Squid Pole Use for HF Antennas - A Topic Revisited

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10 April 2015

My original squid pole use article is **here (/~vk4adc/web/index.php/hf-projects/45-hf-antennas/103-bearing-info-software)** and it shows a lot of detail of the mounting of the bottom of the squid pole.

I recently had cause to revisit the use of my 7 metre fibreglass squid pole so that I could have it available as a HF antenna for the 2015 John Moyle Memorial Field Day. My previous use for the squid pole was as the center-mounting point for my homebrew trapped inverted-V antenna but I now have a stronger alternative created from the metal tubes normally used to support the netting around a kid's trampoline. That left the fibreglass squid pole as effectively surplus now.

There were articles on the internet ideas of using a few kid's metallic Slinky toys as the radiating element (e.g. http://www.nsw.wicen.org.au/bbq/2012/autumn (http://www.nsw.wicen.org.au/bbq/2012/autumn) or local PDF copy (http://www.vk4adc.com/UserFiles/File/squidpoles/slinky%20loading.pdf)) stretched down along the outside of a squid pole, and elsewhere for using the thing to support a centre-loaded wire dropping down the outside. I could foresee that the first option was likely to introduce a lot of inductance (or loading) effects along with a big question mark about the efficiency of what was effectively a helically wound antenna and the second was not going to be suitable enough for me to use as a ready-to-use multiband antenna. I also wanted something quick to erect without any real tuning requirement once setup for a temporary field installation.

I wanted something physically stable/strong so I elected to feed a multi-strand insulated hookup wire down through the centre of the tubes, and held in place at the top by a rubber grommet over the outside of the innermost tube. The wire was fed out through a hole drilled through the rubber base of the assembly. That meant that I would end up with a 7 metre long vertical wire whip antenna but these types of antennas needed to be fed against a ground / earth plane for them to be effective – or in fact to be able to feed them at all via coax. I will discuss "ground" effects more later. My earliest mounting method was to use the squid pole base inside a 50mm PVC plumbing-tube sleeve with a steel tube plus flanges and two u-bolts and then onto a hinge plate that typically was placed either side of a car / trailer / caravan wheel. The metallic mounting tube was then connected to the vehicles metalwork via a braided flylead. That allowed me to use the metallic structure as a reasonably effective ground plane. Note: That method was subsequently revised, see after the conclusion…

Mouse-over the images to see in more detail.....

Photos from the squidpole setup for 2015 JMFD:	
 The squid pole mounted to the wheel mounting via the hinged bracket.	 The squid pole vertical and ready to extend upwards and fit to the wheel.
 The timber mounting assembly is adjusted to be a tight fit either side of the wheel and pushed under.	 The final step is to attach the RF autotransformer and clip the "ground" leads onto the mag wheel so the vehicle acts as the counterpoise.

Now it was time to turn my attention to determining the electrical characteristics of the proposed antenna. What was the feed impedance of a 7 metre length of wire at the various HF bands ?? Please note that this antenna needed to be fed via 50 ohm coax without an actual antenna tuner at the bottom feed point even though there would typically be one at the transceiver end of the coax, either internal in the transceiver or a unit external to it.

A quarter-wave whip 7 metres long is resonant at around 10.2 MHz (when end-effect is taken into account) so that makes it electrically short for the 7 MHz and 3.5 MHz bands, almost right for 10.1 MHz, and electrically long for the 14, 18, 21, 24 and 28 MHz bands. Since it wasn't actually resonant on any of these HF amateur bands, really that meant that feeding it via coax was going to be difficult.

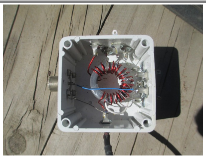
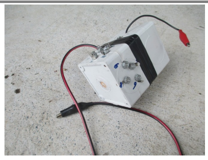
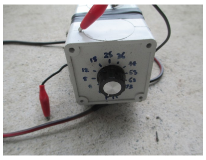
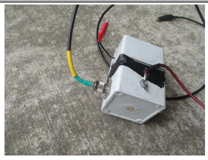
I didn't attempt to computer-simulate the outcome but instead took the "experimental" approach as it provides insight into the practical world and takes into account locality, mounting and cable resonance effects. I knew that it was going to produce a complex impedance regardless of frequency, and in most cases that impedance would be a relatively high value.

Enter the RF equivalent of an autotransformer… The major difference at RF is that while it does provide an impedance transformation, it does introduce considerable inductance into the configuration. This series and shunt inductance effect alters the way you have to think about how it will affect the tuning of an antenna that it is used with. It is not just a series inductance that provides an electrical loading (or effective lengthening) of the physically short wire antenna because there is a shunt inductance as well that affects where it tunes plus there is the impedance transformation to account for too.

My RF autotransformer consisted of an ABS box holding a FT140-61 ferrite core wound with 1.0mm diameter enameled copper wire, tapped about every 2 turns, then 3 turns etc, and a SO239 coaxial socket. The outer of the socket went directly to one end of the winding and also to a screw/nut/lug through one side of the box. Each successive tap went to another screw/nut/lug on two other sides of the box, a total of 9 tapping points being established. The centre pin of the SO239 went to the second tap point as well – or tap 2. The estimated impedances just through the transformer action were about 25 ohms at tap 1, 50 ohms at tap 2, 70 ohms at tap 3, 120 ohms at tap 4, 200 ohms at tap 5, etc.. In essence I had a plastic box marked with tap points numbered 1 to 9 plus a common ground point and an SO239 coax connection. Those only account for the effective transformer ratios though – they did not take into account the inductances introduced. The following inductance tree was created by measuring/guessing with a digital LCR meter on the 2mH range:

TAP POSITION	INDUCTANCE	TURNS
1	1uH **	1
2	2uH **	3
3	4uH	5
4	7uH	7
5	14uH	10
6	20uH	12
7	32uH	15
8	40uH	17
9	60uH	21
	** Guess	

The values are not going to be overly accurate as the LCR meter operates at 1KHz, rather than at RF, but will provide an indication of the magnitudes of inductance being introduced.

<table>
<tr>
<td>
The inside view of my RF autotransformer. The blue wire jumpers across to tap2, the earthy side of the SO239 is connected to the bottom of the toroid.</td>
<td>
The flylead is the ground connection and in this photo, the variable inductance is screwed onto the back of the transformer.</td>
</tr>
<tr>
<td>
The variable inductance is calibrated in microhenries (uH) as determined by the LCR meter. The switch is a 12 position rotary and its contacts connect to taps on a FT240-61-based toroidal inductor. Either red clip can be used as input or output and it can be used as a series or shunt inductance depending on requirements.</td>
<td>
The two boxes are joined together by short metal straps and metal-thread screws. This view shows the SO239 and ground screw connections a little clearer.

I use several sleeves of coloured heatshrink when terminating all of my coaxes to connectors and seldom use the same colours in the same order so that I can readily identify which coaxes are connected between any two particular points.</td>
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My experience is that if an antenna matching arrangement is correctly set, the band noise in the receiver is maximised. I set up a HF transceiver via an SWR meter as one part of the testing arrangement but also had a low power crystal oscillator set up as a signal source, along with crystals at 3.5, 7, 10 and 14 MHz bands and their harmonics for the higher HF bands. The signal source was set up on a short telescopic whip antenna (about 70cm long) at a reasonable distance from the squid pole antenna and then tuned to on the receiver. The tap on the RF autotransformer was then selected / adjusted on each band to provide maximum received signal and the results tabulated for later assessment. The optimum results were recorded as per table 1.

Table 1:

Frequency (KHz)	Tap point
3610	9
7060	5
10130	3
14190	5
18150	6
21175	5
24945	3
28235	3
50090	3

The next test was to transmit with low level RF power via the SWR meter and tabulate the values at the tap settings for each band, table 2.

Table 2:

SWR	Tap	--->							
Freq	1	2	3	4	5	6	7	8	9
3605	>20:1	>20:1	>20:1	>20:1	>20:1	>20:1	>20:1	>20:1	10:1
7085	>20:1	>20:1	10:1	2.5:1	3:1	8:1	>20:1	>20:1	>20:1
14180	>20:1	>20:1	9:1	6:1	5:1	4.5:1	11:1	9:1	>20:1
21190	>20:1	10:1	4:1	2.0:1	1.6:1	2.5:1	5:1	10:1	>20:1
28460	7:1	6:1	5:1	4.5:1	8:1	10:1	>20:1	>20:1	>20:1

Then as determined from the previous tests using the optimised tap settings values, the lowest SWR found was around 2:1 on 21 MHz. Changing to even alternate adjacent taps gave even higher SWR values, this time with the 10, 18 and 24 MHz bands being included in the tests. Table 3.

Table 3:

Frequency (KHz)	Tap point	SWR measured
3610	9	10:1
7060	5	3:1
10130	3	8:1
14190	5	10:1
18150	6	5:1
21175	5	2:1
24945	3	3.5:1
28235	3	4:1
50090	3	5:1

As a matter of personal interest, the actual resonant frequency of the 7 metre whip was checked directly wired as being about 9175KHz, about 1MHz lower than the theoretical value. A calibrated series inductor (photos above) was then inserted in series and the resonant frequency re-measured – Table 4.

Table 4:

Series Inductance ***	Frequency (KHz) ***
0 uH	9175
5uH	8875
8uH	8225
12uH	7770
18uH	7200
25uH	6970

*** Approximate values only

The series inductor was then removed and the RF autotransformer re-inserted. The resonance was then noted at taps 3, 4 and 5 and was found to be around 8400 KHz, 7550 KHz and 6130 KHz respectively. This provides so indication that the effective series inductance was in the order of 7uH at tap 3, 15uH at tap 4 and probably in the order of 40uH at tap 5. This really goes to demonstrate the inductive loading effects of the RF autotransformer, i.e. series and shunt inductances.

An LDG Z100 auto-ATU was then included in-line to the auto-transformer and whip antenna and the operation on the various bands via it was checked. The ATU was able to effect an impedance match on all bands, even on 3.6 and 21 MHz.

Returning to “grounding” the bottom end of the matching arrangement, there are two main methods used in practice. The first is bulk metal style: the drawbar of the caravan, the long metal fence, the large metallic garden shed frame or maybe even a really good ground stake in perpetually moist highly conductive soil. The second style is a tuned radial form: a set of wires just under or just above the ground/soil each a ¼ wavelength at the operating frequency(/ies) or a trapped / loaded radial system of one or more radials. Both forms work but sometimes not without introducing side effects.

The most obvious side effect is when quarter-wave radials, either straight wire sections or loaded/trapped, provide a resonance effect at the operating frequency such that the effective SWR becomes the bandwidth of the radial rather than the bandwidth of the radiator. It does not help when you are tuning the antenna as changes are masked and it is easy to lose track of what you should be adjusting – the radiator or the radial wire. I have recently become a proponent of the bulk metal style “ground” where such ground-plane resonance effects are not as pronounced, regardless of the effect on overall antenna efficiency. That resulted in my bonding the ground side of the antenna matching network to the car wheel, the caravan drawbar etc instead of my previously-preferred/used trapped radial system.

My conclusions were that the 7 metre wire inside the squid pole was only going to be useful if (1) effectively matched and (2) operated against an earth plane / counterpoise suitable for the frequency in use. I knew those facts going in but it is good to be able to confirm them in practice.

Further, the matching arrangement should really be placed at the bottom of the whip and could be of the form of either a manual or automatic L-C style ATU (e.g. Icom AH4 auto-ATU) but the RF autotransformer was a viable alternative IF the user was prepared to alter the tapping point as different bands were to be used and an auto-ATU was used at the transceiver end of the coax feed. The autotransformer option could be remoted by the use of a stepper motor operating a suitable rotary switch with the selection point under the control of a PIC controller.

My use will be limited to 100 watts from a mobile/portable transceiver so power rating of the components is not as critical as at 400W or 1KW, even though the FT140-61 used in the autotransformer will still operate to around 400 watts without saturating. Of course, you don't use RG58 feeders at the 400 watt power level...

Make sure you visit:

http://www.earchi.org/92011endfedfiles/Endfed6_40.pdf (http://www.earchi.org/92011endfedfiles/Endfed6_40.pdf) (local PDF copy (http://www.vk4adc.com/UserFiles/File/squidpoles/Endfed6_40.pdf)) to see a method of creating a 9:1 UnUn transformer for use with end-fed antennas.

http://www.philipstorr.id.au/radio/technical/Squid%20pole.pdf (http://www.philipstorr.id.au/radio/technical/Squid%20pole.pdf) (local PDF copy (http://www.vk4adc.com/UserFiles/File/squidpoles/Squid%20pole.pdf)) by VK5SRP for an alternate method of using the basic squid pole to mount centre-loaded antennas for various HF bands.

http://www.perite.com/vk7jj/squidpoles.html (http://www.perite.com/vk7jj/squidpoles.html) (local PDF copy (http://www.vk4adc.com/UserFiles/File/squidpoles/VK7JJ%20squidpoles.pdf)) is the original article referred to by Phil VK5SRP

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Subsequently, I could foresee using this revised squid pole antenna more on my caravan so that I could operate portable using a fairly broadband antenna rather than the currently used set of helical mobile whips – which all have a fairly narrow operating bandwidth. I set about revising the mounting method so that I could quickly install and set it up, still without limiting its future use on the hinged wheel mount.

That 50mm PVC high pressure pipe sleeve remained as the best way of mounting the pole and by that using a couple of 50mm PVC sleeve joiners plus a short length of tube, I fabricated an easy push fit arrangement onto an existing 50mm vertical metal mounting pipe on the draw bar (or A-frame) of the caravan. The same mounting arrangement could have been achieved quite quickly using a 50mm PVC high pressure pipe T-piece but I had the other plumbing fittings on hand.

When not in use, the protruding 7 metres of hookup wire is simply wound up and tied off just near the mounting base.

 The squid pole with the new mounting in place at its base. The black paint job was to make it similar to the squid pole colour plus that of the drawbar on the caravan.	 The mount still uses the original 50mm tube with the split at the top plus two 50mm tube joiners and a short length of 50mm PVC tube as well. These latter pieces could be replaced with a single 50mm plumbing T-piece. The wound-up hookup wire is easily seen in this view even though the black-shrouded croc-clip on the end isn't super-obvious.
 The top mounting tube containing the squid pole simply pushes into the bottom section and the wire through its base is fed out a 13mm hole in the joiner section. PVC glue was used on the fabricated section but not on the squid pole tube - just in case I later had an even better mounting idea !!!	You might be asking what the red rope and the PVC tube is for. Quite simply, it is a pull-to-remove arrangement as the PVC fitting over the metal tube is quite tight and it is easier to pull on that handle than on the whip mounting tubes : it is far easier to grip.
 This is the whip mounting ready to slide over the 50mm metal tube on the caravan drawbar. I had to scrape paint off the pipe to get the PVC joiner tube to even fit over it - hence the rope and handle...	 The whip mounting is in place. Now it is a matter of unwinding the black hookup wire so it can feed back into the whip itself as the sections of the squid pole are extended.