AMS Antenna Measurement Software

- Modular Designed Software linked with TCP/IP
- ActiveX TM Graphing 2-D and 3-D Capability
- Testing Sequences controlled through Script Language
- Antenna Patterns in Polar, Rectangular, 3-D
- Standalone Equipment Drivers linked with TCP/IP
- Data management with ActiveX link to Microsoft Excel TM
- Report management with ActiveX Microsoft Word TM
- Available with optional Over-The-Air (OTA) CTIA Testing Requirements

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1. Software Overview

Raymond RF's Antenna Measurement Software performs 2-D (polar/rectangular) and 3-D (spherical) antenna pattern measurements for passive antennas and active wireless mobile stations (cell phones). Insertion loss of passive devices is included as part of the calibration component. Data management and reporting of antenna properties such as half power beam-width, directivity, gain, radiation efficiency, total radiated power, and total isotropic sensitivity. AMS performs and reports all measurements required by the CTIA Over-the-Air Performance Test Plan.

Insertion Loss / Gain measurements can be made on cables, preamps and attenuators as part of the calibration process.

There are several sample videos of the AMS on our WEB site at:
http://www.raymondrf.ca/products/products8.htm

1.1. Data Management

AMS links to Microsoft Excel through ActiveX. Custom spreadsheets can be developed for data analysis. Standard spreadsheets are included and custom data analysis is very flexible.

1.2. Report Generation

AMS links to Microsoft Word through ActiveX. Custom reports can be developed. Standard report templates are included and custom report generation is very flexible.

1.3. RF Test Equipment

AMS controls popular Vector Network Analyzers, Spectrum Analyzers, Power Meters, Receivers, Signal Generators, Base Station Emulators, Amplifiers, RF switches and Attenuators. Control can be accomplished through Ethernet, GPIB, or RS232. Drivers are supplied with Raymond RF Positioners and custom drivers can be created for non-Raymond RF Antenna Positioners.

1.4. Test Equipment Setups

Transmit and Receive equipment setups are easily set up and modified on a familiar hierarchy tree. Multiple Setups for each type of test can be saved for easy retrieval.

1.5. Measurement

Once the DUT is in place and the appropriate information is entered, all Measurement Parameters are selected from the main Measurement Tab, and the measurement is run. The script file is run and measured (raw) data is stored to a text file and measured results are plotted in real time. Feedback from each device is also displayed in real time.

Flexible design allows all Test Equipment and Positioners to optionally be controlled manually.

1.6. Graphing

Advanced ActiveX graphing capabilities allow acquired data to be displayed in a variety of 2-D and 3-D formats. Data is linked to Excel through ActiveX, so it can be reviewed directly with Excel.

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Data can be manipulated in Excel allowing users to develop their own data correlation / analysis algorithms.

1.7. Recommended Minimum System Requirements

- Pentium 4, 2500 MHz or compatible
- Microsoft XP / Vista/ 7 TM
- 4 GB RAM
- 50 GB free hard drive space
- CD-ROM Drive
- National Instruments GPIB card (Note: USB-A is not supported)

1.8. AMS Features

- Polar (Azimuth) Patterns: Single and Dual Polarization Tests, Scalar, Vector, Sensitivity
- Polar (Elevation) Patterns: Single and Dual Polarization Tests, Scalar, Vector, Sensitivity
- Spherical Patterns: Single and Dual Polarization Tests, Scalar, Vector, Sensitivity
- Insertion Loss / Gain testing of passive and active devices
- RF Equipment Drivers supplied: Agilent / Anritsu VNA, SA, SG, BSE, Amplifier, Attenuator, RF Switch. Custom RF Equipment Drivers Available
- Positioner Drivers supplied: Raymond RF Single Axis SD-455, and Dual Axis SD-455-3D Custom Positioner Drivers Available
- Word Report Templates
- Excel Data Templates
- Standard Test Scripts. Custom Test Scripts are available
- *ActiveX Link to *Excel and *Word
- Compatible with National Instruments GPIB-B and GPIB-H (USB-A not supported by National Instruments)
- Compatible with Ethernet and RS232
- Upgrades for 2 years

*Microsoft Excel , Microsoft Word and ActiveX are trademarks of Microsoft Corporation

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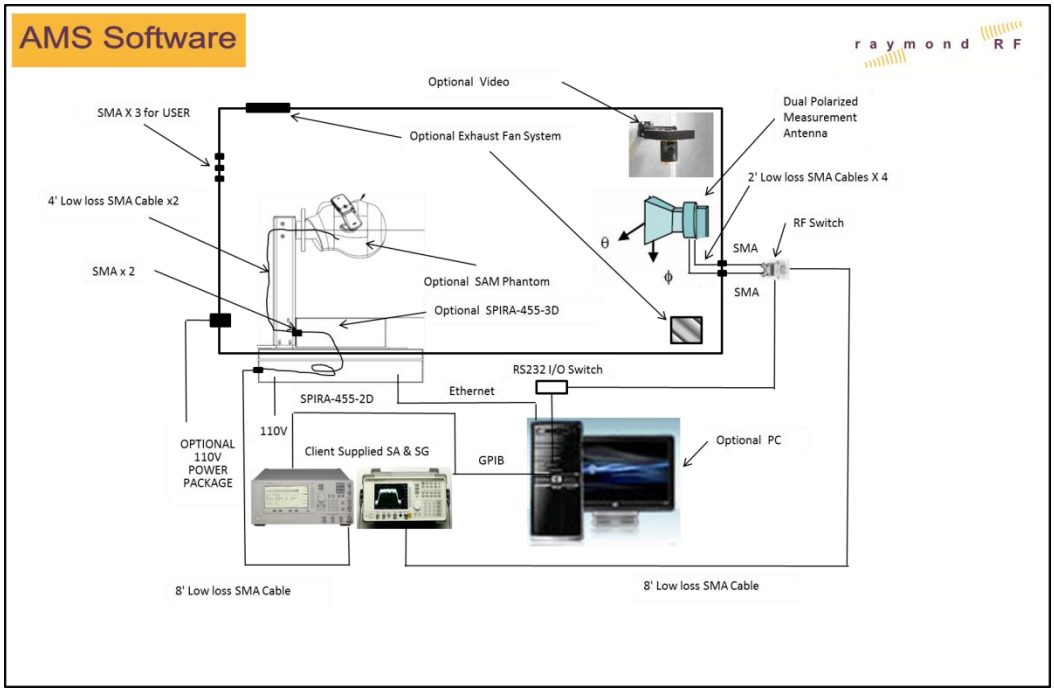
2. Hardware Set Up

Set up the AVS System according to one of the following Block diagrams

2.1. AVS Block Diagram with Signal Generator and Spectrum Analyzer



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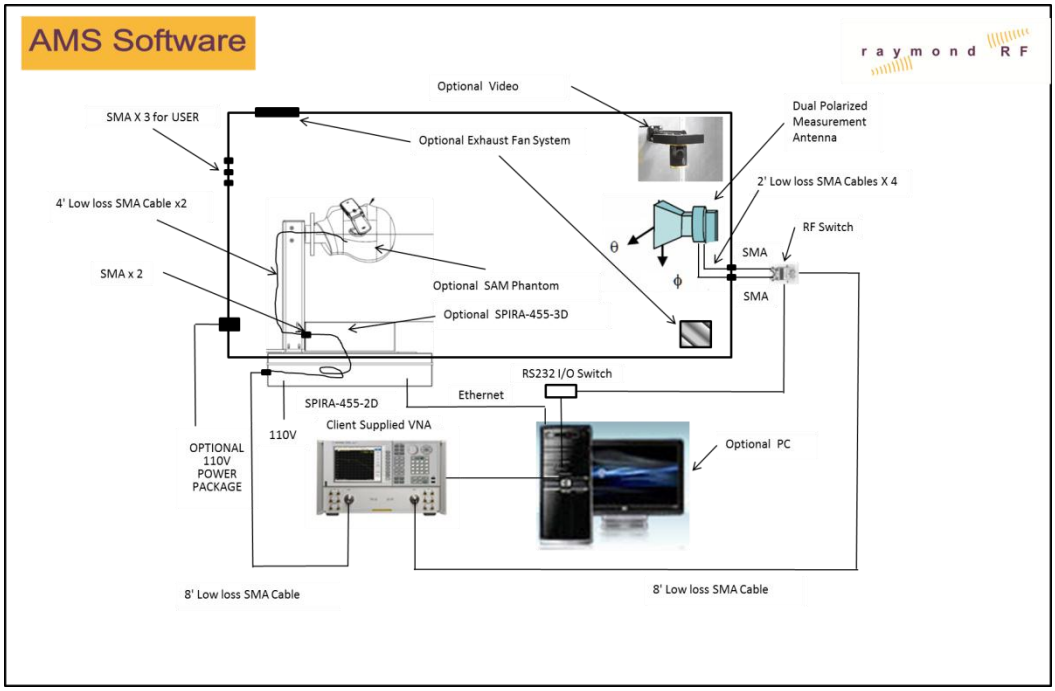
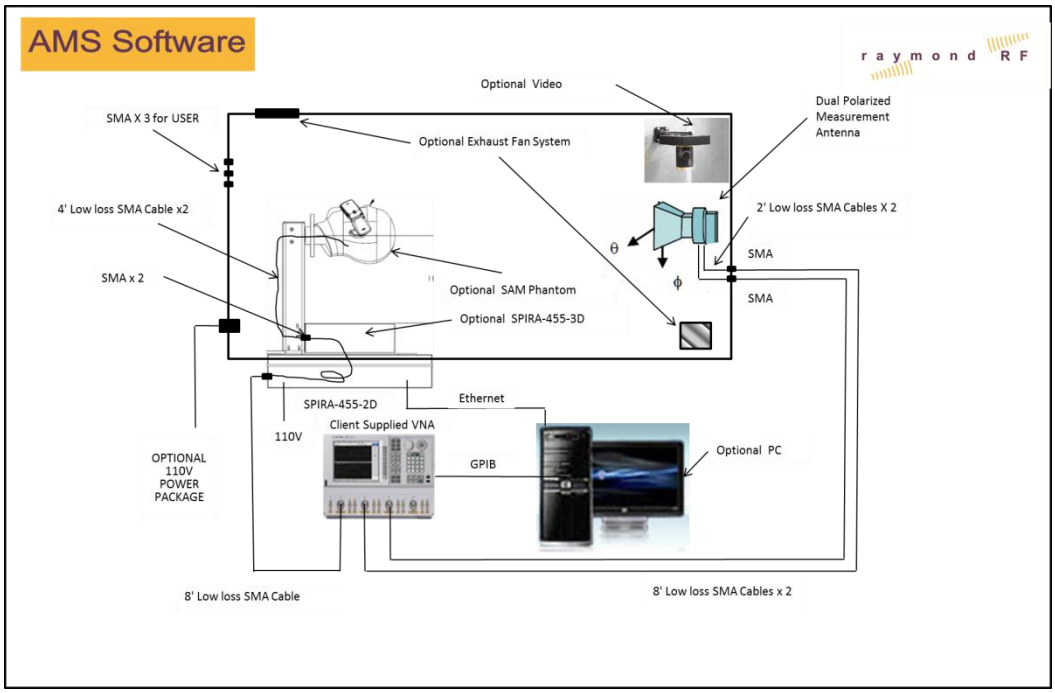
2.3. AVS Block Diagram with 2 Port VNA



2.4. AVS Block Diagram with 4 Port VNA



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3. Software Installation

PC Requirements

- Free Disk Space: 50G Bytes
- RAM: 2GB
- CPU: 2.33 GHz or better
- CD-ROM or internet connection to download / install software
- Two USB-2 connections
- A 10/100 or 10/100/1000 Ethernet Connection. The TCP/IP address of this connection will need to be set before running AMS or any of the control drivers
- Microsoft XP / Vista / Windows 7, All 32 and 64 bit versions.
- Microsoft Excel 97 or newer, Microsoft Word 97 or newer. AMS has only been tested with 32 Bit versions of Excel and Word. At time of AMS Version 3.0 release, Microsoft notes that "Click to Run" versions of Excel and Word do not support all ActiveX clients at time of installation, and are therefore not compatible with AMS. Please refer to Microsoft instructions on how to remove "Click to Run" version and reinstall with "Classic" version. "Click to Run" versions, are down loaded directly from Microsoft and include a virtual drive "Q" or "R" drive on your PC.

AMS:
The AMS Host Computer requires a USB port to attach the National Instruments USB-GPIB Controller, and the USB-RS232 RF-Switch controller. A free 10, 10/100 or 10/100/1000 Ethernet Port to connect the Positioner

- Set the TCP/IP Address of the Ethernet connection on the host computer to 192.168.1.xxx, where xxx can be any number between 1 and 255 except 132 through 139
- Server Port Number is set as 10000 by the AMS software
- Ensure that the host firewall does not block port 10000, 10001, 10010, 10020 and 10030. Depending on the version of Anti-Virus protection, this can normally be done through the automatic pop-ups, the first time AMS or a device is run.
- For computers with multiple Ethernet cards, ensure that the Ethernet Card attached to the positioner, is the first in the bindings list. Navigate to: "Control Panel\Network and Internet\Network Connections", select the Ethernet Card and press the "Alt" key, then select "Advanced" > "Advanced Settings". Promote the Ethernet Card to the top, using the arrows, (or other method depending on version of window). Some versions of windows may require a reboot.

Load the CD supplied by National Instruments, and install:

- National Instruments USB-GPIB Driver Software.. as per NI instructions and license.
- If your system utilizes an RF Switch, install the National Instruments NI-DAQmx Driver Software.. as per NI instructions and license.

Load the CD supplied by Raymond RF (or download as per instructions from Raymond RF and run the following Setups as required, in the sequence listed below; Install all programs on the same hard drive

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- Upgrading Steps (**IMPORTANT**): For users whom are upgrading from prior Versions of AMS, or SpiraTable positioners, it is very important that the "Backup" utility is installed first. Both AMS and SpiraTable installations include default data files, which will overwrite some of your existing data during the installation of AMS. Exit AMS and all drivers prior to upgrading and software. Install the "Backup V4" utility and run a backup. Once the newer version(s) of AMS and / or SpiraTable-455-3D / SpiraTable are installed, use the restore feature of the "Backup" to restore your original data.
- Backup V4.0 .. Install in the default directory C:\AMS\Backup. Run the Backup prior to installing AMS V4.0
- Convert V4.0 .. Install in the default directory C:\AMS\Convert. IMPORTANT! The convert utility is required to update files for use with Version 4.0.
- AMS.. install in the default directory C:\AMS
- If this is a new installation only, install the default data from "default data", as follows:
  - Copy all of the files and directories from "data" to C:\Ams\data\
  - Copy all of the files and directories from "Dbase" to C:\Ams\Dbase\. Note: This is a new Directory and will be created by the convert utility for users installing an upgrade.
  - Copy all of the files from "script" to C:\Ams\script\
  - Copy all of the files from "templates" to C:\Ams\templates\
- If this is an upgrade installation, once the new version of AMS 4.0 is installed, run Backup V 4.0 and select "Restore".
- If this is an upgrade installation from a Version prior to AMS V4.01, Run the Convert utility prior to running AMS V4.xx
- Script Editor .. (OPTIONAL) Install in the default directory C:\Ams\Script
- The following drivers are all standalone programs and can be utilized to control each device independently from AMS. Each driver should be tested with the appropriate device to verify functionality prior to running AMS. The GPIB address of the device must be set to the default GPIB address for driver standalone execution. However, the GPIB address of any device and driver can be modified to any available GPIB address through the AMS program.
  - SpiraTable-455-3D.. install in default directory C:\AMS\SpiraTable-455-3D. This is the Control Driver for 3D Positioners
  - SpiraTable-455 .. install in default directory C:\AMS\SpiraTable. This is the Control Driver for 2D Positioners
  - HP8563E .. install in default directory C:\AMS\HP8563E. This is an Agilent Spectrum Analyzer Controller / Driver. The default GPIB address is 11.
  - AGPSA.. install in default directory C:\AMS\AGPSA. This is an Agilent PSA series Spectrum Analyzer Controller / Driver. The default GPIB address is 18.
  - E4405B .. install in default directory C:\AMS\E4405B. This is an Agilent Spectrum Analyzer Controller / Driver. The default GPIB address is 18.
  - 8647A .. install in default directory C:\AMS\8647A. This is an Agilent Signal Generator Controller / Driver. The default GPIB address is 19
  - E8247C .. install in default directory C:\AMS\E8247C. This is an Agilent Signal Generator Controller / Driver . The default GPIB address is 19.
  - MG3692B .. install in default directory C:\AMS\MG3692B. This is an Anritsu Signal Generator Controller / Driver. The default GPIB address is 5.

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  - N5230A .. install in default directory C:\AMS\N5230A. This is an Agilent 2 port PNA (VNA) Controller / Driver. The default GPIB address is 16.
  - N5230C .. install in default directory C:\AMS\N5230C. This is an Agilent 4 port PNA (VNA) Controller / Driver. The default GPIB address is 16.
  - Accessories.. install in default directory C:\AMS\Accessories. These are the default RF-Switch, Remote Attenuator and Remote Amplifier Drivers
- Reference.. additional reference files including IVI drivers for 32 and 64 bit systems. Install the appropriate IVI driver for your system. If your system is Windows Vista, install the IVI Vista patch as well.
- SpiraTable Server .. (OPTIONAL) install in default directory C:\AMS\SpiraTable Server. This program and source code is provided for users who want to control the positioner with their own software. It is not required by the AMS.
- SpiraTable Client .. (OPTIONAL) install in default directory C:\AMS\SpiraTable Client. This program and source code is provided for users who want to control the positioner with their own software. It is not required by the AMS.

SpiraTable (Spira-455):
The SpiraTable Positioner, Spira-455, is controlled by SpiraTable.exe.

- It runs as a standalone application and is automatically launched from AMS or optionally by SpiraTable Server (see below).
- It can be launched and then controlled through SpiraTable Client as well, see below.
- It can be manually launched to control the positioner.. this may be useful during setups. To run SpiraTable in standalone mode, just run SpiraTable.exe without any parameters, from the start menu.
- Parameters: SpiraTable.exe PortType PortRate Address ServerPortNum;
  - i.e. SpiraTable.exe 2 10 192.168.1.129 10000
  - PortType = 2 for TCP/IP
  - PortRate = 10 for 10BaseT; is compatible with any rate
  - Address of the Ethernet connection on the host computer is to be set as 192.168.1.xxx, where xxx can be any number between 1 and 255 except 132 through 139. Skip this step if it was done in AMS above.
  - ServerPortNum = 10000
- Runs as both Client and Server at the same time
- TCP/IP Address is 192.168.1.xxx; This is the same address as AMS if the SpiraTable is connected to the same host computer
- Server Port is set as 10010, SpiraTable.exe is set to check for clients wanting to logon through this port.
- Client Port set by AMS or SpiraTable Server
- Theta Controller (on the positioner) TCP/IP Address 192.168.1.132 Port Number 10001

SpiraTable-455-3D:
The SpiraTable-455-3D Positioner, SpiraTable-455-3D, is controlled by SpiraTable-3D.exe.

- It runs as a standalone application and is automatically launched from AMS or optionally by SpiraTable Server (see below).
- It can be launched and then controlled through SpiraTable Client as well, see below.

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- It can be manually launched to control the positioner.. this may be useful during setups. To run SpiraTable-455-3D in standalone mode, just run SpiraTable-455-3D.exe without any parameters, from the start menu.
- Parameters: SpiraTable-455-3D.exe PortType PortRate Address ServerPortNum;
    - i.e. SpiraTable.exe 2 10 192.168.1.129 10000
    - PortType = 2 for TCP/IP
    - PortRate = 10 for 10BaseT; is compatible with any rate
    - Address of the Ethernet connection on the host computer is to be set as 192.168.1.xxx, where xxx can be any number between 1 and 255 except 132 through 139. Skip this step if it was done in AMS above.
    - ServerPortNum = 10000
- Runs as Client and Server at the same time
- TCP/IP Address is 192.168.1.xxx; This is the same address as AMS if the SpiraTable is connected to the same host computer
- Server Port is 10020
- Client Port set by AMS
- Theta Controller (on the positioner) TCP/IP Address 192.168.1.132 Port Number 10001
- Phi Controller (on the positioner) TCP/IP Address 192.168.1.133 Port Number 10001

SpiraTable Client "Optional"

- Logs on to SpiraTable with Port Address 10010
- This program and source code is provided for users who want to control the positioner with their own software. It is not required by the AMS.

SpiraTable Server "Optional"

- SpiraTable logs on with Port Address 10000
- This program and source code is provided for users who want to control the positioner with their own software. It is not required by the AMS.
- Note: SpiraTable Server and AMS cannot run at the same time on the same host computer as they would both compete to control the SpiraTable.

Test each driver individually from the Windows Start Menu and verify that each device / instrument is functioning correctly.

Please also review the videos which are located under the “Videos” directory.

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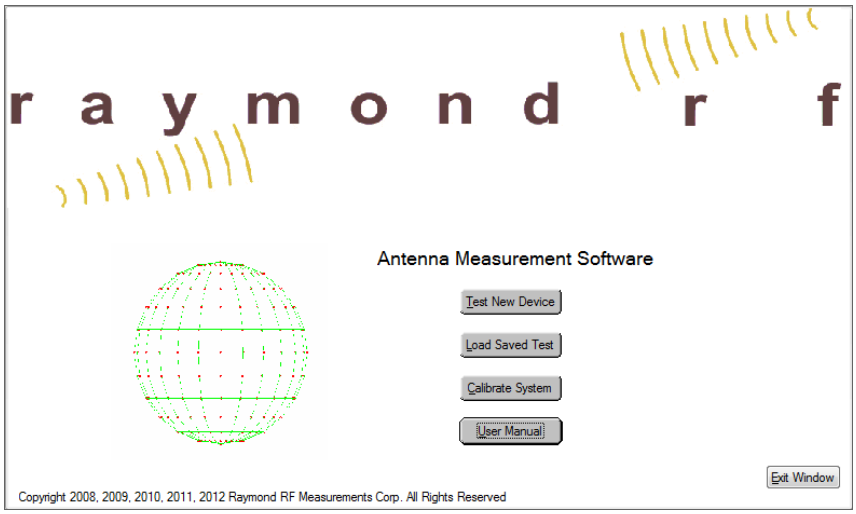
4. Software Layout

4.1. Start Window



4.1.1. Test New Devices

4.1.2. Load Saved Test

4.1.3. Calibrate System

4.1.4. User's Manual – Opens this manual

4.1.5. Exit Window

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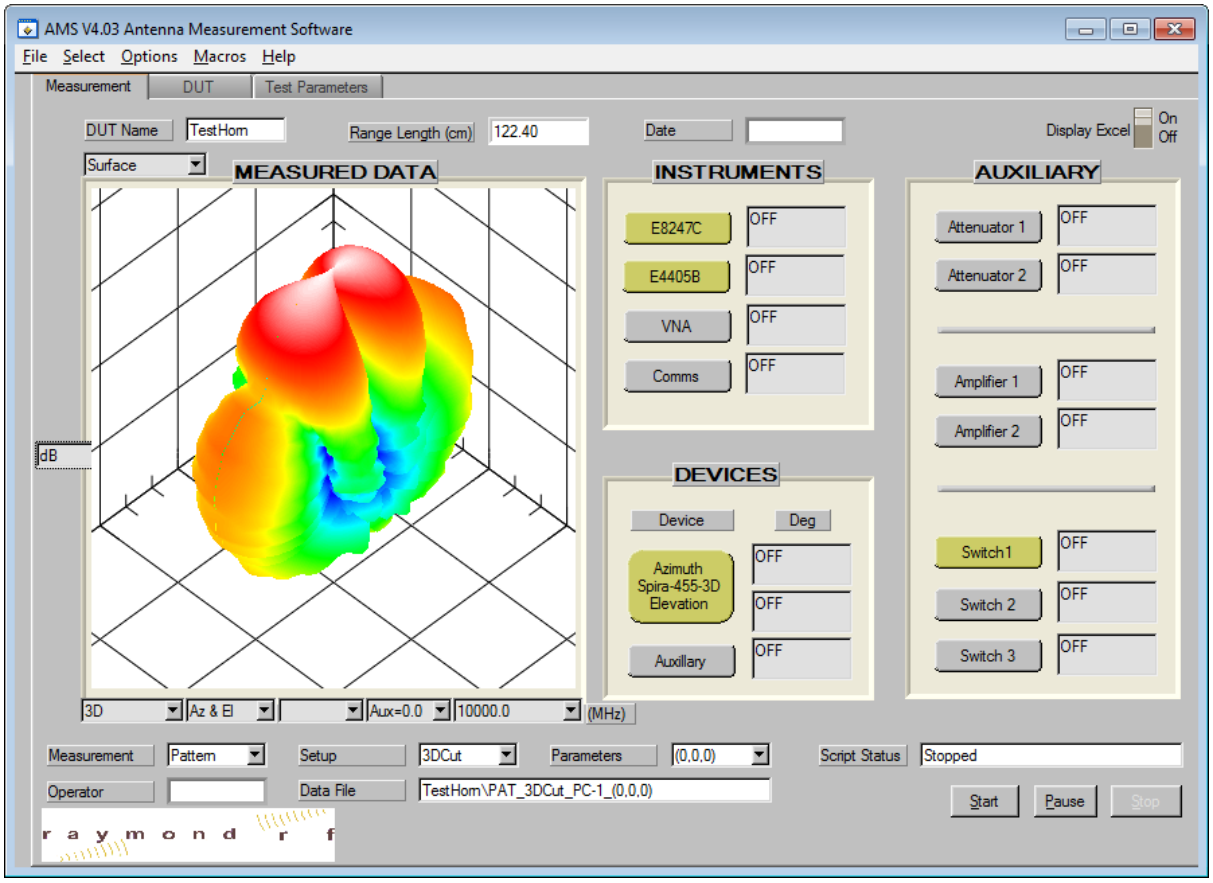
4.2. Measurement Tab



This is the main tab for controlling test procedures and viewing test results. To access the Measurement Tab, Select>Measure from the main menu, then select the Measurement Tab. The Main menu also has:

- File>Open to open previously saved test setups.
- File>Save to save test setups
- File>Print to print results
- File>Exit to Exit AMS and close all open drivers and excel data sheets.
- Select>Measure to access the Measure, DUT and Test Parameters Tabs
- Select>Setups to access the Equipment, Accessories, Equipment Setups and Devices Tabs
- Select>Reports to access Reports and Views Tabs
- Options>Graph Options to toggle graph options on and off, on the Measurement Tab
- Macros> Run predefined and user defined Excel Macro
- Help>Help to access this document

The Macros are processed from Excel i.e. “PAT-Macro” in the templates directory. AMS reads in the Macro Names and makes them available to the user. The user can review the Macros in Visual Basic from the Development Tab in Excel. If Excel doesn’t have the Development Tab, it will need

to be enabled. The user can make any changes to the Macros, as they are user definable. Additional Macros can also be added.

4.2.1. DUT Name, Range Length (cm), Test Date

- The DUT Name is selected from the DUT tab (see below)
- The Range length is the distance between the electrical centre of the Measurement antenna and the centre of the positioner. It is set by Raymond RF, however it may be adjusted by the user.
- Enter the test date as DD-MMM-YYYY

4.2.2. 3D Graph and controls

- The data can be displayed with the Y-axis as degrees, dB, mV/m or uV/m
- AMS reads the Excel data file and allows selection of graph type as Cartesian, Polar or 3D depending on available data
- The X-axis as Frequency, Azimuth, Elevation, Aux (polarization), depending on available data
- Discrete 2D cuts can be viewed, depending on available data
- The Frequency Ranges, or Discrete Frequency settings can be selected according to the Test type and Test Setup selected.
- The ActiveX 3D Graph can be rotated and zoomed interactively with the mouse.
- The controls surrounding the Graph are used to manipulate Graph settings and parameters.

4.2.3. Measurement Type, Setup, Parameters, Script Status

- Once the DUT is selected, The Measurement type, Test Setup Parameters, and Frequency Ranges are selected. If the data exists, Excel will open with the data file and the data is plotted on the AMS graph. If this is a new test, the graph will remain blank.
- During a test, the Script Status is displayed line by line as it is executed.

4.2.4. Operator, Data File

- Enter the name or initials of the test operator for reference purposes
- The Data file is set by AMS and is for reference purpose

4.2.5. Equipment Drivers

Command Buttons for the Equipment drivers which are part of the selected test setup, are highlighted in Yellow. Prior to making a measurement each driver must be selected. Once the driver is active, its command button will change to green. If an Equipment Driver is not part of the test setup (Tx or Rx Chain), the command button will remain Grey, and not be accessible. AMS controls:

- Source, Receiver, VNA, Communications Unit
- Positioners: Azimuth, Elevation, 3rd Axis
- Remote Attenuators, Remote Amplifiers, Remote RF-Switches

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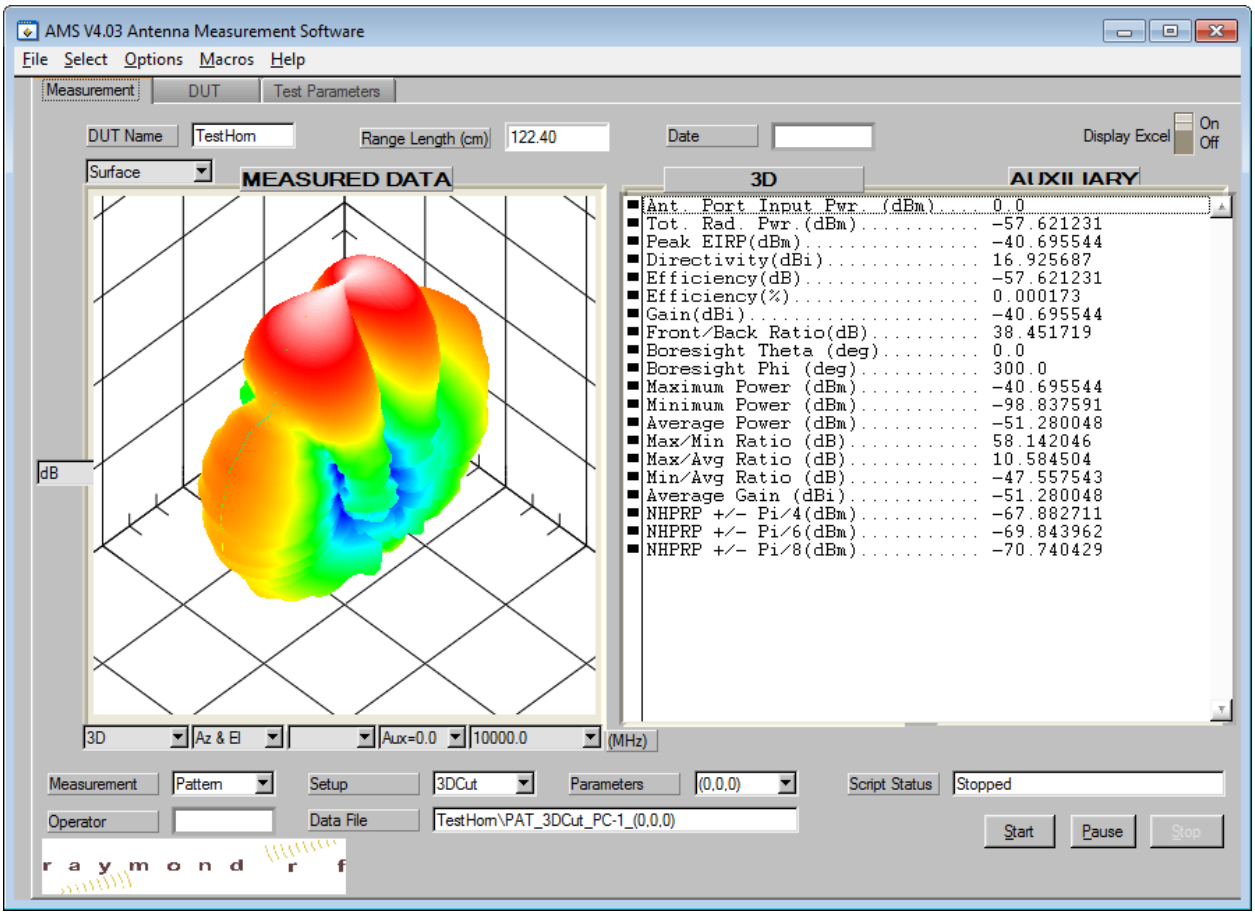
4.2.6. Start, Pause, Stop

Once all of the appropriate drivers are activated, the Start, Pause and Stop buttons will change from Grey to Green, Yellow and Red, respectively. To start a test, select the Green Start Button. If data exists for the selected test, a pop-up menu will appear to request permission to overwrite data and repeat the measurement.

4.2.7. Display Excel (On/Off)

4.2.8. Graph Options

Shown with the Macro CalcTRP



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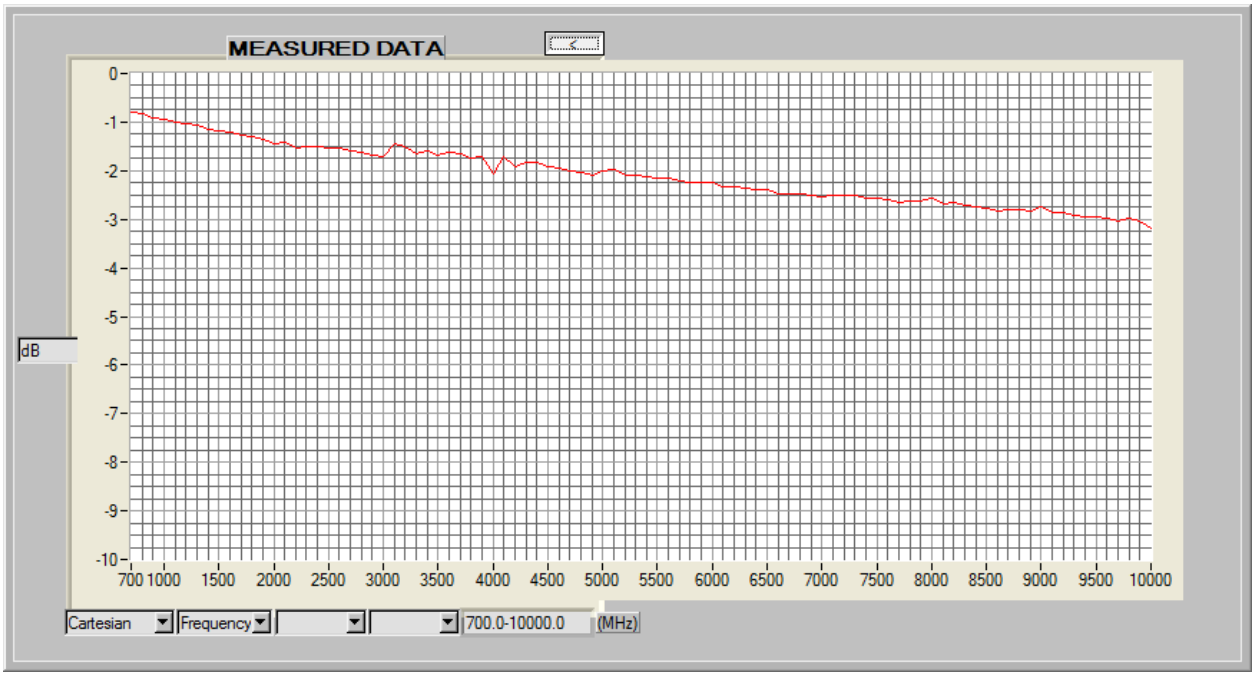
4.2.9. Options: Pop Out Graph

Shown in Wide Mode with Cable Insertion Loss Data



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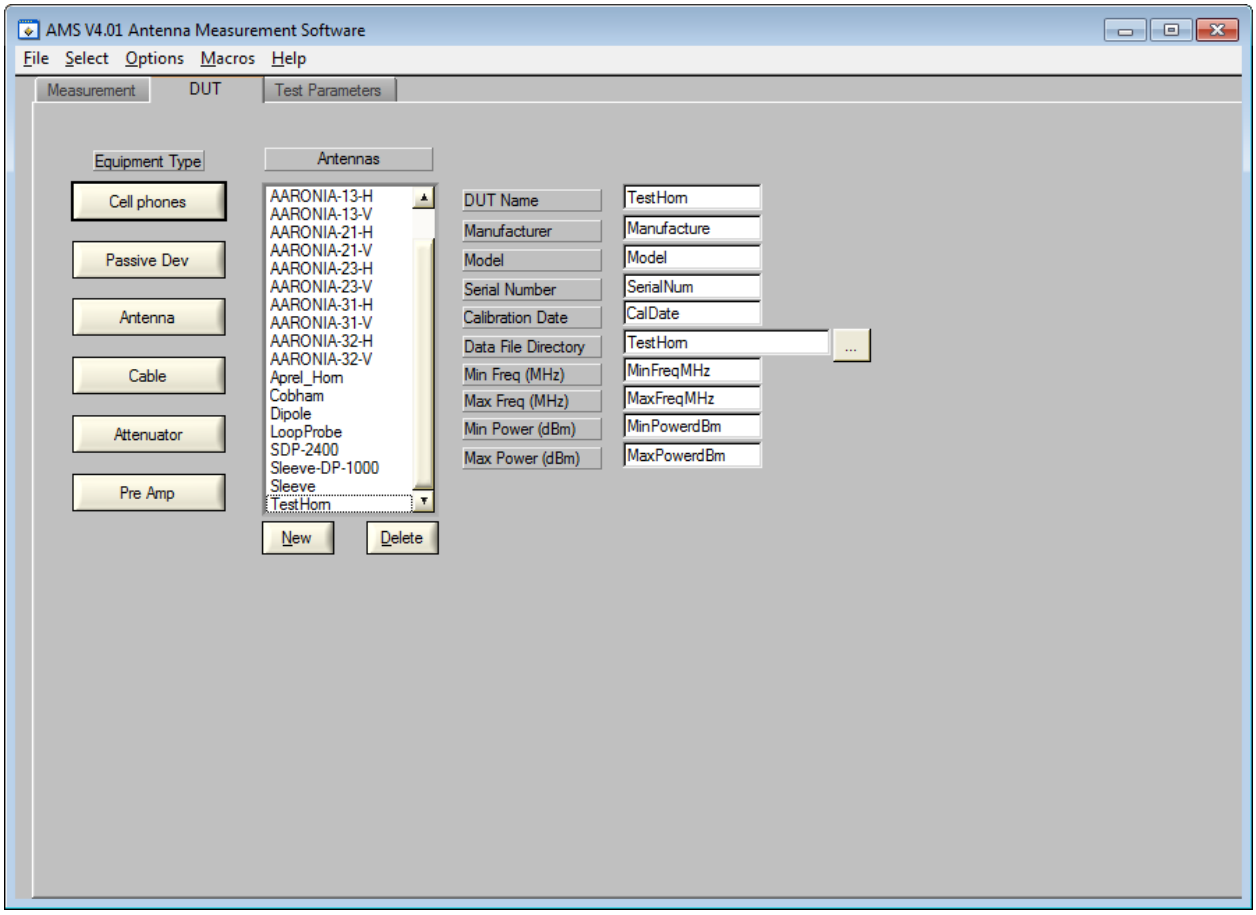
4.3. DUT Tab



To access the DUT Tab, Select>Measure from the main menu, then select the DUT Tab.

4.3.1. Cell Phones, Passive Devices, Antennas, Cables, Attenuators, Preamps

Data for each DUT must be entered prior to making a test. Existing DUT information can be edited or a new DUT can be entered as required. Select the DUT type from the command buttons on the left.

4.3.2. DUT Name New / Delete

To enter a new DUT, select New and enter the information as required. Unwanted DUTs can be deleted, and reentered at a later date if required.

4.3.3. DUT Information

Enter as required for reference purpose. Enter the date as DD-MMM-YYY. Select the Data File Directory Button  to select the Data Storage Directory.

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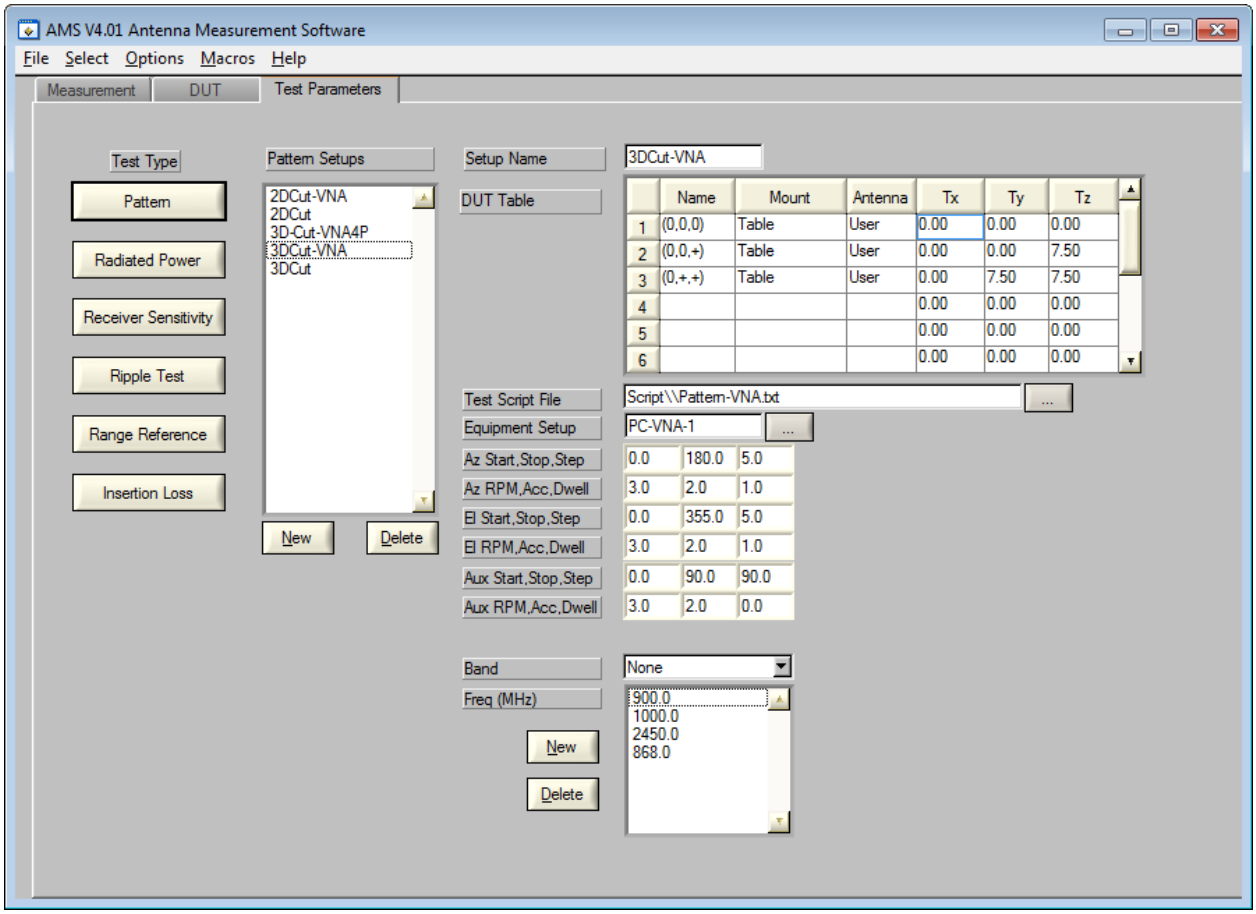
4.4. Test Parameters



To access the Test Parameters Tab, Select>Measure from the main menu, then select the Test Parameters Tab.

4.4.1. Pattern, Radiated Power, Receiver Sensitivity, Range Reference, Ripple Test, Insertion Loss

Test Setup parameters can be edited, or new Setups can be created as may be required for any of the tests

- Select the Test Type as per the command buttons on the left.
- Select the appropriate Setup or select New.
- Edit the information as required.

4.4.2. New / Delete

Select New or Delete as required.

4.4.3. DUT Table

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Enter any parameters in the DUT table. Up to 12 setups can be entered. Name, Mount and Antenna are for reference purpose only. The Tx, Ty and Tz are the offsets from the centre of the positioner, in cm. The coordinate system is described in section 4.

4.4.4. Test Script File Name

Select the Script file Button  to select any available script file. The script file is in text format and can be edited as may be required.

4.4.5. Equipment Setup

Select the Equipment Setup Button  to select any available Equipment Setups. A pop-up window will appear with all available Equipment Setups. Equipment Setup (chains) are discussed below.

4.4.6. Positioner Parameters

Edit as required.

4.4.7. Frequency Parameters

Edit as required.

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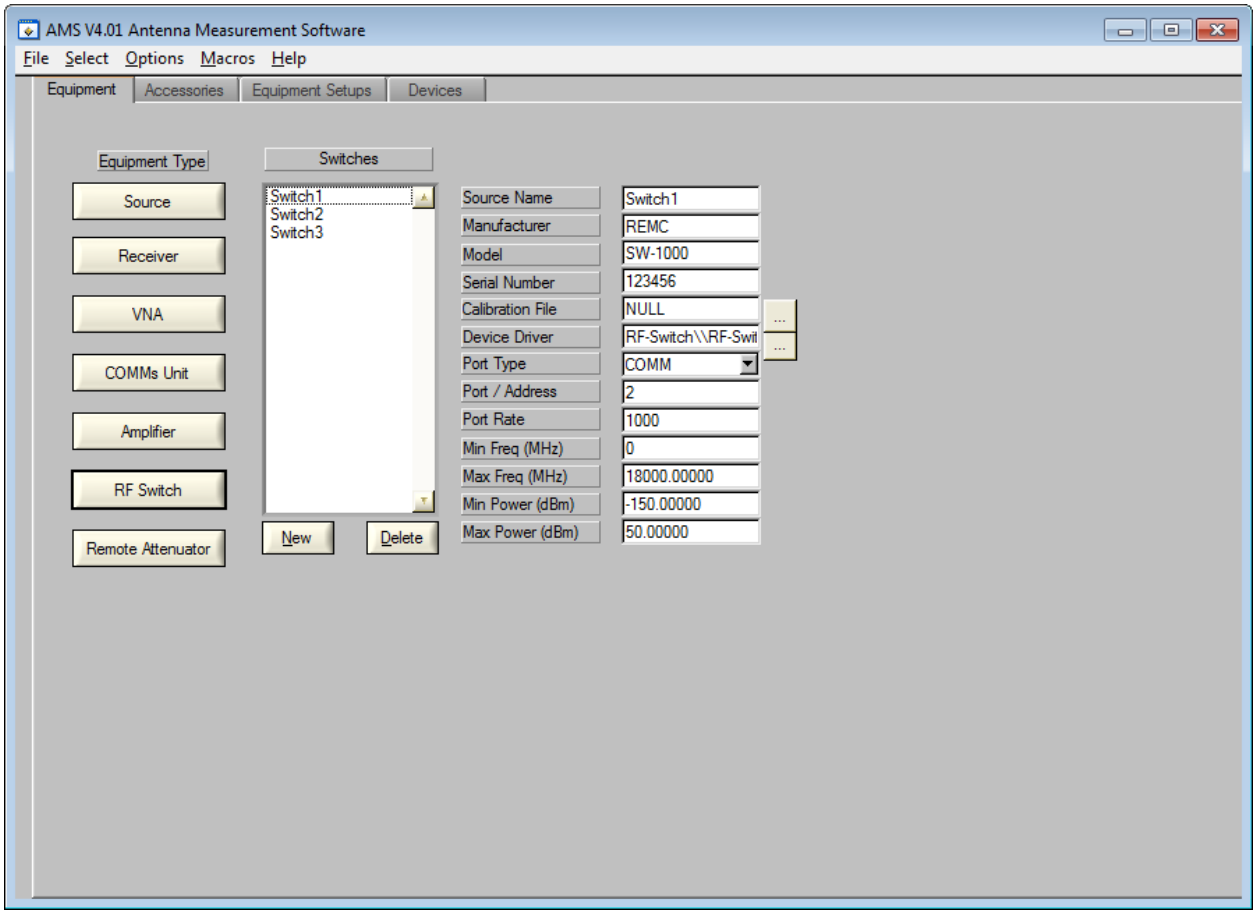
4.5. Equipment Tab



To access the Equipment Tab, Select>Setups from the main menu, then select the Equipment Tab.

4.5.1. Source, Receiver, VNA, Communications Unit, Amplifier, RF Switch, Attenuator

Equipment Drivers can be edited, or new Drivers can be created as may be required for any of the tests

- Select the Equipment Type as per the command buttons on the left.
- Select the appropriate piece of Equipment or select New.
- Edit the information as required.

4.5.2. New / Delete

Select as required.

4.5.3. Equipment Information

Enter all of the information as required.

Select the Calibration File Button ... to select the appropriate directory which contains the calibration data for the equipment.

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Select the Device Driver Button  to select the appropriate driver for the equipment.

4.5.4. Equipment Parameters

Enter information as required for reference purposes

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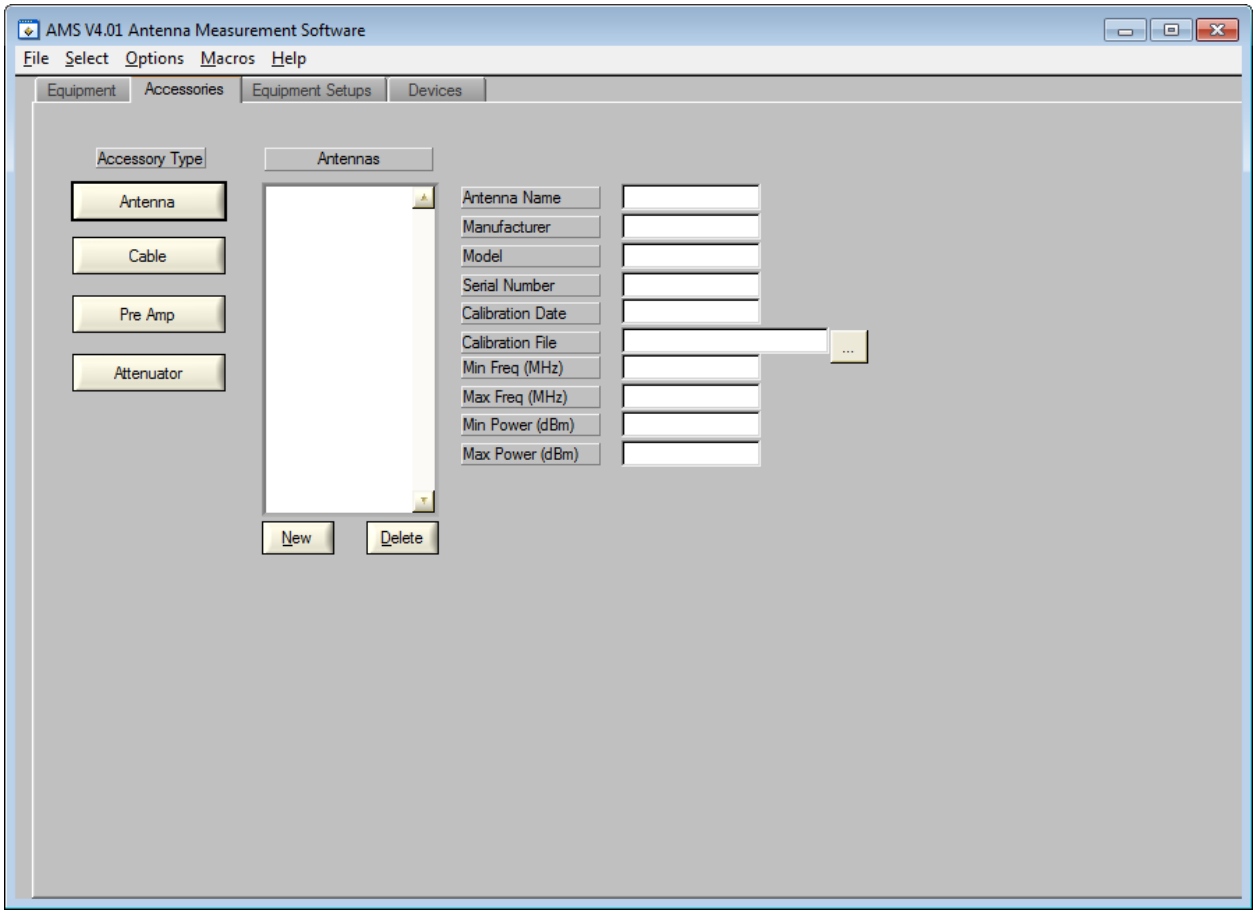
4.6. Accessories Tab



To access the Accessories Tab, Select>Setups from the main menu, then select the Accessories Tab.

4.6.1. Antenna, Cable, Pre Amp, Attenuator

Accessory Equipment which do not require drivers can be edited, or new accessories can be created as may be required for any of the tests

- Select the Accessory Type as per the command buttons on the left.
- Select the appropriate piece of Equipment or select New.
- Edit the information as required.

4.6.2. New / Delete

Select as required

4.6.3. Accessory Information

Enter all of the information as required.

Select the Calibration File Button ... to select the appropriate directory which contains the calibration data for the equipment.

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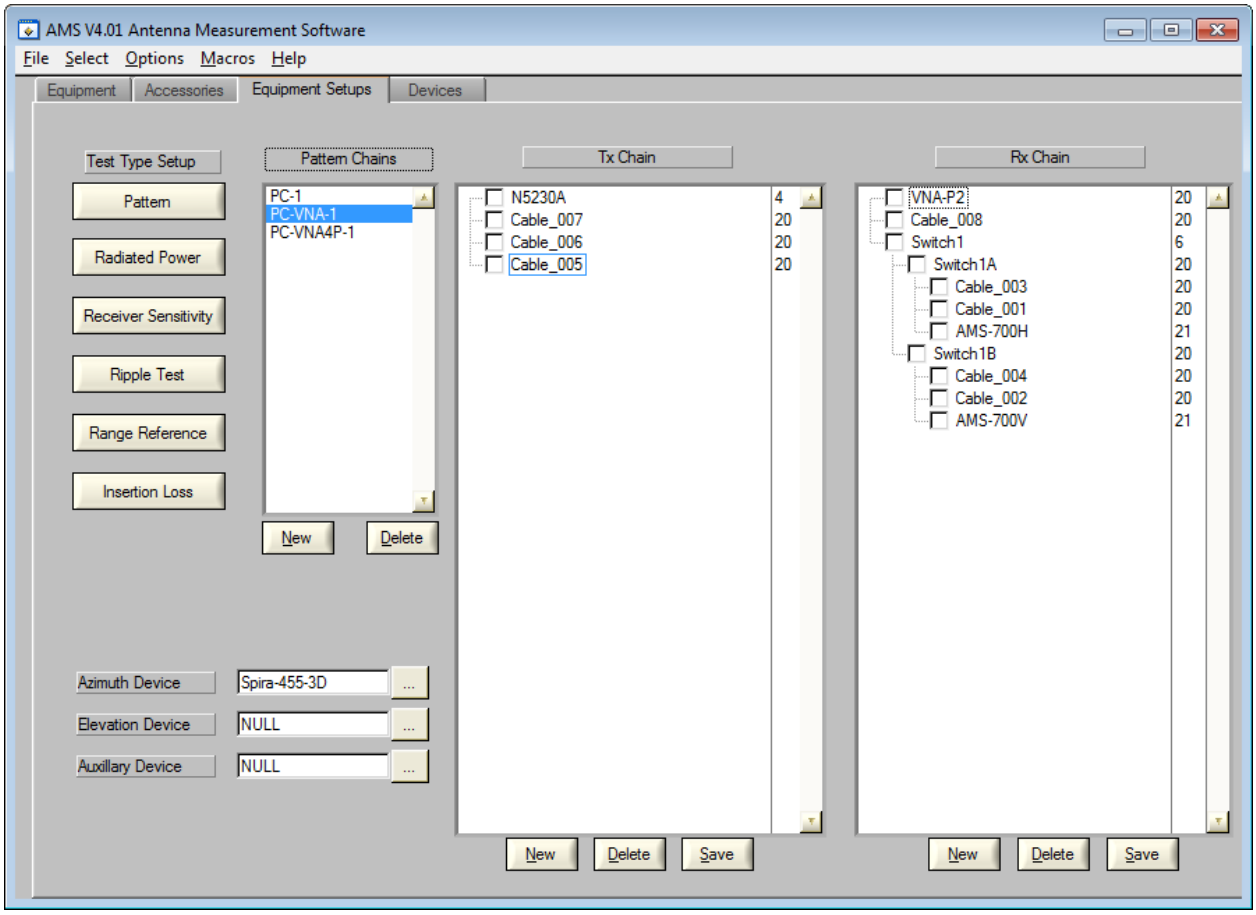
4.7. Equipment Setups Tab



To access the Equipment Setups Tab, Select>Setups from the main menu, then select the Equipment Setups Tab. All of the devices in the Tx and Rx chains is identified in this Tab.

4.7.1. Pattern, Radiated Power, Receiver Sensitivity, Range Reference, Ripple Test, Insertion Loss

Select the appropriate Test Setup Type Command Button on the left. Default Chain Setups will appear in the Chain list. Select the appropriate chain or select New or Delete as required.

4.7.2. New / Delete Chain

Select as required.

4.7.3. Azimuth, Elevation, Auxiliary Devices

Select as required. Note that if the SpiraTable-455-3D is selected as the azimuth device, there is no need to select an elevation device

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4.7.4. Transmit Chain List

Select New / Delete Tx Equipment as required. A pop-up menu will appear with all available Equipment and Accessories. Select as required. Items in the chain can be dragged with the mouse into position as required. Select Save Tx Chain when complete. A special case is for the VNA port 2, as this is the Transmit Port for calibration purpose, and does not have a driver. VNA-P2 is found in the accessory cables. The VNA driver is entered in the RX chain below.

4.7.5. Receive Chain List

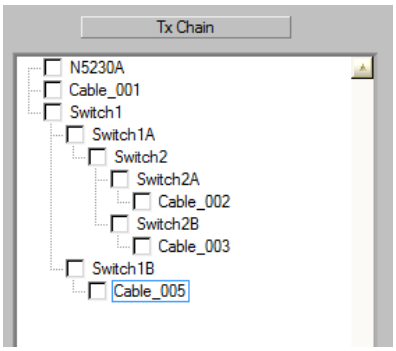
Select New / Delete Rx Equipment as required. A pop-up menu will appear with all available Equipment and Accessories. Select as required. Items in the chain can be dragged with the mouse into position as required. Select Save Rx Chain when complete.

4.7.6. Remote RF Switches

AMS supports up to 3 Remote RF Switches. These switches can be assigned in both the Tx and Rx chain. The following rules apply to the use of Switches:

1. Switches are numbered 1 through 3 starting with their appearance in the Tx chain first, then as they appear in the Rx chain.
2. Each switch can have a maximum of 3 ports, A, B and optional C.
3. Each switch must utilize a minimum of ports A and B
4. Switch ports for Switch1 are labeled Switch1A, Switch1B and Switch1C
5. Switch ports for Switch2 are labeled Switch2A, Switch2B and Switch2C
6. Switch ports for Switch3 are labeled Switch3A, Switch3B and Switch3C
7. The second switch in a chain must be attached directly to one of the ports of the first switch. Please see Tx Switch example, below.

Tx Switch Example



8. A third switch can either be attached directly to one of the ports on the first switch or one of the ports on the second switch.
9. All sub components such as cables, attenuators, antennas, VNA ports etc. must start after the switch port
10. The purpose of listing components after the appropriate switch port is to ensure that AMS selects the correct calibration files for each component when calculating the overall insertion loss / gain of the active chain.

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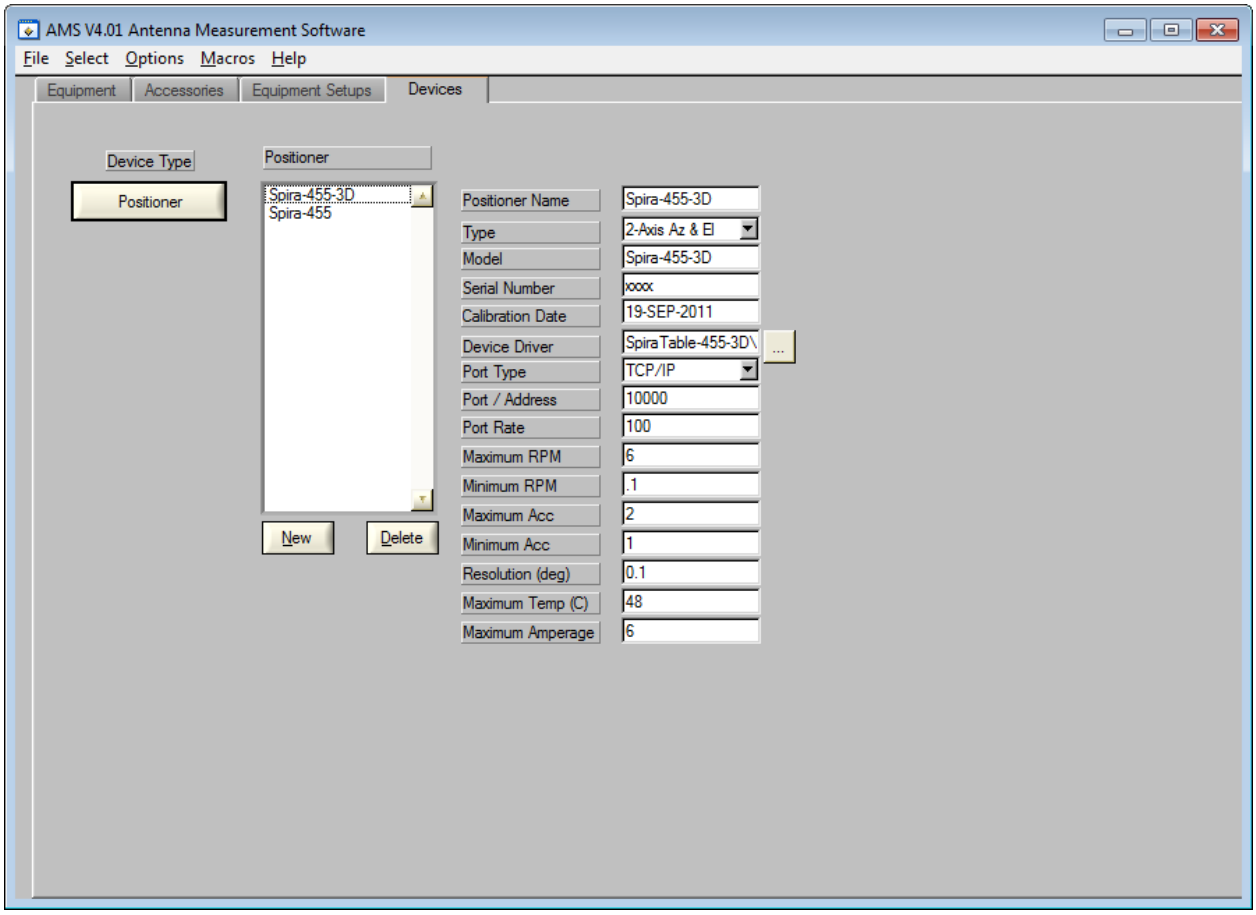
4.8. Positioner Devices Tab



To access the Devices Tab, Select>Setups from the main menu, then select the Devices Tab. All of the positioning devices are identified in this Tab.

4.8.1. Positioner

Select Positioner Command Button on the Left. A list of defined positioners will appear in the list.

4.8.2. New / Delete

Select as required.

4.8.3. Positioner Information

Enter the positioner name and select the type as 1- Axis Az (theta), 2-Axis Az & El (theta & phi), 3-Axial Aux axis. Only 2 positioners can be activated at one time. Either a single axis Az and an Axial Aux, or a 2-Axis Az & El and an Axial Aux.

4.8.4. Positioner Parameters

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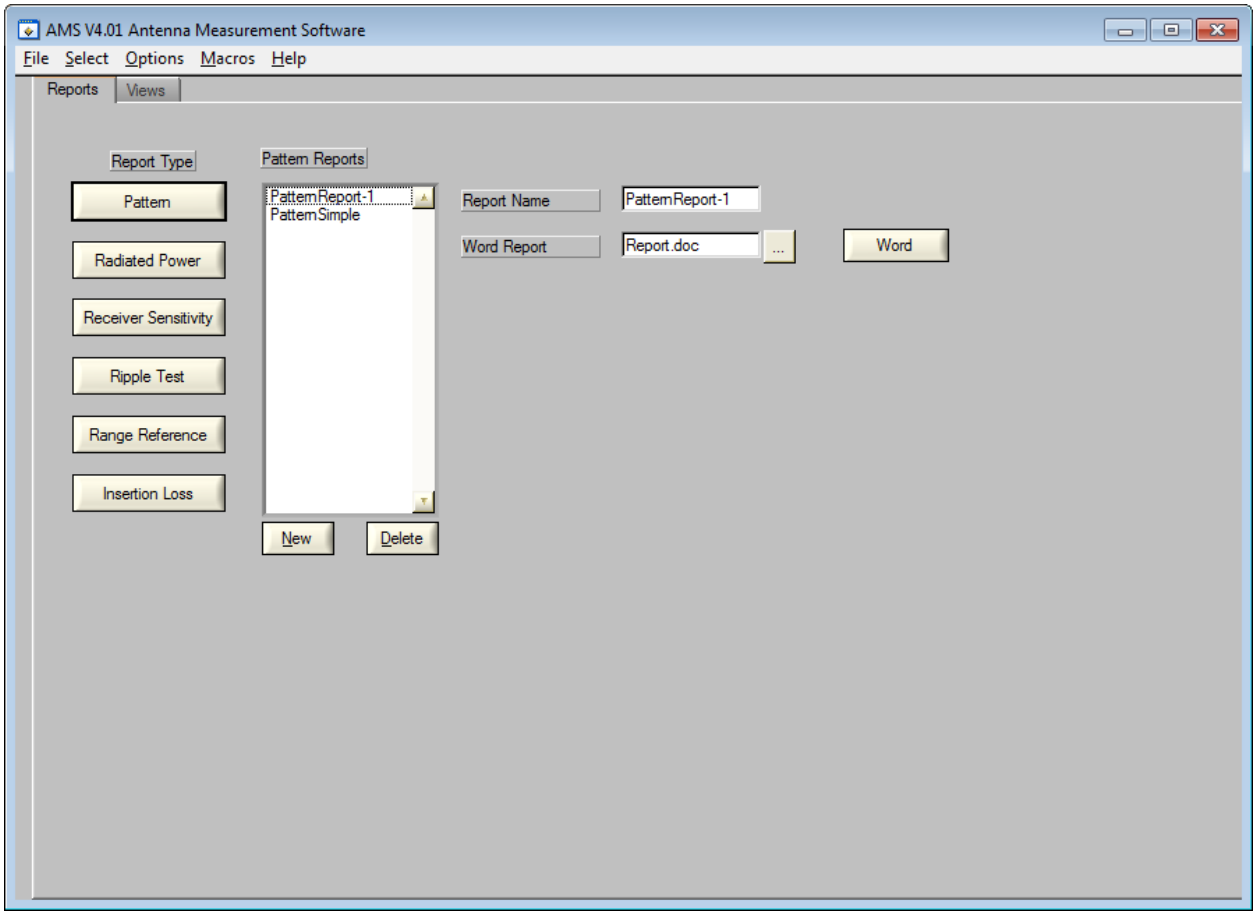
Enter information as required for reference purpose. Select the Device Driver Button ... to select the appropriate driver for the positioner. Other parameters are discussed in Section 3 above.

4.9. Reports Tab



4.9.1. Pattern, Radiated Power, Receiver Sensitivity, Range Reference, Ripple Test, Insertion Loss

4.9.2. Report Name, New / Delete

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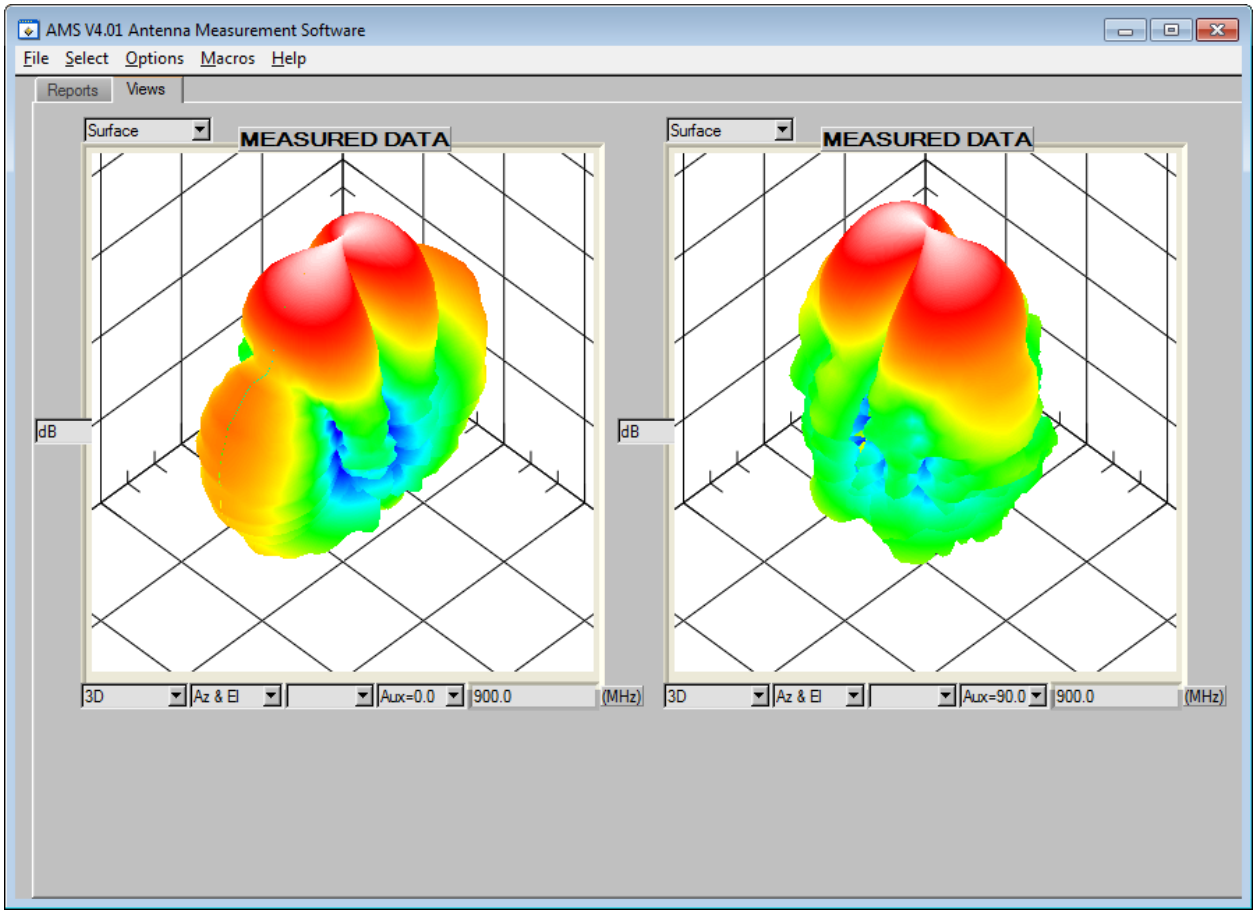
4.10. Graphed Data Views Tab



The Views tab allows the user to view and compare results for different parameters.

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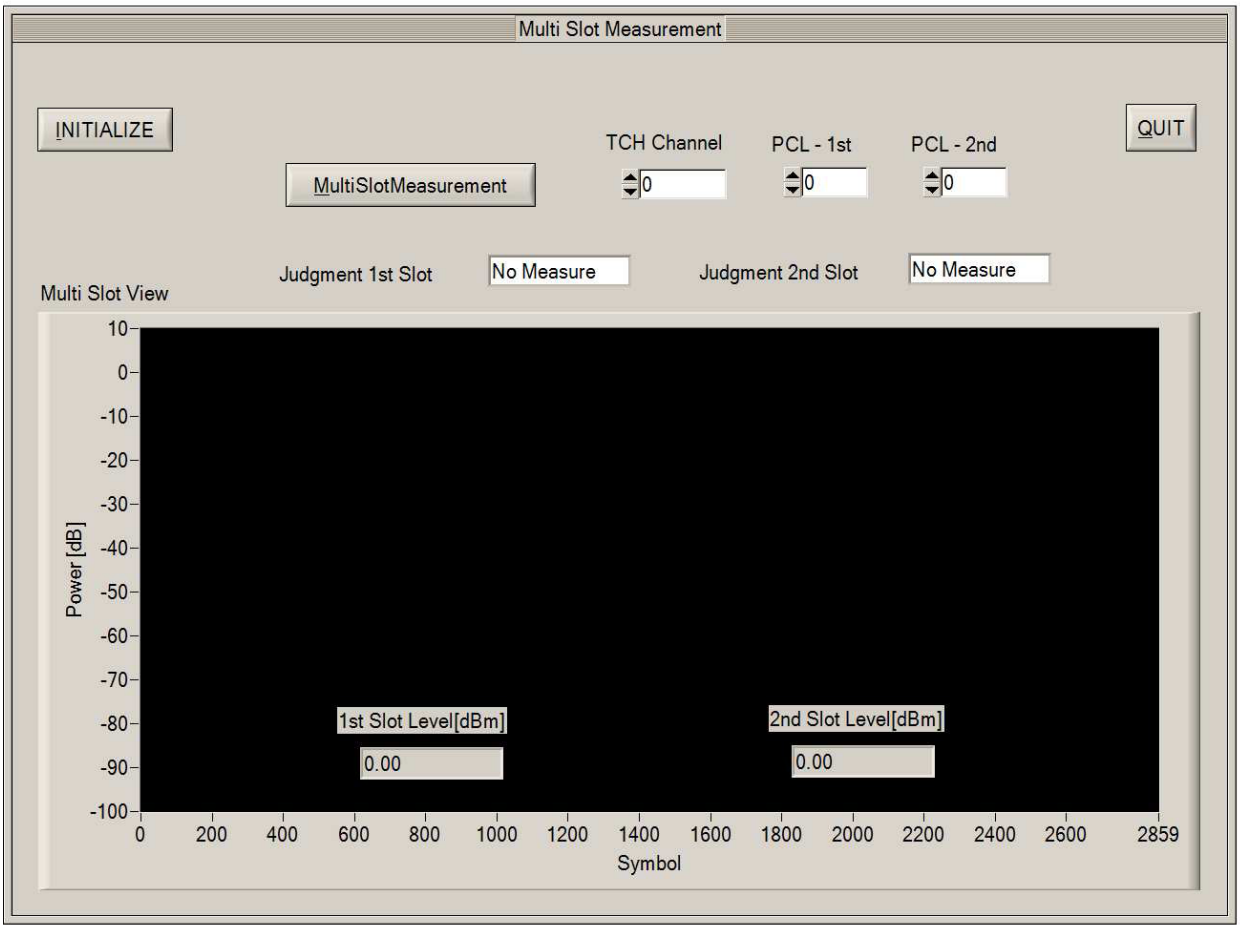
4.11. Communications Unit Driver



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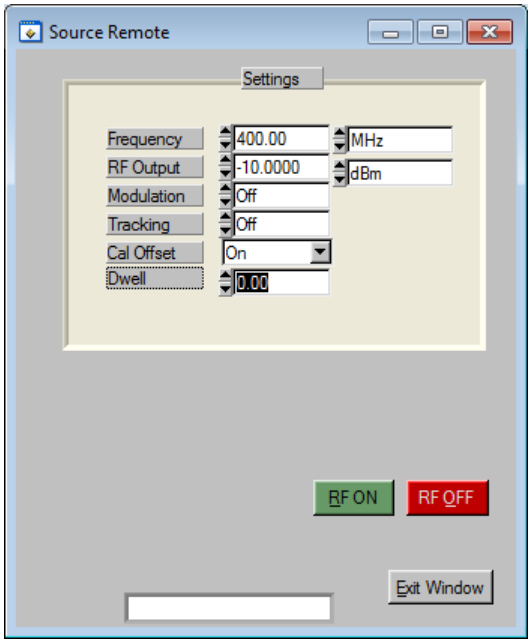
4.12. Source Driver



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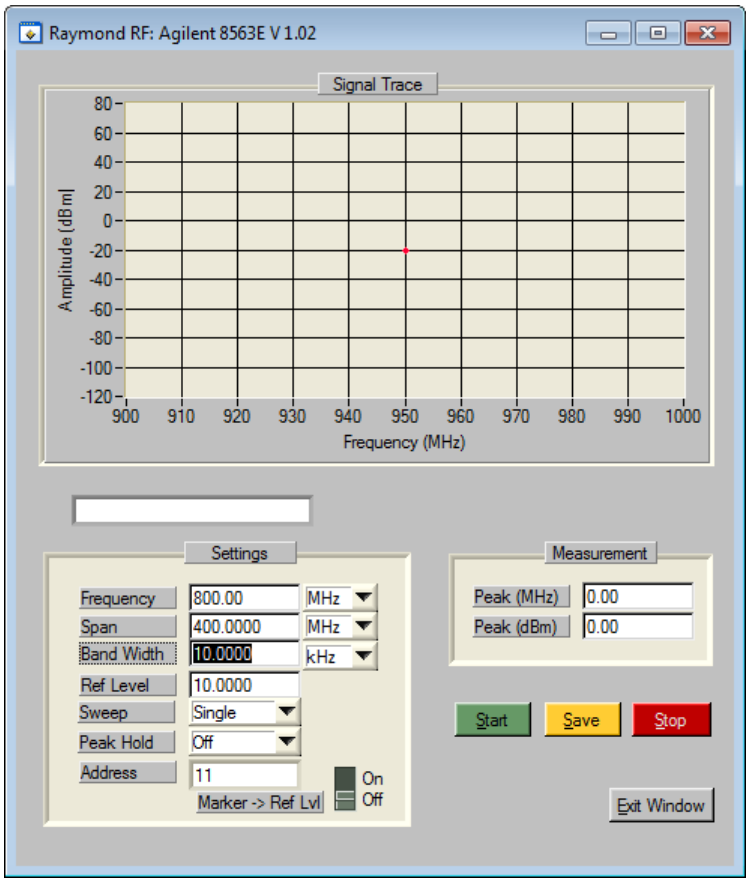
4.13. Receiver Driver



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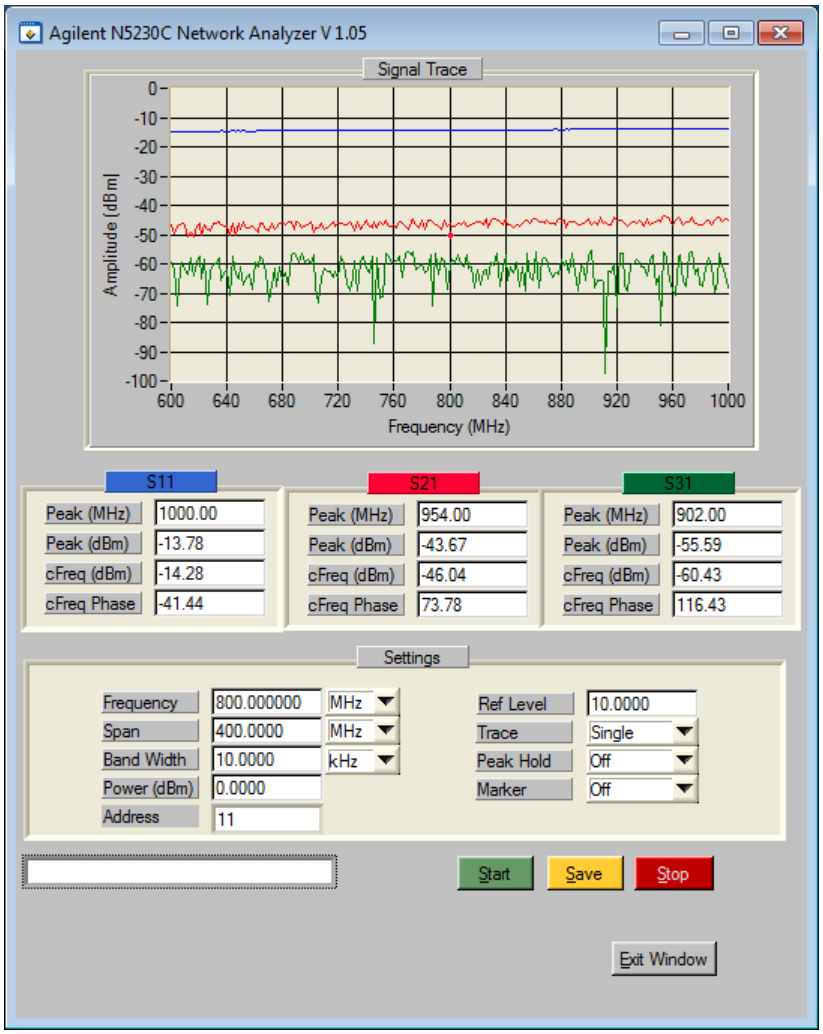
4.14. VNA Driver



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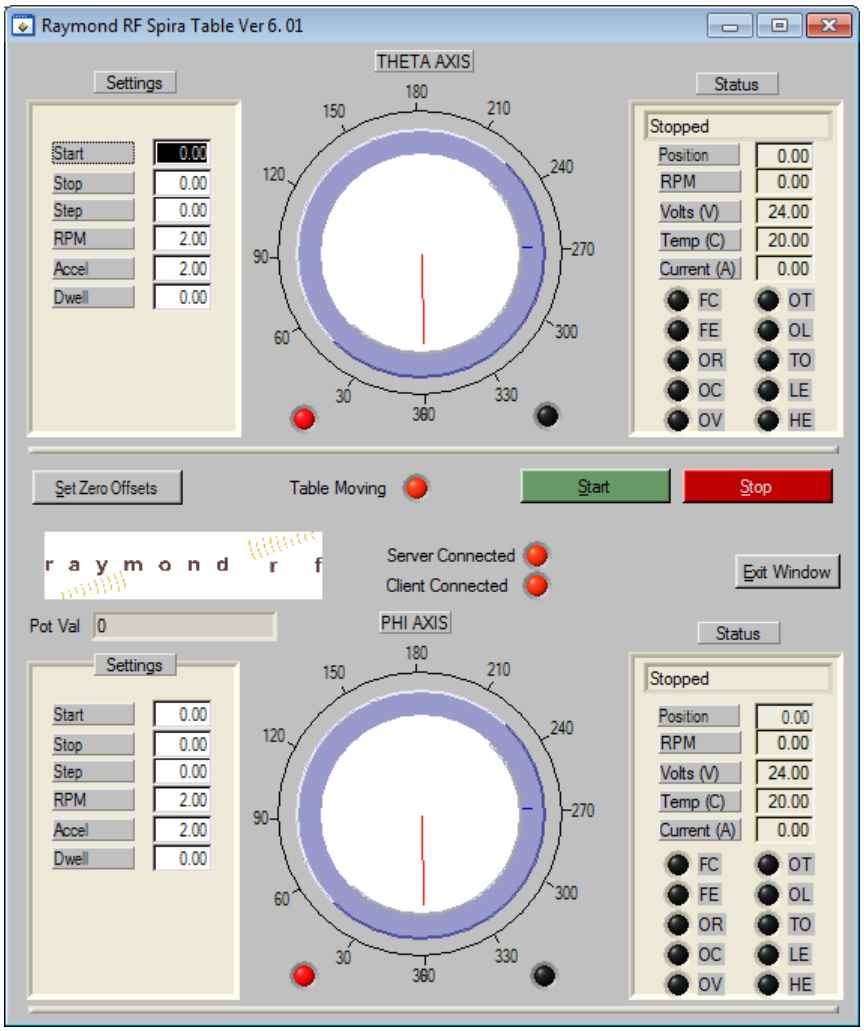
4.15. Positioner Driver



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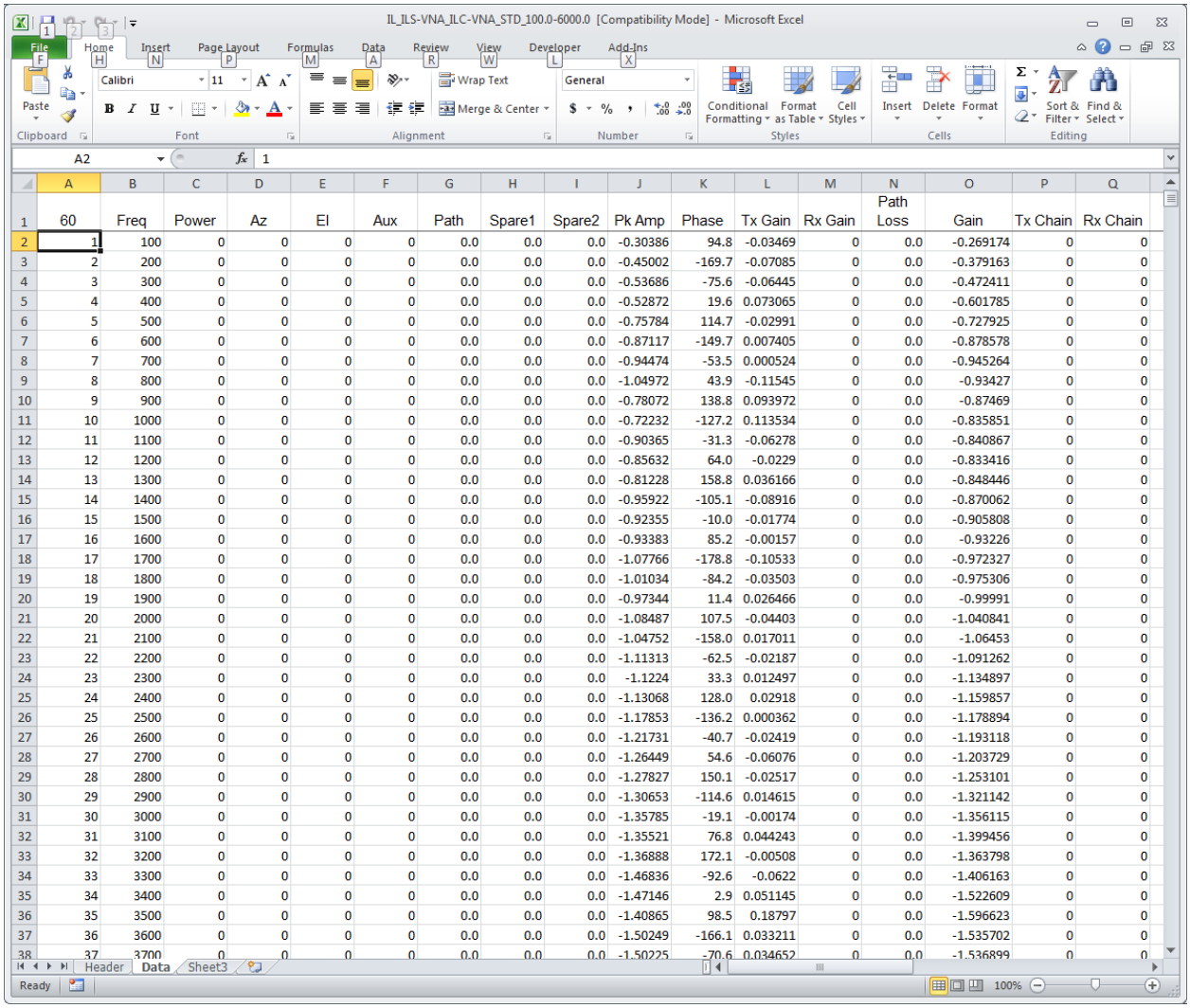
4.16. Excel Measurement Data Table



IL_ILS-VNA_ILC-VNA_STD_100.0-6000.0 [Compatibility Mode] - Microsoft Excel

60	Freq	Power	Az	El	Aux	Path	Spare1	Spare2	Pk Amp	Phase	Tx Gain	Rx Gain	Path Loss	Gain	Tx Chain	Rx Chain
1	100	0	0	0	0	0.0	0.0	0.0	-0.30386	94.8	-0.03469	0	0.0	-0.269174	0	0
2	200	0	0	0	0	0.0	0.0	0.0	-0.45002	-169.7	-0.07085	0	0.0	-0.379163	0	0
3	300	0	0	0	0	0.0	0.0	0.0	-0.53686	-75.6	-0.06445	0	0.0	-0.472411	0	0
4	400	0	0	0	0	0.0	0.0	0.0	-0.52872	19.6	0.073065	0	0.0	-0.601785	0	0
5	500	0	0	0	0	0.0	0.0	0.0	-0.75784	114.7	-0.02991	0	0.0	-0.727925	0	0
6	600	0	0	0	0	0.0	0.0	0.0	-0.87117	-149.7	0.007405	0	0.0	-0.878578	0	0
7	700	0	0	0	0	0.0	0.0	0.0	-0.94474	-53.5	0.000524	0	0.0	-0.945264	0	0
8	800	0	0	0	0	0.0	0.0	0.0	-1.04972	43.9	-0.11545	0	0.0	-0.93427	0	0
9	900	0	0	0	0	0.0	0.0	0.0	-0.78072	138.8	0.093972	0	0.0	-0.87469	0	0
10	1000	0	0	0	0	0.0	0.0	0.0	-0.72232	-127.2	0.113534	0	0.0	-0.835851	0	0
11	1100	0	0	0	0	0.0	0.0	0.0	-0.90365	-31.3	-0.06278	0	0.0	-0.840867	0	0
12	1200	0	0	0	0	0.0	0.0	0.0	-0.85632	64.0	-0.0229	0	0.0	-0.833416	0	0
13	1300	0	0	0	0	0.0	0.0	0.0	-0.81228	158.8	0.036166	0	0.0	-0.848446	0	0
14	1400	0	0	0	0	0.0	0.0	0.0	-0.95922	-105.1	-0.08916	0	0.0	-0.870062	0	0
15	1500	0	0	0	0	0.0	0.0	0.0	-0.92355	-10.0	-0.01774	0	0.0	-0.905808	0	0
16	1600	0	0	0	0	0.0	0.0	0.0	-0.93383	85.2	-0.00157	0	0.0	-0.93226	0	0
17	1700	0	0	0	0	0.0	0.0	0.0	-1.07766	-178.8	-0.10533	0	0.0	-0.972327	0	0
18	1800	0	0	0	0	0.0	0.0	0.0	-1.01034	-84.2	-0.03503	0	0.0	-0.975306	0	0
19	1900	0	0	0	0	0.0	0.0	0.0	-0.97344	11.4	0.026466	0	0.0	-0.99991	0	0
20	2000	0	0	0	0	0.0	0.0	0.0	-1.08487	107.5	-0.04403	0	0.0	-1.040841	0	0
21	2100	0	0	0	0	0.0	0.0	0.0	-1.04752	-158.0	0.017011	0	0.0	-1.06453	0	0
22	2200	0	0	0	0	0.0	0.0	0.0	-1.11313	-62.5	-0.02187	0	0.0	-1.091262	0	0
23	2300	0	0	0	0	0.0	0.0	0.0	-1.1224	33.3	0.012497	0	0.0	-1.134897	0	0
24	2400	0	0	0	0	0.0	0.0	0.0	-1.13068	128.0	0.02918	0	0.0	-1.159857	0	0
25	2500	0	0	0	0	0.0	0.0	0.0	-1.17853	-136.2	0.000362	0	0.0	-1.178894	0	0
26	2600	0	0	0	0	0.0	0.0	0.0	-1.21731	-40.7	-0.02419	0	0.0	-1.193118	0	0
27	2700	0	0	0	0	0.0	0.0	0.0	-1.26449	54.6	-0.06076	0	0.0	-1.203729	0	0
28	2800	0	0	0	0	0.0	0.0	0.0	-1.27827	150.1	-0.02517	0	0.0	-1.253101	0	0
29	2900	0	0	0	0	0.0	0.0	0.0	-1.30653	-114.6	0.014615	0	0.0	-1.321142	0	0
30	3000	0	0	0	0	0.0	0.0	0.0	-1.35785	-19.1	-0.00174	0	0.0	-1.356115	0	0
31	3100	0	0	0	0	0.0	0.0	0.0	-1.35521	76.8	0.044243	0	0.0	-1.399456	0	0
32	3200	0	0	0	0	0.0	0.0	0.0	-1.36888	172.1	-0.00508	0	0.0	-1.363798	0	0
33	3300	0	0	0	0	0.0	0.0	0.0	-1.46836	-92.6	-0.0622	0	0.0	-1.406163	0	0
34	3400	0	0	0	0	0.0	0.0	0.0	-1.47146	2.9	0.051145	0	0.0	-1.522609	0	0
35	3500	0	0	0	0	0.0	0.0	0.0	-1.40865	98.5	0.18797	0	0.0	-1.596623	0	0
36	3600	0	0	0	0	0.0	0.0	0.0	-1.50249	-166.1	0.033211	0	0.0	-1.535702	0	0
37	3700	0	0	0	0	0.0	0.0	0.0	-1.50225	-70.6	0.034652	0	0.0	-1.536899	0	0

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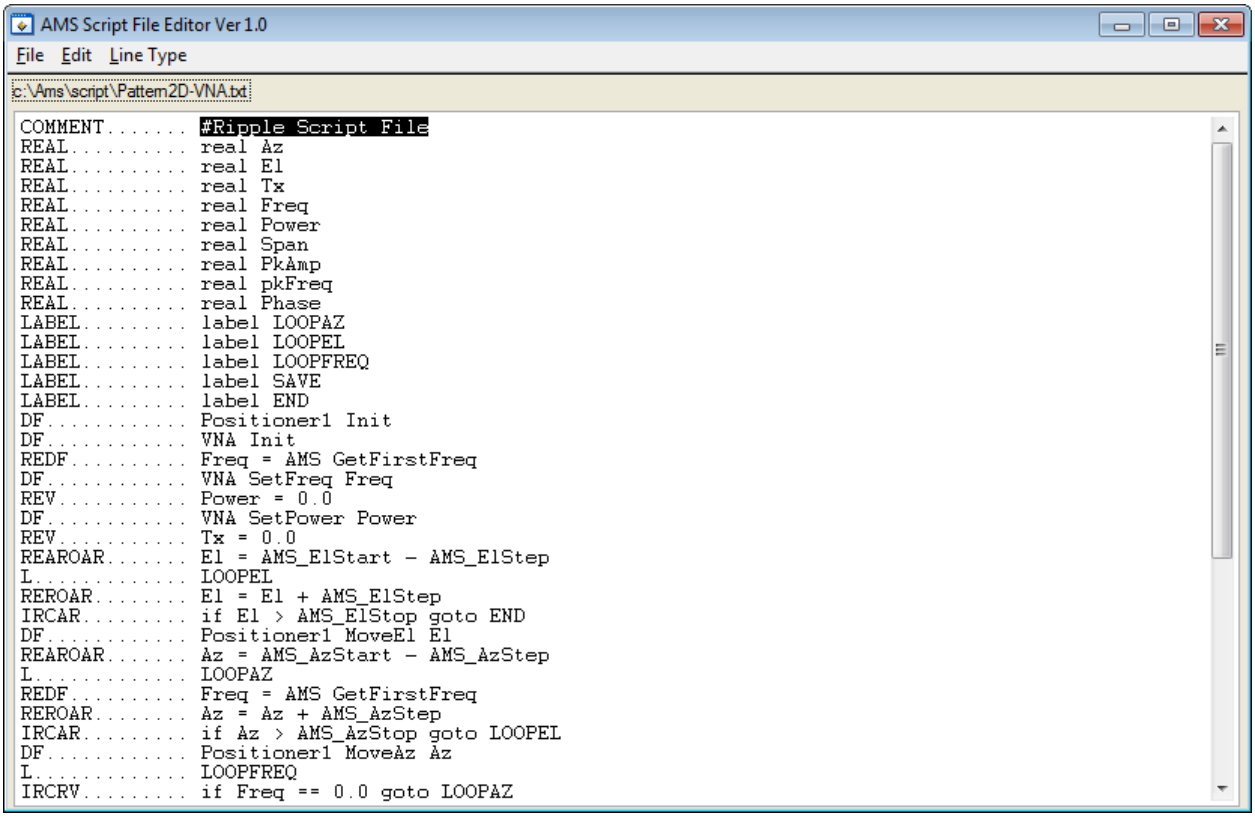
4.17. Script Code

AMS uses a customizable proprietary script code, which is provided for all standard measurements. Raymond RF can also provide custom script code, if required. Instructions for developing custom script code are provided for users wishing to develop their own custom script code.

Please note that all parameters are separated with a space and not commas, as the spaces are used for tokens when parsing.

Script code can be created or edited with any text editor such as MS NotePad or with the included Script editor, which also includes error checking.



4.17.1. Sample Script Code for “RippleTest.txt”

#Ripple Script File
real Az
real El
real Tx
real Freq

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```
real Power
real Span
real PkAmp
real pkFreq
real Phase
label LOOPAZ
label LOOPEL
label LOOPFREQ
label SAVE
label END
Phase = 0.0
Positioner1 Init
Switch1 Init
Source Init
Freq = AMS GetFirstFreq
Source SetFreq Freq
Power = 0.0
Source SetPower Power
Receiver Init
Switch1 A
Tx = 0.0
El = AMS_ElStart - AMS_ElStep
LOOPEL
El = El + AMS_ElStep
if El > AMS_ElStop goto END
Positioner1 MoveEl El
Az = AMS_AzStart - AMS_AzStep
LOOPAZ
Freq = AMS GetFirstFreq
Az = Az + AMS_AzStep
if Az > AMS_AzStop goto LOOPEL
Positioner1 MoveAz Az
LOOPFREQ
if Freq == 0.0 goto LOOPAZ
Source SetFreq Freq
Receiver SetFreq Freq
Span = Freq * 0.1
Receiver SetSpan Span
Switch1 A
Tx = 0
Receiver Sweep
PkAmp = Receiver GetPeakAmp
```

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```
pkFreq = Receiver GetPeakFreq
SaveData Freq Power Az El Tx PkAmp Phase
Switch1 B
Tx = 90
Receiver Sweep
PkAmp = Receiver GetPeakAmp
pkFreq = Receiver GetPeakFreq
SaveData Freq Power Az El Tx PkAmp Phase
Freq = AMS GetNextFreq
goto LOOPFREQ
END
El = AMS_ElStart
Az = AMS_AzStart
Positioner1 MoveAz Az
Positioner1 MoveEl El
Popup "Test Complete"
```

4.17.2. Script Text Files

Script code files are located in the directory C:\AMS\Script\. Script code files may have a maximum of 199 lines. Nomenclature:

- “real” refers to a declared variable with double precision
- “int” refers to a declared integer
- “AMS_real” refers to any of pre declared AMS real variables listed below
- “AMS_int” refers to any of pre declared AMS integer variables listed below
- “real value” refers to any real number

4.17.3. Comments

Script code lines starting with # are comments and are ignored

4.17.4. Declarable Variables

Variables can be declared as real or int. Variables must be declared at the beginning of the script. A variable name must not duplicate an AMS variable, as described below.

4.17.5. Labels

Labels are used for “goto” and “if goto” Statements

4.17.6. Device functions

Device functions are used to control and communicate with the device drivers. Control Device functions have the format of “Device Par1 Par2 Par3…”.

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Communication device functions retrieve data from the device, and have the format of “real = Device Par1 Par Par3 …”.

Positioner 1 and 3 Device Functions: (Positioner2 is the second axes of Positioner1)

- Positioner1 Init
- Positioner1 MoveAz real (where real is between 0.0 and 360.0)
- Positioner1 MoveEl real (where real is between 0.0 and 360.0)
- Positioner1 Stop

Source

- Source Init
- Source SetFreq real (AMS_Freq is updated to real MHz value)
- Source SetPower real (AMS_Power is updated to real dBm value)

Receiver

- Receiver Init
- Receiver SetFreq real (AMS_Freq is updated to real MHz value)
- Receiver SetSpan real (AMS_Span is updated to real MHz value)
- Receiver SetBandWidth real (AMS_BandWidth is updated to real MHz value)
- Receiver SetPeakHold real (AMS_PeakHold is updated to int value, 0 = off, 1= on)
- Receiver Sweep
- Receiver SaveTrace (Saves trace to C:\AMS\Data\Trace.csv, see PlotTrace below)
- real = Receiver GetPeakFreq
- real = Receiver GetPeakAmp

VNA

- VNA Init
- VNA SetFreq real (AMS_Freq is updated to real MHz value)
- VNA SetPower real (AMS_Power is updated to real dBm value)
- VNA SetSpan real (AMS_Span is updated to real MHz value)
- VNA SetBandWidth real (AMS_BandWidth is updated to real MHz value)
- VNA SetPeakHold real (AMS_PeakHold is updated to int value, 0 = off, 1= on)
- VNA Sweep
- VNA SaveTraceS11 (Saves trace to C:\AMS\Data\Trace.csv, see PlotTrace below)
- real = VNA GetPeakFreqS11
- real = VNA GetPeakAmpS11

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- real = VNA GetCFreqAmpS11
- real = VNA GetCPhaseS11
- VNA SaveTraceS21 (Saves trace to C:\AMS\Data\Trace.csv, see PlotTrace below)
- real = VNA GetPeakFreqS21
- real = VNA GetPeakAmpS21
- real = VNA GetCFreqAmpS21
- real = VNA GetCPhaseS21
- VNA SaveTraceS31 (Saves trace to C:\AMS\Data\Trace.csv, see PlotTrace below)
- real = VNA GetPeakFreqS31
- real = VNA GetPeakAmpS31
- real = VNA GetCFreqAmpS31
- real = VNA GetCPhaseS31
- VNA SaveTraceS12 (Saves trace to C:\AMS\Data\Trace.csv, see PlotTrace below)
- real = VNA GetPeakFreqS12
- real = VNA GetPeakAmpS12
- real = VNA GetCFreqAmpS12
- real = VNA GetCPhaseS12
- VNA SaveTraceS13 (Saves trace to C:\AMS\Data\Trace.csv, see PlotTrace below)
- real = VNA GetPeakFreqS13
- real = VNA GetPeakAmpS13
- real = VNA GetCFreqAmpS13
- real = VNA GetCPhaseS13

Comms

- Comms String
- real = Comms String
- int = Comms String
- String varies as required with a maximum of 9 words. Spaces are treated as tokens to parse the string. Each word may be a maximum of 24 characters.

Amplifier1

- Amplifier1 Init
- Amplifier1 SetGain real (AMS_Amp1_Gain is updated to real dBm value)
- Real = Amplifier1 GetGain

Amplifier2

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- Amplifier2 Init
- Amplifier2 SetGain real (AMS_Amp2_Gain is updated to real dBm value)
- Real = Amplifier2 GetGain

Attenuator1

- Attenuator1 Init
- Attenuator1 SetGain real (AMS_Att1_Gain is updated to real dBm value)
- Real = Attenuator1 GetGain

Attenuator2

- Attenuator2 Init
- Attenuator2 SetGain real (AMS_Att2_Gain is updated to real dBm value)
- Real = Attenuator2 GetGain

Switch1

- Switch1 Init
- Switch1 A (AMS_Switch1 is updated to 1, used for calculating chain number)
- Switch1 B (AMS_Switch1 is updated to 2, used for calculating chain number)
- Switch1 C (AMS_Switch1 is updated to 3, used for calculating chain number)

Switch2

- Switch2 Init
- Switch2 A (AMS_Switch2 is updated to 1, used for calculating chain number)
- Switch2 B (AMS_Switch2 is updated to 2, used for calculating chain number)
- Switch2 C (AMS_Switch2 is updated to 3, used for calculating chain number)

Switch3

- Switch3 Init
- Switch3 A (AMS_Switch3 is updated to 1, used for calculating chain number)
- Switch3 B (AMS_Switch3 is updated to 2, used for calculating chain number)
- Switch3 C (AMS_Switch3 is updated to 3, used for calculating chain number)

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AMS

- real = AMS GetFirstFreq (this is the first frequency from the frequency list)
- real = AMS GetNextFreq

4.17.7. Predefined AMS_reals

AMS reals are initialized from the Test Setup Tab at the start of the script. They can only be referenced and not changed during script execution.

- AMS_AzStart
- AMS_AzStop
- AMS_AzStep
- AMS_AzRPM
- AMS_AzAcc
- AMS_AzDwell
- AMS_ElStart
- AMS_ElStop
- AMS_ElStep
- AMS_ElRPM
- AMS_ElAcc
- AMS_ElDwell
- AMS_AxStart
- AMS_AxStop
- AMS_AxStep
- AMS_AxRPM
- AMS_AxAcc
- AMS_AxDwell
- AMS_FreqStart
- AMS_FreqStop
- AMS_FreqStep
- AMS_GrossPowerStep
- AMS_FinePowerStep
- AMS_MaxBER
- AMS_MaxPower
- AMS_Phase

4.17.8. Process Operators (po)

- "=" Equals
- "+" Plus
- "-" Minus
- "/" Divide by
- "*" Multiply
- Allowable uses of Operators

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- real = real value
- real = real
- real = AMS_real
- real = real op real value, i.e Span = Freq * 0.001
- real = real op real, i.e. Span = Freq + Step
- real = real op AMS_real
- real = AMS_real op AMS_real
- Int = int value
- int = int
- int = AMS_int
- int = int op int value, i.e Index = Index + 1
- int = int op int, i.e. Span = Freq + Step
- int = int op AMS_int
- int = AMS_int op AMS_int

4.17.9. Process Comparators (pc)

- "==" Equals
- "<=" Less than or equal to
- ">=" Greater than or equal to
- "!=" Not equal to
- "<" Less than
- ">" Greater than

4.17.10. If goto

- if real pc real goto lable
- if int pc int goto lable
- if real pc AMS_real goto lable
- if int pc AMS_int goto lable
- if real pc real value goto lable
- if int pc int value goto lable

4.17.11. goto

- goto lable

4.17.12. SaveData

SaveData is used to store measured data into the Excel Data Sheet

- SaveData freq power Az El Aux PkAmp Phase Spare1 Spare2
- All parameters are real
- Spare1 and Spare2 are optional

4.17.13. PlotTrace

PlotTrace is used to save the trace data into the Excel Data Sheet

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- There are no parameters required

4.17.14. Popup

- Popup Any message up to 9 words. Spaces are treated as tokens to parse the string. Each word may be a maximum of 24 characters.

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5. Coordinate System

The coordinate system is as described by the CTIA Test Plan for the "Great Circle"

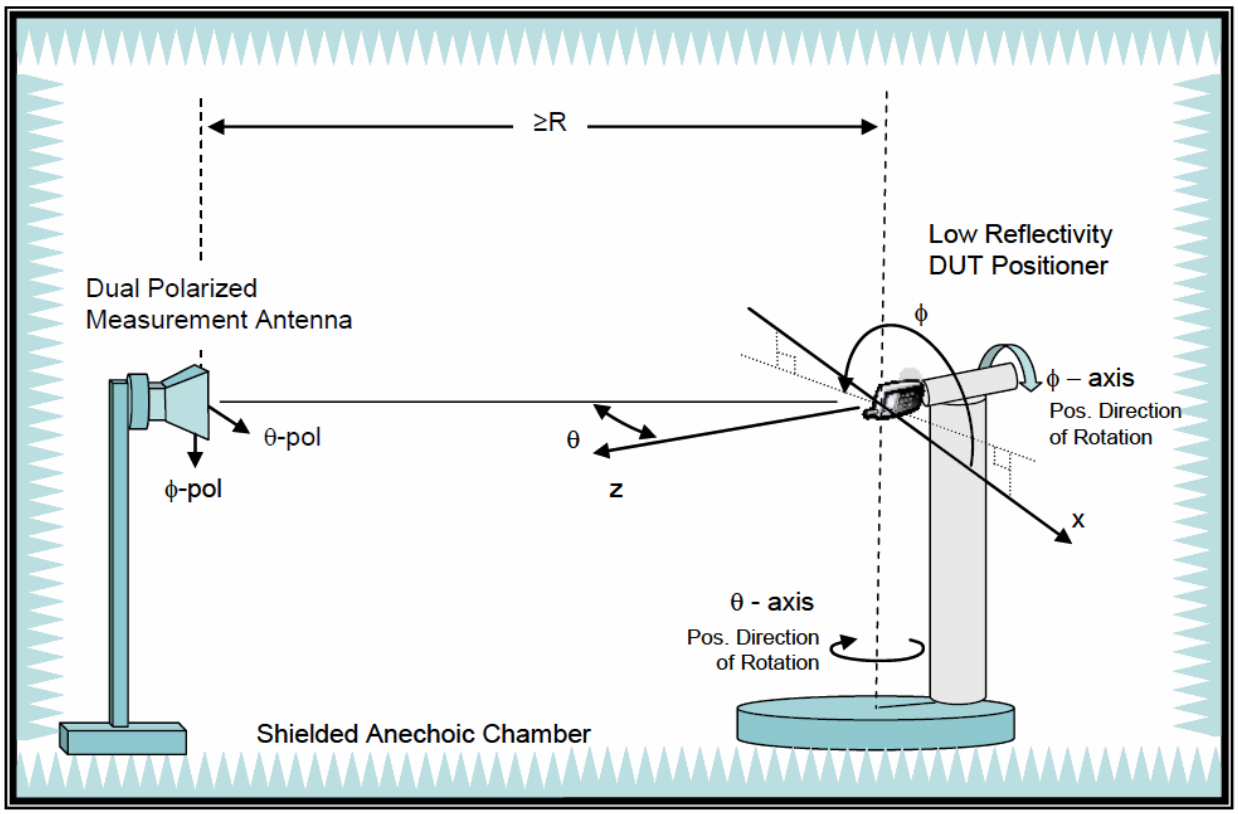

Figure 5-1 Great Circle Setup

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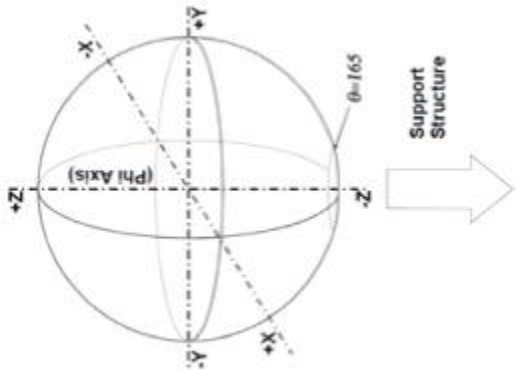

Figure 5-2 Coordinate System

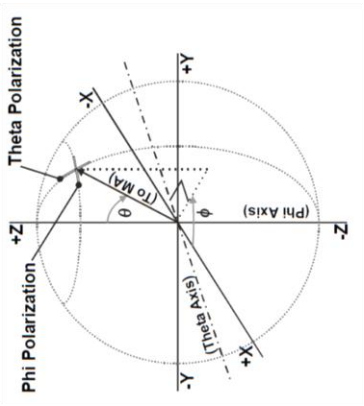

Figure 5-3 Great Circle Coordinates

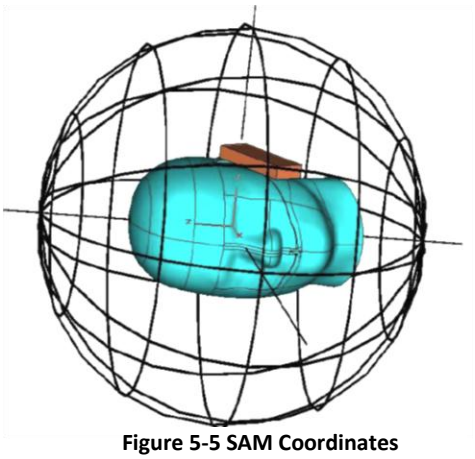

Figure 5-5 SAM Coordinates

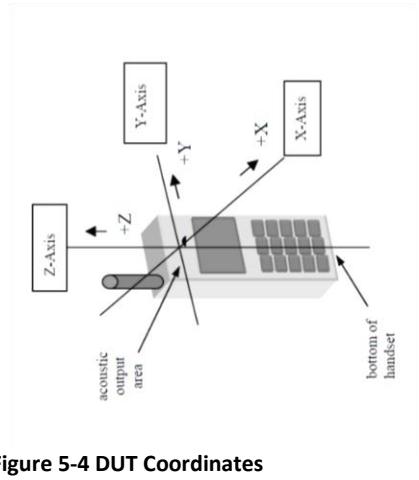

Figure 5-4 DUT Coordinates

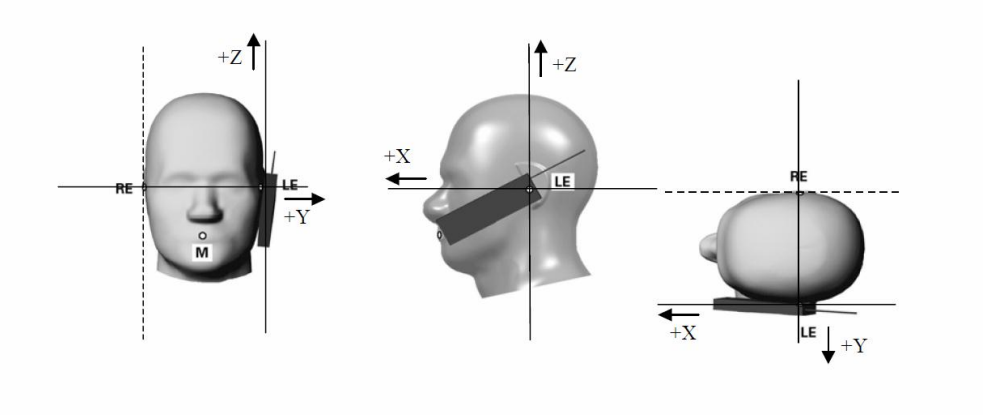

Figure 5-6 DUT / SAM Coordinates

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6. System Calibration

The AVS system relies on the Receiver (Power Meter / Network Analyzer / Spectrum Analyzer) and the measurement antenna being in calibration. Once the entire system is calibrated, routine calibration checks can be performed utilizing a reference antenna such as a standard gain horn or sleeve dipole as may be required.

The Dual Polarized Measurement Antenna was installed with the system and is called "AVS700-H" and “AVS700-V”. The calibrated gain values for this antenna were entered at Raymond RF. This antenna should be calibrated bi-annually to ensure system accuracy. Instructions for entering calibration data for the Measurement Antenna are included in section 6.4 below.

All of the cables which were shipped with the AVS System were calibrated at Raymond RF. However the user can recalibrate the cables, or add new cables as described in section 6.1 below.

Accuracy of the system was validated by Raymond RF utilizing the Ripple Test Method. The entire system was validated by Raymond RF using a calibrated reference antenna to establish the Range Reference. However the user can validate the system as described in section 6.6 below.

The complete validation process is:

1. Calibration of Cables and Source
2. Enter Measurement Antenna Gain (dBi)
3. Reference Antenna Symmetry Test
4. Range Reference
5. Ripple Test
6. Optional for CTIA type measurements: Calculation of Uncertainties, refer to CTIA test procedures.

6.1. Cable and Source Calibration with a SA or PM

The Receiver (Power Meter / Spectrum Analyzer) must be in calibration to proceed. The following instructions are for a calibration range of 100MHz (start) to 20000MHz (stop) in 100MHz steps. The start, stop and step frequencies can be change to match the SG and SA ranges. Remove all of the cables from the AVS system. Ensure that cables are labeled Cable-001, Cable-002, … Cable-xxx .

Step 1 Measure combined Gain of SG and Cable-001

1. Install Cable 001 between SG and SA
2. Run AMS

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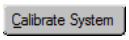
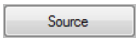
3. From the Introduction Panel, Select "Calibrate System" 

4. Select Devices Tab
5. Select "Positioner" 

6. Select Positioner "Spira-455-3D" or "Spira-455" (for 2D system) from list
7. Edit information as required:
    a. Positioner Name: Spira-455-3D or Spira-455
    b. Type: 2-Axis Az & El or 1-Axis Az
    c. Model: Spira-455-3D or Spira-455
    d. Serial Number: xxxx
    e. Calibration Date: DD-MMM-YYYY
    f. Device Driver: Select the Device Driver Button  to select the appropriate driver for the positioner.
    g. Port Type: TCP/IP
    h. Port Address: 10000
    i. Port Rate: 100
    j. Maximum RPM: 6
    k. Minimum RPM 0.1
    l. Maximum Acc: 2
    m. Minimum Acc: 1
    n. Resolution (deg): 0.01
    o. Maximum Temp (C): 48
    p. Maximum Amperage: 6
8. Select the Equipment Tab
9. Select "Source" 

10. Select the source from the list. If the appropriate source does not exist, ensure that the appropriate driver was installed as per section 3 above. Then select “New” and name it with the model name, such as “E8247C-Uncal”.
11. Edit the Source info:
    a. Manufacturer: i.e. “Agilent”
    b. Type: Select “Signal Generator” from the list
    c. Model as required
    d. Serial Number as required
    e. VERY IMPORTANT! Set Calibration File Name to "NULL", without the “”, type over any exiting information.
    f. Select the Device Driver Button  to navigate and select the appropriate driver for the equipment

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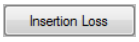
g. Port Type: Select as “GPIB”
h. Port / Address: Typically 19 for an SG, edit as required.
i. Port Rate: 100
j. Min Freq. (MHz): as per SG specs
k. Max Freq. (MHz): as per SG specs
l. Min Power (dBm): as per SG specs
m. Max Power (dBm): as per SG specs

12. Select "Receiver" if using a Spectrum Analyzer, 

13. Select the Spectrum Analyzer from the list. If the appropriate SA does not exist, ensure that the appropriate driver was installed as per section 3 above. Then select “New” and name it with the model name, such as “8563EC”.
14. Edit the Source info:
    a. Manufacturer: i.e. “Agilent”
    b. Type: Select “Spectrum Analyzer” from the list
    c. Model as required
    d. Serial Number as required
    e. VERY IMPORTANT! Set Calibration File Name to "NULL", without the quotation marks
    f. Select the Device Driver Button  to navigate and select the appropriate driver for the equipment
    g. Port Type: Select as “GPIB”
    h. Port / Address: Typically 11 for an SA, edit as required.
    i. Port Rate: 100
    j. Min Freq. (MHz): as per SA specs
    k. Max Freq. (MHz): as per SA specs
    l. Min Power (dBm): as per SA specs
    m. Max Power (dBm): as per SA specs
15. Select "Equipment Setups" Tab
16. Select Test Type Setup: "Insertion Loss" 

17. Select "ILC-Cal1", from Insertion Loss Chains List
18. Enter “NULL” in Azimuth, Elevation and Auxiliary Device fields
19. Select New Tx Chain Item,  The Select Window will popup

20. Select Source from the Select Popup Window
21. Select the SG-Uncal from the list
22. Exit popup Window
23. Ensure that the SG-Uncal is the only item on the chain list, delete any other items.
24. Save Tx Chain 

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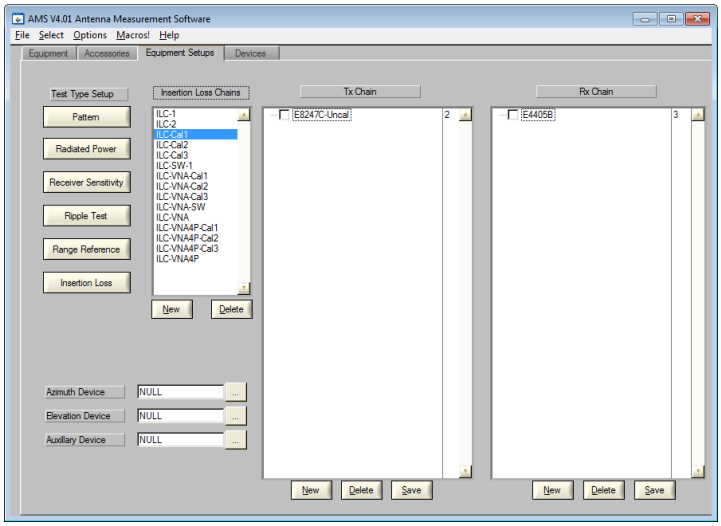
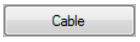
25. Select New Rx Chain Item, The Select Window will popup
26. Select the SA / Receiver from the Select Popup Window
27. Ensure that the SA / Receiver is the only item on the chain list, delete any other items.
28. Select the SA from the list
29. Exit popup Window
30. Save Rx Chain, The Panel should be as follows



31. Select Equipment Tab
32. Select Source
33. Select the SG-Uncal from the sources
34. VERY IMPORTANT! If not already completed in step 14.e above, Delete any text in the Calibration File field and enter "NULL" (without the quotation “” marks).
35. From Main Menu Bar, Select > Measure
36. Select Test Parameters Tab
37. Select Test Type: "Insertion Loss"
38. Select "ILS-Cal1", from the Insertion Loss Setups List
39. Set the Start, Stop and Step as 700, 10000 and 100 and select MHz. Ensure that all values are within the test equipment range.
40. Select the DUT Tab
41. Select "Cable" Equipment Type 

42. Select "Cable-001-Cal1"
43. Edit Information as required
44. Select Data File Directory "...", in popup window, navigate to "Cable-001-Cal1", select “Done” . Ensure that the directory "Cable-001" was not selected, as it will be utilized further

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on. Enter the same frequency values as per the Start and Stop, above. Enter min / max power values as per the SA / Receiver range.

45. Select Measurement Tab
46. Enter Date "DD-MMM_YYYY"
47. Enter Operator
48. Select Measurement Type: "Insertion Loss"
49. Select Setup "ILS-Cal1"
50. Select Parameters "STD"
51. Select Frequency "700-10000 MHz", are as per the appropriate range above.
52. If the Display Excel Button is “On”, Excel will open up in the back ground.
53. NOTE: AMS controls Excel through ActiveX calls; Never make changes to the excel file while measurements are being taken as the data and the file will most likely be corrupted
54. From Main Menu Bar, Select File, Save, select ILS-Cal1, OK, Yes Overwrite
55. Select the yellow "Source".. Source driver will open and the button will turn to green. Note that any Equipment driver may be hidden by either selecting "Exit Window" on the driver, or by selecting the associated green driver button on the AMS Measurement tab and then selecting "Hide". To view the driver again, select the green driver button and then select "Hide".
56. Select "Receiver".. Receiver driver will open and the button will turn to green
57. Select the AMS Application
58. Select "Start" to start measurement, if prompted to repeat measurement, select “Yes”.
59. Popup will appear once the measurement is complete
60. Results are graphed
61. Select Green "Source" button, Select "Close", SG driver will close
62. Select Green "Receiver" button, Select "Close", SA driver will close

Step2 Measure combined gain of SG, Cable-001 and Cable-002. The Gain from Step 1 will be subtracted from this and the result will be the Gain / Insertion loss of Cable-002.

63. Install Cable-002 between Cable-001 and SA, so it is: SG, Cable-001, Connector, Cable-002 and then SA
64. From the Main Menu Bar, select "Setups"
65. Select "Equipment Setups" Tab
66. Select Test Type Setup: "Insertion Loss"
67. Select "ILC-Cal2", from Insertion Loss Chains List
68. If there is no SG in the Tx Chain"
    a. Select New Tx Chain Item, The Select Window will popup

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b. Select Source from the Select Popup Window
c. Select the SG-Uncal from the list
d. Exit popup Window
e. Delete any other entries. The SG-Uncal must be the first and only entry in the Tx Chain.
f. Save Tx Chain

69. If there is no SA or Cable in the Rx Chain
    a. Select New Rx Chain Item, The Select Window will popup
    b. Select "Cables" from the Select Popup Window
    c. Select the Cable-001-Uncal from the list
    d. Select "Receivers" from the Select Popup Window
    e. Select the SA from the list
    f. Exit popup Window
    g. Delete any other entries. The SA should be the first entry and the Cable-001-Uncal should be the second entry in the Rx Chain. Entries can be dragged into position as required.
    h. Delete any other entries in the Rx Chain
    i. Save Rx Chain
70. Select "Accessories" Tab
71. Select Accessory Type "Cable"
72. Select Cable-001-Uncal from the Accessory Cables
73. Edit information as required
74. Select Calibration file "...", navigate to directory: "Cable-001-Cal1" and select file ie.: "IL_ILS-Cal1_ILC-Cal1_STD_700.0-10000.0". This is the calibration file from the previous test. Ensure the file with the appropriate range from above is selected.
75. From Main Menu Bar, Select > Measure
76. Select Test Parameters Tab
77. Select Test Type: "Insertion Loss"
78. Select "ILS-Cal2", from the Insertion Loss Setups List
79. Set the Start, Stop and Step values as per the ILS-Cal1 above, ie.: 700, 10000 and 100 and select MHz.
80. Select the DUT Tab
81. Select "Cable" Equipment Type
82. Select "Cable-002-Cal2"
83. Edit Information as required
84. Select Data File Directory "...", in popup window, navigate to "Cable-002-Cal2", select done. Ensure that directory "Cable-002" was not selected, as it will be utilized further on.

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85. Select Measurement Tab
86. Select Measurement Type: "Insertion Loss"
87. Select Setup "ILS-Cal2"
88. Select Parameters "STD"
89. Select Frequency "700-10000 MHz"
90. From Main Menu Bar, Select File, Save, select ILS-Cal2, OK, Yes Overwrite
91. Select the yellow "Source" button .. Source driver will open and the button will turn green
92. Select the AMS application
93. Select the yellow "Receiver" button .. Receiver driver will open and the button will turn green
94. Select the AMS application
95. Select "Start" to start measurement
96. Popup will appear once the measurement is complete
97. Results are graphed
98. Select "Source", Select "Close", Source driver will close and the button will turn yellow
99. Select "Receiver", Select "Close" .. Receiver driver will close and the button will turn yellow
100. The actual insertion loss of Cable-002 is now known, (with the exception of the connector)

Step 3 Measure Actual SG Output / Gain

101. Remove Cable-001 and Install Cable-002 between the SG and SA, so it is: SG, Cable-002, SA
102. From the Main Menu Bar, select "Setups"
103. Select "Accessories" Tab
104. Select Accessory Type "Cable"
105. Select Cable-002-Cal2 from the Accessory Cables
106. Edit information as required
107. Select Calibration file "...", navigate to directory: "Cable-002-Cal2" and select file ie.: "IL_ILS-Cal2_ILC-Cal2_STD_700.0-10000.0". This is the Calibration file from the previous test. Ensure that directory "Cable-002" was not selected.
108. Select "Equipment Setups" Tab
109. Select Test Type Setup: "Insertion Loss"
110. Select "IL-Cal3", from Insertion Loss Chains List
111. If there is no SG in the Tx Chain
    a. Select New Tx Chain Item, The Select Window will popup
    b. Select Source from the Select Popup Window
    c. Select the SG-Uncal from the list

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d. Exit popup Window
e. Delete any other entries. The SG-Uncal must be the first and only entry in the Tx Chain.
f. Save Tx Chain

112. If there is no SA or cable in the Rx Chain
    a. Select New Rx Chain Item, The Select Window will popup
    b. Select "Cables" from the Select Popup Window
    c. Select the Cable-002-Cal2 from the list
    d. Select "Receiver" from the Select Popup Window
    e. Select the SA from the list
    f. Exit popup Window
    g. The SA should be the first entry and Cable-002-Cal2 should be the second entry. Entries can be dragged into position as required. Delete any other entries.
    h. Save Rx Chain
113. From Main Menu Bar, Select > Measure
114. Select Test Parameters Tab
115. Select Test Type: "Insertion Loss"
116. Select "ILS-Cal3", from the Insertion Loss Setups List
117. Set the Start, Stop and Step, as per the ILS-Cal2 above, ie.: 700, 10000 and 100 and select MHz
118. Select the DUT Tab
119. Select "Passive Dev" Equipment Type
120. Select Signal Generator, i.e. "E8247C"
121. Edit Information as required
122. Select Data File Directory "...", in popup window, navigate to "E8247C", select done
123. Select Measurement Tab
124. Select Measurement Type: "Insertion Loss"
125. Select Setup "ILS-Cal3"
126. Select Parameters "STD"
127. Select Frequency ie. "700-10000 MHz"
128. From Main Menu Bar, Select File, Save, select ILS-Cal3, OK, Yes Overwrite
129. Select the yellow "Source".. Source driver will open and the button will turn green
130. Select the yellow "Receiver".. Receiver driver will open and the button will turn green
131. Select "Start" to start measurement
132. Popup will appear once the measurement is complete
133. Results are graphed
134. The actual Output of SG is now known

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135. Select green "Source", Select "Close", Source driver will close and the button will turn yellow
136. Select green "Receiver", Select "Close" .. Receiver driver will close and the button will turn yellow
137. From the Main Menu Bar, select "Setups"
138. Select "Equipment" Tab
139. Select Equipment Type "Source"
140. Select the appropriate SG ie. "E8247C" from the Sources. If it does not exist, Select the "E8247C-Uncal", created above, and select "New". Enter the new Name "E8247C".
141. Edit information as required
142. Select Calibration file "...", navigate to directory: "E8247C " and select file ie.: " IL_ILS-Cal3_ILC-Cal3_STD_700.0-10000.0 ". This is the calibration file which was created in the previous test.
143. The SG calibration is now complete

Step 4 Calibrate all Cables

144. From the Main Menu Bar, select "Setups"
145. Select "Equipment Setups" Tab
146. Select Test Type Setup: "Insertion Loss"
147. Select "ILC-1", from Insertion Loss Chains List
148. If there is no "ILC-1" select new chain and name it "ILC-1"
    a. Select New Tx Chain Item, The Select Window will popup
    b. Select Source from the Select Popup Window
    c. Select the SG, i.e. "E8247C" from the list
    d. Exit popup Window
    e. Ensure that the SG is the first and only item in the Tx chain, delete any other items.
    f. Save Tx Chain
    g. Select New Rx Chain Item, The Select Window will popup
    h. Select Receiver from the Select Popup Window
    i. Select the SA from the list
    j. Exit popup Window
    k. Ensure that the SA is the first and only item in the Rx chain, delete any other items.
    l. Save Rx Chain
149. From Main Menu Bar, Select > Measure
150. Select Test Parameters Tab
151. Select Test Type: "Insertion Loss"

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152. Select "ILS-1", from the Insertion Loss Setups List
153. Set the Start, Stop and Step ie. 700, 10000 and 100 and select MHz
154. Select Measurement Tab
155. Select "Source".. Source driver will open
156. Select "Receiver".. Receiver driver will open
157. Repeat the following steps for each cable...
158. Close the Source and Receiver drivers.
159. Select the DUT Tab
160. Select "Cables" Equipment Type
161. Select "Cable-002"
162. Edit Information as required
163. Select Data File Directory "...", in popup window, navigate to "Cable-002", select done
164. Select Measurement Tab
165. Select Measurement Type: "Insertion Loss"
166. Select Setup "ILS_1"
167. Select Parameters "STD"
168. Select Frequency ie.: "700-10000 MHz"
169. From Main Menu Bar, Select Save, select ILS_1
170. Open the Source and Receiver drivers
171. Select "Start" to start measurement
172. Popup will appear once the measurement is complete
173. Results are graphed
174. From the Main Menu Bar, select "Setups"
175. Select "Accessories" Tab
176. Select Accessory Type "Cable"
177. Select Cable-002 from the Accessory Cables
178. Edit information as required
179. Select Calibration file "...", navigate to directory: "Cable-002" and select file: "IL_ILS-1_ILC-1_STD_700.0-10000.0". Enter calibration date DD-MMM-YYYY. Label Cable-002 calibration date DD-MMM-YYYY.
180. Cable-002 is now complete.
181. Compare the files "Cable-002\ IL_ILS-1_ILC-1_STD_100.0-20000.0.txt" and "Cable-002-Cal2\IL_ILS-Cal2_ILC-Cal2_STD_700.0-10000.0.txt" ... Gains should be within 0.1 dB.
182. Remove Cable-002 and Install Cable-001 between the SG and SA, so it is: SG Cable-001 SA
183. Repeat this step for remaining Cables

6.2. Switch Calibration with SA / PM and SG

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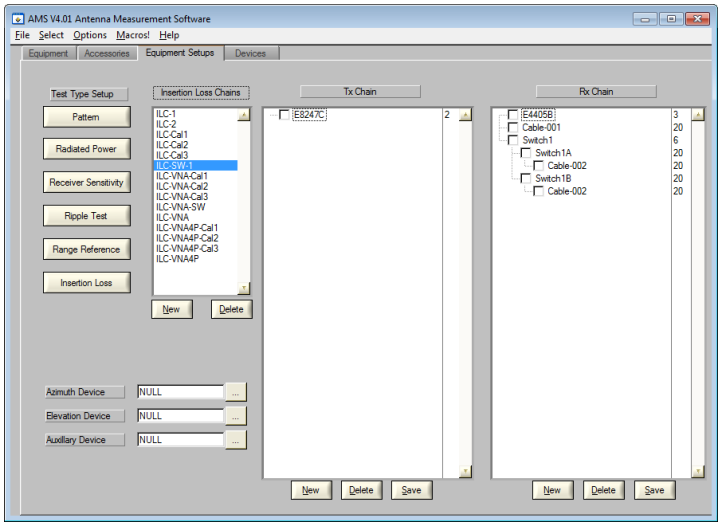
The Receiver (Power Meter / Spectrum Analyzer), the signal generator and all cables must be in calibration as per the previous section to proceed. The following instructions are for a calibration range of 700MHz (start) to 10000MHz (stop) in 100MHz steps. The start, stop and step frequencies can be change to match the SG and SA ranges.

1. Setup as follows: SG > Cable-001 > Switch1(common port) > Switch1(Port A, the NC port) > Cable-002 > SA. Cables_001 and 002 were selected because they are the shortest, however any calibrated cables could be used.
2. From the Main Menu Bar, select "Setups"
3. Select “Accessories” Tab
4. Select “Cables”
5. Select “Switch1A” and ensure that the Calibration file is set to “NULL”
6. Select "Equipment Setups" Tab
7. Select Test Type Setup: "Insertion Loss"
8. Select "ILC-SW-1", from Insertion Loss Chains List
9. If there is no "ILC-SW-1" select new chain and name it "ILC-SW-1". Create the following chain:



10. From Main Menu Bar, Select > Measure
11. Select Test Parameters Tab
12. Select Test Type: "Insertion Loss"
13. Select "ILS-SW-1", from the Insertion Loss Setups List
14. Set the Start, Stop and Step as i.e. 700, 10000 and 100 and select MHz
15. Select Measurement Tab
16. Select "Source".. Source driver will open

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17. Select "Receiver".. Receiver driver will open
18. Repeat the following steps for each Switch and Port...
19. Select the DUT Tab
20. Select "Cables" Equipment Type
21. Select ie. "Switch1A"
22. Edit Information as required
23. Select Data File Directory "...", in popup window, navigate to "Switch1A", select done
24. Select Measurement Tab
25. Select Measurement Type: "Insertion Loss"
26. Select Setup "ILS-SW-1"
27. Select Parameters "STD"
28. Select Frequency i.e. "700-10000 MHz"
29. From Main Menu Bar, Select Save, select ILS-SW-1
30. Select The “Yellow” Switch Button. The driver will open and the Switch Button will change to “Green”
31. On the Switch Driver panel, select the Port which is being calibrated, i.e. “A”
32. Select "Start" to start measurement
33. Popup will inform you to select the appropriate Switch Port under test, Select A, B or C on the Switch driver and then press OK on the Popup window.
34. Popup will appear once the measurement is complete
35. Results are graphed
36. From the Main Menu Bar, select "Setups"
37. Select "Accessories" Tab
38. Select Accessory Type "Cable"
39. Select Switch1A from the Accessory Cables
40. Edit information as required
41. Select Calibration file "...", navigate to directory: "Switch1A" and select file: "IL_ILS_SW_1-ILC-SW-1_STD_700.0-10000.0". Enter calibration date DD-MMM-YYYY. Label Switch Switch1 with calibration date DD-MMM-YYYY.
42. Switch1A is now complete.
    Move Cable-002 from Port A (NC) to Port B (NO) on the RF Switch and repeat the steps from 18 on for Switch1B
43. If your system requires Switch1C Move Cable-002 from Port B to Port C on the RF Switch and repeat the steps from 18 on for Switch1C
44. Repeat the entire section for additional Switch2 and Switch3 if required. Switch 1, 2 and 3 can be interchanged for this calibration process.

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6.3. Cable and Source Calibration with a VNA

The VNA must be in calibration to proceed. The following instructions are for a calibration range of 700MHz (start) to 10000MHz (stop) in 100MHz steps. The start, stop and step frequencies can be change to match the VNA ranges. Remove all cables from the AVS system. Ensure that cables are labeled Cable-001, Cable-002 … Cable-xxx.

Step 1 Measure combined Gain of VNA Port2 and Cable-001

1. Install Cable-001 between Ports 1 and 2 of the VNA
2. Run AMS
3. Select "Calibrate System"
4. In Equipment Tab, Select "VNA"
5. Select VNA from list
6. Edit information as required
7. Set Calibration File Name to "NULL"
8. Select "Equipment Setups" Tab
9. Select Test Type Setup: "Insertion Loss"
10. Select "ILC-VNA-Cal1", from Insertion Loss Chains List
11. Select New Tx Chain Item, The Select Window will popup
12. Select VNA from the Select Popup Window
13. Select the VNA from the list
14. Exit popup Window
15. Save Tx Chain
16. Select New Rx Chain Item, The Select Window will popup
17. Select "Cable" from the Select Popup Window
18. Select the VNA-P2-Uncal from the list. Note that the VNA port number 2 is grouped with the cables for reference purpose only.
19. Exit popup Window
20. Save Rx Chain
21. Select the Accessories Tab
22. Select "Cable"
23. Select "VNA-P2-Uncal" from the Sources
24. Edit information as required
25. VERY IMPORTANT! Delete any text in the Calibration File field and enter "NULL" (without the quotation marks.
26. From Main Menu Bar, Select > Measure
27. Select Test Parameters Tab

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28. Select Test Type: "Insertion Loss"
29. Select "ILS-VNA-Cal1", from the Insertion Loss Setups List
30. Set the Start, Stop and Step as 700, 10000 and 100 and select MHz
31. Select the DUT Tab
32. Select "Cable" Equipment Type
33. Select "Cable-001-Cal1"
34. Edit Information as required
35. Select Data File Directory "...", in popup window, navigate to "Cable-001-Cal1", select done. Ensure that directory "Cable-001" was not selected, as it will be utilized further on.
36. Select Measurement Tab
37. Enter Date "dd-mmm-yyyy"
38. Enter Operator Name or initials for reference
39. Select Measurement Type: "Insertion Loss"
40. Select Setup "ILS-VNA-Cal1"
41. Select Parameters "STD"
42. Select Frequency "700-10000 MHz"
43. If the Display Excel Button is “On”, Excel will open up in the back ground.
44. NOTE: AMS controls Excel through ActiveX calls; Never make changes to the excel file while measurements are being taken as the data and the file will most likely be corrupted
45. From Main Menu Bar, Select File / Save, select ILS-VNA-CAL1, OK, Yes Overwrite
46. Select the yellow "VNA" button... VNA driver will open and the button will turn to green. Note that any Equipment driver may be hidden by either selecting "Exit Window" on the driver, or by selecting the associated green driver button on the AMS Measurement tab and then selecting "Hide". To view the driver again, select the green driver button and then select "Hide".
47. Select the AMS Application
48. Select "Start" to start measurement
49. Popup will appear once the measurement is complete
50. Results are graphed: Select Degs or dBm to view data
51. Select Green "VNA" button, Select "Close", VNA driver will close

Step2 Measure combined gain of VNA-P2, Cable-001 and Cable-002. The Gain from Step 1 will be subtracted from this and the result will be the Gain / Insertion loss of Cable-002.

52. Install Cable-002 between Cable-001 and VNA, so it is: VNA-P2, Cable-001, Connector, Cable-002, and then VNA-P1

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53. From the Main Menu Bar, select "Setups"
54. Select "Equipment Setups" Tab
55. Select Test Type Setup: "Insertion Loss"
56. Select "ILC-VNA-Cal2", from Insertion Loss Chains List
57. If there is no VNA on the Tx or Rx Chain:
    a. Select New Tx Chain Item, The Select Window will popup
    b. Select "VNA" from the Select Popup Window
    c. Select the VNA from the list
    d. Exit popup Window
    e. VNA should be the first and only entry in the Tx chain. Delete any other entries.
    f. Save Tx Chain
    g. Select New Rx Chain Item, The Select Window will popup
    h. Select "Cables" from the Select Popup Window
    i. Select VNA-P2 from the list
    j. Select the Cable-001-Uncal from the list
    k. Exit popup Window
    l. VNA-P2 should be the first entry and Cable-1-Uncal should be the second entry in the Rx Chain. Delete any other entries.
    m. Save Rx Chain
58. Select "Accessories" Tab
59. Select Accessory Type "Cable"
60. Select Cable-001-Uncal from the Accessory Cables
61. Edit information as required
62. Select Calibration file "...", navigate to directory: "Cable-001-Cal1" and select file: "IL_ILS-VNA-Cal1_ILC-VNA-Cal1_STD_700.0-10000.0"
63. From Main Menu Bar, Select > Measure
64. Select Test Parameters Tab
65. Select Test Type: "Insertion Loss"
66. Select "ILS-VNA-Cal2", from the Insertion Loss Setups List
67. Set the Start, Stop and Step as 700, 10000 and 100 and select MHz
68. Select the DUT Tab
69. Select "Cable" Equipment Type
70. Select "Cable-002-Cal2"
71. Edit Information as required
72. Select Data File Directory "...", in popup window, navigate to "Cable-002-Cal2", select done. Ensure that directory "Cable-002" was not selected, as it will be utilized further on.
73. Select Measurement Tab

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74. Select Measurement Type: "Insertion Loss"
75. Select Setup "ILS-VNA-Cal2"
76. Select Parameters "STD"
77. Select Frequency "700-10000 MHz"
78. From Main Menu Bar, Select File / Save, select ILS-VNA-CAL2, OK, Yes Overwrite
79. Select the yellow "VNA" button... VNA driver will open and the button will turn to green
80. Select the AMS Application
81. Select "Start" to start measurement
82. Popup will appear once the measurement is complete
83. Results are graphed
84. Select Green "VNA" button, Select "Close", VNA driver will close and the button will turn yellow
85. The actual insertion loss of Cable-002 is now known, (with the exception of the connector)

Step 3 Measure Actual VNA P2 Output / Gain

86. Remove Cable-001 and Install Cable-002 between the P1 and P2, so it is: VNA-P2, Cable-002, VNA-P1
87. From the Main Menu Bar, select "Setups"
88. Select "Accessories" Tab
89. Select Accessory Type "Cable"
90. Select Cable-002-Cal2 from the Accessory Cables
91. Edit information as required
92. Select Calibration file "...", navigate to directory: "Cable-002-Cal2" and select file: "IL_ILS-VNA-Cal2_ILC-VNA-Cal2_STD_700.0-10000.0". Ensure that directory "Cable-002" was not selected.
93. Select "Equipment Setups" Tab
94. Select Test Type Setup: "Insertion Loss"
95. Select "ILC-VNA-Cal3", from Insertion Loss Chains List
96. If there is no VNA or Cable in the Tx Chain:
    a. Select New Tx Chain Item, The Select Window will popup
    b. Select VNA from the Select Popup Window
    c. Select the VNA from the list
    d. Exit popup Window
    e. VNA should be the first and only entry in the Tx Chain. Delete any other entries.
    f. Save Tx Chain
97. If there is no Cable-002-Cal2 or VNA-P2-Uncal in the Rx Chain:

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a. Select New Rx Chain Item, The Select Window will popup
b. Select "Cables" from the Select Popup Window
c. Select "VNA-P2-Uncal" from the list
d. Select the Cable-002-Cal2 from the list
e. Exit popup Window
f. VNA-P2-Uncal should be the first entry and Cable-002-Cal2 should be the second entry in the Rx Chain. Entries can be dragged into position as required. Delete any other entries.
g. Save Rx Chain

98. From Main Menu Bar, Select > Measure
99. Select Test Parameters Tab
100. Select Test Type: "Insertion Loss"
101. Select "ILS-VNA-Cal3", from the Insertion Loss Setups List
102. Set the Start, Stop and Step as 700, 10000 and 100 and select MHz
103. Select the DUT Tab
104. Select "Cable" Equipment Type
105. Select "VNA-P2"
106. Edit Information as required
107. Select Data File Directory "...", in popup window, navigate to "VNA-P2", select done
108. Select Measurement Tab
109. Select Measurement Type: "Insertion Loss"
110. Select Setup "ILS-Cal3"
111. Select Parameters "STD"
112. Select Frequency "700-10000 MHz"
113. From Main Menu Bar, Select File / Save, select ILS-VNA-CAL3, OK, Yes Overwrite
114. Select the yellow "VNA" button... VNA driver will open and the button will turn to green
115. Select the AMS Application
116. Select "Start" to start measurement
117. Popup will appear once the measurement is complete
118. Results are graphed
119. The actual Output of the VNA P2 is now known
120. Select Green "VNA" button, Select "Close", VNA driver will close and the button will turn yellow
121. From the Main Menu Bar, select "Setups"
122. Select "Accessories" Tab
123. Select "Cable"
124. Select "VNA-P2" from the Sources

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125. Edit information as required
126. Select Calibration file "...", navigate to directory: "VNA-P2" and select file: " IL_ILS-VNA-Cal3_ILC-VNA-Cal3_STD_700.0-10000.0 "
127. VNA calibration of P2 is now complete. All measurements will be referenced to P1 of the VNA

Step 4 Calibrate all Cables

128. From the Main Menu Bar, select "Setups"
129. Select "Equipment Setups" Tab
130. Select Test Type Setup: "Insertion Loss"
131. Select "ILC-VNA", from Insertion Loss Chains List
132. If "ILC-VNA" does not exist select new chain and name it "ILC-VNA"
    a. Select New Tx Chain Item, The Select Window will popup
    b. Select "Cable" from the Select Popup Window
    c. Select "VNA-P2" from the list
    d. Exit popup Window
    e. Save Tx Chain
    f. Select New Rx Chain Item, The Select Window will popup
    g. Select Receiver from the Select Popup Window
    h. Select the VNA from the list
    i. Exit popup Window
    j. Ensure that the VNA is the first and only item in the Rx chain, delete any other items.
    k. Save Rx Chain
133. From Main Menu Bar, Select > Measure
134. Select Test Parameters Tab
135. Select Test Type: "Insertion Loss"
136. Select "ILS-VNA", from the Insertion Loss Setups List
137. Set the Start, Stop and Step as 700, 10000 and 100 and select MHz
138. Select the DUT Tab
139. Select "Cables" Equipment Type
140. Select "Cable-002"
141. Edit Information as required
142. Select Data File Directory "...", in popup window, navigate to "Cable-002", select done
143. Select Measurement Tab
144. Select Measurement Type: "Insertion Loss"
145. Select Setup "ILS-VNA"

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146. Select Parameters "STD"
147. Select Frequency "700-10000 MHz"
148. From Main Menu Bar, Select File / Save, select ILS-VNA, OK, Yes Overwrite
149. Repeat the following steps for each cable. The VNA driver does not have to be closed and opened between the following tests.
    a. Select the DUT Tab
    b. Select "Cables" Equipment Type
    c. Select "Cable-002"
    d. Edit Information as required
    e. Select Data File Directory "...", in popup window, navigate to "Cable-002", select done
    f. Select Measurement Tab
    g. Select Measurement Type: "Insertion Loss"
    h. Select Setup "ILS-VNA"
    i. Select Parameters "STD"
    j. Select Frequency "700-10000 MHz"
    k. Select the yellow "VNA" button... VNA driver will open and the button will turn to green
    l. Select the AMS Application
    m. Select "Start" to start measurement
    n. Popup will appear once the measurement is complete
    o. Results are graphed
    p. Select Green "VNA" button, Select "Close", VNA driver will close and the button will turn yellow
    q. From the Main Menu Bar, select "Setups"
    r. Select "Accessories" Tab
    s. Select Accessory Type "Cable"
    t. Select Cable-002 from the Accessory Cables
    u. Edit information as required
    v. Select Calibration file "...", navigate to directory: "Cable-002" and select file: "IL_ILS-VNA-ILC-VNA_STD_700.0-10000.0". Note when selecting Cable-002 make sure that the data file is in directory "Cable-002" and not "Cable-002_Cal1". The data in "Cable-002_Cal1" was used for calibrating purposes only and is not used from this point on. Enter calibration date DD-MMM-YYYY and label Cable-002 calibration date.
    w. Cable-002 is now complete
    x. Select the DUT tab and select the next cable, excel will close
    y. Remove Cable-002 and Install the next cable (Cable-001, 003,004 etc)between the VNA P1 and P2, so it is: P1 Cable-xxx P2

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z. Repeat these steps, from a above, for remaining Cables. Note when selecting Cable-001 make sure that the data file is in directory Cable-001 and not Cable-001_Cal1. The data in Cable-001_Cal1 was used for calibrating purposes only and is not used from this point on.

150. Exit AMS and then Compare the files "Cable-002\ IL_ILS-VNA_ILC-VNA_STD_700.0-10000.0.xls" and "Cable-002_Cal2\IL_ILS-VNA-Cal2_ILC-VNA-Cal2_STD_700.0-10000.0.xls" ... Gains should be within 0.1 dB or so depending on the VNA

6.4. Calibrated Measurement Antenna

Calibration data was entered by Raymond RF for the Measurement antenna. The Measurement Antenna should be calibrated every two years. Calibration Data is updated as follows:

1. With Explorer, navigate to C:\AMS\Data\AVS-700\
2. Open the excel file “AVS-700H Calibration.xls”
3. Enter the calibration data for the horizontal polarization as required
4. Select the “Save Calibration Data” button.
5. Exit Excel
6. Open the excel file “AVS-700V Calibration.xls”
7. Enter the calibration data for the vertical polarization as required
8. Select the “Save Calibration Data” button.
9. Exit Excel
10. Repeat the above for the H polarization

New calibration files can be created for other reference antennas as follows:

1. With Explorer, navigate to C:\AMS\Data\
2. Create a new directory for the reference antenna i.e. C:\AMS\Data\AH-Horn
3. With Explorer, navigate to C:\AMS\Data\AVS-700\
4. Copy file “AVS-700H Calibration.xls”
5. With Explorer, navigate to C:\AMS\Data\AH-Horn\
6. Paste files
7. Rename “AVS-700H Calibration.xls” to “AH-Horn Calibration.xls”
8. Open the excel file “AH-Horn Calibration.xls”
9. Enter Antenna Name: AH-Horn
10. Enter the calibration data for the antenna as required
11. Select the “Save Calibration Data” button.
12. Exit Excel

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6.5. Calibration of Switches with VNA

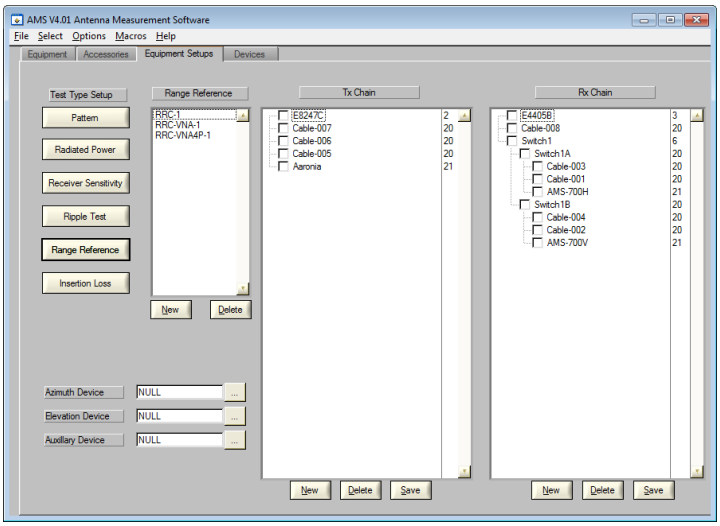
Follow the same instructions as for the SA & SG above and substitute Insertion loss chain and setup ILC-SW-1 and ILS-SW-1 for ILC-VNA-SW1 and ILS-VNA-SW-1.

6.6. Range Reference Test

The Range Reference Test is utilized to validate the overall loss / gain of the system, including path loss. The AMS is designed to allow the user to either set up the system to calculate the overall loss / gain and set this as a reference as described by the CTIA test procedure; or to track all of the losses of each individual component separately and combine them for the overall loss / gain calculation.

Range Reference Setup instructions for a system utilizing a SG and SA, and an Aaronia broadband Calibrated Antenna:

1. Ensure that calibration procedures have been completed as described above.
2. From the Main Menu Bar, select "Setups"
3. Select the Accessories Tab, and select “Antennas”
4. Select the Aaronia Antenna
5. Ensure that the Calibration File is set to data/Aaronia/Aaronia-60180.txt
6. Select "Equipment Setups" Tab
7. Select Test Type Setup: "Range Reference"
8. Select "RRC-1", from Range Reference Chains List. The Tx and Rx Chains should be as follows:



9. If there is no "RRC-1" select new chain and name it "RRC-1"
10. Edit Tx Chain if required:
    a. Select New Tx Chain Item, The Select Window will popup

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b. Select Source from the Select Popup Window
c. Select the SG, i.e. E8247C, from the list
d. Exit the Popup Panel
e. Select Cables from the Select Popup Window
f. Select Cables which are between the SG and the reference antenna, i.e. Cable-007, Cable-006 and Cable-005
g. Select Antennas from the Select Popup Window
h. Select Aaronia
i. Exit the Popup Window and arrange the chain items as per the above chain diagram. Note that the Tx and Rx Lists are Hierarchal lists and items can be dragged, promoted, and demoted.
j. Save Tx Chain

11. Edit Rx Chain if required:
    a. Select New Rx Chain Item, The Select Window will popup
    b. Select Receiver from the Select Popup Window
    c. Select the SA, i.e. 8563EC, from the list
    d. Select Cables from the Select Popup Window
    e. Select Cable Cable-008
    f. Select RF-Switches from the Select Popup Window
    g. Select Switch1
    h. Select Cables from the Select Popup Window
    i. Select Cables Switch1A, Switch1B, Cable-001 through Cable-004
    j. Select Antennas from the Select Popup Window
    k. Select Antennas AVS-700H and AVS-700V
    l. Exit the Popup Window and arrange the chain items as per the above chain diagram. Note that the Tx and Rx Lists are Hierarchal lists and items can be dragged, promoted, and demoted.
    m. Save Rx Chain
12. Ensure that the Azimuth, Elevation and Auxiliary device fields are all set to “NULL”. If not, type in NULL in each field.
13. From Main Menu Bar, Select > Measure
14. Select Test Parameters Tab
15. Select Test Type: "Range Reference"
16. Select "RRS-H", from the Range Reference Setups List. The Test Parameters should be as follows:

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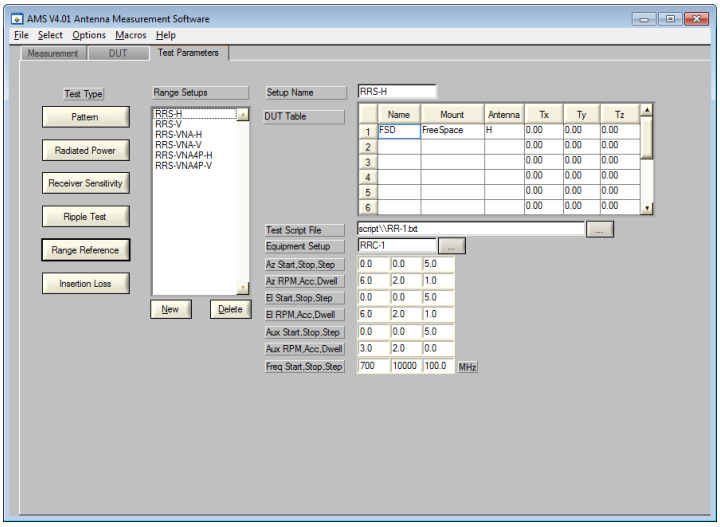
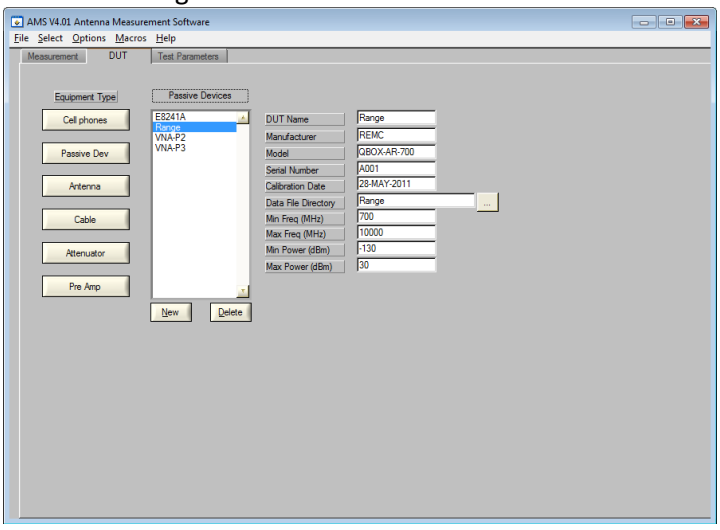


17. Mount the Aaronia antenna in the horizontal position at the center of the positioner. If the Reference Antenna is not mounted exactly at the center of the positioner, Adjust the Tx, Ty, and Tz offsets of setup name (0,0,0) according to the coordinate system in the previous section.
18. Adjust the Frequency Start, Stop and Step as required, in MHz
19. Select Measurement Tab
20. Select DUT Tab
21. Select “Passive Dev”
22. Select Range. The DUT screen should be as follows:



23. If Range does not exist Add a new DUT by selecting “New”. Enter Name as Range.
24. Enter Manufacturer, Model, Serial Number, Calibration Date DD-MMM-YYYY (this is Todays Date and not the calibration date on the antenna)

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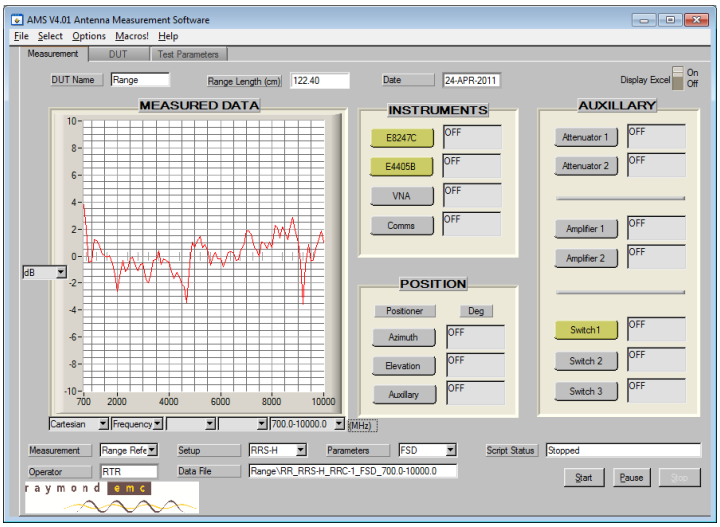
25. Enter the Data File directory by selecting [...]. If the directory for the Range does not exist, create a new directory “with the same name, i.e “Range:. Then select the new directory, and select “Done”.
26. Enter the remaining data as required
27. Select Measurement Tab
28. Select Measurement Type: "Range Reference"
29. Select Setup: "RRS-H"
30. Select Parameters: “FSD”
31. Select Frequency: i.e. "700.0-10000.0"
32. If the Display Excel Button is “On”, a new Excel Data File will open in the back ground.
33. Enter Operator Name
34. Enter Test Date: DD-MMM-YYYY
35. The Measurement Screen should be as follows:



36. From Main Menu Bar, File>Select Save, select “RangeRef-H”, OK, Yes to Over write file.
37. Select the Yellow driver buttons for the SG, SA and Switch1. They will open and change to Green indicating that they are active and initialized. The drivers can be hidden by either selecting “Close Window” on driver, or by pressing the green button on the AMS Measurement Tab, and then selecting “Hide”. They can be viewed again by pressing the green button on the AMS Measurement Tab, and then selecting “Hide”.
38. Once all of the drivers are open,
39. Select "Start" to start measurement
40. Popup will appear once the measurement is complete
41. Results are graphed
42. Select Green "Source" button, Select "Close", SG driver will close
43. Select Green "Receiver" button, Select "Close", SA driver will close

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44. Select Green "Switch" button, Select "Close", Switch driver will close
45. Select Green "Positioner" button, Select "Close", Positioner driver will close
46. Verify that the measure insertion loss is within expected tolerance. In a perfect world, The results should be 0 dB throughout the measurement band. This test data will be utilized to remove the accumulated errors associated with the range and the cable calibrations above.
47. From the main menu bar, Select>Setups
48. From the Accessories Tab, Select Antennas, and then Select Range-H
49. Ensure that the Calibration File is set to “data\Range\RR-H.txt”
50. Repeat this entire step for the Vertical Polarization

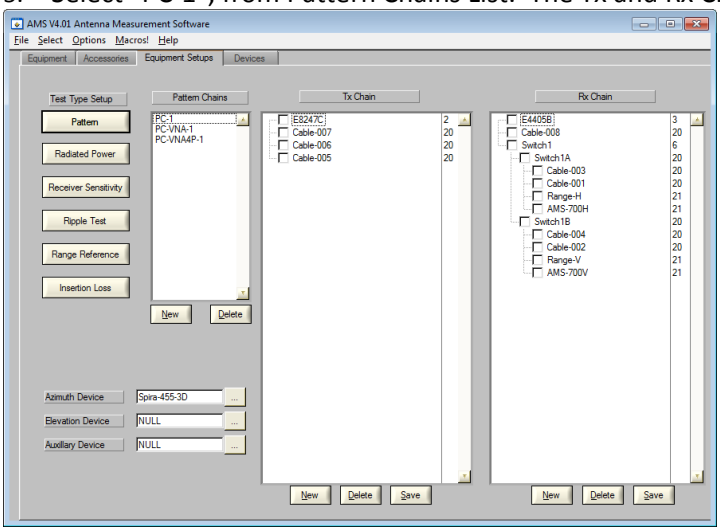
6.7. Reference Antenna Pattern (Symmetry of Dipole)

The reference antenna with a known gain pattern is mounted on the positioner and measurements are taken at various angles to verify the antennas pattern. Typically a sleeve dipole is utilized and the symmetry of the reference antenna is verified. The CTIA test plan requires a tolerance of +/- 0.1 dB for the sleeve dipole.

2D Antenna Pattern Setup instructions for a system utilizing a SG and SA:

1. Ensure that calibration procedures have been completed as described above.
2. From the Main Menu Bar, select "Setups"
3. Select "Equipment Setups" Tab
4. Select Test Type Setup: "Pattern" 

5. Select "PC-1", from Pattern Chains List. The Tx and Rx Chains should be as follows:



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6. If there is no "PC-1" select new chain and name it "PC-1"
7. Edit Tx Chain if required:
    a. Select New Tx Chain Item, The Select Window will popup
    b. Select Source from the Select Popup Window
    c. Select the SG, i.e. E8247C, from the list
    d. Select Cables from the Select Popup Window
    e. Select Cables which are between the SG and the reference dipole, i.e. Cable-007 and Cable-006 and Cable-005.
    f. Exit popup Window
    g. Ensure that the SG is the first and the cables are the only other items in the Tx chain, delete any other items. Items can be dragged in the list box as may be required.
    h. Save Tx Chain
8. Edit Rx Chain if required:
    a. Select New Rx Chain Item, The Select Window will popup
    b. Select Receiver from the Select Popup Window
    c. Select the SA, i.e. 8563EC, from the list
    d. Select Cables from the Select Popup Window
    e. Select Cable Cable-008
    f. Select RF-Switches from the Select Popup Window
    g. Select Switch1
    h. Select Cables from the Select Popup Window
    i. Select Cables Switch1A, Switch1B, Cable-001 through Cable-004,
    j. Select Antennas from the Select Popup Window
    k. Select antennas AVS-700H and AVS-700V
    l. Exit the Popup Window and arrange the chain items as per the above chain diagram. Note that the Tx and Rx Lists are Hierarchal lists and items can be dragged, promoted, and demoted.
    m. Save Rx Chain
9. In the Azimuth Device Field ensure that the appropriate positioner is selected“SpiraTable-455-3D” or “SpiraTable-455”. If not, select the … and choose the appropriate device and then exit the popup panel
10. From Main Menu Bar, Select > Measure
11. Select Test Parameters Tab
12. Select Test Type: "Ripple Test"
13. Select "RS-H", from the Pattern Setups List. The Test Parameters should be as follows:

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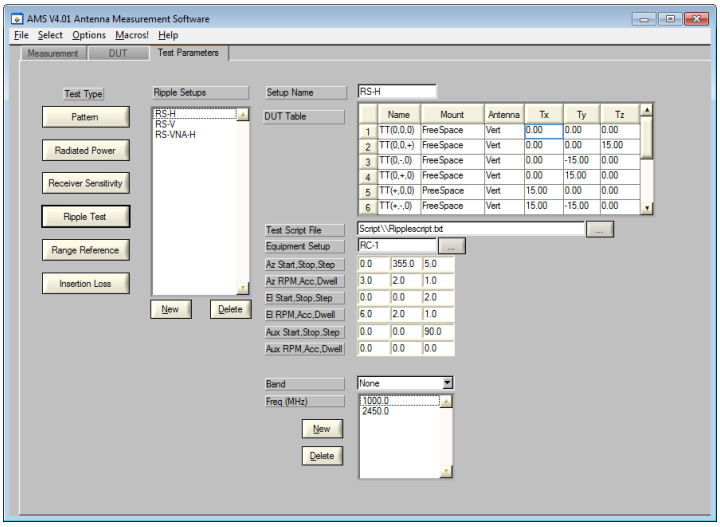
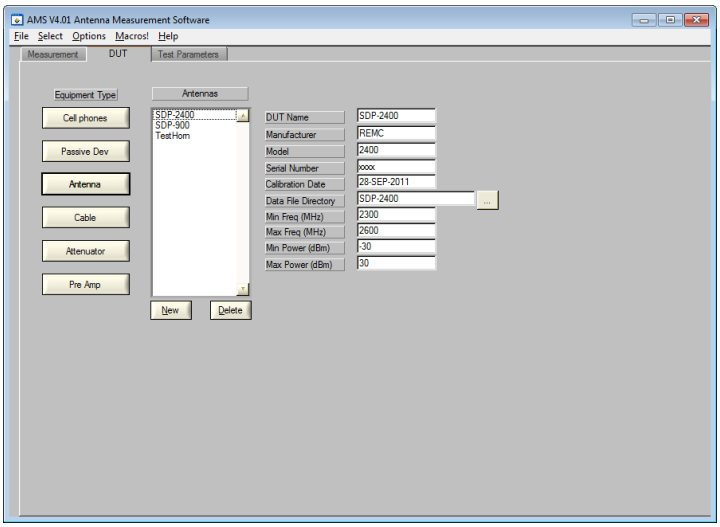


14. If the Sleeve Dipole is not mounted exactly at the center of the positioner, Adjust the Tx, Ty, and Tz offsets of setup name (0,0,0) according to the coordinate system in the previous section.
15. If the Tuned dipole frequency is not on the Frequency list at the bottom, add it by selecting “New”, and enter the frequency in MHz
16. Select Measurement Tab
17. Select DUT Tab
18. Select Antenna
19. Select the appropriate Sleeve Dipole, such as SDP-2400, for a 2400MHz test. The DUT screen should be as follows:



20. If the Sleeve Dipole does not exist add a new DUT by selecting “New”. Enter Name as SDP-xxxx, where xxxx = MHz such as 1000.

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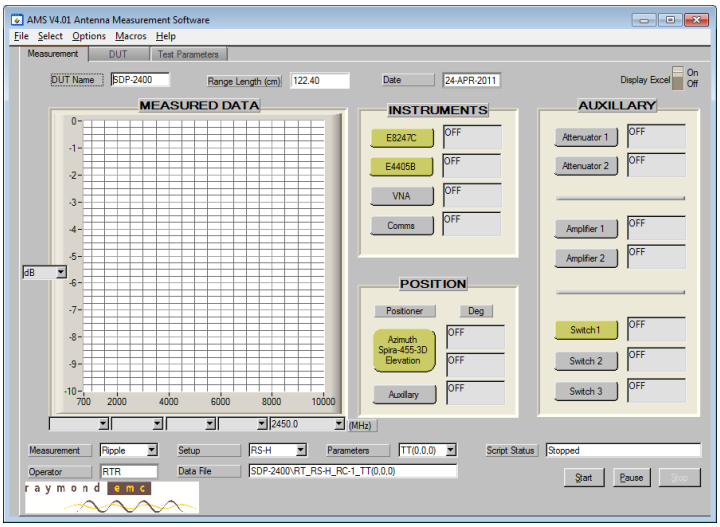
21. Enter Manufacturer, Model, Serial Number, Calibration Date DD-MMM-YYYY (this is Todays Date and not the calibration date on the antenna)
22. Enter the Data File directory by selecting ... . If the directory for the Sleeve Dipole does not exist, create a new directory “with the same name, i.e. SDP-2400. Then select the new directory, and select “Done”.
23. Enter the remaining data as required
24. Select Measurement Tab
25. Select Measurement Type: "Ripple"
26. Select Setup: "RS-H"
27. Select Parameters: “(0,0,0)”
28. Select Frequency: i.e. "2450 MHz"
29. If the Display Excel Button is “On”, a new Excel Data File will open in the back ground.
30. Enter Operator Name
31. Enter Test Date: DD-MMM-YYYY
32. The Measurement Screen should be as follows:



33. From Main Menu Bar, Select Save, select “Ripple-H”, OK, Yes to Over write file.
34. Select the Yellow driver buttons for the SG, SA, Positioner, and Switch1. They will open and change to Green indicating that they are active and initialized. The drivers can be hidden by either selecting “Close Window” on driver, or by pressing the green button on the AMS Measurement Tab, and then selecting “Hide”. They can be viewed again by pressing the green button on the AMS Measurement Tab, and then selecting “Hide”.
35. Once all of the drivers are open,
36. Select "Start" to start measurement
37. Popup will appear once the measurement is complete
38. Results are graphed
39. Select Green "Source" button, Select "Close", SG driver will close

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40. Select Green "Receiver" button, Select "Close", SA driver will close
41. Select Green "Switch" button, Select "Close", Switch driver will close
42. Select Green "Positioner" button, Select "Close", Positioner driver will close
43. Verify that the measured Pattern is within expected tolerance.

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6.9. Ripple Test

The Ripple test as described by the CTIA Test Plan is utilized to validate the accuracy of the AVS Quiet Zone. The Ripple Test utilizes the already available 3D positioner. Only the Theta Ripple test can be completed with a 2D positioner, therefore additional Theta locations have been added for 2D Systems. Note that the Ripple Test is an alternative method to the more traditional VSWR method which utilizes an axial or linear positioner and measures the reflections from each of the chamber surfaces.

A calibrated reference antenna is required for the following this test. The calibrated reference antenna, such as a sleeve dipole with a known Omni-directional gain pattern, is mounted on the positioner and measurements are taken at various angles and polarizations. Measurements are repeated at different mounting offsets to determine the quality of the measurement quiet zone. This test should be performed for each frequency range of interest.

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The following measurements should be performed to validate the quality of the Quiet Zone.

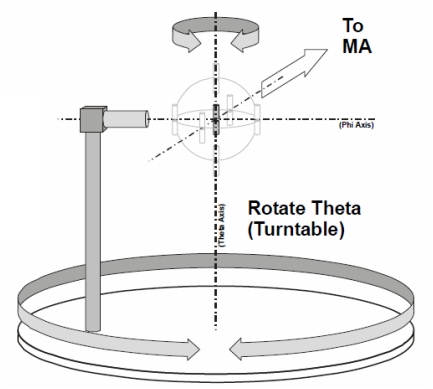


Figure 6-1 Theta Ripple Test

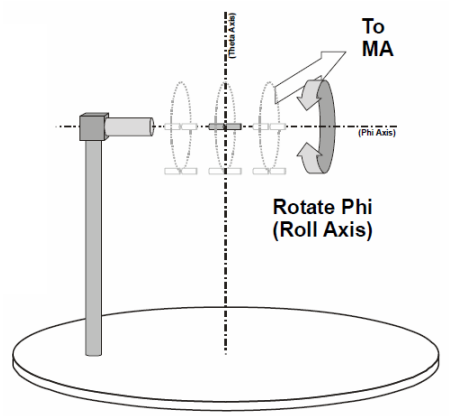
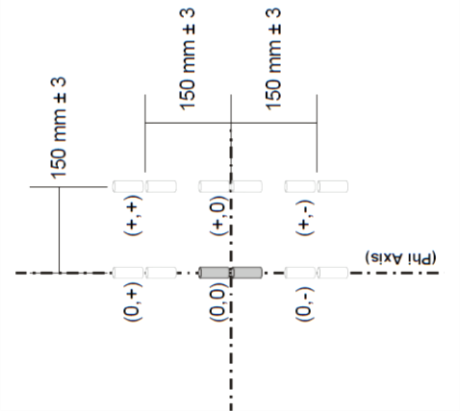
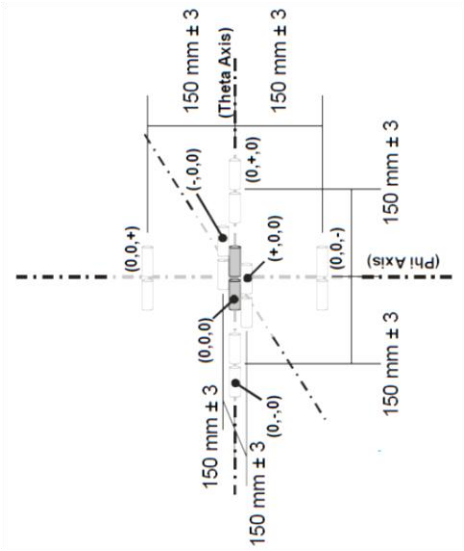


Figure 6-2 Phi Ripple Test





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6.9.1. Ripple Test Parameters

Test	Reference Antenna	Azimuth (Theta) range, step	Elevation (Phi) range, step	X Offset (cm)	Y Offset (cm)	Z Offset (cm)	Aux MA Antenna (Pol)
Theta(0,0,0) Symmetry	Vert	0-358, 2 deg	0	0	0	0	90-Vert (Theta)
Theta(0,0,+)	Vert	0-358, 2 deg	0	0	0	15	90-Vert
Theta(0,-,0)	Vert	0-358, 2 deg	0	0	-15	0	90-Vert
Theta(0,+,0)	Vert	0-358, 2 deg	0	0	15	0	90-Vert
Theta(+,0,0)	Vert	0-358, 2 deg	0	15	0	0	90-Vert
Theta(+,-,0)*	Vert	0-358, 2 deg	0	15	-15	0	90-Vert
Theta(+,+,0)*	Vert	0-358, 2 deg	0	15	15	0	90-Vert
* 2D Positioner only							
Phi(0,0)**	Horz	90	0-358, 2 deg	0	0	0	0-Horz (Phi)
Phi(+,0)**	Horz	90	0-358, 2 deg	0	15	0	0-Horz
Phi(0,+)**	Horz	90	0-358, 2 deg	0	0	15	0-Horz
Phi(+,+)**	Horz	90	0-358, 2 deg	0	15	15	0-Horz
Phi(0,-)**	Horz	90	0-358, 2 deg	0	0	-15	0-Horz
Phi(+,-)**	Horz	90	0-358, 2 deg	0	15	-15	0-Horz
** requires 3D Positioner							

Ripple Test Setup instructions for a system utilizing a SG and SA:

1. Ensure that calibration procedures have been completed as described above.
2. Select a Calibrated Sleeve Dipole for the Ripple Test and mount it according to Ripple Test Parameters above.
3. From the Main Menu Bar, select "Setups"
4. Select "Equipment Setups" Tab
5. Select Test Type Setup: "Ripple Test"
6. Select "RC-1", from Ripple Test Chains List. The Tx and Rx Chains should be as follows:

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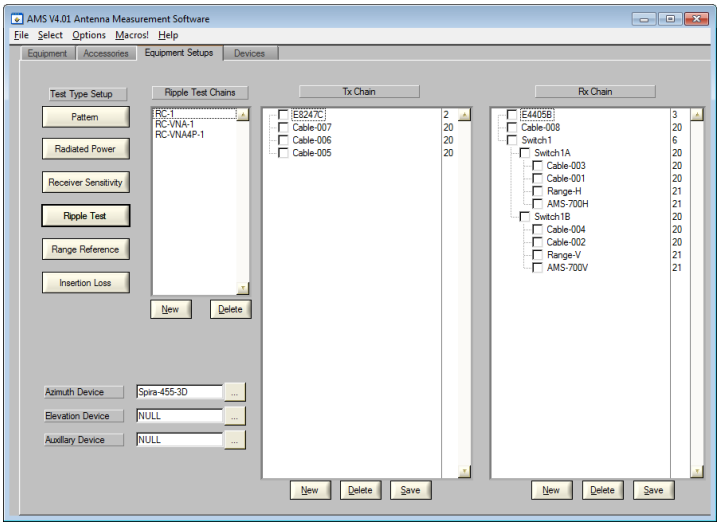

7. If there is no "RC-1" select new chain and name it "RC-1"
8. Edit Tx Chain if required:
   a. Select New Tx Chain Item, The Select Window will popup
   b. Select Source from the Select Popup Window
   c. Select the SG, i.e. E8247C, from the list
   d. Select Cables from the Select Popup Window
   e. Select Cables which are between the SG and the reference dipole, i.e. Cable-007, Cable-006 and Cable-005
   f. Exit popup Window
   g. Ensure that the SG is the first and the cables are the only other items in the Tx chain
   h. delete any other items. Items can be dragged in the list box as may be required.
   i. Save Tx Chain
9. Edit Rx Chain if required:
   a. Select New Rx Chain Item, The Select Window will popup
   b. Select Receiver from the Select Popup Window
   c. Select the SA, i.e. 8563EC, from the list
   d. Select Cables from the Select Popup Window
   e. Select Cable Cable-008
   f. Select RF-Switches from the Select Popup Window
   g. Select Switch1
   h. Select Cables from the Select Popup Window
   i. Select Cables Switch1A, Switch1B, Cable-001 through Cable-004,
   j. Select Antennas from the Select Popup Window
   k. Select antennas AVS-700H and AVS-700V
   l. Select Range-H and Range-V

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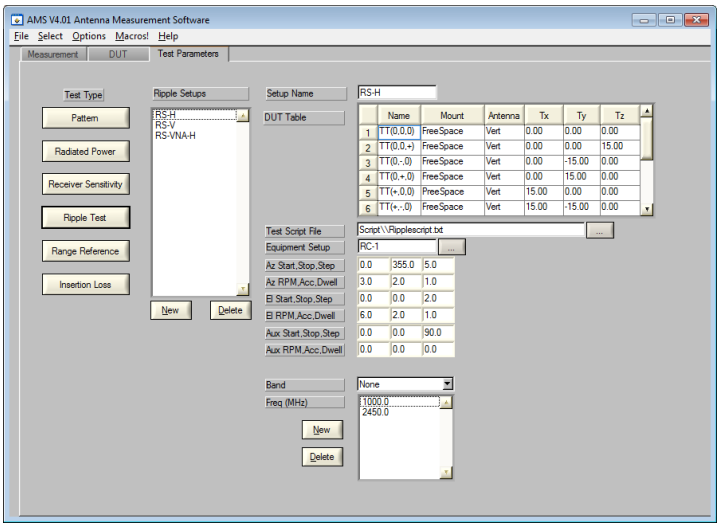
m. Exit the Popup Window and arrange the chain items as per the above chain diagram. Note that the Tx and Rx Lists are Hierarchal lists and items can be dragged, promoted, and demoted.
n. Save Rx Chain

10. Ensure that the Azimuth Device Field has the appropriate positioner selected
11. From Main Menu Bar, Select > Measure
12. Select Test Parameters Tab
13. Select Test Type: "Ripple Test"
14. Select "RS-H", from the Ripple Test Setups List. The Test Parameters should be as follows:



15. If required, adjust the Tx, Ty, and Tz offsets of setup names according to the coordinate system in the previous section.
16. If the Tuned dipole frequency is not on the Frequency list at the bottom, add it by selecting “New”, and enter the frequency in MHz
17. Select "RS-V", from the Ripple Test Setups List. The Test Parameters should be as follows:

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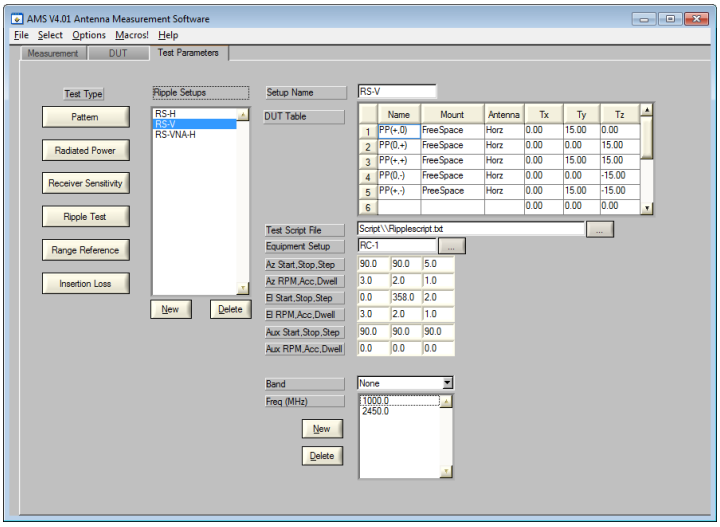
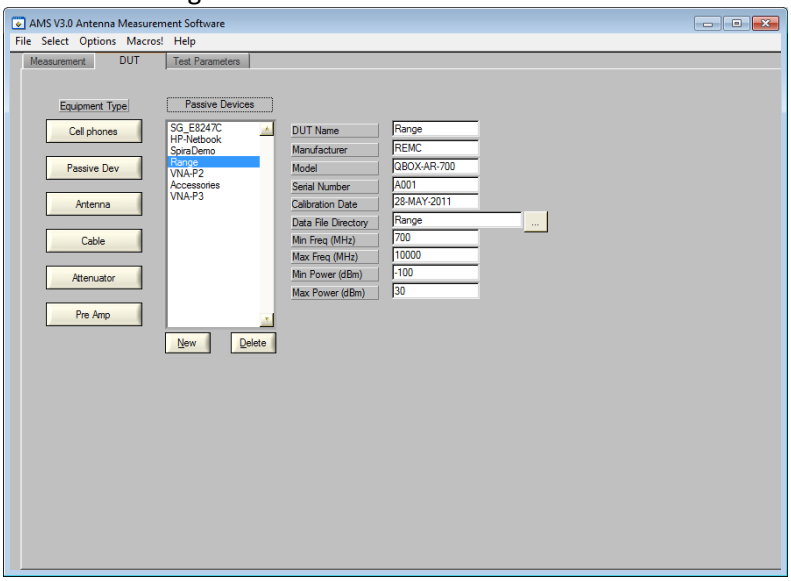


18. If required, adjust the Tx, Ty, and Tz offsets of setup names according to the coordinate system in the previous section.
19. If the Tuned dipole frequency is not on the Frequency list at the bottom, add it by selecting “New”, and enter the frequency in MHz
20. Select Measurement Tab
21. Select DUT Tab
22. Select “Passive Dev”
23. Select “Range”. The DUT screen should be as follows:



24. If the “Range” does not exist, add a new DUT by selecting “New”. Enter Name as “Range”.

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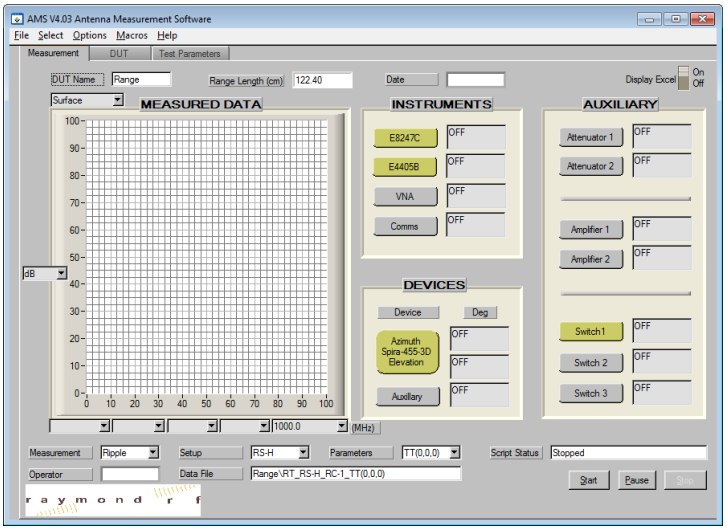
25. Enter Manufacturer, Model, Serial Number, Calibration Date DD-MMM-YYYY (this is Todays Date and not the calibration date on the antenna)
26. Enter the Data File directory by selecting ... . If the directory for the Range does not exist, create a new directory “with the same name, i.e. “Range”. Then select the new directory, and select “Done”.
27. Enter the remaining data as required
28. Select Measurement Tab
29. Select Measurement Type: "Ripple "
30. Select Setup: "RS-H"
31. From Main Menu Bar, Select Save, select “Ripple-TT”, OK, Yes to Over write file.
32. Select Parameters: i.e. “TT(0,0,0)”
33. Select Frequency: i.e. "2450 MHz"
34. If the Display Excel Button is “On”, a new Excel Data File will open in the back ground.
35. Enter Operator Name
36. Enter Test Date: DD-MMM-YYYY
37. The Measurement Screen should be as follows:



38. Select the Yellow driver buttons for the SG, SA, Positioner, and Switch1. They will open and change to Green indicating that they are active and initialized. The drivers can be hidden by either selecting “Close Window” on driver, or by pressing the green button on the AMS Measurement Tab, and then selecting “Hide”. They can be viewed again by pressing the green button on the AMS Measurement Tab, and then selecting “Hide”.
39. Once all of the drivers are open,
40. Select "Start" to start measurement
41. Popup will appear once the measurement is complete
42. Results are graphed

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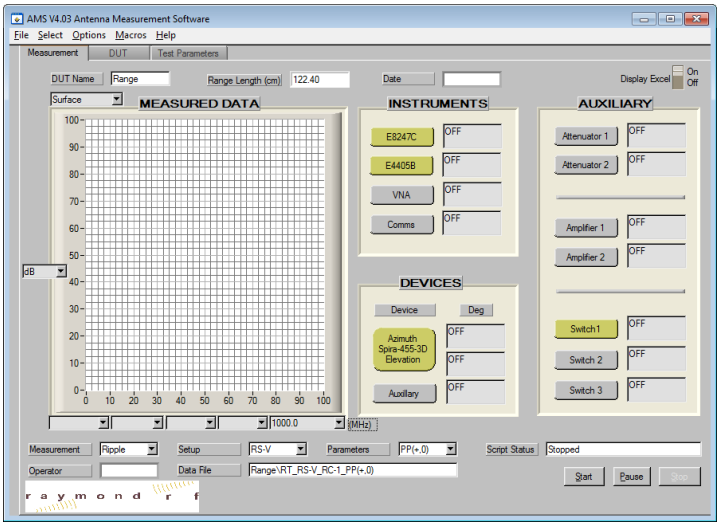
43. Move the Antenna to the next position and repeat from step 32 until all TT positions are complete.
44. Once all of the TT positions are complete, position the antenna for the first Phi Axis, Phi Polarization (PP) measurement.
45. Select Green "Source" button, Select "Close", SG driver will close
46. Select Green "Receiver" button, Select "Close", SA driver will close
47. Select Green "Switch" button, Select "Close", Switch driver will close
48. Select Green "Positioner" button, Select "Close", Positioner driver will close
49. Select Measurement Type: "Ripple "
50. Select Setup: "RS-2"
51. From Main Menu Bar, Select Save, select “Ripple-PP”, OK, Yes to Over write file.
52. Select Parameters: i.e. “PP(+,0)”
53. Select Frequency: i.e. "2450 MHz"
54. If the Display Excel Button is “On”, a new Excel Data File will open in the back ground.
55. The Measurement Screen should be as follows:



56. Select the Yellow driver buttons for the SG, SA, Positioner, and Switch1. They will open and change to Green indicating that they are active and initialized. The drivers can be hidden by either selecting “Close Window” on driver, or by pressing the green button on the AMS Measurement Tab, and then selecting “Hide”. They can be viewed again by pressing the green button on the AMS Measurement Tab, and then selecting “Hide”.
57. Once all of the drivers are open,
58. Select "Start" to start measurement
59. Popup will appear once the measurement is complete
60. Results are graphed
61. Move the Antenna to the next position and repeat from step 32 until all PP positions are complete.

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62. Select Green "Source" button, Select "Close", SG driver will close
63. Select Green "Receiver" button, Select "Close", SA driver will close
64. Select Green "Switch" button, Select "Close", Switch driver will close
65. Select Green "Positioner" button, Select "Close", Positioner driver will close
66. Verify that the measured Patterns are within expected tolerance.

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