Introducing the squid pole

Fancy a cheap, collapsible self-contained portable antenna for 80, 40, 30, 20 and 15m that works really well and can be erected in minutes? This article describes an antenna built with a 9 Metre pole but with a little experimenting you can use the other length poles that are available.

Motor-home mobile round Australia gave me time to model every portable antenna I could think of using MMANA modelling software, plus test them in the field. Travelling Australia and camping outdoors for eight months at a time provides strong motivation to build and improve antenna systems capable of reliable schedules with mates back home.

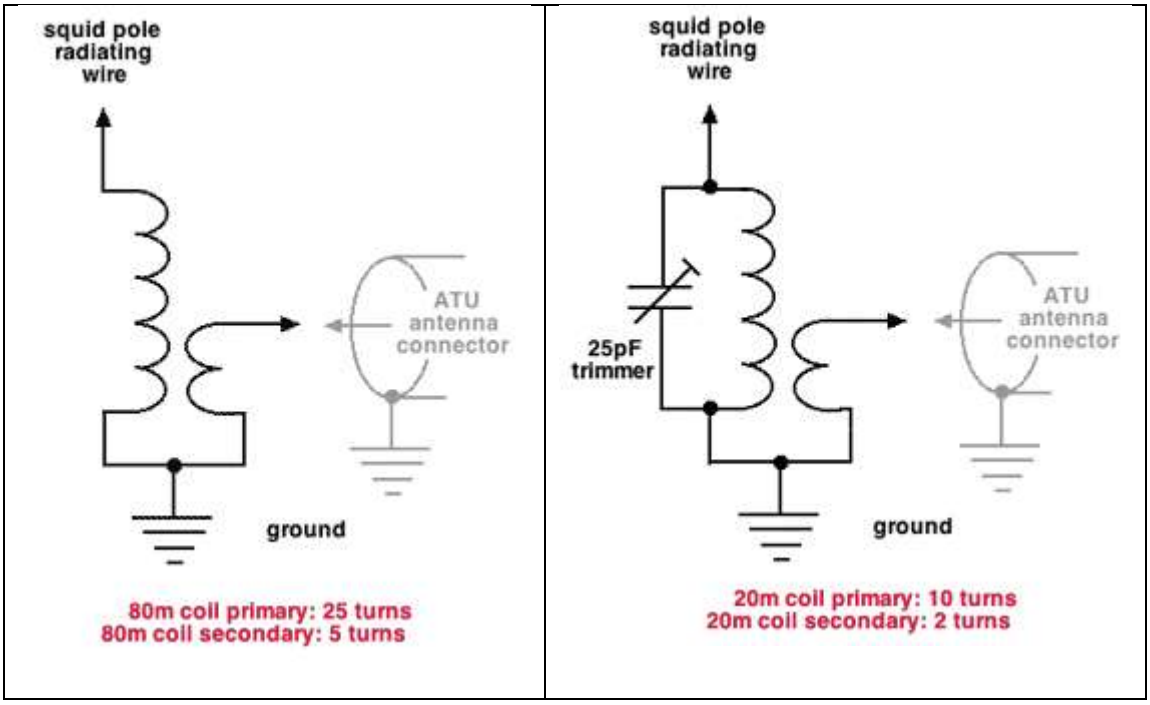
The NERC and other radio clubs around Australia sell inexpensive 9m long ultra-light telescopic fishing poles known in Australia as the squid pole. Squid poles are available in lengths from seven to ten meters and sell for less than $50.00. The 9 Metre one consists of 9 sections each a bit longer than 1m, extending to a full 9m. It is self supporting even in a brisk breeze and easily mounts in a short section of 50mm PVC similar to a surf fishing rod holder. Most surf rod holders are too narrow to accommodate the base of the 47 mm diameter poles.

Squid poles are thin and flexible at the top and can't support the weight of even a light dipole or G5RV so the pole is used as a support for a vertical wire wound along its length as per the photo on the left.

The squid pole as an antenna

• Winding a length of light insulated wire helically around the pole as you slowly extend it is the easiest way of attaching a wire for use as an antenna.
• The wire is most easily end fed at the bottom and the pole is mounted high up on a 4WD or a motor-home or mounted on a steel fence star dropper driven into the ground.
• The poles are 9m long which is a little less than a quarter wavelength on 40m and half wave on 20m; this is taken into account with the matching systems described below.
• A small and easily built slightly off-centre* loading coil brings the vertical wire to resonance on 40, 20 and 15m and remains in place on all bands.
• Ground losses can be reduced by simple improvements to your vehicle or site ground. Use two or more cheap metal 5m long tape measures. Solder banana plugs or bull-dog clips to the ends of the metal tapes and run them from the base of the antenna sloping out and down to ground. A direct wire to a ground stake is a total waste of time.

The construction details below optimise the antenna for use on 80, 40 and 20m. It also radiates well on 30 and 15m. The 80m the squid pole is a bottom loaded quarter wave.



An 80m vertical provides low angle radiation (around 20 degrees) making it better than my portable G5RV for long distance contacts, e.g. up to 3,700 km regular scheds from the WA coast and Cape York to Tasmania. It's not as good as the G5RV for the usual local rag-chews, as the G5RV radiates straight up at 90 degrees providing high angle sky wave that bounces back down locally - good for short comms.

A low-loss 25 turn loading coil with a 5 turn secondary winding provides a near 50 ohm feed point on 80m.

MMANA modelling shows a radiation resistance of about 5 ohms which makes the 9m long squid pole a very much more efficient antenna than a typical short HF whip.

For example a typical 1.5m long whip on 80m has a radiation resistance of just 0.1 ohms; that's right , one tenth of an ohm!

That means if the ohmic resistance of the loading coil wire and associated connectors is (typically) 2 ohms, more than 95% of your transmitter power is NOT radiated and simply turned into heat by that resistance.

In addition:

(a) people tend to overlook the fact that a coil does NOT radiate - so with a typical 80m whip the only part that radiates is the stinger adjusting rod at the very top.

(b) because most radiation occurs from the high current bottom section of a quarter wave vertical, you are replacing the most important and effective part of your antenna with a non-radiating inductance.

On 20m the squid pole is an end-fed halfwave.

On 20m a parallel tuned circuit matches the high impedance of the 20m end-fed halfwave and the 2 turn secondary winding provides a near 50 ohm feed point. The trimmer is tuned for resonance at 14.2MHz

The end-fed half wave squid pole is 'ground independent' with an elevated high current radiation point providing excellent low angle radiation; you'd need a Yagi or a curtain or 4-square array to beat it.

The trimmer capacitor is easily adjusted for a flat SWR into a 50 ohm load so it works with no ATU.

Using the squid pole on other bands:

The radiating wire with centre coil is directly fed at its bottom end on all other bands via an ATU.

On 40m, because of the centre loading coil, the antenna is a full quarter wave resonant at about 7.1MHz. MMANA modelling shows the radiation resistance is about 25 ohms which together with the series ground return losses (depending on how bad your ground is) brings the feed point impedance up to about 40 ohms. Performance on 40m is excellent with good low angle radiation.

On 30m the antenna also has a good low angle radiation pattern. It is not resonant, but that does not affect any antennas ability to radiate - it just means an ATU is required.

On 15m the antenna is resonant at 21.3MHz which is the 3rd harmonic of 7.1MHz so an ATU can easily match the ~200ohms non-reactive feed point impedance.

Parts required

- 12 meters of insulated multi-strand copper hookup wire; the copper inner is 1mm in diameter. This wire is strong and flexible and not too heavy. It is used as the radiator and for the secondary windings on the 80 and 20m coils. Short lengths are also used to connect the coils to the ATU.
- 5 meters of enamel copper wire approx 1mm diameter. Diameters smaller than 0.7mm need a couple *fewer* turns and greater than 1.2mm need a couple *more* turns. That might sound counter-intuitive but it is caused by the inter-turn coupling which reduces as the wire gets thicker.
- 150 mm of 42mm outside diameter PVC pipe. This is used for the coil formers. Other diameters and materials will change the calculations so please stick to 42mm PVC.
- 3 x chassis mount banana sockets, 4 x banana plugs.
- 1 x 25pF mica compression trimmer capacitor. A small bee-hive concentric trimmer will also work OK. (See † footnote)
- A roll of good insulation tape.
- A short length of thin nylon strap or cord.
- A small diameter plastic Rawl plug that is a firm push-on / pull-off fit on the tip of your squid pole, or a fishing swivel with a safety-pin style clip.
- A self adhesive Velcro patch.

Construction details

The Velcro patch on the left of the illustration is a simple way of holding the radiating wire captive to stop it unwinding. The top Velcro layer lifts back to release the wire.

The black taped over nylon strap on the right of the illustration is a sort of buffer/collar that helps prevent the bottom end of the squid pole from rattling round inside the PVC 'fishing rod' holder.

Because the squid pole is tapered and has a slightly larger diameter screw end on the bottom, a layer of nylon strap or cord needs to be wrapped around the pole about 20cm from the bottom.

This helps provide a snug fit for the pole base in the 50mm PVC holder.

I roll up my radiator wire on a cheap plastic fishing line hand reel for storage.

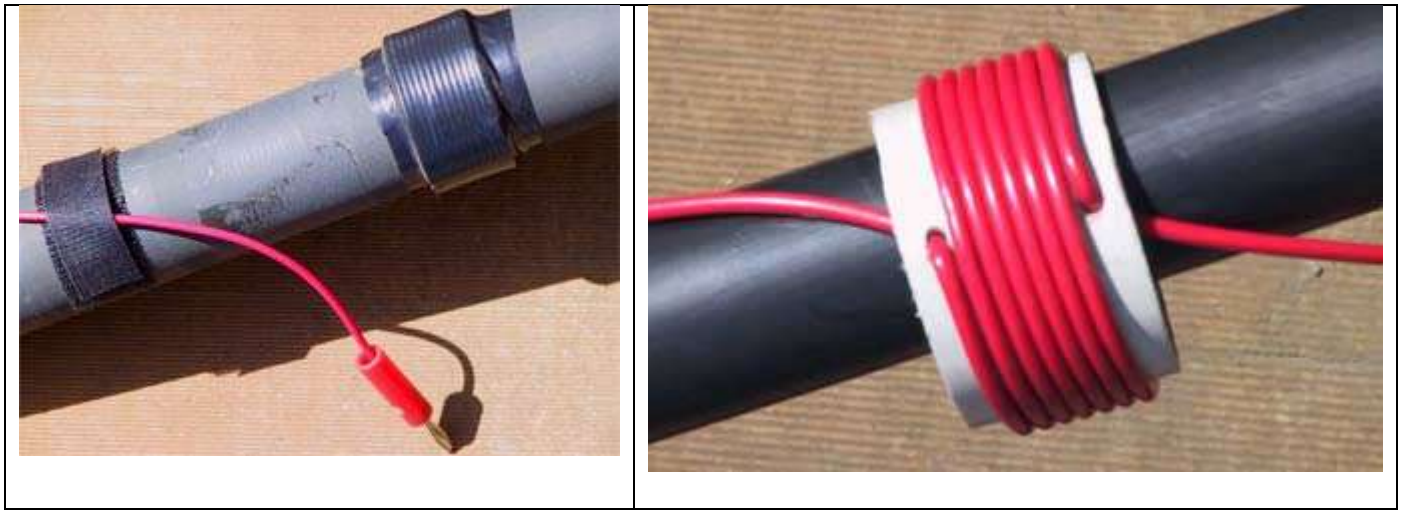


Figure 1*: The Velcro holds the radiating wire at the bottom of the pole.*

The Velcro patch on the left of the illustration is a simple way of holding the radiating wire captive to stop it unwinding. The top Velcro layer lifts back to release the wire.

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I roll up my radiator wire on a cheap plastic fishing line hand reel for storage.

Figure 2*: The 7 turn centre loading coil* is integrated into the radiating wire.*

1. Cut the radiating wire to a length of 10.1m. This *includes* the wire for the coil.

2. Cut a 30 mm length of 42mm diameter PVC pipe for the off-centre* coil former.
- drill two 2mm diameter holes in the PVC to thread the radiating wire through. Each hole is positioned about 3mm in from each end of the PVC, the exact spacing will vary depending on the wire you use. I later re-drilled my holes closer to the coil and trimmed the PVC for a neat finish.

3. Wind 7 turns of the radiating wire round the PVC former, poking the wire through the holes as illustrated.
- make sure that you position the coil on the wire so that it is exactly 4.7m down from the top of the wire.
- connect a banana plug to the bottom end of the wire.
- tape the rawl plug to the top of the wire leaving the bottom of the rawl plug free to slide onto the top of the squid pole.

4. The resulting length of wire + coil is used as the radiating element on all bands.

5. Congratulations. Your squid pole is now ready for use on 40, 30 and 15m

Figure 3below*: The Rawl plug holds the radiating wire at the top of the pole.*

A small diameter Rawl plug is used to slide firmly over the top of the squid pole after the tiny wire loop at the top of the squid pole is cut off.

The radiator wire is taped to the Rawl plug so that the wire is able to be easily plugged onto the top of the squid pole. I used red tape which makes the picture a bit confusing, sorry.

NOTE: Some constructors tell me they used a fishing swivel to clip onto the tiny eyelet on the top of the squid pole and I think that is a superior method to my original system.

Next we build the 80 and 20m additions.

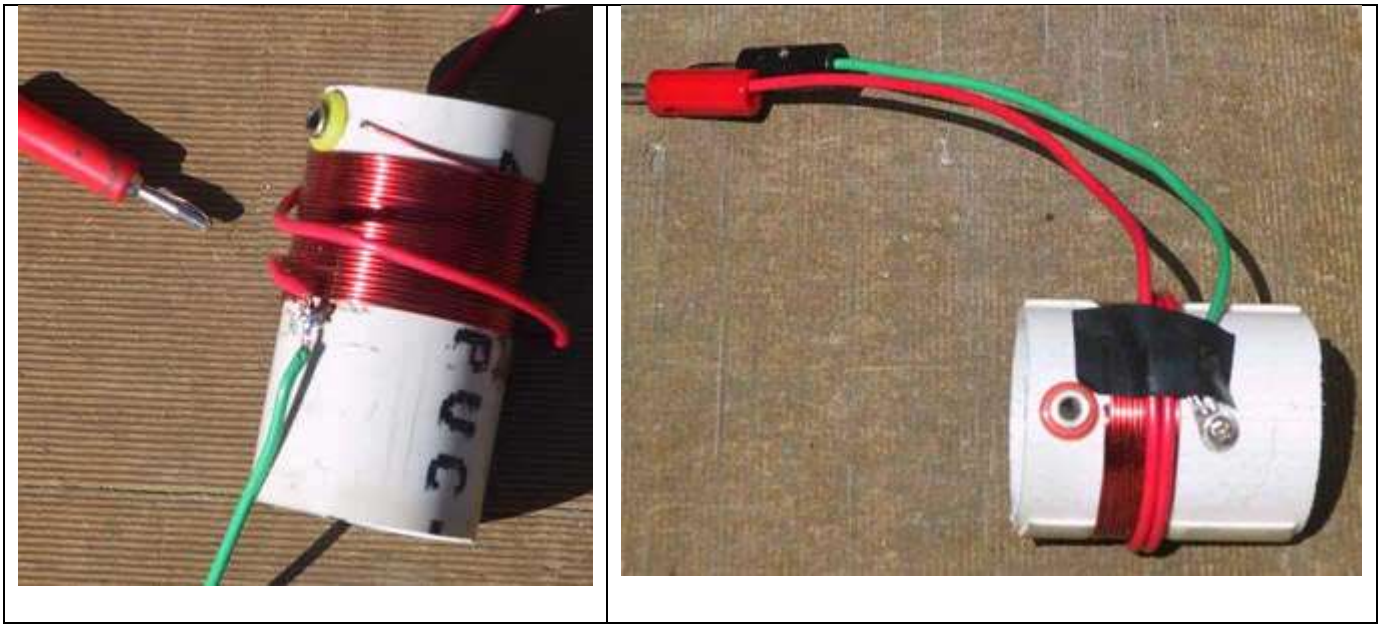


Figure 4*: The 80m coil: 25 turns of 0.8mm enamelled copper*

1. Cut a 70 mm length of 42mm diameter PVC pipe for the 80m coil former.
2. Drill a hole close to one end of the PVC and mount one of the banana sockets in the hole with its solder tab on the inside of the PVC pipe. My banana socket is the yellow one shown on the left.
3. Drill a small hole near the banana socket for neatly feeding the enamel wire through.
4. Bare 2cm of one end of your spool of enamel copper wire, scrape the enamel off with a sharp knife and poke it through the hole in the PVC and the banana solder tab. Solder the wire to the tab.
5. Wind 25 turns of the enamel copper wire neatly and tightly onto the PVC former.
6. After winding all the turns on, cut the wire so you have about 4cm remaining. Bare the wire by scraping it carefully.
7. Drill a hole right at the bottom of the winding and poke the end of the wire through and then a second hole to bring it back out again, so it can be soldered to.
8. Solder a length of spare radiating wire to the enamel wire as per the red wire you see on the left and wind 5 turns of it over the bottom end of the enamel wire winding (look at the secondary winding on the 20m coil below to see where to place it), leaving enough spare as a tail to connect to ATU or coax. In this illustration I'm about to start winding the 5 turn secondary.
9. Solder a second 15cm length of spare radiating wire to the other two wires (my wire was green to make it easy to remember that its the earth wire). This tail will connect to the ground point on your ATU or coax. See the 20m coil below which shows the similar two tails. You can adjust the SWR by slightly repositioning

the secondary turns closer to or further from the bottom of the enamel winding. When the windings are in place, cover them tightly with insulation tape.

Figure 5*: The 20m coil: 10 turns of 0.8mm enamelled copper*

1. Cut a 50 mm length of 42mm diameter PVC pipe for the 80m coil former.
2. Exactly the same technique is used as for the 80m coil above. Mount the banana socket (mine was red), solder the wire to it, and wind the 10 turns.
3. With this coil I decided to drill a hole at the end of the winding and place a small bolt and nut through it, with solder tabs on the inside and the outside to help provide a solder point for the 25pF trimmer inside the coil former.
4. Solder the secondary wire (mine is the red wire) to this point and wind the 2 turns as illustrated.
5. Solder the earth tail to the same point; mine is the green wire shown.
6. When the windings are in place cover them tightly with insulation tape.
7. The 25pF trimmer stretches between the banana socket and the bolt lug inside the PVC pipe. It is soldered to both those points so that it is electrically wired in parallel with the enamel wire coil.

Tuning

Tune the 25pF trimmer for maximum received signal strength at 14.2MHz. Fine tune it by adjusting it for minimum SWR at low power output on the same frequency.
If the tuned circuit is working properly there will be a *single very obvious spot* where RX and TX work brilliantly. If you have an antenna analyser like the MFJ-259B you can tune it perfectly and expect to achieve a nice 50 ohm non-reactive load.

Connecting to your ATU

For portable use it is highly desirable to position the ATU right at the bottom of the squid pole. That way there is no coax between the ATU and the squid pole and thus no RF coming back down the coax into the portable radio shack. Stray RF with a poor earth is usually overcome when the ATU is at the base of the antenna because that configuration provides properly matched coax running back into the vehicle or tent.

The *perfect* solution is a *remote ATU* and if you are doing much portable work you should rush out and buy one now. I use the Yaesu FC-400.

If it is not possible to connect directly to the ATU, use as short a length of coax as conveniently possible and wire it with banana sockets and something to connect it to the nearest piece of metal at the base of the squid pole mount.

On 80 and 20m the radiating wire plugs into the banana socket on that band's coil former. The active banana plug from the coil secondary winding (e.g. the red wire illustrated above) plugs directly into the SO239 socket on the back of the ATU. The fact that bananas *can* plug into SO239 sockets is one of the joys of banana plugs.

Wire a banana socket to the earth lug on the ATU to plug in the coil earth lead. That allows simple swapping of coils by plugging them in and out.

On 40, 30 and 15m the coils are not used and the radiating wire plugs directly into the ATU SO239 socket.

Ground

If the squid pole is not mounted on something like a car, trailer or truck that can provide at least a minimum workable ground plane, you should consider making some plug-on radials from cheap metal tape measures as mentioned above. Make them anyway, radials help with any portable installation and you can never have enough of them for any vertical.

Typical ground return losses are in the vicinity of 10 to 20 ohms and this value is in series with the antenna radiation resistance. This means that the lower the frequency, the more the ground loss effects the overall efficiency. E.g. on 80m a ground loss of (say) 20 ohms in series with the 5 ohm radiation resistance would turn 75 watts of your 100 watt transmit power into heat.

Radials work best away from the ground and are easily arranged so they droop from the bottom of a squid pole that's 2m or more off the ground. 4 x 5m tapes are long enough to help a lot, they are trivially easy to deploy in the field and cost as little as $2 each. A star-dropper or earth stake will NOT provide any effective ground at all.

What ground you have will also effect the direction in which your antenna works best, especially on the higher frequencies. E.g. if there was a very poor ground in a northerly direction from your antenna and a good ground in a southerly direction, more of your signal would be lost in the poor ground to the north than the good ground to the south, so the antenna would work best with stations to the south of you.

* The centre loading coil is actually placed a little lower down the squid pole than the centre, being exactly 4,700 mm from the top of the wire.

This position was calculated using MMANA modelling software to provide simultaneous resonance on 20m and 40m. The complication is because a loading coil has maximum effect at a high current point and needs more inductance the further it moves from the high current point. On the 20m half wave the current maximum is at the middle of the squid pole while on the 40m quarter wave the current maximum is at the bottom of the pole.

Trouble shooting

1. Wire : Do you want to use different wire?

a) The red coloured insulated wire I used that you can see in the photos had a multi-stranded copper core of about 1mm diameter and a fairly strong PVC insulation with an external diameter of about 2mm.

You can use thicker wire or wire with thicker insulation but it complicates things. It can be compensated for during the first stage of construction which is building the centre loading coil and getting the squid pole resonant on 40m, specifically 7.1MHz.

BUT you have to have access to an antenna analyser or at least a grid dip oscillator to measure the resonant frequency exactly. Checking the SWR will NOT give you the exact resonant point as the resonant point does not give lowest SWR.

If you have thicker wire these are the steps I suggest:

1.Use 10.2m wire length and add an extra 2 turns to the existing 7 turns on the centre loading coil, making it 9 turns total.
2. Mount the squid pole on some reasonable ground system and measure its resonant frequency with the antenna analyser or GDO.
2. If it resonates below 7MHz remove a turn from the coil and try again.
4. Fine adjustments can be made by spreading the centre loading coil turns apart.
5. Keep repeating the procedure until you get it right on 7.1MHz

(It might seem counter-intuitive that you need *extra* turns if the wire is thicker, but that is because the turns are forced further apart from each other by the thicker wire and/or the thicker insulation and this lessens the coupling between turns and reduces the inductance.)

It is really important to achieve resonance at 7.1MHz before you proceed with the rest of construction. The reason is that 20m is exactly twice that frequency and 15m is exactly three time that frequency, so any error will be doubled and tripled! On 20m you want resonance at 14.2Mhz and on 15m you want resonance at 21.3MHz.

Thinner wire is not recommended because it's too flimsy but if you want to persist then go ahead and measure the resonant frequency and adjust the centre loading coil until you get it right on 7.1MHz

b) The enamelled copper wire used for the 20m and 80m coils is also 1mm in diameter. Try hard to get hold of the same diameter unless you are experienced enough to roll your own and measure your system accurately with an antenna analyser.

1mm enamelled wire is usually available from Jaycar/Altronics/AZTronics on small spools and from some speaker inductors sold at Jaycar. You may even be able to get some from an electric motor rewinding businesses. Electric motor rewinding businesses are a good source and usually sell it cheaply by the meter. Sometimes old power or speaker transformers have the right diameter. You will need about 5 meters of enamelled wire in total.

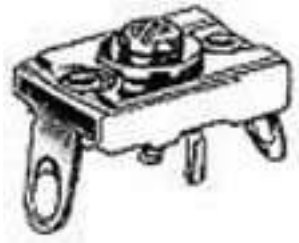
2. PVC pipe : Do you want to use different diameter coils?

I've received feedback from England that their PVC is 40mm but that's not different enough to break the design.

Several local constructors here have used different diameters, Peter VK7KPC used a much smaller diameter former so that he could put it *inside* the squid pole; he used MMANA to calculate the required inductance and position on the wire, and has it working well. Joe VK7JG mounted his 20m coil on a former on the end of a piece of Heliax and got it going first try...

It's beyond the scope of my article to cater for anything other than the 42mm common garden variety I used (you can find bits of it on building sites all over the country). Feel free to play and let me know how you go!

3. Trimmer capacitors : What types are there and what are the limits?




The first image above shows a typical mica compression trimmer capacitor. They work well for this project. Unfortunately many in junk boxes have too high a value which makes them too hard to tune. The range you need is from 5pF to a maximum of 25pF.

The next image shows several beehive trimmers. Again, they work well. Make sure they cover the range up to 25pF or 33pF maximum. There are very long ones that have a range of 60pF, do not use these.

The third image shows what plastic or Teflon trimmers look like. They also work well. Same comments apply to the desirable maximum 25pF.

The small coloured ceramic trimmers as shown in the last image are *generally not suitable for 100 watts* as they have too low a break down voltage. They come in a variety of colours, depending on value.

Tuning and problem solving:

Problem: I can't seem to find resonance, resonance is not obvious, resonance is 'fuzzy' and 'broad'

You are probably experiencing those problems because you have a poor ground system. This is especially true of 80m.

In order to tune the squid pole (and operate it!) you do need a reasonable ground of some sort. I use my truck, or where the squid pole is attached to a post or star dropper, I use four tape measures of 5 to 8m long as radials; that is the *absolute bare minimum* and may still not be enough.

Problem: Resonance on 40m or 20m seems "stuck" and doesn't change when I tune the trimmer or change the turns on the coil

You probably have *tuned* radials or attached the pole to something that is accidentally resonant on the band in question thus swamping the measurements.

If you have carefully cut 1/4 wavelength radials for use on 20m or 40m then they are probably the culprit. This can happen accidentally, as you may have mounted your squid pole on some structure that is accidentally resonant at or near one of the bands of interest.

The effect of tuned radials can be very marked and can swamp the measurement of resonance of the squid pole itself. For example if your radials were accidentally tuned to (say) exactly 14.5MHz, then they would have such a large influence on the tuning of the whole antenna system that despite any adjustments you made to the actual squid pole wire or it's 20m trimmer, it could still show up as resonant on 14.5MHz.

You will be much better off with radials that are *not* anywhere close to 1/4 wave at all of the frequencies in use.

If you think that's happening to you, try mounting your “squiddy” temporarily on some other ground system and measuring it again.

Problem: I can't seem to get the 80m coil tuned to 3.6MHz

Almost all the problems on 80m are caused by a poor ground plane. Remember that the real ground is NOT a ground plane, real ground is a very poor conductor and absorbs much of your signal - and that does not change no matter how many fantastic metal earth stakes you drive into it.

The performance limitations on 80m (and to a slightly lesser extent on 40m) are ground losses. That is the case for all vertical antennas. If you plan to use it seriously on 80m, then you might consider a pair of nice long 80m radials in addition to your normal ground. The good news is that you can get more and more performance out of any vertical by improving your ground system!

If you have access to an antenna analyser or grid dip oscillator, then here is the way to troubleshoot your 80m coil:

- wind the 80m coil *primary* to my specifications
- do not wind on the secondary, but check resonance of the loading coil itself first.
- connect the bottom of the coil either to your antenna analyser, or your transmitter via your SWR meter, so you can check it for resonance (or best SWR) at 3.5MHz, or if you are using a GDO connect the coil bottom to ground and 'sniff' the coil.

The idea is to temporarily connect up the 80m coil in series with the squid pole (ie. use it as a simple loading coil at the base of the pole) and then measure it's resonant frequency using whatever equipment you have. Adjust the number of turns to achieve resonance at 3.5MHz. Winding the secondary on will raise the

frequency slightly. Remember, it is easy to spread the windings apart a little to raise it to resonance on 3.6MHz, it's much harder to add on an extra turn of wire!

If you don't have access to any test gear then try adjusting the coil as described above for lowest SWR. Use low power on 3.5MHz.

When you have it resonant on 3.5MHz, then go ahead and wind the 5 secondary turns, and connect it as per the construction details.

Problem: I can't seem to get a good 50 ohm match on 20m or 80m

If you find it's close enough and you are sick of fiddling with it then maybe just use an ATU!

On the other hand, with care and a little effort it is certainly possible to get a *perfect* 50 ohm match on 20 and 80.

Here is an outline of what you are trying to achieve:

a. 40m: Get the squid pole with centre loading coil resonant and working with a 1:1 (or very close) SWR on 7.1MHz when mounted over a good ground.

Do not proceed with any other construction until you've achieve that because if you go back and change things on 40m it will throw all your other work out the window. It will not stay perfect across the band of course but you should expect to achieve better than 1:1.5 SWR from 7.0MHz to 7.4MHz.

b. 20m: Build the 20m tuned circuit complete with secondary coil. If you have a GDO or antenna analyser, you can check the 20m tuned circuit for nice clean sharp resonance on 14.2MHz *before* you attach it to the squid pole wire.

If you have no test instruments, then connect the 20m coil to the squid pole wire, as for normal use. Using your SWR meter and transmitting on minimum power on 14.2MHz, slowly adjust the trimmer and watch for a nice dip in the SWR at some point. Even if the dip does not go to zero, the SWR dip should be nice and obvious and smooth at some point.

If your trimmer capacitor is too high in value, you will probably see a small dip occur at the trimmer minimum value. You could take off a turn of enamelled wire from the 20m coil and try again, otherwise you will need to find a trimmer that is capable of a lower minimum value.

If the dip occurs at a reasonable spot on your trimmer (halfway would be perfect) but you still can't get the SWR perfect, then you need to adjust the secondary turns on the 20m coil.

Loosen the insulation tape on the 2 turn secondary winding, and try moving those two turns either down slightly off the bottom of the primary, or slightly above the bottom of the primary and trying again. You might try spreading those 2 turns apart a little. You will need to remove your hand and re-tape it temporarily to test it, as your hand will stuff the measurements.

If you have an antenna analyser you can see exactly what effect moving the secondary has, and by playing around achieve exactly 50 ohms non-reactive. It will not stay perfect across the band of course but you should expect to achieve better than 1:1.5 SWR from 14.0MHz to 14.35MHz.

c. 80m: Assuming you have achieved resonance at the target frequency of 3.5MHz by using the 80m coil (minus secondary) as a simple base loading coil, then you can wind on the secondary.

The way to get a perfect 50 ohm match is by trial and error, as described on 20m above. Move the start of the 5 turns slightly below the enable winding, or spread the turns apart a little, or remove a turn. If you can measure the results on an antenna analyser you can achieve a perfect 50 ohm match.

It will not stay perfect across the band of course but you should expect to achieve better than 1:1.5 SWR from 3.5MHz to 3.7MHz.

Question: Does it matter how I wind the wire up the squid pole?

Nope!

The helical winding of the wire up the squid pole is simply so that a) the wire stays on the pole without having to be taped to it and b) the wire is as long as possible so that the centre loading coil inductance can be as small as possible.

Just wind it evenly and neatly as per the photo of the squid pole at the top of the previous page.

The helical turns on the squid pole do not have any effect like a "coil" because their spacing is too great. The inter-capacitive coupling between their "turns" is effectively zero, and inter-capacitive coupling between turns it what makes a coil have inductance. Think of a capacitor: the plates have negligible capacitive effect unless they are very close together.

Question: Should I have resonant radials, do they help?

Nope!

Radials do not need to be 1/4 wave long, especially on HF and close to the ground; according to Cebik the effect of the ground being so close nullifies any real benefit from making them longer than something like 0.2 of a wavelength. Unless you install dozens of radials of course, which would be *ideal*...

If you have the space and inclination you might make them about 0.15 of a wavelength long on 40m. That's about 6m long, so you can see that 8m tape measures would be fine as an all-round compromise.

One problem with "tuned" radials is that they can swamp the effective resonant frequency of the squid pole as described in the "my squid pole resonance seems stuck" problem above.

Adapted from this web site http://www.perite.com/vk7jj/squidpoles.html by Phil - VK5SRP so it could be saved as a PDF file making it easy to print and pass round the members of the NERC who do not use a computer. (Yes there are still folk out there that have not discovered the wonders of the World Wide Web). The original author is Phil - **VK7JJ.**

Visit VK5SRP’s shack pages at: http://www.philipstorr.id.au/radio/index.htm