23 cm Band Repeater and Coaxial Collinear Antenna for Mt. Climie 1292 MHz

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Revision: MK2 Antenna added (May 2013)

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.
A superb site for a 23 cm band FM repeater.
The following is a sequence of events leading to the construction of the repeater and its antenna.
Construction detail is published below to assist anyone wanting to make there own home base antenna.

A 23 cm FM Repeater 1271.2 MHz was already operational for many years from a central Wellington site of Mt Victoria. Very limited coverage and QRM prevented this repeater from being useable to the majority of active amateurs.

A group consisting of Jens ZL2TJT, Chris ZL2DX, Paul ZL2UGR, Michael ZL2BPL and John ZL2TWS were all having difficulty making contacts through the 1271.2 MHz repeater.
In August 2008 Jens ZL2TJT sent out an email to active and potentially active 23 cm band users simply titled “Show of hands, 23 cm repeater?”

The response was unexpected. By March 2009 there were twelve people wanting to be involved. Branch 63 NZART were prepared to host the new repeater. Power needed to be connected to the North Hut at Mt Climie and the 19 inch rack secured to the floor.
The old 860 4 dipole stack pole was chosen as a suitable antenna location
Mark ZL2UFI, as repeater administration trustee, became the project manager.

Many hours of work were required to both build a repeater from scratch drawings and have an antenna constructed to withstand the ice and high wind loading at Mt Climie.
John ZL2TWS and Chris ZL2UKT connected a 230V feed cable and switchboard. Phil ZL2HF, Mark ZL2UFI and Mark ZL2UP secured the 19 inch rack in position.
The club membership became fully involved in this new project.
New member Simon ZL2BRG became involved and soon after was elected to be repeater trustee filling the position previously held by Neil ZL2TNG.

Many donations of equipment, expertise and labour were received by the club.
This had become a Wellington regional project encouraging new membership.

John ZL2TWS and Simon ZL2BRG headed the technical team and set about purchasing suitable 23 cm RF / VHF IF equipment. Minikits Australia was chosen for the 23 cm RF deck as they sold a repeater package. Simon ZL2BRG built the RF deck while John ZL2TWS built the VHF IF deck consisting of a surplus Tait VHF repeater.
John also built the linear PSU, donated the 23 cm duplexer and antenna package.
Chris ZL2DX supplied RF cables and filters for the final RF deck assembly.

Paul ZL2UGR completed the VK5DJ repeater controller donated by Neil ZL2TNG.

Jens ZL2TJT and Malcolm ZL2UDF worked on restoring the antenna pole.

Malcolm ZL2UDF took his turn at grinding the heavy rust layer off the standing lower section of the pole. It was then primed with anti rust paint.

Jens ZL2TJT took the top section home, ground it clean, cut it into two to one proportions for later determination of which to use.
Phil ZL2HF welded blanks on both cut ends.

One omission was not seeing that the large holes in the two flanges were not the same pitch circle, only the smaller holes matched up.
On the day of installation this omission meant that Peter ZL2HM, also repeater Trustee, had to go back down the hill to scratch up another set of smaller bolts and nuts.

Mark ZL2UFI, Peter ZL2HM and Jens ZL2TJT got the cable fed through an existing PVC conduit after cleaning a bit of debris out of it, by dragging bits of rag through with the aid of very handy electricians "snake" borrowed from Chris ZL2UFT.
The pre-terminated 10m length of Heliax was just long enough to reach from the antenna and securely inside the hut.

Coaxial Collinear Antenna

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. It failed due to a mechanical corrosion at the base N connector mount.

I decided to improve on this design where the mechanical failure had occurred. This was done by extending the lower section of the antenna shroud, turning it into a solid base with coax feeder connection tail. Two antennas were built. The first one with a short tail (pictured here), the second was finally installed at Mt. Climie with the longer tail.

Phil ZL2HF designed a mounting sleeve socket fit for this purpose. This was the first antenna and was later replaced with a longer tail version for ease of connection to the LDF-450 Heliax feeder on site.

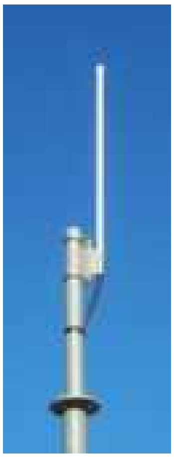
Construction followed the original published article in Reference 1.

The following pictures show the stages of cable preparation.


Elements were cut 2% less than the published length to force downwards beam tilting. Elements tinned using 2% silver solder. The dielectric was then cut off and copper ends tinned. Interconnection as shown below. Centre to outside as in the original design in Reference 1.

Silver plated wire was wrapped around the connection point for sweat soldering to the copper sleeve balun. A hot plumbers iron was used for a quick solder. This avoids over heating the coax braid and melting the coax dielectric. The antenna is now complete and ready for fitting to the PVC shroud.


“Plasticast” Epoxy resin cable jointing compound was used to fill the PVC pipe encasing the assembled coax collinear. My method to do this was to cap the end of the cut length of high pressure water pipe. The pipe is a 17.5mm ID and 21mm OD. Available from plumbing merchants. A cut off plastic soft drink bottle fits perfectly over the top of the open end of the pipe. Note the pipe has to be on an angle to allow the air to escape. Resin is mixed in a tin can and poured in to half fill the pipe. The assembled coax collinear is then pushed down to the end of the pipe cap. Air and excess resin escapes back into the funnel. The resin starts to harden after 15 minutes so planning is essential. I used a heat gun to warm the outside of the tube causing it to expand before the collinear was pushed down the pipe. This helps as the clearance is not great. The aim here was to increase the gap between coax and pipe to ensure resin had settled around all coax elements and air could escape. The next day the end cap was cut off to reveal a solid resin knob. I was convinced that all the resin had surrounded the coax element.



With a high speed cutting disk the resin knob was cut off. The tuning stub could now be adjusted. A sliver plated 3mm diameter wire was used to fine tune the antenna. After tuning a new cap is resin filled and placed back on top. A small 2mm hole is required to release the air as it is pushed on. Tape around the hole until the resin has hardened.

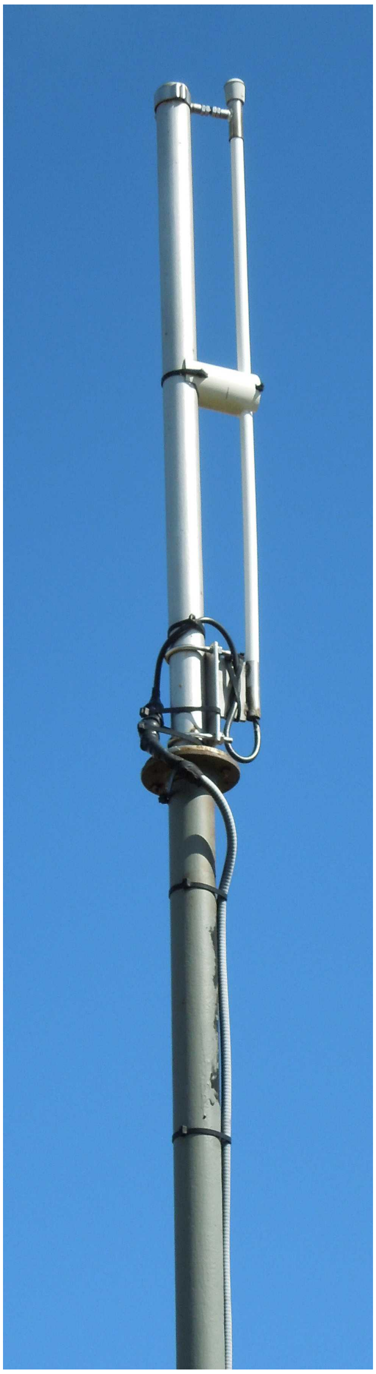
SWR 1.35 on 1292 and 1.5 on 1272

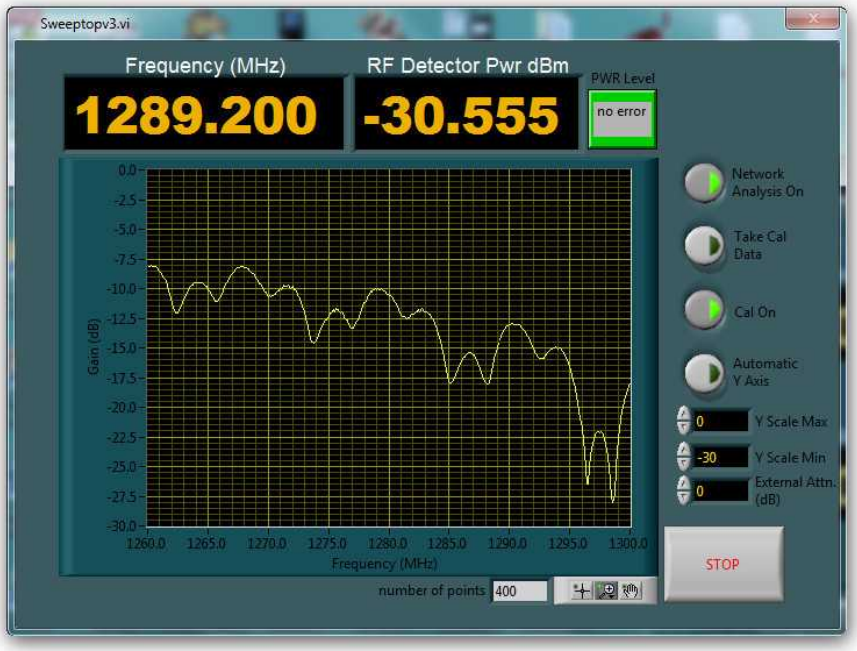
Completed antenna as installed 29th December 2010

After switch on contacts logged were ZL2BRG, ZL2TJT, ZL2DX, ZL2TWS, ZL2UFI, ZL2UGR, ZL2NN, ZL2UGL, ZL2BPL, ZL2HI. Soon after ZL2ADP joined the list of users. ZL2TDN and ZL2BPS have joined the users group in 2012 and 2014. ZL2TNG has been worked sometimes when in Upper Hutt with his portable.

MK2 Antenna (side mounted May 2013)

After two years of service and many severe winter storms the base of the antenna snapped off. Somewhat of a surprise as this new antenna was supposed to be stronger! Not to be beaten I build yet another antenna but this time side mounted it. The short stub pipe shown above was removed and replaced with a longer pipe. I did not use epoxy resin this time because when the broken antenna was opened up for inspection I found contamination of the copper braid from the epoxy resin. Clean copper has better conduction at these frequencies. Each coax section was changed to use a standard VF of 0.66 but retained 2% down tilt as seen in the plots. (Higher resonant frequency but used lower causes down tilt) The new antenna was installed May 2013 and has now completed 18 months of trouble free service. Network analyzer sweeps showed the frequency response varied due to feeder cable length. The antenna choke was not working perfectly and not easily adjusted. The return loss reduced after installing at Climie but was still acceptable with 10m of LDF-450 feeder connected. Field strength testing showed an increase in signal in some areas in front of the antenna. This indicated a gain from the mounting pipe acting as a reflector. The antenna pipe length was extended so that the top SS pipe clamp and metal cap did no influence the antenna tuning.





Reference 1:

"A High Gain Collinear for 1296MHz" Peter Williams ZL2ARW (May 1986)

A High Gain Collinear Antenna for 1296 MHz

by PETER WILLIAMS, ZL2ARW

The design of this collinear was developed last year to be used as the antenna for the Wellington 120 repeater. It is however also ideal for home station use, and if the size is reduced, for mobile operations. The antenna to be described has 10-elements, providing nearly 10 dB gain over a dipole.

The requirements for the repeater were for a vertically polarised antenna with an omni-directional radiation pattern, but achieving high gain by reducing the vertical beamwidth. Traditional broadside collinear arrays possess these properties, but are difficult to construct, and to individually feed each radiating element in a large array requires a mess of coax cable or balanced feed lines.

For simplicity it was therefore decided to use a coaxial collinear. In this type of antenna, each radiating element is a half-wavelength piece of coax cable which, as well as acting as the antenna element, also serves as a transmission line to feed the RF to the next element. Because the phase is shifted by 180 degrees passing through each element, the inner and outer of the coax is crossed over before connecting to the next element to ensure all dipoles radiate in-phase.

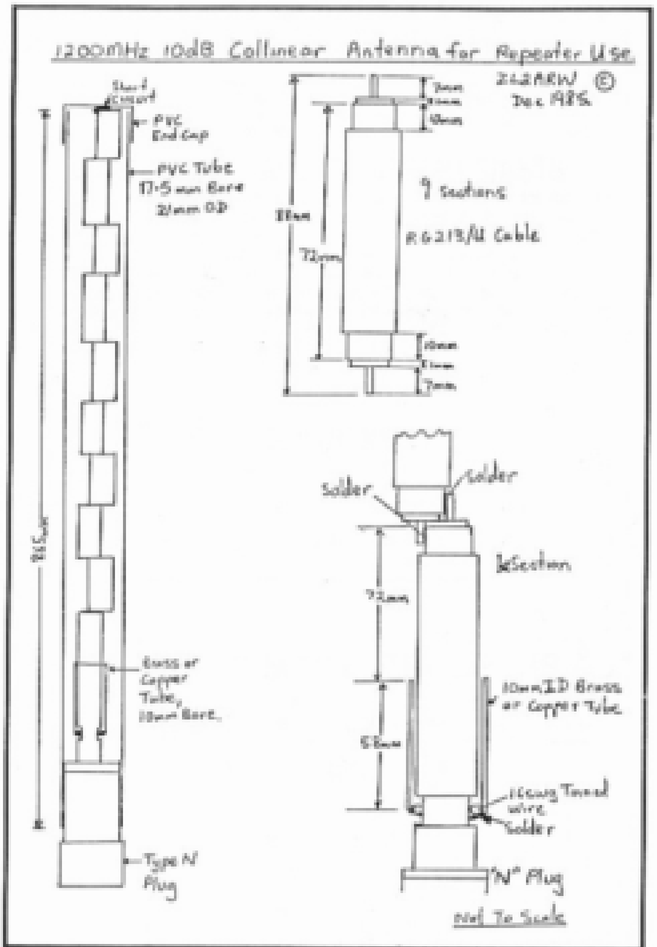
The only problem with this concept is that because a small amount of the RF is radiated from each element, the top dipole receives less power than the bottom one, resulting in slightly less gain than with a uniform power distribution. This is, however, a small price to pay for the ease of construction and convenient shape of this design.

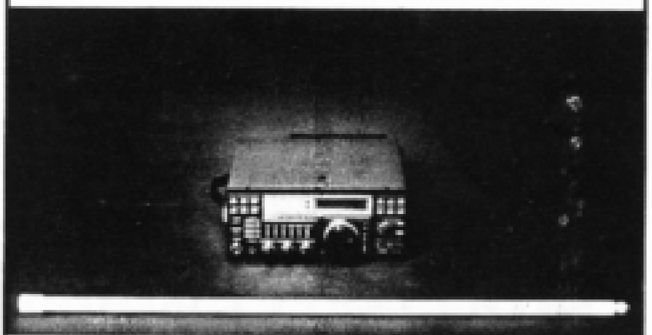
Construction

The antenna is made out of low loss coax cable such as RG213/U or RG8/U. Good quality cable with plenty of braid should be chosen, as we are dealing with microwave frequencies, nearly at the useful upper limit of this type of cable. Do not attempt to use cable offcuts of unknown parentage lying around the shack.

Because of the short wavelength involved, all measurements given in the drawing should be carefully followed, preferably with a tolerance of better than 1 mm. Begin by cutting nine pieces of cable 88 mm long and prepare the ends as shown in the drawing. This is most easily done by first removing the 18 mm of outer jacket, then tinning the braid. A sharp knife or fine-bladed hacksaw may then be used to remove the end 8 mm of braid, followed by a sharp knife to cut away the end 7 mm of polythene.

Attach a straight N connector onto the other end. This should be one of the older type of connector with a long body and 17.5 mm OD. Next "ring-bark" the outer





The 9 dB collinear antenna is shown in the foreground in comparison with the new Icom IC-1271 23 cm transceiver.

jacket of the cable 138 mm from the top end with a gap approximately 10 mm wide, and tin the braid. Wrap a ring of approximately 16 swg tinned wire around the braid.

Cut a piece of 10 mm ID copper or brass tube to a length of 58 mm, to serve as a coaxial sleeve balun and prevent radiation down the outside of the feeder. Using a high wattage soldering iron, solder this sleeve onto the already prepared cable ensuring it is soldered around the circumference.

Next, solder the ten pieces of prepared cable together, alternately connecting inner to outer, and check with a multimeter that there is no short circuit between inner and outer.

Finally, bend the inner conductor of the top end of the top element over and solder it to the braid. The exact length of this shorting link will affect the SWR of the antenna—refer to the paragraph on adjustment to follow. Using a brush or cloth soaked in methylated spirits, remove surplus solder flux from each joint.

Insert the antenna into a length of 17.5 mm ID PVC pipe (available from plumbing suppliers), and put a smear of epoxy glue around the N plug before inserting it into the pipe. The plug should be a tight fit in the PVC tube. The antenna should next be potted in epoxy to waterproof it and add to its strength. A suitable potting compound is "~~Plasticoat~~" 'PLASTICAST' Cable Jointing Resin, sold by NEECO.

Thoroughly mix about half of each container of the 400 ml pack together, and pour into the vertical antenna, leaving the top shorting strap exposed. Allow one day to harden.

Adjustment

If a reliable 1296 MHz SWR bridge is not available, this step may be omitted and the antenna performance will still be adequate.

Contact a transmitter on the required frequency to the antenna via an SWR bridge, using short low-loss feeders. Ensure the antenna is clear of any nearby obstructions. Alter the length of the shorting strap at the top of the antenna for minimum reflected power.

Note that this procedure must be carried out after the antenna is cast in resin, as this significantly alters its characteristics. In fact, the resin and the PVC tube have the effect of reducing the velocity factor of the antenna from 0.66 to 0.60. Because of this, if an antenna is built without being potted, the length of each antenna element would have to be increased by 5.5 mm to compensate.

Lastly, glue a PVC end cap onto the top of the antnna with PVC cement or epoxy.

Reference

"1200 MHz Collinear Antennas", CQ *HAM Journal*, Summer 1981.