Receive Performance of LWA Big Blade Prototype Antenna Below 20 MHz

D.G. Finley, NRAO
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In order to determine, at a basic level, the capability of the 20-80 MHz LWA Big Blade Prototype Antenna to be used for reception below its design frequencies, a test was conducted using an amateur radio HF transceiver.

Test Equipment

The test was conducted using a Yeasu (Vertex Standard) FT-817 HF/VHF/UHF all-mode transceiver, designed for use in the amateur radio bands. This unit can receive continuously from 100 KHz to 30 MHz, in addition to VHF/UHF capability. For this test, the unit was used with nominal selectivity of 6 KHz at -6 dB for AM and 2.2 KHz at -6 dB for CW/SSB (1). The unit, which has a nominal antenna impedence of 50 Ohms, was connected directly to the coaxial-cable input from the test antenna.

Signal strengths were measured using the transceiver's bar-LCD S-meter, which also provides an alphanumeric readout for signal strength. S-meters in communication receivers are notoriously imprecise. Their readouts are in integers from S-0 to S-9, then in dB over S-9 for stronger signals. The "official standard" for S-meters, for reception below 30 MHz, is that S-9 corresponds to a power level of -73 dBm at the receiver's antenna input, and one S-unit corresponds to a signal level difference of 6 dB (2).

An S-9 signal also is supposed to correspond to an RF input signal of 50 microvolts. In a laboratory test on an FT-817 similar to the unit used in this test, an S-9 signal at 14.2 MHz, with the receiver's preamplifier on (the configuration in this test), corresponded to an RF input signal of 16.2 microvolts (3). In a different lab test of an FT-817, the unit's S-9 level corresponded to -80 dBm. This second test gave the following correspondences for the FT-817:

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        S-0: -104 dBm
        S-1: -103 dBm
        S-2: -102 dBm
        S-3: -101 dBm
        S-4: -101 dBm
        S-5: -100 dBm
        S-6: -99  dBm
        S-7: -98  dBm
        S-8: -95  dBm
        S-9: -80  dBm
 S-9 +20 dB: -77  dBm
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The test that produced these numbers was on a "stock" FT-817 whose alignment and software configuration was that which came from the factory (4), as was the unit used for this LWA antenna test. With no antenna connected to this unit, it registers S-0.

The figures above, while resulting from lab tests on the same model of transceiver, cannot be assumed to apply to the specific unit used for this antenna test.

In the test, the transceiver was connected to one dipole (out of two) on the 20-80 MHz LWA Big Blade Prototype Antenna.

Test Results

The test was conducted at the LWDA site on 25 January 2007, from 2133 to 2203 UTC.

AM Mode (Time Station Frequencies)

- 2.5 MHz -- S-8 noise level, No signal heard
- 5.0 MHz -- S-8 noise level, WWV heard strongly at same signal strength
- 10.0 MHz -- S-8 noise level, Weak time signal heard; unable to determine if it was WWV or WWVH. Continuous tone (carrier) heard from undetermined source.
- 15.0 MHz -- S-8 noise level, Very weak, intermittent signal heard from time station with different format than WWV/WWVH
- 20.0 MHz -- S-7 noise level, No signal heard

CW/SSB Mode (Amateur Radio Bands)

- 3.5 MHz -- No signals heard
- 7.0 MHz -- Numerous CW and SSB stations heard; SW broadcast stations heard above the amateur band
- 10.1 MHz -- Numerous CW signals heard, none registering above the S-7 noise floor
- 14.0 MHz -- Numerous CW signals heard registering S-9 and above, including one station identifying as near Kelso, WA
- 18.1 MHz -- No signals heard; S-4-6 noise level
- 21.0 MHz -- No signals heard; S-3-4 noise level

Conclusions

The LWA Big Blade Prototype Antenna performed sufficiently well to produce readable signals at frequencies as low as 5 MHz in an HF communications receiver of standard design and average performance for amateur use. The failure to detect signals at 2.5 and 3.5 MHz most likely was due to D-layer absorption at those frequencies at the time of day the test was held. The lack of signals at frequencies above 14 MHz probably was because the Maximum Usable Frequency (MUF) at the time was too low to support propagation at those frequencies. Because the transceiver used in this test was not calibrated in a laboratory and because S-meters on such equipment are quite imprecise, these results should be considered more qualitative than quantitative.

References:

(1) Vertex Standard Co., Ltd., "FT-817 Operating Manual," Tokyo, 2001.

(2) International Amateur Radio Union, "IARU Region 1 Technical Recommendation R.1," Brighton, 1981, Torremolinos 1990.

(3) American Radio Relay League, "ARRL Laboratory Expanded Test-Result Report: Yaesu FT-817," Newington, CT., 2001.

(4) Gajdos, Csaba, YO5OFH, "Automatic Gain Control," online: http://www.cqham.ru/projects/agc/agc.htm