

L-Band branch-line coupler

May 10th 2018 Matthias DD1US

Hello,

I am looking for a high-power amplifier for 23cm EME operations. However, I am also exploring different concepts including combining two amplifiers. For this I will need a high-power power splitter and combiner.

I found 2 interesting looking devices and bought them. They are marked with:

Combiner COM 654-100D/2

Part. No. 977-516-004

Serial No. PRD0281581-010 respectively PRD0281581-078



I was quite lucky because it turned out that they can be easily modified to fit almost perfectly to my purpose. This is shown later - in this analysis.

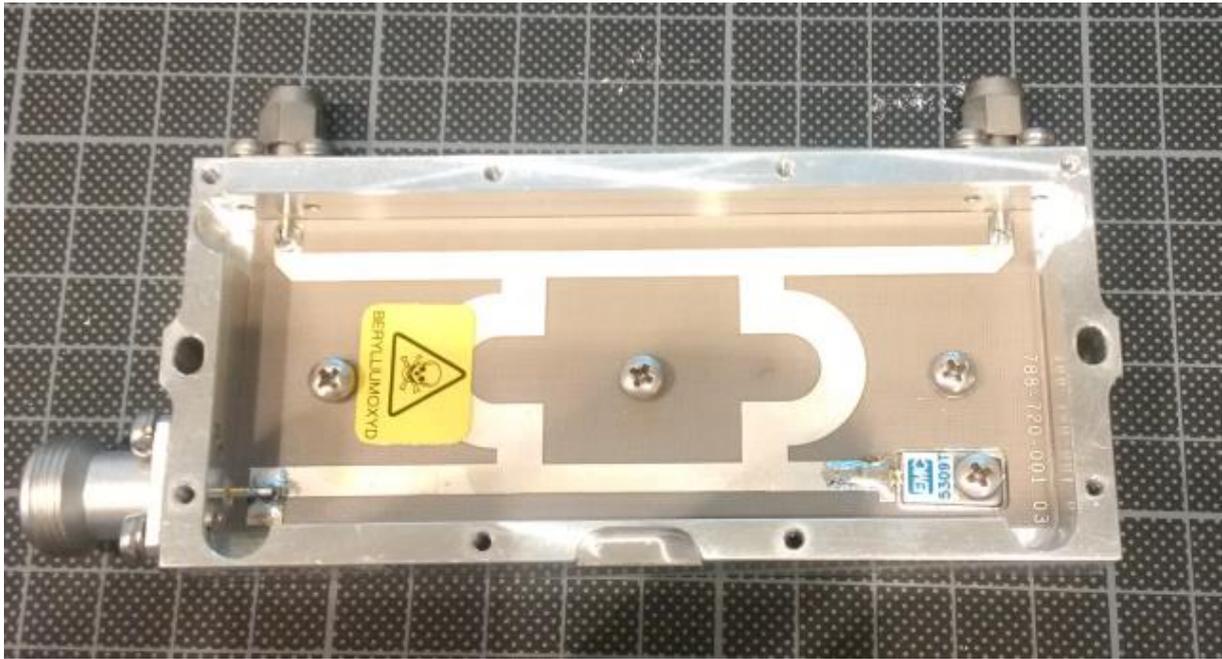
Here are some pictures of those branch-line power splitters. The common port has a N-jack and the ports 1 and 2 with the to be splitted or combined signals have SMA-plugs. The coupler is in a professionally milled aluminum case which can be attached to a heat-sink if needed.



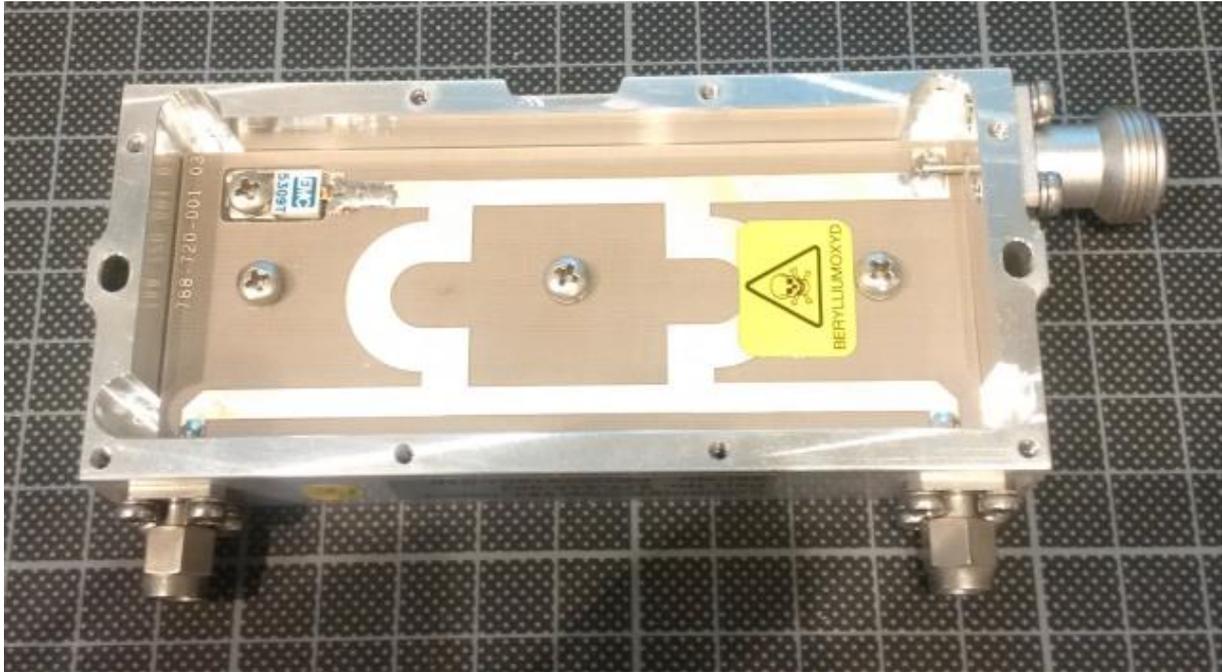
Top view of the branch-line coupler



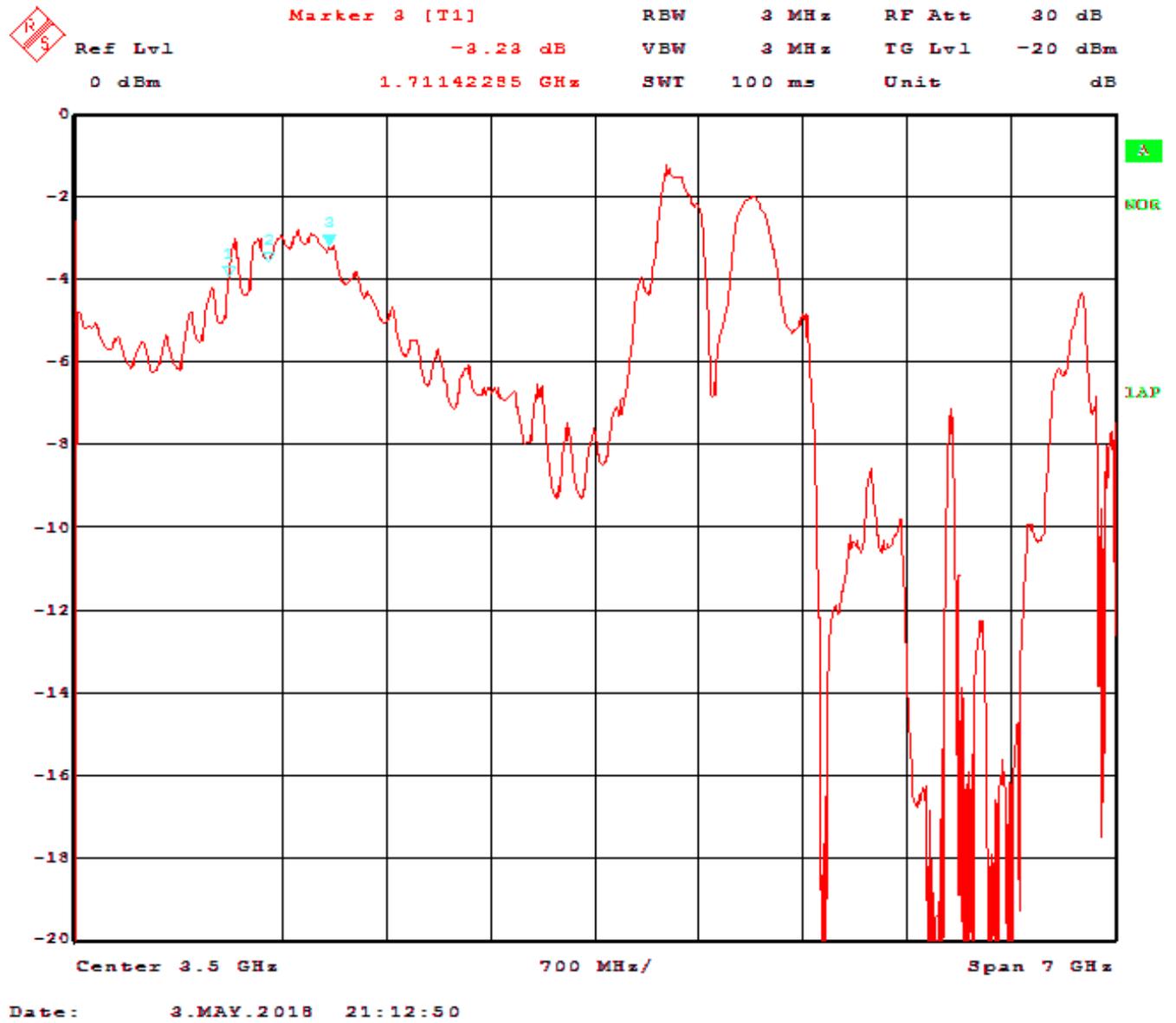
Bottom view of the branch-line coupler



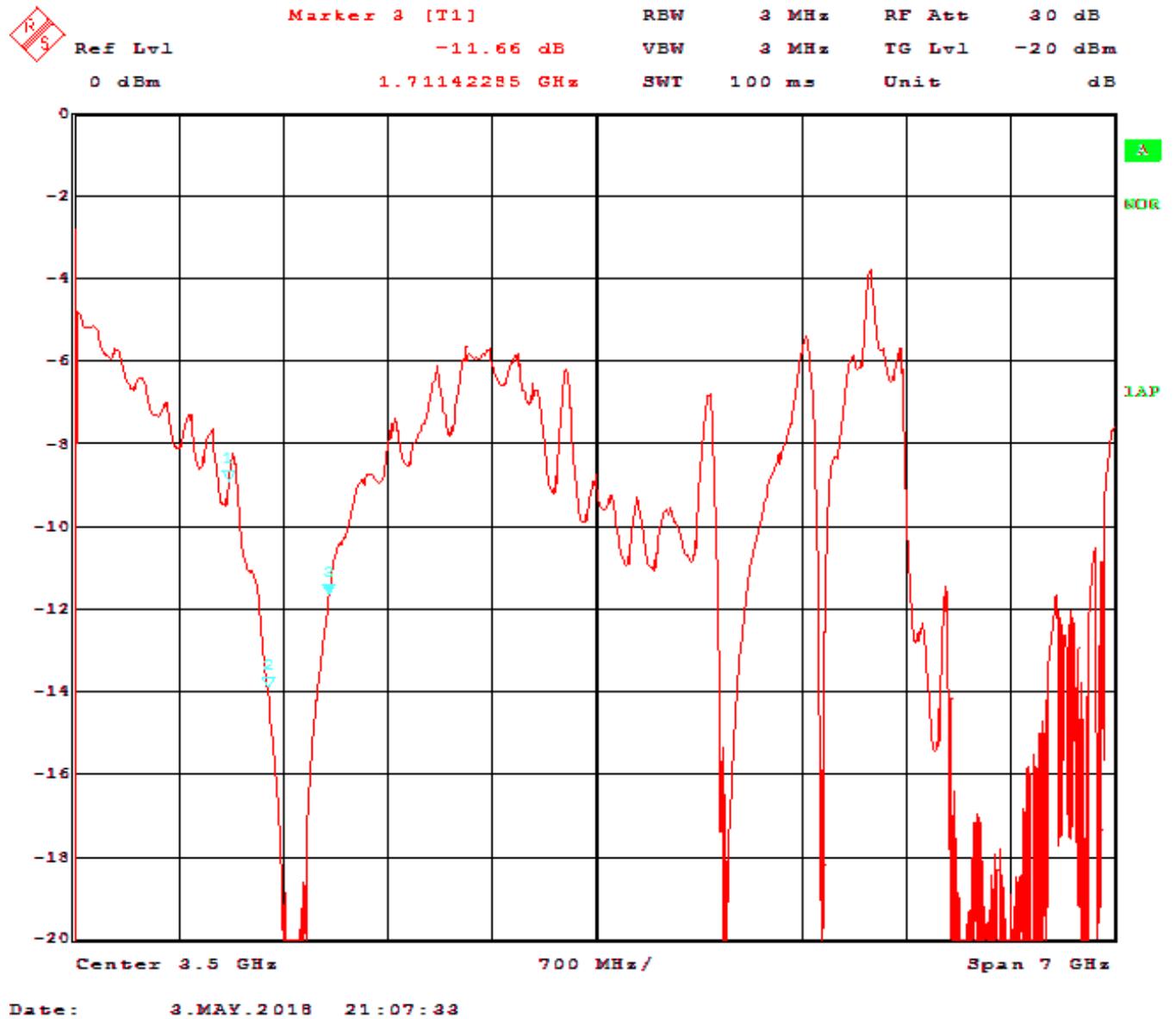
Inside we can see the branch-line structure and a 50 Ohms power resistor. It is an AMC 5309T RF load with a specified frequency range of 4 GHz and power handling capability of 25 Watts. The resistor is based on Beryllium-Oxide which is toxic.



First, I measured the characteristics of one coupler injecting a signal in port 1 and measuring the output at the common port (while port 2 was terminated with 50 Ohms):

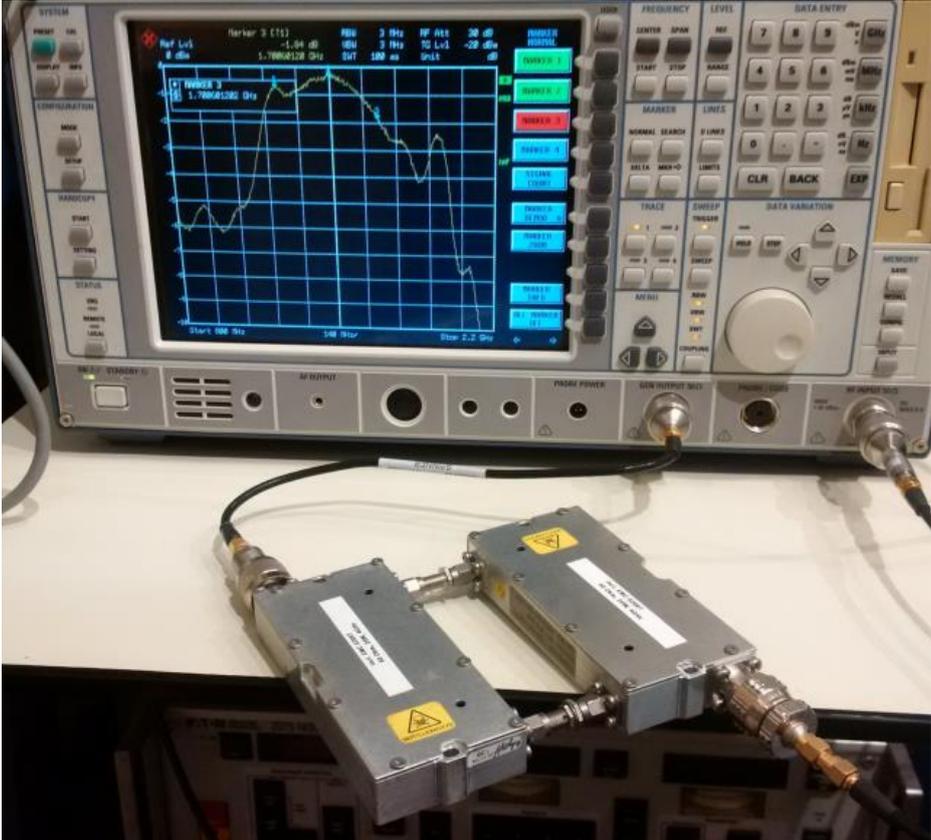


Next, I measured the isolation between port 1 and port 2 while the common port was terminated with 50 Ohms.

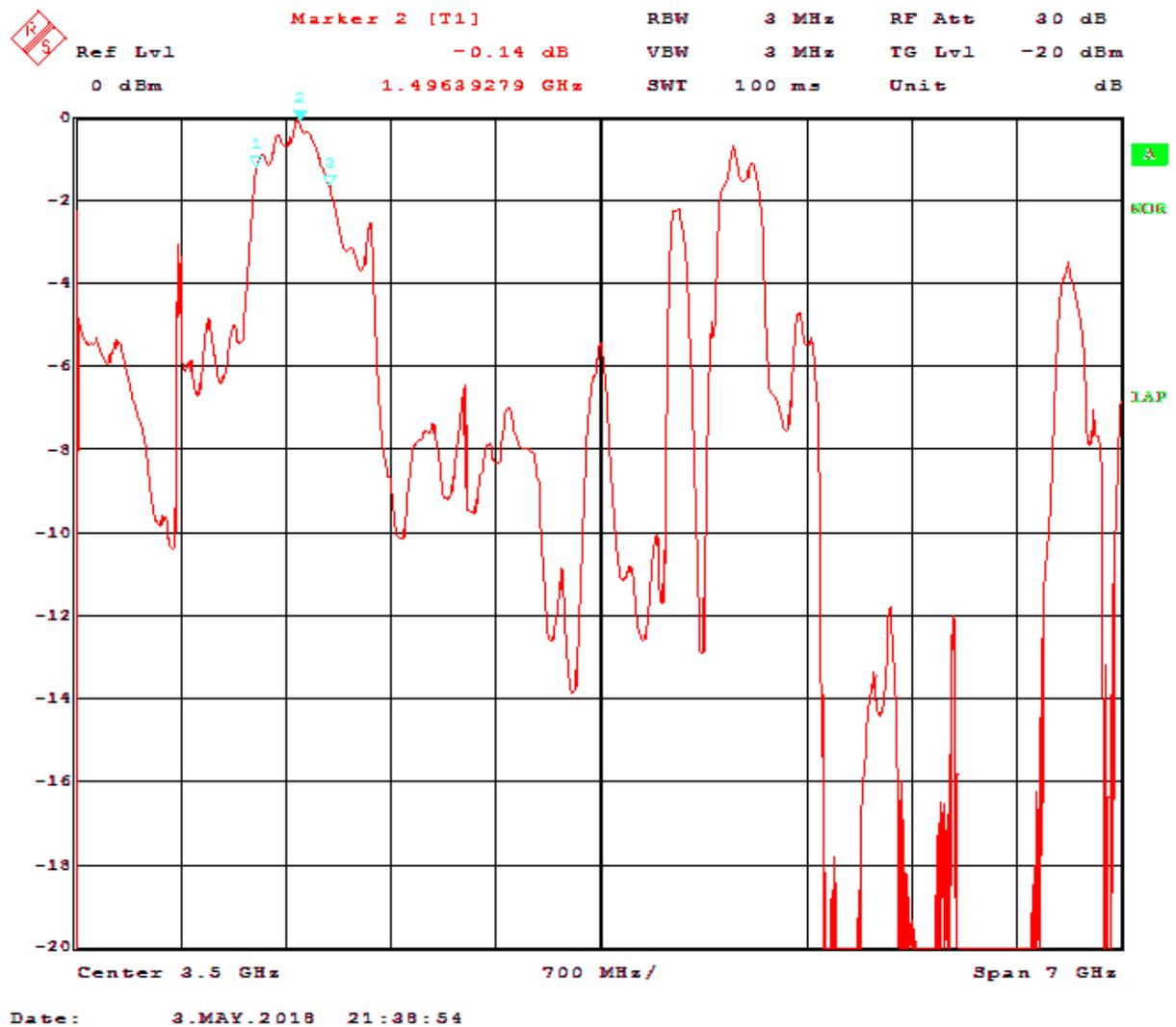


It can be seen that the coupler is designed for the L-band frequency range between 1300 and 1700 MHz, centered at about 1500 MHz.

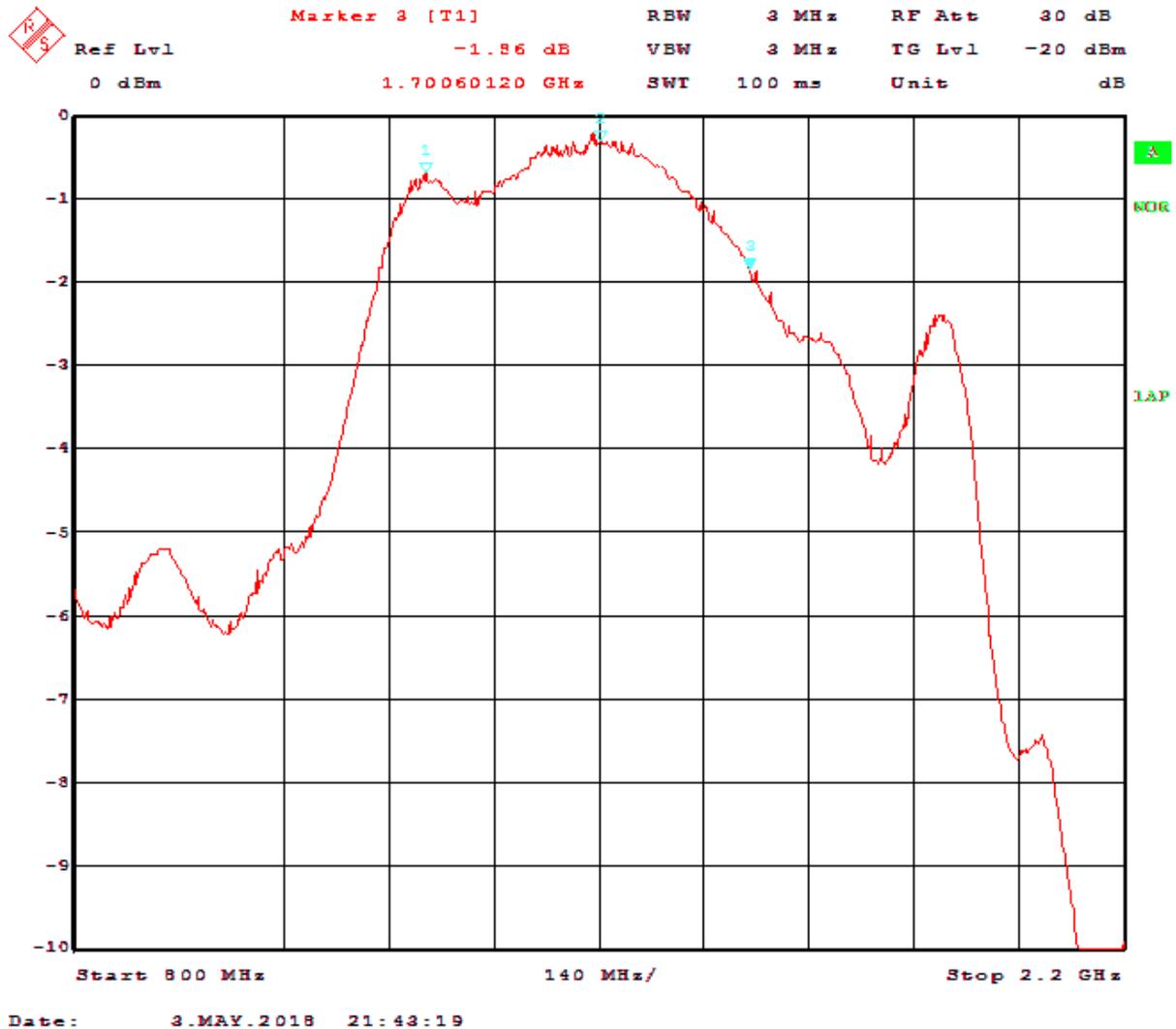
Next, I connected the 2 couplers together to measure the combined insertion loss. Here is the setup:



Here are the measurement results:



Here is the same measurement with a smaller frequency span and higher amplitude resolution (1dB/div instead of 2dB/div).



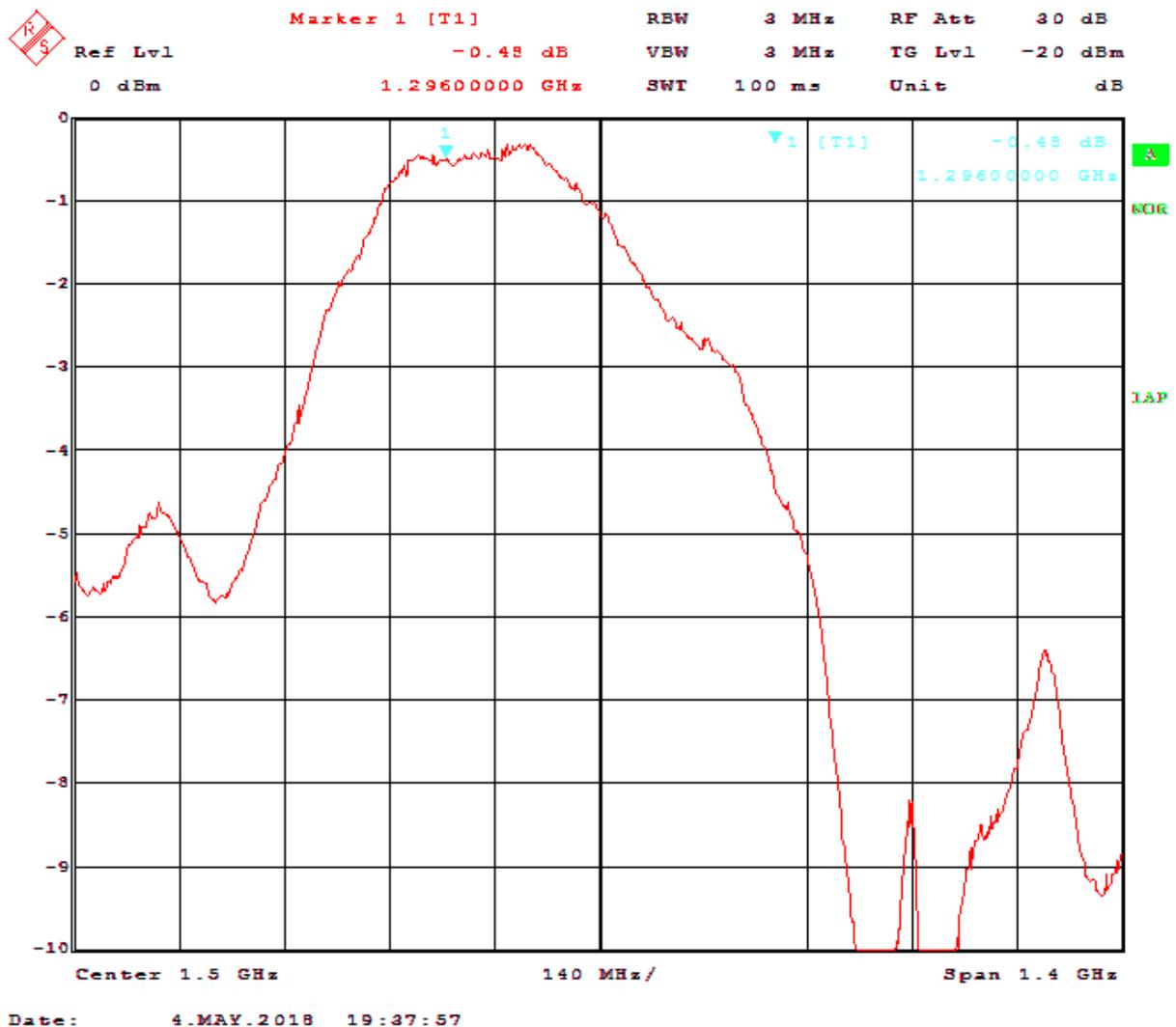
The markers are set at 1300 MHz, 1500 MHz and 1700 MHz respectively. The insertion loss at the center frequency of 1500 MHz is less than 0.2dB. At 1300 MHz the insertion loss is approximately 0.8dB.

I tried to retune the coupler to 1300 MHz in order to reduce the insertion loss. I used different approaches and the best solution I found was placing a 3mm thick Teflon plate on top of the coupler branch-lines and then an aluminium plate on top of the Teflon plate.

Here is a picture of the modified couplers:



Here is the resulting transfer characteristics of the two couplers connected together:



After this modification the center frequency is shifted down by approximately 150 MHz. The insertion loss at 1296 MHz is now 0.5dB and thus improved by 0.3dB. Assuming that the insertion loss is equally distributed in the two couplers the loss is approx. 0.25dB per coupler.

Thus, the improvement in output power when combining two identical power amplifiers is reduced from 3dB to 2.75dB.

I am very interested in any feedback especially on how to possibly improve the couplers even more. I would also like to find out from which company these couplers are. If you have any information I appreciate an appropriate hint. Many thanks in advance.

Best regards

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