160-80-40 Metre Trapped V - Dipole

2 June 2017

PLEASE NOTE: The construction details that follow are for temporary installation (eg portable for a contest duration). Permanent installations will require additional ruggedising and waterproofing however the basic electronics concepts remain the same.

Mouse-over images for larger view.

The Trans Tasman Low Bands Challenge is coming up on the contest calendar shortly and there is a possibility that I might be portable that weekend so that presented an additional challenge: I don't have an efficient 160 metre antenna available when portable. The other thing is that the Low Bands Challenge is only for 40, 80 and 160 metres. Yes, I have a trapped V that I can use on 80, 40 and up to even 6 metres but I didn't really like the concept of multiple antennas and switching coax feeders. That meant building up a new portable antenna just for 160, 80 and 40 metres with frequencies around 1840, 7120 and 3620 as the targets for each band.

A quick Google search produced an 80 and 40 trapped dipole V, with an option to do 20 metres as well: http://vk3zpf.com/trapped-dipole-antennas (http://vk3zpf.com/trapped-dipole-antennas) The wire lengths for the 80/40 version weren't really published in that article so that meant doing it all from scratch… as well as doing the 160 metre band inclusion.

Before I go further, there are a few concepts around about the tuning of the traps:

1. Tune toward the low end of the band eg 7000-7030 for operating frequencies of 7100
2. Tune at the operating frequency eg 7100
3. Tune to the mean of the two bands being used each side of the trap – eg 7100+3620 = 10720 /2 = 5360 KHz. Using this technique supposedly makes the tuning of the individual dipole sections easier but I have had good success without really resorting to this idea.

I chose to try #2 simply because I forgot to stop 'down the band a bit' when I was trimming the traps – and it isn't easy putting coax bits back together!!! I know I could have just replaced the coax inside each trap with a longer piece and started again but RG316 teflon coax is not cheap or usually easy to come by.

My approach was to build up two traps for 7100 KHz plus two more on 3590 KHz, details later, then create each band's (effective) dipole before adding the next band's wire. An important thing to take note of: check if your 1:1 balun is rated down to 1.8 MHz – in my case, it was a Comet CBL-2000 rated from 0.5 to 60 MHz at 2KW so that was ok for 160 metres.

The other factor is that I like to have preset lengths between the antenna traps and frequency adjustments at other than the lowest band is via "tails" - dangling short lengths of wire attached at the centre(/balun) side of the traps (as appropriate). That means that the wire lengths between the traps is actually shorter than normal as the "tail" adds to the length to make up the entire 'dipole' for that band. The other feature is to not cut the dangling tails but simply wind back up along the wire towards the trap connection thus allowing for future fine tuning when the antenna is used as different heights (and the centre frequency changes!). My wire "tails" always use solder lugs on one end to attach at the trap so that you can always replace them with longer ones if you do trim them too short along the line. In a similar vein, the outside / longest dipole leg wires are wound back along the antenna wire to adjust their lengths – not cut and terminated exactly to length.

Apart from those things already mentioned, the construction is fairly easy. Be aware that using antenna traps narrows the SWR curve versus a standard antenna dipole but the trapped arrangement has two factors that are beneficial :

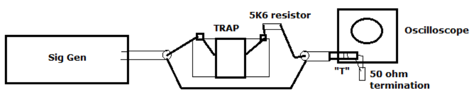
1. Shorter overall physical length (eg the antenna described here is 26.3 metres long versus about 40 metres for a standard half wave dipole, i.e 2/3 full size)
2. Multi-band operation with a single coax feeder….

THE TRAPS

The traps are made from 85-90mm long pieces of 49mm OD PVC plumbing pipe (DN-40), with holes spaced 60mm apart for the trap termination screws. The 80 metre trap is 26 turns of 1.25mm enamelled copper wire (about 4.15 metres of PEI wire required) coiled to 40mm in length (i.e. closewound) giving an inductance of about 25.7uH. It requires around 76pF to resonate at 3600 KHz, and in my case the capacitor was created with a length of RG316 teflon coax soldered across the coil, inner to one end and outer to the other, loosely coiled and placed within the coil former tube. Be aware that the RG316 is ok for transmit powers to 100 watts – if you are going to run higher transmitter power then you will need to upgrade to RG58 coax or better. The RG316 cable has a nominal internal capacitance of 96pF/metre but always start with a much longer piece than calculated as the coil may not be exactly the inductance expected and it is fairly simple to cut off a bit of the teflon coax, a few mm at a time rather than adjusting the coil itself. My trimmed length for 80M finished up at about 740mm of complete coax (plus another 40 to 50mm of separated inner and outer to the solder lugs) but RG316 starting length value should be at least 850mm to 900mm. (Other coax: different velocity factor = different lengths required)

The 40 metre trap is 16 turns of 1.25mm enamelled copper wire (about 2.6 metres of PEI wire required) coiled to 25mm in length (i.e. closewound) giving an inductance of about 12.8uH. It requires around 39pF to resonate at 7100 KHz, and in my case the capacitor was again created with a length of RG316 teflon coax soldered across the coil, inner to one end and outer to the other, loosely coiled and placed within the coil former tube. My 40M trimmed length finished up at about 370mm of complete coax (plus another 40 to 50mm of separated inner and outer to the solder lugs) but starting length value should be at least 450mm to 500mm.

The traps were tuned to the final frequencies using a signal generator and an oscilloscope, cutting the RG316 slightly each time until the frequency was close to that desired, ideally with each of the pairs of traps within about 20-25 KHz of the other:



The series 5K6 resistor plus the parallel 50 ohm termination on the CRO 'T" was used to ensure that the absolute minimum was seen without the input capacitance of the CRO affecting the resonant frequency of the trap.

Fine tuning can be done by removing a part of the coax's shroud at the cut end (eg 10mm) and simply bunching up the braid over the inner dielectric. Make sure it is physically stable and weatherproof afterwards if you use this technique.

See also Tuning Traps Info (/~vk4adc/web/index.php/hf-projects/46-antenna-traps/114-tuning-hf-coax-traps)

DIMENSIONS

Make sure that longer main wire lengths are used initially when setting up and then trim back as needed for termination and/or coarse tuning:

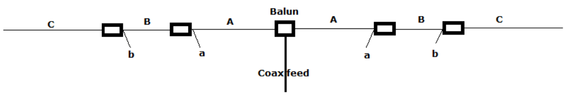
Length A : 9.16 metres, Tail 'a': 550mm – with 140mm of wind-back (= 410mm actual) = 7090 KHz

Length B : 5.80 metres, Tail 'b': 300mm – with 110mm of wind-back (= 190mm actual) = 3590 KHz

Length C : 10.30 metres with 650mm wind-back (ie 10.95 metres of wire each side) = 1830 KHz

These frequencies are intentionally on the low side as the antenna leg heights were not as high as would be expected in an actual portable environment. Note: Installing with the wire legs higher above the ground will cause a frequency shift upwards!

The frequencies above were as read off my homebrew impedance analyser with indicative SWRs of below 2:1 across some sections of all bands. Final SWR tests have been done with low transmit power and an SWR meter to produce graphical indications of the SWR bandwidths (tabulated below).



I used some old RG-58 sized coax as the wires between the 40 and 80 metre traps and also the 160 metre end sections simply because I didn't have enough of the 2.5mm sq building wire (as used for the 40m dipole section) to do the whole lot from that material. The coax shroud was trimmed to give about 20mm of braid visible, the braid was then pushed back to show about 15mm of inner dielectric and that was removed exposing the inner conductor. The braid plus inner were simply drawn out together and fed into a solder lug for termination and soldering. The use of the coax effectively makes for a larger diameter conductor (i.e. the braid diameter) and hopefully lower losses without the weight of the likes of hard drawn copper wire.

SWR DATA

Freq	SWR	
7000	1.7	
7010	1.55	
7020	1.5	
7030	1.4	
7040	1.35	
7050	1.3	**
7060	1.35	
7070	1.35	
7080	1.45	
7090	1.5	
7100	1.6	
7110	1.7	
7120	1.75	
7130	1.8	
7140	1.9	
7150	2	
7160	2.1	
7170	2.2	
7180	2.4	
7190	2.5	

Freq	SWR	
3500	7	
3510	6	
3520	5	
3530	4.5	
3540	4	
3550	3.56	
3560	3	
3570	2.2	
3580	1.75	
3590	1.35	
3600	1.05	**
3610	1.2	
3620	1.65	
3630	2.1	
3640	2.6	
3650	3.2	
3660	3.8	
3670	4.4	
3680	5	
3690	5.5	
3700	6	

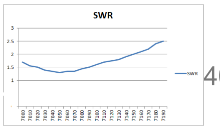
Freq	SWR
1800	2.6
1810	2
1820	1.6
1830	1.15 *
1840	1.15 *
1850	1.6
1860	2.1
1870	2.8
1880	3.5

Note that the lowest 40 metre SWR is on 7050 KHz, which while not in the primary SSB segment of the band, simply means that the 40M adjustment tails on each side are slightly too long and need to be wound-back up a bit more.

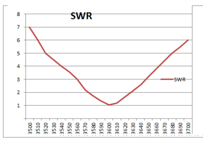
The lowest 80 metre SWR is right on 3600, but maybe it should be up 10 to 20 KHz higher to centre it for SSB operation.

The lowest 160 metre SWR is right on 1835, around about right for SSB operation.

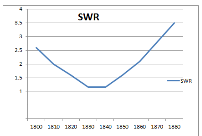
Note that these frequencies will move with different antenna heights, either centre and/or the leg ends.



40 Metres



80 Metres



160 Metres

The more important info to be gleaned from these results is the shape of the SWR curve on each band, particularly the 2:1 SWR bandwidth. The lower the natural SWR at the desired operating frequency, usually the antenna willperform more efficiently! { Basic solid state HF transceivers (ie no tuners inbuilt or in-line) usually want an SWR of less than 2:1 for proper operation. }

The use of in-line tuners to synthesise a 50 ohm impedance match may make the transmitter deliver more RF power but certainly does not improve antenna efficiency.

Project Images Mouse-over images for larger view.

The completed antenna sides wound up for storage...

A pair of traps, one marked 7130 and the other 3590. Note the differences in the coil\ lengths under the white insulation tape, 25mm at left and 40mm at right.

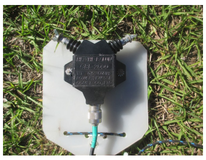
The 80 metre trap as a closer view. The wingnut at top LHS is used to attach the 160 metre dipole wire as the V/dipole might be used as just a 80/40 version when 160 operation is not required.

The 40 metre trap in clearer detail. The wires to and from this trap are permanently terminated with the wire through the hole in the former plus the nylon tie taking the stress of the antenna weight - rather than the 3mm coil termination screws.

The "top" end of the 40 metre trap

The "bottom" end of the 80 metre trap - note more RG316 is coiled inside the coil former than was used in the 40 metre version

The "top" of the 80- metre trap.



The Comet CBL-2000 1:1 balun, 0.5 to 60 MHz and 2KW power rating. The piece of chopping board as a backing makes it easier to hang vertically in some situations.

Now it is a matter of whether the portable operation requirement for the Trans Tasman Low Bands Challenge actually comes off… (If not, it will eventually be used in a portable setup somewhere along the line.)