



## Technology Brief: EpsilTime™ Synchronization Algorithm

### What it Means to You:

- Exact synchronization between 10 MHz and 1PPS outputs as necessary for applications such as digital video broadcast
- Improved frequency and phase accuracy when locked to GPS
- Improved accuracy in the event of loss of GPS (holdover)

### Introduction

GPS clocks offer high performance with relative affordability by “slaving” a quartz oscillator to the GPS reference. Many GPS clocks use simple algorithms to generate the 10 MHz and 1 pulse-per-second signals required for synchronization applications. Performance is affected by sources of noise and the correction for drift. Typically the 1PPS output is suddenly resynchronized to the GPS reference without regards to the frequency output. The result is a phase discontinuity that affects critical time and frequency applications such as digital video broadcast (DVB) utilizing single frequency networks. The Spectracom EpsilTime™ algorithm eliminates these problems by using smart predictive technology to mitigate the effects of inherent GPS and oscillator noise, improves accuracy if GPS is lost (holdover), and corrects drift in the 10 MHz and 1PPS outputs simultaneously.

### 1PPS In-Sync with 10 MHz

- 10 MHz output is synthesized from the internal 10 MHz quartz oscillator (OCXO).
- This 10 MHz is divided  $10^7$  times to derive the 1PPS output.
- The 1PPS output is compared to the GPS 1PPS reference to tune the 10 MHz immediately.
- No cycles are added nor removed to the 10 MHz during the correction eliminating any phase discontinuity to sync the 10 MHz to the reference.

### Smart Predictive Kalman Filtering Improves Accuracy

- Kalman filtering mitigates the effect of short- and long-term noise (oscillator noise, GPS reference noise) and drift (oscillator aging, temperature variation).
- Accuracy is improved when calculating the differences for frequency and phase during the slaving process to GPS.
- The filter uses the last evaluated values to predict future performance of the system in order to respond very quickly to differences.