SEIBERSDORF LABORATORIES

EMC & OPTICS

MANUAL
CalStan 11

RF Measurement Software

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Manual Version 1.0.12

CalStan Version b291

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Contact

Seibersdorf Labor GmbH

EMC & Optics

T +43(0) 50550-2882 | F +43(0) 50550-2881

rf@seibersdorf-laboratories.at

rf.seibersdorf-laboratories.at

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1. INTRODUCTION

CalStan 11 is a software tool for automation of radio frequency (RF) calibrations and measurements. The software controls the instruments via GPIB bus or LAN, reads the measurement values and computes the results. The purpose of the software is to perform calibrations and validations of equipment, 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 https://rf.seibersdorf-laboratories.at/products-services/products/calstan for the latest version.

What is New in CalStan 11?

1. Complete GUI redesign to improve user experience
2. Complete reimplementation of measurement modules for more effectivity during measurements
3. Added new measurement procedure Site Insertion Loss (Loop)
4. New functionality in drivers, e.g. Antenna Mast polarization control available.

For up-to-date changes history you can look in the Help Menu in the “About” section.

2. SYSTEM REQUIREMENTS

Operating systems	Windows 7 Windows 8 Windows 8.1 Windows 10
Minimum computer requirements	2 GHz CPU 4 GB RAM
Additional hardware	National Instruments GPIB card or GPIB-USB-HS interface
Installed software	.NET framework version 4.8 (or higher) [1] National Instruments Runtime v18.5 [2]

Table 1: System Requirements

A list of the supported measurement instruments can be found in the Help Menu in the “About” section

[1] The .NET framework can be downloaded from https://dotnet.microsoft.com/download/dotnet-framework/net45

[2] National Instruments Runtime is usually shipped with the GPIB card.

3. INSTALLATION AND UPDATE OF CALSTAN 11

3.1. Installation

The CalStan 11 software can be downloaded from our webpage https://rf.seibersdorf-laboratories.at/products-services/products/calstan 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. So, the supported test instruments and the compatibility can be checked and the licensed can be ordered when satisfied.

The standard way of CalStan 11 distribution is 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 "CalStan11_setup.exe" file, an installation dialog pops up.

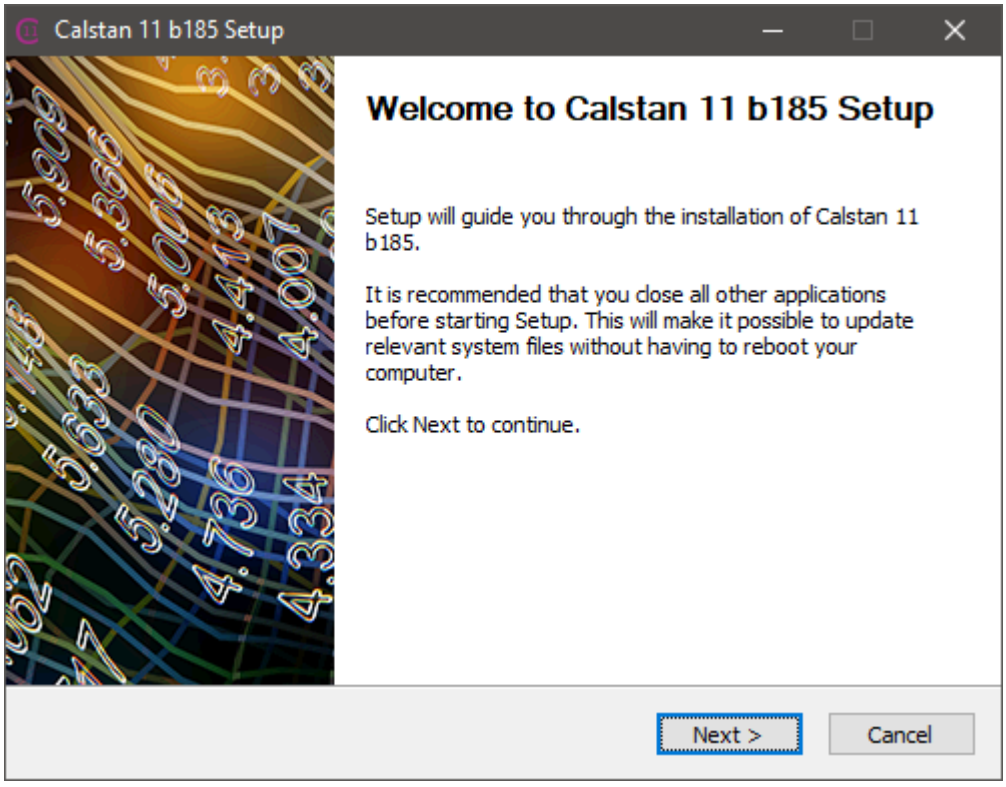


Figure 1: Setup – Welcome dialog

Clicking the "*Next*" button a window appears where the dialog (**Figure 2**) where you can select measurement modules to be installed.

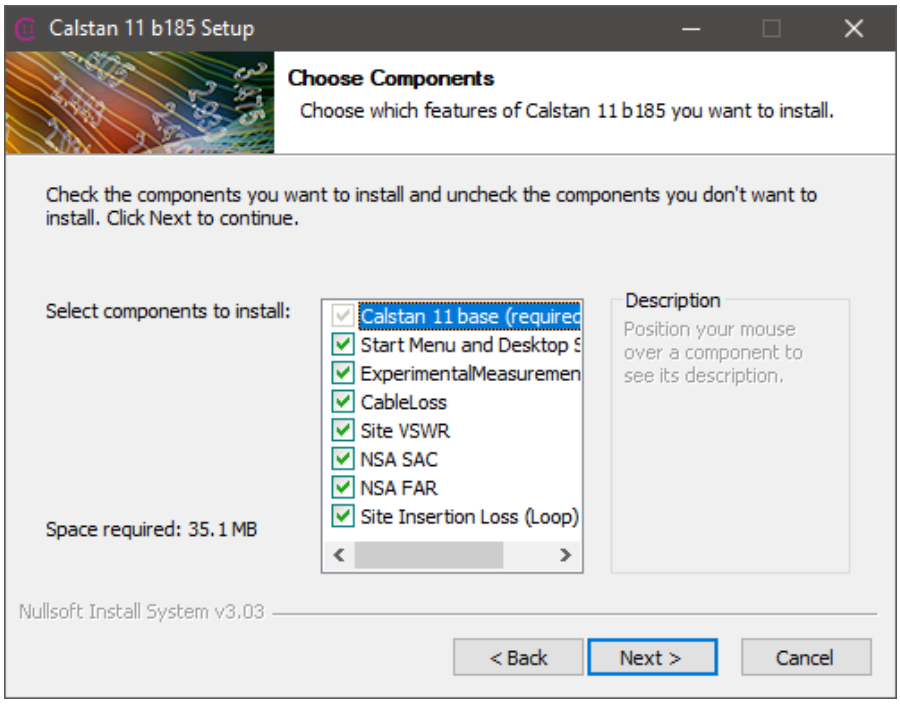


Figure 2: Measurement modules selection dialog

Clicking the "*Next*" button a window appears where the installation destination location can be selected (**Figure 3**). We recommend using default one. After a selection of the destination folder for CalStan 11, to start the installation procedure, click the "*Install*" button, to go one step back press "*Back*" or "*Cancel*" to quit the installation.

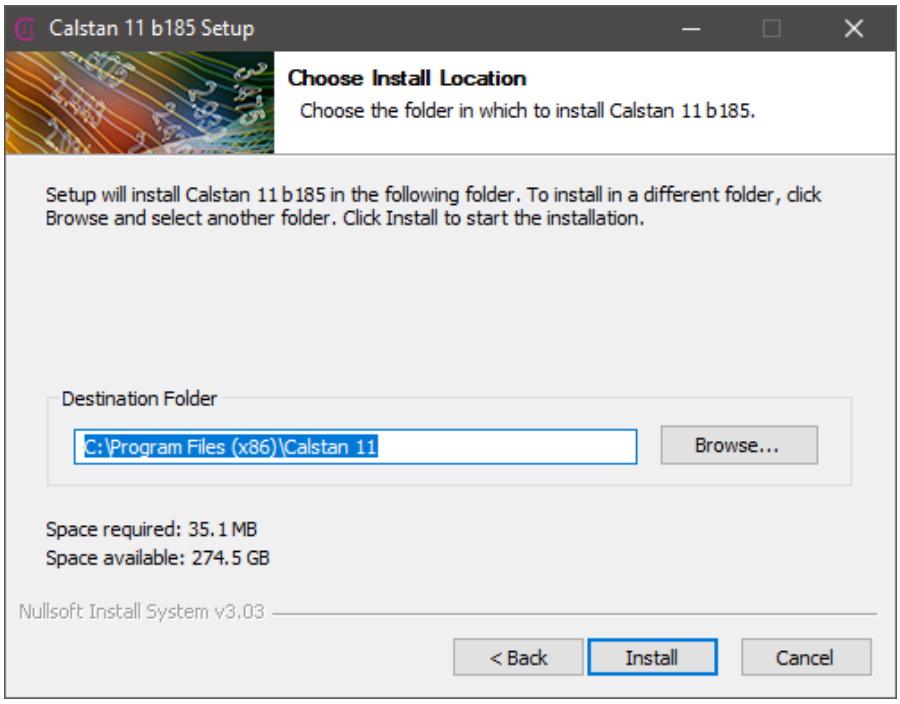


Figure 3: Installation directory selection dialog.

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

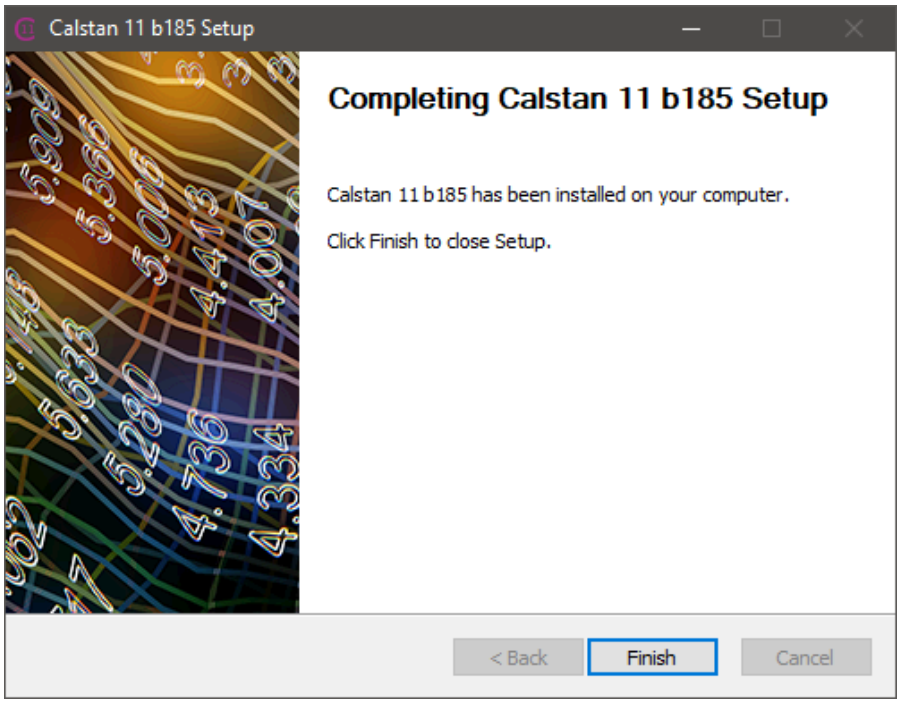


Figure 4: Setup – CalStan completed dialog

By clicking “Finish” the CalStan 11 setup ends, and an icon appears on the desktop.

Figure 5: CalStan Icon

Run CalStan 11 from the start menu group or the icon on the desktop. If the start menu and the desktop shortcut were not installed, execute CalStan 11 from the installation folder.

3.2. Update

By clicking the red caption in the right top corner of the application window (Figure 6) 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.

Figure 6: Update available indicator

This way the user can install new device drivers and get latest bug fixes.

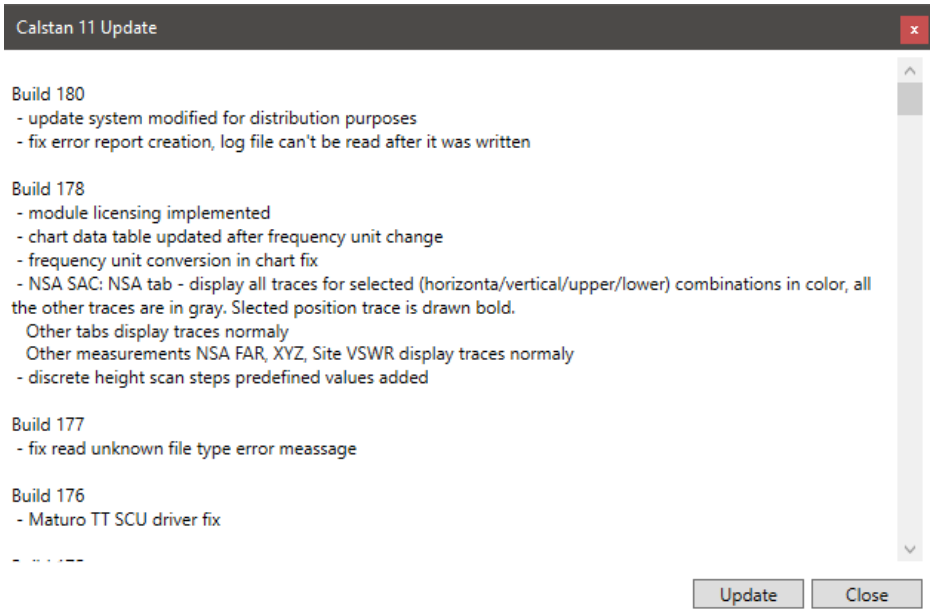


Figure 7: Online application updater.

Clicking the update button, the update process starts. After successful completion, CalStan is restarted automatically.

Note: the updater doesn't work behind the proxy server.

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

1. Download new CalStan installer from: https://rf.seibersdorf-laboratories.at/products-services/products/calstan
2. Uninstall old CalStan 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 types may be more complex - but the basic procedure does not change.

1. To start a new measurement, choose "*File->New*…" and select the desired measurement type.
2. Modify the parameters in the "*Measurement settings*" panel (in the upper left part of the screen). Most common ones are the frequency range, frequency step, measurement bandwidth and limit. If needed load some factor files (e.g. Antenna Factor or Cable Loss file).
3. Set your measurement devices by the Menu Hardware/Select 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. Set the parameters of the test instruments below the "*Measurement settings*" if necessary (e.g. select input 1 or Input 2 of the receiver)
5. Select the measurement position and run the measurement by clicking the "Start" button (lower left corner of the start measurement panel on the right side of the screen). If settings are incorrect the software shows an info message with instructions.
6. To save the measurement go to "*File->Save*".

5. CALSTAN 11 WORKSPACE

The CalStan 11 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

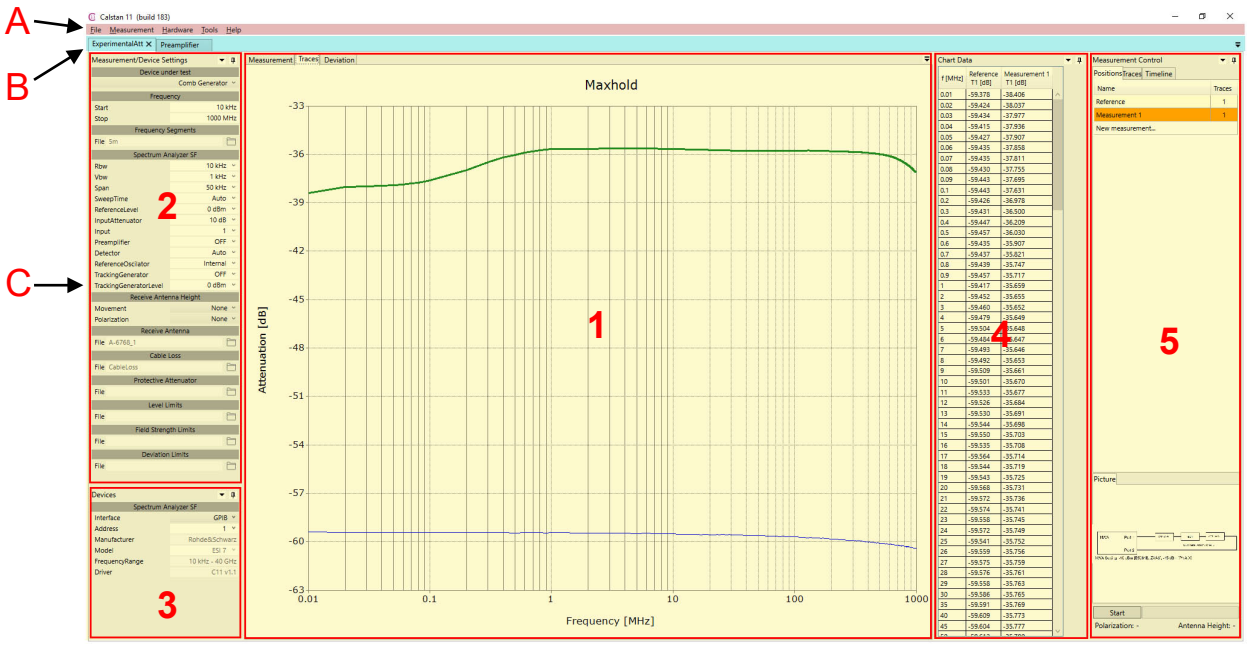


Figure 8: CalStan main window

The measurement window can be divided into sub areas (panels)

1. Measurement display – shows the measurement data in a chart
2. Measurement settings – defines parameters for the measurements
3. Instrument settings – contains settings for the selected instruments
4. Chart Data – shows the table of data as currently displayed in the measurement display
5. Measurement control panel with the "*Start*" button – controls the measurement sequence

The individual window panels are sizable. By clicking the button or , selected window panels can be maximized/minimized (**Figure 9**).

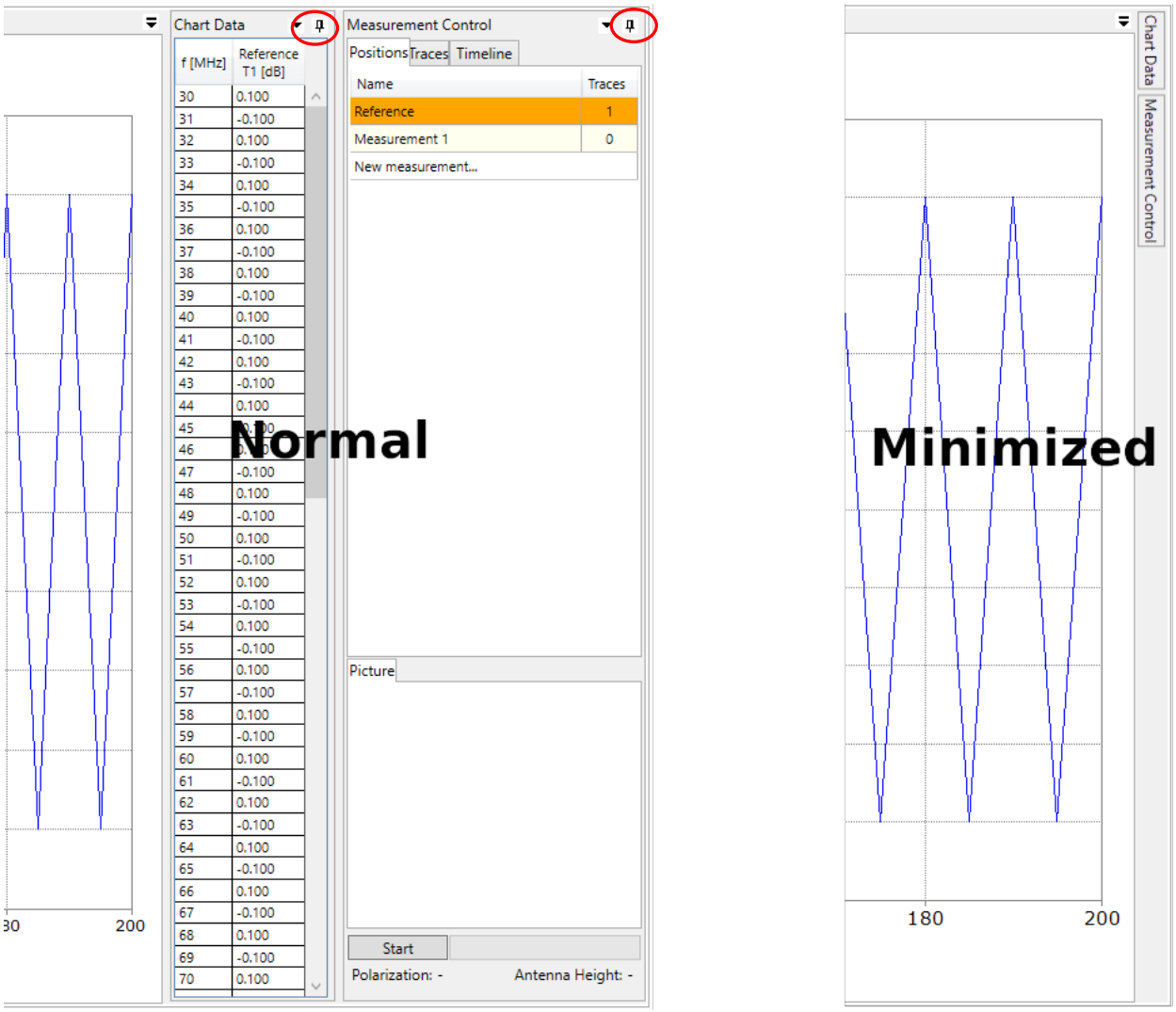


Figure 9: Measurement window with measurement settings, hardware settings and chart legend panel minimized.

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

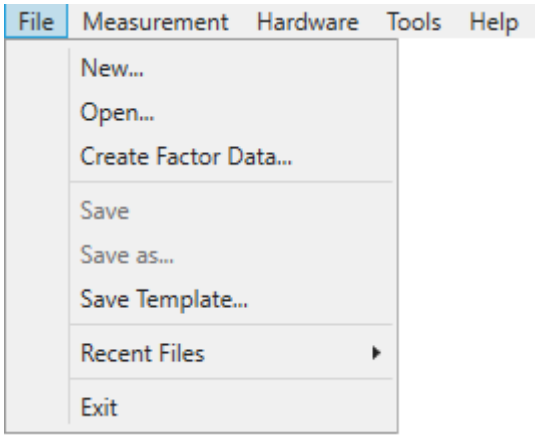


Figure 10: The file menu

New	Creates a new measurement.
Open	Opens a previously saved measurement. Opening of the CalStan 10 measurements are also supported with some measurement module specific limitations.
Create Factor Data…	Opens dialog where the factor data file can be created (e.g. Cable loss) or imported from CalStan 10 file.
Save (disabled in demo mode)	Saves a measurement. The default file extension of the CalStan 11 measurement files is “.c11”.
Save As (disabled in demo mode)	Saves a measurement with a user defined file name into an individual directory. The default file extension of the CalStan 11 measurement files is “.c11”.
Save Template…	Saves a measurement as a template. Template can then be used for creation of new measurement of the same type with the same settings.
Recent Files	List of recently opened files which can be reopened.
Exit	Closes the CalStan software. User is asked to save changes. If changes are discarded the 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

In the New measurement dialog (Figure 11) two panels are shown:

Measurements panel contains available measurement types. Selection from the list creates the specific measurement using last measurement settings and instruments for this type. The measurement positions are set to default. This Template is created automatically on measurement start/measurement saving. “Last” label contains name of the last created measurement or template.

Templates panel contains both automatically and manually created measurement templates with measurement settings, instruments and measurement positions names.

Clicking Folder icon in the top right corner opens the templates directory in the file browser.

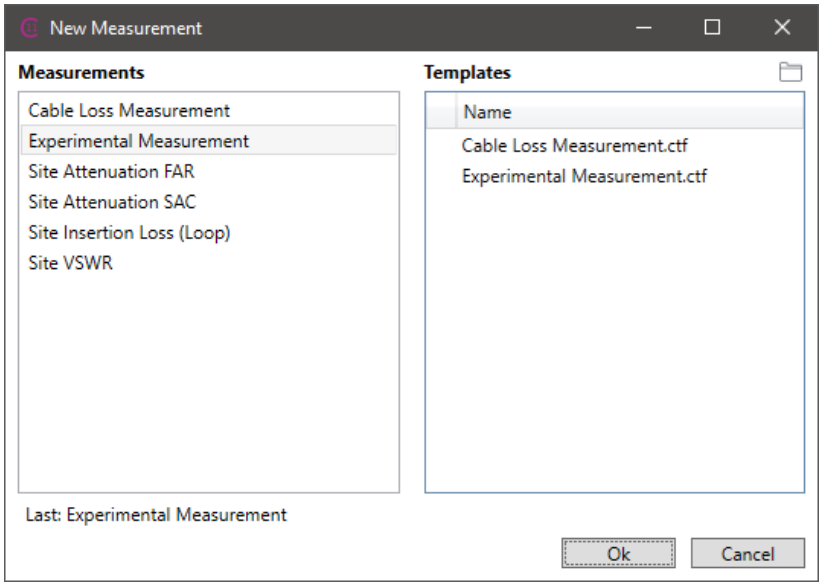
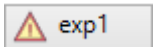


Figure 11: New measurement dialog

Note: There is a possibility that the previously saved mesurements/templates have compatibility issues with the latest CalStan software version. If this is the case, the message box is shown on actual file opening.

The opened measurement compatibility issue is indicated by yellow icon in the measurement tab.



It is not possible to save incompatible measurements as template.

6.2. Measurement Menu

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

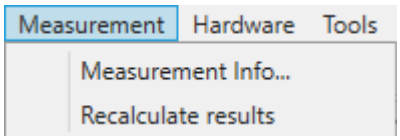


Figure 12: The measurement menu

Measurement Info	Opens a collection of general measurement information (Figure 13) in a dialog box. Some of the parameters are editable; others are locked as they are overtaken from measurement and hardware settings, indicated with the lock symbol
Recalculate Results	Recalculates the results of an active measurement. Results can be recalculated only if certain measurement specific conditions are fulfilled.

Table 3: Measurement menu

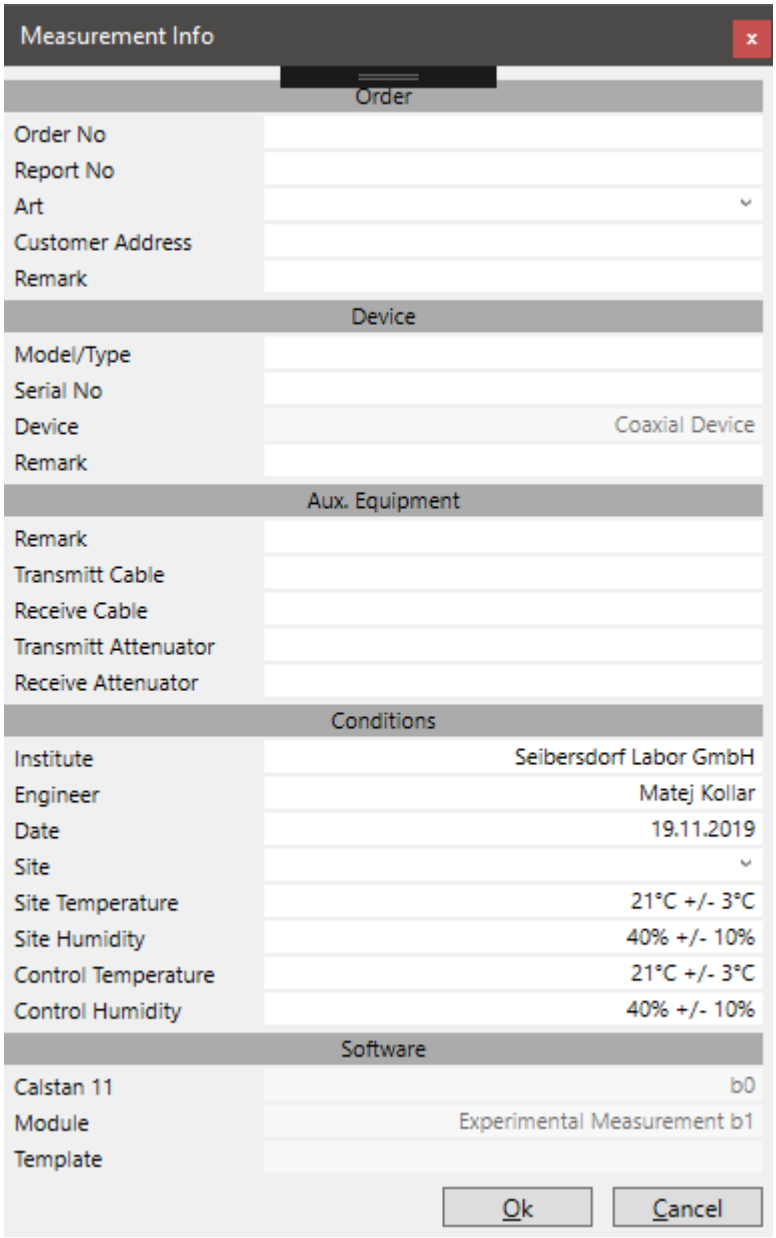


Figure 13: Measurement info dialog box

6.3. Hardware Menu

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

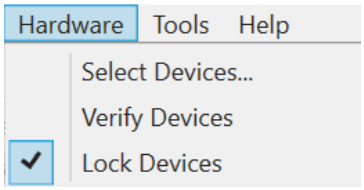


Figure 14: Hardware menu

Select Devices	Shows dialog (Figure 15) where the measurement instruments can be selected manually or detected automatically. Clicking the “Detect” button, the detection process of GPIB/TCPIP/USB connected devices starts. If the detection procedure is successful, a dialog box with a list of devices pops up, showing information about device manufacturer, model and communication interface. Individual devices/appropriate driver versions can be selected then. Next to the “Detect” button is a search field where user can type an instrument manufacturer, model or type according to which the table below is filtered. The table also contains information about the device driver version, CalStan version the driver was created for and communication interfaces the driver supports. Manual instrument/driver selection is accomplished double-clicking the table row or clicking the “+” button. The “Selected Devices” panel contains all selected devices/drivers. Only one device of the same type can be selected (existing ones are replaced). By closing the Device Selection dialog box using the “Ok” button, the selected devices drivers are displayed in the Devices panel. For each measurement module (procedure) there are defined appropriate device combinations. Device selection dialog will not allow exit on “Ok” button click if selected device doesn’t fulfill the criterion.
Verify devices	This functionality detects connected devices and checks if all of the selected devices in the measurement settings are present. The address and interface is updated, devices pre-initialization is triggered and valid measurement parameters are updated. This works only for NI Visa devices.
Lock Devices	Controls the device locking mechanism to prevent simultaneous use of a device by different measurements.

Table 4: Hardware menu

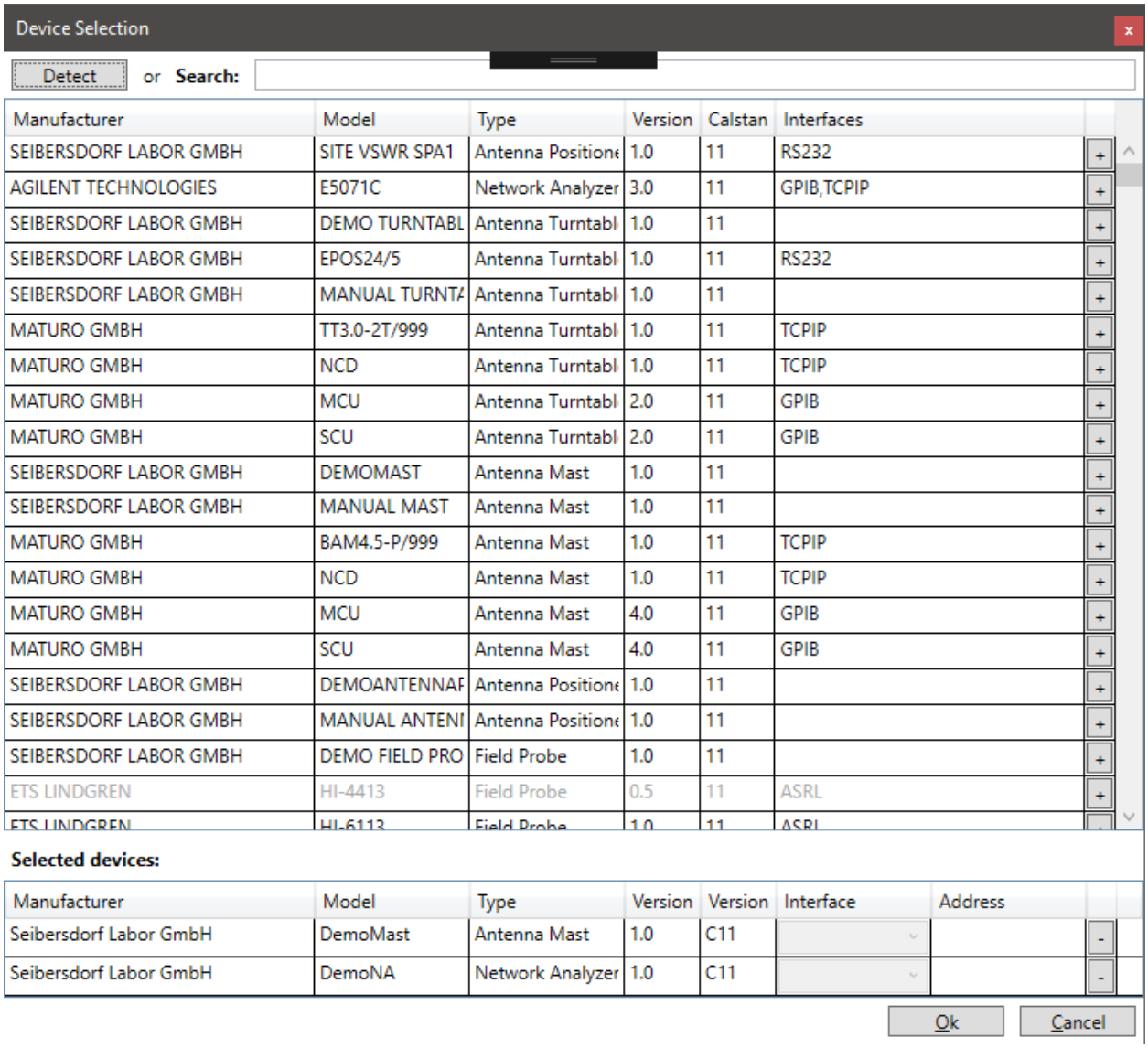


Figure 15: Device Selection Dialog, see Table 4 for explanation

6.4. Tools Menu

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

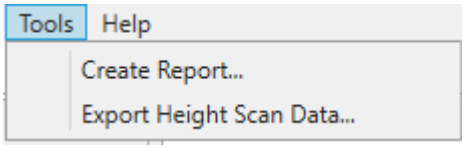


Figure 16: Tools menu

Create Report (disabled in demo mode)	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.
Export Height Scan Data	Saves the heights scan sweeps data in MS Excel file format. This function is available only in the measurement types which includes height scan.

Table 5: Tools menu

6.5. Help Menu

The help menu contains software related information, such as access to the manual and a list of installed components.

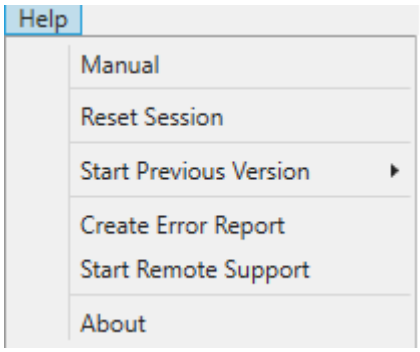


Figure 17: Help menu

Manual	Opens the CalStan manual which is stored in pdf format (Adobe Acrobat Reader or other pdf reader application is needed).
Reset Session	Session reset deletes hardware session data and automatically saved measurement templates.
Start Previous Version	Starts last version of Calstan (before update). This is useful when something doesn't work after update.
Create Report Error	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.
Start Remote Support	If problems occur with a measurement performed by CalStan, we can provide you with online support directly at your computer. The computer needs to be connected to the internet and the "Ready to connect" icon has to show at the bottom of the quick support dialog (Figure 18). 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.
About	Opens a dialog box which shows various information about the installed CalStan software including program version and a list of the installed measurements (Figure 19) and device drivers (Figure 20). It also contains version changes history (Figure 21) and system information (Figure 22).

Table 6: Help menu

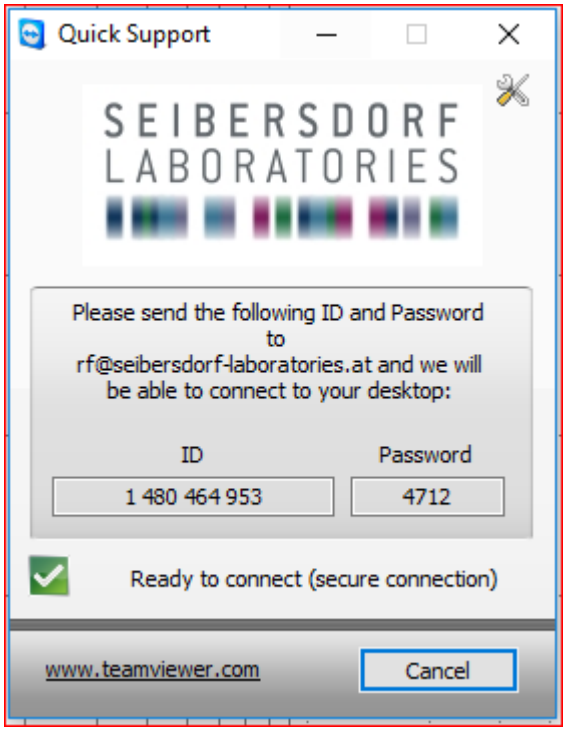


Figure 18: Quick support dialog for remote control

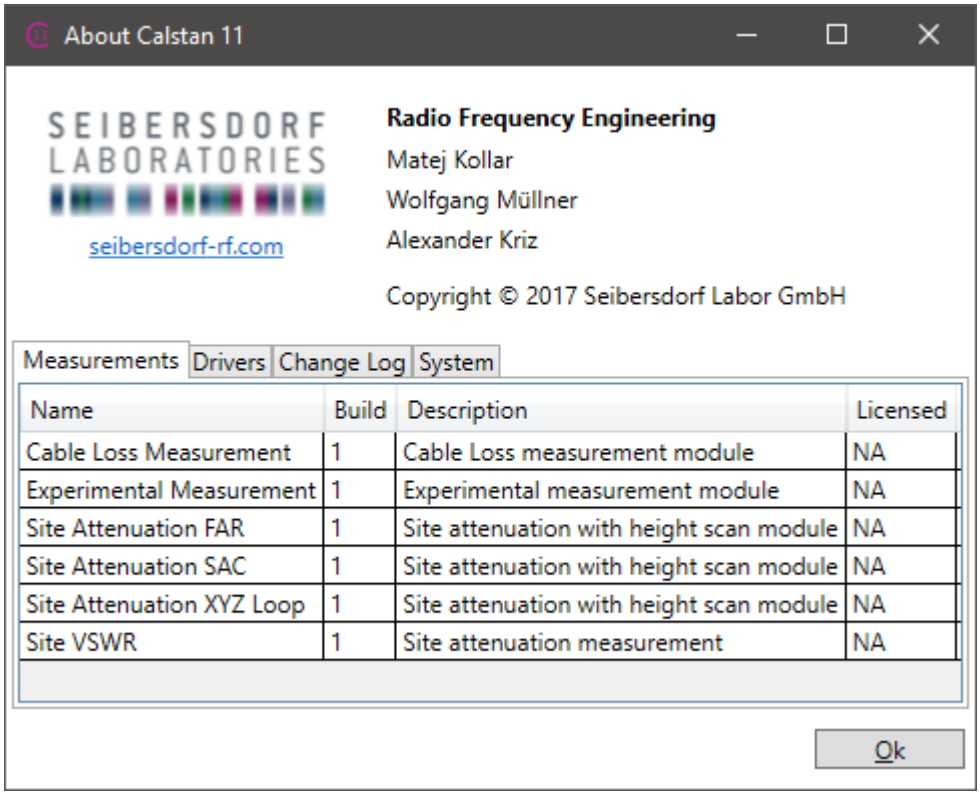


Figure 19: Dialog boxes in the About dialog, showing the installed and licensed measurement modules

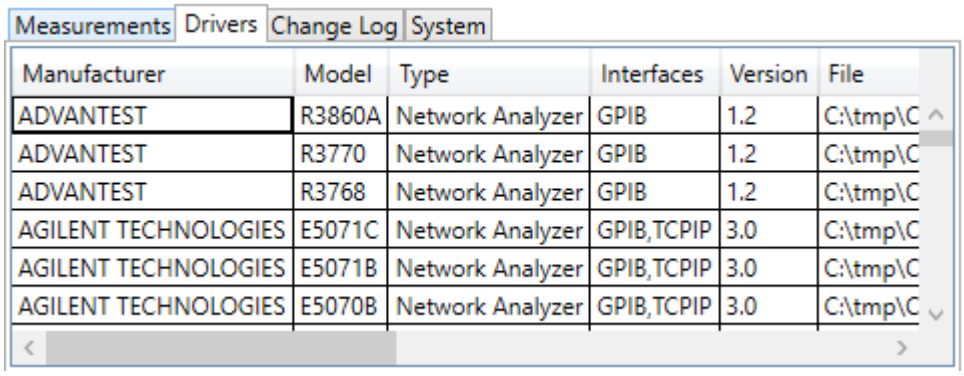


Figure 20: Dialog boxes in the About dialog, showing the instrument drivers

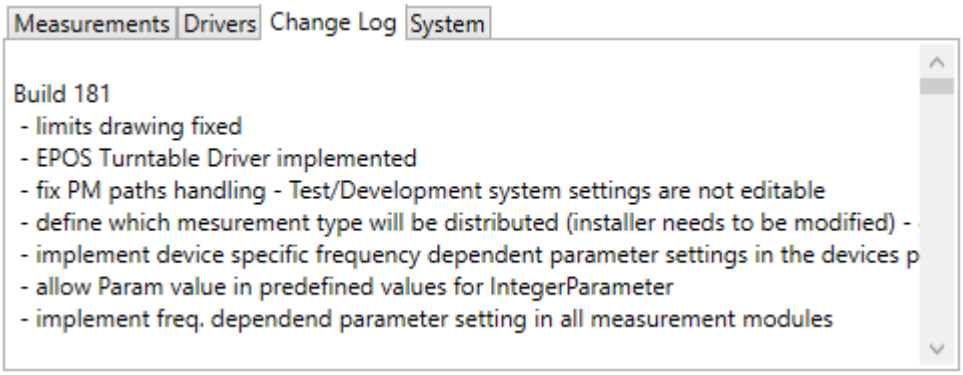


Figure 21: Dialog boxes in the About dialog, showing the latest changes in the software

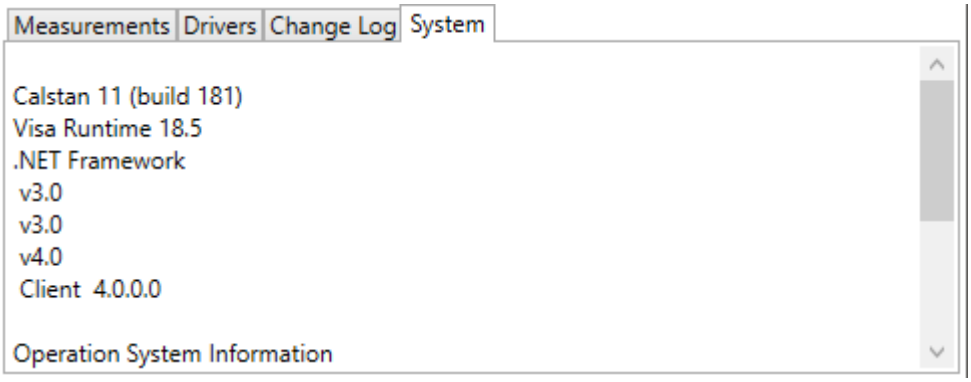


Figure 22: Dialog boxes in the About dialog, showing system information

7. CALSTAN 11 SETTINGS

This section describes parameters used in most measurement procedures.

7.1. Measurement Settings

The measurement setting panel is located in the upper left corner of the main window (Figure 8). It contains all measurement specific parameters such as frequency range, frequency steps and others. For measurements which involves height scan of the receive antenna, the “Receive Antenna Height” 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 “None”.

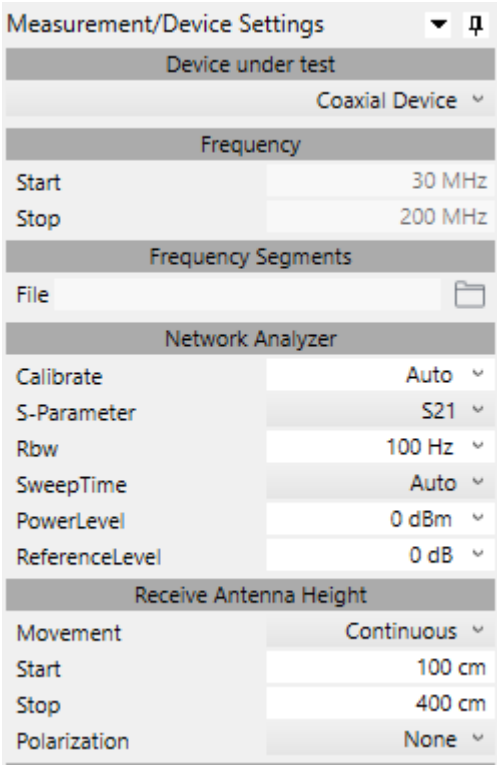


Figure 23: Measurement settings panel, for e.g. Site VSWR measurement

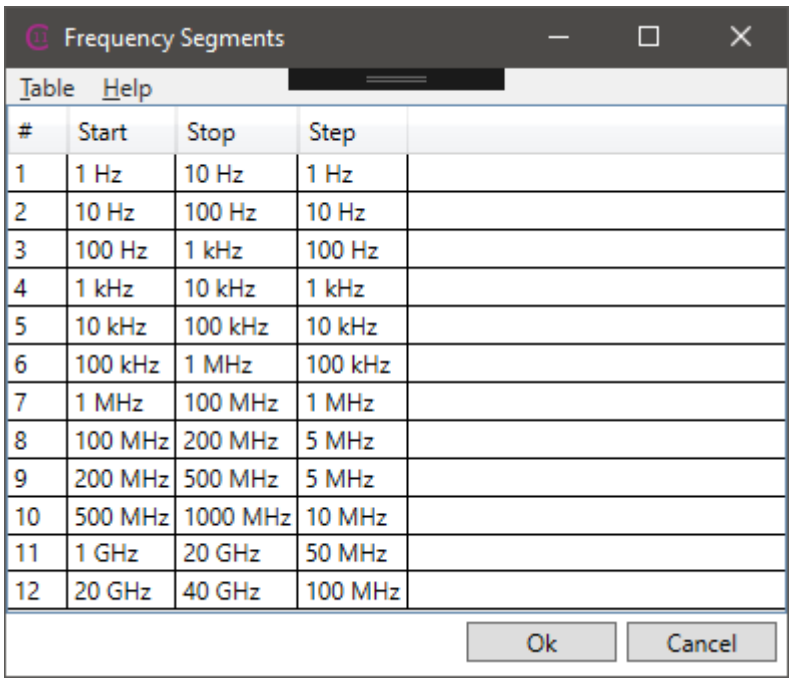
7.1.1. Frequency Step

Measurements with CalStan 11 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 Segments*” dialog box which can be opened by clicking the folder icon in the related row of the measurement settings panel.

In the “*Frequency Segments*” dialog box (Figure 24) 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.



#	Start	Stop	Step
1	1 Hz	10 Hz	1 Hz
2	10 Hz	100 Hz	10 Hz
3	100 Hz	1 kHz	100 Hz
4	1 kHz	10 kHz	1 kHz
5	10 kHz	100 kHz	10 kHz
6	100 kHz	1 MHz	100 kHz
7	1 MHz	100 MHz	1 MHz
8	100 MHz	200 MHz	5 MHz
9	200 MHz	500 MHz	5 MHz
10	500 MHz	1000 MHz	10 MHz
11	1 GHz	20 GHz	50 MHz
12	20 GHz	40 GHz	100 MHz

Figure 24: The „*Frequency Segments*“ 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; for this file type the file extension “.cfs” is used.

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

It is also possible to set some measurement parameters as frequency dependent by selecting the “Param” value from the parameter values list (e.g. Rbw parameter in Figure 25).

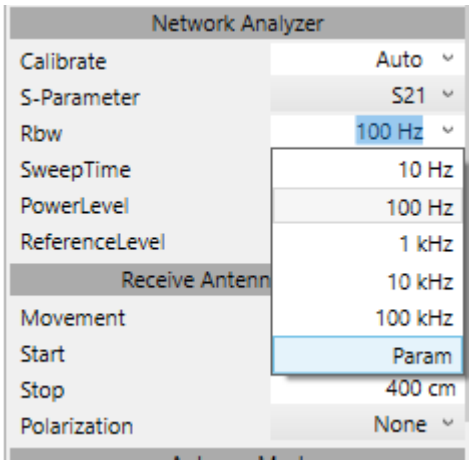


Figure 25: Parameter dialog

Then in the „Frequencvy Segments“ dialog, specific parameter value (see Rbw in Figure 26) can be defined for each frequency segment (range).

Frequency Segments

Table Help

#	Start	Stop	Step	Rbw
1	1 Hz	10 Hz	1 Hz	1 Hz
2	10 Hz	100 Hz	10 Hz	10 Hz
3	100 Hz	1 kHz	100 Hz	1 kHz
4	1 kHz	10 kHz	1 kHz	2 kHz

Figure 26: The „*Frequency Segments*“ dialog with measurement parameters

7.1.2. Limit

To determine if the measurement results range within a particular tolerance, limit boundaries are defined for specific frequency intervals. These intervals are specified in the “*Limit*” dialog box (Figure 28, Figure 29) which can be opened by clicking the folder icon in the related row of the measurement settings panel. When the result chart is viewed, the limit data are displayed too.

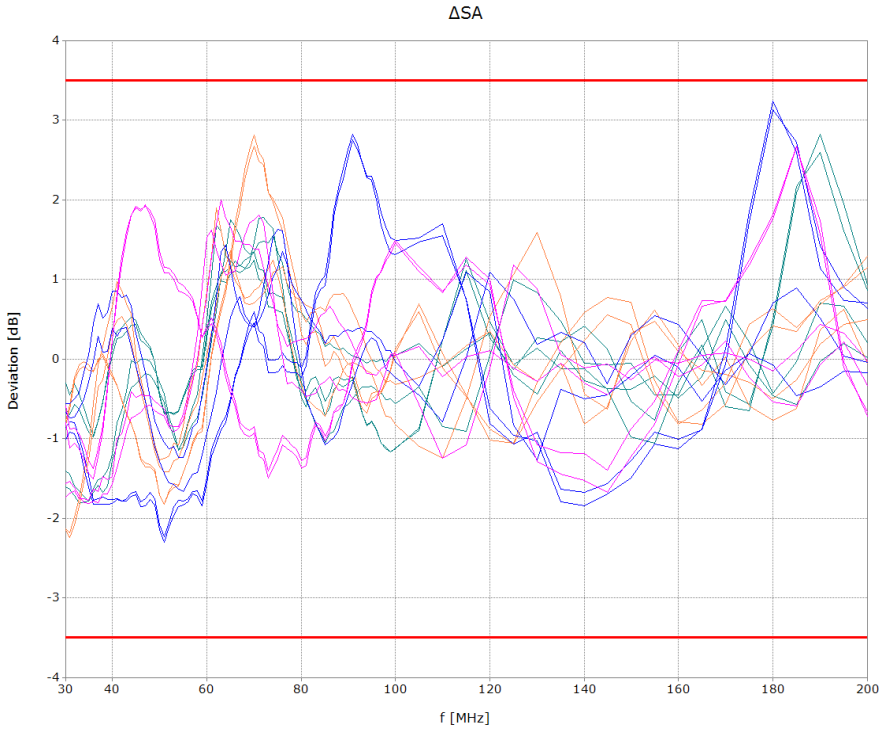


Figure 27: The limit boundaries in the measurement result chart

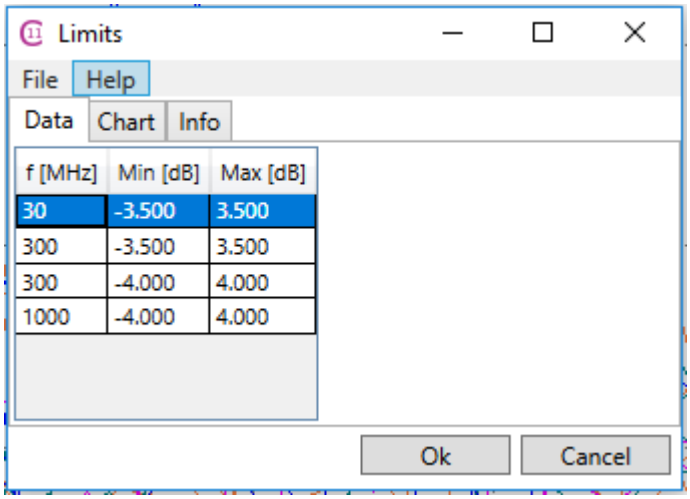


Figure 28: The „Limit“ dialog box with the data view

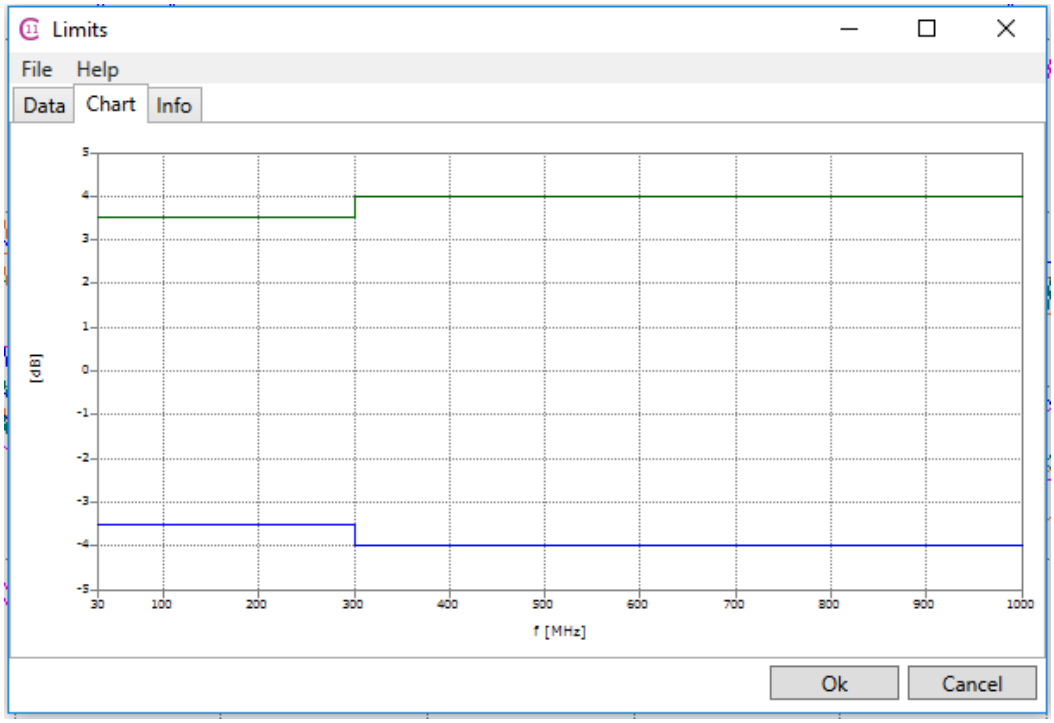


Figure 29: The „Limit“ dialog box showing the graph

7.1.3. Factor files

Some measurement types require various factor files to be set in their measurement settings. This involves cable loss factor, transmit/receive antenna factors, dual antenna factors and others. Clicking the folder button in the measurement settings panel of a factor file parameter, opens the factor file dialog. This dialog contains three tab pages:

1. Data page – shows factor data (see Figure 30 and Figure 31)
2. Chart page – here the factor data chart is shown (see Figure 32)
3. Info page – displays description of the given factor measurement (see Figure 33)

Both data and info page can be modified using context menu.

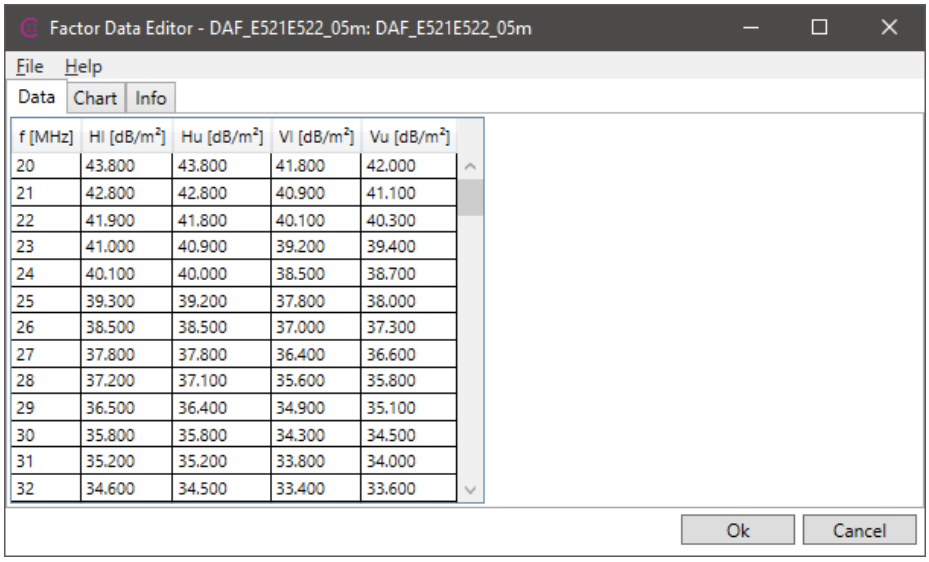


Figure 30: Factor file dialog – Data tab for Dual Antenna Factor

When more than one factor is available you need to choose the one to use, see Figure 31 where “Attenuation T2” is selected as example.

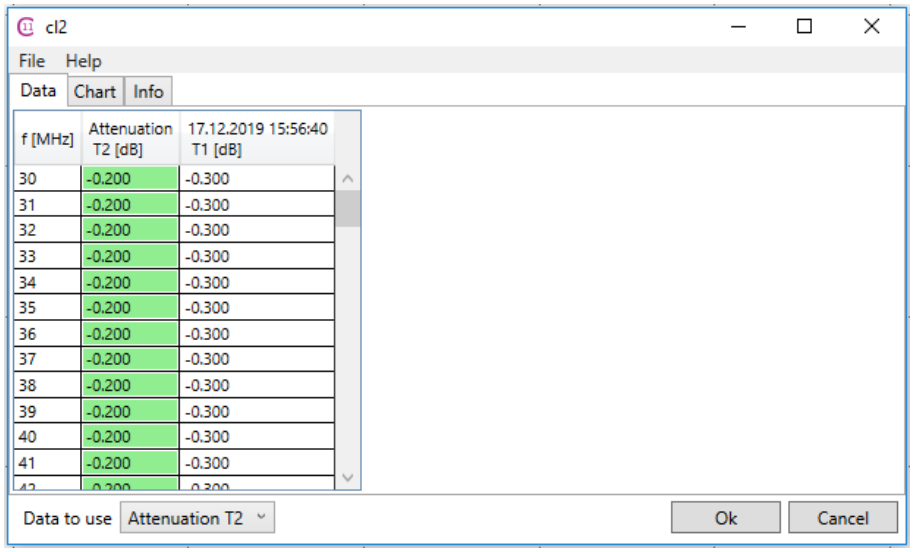


Figure 31: Factor file dialog – Data tab for Cable Loss

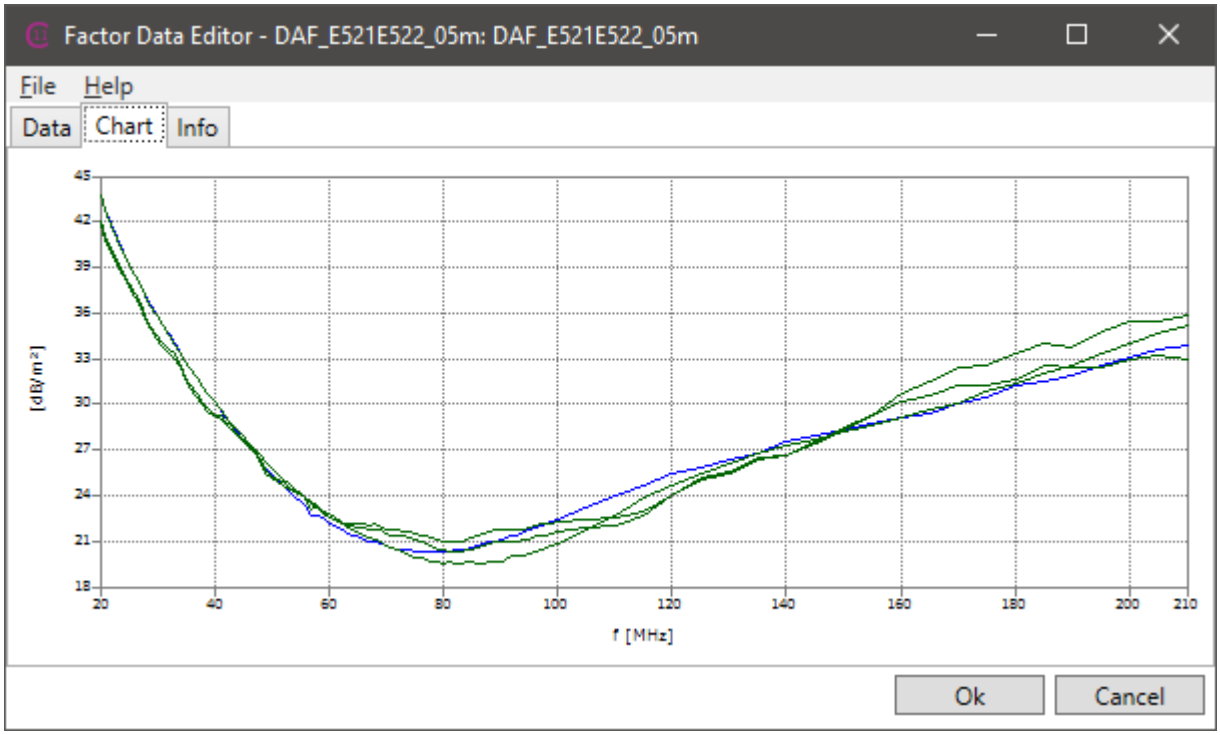


Figure 32: Factor file dialog – Chart tab

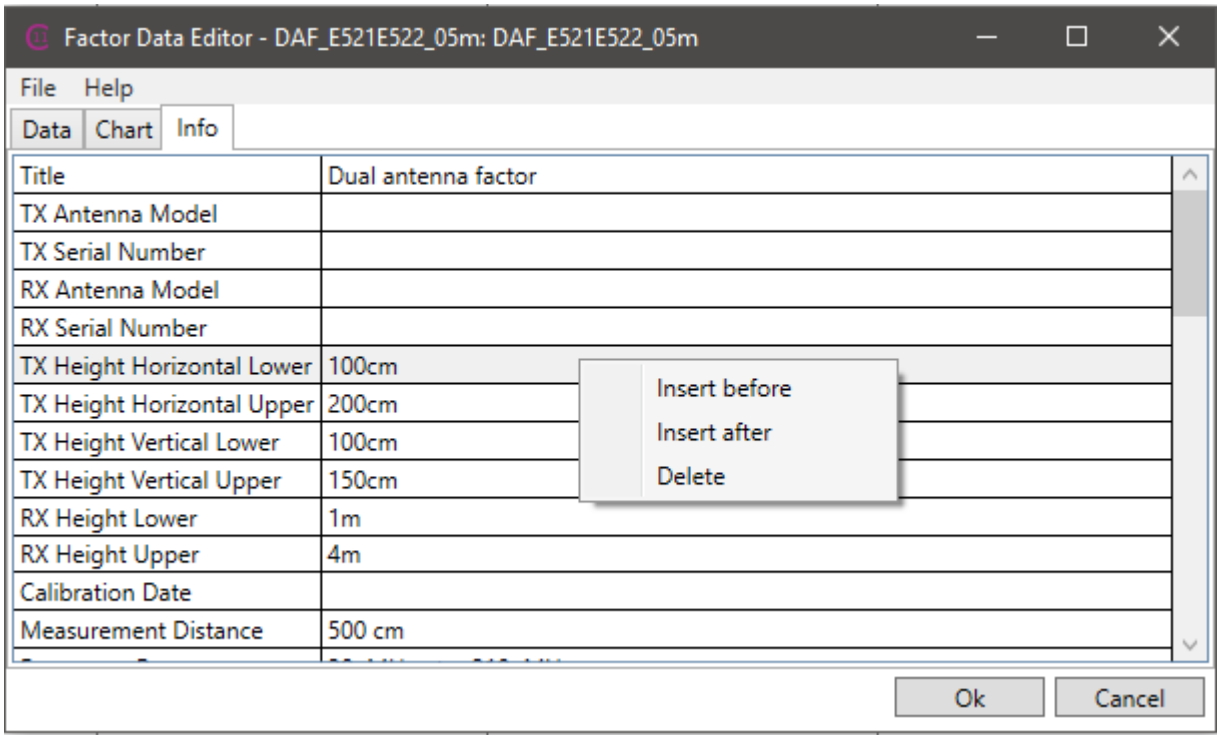


Figure 33: Factor file dialog – Info tab for Dual Antenna Factor

Note: In the GUI where the factor file editing dialog can be opened, is displayed file name or "Not saved" if a filename is not present and there are factor data available.

File Menu

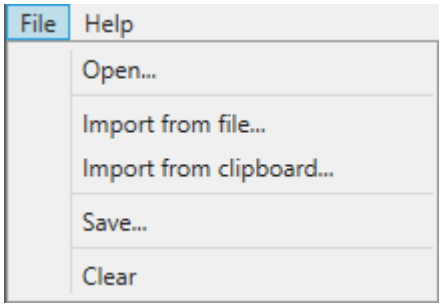


Figure 34: The file menu

Open	Opens a previously saved factor file. CalStan factor files have extension cff.
Import from file…	Imports factor data from a text file. In the Info tab page, the factor measurement description can be filled out. Then switching to Data page a text file containing the physically measured values can be loaded. This can be a 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 35) if the Help button is pressed. Factor files imported this way can then be saved in the CalStan 11 native format to make loading the data more convenient when needed next time.
Import from clipboard	Imports factor data from clipboard. In this way the data can be copied conveniently from MS Excel spreadsheet and pasted here.
Save…	Saves a measurement as a template. Template can be then used for creation of new measurement of the same type with the same settings.
Clear	List of recently opened files which can be reopened.

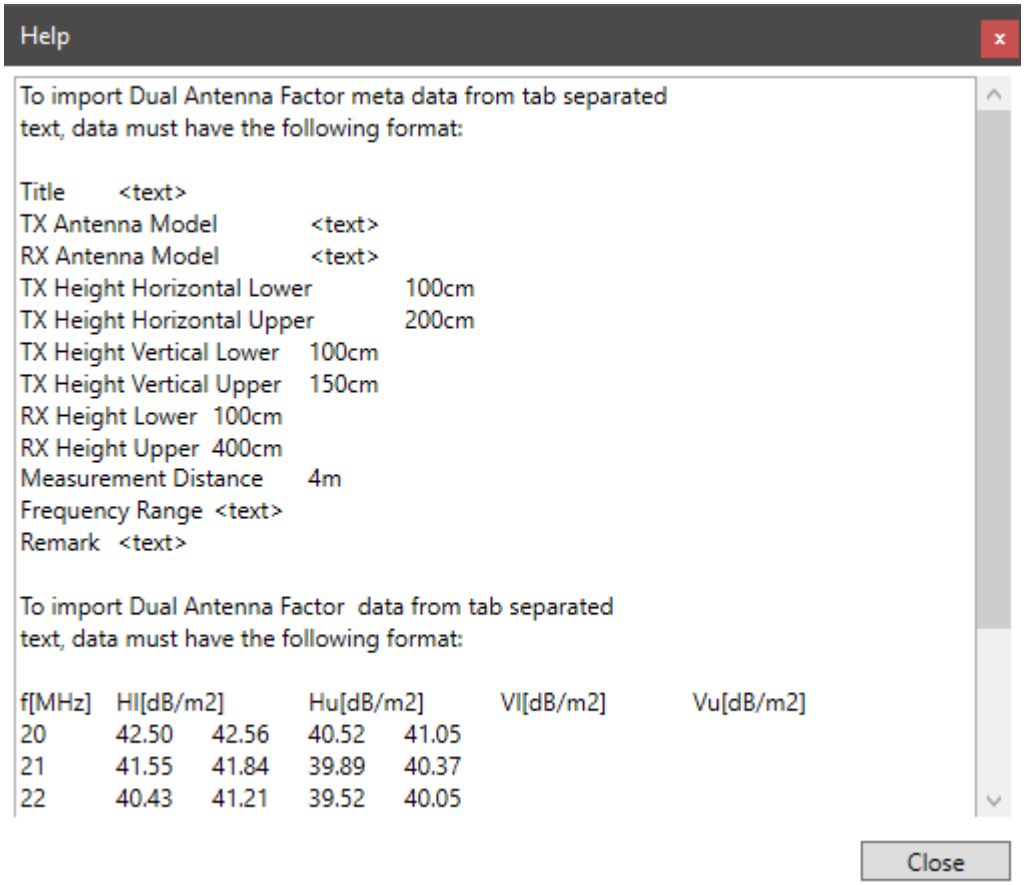


Figure 35: Help dialog – Dual Antenna Factor import file format.

7.1.4. Measurement specific hardware parameters

Measurements have to be done according to certain requirements defined in standards or SOPs. This could be the measurement bandwidth (RBW) for example. In Figure 36 the measurement specific settings when a network analyzer is used are shown.

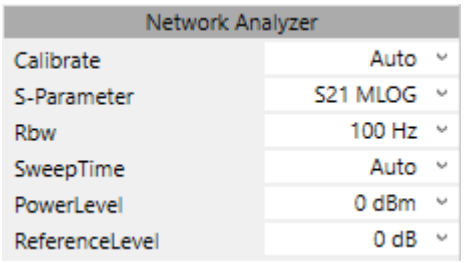


Figure 36: Measurement settings for network analyzer.

The settings of the network analyzer for a specific measurement are used for all different models of network analyzer as they are defined in the measurement setting.

7.2. Instrument Settings

To setup instrument related device parameters, a panel similar to one displayed in Figure 36 is present in the ‘Measurement/Device Settings’ part of the application (Figure 37). For every model a separate panel exists. For illustration purposes the Agilent Technologies E5071C network analyser driver is used.

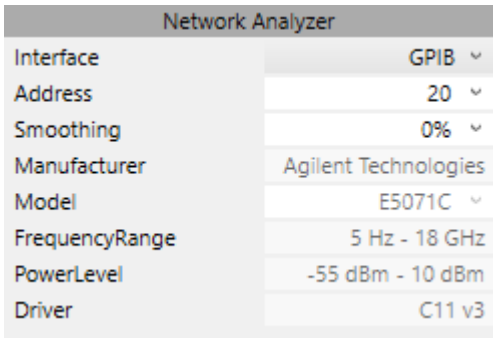


Figure 37: Instrument info and parameters.

The panel contains general information about the device such as manufacturer, model, frequency range etc. These values have only informative character and can’t be edited.

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

8. MEASUREMENT CONTROL

Every measurement type contains the ‘Measurement Control’ panel where the measurement configuration is selected, 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 of a **Site VSWR measurement** is shown. The layout is divided into two tabs.

The “*Positions*” tab (Figure 38) shows a table with a list of measurement positions. Its columns have the following meanings:

The name of the position - when clicked, the position is set active and is highlighted in the chart.

Number of traces measured at the position.

In the context menu (mouse right click) a picture can be assigned to the position (drag&drop functionality is also supported).

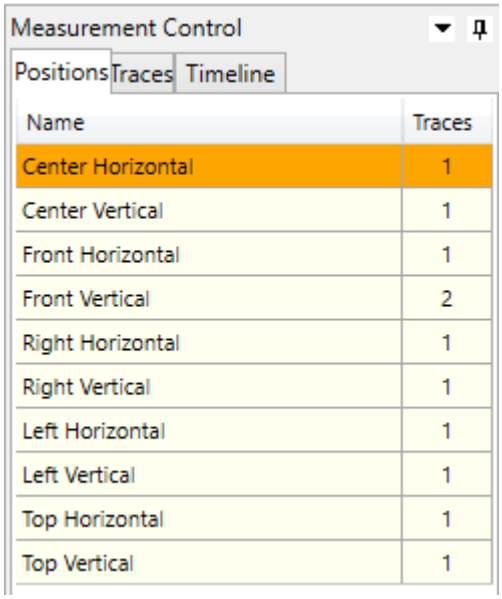


Figure 38: Measurement Control panel with Positions view

The “*Traces*” tab (Figure 39) includes a table with a list of measurements finished at the active position. The columns have the following meaning:

Trace number

Comment – short text describing the measurement (user defined; after a second measurement of the same measurement point, the input of a comment is requested)

Indicator (green dot) – shows 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 from the context menu.

In the context menu a picture can be assigned to the trace (drag&drop functionality is also supported).

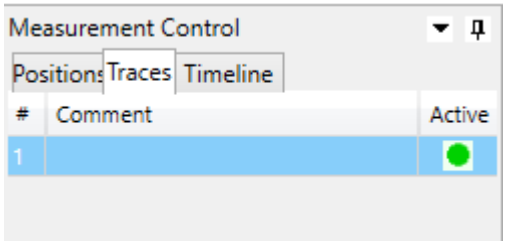


Figure 39: Measurement Control panel with Traces view

The "*Timeline*" tab (Figure 40) includes a table with a list of measurements (traces) in the order they were finished. In the context menu (mouse right click) the measurement timestamp can be examined as well as a picture can be assigned (drag&drop functionality is also supported). Trace timestamp is stored in UTC format and converted to local time when displayed.

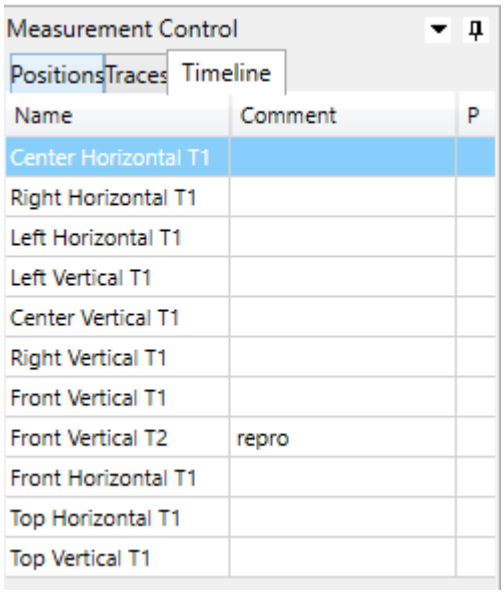


Figure 40: Measurement Control panel with Timeline view

In the *"Layout"* tab a graphic shows the layout of a currently active position (Figure 41 left). With the radio buttons the desired measurement position can be selected conveniently. Finished positions are indicated by green color. Slider control at the bottom of the panel can be used to adjust the measurement setup orientation (left/right).

In the *"Picture"* tab is displayed an image associated by the selected Position/Trace. Images are saved as 1500pixel jpeg of 75% quality level. One picture consumes 190kb of file space. Supported image file formats: BMP, GIF, JPEG, PNG, TIFF

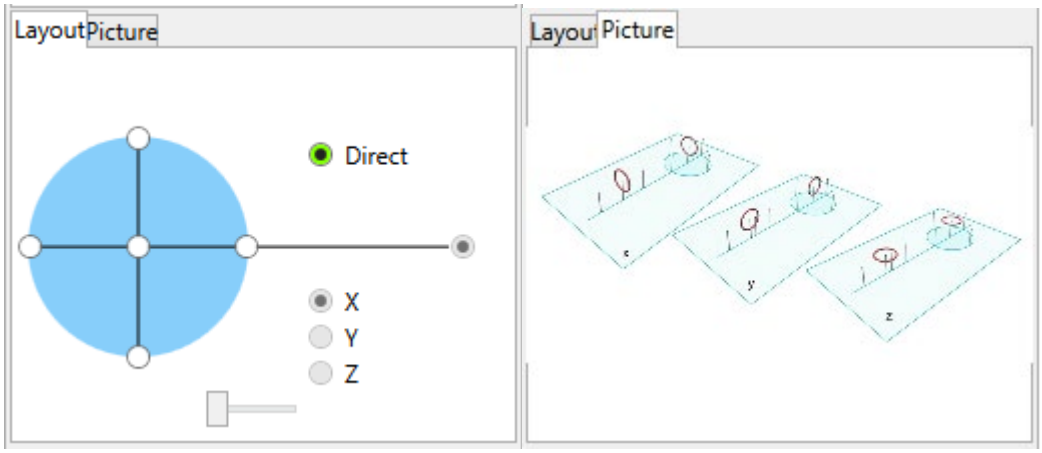


Figure 41: Layout view (left) and Picture (right)

By clicking the "Start" button in the measurement control panel (Figure 42) the measurement procedure is started.

Figure 42: Start measurement.

When the measurement is started for the first time or the receiver parameters were changed, the devices are initialized.

When the test instrument is a network analyzer and its S-parameter is set to S11 or S22, the calibration dialog box appears (Figure 43). The calibrate behavior can be controlled by the calibrate parameter which appears in the measurement settings panel (Figure 36) on some types of instruments. If the parameter is set to auto, the message appears only if the device was initialized, and the S-parameter is set to S11 or S22. Other options are "Yes" which shows the message always or "No" in which case the message will not be shown despite of the device initialization or S-parameter setting.

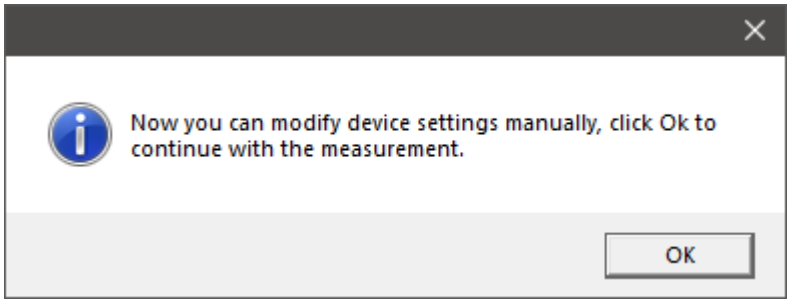


Figure 43: Devices calibration dialog box.

At this point some device settings can be changed manually 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 the current measurement or if the receiver parameters changed.

During the measurement the "*Start*" button is replaced by a "*Stop*" button. A progress bar shows the advance of the measurement. At the same time the measurement chart area is changed to the *"Measurement"* 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 antenna position (distance).

Figure 44: Measurement progress bar

To stop the measurements, click the "*Stop*" button. The suspend measurement dialog box pops up (**Figure 45**) 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.

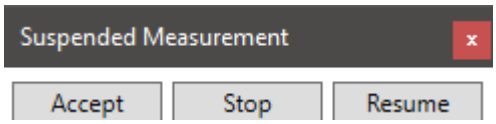


Figure 45: Suspended measurement dialog box.

During the measurement the data is displayed in the "*Measurement*" tab of the chart area.

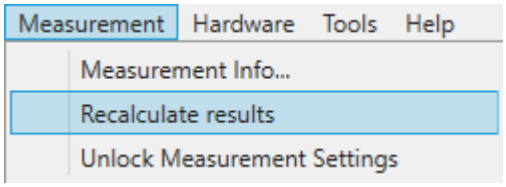
Tip: To play a notification sound on successful measurement finish, create file:

c:\Users\[user name]\AppData\Roaming\Calstan 11\sounds\measurement_finished.wav

(e.g. you can download and rename https://upload.wikimedia.org/wikipedia/commons/5/55/Buzzer.wav)

9. RESULTS - MEASUREMENT DATA DISPLAY

By default, the results are calculated only for active traces. Results are calculated on measurement finished or Active trace change. Recalculation can be executed explicitly by clicking Measurement->Recalculate Results.



The measurement data and the results of the measurement are displayed in the chart area in the appropriate tabs which are described in this chapter.

The first tab ("*Measurement*") shows the actual measurement data during a measurement progress. After measurement is finished sweep data at specific position (e.g. height scan) are shown if available, otherwise the active trace is displayed (Figure 46).

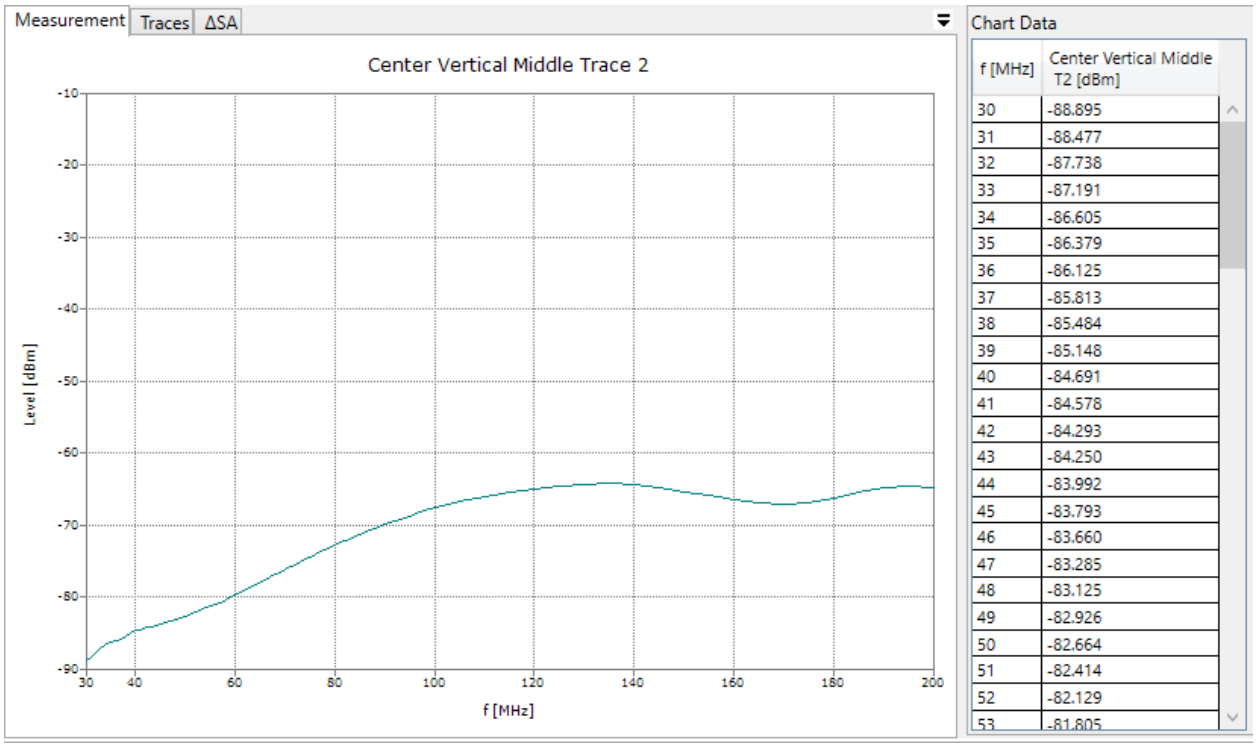
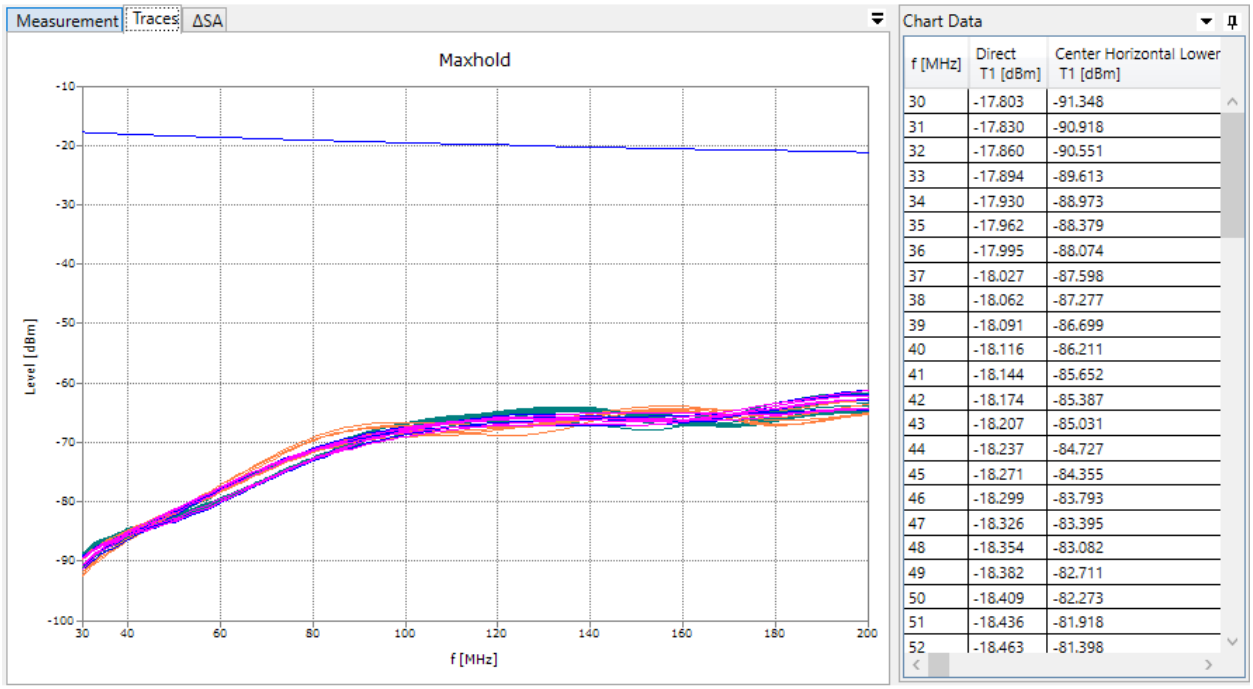


Figure 46: The measurement display

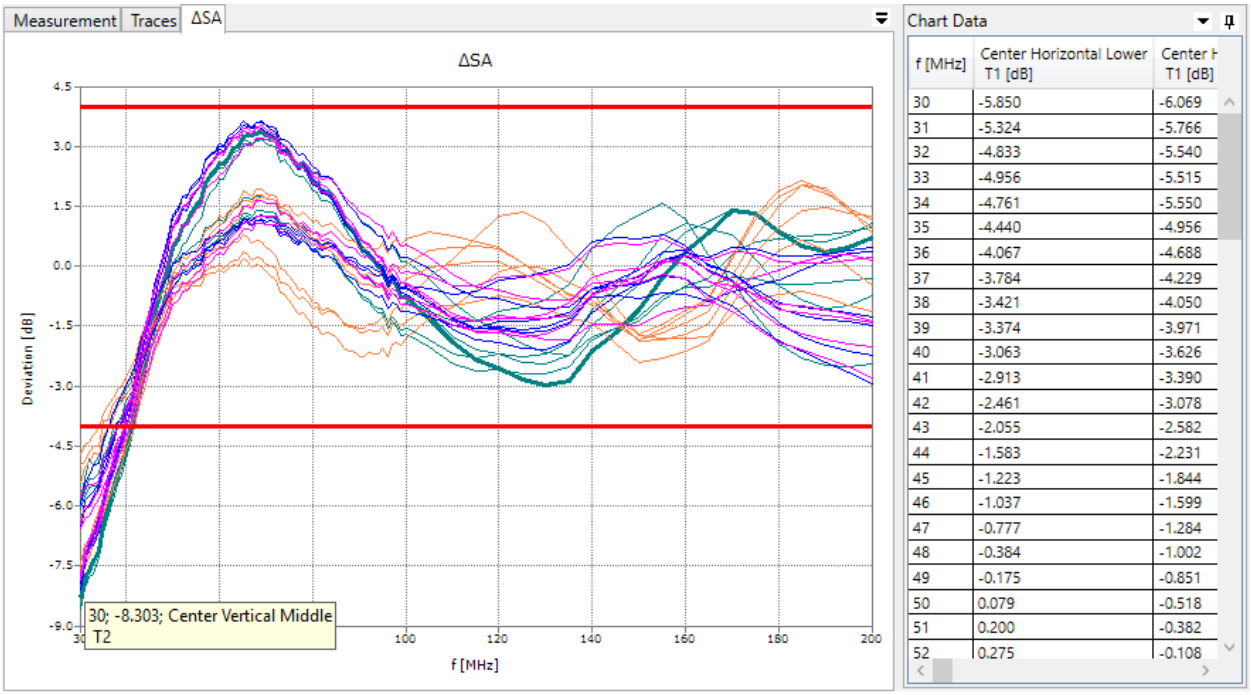
The next tab marked as “*Traces*” shows raw or e.g. maxhold measurement data after a measurement is finished (Figure 47).



f [MHz]	Direct T1 [dBm]	Center Horizontal Lower T1 [dBm]
30	-17.803	-91.348
31	-17.830	-90.918
32	-17.860	-90.551
33	-17.894	-89.613
34	-17.930	-88.973
35	-17.962	-88.379
36	-17.995	-88.074
37	-18.027	-87.598
38	-18.062	-87.277
39	-18.091	-86.699
40	-18.116	-86.211
41	-18.144	-85.652
42	-18.174	-85.387
43	-18.207	-85.031
44	-18.237	-84.727
45	-18.271	-84.355
46	-18.299	-83.793
47	-18.326	-83.395
48	-18.354	-83.082
49	-18.382	-82.711
50	-18.409	-82.273
51	-18.436	-81.918
52	-18.463	-81.398

Figure 47: The traces display.

The “ΔSA” tab (Figure 48) shows the calculated results for NSA FAR measurement and the specified limit boundaries. Some measurement procedures can have more than one result tab and can display various data.



f [MHz]	Center Horizontal Lower T1 [dB]	Center H T1 [dB]
30	-5.850	-6.069
31	-5.324	-5.766
32	-4.833	-5.540
33	-4.956	-5.515
34	-4.761	-5.550
35	-4.440	-4.956
36	-4.067	-4.688
37	-3.784	-4.229
38	-3.421	-4.050
39	-3.374	-3.971
40	-3.063	-3.626
41	-2.913	-3.390
42	-2.461	-3.078
43	-2.055	-2.582
44	-1.583	-2.231
45	-1.223	-1.844
46	-1.037	-1.599
47	-0.777	-1.284
48	-0.384	-1.002
49	-0.175	-0.851
50	0.079	-0.518
51	0.200	-0.382
52	0.275	-0.108

Figure 48: The results display with data tab selected

Using the chart context menu (Figure 50) it is possible to switch between linear and logarithmic scale of the domain axis, reset chart zoom, copy/save chart image or set displayed data frequency units.

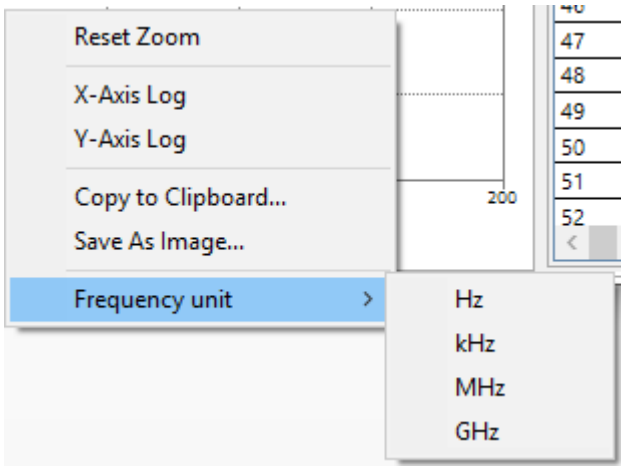


Figure 49: Chart context menu.

The "*Chart Data*" tab (see right part in Figure 46 to Figure 48) 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. Clicking the table cell will highlight the given point in the chart, and similarly clicking the curve point in the chart will select the appropriate cell in the table.

10. MEASUREMENT MODULES

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 11 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.

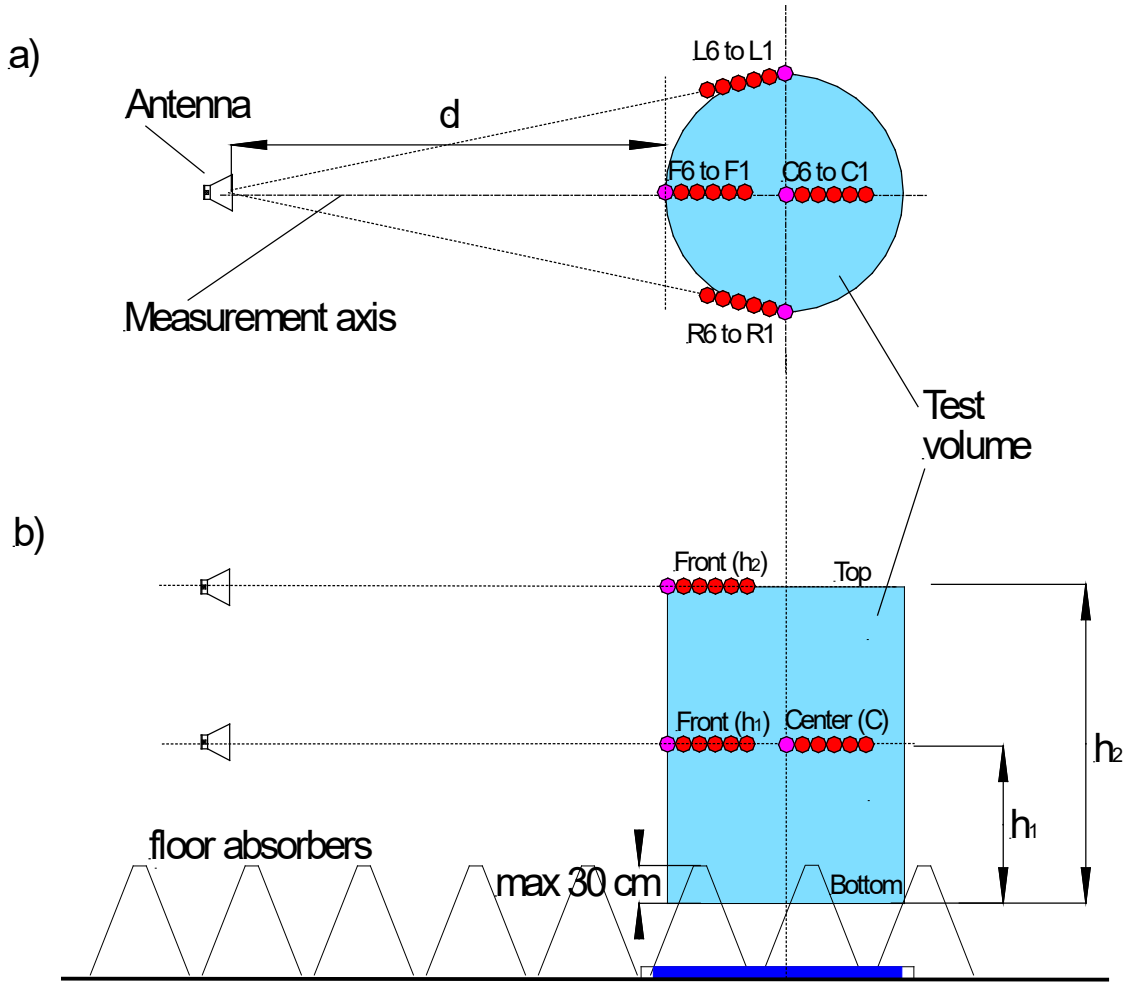


Figure 50: Location of test points for Site VSWR
a) top view
b) side view

In Figure 50 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. For this purpose, scan distance segments are predefined (Figure 51).

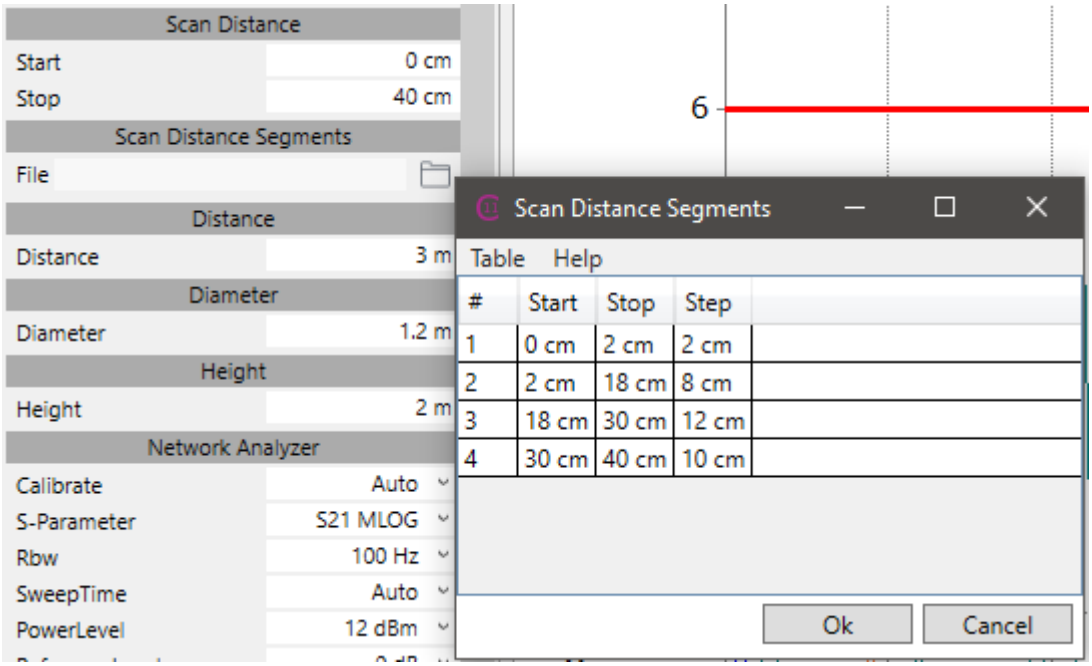


Figure 51: Scan distance segments definition: this setting will generate the standard positions at 0 cm, 2 cm, 10 cm, 18 cm, 30 cm and 40 cm.

10.1.1. Setup

Allowed measurement instrument combinations:

Preferred	Inst1	Inst2	Inst3
x	Network Analyser	-	Positioner
	Signal Generator	Spectrum Analyser	Positioner

Before starting the measurement, all measurement parameters have to be defined in the "Measurement Settings" panel (Figure 53, 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 segments configuration for consistency with the standards requirements of 50 MHz step size.

The POD antenna can be positioned manually or using automated SPA2 positioner. In Figure 52 the available positioner drivers are listed.

Device Selection

Detect or **Search:** Posi

Manufacturer	Model	Sensor	Type	Version	Calstan	Interfaces	
SEIBERSDORF LABOR GMBH	SITE VSWR SPA2		Antenna Positioner	2.0	11	RS232	+
SEIBERSDORF LABOR GMBH	MANUAL ANTENNA POSITIONER		Antenna Positioner	1.0	11		+
SEIBERSDORF LABOR GMBH	SITE VSWR SPA1		Antenna Positioner	2.0	11	RS232	+

Figure 52: Site VSWR Antenna Positioners.

The automated positioner measures all positions which are selected in the positions table, one after another. When using manual positioner, a message box with desired position information is displayed at each position.

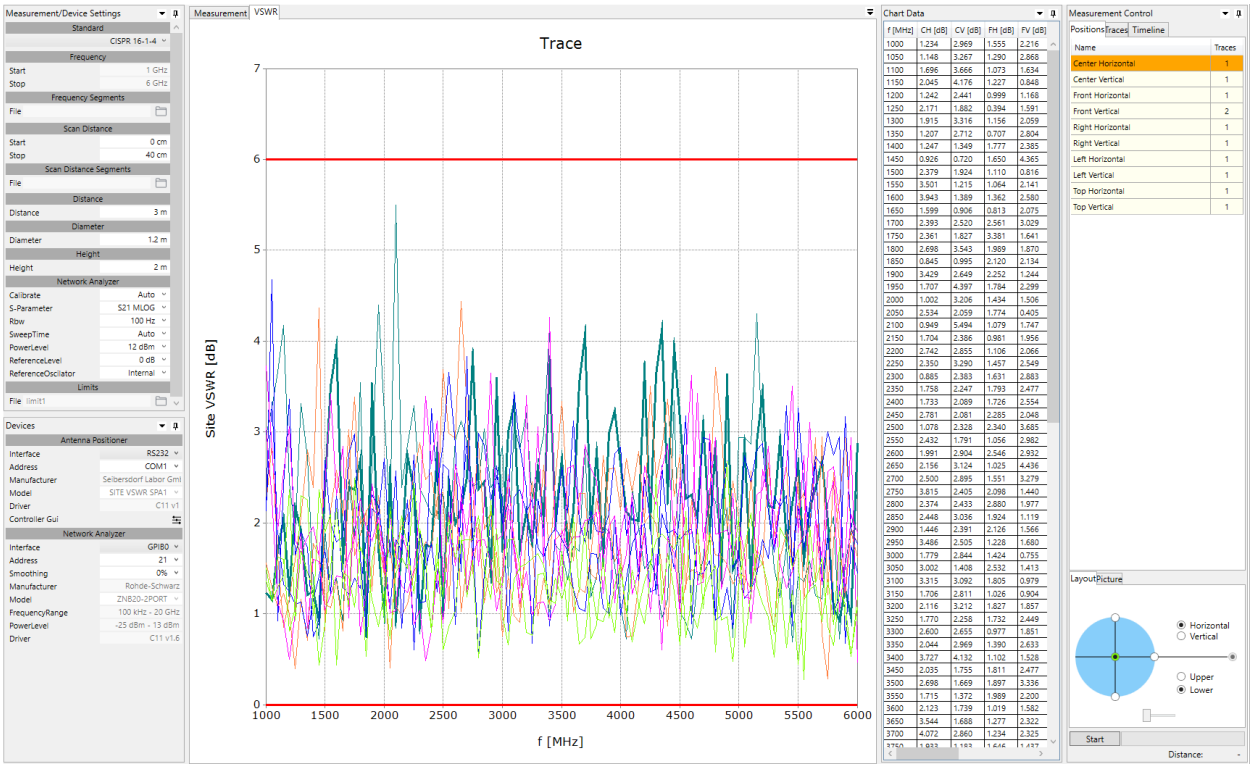


Figure 53: Site VSWR window

10.1.2. Using SPA2 Automatic Site VSWR Positioner

The SPA2 detection can be done automatically (Select Devices) or the COM port for remote control can be set manually in the instrument specific hardware settings (Figure 54). By clicking the Controller GUI a specific tool allows the check of the proper instrument operation and for moving to the “Home” position manually.

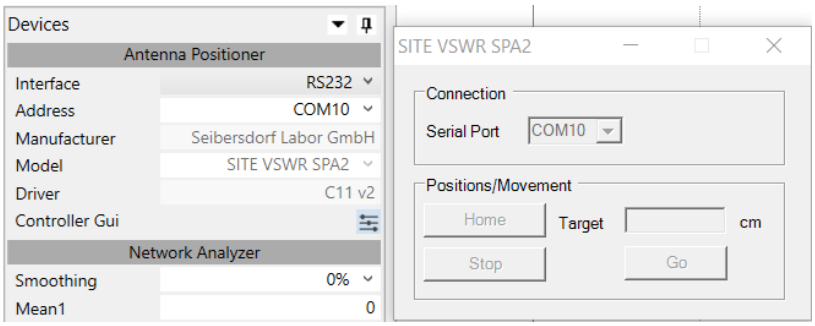


Figure 54: SPA2 Controller GUI

Using the automatic positioner, the measurement procedure can be highly automated. By selecting desired position, setting up the antenna on the corresponding location and clicking the start button, the positioner moves the antenna to correct distances in the 40 cm line and performs the measurements.

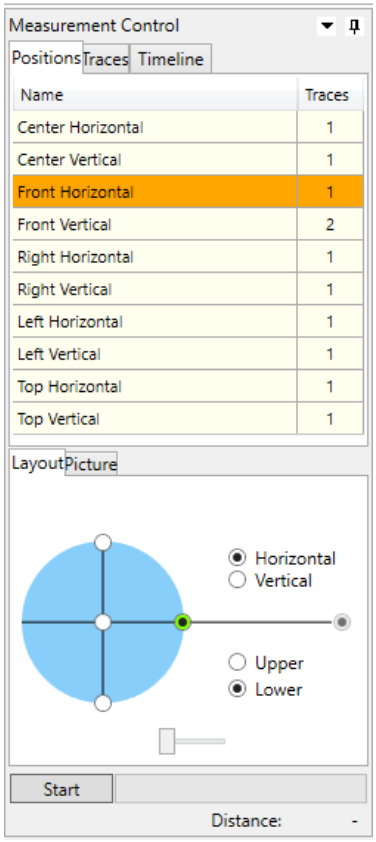


Figure 55: Selecting position to be measured

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 and top) for 2 polarizations (horizontal, vertical). All six positions are depicted in the start measurement panel as shown in the right part of Figure 55.

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:

$VSWR\ A = \max(modif_{A,1}, modif_{A,2}, \ldots, modif_{A,6}) - \min(modif_{A,1}, modif_{A,2}, \ldots, modif_{A,6})$

where $modif_{A,i} = corr_{A,i} + mes_{A,i}$

with:

$corr_{A,6} = 20 * \log10((D + 0.00)/D)$,

$corr_{A,5} = 20 * \log10((D + 0.02)/D)$,

$corr_{A,4} = 20 * \log10((D + 0.10)/D)$,

$corr_{A,3} = 20 * \log10((D + 0.18)/D)$,

$corr_{A,2} = 20 * \log10((D + 0.30)/D)$,

$corr_{A,1} = 20 * \log10((D + 0.40)/D)$,

$mes_{A,i}$ is a measured value at the specific location “A” in position “i”

where

D = d	for front and top location,
D = d + r	for center location,
D = sqrt((d +r)^2 + r^2) – 0.40	for right and left location,

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 56 shows an Excel document containing several worksheets and Table 7 describes the content of the EXCEL file.

Measurement Info	Contains the same information as the Measurement Info dialog box – general measurement information.
Result Data	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).
Limits	Limit data used for the measurement
Measurement Settings	Represents the Measurement Settings panel.
Instruments	Holds the device parameters used for measurement.

Table 7: Description of the MS Excel file

f [MHz]	CH [dB]	FH [dB]	RH [dB]	LH [dB]	TH [dB]	CV [dB]	FV [dB]	RV [dB]	LV [dB]	TV [dB]
6000	1.30	1.51	1.75	1.34	0.95	1.53	0.91	1.45	1.39	2.25
6050	1.32	1.49	0.72	0.88	1.57	1.54	1.14	1.16	1.35	1.55
6100	1.06	0.90	0.57	1.06	0.94	0.98	2.24	0.93	1.53	1.55
6150	1.59	0.80	1.54	0.76	1.12	0.77	1.18	0.82	1.34	1.19
6200	0.96	0.62	0.93	1.75	0.42	1.23	0.60	1.02	0.60	1.10
6250	0.86	1.33	0.84	1.23	0.68	1.95	1.16	0.47	1.16	1.21
6300	1.34	1.97	1.16	0.71	1.53	2.32	0.51	0.64	1.11	0.95
6350	1.39	0.58	1.29	1.38	0.78	2.29	0.81	1.34	1.13	0.54
6400	1.02	1.49	1.26	1.72	1.22	1.32	0.70	0.89	1.33	1.17
6450	0.95	1.15	1.07	1.47	1.03	1.55	0.72	0.71	0.59	0.77
6500	1.20	1.38	1.02	0.57	0.66	0.99	0.74	0.67	0.96	0.86
6550	1.19	1.14	0.94	1.39	0.90	0.85	0.70	1.13	1.15	1.14
6600	1.37	1.22	1.88	1.78	0.92	1.47	1.19	0.94	1.13	1.38
6650	1.59	1.58	0.77	0.91	0.69	0.41	0.93	1.07	0.99	1.78
6700	1.36	1.48	0.64	1.06	1.02	1.22	0.88	0.97	0.55	1.97
6750	1.88	0.63	1.08	1.32	1.05	1.95	1.22	0.99	0.87	1.95
6800	1.18	0.57	0.75	1.00	1.19	1.37	0.54	1.91	1.11	1.51
6850	2.40	1.21	1.06	1.75	1.32	3.10	0.47	1.34	1.13	1.71
6900	2.22	1.22	0.58	1.62	0.98	1.51	1.55	1.39	1.70	1.53
6950	1.72	1.29	0.57	1.38	0.60	1.00	1.42	1.02	0.95	1.99
7000	2.09	0.90	1.01	0.89	0.87	0.60	0.61	1.27	0.87	2.42
7050	2.13	1.75	0.76	1.66	0.78	2.00	1.05	1.18	1.14	2.37
7100	2.44	1.13	1.44	1.31	1.29	1.87	1.74	1.39	0.99	2.63
7150	1.59	1.23	1.46	1.30	0.97	1.96	2.08	0.86	0.81	2.14
7200	1.42	0.73	1.91	1.69	1.28	1.84	1.64	1.36	1.92	1.40
7250	1.17	1.55	1.87	1.93	1.70	1.04	1.69	1.37	1.94	1.60
7300	2.65	1.34	1.41	1.22	0.95	0.78	0.45	1.21	2.52	1.96
7350	2.87	0.90	1.71	0.27	2.12	1.72	1.05	3.30	2.38	1.04
7400	3.41	1.84	1.06	2.09	0.93	1.51	0.97	1.32	2.36	2.63
7450	1.20	1.37	1.11	1.60	1.01	0.52	1.45	1.84	1.30	1.89
7500	1.01	2.24	1.06	1.91	1.47	1.47	1.46	1.69	1.51	2.81
7550	0.86	0.65	0.99	0.87	1.75	2.04	1.56	1.31	1.10	2.48
7600	1.02	1.03	1.27	1.07	2.13	1.70	2.18	1.12	1.56	2.83
7650	1.79	1.37	1.60	1.58	1.48	2.04	1.62	0.65	1.47	2.86
7700	1.27	1.54	1.98	1.73	1.94	1.72	1.27	1.43	1.61	2.63

Measurement Info | Result Data | Limits | Measurement Settings | Instruments

Figure 56: Measurement output exported to a MS Excel file.

Additionally, to the measurement report it is possible to export also the raw data measured at individual distances at specific positions (Figure 57).

	A	B	C	D	E	F	G	H	I	J	K	L
1	f [MHz]	40 cm	30 cm	18 cm	10 cm	2 cm	0 cm					
2	6000	-74.05	-72.96	-72.47	-72.88	-71.97	-72.15					
3	6050	-74.10	-72.73	-73.19	-72.91	-72.73	-73.43					
4	6100	-73.03	-72.83	-72.96	-72.97	-73.31	-72.68					
5	6150	-73.84	-72.85	-73.84	-73.90	-73.85	-73.41					
6	6200	-73.88	-73.80	-73.63	-74.23	-73.15	-73.16					
7	6250	-73.80	-73.20	-73.76	-72.74	-73.43	-73.05					
8	6300	-74.43	-73.51	-73.40	-72.62	-72.82	-72.27					
9	6350	-74.97	-74.63	-74.03	-73.91	-72.79	-74.01					
10	6400	-75.12	-74.04	-74.42	-73.63	-73.98	-73.27					
11	6450	-75.17	-74.08	-73.97	-74.05	-73.44	-74.00					
12	6500	-75.12	-74.68	-73.47	-74.05	-73.43	-73.59					
13	6550	-74.91	-75.64	-74.42	-74.36	-74.27	-73.82					
14	6600	-75.82	-74.91	-74.57	-73.83	-74.14	-73.65					
15	6650	-76.49	-75.38	-74.45	-74.58	-74.43	-74.78					
16	6700	-76.29	-75.25	-74.98	-74.64	-74.15	-74.13					
17	6750	-76.30	-75.12	-75.79	-74.59	-74.43	-73.59					
18	6800	-75.91	-75.27	-75.30	-74.12	-74.04	-73.92					
19	6850	-76.53	-75.13	-74.17	-74.60	-73.34	-73.67					
20	6900	-76.72	-74.70	-75.00	-74.42	-73.90	-73.67					
21	6950	-76.00	-74.88	-75.01	-74.97	-73.49	-74.97					
22	7000	-76.13	-76.61	-75.17	-74.79	-74.81	-73.89					
23	7050	-76.88	-77.13	-75.44	-74.59	-74.90	-74.89					
24	7100	-78.09	-76.22	-75.66	-75.04	-75.19	-74.83					
25	7150	-76.90	-76.44	-75.84	-74.70	-75.34	-75.06					
26	7200	-76.44	-76.01	-75.94	-74.40	-75.17	-74.73					
27	7250	-76.88	-76.10	-75.48	-75.13	-74.93	-75.78					
28	7300	-77.76	-75.74	-74.67	-75.31	-75.84	-76.23					
29	7350	-77.75	-75.19	-75.02	-76.35	-76.22	-77.42					
30	7400	-78.22	-74.61	-75.29	-76.83	-76.93	-76.22					
31	7450	-76.61	-76.05	-76.39	-75.68	-76.67	-76.12					

Center Horizontal T1 | Center Vertical T1 | Front Horiz ...

Figure 57: Distance scan data exported to a MS Excel file

10.1.5. CalStan 10 file import limitations

It is possible to open Site VSWR measurements done in CalStan 10.

Only active trace positions are imported from the CalStan 10 Site VSWR measurement file.

10.1.6. Literature

[1] CISPR 16-1-4, Specification for radio disturbance and immunity measuring apparatus and methods - Part 1-4: Radio disturbance and immunity measuring apparatus - Antennas and test sites for radiated disturbance measurements

10.2. Site Attenuation 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 11 according to following standards:

Standard	Description and Calibration File(s)
ANSI C63.4	The NSA method as described in ANSI C63.4 using AFT, AFR and GSCF. The geometry data are taken from the GSCF info.
CISPR 16-1-4, NSA	The NSA method as described in CISPR 16-1-4 using AFT and AFR (no setup geometry considered, bad procedure)
CISPR 16-1-4, RSM	The RSM (Reference Site) method as described in CISPR 16-1-4 using the antenna pair reference. The geometry data are taken from the APR info
Dual Antenna Factor Method	The NSA method using the DAF (Dual Antenna Factor). The geometry data are taken from the DAF info

Table 8: 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.

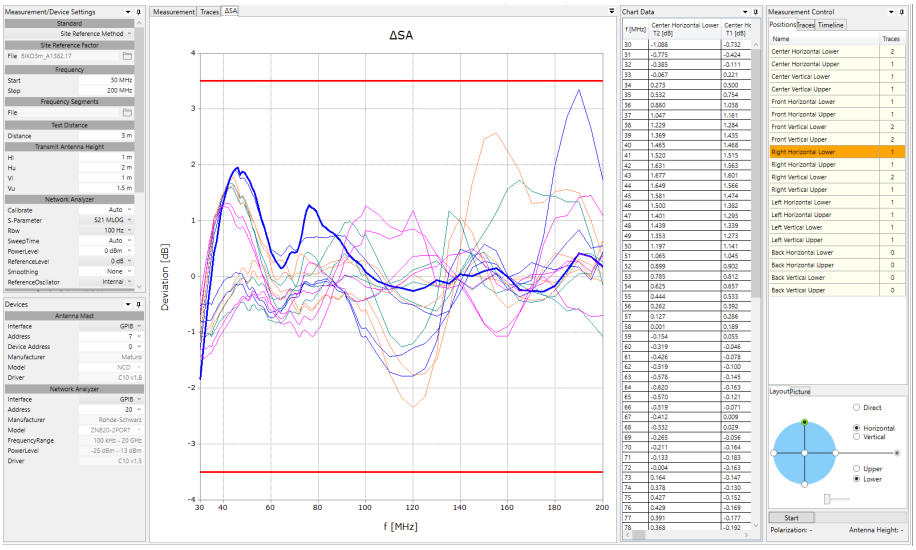


Figure 58: NSA SAC measurement window.

10.2.1. Setup

Allowed measurement instrument combinations:

Preferred	Inst1	Inst2	Inst3
x	Network Analyser	-	Antenna Mast
	Comb Generator	EMI-Receiver	Antenna Mast
	-	EMI-Receiver (incl. TG)	Antenna Mast
	Signal Generator	Spectrum Analyser	Antenna Mast
	Comb Generator	Spectrum Analyser	Antenna Mast

Before starting the measurement, all measurement parameters have to be defined in the "Measurement Settings" panel (Figure 58, upper 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_{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_{direct} measurement readout of the receiver. The V_{direct} measurement value stored in CalStan 11 already includes the correction of the protective attenuator value.
6. Select appropriate devices and their parameters. To operate a specific device, the correct IGPIB address has to be set.

10.2.2. Measurement Procedure and Result Calculation

Measure V_{direct} first. To do so select the “Direct” position in the positions table (Figure 58). Connect the generator via the transmit cable and the receive cable to the receiver; insert two 10 dB attenuators. This configuration ensures that the cable loss of the receive cable is taken into account automatically.

Then V_{site} can be measured:

1. Set up the antennas as required by the standard (distance, height, position, polarization).
2. 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.
3. Select the position in CalStan 11 and start the measurement.
4. 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

5. 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 using a cable with ferrite rings (2 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.

The NSA and the deviations from the NSA (ΔSA) are calculated automatically after each measured position according to the selected measurement standard (see Table 9). To show the results click the NSA or ΔSA tab in the chart area. If at least one result is shown, the limit-lines are displayed additionally. The results for specific position trace are computed using the direct measurement trace which is set active at time of result calculation. In the NSA chart, data for selected position are grouped and displayed in color according to polarization and height. E.g. all horizontal upper positions (front, left, right, center, back) are colored and the rest is displayed in gray.

Note: this is different to the behavior of CalStan 10 where the result was calculated using the direct trace that was set active at the time of measurement of that position.

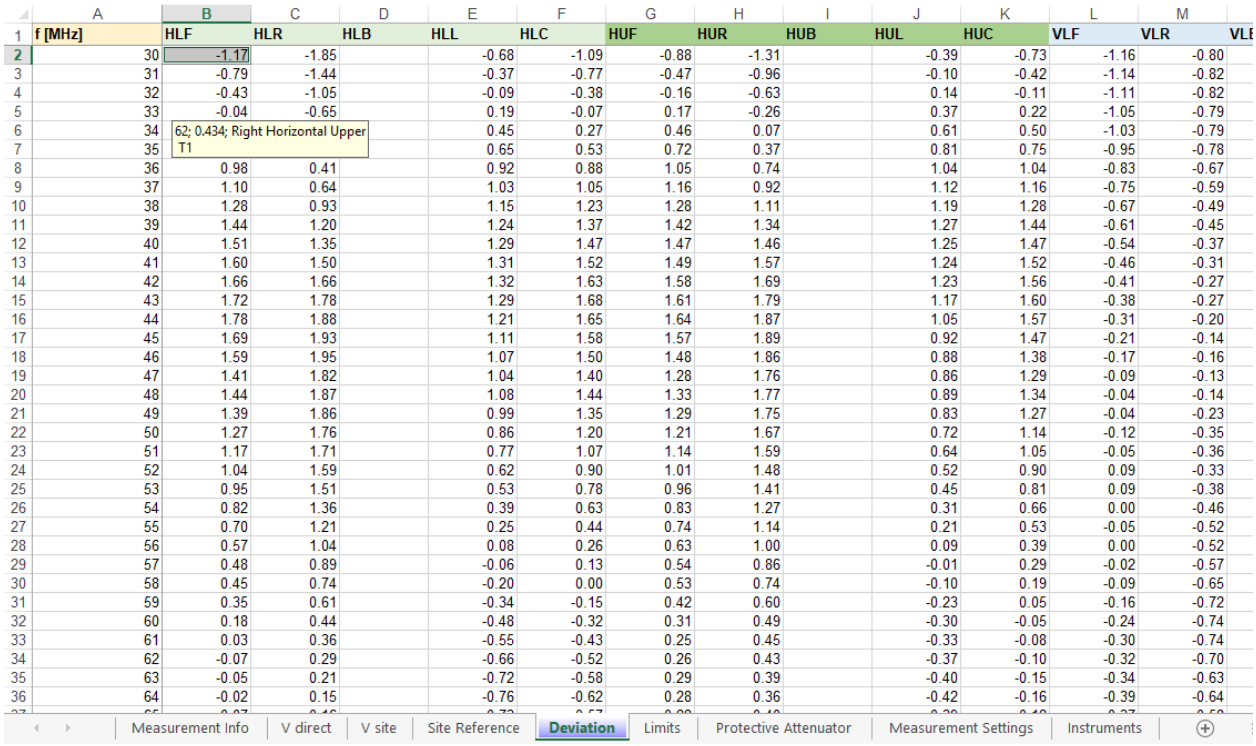
The NSA reference values need not to be specified separately. All theoretical factors are computed by CalStan 11 using the formulas given in the respective standards.

ANSI C63.4 [2]	$NSA = V_{dir} - V_{site} - AF_T - AF_R - GSCF$ $\Delta SA = Theo - NSA$
CISPR 16-1-4, NSA [1]	$NSA = V_{dir} - V_{site} - AF_T - AF_R$ $\Delta SA = Theo - NSA$
CISPR 16-1-4, RSM [1]	$\Delta SA = V_{dir} - V_{site} - SA_{ref}$
Dual Antenna Factor Method [3]	$NSA = V_{dir} - V_{site} - DAF$ $\Delta SA = NSA - Theo$
where NSA – normalized site attenuation ΔSA – deviation from normalized site attenuation Theo - theoretical value of the site attenuation V_{dir} – direct measurement V_{site} – values measured at the site AF_T – transmit antenna factor AF_R – receive antenna factor GSCF – geometry specific correction factor SA_{ref} – site reference DAF – dual antenna factor	

Table 9: NSA SAC results calculation for specific standards.

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 59) you can see an Excel document containing several worksheets.



	A	B	C	D	E	F	G	H	I	J	K	L	M
1	f [MHz]	HLF	HLR	HLB	HLL	HLC	HUF	HUR	HUB	HUL	HUC	VLF	VLR	VLE
2	30	-1.17	-1.85		-0.68	-1.09	-0.88	-1.31		-0.39	-0.73	-1.16	-0.80	
3	31	-0.79	-1.44		-0.37	-0.77	-0.47	-0.96		-0.10	-0.42	-1.14	-0.82	
4	32	-0.43	-1.05		-0.09	-0.38	-0.16	-0.63		0.14	-0.11	-1.11	-0.82	
5	33	-0.04	-0.65		0.19	-0.07	0.17	-0.26		0.37	0.22	-1.05	-0.79	
6	34	62; 0.434; Right Horizontal Upper T1			0.45	0.27	0.46	0.07		0.61	0.50	-1.03	-0.79	
7	35				0.65	0.53	0.72	0.37		0.81	0.75	-0.95	-0.78	
8	36	0.98	0.41		0.92	0.88	1.05	0.74		1.04	1.04	-0.83	-0.67	
9	37	1.10	0.64		1.03	1.05	1.16	0.92		1.12	1.16	-0.75	-0.59	
10	38	1.28	0.93		1.15	1.23	1.28	1.11		1.19	1.28	-0.67	-0.49	
11	39	1.44	1.20		1.24	1.37	1.42	1.34		1.27	1.44	-0.61	-0.45	
12	40	1.51	1.35		1.29	1.47	1.47	1.46		1.25	1.47	-0.54	-0.37	
13	41	1.60	1.50		1.31	1.52	1.49	1.57		1.24	1.52	-0.46	-0.31	
14	42	1.66	1.66		1.32	1.63	1.58	1.69		1.23	1.56	-0.41	-0.27	
15	43	1.72	1.78		1.29	1.68	1.61	1.79		1.17	1.60	-0.38	-0.27	
16	44	1.78	1.88		1.21	1.65	1.64	1.87		1.05	1.57	-0.31	-0.20	
17	45	1.69	1.93		1.11	1.58	1.57	1.89		0.92	1.47	-0.21	-0.14	
18	46	1.59	1.95		1.07	1.50	1.48	1.86		0.88	1.38	-0.17	-0.16	
19	47	1.41	1.82		1.04	1.40	1.28	1.76		0.86	1.29	-0.09	-0.13	
20	48	1.44	1.87		1.08	1.44	1.33	1.77		0.89	1.34	-0.04	-0.14	
21	49	1.39	1.86		0.99	1.35	1.29	1.75		0.83	1.27	-0.04	-0.23	
22	50	1.27	1.76		0.86	1.20	1.21	1.67		0.72	1.14	-0.12	-0.35	
23	51	1.17	1.71		0.77	1.07	1.14	1.59		0.64	1.05	-0.05	-0.36	
24	52	1.04	1.59		0.62	0.90	1.01	1.48		0.52	0.90	0.09	-0.33	
25	53	0.95	1.51		0.53	0.78	0.96	1.41		0.45	0.81	0.09	-0.38	
26	54	0.82	1.36		0.39	0.63	0.83	1.27		0.31	0.66	0.00	-0.46	
27	55	0.70	1.21		0.25	0.44	0.74	1.14		0.21	0.53	-0.05	-0.52	
28	56	0.57	1.04		0.08	0.26	0.63	1.00		0.09	0.39	0.00	-0.52	
29	57	0.48	0.89		-0.06	0.13	0.54	0.86		-0.01	0.29	-0.02	-0.57	
30	58	0.45	0.74		-0.20	0.00	0.53	0.74		-0.10	0.19	-0.09	-0.65	
31	59	0.35	0.61		-0.34	-0.15	0.42	0.60		-0.23	0.05	-0.16	-0.72	
32	60	0.18	0.44		-0.48	-0.32	0.31	0.49		-0.30	-0.05	-0.24	-0.74	
33	61	0.03	0.36		-0.55	-0.43	0.25	0.45		-0.33	-0.08	-0.30	-0.74	
34	62	-0.07	0.29		-0.66	-0.52	0.26	0.43		-0.37	-0.10	-0.32	-0.70	
35	63	-0.05	0.21		-0.72	-0.58	0.29	0.39		-0.40	-0.15	-0.34	-0.63	
36	64	-0.02	0.15		-0.76	-0.62	0.28	0.36		-0.42	-0.16	-0.39	-0.64	

Measurement Info | V direct | V site | Site Reference | Deviation | Limits | Protective Attenuator | Measurement Settings | Instruments

Figure 59: Measurement output exported to a MS Excel file

Measurement Info	Contains general information about measurements from the Measurement Info dialog box
V direct	V_{direct} measurement data for every measurement position. When a protective attenuator is selected the attenuation is automatically corrected.
V site	V_{site} measurement data for every measured position
Transmit antenna factor	Transmit antenna factor data for every measurement position. This sheet is present only if one of the measurement standards ANSI C63.4 or CISPR 16-1-4, NSA is used.
Receive antenna factor	Receive antenna factor data for every measurement position. This sheet is present only if one of the measurement standards ANSI C63.4 or CISPR 16-1-4, NSA is used.
Site reference factor	Site reference data for every measurement position. This sheet is present only if the CISPR 16-1-4, RSM method is used as a measurement standard.
Geometry specific correction factor	Geometry specific correction factor data for every measurement position. This sheet is present only if the measurement standard ANSI C63.4 is used.

Dual antenna factor	Dual antenna factor data for every measurement position. This sheet is present only if the Dual Antenna Factor method is used as a measurement standard.
AN Measured	NSA results computed from V_{direct}, V_{site} and antenna factor data. For some measurement standards the NSA is not computed, in that case this worksheet is not present.
AN Theoretical	Contains theoretically computed data for specific position according to used measurement standard
Deviation	ΔSA values computed as given in Table 9
Limit	Upper and lower limit data as set in the limit dialog
Protective Attenuator	Protective attenuator data if used
Measurement Settings	Measurement Settings panel content
Instruments	Holds the device parameters used for measurement

Table 10: Description of the MS Excel file

Additionally, to the measurement report it is possible to export also the raw data measured at individual receiving antenna heights at specific positions.

10.2.4. Literature

[1] CISPR 16-1-4, Specification for radio disturbance and immunity measuring apparatus and methods - Part 1-4: Radio disturbance and immunity measuring apparatus - Antennas and test sites for radiated disturbance measurements

[2] ANSI/IEEE C 63.4, 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] 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. Site Attenuation FAR (fully anechoic rooms)

Normalized site attenuation (NSA) measurements in fully anechoic chambers, carried out with broadband antennas are implemented in CalStan 11 according to following standards:

Standard	Description and Calibration File(s)
CISPR 16-1-4, NSA	The NSA method as described in CISPR 16-1-4 using AFT and AFR (no setup geometry considered)
CISPR 16-1-4, RSM	The RSM (Reference Site) method as described in CISPR 16-1-4 using the antenna pair reference. The geometry data are taken from the APR info
Dual Antenna Factor Method	The NSA method using the DAF (Dual Antenna Factor). The geometry data are taken from the DAF info

Table 11: 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.

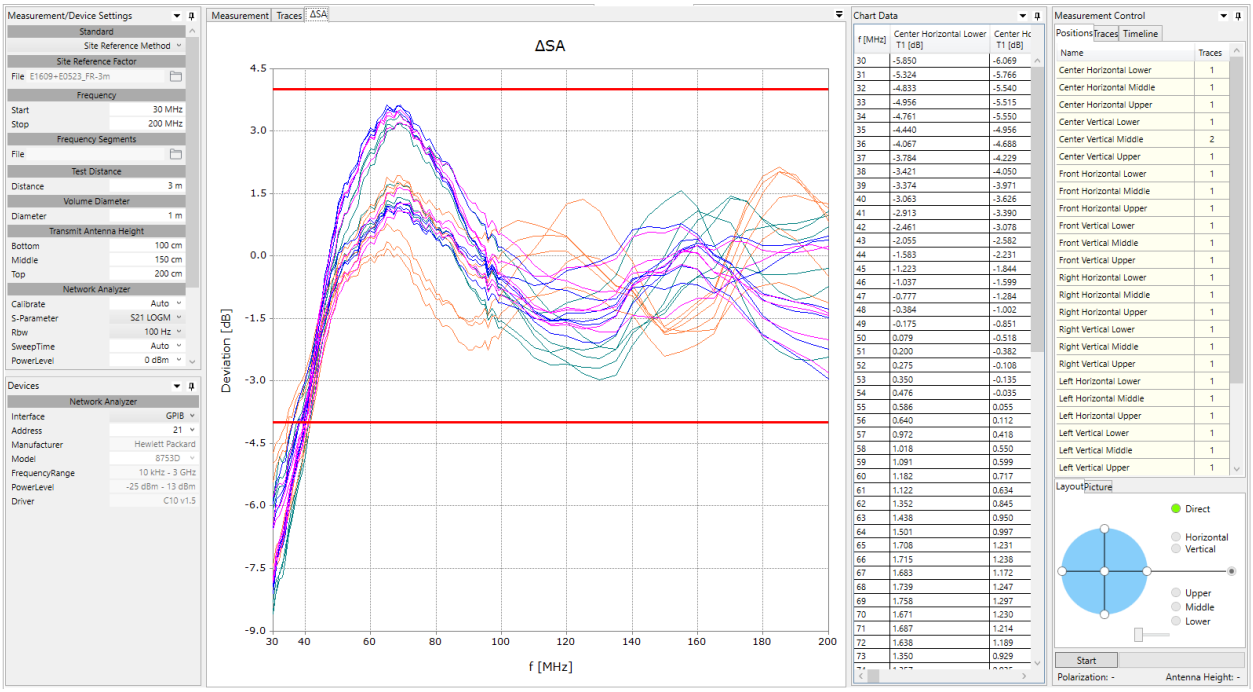


Figure 60: NSA FAR measurement window.

10.3.1. Setup

Allowed measurement instrument combinations:

Preferred	Inst1	Inst2
x	Network Analyzer	-
	Comb Generator	EMI-Receiver
	-	EMI-Receiver (incl. TG)
	Signal Generator	Spectrum Analyzer
	Comb Generator	Spectrum Analyzer

Before starting the measurement, all measurement parameters have to be defined in the "Measurement Settings" panel (Figure 60, 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_{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_{direct} measurement readout of the receiver. The V_{direct} measurement value stored in CalStan 11 already includes the correction of the protective attenuator value.
6. Select appropriate devices and their parameters. To operate a specific device, the correct GPIB address has to be set.

10.3.2. Measurement Procedure and Result Calculation

Measure V_{direct} first. To do so select the “Direct” position in the positions table (Figure 58). 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.

Then V_{site} can be measured:

1. Set up the antennas as required by the standard (distance, height, position, polarization).
2. 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.
3. Select the position in CalStan 11 and start the measurement.
4. 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

5. 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 using a cable with ferrite rings (2 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.

The NSA and the deviations from the NSA (ΔSA) are calculated automatically after each measured position according to the selected measurement standard (see Table 12). To show the results click the NSA or ΔSA tab in the chart area. If at least one result is shown, the limit-lines are displayed additionally. The results for specific position trace are computed using the direct measurement trace which is set active at time of result calculation.

Note: this is different to the behavior of CalStan 10 where the result was calculated using the direct trace that was set active at the time of measurement of that position.

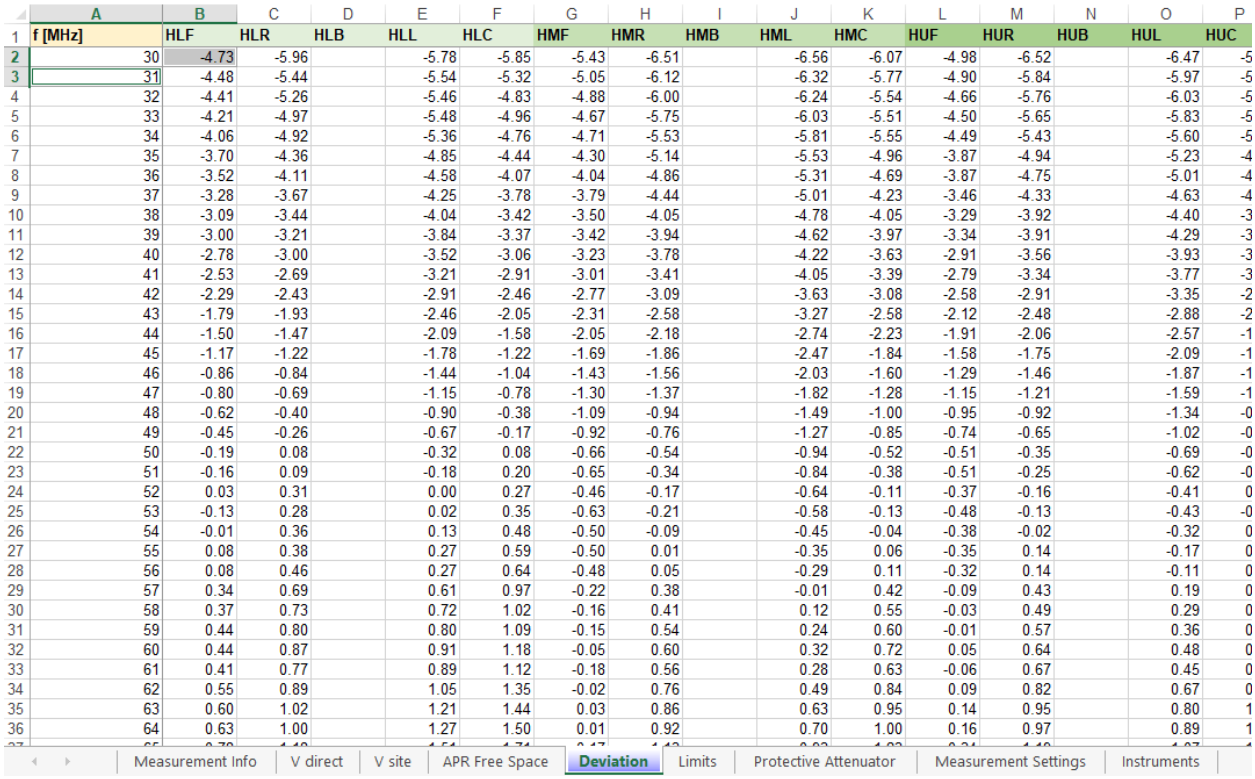
The NSA reference values need not to be specified separately. All theoretical factors are computed by CalStan 11 using the formulas given in the respective standards.

CISPR 16-1-4, NSA [1]	NSA = V_{dir} – V_{site} – AF_T [dB/m]– AF_R [dB/m] ΔSA = Theo – NSA
CISPR 16-1-4, RSM [1]	ΔSA = V_{dir} – V_{site} – A_{APR} [dB]
Dual Antenna Factor Method	NSA = V_{dir} – V_{site} – DAF [dB/m^2] ΔSA = NSA - Theo
Where NSA – normalized site attenuation DSA – deviation from normalized site attenuation Theo - theoretical value of the site attenuation V_{direct} – direct measurement V_{site} – values measured at the site AF_T – transmit antenna factor AF_R – receive antenna factor A_{APR} – site reference (antenna pair reference) DAF – dual antenna factor	

Table 12: 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 61) you can see an Excel document containing several worksheets.



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1	f [MHz]	HLF	HLR	HLB	HLL	HLC	HMF	HMR	HMB	HML	HMC	HUF	HUR	HUB	HUL	HUC
2	30	-4.73	-5.96		-5.78	-5.85	-5.43	-6.51		-6.56	-6.07	-4.98	-6.52		-6.47	-5
3	31	-4.48	-5.44		-5.54	-5.32	-5.05	-6.12		-6.32	-5.77	-4.90	-5.84		-5.97	-5
4	32	-4.41	-5.26		-5.46	-4.83	-4.88	-6.00		-6.24	-5.54	-4.66	-5.76		-6.03	-5
5	33	-4.21	-4.97		-5.48	-4.96	-4.67	-5.75		-6.03	-5.51	-4.50	-5.65		-5.83	-5
6	34	-4.06	-4.92		-5.36	-4.76	-4.71	-5.53		-5.81	-5.55	-4.49	-5.43		-5.60	-5
7	35	-3.70	-4.36		-4.85	-4.44	-4.30	-5.14		-5.53	-4.96	-3.87	-4.94		-5.23	-4
8	36	-3.52	-4.11		-4.58	-4.07	-4.04	-4.86		-5.31	-4.69	-3.87	-4.75		-5.01	-4
9	37	-3.28	-3.67		-4.25	-3.78	-3.79	-4.44		-5.01	-4.23	-3.46	-4.33		-4.63	-4
10	38	-3.09	-3.44		-4.04	-3.42	-3.50	-4.05		-4.78	-4.05	-3.29	-3.92		-4.40	-3
11	39	-3.00	-3.21		-3.84	-3.37	-3.42	-3.94		-4.62	-3.97	-3.34	-3.91		-4.29	-3
12	40	-2.78	-3.00		-3.52	-3.06	-3.23	-3.78		-4.22	-3.63	-2.91	-3.56		-3.93	-3
13	41	-2.53	-2.69		-3.21	-2.91	-3.01	-3.41		-4.05	-3.39	-2.79	-3.34		-3.77	-3
14	42	-2.29	-2.43		-2.91	-2.46	-2.77	-3.09		-3.63	-3.08	-2.58	-2.91		-3.35	-2
15	43	-1.79	-1.93		-2.46	-2.05	-2.31	-2.58		-3.27	-2.58	-2.12	-2.48		-2.88	-2
16	44	-1.50	-1.47		-2.09	-1.58	-2.05	-2.18		-2.74	-2.23	-1.91	-2.06		-2.57	-1
17	45	-1.17	-1.22		-1.78	-1.22	-1.69	-1.86		-2.47	-1.84	-1.58	-1.75		-2.09	-1
18	46	-0.86	-0.84		-1.44	-1.04	-1.43	-1.56		-2.03	-1.60	-1.29	-1.46		-1.87	-1
19	47	-0.80	-0.69		-1.15	-0.78	-1.30	-1.37		-1.82	-1.28	-1.15	-1.21		-1.59	-1
20	48	-0.62	-0.40		-0.90	-0.38	-1.09	-0.94		-1.49	-1.00	-0.95	-0.92		-1.34	-0
21	49	-0.45	-0.26		-0.67	-0.17	-0.92	-0.76		-1.27	-0.85	-0.74	-0.65		-1.02	-0
22	50	-0.19	0.08		-0.32	0.08	-0.66	-0.54		-0.94	-0.52	-0.51	-0.35		-0.69	-0
23	51	-0.16	0.09		-0.18	0.20	-0.65	-0.34		-0.84	-0.38	-0.51	-0.25		-0.62	-0
24	52	0.03	0.31		0.00	0.27	-0.46	-0.17		-0.64	-0.11	-0.37	-0.16		-0.41	0
25	53	-0.13	0.28		0.02	0.35	-0.63	-0.21		-0.58	-0.13	-0.48	-0.13		-0.43	-0
26	54	-0.01	0.36		0.13	0.48	-0.50	-0.09		-0.45	-0.04	-0.38	-0.02		-0.32	0
27	55	0.08	0.38		0.27	0.59	-0.50	0.01		-0.35	0.06	-0.35	0.14		-0.17	0
28	56	0.08	0.46		0.27	0.64	-0.48	0.05		-0.29	0.11	-0.32	0.14		-0.11	0
29	57	0.34	0.69		0.61	0.97	-0.22	0.38		-0.01	0.42	-0.09	0.43		0.19	0
30	58	0.37	0.73		0.72	1.02	-0.16	0.41		0.12	0.55	-0.03	0.49		0.29	0
31	59	0.44	0.80		0.80	1.09	-0.15	0.54		0.24	0.60	-0.01	0.57		0.36	0
32	60	0.44	0.87		0.91	1.18	-0.05	0.60		0.32	0.72	0.05	0.64		0.48	0
33	61	0.41	0.77		0.89	1.12	-0.18	0.56		0.28	0.63	-0.06	0.67		0.45	0
34	62	0.55	0.89		1.05	1.35	-0.02	0.76		0.49	0.84	0.09	0.82		0.67	0
35	63	0.60	1.02		1.21	1.44	0.03	0.86		0.63	0.95	0.14	0.95		0.80	1
36	64	0.63	1.00		1.27	1.50	0.01	0.92		0.70	1.00	0.16	0.97		0.89	1

Measurement Info | V direct | V site | APR Free Space | Deviation | Limits | Protective Attenuator | Measurement Settings | Instruments

Figure 61: Measurement output exported to a MS Excel file

Measurement Info	Contains general information about measurement from Measurement Info dialog box
V direct	V_{direct} measurement data for every measurement position. When a protective attenuator is selected the attenuation is automatically corrected.
V site	V_{site} measurement data for every measured position
Transmit antenna factor	Transmit antenna factor data for every measurement position. This sheet is present only if the CISPR 16-1-4, NSA method is used as a measurement standard.
Receive antenna factor	Receive antenna factor data for every measurement position. This sheet is present only if the CISPR 16-1-4, NSA method is used as a measurement standard.
APR Free Space	Site reference data for every measurement position. This sheet is present only if one of the CISPR 16-1-4, RSM method is used as a measurement standard.
Dual antenna factor	Dual antenna factor data for every measurement position. This sheet is present only if the Dual Antenna Factor method is used

	as a measurement standard.
AN Theoretical	Contains theoretically computed data for specific position according to used measurement standard
Deviation	ΔSA values computed as given in Table 13
Limit	Upper and lower limit data as set in the limit dialog
Protective Attenuator	Protective attenuator data if used
Measurement Settings	Measurement Settings panel content
Instruments	Device parameters used for measurement

Table 13: Description of the MS Excel file

10.3.4. CalStan 10 file import limitations

To import CalStan 10 NSA FAR file, measurement results must be computed with the current active direct position trace.

10.3.5. Literature

[1] CISPR 16-1-4, Specification for radio disturbance and immunity measuring apparatus and methods - Part 1-4: Radio disturbance and immunity measuring apparatus - Antennas and test sites for radiated disturbance measurements

10.4. Site Insertion Loss (Loop)

Measurement of the Site Insertion Loss Deviation (ΔAS) on test sites using calibrated antennas.

Standard	Description and Calibration File(s)
CISPR 16-1-4, RSM	Antenna Pair Referece [dB]
CISPR 16-1-4, NSIL	AF_T [dBS/m] AF_R [dBS/m] Theoretical NSIL [dBm^2/S^2] values
CISPR 16-1-4, NSIL, Annex N	Sum of Antenna Factors [dBS^2/m^2] Theoretical NSIL [dBm^2/S^2] values

Table 14: List of possible measurements as defined in the standards.

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 antennas are operated in three orientations X,Y,Z in one height. Site insertion loss between transmit and receive antenna is measured according to the standard test procedure for each frequency and orientation.

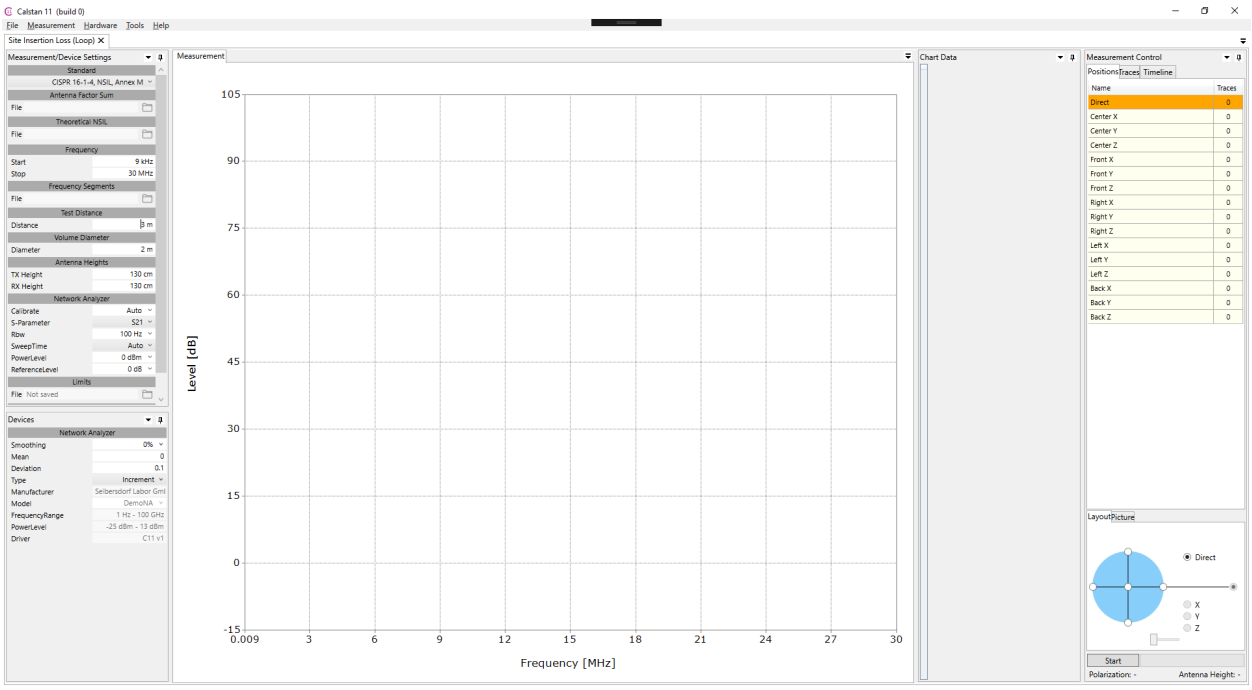


Figure 62: Site Insertion Loss measurement window.

10.4.1. Setup

Allowed measurement instrument combinations:

Preferred	Inst1	Inst2	Inst3 (Optional)
x	Network Analyser	-	Active Transmit Antenna
	-	EMI-Receiver (incl TG)	Active Transmit Antenna
	Signal Generator	Spectrum Analyser	Active Transmit Antenna

Before starting the measurement, all measurement parameters must be defined in the "Measurement Settings" panel (Figure 60, lower left).

1. First, select measurement standard and load the appropriate file(s) for used transmit and receive antennas. If the factors are 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 measurement.
3. Adjust the frequency step table if needed.
4. Set the desired limit.
5. Select appropriate devices and their parameters. To operate a specific device, the correct GPIB address must be set.

10.4.2. Measurement Procedure and Result Calculation

Measure V_{direct} first. To do so select the “Direct” position in the positions table (Figure 58). Connect the generator via the transmit cable and the receive cable to the receiver. This configuration ensures that the cable loss of the receive cable is taken into account automatically.

Then V_{site} can be measured:

1. Set up the antennas as required by the standard (distance, height, position, polarization).
2. Connect the transmit antenna via the transmit cable to the signal generator. Connect the receive antenna to the receive cable with the receiver.
3. Select the position in CalStan 11 and start the measurement.
4. During the measurement the monitor display shows two traces:
   blue: the ideal measurement data that would obtain zero dB deviation
   black: the actual measurement data for the current antenna mast height

The SIL and the deviations from the deviation from the theoretical NSIL (ΔAS) are calculated automatically after each measured position according to the selected measurement standard (see **Table 12**). To show the results click the NSA or ΔSA tab in the chart area. If at least one result is shown, the limit-lines are displayed additionally.

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, RSM	ΔA_s [dB] = V_{dir} + α_{ATT} – V_{site} – $F_{a,TX}$ – $F_{a,TX}$ – A_N
CISPR 16-1-4, NSIL	ΔA_s [dB] = V_{dir} – V_{site} – $F_{a,TX}$ – $F_{a,TX}$ – A_N
CISPR 16-1-4, NSIL, Annex N	ΔA_s [dB] = V_{dir} – V_{site} – (DAF)- A_N

Where

ΔA_s – site insertion loss deviation

$F_{a,TX}$ – magnetic field antenna factor of the transmit antenna

$F_{a,TX}$ – magnetic field antenna factor of the receive antenna

DAF – Sum of antenna factors

A_N – theoretical normalized site attenuation

α_{ATT} – Attenuator

V_{dir} – direct measurement

V_{site} – values measured at the site

Table 15: Results calculation for specific standards.

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 63) you can see an Excel document containing several worksheets.

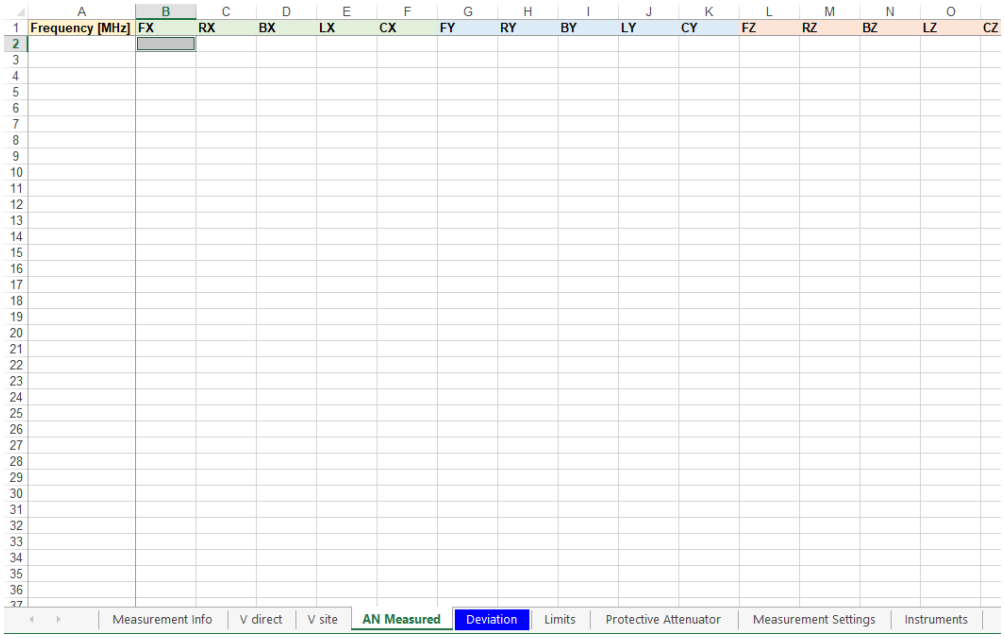


Figure 63: Measurement output exported to a MS Excel file

Measurement Info	Contains general information about measurement from Measurement Info dialog box
V direct	V_{direct} measurement data for every measurement position. When a protective attenuator is selected the attenuation is automatically corrected.
V site	V_{site} measurement data for every measured position
AN Measured	
AN Theoretical	Contains theoretically computed data (NSIL) for specific position according to used measurement standard
SA Measured	Measured site insertion loss (SIL) for every measurement position. This sheet is present only in RSM method.
Site reference factor	Calibrated Site reference data (SIL) for every measurement position. This sheet is present only in RSM method.
Transmit antenna factor	Transmit antenna factor data This sheet is present only in NSIL method
Receive antenna factor	Receive antenna factor data This sheet is present only in NSIL method
DAF	Sum of Antenna factors. This sheet is present only in NSIL, Annex N method

Deviation	ΔA_s values computed as given in Table 13
Limits	Upper and lower limit data as set in the limit dialog
Measurement Settings	Measurement Settings panel content
Instruments	Device parameters used for measurement

Table 16: Description of the MS Excel file

10.4.4. Literature

[1] CISPR 16-1-4 Specification for radio disturbance and immunity measuring apparatus and methods - Part 1-4: Radio disturbance and immunity measuring apparatus - Antennas and test sites for radiated disturbance measurements

10.5. Cable Loss

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

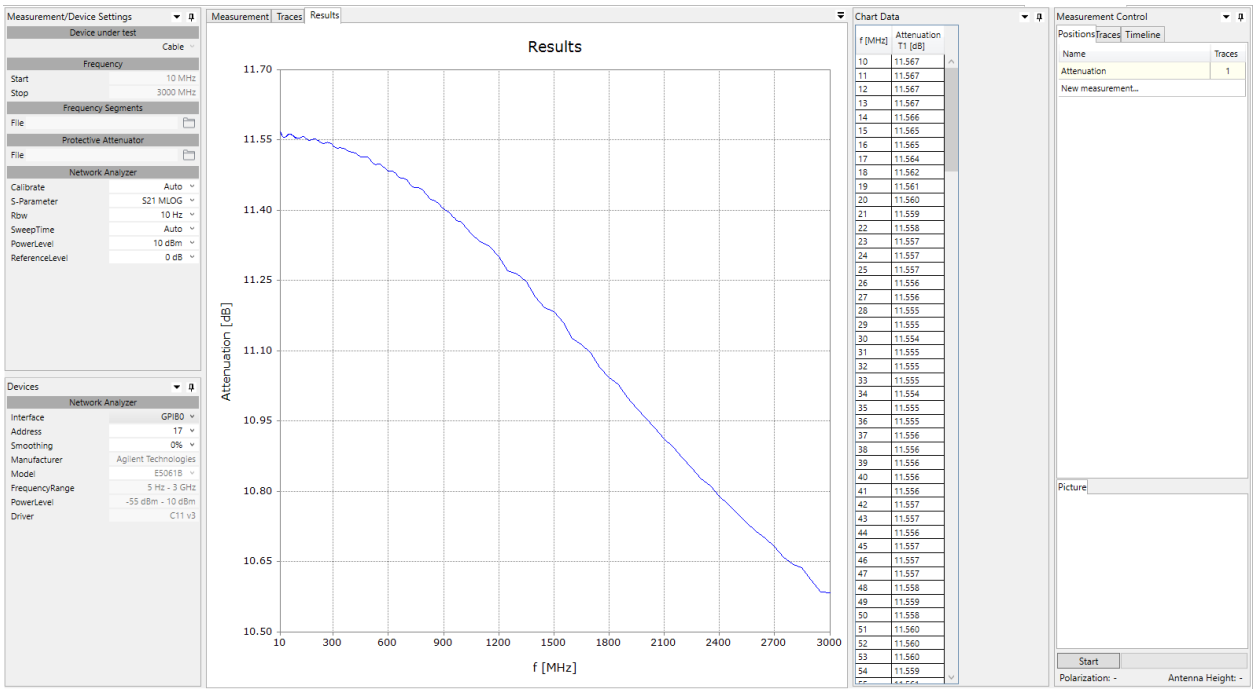
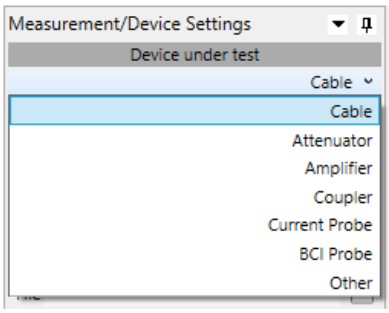


Figure 64: Cable loss measurement window.

The specific device under test can be selected at the top of the measurement settings panel.



10.5.1. Setup

Allowed measurement instrument combinations:

Preferred	Inst1	Inst2
x	Network Analyser	-
	Power Meter	Signal Generator
	EMI-Receiver	Comb Generator
	Spectrum Analyser	Signal Generator
	Spectrum Analyser	Comb Generator

Before starting the measurement, all measurement parameters have to be defined in the "Measurement Settings" panel (Figure 64, lower left).

1. Choose the frequency range.
2. Adjust the frequency step table if needed.
3. Set the protective attenuator (used for V_{direct} 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 or for measurements with preamplifier to protect the receiver from overload when measuring V_{direct}. The protective attenuator value is added to the V_{direct} measurement readout of the receiver. The V_{direct} measurement value stored in CalStan 11 already includes the correction of the protective attenuator value. V_{cable} measurements are not influenced by the protective attenuator.

   In case of cable loss measurement with a comb generator it’s advised to use the protective attenuator for measurement of V_{direct} and V_{cable}. In this case do NOT select a protective attenuator file because it is present in both measurements and has no effect on the measured attenuation.
4. Select appropriate devices and their parameters. To operate a specific device, the correct GPIB address has to be set.

10.5.2. Measurement Procedure and Result Calculation

Measure V_{direct}. Select the “Direct” position in the positions table (Figure 58). Connect the generator to the receiver via the auxiliary cable. 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 plug it now between transmitter and auxiliary cable. The measurement value stored in CalStan 11 is the receiver readout plus the protective attenuator value.

Measure V_{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 11 and start the measurement.
During the measurement the monitor window shows the current measurement data.

After the measurement is finished, results are calculated using the formula:

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

where V_{direct} – direct measurement value
V_{cable} – measured value

At the beginning there are only two positions - Direct and Measurement 1. Right mouse click displays the context menu where new measurement position can be added. Measurement position names can be edited by double clicking the name cell.

10.5.3. Report Format

As described in section 7.4 the measurement output can be exported in MS Excel format. The picture below (Figure 65) shows an Excel document containing several worksheets.

	A	B	C	D	E	F	G	H	I	J
1	f [MHz]	Attenuation								
2	10	19.83								
3	11	19.83								
4	12	19.84								
5	13	19.84								
6	14	19.84								
7	15	19.84								
8	16	19.84								
9	17	19.85								
10	18	19.85								
11	19	19.85								
12	20	19.85								
13	21	19.85								
14	22	19.86								
15	23	19.86								
16	24	19.86								
17	25	19.86								
18	26	19.86								
19	27	19.86								
20	28	19.87								
21	29	19.87								
22	30	19.87								
23	31	19.87								
24	32	19.87								
25	33	19.87								
26	34	19.88								
27	35	19.88								
28	36	19.88								
29	37	19.88								
30	38	19.88								
31	39	19.88								
32	40	19.88								
33	41	19.89								
34	42	19.89								
35	43	19.89								
36	44	19.89								
37	45	19.89								
38	46	19.89								
39	47	19.89								
40	48	19.89								
41	49	19.90								
42	50	19.90								
43	51	19.90								
44	52	19.90								
45	53	19.90								
46	54	19.90								
47	55	19.90								
48	56	19.90								

Measurement Info | Measurements | Attenuation | Protective Attenuator | Measurement Settings | Instruments

Figure 65: Measurement output exported to a MS Excel file

Measurement Info	Contains general information about measurement from Measurement Info dialog box
V direct	V_{direct} measurement data for every measured position. When a protective attenuator is selected the attenuation is corrected automatically.
V cable	V_{cable} measurement data for every measured position
Attenuation	Measurement results
Protective Attenuator	Protective attenuator data if used
Measurement Settings	Measurement Settings panel content
Instruments	Holds the device parameters used for measurement

Table 17: Description of the MS Excel file

10.6. 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 optional cable loss correction. 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.

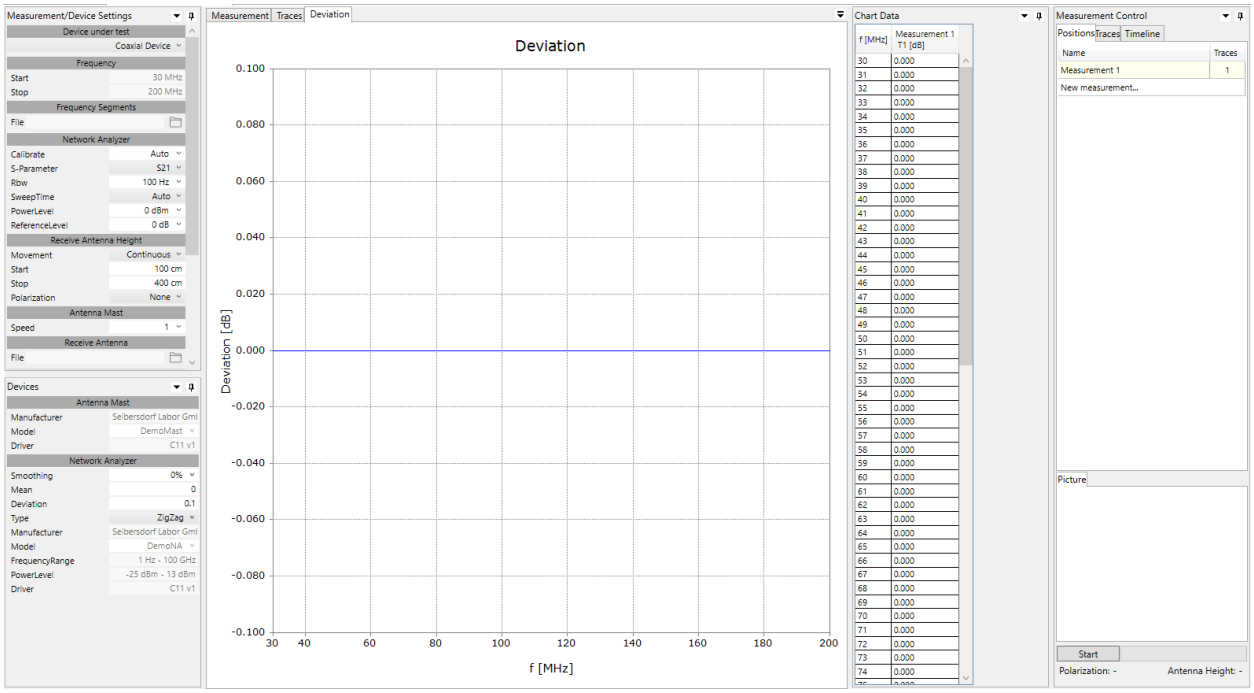


Figure 66: Experimental Measurement window.

To document specific measurement layout (e.g. antenna positions), it is possible to load pictures for every measurement 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 (see Figure 41). Right click on the pictures list in the context menu to rename, delete or select the picture as default.

10.6.1. Setup

Allowed measurement instrument combinations:

Preferred	Inst1	Inst2 (b1 only)	Inst3 (optional)
x	Network Analyser	-	Antenna Mast
	EMI-Receiver	Comb Generator	Antenna Mast
	Spectrum Analyser	Signal Generator	Antenna Mast
	Spectrum Analyser	Comb Generator	Antenna Mast

Before starting the measurement following measurement parameters have to be defined in the "Measurement Settings" panel (Figure 66, lower left).

1. Choose the frequency range.
2. Adjust the frequency step table if needed.
3. Optionally set the receive antenna parameters to adjust height scan (see 7.1).
4. Optionally set receiver antenna factor or cable loss factor file. Cable loss measurement performed by CalStan can also be used here. Don't forget to select the correct result column from the combo box in the data tab as described in 7.1.3
5. Optionally 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 or pre-amplifiers to protect the receiver from overload at the Reference measurement. The protective attenuator value is added to the Reference measurement readout of the receiver and stored in CalStan 11. 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 address must be set.

10.6.2. Measurement Procedure and Result Calculation

In the experimental measurement there are two measurement types:

The **reference measurement M_R** - done only once - serves as reference according to which the results are computed. It's represented by the "Reference" position at the top of the positions table (see Figure 66). Protective attenuator data and cable loss data are added to readout values if their unit is dB or dBm.

A multitude of **measurement M_x** can be performed. By clicking the positions table "New measurement" menu item (see Figure 67) a new measurement is added at the bottom of the list. The name of the measurement is set to current date & time by default but can be changed anytime. No protective attenuator data but cable loss is added to the measured values.

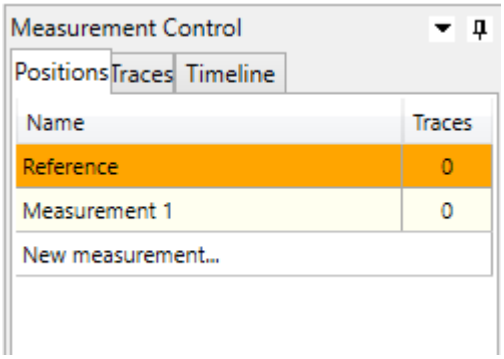


Figure 67: Adding new measurement in the positions table

Results are computed as following:

M_R = Readout + cl + pa

M_X = Readout + cl

where

cl: cable loss factor value (if available)

pa: protective attenuator (if available)

If receive antenna factor file is set and measurement data unit is dBm, the field strength E [dBµV/m] is calculated according to the following formula and a “Field strength” chart tab is then added in the charts panel:

E = M + 107 + afr

Where

M: measured value (M_R or M_X) [dBm]

afr: receive antenna factor value [dB/m]

When custom measurement is finished, and reference measurement is available the difference D [dB] of reference measurement and the custom measurement is computed and displayed in a separate “Deviation” tab in the charts panel.

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

$D = M_R - M_x$

10.6.3. Report Format

As described in section 7.4 the measurement output can be exported in a MS Excel format. In the picture below (Figure 68) you can see an Excel document containing several worksheets.

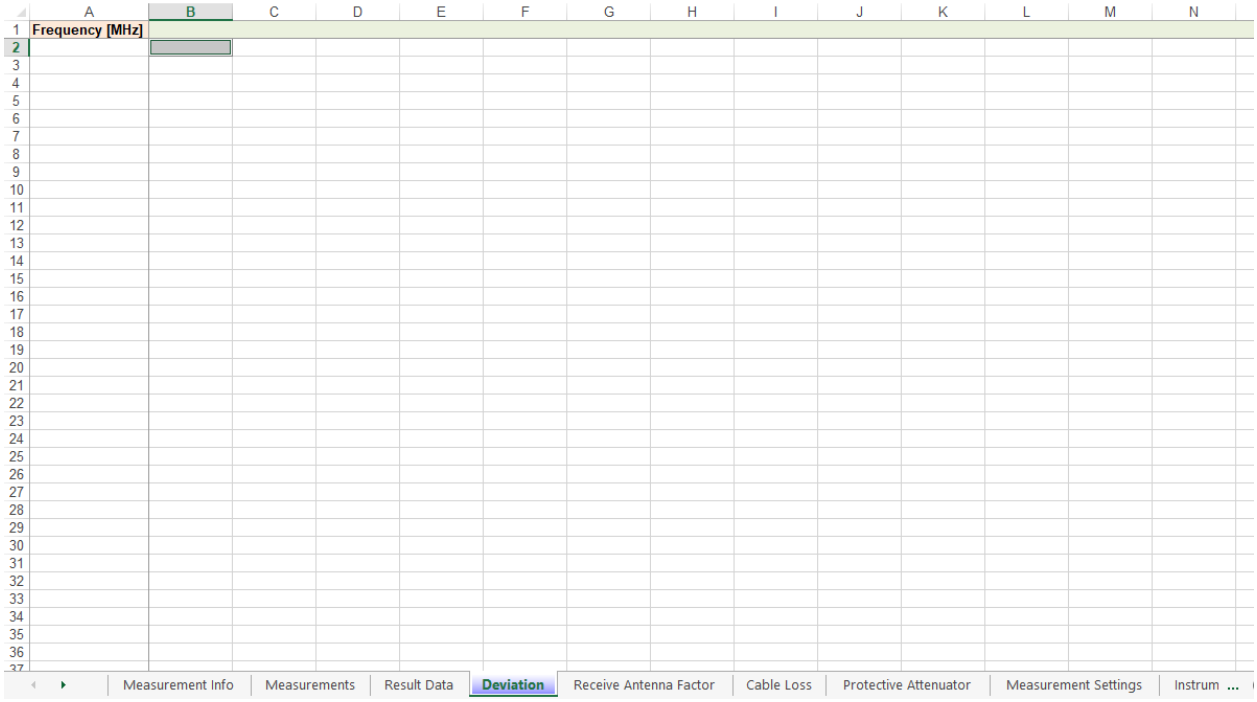


Figure 68: Measurement output exported to a MS Excel file

Measurement Info	Contains general information about measurement from Measurement Info dialog box
Measurements	Measured data
Field Strength	Computed field strength
Deviation	Measurement results
Receive Antenna Factor*	Receive antenna factor data
Cable loss*	Cable loss data
Protective Attenuator*	Protective attenuator data
Measurement Settings	Measurement Settings panel content
Instruments	Device parameters used for measurement
* worksheets are added only if factor files are used	

Table 18: Description of the MS Excel file

11. TROUBLESHOOTING

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

Possible reasons:

a) The 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)

b) The 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

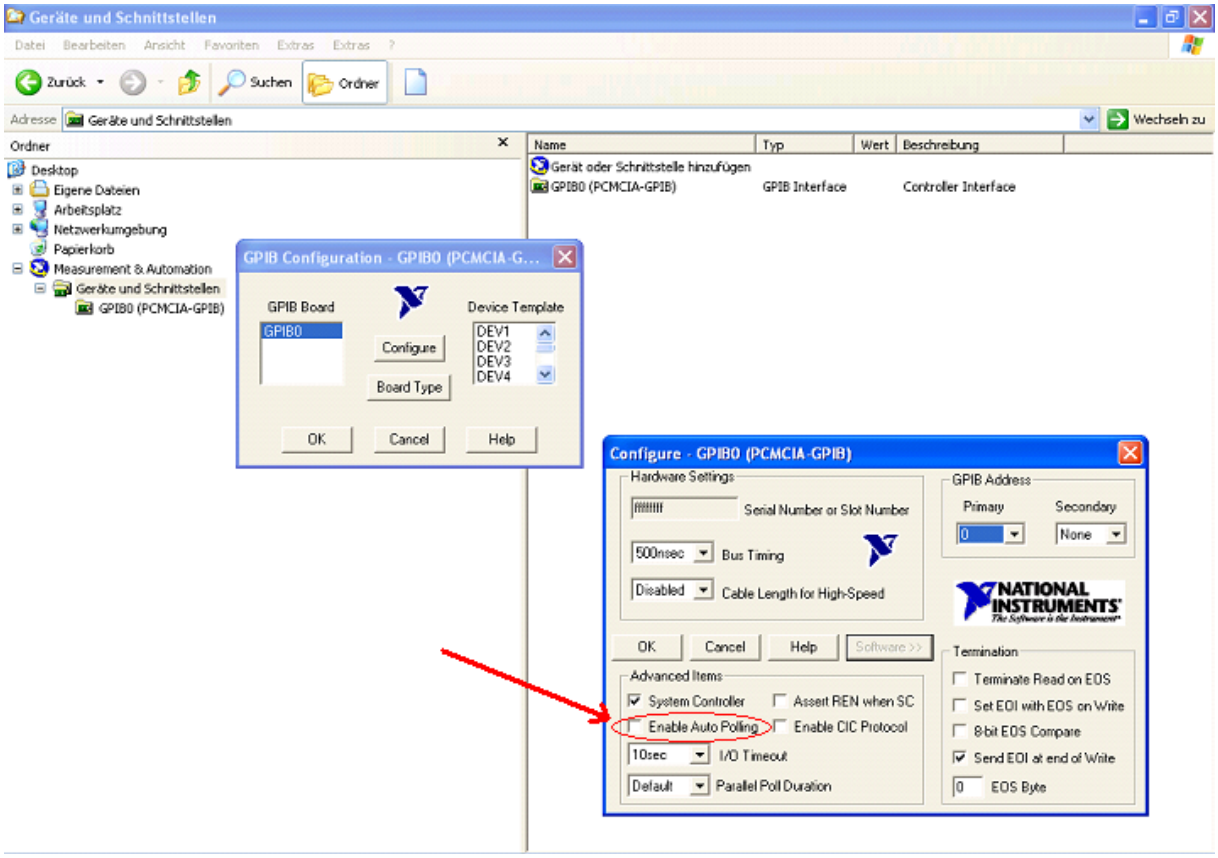


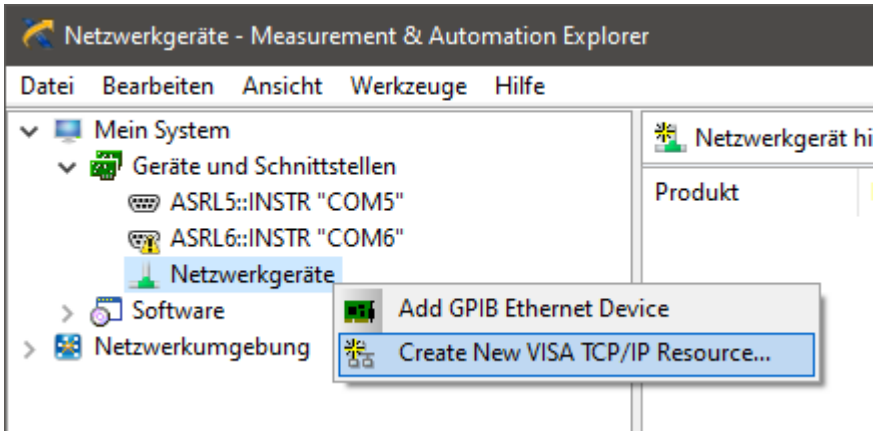
Figure 69: Disabling Serial Polling in the GPIB card configuration

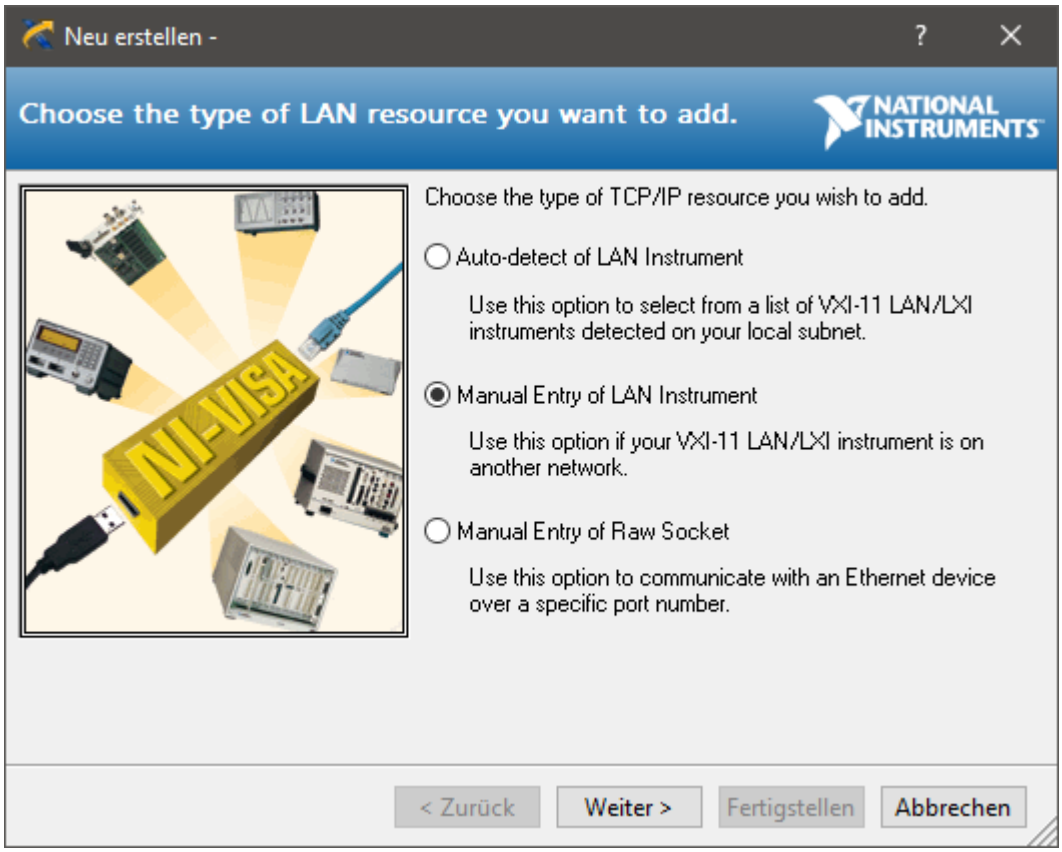
11.3. Measurement fails with error message "error -108: Parameter not allowed”

This may be a decimal separator problem in the device driver Try to change you regional settings and use “.” As decimal and “ ” as thousands separator. Please let us know about this problem.

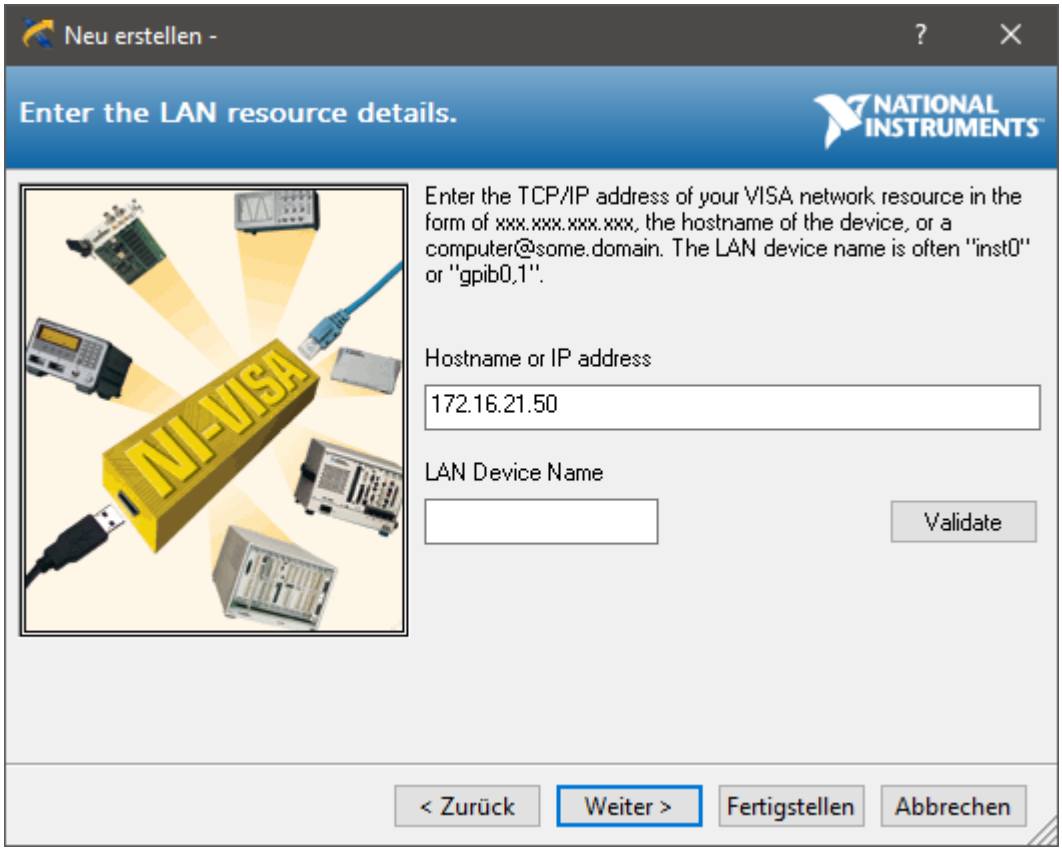
11.4. “No instrument found” message appears on device detection

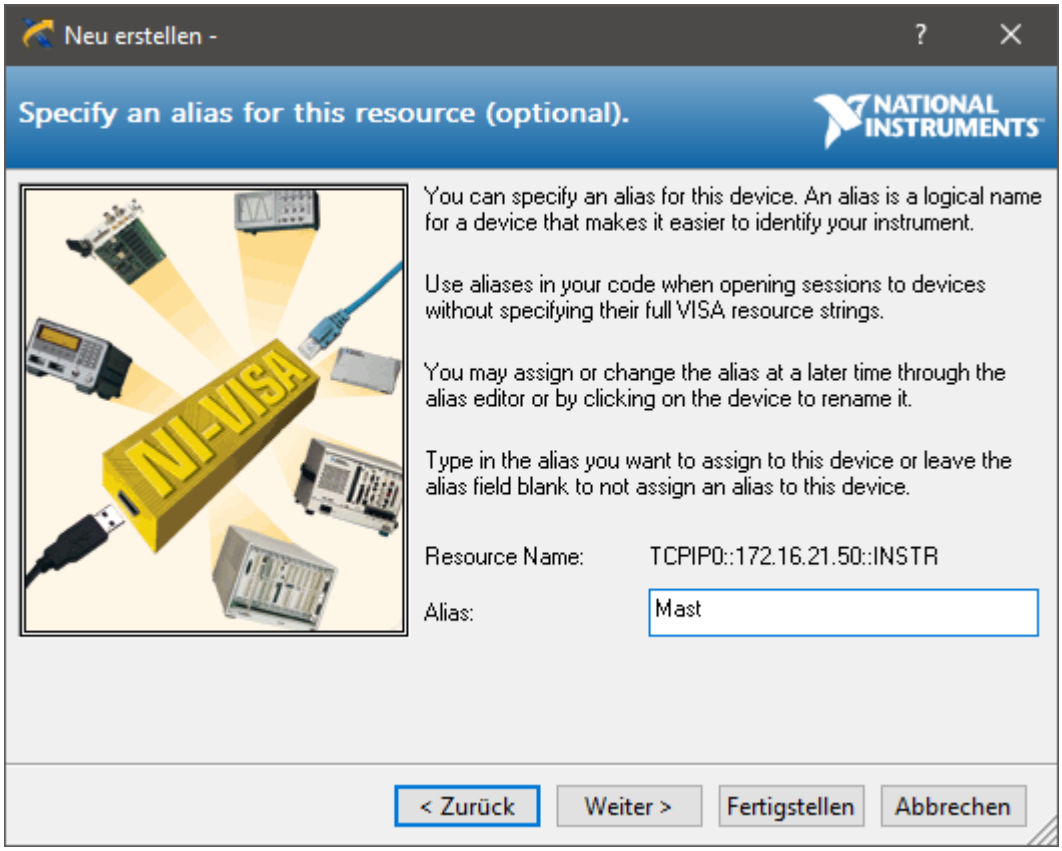
a) The network connected devices have to be defined in the NI Max software.





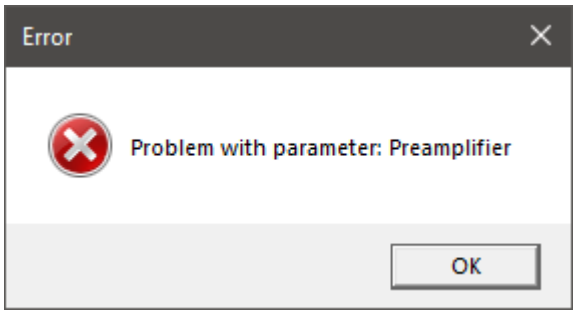
Note: If the instrument uses specific TCP/IP port e.g. select the “Manual Entry of Raw Socket”.





b) If devices are detected/defined in the National Instruments Measurement & Automation software but CalStan can't find them National Instruments software has to be reinstalled with latest version.

11.5. “Problem with parameter: Preamplifier” message appears on device selection



The measurement file is not compatible with the given device driver.

If this happends on creating new measurement. The given measurement template have to be deleted.

11.6. Communication with the device doesn’t work using USB cable

Try to use USB 2.0 cable.

11.7. Communication with the TCP/IP device doesn’t work.

In some cases, the communication between the measurement device and the PC is blocked a firewall. This could be a software firewall like the Windows Defender Firewall, or an additional firewall introduced by VPN software. A hardware firewall may be the reason if the PC and the measurement device are operating on different IP subnets.

Extensive information about the correct configuration can be found at:

https://www.ni.com/en-us/support/documentation/supplemental/10/configuring-software-and-hardware-firewalls-to-support-national-.html

11.8. Measurement with spectrum analyzer is extremely slow

Disable serial auto polling for slow measurement with signal generator/spectrum analyzer (see 11.2)

11.9. Operation finished with error -1073807342

Check the serial number of the GPIB card on NI.com. The cards is probably not original, but cheap copy.

12. FIGURES

13. TABLES