September 7th, 2006

Interconnecting Trimble GPS Smart Antenna & Spectratime Smart Rubidium SynClock+™

Interconnecting & Evaluating the System Performance of Trimble Acutime™ 2000 GPS Smart Antenna & Spectratime Smart SRO-100 Rubidium SynClock+®

Contents

Introduction

In this AppNote, Spectratime's Smart SRO-100 Rubidium SynClock+® is referred to as the "*Smart SynClock+®*" and Trimble's Acutime™ 2000 GPS Smart Antenna is referred to as the *"Smart GPS".*

The patented SynClock+® is the industry's first smart Rubidium clock, integrating a host of complex timing and synchronization functions all in one low-cost, ultra-small package. It intelligently synchronizes, disciplines, and controls any Stratum-1 reference such as GPS, Cesium, Hydrogen Maser, and T1/E1 at cutting-edge 1ns (nanosecond) resolution. The SynClock+® utilizes SmarTiming+™ technology to perform the following functions, which were previously implemented externally on a separate circuit board:

- Multi-vendor GPS interface with auto-adaptive reference filtering, disciplining, control, and Time RAIM/Position Hold signal optimization
- Auto-adaptive Stratum-1 reference disciplining and jitter/wander/noise filtering between 0-100,000 at 1ns resolution, exceeding MTIE/TDEV G.823/T1.101 standards for T1/E1 reference
- Auto-adaptive frequency stability over fast temperature changes at 0.1ºC resolution
- Auto-adaptive frequency stability over temperature range within 2E-11
- Programmable 1PPS output phase/time offset adjustments between 0-1 sec through a 1ns-phase comparator
- Programmable or hardware Sync/Track setting mode to either a) phase align 1PPSout from a 1PPS GPS reference through the Sync mode or b) to frequency track 1PPSout from a 1PPS Startum-1 reference through the Track mode
- Programmable EEPROM for TIE performance measurements, frequency calibration and backup setting in case of power failure, and seamless software upgrades
- Standard RS-232 communication interface with user-friendly ASCII commands for control, configuration, fault, and performance management

The purpose of this AppNote is to help engineers quickly design a complete GPS and Rubidium timing reference solution. The AppNote addresses the following design issues:

- How to connect, set up, and monitor the Smart GPS/SynClock+® timing system
- What kind of cutting-edge performance can be achieved through the Smart GPS/SynClock+® timing system

Interconnecting the Smart GPS/SRO SynClock+® Timing System

The interconnection of the Smart GPS/SynClock+® is performed through an easy, plug-&-play environment thanks to the default timing configuration of the Smart GPS.

Hardware Setup

Figure 1 illustrates how to easily interconnect the Smart GPS Synchronization Kit, which includes Trimble's Synchronization Interface Module (SIM), and the Jumpstart Smart SynClock+® Designer Kit (JSDK).

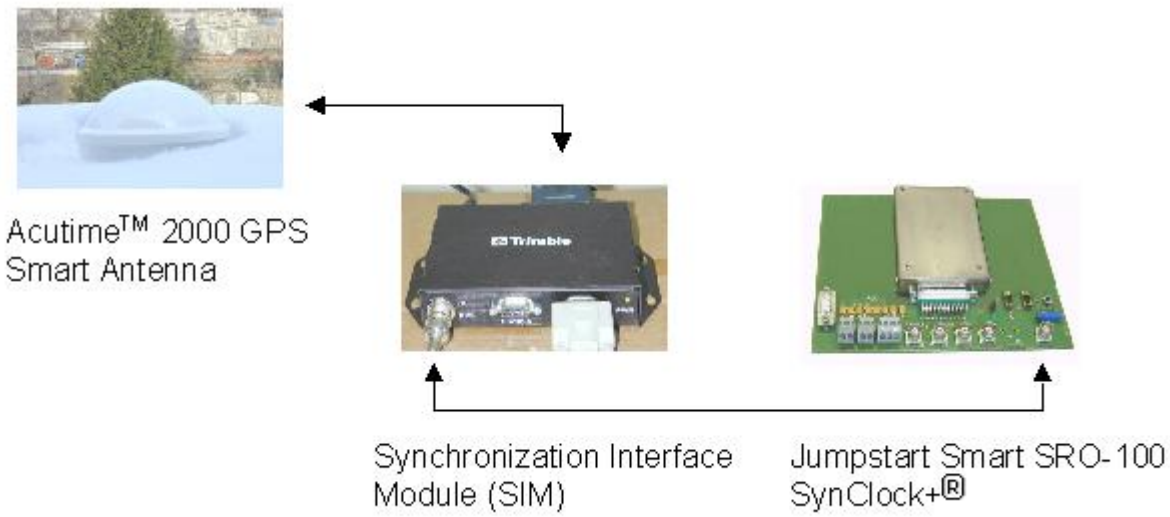


Figure 1 – Interconnection Setup

The kit Jumpstart Smart SRO-100 Synclock+® is obsolete. Use PCB GDK-2 in place. Switch "GPS" on "1 way", left.

The Smart GPS integrates a smart antenna and a GPS receiver in a small hemispheric box, avoiding the need for an expensive HF cable, which is required when a GPS receiver is not integrated in the antenna. The Smart GPS Synchronization Kit uses an inexpensive 100-feet interface cable, which is provided in the kit, to interconnect and feed the 1PPS reference from the Smart GPS to Trimble's Interface Unit. The same cable is used to feed the power and communicate through the RS-422 interface to the Smart GPS.

A 50Ω shielded cable with BNC connectors is used to feed the 1PPS reference from Trimble's SIM to the Spectratime' s JSDK.

In order to synchronize the system, the user should set the Track/Sync switches on the JSDK to ON. After few minutes, the green LED on the JSDK will turn on, indicating that the smart SynClock+® is tracking UTC time through the Smart GPS.

Software Setup

Figures 2 and 3 illustrate how the Smart GPS/SynClock+® timing system can be monitored and managed through a PC-based serial interface, running a software program provided by Trimble and Spectratime.

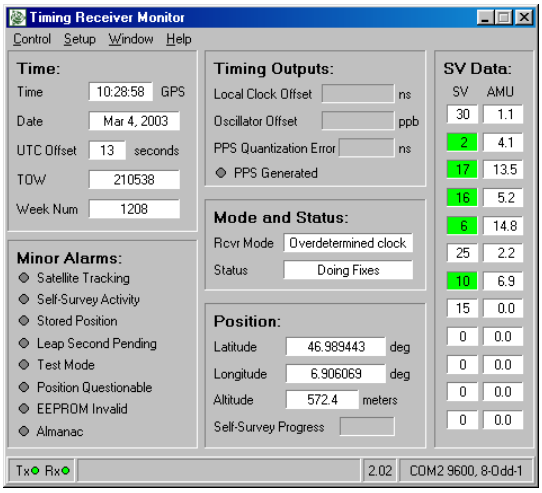


Figure 2 – Smart GPS Monitor

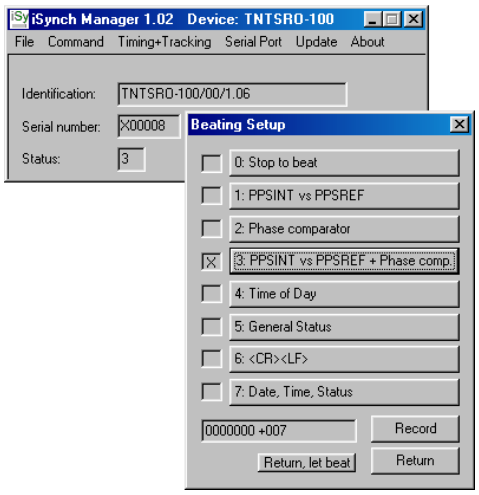


Figure 3 – Smart SynClock+® Manager

Evaluating the Smart GPS/SRO SynClock+® System Performance

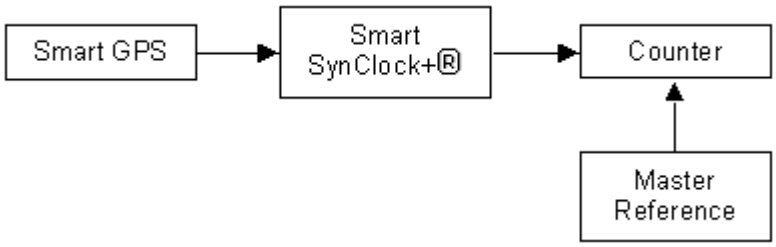
Below is a series of typical cutting-edge phase performance graphs that can be achieved through the Smart GPS/SynClock+® timing system.

Test Equipment & Diagram

The following equipment was used to test and measure the performance of the Smart GPS/SRO SynClock+® system:

GPS Vendor:	Trimble at www.trimble.com/timing.html
GPS Product:	Acutime™ 2000 GPS Synchronization Kit
Spectratime Master Reference:	Hydrogen Maser, type H-MASER EFOS-C
Spectratime Clock:	Smart SRO-100 Rubidium SynClock+®
Counter Vendor:	Agilent, type 53131A counter
Notes:	A frequency difference of 3E-12 between the Hydrogen Maser and the GPS was removed to compute the performance data.

The testing diagram is as follows:



System Performance

Figure 4 illustrates the performance of the Smart GPS, which was installed in a poor location where the reception of the GPS signal was weak. The Smart GPS was located on the balcony of Spectratime's building in Neuchâtel, Switzerland. The building is located in a small valley which blocks the constant line-of-sight view of the satellites to the building's balcony.

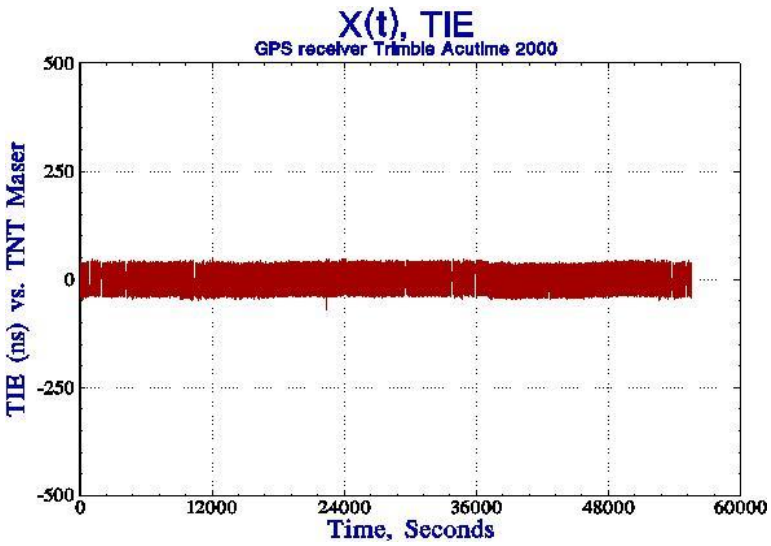


Figure 4 – Smart GPS Time Interval Error Performance

Figure 5 illustrates the holdover performance of Smart SynClock+® when the Smart GPS reference was absent for 1 day. It also shows the tracking behavior of the Smart SynClock+® before and after the holdover transition. The initial frequency stability of the Smart SynClock+® is auto-adaptively tracked to the long-term stability of the Smart GPS. After the Smart GPS reference is restored (or after the holdover transition), the Smart SynClock+® tracks again the Smart GPS.

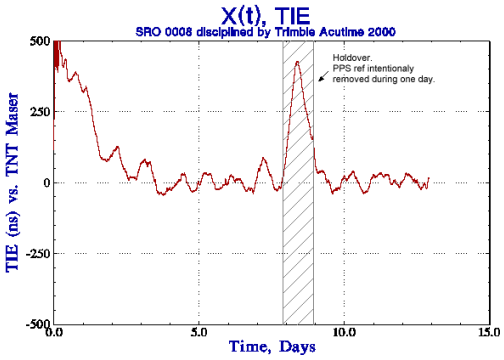


Figure 5 – Smart SynClock+® Holdover Performance

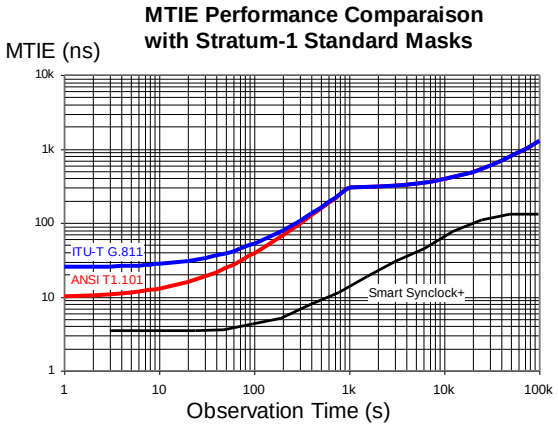


Figure 6 – Smart SynClock+® Tracking Performance vs. Stratum-1 Standard Masks. From the day 2 to the day 8 of Figure 5

Figure 7 illustrates the Holdover MTIE performance of Smart SynClock+® versus Stratum-1 ITU-T G.811 and ANSI T1.101 standard masks.

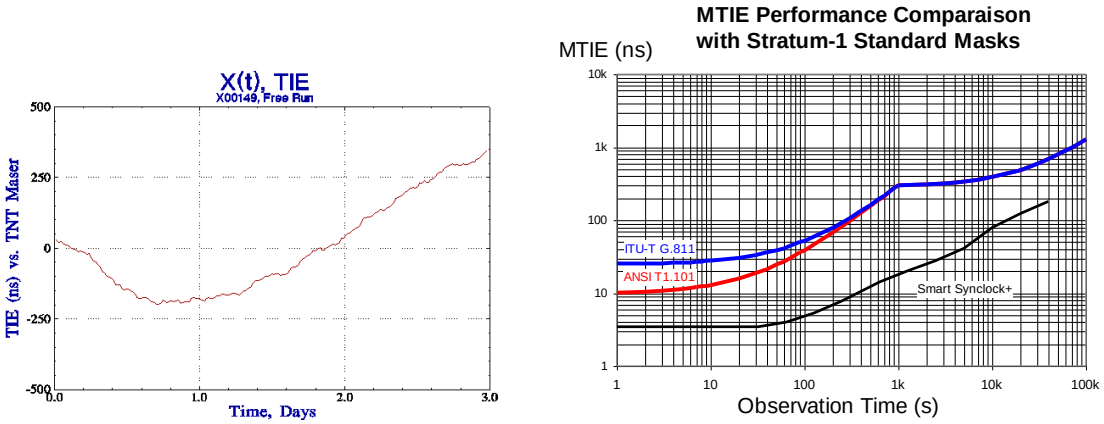


Figure 7a,b – Smart SynClock+® Holdover Performance vs. Stratum-1 Standard Masks

Fast Q&A Support

If you have any questions about this AppNote or need tech support with your specific timing design and requirements, please feel free to contact us at fastsupport@spectratime.com.

Ordering Spectratime Smart SynClock+®

If you are interested in ordering the Smart SynClock+®, please contact us at sales@spectratime.com. For ordering the Smart GPS, please contact Trimble at www.trimble.com.