Precompliance Test Receiver ESPI

Multitalent in the development lab

The EMI Test Receiver ESI from Rohde & Schwarz has established itself worldwide as a standard in the area of compliance testing. If the measurement task, however, is the testing of EMC properties during development rather than compliance testing to standards, the need often arises for a "smaller" and more cost-effective solution. And if this solution offers the complete repertoire of a standard spectrum analyzer in addition to receiver functions, it is ideal for development laboratories and other facilities which do not absolutely need to conform to the strict CISPR measurement requirements.

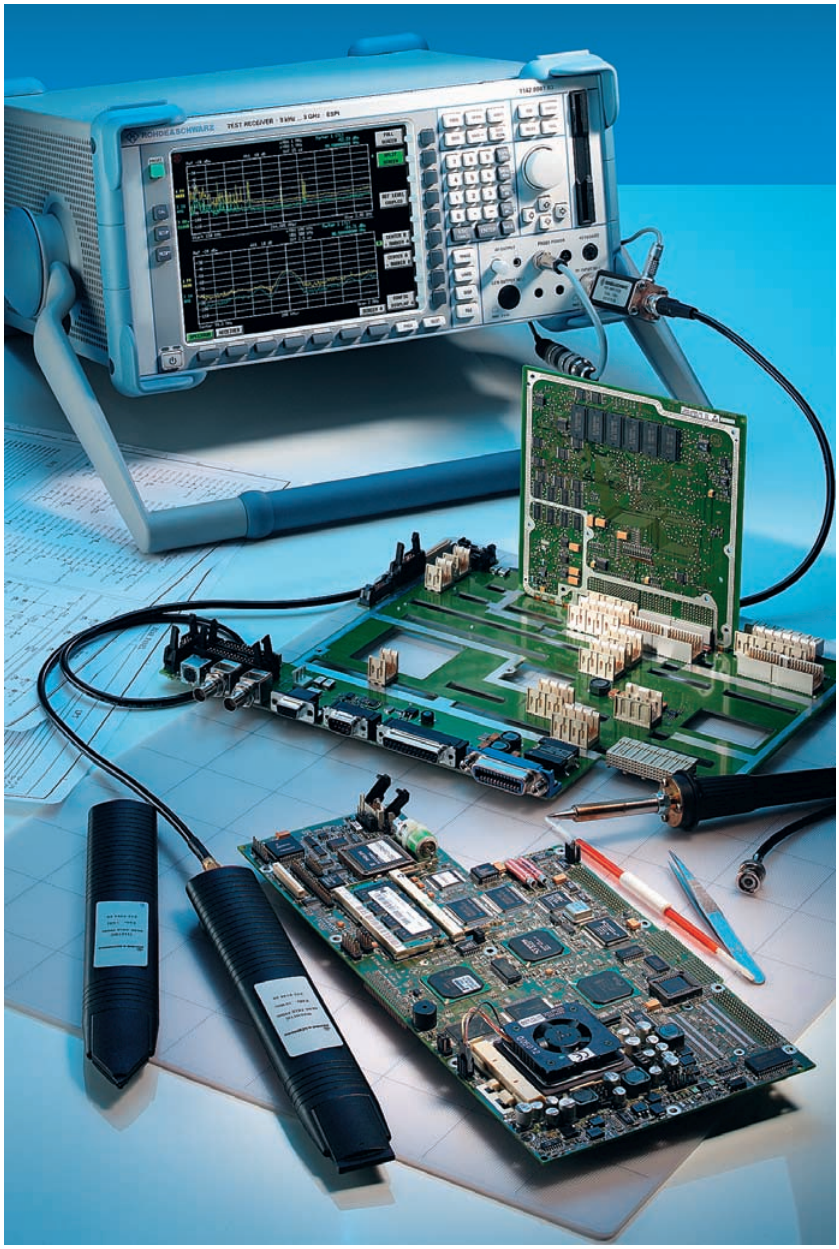

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FIG 1 The ESPI defines the decisive criteria in the precompliance class such as range of functions, measurement speed and measurement accuracy

Precompliance has a new name: ESPI

In many areas of electronics such as radiocommunication or data technology, there is a steady increase in applications which use ever higher frequencies. This is accompanied by a definite increase in EMC measurement requirements and in the demand for measurements above 1 GHz. As a result, these issues have been addressed in the two new Precompliance Analyzers / Test Receivers ESPI3 (9 kHz to 3 GHz) and ESPI7 (9 kHz to 7 GHz) (FIG 1).

The two new models are based on the modern FSP [1] spectrum analyzer family, and add the advantages of an analyzer to those of a classic test receiver to form a combination which sets new standards for versatility and performance in the area of precompliance measurements.

The range of functions is particularly tailored to the interests of the development laboratory. Numerous integrated measurement functions such as power measurement in frequency and time domain, APD (amplitude probability distribution) and CCDF (complementary cumulative distribution function) signal statistics, measurement of noise and phase noise or of the third-order intercept point, plus the standard functions of a spectrum analyzer, cover practically all basic measurement tasks. Based on this, the ESPI models provide all functions required for EMC measurements (see box below).

Through the combination of the flexibility and high measurement speed of a spectrum analyzer with the specific properties of a test receiver in one device, the ESPI is equally well suited for general spectrum analysis applications and EMI diagnostic measurements, and is therefore a true multitalent for every development laboratory.

EMC-relevant performance features of the ESPI

- Receiver mode
- Scan mode with user-definable frequency ranges including receiver settings
- EMI bandwidths
- Parallel weighting with Peak, Quasi-Peak and Average detectors
- Evaluation functions for prescan, data reduction and final measurement
- Predefined and user-programmable limit lines (FIG 2)
- Consideration of transducer factors (FIG 3)

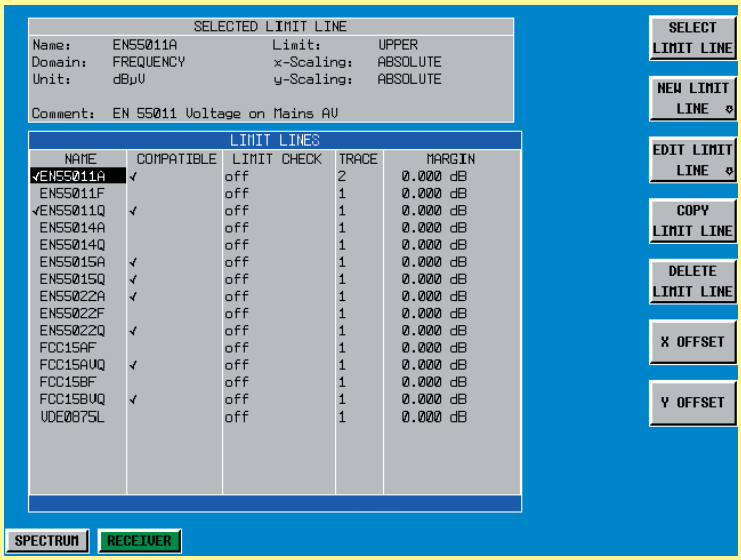


FIG 2 The ESPI supports the convenient generation and saving of practically any number of limit lines, with up to 50 reference points per line. Each limit line can have a fixed relation to one of three traces. Furthermore, a margin for a limit line (MARGIN) can be predefined and monitored (LIMIT CHECK). The limit values of the most important commercial standards have already been programmed in the ESPI.

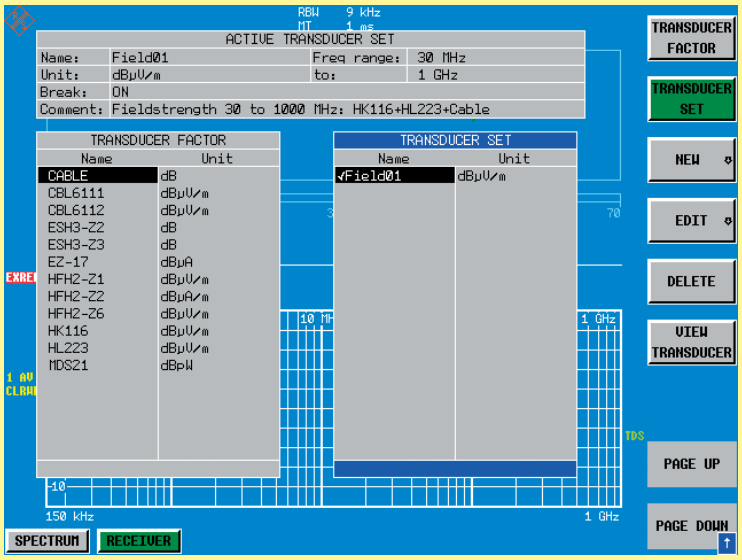


FIG 3 Frequency-dependent correction values with up to 50 reference values per data record (antenna transducer, cable attenuation etc) can be simply and easily generated and saved as a TRANSDUCER FACTOR. In addition, several transducer factors can be combined to form a TRANSDUCER SET. An automatic compatibility check ensures that settings are error-free. The number of transducer factors and sets which can be saved is practically unlimited. A variety of factors have already been programmed in the factory. With VIEW TRANSDUCER, every saved factor can be graphically displayed on the screen as a trace.

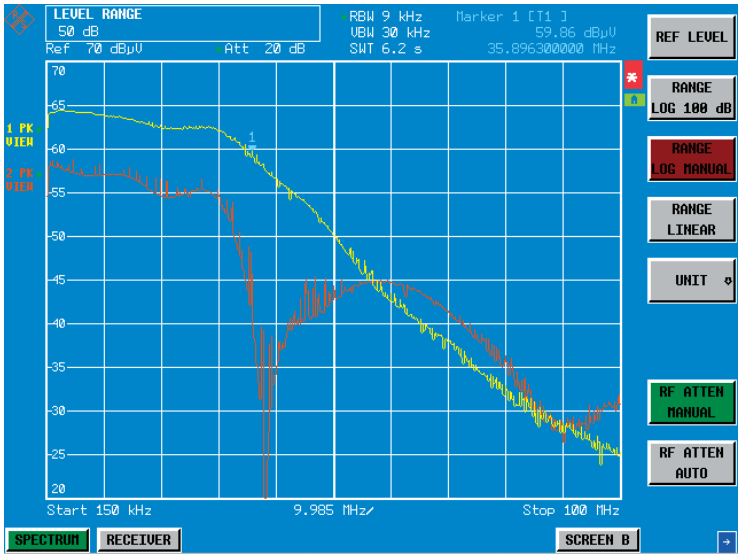
Why precompliance measurements?

Testing of electric or electronic devices for compliance with legal EMC regulations and limit values requires either an in-house EMC test laboratory or support from an external service provider. For small and medium-sized companies which often need to carry out these types of measurements, both options can be too expensive.

As an economical alternative, the precompliance receiver and/or analyzer allows development-related measurements and preparation for compliance testing to be carried out in the in-house development laboratory.

The main task of such precompliance EMI measurements is to get a comprehensive idea of the fundamental interference behaviour of a product, and recognize potential problems at an early stage. The development of complex electronic products is too costly and expensive to wait until the final acceptance test for evaluation and diagnosis of EMC characteristics and to put up with the high risk of time-intensive and costly improvements involving one or more repetitions of the acceptance measurements. The market launch schedule can be quickly delayed due to subsequent modifications, since serious flaws in the EMC-compliant design can hardly be repaired. The earlier EMC regulations are observed during the development phase, the lower the time and financial expenditure for securing EMC conformance of a product will be. Clearing the last hurdle of "certification", i.e. proof that the prescribed limits have been complied with, is then only a formality.

FIG 4
Result of measuring pulsed broadband interference with preselection (yellow) and without preselection (red). When preselection is disabled, the measurement result may be partly falsified by more than 10 dB, due to compression and intermodulation.



Preselection – important quality feature or unnecessary cost factor?

Compliance with the requirements specified in CISPR 16-1 for measuring equipment, i.e. the standard-conformant measurement of electromagnetic interference, places very high demands on the characteristics of the test receiver, which must correctly record and evaluate the pulsed or sinusoidal, modulated or intermittent interference sources. Pulse weighting with a CISPR quasi-peak detector, as specified in the standard, for example, requires a dynamic range which can only be realized with highly complex circuitry. Professional devices of this type [2] are absolutely required for compliance measurements, however they are also quite costly.

Such a technical expenditure cannot be justified in so-called precompliance receivers or analyzers. It is most important for the appropriate measuring equipment to be cost-effective. Nevertheless, a series of fundamental quality requirements exists for devices of this class, whose fulfilment is indispensable if the results achieved are to be reliable and meaningful.

If it is really certain that the DUT emits only narrowband interference and no broadband pulsed signals, a spectrum analyzer without preselection can be used, such as the basic version of the ESPI. The broadband input of the analyzer is quickly overdriven, however, when pulsed interference signals occur. An example of this is shown in FIG 4: With preselection enabled (ESPI-B2 option), the ESPI can correctly display the broadband signal spectrum with its typical trace waveform (yellow). The bandpass filters connected ahead significantly reduce the signal level at the input mixer so that neither compression nor intermodulation can distort the measurement results. The red trace shows the measurement results determined for the same interference signal, but with preselection disabled.

In addition, the overload detector, which reliably reacts to pulsed signals, warns the user if a level in the signal path is overdriven and the measurement result is therefore invalid. For this reason, the ESPI continuously monitors the receive path and thus guarantees the reliability of the measurement results.

It quickly becomes apparent that the use of a preselection filter also offers clear advantages for precompliance measurements:

- This is the only way to measure pulsed and broadband interference signals
- Measurement results will be reproducible and reliable

Top-class technical performance at a low price

The ESPI offers a complete range of detectors: Max Peak, Min Peak, Average, Quasi-Peak and RMS. In the spectrum analyzer mode, the Sample detector is also available. Any combination of three detectors, e.g. Max Peak, Quasi-Peak and Average, can be simultaneously displayed as a bargraph or frequency spectrum. If desired, the quasi-peak detector can automatically be linked with the bandwidths and time constants prescribed by the CISPR standard, in order to ensure correct operation.

For carrying out EMI measurements, the CISPR bandwidths of 200 Hz, 9 kHz and 120 kHz as well as a filter with 1 MHz pulse bandwith for the range above 1 GHz can be set in both analyzer and test receiver modes (FIG 5).

In addition to the standard 3 dB bandwidths (10 Hz to 10 MHz in 1, 3, 10 sequence), the ESPI is also equipped with approx. 40 digitally implemented channel filters for all the common radio services. Thus, measurements on radiocommunications spectra can be carried out considerably easier and faster. The filters mentioned can again be used in both analyzer and receiver mode.

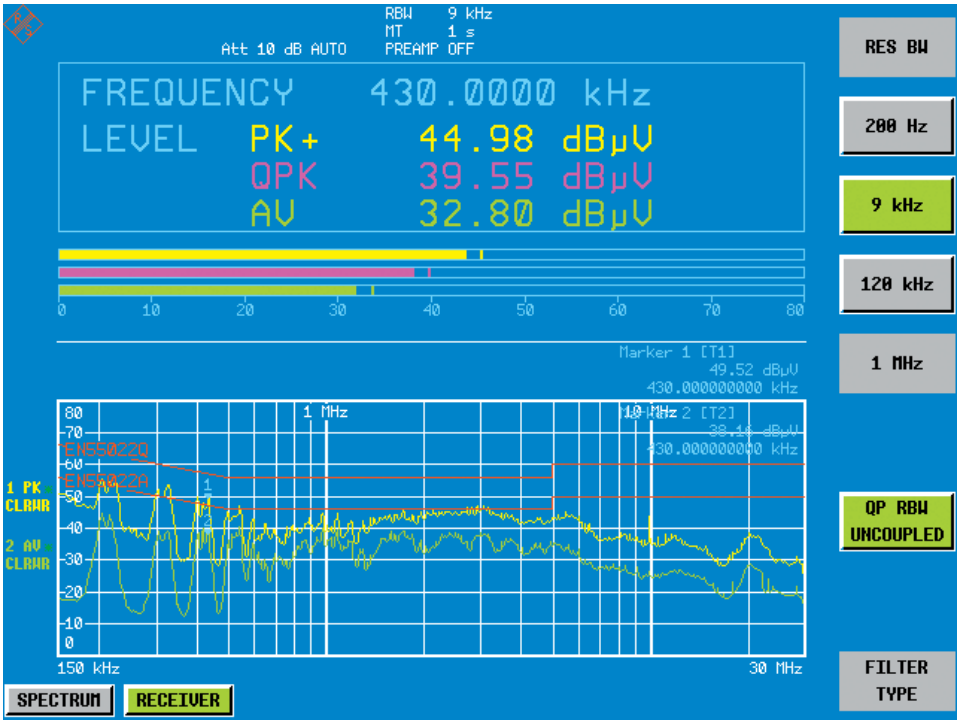


FIG 5 The standard SPLIT SCREEN display in the receiver mode shows the continuously updated level values for the selected detectors and the set frequency in the upper window. With TUNE TO MARKER or MARKER TRACK, frequency tuning and numeric level measurement can be linked to the marker settings in the lower window. Thus, final measurements on "critical frequencies" become considerably easier.

For EMC measurements, the scan, i.e. the recording of the frequency spectrum with defined step widths and dwell time per measurement result, is often preferred instead of the sweep. The ESPI handles this easily, since the high measurement speed of the analyzer is also available in this typical receiver mode. Very little additional internal processing time is required beyond the actual measurement time. Even the parallel transfer of all measured level values via IEEE/IEC bus or the optional LAN interface (100Base-T) does not noticeably slow down the measurement. Only 5 s are required for a continuous scan with the standard 120 kHz resolution bandwidth that covers the CISPR bands C and D (30 MHz to 1000 MHz), using a set measurement time of 100 µs and the peak detector. During this time, the ESPI calculates and stores nearly 20000 measurement values, i.e. the measurement takes only 250 µs per frequency step. This type of measurement is based on a scan table with up to ten subranges, each with individually settable parameters such as start and stop frequency, step width, resolution bandwidth, measurement time and fixed or automatic RF attenuation (FIG 6). If the preselector / preamplifier option is available, the preamplifier can also be separately enabled for each subrange.

As with the spectrum analyzer mode, the displayed trace is compressed to 501 measurement values. However, the ESPI internally saves all measured levels – up to 100000 values for each of the three traces. Once the scan is completed (which can be time-consuming, depending on the test specification), the exact values can be recalled from the background memory at any time for evaluation. The zoom function can, for example, show a portion of the spectrum and reveal details which are hidden in the overall display. With the marker, the peaks are determined and the corresponding bargraph is automatically set

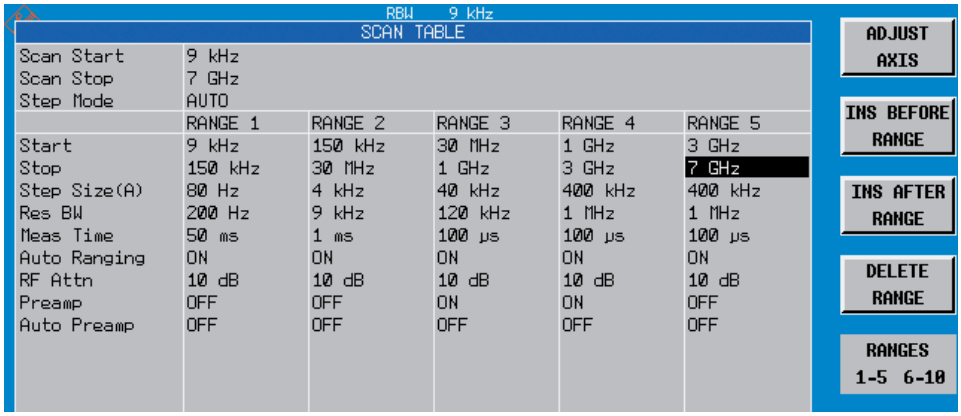


FIG 6 In the RECEIVER mode, the ESPI is tuned in fixed frequency steps according to the settings in the scan table. The scan table can be programmed for a maximum of ten frequency subranges with individually settable parameters (e.g. start/stop frequency, step width, measurement time, IF bandwidth and input attenuation). By simply setting the START and STOP frequencies, subsequent scans will automatically load the parameters previously set in the scan table. This guarantees a reproducible and standard-conformant measurement sequence every time.

to the frequency of the interference found by the prescan. For further processing, the measurement results can be saved to the built-in disk drive or internal hard disk. In addition, the frequency and level of the trace can be saved as ASCII files. Statistical assessment or comparison of several scans can be easily automated by means of a spreadsheet analysis program, for example.

In the spectrum analyzer mode, however, all functions which are required for EMC measurements according to civil standards are also available: bandwidths, detectors, evaluation functions and the optional preselector and preamplifier.

The FSP-B9 option (internal tracking generator up to 3 GHz) and the FSP-B10 option (generator control) enhance the ESPI test receivers to scalar network analyzers. Through selective measurement, the gain, frequency response, insertion loss and return loss can be measured with a wide dynamic range without being influenced by harmonics or spurious emissions from the generator. Thus, inspecting a test cable and determining its attenuation are easy, which increases the reliability of the measurements.

Document and report generation made easy

The measurement alone is not enough; the results should be documented without great expenditure and in the most flexible manner. Due to its PC-compatible processor, the ESPI offers the best prerequisites. This includes screenshots without requiring additional conversion software, Windows printer support and print-to-file functions in the WMF, EMF and BMP data formats.

Measurement results and their associated settings can be jointly or separately saved to the internal hard disk or built-in 3½" disk drive. For connection to usual data networks, a LAN interface is available, which permits output via a network printer or file storage on a network server.

Condensed data of ESPI3 / ESPI7

Frequency range	ESPI3: 9 kHz to 3 GHz ESPI7: 9 kHz to 7 GHz
Frequency scan	
Receiver mode	scan with max. 10 subranges with different settings, e.g. measurement time per frequency: 100 µs to 100 s
Analyzer mode	sweep time (span ≥10 Hz): 2.5 ms to 16000 s zero span (0 Hz): 1 µs to 16000 s
IF bandwidths (available in analyzer and receiver modes)	user-selectable: 10 Hz to 10 MHz (–3 dB), in 1, 3 ,10 sequence CISPR: 200 Hz, 9 kHz, 120 kHz (–6 dB), 1 MHz (pulse bandwidth), various channel filters
Detectors (3 simultaneously)	
Receiver mode	Max/Min Peak, Quasi-Peak, Average, RMS
Analyzer mode	Max/Min/Auto Peak, Sample, Quasi-Peak, Average, RMS
Displayed average noise level	
RBW 10 Hz, Avg, preamp on (opt. -B2)	typ. –155 dBm / –153 dBm (ESPI 3 / 7); 0.01 GHz to 1 GHz
1 dB compression (input mixer)	(0 dB attenuation, f >200 MHz): 0 dB nominal
Phase noise	10 kHz / 1 MHz: –113 dBc / –125 dBc (1 Hz)
Level measurement accuracy	total error: 1.5 dB in receiver mode 0.5 dB in analyzer mode without preselection (ESPI-B2); QP display: in line with CISPR16-1, ≥10 Hz pulse repetition frequency (with option ESPI-B2)
Options	
ESPI-B2	preselector/preamplifier 11 bandpass/highpass filters (can be disabled in analyzer mode); preamplifier 20 dB, switchable; 9 kHz to 3 GHz
FSP-B1	rugged case, carrying handle
FSP-B4	OCXO reference frequency
FSP-B9	internal tracking generator 9 kHz to 3 GHz, IQ modulator
FSP-B10	external generator control
FSP-B16	LAN interface (100Base-T)

Ergonomics and design set high standards

Due to its large 21 cm colour TFT display, the clarity and readability of the displayed traces and selected parameters are not an issue – even in split-screen mode. The ESPI sets new standards beyond its class.

Complex measurement settings are easily carried out through a combination of vertical and horizontal rows of softkeys. For the most important parameters such as frequency, amplitude / attenuation and bandwidth, separate hardkeys and unit keys are provided.

In addition to functioning as a desktop unit, the ESPI with its compact dimensions and its light weight of 11 kg is especially suited for mobile use. A particularly robust version with shock absorbing corners and adjustable handles that also serve as a stand is optionally offered.

Naturally, the ESPI is environmentally friendly. The unit was designed with a minimal amount of materials, mutual compatibility of materials to ensure easy identification of substances as well as fast and easy disassembly.

Matthias Keller; Karl-Heinz Weidner

More information and data sheet at www.rohde-schwarz.com (search for ESPI)

REFERENCES
[1] Spectrum Analyzer FSP – Medium class aspiring to high end. News from Rohde & Schwarz (2000) No. 166, pp 4–7
[2] EMI Test Receivers ESI – EMI professionals through to 40 GHz. News from Rohde & Schwarz (1999) No. 162, pp 7–9

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Latest news on the homepage of Rohde & Schwarz

Interested visitors of the Rohde & Schwarz Internet site have certainly noticed that since the end of May, the News section has been considerably expanded. An online editorial service that is exclusively dedicated to this task, prepares the news from the various divisions of the company, which are of interest for worldwide publication, and according to the medium, presents them in condensed journalistic form. Customers and interested individuals are thus supplied with more immediate and relevant news from Rohde & Schwarz. Detailed information for each of the subjects can be obtained via the corresponding links. Interested? Take a look at www.news.rohde-schwarz.com