuracy of position or time solutions increases so does the complexity of the receiver. In pursuing the 300-m goal, the reader will gain an understanding of the core principles present in all GPS receivers. It is hoped that the reader will then be able to proceed from there to understand the later techniques presented that achieve accuracy above this level.

A major problem in writing this text is the assumed background of the reader. It is not possible inside this text to start at receiver fundamentals and work from there. An assumed background level is needed. The basic background of the reader should include an understanding of analog narrow-band radio receivers, basic digital circuits, algebra, trig and concepts from calculus. The solution of the equations for user position is the most challenging in terms of the math needed. Linear algebra and calculus are used.

Regardless, it is not the intent of this text to smother the reader in math, equations, and the like. A more practical approach will be pursued. An attempt will be made to describe the concepts and phenomenon with as little math as possible. It is impossible to write such a text without equations so where appropriate they will be used.

GPS receivers must solve two fundamental problems: First is the receiver itself, which gets the raw range and Doppler to each SV (the observables), the second is the manipulation and computations done on that data to calculate the user position. These two problems are intertwined in such a fashion which makes complete separation impossible. It would seem natural to start at the receiver antenna and work backward into the receiver. But this approach does not lay the needed foundation of understanding of basic principles at work in the GPS. Instead, the text will be split into three parts.

Part I will introduce the reader to fundamental process behind all GPS receivers. Simplified models will be used wherever possible. The details of the GPS signal and its data stream will be explored. With this knowledge, the solution of users position will be presented without getting into the details of the receiver hardware. Therefore, understanding the Part I of this text does not require the reader to have intimate knowledge of radio receiver methods.

Part II explores the details of the receiver. The reader will need to understand radio principles very well to completely follow the discussions presented. This text will develop receiver concepts using a hybrid design. Although most commercial (if not all) GPS receivers today use DSP methods, it is the author's view that these techniques are difficult to learn the fundamentals from. The approach pursued in this text is just easier to understand. Digital methods will be used and their analog counter part, if any, will be discussed.

In Part III, more advanced receivers and topics are covered. In Chap. 8, we will examine GPS time receivers, time and frequency measurements using GPS receivers and simple time transfer. In Chap. 9, the Zarlink GPS receiver chip set is discussed as introduction to more modern receiver using DSP methods. In Chaps. 10 and 11, the most advanced material is presented with the majority of the material focused on Carrier Phase Methods. Chapter 11 discusses the Turbo Rogue Receive, one of the most accurate GPS receivers ever made. In Chapter 12 the new GPS signal L2C is detailed along with receiver methods for L2C signal. Chapter 12 is contributed by Danilo Llanes.

As a final comment, many readers may come to this subject with the idea that GPS is only about the physical position of the user and satellites. As one learns more about GPS it becomes apparent what GPS is really about is *Time and Movement*. The GPS receiver uses observations of Time (Clocks) to *Measure* movement. The result is that the electronic clock signals as received, inside the receiver, will also be found to be moving in Time in direct relation to the physical movement of the receiver/satellite system.

Nipomo, CA, USA Dan Doberstein

http://www.springer.com/978-1-4614-0408-8

Fundamentals of GPS Receivers
A Hardware Approach
Doberstein, D.
2012, XVI, 329 p., Hardcover
ISBN: 978-1-4614-0408-8