NEWS

202/10

ROHDE&SCHWARZ

Unique on the market:

Real-time spectrum analyzer and full-featured signal and spectrum analyzer in one instrument – it detects everything, even infrequent or ultrashort events

GENERAL PURPOSE

Superb in every sense: 40 GHz wideband power sensors for universal applications

BROADCASTING

Monitoring digital TV signal quality – straightforward and economical

RADIOMONITORING / RADIOLOCATION

Fast digital traffic control direction finder succeeds worldwide established Doppler DF family

NEWS

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Cover feature

"It is often difficult and time-consuming to find the cause of sporadic errors using a conventional swept spectrum analyzer. A real-time spectrum analyzer can be an enormous help. Our goal was to combine the advantages of both analysis processes in one instrument," says Josef Wolf, Director of the Spectrum and Network Analyzers Subdivision.

The article starting on page 14 describes how this first-ever integration of a real-time spectrum analyzer and a full-featured spectrum and signal analyzer into one instrument was successful in every way. This dual-talented instrument offers measurement without blind times, a major advantage for developers of RF components used in commercial transmission systems such as LTE, WiMAX™, WLAN, Bluetooth® and RFID, and for general RF applications such as radar or frequency hopping transmission.

Overview
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Articles not published in this issue are available as PDF files in German, English, French and Spanish at:
http://www.newsmag.rohde-schwarz.com.

WIRELESS TECHNOLOGIES

R&S®TS8980FTA test system.

GENERAL PURPOSE

Comprehensive measurements on base station modules via the CPRI™ interface

New options for the R&S®EX-IQ-Box digital interface module make it possible to perform comprehensive measurements on base station RF and baseband modules via the CPRI™ interface.

Digital interfaces becoming increasingly popular

As in many other areas, digital interfaces are also being used increasingly in wireless communications. Instead of using analog I/Q signals, the baseband and RF modules of base stations communicate by means of digital baseband signals. Wireless communications network operators, in particular, are demanding the possibility of combining base station modules from different manufacturers to avoid being completely dependent on one supplier. The interfaces must therefore be standardized.

The common public radio interface (CPRI) standard is an attempt at creating a standardized platform for digital communications between baseband and RF. It defines the interface between the baseband unit of a base station (the REC, radio equipment control) and the RF unit (the RE, radio equipment). The trend toward digital interfaces also creates new requirements regarding measurement methods and measuring equipment for base stations. The RE and REC are now to be tested independently of one another, since an RE must function with every REC, and vice versa. The measuring equipment that is used must therefore be capable of sending or receiving suitable test signals to and from the device under test via the CPRI™ interface.

R&S®EX-IQ-Box – the universal I/Q interface

The R&S®EX-IQ-Box* provides versatile digital baseband inputs and outputs for Rohde & Schwarz measuring instruments, e.g. for the R&S®SMU200A and R&S®SMBV100A vector signal generators as well as for the R&S®FSQ and R&S®FSV signal and spectrum analyzers. New options allow the box – together with these measuring instruments or even independently – to perform tests on the base station modules via the CPRI™ interface. The R&S®EXBOX-B85 option provides the necessary hardware as a CPRI™-compliant breakout board. The R&S®EXBOX-K10 and -K11 options include the functionality needed for testing REs and RECs. The R&S®EX-IQ-Box currently supports version 4.0 of the CPRI™ standard with line bit rates of up to 3072 Mbit/s. Ready-to-use interface settings are available for the 3GPP FDD / HSPA / HSPA+, 3GPP LTE and WiMAX™ standards primarily supported by CPRI™. However, the box also enables user-defined configurations, providing users with maximum flexibility.

* Bidirectional digital I/Q interface with flexible user configuration. NEWS (2008), No. 196, pp. 28–30.

Measurements on the CPRI™ RE

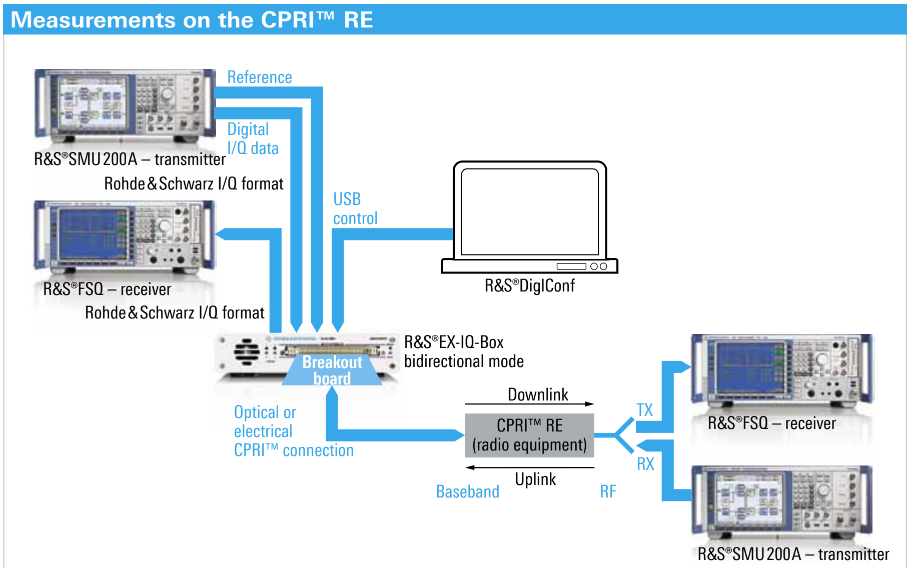


FIG 1 Test setup for tests on CPRI™ radio equipment: Fully duplex-capable, the uplink and downlink can be tested simultaneously or consecutively.

Tests on the RE

FIG 1 shows the test setup for comprehensive tests on the RE, comprising an R&S®EX-IQ-Box with corresponding options for CPRI™ as well as vector signal generators (R&S®SMU200A) and signal analyzers (R&S®FSQ) with options for generating and analyzing baseband or RF signals. Transmitter tests on the RE (downlink direction), for example, can be carried out in the same way as on a complete base station. The baseband section of the generator generates the required digital I/Q signals, and therefore plays the role of an "ideal" REC. The R&S®EX-IQ-Box acts as the CPRI™ interface of the REC and sends the I/Q data, embedded in the CPRI™ protocol and together with the necessary CPRI™ control data, from the generator to the RE.

All of the box parameters are conveniently configured using the R&S®DigIConf PC software (FIG 2). The software can be remote-controlled via LAN in the same way as the measuring instruments so that the complete system can be embedded in existing test environments. The quality of the RF signals output by the RE can then be measured in the same way as with a complete base station using a suitable signal and spectrum analyzer such as the R&S®FSQ.

For tests in the uplink, the R&S®SMU200A generator sends RF test signals to the RX port of the RE. The resulting digital I/Q signals are sent from the RE to the R&S®EX-IQ-Box via the CPRI™ interface. The signal and spectrum analyzer is connected to the box via its optional digital baseband interface and analyzes the I/Q signals. The performance of the RE can be determined via measurands such as noise figure or EVM.

The major advantage of this concept is that the same measuring instruments – and for the most part, the same measurement methods – can be used as are also employed for testing the complete base station. This makes expensive new investments superfluous in many cases. Plus, measurements on the modules and on the complete base station are easier to compare – which can significantly speed up DUT optimization and troubleshooting.

In addition, users are able to tailor the test setup precisely to their requirements by simply selecting the suitable instruments from Rohde&Schwarz. The test setup shown is fully duplex-capable, i.e. uplink and downlink can be tested simultaneously. If only one direction is required or the uplink and downlink are tested consecutively, one generator/analyzer pair is sufficient. If the performance of the R&S®FSQ and R&S®SMU200A high-end instruments is not actually required, they can be replaced by the less expensive R&S®FSV, R&S®SMJ100A or R&S®SMBV100A.

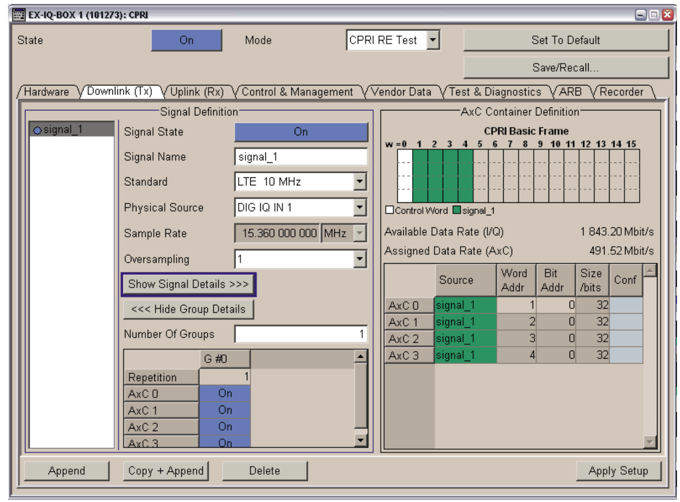


FIG 2 CPRI™ menu of the R&S®DigIConf software allows easy configuration of all R&S®EX-IQ-Box parameters.

Test on the CPRI™ RE in the downlink

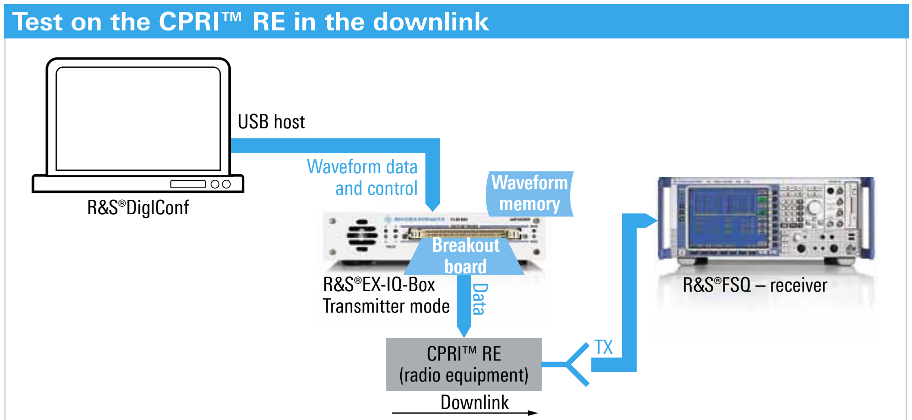


FIG 3 Reduced test setup for tests on CPRI™ radio equipment in the downlink. The R&S®EX-IQ-Box provides the necessary I/Q signals with the aid of its integrated ARB generator.

Test setup for tests on the CPRI™ REC

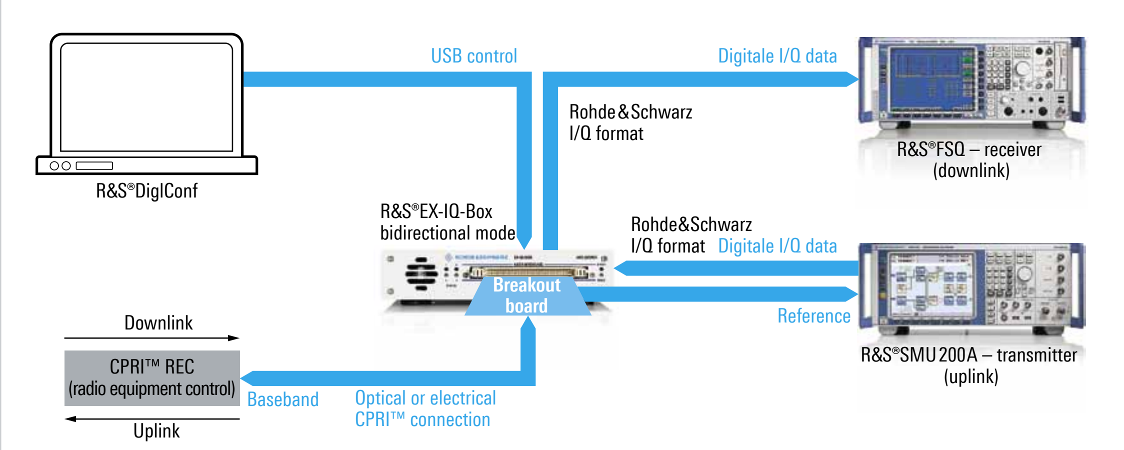


FIG 4 Test setup for tests on the CPRI™ radio equipment control.

Optional ARB generator

If testing is only required in the downlink, it is even possible to dispense with a signal generator completely, since the R&S®EXBOX-K90 arbitrary (ARB) waveform generator option for the R&S®EX-IQ-Box generates digital I/Q signals itself. It is also supported by the R&S®WinIQSIM2™ simulation software. Combined with the R&S®EXBOX-K240 to -K259 options, digital I/Q signals can be quickly and conveniently generated for all important wireless communications standards (FIG 3).

The ARB waveform generator of the R&S®EX-IQ-Box can also be used for complex signal scenarios. The multiwaveform playback option (R&S®EXBOX-K91) outputs up to four waveforms at the same time. This means, for example, that up to four TX signals for testing REs with transmit diversity, i.e. multiple transmit antennas, can be generated and transferred to the RE via the CPRI™ interface. Another application is the testing of state-of-the-art multistandard base stations where signals of different standards are transferred simultaneously via one CPRI™ interface. The R&S®EXBOX-K94 recorder option enables users to also record I/Q signals coming in from the DUT and transfer them to the control PC so that the signals are available for their own analyses.

Tests on the REC

The Rohde&Schwarz concept also clearly demonstrates its advantages in tests on the REC. FIG 4 shows a corresponding test setup. The R&S®SMU200A signal generator, which has proven its effectiveness in many base station tests, provides the signals for testing the REC receiver, in this case not as RF signals but as digital I/Q signals. The R&S®EX-IQ-Box acts as the CPRI™ interface of an RE and sends the signals from the generator to the REC receiver. The R&S®SMU200A not only provides options for all important digital communications standards such as 3GPP FDD / HSPA / HSPA+, 3GPP LTE FDD and TDD, WiMAX™, TD-SCDMA and CDMA2000®, but also exceptional signal processing and realtime capabilities such as fading, MIMO or HARQ feedback. All of these functions are also beneficial when used for REC tests. For tests in the downlink, the R&S®EX-IQ-Box can record the REC transmission signals with the recorder option, or send them to the baseband input of an R&S®FSQ or R&S®FSV and use their extensive capabilities for signal analysis.

Conclusion

The new options for the R&S®EX-IQ-Box digital interface module make it possible to perform versatile tests on baseband and RF modules via the CPRI™ interface. The box can be used both independently as well as in combination with Rohde&Schwarz vector signal generators and signal and spectrum analyzers, and allows comprehensive characterization of REs and RECs.

Dr. René Desquiotz

R&S®EX-IQ-Box options for CPRI™

R&S®EXBOX-B85	CPRI breakout board
R&S®EXBOX-K10	CPRI RE test
R&S®EXBOX-K11	CPRI REC test
R&S®EXBOX-K90	Waveform memory
R&S®EXBOX-K91	Multiwaveform playback
R&S®EXBOX-K94	Recording memory
R&S®EXBOX-K240 to -K259	Digital standards such as 3GPP FDD / HSPA / HSPA+, 3GPP LTE, CDMA2000® etc.

Time-optimized WLAN MIMO transmitter measurements in production

To boost transmission rates, WLAN technology uses (radio) space as part of the air interface in addition to conventional resources such as bandwidth, time and coding. This requires multiple antennas at the transmitting and receiving ends and forms complex systems with their own specific test requirements. The R&S®CMW-KM652 option for the R&S®CMW500 / R&S®CMW270 testers fully covers these tests in production. No additional hardware is necessary.

Divergent test requirements in development and production

In WLAN MIMO devices, conventional transmitter characteristics as well as MIMO-specific parameters must be verified (see box on page 10 for basic information about WLAN and MIMO). Depending on the desired measuring depth, one or more vector signal analyzers and vector signal generators are required, or a radiocommunications tester with one or more channels.

During the development and design of WLAN MIMO devices, multiple analyzers and generators allow users to make power and spectrum measurements and also measure transmitter characteristics such as error vector magnitude (EVM), carrier frequency offset, carrier leakage and spectral flatness along with MIMO-specific parameters. The MIMO-specific parameters are, for example, the channel crosstalk or the isolation that prevails during concurrent transmission via multiple transmit antennas and is reflected in each element of the channel matrix H.

This equipment requirement with its associated costs is appropriate for development, but it is not necessary for the special needs encountered in production. Taking into account the test time, procurement costs and necessary measuring depth, it is clear that a single-channel test instrument is adequate in this case. This is because production is primarily interested in verifying whether the transmitted signals comply with the relevant standards and the physical properties lie within the specified limits so as to ensure smooth operation.

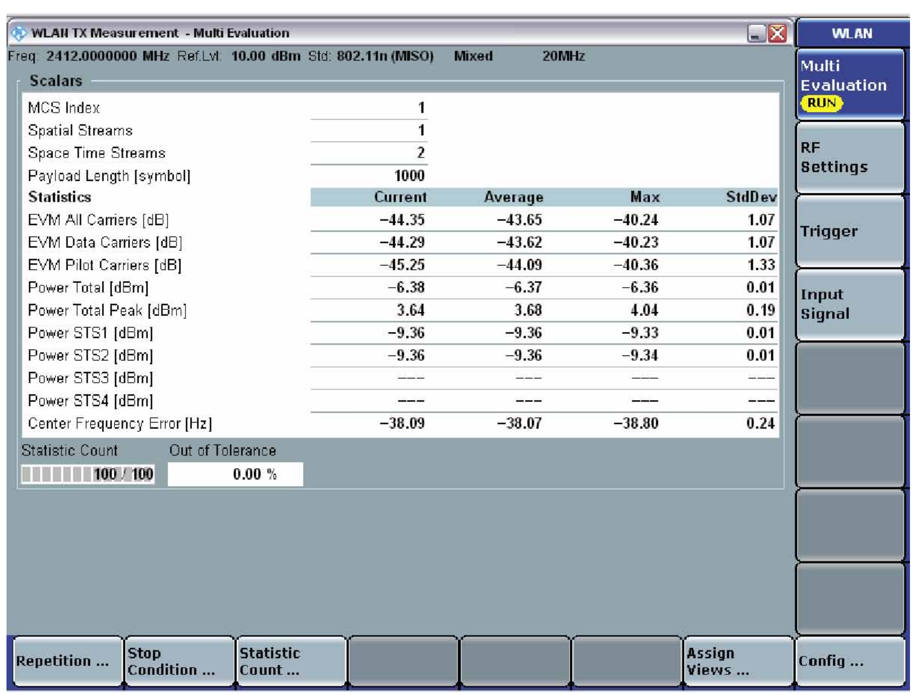


FIG 1 Based on the sum signal from a maximum of four transmit antennas, the R&S®CMW-KM652 option needs only a single measurement to determine all the TX measurement values that are needed in production. Besides EVM and carrier frequency offset, these values include the output power of all space time streams. As a result, any deficiencies in the antenna contacts can be detected immediately in production, for example.

Customized option for production

The R&S®CMW-KM652 option (FIG 1) enables multiple transmitter measurements on WLAN MIMO devices using an R&S®CMW500 or R&S®CMW270 single-channel tester. Even the maximum configuration involving simultaneous operation of up to four transmit antennas can be tested in this manner. Here, the testers evaluate the sum signal resulting from the different transmit signals, e.g. during transmission via the air interface or through usage of a power combiner. The measuring depth and the delivered results are tailored to meet the requirements of production applications.

One critical factor for successful MIMO operation is uniform distribution of the total signal power among all transmit antennas. The basic prerequisite here is that all the transmit antennas make proper contact and are correctly installed during production. The R&S®CMW-KM652 option can detect any defects in the antenna contacts and assess the performance of all transmit antennas. Moreover, it computes the center frequency error and the EVM value for the pilot sequences. For 2×1 MIMO (= multiple input single output, MISO), the data stream to be transmitted is emitted simultaneously via two transmit antennas for transmit diversity using the Alamouti technique. In this case, the R&S®CMW-KM652 option provides EVM results for the pilots as well as for the entire OFDM signal including all data carriers.

Composite EVM

In production, the modulation accuracy of the overall signal is of particular interest. The EVM measurement summarizes amplitude and phase errors and is generally a good indicator for the signal quality of a transmitter. The composite EVM measurement made using the R&S®CMW-KM652 option relates to the sum signal representing all simultaneously received transmitters and not any particular one of them. It is highly practical, optimized for production and ensures short test turnaround times.

Summary

Due to the very short test time and good test coverage, the R&S®CMW-KM652 option ideally meets the test requirements of transmitters in WLAN MIMO devices in production. Plus, it is a cost-efficient solution because it does not require any additional hardware.

Thomas A. Kneidel

The PDF file of this article available at **http://www.newsmag.rohde-schwarz.com** contains a more detailed version (two additional pages) of the basic information in the box below.

Basic information about WLAN and MIMO

Multipath propagation

WLAN technology takes advantage of multipath propagation to boost the data throughput and improve the signal-to-noise ratio, which enhances the data rate and transmission quality without having to increase the bandwidth or transmit power.

MIMO technology

In comparison with conventional single input single output (SISO) systems with only one transmit antenna and one receive antenna, multiple input multiple output (MIMO) technology involving the simultaneous use of multiple transmit and receive antennas has clear benefits. A MIMO system with M transmit antennas and N receive antennas is also known as an M×N system. Using appropriate weighting and coding, the signals to be transmitted are adapted to the prevailing conditions of the propagation channel and distributed to the transmit antennas. The receiving end processes the signals resulting from multipath propagation so that crosstalk is compensated insofar as possible, the signals are separated and data transmission, in the ideal case, is error-free.

Diversity reception

If signals can be received on independent transmission paths using a suitable arrangement and configuration of the receive antennas (FIG 2), then simultaneous fading dips on all channels will be unlikely and can possibly be compensated for. The signals received via the different antennas are summed up in a weighted manner and combined to form an overall signal. Using the maximum ratio combining technique, a significantly improved signal-to-noise ratio can be attained which is further improved with each additional, independent transmission path (FIG 3).

FIG 2 In the ideal case, signals are received via different antennas. These signals reach the receiver via different transmission paths that should be independent of each other.

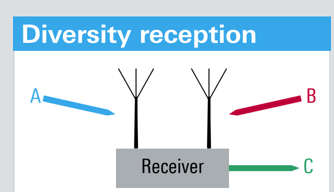
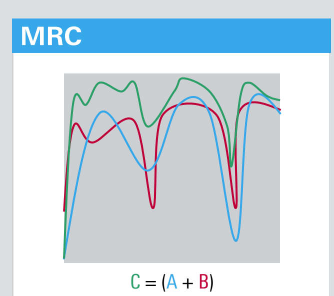


FIG 3 Maximum ratio combining in a receiver with two antennas. By adding up the received signals (which, in the ideal case, are not impaired by any correlated interference), fading dips can be compensated for the most part and the receive quality improved overall.



Recording and playing digital I/Q data in realtime

The R&S®IQR I/Q data recorder can record and play I/Q data in realtime in combination with numerous Rohde&Schwarz instruments that have the company's proprietary digital I/Q interface. This opens up new applications for users of these instruments, e.g. for drive tests (i.e. mobile data acquisition) as well as in research and development.

The I/Q data recorder is versatile

The real and imaginary parts of digital I/Q data make it possible to completely describe RF signals. Many Rohde&Schwarz T&M instruments have an interface for these I/Q signals for analyzing and generating RF signals or for outputting measurement and analysis results. The R&S®IQR I/Q data recorder (FIG 1) is designed for rapid recording and playing of digitized RF data via this Rohde&Schwarz specific I/Q interface. It can provide interference or test signals, store data during drive tests, archive data from RF signals in realtime and play recorded I/Q signals. The instrument can be used for research and development applications, for drive tests when measuring wireless communications and broadcast signals, and for military applications, for example.

Compact and rugged

The compact recorder is extremely rugged; its system disk and RAM featuring solid-state technology make it ideal for mobile deployment. It is easy to operate via the color touchscreen and the flat menu structure. The normal mode or expert mode is selected, depending on the application. Softkeys simulate the buttons of a recorder for manual control of recording and playing. Of course, the I/Q recorder can also be remote-controlled via LAN or external trigger events.

The I/Q input/output module in the R&S®IQR converts the I/Q data streams, synchronizes the data and controls recording and playing in accordance with the trigger conditions. The FPGA-based design of the digital I/Q interface and the internal data processing is open for enhancements with regard to data rate and data width.

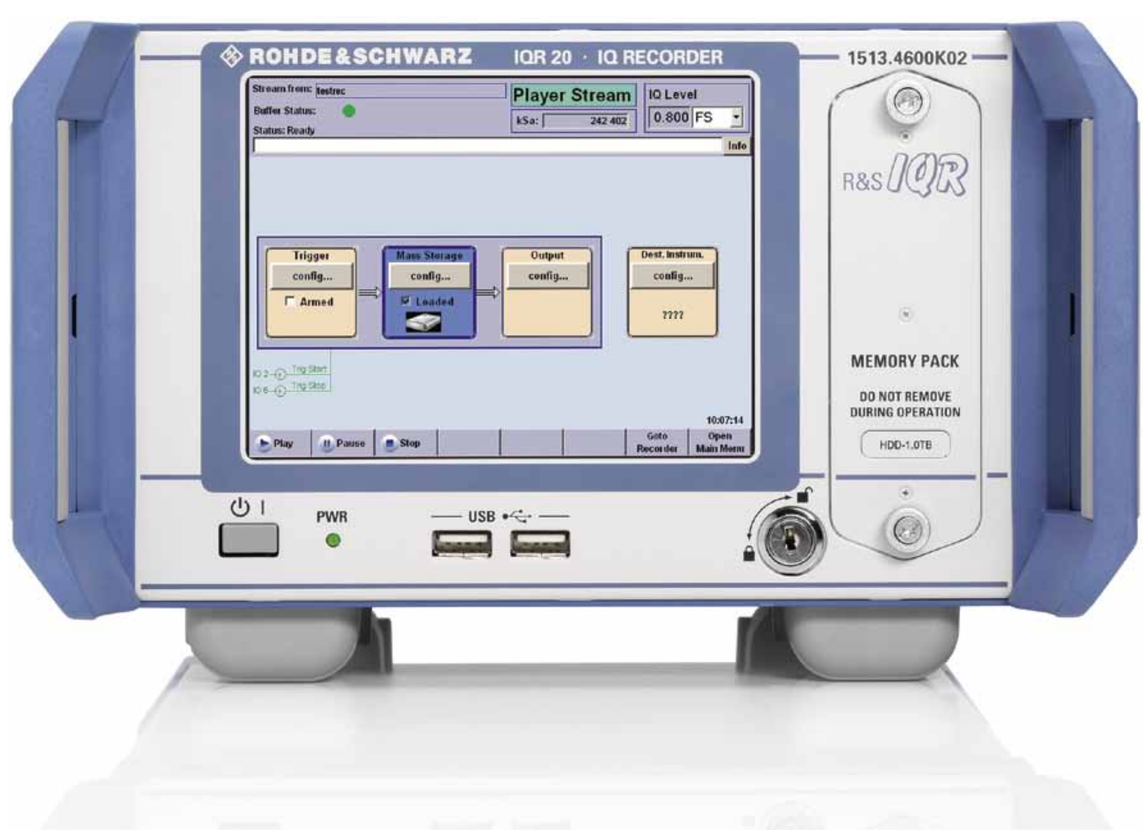


FIG 1 In combination with Rohde&Schwarz instruments that have the company's proprietary digital I/Q interface, the R&S®IQR digital I/Q data recorder opens up new applications in the area of RF data storage, evaluation and provision.

The removable I/Q data memory pack on the front panel, which is equipped with hard disk or solid-state disks depending on the model, makes it easy to handle large quantities of data – no time-consuming copying is required. This is particularly beneficial for drive tests and subsequent evaluation at a central location.

Touchscreen operation and sophisticated triggering possibilities

The operating concept distinguishes between the main menu for configuration and self-testing, and the recording and playing menu. The different color schemes of the menus

The R&S®IQR in combination with other Rohde&Schwarz instruments

Stimulation of DUTs and error analysis using digital I/Q data

Via the R&S®EX-IQ-Box interface module – which converts the digital I/Q data into the Rohde&Schwarz specific I/Q data format and vice versa – the R&S®IQR can record and play parallel or serial digital I/Q data in realtime (FIG 2). This also makes it possible to exchange customer-specific I/Q data. A DUT's I/Q data stored in the recorder can be used for subsequent error analysis. Conversely, data streams played by the recorder can be used to stimulate a DUT via the R&S®EX-IQ-Box.

Recording and playing of RF broadband spectra for tests on broadcast receiver modules

Tests under realistic conditions are essential for developing broadcast receivers. For example, such tests allow Asian manufacturers to test their devices under "European locational conditions" using broadband spectra that have been recorded in Europe. For this purpose, the relevant broadcast signals must be recorded on-site. FIG 3 shows, as an example, an FM spectrum recorded in Munich. These recordings can be made from a stationary position over an extended period of time, or during a drive test.

The R&S®TSMW universal radio network analyzer is the ideal RF frontend for mobile applications up to a bandwidth of 2 × 20 MHz, also because of its compact dimensions and the 12 V power supply. The R&S®IQR, connected via the digital I/Q interface, stores the data received from the R&S®TSMW in realtime (FIG 4). The recorder can subsequently play the recorded data, which can then be used to parameterize or test broadcast modules – modulated by the R&S®SFE broadcast tester, for example.

Recording/playing of digital I/Q data

FIG 2 Recording (red) and playing (green) of digital I/Q data. The R&S®EX-IQ-Box converts the I/Q data into the Rohde&Schwarz specific format.

FM frequency spectrum

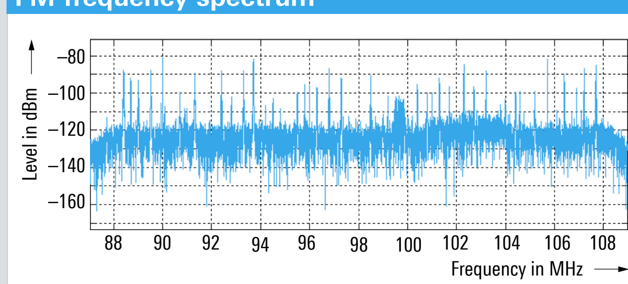


FIG 3 Recorded FM broadband frequency spectrum for testing broadcast receiver modules.

Recording/playing of RF spectra

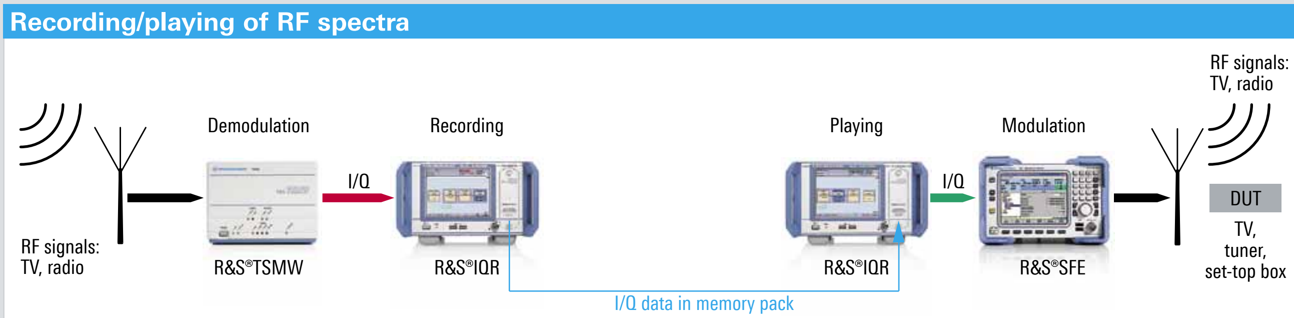


FIG 4 Separate recording and playing of broadcast signals.

for controlling recording and playing, which have an otherwise similar structure, make orientation easier. The information field displays parameters such as file name, sample counter and I/Q level. The trigger conditions and the file names, for example, are defined using the function blocks in the middle section of the touchscreen.

The extensive trigger menu provides numerous control options to start and stop recording and playing. Continuous, one-shot (single) and repeating (retrigger) modes are available, depending on the trigger source. The following trigger variants are available:

- Triggering on I/Q level, which prevents the recording of non-relevant data
- Triggering on external signals at the BNC sockets, e.g. in a test setup
- Temporal control for recording and playing without operating personnel
- Remote control via Ethernet for integration in systems
- Manual control for easy direct access via virtual control keys

Instrument models and memory packs

Appropriate instrument models and memory packs are available for the different requirements with regard to data rate and area of application (FIG 5):

- The R&S®IQR20 base unit provides sampling rates of up to 20 Msample/s and a maximum data rate of 80 Mbyte/s, and is suitable for stationary operation
- The R&S®IQR100 is prepared for sampling rates of up to 100 Msample/s. A rate of 66.6 Msample/s and data rates of 270 Mbyte/s can be achieved with the currently available R&S®IQR-B110 solid-state memory packs

The recorders can be cost-effectively configured with two alternative memory packs for the respective application:

- The lower-priced R&S®IQR-B010 hard disk memory packs are suitable for stationary use with slower data rates of up to 80 Mbyte/s, and are therefore ideal for use with the R&S®IQR20.
- The rugged R&S®IQR-B110 solid-state memory packs provide much faster data rates and are recommended for applications that require greater mechanical stability, as is the case with drive tests, for example.

Recording and playing times

Crucial factors for the practicality of a recording and playing system are the frontend bandwidth as well as the data rate and the usable recording time. The recording time is directly dependent on the sampling rate that is used. For example, with a 1 Tbyte memory pack, the entire FM frequency spectrum can be recorded at a bandwidth of 20 MHz for a period of up to three hours (FIG 6).

Rohde&Schwarz specific digital I/Q interface
Since there is no standardized I/Q interface, Rohde&Schwarz has defined a proprietary I/Q and information interface for rapid data exchange of RF signals between Rohde&Schwarz instruments. Enables, samples, triggers and markers are transmitted via this I/Q interface. The instruments communicate with each other via the information interface, which facilitates setting up the connected instruments. Parallel or serial I/Q signals can be converted into Rohde&Schwarz format by the R&S®EX-IQ-Box.

Model	Data memory	Achievable data rate
R&S®IQR20	R&S®IQR-B010, 1 Tbyte hard disk	max. 20 Msample/s, max. 80 Mbyte/s
R&S®IQR100	R&S®IQR-B110, 1 Tbyte solid-state disks	max. 66 Msample/s, max. 270 Mbyte/s

FIG 5 Models of the R&S®IQR and memory packs.

Recording time versus data rate

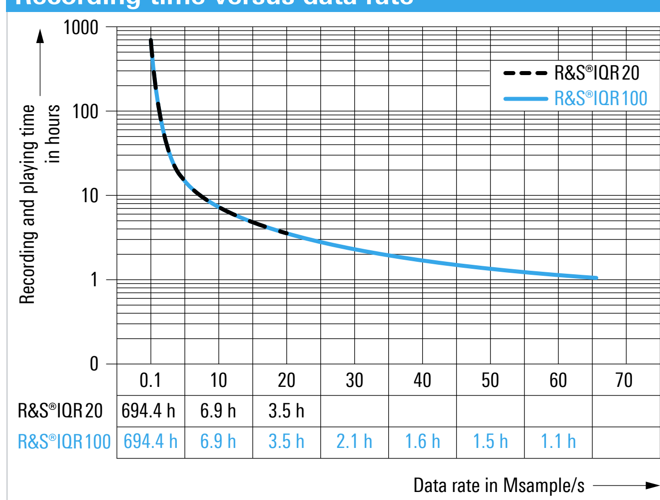


FIG 6 Recording time as a function of data rate (1 Tbyte memory pack, 32 bit I/Q data).

Summary

In combination with instruments that have the proprietary digital I/Q interface from Rohde&Schwarz, the R&S®IQR digital I/Q data recorder opens up new applications in the field of RF data storage, evaluation and provision.

Gert Heuer; Joachim Stegmaier

It detects everything: the R&S®FSVR real-time spectrum analyzer

Premiere: The R&S®FSVR is the first device on the market to combine a full-featured spectrum and signal analyzer and a real-time spectrum analyzer. It seamlessly captures and displays the frequency spectrum over a 40 MHz bandwidth. The spectrogram display and the persistence mode ensure that even infrequent or ultrashort events are detected. Sporadically occurring signals in the spectrum can be reliably detected and investigated using the analyzer´s frequency-selective trigger.

Real-time spectrum analysis up to 40 GHz

Interference caused by sporadic and brief events in the frequency range, spectral behavior of signal sources during frequency changeovers, digital circuits that affect RF signals – these are problems that are all too familiar to developers in the field of RF engineering. Until now, the causes of such problems were usually difficult and time-consuming to locate. This is now a thing of the past with the R&S®FSVR (FIG 1), which is based on the R&S®FSV*, because it detects everything in real-time mode. In real-time mode, it seamlessly records RF signals with a bandwidth of 40 MHz in the time domain, converts them into the frequency domain and displays them as a spectrum. To achieve high time resolution and therefore accurate level measurements, even of short-term or pulsed signals, the R&S®FSVR can overlap the time windows for fast Fourier transformation (FFT) by at least 80 percent. Since all the data captured is processed in real time without any gaps, users do not miss even very short signals. The R&S®FSVR is the first analyzer to provide this real-time capability for input frequencies up to 40 GHz, and even up to 110 GHz with external mixers.

* The fastest and most accurate signal analyzer in the medium class. NEWS (2008) No. 197, pp. 18–23.

FIG 1 The R&S®FSVR real-time spectrum analyzer is available in four models up to 7 GHz, 13 GHz, 30 GHz or 40 GHz.

The analyzer digitizes the RF signal with a sampling rate of 100 MHz and converts it into the frequency domain in real time, calculating up to 250000 spectra per second in the process. Since this is too fast for the human eye, the R&S®FSVR combines the measurements in a detector and displays the result on the screen about 30 times per second. This is roughly the refresh rate the human eye is capable of processing. The peak detector ensures that no RF signal in the observed frequency range is lost, and that every signal that occurs during the monitoring period is also displayed.

Since the R&S®FSVR combines several spectra into one trace in this mode, the time resolution is reduced significantly. In order to provide a clear picture of the spectrum variation versus time, the analyzer is equipped with various display and measurement functions.

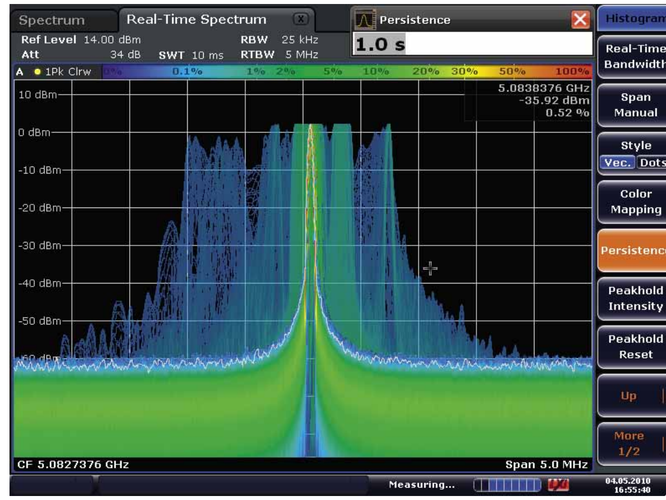


FIG 2 Transient response of a VCO for WLAN applications in persistence mode.

Persistence mode visualizes signal occurrence probability

The persistence mode is an effective means of visualizing ultrashort signals. The R&S®FSVR superimposes the gapless spectra in a diagram. Depending on how often a specific signal with a given amplitude occurs, the R&S®FSVR changes the color of the corresponding pixel on the display. Signals that are continuously present are displayed in red, for example, and extremely infrequent signals are displayed in blue. If specific signals cease to occur, they disappear from the display when the chosen persistence time has elapsed. The persistence mode represents a kind of spectral histogram. It is an unbeatable tool for examining signals that change over time. For example, users are now able to analyze the fast transient response of phase-locked loops (PLL). Gapless visualization of all frequencies and amplitudes that occur, including probability weighting, provides a completely new impression of the system's dynamic behavior in the frequency range. Users can see whether a transmitter makes rapid frequency hops or whether there are significant changes in amplitude for brief periods of time. Effects like these, which can considerably affect the behavior of an entire system, are difficult to detect using sweeping spectrum analyzers.

FIG 3 Superposition of a WLAN and Bluetooth® signal in the ISM band. The persistence mode makes it possible to clearly identify the different signals.

FIG 2 shows a typical measurement. The analyzer captures and displays even very short signals, providing a complete picture of the time variation of the frequencies and amplitudes occurring in the frequency domain. In this display mode, superimposed signals can be separated if they have different frequency level probabilities, which could be due to different modulation types or symbol rates, for example (FIG 3).

Spectrogram function seamlessly records spectra

The persistence mode provides users with new ways of analyzing errors by visualizing the time variation of signals in the frequency domain. To accurately capture this time variation, the R&S®FSVR uses the spectrogram function. It assigns a color to the signal amplitude, allowing the spectrum to be displayed with just a single horizontal line. The spectrogram is created by continuously lining up the horizontal lines next to each other. In real-time mode, it provides a seamless display of the spectrum over time. In this mode, the R&S®FSVR captures and records up to 10000 traces per second and writes them to a ring buffer. Here, too, the analyzer uses a detector to reduce the data for the display. The ring buffer memory depth is sufficient to store up to 100000 traces. Depending on the selected update rate, the R&S®FSVR can measure continuously for a period of up to five hours.

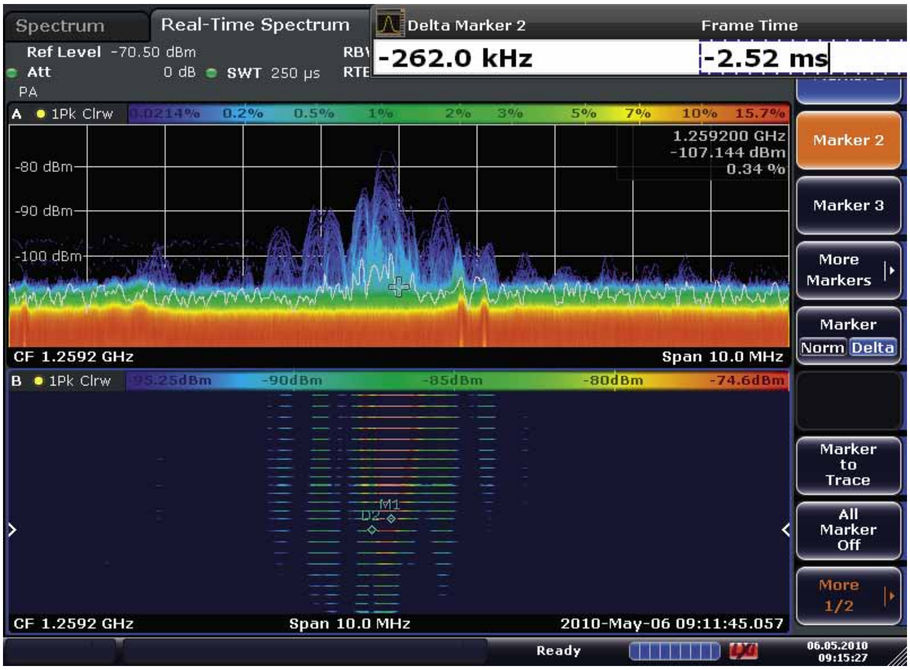


FIG 4 Airport radar signal. The spectrogram shows the pulsed structure of the signal and allows the pulse repetition rate to be measured, in this example 2.5 ms.

To allow completed measurements to be examined in detail, the analyzer provides markers that users can move along the time and frequency axes. This allows the duration of events or time intervals between events, for example, to be measured at a certain frequency (FIG 4), making it easy to seamlessly monitor frequency bands. This is also useful when hunting for sporadically occurring interference signals. The R&S®FSVR is also an invaluable tool for radio transmissions with frequency changes, such as the ones that occur in RFID and Bluetooth® applications, since it tracks frequency hops and characterizes transmitter characteristics. Finding sporadically occurring faults during frequency switching of transmitters or interference sources from digital circuits is easier and significantly faster.

Triggering on events in the signal spectrum

The information that is collected using the spectrogram can subsequently also be used to define a trigger in the spectral range. This frequency mask trigger (FMT) responds to events in the spectrum. The R&S®FSVR evaluates each individual spectrum – up to 250 000 per second – and compares each spectrum with a defined, frequency-dependent mask. If a trace violates this mask, the R&S®FSVR generates a trigger event, displays the current spectrum and provides the recorded data for further processing, for example in a test application. The impact of interference from RF transmitters or frequency changes can be quickly and specifically analyzed. Via a trigger output, other T&M instruments needed to analyze a fault can be triggered on a certain frequency event.

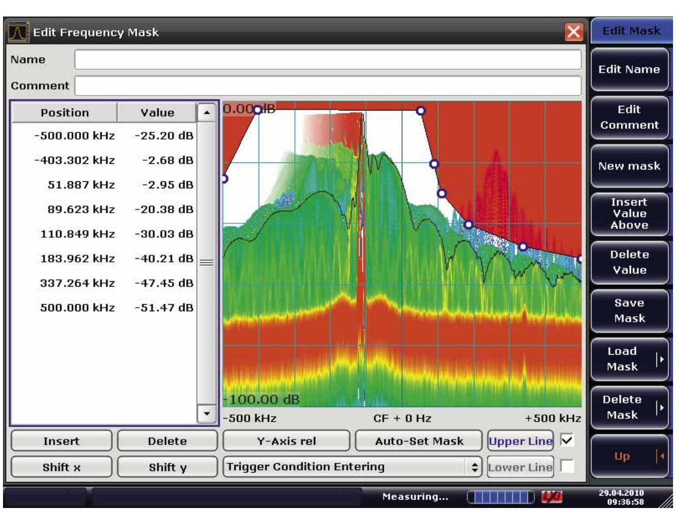


FIG 5 Input window for the limit line of the frequency mask trigger (FMT). The current trace is displayed, and the individual points for the limit line can either be entered manually, moved to the desired position on the screen, or adjusted automatically. Here, the user is triggering on an error signal approximately 400 kHz above the actual signal frequency of a swept source. The error signal is extremely short and would be difficult to detect using a conventional analyzer.

The mask for the spectral trigger can be conveniently defined on the R&S®FSVR touchscreen, but can also be generated automatically. Clearly structured tables and graphics provide users with the means to adapt masks quickly to changing situations. FIG 5 provides an impression of how easy and straightforward it is to operate the instrument. Both an upper and a lower limit line can be defined. The above trigger conditions can be especially useful when the signal being monitored has to remain within a specific tolerance band.

Its 200 Msample I/Q memory depth allows the R&S®FSVR to continuously record spectra over a long period, even at large bandwidths and correspondingly high sampling rates. The signal can be analyzed in more detail during post-processing.

RF characteristics of the R&S®FSVR

- Displayed average noise level (DANL) –155 dBm (1 Hz) at 1 GHz, –147 dBm (1 Hz) at 30 GHz
- DANL with preamplifier: –165 dBm (1 Hz) at 1 GHz, –162 dBm (1 Hz) at 30 GHz
- DANL of only –140 dBm (1 Hz) starting as low as 9 kHz
- Third-order intercept (TOI) typ. +16 dBm (f < 3.6 GHz)
- Phase noise at 10 kHz offset from carrier: –106 dBc (1 Hz), typ. –110 dBc (1 Hz)
- ACLR dynamic range for 3GPP WCDMA: 73 dB
- Resolution bandwidths from 1 Hz to 10 MHz, 20 MHz / 40 MHz in zero span

Full-featured signal and spectrum analyzer

If it is not in the real-time mode, the R&S®FSVR behaves like a sweeping spectrum analyzer or a signal analyzer. It sweeps the selected frequency range (up to 40 GHz, depending on the model) and displays the spectrum. It is extremely fast, with a minimum sweep time of less than one tenth of a second for the full display range. The resolution bandwidths are user-selectable. Unlike in real-time mode, there are no restrictions with regard to the number of FFT points and real-time bandwidth. In addition to sweep filters that have been adjusted for maximum speed, channel filters and filters for wireless communications standards are also available.

Like all Rohde&Schwarz spectrum analyzers, the R&S®FSVR provides numerous special measurement functions as standard. These include adjacent channel power, spectrum emission mask, intermodulation, CCDF and spurious emission measurements. With a level measurement uncertainty of 0.4 dB up to 7 GHz, the R&S®FSVR delivers precise and reliable results. In terms of total measurement uncertainty, it delivers leading performance, just like the R&S®FSV signal and spectrum analyzer. With the R&S®FSV-K9 option, power sensors from the R&S®NRP-Z product range can be connected, eliminating the need for a separate power meter in situations requiring especially high measurement accuracy. The R&S®FSVR offers outstanding RF characteristics for a general-purpose spectrum analyzer (see box).

With more than 1000 sweeps/s in spectrum analysis mode, the R&S®FSVR is up to five times faster than other spectrum and signal analyzers. This fast measurement rate not only speeds up systems during production. It also shortens the measurement time if a large number of measurements have to be averaged, as prescribed by many standards.

In addition to the extensive functionality incorporated as standard, the R&S®FSVR offers options for measuring basic physical characteristics, including phase noise (R&S®FSV-K40), noise figure (R&S®FSV-K30), and the parameters of signals with analog (AM / FM / ΦM) and digital modulation (R&S®FSV-K70).

The R&S®FSVR is not just the right instrument for classic spectrum analysis applications, it is also ideal for verifying compliance with wireless communications standards. It currently supports the following standards:

- GSM / EDGE / EDGE Evolution
- WCDMA
- TD-SCDMA
- CDMA2000®
- 1xEV-DO
- WLAN 802.11 a/b/g/n
- WiMAX™
- LTE (TDD / FDD)

Summary

The R&S®FSVR, a combination of real-time analyzer and full-featured signal and spectrum analyzer, is unique on the market. The comprehensive and easy-to-operate real-time functions provide users with new, powerful analysis facilities. At the same time, they can continue to work with the same signal and spectrum analysis functions with which they are already familiar. The intuitive user interface, which is designed along the same lines as spectrum analyzers, simplifies the use of the instrument and integrates real-time analysis within a cohesive overall design concept.

Dr. Wolfgang Wendler

R&S®RTO: minimized blind time for rapid fault detection and analysis

High acquisition rates and short blind times are just two of the exceptional features of the R&S®RTO digital oscilloscopes. Their speed and performance mean they are capable of finding even the most sporadic faults and of delivering statistically conclusive results quickly and reliably even when complex waveform analyses are applied.

Blind time – digital oscilloscopes' Achilles heel

Users of analog oscilloscopes are accustomed to seeing almost all of signal details on the screen. The glow of the screen's phosphor provides a natural persistence that helps to quickly detect signal faults. By contrast, it takes digital oscilloscopes a long time to display a signal's sample points due to the large quantities of data they capture and process. The processing time they require renders them temporarily blind and unable to continue measuring the signal, which means that they can miss potentially important signal changes that point to a fault in the device under test.

Given the amount of data oscilloscopes have to process, this is hardly surprising: An 8-bit A/D converter sampling at 10 Gsample/s delivers data continuously at a rate of 80 Gbit/s, and scopes have to capture and save this stream in realtime (FIG 1). The sample points stored in the scope also need to be processed, measured and analyzed using a variety of functions before they can be displayed on-screen. This inevitably results in blind time, despite the constant technological advances and improvements in the processing power of digital oscilloscopes such as are used in R&D labs.

FIG 2 shows a typical acquisition cycle for a waveform. It consists of active acquisition time and blind time. During the active acquisition time the oscilloscope acquires the defined number of waveform samples and writes them to the acquisition memory. The length of the acquisition time depends on the number of samples and the selected sample rate. The blind time – the period during which the data is processed and displayed – consists of a fixed time (determined by the system architecture) and a variable time. The variable blind time depends on the number of sample points and the amount of computation involved for the selected processes (interpolation, mathematical operations or measurement and analysis functions, for example). In a final step within the blind time, the oscilloscope renders the waveforms as graphics and displays them on-screen.

The ratio of the active acquisition time to the blind time is an important characteristic of a digital oscilloscope. It can be defined either as the blind time ratio or the waveform acquisition rate:

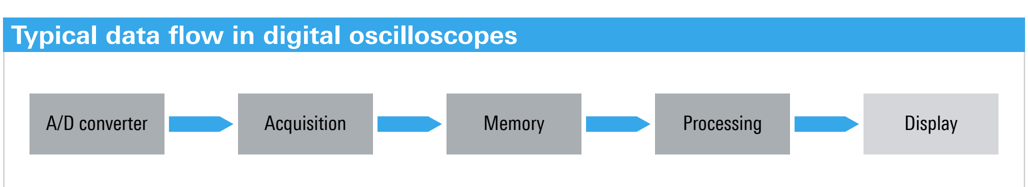


FIG 1 The time digital oscilloscopes need to process the large volumes of data until the waveforms are displayed causes blind time during which they cannot capture potentially important changes in signals.

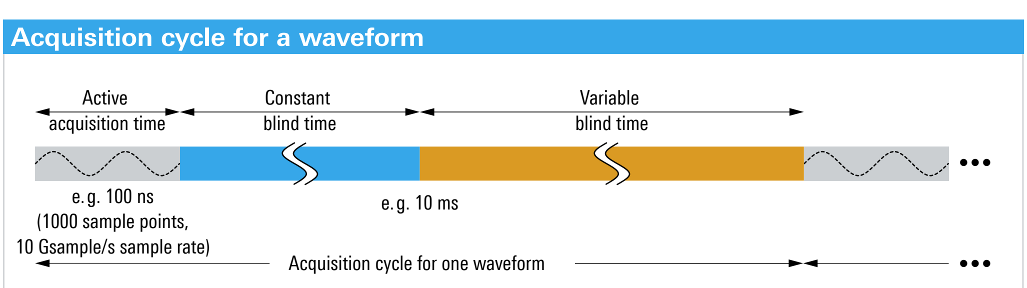


FIG 2 A digital oscilloscope's acquisition cycle consists of active acquisition time and blind time.

$$\text{Blind time ratio} = \frac{\text{blind time}}{\text{acquisition cycle time}}$$

$$\text{Acquisition rate} = \frac{1}{\text{acquisition cycle time}}$$

For example, oscilloscopes with an active acquisition time of 100 ns (1000 samples at a rate of 10 Gsample/s) will typically have a blind time of 10 ms (FIG 2). This means they have an overall acquisition cycle of 10.0001 ms, with 99.999 % blind time, and an acquisition rate of 100 waveforms per second. Because blind times like this are too long for many applications, Rohde&Schwarz built its R&S®RTO oscilloscopes around an architecture designed to minimize blind time.

The goal: high acquisition rate and short blind time

If the parameters of signal faults are known, users can define specific trigger conditions to achieve more precise analysis. If not, they have to choose a standard trigger ("edge", for example) and observe the signal in persistence mode over a longer period of time (FIG 3).

Faced with a typical blind time in excess of 99 %, users depend on signal faults recurring, and the longer the measurement time, the greater the probability that the fault will recur during the active acquisition period. The average measurement time required can be computed using statistical methods. The probability of a fault being detected and displayed depends on the acquisition rate, glitch rate, active acquisition time and measurement time:

$$P = 100 - 100 \times (1 - GlitchRate \times T)^{AcqRate \times t_{\text{measure}}}$$

P	Probability of fault detection [%]
$GlitchRate$	Fault repetition rate [1/s]
T	Active acquisition time or waveform display time (recording length/sample rate, or recording length × resolution, or 10 × time scale per div) [s]
$AcqRate$	Oscilloscope's acquisition rate [waveforms/s]
t_{measure}	Measurement or observation time [s]

FIG 4 shows the probability of fault detection for different acquisition rates with a fault repetition rate of 10/s, a recording length of 1000 sample points and a sample rate of 10 Gsample/s.

The following equation calculates the required measurement time for a specific probability:

$$t_{measure} = \frac{\log\left(1 - \frac{P}{100}\right)}{AcqRate \times \log(1 - GlitchRate \times T)}$$

FIG 5 shows the measurement times required at various acquisition rates for the above example.

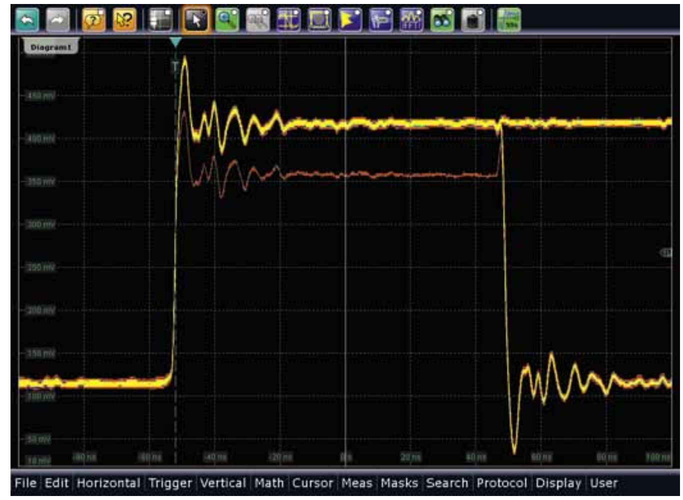


FIG 3 High acquisition rates mean rare signal faults are detected faster. In persistence mode, they are highlighted in color for easy identification.

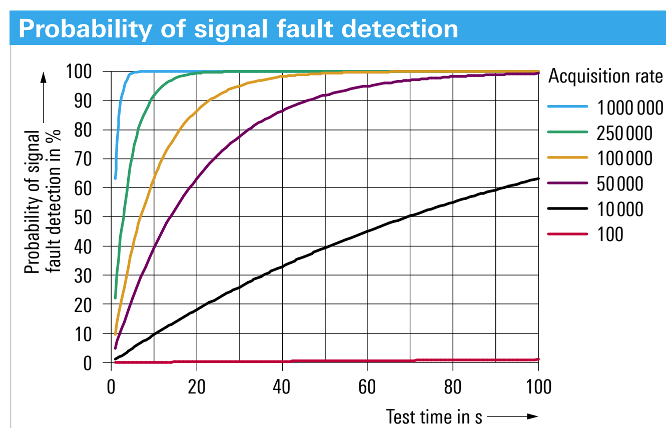


FIG 4 The probability of detecting a signal fault at different acquisition rates (10 faults/s, T = 100 ns; 1 ksample recording length; 10 ns/div.).

FIG 5 Average measurement time required to detect repeating signal faults with 99.9 % probability (T = 100 ns, glitch rate = 10/s).

Acquisition rate (waveforms/s)	Measurement time
100	19 h : 11 min : 08 s
10 000	11 min : 31 s
100 000	1 min : 09 s
1 000 000	7 s

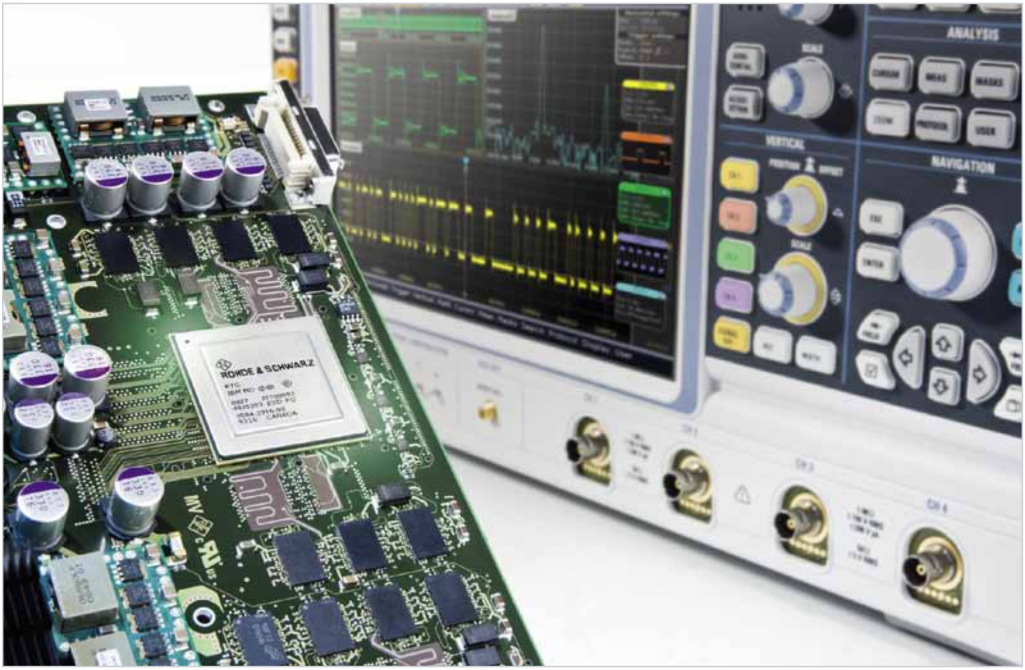


FIG 6 The high-speed ASIC in the R&S®RTO oscilloscopes from Rohde&Schwarz.

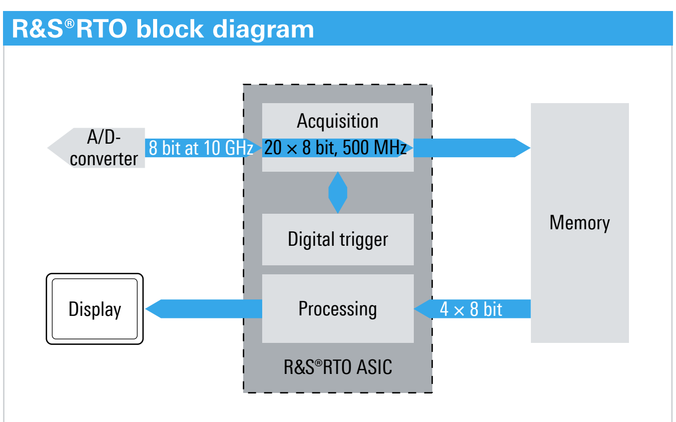


FIG 7 The R&S®RTO oscilloscopes' architecture integrates acquisition and processing functionality in a high-speed ASIC to minimize blind time.

R&S®RTO: one million waveforms per second

Oscilloscopes which are capable of higher acquisition rates, such as the R&S®RTO from Rohde&Schwarz, have the advantage that they can also detect rare signal events (often, the really critical faults) and quickly perform waveform analyses such as histograms or mask tests that return statistically reliable results. The reason: Unlike other oscilloscopes on the market today, the R&S®RTO scopes have most of their measurement and analysis functionality in a highly integrated ASIC (FIG 6). They are capable of running multiple parallel processes, which radically reduces blind time.

The ASIC provides a wide range of processing functionalities used in acquiring data and analyzing waveform samples stored in memory (FIG 7). The ASIC's function block for data acquisition has to pass the data coming from the A/D converter to the acquisition memory in realtime. The acquisition block contains new capabilities, including flexible filter settings and simple math functions such as ADD, SUB and INV, and can simultaneously execute up to three decimation functions (Sample, PeakDetect, HiRes, RMS).

Many of the scopes' analysis functions are implemented directly in hardware in the ASIC processing block. These include waveform interpolation, waveform arithmetic, math functions, and various measurement and analysis functions such as cursors, histograms and masks. The ASIC's impressive feature set also includes high-performance memory controllers, the world's first realtime digital trigger system, and multiple graphics controllers.

This wealth of functionality in a single ASIC is the key to the scopes' industry-leading maximum acquisition rate of one million waveforms per second. Engineered in 90 nm technology, the ASIC has 15 million gates, 1295 pins and is clocked at 500 MHz.

Analysis function	Max. acquisition rate (waveforms/s)
None	> 1000000
Histogram	> 1000000
Mask test	> 600000
Cursor measurement	> 1000000
Zoom	> 500000

FIG 8 Maximum acquisition rates of the R&S®RTO oscilloscopes for various analysis functions.

This is especially evident in mask tests, for example, which are used to verify the quality of a data interface's physical layer. These tests require a large number of waveforms in order to achieve conclusive results. Older scopes with acquisition rates of less than 100 waveforms/s in mask test mode take a long time to complete these tests. The acquisition rate of the R&S®RTO scopes, however, remains exceptionally high because the mask test functionality is implemented in hardware, allowing mask violations to be detected rapidly and reliably (FIG 9).

Rapid results, even with analysis functions

In standard mode, the R&S®RTO oscilloscopes offer high acquisition rates without any limitations. However, short blind times are often particularly important when performing additional measurement and analysis functions. If these functions are implemented in software, blind time is significantly longer, and a scope will take a long time to capture and process the number of waveforms needed to deliver statistically meaningful results. With the R&S®RTO oscilloscopes, such limitations are a thing of the past. Their analysis functions are implemented in hardware, and their ability to execute processes in parallel ensures high acquisition rates, even when sophisticated analysis functions are activated (FIG 8).

Summary

All digital oscilloscopes are temporarily blind. However, the R&S®RTO oscilloscopes' acquisition and processing functionality is implemented in hardware to minimize blind time. This outstanding design offers crucial advantages when it comes to detecting faults, and enables the scopes to deliver statistically reliable measurement results quickly, even when performing complex analysis tasks.

These advantages, in combination with the innovative digital trigger system, high measurement accuracy, low-noise frontends, single-core A/D converter with a sample rate of 10 GHz, and an intuitive user interface make the R&S®RTO oscilloscopes the tool of choice for R&D labs.

Guido Schulze

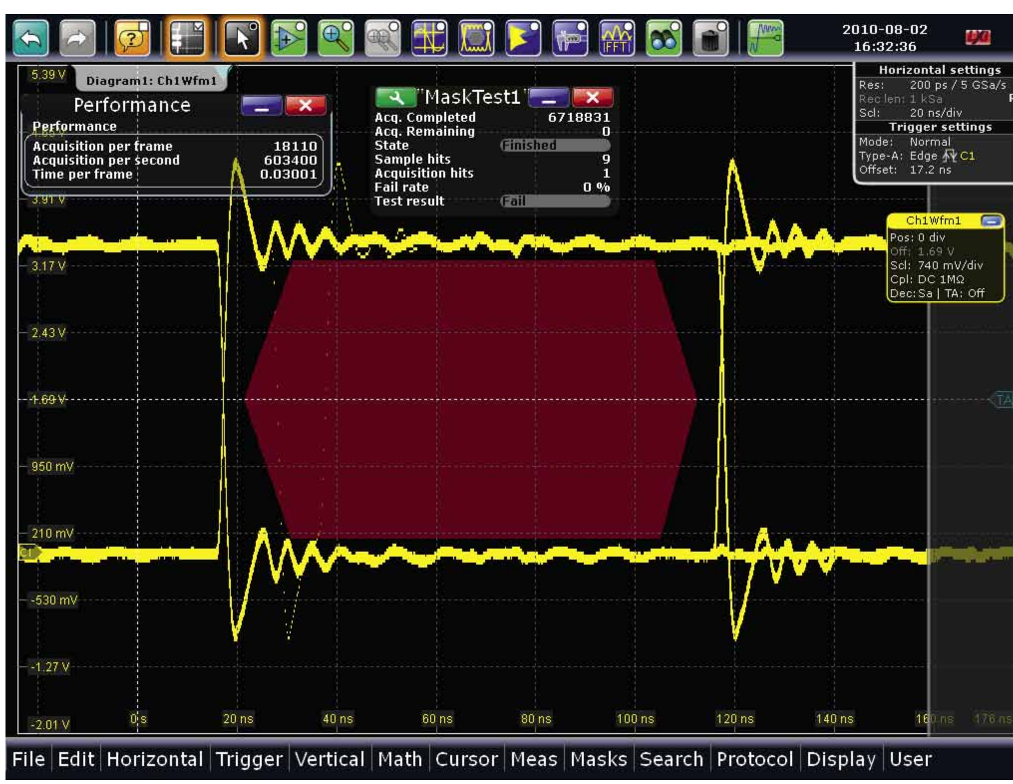


FIG 9 With their maximum acquisition rate of more than 600000 waveforms per second, the R&S®RTO oscilloscopes are the first to enable high-speed mask tests with high statistical reliability.

40 GHz wideband power sensors for universal applications

The new R&S®NRP-Z85 and R&S®NRP-Z86 power sensors measure all relevant power and time parameters of modulated signals at a video bandwidth of 30 MHz and provide average power measurements over a dynamic range of 80 dB. Diode sensors, which were previously available for this frequency range, are outperformed in many aspects.

Not all power sensors are the same

Out of the six sensor technologies available today, three dominate the market. This means that three types of sensors are predominantly used and will continue to be the instruments of choice in the foreseeable future. These are multipath, wideband and thermoelectric sensors. Thermoelectric sensors play a prominent role on account of their high accuracy, which makes them the only current alternative for reference applications and for measurements in the upper microwave range.

For all other applications, diode sensors designed as multipath or wideband sensors provide superior performance. They offer approximately 30 dB higher dynamic range and usually higher measurement speed. They are also able to represent envelope power as a function of time, analyze this statistically, and automatically determine the parameters of interest. While multipath sensors offer a vast dynamic range, wideband sensors such as the new R&S®NRP-Z85 and R&S®NRP-Z86, featuring large video bandwidth and high sampling rates, provide excellent capability when it comes to analyzing modulated signals (FIG 2). Their automatic pulse analysis function measures as many as 13 pulse parameters, including pulse rise and fall time, pulse width and pulse top level, all with a minimum of settings (see box).

What makes the new power sensors special

The R&S®NRP-Z81[1] / -Z85 / -Z86 power sensors are the first wideband sensors in the world that need not be operated together with a specific base unit. Instead, they can be controlled from any PC as well as from other Rohde&Schwarz instruments. Of course, operation is also possible via the sensors' base units, the universal R&S®NRP / R&S®NRP2 power meters. This has been made possible by integrating complete, high-end power meter functionality into the sensors, as well as a USB remote control interface. Consequently, a graphical user interface (GUI) such as the R&S®PowerViewer+ tool, which is available free of charge, is all that is needed at the

FIG 1 The R&S®NRP-Z85 and R&S®NRP-Z86 wideband power sensors. The R&S®NRP-Z85 has a 2.92 mm connector, the R&S®NRP-Z86 a 2.4 mm connector.

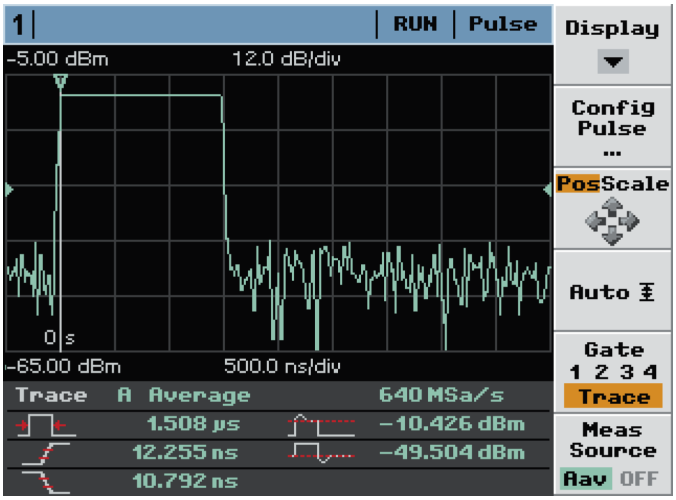


FIG 2 Power envelope of a pulsed microwave signal displayed on the R&S®NRP2 base unit operating in trace mode. The parameter values obtained with automatic pulse analysis[2)] are shown at the bottom.

host end to perform measurements as on a modern digital oscilloscope. In addition, the sensors offer a matchless price/performance ratio and T&M characteristics that clearly surpass commercial standards.

For example, the wide dynamic range yields a lower limit of –47 dBm for envelope power and –60 dBm for average power measurements. With a sensitivity that is 12 dB higher for envelope power and 25 dB higher for average power, the sensors outperform competitor products. Users will benefit from improved reproducibility, higher measurement speed and higher resolution in the graphical power envelope display.

The statistical characteristics of a power envelope are of ever increasing importance in analyzing modern communications signals. Here, the R&S®NRP-Z81 / -Z85 / -Z86 sensors are in a league of their own – since the entire signal processing takes place in realtime, acquisition times are extremely short. Creating a complementary cumulative distribution function (CCDF) from one million samples takes less than 25 ms, which is many times faster than usual in the market. Analysis can be performed in free-run / continuous or triggered mode with user-definable gates.

Internal or external triggering can be used for statistical analysis and envelope power measurement versus time. A digital trigger signal can be output simultaneously with the internal trigger event to synchronize other measurements, for example to trigger other R&S®NRP sensors via the R&S®NRP-Z5 USB sensor hub. This can be used to create a common timebase for signal analysis or to acquire signals from which it is difficult to extract an internal trigger signal.

High-resolution automatic pulse analysis

During **automatic pulse analysis**, a power meter – or an integrated R&S®NRP-Z81 / -Z85 / -Z86 power sensor, for example – analyzes the key time and power characteristics of a pulsed test signal largely automatically. Automatic analysis offers a tremendous speed advantage over manual measurements using cursors or markers and is less error-prone. In the series production of microwave components, where the shape of the power envelope is known and need not be measured for each item under test, only pulse parameters are of interest.

The initial step in performing automatic pulse analysis with an R&S®NRP-Z81 / -Z85 / -Z86 sensor is to determine a representative pulse top level value. The Rohde&Schwarz wideband sensors provide three common methods to determine this value, which considerably expands the sensors' application range. These methods are histogram-based, derived from pulse energy, and identical to absolute peak power. The histogram method is the most common approach. Deriving the value from pulse energy yields results such as those obtained with a thermal power sensor with pulse duty cycle correction. Absolute peak power is the method of choice for measuring pulses with a round top.

A **high-resolution mode** is available for repetitive signals. This involves sampling a series of consecutive waveforms of a pulsed signal. The measurements are time-shifted relative to one another, yielding a compacted sequence of samples, which over time are combined into a complete waveform. This method is referred to as equivalent time sampling. By performing linear interpolation between the samples, a time resolution in the range of 100 ps can be achieved at very low trigger jitter.

Further unique features of the new sensors include the embedding of upstream components in the form of their S-parameter data, gamma correction for enhanced measurement accuracy, and fixed-noise averaging. This type of averaging involves automatic calculation of the averaging factor required for a defined noise component in measured average power values.

All these performance features combine to make the new power sensors a safe investment for those requiring to determine the precise time characteristics and average power of microwave signals – in service and maintenance, production, R&D or product development

Thomas Reichel

1) The R&S®NRP-Z81 wideband sensor, an 18 GHz version with an N connector, was successfully launched three years ago (see article "R&S®NRP-Z81 Wideband Power Sensor: State-of-the-art technology for wireless digital communications". News from Rohde&Schwarz (2007) No. 192, pp. 33–37).
2) The R&S®NRP2 will support color display and automatic pulse analysis as of the first quarter of 2011.

Modules with terminated RF relays for the R&S®OSP switch and control platform

New modules featuring terminated RF relays expand the application range of the R&S®OSP open switch and control platform. The relays terminate open contacts with built-in 50 Ω resistors to reduce frequency-dependent reflections in otherwise unterminated RF cables – a precondition for reliable measurement results.

Termination ensures defined RF operating conditions

Open, unused paths in an interconnection of several RF devices, e.g. in test systems, can cause inputs of amplifiers or connectors of splitters, combiners or couplers to remain open. This produces undesirable effects. Open inputs of amplifiers without protective circuits can lead to oscillation or may cause undefined states at the output. Open inputs of splitters, combiners or directional couplers cause reflections – i.e. superposition of the useful signal and the reflected wave – which influences the parameters of other connectors.

Reflections are avoided by terminating RF circuits properly according to wave impedance. This is accomplished in the active path of an RF circuit through the use of 50 Ω cables and the 50 Ω impedance of the measuring instruments. Terminated RF changeover relays are used to prevent any paths from remaining open if the wiring of components in an RF system is changed. These relays are equipped with internal resistors that can terminate open paths into 50 Ω (FIG 1).

Basic architecture of terminated relays

With terminated relays, the open contact is switched to ground via an internal 50 Ω resistor. FIG 2 shows the basic technical implementation of a terminated changeover relay as well as an alternate circuit containing unterminated changeover relays. The alternate circuit may be required if the power exceeds the magnitude that the relay's built-in resistor can handle; in this case, suitable external resistors have to be used. Terminated multiposition relays have a similar architecture.

The R&S®OSP open switch and control platform was first presented in News from Rohde&Schwarz (2008) No. 195, pp. 28–31. Another article appeared in NEWS (2008) No. 197, pp. 27–29, describing the new R&S®OSP130 base unit with integrated display (shown below) and the expanded range of modules.

Example of signal distribution

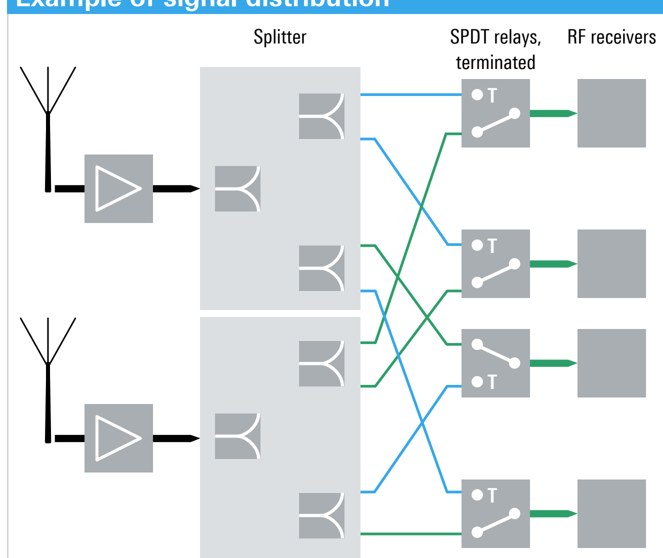


FIG 1 Distribution of two antenna signals to four receivers via splitters. When switching, terminated RF changeover relays use their built-in 50 Ω resistors (blue) to terminate non-active RF paths.

SPDT relay concept

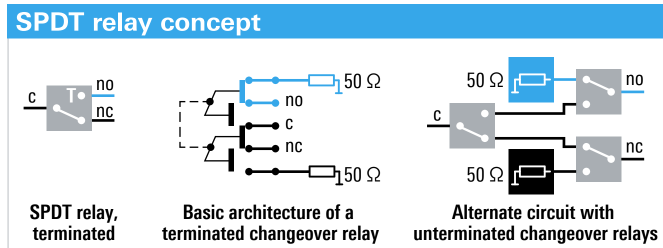


FIG 2 Basic wiring of terminated changeover relays (SPDT).

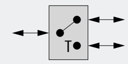
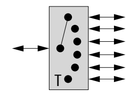
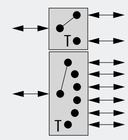
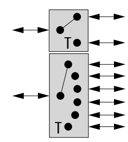
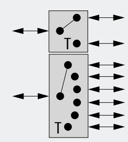
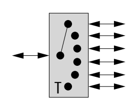
Connectors	Module	Symbol	Features
	**R&S®OSP-B121 RF switch module** (1515.5504.02)		3 × RF changeover relay (SPDT), 0 Hz to 18 GHz, terminated
	**R&S®OSP-B122 RF switch module** (1515.5510.02)		1 × RF multiposition relay (SP6T), 0 Hz to 18 GHz, terminated
	**R&S®OSP-B123 RF switch module** (1515.5527.02)		6 × RF changeover relay (SPDT), 1 × RF multiposition relay (SP6T), 0 Hz to 18 GHz, terminated
	**R&S®OSP-B124 RF switch module** (1515.5533.02)		3 × RF changeover relay (SPDT), 2 × RF multiposition relay (SP6T), 0 Hz to 18 GHz, terminated
	**R&S®OSP-B125 RF switch module** (1515.5540.02)		6 × RF changeover relay (SPDT), 3 × RF multiposition relay (SP6T), 0 Hz to 18 GHz, terminated
	**R&S®OSP-B126 RF switch module** (1515.5556.02)		3 × RF multiposition relay (SP6T), 0 Hz to 18 GHz, terminated

FIG 3 Overview of new modules for the R&S®OSP open switch and control platform.

Overview of R&S®OSP modules

Among the new modules with terminated coaxial relays (FIG 3) for the R&S®OSP open switch and control platform are the two base modules: the R&S®OSP-B121, with three RF changeover relays (single pole double throw: SPDT), and the R&S®OSP-B122, with one multiposition RF switch (single pole six throw: SP6T).

The relays are monostable, i.e. they return to the starting position if there is no control voltage. In the case of SPDT relays, this is connection c and nc (normally closed); with SP6T relays, however, all six contacts are open and terminated. This feature can be used, for example, to ensure defined states during a power failure or at system startup.

Due to the increased volume of terminated relays, the packing density of the modules is lower as compared with unterminated relays. As a result, a standard module contains only three terminated SPDT relays instead of six unterminated relays or only one terminated SP6T relay instead of two unterminated relays. To accommodate as many relays as possible in the R&S®OSP, mixed modules with terminated SPDT and SP6T relays are offered.

Summary

The addition of terminated relays to the range of available switch modules for the R&S®OSP switch and control platform opens up new applications and simplifies the implementation of switching matrices. A further expansion of the range of modules is in the pipeline.

Gert Heuer

A more detailed version of this article including an overview of all modules is available as a PDF file at **http://www.newsmag.rohde-schwarz.com**

Monitoring digital TV signal quality – straightforward and economical

The new R&S®DVMS1 and R&S®DVMS4 DTV monitoring systems keep track of the quality of digital TV signals – they detect all relevant errors at the RF and transport stream levels. They provide parallel monitoring of up to four signals and carry out in-depth signal analysis. These capabilities combine with an ultra-compact size of just one height unit and an attractive price, which makes the systems unique on the market.

Adaptable to numerous applications

The R&S®DVMS1 and R&S®DVMS4 DTV monitoring systems (FIG 1) can be equipped as required with signal inputs and with measurement and analysis functions. Receiver modules for DVB-T/-H and DVB-S/-S2 are available. At the transport stream (TS) level, the systems monitor and analyze DVB, ATSC and ISDB-T/-T_B specific characteristic.

The R&S®DVMS4 has four TS interfaces and can accommodate four RF modules. The system can monitor the RF and transport stream characteristics of up to four signals simultaneously. The signal inputs can be connected to the four monitoring units as required via the graphical user interface (GUI). Extensive signal analysis can be performed simultaneously with signal monitoring. This makes the R&S®DVMS4 ideal for monitoring multiple transmitters installed at one site, and/or monitoring signals fed in via satellite, as well as for use at headends.

The R&S®DVMS1 offers space for one RF module. Simultaneously with the RF signal, it can monitor one TS signal, which is applied via a separate connector on the RF module (FIGs 2 and 3). This makes the system a good choice for applications requiring the simultaneous monitoring of the TS signal fed to and the RF signal emitted by the transmitter in single-transmitter broadcast stations.

All relevant errors are detected immediately

The R&S®DVMS1 and the R&S®DVMS4 monitor more than 100 characteristics of each signal continuously. Monitored RF characteristics include, for example, the level, frequency offset, MER and BER. The transport stream characteristics are verified in accordance with TR 101 290 (priorities 1, 2 and 3). Characteristics relating to program services are also monitored, for example the data rate of each PID, the availability of EIT tables / EPG data, the names of the individual services, as well as the availability of auxiliary services such as subtitles, teletext or additional audio signals. For each monitored signal, detailed information about the transport stream configuration and its characteristics can be stored in the system in the form of a template.

FIG 1 The R&S®DVMS1 and R&S®DVMS4 DTV monitoring systems can be equipped with signal inputs as well as measurement and analysis functions to meet user requirements.

The systems log any deviations from defined limits or templates, display them on the GUI with colored symbols, and, if necessary, report them to a central station via SNMP traps. This makes it possible to immediately identify signal failures and faults and take remedial action quickly so that downtimes can be kept to a minimum.

Simultaneous signal analysis and visualization

Additional analysis and viewing functions provide a good overview of the broadcast contents and enable detailed signal analysis to identify errors, for example. The thumbnail view displays all the programs carried in a transport stream in the form of small decoded images together with additional information (FIG 4). For the EPG view, the data of all EIT tables (actual and other) contained in a transport stream is processed to yield a tabular EPG representation. Details about individual broadcasts can be displayed by clicking the table cell of interest. This representation makes it easy to check EPG content, completeness and consistency. Moreover, the R&S®DVMS systems determine data rates, table repetition rates and PCR characteristics, and verify compliance with buffering requirements for video and audio elementary streams. They even perform complete, in-depth analysis of data carousels and object carousels.

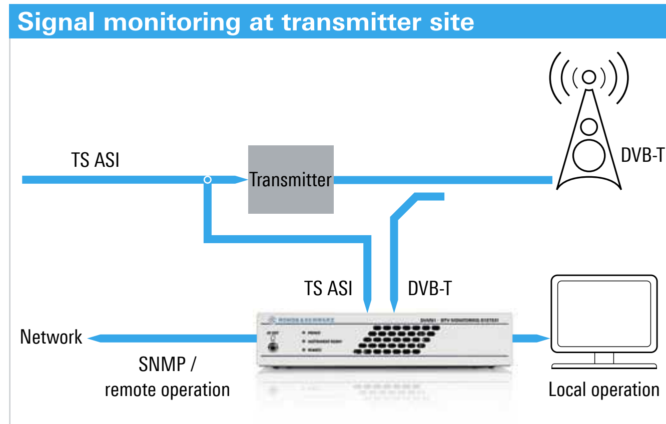


FIG 2 Transmitter monitoring with the R&S®DVMS1 DTV monitoring system.

FIG 3 Rear panel of the R&S®DVMS1 with DVB-T/-H receiver module (RF input and TS input/output).

FIG 4 The thumbnail view displays all the programs carried in a transport stream in the form of small decoded images together with additional information.

Simple and straightforward operation and configuration

All settings are made in three windows with separate content which are accessed via buttons at the top right of the GUI (FIG 5). The monitoring configuration window is used to make all settings relevant to monitoring. This includes the definition of limits and templates, the classification of measurements, and the deactivation of individual measurements where necessary. The input configuration window is used to make all signal-input-specific settings. This includes, for example, the input signal frequency and the monitoring configuration to be used for the selected input. The remaining settings are made in the instrument configuration window. These include, for example, the IP address, SNMP characteristics, authorization levels of individual instrument users and display options. The clear structure of the GUI and fast access to the various settings help to simplify operation and minimize the time needed to start working with the instrument. The signal input and individual TS elements are selected with a mouseclick from the left-hand section in the GUI. The different measurement views are accessed via the view selector (FIG 6). Each view is categorized, labeled and marked with an icon for quick and easy access.

Comprehensive overview even with many monitoring points

The instruments of the R&S®DVMS family have a powerful SNMP interface for easy integration into centralized network management software. For broadcast applications, Rohde & Schwarz offers the R&S®TS4570 broadcast network monitoring and control software. Any instruments with an SNMP interface can be integrated. Functions are implemented as required for the specific application – by the user or by Rohde & Schwarz.

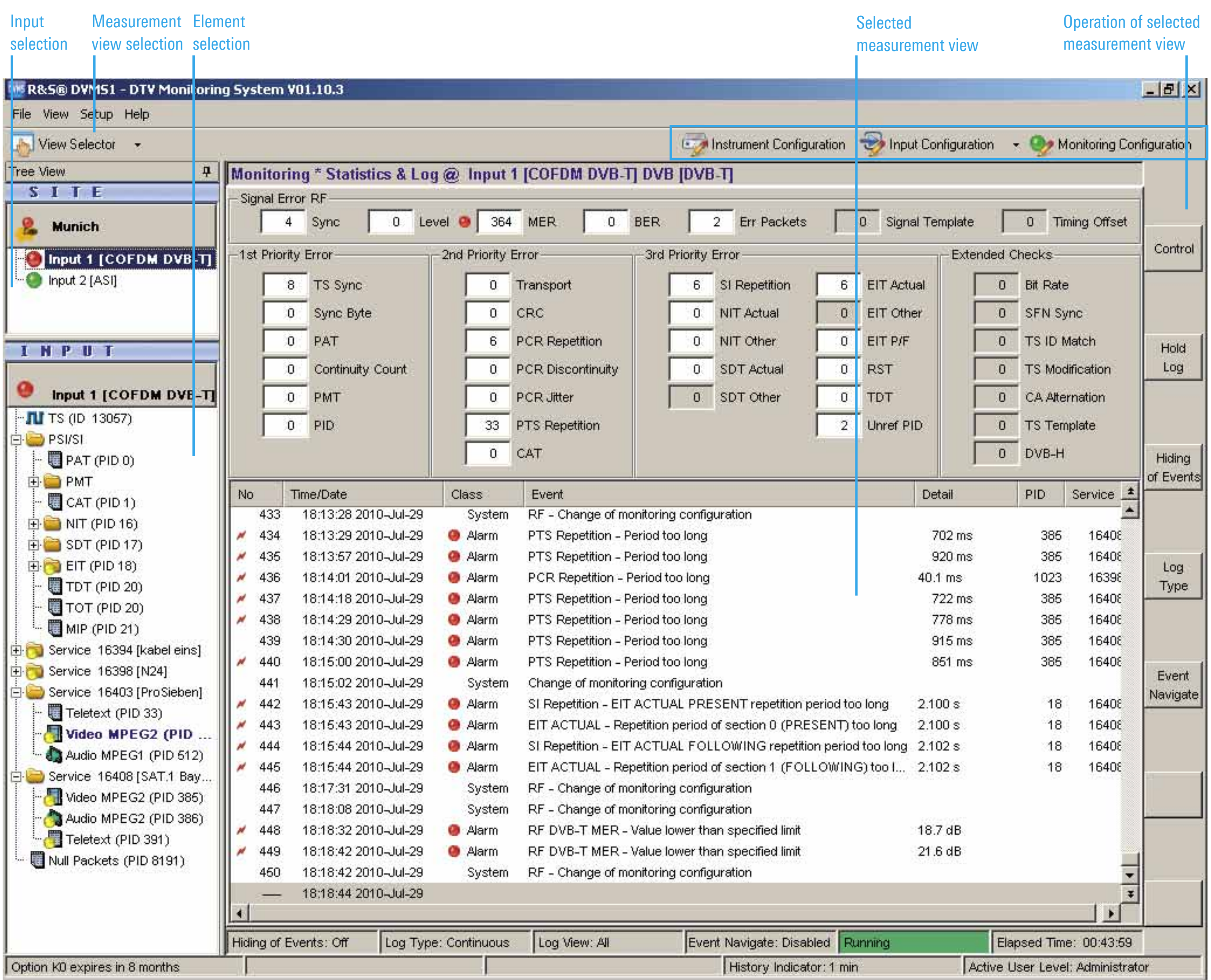


FIG 5 Graphical user interface (GUI) of the R&S®DVMS DTV monitoring systems.

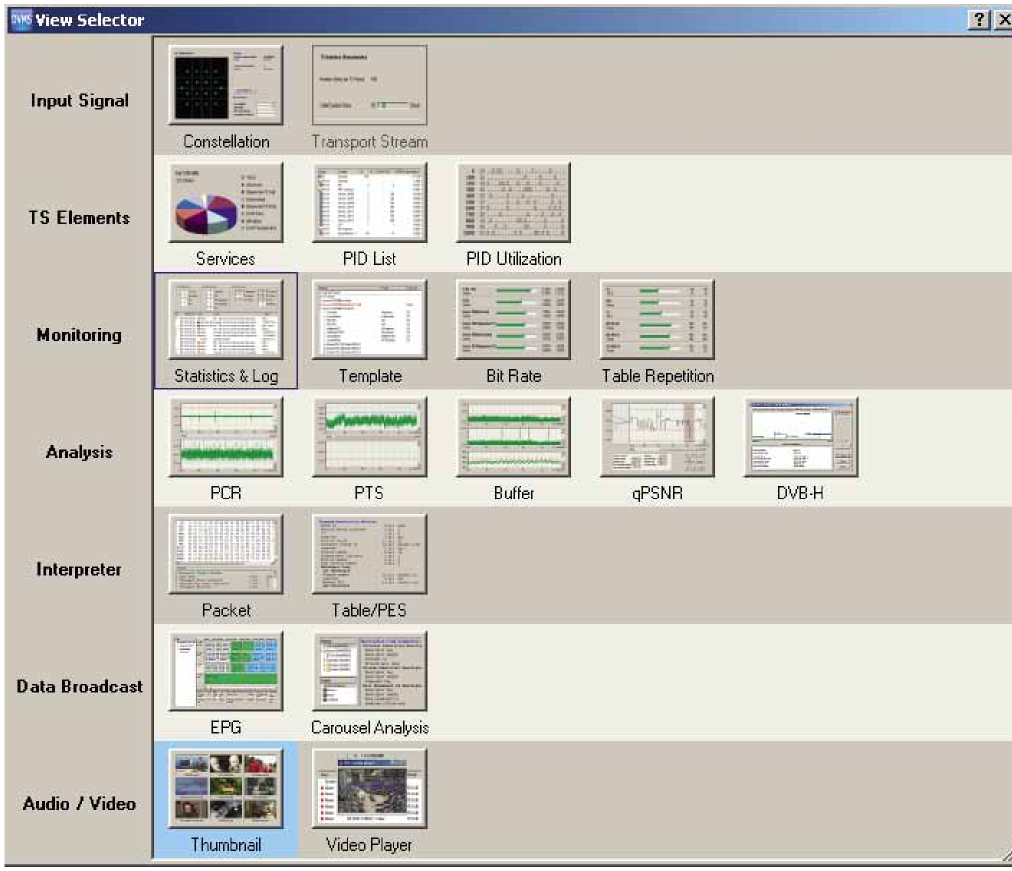


FIG 6 View selector.

If only instruments from the R&S®DVM or R&S®DVMS families need to be combined in one view, the R&S®DTV monitoring manager software is a good choice (FIG 7). The software provides a centralized display of the monitoring results from all instruments deployed. The GUI of any desired instrument can easily be accessed by clicking the corresponding icon. To integrate the measuring instruments into the software, only their IP address must be known. No other settings or SNMP knowledge are required.

Summary and future developments

The R&S®DVMS1 and R&S®DVMS4 DTV monitoring systems represent new developments, and their combined features are unrivaled in the market. They enable simultaneous monitoring of the quality of up to four digital TV signals at an attractive price. They detect all relevant errors at the RF and transport stream levels and occupy only one height unit of space. Detailed analysis functions allow in-depth signal analysis in parallel with signal monitoring. At the transport stream level, the instruments support the monitoring and analysis of DVB, ATSC and ISDB-T/-T_B specific characteristics. Interfaces are currently available for DVB-T/-H and DVB-S/-S2 and are under development for DVB-T2 and Gigabit Ethernet IP.

Thomas Tobergte

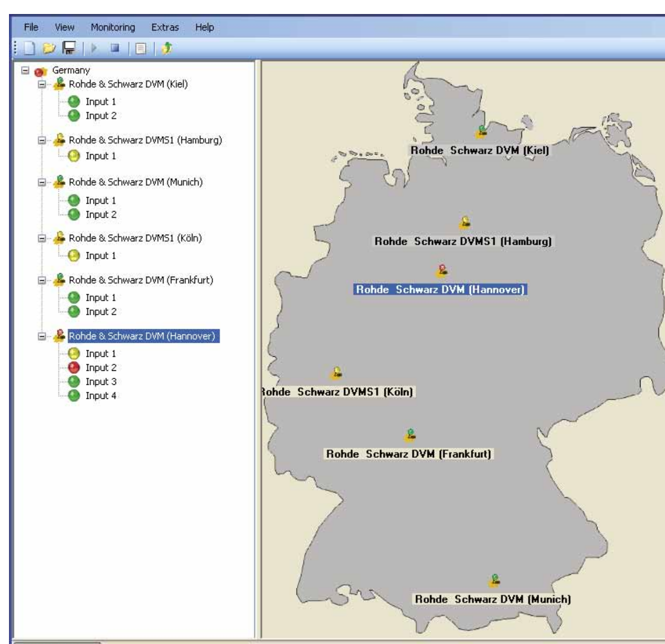


FIG 7 R&S®DTV monitoring manager.

Analyzing DVB-T2 signals in realtime

The DVB-T2 digital standard for the terrestrial transmission of TV signals uses new, complex, second-generation modulation and error protection methods that meet the demand for higher transmission capacity. These are accompanied by new test methods that are provided by the R&S®ETL TV analyzer with its new options for analyzing DVB-T2 signals in realtime. The R&S®ETL performs all of the measurements that are needed to install and operate DVB-T2 transmitters.

Realtime analysis – a must for second-generation terrestrial TV signals

The special quality about second-generation terrestrial TV transmission methods is that they can combine digital content for stationary and mobile devices in just one channel and also provide appropriate error protection. Physical layer pipes (PLPs) that can each carry a transport stream have been defined for DVB-T2. A DVB-T2 transmission can be performed in single-PLP or multi-PLP mode. Simple examination of the signal level and the modulation error ratio (MER) is no longer sufficient for assessing the quality of such complex DVB-T2 signals.

The R&S®ETL TV analyzer demodulates and analyzes DVB-T2 signals in realtime using its new R&S®ETL-K340 option. This makes it possible not only to record brief interference on the basis of a detailed bit error ratio measurement but also to perform additional analyses on a demodulated PLP at the ASI output of the analyzer.

The new option can be installed on any R&S®ETL equipped with the new R&S®ETL-B300 FPGA extension board. Due to its investment-protecting instrument concept, any R&S®ETL TV analyzer that is already being used for DVB-T can be easily upgraded for DVB-T2.

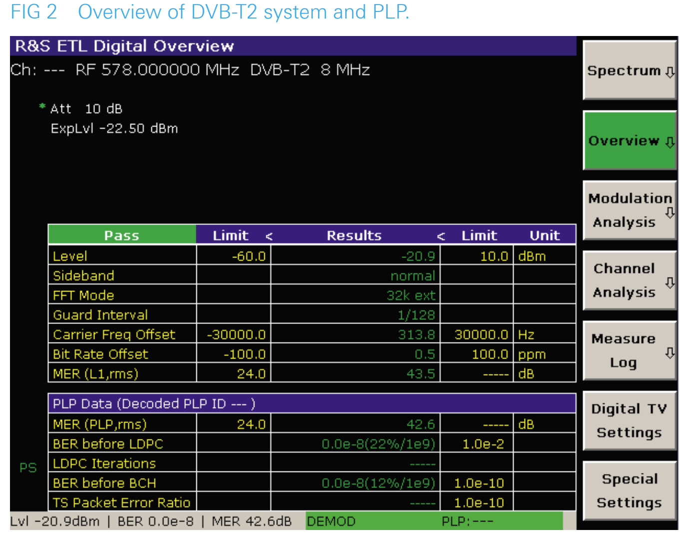
Straightforward presentation of complex signaling

Complex, hierarchically structured signaling has been defined for reliable synchronization on a DVB-T2 signal and reliable demodulation of one or more PLPs. An overview of L1 pre-signaling (FIG 1) provides information about the selected parameters of the transmission system, e.g. the duration of the guard interval, the pilot signal sequence and the L1 post-signaling modulation. The modulation of the L1 post-signaling is presented in an additional overview. The information listed there is used to demodulate a PLP. In future it will be possible to select a specific PLP for demodulation when using the multi-PLP mode.

The "Overview" window provides a compact overview of the measurement values of the transmission system and those of a demodulated PLP (FIG 2). In this way, the user can obtain an impression of the quality of a DVB-T2 signal in just a few steps – both after putting a transmitter into operation or within the scope of regular maintenance.

FIG 1 Overview of L1 pre-signaling.

FIG 2 Overview of DVB-T2 system and PLP.



Unique constellation analysis

Normally it is sufficient to view the constellation of a demodulated PLP (FIG 3) in order to make sure that transmission is functioning properly. But what should be done if an error occurs? In this case, the R&S®ETL provides a unique constellation analysis. Constellations of individual signal components can be selected for a specific analysis using a selection box. A block diagram makes selection easier and shows the demodulator location where the constellation is currently being tapped (FIG 4). If the rotated constellation capability provided by DVB-T2 is employed, the analyzer can be used to check whether the Q components in the modulator are being delayed correctly (FIG 5).

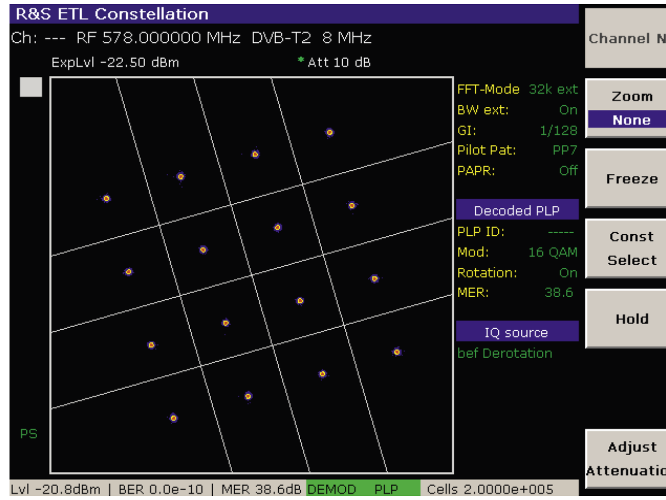


FIG 3 Rotated constellation.

Measurements for transmitter and network optimization

Of course, the R&S®ETL TV analyzer also provides additional measurements for optimizing transmitter settings for DVB-T2 in the customary way. This means that the quality of precorrection can be checked by measuring the characteristics of the amplitude and the group delay. For stationary measurements within single-frequency networks, the echo pattern measurement in SISO mode is available. This measurement shows the delays of all involved transmitters in graphical and tabular form with utmost precision. The echo pattern measurement in MISO mode is in the pipeline.

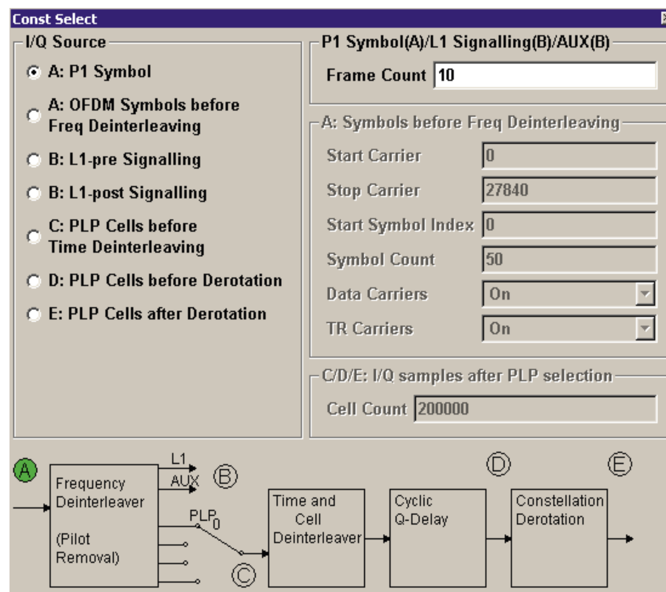


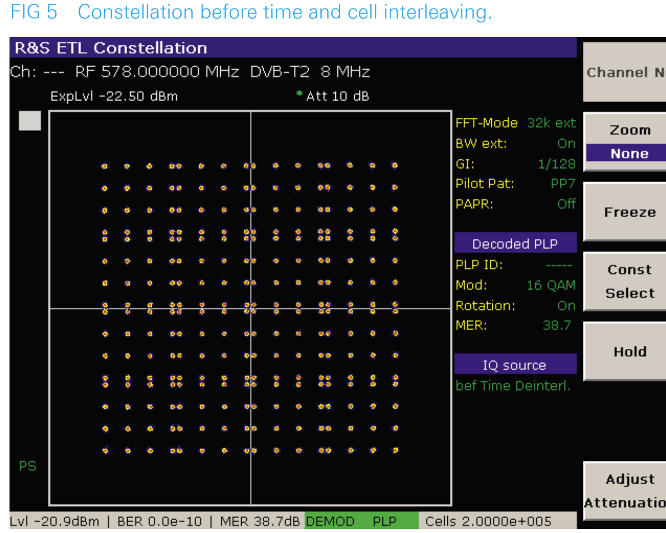
FIG 4 Constellation selection.

Summary

Both at the transmitter and in the coverage area, the R&S®ETL TV analyzer with its new options for DVB-T2 reliably supports transmitter network operators who are making the transition into a new era of terrestrial transmission of digital TV signals.

Werner Dürport

FIG 5 Constellation before time and cell interleaving.



Multiplexer assures smooth start in ATSC Mobile DTV

The R&S®AEM100 ATSC-M/H emission multiplexer is a key component for ATSC Mobile DTV (MDTV). Thanks to its compact size, it is ideal for network operators who want to expand their ATSC networks quickly and easily for the new mobile services, or set up new networks. It provides the entire functionality specified in the A/153 standard.

Complete program for ATSC Mobile DTV

Rohde&Schwarz was significantly involved in the development of the ATSC Mobile DTV standard (MDTV – A/153), and its portfolio for the standard has been available on the North American market for more than a year now. The portfolio includes encoders (R&S®AVE264), multiplexers (R&S®AEM100), TV transmitters (e.g. R&S®NV8600), exciters (R&S®SX800), test equipment (R&S®ETL) and signal generators (R&S®SFU).

The new R&S®AEM100 ATSC-M/H emission multiplexer (FIG 1) is the core of the MDTV transmission chain. It processes the regular ATSC transport stream, adds new mobile services to it, and then passes it along to the transmitter. Its standard interfaces and protocols make it a good team player: It works well with many encoders, transmitters and additional data management systems from other manufacturers, is exceptionally easy to integrate into existing systems, and is ideal for use in frequency-efficient single-frequency networks (SFN).

Web-based, easy operation

Thanks to the intuitive and straightforward graphical user interface, users can immediately configure, operate and monitor the R&S®AEM100. Example of a status page (FIG 2): The main pages can be accessed via the navigation tree ❶, via classic linking within the pages ❷, and via symbols ❸.

Signal colors and symbols provide an overview of the data flow and the status of the individual inputs and outputs. Green components signify that everything is running smoothly. Yellow (warning) and red (error) components indicate a problem.

Another main page is the configuration management page (FIG 3) which displays key parameters such as configuration name, number of parades and services, and (live) data rates. The concept of simultaneously displaying the current configuration and the next configuration on a single page is consistently used throughout. Changes are made in the next configuration and can be activated to become the current setting either "Now" or at the date and time set in the "Timer".

The services and parades are displayed on two separate pages in straightforward sliders. The individual services (FIG 4) are symbolized by miniature logos which can be used by the electronic service guide (ESG). The parade slider is similarly structured (FIG 5). Instead of logos, it displays the parade's current level of use, whether the parade consists of one or two ensembles, and what error correction is used. On both pages, the user can select an element in order to obtain more detailed information and make changes. The R&S®AEM100 can be controlled and monitored both locally and remotely.

FIG 1 The R&S®AEM100 ATSC-M/H emission multiplexer.

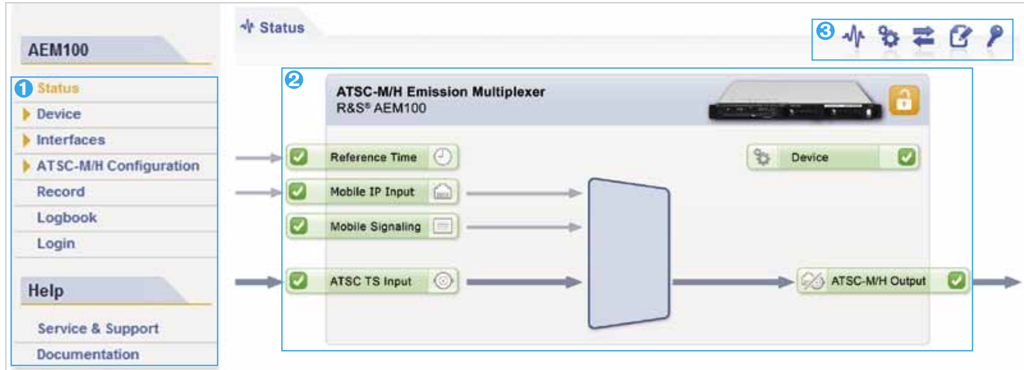


FIG 2 The status page in the R&S®AEM100 user interface: Main pages can be reached via the navigation tree ❶, via classic linking within the pages ❷ and via symbols ❸.

FIG 3 Configuration management is where all key parameters are set.

FIG 4 Services slider. The service type is identified by the miniature logo on the upper left. Modified services are highlighted in orange.

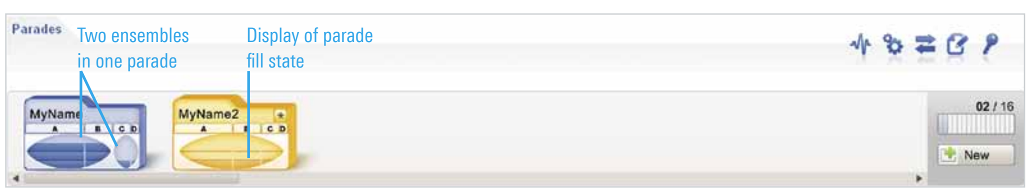


FIG 5 Parades slider. The football-shaped forms in the parade slider symbolize the ensembles.

Device cloning for easy and fast configuration of other multiplexers

This feature is used to quickly set up new instruments in the network and to verify new configurations in the test system. It is the fastest way to get redundancy instruments up and running, because the entire setup procedure does not have to be repeated for each instrument. The R&S®AEM100 instrument settings, MDTV configurations and software version are stored on an R&S®AEM100I license hardlock (USB dongle) and can be easily and quickly transmitted from one instrument to another – fully automatically in the background and without explicit synchronization. If the dongle is plugged into a second R&S®AEM100, then either the dongle's license can be used to work in the normal operating mode, or the information stored on the dongle can be transferred from the first multiplexer to this instrument.

An employee prepares the dongle as necessary and sends it to the new multiplexer site where it is simply plugged into the instrument which then takes control of the configuration and settings. This saves money and time, and prevents potential errors.

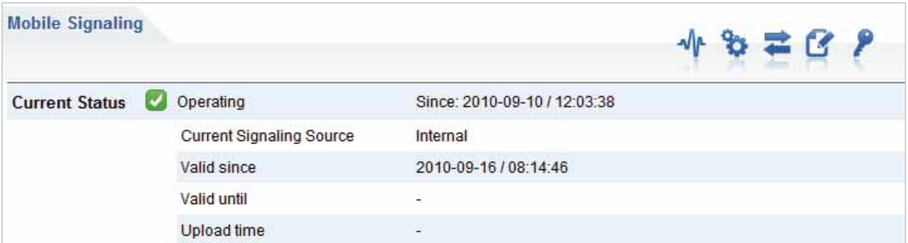


FIG 6 Signaling control and monitoring: The user has the choice of an internal signaling generator, an external source or the auto mode, which switches to the internal mode when the external source is no longer available.

Open interfaces and common protocols

Since the multiplexer is a central connection point in the MDTV system, its interfaces are based on standardized protocols and are open to other components.

Interfaces for easy integration

The R&S®AEM100 has two different physical interfaces for connecting to the upstream ATSC multiplexer and the downstream transmitters:

- Asynchronous serial interfaces (ASI, input and output) and
- Ethernet interfaces (output).

Standard protocols help ensure interoperability

The multiplexer operates with open, frequently used protocols for easy cooperation with other instruments in the playout center:

- Three variations of TS over IP for transmission of the transport stream to the transmitter
  - **UDP/IP:** The transport stream packets are packed one directly after another into a UDP/IP packet and then sent to an IP address (multicast or unicast) and a UDP port.
  - **RTP/UDP/IP:** Adds an RTP header to the UDP/IP packet. The header contains supplementary information such as time stamps and sequence numbers which make it possible to detect lost UDP/IP packets and to return out-of-sequence packets to the correct sequence.
  - **Pro-MPEG FEC:** This protocol is based on the above protocol, but adds the capability to detect, correct and recreate both bit errors within packets and RTP/UDP/IP packets that are completely missing
- HTTP/HTML/Javascript for the user interface

The commonly used hypertext transfer protocol (HTTP), together with HTML and Javascript, is used for the user interface. This ensures short response times and allows the interface to be called up on almost any instrument with a web browser.

- SNMP for remote control

All parameters visible over the user interface can also be queried or set using the simple network management protocol (SNMP).

- Multicast protocols for linking mobile (additional) data

The A/153 MDTV standard specifies that the ATSC-M/H data stream must provide audio/video data via RTP/UDP/IP protocol, and additional data (ESG, datacasting, etc.) via UDP/IP protocol. This additional data is becoming increasingly significant. The use of interactive ESG functionality such as advertising banners, voting, and video on demand is steadily increasing. Consistent implementation of these interfaces in the R&S®AEM100 means the instrument can work with all commercially available A/V encoders and ESG generators that use these protocols.

- NTP for time synchronization

The R&S®AEM100 uses the network time protocol (NTP) for time synchronization, thereby providing users with a favorably priced alternative for distributing the GPS signal even beyond the local site. Time synchronization is essential for the ATSC time described in the standard and for the operation of SFNs.

- XML over HTTP for signaling

In cooperation with Triveni Digital Inc., one of the leading suppliers of metadata management systems, Rohde&Schwarz has implemented an interface for external signaling in the R&S®AEM100 ATSC-M/H (FIG 6). The interface uses the XML-over-HTTP format to exchange signaling data. The data is transmitted from the ESG source (GuideBuilder™ from Triveni Digital Inc.) to the MDTV multiplexer. The multiplexer then cyclically outputs the data in a carousel fashion until the data is replaced or is no longer valid. The interface and its specification are open, and other major manufacturers have already implemented the interface in their equipment.

Summary

The R&S®AEM100 ATSC-M/H emission multiplexer provides network operators with a module that fits extremely well in their existing network structure and whose simple operation allows them to quickly get started with this mobile entertainment standard.

Claudia Görig; Denis Hagemeier

R&S®SCx8000 compact transmitter family: now also for VHF and L band

New transmitters for VHF and the L band have been added to the R&S®SCx8000 family of transmitters [1] to cover all broadcast frequency ranges plus the world's most important TV and digital audio broadcasting standards. Compact dimensions and high efficiency are also the outstanding characteristics of these transmitters, making them the market benchmark.

R&S®SCW8000 / R&S®SCA8000 VHF transmitters

The R&S®SCW8000 and R&S®SCA8000 VHF transmitters for TV and digital audio broadcasting (DAB, DAB+), respectively, are available with output powers of up to 600 W for digital standards and up to 1100 W for analog TV. The transmitters are of ultracompact design. Together with the R&S®SX801 multistandard exciter [2], which also provides transmitter control functionality, they take up no more than four 19" height units. This makes it very easy to install multiple transmitters in a single rack, or accommodate transmitters in unused spaces in crowded racks. The transmitters can also be installed in outdoor racks. Their efficiency of up to 24 % translates into significant cost savings.

R&S®SCQ8000 / R&S®SCL8000 L-band transmitters

For the L band (1452 MHz to 1492 MHz), the R&S®SCQ8000 TV transmitters and the R&S®SCL8000 DAB, DAB+ and T-DMB transmitters are available. They offer an efficiency of up to 22 %, which is unparalleled in this frequency range. Powers of up to 300 W for TV and up to 400 W for digital audio broadcasting can be implemented, as in the case of the VHF and UHF transmitters, together with the R&S®SX801 multistandard exciter and one amplifier in just four 19" height units.

Four amplifiers (photo) are required to implement output powers of up to 1200 W for TV and 1500 W for DAB. The amplifiers are coupled together by means of a unit integrated into the rack. In addition to the power coupler, this unit also contains an input signal splitter, a harmonics filter, power absorbers and lightning protection. The transmitter is controlled by the R&S®NetCCU800, which can also be used to control a dual-drive transmitter. Taking up only 20 height units, the four-amplifier transmitter configuration is also the most compact in this class.

Christian Wachter

[1] The R&S®SCx8000 family of UHF transmitters for TV: a new dimension in compactness. NEWS (2009) No. 199, pp. 66–67.
[2] R&S®SX801 multistandard exciter for ATV, DTV and digital sound broadcasting. NEWS (2009) No. 199, pp. 58–59.

The R&S®SCx8000 L-band transmitter, configured as an R&S®SCL8304V dual-drive transmitter, installed in a 19" rack with 20 height units. This configuration provides maximum output power of 1200 W for DTV and 1500 W for DAB, DAB+ and T-DMB. The transmitter includes two R&S®SX801 multistandard exciters, an R&S®NetCCU800 transmitter control unit, four R&S®VL8301C1 amplifiers and an R&S®ZR800Z10 mains distribution.

Spectrum in a new light – wideband options for the R&S®ESMD

The R&S®ESMD wideband monitoring receiver is attracting significant attention with its wide range of new features: 80 MHz realtime bandwidth, very high scan speed, digital handoff receivers, innovative spectrum display and 10 Gbit Ethernet interface for signal output. Even the most challenging monitoring tasks can be handled faster and at less expense with this wideband monitoring receiver.

Always open for progress

The modular architecture of the R&S®ESMD wideband monitoring receiver was conceived from the very start with expandability in mind, allowing existing instruments to be retrofitted with the latest technology. Simply install the new multifunction board to increase the efficiency of the R&S®ESMD including its new wideband options:

- 80 MHz realtime bandwidth
- Reliable detection of extremely brief signals based on gapless monitoring and calculation of the spectrum
- 75 GHz/s scan speed with small resolution bandwidth
- Polychrome IF panorama for displaying the timing characteristics of signals starting in the spectrum
- Four digital downconverters (DDCs) within the realtime bandwidth
- 10 Gbit Ethernet interface for outputting wideband data

80 MHz realtime bandwidth

Short interfering signals that occur at irregular intervals are difficult to detect, since their exact frequency and the exact time of their occurrence are generally unknown. This is why scanning for pulsed signals of this kind is one of the most time-consuming radiomonitoring tasks, using typically scarce resources for above-average amounts of time.

The new wideband options for the R&S®ESMD can help, since they drastically increase the probability of intercepting pulsed signals of this kind. An A/D converter on the new multifunction board samples the IF signal at 400 MHz and increases the realtime bandwidth of the R&S®ESMD to 80 MHz. Large frequency ranges and even entire radio bands can be monitored all at once (FIG 1). A powerful FPGA calculates the spectrum (FFT), which ensures that there are no gaps or blind times and even the briefest of emissions can be reliably detected.

The 80 MHz realtime bandwidth also enables faster scanning of large frequency ranges in the panorama scan mode (PSCAN)*. The scan speed in any frequency range is boosted from the previous value of 20 GHz/s to 75 GHz/s. Careful attention was paid to the details especially for demanding applications. Using elaborate resampling, the channel spacings for the most common radio services can be directly selected as resolution bandwidths in the spectrum both for the IF panorama and for the panorama scan. As a result, cumbersome post-processing of measurement results due to an improper frequency resolution is avoided.

"Fast detection of signals, highly accurate measurements and demodulation, and versatility": The R&S®ESMD wideband monitoring receiver was presented with these outstanding features*.

Now the instrument is back in the limelight. The new wideband options make it one of the most powerful radiomonitoring receivers that is currently available on the market.

* News from Rohde&Schwarz (2009) No. 195, pp. 62–67.

Polychrome IF panorama (PIFPAN)

Depending on the selected resolution bandwidth, the new multifunction board computes up to two million spectra per second. To make them visible to the human eye, the spectra are summarized in realtime using the customary MaxHold, MinHold, Average and ClearWrite weighting filters. MaxHold is ideal for detecting pulse-type emissions, while the Average filter is beneficial for investigating continuous signals.

However, what should be done when short-duration signals are superimposed on the continuous signals so that none of the methods listed above are optimal? Even in this situation, the R&S®ESMD has a suitable method. An innovative type of spectrum display for radiomonitoring combines the benefits of the familiar weighting filters. The polychrome IF panorama (PIFPAN) can distinguish short-duration signals from continuous signals and shows the timing characteristic of the signals

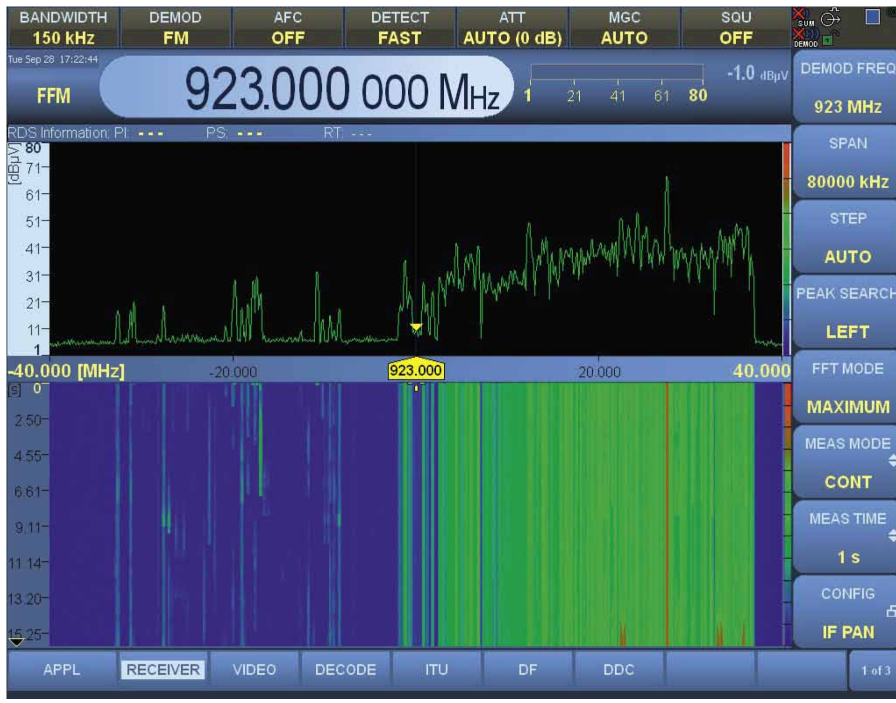


FIG 1 The GSM900 band in the IF panorama provided by the R&S®ESMD with an 80 MHz bandwidth. The left half of the spectrum shows the uplink (mobile phones) while the right half shows the downlink (base stations) with significantly higher signal strength.

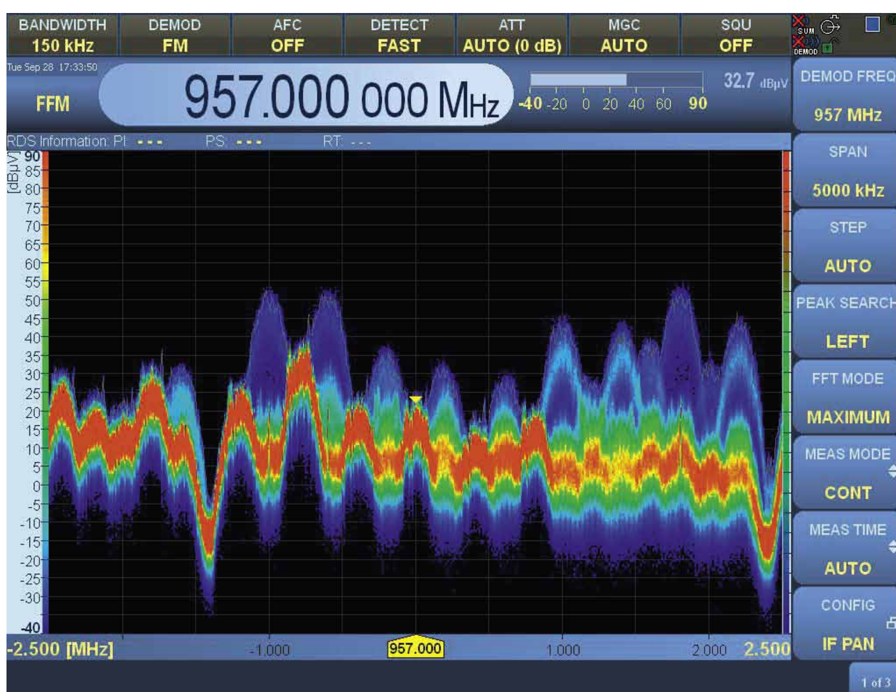


FIG 2 A section of the GSM900 downlink shown using the polychrome IF panorama display. Signal components shown in blue exhibit pulse-like behavior while red indicates signals that are permanently present. The color coding indicates how the timeslots in the individual GSM channels are occupied.

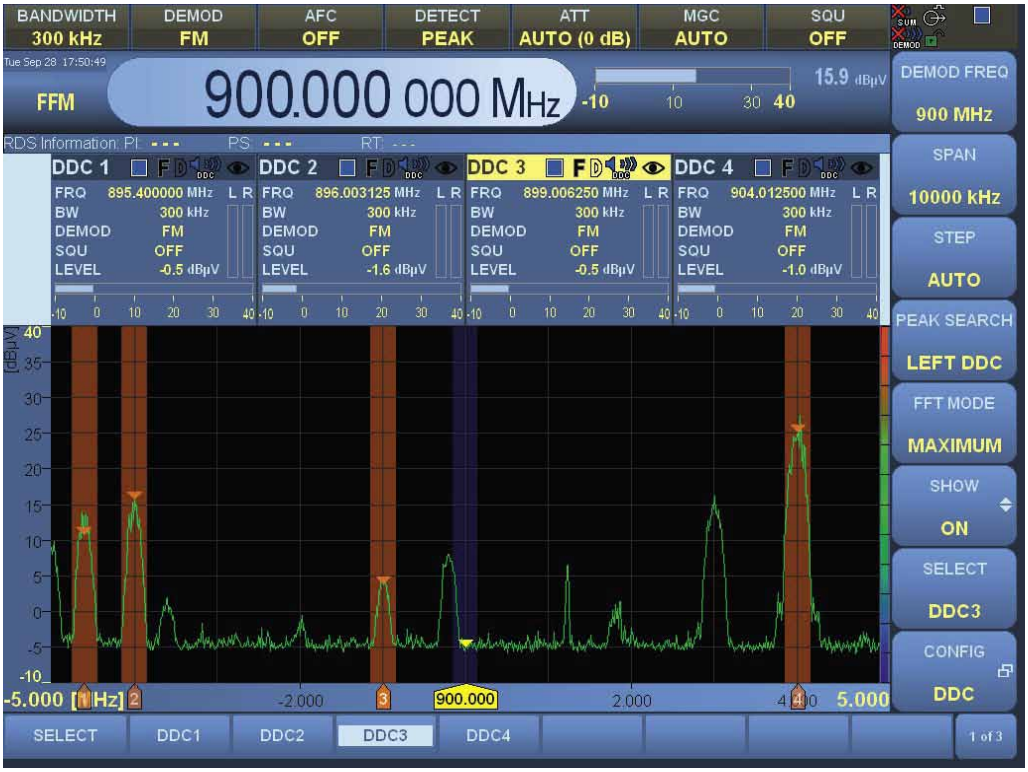


FIG 3 The four digital downconverters provided by the R&S®ESMD in use. Each of the orange-colored bars in the IF panorama indicates the current position and bandwidth of a DDC. Their configuration can be read off from the four status fields above.

already in the spectrum (FIG 2). The spectrum is divided into a grid of frequencies and level values. The individual spectra that occur within an adjustable time interval are depicted on this grid. The display uses colors to indicate the frequency whith which each point in the grid has been captured: This ranges from blue for seldom through green and yellow to red for permanent. In this manner, the polychrome IF panorama helps to highlight signal scenarios at a glance which before would not have been detected at all.

Digital downconverters (DDCs)

If multiple signals need to be simultaneously detected and demodulated, many systems use a wideband search receiver along with multiple dedicated handoff receivers. The new wideband options of the R&S®ESMD will greatly simplify such systems in the future, since the receiver offers four DDCs in addition to the wideband demodulation path. These DDCs function entirely in parallel within the realtime bandwidth up to 80 MHz and can be parameterized independently of one another. Each of the individual DDCs supports AM, FM, PULSE, I/Q, LSB, USB and CW demodulation modes as well as a comprehensive set of 25 IF bandwidths from 100 Hz to 1 MHz, automatic gain control (AGC) and a squelch function. Moreover, each DDC provides the complex baseband (I/Q), the associated signal level and an audio signal (FIG 3).

10 Gbit Ethernet interface

Detailed analysis of unknown or complex signal scenarios is costly and very difficult to manage in realtime. This is why the R&S®ESMD outputs the IF signal up to the full realtime bandwidth of 80 MHz as a complex baseband signal on a standardized 10 Gbit Ethernet interface. This signal can be recorded on hard disks and evaluated at a later point in time, for example. Copper or fiber-optic cables can be used as the transmission medium.

Summary

The new wideband options have turned the R&S®ESMD into one of the most powerful radiomonitoring receivers currently available on the market. Owing to its modular instrument architecture, future advances in the field of radiomonitoring can also be incorporated and retrofitted accordingly. Additional options are currently being developed.

Paul Renardy

Success story continues: The R&S®DDF04E direction finder succeeds the R&S®PA100

The R&S®PA100 family of Doppler direction finders has for decades been in use in large numbers in air and maritime traffic control worldwide. It is now being gradually phased out and replaced by the R&S®DDF04E digital direction finder for traffic control. This new generation can take bearings on up to 32 frequency channels using only one direction finder.

One direction finder for up to 32 frequency channels – with high DF accuracy and sensitivity

The R&S®PA100 Doppler direction finder family, deployed in large numbers worldwide, now has a high-speed successor: the R&S®DDF04E digital direction finder for traffic control (FIG 1). Conventional DF systems for traffic control consist of multiple DF plug-in modules connected to the same DF antenna. Each of these plug-in modules is a full-featured fixed-frequency direction finder. In contrast, the R&S®DDF04E state-of-the-art digital wideband direction finder is fast enough to process a multitude of frequency channels simultaneously: Between 100 MHz and 450 MHz, it can monitor up to 32 channels (optionally) at the same time, with high DF quality and high measurement speed on all channels. This allows parallel monitoring of typical aviation distress frequencies such as 121.5 MHz and 243 MHz, and any activity on these frequencies immediately triggers an alarm to the controller.

The receiver characteristics of the R&S®DDF04E, such as large-signal immunity, selectivity and sensitivity, are excellent. In fact, the R&S®DDF04E exceeds the recommendations of the International Telecommunication Union (ITU) for direction finders and monitoring receivers in many cases and also meets the stringent requirements of Deutsche Flugsicherung GmbH (German air navigation services organisation).

FIG 1 The R&S®DDF04E digital direction finder for traffic control. Standard PCs can be used to control the direction finder and display the results, which greatly reduces the costs per workstation and increases flexibility.

Another major advantage of the R&S®DDF04E is that it is ideally suited to handle forthcoming ATC requirements. For example, the 8.33 kHz channel spacing for aeronautical radio is already integrated. In addition, the frequencies of the channels being monitored can be changed via mouse click.

The R&S®DDF04E uses the correlative interferometer DF method. This method is based on measuring the phase differences between the antenna elements of a circular-array DF antenna, permitting the use of wide-aperture antennas. The higher level of DF accuracy and immunity to reflections is particularly evident when compared to conventional Watson-Watt DF methods, which are still used in maritime traffic control applications.

Example of application in air traffic control

R&S®DDF04E at Brumowski air base in Austria (ICAO code: LOXT)

The Brumowski air base of the Austrian Air Force, which is under the control of the Austrian Federal Ministry of Defense and Sports (BMLVS), is located west of Vienna, in Langenlebarn near Tulln. The air base houses the maintenance hangar 1, the air support wing, a school for air and anti-aircraft defense and the federal school for aeronautical engineering.

The R&S®PA008 direction finder, installed in the 1980s, operated reliably throughout the many years and contributed significantly to overall air traffic safety – until aging of the system and its limitation to only four DF channels prompted the BMLVS to purchase a replacement.

The R&S®ADD050SR DF antenna was mounted on a steel mast five meters high, together with an LED obstruction light (FIG 2). This mast height is a compromise between contradictory technical requirements: To avoid nulls in the vertical antenna pattern resulting from ground reflections, the mast height should be kept as low as possible; for increasing the range, however, a higher mast would be necessary. Except for reliable grounding of the antenna, no other measures are required because the antenna elements and the DF receiver are already equipped with integrated lightning protection. An insulated and fully air-conditioned outdoor cabinet at the mast base houses the DF equipment and the DF server. Suitable overvoltage arresters for the power supply and data lines were installed at the housing inlet.

The data connection to the control units for the two radar workstations and for the tower workstation runs via a four-wire VDSL data modem (copper cables). A PC in the equipment room for online monitoring allows direct access to the server PC and to the workstations. Two compact R&S®GB4000T control units in the radar room and one in the tower are specially designed for use in air traffic control consoles. They are touch input devices (TID) and are also used, for example, to operate R&S®Series4200 airborne radios via voice over IP.

The R&S®GB4000T control unit is used for the controller settings and as an additional display if the radar fails, or to monitor an additional frequency of neighboring civil airports or airfields. The tower workstation is equipped with an R&S®EB110 miniport receiver and the R&S®GB4000V audio unit.

Photo: Author

FIG 2 The R&S®DDF04E direction finder at Brumowski air base. An insulated and fully air-conditioned outdoor cabinet at the mast base houses the DF equipment and the DF server.

Example of application in air traffic control

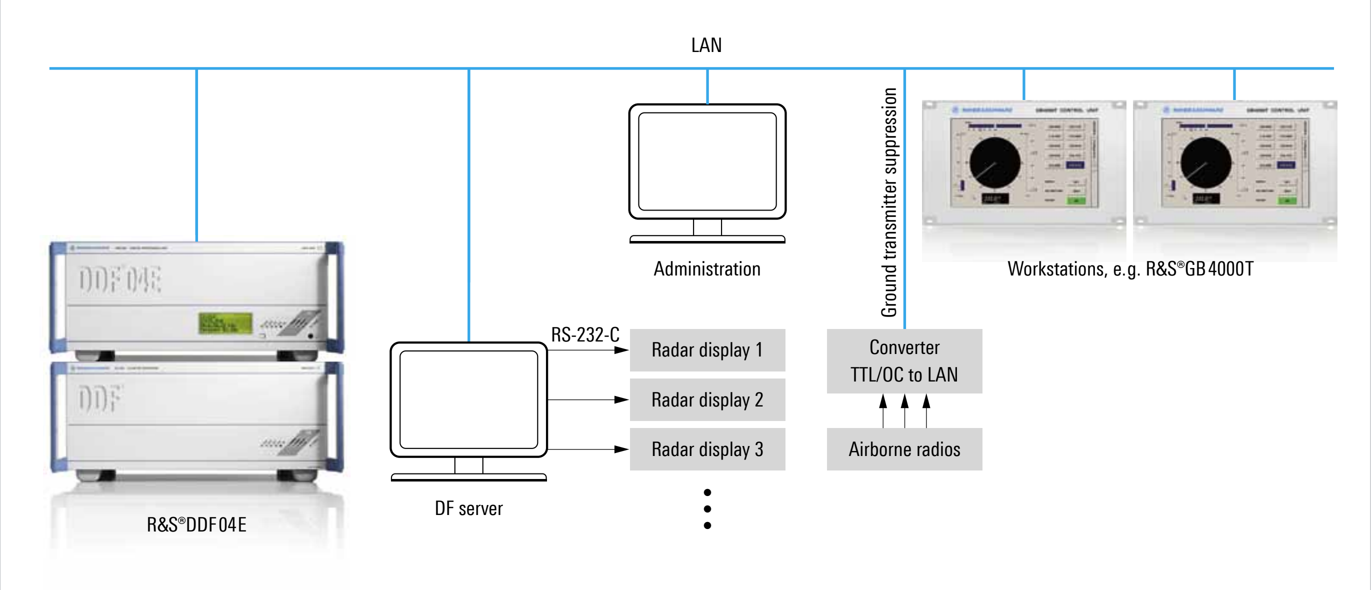


FIG 3 Typical air traffic control system featuring the R&S®DDF04E digital direction finder for traffic control.

Wide frequency range with only one antenna

The R&S®ADD050SR wide-aperture DF antenna covers the entire frequency range of the R&S®DDF04E, from 100 MHz to 450 MHz. With a diameter of 3 m and a total of nine antenna elements, it offers high DF accuracy and sensitivity plus outstanding immunity to reflections. For mobile and semi-mobile use, the R&S®ADD153SR compact antenna with a diameter of 1.1 m is available.

Simple networking and control

Standard PCs can be used to control the direction finder and display the results. This greatly reduces the costs per workstation and increases flexibility. For example, TIDs such as the R&S®GB4000T and, in mobile systems, laptops can be utilized. The direction finder and the PCs (control PC and DF server) can be networked via LAN (TCP/IP); standard products can also be used for this purpose (FIG 3).

Customer-specific traffic management systems and/or radar displays can likewise be linked via LAN. As an alternative, RS-232-C interfaces are available. The data format matches that of the R&S®PA100 – which can therefore be replaced with an R&S®DDF04E with no additional effort. Control information for ground transmitter suppression is first converted to the TCP/IP format by means of one or more converters. The data can then be queried and utilized by the R&S®DDF04E via the network.

Built-in selftest (BITE) capabilities are indispensable, particularly in safety-relevant applications such as air and maritime traffic control. The R&S®DDF04E continuously checks the measured values of more than 170 test points during operation and compares the results with the nominal values. A value outside the nominal value range automatically triggers an error message.

Robert Matousek

Key features of the R&S®DDF04E at a glance

- Parallel direction finding on up to 32 channels (optional) with the same high level of DF quality and sensitivity on all channels
- Seamless coverage of a wide frequency range from 100 MHz to 450 MHz with only one DF antenna
- Future-ready through simple change of the receive frequency and number of channels via the control software, as well as through the forthcoming 8.33 kHz channel spacing that is already integrated
- Standard PCs, monitors and network technology for control and display
- Flexible networking of direction finder, data server and display units via Ethernet
- Output of results on radar displays and in traffic management systems via an RS-232-C or TCP/IP interface

Winfried Wirth appointed President of Rohde&Schwarz SIT GmbH

As of September 1, 2010, Winfried Wirth is the new President of Rohde&Schwarz SIT GmbH in Berlin. He succeeds Henning Krieghoff, who has left the company for personal reasons. Wirth joined Rohde&Schwarz in Munich in 1989. Since September 2005, he headed the radiocommunications equipment subdivision of the Radiocommunications Systems Division. Krieghoff, who joined Rohde&Schwarz in 1982, established the Rohde&Schwarz subsidiary SIT as a market leader in Germany and one of the leading providers in Europe in the field of high-security cryptology solutions. Another outstanding achievement of Krieghoff was the successful integration of the Siemens and Bosch cryptology businesses into SIT.

The Bavarian Research Foundation promotes printed board development project

During his visit to the Teisnach plant, the Bavarian Minister of Economic Affairs, Martin Zeil, presented the grant approval of EUR 900000 for the PHERES (printed circuit boards for higher frequency systems) project. Funding this project aims at finding methods for cost-efficient production of reliable printed boards for extended signal frequency ranges.

The board of the Bavarian Research Foundation, led by the Bavarian Minister of Science, Research and the Arts, Dr. Wolfgang Heubisch, awarded about seven million euros of funds in 2010. Altogether, 25 Bavarian commercial enterprises and 22 representatives of Bavarian scientific institutions are taking part in the research projects. "We directly and unbureaucratically support innovative cooperation projects of science and economy," Heubisch explained. "The foundation significantly contributes to the transfer of knowledge and to strengthening Bavaria as a technology and research location."

From left to right: Prof. Dr. Joachim Heinzl, President of the Bavarian Research Foundation; Johann Kraus, Plant Manager of Rohde&Schwarz Teisnach; Bavarian Minister of Science, Research and the Arts, Martin Zeil; Dorothea Leonhardt, Managing Director of the Bavarian Research Foundation; Rita Röhrl, Mayor of Teisnach.

Minister of the Interior de Maizière at the ISSE

Federal Minister Thomas de Maizière visited the joint booth of secunet and Rohde&Schwarz SIT at this year's ISSE (Information Security Solutions Europe) conference, where he learned about new IT security solutions. Together with the presidents of the two companies, which are both IT security partners of the Federal Government of Germany, de Maizière discussed the long-term preservation of Germany as a location for IT security business. Rohde&Schwarz SIT and the German Federal Office for Information Security have been developing products and solutions for communications in confidential areas of the German authorities for many years.

Federal Minister de Maizière (second from left) receiving information from SIT Vice President Volker Schneider (far left), SIT President Winfried Wirth (second from right) and Dr. Rainer Baumgart, CEO of secunet (right).

Transmitters for Anvia TV

Anvia TV is establishing the first DVB-T2 network in Finland, Helsinki region, with Rohde&Schwarz transmitters. Transmission is scheduled to start at the end of 2010. Up until now, the Finnish government has approved four DVB-T2 networks; licenses for two of these have been awarded to Anvia. Rohde&Schwarz will also contribute to the second network. Over 50 years of experience in broadcasting and the company's market leadership in DVB-T and DVB-T2 transmitters helped to secure the contract for Rohde&Schwarz.

NMDG and Rohde&Schwarz in cooperation

Rohde&Schwarz has announced a cooperative agreement with the Belgian company NMDG, a highly specialized provider of nonlinear network analysis T&M equipment. This cooperation will allow Rohde&Schwarz to expand its extensive network analysis portfolio of nonlinear measurement solutions.

Today's advanced RF components and systems need to support complex modulation techniques and accommodate ever wider transmission bandwidths. The goal is to achieve higher data throughput while simultaneously lowering power consumption. The two companies together have provided test equipment for analyzing nonlinear components since 2008.

Rohde&Schwarz R&S®RTO oscilloscope receives Pick Hit Award

The R&S®RTO got very positive feedback at the IBC 2010 in Amsterdam, where Rohde&Schwarz presented it in a test setup tailored to the requirements of developers of set-top boxes and broadcast receivers. For this presentation, the oscilloscope won Broadcast Engineering magazine's Pick Hit Award. Broadcast Engineering, an internationally renowned trade journal, bestows the prize annually on especially innovative products. The jury consists of experts from the broadcasting industry. Selection criteria include positive impact on everyday work and a reasonable price.

Readers' choice: R&S®SMU200A is "ICT product of the year"

The readers of the German magazine Funkschau have chosen the R&S®SMU200A as the "2010 ICT product of the year". The high-end signal generator is among the three winners in the category "T&M equipment" and will receive a gold medal. A total of over 7434 votes were cast in ten categories. The prize is awarded annually by Germany's leading communications technology journal.

Representing the R&S®SMU200A developer team, (from left) Andreas Hecht, Andreas Pauly, Klaus Wielandner, Thomas Braunstorfinger (project leader) and Dr. René Desquiotz receive their prize by Funkschau deputy editor-in-chief Markus Kien.

Teisnach plant honored as "2010 Plant of the Year"

The German business magazine *Produktion*, in cooperation with the A.T. Kearney consulting firm, has selected the Teisnach plant as the "2010 Plant of the Year" in the "Outstanding small series production" category. The annual benchmark competition, launched in 1992, is regarded as the toughest and best-established one for German manufacturing companies. The Teisnach plant impressed the jury especially with its high degree of flexibility, its straightforward processes for faster turnaround times and its high delivery reliability. In addition, the plant scored points for its excellent manufacturing depth. High-tech products are produced efficiently and delivered to the end customers in good time.

Case Study Competition 2010: all about DVB-T2

175 students from all over Germany and two teams from Singapore took part in the final round of the 7th Case Study Competition in Munich. Following the invitation from Rohde&Schwarz and the German Association for Electrical, Electronic and Information Technologies (VDE), the contestants took a close look at the opportunities and challenges presented by DVB-T2. This year's winner was the Aachen Technical University (RWTH) team. The team received EUR 2000 and each participant was awarded an iPad.

The RWTH Aachen team impressed the jury in the Case Study Competition 2010.