Optimization

The optimization module is a part-by-part iteration tool that allows the user to improve the performance of networks that were designed using procedures that could be considered as less than exact. Optimization can be performed on any of 3 different parameters which the program refers to as the "job". Group delay, return loss or amplitude flatness are the three parameter "jobs" which can be optimized.

A good use for return loss optimization would be to force a stand- alone highpass and lowpass filter joined together to form a non-contiguous diplexer to coexist properly. Delay optimization works well with linear phase designs.

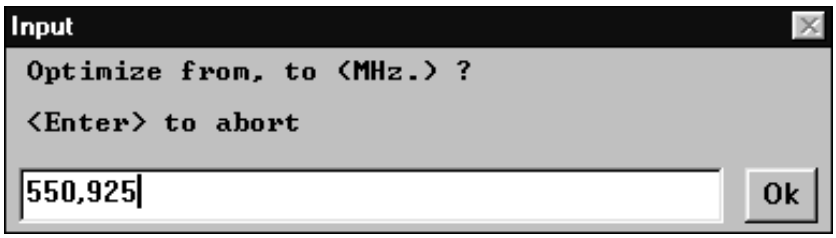
The operator is required to select the branch or range of branches that is to be iterated on manually. Experience with the use of this module and with tuning actual hardware has shown that the selection of the correct part to optimize at a given time, and over what frequency range is critical. It will take some time to get familiar with this module and to get maximum benefit from it. Using this module can be thought of as "tuning" the filter in the computer, therefore no more can be expected of optimization than could be expected of "tuning" the same design in real hardware form.

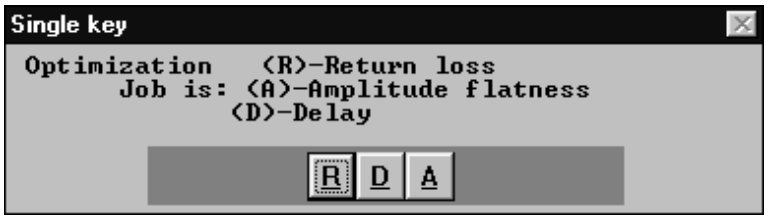
The program strives for lowest possible error by looking for the worst case of several frequency points and making changes to the selected branches in steps that get smaller each time the direction of the steps is reversed. The step direction is reversed every time a step causes the worst case error to get worse. Each reversal is referred to as a "stage". This reversal process is repeated as many times as you request.

The selection of frequency range is the most critical variable of all, and is best chosen by first analyzing a design and selecting a range over which improvement can be expected. The analysis and high resolution graphics modules are available from this module so that frequency changes can be made by simply moving the marker and pressing the <Ctrl F1> or <Ctrl F2> keys.

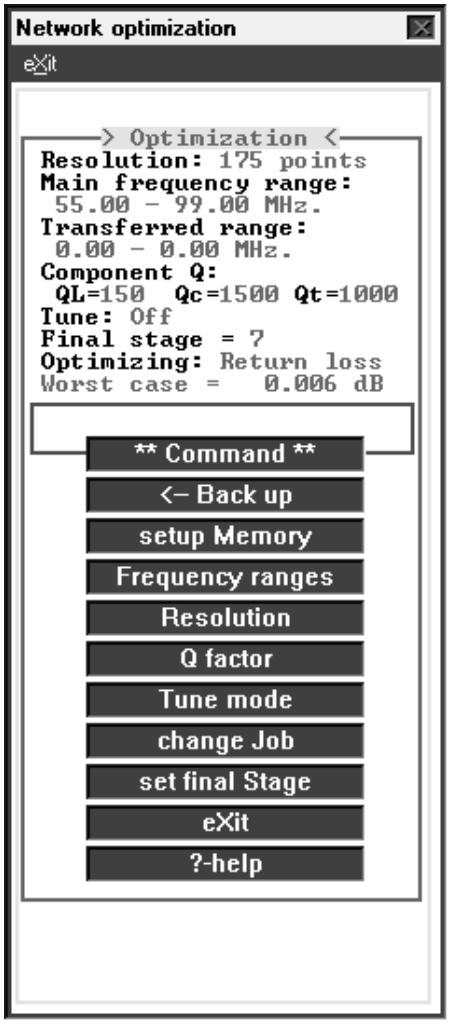
The optimization screen consists of the controls to perform the optimization only. The results are displayed on the same pot as used by the main analysis program. The plot window will be forced up by the optimization window. It is best positioned to the side of the optimization window without overlap. The two windows will not operate together if one or the other is maximized.

When entering the optimization module from the utilities menu, the program will request the "job" and frequency range (if it was not previously set using the graphics module).





To pick the “Job” select **[R]** Return loss, **[A]** Amplitude flatness or **[D]** Delay. The default is R



The optimization window and graphic plot window will come up as soon as the job is selected. Set them side-by-side.

The buttons are used to control the optimization. The function of each is explained:

[**Command **]

#,#-#,#/#,#&#

L, A, B..G and R

The branches that are to be iterated on are picked by this option. The branch numbers are the numbers that appear on the schematic as drawn by the edit module. The actual command line will appear in the form of a dialog box when the [**Command**] button is pushed. The program will iterate on a single branch at a time, or on a range of branches, in turn. There is also a command that will allow the previous command line to be repeated continuously.

A list of single branches can be input separated by commas. Each of these branches will be iterated on in the order shown.

—> 1,6,2,5

A range of branches can also be programmed by using the "-" symbol to count up or down. 10-15 will count up: 10,11,12..15. By specifying the range in the reverse order, 15-10 the branches will count down: 15,14,13...10. In this case, every branch between 1 and 15 except 6,7,8 and 9 will be iterated on in numerical order.

—> 1-5,10-15

The program also allows the L/C ratio of a "tank" to be iterated on without changing its resonant frequency. Specify the two branches of the "tank" with a "/". To optimize the L/C ratio of the resonant circuits at branches 4 and 5, and at 10 and 11, do this:

—> 4/5,10/11

The letter "L" will optimize all branches containing inductors.

—> L

Branches can be iterated on in any order or pattern needed.

```
—> 2,1/2,6-8,3,5,6/7,L
```

It is often desirable to do optimization on a symmetrical network so that branches are changed in pairs retaining symmetry. To do this you may specify two branches that you wish to remain equal separated by the "&" "and" symbol. In the example below, branches 14 "and" 23 will be iterated at the same time, in equal steps.

```
—> 14&23
```

The previous command line can be repeated continuously until the [BAck] key is pressed by using the "R" (Repeat continuously) command.

```
—> R
```

WARNING: If you use the "R" command like this, it MUST be the only thing on the command line. If anything else is there, including spaces, **the last command line will be lost!**

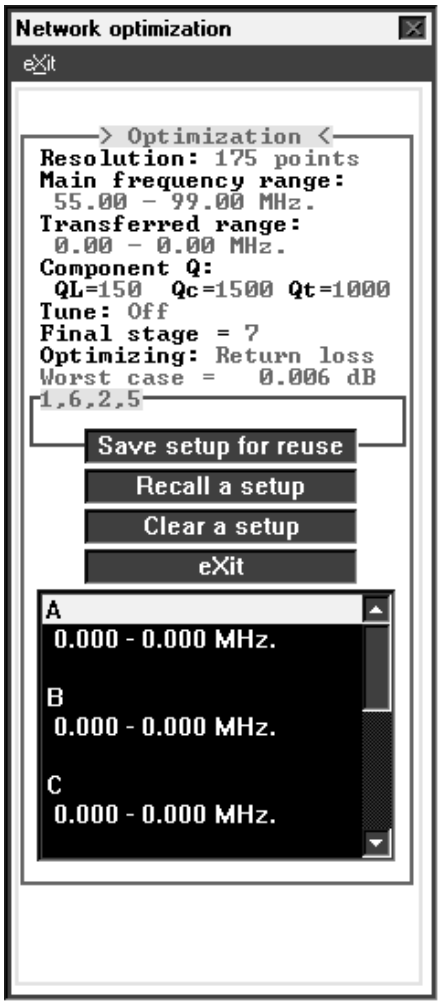
You may also just stick the repeat command into the command line.

```
—> 1,2,4R
```

Entire command lines may also be stored and referred to later as letters A through G by using the setup memory feature.

[<-Back up]

Use this to Un-Do the last optimization. Everything done by the last command will be undone.



[Setup memory] (save setup)

Setup memory is used to store up to 7 previously used command line, "job" and frequency range settings so that they may be called up later.

This feature is primarily intended to be used with multiplexers where each frequency channel will require a different frequency range and group of branch numbers. The frequency ranges are better controlled using the Frequency range segments on the main menu and selecting job and branch numbers here.

The options for setup memory control are:

[Save setup for reuse]

Any previously used setting may be recorded unless the command line refers to other previously recorded memory registers (A,B etc.). That is, they can't be nested.. Only command lines referring to branch numbers may be recorded. Up to 7 setups may be recorded and will remain until you manually clear them, even after exiting from the optimization module.

[Recall a setup]

Although any recorded setup may be reused by calling it in the main command line (on the main screen) by its letter designation (A,B etc.), the current setup will return on completion. it is often necessary to

make one of the recorded setup conditions the current one. On recall, the current set up is lost. The recalled command line may also be edited this way. To make recorded setup B: the current set up, for example, highlight it by clicking on any of the three lines in each memory with your mouse and press the [Recall a setup] button.

[**Clear a setup]**

Wipe clean any recorded settings that are no longer needed leaving room for new ones. Select the memory you want to erase by highlighting it with your mouse and press the [Clear s setup] button.

[eXit]

Teturn to optimization menu.

Once a setup has been recorded it may be called from the command line just as if it was a branch number. Any combination of branch numbers and memory setups may be used. You can also use the repeat command (R) along with the memory feature. Like this:

--> 5,6,A,B,16-18R

--> A-C,17,19,D-FR

Remember that any branch numbers that are specified will be done with the other settings ("job" and frequency range) that are showing when the command is given, as is normally the case. During the execution of the memory setups called, the settings will change to those recorded and back again when done.

Frequency ranges

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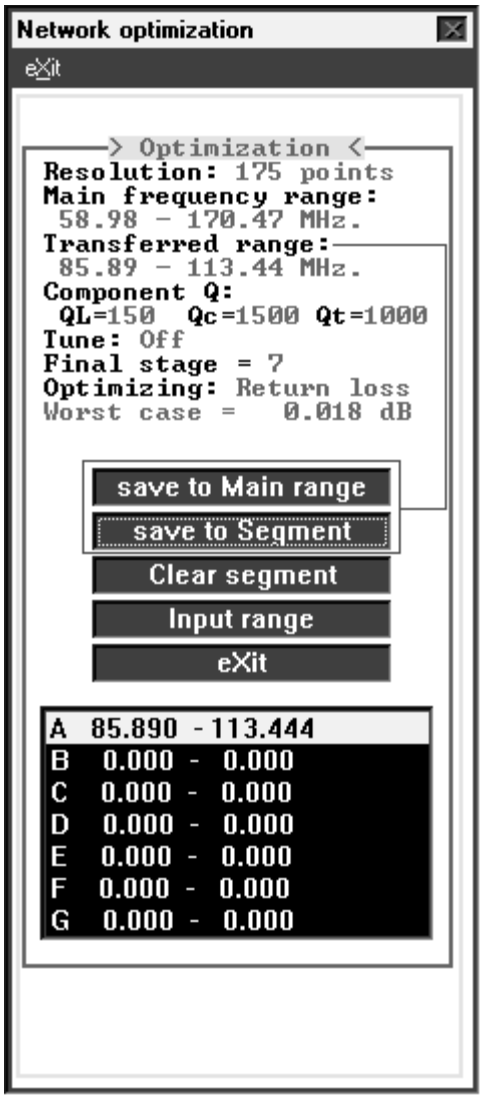
[Frequency ranges]

The range of frequency over which optimization takes place is set up using this menu. Two different frequency range types are available. The first is the "*Displayed range*" which is the start and stop frequency displayed on the graphic plot. It is also the frequency range over which optimization takes place if the second set of ranges are all set to zero.

The second set of 7 ranges, identified as A - G, will define frequency segments or bands of interest over which optimization is required. These are the frequency ranges or bands within the displayed range where optimization is to take place. These can be the frequency ranges of each channel of a multiplexer, for example. Any range that is set to zero frequency is out of action. If all the segments are zero, optimization is done over the entire *displayed range.*

When these frequency ranges are used along with the "Setup Memory" frequency ranges, **the frequency segments will take precedence.** The frequency ranges of the "Setup memory" are equivalent to the "Displayed range" and will **BECOME** the displayed range when that setup is used in the command line or recalled. All six frequency ranges are "static" and will remain until you clear them. They will still be there even if you exit the optimization module and return later.



[save to Main range]

Use this to set the frequency range that is displayed on the graphic plot window. The you press this button the "*Transferred range*" becomes the "*Main frequency range*".

[save to Segment]

Use this button to set the highlighted segment to the frequency range showing as the "*Transferred rage*".

[Clear segment]

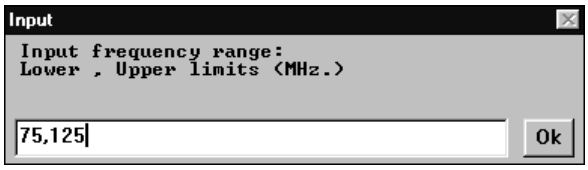
Used to clear the segment ranges to zero, one at a time, putting them out of action. Each segment, A through G, may be cleared individually by highlighting the one you want to clear with the mouse left button..

Entering the frequency ranges

The frequency ranges can be keyed in directly, separated by commas:

[Input range]

The frequency ranges can also be transferred from the plot using the transfer menu option or the <Ctrl F1>, <Ctrl F2>, and <Ctrl F3> keys. Using either method, the range transferred or keyed in will become the "*Transferred range*" and is all set to be assigned to the "*Main range*" or to a frequency "Segment".



[eXit]

Exit the frequency range menu back to the main optimization menu.

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[Resolution]

Resolution is the number of frequency points being analyzed during each iteration. The higher the number, the more detail can be seen, but the slower the iteration will run. Higher resolution is often necessary with higher order networks. This option allows the number of frequency points to be specified. The number of points range is 2-1000. The default is an automatic mode that selects the correct number of points to fill the plot at HALF resolution (Every OTHER pixel).

[Q factor]

This is the same "Q" factors as shown on the main control menu and can be changed here.

[Tune]

TUNE mode

When tune mode is on, the value of any single branch or pair of branches (having the same value) in a network may be adjust manually.

[Up] [Down]

Adjusts the selected branch value either up or down by an amount that can be adjusted by the [Finer step] and [Courser step] buttons.

[<–Back up]

This will back up from the last operations done on the current branch.

[Specify value]

Rather then adjusting the value up or down in steps you can specify the value directly. This is good for forcing standard part values at a particular branch.

[Pick branches]

Used to pick which branch or pair of branches are being tuned.

[Finer] [Courser]

These two buttons adjust the steps made by the [Up] and [Down] buttons.

[eXit]

Back to the main optimization menu.

The value at the branch you are tuning is displayed (Yes, even a reference frequency is a valid branch and my be “tuned”!). The degree of step (Up and Down) is also displayed.

[Job]

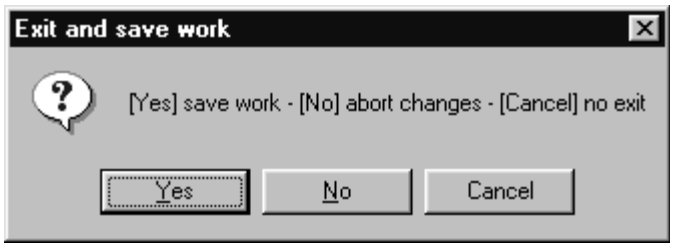
Use this option to change the parameter or "job" selected. It brings up the same prompt that you set when you first entered the optimization window. Select Return loss, Amplitude flatness or Group delay.

[set final Stage]

The number of "step reverse" cycles before the next branch is iterated and the graphics up-date is done can be set here. The default is 7, but reducing it to 4 or 5 can "rough in" the performance faster when first starting. Increasing the final stage to 8 is a good idea when using the continuous repeat ("R") feature.

[eXit]

Leave the optimization module when done. You have the option to totally disregard all changes if the session did not accomplish your purpose.



Operation

When optimizing group delay, you should be aware that the main analysis module is operating in the background and will be using whatever one of its delay modes that you have set, most likely the "Precise" mode. The maximum number of frequency points that can be accommodated is 300. It takes 50 or more points before the "automatic" delay mode will switch from "precise" to "fast" mode. Switching to the "Fast" mode manually will give you a 2 to 1 speed increase allowing you to use more resolution points in less time. Since the first point is always done using the "precise" mode, any significant distortion seen between the first and second points would indicate that the "precise" delay mode should be used instead. You can start by using the "fast" mode and switch to "precise" to finish the job if speed is a problem.

When iterating on return loss or amplitude flatness, group delay is tuned off except for the very last iteration before displaying the graphic results, so the delay mode should be set to the slower "precise" or "automatic" mode. The speed difference will be insignificant. The delay will be seen when the optimization stops.

The [Back] .(“~”) key will safely abort any optimization in progress and perform a "back up". This is the only way to stop a continuously repeating optimization that is in progress. You can use the [Back] key at any time the "[Back] to abort" warning is showing. After an abort, all the menu options are available again.

Error condition warnings

Value went through ZERO !

This indicates that the program has iterated a part value through zero value. When this happens, an automatic back-up is done restoring the branch to its initial value. The iteration proceeds on to the next branch.

Stage = **Next!**

In the event the iteration is stuck or is working too long on one branch, the iteration will proceed to the next branch after displaying this message. This warning happens when the number of iterations exceeds 11 times the stage number. This is really not an error, the program is just keeping you informed about what is going on.

WORSE - backing up!

If the performance is worse after iterating on a branch than before, this warning will appear. An automatic back-up is performed. You could increase the final "stage" number, but this usually indicates that you should work on some other branch number.