19 November 2002

TO: **ARRL FMT Reports**

FROM: **John Ackermann N8UR**
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RE: **FMT Results from N8UR**

Here are my measured frequencies for 80, 40, and 20 meters. I was unable to get a reading on 15M. My measurement resolution is 0.03Hz; see more on that below.

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80M:      3 579 334.69 Hz
40M:      7 046 882.39 Hz
20M:     14 049 072.27 Hz
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MEASUREMENT TECHNIQUE:

I used a Kachina 505DSP set to 1kHz bandwidth as a tunable spectrum window and injected a known reference frequency within about 50Hz of the W1AW signal; I measured the delta between the two to determine the actual W1AW frequency. The reference frequency was generated from an HP8920B service monitor using a Z3801A GPS-disciplined oscillator as its reference.

I fed the audio output from the Kachina into a soundcard and spectrum analysis software (I'm running Linux and used a free program called baudline -- http://www.baudline.com). To get better frequency resolution, I used a sampling rate of 1000 samples/second, which yields a bandwidth from 0 to 500Hz (actually, with the anti-aliasing filter, about 450Hz is the top of the range).

I tuned W1AW to a note of about 350Hz, and put the reference signal 40-50Hz above that. With an FFT 2048 bins deep, the "eyeball" resolution was a couple of Hz and the response time was fast enough to get the signals properly tuned.

I saved the audio to a disk file, and then post-processed using a 32768 bin FFT, which yields a frequency resolution of about 0.03Hz. I measured the delta between the W1AW signal and the reference, and subtracted that delta from the known signal to determine W1AW's frequency.

I also calibrated the soundcard to verify that its clocking was not introducing any error; because the frequencies have been translated down so much, and since only the ~50Hz delta and not the absolute frequency is important, the accuracy requirements aren't too hard to meet. A 400Hz GPS-referenced audio tone shows as 400.00Hz in the spectrum analyzer, so I discount the card as a source of error.

On 40M, I was able to get a very solid trace of W1AW with virtually no atmospheric effects. 20M was almost as good. On both bands there was a very well defined signal peak that didn't seem to move during my observation. 80M had some smearing, probably from multipath, and I found that averaging the captured data made it a bit easier to find the most likely signal center on that band. As a result, I don't have quite as much confidence in my results on 80M as I do on the other bands. I could barely hear the signal on 15M, and didn't spend my limited time trying to dig it out.

I'm very confident that this measurement technique works and can yield impressive results. If there are significant errors in my measurements above, they are because I made a mistake in the manual parts of the process, like writing down a wrong frequency or something equally dumb.

Lessons learned for next time (I sure hope there is a next time!):

1. I need to have a better process in place for the manual part of the process to keep track of the data; I have a nagging fear that I mis-transcribed some number that will put me way off. I'm particularly suspicious about the 20M frequency since I calculate W1AW to be about 1kHz above the nominal frequency; I hope that's not because I misread the readout on the service monitor.

2. I ended up tuning W1AW to very similar notes on each band, and that made it challenging to separate the data later. Next time, I'll make sure that I tune each band so that the note is offset by 50Hz or so from the previous band. That'll make it much easier to separate the data. (With only a five minute test period, I didn't feel I could waste time saving each band's data to a separate disk file, so I just stored one big buffer and split each band out later.)

3. The Kachina is an interesting radio. It has continuously variable AGC decay, and an adjustable digital AGC action. However, I haven't found a way to turn the AGC off, and that made setting the level of the injected reference signal quite touchy; too much reference power and the W1AW signal would drop into the noise.

This was great fun, and I really hope you do it again so I can put what I've learned this time into practice.

73,

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