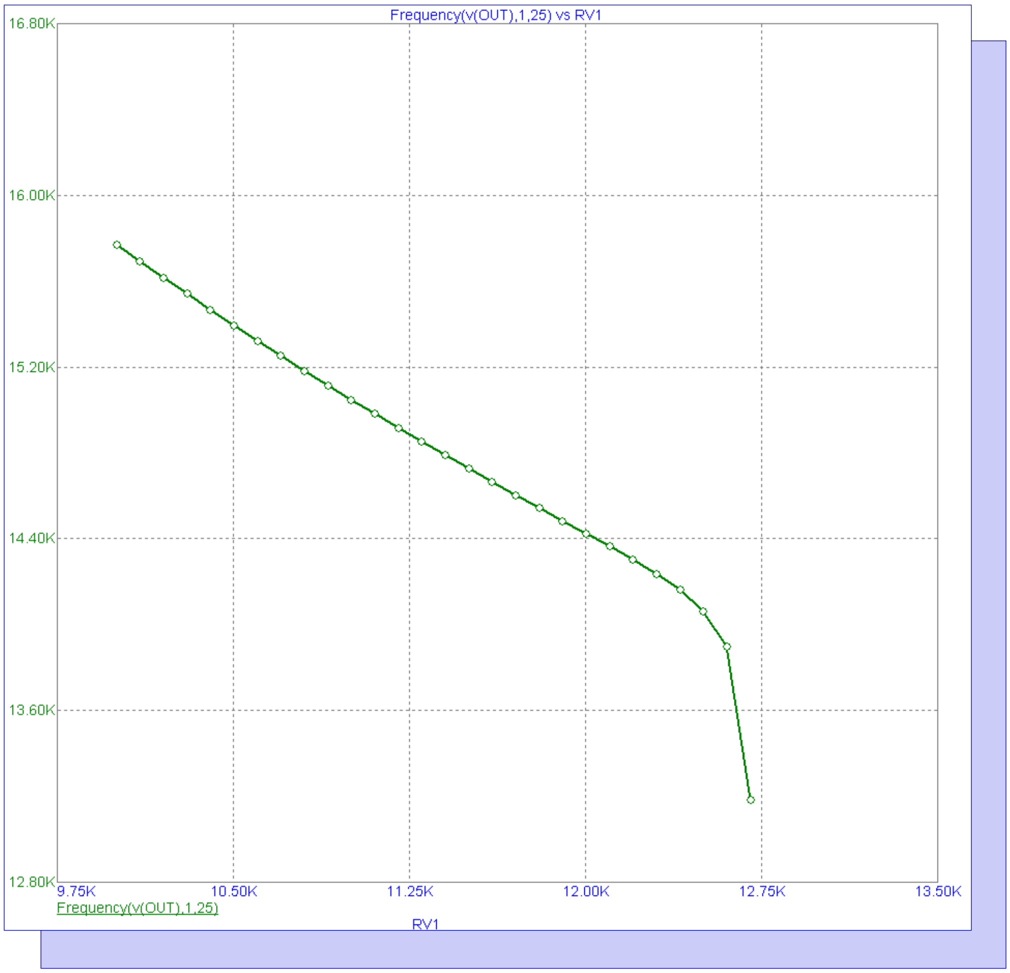
spectrum news

Applications for Micro-Cap™ Users

Winter 2013



Performance Plot

Featuring:
- Performance Functions
- Analysis Plot Labels
- Periodic Steady State

News In Preview

This newsletter's Q and A section describes several Micro-Cap installation issues. The Easily Overlooked Feature section describes the capability of the Localize command to add or update modeling information within the circuit to make it entirely portable.

The first article describes the many uses of performance functions in tags, analysis text, Performance Plots, Monte Carlo runs, and the Go To Performance function.

The second article describes the use of labels to clarify and enhance circuit analysis plots.

The third article describes Periodic Steady State and its use in transient analysis to eliminate the transient portion of waveforms.

Contents

Book Recommendations

General SPICE

• *Computer-Aided Circuit Analysis Using SPICE*, Walter Banzhaf, Prentice Hall 1989. ISBN# 0-13-162579-9

• *Macromodeling with SPICE*, Connelly and Choi, Prentice Hall 1992. ISBN# 0-13-544941-3

• *Inside SPICE-Overcoming the Obstacles of Circuit Simulation*, Ron Kielkowski, McGraw-Hill, 1993. ISBN# 0-07-911525-X

• *The SPICE Book,* Andrei Vladimirescu, John Wiley & Sons, Inc., 1994. ISBN# 0-471-60926-9

MOSFET Modeling

• *MOSFET Models for SPICE Simulation, William Liu, Including BSIM3v3 and BSIM4*, Wiley-Interscience, ISBN# 0-471-39697-4

Signal Integrity

• *Signal Integrity and Radiated Emission of High-Speed Digital Signals*, Spartaco Caniggia, Francescaromana Maradei, A John Wiley and Sons, Ltd, First Edition, 2008 ISBN# 978-0-470-51166-4

Micro-Cap - Czech

• *Resime Elektronicke Obvody,* Dalibor Biolek, BEN, First Edition, 2004. ISBN# 80-7300-125-X

Micro-Cap - German

• *Simulation elektronischer Schaltungen mit MICRO-CAP,* Joachim Vester, Verlag Vieweg+Teubner, First Edition, 2010. ISBN# 978-3-8348-0402-0

Micro-Cap - Finnish

• *Elektroniikkasimulaattori,* Timo Haiko, Werner Soderstrom Osakeyhtio, 2002. ISBN# 951-0-25672-2

Design

• *High Performance Audio Power Amplifiers,* Ben Duncan, Newnes, 1996. ISBN# 0-7506-2629-1

• *Microelectronic Circuits,* Adel Sedra, Kenneth Smith, Fourth Edition, Oxford, 1998

High Power Electronics

• *Power Electronics,* Mohan, Undeland, Robbins, Second Edition, 1995. ISBN# 0-471-58408-8

• *Modern Power Electronics,* Trzynadlowski, 1998. ISBN# 0-471-15303-6

Switched-Mode Power Supply Simulation

• *SMPS Simulation with SPICE 3,* Steven M. Sandler, McGraw Hill, 1997. ISBN# 0-07-913227-8

• *Switch-Mode Power Supplies Spice Simulations and Practical Designs*, Christophe Basso, McGraw-Hill 2008. This book describes many of the SMPS models supplied with Micro-Cap.

Micro-Cap Questions and Answers

Question: We're doing a professional Lan version: Client (Local Files) install. We have a license server that's remote to the local machine that hosts the license. This is indicated in the nethasp.ini file.

I reinstalled it a few times and got the Aladdin device drivers to say they installed. But every time I run it I get an error saying it has encountered a problem and needs to close. This happens right after it reads the ini file and determines there's no hasp on the local machine.

If I set the ini file to the default, it opens and says there's no hasp on the machine and then exits.

I should mention that we are running RDP.

What am I doing wrong?

Answer: The current version of Micro-Cap (MC10) does not support RDP (Remote Desktop Protocol) or any other form of remote terminal services. If you try to run Micro-Cap over RDP it will generate this error. Try running it directly connected and the error will go away.

Future versions of Micro-Cap may support RDP.

Question: I am trying to port our engineering client PC's to a new license server where we will be moving our license dongle. I would like to use the server name in the INI file on the appropriate line

NH_SERVER_NAME = puscwa0d

The documentation says that the limit to the server name is 7 characters. That seems quite small. Is this correct for the INI line, and if so, is there another way of using the name instead of the IP address?

Answer: Yes. It's true. If you use a server name, its length is limited to 7 characters. You can always use the IP address which can be and usually is longer than 7 characters.

Question: We are testing Micro-Cap 10.0.9.1 and we are having a problem saving files on our Windows 7 desktop with the error, "Permission denied 'C:\Users\username\Desktop\circuit1.cir". We are just wondering whether this is one of the known issues.

Answer: Up until version 10.0.9.2 this was a problem with both the demo and main program. We have fixed it by using newer libraries for the Save command. Version 10.0.9.2 now allows saving any kind of file to desktop folders.

Easily Overlooked Features

This section is designed to highlight one or two features per issue that may be overlooked among all the capabilities of Micro-Cap.

Localize Command

If you've ever had to send a circuit file to a colleague or a client, you probably remember the hassle of also sending along the necessary modeling information.

The Localize command makes this easy by incorporating all of the necessary model statements, macros, and subcircuits within the circuit. All your colleague has to do is run the circuit. There are several options in the dialog box.

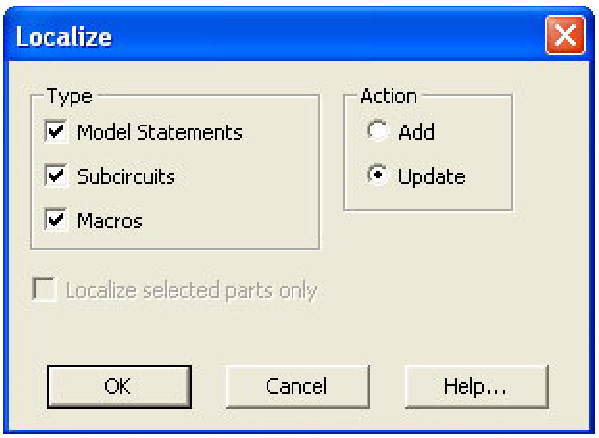


Fig. 1 - Localize dialog box

You can select whether to add or simply update and you can select the type of model information to add or update. The Localize selected parts only option does just that, it adds or updates model info only for components that have been selected in the schematic.

Model statements and subckts are added to the Model page. Macros are placed in their own pages and new tabs are added to identify them.

The Localize command is called that because it reads all of the globally available model information required to run the circuit and then "localizes" it by copying the information into the circuit so that the circuit is self-contained. This works because Micro-Cap always searches the circuit file first for model information and only if it can't find something does it look in global libraries.

Performance Functions

Micro-Cap comes with a library of functions that measure curve parameters. There are functions that measure pulse width, rise and fall time, frequency, period, X and Y level and many more.

These functions can be used in many ways:

- As tags that are drawn with arrows to show how the measurement was done
- In analysis text added to the plot to report the values
- In Performance Plots that show the measured value vs. a stepped value
- In Monte Carlo histograms
- In the analysis plot GoTo function

In each use, the function takes a specified curve and measures one parameter. Usually the parameter is important to the design of the circuit and so the functions are called performance functions.

The complete list of functions is shown in the Reference Manual so here we will just be illustrating a few functions to emphasize their usage and value.

Here is the circuit we'll use: a Wein bridge oscillator.

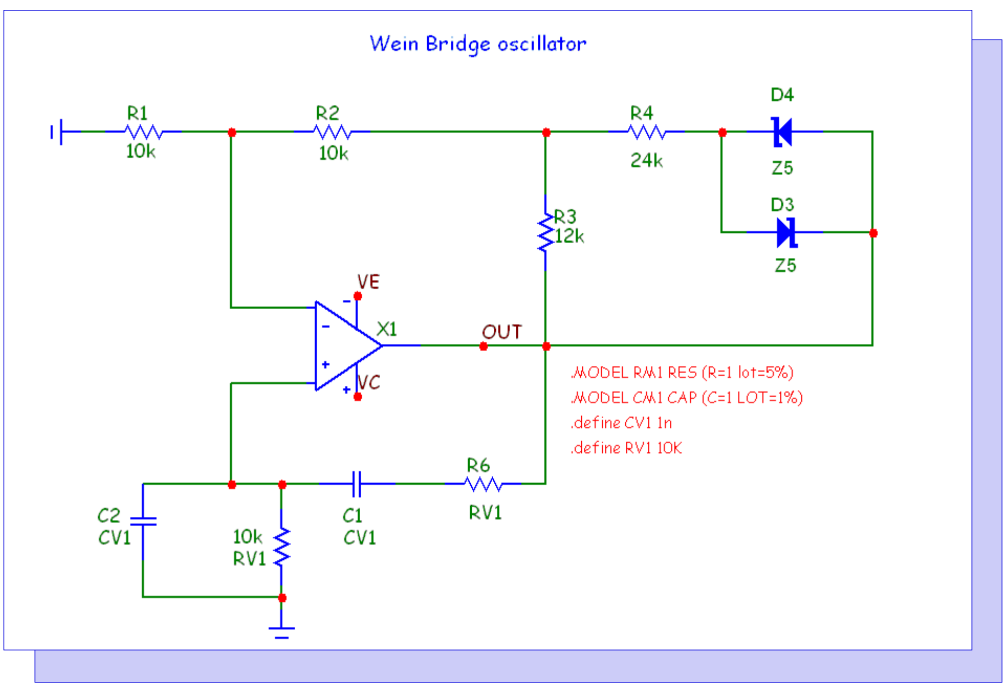


Fig. 2 - Wein bridge oscillator

This circuit is set to start oscillating almost immediately. Run transient to get the first plot shown in the next figure.

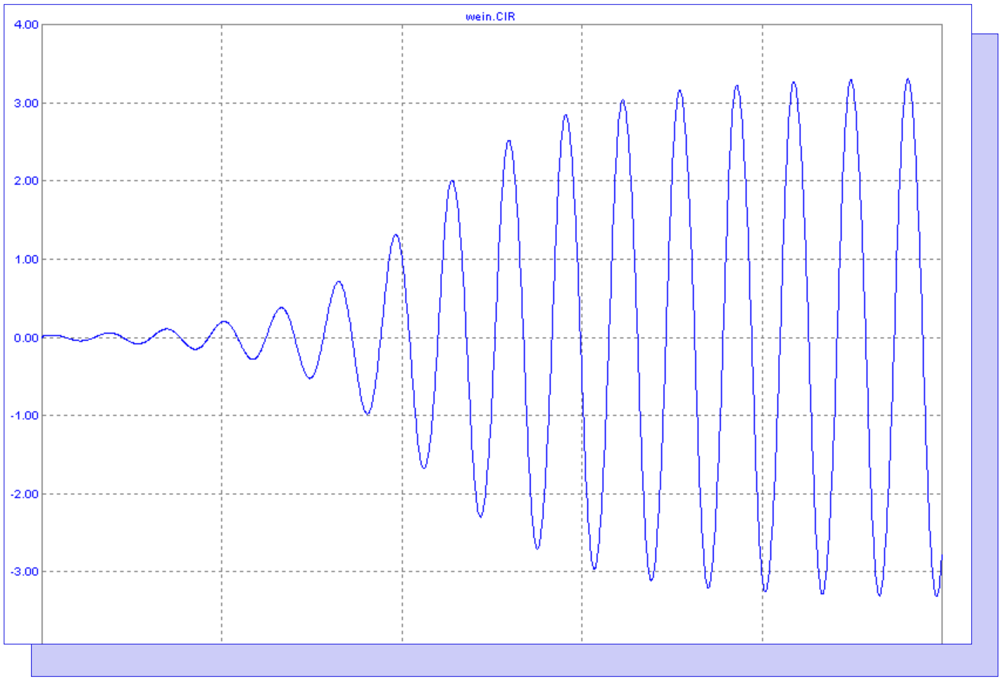


Fig. 3 - The initial transient run

Let's suppose you are interested in measuring the oscillation frequency. You can do that this way:

First click on the Performance Tag Mode button, . Then click on the analysis plot anywhere. When the dialog box pops up click on the Get button. This loads a second dialog box which lets you select the performance function. Select Frequency from the pop down list and enter 10 in the N data field. This tells the program to find the frequency and use the tenth measurable instance. Why 10? Because we're simulating the startup phase and it takes a little time before the frequency has stabilized. Click OK on the dialog boxes and the plot looks like this:

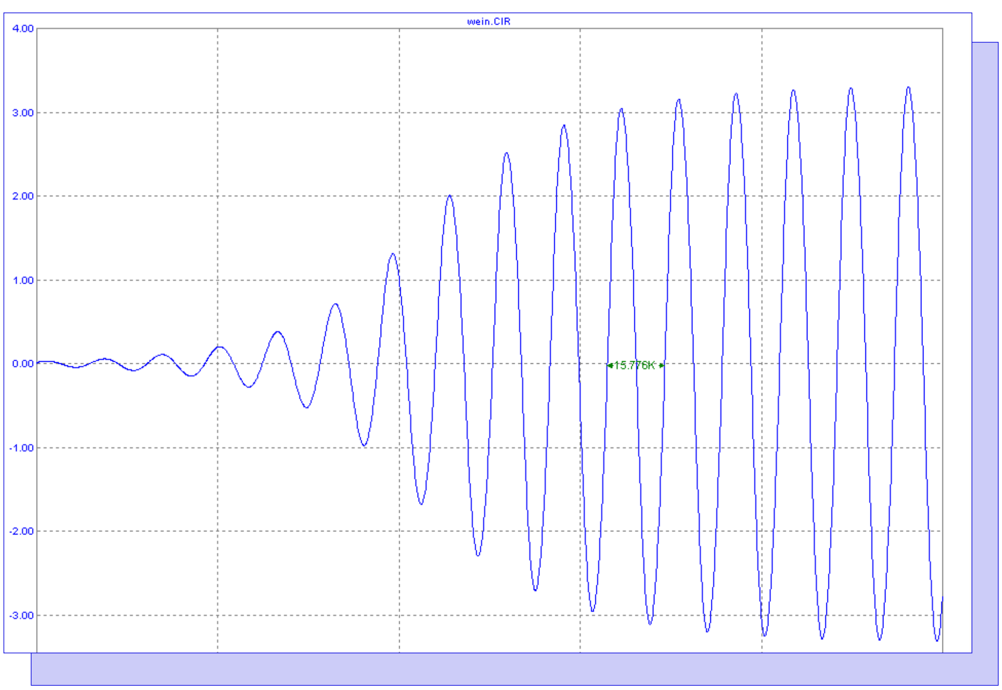


Fig. 4 - The Frequency performance tag

The function measures a frequency of 15.776 KHz by measuring the time between subsequent instances of the waveform average. It denotes the two points used in the measurement with an arrow so you can see where the frequency measure is taken.

To see that a little more clearly click on the Scale icon  and drag a box like so.

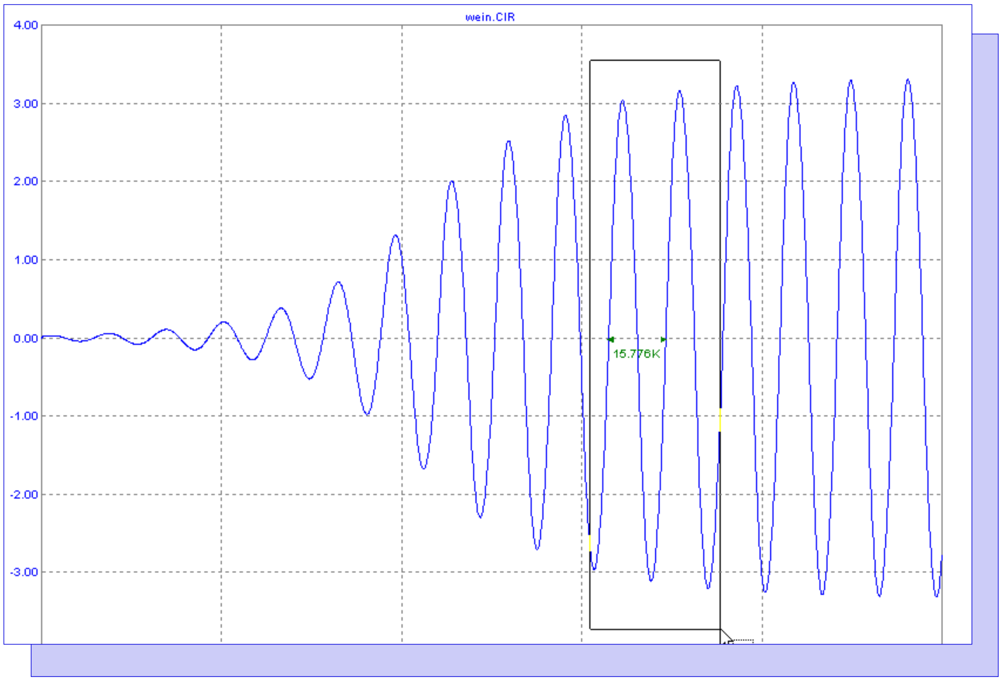


Fig. 5 - Blowing up the measurement area

Release the mouse button and you'll see this display.

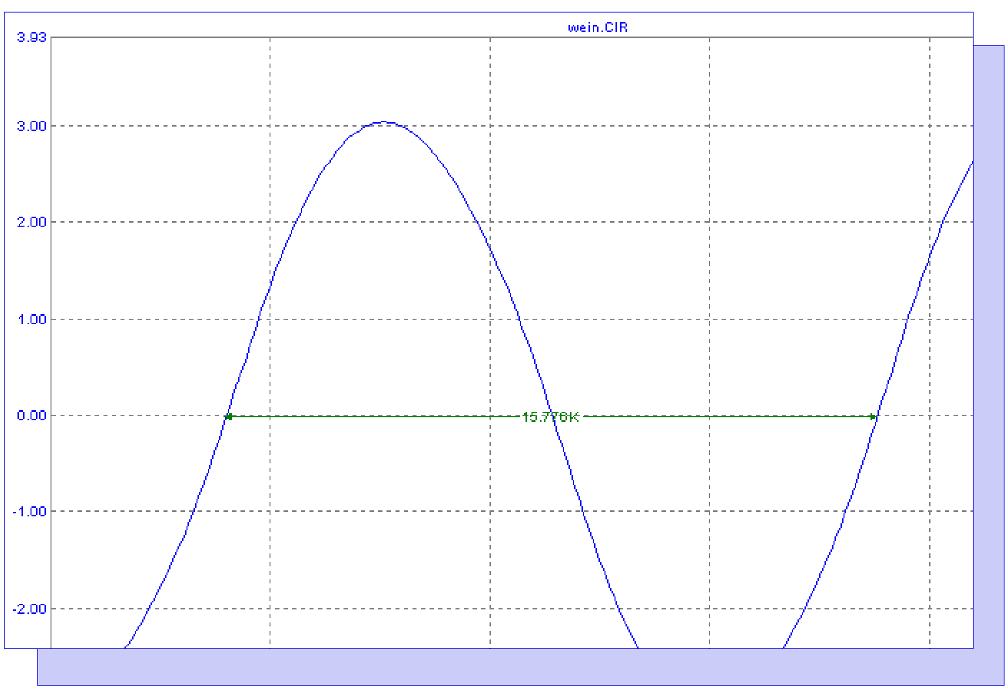


Fig. 6 - Enlarged view of the Frequency tag

Press the Spacebar to get to Select mode. Double-click on the measurement value. Use the mouse to select the entire text 'Frequency(v(OUT),1,10)'. Then click on the Get button and in the Function list of the dialog box that comes up, select Period from the list. Type 10 into the N field. Click on the OK button and on the OK button in the tag dialog box. You should see this display

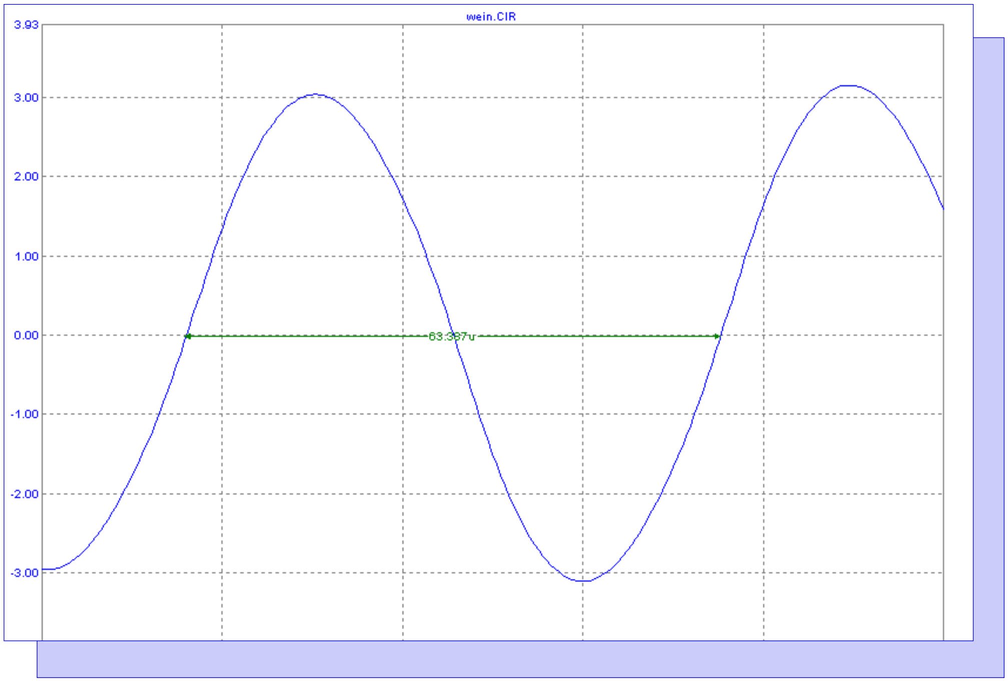


Fig. 7 - The Period performance tag

The period tag should show 16.387u. Now suppose you want to know the pulse width. You repeat the prior procedure but select Width instead of Period. Enter 11 into the N field and 0 in the Level field. You should now see this display.

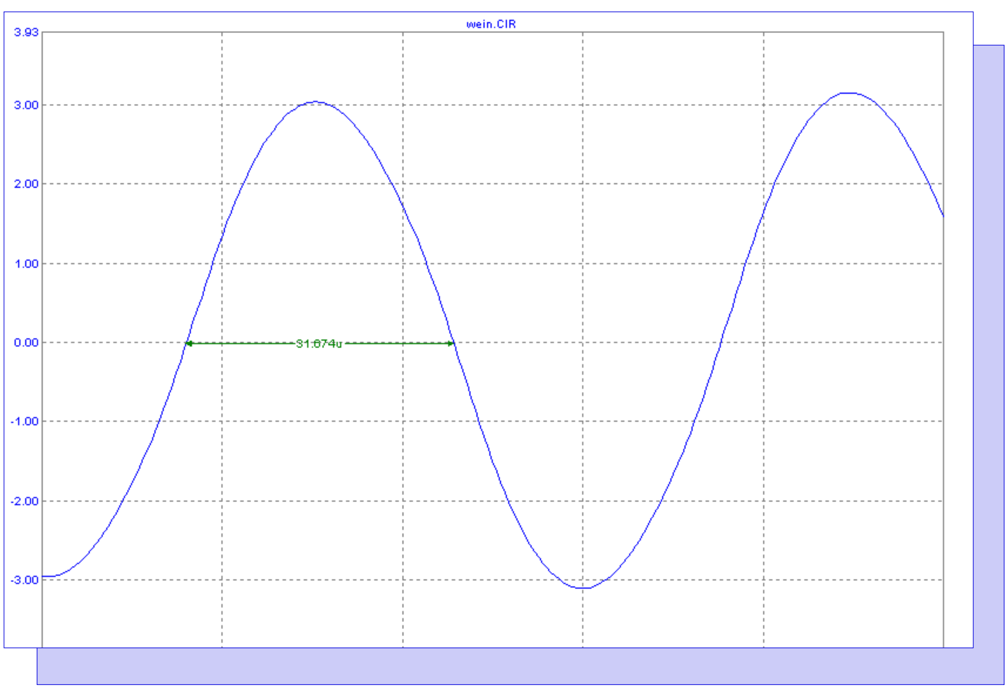


Fig. 8 - The Width performance tag

The function measured the 11'th instance of a pulse that crossed 0 volts. How do you know which value of N or which value of Level to use? The value of N is obtained by estimating the number of pulses from T=0 and then tweaking the value plus of minus. The value of Level is clear in this case because the oscillator moves about zero. In general to meaningfully measure width you'll have to know something about the circuit.

How else can the performance function be used? Well you can use them to measure a performance parameter and then include that function in analysis plot text like this:

Oscillation frequency = [Frequency(V(OUT),1,10)]

In this text the [] brackets denote the area that contains formula text. The "Frequency(V(OUT),1,10)]" text between the brackets is the performance function. The rest is just text. To see how this works press CTRL+Home to restore the limit scales. Click on the Performance Tag icon and then somewhere in the analysis plot. In the Performance Tag dialog box click on the Get button and select Frequency(v(OUT),1,10) as we did earlier. Click on the OK button and then select the Frequency(V(OUT),1,10) text and press CTRL+C to place it in the clipboard. Click Cancel because we are only using the Performance Tag dialog box to capture the function text we want.

Click on the Text icon and then click in the analysis plot where you want the text to be placed. Enter the text above (you can paste in the function text from the clipboard) into the text dialog box. Check the Formula option in the dialog box and then click OK. The plot should now look like this:

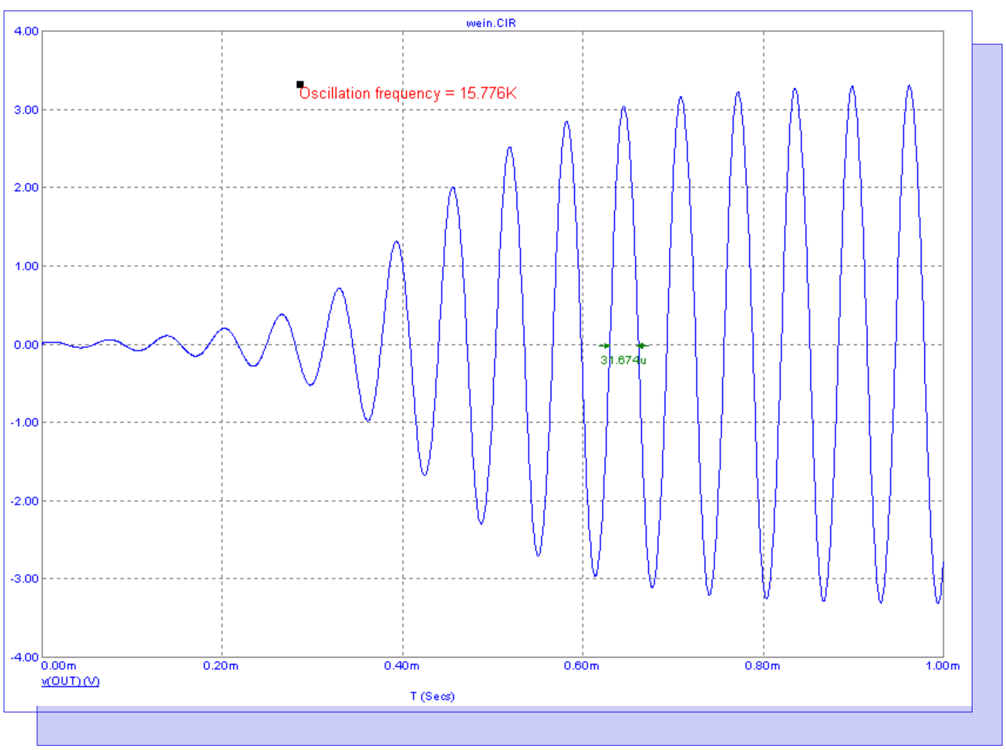


Fig. 9 - Using Performance Functions in analysis formula text

The function is evaluated, the frequency measured, and the result printed in the text wherever it is placed. This form is sometimes a convenient alternative to the tag as a way to measure and display important parameters.

There are other ways that performance functions are used. Here is the same circuit but set up to step the RV1 parameter and plot the frequency vs. RV1. The function is Frequency(v(OUT),1,25) and the simulation run is for 2ms.

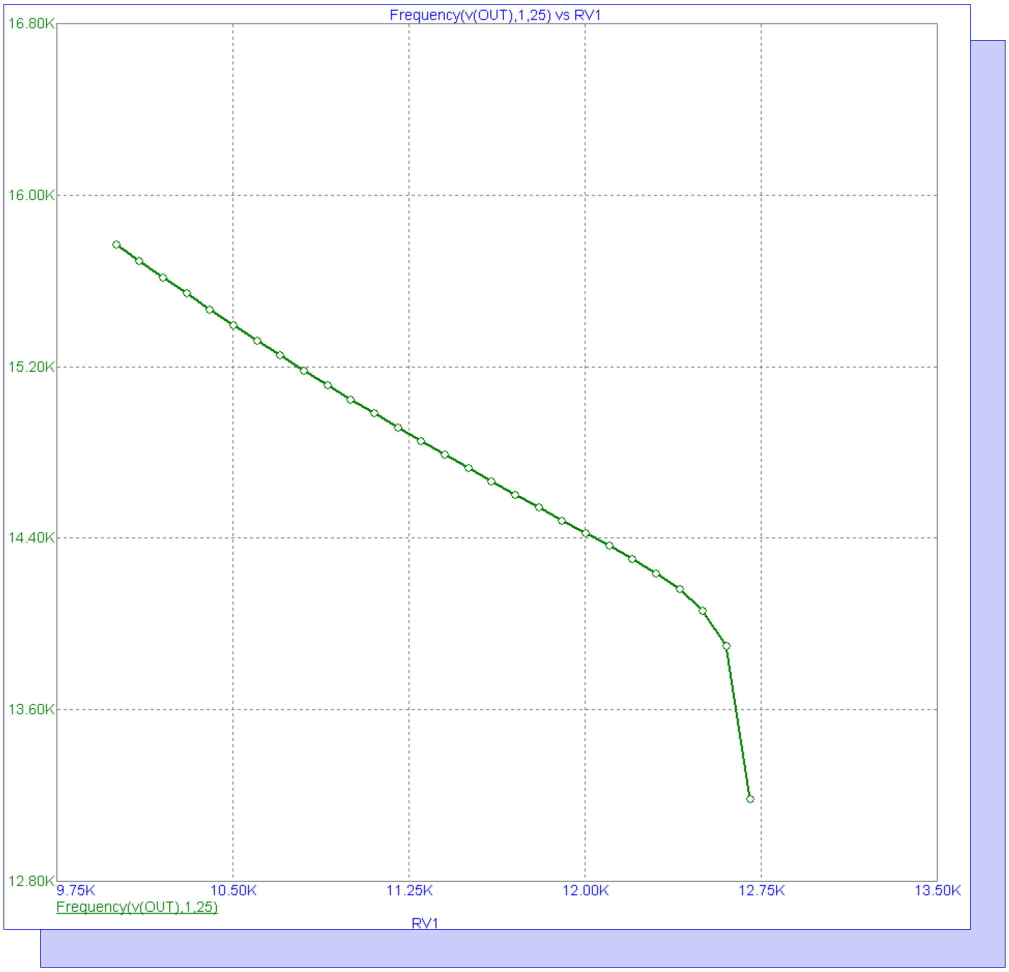


Fig. 10 - Performance Plot of Frequency vs.. RV1

This Performance Plot shows the measured frequency vs. the stepped RV1 parameter. There is a clear linearity up to about 12K and then the curve becomes nonlinear, an important piece of design information.

Performance Plots use performance functions and plot these functions versus a stepped parameter.

Performance functions are also used in Monte Carlo runs. Here is a version of the Wein bridge circuit that runs a Monte Carlo set of runs and plots a histogram of the frequency spread.

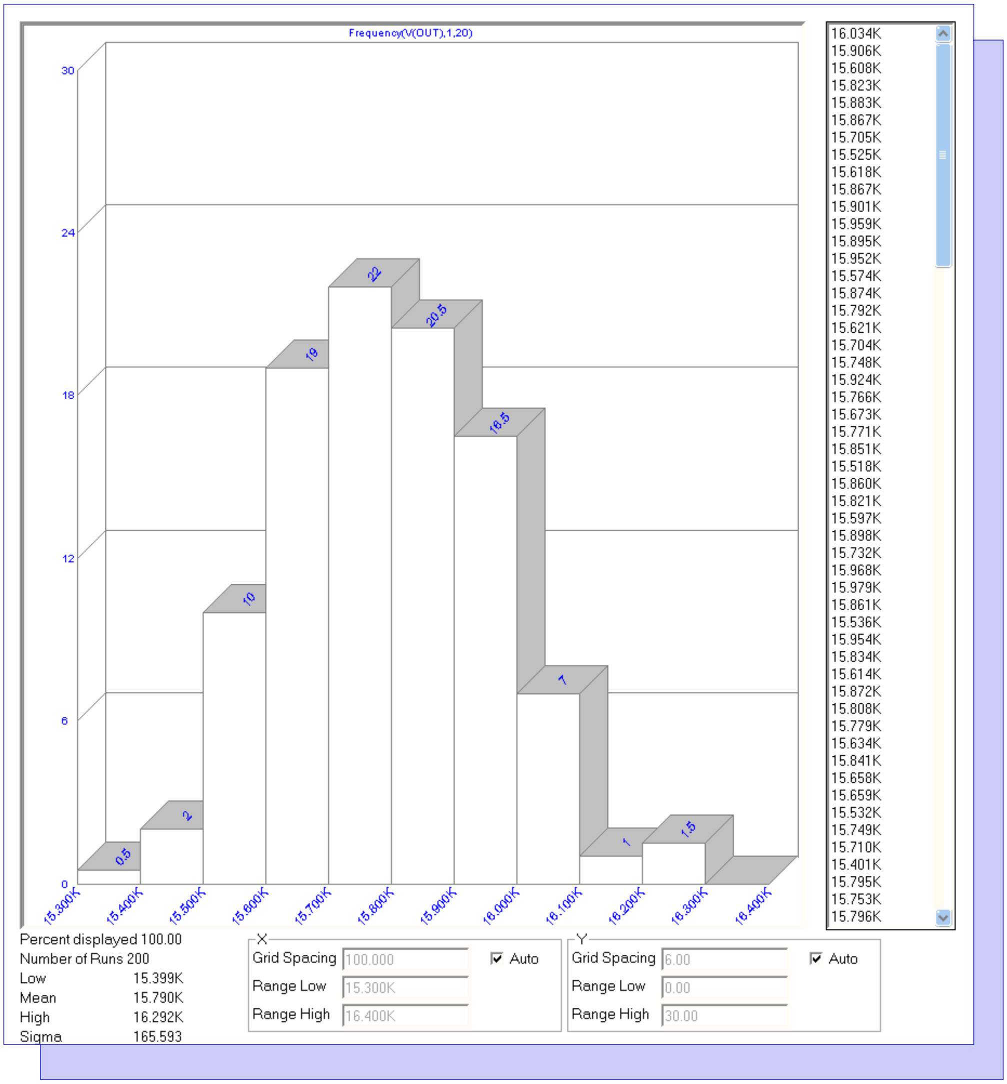


Fig. 11 - Using Performance Functions in Monte Carlo

The function used is Frequency(v(OUT),1,25) and the simulation run is for 2ms.

The 200 runs produced a mean frequency of 15.772KHz with a standard deviation of 146.4 Hz. These numbers will change somewhat with each Monte Carlo run but the mean is fairly constant.

Performance functions are important tools for measuring critical circuit function. Understanding their use will greatly enhance the user's ability to get the most from using Micro-Cap.

Performance functions are also used in the GoTo command. To illustrate we'll use the first Wein circuit again. Run transient and click on the Go To Performance button. This pops up the Go To Performance dialog box, from which you select the desired function. Pick Frequency and enter 5 in the N field. Click on the Go To button. The cursors are placed on the two data points of the 5'th frequency measurement. The measured frequency of about 15.66 KHz is printed in the dialog box. Click again and the N field is incremented to 6 and the 6'th frequency is measurement is displayed. The display should now look something like this:

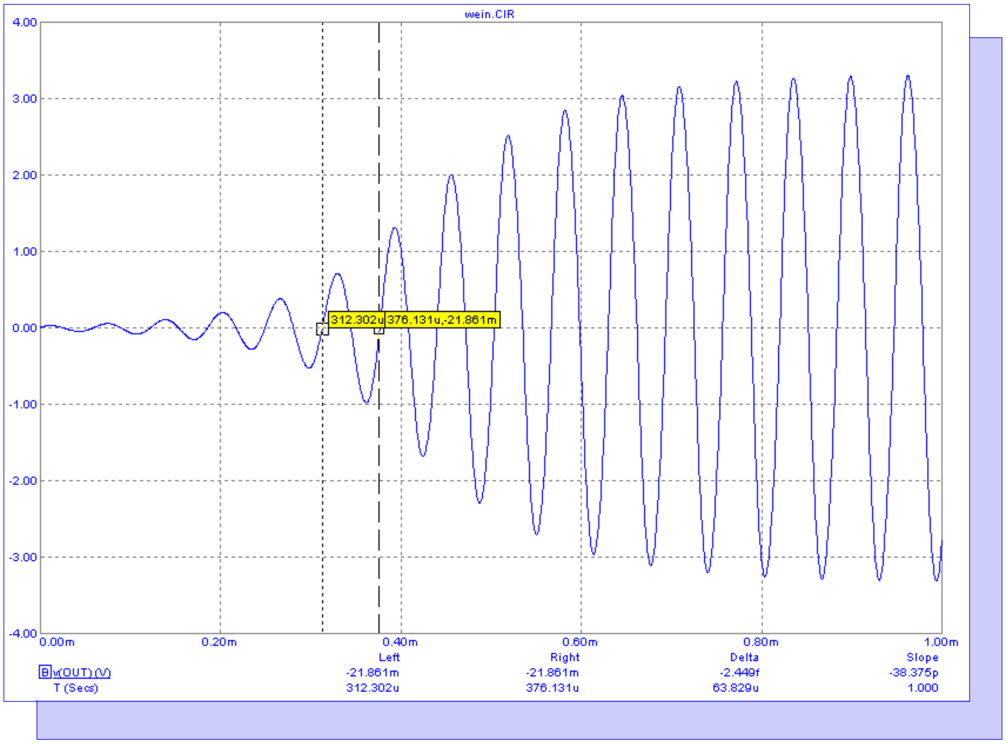
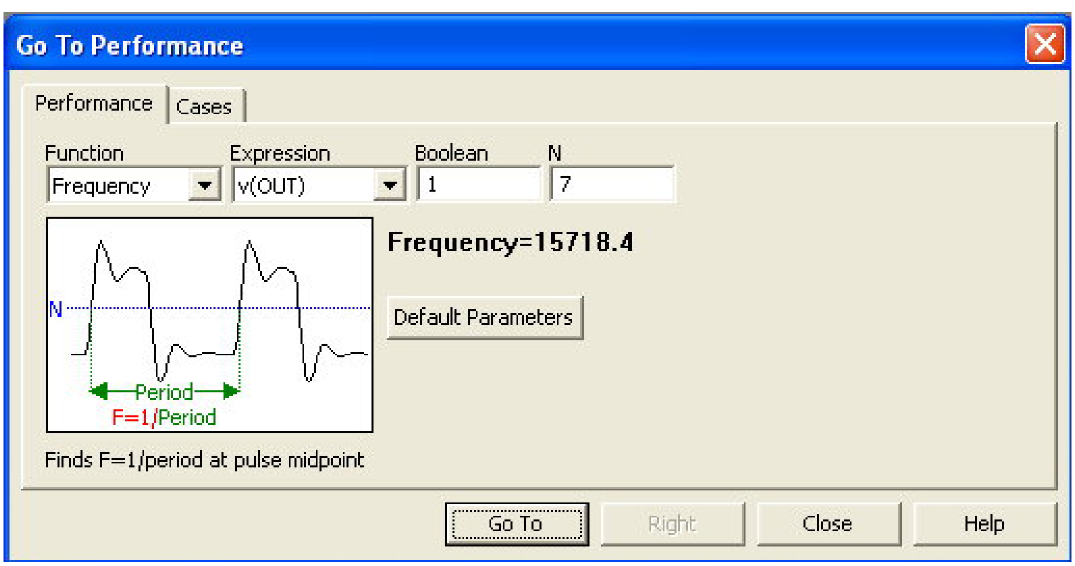


Fig. 12 - Using Performance Functions in analysis formula text

The dialog box shows the measured frequency. Each click of the Go To button increments the N value and finds the next measurement. The frequency value will change a little with each measurement until the circuit stabilizes.



Analysis Plot Labels

When stepping parameter values you will usually see an array of curves. How do you tell which curve goes with which stepped value? You could invoke Cursor mode and use the up and down arrow keys to cycle through the curves and watch the plot title reveal the stepped values. If you want a more permanent delineation you can use labels. Here's a stepped plot without labels:

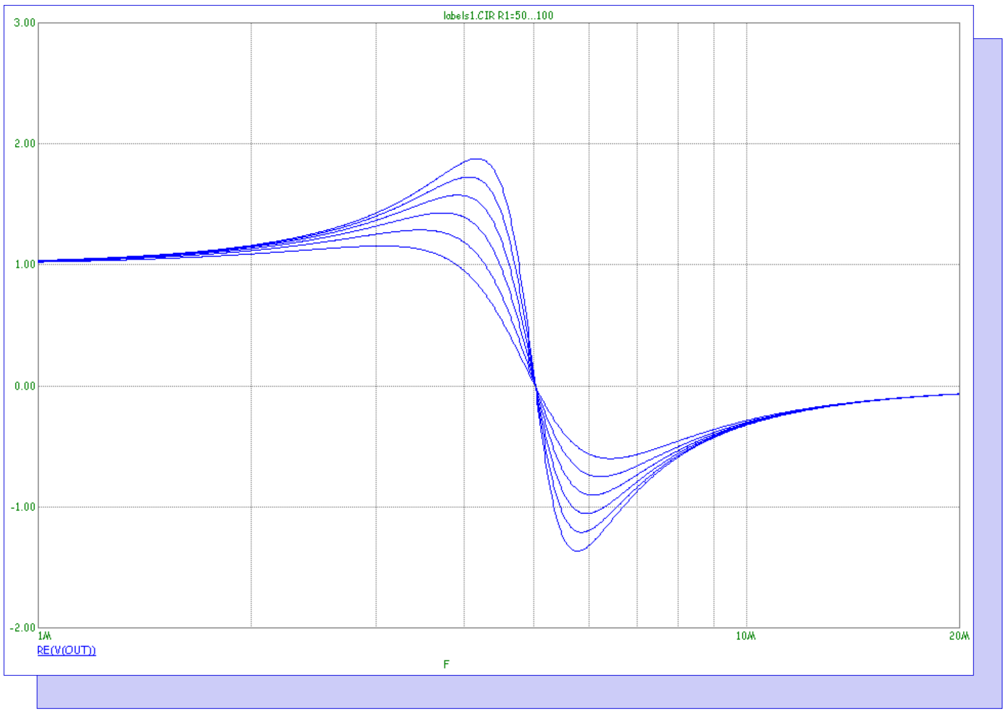
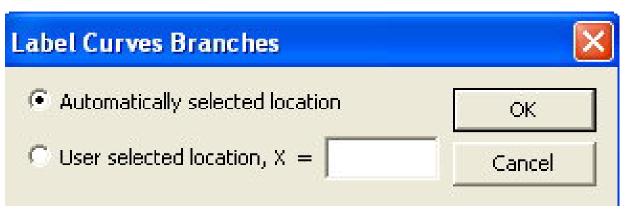


Fig. 13 - Stepped plot without labels

You can add labels that show the stepped values for each curve as follows. From the Scope menu select Label Branches. This will display the Labels dialog box as shown below:



Click on the Automatically selected location option, then click on the OK button. This tells the program to automatically select the label's X location based on the maximum vertical separation between curves. This is usually close to optimal. If the selected location is a little off you can use the User selected location by specifying the X coordinate for the labels. The next figure shows what the auto option produces.

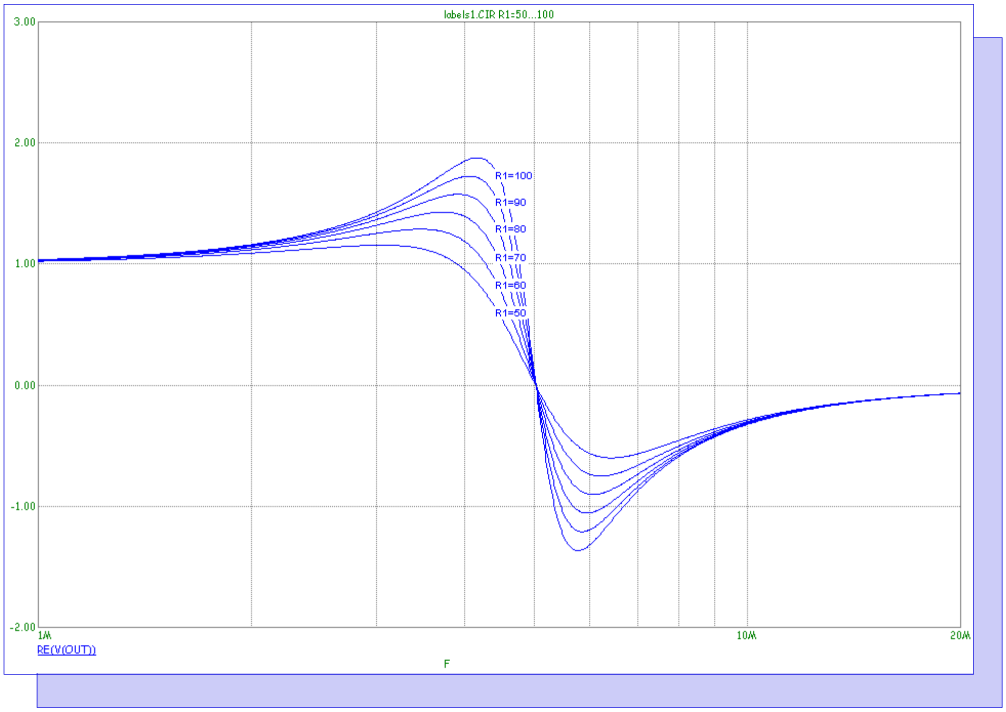


Fig. 14 - Plot with automatically selected label locations

Here is the plot with User selected location set to 4e6. The location is in the units of whatever is plotted horizontally, in this case frequency.

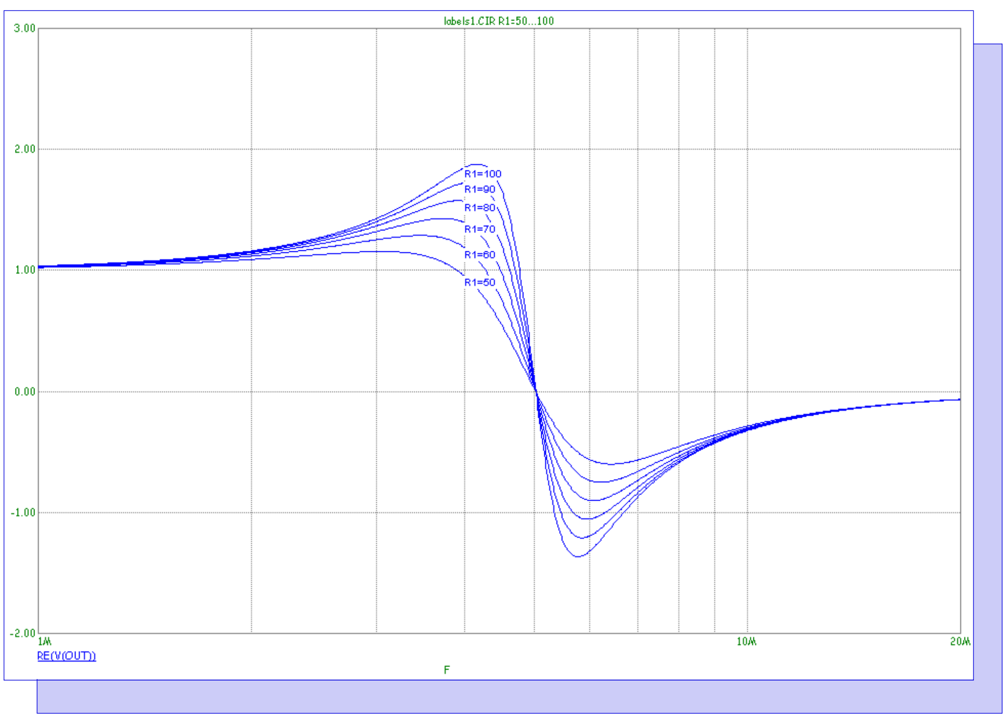


Fig. 15 - Plot with user selected location labels

Branch labels are just text. Once placed they can be moved about, or as in this case, selected and deleted to make room for the User selected location option.

Note that the color of the labels is initially the same as the waveform. Once placed the label color can be changed. To do this you drag select the set of labels using the Select tool. Then you click on the Color and or Font buttons to select a new font, size, and/or color. Here, for example, is the same run with the font set to green 20 point Comic Sans.

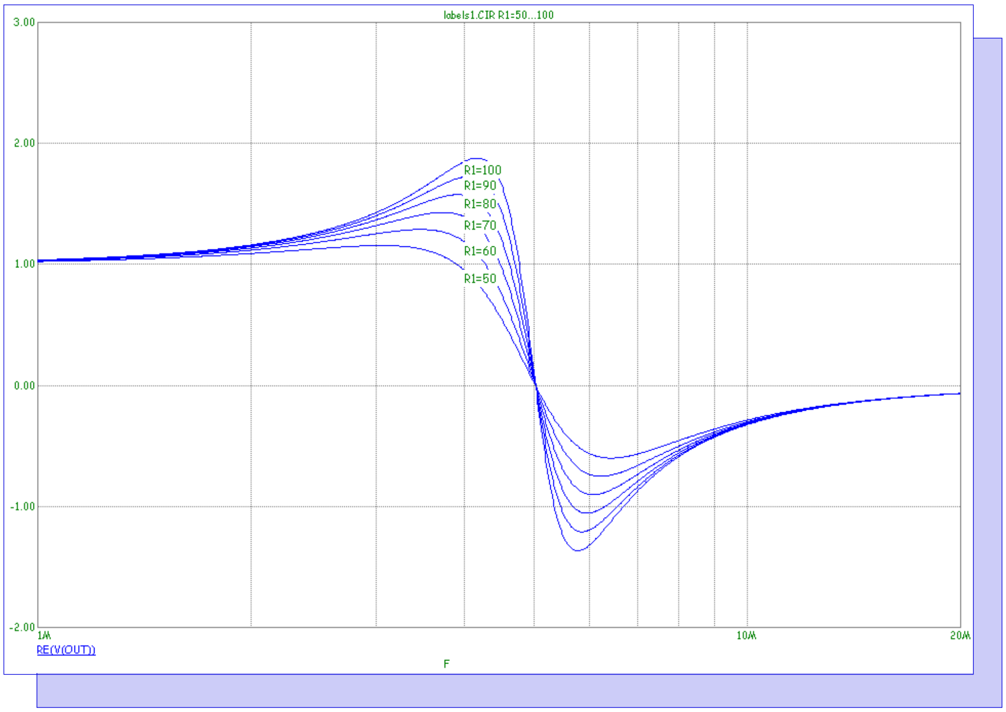


Fig. 16 - Changing the label text

Here are some things to remember when using branch labels.

1) Branch labels are ordinary text. Once placed they can be individually edited or deleted.

2) Branch labels are placed so that the text 'hangs down' from the specified X,Y point. The X coordinate of the point is either automatically computed or entered by the user. The Y coordinate is the curve's Y value at the specified X coordinate.

3) To quickly remove a set of labels, use CTRL+A to select all, then press the Delete key. This action deletes all plot artifacts, including text and tags. To delete one set of labels, use the Select mode and drag select the labels and then press the Delete key.

Periodic Steady State

Periodic steady state is a feature that is new to MC10. It computes steady state waveforms, eliminating the transient part of the solution. Very often the steady state is the desired portion and the transient portion merely a nuisance. Consider this voltage quadrupler circuit.

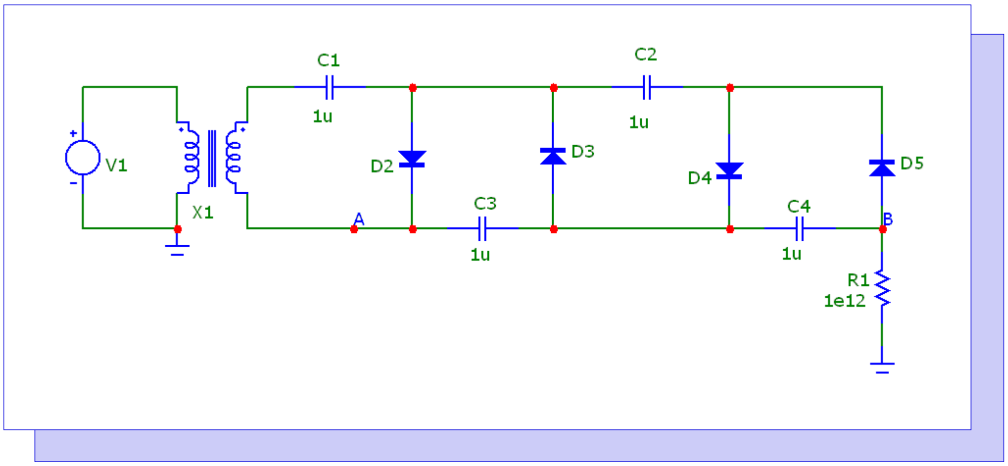


Fig. 17 - Voltage quadrupler circuit

Here is its transient run over 10mSec. It's clear that the transient response will require hundreds of 1ms periods to dissipate the initial transient to reach a steady state. In fact more than 1000 1mS periods will be needed to achieve a steady state accurate to less than 100uV.

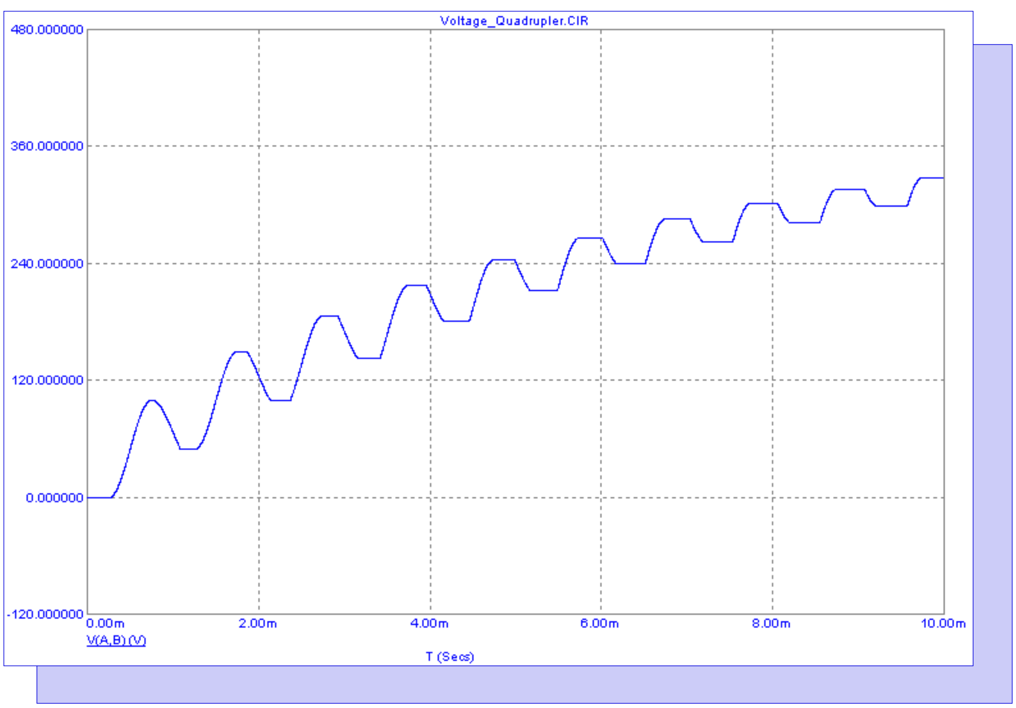


Fig. 18 - Run over 10ms without using PSS

Now consider this run using Periodic Steady State.

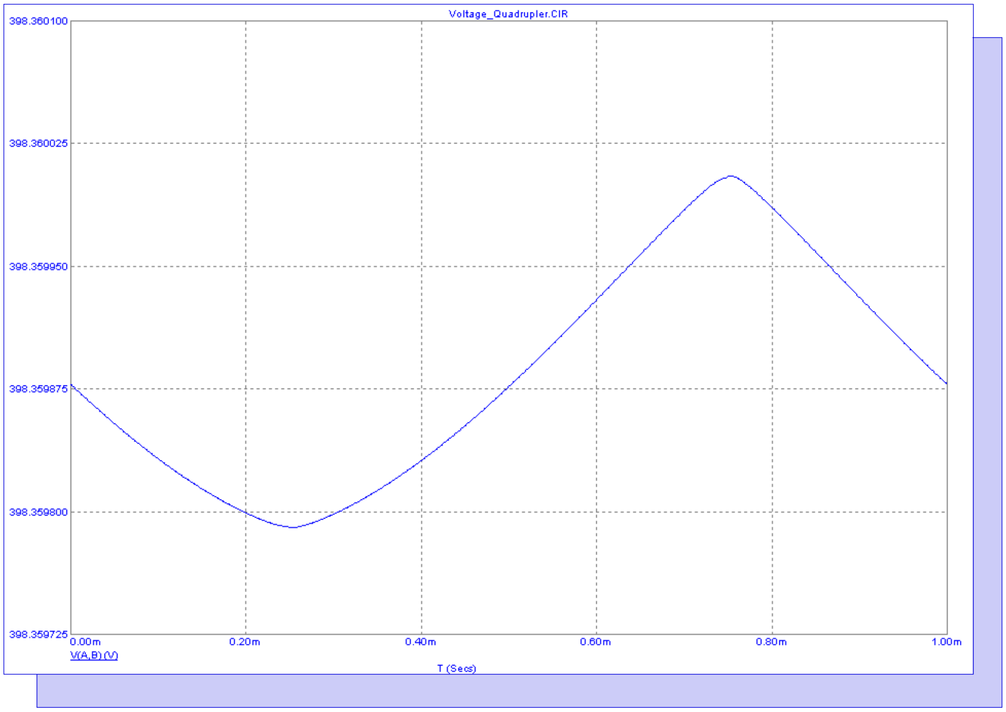


Fig. 19 - Run over 1ms using PSS

Here PSS has computed the steady state. It shows a ripple of about 200uV riding on a DC level of about 398 volts. The original run using 1000 1mS periods took about 10 seconds. The PSS run took about 1 second.

Now consider this circuit.

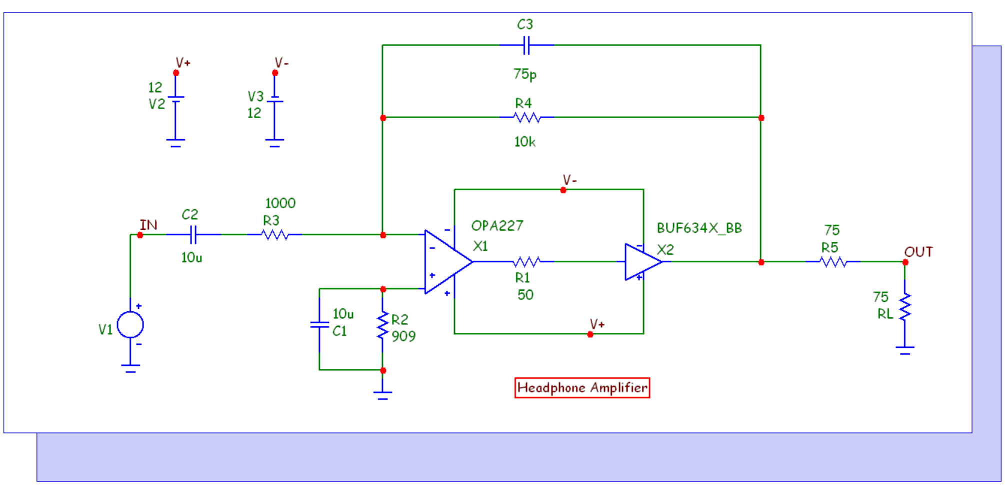


Fig. 20 - Circuit for FFT

Here is its FFT without using PSS.

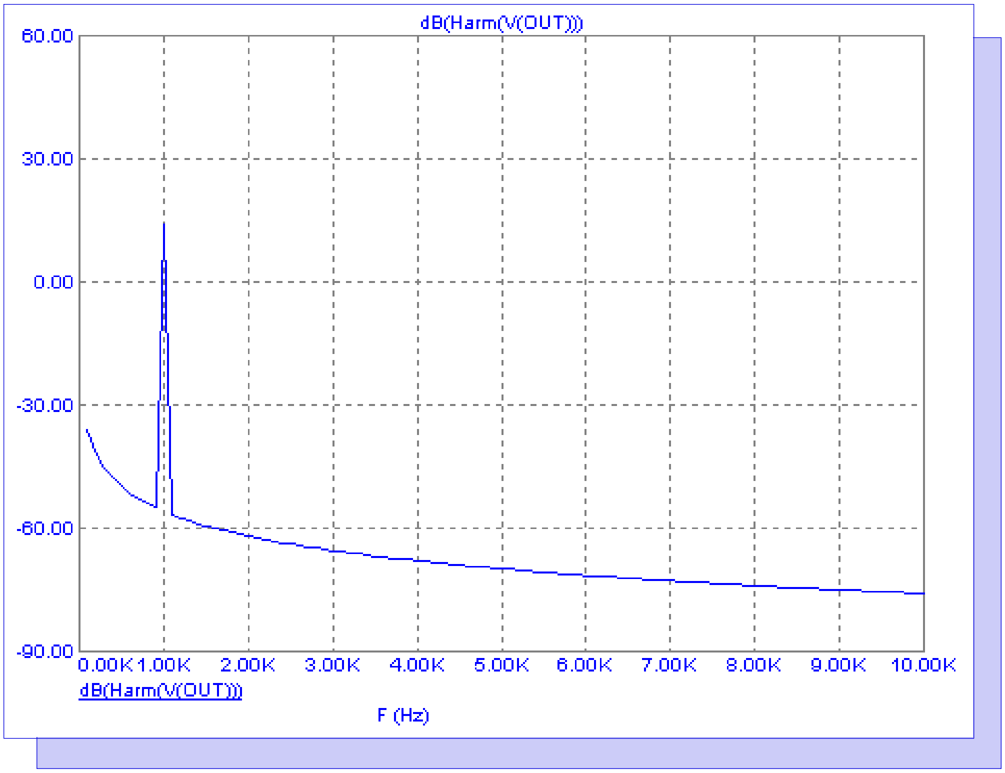


Fig. 21 - FFT without PSS

Here is its FFT with PSS.

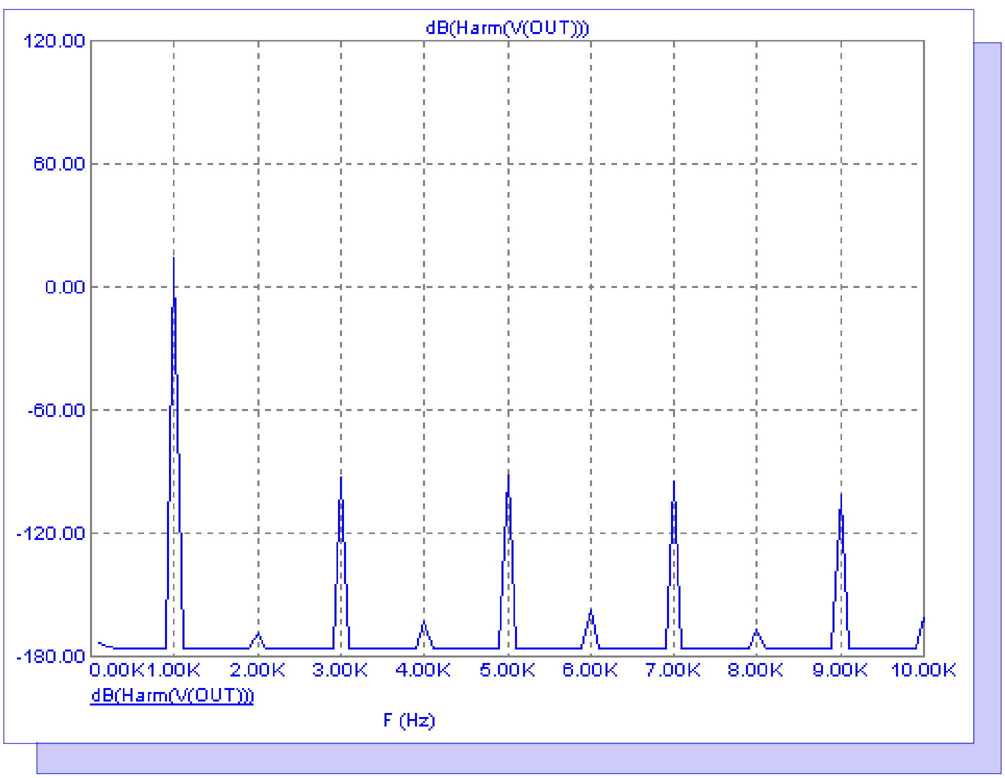


Fig. 22 - FFT with PSS

You can see from the last FFT window plot that the circuit has a noise floor of about 175 dB and contains mainly odd harmonics. Without PSS the odd harmonics are completely lost. This is due to the fact that without PSS the waveform being analyzed is not really periodic. There are still initial transients present. With PSS the initial transient error is reduced to about 1nV and with this small error it is possible for the FFT window to more accurately see smaller harmonics.

Here are some guidelines for using PSS:

Periodicity: The circuit response must be periodic. If it is driven by multiple sources, tmax must be an integer multiple of the periods of those sources.

Linearity: The relationship between the initial and final points over the shooting interval must be near linear. With perfect linearity, convergence usually occurs within 1-3 iterations. If the relationship is highly nonlinear many more iterations may be required or PSS may not converge at all.

Non-chaotic Circuits: PSS cannot handle oscillators (unless the period is known) nor circuits that respond chaotically, such as delta-sigma modulators and some SMPS circuits.

Limitations: PSS does not work with circuits containing digital components, transmission lines, Laplace sources, Z-transform sources, or N-ports.

Product Sheet

Latest Version numbers

Micro-Cap 10 .... Version 10.0.9.2
Micro-Cap 9 .... Version 9.0.9.0
Micro-Cap 8 .... Version 8.1.3
Micro-Cap 7 .... Version 7.2.4

Spectrum's numbers

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