Calibration & S-parameter Measurements with the Network Analyzer

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1. **Put on a grounding strap** (everybody ALL the time!)

2. Turn on the power (start with the source under the bench, and move up.) You will turn on four "Line/Power" buttons.

3. Attach connectors and extra cables to the network analyzer as needed. Be careful with the network analyzer cables. Do not overbend them.

4a. Calibrate the network analyzer (S11 or S22 Reflection Measurements only).

   a. Choose a calibration kit for the type of connector you are using.

   b. Set your frequency range. On the STIMULUS control, press start and type the frequency you want to start. Do the same for the stop frequency.

   c. On the MENUS control, press CAL. Delete a calibration set to make room for yours. Do this by pressing MORE on the soft menu on the screen, then DELETE CAL SET, then choose a number.

   d. Select a calibration type. Generally this is CAL1-7mm because that is the type of cable connected to the network analyzer.

   e. Choose S11-1 port or S22- 1 port (depending on which cable you want to use).

   f. You will be prompted to put calibration standards on the end of your cable. They are in the wooden box.

      1. Start with the short (it is labeled). Connect the short, press the softkey SHORT, and when it is done measuring (quickly) it will underline the SHORT. Take it off, put the plastic cover back on the standard, and find the open.

      2. Open. It is the same length as the short, but with a smaller radius and a hole in the end. Press OPEN, wait until open is underlined, remove the open and replace the plastic cover.

      3. Find the load standard. They are the long, sliding cylinders in the box. Connect it, and press LOAD. Then BROADBAND. Then DONE LOADS. We are assuming our load is acccurate over the whole frequency range of calibration and is therefore "broadband." Replace the plastic cover, put all the standards back in the box. (PLEASE! These standards are little and expensive, and if they get lost, we don't have any others.)

      4. Omit Isolation measurements.

         i. Press SAVE 1-port CAL. Press the number where you want to save the cal set. It should say "Correction ON"

         ii. Test your calibration. The worst is usually the open, so put the open standard on again. On the FORMAT menu, press SMITH CHART. You should see a small dot on the right side of the smith chart, but you will probably see a short line. Test the short and load the same way. For the short, you should see a dot on the left side

of the smith chart. For the load, the dot should be in the center. IF these are not "clean", redo the calibration. Factors that can affect your calibration: tightness of cables and connectors, between elements and to the network analyzer.

iii. If your calibration is good. PUT THE BOX of standards back in the closet.

4b. Calibrate the network analyzer (Full 2-port calibration for Reflection and Transmission Measurements)

a. Choose a calibration kit for the type of connector you are using.

b. Set your frequency range. On the STIMULUS control, press start and type the frequency you want to start. Do the same for the stop frequency.

c. On the MENUS control, press CAL.

d. Delete a calibration set to make room for yours. Do this by pressing MORE on the soft menu on the screen, then DELETE CAL SET, then choose a number.

e. Select CAL 1 (7 mm A.1) because you are using cables with 7mm connectors attached to the network analyzer.

f. Choose REFLECT'N soft key (on side of screen panel).

g. Proceed to connect each of the calibration terminations for open, short, and matched load for S11 (port 1) and S22 (port 2) as described in 4a part f above. After each termination is placed on the cables, press the respective soft key, remove the termination, and repeat the procedure until all of the calibrations have been made for both ports.

h. Press REFLECT'N DONE.

i. Choose the TRANSMISSION soft key. Connect cable 1 to cable 2 using a nipple (1/2" long connector with screw threads on both sides). Press each of the four soft keys and wait until the key is underlined. Press TRANS. DONE.

j. Press the ISOLATION soft key. Select the OMIT ISOLATION soft key. Press ISOLATION DONE.

k. The calibration is complete and must be saved. Select SAVE 2-PORT CAL. Save the calibration to the location (1-8) deleted previously. (It doesn't matter which you use, and you can use several at a time when performing different tests over different frequency ranges). The network analyzer should now say "Correction ON"

l. Test your calibration. The worst is usually the open, so put the open standard on again. On the FORMAT menu, press SMITH CHART. You should see a small dot on the right side of the smith chart, but you will probably see a short line. Test the short and load the same way. For the short, you should see a dot on the left side of the smith chart. For the load, the dot should be in the center. IF these are not "clean", redo the calibration. Factors that can affect your calibration: tightness of cables and connectors, between elements and to the network analyzer.

m. If your calibration is good. PUT THE BOX of standards back in the closet.

4c. Calibrate the network analyzer (TRL 2-port calibration for microstripline measurements)

a. See 4a (parts a-e) above for details. Set the frequency.

b. Choose CAL

c. Delete a cal set.

d. Choose CAL 1 (7 mm A.1).

e. Select TLR 2-port soft key.

f. Connect the microstrip test holder to the cables attached to port 1 and port 2.

g. You will be using the microstrip calibration TRL set for this calibration.

h. Place the segment of microstrip line labeled THRU in the test holder and adjust the test holder until it is snug at both ends. You can look in the holes in the top of the holder to make sure that everything is lined up properly. Press the THRU soft key and wait until undefined is underlined.

i. Loosen the test holder and place the shorter piece of microstrip line labeled REFLECT on the port 1 side of the test holder. (The other side of the line is not connected to the other side of the test holder. This allows for the reflection calibration to take place.) Press S11 REFLECT and wait for it to be underlined. Place the segment of line on the S22 side. Press S22 REFLECT and wait for it to be underlined.

j. Press the ISOLATION soft key. Press OMIT ISOLATION and then ISOLATION DONE.

k. Place the long piece of microstrip line labeled LINE in the test holder and press the key LINE/MATCH. When it is underlined, press the SAVE TRL 2-port button and save the calibration coefficients in the location that was previously deleted.

l. Proceed to test microstrip circuits as desired.

AN IMPORTANT NOTE ABOUT TRL CALIBRATION:

You will see low frequency data in ADMITTANCE form instead of the IMPEDANCE form you are expecting. The cutoff is about 2 GHz for our cal set.

TO measure impedance. On the FORMAT menu, press Smith Chart. On the MENU menu, press MARKER> Use the thumb dial to move the marker to the frequency you are interested in (printed on the top left side of the screen). You will also two numbers followed by W This is the impedance (real and imagninary) in ohms. For more markers, press marker, and choose another number. You can have up to 5 markers at a time (on different frequencies)

TO see the reflection coefficient (S11 or S22) on the FORMAT menu, press LOG MAG. Press MENU (on the FORMAT menu), and this will give you many options for what to print. Originally, it is showing LOG MAG, and the value (at the frequency marked with the marker) is shown in the upper left corner. Other options are LIN MAG, SWR, REAL, IMAG, POLAR, etc.

To change to the scale of a graph, on the RESPONSE menu, press SCALE, and turn the thumb knob until the graph looks like you want it to. Alternatively, choose a scale on the number pad (then press x1 on the number pad).

To get a hard copy on the plotter:

1. Put paper in the plotter (single sheet, set against the light gray stop 2/3 of the way into the plotter.) Hold down with switch on right. Turn on plotter (back left side).

2. On AUXILLARY menu (bottom of Network analyzer panel), Press COPY, Plot to Plotter, specify what to plot (ALL).

To save to disk:

1. Use a DOS formatted floppy.

1. On AUXILLARY menu, press DISC.

2. STORE. More. Data - DATA.

3. This will bring an ABCDEF .. line, prompting for filename. Use the thumb wheel to move to letters, press SELECT LETTER, press Store. This will store in a tabular format. Open it with a simple text editor, load into matlab, etc.