Wireless Circuits and Systems Laboratory

Procedure #3 Creating a Circuit Element Using Measured Data in ADS

This procedure relies on information contained in WAMI Lab Procedure 1. Contained in this procedure:

1) Description of 1- and 2-port S parameter data files that can be used with ADS
2) Creating a circuit schematic that is based on measured data

The first portion of this procedure describes the types of data files that can be used with ADS. In Part 2, we will create a circuit "design" that consists of a "data file element." With this type of element, measured S-parameters in your data file are used by ADS when you simulate the circuit. One reason for doing this is that measured data can be plotted from within ADS, and compared to simulated results of your circuit designs. It also allows you to combine measured data and modeled data into a single schematic.

1. Data File Formats Used with ADS

There are several different file **types** and **formats** that can be used with ADS. The main **types** of files are Touchstone, Dataset and CITIFile. Herein we discuss only the **Touchstone** file type, which can be created using different formats.

Common to all the Touchstone formats is the requirement of a "header" line that appears at the top of the file. The first character in the line is the pound sign (#). The # character is followed by the frequency units, the type of parameters included in the file (e.g., S-, Z-, Y-parameters), the format of the parameters and the reference impedance. For example, the header line # MHZ S MA R 50 specifies that the frequency units are MHZ, the file contains S-parameter data, the data format is magnitude and angle, and the reference impedance is 50 Ω. Refer to the ADS documentation for more information on data file structures.

After the header line the data follows. The first column is the frequency. For a 1-port data file, the second and third columns are S11 (depending on the format, the columns could be magnitude/angle, real/imaginary, dB/angle, etc.) For a 2-port data file, there must be 8 columns after the frequency column, corresponding to S11, S12, S21 and S22. An example data file is shown in Figure 1.

```
# Hz S RI R 50.00
500000000.000  -0.976159   0.152166   0.005422   0.011683   0.005218   0.011620  -0.973549   0.157030
579000000.000  -0.972984   0.180075   0.006586   0.013532   0.006498   0.013443  -0.970046   0.181458
658000000.000  -0.968357   0.201542   0.007268   0.014807   0.007410   0.014810  -0.960183   0.208385
737000000.000  -0.959034   0.225961   0.008320   0.016220   0.008545   0.016186  -0.958646   0.228456
816000000.000  -0.957933   0.247474   0.009188   0.017857   0.009261   0.017794  -0.953856   0.251426
```

Figure 1. Example of a Touchstone type file containing 2-port S-parameters. The frequency unit is Hz, the S-parameters are given in Real/Imaginary format, and the reference impedance is 50 Ohms.

Another feature that is important is the filename extension. For a 1-port Touchstone datafile, the extension must be **.s1p**. Likewise, for a 2-port datafile the extension must be **.s2p**, and so on.

Finally, when using data files, it is best to keep them in the **Data** subdirectory of our project directory. This is where ADS expects to find them by default.

In the following section, it is assumed that you have already created a data file called test.s1p and placed it in the Data subdirectory of your project. If you have not already created a file to use, you can refer to WAMI Laboratory Procedure #9. This procedure explains how to acquire data from the 8714 VNA and create an ADS-ready data file using Excel.

2. Creating a Circuit Schematic that References Measured Data

1. Open an ADS project directory so that you have a fresh schematic window. If you already have an open schematic window with a circuit design in it, save your design and create a new (blank) schematic.

2. Click on the Component Palette List pull-down menu and select the Data Items list. Among the buttons on the left-hand side of the schematic window you will now see a series of "S Networks" with the numbers 1 through 10 in the center of the box. The numbers in the center of the boxes represent the number of ports assumed for the S networks.

3. For the purposes of this procedure, assume you have measured data for a two-port network that you want to incorporate into an ADS schematic. Click on the button with the **2** in the box that represents an S2P file, and place a copy of the element into your schematic. **NOTE**: on the left-hand side of the schematic window there are actually TWO buttons with a 2 in the box, however one represents an S2P file and the other a S2PMDIF file (a different file format). If you hold the mouse over the buttons for a second or two, you will see text pop-up that indicates which is which. Also, after you place the element in the schematic it will have a label that is either S2P or S2PMDIF.

4. Save your schematic (e.g. tests2p.dsn).

5. The element in your schematic is labeled as an "S2P" element, but you will notice that there are actually 3 terminals -denoted as 1, 2 and Ref. The Ref terminal is the reference potential point, which in most cases will be set to a common ground.

6. Double click on the S2P element. In the upper right-hand corner of the pop-up window, make sure that the parameter entry mode is set to Network parameter filename.

7. In the Parameter list, select File=. Now click on the Browse button to locate and select the file that contains the measurement data (in reality, this can be any valid datafile---i.e., it does not have to be measured data, but can be simulated data from another program, for example). Once you locate the file, which must have an .s2p extension, select it and click on Open.

8. Once you have returned to the Parameter list, make sure that the Filetype=Touchstone.

9. The third entry in the Parameter list is the InterpMode. This parameter determines the manner in which data at frequencies between those specified in the actual datafile will be computed. Typically, either Linear or Cubic Spline will be suitable modes of interpolation.

10. The remaining parameters in the list are generally not needed, at least for the purposes of this procedure. Click on OK to close the pop-up window for the S2P element.

11. In order to set the reference potential to common ground, click on the Ground button (two to the left of the Library (books) icon), place it in the schematic near the Ref terminal, and connect the ground using the wire tool.

At this point, your schematic should resemble that shown in Figure 2.

In order to simulate the schematic and generate graphs of the S-parameters, you would need to add "terminations" to the schematic, as described in Procedures 1 and 2.

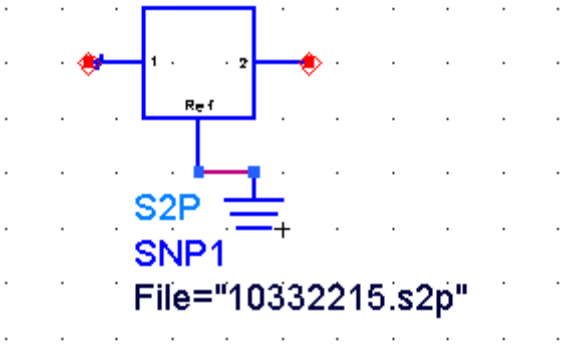

Figure 2. S2P element used in ADS to reference datafiles (in this example, the datafile is called 10332215.s2p).