PCFILT Overview and general information

* * * * * * * * DEDICATION * * * * * * * *

To my friend Fredrick J. Radler

1937 - 1991

Whose heart attacked him fatally in retaliation for a long term cigarette habit and without whose help the transmission line designs in this program would not have been possible.

———— Overview ————

The PCFILT program was developed to design microwave transmission line and L-C filters in a manner compatible with real world situations. Designs done on a theoretical basis often are either unrealizable because of awkward mechanical dimensions or do not perform as expected due to distributed factors such as losses in lumped components. This is why a network analysis module is an integral part of the package.

Each transmission line filter design module in the program generates an open wire transmission line equivalent to the filter being designed. This equivalent is available to the internal network analysis module allowing the designer to calculate and display the performance of the design taking real world losses into account just as easily as with L-C designs. The effects of lumped component losses, changes in resonator length, matching methods and resonator unloaded Q may be seen from the analysis and compensated for.

The circuit editor and analysis modules in PCFILT contain all of the functions necessary to manipulate and evaluate lumped component designs or to add lumped component elements to the equivalent microwave networks.

In order that the mechanical dimensions for transmission line designs be practical, capacitance matrix transformations are used to generate equal resonator diameters for bandpass filters and automatic Kuroda transformations are performed on band-reject filters. All of the critical factors involved in the design are under the user's control.

———— Installation and Start up ————

To install PCFILT on your hard drive, simply run the installation program provided (INSTALL.COM), it will take care of all the details. INSTALL will make a new subdirectory and copy all the main PCFILT files to it. Note that PCFILT should be installed in directory (folder) C:\PCFILT. If a different directory is necessary for some reason that path must be specified in the operating system “Environment”.

For example, if the program is installed in c:\program files\alkeng:

PCFILT_HOME=C:\PROGRAM FILES\ALKENG

This line must appear in the system environment (SET).

under Windows 98 this is done in c:\autoexec.bat. Simply add the line:

SET pcfilt_home=c:\program files\alkeng

Under Windows XP it is entered into "My computer", properties:

1. Right-click My Computer, and then click Properties.
2. Click the Advanced tab.
3. Click Environment variables.
4. Click New to add a new variable name: **pcfilt_home**. Add the new value (path): **c:\program files\alkeng**

The path for temporary files can also be specified in the environment.

The variable names for this are: **tmpcfilt, temp** or **tmp** in that order. The last two possibilities will probably be already set up by Windows but **tmpcfilt** may be added in the same way as the **pcfilt_home** variable name.

———— General in formation ————

* A CPU with a built in math coprocessor is required.

* Keep <Caps Lock> and <Num Lock> engaged (these are set automatically on entry). Only upper case responses at all times.

* Every design generates 2 files on exit from the program or when a design is saved: file_name.DZN is the part-by-part design. file_name.SPK is the design parameters for the design. Additional files: ANAL.DAT is the analysis data that can be recorded or recalled from the Utilities menu. file_name.PPD is generated when the pole placer is used.

* The <**Es**c> key or the <~> key (this is the "Tilde" key located in the upper left corner of the keyboard) will drop you back one menu when pressed. These keys are referred to as the "Back" key throughout the program.

* Remember to save each design you want to keep before starting a new one. No design files are recorded except at eXit, or with the Save option on the main control File menu.

```
* To call up the program from a DOS command prompt:
C>PCFW file_name
if you type:
C>PCFW      file_name will be: ——> default
```

* The "Q" values displayed in the window on the main control menu are used universally by all modules.

* Operation using a mouse is supported.

The RIGHT button is equivalent to the <Esc> or [Back] key and will also function as the <Enter> key at any "(Cr) to continue" prompt.

Configuration:

PCFILT is self configuring as you use the program. Since all of your choices to the configuration options are recorded in the specifications file that accompanies each design (".SPK" file), every design can be configured as needed for that design. If the first design you do is recorded back to disk under the "default" filename, all subsequent designs recorded will contain the "default" configuration unless you change it.

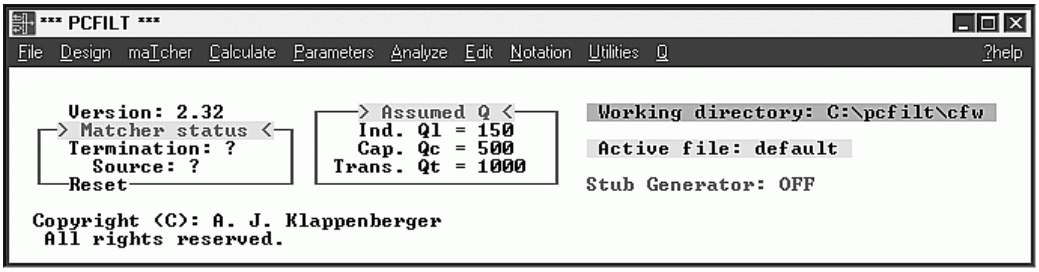
The configuration options that are recorded include what parameters show on the graphics, what parameter notation was used and the like. All of these options are chosen as you go through and no special notice has to be taken of them. You will most likely not even realize you have done the configuration at all.

Configuration options are recorded in the file_name.SPK "specs" file. Most "toggle state" options are recorded in the second string position. Note the some of the recorded information is for compatibility with the DOS version of PCFILT and is ignored by the Windows version. The first lines in a typical ".SPK" file might look like this:

```
1.0000000e+00   0.0000000e+00 Y -111-11111-111-1-----
   5.0000000e+00   0.0000000e+00 x 100011021101 ————┐
   5.0000000e-02   0.0000000e+00 x x                 |
     . . . . . .     . . . . . . .                   |
 ABCDEFGHIJKLM <———————————————————————————————————┘
 ————————————
 A = plot Attenuation  1=on 0=off
 B = plot Group delay  1=on 0=off
 C = plot Phase        1=on 0=off
 D = plot extra        1=on 0=off
 E = plot Return loss  1=on 0=off
 F = plot Scale style  0=horizontal lines      1=vert. ticks
                       2=calibrated frequency  3=calibrated grid
 G = plot Line styles  0=solid lines 1=unique lines
 H = Graphics mode     0=CGA mono              1=EGA 640 X 200 color
```

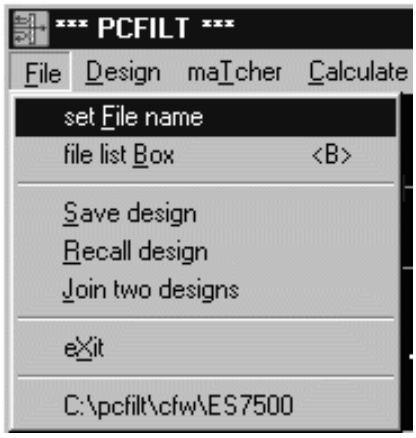
```
                          2=EGA 640 X 350 color   3=VGA 640 X 480 color
                          4=EGA 640 X 350 mono    5=VGA 640 X 480 mono
                          ?=Ask user (same as <F1> function key pressed)
 I = analysis Graphic mode     0=off 1=on
 J = analysis Auto delay mode  0=off 1=on
 K = Mouse operation           0=off 1=on
 L = Editor mouse mode         0=Line edit 1=Use Mouse
 M = plot Smith chart          0=off 1=on
 N = Schematic character set   0=Generic 1=IBM Extended
 O = Text color                0=Monochrome      1=Normal color
                               2=Shades of blue  3=Color on blue
 P = <NumLock> key status      0=on  1=off (1 is for Lap-top computers)
```

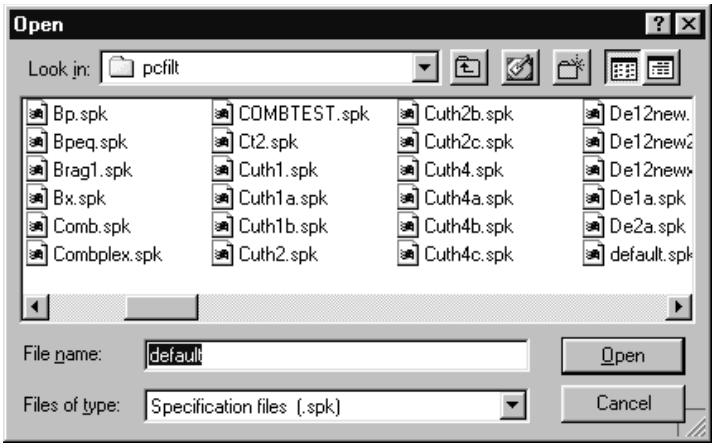
MAIN CONTROL MENU:



File

The first option on the file menu opens a standard "Open" dialog box common to many Windows programs. It is used here ONLY to set the filename. The decision to Save, Recall or Join the file is made later.





The next three options deal with the files themselves.

File list Box <B> - Holds a list of associated filenames for quick recall.

Recall design <R> - Recalls design and specs in file_name shown.

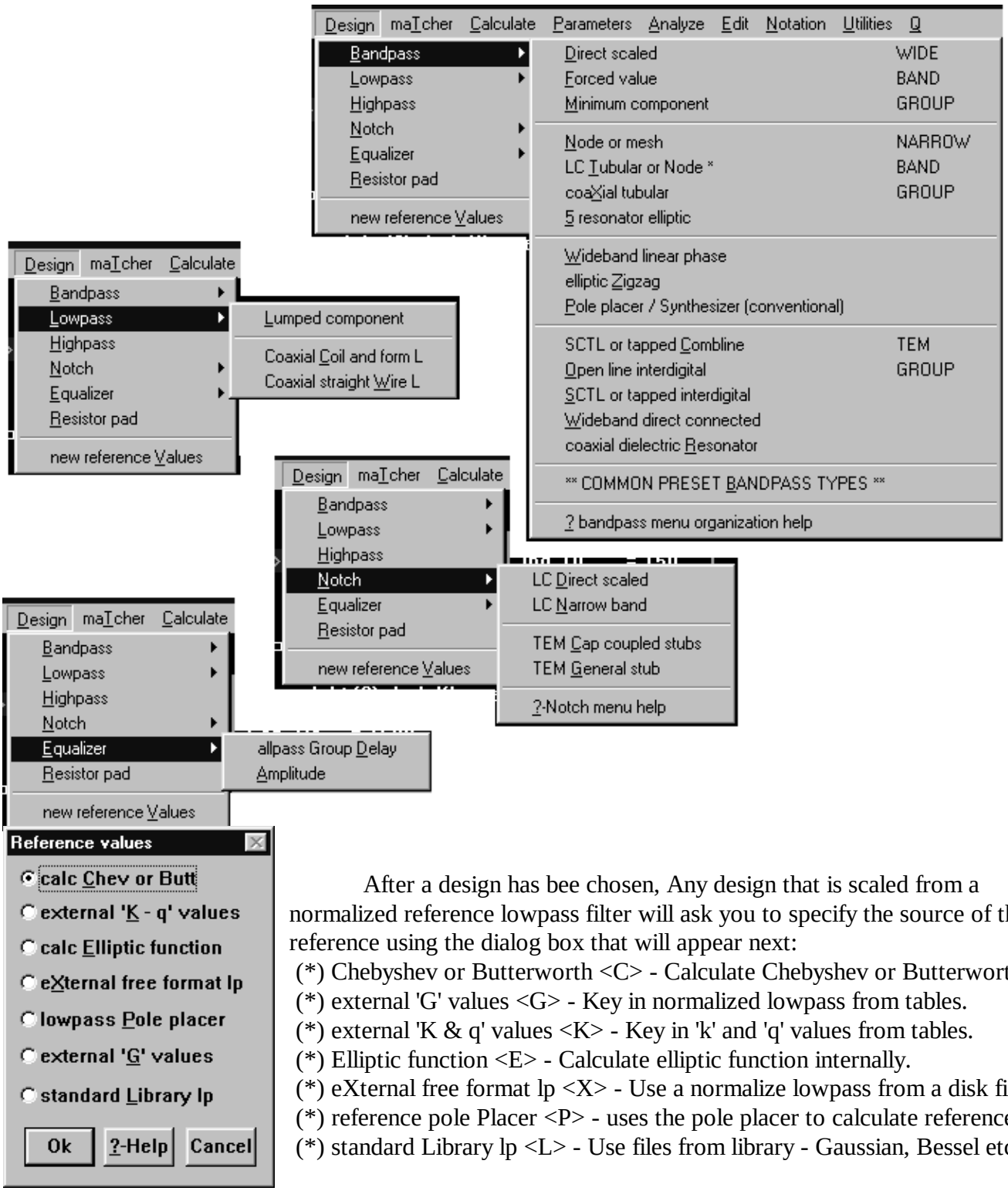
Save design <S> - Save the current design in file_name shown.

Join two designs <J> - the Join option will tack the design in the file displayed onto the design in memory, either in series or as a multiplexer side port (at the source or bottom end).

Design

This option uses a series of menu to start a completely new design.

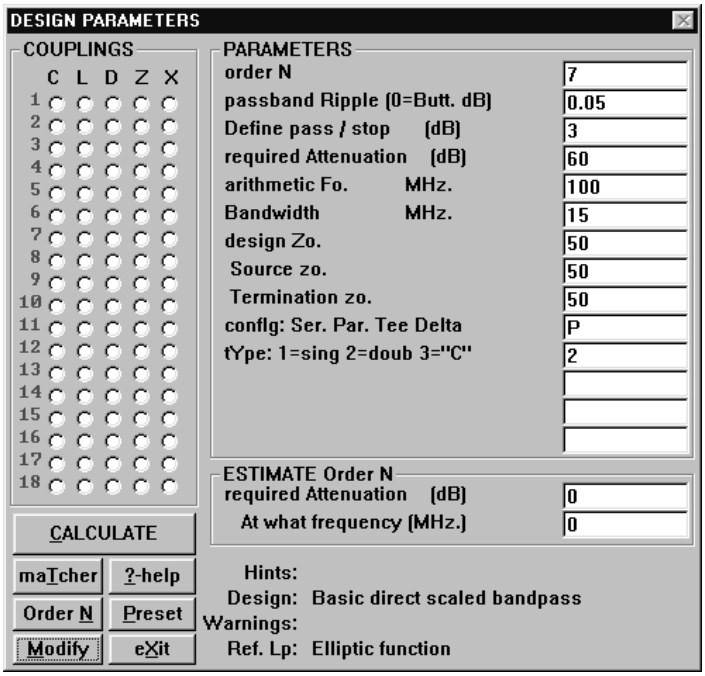
Lowpass reference values



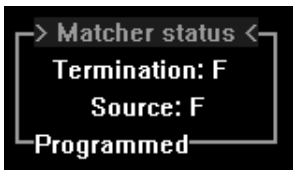
After a design has bee chosen, Any design that is scaled from a normalized reference lowpass filter will ask you to specify the source of the reference using the dialog box that will appear next:

(*) Chebyshev or Butterworth <C> - Calculate Chebyshev or Butterworth.
(*) external 'G' values <G> - Key in normalized lowpass from tables.
(*) external 'K & q' values <K> - Key in 'k' and 'q' values from tables.
(*) Elliptic function <E> - Calculate elliptic function internally.
(*) eXternal free format lp <X> - Use a normalize lowpass from a disk file.
(*) reference pole Placer <P> - uses the pole placer to calculate reference.
(*) standard Library lp <L> - Use files from library - Gaussian, Bessel etc.

Parameters menu will follow



maTcher <T>



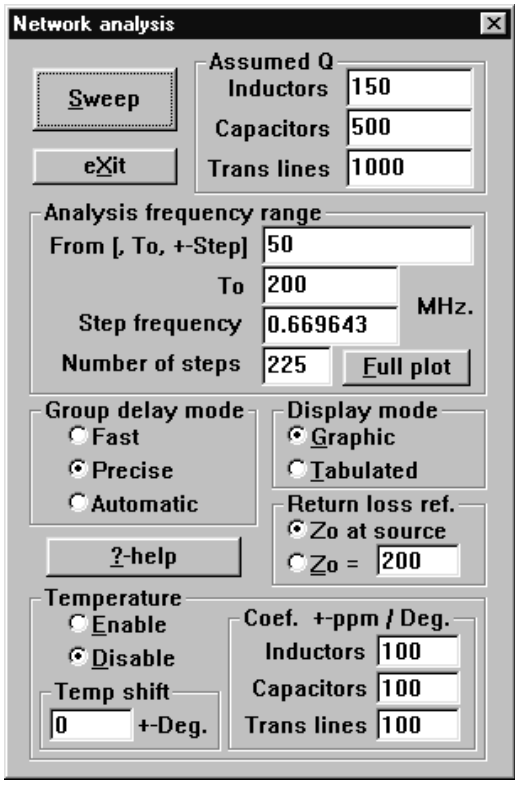
This is used to reset the automatic L-C impedance matcher and is not needed for transmission line designs. This is identical to the maTcher button on the Parameters menu.

Calculate <C>

This menu option initiates the design. This is identical to the Calculate button on the parameters menu.

Parameters <P>

This option brings up the parameters menu where design specifications are set and modified. This is the same dialog box as comes up automatically when a new design is started using the Design menus.

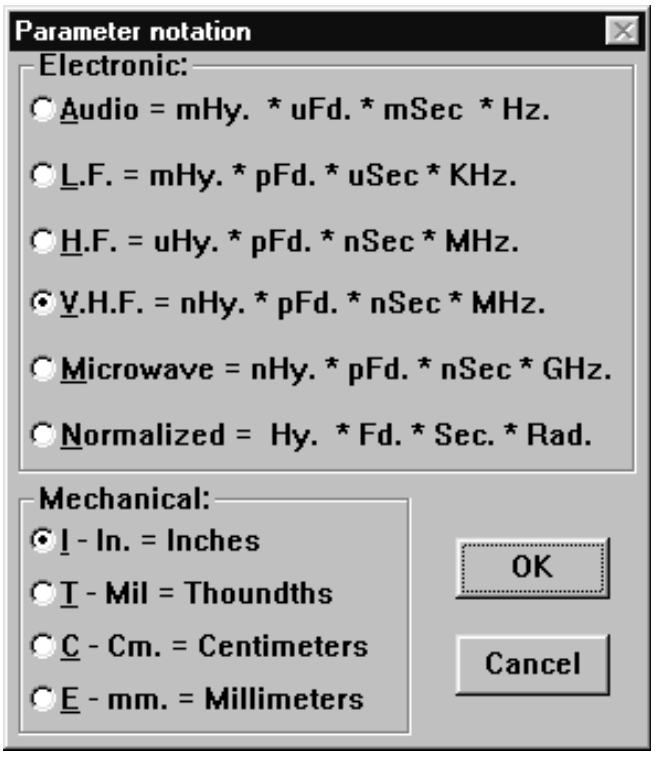


Analyze <A>

The Analysis option is straight analysis of up to 1000 frequency points. (Power analysis is available from the Utilities menu). Analysis frequency range is set from start frequency to stop frequency. Frequency steps are either specified directly in units of frequency, or as a negative integer from -2 to -1000 corresponding to the number of points desired..

Edit <E>

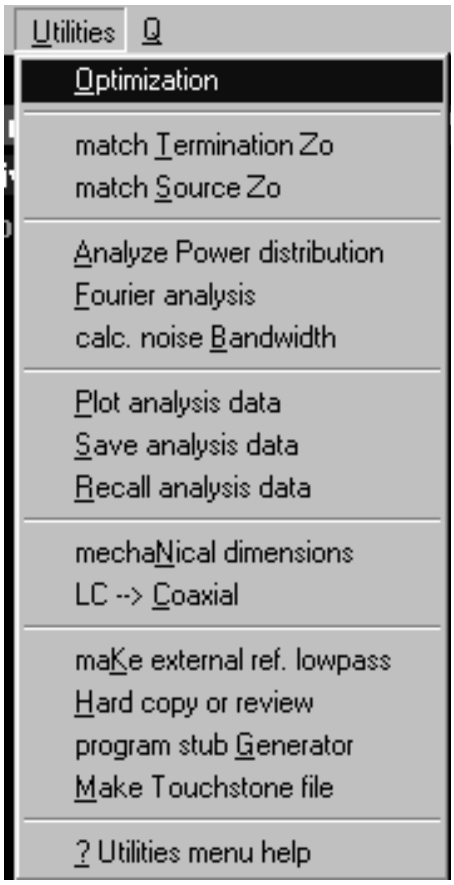
The circuit edit module draws the circuit diagram. The schematic may be scrolled up or down using the up / down arrow keys or scroll bar. Many advance circuit editing functions and transformation are available from the edit menus. For more information see the chapter on the circuit edit module.



Notation

The Notation dialog box option sets the units used throughout the entire program. For electronic parameters, inductance, capacity, time, and frequency: Mechanical dimensions may be displayed in English or metric units:
Selection is made by frequency range. The set of units most practical for that range are all set together.

Transmission lines and stubs are always displayed in degrees and Ohms Zo.



UTILITIES MENU:

Optimization <O>

The Optimization module will handle anything the analysis program will handle; Diplexers, equalizers or the like.

impedance match:

match Termination Zo <T>

match Source Zo <S>

The S and T options will apply impedance matching to one end of a circuit at any time and reprogram the main menu matcher window at the same time, even if the condition shown on the main screen is X.

Analyze power distribution <A>

The analysis option will do a voltage/current/loss distribution analysis. You can plot a single parameter over a frequency range and display it graphically, or display the power distribution throughout the entire network at once. All branch numbers are the same as that shown by the circuit editor.

Fourier analysis <F>

Brings up the Fourier impulse response module. This will display the time domain response of any network.

Calc. Noise Bandwidth <B>

After analyzing the filter in memory using the main analysis this option will display the equivalent noise bandwidth of the filter. The results are displayed on the main control window. The analysis data must contain attenuation information for all frequencies with less then 60 dB attenuation. The more analysis points the better.

****** The next three options deal with analysis data *****

Plot analysis data <P>

Calls the graphic plot module to display the data in memory.

Save analysis data <S>

Records the analysis data in memory in file ANAL.DAT.

Recall analysis data <R>

Recalls the analysis data in ANAL.DAT into memory.

Write S2P file <W>

This will write a standard S-parameter file for the network in memory. Set up the start, stop and step frequency and component Q on the analysis dialog box. You will be asked the system impedance.

mechaNical dimensions <N>

This calculates the mechanical spacings and physical dimensions of resonators. It also provides a special screen and menu for calculating microstrip dimensions using the L-C to Stub generator..

LC --> Coaxial <C>

This is used to calculate the physical dimensions for the parts for any L-C filter that is to be built into a metal tube. This would include some bandpass and most lowpass filters. This calls the same screen as when a coaxial filter is designed from the Design menu.

MaKe external ref. Low pass <K>

The K option will make an external reference lowpass out of whatever numbers you are using for the design in memory. They could have come from "G" values or normalized "k" and "q" values. The design in memory is NOT lost. For more details, see the section on reference values.

Hard copy or review <H>

This option provides a central facility for recording designs on a printer or in disk files. The same data may also be reviewed on screen.

program stub Generator <G>

Many microwave filter designs can be done by substituting transmission line components for lumped components. This option activates and programs a utility which will convert selected L or C components in any design to distributed form. It can be programmed to operate automatically each time the "Calculate" command is given. It may also be used manually through the circuit editor to convert one component at a time. It is best used through the mechanical dimensions screen.

MakeTouchstone(R) file <W>

(Touchstone is a trademark fromerly of EEsof Inc.)

It is often desirable to perform optimization on a network or to combine filters with other networks. This option will write a file compatible with EEsof Touchstone describing the network in memory. A typical use might look like this:

—> TOUCHSTONE file generator <—
Touchstone file will be: default.CKT

The file generated will have the same name as the file name displayed on the main control menu but with the ".CKT" extension added. The file name is displayed here.

Use L and C elements including component Q (N or Cr) ?
Use transmission line physical elements (N or Cr) ?

Any components in the network can either be put to the file using infinite Q elements or elements which include losses. The Q values used are those shown in the "Assumed Q" window on the main control menu.

What is starting node number (Cr = 1) ?

This selects the node number associated with the first element in the CKT block of the file. The default is 1, but it can be any number you select.

FREQ block: Any commas (,) will be removed. (MHZ) will be added:
(Cr) to transfer 1500 to 5500 step 26.49 (MHZ)

SWEEP freq range: From To Step (MHZ) ? 1500 5500 50

This defines the sweep range in the FREQ block of the file. You are actually inputting a "string" of characters rather than 3 numbers. This string will be placed in the file exactly as you type it with two exceptions:

1 - The frequency notation (Units) will be added (MHZ in this example)
2 - Any commas (,) you might inadvertently have added are replaced by spaces.

Last node number used is 9
(Cr) to continue

After the file is written, the final node number used is displayed. Just press the <Enter> key to return to the Utilities menu.

==========

Resistor pads.

When designing an attenuator between two different load and source Zo levels, the S or P input configuration selection will choose a "Tee" (S input), or a "Pi" (P input) so long as the level of attenuation you request is possible between those loads. To design a minimum loss "L" pad, request 0 dB attenuation. The program will select the minimum loss and design the two resistors in the necessary configuration ignoring the S or P input configuration you have selected. Any time you request a lower loss than is possible between unequal load and source, a minimum loss "L" pad will result.

The standard selection dialog box

Many of the design modules use a standard dialog box to make selections. The one shown above is the one used by the power analysis. Notice that the [**8 Up**] and [**2-Down**] buttons as well as the other keys associated with the keypad are operated by the numeric keypad rather then the usual arrow keys. This is because Windows filters out these keys from dialog boxes. Windows uses the normal arrow keys to select the buttons themselves. Buttons may be selected highlighting the correct button with the arrow key and pressing either <**Enter**> or the <**Space bar**>. The best way however is simply to press the key shown underlined on the button itself. 3 other buttons are provided on the left. These are <**Esc**> which is normally equivalent to "exit" or "quit". The middle button displays the help screen for the associated window just above. The "**siZe**" button will adjust the associated window above to the correct size.

In general, in dialog boxes, the arrow keys will move between controls in a group and the <Tab> key will move between groups and between parameter edit boxes. After inputting or editing a value in a edit box the <Enter> key can be used to end the input.

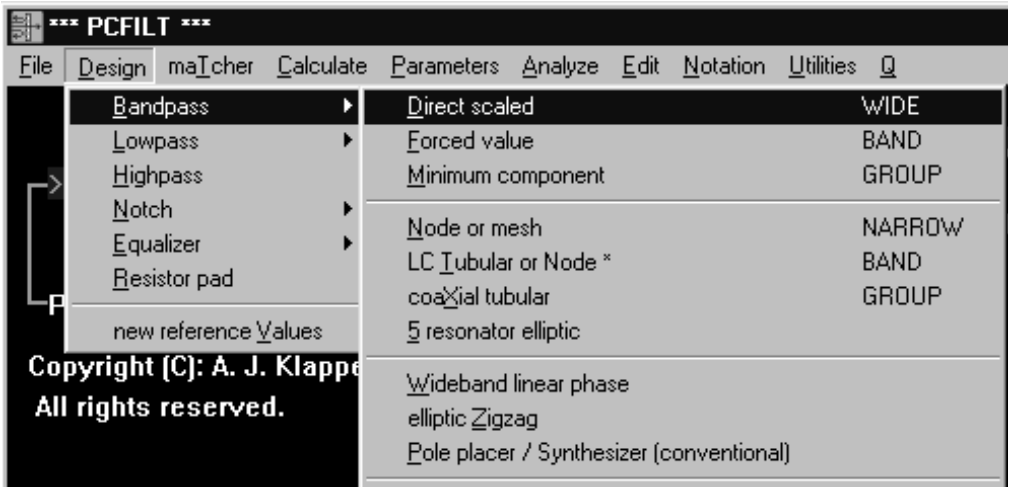
++++++++++++++++++++++++ A Sample session ++++++++++++++++++++++++++

In order to illustrate the use of PCFILT to solve a typical filter design problem, we will assume the following set of specifications for a bandpass filter:

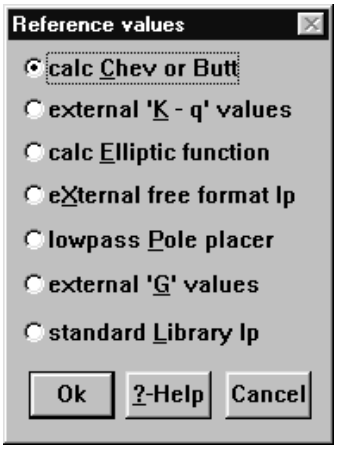
Passband characteristics:
    3 dB passband limits: 200 - 250 MHz.
Less than 1.5:1 VSWR across most of the passband
Stopband requirements:
    Greater then 50 dB at 300 Mhz.

The first step is to make a good guess based on your experience as to what type of filter is best suited for this set of requirements. In this case, the bandwidth is a bit too wide for a narrow band reactance coupled type of design, so a direct scaled design will be used. The stopband requirements don't seem to be too tight, so an all-pole Chebyshev design will be tried. The 1.5:1 VSWR requires a passband ripple of less then .1 dB. A passband ripple of .05 dB will suffice.

It is not necessary to be correct in your initial assumptions since PCFILT allows changes to be made so quickly that other designs can be tried with very little effort if you don't like the results you are getting.



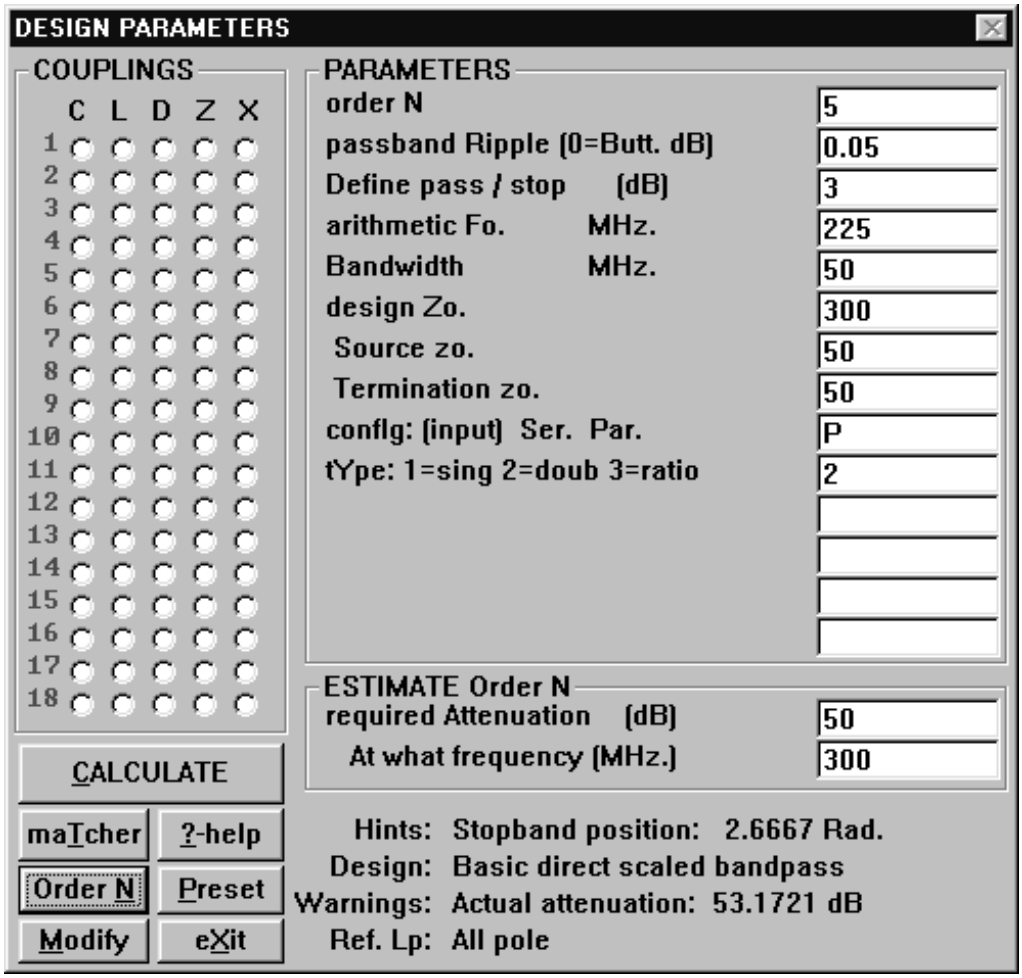
To select a direct scaled design for evaluation, from the Main control menu. Using your mouse, select “Design”, the “Bandpass” and finally “Direct scaled” from the menus.



The next menu to appear, the "Reference values" dialog box, gives the operator control over one of the most powerful features of the PCFILT program, the ability to scale any filter from any type of normalized reference lowpass filter. Normally, and in this case, we want to synthesize an equal ripple passband Chebyshev response. It is convenient to point out here that you can return directly to this menu by selecting the "new ref. Values" option in case it turns out that you need an elliptic response, or even a pole placed response to satisfy your requirements. You do not need to select the bandpass type again.

Now that the type of design and the reference lowpass from which it will be scaled has been established, the actual parameters used by the design equations in the program must be keyed in. This will be done using the "Design Parameters" dialog box which appears next.

Because the parameters used in the last design done are saved, both in memory and in the files generated when a design is saved to disk, the parameters displayed will be those of that last design.



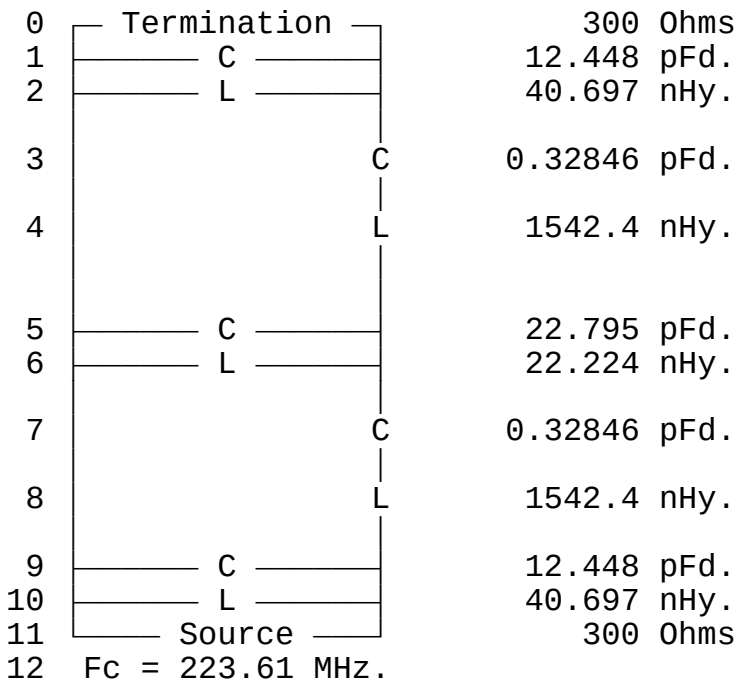
The parameters should be changed to that shown. Use you mouse to select the top parameter (order N) and moved down one parameter at a time using the <Tab> key.

Key in the 50 dB at 300 MHz. requirement from our specifications in the ESTIMATE Order N area. Press the [Order N] button.. The program changes the "order N" parameter to 5 poles no matter what it had been set to initially. It also informs you that there will be 53.1721 dB attenuation at that frequency with infinite component Q. Since this is only a 3.1 dB margin, most likely 6 poles will actually be required considering losses. Let's leave it like that for now and proceed with the design anyhow. We will come back and change it later!

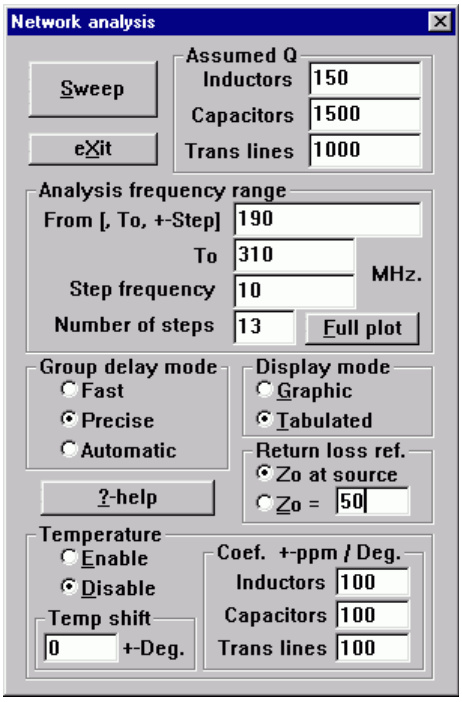
This design does not require the use of the impedance matcher so we need to press the [maTcher] button several time if needed until the matcher window on the main screen shows “X” and “X” for Source and Termination and “Disabled” below.

Simply press the [CALCULATE] button.

After the design is done, which will take only a fraction of a second, the parameters dialog box will disappear. At this point you will evaluate the design to see if the design requires modification. To see the schematic diagram simply select the circuit editor “Edit” from the top menu. The circuit editor will allow the schematic to be scrolled up or down in the case the window is too small to display the entire network. The schematic will lik like this:



At this point, the part values are not so good, but, we can worry about that later. The main thing we want to know now is how well the filter performs. To do an analysis run on the filter select “Analyze” from the main control window menu.



Set up the Network Analysis dialog box as shown. This will analyze filter at 13 frequency points between 190 and 310 MHz. The Tabulated display must also be selected. The Group delay mode is best left in the “Precise” mode. The Fast ands Automatic modes are only an advantage when using extremely slow computers.

Press the [Sweep] button.

The results are shown below:

```
Freq. (MHz.) Ret L (dB.)  Atten. (dB.)  Delay (nSec)   Phase (Deg.)
```

190.0000	0.433	24.452	11.2641	-363.071
200.0000	4.905	5.023<– F1	47.7895	-274.648
210.0000	26.662	1.290	30.3814	-129.324
220.0000	22.639	1.129	24.9504	-32.065
230.0000	20.351	1.160	24.1886	55.829
240.0000	21.462	1.375	27.8727	148.086
250.0000	4.869	5.019<– F2	38.1703	274.543
260.0000	0.537	20.336	10.9157	352.426
270.0000	0.226	31.884	5.0352	378.902
280.0000	0.133	40.537	3.0124	392.883
290.0000	0.090	47.464	2.0376	401.791
300.0000	0.065	53.243<– F3	1.4821	408.043
310.0000	0.050	58.199	1.1320	412.704

The stop frequency at 300 MHz. (F3) has a 3 dB margin, but note that the passband corners (F1 and F2) are over 5 dB down. Even on a relative basis (minus insertion loss) the passband corners are greater than the 3.0 dB down that our specifications call for. This is what component losses do to the response. The stopband attenuation is actually increased slightly, but the passband shrinks up requiring you to make the passband wider to compensate. So, let's do that.

With the main control menu displayed, select the “Parameters” menu option and move to the bandwidth parameter. Change it from 50 to 55 MHz and press the [CALCULATE] button.

Back at the main control window, select the “Analyze” menu option again. The Network analysis dialog box will reappear. All of your previous settings remain. You need only press the [Sweep] button again to analyze the filter over the same range again.

Freq. (MHz.)	Ret L (dB.)	Atten. (dB.)	Delay (nSec)	Phase (Deg.)
190.0000	0.615	18.872	14.9223	-348.903
200.0000	12.613	2.267<– F1	45.8814	-233.413
210.0000	34.797	1.123	26.6607	-113.612
220.0000	23.749	1.020	22.6340	-26.759
230.0000	20.348	1.055	21.9059	53.027
240.0000	24.163	1.196	24.4991	135.528
250.0000	10.266	2.618<– F2	37.3868	242.168
260.0000	0.797	15.537	14.0744	337.941
270.0000	0.278	27.365	5.9515	370.601
280.0000	0.155	36.175	3.4424	386.835
290.0000	0.103	43.185	2.2921	396.932
300.0000	0.074	49.010<– F3	1.6528	403.933
310.0000	0.056	53.996	1.2557	409.117

Now, the passband corner frequencies are less than 3 dB down, but look at the stopband (F3)! We need another section to get 50 dB at 300 MHz.

To make the change, go back to the Parameters menu and change the “order N” parameter from 5 to 6 and re-calculate. Do another analysis run:

Freq. (MHz.)	Ret L (dB.)	Atten. (dB.)	Delay (nSec)	Phase (Deg.)

```
190.0000      0.599      24.259        16.2199        -433.543
200.0000     17.814       2.514<— F1   58.4357        -288.139
210.0000     21.430       1.413        32.6473        -140.433
220.0000     23.377       1.256        27.9799         -32.841
230.0000     33.477       1.263        27.3963          65.523
240.0000     26.904       1.470        30.3737         167.427
250.0000     14.078       2.849<— F2   48.9860         299.567
260.0000      0.755      20.064        15.5368         421.589
270.0000      0.282      34.894         6.3072         456.749
280.0000      0.160      45.677         3.6212         473.886
290.0000      0.106      54.191         2.4023         484.487
300.0000      0.076      61.242<— F3    1.7283         491.817
310.0000      0.058      67.263         1.3109         497.233
```

Now, That's what we want to see! The next problem is the bad element values we noted earlier. To fix this requires that we select a different bandpass filter option from the new design menu.

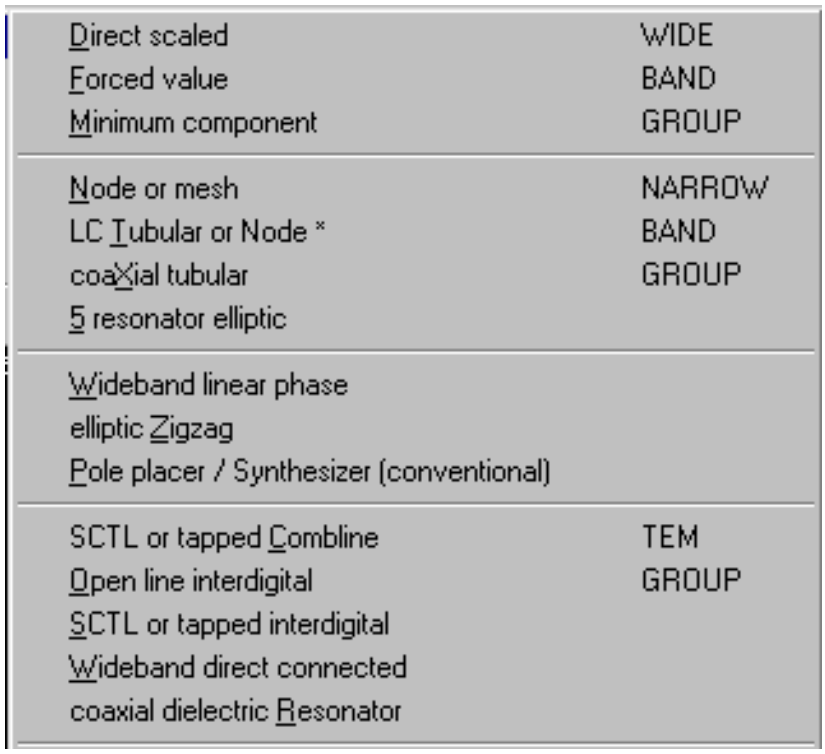
You might try the “Forced value” option from the WIDE BAND GROUP.

The parameters you have established by analyzing the basic direct scaled filter will be an excellent starting point for the Forced value or minimum component type of filter. For details on these two bandpass designs, see the section on the direct scaled filter design module.

Choosing commonly used bandpass filter types

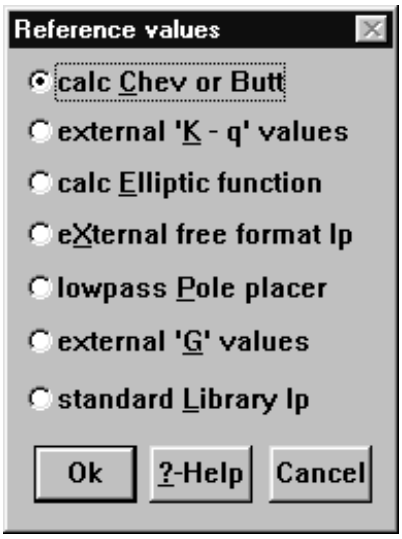
In the initial phase of learning PCFILT, there is often confusion about how to select the desired filter topology from the menus. Several of the more common filter types are displayed below with the menu items to choose for that type filter listed to the right. The location of these menu items are displayed below.

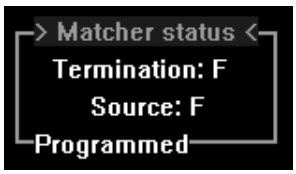
NOTE: These menu selections are only suggestions! Most combinations ARE legal! Any combination that is not logical will simply generate a warning message. No harm will be done! You are encouraged to experiment!



First, select the “Bandpass” menu from "Design" and second, select the bandpass design module.

Third, picked the reference lowpass.



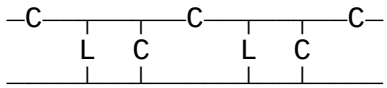


The "confIg" (configuration) option will appear on the PARAMETERS menu. Reset the matcher last of necessary.

There is also a group of very common bandpass filter types that are preset and can be selected quickly. These are available from the bottom of the bandpass menu.

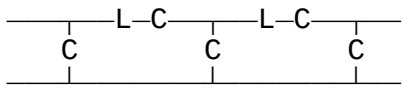
The organization of the bandpass menu may seem cryptic at first. The help option should be studied carefully as it will help explain the PCFILT “philosophy”. The arrangement is set up for maximum flexibility.

Filter — Menu items to choose



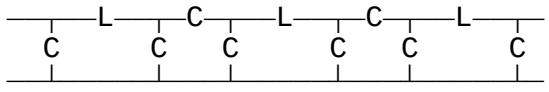
Top C Coupled Node (Tank)

[Use]--> Node or mesh
[either]-> L-C Tubular or Node
Chebyshev or Butterworth
configg: Ser. Par. Tubular P
Reset matcher Design Zo: 200-2000Ω



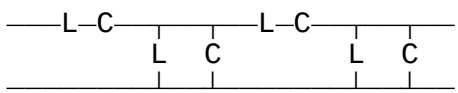
Shunt C coupled Mesh

Node or mesh
Chebyshev or Butterworth
configg: Ser.=mesh Par.=node S
Reset matcher Design Zo: 5-45Ω



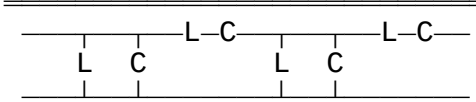
L-C Tubular

L-C Tubular or Node
Chebyshev or Butterworth
configg: Ser. Par. Tubular T
Reset matcher Design Zo: 5-45Ω



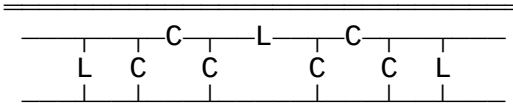
Series input direct scaled

Direct scaled
Chebyshev or Butterworth
configg: (input) Ser. Par. S
Disable matcher Design Zo: desired



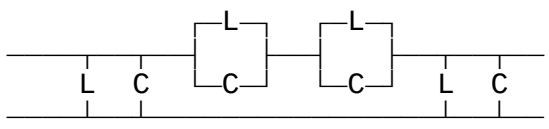
Parallel input direct saled

Direct scaled
Chebyshev or Butterworth
configg: (input) Ser. Par. P
Disable matcher Design Zo: desired



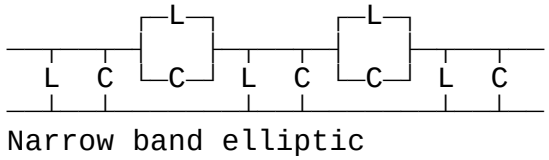
Forced shunt direct scaled

Forced value
Chebyshev or Butterworth
configg: (input) Ser. Par. P
Reset matcher Design Zo: 200-1500Ω



Direct scaled elliptic

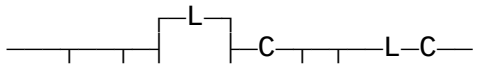
Direct scaled
Elliptic function
configg: Ser. Par. Tee Delta P
Reset matcher Design Zo: 50-300Ω



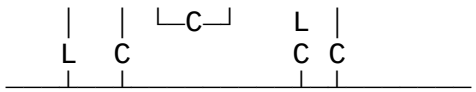
Narrow band elliptic

5 resonator elliptic

configg: (input) Ser. Par. P
Reset matcher Design Zo: 100-1000Ω



elliptic ZigZag

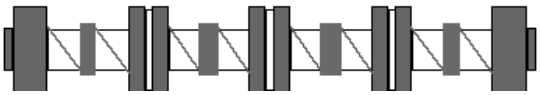


Even order elliptic Zig-Zag

confIg: Standard Transform S
Reset matcher   Design Zo: 40-60Ω

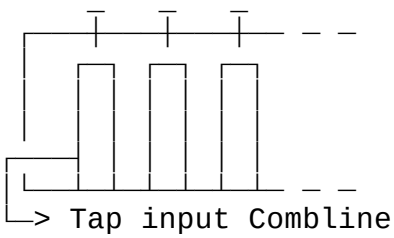
---

coaXial Tubular

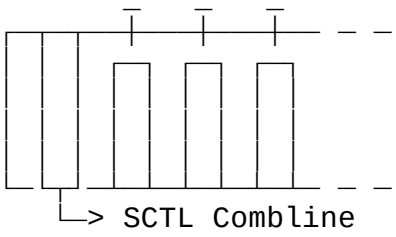


Coaxial tubular

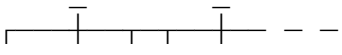
Chebyshev or Butterworth
do NOT reset matcher
Design Zo: 2-30Ω



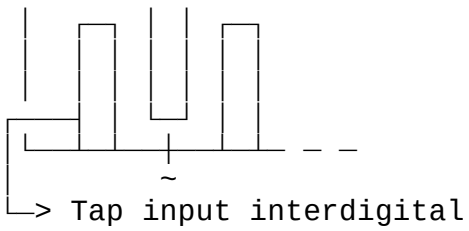
SCTL or tapped Combline
Chebyshev or Butterworth
confIg: S=SCTL T=Tap C=Cap. T
Matcher is OFF
Design Zo: 60-110Ω



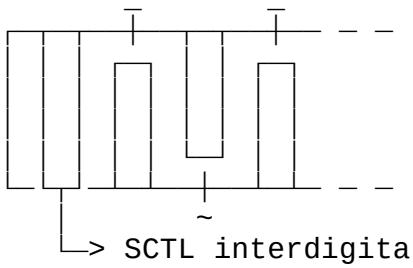
SCTL or tapped Combline
Chebyshev or Butterworth
confIg: S=SCTL T=Tap C=Cap. S
Matcher is OFF
Design Zo: 60-110Ω



SCTL or tapped Interdigital
Chebyshev or Butterworth

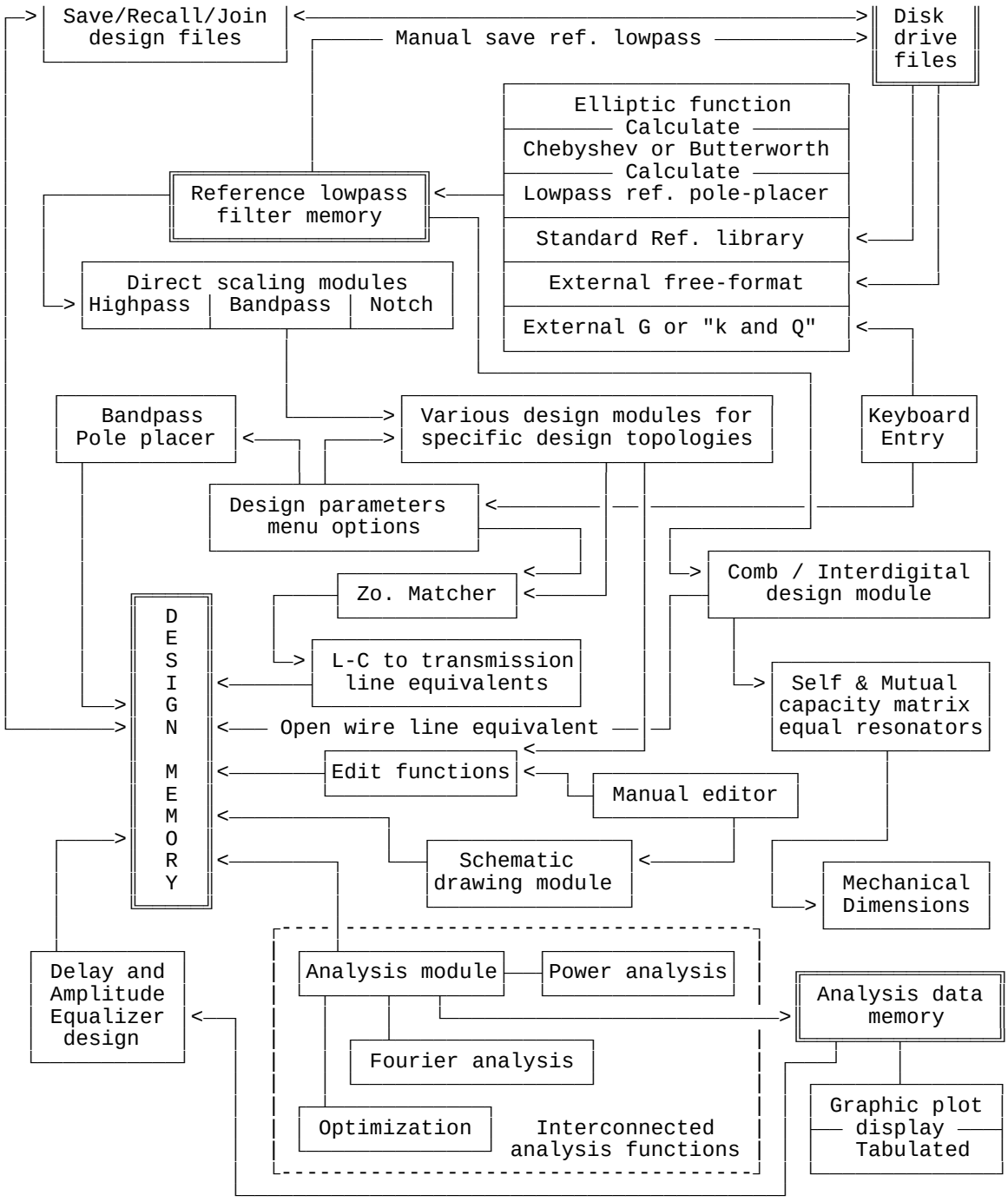


confIg: S=SCTL T=Tap C=Cap. T
Matcher is OFF
Design Zo: 60-110Ω



SCTL or tapped Interdigital
Chebyshev or Butterworth
confIg: S=SCTL T=Tap C=Cap. S
Matcher is OFF
Design Zo: 60-110Ω

Simplified block diagram of PCFILT modules


Save/Recall/Join design files
Disk drive files
Manual save ref. lowpass
Elliptic function
Calculate
Chebyshev or Butterworth
Calculate
Reference lowpass filter memory
Lowpass ref. pole-placer
Standard Ref. library
Direct scaling modules
Highpass
Bandpass
Notch
External free-format
External G or "k and Q"
Bandpass Pole placer
Various design modules for specific design topologies
Keyboard Entry
Design parameters menu options
Zo. Matcher
Comb / Interdigital design module
DESIGN MEMORY
L-C to transmission line equivalents
Self & Mutual capacity matrix equal resonators
Open wire line equivalent
Edit functions
Manual editor
Schematic drawing module
Mechanical Dimensions
Delay and Amplitude Equalizer design
Analysis module
Power analysis
Analysis data memory
Fourier analysis
Graphic plot display
Tabulated
Optimization
Interconnected analysis functions