

## L-C → Stub Generator

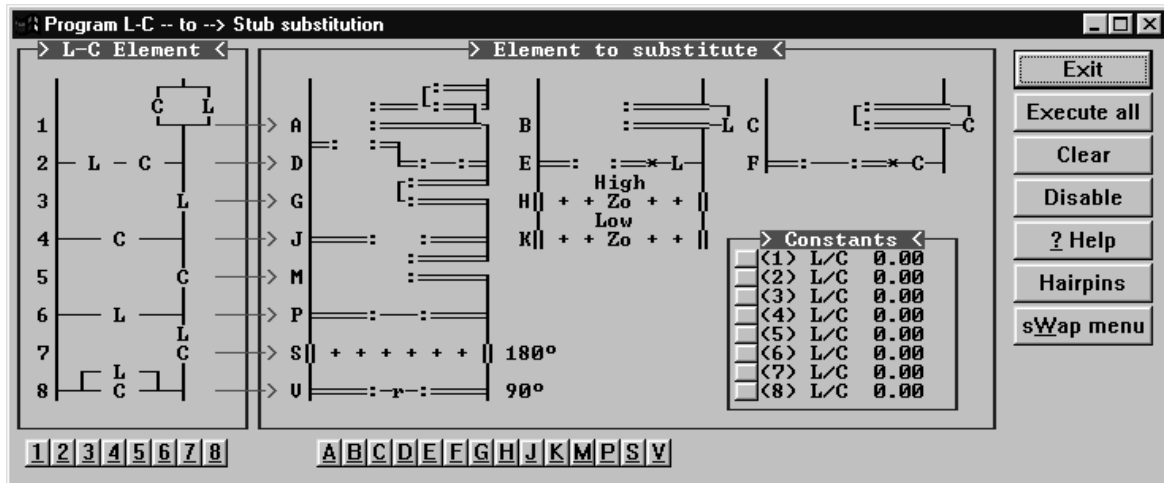
In some applications, lumped components must be replaced by transmission line stubs or series lines. A "stub" is a transmission line with one end either open or short circuited. A transmission line less than  $\frac{1}{4}$  wavelength (less than 90 Deg.) long with a short circuit at one end will appear as an inductor at the other end. A similar open transmission line will resemble a capacitor. A series connected line can also be used to simulate a series resonant L-C "tank" circuit, a series inductor or a parallel connected capacitor, depending on its length and relative impedance.

Note: You should keep in mind that these equivalents are not exact. The final design may require optimization for return loss after all the substitutions are done. Transmission lines will also exhibit responses which alternate at multiples of  $\frac{1}{4}$  wavelength causing multiple passbands and stopband anomalies to occur in any filter made from them.

A facility is provided that, once programmed, will make these substitutions either automatically, to the entire network when the "Calculate" command is given, or manually, using the circuit editor to convert one component at a time.

The stub generator is available for programming from the UTILITIES menu.

When the "Stub Generator" is called, this screen will appear:



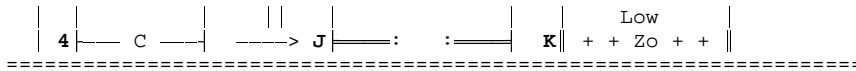
At this point, the stub generator is now enabled and will remain enabled until it is turned off by pressing the **[Disable]** key. Displaying the stub generator menu activates (enables) the stub generator.

When the stub generator is enabled, a warning message will be displayed just below the main control menu and on the mechanical dimensions menu. The stub generator may also be turned off (disabled) by clicking the left mouse button while the mouse marker is resting on this warning message.

Stub Generator enabled

Eight basic, purely L-C lumped component branch types are displayed on the left of the L-C → Stub Generator menu (options 1,2,3,4,5,6,7,8). To the right are several stub equivalent networks that may be substituted in a filter. Each of the 8 L-C type substitutions operate independently of the others.

For example, if you wished to have shunt capacitors replaced with stubs, you have these two possibilities (J or K):

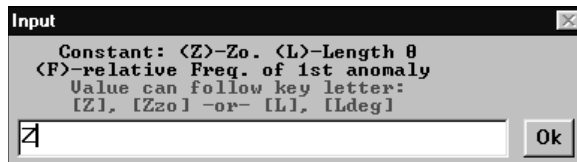


Option (**J**) will replace a shunt capacitor with a shunt open stub.  
 Option (**K**) will substitute a series connected low impedance line.  
 Selecting option (**4**) will turn OFF all substitutions for shunt caps.

Selections of what element to substitute can be made in three different ways. The first way is by pointing to the desired element right on the menu using your mouse then clicking the LEFT mouse button. An array of buttons located below the menu provides another way to select the elements. There is a button corresponding to each element type. These buttons also provide hot keys so that you may make the selections by pressing the keyboard key letter that identifies each element type.



After the type of stub is selected, a second prompt appears requesting the constant parameter for the stub. Two parameters are required for a line used to make an equivalent stub, line impedance and the line length. You must select one manually and the computer calculates the other.



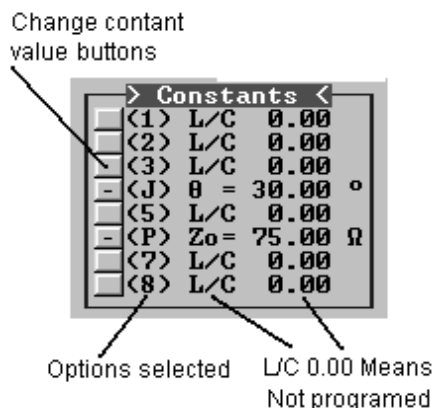
(Z)-Zo. - You specify the impedance of the stub and the computer will calculate the necessary length for that Zo.

(L)-Length Θ - You specify the length of the stub (in Deg.) and the computer calculates the required impedance for that electrical length.

(F)-relative Freq. of 1st anomaly - You specify the relative frequency where the first resonance of the stub will occur. This will determine the length of the stub. The computer calculates the impedance. If you specify 5.0 for example, the first anomaly will occur at 5 times the reference frequency for the line. This feature is implemented only for



simple stubs (selections: J, N, R and V).



You may run-on the responses to the constant parameter prompt. For example, do this to specify a line length of 45 degrees:

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Constant: (Z)-Zo. (L)-Length Θ
(F)-relative Freq. of 1st anomaly
L45
```

The options and constants you have programmed are displayed in the small window in the lower right corner of the menu. These constants may be changed by selecting the appropriate button just to the left. with the mouse. Series connected lines simulating series L-C tank circuits will show as 180 Degrees. "z" type stopband notch stubs will show as 90 Degrees in the same way. This is for your information only. In these two cases, changing the lengths will have no effect.

This information is also saved with the design in the ".SPK" specifications file. The stub generator enabled / disabled state is also recorded.

Several command buttons are located to the right of the menu. These are used to control how the stub generator operates.

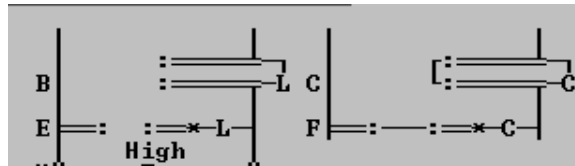
**[Exit]** - Press the <Space> bar when programming is complete and you want to exit. Nothing will happen yet (no substitutions will be done).

**[Execute all]** - Press this and the stub generator will perform all of the programmed substitutions to the network in memory and remain active.

**[Clear]** - The clear key will clear all the substitutions, just as if you selected the 1,2,3,4,5,6,7 and 8 options separately. Even though the stub generator is actually still enabled, it will do nothing as all the options are programmed out. Use this when you want to reprogram all of the options from scratch.

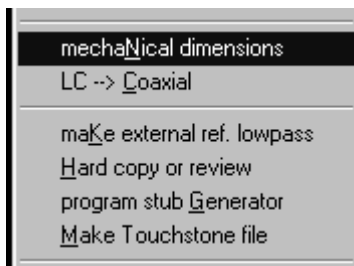
**[Disable]** - This will turn the stub generator OFF, that is, deactivate it without deprogramming it.

**[sWap menu]** - Swap menu - Pressing the (W) key will cause and alternate menu of stub options to appear for selections C, E and F.



**[Hairpins]** This programs the stub generator to assume hairpin inductors if 350 Ohm impedance for 6 different situations. The stubs associated with network codes 46 and 47 are also programmed internally but do not show.

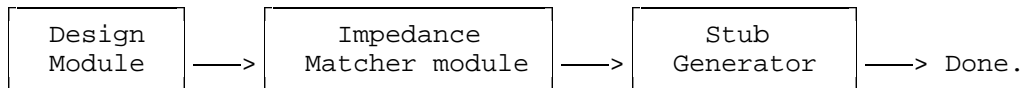
The [Back] or **[Exit]** keys will exit and close the window.



The stub generator can be used in 3 different ways.

1 - It may be used to make substitutions to every equivalent you have programmed that it can find in the network now in memory by using the **[eXecute]** button immediately after programming.

2 - You can program the substitutions that you want and then simply exit with the **[exiT]** button. Nothing will happen until you select "Calculate" the next time. The stub generator is called every time a design is done (following the impedance matcher) if it is active (enabled).



3 - The stub generator can be programmed and used later to make substitutions one branch at a time using the circuit editor **Stub** command from the **[MIS3:]** menu. To do this, simply exit the stub generator with the [Back] key and enter the circuit editor. You can also program the stub generator using the **Prog Stuber** command directly from the editor.

## Mechanical dimensions for microstrip

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Microstrip dimensions can be calculated for filters designed in this manner using a special menu screen optimized for this purpose. It has been included in the mechaNical dimensions & spacing module accessible from the UTILITIES menu.

This module will operate on any L-C design and will display the width and length of any transmission lines that happen to be in the design. Microstrip lines are assumed for all lines. Any L-C components in the design are simply ignored. This allows L-C and transmission line elements to be in the network at the same time. All of the major development features of PCFILT (analysis, optimization, etc.) are available directly from this screen allowing development of a filter with both performance and realizability in mind.

A typical design might look like this:

> MECHANICAL DIMENSIONS and SPACING <				Stub generator enabled	
** General microstrip **				> Control <	
Branch	Line Zo	Width	Length	Substrate	
number	Ohms	In.	In.	K=2.22	
				thick=0.032	(S) Substrate thick = 0.032
2	26.000	0.2342	0.2643		(D) Dielectric k = 2.220
4	38.952	0.1375	1.0198		(G) L-C —> stub Generator
6	26.000	0.2342	0.3716		(C) + Calculate design +
8	38.952	0.1375	0.9018		(P) Parameters
10	26.000	0.2342	0.3814		(A) Analyze
12	38.952	0.1375	0.9018		(E) Edit
14	26.000	0.2342	0.3716		(O) Optimize
16	38.952	0.1375	1.0198		(X) eXit to main menu
18	26.000	0.2342	0.2643		(N) Next screen

The control menu for the general microstrip development screen are described below:

**(S) Substrate thick = 0.032**

**(D) Dielectric k = 2.220**

These two options set the specifications for the microstrip substrate to be used. These values are stored in the ".SPK" design file. The values are stored in the same file location as other mechanical dimension for combline and interdigital filters. This means that the substrate thickness and dielectric constant values initially shown may be dimensions used for the last comb filter design you did.

**(G) L-C —> stub Generator**

This provides access to the stub generator screen. It operates exactly as it does when called from the UTILITIES menu or the circuit editor. You can turn the stub generator off by clicking on the "Stub generator enabled" warning message with your mouse. Simply displaying the Stub generator screen will turn it back on.

**(C) + Calculate design +**

This does a total recalculation of the design from the initial design parameters. The stub generator

and matcher modules operate normally.

**(P) Parameters**

This option calls the design parameters menu. All options operate normally including "(\*)-Calculate".

**(A) Analyze**

Use this to analyze the design to evaluate any changes in transmission line impedances made for realizability.

**(E) Edit**

Calls the circuit editor to draw the schematic or do editing. You can call the stub generator from the editor if you choose to. Individual stubs may be converted manually using unique parameters without effecting the others.

**(O) Optimize**

This option calls the optimization screen. You can use all of its options without any conflicts, including analysis and circuit editing. The elements that usually require optimization are series lines used as series inductors or shunt capacitors, particularly those involved in end section "matcher" networks.

**(X) eXit to main menu**

Returns to the main control menu.

**(N) Next screen**

Because there are often more stubs and lines in a design than there are rows on the screen to display them, this option will allow one screen at a time, in turn, to be displayed. This will only be needed for large networks. Each time it is invoked, the display moves down the network, toward the source end, by 20 "lines".

### Hard copy printouts

To make hard copy printouts or disk files of the final dimensions, use the "Hard copy" option available from the UTILITIES menu. If a disk file is generated, it will be named "filename.5HC". Dimensions for the entire network will be printed regardless of its size.