Performing Operation Point Analyses with Variable Sweeps

Introduction

The close analysis of the operation point or other critical regions of circuit functionality can be required for the development of a circuit. This can be done in a cross sectional plot. The SmartView tool Cross Section Marker performs the analysis of how a swept viable affects an output. The sweeps can be performed in AC, DC and transient simulations, with the variables of: voltage or current source, device parameter, temperature and parameter statements.

Setup in SmartSpice

To produce a cross sectional plot, a simulation with some form of data that is swept can be in the form of a sweep command, a .ST or .PARAM statement or a nested .DC sweep. An example of this is .DC vds 0 5 0.5 vgs 1 5 1 where the .DC statement change V_{DS} from 0V to 5V in half volt steps for V_{DS}, and then repeats for different V_{GS} from 1V to 5V in steps of 1V. This is the analysis for an I_D-V_{GS} characteristic of a single MOSFET. This plot is shown in Figure 1. Another example is
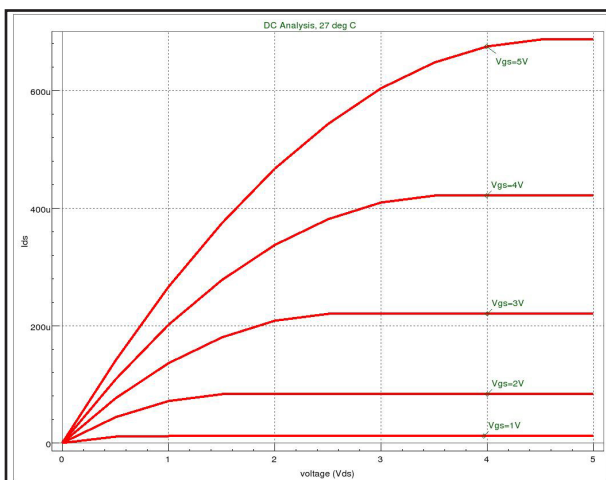
.AC DEC 20 10 1000MEG SWEEP TEMP -60 120 20

.AC sweep of the circuit is sweep by decades with 20 points per decade in the sweep from 10Hz to 100MEG. This AC sweep will be run 9 times from temperatures of -60°C to 120°C in steps of 20 °C. The AC response of a small buffer is shown in Figure 2. To have SmartView plot an output versus a sweep data graph, SmartSpice must produce the data in the correct form. This means a single real vector that contains all the data from the different sweeps. Some simulations will do this automatically however others will require the use of a small section of control code. This code tells SmartSpice to connect all the simulation data together. The control code is as flows

```
.control
set flattened_sweep=true
set parametric_data_in_raw=true
.endc
```

flattened_sweep=true changes the format of the saved simulation results and forms it into one long vector. The second is parametric_data_in_raw=true. Setting this variable to true makes it possible to save the parametric
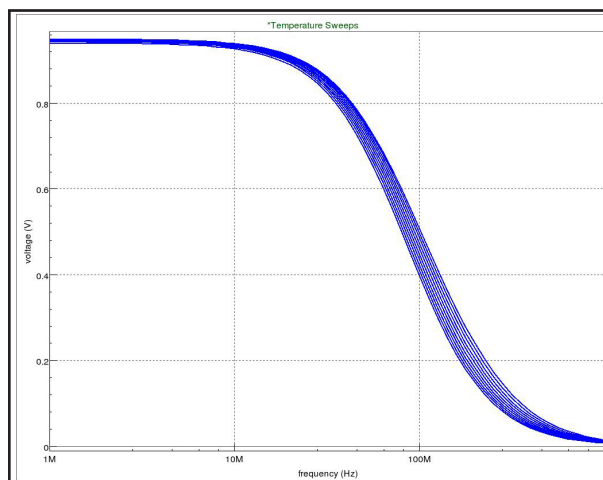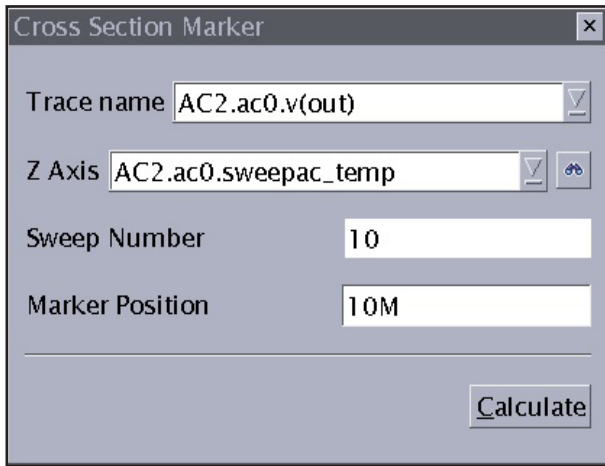

Figure 1. I_D – V_{DS} characteristics of a MOSFET.

Figure 2. AC sweep of a buffer.

Figure 3. Cross Section Marker Window.

Figure 5. Temperature vs. gain in a buffer at 10MHz.

analysis data (ST, MODIF and SWEEP secondary and nested) which is not normally done. These commands also can be inputted into the command line in the Smart-Spice GUI. This is needed for sweeps, like temperature and parameter and not for nested DC sweep statements. With the circuit setup and the data simulated, use the vector to window pass both the output data and the sweep variable data to SmartView.

Move to SmartView

In SmartView, starting from a cleared window, the data browser is used to plot the output data. Go to the pull down menu Object then the Cross section, or use the Cross section maker button. Place the cursor on the date and click. A new window will popup Figure 3. In this window, select the desired data and in the Z-Axis field
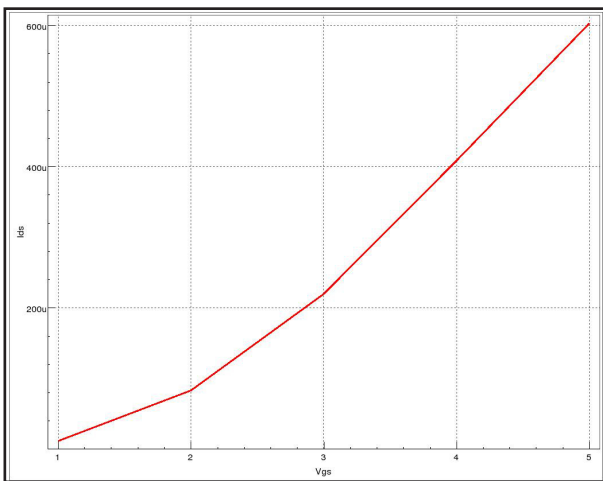
enter the sweep paramour vector. Confirm the marker position is also shown to be the correct value. Click the calculate button. This will generate a new plot that shows how the output data is affected by the swapped value. The Cross Section Marker can be moved by clicking on it and dragging it. SmartView will automatically update the plot. Figure 4 shows the cross section at 3V from the first example, showing that the drain current increases as the voltage V_{GS} increases. Figure 5 shows the cross section of the AC sweep at 10 MHz showing that the amplitude degrades as the temperature increases.

Conclusion

In conclusion, the Cross Section Maker can be a useful tool in the analysis of circuits. It produces a plot so the designer can tell at a glance tell how the swept data is changing.

Figure 4. I_D – V_{GS} characteristics of a MOSFET at V_{DS}=3V