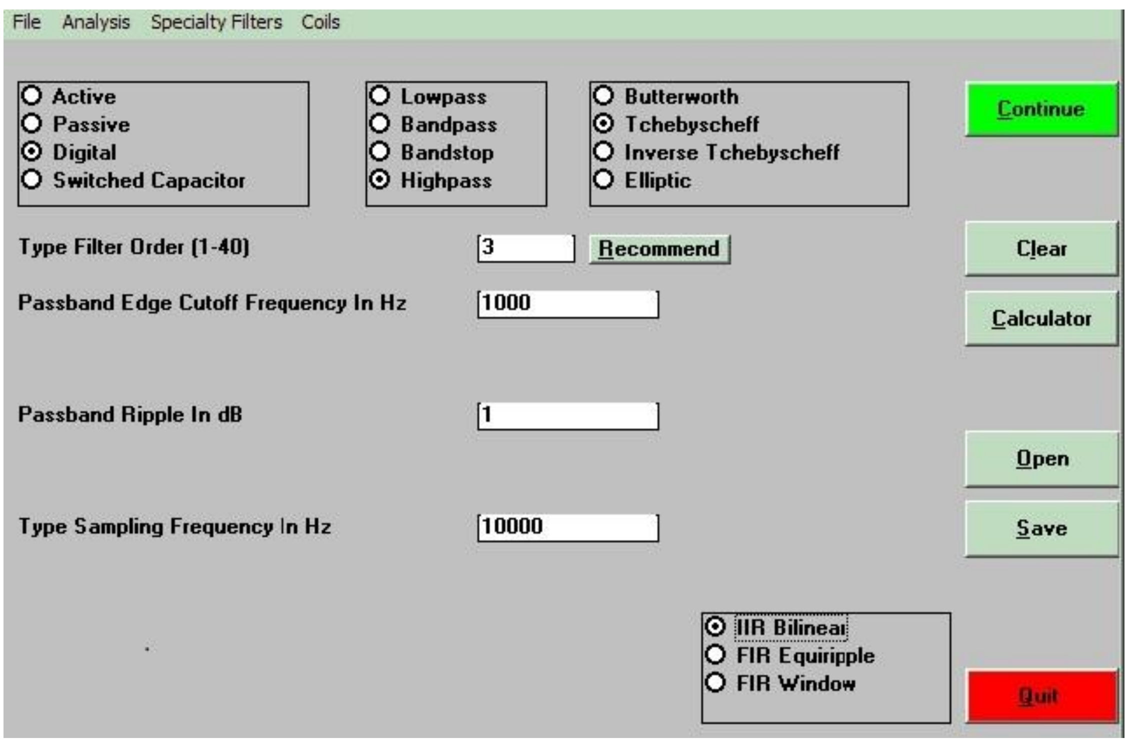
Electronic Filter Design Quick Reference Brochure

Link to ElecFilDes

ElecFilDes is a program for the design of active, passive, digital, and switched capacitor filters. It is an update, for Windows XP, Windows 7, and Windows 8, of a program that has been used for over 20 years. It implements all the filters described in the book “Electronic Filter Analysis and Design”, ISBN 0-89006-616-7. All analog filters can be saved in PSPICE compatible files for independent simulation.

Introduction:

Once the program is installed, the opening screen will appear similar to the screen below. Values, that are automatically inserted into the text boxes, are taken from the immediate previous design, but other previous saved designs can be opened, and/or modified, for repeat design and analysis.



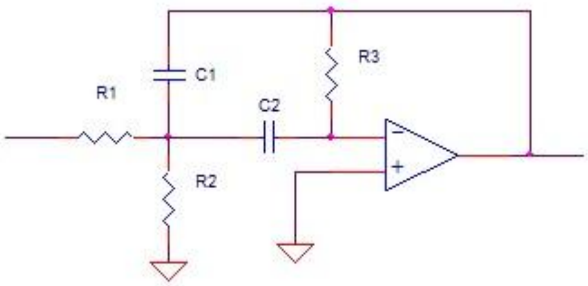
Active Filters

ElecFilDes has a variety of active topologies that include cascadable sections up to order 40. All active filters are available in lowpass, bandpass, bandstop and highpass configurations for Butterworth, Tchebyscheff, Inverse Tchebyscheff, and Elliptical (Cauer) bandpass characteristics.

Example active filters are shown below.

The Multiple Feedback (MFB) topology.

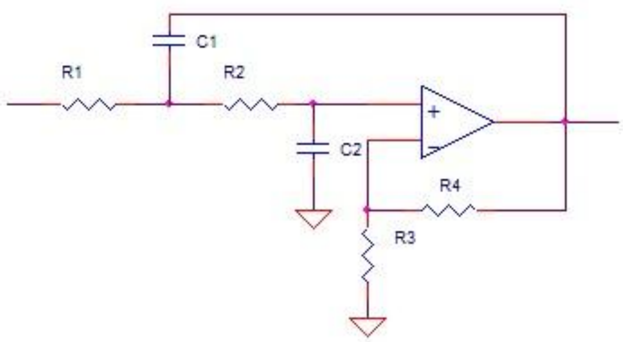
```
THE  QUADRATIC FUNCTION FOR STAGE 2 OF 3 IS
( 2272.931 S)/( 1 S^2+ 1049.176 S+ 4.029575E+07 )                Q=  6.050363
```




```
R1=  43996.07  ohms
R2=  1341.54  ohms
R3=  190625.8  ohms
C1=  0.01  uf
C2=  0.01  uf
```

The VCVS topology

THE QUADRATIC FUNCTION FOR STAGE 2 OF 2 IS
(3.924962E+07)/(1 S^2+ 3104.966 S+ 3.924962E+07)   Q= 2.01772

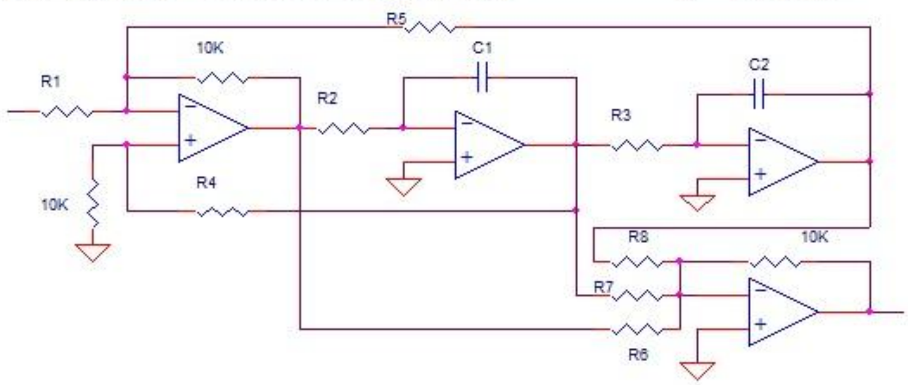


R1 = 5971.435 ohms   R2 = 1939.381 ohms
R3 = INFINITY   R4 = 0
C1= 0.22 uf
C2= 0.01 uf

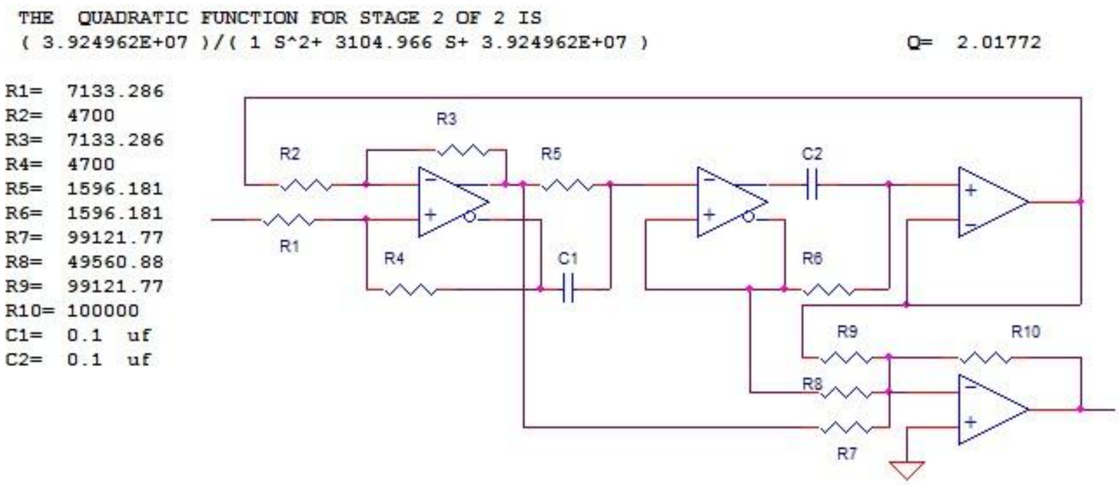
The State Variable Topology

THE QUADRATIC FUNCTION FOR STAGE 1 OF 3 IS
(1 S^2+ 7.895683E+07)/(1 S^2+ 68943.56 S+ 7.895683E+07)   Q= 0.1288846

R1= 9942.303
R2= 1458.874
R3= 87318.34
R4= 19942.4
R5= 9942.303
R6= 10058.03
R7= INFINITY
R8= 10000
C1= 0.01 uf
C2= 0.01 uf

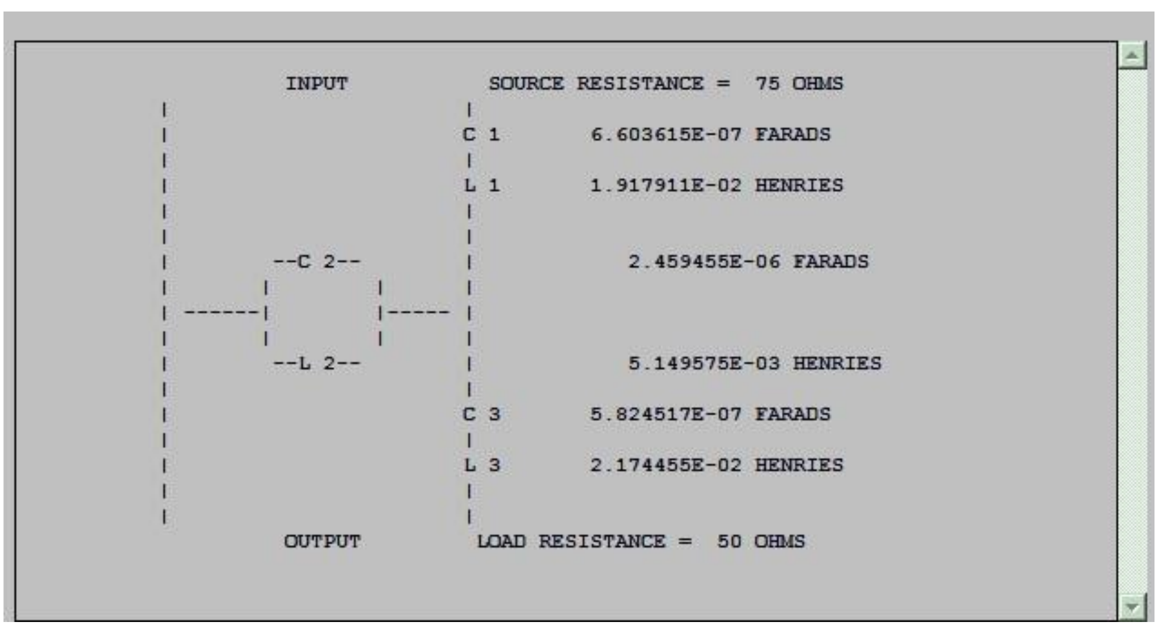


A stable differential topology for very high Q active filters.



Passive Filters

Available in Butterworth, Tchebyscheff, and Elliptic configurations, these filters offer the option for unequal termination, except for the elliptic. Lowpass, bandpass, bandstop, and highpass topologies are fully supported.



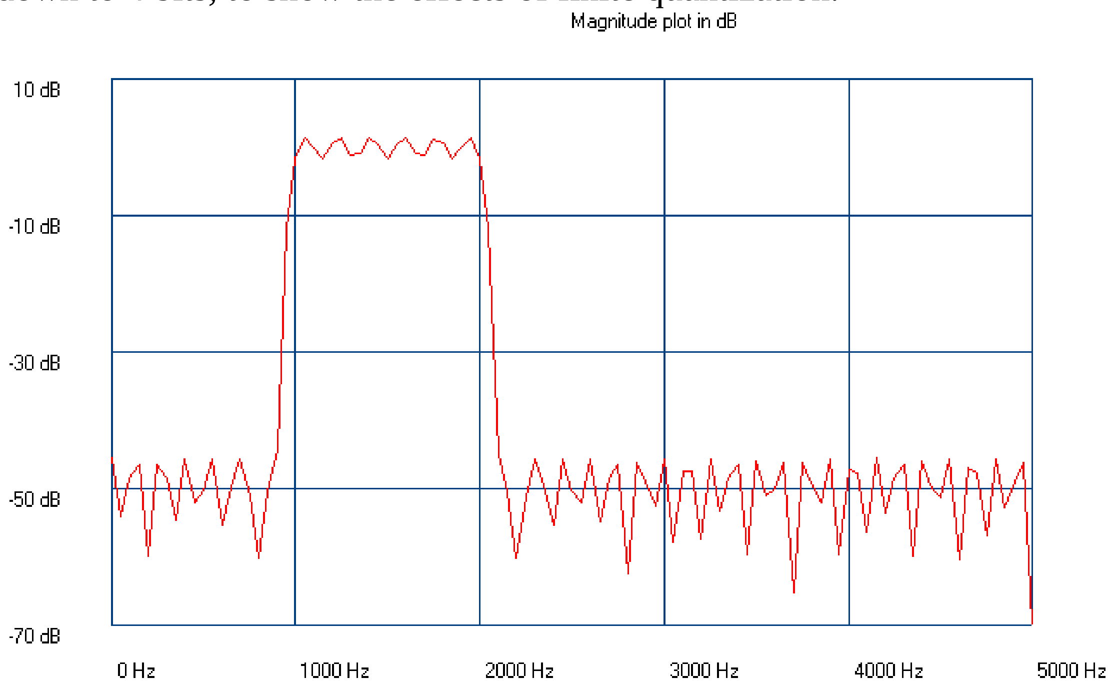
```
              INPUT             SOURCE RESISTANCE =  75 OHMS
        |                     |
        |                     C 1        6.603615E-07 FARADS
        |                     |
        |                     L 1        1.917911E-02 HENRIES
        |                     |
        |                     |
        |         --C 2--     |             2.459455E-06 FARADS
        |        |       |    |
        | ------|       |----- |
        |        |       |    |
        |         --L 2--     |             5.149575E-03 HENRIES
        |                     |
        |                     C 3        5.824517E-07 FARADS
        |                     |
        |                     L 3        2.174455E-02 HENRIES
        |                     |
        |                     |
              OUTPUT           LOAD RESISTANCE =  50 OHMS
```

Digital Filters

Variations include

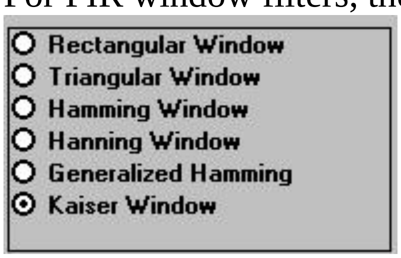
1. IIR transform of any analog filter, using the bi-liinear transform
2. FIR window filters to order 512
3. FIR equiripple filters, using the Remex exchange algorithm, to order 512

For FIR filters, the post-design quantization can be changed from 32 bits, down to 4 bits, to show the effects of finite quantization.



Output graph for a 128 length Remez exchange design

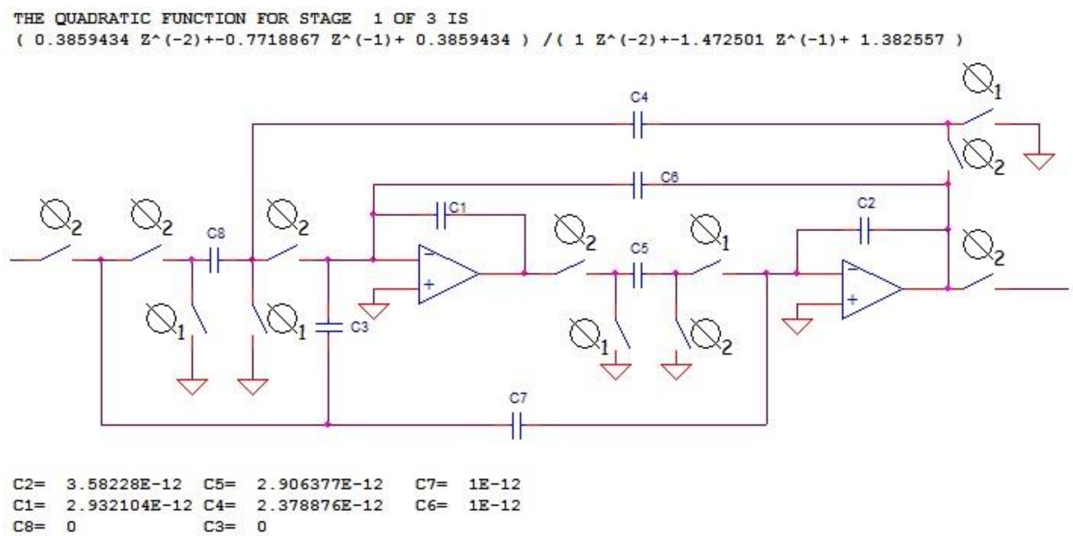
For FIR window filters, the following window types are supported



In addition to filter coefficients, all window coefficients are available and can be saved.

Switched Capacitor Filters

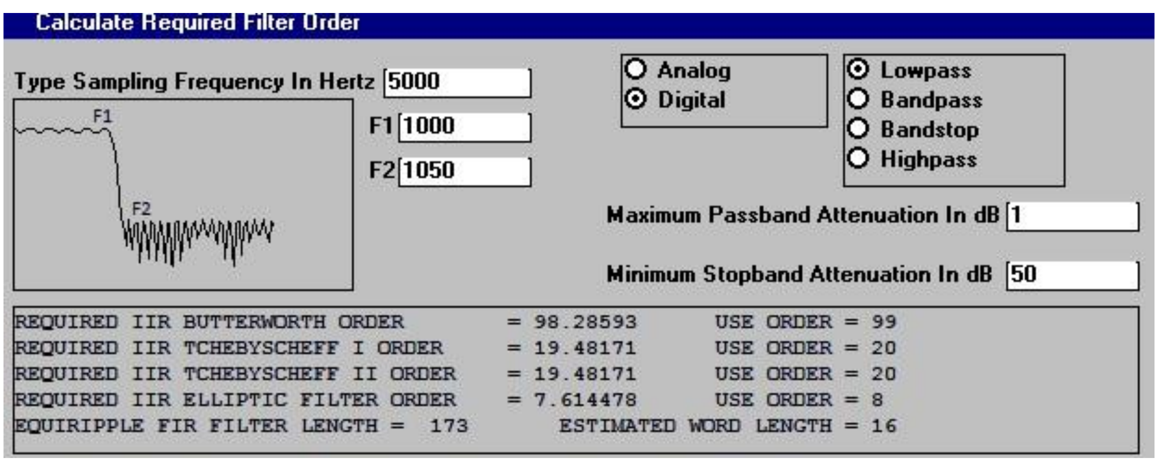
A single design, based on the Martin and Sedra biquad, is including in this package.



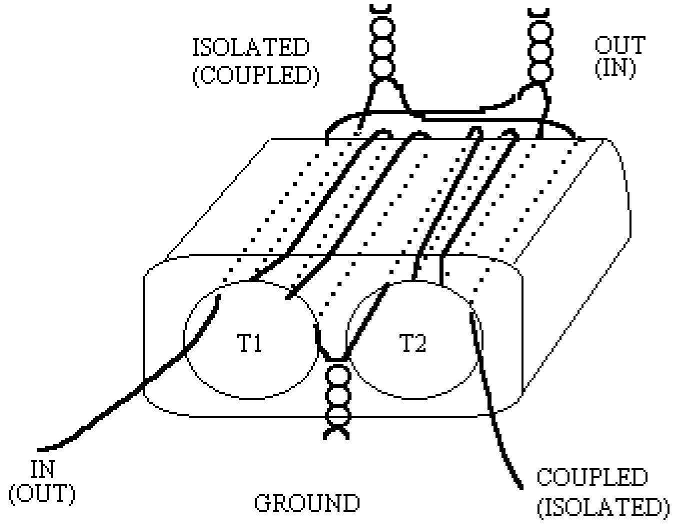
Stage 1 of 3 for a Martin and Sedra switched capacitor design.

Options

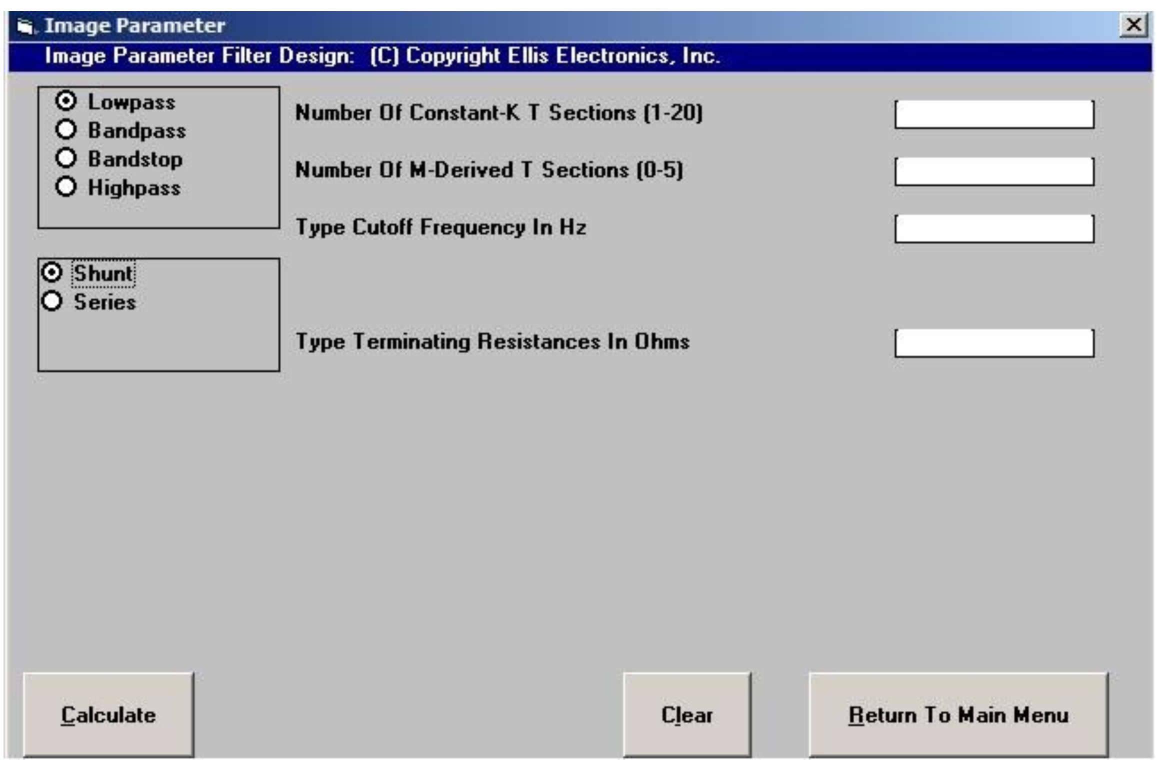
1. A utility to allow for the estimation of the filter order is included.



2. RF directional coupler design utility can be used to determine the number of turns for a given coupling loss.

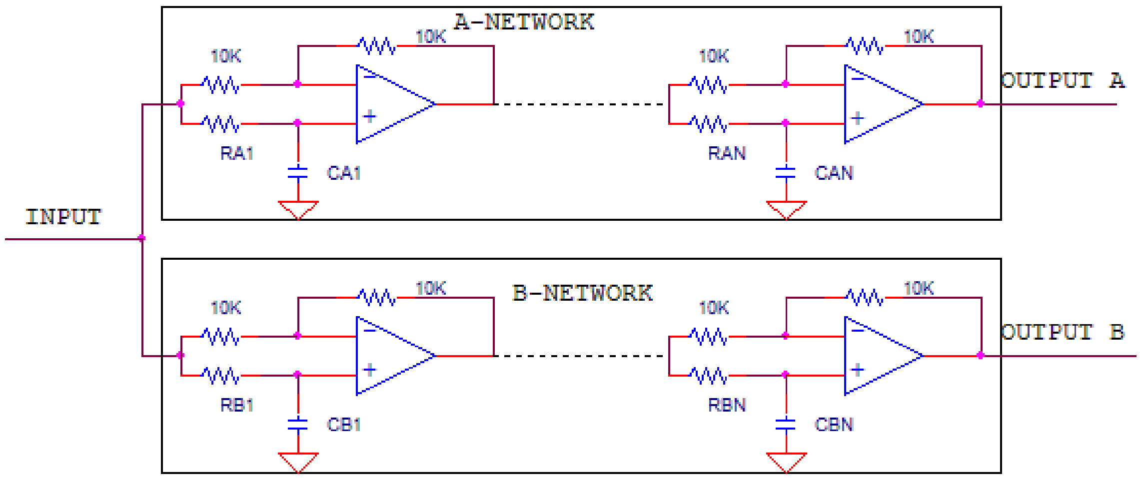


3. Image parameter designs, based on techniques from the 1930s, are included.

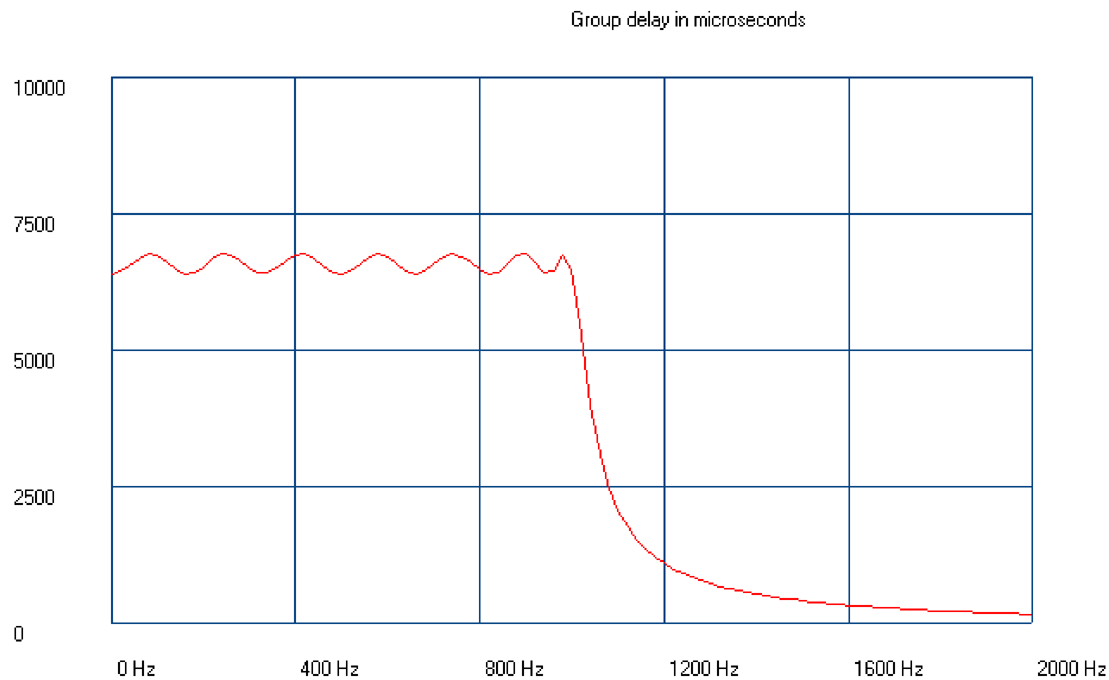


4. For the 90 degree phase splitters for active network, data can be entered in terms of a) order of each section, or b) required dB sideband rejection, or c) maximum allowed phase deviation from 90 degrees.

THIS PROGRAM SYNTHESIZES TWO ALL-PASS NETWORKS SUCH THAT FOR A GIVEN INPUT, THE OUTPUTS TRACK WITH A CONSTANT 90 DEGREE PHASE DIFFERENCE. THESE TWO NETWORKS WILL BE DENOTED AS A-NETWORK & B-NETWORK.

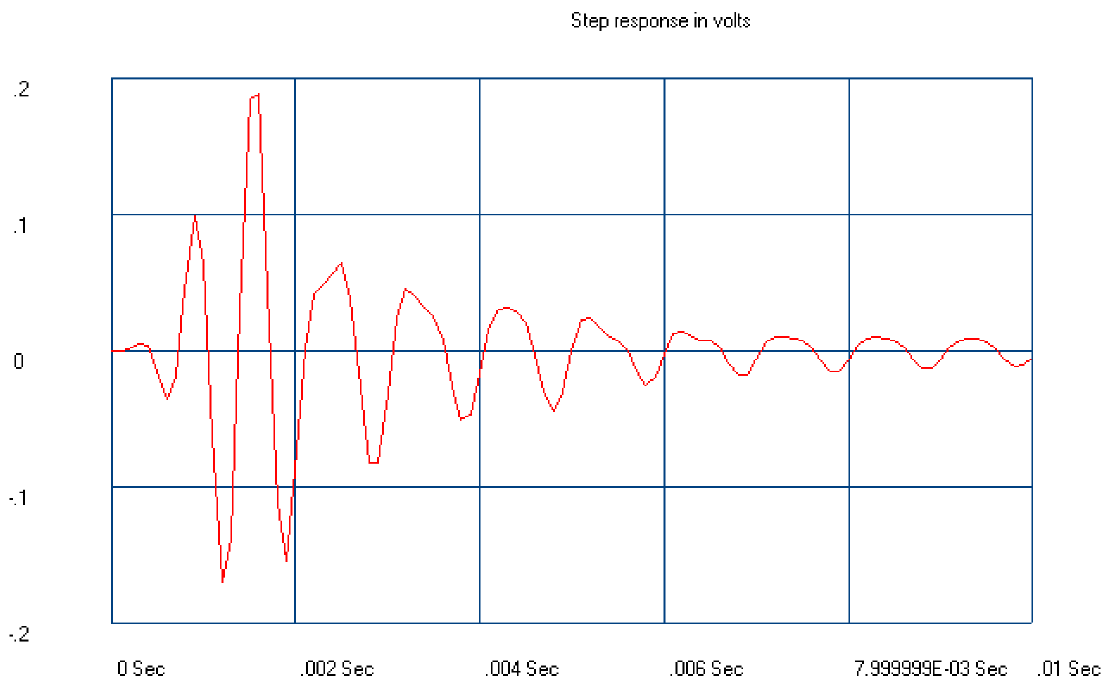


5. An experiment group delay equalizer is being developed, and is in the Beta testing stage. This option currently only determines the equalizer poles and zeroes for active lowpass filters. Linearized Newton method is used for equiripple approximation. The follow graph shows the group delay of a 7th order Tchebyscheff lowpass filter when cascaded with 12th order group delay equalizer.



Group delay equalization of 7th order Tchebyscheff lowpass.

6. Inverse Laplace transforms can be obtained on any analog filter up to order 12. These include the time domain output for either impulse, or step, response in equation, and graphical form. An example step function response is given below. The analytical equations used to plot this step response follow the graph.



Partial Fraction Expansion / Inverse Laplace Transforms
Step Response Calculation
The Degree of the Numerator = 5
The Degree of the Denominator = 10

The NORMALIZED Numerator Coefficients Are

S^ 0	0
S^ 1	0
S^ 2	0
S^ 3	0
S^ 4	0
S^ 5	.1228267

The NORMALIZED Denominator Coefficients Are

S^ 0	32
S^ 1	14.98912
S^ 2	93.51053
S^ 3	33.87583
S^ 4	101.4269
S^ 5	26.50409
S^ 6	50.71343
S^ 7	8.468957
S^ 8	11.68882
S^ 9	.9368201
S^ 10	1

THE DENOMINATOR TERMS IN THE PARTIAL FRACTION EXPANSION ARE

S + 0
S^2 + 376.2989 S + 3.972809E+07
S^2 + 1159.41 S + 5.132221E+07
S^2 + 1818.94 S + 7.895683E+07
S^2 + 1783.698 S + 1.214714E+08
S^2 + 747.868 S + 1.569213E+08

THE RECONSTRUCTED DENOMINATOR COEFFICIENTS ARE

0	S^ 0
32	S^ 1
14.98912	S^ 2
93.51053	S^ 3
33.87583	S^ 4
101.4269	S^ 5
26.50409	S^ 6
50.71343	S^ 7
8.468957	S^ 8
11.68882	S^ 9
.9368201	S^ 10
1	S^ 11

THE RESPECTIVE RESIDUES ARE
7.836823E-03
-237.9758S + 1948271
373.4926S + -7118877
-.8486907S + 1.258984E+07
-372.3636S + -1.160822E+07
237.6878S + 4044475

THE ERROR IN THE PARTIAL FRACTION EXPANSION IS
1.636595E-11 %

Time In Seconds For Time Domain Evaluation = .01

THE TIME DOMAIN FUNCTION FOR t > 0 IS
1.247269E-06*e^(0*t)
-3.787503E-02*e^(-188.1494*t)*COS(6300.213*t)+ .050348*e^(-188.1494*t)*SIN(6300.213*t)
5.944319E-02*e^(-579.7048*t)*COS(7140.458*t)+-.1634998*e^(-579.7048*t)*SIN(7140.458*t)
-1.350733E-04*e^(-909.4702*t)*COS(8839.101*t)+ .2267039*e^(-909.4702*t)*SIN(8839.101*t)
-.0592635*e^(-891.8489*t)*COS(10985.26*t)+-.163369*e^(-891.8489*t)*SIN(10985.26*t)
3.782919E-02*e^(-373.934*t)*COS(12521.24*t)+ 5.027877E-02*e^(-373.934*t)*SIN(12521.24*t)