Application note RigExpert TBR-AN-2 (12-Jul-2022)

Tokenblauser:

Receiving 10 GHz beacons from geostationary and LEO satellites

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In this application note, we describe the usage of the Tokenblauser GPSDO as a signal generator to receive satellite beacons from geostationary as well as low Earth orbit (LEO) satellites.

Satellites and beacons

Almost every commercial satellite has a steady carrier (CW) or low-baudrate telemetry beacons. Many of them are listed on specialized websites, such as http://frequencyplansatellites.altervista.org/ .

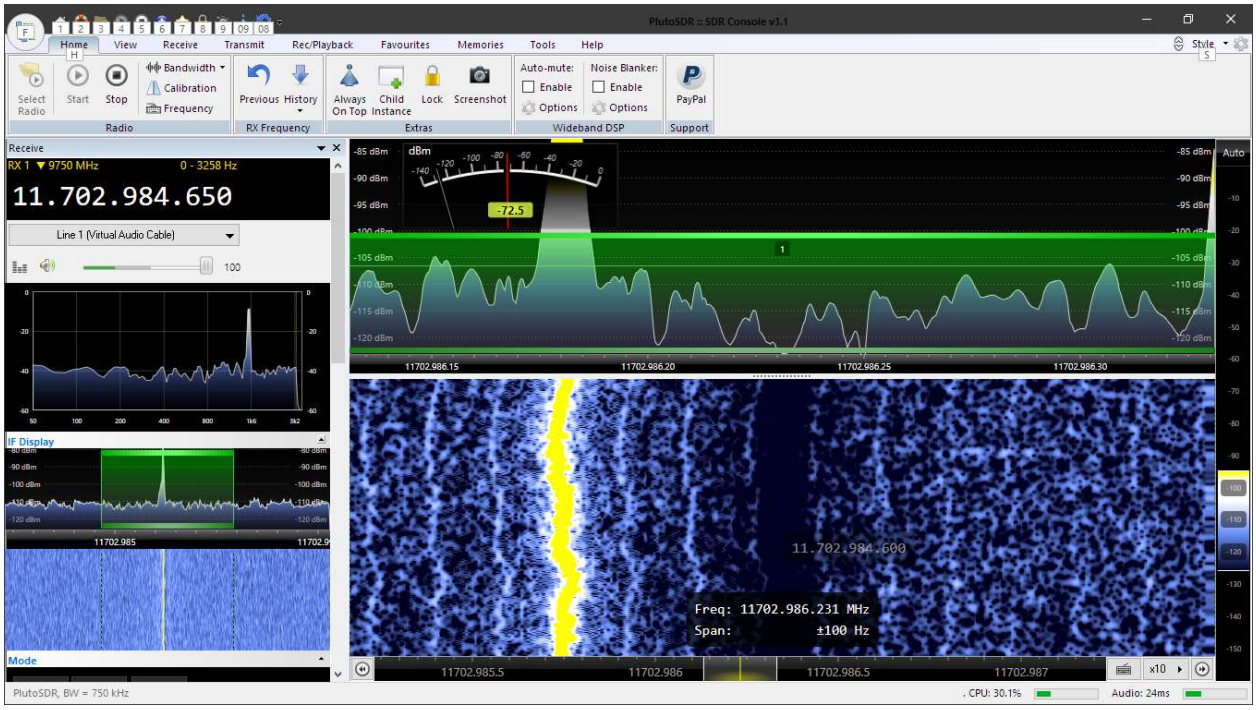
Prerequisites

Please see Application note RigExpert TBR-AN-1 for the hardware requirements. The LNB was pointed to the direction of the QO-100, also being able to receive nearby satellites.

For precise frequency measurement, we recommend using the Spectrum Lab software, https://www.qsl.net/dl4yhf/spectra1.html .

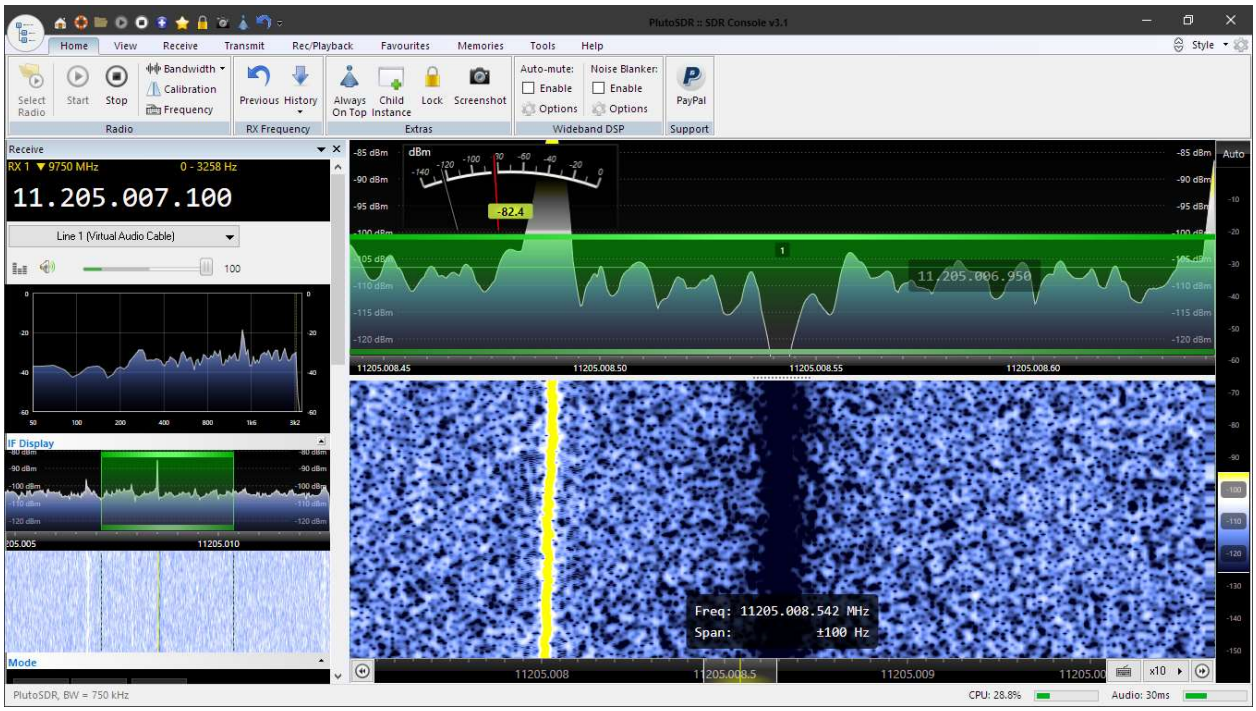
Beacon at 11.703 GHz

A strong CW beacon can be received at the frequency of about 11.703 GHz, but the signal is unstable and noisy:



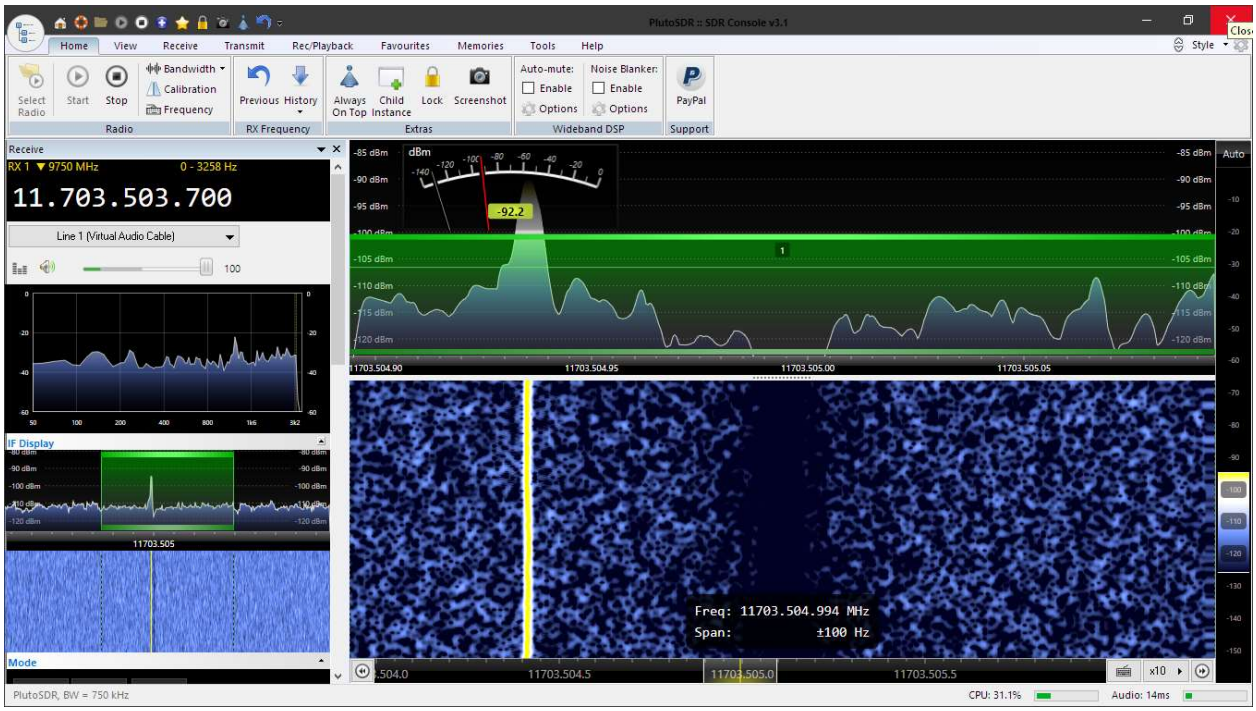
Beacon at 11.205 GHz

Another beacon at the frequency around 11.205 GHz is slightly less noisy and more stable:

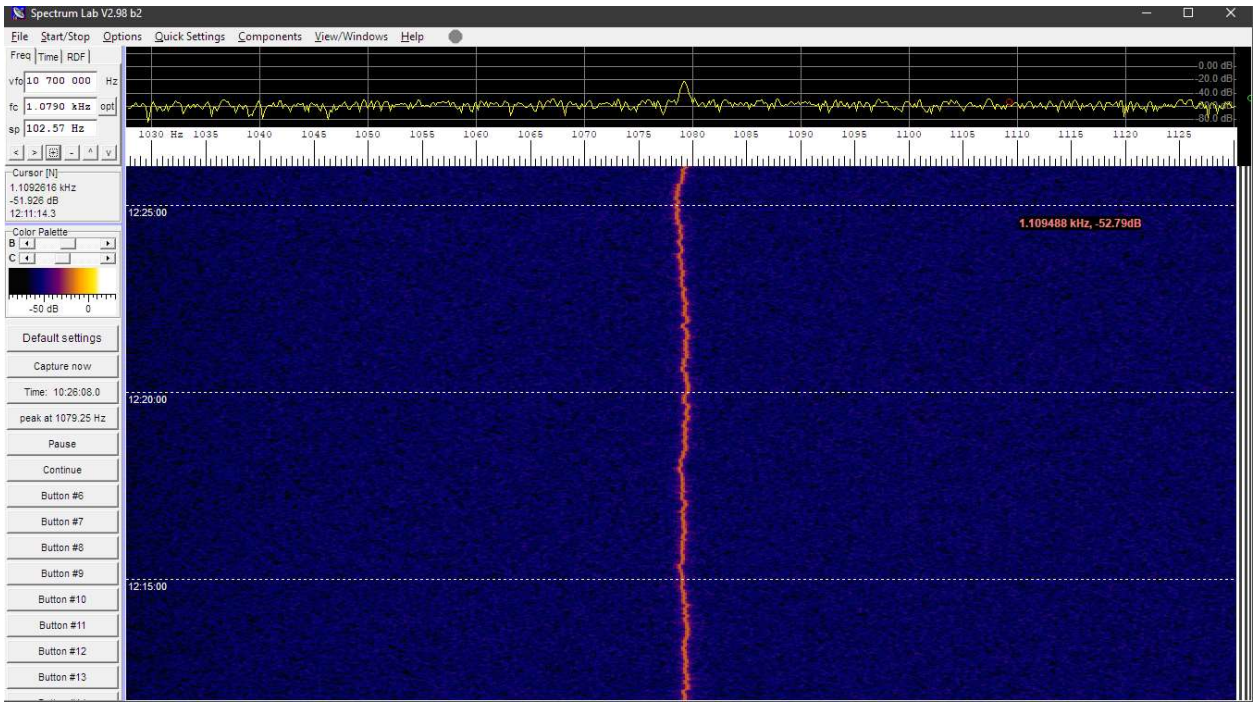


Beacon at 11.7035 GHz

The highest-quality beacon was received at about 11.7035 GHz:



The Spectrum Lab software has excellent capabilities to study the frequency stability of RF signals. During several 5-minute periods, the frequency stability was better than ±2 Hz (or $\pm 2 \cdot 10^{-10}$, or ±0.2 ppb)!



The sources of instability may include:

- Instability of the Tokenblauser GPSDO;
- Atmospheric fluctuations;
- Instability of the satellite's clock.

Receiving LEO satellites

It is well known that one may receive beacon signals from Starlink satellites: https://www.rtl-sdr.com/receiving-starlink-beacons-with-an-rtl-sdr-and-lnb/ . Frequencies are 11.325, 11.575, 11.950 GHz and others. Traces of many satellites are observable at these frequencies; the Doppler shift is clearly visible: