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Impact of External Frequency Source on the Timing Performance of a GNSS Receiver

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Global Navigation Satellite System (GNSS) provides precise Position, Velocity, and Timing (PVT) solutions. Currently, four global and two regional navigation satellite systems are operational; to cater to the users' needs, various types of GNSS hardware are commercially available, including the geodetic receivers, primarily used for precise positioning applications. Most GNSS receivers are provided with a 1PPS hardware output. This very provision has immensely intensified their applications for timing purposes. Consequently, many efforts have been initiated to explore the behaviour of such receivers for timing applications.

In a GNSS receiver, the internal oscillator is one of the essential components. The temperature-controlled crystal oscillator (TCXO) is commonly used as an internal oscillator to reduce cost. The stability of the TCXO oscillator is of the order of a few parts in 10^{10}. However, the expensive receivers generally utilize the oven-controlled crystal oscillator (OCXO), whose frequency stability is one order better than TCXO. It is important to note that most GNSS receivers can be fed with an external frequency source to synchronize the internal oscillator. However, no study on the effect of feeding external frequency sources on the receiver's performance has yet been reported. Extensive work has been undertaken through a unique campaign mode experiment to investigate this aspect. This paper presents a detailed report of this effort.

The campaign mode experiment has been arranged at the CSIR-NPL, New Delhi premise to access the standard reference frequency. The experiment has been conducted in two distinct modes – one without feeding any external frequency to the GNSS receiver and the other one where a 10 MHz standard frequency of CSIR-NPL (i.e. (UTC)NPLI)) is fed to the receiver as shown in Figure 1. In the experiment, the 1PPS of the receiver is compared with the standard 1PPS of CSIR-NPL through a high-resolution interval counter. In this study, two separate receivers have been used to inspect the effect of the external frequency for two different GNSS constellations- GPS and NavIC. The time offset values between time from the GNSS receiver and UTC(NPLI) and respective frequency stabilities have been analyzed and discussed.

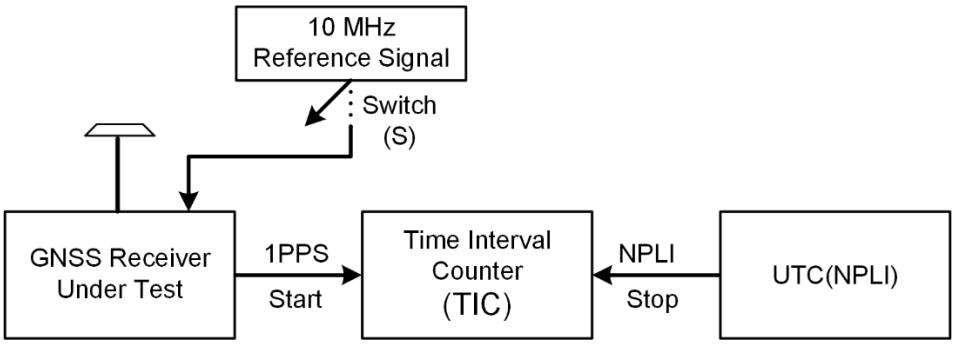

Figure 1. Experimental setup

This paper presents detailed experimental plans and observation data and includes a detailed discussion highlighting the perceptible differences in the receiver's timing performance. A significant improvement in timing is noted when the GNSS receiver is fed with the standard external frequency signal. Time offset has improved 1σ jitter from 8-10 nanoseconds to sub-nanosecond jitter when the standard frequency is fed to the receiver. One order of improvement in frequency stability has also been observed.
The presentation would elaborate on all these aspects.