Automatic programmable Zo matcher

In order to allow a design to be done at the impedance level (design Zo) that yields the most desirable parts values, a method must be provided to match this design impedance to the needed load and source level. This module has been developed to do this job in a semi-automatic fashion.

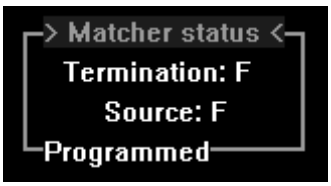
Once the matching method (topology) has been chosen from the list of options presented, a filter may be designed at any impedance level, adjusted for center frequency or bandwidth and recalculated at will. The matcher is then said to be "programmed". Only in the event that the chosen matching method becomes invalid will it be necessary to specify the matching set up again. Matching may be done to any filter that falls into one of these two major categories:

(1) Parallel input or output with a design Zo GREATER than the needed load impedance.
(2) Series input or output with a design Zo LOWER than the needed load impedance.

Each end of the network being matched is treated separately and can be of either the series or parallel input type. The ends are identified as LOAD and SOURCE. Source is the end displayed at the bottom of the schematic as drawn by the circuit editor module. The termination end is at the top. Matching methods may be mixed as desired.

All of the matching methods utilized by this module should be considered NARROW BAND IN NATURE and will have increasingly detrimental effects on the passband return loss of a filter as its bandwidth increases. In most designs however, this effect is of very little consequence. These matching circuits will also have increasing effects on the skirts of a filter with widening bandwidth making the choice of networks an additional tool in controlling stop band performance.

The desired load and source impedances into which the filter must be matched are set on the parameters menu. The matching method is selected from a menu that will be presented after the initial design (Calculate command) if the matcher was reset at the main control menu, or if the selected method becomes invalid. A selected method could become invalid for many reasons. The users decision to use a different type of filter without resetting the matcher is one common and normal reason.



In order to keep the operator informed as to the matching method that is selected, a window is provided on the main control that indicates the status of the matcher.. The selected matching method is displayed for both the source and termination ends of the design.

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╒==> Matcher status <==╕          The selections will be:
|   Termination: X    |          A-H or T indicates the matching method.
|     Source: X       |          X indicates that matching is bypassed (none).
└── Disabled ─────────┘          ? (Question mark) indicates a reset condition.
        |
        └── This will say: Disabled, Reset or Programmed.
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The matcher is controlled by selecting the matcher option on the main control menu or clicking the mouse LEFT button while the mouse marker is in the status window. The action taken when the selection is made will depend on the status of the matcher at that time. The states will rotate between these three conditions:

Reset: Source and termination selections are set to question marks (?). This tells the matcher to present the list of valid matching methods immediately after the design is done (after Calculate).

Disabled: Causes the matcher to bypass matching on both ends. The status window will show (X) for both source and termination.

Programmed: Indicates that the matcher is all set to quietly apply the previously chosen matching networks to the filter each time the “Calculate” command is given. Only if some change in the parameters causes a selected matching method to become invalid the matcher dialog box will reappear to present the latest menu of valid matching options

The matcher can also be controlled from the parameters menu in the same way except that only a [maTcher] reset button is provided.

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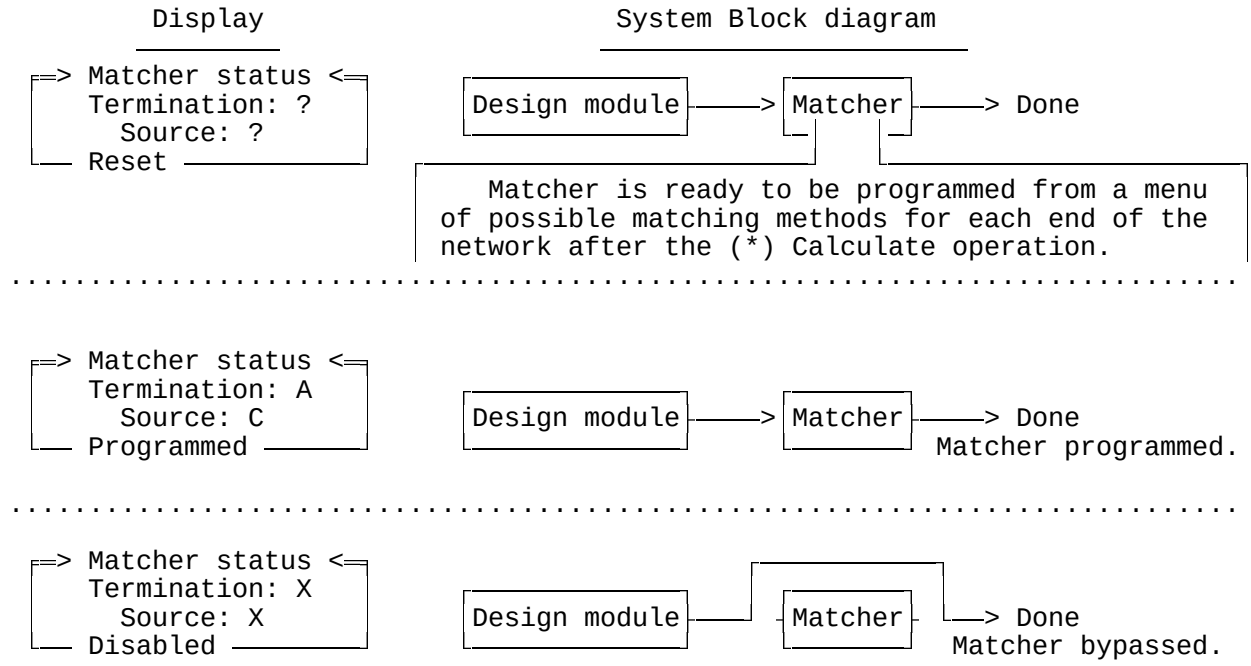
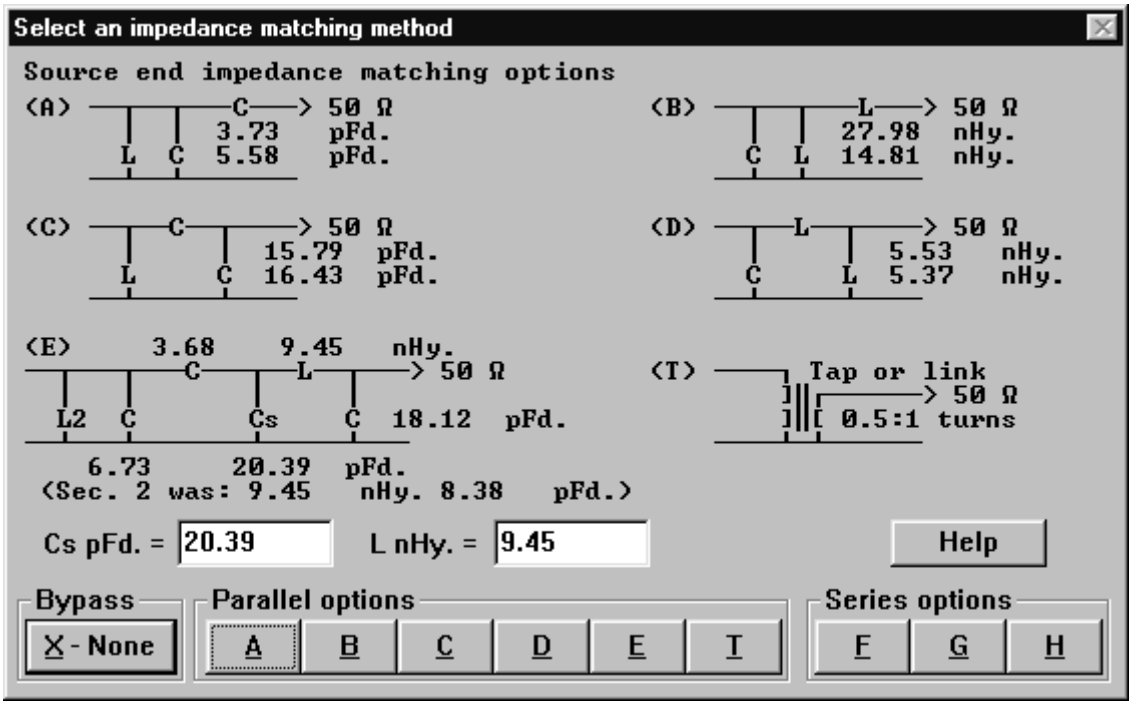
In addition to the semi-automatic operation of the matcher, either end of a network may be matched manually from the utilities menu. When the matcher is called manually, the list of valid options is presented without resetting the matcher at the main menu. This also sets the matcher at that end.

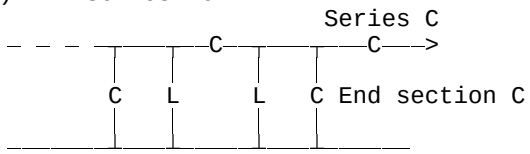


The matching circuits provided are:

Parallel input options



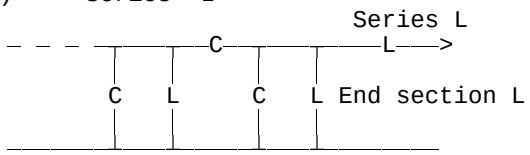
(A) Series "C"



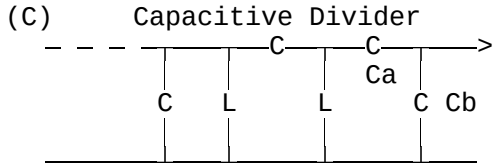
This method is very neat, simple and widely used. It will have the effect of sharpening the lower skirt of a wideband design at the expense of the upper skirt as it adds and additional transmission zero at DC.

In some cases the net capacity as seen by the filter through the load can be greater than the capacity of the filter being loaded, in this event, the section capacity required becomes negative. If this happens, this method invalid and is not displayed.

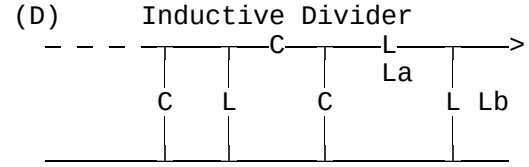
(B) Series "L"



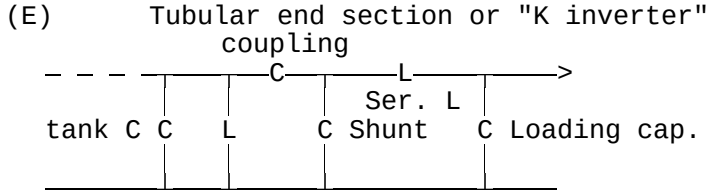
Series inductance loading is best used in a wide bandwidth capacitively coupled node filter having only a few poles. It tends to skew the stopband in the opposite direction than the series C method, thus squaring up the sloppy upper skirt of that type design. This method can cause excessive insertion loss in narrow bandwidth applications usually making series C the better choice. As with series C loading, negative values will sometimes appear making this method invalid. This method adds a transmission zero at infinite frequency.



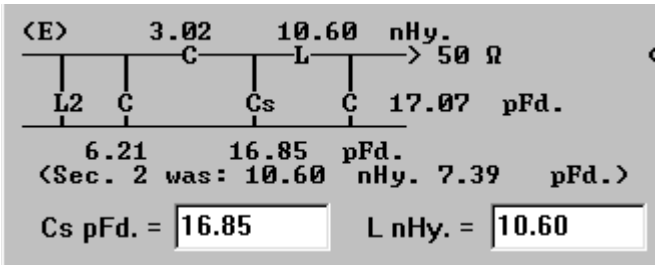
This method will show rather large values of capacity at the shunt position (Cb) with narrow bandwidths, but seems to have very little effect on the passband of wider bandwidth designs making it a good choice for direct scaled designs such as elliptic filters. Under certain conditions, an imaginary root condition can develop in its design equations making the method invalid.



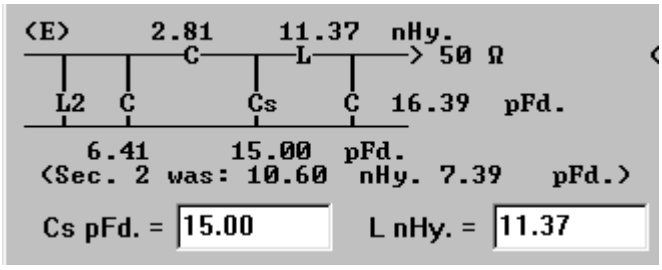
The performance of this method is virtually identical to capacitive divider matching except that it provides a DC path to ground.



This method uses a "K" inverter to transform the last section into a series tuned circuit. The impedance at the input to this series section will be chosen less than the desired load impedance so that it may be further converted back up to the desired Zo by a "shunt C" capacitor marked "Loading cap" above.



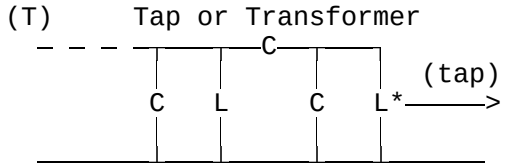
Initially the (E) option presents the values calculated to make the series inductor (Ser. L) equal to the other inductors in the network. The values of the series inductor and the second shunt capacitor (Cs) are presented in edit boxes which allow to the change the value to whatever you need, most likely a standard capacitor value for Cs.

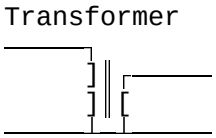


Once you have keyed in the value you want for either Cs or for the series inductor, press the (E) button again. The display will present the new network with all of the components recalculated to accommodate the value you have keyed in. In the example shown here, the 16.85 pFd shunt capacitor (Cs) has been forced to a standard 15 pFd. Capacitor. Press the (E) button again and the matching is complete for this particular end of the filter.

(X - Done) - Bypass-No matching

This option disables the matching on one end of the network. Use it on both ends to take the matcher off line without disabling it at the main control menu. You may also bypass matching on one end only by this method.

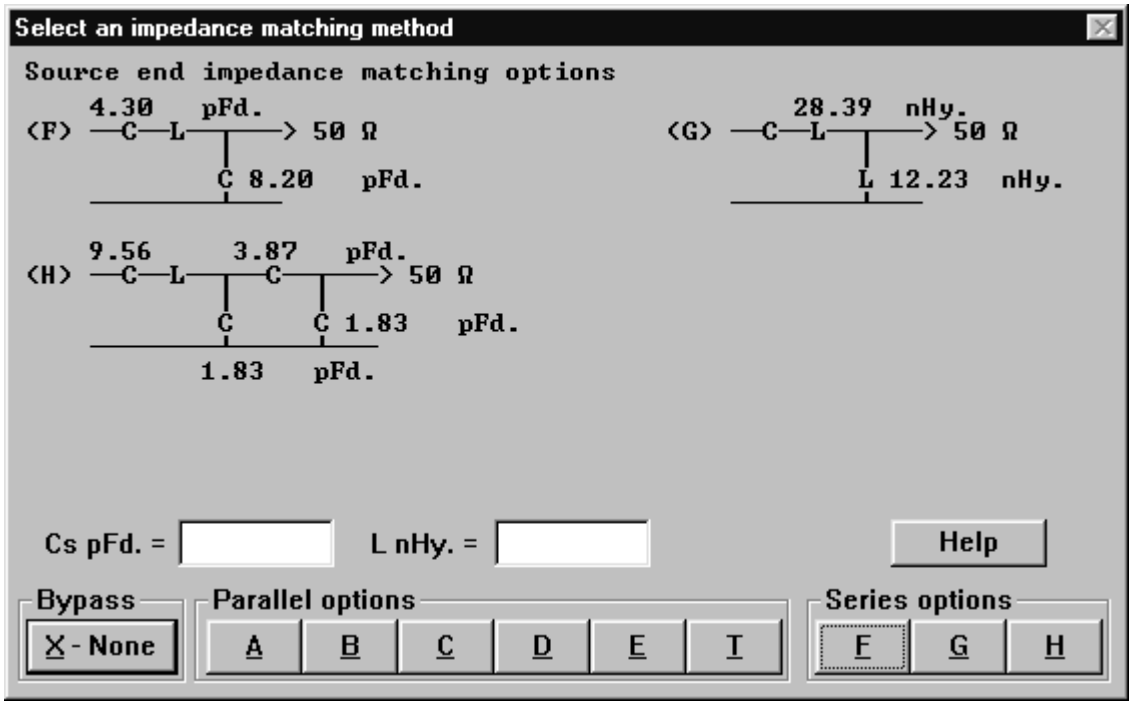




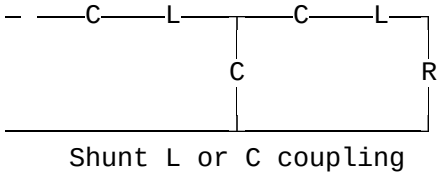
In designs where a toroid core wound with many turns of wire is used for the section inductor, it is convenient to tap or link the winding making a simple transformer. If this method is desired, it may be considered to have no effect whatever on the performance of the filter.

Series input options

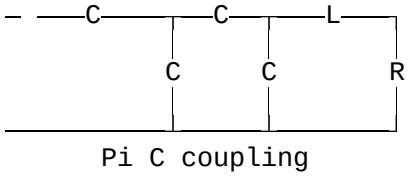
Note that the matcher is compatible with filters that have EITHER of the following topologies at



either end.

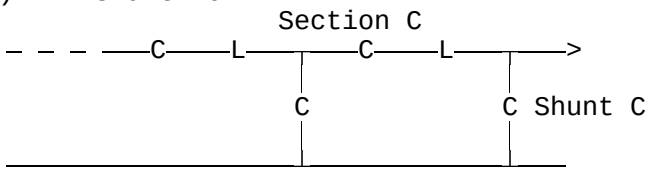


Shunt L or C coupling



Pi C coupling

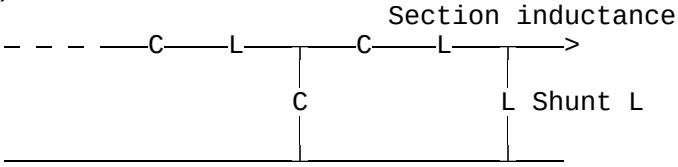
(F) Shunt "C"



This method is clearly the method of choice for most designs. It has little effect on passband, but tends to sharpen the upper skirt at the expense of the lower. In some cases, the net capacity seen by the filter can cause the end section series capacitor to become huge or even negative.

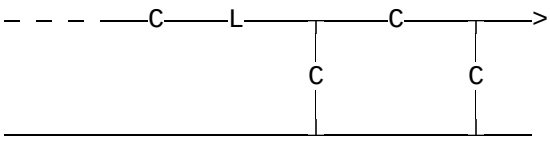
In the event the section capacity becomes too big, or goes negative, the best thing to do is to redesign the filter with a different design Zo.

(G) Shunt "L"



Shunt L is best used when a DC path to ground is desired for compatibility with external circuits. It can also be used to increase attenuation slightly in the lower stopband at the expense of the upper one.

(H) "Pi end slug"



The "Pi end slug" is primarily for use with very narrow bandwidth coaxial tubular filters to reduce the size of the large end slug associated with the "Shunt C" matching method. It can also be used with L-C designs.