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FIG 1 The new EMI Test Receiver R&S®ESCI for compliance measurements to all commercial standards from 9 kHz to 3 GHz.

The new EMI Test Receiver R&S®ESCI (FIG 1) is the successor to the EMI Test Receiver R&S®ESCS, which was launched in 1996 and became a measurement standard for EMC certification to commercial requirements. The R&S®ESCI sets new standards in terms of measurement speed, accuracy and scope of functions in the instrument class up to 3 GHz.

EMI Test Receiver R&S®ESCI

Compact test receiver for full-compliance measurements up to 3 GHz

Test receiver or analyzer?

EMI full-compliance test receivers are needed when certification in accordance with relevant standards is to be obtained. Featuring a pulse-resistant attenuator, preselection with a 20 dB preamplifier and a frontend withstanding high loads, the EMI Test Receiver R&S®ESCI fully meets the requirements of the CISPR, VDE, ANSI, FCC, EN and VCCI commercial standards and is thus ideal for this type of measurement.

The R&S®ESCI adheres to the proven concept of combining a test receiver and an analyzer in a single unit. While typical EMC parameters such as RFI voltage, RFI power and RFI field strength can be measured both with the analyzer and the test receiver, each mode has its strengths and weaknesses. The analyzer comes into its own where fast prescan sweeps have to be performed and evaluated with marker functions. The test receiver, on the other hand, offers the more sophisticated techniques for data reduction and standard-conforming final measurements. The R&S®ESCI

combines the two operating modes in its mixed mode function, allowing the user to optimally benefit from the advantages of either mode.

A number of operating parameters can be coupled or decoupled for test receiver mode and spectrum analyzer mode. When the same center frequency is set in the two windows, for example, IF analysis will be displayed automatically (FIG 2). For a test sequence using the spectrum analyzer in the prescan measurement and the test receiver in the final measurement, it is useful to couple the resolution bandwidths.

Added functionality through analyzer platform

Like the precompliance Test Receiver R&S®ESPI [1], the full-compliance Test Receiver R&S®ESCI was designed on the basis of the R&S®FSP family of spectrum analyzers. As a result of this close relationship, the R&S®ESCI not only offers the comprehensive standard functionality of a spectrum analyzer, but also many special functions such as adjacent channel power (ACP) measurement and statistics functions (APD, CCDF), which considerably expand the test receiver's range of applications.

Full-compliance measurements

EMI measurements conforming to CISPR 16-1-1 place exacting demands on T&M equipment, since it must be capable of handling a wide variety of signals. These include pulse-shaped and sinusoidal signals as well as modulated and intermittent signals, all of which have to be weighted accurately. In this scenario the R&S®ESCI comes into its own, with an excellent total measurement uncertainty of the amplitude of <1 dB (up to 3 GHz) and a noise figure of typ. 7 dB (at 1 GHz with the preamplifier switched on). This makes the new test receiver ideal for use in development, EMC laboratories, mobile applications or certification measurements in conformance with commercial standards.

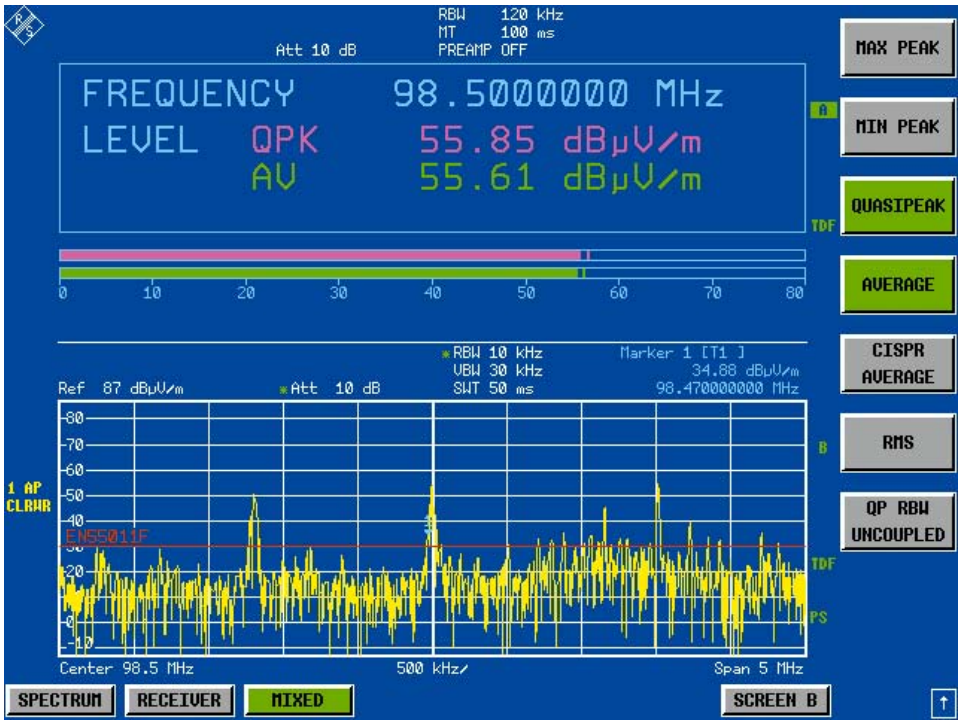
The R&S®ESCI performs measurement tasks fast and reliably by means of selectable detectors, including max/min peak, quasi-peak, RMS, average and CISPR-AV. Up to three detectors may be switched on simultaneously for each trace. The test receiver stores up to 100 000 points per trace. The displayed frequency range always shows real results, even when zooming in closely (for example during subsequent analysis by the user).

The analysis of results is based on a test method patented for Rohde & Schwarz, involving the sequence of **prescan measurement**, **data reduction** and **final measurement**. Results are compared with EMC limit lines; common limit values are stored in the test receiver's internal database. The values to be used in the final measurement are listed in a frequency table that can be edited manually, e.g. further critical frequencies can be added or known harmonics deleted. After completion of the prescan measurement, the final measurement with standard-conforming measurement time is started, using the quasi-peak and/or the average detector.

Based on this method, the following measurements can be performed at low effort and with good reproducibility, using accessory equipment:

- RFI voltage (with line impedance stabilization network)
- RFI power (with absorbing clamp)
- RFI field strength (with antennas for magnetic and/or electric fields)

FIG 2 The R&S®ESCI in MIXED mode: standard-conforming measurement with bargraph display (top), and spectrum obtained with fast sweep (bottom).



The bargraph display with Max Hold indication proves very useful in these measurements as it allows you, for example, to align the antenna in the direction of maximum field strength emitted by a DUT.

Functions such as marker track and marker frequency, coupled with the center frequency in split screen mode, make the final measurement easier and more reliable, as hidden spurious and other unwanted emissions can be detected with higher resolution.

Frequency-dependent transducer tables

To take into account the frequency response of accessory test equipment and thus minimize total measurement uncertainty, correction values can be entered into transducer tables and considered in the calculation of the current trace. Several transducer tables can be combined into a set. In this case, the sum of the individual correction values of, for example, an absorbing clamp, a cable and an extra attenuator will be considered in the result displayed.

CISPR-AV average detector

CISPR 16-1-1 (2003-08) stipulates an average detector with modified time constants to increase the amplitude with low pulse repetition rates [2]. The R&S®ESCI already includes this detector. Many of the instruments available on the market will have to be retrofitted to meet this new requirement, as far as this is technically feasible. The EMI test receivers from Rohde & Schwarz are state of the art or optimally prepared for an easy upgrade.

Time-domain measurements

Devices with thermostatic or program control generate discontinuous interference. CISPR 14 and EN 55014 therefore specify limit values for RFI voltage with click rate weighting in the range 0.15 MHz to 30 MHz. A critical factor in measurements with conventional click rate analyzers is the occurrence of successive pulses. The individual pulse amplitudes cannot be exactly allocated due to the time constants used in quasi-peak weighting, which may result in limit values being exceeded.

The R&S®ESCI's time domain analysis function can determine the pulse amplitude and duration and can thus prove very useful in such cases. It satisfies the requirements of CISPR 16-1-1 in terms of accuracy of the pulse duration measurement when the pulse duration is 10 ms or longer (FIG 3).

The result memory can store 1.44 million measured values per trace in time domain analysis. The user can, for example, subsequently zoom in on these values and analyze them by means of various marker functions. Each individual click interferer can thus be evaluated in detail if necessary. At a measurement time of 5 ms per measured value, the memory depth is large enough to record the peak values and quasi-peak values continuously for two hours. Thus, DUTs such as washing machines can be evaluated for click interference [3].

Automatic measurements with EMC software

Using the R&S®ES-K1 and R&S®EMC32-E EMI software packages [4], you can perform fully automatic and standard-conforming EMC measurements with external equipment such as absorbing clamps/slideways, masts and turntables. The required drivers for the R&S®ESCI are also provided. In addition, the software packages provide support in generating test reports which can, in the case of R&S®EMC32-E, for example, be stored as PDF, HTML or RTF files.

Sturdy construction – for use under any conditions

For outdoor applications, the R&S®ESCI is also available with a rugged case with shock-absorbing corners and a carrying handle (FIG 4). In vehicles, the test receiver can be operated from 12 V to 28 V using an optional DC power supply (R&S®FSP-B30). At outdoor test sites, the R&S®ESCI can perform measurements for several hours if equipped with the optional R&S®FSP-B31 battery pack. Additional battery packs can be used to extend the operating time, if necessary.

In the R&S®ESCI standard unit, the vast amount of data collected is stored on a hard disk. For use in vehicles, a flash disk can be used instead of the hard disk to withstand significant temperature fluctuations (0°C to 55°C) and higher levels of shock and vibration (R&S®ESCI-B20 option).

The optional internal tracking generator from 9 kHz to 3 GHz (R&S®FSP-B9) and the optional external generator control (R&S®FSP-B10) extend the R&S®ESCI to include scalar network analyzer functionality. Detailed information on these and other options can be found in the R&S®ESCI data sheet, which you can download from the Rohde & Schwarz website.

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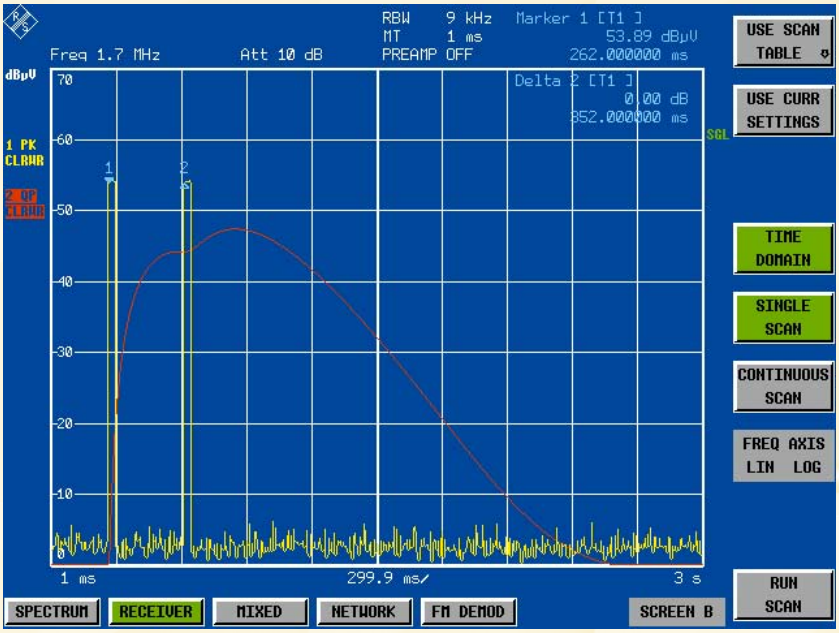

FIG 3
Two click interferers at an interval of 352 ms, with peak value shown in yellow and quasi-peak value in red.

Condensed data of the R&S®ESCI

Frequency range	9 kHz to 3 GHz
Amplitude measurement uncertainty	<1 dB up to 3 GHz in receiver mode
1 dB compression	typ. +6 dBm
RF attenuation	0 dB to 75 dB in steps of 5 dB
Pulse resistance	150 V (10 µs) 10 mWs (20 µs)
Test procedure	
in receiver mode	scan table of up to 10 subranges with independent settings; measurement time per frequency point 50 µs
in analyzer mode	sweep time (span > 10 Hz, 2.5 ms to 16000 s zero span (0 Hz): 1 µs to 16000 s
Detectors	Max/Min Peak, Quasi Peak, RMS, Average, CISPR-AV
Bandwidths	200 Hz, 9 kHz, 120 kHz, 1 MHz (EMI bandwidths) 10 Hz to 3 MHz (–3 dB bandwidths)
Displayed average noise level (DANL) (1 Hz RBW)	
without preamplifier	–45 dBµV (typ. –48 dBµV)
with preamplifier	–55 dBµV (typ. –60 dBµV)

More information and data sheet at www.rohde-schwarz.com (search term: ESCI)

REFERENCES

[1] Precompliance Test Receiver R&S®ESPI: Improved, patented EMC test method for drifting interference signals. News from Rohde & Schwarz (2004) No. 181, pp 42–43

[2] International Basic Standard CISPR 16-1-1, Chapter 6 "Average Measuring Receiver", and Chapter 6.4.3 "Response to Intermittent, Unsteady and Drifting Narrowband Disturbances"

[3] International Basic Standard CISPR 16-1-1, Chapter 10 "Disturbance Analyzers"

[4] EMC Measurement Software R&S®EMC32-E: Automatic RFI field strength measurements. News from Rohde & Schwarz (2003) No. 179, pp. 23–25

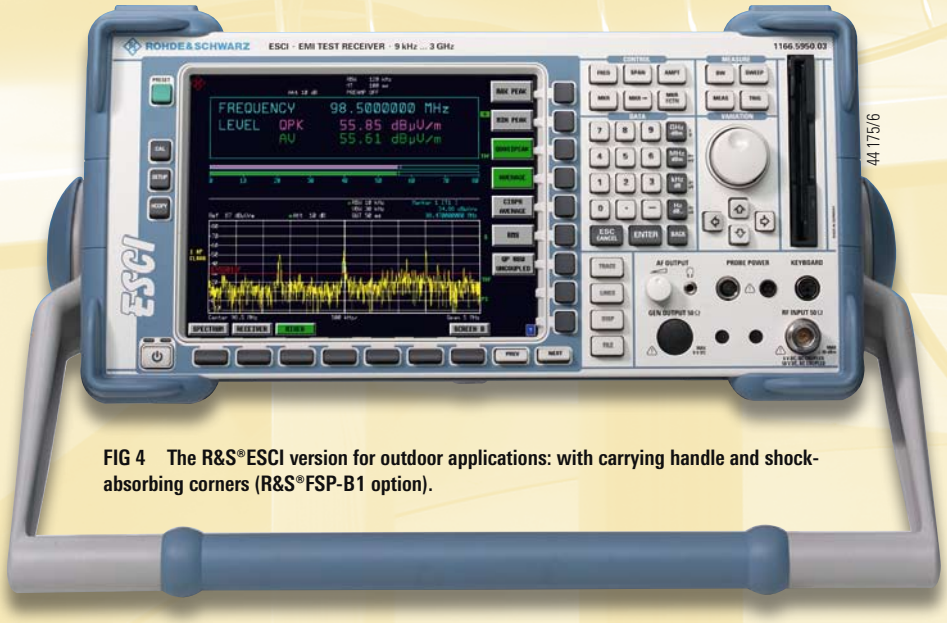

FIG 4 The R&S®ESCI version for outdoor applications: with carrying handle and shock-absorbing corners (R&S®FSP-B1 option).