BUDDIPOLE COILS
FACT SHEET

Buddipole Coil Types

The modularity of the Buddipole system allows easy interchange of the various Buddipole components providing a lot of system possibilities. With three types of coil, how do you know which type can be used for any specific setup? Read this and you will know all about the mix and match capability of Buddipole coils.

What do coils do?

The unique electrical feature of a coil is a parameter known as inductance (measured in Henries). Inductance opposes the flow of ac (or RF) current and the higher the frequency of the current, the more the opposition. For more on this concept see the last section (Advanced Stuff).

Why do we need coils?

The physical size of a full size antenna is related to the band that it is used on, which is why refer to bands by their wavelength (as opposed to the frequency). A full size (half wave) antenna for the 80m band is about 80/2 = 40m in length which is highly impractical for a portable antenna. When an antenna is much shorter than full size, the antenna has a large amount of negative reactance, but this can be canceled by the positive reactance that a coil provides. When the antenna has been tuned this way it is said to be resonant. The reactance of the coil is directly related to the inductance of the coil and the operating frequency. The higher the frequency, the higher the reactance, while the reactance goes down with a lower operating frequency.

The inductance of a coil is related to the number of turns, the diameter of the coil and its length, so coils for the long wavelength bands must be larger than those for the shorter wavelength (higher frequency) bands. As you go up in frequency you need fewer and fewer turns on the coil until you get to a frequency where you need no turns at all. This is why you can operate a horizontal dipole on the 6m band with standard whips but without coils.

There are three basic types of Buddipole coils.

- Mini coil
  - The Mini coil is intended for use on 20-10 m bands
- Standard coils (Red and Black)
  - The standard coils adds 40 and 30 m capability to the range that the mini coil supports.
- Low-band coil
  - The low-band coil extends the Buddipole operating frequency range down to 80m.

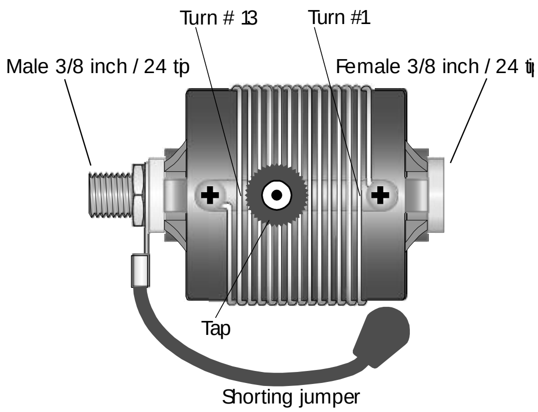
Why do we need two different standard coils?

Strictly speaking we don't, the Red and Black coils are different for convenience only.
You might expect because the horizontal dipole looks symmetrical that the coils should be identical, but they are not. Why? (this is a common question).

The reason is that when operating on the lower frequency bands, the resistive part of the feed point impedance is lower than the ideal 50 Ω output impedance of the transmitter. To get the most power into the antenna (indicated by low SWR) we need to increase this resistive part closer to 50 Ω , and that is accomplished by setting the dipole up as an Off Center Fed Dipole. The antenna is electrically asymmetric the left side being different than the right side. On 40m the we need maximum inductance but this asymmetry means that amount of inductance is different on each side of the antenna. Maximum inductance implies no tap, but if the coils were identical one would coil would be tapped and the other would not.

Mini coil

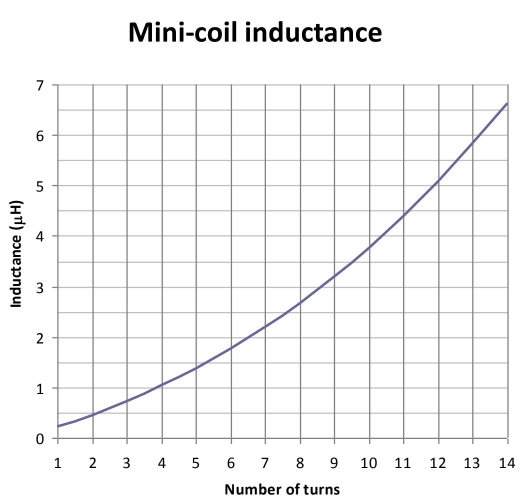
The mini coil is a shortened version of the standard coils, it is lighter in weight and size, and is intended for use on the 20m through 10m bands.



MINI COIL PARAMETERS	
Number of turns	14
Max. inductance	6.8 μH
Length (inches)	2.5 in
Weight (ounces)	2 9 oz

The shorting jumper is used to select the number of active turns. The number of turns is counted from the whip end of the coil (end with the female thread). The position of the tap can be changed by unscrewing the terminal screw, unhooking the tap and repositioning it in the desired position. Carefully inspect the position of the tap to make sure that it is not shorting adjacent turns together.

The most important figure for a coil is the inductance. The graph and table below show the inductance for each setting of the tap (to get 14 turns leave the jumper wire disconnected).

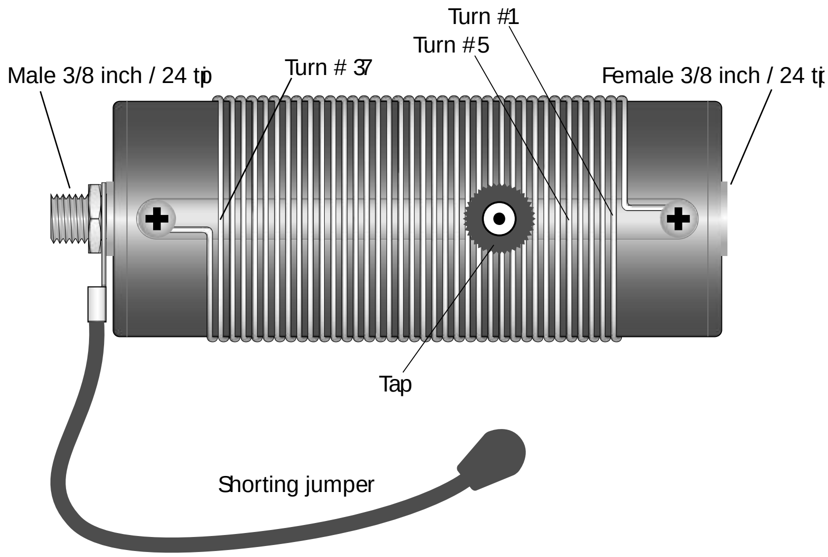


Turn	L (uH)	Turn	L (uH)
1	0.24	8	2.751
2	0.371	9	3.26
3	0.69	10	3.80
4	1.02	11	4.39
5	1.39	12	5.027
6	1.80	13	5.88
7	2.25	14	6.83

Notice that the shape of the Inductance vs num of turns chart above is not a straight line but is curved. This is typical of all coils with a small number of turns. This means that if you halve the number of turns, the value of inductance is not reduced in a similar way. If you need to find an exact value of inductance then refer to the chart or the table above.

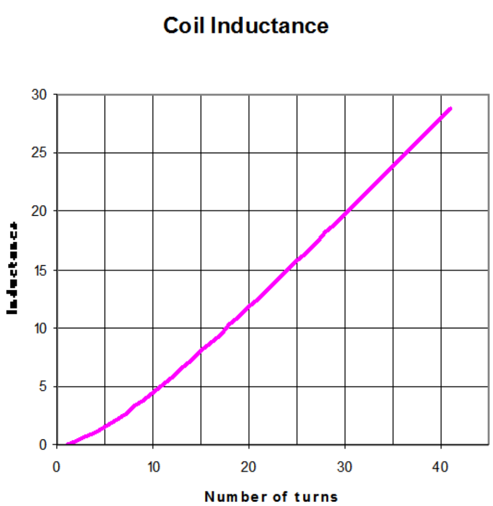
Standard coils

The red and black coils are identical except for the number of turns.
These coils are typically used in antenna configurations for the 40 through 10m bands.



The active turns are counted from the whip (or outer) end of the coil. If the maximum inductance is required the jumper wire should be disconnected and allowed to dangle.

STANDARD COIL COMPARISONS		
Coil	**Total turns**	**Inductance**
Black	38	26 µH
Red	41	29 µH

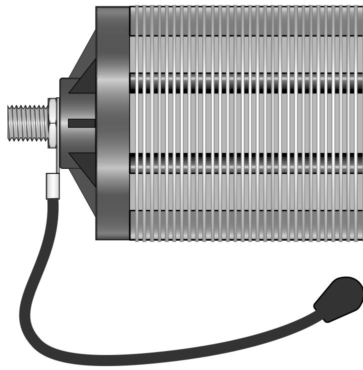


Turn	**L (uH)**	Turn	**L (uH)**
1	0.18	22	13.35
2	0.31	23	14.14
3	0.64	24	14.93
4	1.05	25	15.72
5	1.52	26	16.52
6	2.05	27	17.32
7	2.61	28	18.13
8	3.21	29	18.93
9	3.84	30	19.74
10	4.49	31	20.56
11	5.16	32	20.56
12	5.85	33	21.37
13	6.56	34	22.19
14	7.28	35	23.83
15	8.01	36	24.65
16	8.75	37	25.47
17	9.50	38	26.30
18	10.26	39	27.12
19	11.02	40	27.95
20	11.79	41	28.78
21	12.57		

Note that the table for the black coil stops at turn 38.

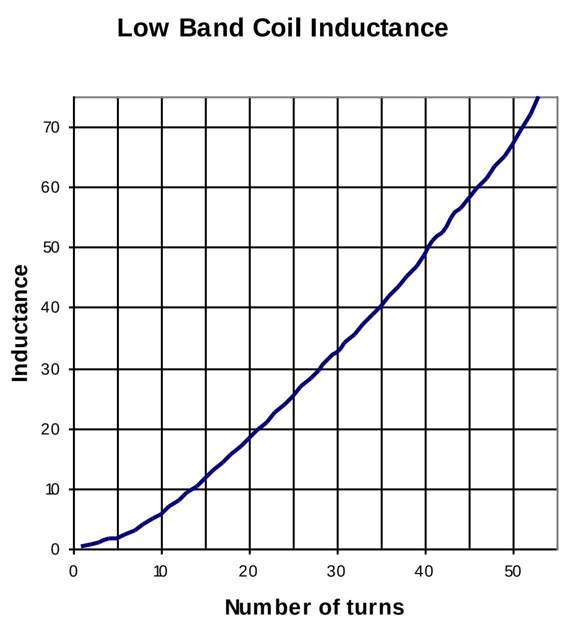
Low-band coil

The low-band coil is larger than the standard coils and has significantly higher inductance making it particularly suitable for use on the lower frequency bands including 80 and 160 meters.



The low band coil is physical much larger than the standard coil and the maximum inductance Is considerably higher. This provides complete coverage from the 80m band through the 10m band.

LOW BAND COIL PARAMETERS	
Total turns	Total Inductance
52	75 µH



Tap	µH	Tap	µH	Tap	µH
1	0.3	19	16.9	37	43.5
2	0.6	20	18.2	38	45.1
3	1.1	21	19.6	39	46.7
4	1.6	22	21.0	40	48.7
5	1.7	23	22.4	41	51.2
6	2.3	24	23.9	42	52.6
7	3.1	25	25.3	43	54.8
8	4.0	26	26.8	44	56.4
9	4.9	27	28.2	45	58.1
10	5.8	28	29.7	46	59.8
11	7.0	29	31.4	47	61.6
12	8.1	30	32.6	48	63.2
13	9.3	31	34.2	49	65.1
14	10.4	32	35.7	50	67.2
15	11.7	33	37.3	51	69.5
16	13.0	34	38.8	52	72.0
17	14.3	35	40.3	53	74.9
18	15.5	36	41.9		

Substituting coils

If you don't have the type of coil called out for in a specific antenna configuration can you use what you have? This is a question that we will answer in this section.

Using mini coils in place of the standard coils

The mini coils are shortened versions of the standard coils. If you know what tap setting to use for the standard coil for the mini-coil use the same tap setting (up to the 14^{th} tap) if you have two mini-coils, you can connect them together to make a larger coil. The maximum inductance would be about twice the inductance of a single mini coil. For example if you needed 22 turns you would set one coil to have an open tap (14 turns, the maximum inductance) and set the other coil to tap number 8 (14+8=22). The maximum inductance of two mini-coils connected together is equivalent to 28 turns, which is quite a way shy of the 41 turns of the standard red coil.

Using standard coils in place of the low band coil

Coupling the red and black coils directly together provides a total inductance of 53 μH which is equivalent to using the low band coil with the tap set to use 40 turns. Antennas designed to use the low-band coil requiring 40 turns or less can utilize a combination of the red and black coils.

Using the low band coil in place of a standard coil

The low band coil provides over 2 ½ times more inductance than the standard coils. Because the coil is tapped, it can generally but used as a substitute to the standard coil. Use the equivalent tap settings shown in the table below.

TAP SETTING EQUIVALENCE TABLE (Standard coil to Low Band Coil)							
Std	**Low band**	**Std**	**Low band**	**Std**	**Low band**	**Std**	**Low band**
40	26	30	19	20	14	10	7
39	26	29	19	19	13	9	6
38	25	28	18	18	12	8	6
37	24	27	17	17	12	7	5
36	24	26	17	16	11	6	4
35	23	25	16	15	10	5	4
34	23	24	15	14	10	4	3
33	21	23	15	13	9	3	3
32	21	22	15	12	8	2	2
31	20	21	14	11	8	1	1

For example if the standard coil should be set tap position 10, the equivalent setting on the low-band coil will be 7. This works well for the higher settings used on the lower frequency bands, but it becomes a little more difficult for small numbers of turns. You will then have to find fractional turns (1/2,1/4) making it more difficult to find exactly the right spot on the low band coil. Don't worry about the efficiency difference between the two coils, there isn't any significant degradation in performance.

Starting from scratch

There is much information provided on how to set up different configurations of a Buddipole using different coils. If you want to do some experimenting however, how do you figure out which tap to use? There are several ways to accomplish this as outlined below.

Basic method

A simple way to find out is to use your radio and your ears. Tune your radio to the frequency that you are intending to use and turn up the volume so that you can hear the background noise (and signals). Take the free end of the jumper wire, touch it to the coil and run it up and down the coil. The point on the coil where the noise is loudest is the resonant frequency of the antenna. Move the tap to that position and connect the jumper wire to the tap. Many people do this routinely when experimenting with setting up their Buddipole or Buddistick.

This method works because in general an antenna behaves the same way for transmit or receive. So the sweet spot for transmit and receive are at the same. Although we focus on getting a good SWR for the transmitter, it is also important for the receiver. Optimizing it for transmit will also give best results for receive and vice versa. This is good because there is no harm in running the receiver with a high SWR, although for the transmitter that is certainly not true.

Analyzer method (simple)

An antenna analyzer is not a required accessory, but it is so helpful that it is highly recommended especially if you want to tune your antenna without an Automatic Tuning Unit (ATU). There are a couple of different ways to use your analyzer and we will discuss the simplest of these first.

Set the taps on your coils to where they think they should be, or if you don’t know, then pick some arbitrary place. Connect the analyzer to the antenna in place of the radio.

There are many different types of analyzers, but we are going to assume that yours is like the majority of them in that it has the ability to be tuned across the bands. Monitor the SWR display on the analyzer (may be an analog meter or digital display) and tune the analyzer across the bands looking for the frequency at which the antenna SWR is a minimum. Take a note of this frequency as it is the resonant frequency. If this frequency is lower than your need, then you have set too much inductance in the coil. Conversely if the frequency is higher than you need you will need to add more inductance.

If you are close in frequency, then move the position of the tap by only one turn, and then perform the test again. If the resonant frequency did not move enough then move the tap again by one turn, or more if it seems that you are not moving close enough. If the resonant frequency moved the wrong way, then you are moving the tap the wrong way so move it back the other way.

If you are a long way off in frequency move the tap position by four or five turns and see whether the frequency moved much closer (and in the right direction). Remember that when moving the tap position by several turns at a time you may jump right past the position you are looking for.

Analyzer method (advanced)

The more expensive types of analyzer provide an indication of the reactance of the antenna in addition to the SWR. Some of them (even more expensive) indicate whether the reactance is positive or negative. That is useful because when the analyzer is tuned to the frequency of interest, the sign of the reactance should show you whether you need to add or subtract inductance. It also shows whether the actual resonant frequency is above or below your intended frequency. If the reactance is positive then the analyzer is below the resonant frequency, and if it is negative then the resonant frequency is above the test frequency.

Advanced Stuff

So you want to know more– adventurous souls read on !

Inductance and Reactance

So far I have been talking about both inductance and reactance without explaining the relationship between them. Inductance and reactance are related even though they are not the same thing. Inductance is a quality of the coil and theoretically is independent of frequency. Because of this it is simple to talk about the coil without having to state the frequency. Antennas however are frequency sensitive.

So what is reactance?

Reactance has some similarity to resistance with a big exception. Like resistance it opposes the flow of current in a circuit. The more reactance, the more the opposition to current and similarly for resistance So what is the difference? A simple way to understand this is with an analogy. If you try to push a large, heavy cardboard box across a rough concrete floor it will take some effort because of the friction between the box and the floor. That is the mechanical equivalent to electrical resistance. If instead you pushed against a large automobile style spring you will notice strong resistance when you push on it, but when you stop pushing it pushes back. This is like reactance. It pushes back and returns the energy you provided. With RF signals the current alternates back and forwards continuously (AC)

Simply put the reactance of an inductor increases with frequency. Most people are shy of looking at formulas but don’t shrink from this one, they don’t get much simple, the reactance is simply the inductance multiplied by the frequency and just to confuse is also multiplied by $2 \times \pi$

Inductive reactance is positive, and the higher the frequency the higher the reactance. A capacitor however has the opposite effect. Capacitive reactance decreases as the frequency increases and it is negative.

Short antennas naturally have negative reactance (capacitive reactance) and this increases as the frequency decreases. To offset this we add inductance as it provides positive reactance.

How much inductance will I need?

There is not a single answer to this question because it depends upon the physical location of the coil. If the coil is located at the feed point then the answer is simple. Use an antenna analyzer to find out how much reactance you need to cancel, and then you can calculate the inductance directly from that.
If you want to try that out all that you need to know is that the inductance L is related to the reactance by this simple formula. Simple enough that you can use your cell phone calculator!

—— (where f is frequency in MHz and X_l is reactance in ohms).

If your cell phone doesn't know what the value of π is then use that favorite school approximation 22/7. Bear in mind that because you have two coils, the reactance required for each coil is half of that shown by the analyzer.

Moving the coils away from the feed point is beneficial because it improves the current distribution in the antenna. This raises the radiation resistance which improves the antenna efficiency. Another consequence of this is that the amount of inductance required increases as the coils are moved further from the feed point.

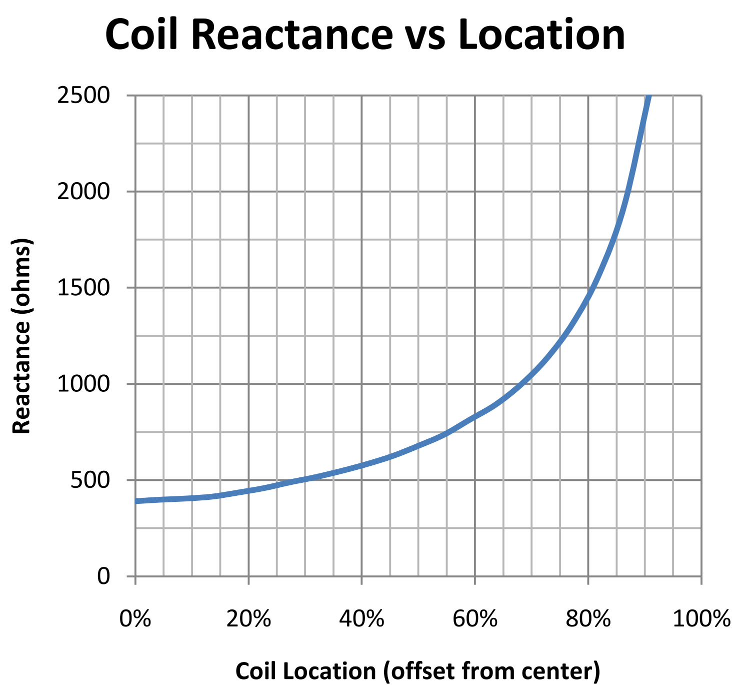


Figure 1 Reactance required for each coil

The figure above shows the required reactance required to tune an inductively loaded shortened horizontal dipole tuned for the 20m band. Of course what you really need to set the coil taps is to know the inductance but we can easily figure that out from the frequency.