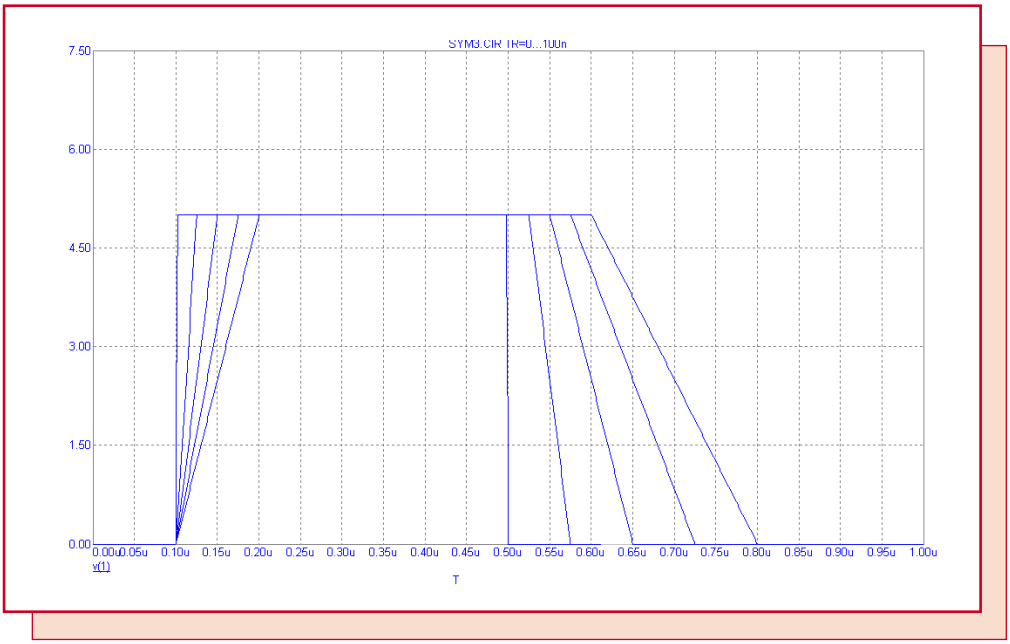
spectrum news

Applications for Micro-Cap™ Users

Winter 2002

News



Symbolic Variables

Featuring:

- Using Symbolic Variables
- Simulating the Multiplier (M) parameter in BJT Models
- Porting Micro-Cap 5 and 6 Files To Micro-Cap 7

News In Preview

This newsletter's Q and A section describes how to plot waveforms from prior runs and how to gracefully exit the text box in MC7. The Overlooked Features gives some tips on getting the most from Probe and shows you how to highlight a node.

The first article describes a method for using symbolic variables to step or have Monte Carlo tolerancing in parameters that are not otherwise accessible.

The second article describes a method for adding a "multiplier" parameter to BJT parts similar to the one provided for MOSFETs.

The third article describes how to port Micro-Cap 5 and 6 files to Micro-Cap 7.

Contents

Book Recommendations

Micro-Cap / 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

• *Semiconductor Device Modeling with SPICE*, Paolo Antognetti and Giuseppe Massobrio McGraw-Hill, Second Edition, 1993. ISBN# 0-07-002107-4

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

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

MOSFET Modeling

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

• *MOSFET Modeling with SPICE Principles and Practice*, Daniel Foty, Prentice Hall, First Edition, 1997. ISBN# 0-13-227935-5

German

• *Schaltungen erfolgreich simulieren mit Micro-Cap V*, Walter Gunther, Franzis', First Edition, 1997. ISBN# 3-7723-4662-6

Design

• *Microelectronic CircuitsHigh Performance Audio Power Amplifiers*, Ben Duncan, Newnes, First Edition, 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, First Edition, 1997. ISBN# 0-07-913227-8

• *Switch-Mode Power Supply SPICE Simulation Cookbook*, Christophe Basso, McGraw-Hill 2001. This book describes many of the SMPS models supplied with Micro-Cap.

RF Electronics

• *Microwave Circuit Design*, Vendelin, Pavio, and Rhoda, First Edition, 1990. ISBN# 0-471-60276-0

Micro-Cap Questions and Answers

Question: I would like to know whether it is possible to keep previous analysis plots open for comparison with the latest analysis plot.

Answer: Yes it is possible to save and recall curves for later display. After the run press F10 to access the Plot Properties dialog box. Click on the Save Curves tab. Select which curve you want to save and press the Save button. In general, you can save any curve that was plotted or printed to numeric output to a User file.

Waveforms contained in User files can be plotted on subsequent runs by adding a new waveform line in the Analysis Limits (F9) dialog box, then right clicking the mouse in the Y expression field and from the Curves option, selecting a previously saved curve for plotting.

These curves may also be assigned to a User source in the schematic and used to provide a voltage waveform for the source.

Question: In Micro-Cap 6 I used to be able to terminate text entry by pressing the Enter key. Now that just moves the cursor to the next line. To quit I have to click on the OK button. What's going on?

Answer:
When entering text in Micro-Cap 6, you simply type the text, then press the Enter key because the Enter key means quit the text dialog box and thus terminate the text. Adding a line feed to the text is done by pressing the CTRL key and the Enter key simultaneously.

When entering text in Micro-Cap 7, you simply type the text and press the Enter key to add line feeds to the text. To terminate the text, you exit the dialog box by clicking on the OK button. Alternatively, you can exit by pressing the Tab key to move the focus to the OK button, then pressing the Enter key.

To summarize the keys are as follows:

	Text Line Feed	**Exit Text Dialog Box**
Micro-Cap 6	CTRL+Enter	Enter, or click OK
Micro-Cap 7	Enter	Tab, then Enter or click OK

Question: I am trying to install Micro-Cap 6 in a machine with Windows XP. I get the following error: "Can't find NetHasp Server". Any suggestions would be appreciated.

Answer:
The old MC5 / MC6 HINSTALL program that installs the license manager will not work with Windows XP. The MC5/MC6 programs work fine. It is just the license manager that doesn't work. To correct this problem download the latest HINSTALL.ZIP file from Download section of our web site (www.spectrum-soft.com), extract the HINSTALL.EXE program and run it as shown on the web site instructions. This will remove the old manager and install a new one compatible with the idiosyncrasies of the XP system.

Easily Overlooked Features

This section is designed to highlight one or two features per issue that may be overlooked because they are not made visually obvious with an icon or a menu item.

Generating multiple curves in Probe
In Micro-Cap 6 you choose whether each probe click will add a new curve (Many Curves option), or replace the existing curve (One Curve option).

In Micro-Cap 7, there is another, somewhat hidden, option. Holding the *Ctrl* key down while clicking adds a new curve or deletes it if the curve is already displayed. It does this in either Many Curves or One Curve mode.

In you are in One Curve mode you can quickly add another curve by pressing the Ctrl key and clicking. Clicking again without holding down the Ctrl key, eliminates all curves and draws only the newly clicked one. Its a flexible, rapid way of switching back and forth between one or more curves.

Plotting a differential voltage in Probe
In Micro-Cap 6 you can create a differential voltage only by using the Add Plot function on the Probe menu, and type in an expression like V(Node1,Node2).

In Micro-Cap 7 there is an easier way. Press and hold the *Shift* key down. Click on the first node (Node1) and then the second node (Node2). This plots the V(Node1,Node2).

Highlighting a node
A node is a collection of wires that connect one or more pins together. When you connect a new part to the node or you are simply tracing connections, you may want to see where the node is. If it is a large node with many connections it may be hard to visually take it all in. Micro-Cap provides an easy way to do this. Press the Alt key while clicking on any part of the node and Micro-Cap will highlight all of the constituent wires and pin connections that comprise the node, making it easy to see it as a whole.

Using Symbolic Variables

Micro-Cap provides a way of creating symbolic variables that can be very useful. In particular it lets you step and vary parameters in Monte Carlo that would otherwise be impossible.

A good example is the SPICE V (and I) source. Let's say you want to build a pulse source and vary its parameters. The SPICE V source does not use a MODEL statement so its parameters cannot be stepped directly. But there is another way. Here is how you use symbolic variables to do it.

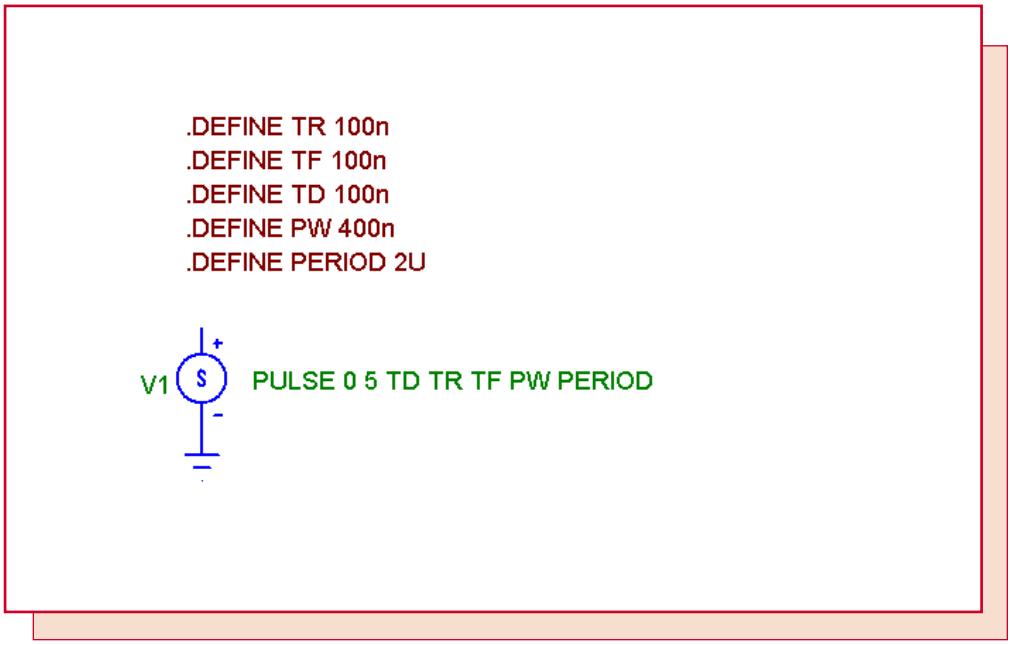


Fig. 1- SPICE V source with stepped parameters

The circuit contains a SPICE V source, where the parameters, usually defined with numbers, are defined in term of the symbolic variables, TD, TR, TF, PW, and PERIOD. These *symbolic variables* are declared and given nominal values using DEFINE statements. These are pieces of text located in the text or schematic area of a circuit. Since Micro-Cap can step symbolic parameters, defining the V source parameters in terms of symbolic parameters means we can now step the key parameters of the SPICE V (and I) source.

To step these parameters, run transient analysis, invoke the Stepping dialog box with F11 and make the following selections:

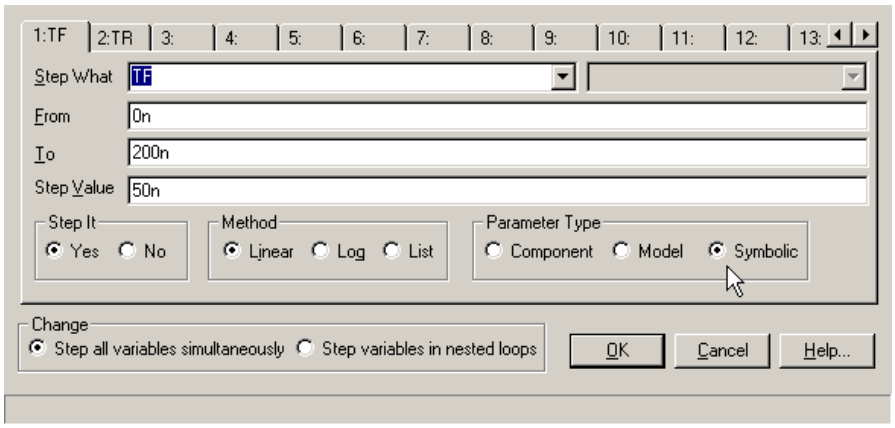


Fig. 2- Stepping dialog box options to step the TF parameter

Fig. 2- Transient analysis of transformer primitive and equivalent circuit are the same

Click OK and press F2 to start the run. This is what you will see.

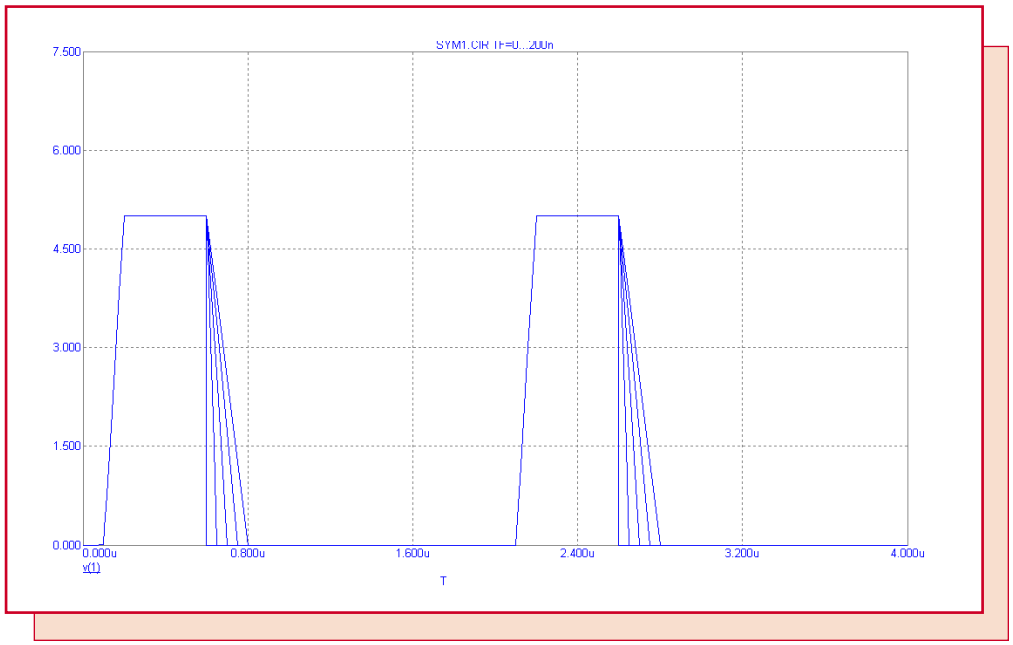


Fig. 3- Stepping the fall time (TF) parameter

Here we have stepped the source's fall time by stepping the TF parameter from 0 to 200ns in steps of 50ns. The plot shows five branches, one for 0ns, 50ns, 100ns, 150ns, and 200ns. In each case the other pulse parameters are constant at their (symbolically) defined values.

As another example let's step the pulse width. To do so we step the PW parameter by setting up the stepping options like this:

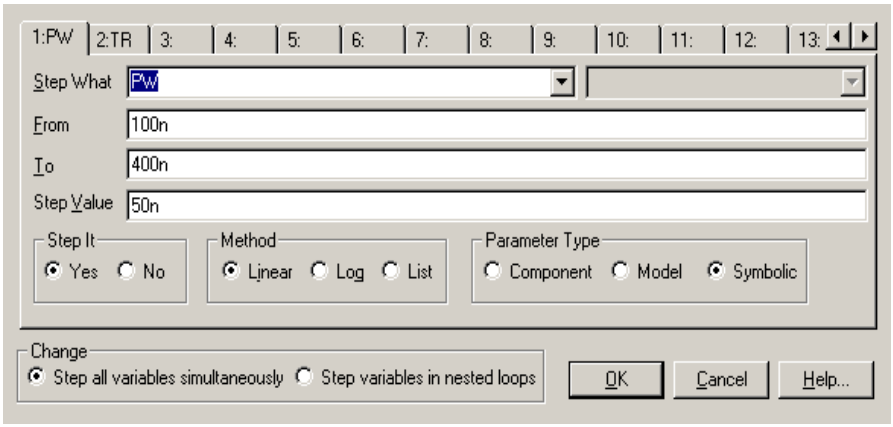


Fig. 4- Stepping dialog box options to step the PW parameter

The results are shown in Figure 5.

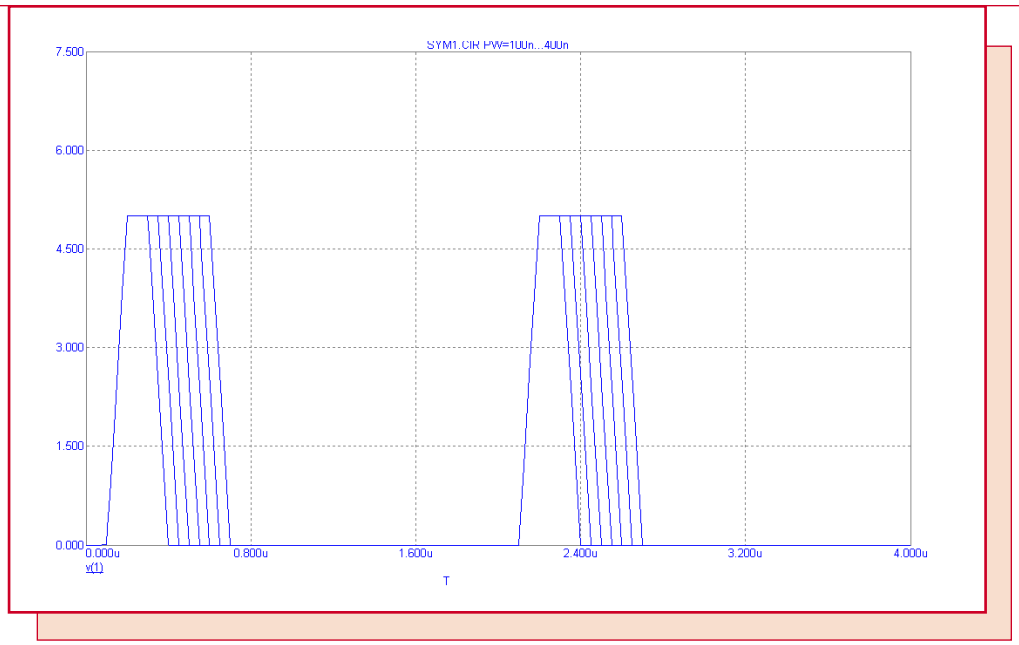


Fig. 5- Stepping the pulse width (PW) parameter

Suppose you wanted to step two parameters together so that the two were always related to one another. For example, suppose you wanted the fall time to always be double the rise time. Here is one way to do that.

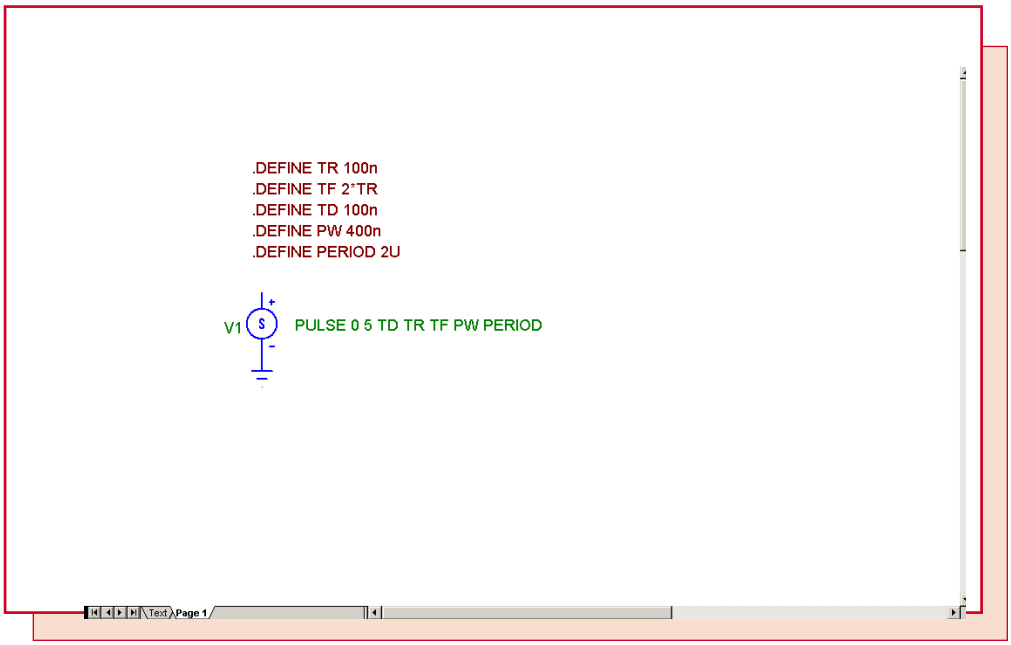


Fig. 6- Linking symbolic parameters

Here we have defined the rise time parameter as TR and the fall time parameter as TF. TR is then defined as 100ns and TR as 2*TR. The rise time can be changed by editing the DEFINE statement, by stepping, or by Monte Carlo. The fall time will always be twice the rise time regardless of how the rise time is changed.

Here is the Stepping dialog box for this run. Note that we are only stepping the TR parameter.

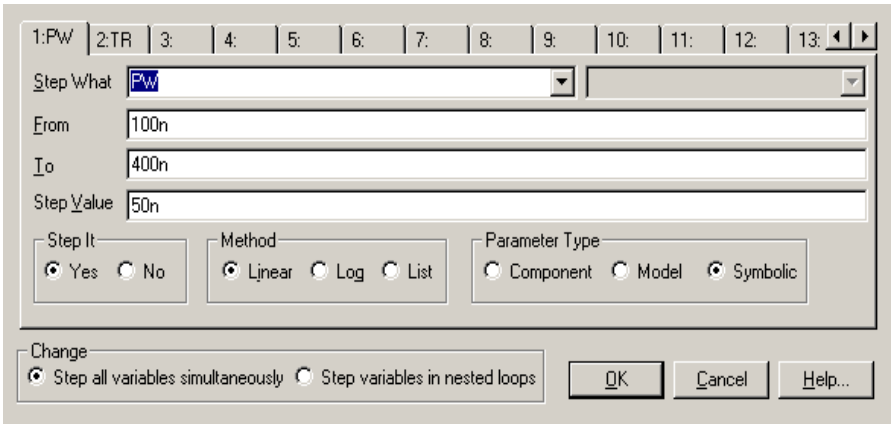


Fig. 7- Stepping dialog box options to step the TR and related TF

Here is how the plot looks for a run time of 1us. Note that while we only stepped TR, both TR and TF varied because TF was defined in terms of TR.

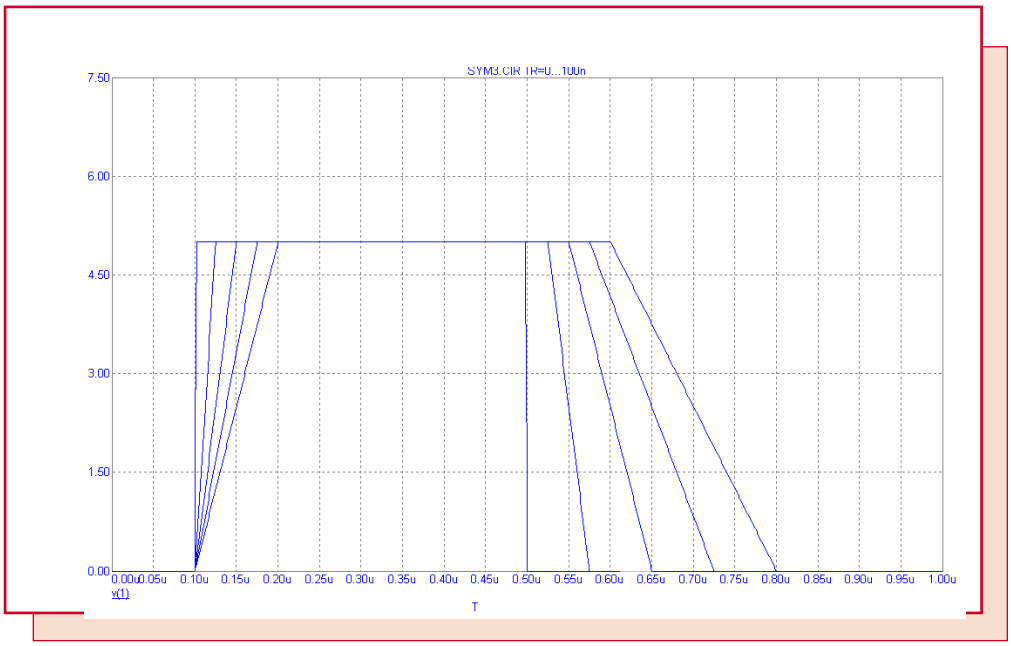


Fig. 8- Stepping two related symbolic parameters

Suppose we wanted to vary all of the parameters except the period in a Monte Carlo analysis. How can we do that? Figure 9 shows how.

Here we have added tolerance values to each of the symbolic parameters except the period parameter, PERIOD.

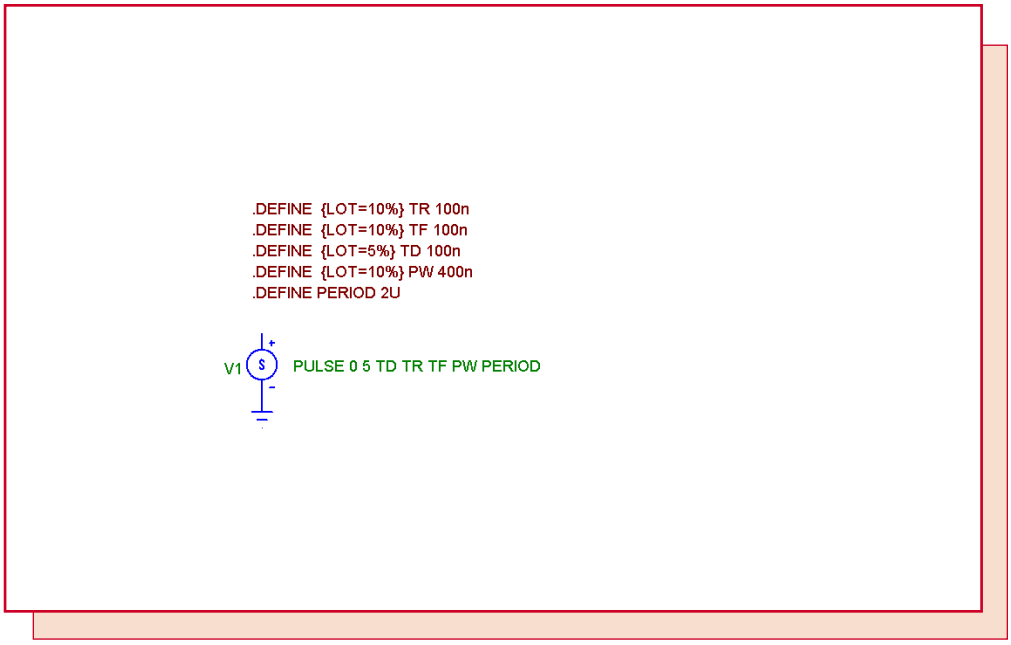


Fig. 9- Using tolerances with symbolic parameters

To add a lot tolerance you simply add the term {LOT=10%} before the symbolic variable name. Here is the result of these tolerances in a Monte Carlo run. There are more options that you can read about on page 234 of the Micro-Cap 7 Reference Manual.

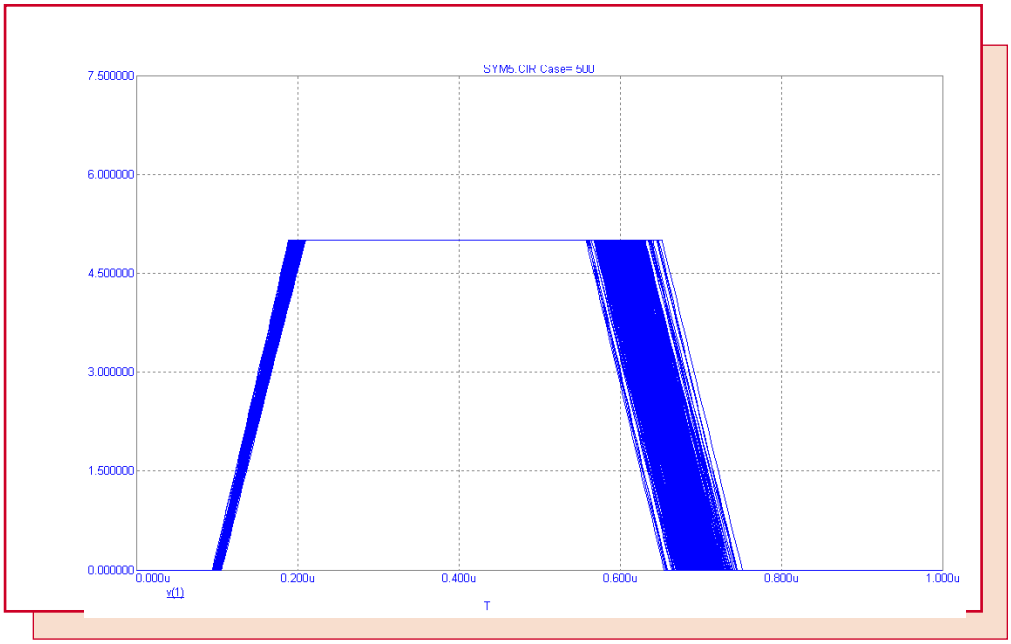


Fig. 10- Tolerancing symbolic parameters for a Monte Carlo analysis

Here is a Monte Carlo histogram of the pulse width distribution for these runs.

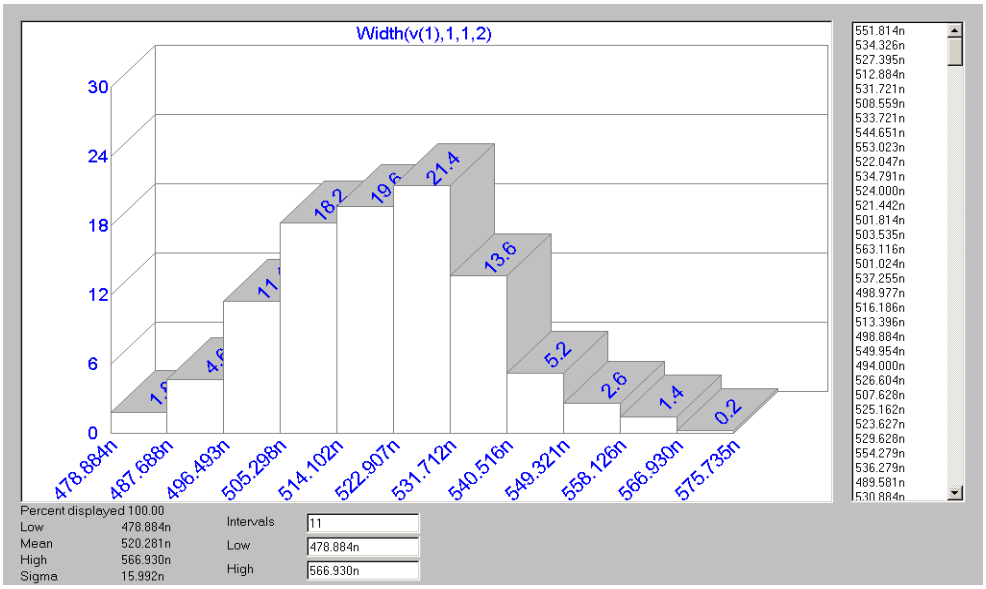


Fig. 11- Width distribution histogram

Symbolic parameters give you great flexibility in stepping and Monte Carlo. The same techniques used here in the parameters of simple sources can also be employed in other more complex parts such bipolar transistors and MOSFETS. These parts may employ expressions for their model parameter values. For example, you might typically specify the VTO of a MOSFET this way.

.MODEL 2N6661 NMOS (VTO=1.6)

But you could also use an expression for VTO like this:

.MODEL 2N6661 NMOS (VTO={1.6-TCX*TEMP})

Where TCX would be a symbolic parameter perhaps defined as follows:

.DEFINE TCX 0.25

TEMP is a global variable for the run's operating temperature.

Expressions like this must always be *run-invariant* expressions. That is, they must use only parameters that are known at the start of the run and do not vary during the run. This means primarily 1) symbolic variables and 2) static parameters like TEMP (operating temperature) and TMAX (Maximum Run Time) that are know at the start of the run and do not vary during the run.

The reason for this restriction is that expressions that vary during the run would have to be recomputed at every time point. This would be a horrendous burden to do for MOSFETS, for example, which can have hundreds of model parameters.

Simulating the Multiplier Parameter in BJT Models

The M parameter lets you model devices that are parallel combinations of smaller "unit" devices. If the model parameters of the "unit" device are known, then the model parameters of the larger aggregate device can be easily be specified.

MC6 and MC7 have an M multiplier parameter for the MOSFET but not for the BJT. Here is a method for implementing such a multiplier.

Make a circuit with the BJT in it. Add the following symbolic definition statement to the circuit:

.DEFINE M 1.0

This creates the symbolic variable, M and assigns it a nominal value of 1.0.

Now make the following edits to the indicated BJT model parameters:

1) Divide the resistance-related terms by M (RB, RBM, RE, RC)
2) Multiply the current-related terms by M (IS, ISS, IKF, ISE, IKR, ISC, ITF)
3) Multiply the capacitance-related terms by M (CJE, CJC, CJS, TR, TF)

Now the variable M can be edited to reflect the number of parallel devices. Here is a circuit that compares using a set of three "unit" devices connected in parallel at OUTA and a circuit using a "multiplied" device with the M value set to 3.0 at OUTB.

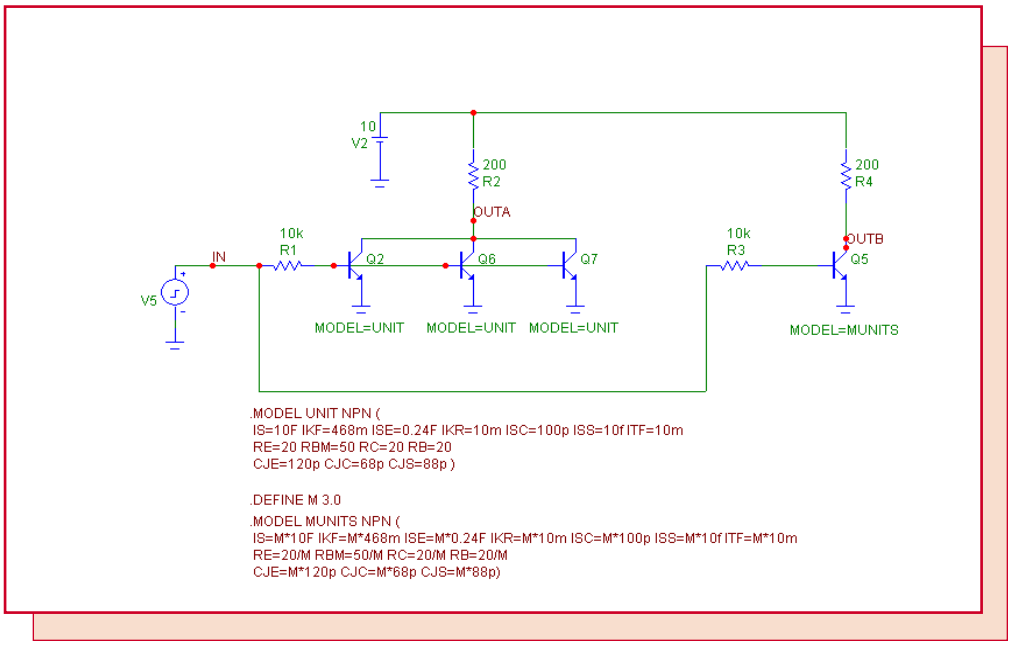


Fig. 12- A BJT Multiplier implementation

Here is the transient analysis of the circuit showing plots of the two outputs OUTA and OUTB. The plots are identical indicating that the BJT with a "multiplier" of 3.0 is equivalent to three "unit" devices in parallel.

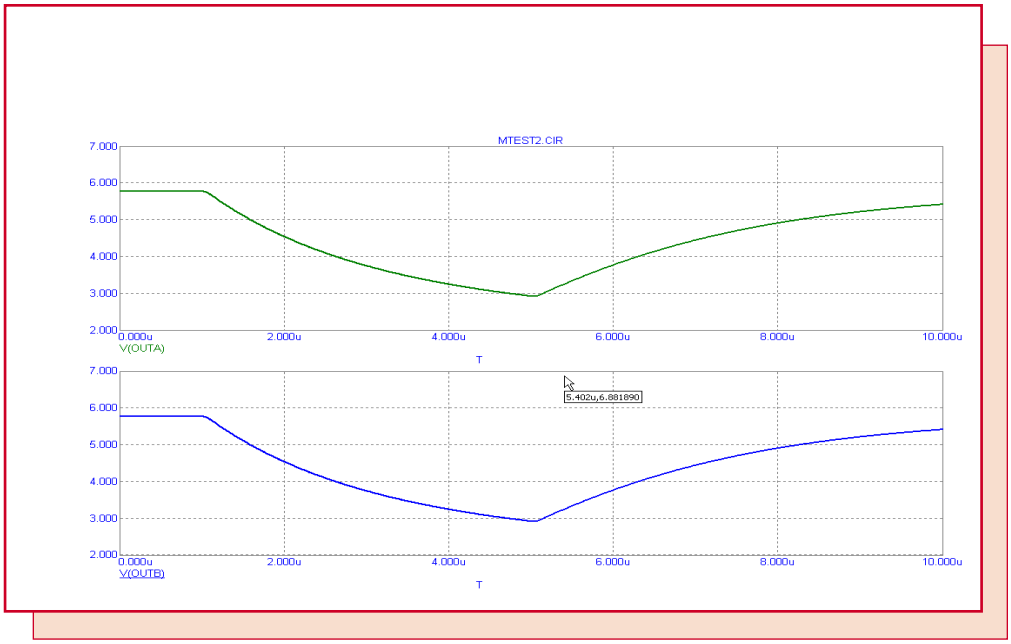


Fig. 13- Transient analysis of the M-test circuit

As an additional check, here is the AC analysis. The gain and phase plots are identical and coincident, indicating complete equivalence between the two circuits.

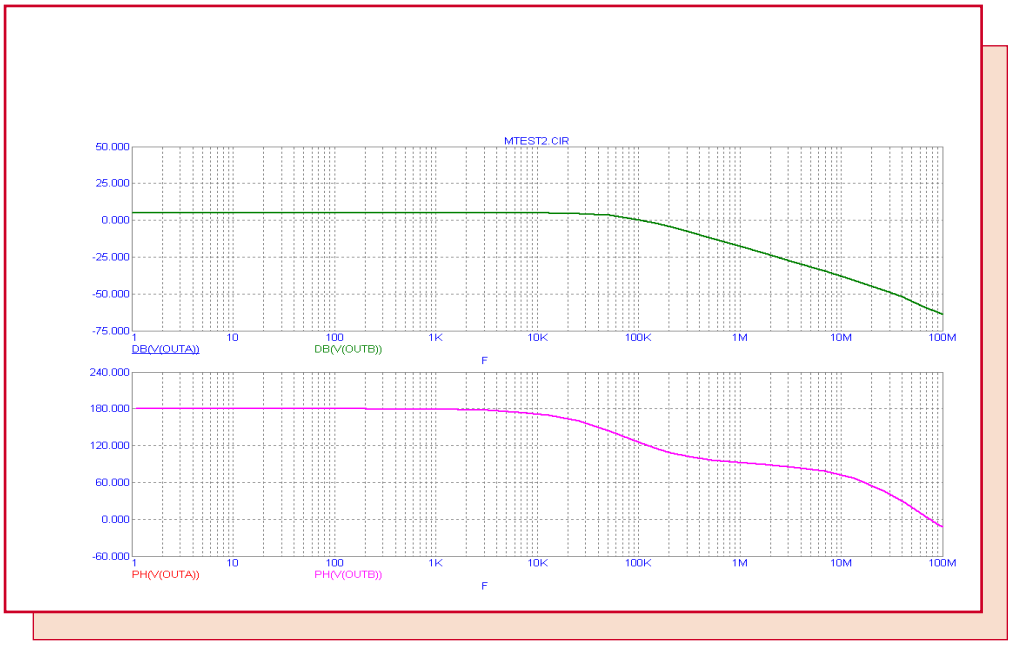


Fig. 14- AC analysis of the M-test circuit

Porting Micro-Cap 5 and 6 Files To Micro-Cap 7

Micro-Cap 7 reads circuit files all the way back to Micro-Cap 4, but to be able to draw the schematic and run the simulations you must also make the Shape and Component library information available to Micro-Cap 7.

Porting files from Micro-Cap 6
Here is a summary of the main Micro-Cap 6 and 7 file types:

File Types	File Names	Where in MC6	Where in MC7
Circuit Files	*.CIR *.CKT	DATA Folder	DATA Folder
Electrical Modeling	*.LBR *.LIB	DATA Folder	LIBRARY Folder
Macro Files	*.MAC *.CIR	DATA Folder	LIBRARY Folder
Shape Data	STANDARD.SHP	MC6 Folder	MC7 Folder
Component Data	STANDARD.CMP	MC6 Folder	MC7 Folder
Misc. Files	*.USR, *.TNO. etc	DATA Folder	DATA Folder

In general, install Micro-Cap 7 in a different folder from Micro-Cap 6. DO NOT USE THE SAME FOLDERS FOR BOTH PROGRAMS.

To port all of your MC6 material all at once, perform the following steps:

1) From the Micro-Cap 7 Component Editor, use the Merge button to merge the old Micro-Cap 6 Component library, STANDARD.CMP, with the new Micro-Cap 7 Component library, also called STANDARD.CMP. When you click on the Merge button, you are asked for the name of the file to merge the current library with. Browse to the Micro-Cap 6 folder and select the STANDARD.CMP file. If you have created other component library files (*.CMP), you should merge them as well.

You may also open the file rather than merging it if you prefer. Micro-Cap 7 will ask you to save it. Give it a new name like STARNDARD6.CMP. Its contents are then found under its new name rather than the STANDARD.CMP group.

2) From the Micro-Cap 7 Shape Editor, use the Open command. Browse to the Micro-Cap folder and select the STANDARD.SHP file. Micro-Cap 7 will ask you to save it. Give it a new name like SHAPE6.SHP.

3) Copy all macro files (in MC6 they may have either of the extensions .CIR or .MAC), and library files (*.LBR and *.LIB) to the LIBRARY folder, (usually at C:\MC7\LIBRARY). See the File Menu / Path command if you are unsure where the LIBRARY folder is.

4) Copy any circuit files (*.CIR) any circuit support files like user files (*.USR) and initial condition files (*.TOP) to the DATA folder, (usually at C:\MC7\DATA). See the File Menu / Path command if you are unsure where the DATA folder is.

Porting files from Micro-Cap 5

Porting files from Micro-Cap 5 is very similar and differs mainly in the names of the Component and Shape libraries.

Here is a summary of the main Micro-Cap 5 and 7 file types:

File Types	File Names	Where in MC5	Where in MC7
Circuit Files	*.CIR *.CKT	DATA Folder	DATA Folder
Electrical Modeling	*.LBR *.LIB	DATA Folder	LIBRARY Folder
Macro Files	*.CIR	DATA Folder	LIBRARY Folder
Shape Data	SHAPE.MC5	MC5 Folder	MC7 Folder
Component Data	COMP.MC5	MC5 Folder	MC7 Folder
Misc. Files	*.USR, *.TNO. etc	DATA Folder	DATA Folder

In general, install Micro-Cap 7 in a different folder from Micro-Cap 5. DO NOT USE THE SAME FOLDERS FOR BOTH PROGRAMS.

To port all of your MC5 material all at once, perform the following steps:

1) From the Micro-Cap 7 Component Editor, use the Merge button to merge the Micro-Cap 5 Component library, COMP.MC5, with the Micro-Cap 7 Component library, STANDARD.CMP. When you click on the Merge button, you are asked for the name of the file to merge the current library with. Browse to the Micro-Cap 5 folder and select the COMP.MC5 file.

You may also open the file rather than merging it if you prefer. Micro-Cap 7 will ask you to save it. Give it a new name like STARNDARD5.CMP. Its contents are then found under its new name rather than the STANDARD.CMP group.

2) From the Micro-Cap 7 Shape Editor, use the Open command. Browse to the Micro-Cap folder and select the SHAPE.MC5 file. Micro-Cap 7 will ask you to save it. Give it a new name like SHAPE5.SHP.

3) Copy all macro files (in MC5 they have the extension .CIR), and library files (*.LBR and *.LIB) to the LIBRARY folder, (usually at C:\MC7\LIBRARY). See the File Menu / Path command if you are unsure where the LIBRARY folder is.

4) Copy any circuit files (*.CIR) any circuit support files like user files (*.USR) and initial condition files (*.TOP) to the DATA folder, (usually at C:\MC7\DATA). See the File Menu / Path command if you are unsure where the DATA folder is.

Once a file has been loaded and saved by MC7, it contains its own library and shape information and so it is highly portable, eliminating the need for all of the foregoing steps except the copying of macros. Future upgrades will be much easier.

Product Sheet

Latest Version numbers

Micro-Cap 7 ..... Version 7.12
Micro-Cap 6 ..... Version 6.32
Micro-Cap V ..... Version 2.1.2

Spectrum's numbers

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