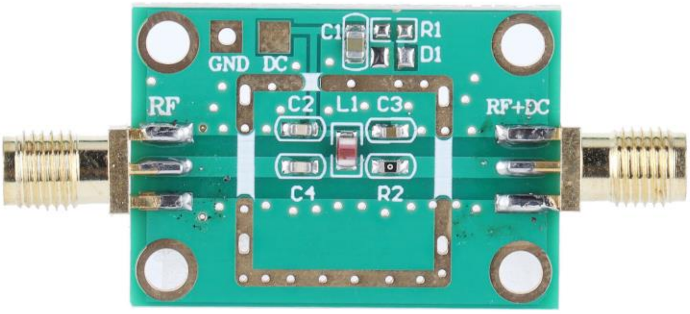
Building some Bias-Ts

Matthias, DD1US, April 2nd 2024, rev 1.0

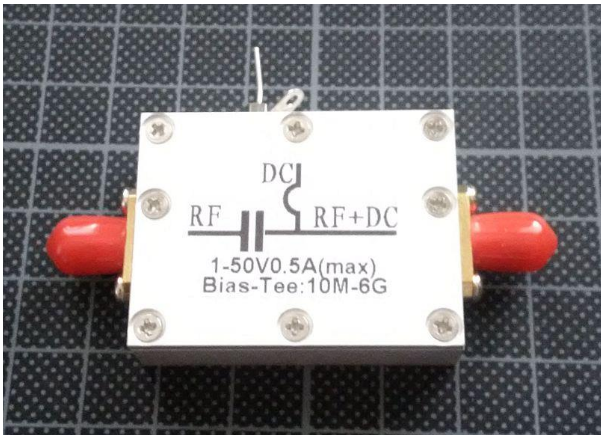
I guess we have never enough Bias-Ts 😉

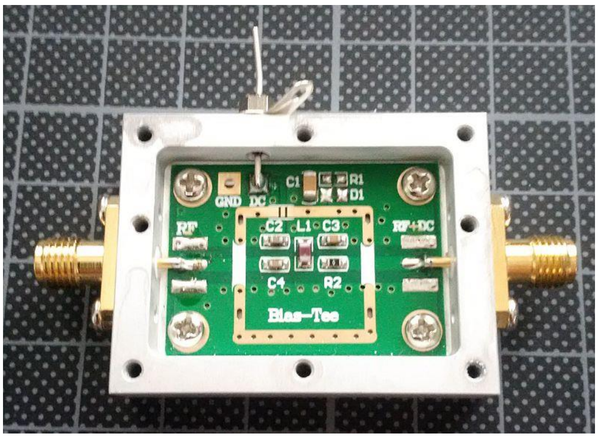
I am using various Bias-Ts to power my LNAs as well as downconverters which are usually mounted close to my antennas on the roof, by "phantom feed".

There are Bias-Ts available from China, which are readily assembled on a PCB with SMA jacks. The price including shipping is less than 6 Euros. They are advertised to be usable in the frequency range 10MHz to 6GHz.



As I care about proper shielding of all my RF circuits, I typically buy those PCBs readily mounted in a milled aluminium encasing when I need SMA connectors. The price including shipping is less than 12 Euros.





You can find a description with measurement results on my website www.dd1us.de.

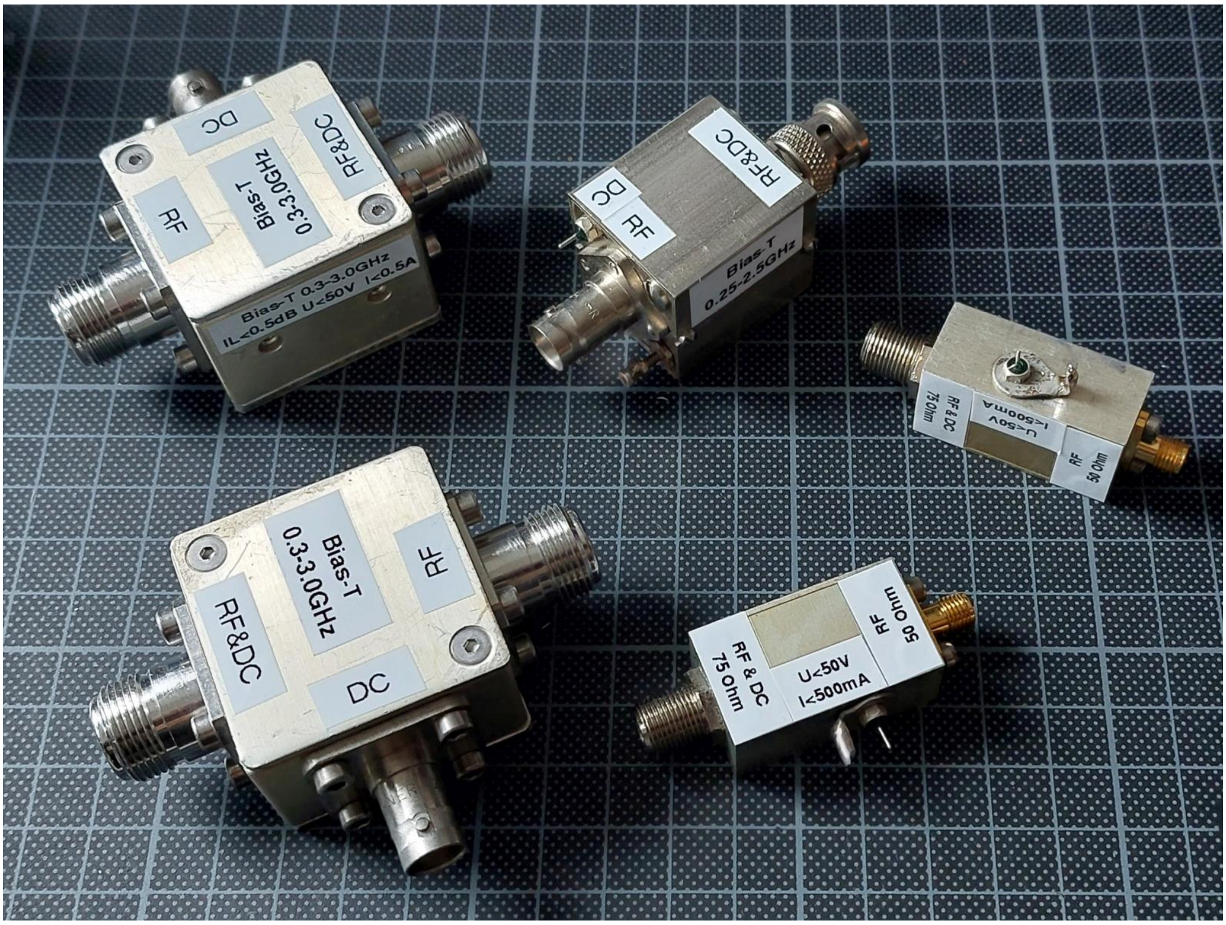
However sometimes I need N- or BNC-connectors and thus recently mounted some of such Chinese PCBs in surplus encasings which I had at hand.

In addition, I modified some 50Ω to 75Ω impedance transverter modules / matching pads which my friend Wilhelm DL6DCA kindly sent me. Their specified operating range is 1MHz to 1GHz.

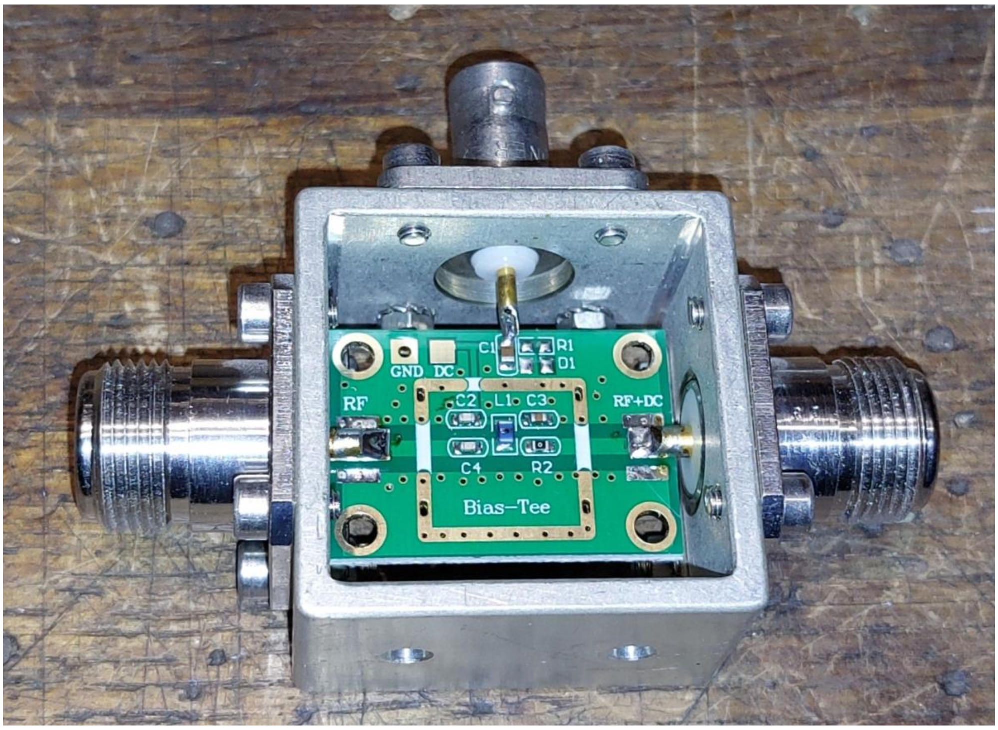
Those modules feature an SMA jack on the 50Ω side and an F-jack on the 75Ohm side. The impedance conversion is accomplished using a transformer. Wilhelm has kindly documented his measurements here:
https://www.darc.de/fileadmin/filemounts/distrikte/o/ortsverbaende/38/Downloads/Bericht_Anpassglied.pdf

As some of my transverters and LNBs are featuring a 75Ohm output I am using 75Ohm cable from their output to the receiver. Thus, I decided to add a Bias-T function to the impedance converters. The IF frequency of my transverters is typically in the frequency range 145MHz to 800MHz. I want to use the especially for biasing my LNBs in my QO-100 setups with an IF of about 739MHz

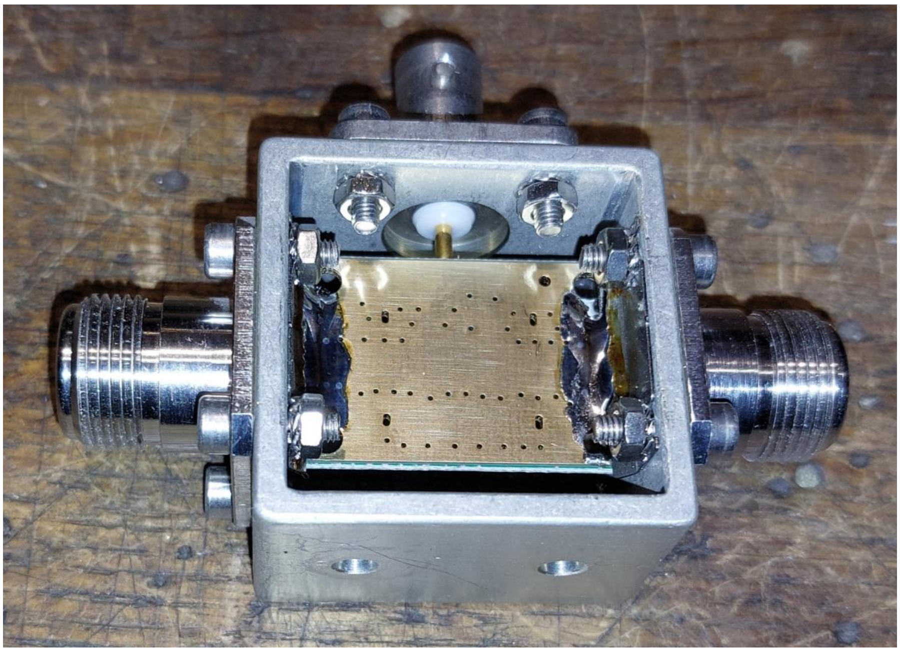
Well, here is the outcome of my Bias-T build session:



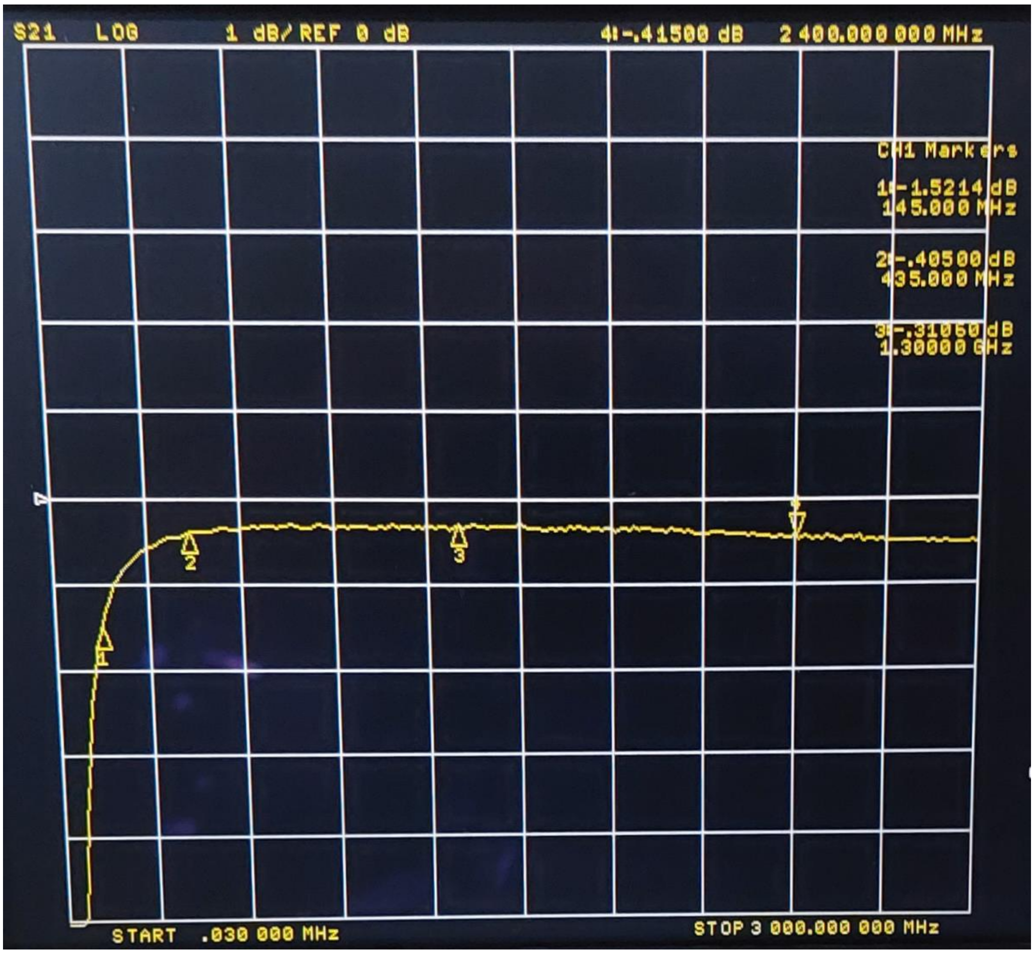
I started with the encasings featuring N-jacks at input and output. Originally also the 3rd port was using an N-jack but I replaced it with a BNC-jack as this port will be used to inject the DC supply. The PCBs fit perfectly in the surplus encasings.



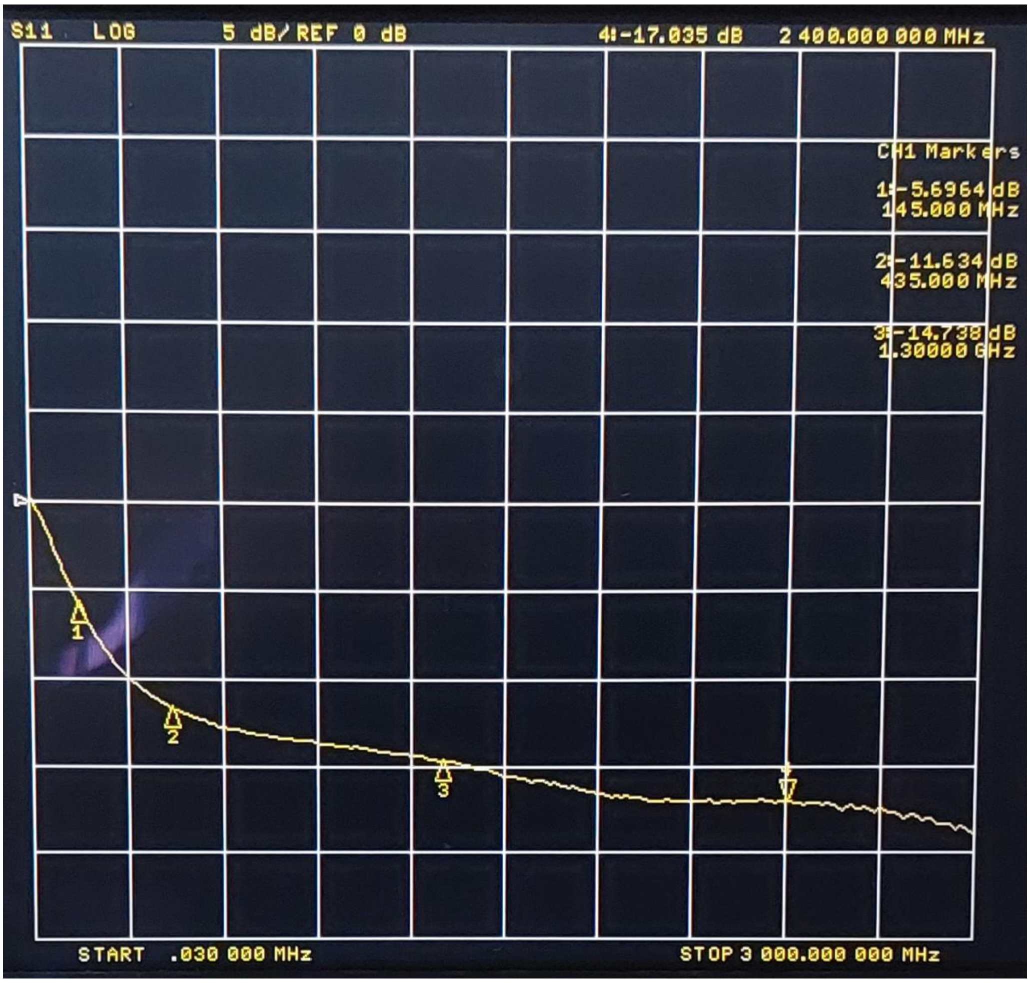
Special care was taking to provide a good ground connection to the PCB.



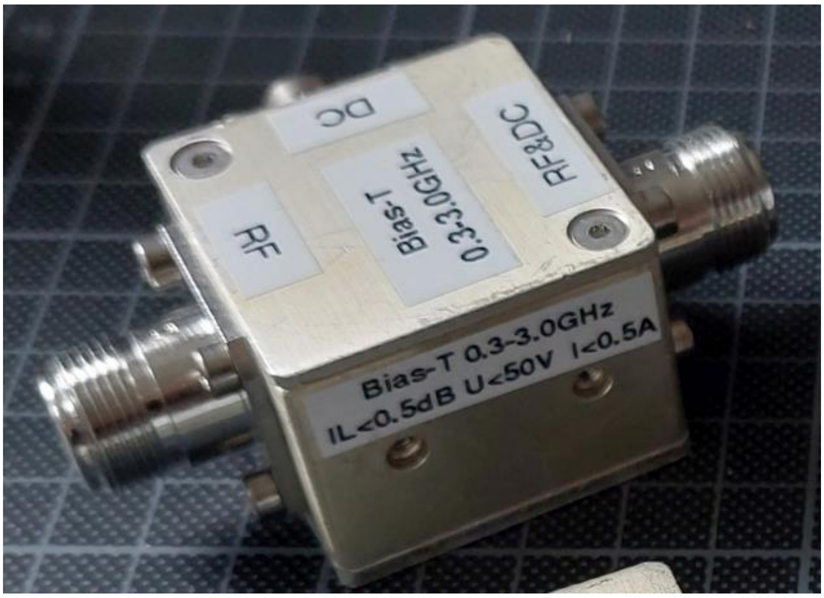
The insertion loss of the RF path between the 2 N connectors as shown in the next picture reveals, that the minimum usable frequency is rather 300MHz than 10MHz. When comparing the components on the PCB used for the used Bias-Ts with older PCBs I recognized that components have been changed. Especially the inductor has fewer windings and thus probably a lower inductance which explains the increase of the lower frequency limit.



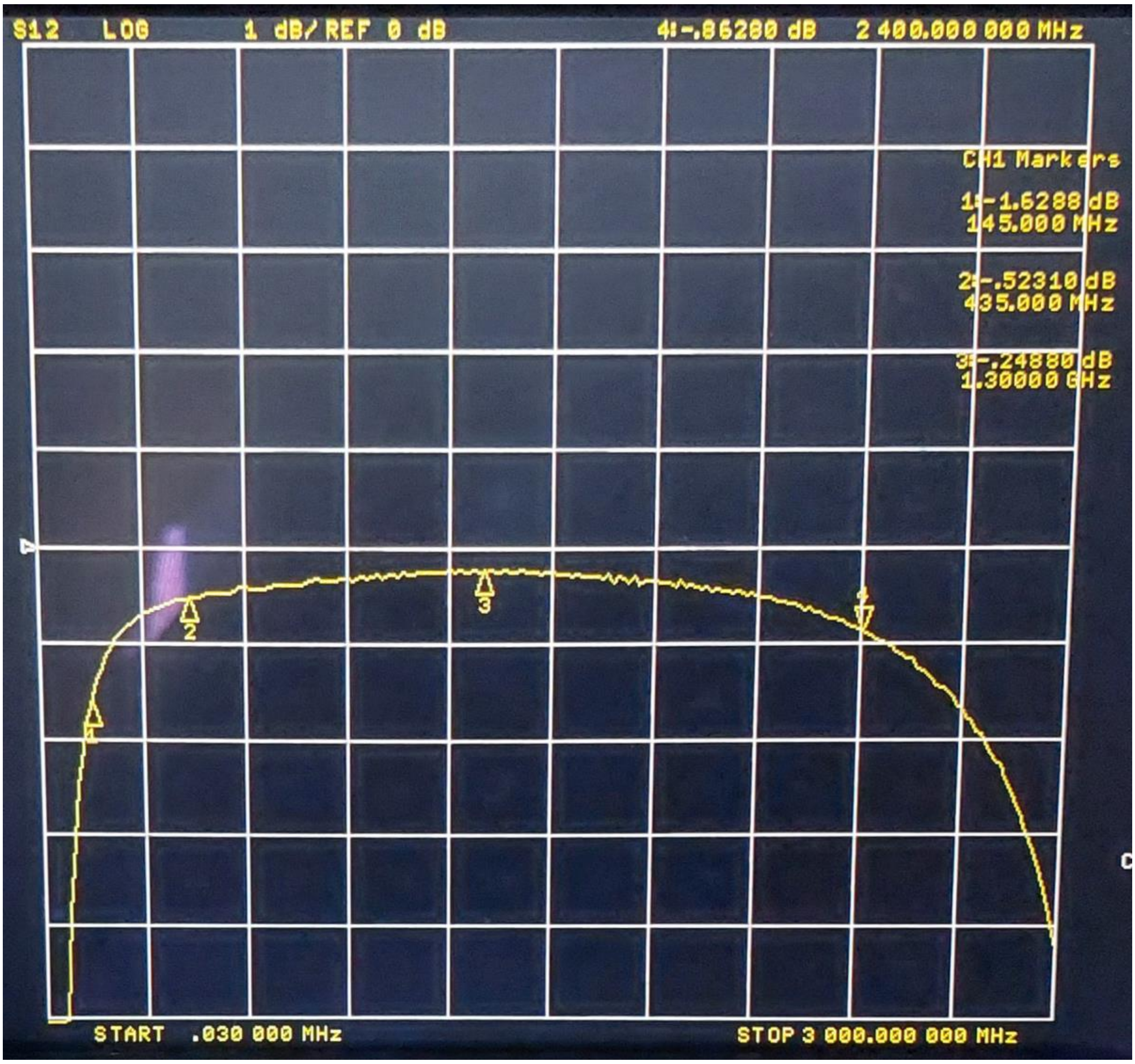
Insertion loss in the frequency range 300MHz to 3GHz is below 0.5dB. Input and output return are better than 10dB above 300MHz as show in the next picture. A return loss of 10dB results in a mismatch loss of 0.5dB which is the main contributor to the increasing insertion loss at lower frequencies.



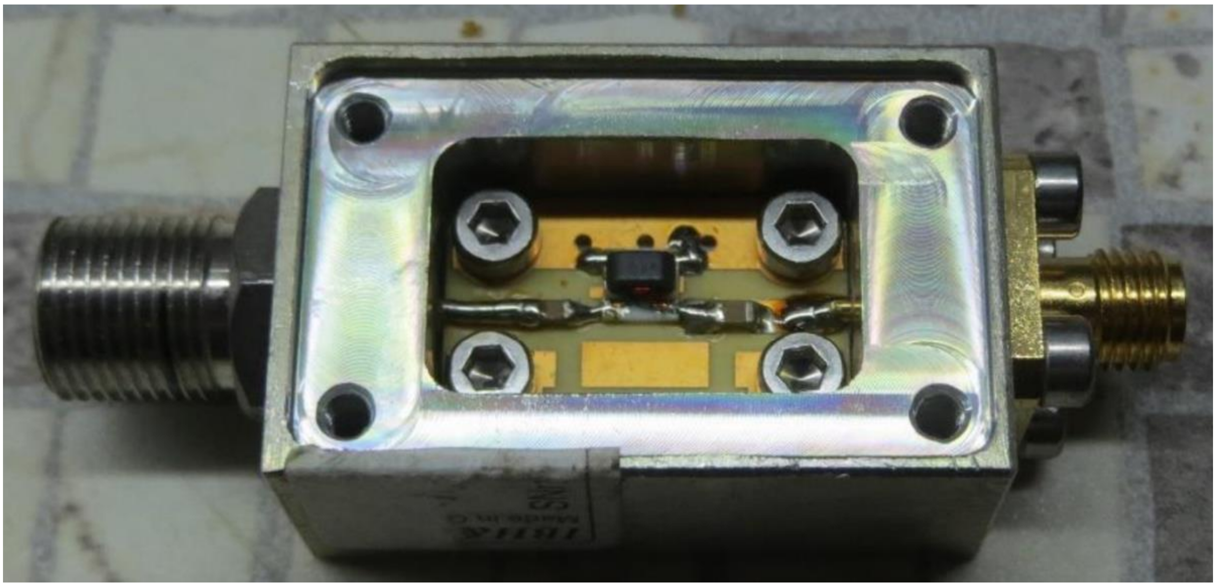
As I plan to use these Bias-Ts in the frequency range 430MHz and above I did not care to exchange the inductor.



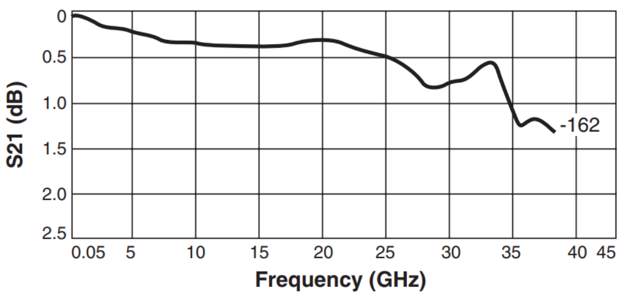
Next, I built the Bias-T with BNC connectors. I had to shorten the PCB and make compromises with respect to the connection of the ground plane of the PCB to the encasing. You can see that the frequency response of the insertion loss is almost identical at lower frequencies but the maximum frequency range is limited to about 2.5GHz certainly due to the less optimum ground plane connection.

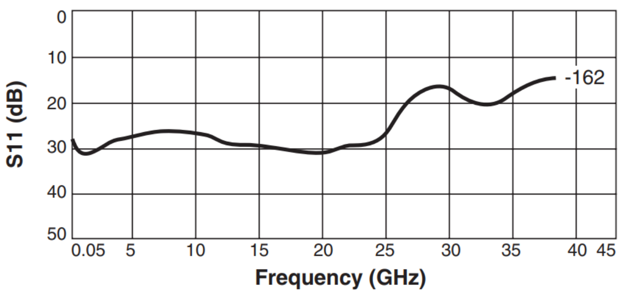


Finally, I modified the 50Ω to 75Ω impedance transverter modules. The are very well built in a solid milled aluminium encasing. The impedance conversion is accomplished using a transformer. The PCB provides enough space to add the needed inductor and two capacitors to block the DC port from the RF path.

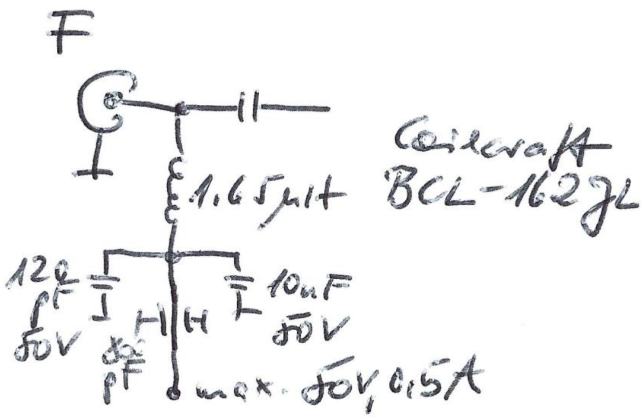


I used a broadband conical inductor from Coilcraft with an inductivity of 1.65uH (BCL-162JL) and a maximum current of 490mA. They are optimized for ultra broadband Bias-Ts as can be seen in the specifications below (data from Coilcraft measured in a Bias-T setup).

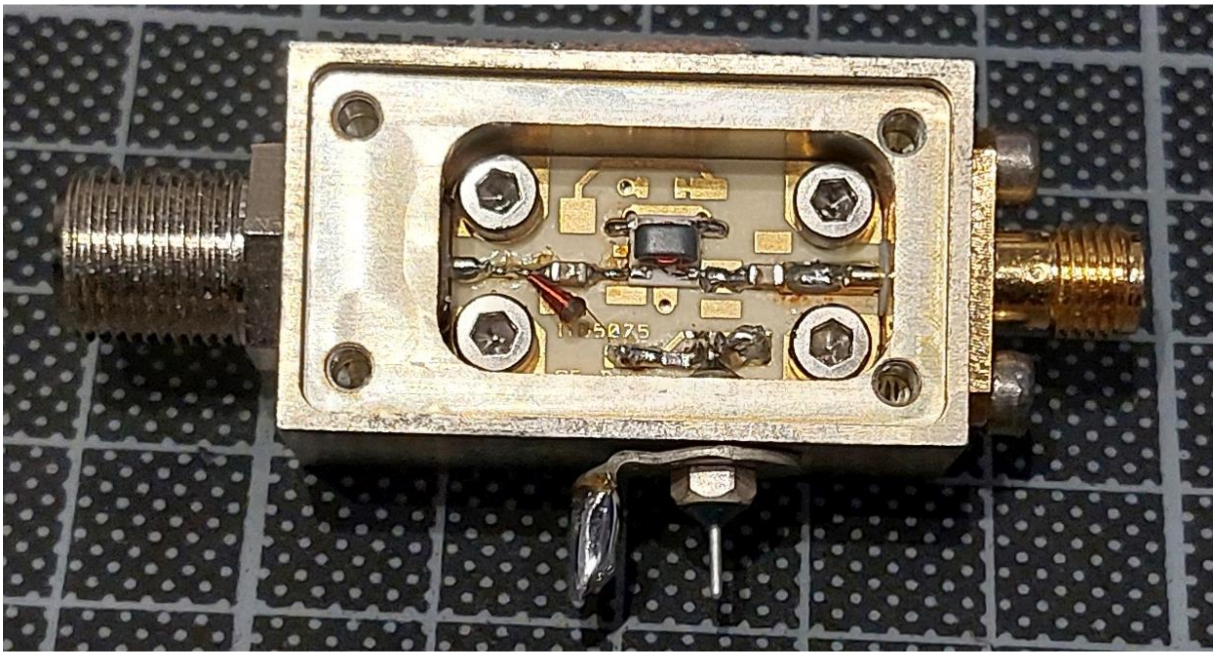


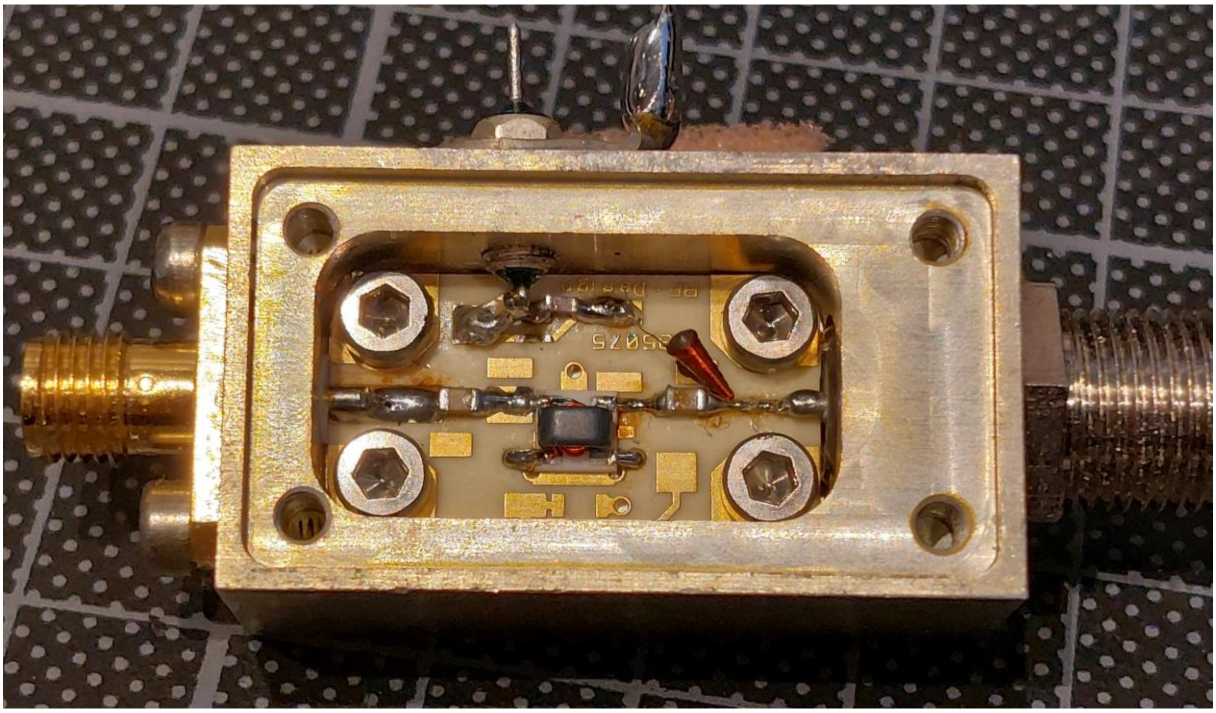


Two blocking ceramic capacitors with a capacitance of 120pF and 10nF and a maximum voltage of 50V are used.



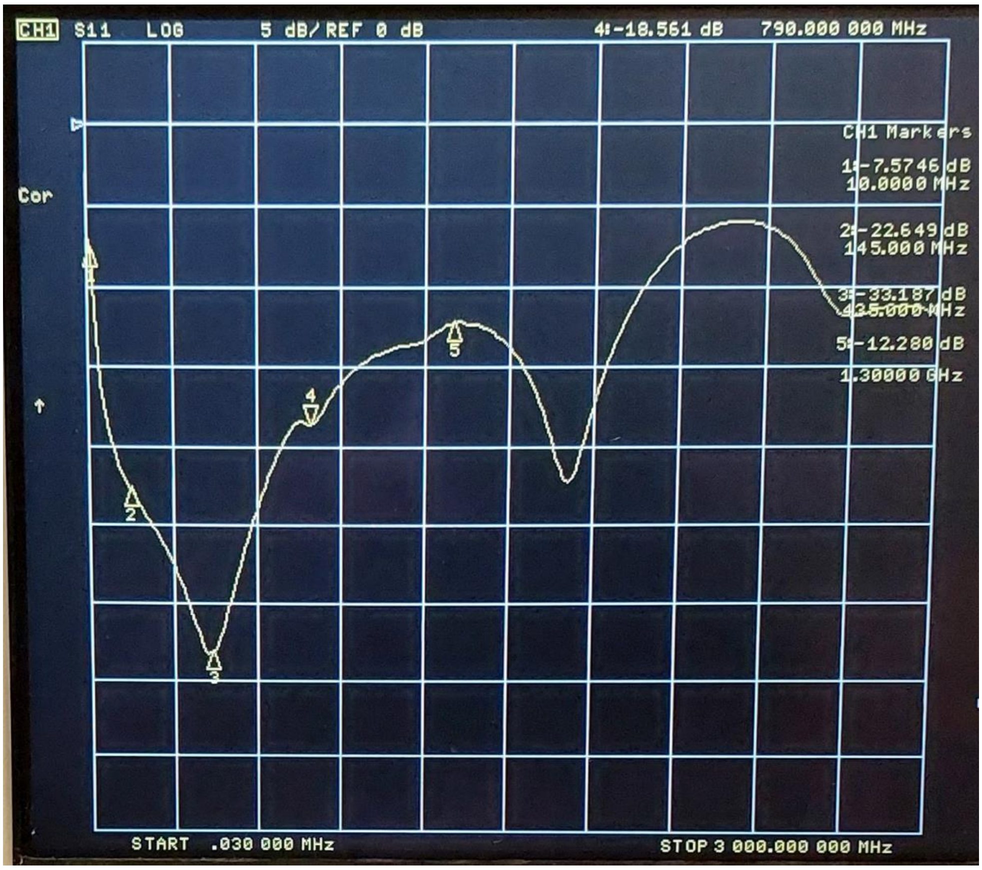
In the following pictures you can see the 50Ω to 75Ω impedance transverter module with the added Bias-T functionality:





Next, I measured the insertion loss of two such modules connected to each other directly at the 75Ω ports. As I verified in other measurements that both modules show an almost identical performance it can be safely assumed, that the resulting insertion loss per module is half of the value shown in the subsequent measurement graph. The resulting insertion loss per module is thus 0.36dB @145MHz, 0.41dB @435MHz, 0.69dB @790MHz and 1.04dB @1300MHz. These are excellent values as they include the transfomer losses of the 50Ω to 75Ω impedance transverter. These values match very much with the measurements Wilhelm had performed at the unmodified modules.

Input return loss at the 50Ω ports were also measured. The show return loss values of better 18dB in the frequency range of interest (145MHz to 800MHz).



I am sure these small but rugged modules will serve my purpose of biasing LNBs for QO-100 very well.

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

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

Best regards

Matthias DD1US

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