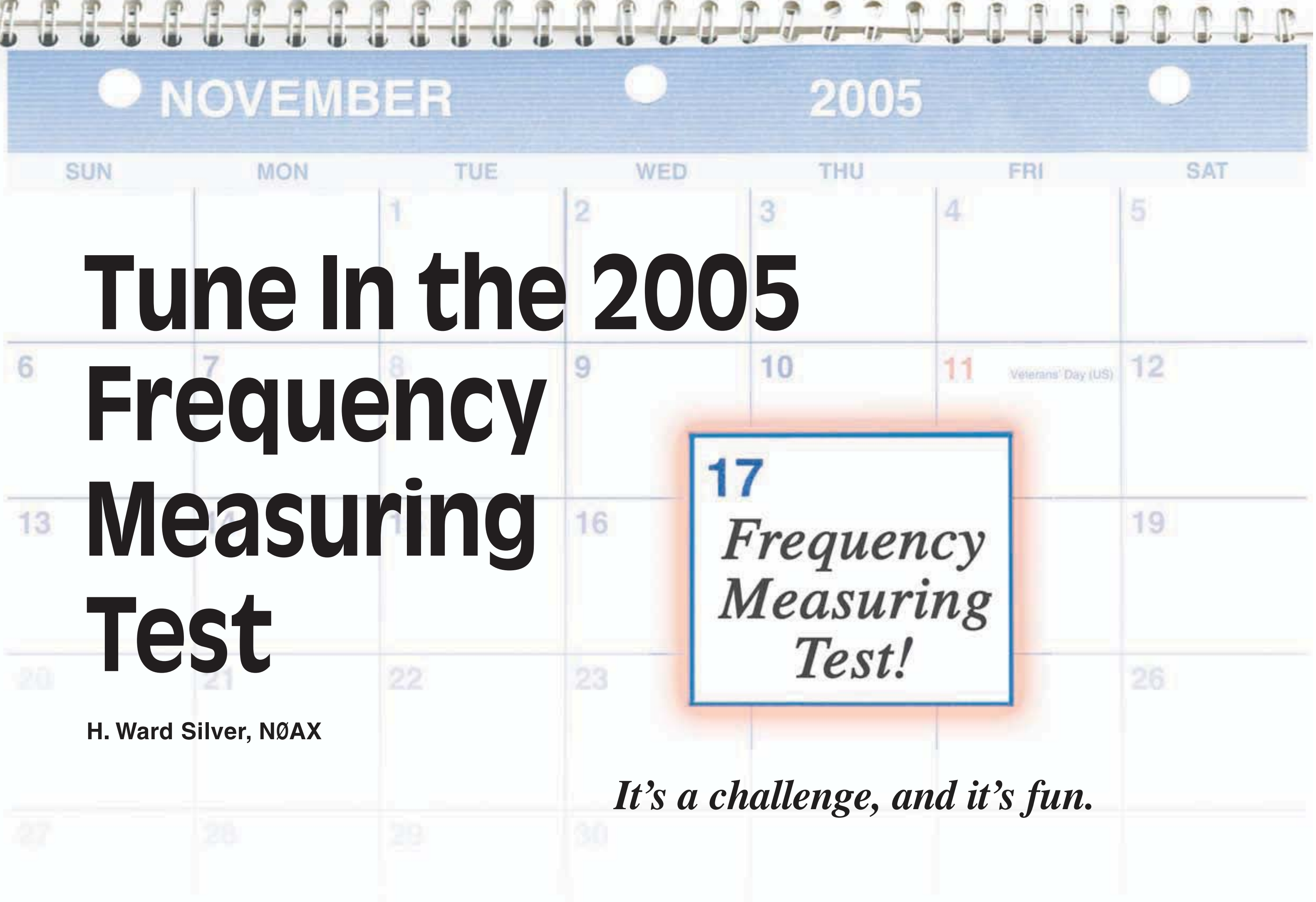


Tune In the 2005 Frequency Measuring Test

H. Ward Silver, NØAX

It's a challenge, and it's fun.

Returning to the airwaves this year, the 2005 Frequency Measuring Test (FMT) will repeat the challenge of last year's successful event. The test requires participants to measure the frequency of an audio tone modulating the carrier.

Measuring the tone frequency, as opposed to that of the carrier, reinforces the understanding of the relationship between carrier frequency and the actual components of a transmitted signal. With the carrier largely suppressed for SSB signals, only the sideband components remain. A single modulating tone results in a single transmitted component. Yet the frequency of the absent carrier is what the radio displays for the operator!

Digital mode mavens, a rapidly growing population in the amateur world, know that on HF the data is transmitted as tones modulating an SSB transmitter. Those tones can only be translated back to data at the receiving station if their frequencies are correct. Errors of only a few dozen hertz can garble the transmission, so it's important to set the receive frequency correctly—which is the frequency of the suppressed carrier. This requires an understanding of

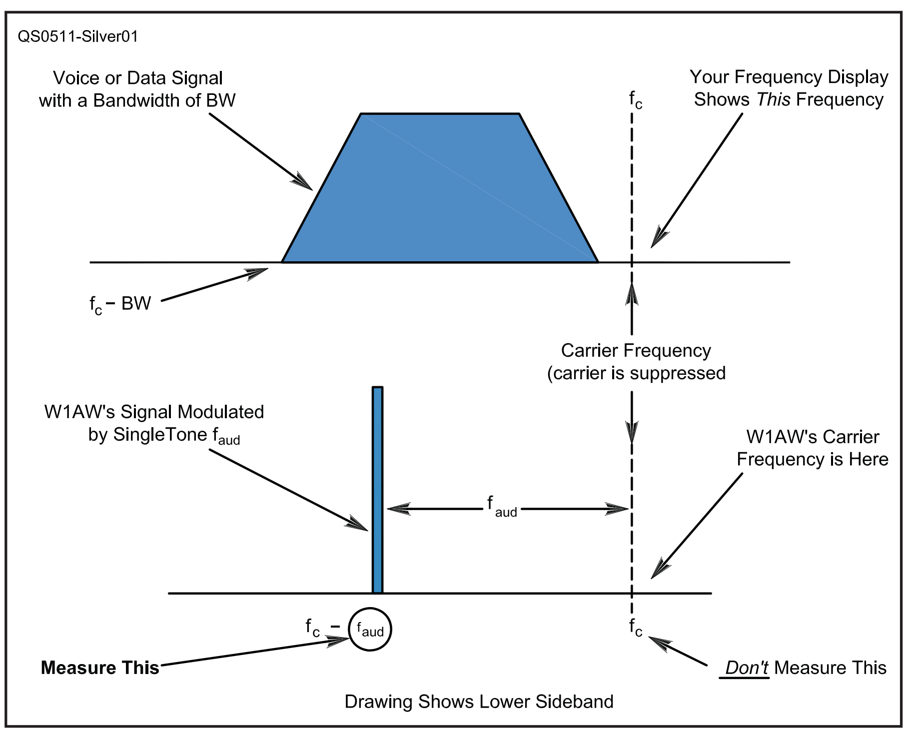


Figure 1—The components of an SSB signal (shown here as LSB) form a sideband above or below the carrier frequency. An SSB signal modulated by a single audio tone appears as a single transmitted signal offset from the carrier by the audio tone's frequency.

how carrier and sideband are related.

Figure 1 shows a typical LSB signal, with the transmitted sideband *below* the carrier frequency. For example, if you're transmitting on LSB with the frequency display showing 7.151 MHz, your actual signal is mostly out of the phone band! The transmitter's frequency display for this signal shows f_C, leaving it up to the operator to remember that what is actually coming out of the transmitter is *below* f_C. For USB signals, the transmitted signal is *above* the displayed frequency.

As last year's FMT, W1AW's exact carrier frequencies will be published and the frequency of the modulating tone will be unknown. The job of the test participants is to report the audio tone's frequency as accurately as possible. Note that due to poor conditions on 20 meters, transmissions will only be made on 40, 80 and 160 meters this year. All transmissions will be made using LSB.

The Trouble with Sky Wave

If you're close enough to W1AW to receive a solid ground-wave signal, you're in luck. You can measure frequency to the limits of your test equipment, confident that you're measuring what W1AW's transmitters are pumping out. Those farther away, whose only reception comes by way of the ionosphere, have to deal with a joker in the deck—Doppler shift.

The ionosphere is drawn as an orderly layer cake—D, E, F1, F2—but is, in reality, in constant motion in all directions. You can see and hear this motion in the rapid fades of DX signals, for example. Vertical movement and tilt of the ionosphere's reflecting layers change the apparent height of the reflection, introducing short-term errors of less than one ppm generally lasting no more than a few seconds. That's a few hertz at HF frequencies. The Doppler shift will vary from band to band, becoming more pronounced at higher frequencies.

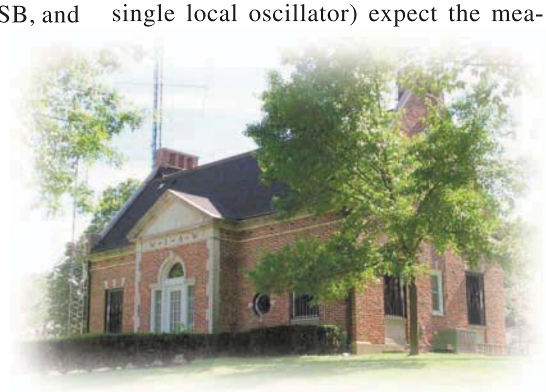
No need to throw up your hands and give up, however. You can take several measurements and average them to minimize the temporary Doppler shift errors. If you're able to log measured frequency every second or so using a computer, you may be able to visually discern or mathematically generate a good estimate of the true frequency.

Measurement Techniques

Direct measurements assume a carrier frequency and measure the audio tone frequency directly. Indirect measurements obtain the transmitted frequency of the tone component at RF, then compute the difference between the published carrier frequency and measured frequency. Methods for making direct and indirect measurements were discussed and references provided in the articles announcing the 2002 and 2003 Frequency Measuring Test[1,2] You may also find articles on the FMT Web site (**www.arrl. org/w1aw/fmt**) to be instructive.

Direct Measurement Example

The ARRL published carrier frequency is 7.290 MHz. You set your receive frequency to 7.290 MHz, LSB, and receive a tone that is measured by a frequency counter. The counter displays the frequency of the audio tone, which also includes receiver carrier frequency errors and errors from noise and ionospheric Doppler shifts.



Indirect Measurement Example

The ARRL published carrier frequency is 1.855 MHz. You measure the transmitted signal's frequency as 1.852377 MHz, which is the carrier's frequency minus that of the audio tone. The audio tone's frequency is 1.855 – 1.852377 MHz = 2623 Hz, including any errors in the receiver's displayed carrier frequency.

Schedule

The W1AW FMT will run on November 17, 2005 at 0245Z (local time would be November 16, 2005, at 9:45 PM EST). It will replace the W1AW Phone Bulletin normally scheduled at that time. It is recommended that participants listen to W1AW's CW/digital transmissions prior to the event to get an idea on conditions to see which band (or bands) will be best for measurement purposes.

Format

The FMT will begin with a general W1AW (*QST*) call-up beginning at 0245Z sent simultaneously on three of W1AW's phone transmission frequencies. The test will consist of three 60-second tone transmissions (for each band) followed by station identification. The test will last for a period of approximately 15 minutes total. The test will end by station identification. Please note that since the exciters are independent units (and not fed with a single local oscillator) expect the measured tone frequency to be slightly different on each band.

During the course of the FMT, W1AW will indicate the band on which participants should measure. For example, after the initial call-up, we will begin by saying NOW 80 METERS. During the 80-meter measuring time frame, we will continue to indicate the band by first IDing, and then indicating the band, for example, THIS IS W1AW–80 METERS.

With the exception of the tone transmission, all other transmissions will be done using phone.

The phone carrier frequencies will be as follows:[3]

160 meters: 1855 kHz (LSB)
80 meters: 3990 kHz (LSB)
40 meters: 7290 kHz (LSB)

Reporting and Results

The submitted report should include the time of reception and the *tone* frequency. If you used an indirect method of measurement, show your calculation of the tone frequency. Include your name, call and QTH. Participants may submit a separate report for each band.

A *Certificate of Participation* will be available to all entrants. Those entrants that come closest to the measured frequency as measured by the ARRL laboratory will be listed in the test report and will also receive special recognition on their certificate.

Entries should be received at **fmt@arrl.org** or postmarked by December 16, 2005 to be eligible. Send entries to W1AW/FMT, 225 Main St, Newington, CT 06111.

Notes

[1]H. W. Silver, NØAX, "The ARRL Frequency Measuring Tests," *QST*, Oct 2002, p 51.

[2]H. W. Silver, "The Frequency Measuring Test Strikes a New Tone," *QST*, Nov 2004, p 52.

[3]All frequencies will be accurate to at least 0.25 ppm (that is, 3990 ±1.0 Hz).

H. Ward Silver, NØAX, is an engineer, author and teacher who enjoys contesting and DXing. Ward is the author of Ham Radio for Dummies, *as well as the current* QST *series, "Hands-On Radio." He can be reached at 22916 107th Ave SW, Vashon, WA 98070 or at* **n0ax@arrl.org**.