

VHF/UHF Digital Wideband Receiver R&S®EM 550

Efficient and versatile solution for radiomonitoring applications

The R&S®EM 550 is a fully digitized VHF/UHF receiver of advanced design based on state-of-the-art technology. It covers the frequency range 20 MHz to 3.6 GHz.

Excellent RF characteristics and dynamic performance paired with powerful digital signal processing are the basis for optimum system solutions.

- ◆ Wideband operation
 - I/Q data up to 10 MHz bandwidth
 - Demodulation up to 10 MHz bandwidth
 - IF analog output up to 50 MHz bandwidth
 - Analog TV, radar
- ◆ 23 IF filters, 150 Hz to 10 MHz
- ◆ Panorama scan up to 16 GHz/s or 600000 channels/s
- ◆ Frequency/memory scan up to 850 channels/s
- ◆ IF panorama up to 9.6 MHz span
- ◆ Video panorama, AM, FM, AM², FM², I/Q
- ◆ Audio filter: notch, noise reduction, bandpass
- ◆ Two-channel analog video output: AM, FM or I, Q
- ◆ ITU measurements
- ◆ Selective call decoding
- ◆ LAN interface (SCPI)



ROHDE & SCHWARZ

Overview

The VHF/UHF Digital Wideband Receiver R&S®EM 550 is ideally suited for military monitoring tasks and spectrum monitoring in line with ITU recommendations as well as for radio investigation services.

The R&S®EM 550 is prepared to meet any future demands in the field of receiver and analyzer technology for the purpose of frequency spectrum and signal analysis. The receiver is software-compatible with the R&S®EB 200/ESMB family, thus providing an easy way to upgrade existing radiomonitoring systems.

Description

The R&S®EM 550 covers the wide frequency range from 20 MHz to 3.6 GHz.

High level mixers and amplifiers make sure that even in critical scenarios the intermodulation products are extremely low. Additionally the receiver features comprehensive preselection to reduce the signal sumload on the input. Local oscillators with low phase noise are the basis for optimum detection of weak signals in the close vicinity of strong emitters.

A large number of IF bandwidths is available to process the various signals with optimum signal-to-noise ratio. To ensure maximum quality, modern digital signal processing is used throughout.

The receiver is equipped with digital IF filters with 23 different bandwidth settings from 150 Hz to 10 MHz. Demodulation with analog and digital video data as well as digital base band data can be performed over this wide range of IF filters.

Many interfaces, both digital and analog, provide nearly unlimited processing of the gained data.

Operation

The receiver is controlled via the LAN interface (TCP/IP) based on the SCPI syntax.

The receiver operates in the following modes:

- ◆ Fixed frequency mode (FFM)
- ◆ Memory scan
- ◆ Frequency scan
- ◆ Panorama scan (option)
- ◆ Wideband FFM
- ◆ Test

Data output is possible in the following formats:

- ◆ IF² wideband analog, $f = 405.4$ MHz, $BW \geq 50$ MHz
- ◆ IF³ analog, $f = 21.4$ MHz, $BW \geq 8$ MHz
- ◆ Baseband signal (I and Q) in digital form via
 - LAN ($BW_{max} = 1$ MHz)
 - FPDP ($BW_{max} = 10$ MHz)
- ◆ Video analog, DC to $\frac{1}{2}$ BW, two channels (AM/FM or I/Q) or IF analog, gain-controlled, variable center frequency 0 MHz to 21.4 MHz, two channels
- ◆ Video digital via LAN, two channels, AM/FM ($BW_{max} = 250$ kHz) or I/Q ($BW_{max} = 500$ kHz)
- ◆ AES3 for recording audio data
- ◆ Audio digital via LAN
- ◆ Audio analog (600 Ω line and headphones)

Operating modes

In the fixed frequency mode, a fixed frequency channel is set at which the signal is received, filtered and demodulated.

The following parameters can be set:

- ◆ Frequency
 - Setting range from 20 MHz to 3.6 GHz in 1 Hz steps
- ◆ Demodulation mode
 - The following demodulation modes can be selected:
 - FM
 - AM
 - PULSE (AM PULSE)
 - PM
 - USB
 - LSB
 - ISB
 - CW
 - I/Q
 - TV
- ◆ Bandwidth
 - The IF bandwidths can be selected in 23 steps between 150 Hz and 10 MHz
- ◆ Measurement time
 - Automatic or settable between 0.5 ms to 900 s
- ◆ Detector modes "continuous" or "periodic"
- ◆ Squelch
 - The level squelch can be set in 1 dB steps in the range -30 dB μ V to $+130$ dB μ V
- ◆ Automatic frequency control (AFC)
 - With AFC switched on, the receiver frequency is tuned within the IF bandwidth
- ◆ Level detector
 - For level measurement, the detector can be switched to AVG, PEAK, RMS or FAST
- ◆ Frequency offset detector
- ◆ Attenuator
 - Manual (0 dB to 40 dB) or automatic mode

- ◆ Gain control (GC)
 - Automatic (AGC) and manual (MGC) gain control; the MGC setting covers the input signal range from $-30\text{ dB}\mu\text{V}$ to $+130\text{ dB}\mu\text{V}$
- ◆ Video panorama
 - Spectrum of the demodulated signal with analysis features (squared AM, FM)
- ◆ IF panorama (option)
 - Span range 10 kHz to 9.6 MHz
- ◆ ITU measurement (option)
 - AM modulation index (AM+, AM-, AM)
- ◆ FM deviation (FM+, FM-, FM)
- ◆ PM deviation (0π to 4π)
- ◆ Bandwidth (0 MHz to 9.6 MHz)

In the **Memory Scan** mode, the receiver settings can be programmed for the monitoring of up to 10000 channels. These channels can be scanned with the Memory Scan command. A single channel can be called with the Recall command.

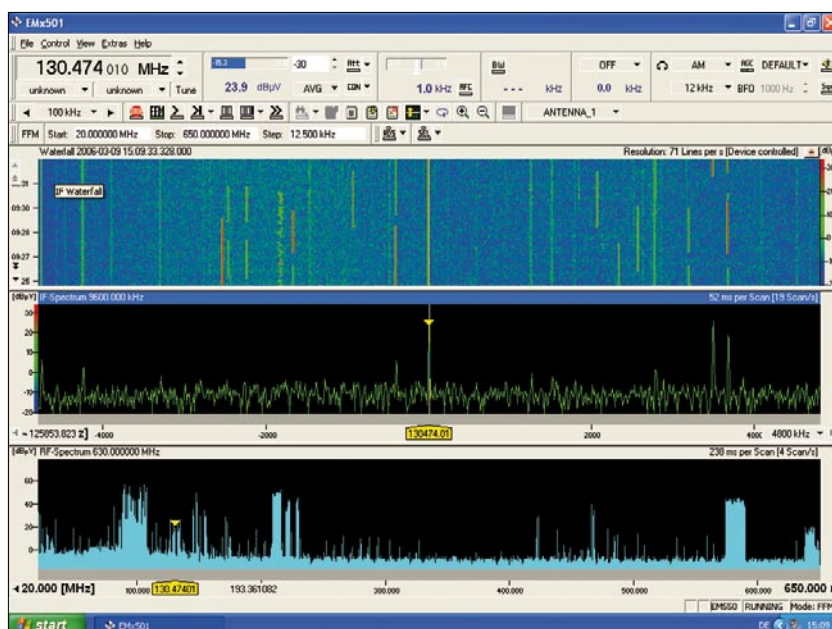
The squelch level serves as a criterion for dwelling at the same frequency or switching to the next channel. If the level criterion is met, the receiver allows the selectable dwell time to elapse and then switches to the next channel.

The following parameters are selectable for each channel:

- ◆ Memory location status
- ◆ Frequency
- ◆ Demodulation mode
- ◆ Bandwidth
- ◆ Attenuator
- ◆ AFC settings
- ◆ Squelch parameters
- ◆ Antenna number

The Continue command can be used to switch to the next channel before the dwell time has elapsed.

In the **Frequency Scan mode**, start frequency, stop frequency, and frequency step are defined for monitoring a specific



RF panorama, IF panorama and waterfall

frequency range. This frequency range can be scanned with the Frequency Scan command.

The squelch level serves as a criterion for dwelling at the same frequency or switching to the next frequency. If the level criterion is met, the receiver allows the selectable dwell time to elapse and then switches to the next frequency. The demodulator settings are fixed for the defined search range.

The Continue command can be used to switch to the next frequency before the dwell time has elapsed.

In the **Memory Scan** or **Frequency Scan mode**, a selectable number of different measurements (e.g. level offset, AM modulation index, FM deviation, bandwidth) are performed in parallel.

In the Panorama Scan mode, the receiver is tuned from the start to the stop frequency in steps of nearly 10 MHz, performing a high resolution FFT at each step. The resolution bandwidth covers the range from 125 Hz up to 100 kHz, resulting in an outstanding scan speed of up to 16 GHz/s or 600000 channels/s.

In the **Wideband mode**, the receiver offers an analog IF output with 50 MHz bandwidth and a center frequency of 405.4 MHz. In this mode, the IF section is not active, and demodulation is not possible.

Operation via standard software and PC

The receiver comes with comprehensive operating software. After quick and easy installation of the software on the control PC, the receiver can be operated with full functionality.

Depending on the installed options, the results are displayed on the PC screen in realtime as, for example, the following:

- ◆ Level, offset, modulation parameters, bandwidth
- ◆ Frequency scan (scan and search)
- ◆ Memory scan (scan and search)
- ◆ Spectra
 - RF panorama
 - IF panorama
 - Video panorama
- ◆ Waterfall presentation of spectra

The windows for spectra and waterfall can be adapted to different tasks.

Applications

Due to its high scan speed, the receiver is ideally suited for fast and reliable detection of all types of signals in the wide field of civil and military monitoring, paramilitary monitoring, homeland security, secret services, signal investigation services, etc.

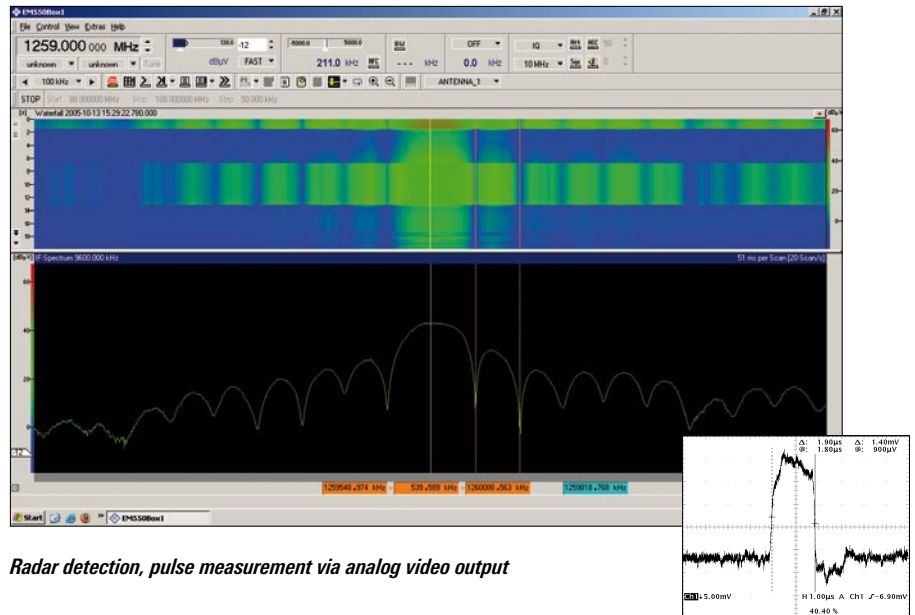
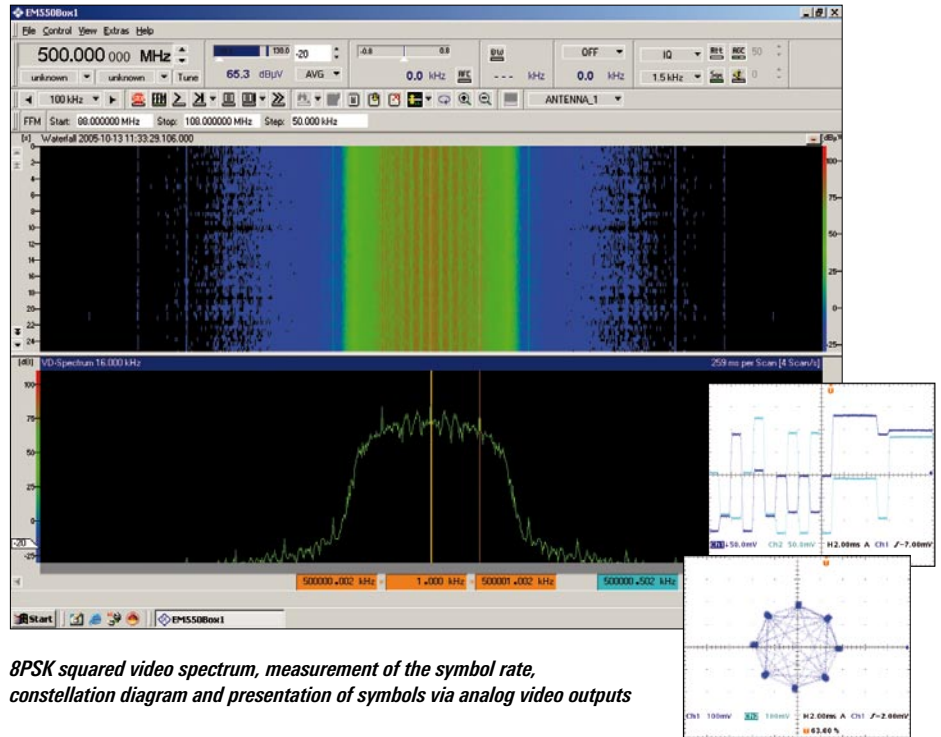
No matter whether fixed frequency emissions, frequency-agile signals such as hoppers, pulsed periodic or non-periodic emissions are to be detected, nothing is lost in the scenario.

This includes the following:

- ◆ Detection of signals in the RF spectrum
- ◆ Memory scan of up to 10000 memory channels
- ◆ Frequency scan in predefined frequency ranges
- ◆ Visualization of the signal and the signal vicinity
- ◆ Identification of the signal type (analog or digital)
- ◆ Recording of baseband and audio data
- ◆ Demodulation of the signal
- ◆ Audio monitoring of AM, FM, CW and SSB transmissions
- ◆ Signal analysis
- ◆ Demodulation of analog hoppers
- ◆ Pulse detection and pulse measurements

The outstanding video panorama with AM, FM, AM², FM² and I/Q functions enables the user to visualize the demodulated spectrum. In the AM² and FM² modes, most digitally modulated signals can be identified and further measurements performed as, for example, the following:

- ◆ Symbol rate
- ◆ Chip rate of DSSS transmissions
- ◆ Transmission rate of GSM systems



Civil monitoring in line with ITU recommendations

Owing to its performance, the R&S®EM 550 fulfills all the requirements for measurements in line with ITU-R specifications (ITU Spectrum Monitoring Handbook, 2002).

If the R&S®EM 510IM option is installed, the following measurements can be performed:

- ◆ Frequency and frequency offset in line with ITU-R SM377
- ◆ Field strength in line with ITU-R SM378
- ◆ Modulation in line with ITU-R SM328
- ◆ Spectrum occupancy on control PC in line with ITU-R SM 182/SM 328
- ◆ Bandwidth in line with ITU-R SM443
- ◆ Detection of mono or stereo transmissions

Radio data system (RDS) analysis

The signal content will be demodulated and decoded. The results can be displayed via a standard Internet browser or in customer-specific MMIs. Messages such as station name, frequency lists, traffic information, etc. can be seen at a glance.

TV picture as bitmap

When analog TV transmissions are demodulated, a bitmap picture is calculated in the receiver and presented on the PC screen. The original voice is audible simultaneously. With this feature, TV stations can be identified very easily.

By connecting a video monitor (or projector with video input) to the AM video output of the receiver, the original TV picture can be displayed.

Selective call analysis

When equipped with the R&S®EM 550SL option, the following selective call methods can be identified, demodulated and decoded:

CCIR1, CCIR7, CCITT, EEA, EIA, EURO, NATEL, VDEW, ZVEI1, ZVEI2, DTMF, CTCSS, DCS.

Further methods under development.

The results can be displayed either in the R&S®EM 550 control software, via a standard Internet browser or in customer-specific MMIs.

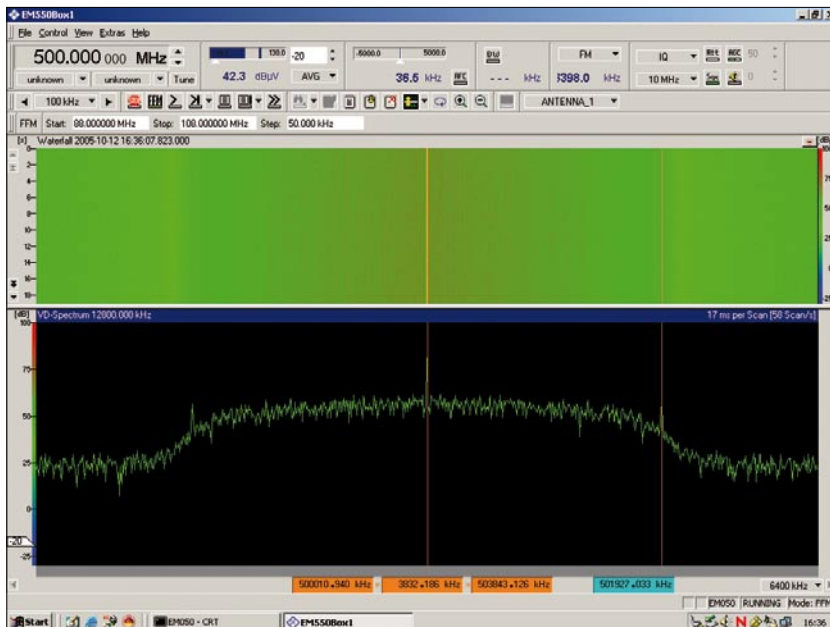
Customer-specific systems

Due to its favorable LAN control interface, the R&S®EM 550 is ideal for customer-specific system solutions. All interfaces are open and well described. The protocol on the LAN interface is in line with the SCPI command syntax.

All features, e.g. panorama scan, IF panorama, video panorama and ITU measurements, are performed in the receiver itself without any additional hardware being required.

Multichannel systems

Especially for multichannel applications where a large number of receivers is required, Rohde & Schwarz offers the VXI VHF/UHF Digital Wideband Receiver R&S®EM 050. The R&S®EM 050 is accommodated in a two-slot VXI box and features the same functionality and performance as the R&S®EM 550 (see R&S®EM 050 data sheet).



DSSS transmission, measurement of the chip rate

Designed to meet the standards

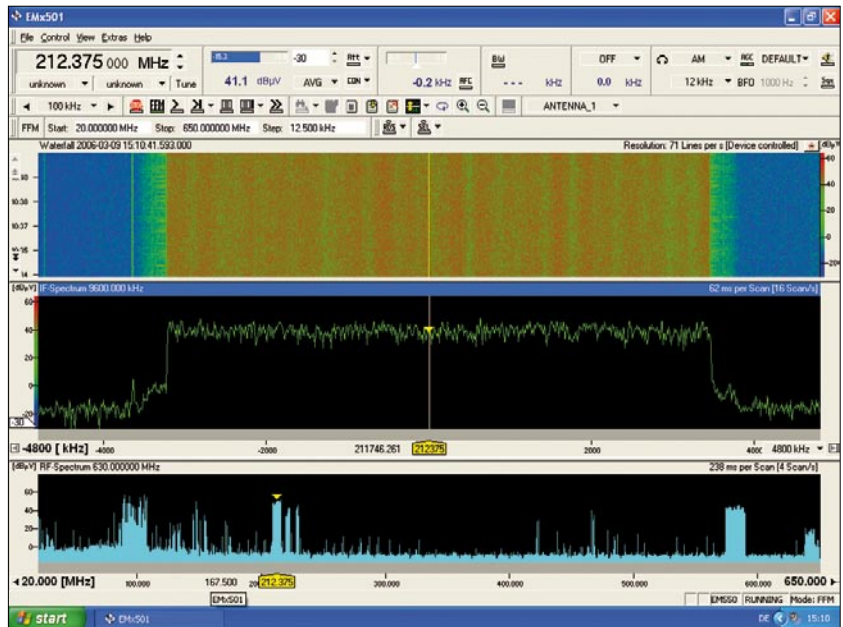
The receiver has been designed for stationary and mobile use in accordance with the recommendations for class C instruments. Careful shielding and filtering of all input and output lines ensure ultralow spurious emissions and low EMS.

For applications in a vehicle the receiver can be operated via the DC input directly from the vehicle battery.

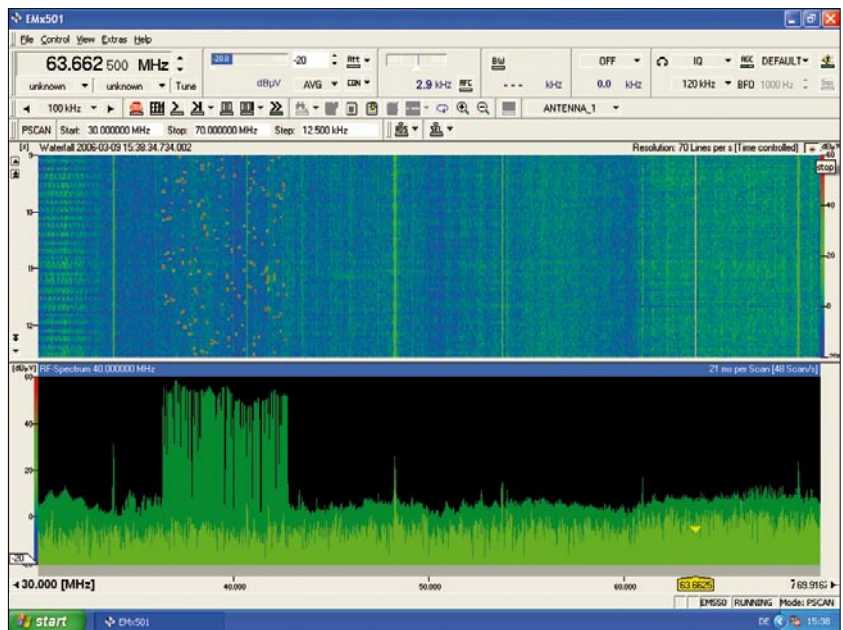
Diagnostics included

The receiver is permanently monitored by built-in test (BIT). If deviations from nominal values are detected, an error message is generated with a code indicating the type of fault. For detailed information, the values of internal test probes including upper and lower limits are available via control interface. Any out-of-range values are marked.

In a loop test triggered by the user, the complete signal path between the antenna input and the demodulated output is checked. This test is carried out with internally generated and modulated test signals of calibrated frequencies.



Detection of a DVB transmission



Detection of a frequency hopping transmission

Specifications

Frequency	
Frequency range	20 MHz to 3.6 GHz
Frequency resolution	1 Hz
BFO	-8 kHz to +8 kHz
Frequency accuracy	$\leq 1 \times 10^{-7}$
Aging per year	$\leq 1 \times 10^{-7}$
Input for external reference	10 MHz
Synthesizer setting time	typ. 1 ms, ≤ 5 ms (any step width)
Oscillator phase noise	≤ -120 dBc/Hz at 10 kHz offset, f = 640 MHz
Antenna input	
VSWR	≤ 2.5 , f ≤ 1 GHz ≤ 3 , f > 1 GHz
Input level	-137 dBm to +3 dBm (-30 dB μ V to +120 dB μ V)
Max. input level	+15 dBm
Oscillator reradiation	≤ -107 dBm, typ. -120 dBm
Input selection	
0 Hz to 215 MHz	bypass for broadband applications
20 MHz to 1500 MHz	tracking preselection
1500 MHz to 2300 MHz	highpass/lowpass filters
1500 MHz to 3000 MHz	highpass/lowpass filters
Input attenuation	0 dB to 40 dB, selectable in 1 dB steps hold time 0 s to 10 s (default 0 s)
Interference rejection	
Image frequency rejection	≥ 90 dB, typ. 100 dB
IF rejection	≥ 90 dB, typ. 100 dB
Internal spurious signals	≤ -103 dBm
Linearity	
2nd order intercept point	typ. 55 dBm (low distortion mode) typ. 50 dBm (normal mode)
3rd order intercept point	
Inband ¹⁾	≥ 17 dBm, f ≤ 300 MHz ≥ 20 dBm, f > 300 MHz (low distortion mode) typ. 23 dBm ≥ 8 dBm, f ≤ 1500 MHz ≥ 10 dBm, f > 1500 MHz (normal mode) typ. 12 dBm
Out-of-band	typ. 32 dBm
Noise figure	
	≤ 12 dB, typ. 10 dB, f ≤ 2000 MHz ≤ 15 dB, typ. 12 dB, f = 2000 MHz to 3000 MHz ≤ 17 dB, typ. 15 dB, f > 3000 MHz (low noise mode) ≤ 16 dB, typ. 13 dB, f ≤ 2 GHz ≤ 18 dB, typ. 15 dB, f = 2000 MHz to 3000 MHz ≤ 20 dB, typ. 17 dB, f > 3000 MHz (normal mode)

Sensitivity	
	measurement with telephone filter in accordance with CCITT low noise mode
AM: BW = 6 kHz, SINAD = 10 dB	≤ 1 μ V, f ≤ 2000 MHz
f _{mod} = 1 kHz, m = 0.5	≤ 1.4 μ V, f = 2000 MHz to 3000 MHz ≤ 1.8 μ V, f > 3000 MHz
FM: BW = 15 kHz, SINAD = 20 dB	≤ 1 μ V, (≤ -107 dBm), f ≤ 2000 MHz
f _{mod} = 1 kHz, deviation = 5 kHz	≤ 1.4 μ V, (≤ -104 dBm), f = 2000 MHz to 3000 MHz ≤ 1.8 μ V, (≤ -102 dBm), f = 2000 MHz to 3000 MHz
SSB: BW = 2.4 kHz, SINAD = 10 dB	≤ 0.5 μ V (≤ -113 dBm)
CW: BW = 300 Hz, SINAD = 10 dB	≤ 0.22 μ V (≤ -120 dBm)
Demodulation modes	
	AM, FM, PM, PULSE, I/Q (all IF bandwidths) USB, LSB, CW (IF bandwidth ≤ 9 kHz) ISB (IF bandwidth ≥ 1 kHz to 9 kHz) TV (analog)
IF bandwidths	
For demodulation, level and offset measurement (3 dB bandwidth)	23 filters, (150/300/600 Hz/1.5/2.4/6/9/12/15/30/50/120/150/250/300/500/800 kHz/1/1.25/1.5/2/5/10 MHz)
Shape factor (3 dB : 60 dB)	≤ 1 : 1.7, for filter 150 Hz to 2 MHz ≤ 1 : 1.6, for 5 MHz filter (3 dB : 50 dB) ≤ 1 : 2, for 10 MHz filter (3 dB : 50 dB)
Roofing filter	120 kHz/800 kHz/3 MHz/10 MHz (10 MHz = 2nd IF filter)
Squelch (level squelch)	-30 dB μ V to +120 dB μ V, selectable in 1 dB steps
Audio filter	notch/noise reduction/bandpass 300 Hz to 3.3 kHz
Gain control	AGC, MGC, 130 dB AGC modes: FAST/DEFAULT/SLOW MGC selectable in 1 dB steps
Automatic frequency control (AFC)	auto-retuning for frequency-unstable signals $\pm 1/2$ IF bandwidth (150 Hz to 10 MHz)
ADC resolution	14 bit
Level and offset measurement	
Signal level	-30 dB to +120 dB μ V resolution 0.1 dB
Indication error	max. ± 3 dB, typ. ± 1.5 dB
Level indication modes	AVG, PEAK, FAST, RMS
Offset	up to $\pm 1/2$ IF bandwidth (150 Hz to 10 MHz), resolution 1 Hz
IF panorama	
(with option R&S [®] EM 050SU)	internal FFT (2048 points), 20 pictures/s
Span range	10 kHz to 9.6 MHz (10/25/50/100/150/256/300/400/600/800 kHz/ 1.2/2.4/4.8/9.6 MHz)

Modulation measurement (with option R&S®EM050IM)	
AM (modulation index)	m = 0% to 999.9% resolution 0.1% f _{max} = 4 MHz
Indication error	<5%, for BW ≤ 1 MHz <7%, for BW > 1 MHz (S/N > 40 dB, AF = 1 kHz, measurement time < 1 s)
FM (FM deviation)	Δf = 0 Hz to 4 MHz resolution 0.001 kHz f _{max} = 4 MHz (f _{mod} + deviation)
Indication error	<2% of the IF bandwidth used (absolute) (S/N > 40 dB, AF = 1 kHz, measurement time < 1 s)
PM	Δφ = 0 rad to 12.5 rad resolution 0.01 rad f _{max} = 4 MHz (f _{mod} + deviation)
Indication error	<0.1 rad (S/N > 40 dB, AF = 1 kHz, measurement time < 1 s)
Bandwidth measurement	up to 10 MHz automatically, >10 MHz with external software x dB and % method
Scan characteristics	
Memory scan	10000 definable memory locations scan speed up to 850 channels/s
Frequency scan	f _{start} , f _{stop} , f _{step} , free selectable, 100 suppress frequencies scan speed up to 850 channels/s
Panorama scan (with option R&S®EM050PS)	RF spectrum with user-specific selectable f _{start} , f _{stop} selectable steps: 125/250/500/625 Hz/ 1.25/2.5/3.125/6.25/12.5/25/50/ 100 kHz scan speed up to 16 GHz/s or 1600 frames/s or 600 000 ch/s
Inputs/outputs	
Inputs	
Antenna input	20 MHz to 3600 MHz, N female, 50 Ω
External reference input	10 MHz input level 0 dBm to +10 dBm
Outputs	
L01	4649.4 MHz to 8229.4 MHz, level ≥ 2 dBm
L01 Aux	4649.4 MHz to 8229.4 MHz, level ≥ -7 dBm
IF2 ²⁾	405.4 MHz, BW ≥ 50 MHz (-3 dB), uncontrolled, typ. 11 dB above antenna input (normal mode)
IF3 ³⁾	21.4 MHz, BW ≥ 8 MHz (-3 dB), typ. 10 MHz, uncontrolled, typ. 14 dB above antenna input (normal mode)
Internal reference output	10 MHz output level 7 dBm to 13 dBm

Video A, Video B	video analog, AM (A) and FM (B), DC to ½ IF BW or: IF analog, gain-controlled, two channels, adjustable center frequency 0 MHz to 21.4 MHz, BW up to 2 MHz, level ≥ 0 dBm
Video digital	LAN (BW ≤ 500 kHz) serial FPDP (BW ≤ 5 MHz)
I/Q digital	LAN (BW ≤ 1 MHz) serial FPDP (BW ≤ 10 MHz)
Audio analog	headphone connector: 0 V to ≥ 2 V R _i = 100 Ω f = 10 Hz to 300 Hz to 12.5 kHz (depending on IF BW and modulation) AF line: 0.5 V ± 0.3 V (m = 0.5) R _i = 100 Ω f = 10 Hz to 300 Hz to 12.5 kHz (depending on IF BW and modulation) AF symmetrical: 600 Ω symmetrical: 0.4 V ± 0.2 V (m = 0.5) R _i = 600 Ω f = 100 Hz to 12.5 kHz
Audio digital	LAN AES/EBU interface (ANSI 4.40)
BITE	monitoring of test signals by means of loop test as short test or long test, permanent monitoring of test points
Data and control interface	LAN (ETHERNET 10/100BaseT)
Optical data interface	serial FPDP 1 Gbit/s
General data	
Climatic conditions	EN 60068-2-1, EN 60068-2-2
Operating temperature range	0 °C to +50 °C
Permissible temperature range	-10 °C to +55 °C
Storage temperature range	-40 °C to +70 °C
Humidity	EN 60068-2-30 max. 95%, cyclic test 25 °C/55 °C
Shock	EN 60068-2-27 40 g/11 ms MIL-STD-810E, method 516.4
Vibration (sinewave)	EN 60068-2-6, EN 61010-1 MIL-T-28800 D, class 5
Vibration (random)	EN 60068-2-64
Electromagnetic compatibility (EMC)	EN 300339, ETSI EN 301 489-1, ETSI EN 301 489-22 MIL-STD-461E, CE 102, RE 102, RS 103
MTBF	≥ 20 000 h (IEC 1709)
Power	AC: 100 V to 120 V/200 V to 240 V ≤ 110 VA DC: 12 V/24 V ≤ 95 VA
Dimensions (W × H × D)	19", 2 HU 426.7 mm × 87.6 mm × 450 mm (without feet and handles)
Weight	11 kg

Ordering information

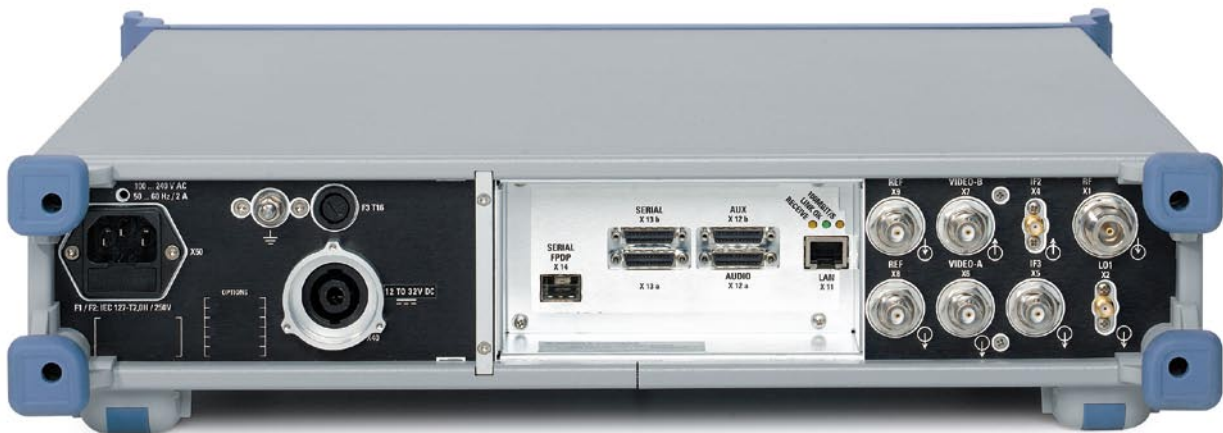
Designation	Type	Order No.
VHF/UHF Digital Wideband Receiver	R&S®EM 550	4065.5083.02
Options		
Panorama Scan (RF Spectrum)	R&S®EM 550PS	4065.5348.02
IF Panorama (IF Spectrum)	R&S®EM 550SU	4065.5331.02
ITU Measurement Software ¹⁾	R&S®EM 550IM	4065.5325.02
SEL CALL Analysis	R&S®EM 550SL	4065.5354.02

¹⁾ Frequency spacing between intermodulating signals ≥ 1 MHz.

²⁾ When this output is used, the narrowband function/demodulation is deactivated.

³⁾ When this output is used, all receiver functions except IF2 are activated.

⁴⁾ IF Panorama R&S®EM 550SU is included in option R&S®EM 550IM.



Rear view of the R&S®EM 550



More information at
www.rohde-schwarz.com
(search term: EM550)



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