

RFID Tag Antenna Measurement Using the DAMs6000 System And A Calibrated Reference Horn

This note demonstrates a measurement procedure using a calibrated reference horn to determine the Gain and Beam pattern of an RFID Tag antenna

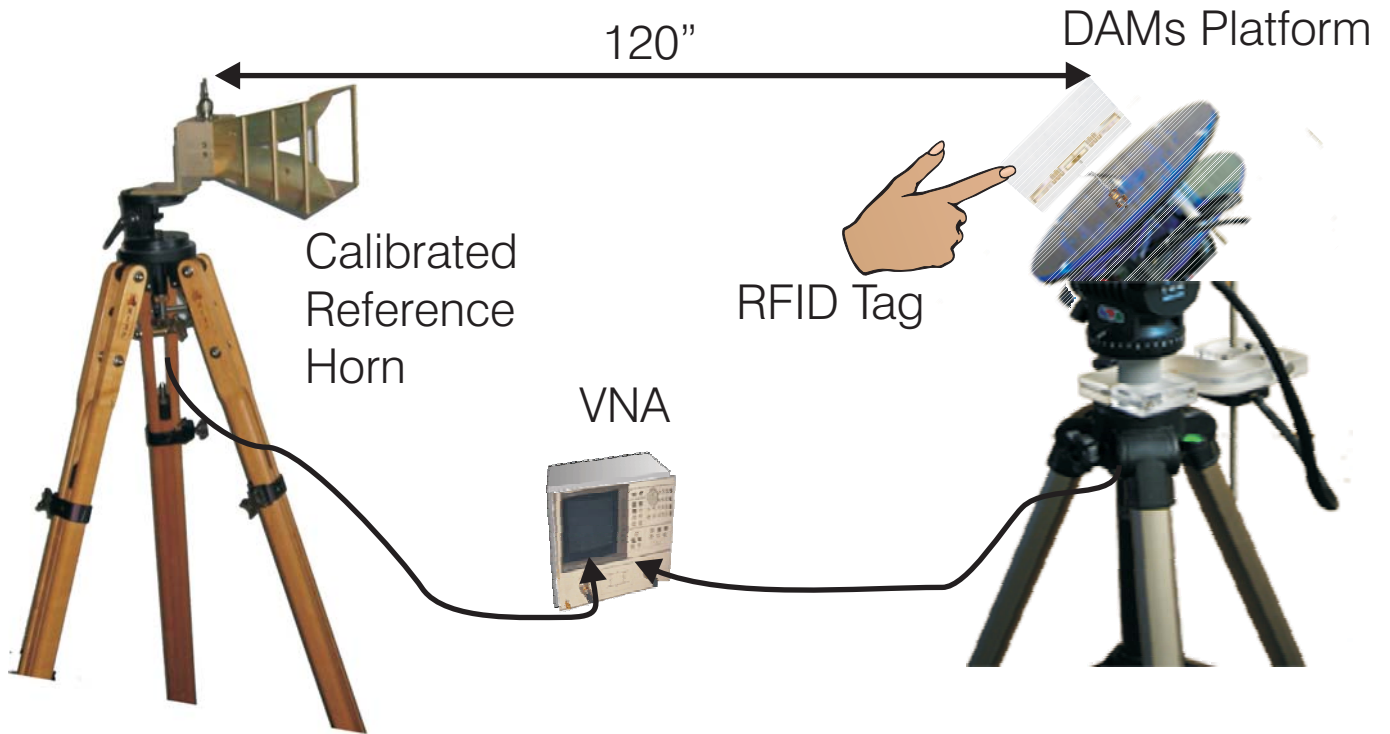
Statement Of The Measurement

Determine the Antenna Gain And Beamwidth properties for an RF ID tag antenna of unknown Tx Rx frequency bands.

Test Freq : .8GHz to 2GHz 201 points
Azimuth: 0 to 360deg 5 deg resolution
Elevation: -45 to +45deg 5 deg resolution
Gain: Max Gain dBi & dBd
Beamwidth: NA

Find the front to back and Max to Min Gain at Fmax

Generate the spherical profile compared to Isotropic



Typical RFID Tag with .026 Micro-coax attached in place of chip transponder





Set Up The Measurement Equipment

1. First Use the Pull Down to select the VNA

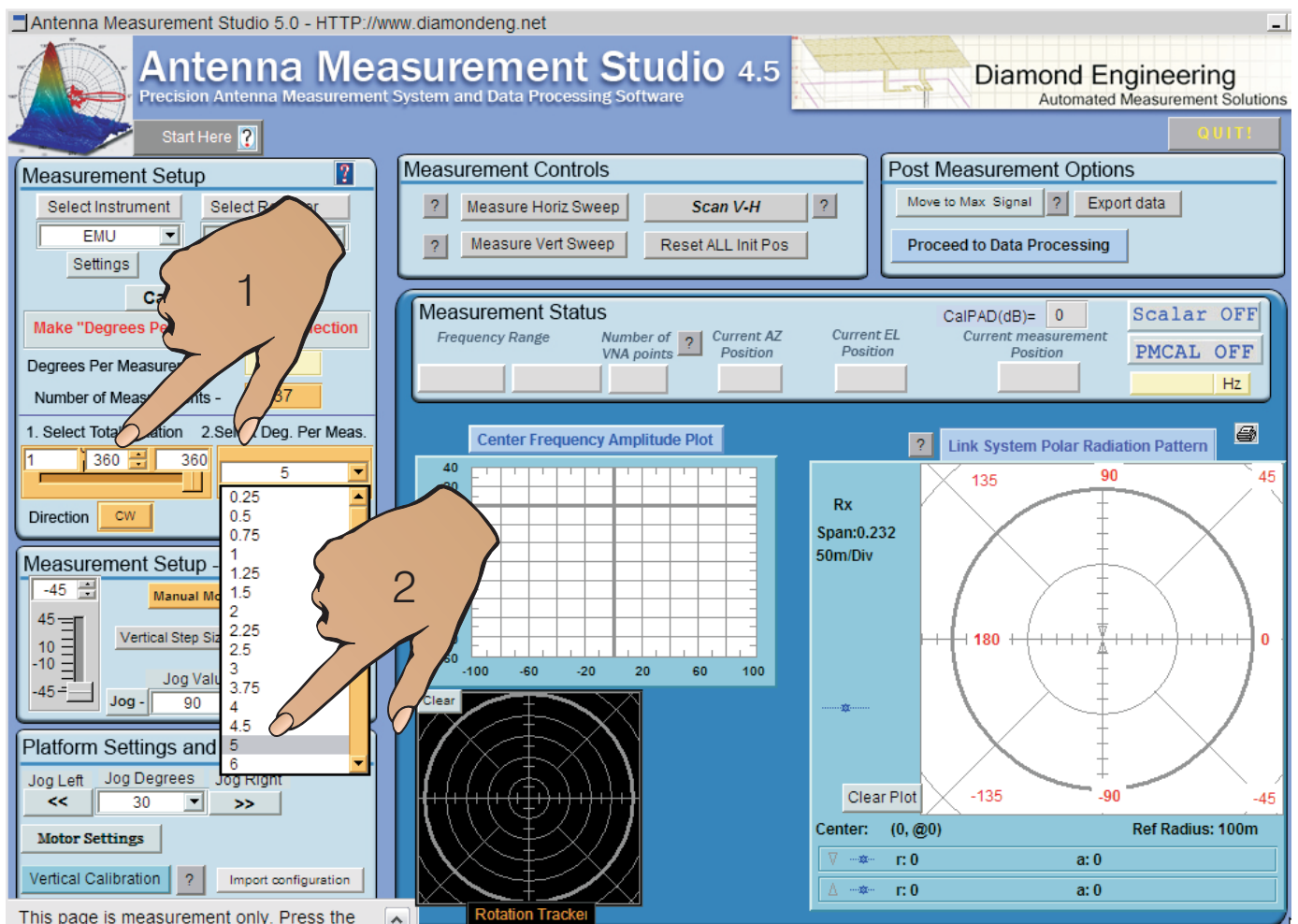
2. Use the Settings Menu to set the properties of your equipment

Set The DAMs For Scan Mode

1. Slide the Azimuth rotation to the rotation value
2. Select the Azimuth movement resolution degrees

Note: If you wanted to scan about the main beam of an antenna from say +10deg to -10deg then first use the Manual Move to +10deg. Then slide the total rotation slider to 20deg and the Direction to CW or opposite. Scan will move from 20 deg from current position to -10deg.

During Scan Mode the DAMs always scans back and forth.



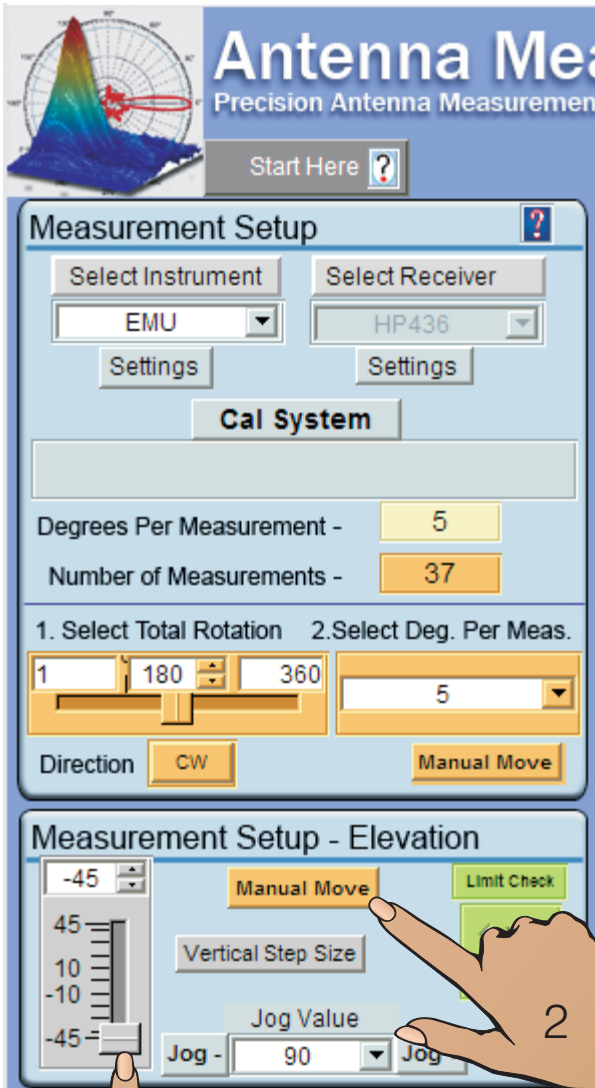
The screenshot displays the Antenna Measurement Studio 5.0 interface. The title bar reads "Antenna Measurement Studio 5.0 - HTTP://www.diamondeng.net". The main window title is "Antenna Measurement Studio 4.5 Precision Antenna Measurement System and Data Processing Software". The interface is divided into several panels:

- Measurement Setup:** Contains controls for "Select Instrument" (set to EMU), "Settings", "Make 'Degrees Per Measure'", "Degrees Per Measure" (set to 5), "Number of Measurements" (set to 37), "1. Select Total Rotation" (set to 360), "2. Select Deg. Per Meas." (set to 5), and "Direction" (set to CW).
- Measurement Controls:** Includes buttons for "Measure Horiz Sweep", "Scan V-H", "Measure Vert Sweep", and "Reset ALL Init Pos".
- Post Measurement Options:** Includes buttons for "Move to Max Signal", "Export data", and "Proceed to Data Processing".
- Measurement Status:** Displays "Frequency Range", "Number of VNA points", "Current AZ Position", "Current EL Position", "CalPAD(dB)= 0", "Current measurement Position", "Scalar OFF", and "PMCAL OFF".
- Center Frequency Amplitude Plot:** A graph showing amplitude vs. frequency.
- Link System Polar Radiation Pattern:** A polar plot showing the radiation pattern. It includes a "Clear Plot" button and parameters: "Rx Span: 0.232 50m/Div", "Center: (0, @0)", and "Ref Radius: 100m".
- Platform Settings and Motor Settings:** Includes "Jog Left", "Jog Degrees" (set to 30), "Jog Right", "Motor Settings", "Vertical Calibration", and "Import configuration".

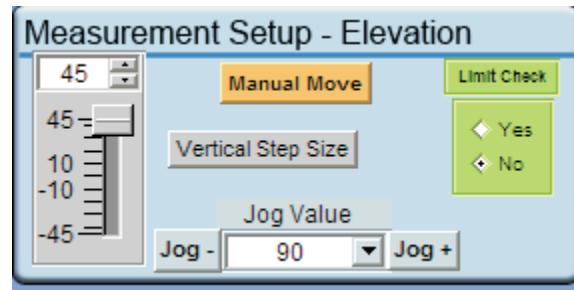
Two hands are overlaid on the interface to indicate the steps: Hand 1 points to the "Degrees Per Measure" dropdown menu, and Hand 2 points to the "Number of Measurements" dropdown menu.

This page is measurement only. Press the **Rotation Tracker** button.

Set The DAMs For Scan Mode



1. Set the Elevation Slider to -45deg
2. Use Manual Move to position the platform to -45deg.
3. Set the Elevation slider to the final scan destination ie. 45 deg.



The system is now ready for Scan

4. Invoke the Scan Measurement



When Scan is complete the button will depress



5. Enter the Advanced Menu

Advanced Processing Module

1. Save data to a register
2. Add notes to be saved with reg
3. Save Regs to disc
4. Recall Reg to load display Reg0

Advanced Processing. Go to "Start Here" to proceed

Antenna Measurement Studio 4.5
Precision Antenna Measurement System and Data Processing Software

Diamond Engineering
Automated Measurement Solutions

C:\DAMS\AdvancedData\RFID_SCAN_with_horn_path

Return to Main

Data Register

Clear All Regs

Load Reg1-4 From Disc

Save Reg1-4 To Disc

Active = **Reg 1 Loaded** Start 800M Stop 2G Data Points 70.74k

Data Visualization Options-

View 3D AZ Plot Az_EL_3-d

Spherical 3D Az/EI

Polar & Amplitude Plot

Group Delay

Merge Scans

Data Manipulation Options

Import REF Antenna

Generate Path Loss

Deviation Swing Corr.

Register Math

Calculator Status

Linear Vector |REGx|

10Log(REGx)

REGx^2

SQRT(REGx)

REGx(Max)

REGx(Min)

1/REGx

+

X

/

Linear Vector |REGx|

10Log(REGx)

REGx^2

SQRT(REGx)

REGx(Max)

REGx(Min)

1/REGx

Reg0

Reg1

Reg2

Reg3

Reg4

K= 4

Advanced Calculator

135k

0

Be sure to save data into the Data Storage Regs. After an initial measurement Reg0 will be viewable but the data will be lost if you exit without saving to a Ram register. If you try to use the calculator without first having saved the measurements NOTHING will happen when you attempt to perform "=" at the calculator

The advanced features enable measurements to be preformed over frequency. Each movement has a frequency measurement band associated with it. 3-D plotting is enabled for good visualization of the data. The amplitude/frequency plot is

Measurements

* Data Storage Reg 1 Recall Reg 1 70.74k

RFID 800M 2G SCAN 360/5 -45 to +45 / 3

* Data Storage Reg 2 Recall Reg 2 70.74k

Notes to be saved with Reg2

* Data Storage Reg 3 Recall Reg 3 70.74k

Notes to be saved with Reg3

Data Storage Reg 4 Recall Reg 4 51

Notes to be saved with Reg4

Clip Value > 20m

Active Register Mag

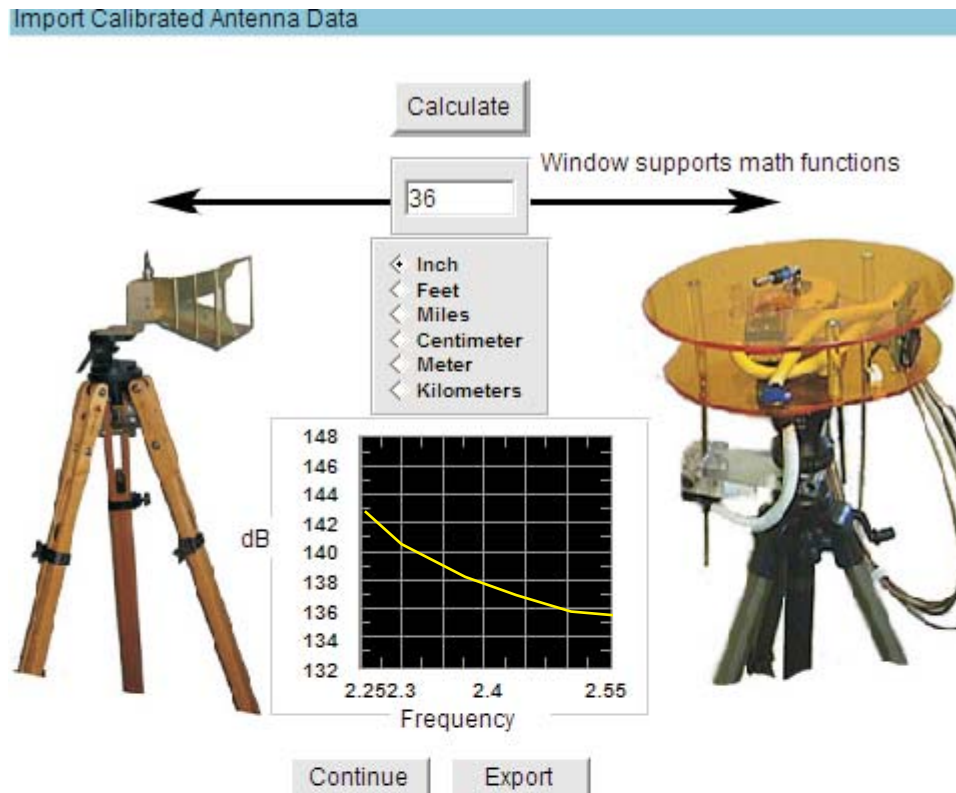
000:	001:	002:
0000: 4.816m	5.857m	6.092m
0001: 2.792m	4.597m	5.259m
0002: 2.643m	4.475m	5.038m
0003: 2.534m	4.417m	5.063m
0004: 2.51m	4.348m	4.909m
0005: 2.432m	4.249m	4.827m
0006: 2.325m	4.151m	4.68m

Active Register Phase

000:	001:	002:
0000: -160.8	100.5	-5.18
0001: -168.7	96.08	-12.73
0002: -172	93.56	-15.95
0003: -174.5	93.38	-16.5
0004: -170.3	95.15	-15.36
0005: -169	95.62	-15.18
0006: -170.7	95.82	-15.88

5. Generate the path loss with the same shape and frequency extent as the display register reg0

Generating A path loss array



IMPORT PATH LOSS CALCULATION

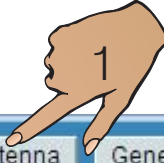
This will calculate and load path loss data into the display REG0 with the size shape and frequency extents of the data currently in REG0.

IMPORTANT Log values are converted to linear S21 for instrument compatibility

TO establish your measurement gain use the calculator and divide your measurement set by the reference gain and the path loss.

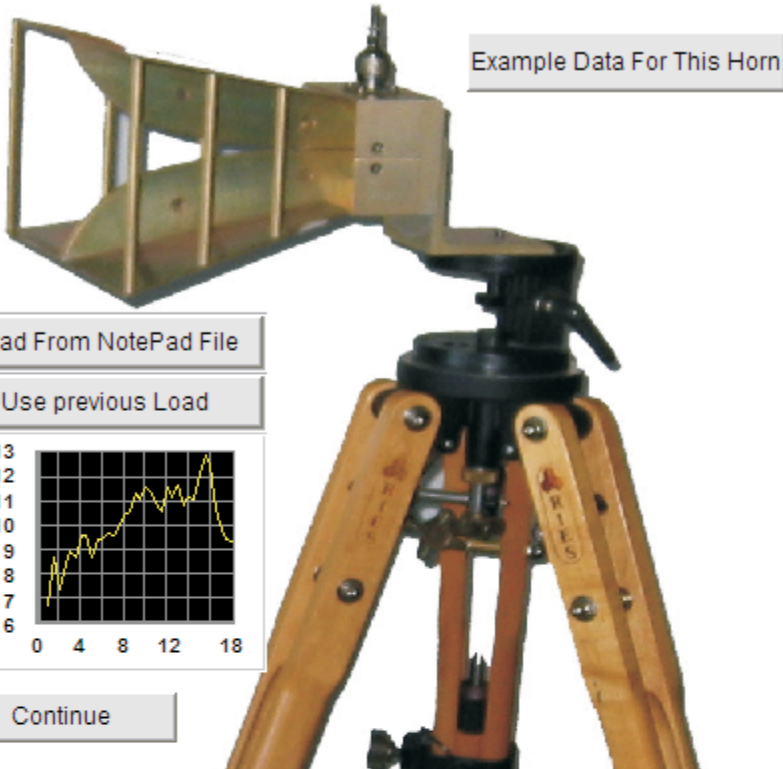
Save the path loss data into a storage reg2(in this case)

Input Horn Calibration Data



Data Manipulation Options

Import Calibrated Antenna Data

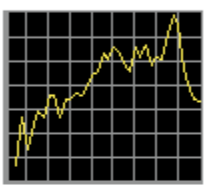


Example Data For This Horn

Load From NotePad File

Use previous Load

13
12
11
10
9
8
7
6



0 4 8 12 18

Continue

Horn calibration data files can be generated using Notepad or entered directly. The DAMs software will interpolate between frequency calibration points as required.

Re-save the calibration array to a reg

IMPORT ANTENNA CALIBRATION

This will load antenna calibration gain data into the display REG0 with the size shape and frequency extents of the data currently in REG0. Interpolation is used between gain data cal points.

Use NOTEPAD and create a gain table like:

1	8	IMPORTANT: Gain data is converted
2	8.5	to S21 for compatibility with
3	8	instrument data

etc. where col.1 is f(GHz) and col2. is gain (dB)

Be sure the frequency extents are => your data Freq.

When you exit you will see the data in the display



Calculate the AUT(antenna under test) Gain

1. Perform the gain calculation Reg1/Reg2 → Reg0 (display)
2. Remove the path loss Reg0/Reg3 → Reg0 (display)
3. Save the gain data to Reg4

The screenshot shows the Antenna Measurement Studio 4.5 interface. The 'Data Registers' panel on the left shows the formula $AUT = S21 / (Gref * PathLoss)$ in Reg4. The 'Active Register' panel shows 'Ram Saved Reg4' is active. The 'Data Manipulation Options' panel shows a calculator interface where the formula $Reg0 = Reg4 / Reg3$ is entered. The 'Advanced Calculator' panel shows the result of the calculation. The 'Active Register' panel shows the result of the calculation is 135k. The 'Data Registers' panel shows the result of the calculation is 201.

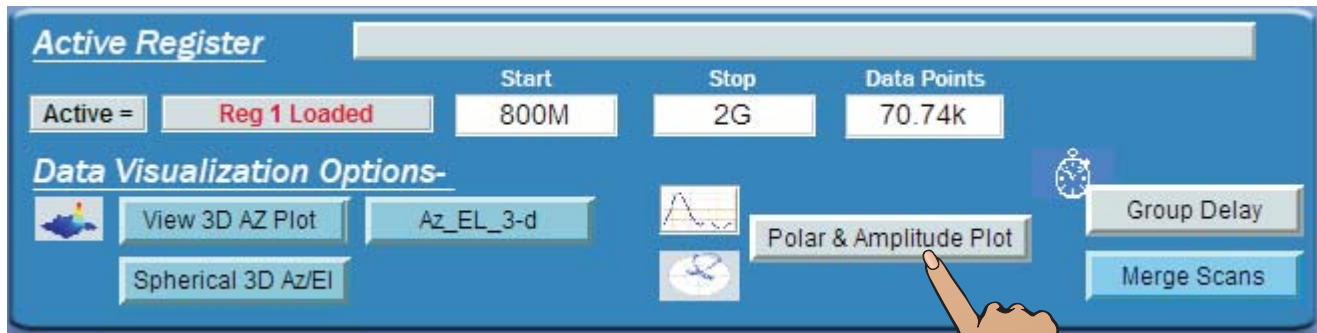
Annotations with hand icons indicate the following steps:

1. Select the formula in Reg4.
2. Select the result in Reg0.
3. Select the formula in Reg4.
4. Select the result in Reg0.
5. Select the formula in Reg4.
6. Select the result in Reg0.
7. Select the formula in Reg4.
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93. Select the formula in Reg4.
94. Select the result in Reg0.
95. Select the formula in Reg4.
96. Select the result in Reg0.
97. Select the formula in Reg4.
98. Select the result in Reg0.
99. Select the formula in Reg4.
100. Select the result in Reg0.

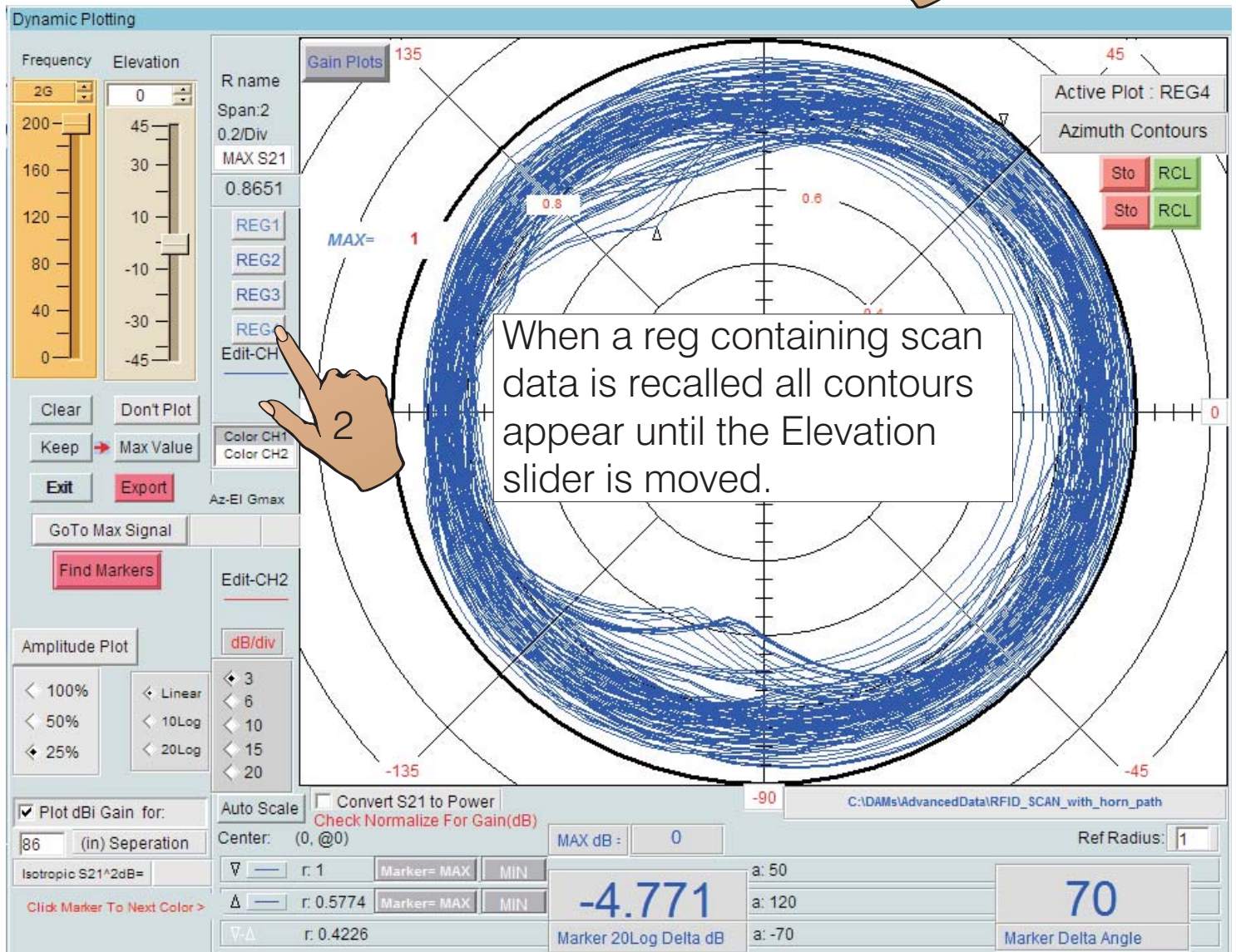
Reg0 will contain the linear AUT gain data

Plot the contours and find Max Gain

1. Invoke the Polar/Amplitude Plot Module



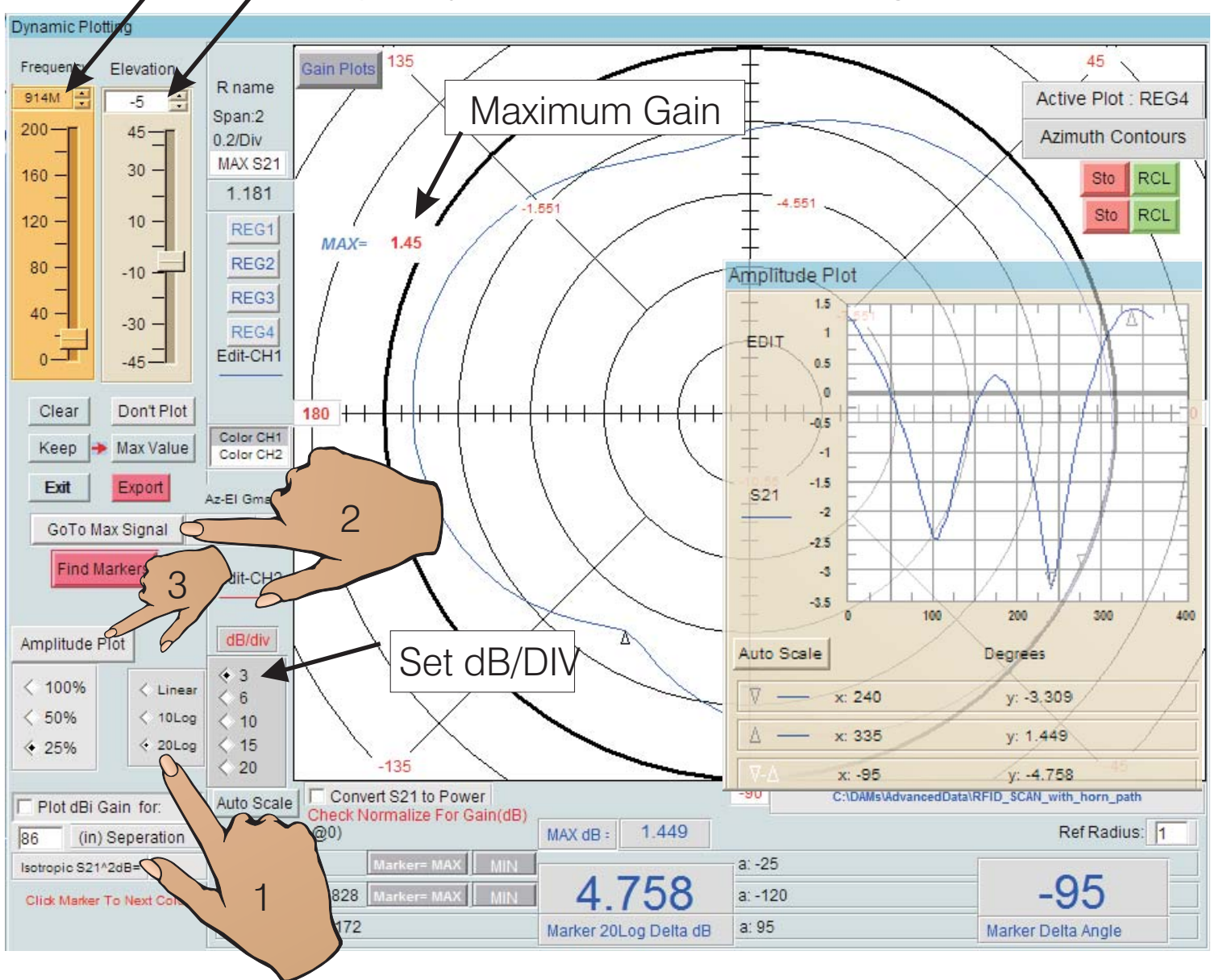
2. Recall the AUT gain data



Plot the contours and find Max Gain

1. Change the scale from linear to 20Log
2. Invoke GoTo Max Signal. The frequency slider and the Elevation slider will move to the max signal contour.

Maximum Gain Frequency (914MHz) Elevation -5deg

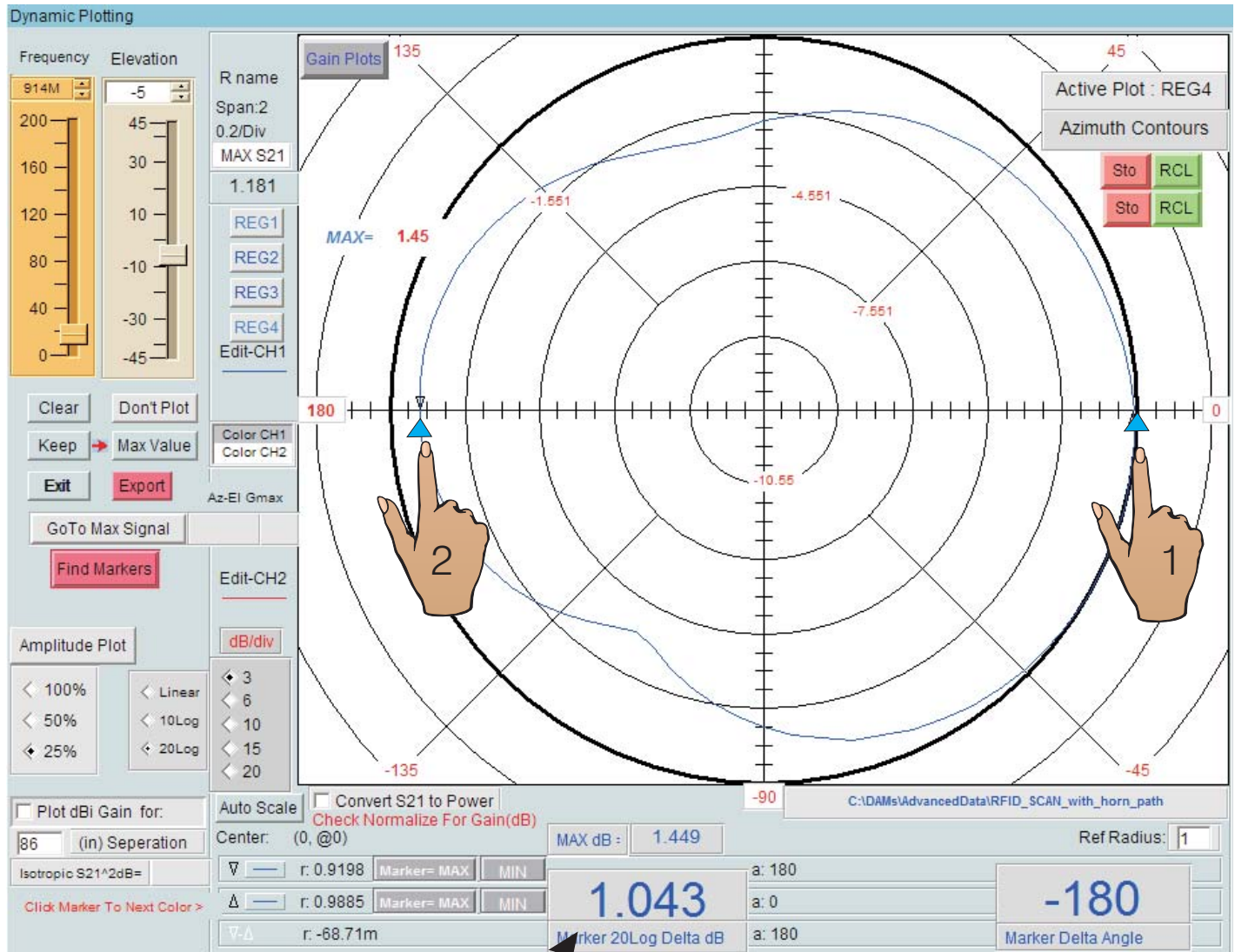


3. Invoke the Amplitude Plot for reference

Note: For absolute data log mode must be used. Linear mode normalizes all data to 1 unless KEEP MAX is invoked

Find the front to back and Max to Min G

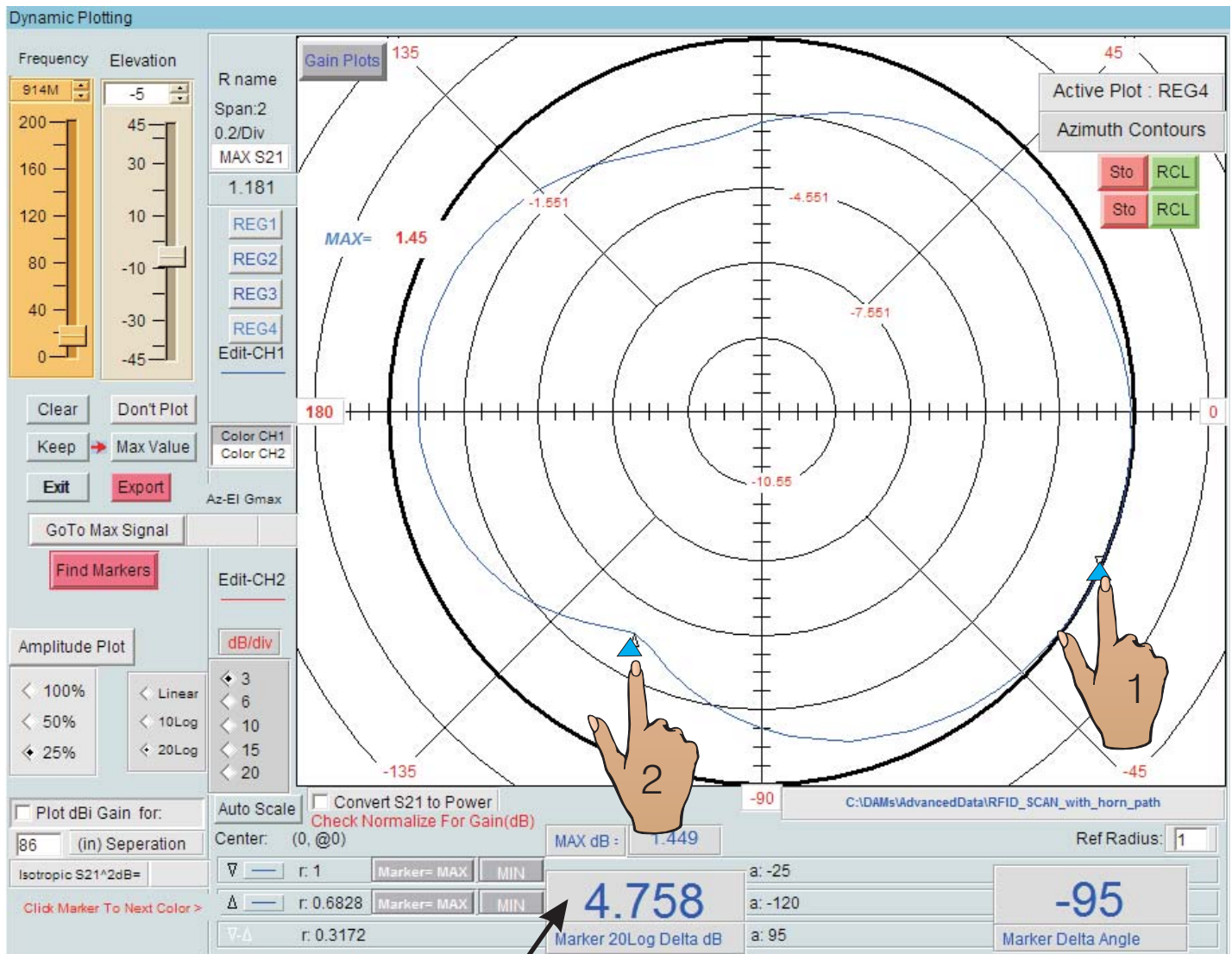
1. Position Marker1 to front (0 deg)
2. Position Marker2 to back (180 deg)
3. Read Marker delta dB = 1.043dB



Front to back ratio

Find the front to back and Max to Min G

1. Use Marker1 = Max to locate marker1 on the maximum
2. Use Marker2 = Min to locate marker2 on the minimum



Max to min ratio

Generate the spherical profile compared to Isotropic

From the Advance page enter the Spherical Plot module

1. Set the frequency slider to the max contour (914MHz)
2. Invoke the Isotropic link and enter the separation
3. Plot the response

3-d Spherical Az-EL Plotting

Generate Plot
 Data Plotting Options

Frequency
 914M
 19
 200
 160
 120
 80
 40
 0
 A Freq #

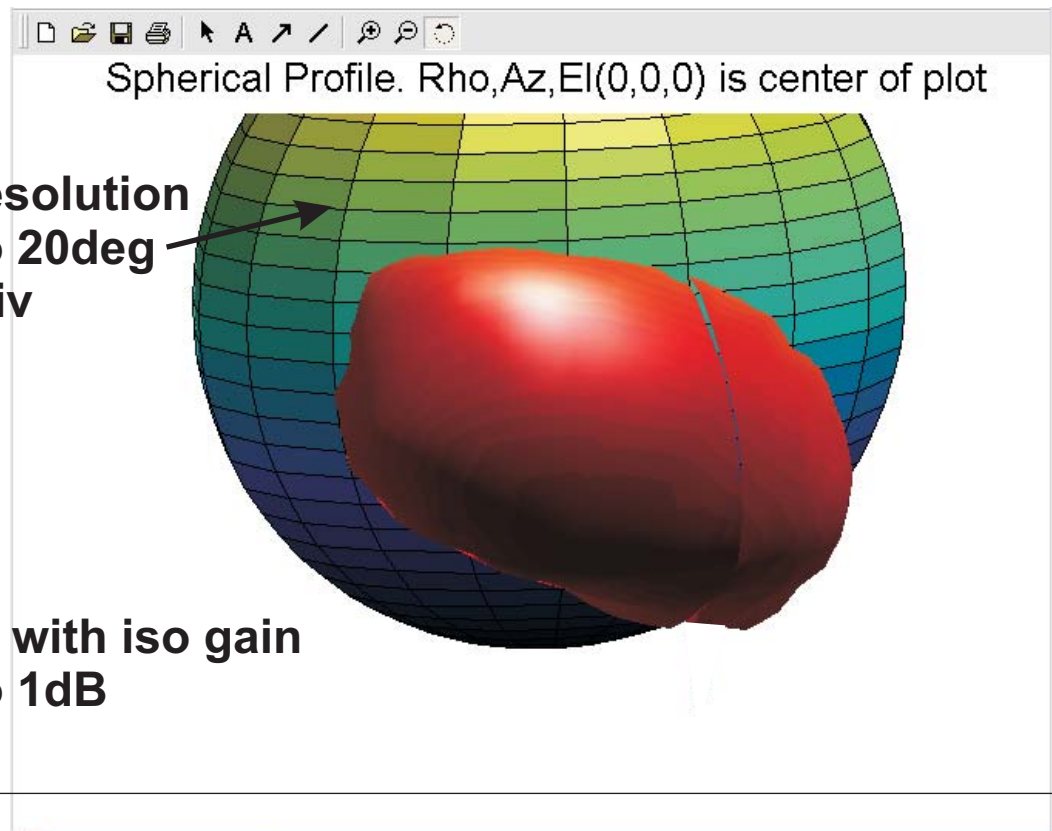
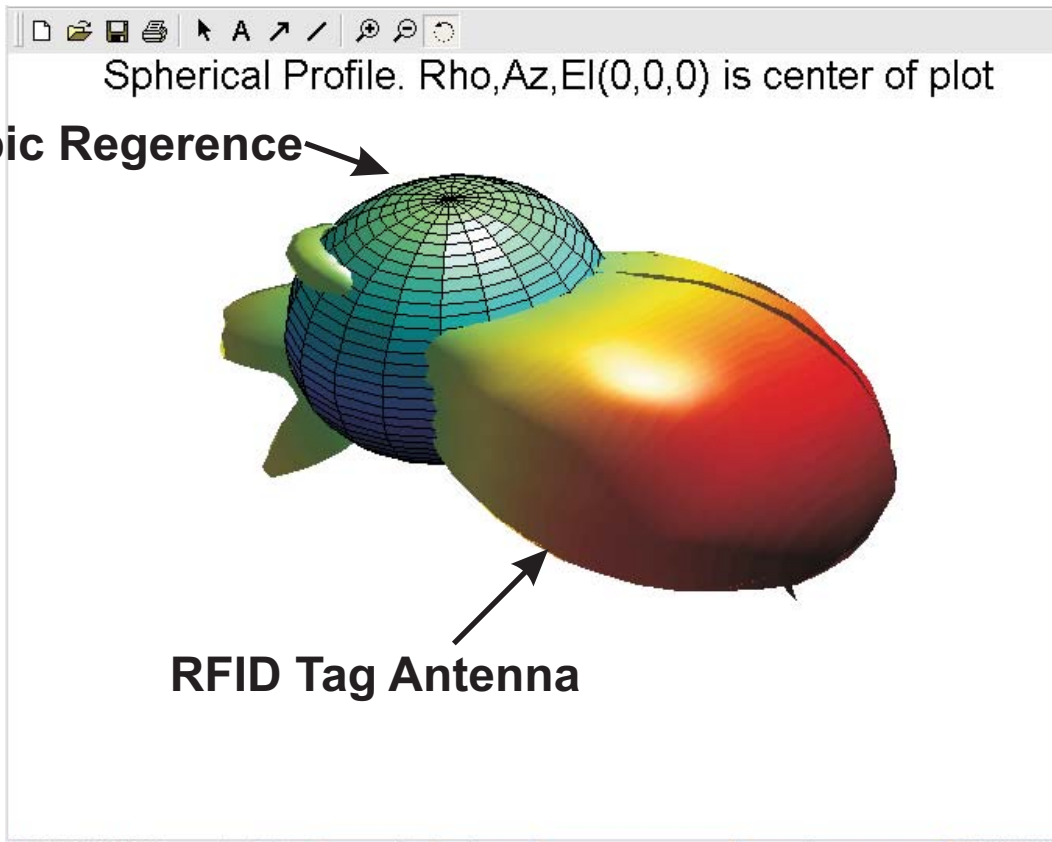
Map to Sphere R(in)
 Use Linear S21^2
 Use 20Log(S21)
 Wireframe
 Export Plot Data
 Az-El View Point
 45 45

1/2 λ Dipole
 Add 1/2w Dipole (dBd)
 (+dBd) = 0
 R(in) = 60
 Half Cut
 5 GridRES(deg)
 wireframe

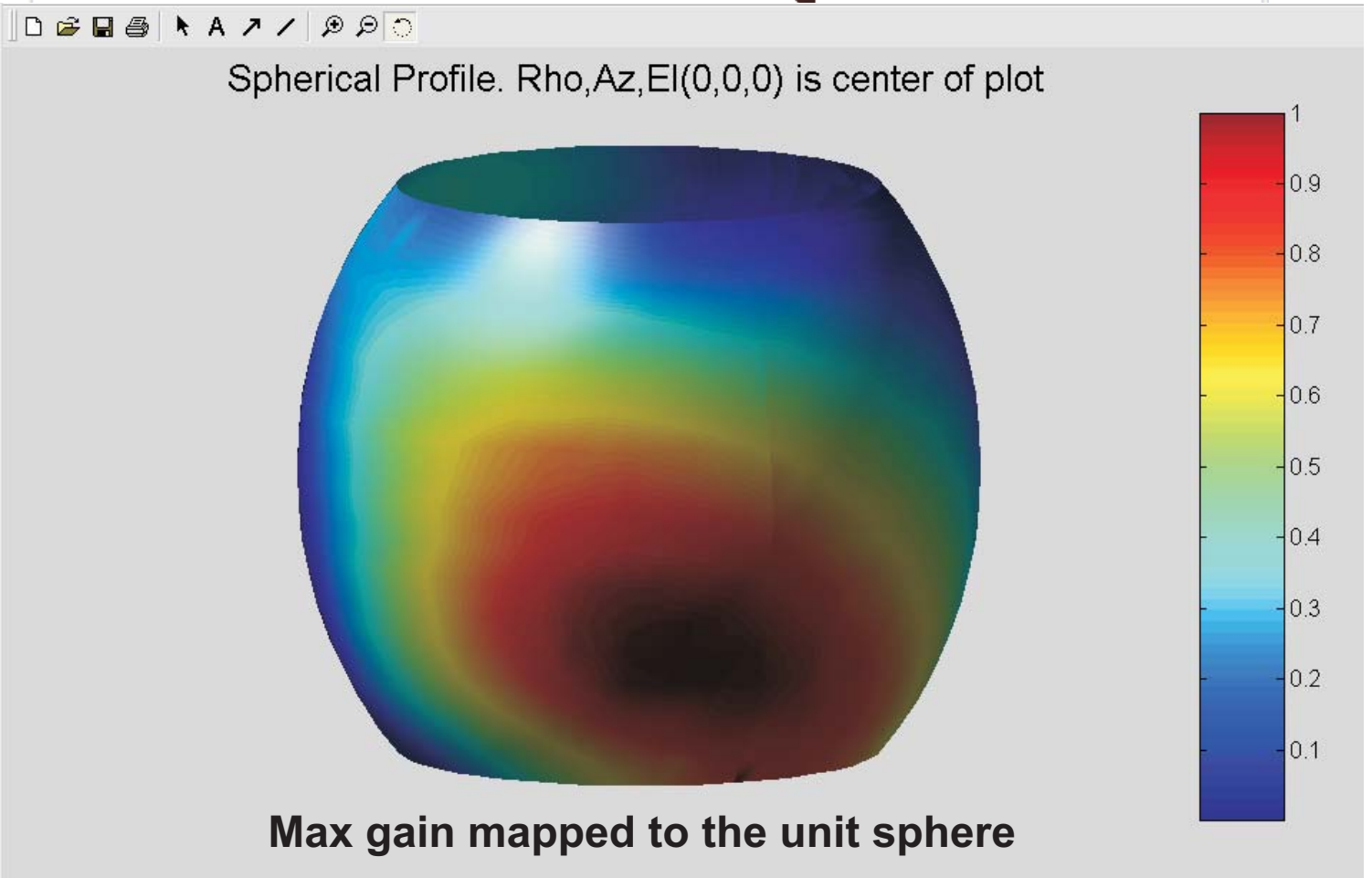
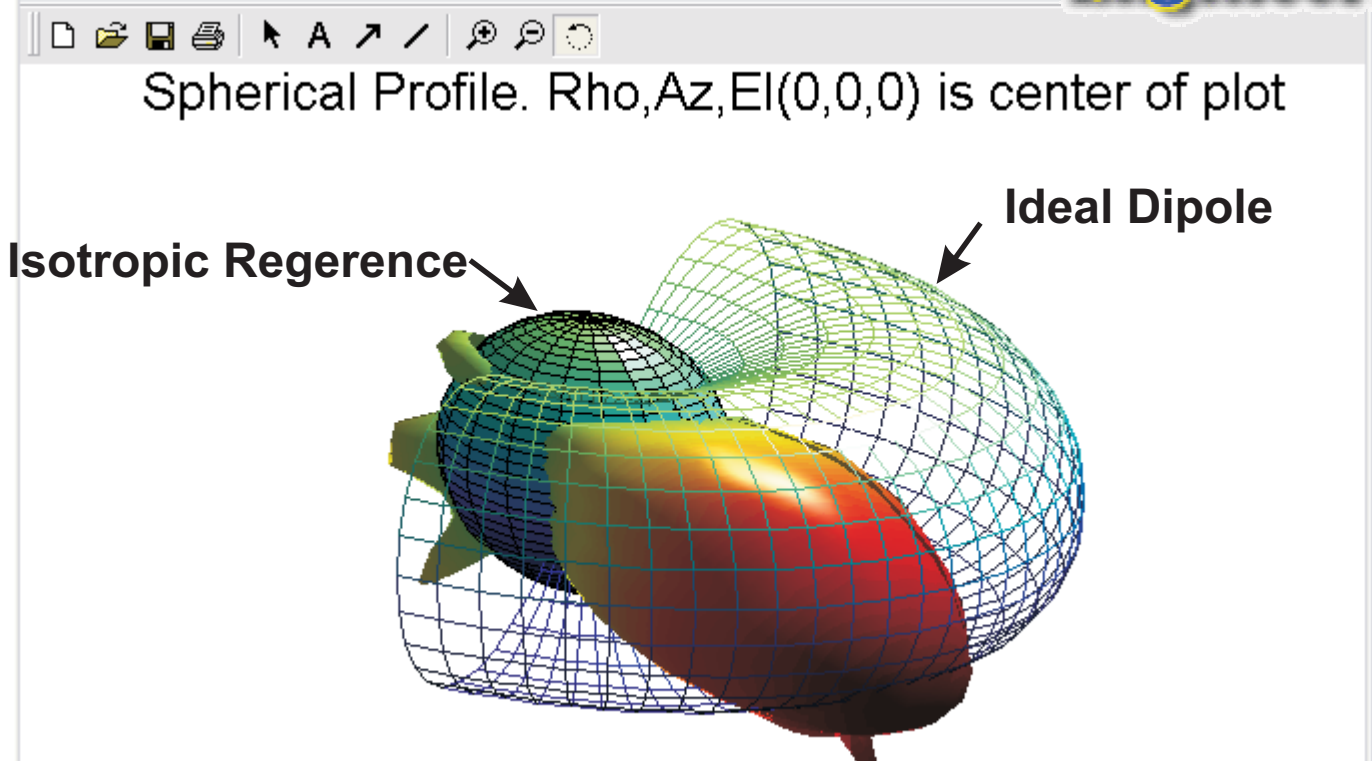
Iso-Sphere
 Add Isotropic (dBi)
 (+dBi) = 0
 R(in) = 120
 20 GridRES(deg)
 wireframe

NOTE: The S21 measurement array is squared from volt to Power ratio for this calculation. It is not re-saved to REG0.
 READ BELOW TO CALCULATE dBi or dBd POWER GAIN
 Use the slider to select the measurement frequency

Generate the spherical profile compared to Isotropic



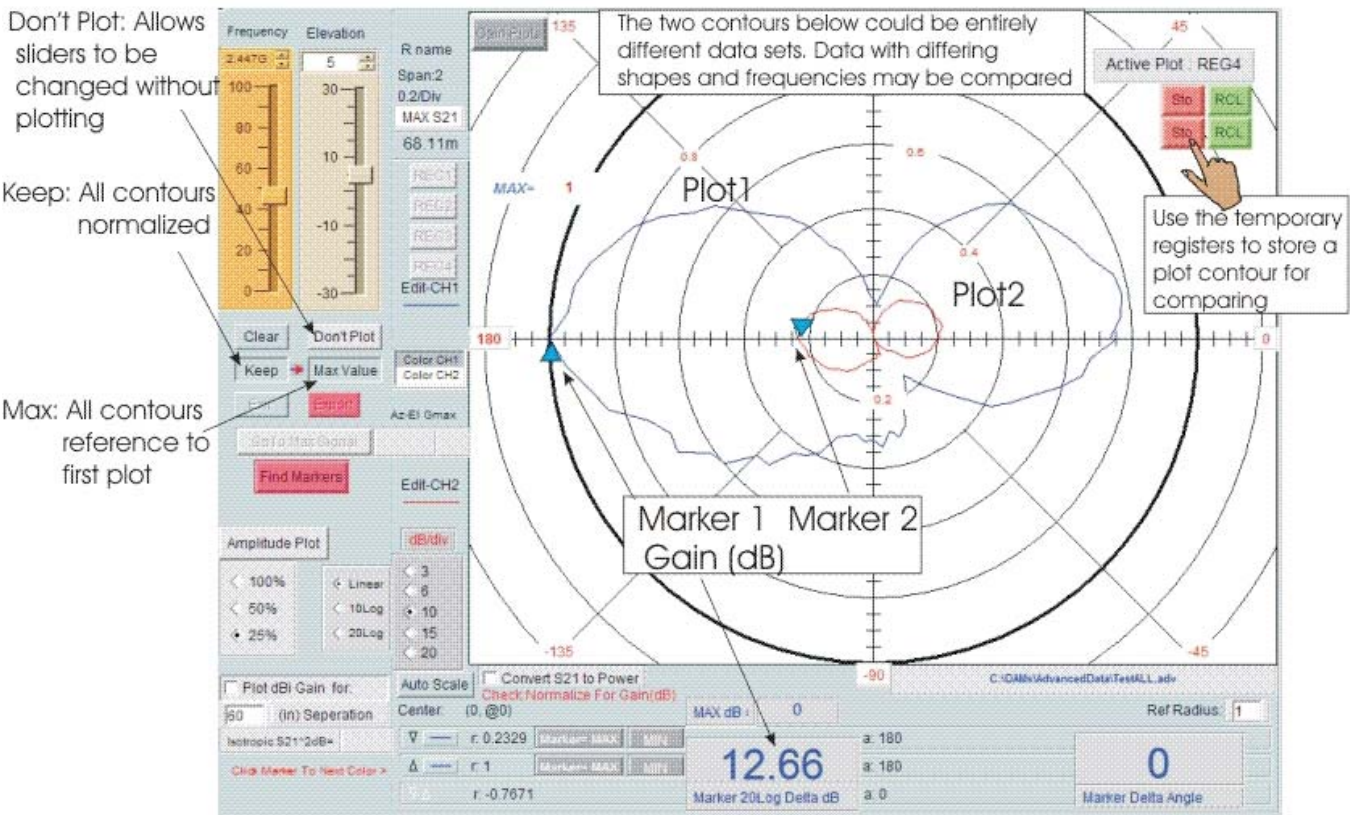
Max Gain with Isotropic and dipole link



Linear Plot Using Two Separate Measurements

Linear Plot is Always normalized to 1 unless Keep or Keep Max Value is invoked.

Use 20Log Marker Delta to compare two linear S21 plots



Linear Plot Using Single Measurement And Isotropic Link

Must be Log Plot. When Plot dBi Gain is checked the polar plot scale (red) is the difference between the isotropic link gain and the measurement link S21 dB

