Evaluation of low-cost Chinese directional couplers 800-2500 MHz for the 23cm and 13cm bands

Matthias, DD1US, Updated June 9th2020, Rev 1.4

Recently some interesting directional couplers from Chinese vendors have been showing up on Ebay.
They are specified for the frequency range 800-2500 MHz, a maximum input power of 200W and are available with different coupling ratios i.e. 10dB, 20dB, 30dB and 40dB. The insertion loss is specified to be <0.05dB and a VSWR <1.20. The isolation is specified to be >20dB (I suppose that isolation means directivity). For all 3 ports female N-connectors are used.

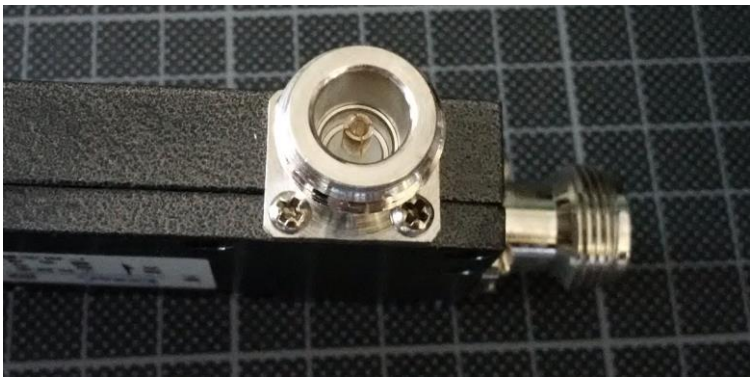
Meanwhile I was able to measure 3 different couplers. All 3 were in slightly different encasings. The first 2 are specified with coupling ratios of 30dB, the third device with a coupling ratio of 20dB.

1.) First version with a coupling ratio of 30dB:

I decided to try the 30dB version and bought it for 5,35 Euros including shipping at:
https://www.ebay.de/itm/Accessories-Coupler-N-Type-Female-RF-Coaxial-Directional-800-2500MHz-200W/123863443543?ssPageName=STRK%3AMEBIDX%3AIT&var=424588203062&_trksid=p2057872.m2749.l2649

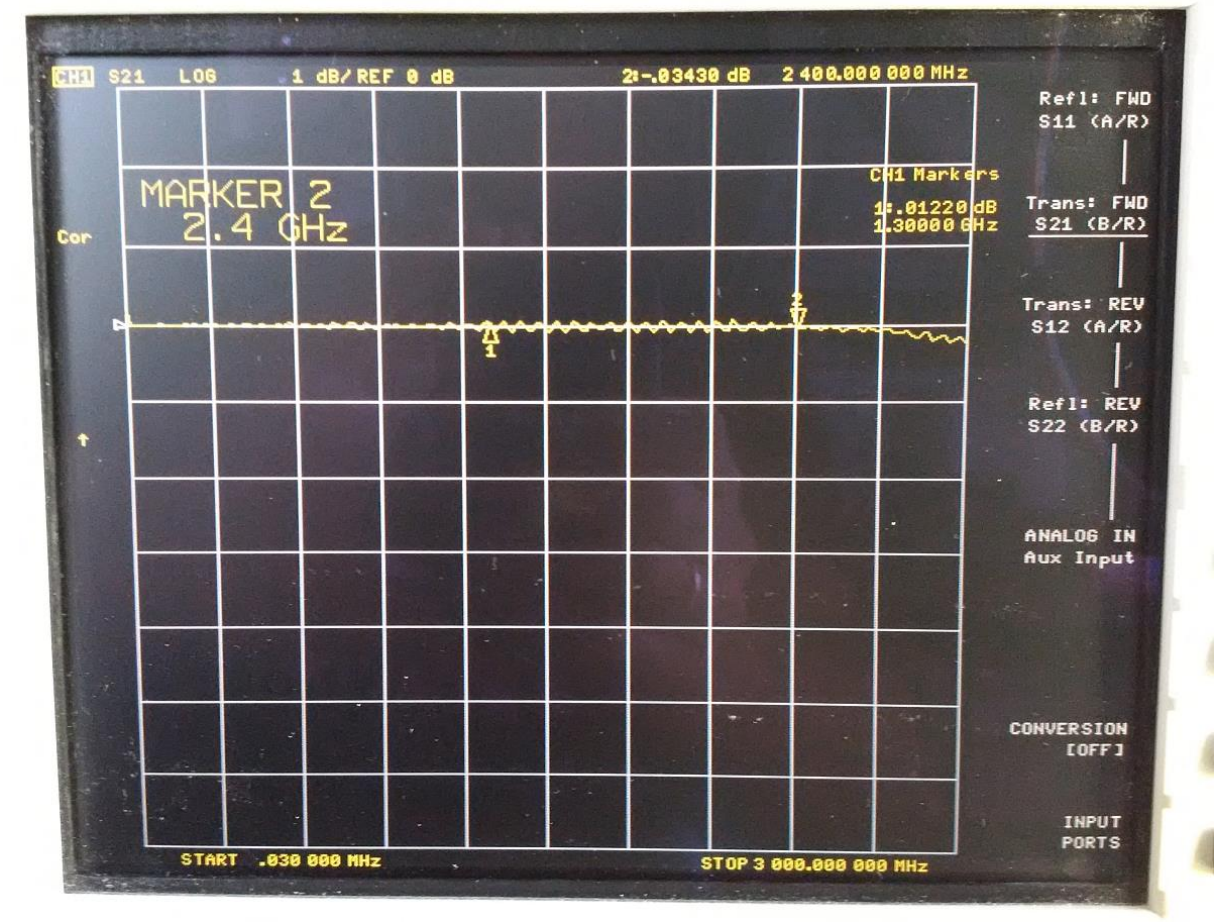
After 3 weeks I received the coupler. The encasing looks a bit different than the advertised unit but is quite nice. The “brand” on the unit I got is “JIESAI” and the part number is OHQQ-L-30. Here are some pictures of the actual unit which I received:

The N-connectors are not really high quality but should be ok if the unit is used in a permanent setup as I am planning for. The outer thread is reasonably precise so that the N-Connectors can be easily screwed on.



First, I measured the insertion loss S21 of the coupler from 30kHz to 3 GHz with the measurement port terminated with a high quality 50 Ohm load:

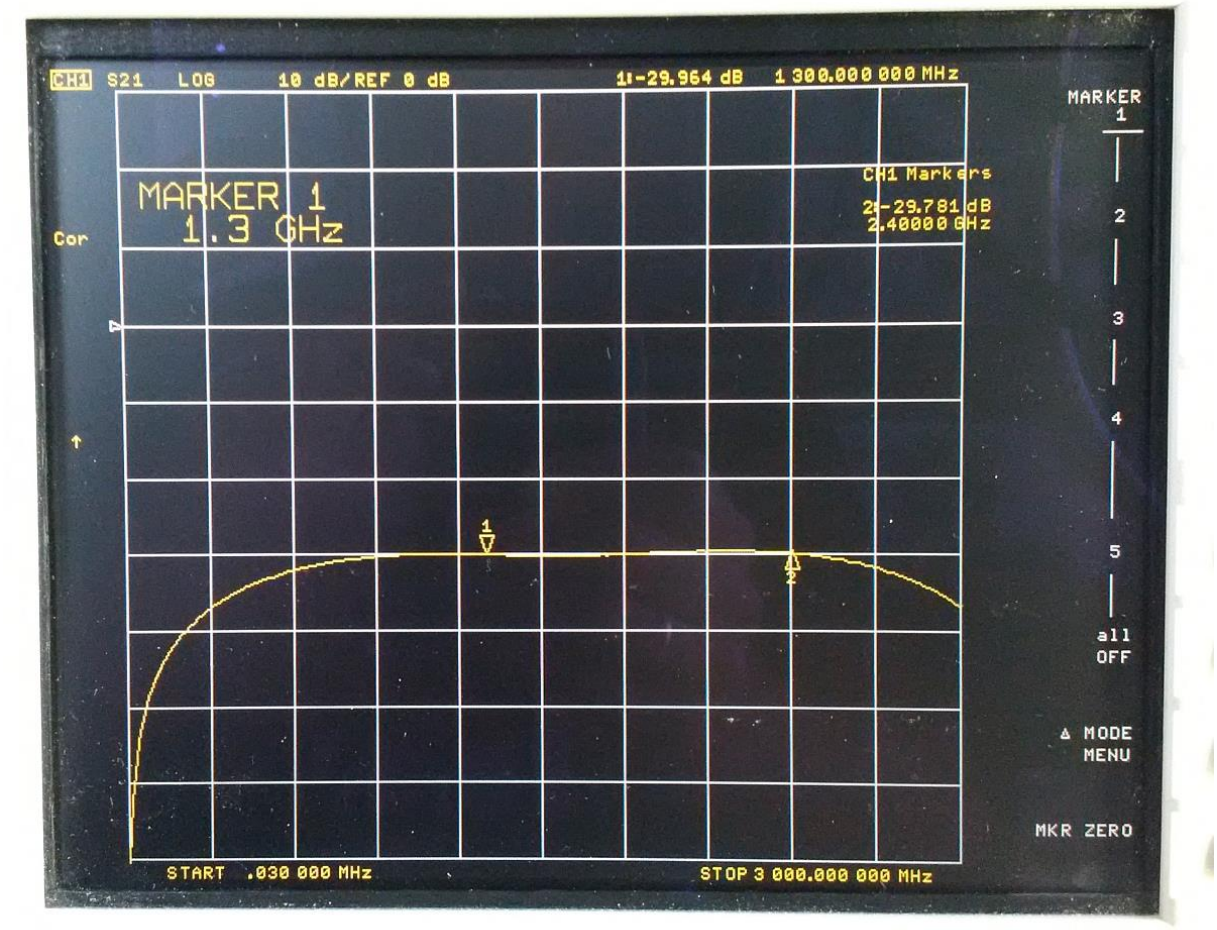
As can be seen in the next graph the insertion loss at 1.3GHz was measured as 0.012dB and at 2.4 GHz as 0.034dB. This is well in the spec of better than 0.05dB.



I have not tested the maximum power but the very low insertion loss indicates that there should be no problem. The insertion loss of 0.034dB means that using an input power of 200W less than 2W are dissipated in the coupler.

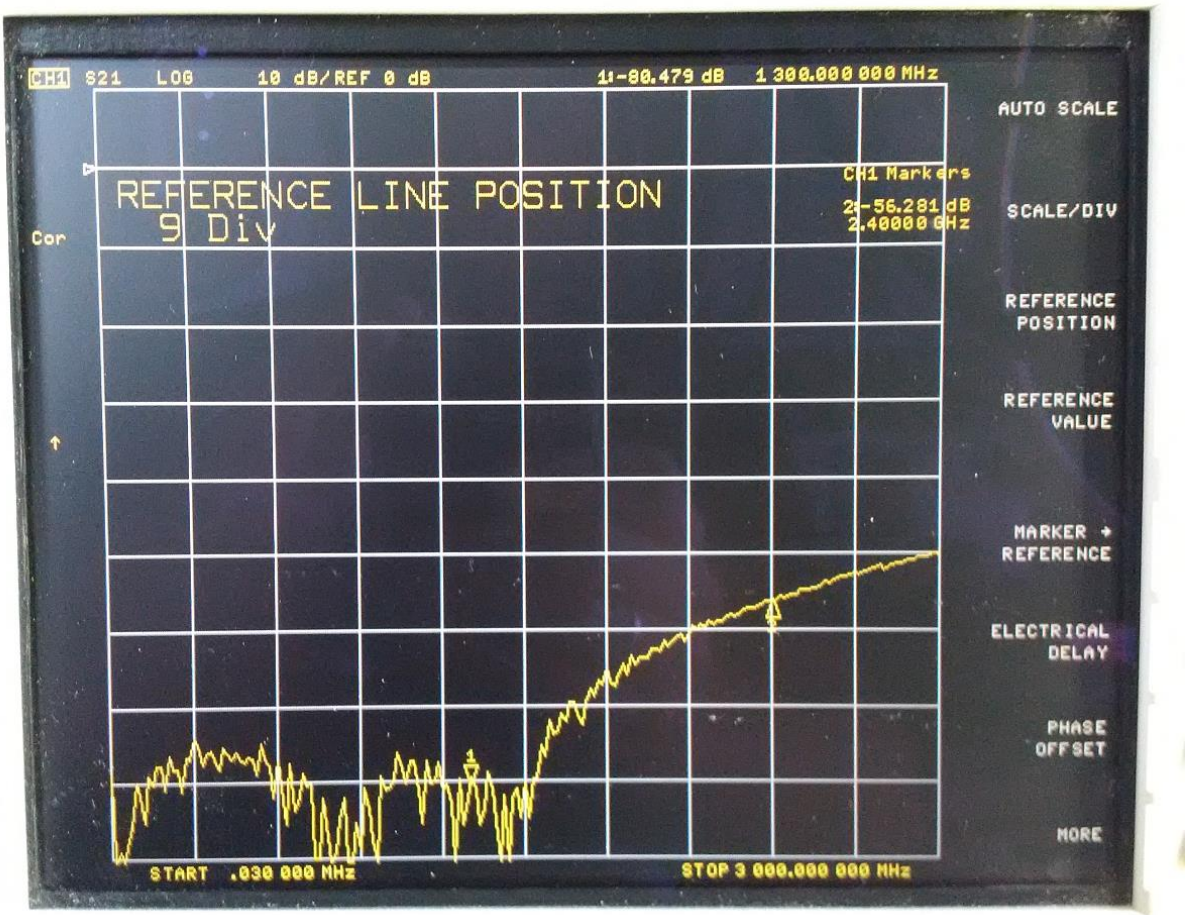
Next, I measured the coupling S31 from the input to the measurement output, which is nominally 30dB. The output was terminated with a high quality 50 Ohm load.

As can be seen in the next graph the coupling factor at 1.3 GHz was measured as 29.6dB and at 2.4 GHz as 29.8dB. This is amazing close to the specified value of 30dB for such a low-cost device.

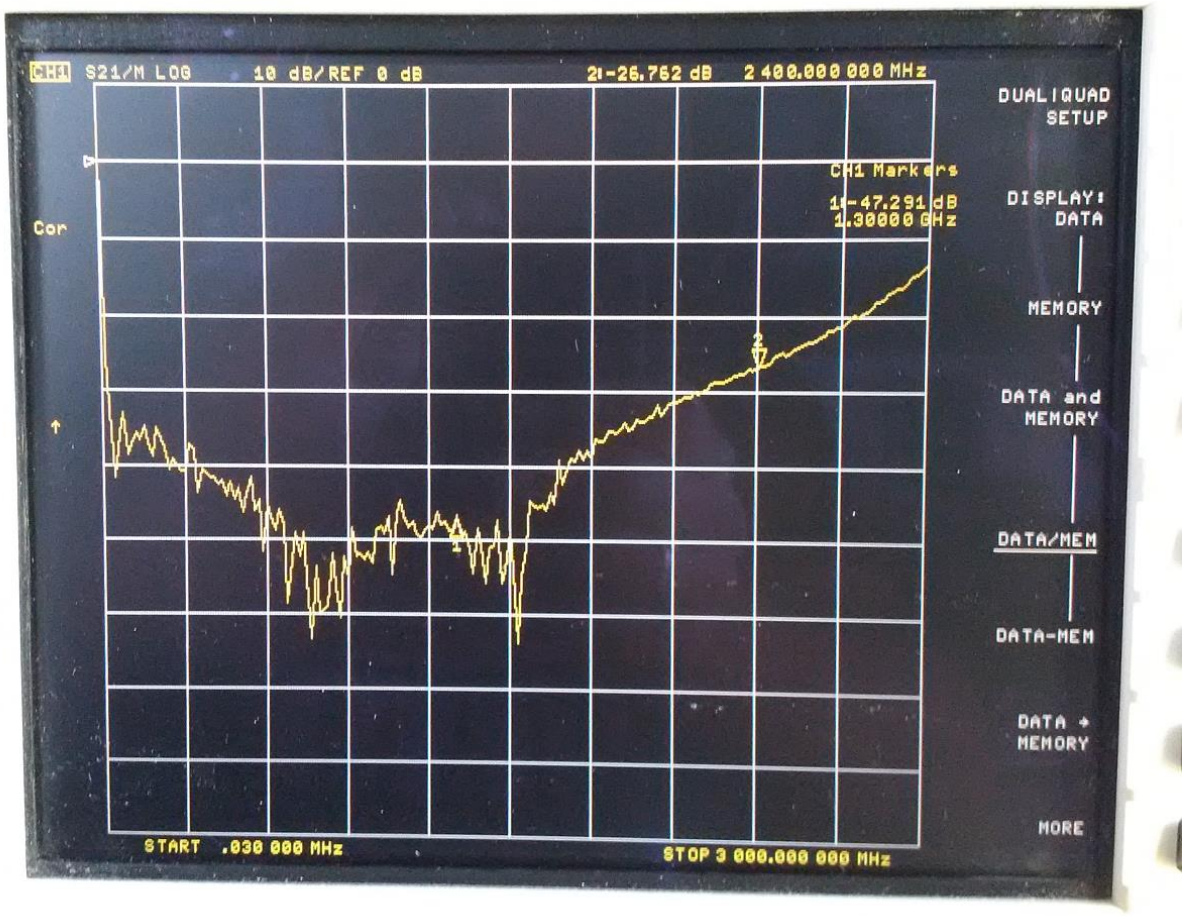


Next, I measured the isolation S23 from the output port to the measurement port. The input was again terminated with a high quality 50 Ohm load.

The isolation including the 30dB coupling factor was measured to be 80.5dB at 1.3 GHz and 56.3dB at 2.4 GHz respectively.



Finally, I measured the directivity, which is the ratio S31 to S32.



The directivity was measured to be 47.3dB at 1.3 GHz and 26.8dB at 2.4 GHz respectively. This is significantly better than the specified value of >20dB. This coupler works especially well at the 23cm ham radio band.

Overall this directional coupler performs extremely well for a price of only 5,35 Euros.

2.) Second version with a coupling ratio of 30dB:

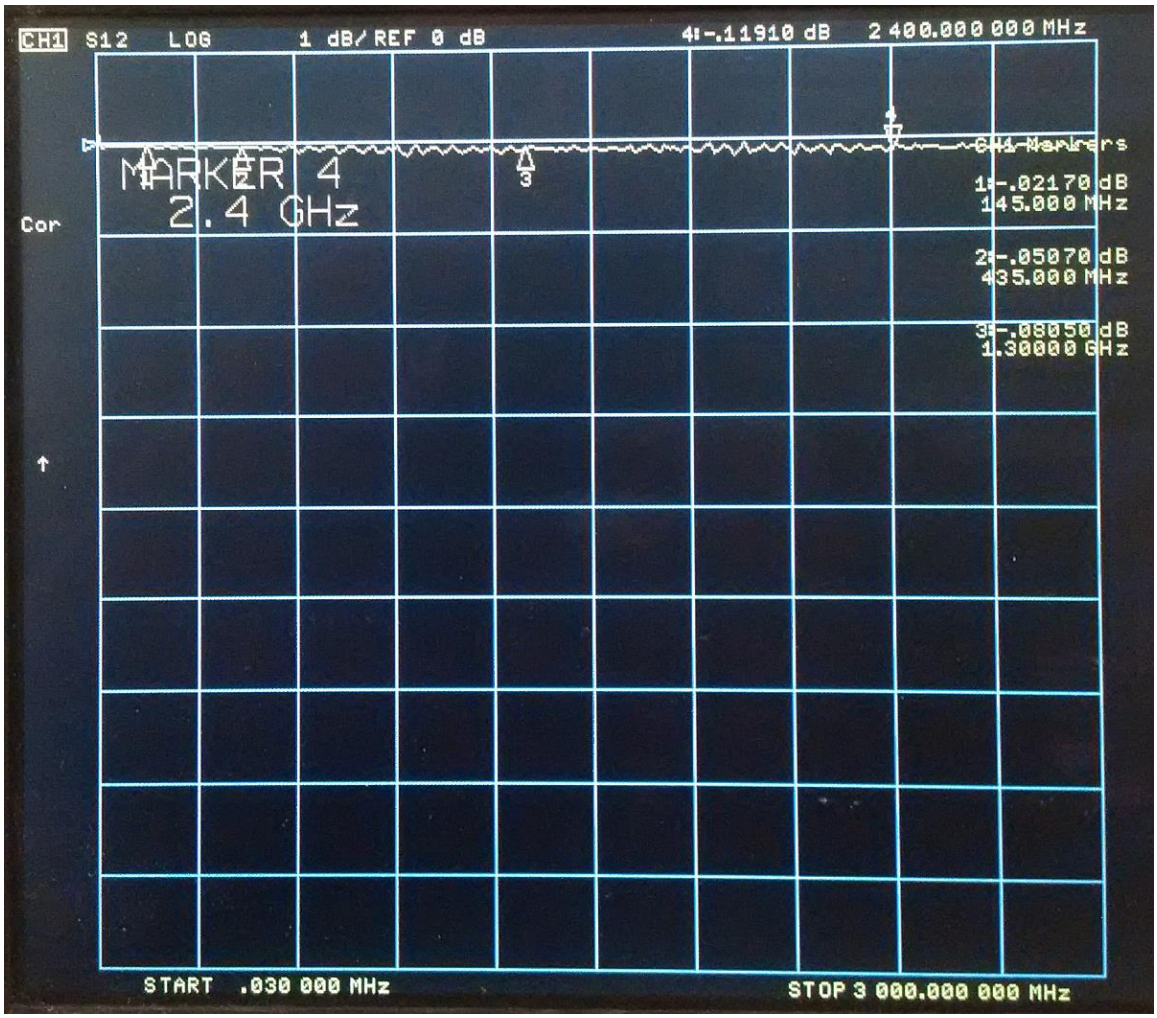
I ordered another device with a coupling ratio of 30dB for a friend from a source in Germany. Shipment was much quicker (about 1 week) and the price including shipping was 7,49 Euros. Here is the link to the source: https://www.ebay.de/itm/RF-Koaxial-Directional-Coupler-800-2500MHz-200Watt-10-20-30-40dB-DE/283587456504?ssPageName=STRK%3AMEBIDX%3AIT&var=584844056665&_trksid=p2057872.m2749.l2649

As with the first device the encasing looks a bit different than the advertised unit and also different than the first unit. However, the encasing is quite nice. Also, this seconded unit is branded as SUNWAVE with the part number CP30-0825-N200U3A. Here are some pictures of the actual unit which I received:

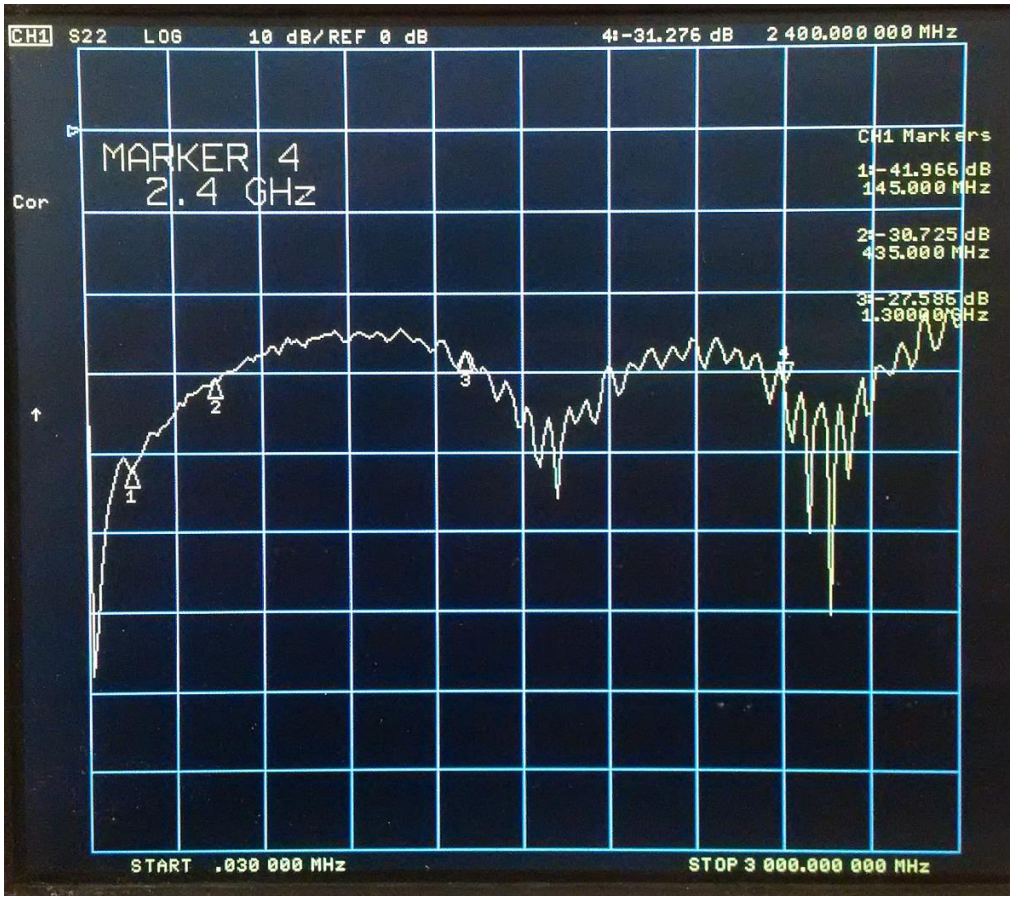
The N-connectors are not really high quality but should be ok if the unit is used in a permanent setup. The outer thread is reasonably precise so that the N-Connectors can be easily screwed on.

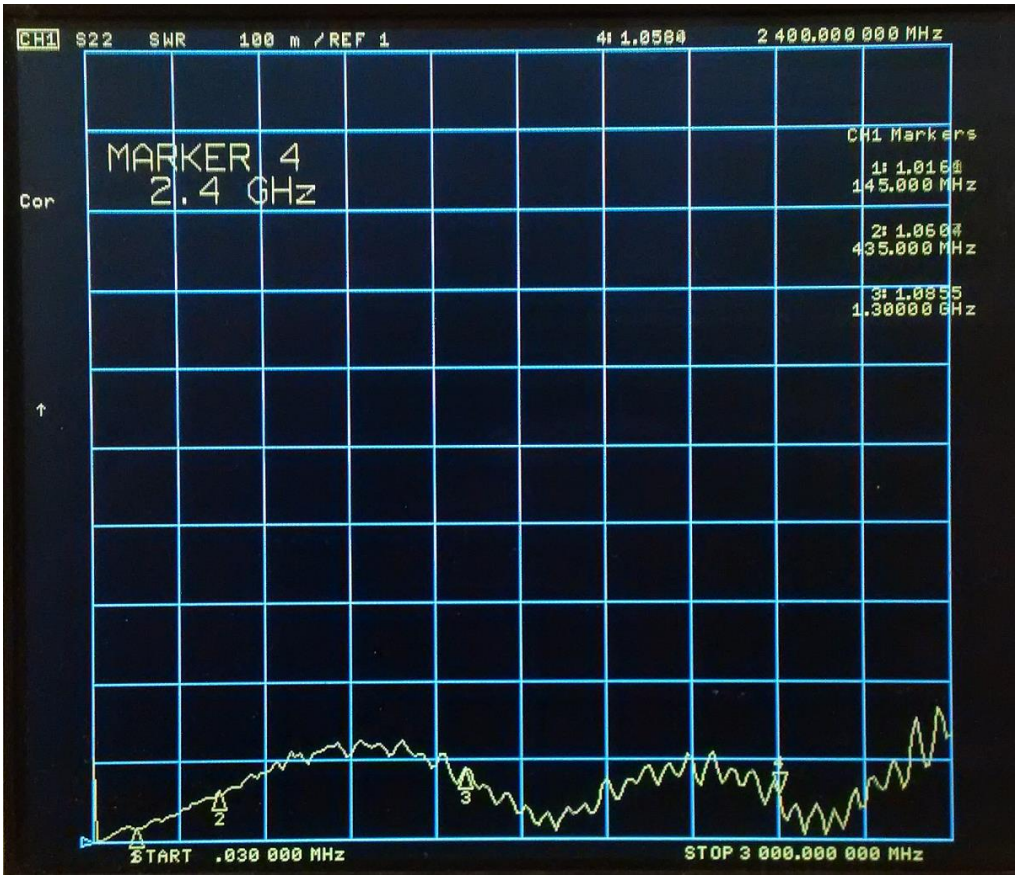
First, I measured the insertion loss S21 of the coupler from 30kHz to 3 GHz with the measurement port terminated with a 50 Ohm load:

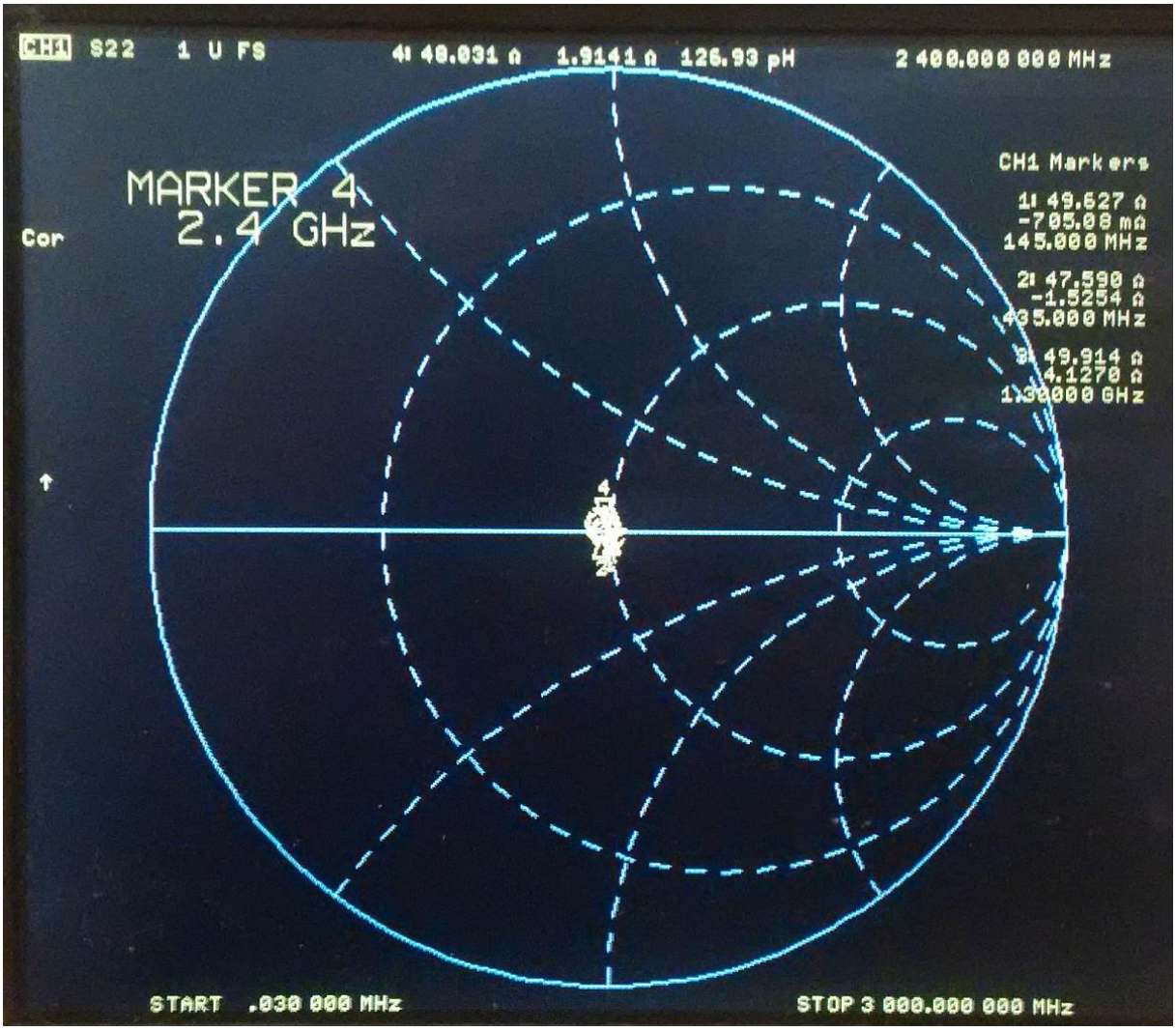
As can be seen in the next graph the insertion loss at 1.3GHz was measured as 0.08dB and at 2.4 GHz as 0.12dB. This is slightly higher than the spec of better than 0.05dB.



I also measured the input and output return loss, which are both excellent and almost identical.

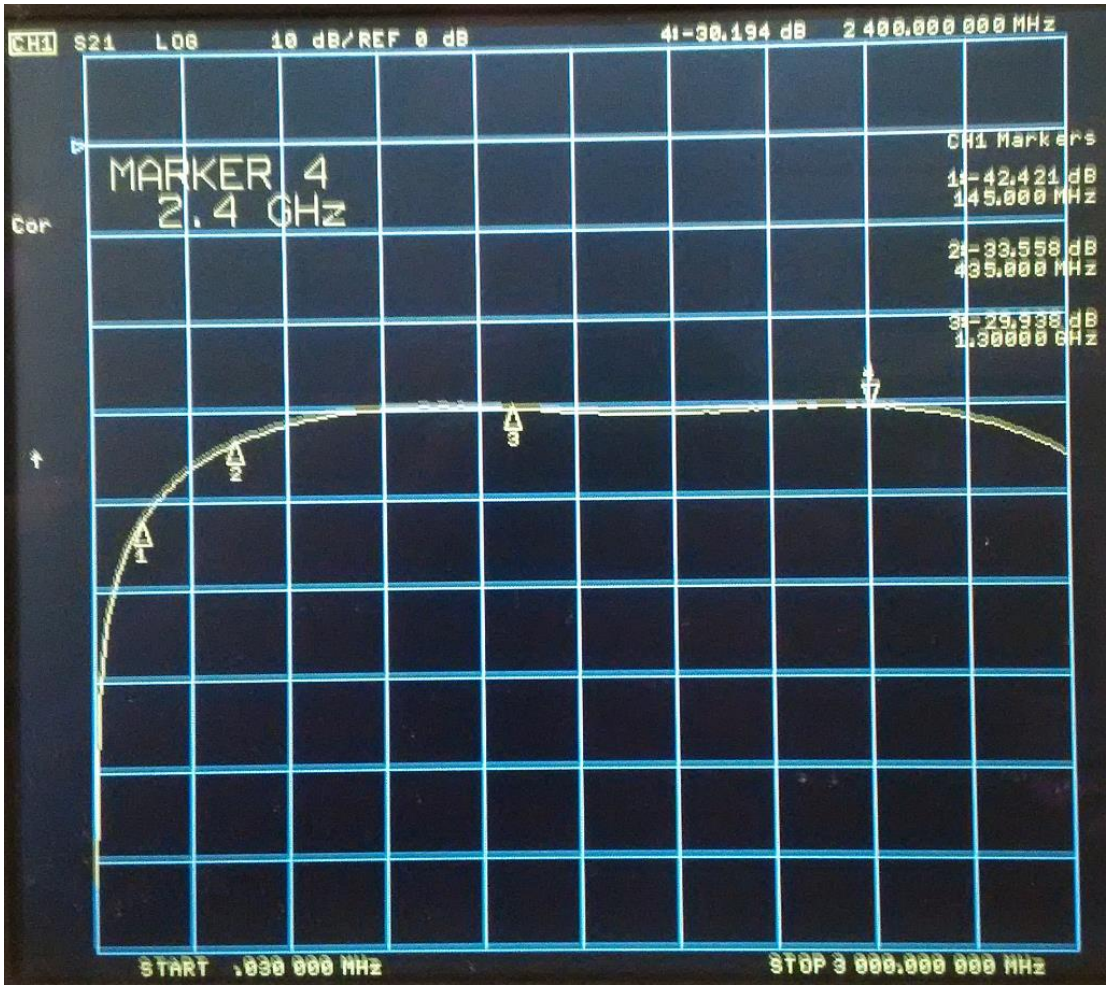





CH1 S22 1 U FS
4: 48.031 Ω 1.9141 Ω 126.93 pH
2 400.000 000 MHz
MARKER 4
2.4 GHz
Cor
CH1 Markers
1: 49.627 Ω
-705.08 mΩ
145.000 MHz
2: 47.590 Ω
-1.5254 Ω
435.000 MHz
3: 49.914 Ω
4.1270 Ω
1.30000 GHz
START .030 000 MHz
STOP 3 000.000 000 MHz

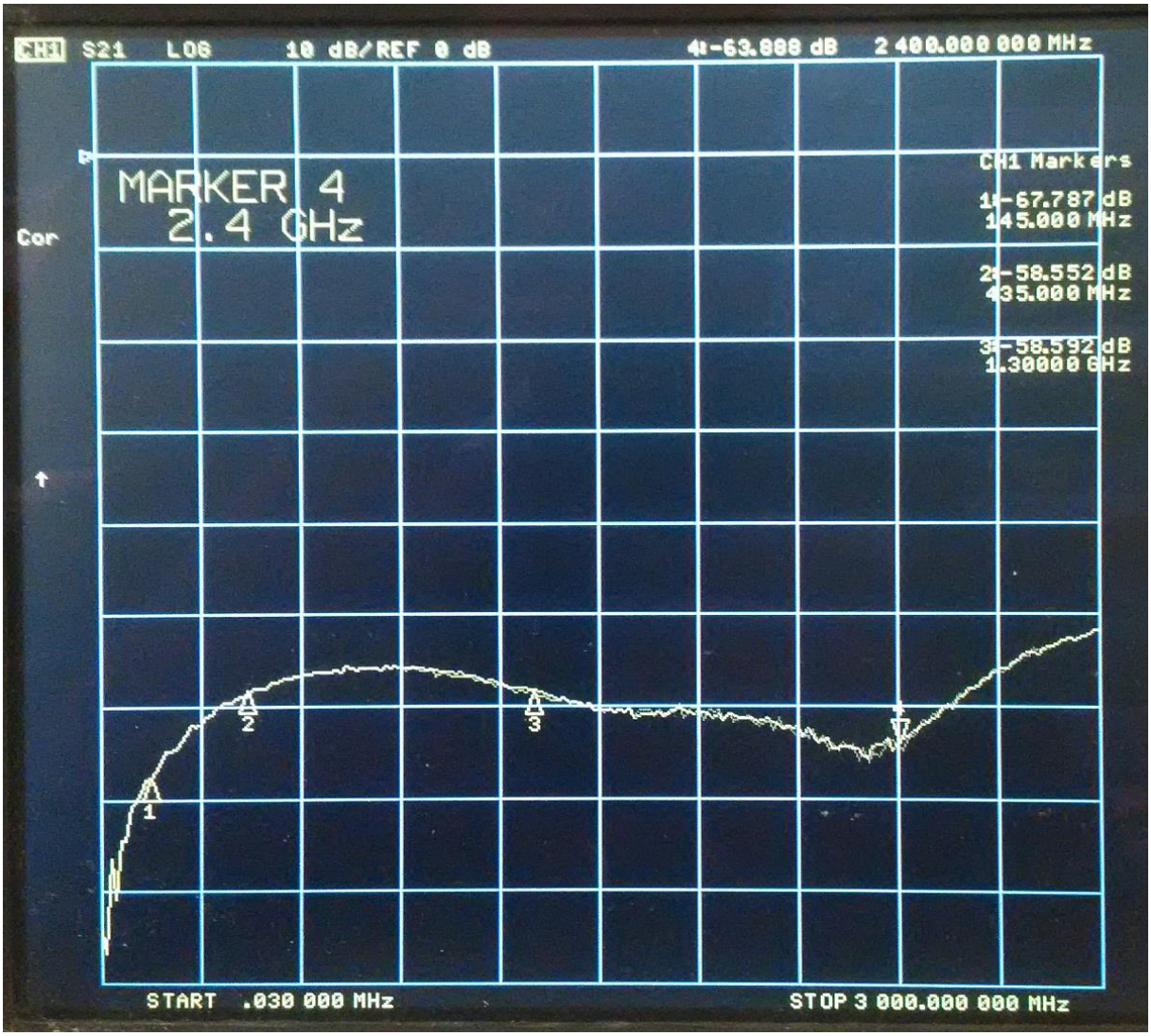
Next, I measured the coupling S31 from the input to the measurement output, which is nominally 30dB. The output was terminated with a 50 Ohm load.

As can be seen in the next graph the coupling factor at 1.3 GHz was measured as 29.94dB and at 2.4 GHz as 30.19dB. This is amazing close to the specified value of 30dB for such a low-cost device.

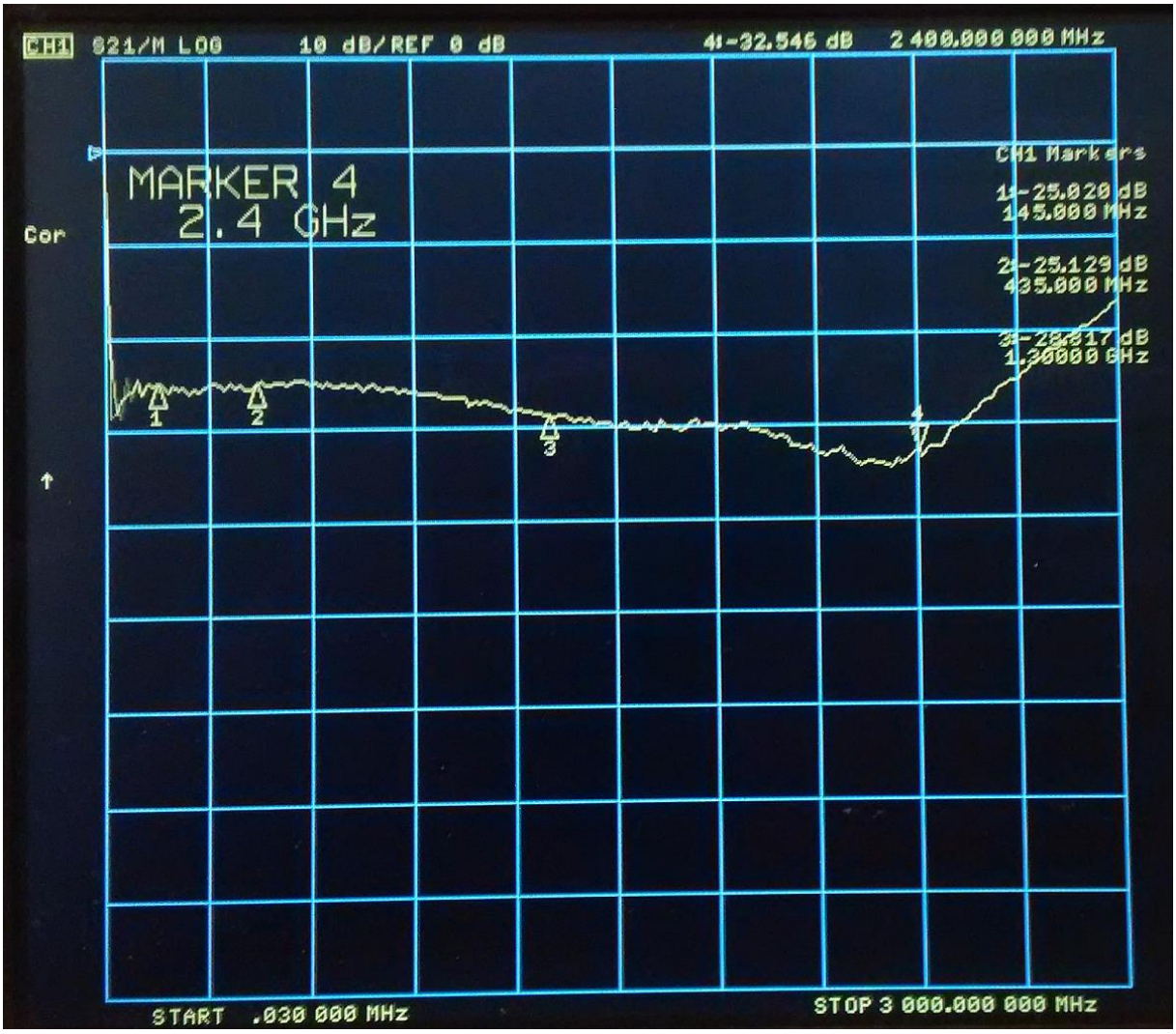


Next, I measured the isolation S23 from the output port to the measurement port. The input was again terminated with a 50 Ohm load.

The isolation including the 30dB coupling factor was measured to be 58.6dB at 1.3 GHz and 63.9dB at 2.4 GHz respectively.



Finally, I measured the directivity, which is the ratio S31 to S32.



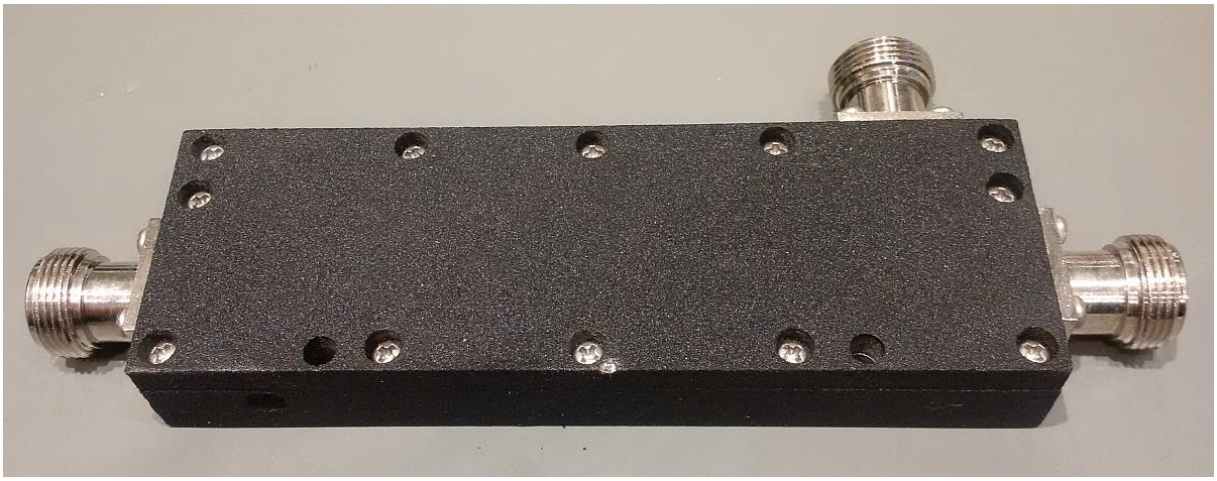
The directivity was measured to be 28.8dB at 1.3GHz and 32.5dB at 2.4GHz respectively. This is significantly better than the specified value of >20dB. This coupler works especially well at the 13cm ham radio band.

Overall all this directional coupler performs extremely well for a price of only 7,49 Euros.

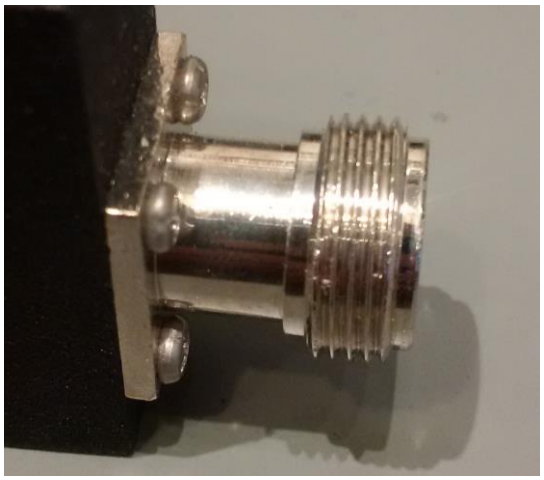
3.) Third version with a coupling ratio of 20dB:

The third device I measured is a similar directional coupler from China but with a nominal coupling ratio of 20dB. I got it for loan from a friend. The cost was also less than 8 Euros including shipping from China.

This unit has again a different encasing then the first two couplers. In my opinion it is the worst as the encasing has rather sharp edges and the connectors seem to have the lowest quality. This unit is branded as WINHAP with the part number WHDSCP-20. Here are some pictures of the unit.

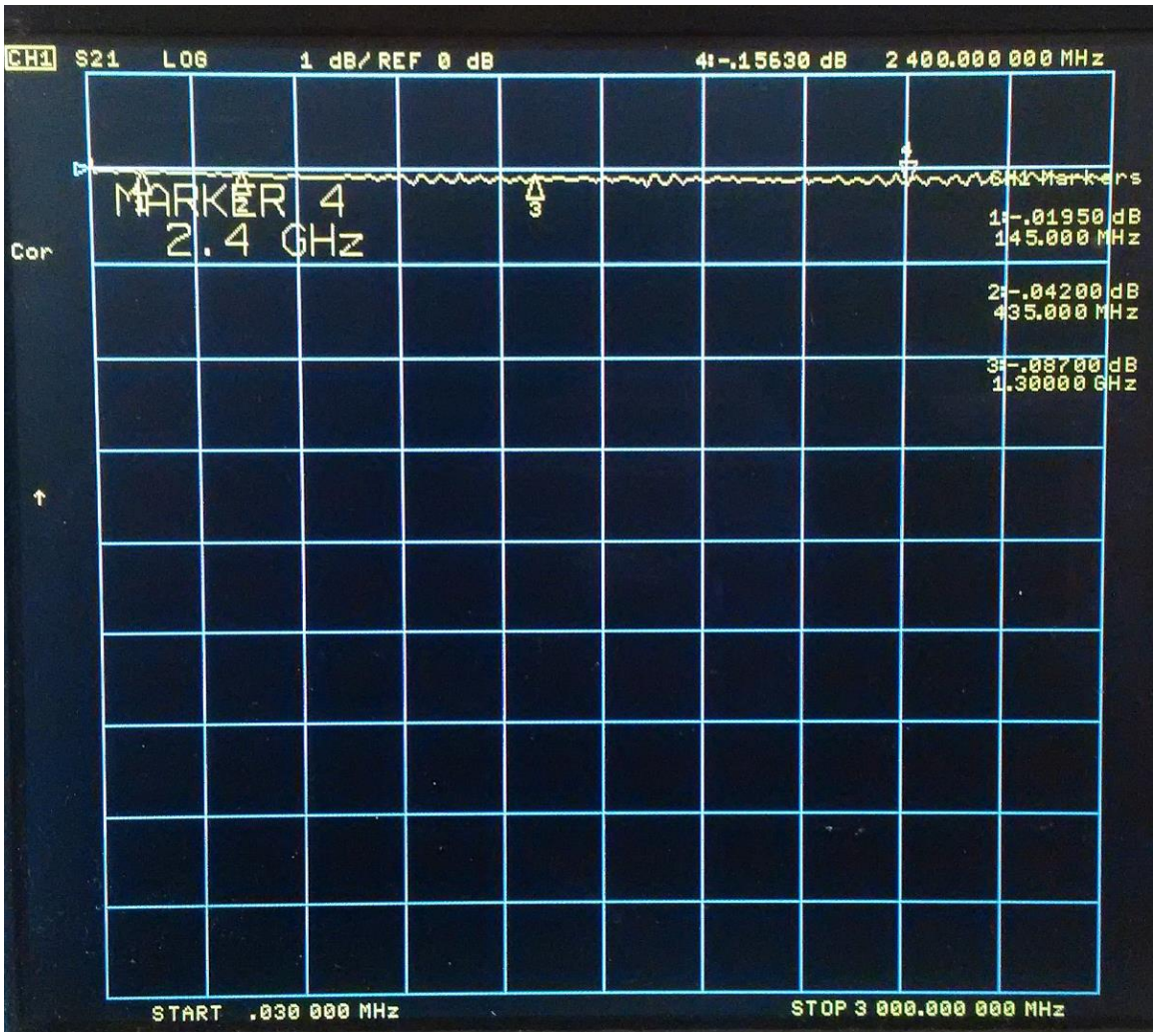


The N-connectors are really low quality. The outer thread is quite rough and I was afraid damaging the high-quality connectors of my measurement setup when screwing them onto the plugs of this directional coupler.



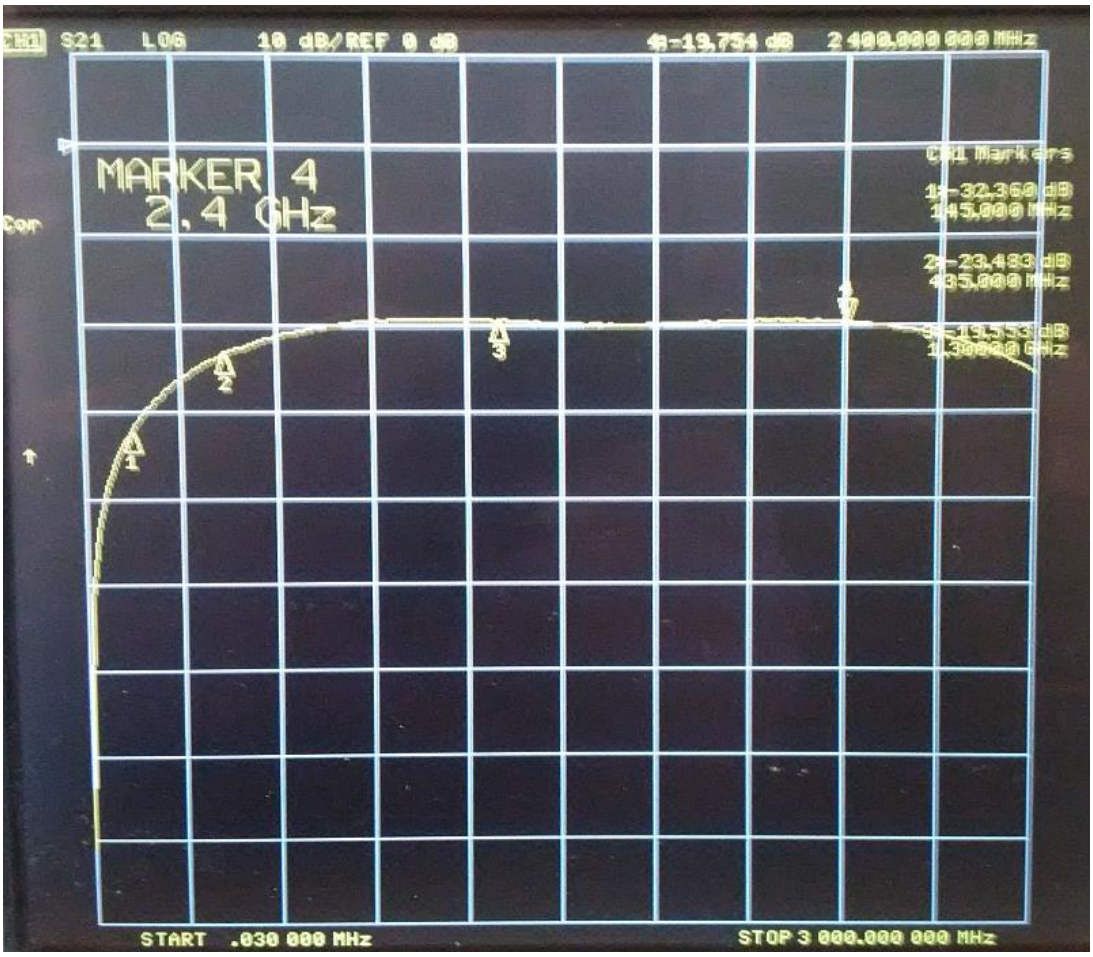
First, I measured the insertion loss S21 of the coupler from 30kHz to 3 GHz with the measurement port terminated with a 50 Ohm load:

As can be seen in the next graph the insertion loss at 1.3GHz was measured as 0.087dB and at 2.4 GHz as 0.156dB. These values are slightly worse than the specified values of better than 0.05dB.



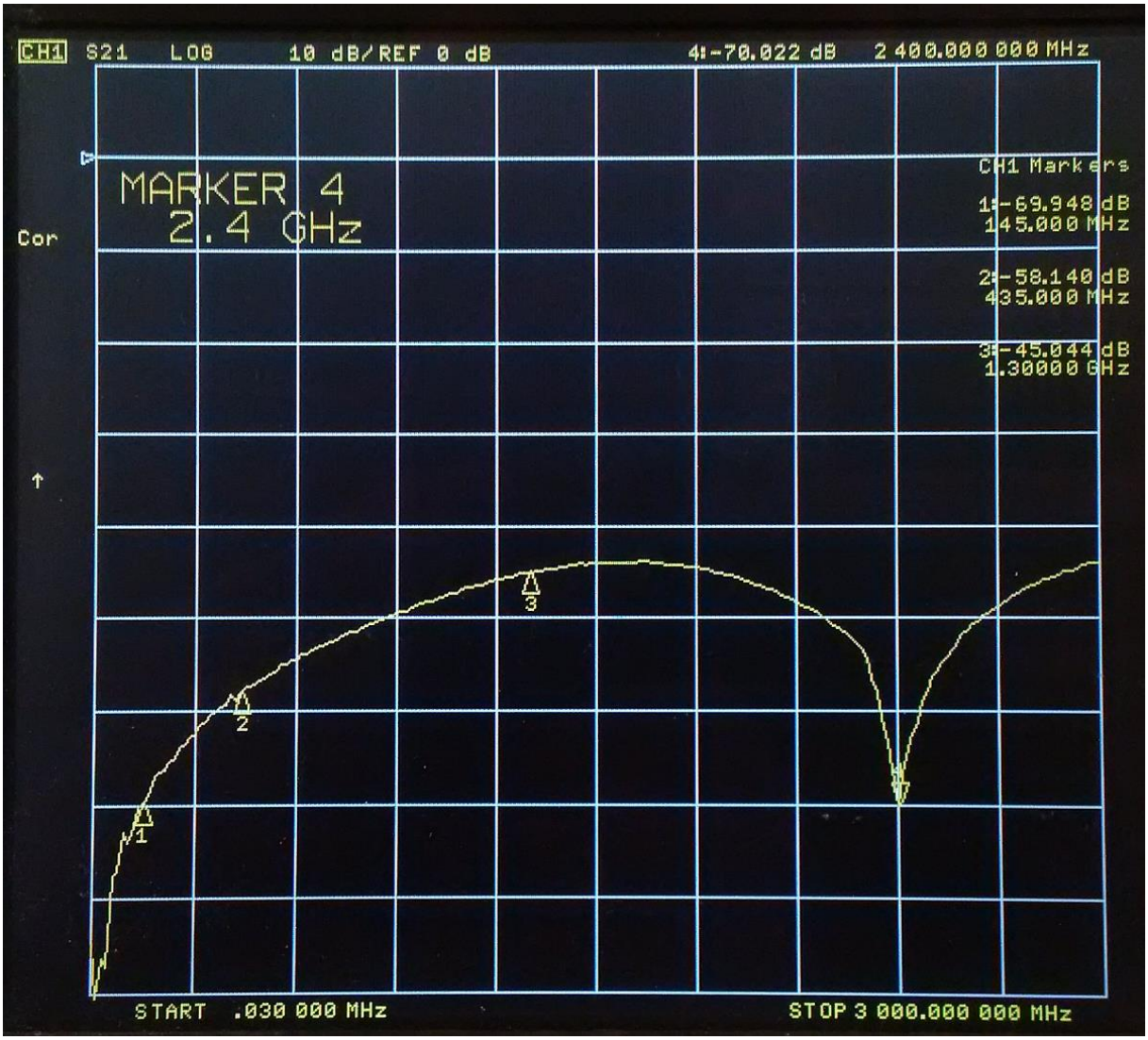
Next, I measured the coupling S31 from the input to the measurement output, which is nominally 20dB. The output was terminated with a 50 Ohm load.

As can be seen in the next graph the coupling factor at 1.3 GHz was measured as 19.55dB and at 2.4 GHz as 19.75dB. This is amazing close to the specified value of 20dB for such a low-cost device.



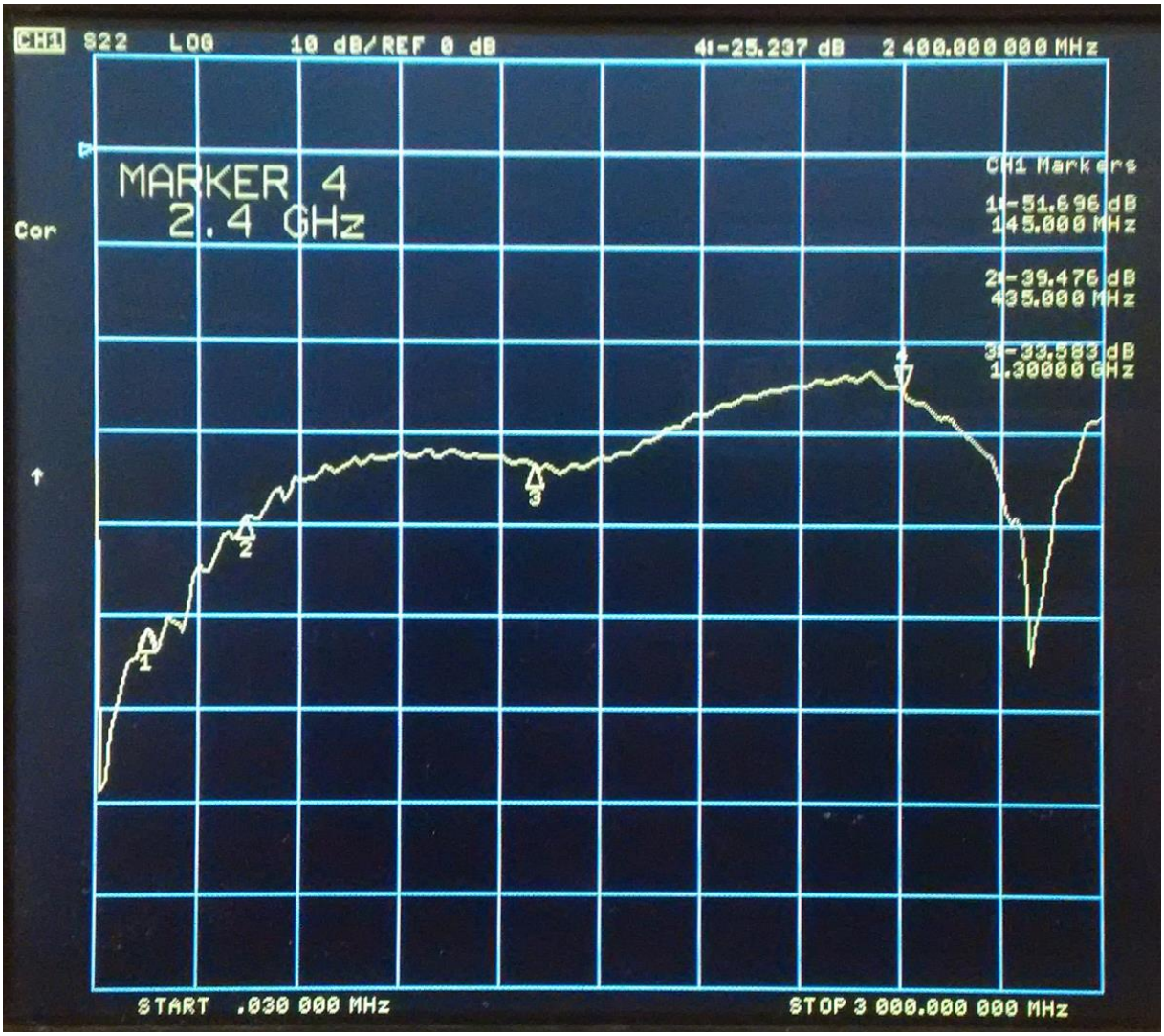
Next, I measured the isolation S23 from the output port to the measurement port. The input was again terminated with a 50 Ohm load.

As can be seen on the next plot the isolation including the 20dB coupling factor was measured to be only 45dB at 1.3 GHz but amazing high 70dB at 2.4 GHz. Exactly at 2.4 GHz this coupler shows a strong resonance with respect to its isolation.



The resulting directivity is 25.6dB at 1.3GHz and 50.3dB at 2.4GHz respectively. This is significantly better than the specified value of >20dB. This coupler works especially well at the 13cm ham radio band.

As I was a bit worried by the strong resonance this coupler showed at 2.4GHz I also measured the output return loss. As can be seen in the next plot the return loss at 2.4GHz was still 25.2dB and thus ok. Another resonance showed up at approx. 2.8GHz which is outside the frequency bands I am interested. I suspect that the strong resonances will vary from device to device and thus recommend to measure the coupler to verify its performance before using it.

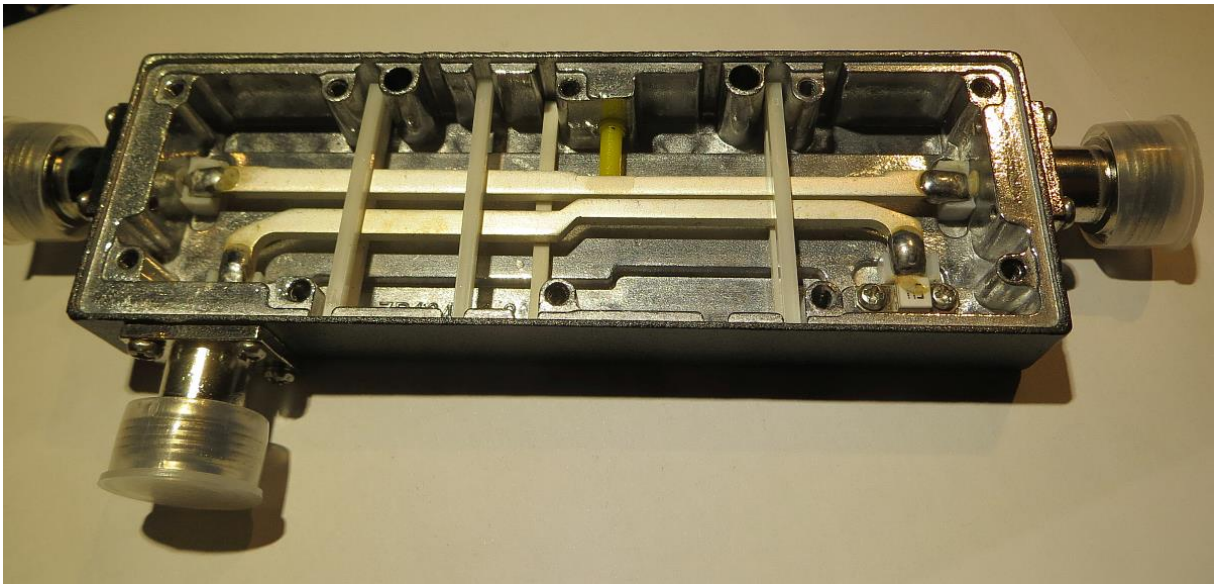


Overall also this directional coupler performs very well for a price of less than 8 Euros.

In summary all three directional couplers work quite well. The very low specified insertion loss of 0.05dB was only achieved by one coupler. However, the other couplers still performed very good. Especially the coupling factors were always very tightly controlled and the directivity of all couplers was better than specified.

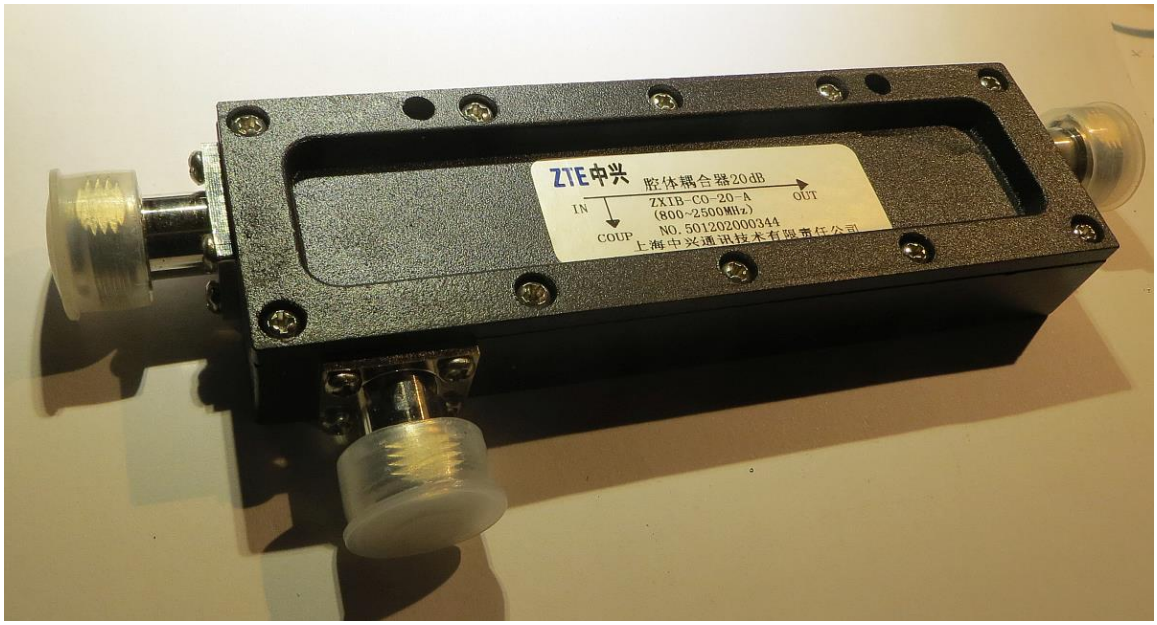
In case you have also wondered, how those couplers look inside, here are some pictures which were kindly provided by a friend who is also a ham radio amateur.

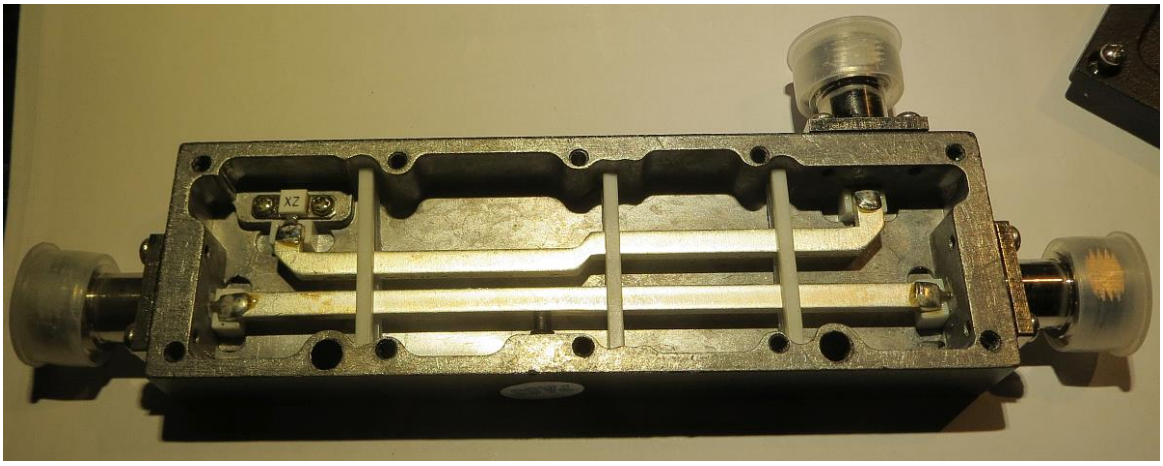
The first pictures are from a 10dB directional coupler from SUNWAVE, the part number is CP10-0825-N200T2A

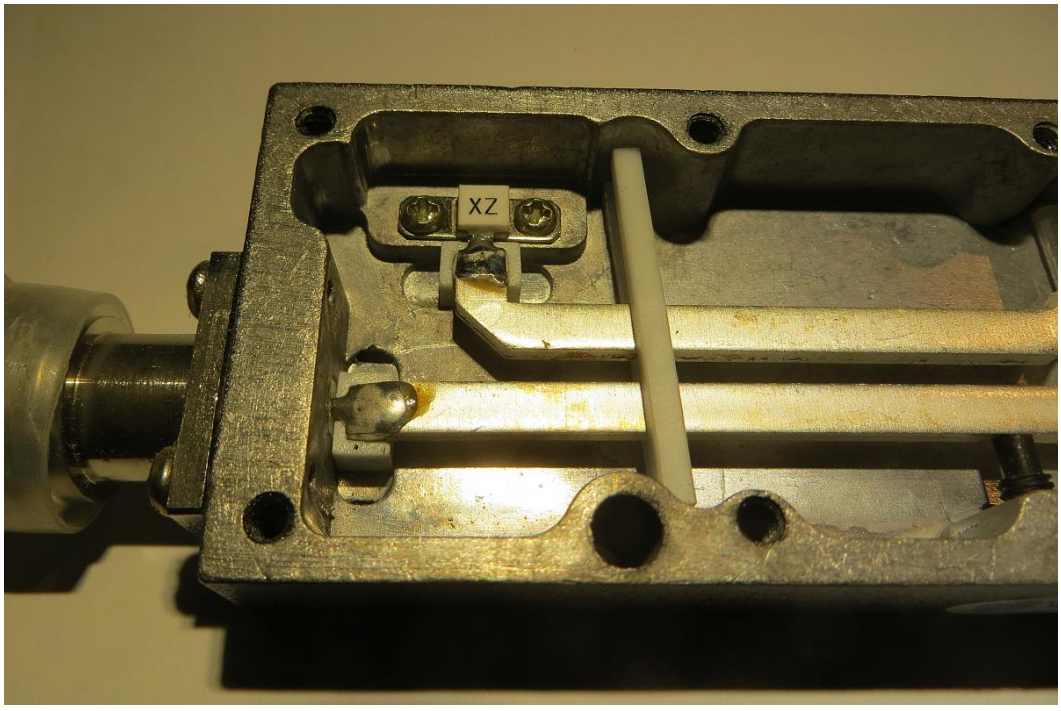


Please note that yellow plastic screw which can be moved from outside. This screw is pushing against the upper tranmission line (bar) and thus the distance to the second line can be adjusted. Thus the coupling factor can be tuned in production. After alignment a sticker like QC or similar is glued over the screw to hide / protect it.

The next pictures are from a 20dB coupler from ZTE, the part number isZXIB-CO-20-A.



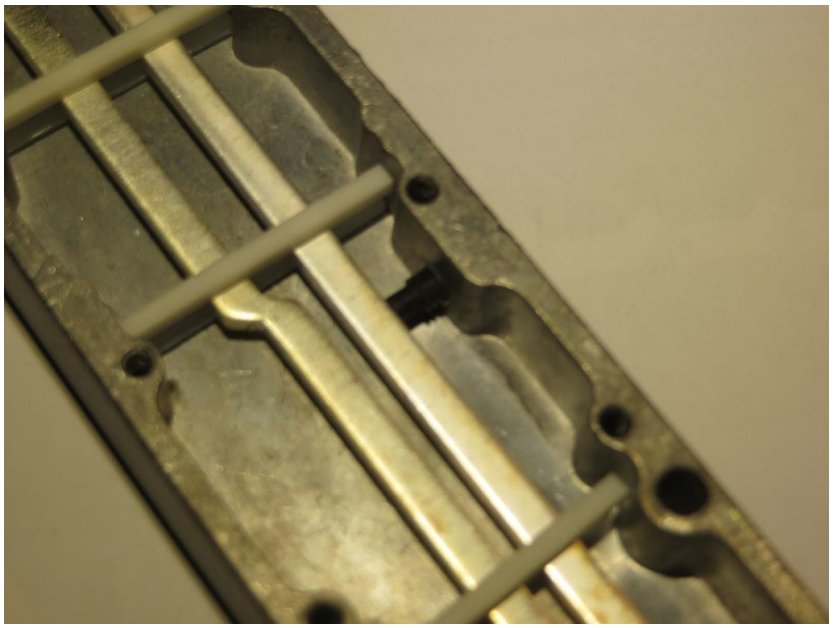




Please note that 50 Ohms termination resistor which is terminating one end of the measurement line. It is screwed to the aluminum encasing and I estimate that it should be capable of handling at least 20W RF power. With the coupling factor of 20dB that would be equivalent to an input power of the directional coupler of 2kW.

This might be a bit high but my guess is that the coupler should be able to handle several hundred watts.

In the next picture you can see the screw in the 20dB coupler. It is made from black plastic and is almost at the same place as in the 10dB coupler.



I am always grateful to get feedback and will be happy to answer questions.

Please direct them to the Email address which you will find below.

Best regards

Matthias DD1US

Email: DD1US@AMSAT.ORG Homepage: http://www.dd1us.de