2m band circulator TDK CU519A retuned from 154 MHz to 145 MHz

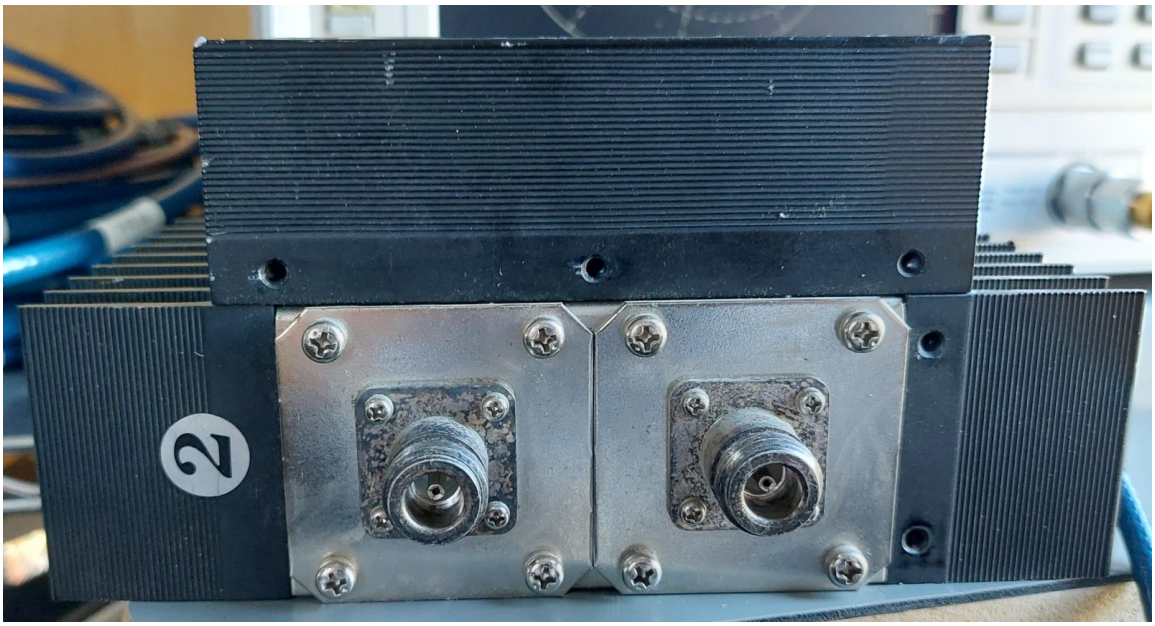
Matthias, DD1US, April 2nd 2025

Hello,

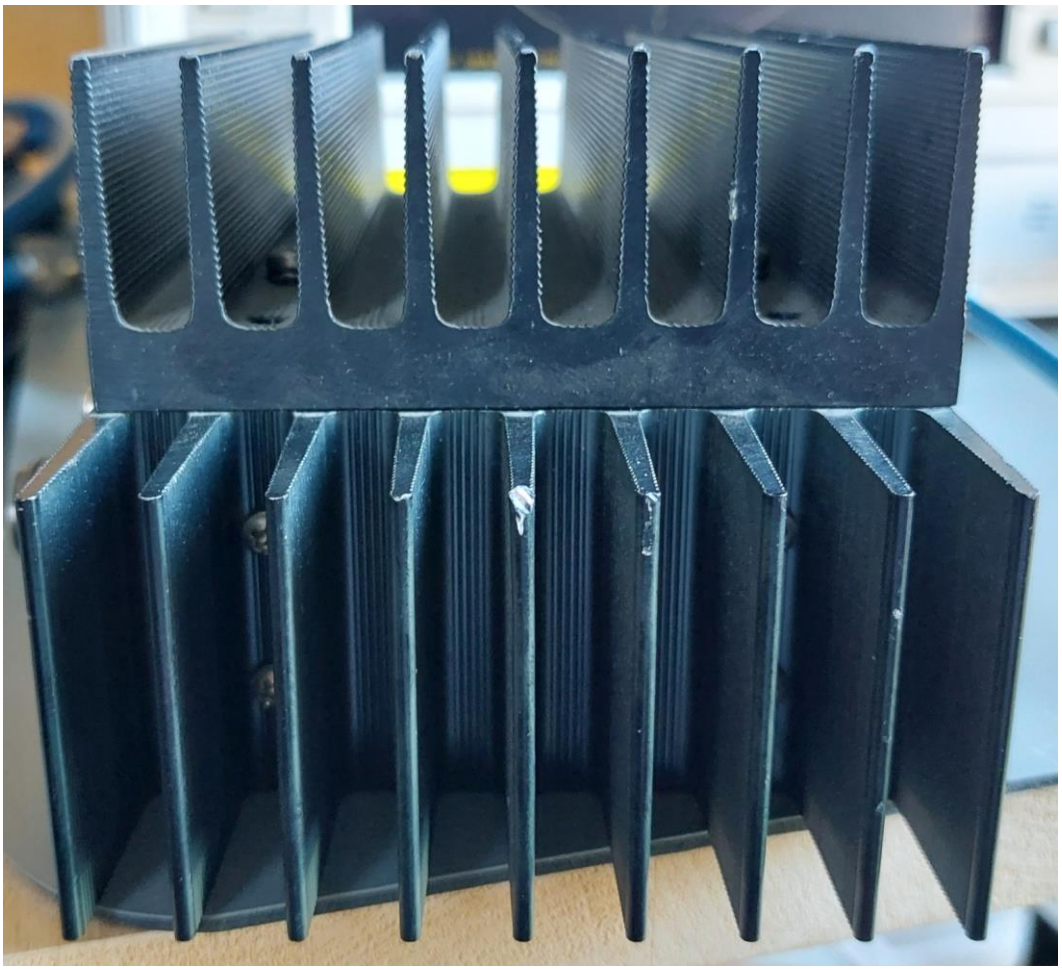
Recently I was able to acquire a heavy duty circulator. It was produced by TDK, is almost entirely covered by heatsinks and has the stunning weight of 2700g. The part number is CU518A. The unit is intended to be used at a frequency of 154MHz. All three connectors are female N connectors. The production date is October 1987.

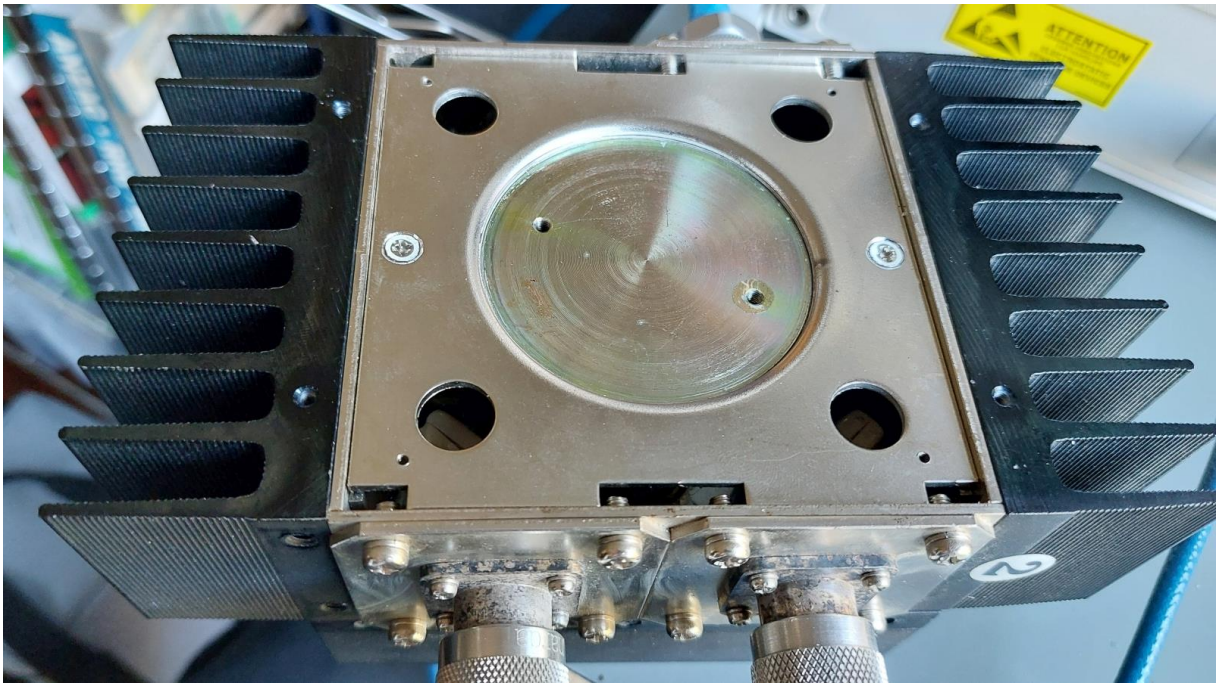
I did not find any data on the device and was curious to see whether I would be able to retune it from 154MHz to the 2m ham radio band with a center frequency of 145MHz.

Here are some pictures of the circulator.

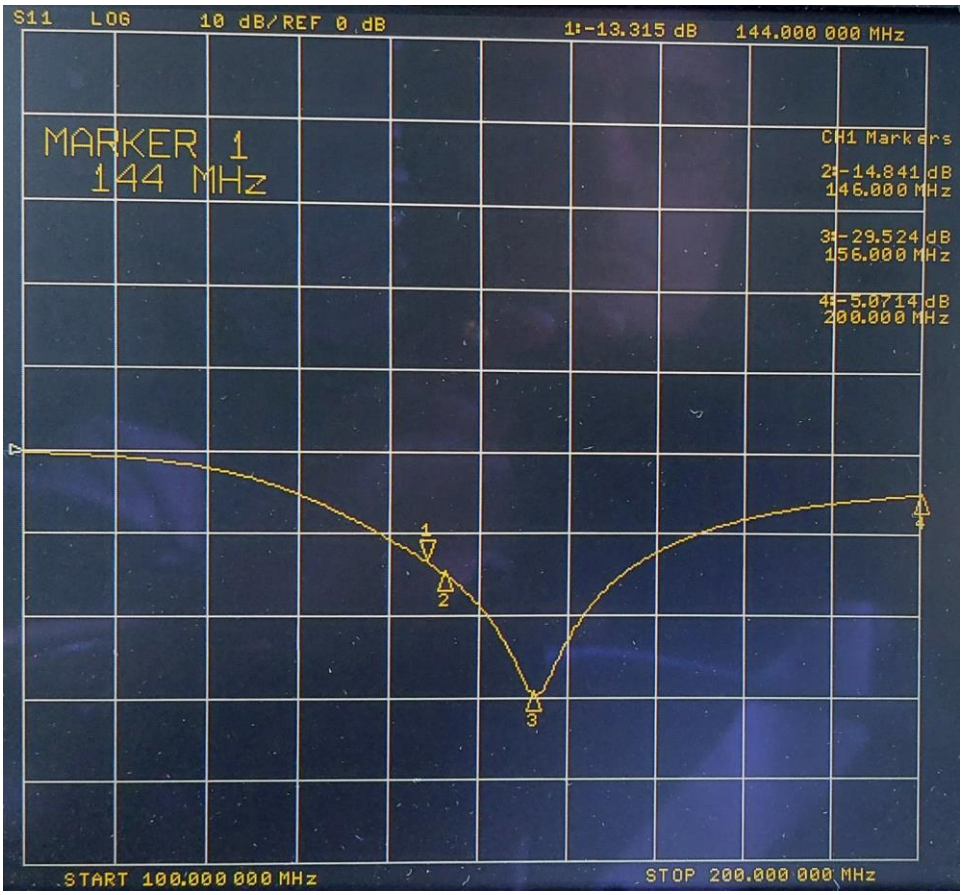


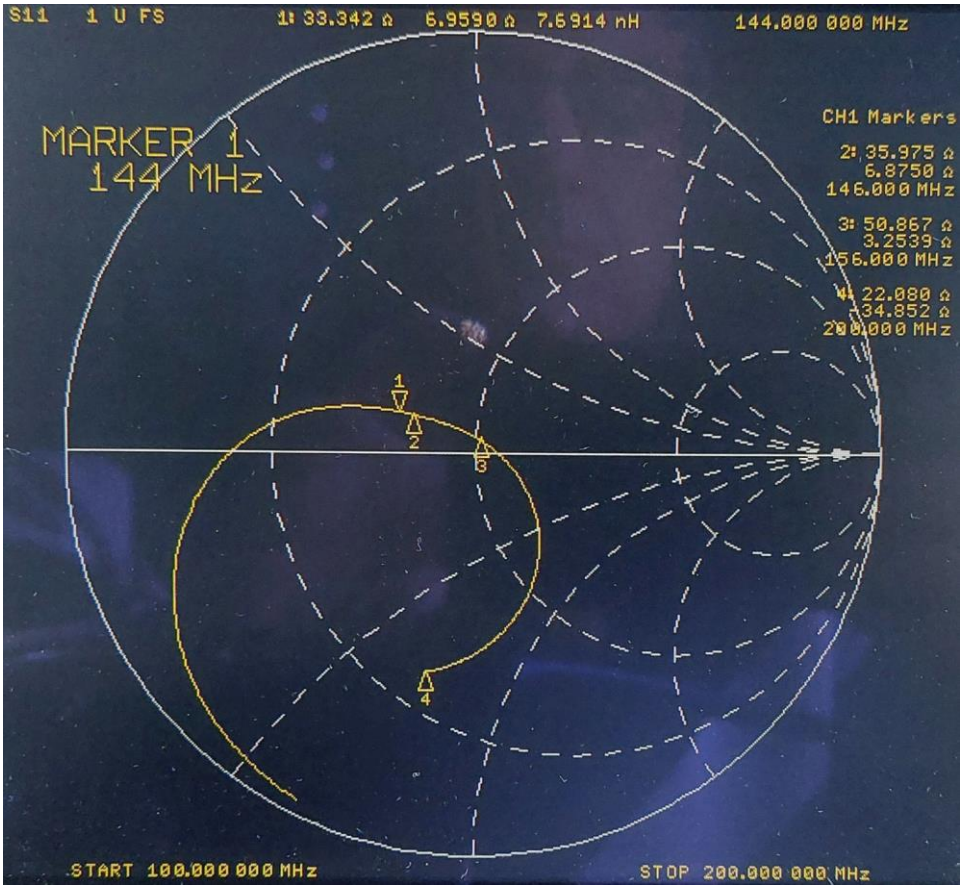

PT. Nº
SER. Nº.
FREQ
100117
2083
154 MHz



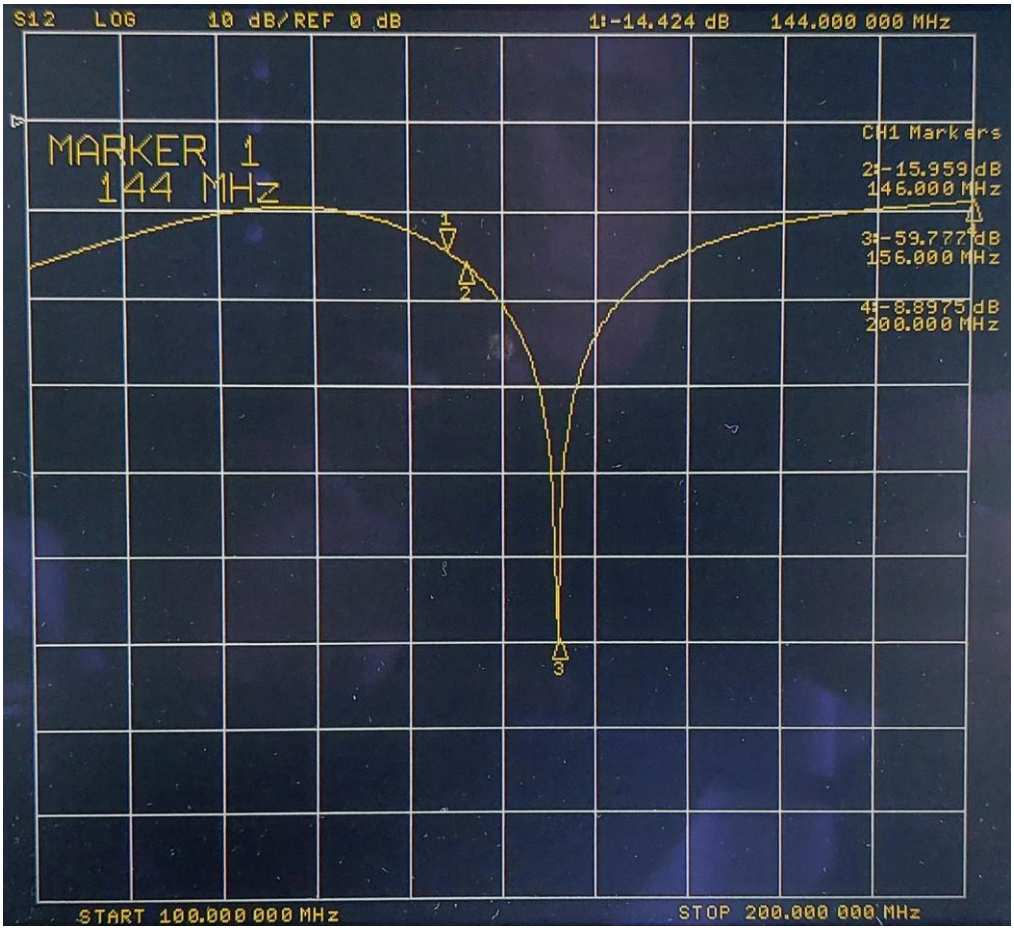

ATTENTION

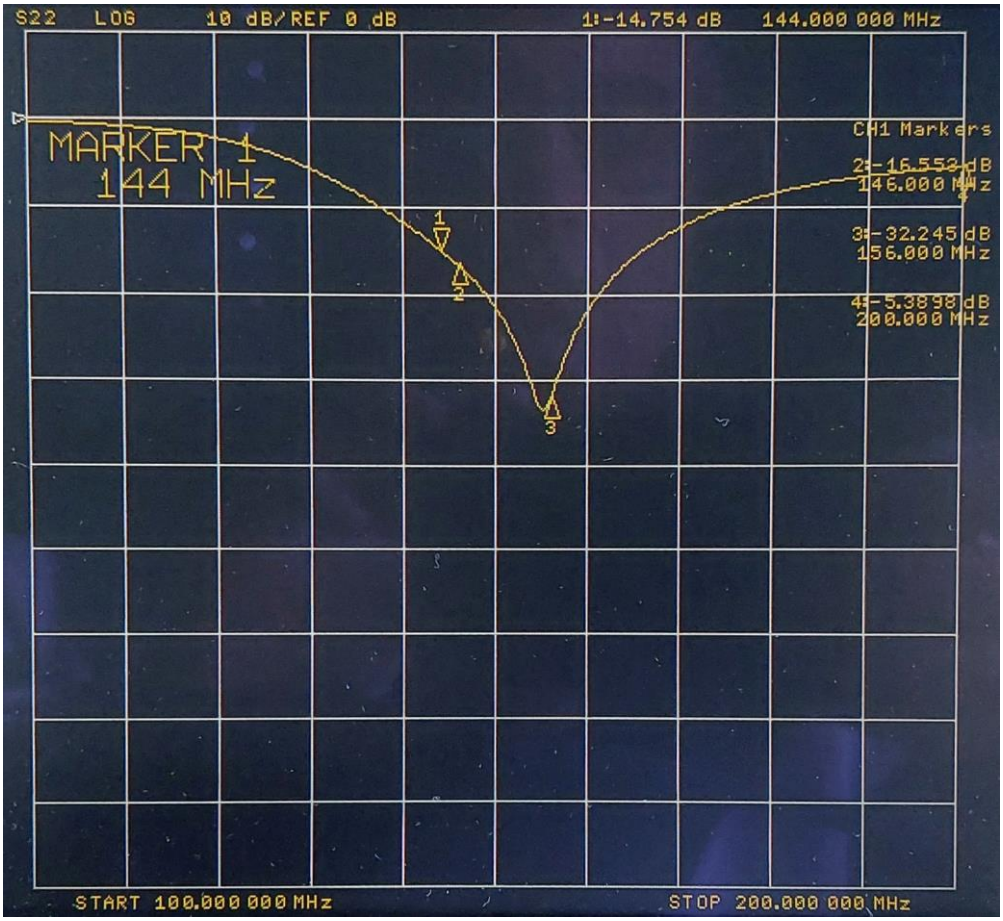
First, I measured the s-parameters of the unit. Subsequently you will find the measurement results using port 1 as the input and port 2 as the output.

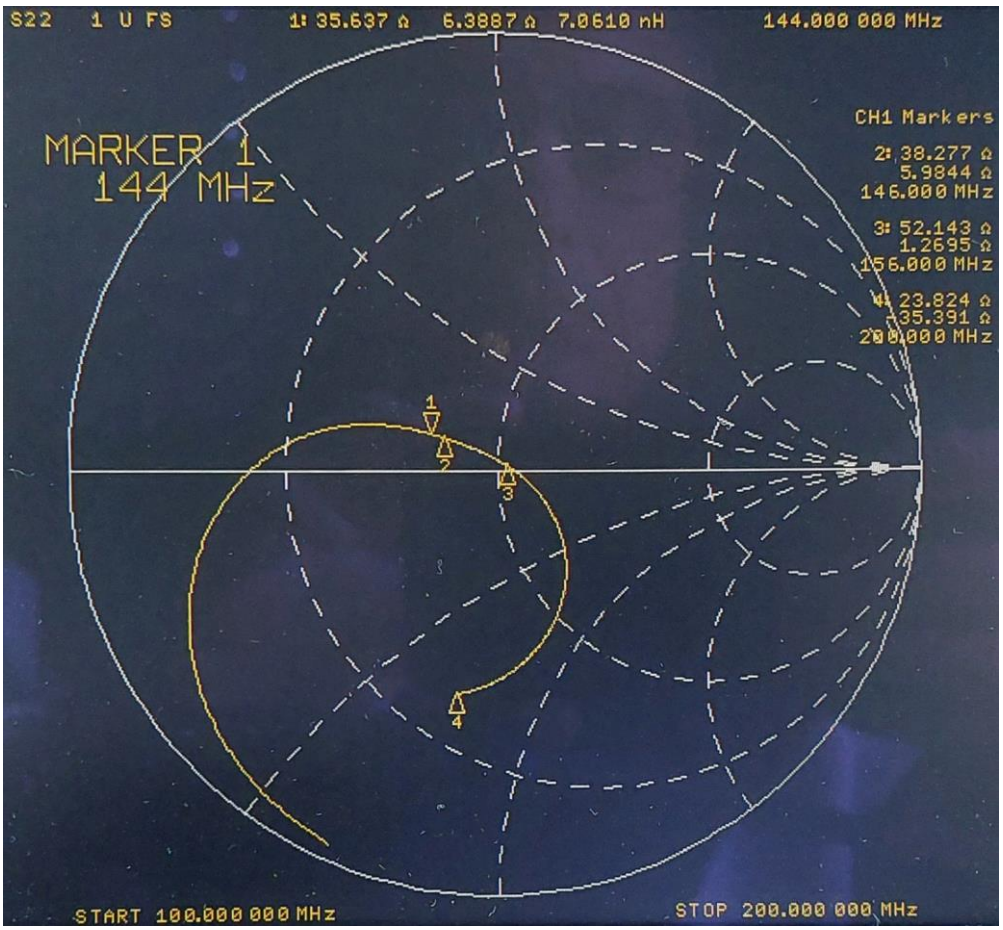





S21 LOG 3 dB/ REF 0 dB
1:-.61430 dB 144.000 000 MHz
MARKER 1
144 MHz
CH1 Markers
2:-.49770 dB
146.000 MHz
3:-.25210 dB
156.000 MHz
4:-2.8516 dB
200.000 MHz
START 100.000 000 MHz
STOP 200.000 000 MHz

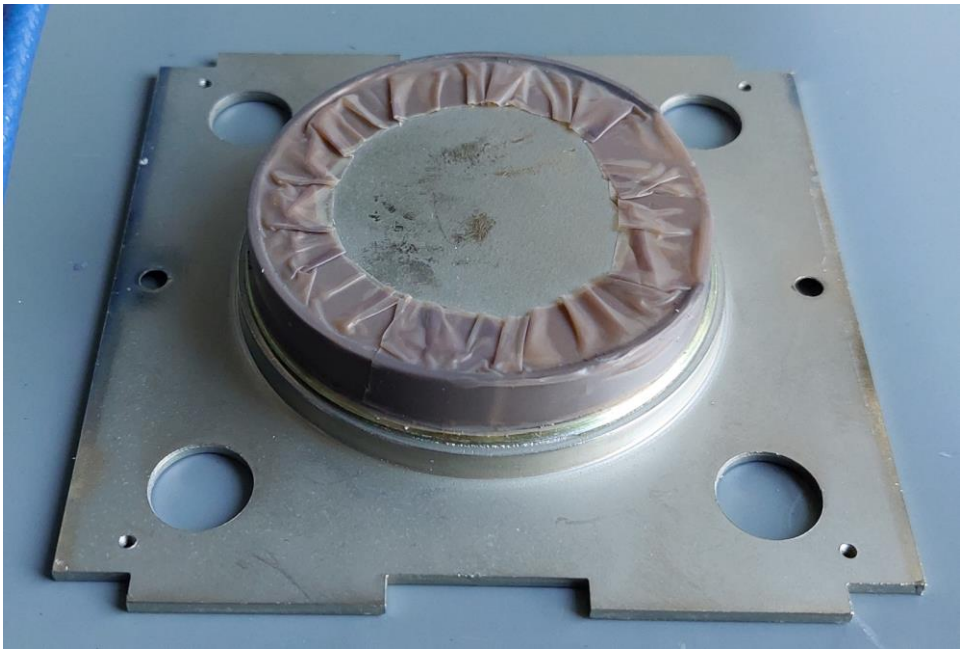

S12 LOG 10 dB/ REF 0 dB
1:-14.424 dB 144.000 000 MHz
MARKER 1
144 MHz
CH1 Markers
2:-15.959 dB
146.000 MHz
3:-59.777 dB
156.000 MHz
4:-8.8975 dB
200.000 MHz
START 100.000 000 MHz
STOP 200.000 000 MHz


S22 LOG 10 dB/ REF 0 dB
1: -14.754 dB 144.000 000 MHz
MARKER 1
144 MHz
CH1 Markers
2: -16.553 dB
146.000 MHz
3: -32.245 dB
156.000 MHz
4: -5.3898 dB
200.000 MHz
START 100.000 000 MHz
STOP 200.000 000 MHz

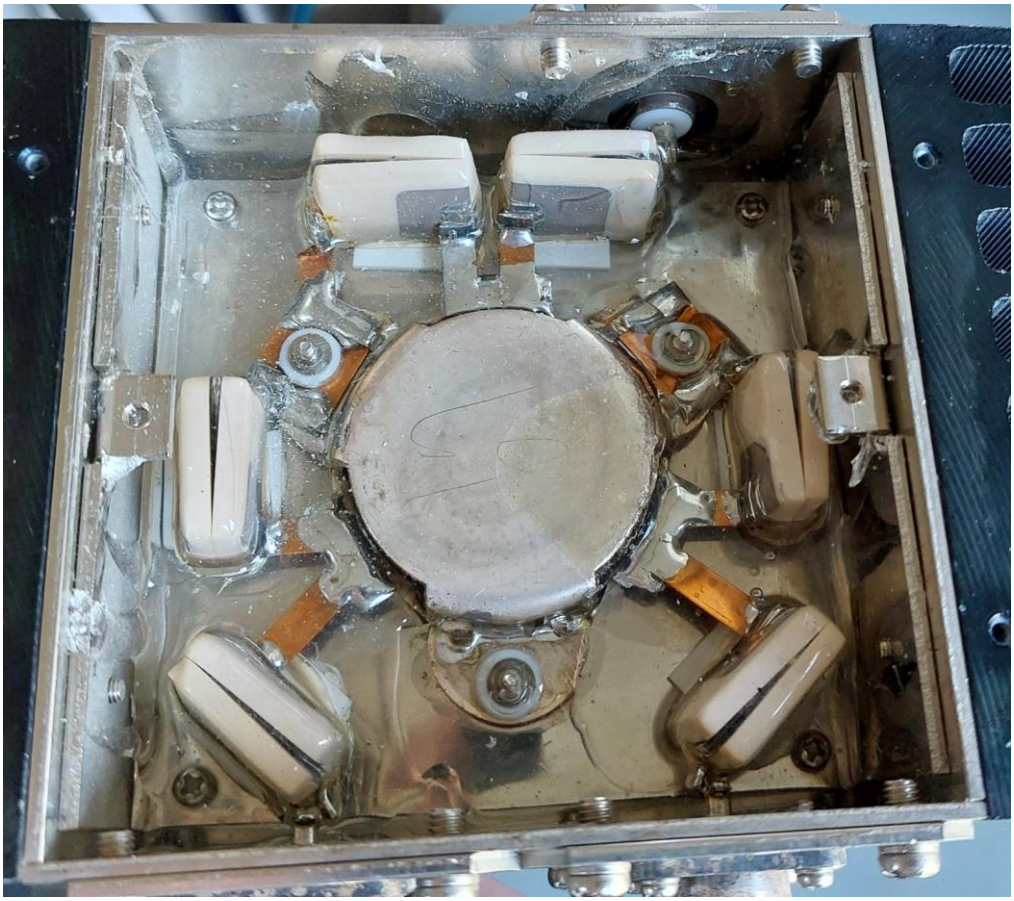

S22 1 U FS
1: 35.637 Ω 6.3887 Ω 7.0610 nH
144.000 000 MHz
MARKER 1
144 MHz
CH1 Markers
2: 38.277 Ω
5.9844 Ω
146.000 MHz
3: 52.143 Ω
1.2695 Ω
156.000 MHz
4: 23.824 Ω
-35.391 Ω
200.000 MHz
START 100.000 000 MHz
STOP 200.000 000 MHz

The unit is indeed very properly tuned and has a minimum insertion loss of 0.25dB at 156MHz. The isolation at the same frequency is 59.8dB. Input and output return loss are about 30dB.

Time to open the device and see what can be done to retune it to the 2m ham radio band. Here are some pictures after removing the lid from the bottom.

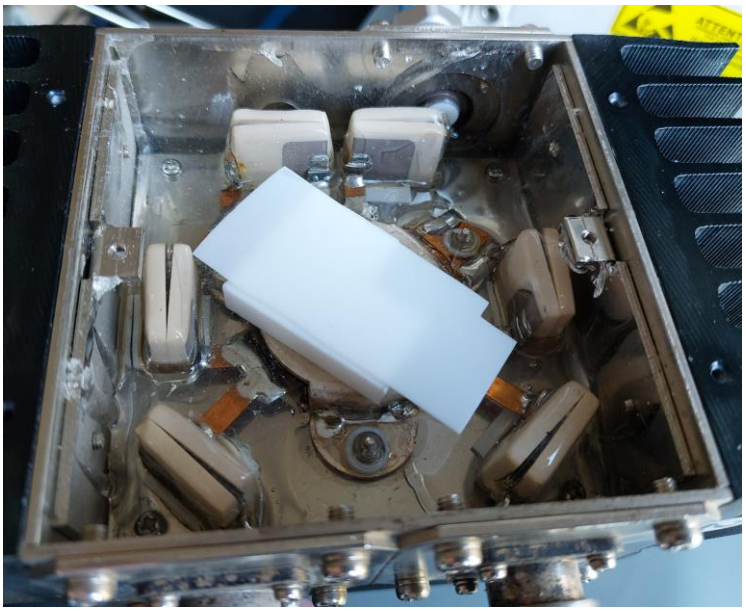


There is a big magnet attached to the inside of the bottom lid.

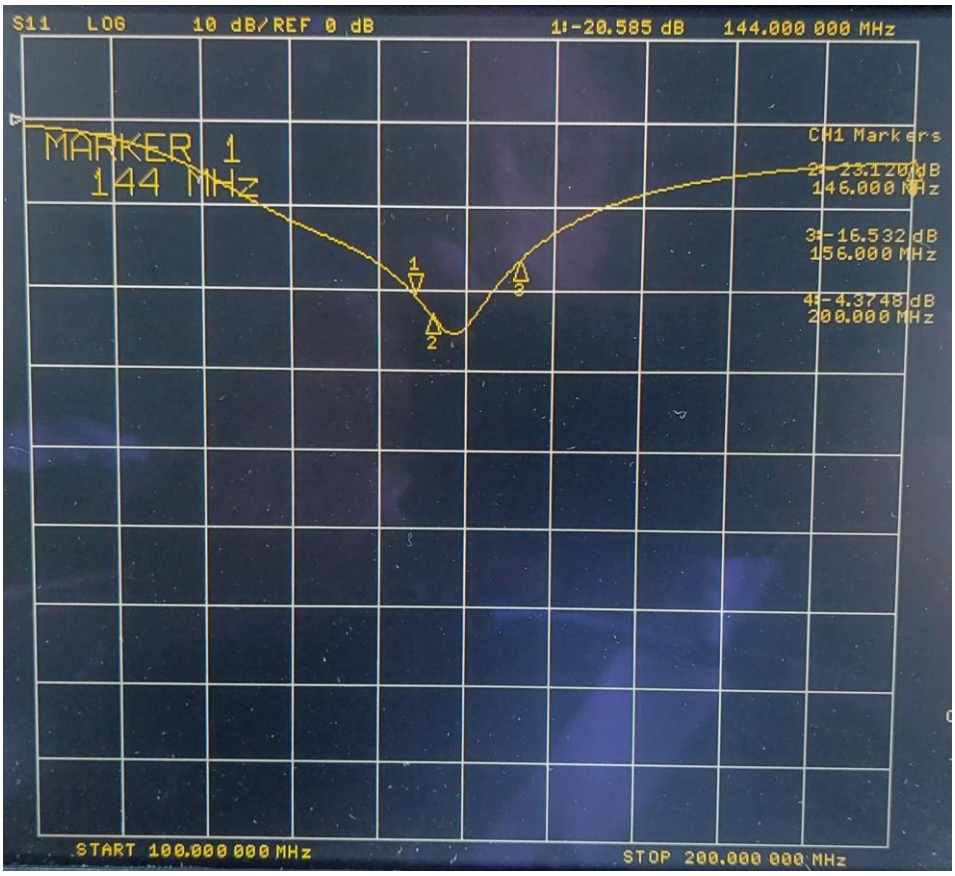


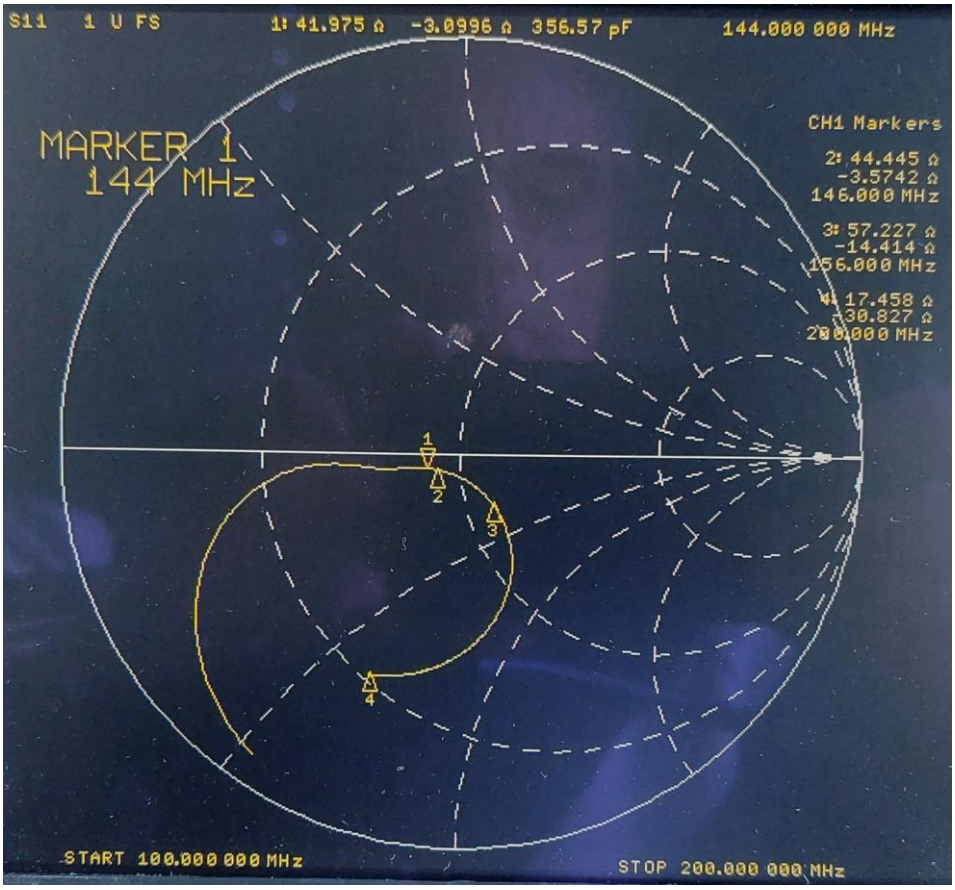
All three ports are connected from the N-jack with a high power ceramic capacitor to the respective port of the circulator. In addition there is a shunt capacitor of the same type connected from each port of the circulator device to ground, The encasing is about 30% filled with a transparent gel, probably some kind of silicone. I assume this is to protect the circulator device from humidity and increase the isolation voltages.

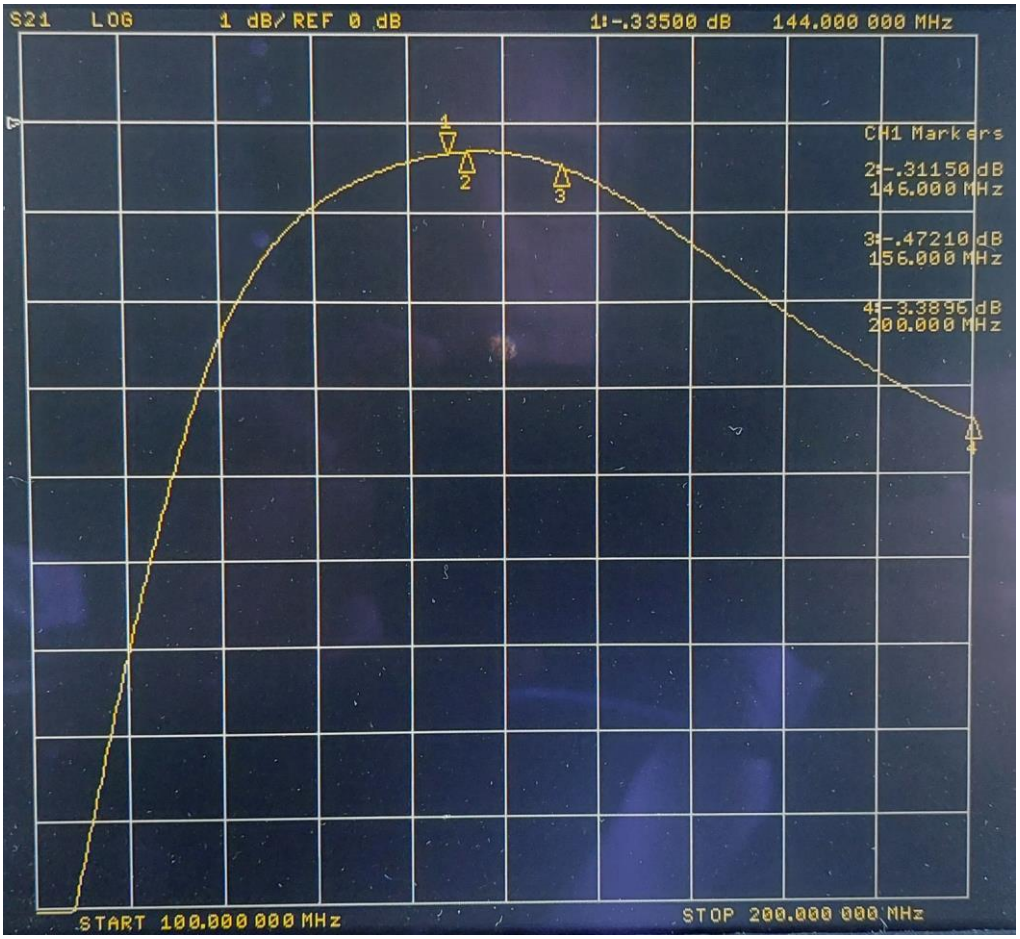
I checked and when increasing the gap between the circulator device and the magnet in the bottom plate the optimum frequency was shifted down. After some trials I ended up with adding a thick teflon spacer plus a thinner teflon sheet for finetuning between the circulator device and the magnet in the bottom plate.

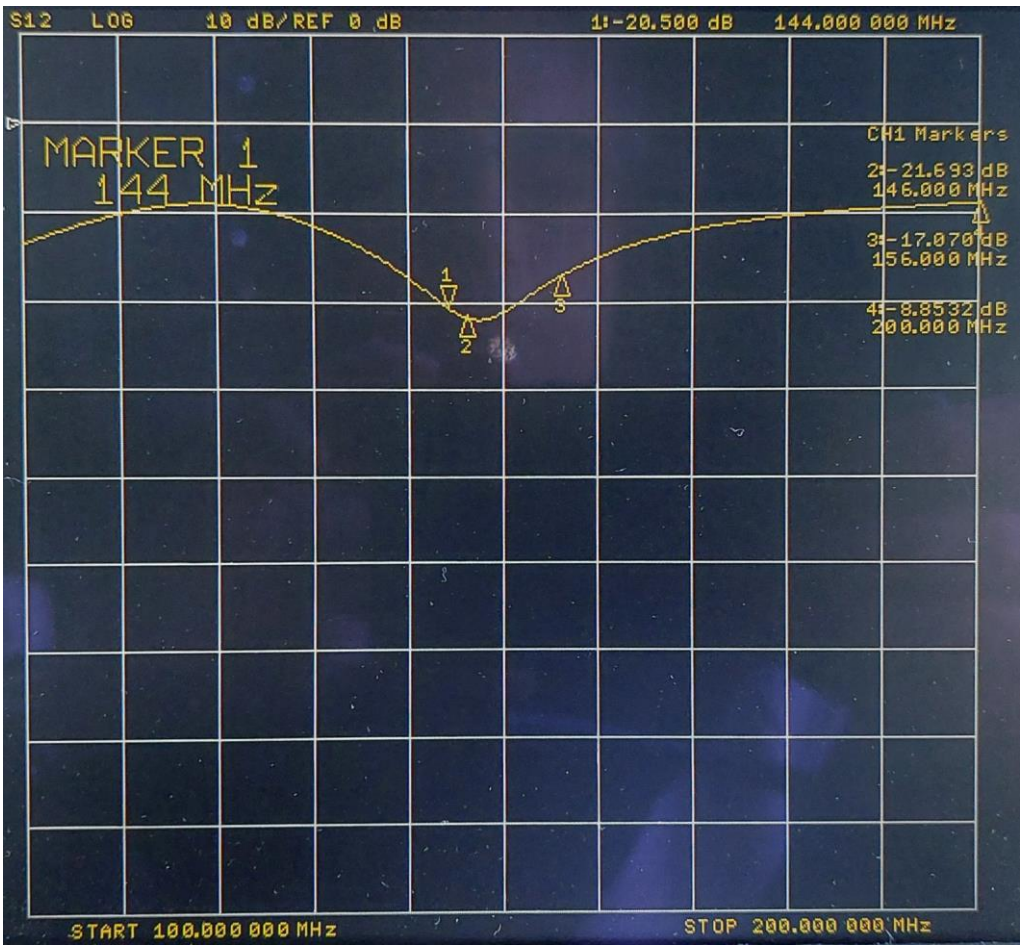


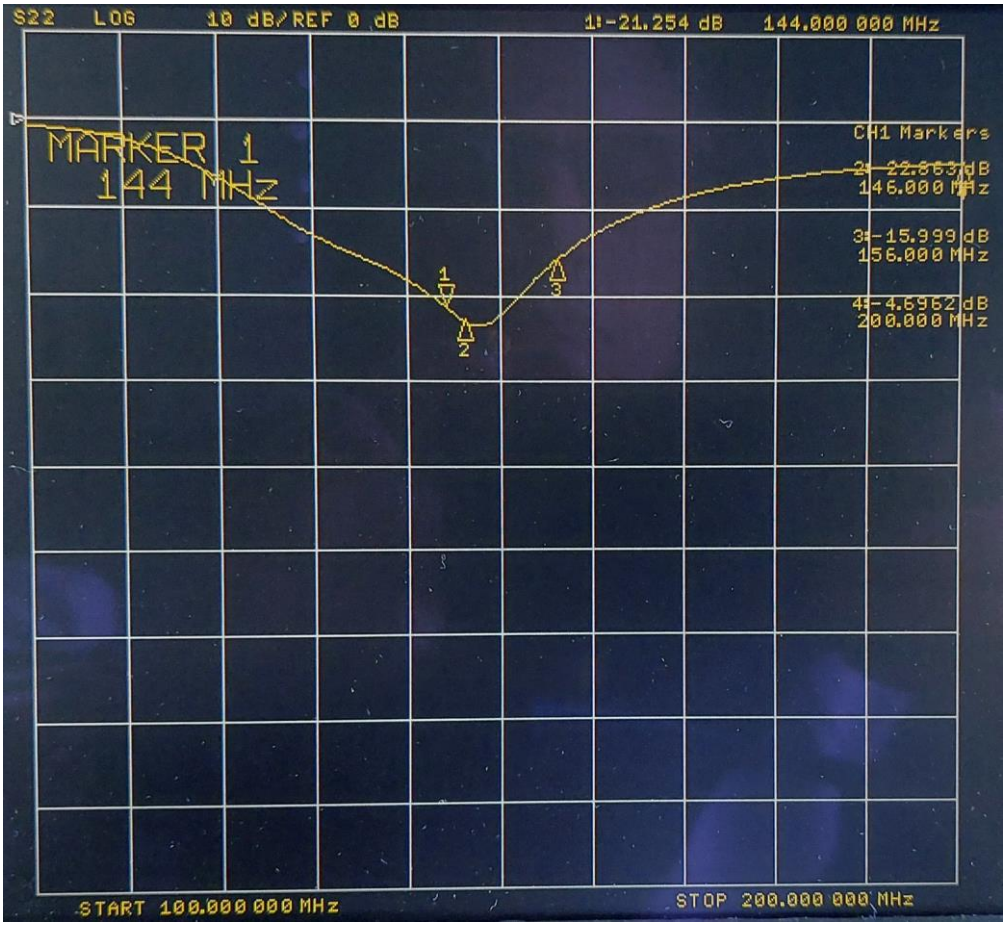
The bottom plate with the magnet clamps the teflon parts whe screwing it down to the encasing. Here are the measurement results after retuning the circulator to 145 MHz:

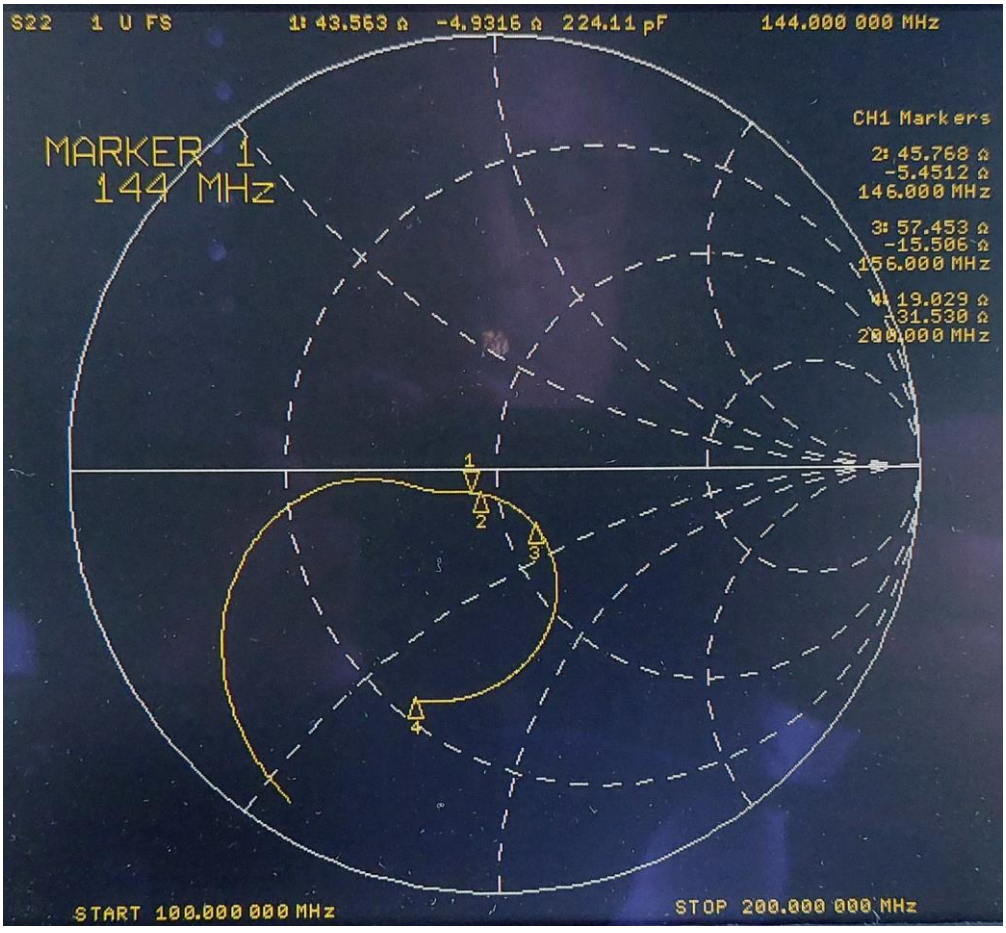





S21 LOG 1 dB/ REF 0 dB
1:-.33500 dB 144.000 000 MHz
CH1 Markers
2:-.31150 dB
146.000 MHz
3:-.47210 dB
156.000 MHz
4:-3.3896 dB
200.000 MHz
START 100.000 000 MHz
STOP 200.000 000 MHz


S12 LOG 10 dB/ REF 0 dB
1:-20.500 dB 144.000 000 MHz
MARKER 1
144 MHz
CH1 Markers
2:-21.693 dB
146.000 MHz
3:-17.070 dB
156.000 MHz
4:-8.8532 dB
200.000 MHz
START 100.000 000 MHz
STOP 200.000 000 MHz


S22 LOG 10 dB/ REF 0 dB
1: -21.254 dB 144.000 000 MHz
MARKER 1
144 MHz
CH1 Markers
2: -22.663 dB
146.000 MHz
3: -15.999 dB
156.000 MHz
4: -4.6962 dB
200.000 MHz
START 100.000 000 MHz
STOP 200.000 000 MHz


S22 1 U FS
1: 43.563 Ω -4.9316 Ω 224.11 pF
144.000 000 MHz
MARKER 1
144 MHz
CH1 Markers
2: 45.768 Ω
-5.4512 Ω
146.000 MHz
3: 57.453 Ω
-15.506 Ω
156.000 MHz
4: 19.029 Ω
31.530 Ω
200.000 MHz
START 100.000 000 MHz
STOP 200.000 000 MHz

In summary the measurement results from port 1 to port 2 with port 3 terminated with 50 Ohm are:

144MHz:	146MHz:
S11=-20.6dB	S11=-23.2dB
S21=-0.34dB	S21=-0.31dB
S12=-20.5dB	S12=-21.7dB
S22=-21.3dB	S12=-22.9dB

I also checked when using port 2 as the input and port 3 as the output, respectively using port 3 as the input and port 1 as the output and the results are always very similar to the measurements above.

I also made some calculations about the dissipated power in the circulator when operated with 750W @144MHz (which is the legal power in Germany for the 2m band):

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

Insertion loss S21=-0.34dB	Dissipated power due to insertion loss: 56W
Isolation S12=-20.5dB	Dissipated power in port 3: 6.24W
Input return loss S11=-20.6dB	Reflected power at port 1: 6.5W

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 Pdissipated=56W-6.24W-6.5W=43.26W

As the insertion loss after retuning the circulator to 145MHz is slightly higher, the dissipated power at 750W increased to about 43Watt. Based on the massive build with the extensive heatsinks my guess is that this circulator should be still good enough to withstand a maximum power of 750W but I am not sure.

If anyone has an opition about this or even any specifications for this circulator I appreciate if you contact me preferable by Email. You will find my Email address on my website.

Kind regards

Matthias

www.dd1us.de