

Products: R&S[®]SMU, R&S[®]SMA, R&S[®]SMB, R&S[®]SMJ, R&S[®]SME, R&S[®]SMGU, R&S[®]SMHU, R&S[®]SMHU58, R&S[®]SMIQ, R&S[®]SML, R&S[®]SMP, R&S[®]SMR, R&S[®]SMT, R&S[®]SMY, R&S[®]SMV, R&S[®]SM300, R&S[®]CMU200, R&S[®]CMW, R&S[®]ESCI, R&S[®]ESU, R&S[®]ESCS, R&S[®]ESHS, R&S[®]ESIB, R&S[®]ESPC, R&S[®]ESS, R&S[®]ESVB, R&S[®]ESVD, R&S[®]ESVN, R&S[®]ESVS, R&S[®]FSE, R&S[®]FSP, R&S[®]FSU, R&S[®]FSQ, R&S[®]FSL, R&S[®]FSUP, R&S[®]FS300, R&S[®]NRVD, R&S[®]NRVS, R&S[®]NRT, R&S[®]NRP, R&S[®]URV35, R&S[®]URV55, R&S[®]NRP-Zx

Program for Frequency Response Measurements

FreRes

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



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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 runs under Windows 2000/XP/Vista and comes with a comprehensive help file **FRERES.CHM**.

Table 1-1 Supported sources and indicators

Supported sources		Supported indicators	
R&S [®] SMU200A	Vect. Signal Generator	R&S [®] ESxx	Test Receiver
R&S [®] SMJ100A	Vect. Signal Generator	R&S [®] FSUP	Test Receiver
R&S [®] SMIQ	Vect. Signal Generator	R&S [®] FSEx	Spectrum Analyzer
R&S [®] SMV	Vect. Signal Generator	R&S [®] FSIQ	Spectrum Analyzer
R&S [®] SM300	Vect. Signal Generator	R&S [®] FSP	Spectrum Analyzer
R&S [®] SMA	Signal Generator	R&S [®] FSU	Spectrum Analyzer
R&S [®] SMB	Signal Generator	R&S [®] FSQ	Spectrum Analyzer
R&S [®] SML	Signal Generator	R&S [®] FSL	Spectrum Analyzer
R&S [®] SME	Signal Generator	R&S [®] FS300	Spectrum Analyzer
R&S [®] SMGU	Signal Generator	R&S [®] NRVD	Dual Ch.P-Meter
R&S [®] SMHU	Signal Generator	R&S [®] NRVS	Single Ch.P-Meter
R&S [®] SMHU58	Signal Generator	R&S [®] NRT	Power Refl. Meter
R&S [®] SMP	Signal Generator	R&S [®] NRP	Power Meter
R&S [®] SMR	Signal Generator	R&S [®] NRP-Zx	All avail. P-Sensors
R&S [®] SMT	Signal Generator	R&S [®] URVxx	Level Meter
R&S [®] SMY	Signal Generator		
R&S [®] SMF	Microwave Gen		
R&S [®] SFU	Broadc. Test System		
R&S [®] CMU200	Radio.Comm. Tester		
R&S [®] CMW	Radio.Comm. Tester		

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 Pentium II 450 MHz processor or higher, 128 MByte RAM, 50 MByte free harddisc space, XGA monitor (1024x768) with optional RS232, LAN or USB interface with Windows 2000/XP/Vista operating system.
- 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 v2.1	NI-VISA v3.01	Agilent I/O Library M01.01	NRP Toolkit & Driver	R&S®SM300 VXiPnp driver	R&S®FS300 VXiPnp driver
GPIB device & NI controller						
GPIB device & Agilent controller						
RS232 device						
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 National Instruments GPIB controller (AT-GPIB, PCI-GPIB or PCMCIA-GPIB) the NI-VISA Runtime version is free of charge. If no NI hardware or software (LabWindows/CVI or LabVIEW) is installed but need NI-VISA for LAN control please regard National Instruments liscencing regulations (see <http://www.ni.com> for details).

- In case you are using an Agilent GPIB controller you only need the Agilent I/O Library M01.01 (or higher) which may be obtained at <http://www.agilent.com>.
- When using a R&S NRP-Zx Power Sensor install the NRP-Toolkit first, then the NRP-Z VXIpn driver (see <http://www.rohde-schwarz.com> for latest revision) and read the installation instructions before running it with FreRes.
- When using a R&S SM300 Vector Signal Generator and/or FS300 Analyzer install the corresponding VXIpn driver(s) first (see <http://www.rohde-schwarz.com> for latest revisions) and read the installation instructions before running them with FreRes.

4 Connecting the Instruments

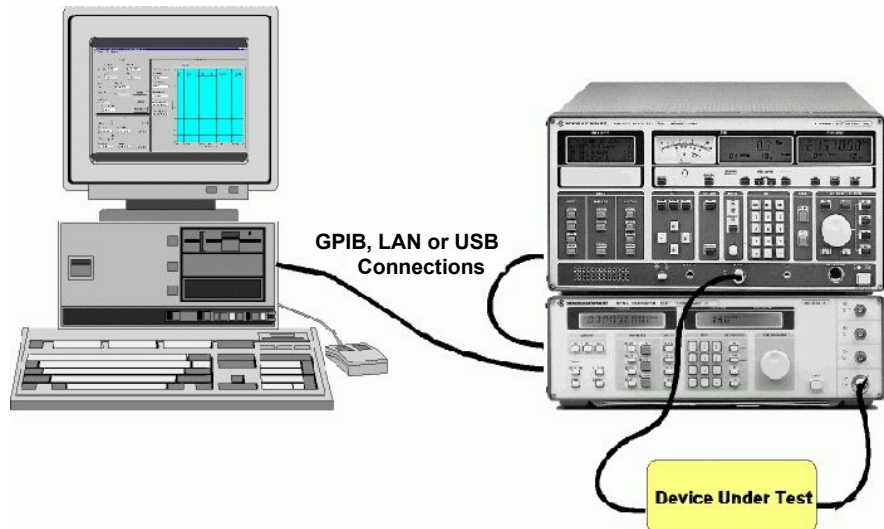


Fig. 1 Connecting computer to instruments

- 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

Download

FreRes_x.x.x.exe is a self extracting compressed file that can be downloaded from <http://www.rohde-schwarz.com/appnote/1MA09.html>.

Installation

Execute **FRERES_4.X.X.EXE** first and follow the installation instructions.

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.

User Interface

Main Menu

The main menu appears as shown below and features 5 pull-down menus; File, Settings, Run, Results and Help.

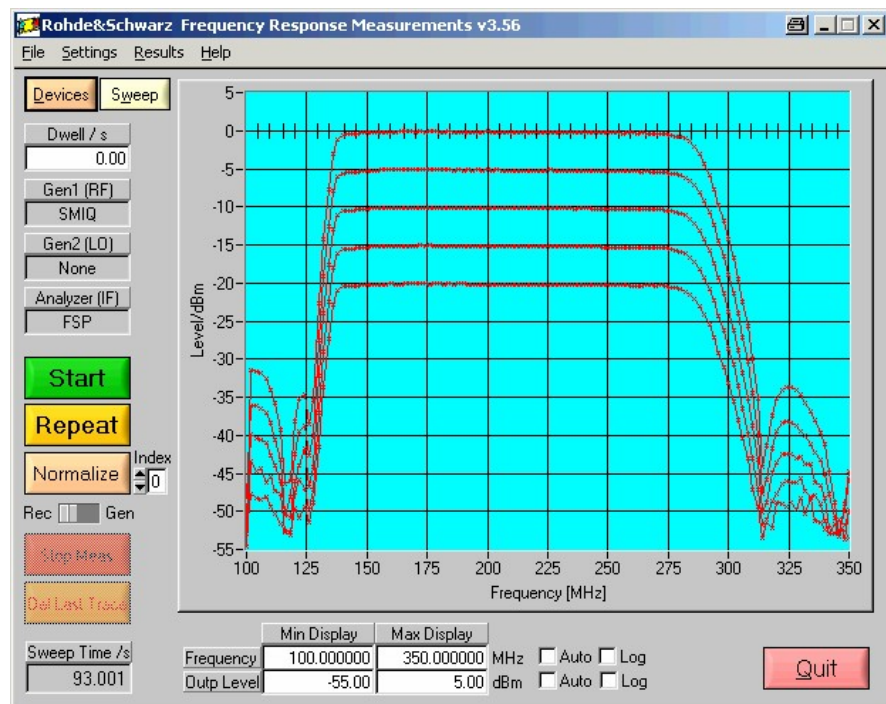


Fig. 2 Main Menu

File

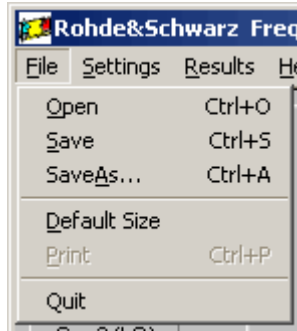


Fig. 3 File Menu

- **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.

Settings

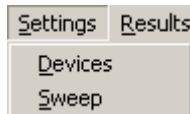


Fig. 4 Settings Menu

- **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.

Results

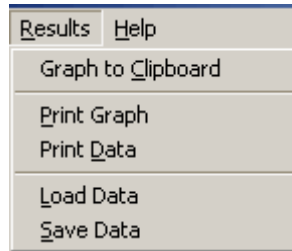


Fig. 5 Results Menu

- **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 default extension is *.rdt.
- **LOAD DATA** – Loads and displays previously stored results.

Help

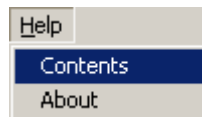


Fig. 6 Help Menu

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

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.

Select Devices

From Settings > Device select the source(s) and indicator to use.

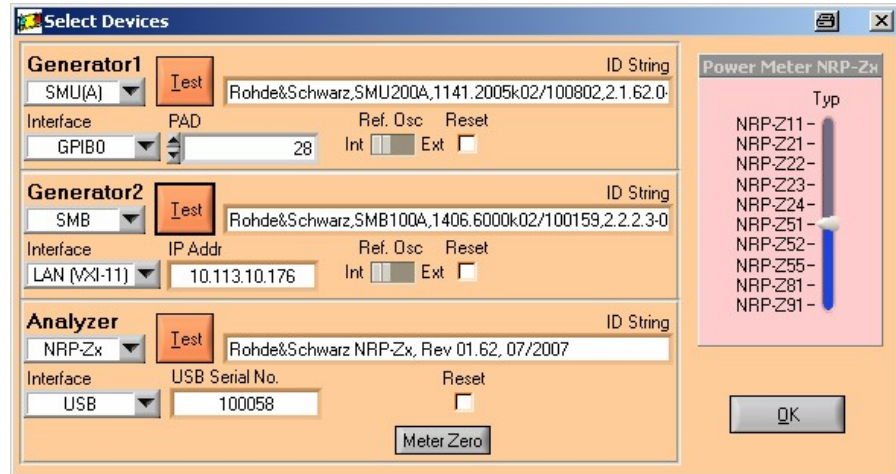


Fig. 7 Select Devices

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** list and enter the correct GPIB address. **TEST** will query the instrument's ID string and display it in the message box.

When the **RESET** checkbox is turned ON the instrument performs a reset as soon as the according **TEST** or **START** button (see fig. 2, p. 6) is pressed.

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 ->

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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 **INTERNAL** or **EXTERNAL** 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.

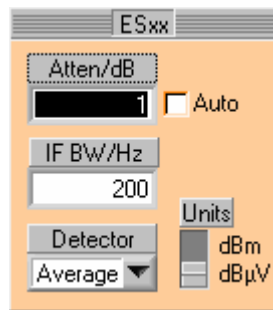


Fig. 8 ESPC Detector Setup

Configure Sweep Parameters

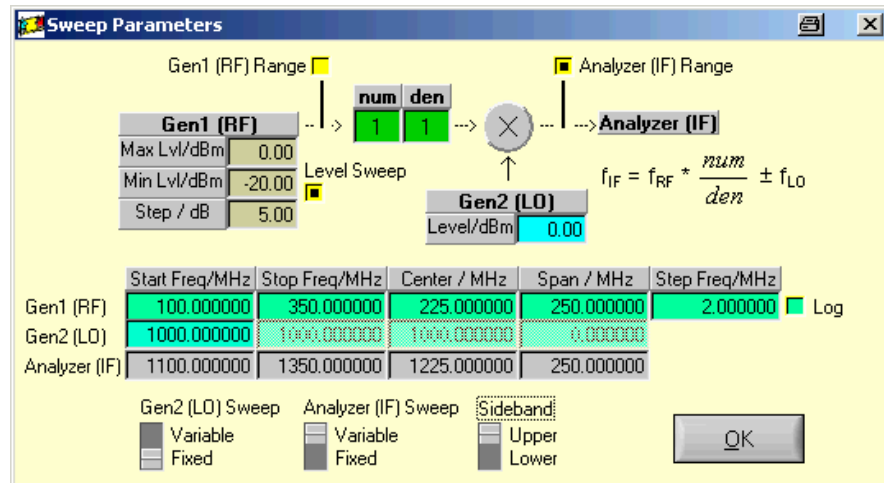


Fig. 9 Sweep Parameters

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 FREQUENCY** – Sweep start frequency. This value is changed, if CENTER or SPAN controls are used.
 - **STOP FREQUENCY** – 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.
 - **SPAN** – 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.
 - **SPAN** – 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.

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- **Generator2 (LO)** – The generator acting as local oscillator.
 - **LEVEL** – absolute LO level.
 - **START FREQUENCY** – LO start frequency. Is dimmed if GEN2 (LO) SWEEP is set to FIXED.
 - **STOP FREQUENCY** – LO stop frequency. Is dimmed if GEN2 (LO) SWEEP is set to FIXED.
 - **CENTER** – LO center frequency. This value is changed, if START FREQ or STOP FREQ controls are used.
 - **SPAN** – LO start frequency. This value is changed, if START FREQ or STOP FREQ controls are used.
- **ANALYZER (IF)** – Analyzer settings.
 - **START FREQUENCY** – Analyzer start frequency.
 - **STOP FREQUENCY** – 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.

- **SIDEBAND** – In case a mixer and a second generator are involved, the resulting analyzer frequency is $f_{IF} = f_{Gen1} * num / den + f_{Gen2}$ when the switch is set to **UPPER**. In case **LOWER** is chosen, the analyzer frequency results to $f_{IF} = |f_{Gen1} * num / den + f_{Gen2}|$.

Configure Graphics Display

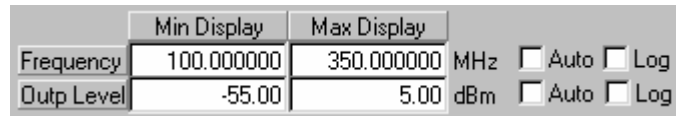


Fig. 10 Graphics Display

Set 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.

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. 11 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.
- **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.

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).*

7 Additional Information

Please contact TM-Applications@rsd.rohde-schwarz.com for comments and further suggestions.

8 Ordering Information

Signal Generator

R&S® SMU200A	(100 kHz to 3 GHz)	1141.2005.02
R&S® SMA100A	(9 kHz to 3 GHz)	1400.0000.02
R&S® SMB100A	(9 kHz to 6 GHz)	1406.6000.02
R&S® SMJ100A	(100 kHz to 6 GHz)	1403.4507.02
R&S® SMF100A	(1 GHz to 44 GHz)	1167.0000.02
R&S® SFU	(100 kHz to 3 GHz)	2110.2500.02
R&S® SML0x	(9 kHz to 3.3 GHz)	1090.3000.1x
R&S® SMP22	(10 MHz to 20 GHz)	1035.5005.22
R&S® SMRxx	(10 MHz to 60 GHz)	1104.0002.xx
R&S® SMV03	(9 kHz to 3.3 GHz)	1147.7509.13
R&S® SM300	(9 kHz to 3 GHz)	1147.1498.03

Test Receiver

R&S® ESCI	(9 kHz to 3 GHz)	1166.5950.03
R&S® ESIBxx	(20 Hz to 40 GHz)	1088.7490.xx
R&S® ESPIx	(9 kHz to 7 GHz)	1164.6407.xx
R&S® ESUxx	(20 Hz to 40 GHz)	1302.6005.xx
R&S® FSMRxx	(20 Hz to 50 GHz)	1166.3311.xx

Spectrum Analyzer

R&S® FSPxx	(9 kHz to 40 GHz)	1164.4391.xx
R&S® FSUxx	(20 Hz to 26.5 GHz)	1129.9003.xx
R&S® FSQxx	(20 Hz to 26 GHz)	1155.5001.xx
R&S® FSLx	(9 kHz to 6 GHz)	1300.2502.1x
R&S® FSUPxx	(20 Hz to 50 GHz)	1166.3505.xx
R&S® FS300	(9 kHz to 3GHz)	1147.0991.03

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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
R&S® NRP-Z11	(10 MHz to 8 GHz)	1138.3004.02
R&S® NRP-Z21	(10 MHz to 18 GHz)	1137.6000.02
R&S® NRP-Z22	Average Power Sensor	1137.7506.02
R&S® NRP-Z23	Average Power Sensor	1137.8002.02
R&S® NRP-Z24	Average Power Sensor	1137.8502.02
R&S® NRP-Z51	Thermal Power Sensor	1138.0005.02
R&S® NRP-Z52	Thermal Power Sensor	1138.0505.18
R&S® NRP-Z55	Thermal Power Sensor	1138.2008.02
R&S® NRP-Z81	Wideband Power Sensor	1137.9009.02
R&S® NRP-Z91	Average Power Sensor	1168.8004.02
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® CMU200	Univ.Radio Comm. Tester	1100.0008.xx
R&S® CMW	Communication Tester	



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