Spectrum Analyzers FSEx

20 Hz to 40 GHz

- Spectrum analysis with ultra-wide dynamic range
  Noise figure = 18 dB/TOI = 20 dBm typ. (FSEB)
- Universal analysis of digital and analog modulated signals (option) such as
  BPSK, QPSK, π/4-DQPSK, 8PSK, QAM, MSK, GMSK, 2FSK, AM, FM, PM
- High-speed synthesizer
  5 ms for full span (FSEA, FSEB)
- Refresh rate, quasi-analog
  25 sweeps/s
- Large LC TFT display
  24 cm/9.5", active
- Future-proof modular design
  Customized solutions through wide variety of options

ROHDE&SCHWARZ

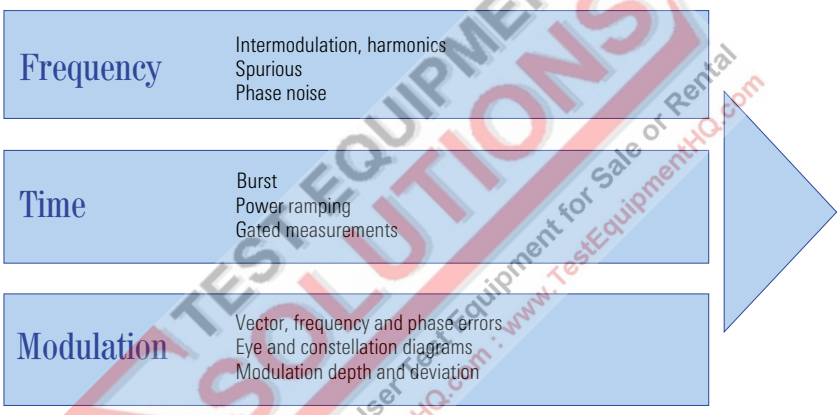
The spectrum analyzers from Rohde&Schwarz

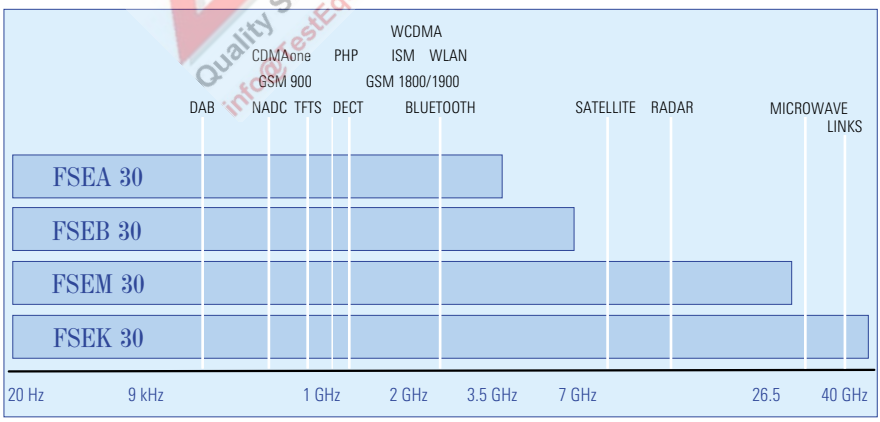
Overview

The FSE spectrum analyzers from Rohde&Schwarz have been optimized both for general-purpose measurements and meeting the stringent requirements of testing advanced digital communication systems. High measurement speed, future-proof modular design and excellent characteristics put the analyzers right at the top of today's market – at an attractive price.

Characteristics

- Combines the following functions: spectrum analysis and analysis of digitally modulated signals (option)
- Spectrum analysis with maximum dynamic range
- Adaptation of all models to your specific requirements by means of a wide range of options





Modular design for a safe investment

The FSE "option building blocks"

Option/function/software	Designation	FSEA30	FSEB30	FSEM30	FSEK30
Frequency range up to 3.5 GHz	–	●	–	–	–
7 GHz Frequency Extension	**FSE-B2**	❍	●	–	–
Vector Signal Analyzer	**FSE-B7**	❍	❍	❍	❍
Tracking Generator 3.5 GHz	**FSE-B8**	❍	–	–	–
Tracking Generator 3.5 GHz with I/Q Modulator	**FSE-B9**	❍	–	–	–
Tracking Generator 7 GHz	**FSE-B10**	–	❍	❍	❍
Tracking Generator 7 GHz with I/Q Modulator	**FSE-B11**	–	❍	❍	❍
Switchable Attenuator for Tracking Generator	**FSE-B12**[1]	❍	❍	❍	❍
1 dB Attenuator	**FSE-B13**[1)2)]	❍	❍	❍	❍
Controller	**FSE-B15**	❍	❍	❍	❍
Ethernet Interface	**FSE-B16**	❍	❍	❍	❍
2nd IEC/IEEE-Bus Interface	**FSE-B17**	❍	❍	❍	❍
Removable Hard Disk	**FSE-B18**[3)]	❍	❍	❍	❍
2nd Hard Disk for FSE-B18	**FSE-B19**	❍	❍	❍	❍
External Mixing	**FSE-B21**	–	–	❍	❍
Increased Level Accuracy up to 2 GHz	**FSE-B22**[3)]	❍	❍	❍	❍
Broadband Output 741.4 MHz	**FSE-B23**[3)]	❍	❍	❍	❍
44 GHz Frequency Extension for FSEK	**FSE-B24**[3)]	–	–	–	❍
Noise Measurement Software	**FS-K3**	❍	❍	❍	❍
Phase Noise Measurement Software	**FS-K4**	❍	❍	❍	❍
GSM Application Firmware	**FSE-K10/-K11**	❍	❍	❍	❍
EDGE Application Firmware	**FSE-K20/-K21**	❍	❍	❍	❍

● Incorporated in basic model ❍ Can be retrofitted (option)

1) FSE-B12 and FSE-B13 cannot be fitted together.
2) In combination with FSE-B22 factory-fitted only.
3) Factory-fitted only.

Getting down to analysis

Specifications in brief

- Resolution bandwidths 1 Hz to 10 MHz, adjustable in steps of 1/2/3/5/10
- Displayed noise floor –150 dBm (typ.) in 10 Hz bandwidth
- 3rd-order intercept point +20 dBm typ.
- 1 dB compression point of RF input +10 dBm
- Phase noise at 10 kHz from carrier: –123 dBc (Hz) (typ.) (FSEA 30)
- Total level measurement uncertainty up to 1 GHz <1 dB, up to 7 GHz 1.5 dB
- AM/FM audio demodulator (with built-in loudspeaker and headphones connector)
- Internal RF trigger (trigger threshold approx. –20 dBm)
- 5 ms full-span sweep time with fully synchronized sweep (FSEA, FSEB), 150 ms with FSEM, 230 ms with FSEK
- 1 µs zero-span sweep time
- Pretrigger and trigger delay
- Gated sweep

Vector analysis for digital communication

The analyzers of the FSE family combine the capabilities of high-end RF or microwave spectrum analysis with those of universal digital-signal demodulation and analysis. This becomes possible with the vector signal analyzer option. The spectrum analyzer function offers the wide dynamic range necessary for many measurements on digitally modulated signals (e.g. burst measurements), and the vector signal analyzer option adds demodulation capability to bit stream level for signals such as

– BPSK, QPSK, π/4-DQPSK
– 16QAM, (G)MSK, (G)FSK

All this is backed up by a variety of display types:

- Eye diagram
- Vector and constellation diagram
- Frequency and phase error
- Vector error

With a spectrum analyzer of the FSE family, you are perfectly equipped for the future of digital communication.

Modularity safeguards investments

Series FSE analyzers are of modular design throughout. From the wide variety of options, you can choose exactly those needed for your particular application (see also fold-in page).

You thus get an instrument tailor-made to your requirements and pay for no more than what you actually need. At the same time, you can feel sure that FSE will grow with your tasks and requirements as virtually all options can be retrofitted. Even extending the frequency range from 3.5 GHz to 7 GHz is no problem with option FSE-B2.

Your decision for Spectrum Analyzer FSE is a decision for a safe investment.

FSE options and their applications

Digital mobile radio systems	Analog mobile radio systems	TV and CATV	AM and FM sound broadcasting	General-purpose RF measurements		
❍				❍	**FSE-B2**	7 GHz Frequency Extension
●	❍		●		**FSE-B7**	Vector Signal Analyzer
		❍		❍	**FSE-B8/-B9/-B10/-B11**	Tracking Generator
❍					**FSE-B13**	1 dB Attenuator
❍				❍	**FSE-B15**	Controller
				❍	**FSE-B21**	External Mixing
				❍	**FSE-B23**	Broadband Output 741.4 MHz
❍	❍	❍		❍	**FS-K3**	Noise Measurement Software
❍	❍			❍	**FS-K4**	Phase Noise Measurement Software
❍					**FSE-K10/-K11**	GSM Application Firmware
❍					**FSE-K20/-K21**	EDGE Application Firmware

● Required ❍ Recommended

High speed increases efficiency

The high speed of FSE increases efficiency in development and production:

- FSE features a minimum full-span sweep time of 5 ms (FSEA/B) with a fully synchronized sweep. This means that added speed is not at the expense of frequency accuracy but even enhances it
- The shortest zero-span sweep time is 1 µs (100 ns/div) – ideal for high-resolution measurements on pulse edges
- Up to 25 sweeps per second is an optimal prerequisite for rapid and easy alignments and for applications in production

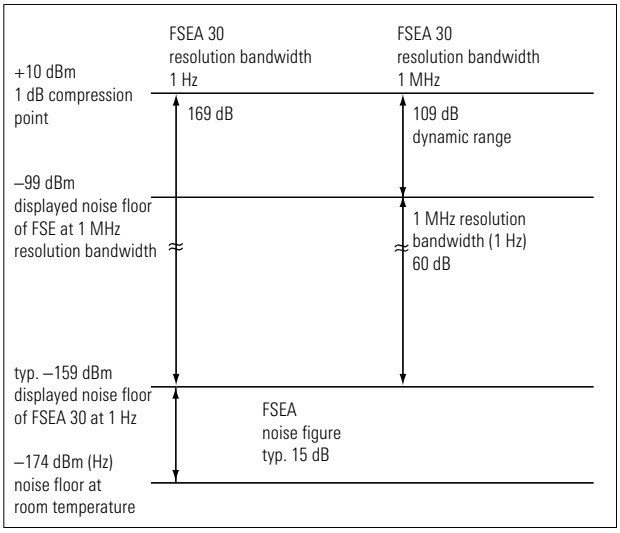
With its high measurement speed and great ease of operation, FSE will solve even highly complex measurement tasks in next to no time.

Spectrum Analyzer FSEM30

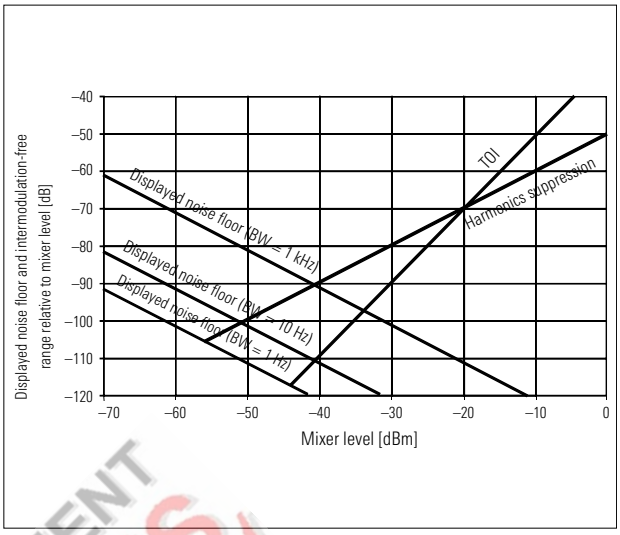
Certified Quality System
ISO 9001
DQS REG. NO 1954

Certified Environmental System
ISO 14001
REG. NO 1954

The features in detail ...



Dynamic range, noise and 1 dB compression point of Spectrum Analyzer FSEA30 at different resolution bandwidth



Dynamic range, noise, 3rd-order intercept point

Tops in dynamic range

FSE is outstanding for its extremely low noise floor without any impairment to the dynamic range at large signal levels. This can be seen, for example, from the 1 dB compression point of +10 dBm, which yields the best dynamic range available even at a resolution bandwidth of 1 MHz, allowing GSM and DECT power ramps to be determined.

An extremely wide intermodulation-free dynamic range of 115 dB is obtained due to the low noise figure and the high 3rd-order intercept point. This not only yields reliable intermodulation measurements on highly linear amplifiers, but also ensures a sufficient dynamic range for adjacent-channel power measurements on digitally modulated signals.

Taking as a figure of merit of an analyzer the difference between its 3rd-order intercept point and its noise figure, FSEA has a value of around 0 dB. Put this figure to the test.

From AF to microwave

FSEM/K30 open up the microwave range through to 26.5 GHz/40 GHz and retain the excellent characteristics of the basic models:

- Continuous full-span sweep
- Fundamental mixing (low noise floor) as well as wide dynamic range up to 26.5 GHz
- Fully synchronized sweep with high frequency accuracy even for Full span (26.5 GHz/40 GHz)
- RF input adapters for N or PC 3.5 mm, or K connector (FSEM or FSEK)

Option FSE-B21 allows the frequency range of FSEM and FSEK to be extended by means of external mixers. Mixers FS-Z60 (40 GHz to 60 GHz), FS-Z75 (50 GHz to 75 GHz), FS-Z90 (60 GHz to 90 GHz) and FS-Z110 (75 GHz to 110 GHz) are available as extras. Continuous automatic signal identification, which is used to suppress unwanted image frequency bands and mixture products, ensures fast and easy measurements. Due to the built-in diplexer, two-port as well as three-port mixers can be used.

The external mixer measurement function features great ease of operation:

- Definition of frequency range and harmonics by selecting a waveguide band
- Definition of all important parameters for each waveguide band separately
- Frequency-dependent consideration of mixer conversion loss
- Storage of parameters on hard disk

Unattained measuring convenience

FSE makes measuring easy for you through a large number of convenient test functions:

- 4 markers, 4 delta markers
- Marker functions for direct measurement of
  - phase noise and noise power density
  - NEXT MIN/PEAK, NEXT MIN/PEAK RIGHT, NEXT MIN/PEAK LEFT
  - bandwidths and shape factor
- Measurement of channel power, adjacent channel power and occupied bandwidth
- Frequency counter with selectable resolution
- LOW NOISE, NORMAL and LOW DISTORTION modes for low-intermodulation and low-noise operation
- Hardcopy at a keystroke
- Simultaneous measurement of four active traces
- Level, frequency and user-definable limit lines as evaluation help with pass/fail information
- Split screen with independent measurement windows

Frequency accuracy – to the point

Tuning on FSE is absolutely synchronous to the reference frequency for each span including full span. This means that every point on the frequency axis is determined with the accuracy of the internal reference frequency and the pixel resolution. Thus, when reducing the span for detailed signal analysis, the tiresome readjustment of the center frequency is no longer needed.

FSE in its basic configuration includes an AM/FM audio demodulator. Unknown signals can easily be identified via headphones or the built-in loudspeaker. Modulation measurements are possible using the optional Vector Signal Analyzer FSE-B7.

Limit lines facilitate checking whether results are within predefined tolerances. Virtually any number of limit lines can be defined with high accuracy by means of 50 points to meet even the most exacting requirements.

Scalar network analysis

The optional tracking generators (see data sheet for FSE-B8/9/10/11 PD 0757.3434) are an ideal tool for determining frequency response, attenuation or VSWR and feature the following characteristics:

- Wide dynamic range for attenuation measurements (up to 120 dB)
- Frequency range from 9 kHz to 3.5/7 GHz
- Frequency offset up to ± 200 MHz for measurements on frequency-converting modules

The tracking generators with built-in I/Q modulator are ideal for generating digitally modulated signals. An external two-channel Arbitrary Waveform Generator (e.g. AMIQ from Rohde&Schwarz) serves as modulation source.

By adding the optional Vector Signal Analyzer FSE-B7, FSE can be expanded to a test assembly enabling direct measurement of the influence of amplifiers or filters on phase error for instance.

Operation – as you like it

Despite their comprehensive functionalities the analyzers feature great ease of operation. Basic functions and frequently used help tools such as markers can be called at a keystroke. The full operating convenience based on a wide variety of evaluation routines and marker functions can be accessed via the menus.

All essential parameters and results can be seen at a glance. All test data, scale factors and setting parameters are logically arranged and therefore easy to find. Setups, traces and graticules displayed in colour make for error-free analysis of complex results.

All models are equipped with a large 24 cm (9.5") TFT colour display with VGA resolution (640 x 480 pixels).

The USER key allows the FSE operation to be tailored to your specific requirements. With this key, you can compile the functions mainly needed for your measurement tasks, which does away with frequent menu changes and speeds up measurements on the whole.

Test results – perfectly documented

FSE affords uncomplicated logging of results. It supports a wide variety of printers such as:

- Printer with HP-PCL4 and HP-PCL5
- HP Deskjet/HP Laserjet
- Postscript

Print files cannot only be output via an interface but can also be stored on diskette or the internal hard disk. With PCX, WMF and HP-GL (without option

... The features in detail

Designation	Type	Use	Functions
Noise Measurement Software	FS-K3	Noise figure measurements	- Measurement of noise figure and temperature to Y-factor method - Measurements on frequency-converting devices - Frequency range same as basic unit, starting from 100 kHz - Editor for ENR tables - Runs on the internal controller (option) or on an external PC (Windows NT/Windows 98)
Phase Noise Measurement Software	FS-K4	Phase noise figure measurements	- Easy-to-use phase noise measurements - Measurement of residual FM and PM - Logarithmic plot over 8 decades - Runs on the internal controller (option) or on an external PC (Windows NT/Windows 98)
Application Firmware[1)]	FSE-K10, Mobile FSE-K11, BTS	Mobile radio transmitter measurements to GSM standards 11.10 and 11.20	- Power ramp and power template - Spectrum due to modulation/switching - Spurious emissions - Mean carrier power - Phase/frequency error (with option FSE-B7)
Application Firmware[2)]	FSE-K20, Mobile FSE-K21, BTS	EDGE capability added to Application Firmware FSE-K10 and FSE-K11	- Modulation accuracy measurement including EVM measurement using weighting filter to ETSI 95:th-percentile measurement measurement of origin offset suppression - Limit lines for EDGE to ETSI 05.05

1) See data sheet FSE-K10/-K11.
2) See data sheet FSE-K20/-K21.

FSE-B15) as well as BMP and WMF (with option FSE-B15) print formats being available, there is no problem in further processing print files in standard text processing systems. Using Controller FSE-B15, it is particularly easy to generate test reports and integrate the results. Texts can then be processed under Windows on FSE itself.

FSE as a controller

The optional Controller FSE-B15 provides a further VGA card, a memory extension to 64 Mbyte, a serial mouse and a keyboard. With this option, Windows NT applications, e.g. statistics programs or spreadsheet analysis, can be installed on FSE. FSE can even be linked to a network using the optional Ethernet Interface FSE-B16.

Complete setups, traces, limit lines and macros can be stored on the internal hard disk or on a diskette using the built-in 1.44 Mbyte drive.

FSE in automatic test systems

FSE is ideal for use in automatic test systems, affording not only fast processing of results but also an IEC/IEEE-bus command set conforming to SCPI.

Moreover, with optional Controller FSE-B15 and a second IEC/IEEE-bus card (option FSE-B17), FSE can be used as a controller for test systems, thus eliminating the need for further units and saving space in the system cabinet.

Low overall costs

In designing FSE, special emphasis was placed on keeping after-sales costs to a minimum:

- Temperature-controlled fans
- Calibration interval up to 2 years
- Built-in calibration routines
- Numerous selftest routines
- Modular design

Calibration routines

Built-in calibration routines ensure that FSE remains within defined tolerances and thus maintains its accuracy of measurement. The routines are not performed automatically by the instrument but can be started by the user, thus avoiding ongoing measurements to be interrupted. The results of calibration routines are output by FSE in the form of comprehensive correction tables. Comparing these tables over an extended period of time, the user can detect changes early and take corrective steps in time. This enhances confidence in the unit's reliability and measurement accuracy.

A particular asset in system applications is the internally selectable, high-precision level calibration source, which reduces the number of cables required.

Selftest – the built-in diagnostic system

The instrument selftest rapidly locates any faults down to module level. Defective modules can be replaced nearly without adjustments or extra test equipment being required. This in conjunction with the quick spare parts service from Rohde&Schwarz reduces any repair or downtime costs that might arise. The low operating costs go easy on your budget.

Modular design – easy retrofitting of options

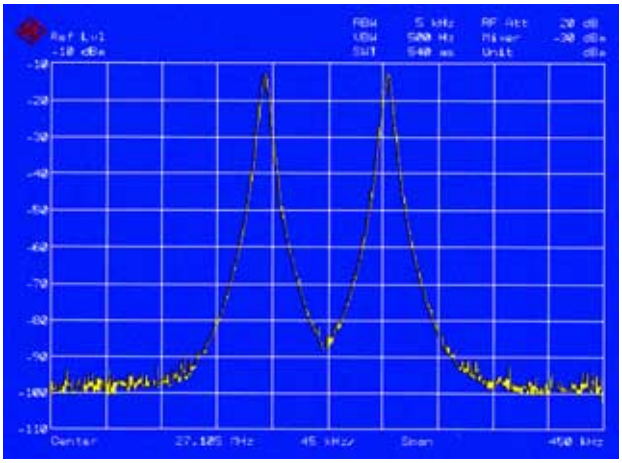
The modular concept of the most important options such as Vector Signal Analyzer and 7 GHz Frequency Extension, as well as the alignment-free incorporation of the remaining options make it possible to retrofit the instrument with a minimum of downtime or installation costs being involved.

Quality management at Rohde&Schwarz

Lasting customer satisfaction is our primary objective. The quality management system of Rohde&Schwarz meets the requirements of ISO 9001 and encompasses largely all fields of activity of the company.

Rear view of FSE

Applications ...



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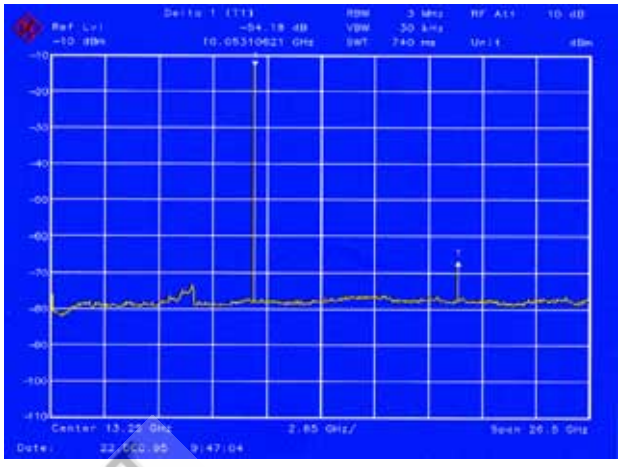

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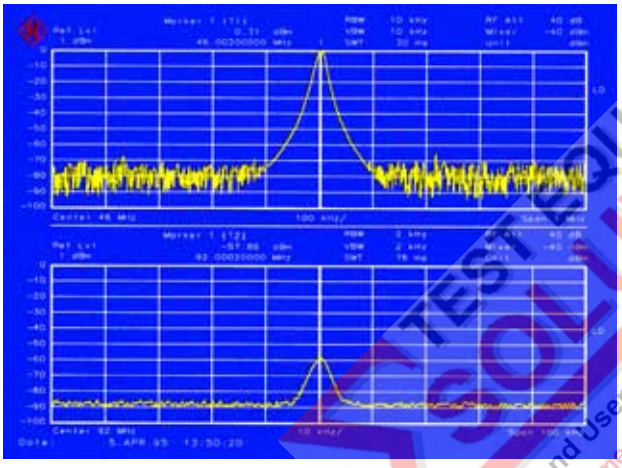

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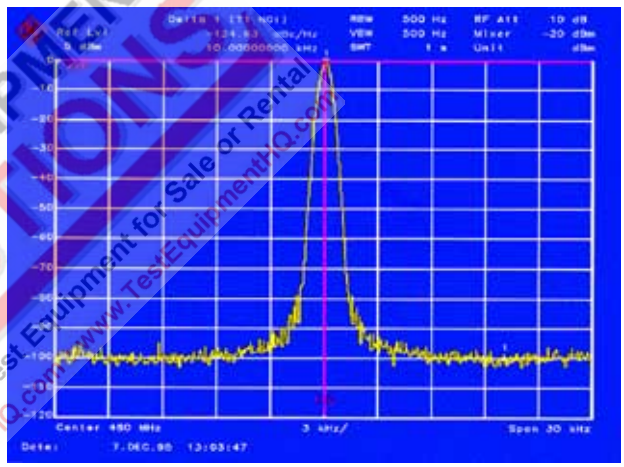

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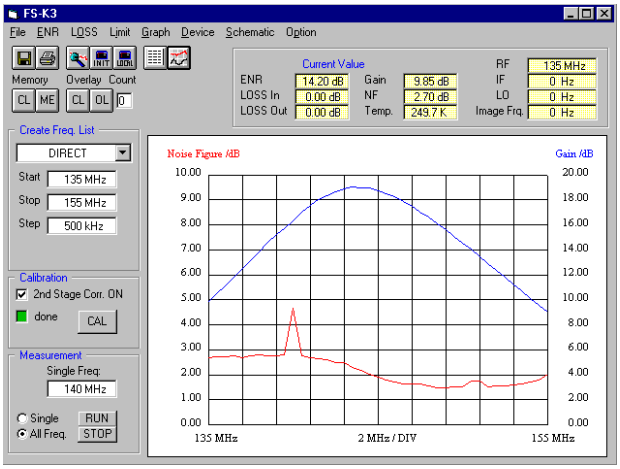
General-purpose RF measurements

Two-tone measurements (1)
FSE facilitates intermodulation measurements with its wide intermodulation-free dynamic range, which reduces measurement errors. This feature is enhanced by the LOW DISTORTION mode, which ensures optimum RF attenuation. Evaluation of results is rapid and easy by means of markers and delta markers.

Harmonics measurements with split screen (2)
The split-screen function has been provided for the convenient analysis of results. In harmonics measurements, for example, the fundamental and the first harmonic can be displayed simultaneously with high resolution.

Low noise floor even in the microwave range (3)
Thanks to fundamental mixing FSEM features the same constantly low noise floor as an RF analyzer up to 26.5 GHz. As a consequence, FSEM offers not only a wide dynamic range, but also a considerably increased speed for measuring small signals in the microwave range: Larger resolution bandwidths and high sensitivity reduce sweep time while maintaining the S/N ratio. This is of great advantage when measuring spurious and harmonics alike.

FSE phase noise as a function of carrier spacing (4)
With a phase noise of –123 dBc (Hz) at 10 kHz from the carrier, the synthesizer incorporated in FSEA 30 is ideal for measuring the phase noise of oscillators or the adjacent-channel power of radio equipment.



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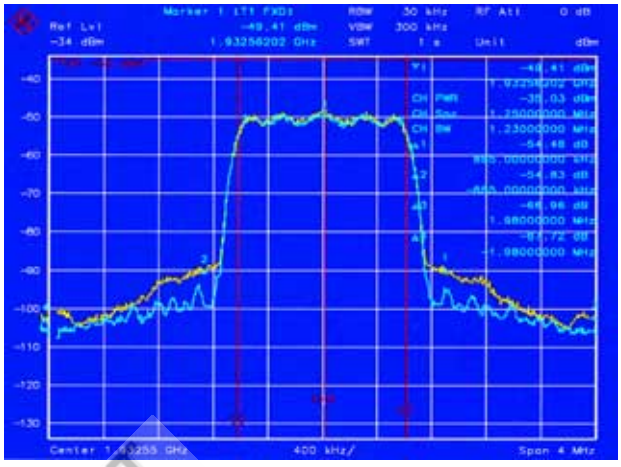

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Noise figure measurements

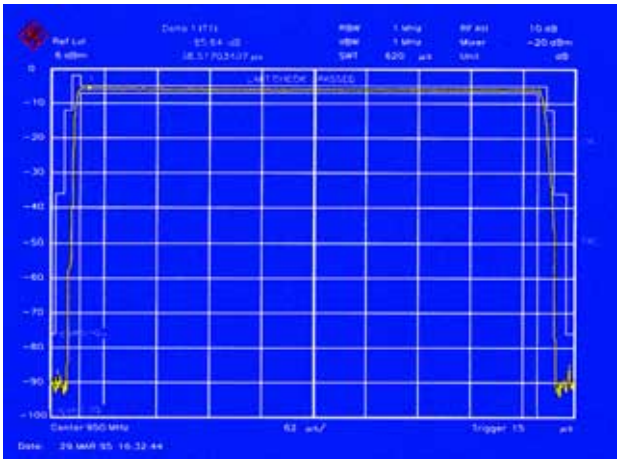
Noise Measurement Software FS-K3 (5)
FS-K3 turns your FSE into a noise measurement system offering the advantages of an analyzer (see also data sheet PD 0757.2380):

- Wide variety of resolution bandwidths for every application, even for measurements on narrowband DUTs
- If results are doubtful, the analyzer allows the test setup to be checked for radiated interference or nonharmonics
- Lower frequency limit of 100 kHz
- Measurements on frequency-converting DUTs supported by external generator

Phase Noise Measurement Software FS-K4 (6)
With FS-K4 (see also data sheet PD 0757.4201), FSE can be used as a phase noise analyzer. The phase noise of an input signal can easily be measured over several decades and displayed on a logarithmic frequency axis. The residual FM or PM can be determined conveniently within freely selectable limits.

RMS detector: power measurement without correction factors (7)
In the example, the power of a CDMA signal in the transmission channel and the adjacent channels is measured. The two traces show the influence of the DUT on the adjacent-channel power. Measuring power and adjacent-channel power of digitally modulated signals requires a spectrum analyzer to be equipped with special detectors and test routines. FSE is the first spectrum analyzer that features a real power detector with wide dynamic range – the RMS detector. Like a thermocouple power meter, this detector guarantees stable and accurate test results without any correction factors. Considerably higher test throughput is achieved than with the usual sample detector. Using the available default settings for ACP measurements in line with common standards (NADC, PDC, CDMA, WCDMA, etc) precise test results are obtained easily and fast.

... Applications



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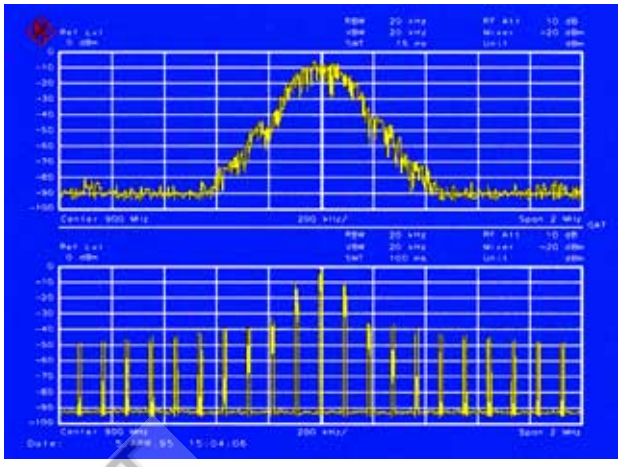

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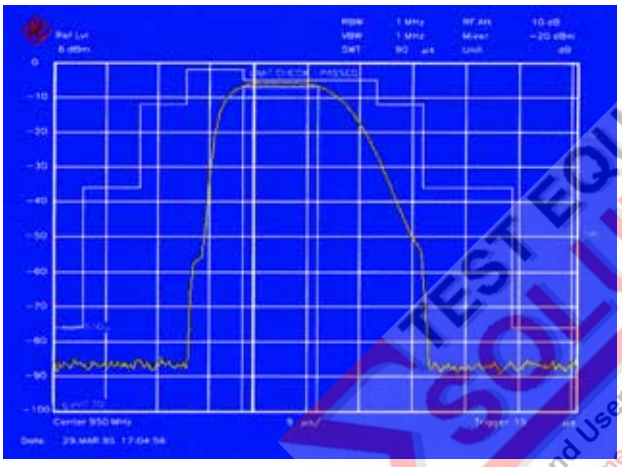

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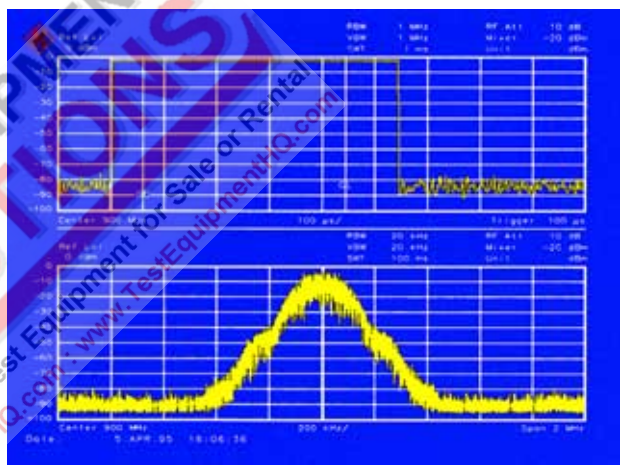

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Mobile radio – digital and analog

RF power trigger replaces external trigger (no illustration)
An internal broadband level detector (center frequency ±50 MHz) with a fixed switching threshold of approx. –20 dBm at the first mixer is used as a trigger source. With this detector it is possible, for example, to perform "spectrum due to switching" and "spectrum due to modulation" measurements to GSM specifications without an external trigger. The detector replaces the external trigger needed in the gated sweep mode.

Gap sweep: simultaneous measurement of pulse rise and fall times with high time resolution (8 and 9)
The fast sweep time of 100 ns/div as well as the gap sweep and pretrigger functions of Spectrum Analyzer FSE make it possible to measure the rise and fall times of an RF pulse simultaneously and with high time resolution. The center of the pulse, which is of no interest, is blanked. Even at a resolution bandwidth of 1 MHz FSE offers a dynamic range of over 80 dB thanks to the high 1 dB compression point of +10 dBm.

Gated sweep (10 and 11)
The gated sweep function is indispensable for analyzing TDMA signals used in modern communication systems. With this function, the spectrum of burst signals can be investigated without any interference being caused by switching the signals on and off. The selected gate time determines over what interval a pulse is to be analyzed. Selection of the gate time is easy and convenient in the time domain display (zero span) of the pulse.

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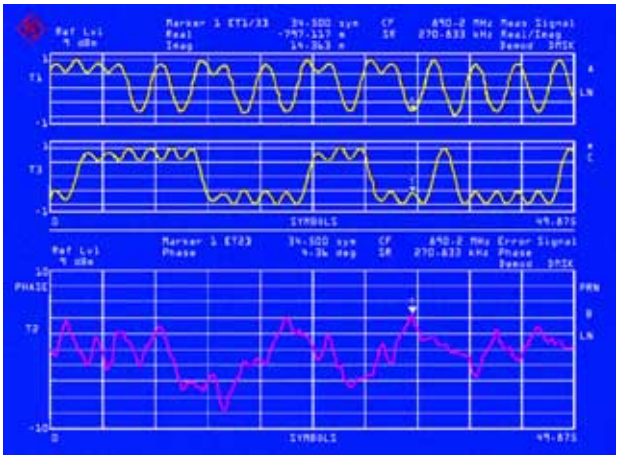

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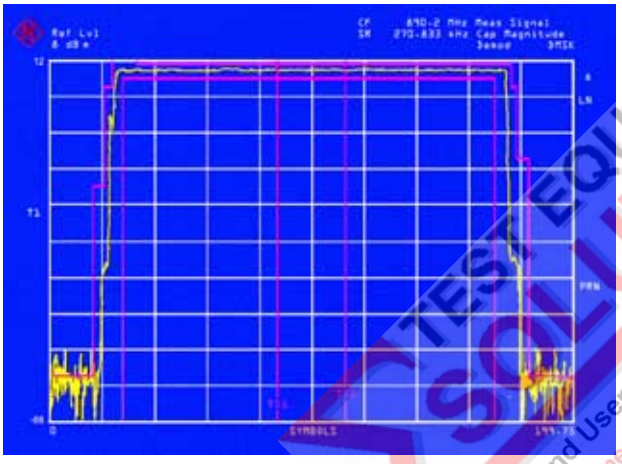


12 I/Q signal and phase error measurements over 50 symbols of a GSM mobile

13 Measurement of GSM power ramps to standards with high-precision time reference through synchronization to mid-amble

14 Measurement of modulation errors of π/4-DQPSK signals (NADC)

Vector signal analysis

Universal analysis of digital signals

Spectrum Analyzer FSE in conjunction with the optional Vector Signal Analyzer FSE-B7 is ideal for demodulating and measuring digitally modulated signals with frequencies up to 3.5 GHz, 7 GHz, 26.5 GHz or 40 GHz. This universal tool offers a wide variety of settings:

- Demodulation of all common mobile-radio signals
- Symbol rates up to 2 MHz
- Type of filter
- Roll-off factor or BT product of filter
- Synchronization bit sequences
- Predefined, application-specific settings for all common standards, e.g. GSM, PCS 1900, NADC, CDMA (IS95)

Versatile display of results

- Inphase and quadrature signals
- Magnitude and phase
- Vector and constellation diagrams
- Eye and trellis diagrams
- Sum fault: amplitude, frequency, phase, vector

Power ramp measurements

To perform power ramp measurements to standards on TDMA systems such as GSM or DECT, reference must be made to synchronization sequences (pre- or mid-amble) in order to establish a time reference. Making such measurements to standard is not possible using conventional analyzers – but it is no problem with FSE!

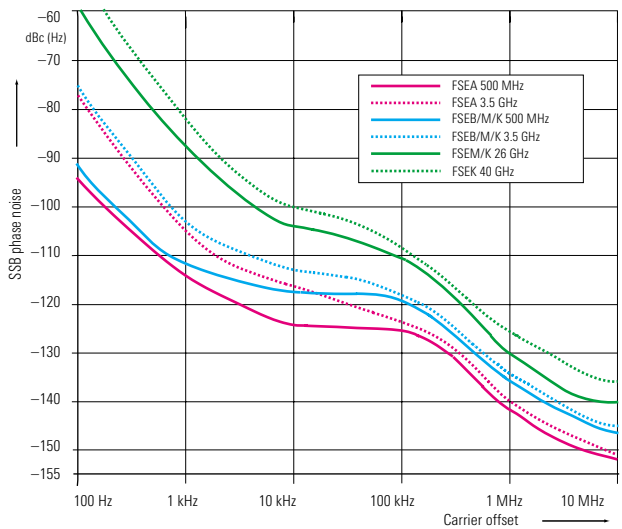
Accurate AM, FM and PM measurements

Featuring high-accuracy measurement of the modulation depth and frequency deviation coupled with the display of demodulated signals in the time domain, FSE not only enables testing of analog and dual-mode radio equipment but also the determination of the transient response in frequency and amplitude (see data sheet PD 0757.2167).

Spectrum Analyzer FSE and the optional vector signal analyzer provide universal test capabilities in one unit.

Specifications

	FSEA30	FSEB30	FSEM30	FSEK30
Specifications are guaranteed under the following conditions: 30 minutes warmup time at ambient temperature, specified environmental conditions met, calibration cycle adhered to, and total calibration performed. Data without tolerances: typical values only. Data designated "nominal" apply to design parameters and are not tested.				
Frequency				
Frequency range	20 Hz to 3.5 GHz	20 Hz to 7 GHz	20 Hz to 26.5 GHz	20 Hz to 40 GHz
Frequency resolution	0.01 Hz			
Internal reference frequency, nominal				
Aging per day[1)]	1×10^{-9}			
Aging per year[1)]	2×10^{-7}			
Temperature drift (0 °C to +50 °C)	5×10^{-8}			
Total error limit (per year)	2.5×10^{-7}			
External reference frequency	10 MHz or n × 1 MHz, n = 1 to 16			
Frequency display	with marker			
Resolution	0.1 Hz to 10 kHz (as a function of span)			
Error limit (sweep time >3 × auto sweep time)	±(marker frequency × reference error + 0.5 % × span + 10 % × resolution bandwidth + 1/2 (last digit))			
Frequency counter	measures the marker frequency			
Resolution	0.1 Hz to 10 kHz (selectable)			
Count accuracy (S/N >25 dB)	±(frequency × reference error + 1/2 (last digit))			
Display range for frequency axis	0 Hz, 10 Hz to full span			
Resolution/error limit of display range	0.1 Hz/1%			
Spectral purity (dBc (Hz)) SSB phase noise, f ≤500 MHz	for f >500 MHz see diagram below			
Carrier offset 100 Hz	<–87	<–81		
1 kHz	<–107	<–100		
10 kHz	<–120	<–114		
100 kHz[2)]	<–119	<–113		
1 MHz[2)]	<–138	<–132		
Sweep time				
Span = 0 Hz	1 µs to 2500 s in 5% steps			
Span ≥10 Hz	5 ms to 16 000 s in steps ≤10%			
Error limit	<1%			
Picture refresh rate (span ≤7 GHz)	>20 updates/s with 1 trace, >15 updates/s with 2 traces			
Sampling rate	50 ns (20 MHz A/D converter)			
Number of pixels	500			
Time measurement	with marker and cursor lines			
Resolution	50 ns			
Sweep trigger	free run, single, line, video, gated, delayed, external			
Zero span	additionally pretrigger, posttrigger, trigger delay			
Resolution bandwidths				
3 dB bandwidths (in 1/2/3/5 steps)	1 Hz to 10 MHz			
FFT filter (in 1/2/3/5 steps) (see also page 16)	1 Hz to 1 kHz			



SSB phase noise (typical values)

Specifications

		FSEA30	FSEB30	FSEM30	FSEK30
Bandwidth error	≤3 MHz	<10%			
	5 MHz	<15%			
	10 MHz	+25%, –10%			
Shape factor 60:3 dB	<1 kHz	<6			
	1 kHz to 2 MHz	<12			
	>2 MHz	<7			
Video bandwidths		1 Hz to 10 MHz, 1/2/3/5 steps			
Level					
Display range		noise floor displayed to 30 dBm			
Maximum input level					
RF attenuation 0 dB					
DC voltage		0 V			
CW RF power		20 dBm (=0.1 W)			
Pulse spectral density		97 dBµV (MHz)			
RF attenuation ≥10 dB					
DC voltage		0 V			
CW RF power		30 dBm (=1 W)			
Max. pulse voltage		150 V		50 V	
Max. pulse energy (10 µs)		1 mWs		0.5 mWs	
1 dB compression of input mixer (0 dB RF attenuation)		+10 dBm nominal			
Displayed average noise floor		**in dBm** (0 dB RF attenuation, RBW 10 Hz, VBW 1 Hz, 20 averages, trace average, span 0 Hz, termination 50 Ω)			
Frequency	20 Hz	<–80	<–74		
	1 kHz	<–110	<–104		
	10 kHz	<–125	<–119		
	100 kHz	<–135	<–129		
	1 MHz	<–145, –150 typ.	<–142, typ. –145		
	10 MHz to 3.5/6 GHz	<–145, –150 typ.	<–142, –147 typ.	<–138, –140 typ.	
	6 GHz to 7 GHz	–	<–139	<–135, –138 typ.	
	7 GHz to 18 GHz	–	–	<–138, –140 typ.	<–134, –139 typ.
	18 GHz to 26.5 GHz	–	–	<–135, –138 typ.	<–131, –136 typ.
	26.5 GHz to 30 GHz	–	–	–	<–120, –125 typ.
	30 GHz to 40 GHz	–	–	–	<–116, –122 typ.
Max. dynamic range, bandwidth 1 Hz					
Displayed noise floor to 1 dB compression		165 dB	162 dB	160 dB	
Max. harmonics suppression, f >50 MHz		>90 dB			
Max. intermodulation-free range					
50 MHz to 3.5 GHz (nominal)		115 dB	–	–	
150 MHz to 7/26.5 GHz (nominal)		–	115 dB	112 dB	
Intermodulation					
TOI, intermodulation-free dynamic range, level 2 × –30 dBm, Δf >5 × RBW or >10 kHz		>84 dBc for f >50 MHz (TOI >12 dBm, 18 dBm typ.)	>90 dBc for f >150 MHz (TOI >15 dBm, 20 dBm typ.)	>94 dBc for f >100 MHz, >80 dBc for f >7 GHz, (TOI >17 dBm, 22 dBm typ.; >10 dBm for f >7 GHz)	
Intermodulation-free range at –40 dBm mixer level		105 dB			
Intercept point k2 (dBm)		>25, >40 typ. for f <50 MHz, >45, >50 typ. for f >50 MHz	>25 for f <150 MHz, >35 typ., >40 for f >150 MHz, >45 typ.		
Immunity to interference					
Image frequency (dB)		>80, >90 typ.		>80, >90 typ. for f <22 GHz, >75, >80 typ. for f >22 GHz	
Intermediate frequency (dB)		>100 dB	>75 dB		
Spurious response (f >1 MHz, without input signal, 0 dB attenuation)					
Span <30 MHz		<–110 dBm			
Span ≥30 MHz		<–100 dBm			
f_{in} = 25.06 MHz, 25.175 MHz, 5.7172 GHz		<–100 dBm			
f_{in} = 60 MHz		<–110 dBm	<–100 dBm		
f_{in} = 14.1894 GHz, 15.6722 GHz					
Span >10 MHz		–90 dBm			
Other interfering signals (mixer level <–10 dBm)		<–80 dB[3)]	<–75 dB[3)]		

Specifications

	FSEA30	FSEB30	FSEM30	FSEK30
Level display				
Measurement display	500 × 400 pixels (with one diagram displayed); max. 2 diagrams with independent settings			
Logarithmic level range	10 dB to 200 dB, in steps of 10 dB			
Linear level range	10% of reference level per division (10 divisions) or logarithmic scaling			
Traces	max. 4 per diagram (max. 2 if 2 diagrams are displayed) quasi-analog display of all results			
Trace detector	max peak, min peak, auto peak (normal), sample, rms, average			
Trace functions	clear/write, max hold, min hold, average			
Setting range of reference level				
Logarithmic level display	–130 dBm to 30 dBm, in steps of 0.1 dB			
Linear level range	7.0 nV to 7.07 V in steps of 1%			
Units of level axis	dBm, dBµV, dBmV, dBµA, dBpW (logarithmic and linear level display); mV, µV, mA, µA, pW, nW (linear level display)			
Level measurement uncertainty (–40 dBm, RF attenuation 20 dB, reference level –15 dB, RBW 5 kHz)	**The values are guaranteed for bandwidths from 10 Hz to 30 kHz and 100 kHz to 10 MHz.**			
Absolute error limit at 120 MHz	<0.3 dB			
Frequency response (10 dB RF attenuation)				
<1 GHz	<0.5 dB			
1 GHz to 3.5/7 GHz	<1 dB			
7 GHz to 18 GHz	–	<2 dB[4)]		
18 GHz to 26.5 GHz	–	<2.5 dB[4)]		
26.5 GHz to 40 GHz	–	–	<3 dB[4)]	
Attenuator error limit	<0.3 dB			
IF gain error	<0.2 dB (0.1 dB typ.)			
Display nonlinearity				
Logarithmic level display				
(RBW ≥1 kHz, analog)				
0 dB to –50 dB	<0.3 dB			
–50 dB to –70 dB	<0.5 dB			
–70 dB to –80 dB	–			
–70 dB to –95 dB	<1 dB			
Linear level display	5% of reference level			
Bandwidth switching error				
1 Hz to 30 kHz/100 to 500 kHz	<0.2 dB			
1 MHz to 10 MHz	<0.3 dB			
Total measurement uncertainty (0 dB to 50 dB below reference level, span/RBW <100, rss 95% reliability)				
<1 GHz	<1 dB			
1 GHz to 3.5/7 GHz	<1.5 dB			
7 GHz to 18 GHz	–	<2.5 dB[4)]		
18 GHz to 26.5 GHz	–	<3 dB[4)]		
26.5 GHz to 40 GHz	–	–	<3.5 dB[4)]	
Pulse amplitude error (single pulses)				
Bandwidth <1 MHz/≥1 MHz	<0.5 dB, nominal/<2 dB, nominal			
Trigger functions				
Trigger	free run, line, video, RF, external			
Delayed sweep				
Trigger source	free run, line, video, RF, external			
Delay time	100 ns to 10 s, resolution 1 µs min. or 1% of delay time			
Error of delay time	±(1 µs + (0.1% x delay time))			
Delayed sweep time	2 µs to 1000 s			
Gated sweep				
Trigger source	external, RF level			
Gate delay	1 µs to 100 s			
Gate length	1 µs to 100 s, resolution min. 1 µs or 1% of gate length			
Error of gate length	±(1 µs + (0.05% × gate length))			
Gap sweep (span = 0 Hz)				
Trigger source	free run, line, video, RF, external			
Pretrigger	1 µs to 100 s, 50 ns resolution, dependent on sweep time			
Trigger to gap time	1 µs to 100 s, 50 ns resolution, dependent on sweep time			
Gap length	1 µs to 100 s, 50 ns resolution			

Specifications

	FSEA30	FSEB30	FSEM30	FSEK30
Audio demodulation				
AF demodulation types	AM and FM			
Audio output	loudspeaker and headphones output			
Marker stop time	100 ms to 60 s			
Inputs and outputs (front panel)				
RF input	N female, 50 Ω		adapter system, 50 Ω, N male and female, 3.5 mm male and female	adapter system, 50 Ω, N male and female, K male and female, 2.4 mm female
VSWR (RF attenuation ≥10 dB)				
f <3.5 GHz	<1.5			
f <7 GHz	–	<2.0		
f <26.5 GHz	–		<3	<2.5
f <37 GHz	–		–	<2.5
f <40 GHz	–		–	2.5 typ.
Attenuator	0 dB to 70 dB, selectable in 10 dB steps			
Probe power	+15 V DC, –12.6 V DC and ground, max. 150 mA			
Power supply and coding connector for antennas etc (antenna code)	12-contact Tuchel			
Supply voltages	±10 V, max. 100 mA, ground			
AF output	Z_{out} = 10 Ω , jack plug			
Open-circuit voltage	adjustable up to 1.5 V			
Inputs and outputs (rear panel)				
IF 21.4 MHz	Z_{out} = 50 Ω , BNC female, bandwidth >1 kHz or resolution bandwidth			
Level	0 dBm at reference level, mixer level > –60 dBm			
Video output	Z_{out} = 50 Ω , BNC female			
Voltage (resolution bandwidth ≥1 kHz)	0 V to 1 V, full scale (open-circuit voltage); logarithmic scaling			
Reference frequency				
Output, usable as input	BNC female			
Output frequency	10 MHz			
Level	10 dBm nominal			
Input	1 MHz to 16 MHz, integer MHz			
Required level	>0 dBm into 50 Ω			
Sweep output	BNC female, 0 V to 10 V in sweep range			
Power supply connector for noise source	BNC female, 0 V and 28 V, selectable			
External trigger/gate input	BNC female, >10 kΩ			
Voltage	–5 V to +5 V, adjustable			
IEC/IEEE-bus control	interface to IEC625-2 (IEEE 488.2), command set: SCPI 1994.0			
Connector	24-contact Amphenol female			
Interface functions	SH1, AH1, T6, L4, SR1, RL1, PP1, DC1, DT1, C11			
Serial interface	RS-232-C (COM 1 and COM 2), 9-contact female connectors			
Mouse interface	PS/2 mouse compatible			
Plotter[5)]	via IEC/IEEE bus or RS-232-C; plotter language: HP-GL			
Printer interface	parallel (Centronics compatible) or serial (RS-232-C)			
Keyboard connector	5-contact DIN female for MF-2 keyboard			
User interface	25-contact Cannon female			
Connector for external monitor (VGA)	15-contact female			
General data				
Display	24 cm LC TFT colour display (9.5")			
Resolution	640 × 480 pixels (VGA resolution)			
Pixel failure rate	$<2 \times 10^{-5}$			
Mass memory	1.44 Mbyte 3 ½" diskette drive, hard disk			
Operating temperature range				
Nominal temperature range	+5 °C to +40 °C			
Limit temperature range	0 °C to +50 °C			
Storage temperature range	–40 °C to +70 °C			
Humidity	+40 °C at 95 % relative humidity (IEC 68-2-3)			
Mechanical resistance				
Vibration, sinusoidal	5 Hz to 150 Hz, max. 2 g at 55 Hz; 55 Hz to 150 Hz, 0.5 g const. to IEC 68-2-6, IEC 68-2-3, IEC 1010-1, MIL-T-28800D, class 5			
Vibration, random	10 Hz to 300 Hz, acceleration 1.2 g (rms)			

Specifications

	FSEA30	FSEB30	FSEM30	FSEK30
Shock	40 g shock spectrum, to MIL-STD-810 D and MIL-T-28800 D, classes 3 and 5			
Recommended calibration interval	1 year (2 years for operation with external reference)			
RFI suppression	to EMC directive of EU (89/336/EEC) and German EMC legislation			
Power supply				
AC supply	200 V to 240 V: 50 Hz to 60 Hz, 100 V to 120 V: 50 Hz to 400 Hz, class of protection I to VDE 411			
Power consumption	180 VA	195 VA	230 VA	230 VA
Safety	to EN 61010-1, UL 3111-1, CSA C22.2 No. 1010-1, IEC 1010-1			
Test mark	VDE, GS, UL, cUL			
Dimensions in mm (W x H x D)	435 x 236 x 460 (5 HU)		435 x 236 x 570	435 x 236 x 570
Weight in kg	22.7	23.2	25.2	25.8

1) After 30 days of operation.
2) Valid for span >100 kHz.
3) For models with option FSE-B23: <–50 dBm.
4) For frequencies >7 GHz: error after calling peaking function. For sweep times <10 ms/GHz: additional error 1.5 dB.
5) The plot function is not available if option FSE-B15 is installed.

Specifications

FFT filter

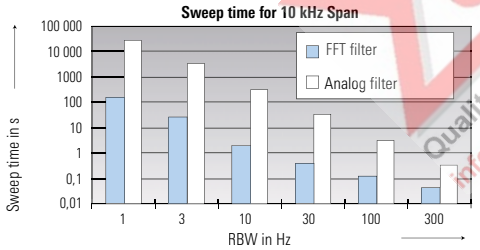
High frequency resolution due to very small shape factor of 2.5
Extremely short measurement time, up to 150 times faster than with conventional filters

Resolution bandwidths (RBW)

3 dB bandwidth	
in 1/2/3/5 steps	1 Hz to 1 kHz
Bandwidth error	2%, nominal
Shape factor 60:3 dB	2.5, nominal

Display range for frequency axis

Min. span	25 x RBW
Max. span	100000 x RBW, max. 2 MHz



Level measurement error

Additional total level error, referred to RBW 5 kHz	<1 dB

Max. display range 100 dB

Immunity to interference

Spurious response	≤100 dBm

1 dB Attenuator FSE-B13

Frequency range	max. 7 GHz (stop frequency ≤7 GHz)
Setting range of RF attenuation	0 dB to 70 dB
Step width	1 dB
Additional attenuator uncertainty	<0.1 dB

External Mixing FSE-B21

LO output/IF input (front panel)	SMA female, 50 Ω
LO signal	7.5 GHz to 15.2 GHz
Amplitude	+15.5 dBm ±3 dB
IF signal	741.4 MHz
Full-scale level	–20 dBm
IF input (front panel)	SMA female, 50 Ω
IF signal	741.4 MHz
Full-scale level	–20 dBm
Level measurement error at IF inputs (IF level –30 dBm, reference level –20 dBm, RBW 30 kHz)	<1 dB

Increased Level Accuracy FSE-B22

Total level error	≤0.5 dB with 10 dB RF attenuation ≤0.6 dB with 20/30/40 dB RF attenuation

Specifications are valid for:	
Temperature range	-/+20°C to +30°C
Frequency range	10 MHz to 2 GHz
Resolution bandwidths	5 kHz to 30 kHz/300 kHz/1 MHz
Signal level	10 dB to 50 dB below reference level
Stop frequency	≤2 GHz
Sweep time	≥3 x auto sweep time

Broadband Output 741.4 MHz FSE-B23

FSE-B23 reduces the suppression of other interference signals to –50 dBm and must not be combined with FSE-K10/-K11.

	FSEA	FSEB	FSEM	FSEK
Gain from RF input to IF output (dB)	6	6	4	4
3 dB BW (MHz)	60	150	150[1] 40 to 80[2]	150[1] 40 to 120[3]

1) f <7 GHz.
2) 7 GHz to 26.5 GHz.
3) 7 GHz to 40 GHz.

Connector	BNC
Impedance	50 Ω

For maximum bandwidth set instrument to 10 MHz RBW. The output level is a function of the mixer level, which equals the input signal level minus the set RF attenuation.
The typical loss between mixer level and IF output is 2 dB for FSEM/K, and 0 dB for FSEA/B.

44 GHz Frequency Extension for FSEK FSE-B24

Frequency range 20 Hz to 44 GHz

Level

Displayed average noise level (DANL)
(0 dB RF attenuation, RBW = 10 Hz, VBW = 1 Hz, 20 averages, trace average, span 0 Hz, 50 Ω termination)

40 GHz to 42 GHz	<–112, –128 dBm typ.
42 GHz to 43 GHz	<–108, –113 dBm typ.
43 GHz to 44 GHz	<–105, –110 dBm typ.

Intermodulation

3rd-order intercept point (TOI) Δ f >5 x resolution bandwidth or >10 kHz

>40 GHz	+15 dBm typ.
2nd harmonic intercept point (SHI)	>25 dBm for f <150 MHz >40 dBm for f >150 MHz

Level measurement error

Frequency response (10 dB RF attenuation)

40 GHz to 44 GHz	<4.0 dB[1)2)]

Total measurement error
(0 dB to 50 dB below reference level)

40 GHz to 44 GHz	<4.5 dB[1)2)]

Inputs and outputs (front panel)

RF input	adapter system, 50 Ω, N male und female, K male und female, 2.4 mm female

VSWR (RF attenuation >0 dB)

f >40 GHz	<3.0:1 typ.

1) Error after running the preselector peaking function. For sweep <10 ms/GHz: additional error 1.5 dB.
2) Temperature range 20 °C to 35 °C.

Ordering information

Order designation	Type	Order No.
Spectrum Analyzer 20 Hz to 3.5 GHz	FSEA30	1065.6000.35
Spectrum Analyzer 20 Hz to 7 GHz	FSEB30	1066.3010.35
Spectrum Analyzer 20 Hz to 26.5 GHz	FSEM30	1079.8500.35
Spectrum Analyzer 20 Hz to 40 GHz	FSEK30	1088.3494.35
Accessories supplied Power cable, operating manual, spare fuses; **FSEM**: test-port adapter 3.5 mm female (1021.0512.00) and N female (1021.0535.00) **FSEK**: test-port adapter K female (1036.4790.00) and N female (1036.4777.00)		
Options (see also fold-in page)		
7 GHz Frequency Extension for FSEA	FSE-B2	1073.5044.02
Vector Signal Analyzer	FSE-B7[1)]	1066.4317.03
Tracking Generator 3.5 GHz	FSE-B8[1)]	1066.4469.02
3.5 GHz with I/Q modulator	FSE-B9[1)]	1066.4617.02
7 GHz	FSE-B10[1)]	1066.4769.02
7 GHz with I/Q modulator	FSE-B11[1)]	1066.4917.02
Switchable Attenuator for Tracking Generator	FSE-B12[2)]	1066.5065.02
1 dB Attenuator	FSE-B13[2)3)]	1119.6499.02
Controller for FSE (mouse and keyboard included)	FSE-B15[4)]	1073.5696.06
Ethernet Interface 15-contact AUI connector	FSE-B16[5)]	1073.5973.02
Thin-wire BNC connector	FSE-B16[5)]	1073.5973.03
RJ-45 connector (twisted pair)	FSE-B16[5)]	1073.5973.04
2nd IEC/IEEE-Bus Interface for FSE	FSE-B17[5)]	1066.4017.02

Order designation	Type	Order No.
Removable Hard Disk	FSE-B18[4)]	1088.6993.02
2nd Hard Disk for FSE-B18 (firmware included)	FSE-B19	1088.7248.02
External Mixing	FSE-B21	1084.7243.02
Increased Level Accuracy up to 2 GHz	FSE-B22[4)]	1106.3480.02
Broadband Output 741.4 MHz	FSE-B23[4)]	1088.7348.02
44 GHz Frequency Extension for FSEK	FSE-B24[4)]	1106.3680.02
Software		
Noise Measurement Software, Windows	FS-K3[1)]	1057.3028.02
Phase Noise Measurement Software, Windows	FS-K4[1)]	1108.0088.02
GSM Application Firmware Mobile station	FSE-K10[1)]	1057.3092.02
Base station	FSE-K11[1)]	1057.3392.02
EDGE Application Firmware Mobile station	FSE-K20[1)]	1106.4086.02
Base station	FSE-K21[1)]	1106.4186.02
Recommended extras		
Service Kit	FSE-Z1	1066.3862.02
DC Block 5 MHz to 7000 MHz (type N)	FSE-Z3	4010.3895.00
10 kHz to 18 GHz (type N)	FSE-Z4	1084.7443.02
Microwave Measurement Cable and Adapter Set for FSEM	FSE-Z15	1046.2002.02
Harmonic Mixer 40 GHz to 60 GHz	FS-Z60[1)]	1089.0799.02
50 GHz to 75 GHz	FS-Z75[1)]	1089.0847.02
60 GHZ to 90 GHz	FS-Z90[1)]	1089.0899.02
75 GHZ to 110 GHz	FS-Z110[1)]	1089.0976.00

Order designation		Type	Order No.
Service Manual		–	1065.6016.24
Headphones		–	0708.9010.00
Keyboard	German	PSA-Z2	1007.3001.31
	US	PSA-Z2	1007.3001.02
PS/2 Mouse		FSE-Z2	1084.7043.02
IEC/IEEE-Bus Cable	1 m	PCK	0292.2013.10
	2 m	PCK	0292.2013.20
19" Rack Adapter, with front handles		ZZA-95	0396.4911.00
Transit Case		ZZK-954	1013.9395.00
Transit Case (FSEM30 and FSEK30 only)		ZZK-955	1013.9408.00
Matching Pads, 75 Ω	L section	RAM	0358.5414.02
	Series resistor, 25 Ω	RAZ	0358.5714.02
Accessories for current, voltage and field-strength measurement		see accessories for Test Receiver and Spectrum Analyzers, data sheet PD 0756.4320	
SWR Bridge	5 MHz to 3000 MHz	ZRB2	0373.9017.52
	40 kHz to 4 GHz	ZRC	1039.9492.52

Order designation		Type	Order No.
High-Power Attenuators Steps: 3/6/10/20/30 dB	100 W 50 W	RBU 100 RBU 50	1073.8820.xx 1073.8895.xx xx: 03/06/10/20/30
		ESV-Z3	0397.7014.52
For FSEM only: Test-Port Adapter	N male	–	1021.0541.00
	3.5 mm male	–	1021.0529.00
For FSEK only: Test-Port Adapter	N male	–	1036.4783.00
	K male	–	1036.4802.00
	2.4 mm female	FSE-Z5	1088.1627.02
Probe Power Connectors 3-contact		–	1065.9480.00

1) Extra data sheets available.
2) FSE-B12 and FSE-B13 cannot be fitted together.
3) In combination with FSE-B22 factory-fitted only.
4) Cannot be retrofitted, factory-fitted only.
5) FSE-B16 and FSE-B17 require option FSE-B15.

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