Testing a simple FM (88-108 Mhz) notch filter for SATNOGS purposes (435 – 438 Mhz)

Since I use a simple LNA (SPF5189Z) for satellite reception in the UHF segment, I tried to find a solution to avoid interference from nearby FM broadcasting stations.
The simplest solution seemed to me to be a notch filter made of coaxial cable (an open quarter-wave segment connected in parallel to the input of the LNA). The parameters followed in making this filter are:

- attenuation in the range 88 - 108 Mhz
- insertion loss in the useful reception area 435 - 438 Mhz
- standing wave ratio (SWR) in the useful reception area 435 - 438 Mhz

For this purpose I made 3 different filters, 2 from coaxial cable, and the third one I built from copper pipes, simulating a coaxial line with dielectric air.

1. Coaxial cable type SCF12-50J - 1/2" CELLFLEX® Superflexible Foam-Dielectric Coaxial Cable

Size 1/2	
Inner Conductor Diameter mm (in)	3.6 (0.142)
Inner Conductor Material	Copper-Clad Aluminum Wire
Dielectric Diameter mm (in)	9.3 (0.366)
Dielectric Material	Foam Polyethylene
Outer Conductor Diameter mm (in)	12.3 (0.484)
Outer Conductor Material	Corrugated Copper
Jacket Diameter mm (in)	13.7 (0.539)
Jacket Material	Black Polyethylene
Velocity	% 77

2. 1/2" CELLFLEX® Low-Loss Foam-Dielectric Coaxial Cable

Size 1/2	
Inner Conductor Diameter mm (in)	4.8 (0.189)
Inner Conductor Material	Copper-Clad Aluminum Wire
Dielectric Diameter mm (in)	11.3 (0.445)
Dielectric Material	Foam Polyethylene
Outer Conductor Diameter mm (in)	13.8 (0.543)
Outer Conductor Material	Corrugated Copper
Jacket Diameter mm (in)	15.8 (0.622)
Jacket Material	Black Polyethylene
Velocity %	87

3. Home made air line build from copper pipes

D_int = 16 mm
D_inner = 6 mm
Vf=100%

For the length calculation I chose the filter frequency at 98 Mhz, in the middle of the 88 - 108 Mhz broadcast band.

F_notch = 98 Mhz
λ = 3059 mm
λ/4 = 765 mm

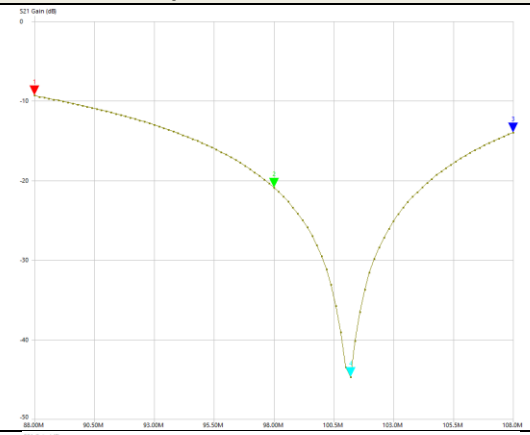
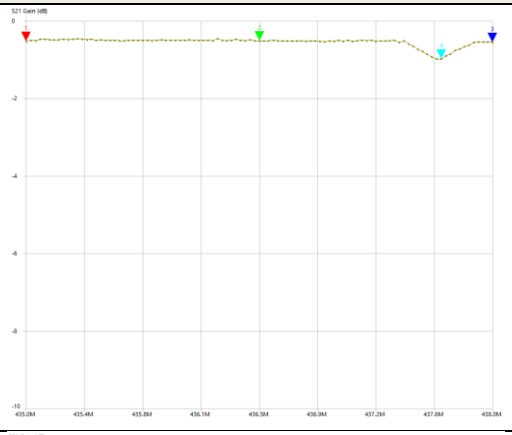
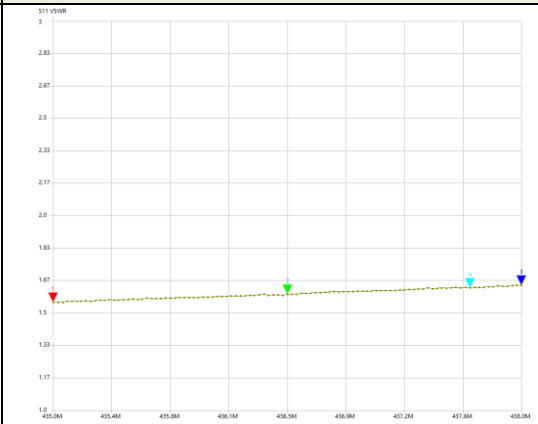
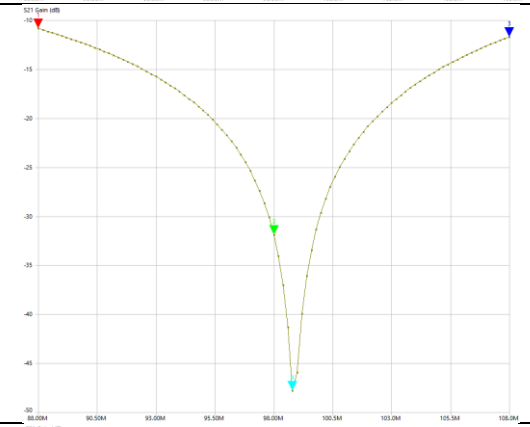
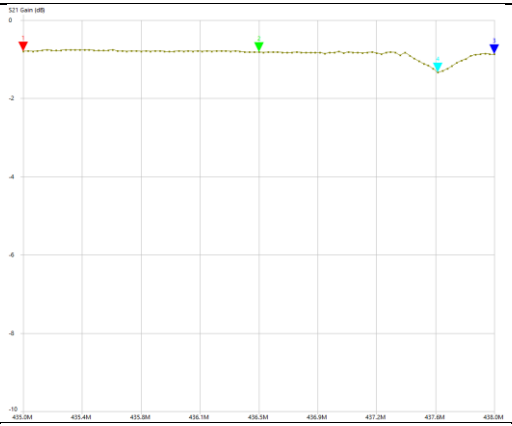
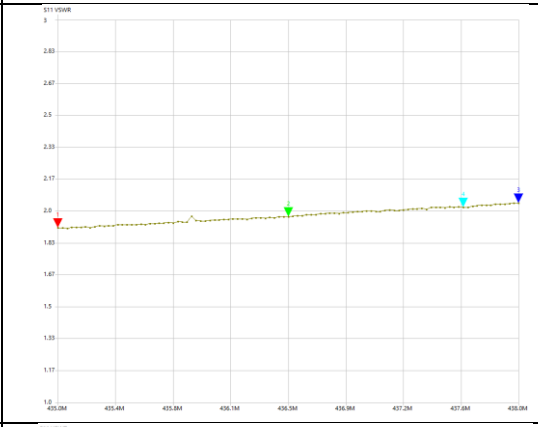
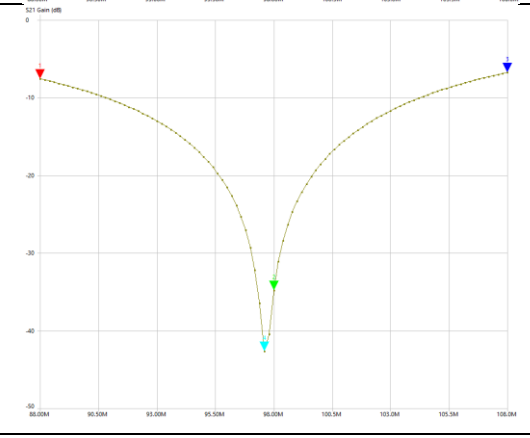
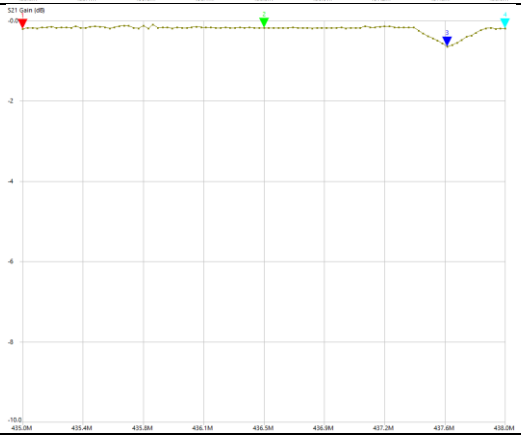
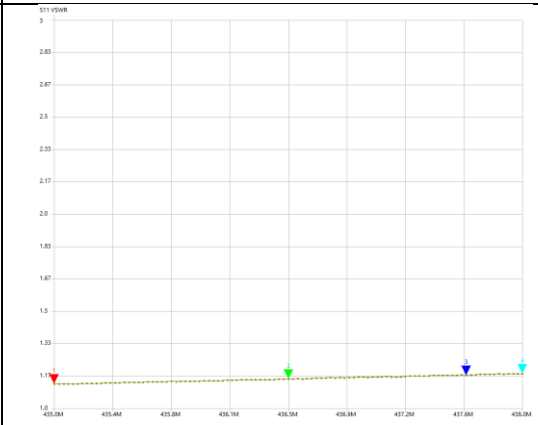
H1000 λ/4 x Vf = 765 x 0.83 = 635 mm
SCF12-50J λ/4 x Vf = 765 x 0.77 = 589 mm
HM air-line λ/4 x Vf = 765 x 1.00 = 765 mm

The results obtained, measured with Nano-vna f v2

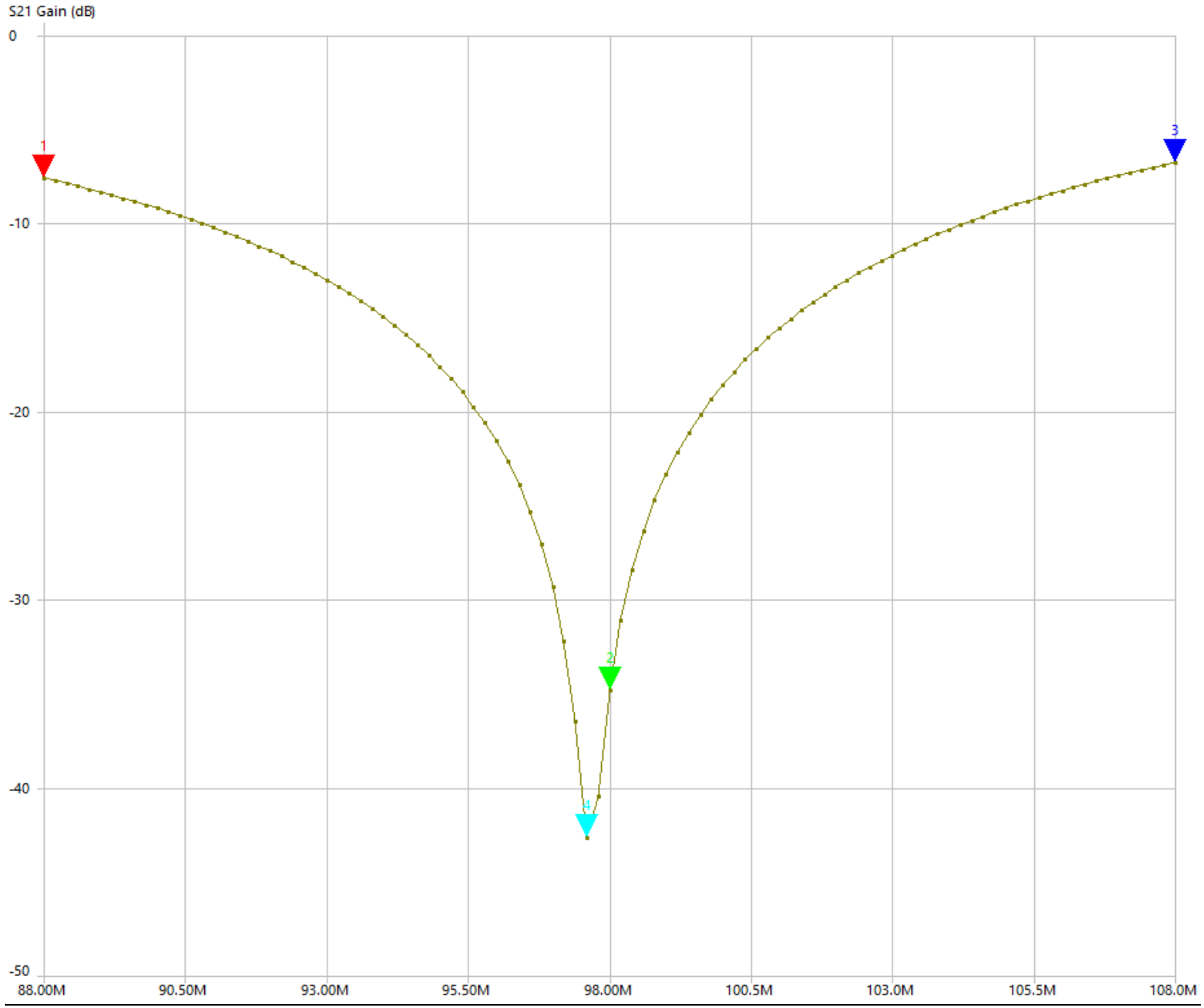
Type of coaxial	Notch results (88 – 108 Mhz)					Attenuation in working bandpass (435 – 438 Mhz)		
	Best att.	Frequency	att@88 Mhz	att@98 Mhz	att@108 Mhz	att@435Mhz	att@436.5Mhz	att@438Mhz
H1000 coaxial cable Vf=83% Nom. Insertion Loss 400 MHz 8.4 dB/100m	-44.724 dB	101.200 Mhz	-9.351 dB	-20.909 dB	-13.965 dB	-0.510 dB	-0.510 dB	-0.539 dB
SCF12-50J 1/2" CELLFLEX Vf=77% Nom. Insertion Loss 450 MHz 7.04 dB/100m	-47.840 dB	98.800 Mhz	-10.872 dB	-31.939 dB	-11.715 dB	-0.804 dB	-0.821 dB	-0.869 dB
Home made air line D_int = 16 mm D_inner = 6 mm Vf=100% Nom. Insertion Loss - NA	-42.666 dB	97.600 Mhz	-7.57 dB	-34.83 dB	-6.773 dB	**-0.077 dB**	**-0.183 dB**	**-0.204 dB**

Observations:

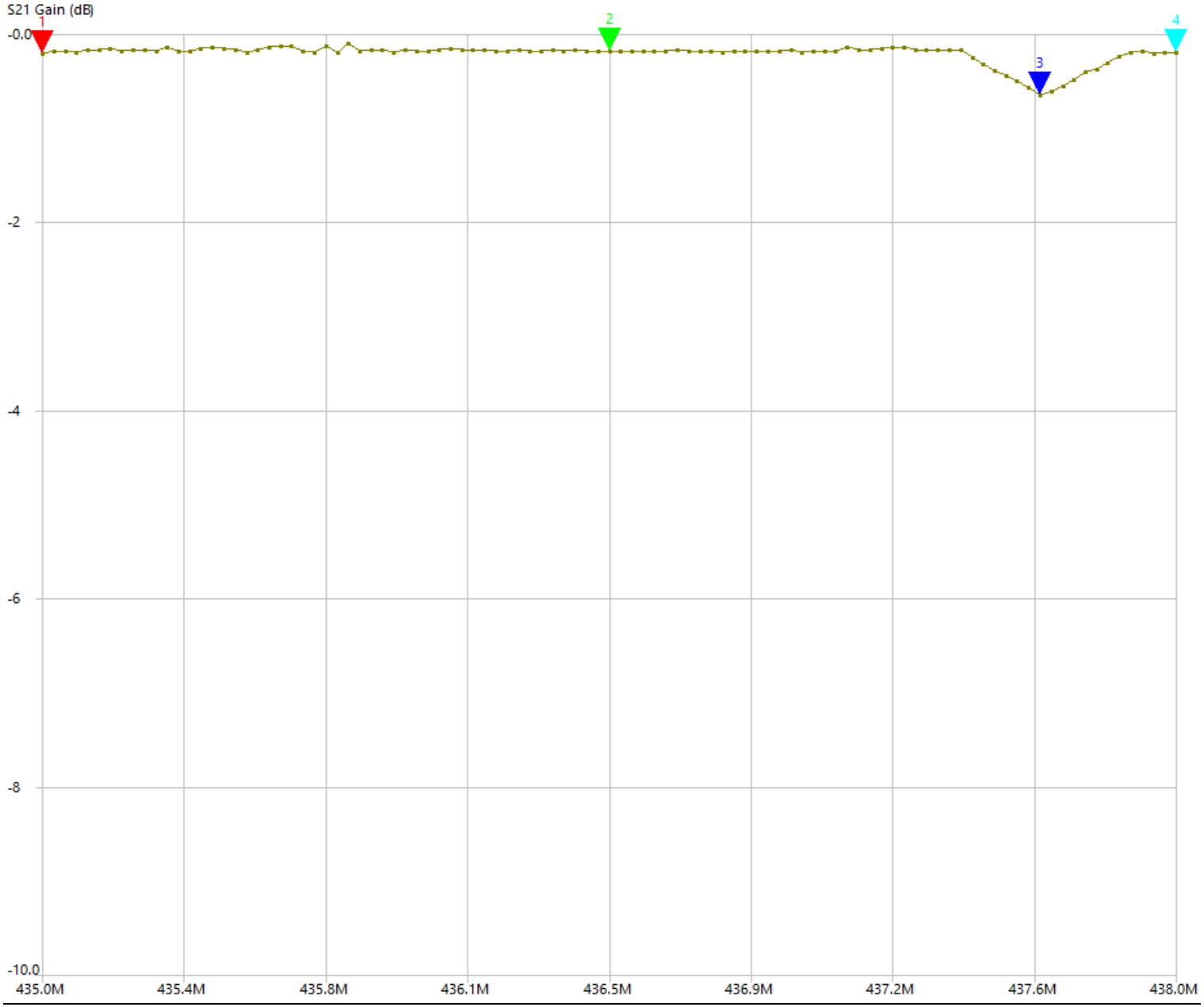
1. The relatively large resonance frequency deviations obtained in the case of filters made with coaxial cable are (probably) due to the fact that we used old pieces of cable.
2. Another point of confusion would be the higher insertion loss in the case of the filter made with Cellflex cable versus H1000 cable (although Cellflex cable has lower loss in the data sheet than H1000 cable). The explanation could be the same as in the previous point, the cables are not new.
3. In the case of the coaxial line made with copper pipes, although the insertion losses are the lowest, the maximum attenuation is inferior to that obtained in the case of filters made with 50 ohm cables. The explanation would be the impedance of the constructed line, which is 83 ohms, not 50 ohms. We chose this constructive variant taking into account the experience in the construction of resonant cavities (see appendix).

Type of filter	Stop band 88 -108 Mhz	435 – 438 Mhz insertion loss	435 – 438 SWR
H1000 coaxial cable			
SCF12-50J 1/2" CELLFLEX			
Home made air line			

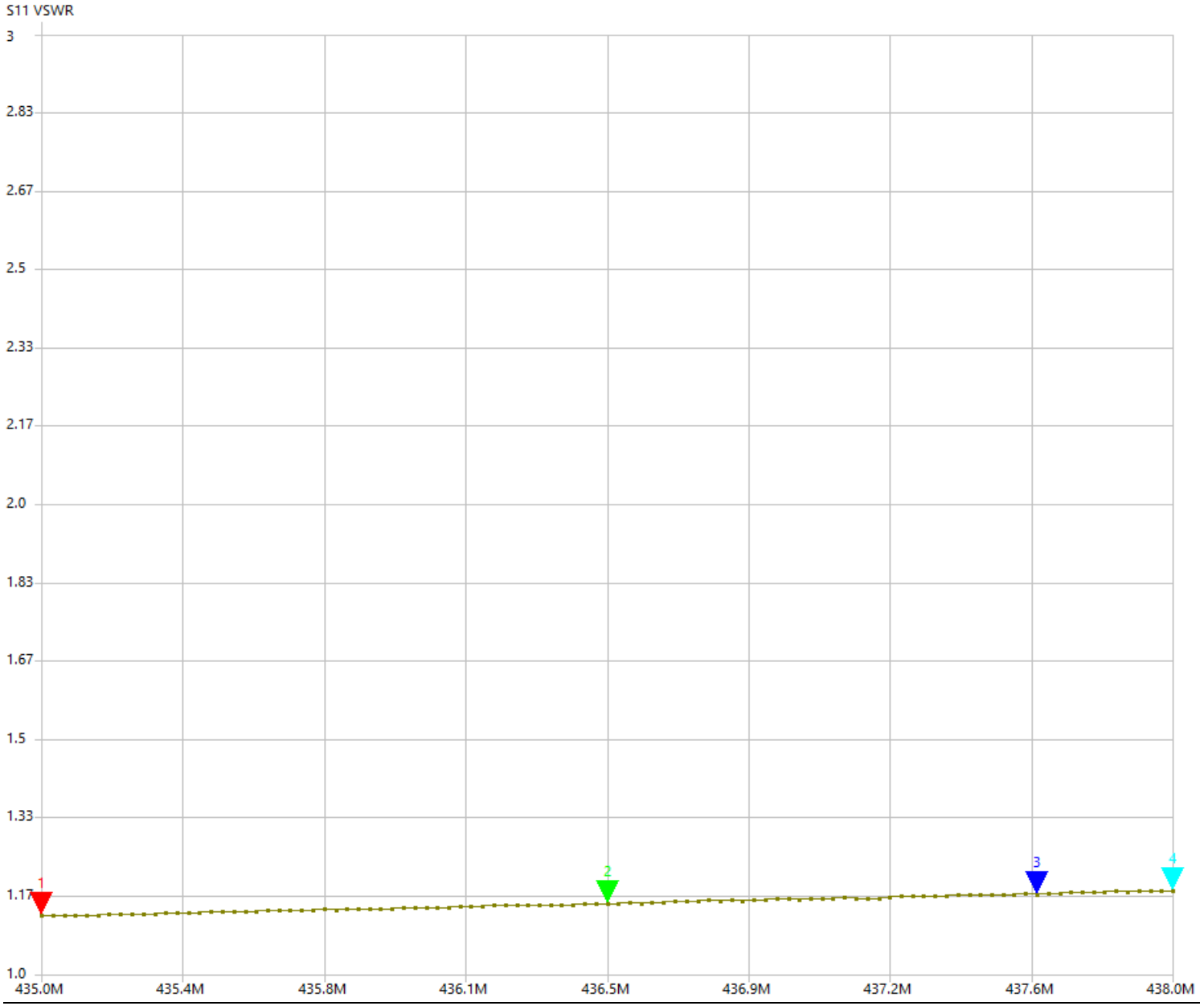
Home made air line – stop band 88 – 108 Mhz

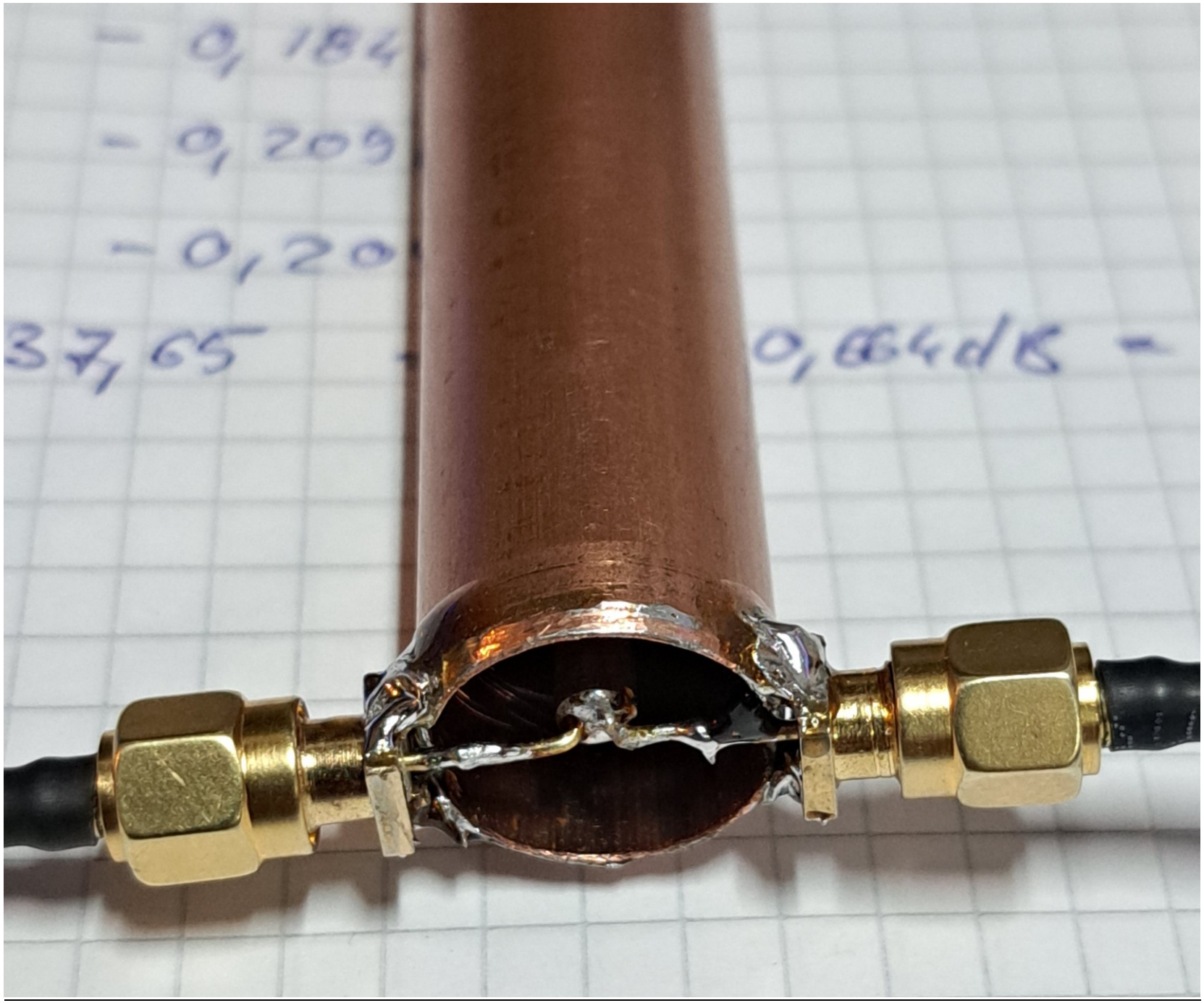


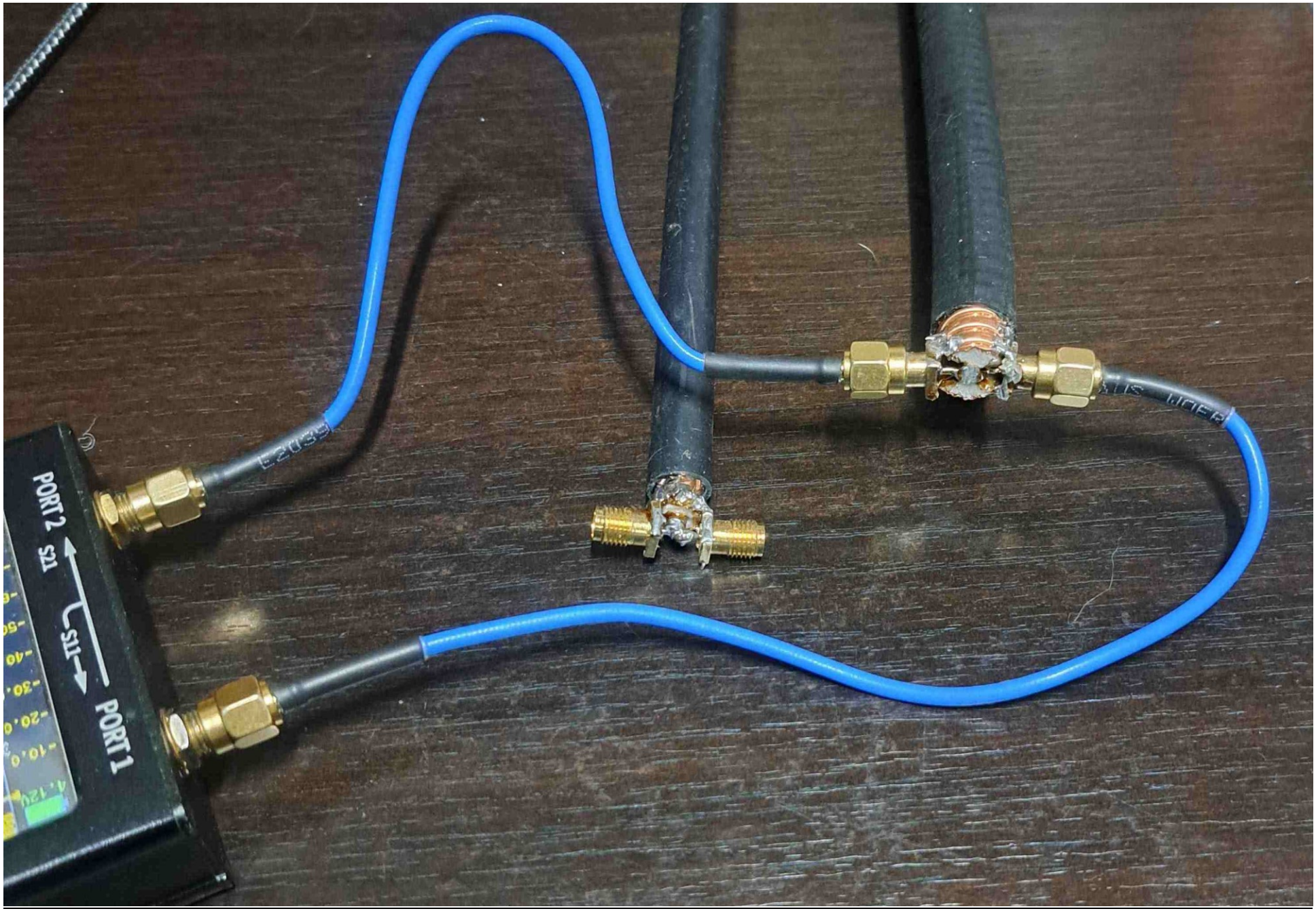
Home made air line – insertion loss 435 – 438 Mhz



Home made air line – SWR, 435 – 438 Mhz



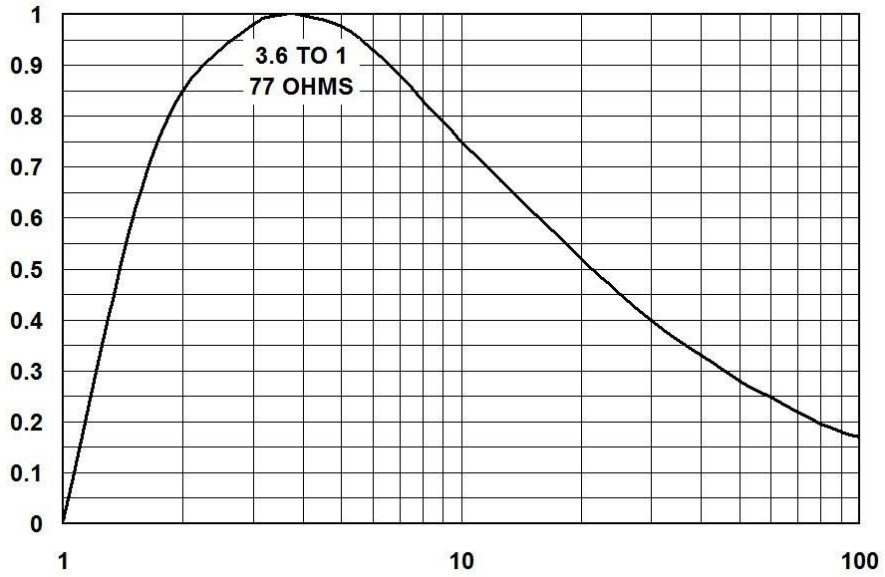

- 0,184
- 0,209
- 0,20
37,65
0,664dB -


PORT2
S21
S12
PORT1

Appendix
(see https://www.repeater-builder.com/antenna/w6nbc-duplexer-book/ch8.html)

Home made air line
(made with copper pipes)

	Inner = 4 mm	Inner = 6 mm	Inner = 8 mm
15 x 0.5 mm (14 mm)	**75.1**	50.8	33.5
15 x 0.7 mm (13.6 mm)	**73.3**	49.0	31.8
15 x 1 mm (13 mm)	**70.6**	46.3	29.1
18 x 0.5 mm (17 mm)	**86.7**	62.4	45.2
18 x 0.7 mm (16.6 mm)	**85.3**	61.0	43.7
18 x 1 mm (16 mm)	***83.1***	***58.8***	***41.5***



Inner to outer conductor diameter ratio vs. relative loss