# 70cm band circulator Valvo 2722 162 05381 Y700/V-1-7/16 retuned from 590-720 MHz to 435 MHz

Matthias, DD1US, October 16th 2022

Hello,

Recently I got 2 heavy duty circulators from a friend. They were produced by Valvo and have a stunning weight of 2400g. Their part number is 2722 162 05381. They are also marked as Y700/V-1-7/16 which indicates that they are built to handle 700W RF power in the UHF-band V. They are intended to be used in the frequency range 590-720MHz. All three connectors are female 7/16 connectors.

I was curious to see whether I would be able to retune them to the 70cm ham radio band with a center frequency of 435MHz.

Here are some pictures of the circulator (the labels reflect the measurement results after retuning):


Zirkulator 70cm Band, Pmax=700W
S11, S22 >20 dB, S21=0.36dB, S12>27dB
2722 162 05381
Freq: 590-720 MHz
DSJ
Y700/V-1-7/16


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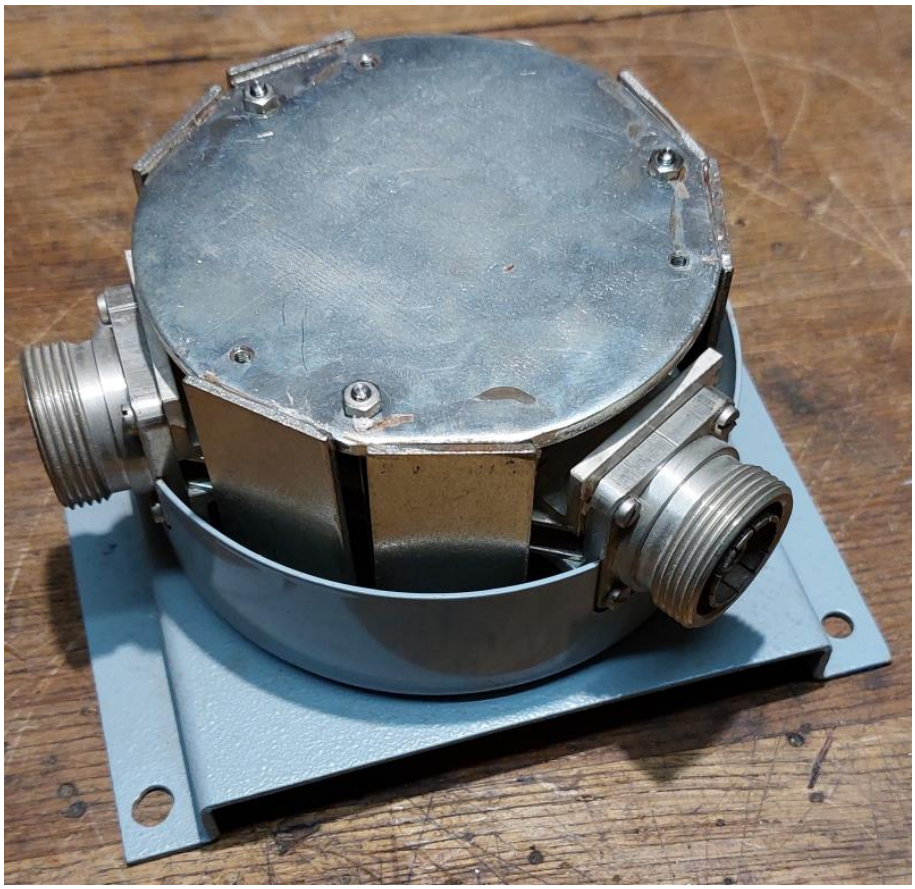
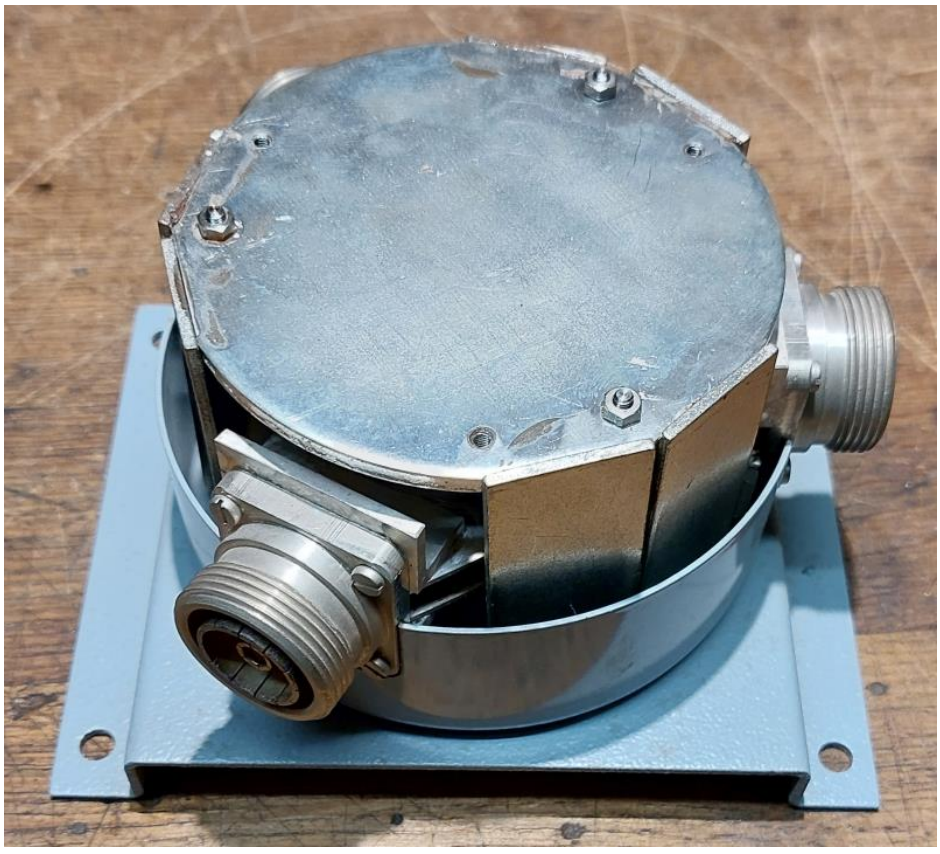
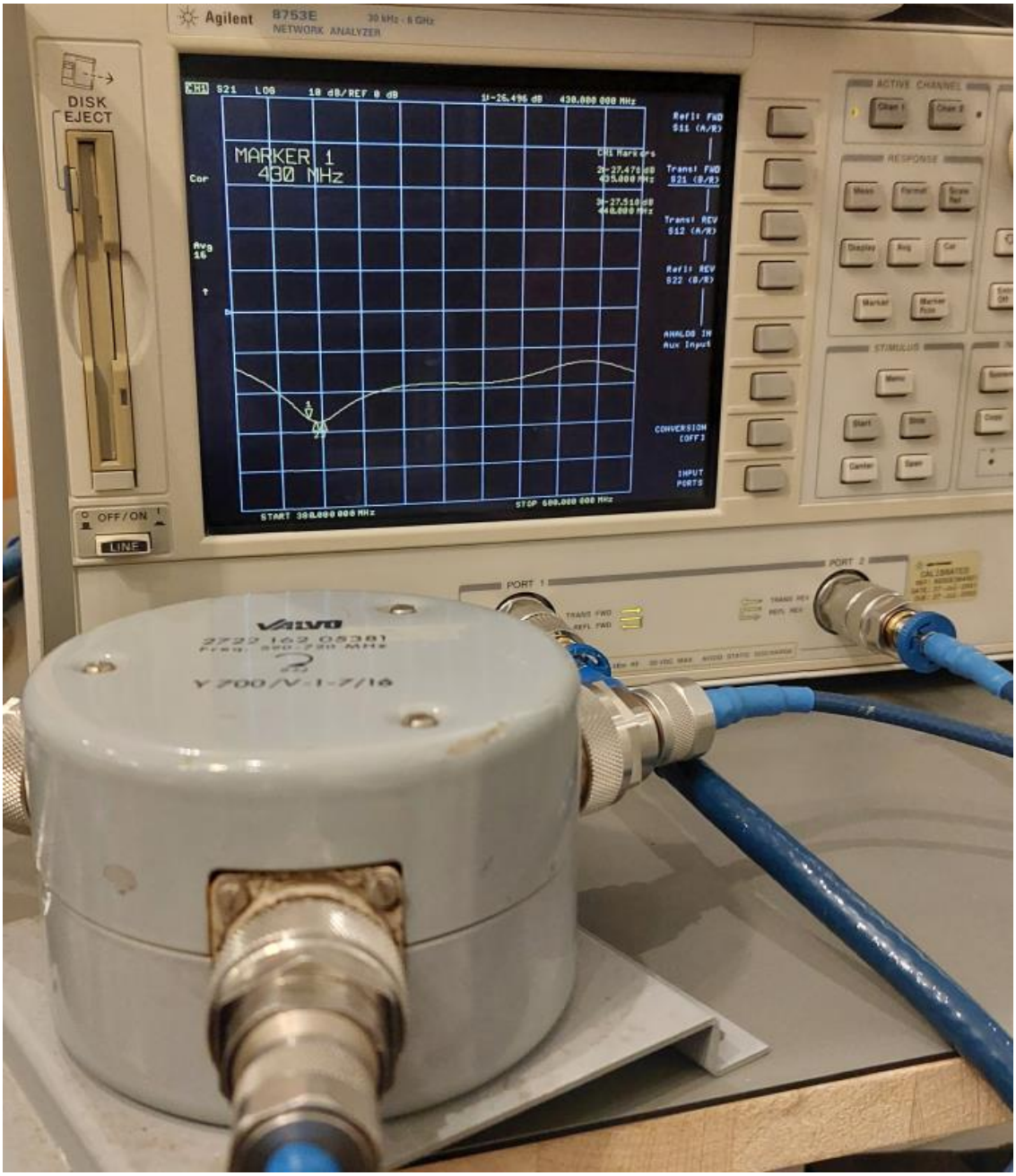
Here are some pictures of the open circulator before modification. There are 2 big magnets under and on top of the circulator part itself. The magnetic circuit includes ferromagnetic plates on top and at the bottom of the construction and 6 ferromagnetic plates spread around the circumference.





Next, I characterized the circulator before making any modifications. Please note that the encasing of the circulator is also made from ferromagnetic material (iron) and contributes to the magnetic circuit. Thus, the lid has to be remounted before doing the measurements.

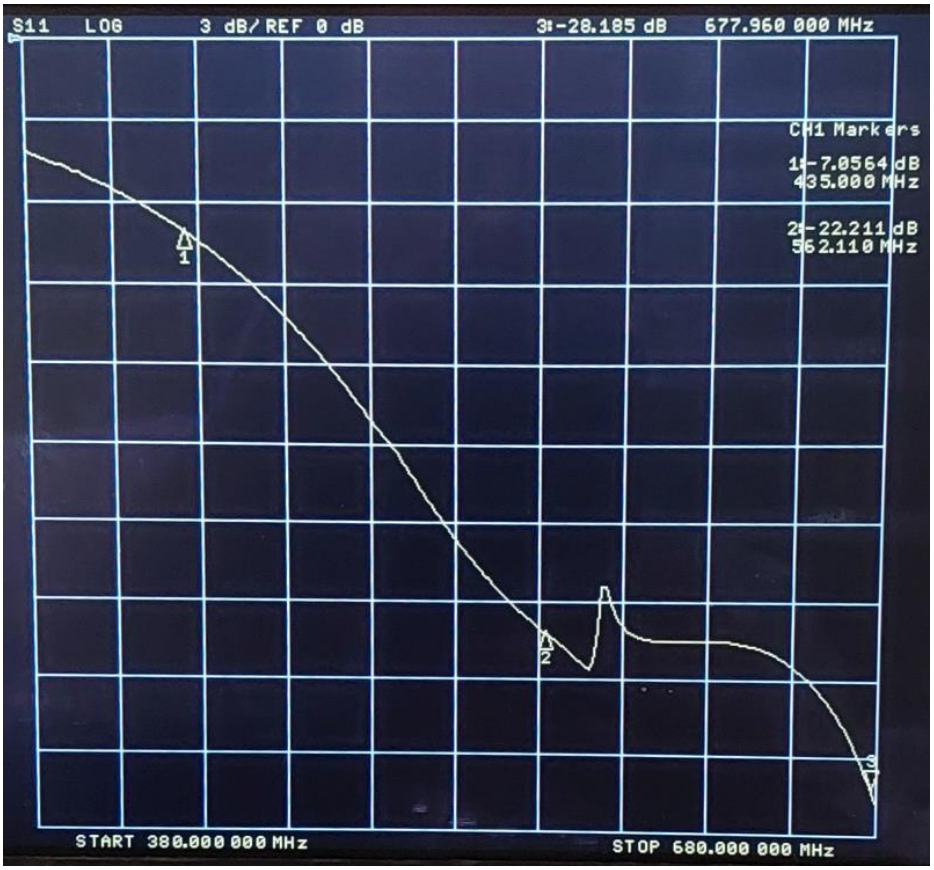



Please note that the 3 adapters 7/16 male to N female were not included in the calibration of the measurement setup. This the measured values especially S21 and S12 might be a little bit too high but my judgement is that each adapter has an insertion loss well below 0.1dB. I might repeat the measurements eventually including the adapters in the calibration as I also have a 7/16 ECAL kit available.

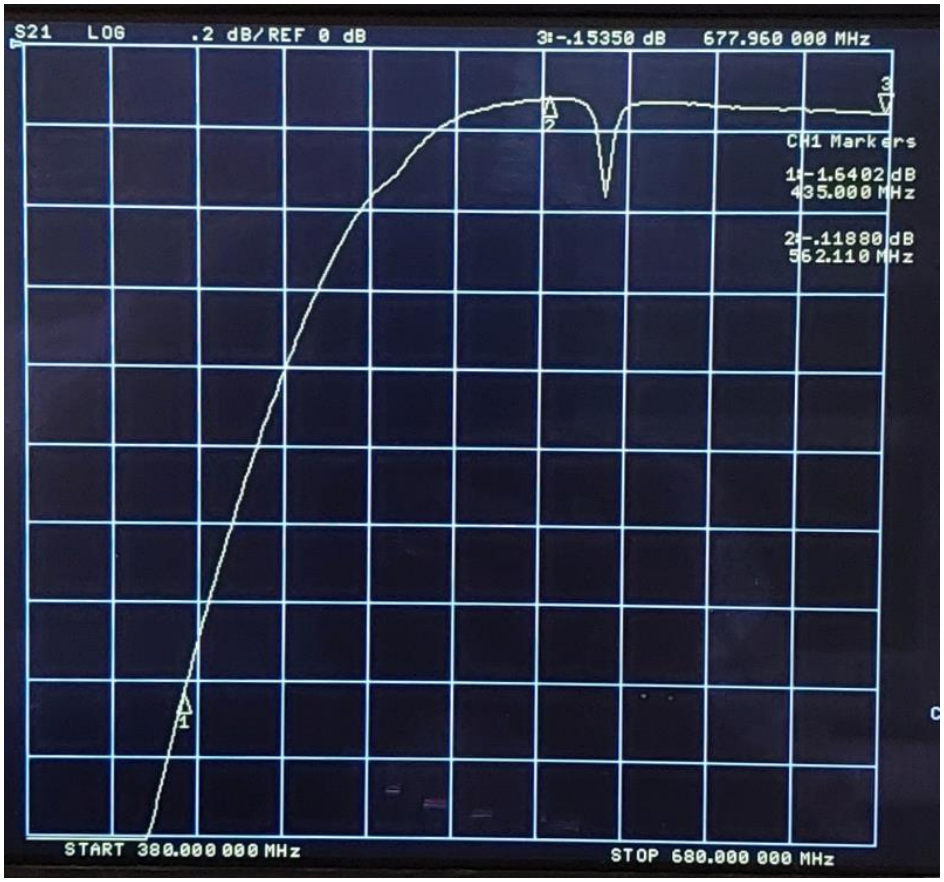
The two circulators are of the same type. However, they were tuned to different optimum frequencies (while probably still fulfilling the guaranteed specifications in the frequency range 590-720MHz).

The 3rd port was terminated with 50 Ohm.

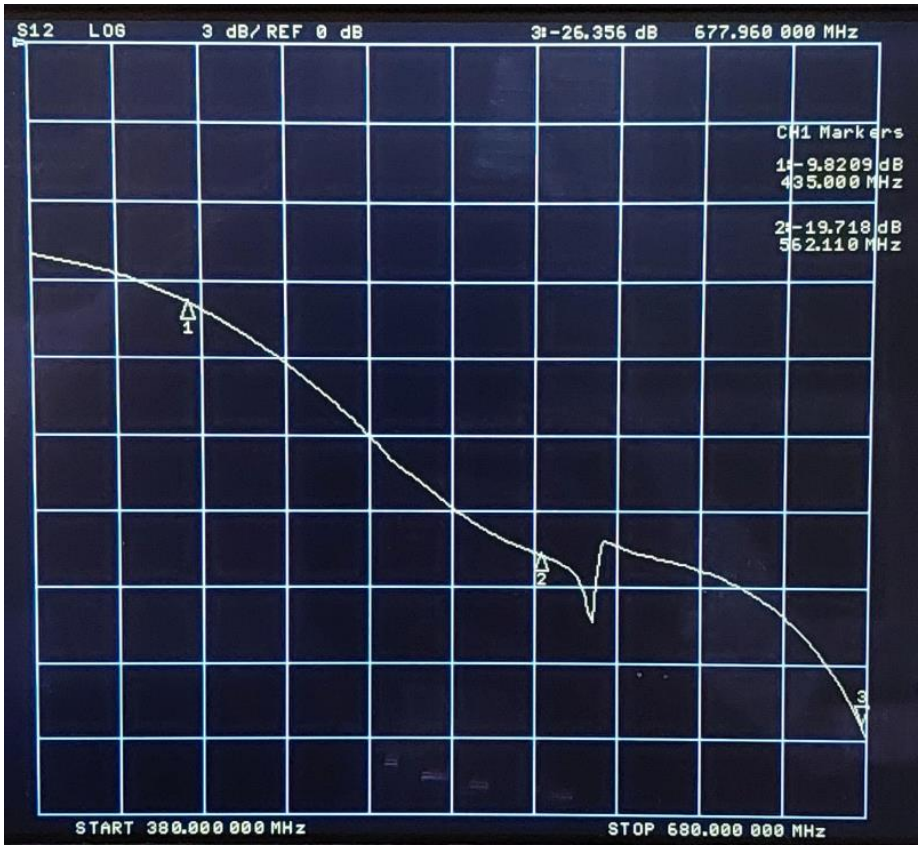
S11 input matching (return loss 22dB@562MHz)



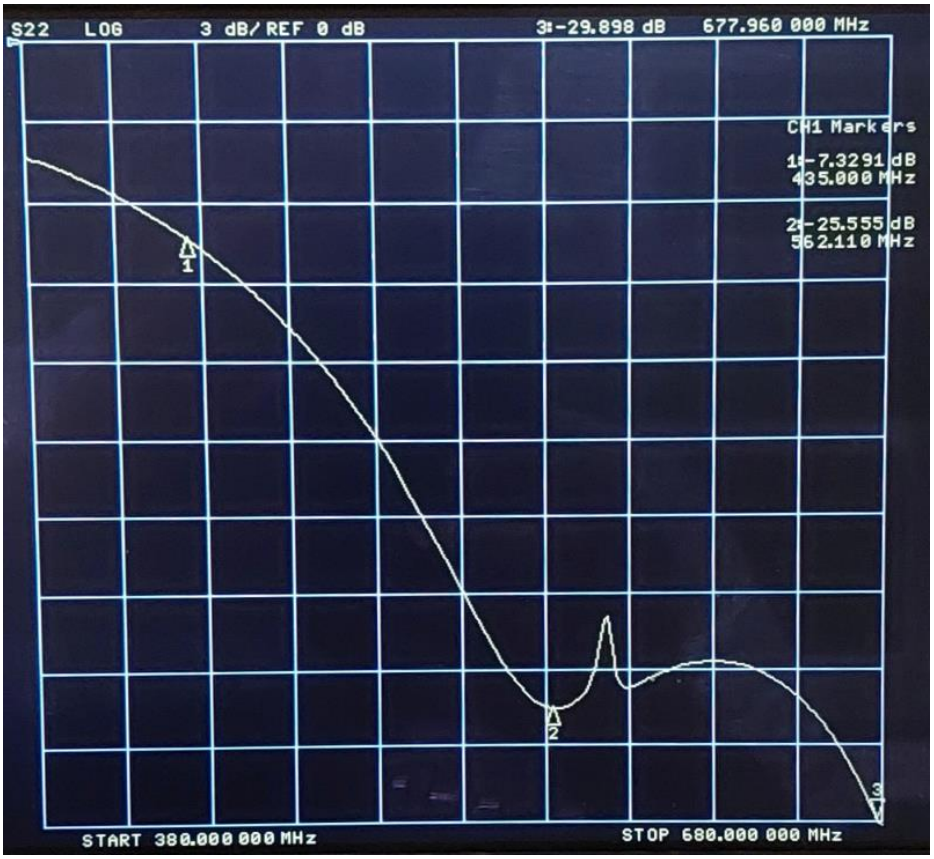

S21 forward transmission (insertion loss at 0.12dB@562MHz)



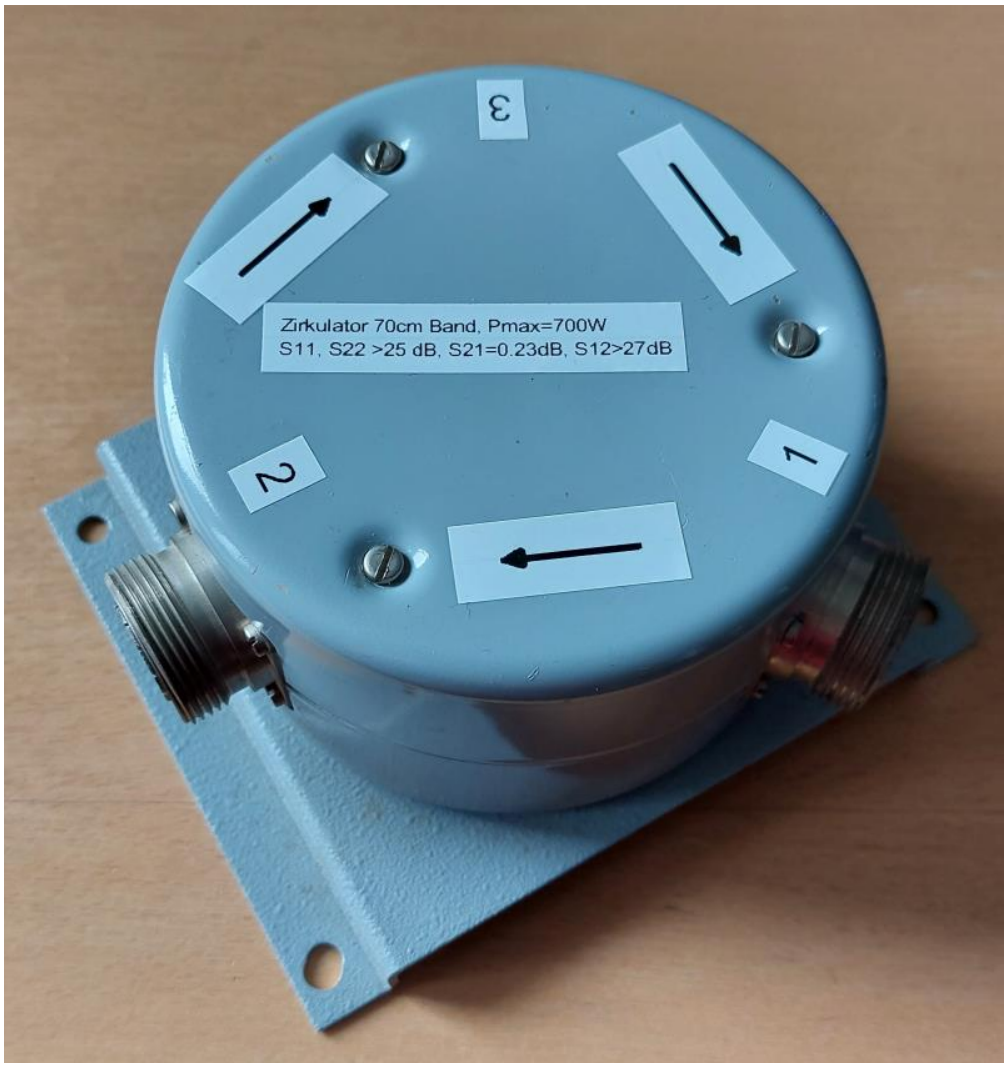
S12 reverse transmission (isolation is 19.7dB@562MHz)



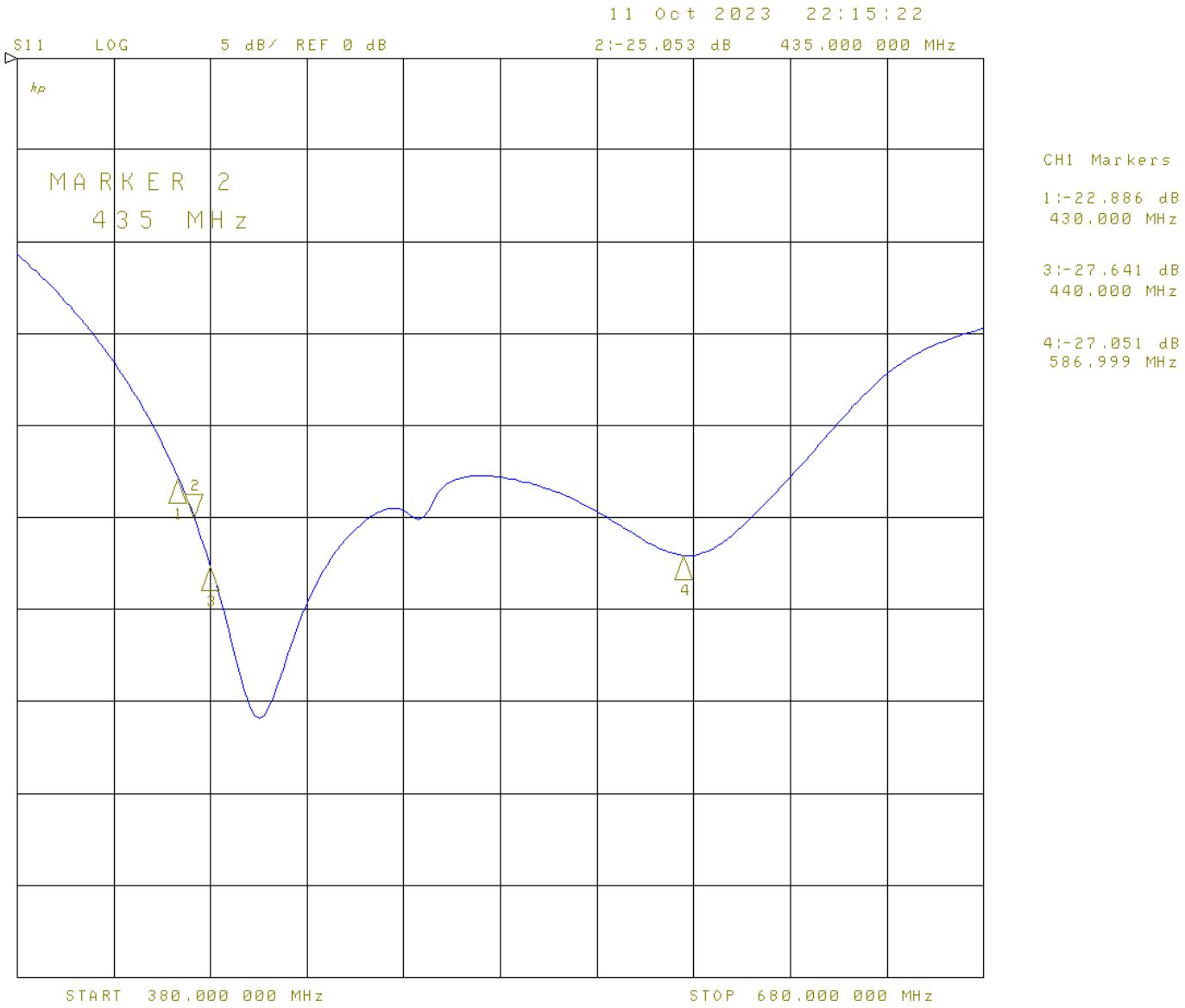

S22 output matching (return loss is 25.6dB@562MHz)



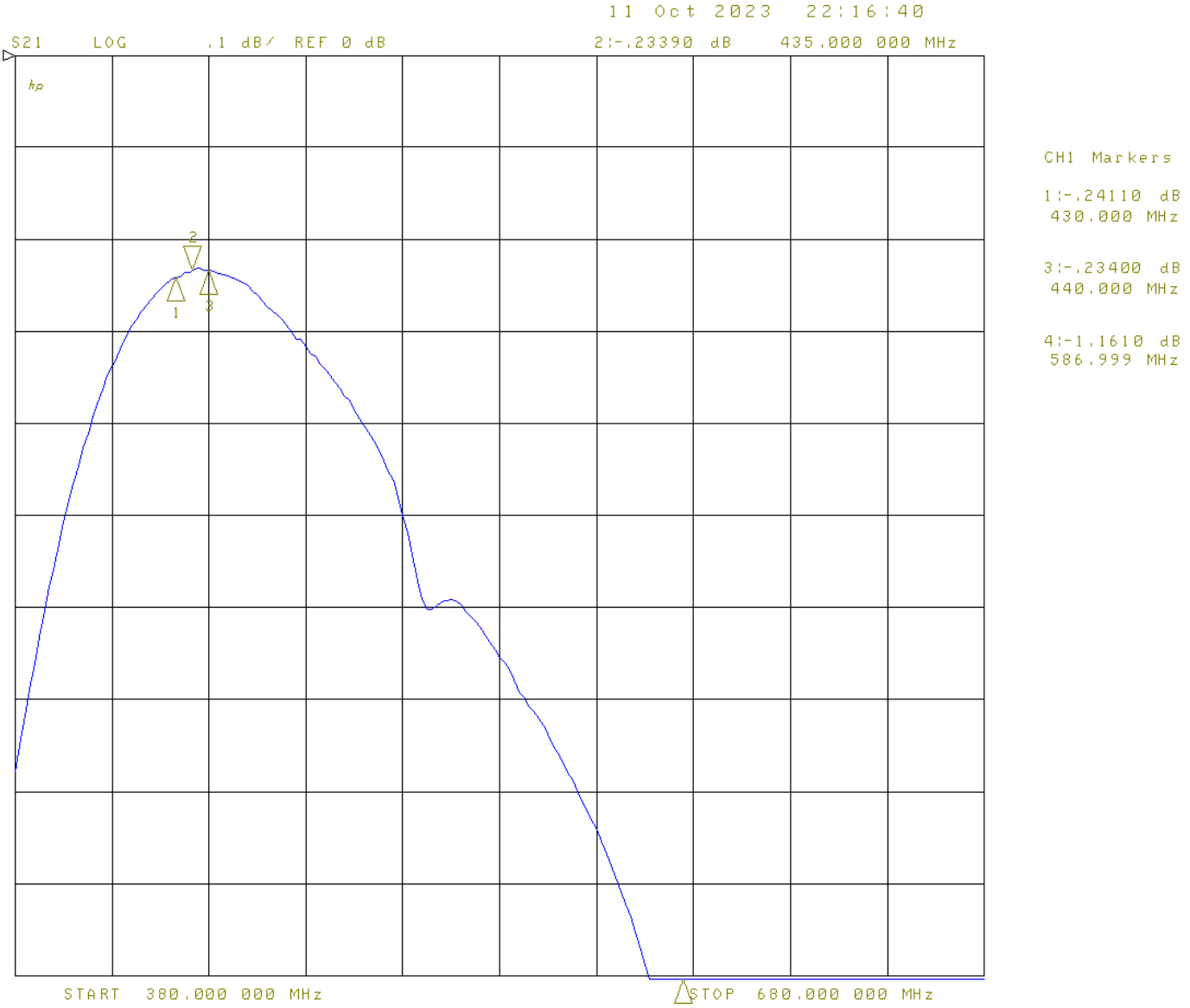
Next, I modified the circulator. As the optimum frequency for S21 and S12 was too high I had to reduce the magnetic field strength. Thus, I removed the six ferromagnetic plates one by one and watched how the optimum frequency moved down. At one of the circulators, I ended up removing all six plates, at the other circulator I got the optimum results by keeping one plate in place. Here are some pictures of the modification (all six plates removed):



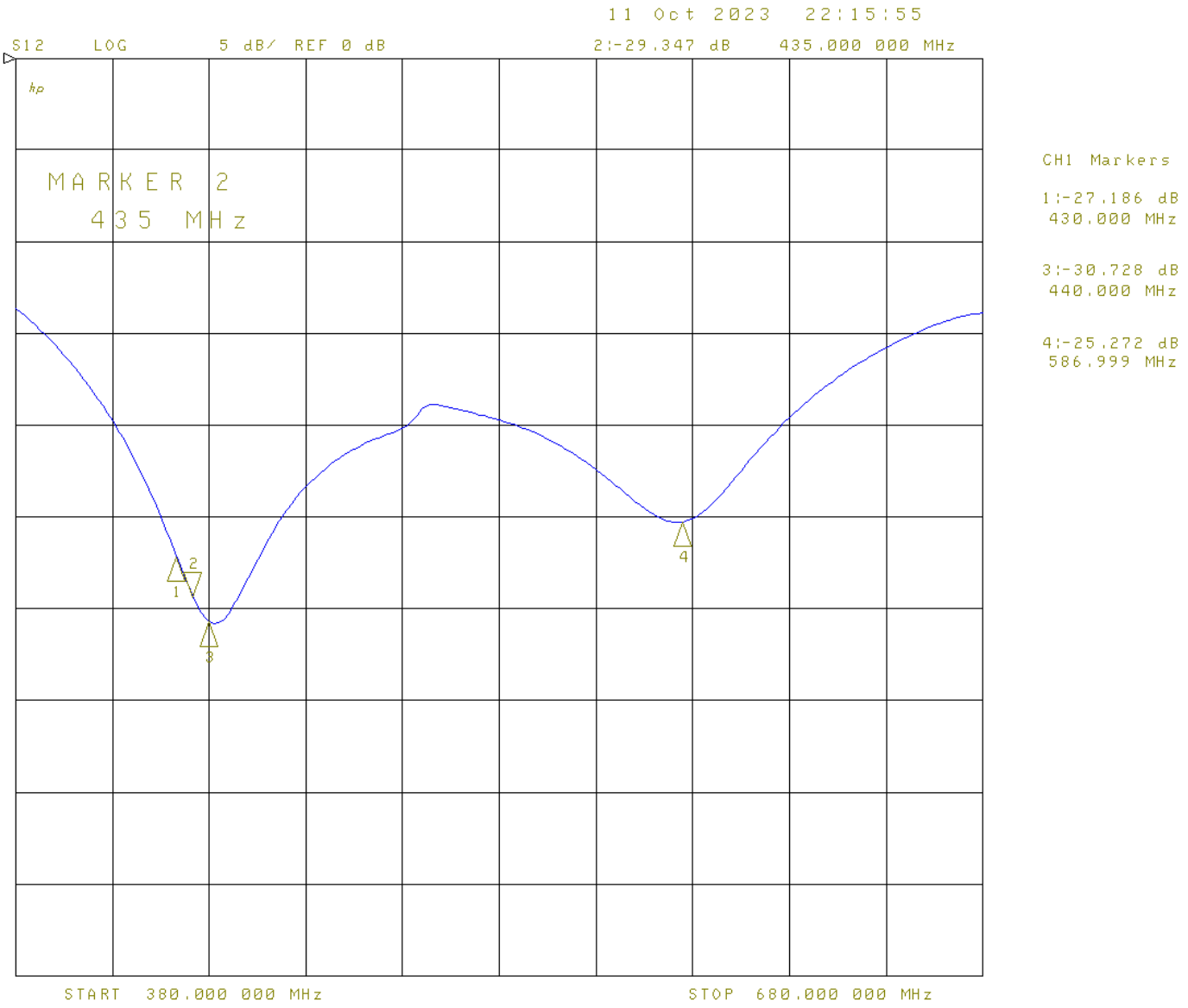

S11 input matching (return loss 25.1dB@435 MHz)



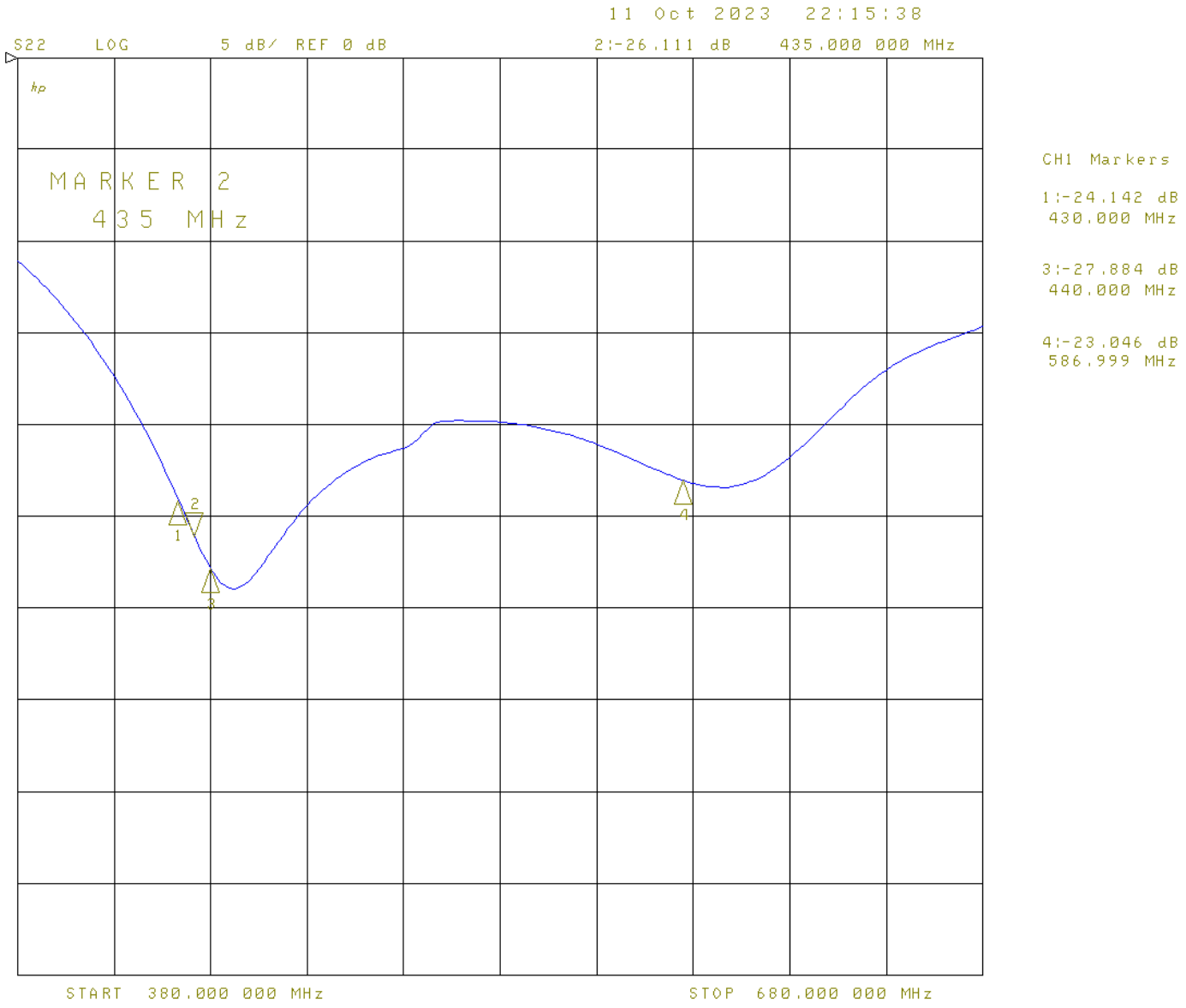
S21 forward transmission (insertion loss at 0.234dB@435MHz)



S12 reverse transmission (isolation is 29.3dB@435MHz)



S22 output matching (return loss is 26.1dB@435MHz)



Below find a table with all measurements of the 3 ports:

1.) Measurement from port 1 to port 2 with port 3 terminated with 50 Ohm:
S11=-25.05dB
S21=-0.234dB
S12=-29.35dB
S22=-26.11dB

2.) Measurement from port 2 to port 3 with port 1 terminated with 50 Ohm:
S11=-25.42dB
S21=-0.220dB
S12=-26.80dB
S22=-28.78dB

3.) Measurement from port 3 to port 1 with port 2 terminated with 50 Ohm:
S11=-27.90dB
S21=-0.229dB
S12=-34.28dB
S22=-25.42dB

I also made some calculations about the dissipated power in the circulator when operated with 700W @435MHz:

1.) Operation from port 1 to port 2 with port 3 terminated with 50 Ohm:

| | |
|---|---|
| Insertion loss S21=-0.234dB | Dissipated power due to insertion loss: 36W |
| Isolation S12=-29.35dB | Dissipated power in port 3: 0.82W |
| Input return loss S11=-25.05dB | Reflected power at port 1: 2.2W |

As the isolation S12 and the input return loss S11 are quite high, the effective dissipated power in the circulator is only slightly reduced. It is $P_{dissipated}$=36W-0.82W-2.2W=33W

2.) Measurement from port 2 to port 3 with port 1 terminated with 50 Ohm:

| | |
|---|---|
| Insertion loss S21=-0.220dB | Dissipated power due to insertion loss: 35W |
| Isolation S12=-26.80dB | Dissipated power in port 1: 1.46W |
| Input return loss S11=-25.42dB | Reflected power at port 2: 2.0W |

As the isolation S12 and the input return loss S11 are quite high, the effective dissipated power in the circulator is only slightly reduced. It is $P_{dissipated}$=35W-1.46W-2.0W=31.5W

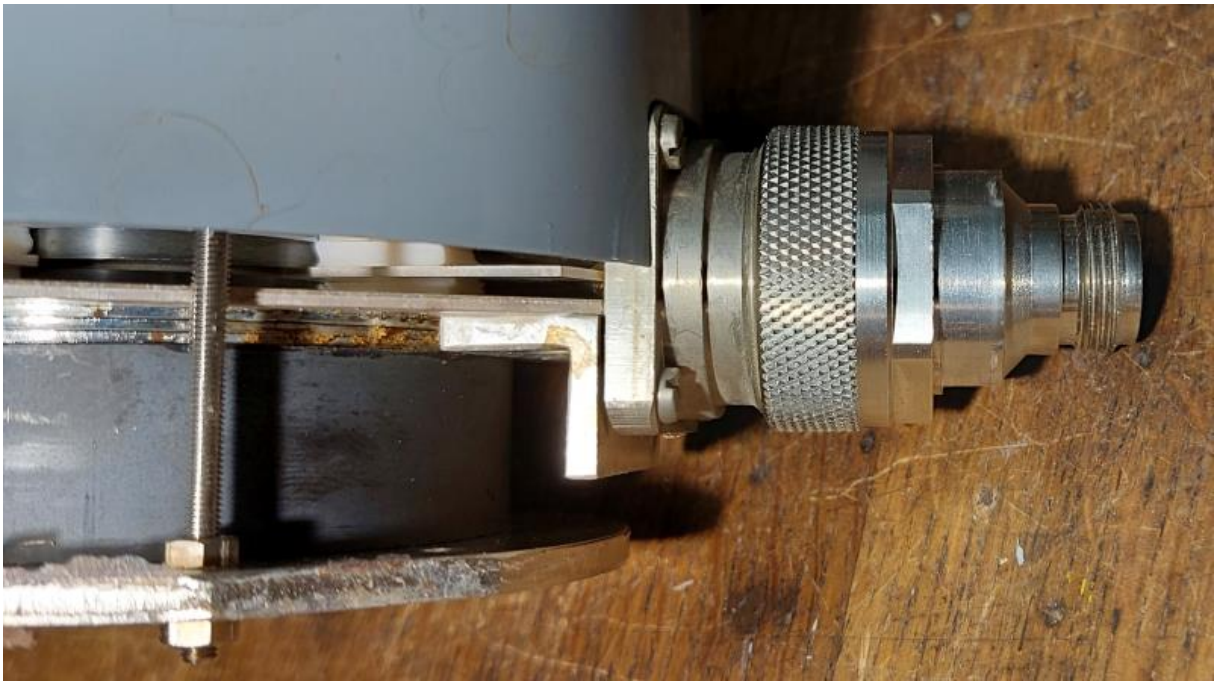
3.) Measurement from port 3 to port 1 with port 2 terminated with 50 Ohm:

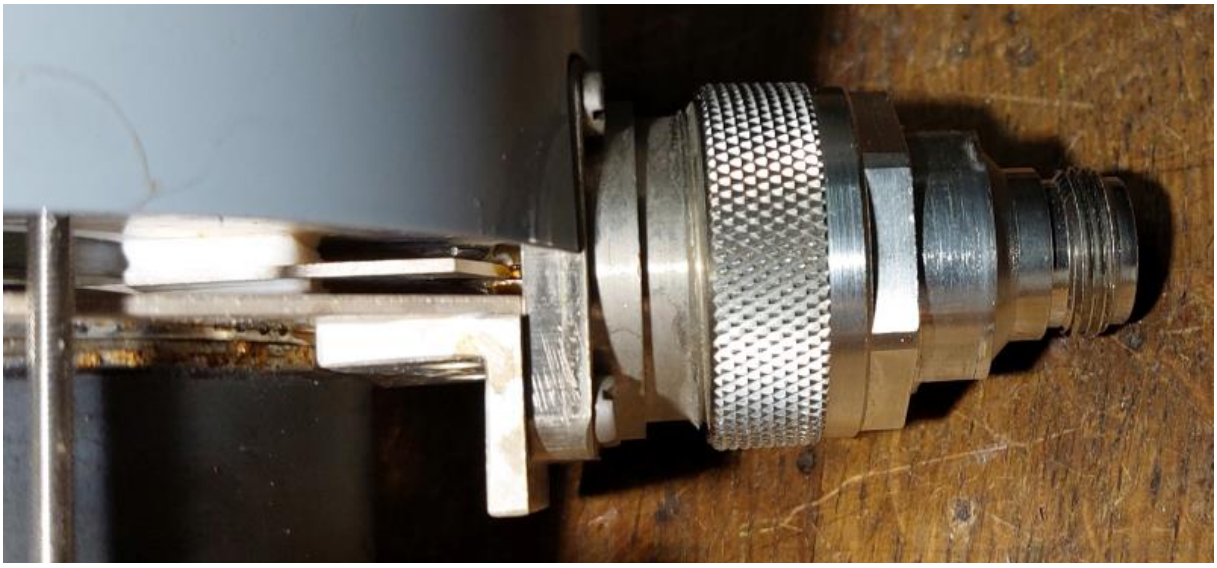
| | |
|---|---|
| Insertion loss S21=-0.229dB | Dissipated power due to insertion loss: 36W |
| Isolation S12=-34.28dB | Dissipated power in port 2: 0.26W |
| Input return loss S11=-27.90dB | Reflected power at port 3: 1.1W |

As the isolation S12 and the input return loss S11 are quite high, the effective dissipated power in the circulator is only slightly reduced. It is $P_{dissipated}$=36W-0.26W-1.1W=34.5W

As the insertion loss after retuning the circulator to 435MHz is slightly higher, the dissipated power at 700W increased to about 36Watt. Whether this might be too much for very long transmission cycles needs to be tested.

The internal construction is very robust as can be seen in the next pictures:





These heavy-duty circulators can be easily modified and then show excellent performance in the 70cm ham radio band. The two units I modified show insertion losses of 0.36dB and 0.23dB and isolation values of >27dB.

If you have a datasheet of this isolator, I appreciate getting an electronic copy.

I will be happy to answer questions and always appreciate feedback. Many thanks in advance.

Best regards

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