Unknown Bias-T with variable attenuator

Rev 1.0
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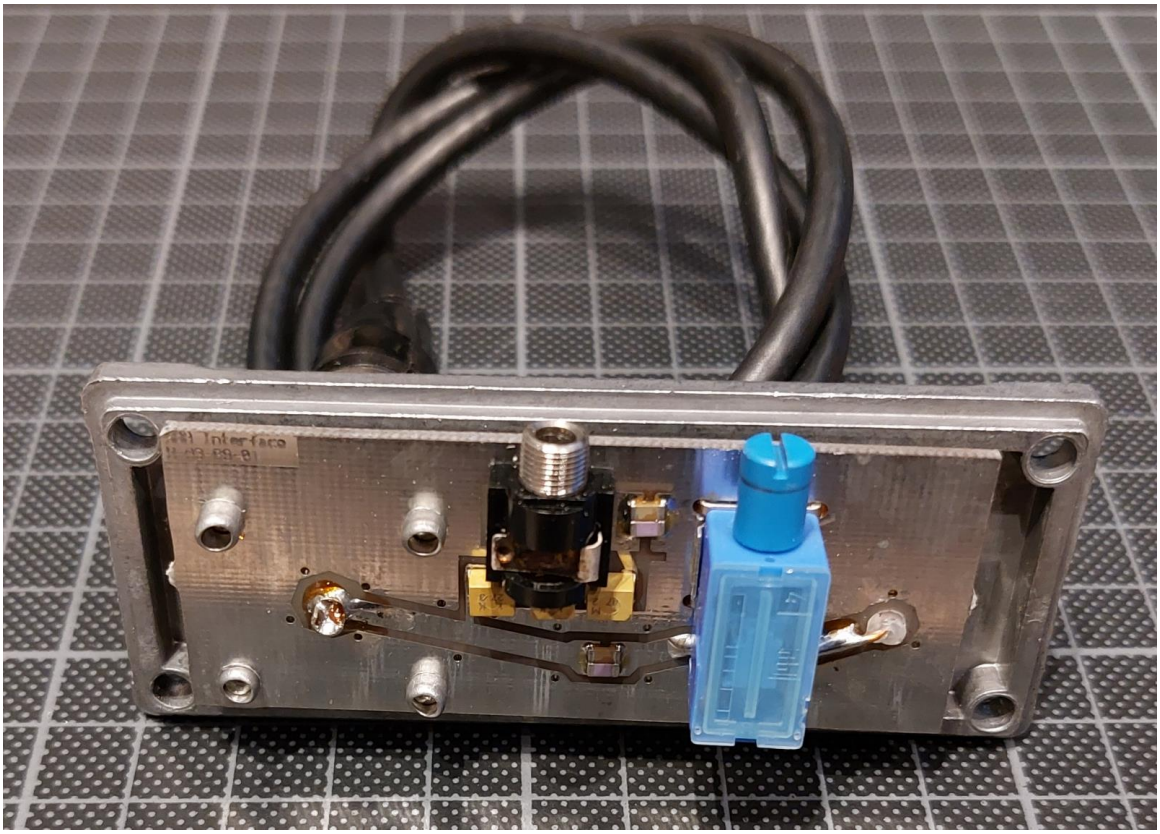
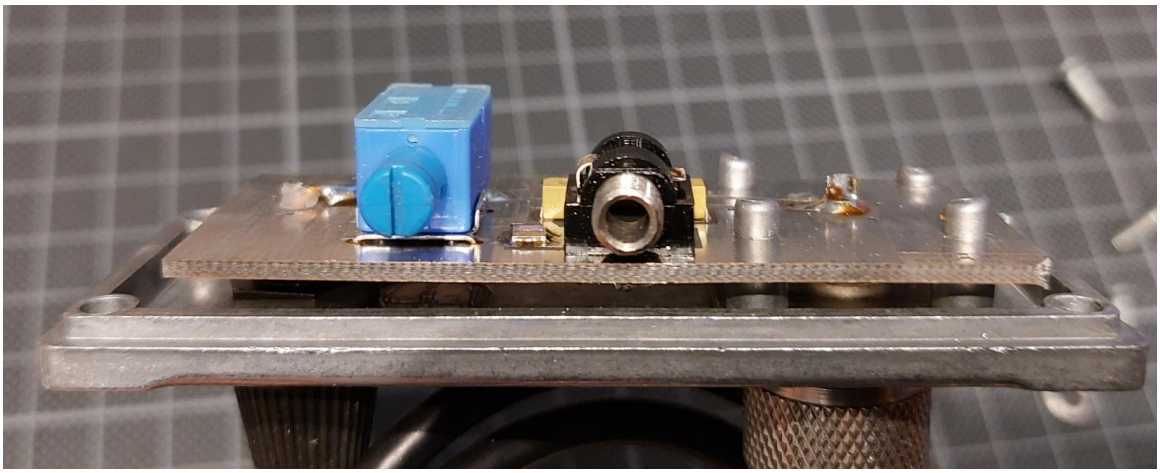
Hello,

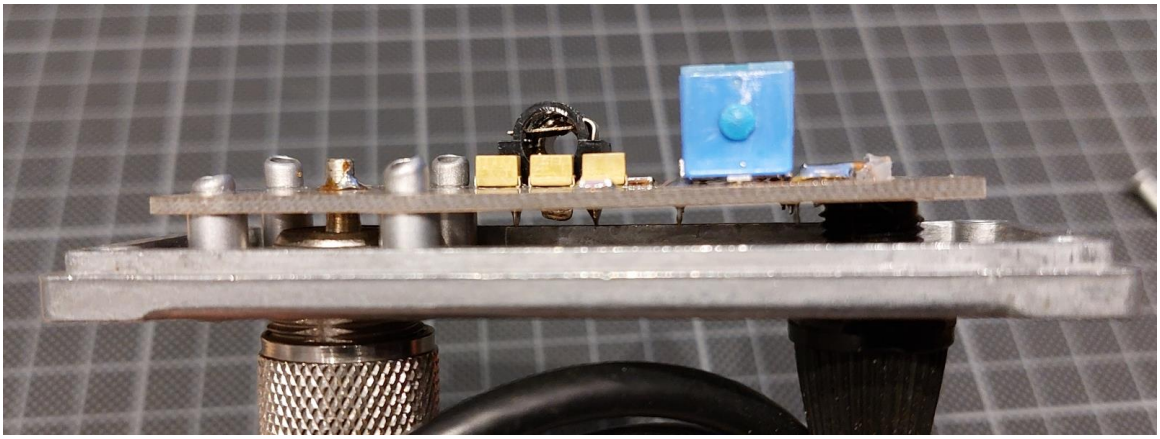
I have a Bias-T from an unknown vendor which features an integrated variable attenuator. It is mounted in a solid die-cast aluminum encasing. As the connectors are PL-type I assume that it is intended to be used for the HF-bands. Here are some pictures of the device:

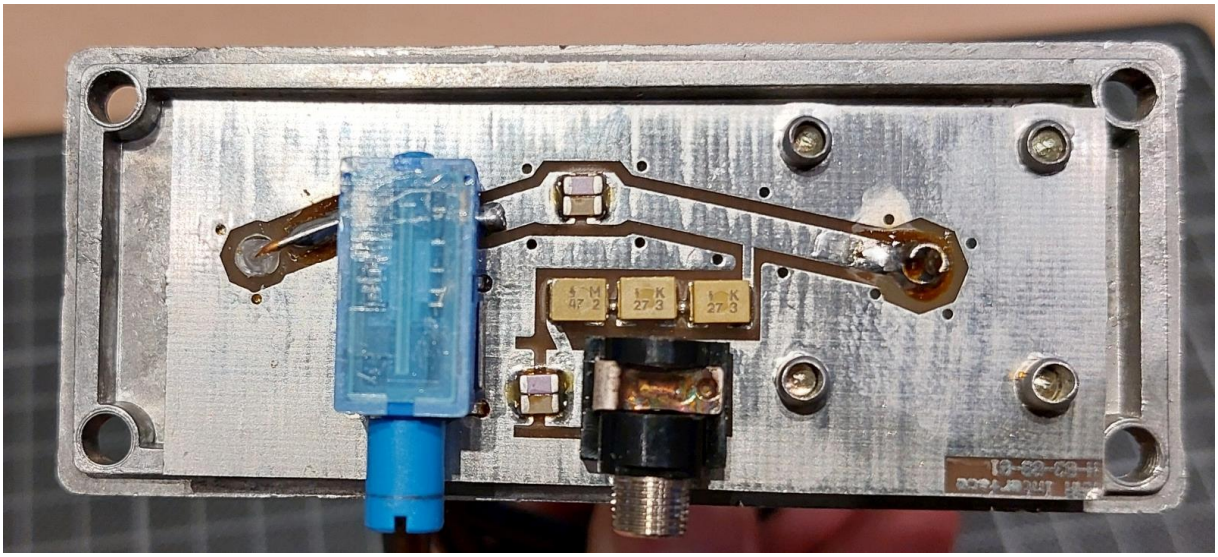
The DC-input is a 3.5mm jack and the attenuator can be adjusted using a screwdriver by turning the blue little knob. The attenuator can be used to reduce the output level to the receiver in case it gets overloaded.

Here are some pictures of the inside of the device:

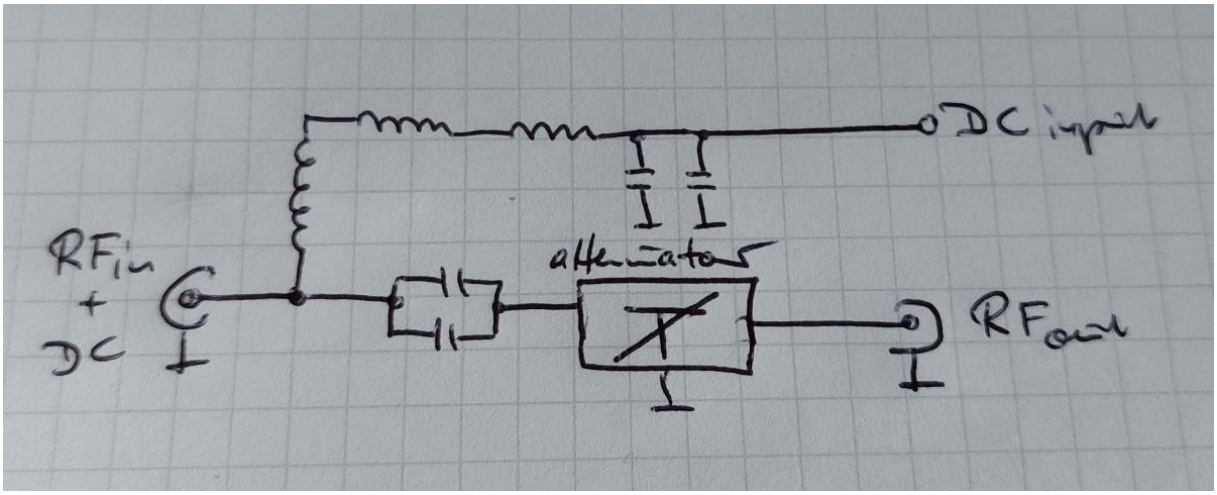






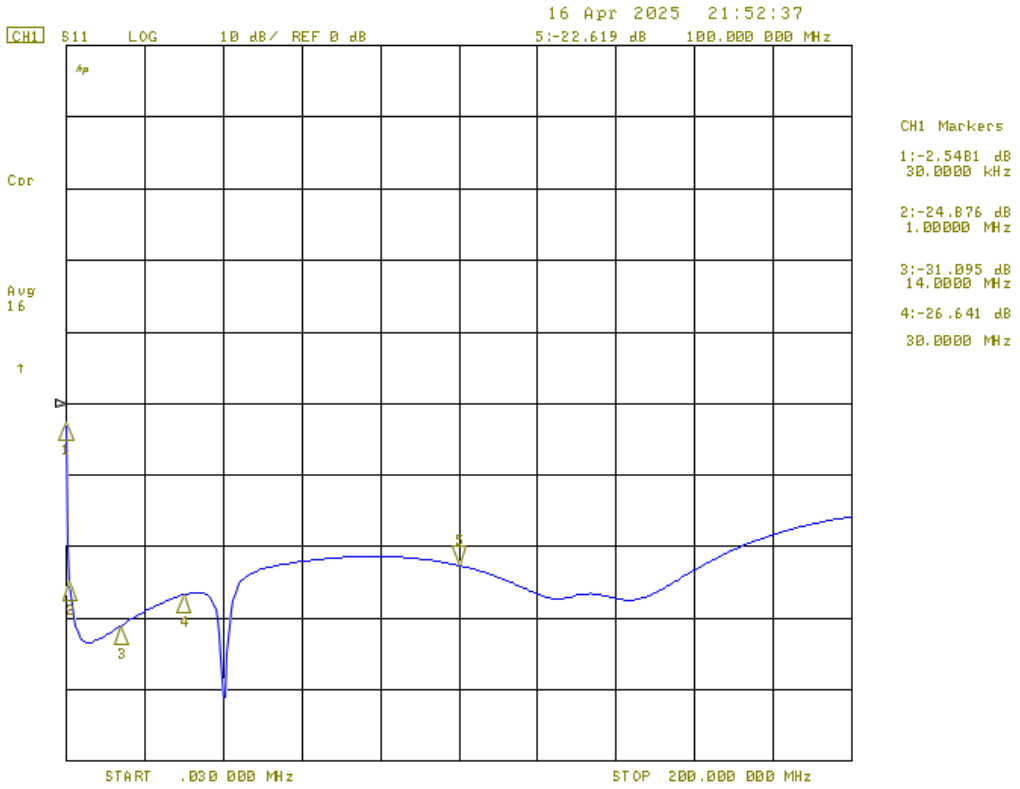


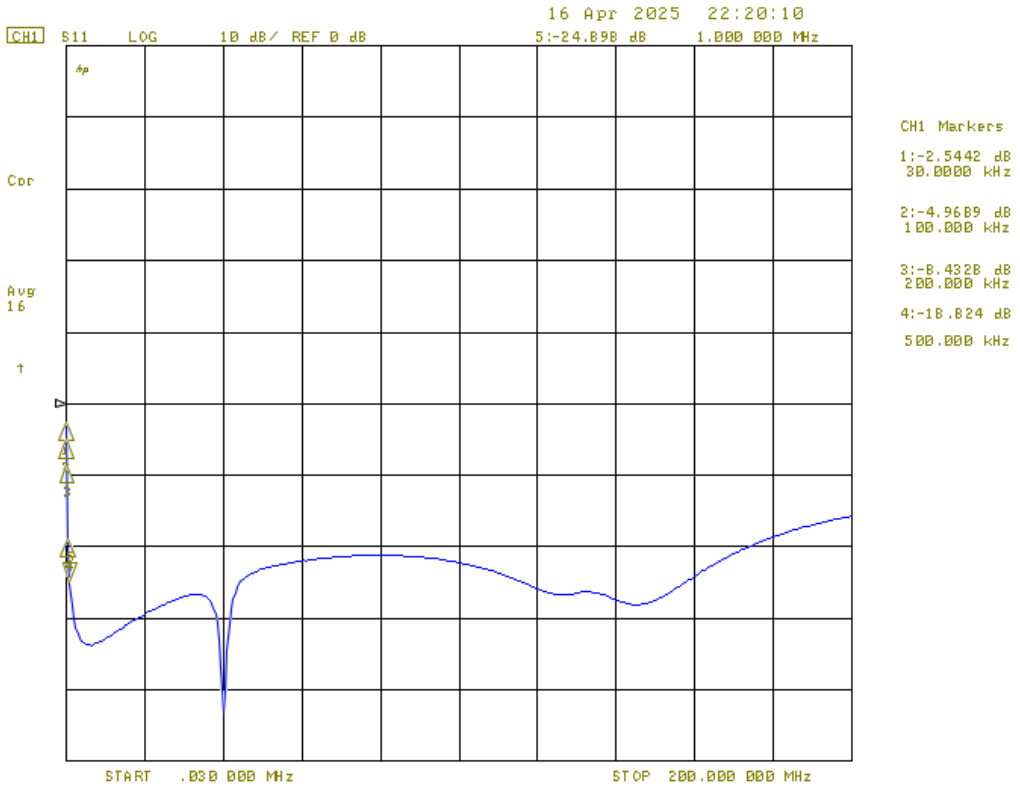
The simple but professionally made Bias-T is using 3 inductors in series to decouple the RF path from the DC path. In addition, ceramic capacitors are used for blocking the DC respectively providing low impedance for the RF signal at the DC input. The attenuator is based on a special potentiometer, which keeps the impedance constant when changing the attenuation. Here is a simple sketch of the schematic:



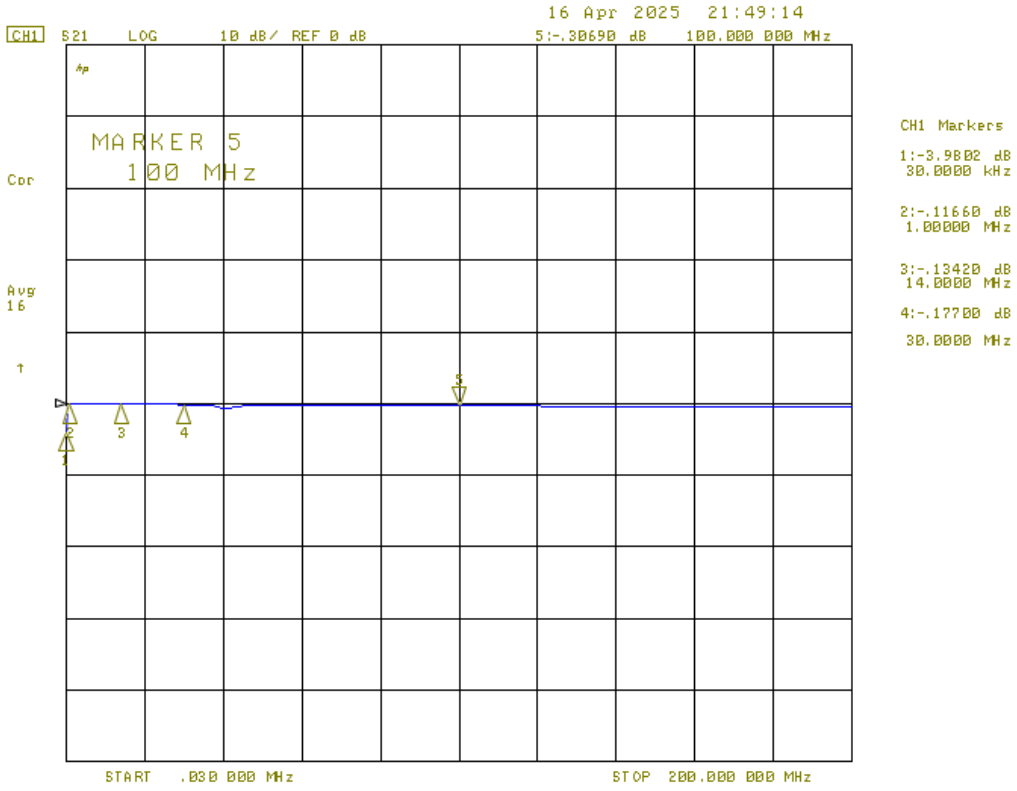
As I did not have any data of the device I measured its S-parameters as a function of the attenuator setting.

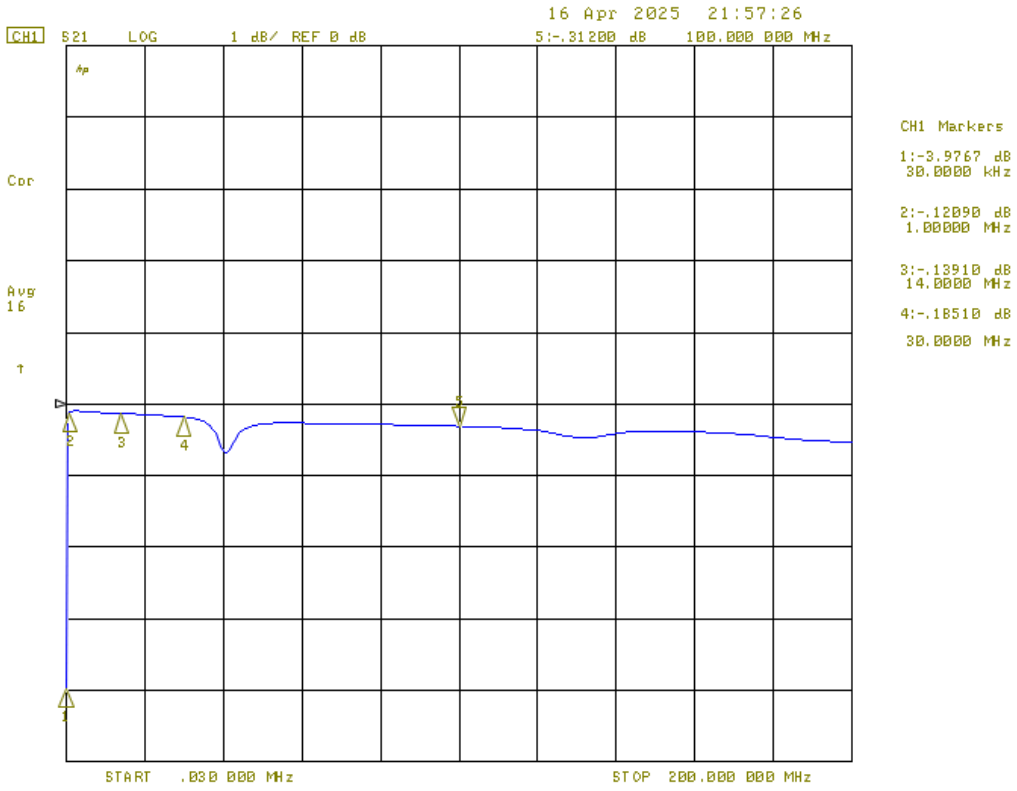
First, I measured the S-parameters with the attenuator set to minimum insertion loss:

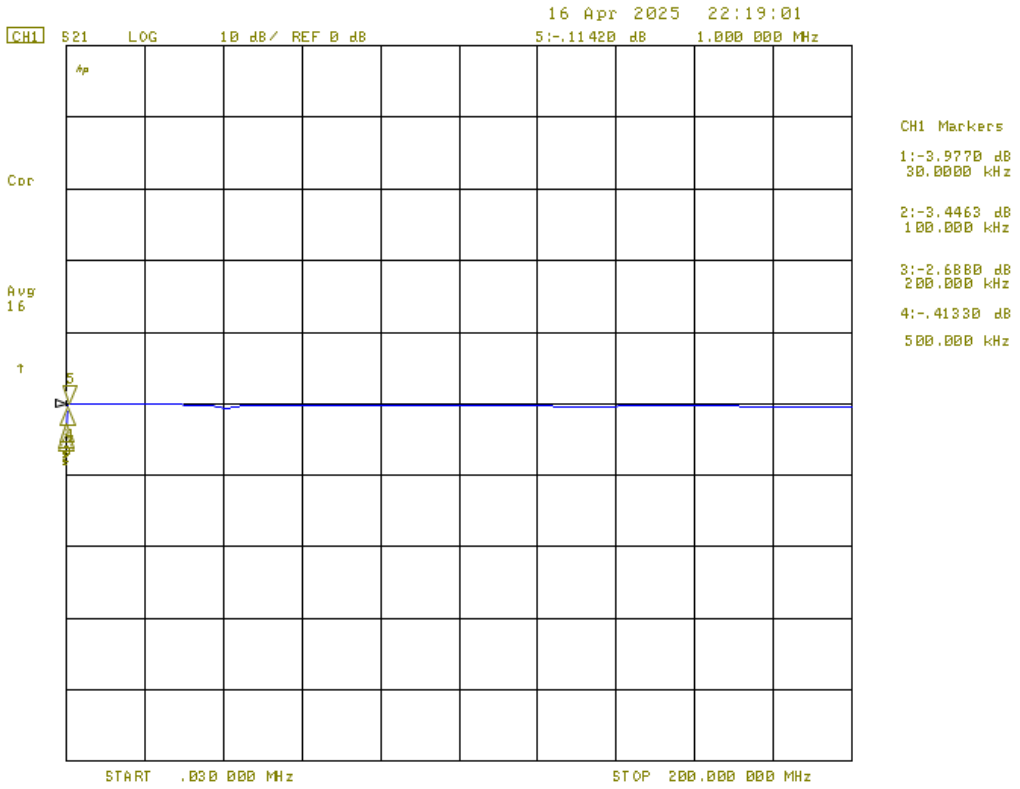




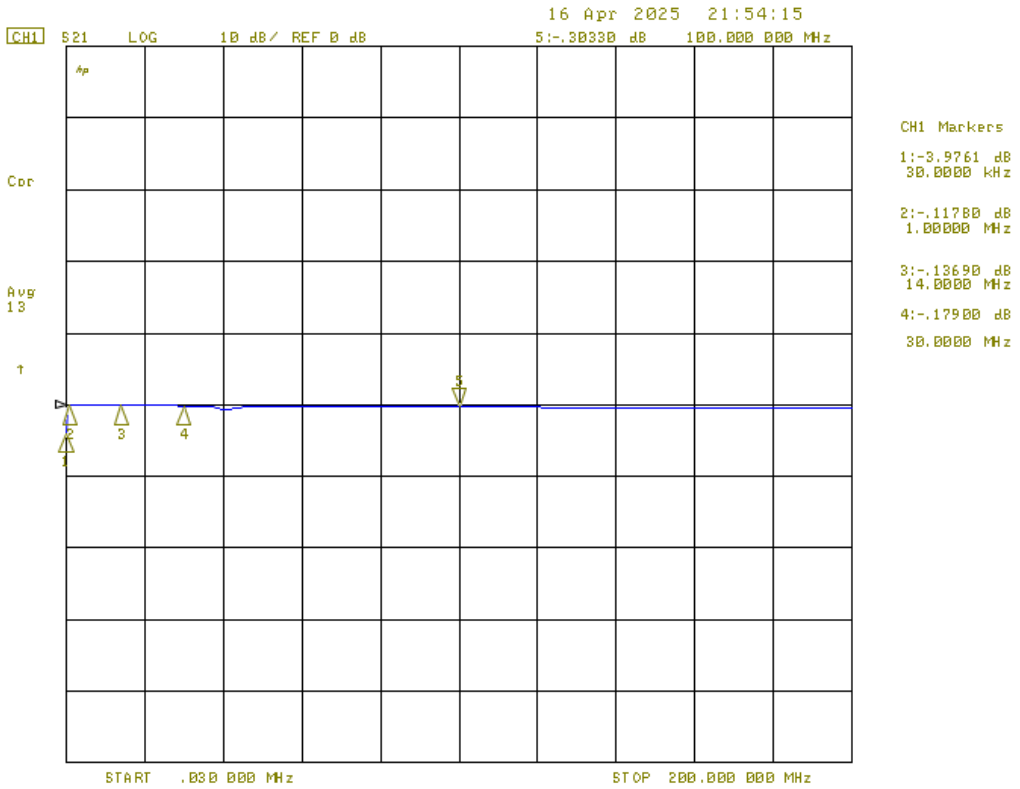
Input return loss S12 is better than 10dB in the frequency range 300kHz up to 200MHz respectively better than 20dB in the frequency range 600kHz up to 150MHz.


16 Apr 2025 21:49:14
CH1 S21 LOG 10 dB/ REF 0 dB
5:-.30690 dB 100.000 000 MHz
MARKER 5
100 MHz
Cor
Avg
16
START .030 000 MHz
STOP 200.000 000 MHz
CH1 Markers
1:-3.9802 dB
30.0000 kHz
2:-.11660 dB
1.00000 MHz
3:-.13420 dB
14.0000 MHz
4:-.17700 dB
30.0000 MHz

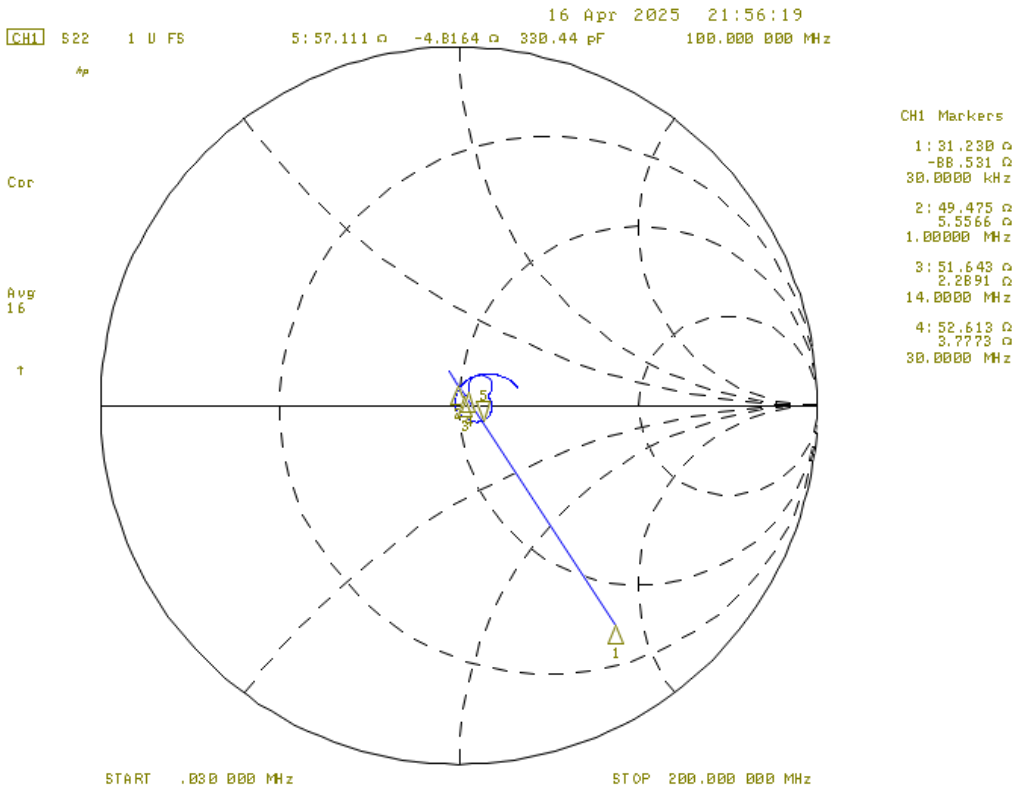

16 Apr 2025 21:57:26
CH1 S21 LOG 1 dB/ REF 0 dB
5:-.31200 dB 100.000 000 MHz
Cor
Avg
16
START .030 000 MHz
STOP 200.000 000 MHz
CH1 Markers
1:-3.9767 dB
30.0000 kHz
2:-.12090 dB
1.00000 MHz
3:-.13910 dB
14.0000 MHz
4:-.18510 dB
30.0000 MHz



Insertion loss S21 is 0.3dB or lower in the frequency range 600kHz up to 100MHz. Even down to 30kHz insertion loss is less than 3.5dB and thus in many applications still acceptable.

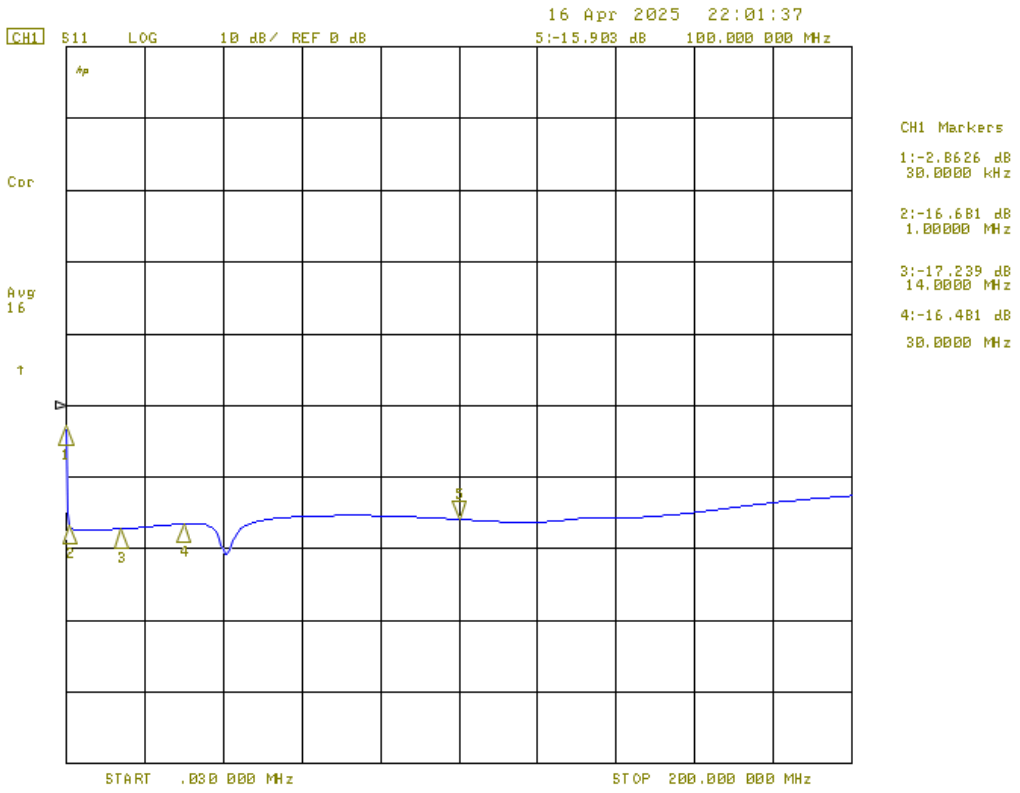


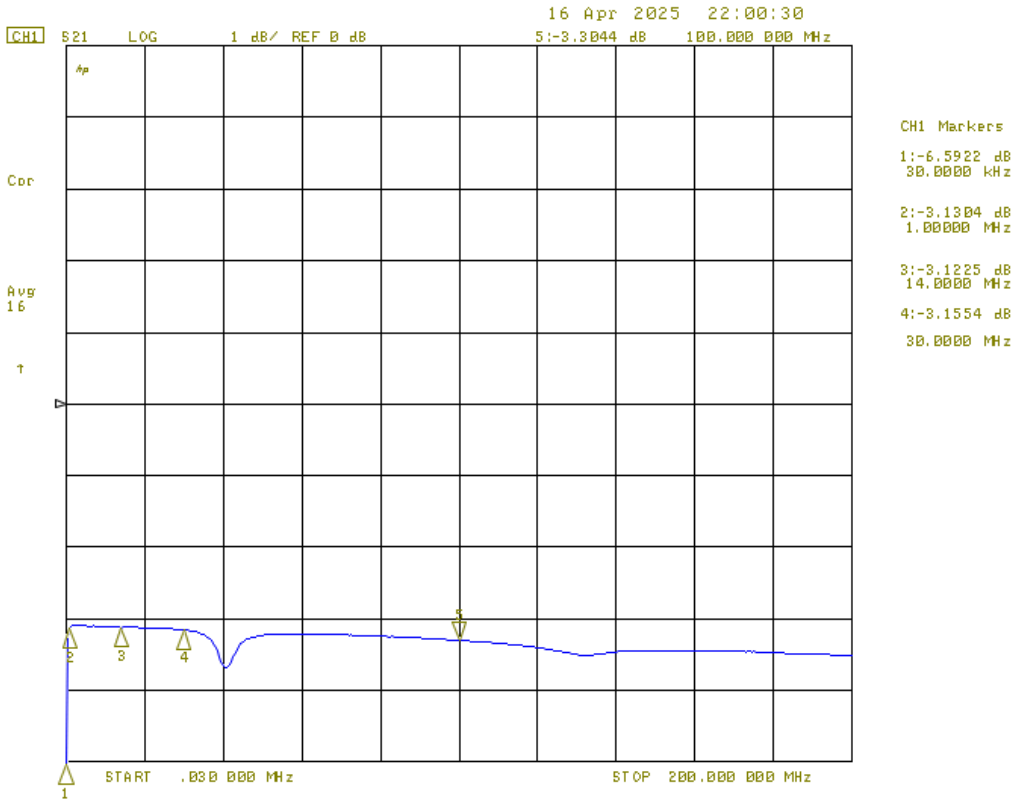
S12 is basically the same as S21.

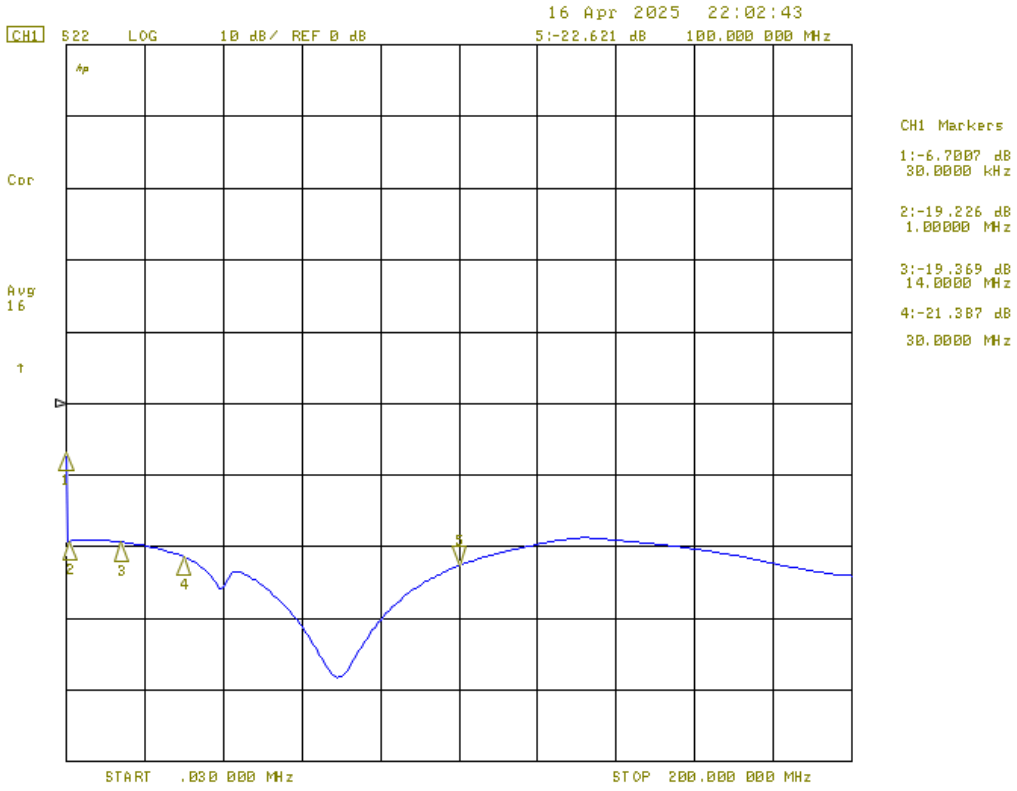


S22 is very close to 50Ohm in the frequency range 1MHz to 200MHz. The point far from the center of the Smith Chart is measured at 30kHz.

Next, I measured the S-parameters with the variable attenuator set to 3dB attenuation.

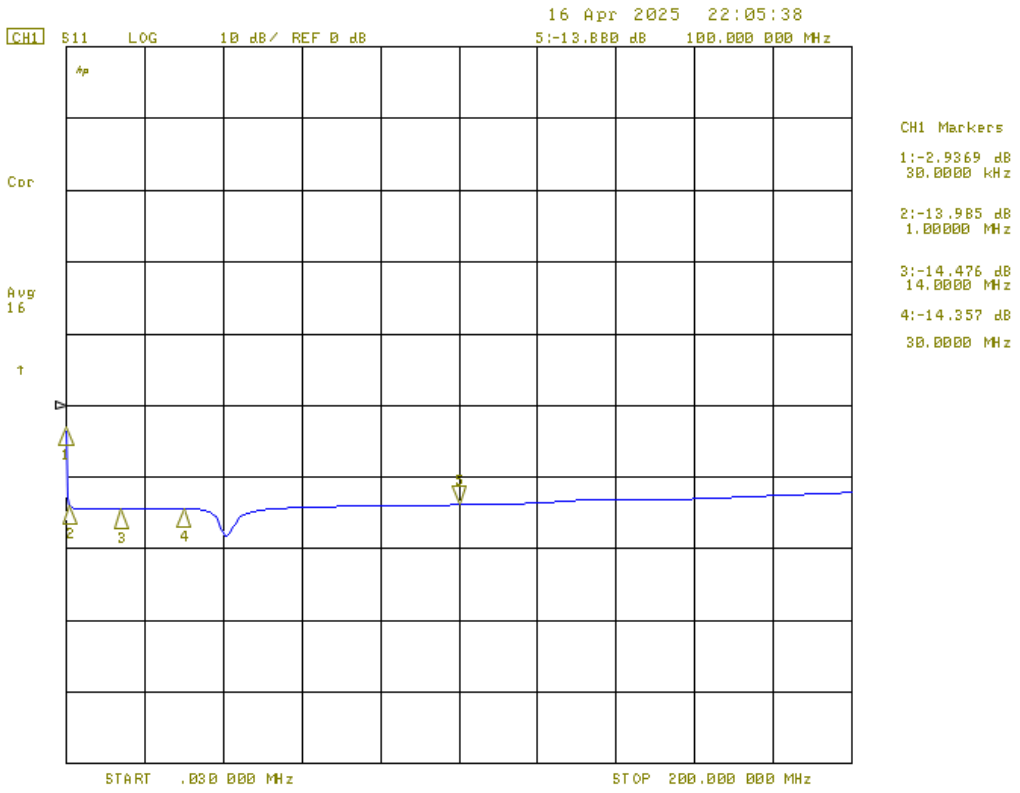


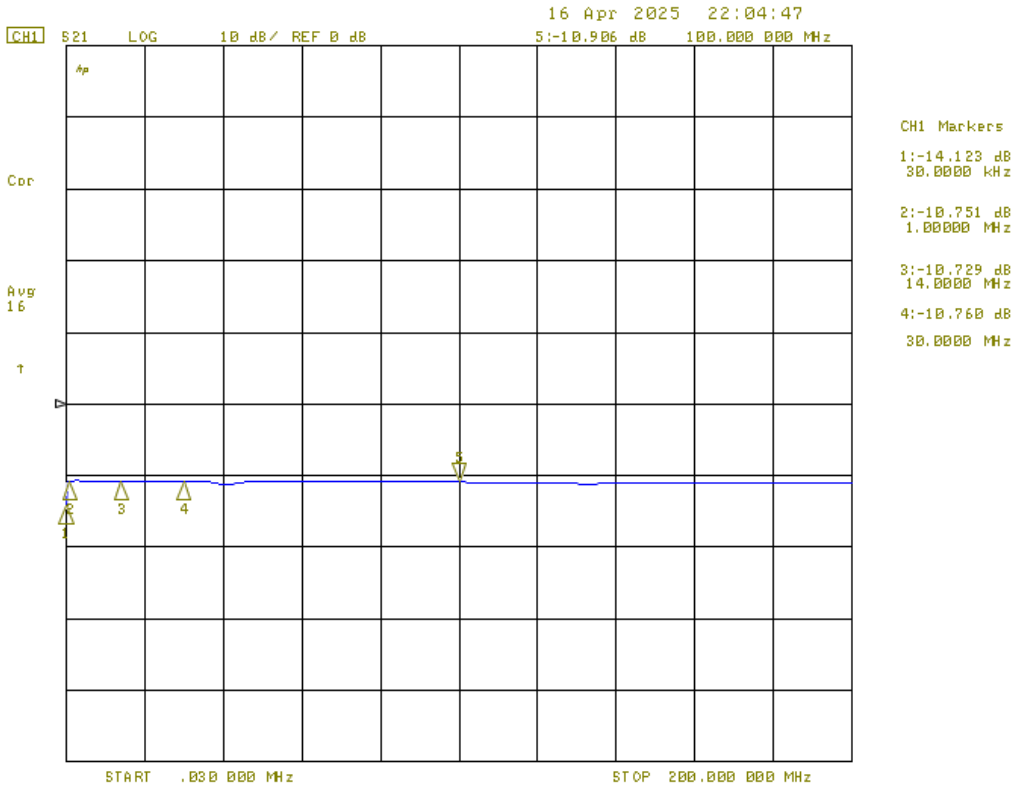


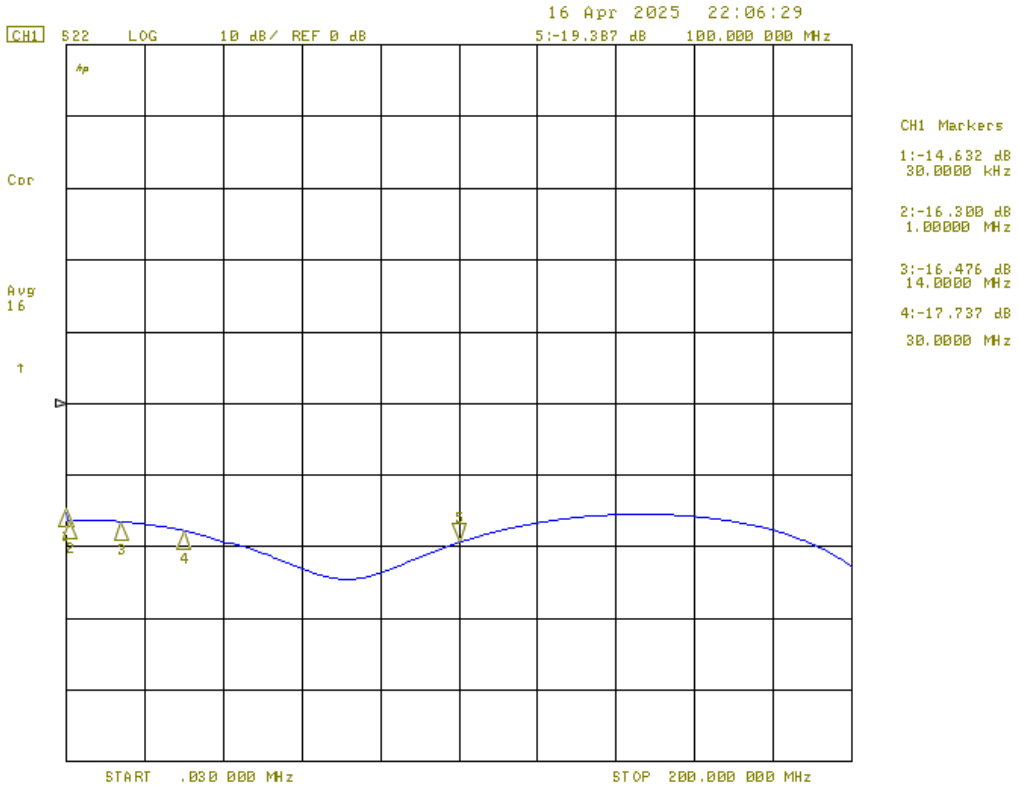


When the attenuation is set to 3dB the frequency response S21 is quite flat. Input return loss S11 is about 15dB or better in the frequency range 1MHz to 150MHz. Output return loss S22 is better than 19dB in the frequency range 1Mhz to 150MHz.

In the next step I measured the S-parameters with the attenuator set to 10dB insertion loss.

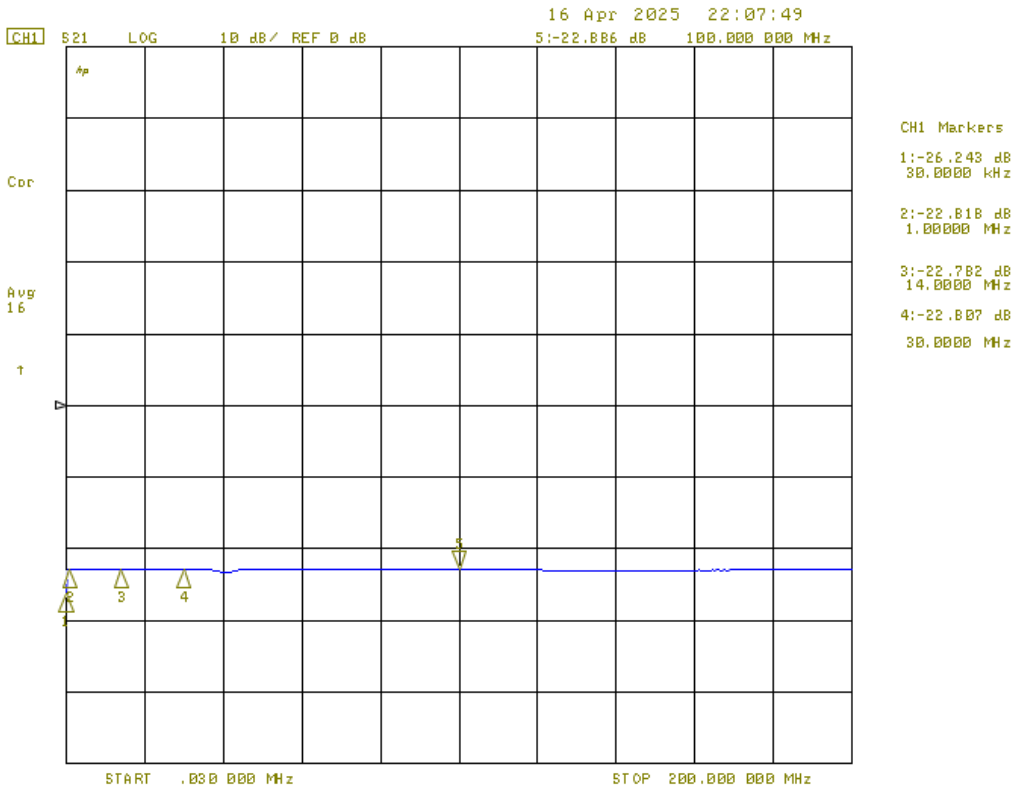


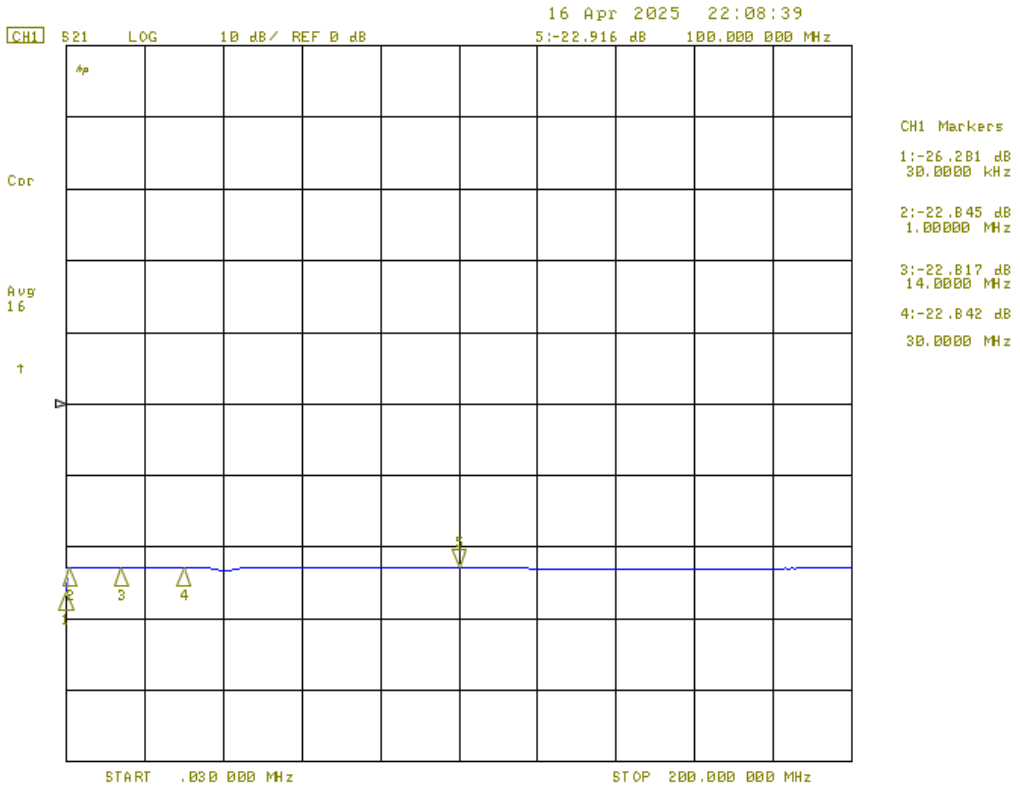


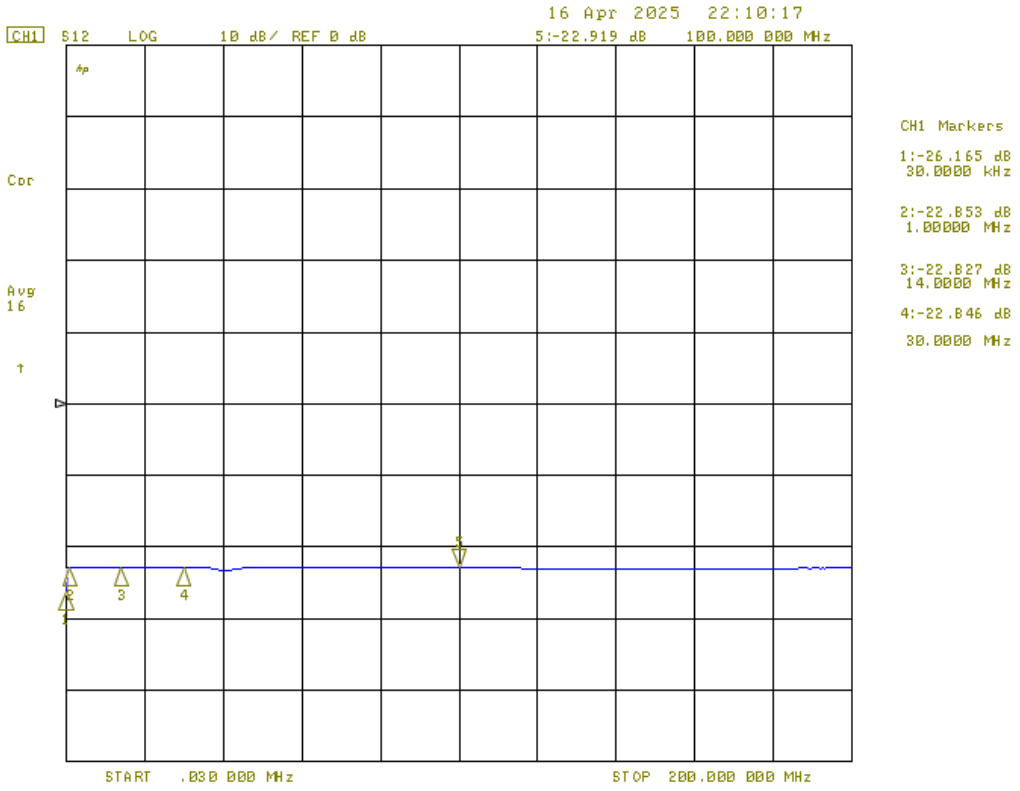


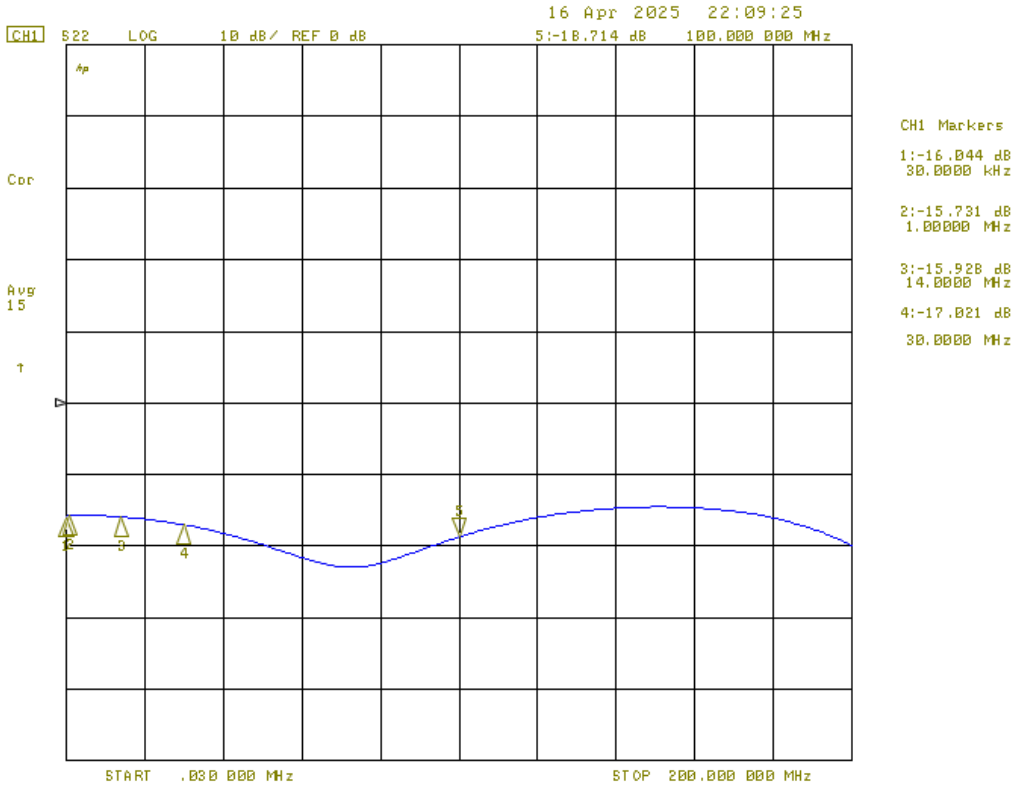
Also, when the attenuation set to 10dB the frequency response S21 is very flat. Input return loss S11 is about 14dB or better in the frequency range 1MHz to 100MHz. Output return loss S22 is better than 16dB in the frequency range 1Mhz to 200MHz. Even at 30kHz output return loss is better than 14dB.

Finally, I measured the S-parameters with the attenuator set to maximum attenuation which is about 22dB.





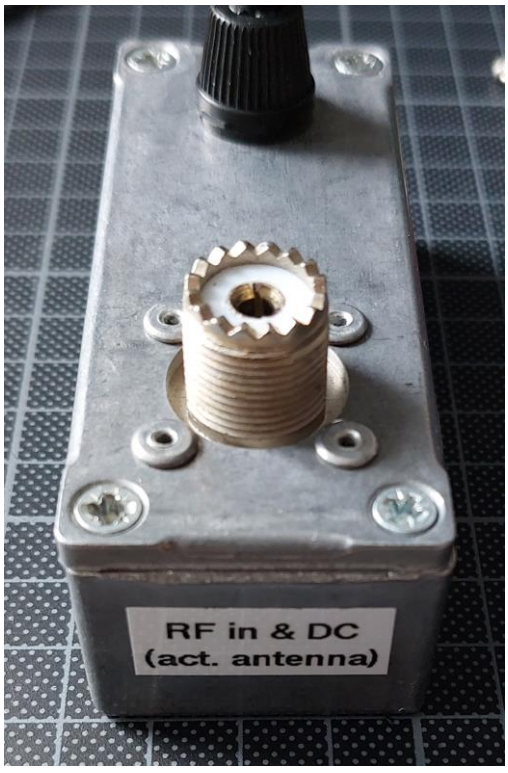




When setting the attenuator to maximum attenuation input return loss stays better than 22dB in the frequency range 30kHZ to 200MHz. Insertion loss S21 and S12 are very flat up to 200MHz. Output return loss S22 is better than 15dB in the frequency range 30kHz up to 200MHz.

In summary this is an excellent Bias-T for the frequency range 0.3 … 200MHz. It can also be used at lower frequencies with a slightly degraded performance. The integrated variable attenuator provides the option, to reduce the level of the signals from the antenna up to 22dB and thus avoid overloading of the receiver in the presence of strong signals.

Here are some pictures of the complete setup:



I always appreciate feedback. Please also let me know if you may know the supplier of such Bias-Ts.
Please send it to the Email address below.

Best regards

Matthias DD1US

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