# Tokenblauser:

Frequency stability measurement using a satellite beacon at 11.703505 GHz, GNU Radio and TimeLab

In this application note, we will measure the frequency stability of the Tokenblauser GPSDO, receiving a stable signal from a geostationary satellite.

Prerequisites

Please see Application note RigExpert TBR-AN-1 for the hardware description. The structure diagram of the hardware is located below:
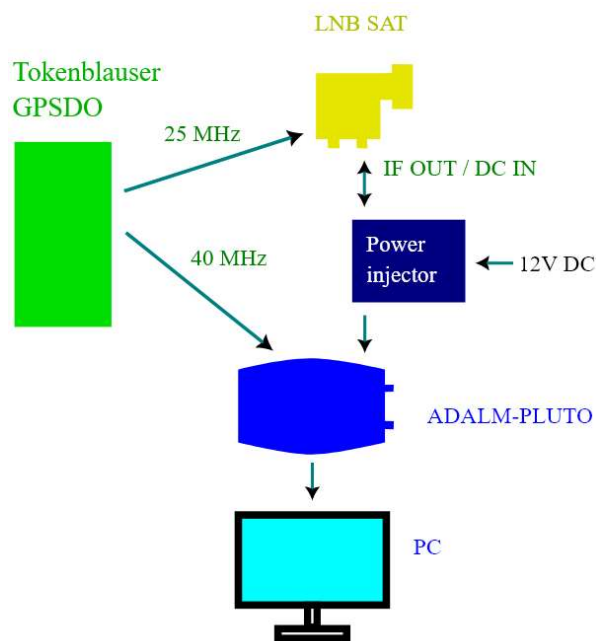


Satellite beacon at 11.703505 GHz

It is believed that most of satellite transmitters are locked to very stable Cesium oscillators. By using GNU Radio, we will lock the frequency of a virtual oscillator to such a beacon to try to estimate how stable the GPSDO is.

The beacon at 11.703505 GHz is a steady carrier. The WSJT software does not indicate any fluctuations or instability:
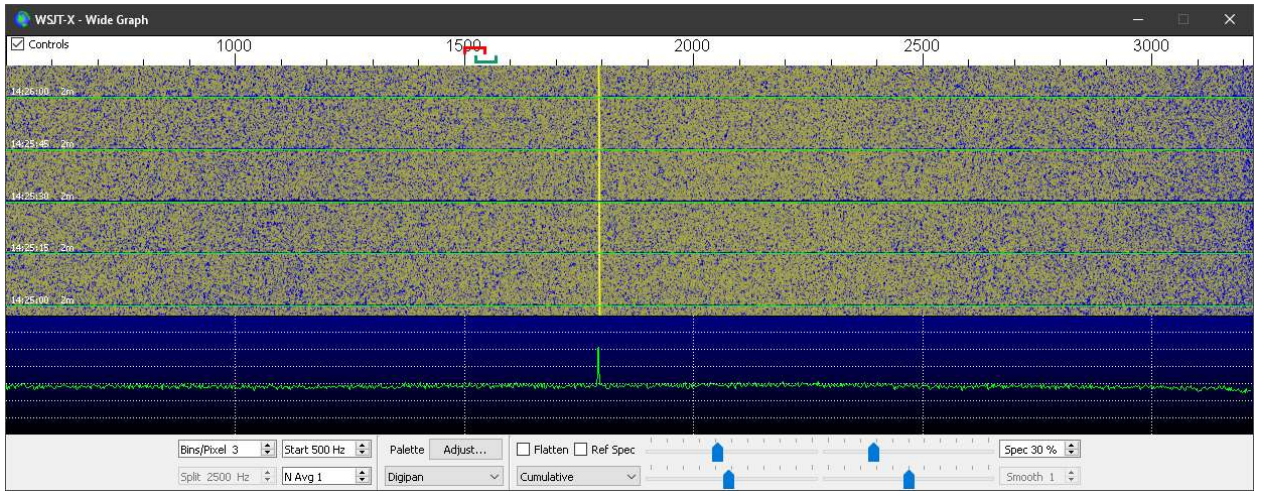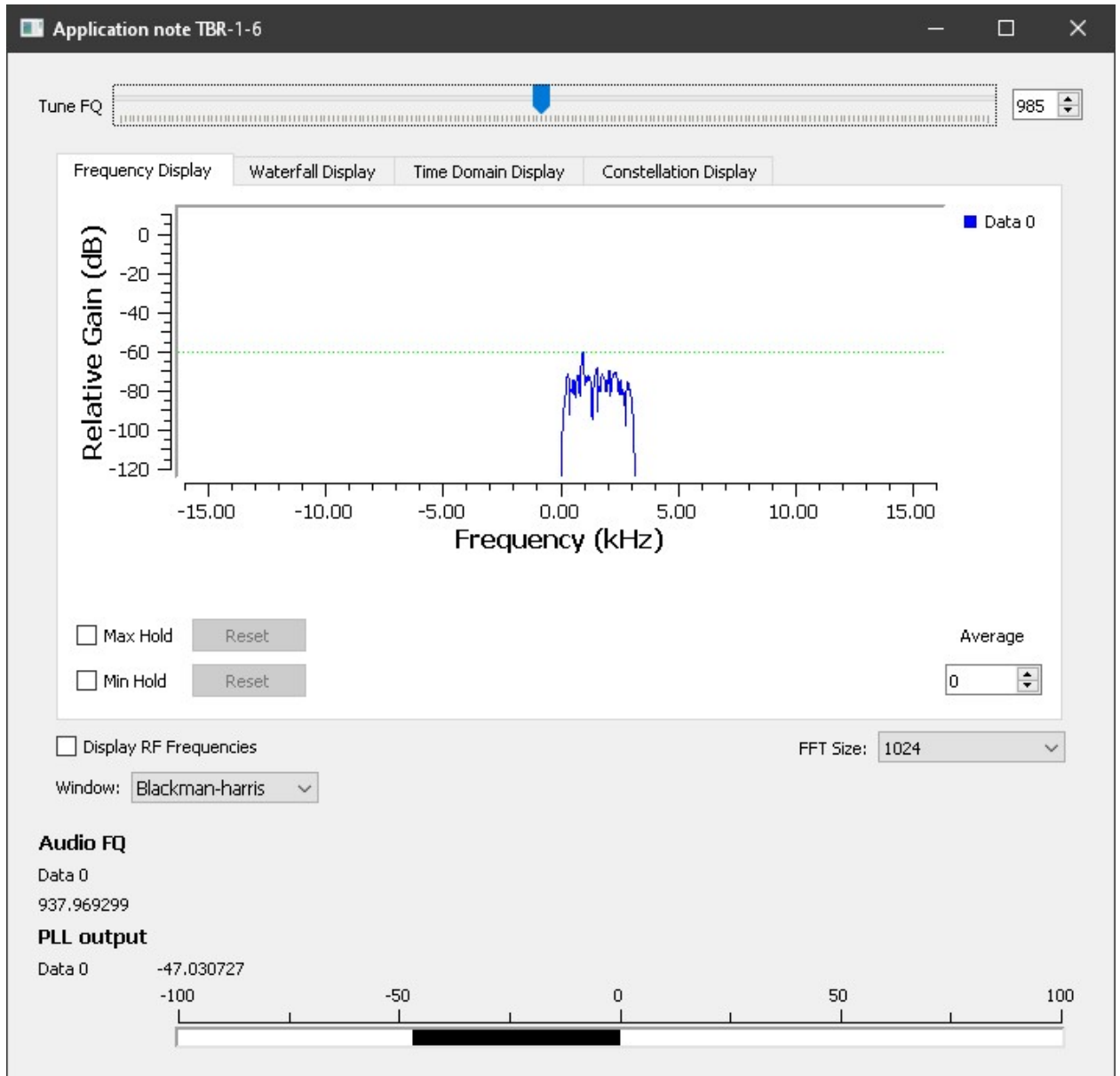
GNU Radio and GNU Radio Companion

With the GNU Radio Companion, the use of GNU Radio is easy. The following flowgraph represents the receiver:
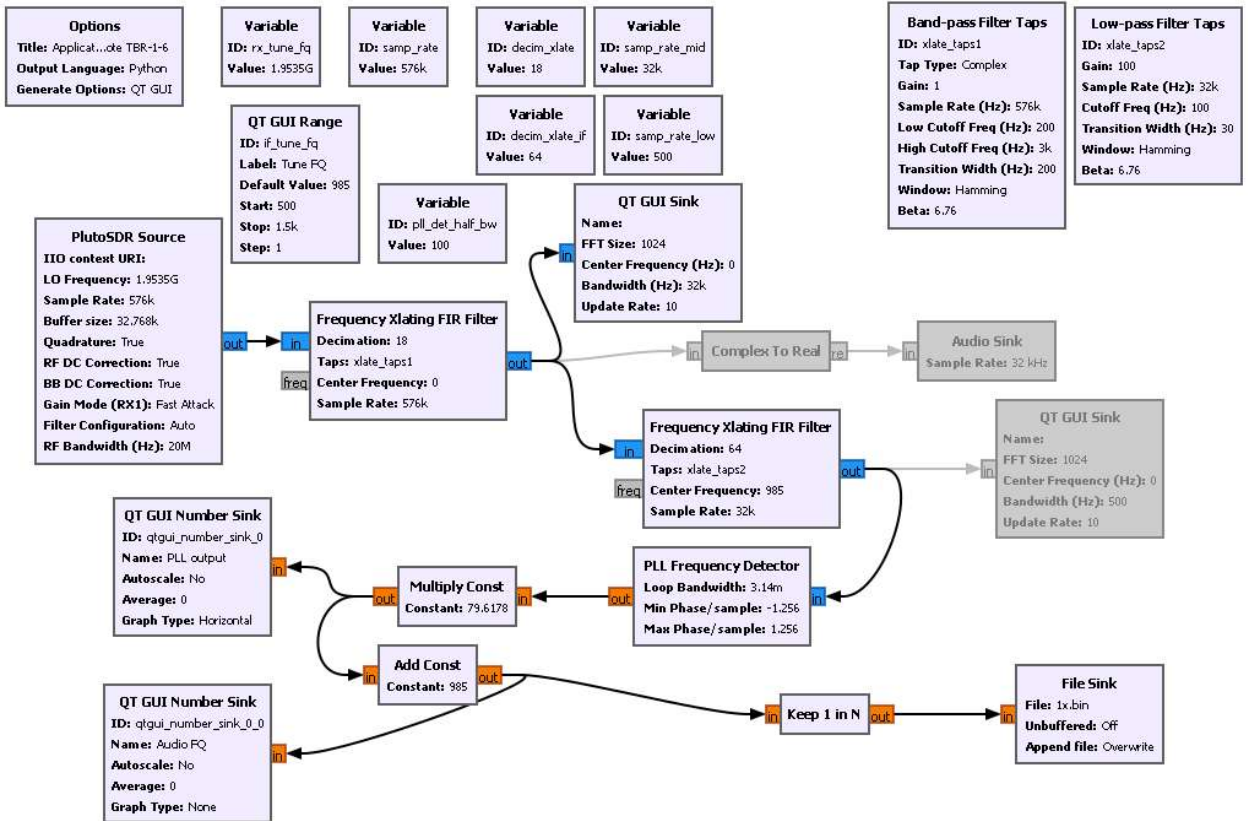
Here is a screen shot of a running application:

The program will create the **1x.bin** file, where the audio frequency is stored, using float-32 values with 1-second period.

A small python program (named **1x.py**) is used to convert binary file to a more readable text file:

```
import numpy as np

data = np.fromfile(open("1x.bin"), dtype=np.float32)

data.tofile("1x.txt", sep='\n')
```

The resulting **1x.txt** file will contain the sequence of measured frequencies:

```
990.8973999023438

990.8485107421875

990.99658203125

…
```

TimeLab software

In the TimeLab software, go to File – Import ASCII phase of frequency data, and then choose **1x.txt**.

In the Import dialog, select Frequency difference, enter 1 x 1e-10 in the Numeric field # edit boxes, and then click Import:

Go to Measurements – Frequency difference menu to switch to the corresponding view:

By using a computer mouse, select area where the frequency is not yet stabilized, such as 0s to 250s:

Go to Edit – Remove selected or zoomed phase data menu and click Yes to confirm. Righ-click to unzoom.

Now go to Edit – Subtract linear phase trend (frequency offset). The Frequency Difference graph will now show the slight frequency drift.

You may switch to Allan Deviation or other measurement modes:

Conclusion

Doppler shift and other effects must have caused the global frequency drift. Longer recordings will uncover periodic nature of the drift. By subtracting the periodic offset from the measurement results, the true stability of the GPSDO may be seen.

Downloads

- GNU Radio – https://www.gnuradio.org/
- TimeLab – https://www.miles.io/timelab/beta.htm
- GRC flowgraph of the experiment – https://github.com/rigexpert