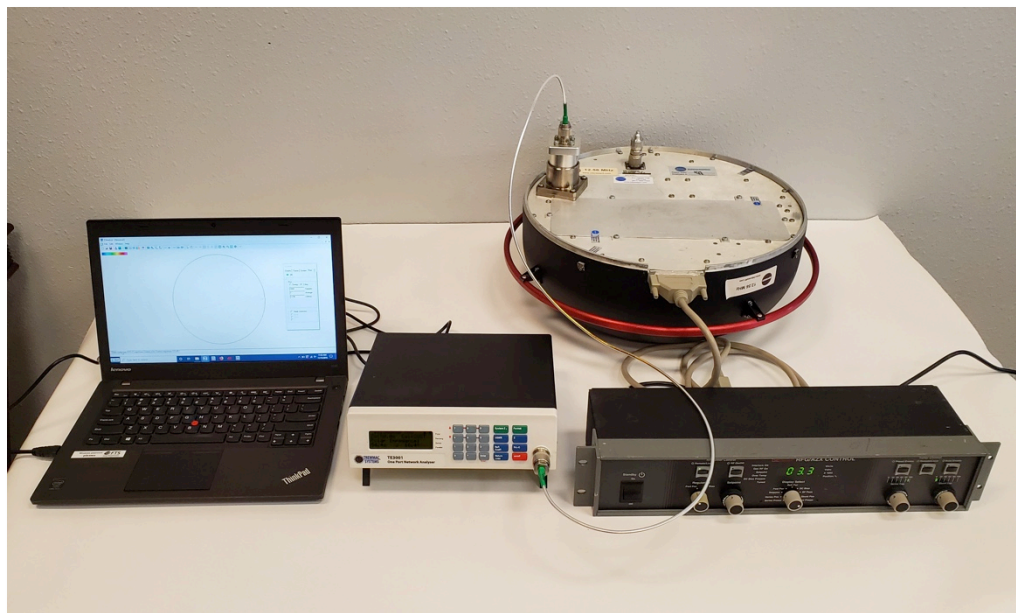


Matching Network Diagnostics for AE AZX DPS Dome Network Match



Procedure 507.1
Nov 2019

Preface

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Network Analyzer Calibration

Most DPS Poly applications run at 12.56 MHz and your matching network will need to be calibrated at this frequency. To set network analyzer frequency, turn on your network analyzer and type in “**12.56**” followed by “**Enter**”. Ensure that for all measurements that Z’Analyze is set to 12.56 MHz.

Before performing the testing procedure, ensure the network analyzer is properly calibrated and the correct COM port is selected. If you are uncertain of the unit calibration, it is recommended that you recalibrate.

If the network analyzer has recently been calibrated and connected through 12.56 MHz, you can move directly to the next section.

Verify TE3001 Network Analyzer Calibration

1. Turn on the network analyzer.
2. Connect the 50 ohm precision test cable to the network analyzer output port.
3. Install the 50R load at the end of the precision cable.
4. Press the “**Z**” button to set the network analyzer to impedance mode.
5. Set to rectangular impedance by pressing the “**Format**” button until screen shows “Rect Impedance”.
6. Verify that the 50R load reads $50 \pm j0.1$ Ohm at 12.56 MHz.

→ **If load does not read as above, perform following calibration procedure.**

TE3001 Calibration Procedure

1. Press “**System Z_o**” to enter the System Parameters menu.
2. Use the red arrows to scroll down to “**Calibration...**”
3. Press the **Enter** button to bring up the Calibration menu.
4. With the selection arrow pointing to “Cal Type”, pressing **Enter** will alternate between Standard and Custom calibration. Select “**Custom**”.

5. Press the down arrow to set the following parameters:
 - **Cal Kit: N-female**
 - **Cal Start: 0.03 MHz**
 - **Cal Stop: 300 MHz**
6. Press **Enter** when you have gotten to “Perform Cal” to start the process.
7. Arrow down and follow the on-screen prompts, which will take you through the calibration process.
8. Install the 50R load at the end of the test cable when prompted, followed by the short load and finally the open load.
9. When the calibration process is complete, scroll to “Done” and press **Enter**.

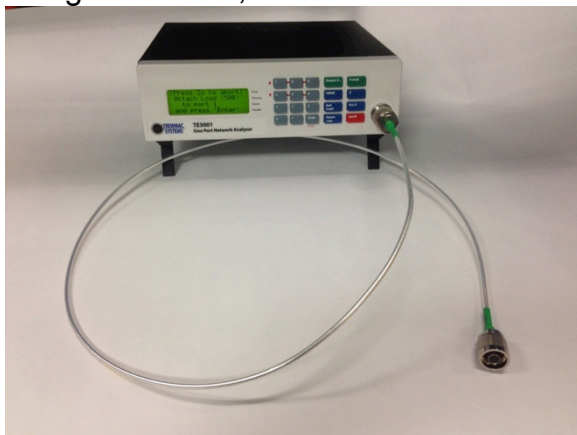
Custom S-O-L Calibration Loads

The N - type calibration kit comes standard with the TE3001

50R Load	"Short" Load	"Open" Load
<p>(Press Zo to abort) Attach Load (50R) to port 1 and press 'Enter'</p> <p>EWMAC SYSTEMS TE3001 One Port Network Analyser</p>	<p>(Press Zo to abort) Attach Short to port 1 and press 'Enter'</p> <p>EWMAC SYSTEMS TE3001 One Port Network Analyser</p>	<p>(Press Zo to abort) Attach Open to port 1 and press 'Enter'</p> <p>EWMAC SYSTEMS TE3001 One Port Network Analyser</p>
<p>50Ω JYE BAO</p>		

TE3001 Calibration Setup

During calibration, the loads are connected to the precision test cable tip



Select Com Port

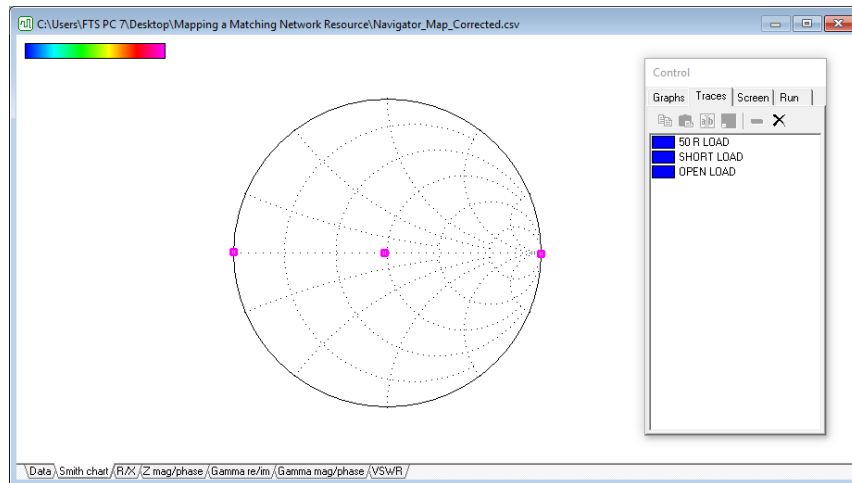
Ensure the Com port selected corresponds to the Com port on the computer that the network analyzer is plugged into. Selecting the incorrect port will result in a connection error.

1. Navigate to Windows > Device Manager > Ports (COM and LPT) > USB Serial Port (COM#). This number is the Com port you will be using.
2. In the Z'Analyze software, click the **Edit Settings** button.
3. Under the Serial tab, select the corresponding COM port from step 1. COM ports higher than COM8 can be manually entered by typing in the configured COM port number, ex. COM17.
4. Select the button "**Check connection...**"
5. If successfully connected, a popup window will display "Connected to: TE3001 F/W V12.0".

Map Calibration Loads

Test the short, 50R, and open loads to verify they display properly on the Smith Chart:

1. Connect network analyzer to a USB port on your PC and open Z'Analyze software.
2. In Z'Analyze Software, under the "Run" tab of the Control Panel, set values to:
 - **1 freq. selected**
 - **1 Samples**
 - **32 Average**
 - **12.56 f (MHz)**
3. Install the open load on the network analyzer precision test cable tip. In Z'Analyze software, press "Run" to obtain a data point on the Smith chart.
4. Repeat these steps for the 50R and short load. This should result in 3 data points across the center Smith Chart:



Mapped Calibration Loads (Short, 50R, Open)

5. If the three horizontal points do not display as above, ensure the network analyzer is properly set up and calibrated according to the previous sections.

When this process is completed, connect the network analyzer to the matching network output adaptor.

Setup Instructions




Required Tools


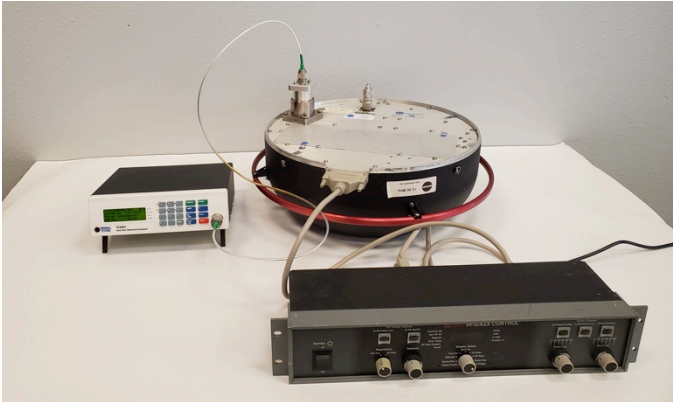
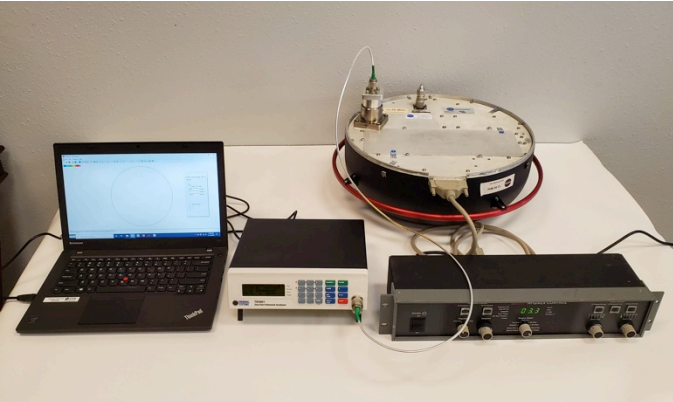
- AE AZX DPS Dome Network RF Match
- 50 ohm Load
- Match Output Coaxial Adaptor
- Advanced Energy RFG/AZX Minipanel Controller
- TE3001 Network Analyzer
- Network Analyzer Precision Test Cable
- Windows PC with Z'Analyze Software Installed
- Golden Match (or known good test values) for comparison

Hardware Setup

Step Action Table: Test Bench Setup

STEP	ACTION
1	<p>Start with the AE AZX DPS Dome Network RF Match and a new workspace.</p> 

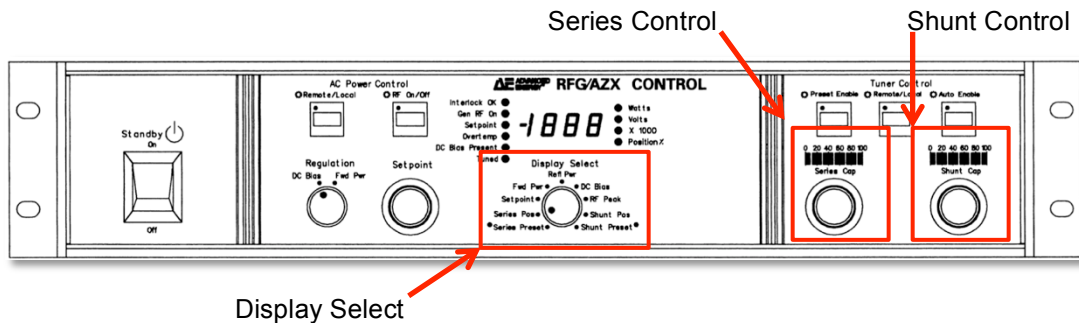
<p>2</p>	<p>Terminate the RF input port with a 50 ohm load.</p> 
<p>3</p>	<p>Install the match output coaxial adaptor on the match output port.</p> 
<p>4</p>	<p>Connect the Minipanel Controller to the Dome Match and ensure the controller is plugged into a power source.</p> 

<p>5</p>	<p>Connect the Network Analyzer precision test cable to the match output coaxial adaptor.</p> 
<p>6</p>	<p>Connect the other end of the test cable to the network analyzer.</p> 
<p>7</p>	<p>Using a USB cable, connect the network analyzer to a PC with <i>Frontier Technical Services Z'Analyze</i> Software installed.</p> 

Mapping Procedure

Testing a Match

1. Turn on the network analyzer and Minipanel Controller if you have not already done so. If no numbers display on the Minipanel center display, check the connection with the Dome Match. The Minipanel GUI will only work when properly connected to a match.

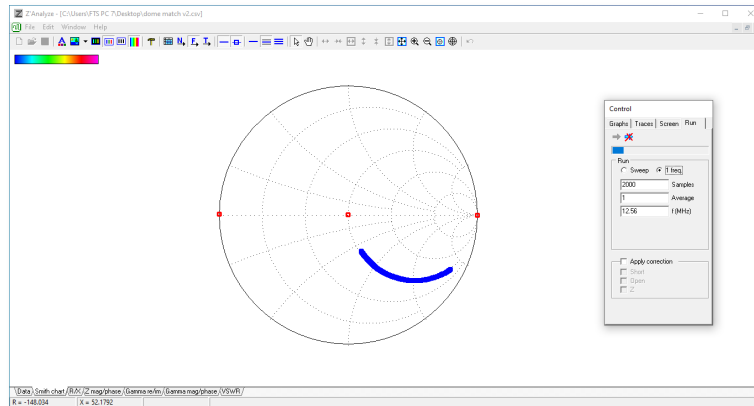


2. Using the series and shunt control knobs on the right-hand side of the controller, ensure both values are set to 0. Position percent is displayed on the meter above each control knob. For a more precise reading, the Display Select knob can be switched to "Series Pos" or "Shunt Pos" to display the numerical value on the center display.

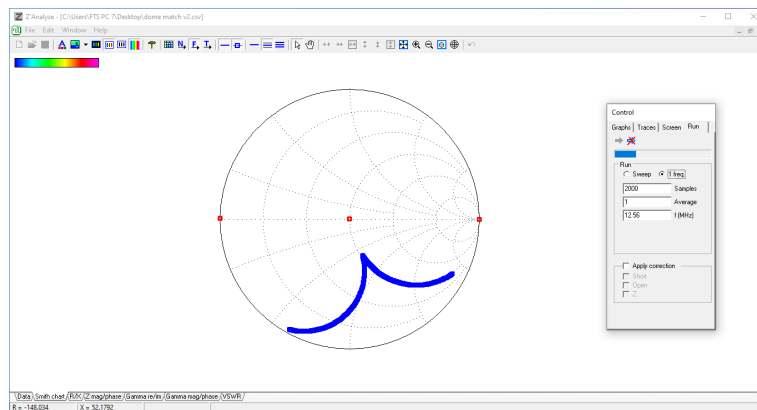


3. Open the Z'Analyze software with mapped calibration loads.
4. Set view to **"Smith Chart"** using the tab at the bottom of the main display window.

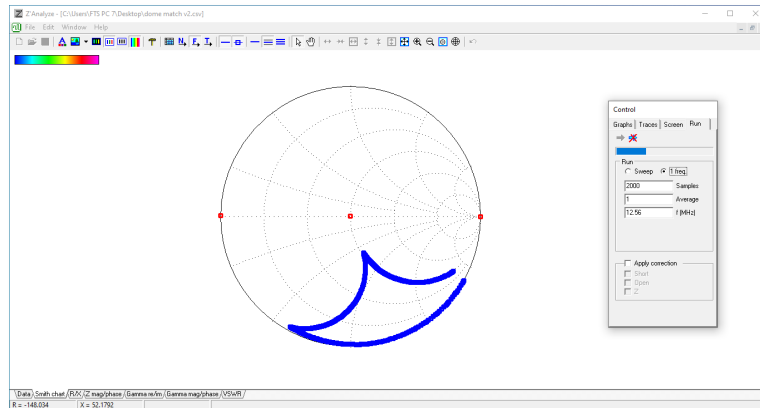
5. In the control panel under the run tab, change the settings to:
 - **1 freq. selected**
 - **2000 samples**
 - **1 Average**
 - **12.56 f (MHz)**
6. Press the blue “**Run**” arrow in the Z’Analyze Software control panel.
7. Using the **Series Cap** knob on the Minipanel, **slowly** increase series cap value to 30%. Positions ranging from 0-30% are more sensitive and require slower movement speed. Once you have reached 30%, increase value to 100%. The data points on the smith chart will move along a set of curves as the sweep runs. Wait until the capacitors have stopped moving inside the match to continue to the next step.



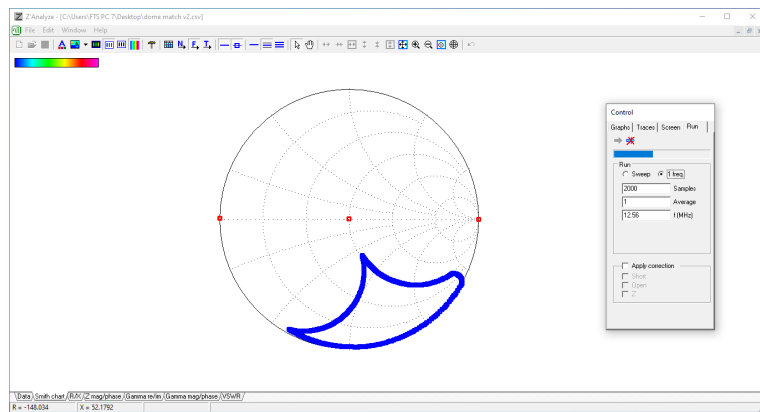
8. Using the **Shunt Cap** knob, **slowly** increase shunt cap value to 30%. Once you have reached 30%, increase value to 100%. Wait until no movement is heard from within the match before continuing to the next step.



9. Using the **Series Cap** knob, decrease the series cap value from 100% to 30%. Once you have reached 30%, **slowly** decrease the value to 0%. Continue when the match has finished moving.

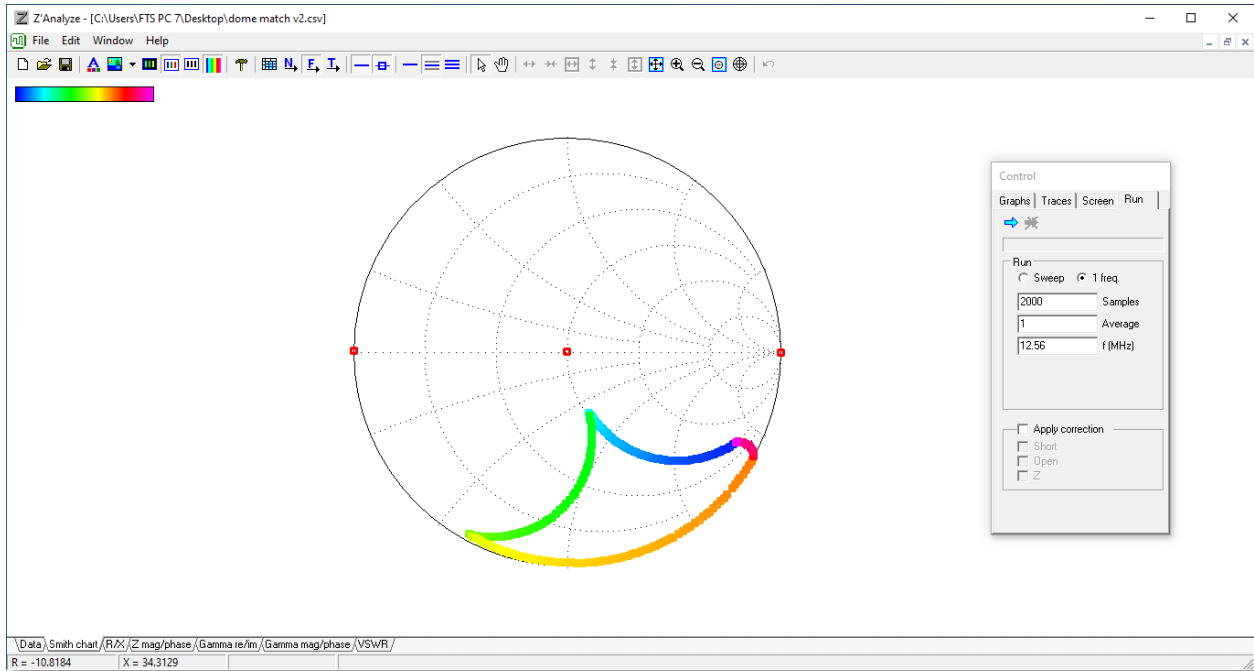


10. Next, using the **Shunt Cap** knob, decrease the shunt cap value from 100% to 30%. Once you have reached 30%, **slowly** decrease the value to 0%.



11. Press the **“Stop”** button in Z'Analyze software once the data points on the smith chart return to the start position.

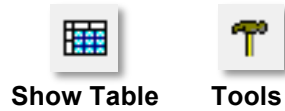
The test should result in a completed impedance curve similar to the following. If the curve is incomplete, compressed, or choppy, the match may need attention.



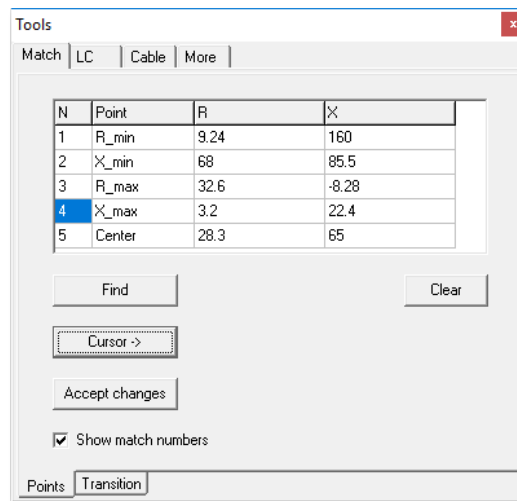
Completed Impedance Map

Find Map Corners

1. In Z'Analyze software, press the “**Show Table**” icon.



2. Next, press the “**Tools**” icon. Under “**Match**”, with the “**Points**” sub tab selected, press the “**Find**” Button.



This will add impedance points to the corners of the smith chart labeled 1 through 4.

Point Correction

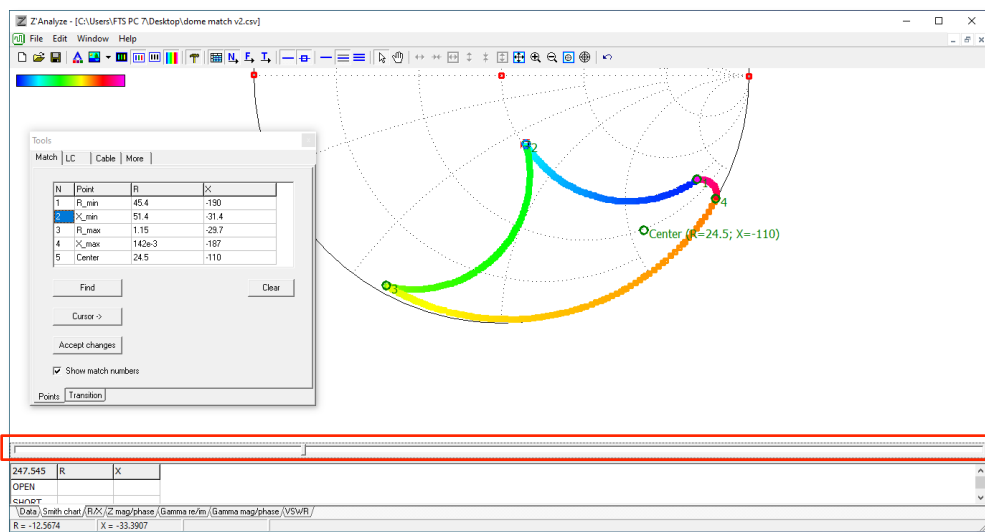
The Z'Analyze automatic algorithm is not always perfect, and these points may need to be corrected.

1. In the Tools window, select the first point under the “N” column by clicking the number 1.
2. In the main display window, press the Sample Number button. This will display a blue circle on the smith chart, highlighting a selected point.

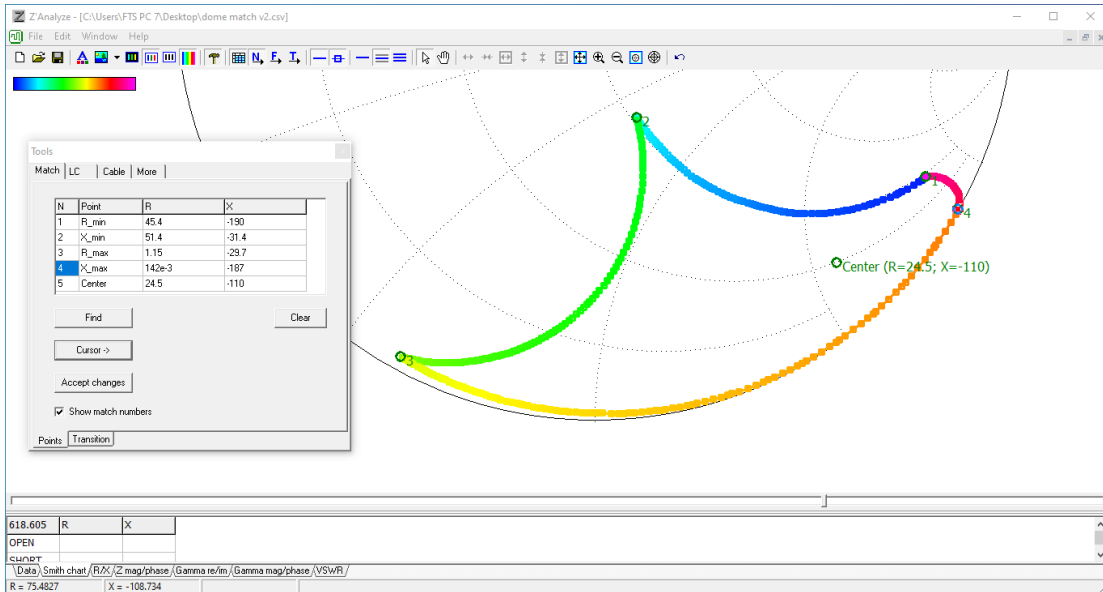


Sample Number

3. Point 1 should already be highlighted at the start of the impedance curve. Press the “**Cursor ->**” button in the Tools window to accept changes and mark this point as N1.
4. Change selection to ‘2’ in the N column.
5. Drag the slider located directly below the smith chart to move the selected point to the second corner. Press the “**Cursor ->**” button in the Tools window to accept these changes for N2.

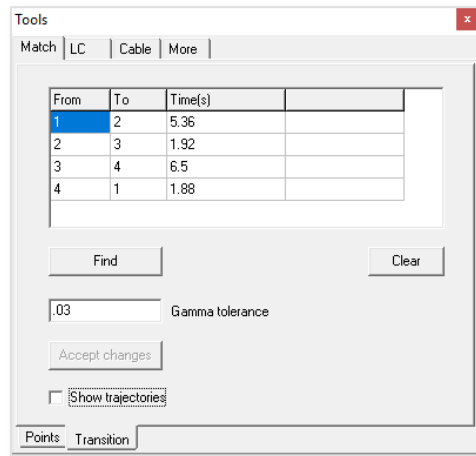


- Repeat this process for points 3 and 4. The result should look similar to the following, with the impedance points sequentially labeled from 1 to 4 and a corrected center point value:



Match Timing Calculations

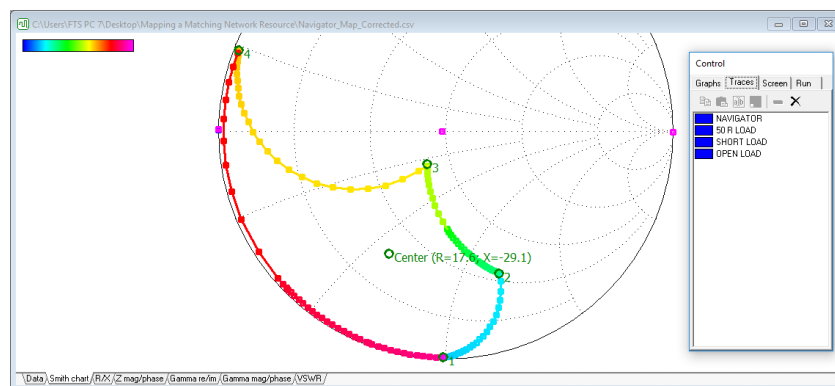
Open the tools window, under the Match tab with the “Transition” sub tab selected. In the Gamma tolerance box, enter **.03** and press “**Accept changes**”.



This will provide calculations for the transition time between each impedance curve. These timing metrics can be compared to a golden match. Deviation from these values may mean a motor or an RF element is deficient.

Interpreting Results

The corrected center point will consist of two values: resistance (R) and reactance (X). These data points can be numerically compared to a known good matching network map. More commonly, your matching network map can be visually compared to a good matching network to check for a similar curve, smooth transitions, and complete corners.

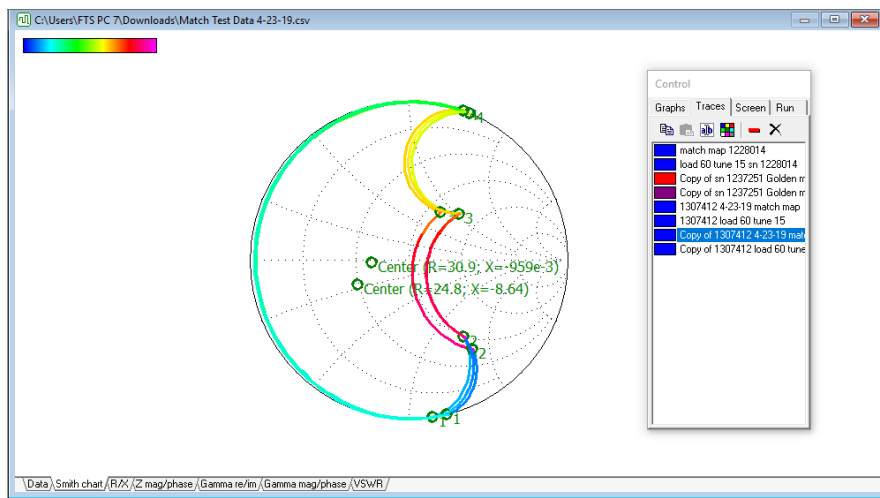


Healthy Matching Network Map

Matching network traces can be copied and pasted into a single file for direct comparison using FTS Z'Analyze software. See page 13 of the **Z'Analyze Software Manual**, which can be downloaded from:

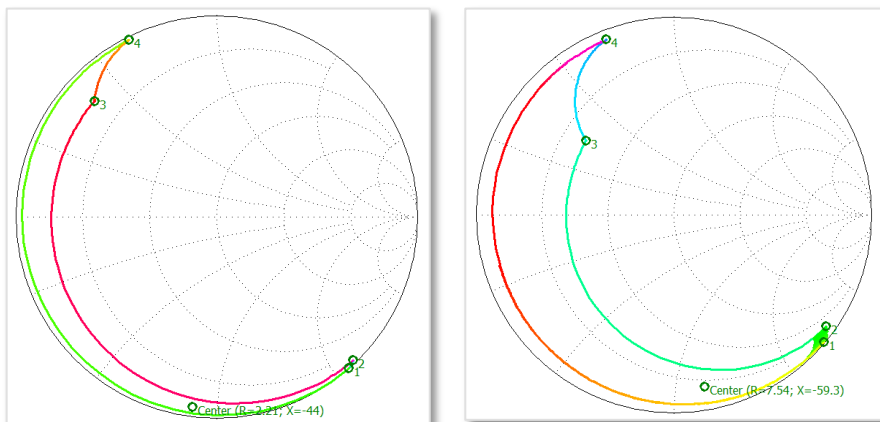
www.ftsplasma.com/manuals

Below is an example of acceptable variance between 3 matching network maps that all perform correctly. Acceptable variance will depend on the specific instrumentation being used and intended application.



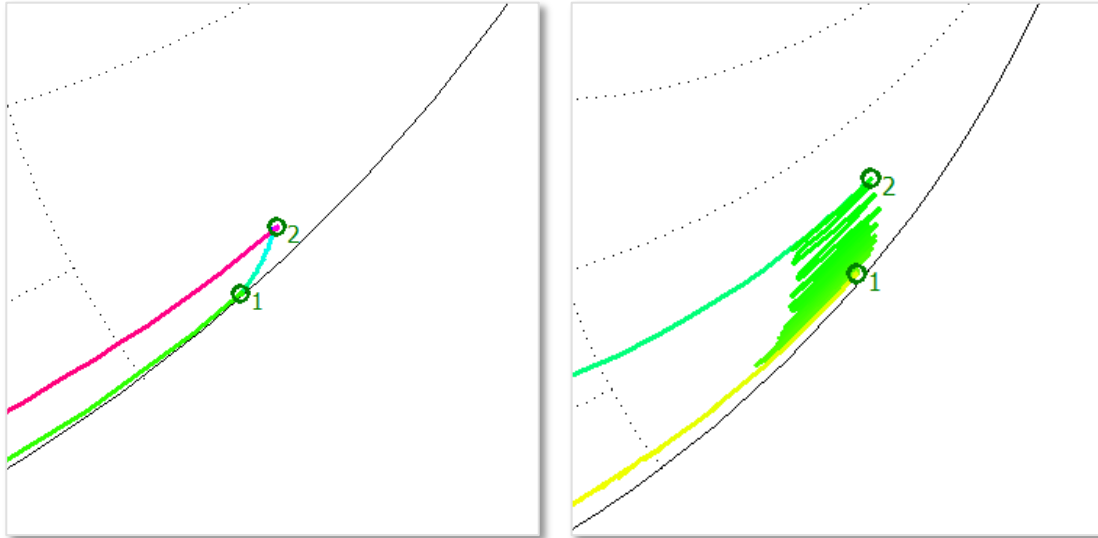
Acceptable Variance

Wide deviation from a golden match impedance range may indicate misadjusted or failing match components.



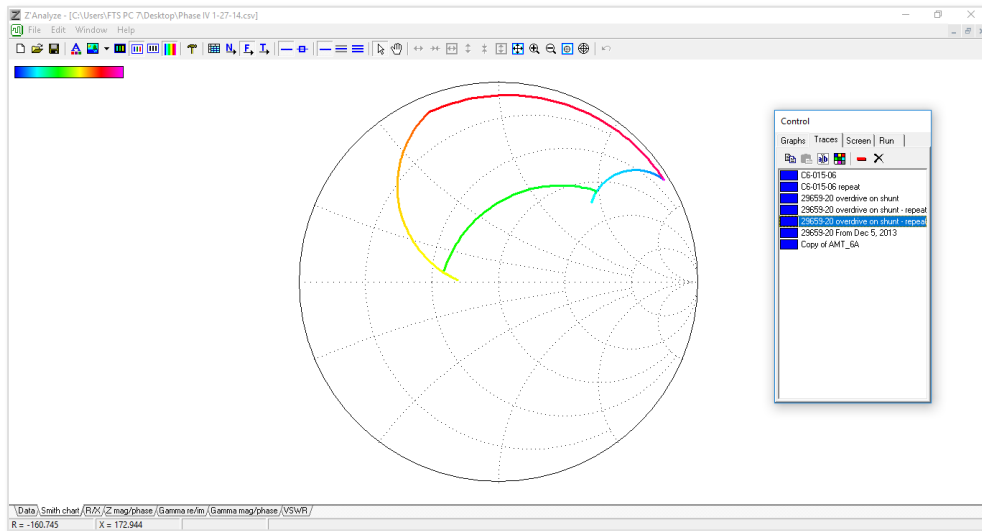
Golden Match (Left) vs. Unacceptable Impedance Range (Right)

Widely varied and choppy corners may indicate burned load capacitor contacts.



Healthy Load Capacitor Contacts (Left) vs. Burned Contacts (Right)

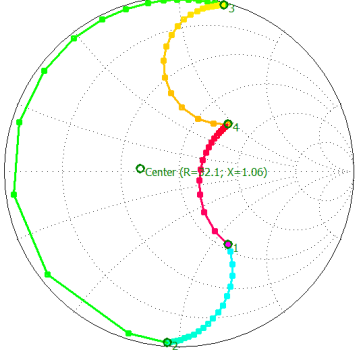
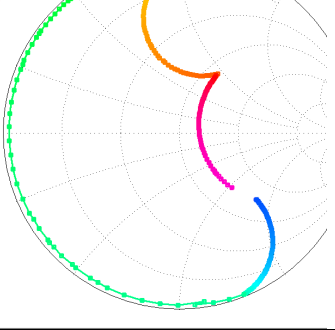
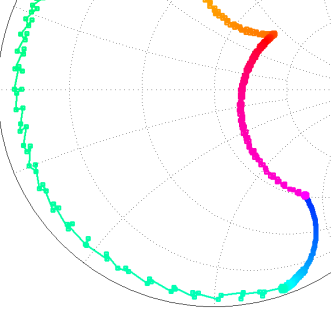
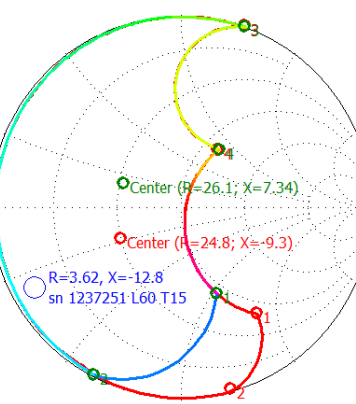
Corner points that move beyond the full mesh may indicate an issue with the capacitor movement overdrive in the matching network.



Misaligned Corners from Capacitor Movement Overdrive

If your matching network map has a different shape, incomplete corners, or jagged transitions compared to a known good matching network map, the match likely needs attention. Use of a match with these characteristics could result in production issues (See more troubleshooting on next page).

Troubleshooting

Example	Common Problem
	<p>Curve is Choppy</p> <p>The test was run too quickly or with too low of a sample rate. Change settings in Z'Analyze software to ensure enough samples are being collected. (See page 13)</p>
	<p>Curve is Incomplete or Broken</p> <p>Likely caused by sticking capacitor movements in the matching network. Match may need attention.</p>
	<p>Curve is Jagged</p> <p>Likely caused by Network Analyzer calibration, check the "Network Analyzer Calibration and Setup" Section. If this does not resolve the problem, it may be an issue with the match.</p>
	<p>Curve Varies Widely from Known Good Match / Missing Curves</p> <p>When a curve is significantly different from your map (colored with a gradient) compared to a known good matching network map (colored in red), the match may need attention.</p>