Amateur 70CM Band Repeater Coaxial Collinear Whip: Mt. Climie 860

Author: John M Wysocki ZL2TWS (June 2011)

Mt. Climie is a high elevation site north of the Capital city of Wellington, New Zealand. The altitude above sea level is 867 meters or 2845 feet. Mt. Climie is exposed to weather from the Southern Ocean with an unobstructed view towards Antarctica.

During the winter freezing conditions leave the antennas covered with snow and ice for many hours or days on end. High wind speeds of 170kms/hr are often recorded on Wellington high altitude sites. During the sunlight hours antenna connections are subjected to expansion with sun light and contraction in the cold of night along with adverse weather.

Maintaining the Mt. Climie site had been plagued with antenna connector faults for many years, although the amateur club, Upper Hutt Branch 63 (NZART) has done its best to counter these extreme conditions. The antenna system typically used on site is a four dipole stacked array with a coaxial phasing harness. The VHF repeaters on the same site continue to use these types of antenna but consideration of their continued use will need to be reassessed when they next fail.

The club technicians decided to investigate an alternative antenna system for use on the 23CM 1292 MHz repeater and later the 70CM 438.6 MHz repeater.

A single point RF connection was mandatory in order to eliminate the use of eight plugs and three "T" pieces used in the four dipole stack design. The theoretical gain from a four dipole stack is 6dBd.

On UHF this is never achieved in practice due to interconnection cables and connector losses. The actual gain is not known but we can assume at best 5dBd. A coaxial collinear will have a gain determined by coax loss and the number of elements used over the designed length.

It was decided to experiment with a 4dBd design that would have gain boosted by 2dB when side mounted off a reflector pole. Antenna beam down tilting can also easily be achieved with a coax collinear. This is the "all in one" solution to ensure it can withstand Mt. Climie conditions (as previously outlined).

From the repeater builder's web site an extremely useful article was downloaded regarding the use of coaxial collinear antennas. This is written by Mike Collis WA6SVT.

(LINK: http://www.repeater-builder.com/antenna/wa6svt.html)

In 1986 Peter Williams ZL2ARW had made a design to work on the first Wellington 23 CM repeater 1271.2 MHz. This was based on the CQ Ham Journal Summer 1981 “1200 MHz Collinear Antennas”. This antenna worked well for many years in a harsh environment.

In October 2003 I built and installed a vertical 10M beacon antenna. The idea was to use strong PVC pipe with the dipole inside filled with electrical jointing epoxy compound at the “T” junctions and feeder connection point.

A suitable standoff mounting arrangement was thought out by Ted Colgan ZL2TED. Strong wooden blocks were nailed into the wooden pole and the PVC horizontal sections glued in place.

Figure 1 shows the 10M (28.229 MHz) beacon antenna construction.

Figure 1: Mt Clime 10M beacon antenna taken in June 2011.

An inspection in June 2011, almost 8 years on, the antenna is as good as the day it was installed and radiates a solid continuous signal. QSL cards are received worldwide for ZL2MHF (the transmitted call sign from the beacon).

Vertical whips have been tried on both the 6M Beacon 52.275MHz and UHF. These only lasted a few years as the antenna length exceeds that required to withstand the wind and ice loading. Eventually fatigue causes the base to break up allowing water ingress and in the worse case lead to the 6M whip to actually snap clean off. This was found on a maintenance trip on December 2010.

Dipoles were also found to have suffered from “micro bending” of the internal elements. This occurs due to a resonance built up from continuous strong winds. The only way to resolve this problem was to epoxy fill the antenna shroud tube. This traps the elements solid inside the PVC tube, thereby removing the issue.

With the knowledge gained from the successful mounting of the 10M beacon antenna I decided to make a coax collinear from 4 x ½ wave elements of high quality RG-213. The theoretical gain using four elements = 3.5dBd and eight elements = 6dBd. Keep in mind that adding more elements does not mean a linear gain increase. The coax sections have loss and the signal diminishes as the lower sections radiate the energy first.

During final testing using a line of sight signal source the collinear was compared to a single dipole and found to have at least 4dBd gain. As mentioned earlier an additional 2db can be achieved with ¼ to ½ wave spacing from the metal mounting pipe.

The loss could be further reduced, and efficiency increased, with a foam coax but the velocity factor of the cable results in longer elements and an overall longer antenna. Overall size was also important as mentioned earlier.

The 70CM coax collinear is a scaled copy of the ten element 23CM 1292MHz antenna but using fewer elements. An increased number of elements made the antenna longer than the available pole space.

The four element antenna and associated matching sections completed top to bottom was just 2160mm long. Clear space at the top was required for the WA6SVT design. The side spacing inside antenna PVC pipe to inside pole mounting is 150mm.

A total of three of the ZL2ARW 1986 designs were built with different mounting and down tilt corrections on each one. Once Mt. Climie 1292MHz was on air from 29 December 2010, users were able to confirm the antenna had gain and good coverage.

For the 70CM design, elements consist of 4 x ½ wave sections, 1 x ¼ section and a ¼ whip mounted on top. This was based on the original WA6SVT completed antenna.

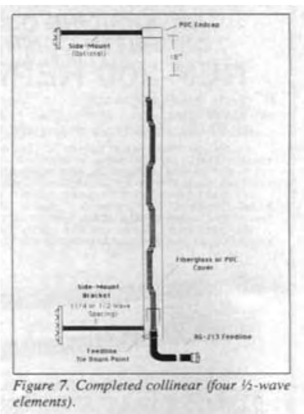


Figure 2: Original WA6SVT design page.

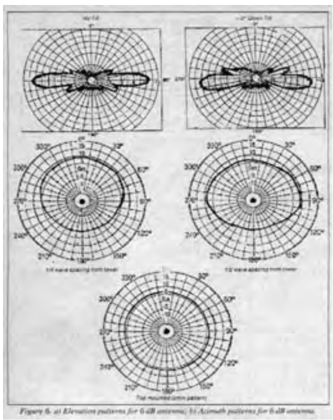


Figure 3: Original WA6SVT radiation

The only difference I made was to use a velocity factor of 0.6 instead of 0.66 to compensate for the "Plasticast" and 2% element shortening for down tilt.
The side mounting was made at three points rather than two for increased strength.

The radiation pattern (see Figure 3) model showing the expected down tilt. "Plasticast" epoxy high voltage electrical jointing compound was poured into the PVC high pressure water pipe allowing the air to escape and used in the "T" pieces for side mounts.

Figure 4: "Plasticast" epoxy high voltage electrical jointing compound poured into the various "T" joints.

A suitable sized circular hole saw was used to make clearance for the PVC horizontal mounts. I used stainless threaded rod after tapping the drilled "T" piece centres. More epoxy was applied to set everything together.

After completing the three horizontal mounts, stainless pipe ring clamps were fitted. Note: that all metal work used quality stainless material.

PVC high pressure pipe fittings obtained from the local plumbing supplies merchant. "Plasticast" was obtained from an electrical wholesaler. It has electrical insulation properties of up to 11kV is waterproof and has a wide service temperature range.

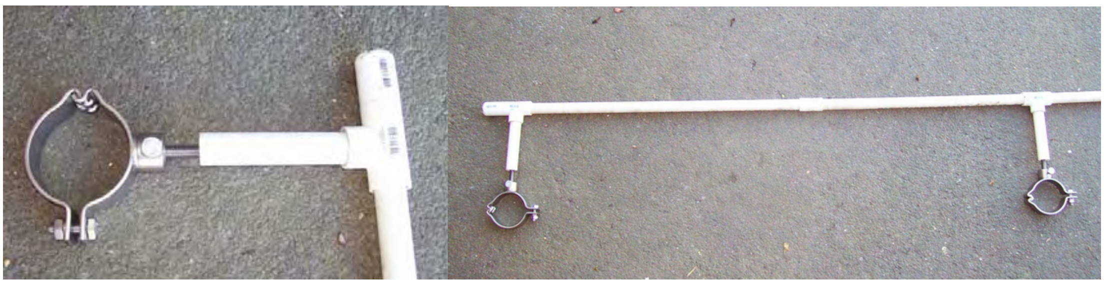
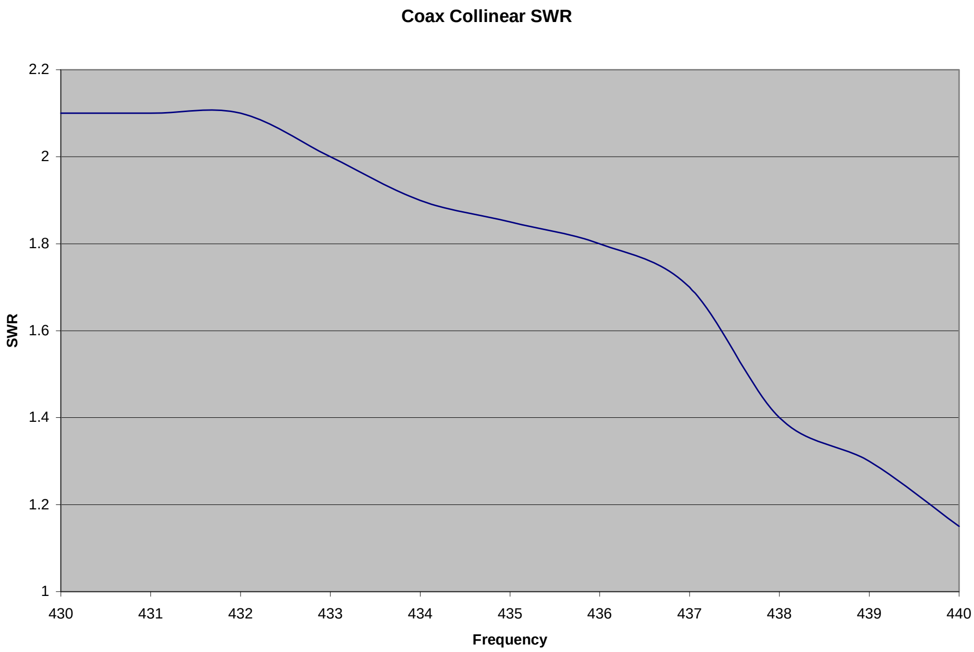


Figure 5: "T" mounting brackets with stainless steel collars for the vertical pole mount.

The bottom section is supported by a swaged stainless sleeve socket. This was designed and manufactured by Phil ZL2HF. The same was used first to self support the 1292MHz coax collinear whip. The PVC pipe is also secured using “plasticast”

Figure 6: Bottom “T” section on the left. On the right is the completed antenna with the coaxial pigtail attached.

Testing was carried out by side mounting to the same diameter pipe as used on Mt. Climie. A 12M length of RG-213 was used to simulate on site cable loss. The following SWR results are graphed below.



After installation at Mt. Climie the SWR was seen to be identical to test results. Note that 2% shorter elements for down tilt cause the SWR to rise on the lower frequencies.

The completed antenna is above the VHF dipoles at the southern site.

Figure 7: The installed collinear on the antenna pole at Mt. Climie. The larger antenna below the collinear is the top dipole of the VHF Stacked array for Climie 5425, data/voice repeater.

After replacing the single dipole antenna 860 signal levels have increased and down tilt has assisted in improving the signals as well. The signal now reaches areas not line of sight with ease.

Stations on the eastern side of the Lower Hutt Valley and Wainuiomata all report workable signals.

Reports from Jim ZL2ADO from the Wairarapa have gone from S-9 to 60dB over. Simon ZL2FAE in Waikanae can now work 860 where previously it was not even received. Neil ZL2TNG can now work 860 using 1W where he previously needed a minimum of 5W.

Paul ZL2UGR and Justin ZL2UGL all report stronger signals from the western shielded side of Newlands with Mike ZL2MM in south Wellington also reporting a signal strength increase.

Special thanks to Phil ZL2HF, Simon ZL2BRG and Jens ZL2TJT with their assistance.

References:

1) "A High Gain Collinear for 1296MHz" Q-Bit 1986 Peter Williams ZL2ARW.
2) "Omni-gain vertical for VHF and UHF" Mike Collis WA6SVT.
3) "Build a 9dB, 70cm, collinear Antenna from Coax" N1HFX.