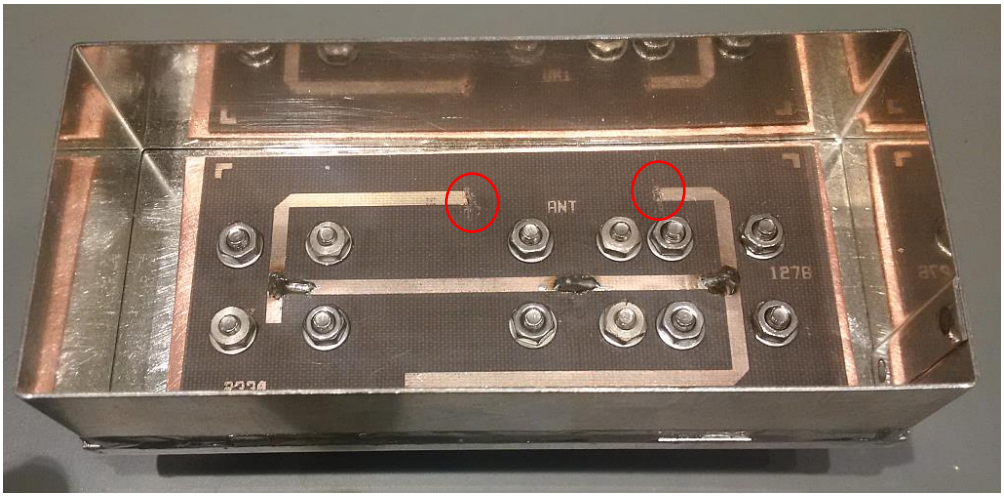
A 23cm / 13cm Diplexer

Matthias, DD1US, February 3rd 2020, rev 2.0

Trying to minimize the cabling to my portable setup for QO-100, I decided to characterize some diplexer PCBs which I had bought several years ago on a flea market. The PCBs are based on a 0.79mm thick Teflon substrate, most likely RT-Duroid.
It is recommended to mount the PCB on a brass or copper plate to provide a solid ground connection and proper mechanical stability. The PCB and the plate are then mounted in a tin-plated cabinet.
There is one common port and the two ports for the 23cm and the 13cm band respectively. The common port and the 23cm port are placed very tightly together. Thus, I could not use N-sockets for both ports because I would then not be able to screw on regular N-plugs. Therefore, I decided to use N-jacks for the common and the 13cm port and a SMA-jack for the 23cm port.

Here are some pictures of the diplexer after final assembly:

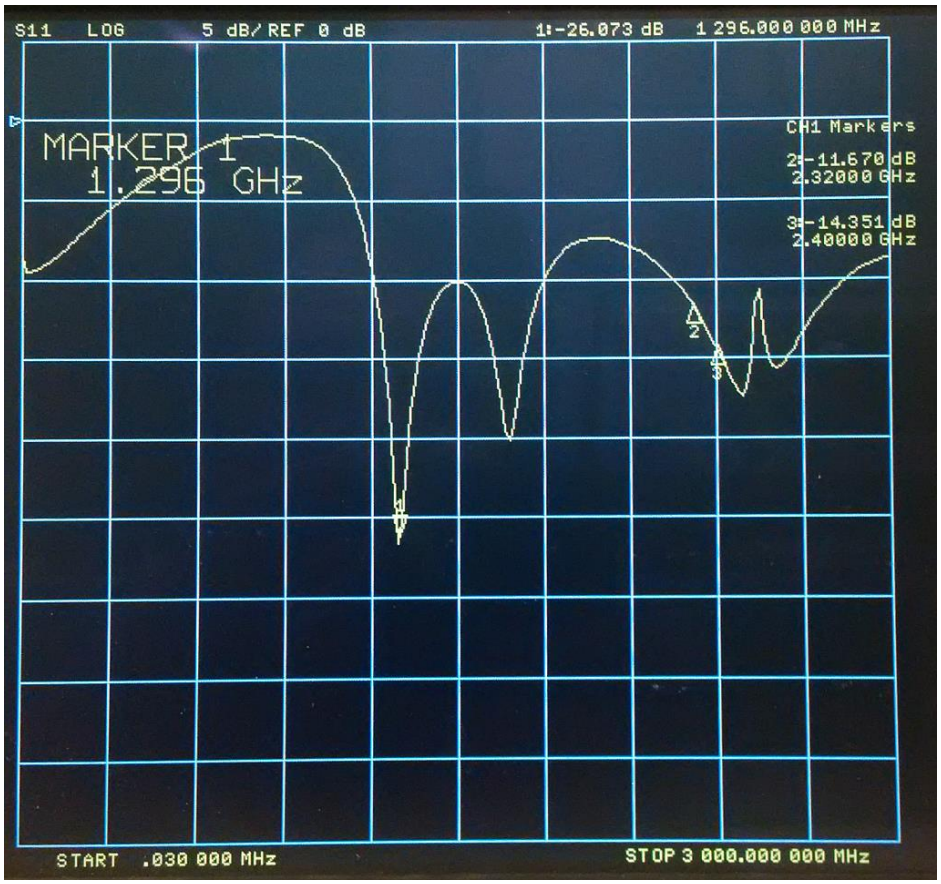
After performing my first series of measurements I had to notice, that stop band attenuation at 13cm, when measuring S21 from the common port to the 23cm port, was only 14dB. In addition, insertion loss at 13cm, when measuring S21 from the common port to the 13cm port, was almost 1dB. Therefore, I optimized the setup including tuning some open stubs by cutting them with a scalpel. Here is a picture of the same unit after the optimization:

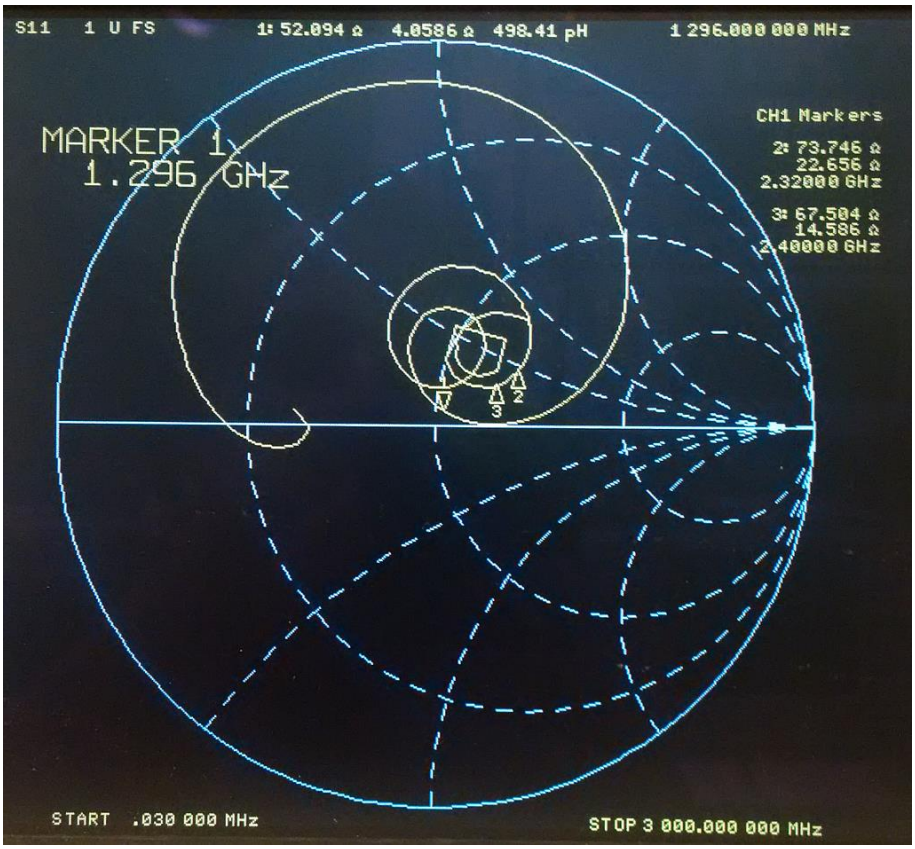


Subsequently you will find the diplexer's S-parameters focusing on insertion loss, stop band attenuation, input and output matching.

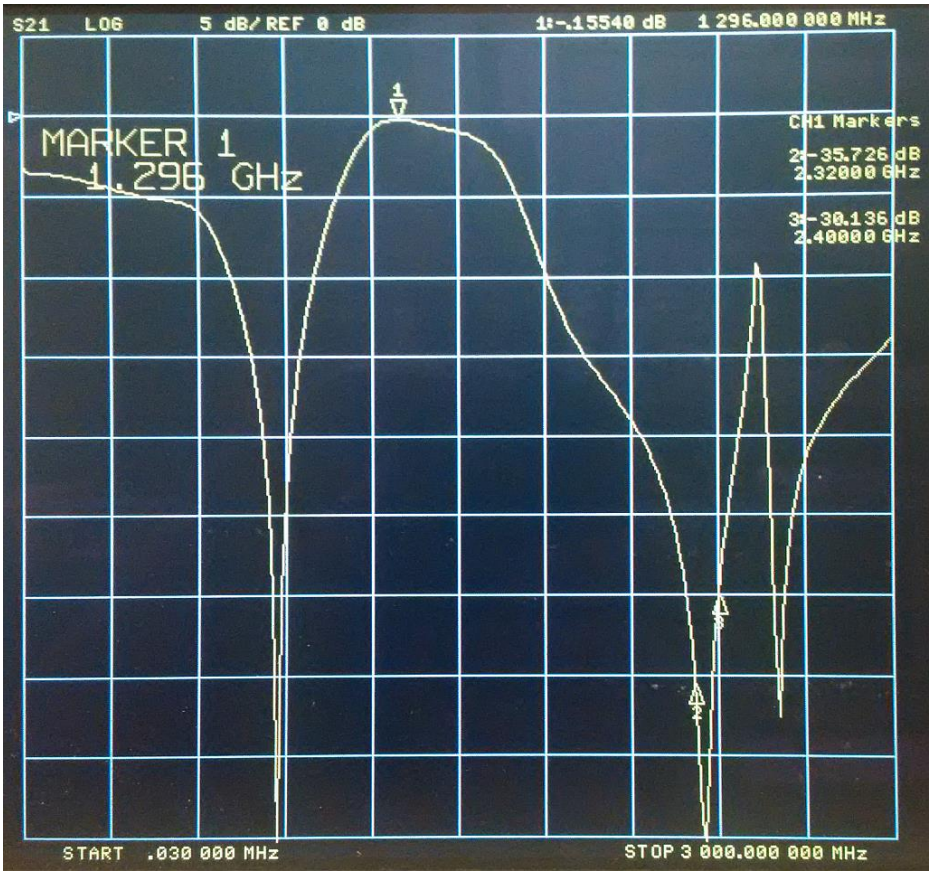
In the first series of measurements, I used the common port as port #1 and the 23cm port as port #2. The 13cm port was terminated with 50 Ohms.

Input matching S11 of the common port is 26dB at 1296 MHz and 14.3dB at 2400 MHz.

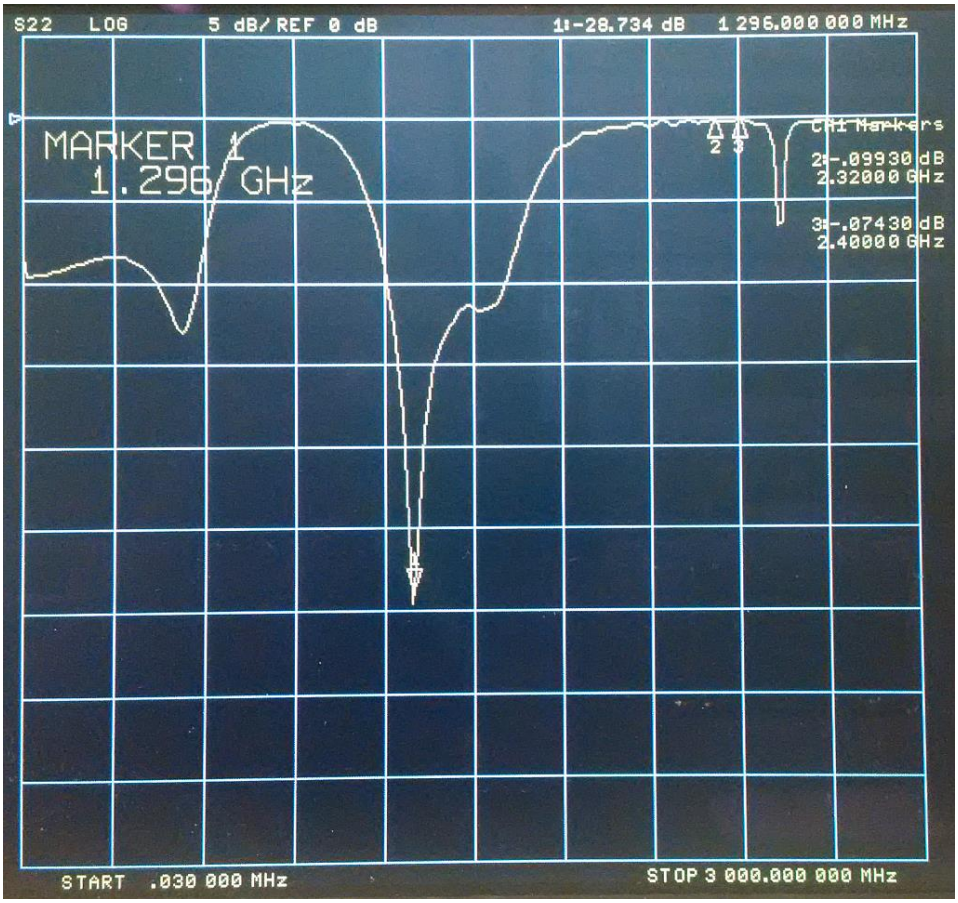


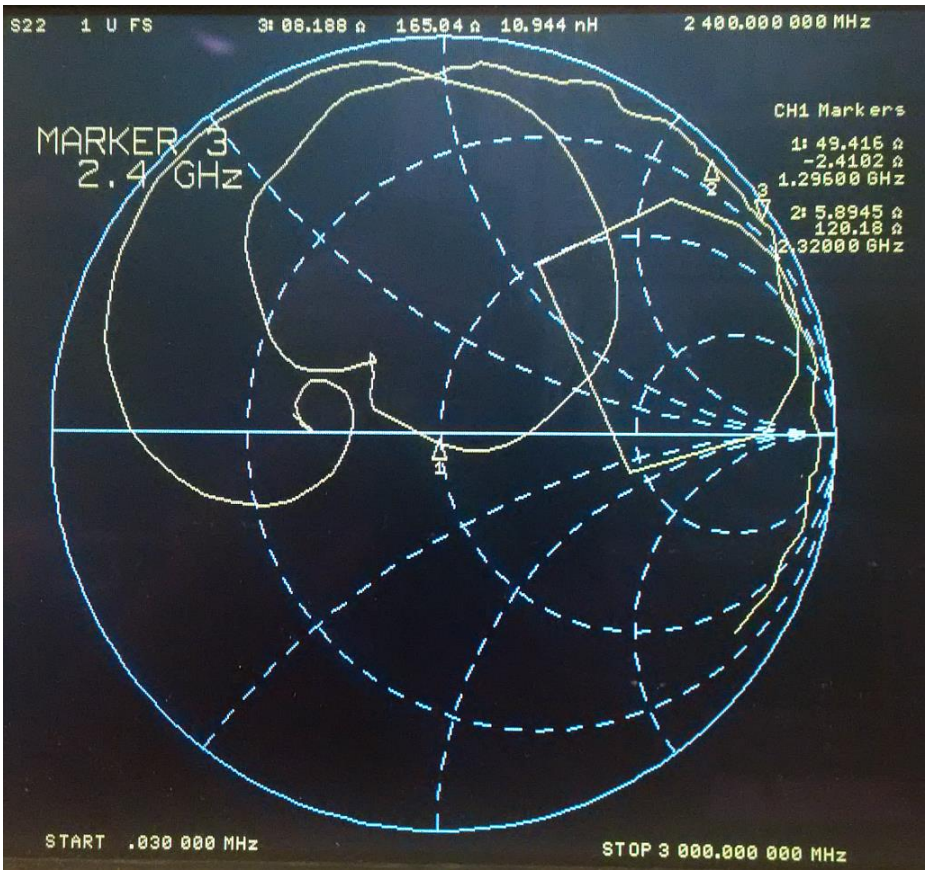


Insertion loss S21 from the common port to the 23cm port is 0.16dB at 1296 MHz. Stop-band attenuation at 2320 MHz is 35dB, at 2400 MHz it is 38dB.

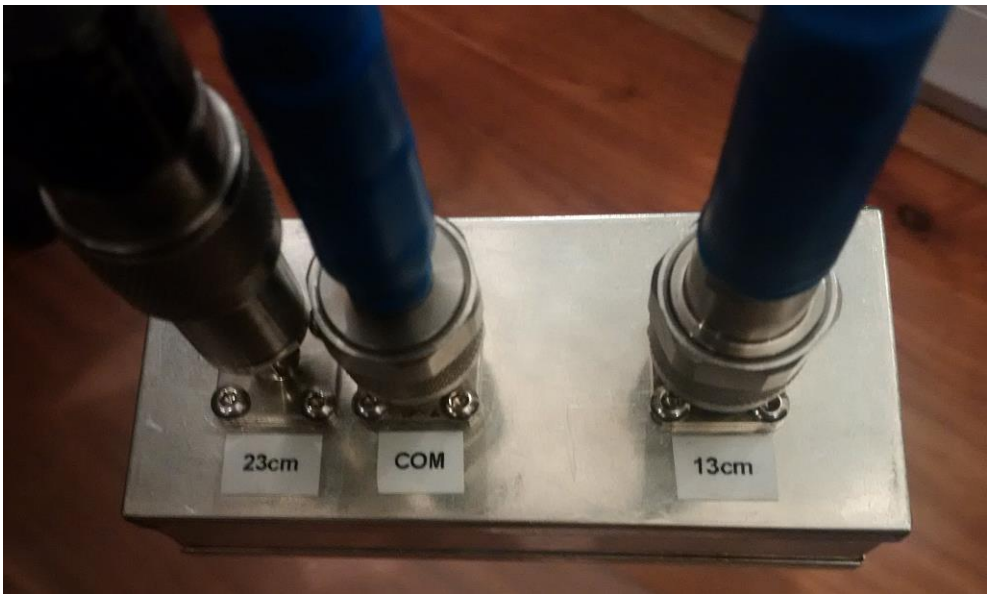


Output matching S22 of the 23cm port is 28.7dB at 1296 Mhz.

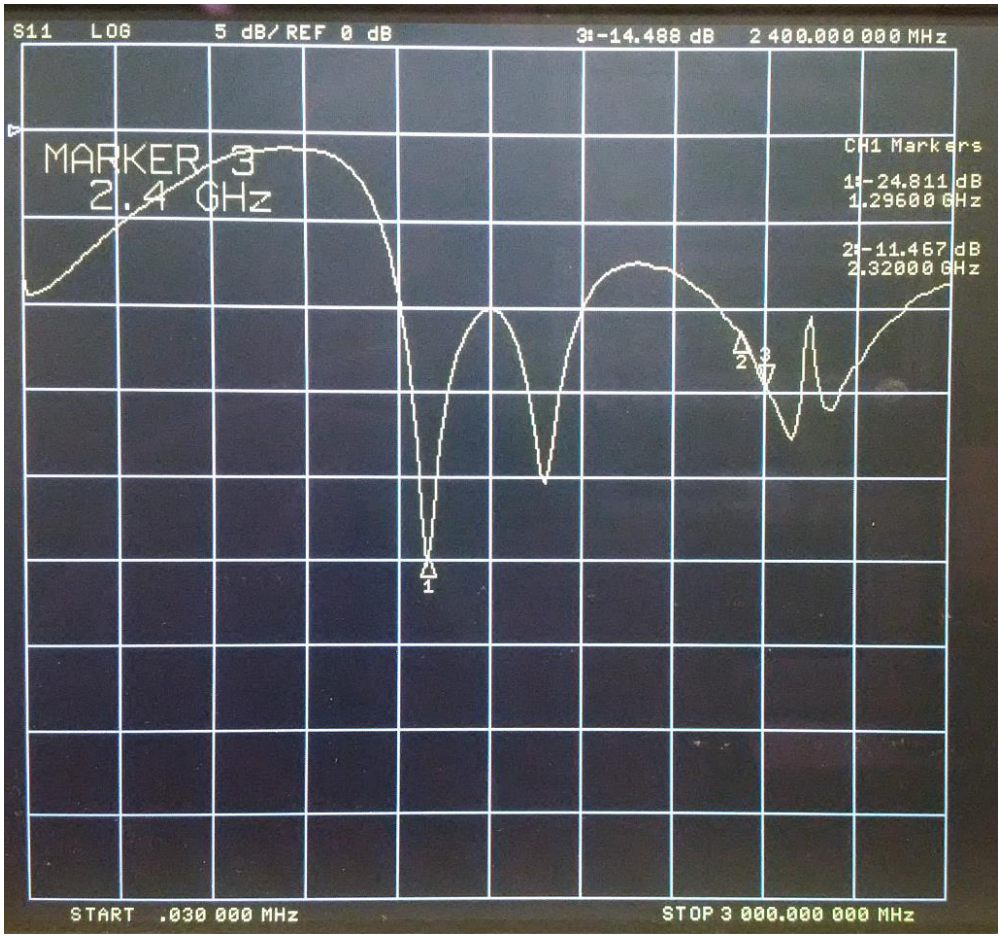




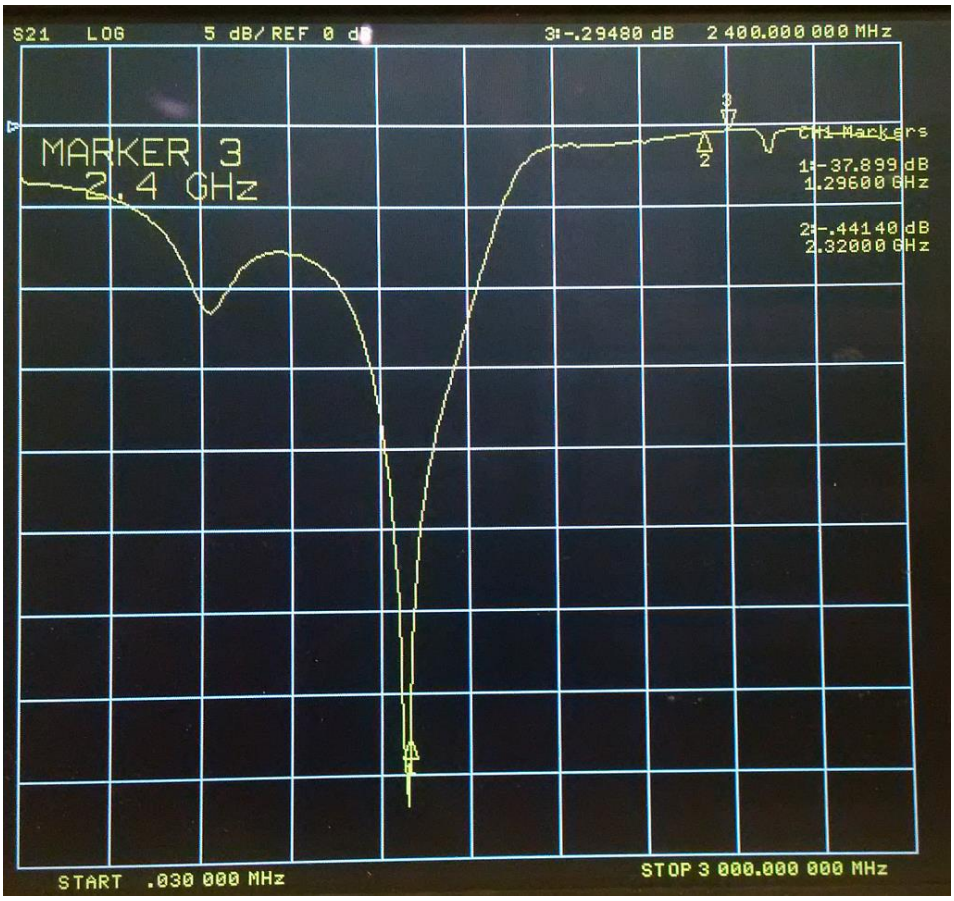
In the next series of measurements, I used the common port as port #1 and the 13cm port as port #2. The 23cm port was terminated with 50 Ohms.



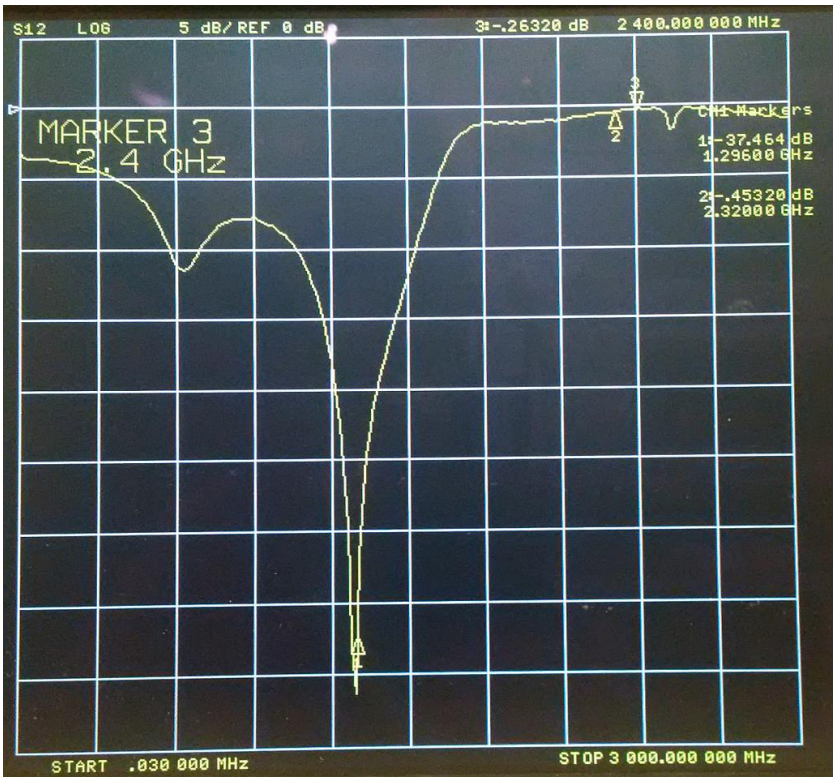
As to be expected the input matching S11 of the common port is basically identical to the previous S11 measurement.



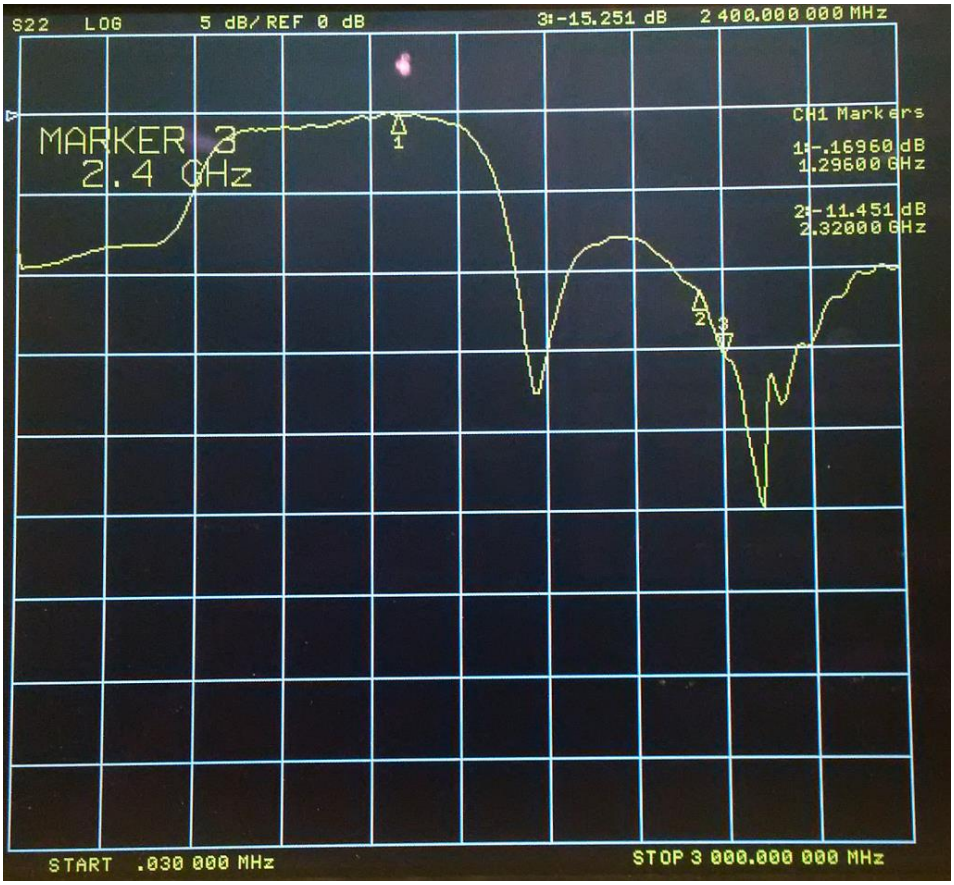
Insertion loss S21 from the common port to the 13cm port is 0.44dB at 2320 MHz and 0.29dB at 2400 MHz. Stop-band attenuation is 37.9dB at 1296 MHz.

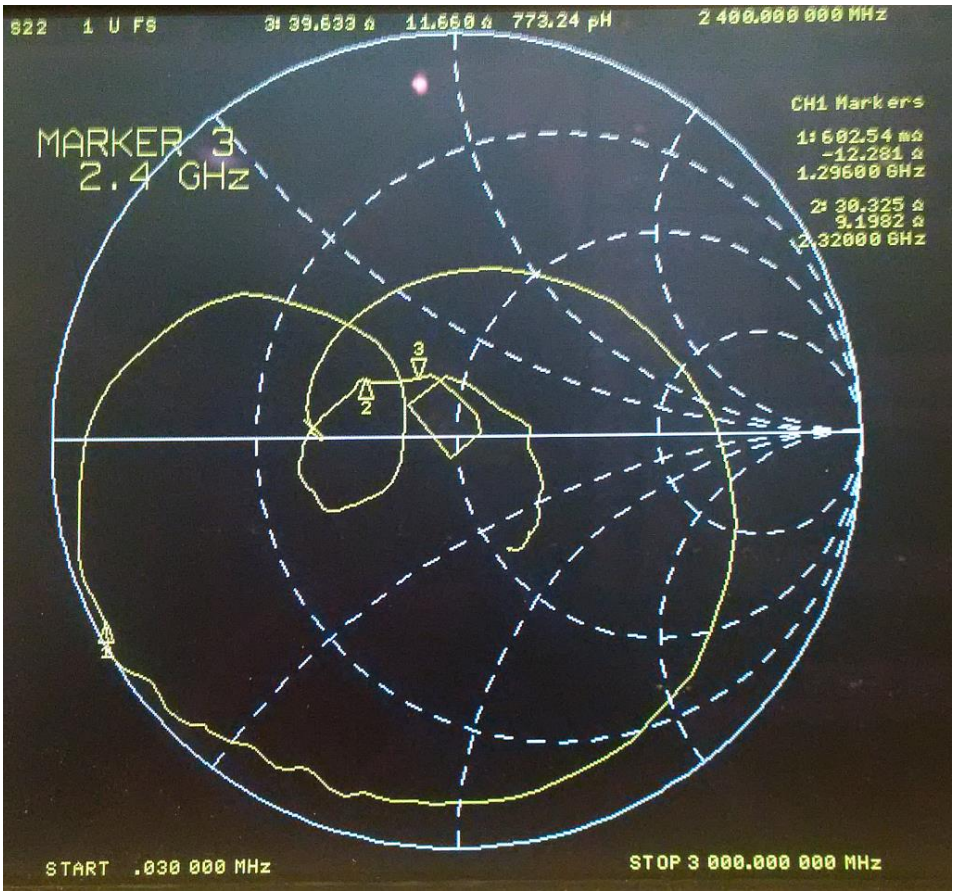


Insertion loss S12 from the 13cm port to the common port is basically identical to S21.



Output matching S22 of the 13cm port is 11.5dB at 2320 MHz and 15.3dB at 2400 MHz.



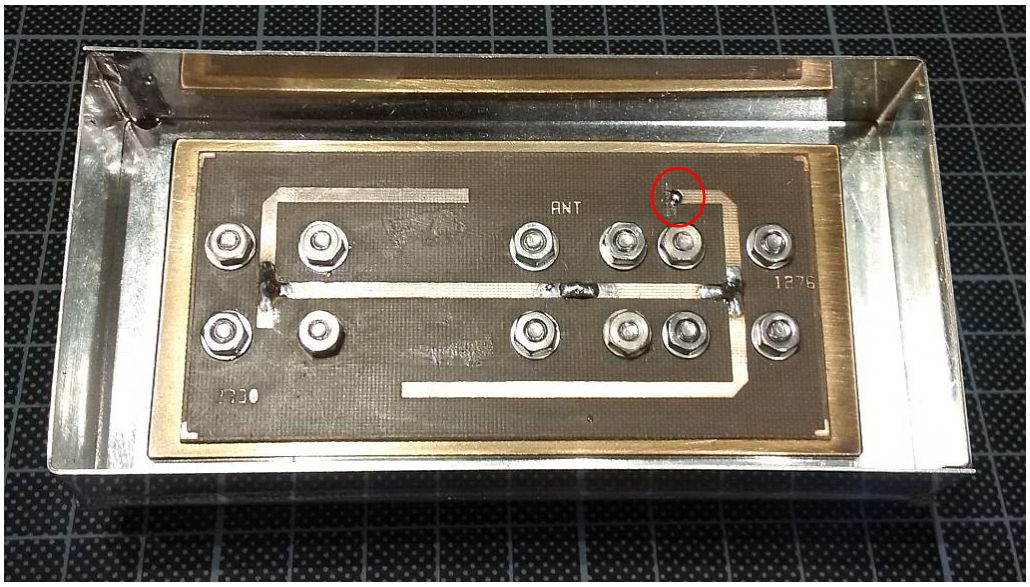


In summary this 23cm/13cm Diplexer has quite low insertion loss and good stop band attenuation.

In my intended setup I will need 2 of such diplexers, one at the antenna and one at the transceiver in order to share a single cable for RX and TX signals. The transmit signal would be in the 13cm band and the receive signal in the 23cm band.

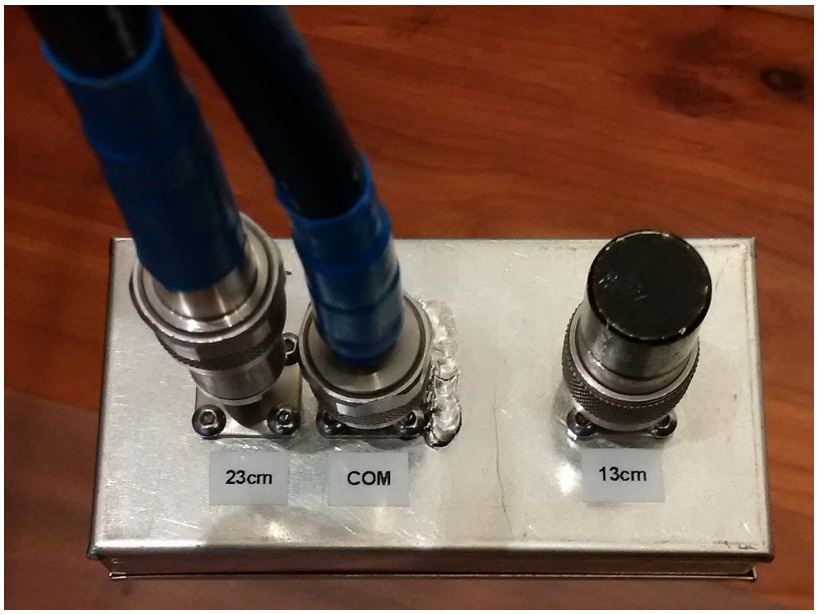
Depending on the used transmit power additional lowpass filters may be needed at each diplexer to suppress the 13cm signal even further and thus not harm the LNB or the receiver.

Accordingly, I built a second unit. I tuned the second unit also by cutting some open stubs with a scalpel. Here is a picture of the unit after the optimization:

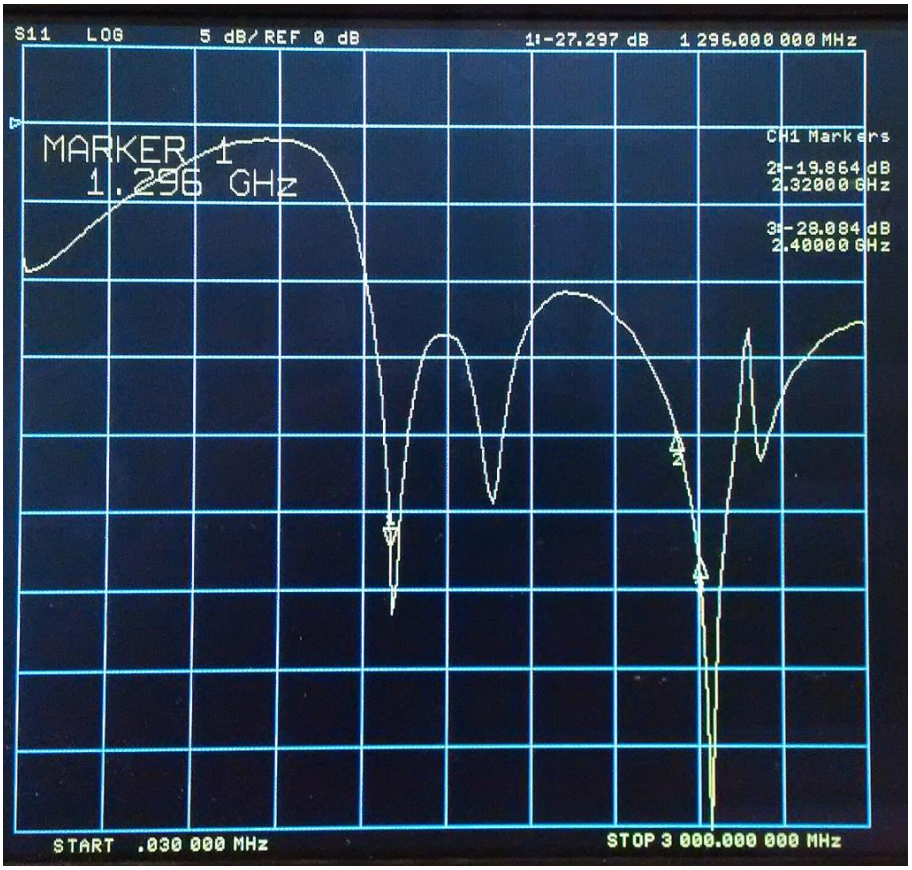


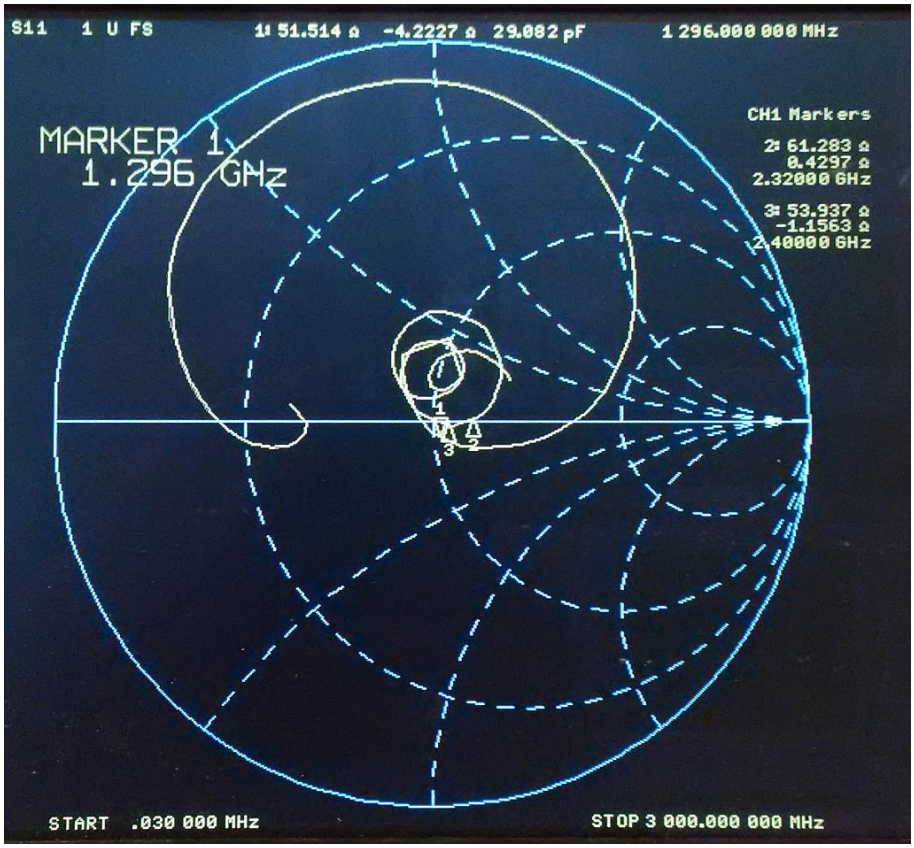
Below you will find the measurement results of the second unit.

In the first series of measurements, I used the common port as port #1 and the 23cm port as port #2. The 13cm port was terminated with 50 Ohms.

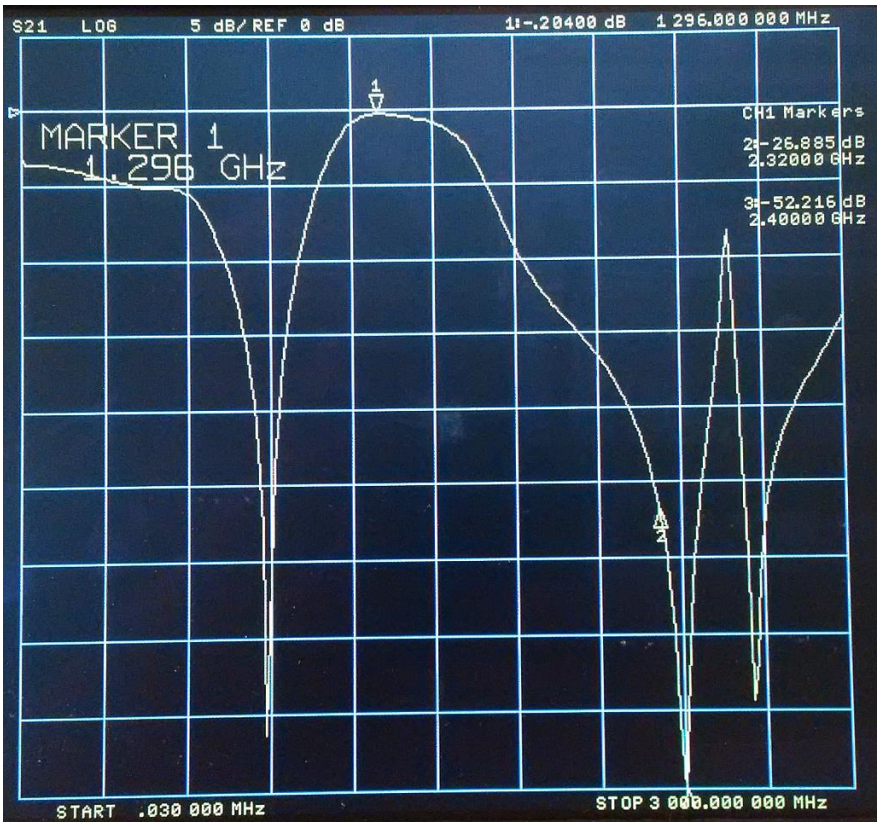


Input matching S11 of the common port is 27.3dB at 1296 MHz and 28dB at 2400 MHz.

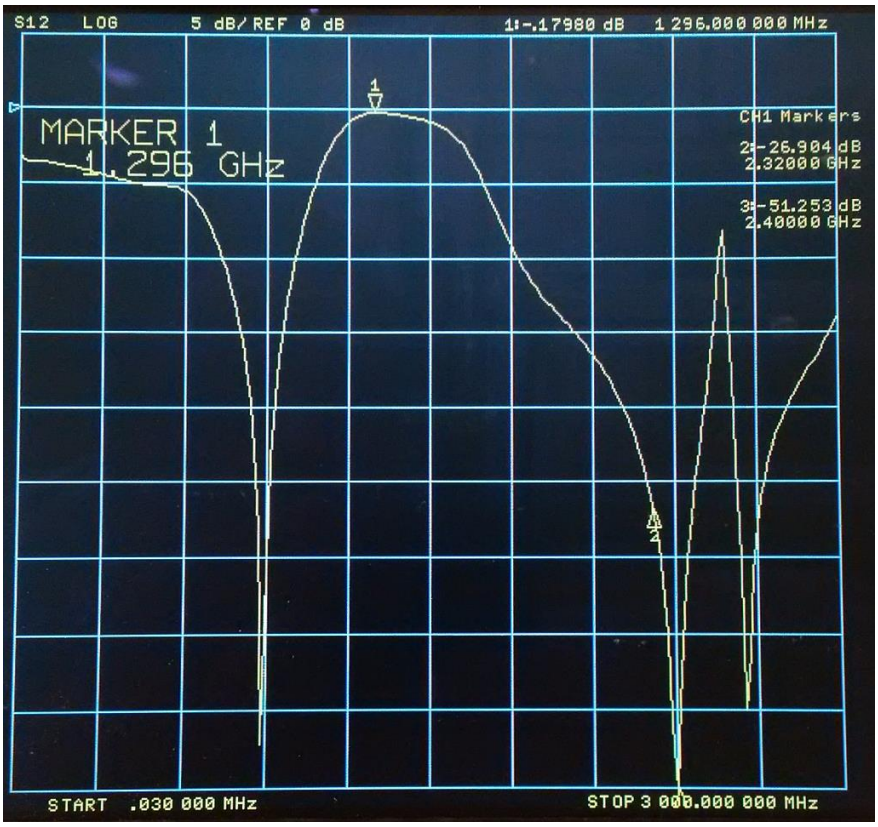




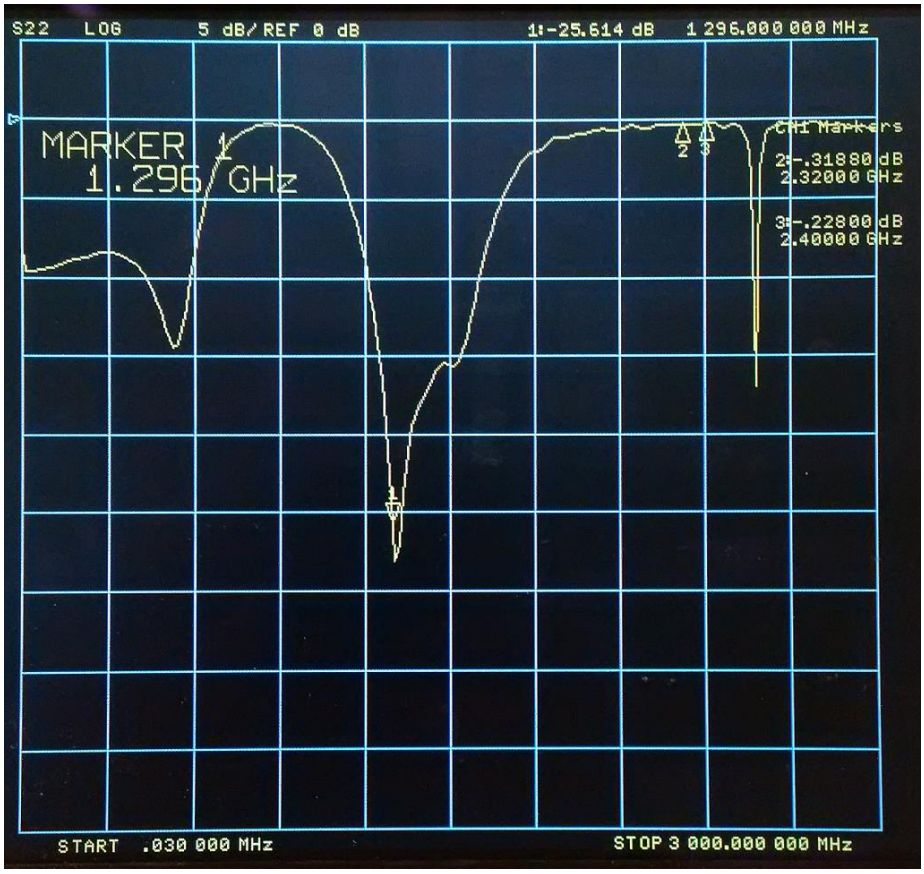
Insertion loss S21 from the common port to the 23cm port is 0.20dB at 1296 MHz. Stop-band attenuation at 2320 MHz is 26.9dB and 52dB at 2400 MHz.



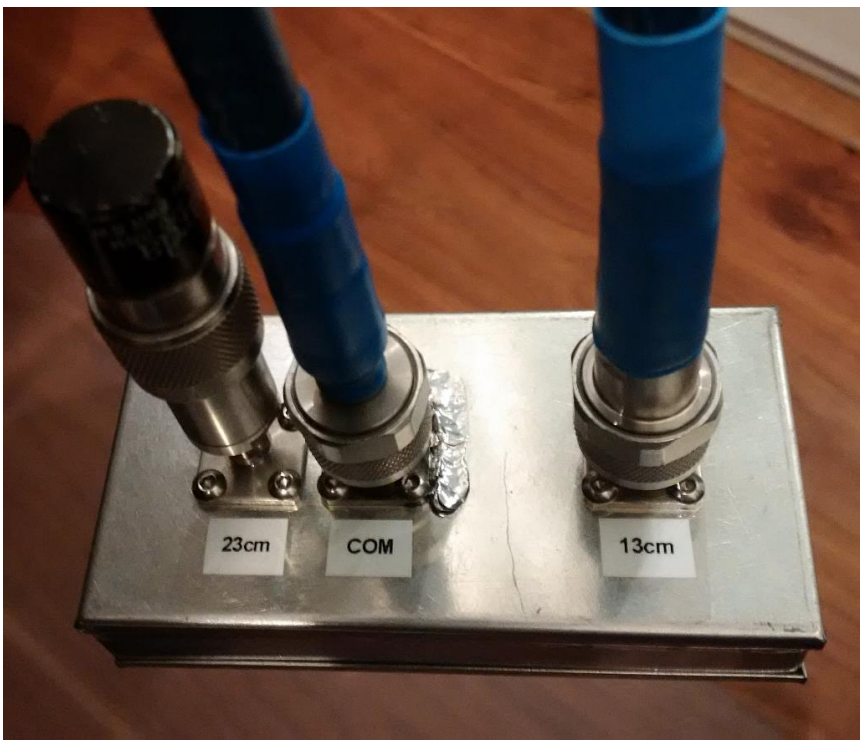
As to be expected S12 is basically identical to S21.



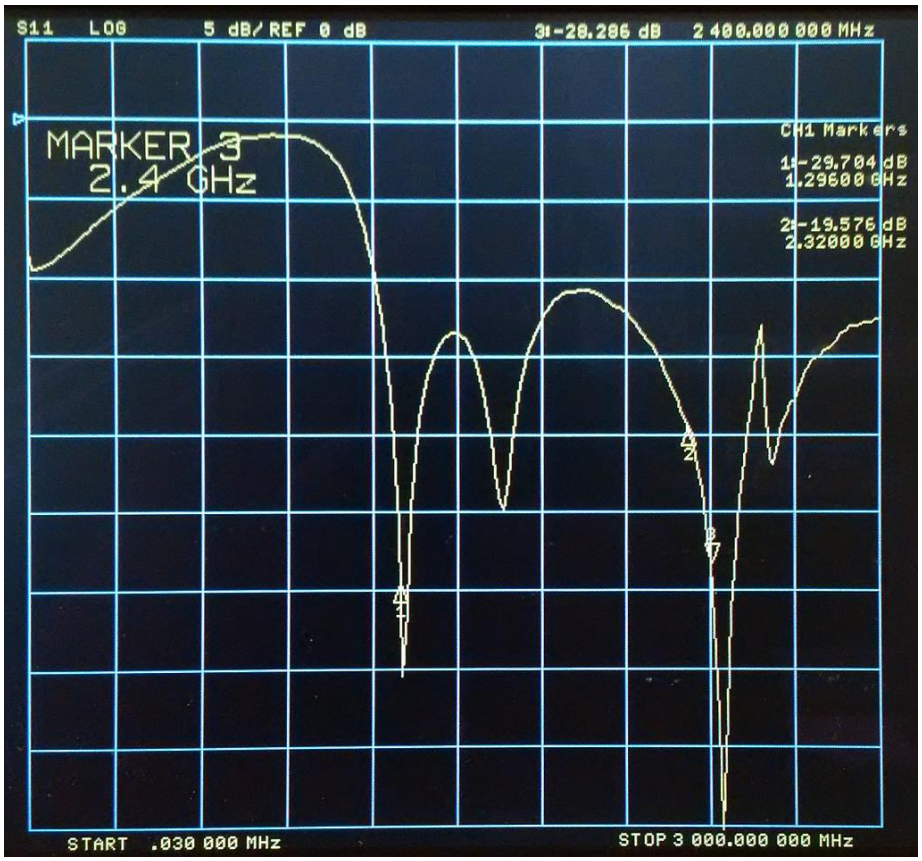
Output matching S22 of the 23cm port is 25.6dB at 1296 Mhz.

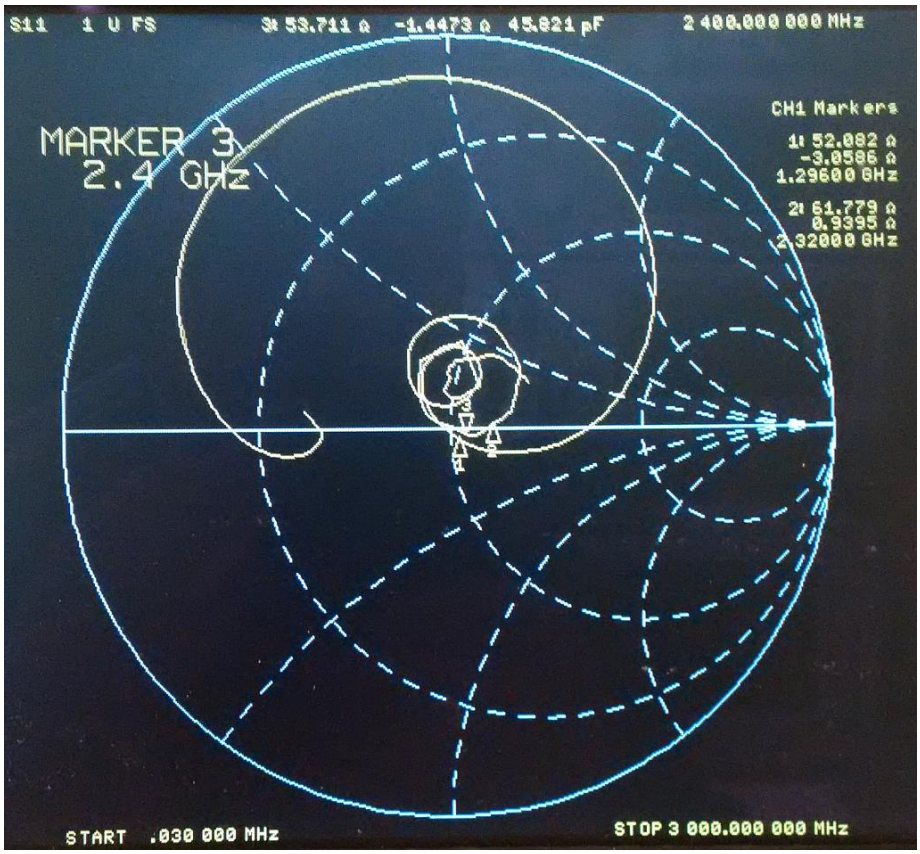


In the next series of measurements, I used the common port as port #1 and the 13cm port as port #2. The 23cm port was terminated with 50 Ohms.

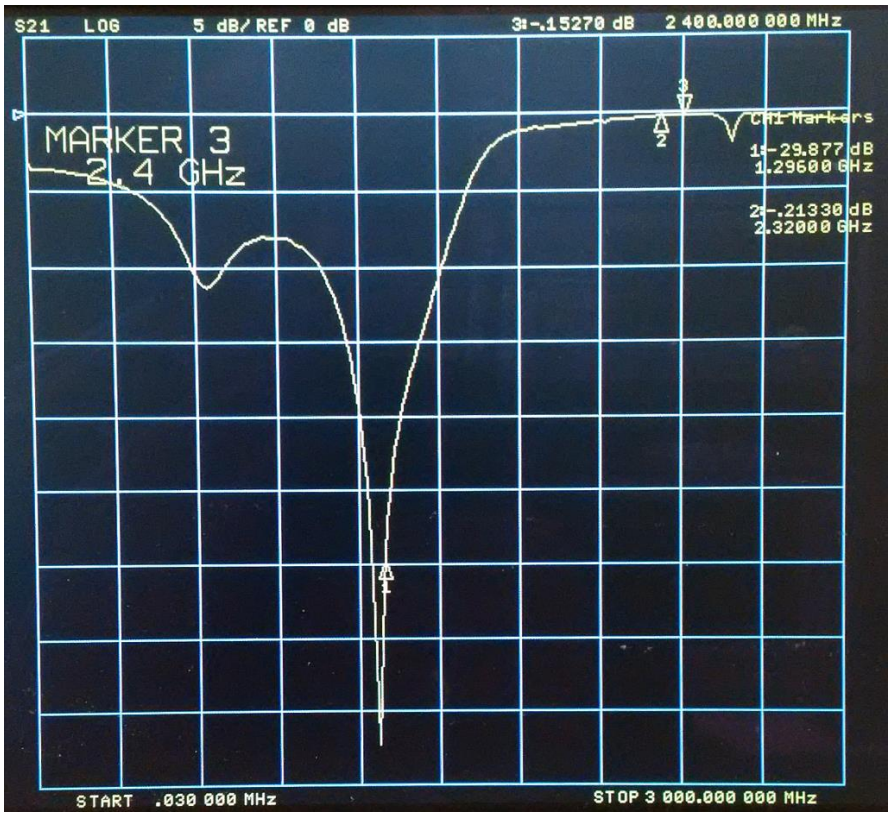


As to be expected the input matching S11 of the common port is basically identical to the previous S11 measurement.

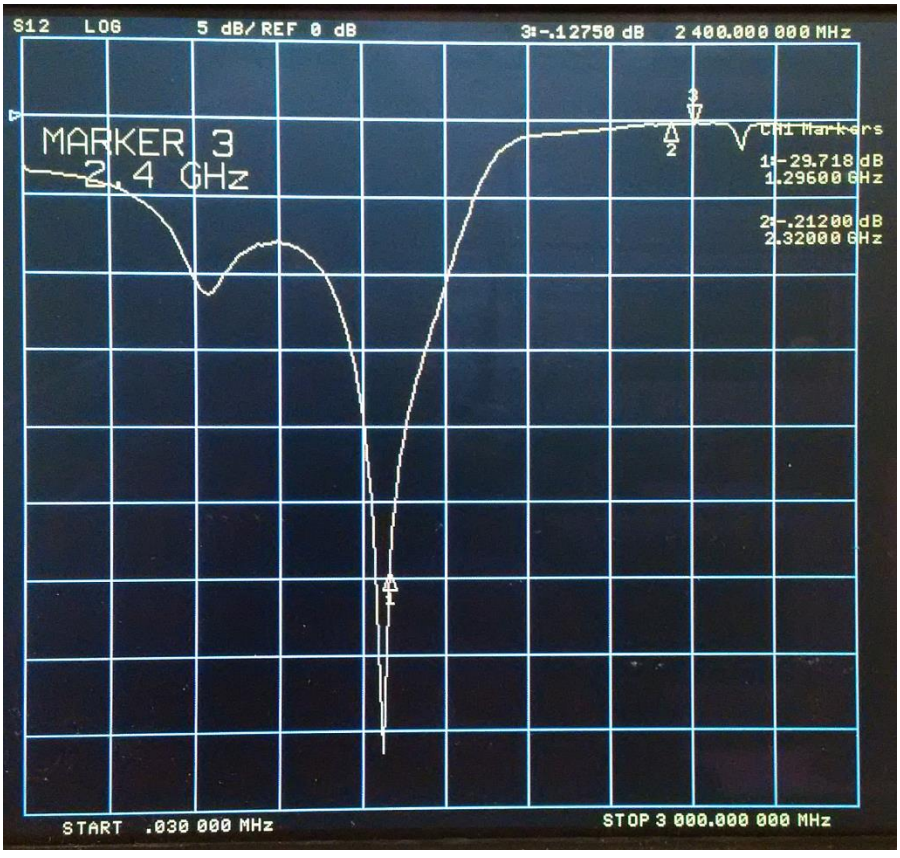




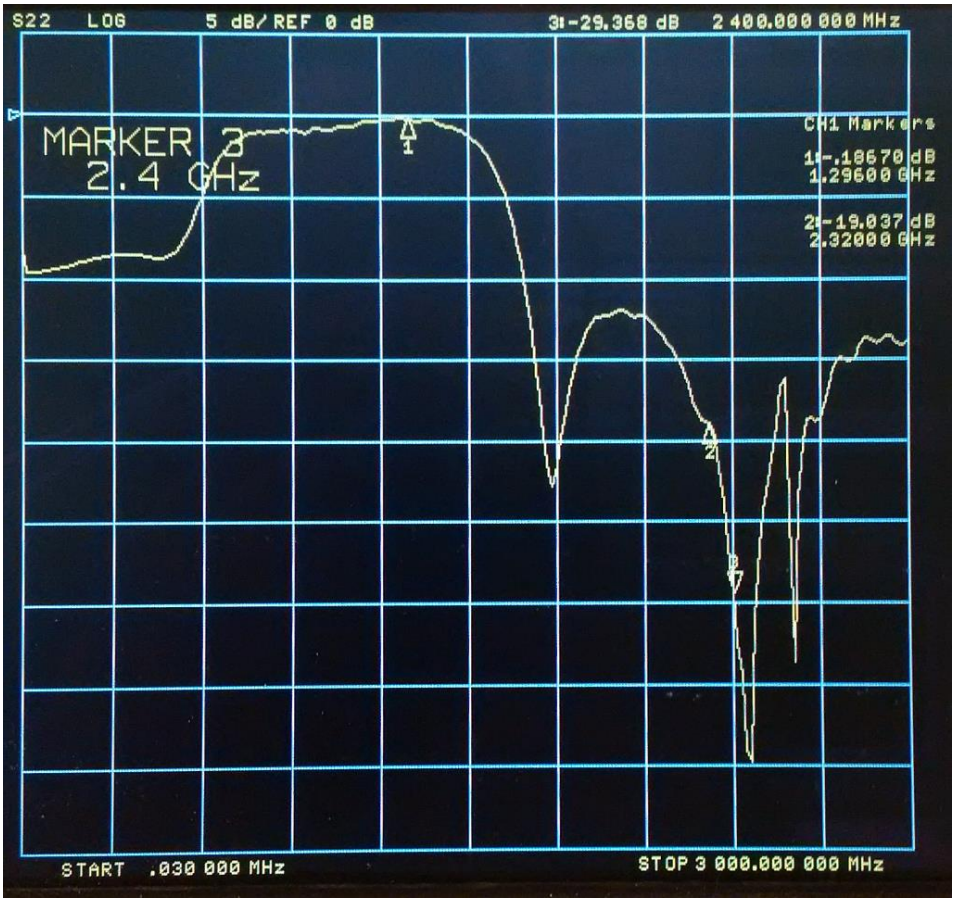
Insertion loss S21 from the common port to the 13cm port is 0.21dB at 2320 MHz and 0.15dB at 2400 MHz. Stop-band attenuation is 29.9dB at 1296 MHz.

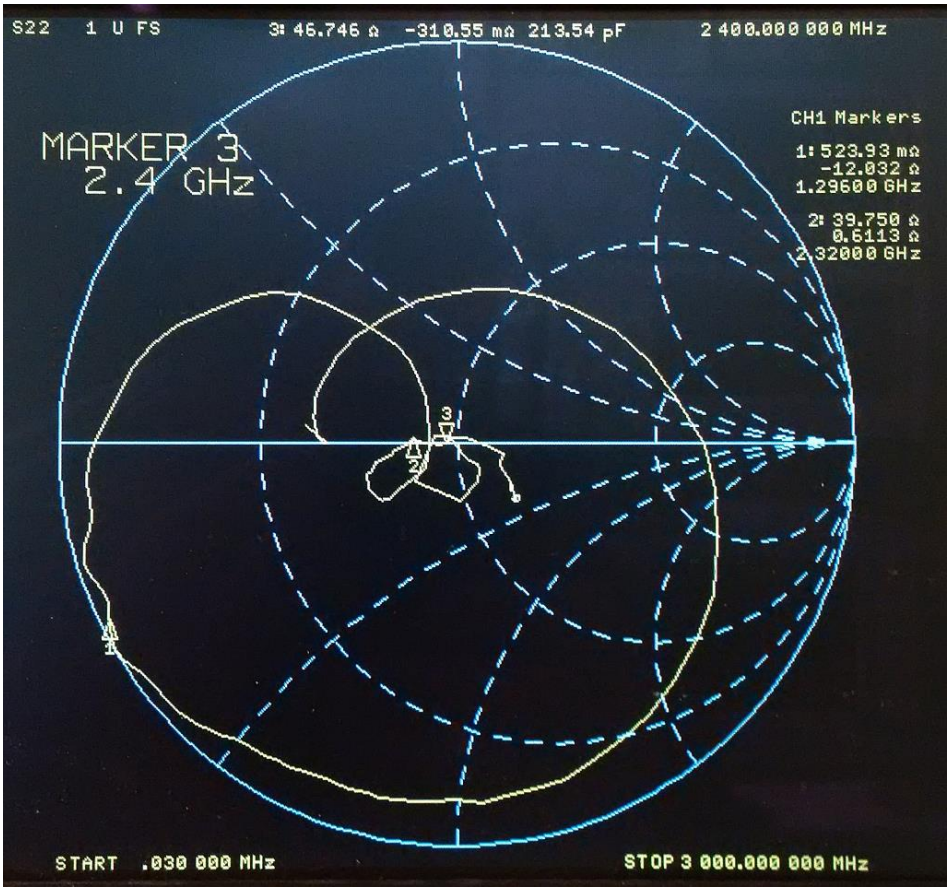


Insertion loss S12 from the 13cm port to the common port is basically identical to S21.



Output matching S22 of the 13cm port is 19.0dB at 2320 MHz and 29.4dB at 2400 MHz.





Summary:

This 2nd 23cm/13cm Diplexer is showing slightly better results compared the first unit. It has excellent insertion loss and very good stop band attenuation. Also input- and output matching is improved.

Without tuning the results of the PCBs were quite different. I do not know the root cause. It could be tolerances in the PCB or differences in my assembly of the PCB in the encasing.

I am always interested in feedback and will be happy to answer questions. Please send them to the Email address given below.

Best regards

Matthias DD1US

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