

Report: Frequency Measuring Test – 2006

Black Hills Amateur Radio Club Rapid City, SD



by:
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1) Summary & Result

The Black Hills Amateur Radio Club participated in the ARRL – sponsored Frequency Measuring Test on 15 November 2006. Eleven club members attended the event which consisted of a social hour, class, demonstration, and measurement of the test frequency.

The FMT transmissions were copied here in Rapid City, SD on Wednesday evening, 15 November, from 7:45pm to 8:00pm Mountain Standard Time.

The measured frequencies from W1AW were:

- 160 meters: data not reliable due to reception conditions
- 80 meters: 3587.1180 kHz
- 40 meters: 7038.8043 kHz

2) Introduction

Members of the club's Technical Committee expressed interest in participating in the FMT in 2002 when the event was resurrected by the ARRL. Ideas were discussed including: the need, if any, for accurate external frequency measurement with the advent of modern synthesized gear, history of past FMTs, use of vintage test gear, and use of modern high precision / high accuracy test equipment. The consensus was that this event could be tailored into something of interest to the club's general membership.

As the Novembers approached annually, participation in the FMT was still deemed to be interesting and desirable, but other activities seemed to take priority, and nothing was scheduled.

This year, in October, it was decided to retreat from our grand plan and try to put together an event of more modest scope. The use of the vintage equipment (absorption wavemeter, heterodyne frequency meter, and 100 kHz marker generator - items used by participants in the 1st FMT in 1931) was put on the list for next year, as was the borrowing of high precision / high accuracy measurement equipment. The event was re-planned using readily available receivers and transceivers and the general procedure discussed in the November 2006 issue of QST. A presentation reviewing the techniques used by this equipment to receive the linear CW modulation modes was put together along with a demonstration. It was decided that for this first FMT attempt, we would record the frequency display readouts of the various receivers, and just compare the results - we did not think we were prepared enough to actually take and submit frequency measurements. The coffee / social hour agenda item from the original plan was retained.

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3) Set-Up

The club's clubhouse was selected as the site for the FMT exercise. The clubhouse is located on Radar Hill Road approximately 5 miles east of Rapid City.

On the Monday and Tuesday prior to the event, equipment was borrowed and set up in the clubhouse meeting room as shown in photo 1. The receiving and measurement equipment selected was (from left to right):

- Knightkit KG-650 RF Generator
- Kenwood TS-830 Transceiver
- Drake SPR-4 Receiver
- Collins KWM-380 Transceiver
- Kenwood TS-440 Transceiver
- Sencore FC-51 1 GHz Counter
- Goldstar FG-8002 Function Generator
- Tenma 72-5000 1.3 GHz Multifunction Counter
- Yeasu FT-1000MP Mark V Transceiver
- Eico 330 RF Signal Generator (backup)
- Heathkit IG-102 RF Signal Generator (backup)
- Knightkit KG-650 RF Generator (backup)

Other items shown in the photo background were to be sold at the club's boat anchor auction on the following Friday and were not used in the FMT.



Photo 1: FMT Equipment Set-Up

The RF and function generators and the receivers were used for the equipment demo following the presentation. The Collins KWM-380 and the Sencore FC-51 counter were selected for use during the actual W1AW receiving test.

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4) Presentation

Scott Rausch WAØVKC gave the presentation entitled "FMT-2006" which covered the following topics:

- History: state of receiver, transmitter, and measurement equipment technology in 1931
- ARRL field organization (OO, ORS) station participation
- Sources of error: rig oscillators, frequency display, operator familiarity, medium
- Sample calculations: PPM and %
- PPM calculation: FT-1000
- PPM, % frequency measurement, band usage chart – Grammer, Sept 1930 QST
- Vintage frequency measurement techniques using absorption wavemeter, heterodyne frequency meter, 100 kHz marker
- Modulation methods: OOK/ICW, AM, SSB
- Frequency display on TS-440, KWM-380, SPR-4, FT-1000, TS-830 receivers / transceivers when receiving OOK/ICW, AM, SSB modes
- Procedure to be used during the W1AW test transmission

5) Demonstration

After the presentation, the equipment was used to demonstrate the concepts discussed in the presentation material.

6) Measuring the W1AW Test Signal

The equipment was powered up at approximately 10:30am on Wednesday, the day of the FMT, and was not powered down until the conclusion of the ARRL transmissions at approximately 8:15pm (all times CST). The room temperature was approximately 65 degrees.

At 7:30pm, the demonstration was halted in order to get ready to receive the ARRL test transmission. The Sencore FC-51 counter was used with the KWM-380 to determine the beat oscillator frequencies used by the 380. Both the CW and LSB/USB internally generated beat tones were identified. The 380's displayed frequency contained one MHz digit, three kHz digits, hundreds and tens of Hz digits.

After the class and demonstration, with added enthusiasm and confidence, we decided to attempt an official frequency measurement, even though we had initially felt we were not adequately prepared.

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Our measurement strategy was:

- Use the carrier frequency of WWV to determine the relationship between the KWM-380's displayed frequency and the measured audio beat tone.
- Tune in the W1AW ICW transmitted carrier to coincide with the "spot" tone of the KWM-380.
- Confirm that the measured audio tone was "exactly" the same as the 380's internally generated ICW beat / spot tone.
- Measured frequency = displayed frequency + measured audio tone – internally generated beat tone.

After some confusion as to the details of the W1AW transmission schedule, the CW (unmodulated carrier) transmissions were located on 160, 80, and 40 meters. We could not copy the phone bulletin.

The 160 meter frequency reading was attempted first per the FMT instructions. Reception was poor at our location on 160 meters due to QRN at that time. Frequency readings were taken, but they were not stable enough to be deemed reliable.

The 80 meter frequency reading was attempted next per the FMT instructions. Reception was poor at our location due to QRM at that time. Frequency readings were taken and were later deemed to be good enough to submit.

The 40 meter frequency reading was attempted next per the FMT instructions. Reception was good. Reliable readings were taken and are submitted in this report.

Because of the excellent and intriguing write-up in QST describing the West Coast station ("powered by Heathkit"), we intended to attempt to copy that transmission also. But in the excitement of completing a solid reading from W1AW, we completely forgot about the West Coast station.

7) Calculation of Result

Calibration of KWM-380 and Sencore FC-51 counter:

- WWV was received on 10 MHz, AM mode
- Verify tuning & sideband directions

<u>Tune</u>	<u>Freq</u>	<u>Mode</u>	<u>BW &PBT</u>	<u>Displayed Freq</u>	<u>Tone</u>
Up	Up	LSB	2.2 10:00	5001.00	1.000
Dn	Up	USB	2.2 02:00	4999.00	1.000
Dn	Up	USB	2.2 02:00	7334.01	0.990
Up	Up	LSB	2.2 10:00	7336.01	1.010
Up	Dn	CW	2.2 12:00	5000.20	0.6223

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- USB mode selected, PBT to 2:00 position
- 380 frequency display = 9.999.00
- Measured audio tone = 993 Hz
- Tuned freq = displayed freq + tone + error
- $10000.00 = 9999.00 + .993 + .007$

- LSB mode selected, PBT to 10:00 position
- 380 frequency display = 10.001.00
- Measured audio tone = 1007 Hz
- Tuned freq = displayed freq – tone + error
- $10000.00 = 10001.00 - 1.007 + .007$

- CW mode selected, PBT to 12:00 position
- WWV @ 5000.00 tuned, verify “spot” tuning tone
- Tuned freq = displayed freq + tone – offset
- $5000.00 = 5000.00 + .823 - .823$

Receive test signal from ARRL

160 meters:

- Unreliable

80 meters:

- CW mode selected
- Attempt #1
 - 380 frequency display: 3586.45
 - measured audio tone: .996
- Attempt #2
 - 380 frequency display: 3587.10
 - measured audio tone: .841
- Attempt #3:
 - Not reliable

40 meters:

- CW mode selected
- Attempt #1
 - 380 frequency display: 7038.80
 - measured audio tone: .8273
- Attempt #2
 - Same
- Attempt #3
 - 380 frequency display: 7038.80
 - measured audio tone: .8274

Calculations and results are shown in Section 1 above.

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8) FMT Attendees

Doug Aldrich, WØWSP
Dave Cross, KCØFCJ
Charles Douvier, KCØTKO
Jeff Halgerson, KØHF
Bob Henriksen, KFØAM
Jim Irvine, KCØWNH
Harry Martens, WAØMFZ
Gary Peterson, KØCX
Scott Rausch, WAØVKC
Rich Smith, WØCOV
Chris Stallkamp, WØADZ

Cover photo (those remaining until the measurement period and debrief was completed, left to right):

Jim Irvine, KCØWNH
Gary Peterson, KØCX
Charles Douvier, KCØTKO
Scott Rausch, WAØVKC
Bob Henriksen, KFØAM
Doug Aldrich, WØWSP
Chris Stallkamp, WØADZ