By H. Ward Silver, NØAX

The FMT Strikes a New Tone

This year's Frequency Measuring Test, to be held November 18 UTC, has a new twist.

Growing in popularity with each running since its return to the airwaves in 2002, the Frequency Measuring Test will offer a new challenge to ham radio metrologists this year. Instead of measuring a carrier frequency, the test asks for the measurement of an audio tone modulating the carrier.

Why measure a tone? First, it reinforces the understanding of the relationship between carrier frequency and the actual components of a transmitted signal. The carrier is suppressed for SSB signals, leaving only the sideband components. The frequency of components of the modulating audio signal is preserved as the difference between the carrier frequency and the transmitted component. A single modulating tone results in a single transmitted component.

Figure 1 shows a typical USB 'phone signal, with the transmitted sideband *above* the carrier frequency. For example, if you're on USB with the frequency display showing 14.349 MHz, the actual transmitted signal is mostly out of the 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 *above* f_C. For LSB signals, the transmitted signal is *below* the displayed frequency.

Another reason to practice measuring a tone's frequency is that digital modes use tones to encode the transmitted data. The equipment or program that translates the tones back into data depends on the tones having the proper audio frequencies. If the data is transmitted via SSB, that means you have to know the relationship of the carrier to the transmitted tones in order to receive them with the proper frequency. Demodulation can be severely compromised by a carrier frequency error of only a few tens of Hz.

In past FMTs, W1AW transmitted on a "mystery frequency" near a published frequency. This year, the 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.

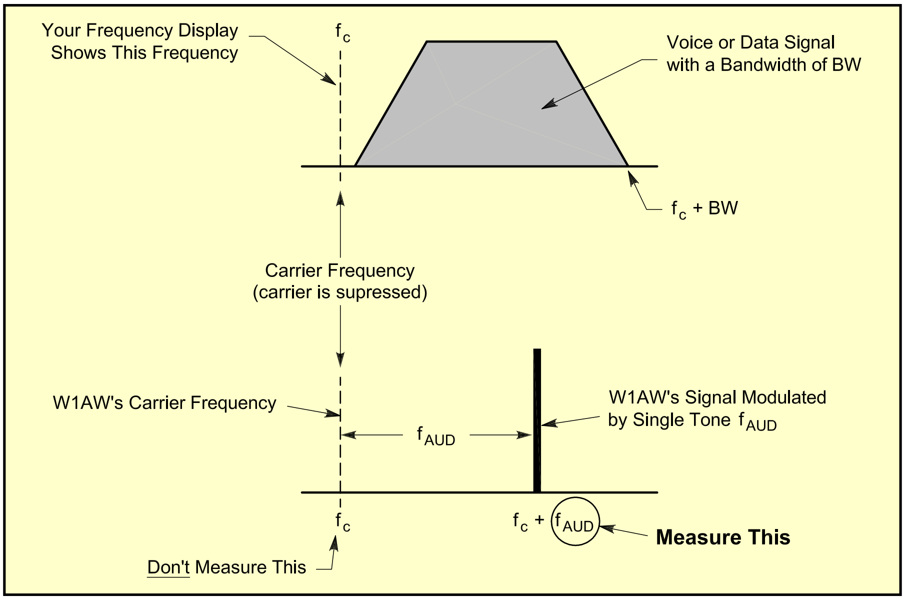


Figure 1—The components of SSB signal form a sideband above or below the carrier frequency. An SSB signal modulated by a single audio tone appears as a single transmitted signal offset from the carrier by the audio tone's frequency.

Measurement Techniques

There are two basic ways to measure the tone's frequency: *indirect* and *direct*. In the indirect method, the frequency of the transmitted signal, which consists of a single component as shown in Figure 1, is measured as if it were an unmodulated carrier. The *difference* between the published frequency and measured frequency is the tone frequency. It's important to remember that the tone will be *above* the published frequency for USB and below it for LSB. In this method, the primary source of error is the receiver's master oscillator. A number of techniques for making this measurement are presented in the November 2002 *QST* article on the Frequency Measuring Test.[1]

In the direct method, the measuring receiver is set to the published carrier frequency and the audio tone frequency is measured with a frequency counter. This is the way a digital mode signal would normally be received. However, the stability of the frequency counter is an extra source of error. Noise in the received signal will also affect the counter's measurement. The more successful participants will have to account for error and noise in both their receivers and counters.

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

Direct Measurement Example

The ARRL published carrier frequency is 7.153 MHz. You set your receiver to 7.153 MHz, LSB, and receive a tone that is connected to your counter. The counter's displayed frequency is that 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 14.165 MHz. You measure the transmitted signal's frequency as 14.166231 MHz, which is the carrier's frequency plus that of the audio tone. The audio tone's frequency is 14.166231 – 14.165 = 1231 Hz, including any errors in the receiver's displayed carrier frequency.

For measurements on 80-meters, LSB will be used. If the published carrier frequency is 3.785 MHz and you measure the transmitted signal as 3.782476 MHz, the audio tone's frequency is 3.785 – 3.782476 = 2524 Hz.

2004 ARRL Frequency Measuring Test Schedule

The W1AW FMT will run on November 18, 2004 at 0245Z (or November 17, 2004, at 9:45 PM EST). It will replace the W1AW Phone Bulletin normally scheduled at that time. It is recommended that participants evaluate conditions by listening to W1AW's CW/digital transmissions prior to the event 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. The tone frequency will be *the same* on all three bands.

During the course of the FMT, W1AW will indicate the band 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; that is, "This is W1AW—80 meters."

With the exception of the tone transmission, all other transmissions will be voice.

The phone frequencies are as follows:
80 meters—3990 kHz—(LSB)*
40 meters—7290 kHz—(LSB)*
20 meters—14,290 kHz—(USB)*

*All frequencies will be accurate to at least 0.1 ppm (that is, 3990 ±0.4 Hz).

Reporting and Results

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

A *Certificate of Participation* will be available to all entrants. Those entrants coming 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 postmarked by December 17, 2004 to be eligible. Send entries to W1AW/FMT, 225 Main St, Newington, CT 06111.

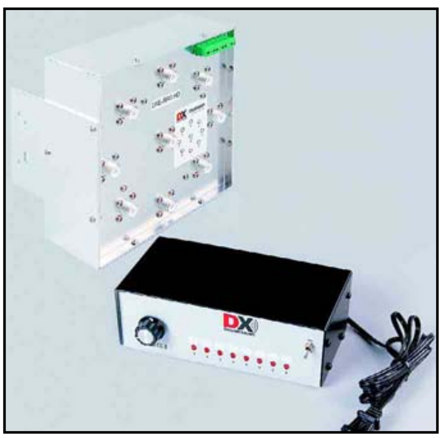
H. Ward Silver, NØAX, is an engineer, author and teacher who enjoys contesting and DXing. Ward is the author of the recently published Ham Radio for Dummies*, as well as the current* QST *series, "Hands-On Radio." He can be reached at 22916 107th Ave SW, Vashon, WA 98070 or at* **n0ax@arrl.org**.

NEW PRODUCTS

REMOTE ANTENNA SWITCH

◊ DX Engineering has announced a remote antenna switching system, the RR8-HD. Users can select a single port, or multiple ports for antenna stacking and phasing applications. They can also designate unused ports to be open or grounded. The RR8-HD offers built-in lightning protection and is said to offer unterminated port-to-port isolation of more than 70 dB at 30 MHz.

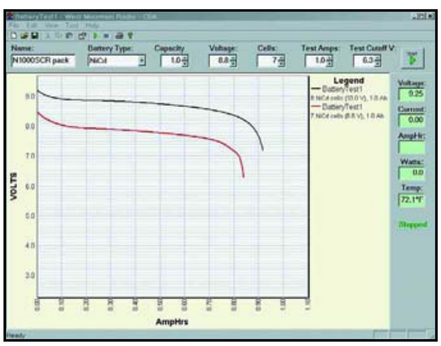
The unit uses sealed 20 A relays in an aluminum enclosure with stainless steel hardware and silver and Teflon UHF connectors. It is specified to operate at over 2 kW CCS RTTY. The RR8-HD allows the use of CAT 5 style control cable with a plug-in control line connector, eliminating the need to disassemble the unit on the tower. A 12 V control console, the CC-8 is included. The control console has automatically resetting fuses, LEDs adjustable for brightness and a solderless connector on the back panel. The CC-8 can be powered by 120 or 240 V ac. Price: $249.95. For more information, see **www.dxengineering.com**, or contact DX Engineering at PO Box 1491, Akron, OH 44309; tel 800-777-0703, fax 330-572-3279.



COMPUTERIZED BATTERY ANALYZER

◊ The West Mountain Radio computerized battery analyzer (CBA) is designed to determine if batteries will perform up to specification, or if they might fail prematurely during operation.

The CBA is designed to test any battery, up to 48 V. The CBA is said to be capable of test rates up to 40 A or 150 W, whichever is reached first. In addition to testing the total amount of energy stored in a battery in Ah, it graphically displays these tests on a standard *Windows* computer with a USB interface. An optional external temperature probe



can be used to measure the temperature of a battery during a test. The CBA uses a constant current load rather than a resistor.

Battery test graphs may be displayed, saved and printed. Multiple graphs of the same battery, or multiple batteries, may be overlaid. The CBA will also print test labels that may be placed directly on batteries to keep track of the last time they were tested and how they performed.

The CBA uses an 8051-based microcontroller to measure voltage, current and temperature with 10 bit resolution in three auto-switched voltage ranges. It is supplied with wire and Powerpole connectors, a cooling system with fan and LED indicators that display communication and test status visible from across a room. Price: CBA, $89.95; temperature probe, $9.95. For more information, or to place an order, see **www.westmountainradio.com** or contact West Mountain Radio, 18 Sheehan Ave, Norwalk, CT 06854; tel 203-853-8080.