

22 November 2004
15 Grandon Road
Dayton, OH 45419

ARRL
Attn: Frequency Measuring Test
225 Main Street
Newington, CT 06111

Re: N8UR FMT Results

Here are my results for the 2004 Frequency Measuring Test:

80M: **1105.013 Hz** (RF Frequency: **3 988 894.987 Hz**)

40M: **1108.279 Hz** (RF Frequency: **7 288 891.721 Hz**)

Band conditions were really bad. I got a quite stable, but not overly loud, signal on 80M. On 40M, the signal was weak and there was significant broadcast QRM; it was very difficult to pick out the right signal. I actually have two signal peaks on 40M, about 0.3Hz apart. My measurement is based on the stronger of the two. 20M was totally dead here, same as last year.

I used the same measurement technique as last year. I derived the RF frequency of the signal, then subtracted that from the published frequency (since both bands copied used LSB) to obtain the audio note. More on the measurement algebra below.

A surplus HP 3586C selective voltmeter served as both the receiver and, by using its built-in tracking generator, the reference or marker generator. The tracking generator went into a 0-120dB attenuator and then was combined with the off-air signal through a MiniCircuits 2-way splitter/combiner.

I tuned in the W1AW tone using the 3586C's 400Hz filter, and then injected the tracking generator, using the attenuator to get the two signals within 20dB or so of each other. I adjusted the frequency so there was a small (~25Hz) offset between the two signals, and fed the audio into the computer for further processing. The sound card was an M-Audio Delta44 which has a pretty good clock; its absolute frequency error was measured at less than 0.1Hz just before the contest, and delta frequency measurement error should be less than 1milliHertz.

Using the "Baudline" (<http://www.baudline.com>) Linux-based spectrum analysis software, I was able to measure the difference between the W1AW signal and the reference with a resolution of 1uHz, though not nearly that much accuracy. Baudline keeps getting better, and with its new measurement tools I feel fairly confident of resolution with a good signal at the milliHertz level. However, given the difficult

propagation on 40M, I very much doubt I'll be anything like that close to the correct frequency. On 80M, we'll see...

I've put some screenshots of the spectrum analyzer displays at <http://www.febo.com/time-freq/fmt/fmt2004.html> (there are also reports of the previous two tests at the parent page). Taking a look at the 40M plot will show you how difficult things were here.

The antenna used was the same Gap vertical as last year. We also had a 20M dipole up about 30 feet, but it didn't help with the dead 20M band. The frequency reference that drove all the gear was an HP 5065A Rubidium standard with a 12 channel distribution amplifier. I've been monitoring the 5065A against GPS and it was accurate during the test to within 1×10^{-12} .

Because the HP 3586C frequency readout shows the passband center, rather than the suppressed carrier frequency (there's a nominal 1850Hz offset between the two), the following is the algebra to derive the audio frequency with the 3856C set in LSB mode:

$$F_{W1AW_tone} = F_{W1AW_carrier} - F_{RX_tune} - F_{center_tone} + F_{audio_tone}$$

where F_{center_tone} is the nominal 1850Hz note generated by 3856C tracking generator, and F_{audio_tone} is the audio tone of the received signal.

I say "nominal" 1850Hz because the BFO in the 3856C is derived from two crystal oscillators (one for LSB, one for USB) that aren't locked to the reference frequency input. This isn't a problem because measuring the delta between the two audio notes eliminates any error in the BFO frequency (which is about 0.1Hz on LSB in my receiver). Nonetheless, one of my projects is to replace the BFO with a synthesized signal that's locked to the reference.

We once again did a multi-multi operation this year, with Daun, N8ASB, and Mike, KA8ABR, also operating from my basement and using the same reference and antenna, but different hardware and techniques. They'll submit their reports separately.

We had great fun with the FMT this year, and look forward to doing it again in 2005, but it sure would be nice to have better conditions!

73,

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