

HF/50MHz Receiving and Transmitting Band Pass Filters with 3 Equal Inductors –part3

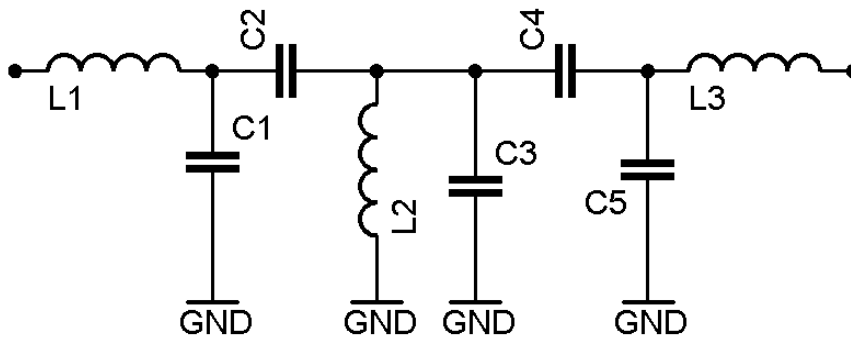
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I designed and realized a lot different types filters. Starting SDR design the new moments for me was that it is necessary to have band-pass (BP) filters which can be used in receiving and transmitting paths. This series of 4-5 articles are my research how to do and solve these requirements at the best and simple way. Different filters in other parts are results of some transformation delta to tee and vice versa and different schematics approach. I added some files from simulation in LT Spice [2] freeware software also to see voltage in all nodes to be aware C component quality from break voltage and current point of view. All components are taken in analyses with real losses. The designer's target specification at the start was:

1. Filters have IL(insertion loss) lower than 0.5dB (~11% power loss with inductors $Q_o \sim 150-200$)
2. All filter components values have to be standard values.
3. Coils are without taps!
4. Inductors can be changed with RF chokes than filter IL have to be smaller than 2dB.
5. Termination return loss S11, S22 are better than -20dB (VSWR=1.22).
6. Frequencies harmonically related to central frequency from lower and upper side are attenuated ~30dB or more.
7. BP filters have 50Ohms termination impedance and filters are symmetrical structure. It is not important what is input or output.
8. Calculated bandwidth -3dB is 10-25% of central frequency.
9. No tune design and design with low sensitivity to component tolerances

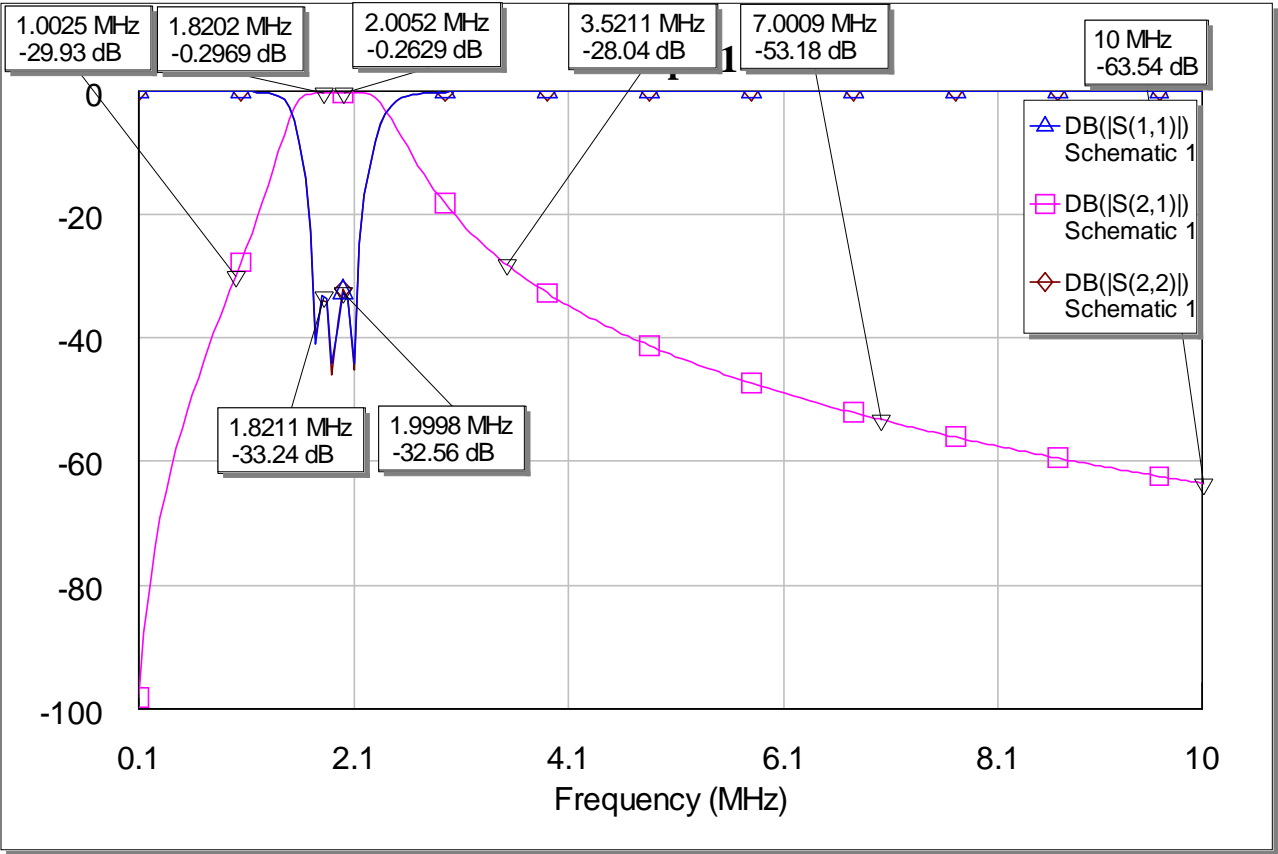
The third BP filter is realized like it is proposed at picture 1 down. This filters I saw in article from Werner DC4KU German's HAM few years ago and when I checked possibility of this design I was pleasantly surprised. It is L section matching to the capacitive coupled resonator. This type of filter has very good RF performances and it is good for cascading without parasitic pass-bands. I proposed some similar solution in article BP for MULTI/MULTI contest stations.



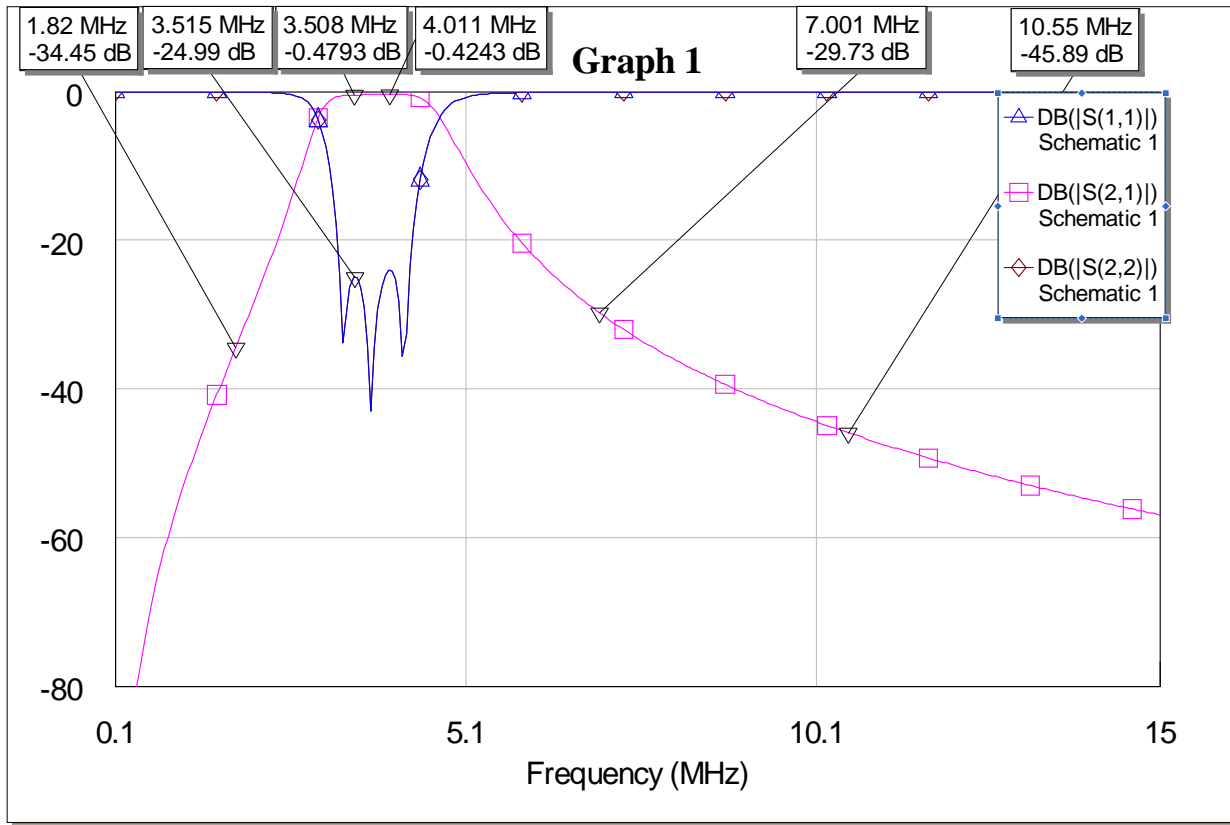
HF/50MHZ band-pass filter ver3 YU1LM

OPSEG	L1,L2,L3	C2,C4	C1,C5	C3
1.8 MHz	10uH	220 pF	470 pF	390 pF
3.5 MHz	5.6 uH	100 pF	220 pF	180 pF
7 MHz	3.3 uH	47 pF	120 pF	100 pF
10.1 MHz	2.2 uH	33 pF	82 pF	68 pF
14 MHz	1.5 uH	18 pF	56 pF	47 pF
18-21 MHz	0,82 uH	27 pF	47 pF	39 pF
24-30 MHz	0.68 uH	18 pF	33 pF	27 pF
50 MHz	0.39 uH	8.2 pF	18 pF	15 pF

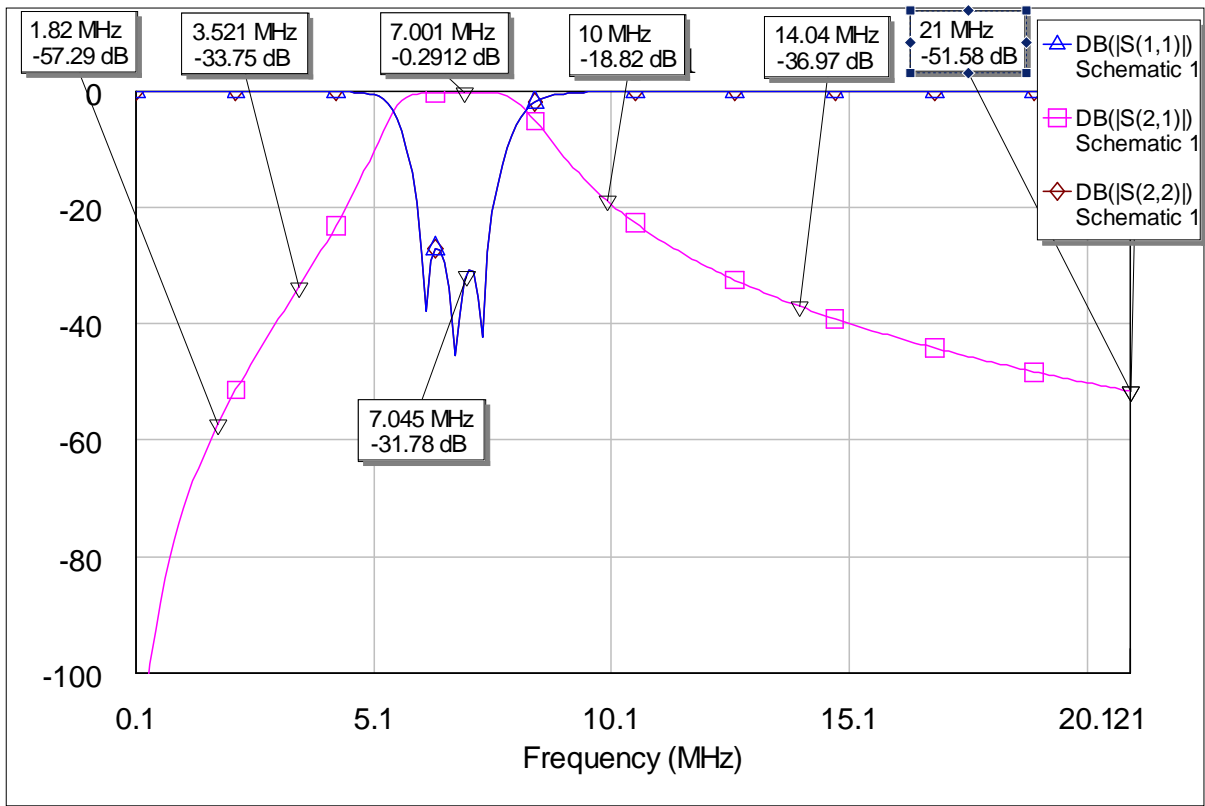
Table1. Element values for BP filters ver3



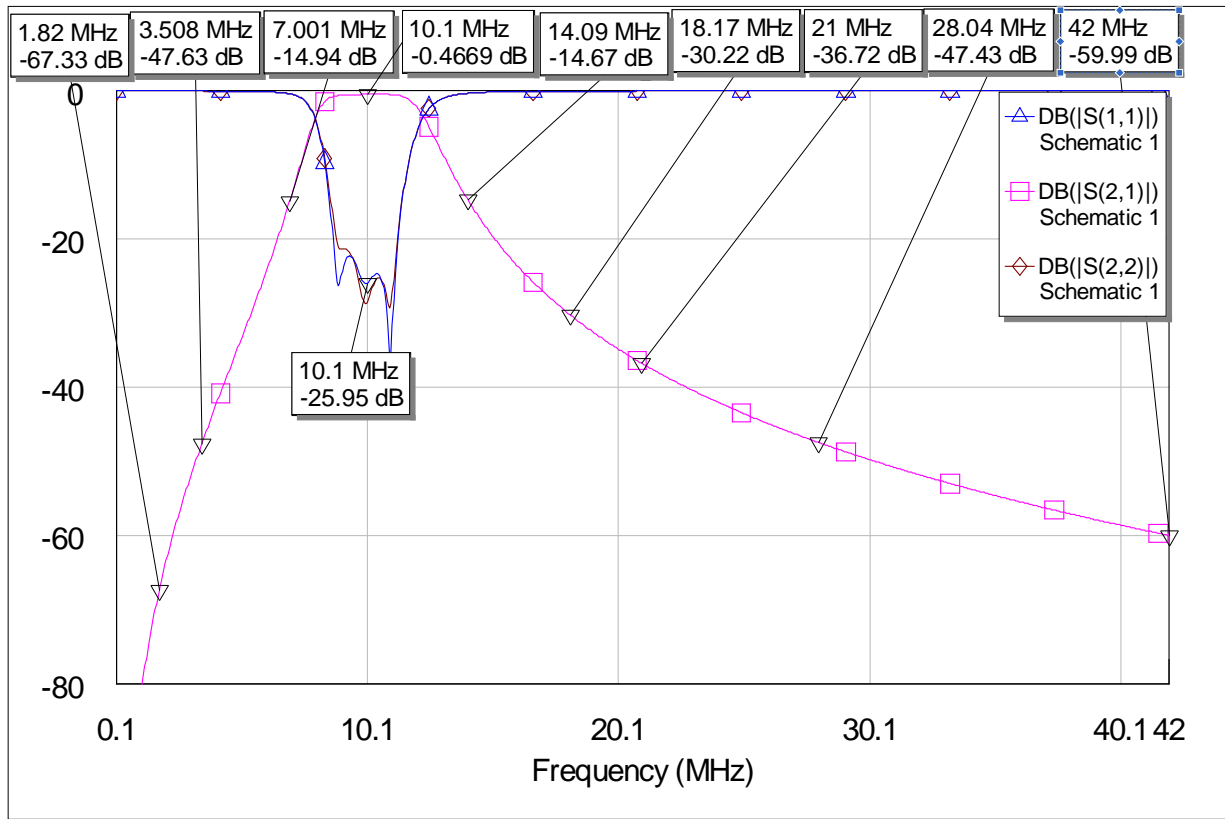
BP for 1.8MHz



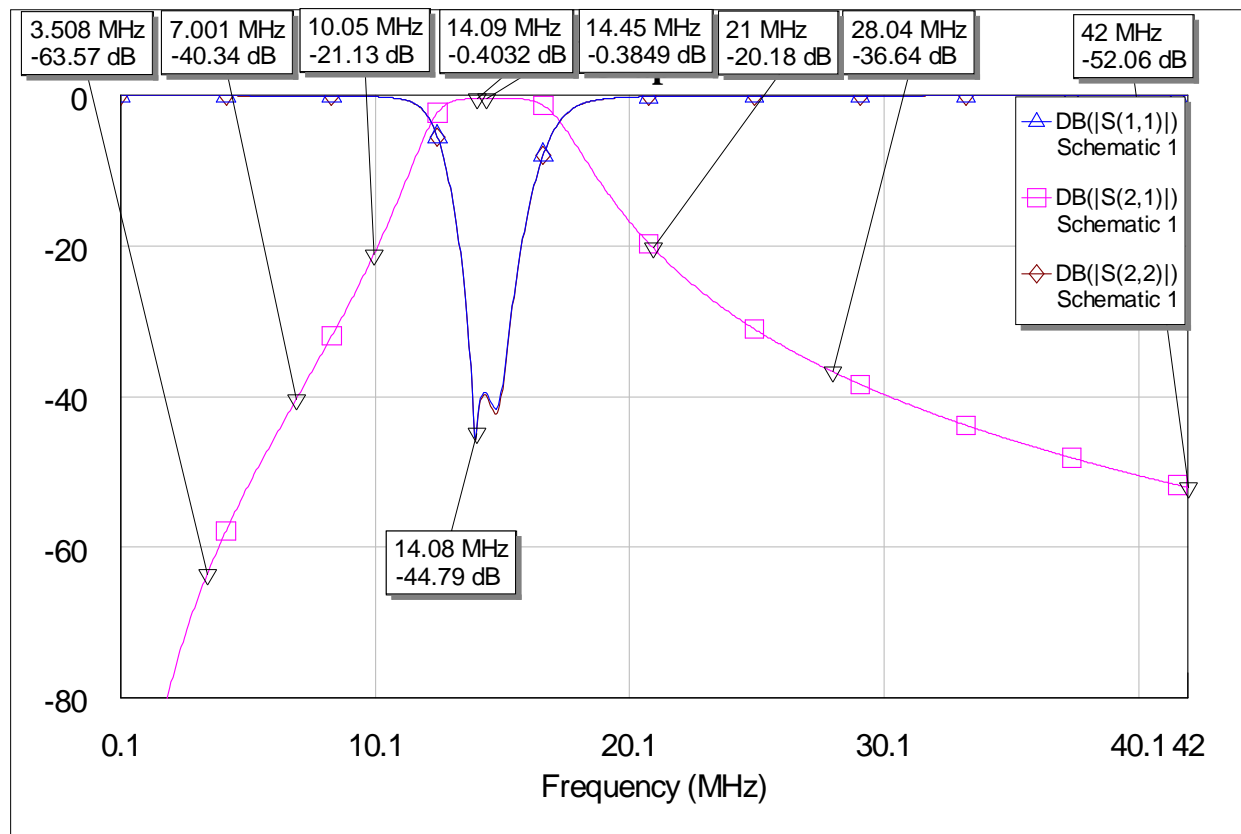
BP for 3.5MHz



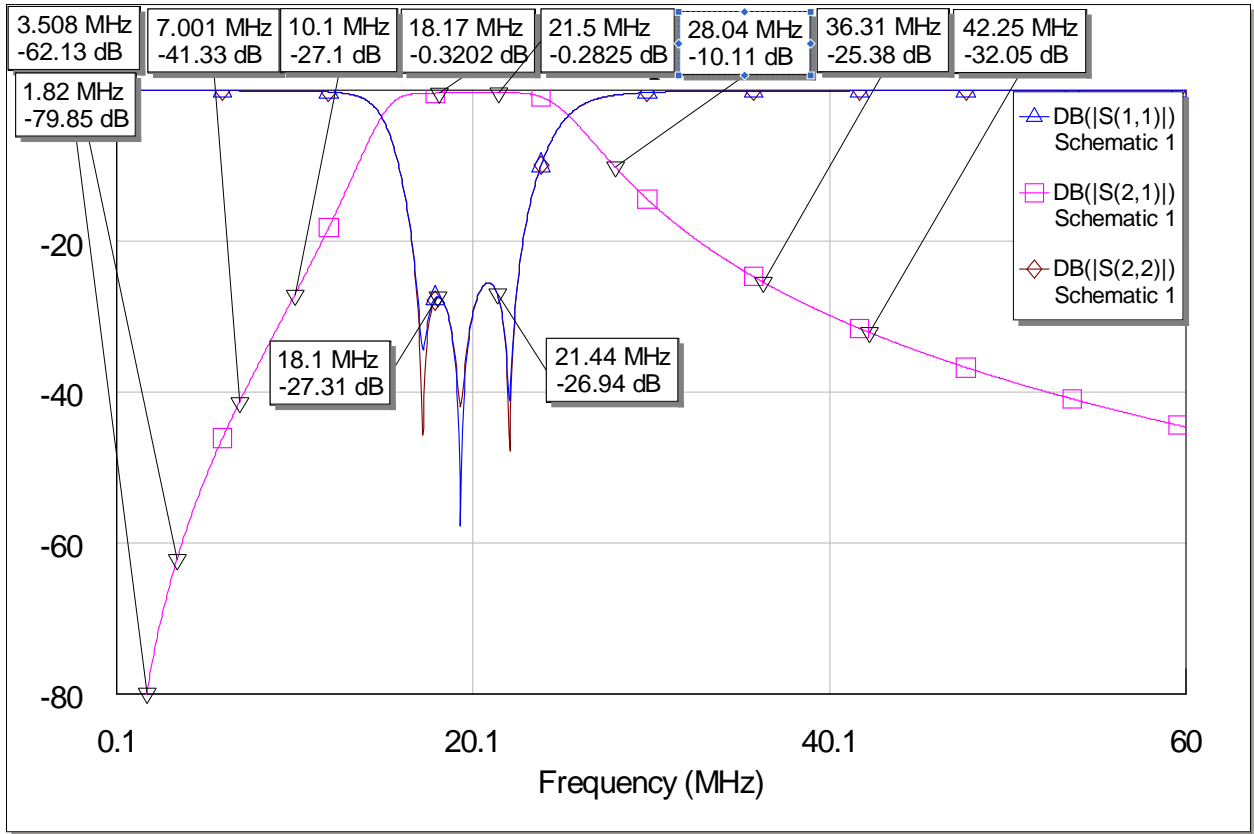
BP for 7MHz



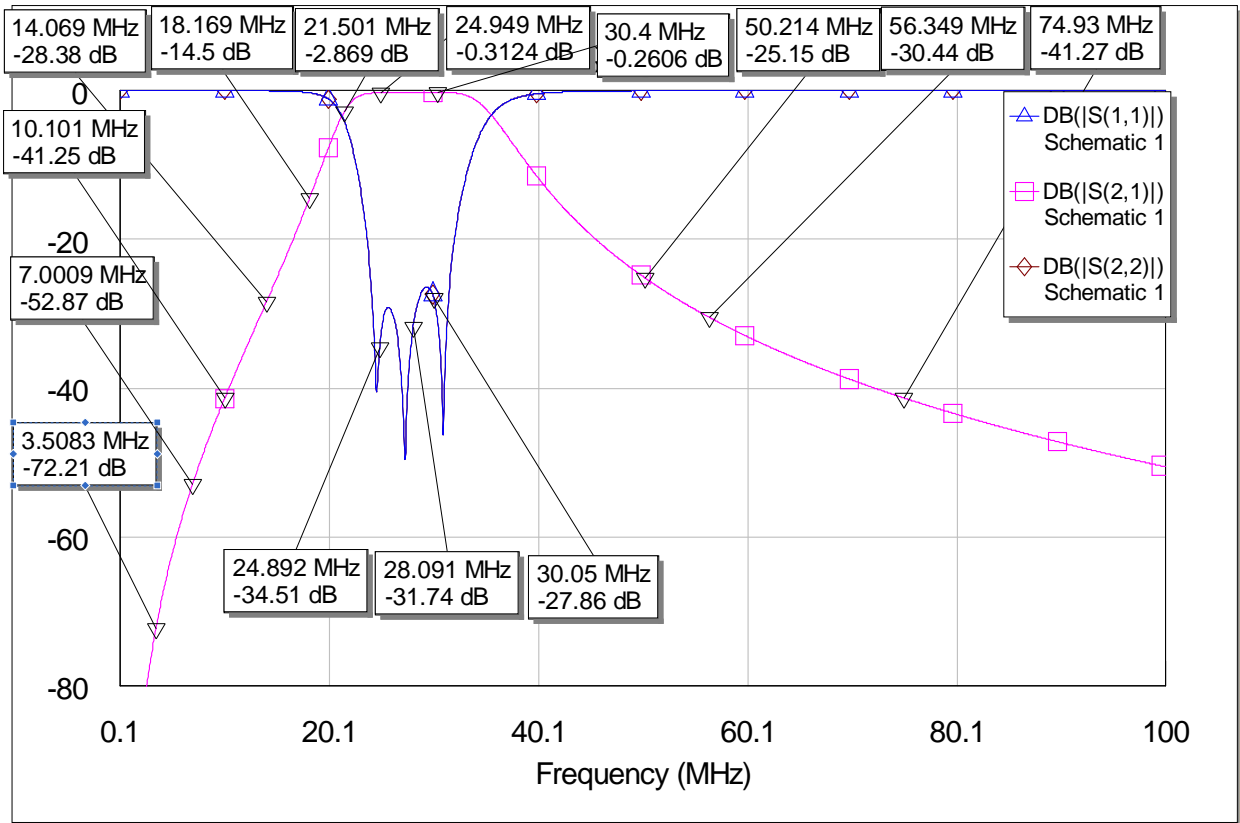
BP for 10MHz



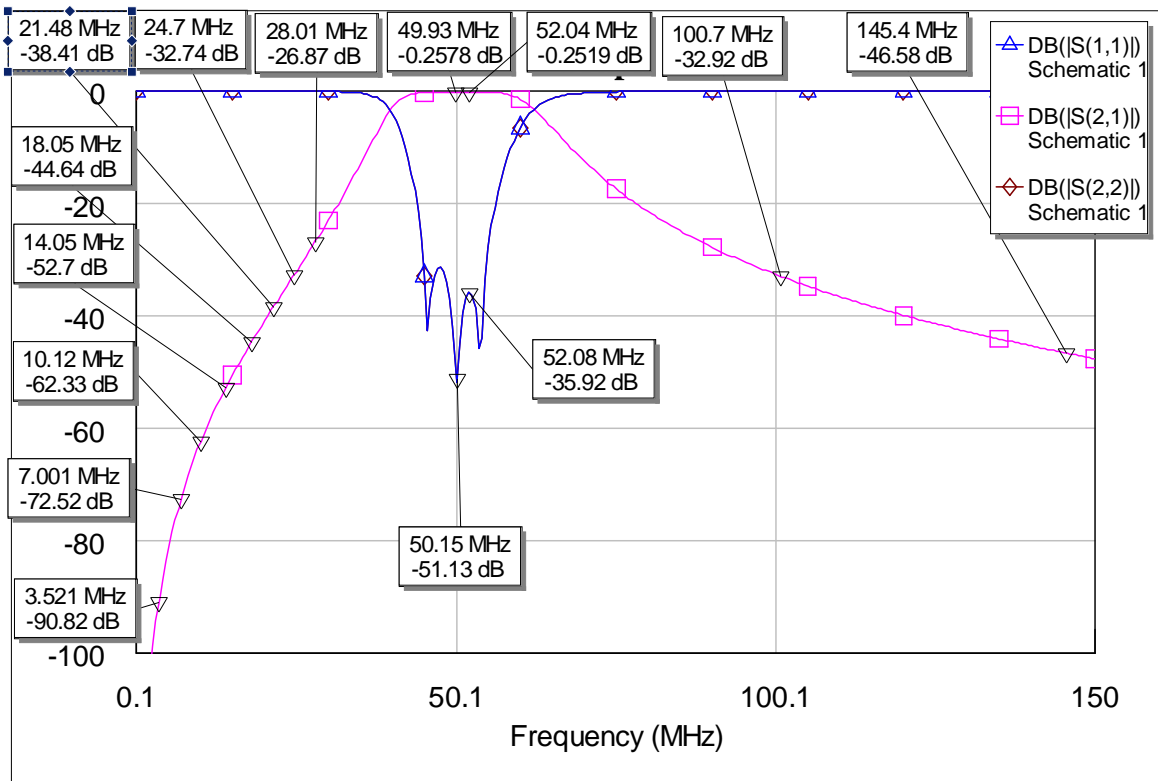
BP for 14MHz



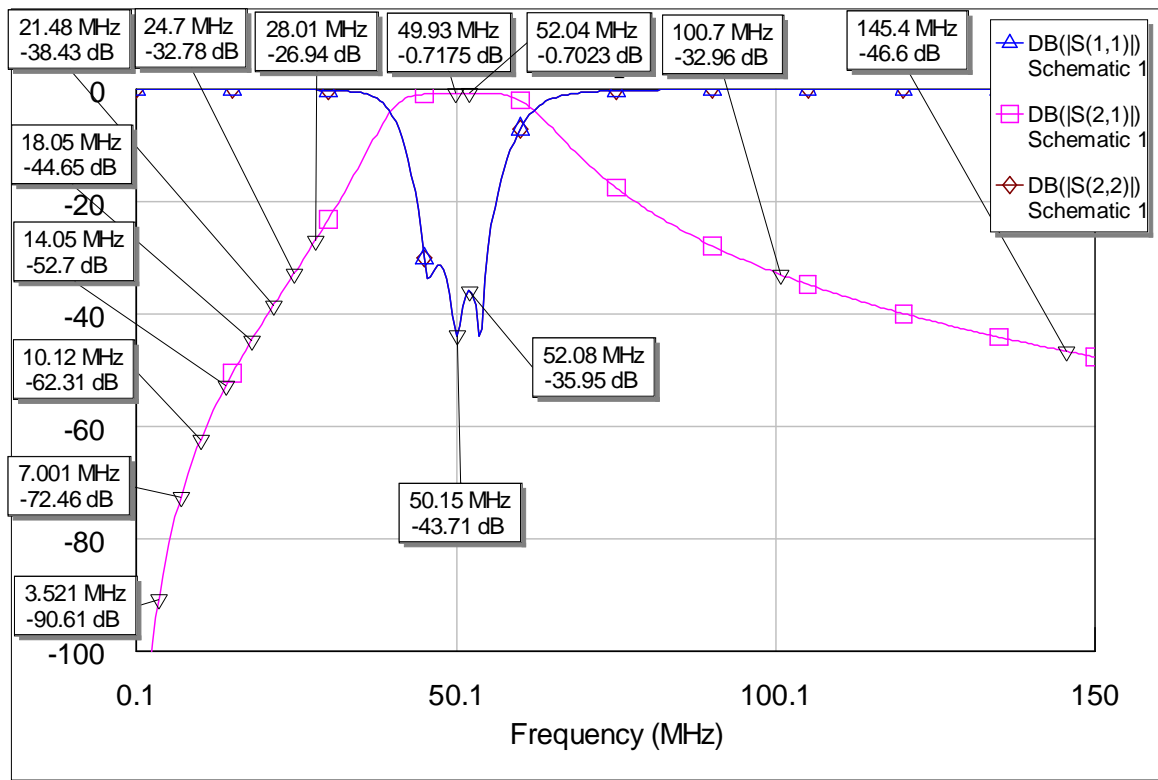
BP for 18-21MHz



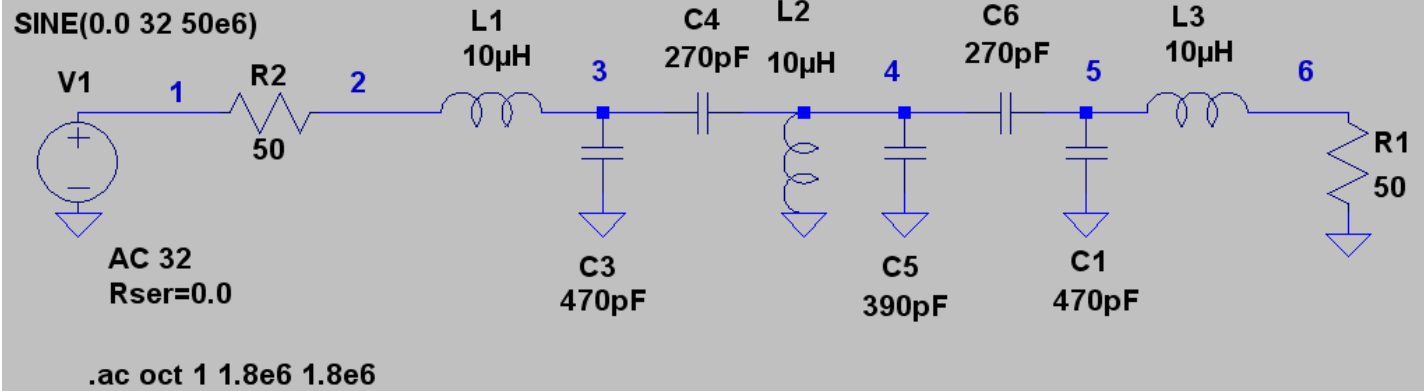
BP for 24-30MHz



BP for 50MHz



BP Filter for 50MHz ver1 high Q inductors were changed with choke $Q_0 \sim 60$. BP IL is increasing for 0.5dB (use only in receiving part)



TX=100W VSWR=1.0 voltage magnitude in [V] and current in [A] peak

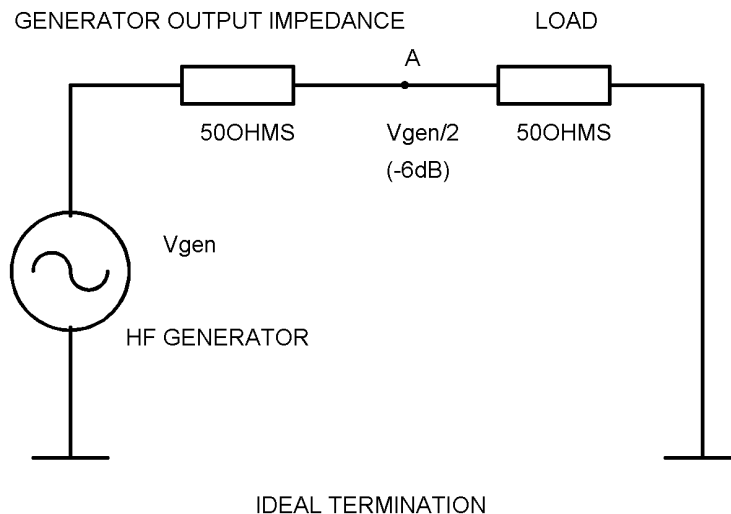
frequency:	1.8e+006	Hz			
V(n003):	mag:	250.48	phase:	-65.1063°	voltage
V(n004):	mag:	276.229	phase:	5.99951°	voltage
V(n002):	mag:	100.538	phase:	-1.24064°	voltage
V(n005):	mag:	247.244	phase:	79.4299°	voltage
V(n006):	mag:	99.9715	phase:	13.2804°	voltage
V(n001):	mag:	200	phase:	-2.54444e-016°	voltage
I(C1):	mag:	1.31424	phase:	169.43°	device_current
I(C6):	mag:	0.958269	phase:	46.9608°	device_current
I(C5):	mag:	1.21839	phase:	-84.0005°	device_current
I(C4):	mag:	0.937382	phase:	-33.4664°	device_current
I(C3):	mag:	1.33145	phase:	-155.106°	device_current
I(L3):	mag:	1.99943	phase:	13.2804°	device_current
I(L2):	mag:	2.4424	phase:	96°	device_current
I(L1):	mag:	1.99019	phase:	1.25346°	device_current
I(R2):	mag:	1.99019	phase:	-178.747°	device_current
I(R1):	mag:	1.99943	phase:	13.2804°	device_current
I(V1):	mag:	1.99019	phase:	-178.747°	device_current

TX=5W VSWR=1.0 voltage magnitude in [V] and current in [A] peak

frequency:	1.8e+006	Hz			
V(n003):	mag:	56.3581	phase:	-65.1063°	voltage
V(n004):	mag:	62.1515	phase:	5.99951°	voltage
V(n002):	mag:	22.621	phase:	-1.24064°	voltage
V(n005):	mag:	55.6299	phase:	79.4299°	voltage
V(n006):	mag:	22.4936	phase:	13.2804°	voltage
V(n001):	mag:	45	phase:	-1.41358e-016°	voltage
I(C1):	mag:	0.295705	phase:	169.43°	device_current
I(C6):	mag:	0.21561	phase:	46.9608°	device_current
I(C5):	mag:	0.274137	phase:	-84.0005°	device_current
I(C4):	mag:	0.210911	phase:	-33.4664°	device_current
I(C3):	mag:	0.299575	phase:	-155.106°	device_current
I(L3):	mag:	0.449872	phase:	13.2804°	device_current
I(L2):	mag:	0.54954	phase:	96°	device_current
I(L1):	mag:	0.447793	phase:	1.25346°	device_current
I(R2):	mag:	0.447793	phase:	-178.747°	device_current
I(R1):	mag:	0.449872	phase:	13.2804°	device_current
I(V1):	mag:	0.447793	phase:	-178.747°	device_current

Tables are taken from LTspice CAD simulation BP filter for 1.8MHz. Little explanation of picture ideal voltage generator have output impedance zero at HF systems output impedance is 50ohms and load is also 50 Ohms in ideal case that mean that we are losing half voltage (-6dB) in transfer from ideal generator to ideal load VSWR=1.0

Notice at diagram that it is difference between input port 2 and critical nodes 3 2,5 times but most critical is. In case normal HF/VHF RIG with power amplifier $P_{out}=100W=50dBm$ $V_{eff}=70.1V$ and peak value is $V_{peak}=100V$. Built in capacitors have to be with breaking voltage of min 300V. In the case QRP power amplifier $P_{out}=5W=37dBm$ $V_{eff}=15.83V$ or $V_{peak}=22.5V$. Built in capacitors for QRP output power have to be with minimum breaking voltage of 100V and this is quite different compared with classic LP low pass in power amplifiers!!!! For classic solution with LP and for QRP output power it is enough build in capacitors with breaking voltage of 50V!!! All this observations and calculations are valid OK if we have acceptable VSWR up to VSWR=2. With VSWR over 3 capacitors must be with higher breaking voltage specification for 100W 500V and for QRP powers 200V!



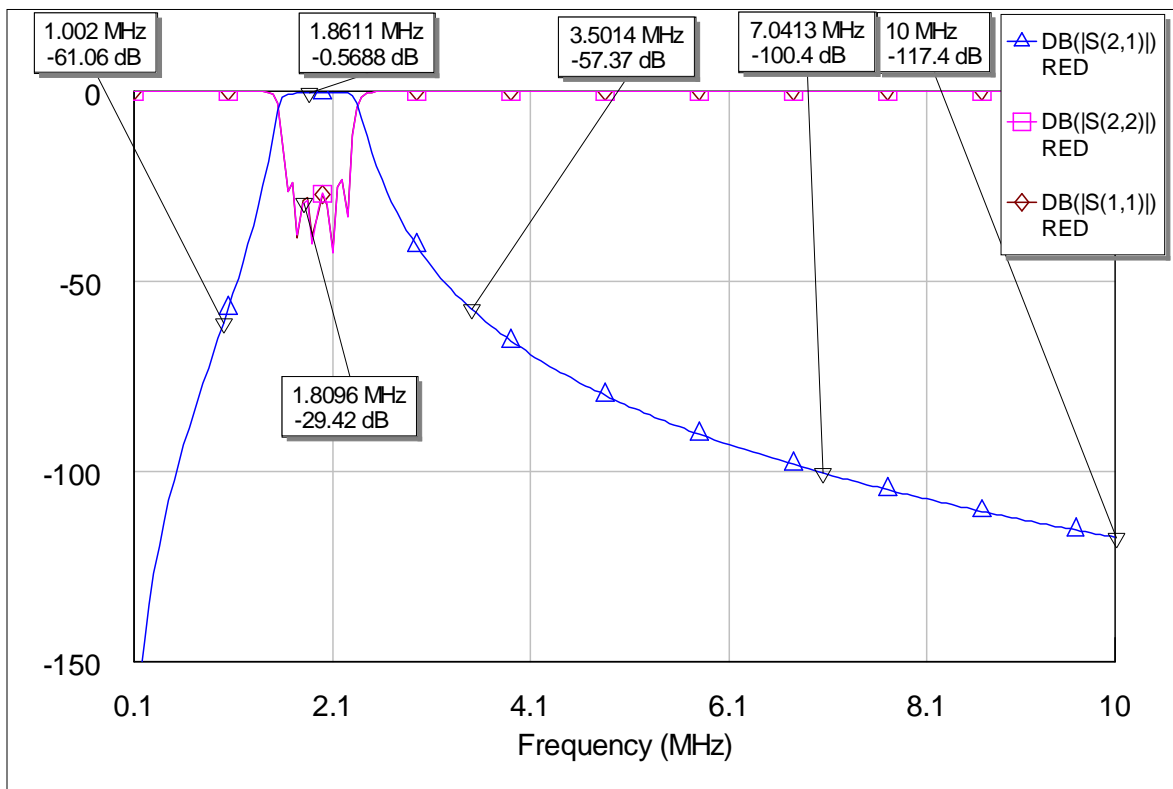
WARNING!

All built in components have to be adequate quality very high Q. This mean that capacitors have adequate breaking voltages, high current and that ring cores are from adequate RF materials for used frequency and square surface for used output power to avoid filter destruction or equipment damages. About selection component for high power RF BP filters please read article [4, 5] from well known filter designer expert Ed W3NQN.

I am using very good freeware software from Wilfried DL5SWB for ring and air coils turns calculation [3]. Fine inductance adjustment for better SWR is possible with squeezing or unfolding wire turns on ring before fixing with small quantity of glue or silicon.

My proposal for BP realization is usage better SMD porcelain capacitors from ATC [7]. These capacitors have extremely good performances for HF /VHF /UHF bands in high power filters/amplifiers. Only small disadvantage is price but all other things are better than with high performances classic capacitors. Also this capacitors enable calculation predictable realization at higher frequencies (21MHz and up) which isn't common case with capacitors with leads.

If we are cascading two equal filters for example filters for band 1,8MHz we can expect next frequency response from that new filter picture down. These types of filter are generally very good choice for cascading without parasitic pass bands.



Two equal BP for 1.8MHz cascaded, very good performance without parasitic band-passes.

I wish you successful BP realization and I apologize for some possible mistakes. I made great effort to share my projects with all who are interesting for. Anyway, send me your comments positive or negative, results or photos of your realization are welcome.

July 2008

VY 73/72 and GL in homebrew Tasa YU1LM/QRP

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