Using the Buddipole as a Balanced-Fed Doublet[1]

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Abstract

The well-known Buddipole antenna is a "construction kit" commonly configured into an asymmetrical off-center-fed dipole with loading coils on each element, and fed with coax via a small ferrite bead current balun. It is typically tuned to an operating frequency by moving coil taps and changing whip lengths, which can be tricky both physically and due to unforeseen environmental influences on the antenna in portable operations. Also, adjustments usually require lowering the antenna. This article reports on experiments with configuring the Buddipole as a symmetrical, balanced dipole fed with balanced line (a *doublet*) and matched remotely with an autotuner, keeping whip lengths and coil positions unchanged. We give the rationale for these experiments, detail the experimental setup, and present the resulting SWR plots for frequencies across six HF amateur bands (40M, 30M, 20M, 17M, 15M, and 10M). The antenna system was easily tunable to lower than 1.6:1 SWR on all bands. The doublet configuration may eliminate the need to tune by adjusting whips and coil taps which can require lowering the antenna. However, unlike the standard Buddipole configurations, the radiating element in this doublet configuration is not necessarily operating at resonance, even though the tuned antenna system (including tuner and feedline) may present close to a 50 Ω load and low SWR to the transmitter. No theoretical analyses or modeling have yet been done, and no measurements of actual radiated power, radiation pattern, on-air performance, or performance comparisons to standard Buddipole configurations have yet been made.

Introduction

The Buddipole antenna system[1] is a marvelous and well-constructed "erector set" for portable antenna construction. Many different configurations of vertical and horizontal antennas can be built, and the system has a large number of dedicated users. I own a number of Buddipole parts assembled from several used Buddipole kits over a few years, and have used the Buddipole in both vertical and horizontal configurations with success. The principal difficulty of using the Buddipole across bands (and across wide ranges within bands) is initially tuning the system for the frequency of use by changing whip lengths and coil tap positions (see below), and re-tuning when changing bands/frequencies.

After a spring weekend of QRP success using a very simple balanced 44' "Norcal Doublet" antenna [Hendricks, n.d.] with a balun and autotuner, I thought about trying to feed the Buddipole as a doublet, in order to work around some of the hassles of tuning with whip and coil tap changes. The topic of using the Buddipole as a doublet has been mentioned before in the Buddipole Yahoo group archives, but a quick search didn't show much in the way of actual implementation details or tests. I decided to remedy this with some specific experiments.

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[1] This note assumes some familiarity with the Buddipole system. See http://www.buddipole.com

Configuring and Tuning the Buddipole

The Buddipole is designed as an inductively-loaded off-center-fed (asymmetric) dipole. The basic elements from which the radiating parts of the antenna are assembled include rigid "arms", loading coils, adjustable whips, and a variety of connectors such as the "Versatee" center support and the "rotating arm kit". Each of these is fixed with male and/or female standard 3/8x24 threaded connectors, and they can be assembled in a variety of ways to construct different antenna configurations [Anderson, 2010].

For a given configuration, the operator typically adjusts the Buddipole's tuning for each band or band segment by changing the length of the whips and/or by moving taps on the loading coils. Each tap is constructed as a small flat sharp hook attached to a mini-banana jack with external threads. This hook clips under one turn of a loading coil. A color-coded plastic knob screws onto the jack's external threads securing the hook to the coil, and a mini-banana plug attaches a coil shorting wire to the jack. To change the location of a tap, one must unplug the shorting wire, carefully unscrew the retaining knob part way to release the hook, twist the hook to remove it from the coil, move the hook to a different coil location, twist and wiggle the hook to re-attach it to the coil, tighten the retaining knob to secure the hook, and re-insert the shorting wire plug into the jack. It's somewhat tricky to do this without dropping the hook or the knob, or marring the coil itself. Moreover, if the antenna is mounted on a mast (as in Figure 1), it must be lowered to adjust either the taps or the whip lengths. Though laborious, ideally this process can be done "off-line": The operator can develop a table of whip lengths and tap positions for each desired operating frequency (cf. [Anderson, 2010]), and some taps can be left "permanently" attached to useful coil positions. If this is done, tuning reduces to removing and re-inserting the shorting wire plugs and possibly changing the whip lengths. This still requires lowering the antenna, and quick band/frequency changes are limited to pre-tapped positions. Finally, in portable operations unforeseeable environmental objects and conditions may affect the antenna resonance and SWR, unexpectedly rendering pre-set taps less effective for tuning to their intended frequencies.

One prospect, then, might be to configure the Buddipole elements and feedline as a balanced doublet, and rely on a remote antenna tuner to match the balanced antenna system to the transmitter at low SWRs across multiple bands. This would eliminate any reliance on coil taps or differing whip lengths, and would also accommodate local environment-antenna interactions to the extent the tuner can compensate for them. Hence I decided to experiment with the Buddipole in a remotely tunable balanced doublet configuration, across a wide range of HF amateur bands.

Setup

My approach was to make the Buddipole as electrically long as practicable, feed it with balanced line from a balun and tuner, and measure how it loaded (i.e., SWR) across several bands. Here's specifically what I did (See Figure 1 below for a diagram of this experimental setup):

1. ***Antenna configuration:*** (from center outwards; same on each side for balanced configuration):
    a. 22" arm,
    b. 11" arm,
    c. Buddipole "red" coil,
    d. Fully extended 9'6" black "long whip".

    The "red coil" is the one with the most windings. The same coil (but in black plastic) comes with the Buddistick. I happen to have 2 of them. You could probably use the regular unbalanced Buddipole coils and achieve balance by just tapping the red coil down to equal the open turns on the untapped black coil.
2. ***Whip support:*** I support the whips about 1/3 of the way from the ends. To do this, I use a ~24" piece of PVC vertically out the top of the Versatee, with an adjustable "vee" of twine to rubber grommets slipped over the whip ends. This adds stability and reduces "whip droop" and related stresses (Figure 1 diagrams this support).
3. ***Mast:*** 16-foot yellow all-fiberglass Mr. Longarm painter's pole, guyed with nylon rope, and extended so the Versatee was at about 14 feet (maximum safe extension).

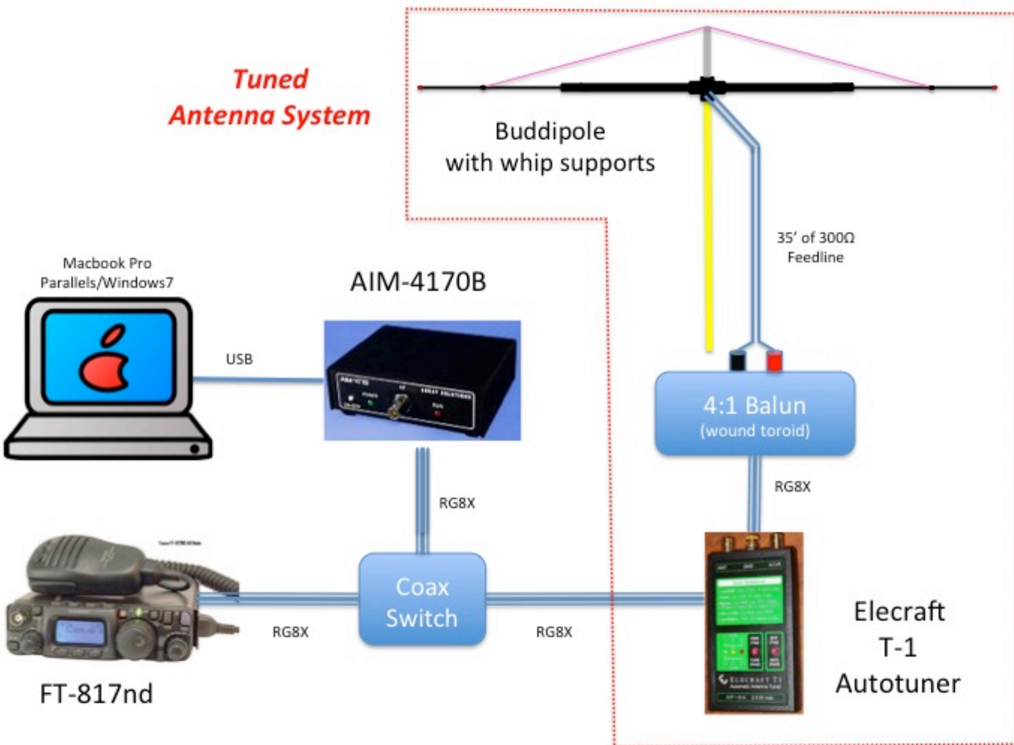

Figure 1: Experimental Setup

4. ***Feedline:*** The feedline was ~35' of regular 300Ω Radio Shack TV twinlead. (I will run some more tests with real open wire ladderline). I just put 3/8"-hole terminals on the ends of the twinlead, mounted them under the 22" arm connections to the

Versatee, and ran the twinlead down the pole and through the air to the station. (The hardest part is cutting and stripping this twinlead).

5. ***Balun:*** Homebrew 4:1 balun to RG8x coax. (I just picked 4:1 because I just happened to have that fixed-ratio balun laying around. I don't yet know what is the actual system impedance to be transformed, and I'm sure it varies by frequency.)
6. ***Tuner:*** Elecraft T-1 autotuner (of course other (auto)tuners will also work).
7. ***Analyzer:*** Calibrated AIM-4170B analyzer and laptop (this gives SWR plots, which are screen grabs).
8. ***Signal source:*** FT-817nd, CW mode, 2.5 watts (other transmitters will also work).
9. ***Switch:*** SPDT Coax switch to change the antenna between the AIM-4170 and the FT-817nd.

Process

First, I positioned the coax switch to connect the FT-817nd to the T-1. Then I set up the FT-817nd on the respective band's test frequency. Next, I activated the T-1 to tune the antenna to the lowest SWR it could find. I then switched the coax from the FT-817nd to the AIM-4170 and ran an SWR plot on the *tuned antenna system* (which of course now includes the tuned T-1, balun, feedline, and Buddipole – see the dotted red line in Figure 1). I repeated this process for one or more frequencies in each of seven HF amateur bands: 80M, 40M, 30M, 20M, 17M, 15M, and 10M. I did not test any frequencies in the 60 Meter or 12 Meter bands.

Results

Figures 2-7 present the test results as SWR plots from the AIM analyzer, some taken at multiple retuned frequencies within one band. The Buddipole-as-doublet easily tuned to lower than 1.6:1 SWR on/across all six 40M-10M bands tested. Typically the rough indicator T-1 LEDs showed a 1:1 match, while the more detailed AIM 4170B plots showed between 1.2-1.6:1 minimum SWRs at or near the selected test frequencies. The narrowest 2:1 SWR bandwidth was about 170KHz, and this was on 40M as could be expected. Tested frequencies always fell within the 2:1 SWR band segment. Presumably when the low SWR points varied from the actual test frequencies it was due to the limitations of the tuning quanta of the T-1. I tested the configuration on several frequencies in the 80 Meter band but the T-1 could only tune down to about 4:1 SWR on those frequencies, and I haven't included those plots.

Conclusions

I have not yet made any on-the-air tests, so can't report those. I can say that during these tests received signal strengths and background noise levels clearly reflected the tuned vs. un-tuned conditions of the antenna system. When the antenna system was in a tuned state, plenty of good signals could be heard on active bands - so I don't anticipate problems radiating a useful signal.

The doublet configuration may eliminate the need to tune the Buddipole by changing coil taps and whip lengths, which can be tricky, environmentally sensitive, and which usually requires lowering the antenna for access. However, unlike the standard Buddipole configurations, the radiating element in this doublet configuration is not necessarily operating at resonance, even though the tuned antenna *system* (including tuner and feedline) may present very close to a 50Ω load and low SWR to the transmitter. Note that some take the position that actual resonance of the radiator is always a compromise for frequency-varying operation and may not be an overly significant factor in practical antenna performance: "Open-air-dielectric feedline….[or] window line [is] cheap, virtually ignores standing waves, and allows you to use one non-resonant-in-most-places antenna across a broad part of the radio spectrum. ... With the proper circuitry (antenna matching components) and a feedline that is not a stickler for resonance, you can still use a very, very non-resonant antenna with very, very good results." [Keith, 2011]; see also [Keith, 2007], and for a more complete analysis, [Duffy, n.d.]; [Fair, n.d.] is quite helpful for thinking through the issues.

Future Work

No theoretical analyses or modeling have yet been done, and no measurements of actual radiated power, radiation pattern, on-air performance, or performance comparisons to standard Buddipole configurations have yet been made. Some obvious next steps are:

- Analyze more formally and completely the impact of resonance – the degree of performance difference between resonant-radiator and non-resonant-radiator-but-matched-system (typical multiband doublet) configurations. See e.g. [Duffy, n.d.; Fair, n.d.].
- Using 1:1 and 4:1 baluns, measure actual complex impedances (resistive and reactive components) of the doublet system outward of the tuner, across frequencies of use, with AIM-4170 analyzer. This would give some idea of the range of balun ratios needed for ideal matching. (Multiple-ratio baluns such as the WB6ZQZ Triple Ratio Balun [Biocca, n.d.] and the Buddipole TRSB derived from it do exist.)
- Make a NEC model of the doublet configuration and compare it to theoretical analyses, actual measurements, and available Buddipole NEC models (e.g. [Anderson, 2005; Carter, 2009]).
- Retest with pure open-wire ladderline instead of 300Ω twinlead.
- Test additional frequencies; promising bands include 12 Meters and 6 Meters. 60 Meters is also a possibility to be explored to see how low the tunability is effective.
- Use the doublet configuration on the air as an informal check of performance. Possibly some on-air comparisons can be made to the standard Buddipole configurations.

Note on Practical Use

For a diagram of "normal" station operation with this setup, just a) delete the laptop, AIM-4170B, and coax switch from Figure 1; b) connect the transceiver's antenna connector straight to the autotuner; and c) pick a frequency, tune, and operate.

References

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SWR Plots of the Tuned Antenna System in Figure 1 (40-10 Meter HF Bands)

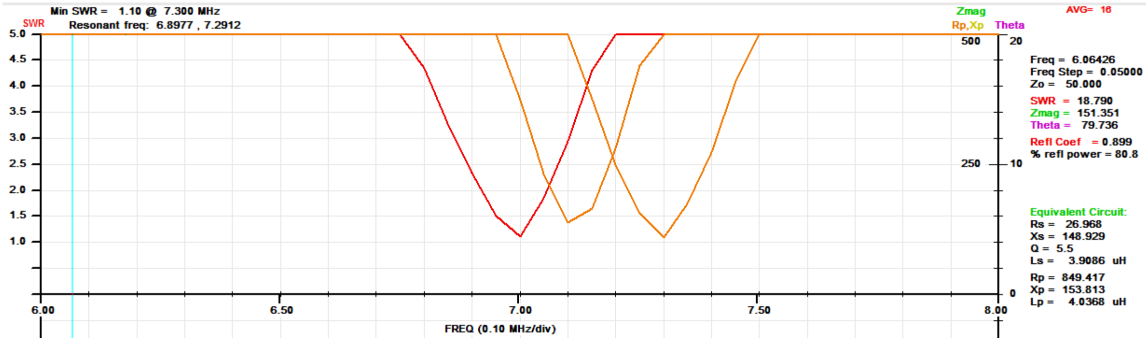

Figure 2: 40 Meters, Multiple Frequencies

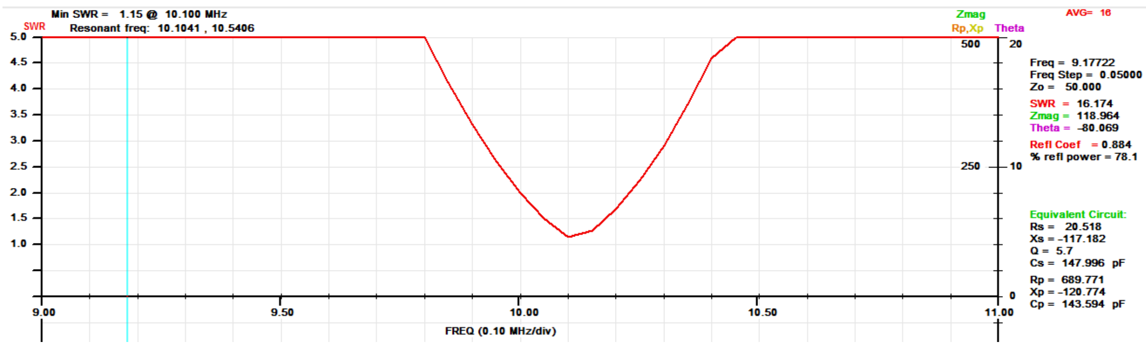

Figure 3: 30 Meters, Single Frequency

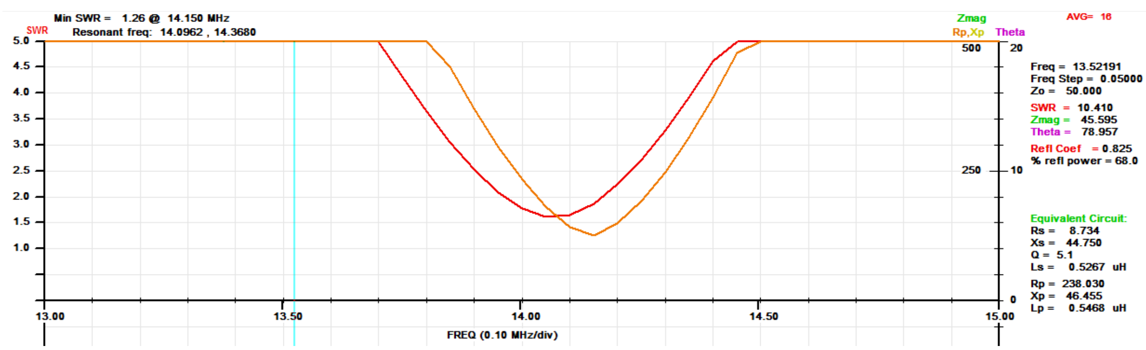

Figure 4: 20 Meters, Multiple Frequencies

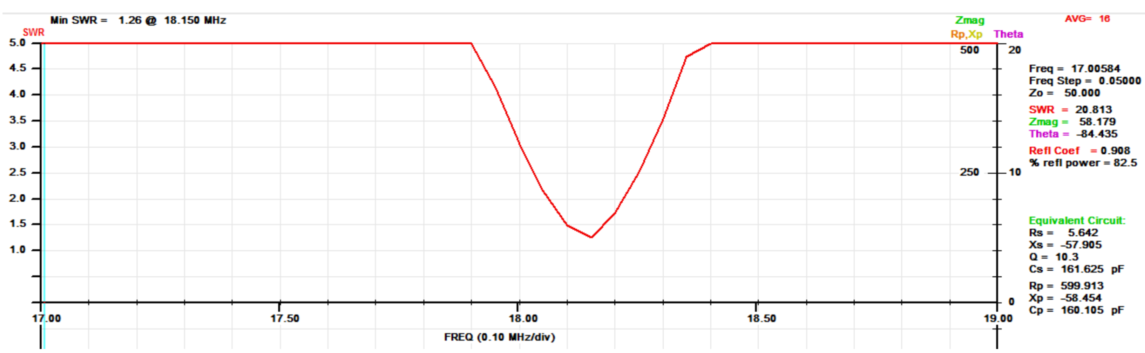

Figure 5: 17 Meters Single Frequency

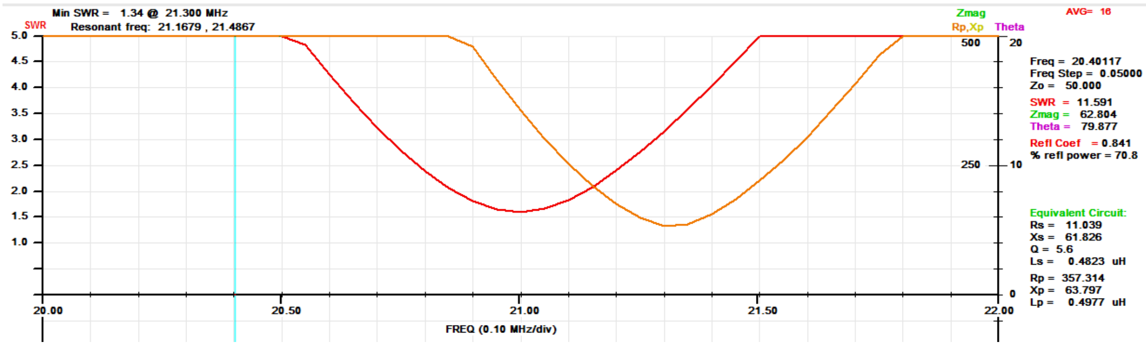

Figure 6: 15 Meters, Multiple Frequencies

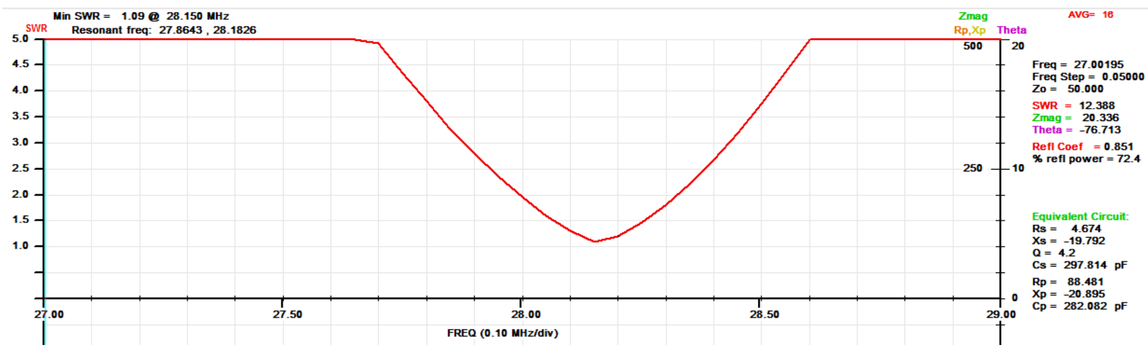

Figure 7: 10 Meters, Single Frequency