TRANSRADIO
SenderSysteme Berlin

MW- diplexer
1188 kHz, 150 kW
1341 kHz, 150 kW

Szolnok
(Hungary)

Technical Documentation

for acceptance tests

Feb. 2007

Waniewski

Contents

1.0 Introduction

The antenna in Szolnok (119 m high, base fed with two levels of guy ropes) was already used for the Catholic Radio on 1341 kHz. For simultaneously radiating a second program (Ethnic and Parliarment) on 1188 kHz a diplexer had to be designed and realized. This was a challinging task for the narrow distance of the frequencies and the rather high power of 150 kW of each transmitter. It was necesssary to use compensated filters in order to avoid high reactive power in the filter elements which would have been difficult to handle. A compensated filter is a filter which filters a frequency without affecting the operating frequency.

2.0 Design of antenna tuning unit as diplexer and operational values

The design of the antenna tuning unit as diplexer is shown next page. The same document is given as file 51-8900-813-00 WSP_SZOLNOK_ATU_AE05.pdf (A3 format) in the appendix (1). All operational values like impedances, currents and voltages are given after tuning the elements.

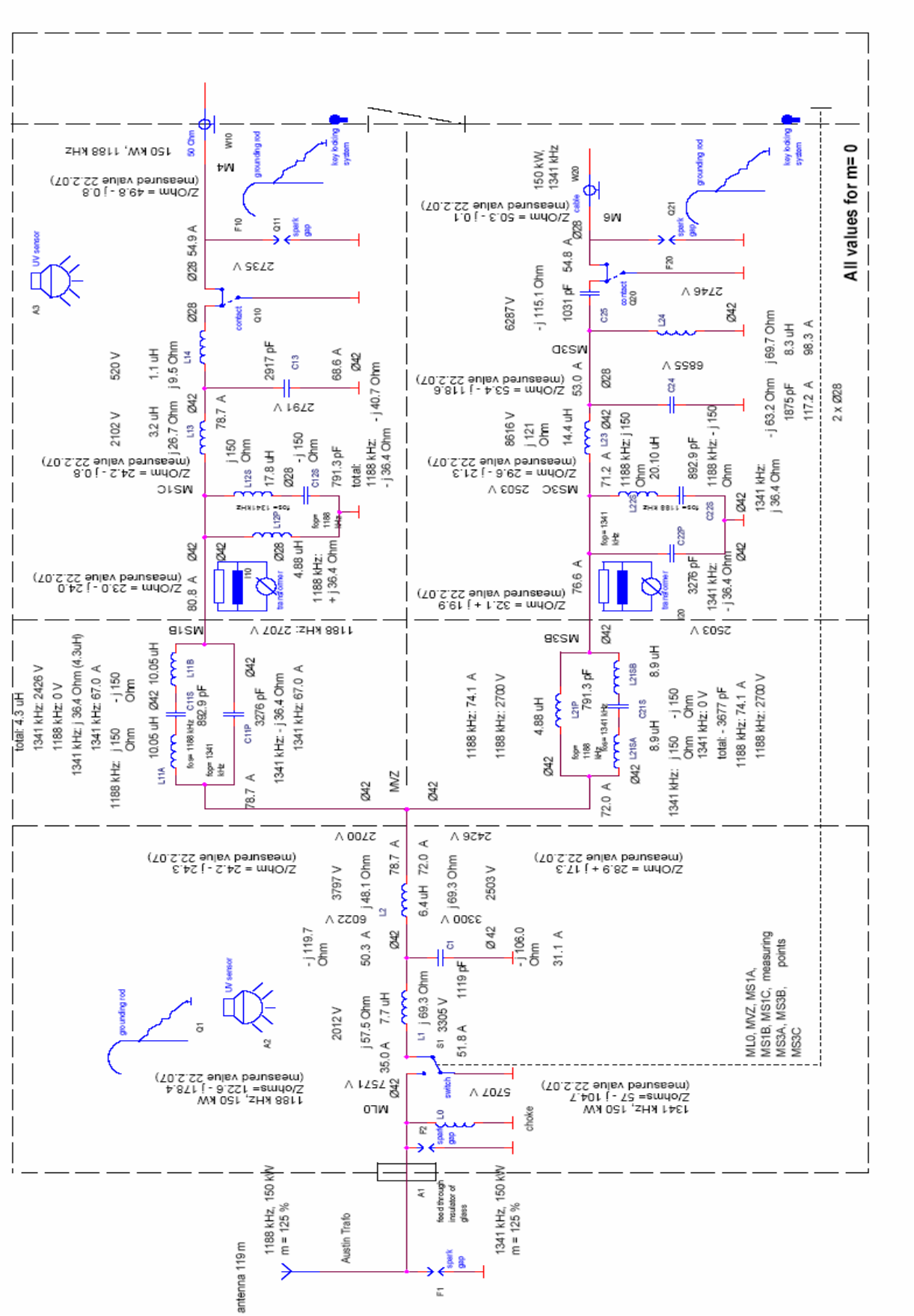
At the base of the antenna the coil L0 for protection against lightning is installed. Lightning current flowing from the mast into this coil increases the voltages at the spark gaps F1 and F2 ($u = L \bullet di/dt$) avoiding damages of antenna tuning components by lightning.

The diplexer contains compensated filters in order to avoid high reactive power in the filter elements. A rejection filter without compensation (i.e. for 1341 kHz) consists of two components in parallel (coil and capacitor). It behaves like an infinitive reactance for the filter frequency when both components have the same reactance but opposite algebraic signs (+ and -). To make it an compensated filter one of the two components in parallel have to be a resonant circuit in series for the operating frequency. The filter is a short circuit for the operating frequency.

The drawing contains also operational values as currents and voltages.

MW- diplexer Szolnok (Hungary) 1188 kHz, 150 kW - 1341 kHz, 150 kW

Technical Documentation for acceptance tests Feb. 2007



3.0 Measured values of impedances for 1188 kHz

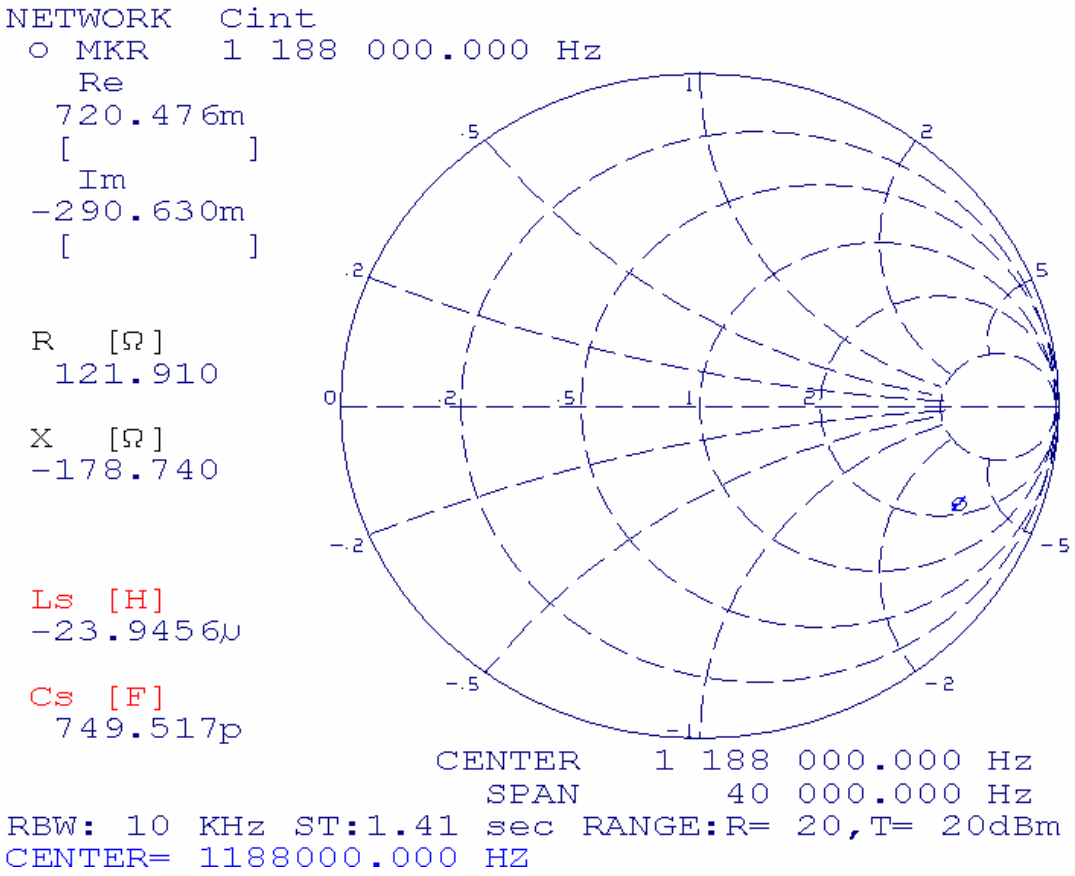
3.01 Antenna impedances for 1188 kHz +- 20 kHz

The antenna impedance was measured at the grounding switch inside of the antenna hut. The grounding choke was included. Measuring point: ML0 in the drawing .

Table of measured antenna impedances:

Frequenz [Hz]	Re{Z_in} [Ω]	Im{Z_in} [Ω]	remark
1168000	138,8	-189,5	
1169000	137,0	-188,3	
1170000	135,8	-187,8	
1171000	134,1	-187,3	
1172000	133,7	-186,6	
1173000	133,8	-186,0	
1174000	132,9	-186,6	
1175000	133,3	-185,4	
1176000	131,3	-183,4	
1177000	129,7	-184,7	
1178000	130,6	-184,5	
1179000	129,0	-183,2	
1180000	127,8	-181,5	
1181000	129,7	-182,7	
1183000	127,6	-180,5	
1184000	126,6	-179,7	
1185000	125,2	-179,9	
1186000	124,4	-178,9	
1187000	125,6	-179,9	
1188000	121,9	-178,7	Little deviation from value in drawing (second measurement)
1189000	121,3	-178,3	
1190000	121,9	-178,2	
1191000	122,5	-175,6	
1192000	120,0	-176,2	
1193000	120,4	-174,6	
1194000	119,4	-175,0	
1195000	119,5	-174,6	
1196000	117,4	-172,9	
1197000	119,0	-169,7	
1198000	120,6	-172,2	
1199000	117,8	-173,4	
1200000	115,9	-172,0	
1201000	115,7	-170,7	
1202000	114,3	-171,6	
1203000	113,6	-171,2	
1204000	113,7	-170,0	
1205000	113,3	-169,8	
1206000	113,5	-169,6	
1207000	112,8	-168,5	
1208000	111,2	-167,8	

Smith Chart: Measuring point ML0 in the drawing
51-8900-813-00 WSP_SZOLNOK_ATU_AE05.pdf



3.02 Impedances for 1188 kHz +- 25 kHz at cable output

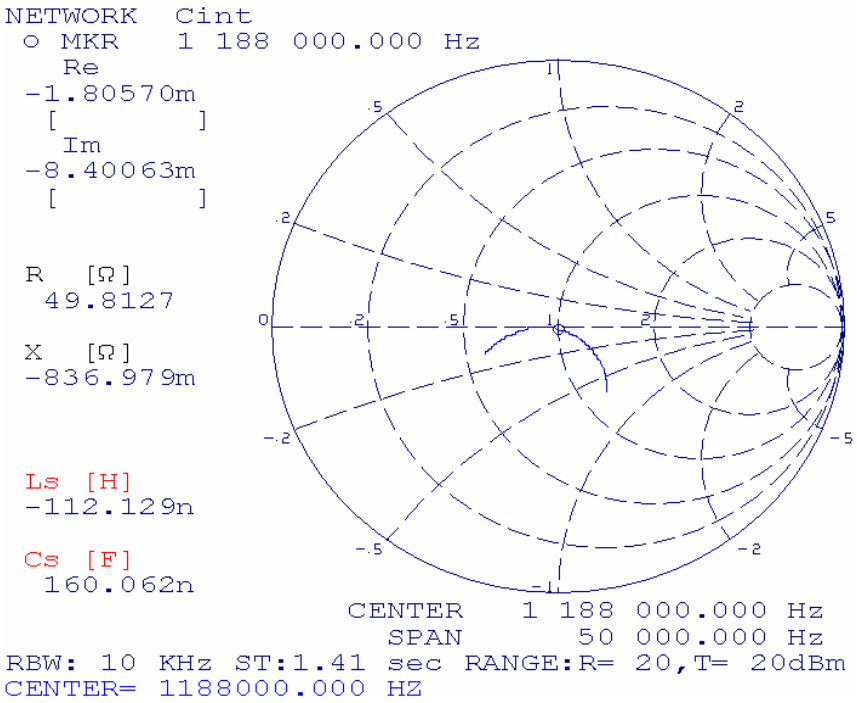
The measured values of impedances for 1188 kHz +- 25 kHz at the cable output are given in the following table and the plot below. (Measuring point M4 in the drawing)

Table:

Frequenz [Hz]	Re{Z_in} [Ω]	Im{Z_in} [Ω]
1163000	29,1	-6,2
1164000	29,7	-5,8
1165000	30,2	-5,3
1166000	30,9	-4,8
1167000	31,4	-4,4
1168000	32,1	-3,9
1169000	32,7	-3,6
1170000	33,4	-3,1
1171000	34,1	-2,7
1172000	34,8	-2,4
1173000	35,5	-2,1
1174000	36,3	-1,7
1175000	37,1	-1,4

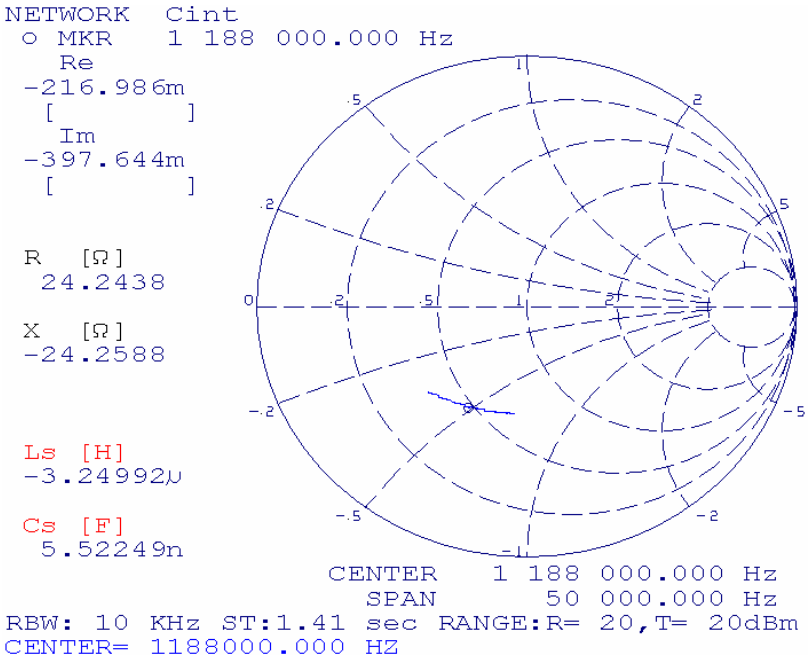
1176000	37,9	-1,1
1177000	38,7	-0,9
1178000	39,6	-0,6
1179000	40,5	-0,5
1180000	41,4	-0,3
1181000	42,3	-0,1
1182000	43,3	0,0
1183000	44,3	-0,1
1184000	45,4	-0,1
1185000	46,5	-0,1
1186000	47,4	-0,2
1187000	48,7	-0,4
1188000	49,8	-0,8
1189000	50,9	-1,1
1190000	52,1	-1,4
1191000	53,2	-2,0
1192000	54,3	-2,6
1193000	55,3	-3,2
1194000	56,5	-3,9
1195000	57,5	-4,8
1196000	58,5	-5,9
1197000	59,6	-7,0
1198000	60,5	-8,1
1199000	61,4	-9,3
1200000	62,2	-10,7
1201000	62,8	-12,1
1202000	63,4	-13,7
1203000	63,9	-15,2
1204000	64,2	-16,9
1205000	64,5	-18,6
1206000	64,7	-20,4
1207000	64,5	-22,1
1208000	64,4	-23,9
1209000	64,0	-25,7
1210000	63,6	-27,5
1211000	62,9	-29,3
1212000	62,0	-31,1
1213000	61,1	-32,7

Smith Chart: measuring point M4 in the drawing
51-8900-813-00 WSP_SZOLNOK_ATU_AE05.pdf

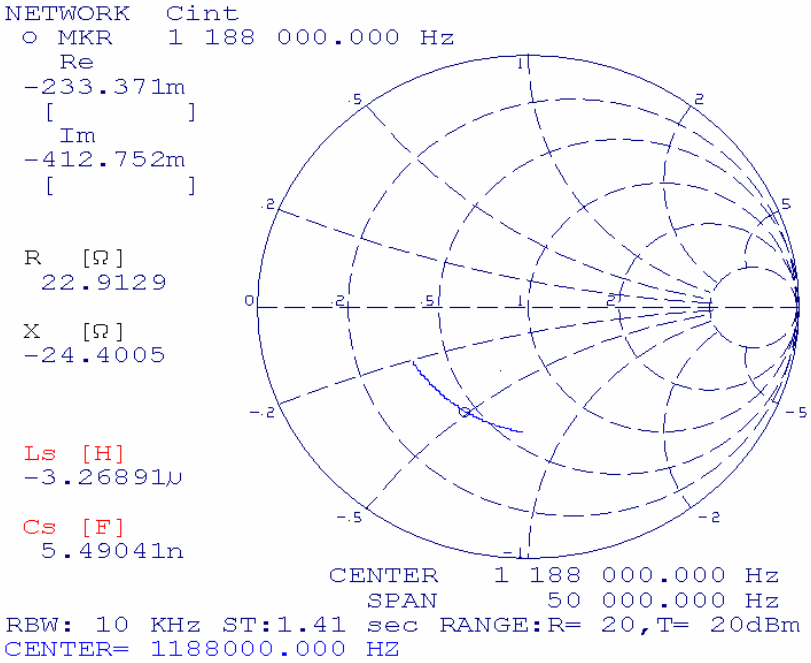


3.03 Impedances for 1188 kHz +- 25 kHz at several measuring points

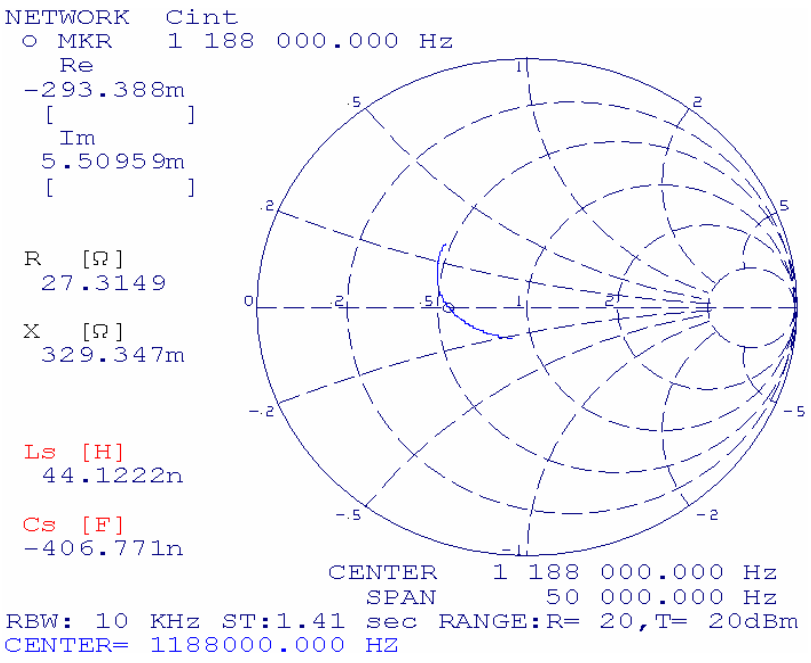
Measuring point MVZ in the drawing
51-8900-813-00 WSP_SZOLNOK_ATU_AE05.pdf



Measuring point MS1B in the drawing
51-8900-813-00 WSP_SZOLNOK_ATU_AE05.pdf



Measuring point MS1C in the drawing
51-8900-813-00 WSP_SZOLNOK_ATU_AE05.pdf



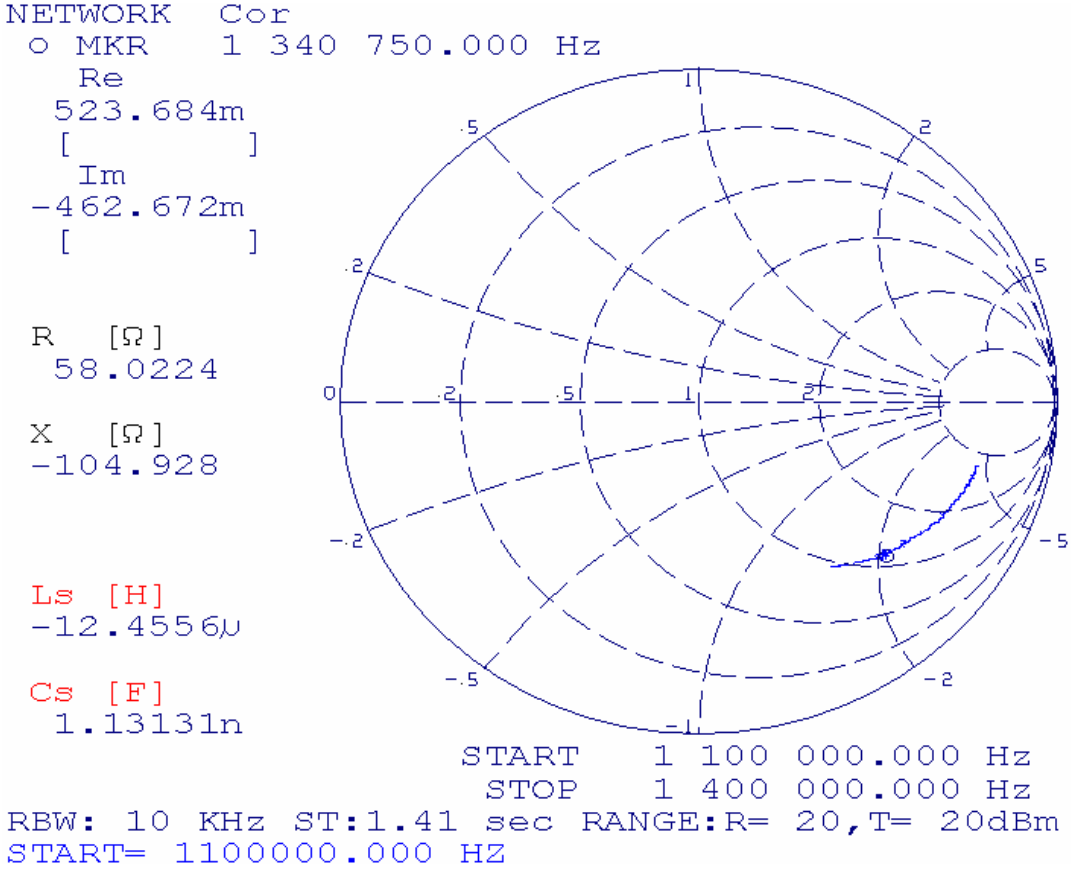
4 Measured values of impedances for 1341 kHz

4.01 Antenna impedances for 1341 kHz +- 20 kHz

The antenna impedance was measured at the grounding switch inside of the antenna hut. The grounding choke was included. (Measuring point ML0 in the drawing)

Frequenz [Hz]	Re{Z_in} [Ω]	Im{Z_in} [Ω]	
1321000	65,43	-112,49	
1322000	64,85	-111,50	
1323000	64,25	-111,06	
1324000	64,03	-110,29	
1325000	64,16	-109,49	
1326000	63,58	-109,27	
1327000	63,43	-109,47	
1328000	63,44	-109,40	
1329000	62,34	-107,82	
1330000	62,51	-107,01	
1331000	61,25	-106,20	
1332000	61,69	-106,59	
1333000	61,55	-106,48	
1334000	61,40	-104,22	
1335000	60,84	-104,24	
1336000	59,50	-104,06	
1337000	58,49	-105,52	
1338000	61,59	-103,94	
1339000	61,37	-102,20	
1340000	60,79	-104,61	
1341000	57,87	-104,38	Little deviation from value in drawing (second measurement)
1342000	56,95	-104,28	
1343000	60,42	-104,86	
1344000	58,68	-100,43	
1345000	58,35	-101,23	
1346000	57,93	-100,50	
1347000	57,50	-99,72	
1348000	57,54	-99,82	
1349000	59,47	-98,79	
1350000	58,21	-98,40	
1351000	57,06	-97,66	
1352000	57,68	-97,66	
1353000	57,20	-96,38	
1354000	56,87	-96,69	
1355000	56,53	-96,17	
1356000	56,39	-96,10	
1357000	55,67	-94,96	
1358000	56,23	-94,87	
1359000	56,09	-94,25	
1360000	55,83	-94,05	
1361000	55,02	-93,18	

Smith chart: measuring point ML0 in the drawing
51-8900-813-00 WSP_SZOLNOK_ATU_AE05.pdf



4.02 Impedances for 1341 kHz +- 25 kHz at cable output

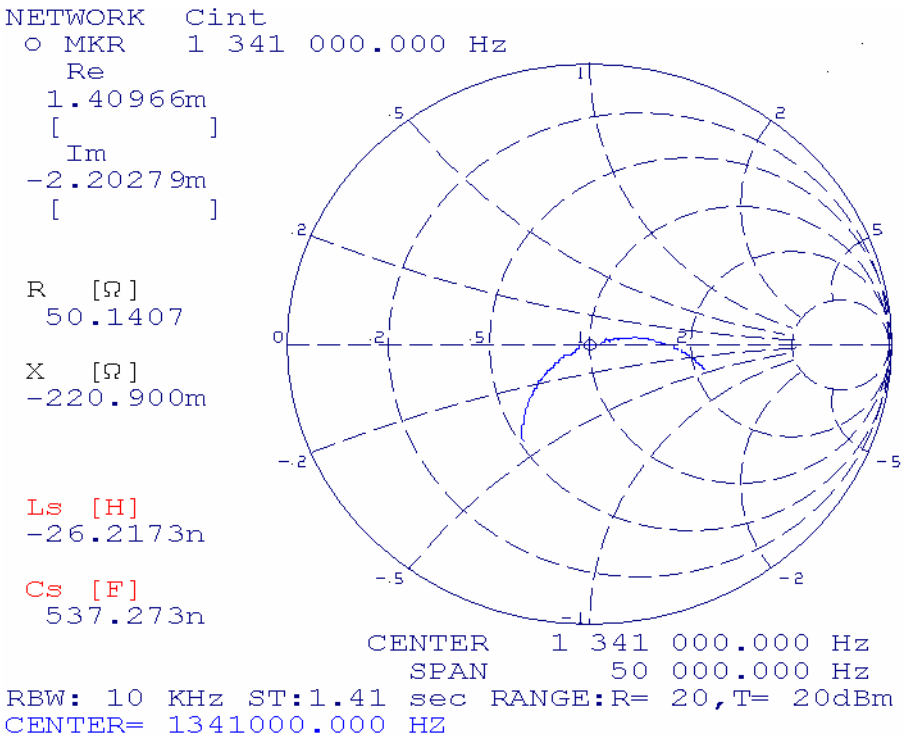
The measured values of impedances for 1341 kHz +- 25 kHz at the cable from the transmitter building are given in the following table and the plot below. (Measuring point M6 in drawing 51-8900-813-00 WSP_SZOLNOK_ATU_AE05.pdf)

Table:

Frequenz [Hz]	Re{Z_in} [Ω]	Im{Z_in} [Ω]
1316000	26,1	-21,0
1317000	26,4	-20,2
1318000	26,9	-19,4
1319000	27,3	-18,6
1320000	27,9	-17,8
1321000	28,4	-16,9
1322000	29,0	-16,0
1323000	29,6	-15,2
1324000	30,3	-14,3
1325000	31,0	-13,4
1326000	31,8	-12,5
1327000	32,7	-11,6
1328000	33,5	-10,7

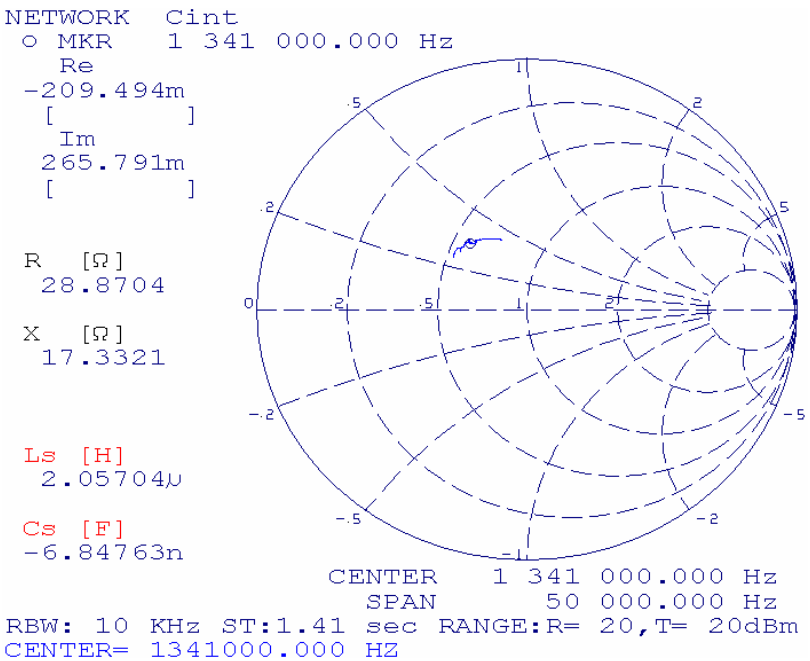
1329000	34,4	-9,7
1330000	35,3	-8,8
1331000	36,2	-8,0
1332000	37,4	-7,0
1333000	38,6	-6,3
1334000	39,6	-5,0
1335000	40,9	-4,3
1336000	41,9	-3,3
1337000	43,7	-3,2
1338000	45,6	-1,8
1339000	47,0	-0,6
1340000	49,0	-0,5
1341000	50,1	-0,2
1342000	51,8	0,3
1343000	54,8	1,2
1344000	55,9	2,1
1345000	58,4	2,4
1346000	60,1	2,5
1347000	61,9	2,8
1348000	64,8	3,2
1349000	67,1	4,0
1350000	69,4	3,6
1351000	71,8	3,2
1352000	74,3	3,2
1353000	77,0	2,6
1354000	79,7	1,9
1355000	82,5	1,2
1356000	85,0	0,1
1357000	87,8	-1,0
1358000	90,4	-2,5
1359000	93,1	-4,2
1360000	95,8	-6,0
1361000	98,1	-8,4
1362000	100,5	-10,6
1363000	102,8	-13,2
1364000	104,7	-16,0
1365000	106,4	-19,0
1366000	108,0	-22,1

Smith chart: Measuring point M6 in drawing
51-8900-813-00 WSP_SZOLNOK_ATU_AE05.pdf

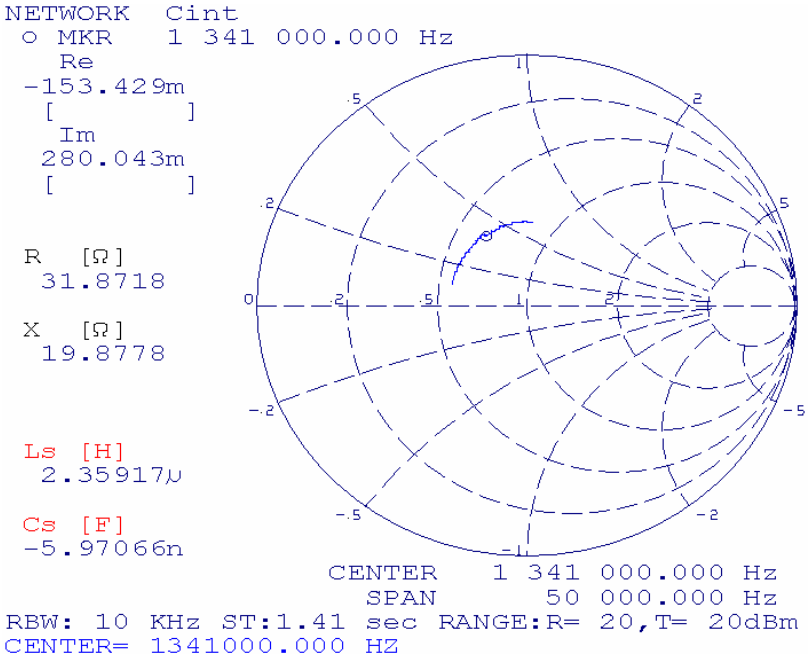


4.03 Impedances for 1341 kHz +- 25 kHz at several measuring points

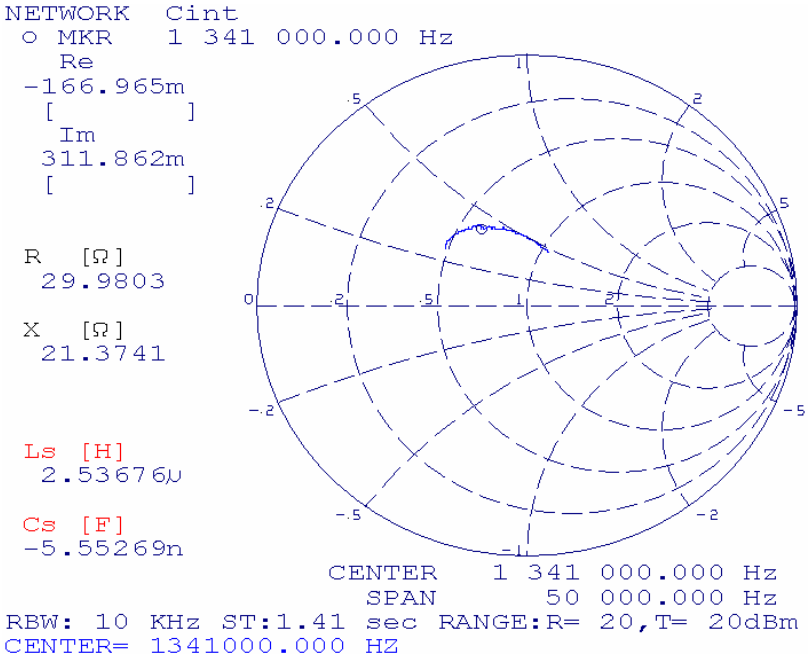
Measuring point MVZ in the drawing
51-8900-813-00 WSP_SZOLNOK_ATU_AE05.pdf



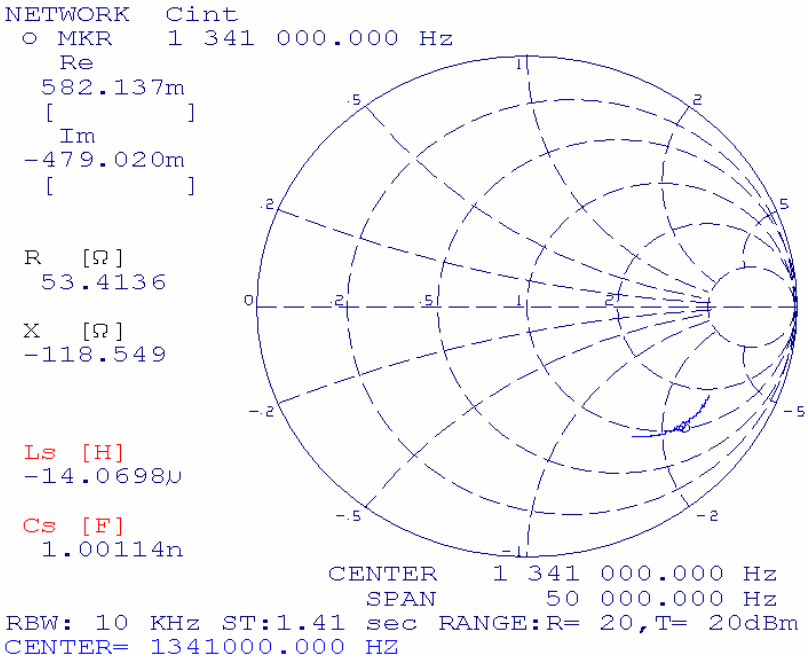
Measuring point MS3B in the drawing
51-8900-813-00 WSP_SZOLNOK_ATU_AE05.pdf



Measuring point MS3C in the drawing
51-8900-813-00 WSP_SZOLNOK_ATU_AE05.pdf



Measuring point MS3D in the drawing
51-8900-813-00 WSP_SZOLNOK_ATU_AE05.pdf



5 Coils and condensors, operational settings

Coils in alphabetic order:

coil	D/mm	d/mm	windings total	windings active
L0 grounding choke				all
L1	450	42	7	4,7
L2	450	42	7	3,2

L11A	450	42	7	7 (complete)
L11B	450	42	7	5,065
L12P	300	28	5	3,3
L12S	300	28	16	11,75
L13	450	35	11	2,4
L14	300	28	16	2,25

L21P	450	42	7	4,3
L21SA	450	42	7	5,35
L21SB	450	42	7	5,3
L22S	450	35	11	7,75
L23	450	42	7	4,8
L24	450	42	7	5,5

Condensors in alphabetic order:

C1	pF	pF	pF
	top		
	three columns in parallel		
	seven rows in series		
	3000	3000	1000
	3000	3000	1000
	3000	3000	1000
	3000	3000	1000
	3000	3000	1000
	3000	3000	1000
		3000	1000
	bottom		
	Total :	**903.2 pF**	

C11S	pF	pF	pF	pF	pF	pF	pF
	top						
	seven columns in parallel						
	eight rows in series						
	1000	1000	1000	1000	1000	1000	1000
		1000	1000	1000	1000	1000	1000
		1000	1000	1000	1000	1000	1000
		1000	1000	1000	1000	1000	1000
		1000	1000	1000	1000	1000	1000
		1000	1000	1000	1000	1000	1000
	1000	1000	1000	1000	1000	1000	1000
	bottom						
	Total :	**778 pF**					

C11P	pF	pF	pF	pF	pF	pF	pF
	top						
	seven columns in parallel						
	two rows in series						
	1000	1000	1000	1000	1000	1000	400
		1000	1000	1000	1000	1000	
	bottom						
	Total :	**3077 pF**					

C12S	pF	pF	pF	pF	pF
	top				
	five columns in parallel six rows in series				
	1000 1000	1000 1000	1000 1000	1000 1000	1000 1000
	1000 1000	1000 1000	1000 1000	1000 1000	1000 1000
	1000 1000	1000 1000	1000 1000	1000 1000	1000 1000
	bottom				
	Total :	**833 pF**			

C13	pF	pF	pF
	top		
	three columns in parallel two rows in series		
	3000 3000	3000 1000	1000 1000
	bottom		
	Total :	**2917 pF**	

Condensors (continued):

C21S	pF	pF	pF	pF	pF	pF	pF
	top						
	seven columns in parallel nine rows in series						
	1000	1000 1000	1000 1000	1000 1000	1000 1000	1000 1000	1000 1000
		1000 1000	1000 1000	1000 1000	1000 1000	1000 1000	1000 1000
		1000 1000	1000 1000	1000 1000	1000 1000	1000 1000	1000 1000
		1000 1000	1000 1000	1000 1000	1000 1000	1000 1000	1000 1000
		1000	1000	1000	1000	1000	1000
	bottom						
	Total :	**778 pF**					

C22P	pF	pF	pF	pF	pF	pF	pF
	top						
	seven columns in parallel two rows in series						
	1000 1000	1000 1000	1000 1000	1000 1000	1000 1000	1000 1000	1000 1000
	bottom						
	Total :	**3500 pF**					

C22S	pF	pF	pF	pF	pF	pF
	top					
	six columns in parallel six rows in series					
	1000 1000	1000 1000	1000 1000	1000 1000	1000 1000	1000 1000
	1000 1000	1000 1000	1000 1000	1000 1000	1000 1000	1000 1000
	1000 1000	1000 1000	1000 1000	1000 1000	1000 1000	1000 1000
	bottom					
	Total :	**1000 pF**				

C24	pF	pF	pF	pF	pF	pF
	top					
	six columns in parallel three rows in series					
	1000 1000	1000 1000	1000 1000	1000 1000	1000 1000	1000 1000
		1000	1000	1000	1000	1000
	bottom					
	Total :	**1875 pF**				

C25	pF	pF	pF
	top		
	three columns in parallel three rows in series		
	1000 1000 1000	1000 1000 1000	1000 400 1000
	bottom		
	Total :	**923 pF**	

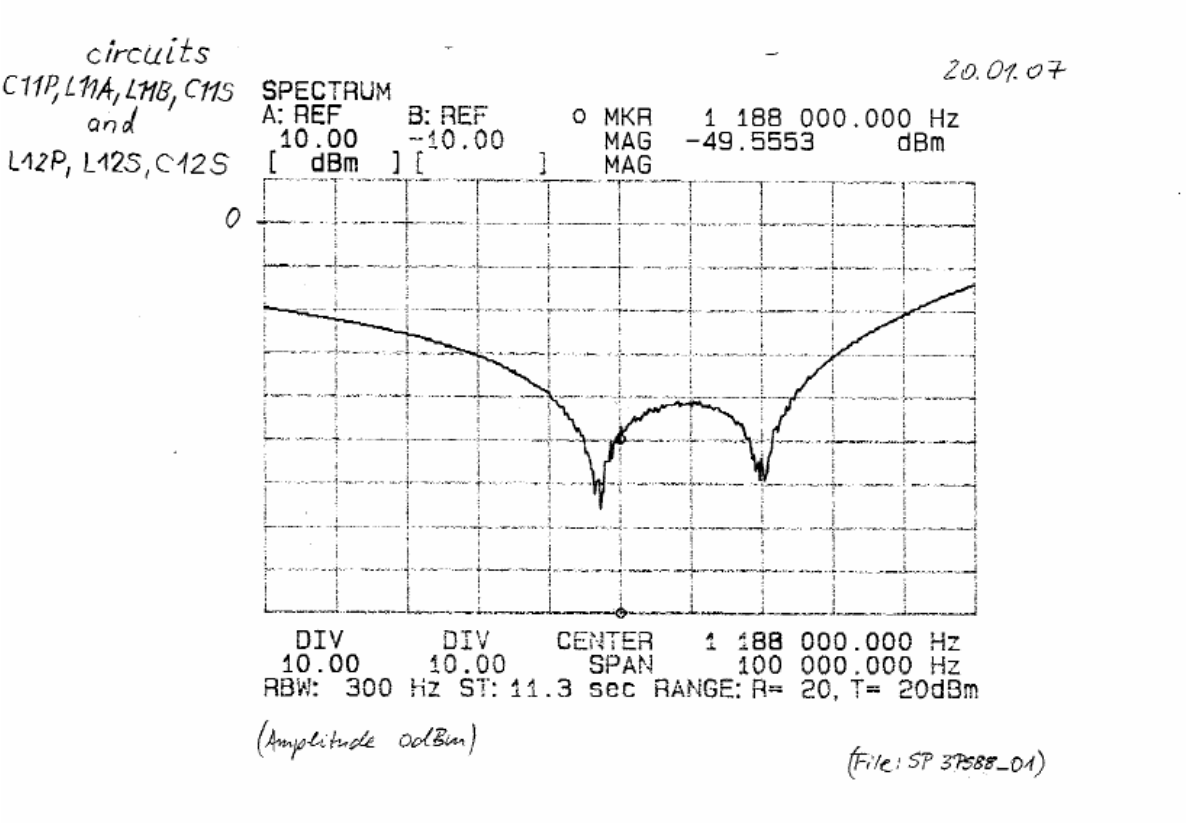
6 Decoupling by filters

The measurement of the following filters has been carried out:

- **Filters for fo = 1188 kHz**

Tuning elements L21 in parallel C21S, L21SA, and L21SB as rejection filter and L22S in series C22S as drain filter

Transmission measurement was carried out between measuring points MVZ and MS3C. MVZ and MS3C are open and disconnected from the other tuning elements.

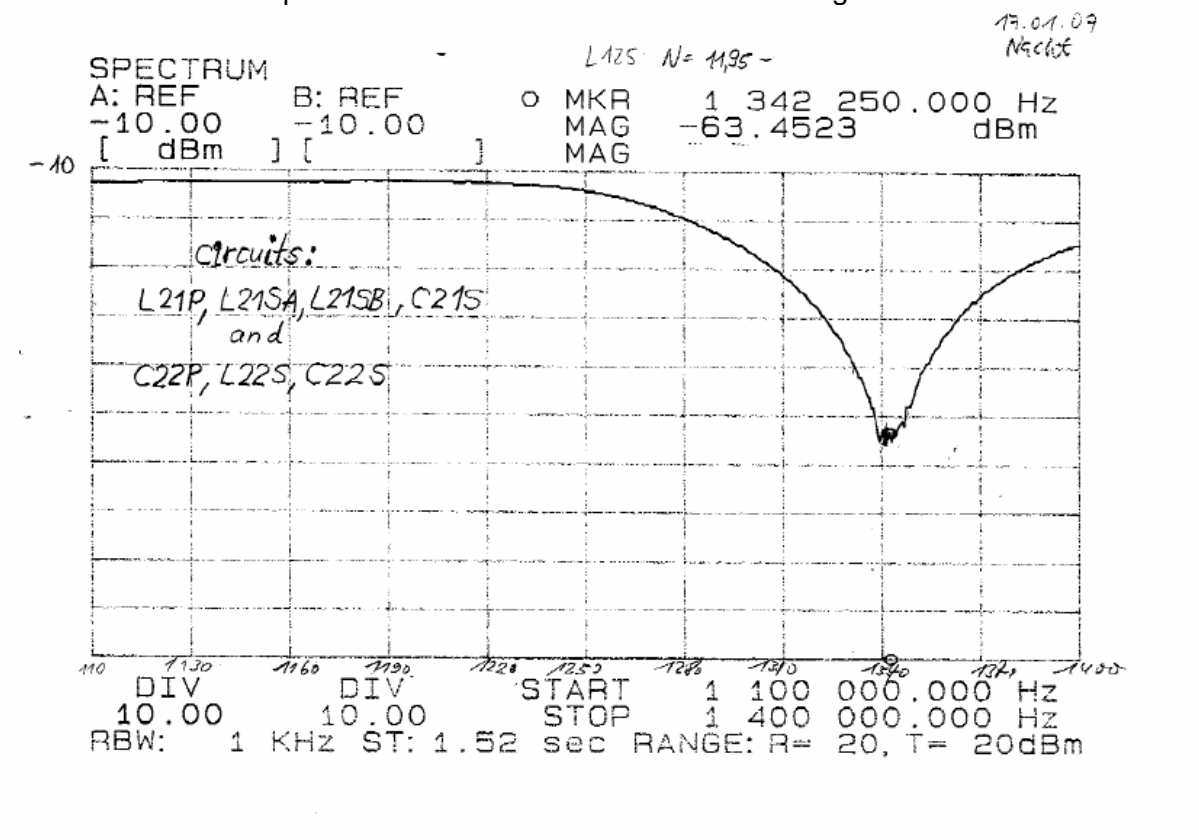


The same document is given as file “Filter fo=1188 kHz.pdf” in the appendix (2).

- **Filters for fo = 1341 kHz**

Tuning elements C11P in parallel C11S, L11A, and L11B as rejection filter and L12S in series C12S as drain filter

Transmission measurement was carried out between measuring points MVZ and MS1C. MVZ and MS1C are open and disconnected from the other tuning elements.



The same document is given as file “Filter fo=1341 kHz.pdf” in the appendix (3).

7 Spark gaps

The setting of the spark gaps:

Spark gap	sphere diameter mm	Spacing mm
F1 base of mast	80	50
F1A Austin transformer	80	50
F2 feed through insulator	50	40
F10 cable 1188 kHz	50	20
F20 cable 1341 kHz	50	20

8 Measuring instruments

The equipment of TRANSRADIO consists of:

Network- Analyzer:	HP 4195A
Directional coupler :	TELEFUNKEN/TRANSRADIO
Amplifier:	EIN Model A150
Plotter:	HP Color Pro

9 Appendixes

Anlage	Document	Pdf- file	Contents
1	Dwg. 51-8900-813-00 WSP	51-8900-813-00 WSP_SZOLNOK_ATU_AE05.pdf	Design of diplexer Operational values
2	Plot	Filter fo=1188 kHz.pdf	Attenuation by filter
3	Plot	Filter fo=1341 kHz.pdf	Attenuation by filter