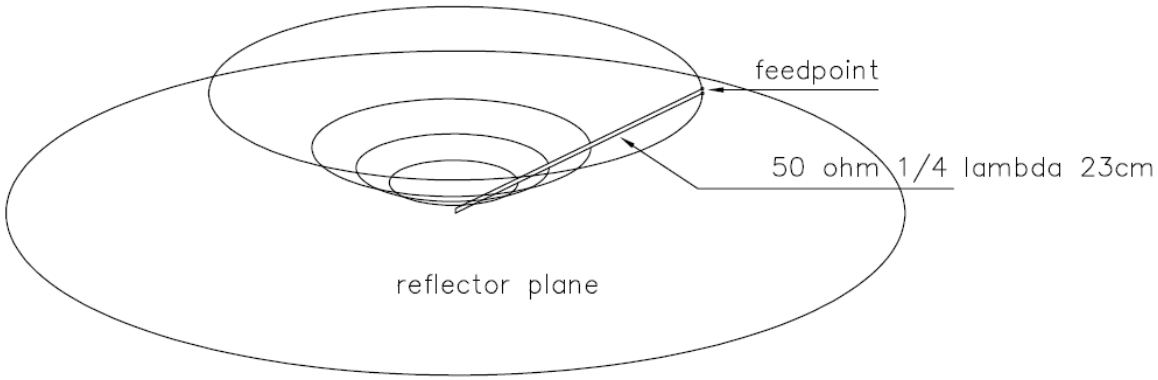
23, 13, 9 and 6cm Dish-feed on one cable.

For many years I have been looking for a 4 band dish feed on my 1.5 m parabolic dish with only 1 coaxial connection. I want to use 1 low loss cable from the antenna to the shack, and no active parts in the antenna mast. Until a few years ago the amateur designs with one cable were limited to LPA, Vivaldi or double rigid-horn feeds. Each type has a number of disadvantages when used in a parabolic dish. Biggest drawbacks are: A phase center which moves with the frequency, and a changing radiation pattern on different frequencies.

My problem seemed solved with the publication of the "BBT 4 band feed" as described in the BBT notes. This feed has the phase center for all bands at 1 position and the same radiation pattern on all bands, but this radiation pattern is not suitable for my dish with a F / D of 0.5. Chris PA3CRX has made some simulations that show that the F / D of the dish for this feed must be around 0.3.

Now what? The same simulations from Chris show that ring feeds as used by many have a great radiation pattern for my F / D 0.5 dish. These feeds have a full wave loop for each band on 1/8 wave distance in front of a reflector plate. Each loop has its own coaxial connection. This therefore does not meet my 1 cable requirement! Connecting the 4 rings in parallel is not going to work, so I have to find of a smart way to put the 4 rings in parallel, in a way that they are all 1/8 wave in front of the reflector plate and have no matching issues.

In a bright moment I came up with the following construction:

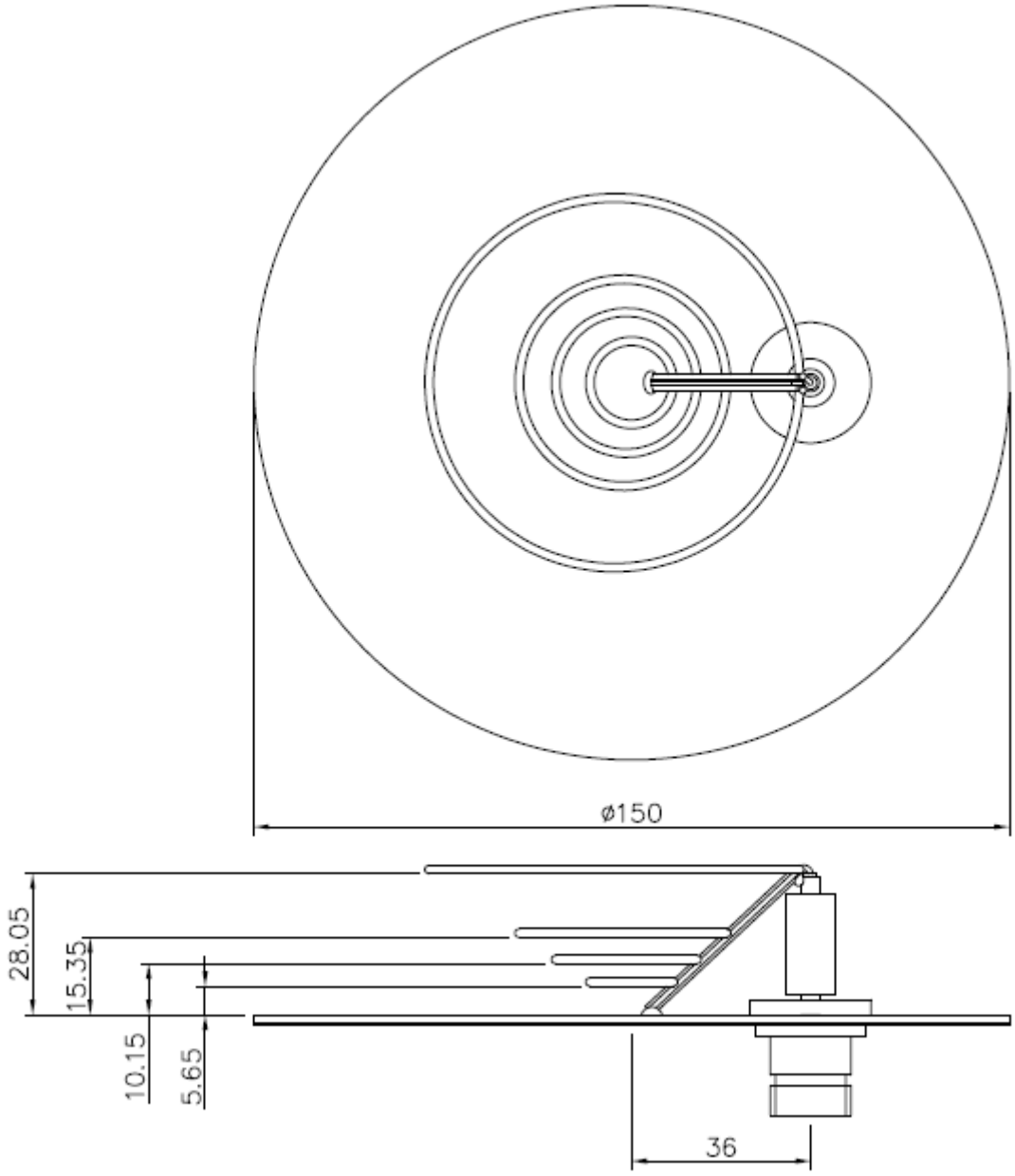


A symmetrical 50 Ohm ¼ wave (at 23 cm) stub runs from the center of the reflector plate to the feeding point of the 23 cm ring. This ring is positioned at 1/8 wave in front of the reflector plate. The stub runs diagonally towards this. The two ends of the ring are soldered at both ends of the stub, the other side of the stub is short-circuited at the reflector center. The rings for the other bands are all soldered to the stub on ¼ wave from the short circuit. They are therefore automatically 1/8 wave in front of the reflector. The antenna is fed at the open end of the stub where the 23 cm ring is attached. For the higher bands, the stub is first a piece of feeding line until the relevant ring, Further on it is a ¼ wave stub that no longer has any influence.

So far the theory. In practice there are still some issues to solve. The most important thing is that we want the rings to be as concentric as possible. In that case the ¼ golf stub must be 46 mm long! However, in air a ¼ wave at 23 cm is 58 mm. So we have to shorten! By making the stub from a strip

of RT-Duroid (0.787mm thick), we get pretty close. At the feeding point I soldered a piece of 3.65 mm semi rigid coax, which goes back through the reflector.

Below a practical implementation of the construction:



- Reflector is made of 1,6mm FR4 epoxy, copper on both sides.
- Stub is made of 0,787 mm RT-Duroid, copper on both sides. (l = 42mm w = 2,4mm)
- A 1mm copper wire is soldered on both sides of the stub for stability
- A ferrite tube is placed around the feed line to adjust the coax to a symmetrical line.
- The length of the rings is a theoretical full wave minus 2 mm.
- Rings are made of 2,5mm2 electrical wire. (d = 1,7mm)
- I had to optimize the 6 cm ring with an extra piece of wire (l = 6 mm), see photo. This is probably not necessary if you optimize the length of the ring.

The above version is the third prototype that I have made and the model I have used in the tests.

I have carried out the following tests:

- Measuring Return Loss on all 4 bands.
- Gain and radiation pattern compared to “double quad” antennas on the 4 bands.
- Power test at 13 cm

Results:

- Return Loss: 23cm -> -18dB, 13cm -> -13dB, 9cm -> -11dB, 6cm-> -14dB*.
- The feed had same characteristics on al bands.
- Forward gain is 1dB less as doppelquad on all bands.
- Main Lobe is little wider as doppelquad.
- The feed can handle 100 Watt on 13cm!

*) with the wire optimization.

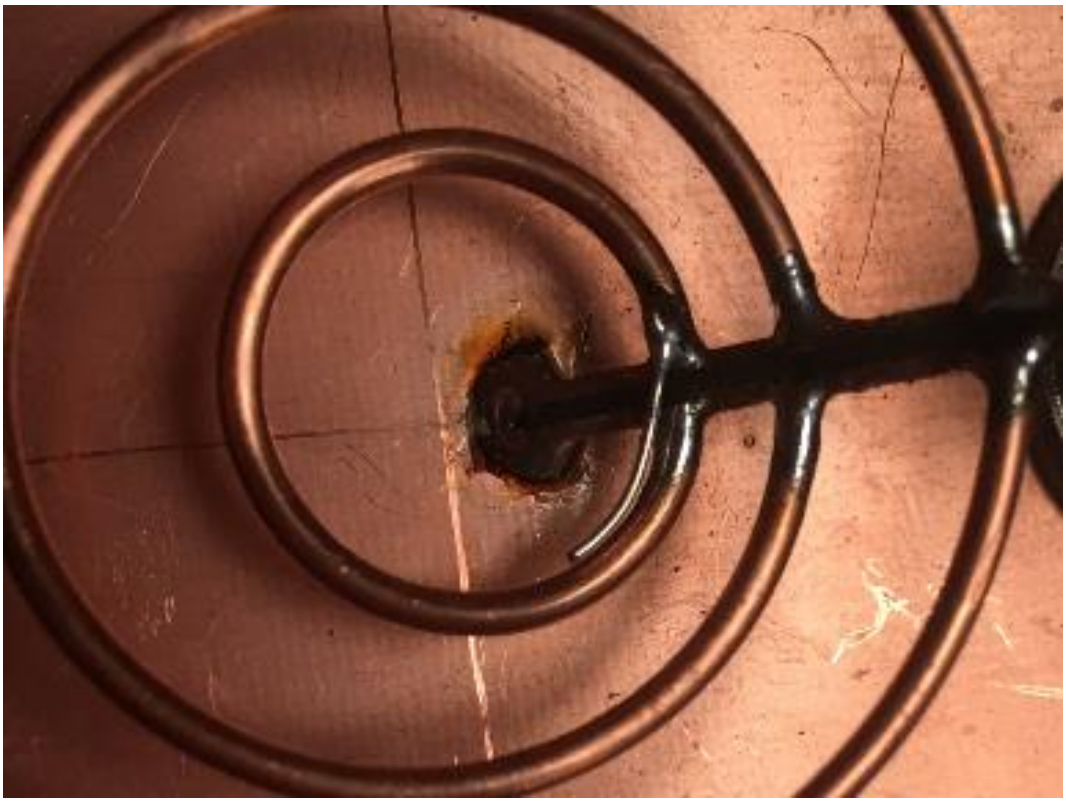
Conclusion:

The Return Loss can be better, I leave it at as it is, for me it works fine. You may be able to improve the Return Loss by adjusting the length of the rings. The reference measurements with the Doppelquad indicate that this feed should work better for my 0.5 f / d dish than the BBT feed.

Some photos:

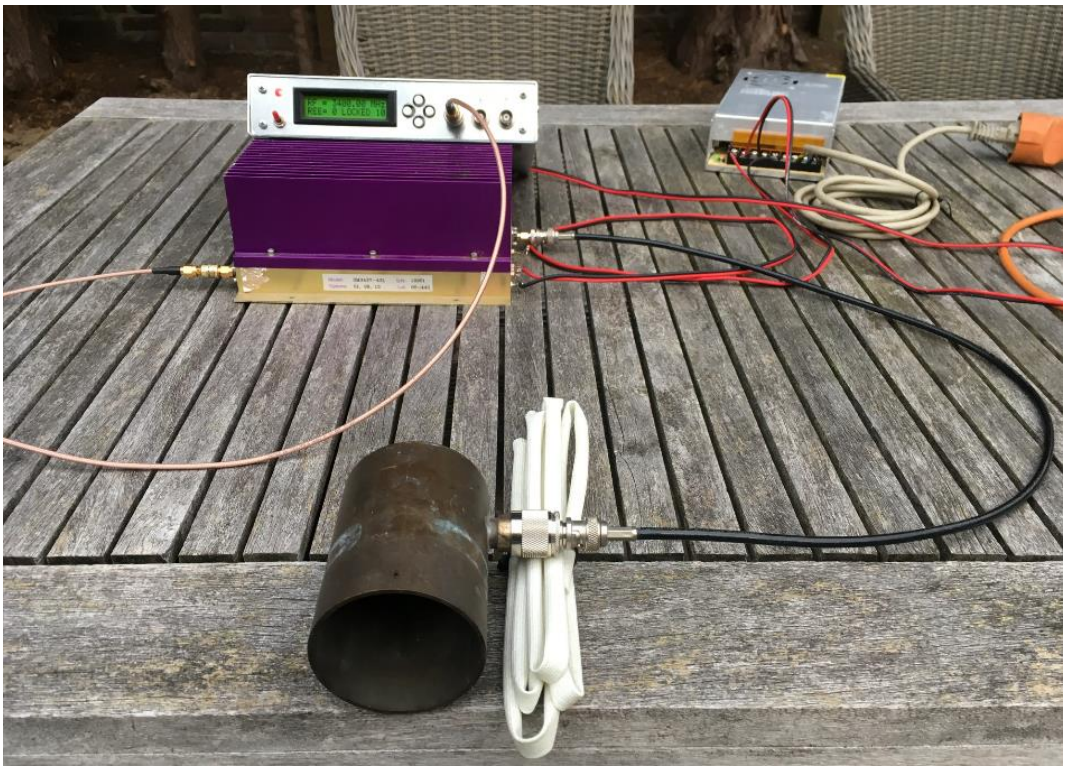
Earlier prototype with square reflector.

Final version, enclosure had to be closed with thin epoxy glass sheet.



Fix at 6cm ring. By bending this small piece of wire the match can be optimized.

Backside of the feed with the dish mounting.



Signal source in the back of the garden to evaluate the antenna pattern. (9cm)

Receive side on the other side of the garden. I use the power meter to make the measurements. There are some feeds to compare with and an earlier 2 band prototype of the ring feed.

Reference material!

Hans Holsink, PE1CKK, 8-5-2019