3 December 2005
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 2005 Frequency Measuring Test:

160M: **1050.532 Hz** (RF Frequency: **1 853.949 468 kHz)**

80M: **1047.057 Hz** (RF Frequency: **3 988.952 943 kHz)**

40M: **1056.512 Hz** (RF Frequency: **7 288.943 488 kHz)**

Band conditions were fair; the strong electrical storms a couple of days prior to the test made me think QRN would be a serious problem, but the noise wasn't too bad. The signal on 160 was quite good without much ionospheric distortion. 80M had a strong signal, but lots of fuzz from the ionosphere. 40M was the biggest challenge. The signal was not strong, and the broadcast QRM was severe. In fact, I inadvertently tuned to a broadcast signal but fortunately W1AW was still in the passband, so I was able to recover it with post-processing. However, the signal was both weak and somewhat fuzzy.

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 all bands used LSB) to obtain the audio note. More on the measurement algebra below.

Two surplus HP 3586C selective voltmeters served as receivers and, using their built-in tracking generators, reference or marker generators. One receiver was on 40M for the whole test, while the other split its time between 160M and 80M. 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. An HP 5065A Rb frequency standard drove all the gear; it was checked via Loran-C through the test period and was within about 2×10^{-12}.

On 160 and 80 meters, I used an AMRAD LF active antenna (from the QST article) mounted on my roof. On 40M, I used a ground mounted GAP Titan vertical antenna. I have very strong local AM broadcast stations here, so I had an ICE high pass filter in line with both antennas.

I tuned in the W1AW tone using the 3586C's 3.1kHz 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 (~50Hz) 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 0.1 Hz just before the contest, and delta frequency measurement error should be less than 0.001 Hz.

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 1 uHz, though not nearly that much accuracy. I am very confident that I can measure a stable signal to the milliHertz level. Of course, the signals in the test aren't necessarily stable...

I've put some screenshots of the spectrum analyzer displays at http://www.febo.com/time-freq/fmt/fmt2005.html (there are also reports of the previous tests at the parent page).

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 (the 1850Hz note isn't precisely that, so I measure it separately), and F_{audio_tone} is the audio tone of the received signal.

We once again did a multi-multi operation this year, with Mike, WB8GXB, Tom, N8ZM, Adam, N1GX, and Bruce ND8I also operating from my basement and using the same reference and antennas, but different hardware and techniques. They'll submit their reports separately.

We had great fun with the FMT, and I'm looking forward to next year – with hopefully a new measurement technique to test out.

73,

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