R&S®FSH20-N
Spectrum Analyzer
Operating Manual

MANUAL ISSUE

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Operating Manual

ROHDE&SCHWARZ

The Operating Manual describes the following R&S®FSH models:

- R&S FSH20-N (1314.2000.80)

Throughout this manual, products from Rohde & Schwarz are indicated without the ® symbol and the model designation, e.g. R&S®FSH is indicated as R&S FSH.

Table of Contents

Documentation Overview

The user documentation for the R&S FSH is divided as follows:

Manual

The Manual contains information for manual operation of the R&S FSH and for maintenance (service) of the R&S FSH.

It covers the following topics:

- overview of all elements of the front and rear panels
- basic information on how to set up the R&S FSH
- information on how to operate the R&S FSH in a network
- instructions on how to perform measurements
- instructions on how to set up and operate the R&S FSH in its various operating modes
- instructions on how to perform measurements with the R&S FSH
- instructions on how to work with the available software options and applications

Service Manual

The Service Manual provides information on maintenance.

It covers the following topics:

- instructions on how to perform a performance test
- instructions on how to repair the R&S FSH including a spare parts list

Software Manual for remote control

The Software Manual contains information for remote operation of the R&S FSH.

It covers the following topics:

- information about the SCPI command structure and syntax
- information on how to set up a remote connection with the R&S FSH
- information about command processing
- information about the status reporting system
- description of supported remote commands

Conventions Used in the Documentation

The following conventions are used throughout the R&S FSH Manual:

Typographical conventions

Convention	Description
“Graphical user interface elements”	All names of graphical user interface elements both on the screen and on the front and rear panels, such as dialog boxes, softkeys, menus, options, buttons etc., are enclosed by quotation marks.
“KEYS”	Key names are written in capital letters and enclosed by quotation marks.
Input	Input to be entered by the user is displayed in italics.
`File names, commands, program code`	File names, commands, coding samples and screen output are distinguished by their font.
"Links"	Links that you can click are displayed in blue font.
"References"	References to other parts of the documentation are enclosed by quotation marks.

Other conventions

- **Remote commands**: Remote commands may include abbreviations to simplify input. In the description of such commands, all parts that have to be entered are written in capital letters. Additional text in lower-case characters is for information only.

1 Safety Information

The product documentation helps you to use the R&S FSH safely and efficiently. Follow the instructions provided here and in the "Basic Safety Instructions" brochure.

Keep the product documentation nearby and offer it to other users.

Intended use

The R&S FSH is designated for the development, production and verification of electronic components and devices in industrial, administrative, and laboratory environments. Use the R&S FSH only for its designated purpose. Observe the operating conditions and performance limits stated in the data sheet.

Where do I find safety information?

Safety information is part of the product documentation. It warns you about the potential dangers and gives instructions how to prevent personal injuries or damage caused by dangerous situations. Safety information is provided as follows:

- The printed "Basic Safety Instructions" brochure provides safety information in many languages and is delivered with the R&S FSH.
- Throughout the documentation, safety instructions are provided when you need to take care during setup or operation.

The R&S FSH has been designed for lab operation as well as for service and maintenance applications in outdoor areas. Thus, the following rules apply in addition to or contrary to the "Basic Safety Instructions" brochure.

- The R&S FSH is protected against dripping water and dust (IP degree 51) and can thus be used in outdoor areas to a certain degree.
- The R&S FSH’s max. operating altitude is 4600 m above sea level and its max. transport altitude is 12000 m above sea level.

2 Introduction

Purpose and function capabilities of the R&S FSH

The R&S FSH spectrum analyzer is rugged, handy and designed for use in the field. Its low weight, its simple, well-conceived operation concept and the large number of measurement functions make it an indispensable tool for anyone who needs an efficient measuring instrument for outdoor work.

The R&S FSH is ideal for rapid, high-precision and cost-effective signal investigations while providing a large number of measurement functions. These functions allow the The R&S FSH to handle and extensive range of applications from the installation or maintenance of a transmitter station, to on-site fault location of RF cables as well as development and service applications.

Weighing only 3 kg, the R&S FSH is a handy instrument. All frequently used functions have their own function keys and are within fingertip reach. The brilliant color display is easy to read even under poor lighting conditions, and it has a monochrome mode for extreme conditions.

The capacity of the R&S FSH battery enables uninterrupted operation for up to 3 hours. The battery is changed within seconds.

Key facts

- Frequency range up to 20 GHz
- High sensitivity
- Low measurement uncertainty
- Measurement functions for all important measurement tasks related to the startup and maintenance of transmitter systems
- Rugged, splash-proof housing for rough work in the field
- Easy handling due to low weight (3 kg with battery) and easy-to-reach function keys
- Up to 6 markers, with marker measurement functions like frequency counter and noise power density
- Remote control via USB or LAN

3 Putting into Operation

This chapter assists you in using the R&S FSH for the first time.

It contains general information about the R&S FSH as well as information about the available connectors and the general system configuration.

3.1 Inspecting the R&S FSH

Before putting the R&S FSH into operation, check the packaging material and the instrument itself for visible damage. If it is damaged, immediately notify the carrier.

Also check if the contents and accessories are all part of the delivery.

Keep the original packing material and the box the R&S FSH is delivered in, at least until it has been tested electrically and mechanically. If the instrument needs to be transported or shipped at a later date, you can use the material to protect the control elements and connectors.

NOTICE

Risk of instrument damage during transportation and shipment

Insufficient protection against mechanical and electrostatic effects during transportation and shipment can damage the instrument.

- Always make sure that sufficient mechanical and electrostatic protection is provided.
- When shipping an instrument, the original packaging should be used. If this is not available, allow for sufficient padding to prevent the instrument from moving around inside the box. Pack the instrument in antistatic wrap to protect it from electrostatic charging.
- Secure the instrument to prevent any movement and other mechanical effects during transportation.

3.2 Warranty

The warranty period for the R&S FSH is 12 months from the date of delivery. The warranty expiration date is indicated on the type sticker at the rear panel of the instrument.

For more information on the warranty conditions for the R&S FSH refer to the terms of the delivery documents.

3.3 Calibration Interval

The recommended calibration interval for the R&S FSH20-N is 12 months.

3.4 List of Accessories

The following items are part of the shipment.

- R&S FSH20-N, Spectrum Analyzer

Accessories

- R&S HA-Z210, LAN Interface Cable
- R&S HA-Z211, USB Interface Cable
- R&S HA-Z220, Soft Carrying Bag
- External AC Power Supply
- Operating Manual
- CD-ROM with R&S InstrumentView software and documentation

3.5 List of Items Required

None

3.6 Checking the Items Furnished

The instrument may be equipped with both hardware and firmware options. In order to check if the software and hardware configuration corresponds to the configuration indicated on the delivery note, proceed as follows.

► Turn on the R&S FSH.

► Press the SETUP key.

► Press the "HW/SW Info".

The R&S FSH shows the characteristics of the currently installed hard- and software.

Checking if the installed options correspond to those indicated on the delivery note works similar.

► Turn on the R&S FSH.

► Press the SETUP key.

► Press the "Install Options".

The R&S FSH shows a list of the currently installed options and applications.

3.7 Maintenance and Cleaning

The R&S FSH does not require regular maintenance. Maintenance is essentially restricted to cleaning the R&S FSH. It is however advisable to check the nominal data from time to time.

NOTICE

Instrument damage caused by cleaning agents

Cleaning agents contain substances that may damage the instrument, e.g. cleaning agents that contain a solvent may damage the front panel labeling or plastic parts.

Never use cleaning agents such as solvents (thinners, acetone, etc), acids, bases, or other substances.

The outside of the instrument can be cleaned sufficiently using a soft, lint-free dust cloth.

The storage temperature range for the R&S FSH is specified in the data sheet.

Battery safety

Refer to the flyer about battery safety available on the CD-ROM that is part of the delivery.

Battery storage

The battery self-discharges while not in use. When storing the battery for an extended period of time, make sure to

- handle the battery carefully to avoid short circuits. Make sure that leads and terminals are insulated.
- keep the battery in the supplied packaging prior to use. The temperature should not exceed 30°C.
- store the battery at an initial state of charge between 15% and 50% of its capacity. When calculating the initial state of charge, consider
  - the maximum consumption of electronic devices
  - the self-discharge of the battery - the higher the state of charge, the higher the rate of self-discharge
- avoid a deep discharge of the battery. A deep discharge occurs when the state of charge falls below 5% of the battery's capacity.
- recharge the battery at least every six months.

Should the battery voltage be low or even 0 V, the battery protection circuit may have gone into a sleep mode. In that case, reset the battery with an approved charger.

3.8 Unpacking the R&S FSH

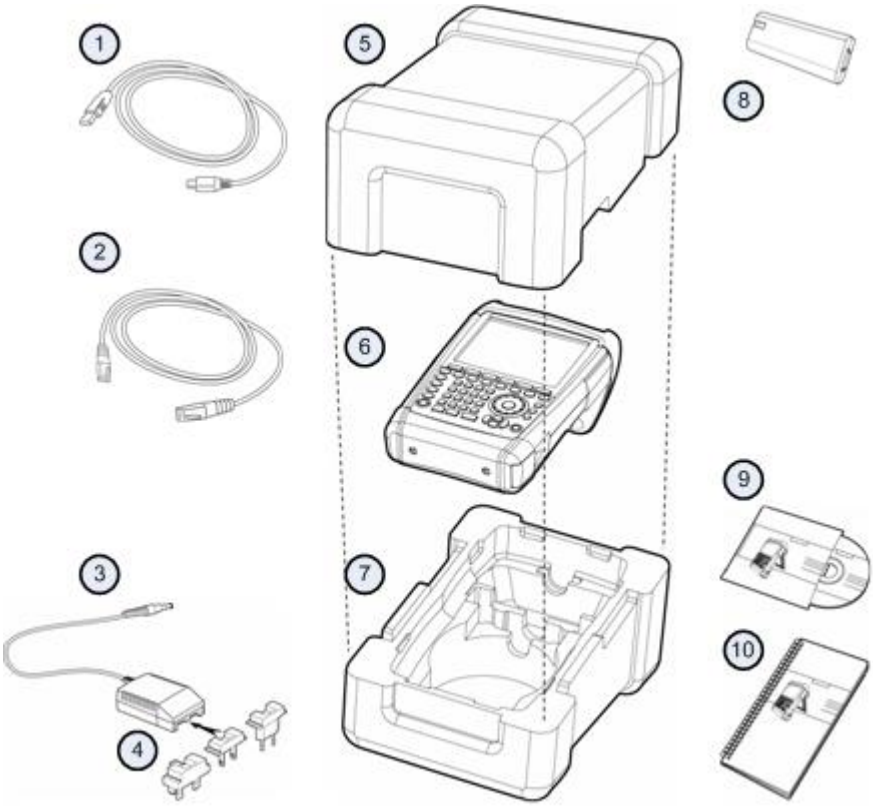
The R&S FSH is delivered in formfitting packaging. It consists of an upper and a lower shell. The two shells are held together by tape.

The packaging contains all accessories that are supplied with the instrument.

► Remove the tape and open the packaging.

► Remove the R&S FSH and its accessories.

► Remove the protective film from the screen.



1 USB cable
2 LAN cable
3 AC adapter
4 AC plug (country specific)
5 Upper shell
6 R&S FSH
7 Lower shell
8 Lithium ion battery
9 CD-ROM
10 Quick start guide

3.9 Overview of Controls

1 RF input (N-connector)
2 Headphone jack
3 BNC connectors (behind protective cap)
4 LAN and Mini USB ports (behind protective cap)
5 Softkey labels (on display)
6 Softkeys
7 Function keys
8 Alphanumeric keypad
9 Kensington lock
10 DC port
11 On/Off key
12 Entry keys
13 Unit keys
14 Cursor keys
15 Preset key
16 Rotary knob
17 Screenshot key
18 Setup key
19 Display
20 SD card slot / USB port (behind protective cap)
21 Tracking generator output (N-connector)
22 Power sensor jack

3.10 Setting up the R&S FSH

The R&S FSH has been designed for lab operation as well as for service and maintenance applications on-site.

Depending on the environment, you can adjust the viewing angle of the display and either lay it out flat or prop it up using the support on the back of the R&S FSH.

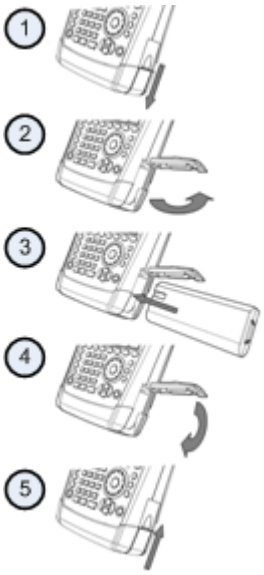
When laid out flat for operation from above, the R&S FSH is still tilted forward slightly because of the grip on its top. This position provides the optimum viewing angle for the display.

To allow easy operation from the front and still be able to read the display, you can swing out the support on the back of the R&S FSH.

For use on-site or service measurements, it is best to hold the instrument in both hands. All controls are easy to reach. It is also recommended to use the R&S HA-Z222 carrying bag in order to leave both hands free for work on the device under test (DUT).

You can also use the grip on the top of the R&S FSH to, for example, hang it from cabinet doors.

Before you turn on the R&S FSH, you should insert the lithium ion battery included in the delivery into the battery compartment. The battery compartment is located on the bottom right of the R&S FSH.



(1) Press a finger against the recessed grip and push the cover down.

(2) Open the cover.

(3) Insert the battery into the R&S FSH as far as it will go. The round side faces up and the grip is on the right side.

(4) Close the cover.

(5) Push it upward until it clicks fully into place.

You can operate the R&S FSH with the AC adapter or the battery. Both are included in the delivery.

3.10.1 Using the AC Adapter

Connect the AC adapter (R&S HA-Z201) to the DC port on the left side of the R&S FSH (1). Make sure to fully insert the plug into the port.

Depending on the system you need, firmly connect the appropriate plug included in the delivery (2) to the AC adapter.

Finally, connect the plug to an AC power outlet.

The voltage range of the AC power supply is 100 V to 240 V AC.

After the R&S FSH is supplied with power, you can turn it on with the button on the front panel.

NOTICE

Risk of instrument damage

- Use the power supply included in the delivery (R&S HA-Z201) only.
- AC supply voltage must be compatible to the voltage specified on the power supply unit.
- Attach the appropriate adapter to the power supply.

3.10.2 Battery Operation

The lithium ion battery has a capacity of approximately 4 Ah and allows operation of up to three hours when it is fully charged.

The actual operation time depends on the current charge status, the ambient temperature and the operating mode of the R&S FSH.

The R&S FSH shows the current charge status at the top of the display.

When fully charged, the battery icon is completely white. As the battery loses power, the battery icon will lose the white color until it gets red and starts to blink. When the icon starts to blink, the battery low level has been reached. For more information see "Power Settings" on page 37.

Note that the battery is not fully charged when it is dispatched. For battery operation you have to charge it first.

To charge the battery, connect the AC power adapter included in the delivery. For more information see "Using the AC Adapter" on page 18.

Charging time is about 2.5 hours when the R&S FSH is switched off. If it is switched on, the charging time is extended to about 3.5 hours, because the charging current is reduced by the power drain of the R&S FSH.

During operation in the field, you can also charge the battery with the R&S HA-Z202 car adapter (order no. 1309.6117.00). You can connect the car adapter to the corresponding DC port. With the car adapter, you are able to charge the R&S FSH via the car's cigarette lighter socket.

While charging, the R&S FSH displays an arrow within the battery charge status indicator at the top right of the display to show that it is connected to the power supply and is charging.

If the battery is fully charged, a plug icon is displayed instead of the battery icon.

You can set up the R&S FSH to automatically turn off if no input is made after a particular time period. The possible range is from 0 to 99 minutes. For more information see "Display Settings" on page 35.

In the default state, the automatic cut-off is inactive.

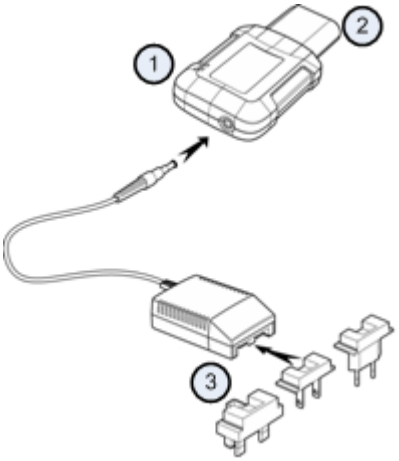
A replacement battery (R&S FSH-Z206) with a capacity of approximately 6 Ah and an operating time of 4.5 hours is available as an accessory. Charging time for the replacement battery is about 3.5 hours if the R&S FSH is switched off and about 4.5 hours if the R&S FSH is switched on.

Using an external battery charger

You can also use an external battery charger (R&S HA-Z203, order no. 1309.6123.00) to charge an additional replacement battery.

To charge the battery externally, put the battery into the external charger and supply it with power via the AC power adapter.

An orange LED (CHARGE) on the charger indicates the charging process. The LED turns off when the battery is fully charged. Instead a green LED (READY) turns on.



1 External charger R&S HA-Z203
2 Lithium ion battery R&S HA-Z204 or HA-Z206
3 Power supply unit R&S Z201 or car adapter R&S HA-Z202

WARNING

Turn off the R&S FSH while driving or while the engine is on.

Operation of the R&S FSH via the cigarette lighter socket while driving or while the engine is on is prohibited.

3.11 Connectors on the R&S FSH

The R&S FSH has several connectors. The connectors are either on the upper, left or right side.

3.11.1 RF Input

The RF input is located on the top of the R&S FSH.

Connect a cable or DUT to the RF input with an N connector. Use a cable to connect the DUT to the R&S FSH, if necessary.

Make sure not to overload the R&S FSH when a DUT is connected.

The maximum power that is permissible at the RF input is 20 dBm (or 100 mW).

The R&S FSH may be loaded with up to 30 dBm (or 1 W) for up to three minutes. If you apply 1 W for a longer period, the R&S FSH may be destroyed.

The RF input is protected from static discharges and voltage pulses by a limiting circuit.

WARNING

Risk of electrical shock

In order to avoid electrical shock the DC input voltage you must never exceed the value specified on the housing.

NOTICE

Risk of damage to the R&S FSH

To avoid damage to the coupling capacitor, input attenuator or the mixer, the DC input voltage must never exceed the value specified in the data sheet.

3.11.2 Tracking Generator Output

The tracking generator output is located on the top of the R&S FSH.

The tracking generator output power of the R&S FSH is 0 dBm nominal.

With an integrated step attenuator, you can reduce the tracking generator output power by a maximum of 40 dB in 1 dB steps.

NOTICE

Risk of damage to the R&S FSH

To avoid damage to the tracking generator output, the reverse voltage up to the voltage stated on the R&S FSH housing must not be exceeded.

3.11.3 Power Sensor Port

The connector for power sensors is located on the top of the R&S FSH.

The connector is configured especially for power sensors. It is used for both the power supply and data transfer via the power sensor interface.

Additionally, you can connect accessories like the R&S TS-EMF isotropic antenna (order no. 1158.9295.13) to the power sensor port.

3.11.4 Headphone Jack

The 3.5 mm connector for headphones is located on the top of the R&S FSH.

The internal impedance of the connector is approximately 10 Ohm.

3.11.5 AUX Input

The AUX input is located on the left side of the R&S FSH under a protective cap.

You can connect various accessories like the GPS receiver R&S HA-Z240 (order no. 1309.6700.02) to the AUX connector.

3.11.6 BNC Connectors

The BNC connectors are located on the left side of the R&S FSH behind a protective cap.

You can configure both BNC connectors for various applications. The names of the connections are embossed on the insides of the protective caps.

3.11.6.1 EXT TRIG / EXT REF

The first (upper) BNC connector is for application of an external trigger or an external reference signal.

The external trigger is only for input configuration. It controls the start of a measurement and has to be selected in the "Sweep" menu. The trigger threshold is similar to that of TTL signals.

The 10 MHz reference signal that you can apply is used for frequency synchronization. The level of the reference signal must be larger than 0 dBm. If the input is configured for the external reference and but no reference signal is present, the R&S FSH will show a warning in the display. This is to prevent users from carrying out a measurement without a valid reference.

For more information see "Configuring the R&S FSH" on page 30.

3.11.6.2 BIAS Port 1 / BIAS Port 2

When you use them as BIAS ports, the two BNC connectors are direct current inputs.

Active equipment under test can be supplied with power via the BIAS Port 1 and BIAS Port 2 direct current inputs. Direct current is supplied with the assistance of a suitable power adapter (600 mA max. / 50 V max.).

3.11.6.3 IF Output / Video Out

The second (lower) BNC connector can be used as an intermediary frequency output (21.4 MHz) or a video output.

NOTICE

Risk of damage to the R&S FSH

To avoid damage to the tracking generator output, never apply currents greater than 600 mA or voltages greater than 20 V to the BNC connectors if the BNC connectors are not configured as BIAS input ports.

If they are configured as BIAS ports, never apply currents greater than 600 mA or voltages greater than 50 V.

3.11.7 Mini USB and LAN Ports

The mini USB and LAN ports are located on the left side of the R&S FSH behind a protective cap.

You can connect the R&S FSH to a PC via USB or LAN and transfer data in both directions.

Configure the USB and LAN connection via the "Instrument Setup". For more information see "Configuring the R&S FSH" on page 30.

3.11.8 Mechanical Locking Device

A Kensington Lock can be anchored to the R&S FSH housing to secure the R&S FSH to a workstation mechanically.

3.11.9 DC Port

The DC port is located on the left side of the R&S FSH.

The R&S FSH is supplied with power by the AC/DC transformer power supply via the DC connector. You can also use the DC connector to charge the battery.

3.11.10 USB Port

The USB port is located on the right side of the R&S FSH behind a protective cap.

You can use the USB interface to connect a memory stick and store data sets or screenshots.

3.11.11 SD Card Slot

The SD Card slot is located on the right side of the R&S FSH behind a protective cap.

3.12 Managing Options

For special measurement tasks, you can equip the R&S FSH with various software options.

3.12.1 Enabling Options

To enable options, you have to enter a key code. The key code is based on the unique serial number of the R&S FSH.

► Press the SETUP key.

► Press the "Installed Options" softkey.

► Select the "Install Option..." item.

► Press the ENTER key.

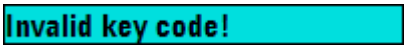
The R&S FSH opens an entry field to enter the option key.

► Enter the appropriate option key.

► Confirm the entry with the ENTER key.

If you have entered the correct code, the R&S FSH shows

If you have entered an incorrect code, the R&S FSH shows



► Enter the correct code again.

3.12.2 Checking Installed Options

In the "Setup" menu, the R&S FSH shows all options that are currently installed.

► Press the SETUP key.

► Press the "Installed Options" softkey.

The R&S FSH shows a list of all available options and the current status of the option:

- "Installed": the option is installed and working.
- "Installed Portable": the option is installed and working, the license is a portable one.
- "Removed: <option key>": indicates that a portable license has been removed from the R&S FSH and is ready to be transferred to another R&S FSH.

3.12.3 Managing Options with the R&S License Manager

If you are using the R&S FSH in a local area network (LAN), you can manage firmware options with a web browser (e.g. Microsoft Internet Explorer or Mozilla Firefox).

For more information on connecting the R&S FSH to a LAN see "Connecting the R&S FSH to a PC" on page 40.

After you have connected the R&S FSH, open your web browser.

► Enter the IP address of the R&S FSH in the address bar of the web browser.

The browser will access the R&S License Manager. In this part of the R&S License Manager, you can install and activate licenses on the R&S FSH.

This page features three areas.

- The first area shows the details of the connected device including the device ID and the IP address.

- The second area provides functionality to install and activate licenses.

  - Install Registered License Keys and Activate Licenses

    Follow this link if you have purchased a registered license. Registered licenses only work in combination with a specific device ID.

  - Register Licenses, Install License Keys and Activate Licenses

    Follow this link if you have purchased an unregistered license. Unregistered licenses are not connected to a specific device ID.

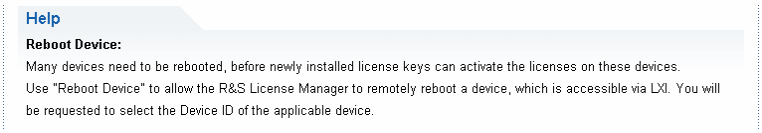
  - Reboot Device

    Follow this link to reboot the R&S FSH.

  - 

    Opens a detailed online help to the corresponding topic.

- The third area provides hints on using the license manager if you move the mouse over one of the options.



If you already have one or more R&S FSH that are equipped with options, you can also manage the licenses of these options on the license manager web page.

► Press the Manage Licenses button.

The browser will access another part of the R&S License Manager. In this part of the license manager you can manage licenses already installed on your R&S FSH.

This page features two areas.

- The first area provides functionality to manage licenses already installed on a device.

  - Register Licenses

    Follow this link if you have purchased an unregistered license. Unregistered licenses only work in combination with a specific device ID.

  - Unregister License

    Follow this link if you have installed a portable license. Portable licenses work in combination with several device IDs. However, you have to unregister it on one device before you can use it on another.

  - Move Portable License

    Follow this link if you want to move a portable license. Moving a portable license is possible without unregistering the license.

  - 

    Opens a detailed online help to the corresponding topic.

- The second area provides hints on using the R&S License Manager if you move the mouse over one of the options.

After you have followed one of the links, follow the instructions displayed in the browser. If you encounter any problems during the licensing procedure, you can access the online help at any time with the  icon. The online help contains an extensive description of all functionality that the license manager features.

3.13 Configuring the R&S FSH

In the "Instrument Setup" dialog box, the R&S FSH provides various general settings that are independent of the operating mode of the R&S FSH.

► Press the SETUP key.

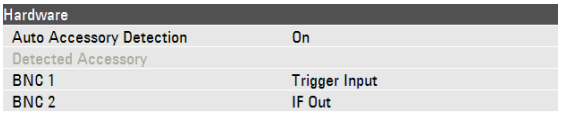
► Press the "Instrument Setup" softkey.

The R&S FSH opens the corresponding dialog box.

► Select the item you want to modify with the rotary knob or the cursor keys.

3.13.1 Hardware Settings

The hardware settings contain settings that control internal and connected hardware.



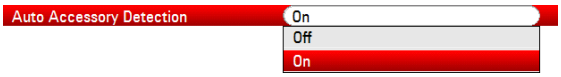
Using auto accessory detection

If you are using any accessories while working with the R&S FSH, the R&S FSH is able to identify the connected hardware.

► In the "Instrument Setup" dialog box, select the "Auto Accessory Detection" item.

► Press the ENTER key.

A dropdown menu to turn automatic detection on and off opens.



► Select "On" to turn automatic accessory detection on.

► Confirm the selection with the ENTER key.

If active, the R&S FSH automatically detects accessories connected to the R&S FSH.

The name of the accessory is displayed in the "Detected Accessory" field.

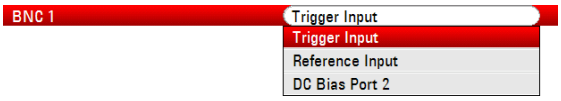
Configuring the BNC connectors

You can use the BNC connectors for various applications. For more information, see "BNC Connectors" on page 24.

► In the "Instrument Setup" dialog box, select the "BNC 1" item.

► Press the ENTER key.

A dropdown menu to select the BNC connector function opens.



► Select the application that you require.

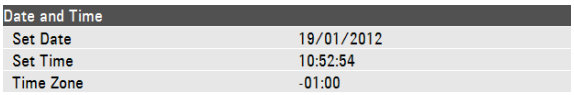
► Confirm the selection with the ENTER key.

The way to configure the second BNC connector is similar.

► Instead of selecting the "BNC 1" item, select the "BNC 2" item.

3.13.2 Date and Time Configuration

The R&S FSH has an internal clock that can apply a date and time stamp. In the "Instrument Setup" dialog box, you can set both date and time.

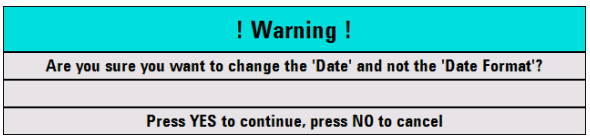


Setting the date

► In the "Instrument Setup" dialog box, select the "Set Date" item.

► Press the ENTER key.

The R&S FSH asks you to confirm the change of the date.



► Enter the date you want with the numeric keys. The sequence depends on the date format.

► Confirm the entry with the ENTER key.

Setting the time

► In the "Instrument Setup" dialog box, select the "Set Time" item.

► Press the ENTER key.

► Enter the time you want with the numeric keys.

► Confirm the entry with the ENTER key.

After you have entered the time, the R&S FSH verifies the validity of the time. If not valid, it sets the next valid time.

Selecting the time zone

► In the "Instrument Setup" dialog box, select the "Time Zone" item.

► Press the ENTER key.

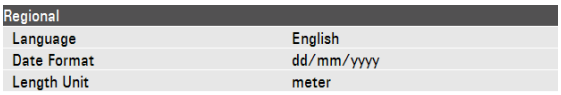
► Enter a positive or negative time offset relative to the system time with the numeric keys.

► Confirm the entry with the ENTER key.

After you have confirmed the time zone, the R&S FSH adjusts the displayed time accordingly.

3.13.3 Regional Settings

The regional settings allow you to select a different language, date format and length unit.



Selecting the language

The R&S FSH provides several languages for the user interface.

► In the "Instrument Setup" dialog box, select the "Language" item.

► Press the ENTER key.

A dropdown menu opens to select the language.

► Select one of the languages from the dropdown menu.

► Confirm the selection with the ENTER key.

Setting the date format

The R&S FSH provides several date formats.

► In the "Instrument Setup" dialog box, select the "Date Format" item.

► Press the ENTER key.

A dropdown menu opens to select the date format.

► Select the date format you are most comfortable with from the dropdown menu.

► Confirm the selection with the ENTER key.

Setting the length unit

► In the "Instrument Setup" dialog box, select the "Length Unit" item.

► Press the ENTER key.

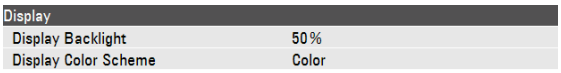
A dropdown menu opens to select the length unit.

► Select the length unit you are most comfortable with from the dropdown menu.

► Confirm the selection with the ENTER key.

3.13.4 Display Settings

The display settings configure the display of the R&S FSH.



The display of the R&S FSH is a TFT color LCD display.

Indoors, its brightness depends on the intensity of the backlight. To strike a balance between battery operating time and screen display quality, set the backlight intensity to the minimum brightness needed.

To optimize the viewing angle, adjust the color settings. To achieve maximum contrast, the screen can be switched from color display to black-and-white display. Under extreme light conditions, it can be of advantage to select the high-contrast monochrome display.

Adjusting the display backlight

► In the "Instrument Setup" dialog box, select the "Display Backlight" item.

► Press the ENTER key.

► Enter the backlight intensity you want with the numeric keys.

The backlight intensity is a percentage from 0% to 100% with 100% being the brightest.

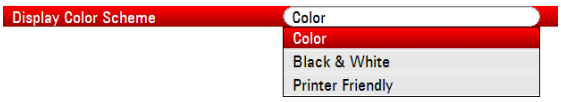
► Confirm the entry with the ENTER key.

Selecting the display color scheme

► In the "Instrument Setup" dialog box, select the "Display Color Scheme" item.

► Press the ENTER key.

A dropdown menu opens to select the color scheme.

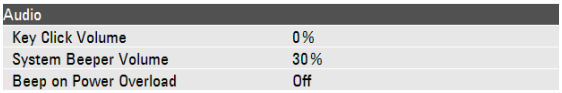


► Select "Color" to set the display to color display or "Black & White" to set it to monochrome display. The "Printer Friendly" color scheme inverses the colors.

► Confirm the selection with the ENTER key.

3.13.5 Audio Settings

The audio settings control the audio output of the system.



Setting the key click volume

The key click volume sets the volume of the sound that the R&S FSH produces when you press a key or softkey.

► In the "Instrument Setup" dialog box, select the "Key Click Volume" item.

► Press the ENTER key.

► Enter the volume you want with the numeric keys.

The key click volume is a percentage from 0% to 100% with 100% being the loudest.

► Confirm the entry with the ENTER key.

Setting the system beeper volume

The system beeper volume sets the volume of the system beeper of the R&S FSH, used for example if a message box turns up.

► In the "Instrument Setup" dialog box, select the "System Beeper Volume" item.

► Press the ENTER key.

► Enter the volume you want with the numeric keys.

The system beeper volume is a percentage from 0% to 100% with 100% being the loudest.

► Confirm the entry with the ENTER key.

Turning audio output in case of a power overload on and off

In case the R&S FSH detects an overload at one of its inputs, you can configure it to make a sound.

► In the "Instrument Setup" dialog box, select the "Beep on Power Overload" item.

► Press the ENTER key.

► Turn the beeper on or off.

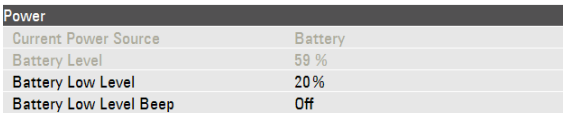
If on, the R&S FSH will make a sound every time it detects an overload.

► Confirm the entry with the ENTER key.

3.13.6 Power Settings

The power settings contain settings that configure the power supply of the R&S FSH.

The "Current Power Source" shows the source the R&S FSH is currently powered by.



Setting the battery low level

When the battery low level is reached, the battery symbol in the title bar turns red and starts blinking.

► In the "Instrument Setup" dialog box, select the "Battery Low Level" item.

► Press the ENTER key.

► Enter the threshold you want in percent of a fully charged battery with the numeric keys.

► Confirm the entry with the ENTER key.

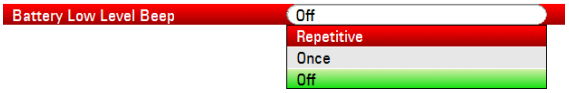
The current battery level is displayed in the "Battery Level" line.

Turning audio output in case of battery low level state on and off

The R&S FSH also allows you to turn on an audio signal that sounds if the battery reaches its low level state.

► In the "Instrument Setup" dialog box, select the "Battery Low Level Beep" item.

► Press the ENTER key.



► Select either "Repetitive" or "Once" to turn the audio signal on.

If you have selected "Once", the R&S FSH will beep once if the battery runs out of power. For a continuous beep, select "Repetitive".

► Select "Off" to turn off the beeper.

3.13.7 Self Alignment

The self alignment calibrates the instrument settings for vector network analysis. During the self alignment, the R&S FSH generates new factory calibration data and overwrites the old factory calibration.

For the self alignment a short circuit (Short), an open circuit (Open) and 50 Ohm match (Load) is required. In addition, a through connection must be established with an appropriate cable.

When you are in Network Analyzer mode, the "Calibration Kit" item becomes available and you can select the calibration kit that you want to use for the self alignment.

► In the "Instrument Setup" dialog box, select the "Calibration Kit" item.

The R&S FSH opens a dialog box to select a calibration kit.

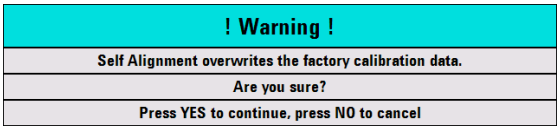
► Select the required calibration kit.

Performing self alignment

► In the "Instrument Setup" dialog box, select the "Self Alignment" item.

► Press the ENTER key.

The R&S FSH initiates the self alignment procedure and shows a warning message box.



If you press "Yes", the self alignment begins. Follow the instructions shown on the screen.

If you press "No", the R&S FSH aborts the self alignment.

3.13.8 PIN Code Protection

The R&S FSH features a PIN protection system with several security levels that protects the R&S FSH from unauthorized access. If PIN protection is on, you have to enter the PIN whenever you turn the R&S FSH on.

For more information, please refer to the Operating Manual.

3.13.9 Resetting the R&S FSH

You can either preset the R&S FSH or reset it to factory settings.

Presetting the R&S FSH

The PRESET key resets the R&S FSH to the default setup of the currently active operating mode.

This allows you to define a new configuration based on defined measurement parameters without parameters from a previous measurement unintentionally still being active.

► Press the PRESET key.

Resetting the R&S FSH

A "Reset to Factory Settings" resets the R&S FSH to the factory defaults.

During a reset, the R&S FSH restores the original configuration. It also deletes all customized datasets (limit lines, standards, channel tables, cable models etc.). Instead, it will reinstall all the datasets that have been available after delivery.

NOTICE

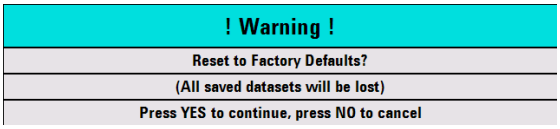
Risk of data loss

All datasets you have saved will be deleted during a factory reset.

► In the "Instrument Setup" dialog box, select the "Reset to Factory Settings" item.

► Press the ENTER key.

The R&S FSH initiates the reset procedure and shows a warning message box.



If you press "Yes", the R&S FSH performs the reset. During the reboot, it shows an information window.

If you press "No", the R&S FSH aborts the reset.

3.14 Connecting the R&S FSH to a PC

The R&S FSH comes with the R&S InstrumentView software package. This software package features several tools that allow you to document measurement results or create and edit limit lines or channel tables among other things.

Note that .NET Framework 2.0 or higher is required to run the software properly.

You can set up a connection between the R&S FSH and R&S InstrumentView either via its LAN port or its mini USB port.

You have to install the R&S InstrumentView software on the PC before you are able to establish a connection.

► Run the CD-ROM delivered with the R&S FSH.

► Navigate to the "Software" section and start the setup file.

► Follow the instructions on the screen.

Alternatively, you can download the latest R&S InstrumentView from the R&S FSH product homepage.

Firewall settings

If no connection can be established between the software and the R&S FSH after successful configuration, check the firewall settings on your PC.

3.14.1 Connecting the R&S FSH in a LAN

You can connect the R&S FSH directly to the PC with the LAN cable that is supplied with the R&S FSH. The LAN port is located on the left side of the R&S FSH behind a protective cap.

You can set up the LAN connection in the "Instrument Settings" dialog box.

For a direct connection between a PC and the R&S FSH, DHCP (Dynamic Host Configuration Protocol) has to be turned off (which is the default state).

► In the "Instrument Setup" dialog box, select the "DHCP" item.

► Press the ENTER key.

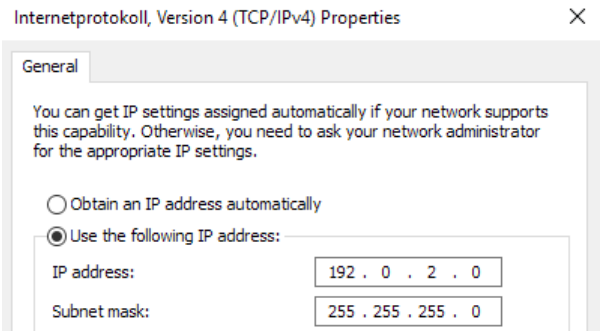
A dropdown menu to select the DHCP state opens.

► Turn DHCP on or off as required.

Setting an IP address and subnet mask

To establish a connection, the PC and the R&S FSH have to be in the same subnet.

► Identify the subnet mask of your PC, for example in the Microsoft Windows "TCP/IP Properties".



► In the "Instrument Setup" dialog box, select the "Subnet Mask" item.

► Press the ENTER key.

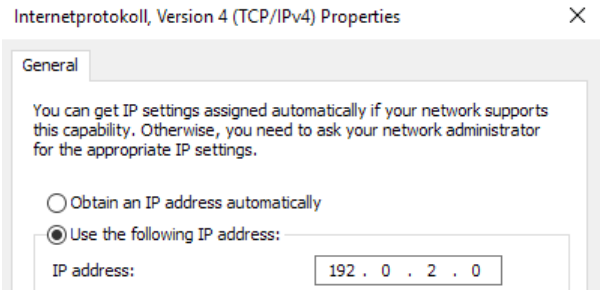
► Enter the subnet mask of the PC with the numeric keys.

► Confirm the entry with the ENTER key.

After you have matched the subnet mask, you can define the IP address. When both devices are in the same subnet, the first three digits of the IP address are usually the same ('192' in the example below).

Example	
IP address PC	192.0.2.0
IP address R&S FSH	192.0.2.10

► Identify the IP address of your PC, for example in the Microsoft Windows "TCP/IP Properties".



► In the "Instrument Setup" dialog box, select the "IP Address" item.

► Press the ENTER key.

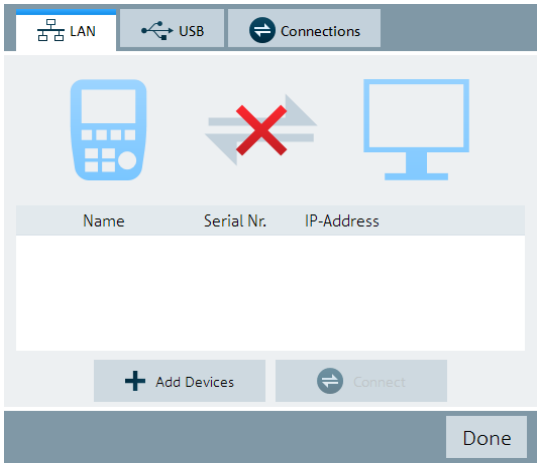
► Enter the IP address of the PC with the numeric keys.

► Confirm the entry with the ENTER key.

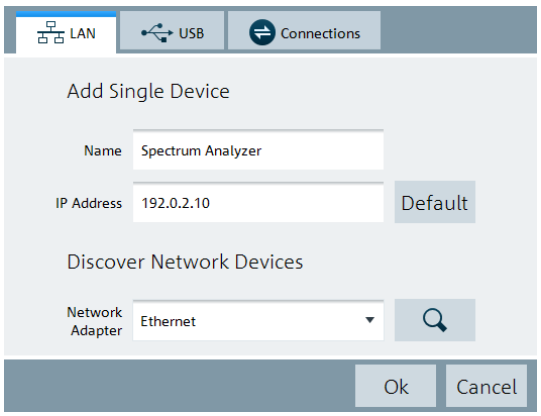
Configuring the R&S InstrumentView software

► Start R&S InstrumentView.

► Select the "LAN" tab in the "Instrument Connect" dialog box.



► Press the "Add Devices" button to create a new network connection.

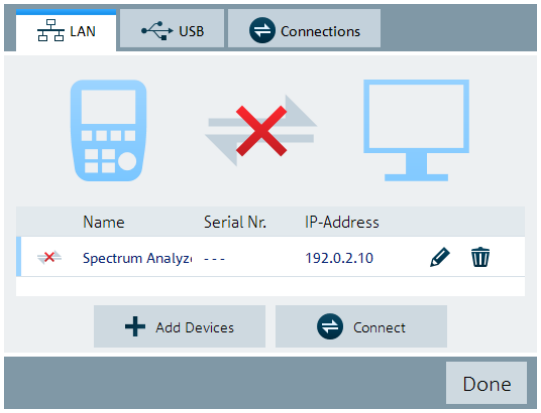


► Specify a name for the new network connection, for example "Spectrum Analyzer".

► Enter the IP address for the R&S FSH (in this case 192.0.2.10)

► Confirm the entry with the "OK" button.

The connection is now created, configured and appears in the device list.



► Select the new connection labeled "Spectrum Analyzer".

► Press the "Connect" button to establish the connection.

3.14.2 Connecting the R&S FSH in an Existing LAN

You can either draw the R&S FSH IP address automatically from the DHCP server or manually assign a fixed address. With manual allocation, a fixed IP address and subnet mask must be assigned to the R&S FSH as described in the chapter on direct LAN connection. Then the R&S InstrumentView software has to be configured as described with the assigned IP address.

Free IP address

Contact your IT system manager to get a free IP address.

In networks with a DHCP server, DHCP permits automatic allocation of the network configuration to the R&S FSH connected via LAN cable. For this purpose, DHCP has to be active on the R&S FSH.

DHCP is off by default. Turn it on like this:

► In the "Instrument Setup" dialog box, select the "DHCP" item.

► Press the ENTER key.

A dropdown menu to select the DHCP state opens.

► Select "On" to activate DHCP.

The R&S FSH is now allocated an IP address and the subnet mask by the DHCP server. This can take several seconds.

The IP address and subnet mask are automatically set in the corresponding input fields and are no longer available for editing.

Configure the R&S InstrumentView software with the IP address and subnet mask as defined by the DHCP server. For more information see "Connecting the R&S FSH in a LAN" on page 41.

3.14.3 Connecting the R&S FSH via USB

Alternatively, you can connect the R&S FSH to the PC with the USB cable that is supplied with the delivery. The Mini USB interface is located on the left side of the R&S FSH behind a protective cap.

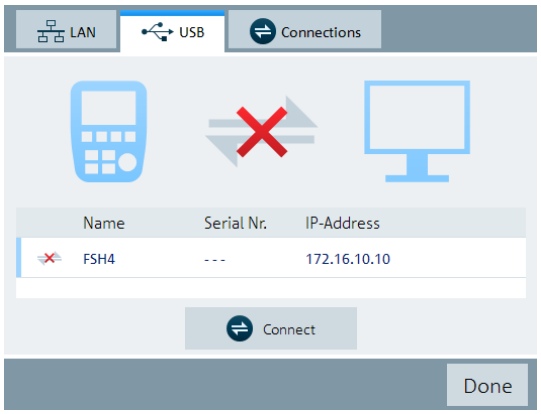
When you connect the R&S FSH to a computer for the first time, Windows tries to install the new hardware automatically. The required drivers are installed along with the R&S InstrumentView software package.

When the drivers have been found on your system and the hardware has been successfully installed, Windows shows a corresponding message.

► Connect the R&S FSH via the Mini USB port to your computer.

► Start R&S InstrumentView on the PC.

► Select the "USB" tab in the "Instrument Connect" dialog box.



► Select the R&S FSH connection.

► Confirm the selection with the "Connect" button.

R&S FSH IP address

The R&S FSH internally emulates a LAN connection. The IP address displayed by R&S InstrumentView for the USB connection is for information only. It is fixed to 172.16.10.10 and cannot be changed.

4 Getting Started

This chapter provides a short overview of the first steps of the measurements you can perform with the R&S FSH.

4.1 Using the Spectrum Analyzer

This chapter provides a short overview of the first steps of the measurements you can perform with the R&S FSH.

4.1.1 Attenuating the Signal

You can attenuate the signal to a suitable level either manually or automatically.

In case of automatic attenuation, the level of attenuation at the RF input depends on the current reference level. The R&S FSH provides two ways of automatic attenuation.

For the highest possible sensitivity it provides the "Auto Low Noise" attenuation mode. For the lowest possible intermodulation, it provides the "Auto Low Distortion" mode.

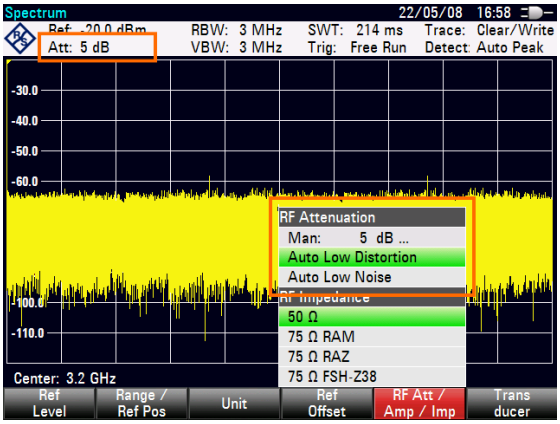
The main difference between the two modes is that the attenuation level is 5 to 10 dB higher in case of "Auto Low Distortion" than it is for "Auto Low Noise". In the default state, "Auto Low Distortion" is active.

► Press the AMPT key.

► Press the "RF Att/Amp/Imp" softkey.

► Select either the "Auto Low Noise" or "Auto Low Distortion" menu item.

The R&S FSH shows the current attenuation level in the hardware settings overview ("Att.:" caption). The currently active menu item has a green background.



You can also set the attenuation manually. The R&S FSH provides attenuation in the range from 0 to 30 dB in 5 dB steps.

► Press the AMPT key.

► Press the "RF Att/Amp/Imp" softkey.

► Select either the "Man: 0 dB" menu item.

The R&S FSH opens an input field to define the attenuation.

The R&S FSH provides several methods to fill in input fields:

- directly with the number keys
- with the rotary knob
- with the cursor keys

While you can enter any number you want with the number keys, using the rotary knob or the cursor keys is coupled to a certain step size in most cases.

If you use the rotary knob to change the attenuation, for example, the step size is 5 dB.

► Enter the attenuation you need.

Again, the R&S FSH shows the current attenuation level in the hardware settings overview ("Att.:" caption).

4.1.2 Measuring CW Signals

A basic task for spectrum analyzers is to measure the level and frequency of sinewave signals. The following examples illustrate an effective way of performing these measurements.

A signal generator, e.g. R&S SMBV provides the signal source.

Test setup

Connect the RF output of the signal generator to the RF input of the R&S FSH.

Signal generator settings:
Frequency: 700 MHz
Level: -30 dBm

Measuring the level

► Press the PRESET key.

The R&S FSH is reset to its default state.

The R&S FSH displays the frequency spectrum over its full frequency span. At 700 MHz, the generator signal is displayed as a vertical line.

To analyze the generator signal at 700 MHz in more detail, reduce the frequency span.

► Press the FREQ key.

The R&S FSH opens an input field to enter the center frequency.

► Enter a center frequency of 700 MHz.

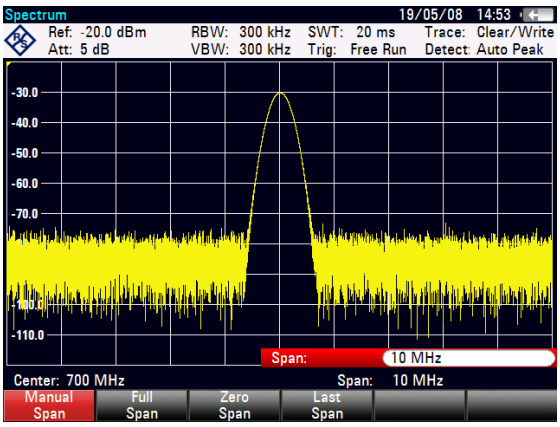
The signal is now in the center of the display.

► Press the SPAN key.

The R&S FSH opens an input field to specify the span.

► Enter a span of 10 MHz.

The R&S FSH now displays the generator signal with a higher resolution.



Setting the reference level

The level at the top of the measurement diagram is called the reference level. To obtain the best dynamic range from the R&S FSH, you should use its full level range. That means that the maximum level value should be at or close to the top of the measurement diagram (= reference level).

► Press the AMPT key.

► Press the "Ref Level" softkey.

► Enter a reference level of -30 dBm.

The R&S FSH reduces the reference level by 10 dBm.

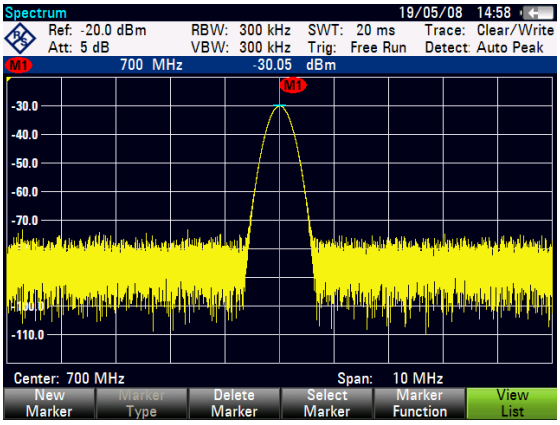
The maximum trace value is close to the maximum scale value of the measurement diagram. The increase in the displayed noise floor is minimal. The difference between the signal maximum and the displayed noise (i.e. the dynamic range) has, however, been increased.

Using Markers

The R&S FSH has markers to read out signal levels and frequencies. Markers are always positioned on the trace. Both the level and frequency at their current positions are displayed on the screen.

► Press the MARKER key.

The R&S FSH activates a marker and puts it on the maximum value on the trace.



A blue vertical line represents the position of the marker on the horizontal axis (e.g. the frequency).

A small blue horizontal dash represents the marker position on the vertical axis (e.g. the level).

The R&S FSH shows the coordinates of all markers in a table above the diagram.

Measuring the frequency

The trace consists of 631 measurement points (frequency points). The marker is always positioned on one of these measurement points. The R&S FSH calculates the marker frequency from the frequency of the measurement point, the center frequency and the frequency span that have been set. The measurement-point resolution, and consequently the accuracy of the marker frequency readout, therefore depend on the frequency span that has been selected.

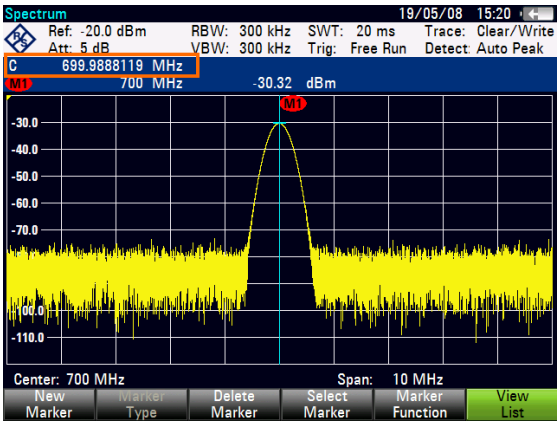
The R&S FSH has a frequency counter to increase the accuracy of the marker-frequency readout. It stops the sweep at the marker position, counts the frequency and then continues the sweep.

► Press the MARKER key.

► Press the "Marker Function" softkey.

► Select the "Frequency Count" menu item.

The marker label "M" turns to a "C" to indicate an active frequency counter. When the frequency counter is active, the resolution of the frequency readout is always 1 Hz, regardless of the span. The accuracy is determined by the internal reference frequency which is far more exact than that of the pixel-oriented marker readout.



4.1.3 Measuring Harmonics

A spectrum analyzer is ideal to measure harmonic levels or harmonic ratios, because it can resolve different signals in the frequency domain.

With marker functions, you can speed up measurement tasks like that.

A signal generator, e.g. R&S SMBV provides the signal source.

Test setup

Connect the RF output of the signal generator to the RF input of the R&S FSH.

Signal generator settings:
Frequency: 100 MHz
Level: -20 dBm

Detecting harmonics

► Press the PRESET key.

The R&S FSH is reset to its default state.

The R&S FSH displays the frequency spectrum over its full frequency span. At 700 MHz, the generator signal is displayed as a vertical line.

In addition you can see the harmonics as smaller vertical lines at frequencies that are multiples of 100 MHz.

To measure the second harmonic ratio, narrow down the span.

► Press the FREQ key.

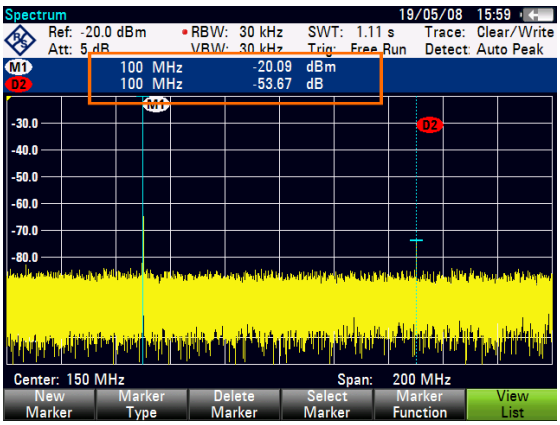
► Press the "Start Freq" softkey.

► Enter a start frequency of 50 MHz

► Press the "Stop Freq" softkey.

► Enter a stop frequency of 250 MHz.

The R&S FSH displays the frequency spectrum in the range from 50 MHz to 250 MHz. This frequency range visualizes the signal itself at 100 MHz and the second harmonic at 200 MHz.



To measure the harmonic ratio, set the marker on the signal and a delta marker on the second harmonic.

► Press the MARKER key.

The R&S FSH sets a marker on the trace maximum. The trace maximum corresponds to the signal.

► Press the "New Marker" softkey.

The R&S FSH activates a delta marker and places it on the next trace maximum. This corresponds to the second harmonic.

The harmonic ratio is the vertical distance of the marker and the delta marker. The R&S FSH displays this value in the marker table (see picture above).

5 Operating the R&S FSH

This chapter provides information about basic functionality and about the user interface of the R&S FSH.

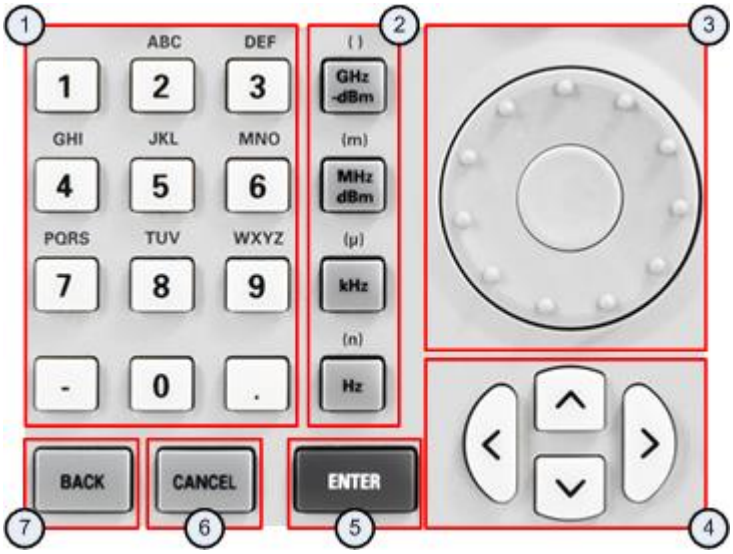
5.1 Screen Layout and Elements

The following figure shows the screen layout in cable and antenna test operating mode. It shows all elements that are the same for all operating modes of the R&S FSH. Screen layouts that show specifics for each operating mode or measurement are provided in the corresponding sections of this manual.

1	Measurement information	12	Horizontal axis labeling
2	Date and time	13	Active menu item
3	Battery status	14	Unavailable menu item
4	Hardware settings	15	Currently selected menu item
5	GPS information	16	Selectable menu item
6	Marker information	17	Input field
7	Reference position	18	Vertical axis labeling
8	Invalid trace indicator and overload information	19	Currently selected softkey
9	Diagram	20	Selectable softkey
10	Marker	21	Active softkey function
11	Trace	22	Unavailable softkey

5.2 Means of Input

The user interface of the R&S FSH provides several elements for you to input data.



1 Alphanumeric keys
2 Unit keys
3 Rotary knob
4 Cursor keys
5 Enter key
6 Cancel key
7 Back key

5.2.1 Using the Alphanumeric Keys

Using the alphanumeric keys, you can enter numeric values or characters. The alphanumeric keys include the numbers from 0 to 9, the alphabet, a minus sign and dot.

If you have to enter a numeric value, press the corresponding key. In case of numeric values, each key covers just the number that's printed on it.

You can enter negative values with the minus sign key and enter values that contain decimal places with the dot key.

If the R&S FSH asks you to enter a character or you need to enter a character (e.g. file names), the key assignment changes. Each key covers one number and more than one character with the first choice being a character. If you need to enter a character, press the key several times until the character you require is selected. The following table shows an overview of character assignment.

You can correct entries with the BACK key. The BACK key moves the cursor one position backwards and deletes the character that was in that place.

Key	1.	2.	3.	4.	5.	6.	7.	8.	9.
1	1								
2	a	b	c	2	A	B	C		
3	d	e	f	3	D	E	F		
4	g	h	i	4	G	H	I		
5	j	k	l	5	J	K	L		
6	m	n	o	6	M	N	O		
7	p	q	r	s	7	P	Q	R	S
8	t	u	v	8	T	U	V		
9	w	x	y	z	9	W	X	Y	Z
0	0	blank	_						
-	-								
.	.								

5.2.2 Confirming and Cancelling Entries

Depending on the input you have made, there are several ways to confirm entries.

- Values without unit or values that have a fixed unit that you enter in an input field can be confirmed with the ENTER key or by pressing the center of the rotary knob.

  Alternatively, you can confirm such an entry by pressing the softkey that has opened the input field in question.

- Values that have flexible units, like frequency or time, can be confirmed with one of the unit keys.

  If you confirm a such a value with the ENTER key, the R&S FSH always uses the smallest possible unit (e.g. Hz).

- If you have opened a submenu or input field by accident, you can close it without making any changes with the CANCEL key.

5.2.3 Using the Rotary Knob

Using the rotary knob, you can do several things.

- The rotary knob works like a cursor key in dialog boxes or softkey submenus. In that case you can navigate to one of the items with the rotary knob. If the dialog box covers more than one screen page, it also scrolls through the dialog box.

  Turning it to the right corresponds to a downward movement. Moving it to the left to an upward movement.

- The rotary knob increases or decreases any kind of numeric value if an input field is active.

  Turning it to the right corresponds to an increase, turning it to the left to a decrease of a numeric value.

  In most cases, the rotary knob changes numeric values with a fixed step size.

- The rotary knob moves markers around.

  Again the step size is fixed.

- Pressing the rotary knob has the same effect as pressing the ENTER key as it confirms an entry or selection.

5.2.4 Using the Cursor Keys

Using the cursor keys, you can do several things.

- The cursor keys navigate through dialog boxes or softkey submenus.
- The up and down keys increase or decrease any kind of numeric value if an input field is active.

  The cursor keys change numeric values with a fixed step size.
- The up and down keys move markers around.

  The step size is fixed.
- The left and right keys move the cursor in an input field in the corresponding direction.

5.2.5 Remote Operation

Remote operation is a way to control the R&S FSH from another device like a PC. To use the R&S FSH this way, you have to establish a connection between both devices via the LAN or USB interfaces of the R&S FSH.

The product range of the R&S FSH provides several tools for remote operation.

Remote control

The R&S FSH allows you to control its functions with remote control commands that are compatible to the SCPI standard.

The software manual is available in electronic format (pdf) on the CD-ROM that is delivered with the R&S FSH.

Remote desktop with R&S InstrumentView

The remote desktop is an application provided by the R&S InstrumentView software. You can use it to access and control the R&S FSH in the R&S InstrumentView environment.

While the R&S FSH is running and connected to the control computer, the screen contents and control elements (keys, softkeys etc.) are displayed. Thus, you can operate the R&S FSH just like the hardware itself.

► Connect the R&S FSH to the control computer.

► Start the R&S InstrumentView software.

► Select "Instrument" > "Remote Display".

The software opens the remote display to operate the R&S FSH remotely.

5.3 Presetting the R&S FSH

Before you prepare a measurement, it is recommended to preset the R&S FSH. During a preset, the R&S FSH resets all settings to their default state. Restoring the default configuration has the advantage that old settings do not affect measurements.

The default setup is specific to the operating mode.

► Press the PRESET key.

The R&S FSH restores its default setup.

You can also define your own default settings via a dataset. These are then loaded after pressing the PRESET key instead of the factory default.

► Press the SETUP key.

► Press the "User Preferences" softkey.

► Select the "Preset Dataset" menu item.

The R&S FSH opens a dialog box to select the dataset that contains the settings you would like to have as the preset settings.

► Select the dataset with the settings you want.

► Select the "Preset Mode" menu item in the "User Preferences" dialog box.

► Select the "User Defined" item from the dropdown menu.

The R&S FSH now loads the settings of the dataset after you press PRESET.

5.4 Configuring Measurements

The "Measurement Setup" dialog box provides an overview of the current configuration of the R&S FSH. In addition, you can also change the configuration in this dialog box.

► Press the SETUP key.

► Press the "Measurement Setup" softkey.

► Select one of the menu items and change the settings as you like.

Note that the contents of the "Measurement Setup" dialog box are customized for each operating mode of the R&S FSH. Therefore, the order and number of displayed settings is different in each mode.

5.5 Configuring the Instrument

The "Instrument Setup" dialog box contains functionality that is independent of the operating mode.

For more information see the "Quick Start Guide".

Protecting the R&S FSH with a PIN

The R&S FSH features a PIN protection system that protects the R&S FSH from unauthorized access. If PIN protection is on, you have to enter the PIN whenever you turn the R&S FSH on.

The protection system provides three levels of security.

- PIN made up of four digits
- Master PIN made up out of 10 digits.

  When you enter the wrong PIN three times in a row, you have to enter the Master PIN to unlock the R&S FSH. By default, the Master PIN is the same as the OEM Master PIN, but you can define a User Master PIN.

  If you unlock the R&S FSH with the User Master PIN, the PIN is automatically reset to its default value ('0000').

- OEM Master PIN code made up out of 10 digits.

  If you

  - have defined a User Master PIN and enter the wrong User Master PIN five times in a row or
  - have not defined a User Master PIN and enter the wrong PIN three times in a row,

  the only remaining way to unlock the R&S FSH is with the OEM Master PIN. The OEM Master PIN is a fix PIN that you receive upon delivery of your R&S FSH. You cannot change the OEM Master PIN.

NOTICE

OEM Master PIN

Make sure not to lose the OEM Master PIN that is delivered with the R&S FSH and keep it in a safe place away from the instrument itself.

If you use PIN protection and forget the User PINs, the OEM Master PIN is the only way you can unlock and use the R&S FSH.

If you unlock the R&S FSH with the OEM Master PIN, the PIN and, if defined, the User Master PIN are automatically reset to their default values:

'0000' (PIN) and '0000000000' (User Master PIN).

If you fail to unlock the R&S FSH with the OEM Master PIN, the R&S FSH will force a reboot of the software until you enter the correct OEM Master PIN.

Firmware update

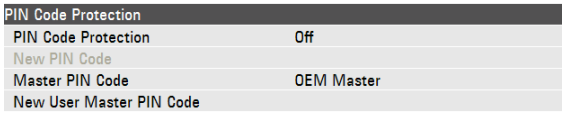
If the R&S FSH is protected with a PIN, a firmware update is only possible after you have entered the correct PIN.

In the initial state after delivery, PIN protection is turned off. So if you want to protect the R&S FSH, you have to turn it on manually.

► Press the SETUP key.

► Press the "Instrument Settings" softkey.

The R&S FSH shows the "Instrument Settings" dialog box.



► Select the "PIN Code Protection" menu item.

► Press ENTER

The R&S FSH opens an input field to define a new PIN.

► Enter a 4-digit PIN.

The R&S FSH opens an input field to confirm the PIN.

► Enter the 4-digit PIN again.

If the PIN confirmation was successful, the R&S FSH shows a corresponding message and activates PIN protection. In that case, you have to enter the PIN every time the R&S FSH boots.

If the PIN confirmation was not successful, the R&S FSH shows a corresponding message and does not activate PIN protection. In that case repeat the last steps.

You can change the PIN any time you want.

► Select the "New PIN Code" menu item.

The R&S FSH opens an input field to define a new PIN.

► Enter the new PIN.

► Confirm the new PIN.

The R&S FSH changes the PIN accordingly.

You can define a User Master PIN the same way. By default, the User Master PIN is the OEM Master PIN as shown in the "Instrument Settings" dialog box.

► Select the "Master PIN Code" menu item.

The R&S FSH opens an input field to define a User Master PIN.

► Enter a 10-digit number for the User Master PIN.

The R&S FSH opens an input field to confirm the User Master PIN.

► Confirm the PIN.

The R&S FSH shows a message if the change was successful or not.

► Alternatively, select the "User Master PIN Code" menu item and enter a 10-digit PIN in the input field that opens.

5.6 Taking Screenshots

You can take and store a screenshot of the current screen anytime with the key.

► Press the key.

The R&S FSH takes a screenshot.

If available, the R&S FSH stores the screenshot on an external storage device (USB memory stick or SD card). If both are connected, the R&S FSH uses the SD card.

If no external device is available, the R&S FSH stores the screenshot in its internal memory (if there is enough left). In that case you can transfer the pictures with the R&S InstrumentView software to your computer.

Saving screenshot and dataset at the same time

Depending on the "Capture" settings available in the "User Preference" menu, using the key also saves a dataset in addition to the screenshot.

For more information see "Managing Datasets" on page 66.

Screenshot file name

All screenshots get a default file name "Screenshot####". The files also get numbers (####) in ascending order, beginning with 0000. You can select a default file name and start number in the "User Preference" menu.

► Press the SETUP key.

► Press the "User Preference" softkey.

► Select the "Default Filename" and "File Name Counter Starts At" items and assign a file name and number as you wish.

Screenshot file format

The file format of screenshots is either *.png or *.jpg, depending on your configuration in the "User Preference" menu.

► Press the SETUP key.

► Press the "User Preference" softkey.

► Select the "Capture Screen Format" item to select the screenshot file format.

Previewing screenshots

If you want to make sure if a screenshot you took contains the wanted information, you can preview screenshots on the R&S FSH.

► Press the SAVE/RECALL key.

► Press the "Recall Screenshot" softkey.

The R&S FSH opens a dialog box to select a screenshot for the preview.

5.7 Saving Events

The R&S FSH provides functionality that automatically saves measurement information if a certain situation or event occurs.

Saving events is possible in all operating modes.

► Press the SETUP key.

► Press the "User Preference" softkey.

► Select the "Save on Event" menu item.

► Select "On" from the "Save on Event" dropdown menu.

The R&S FSH turns on automatic event recognition. You can select one of several events that trigger the storage of measurement data.

Data types

You can select several data types to save when an event occurs.

- A screenshot of the sweep that contains the event (.png or .jpg file)
- A dataset of the sweep that contains the event (.set file)

► Press the SETUP key.

► Press the "User Preference" softkey.

► Select the "Capture Screen" or the "Capture Dataset" menu item and turn it on or off.

If on, the corresponding information is included in the saved data.

Timing of the data capture

Note that the R&S FSH evaluates the measured data after a sweep is done and thus detects and saves an event only after a sweep has been completed.

Event types

To use the "Save on Event" functionality, you have to select an event type that triggers the capture of the selected data. The R&S FSH supports several event types.

► Press the SETUP key.

► Press the "User Preference" softkey.

► Select the "Event Source" menu item and select an event type from the dropdown menu.

- Time interval

  Saves measurement data every <x> seconds.

  You can define the duration of the time interval via the "Time Interval" menu item.

Single sweeps and sweep time

Note that it is not possible to save measurement data every <x> seconds in single sweep mode, because the R&S FSH only performs one sweep and then stops.

Note also that the time interval must be longer than the sweep time. If the time interval would be shorter, the R&S FSH would not be able to save data, because a sweep has to be complete before the R&S FSH is able to save the data.

- Limit failure

  Saves measurement data if a limit line is violated. (not supported by Geotagging mode yet)

  The R&S FSH provides different modes for handling limit check failures. You can select one via the "Limits Save Mode"

  - Start on failure: starts to save measurement data if a limit line is violated.
  - Stop on failure: stops to save measurement data if a limit line is violated.
  - Save only failure: saves only the sweeps that actually fail a limit check.

- Every sweep

  Saves the data of all measurement sweeps that are performed.

Storage device

To use the "Save on Event" functionality, you need an SD card or USB stick to store the data on. The internal memory would probably not be sufficient.

► Press the SETUP key.

► Press the "User Preference" softkey.

► Select the "Recording Storage" menu item.

► From the dropdown menu, select the storage device you prefer (SD card or USB device)

5.8 Managing Datasets

The R&S FSH provides functionality to manage (save, restore etc.) datasets available in its internal memory or an external storage device.

Datasets

Basically, the R&S FSH supports various types of datasets. The instructions below primarily describe managing datasets that you create on the R&S FSH during measurements, for example measurement results and configurations. Note that these datasets have the file extension `.set`.

Datasets with the file extension `.set` are an image of measurement results and configurations. Thus, you can subsequently reproduce the context of the measurement.

You can use datasets for documentation, for example, or use them for a more detailed analysis later on (for example with the R&S InstrumentView software). Note that datasets also contain calibration data if calibration has been performed.

Templates

The R&S FSH also supports various other types of datasets (or templates). Such templates mainly contain additional requirements for a particular measurement, like limit lines or channel tables.

Creating and editing these templates is only possible with the functionality provided by the R&S InstrumentView software package. Note that the file extension depends on the application of the template. For example, a template containing a channel table has the extension `.chntab`.

For more information on working with templates refer to the documentation of the R&S InstrumentView software package.

Data synchronization

The R&S InstrumentView features a data synchronization that matches the data available on the R&S FSH and that on the computer with the R&S InstrumentView installation.

► Select "Instrument" > "Synchronization".

The software opens another dialog box to control synchronization.

By default, the software synchronizes a selected set of data, depending on the synchronization direction.

- Synchronization from PC to R&S FSH: "To Remote" button

  Updates all files on the R&S FSH that have been created or edited with the R&S InstrumentView software package (cable models, limit lines, transducers, channel tables etc.).

- Synchronization from R&S FSH to PC: "To Local" button

  Updates all files on the PC that have been created on the R&S FSH (datasets, screenshots and wizard results).

- Synchronization in both directions: "Synchronize" button

  Updates all files on both the R&S FSH and the PC.

Removing outdated files

When you turn on "Remove Orphans", the software removes all files from the R&S FSH that it cannot find on the PC.

5.8.1 Saving Datasets

The R&S FSH allows you to save the data that is currently analyzed at any time.

► Press the SAVE/RECALL key.

The R&S FSH opens the file manager.

► Press the "Save" softkey.

The R&S FSH opens the "Save Dataset" dialog box.

1 Available datasets and folder structure
2 Dataset name input field
3 Remaining memory on selected data storage device
4 File manager softkey menu

The folder structure shows all available data storage devices. Possible storage devices are the internal memory of the R&S FSH, an SD card or a memory stick.

The default storage device depends on which devices are connected to the R&S FSH.

- If an SD card is connected, datasets are always stored there first.
- If a memory stick is connected, datasets are stored there only if no SD card is connected.
- The internal memory is used only if neither SD card or memory stick are connected.

The internal memory provides approximately 20 MB of data, therefore the number of datasets you save on the R&S FSH is limited. Each dataset needs about 100 kB of memory, but this value can vary.

If you are using an external storage device, the number of datasets you can save is limited only by the size of the storage device.

The R&S FSH shows the remaining memory on the storage device in the dialog box.

► Select the storage device you want to save the data to.

► Select the folder you want to save the data to.

► Enter a file name in the corresponding input field.

The default file name for datasets is "Dataset###.set" with a new number in ascending order for each new dataset. The file extension for datasets is `.set`.

If you enter another name, the R&S FSH uses that name and assigns a new number to the file name if you save the data set the next time. This function allows you to assign consecutive dataset file names without entering a new name every time you want to save a dataset.

You can enter the file name with the alphanumeric keypad. Each key covers more than one character. To get the character you want, press the key in question the appropiate number of times.

Instead of entering a file name character by character, you can also put a name together using the quick naming feature. For more information see "Quick Naming of Datasets" on page 70.

► Press the "Save" softkey.

The R&S FSH saves the dataset.

5.8.1.1 Alternative Ways to Save Datasets

The R&S FSH provides alternative and more comfortable ways to save datasets.

Using the key

You can configure the key to take a screenshot as well as saving a dataset.

► Press the SETUP key.

► Press the "User Preference" softkey.

► Select the "Capture Dataset" item and turn it on.

If on, pressing the key saves a dataset of the current measurement.

Saving events

You can configure the R&S FSH to save a dataset when an event occurs.

► Press the SETUP key.

► Press the "User Preference" softkey.

► Select the "Capture Dataset" item and turn it on.

If on, the R&S FSH saves a dataset of the current measurement if an event occurs. For more information on events see "Saving Events" on page 64.

5.8.1.2 Renaming File Names

If necessary, you can rename files or file directories directly on the R&S FSH.

- ► Enter the "File Manager".
- ► Select the file or directory you want to rename.
- ► Press the "Select Action" softkey.
- ► Select the "Rename" menu item.

  The R&S FSH opens an input field to change the name of the file.

5.8.1.3 Quick Naming of Datasets

The R&S FSH provides a quick naming feature that speeds up the process of naming a file.

Putting together a file name

Basically, using the quick naming feature is a way of compiling a file name by putting one or more predefined text modules or terms together in a logical way.

The various terms are combined in a table, each cell of which contains one term. The table consists of 120 cells. You can define the contents of each cell freely.

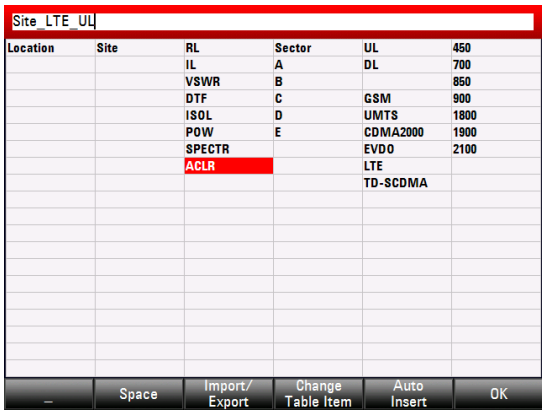
- ► Press the SAVE/RECALL key.
- ► Press the "Save" softkey.
- ► Press the "Quick Naming" softkey.

  The R&S FSH opens a dialog box that contains the terms.
- ► Select the term you want to add with the cursor keys.
- ► Press ENTER to add the term to the file name.

  The current file name is displayed in the line above the table.

  So, if you perform, for example, an ACLR measurement of an uplink LTE signal at a certain location, you might want that information in the file name:

  'Site_LTE_UL_ACLR'



- ► Press the "OK" softkey to exit the quick naming table.

  After you have exited the table, the file name appears in the "Save as:" field in the "Save Dataset" dialog box. If necessary, you can then add additional characters.

Note that by default, the R&S FSH adds a term without separators between each term. If you need a separator between the term, you can add a blank space or an underscore.

► After having added a term, press the "_" softkey or the "Space" softkey.

Or to add a separator automatically upon adding a term.

► Press the "Auto Insert" softkey.

► Select the "Off" menu item to add no separator, the "_" menu item to add an underscore or the "Space" menu item to add a blank space.

Designing a quick naming table

The firmware of the R&S FSH already has some basic mobile communication terms in the table. However, you can add up to 120 terms to the table.

► Press the SAVE/RECALL key.

► Press the "Save" softkey.

► Press the "Quick Naming" softkey.

► Select one of the table cells with the cursor keys.

► Press the "Change Table Item" softkey.

The R&S FSH opens an input field to define a term for the cell.

► Define a term with the number keys and confirm the term with ENTER.

The R&S FSH adds the term to the table.

You can create and edit quick naming tables with the R&S InstrumentView software package and then transfer them into the internal memory of the R&S FSH.

► In the "Quick Naming" softkey menu, press the "Import" softkey.

► Select the "Import Quick Naming Table" menu item.

The R&S FSH opens a dialog box to select a file to import.

The same way, you can also export a quick naming table.

► In the "Quick Naming" softkey menu, press the "Export" softkey.

► Select the "Export Quick Naming Table" menu item.

5.8.1.4 Converting Dataset File Types

The functionality of the R&S InstrumentView software allows you to convert a dataset of the file type *.set into the *.csv format.

The conversion is possible with a command line option for the InstrumentView.exe file.

The general syntax you have to use is:

```
InstrumentView.exe -csv "<InputDataset.set>" "<DestinationFile.csv>"
```

Note that you have to use quotation marks for the file name if it contains blank spaces.

Example:

```
InstrumentView.exe -csv 'Dataset.set' 'Dataset.csv'
```

Renames the file `Dataset.set` into `Dataset.csv`.

Environment variables

The command line option only works if you execute the command from the installation folder of R&S InstrumentView software.

Otherwise, you have to set a "Path" environment variable to the destination of the location of the .exe file.

You can access the environment variable via the MS Windows control panel.

"Start Menu" ⇨ "Control Panel" ⇨ "System" ⇨ "Advanced System Settings"

⇨ "Advanced" tab

⇨ "Environment Variables" button ⇨ "System Variables" ⇨ "Path"

► Add a new variable with the installation path of the software.

The default installation path is

- C:\Program Files\Rohde-Schwarz\InstrumentView\ (32-bit Windows)
- C:\Program Files (x86)\Rohde-Schwarz\InstrumentView\ (64-bit Windows)

If necessary, change the path as required.

5.8.2 Restoring Datasets

You can preview and load previously saved measurement results with the recall function of the R&S FSH. This function also provides easy access to previous measurement settings so that you do not have to set up the R&S FSH again.

► Press the SAVE/RECALL key.

The R&S FSH opens the file manager.

► Select the dataset you want to use.

The R&S FSH restores the configuration that the dataset contains.

By default, the most recently saved dataset is highlighted. If you need another dataset, navigate to the folder or storage device that contains the dataset you need.

5.8.2.1 Previewing a Dataset

The R&S FSH provides a preview of datasets. The preview is like a screenshot and lets you take a quick look at that measurement and its settings. The R&S FSH does not yet activate the measurement settings of that dataset.

► Browse through the available datasets and select the one you want.

► Press the "Recall" softkey.

The R&S FSH shows a preview of the measurement contained in the selected dataset. The preview shows the measurement results as well as the measurement settings.

► Use the rotary knob to browse the previews of all datasets available in the selected folder.

► Press the "Exit" softkey to return to the "Recall Dataset" dialog box.

5.8.2.2 Loading a Dataset

If you find a dataset whose settings you need for your current measurement task, you can load it.

► Press the "Activate" softkey.

The R&S FSH loads the dataset in question and adjusts its measurement settings to those of the dataset.

5.8.2.3 Quick Recall of Instrument Settings

For regular measurement tasks, the R&S FSH allows quick access to previously saved datasets by linking a particular dataset to one of the softkeys.

Assigning a dataset to one of the softkeys

► Press the SETUP key.

The R&S FSH opens the setup menu.

► Press the "User Preference" softkey.

The R&S FSH opens the User Preference Setup menu.

In this menu you can customize the name of one of the softkeys F1 to F6 and assign a dataset to a specific softkey for quick access to that dataset. By default, the name of the label is "User-Pref 1" to "User-Pref 6".

► Select one of the User Key Labels F1 to F6.

► Customize the name of the softkey by entering a new one with the alphanumeric keys, e.g. 'user label 1'.

The first word of the key label is displayed in the first row of the label, the rest in the second row. If a label is too long to be displayed, it is truncated. If you enter no label, the softkey will be inactive.

► Select the User Key Dataset corresponding to the customized User Key Label F1 to F6.

The R&S FSH opens the file manager and displays a list of available datasets.

► Select the dataset you want to assign to the softkey.

The R&S FSH returns to the User Preference Setup menu. The dataset is now assigned to the softkey.

Recalling a dataset

► Press the USER key.

► Press one of the softkeys F1 to F6 in the menu.

Note that the label of the softkeys depends on the settings made in the User Preference Setup menu.

The R&S FSH immediately activates the dataset assigned to that softkey.

5.8.3 Deleting Datasets

If you have to delete a dataset, you can do so with the file manager.

► Press the SAVE/RECALL key.

► Press the "File Manager" softkey.

The R&S FSH opens the file manager.

► In order to delete a single dataset, press the "Select Action" softkey. Select "Delete" and the dataset currently selected is deleted after your confirmation.

In order to delete multiple data sets, the respective datasets have to be marked first.

► Press the "Mark" softkey to mark files for deletion

► Select the dataset you'd like to delete.

► Mark the data sets with the ENTER key.

The selected data sets should be checked in the "Status" column.

Repeat the selection by moving the cursor with the rotary knob or the cursor key and marking more data sets with the ENTER key.

► Press the "Select Action" softkey.

► Select the "Delete" menu item and confirm with the ENTER key or the "Select Action" softkey.

Before deleting the data set, the R&S FSH shows a warning message that you need to confirm. After confirming the deletion process the R&S FSH deletes the selected data sets from its memory.

5.9 Updating the Firmware

Refer to the release notes. The release notes include instructions on how to perform a firmware update.

5.10 Installing Firmware Options

You can equip the R&S FSH with several firmware options to enable additional operating modes or special measurements.

6 Spectrum Analyzer Mode

The default operating mode of the R&S FSH is the spectrum analyzer. The spectrum analyzer provides the functionality to perform measurements in the frequency domain, e.g. to identify the power of signals.

6.1 Performing Spectrum Measurements

In addition to basic spectrum measurements, the R&S FSH provides several specific measurements. These measurements, also in combination with one of the available accessories, allow you to perform advanced and more complex measurement tasks.

6.1.1 Basic Spectrum Measurements

Basic spectrum measurements determine the spectrum of a signal in the frequency domain or keep track of a signal in the time domain. They provide a basic overview of the input signal characteristics.

Frequency domain

In the frequency domain, the R&S FSH analyzes the input signal characteristics over a particular span. You can use it, for example, to obtain basic measurement results like peak levels and the shape of the spectrum.

The horizontal axis shows the frequency, the vertical axis shows the signal levels.

The measurement in the frequency domain is the default measurement mode.

Time domain

In the time domain, the R&S FSH analyzes the characteristics of a signal at a particular frequency over time. The span during time domain measurements is 0 (zero span mode). You can use time domain measurements, for example to monitor the characteristics of a signal.

The horizontal axis shows the time, the vertical axis shows the signal levels.

To perform a time domain measurement, you have to set the span to zero manually.

6.2 Configuring Spectrum Measurements

6.2.1 Configuring the Horizontal Axis

The FREQ key contains all necessary functions to configure the horizontal axis for spectrum measurements.

The contents of the menu depend on the currently selected measurement.

Usually, the horizontal axis contains frequency information in spectrum mode. You can specify the frequency in terms of the center frequency or by defining a start and stop frequency for a particular span.

If you know the frequency of the signal you are measuring, it is best to match the center frequency to the signal's frequency. If you are investigating signals, e.g. harmonics, that are within a particular frequency range, the best option is to enter a start and stop frequency to define the span.

6.2.1.1 Defining the Center Frequency

The center frequency represents the frequency at the center of the horizontal axis in the diagram area.

► Press the FREQ key.

  The R&S FSH opens the frequency menu.

  When you press the FREQ key, the R&S FSH automatically opens an input field to define the center frequency. If the input field is inactive, you can open it with the "Center Freq" softkey.

► Enter the center frequency you need.

  The frequency you have entered becomes the new center frequency.

While adjusting the center frequency, you may obtain a value that is outside the R&S FSH maximum span. If this happens, the R&S FSH automatically reduces the span.

6.2.1.2 Defining a Frequency Step Size

If you set the center frequency with the rotary knob or the cursor keys, the distance of each step that you take depends on the span. With the rotary knob, the smallest possible step is a pixel. As the trace consists of 631 pixels, each step is equal to 1/630 of the span. With the cursor keys, the step is 10% of the span or one division of the grid.

You can set another step size.

► Press the FREQ key.

► Press the "CF Step Size" softkey.

The R&S FSH opens a submenu that contains possible step sizes.

- 0.1 x Span

  The step size equals 10% of the span or 1 division of the horizontal axis.

- =Center

  The step size equals the center frequency.

  This step size is ideal for measurements on harmonics. When you increase or decrease the center frequency, the center frequency automatically moves to the next harmonic.

- Manual…

  Define any step size you want.

  This step size makes it easy to investigate a spectrum with frequencies at constant intervals.

► Select the step size you need from the menu.

The R&S FSH adjusts the step size accordingly.

If you set the step size to 10% of the span or to the center frequency, the R&S FSH sets the step size internally. Manually defining the step size opens an input field to define the step size.

6.2.1.3 Setting a Frequency Offset

For measurements on frequency converters such as satellite downconverters, it is often convenient to reference the results to the frequency prior to conversion. For this purpose, the R&S FSH offers a frequency offset that arithmetically shifts the center frequency to higher or lower frequencies. Thus, the R&S FSH displays the input frequency of the DUT.

Positive frequency offset is possible in the range from 1 Hz to 100 GHz, in steps of 1 Hz. The maximum negative frequency offset depends on the start frequency you have set. The start frequency, taking into account the frequency offset, is always ≥ 0 Hz.

► Press the FREQ key.

► Press the "Freq Offset" softkey.

The R&S FSH opens an input field to set the frequency offset.

► Enter the frequency offset you need.

The R&S FSH adds the frequency offset to the center frequency you have set. A red dot at the center frequency display indicates that a frequency offset has been set.

6.2.1.4 Defining a Start and Stop Frequency

Defining a start an stop frequency is best suited for example for measurements on harmonics or signals whose exact frequency is unknown.

► Press the FREQ key.

► Press the "Start Freq" softkey.

The R&S FSH opens an input field to define the start frequency.

► Enter the start frequency you need.

► Set a stop frequency with the "Stop Freq" softkey.

The R&S FSH adjusts the horizontal axis according to your input, beginning with the start frequency and ending with the stop frequency.

If you have entered a stop frequency that is outside the maximum frequency range, the R&S FSH sets the stop frequency to the possible maximum.

The label of the horizontal axis changes from "Center" and "Span" to "Start" and "Stop".

6.2.1.5 Setting the Span

The span is the frequency range around the center frequency that a spectrum analyzer displays on the screen. The span you should select depends on the signal and the measurement that you are performing. A rule of thumb is that it should be at least twice the bandwidth occupied by the signal.

The available span for frequency domain is 100 Hz to 20 GHz

If you set a span of 0 Hz (zero span), the R&S FSH performs measurements in the time domain.

► Press the SPAN key.

When you press the SPAN key, the R&S FSH automatically opens an input field to define the span. If the input field is inactive, you can open it with the "Manual Span" softkey.

► Enter the span you need.

The R&S FSH adjusts the span of the horizontal axis.

If you have to switch between full span and a smaller span, you can do so without having to enter the numeric values.

► Press the SPAN key.

► Press the "Full Span" softkey.

The R&S FSH displays the spectrum over its entire frequency range.

► Press the "Last Span" softkey.

The R&S FSH restores the span that you have set just before displaying the entire frequency range.

Time domain measurements

You can also activate time domain measurements without having to enter the value manually. When measuring in the time domain, the span is 0 Hz. In that state, the R&S FSH measures the signal at the current center frequency only. Instead of displaying the spectrum, the R&S FSH shows the signal power over a certain time period. The horizontal axis becomes the time axis. The display always starts at 0 s and stops after the currently set sweep time.

► Press the SPAN key.

► Press the "Zero Span" softkey.

The R&S FSH sets a span of 0 Hz and performs the measurement in the time domain.

6.2.2 Configuring the Vertical Axis

All relevant settings to configure the vertical axis are available in the amplitude menu. You can access it via the AMPT key.

6.2.2.1 Setting the Reference Level

The reference level is represented graphically by the grid line at the top of the diagram.

The reference level sets the input signal gain up to the display stage. If the reference level is low, the gain is high. That means that even weak signals are displayed clearly.

If you are measuring strong signals, you have to set a high reference level in order to prevent an overload of the signal path of the analyzer and to keep the signal within the display range. If you are measuring the spectrum of a composite signal, make sure that the reference level is high enough to cover all signals and that all signals are within the measurement diagram.

► Press the AMPT key.

When you press the AMPT key, the R&S FSH automatically opens an input field to define the center frequency. If the input field is inactive, you can open it with the "Ref Level" softkey.

► Enter the reference level you require.

If you change the reference level, the R&S FSH adjusts the position of the trace as you make the changes.

By default, the reference level corresponds to the grid line at the top of the diagram. You can also change the position of the reference level to another grid line if you have a signal that would otherwise overlap with the top of the diagram area. The R&S FSH indicates the current reference level position with a triangle at the corresponding grid line on the vertical axis (

).

► Press the AMPT key.

► Press the "Range / Ref Pos" softkey.

The R&S FSH opens a submenu.

► Select the "Ref Position 10…" menu item.

The R&S FSH opens an input field to define the reference position.

► Enter the number of the grid line you want the reference level at.

The range is from 0 to 10. "0" corresponds to the lowest grid line, "10" corresponds to highest grid line.

6.2.2.2 Setting a Display Range

The display range determines the scaling or resolution of the vertical axis. In the default state, the display range is a logarithmic scaling over a 100 dB. This corresponds to 10 dB per grid division. The R&S FSH provides other display ranges that either increase or decrease the resolution of the vertical axis.

However, increasing resolution does not increase the accuracy of, for example, the marker level readout, but only makes it easier to read values off the trace.

You can also select a linear scale for the vertical axis. In that case, the power levels are expressed as a percentage of the reference level. Linear scaling is useful to display AM modulated carriers in the time domain, for example.

► Press the AMPT key.

► Press the "Range / Ref Pos" softkey.

The R&S FSH opens a submenu to select the display range.

► Select the display range you need.

The R&S FSH adjusts the vertical axis accordingly.

6.2.2.3 Selecting the Display Unit

By default, the vertical axis (and therefore the reference level) is scaled in dBm. However, the units dBmV, dBµV, Watt and Volt are also available. Selecting the right unit is relevant for the marker level display because the unit of the marker level is the same as that of the reference level.

► Press the AMPT key.

► Press the "Unit" softkey.

The R&S FSH opens a submenu to select the display unit.

► Select one of the available units.

The R&S FSH adjusts the labels of the vertical axis accordingly.

6.2.2.4 Setting a Reference Offset

You can define a reference offset for the reference level. With a reference offset, you can increase the reference level by a certain amount. This is useful, for example, if an attenuator or amplifier has been inserted before the RF input. The R&S FSH automatically takes the loss or gain into account when the level is displayed and no manual calculations are necessary. A loss introduced at the RF input must be entered as a positive number and a gain as a negative number.

► Press the AMPT key.

► Press the "Ref Offset" softkey.

The R&S FSH open an input field to

► Enter the offset you need.

The R&S FSH includes the offset in the measurement.

To indicate an offset other than 0, the R&S FSH puts a red dot at the "Ref:" hardware setting (• Ref: -20.0 dBm).

6.2.2.5 Setting the RF Attenuation

RF attenuation adjusts the input range inside the analyzer. It is coupled directly to the reference level. If you have set a high reference level, RF attenuation is turned on in 10 dB steps according to the table below so that the input mixer always remains in the linear range.

The R&S FSH provides three attenuation modes.

- Auto Low Distortion

  If this mode is active, the R&S FSH sets the RF attenuation 10 dB higher according to the table below, making the stress of the input mixer 10 dB less at the specified reference level. If the spectrum is densely occupied with signals, e.g. in a television cable network, the input mixer reduces the R&S FSH inherent spurious products. However, the inherent noise display of the R&S FSH increases due to the increased attenuation in front of the input mixer.

- Auto Low Noise

  If this mode is active, the R&S FSH sets the RF attenuation 10 dB lower. This increases the sensitivity of the R&S FSH, which means that the inherent noise display decreases due to the lower attenuation in front of the input mixer.

- Manual

  Manual selection of the attenuation.

You can check the status of the RF attenuation and the preamplifier in the measurement setup dialog and the hardware settings area of the display.

Reference Level	RF Attenuation	
	Low Noise	Low Distortion
≤-30 dBm	0 dB	0 dB
-29 to -25 dBm	0 dB	0 dB
-24 to -20 dBm	0 dB	0 dB
-19 to -15 dBm	0 dB	5 dB
-14 to -10 dBm	0 dB	10 dB
-9 to -5 dBm	5 dB	15 dB
-4 to 0 dBm	10 dB	20 dB
1 to 5 dBm	15 dB	25 dB
6 to 10 dBm	20 dB	30 dB
11 to 15 dBm	25 dB	30 dB
16 to 20 dBm	30 dB	30 dB
21 to 25 dBm	30 dB	30 dB
26 to 30 dBm	30 dB	30 dB

► Press the AMPT key.

► Press the "RF Att / Amp / Imp" softkey.

► Select either the "Auto Low Distortion" or the "Auto Low Noise" menu item.

The R&S FSH sets the attenuation according to the table above.

► Select the "Manual: 0 dB" menu item for manual selection of the RF attenuation.

The R&S FSH opens an input field to set the RF attenuation. You can set the attenuation from 0 dB to 30 dB in 5 dB steps.

To indicate a manual attenuation, the R&S FSH puts a red dot at the "Att:" hardware setting (• Att: 10 dB).

6.2.2.6 Setting the Input Impedance

In the default state, the input impedance is 50 Ω.

The R&S FSH can also handle 75 Ω systems. The R&S FSH does not select a 75 Ω RF input per se. Instead it selects a 75 Ω matching pad connected at the RF input. The 50/75 Ω matching pad R&S RAZ is recommended for 75 Ω matching (see recommended accessories). The R&S FSH automatically considers the conversion factor when a value of 75 Ω is set.

Press the AMPT key.

► Press the "RF Att / Amp / Imp" softkey.

► Select the impedance you need.

You can also use other matching pads (e.g. R&S RAM or R&S FSH-Z38) by activating transducer factors.

6.2.2.7 Using Transducer Factors

For more information see "Using Transducer Factors" on page 114.

6.2.3 Setting Bandwidths

The bandwidth menu contains all settings to set up filter bandwidths available in the R&S FSH. You can access it with the BW key.

6.2.3.1 Setting the Resolution Bandwidth

The resolution bandwidth in a spectrum analyzer determines the frequency resolution for frequency domain measurements and therefore determines how well it can separate adjacent frequencies. The results as you see them on the display depend on the passband of a resolution filter.

The resolution bandwidth (RBW) has several effects on measurements.

- To be able to display two or more signals whose frequencies are close together separately, you need a (resolution) filter whose bandwidth is small enough. The frequency difference between two sinusoidal carriers can not be less than the selected resolution bandwidth if the carriers are to be resolved, for example.
- The bandwidth of the resolution filter also affects the noise that is displayed by the R&S FSH. The smaller the bandwidth, the less noisy the results are. The rule is, that if you increase or decrease the bandwidth by a factor of 3, the noise goes down or up by 5 dB. If you change the bandwidth by a factor of 10, the displayed noise changes by 10 dB.
- The resolution bandwidth affects the speed of the measurement. If you want to display the true spectrum, the resolution filters have to settle at all frequencies that are of interest. Narrow bandfilters have a longer settling time compared to wide ones. Therefore the sweep time increases the smaller the resolution bandwidth gets. The rule is, that if you reduce the bandwidth by a factor of 3, the sweep time goes up by a factor of 9. If you reduce the bandwidth by a factor of 10, the sweep time goes up by a factor of 100.

The R&S FSH has resolution bandwidths from 1 Hz to 3 MHz in a 1-3-10 sequence. Additionally, the R&S FSH provides a 200 kHz resolution bandwidth that you have to select and enter manually.

Setting the 200 kHz resolution bandwidth

The 200 kHz bandwidth is not coupled to the span, so it will not be selected if automatic selection of the RBW is on.

In fact, you have to enter the 200 kHz resolution bandwidth with the number keys.

When using the rotary knob or the cursor keys, the 200 kHz bandwidth will be skipped.

In the R&S FSH's default state, the resolution bandwidth is coupled to the span, i.e. if you change the span, the R&S FSH adjusts the resolution bandwidth. Therefore, you do not have to set the resolution bandwidth manually in many cases, because the R&S FSH automatically sets the resolution bandwidth if you change the span.

► Press the BW key.

  By default, the resolution bandwidth is coupled to the span.

► Press the "Manual RBW" softkey.

  The R&S FSH opens an input field to define the resolution bandwidth.

► Enter the resolution bandwidth you need.

  The R&S FSH uses the resolution bandwidth you have entered for the measurement.

  If the resolution bandwidth is no longer coupled to the span, the R&S FSH puts a red dot at the "RBW" hardware setting (• RBW: 30 kHz).

► Press the "Auto RBW" softkey to again couple the resolution bandwidth to the span.

Automatic adjustment of the sweep time

In its default mode, the R&S FSH automatically adjusts the sweep time as soon as you change the resolution bandwidth. This is to make sure that the settling time required for the selected resolution filter is properly taken into account.The maximum allowed sweep time is 1000 s. For narrow resolution filters this value would be exceeded for large spans. In order to avoid this, the R&S FSH adjusts the span automatically as soon as the maximum sweep time is reached.

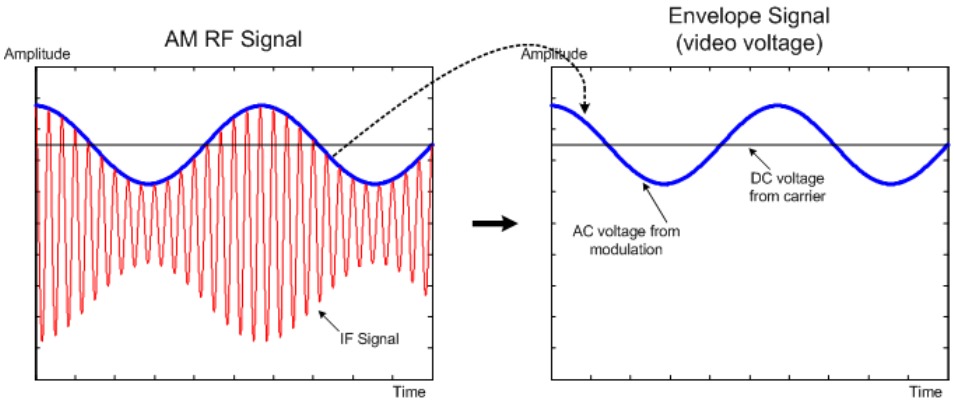
6.2.3.2 Setting the Video Bandwidth

The video bandwidth (VBW) basically smoothes the trace by reducing the noise and therefore making power levels easier to see.

The noise reduction is a result of the video filter. This lowpass filter defines the video bandwidth and filters the higher frequency parts of the voltage from the signal. Video voltage is the (DC) voltage that results from the IF signal passing through the envelope detector which removes the IF components and outputs the envelope only. This output is also known as the video signal.

The figure below shows that process on an AM modulated signal in the time domain.

In case of an AM modulated signal, the envelope (or video) signal contains a DC component that corresponds to the level of the carrier. The video signal also contains an AC component whose frequency is the same as the AM frequency.



If the bandwidth of the video filter is less than the frequency of the AC component, it is suppressed depending on its maximum frequency. If the AM component should be displayed truly, the cutoff frequency of the filter has to be greater than the modulation frequency.

If there is noise on the sine signal, the modulation signal can be thought of as noise. If the video bandwidth is reduced, the high-frequency noise components above the cutoff frequency of the video filter will be rejected. The smaller the video bandwidth, the smaller the noise amplitude at the video filter output.

The R&S FSH provides video bandwidths from 1 Hz to 3 MHz in a 1-3-10 sequence. In its default state, the video bandwidth is coupled to the resolution bandwidth and is the same as the resolution bandwidth. If you change the resolution bandwidth, the R&S FSH adjusts the video bandwidth accordingly.

The effects of the video bandwidth on measurements are as follows.

- if you are performing measurements on modulated signals, the video bandwidth must be sufficiently large so that significant modulation components are not rejected (≥ RBW)
- if you want to keep signals free of noise, you should select the smallest video bandwidth possible (≤ 0.1 x RBW)
- if you are performing measurements on pulsed signals, the video bandwidth should be at least three times greater than the resolution bandwidth so that the pulse edges are not distorted

Like the resolution bandwidth, the video bandwidth has an effect on sweep speed. Before each measurement, the video filter has to settle.

► Press the BW key.

► Press the "Manual VBW" softkey.

The R&S FSH opens an input field to define the video bandwidth.

► Enter the video bandwidth you need.

The R&S FSH uses the video bandwidth you have entered for the measurement.

If the video bandwidth is no longer coupled to the resolution bandwidth, the R&S FSH puts a red dot at the "VBW" hardware setting (• VBW: 300 kHz).

► Press the "Auto VBW" softkey to again couple the video bandwidth to the RBW.

6.2.4 Configuring and Triggering the Sweep

You can find all necessary settings to configure the sweep itself in the sweep menu. To access it, press the SWEEP key.

6.2.4.1 Setting the Sweep Time

The sweep time is the time it takes the R&S FSH to get the results that are contained in one trace.

In the frequency domain (span > 0), the sweep time is the time it takes the R&S FSH to measure the spectrum in the specified span. To avoid the display of spurs in the spectrum, the sweep time has to meet some conditions.

- The sweep time depends on the resolution bandwidth. If the sweep time is too short, the resolution filter has no time to settle. In that case, the displayed levels will be too low. For more information see "Setting the Resolution Bandwidth".
- The sweep depends on the span. If you increase the span, you also have to increase the sweep time.

In its default state, the R&S FSH couples the sweep time to the span and the resolution bandwidth to avoid invalid settings. If the coupling is active, the R&S FSH always sets the shortest possible sweep time to make sure that the display of the spectrum is correct and valid.

The R&S FSH requires a minimum sweep time of 20 ms for every 600 MHz of span. If you increase the span, the R&S FSH will also increase the sweep time.

In the time domain (span = 0), the R&S FSH shows the video voltage over time. The horizontal axis becomes a time axis that starts at 0 s and ends at the sweep time that you selected. The range of the sweep time in the time domain is from 200 µs to 1000 s.

► Press the SWEEP key.

  In the default state, "Auto SWP Time" is active.

► Press the "Manual SWP Time" softkey.

  The R&S FSH opens an input field to set the sweep time.

► Enter the sweep time you need.

  If the video bandwidth is no longer coupled to the span or the resolution bandwidth, the R&S FSH puts a red dot at the "SWT" hardware setting (• SWT: 2.5 s).

6.2.4.2 Selecting the Sweep Mode

The sweep mode is the way the R&S FSH performs the measurement.

In its default state, the R&S FSH measures continuously. In this mode, the R&S FSH automatically repeats the sweep in the defined range of the horizontal axis (frequency or time) and updates the trace accordingly after it has finished with one sweep.

In some cases it may be sufficient to get the results over a single sweep only, e.g. if a particular trigger condition is met. In single sweep mode, the R&S FSH performs the sweep a certain number of times (depending on the number of averages you have set) over the defined range of the horizontal axis (frequency or time) and then stops measuring. It performs another sweep only after you tell it to. For more information on setting the number of sweeps included in a single sweep see "Selecting the Trace Mode (Average)".

► Press the SWEEP key.

► Press the "Single Sweep" softkey.

The R&S FSH activates single sweep mode.

► Press the "Cont Sweep" softkey.

The R&S FSH again starts to measure continuously.

6.2.4.3 Working with Trigger Functionality

If you have to perform measurements according to certain signal conditions, you can use a trigger. A trigger responds to certain events. If a trigger is active, the R&S FSH starts to measure if the trigger conditions are met. The trigger can be generated either externally or internally.

The R&S FSH provides the following trigger functions.

- **Free Run**

  A new sweep starts on completion of the previous sweep. This is the default state of the R&S FSH.

- **Video Trigger**

  A sweep starts when the video voltage exceeds a particular level. The video trigger is available only in the time domain (span = 0).

  In the frequency domain, the R&S FSH would never start a measurement with the video trigger because there is no guarantee that there is a signal that generates video voltage present at the start frequency.

- **External Trigger** (rising or falling slope)

  A sweep starts on the rising edge (RISE) or on the falling edge (FALL) of an external trigger signal. The external trigger signal is fed in via the BNC connector "Ext Trigger". The switching threshold is 1.4 V, i.e. a TTL signal level.

- **Gated Trigger**

  When the gated trigger is active, a gate signal that is applied to the R&S FSH trigger input controls the sweep. The R&S FSH starts measuring when the applied gate signal becomes active and the set gate delay has expired, and it interrupts the measurement as soon as the defined gate length is reached. With the gate signal becoming active the next time the measurement is resumed etc.

  Pulsed signals can be measured by this method, if the gate delay and gate length are selected in a way that the measurement is only performed while the pulse is active. Gated measurements are possible in the frequency domain (span > 0) and the time domain (span = 0), but it is available only in combination with an external gate signal.

► Press the SWEEP key.

► Press the "Trigger" softkey.

  The R&S FSH opens a submenu to select the trigger source.

► Select the trigger source you need.

  The R&S FSH activates the trigger.

Including a Delay Time

When you are using a video trigger in the time domain or an external trigger, you can delay the start of the measurement with respect to the trigger event by entering a delay time. In this way, you can include time differences between the trigger event and the measurement.

The range of the trigger delay is from 0 µs to 100 s. The resolution depends on the subrange.

Trigger delay	Resolution
0 to 1 ms	10 µs
1 ms to 10 ms	100 µs
10 ms to 100 ms	1 ms
100 ms to 1 s	10 ms
1 s to 10 s	100 ms
10 s to 100 s	1 s

► Press the SWEEP key.

► Press the "Trigger" softkey.

► Select the "Trigger Delay…" menu item.

  The R&S FSH opens an input field to define the trigger delay.

► Enter the delay time you need.

Defining the Trigger Level

When you are using the video trigger, you have to define a trigger level. The trigger level is a percentage of the reference level. A trigger level of 100 % is the same as the reference level. A trigger level of, e.g. 50% corresponds to the middle of the vertical axis. The R&S FSH indicates the video trigger level with a triangle.

► Press the SWEEP key.

► Press the "Trigger" softkey.

► Select the "Trace Video" menu item.

The R&S FSH opens an input field to define the trigger level.

► Enter the trigger level.

The R&S FSH shows the trigger level by adding a horizontal line to the diagram area.

Performing Gated Sweeps

When the external trigger is active, it is possible to perform a gated sweep.

► Press the SWEEP key.

► Press the "Trigger" softkey.

► Activate an external trigger.

Now that the external trigger is active, the "Gated Trigger" menu item becomes available.

► Press the "Trigger" softkey again.

► Select the "Gated Trigger" menu item.

In order to get appropriate results, you have to set the gate delay and gate length in a way that the measurement is active during the interesting part of the signal. You can also modify the sweep time in order to match the horizontal axis to the length of the signal and thus set the gate delay and gate length parameters more accurately.

The gate delay parameter defines the time between the trigger event and the beginning of the actual measurement. The gate length defines the duration of the measurement, before it is interrupted and the next gate signal is anticipated to resume the measurement.

► Press the SWEEP key.

► Press the "Trigger" softkey.

► Select the "Gate Settings" menu item.

The R&S FSH opens a softkey submenu to control the gate settings. At the same time, the R&S FSH switches into time domain, as indicated in the display.

► Press the "Manual SWP Time" softkey and set the sweep time in a way that the portion of interest of the signal is visible on the screen.

► Press the "Gate Delay" softkey.

The R&S FSH opens an input field to define the trigger delay.

► Enter the delay time you need.

The measurement now starts after the delay time has passed.

► Press the "Gate Length" softkey.

The R&S FSH opens an input field to define the gate length.

► Enter the length of the gate.

The R&S FSH now measures over the period of the gate length. After the gate has closed, the R&S FSH waits with the measurement until the next gate signal happens.

The delay time and gate length are represented by vertical red lines in the diagram area.

► After setting the gate delay and gate length, exit the gate settings menu with the "Exit" softkey.

The R&S FSH returns to the frequency domain provided it was active before setting up the gated trigger. The original span is restored. The R&S FSH is ready to perform measurements with an accurately set gate.

6.2.5 Working with Traces

The trace menu contains all functions available to customize the trace display.

6.2.5.1 Selecting the Trace Mode

The R&S FSH provides several trace modes. The trace mode defines the way the R&S FSH writes the trace.

- **Clear/Write**

  In its default state, the R&S FSH overwrites the trace after each sweep.

  You can apply all detectors in this mode.

- **Average**

  The trace is the result of the moving average over several sweeps.

  The R&S FSH calculates the (moving) average of the power levels for each pixel over a particular number of sweeps in the range from 2 to 999.

  Averaging reduces the effects of noise, but has no effects on sine signals. Using the trace averaging therefore is a good way to detect signals in the vicinity of noise.

  You can apply all detectors in this mode.

- **Max Hold**

  The trace shows the maximum power levels that have been measured at each pixel.

  To overwrite a max hold trace, change a parameter in a way that the results can not be compared any more, e.g. the span. Using the max hold trace mode is a good way to detect intermittent signals or the maximum values of fluctuating signals, for example.

  Using the max hold trace mode automatically activates the max peak detector.

- **Min Hold**

  The trace shows the minimum power levels that have been measured at each pixel.

  To overwrite a min hold trace, change a parameter in a way that the results can not be compared any more, e.g. the span. Using the min hold trace mode is a good way to highlight signals within noise or suppress intermittent signals.

  Using the min hold trace mode automatically activates the min peak detector.

- **View**

  The view trace mode freezes the current trace and aborts the measurement.

  Using the view trace mode is a good way to evaluate the trace, for example with markers.

► Press the TRACE key.

► Press the "Trace Mode" softkey.

The R&S FSH opens a submenu to select the trace mode.

► Select the trace mode you want to work with.

If you have selected the average trace mode ("Average: 10" menu item), the R&S FSH opens an input field to set the number of sweeps the R&S FSH includes in the averaging.

► Enter the number of sweeps to include in the averaging.

In continuous sweep mode, the R&S FSH now calculates the moving average over the number of sweeps you have specified. In single sweep mode, it stops the measurement after finishing the sweeps and averages the traces.

6.2.5.2 Selecting the Detector

The number of measurement results collected in a single sweep usually is very high, especially if the span is large. However, the display of the R&S FSH can display only 631 results in horizontal direction, as it is limited by the number of pixels that are available on the display. Therefore, it has to combine measurement results to fit them on the display. In that case, one pixel represents a frequency range = span/631.

The detector determines the way the R&S FSH combines and displays the results for one pixel. The data base is the video voltage of the analyzer.

The R&S FSH provides several types of detectors.

- **Auto Peak**

  If the auto peak detector is active, the R&S FSH displays both the maximum and the minimum power levels that were measured in the frequency range covered by a pixel.

  Therefore, the auto peak detector loses no information. If a signal power level fluctuates (e.g. noise), the width of the trace depends on the magnitude of the signal fluctuation.

  The auto peak detector is the default detector.

- **Max Peak**

  If the max peak detector is active, the R&S FSH displays only the maximum power levels that were measured in the frequency range covered by a pixel.

  The max peak detector is useful for measurements on pulse or FM signals, for example.

- **Min Peak**

  If the max peak detector is active, the R&S FSH displays only the minimum power level that were measured in the frequency range covered by a pixel.

  The min peak detector displays sine signals with the correct level and suppresses noise. Therefore it is useful to find sine signals in the vicinity of noise.

- **Sample**

  If the sample detector is active, the R&S FSH shows one random power level that was measured in the frequency range covered by a pixel.

  The sample detector is useful for measurements in the time domain (span = 0 Hz) as it provides the only way to represent the timing of the video signal correctly.

  In the frequency domain, the sample detector is a good way to measure noise power because noise usually has a uniform spectrum with a normal amplitude distribution.

  Signals may get lost if you are using the sample detector for measurements with a span that is greater than "RBW*631".

- **RMS**

  If the RMS detector is active, the R&S FSH measures the spectral power over one pixel. In case of power measurements, the RMS detector always shows the true power of a signal, regardless of the shape of the signal.

  The RMS detector is best for measurements on digitally modulated signals because it provides stable and true power readings. In combination with a high sweep time you can increase the display stability even more because the measurement time for each pixel increases.

  Noise measurements also provide stable results if you apply the RMS detector in combination with a high sweep time.

  However, the bandwidth occupied by the signal to be measured should at least equal the frequency covered by a trace pixel or the selected resolution bandwidth (whichever is larger). Otherwise, the power the R&S FSH shows is too low because there are spectral components within the frequency range covered by the pixel that do not originate from the signal you want to observe (e.g. noise).

  To get the true power, the video bandwidth (VBW) should also be greater than the resolution bandwidth (RBW). Otherwise, an averaging effect caused by video bandlimiting comes into play before the RMS value is calculated.

The R&S FSH provides automatic selection of the detector. In that case, the R&S FSH selects the detector that is most suitable for the current trace mode.

Trace mode	Detector
Clear/Write	Auto Peak
Average	Sample
Max Hold	Max Peak
Min Hold	Min Peak

If you select the detector manually, the detector is independent of the trace mode and will not change.

► Press the TRACE key.

► Press the "Detector" softkey.

► Select the detector you want to use.

If you automatic detector selection is active, the corresponding menu item is marked by an [X].

6.2.5.3 Working with a Second Trace

In spectrum mode, you can use two traces. Both traces are based on the same settings, except the trace settings like the trace mode or the detector. You can use the second trace to compare, for example, two different detector settings.

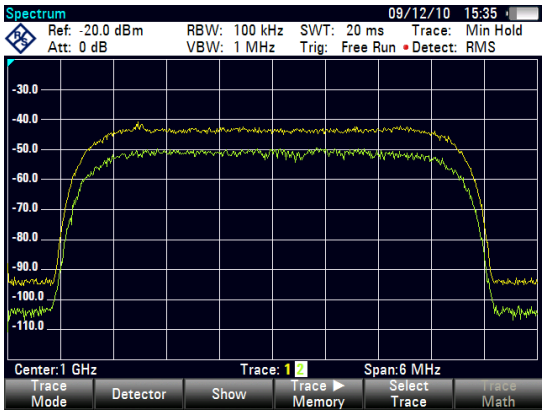
In the default state, only trace 1 is active.

► Press the TRACE key.

► Press the "Show" softkey.

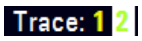
► Select the "Trace 2" menu item.

The R&S FSH shows the second trace. The second trace is in a different color. To show that the second trace is active, the R&S FSH labels the "Trace 2" menu item with an [X].



After you have activated the second trace, this is also the active one. All actions (like changing the detector or trace mathematics) apply to the active trace.

The trace indicator shows the currently active trace with a white background.



► Press the "Select Trace" softkey.

Trace 1 becomes the active trace.

You can put both traces into the internal memory of the R&S FSH and restore them later. Note that the memory trace 1 and memory trace 2 have the same color (i.e. white).

6.2.5.4 Working with Memory Traces

You can save the image of both traces to the memory of the R&S FSH and later restore it and compare it to a live trace. The memory trace is always colored white to distinguish it from the live trace.

Measurement settings

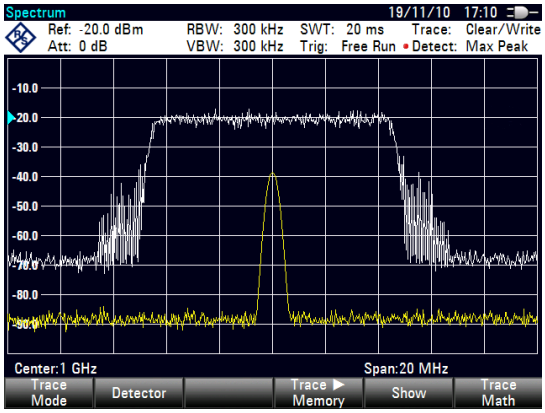
Because the memory trace is just a bitmap, any modifications to measurement settings like span or reference level are nor reflected in the memory trace.

When you save a data set, the R&S FSH also stores the associated trace in the trace memory. If you restore it at a later time, you can display the memory trace as if it is a normal memory trace.

- ► Press the TRACE key.
- ► Select the trace you want to store in the trace memory with the "Select Trace" softkey.
- ► Press the "Trace►Memory" softkey.

  The R&S FSH saves the active trace.
- ► Press the "Show" softkey.
- ► Select the "Memory <x>" menu item.

  The R&S FSH shows the corresponding memory trace. If active, it labels the "Memory <x>" menu item with an [X].

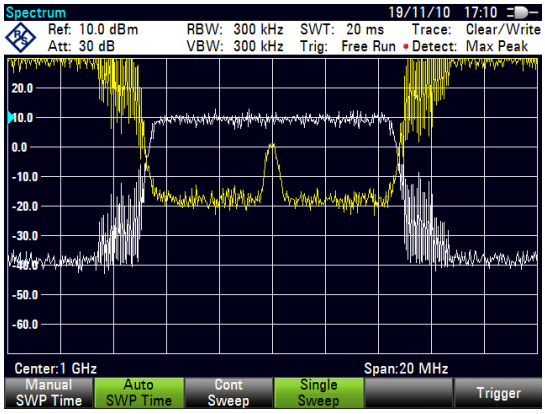


6.2.5.5 Using Trace Mathematics

Trace mathematics substract the memory trace from the live trace and vice versa and then display the results.

- ► Press the TRACE key.
- ► Press the "Trace►Memory" softkey.
- ► Press the "Show" softkey.
- ► Press the "Trace Math" softkey.
- ► Select the "Trace-Memory" or "Memory-Trace" menu item.

  The R&S FSH calculates and shows the resulting trace.



- ► To turn off trace mathematics, select the "Off" menu item.

6.2.6 Using Markers

The spectrum analyzer mode provides marker and deltamarker functionality. In addition, you can use several marker functions.

6.2.6.1 Using Markers and Deltamarkers

The R&S FSH has six markers, five of which can be used as either markers or delta markers.

The markers cannot leave the trace and indicate the horizontal and vertical coordinates of the point they are positioned on. The horizontal position of a marker is shown by a vertical line which extends from the top to the bottom of the measurement diagram. The marker list above the diagram area shows the exact coordinates of all markers in use.

The position of a delta marker is indicated by a dashed line to distinguish it from a normal marker. The delta marker level is always a relative to the main marker level and so the delta marker level unit is always dB. The delta marker frequency is always relative to the main marker – in other words, the delta marker frequency is the frequency difference between the frequency at the point marked by the main marker and the frequency at the point marked by the delta marker.

To measure complex signals, you can activate up to six markers. Marker 1 is always a normal marker and the reference of all delta markers. Markers 2 to 6 are either markers or delta markers depending on your set up.

Screen Layout with Active Markers

1 Marker list
2 Marker label: M(x)
3 Delta marker label: D(x)
4 Active marker label (red label)
5 Delta marker (blue dotted line)
6 Marker (blue line)
7 Marker input field
8 Marker menu

6.2.6.2 Positioning Markers

► Press the MARKER key.

The marker menu opens.

If, as yet, no marker has been activated, the R&S FSH automatically activates the main marker and positions it on the maximum level that has been measured. In addition, the marker frequency input field opens.

You can perform the following actions:

- Position the marker with the cursor keys.

  When positioning the marker with the cursor keys, the step size is 10% of the span.

- Position the marker with the rotary knob

  When positioning the marker with the rotary knob, the step size is one pixel.

- Enter a marker position with the number keys and confirm the entry with one of the unit keys.

► Confirm the marker position with the ENTER key.

The marker input field closes.

By default, the marker list above the diagram area is active. The marker list shows the horizontal position of all markers and the corresponding vertical value. If inactive, the list shows only the coordinates of markers 1 and 2.

You can turn it off and on again whenever you like.

► Press the "View List" softkey.

The marker list turns off or on, depending on its original state.

6.2.6.3 Positioning a Delta Marker

When a normal marker is already in use, you can add delta markers.

► Press the MARKER key.

► Press the "New Marker" softkey.

The R&S FSH activates a delta marker and positions it on the next maximum level that has been measured. In addition, the delta marker input field opens.

The R&S FSH adds the delta marker to the marker list and shows the marker position relative to the normal marker (M1).

You can perform the following actions:

- Enter a delta marker position with the number keys and confirm the entry with one of the unit keys.
- Change the delta marker position with the rotary knob or the cursor keys.

► Confirm the delta marker position with the ENTER key.

The delta marker input field closes.

► To add more markers, press the "New Marker" softkey several times until you have the number of markers you want in the display.

6.2.6.4 Selecting the Marker Type

When you add new markers, they will be delta markers by default. Their coordinates are relative to the first marker (M1). You can turn delta markers into normal markers if you need absolute information about the marker position.

► Press the MARKER key.

► Select the delta marker you want to convert with the "Select Marker" softkey.

The corresponding marker symbol turns red and the marker input field opens.

► Press the "Marker Type" softkey.

The delta marker turns into a normal marker. Its label changes accordingly (e.g. D2 to M2) and its coordinates are now absolute values.

6.2.6.5 Automatic Positioning of Markers

The R&S FSH offers functions that make setting the markers easier or allow to make instrument settings on the basis of the current marker position:

- "Set to Peak"

  The Peak function places the active marker or the delta marker on the highest level value of the trace.

- "Set to Next Peak"

  The Next Peak function places the active marker or delta marker on the next highest level value of the trace, relative to its current position.

- "Set to Minimum"

  The Minimum function places the active marker or delta marker on the lowest value of the trace.

► Press the MKR→ key.

► Press the "Set to Peak", "Set to Next Peak" or "Set to Minimum" softkey.

The R&S FSH positions the marker accordingly.

6.2.6.6 Removing Markers

Remove markers any time you want.

Removing selected markers

► Select the marker you want to delete with the "Select Marker" softkey.

The corresponding marker symbol turns red and the marker input field opens.

► Press the MARKER key.

► Press the "Delete Marker" softkey.

► Select the "Delete Selected" menu item.

► Confirm the selection with the ENTER key.

The R&S FSH deletes the marker.

Deactivating markers

If you delete marker 1 (M1), all delta markers that are relative to that marker are also deleted.

Removing delta markers only

► Press the MARKER key.

► Press the "Delete Marker" softkey.

► Select the "Delete All Delta" menu item.

► Confirm the selection with the ENTER key.

The R&S FSH deletes all delta markers.

Removing all markers at the same time.

► Press the MARKER key.

► Press the "Delete Marker" softkey.

► Select the "Delete All" menu item.

► Confirm the selection with the ENTER key.

The R&S FSH deletes all markers and delta markers.

6.2.6.7 Using Marker Search Limits

The R&S FSH allows you to use only a limited section of the trace for the "Set to Peak", "Set to Next Peak" and "Minimum" functions.

► Press the MKR→ key.

► Press the "Search Limits" softkey.

► Select the "Search Limits On/Off" menu item.

► Confirm the selection with the ENTER key.

The R&S FSH activates the marker search limits.

An [X] indicates an active search limit. Two vertical red lines show the lower and upper limits in the diagram.

By default, the search limit range is over the whole span.

► Press the "Search Limits" softkey

► Select the "Lower Limit" menu item.

► Confirm the selection with the ENTER key.

The R&S FSH opens an input field to define the lower limit of the search range.

► Enter the lower limit.

► Confirm the entry with one of the unit keys.

If the span is wide enough, the R&S FSH displays a red vertical line to indicate the lower limit.

► Define the upper search limit the same way.

Deactivating marker search limits

► Press the "Search Limits" softkey.

► Select the "Search Limits On/Off" menu item.

► Confirm the selection.

The "Search Limits" softkey turns grey again and in the "Search Limits" menu, the [X] is no longer displayed.

6.2.6.8 Using Marker Functions

In addition to the frequency and level readout, the R&S FSH provides several, more complex, marker functions in spectrum analyzer mode.

Deactivating marker functions

Selecting a marker function again while it is still active turns that marker function off.

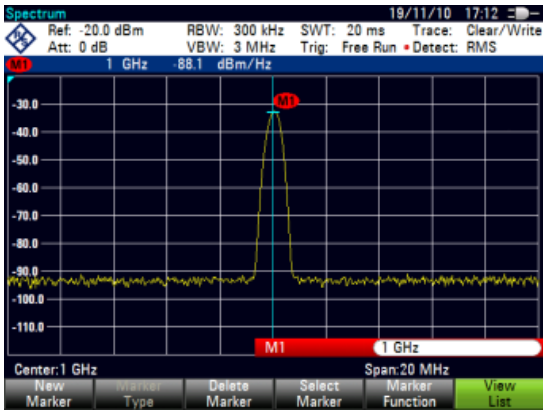
Measuring the Noise Power Density

The marker noise function calculates the noise power density at the marker position in dBm/Hz. The R&S FSH includes several variables in the calculation of the noise power density, including the trace pixel values, the resolution bandwidth, the detector and the level display mode (absolute or relative). To stabilize the noise power display, the R&S FSH uses the pixel the marker is on and four pixels to the right and four pixels to the left of the marker pixel.

Noise power density can provide useful information when you are measuring noise or digitally modulated signals. However, you will get valid results only if the spectrum in the vicinity of the marker has a flat frequency response. When measuring the noise power density on discrete signals, results are not valid.

- ► Press the MARKER key.
- ► Press the "Marker Function" softkey.
- ► Select the "Noise" menu item.

  The R&S FSH shows the level at the marker frequency in dBm/Hz. If you are using a delta marker for the measurement, the results have the unit dBc/Hz with marker 1 being the reference.



Measuring the Frequency

The R&S FSH provides a frequency counter. The frequency counter accurately measures the frequency at the marker position.

When calculating the horizontal position of the marker, the R&S FSH includes the current span, center frequency and the frequency of the pixel the marker is on. As the trace only has 631 pixels, the marker position is just an approximation, especially if the span is very wide.

With the frequency counter, however, you can get a more accurate result of the horizontal marker position. If the frequency counter is active, the R&S FSH stops the measurement at the marker position for a short time and measures the frequency using the internal reference frequency.

The accuracy of the results therefore depends only on the accuracy of the internal reference frequency (TCXO). The frequency counter has a resolution of 0.1 Hz and therefore provides far more accurate results. Despite the accuracy, the measurement is still fast (because of a special algorithm for the I/Q baseband signal).

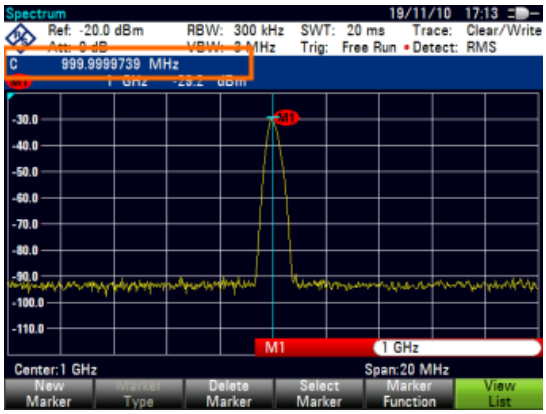
The frequency counter only gives completely accurate readings for sine signals that are at least 20 dB above the noise floor. If the S/N ratio is less, noise affects the results.

► Press the MARKER key.

► Press the "Marker Function" softkey.

► Select the "Frequency Count" menu item

The R&S FSH displays the counted marker frequency with a resolution of 1 Hz. If the frequency counter is on, the marker symbol changes from M1 to C.



Measuring the Signal Bandwidth

The "n dB Down" marker function places two temporary markers to the left and to the right of the reference marker and measures the bandwidth between the two temporary markers. The function therefore is a good way to measure the bandwidth of a signal or the bandwidth of a filter, for example. The temporary markers are represented as two vertical lines.

The distance to the reference marker is by default 3 dB below the reference marker. You can also adjust this value manually. Entering a positive value sets the temporary markers below the reference marker. If it is, for any reason, not possible to calculate the frequency spacing, dashes are displayed instead of a value.

Upon entering a negative value, the function turns into a n dB up function. You can use a n dB up function, for example, for measurements on notch filters.

► Press the MARKER key.

► Press the "Marker Function" softkey.

► Select the "n dB Down" menu item

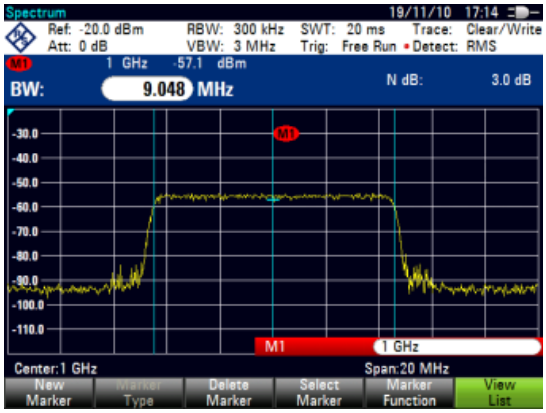
The R&S FSH displays two temporary markers on the left and on the right of the reference marker M1. It also shows the bandwidth between the n dB down markers.

You can then adjust the distance of the temporary markers.

- ► Press the "Marker Function" softkey.
- ► Select the "n dB Down" menu item

  The R&S FSH opens an input field
- ► Enter a different distance (in this case 6 dB).

  The R&S FSH again shows the temporary markers, this time with a broader bandwidth.



Demodulating Signals

The R&S FSH features an AM and FM demodulator to demodulate and monitor audio signals. It demodulates the signal at the marker frequency.

You can listen to the demodulated signal with the internal speaker or headphones that you can connect to the 3.5 mm headphone jack on the top of the R&S FSH.

When demodulating an AM modulated signal, the R&S FSH turns the video voltage into an audible sound. You should therefore set the reference level to about the level of the signal that you are demodulating.

If you perform measurements in the time domain, the R&S FSH demodulates continuously. In the frequency domain, you can define a time period the R&S FSH demodulates the signal at the marker frequency. The frequency sweep then stops at the marker frequency for that time before finishing the sweep.

- ► Press the MARKER key.
- ► Press the "Marker Function" softkey.
- ► Select the demodulation scheme you require from the menu.

  The R&S FSH starts to demodulate the signal.

Demodulating signals

If you turn on the demodulator, the R&S FSH automatically turns off the noise marker or the frequency counter.

Defining the demodulation time period

► Press the MARKER key.

► Press the "Marker Function" softkey.

► Select the "Time…" menu item.

The R&S FSH opens an input field to define the demodulation time.

► Enter the demodulation time you need.

The range is from 100 ms to 500 s. In time domain the R&S FSH demodulates continuously, i.e. the demodulation time is not relevant.

Controlling the volume

► Press the MARKER key.

► Press the "Marker Function" softkey.

► Select the "Volume…" menu item.

The R&S FSH opens an input field to define the demodulation volume.

► Enter the volume you are comfortable with.

The demodulation volume is a percentage (0 % to 100 %) with 100 % being full volume.

For more information on general volume control see the Quick Start Guide.

6.2.7 Using Display Lines

Like markers, display lines help you to determine the level of the signal.

A display line is a straight line that runs horizontally and corresponds to a certain level value. You can move the display line to each pixel in the display. This means that the accuracy and exact vertical position of the display line depends on the resolution of the vertical axis. With a display range of 100 dB, for example, each pixel corresponds to 0.3 dB. In that case, the accuracy of the display line is 0.3 dB. If you enter a value with a higher resolution, the R&S FSH rounds that value.

You can also move the display line with the rotary knob or the cursor keys. The step size for movement with the rotary knob is one pixel. The step size for the cursor keys is 10 % of the display range.

► Press the LINES key.

► Press the "Display Line" softkey.

The R&S FSH displays the display line as a blue horizontal line. It shows the vertical position of the line in a table above the diagram area.

When you activate the display line, the R&S FSH also opens an input field to define the vertical position of the line.

► Enter the level value you need.

The R&S FSH positions the display line accordingly.

Alternatively you can also move the display line with the rotary knob or the cursor keys.

6.2.8 Using Limit Lines

Limit lines help you to identify if a signal complies with certain level characteristics.

A limit line is made up out of two or more points that are connected to a line. Each of the points that define the shape of the limit line consists of two coordinates. One coordinate defines the horizontal position (e.g. frequency), the other one the vertical position. With the R&S FSH you can build limit lines that consist of up to 1000 points.

Values that define the horizontal characteristics of the limit line can be either absolute values (e.g. frequency in MHz) or relative values whose reference is the center of the measurement trace (e.g. the center frequency). Relative values are of advantage if you, for example, measure modulated output signals and you change the center frequency but need the limit line to remain the same. Absolute limit lines have the file extension ".abslim" while relative limit lines have the file extension ".rellim"

Values that define the vertical characteristsics are always level values in dB. If the scaling of the vertical axis is currently a linear one (units V or W), the R&S FSH automatically switches to a logarithmic scaling after you turn on the limit line.

After turning on a limit line, the R&S FSH checks if the signal violates the shape of the limit line. If one or more signal levels violate the limits, the R&S FSH features several indicators that the limit check has failed.

- A general message in the diagram header that indicates if the signal violates the limit line, including the trace that violates the limit: 

- An audio signal that sounds every time a limit is violated
- The trace color turns red in areas of the spectrum that violate a limit

You can create and edit limit lines with the R&S InstrumentView software package and then transfer them into the internal memory of the R&S FSH. The number of limit lines you can store in the memory depends on other datasets available on the R&S FSH or, if you are using an external storage device (e.g. memory stick), the size of it.

For more information see "Managing Datasets" on page 66.

6.2.8.1 Selecting a Limit Line

Before selecting a limit line, you need to decide if you want to use it as an upper or lower limit line. In case of upper limit lines, the R&S FSH checks if the signal is above the limit line. In case of lower limit lines, the R&S FSH checks if the signal is below the limit line.

You also have to make sure that the limit line is compatible to the scale of the horizontal axis.

► Press the LINES key.

► Depending on the application, press the "Upper Limit" or "Lower Limit" softkey.

The R&S FSH opens a dialog box to select the limit line.

► Select the "Load From File…" menu item.

► Press the "Sort/Show" softkey.

► Select the "Show Compatible" menu item.

The R&S FSH shows all limit lines that are compatible to the current settings.

► Select one of the available limit lines.

► Press the "Select" softkey.

The R&S FSH activates the limit line. In the diagram, the limit line is displayed as a red line.

If you have already selected a limit line, you can turn the limit line on and off with the "Limits On/Off" softkey.

Alternatively, you can define a threshold that works like a limit line. A threshold is a simple horizontal limit line.

► Press the "Upper Limit" or "Lower Limit" softkey.

► Select the "Threshold" menu item.

The R&S FSH opens a input field to define the threshold.

► Enter the threshold you need.

The R&S FSH displays the line and performs a limit check for that threshold.

Threshold line and display line

Like the display line, a threshold line is a straight horizontal line. The difference is that the R&S FSH performs a limit check for threshold lines, but not for display lines.

A failed limit check may be an issue if you want to create a measurement report, because measurements with failed limits are not included in this report.

Using a display line, you can use a line and are able to create a measurement report at the same time, regardless if any limits have been violated or not.

The process of turning off a limit line completely is similar to that of selecting a line.

► Press the "Upper Limit" or "Lower Limit" softkey

► Select the "Unselect Limit" menu item.

The R&S FSH deactivates the limit line.

6.2.8.2 Performing Limit Checks

If limit lines are active, the R&S FSH automatically checks the trace for limit violations after each frequency sweep. As long as the signal does not violate the limit line, the R&S FSH shows a "Pass" message in the measurement diagram. As soon as one single value (i.e. one pixel) is outside of the limits, the R&S FSH displays a "Fail" message in the diagram area and, in addition, sounds a beep.

A limit checks relates only to the frequency range defined by the limit line, not the span.

Audio signal

You can turn the acoustic signal that sounds in case of a limit violation on and off.

► Press the "Options" softkey.

► Select the "Audio Beep" menu item.

An [X] in front of the "Audio Beep" menu item indicates that the beeper is active. If the audio beep is active, the R&S FSH beeps each time a limit is violated.

Limit violation

Note that a limit check fails only if the signal *exceeds* the limit line.

If the signal level is the same as the limit value, the limit check passes.

6.3 Working with Channel Tables

Almost all transmission systems divide their assigned frequency ranges into channels. Each channel corresponds to a specific frequency. To keep the handling of such systems simple, you can use channel tables instead of entering frequencies manually.

The R&S FSH already comes with an assortment of channel tables that you can use without doing anything. If you want to test transmission standards that are not listed, you can also build channel tables manually with the "Channel Table Editor" of the R&S InstrumentView software package that is delivered with the R&S FSH. To use one of those, you just have to copy the channel table to the R&S FSH.

For more information see "Managing Datasets" on page 66.

Selecting a channel table

► Press the FREQ key.

► Press the "Frequency Mode" softkey.

► Select the "Channel" menu item.

The R&S FSH opens a dialog box to select a channel table.

► Select one of the available channel tables.

After activating the channel table, the R&S FSH is set up according to the information contained in the channel table. Instead of a center frequency, the R&S FSH shows the currently active channel number including the name of the channel. The center frequency of a channel is defined in the channel table and is the frequency corresponding to the selected channel.

Selecting a channel

Entering a center, start or stop frequency is not possible anymore. Instead you select a channel. The R&S FSH then adjusts the center, start and stop frequency according to the channel table.

► Press the FREQ key.

► Press the "Center Frequency" softkey.

The R&S FSH opens an input field to select the channel.

► Enter the channel you want to perform measurements on.

The R&S FSH changes the channel according to the channel table.

Channel numbers are assigned to frequencies as follows:

- The first channel is assigned a channel number and a frequency.
- All subsequent channels have ascending numbers.
- The frequency spacing between channels is fixed. It can also be negative, i.e. the center frequency of the R&S FSH decreases with ascending channel number.
- In transmission systems containing gaps in the frequency range (as in the case of television, for example), a channel table can comprise multiple ranges.

6.4 Using Transducer Factors

The frequency-dependent transducer factor of transducers and antennas can be directly considered in the measurement result. A transducer factor consists of a numeric value and a unit. The R&S FSH corrects the level values of the trace by the values of the transducer. At the same time, the unit of the transducer is assigned to the level axis. When field-strength measurements are performed with the aid of antennas, for instance, the electrical field strength is directly indicated in dBµV/m on the R&S FSH. A transducer factor can also be used to correct a frequency-dependent attenuation, e.g. of a cable between DUT and RF input of the R&S FSH.

You can create and edit transducer factor with the R&S InstrumentView software package and then transfer them into the internal memory of the R&S FSH. Each transducer factor may consist of up to 1000 reference values.

For more information see "Managing Datasets" on page 66.

Interpolation between the values is performed with the aid of a modified spline algorithm. Even if only relatively few values such as maxima, minima and turning points are available, this algorithm can easily simulate the correction factors of common transducers. Two transducers can be switched on at a time. The second transducer must be assigned the unit dB. The R&S FSH adds the two transducers to a total transducer.

Units supported for transducer factors:

- dB
- dBµV/m
- dBµA/m
- W/m2

The unit dB does not change the unit set on the R&S FSH. It can be used, for instance, to compensate for frequency-dependent loss and gain at the input of the R&S FSH. The units dBµV/m and dBµA/m convert the output power of an antenna into electric or magnetic field strength. The unit W/m2 is used to calculate and display the power flux density.

For example, to compensate for the cable loss between the transducer and the RF input, the R&S FSH can use two transducers at the same time. One of them must have the unit dB, however, i.e. it must correspond to one loss or gain value.

► Press the AMPT key.

► Press the "Transducer" softkey.

Transducer factor availability

Transducer factors are not available for measurements with the tracking generator or the Power Sensors. The "Transducer" softkey is therefore inactive.

You can select two transducer factors, a primary transducer and a secondary transducer. If a transducer factor is active, the menu item has an [X] in front of it.

► Select the "Select Primary Transducer" menu item.

The R&S FSH opens a dialog box to select the transducer factor.

► Select the transducer factor you need.

► Confirm the selection with the "Select" softkey.

The R&S FSH shows the name of the active transducer on the display.

An example would be the transducer factor of the R&S HL223 antenna that is defined between 200 MHz and 1300 MHz. The R&S FSH therefore displays the noise in this frequency range as a function of frequency incremented by the transducer factor. Outside the transducer range, the R&S FSH sets the transducer factor at zero, i.e. measurements in this range do not yield conclusive results.

You can select a second transducer factor with the "Select Secondary Transducer" menu item. The secondary transducer factor in that case is added to the first. The unit of the second transducer factor must always be the relative unit dB as otherwise an addition would not be useful. When you select a secondary transducer factor, the dialog box shows only those transducer factors that have dB as their unit.

6.4.1 Unit for Measurements with Transducers

If the unit of the transducer is dB, the units dBm, dBmV or dBµV remain unchanged. The linear units Volt and Watt are not permissible. They are deactivated in the units menu.

If the unit of the transducer is dBµV/m or dBµA/m, this unit is also used for the R&S FSH level display. This means that both the level axis of the diagram and the level at the marker position are assigned the unit of the transducer. If dBµV/m is selected as the transducer unit, a switch to absolute level indication in V/m is possible.

► Press the AMPT key.

► Press the "Unit" softkey.

► Select the V(olt) menu item.

If you are using a transducer with the unit dBµA/m, it is not possible to select another unit. Level indication is entirely in dBµA/m.

6.4.2 Setting the Reference Level

The transducer shifts the trace by its value as a function of frequency. Positive transducer values increase the level, negative values reduce it. To ensure that the trace is always within the diagram, the R&S FSH adjusts the reference level accordingly. The reference level is shifted by the maximum transducer value in the positive or negative direction.

6.4.3 Frequency Range of Transducer

If the set frequency range is wider than the span in which a transducer is defined, the R&S FSH assumes the transducer values outside the defined range to be zero.

6.4.4 Data Sets Containing Transducer Factors

The R&S FSH stores data sets together with any transducer factors that may have been active for the measurement in question. When such a dataset is recalled, the associated transducer factor(s) are switched on as well. Transducer factors recalled as part of a data set do however not appear in the list of transducer factors.

7 Network Analyzer

To enable the features of the network analyzer mode, you need at least an R&S FSH with tracking generator or one that also has an internal VSWR bridge.

An R&S FSH with tracking generator can perform scalar measurements and determine the reflection or reverse transmission characteristics of the device under test (DUT). Scalar measurements determine the magnitude of the transmitted or reflected power.

Measurements yield the best results when you calibrate the R&S FSH to the test setup. Although the accuracy of measurements is high in the default factory calibration, the R&S FSH also provides all necessary calibration methods to correct the magnitude for these kinds of measurements and make results even more accurate.

► Press the MODE key.

► Press the "Network Analyzer" softkey.

The R&S FSH turns on the tracking generator. Frequency and level settings are inherited from the previous operating mode.

Defining the output level of the tracking generator

The tracking generator generates a signal at the current R&S FSH frequency. The nominal output level of the signal is adjustable from 0 dBm to -40 dBm in steps of 1 dB.

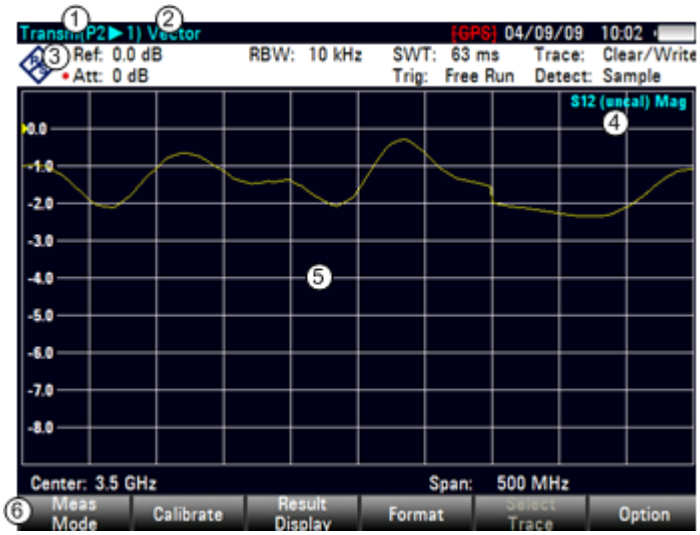
► Press the AMPT key.

► Press the "TG Output Attenuation" softkey.

The R&S FSH opens an input field to set the output level.

The output level is an attenuation between 0 dB and 40 dB that corresponds to the output level. If you, e.g., set an attenuation of 0 dB, the output level is 0 dBm. If you set an attenuation of 40 dB, the output level is -40 dBm.

Screen layout of the network analyzer



1 Result display
2 Measurement mode
3 0 dB reference
4 Status line
- S-matrix
- Calibration status
- Measurement format
5 Trace window
6 Network analyzer softkey menu

7.1 Calibrating Measurements

In its default state, the R&S FSH uses factory calibration. Factory calibration is a full 2-port calibration over the current frequency range (i.e. span) of the R&S FSH. When factory calibration is active, the status line reads (fcal). In many cases, this calibration already provides accurate results.

To get the best and most accurate results, however, you have to calibrate the measurement manually, because factory calibration does not take the actual test setup into account (e.g. cables).

Before you calibrate the R&S FSH for the current measurement, you should set the frequency parameters, reference level and attenuation levels. If you change one of these parameters after a successful calibration, it may become invalid.

To successfully calibrate the test setup, you have to connect the calibration standard at the reference plane, usually the output of the RF measurement cable.

During calibration, the R&S FSH removes systematic errors from the measurement. This process is based on correction data it gets while performing the calibration.

The correction data for transmission measurements is based on the results of comparing the transmission characteristics of the test setup to the frequency response of the tracking generator.

Calibration remains valid after turning off the R&S FSH or changing into another operating mode as calibration data is saved in the internal memory of the R&S FSH. If you save the measurement in a dataset, calibration data is part of that dataset. When you restore the dataset and perform the same measurement again, you do not have to recalibrate the R&S FSH.

7.1.1 Calibration States

The R&S FSH features several calibration states. It displays the current state in the status line. The possible states depend on the calibration type (see below).

- (fcal)

  The R&S FSH uses factory calibration. Factory calibration is restored after a preset or self alignment. The R&S FSH also uses factory calibration if you change a frequency parameter (span, start, stop or center frequency) to a value outside the calibrated frequency range or if you measure another s-parameter than the one the R&S FSH is calibrated for.

  The calibration data for the factory calibration is already in the memory of the R&S FSH when it is delivered. The factory calibration is a full two-port calibration.

  You can restore the factory calibration manually any time.

  - Press the "Calibration" softkey.
  - Select the "User Calibration Off" menu item.

- (fcal?)

  The R&S FSH uses factory calibration. However, the calibration is not accurate because the power of the tracking generator and the attenuation at the RF input are not in line with the default settings. In that case you should repeat calibration.

- (norm)

  The R&S FSH uses normalization. To get that state you have to normalize the transmission.

- (norm?)

  The R&S FSH uses normalization. However, the normalization is not accurate because the TG power and receiver attenuation are not in line with the settings at the time it has been calibrated. In that case you should repeat calibration.

- (interp) (network analysis only)

  The R&S FSH interpolates the correction data between the reference points of the calibration. Interpolation is used when you change one of the frequency parameters (start, stop or center frequency). In that case the distribution of the measurement points is different to the distribution during calibration. This could result in an increasing measurement uncertainty.

When calibration has become invalid for any reason or the calibration data has changed, you can restore the most recent calibration that was valid.

► Press the "Calibration" softkey.

► Select the "Restore Calibration Settings" menu item.

The R&S FSH restores the calibration data and the frequency settings that were active.

7.1.2 Calibration Methods

Scalar measurements provide normalization of transmission.

Normalization is a simple but effective way to calibrate the measurement using one calibration standard only. The correction data is deducted from this measurement.

7.1.3 Performing Calibration

To perform normalization of the transmission measurement, you need a "Through" connection between the two ports only.

► Disconnect the DUT from the RF cable.

After disconnecting the DUT, the R&S FSH is ready for calibration.

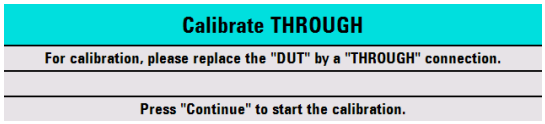
► Press the MEAS key.

► Press the "Calibration" softkey.

► Select the "Normalize Transmission" menu item.

►

The R&S FSH asks you to set up a "Through" connection from port 1 to port 2.



► Firmly connect the "Through" connection to port 1 and port 2.

► Press the "Continue" softkey to start calibration.

The R&S FSH calibrates the "Through" connection.

After finishing the calibration routine, the R&S FSH shows that calibration is finished for a short time (**Calibration done!**). The status line now says (Cal) to indicate successful calibration.

7.2 Performing Scalar Measurements

With scalar measurements, you can measure the magnitude of both reflection and transmission characteristics of a device under test. To calibrate the measurements, only normalization is available.

7.2.1 Measuring the Transmission

The example included here is based on a transmission measurement of a two-port filter. The filter has a center frequency of 2060 MHz and a bandwidth of about 11 MHz.

Test setup

► Connect the input of the DUT to the tracking generator output (port 2).

► Connect the output of the DUT to the RF input (port 1).

Preset the R&S FSH

Before starting the measurement procedure, preset the R&S FSH to restore the default configuration and connect the filter between the measurement ports.

► Press the PRESET key.

► Connect the DUT.

Select the type of transmission measurement

► Press the "Result Display" softkey.

► Select the "Transmission Rev (Port 1►2)" menu item for transmission measurements in reverse direction.

Define the frequency parameters

Before calibrating the measurement, you should define the frequency parameters to avoid inaccurate results because of invalid calibration.

► Press the FREQ key.

The R&S FSH opens an input field to set the center frequency.

► Enter a frequency of 2060 MHz.

► Press the SPAN key.

The R&S FSH opens an input field to define the span.

► Enter a span of 50 MHz to get a high resolution of the results.

Calibrate the measurement for scalar transmission measurements.

Scalar measurements provide normalization only. Normalization is not as accurate as a full calibration, but yields pretty accurate results nonetheless. In addition, normalization needs one calibration standard only and therefore is faster than a full calibration.

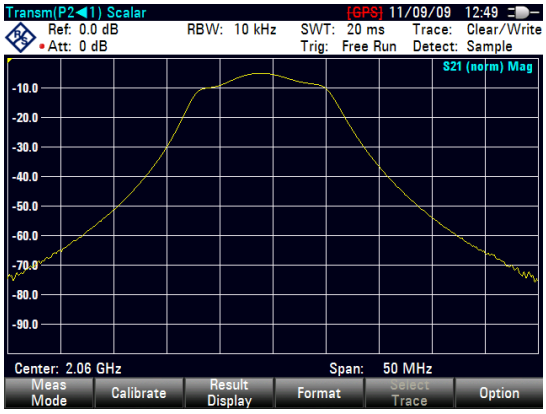
► Press the "Calibration" softkey.

► Select the "Normalize Transmission Rev (Port 1►2) menu item.

► Perform normalization. For more information see "Performing Calibration".

► Reconnect the DUT.

The R&S FSH shows the results of the scalar transmission measurement on the filter.



You can change the measurement configuration (e.g. select another sweep time or detector) without affecting the accuracy of the measurement except the frequency parameters and attenuation.

7.3 Evaluating the Results

7.3.1 Configuring the Vertical Axis

Some results may not fit in the diagram area as it is configured in the default state of the R&S FSH (for example measurements on amplifiers).

If you are performing measurements on an amplifier, you most likely have to change the scaling of the vertical axis in order to see the complete transmission function.

The R&S FSH provides several ways to adjust the scaling of the vertical axis.

Changing the reference value

Changing the reference value works like an attenuation or gain in that it moves the trace to another level. The R&S FSH adjusts the scale of the vertical axis accordingly. The R&S FSH indicates the value and position of the current reference value with a triangle at the vertical axis (0.0). In the default state, it is 0 dB and its position is the grid line at the top of the diagram.

The reference value only changes the 0 dB reference without actually attenuating or amplifying the signal level.

When changing the reference value, make sure that you do not overload the R&S FSH. As long as the trace is completely within the diagram area and the reference position at the top of the diagram, the risk of an overload is eliminated.

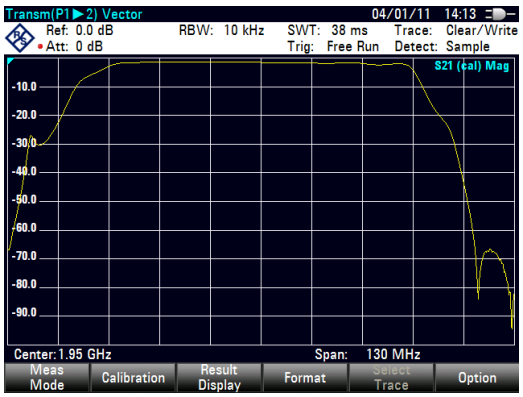
► Press the AMPT key.

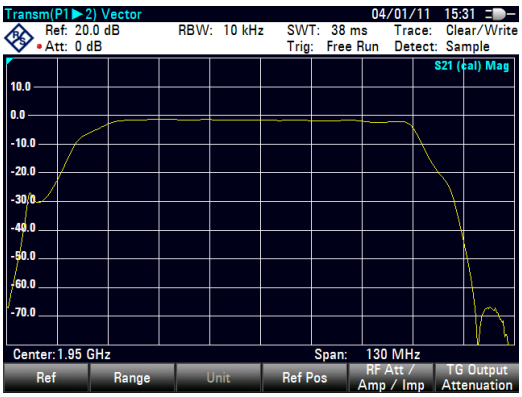
► Press the "Ref" softkey.

The R&S FSH opens an input field.

► Enter the reference value you need to see the trace completely.

The R&S FSH moves the trace accordingly, relabels the vertical axis and shows the new 0 dB reference in the hardware settings display.





Changing the reference position

Changing the reference position moves the position of the reference value up or down. The reference position also moves the trace up or down. The levels and the reference value, however, remain the same. The default reference position is the grid line at the top of the diagram. The reference position is indicated by a triangle at the vertical axis (10.0).

The reference position is a number between 0 and 10 with 0 being the grid line at the bottom and 10 being the grid line at the top of the diagram.

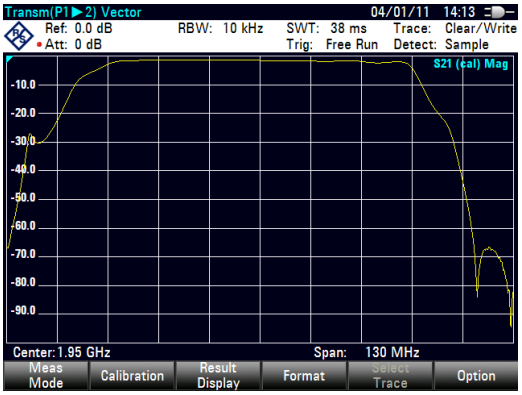
► Press the AMPT key.

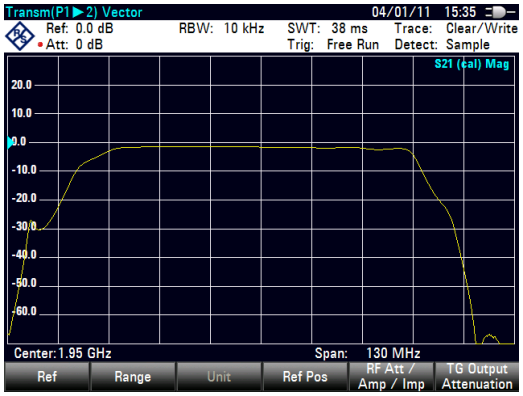
► Press the "Ref Pos" softkey.

The R&S FSH opens an input field.

► Enter the new position of the reference value.

The R&S FSH moves the trace accordingly and moves the triangle to the new position.





Changing the display range

The display range is the value range the vertical axis covers..

When you change the display range, the reference value and position remain the same. Merely the scale of the vertical axis is compressed or expanded.

► Press the AMPT key.

► Press the "Range" softkey.

► Select the display range you need from the submenu.

The R&S FSH adjusts the vertical axis accordingly.

Automatic scaling of the vertical axis

All measurement formats except the Smith chart feature an automatic scale function.

If you use automatic scaling, the R&S FSH automatically sets the display range in a way that the trace best fits on the display.

► In the "Range" submenu, select the "Auto Scale" menu item.

7.3.2 Using Markers

The network analyzer mode also features markers. The functionality is similar to that of the spectrum analyzer.

For more information see "Using Markers" on page 100.

7.3.3 Working with Channel Tables

The R&S FSH allows you to use channel tables in network analyzer mode.

► Press the FREQ key.

► Press the "Channel Table" softkey.

The R&S FSH opens the list of channel tables loaded into the R&S FSH via R&S InstrumentView.

► Select the channel table you need.

The R&S FSH scans the channel table for the channels with the lowest and highest frequencies and sets those as the start and stop frequency.

The R&S FSH already comes with an assortment of channel tables that you can use without doing anything. If you want to test telecommunications standards that are not listed, you can also build channel tables manually with the "Channel Table Editor" of the R&S InstrumentView software package that is delivered with the R&S FSH. To use one of those, you just have to copy the channel table to the R&S FSH.

7.3.4 Using Limit Lines

When working with the magnitude format in the network analyzer, you can use limit lines to set limits for level characteristics on the display that must not be exceeded.

You can create and edit limit lines with the R&S InstrumentView software and load them into the R&S FSH via the USB or the LAN interface. The number of limit lines the R&S FSH can store in its memory depends on the number of other data sets on the R&S FSH.

For more information see "Managing Datasets" on page 66 und "Using Limit Lines" on page 110.

7.3.5 Using Trace Mathematics

Trace mathematics that subtract one trace from another are available for most measurement formats in the network analyzer mode.

For more information see "Using Trace Mathematics" on page 99.

8 Menu and Softkey Overview

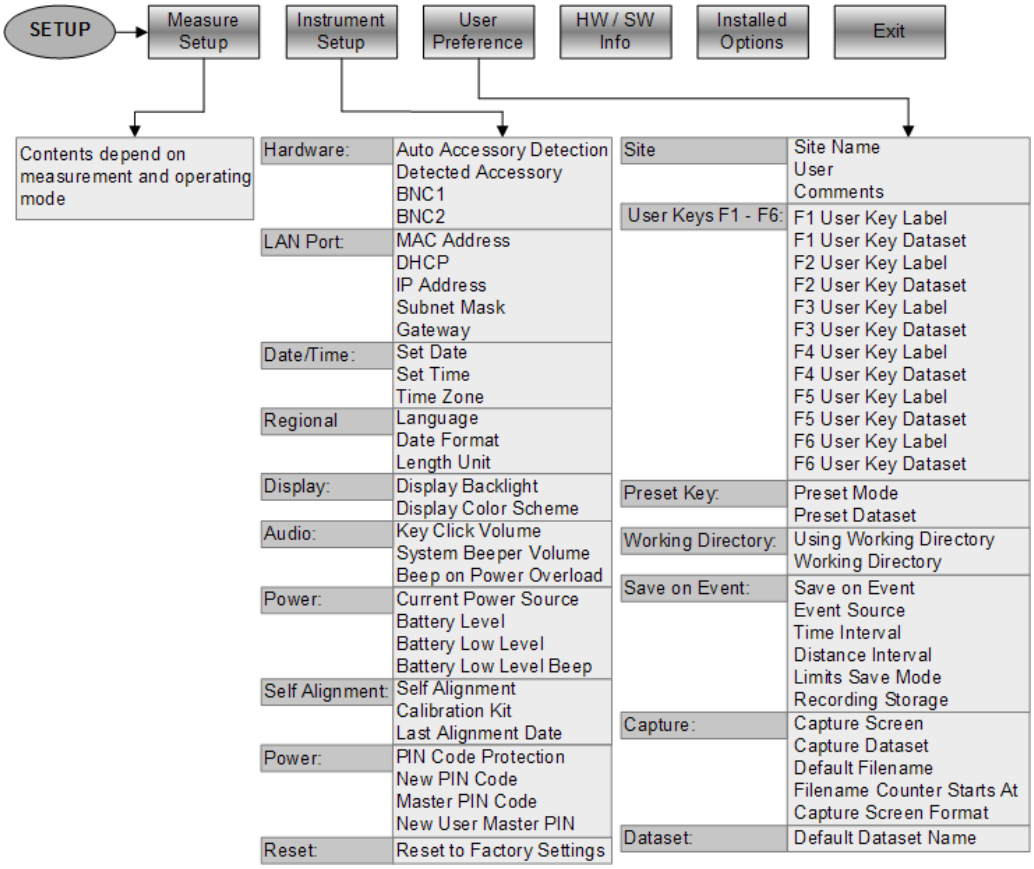
This chapter shows an overview of all instrument functions in the form of softkey and menu overviews.

8.1 General Functions

General functions are those that are available for all operating modes.

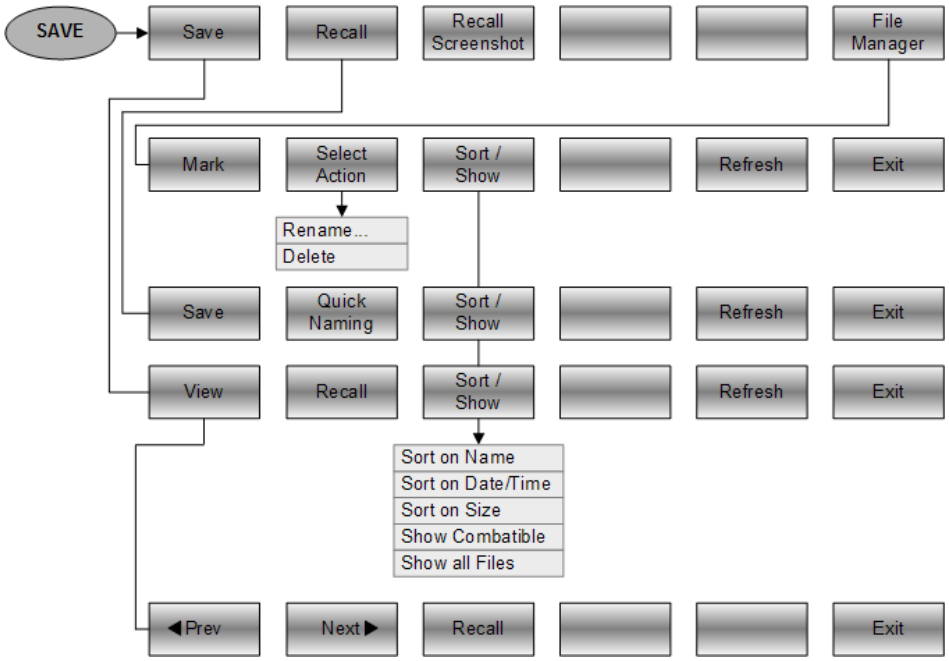
8.1.1 General R&S FSH Setup

The SETUP key opens the setup menu that contains functionality to set up the R&S FSH in general and functionality to set up the measurement.



8.1.2 File Management

The SAVE/RECALL key opens the file manager that contains functionality to manage datasets and other files.



8.1.3 Operating Mode Selection

The MODE key opens the mode menu that contains functionality to select the operating mode of the R&S FSH.

8.2 Functions of the Spectrum Analyzer

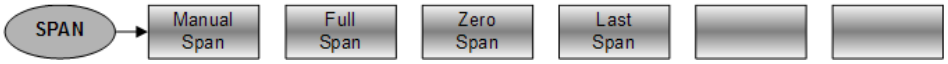
This section contains all softkeys and menus that are available in spectrum analyzer mode.

8.2.1 Frequency Parameters

The FREQ key opens the frequency menu that contains functionality to set up the horizontal axis of the measurement diagram.

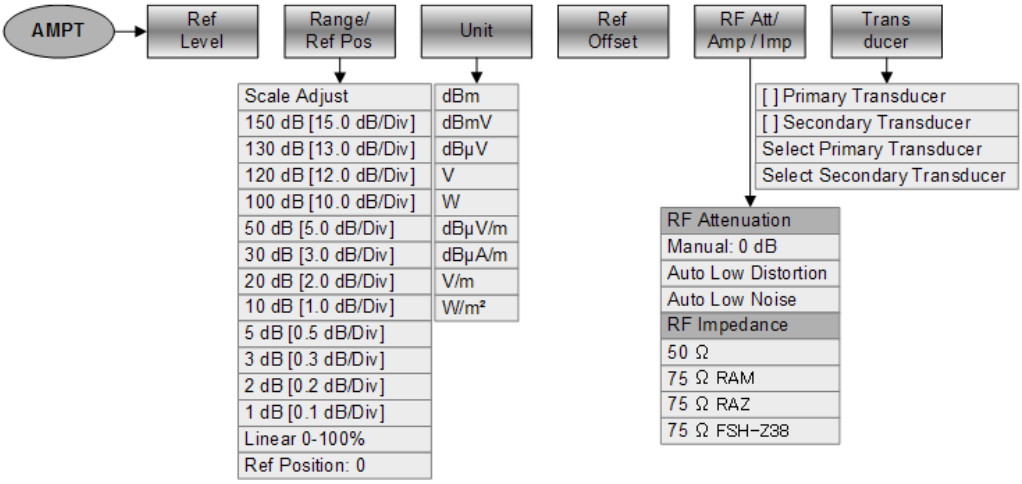
8.2.2 Span Selection

The SPAN key opens the span menu that contains functionality to set the span.



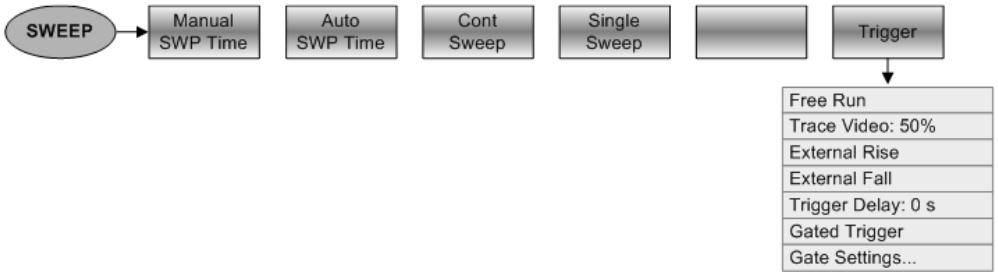
8.2.3 Amplitude Parameters

The AMPT key opens the amplitude menu that contains functionality to set up the vertical axis of the measurement diagram.



8.2.4 Sweep Configuration

The SWEEP key opens a menu that contains all functionality to configure the sweep.

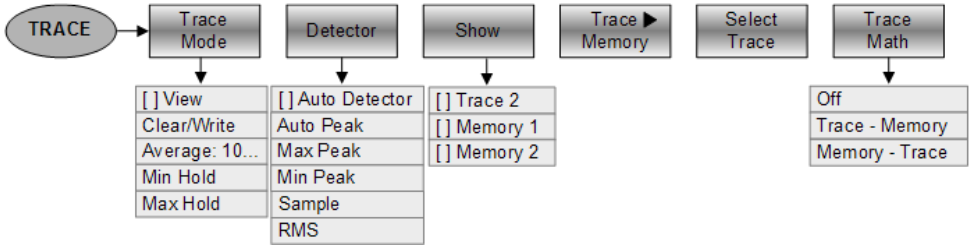


8.2.5 Bandwidth Selection

The BW key opens a menu that contains all functionality to set the bandwidths.

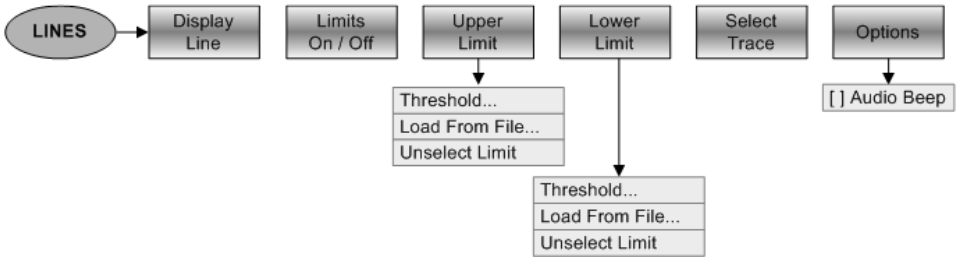
8.2.6 Trace Functionality

The TRACE key opens the trace menu that contains functionality to set up the traces.



8.2.7 Display and Limit Lines

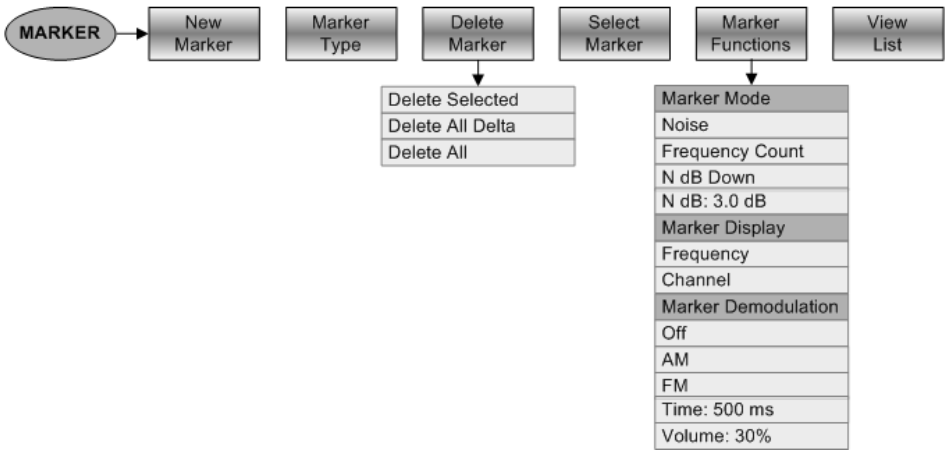
The LINES key opens a menu that contains the functionality to control display and limit lines.



8.2.8 Markers

The MARKER and MKR→ keys open a menus to control markers and use marker functions.

Softkey in the Marker Menu



Softkeys in the Marker To Menu

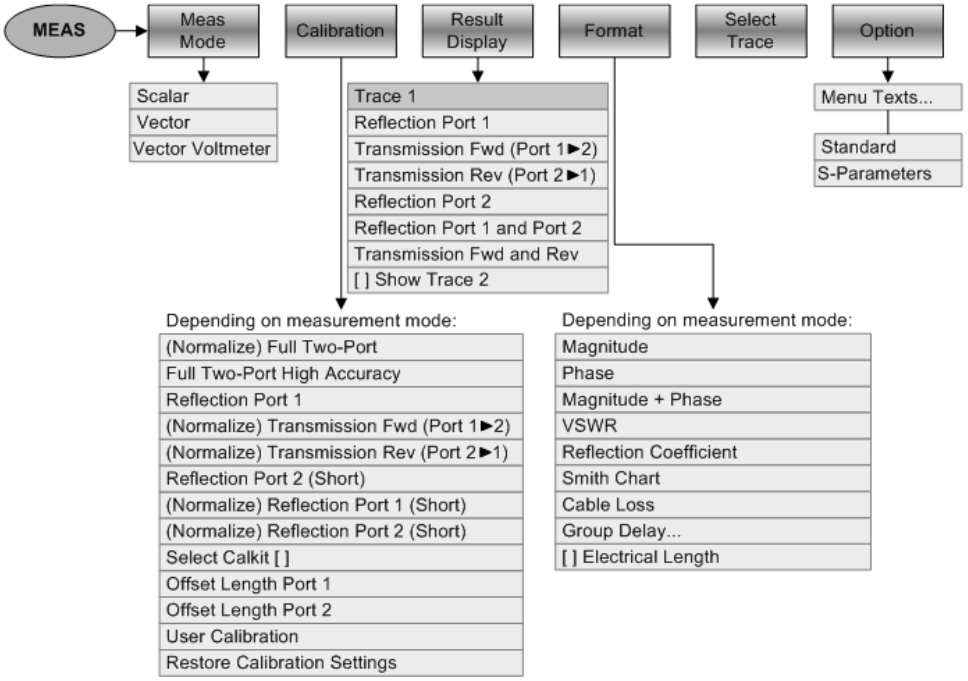
8.3 Functions of the Network Analyzer

This section contains all softkeys and menus that are available in network analyzer mode.

Vector network analyzer functionality is available only with option R&S FSH-K42.

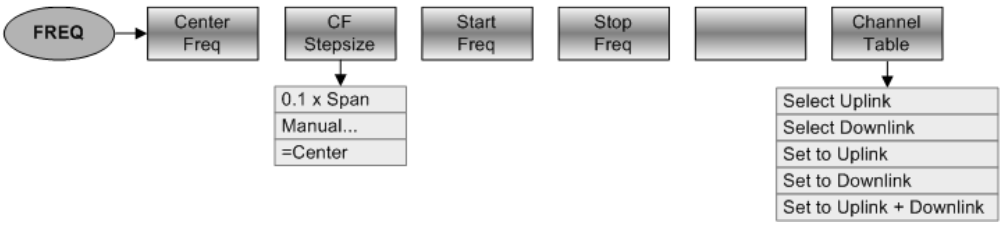
8.3.1 Measurement Configuration

The MEAS key opens the measurement menu that contains functionality to select and configure the measurement.



8.3.2 Frequency Parameters

The FREQ key opens the frequency menu that contains functionality to set up the horizontal axis of the measurement diagram.

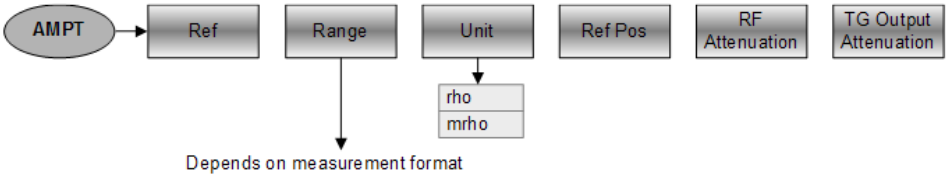


8.3.3 Span Selection

The SPAN key opens the span menu that contains functionality to set the span.

8.3.4 Amplitude Parameters

The AMPT key opens the amplitude menu that contains functionality to set up the vertical axis of the measurement diagram.



8.3.5 Sweep Configuration

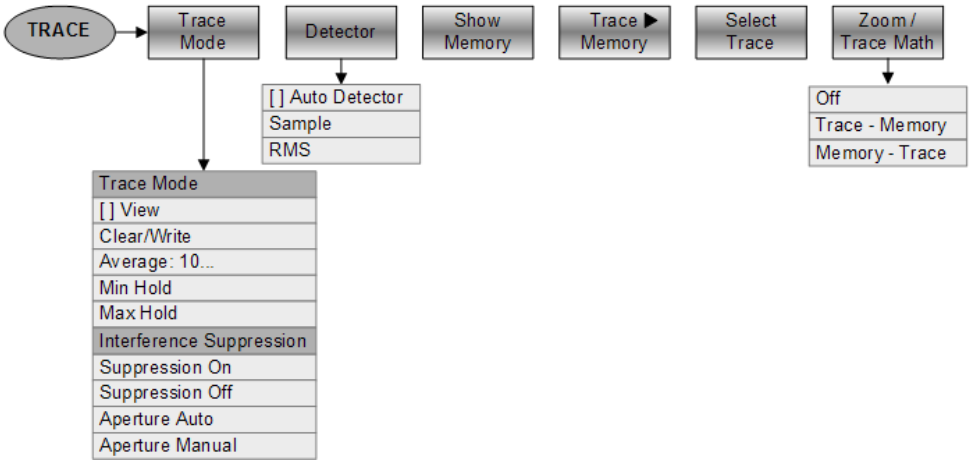
The SWEEP key opens a menu that contains all functionality to configure the sweep.

8.3.6 Bandwidth Selection

The BW key opens a menu that contains all functionality to set the bandwidths.

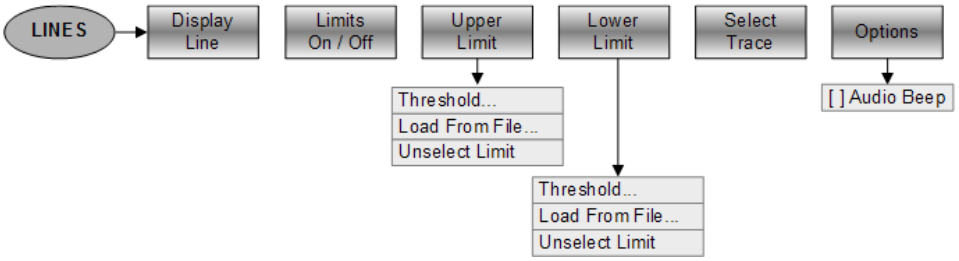
8.3.7 Trace Functionality

The TRACE key opens the trace menu that contains functionality to set up the traces.



8.3.8 Limit Lines

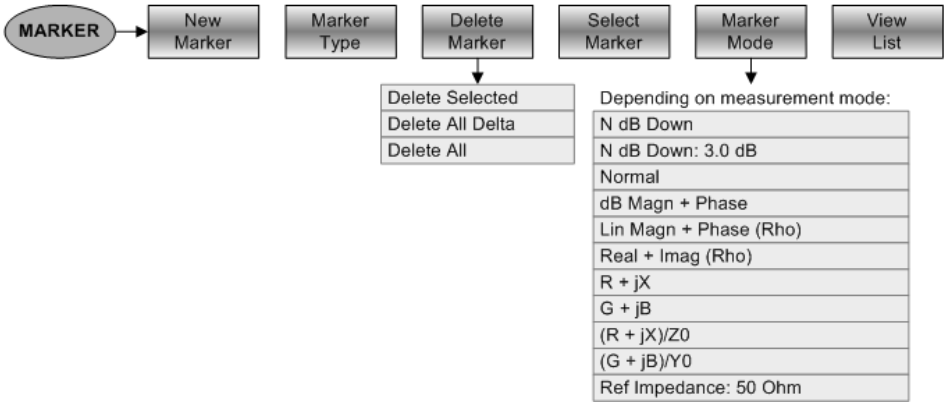
The LINES key opens a menu that contains the functionality to control limit lines.



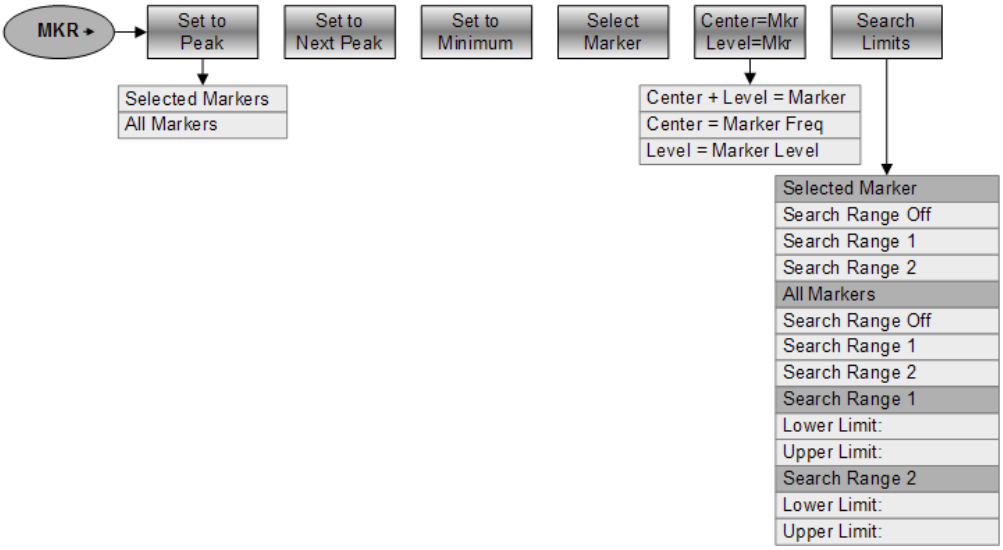
8.3.9 Markers

The MARKER and MKR→ keys open a menus to control markers and use marker functions.

Softkey in the Marker Menu



Softkeys in the Marker To Menu



9 How a Spectrum Analyzer Works

Basically, it is possible to measure and analyze RF signals either in the time domain or the frequency domain.

Measurements in the time domain show signal variations over time. You can perform these with an oscilloscope, for example. Measurements in the frequency domain show the frequency components of a signal. To perform measurements in the frequency domain, you can use a spectrum analyzer.

Both modes are essentially equivalent because applying the Fourier transform to any signal converts it into its spectral components. Depending on the signal characteristic to be measured, one method is usually more appropriate than the other. With an oscilloscope, it is possible to tell whether a signal is a sine wave, a square wave with a certain on/off ratio or a sawtooth wave. However, detecting superimposed low-level signals or monitoring the harmonic content of the signal is easier with a spectrum or signal analyzer.

Figure 9-1 shows the theoretical basis of the two measurement methods. In the time domain, an oscilloscope would, for example, show a section of the signal that is a square wave. The same signal, when viewed with a spectrum analyzer, would show a line spectrum (the fundamental and its harmonics).

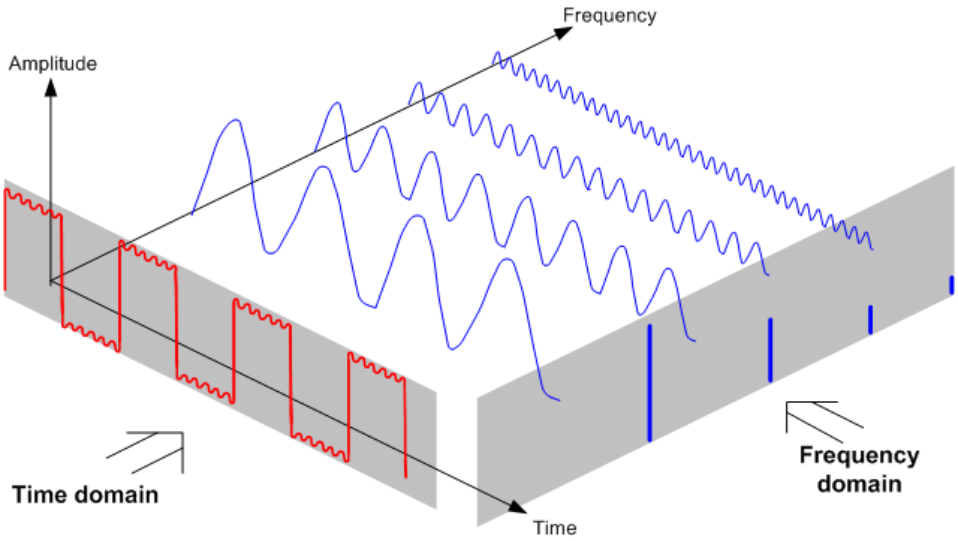


Figure 9-1: Visualization of time domain and frequency domain

Applying the Fourier transform to the periodic square wave transforms it into the frequency domain. The spectrum analyzer would show the fundamental (or frequency of the square wave) and its harmonics.

The spectrum analyzer uses a narrow bandpass filter for measurements in the frequency domain. Only at frequencies containing a signal there is a reading that gives the amplitude of the frequency component.

Figure 9-2 shows the basic principle of how a spectrum analyzer works.

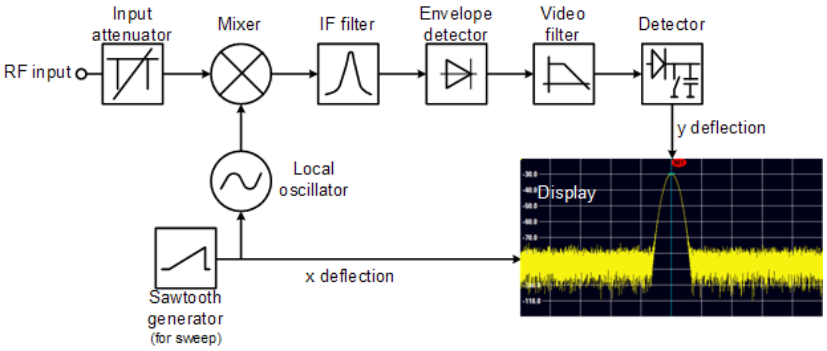


Figure 9-2: Block diagram showing the basic functionality of a spectrum analyzer

The precision attenuator at the R&S FSH input attenuates the signal to a level that the mixer can handle without overdriving the mixer. The attenuator is directly coupled to the reference level. You can attenuate the signal in the range from 0 dB to 40 dB in steps of 5 dB.

The mixer converts the RF signal to a fixed intermediate frequency (IF). This process usually involves several stages. It lasts until you get an IF for which good narrowband filters are available. The R&S FSH needs three mixing stages to get an IF that the filter can handle. Figure 9-3 graphically shows the mixing process.

For models with a frequency limit of 3.6 GHz, the IFs are 4892.8 MHz, 860.8 MHz and 54.4 MHz. The conversion from a specific input frequency to the first IF is done by a local oscillator (LO). This LO can be tuned from 4.8 GHz to 8.4 GHz. All other conversions are handled by single-frequency oscillators.

In case of models with a frequency limit of 8 GHz, the IFs are 8924.8 MHz, 860.8 MHz and 54.4 MHz. The conversion from the first to the second IF for these models is done by a second local oscillator.

The frequency of the local oscillator determines the input frequency at which the spectrum analyzer performs measurements:

$f_{in} = f_{LO} - f_{IF}$.

The first mixer produces the sum frequency $f_{LO} + f_{in}$ (= image frequency f_{image}) as well as the difference frequency $f_{LO} - f_{in}$.

The image frequency is rejected by the bandpass at the IF so that it does not interfere with the subsequent frequency conversions.

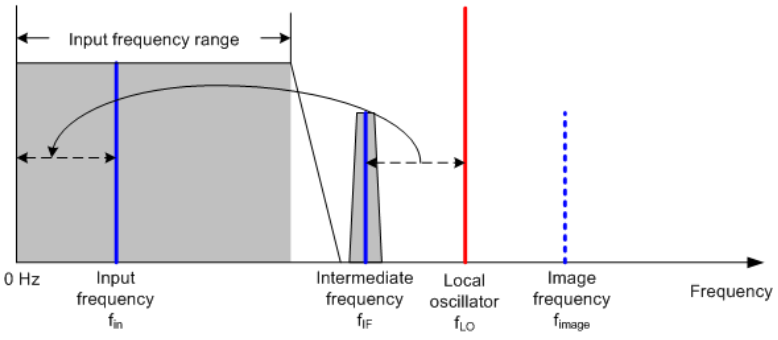


Figure 9-3: Mixing process

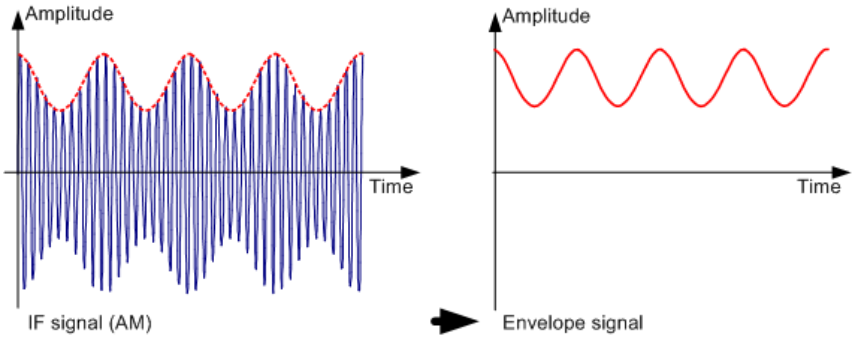
The first local oscillator is tuned with a sawtooth which simultaneously acts as the x deflection voltage for the display. In practice, synthesizer technology is used to generate the frequency of the first local oscillator and for a digital display.

The instantaneous sawtooth voltage therefore determines the input frequency of the spectrum analyzer.

The bandwidth of the IF filter at the IF determines the bandwidth that is used for measurements. Pure sine signals are passed by the IF filter characteristics. This means that signals closer together than the bandwidth of the IF filter cannot be resolved. This is why the bandwidth of the IF filter in a spectrum analyzer is referred to as the resolution bandwidth. The R&S FSH has resolution bandwidths from 1 Hz to 3 MHz.

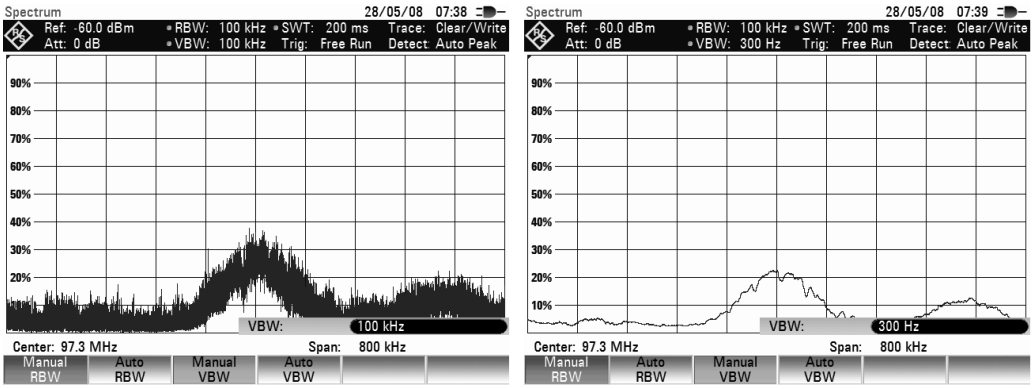
The bandlimited IF is passed to the envelope detector. The envelope detector removes the IF from the signal and outputs its envelope. The output signal from the envelope detector is referred to as the video signal. As it has been demodulated, it only contains amplitude information. The phase information is lost.

With RF sine signals, the video signal is a DC voltage. With AM signals the video signal contains a DC component whose amplitude corresponds to the carrier power and an AC component whose frequency is equal to the modulation frequency, provided the modulation frequency is inside the resolution bandwidth.



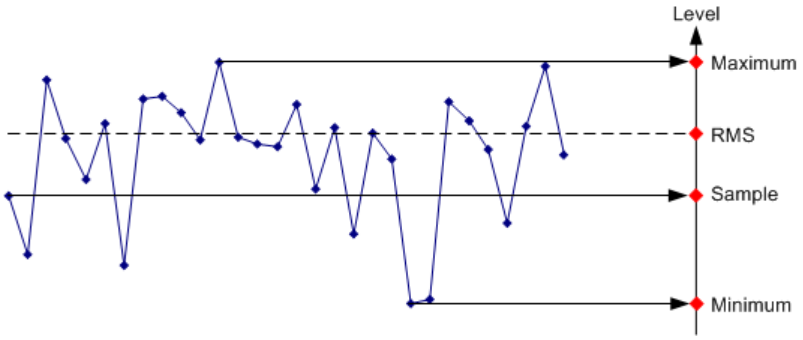
The video filter comes after the envelope detector. The filter is a lowpass with an adjustable cutoff frequency which limits the bandwidth of the video signal. It is particularly useful when sine signals are to be measured in the vicinity of the spectrum analyzer's intrinsic noise. The sine signal produces a video signal that is a DC voltage. At the IF, however, the noise is distributed over the whole bandwidth or, in the case of the video signal, over half the bandwidth of the resolution filter. By selecting a narrow video bandwidth relative to the resolution bandwidth, the noise can be suppressed, while the sine signal to be measured (= DC) is not affected.

The figures below show a weak sine signal. In the first picture, it is measured with a large video bandwidth and in the second with a narrow video bandwidth.



Limiting the video bandwidth smoothes the trace considerably. This makes it much easier to determine the level of the measured signal.

The detector comes after the video filter. The detector combines the measured spectrum so that it can be represented as one pixel in the trace. The R&S FSH uses 631 pixels to form the trace, i.e. the whole measured spectrum has to be represented using just 631 pixels. Common types of spectrum analyzer detectors are the peak detector (PEAK), the sample detector (SAMPLE) and the RMS detector (RMS). An Auto Peak detector which simultaneously displays the maximum peak and the minimum peak is usually also provided. The Fig. below explains how these detectors work.



The figure above shows 30 measured values which are represented by a single pixel. The peak detector determines and displays the maximum measured value. The Auto Peak detector takes the maximum and minimum and displays them together. The two values are joined by a vertical line segment. This gives a good indication of the level variation over the measured values represented by a single pixel. The RMS detector is used by the spectrum analyzer to determine the RMS value of the measured values. It is therefore a measure of the spectral power represented by a pixel. The sample detector takes an arbitrary measurement value and displays it (in the Fig. above, the first). The other measured values are ignored.

On the basis of the operating principles of detectors, a few recommendations can be made as to their use.

- It is best to use the Auto Peak detector or the peak detector for spectrum analysis over large frequency ranges. This ensures that all signals are displayed.
- The RMS detector is recommended for power measurements on modulated signals. However, the display range should be chosen so as not to exceed 100 times the bandwidth of the signal or the resolution bandwidth, whichever is larger.
- The sample detector or the RMS detector (preferred) should be used for noise measurements. Only these two detectors are capable of measuring noise power correctly.
- When measurements are made on sine signals, the level display does not depend on the detector. However, if you use the RMS detector or the sample detector, ensure that the span is not too great. Otherwise, the displayed levels of sine signals may be lower than their true value.

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