

Tests of VK1XX frequency locking of the IC-9700

By VK1XX and VK7MO

VK1XX has developed a prototype board based on a ADF4157 High Resolution 6 GHz Fractional-N Frequency Synthesizer which can be used to lock the existing oscillator in the IC-9700 to a 10 MHz reference. It is briefly described at:

<http://www.cortexrf.com.au/IC9700lock.html>

At this time no decision has been made to produce the board in production quantities. Our preference is that ICOM come up with a firmware modification that produces similar results or perhaps a similar board which can be added in a way that does not void the warranty. The prime purpose of the prototype development is to demonstrate that it is possible to lock the radio.

Fig 1 compares the drift in two situations.

- At the bottom the signal source is locked to a separate GPSDO to that of the radio. Drift of up to +/- 0.2 Hz is seen at 1296 MHz.
- At the top both the signal source and the radio are locked to the same GPSDO and thus any drift on the GPSDO tends to cancel. It is seen that there is now essentially no drift indicating that the drift is entirely dependent on the quality of the GPSDOs.

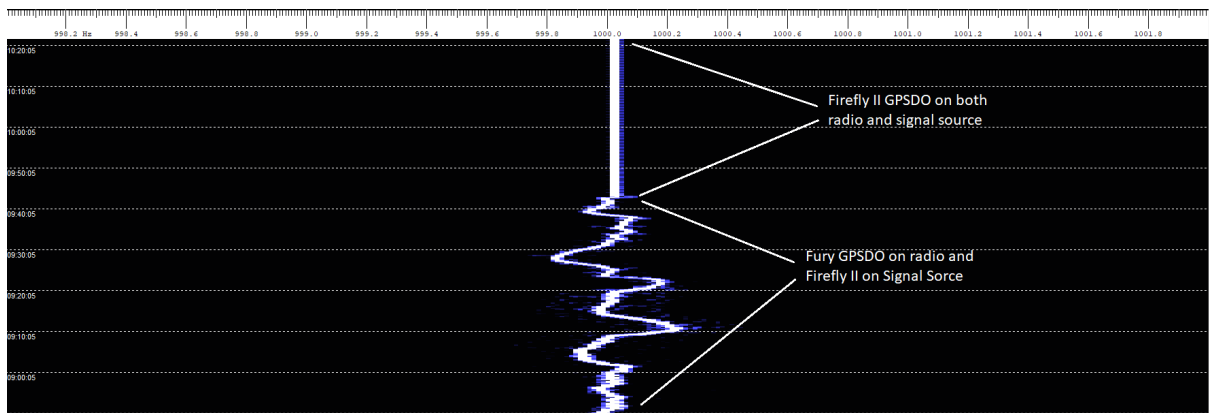


Fig 1: Drift on the IC-9700. Vertical scale is 10 minutes per division as shown by the horizontal lines.

Close in Phase Noise Tests

Close in phase noise is a potential issue for digital modes by producing false tones near the transmitted tone. These tests (Fig 2) were measured with Spectrum Lab against a GPSDO locked signal source. It is not possible by this method to test any wider than about 100 Hz off-set as the phase noise typically drops off by more than 90 dB which is more than the available dynamic range of the IC9700 audio chain.

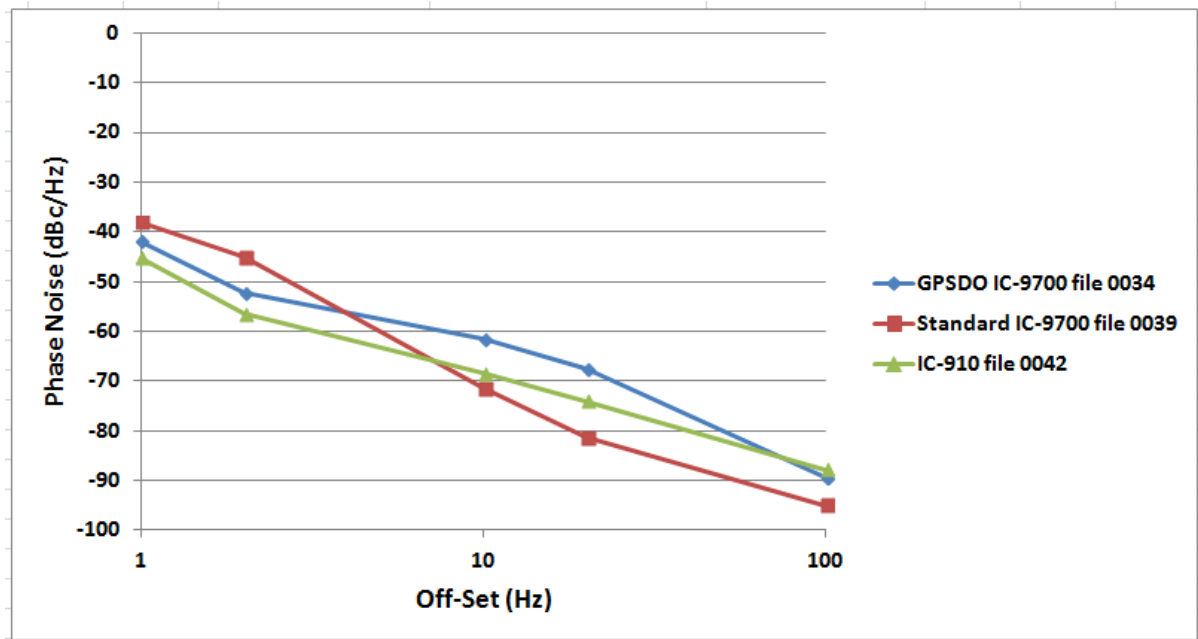


Fig 2: Close in Phase Noise at 2 metres.

Overall there is little difference between the three radios. However, the GPSDO locked radio is about 10 dB worse around 10 Hz off-set which is the loop bandwidth of the locking system. Within the loop bandwidth the internal VCXO should be improved by the much higher quality of the 10 MHz GPSDO reference that was used for these tests. More work is required to track down this apparent anomaly. It is also possible that there are differences between the two radios used for this work as this was not a before and after comparison. It is likely that the 10 Hz off-set phase noise can be improved with the next version of the locking board, although for all practical purposes the phase noise at 10 Hz off-set will have no impact on performance. Any small reduction in close-in phase noise is more than offset by the dramatic improvement in stability for digital modes.

While we cannot test for RX phase noise wider than 100 Hz it is seen that the GPSDO locked radio tends to asymptote to the Standard IC-9700 at wider offsets - this is as we would expect as we are now relying on the short-term stability of the IC-9700 VCXO in both cases. At 1 Hz offset the GPSDO locked radio tends to do better as the Standard Radio has more drift on the time scale of 1 second and more.

The close in phase noise will be $20 \cdot \text{LOG}_{10}(f/144)$ or about 9.5 dB worse at 432 MHz and about 19 dB worse at 1296 MHz (It might be a little worse as there is a second synthesiser used at 1296 MHz).

That still leaves around 20 dB to spare at 1 Hz offset on 1296 MHz which will not be an issue for even WSPR with a tone spacing of 1.45 Hz.