

**EMC & OPTICS**

# MANUAL

## CalStan 10.0

RF Measurement Software

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# 1. INTRODUCTION

CalStan 10.0 is a software tool for automation of radio frequency (RF) calibrations and measurements. The software controls the instruments via GPIB bus, reads the measurement values and computes the results. The purpose of the software is to perform calibrations and validations of equipments, such as antennas, cables, test sites and test setups.

Every measurement type is implemented as a plug-in to the base application. This way the software can be extended to new functionalities. Similar approach is used by implementation of device drivers, so the support for new measurement equipment can be added on customer request.

This manual describes in detail the usage of the software with currently available measurement types.

Check at [www.seibersdorf-rf.com/calstan](http://www.seibersdorf-rf.com/calstan) for the latest version.

## What is New in CalStan 10.0?

For up to date changes history go to <http://www.seibersdorf-rf.com/calstan/updatenew/changelog.txt>

## 2. SYSTEM REQUIREMENTS

Operating systems	Windows XP SP3 Windows Vista
Minimum computer requirements	1500 MHz CPU 256 MB RAM 50 MB HDD
Additional hardware	National Instruments GPIB card or GPIB-USB- HS interface
Installed software	.NET framework version 3.5 (or higher) <sup>1</sup> National Instruments Runtime v4.3 <sup>2</sup>

**Table 1:** System Requirements

A list of the supported measurement instruments can be found at our homepage <http://www.seibersdorf-rf.com/calstan>.

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<sup>1</sup> The .NET framework is part of Windows XP. You can download it from <http://www.microsoft.com/downloads/details.aspx?familyid=333325FD-AE52-4E35-B531-508D977D32A6&displaylang=en>.

<sup>2</sup> National Instruments Runtime is usually shipped with the GPIB card and needs 260 MB of the hard-disc space. You can download it from <http://ftp.ni.com/support/softlib/visa/NI-VISA/4.5/Windows/visa450full.exe>.

### 3. INSTALLATION AND UPDATE OF CALSTAN 10.0

#### 3.1. Installation

The CalStan 10.0 software can be downloaded from our webpage <http://www.seibersdorf-rf.com> free of charge and installed on your local computer. After installation it runs with all its features but data saving is restricted if the user doesn't possess a license for specific measurement types.

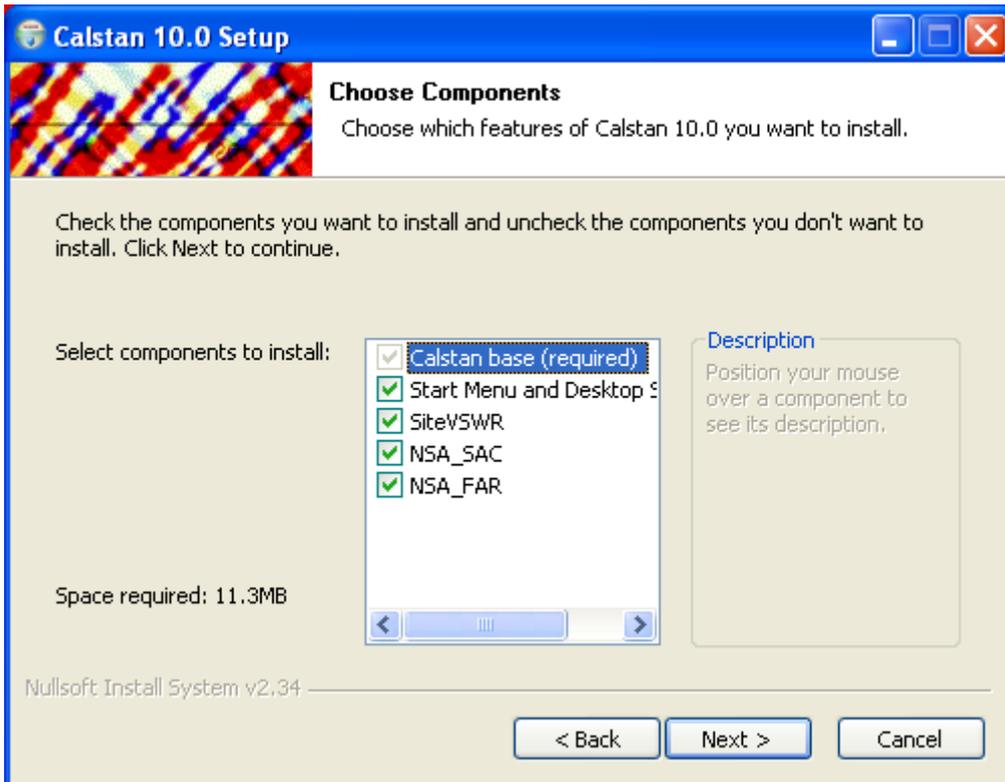
The standard way of CalStan 10.0 distribution is to ship the software on an USB memory stick, which serves as a dongle at the same time. The dongle contains the license files for the user specific measurement types. If it is not connected to the PC the saving of data is disabled. Licenses for additional measurement types can be obtained later if desired.

After executing the "setup.exe" file which was downloaded from our web or located on the USB memory stick, an installation dialog pops up.



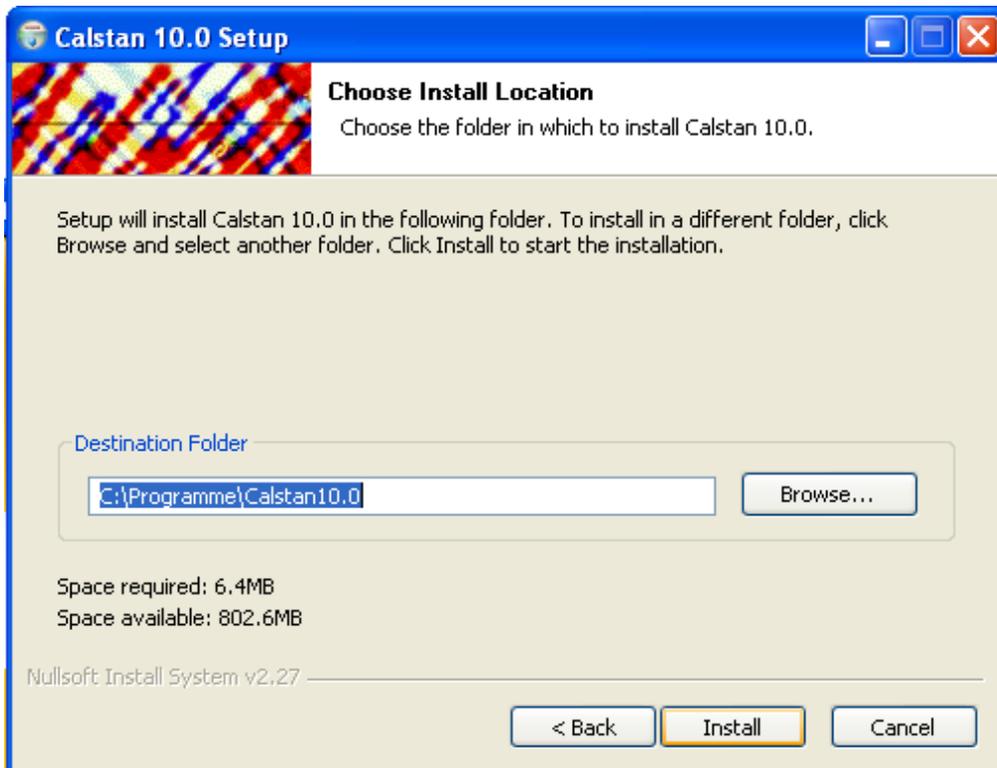
Figure 1: Setup – Welcome dialog

After clicking the "Next" button a window appears where the specific CalStan 10.0 components and types of measurements to install can be selected (Figure 2). By default all measurement types are selected. The input is finished by clicking "Next".



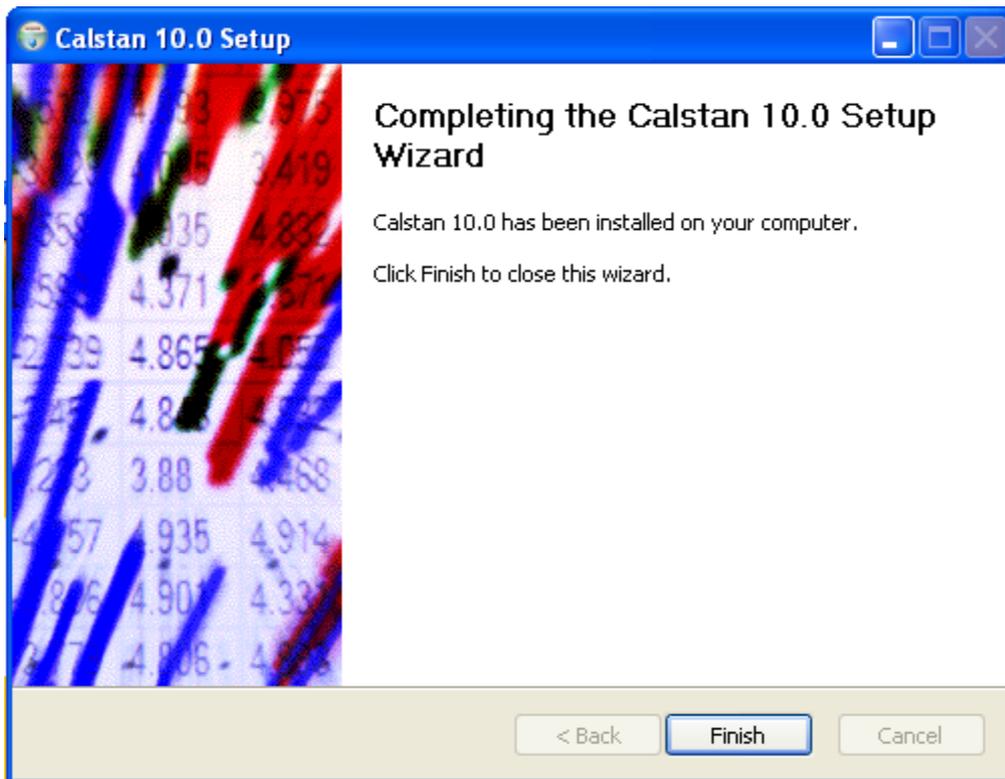
**Figure 2:** Setup - Component selection dialog

The destination folder for CalStan 10.0 has to be selected (**Figure 3**). To start the installation procedure, click the *“Install”* button, to go one step back to change the component selection press *“Back”* or *“Cancel”* to quit the installation.



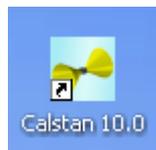
**Figure 3:** Setup – Installation directory selection dialog

When the installation was completed successfully a new dialog pops up:



**Figure 4:** Setup – CalStan completed dialog

By clicking “Finish” the CalStan 10.0 setup ends and an icon appears on the desktop.



**Figure 5:** CalStan Icon

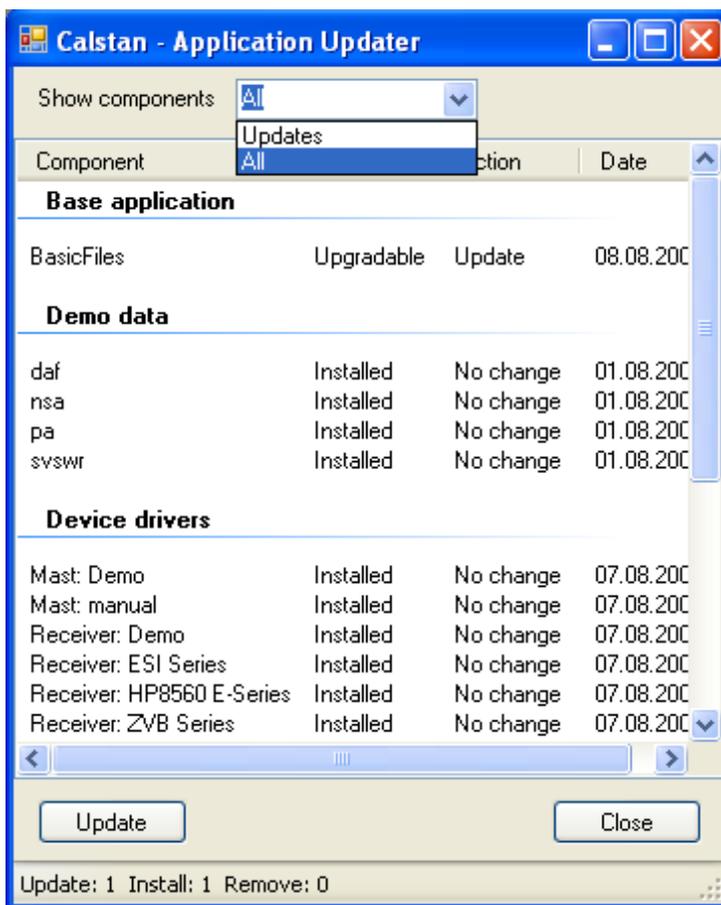
Run CalStan 10.0 from the start menu group or the icon on the desktop. If the start menu and the desktop shortcut were not installed, execute CalStan 10.0 from the installation folder.

## 3.2. Update

By clicking the “*Updates*” menu entry an online updater application starts. This serves for keeping CalStan up to date. If an internet connection is available, the updater checks our remote server for newer versions of software components.

This way the user can install new measurement types, new device drivers and get latest bug fixes. It is also possible to remove already installed components.

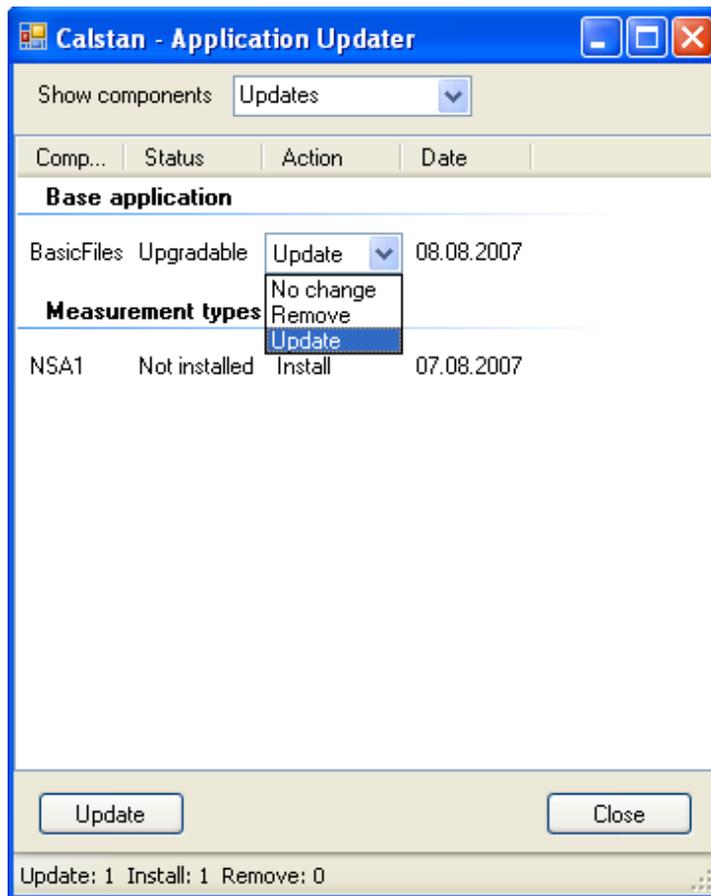
Using the “*Show components*” combo box at top of the window, a list of all installed components can be shown (**Figure 6**) by choosing “*All*”.



**Figure 6:** Online application updater, showing all components

By clicking the “*Update*” button, an update process starts (**Figure 7**). Before starting update, the CalStan application has to be closed manually. When the pop down menu in the “*Action*” column is opened a combo box with possible actions is shown: No change / Remove / Update.

After the update is finished successfully CalStan is restarted automatically.



**Figure 7:** Online application updater, showing available updates

*If internet connection is not available Calstan can be updated to newest version manually in the following steps:*

- 1. Download new Calstan installer from:  
[http://www.seibersdorf-rf.com/docs/downloads/CalStan10.0\\_Setup.exe](http://www.seibersdorf-rf.com/docs/downloads/CalStan10.0_Setup.exe)*
- 2. Uninstall old Castan version. In the process of uninstallation you should be prompted for deleting the 'Session' directory. If not, delete this directory manually. It resides in Calstan installation location.*
- 3. Install new Calstan version by running the downloaded installer.*

## 4. QUICK START

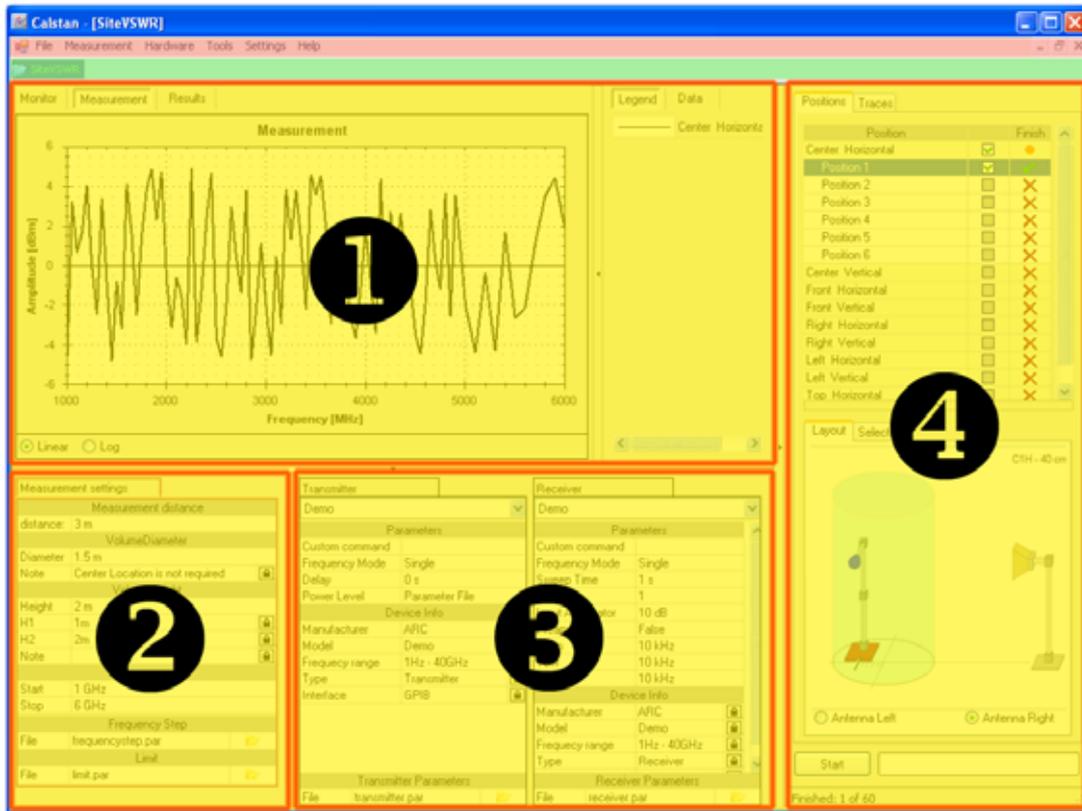
In this chapter the typical steps to start a measurement campaign are described. Some measurement type may be more complex - but the basic procedure does not change.

1. To start a new measurement, choose the "*File->New...*" and select the desired measurement type.
2. Modify the parameters in the "*Measurement settings*" panel (in the bottom left part of the screen). Most common ones are the frequency range, frequency step and limit. If needed load some factor files (e.g. Dual Antenna Factor) or set the protective attenuator for use with special signal generator types (e.g. RefRad system).
3. Set your measurement devices and their parameters in the set of panels right of the "*Measurement settings*". This may differ as specific measurement types use different device classes (Transmitters, Receivers, Masts, and Turntables). Most important of all is to set the right IEC address of the GPIB device, otherwise is not possible to connect to the instrument. To detect devices and their addresses automatically, go to "*Hardware*" menu and choose "*Detect Devices*". If possible CalStan sets the proper device driver for connected devices, if not you have to choose driver manually from the driver list.
4. Run the measurement by clicking the "Start" button (lower left corner of the start measurement panel on the right side of the screen). If some settings are incorrect the software shows an info message with instructions.
5. To save the measurement go to "*File->Save*".

## 5. CALSTAN 10.0 WORKSPACE

The CalStan 10.0 main window (**Figure 8**) consists of three main parts:

- A) Menu bar – shows main menu related to a currently opened measurement
- B) Measurement list bar – contains a list of currently opened measurements
- C) Measurement window – represents the currently opened (active) measurement

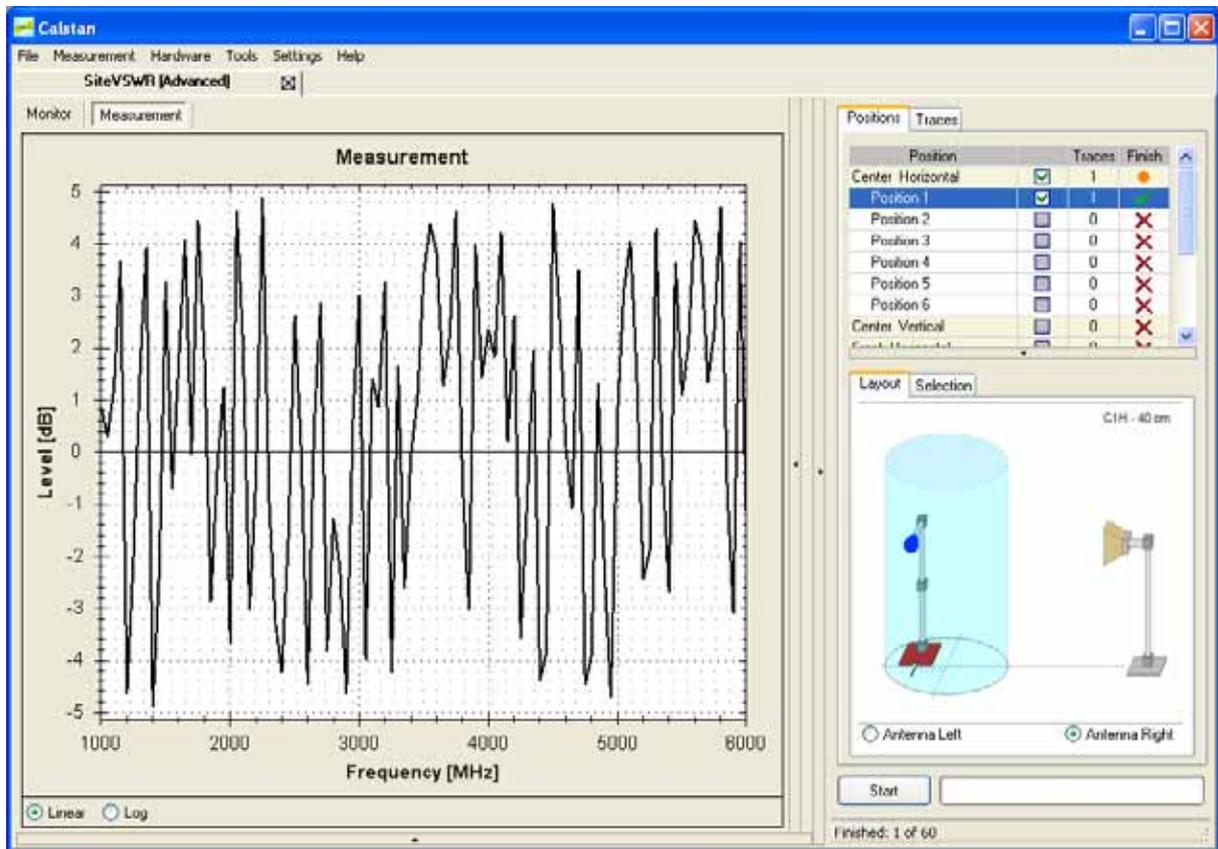


**Figure 8:** CalStan main window

The measurement window can be divided into four sub areas:

1. Measurement display – shows the measurement data in a chart
2. Measurement settings – contain all measurement settings
3. Hardware settings – contain all device settings
4. Measurement control panel with the “Start” button – controls the measurement procedure
5. Chart legend – shows the legend of all measured traces

By clicking the button  or , selected parts of the window can be maximized/minimized (**Figure 9**). Individual panels can also be maximized/minimized using the keyboard shortcuts: <Ctrl + Shift + L> for chart legend, <Ctrl + Shift + M> for measurement control panel and <Ctrl + Shift + S> for panel which contains the measurement and hardware settings.

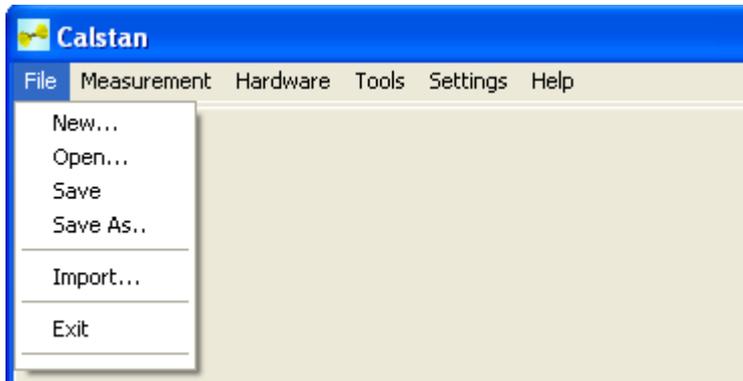


**Figure 9:** Measurement window with measurement settings, hardware settings and chart legend panel minimized.

## 6. MENU BAR

The menu bar is located at the top of the main window. It contains several menus which are described in the following.

### 6.1. File Menu



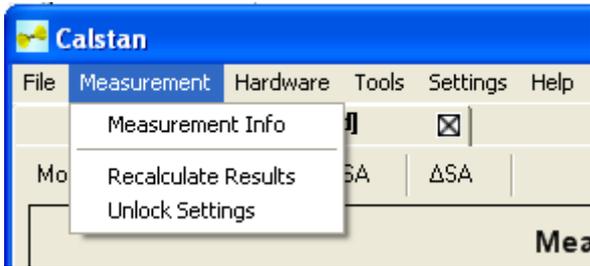
**Figure 10:** The file menu

<b>New</b>	Creates a new measurement.
<b>Open</b>	Opens a previously saved measurement.
<b>Save</b> <i>(disabled in demo mode)</i>	Saves a measurement. The default file extension of the CalStan 10.0 measurement files is “.cmf”.
<b>Save As</b> <i>(disabled in demo mode)</i>	Saves a measurement with a user defined file name into an individual directory. The default file extension of the CalStan 10.0 measurement files is “.cmf”.
<b>Import</b>	Imports a measurement from the previous, today’s obsolete version of CalStan v4.1. An extension of the imported file is not strictly specified. As the import function is measurement type specific, it is always related to the active measurement.
<b>Exit</b>	Closes the CalStan software. User is asked if to save changes made to opened measurements or not. If changes are discarded measurement is closed automatically. If changes are saved or there were no changes made recently in opened measurements, CalStan exists and at the next startup all saved measurements are reloaded.

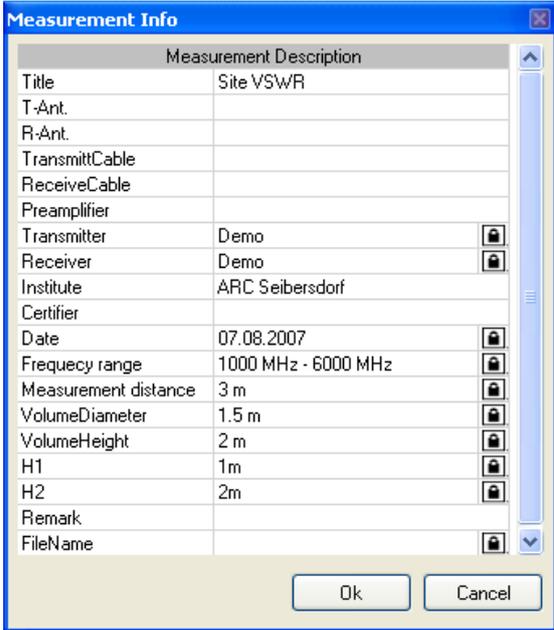
**Table 2:** File menu

## 6.2. Measurement Menu

The measurement menu contains general options related to the active measurement.



**Figure 11:** The measurement menu

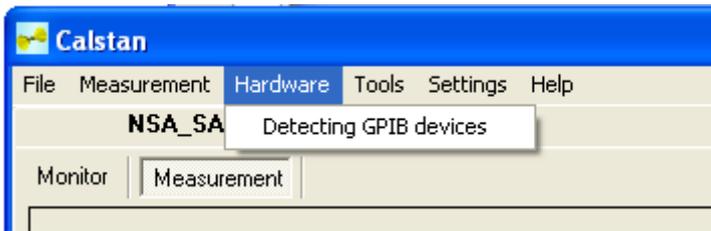
<b>Measurement Info</b>	<p>Opens a collection of general measurement information (<b>Figure 12</b>) in a dialog box.</p> <p>Some of the parameters are editable; others are locked as they are overtaken from measurement and hardware settings, indicated with the lock symbol.</p> <div style="text-align: center; margin: 10px 0;">  </div>
<b>Recalculate Results</b>	<p>Recalculates the results of an active measurement. Results can be recalculated only if certain measurement specific conditions are fulfilled.</p>
<b>Unlock Settings</b>	<p>Unlocks both the measurement and hardware setting.</p>

**Figure 12:** Measurement info dialog box

**Table 3:** Measurement menu

### 6.3. Hardware Menu

The hardware menu contains general options related to measurement devices used by CalStan.



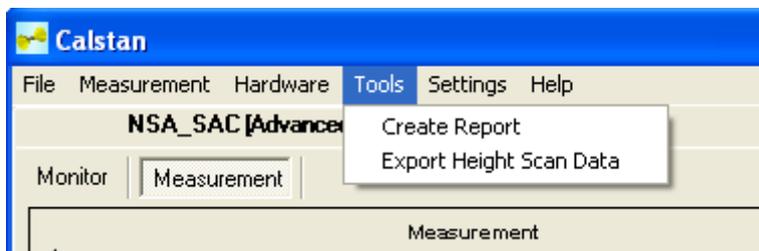
**Figure 13:** Hardware menu

<b>Detect Devices</b>	<p>Detects GPIB measurement instruments connected to the computer. If a detection procedure is successful, a dialog box with a list of devices pops up, showing information about device manufacturer, model and communication interface. After closing the device detection dialog box, the appropriate device drivers are selected in the hardware settings panel.</p>
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**Table 4:** Hardware menu

### 6.4. Tools Menu

The tools menu contains various options applicable to an active measurement.



**Figure 14:** Tools menu

<b>Create Report</b> (disabled in demo mode)	<p>Creates the measurement report according to the active measurement procedure. The report is saved in MS Excel file format, in a user defined directory. In general the report contains measured data as well as computed results together with all settings used during the measurement. See specific measurement procedure for further details.</p>
<b>Export Height Scan Data</b>	<p>Saves the heights scan sweeps data in MS Excel file format. This function is available only in the measurement types which includes height scan.</p>

**Table 5:** Tools menu

## 6.5. Settings Menu

Overall application settings can be set in this menu.

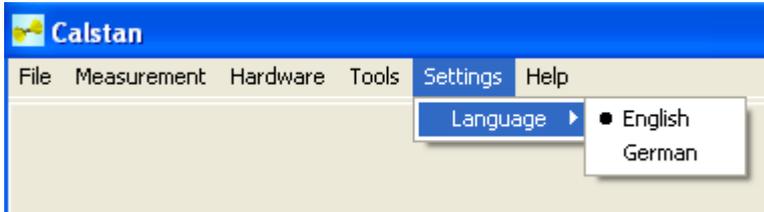


Figure 15: Settings menu

<b>Language</b>	The program language can be selected; currently only English and German are available. English is the default language.
-----------------	---

Table 6: Settings menu

## 6.6. Help Menu

The help menu contains software related information, such as access to the manual and a list of installed components. From this menu is also possible to run the online updater.

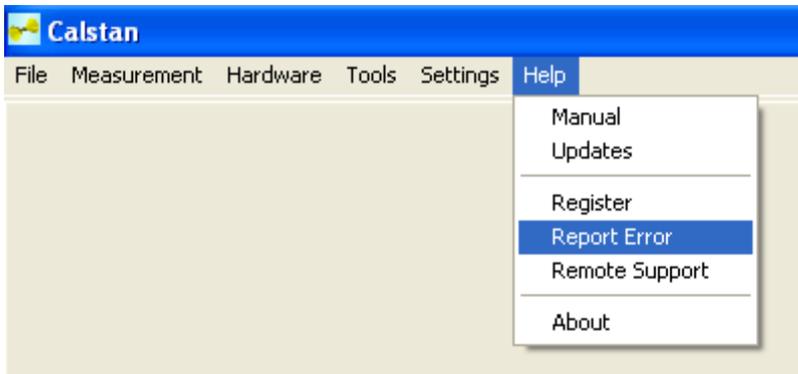


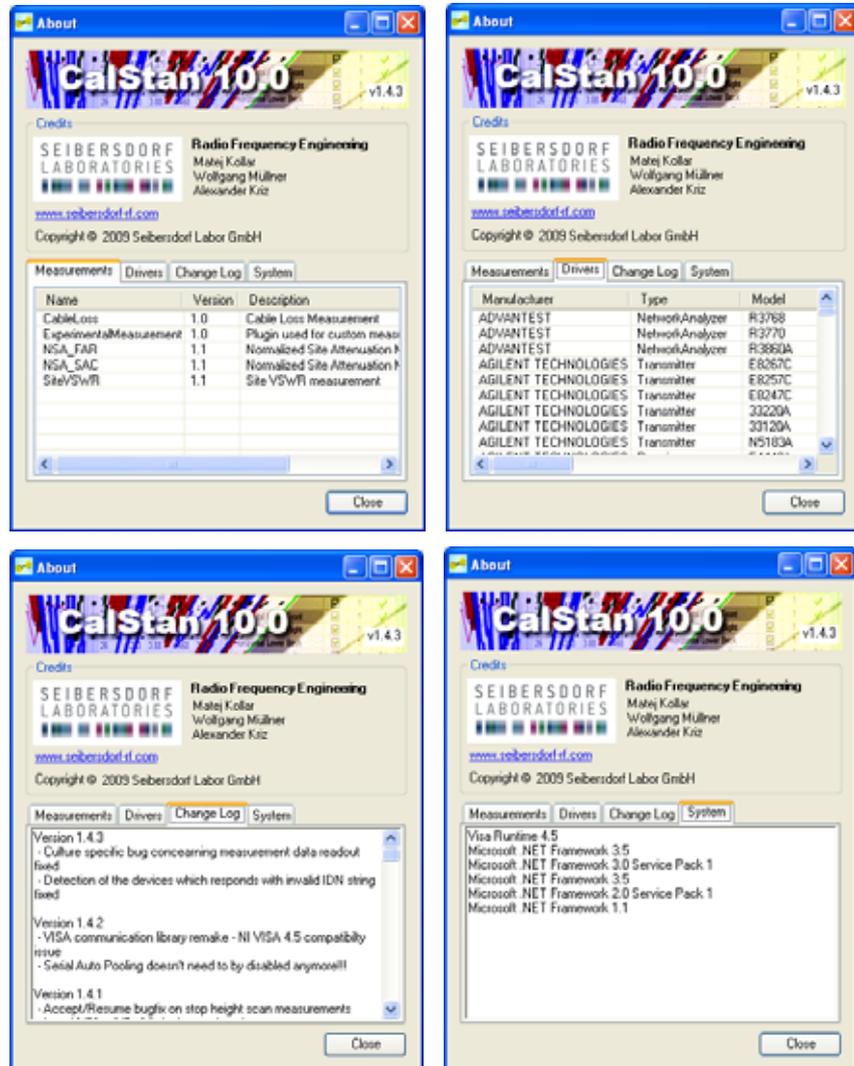
Figure 16: Help menu

<b>Manual</b>	Opens the CalStan manual which is stored in pdf format (Adobe Acrobat Reader or other pdf reader application is needed).
<b>Updates</b>	Software updates can be downloaded (see chapter 3.2).
<b>Register</b>	Opens the registration form which is used for Calstan registration. By registering you provide us with your email address and Calstan version, so we can inform you about important updates.
<b>Report Error</b>	If you encounter problem with our software, by this item you can generate special report file. Send us this file together with your problem description and we will provide you with our support.
<b>Remote Support</b>	<p>If problem occurs with a measurement performed by Calstan, we can provide you with online support directly at your computer running the measurement. All you need is the internet connection and if the “Ready to connect” icon appears at the bottom of the quick support dialog (Figure 17), by sending us the ID and Password you allow us to remotely control your computer and to examine the problem directly. This is necessary if there is some specific device error, which can't be reproduced at our side.</p> <div data-bbox="539 871 1163 1675" data-label="Image"> </div>

**Figure 17:** Quick support dialog for remote control

## About

Opens a dialog box which shows various information about the installed CalStan software including program version and a list of the installed measurements and device drivers (**Figure 18**). It also contains version changes history (Change Log) and system information.



**Figure 18:** Dialog boxes in the About dialog

**Table 7:** Help menu

## 7. CALSTAN 10.0 SETTINGS

This section describes parameters used in most measurement procedures.

### 7.1. Measurement Settings

The measurement setting panel is located in the lower left corner of the measurement window (**Figure 9**). It contains all measurement specific parameters such as frequency range or frequency steps and others. For measurements which involves height scan, the Height Receive Antenna parameters defines the mast movement. The start/stop heights and movement type (discrete or continuous). The height scan can be also disabled by setting the “Heightscan” parameter to “No”.

Measurement Settings		
Frequency Range		
Start	301MHz	
Stop	1000MHz	
Height Receive Antenna		
Start	100 cm	
Stop	400 cm	
Heightscan	Yes	
Movement	Continuous	
Receive Antenna Factor		
File	none	
Cable Loss		
File	none	
Frequency Step		
File	frequencystep.par	
Protective Attenuator		
File	none	

**Figure 19:** Measurement settings panel, for e.g. Site VSWR measurement

#### 7.1.1. Frequency Step

Measurements with CalStan 10.0 are done at discrete frequencies (frequency steps). The discrete measured points are displayed as a line plot in the measurement display window. Measurement results are only correct if the frequency resolution is high enough to cover any 'peaks' or 'resonances' within the measurement range.

These frequency steps are defined in the “*Frequency Step*” dialog box which can be opened by clicking the folder icon in the related row of the measurement settings panel.

In the “*Frequency Step*” dialog box (**Figure 20**) the frequency resolution of several frequency bands can be defined individually. The frequency bands must not overlap.

Open the frequency step dialog box by clicking on the folder symbol. In the pop up window frequency steps can be edited, additional frequency steps can be inserted or existing ones deleted by right mouse click.



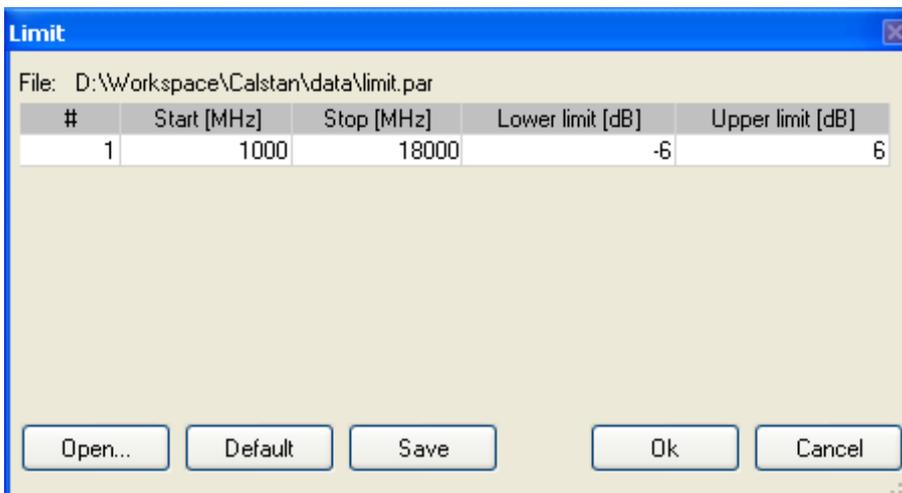
**Figure 20:** The „Frequency Step“ dialog

The frequency steps can be loaded from or saved to a file using the “Open” and “Save” buttons. The frequency steps are classified as an interval dependent parameter; the “.par” file extension is used for this file type.

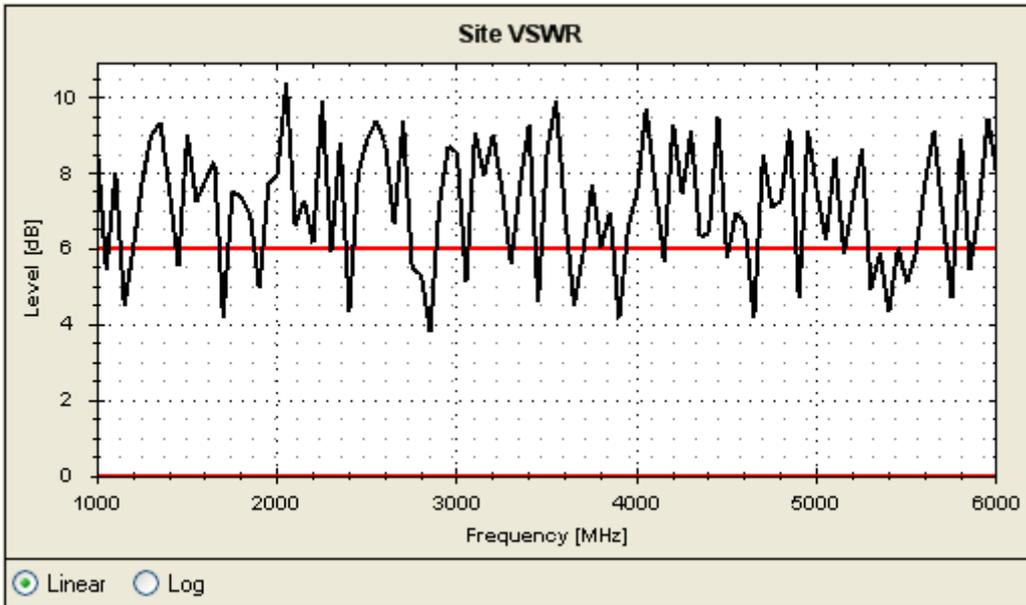
The default frequency steps are recommended for most of the measurement procedures and can be restored by clicking the “Default” button.

### 7.1.2. Limit

To determine if the measurement results fulfill a particular tolerance, limit boundaries are defined for specific frequency intervals. These intervals are specified in the “Limit” dialog box (**Figure 21**) which can be opened by clicking the folder icon in the related row of the measurement settings panel. When displaying the result chart, the limit data are displayed too. **Figure 22** shows the situation when measurement results are not within the specified limit interval.



**Figure 21:** The „Limit“ dialog box

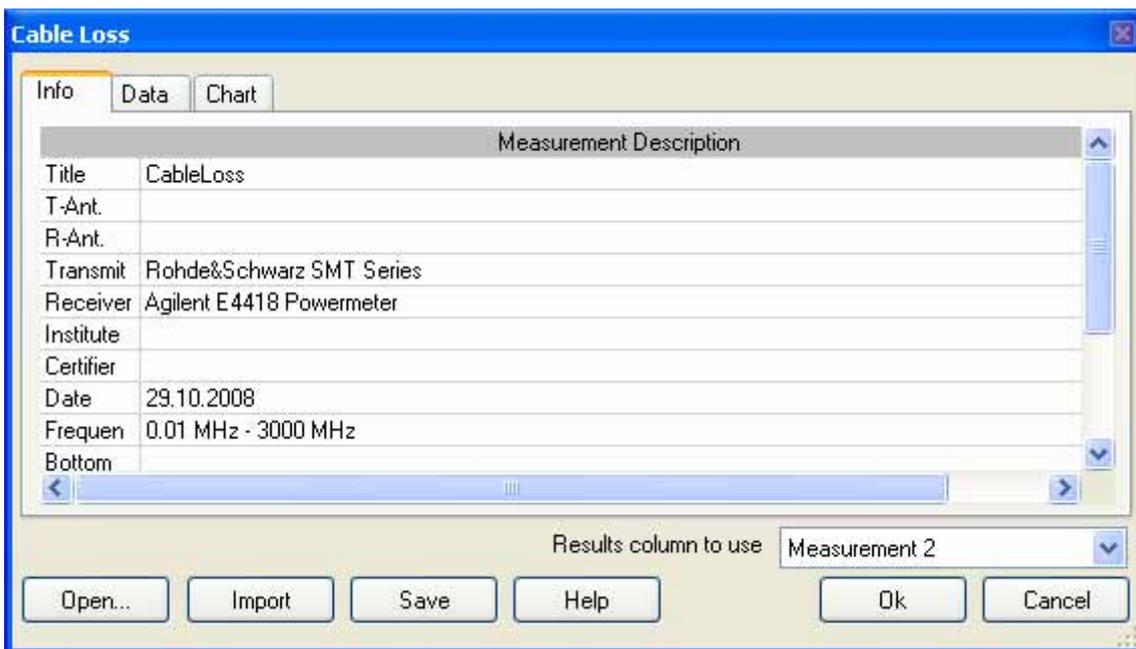


**Figure 22:** The limit boundaries in the measurement result chart

### 7.1.3. Factor files

Some measurement types require various factor files to be set their measurement settings. This involves cable loss factor, transmit/receive antenna factors, dual antenna factors and others. By clicking the folder button in the measurement settings panel at the certain factor file parameter, factors file dialog pops up (see **Figure 23**). This dialog contains three tab pages:

1. Info page – displays description of the given factor measurement (see **Figure 23**)
2. Data page – shows factor data (see **Figure 24**)
3. Chart page – here the factor data chart is drawn (see **Figure 25**)



**Figure 23:** Factor file dialog – Info tab

At the bottom of the dialog the factor data from a CalStan 10.0 native format can be loaded by clicking the Open... button

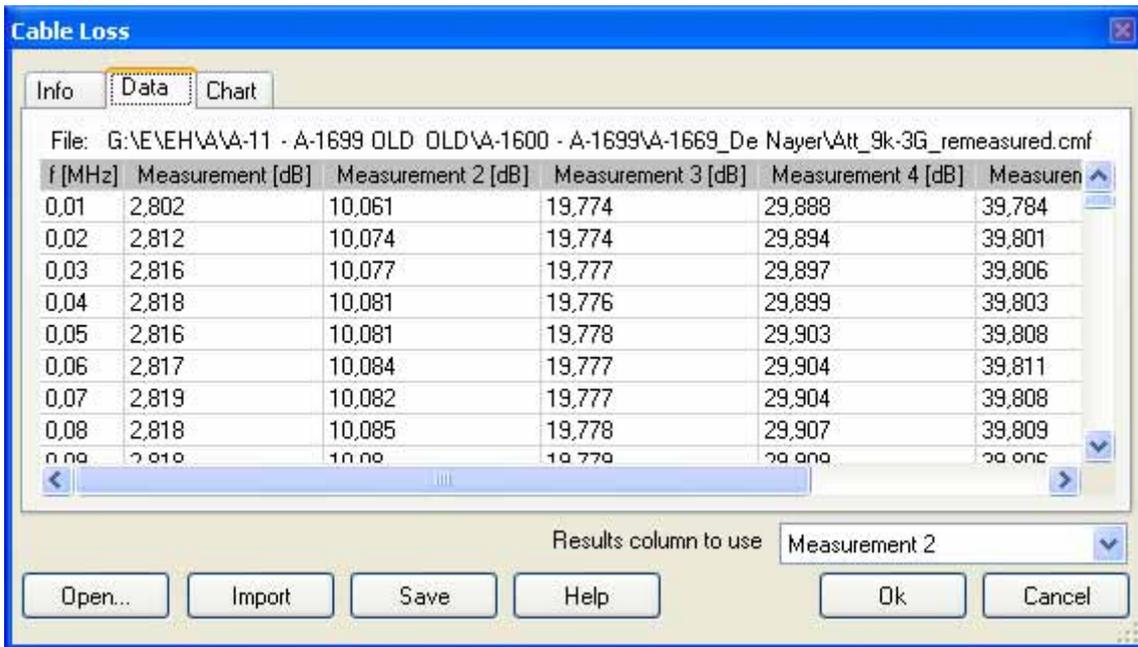


Figure 24: Factor file dialog – Data tab

**Important!**

The combo box located above the Ok and Cancel buttons is used for setting of the proper results column which is intended to be used for results calculation later. This combo box is shown only if the distinction among more results contained in the factor data have to be made.

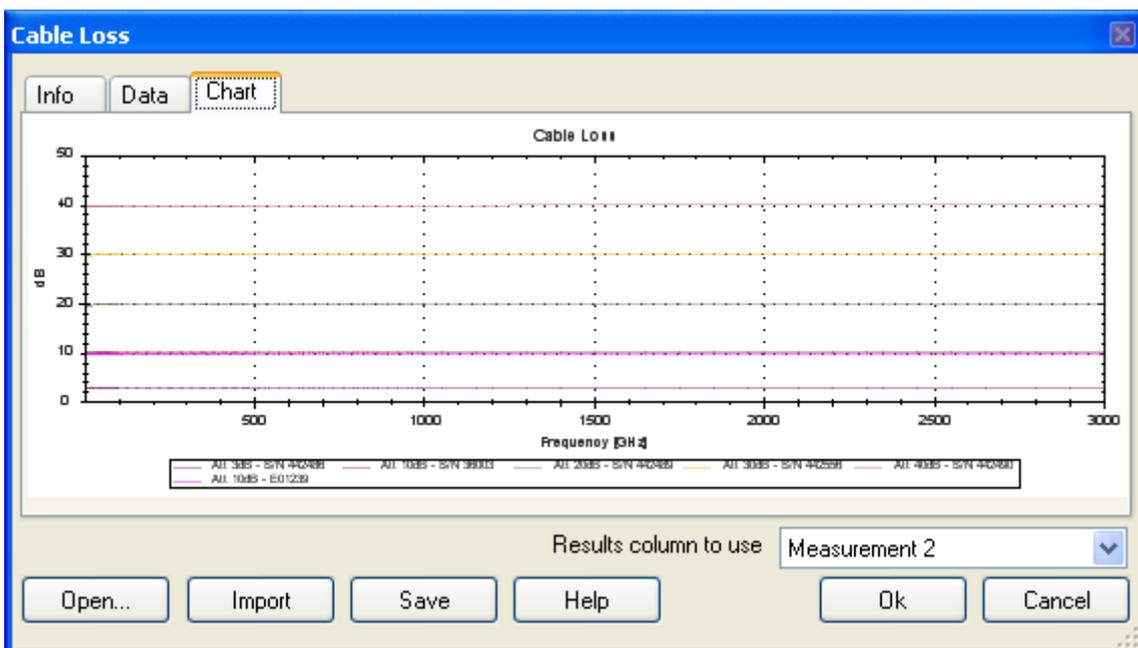
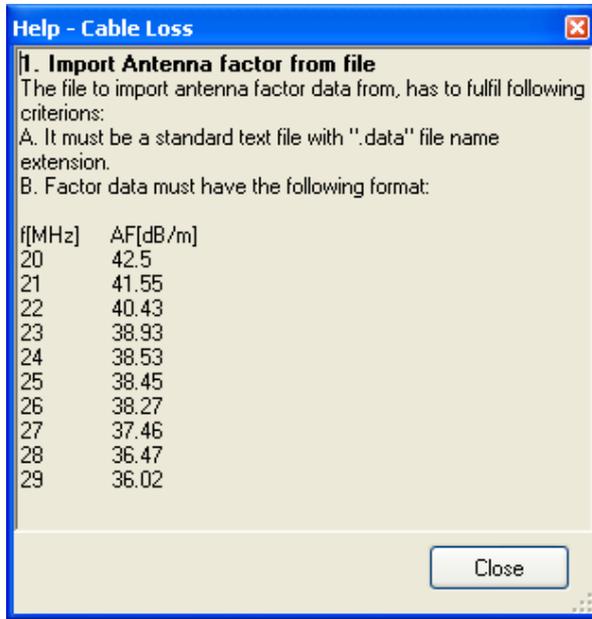


Figure 25: Factor file dialog – Chart tab

Another option is to import factor data from a text file. In the Info tab page the factor measurement description can be filled to available fields. Then switching to Data page and clicking the Import button a text file with “.data” file extension containing the physically measured values can be loaded. This can be for example tab-separated file exported from MS Excel spreadsheet (File->Save As... – Data Type = Tab-Separated values file). The exact format of the “.data” file is shown in separate dialog (**Figure 26**) if Help button is pressed.



**Figure 26:** Help dialog – Cable loss import file format.

Factor file imported this way can be then saved in the Calstan 10 native format to make loading more convenient if needed next time.

## 7.2. Hardware Parameters

The selection of measurement instruments and instrument settings is done in the respective hardware parameter dialogues.

Every measurement type uses specific set of hardware. E.g. for Site VSWR procedure a transmitter, receiver, and optionally positioner is needed. NSA measurement above ground plane incorporates transmitter, receiver and antenna mast. If some of the devices are set to [None], then the device is not used in measurement procedure. In the case of NSA SAC it means, no height scan is performed.

The parameters of the different measurement devices depend on the capabilities of the instrument.

Network analyzers can be chosen in the receiver category. Choosing one automatically sets the transmitter type to [None] and it is not possible to set another transmitter unless the receiver is changed to a spectrum analyzer or test receiver.

## 7.2.1. Instrument Parameters

The instrument parameters itself are explained on the example of a receiver.

Receiver	
Demo	
Parameters	
Address	2
Force Initialisation	No
Frequency Mode	Single
Sweep Time	1 s
Input	1
Input Attenuator	10 dB
Preamplifier	False
Span	10 kHz
Vbw	10 kHz
Rbw	10 kHz
S-Parameter	none
Manufacturer	S11
Model	S21
Frequency Range	S12
Type	S22
Interface	none
Receiver Parameters	
File	receiver.par

**Figure 27:** The hardware panel – device settings for Demo-Receiver

To setup measurement device parameters in general, the panel displayed in **Figure 27** is used (for every device type e.g. receiver, transmitter, etc. a panel exists). At the top of this panel a drop down list exists where the specific device can be selected. For illustration purposes the “Demo” receiver driver was used.

The “*Parameters*” section of this table stores parameters which can be edited by clicking the value cells. The editing style of each parameter depends on its definition in the device driver which reflects capabilities of the device. For example some parameters are restricted to a certain list of values, which the drop down list represents. If a parameter has a range of valid values defined the entered value is checked. By holding the mouse cursor over the value the range of values is shown in a small tool tip (**Figure 27**). A value can be entered with a unit specification (e.g. kHz) otherwise the unit shown in the title is assumed.

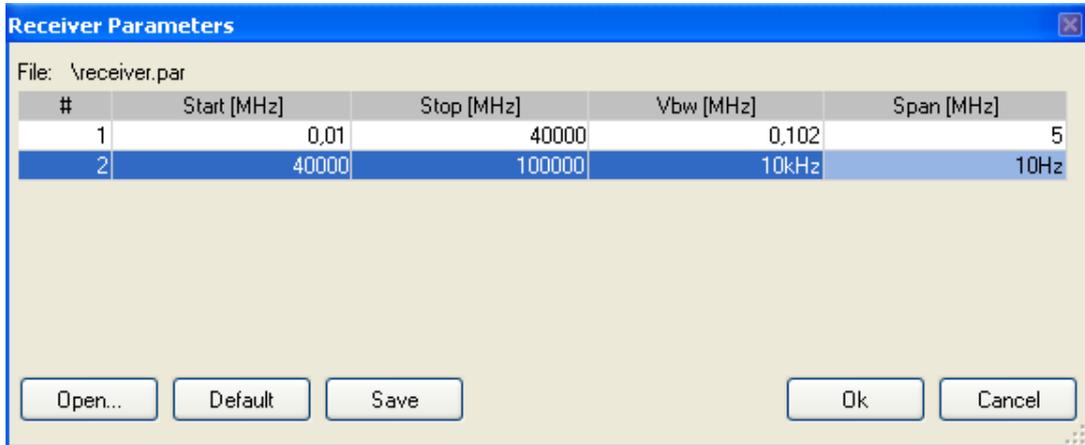
To communicate with an instrument the address parameter has to be set correctly. In case of GPIB devices, the IEC address is detected automatically if “Detect GPIB devices” from Hardware menu is used (see 6.3). For instruments connected via other interfaces (R232, Ethernet) the address have to be set manually.

The “*Device Info*” of the hardware panel contains general information about the device such as manufacturer name, model type, frequency range etc. These values have only informative character and can not be edited as indicated by the small lock icon at end of the row.

### Important!

Unit of the measured data values depend on the receiver hardware settings. If a receiver or spectrum analyzer is used the units are dBm. In the case of Network Analyzer data units depends on S-parameter. Setting it to S11/S22 read out data has no unit on the other hand S12/S21 configuration produces output in dB.

Some parameters can be set to the special parameter file (e.g. “Transmitter Parameters” or “Receiver Parameters”). This means that the parameter is frequency dependent and its value is set individually for specific frequency intervals via the parameter file (table). The parameter file can be accessed by clicking the yellow folder button located in the lower right corner of the panel (**Figure 27**).



**Figure 28:** Device parameter file dialog box.

The parameter file (**Figure 28**) only contains the columns for parameters which are set to the “Parameter File” value. New rows can be inserted into the table via context menu “*Insert*” function. The list of values can be seen by holding the mouse cursor over the specific cell. Values can be entered with or without unit. If no unit is specified, the default unit is used, as listed in the column header.

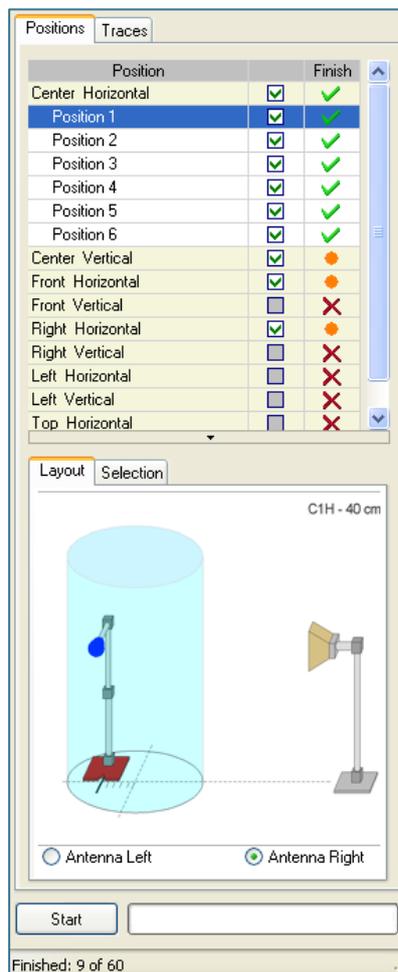
## 8. STARTING THE MEASUREMENT

Every measurement type contains the measurement control panel where the measurement configuration is set and the measurement is started from. For the sake of completeness all features of the measurement control panel are described in this chapter.

As an example the panel from a **Site VSWR measurement** is shown. The layout is divided into two tabs.

The “*Positions*” tab (**Figure 29**) in the upper part shows a table with a list of measurement positions. Its columns have the following meanings:

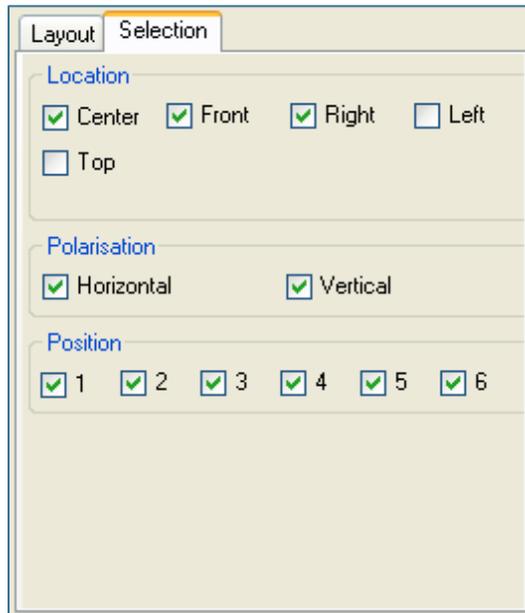
1. The name of the position - when clicked, the position is set active and is drawn in a bold line in the chart.
2. The check box - indicator if the position’s data are displayed in the chart.
3. The finish status of the position – green hook means finished, orange circle marks partially finished measurement and red cross means not finished at all.



**Figure 29:** Measurement control panel - Positions view

In the lower part of the “*Positions*” tab a graphic shows the layout of a currently active position (the “*Layout*” tab). With the radio buttons “*Antenna left*” and “*Antenna right*” the picture can be adjusted to show the antenna positioned left/right equal to the measurement set up.

In the “*Selection*” tab (**Figure 30**) appropriate check boxes can be used for convenient selecting/deselecting specific measurement positions. This panel can also be accessed via context menu of the positions table.



**Figure 30:** A selection filter.

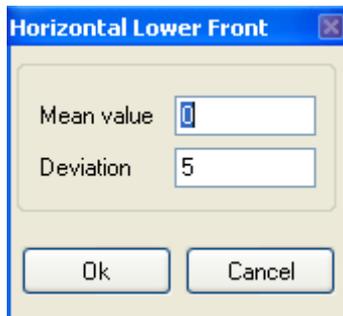
The “*Traces*” tab (**Figure 31**) includes a table with a list of measurements finished at the active position. The columns have the following meaning:

1. Trace number
2. Comment – short text describing the measurement (user defined; after a second measurement of the same measurement point, the input of a comment is requested)
3. Indicator (green dot) which trace is considered as the final (used for results computation – in some measurement types whole results are recalculated if this is changed). To set a specific trace active use the context menu “*Set as active*” function.



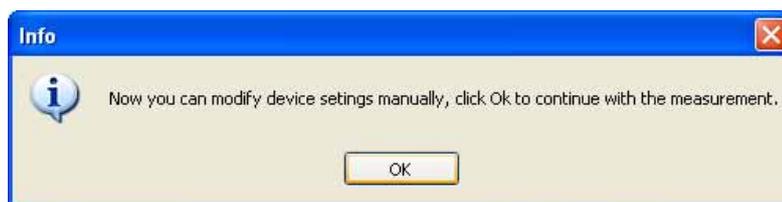
**Figure 31:** Measurement control panel - Traces view

By clicking the “Start” button of the measurement control panel the measurement procedure starts. If the demo receiver driver is used, a small dialog box pops up (**Figure 32**) and a mean value together with a deviation can be set. Then, the demo receiver driver generates a random data set with specified characteristics.



**Figure 32:** Demo measurement parameters

If the measurement is started for the first time, the devices are initialized and a calibration dialog box appears (**Figure 33**).



**Figure 33:** Devices calibration dialog box.

At this point some manual settings on devices can be done before the measurement is started. After the “OK” button is pressed the measurement starts immediately. The devices are initialized only once at the first start of current measurement. If you want to force re-initialization of a selected device due to a change of a parameter before next start, the “Force Ini” parameter has to be set to “Yes”. Changed parameters will then be sent to the devices.

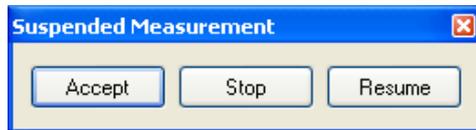
During the measurement the “Start” button is replaced by a “Stop” button. A progress bar is updated while the measurement is running. At the same time the measurement chart area is changed to the monitor display, which shows measurement data as they are read from the devices. At the very bottom of the measurement control panel a status panel indicates the number of already finished measurement positions to the total number of position to be measured.



**Figure 34:** Measurement progress bar

To stop the measurements click the “Stop” button. The suspend measurement dialog box pops up (**Figure 35**) and all devices stop immediately. There are several options how to proceed further:

1. Stop the measurement and discard the data measured so far (since the start button was pressed). Click the “Stop” button for this option.
2. Stop the measurement and preserve the data measured so far. Click the “Accept” button for this option.
3. Resume the measurement – continues the measurement from the stop position. Click the “Resume” button for this option.



**Figure 35:** Suspended measurement dialog box.

During the measurement the data is displayed in the “Monitor” tab of the “Measurement display”. An acoustical signal indicates the end of the measurement.

## 9. RESULTS - MEASUREMENT DATA DISPLAY

The results of the measurement are displayed in the "Measurement display" in the "Results" tab. For the sake of completeness all tabs are described in this chapter.

The first tab ("Monitor") shows the actual measurement data during a measurement progress (Figure 36).

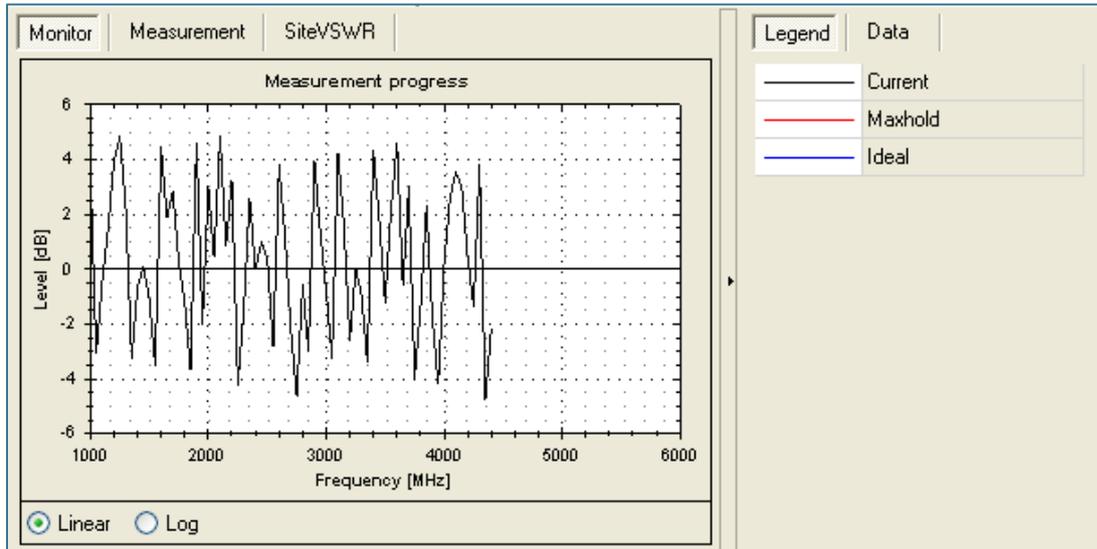


Figure 36: The monitor display (random data).

The next tab marked as "Measurement" shows raw measurement data after a measurement is finished (Figure 37).

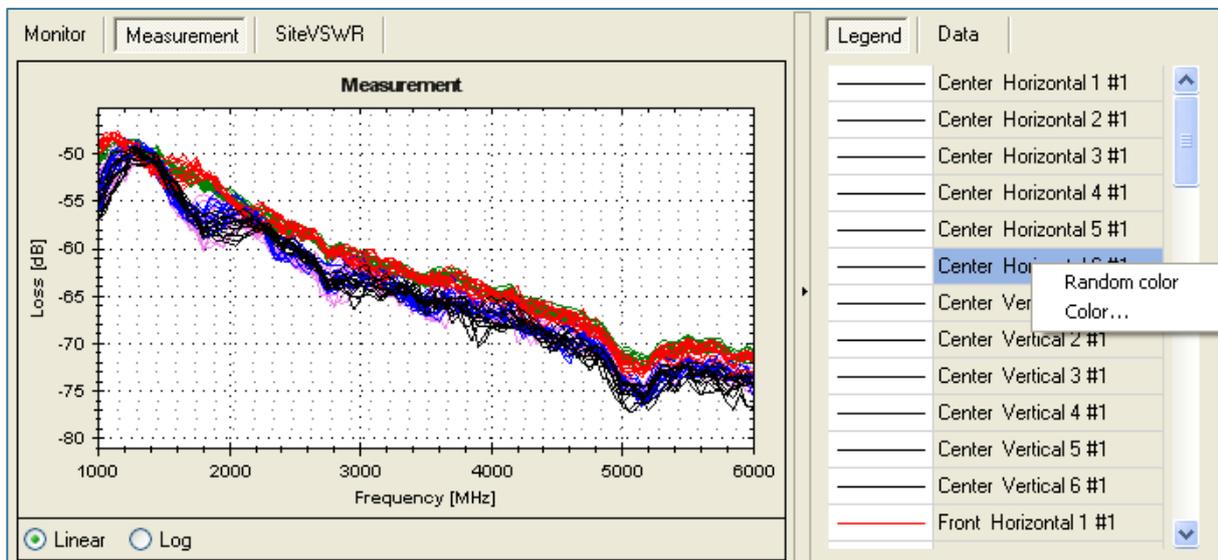
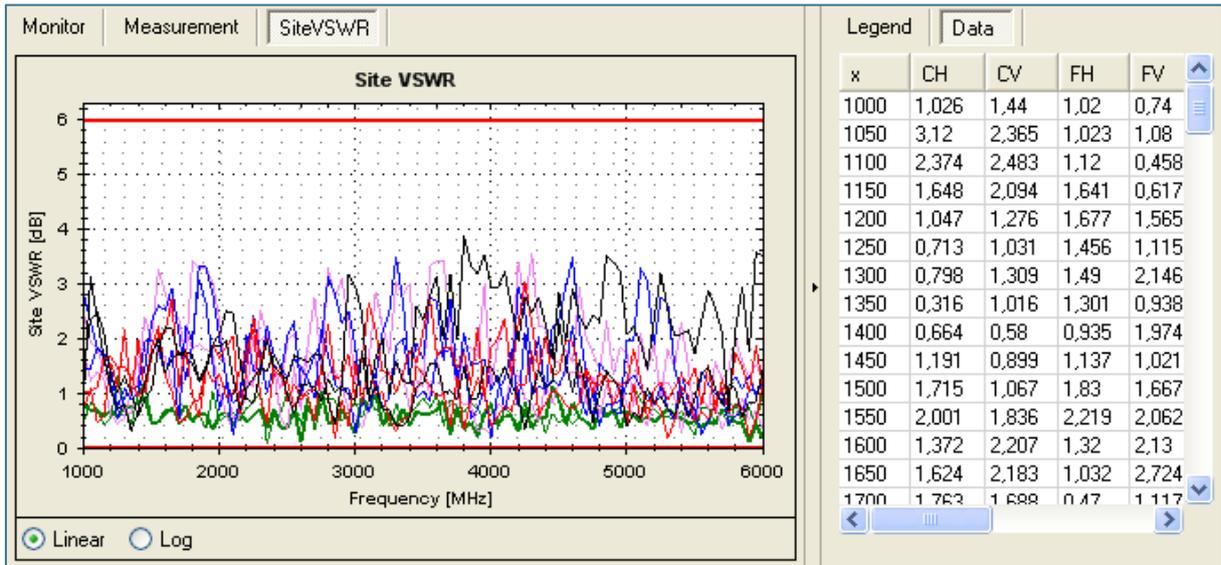


Figure 37: The measurement display and context menu in the legend tab for color selection.



**Figure 38:** The results display with data tab selected (random data)

The “SiteVSWR” tab ( **Figure 38**) shows the calculated results for Site VSWR measurement and the specified limit boundaries. Some measurement procedures can have more than one result tab and can display various data.

By using the radio buttons at the bottom of the chart area it is possible to switch between linear and logarithmic scale of the domain axis.

The right part of the chart area is dedicated to display various data within the chart.

The “Legend” tab (**Figure 37**) contains a list of displayed curves. With mouse right click on this panel a context menu can be accessed to change the color of the selected curves. Curves can be selected individually or a multi selection can be done by holding the “Shift” key. The color code can be randomized (“Random Color”) or selected from a color table which pops up by clicking the “Color...” menu entry.

The “Data” tab (**Figure 38**) holds a table of values displayed in the chart. The first column always contains the domain axis values (e.g. frequency) and the other column refers to the range axis values of the specific curve. Data from this table can be copied to the clipboard by selecting the appropriate rows/columns (hold “Shift” key for multi selection) and pressing “Ctrl+C” key combination. Then the data can be pasted (“Ctrl+V”) e.g. to MS Excel, for further processing.

Additionally the data listed in the table can be sorted according to a specific column by clicking the column header.

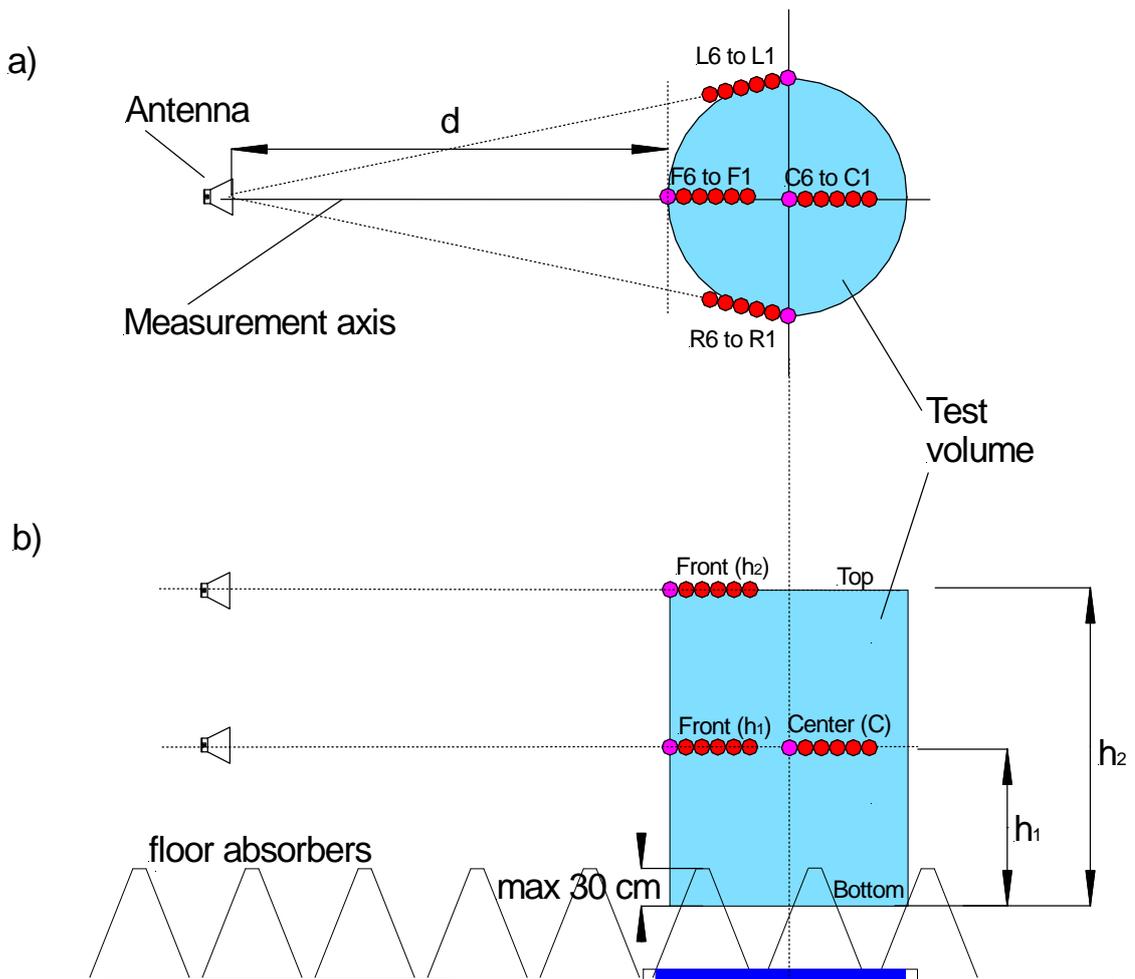
## 10. MEASUREMENT PLUG-INS

Different measurement procedures are described in this section.

### 10.1. Site VSWR

In CISPR 16-1-4 [1] a technique to validate fully anechoic rooms in the frequency range 1 – 18 GHz is described. This method is called Site VSWR.

The POD Antenna and the POD Antenna Stand developed by Seibersdorf Laboratories are designed for this purpose. The software CalStan 10.0 controls measurement instruments (e.g. a network analyzer) to run the tests. Not all information required to perform a Site VSWR test is included in this manual but it gives guidance how to use the products.



**Figure 39:** Location of test points for Site VSWR  
a) top view  
b) side view

In **Figure 39** the heights  $h_1$  and  $h_2$  are depending on the test volume of the chamber. The height  $h_1$  is either half of the height of the test volume, but maximum 1 m and  $h_2$  is the height of the test volume (see also at CISPR 16-1-4).

Also the locations of the test positions according to the standard are shown. Each location requires a sequence of six points on a line to the receive antenna reference point. These six positions are distributed unequally over a 40 cm line.

To help the user to place the POD Antenna Stand correctly a ruler is included in the base plate. On the ruler the designation of the position P1 to P6 (indicating the six measured points on the four possible locations: front F, center C, left L and right R) are marked as well as the distances to P6 in cm.

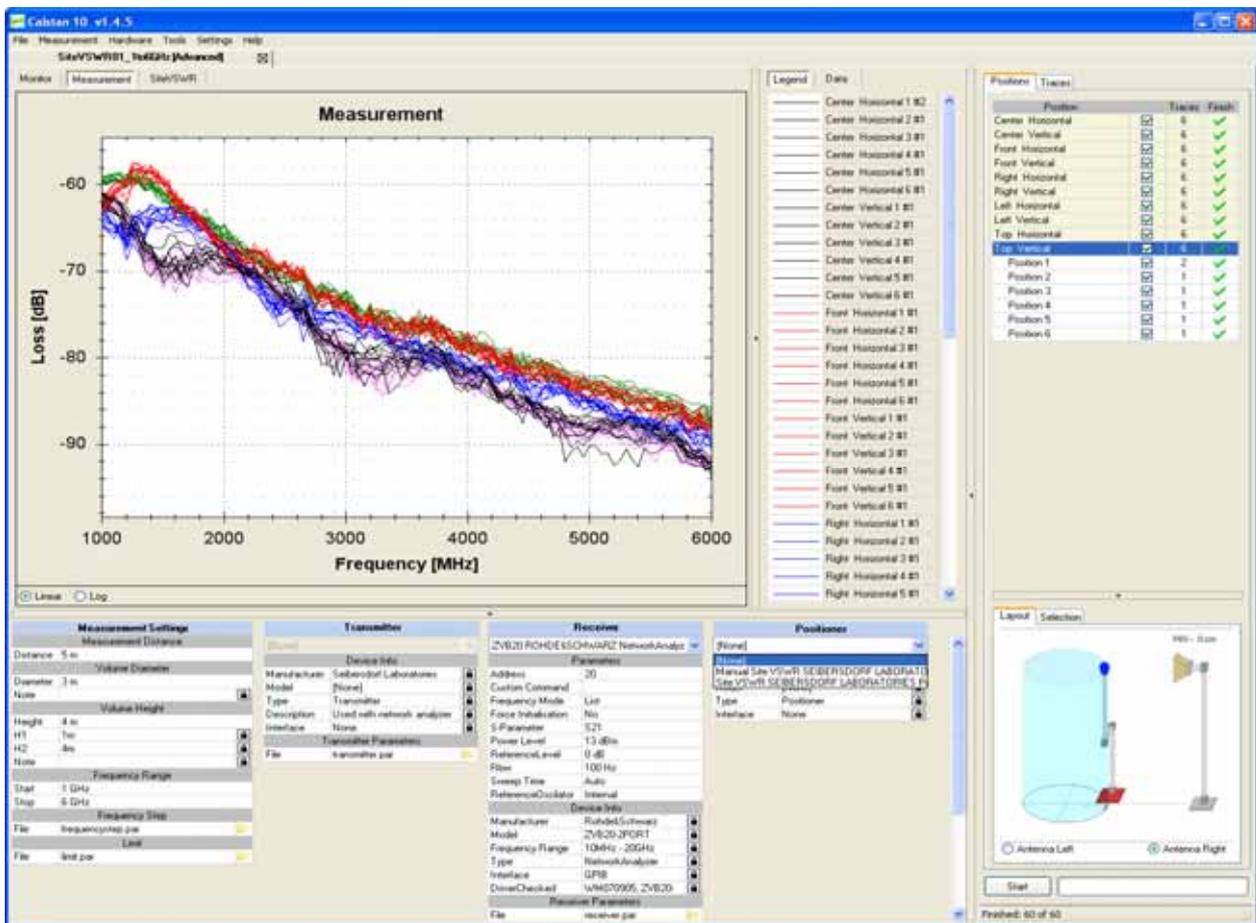
### 10.1.1. Setup

Before starting the measurement all measurement parameters have to be defined in the "Measurement Settings" panel (**Figure 40**, lower left). For a volume diameter of 1.5 m and less the Center position must not be measured.

When the volume height is set the H1 and H2 values are calculated automatically. If the volume height is lower or equal to 1 m the top position does not need to be measured.

The frequency range is set to 1 GHz - 6 GHz when using the POD 16 and to 6 GHz – 18 GHz when using the POD 618. Please check the frequency step parameter file for consistency with the standards requirements of 50 MHz step size. If needed, adjust the limit parameter file.

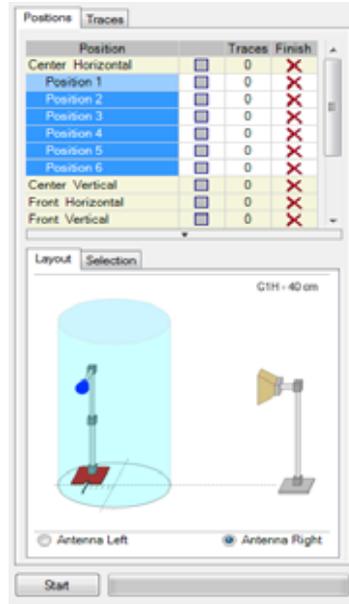
The POD antenna can be positioned manually or using automated positioner. As shown in **Figure 40**, there are 3 positioner options. [None] and Manual represents manual positioning, only difference between them is that if Manual is set, message box with desired position information is displayed at each position. Automated positioner measures all positions which are selected in the positions table, one after another.



**Figure 40:** Site VSWR window

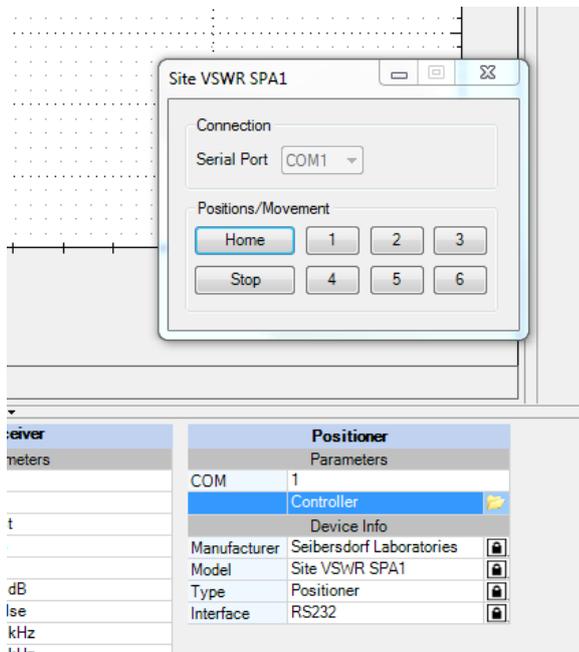
## 10.1.2. Using SPA1 Automatic Site VSWR Positioner

Using the automatic positioner, the measurement procedure can be highly automated. By selecting more positions at once (**Figure 41**: Selecting multiple positions to be measured automatically) and clicking the start button, the positions are measured one after another as the positioner moves the antenna to appropriate distances.



**Figure 41:** Selecting multiple positions to be measured automatically

The specialized tool can be used for controlling the SPA1 positioner (e.g. for moving to the home position). This tool is executed by clicking the yellow icon in the device parameters panel (**Figure 42**: SPA1 Controller GUI).



**Figure 42:** SPA1 Controller GUI

### 10.1.3. Measurement Procedure and Result Calculation

The measurement campaign of the Site VSWR contains 60 measurements at maximum. Six positions (1-6) are measured at 5 locations (left, right, center, front, top) for 2 polarizations (horizontal, vertical). All six positions are depicted in the start measurement panel as shown in the right part of **Figure 40**.

The results for a specific location e.g. center horizontal (index "A") are calculated when the last of the appropriate six positions "i" is measured. This means, that if a user decides to re-measure one of the six already finished positions, the result is recalculated. If a user sets different traces of a position active, the result is also recalculated.

The result for a specific location with index "A" is computed as follows:

$$\text{VSWR A} = \max(\text{modif}_{A,1}, \text{modif}_{A,2}, \dots, \text{modif}_{A,6}) - \min(\text{modif}_{A,1}, \text{modif}_{A,2}, \dots, \text{modif}_{A,6})$$

where  $\text{modif}_{A,i} = \text{corr}_{A,i} + \text{mes}_{A,i}$

with:

$$\begin{aligned} \text{corr}_{A,6} &= 20 * \log_{10}((D + 0.00)/D), \\ \text{corr}_{A,5} &= 20 * \log_{10}((D + 0.02)/D), \\ \text{corr}_{A,4} &= 20 * \log_{10}((D + 0.10)/D), \\ \text{corr}_{A,3} &= 20 * \log_{10}((D + 0.18)/D), \\ \text{corr}_{A,2} &= 20 * \log_{10}((D + 0.30)/D), \\ \text{corr}_{A,1} &= 20 * \log_{10}((D + 0.40)/D), \end{aligned}$$

$\text{mes}_{A,i}$  is a measured value at the specific location "A" in position "i" where

$$\begin{aligned} D &= d && \text{for front and top location,} \\ D &= d + r && \text{for center location,} \\ D &= \sqrt{(d + r)^2 + r^2} - 0.40 && \text{for right and left location,} \end{aligned}$$

where "d" is a distance of the receiver antenna from the volume diameter and "r" is radius of the volume diameter (in meters).

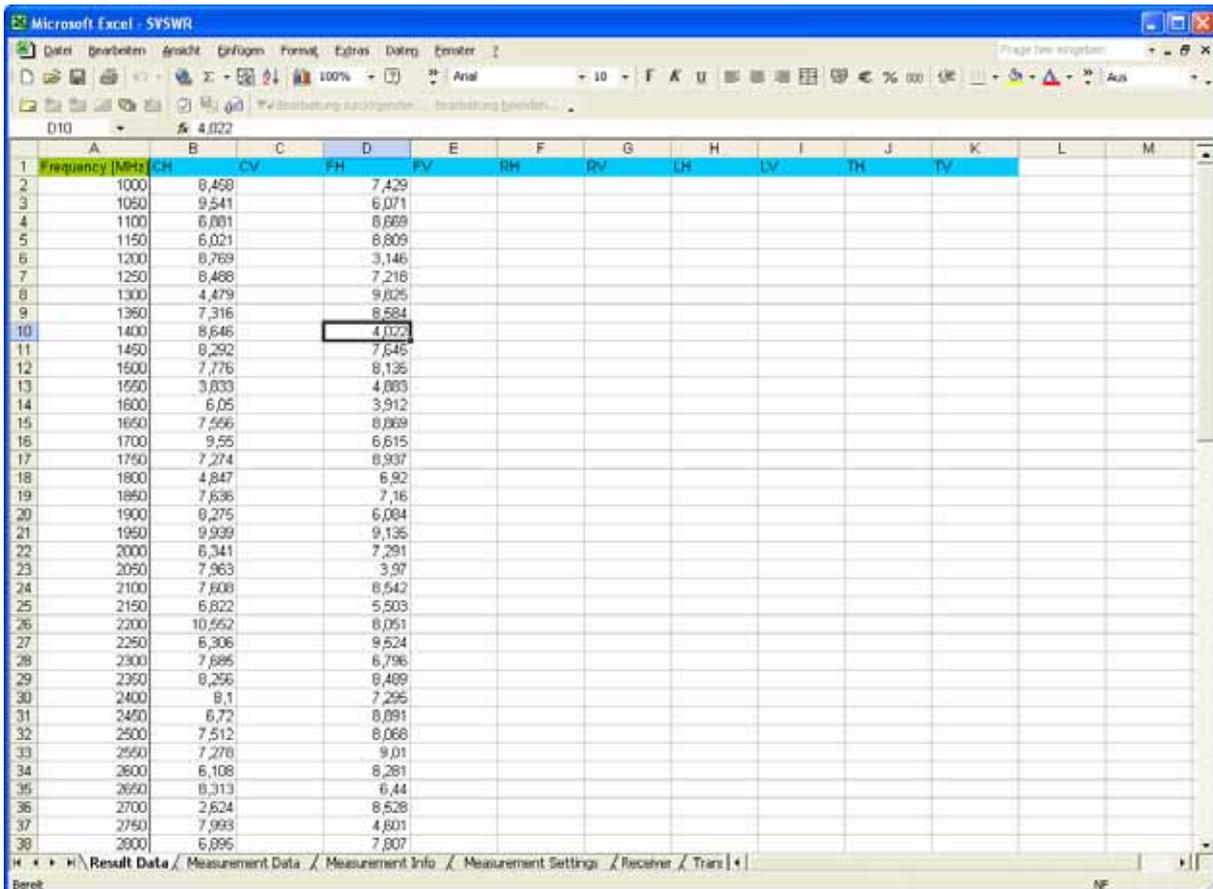
### 10.1.4. Report Format

As described in section 7.4 the measurement output can be exported to a MS Excel format. **Figure 43** shows an Excel document containing several worksheets and **Table 8** describes the content of the EXCEL file.

<b>Result Data</b>	Shows results computed from measured data. First column contains frequency values, while the others hold values for specific measured locations. The column headers are shortened location names ("CH" -> Center Horizontal). As only two locations were measured, only data for Center Horizontal and Front Horizontal positions are present.
<b>Measurement Data</b>	Include raw measurement data for every measured position.

<b>Measurement Info</b>	Contains the same information as the Measurement Info dialog box – general measurement data.
<b>Measurement Settings</b>	Mirrors the Measurement Settings panel.
<b>Transmitter, Receiver</b>	Hold the device parameters used for measurement.

**Table 8:** Description of the MS Excel file



**Figure 43:** Measurement output exported to a MS Excel file.

### 10.1.5. Literature

- [1] CISPR 16-1-4 Consol. Ed. 2.1-2008 & am2 Ed.2.0, Specification for radio disturbance and immunity measuring apparatus and methods Part 1-4: Radio disturbance and immunity measuring apparatus - Ancillary equipment - Radiated disturbances

## 10.2. NSA SAC (Semi-anechoic chambers)

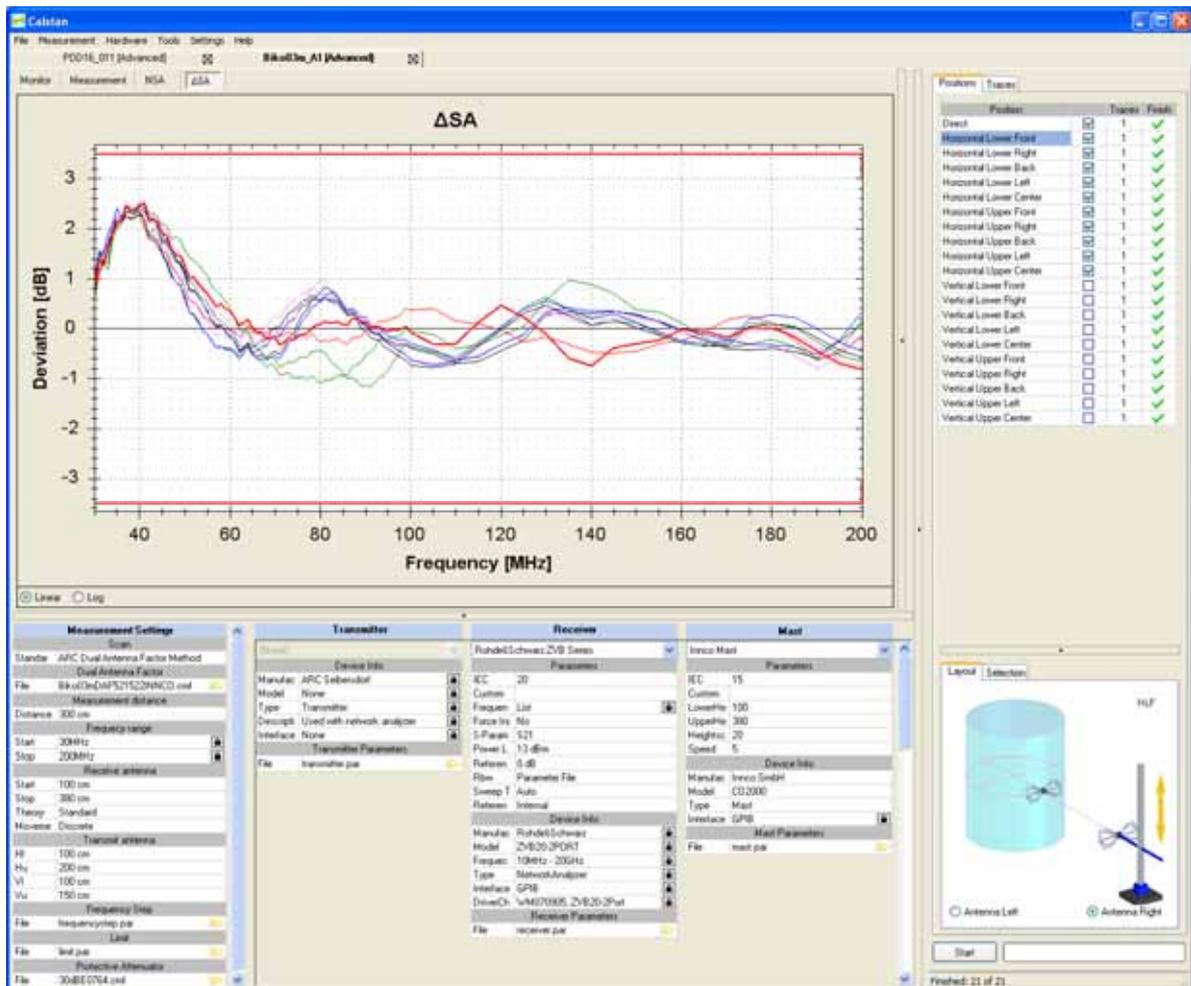
Normalized site attenuation (NSA) measurements, in semi-anechoic chambers or on open area test sites, carried out with broadband antennas are implemented in CalStan 10.0 according to following standards:

ANSI C63.4
ANSI C63.5
CISPR 16-1-4
Site Reference Method
Arc Dual Antenna Factor Method

**Table 9:** List of NSA SAC standards.

The measurement procedures described in the different standards are rather similar. Big differences can be found in the definition and application of the antenna factors.

For all procedures the "volume method" has to be applied: This means that the transmit antenna connected to the signal generator has to be placed at 5 positions on the turntable. These positions are specified in the referenced documents. Furthermore the transmit antenna has to be operated in two heights and both polarizations. The receive antenna is kept co-polarized at constant horizontal distance and is always facing the transmit antenna. Transmission loss between transmit and receive antenna is measured according to the standard test procedure (height scan of the receiving antenna) for each frequency and polarization.



**Figure 44:** NSA SAC measurement window.

## 10.2.1. Setup

Before starting the measurement all measurement parameters have to be defined in the "Measurement Settings" panel (**Figure 44**, lower left).

1. First of all, select measurement standard and load appropriate antenna factor file(s) for your transmit and receive antennas. If the antenna factor is measured with a different frequency step, the data are interpolated (linear). Receive antenna and frequency range settings will be taken from this "antenna factor" file.
2. Choose the frequency range for the NSA measurement.
3. Adjust the frequency step table if needed.
4. Set the desired limit.
5. Set the protective attenuator (used for  $V_{\text{direct}}$  measurement) or select the "none" option (double click the cell and choose "none" from the drop down list). The protective attenuator value is added to the  $V_{\text{direct}}$  measurement readout of the receiver. The  $V_{\text{direct}}$  measurement value stored in CalStan 10.0 includes already the correction of the protective attenuator value.
6. Select appropriate devices and their parameters. To operate a specific device, the correct IEC (GPIB) address has to be set.

## 10.2.2. Measurement Procedure and Result Calculation

1. Measure  $V_{\text{direct}}$  first. To do so select the "Direct" position in the positions table (**Figure 44**). Connect the generator via the transmit cable and the receive cable to the receiver; two 10 dB attenuators shall be inserted. This configuration ensures that the cable loss of the receive cable is taken into account automatically. If the RefRad is used as generator, the enclosed 30 dB protective attenuator must be used within this measurement.
2. Then  $V_{\text{site}}$  can be measured:
  - Set up the antennas as required by the standard (distance, height, position, polarization).
  - Connect the transmit antenna via one 10 dB attenuator and the transmit cable to the signal generator. Connect the receive antenna to the other 10 dB attenuator and via the receive cable with the receiver.
  - Select the position in CalStan 10.0 and start the measurement.
  - During the measurement the monitor display shows three traces:
    - blue:** the ideal measurement data that would obtain zero dB NSA deviation
    - black:** the actual measurement data for the current antenna mast height
    - red:** the maxhold measurement data

When measuring in vertical polarization, make sure that the cable connected to the antenna does not affect the measured values. For best results we recommend to use a cable with ferrite rings (2 pieces every 10 cm) and the same cable layout of the receive antenna as used during the calibration of the antenna. Especially the distance between antenna and the vertical cable is important.

3. The NSA and the deviations from the NSA (DSA) are calculated automatically after each measured position according to the selected measurement standard (see **Table 10**). To show the results click the NSA or DSA tab in the chart area. If at least one result is shown, the limit-lines are displayed additionally.

The NSA reference values need not to be specified separately. All theoretical factors are computed by CalStan 10.0 using the formulas given in the respective standards.

The results for specific position trace are always computed using the direct measurement trace which was set active at the time of that position trace measurement.

ANSI C63.4 [2]	$\text{NSA} = V_{\text{dir}} - V_{\text{site}} - \text{AF}_T - \text{AF}_R$ $\text{DSA} = \text{Theo} - \text{NSA}$
ANSI C63.5 [3]	$\text{NSA} = V_{\text{dir}} - V_{\text{site}} - \text{AF}_T - \text{AF}_R - \text{GSCF}$ $\text{DSA} = \text{Theo} - \text{NSA}$
CISPR 16-1-4 [1]	$\text{NSA} = V_{\text{dir}} - V_{\text{site}} - \text{AF}_T - \text{AF}_R$ $\text{DSA} = \text{Theo} - \text{NSA}$
EN 50147-2 [standard withdrawn]	$\text{NSA} = V_{\text{dir}} - V_{\text{site}} - \text{AF}_T - \text{AF}_R$ $\text{DSA} = \text{Theo} - \text{NSA}$
Site Reference Method [4]	$\text{DSA} = V_{\text{dir}} - V_{\text{site}} - \text{SA}_{\text{ref}}$
Arc Dual Antenna Factor Method [4]	$\text{NSA} = V_{\text{dir}} - V_{\text{site}} - \text{DAF}$ $\text{DSA} = \text{NSA} - \text{Theo}$
<p>where</p> <p>NSA – normalized site attenuation</p> <p>DSA – deviation from normalized site attenuation</p> <p>Theo - theoretical value of the site attenuation</p> <p><math>V_{\text{dir}}</math> – direct measurement <sup>3</sup></p> <p><math>V_{\text{site}}</math> – values measured at the site</p> <p><math>\text{AF}_T</math> – transmit antenna factor</p> <p><math>\text{AF}_R</math> – receive antenna factor</p> <p>GSCF – geometry specific correction factor</p> <p><math>\text{SA}_{\text{ref}}</math> – site reference</p> <p>DAF – dual antenna factor</p>	

**Table 10:** NSA SAC results calculation for specific standards.

The "dual antenna factor" represents the sum of the antenna factors of transmit and receive antenna, used with the measurement. It is recommended to use the dual antenna method, where the antenna pair is calibrated.

<sup>3</sup> Important: The results are computed according to direct measurement trace that was active during the measurements. It means that you can re-measure the "direct" trace as often as required (e.g. temperature drift compensation) in between the "site" measurements.

### 10.2.3. Report Format

As described in section 7.4 the measurement output can be exported in a MS Excel format. In the picture below (Figure 45) you can see an Excel document containing several worksheets.

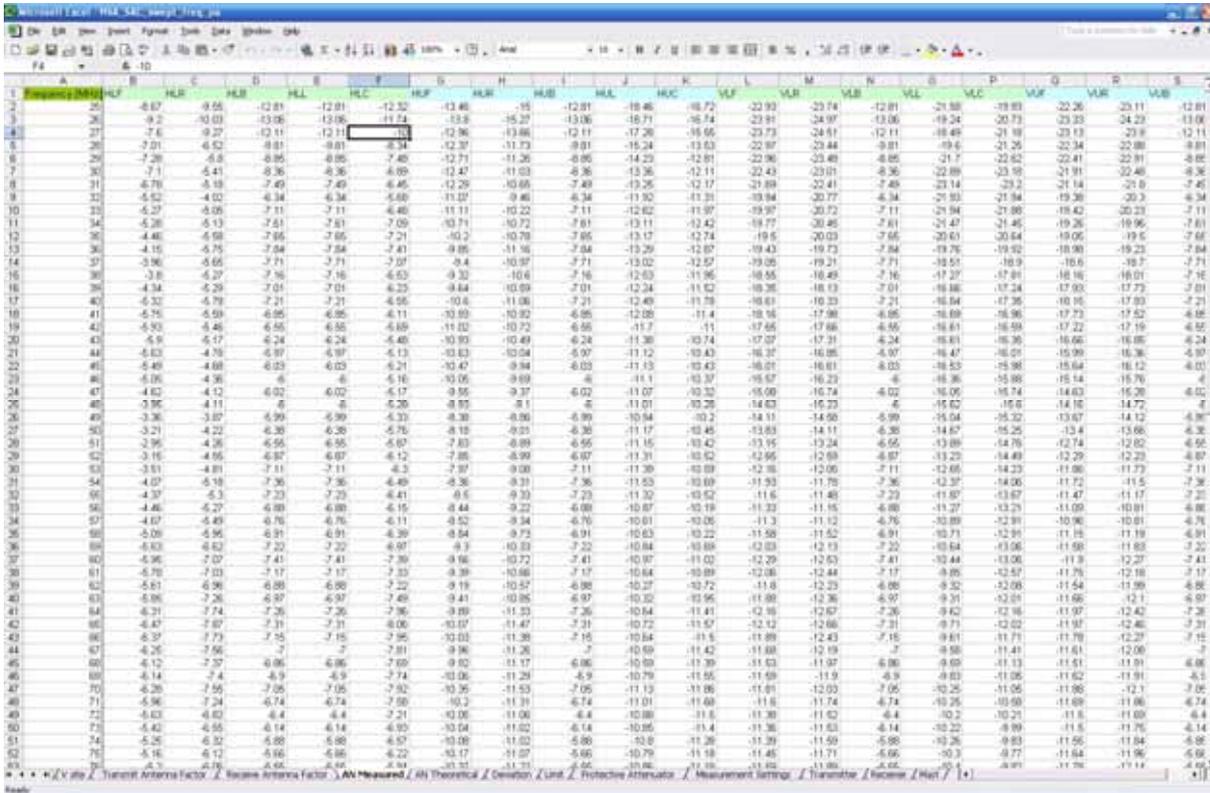


Figure 45: Measurement output exported to a MS Excel file

<b>Measurement Info</b>	Contains general information about measurement from Measurement Info dialog box
<b>V direct</b>	V <sub>direct</sub> measurement data for every measurement position.. When a protective attenuator is selected the attenuation is automatically corrected.
<b>V site</b>	V <sub>site</sub> measurement data for every measured position
<b>Transmit antenna factor</b>	Transmit antenna factor data for every measurement position. This sheet is present only if one of the measurement standards ANSI C63.4-2003, ANSI C63.5-2006, CISPR 16-1-4 ed.2–2007 or EN 50147-2, 1996 is used.
<b>Receive antenna factor</b>	Receive antenna factor data for every measurement position. This sheet is present only if one of the measurement standards ANSI C63.4-2003, ANSI C63.5-2006, CISPR 16-1-4 ed.2–2007 or EN 50147-2, 1996 is used.
<b>Site reference factor</b>	Site reference data for every measurement position. This sheet is present only if the Site reference method is used as a measurement standard.

<b>Geometry specific correction factor</b>	Geometry specific correction factor data for every measurement position. This sheet is present only if the ANSI C63.5-2006 is used as a measurement standard.
<b>Dual antenna factor</b>	Dual antenna factor data for every measurement position. This sheet is present only if the Arc Dual Antenna Factor method is used as a measurement standard.
<b>AN Measured</b>	NSA results computed from $V_{\text{direct}}$ , $V_{\text{site}}$ and antenna factor data. For some measurement standards the NSA is not computed, in that case this worksheet is not present.
<b>AN Theoretical</b>	Contains theoretically computed data for specific position according to used measurement standard
<b>Deviation</b>	DSA values computed as given in Fehler! Verweisquelle konnte nicht gefunden werden.
<b>Limit</b>	Upper and lower limit data as set in the limit dialog
<b>Protective Attenuator</b>	Protective attenuator data if used
<b>Measurement Settings</b>	Measurement Settings panel content
<b>Transmitter, Receiver, Mast</b>	Holds the device parameters used for measurement

**Table 11:** Description of the MS Excel file

#### 10.2.4. Literature

- [1] CISPR 16-1-4 Consol. Ed. 2.1-2008 & am2 Ed.2.0, Specification for radio disturbance and immunity measuring apparatus and methods Part 1-4: Radio disturbance and immunity measuring apparatus - Ancillary equipment - Radiated disturbances
- [2] ANSI C63.4-2003, American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz
- [3] ANSI C63.5-2006, American National Standard Electromagnetic Compatibility–Radiated Emission Measurements in Electromagnetic Interference (EMI) Control–Calibration of Antennas (9 kHz to 40 GHz)
- [4] W. Müllner, H. Garn: From NSA to Site-Reference Method for EMC Test Site Validation. IEEE EMC International Symposium, Montreal, Canada, August 13-17, 2001

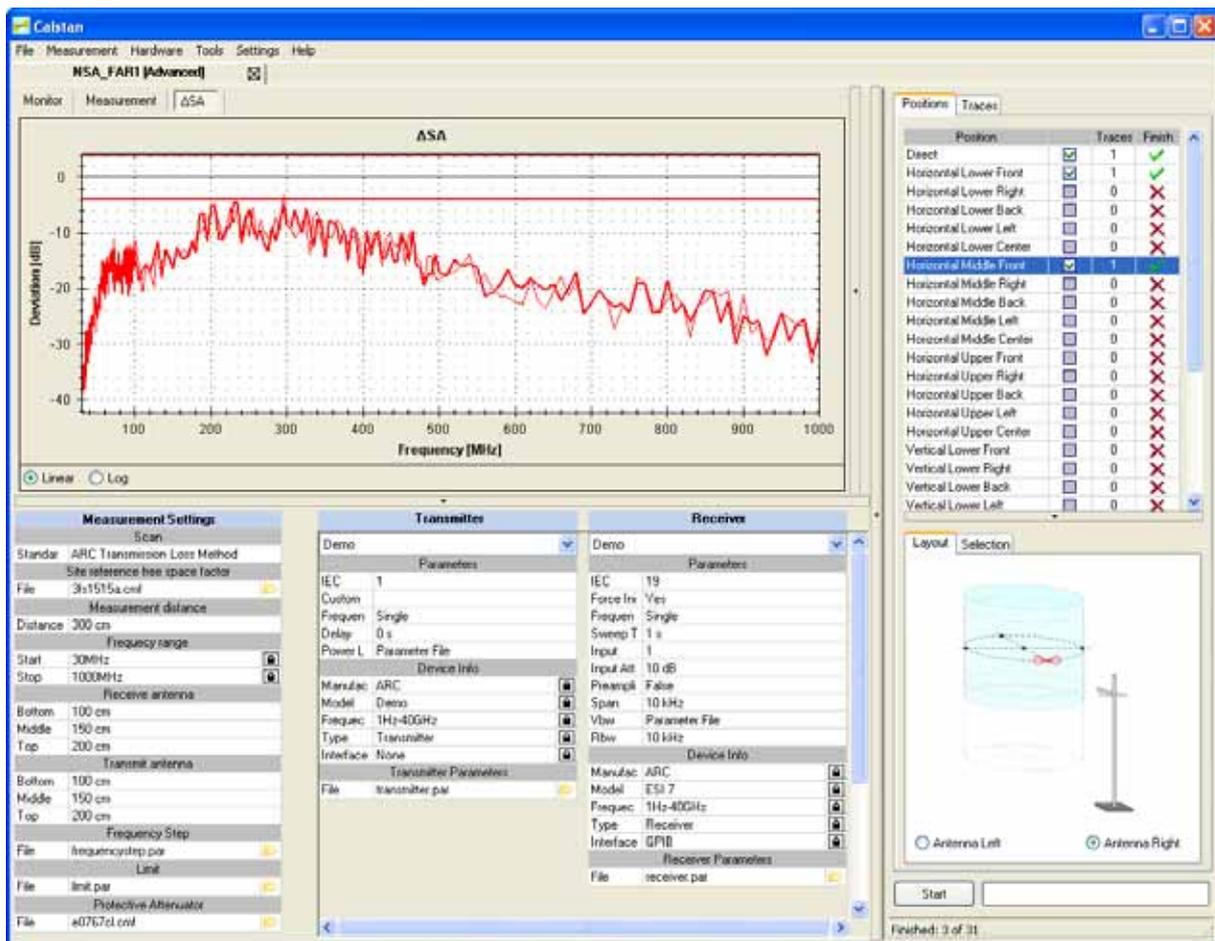
### 10.3. NSA FAR (fully-anechoic rooms)

Normalized site attenuation (NSA) measurements in fully-anechoic chambers, carried out with broadband antennas are implemented in CalStan 10.0 according to following standards:

CISPR 16-1-4 (Site reference)
CISPR 16-1-4 (NSA)
ARC Transmission Loss

**Table 12:** List of NSA FAR standards.

The measurement procedures are described in detail in the standards. For all procedures the "volume method" has to be applied: The transmit antenna connected to the signal generator has to be placed at 5 positions in the test volume. These positions are specified in the referenced documents. Furthermore the transmit antenna has to be operated in two or three heights and both polarizations. The receive antenna is kept co-polarized at constant horizontal distance, is always facing the transmit antenna and sometimes even tilted depending on the chosen procedure. Transmission loss between transmit and receive antenna is measured according to the standard test procedure for each frequency and polarization.



**Figure 46:** NSA FAR measurement window (randomly generated measurement data).

### 10.3.1. Setup

Before starting the measurement all measurement parameters have to be defined in the "Measurement Settings" panel (**Figure 46**, lower left).

1. First of all select measurement standard and load appropriate antenna factor file(s) for your transmit and receive antennas. If the antenna factor is measured with a different frequency step, the data are interpolated (linear). Receive antenna and frequency range settings will be taken from this "antenna factor" file.
2. Choose the frequency range for the NSA measurement.
3. Adjust the frequency step table if needed.
4. Set the desired limit.
5. Set the protective attenuator (used for  $V_{\text{direct}}$  measurement) or select the "none" option (double click the cell and choose "none" from the drop down list). The protective attenuator value is added to the  $V_{\text{direct}}$  measurement readout of the receiver. The  $V_{\text{direct}}$  measurement value stored in CalStan 10.0 includes already the correction of the protective attenuator value.
6. Select appropriate devices and their parameters. To operate a specific device, the correct IEC (GPIB) address has to be set.

### 10.3.2. Measurement Procedure and Result Calculation

1. Measure  $V_{\text{direct}}$  first. To do so select the "Direct" position in the positions table (**Figure 44**). Connect the generator via the transmit cable and the receive cable to the receiver; two 10 dB attenuators shall be inserted. This configuration ensures that the cable loss of the receive cable is taken into account automatically. If the RefRad is used as generator, the enclosed 30 dB protective attenuator must be used within this measurement.
2. Then  $V_{\text{site}}$  can be measured:
  - Set up the antennas as required by the standard (distance, height, position, polarization).
  - Connect the transmit antenna via one 10 dB attenuator and the transmit cable to the signal generator. Connect the receive antenna to the other 10 dB attenuator and via the receive cable with the receiver.
  - Select the position in CalStan 10.0 and start the measurement.
  - During the measurement the monitor display shows two traces:
    - blue:** the ideal measurement data that would obtain zero dB NSA deviation
    - black:** the actual measurement data for the current antenna mast height

When measuring in vertical polarization, make sure that the cable connected to the antenna does not affect the measured values. For best results we recommend to use a cable with ferrite rings (2 pieces every 10 cm) and the same cable layout of the receive antenna as used during the calibration of the antenna. Especially the distance between antenna and the vertical cable is important.

3. The NSA and the deviations from the NSA (DSA) are calculated automatically after each measured position according to the selected measurement standard (see **Table 13**). To show the results click the NSA or DSA tab in the chart area. If at least one result is shown, the limit-lines are displayed additionally.

The NSA reference values need not to be specified separately. All theoretical factors are computed by CalStan 10.0 using the formulas given in the respective standards.

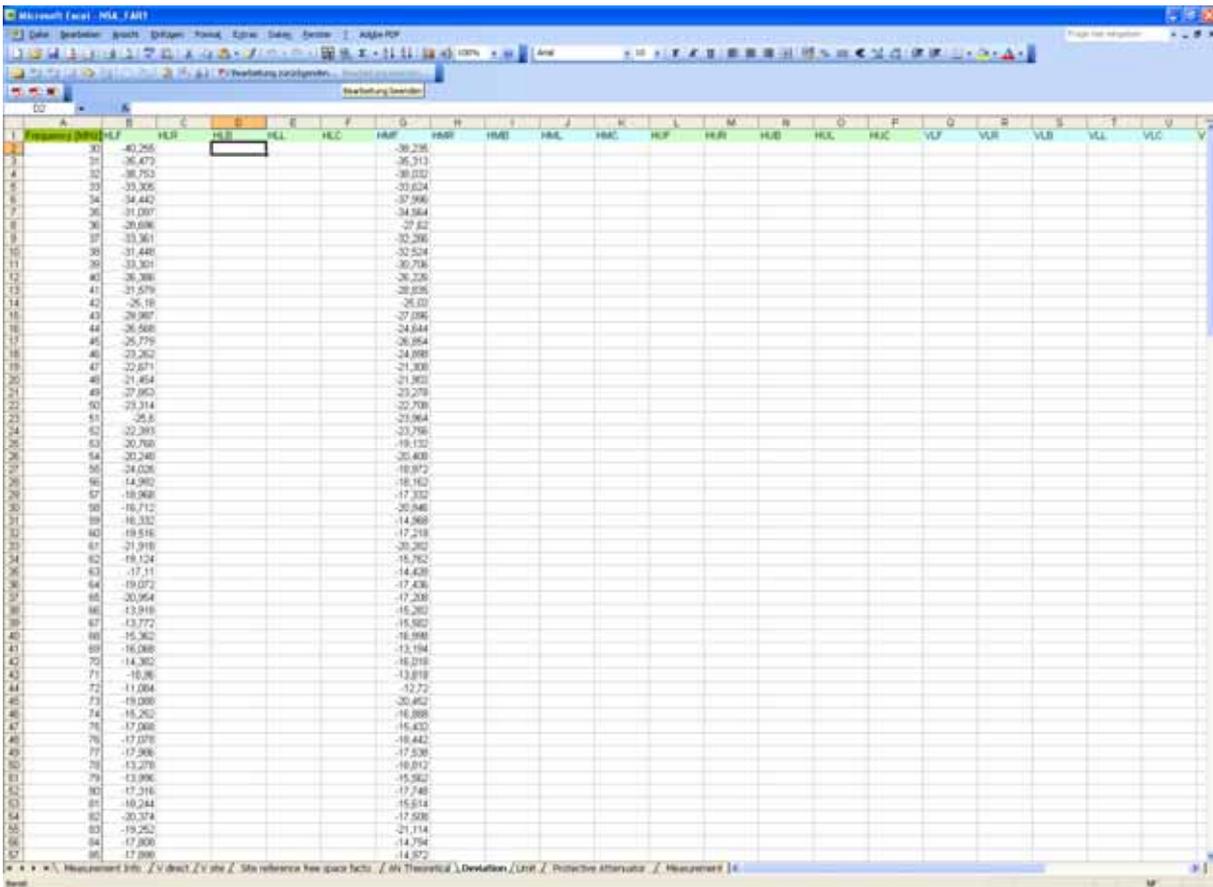
The results for specific position trace are always computed using the direct measurement trace which was set active at the time of that position trace measurement.

CISPR 16-1-4 (Site reference) [1]	$DSA = SA_{ref} - V_{dir} - V_{site}$
CISPR 16-1-4 (NSA) [1]	$NSA = V_{dir} - V_{site} - AF_T - AF_R$ $DSA = NSA - Theo$
ARC Transmission Loss	$DSA = SA_{ref} - V_{dir} - V_{site}$
<p>Where</p> <p>NSA – normalized site attenuation</p> <p>DSA – deviation from normalized site attenuation</p> <p>Theo - theoretical value of the site attenuation</p> <p><math>V_{dir}</math> – direct measurement <sup>4</sup></p> <p><math>V_{site}</math> – values measured at the site</p> <p><math>AF_T</math> – transmit antenna factor</p> <p><math>AF_R</math> – receive antenna factor</p> <p><math>SA_{ref}</math> – site reference</p>	

**Table 13:** NSA FAR results calculation for specific standards.

### 10.3.3. Report Format

As described in section 7.4 the measurement output can be exported in a MS Excel format. In the picture below (**Figure 47**) you can see an Excel document containing several worksheets.



**Figure 47:** Measurement output exported to a MS Excel file

<sup>4</sup> Important: The results are computed according to direct measurement trace that was active during the measurements. It means that you can re-measure the “direct” trace as often as required (e.g. temperature drift compensation) in between the “site” measurements.

<b>Measurement Info</b>	Contains general information about measurement from Measurement Info dialog box
<b>V direct</b>	$V_{\text{direct}}$ measurement data for every measurement position. When a protective attenuator is selected the attenuation is automatically corrected.
<b>V site</b>	$V_{\text{site}}$ measurement data for every measured position
<b>Transmit antenna factor</b>	Transmit antenna factor data for every measurement position. This sheet is present only if the Site CISPR 16-1-4 ed.2–2007 (NSA method) is used as a measurement standard.
<b>Receive antenna factor</b>	Receive antenna factor data for every measurement position. This sheet is present only if the Site CISPR 16-1-4 ed.2–2007 (NSA method) is used as a measurement standard.
<b>Site reference factor</b>	Site reference data for every measurement position. This sheet is present only if one of the measurement standards CISPR 16-1-4 ed.2–2007 (Site reference method) or ARC Transmission loss is used as a measurement standard.
<b>AN Theoretical</b>	Contains theoretically computed data for specific position according to used measurement standard
<b>Deviation</b>	DSA values computed as given in Table 13
<b>Limit</b>	Upper and lower limit data as set in the limit dialog
<b>Protective Attenuator</b>	Protective attenuator data if used
<b>Measurement Settings</b>	Measurement Settings panel content
<b>Transmitter, Receiver</b>	Holds the device parameters used for measurement

**Table 14:** Description of the MS Excel file

#### 10.3.4. Literature

- [1] CISPR 16-1-4 Consol. Ed. 2.1-2008 & am2 Ed.2.0, Specification for radio disturbance and immunity measuring apparatus and methods Part 1-4: Radio disturbance and immunity measuring apparatus - Ancillary equipment - Radiated disturbances

## 10.4. Cableloss

This plug-in allows the measurement of attenuation of an EUT. The EUT can be a cable, an attenuator or any other coaxial device. By connecting the EUT between transmitter and receiver the attenuation is measured and evaluated with customer specific frequency resolution and range.

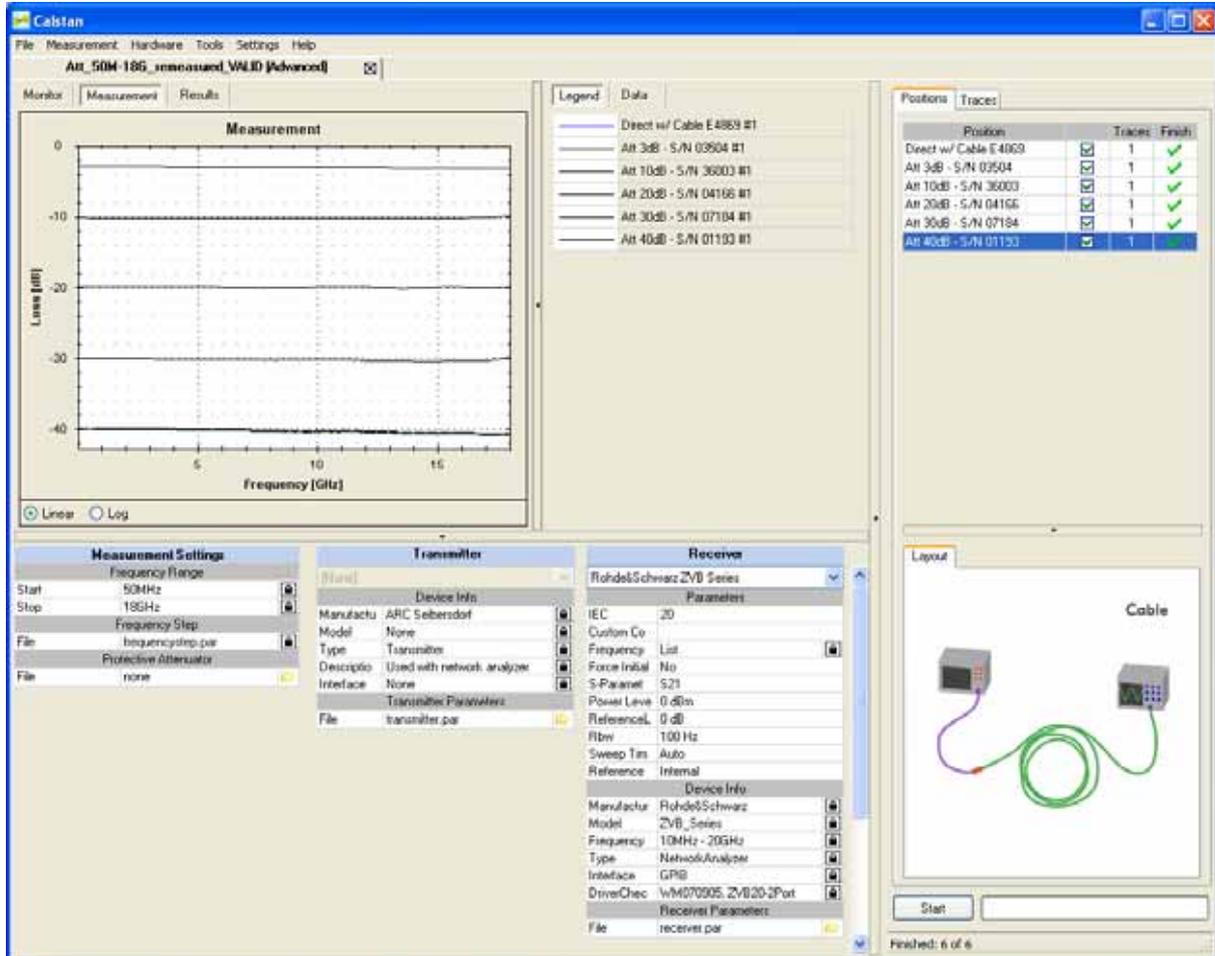


Figure 48: Cableloss measurement window.

### 10.4.1. Setup

Before starting the measurement all measurement parameters have to be defined in the "Measurement Settings" panel (**Figure 48**, lower left).

1. Choose the frequency range.
2. Adjust the frequency step table if needed.
3. Set the protective attenuator (used for  $V_{\text{direct}}$  measurement) or select the "none" option (double click the cell and choose "none" from the drop down list).

Generally the protective attenuator is required for conducted measurements with comb generators to protect the receiver from overload. In case of cable loss measurement with a comb generator it's advised to use the protective attenuator for measurement of  $V_{\text{direct}}$  and  $V_{\text{cable}}$ . In this case do NOT select a protective attenuator file here because it's present in both measurements and has no effect on the measured attenuation.

The protective attenuator value is added to the  $V_{\text{direct}}$  measurement readout of the receiver. The  $V_{\text{direct}}$  measurement value stored in CalStan 10.0 includes already the correction of the protective attenuator value.  $V_{\text{cable}}$  measurements are not influenced by the protective attenuator.

4. Select appropriate devices and their parameters. To operate a specific device, the correct IEC (GPIB) address has to be set.

### 10.4.2. Measurement Procedure and Result Calculation

1. Measure  $V_{\text{direct}}$ . Select the "Direct" position in the positions table (**Figure 44**). Connect the generator via the auxiliary cable to the receiver. This configuration ensures that the cable loss of the auxiliary cable is taken into account automatically. If you selected a protective attenuator in the measurement settings dialog you have to connect it now between transmitter and auxiliary cable. The measurement value stored in CalStan 10.0 is the receiver readout plus the protective attenuator value.
2. Measure  $V_{\text{cable}}$ :
  - Connect the EUT between the auxiliary cable and the receiver. Make sure to remove the protective attenuator when selected in the measurement settings.
  - Select the position (e.g. Measurement 1) in CalStan 10.0 and start the measurement.
  - During the measurement the monitor window shows the actual measurement data.
3. After the measurement is finished, results are calculated using the formula:

$$CL = V_{\text{direct}} - V_{\text{cable}}$$

where  $V_{\text{direct}}$  – direct measurement value  
 $V_{\text{cable}}$  – measured value

4. At the beginning there are only two positions Direct and Measurement 1. By right mouse click context menu can be displayed and new measurement position added. Measurement position names can be edited by double clicking the name cell.

The results for specific position trace are always computed using the direct measurement trace which was set active at the time of that position trace measurement.

### 10.4.3. Report Format

As described in section 7.4 the measurement output can be exported in a MS Excel format. In the picture below (Figure 49) you can see an Excel document containing several worksheets.

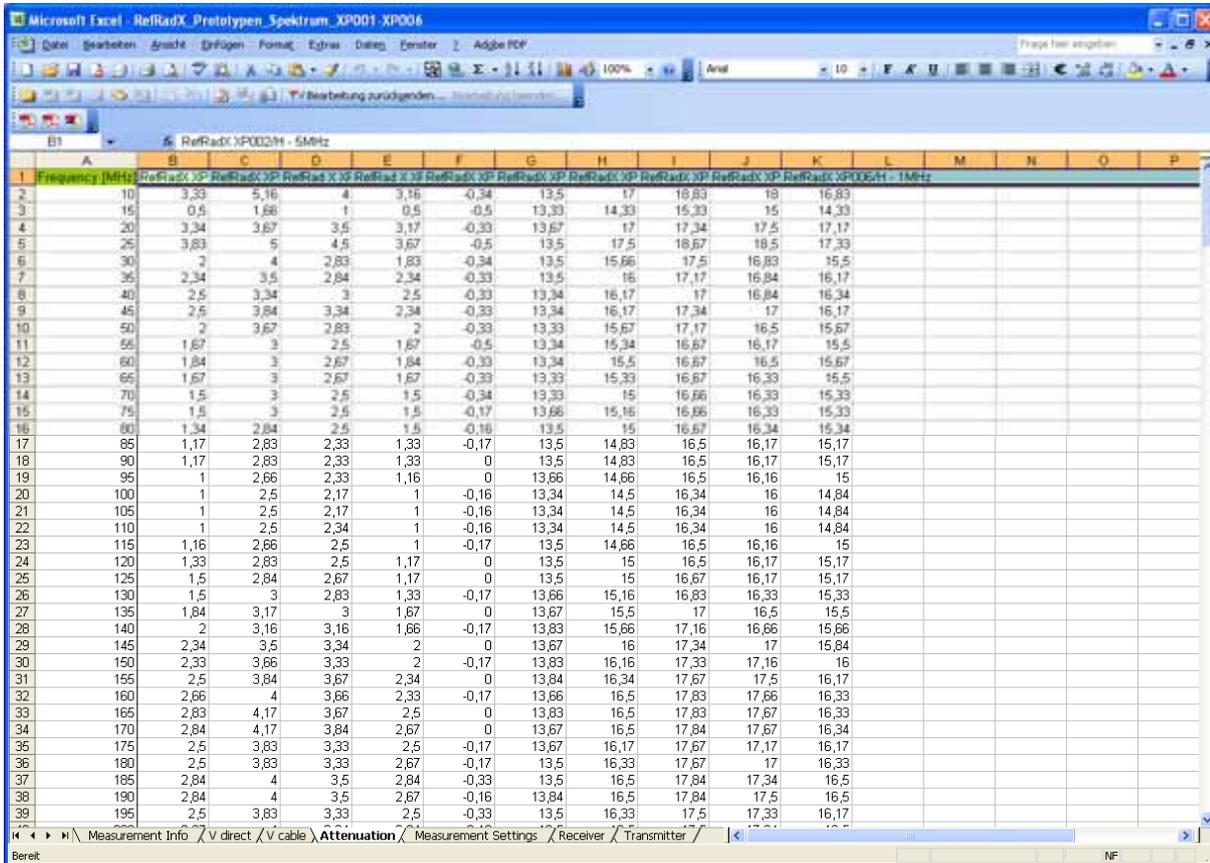


Figure 49: Measurement output exported to a MS Excel file

<b>Measurement Info</b>	Contains general information about measurement from Measurement Info dialog box
<b>V direct</b>	V <sub>direct</sub> measurement data for every measurement position. When a protective attenuator is selected the attenuation is corrected automatically.
<b>V cable</b>	V <sub>cable</sub> measurement data for every measured position
<b>Attenuation</b>	Measurement results
<b>Protective Attenuator</b>	Protective attenuator data if used
<b>Measurement Settings</b>	Measurement Settings panel content
<b>Transmitter, Receiver</b>	Holds the device parameters used for measurement

Table 15: Description of the MS Excel file

## 10.5. Experimental Measurement

Experimental Measurement plug-in is designed to perform measurements which are not strictly bound to any measurement type and standard. Measurement values (level, loss, VSWR) are collected with or without height scan and if a reference position is measured the result is calculated as deviation from the reference. If an antenna factor is loaded the field strength is calculated, additionally cable loss can be considered.

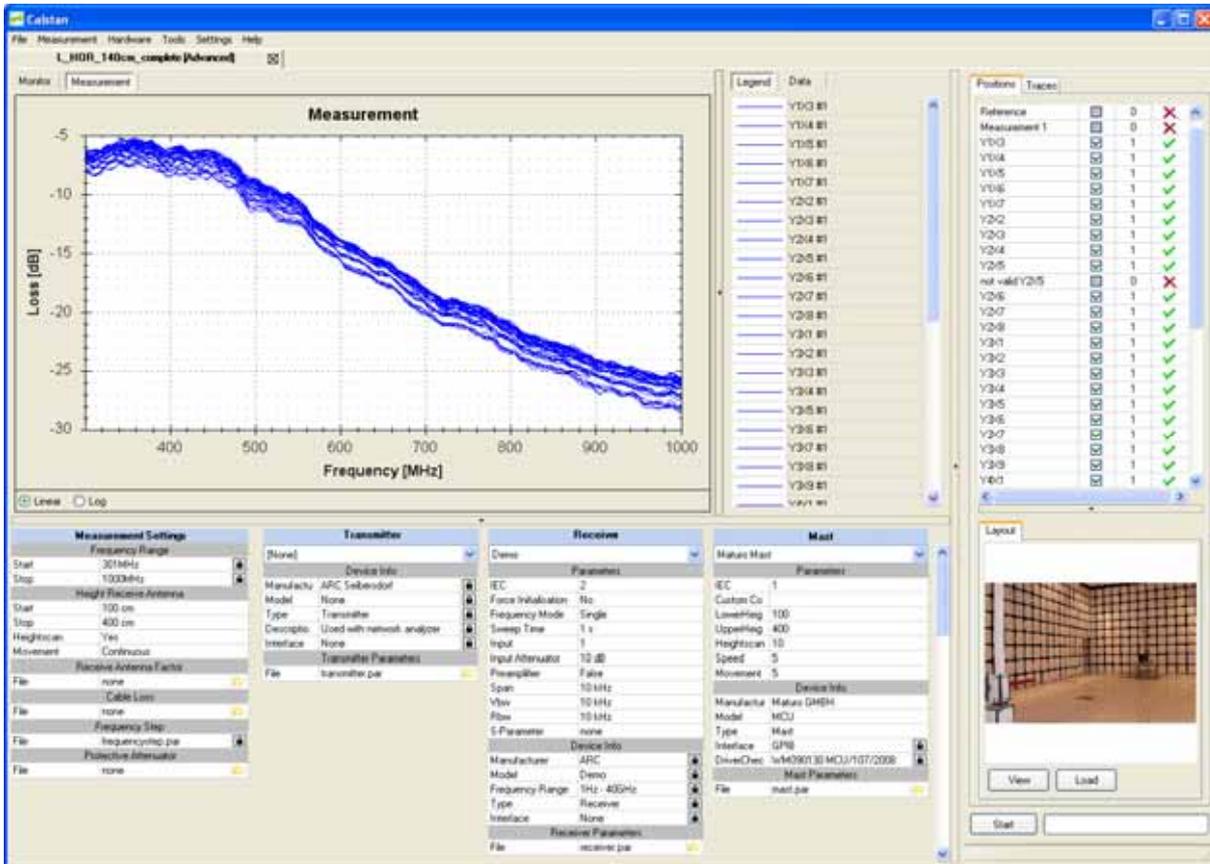
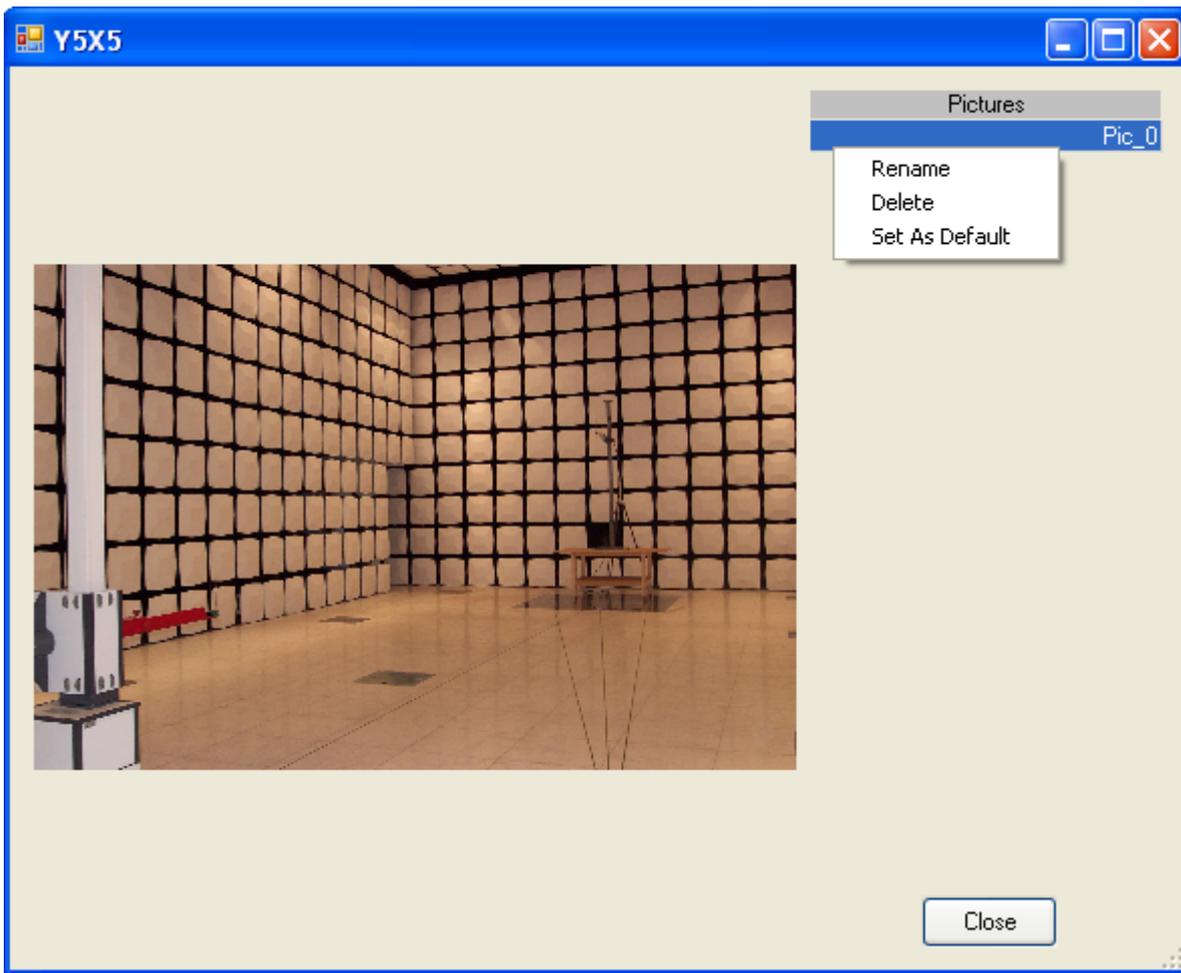


Figure 50: Experimental Measurement window.

To document specific measurement layout (e.g. antenna positions), it is possible to load pictures for every measurement present in the positions table. Click the “Load” button to load a picture from disk, use “View” button to show a preview dialog where all loaded pictures for selected position can be managed. As displayed in **Figure 51**, by right click on the pictures list the context menu allows to renamed, deleted or selected picture as default.



**Figure 51:** Assigning measurement layout picture.

### 10.5.1. Setup

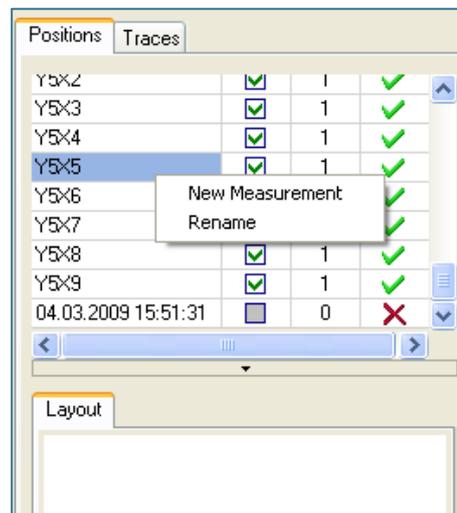
Before starting the measurement following measurement parameters have to be defined in the "Measurement Settings" panel (**Figure 50**, lower left).

1. Choose the frequency range.
2. Adjust the frequency step table if needed.
3. Set the receive antenna parameters to adjust height scan (see 7.1).
4. Set receiver antenna factor or cable loss factor file. Cable loss measurement performed by CalStan can be also used here. Don't forget to select correct result column from the combo box in the data tab as described in 7.1.3
5. Set the protective attenuator (used for Reference measurement only) or select the "none" option (double click the cell and choose "none" from the drop down list).  
Generally the protective attenuator is required for conducted measurements with comb generators to protect the receiver from overload. The protective attenuator value is added to the Reference measurement readout of the receiver and stored in CalStan 10.0. Other measurements are not influenced by the protective attenuator. See next section for more details.
6. Select appropriate devices and their parameters. To operate a specific device, the correct IEC (GPIB) address has to be set.

## 10.5.2. Measurement Procedure and Result Calculation

In the experimental measurement there are two measurement types possible:

1. The **reference measurement** – this is represented by the “Reference” position at the top of the positions table (see **Figure 50**). This measurement serves as reference according to which the results are computed. Protective attenuator data are added to measured values if their unit is dB or dBm. Unit of the receiver device readout is discussed in 7.2.1
2. The **custom measurement** – there is more-less unlimited number of measurements which can be performed. By right clicking the positions table and then choosing the “New Measurement” menu item from the pop upped context menu (see **Figure 52**) new row representing a custom measurement is added at the bottom of the list. Name of the measurement is set to current date by default, but can be changed anytime (context menu -> rename option). No protective attenuator data are added to the measured values.



**Figure 52:** Adding new measurement in the positions table

When measurement is finished results are computed in the following way:

1. If receive antenna factor file is set and measurement data unit is dBm, the field strength is calculated according to formula:

$$fs = ySite + 107 + afr + cl;$$

where: ySite: measured value [dBm]  
afr: receive antenna factor value  
cl: cable loss factor value (if available)

A “Field strength” chart tab is then added in the charts panel.

2. When custom measurement is finished and reference measurement is available. The difference of reference measurement and the custom measurement is computed and displayed in separate “Deviation” tab in the charts panel.

The results for specific position trace are always computed using the direct measurement trace which was set active at the time of that position trace measurement.

### 10.5.3 Report Format

As described in section 7.4 the measurement output can be exported in a MS Excel format. In the picture below (**Figure 53**) you can see an Excel document containing several worksheets.

1	A	B	C	D	E	F	G	H	I	J	K	L
1	Frequency [MHz]			Y1X1 [dB]	Y1X4 [dB]	Y1X5 [dB]	Y1X6 [dB]	Y1X7 [dB]	Y2X2 [dB]	Y2X3 [dB]	Y2X4 [dB]	Y2X5 [dB]
2	301			-6,629	-6,407	-6,36	-6,446	-6,707	-7,17	-6,632	-6,418	-6,362
3	302			-6,7	-6,479	-6,442	-6,535	-6,792	-7,137	-6,608	-6,383	-6,322
4	303			-6,778	-6,561	-6,538	-6,638	-6,898	-7,113	-6,597	-6,36	-6,277
5	304			-6,862	-6,649	-6,636	-6,752	-7,00438	-7,0903	-6,593	-6,33	-6,254
6	305			-6,943	-6,734	-6,711	-6,847	-7,112	-7,0735	-6,581	-6,32	-6,243
7	306			-7,00126	-6,783	-6,777	-6,914	-7,202	-7,0552	-6,573	-6,313	-6,239
8	307			-7,033	-6,813	-6,814	-6,963	-7,257	-7,0263	-6,562	-6,307	-6,239
9	308			-7,0471	-6,829	-6,815	-6,984	-7,295	-6,984	-6,552	-6,275	-6,206
10	309			-7,0661	-6,797	-6,783	-6,957	-7,293	-6,946	-6,512	-6,24	-6,18
11	310			-7,0319	-6,762	-6,732	-6,919	-7,264	-6,925	-6,489	-6,227	-6,168
12	311			-7,02	-6,716	-6,686	-6,851	-7,226	-6,905	-6,496	-6,214	-6,166
13	312			-6,999	-6,662	-6,608	-6,789	-7,183	-6,919	-6,502	-6,226	-6,181
14	313			-6,964	-6,608	-6,529	-6,711	-7,101	-6,938	-6,517	-6,237	-6,189
15	314			-6,908	-6,529	-6,433	-6,605	-7,0025	-6,943	-6,526	-6,24	-6,187
16	315			-6,838	-6,444	-6,34	-6,5	-6,902	-6,945	-6,539	-6,235	-6,184
17	316			-6,776	-6,381	-6,273	-6,422	-6,812	-6,975	-6,574	-6,255	-6,198
18	317			-6,743	-6,352	-6,244	-6,382	-6,757	-7,0415	-6,637	-6,307	-6,242
19	318			-6,718	-6,334	-6,226	-6,358	-6,716	-7,123	-6,71	-6,373	-6,296
20	319			-6,67	-6,299	-6,192	-6,318	-6,665	-7,193	-6,764	-6,418	-6,331
21	320			-6,583	-6,224	-6,122	-6,25	-6,582	-7,232	-6,786	-6,433	-6,336
22	321			-6,483	-6,143	-6,0365	-6,17	-6,489	-7,248	-6,786	-6,428	-6,323
23	322			-6,399	-6,0728	-5,976	-6,107	-6,42	-7,267	-6,791	-6,43	-6,325
24	323			-6,352	-6,0384	-5,95	-6,0763	-6,303	-7,303	-6,817	-6,462	-6,354
25	324			-6,321	-6,0216	-5,938	-6,0678	-6,375	-7,345	-6,848	-6,492	-6,393
26	325			-6,295	-5,980	-5,925	-6,0553	-6,362	-7,359	-6,861	-6,509	-6,418
27	326			-6,234	-5,96	-5,894	-6,0265	-6,338	-7,338	-6,834	-6,496	-6,406
28	327			-6,189	-5,919	-5,861	-5,998	-6,307	-7,299	-6,781	-6,46	-6,376
29	328			-6,156	-5,89	-5,834	-5,972	-6,292	-7,25	-6,723	-6,418	-6,337
30	329			-6,148	-5,886	-5,828	-5,964	-6,291	-7,211	-6,668	-6,374	-6,302
31	330			-6,153	-5,889	-5,828	-5,962	-6,3	-7,157	-6,607	-6,309	-6,249
32	331			-6,166	-5,896	-5,821	-5,963	-6,308	-7,0827	-6,523	-6,226	-6,166
33	332			-6,175	-5,903	-5,811	-5,944	-6,308	-6,998	-6,414	-6,13	-6,0635
34	333			-6,184	-5,897	-5,798	-5,921	-6,295	-6,905	-6,303	-6,0183	-5,946
35	334			-6,195	-5,9	-5,796	-5,902	-6,279	-6,815	-6,192	-5,908	-5,832
36	335			-6,211	-5,918	-5,806	-5,9	-6,265	-6,731	-6,0941	-5,806	-5,724
37	336			-6,24	-5,945	-5,832	-5,907	-6,264	-6,65	-6,0143	-5,711	-5,627

Figure 53: Measurement output exported to a MS Excel file

<b>Measurement Info</b>	Contains general information about measurement from Measurement Info dialog box
<b>Measurements</b>	Measured data
<b>Field Strength</b>	Computed field strength
<b>Deviation</b>	Measurement results
<b>Receive Antenna Factor*</b>	Receive antenna factor data
<b>Cable loss*</b>	Cable loss data
<b>Protective Attenuator*</b>	Protective attenuator data
<b>Measurement Settings</b>	Measurement Settings panel content
<b>Transmitter, Receiver, Mast</b>	Holds the device parameters used for measurement
* worksheets are added only if factor files are used	

**Table 16:** Description of the MS Excel file

## 11. TROUBLESHOOTING

### 11.1. Device is detected as UNKNOWN although it supports \*IDN? Query.

Possible reasons:

- device responds with incompatible string. Correct string format is e.g. Rohde&Schwarz,ESU-40,100031/040,4.23 (manufacturer, model, serial number, firmware version)
- device responds too slowly. In this case device has to be selected manually from the drivers list.

### 11.2. Measurement fails with error message "error -420: Query unterminated INIT\*OPC"

Disable serial auto polling in the GPIB card properties

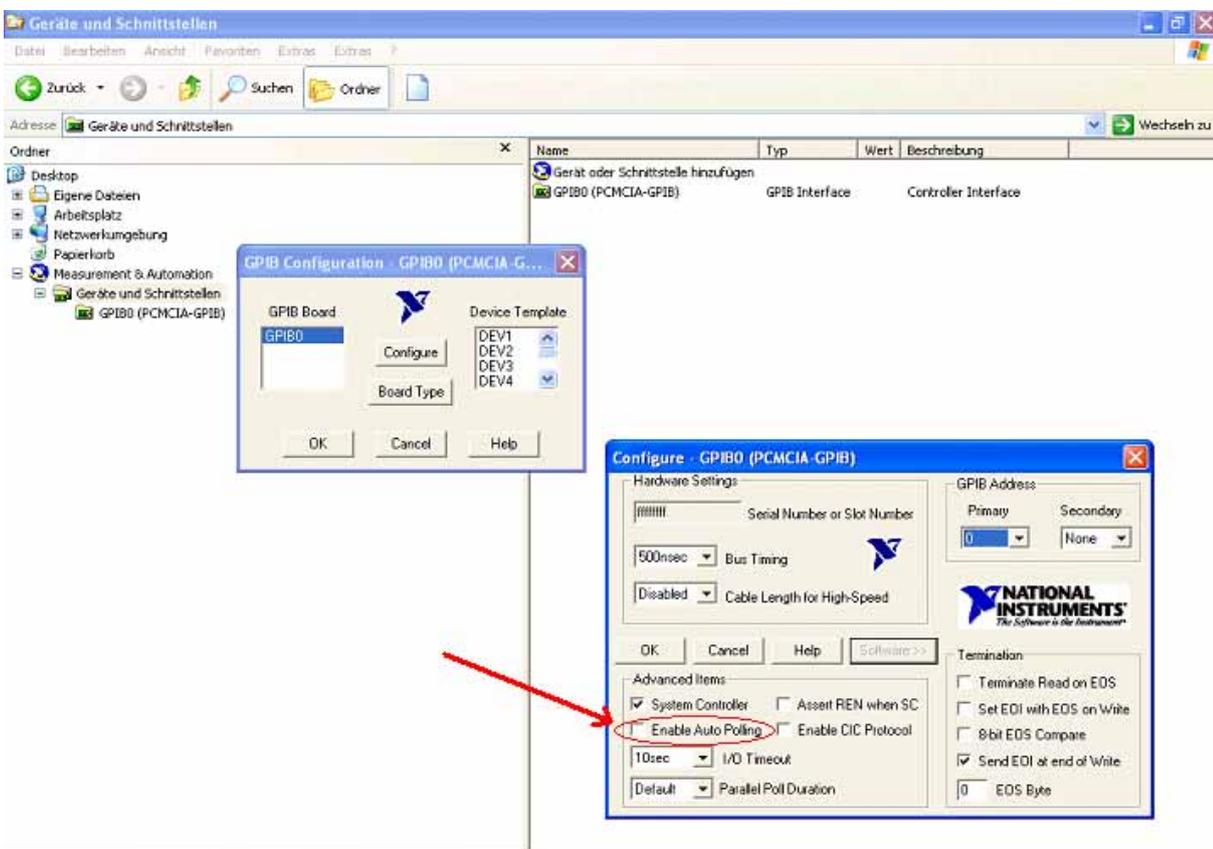


Figure 54: Disabling Serial Polling in the GPIB card configuration

### 11.3. Measurement fails with error message "error -108: Parameter not allowed"

This can be decimal separator problem in the device driver, try to change you regional settings to use "." As decimal and " " as thousands separator. Please let us know about this problem.

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## ANNEX I. WARRANTY

Seibersdorf Labor GmbH, hereinafter referred to as the Seller, warrants that standard Seibersdorf Laboratories products are free from defect in materials and workmanship for a period of two (2) years from the date of shipment.

### **Standard Seibersdorf Laboratories products include the following:**

- Antennas
- Cables
- Reference Radiators
- Software
- Antenna stands and positioners

If the Buyer notifies the Seller of a defect within the warranty period, the Seller will, at the Seller's option, either repair and/or replace products which prove to be defective during the warranty period. There will be no charge for warranty services performed at the location the Seller designates. The Buyer must, however, prepay inbound shipping costs and any duties or taxes. The Seller will pay outbound shipping cost for a carrier of the Seller's choice, exclusive of any duties or taxes.

### **This warranty does not apply to:**

- Normal wear and tear of materials
- Consumable items such as fuses, batteries, etc.
- Products that have been improperly installed, maintained or used
- Products which have been operated outside the specifications
- Products which have been modified without authorization
- Calibration of products, unless necessitated by defects

THIS WARRANTY IS EXCLUSIVE. NO OTHER WARRANTY, WRITTEN OR ORAL, IS EXPRESSED OR IMPLIED, INCLUDING BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. THE REMEDIES PROVIDED BY THIS WARRANTY ARE THE BUYER'S SOLE AND EXCLUSIVE REMEDIES. IN NO EVENT IS THE SELLER LIABLE FOR ANY DAMAGES WHATSOEVER, INCLUDING BUT NOT LIMITED TO, DIRECT, INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES, WHETHER BASED ON CONTRACT, TORT, OR ANY OTHER LEGAL THEORY.