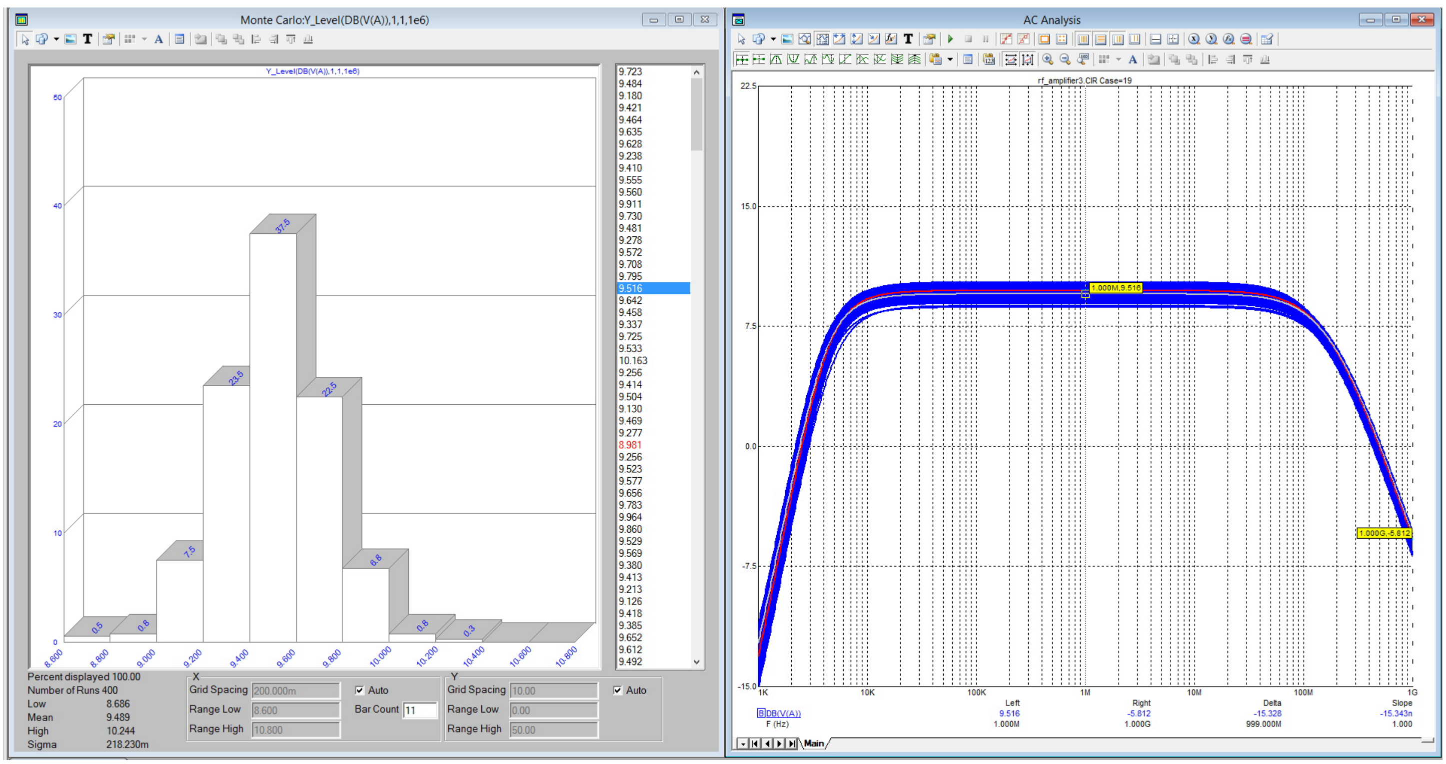
spectrum news

Applications for Micro-Cap™ Users

Fall 2015

News



Monte Carlo Cases

Featuring:

- Working With Nonlinear Capacitors
- Viewing Monte Carlo Circuit Cases
- Making a DPDT Switch

News In Preview

This newsletter's Q and A section describes a common installation situation, the necessity to install using Administrator status. Also covered are Component library issues, and Windows 10 compatibility.

The Easily Overlooked Feature section describes the Attribute dialog box plot feature; a handy way to see at a glance how important component features respond to parameter changes.

The first article describes how to create and use nonlinear capacitors.

The second article describes how to view the individual circuits (cases) that Monte Carlo creates.

The third article describes how to create a DPDT switch using the animated switch component..

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: I'm having a problem on Micro-Cap. I came out of the component editor and I lost the Analog Models, Analog Primitives, etc…under "Components". I went back into Components Editor and I can't figure out how to get it back.

Answer: You have probably deleted the Standard.cmp from the Component library hierarchy. Here's how to fix it. Invoke the Windows menu / Component editor. Use the File Open icon to open the Standard.cmp file, which should still be there in the main Micro-Cap folder. After opening the file, you should see the standard.cmp shown in the library hierarchy list to the right.

Question: We are trying to use the Check for Updates feature to update our Micro-Cap 10. When we attempt to use it we are getting this message:

File update failed

Uncompress: Can't open c:program File (x86)\Spectrum\MC10\dlmcapver.exe

What are we doing wrong?

Answer: Most likely you are attempting to operate out of a folder that is write-protected. You can get around this in two ways:

1) Obtain administrative privileges (usually from your IP department) which allow you to both read and write to Micro-Cap folders. The problem with this is that your admin privileges may be revoked at any time by IP "maintenance updates".

2) Install Micro-Cap in a folder that is always writable, something like C:\MC10. This is the recommended approach.

Micro-Cap must be able to write to all of its folders, including the main folder (where the Micro-Cap executable is), the DATA folders, and LIBRARY folders.

Note that the c:\Program File.. folder choice is always a bad one as it is always write-protected.

Question: Does Micro-Cap work under Windows 10.

Answer: MC8, MC9, MC10, and MC11 work.

Easily Overlooked Features

This section is designed to highlight features that may be overlooked among the many capabilities of Micro-Cap.

Using the Plot Feature

Did you know that you can plot the characteristics of certain components from the dialog box used to place them? This is especially useful with independent sources whose waveform you're trying to create. Here for example is the plot for an FM source.

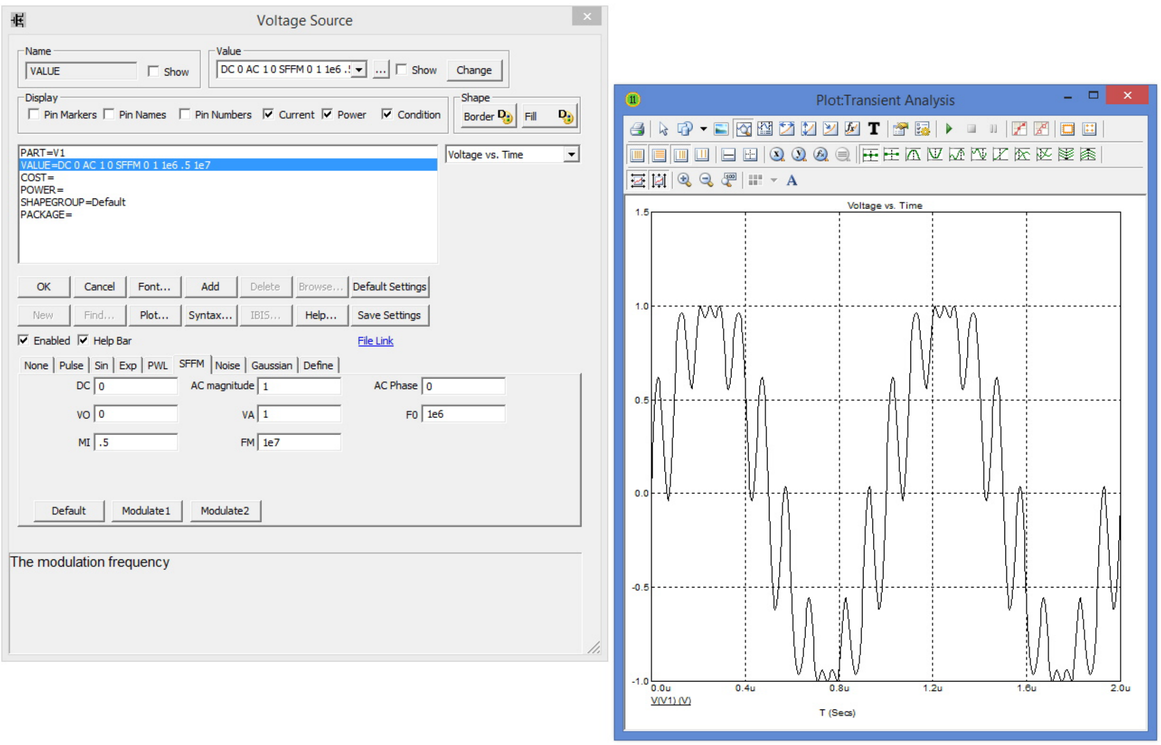


Fig. 1 - The Attribute dialog box Plot command

You can tweak the parameters and the plot responds.

To get a plot, all you need to do is click on the Plot button. For more complex devices you may want to first select the plot type you want as some devices have up to four types of plots. The BJT device for example, has four plots: IC vs. VCE, DC Current Gain, VCE Saturation Voltage, and Beta vs. Frequency.

Note that the plots only work for device primitives. If the part model is a power MOSFET it may be modeled as a subcircuit rather than as a NMOS primitive. In this case no plot will be available.

Note also that the plot is generated using the current settings for the necessary analysis mode. For example, a plot of an independent voltage source would use transient analysis and its current Time Range. Press F9 to get an abbreviated Analyis Limits dialog box where you can change the settings.

Working With Nonlinear Capacitors

Micro-Cap 11 handles user-defined nonlinear capacitors in two different ways. This article will discuss the two methods and the tradeoffs between them.

Method 1: Using the CAPACITANCE attribute. To see how this works, look at this sample file.

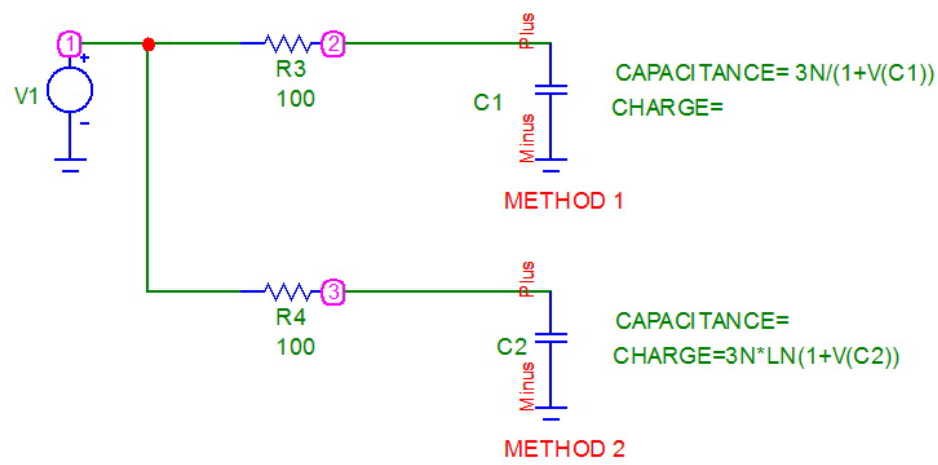


Fig. 2 - Two ways to do nonlinear capacitors

The top capacitor has its capacitance defined as the expression

3n/(1+V(C1))

The capacitance is defined as 3n/(1+V(C1)) and the charge expression is not defined.

Method 2: Using the CHARGE attribute.

Now consider the bottom capacitor. Its charge is defined with the expression

3n*LN(1+V(C2))

The capacitance is not defined and the charge is defined as 3n*LN(1+V(C2)).

Both methods use consistent expressions in that the derivative of the charge expression is equal to the capacitance expression. However, the preferred approach is the Method 2. We shall see why later.

Run transient analysis and you get these plots.

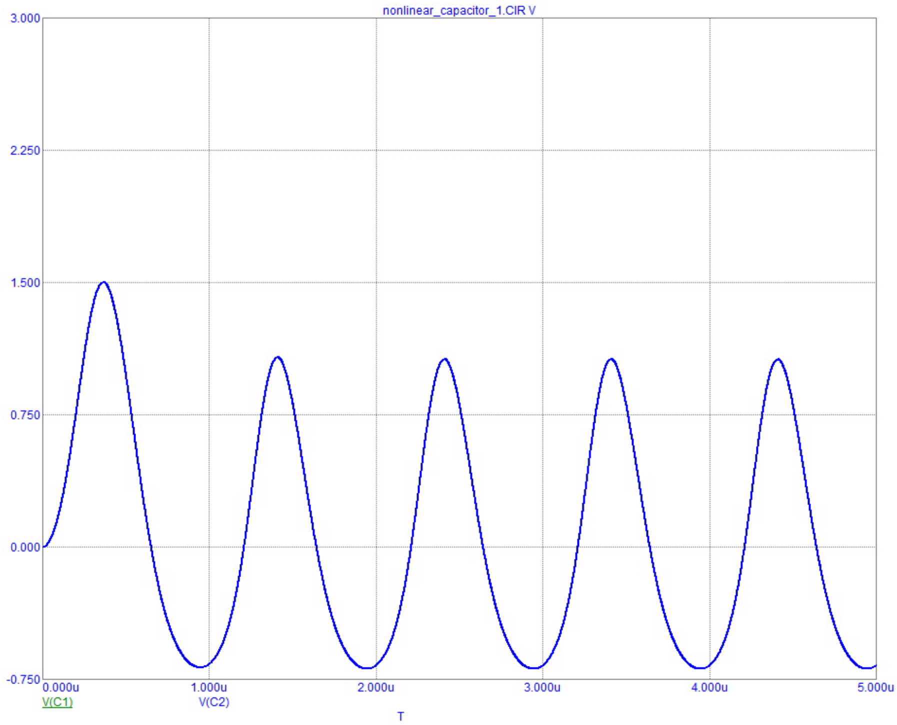


Fig. 3 - Plot of the capacitor voltages

Both capacitors exhibit the same voltage waveforms. Here is the plot of capacitor currents.

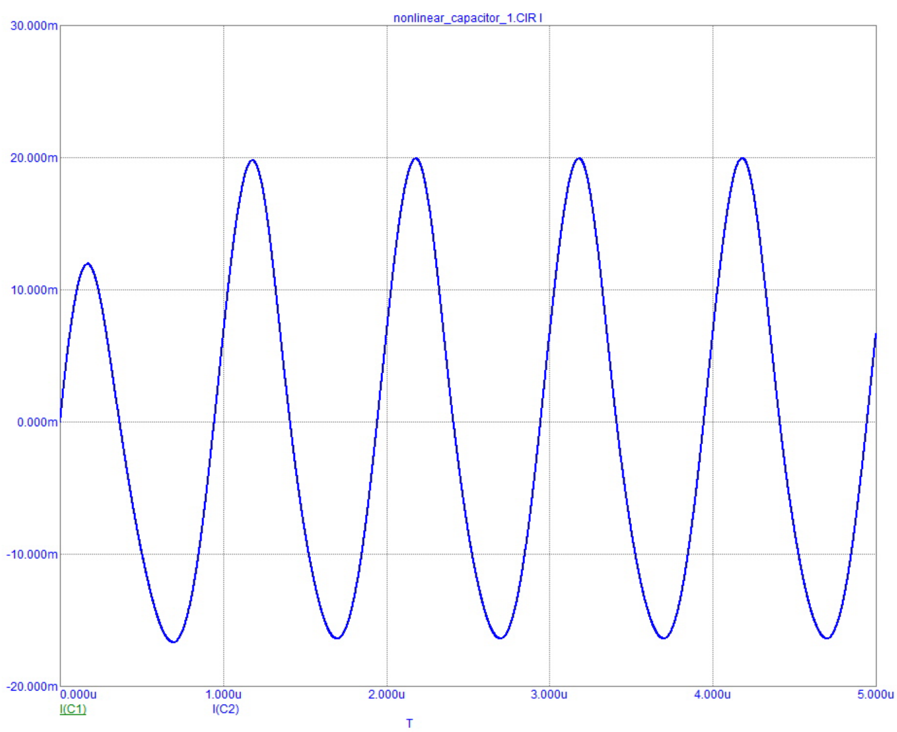


Fig. 4 - Plot of the capacitor currents

As you can see both capacitors produce the same voltage and current waveforms. How about the capacitance and charge plots? Well, here they are:

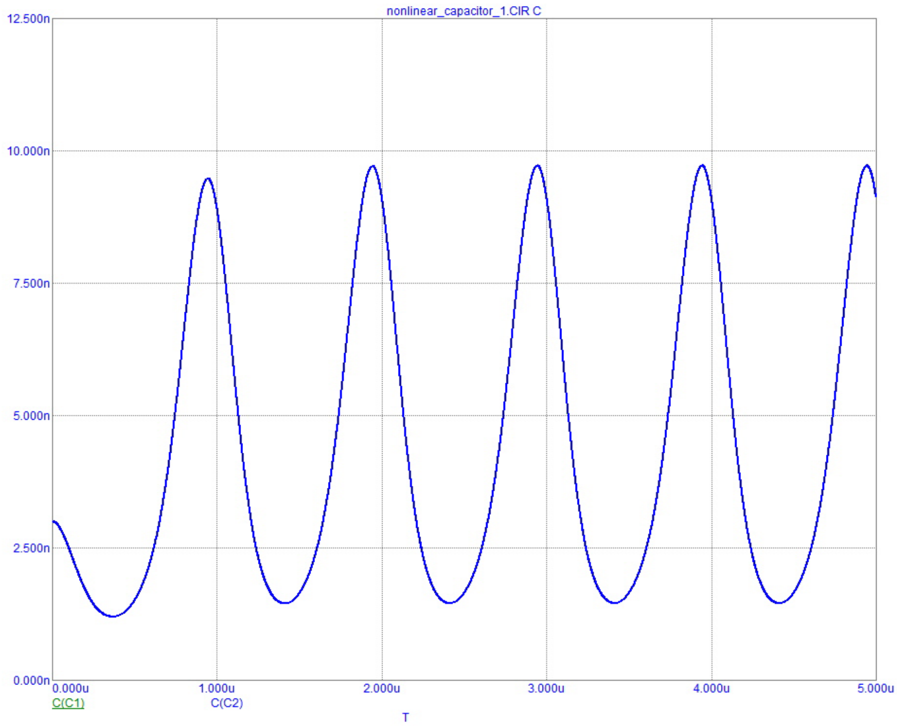


Fig. 5 - Plot of the capacitances vs. time

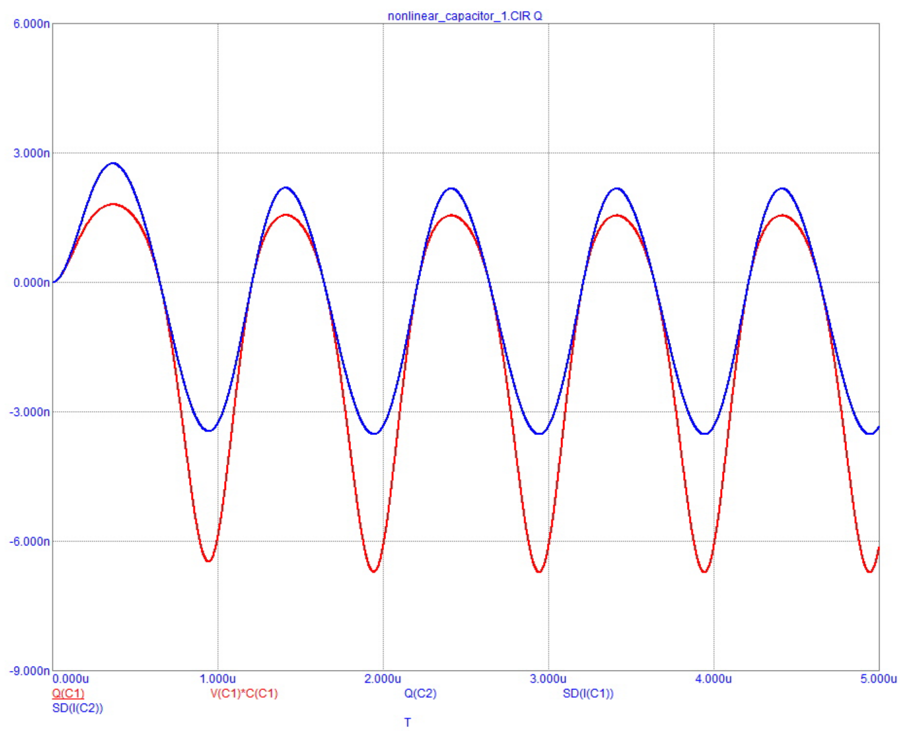


Fig. 6 - Plot of the capacitor charges vs. time

The capacitance and charge curves of C1 are both correct but the charge curve for C2 is not. That's because the charge expression for it is not supplied and must be estimated as C(V1)*V(C1), which in this case is a poor approximation. That is one reason why Method 2 is superior for nonlinear capacitors. There are other, more subtle, reasons which perhaps we'll discuss in a future article. Those other reasons have to do with Method 1 being a more robust technique and more likely to converge. So if you can, use the charge expression method.

Viewing Monte Carlo Circuit Cases

Monte Carlo is one of the best features in Micro-Cap. It provides a statistical summary of how a circuit will perform with component parameter variation. There are times when you may wish to see a circuit that failed a performance test and what component values were used to produce the failure. In turns out that this is pretty easy to do but is somewhat obscure and easy to miss.

We're making it easier to do in MC12, but here is how it may be done in MC5 through MC11.

To illustrate, we'll use this sample circuit, rf_amplifier3.cir

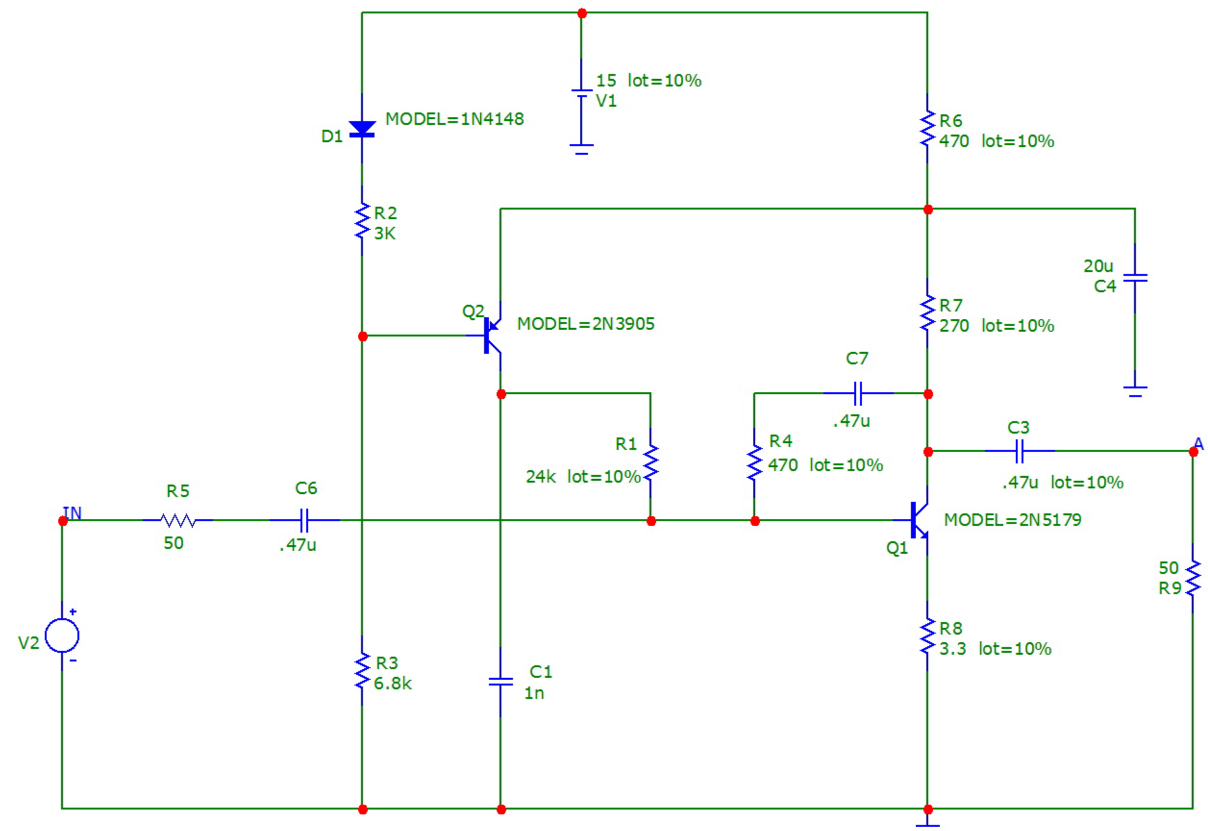


Fig. 7 - Sample circuit for Monte Carlo

Run AC analysis and the program will do a 400 run Monte Carlo analysis and produce a display that looks like the next figure.

On one side you have the Bode plots of gain or DB(V(A)) vs. F for the 400 runs. You can get a feel for the statistical distribution of the Bode plot by just looking at the plot width.

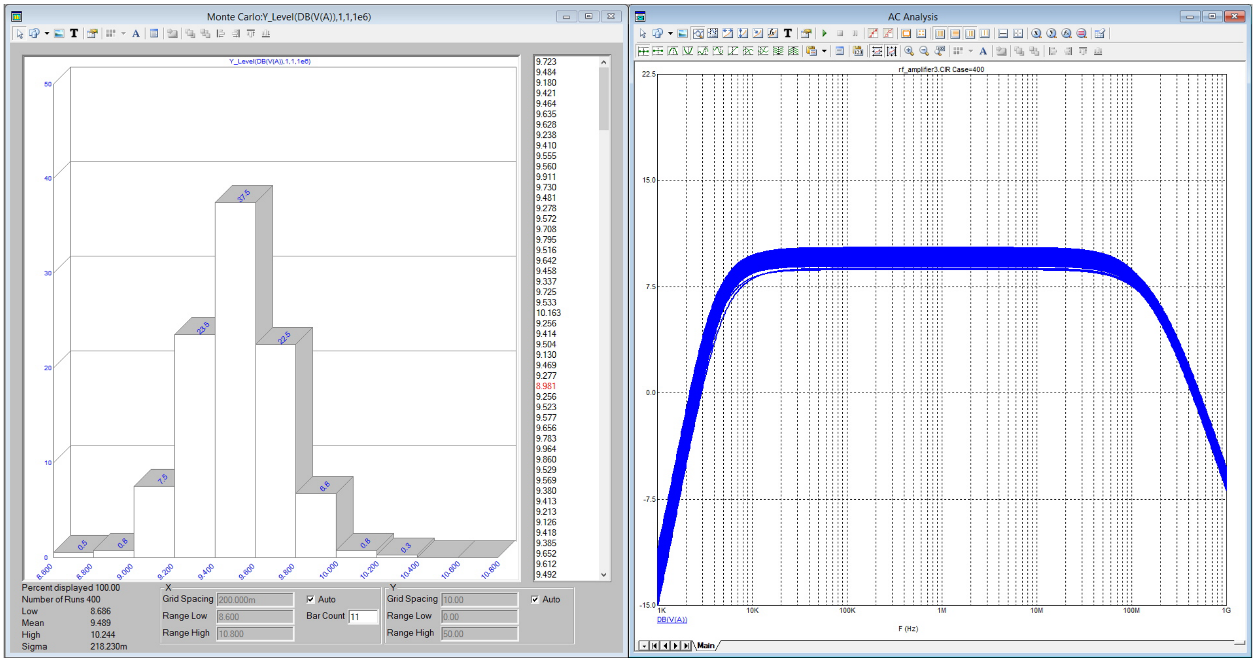


Fig. 8 - Monte Carlo run

For a more detailed statistical description the program produces a histogram of the distribution of Y_Level(DB(V(A)),1,1,1e6), the value of DB(V(A)) at F=1E6. The histogram shows that all but 2.4% of the cases (.5+.8+.8+.3) were between 9 and 10 dB.

What controls all of this? The Monte Carlo Options dialog box accessed from the Monte Carlo menu does. It looks like the next figure.

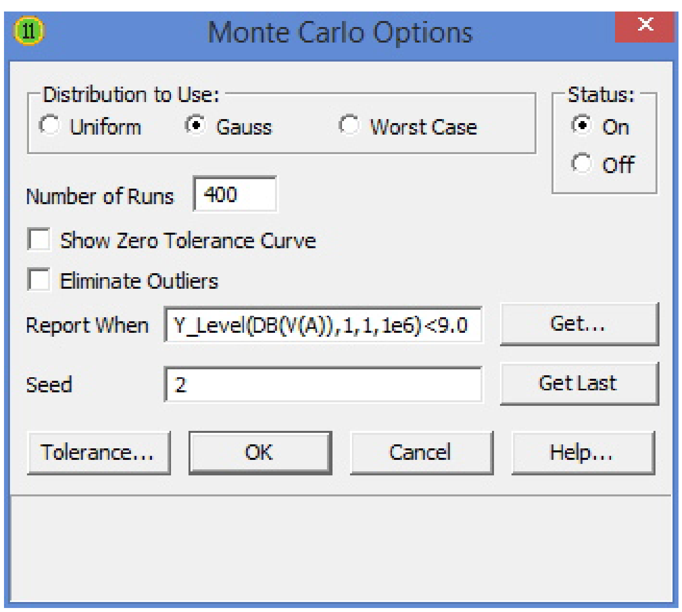


Fig. 9 - Monte Carlo options

Notice the Report When field. It contains this boolean expression:

Y_Level(DB(V(A)),1,1,1e6)<9.0

The Monte Carlo histogram plots the frequency distribution of

Y_Level(DB(V(A)),1,1,1e6)

Y_Level(DB(V(A)),1,1,1e6)<9.0 causes a notation to be made in the numeric output file when the expression is true, i.e. when DB(V(A)) measured at F = 1E6 is less than 9.0.

The list box on the right shows the value of Y_Level(DB(V(A)),1,1,1e6) for each Monte Carlo case. Note that when the Report When expression is true it shows the case number in red font.

Before we illustrate viewing the circuit that causes one of these exceptions, let's look at what happens when we use Cursor mode. Click the mouse in the AC plot window and press F8. Now click the mouse in the list box of the Monte Carlo window. The display should look like this.

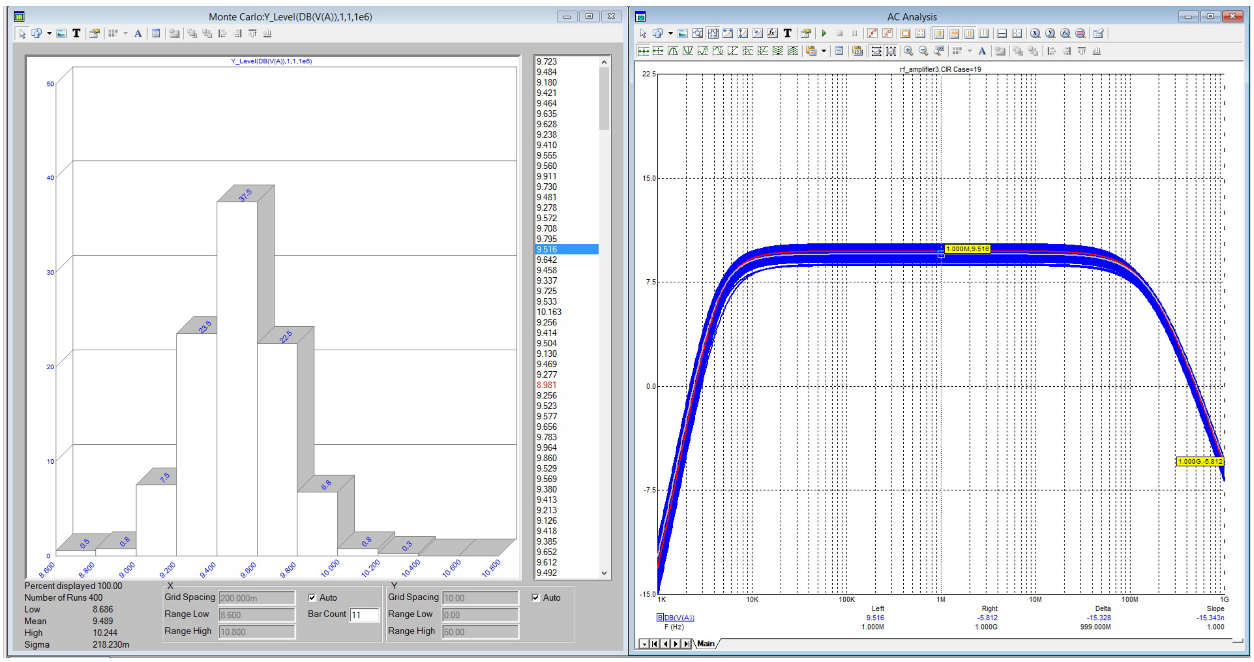


Fig. 10 - Monte Carlo run

Notice that the selected case (in this case when the result was 9.516) is plotted in a contrasting color amidst the other Bode plots. The original case 1 is plotted in red. Press the down arrow cursor key and the next case will be selected and plotted. Continue pressing the key until you have selected the case printed in red. This is the first case that triggered the boolean exception (8.981). You can't yet see the circuit, but you can see the Bode plot it produced together with its value.

Using the Scope Cursor mode you can select and view the plots for any of the Monte Carlo cases, including those that produced a true Report When expression.

Now press F3 to exit the AC analysis. This returns us to the schematic. From the File menu select Load MC File. Browse to and open the file rf_amplifier.ano. The display should look like this:

The program loads the rf_amplifier's numeric output file (rf_amplifier.ano). This file contains the tolerances used in the circuits that produced the cases for which the boolean exception was true. In this case there were five exceptions out of 400 cases.

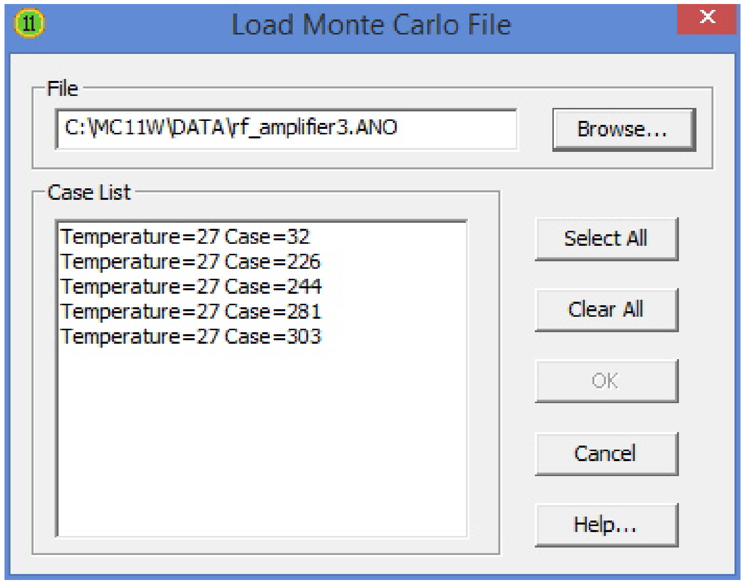


Fig. 11 - The Load MC File dialog box

From this dialog you can load one or more of the circuits and see what set of tolerances produced the exception. To illustrate, load the first circuit, Case 32. It looks like this:

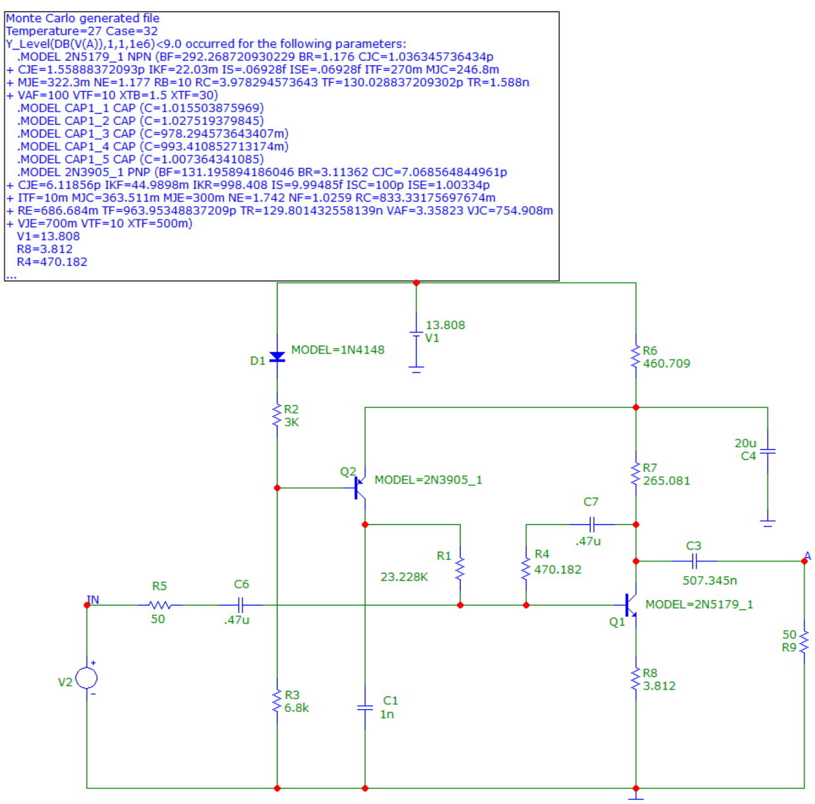


Fig. 12 - The MC circuit case

This is a copy of the original circuit with the addition of the text:

```
Monte Carlo generated file Temperature=27 Case=32
Y_Level(DB(V(A)),1,1,1e6)<9.0 occurred for the following parameters:
  .MODEL 2N5179_1 NPN (BF=292.268720930229 BR=1.176 CJC=1.036345736434p
+ CJE=1.55888372093p IKF=22.03m IS=.06928f ISE=.06928f ITF=270m MJC=246.8m
+ MJE=322.3m NE=1.177 RB=10 RC=3.978294573643 TF=130.028837209302p TR=1.588n
+ VAF=100 VTF=10 XTB=1.5 XTF=30)
  .MODEL CAP1_1 CAP (C=1.015503875969)
  .MODEL CAP1_2 CAP (C=1.027519379845)
  .MODEL CAP1_3 CAP (C=978.294573643407m)
  .MODEL CAP1_4 CAP (C=993.410852713174m)
  .MODEL CAP1_5 CAP (C=1.007364341085)
  .MODEL 2N3905_1 PNP (BF=131.195894186046 BR=3.11362 CJC=7.068564844961p
+ CJE=6.11856p IKF=44.9898m IKR=998.408 IS=9.99485f ISC=100p ISE=1.00334p
+ ITF=10m MJC=363.511m MJE=300m NE=1.742 NF=1.0259 RC=833.33175697674m
+ RE=686.684m TF=963.95348837209p TR=129.801432558139n VAF=3.35823 VJC=754.908m
+ VJE=700m VTF=10 XTF=500m)
  V1=13.808
  R8=3.812
  R4=470.182
...
```

This is a list of the specific parameters toleranced to produce the case. If you run this circuit in AC analysis, it will produce the same exception value of Y_Level(DB(V(A)),1,1,1e6) = 8.981. You can see the same toleranced values by scanning the numeric output file. Use the search command (CTRL+F) and search for the word "occurred". The first instance you'll see is:

```
Y_Level(DB(V(A)),1,1,1e6)<9.0 occurred for the following parameters:
model for:Q1
.MODEL 2N5179 NPN (BF=292.268720930229 BR=1.176 CJC=1.036345736434p
+ CJE=1.55888372093p IKF=22.03m IS=.06928f ISE=.06928f ITF=270m MJC=246.8m
+ MJE=322.3m NE=1.177 RB=10 RC=3.978294573643 TF=130.028837209302p TR=1.588n
+ VAF=100 VTF=10 XTB=1.5 XTF=30)
model for:C7
.MODEL CAP1 CAP (C=1.015503875969)
C7 Device Capacitance=477.287n
model for:C1
.MODEL CAP1 CAP (C=1.027519379845)
C1 Device Capacitance=1.028n
model for:C6
.MODEL CAP1 CAP (C=978.294573643407m)
C6 Device Capacitance=459.798n
model for:C3
.MODEL CAP1 CAP (C=993.410852713174m)
C3 Device Capacitance=504.002n
model for:C4
.MODEL CAP1 CAP (C=1.007364341085)
C4 Device Capacitance=20.147u
model for:Q2
.MODEL 2N3905 PNP (BF=131.195894186046 BR=3.11362 CJC=7.068564844961p
+ CJE=6.11856p IKF=44.9898m IKR=998.408 IS=9.99485f ISC=100p ISE=1.00334p
+ ITF=10m MJC=363.511m MJE=300m NE=1.742 NF=1.0259 RC=833.33175697674m
+ RE=686.684m TF=963.95348837209p TR=129.801432558139n VAF=3.35823 VJC=754.908m
+ VJE=700m VTF=10 XTF=500m)
```

Similar results are presented by the other four exception cases. You can view these by pressing F3 to continue the search.

What if you wanted to see all of the 400 cases? Well there is a way: change the boolean expression to 1. This always evaluates to true and generates an exception report for every case. This causes the Load MC command to create a list of the circuits used for every case. You can load any one or all of them. Be careful though, for the program creates a file for each circuit variant that you select to load. In this case loading all 400 cases would create 400 circuit files on disk, probably more than you want.

Here is what the Load MC command looks like when the boolean expression is 1.

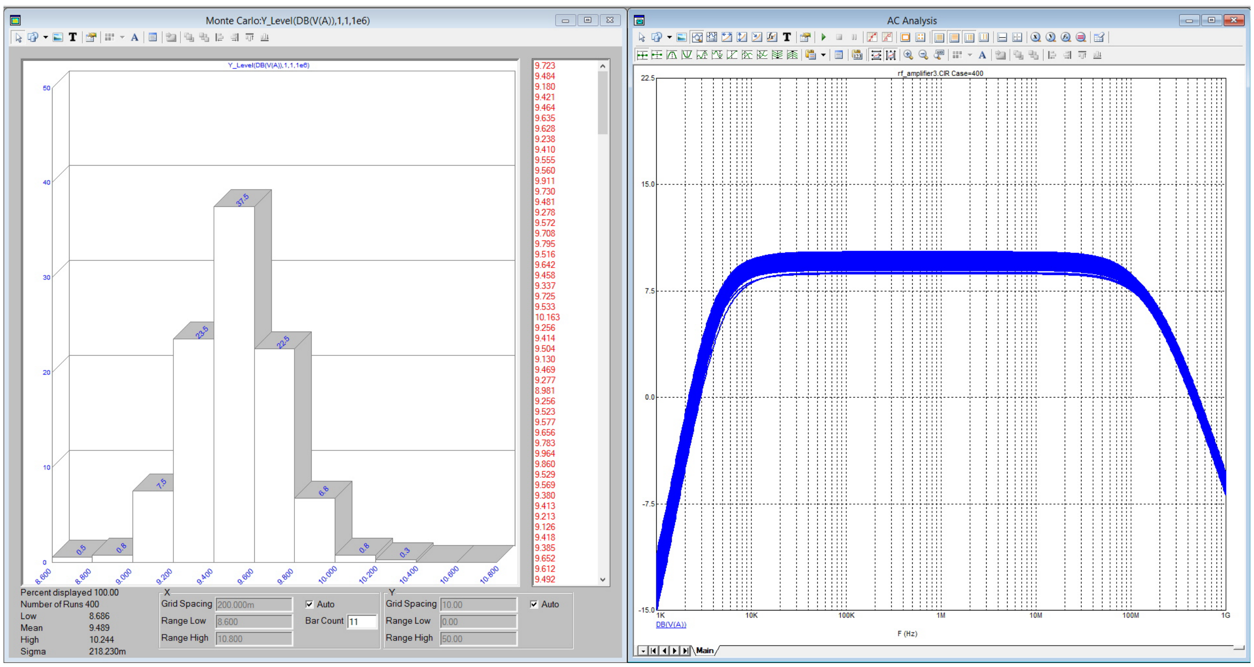


Fig. 13 - The Monte Carlo run when boolean expression = 1

Notice that all the cases are printed in red. Here is the Load MC dialog for this case:

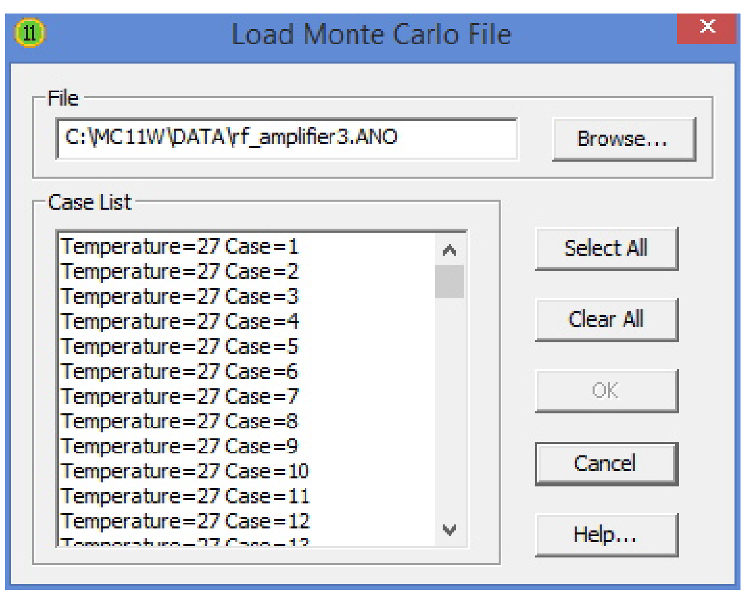


Fig. 14 - The Load MC dialog when boolean expression = 1

Making a DPDT Switch

You may have noticed that Micro-Cap has a SPST, SPDT, and a DPST. Is there a DPDT? No. It was left out. So what do you do if you need one. Well, it's pretty easy to construct.

First of all let us review what the terms mean. The two terms most relevant are Throw and Pole.

THROWS: This is the number of separate wiring paths, other than open, that the switch can provide for each pole.

POLES: This is the number of electrically separate switches controlled by a single physical actuator.

So for a DPDT we need two poles (switches) and two throws (paths) per switch. How do we do that? Well we start with SPST and double it. Here is the SPST.

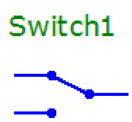


Fig. 15 - The DPST switch

Next we change its GROUP so that when it changes state another switch with the same GROUP name will do the same. The GROUP attribute can be changed in the Attribute dialog box. Double click on the switch and change the GROUP attribute to Double_Throw (or any name you prefer). The screen should now look like this:

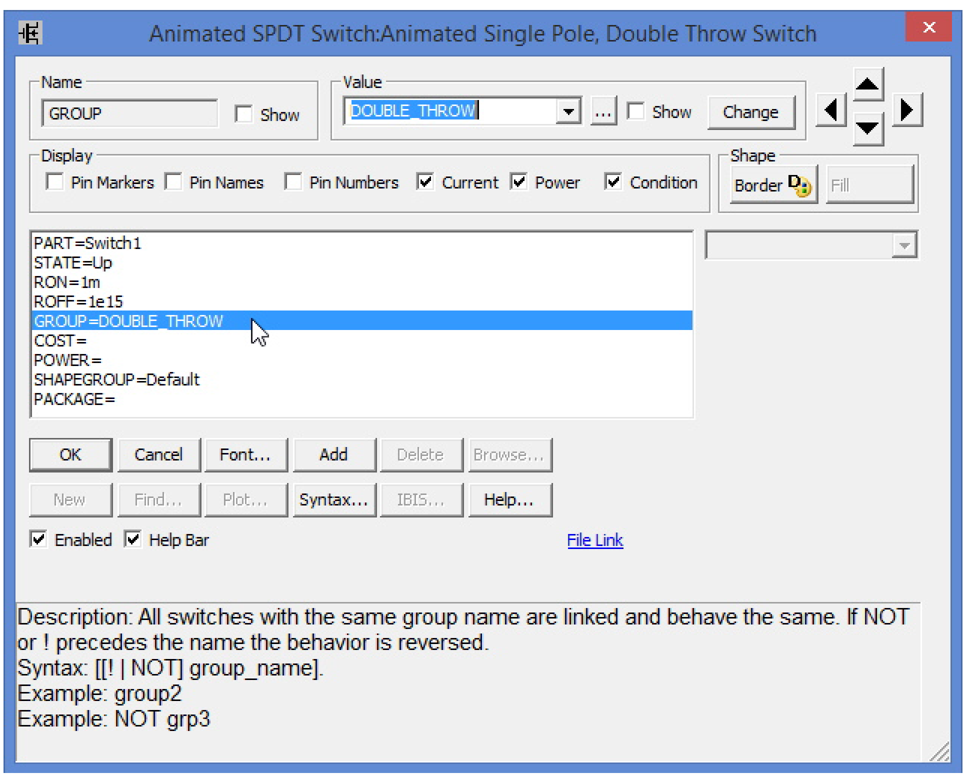
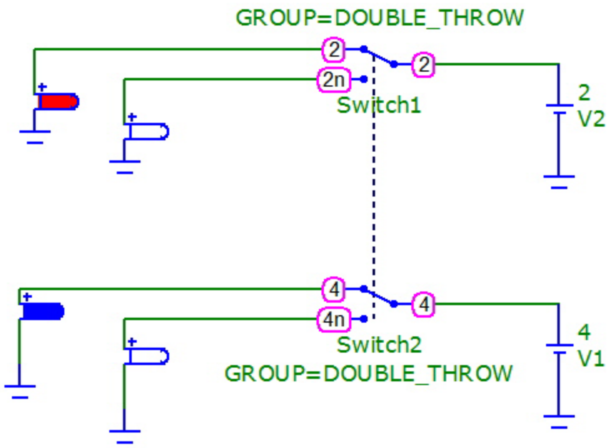


Fig. 16 - Changing the GROUP attribute

Click the OK button and then while holding down the CTRL key, click and drag on the switch. This creates a duplicate of the original switch including the GROUP attribute. When two switches use the same GROUP attribute then any action (such as clicking on it) will be duplicated at the other switch. If you add a battery to each switch and some LEDs to easily show the states, the circuit should look like this.



THROWS = the number of separate wiring paths other than "open" that the switch can adopt for each pole.

POLES = number of electrically separate switches which are controlled by a single physical actuator.

Fig. 17 - A DPDT switch

If you click on either switch, the other switch behaves the same. Essentially this means that the combination of two DPST switches have the same actuator, and as a result the combination of the two makes a DPDT switch.

You can easily make a 3P2T (three pole double throw) switch using this method. It would look like this:

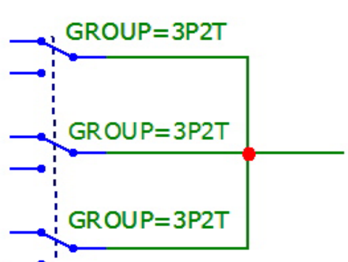


Fig. 18 - A 3P2T switch

You can make an n-pole switch but it must be a 1-throw or 2-throw variety. That's because there are only 1-throw and 2-throw animated switch primitives to use. Perhaps for MC12. Hmm.

Latest Version numbers

Micro-Cap 11	Version 11.0.1.4
Micro-Cap 10	Version 10.1.0.4
Micro-Cap 9	Version 9.0.9.1
Micro-Cap 8	Version 8.1.4.0
Micro-Cap 7	Version 7.2.4

Spectrum's numbers

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