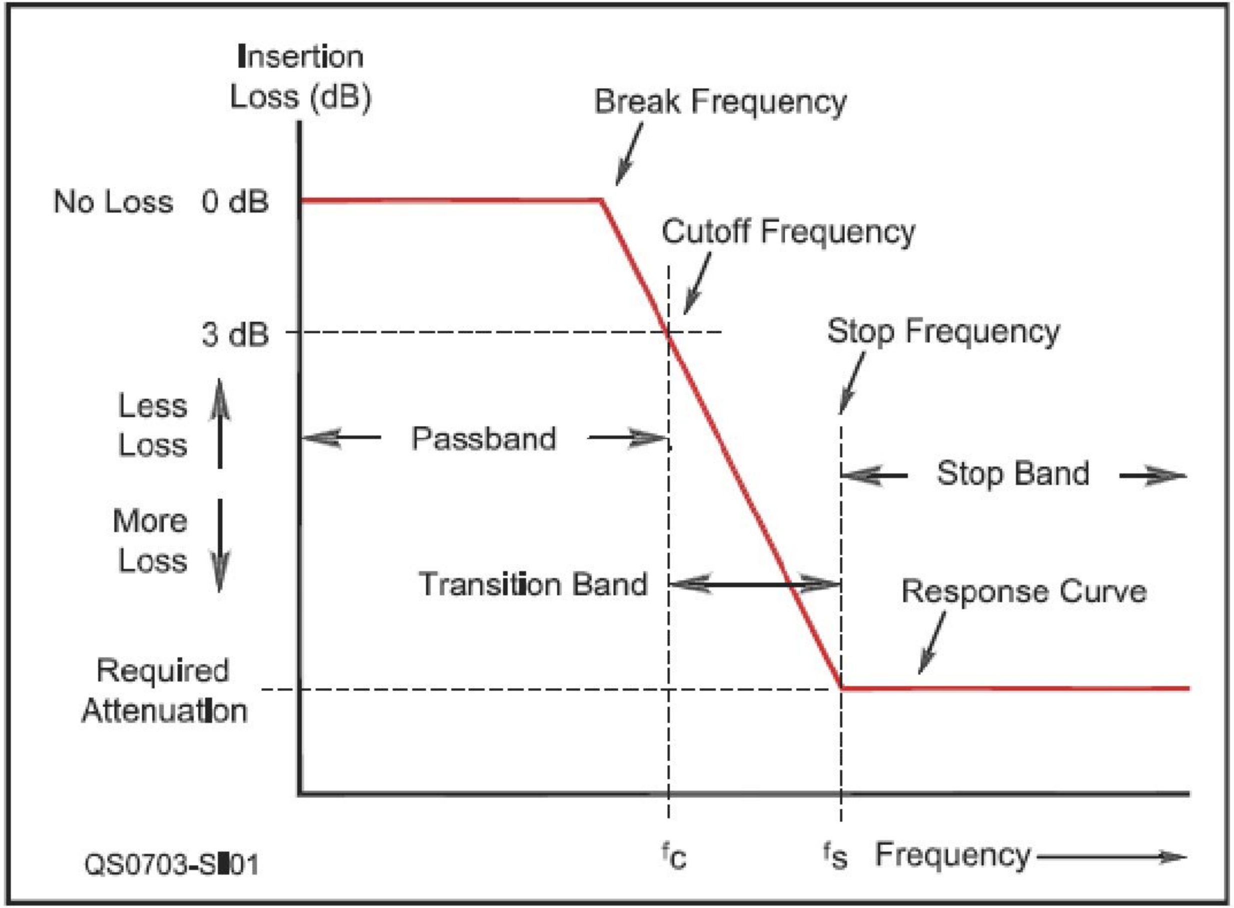
Low Pass Filter Design Example & Simulation

TIARA FEBRUARY 19 2016 ARIE LUKKASSEN

1. Election
2. Treasury Duty Relief & Appointment
3. Any other business



Insertion
Loss (dB)
Break Frequency
No Loss 0 dB
Cutoff Frequency
3 dB
Stop Frequency
Less
Loss
Passband
Stop Band
More
Loss
Transition Band
Response Curve
Required
Attenuation
QS0703-SI01
f_C
f_S
Frequency

Example LPF Design

Clean up a second harmonic at least 17dB below Fc
Freg = 7 Mhz and use a Butterworth filter. Shunt Type.

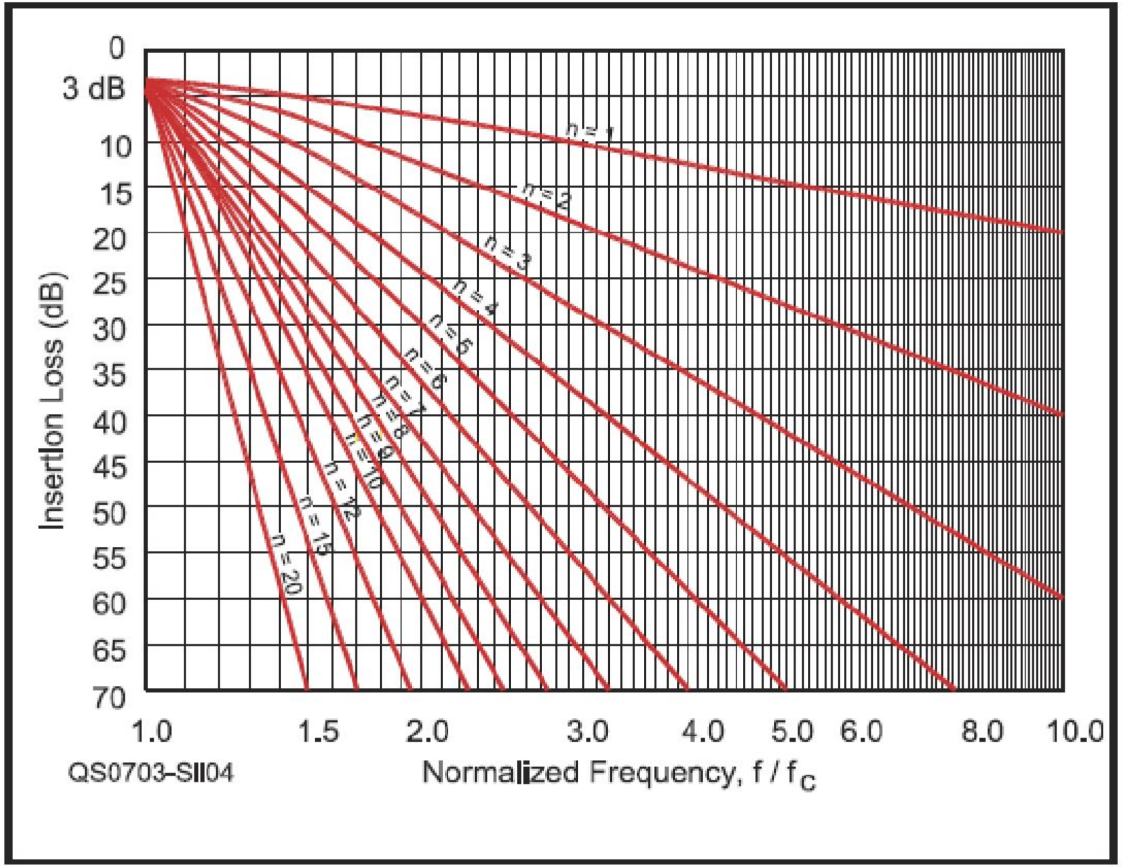
Impedance= 50 Ohm in and 50 Ohm out.

Fc= 7 Mhz
Fs= 14 Mhz

Normalised Freg. = F/Fc = 2.0

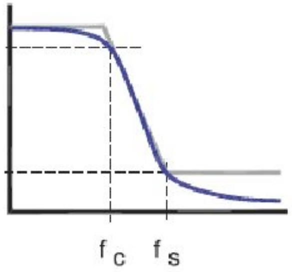
Check Table for Frequency Response.
It shows N=4

Check table with normalized L & C values


0
3 dB
10
15
20
25
30
35
40
45
50
55
60
65
70
Insertion Loss (dB)
n = 1
n = 2
n = 3
n = 4
n = 5
n = 6
n = 7
n = 8
n = 9
n = 10
n = 12
n = 15
n = 20
1.0
1.5
2.0
3.0
4.0
5.0
6.0
8.0
10.0
QS0703-SII04
Normalized Frequency, f / fC

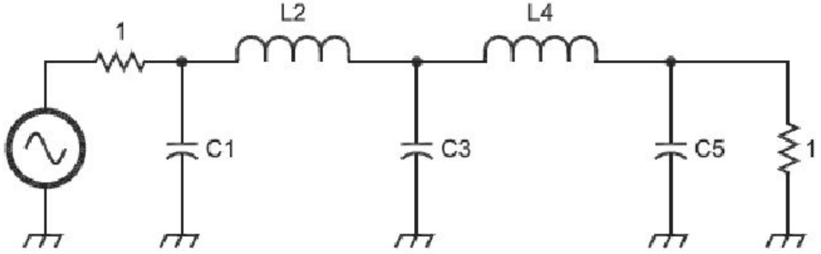
Prototype Butterworth Low-Pass Filters

n	C1 L1	L2 C2	C3 L3	L4 C4	C5 L5	L6 C6
1	2.0000					
2	1.4142	1.4142				
3	1.0000	2.0000	1.0000			
4	0.7654	1.8478	1.8478	0.7654		
5	0.6180	1.6180	2.0000	1.6180	0.6180	
6	0.5176	1.4142	1.9319	1.9319	1.4142	0.5176
7	0.4450	1.2470	1.8019	2.0000	1.8019	1.2470
8	0.3902	1.1111	1.6629	1.9616	1.9616	1.6629
9	0.3473	1.0000	1.5321	1.8794	2.0000	1.8794
10	0.3129	0.9080	1.4142	1.7820	1.9754	1.9754

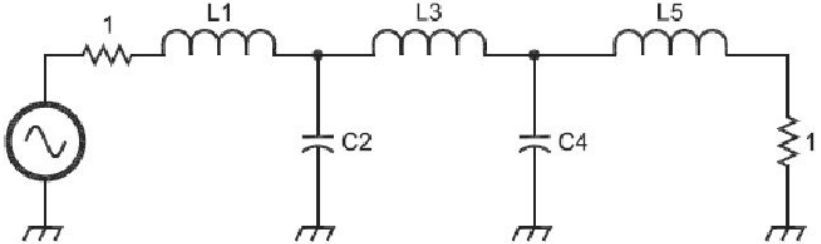


(A)

Figure 2 —
A — Table of normalized component values for a filter with a given number of poles, n.
B — The shunt-input filter schematic.
C — The series-input filter.



(B)



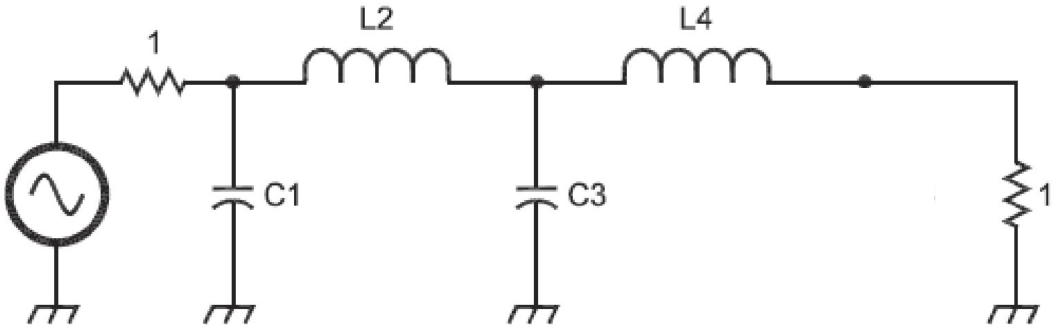
(C)

QS0703-SII02

Example

Check table with normalized L & C values

C1= 0.7654 L2=1.8478
C3=1.8478 L4=0.7654



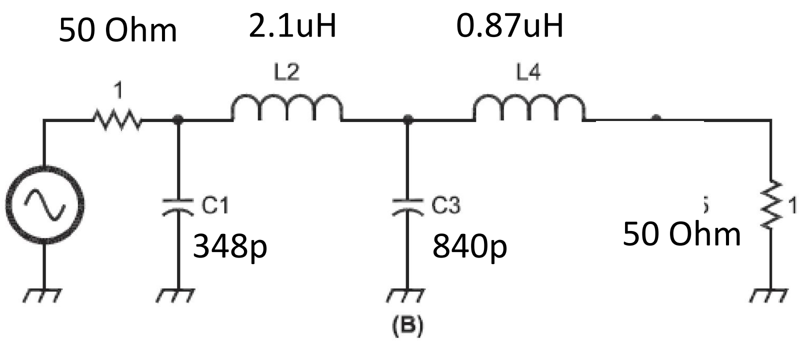
(B)

Example work out

$$L2 = L * \left(\frac{50}{1}\right) * (1/(2\pi * Fc))\, in\ Henry$$

$$L2 = 1.8478 * \left(\frac{50}{1}\right) * (1/(2\pi * 7Mhz))\ in\ Henry$$

$L2 = 2.1\mu H$



$$C1 = C * (1/50) * (1/(2\pi * Fc))\, in\ Farad$$

$$C1 = 0.7654 * (1/50) * (1/(2\pi * 7Mhz))\ in\ Farad$$

$$C1 = 348pF$$

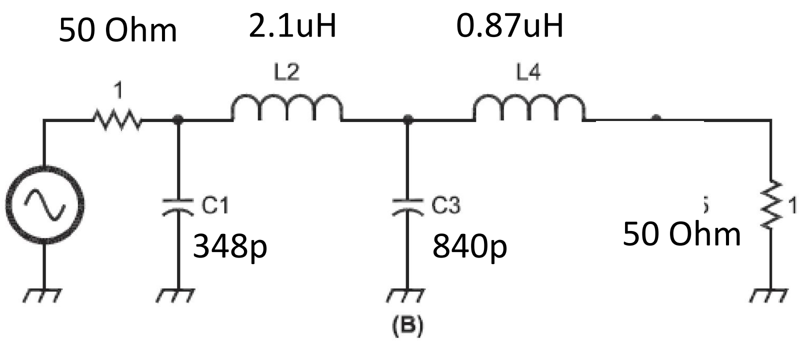
Same Process:

C3= 840pF

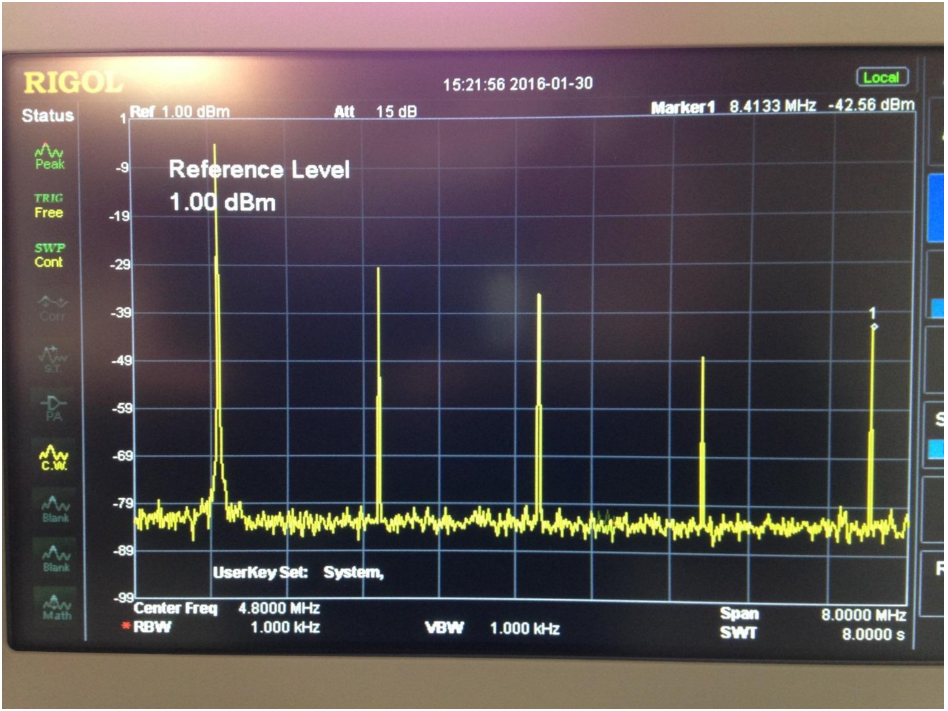
L4= 870nH or 0.87µH

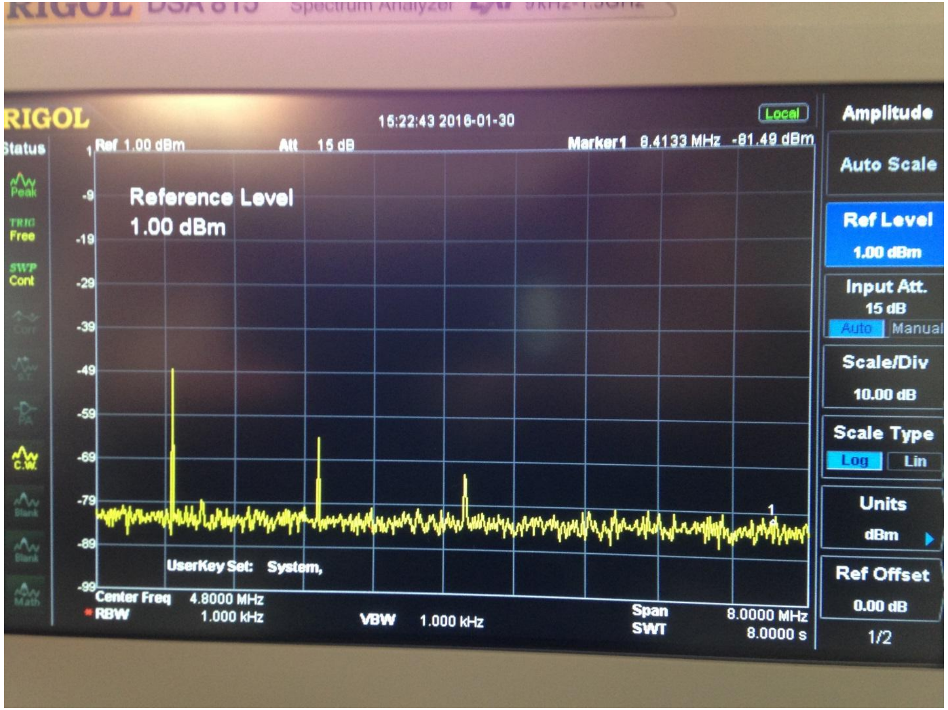
Things to Consider

- Insertion loss and Amplification
- Standard Values versus Calc values
- Coil Type.
- Do you like a high or low Q
- C suitability for the target Frequency
- C max Voltage
- L max Current or Power Rating
- L and T dependence.
- Keep in mind tolerances of C & L
- Rp for C
- Rs for L
- Humidity impact
- T impact on permanent change of C
- G forces impact / Mechanical Structure
- Ultimate Rejection

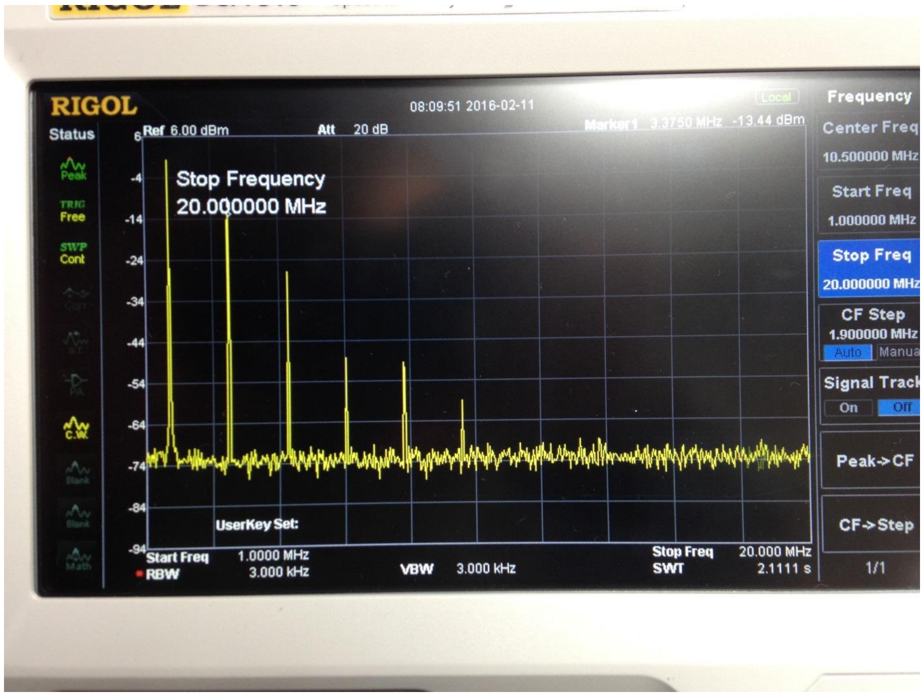


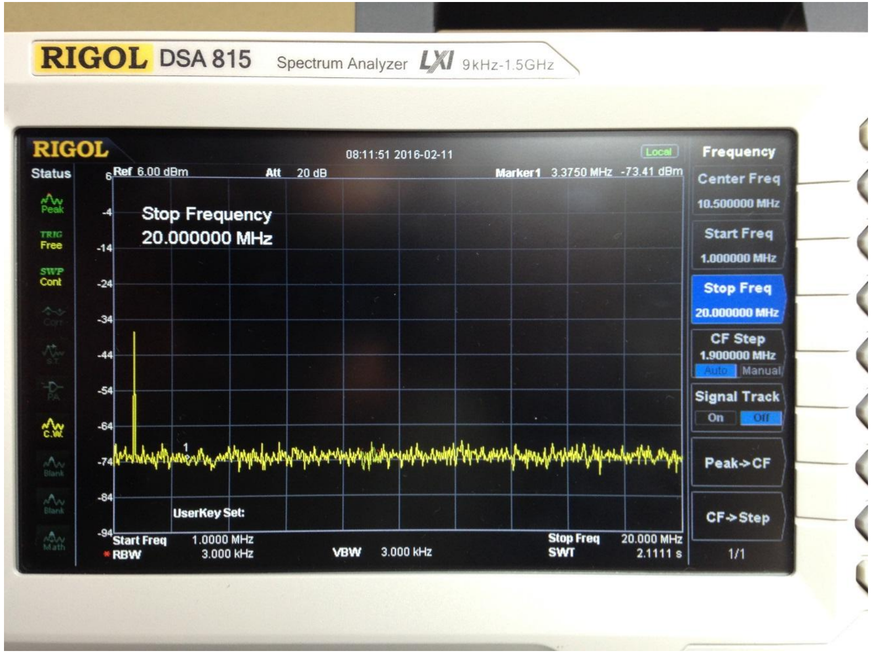
Too much attenuation 5th order LPF
Example of 1680kHz Low Power Transmitter (10mW).
Left no filter / Right after filter .

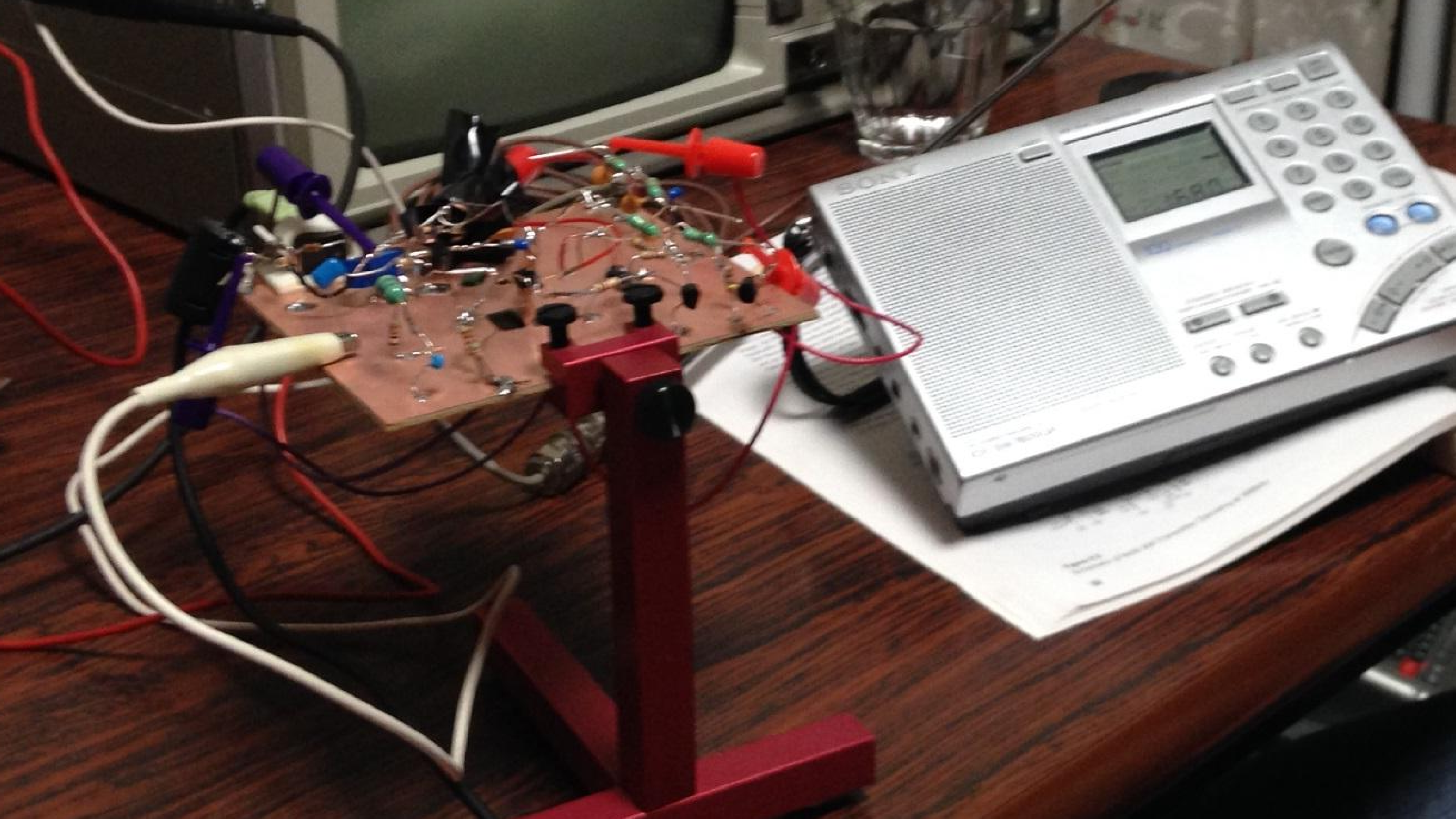




Before and After . Improved matching but still too much attenuation 5th order LPF
Output becomes micro watt QRP levels.






SONY

Sources and References:
ARRL 2006 Handbook

NOW

SIMULATION

Tina Simulator

TI Student Version