Program for Frequency Response Measurements

Application Note

Products:

R&S®SMW200A	R&S®ESL
R&S®SMU200A	R&S®ESR
R&S®SMU-K44	R&S®ESU
R&S®SMA100A	R&S®FSP
R&S®SMB100A	R&S®FSU
R&S®SMC200A	R&S®FSQ
R&S®SMBV100A	R&S®FSL
R&S®SMJ100A	R&S®FSG
R&S®SMR	R&S®FSC
R&S®SFU	R&S®FSW
R&S®CMW270	R&S®FSV
R&S®CMW500	R&S®FSVR
R&S®ZVH	R&S®FSUP
R&S®ESCI	R&S®NRP-Zx

This application note introduces the program FreRes. Use this program to measure the frequency and/or level response of a device under test, using a generator as signal source and a power meter, a receiver or a spectrum analyzer as indicator

Application Note
Ottmar Gerlach
06.2014-1MA09_44e

ROHDE&SCHWARZ

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1 Overview

This application note introduces the program **FreRes**. Use this program to measure the frequency and level response of a device under test, using a generator as signal source and a power meter, an EMI receiver or a spectrum analyzer as indicator. Virtually any Rohde & Schwarz signal generator, spectrum analyzer, or power meter is supported (see table 1-1).The program is available for Windows 7/8 32- or 64-bit or MacOSx and comes with a comprehensive help file.

Supported sources		**Supported indicators**	
R&S®SMW200A	Vect. Sign. Generator	R&S®ESxx	Test Receiver
R&S®SMU200A	Vect. Sign. Generator	R&S®FSUP	Test Receiver
R&S®SMJ100A	Vect. Sign. Generator	R&S®FSEx	Spectrum Analyzer
R&S®SMIQ	Vect. Sign. Generator	R&S®FSIQ	Spectrum Analyzer
R&S®SMBV100A	Vect. Sign. Generator	R&S®FSP	Spectrum Analyzer
R&S®SMV	Vect. Sign. Generator	R&S®FSU	Spectrum Analyzer
R&S®SM300	Vect. Sign. Generator	R&S®FSQ	Spectrum Analyzer
R&S®SMA	Signal Generator	R&S®FSL	Spectrum Analyzer
R&S®SMB100A	Signal Generator	R&S®FSV	Signal and Spectrum Analyzer
R&S®SMC100A	Signal Generator	R&S®FSVR	RT Spectrum Analyzer
R&S®SML	Signal Generator	R&S®FSW	Signal and Spectrum Analyzer
R&S®SME	Signal Generator	R&S®FSG	Spectrum Analyzer
R&S®SMGU	Signal Generator	R&S®FSC	Spectrum Analyzer
R&S®SMHU	Signal Generator	R&S®FS300	Spectrum Analyzer
R&S®SMHU58	Signal Generator	R&S®ZVH	Network Analyzer
R&S®SMP	Signal Generator	R&S®NRVD	Dual Ch.P-Meter
R&S®SMR	Signal Generator	R&S®NRVS	Single Ch.P-Meter
R&S®SMT	Signal Generator	R&S®NRT	Power Refl. Meter
R&S®SMY	Signal Generator	R&S®NRP	Power Meter
R&S®SMF	Microwave Gen	R&S®NRP-Zx	All avail. P-Sensors
R&S®SFU	Broadc.Test System	R&S®NRxx	Level Meter
R&S®CMU200	Radio.Comm.Tester	R&S®CMU200	Radio.Comm.Tester
R&S®CMW270	WiMax Comm.Tester	R&S®CMW270	WiMax Comm.Tester
R&S®CMW500	Radio.Comm.Tester	R&S®CMW500	Wideb.Comm.Tester
		R&S®FS300	Spectrum Analyzer
		R&S®NRVD	Dual Ch.P-Meter
		R&S®NRVS	Single Ch.P-Meter

Table 1-1: Supported Sources and Indicators

2 Software Features

FreRes provides functions for setting up the following measurement instruments and parameters:

- Source selection and GPIB setup
- Indicator selection and GPIB setup
- Sweep parameters setup
- Graphic panel parameters setup
- Measurement normalization
- Repeated measurements
- Save results as an ASCII file or a bitmap
- Print results as a listing or a diagram
- Load and display a previously saved ASCII file
- Store individual measurement configurations.

3 Hardware and Software Requirements

The minimum requirements for running FreRes is a

- PC with Windows 7 / 8 32- or 64-bit operating system or MacOSx PC.
- Optional National Instruments (NI) or Agilent GPIB controller.

Since FreRes supports R&S devices with various interfaces (GPIB, RS232, LAN and USB) it is necessary to install the appropriate driver software first. The following table shows which software must be installed when using devices with certain interfaces.

	NI-GPIB v3.x	NI-VISA v5.xx	Agilent IO Library Suite 16.x	NRP Toolkit & VXIpnp Driver	R&S®SM300 VXIpnp driver	R&S®FS300 VXIpnp driver
GPIB device & NI controller						
GPIB device & Agilent controller						
RS232 device						
LAN device						
NRP-Zx						
SM300						
FS300						

A software driver needs to be installed only once and not separately for each device.

- In case you are using a VISA compatible GPIB controller install the appropriate driver software from the manufacturer's site first.
- Install a compatible VISA driver, e.g. NI-VISA Runtime, Agilent I/O Libraries Suite etc.
- When using a R&S NRP-Zx Power Sensor install the **NRP-TOOLKIT**. For Windows7/8 the **NRPZ VXIPNP** driver (x86 for FreRes or x64 for FreRes64) is additionally required (see http://www.rohde-schwarz.com for latest revision). Read the installation instructions before running it with FreRes(64).
- When using a R&S SM300 Vector Signal Generator and/or FS300/315 Analyzer install the corresponding VXIpnp driver(s) first (x86 for FreRes or x64 for FreRes64, see http://www.rohde-schwarz.com for latest revisions) and read the installation instructions before running them with FreRes(64). Note: The R&S SM300 and FS300/315 drivers are only available for Windows 7/8, not MacOSx.

4 Connecting the Instruments

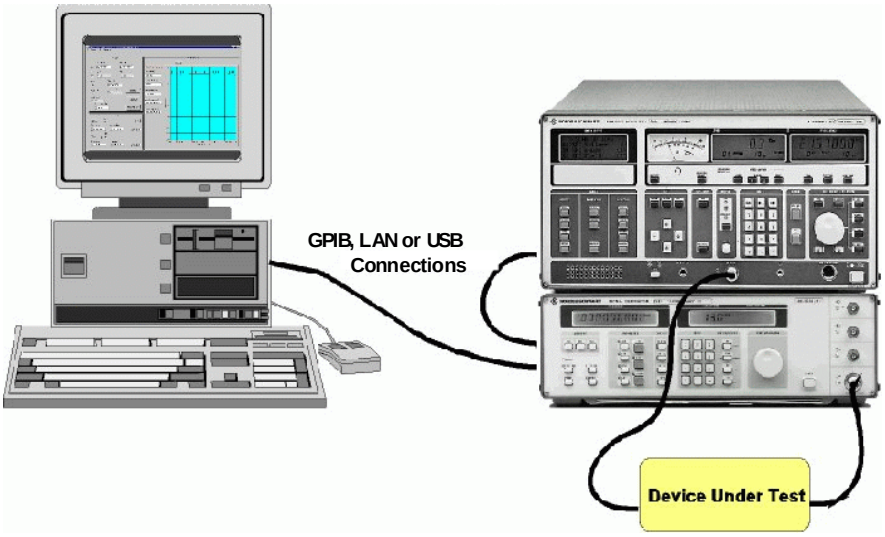


Fig. 4-1: Connecting Computer to Instruments

- Connect the source and the indicator via GPIB cables to the PC acting as controller.
- The DUT (device under test) is normally connected in the cable path between the source and the indicator.

5 Installing the Software

5.1 Download

FreRes_5.0.x.exe or FreRes64_5.0.x.exe are self-extracting compressed files that can be downloaded from http://www.rohde-schwarz.com/appnote/1MA09.html.

5.2 Installation

Execute **FRERES_5.0.X.EXE** for 32 bit (x86) or **FRERES64_5.0.X.EXE**.for 64 bit (x64) version first and follow the installation instructions. FreRes64 only runs on Windows 7/8 64-bit.

On a MacOSx PC install **FRERESMC_50X.DMG** and follow the installation instructions. When using an NRP-Z power sensor, install the NRP-Toolkit first.

6 Starting the Software / Measurement

Start the program with: **START → PROGRAMS → R&S FRERES → FRERES** or double click on **FRERES.EXE** in the installation directory. The main menu appears using the previous configuration. The configuration is saved in the file **FRERES.CFG**. FreRes is largely self-explanatory. See the online help **FRERES.CHM** for additional information.

6.1 User Interface

6.1.1 Main Menu

The main menu appears as shown below and features 5 pull-down menus: **FILE**, **SETTINGS**, **RUN**, **RESULTS** and **HELP**.

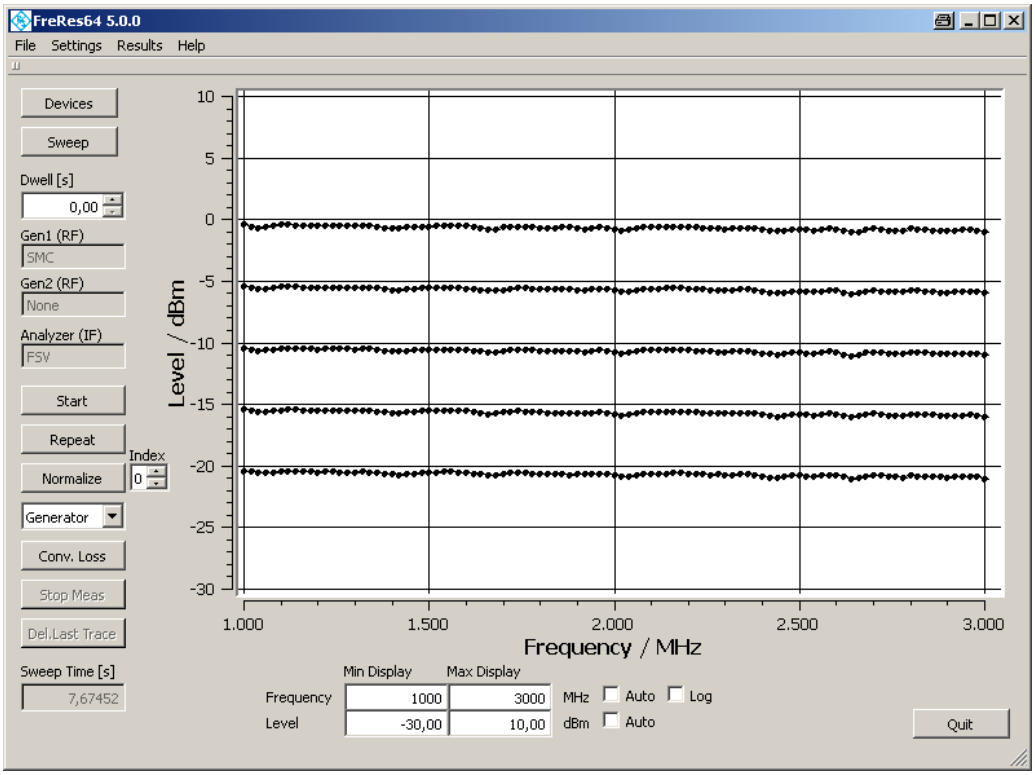


Fig. 6-1: Main Menu

6.1.2 File

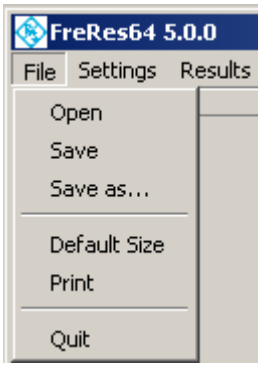


Fig. 6-2: File Menu

- **OPEN** – open a configuration file previously stored with **SAVE** or **SAVE AS…**.
- **SAVE** – store the current configuration into the previously selected file.
- **SAVE AS** – store the current configuration into a selected file.
- **DEFAULT SIZE** – Restores original window size.

The default extension is "**.CFG**". When you close the program the current configuration is saved in "**FRERES.CFG**". This file is automatically loaded when FreRes is run next time.

6.1.3 Settings

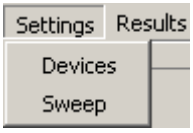


Fig. 6-3: Settings Menu

- **DEVICE** – Opens Device configuration window. See chapter '**SELECT DEVICES**' for details.
- **SWEEP** – Specifies **FreRes** sweep parameters. See chapter '**CONFIGURE SWEEP PARAMETERS**' for details.
- **DISPLAY** – Specifies **FreRes** display parameters. See chapter '**CONFIGURE DISPLAY PARAMETERS**' for details.

6.1.4 Results

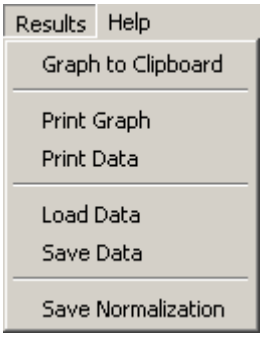


Fig. 6-4: Results Menu

- **GRAPH TO CLIPBOARD** – Transfers results graph to the controller's clipboard for use with other programs.
- **PRINT GRAPH** – Send results graph to a printer.
- **PRINT DATA** – Sends results to a printer. See chapter "*Measurements Data Result*" for a detailed description of the data format.
- **SAVE DATA** – Saves results; a list file is generated. The extensions ***.dat**.(ASCII), ***.xls** (MS Excel) and ***.fda** (R&S®CMW500 list format). See 6.6 for details.
- **LOAD DATA** – Loads and displays previously stored results.
- **SAVE NORMALIZATION** – Saves the nominal – according measured levels to a file.

6.1.5 Help

Fig. 6-5: Help Menu

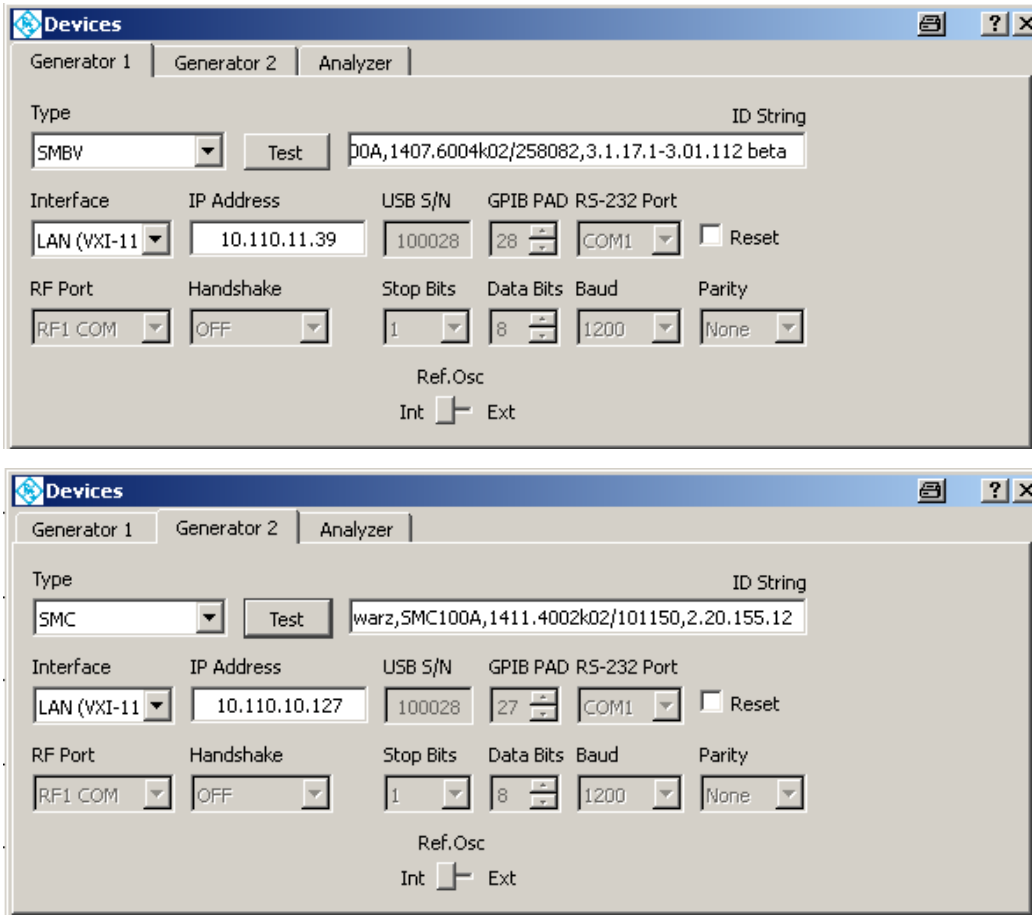
- **CONTENTS** – Opens online help, displaying list of contents.
- **ABOUT** – Displays information about program version.

6.2 Performing a Measurement

This section describes how to prepare a test run, by selecting the source and indicator devices, configuring the test sweep and results display.

6.2.1 Select Devices

From **SETTINGS** → **DEVICE** select the source(s) and indicator to use.



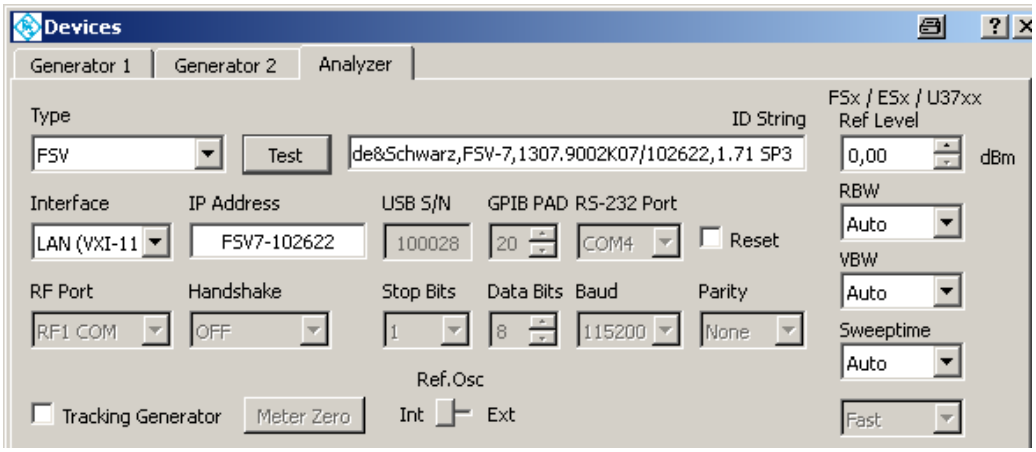


Fig. 6-6: Select Devices

Select the source from the **GENERATOR1** / **GENERATOR2** list and enter the correct GPIB, IP address or USB serial number. TEST will query the instrument's ID string and display it in the message box.

Select indicator from the signal **ANALYZER / POWER SENSOR** list and enter the correct GPIB address. **TEST** will query the instrument's **ID STRING** and display it in the message box. If the **TRACKING GENERATOR** option for FSx or ESx analyzers is checked

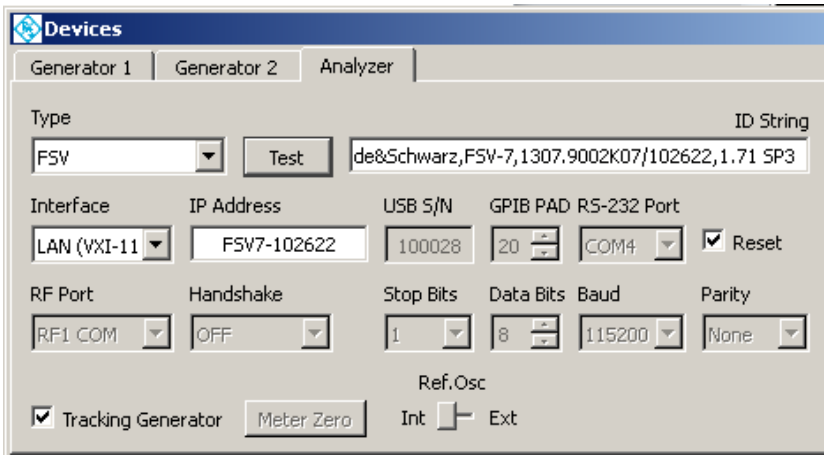


Fig. 6-7: FSx/ESx Tracking Generator

GENERATOR 1 and **GENERATOR 2** are deactivated.

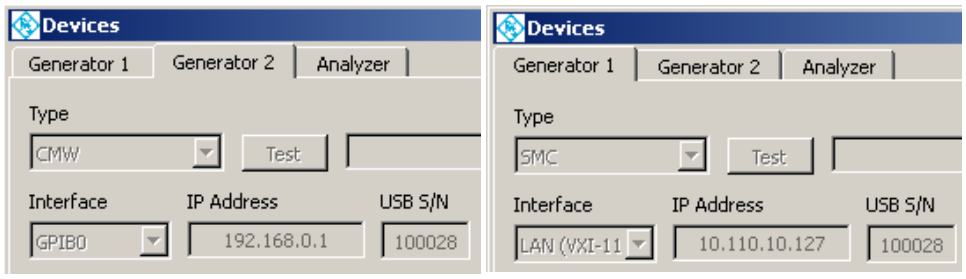


Fig. 6-8: Generator 1 and Generator 2 deactivated

If **ANALYZER** = NRPZ a Power Meter NRP-Zx window pops up requiring following parameters.

- **TYPE** – Choose from 13 different power meter models (default = NRP-Z21).

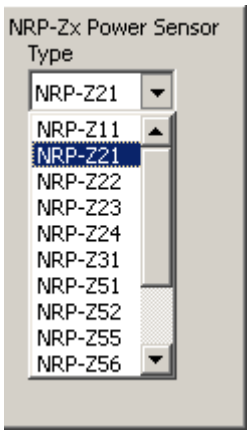


Fig. 6-9: Power Meter Models

- **RESOLUTION** – Measurement precision, i.e. number of digits after decimal point. Range 1 (0.9) to 4 (0.9999) (default = 3). With 3 digits resolution, the power measurements are averaged until the 3rd digit behind the decimal remains stable.

When the **RESET** checkbox is turned ON the instrument performs a reset as soon as the according **TEST** or **START** button is pressed (see Figure 2).

Note: An error message will pop up in case no appropriate VISA driver is installed (e.g. NI-VISA v3.01 and higher) or a R&S®NRP-Zx, R&S®FS300 or R&S®SM300 driver has not been installed before selecting it in the FreRes device menu (see Software Requirements p.4).

- **INTERFACE** (Analyzer) – Allows selection of interface type. Range: GPIB0, GPIB1, LAN (RS-IB) or LAN (VXI-11). In case a SM300, FS300 or NRP-Zx is selected you can only select USB.
- **IP ADDR** – In case the LAN (RS-IB) or LAN (VXI-11) Interface is selected this control is visible. See FSx analyzer / SMU generator manual for correct setup (e.g. 89.10.71.55).
- **USB SERIAL NO** – R&S®SM300 signal generator or R&S®FS300 spectrum analyzer serial number which is printed on the device's rear side or can be displayed on the front panel by pressing SYS -> INFO -> STATISTICS (SM300/FS300). The R&S®NRP-Zx serial no. is printed on the power sensor's label.

Note: The R&S®SM300 Vector Signal Generator and R&S®FS300 Spectrum Analyzer must be set to remote mode manually by pressing SYS -> CONFIG -> INTERFACE-> ENTER -> AUTO -> ENTER before initializing it or starting a scan.

- **REF.OSC** – Selects **INT**ernal or **EXT**ernal reference oscillator of according device.
- **METER ZERO** – Is visible in case a R&S®NRP-Zx, R&S®NRVS, R&S®NRVD, R&S®URV35 or R&S®URV55 power sensors is selected as **ANALYZER** device type. By pressing this button the program turns OFF the Generator1 RF output and zeroes the power sensor. Then the Generator1 RF output is turned back ON.
- **RS232 PORT** – Is visible as soon as an R&S®URV35 meter is selected.
- **BAUD** – Baudrate of RS232 device. Range 9600 bps.
- **PARITY** – Parity of RS232 device. Range 0, 1 or 2.

Some instruments need further information concerning reference level, IF-bandwidth and detector type (R&S®ESPC). An additional window pops up if necessary.

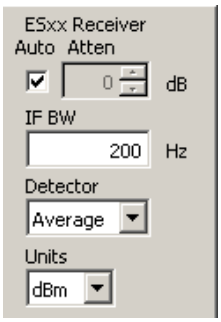


Fig. 6-10: ESPC Detector Setup

6.3 Configure Sweep Parameters

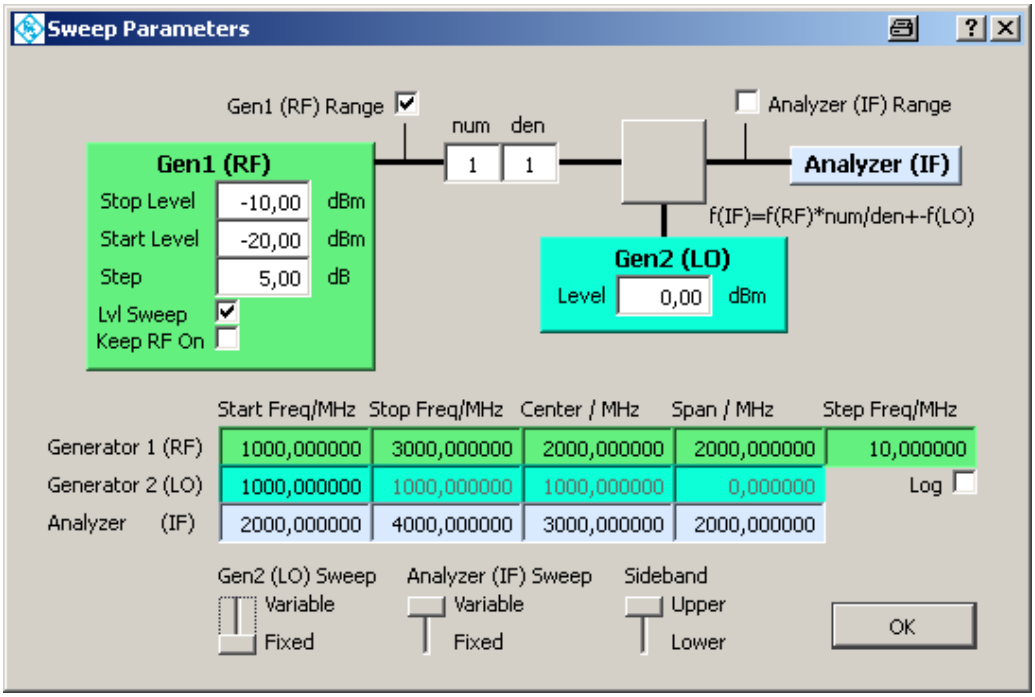


Fig. 6-11: Sweep Parameters

This menu allows configuration of frequency and level sweep. A second generator can be configured for measuring frequency shifting DUTs such as mixers, numerators and denominators.

- **GENERATOR1 (RF)** – The generator providing the RF frequency.
  - **MIN LVL** – minimal (start) level. Range depends on device type.
  - **MAX LVL** – maximal (stop) level. Range depends on device type.
  - **STEP** – step level.
  - **LEVEL SWEEP** – Turn level sweep ON or OFF. When turned OFF MAX LVL and STEP controls are dimmed. The number of level sweeps is calculated as *N = (Max Level – Min Level) / Step Level + 1*
  - **START FREQ**uency – Sweep start frequency. This value is changed, if **CENTER** or **SPAN** controls are used.
  - **STOP FREQ**uency – Sweep stop frequency. This value is changed, if **CENTER** or **SPAN** controls are used.
  - **CENTER** – Sweep center frequency. This value is changed, if **START FREQ** or **STOP FREQ** controls are used.**PAN** – Sweep start frequency. This value is changed, if START FREQ or STOP FREQ controls are used.
  - **STEP** – Sweep step frequency. Is dimmed if LOGARITHMIC sweep mode is selected.
  - **PAN** – Sweep span frequency. Is dimmed if **LINEAR** sweep mode is selected.
  - **LOG** – Linear (not checked) or logarithmic (checked) sweep mode. If **LOG** mode is selected **STEP** is dimmed and **COUNT** undimmed.

- **ANALYZER (IF)** – Analyzer settings.
  - **START FREQ**uency – Analyzer start frequency.
  - **STOP FREQ**uency – Analyzer stop frequency.
  - **CENTER** – Analyzer center frequency.
  - **SPAN** – Analyzer start frequency.

  Note: Analyzer settings are automatically adapted to start-stop (center span) frequencies and Lin/Log mode. This feature ensures correct plot visibility without auto scale activation. Changing display parameters only affects generator1 sweep settings in case ANALYZER (IF) SWEEP is set to FIXED.

- **RF RANGE** – FreRes graph window shows measured level over generator1 frequency range.
- **IF RANGE –** FreRes graph window shows measured level over analyzer frequency range.
- **GEN2 (LO) SWEEP –** Variable / Fixed frequency range.
- **ANALYZER (IF) SWEEP –** Variable / Fixed frequency range. If set to Fixed the frequency sweep range of generator 1 is automatically set to variable.

Note: GEN2 and ANALYZER SWEEP switches cannot be set to FIXED simultaneously.

6.4 Configure Graphics Display

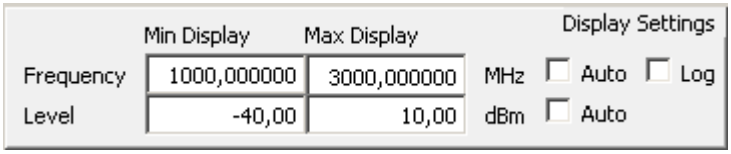


Fig. 6-12: Graphics Display

Sets scaling for X- and Y- Axes. Set the scale type:

- **LOG** – logarithmic display when checked (unchecked for linear display). Set limits manually or automatically.
- **START** – the minimum value shown.
- **STOP** – the maximum value shown.
- **AUTO** – minimum and maximum values are automatically matched to test results.

6.5 Testing

- **START** – starts frequency sweep. Existing measurement plots are deleted prior to the new run. Measured points are displayed in real time. At the end of a sweep all points are connected by a line to enhance readability.
- **REPEAT** – starts measurement without deleting existing measurement plots. Pressing **NORMALIZE** causes all further measurements to be normalized to the first measurement scan invoked by **START**.
- **NORMALIZE** – uses current measurement as reference for measurements to come. There are two different correction methods:

Fig. 6-13: Normalize Measurement

  - **REC –** The resulting value is corrected after measurement.
  - **GEN –** The generator level is corrected before measurement.
  - **INDEX** – selects Level Sweep index to normalize to. If no Level Sweep is selected Index is set to 0.

- **CONV. LOSS** – Displays the frequency response relative to the **GENERATOR 1** Level in dB.
- **STOP MEAS** – stops measurement immediately. After measurement has been stopped both the **NORMALIZE** and the **REPEAT** buttons become active.
- **DEL LAST TRACE** – deletes last trace if there are more than one traces.

6.6 Measurement Data Format (ASCII)

The format used for results data in an ASCII file is shown below. The file's default extension is ***.DAT**".

Example: **D:\RSAPPL\TEST.DAT**

Repetition Count: 001
Level Sweep Count: 005
Measurement Count: 011
1100.000000 -39.516 -36.738 -32.923 -28.101 -23.279
1120.000000 -39.974 -37.379 -33.381 -28.376 -23.584
1140.000000 -40.279 -37.624 -33.839 -28.925 -24.195
1160.000000 -40.706 -37.868 -34.053 -29.108 -24.378
1180.000000 -40.523 -37.837 -34.175 -29.047 -24.836
1200.000000 -41.194 -38.997 -35.335 -30.238 -26.209
1220.000000 -41.805 -39.119 -35.945 -31.459 -27.338
1240.000000 -41.255 -38.966 -35.548 -31.550 -27.582
1260.000000 -42.202 -40.004 -36.922 -32.252 -28.559
1280.000000 -41.591 -39.516 -36.677 -32.557 -28.101
1300.000000 -41.317 -39.424 -36.220 -32.008 -27.491

The format used for results data in an ASCII file is shown below. The left column shows the frequency steps and the resulting level (power) values for one trace with 5 level sweeps.

*Note: To export data correctly to Microsoft Excel, save the file with an ***.xls** extension. Under Excel the data is formatted to match local country settings (e.g. decimal point).*

The ***.fda** data format is compatible with the R&S®CMW Communication Tester series (see example below).

```
<?xml version="1.0" standalone="no"?>
<!DOCTYPE swpl>
<swpl>
<FrequencyDependantExternalAttenuationCorrectionTable properties="true">
<properties>
<TableName value="Patch Loss with cover" type="bstr" />
<TableSize value="11" type="i4" />
<FrequencyNodes type="array|r8">
<Vector count="11" type="r8"
data="1000000000.000000;1200000000.000000;1400000000.000000;1600000000.00
0000;1800000000.000000;2000000000.000000;2200000000.000000;2400000000.000
000;2600000000.000000;2800000000.000000;3000000000.000000;"/>
</FrequencyNodes>
<CorrectionValues type="array|r8">
<Vector count="11" type="r8" data=" -10.628; -10.674; -10.703; -10.786; -10.874; -
10.874; -10.935; -11.173; -11.265; -11.410; -11.364;"/>
```

7 Additional Information

Please contact **TM-APPLICATIONS@ ROHDE-SCHWARZ.COM** for comments and further suggestions.

8 Ordering Information

Ordering Information		
Vector Signal Generator		
R&S® SMW200A		**1412.0000.02**
SMW-B103	100 kHz – 3 GHz (RF Path A)	1413.0004.02
SMW-B106	100 kHz – 3 GHz (RF Path B)	1413.0104.02
SMW-B203	100 kHz – 3 GHz (RF Path B)	1413.0804.02
SMW-B206	100 kHz – 3 GHz (RF Path B)	1413.0904.02
R&S® SMU200A		**1141.2005.02**
SMU-B102	Freq. Range 100kHz – 2.2GHz	1141.8503.02
SMU-B103	Freq. Range 100kHz – 3.0GHz	1141.8603.02
SMU-B104	Freq. Range 100kHz – 4.0GHz	1141.8703.02
SMU-B106	Freq. Range 100kHz – 6.0GHz	1141.8803.02
R&S® SMBV100A		**1407.6004.02**
SMBV-B103	Freq. Range 9kHz – 3.2GHz	1407.9603.02
SMBV-B106	Freq. Range 9kHz – 6.0GHz	1407.9703.02
R&S® SMJ100A		**1403.4507.02**
SMJ-B103	Freq. Range 100kHz – 3.0GHz	1403.8502.02
SMJ-B106	Freq. Range 100kHz – 6.0GHz	1403.8702.02
Signal Generator		
R&S® SMA100A		**1400.0000.02**
SMA-B103	Freq. Range 9kHz – 3.0GHz	1405.0209.02
SMA-B106	Freq. Range 9kHz – 6.0GHz	1405.0809.02
R&S® SMB100A		**1406.6000.02**
SMB-B102	Freq. Range 100kHz – 1.1GHz	1407.2509.02
SMB-B103	Freq. Range 100kHz – 2.2GHz	1407.2609.02
SMB-B104	Freq. Range 100kHz – 3.2GHz	1407.2709.02
SMB-B106	Freq. Range 100kHz – 6.0GHz	1407.2809.02
R&S® SMC100A		**1406.6000.02**
SMC-B102	Freq. Range 9kHz – 1.1GHz	1411.6505.02
SMC-B103	Freq. Range 9kHz – 3.2GHz	1411.6605.02
R&S® SMF100A		**1167.0000.02**
SMF-B122	Freq. Range 1.0 – 22.0GHz	1167.7004.02
SMF-B144	Freq. Range 1.0 – 43.5 GHz	1167.7204.02

Ordering Information		
Broadcast Test System		
R&S® SFU	(100kHz to 3GHz)	2110.2500.02
Spectrum Analyzer		
R&S® FSLx	(9 kHz to 6 GHz)	1300.2502.xx
R&S® FSPxx	(9 kHz to 30 GHz)	1093.4495.xx
R&S® FSP-B9	Tracking Generator for FSP	1129.6991.02
R&S® FSUxx	(20 Hz to 26.5 GHz)	1129.9003.xx
R&S® FSU-B9	Tracking Gen. for FSU, FSQ	1142.8994.02
R&S® FSVx	(9 kHz to 7 GHz)	1307.9002.0x
R&S® FSVRx	(10 Hz to 40 GHz)	1311.0006.xx
R&S® FSGxx	(9 kHz to 13.6 GHz)	1309.0002.xx
R&S® FSQxx	(20 HZ to 40 GHz)	1155.5001.xx
R&S® FSCx	(9 kHZ to 6 GHz)	1314.3006.xx
R&S® FSWxx	(2 HZ to 26.5 GHz)	1312.8000.xx
Test Receiver		
R&S® ESCI	(9 kHz to 3 GHz)	1166.5950.03
R&S® ESLx	(9 kHz to 6 GHz)	1300.5001.0x
R&S® ESPIx	(9 kHz to 7 GHz)	1142.8007.xx
R&S® ESR	(9 kHz to 26.5 GHz)	1316.3003.xx
R&S® ESRP	(9 kHz to 7 GHz)	1316.4500.0x
R&S® ESU	(20 Hz to 40 GHz)	1302.6005.xx
R&S® FSMR	(20 Hz to 50 GHz)	1166.3311.xx
Signal Source Analyzer for Phase Noise		
R&S®FSUPxx	(1 MHz – 50 GHz)	1166.3505.xx
Network Analyzer		
R&S®ZVHx	(100 kHz – 8 GHz)	1309.6800.2x
ZVH-K1	Spectrum Analysis Option	1309.6823.0x
Power Meter		
R&S® NRVD		0857.8008.02
R&S® NRVS		1020.1809.02
R&S® NRT		1080.9506.02
R&S® NRP		1143.8500.02
Power Sensor		
R&S® NRP-Z11	3-path diode, 10 MHz to 8 GHz	1138.3004.02
R&S® NRP-Z21	3-path diode, 10 MHz to 18 GHz	1137.6000.02
R&S® NRP-Z22	3-path diode, 10 MHz to 18 GHz	1137.7506.02
R&S® NRP-Z23	3-path diode, 10 MHz to 18 GHz	1137.8002.02
R&S® NRP-Z24	3-path diode, 10 MHz to 18 GHz	1137.8502.02
R&S® NRP-Z31	3-path diode, 10 MHz to 33 GHz	1169.2400.02
R&S® NRP-Z41	3-path diode, 50 MHz to 40 GHz	1171.8801.02

Ordering Information		
R&S® NRP-Z61	**3-path diode, 50 MHz to 50 GHz**	**1171.7505.02**
R&S® NRP-Z211	**2-path diode, 10 MHz to 8 GHz**	**1417.0409.02**
R&S® NRP-Z221	**2-path diode, 10 MHz to 18 GHz**	**1417.0309.02**
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R&S® NRP-Z86	**Wideband, 50 MHz to 40 GHz**	**1417.0109.02**
R&S® NRP-Z51	**Thermal Power Sensor**	**1138.0005.40**
R&S® NRP-Z52	**Thermal Power Sensor**	**1138.0505.18**
R&S® NRP-Z55	**Thermal Power Sensor**	**1138.2008.02**
R&S® NRP-Z56	**Thermal Power Sensor**	**1171.8201.02**
R&S® NRP-Z57	**Thermal Power Sensor**	**1171.8401.02**
R&S® NRP-Z58	**Thermal Power Sensor**	**1173.7031.02**
R&S® NRP-Z91	**Averaging, 9 kHz to 6 GHz**	**1168.8004.02**
R&S® NRP-Z92	**Averaging, 9 kHz to 6 GHz**	**1171.7005.02**
R&S® NRP-Z28	**Lev. Control, 10 MHz to 18 GHz**	**1170.8008.02**
R&S® NRP-Z98	**Lev. Control, 9 kHz to 6 GHz**	**1170.8508.02**
R&S® NRP-Z27	**Module, DC to 18 GHz**	**1169.2400.02**
R&S® NRP-Z37	**Module, DC to 26.5 GHz**	**1169.3206.02**
R&S® NRP-Z3	USB adapter (active)	1146.7005.02
R&S® NRP-Z4	USB adapter (passive)	1146.8001.02
R&S® NRP-Z2	Sensor Extension Cable 5m	1146.6750.05
R&S® NRP-Z3	Sensor Extension Cable 10m	1146.6750.10
Communication Tester		
R&S® CMW270	**WiMax Comm. Tester**	**1201.0002.75**
R&S® CMW500	**Wideb. Radio Comm. Tester**	**1201.0002.50**

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- Energy-efficient products
- Continuous improvement in environmental sustainability
- ISO 14001-certified environmental management system

Regional contact

Europe, Africa, Middle East
+49 89 4129 12345
customersupport@rohde-schwarz.com

North America
1-888-TEST-RSA (1-888-837-8772)
customer.support@rsa.rohde-schwarz.com

Latin America
+1-410-910-7988
customersupport.la@rohde-schwarz.com

Asia/Pacific
+65 65 13 04 88
customersupport.asia@rohde-schwarz.com

China
+86-800-810-8228 /+86-400-650-5896
customersupport.china@rohde-schwarz.com

Rohde & Schwarz GmbH & Co. KG
Mühldorfstraße 15 | D - 81671 München
Phone + 49 89 4129 - 0 | Fax + 49 89 4129 – 13777

www.rohde-schwarz.com