The R&S®ESR as part of a compact EMC measurement system including EMI and EMS test equipment and components for system control.

The world's fastest EMI test receiver drastically reduces testing times

The new R&S®ESR EMI test receiver uses an FFT-based time domain scan to perform standard-compliant disturbance measurements up to 6000 times faster than conventional EMI test receivers. It offers a wide range of diagnostic tools such as realtime spectrum analysis, spectrogram, persistence mode and IF analysis that effectively help users identify and eliminate disturbances.

More speed, more insight, more intelligence

The R&S®ESR (Fig. 1) is an EMI test receiver for the frequency range from 10 Hz to 7 GHz (Fig. 2). Its main focus is on product certification measurements in line with relevant commercial EMC standards. With its integrated preselection, a 20 dB preamplifier and a highly linear frontend, the R&S®ESR meets the requirements of the CISPR 16-1-1 standard and also complies with all other relevant commercial standards. What makes the instrument truly outstanding is its FFT-based time domain scan that measures electromagnetic disturbances at a speed so far unattained. Disturbance measurements which took hours in the past can now be completed in just seconds. Featuring optional realtime spectrum analysis with a wide range of diagnostic tools, the instrument provides new insight into disturbance signals and their history. Besides offering EMC testing functionality, the R&S®ESR is a full-featured, powerful signal and spectrum analyzer for lab applications. The instrument comes with a clearly structured, intuitive touchscreen interface that makes it very easy to operate in any mode.

Time domain scan for ultrafast, standard-compliant measurements

In the time domain scan mode, the R&S®ESR measures up to 6000 times faster than in the conventional, stepped frequency scan mode, making it the fastest EMI test receiver in the marketplace. The R&S®ESR performs frequency scans in

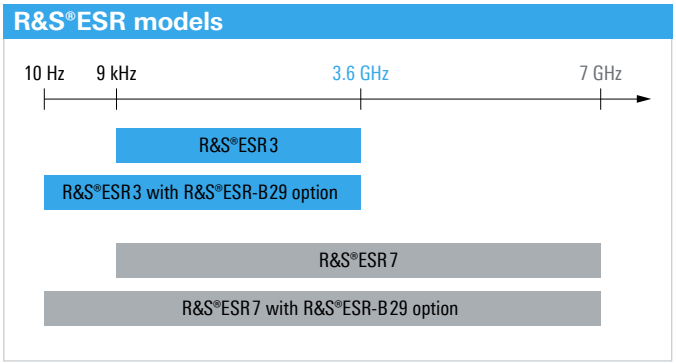


Fig. 2 R&S®ESR models and frequency ranges.

Fig. 1 The new R&S®ESR EMI test receiver uses an FFT-based time domain scan to perform standard-compliant disturbance measurements up to 6000 times faster than conventional EMI test receivers.

the various CISPR bands in just a few milliseconds. It measures conducted disturbances, including quasi-peak weighting, in realtime without any time gaps throughout CISPR band B, i.e. from 150 kHz to 30 MHz (Fig. 3). A preview scan is no longer needed for this application, since the R&S®ESR takes no more than two seconds to deliver the wanted spectrum with quasi-peak weighting, featuring level measurement accuracy in line with CISPR 16-1-1 (Fig. 4). This saves users valuable time on the way to obtaining results. The time domain scan function is particularly useful when testing devices that can be operated, or measured, only during a short period of time, for example starter motors in vehicles. The extremely fast time domain scan delivers results very quickly, making it easy to handle such scenarios. The time saved can be used, for example, to increase observation times in order to reliably detect isolated pulses or narrowband, intermittent interferers with very low pulse frequencies. By increasing the observation time, the highest level even of fluctuating or drifting disturbances is detected without the overall measurement time being unduly extended.

Realtime spectrum analysis provides new insight into disturbance signals

The R&S®ESR combines the functionality of a standard-compliant EMI test receiver with that of a realtime spectrum analyzer to provide analysis capabilities not found in conventional EMI test receivers. If a device fails during certification testing, switchover can be made to realtime mode to analyze the disturbance signals. This approach greatly facilitates measuring sporadic and brief events, narrowband disturbances drifting in frequency, or the spectral behavior of devices under test (DUT)

Fig. 3 Disturbance voltage measurement with quasi-peak and average weighting using a realtime time domain scan, plus limit line check with pass/fail indication.

Frequency range	Weighting detector, measurement time, IF bandwidth (number of test points)	R&S®ESR overall measurement time	
		Stepped frequency scan	Time domain scan (optional)
CISPR band B 150 kHz to 30 MHz	Peak, 100 ms, 9 kHz (13 267)	1326 s	110 ms
CISPR band B 150 kHz to 30 MHz	Quasi-peak, 1 s, 9 kHz (13 267)	3.6 h	2 s
CISPR band C/D 30 MHz to 1000 MHz	Peak, 10 ms, 120 kHz (32 334)	323 s	520 ms
CISPR band C/D 30 MHz to 1000 MHz	Peak, 10 ms, 9 kHz (431 000)	4310 s	820 ms
CISPR band C/D 30 MHz to 1000 MHz	Quasi-peak, 1 s, 120 kHz (32 334)	approx. 9 h	80 s

Fig. 4 Comparison of overall measurement times obtained with stepped frequency scan and time domain scan for typical measurement settings.

during switching operations. Instruments using conventional frequency tuning sequentially measure relatively narrowband frequency ranges. If a DUT's emission behavior is not known in detail, these types of non-stationary signal waveforms may remain undetected by conventional analyzers, or can be very time-consuming to detect and analyze. The R&S®ESR measures a spectrum of up to 40 MHz without any time gaps and therefore reliably captures even very short pulses.

The R&S®ESR offers a spectrogram function that provides seamless spectrum display in the time domain, allowing users to analyze the behavior of disturbance signals versus time. Each spectrum is represented as a horizontal line with different levels assigned different colors. The individual spectral lines are joined continuously at a rate of up to 10 000 lines per second, which corresponds to a time resolution of 100 µs. The spectrogram reveals signal characteristics that are not visible in the spectrum. The R&S®ESR also features a frequency mask trigger (FMT), which makes it possible to detect sporadic events within a spectrum. The test receiver measures every single spectrum and compares it with a frequency-dependent mask. If a spectrum violates the mask, the R&S®ESR activates a trigger and displays that spectrum, allowing users to analyze the disturbance and its effect.

While an individual disturbance signal is not visible in conventional analyzer mode, it becomes immediately apparent in persistence mode. In this mode, the R&S®ESR writes the seamless spectra into a single diagram. The color of each pixel indicates how often a specific amplitude occurs at a specific frequency. If signals no longer occur at a specific frequency with a specific amplitude, the corresponding pixel disappears after a user-defined persistence period. The persistence mode therefore creates a spectral histogram. Users can clearly distinguish between pulsed disturbances, which are present only for very brief periods, and continuous disturbances. Even different pulsed disturbances can easily be distinguished from one another. Plus, the persistence mode makes it possible to identify narrowband disturbances superimposed by a broadband disturbance (Figs. 5 and 6).

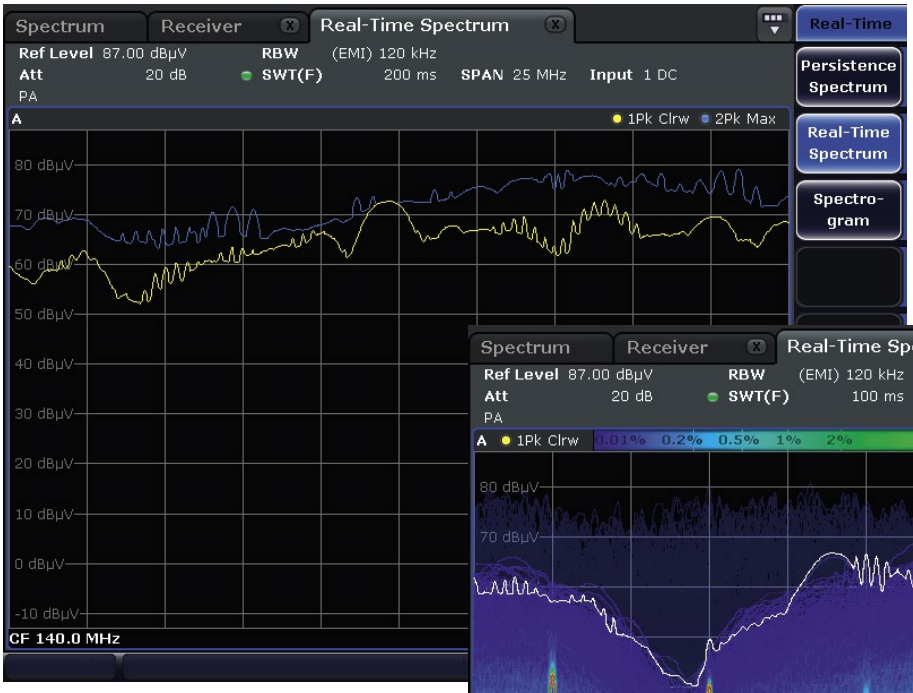


Fig. 5 Display of a broadband disturbance in analyzer mode – in this example caused by an electric motor with poor EMI suppression. The yellow trace represents the current spectrum, the blue trace max. hold.

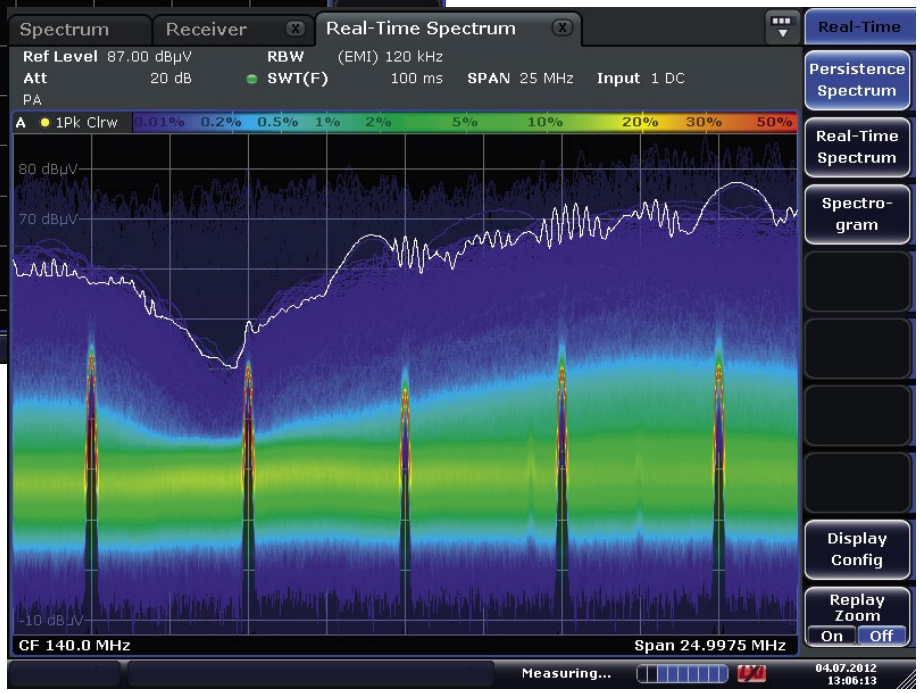


Fig. 6 Disturbance spectrum for the same motor in persistence mode. Here, a second pulsed disturbance is clearly visible, while it cannot be identified in analyzer mode as it is hidden by the broadband disturbance.

IF analysis function for displaying the spectrum around disturbance signals

The optional IF analysis function of the R&S®ESR provides a spectral display of the RF input signal around the EMI receive frequency. The IF spectrum display can be coupled to the bargraph display for the current receive frequency (Fig. 7). Alternatively, the IF spectrum can be displayed together with the stored results of a frequency scan. The receive frequency can be coupled to the position of the marker, which is placed on the EMI signal peaks detected during the frequency scan (marker track function). This is an elegant way of approaching and assessing the highest peaks in the spectrum. The IF spectrum also provides a detailed overview of the spectrum occupancy around the measurement channel and information about the spectral distribution of a modulated signal. Any signals received can be quickly classified as disturbance signals or wanted signals. Visual assessment of the spectrum helps to tune the receiver accurately to the desired frequency. AM or FM audio demodulation can be activated in parallel, making it easier to identify detected signals, for example in order to identify and exclude ambient interferers in open area measurements.

Automatic test sequences at the press of a button

The standard approach to carrying out disturbance measurements is by combining a fast preview measurement with peak and average weighting with a final measurement on the critical frequencies with the required CISPR weighting. For this method, the R&S®ESR offers a choice of preprogrammed limit lines defined in commercial standards for product emission measurements. The limit lines are compared with the results of the preview measurement, which are obtained with a conventional stepped frequency scan or – at tremendously higher speed – with the optional time domain scan. The test receiver then identifies critical frequencies according to user-defined criteria and presents them in a table (peak list). Automatic test sequences can be configured quickly and easily on the touchscreen (Fig. 8) and executed at the press of a button.

For disturbance voltage measurements on power lines, the R&S®ESR can control Rohde & Schwarz line impedance stabilization networks via its AUX port. Measurements can be performed fully automatically on all phases. This ensures reliable detection of the highest disturbance level.

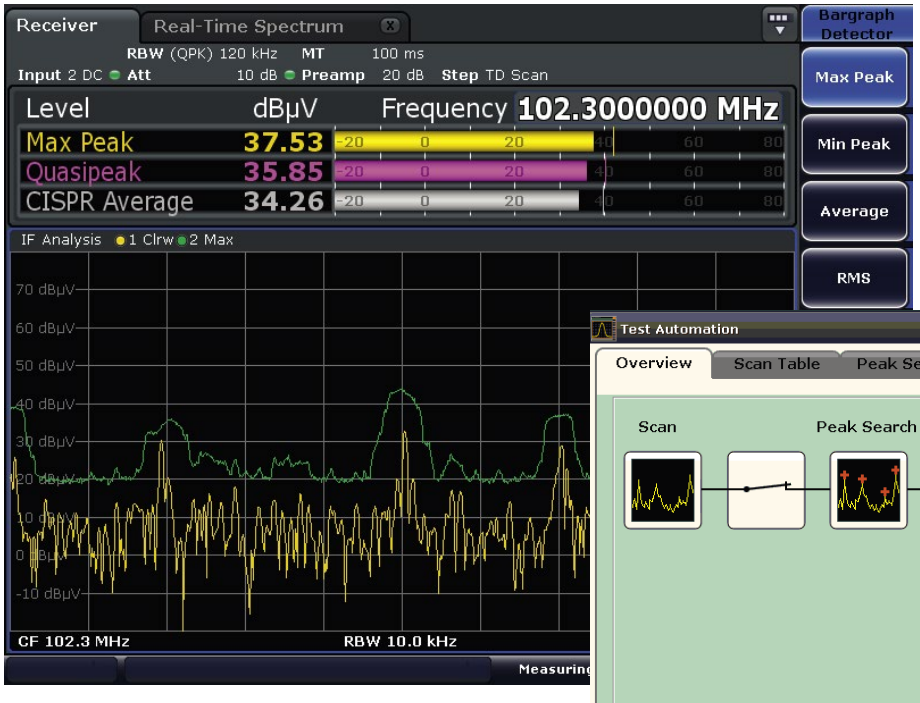


Fig. 7 Display of IF spectrum coupled with combined numerical and bargraph display.

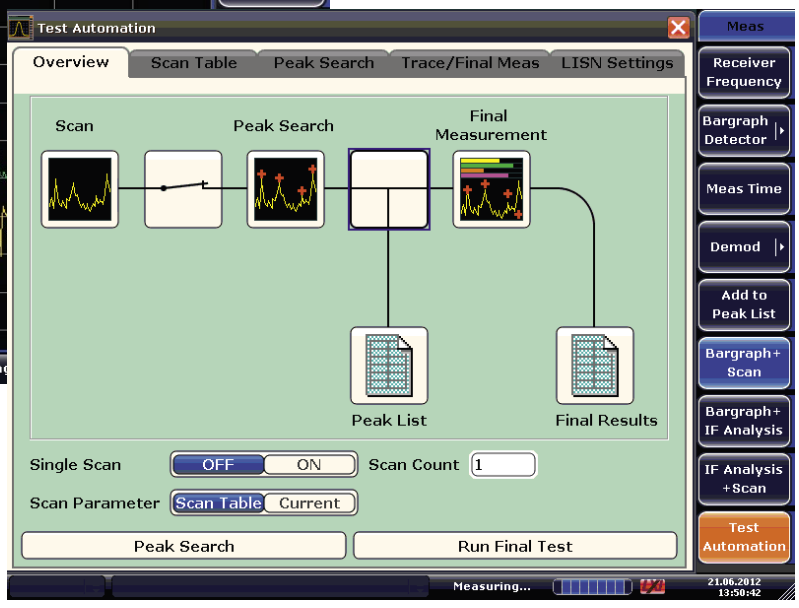
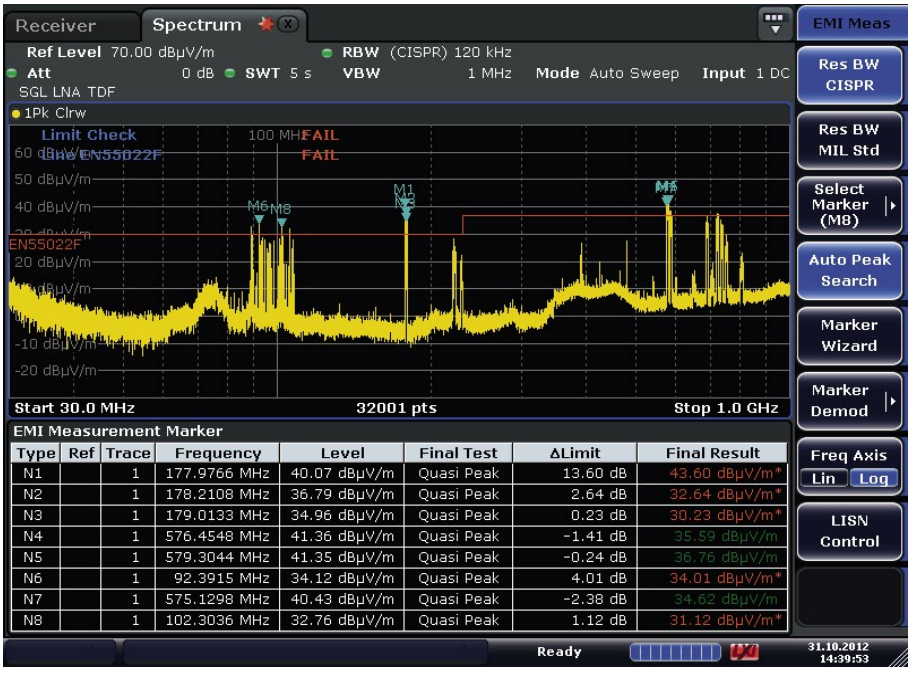


Fig. 8 The R&S®ESR allows users to configure automatic test sequences (preview measurement / data reduction / final measurement) quickly and easily and execute them at the press of a button. The final measurement can also be carried out interactively.



EMI Measurement Marker

Type	Ref	Trace	Frequency	Level	Final Test	ΔLimit	Final Result
N1		1	177.9766 MHz	40.07 dBµV/m	Quasi Peak	13.60 dB	43.60 dBµV/m*
N2		1	178.2108 MHz	36.79 dBµV/m	Quasi Peak	2.64 dB	32.64 dBµV/m*
N3		1	179.0133 MHz	34.96 dBµV/m	Quasi Peak	0.23 dB	30.23 dBµV/m*
N4		1	576.4548 MHz	41.36 dBµV/m	Quasi Peak	-1.41 dB	35.59 dBµV/m
N5		1	579.3044 MHz	41.35 dBµV/m	Quasi Peak	-0.24 dB	36.76 dBµV/m
N6		1	92.3915 MHz	34.12 dBµV/m	Quasi Peak	4.01 dB	34.01 dBµV/m*
N7		1	575.1298 MHz	40.43 dBµV/m	Quasi Peak	-2.38 dB	34.62 dBµV/m
N8		1	102.3036 MHz	32.76 dBµV/m	Quasi Peak	1.12 dB	31.12 dBµV/m*

Fig. 9 Preview measurement of disturbance spectrum in analyzer mode using a frequency sweep (max. 200 001 points) and logarithmic scaling, and final measurement with the required CISPR detector and limit line check.

Standard-compliant spectrum analyzer for EMI measurements and beyond

The R&S®ESR includes the powerful R&S®FSV signal and spectrum analyzer. The combined EMI test receiver and spectrum analyzer functionality provides users with an instrument with multiple capabilities. First, the R&S®ESR performs fast diagnostic measurements in order to determine and analyze a product's EMI characteristics at the various stages of development – with or without preselection. Second, the R&S®ESR can be used to carry out a large number of standard measurements in the RF development lab. Additional measurement functions, such as adjacent channel power (ACP), third-order intercept point (TOI) and occupied bandwidth (OBW), plus statistics functions (APD, CCDF), extend the instrument's range of applications far beyond EMI measurements.

For EMI measurements in spectrum analyzer mode, the R&S®ESR offers up to 16 markers that can be placed on critical frequencies in the disturbance spectrum. Markers can be coupled with CISPR detectors to enable comparison with relevant limit lines. The spectrum can also be displayed along a logarithmic frequency axis. The levels measured on the critical frequencies are listed in a table (Fig. 9).

Touchscreen: unparalleled ease of operation

The R&S®ESR not only offers outstanding functionality, it also scores top marks for ease of operation and its clearly structured user interface. The various measurement modes are distinctly separated, and the operating mode can be switched at the press of a button. Users can easily configure complex measurements and automated test sequences directly on the touchscreen. The R&S®EMC32 software can be used to remotely control the R&S®ESR and integrate it into complex EMC measurement systems for automated test routines.

Summary: a new dimension in EMI test receiver performance

The new R&S®ESR outperforms all existing EMI test receivers not only in terms of measurement speed but also with respect to its diagnostics capabilities, which open up highly versatile applications. The R&S®ESR makes it easy to perform certification measurements (conducted and radiated) in line with EN / CISPR / FCC, as well as EMI analysis during development, on domestic appliances, multimedia devices, lighting equipment or devices for industrial or medical applications. In the automotive sector, the R&S®ESR is ideal for certification testing of vehicles and accessories in line with automobile manufacturer guidelines, and even for mobile applications thanks to its optional DC power supply.

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