Measurement of the Short Term Stability of a Leo-Bodnar GPS Disciplined Oscillator used for a reference at 10GHz

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Test setup

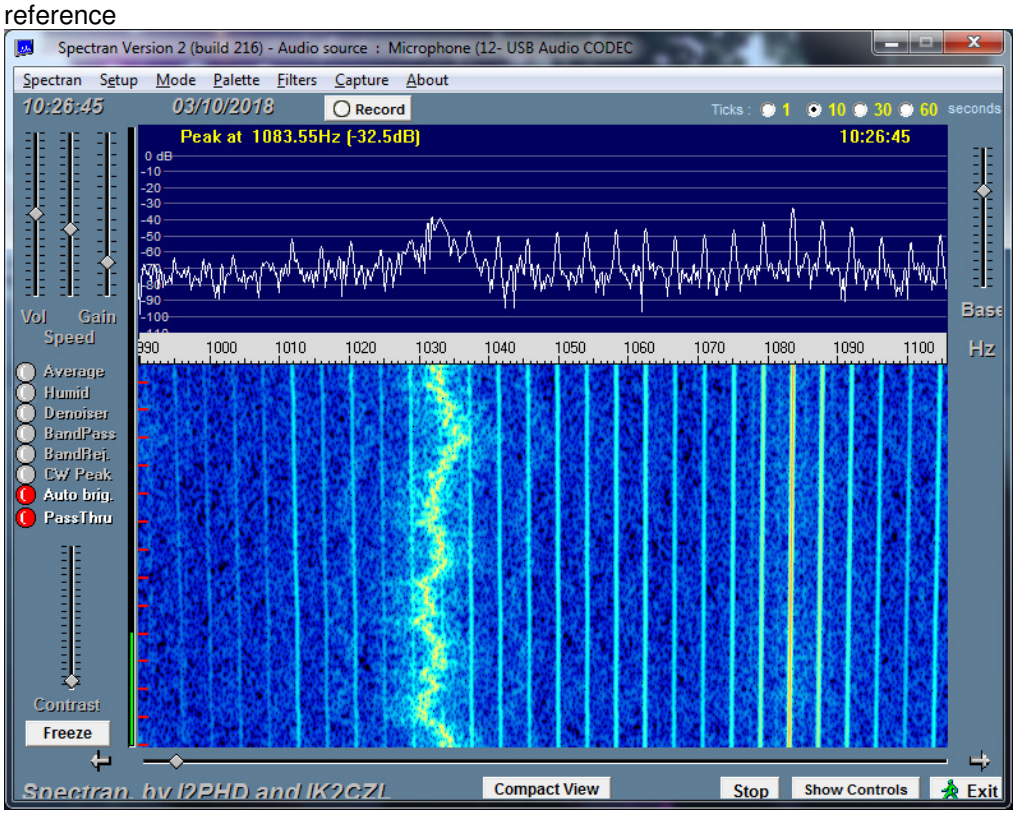
Signal 1 comes from an ADF5355 Synthesizer programmed for 10368.14495MHz (F_{PFD} = 80MHz, D2 register = 4096, exact frequency is about 1mHz high due to integer rounding). Reference input comes from a G4DGU 40MHz TCXO source locked to the 10MHz output from the Leo-Bodnar GPSDO. This forms the test signal

Signal 2 for reference is the output from a Systron Donner 1720 Microwave synthesizer at 10368.145MHz locked to an HP5061A Caesium beam standard. This commercial synthesizer has appreciable close in sidebands spaced at about 4.2Hz due to the narrow PLL loop bandwidth, but the primary carrier is visible on a narrow band spectral display.

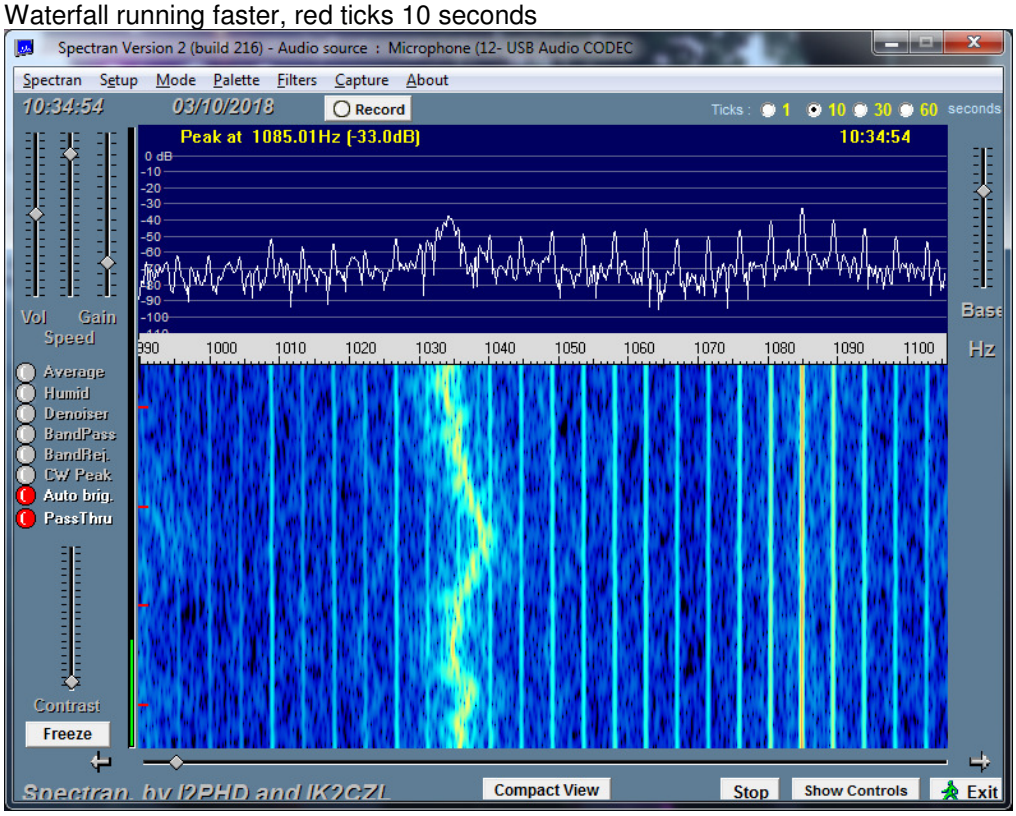
The two signals at 10GHz are attenuated to deliver roughly equal amplitudes. These are combined and fed into a low-added-phase-noise 10GHz converter. The LO for this is 'reverse DDS' locked to the Caesium reference so the entire reference chain is locked to the same source.
The converter output is fed to a FT817 receiver. This is the only part of the system that remains unlocked in frequency, it does however have a TCXO high stability LO source.

The audio from the receiver, containing audio tones from both down converted signals 50Hz apart is fed to 'Spectran' for display of frequency / time on a waterfall display.

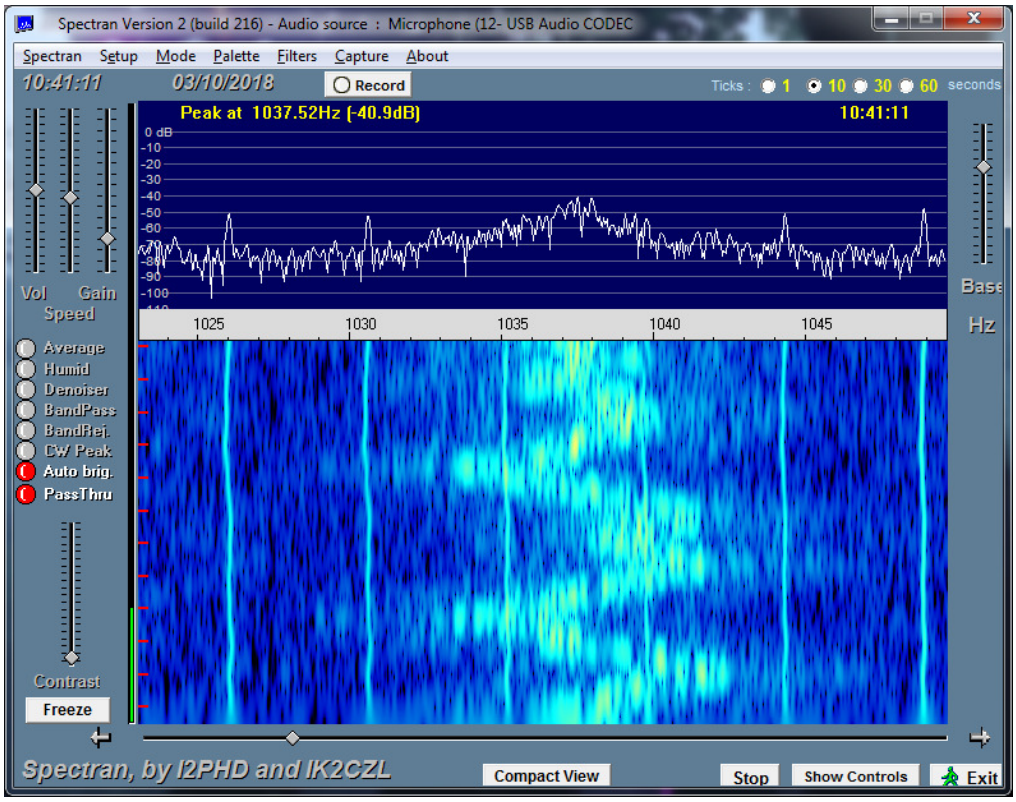
Test 1. The red ticks are at 10 second intervals. FFT resolution is 0.18Hz. The primary peak of the Systron Donner synthesizer is at 1084.8Hz and appears absolutely stable. The Signal from the ADF5355 locked to the LB GPSDO is centred around 1034Hz, ie 50Hz below the reference



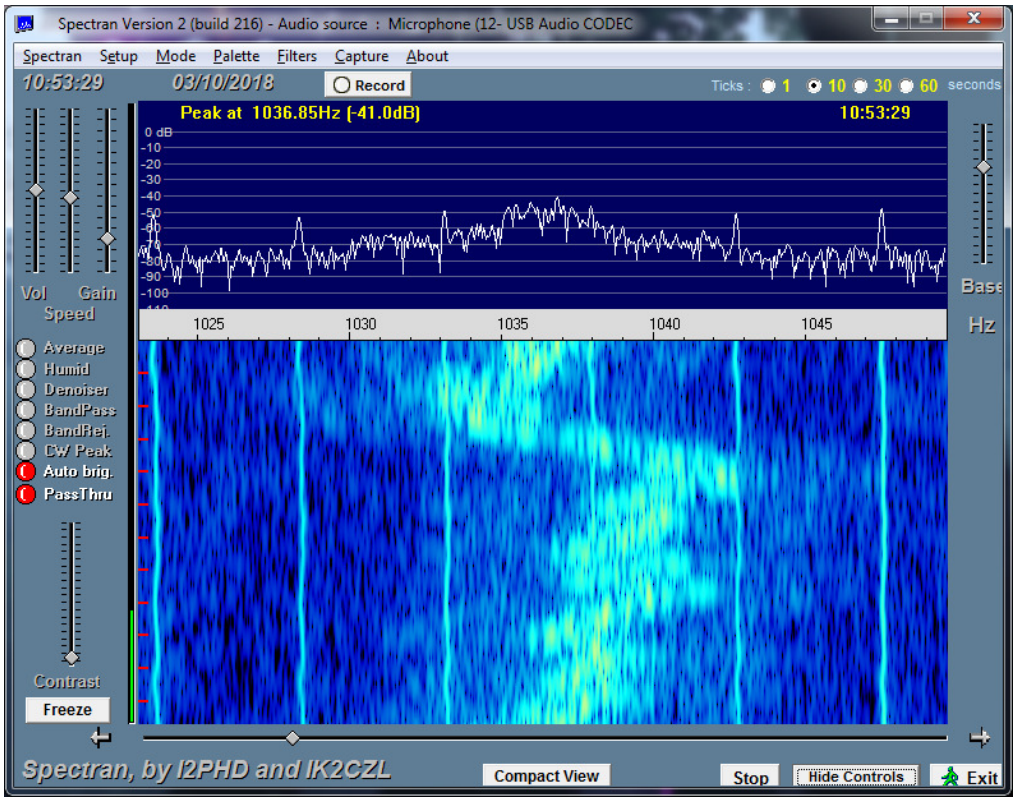
Waterfall running faster, red ticks 10 seconds



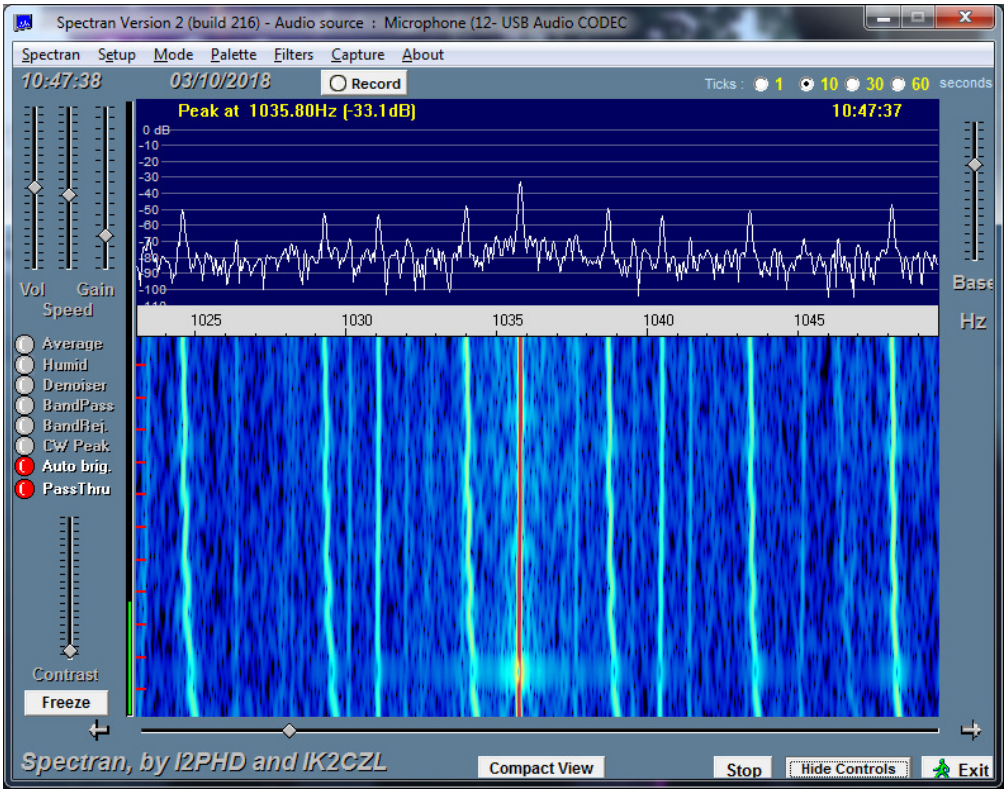
Expanded trace with FFT bin size 0.042Hz, showing the LB derived output. The reference trace is now off the screen, although its sidebands can be seen. These appear to show about 0.1Hz of jitter and a slight drift, most likely due to the unlocked reference in the FT817



A second plot identical to the above, made 12 minutes later



The same scale as above, but with the reference for the ADF5355 now also coming from the HP5061 – so everything apart from the FT817 is now locked to the same source.



Note how the ADF5355 trace now appears to show sidebands at 2.3Hz separation – this is probably an artefact of the Fract-N source. The same sidebands can be extrapolated back and observed on the previous GPSDO traces.

Conclusions

As with all GPSDOs operated with a short time constant, the output exhibits a small short term instability. Based on just the quick observation here, the RMS deviation appears to be very roughly 2Hz at 10GHz with a peak-to-peak of something like 7Hz. This corresponds to $2*10^{-10}$ and $7*10^{-10}$ respectively (0.2 and 0.7 parts per billion) and is appreciably better than seen in other low cost GPSDOs

The random wander appears to be at a rate that see-saws plus / minus 0.2Hz / second.

The GPSDO antenna is placed on a window sill facing east, with a view of the sky blocked to the west so may be sub optimum for best GPS coverage.