# R&S Spectrum Analyzers

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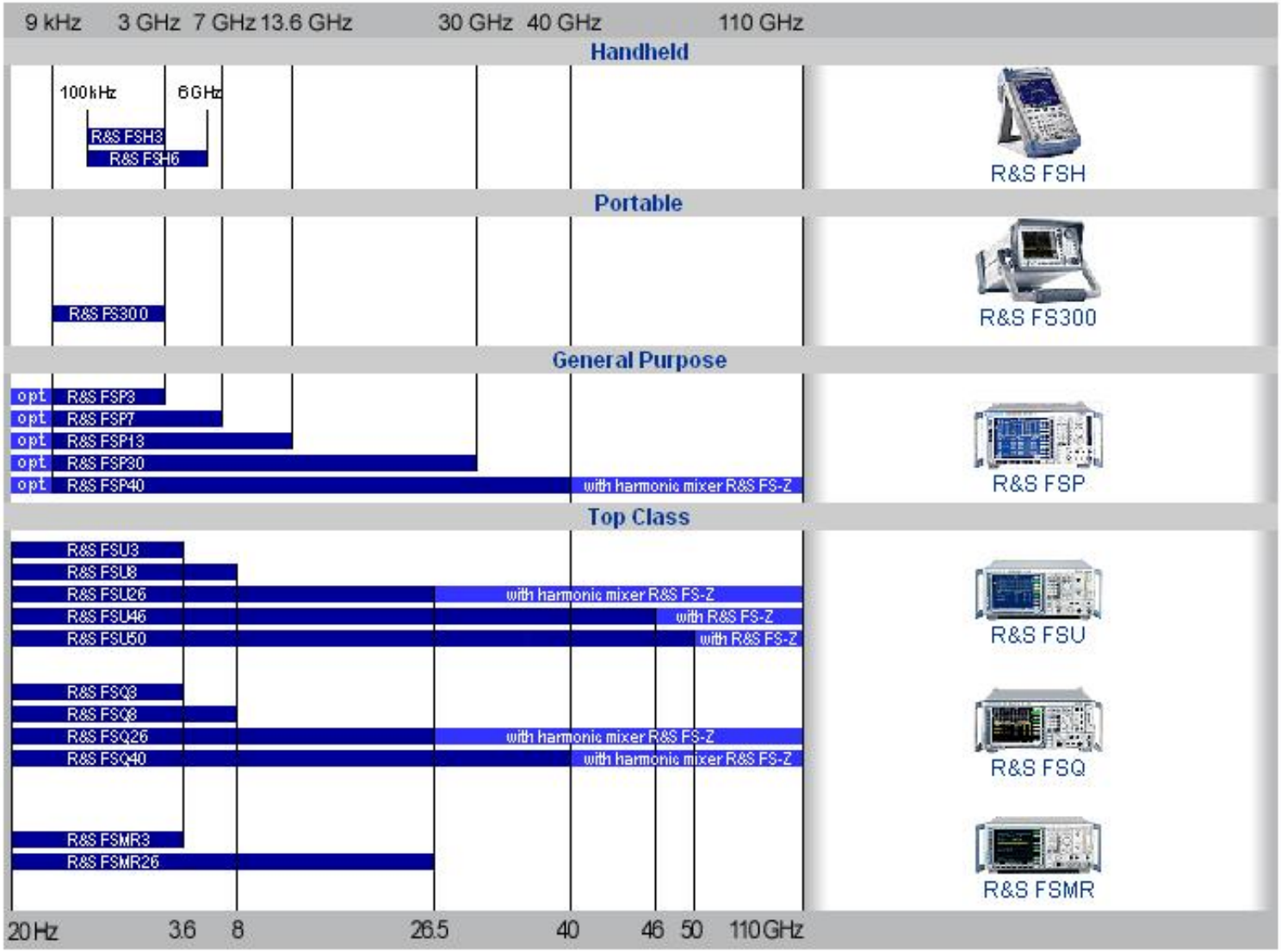
# General Spectrum Analyzers



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# Further extension of the frequency range:
# External mixers

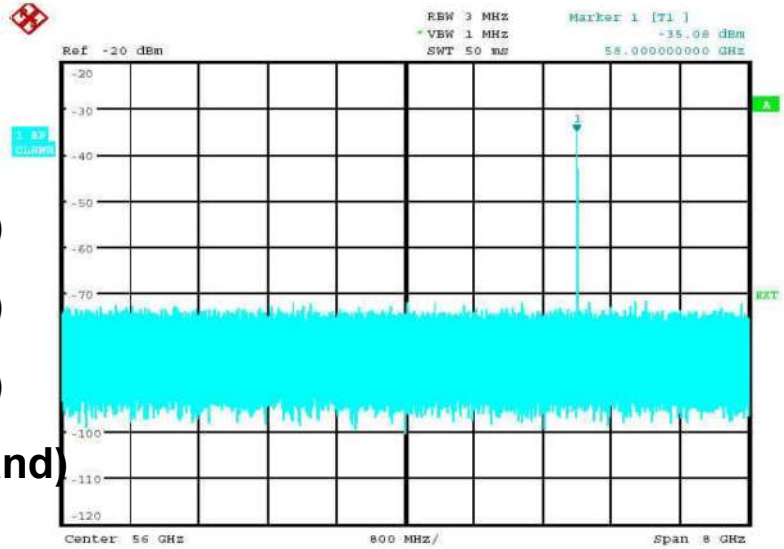
## Avaliable for:

- § FSQ26 & FSQ40
- § FSU 26 & FSU 46& FSU50
- § FSP 40

## LO/IF Ports for External Mixers:

**FSQ & FSU: Option FSU-B21**

**FSP: Option FSP-B21**




## Mixers:

**FS-Z60: 40 GHz to 60 GHz (V band)**

**FS-Z75: 50 GHz to 75 GHz (V band)**

**FS-Z90: 60 GHz to 90 GHz (E band)**

**FS-Z110: 75 GHz to 110 GHz (W band)**



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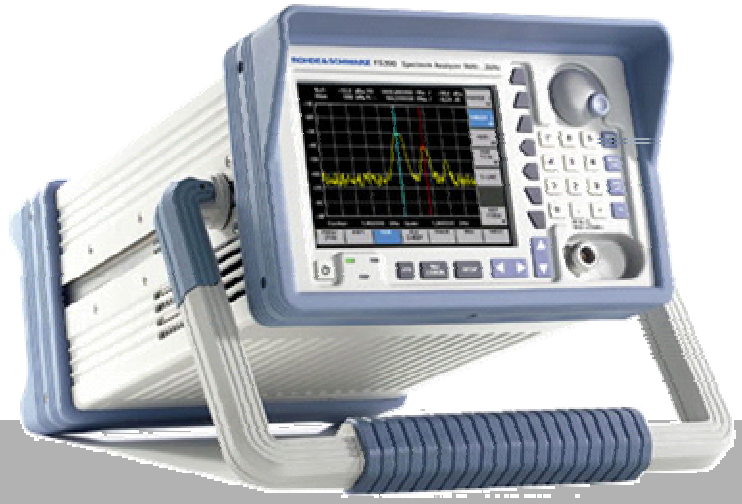
# The FS300 Series



**Applications:**

**The FS300 is the extension of the product palette of R&S spectrum analyzers to the low price segment. The FS300 with its in this price segment unrivalled HF performance is merely designed for:**

**§ orientating measurements in labs where the budget doesn't allow to buy as many high end devices as needed (often old, heavy HP equipment is used)**

**§ measurements in development and production where compliance to highly sophisticated standards (e.g. mobile comm. standards) is not necessary**

**§ training in universities and education sites**

**§ simple lab applications**

**§ portable applications**

# The FSH Series

FSH3 100 kHz – 3 GHz
FSH6 100 kHz – 6 GHz

**Main Applications:**

§ Installation
§ Maintenance
§ Service
§ Simple lab applications
§ Signal Monitoring

**Installation and Maintenance of Transmitter Stations**

Power measurement
Measurement of antenna SWR
Measurement of cable faults / cable loss

**Field-strength Measurement**

Measurement of interferer
Measurement of useful signals



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# General Purpose and Top Class

## FSQ

**High end spectrum analyzer like FSU with demodulation bandwidth of up to 120 MHz and general purpose vector signal analysis option**

## FSU

**High end spectrum analyzer for development and production of high end RF components (e.g. base transceiver stations)**

## FSP

**General purpose spectrum analyzer for development and production**

Wide range of application firmware for communication standards and other relevant RF measurement



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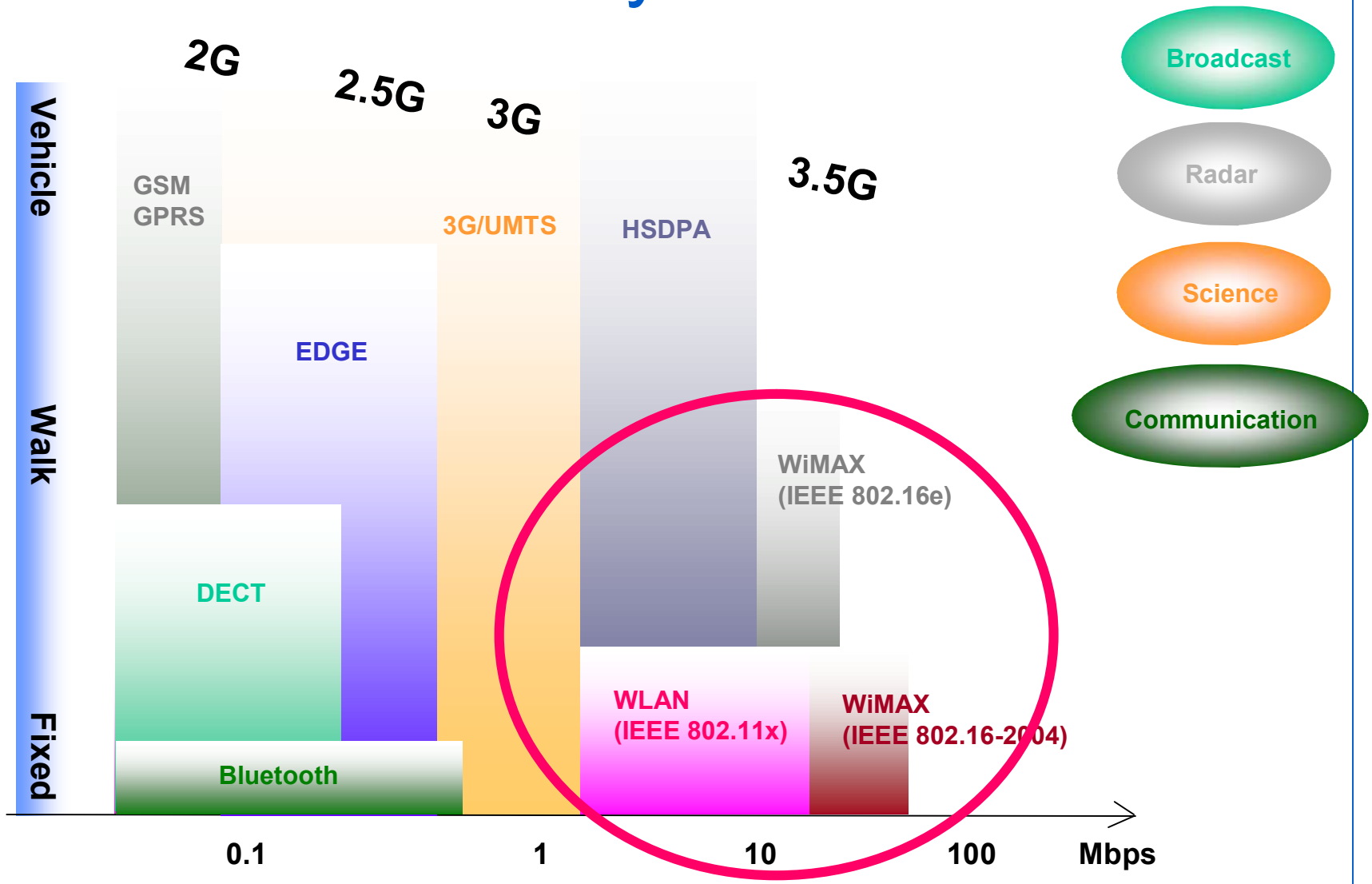
# Wireless Systems



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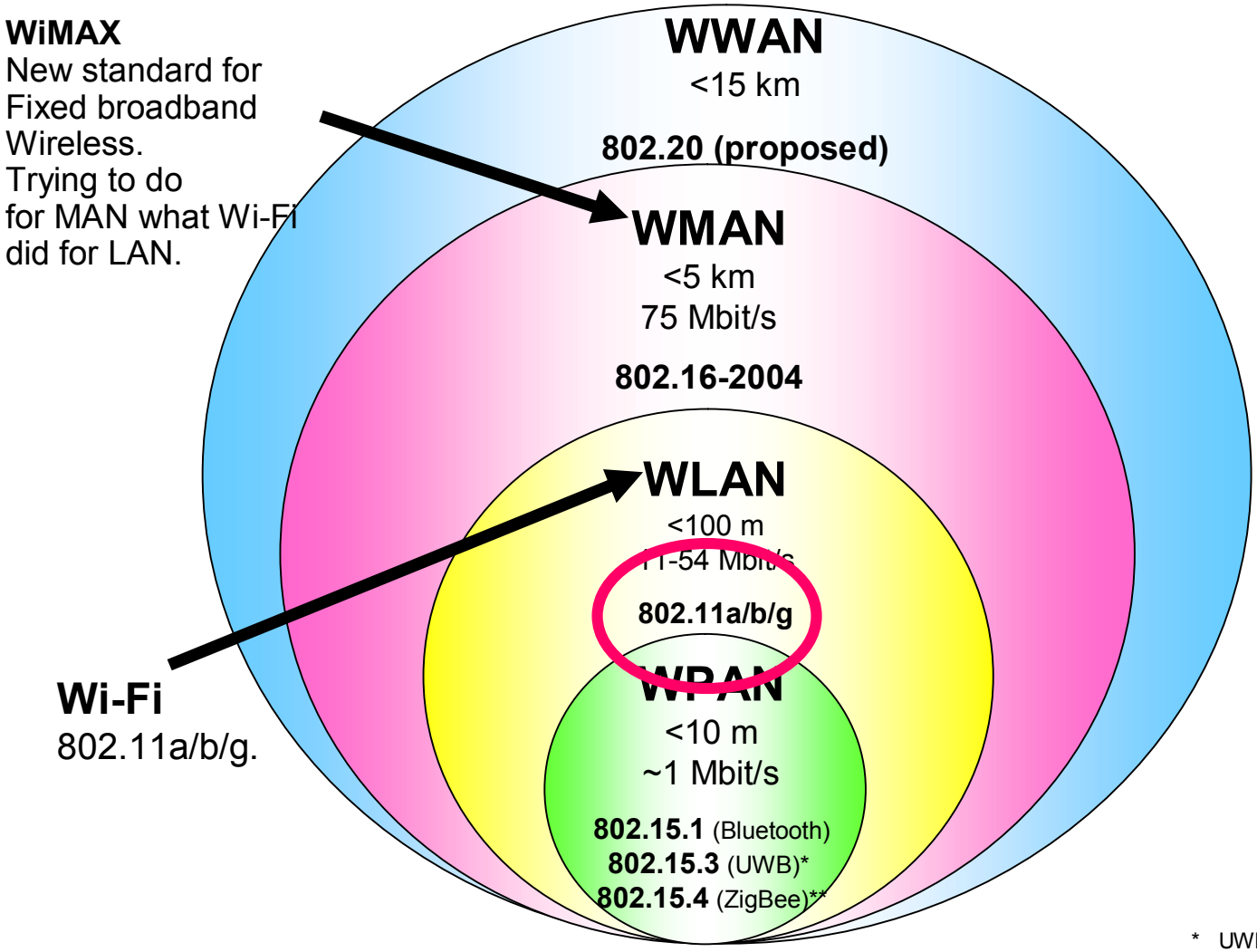
# Wireless Network Technologies




Source: International Telecommunications Union, “Birth of Broadband”, September 2003

* UWB: 100 Mbit/s
** ZigBee: 250 kbps



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# IEEE 802.11a Transmitter Tests

| | |
|---|---|
| 17.3.9.1 | TX power level |
| 17.3.9.2 | TX spectrum mask measurement |
| 17.3.9.3 | TX spurious |
| 17.3.9.4 | TX center frequency tolerance |
| 17.3.9.5 | Symbol clock frequency tolerance |
| 17.3.9.6.1 | TX carrier leakage |
| 17.3.9.6.2 | TX spectral flatness |
| 17.3.9.6.3 | TX constellation error (EVM) |

Adjacent Channel Power Measurement (TX)



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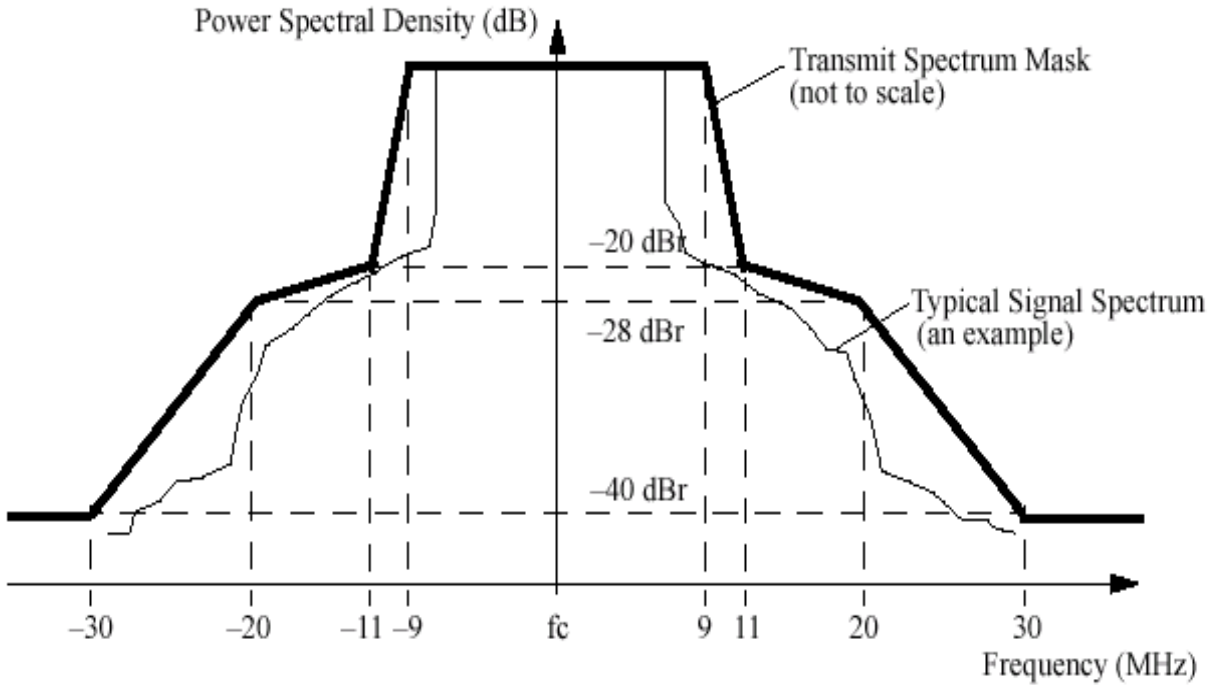
# Spectrum Mask

Spectrum measurement, RBW: 100 kHz, VBW: 30 kHz

Spectral mask:



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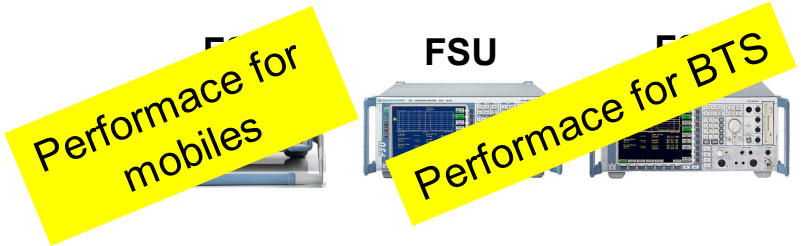
# Instruments

Evaluation of TX spectrum:

- TX power
- TX spurious
- Center Frequency
- Occupied bandwidth
- Spectrum emission mask
- …

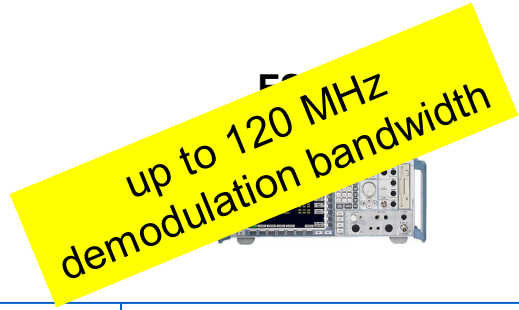
Evaluation of modulation quality (EVM), bandwidth < 10 MHz (3G/UMTS):

- Constellation error
- EVM
- ….




Evaluation of modulation quality (EVM), bandwidth > 10 MHz (WLAN 802.11a/b/g, WiMAX 802.16):

- Constellation error
- EVM
- ….



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# Handheld Spectrum Analyzer R&S FSH

## Model Overview

| Model | Frequency Range | Tracking Generator | Output Level Tracking Generator | Preamplifier | Resolution Bandwidth |
|---|---|---|---|---|---|
| FSH3 Model 03 | 100 kHz to 3 GHz | - | - | þ | 100 Hz to 1 MHz |
| FSH3 Model 13 | 100 kHz to 3 GHz | þ | -20 dBm | - | 1 kHz to 1 MHz |
| FSH3 Model 23 | 100 kHz to 3 GHz | þ | -20 dBm/0dBm | þ | 100 Hz to 1 MHz |
| FSH6 Model 06 | 100 kHz to 6 GHz | - | - | þ | 100 Hz to 1 MHz |
| FSH6 Model 26 | 100 kHz to 6 GHz | þ | - 10 dBm (f<3GHz)<br>- 20 dBm (f>3GHz) | þ | 100 Hz to 1 MHz |



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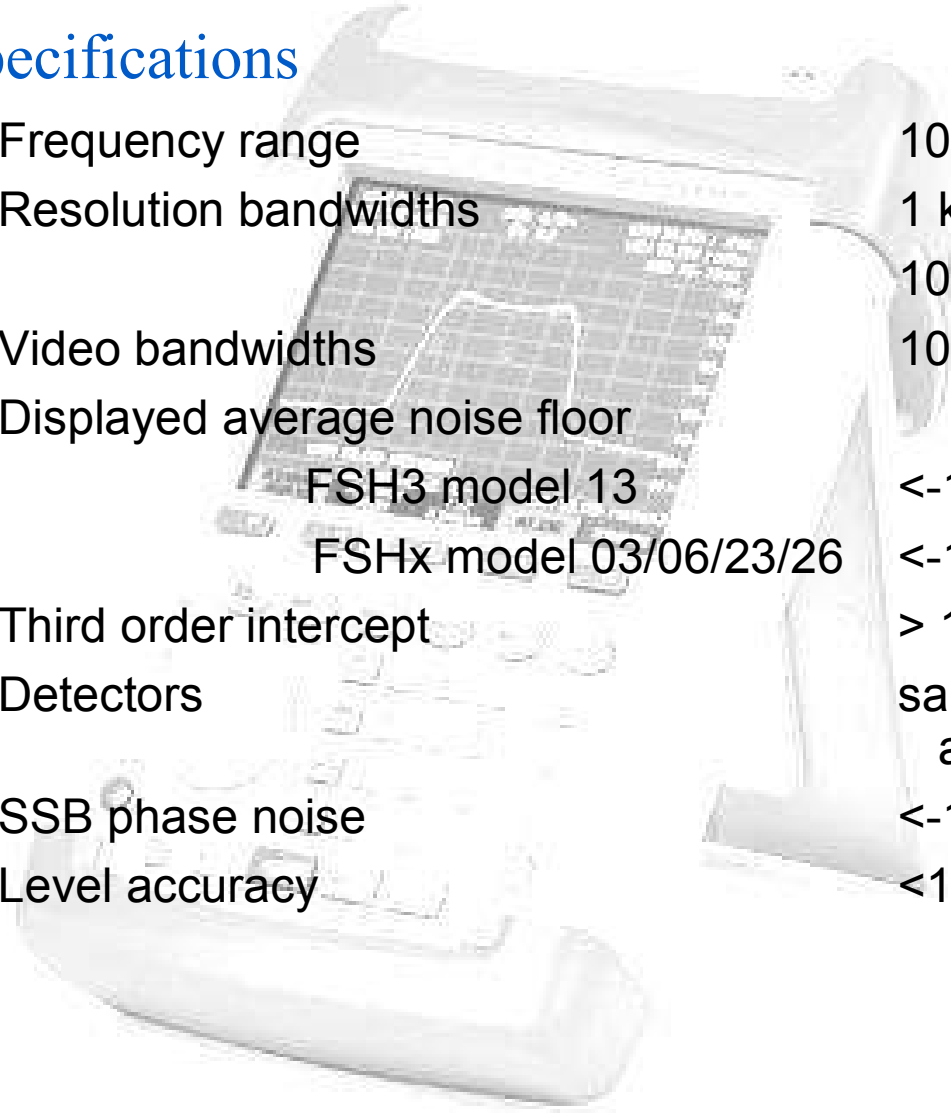
# Handheld Spectrum Analyzer R&S FSH

## Specifications



| | |
|---|---|
| Frequency range | 100 kHz to 3/6 GHz |
| Resolution bandwidths | 1 kHz to 1 MHz (R&S FSH3 model13) |
| | 100 Hz to 1 MHz (R&S FSHx Model 03/23/06/26) |
| Video bandwidths | 10 Hz to 1 MHz |
| Displayed average noise floor | |
| FSH3 model 13 | <-105 dBm, typ. -114 dBm (1 kHz RBW) |
| FSHx model 03/06/23/26 | <-130 dBm, typ. -135 dBm (100 Hz RBW) |
| Third order intercept | > 10 dBm, typ. 13 dBm |
| Detectors | sample, max-peak,min-peak, auto-peak, **RMS** |
| SSB phase noise | <-100 dBc(1 Hz) @100 kHz offset |
| Level accuracy | <1.5 dB typ. 0.5 dB |



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# Handheld Spectrum Analyzer R&S FSH

## Specifications cont.

Display 5.7”, VGA color display, 320 x240 pixels

Power Consumption <7 W (including TG)

Battery operating time up to 4 h

Weight 2.5 kg

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# Handheld Spectrum Analyzer R&S FSH

## Standard Functions

- Channel-power measurement
- TDMA-power measurement
- Occupied  bandwidth measurement
- Field strength measurement
- Channel tables
- C/N measurement
- Frequency counter with 1 Hz resolution
- 6 Marker or delta-marker, noise marker
- Limit line monitoring
- External Trigger IN/ external REF IN
- AM/FM Demodulator (earphone connector)

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# Handheld Spectrum Analyzer R&S FSH

## Options for R&S FSH, all models

- Power sensor 10 MHz to  8 GHz
- Power sensor 10 MHz to 18 GHz
- Directional power sensor 200 MHz to 4 GHz
- Directional power sensor 25 MHz to 1 GHz
- Remote Control via RS232 interface
- Receiver mode

## Options for R&S FSH with tracking generator (model 13/23/26)

- VSWR Bridge (10 MHz to 3 GHz)
- Vector reflection and transmission measurement
- Distance-to-fault measurement

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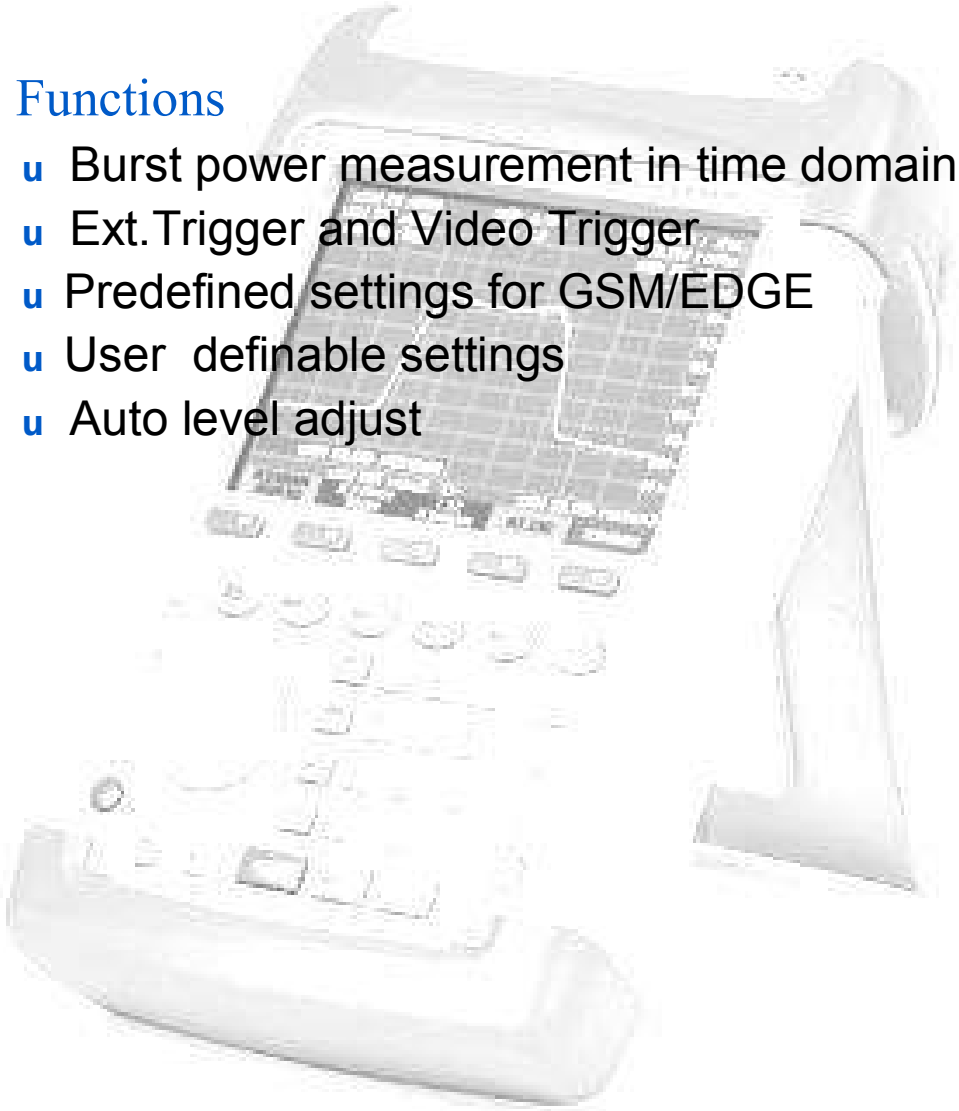
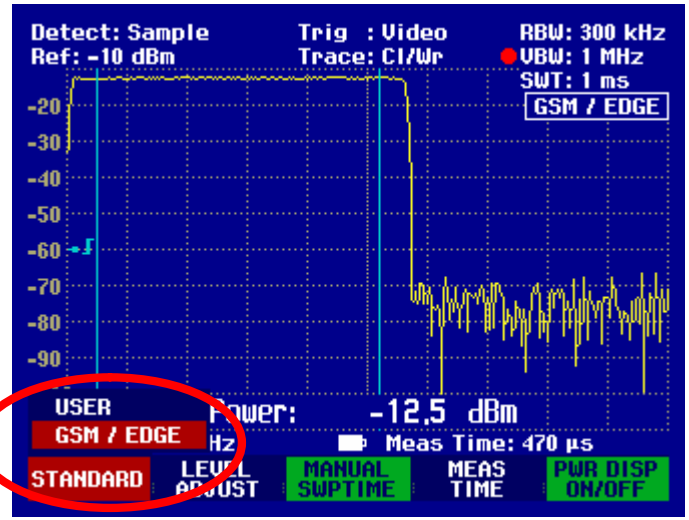
# TDMA Power

## Functions

- Burst power measurement in time domain
- Ext.Trigger and Video Trigger
- Predefined settings for GSM/EDGE
- User definable settings
- Auto level adjust





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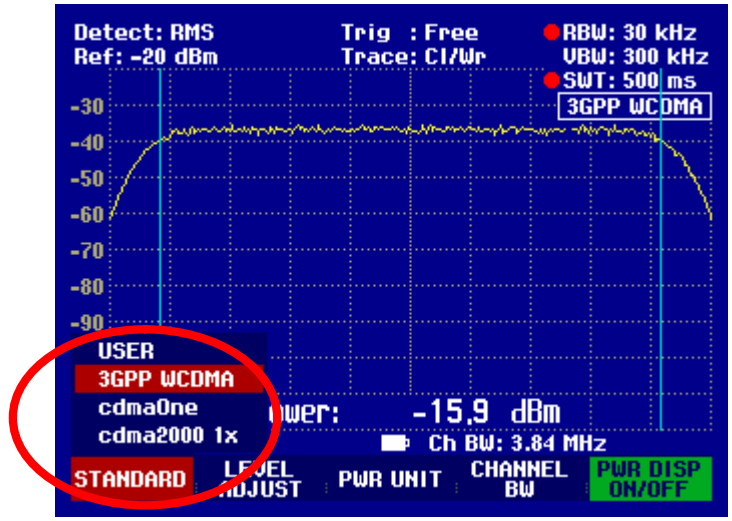
# Channel Power

## Functions

- Channel power measurement using RMS Detector
- Predefined settings for 3GPP, cdmaOne, CDMA2000 1x
- User definable settings
- Auto level adjust



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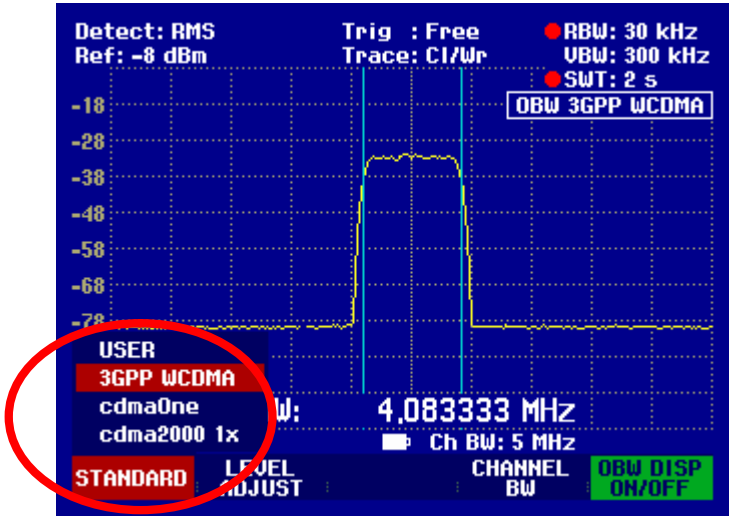
# Occupied Bandwidth

## Functions

- Measuring the occupied bandwidth, which is defined as the bandwidth in which a specified percent (99 %) of power is transmitted.
- Predefined settings for 3GPP, cdmaOne, CDMA2000 1x
- User definable settings
- Auto level adjust



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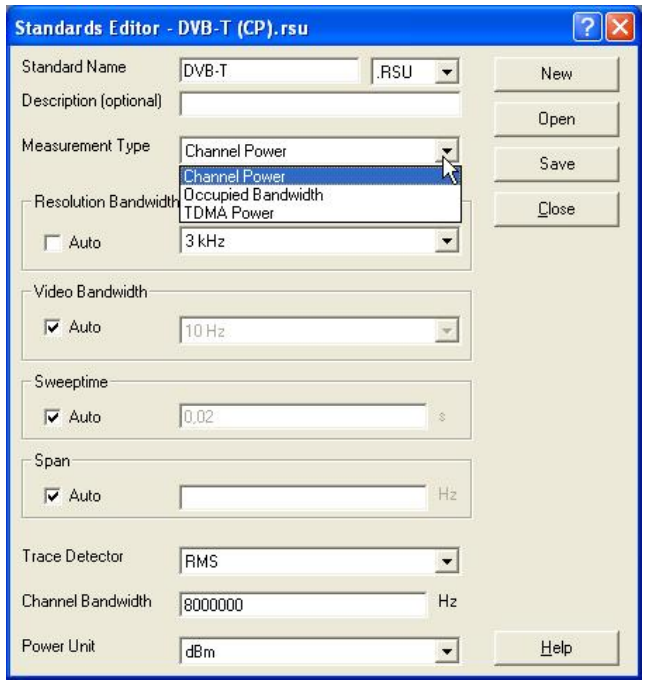
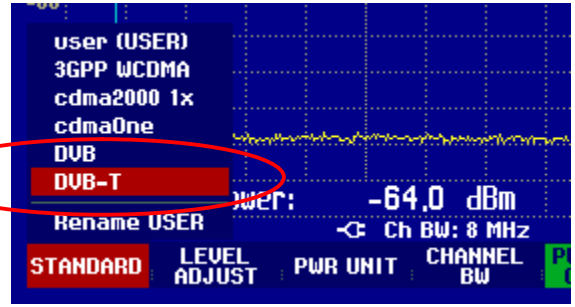
# Customized standards

## Functions

- Available for channel power -, TDMA power- and OBW- measurement
- FSHView software provides a editor for easy creation of customized standards
- Settings for RBW, VBW, sweep time, detector, measurement time, channel bandwidth, span…
- Up to 5 different standards can be loaded into the R&S FSH



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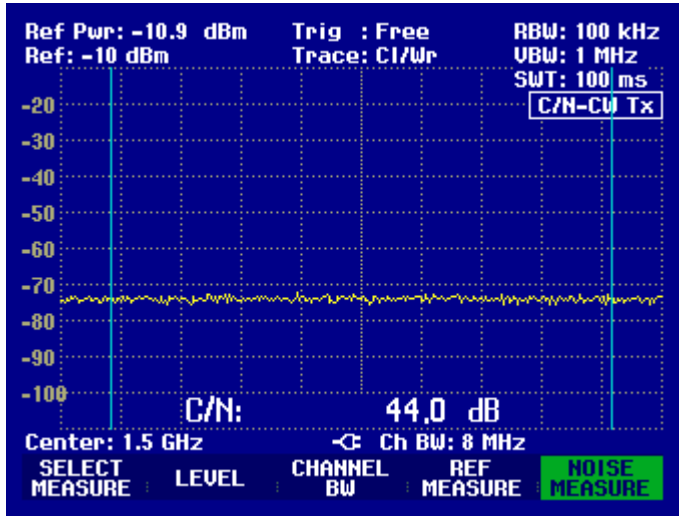
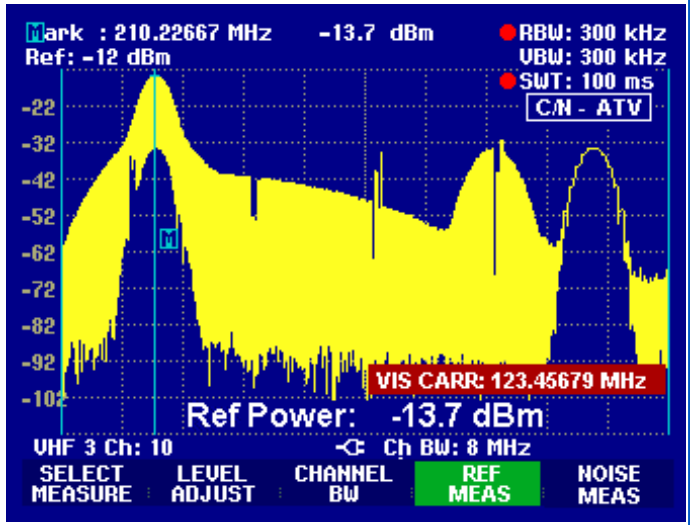
# C/N; $C/N_0$ measurement

## Functions

- For three different carrier types
  - **CW Tx,** for a unmodulated carrier
    - entry of channel no, center frequency or manual reference power
  - **Digital TX**, carrier power = channel power of a reference channel, for DAB and digital TV with OFDM- or QAM- modulation (DVB, DVB-T, DVB-H, J83/A/B/C… ) and ATSC with 8VSB modulation
    - entry of channel no, channel center freq. 8VSB pilot carrier freq. or manual reference power
  - **Analog TV**, carrier power = peak power of the vision carrier for amplitude modulated TV signals
    - entry of channel no, center frequency or manual reference power



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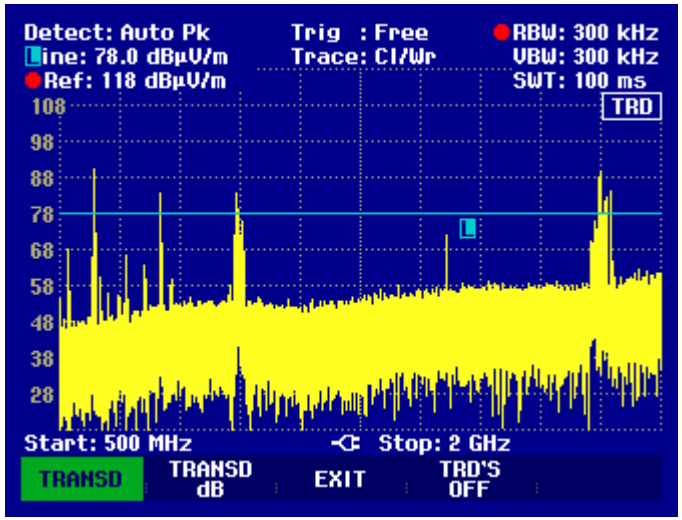
# Field Strength Measurements

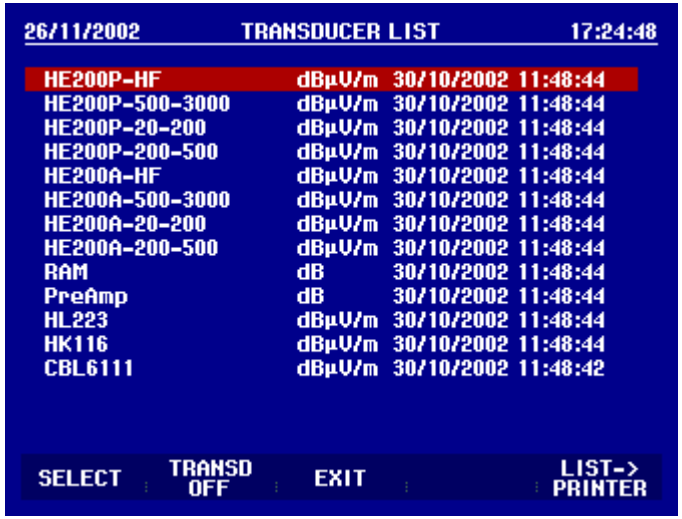
## Functions

- Electrical field strength is directly indicated in dBµV/m
- Two different transducer factors available
  - **for Antenna**
  - **for correction of ext. cables, attenuators, amplifiers**
  - **easy combination of both transducer types**




## FSHView provides:

- Transducer factor editor
- Maximum 60 data points
- Transducer factors for R&S HE200 active directional antenna
- Up- and download of transducer factors



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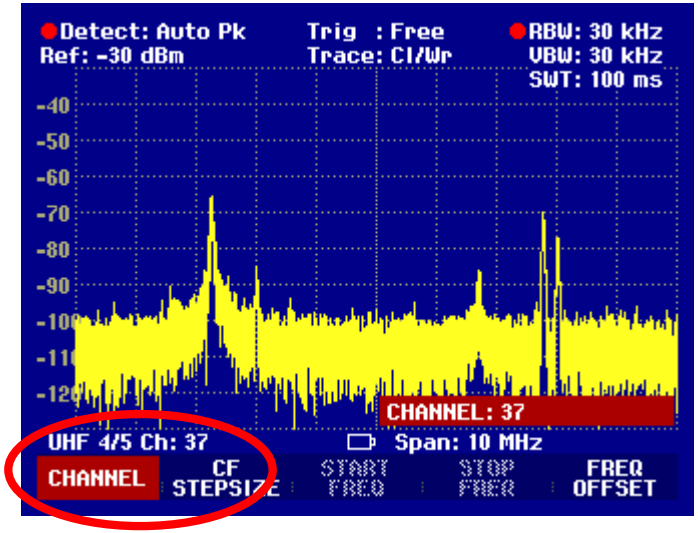
# Channel Tables

## Functions

- Tuning via predefined channel tables
- Display of channel number instead of frequency
- Creating tables with R&S FSHView or directly
- For TV, radio mobile, monitoring applications




## FSHView provides:

- Channel tables editor
- Maximum 15 sub-ranges per table
- TV channel tables for virtually the entire world
- Up- and download of channel tables

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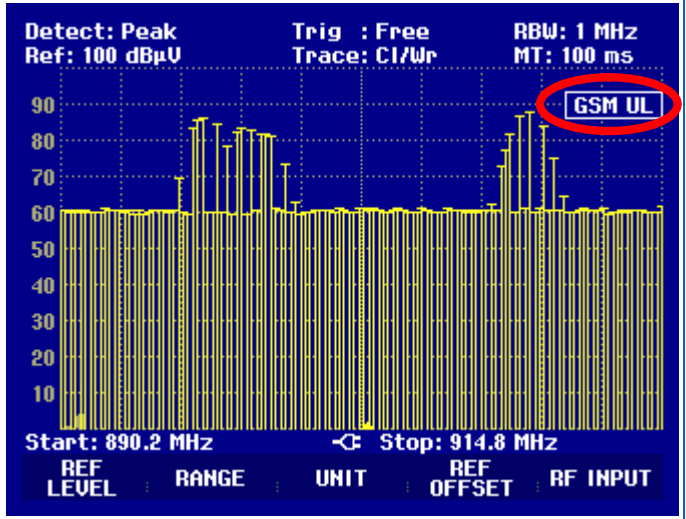
# Receiver Mode

## Functions

- For monitoring and precompliance EMC applications
- Level measurement at a predefined frequency using the selected measurement time and bandwidth and the set detector
- Peak-, average-, RMS-, quasi-peak-detector
- 200 Hz, 9 kHz,120 kHz and 1MHz CISPR bandwidths (-6 dB)
- Scan mode for automatic measurement over a defined frequency range or in defined channels




## Requirements

- R&S FSH (all models)
- R&S FSH-K3 Receiver Mode



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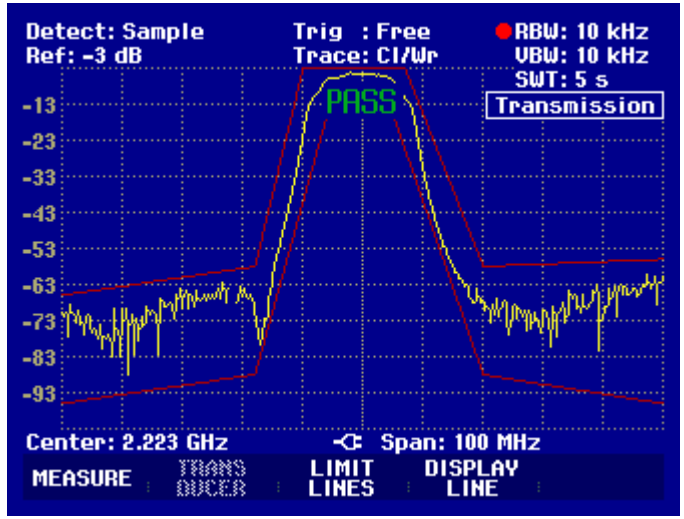
# Limit Value Monitoring

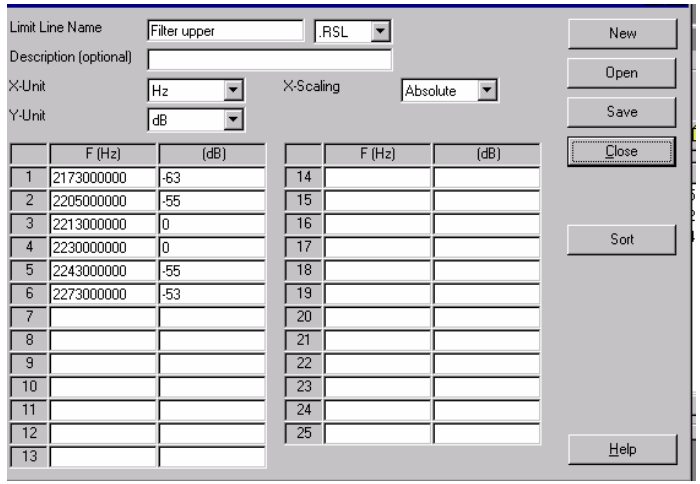
## Limit Lines

- User definable upper and lower limit lines
- Limit lines with pass and fail function

## R&S FSHView provides:

- Limit line editor
- Maximum 25 data points
- Up- and download of limit lines via R&S FSHView



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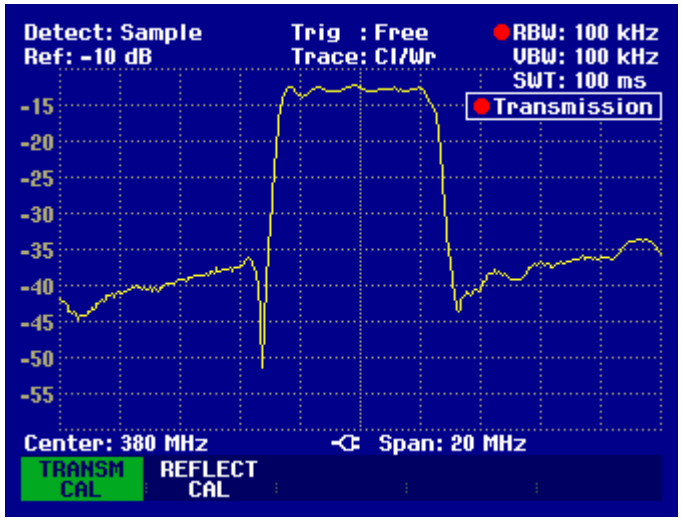
# Scalar Network Analysis

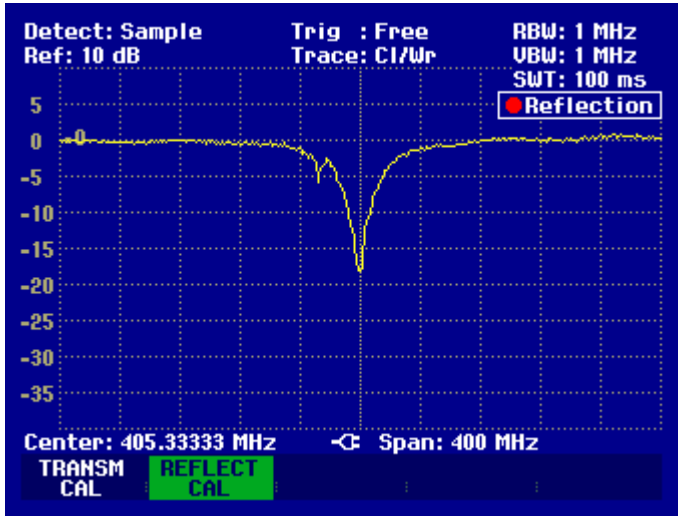
## Functions

- Transmission measurements
- Return loss measurements
- Reflection (VSWR) measurements
- Calibration routines
- Storage of calibration data

## Requirements :

- R&S FSH with tracking generator
- R&S FSH-Z2 VSWR bridge



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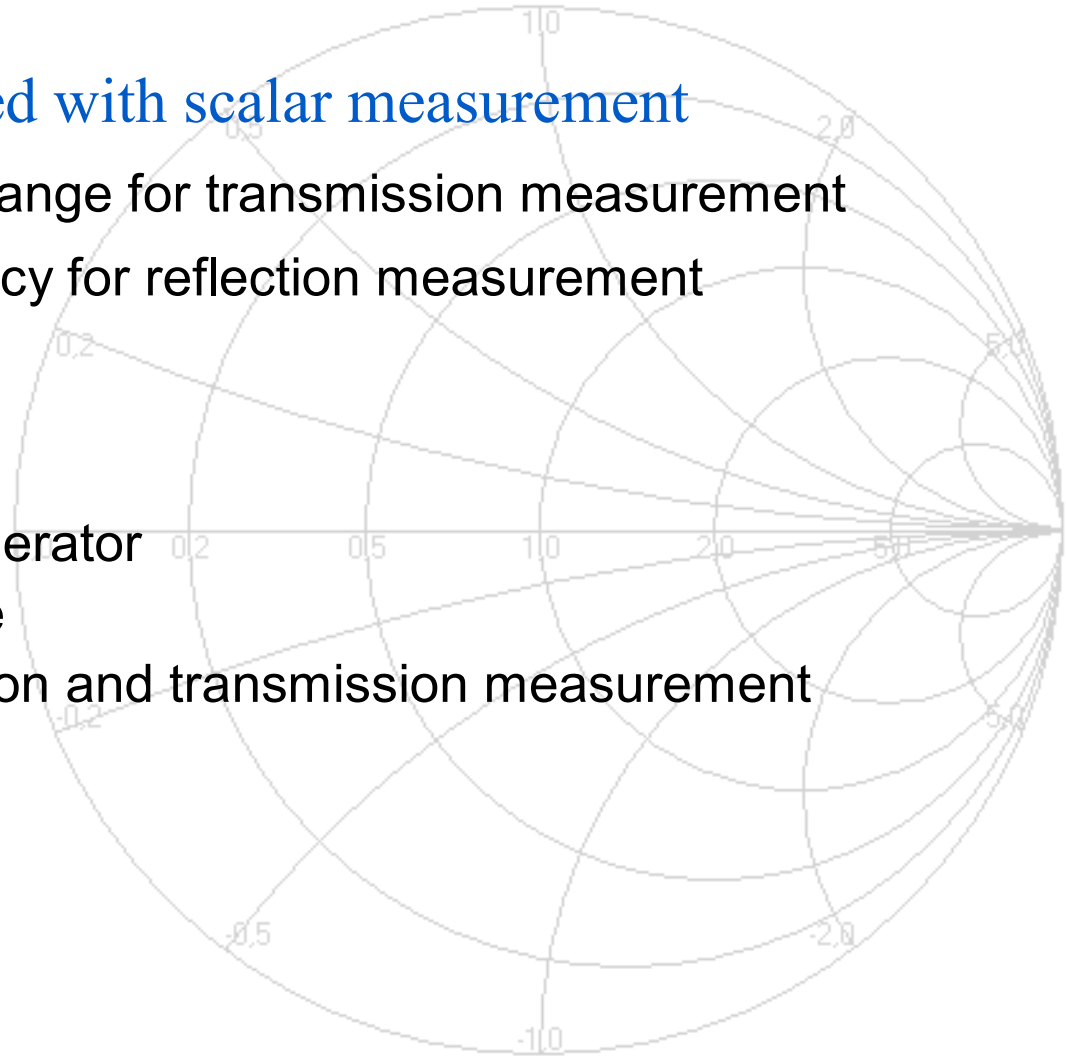
# Vector Network Analysis

## Better performance compared with scalar measurement

- Up to 20 dB more dynamic range for transmission measurement
- Higher measurement accuracy for reflection measurement
- Smith-chart

## Requirements :

- R&S FSH with tracking generator
- R&S FSH-Z2 VSWR bridge
- R&S FSK-K2 vector reflection and transmission measurement





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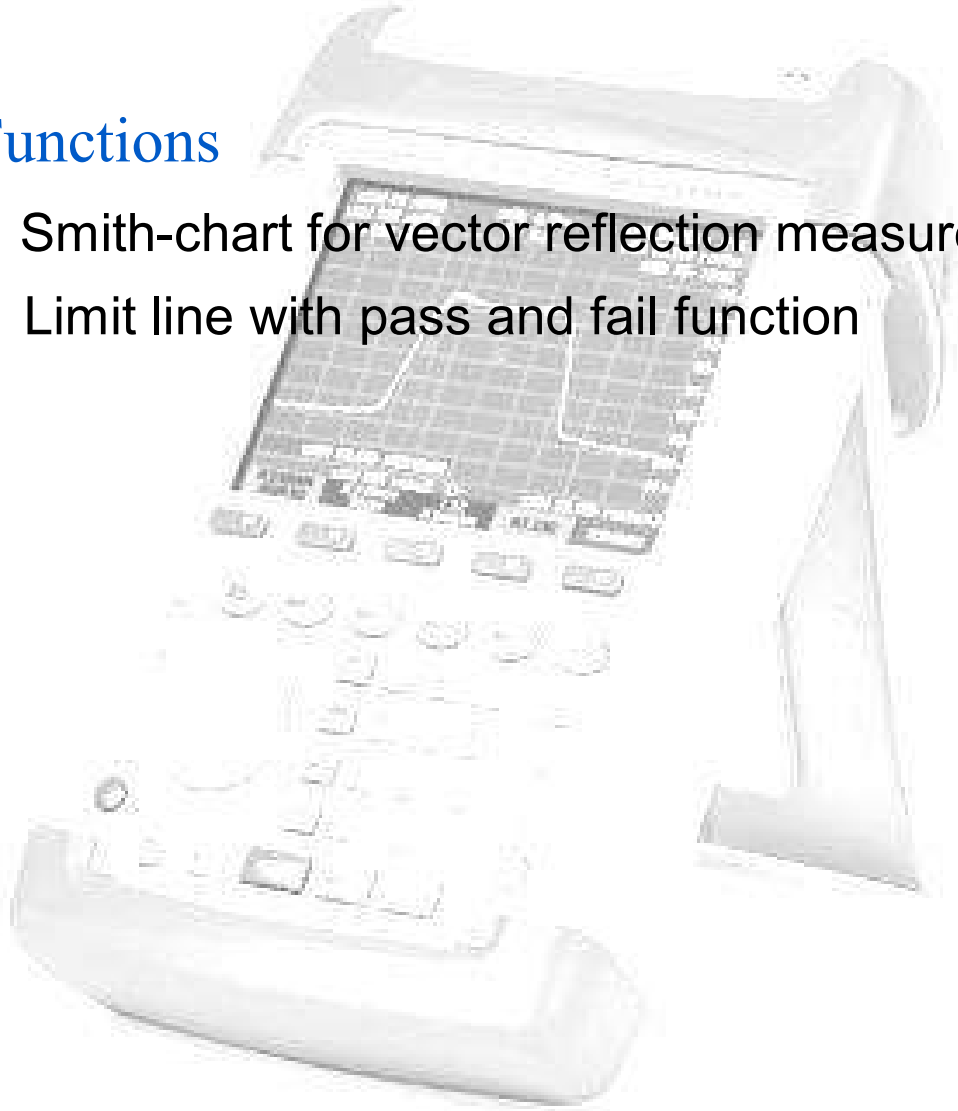
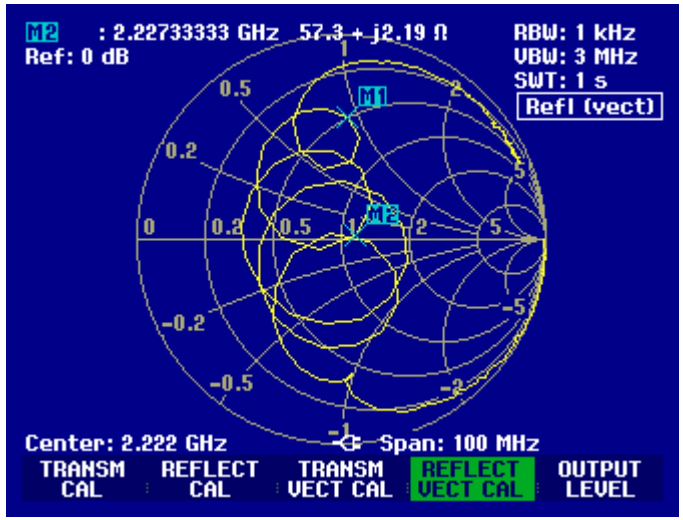
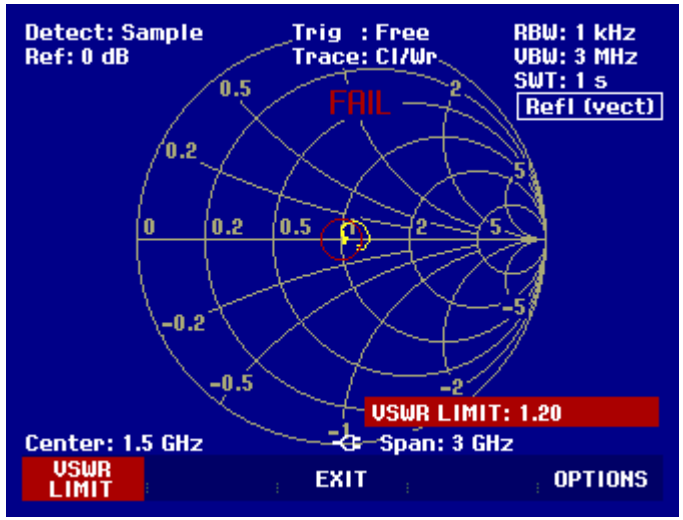
# Vector Network Analysis

## Functions

- Smith-chart for vector reflection measurement
- Limit line with pass and fail function





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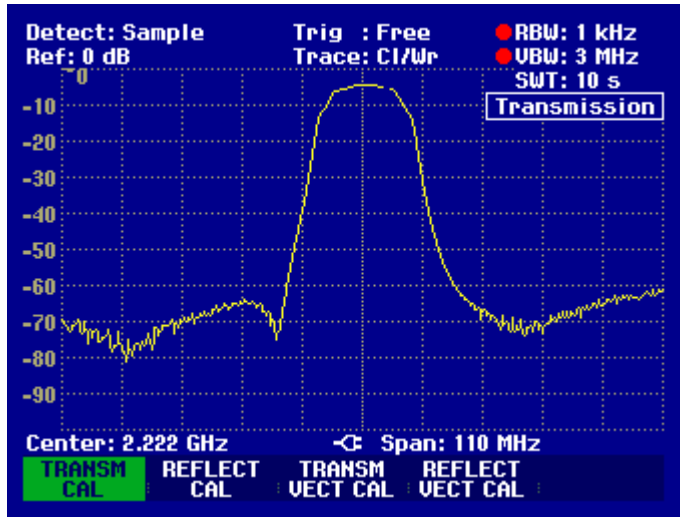
# Comparison of Vector and Scalar Transmission Measurement

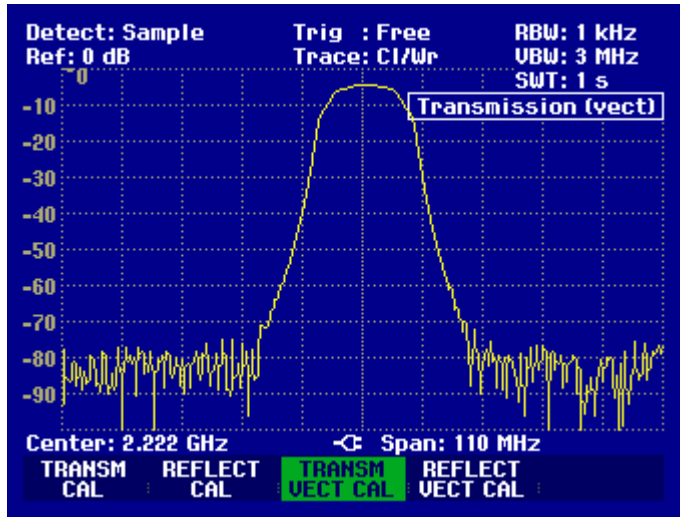
- **Scalar** measurement of transmission function of a bandpass filter

| Dynamic range, scalar transmission measurement | R&S FSH3 | R&S FSH6 |
|---|---|---|
| 10 MHz to 2.2 GHz | 60 dB, typ | 80 dB, typ |
| 2.2 GHz to 3 GHz | 50 dB, typ | 70 dB, typ |




- **Vector** measurement of transmission function of a bandpass filter with clearly wider dynamic range

| Dynamic range, vector transmission measurement | R&S FSH3 | R&S FSH6 |
|---|---|---|
| 10 MHz to 2.2 GHz | 80 dB, typ | 90 dB, typ |
| 2.2 GHz to 3 GHz | 65 dB, typ | 85 dB, typ |



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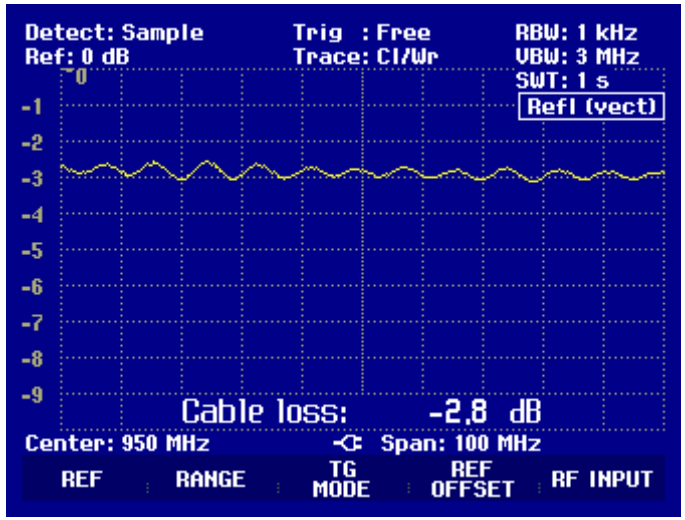
# One-Port Cable Loss Measurement

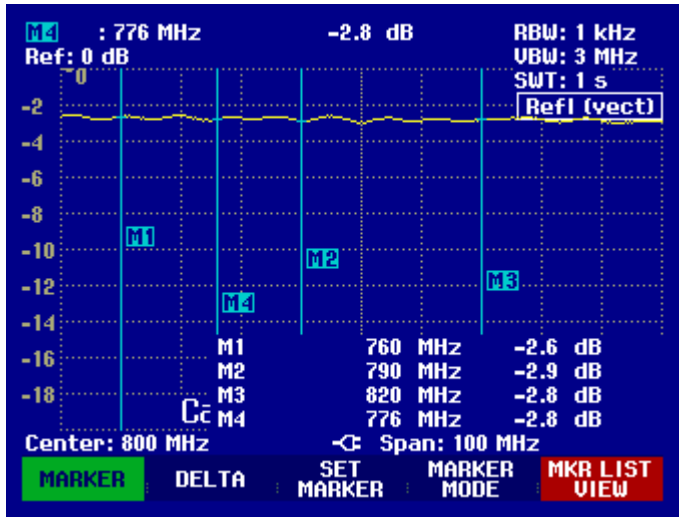
## Functions :

- Easy cable loss measurement on installed long cables
- Cable loss calculation from the average of the maximum and minimum values
- Loss at specific frequencies can be determined with one or more markers

## Requirements :

- R&S FSH with tracking generator
- R&S FSH-Z2 VSWR bridge
- R&S FSK-K2 vector reflection and transmission measurement



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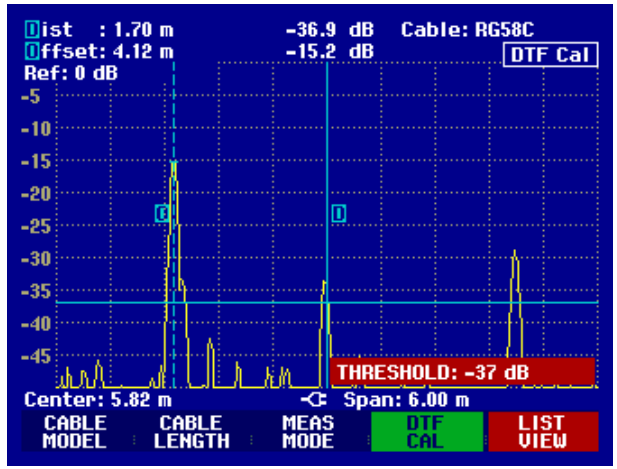
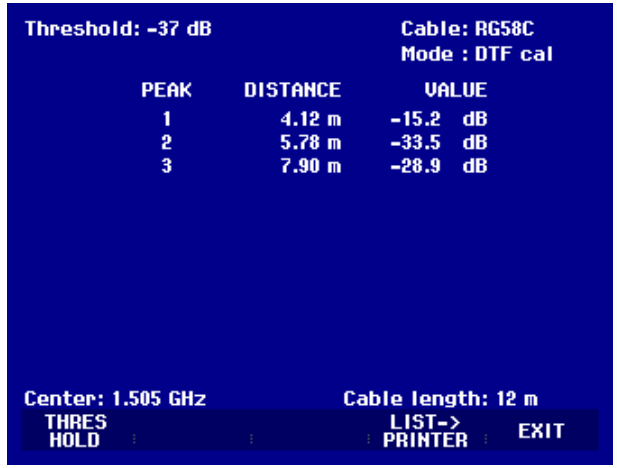
# Distance to Fault Measurement

## Functions

- Get tabular or graphic display of cable faults versus distance
- Cable length from 3m to 300m
- User definable cable types
- Less calibration effort, only one calibration standard necessary
- Storage of calibration data




## Requirements

- R&S FSH with tracking generator
- R&S FSH-B1 Distance to fault measurement
- R&S FSH-Z2 VSWR bridge



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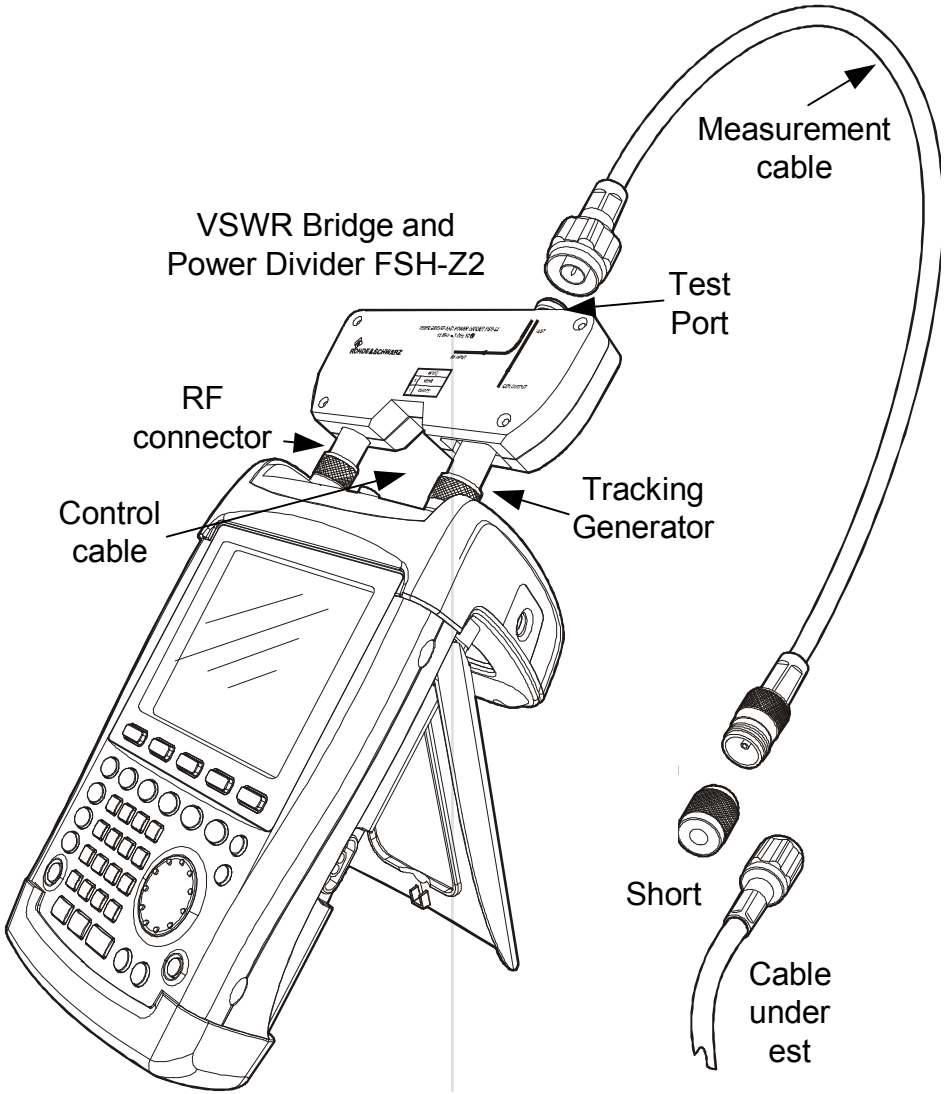
# Distance to Fault Measurement Test Setup



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# Power Meter Function

## Specs

- Frequency range 10 MHz to 8 /18 GHz
- 90 dB dynamic range (-67dBm to +23 dBm)
- Signal weighting : true rms
- Absolute uncertainty < 2.5 % (0.11 dB)
- Measurement of absolute or relative power
- Read-out in dBm or linear

## Requirements

- R&S FSH (all models)
- R&SFSH-Z1 Power sensor
- R&S FSH-Z18 Power sensor

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# Directional Power Measurement with R&S FSH

## Functions

- Simultaneously measurement of forward power or PEP and reflection on transmitters
- Measurement under operational conditions up to 120 W (AVG) / 300 W (PEP)
- Indication of reflection in return loss (dB) or SWR
- Suitable for digital standards GSM,EDGE, 3GPP WCDMA, cdmaOne, cdma2000 1x, DVB-T, DAB, WLAN

## Requirements

- R&S FSH (all models)
- R&S FSH-Z44/-Z14 Directional power sensor



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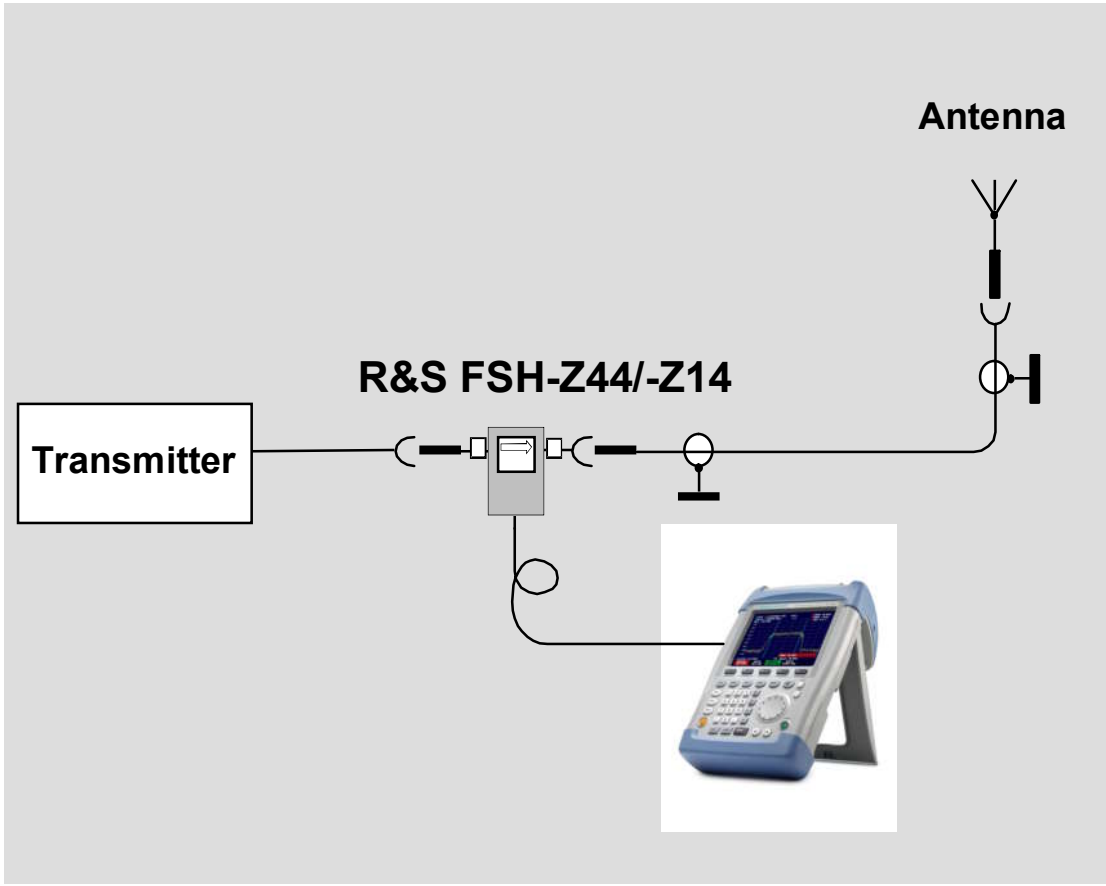
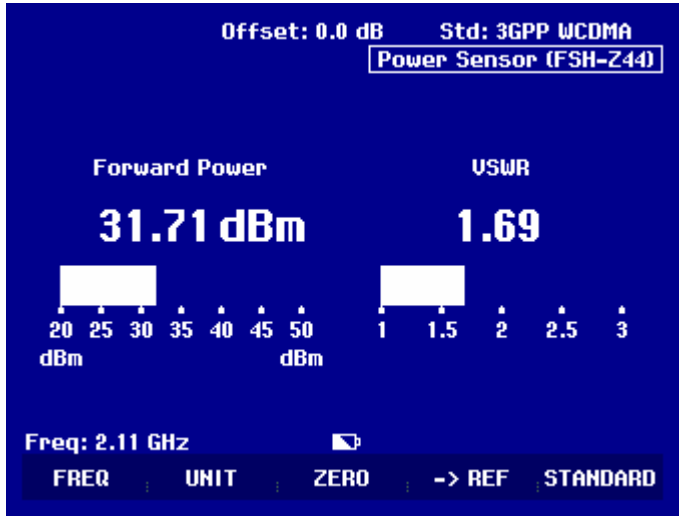
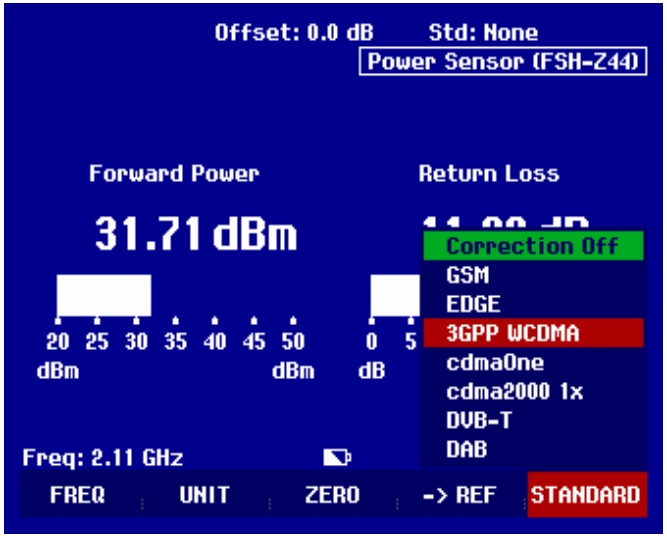
# Directional Power Measurement with R&S FSH



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# Remote Control of R&S FSH

## Requirements

- R&S FSH (all models)
- R&SFSH-K1 remote control via RS232 interface

## Specs

- the FSH-K1 option offers remote control commands via RS232 interface for all essential FSH functions

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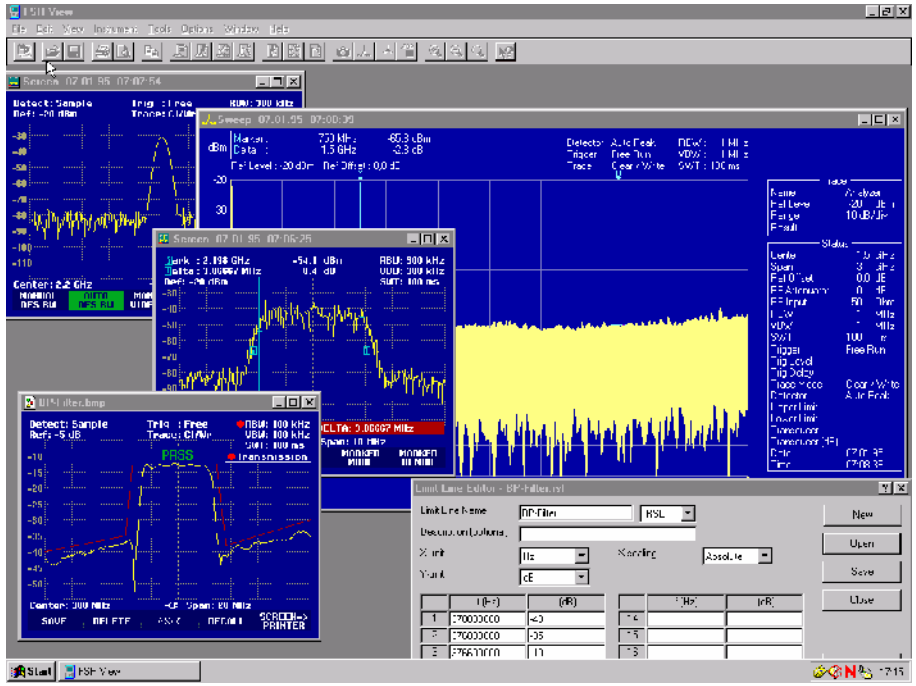
# R&S FSHView Software

## Features :

- Rapid and simple data transfer
- Download of screenshots
- Data export in PCX, BMP, PNG, WMF, ASCII and MS Excel - format
- On-line display of measurements
- Up- and download of settings
- Definition and editing of cable models, limit lines, transducer factors, channel tables
- MS Winword Macro for easy documentation
- Connection to PC via optical RS-232 interface





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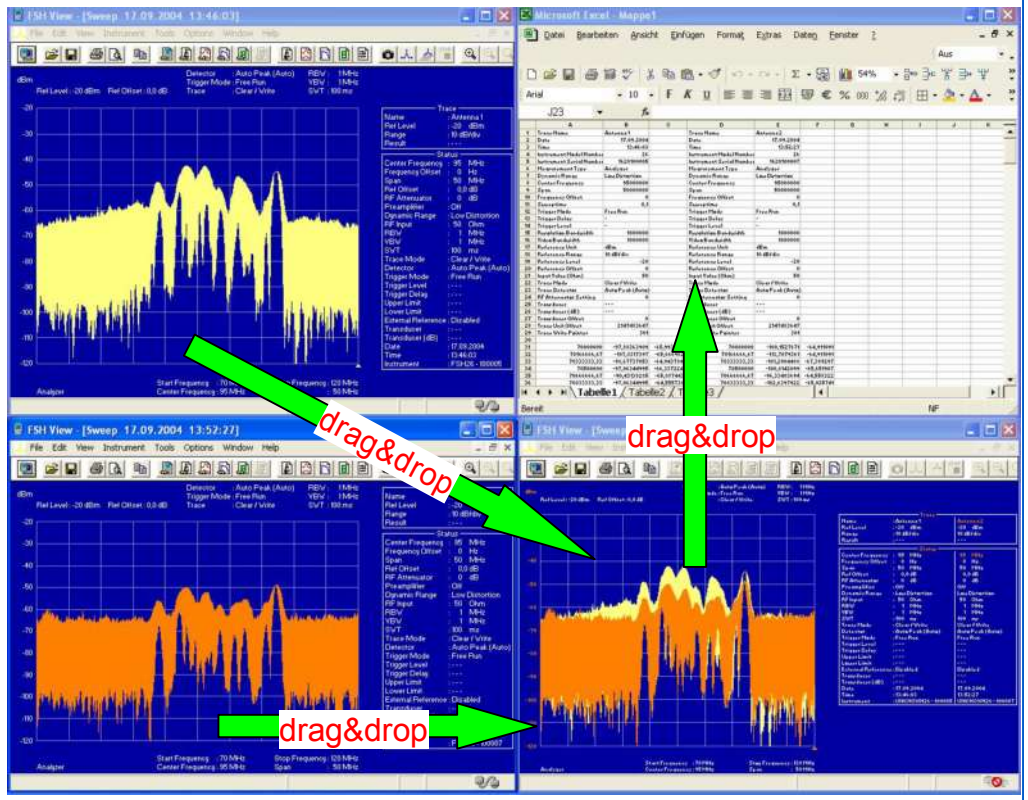
# R&S FSHView Software

## Multi-Unit-Control

NEW

- Up to five R&S FSH can be connected to the PC (COM 1 to COM 5)
- Easy comparison of measurement results (drag&drop)
- Easy data export into MS Word or Excel (drag&drop)



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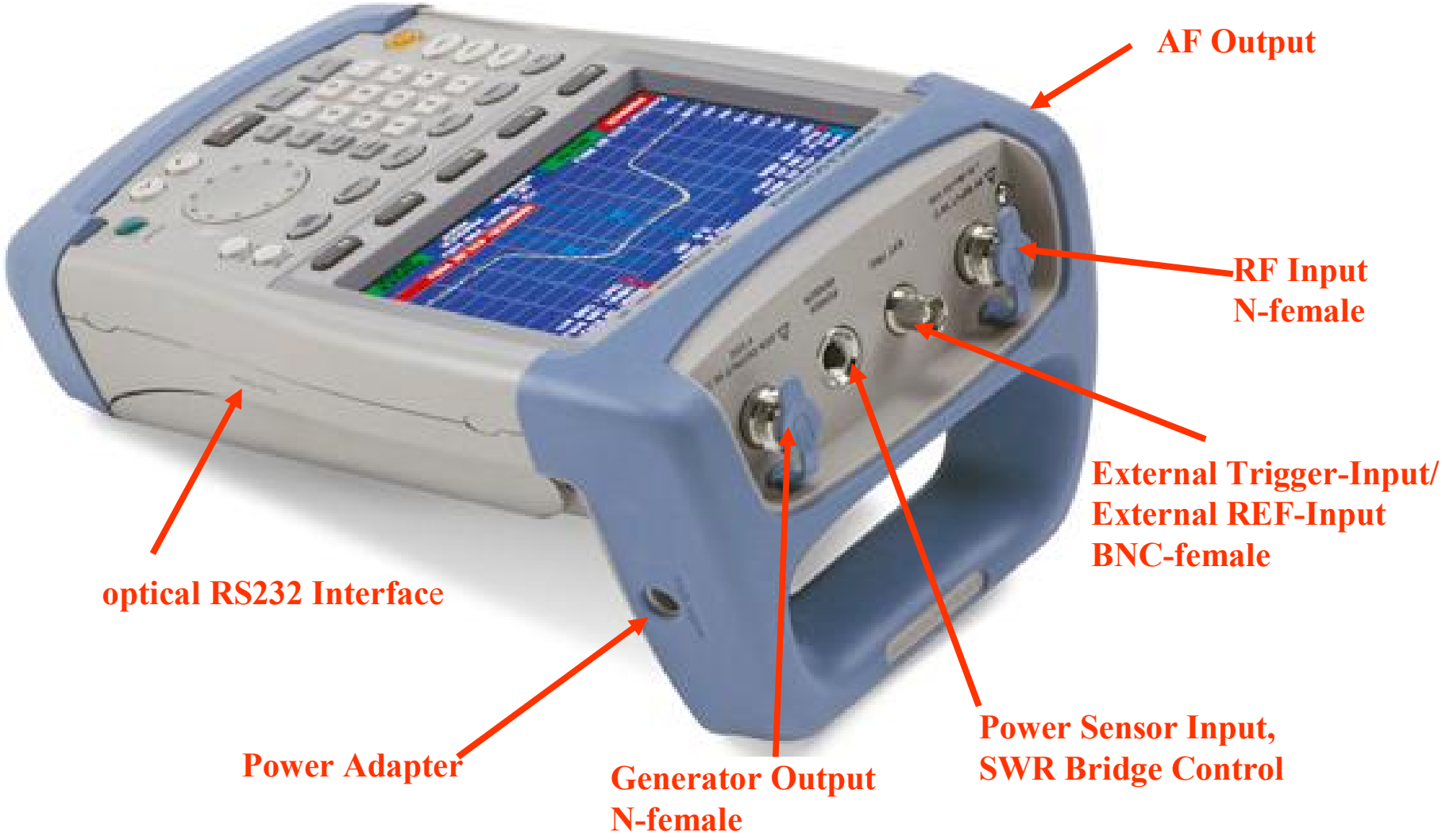
# Interfaces of R&S FSH (with Tracking Generator)



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# R&S FSH Accessories for Field-Use

Transit Hardcase R&S FSH-Z29

12 V Car Adapter R&S FSH-Z21

Soft Carrying Bag R&S FSH-Z25

Combined Open/Short/Load Calibration Standard R&S FSH-Z29



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# Spectrum Analyzer FS300

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# Key Features

High-quality measurement characteristic

Resolution bandwidths from 200 Hz to 1 MHz

Frequency counter with 1 Hz resolution

Maximum input level up to + 33 dBm

Compact housing with flexible handle

Remote control via USB-Interface

High picture refresh rate - up to 10 pictures/s

Versatile measurement functions

# Key Specifications

| | |
|---|---|
| Frequency Range | 9 kHz to 3 GHz |
| Resolution Bandwidths | 200 Hz to 1 MHz (1-,2-,3-,5 steps) |
| Video Bandwidths | 10 Hz to 1 MHz, Off |
| Displayed Average Noise Level | < -110 dBm, typ. -120 dBm (300 Hz) |
| Intermod. Free Dynamic Range | > 70 dBc @ -30 dBm input<br>(IP3 typ. +5dBm) |
| SSB Phase Noise | -90 dBc/Hz @ 10 kHz offset |
| Detector | Max Peak |
| Level Uncertainty | < 1.5 dB |



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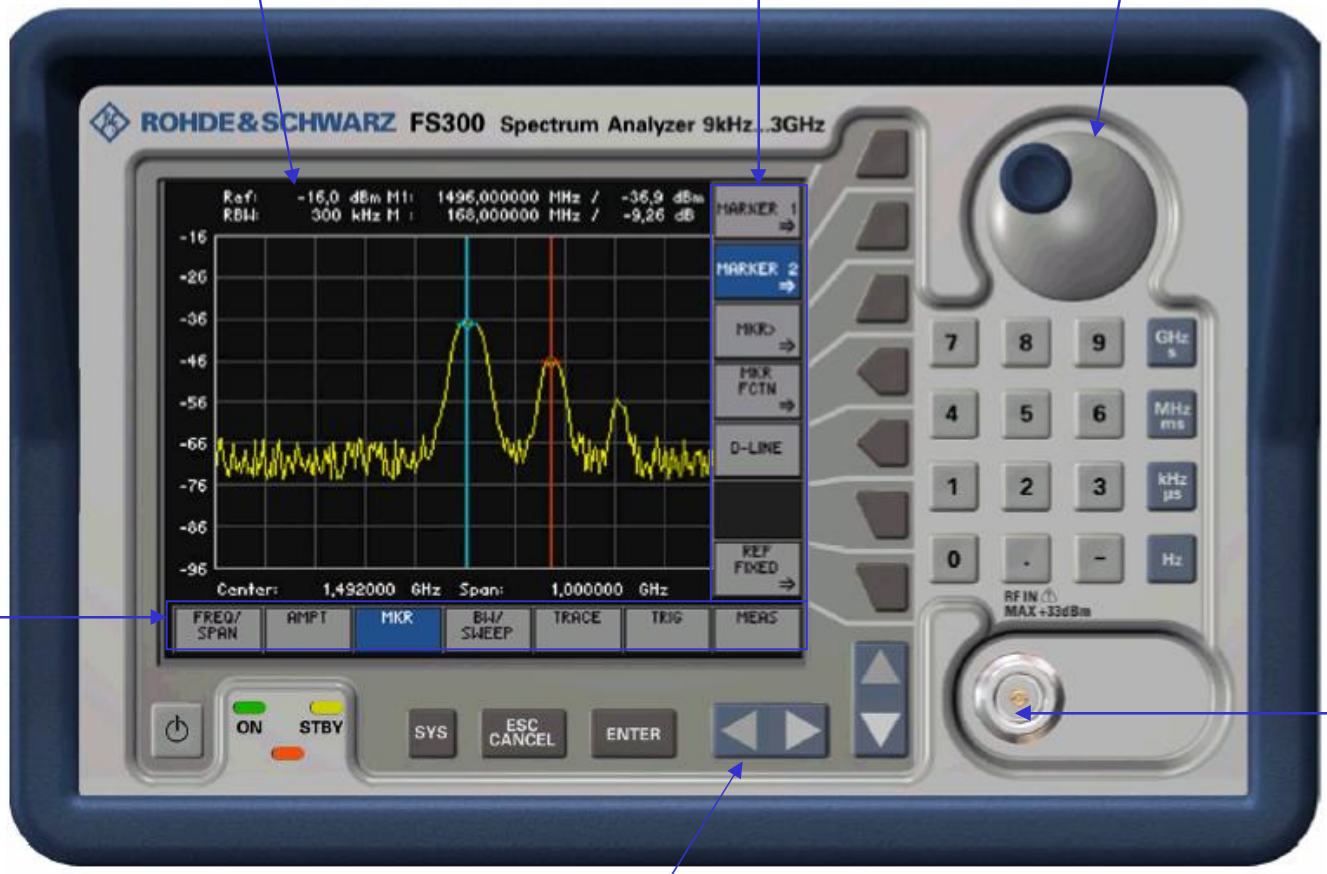
**5.4“ TFT Color Display**
320 x 240 Pixels

**Function Keys**
7 Functions Keys

**Rotary**
Quick Change
of Parameters




**Main Menu**
7 Menus

**RF Input**
9 kHz to 3 GHz
Max. + 33 dBm

**Menu Selection Key**



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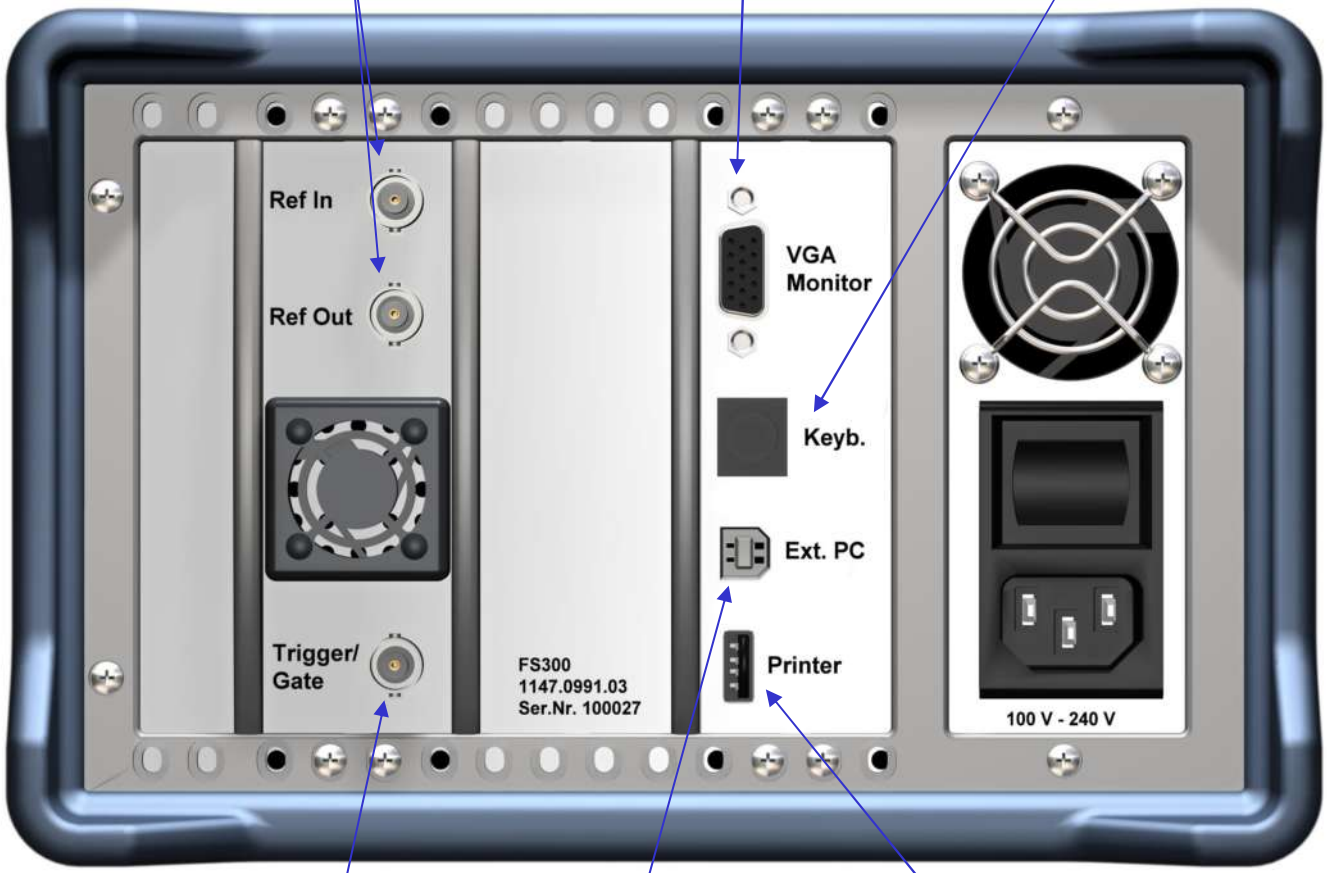
**External Reference**
10 MHz In / Out

**External Monitor**
320 * 240 Points

**External Keyboard**




**Trigger In/ Gate**
1 V...5 V

**USB Host**
ext. PC

**USB Device**
Printer



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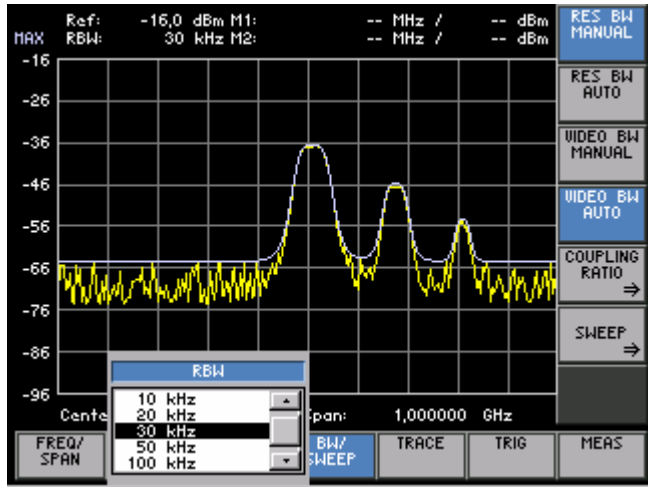
# Spectrum Analyzer FS300

## Features / Benefits 1

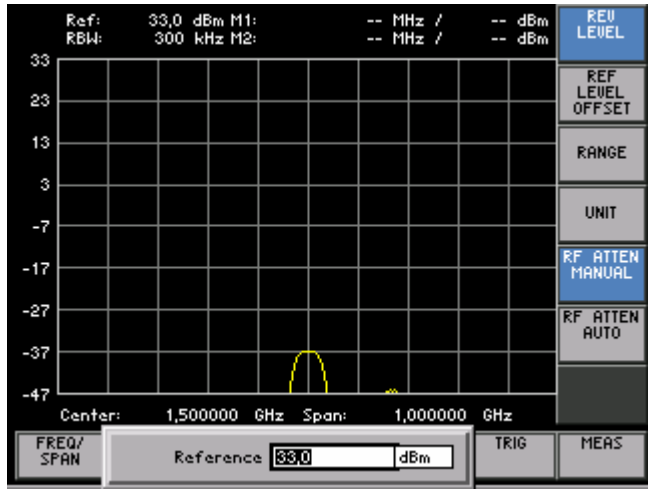
Wide Selection of Resolution Bandwidths: 200 Hz to 1 MHz in 1-2-3-5 steps

- Optimum sweep speed for required selectivity - no trade-off for speed and selectivity




Maximum Input Level + 33 dBm

- Mobile phones can be directly connected to input



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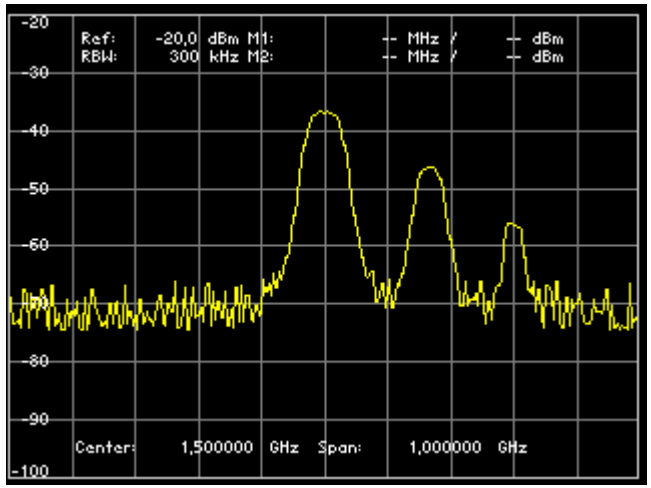
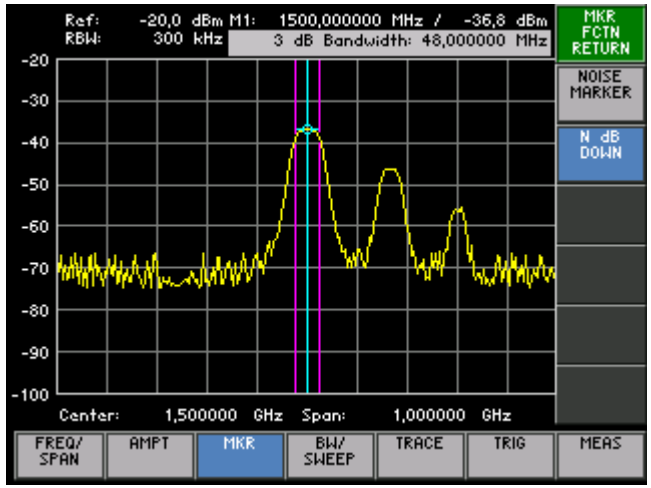
# Spectrum Analyzer FS300

## Features / Benefits 2




Full Screen Mode

- More details of the trace are visible




Marker Functions

- n- dB down
- TOI
- Noise Marker



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# Spectrum Analyzer FS300

## Functions

Memory Trace

Marker and Delta Marker

Noise Marker

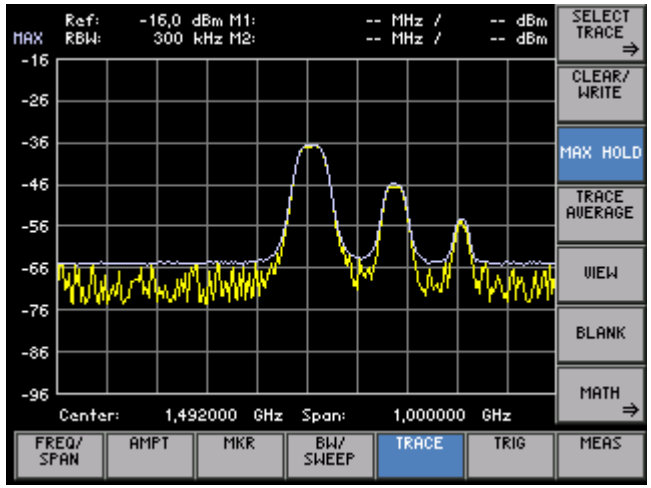
Frequency Counter

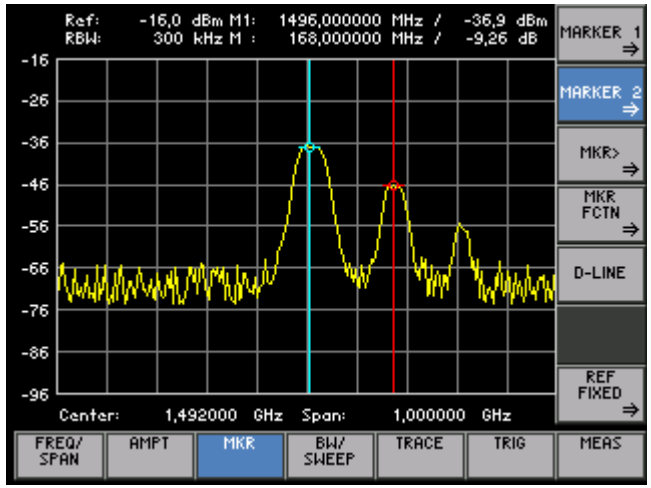
Video / External Trigger

Signal Tracking

Time Domain Power

Third Order Intercept Points



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# Spectrum Analyzer FS300

## Applications

Frequency Domain Measurements

Spectrum Overview Measurements

Measurement of Power and Frequency

Signal Bandwidth

Third Order Intermodulation Measurement

Harmonics Measurement

Spurious measurement



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# Spectrum Analyzer FS300

## Applications

### Time Domain Measurements

Burst Power

Burst Timing



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# PC Software for Spectrum Analyzer FS300

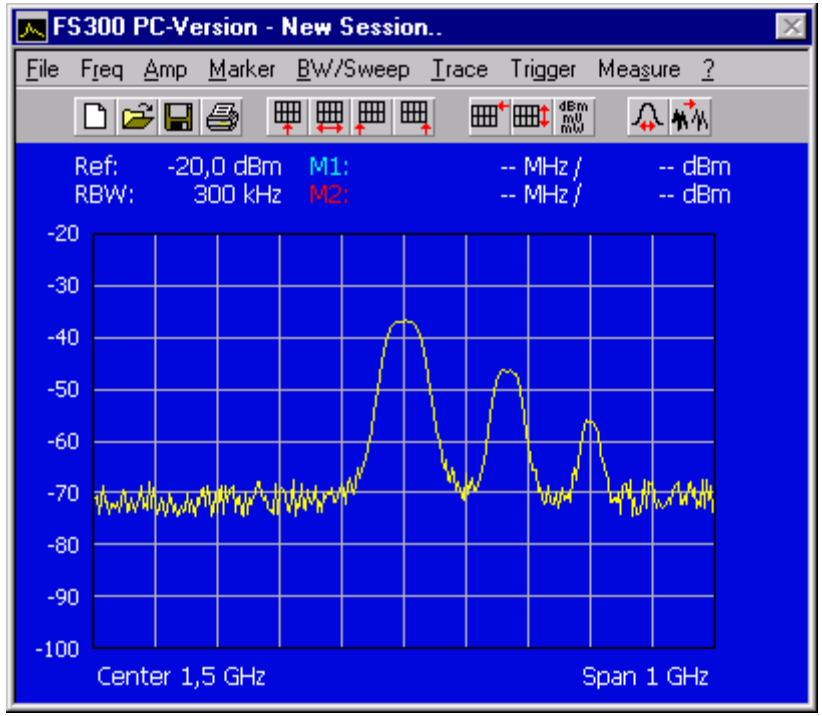
Full Instrument Control from External PC via USB w/o Restrictions

Advanced Measurement Functions in PC Software

- Limit Lines
- Log File

Documentation

- Export of Trace Points (900 points) in TXT-Format for Import in EXCEL
- Export of Screen-Shots in JPEG-Format
- Print-out of Results on Standard Windows Printers



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# Application Firmware - Overview

FSQ

FSU

FSP

| | |
|---|---|
| Phase Noise Measurement Software | FS-K4/FS-K40 |
| GSM/EDGE Application Firmware | FS-K5 |
| FM/PM/AM measurement demodulator | FS-K7 |
| Bluetooth Application Firmware | FS-K8 |
| Power Sensor Measurements | FS-K9 |
| Application Firmware for Noise Figure and Gain | FS-K30 |
| 3 GPP BTS/Node B FDD Application Firmware | FS-K72 |
| 3 GPP UE FDD Application Firmware | FS-K73 |
| 3 GPP HSDPA BTS Application Firmware | FS-K74 |



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FSQ

FSU

FSP

| | |
|---|---|
| 3 GPP TD-SCDMA BTS Application Firmware | FS-K76 |
| 3 GPP TD-SCDMA UE Application Firmware | FS-K77 |
| cdma2000/IS-95(cdmaOne)/1xEV-DV BTS Application Firmware | FS-K82 |
| cdma2000 / 1xEV-DV MS Application Firmware | FS-K83 |
| cdma2000 / 1xEV-DO BTS Application Firmware | FS-K84 |
| cdma2000 / 1xEV-DO UE Application firmware | FS-K85 |

WLAN 802.11a/b/g/j and Turbo Mode Application Firmware FSQ-K90/-K91

WLAN 802.11a Application Firmware FSP-K90

WIMAX IEEE 802.16 OFDM FSQ-K92

General Purpose Vector Signal Analysis FSQ-K70



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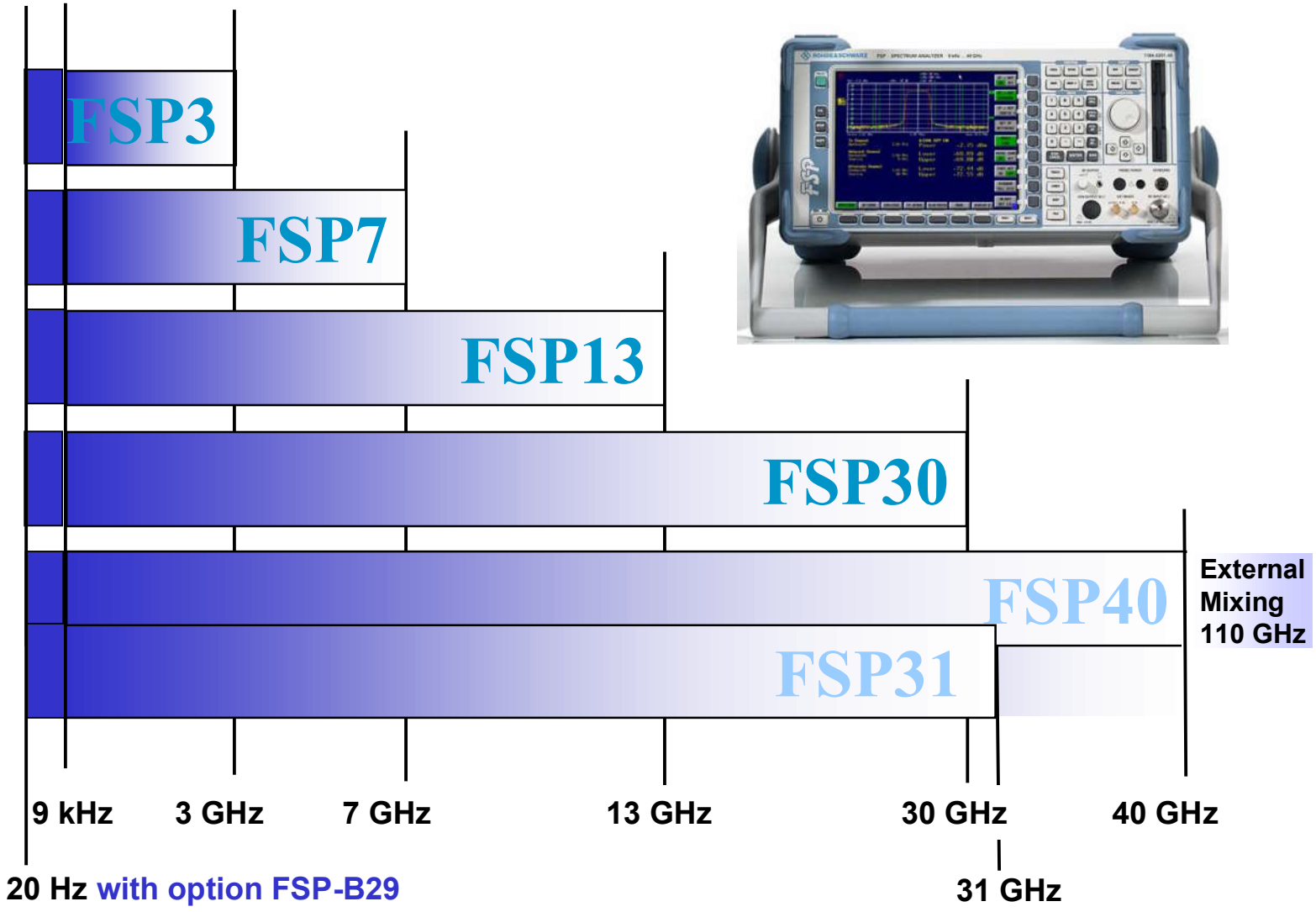
# The FSP Family





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# The FSP Family

**General purpose spectrum analyzer with excellent RF performance and unrivalled number of features**

- Resolution bandwidth 1 Hz to 10 MHz
- Displayed average noise level -155 dBm (1 Hz)
- Phase noise -113 dBc (1 Hz) at 10 kHz
- TOI 15 dBm, 1dB comp. 0 dBm
- Additional filters:
  - Channel filters from 100 Hz to 5 MHz and RRC filters
  - FFT filters from 1Hz to 30 kHz
  - EMI bandwidths and quasi-peak detector
- Total measurement uncertainty 0.5 dB
- Measurement routines for TOI, ACP(R), OBW, CCDF, APD, etc. as standard
- Fast ACP in time domain
- Up to 80 GPIB measurements/s
- Electronic attenuator / preamplifier up to 7 GHz
- Application firmware available for:
  - GSM/EDGE
  - Bluetooth
  - WCDMA/HSDPA
  - TD-SCDMA
  - CDMA2000/1xEV-DV/1xEV-DO
  - WLAN
  - Phase noise measurement
  - FM/PM/AM demodulation
  - ....



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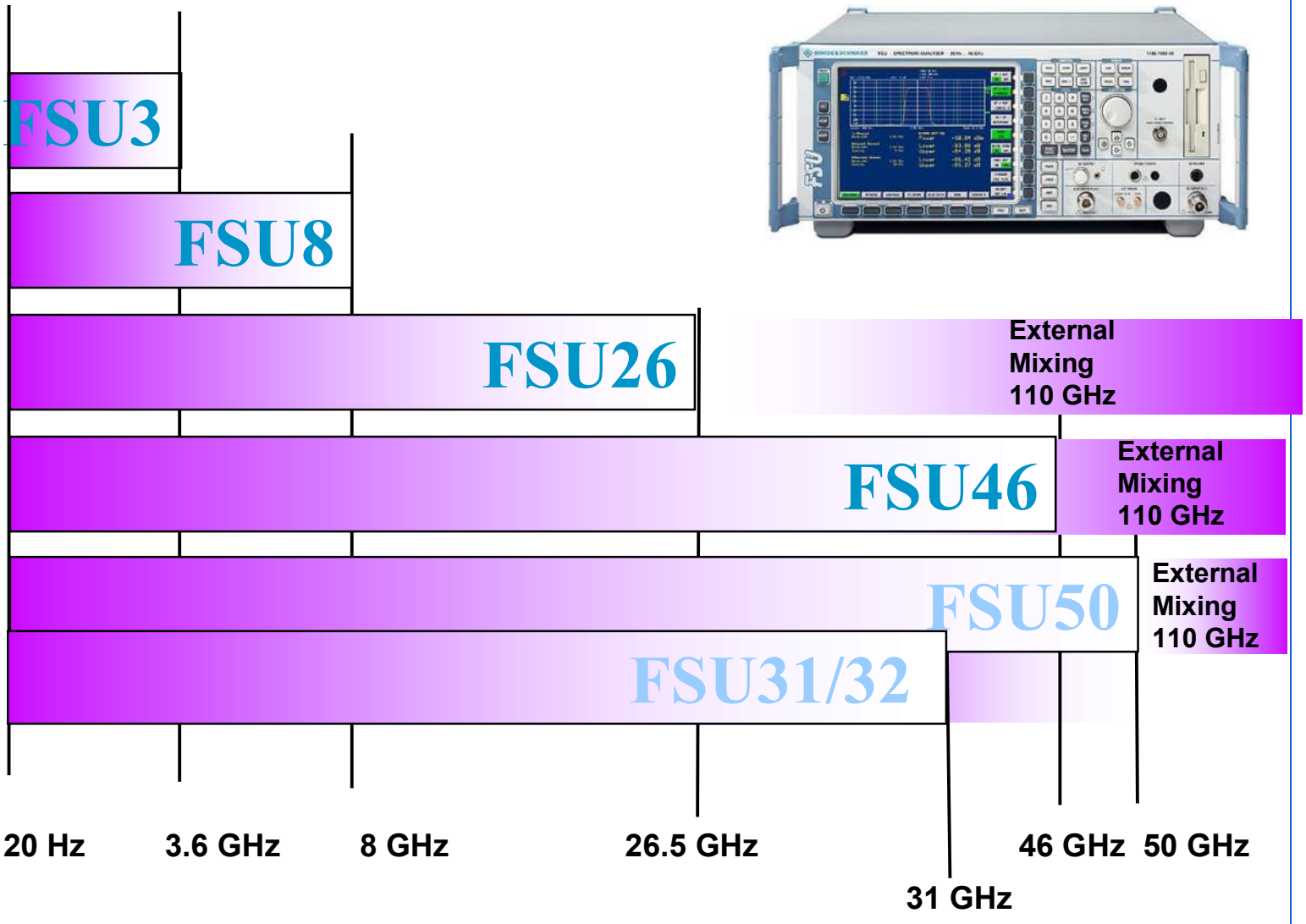
# The FSU Family








ROHDE&SCHWARZ

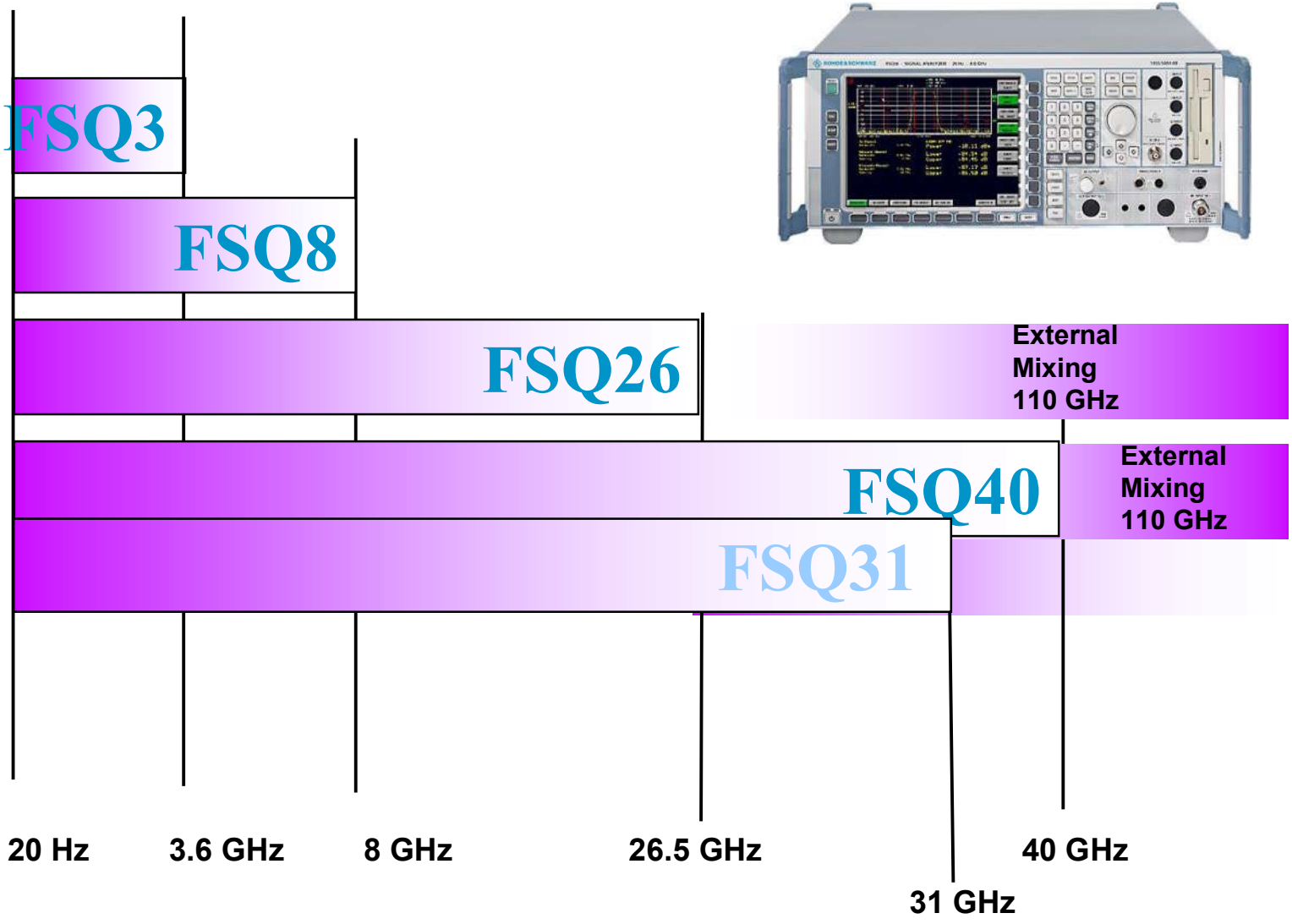
# The FSU Family

**High end spectum analyzer with unrivalled performance in: dynamic range, phase noise, level accuracy, and resolution bandwidth**

- Resolution bandwidth 1 Hz to 50 MHz
- Displayed average noise level -158 dBm (1 Hz)
- Phase Noise -121 dBc (1 Hz) at 10 kHz -> -129 dBc (1 Hz) at 10 kHz  Input: 1 GHz
- TOI 27 dBm, 1dB comp. 13 dBm
- Additional filters:
  - Channel filters from 100 Hz to 5 MHz and RRC filters, 5 pole
  - FFT filters from 1Hz to 30 kHz
  - EMI bandwidths and quasi-peak detector
- Total measurement uncertainty 0.3 dB
- Measurement routines for TOI, ACP(R), OBW, CCDF, APD, etc. as standard
- Spurious Emission Measurement (up to 100001 points, 5 ranges, …)
- WCDMA ACLR dynamic range of 77.5 dB / 84 dB with noise correction
- Fast ACP in time domain
- Up to 70 GPIB measurements/s
- Electronic attenuator/ preamplifier (up to 26 GHz)
- Application firmware available for:
  - GSM/EDGE
  - Bluetooth
  - WCDMA/HSDPA
  - TD-SCDMA
  - CDMA2000/1xEV-DV/1xEV-DO
  - Phase noise measurement
  - FM/PM/AM demodulation
  - ....

# The FSQ Family





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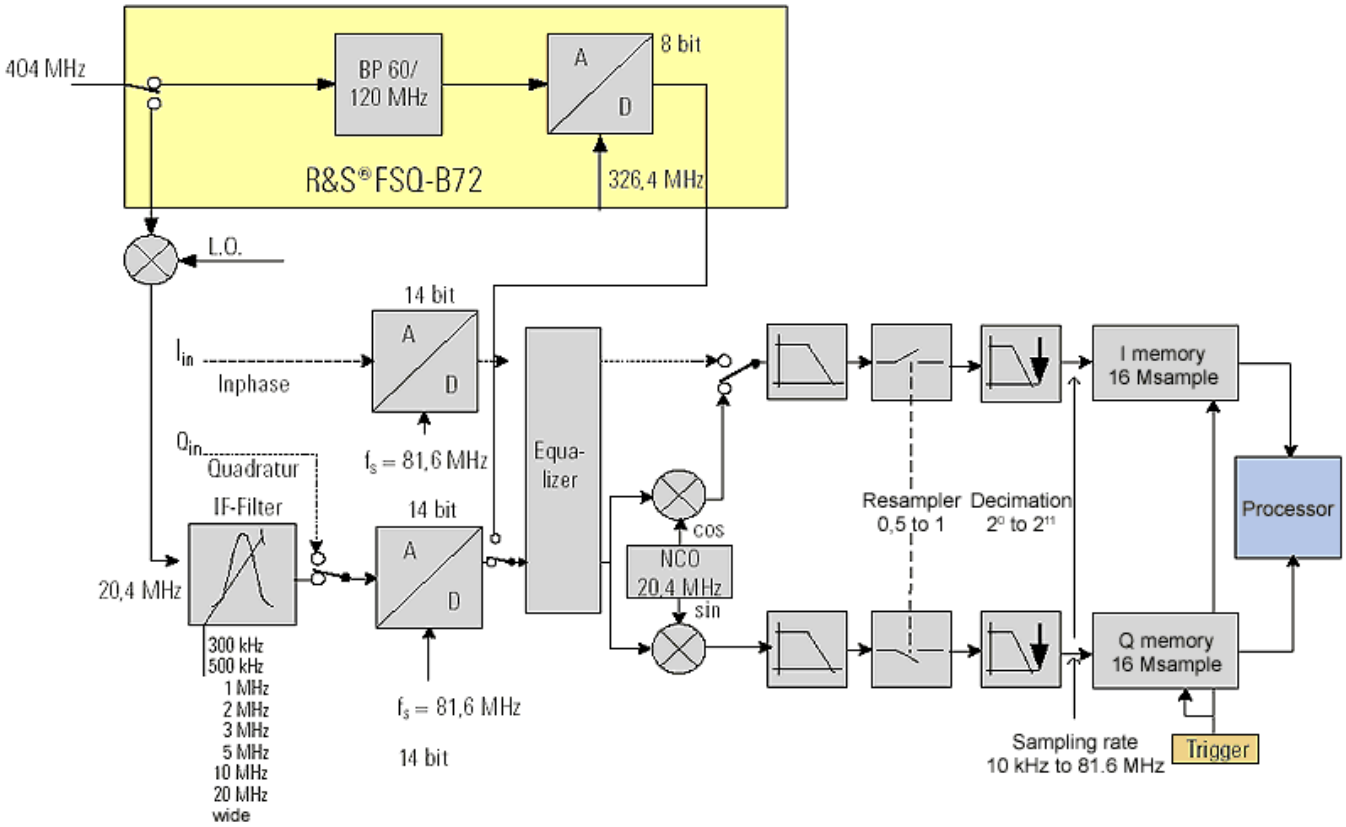
# The FSQ Family

**Signal analyzer with same HF performance as FSU but with up to 120 MHz demodulation bandwidth, 16 Msamples IQ memory, base band inputs and general purpose vector analysis functionality FSQ-K70.**




Block diagram of vector signal analysis section in the R&S FSQ



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