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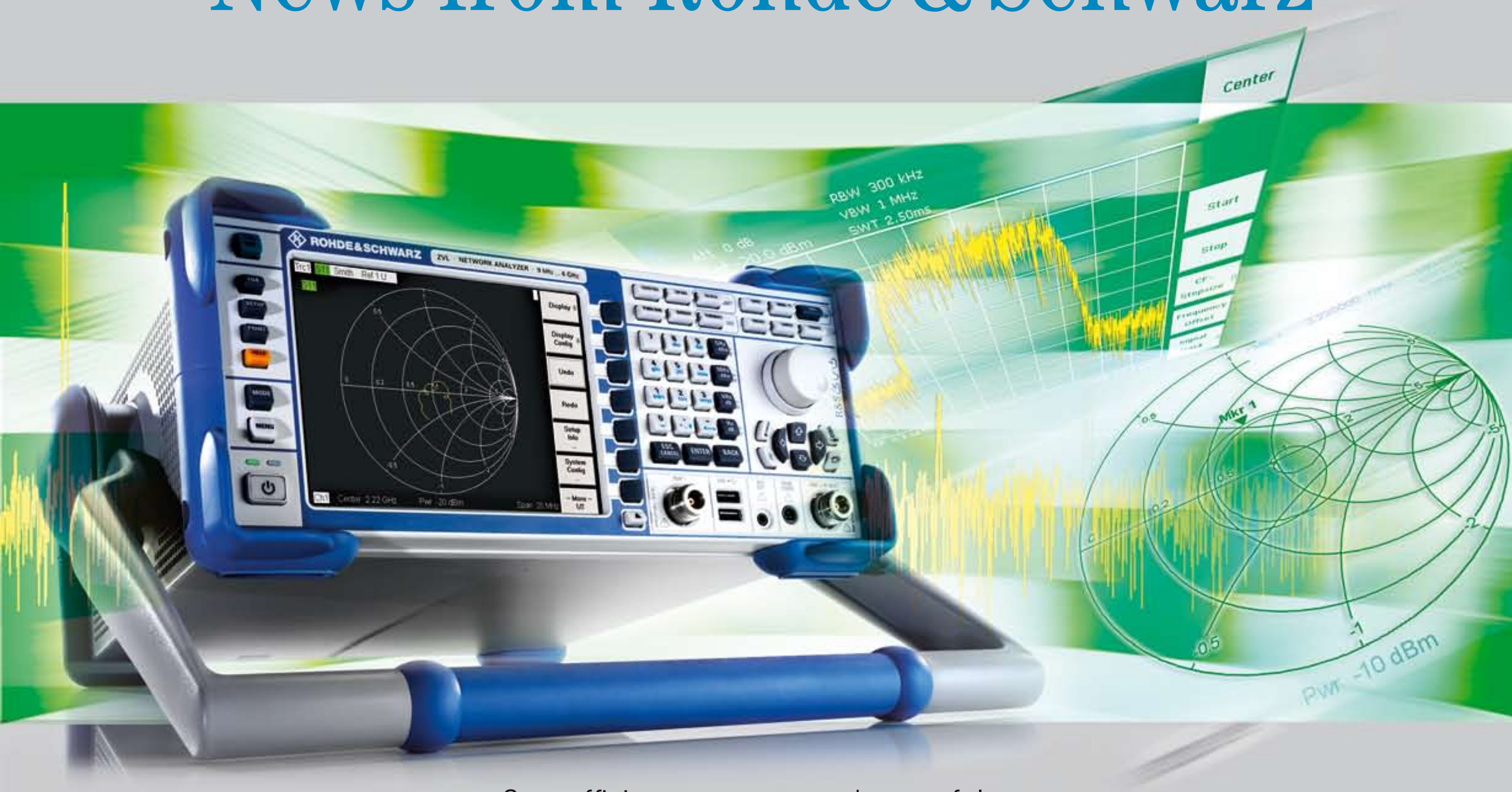

Cost-efficient, compact, and powerful:
combined network and spectrum analyzer

Baseband signal analyzer: all-in-one solution
for RFID, baseband, and IF signals

Analysis system measures and records technical
parameters of unknown satellite radio signals

2007/II
193

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44748

The R&S®ZVL is the lightest and smallest vector network analyzer in its class. On top of this, it can be used as a full-featured spectrum analyzer if desired (page 36).

The R&S®AMU200A baseband signal generator and fading simulator provides two baseband generators plus a dual-channel fading simulator in a single box (page 4).

The modular R&S®CompactTSVP open test platform provides special cost benefits for applications in the development, production, and quality assurance of electronic assemblies and components. Three new digital modules make it even more versatile (page 31).

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The R&S®FMU36 offers developers a variety of analysis capabilities, as it includes an FFT spectrum analyzer and a time domain and vector signal analyzer (page 44).

The R&S®EM510 and R&S®EM550 receivers cover the frequency ranges from 9 kHz to 32 MHz and 20 MHz to 3.6 GHz, respectively, and offer powerful digital signal processing in addition to excellent RF characteristics (page 61).

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PEP A 3 162 mV
PEP B 1 000 mV
Level A 1 000 mV
Level B 1 000 mV
Info
Analog I/Q Out A
Analog I/Q Out B
I/Q OUT OFF
Baseband A config... On MSK
Fading A config... On GSM TU3
AWGN/IMP A config... On IMP
I/Q Out A config... On SINGLE
DIG I/Q OUT
BB Input A config... On
Graphics config... On Graph A+B
BERT config... On BERT
BERT
BB Input B config... On
Baseband B config... On MSK
Fading B config... On Std Del
AWGN/IMP B config... On IMP
I/Q Out B config... On SINGLE
I/Q OUT
DIG I/Q OUT
ROHDE&SCHWARZ
AMU 200A · BASEBAND SIGNAL GENERATOR AND FADING SIMULATOR
AMU
ROHDE&SCHWARZ
UNIVERSAL RADIO COMMUNICATION TESTER · CMU 200
GSM900 Receiver Quality
100 Speech Frames

44 866/11

Baseband tests reduce time to market

The new R&S®AMU 200A baseband signal generator and fading simulator (FIG 1) offers unique capabilities for product development that reduce cost and time to market.

FIG 1 The R&S®AMU 200A combines a dual-channel baseband signal generator and a fading simulator in a single unit – a unique solution available only from Rohde & Schwarz. The instrument not only generates baseband signals in line with a variety of digital standards, but can also be used as a pure fading simulator, e.g. in conjunction with the R&S®CMU 200 universal radio communication tester.

For a description of MIMO receiver tests with the R&S®AMU 200A or the R&S®SMU 200A, refer to the article on page 9.

Tests at module level boost efficiency

Developers of mobile radiocommunications products are facing the challenge of having to launch their products in ever shorter times. Plus, solutions have to be found to cope with the growing cost pressure. A suitable way to solve these problems is to modularize device architectures. Dividing a communications device into independent, standardized functional units allows each unit to be developed – and also produced – separately, maximizing efficiency with respect to both cost and time. When taking this approach, it is vital to bear two factors in mind: First, each module must perform in a defined manner at the interfaces. This is particularly important where interoperability between products from different manufacturers is required. Second, to save cost and time in the overall design process, it is necessary to test the individual functional units of a system completely and under real conditions prior to integrating them into the system.

In mobile radiocommunications, the trend toward modularization is primarily indicated by the separate development of baseband and RF modules. With base stations as well as with mobile terminals, there is a growing need to develop – and also to test – these two types of modules separately. The new R&S®AMU 200A baseband signal generator and fading simulator has been designed for precisely this application.

Scalable for any requirement

The R&S®AMU 200A includes two baseband generators and a dual-channel fading simulator in a 19" box occupying four height units. In addition, it features with its analog and digital inputs and outputs, which makes the R&S®AMU 200A a highly versatile generator that performs all types of baseband tests. Whether you need a single-channel baseband generator, a pure baseband fader, or a dual-channel generator that offers fading capabilities and internal signal generation: The modular concept of the R&S®AMU 200A allows the instrument to be tailored to your specific requirements. This scalability also means that you can easily upgrade the instrument to handle future measurement tasks.

Integrated dual-channel baseband signal generator

The R&S®AMU 200A can be equipped with two internal baseband generators. The generators independently deliver signals in line with the following digital standards: GSM/EDGE, 3GPP FDD (including HSPA), CDMA2000®, TD-SCDMA, WLAN (IEEE 802.11a / b / g / n), WiMAX (IEEE 802.16-2005), DVB-H, GPS, and 3GPP Long Term Evolution (LTE), which is the next generation of the UMTS standard. The signals are in part even generated with channel coding and in realtime. Moreover, you can easily generate multicarrier signals, which may be made up of individual CW carriers or of signals modulated in line with various standards. Moreover, each generator has an arbitrary waveform memory of 16, 64, or 128 Msamples via which waveforms can be output that are calculated by means of simulation programs such as R&S®WinIQSIM2™ or MATLAB®. Using the optional R&S®AMU-K6 pulse sequencer, you can generate pulse trains (e. g. for radar, DFS, or RFID), thus opening up further applications. The above functionalities combine to make the R&S®AMU 200 A a platform suitable for generating proprietary signals and also for simulating signals in accordance with new digital standards that are still at an early stage of development.

FIG 2 Dialog window for defining the R&S®AMU 200 A fading parameters including a graphical display.

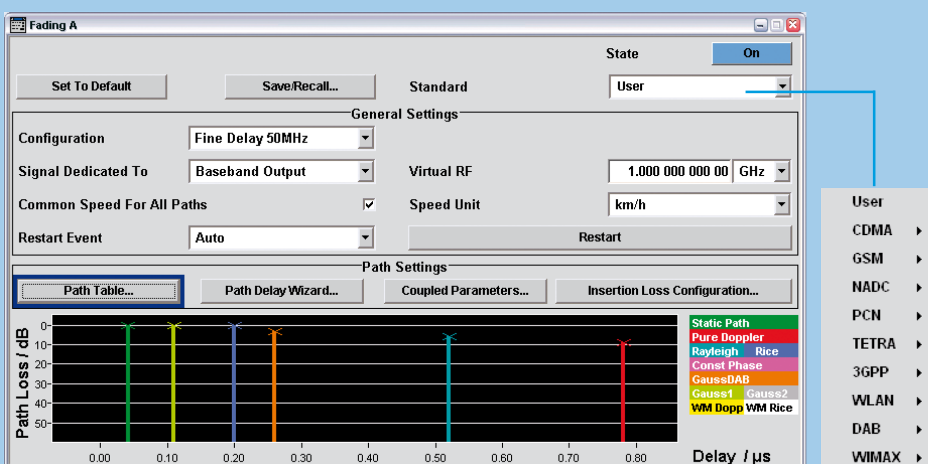


FIG 3 EVM measurement of a WiMAX OFDMA signal generated by the R&S®AMU 200 A.

IEEE 802.16e-2005 OFDMA

Frequency:	0 Hz	Signal Level Setting:	1 V	Ref. Level / Att:	1 V /0 dB
N_{FFT}:	1024	Sweep Mode:	Continuous	Trigger Mode/Offset:	Free Run
Zone/Seg:	DL-PUSC, ID=A, Seg=0	Modulation:	ALL	Zone Offset/Length	1/28 Symbols

Result Summary of Analyzed Zone/Segment

No. of Zones/Segments	3					*
	Min	Mean	Limit	Max	Limit	Unit
BER Pilots	0.00	0.00	0.00	0.00	0.00	%
EVM Data and Pilots	- 58.01	- 58.00	- 30.00	- 57.98	- 30.00	dB
EVM Data	- 57.95	- 57.94	- 30.00	- 57.92	- 30.00	dB
EVM Pilots	- 58.39	- 58.35		- 58.32		dB
Unmod. Subcarrier Error	- 38.79	- 38.77		- 38.76		dB
IQ Offset	- 53.08	- 52.96	- 15.00	- 52.81	- 15.00	dB
Gain Imbalance	0.01	0.01		0.01		dB
Quadrature Error	0.007	0.007		0.007		°
Power DL Preamble	12.28	12.28		12.28		dBm
Power Data and Pilots	3.71	3.71		3.71		dBm
Power Data	3.24	3.24		3.24		dBm
Power Pilots	5.75	5.75		5.75		dBm

Dual-channel fading and AWGN simulation

The trend toward ever higher data rates is leading to increasingly complex digital mobile radio standards. Analyzing the performance of products under realistic transmission conditions is therefore becoming more and more important. The R&S®AMU 200 A is a cost-effective solution, as it can be equipped with up to two baseband fading simulators. In the single-channel mode, up to 40 fading paths are available at a bandwidth of 80 MHz and a path delay resolution of 10 ns. Current – and future – mobile radio standards normally use bandwidths narrower than 40 MHz. For bandwidths of maximally 50 MHz (30 MHz) and a maximum of 16 (24) paths, resolution as high as 0.01 ns is achieved. With dual-channel fading, the R&S®AMU 200 A can simulate up to 20 different propagation paths of a signal for each channel. The R&S®AMU 200 A offers predefined static and dynamic fading scenarios (e. g. for 3GPP FDD, WiMAX, GSM/EDGE, and CDMA2000®) for standard-conforming channel simulations. All fading parameters can also be configured manually (including fading statistics, delay, and correlations). The current configuration can be seen at a glance on the straightforward graphical user interface (FIG 2).

Versatile test capabilities

The R&S®AMU 200 A is a powerful signal source for performing tests at the baseband level including channel simulation. This allows baseband and RF modules commonly used in transmission to be developed separately from each other (FIG 5a).

Featuring excellent signal quality, the R&S®AMU 200 A is an ideal baseband signal source, e. g. for designing I/Q modulators or complete RF frontends

(FIG 5b). Its low EVM (FIG 3) and flat frequency response (FIG 4) ensure that the influence of the signal source on measurements is negligible. Equipped with differential I/Q outputs, the R&S®AMU 200A also performs tests on differential modules.

By using the R&S®AMU 200A in conjunction with a vector signal generator (e.g. the R&S®SMATE 200A), which converts the I/Q signal to the RF, you can carry out receiver tests on RF modules (FIG 5c) or tests on complete devices under test (DUTs) (FIG 5d). For either type of test, the R&S®AMU 200A generates the baseband signal and performs channel simulation including fading and AWGN generation. This does away with the need for an extra RF fader or an external noise source. The R&S®AMU 200A can also be used for optimizing the receiver performance of baseband modules (FIG 5e).

Channel simulation at the baseband makes it possible to perform tests under realistic transmission conditions even at an early stage of development, often before the RF design is completed. It is thus easy to verify the performance of hardware prototypes, and to optimize baseband algorithms from the outset. All this helps to reduce time to market for new technologies.

The R&S®AMU 200A can also be used as a pure baseband fader. For instance, signals from a radiocommunications tester can be fed to the R&S®AMU 200A via its baseband inputs. The R&S®AMU 200A fades the signals, superimposes AWGN, and outputs them again as baseband signals. The signals are either directly applied to the DUT, or upconverted to the RF by the radiocommunications tester.

FIG 4
Typical frequency response of the analog I/Q outputs of the R&S®AMU 200A.

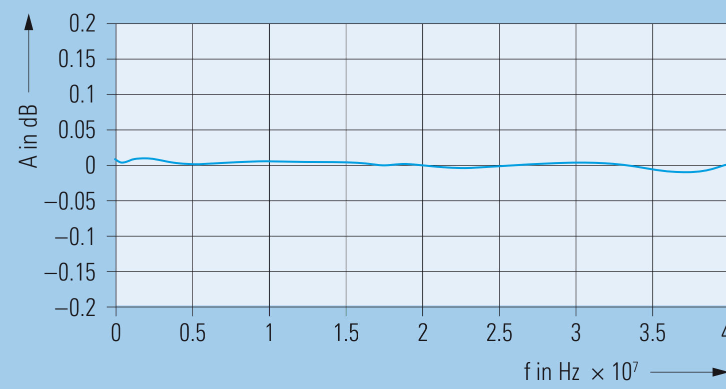
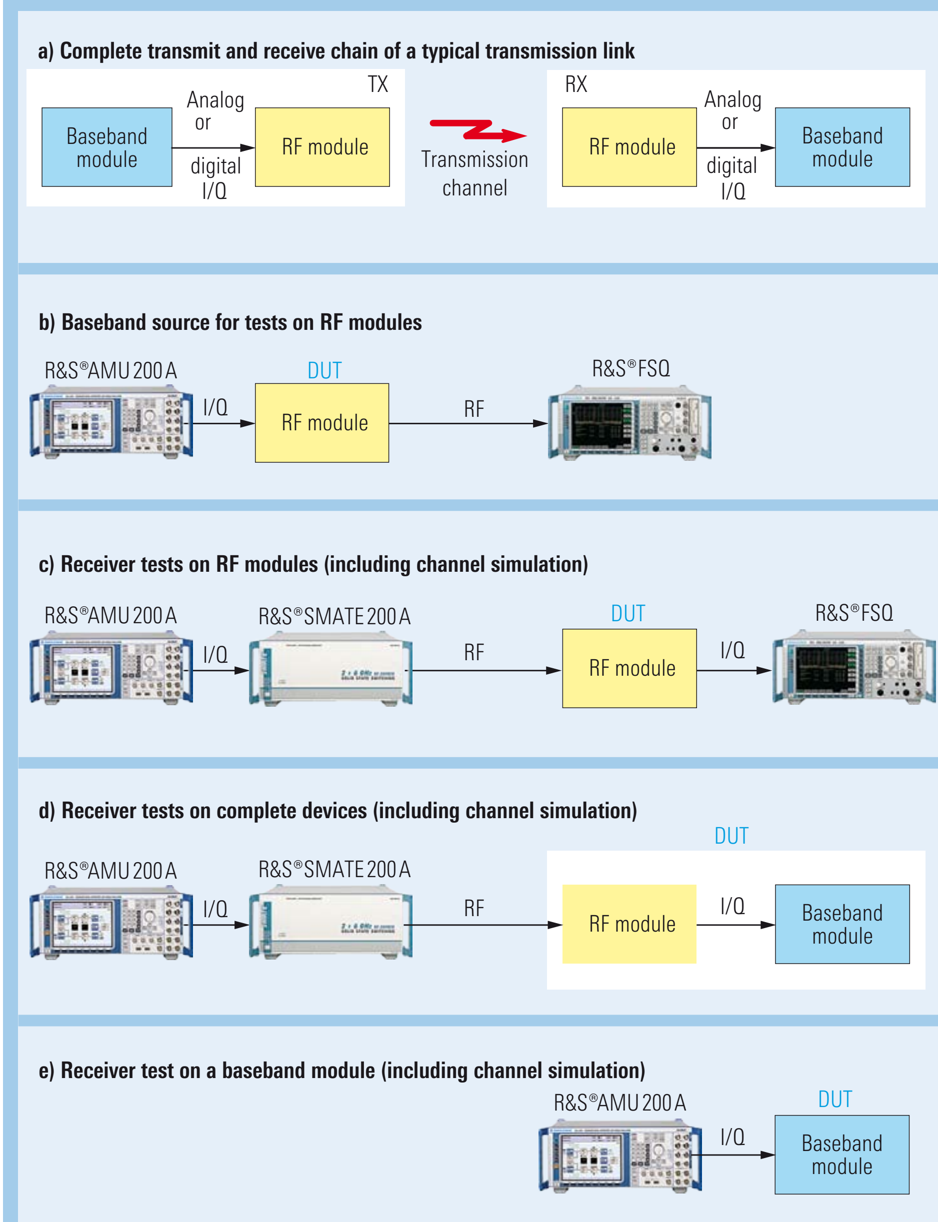


FIG 5 The R&S®AMU 200A allows complex systems to be tested at module level. The integrated fading simulator provides realistic transmission conditions. Due to the instrument's dual-channel concept, TX and RX diversity as well as 2×2 MIMO scenarios can be simulated.



RX/TX diversity and MIMO

In addition to general tests on RF and baseband modules, the R&S®AMU 200 A is also ideal for diversity tests due to its dual-channel concept. Diversity tests usually require two antenna signals, which are both provided by the R&S®AMU 200 A. The instrument's baseband architecture allows the versatile generation of signal scenarios by the internal addition of signals including frequency and level offsets. Signals for TX and RX diversity tests can thus be generated solely by means of the R&S®AMU 200 A's internal signal generators (FIGs 6 and 7).

Using the R&S®AMU-K 74 option, the R&S®AMU 200 A also simulates 2 × 2 MIMO scenarios. The option adds two more fading channels to the R&S®AMU 200 A to give a total of four, which allows the simulation of the four transmission paths between the two transmit and the two receive antennas of a 2 × 2 MIMO configuration. For more information, refer to page 9. By using the R&S®AMU 200 A in conjunction with the R&S®SMATE 200 A dual-channel vector signal generator, you can perform receiver tests covering two receive antennas (up to 2 × 6 GHz) even at the RF level.

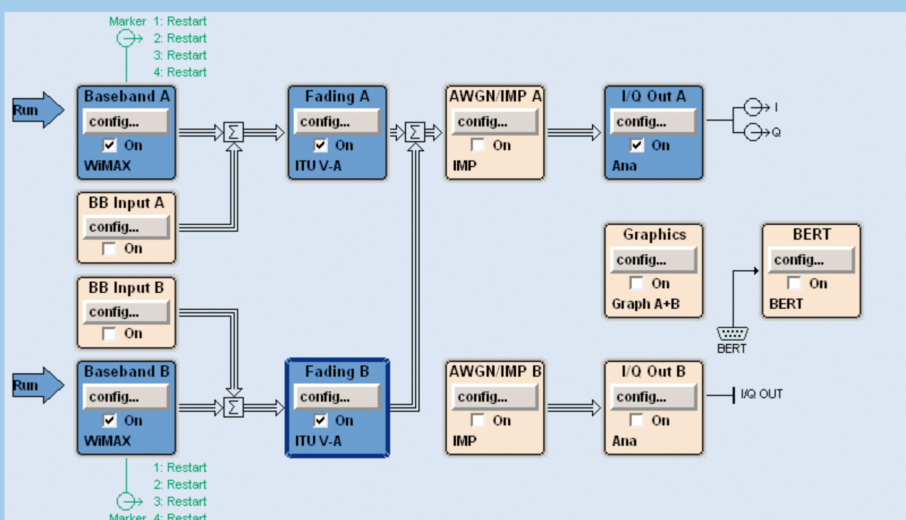
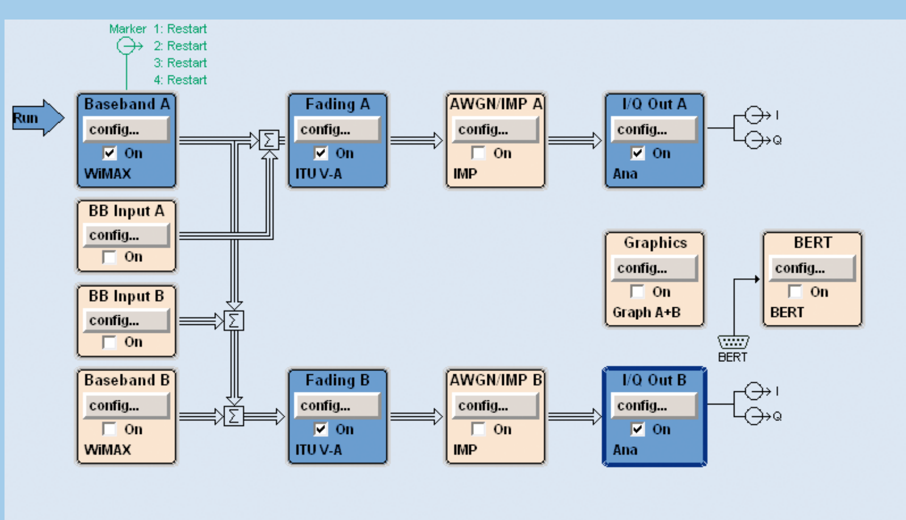


FIG 6 Configuration of the R&S®AMU 200 A for TX diversity tests: The two TX signals are subjected to different fading conditions, added together internally, and output as an RX antenna signal.

FIG 7 Configuration of the R&S®AMU 200 A for RX diversity tests: The TX signal is subjected to different fading conditions, and the resulting signals are output as two RX antenna signals.



Summary

The R&S®AMU 200 A is a universal baseband source that combines the functionalities of a realtime I/Q source, an arbitrary waveform generator, and a channel simulator in a single box. The optional two-path functionality makes it easy to generate even complex signal scenarios. You can simulate interference, noise, multipath propagation, antenna diversity, as well as 2 × 2 MIMO scenarios, and determine their effect on a DUT reproducibly, with minimum effort, and with only one instrument.

These capabilities make the R&S®AMU 200 A an ideal tool for performing complex tests already at the baseband. The R&S®AMU 200 A makes it possible to detect and eliminate design errors at module level even at an early stage of development. This does away with costly and time-consuming redesign work at later stages in product development. The R&S®AMU 200 A can thus play a major role in getting your products to the market faster and at lower cost.

Simon Ache

More information and data sheet at www.rohde-schwarz.com (search term: AMU200A)

MIMO receiver tests using only one signal generator

MIMO (multiple input multiple output) is an effective technique for boosting data rates. It therefore forms an integral part of modern mobile radio standards such as 3GPP Release 7 and EUTRA / LTE, as well as wireless local (802.11n) and regional (WiMAX) radio networks. There are two MIMO concepts: diversity and multiplexing. This article explains the two concepts and shows how to perform MIMO receiver tests with the R&S®SMU 200 A or the R&S®AMU 200 A.

Diversity

A signal traveling from a transmit to a receive antenna is subject to reflection, which causes multipath propagation of the signal. The propagation paths in part add up constructively, i. e. they amplify each other, and in part destructively, i. e. they cancel each other out. All paths between a transmit and a receive antenna taken together are referred to as a channel. If the above type of superposition is present, the channel is referred to as a faded channel. If receive antennas are closely spaced, the incoming signals are correlated, i. e. they have traveled through similar fading channels.

A receive diversity or SIMO (single input multiple output) system has one transmit and usually two receive antennas. If the fading channels are sufficiently different, the combination of several receive signals will yield a better signal-to-noise ratio because the receiver can compensate destructive superposition at one antenna by using the signals at the other antenna.

A transmit diversity or MISO (multiple input single output) system usually contains two transmit antennas and one receive antenna. Identical data contents with different coding (space time coding) are sent via the two transmit antennas. If parts of one signal are lost due to destructive superposition, the data contents can be retrieved from the other signal. For this, the fading channels must be sufficiently different from each other.

Multiplexing

Multiplexing systems transmit different data contents simultaneously on the same carrier frequency via several antennas. The signals are received in parallel by the receive antennas, which results in an increase of the overall data rate (FIG 1). A challenging task for a multiplexing system is to distinguish between the different signals at the receiver. As with diversity systems, this can be done on the basis of the different transmission channels. By way of channel estimation, the characteristics of the individual fading channels are determined. Based on this information, the receiver can differentiate between the transmit antennas and pick up the two data contents simultaneously.

Complex measurement tasks

Diversity as well as multiplexing systems only work if the fading channels between the transmit and the receive antennas are sufficiently different. Since the antennas are closely spaced, similar fading channels will result, which reduces system efficiency. To simulate similar fading channels, the fading simulator has to correlate the attenuation characteristics of the fading channels with one another. This means that performance tests on MIMO receivers require not only several vector signal generators but also a multichannel fading simulator. The R&S®SMU 200 A vector signal generator and the

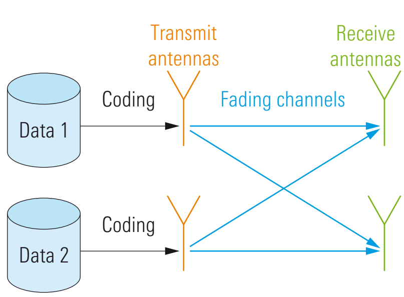


FIG 1 Block diagram of a 2 × 2 MIMO multiplexing system. Two different data contents are emitted via two transmit antennas. The four blue arrows represent four different fading channels to the two receive antennas.

▶ R&S®AMU 200A baseband signal generator and fading simulator (page 4) are the only instruments on the market to combine these complex functionalities in a single unit. The user can configure signals and define fading conditions conveniently via the generator's intuitive user interface. This also does away with any cabling between signal generators and fading simulator.

2 × 2 MIMO systems

Tests on 2 × 2 MIMO systems require four fading channels and two signal sources (FIG 1). Using the R&S®SMU-K74 or R&S®AMU-K74 option, it is now for the first time possible to perform such tests with a single unit. FIG 2 shows the block diagram for a 2 × 2 MIMO test on the R&S®SMU 200A user interface. Each block represents a functionality that is configured in the associated menu. The baseband blocks on the left symbolize the two transmit signals, and the four fading blocks the fading channels, which are shown as blue arrows in FIG 1. The two RF blocks on the right can be used to configure the RF parameters of the two signals.

To simulate fading channels that are similar to one another, the attenuation characteristics of the fading channels can be mutually correlated. With four fading channels, correlation is configured by means of a 4 × 4 matrix. FIG 3 shows the window for entering the matrix elements on the R&S®AMU 200A and the R&S®SMU 200A. Each matrix element correlates one fading channel with another. The matrix elements are complex numbers, since correlation is defined by both magnitude and phase. The phase value is derived from the phase angle between the antennas. The R&S®SMU 200A not only offers the standard matrix assignments defined in the test specifications; it also allows users to create matrix assignments of their own. Thus, the instrument is already prepared to handle future expansions.

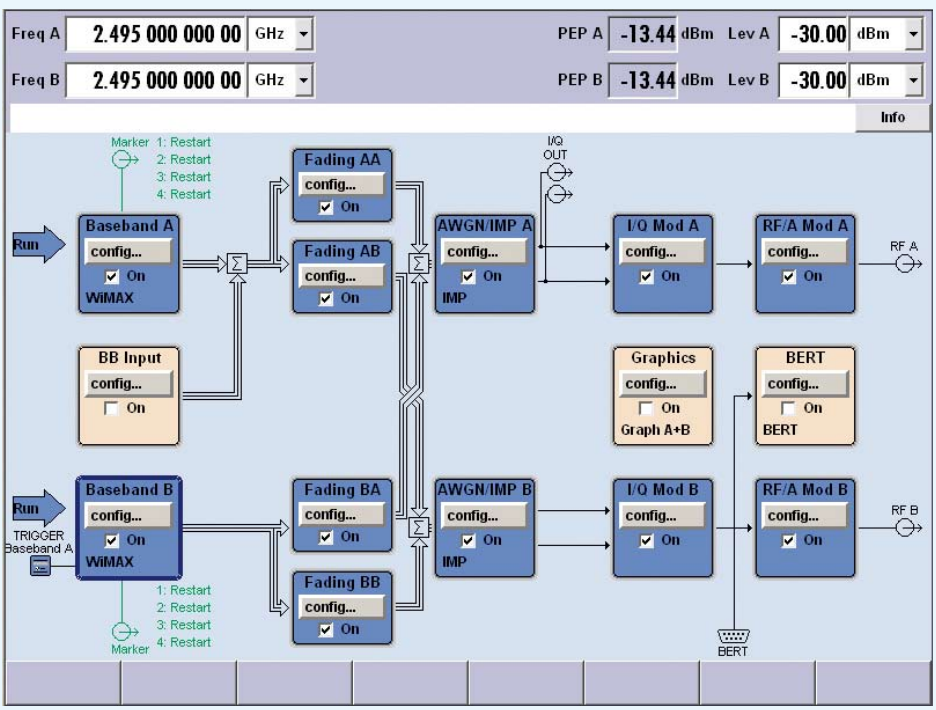


FIG 2 The R&S®SMU 200A user interface for 2 × 2 MIMO tests, showing the signal flow from the generation of the two signals on the left via the simulation of the four fading channels up to the two RF outputs on the right.

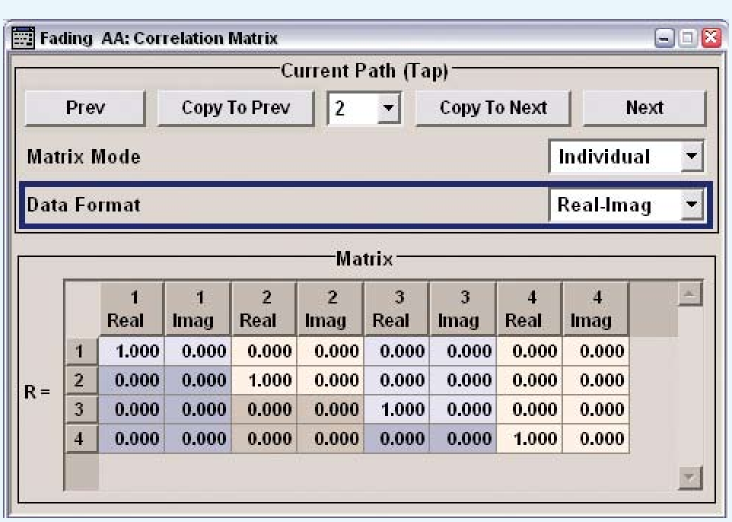


FIG 3 Correlation matrix. The display can be switched between real and imaginary components or polar format.

Summary

Featuring a dual-path concept and an integrated multichannel fading simulator, the R&S®AMU 200A and the R&S®SMU 200A are ideal for tests on diversity systems. The R&S®SMU-K74 and R&S®AMU-K74 options simulate up to four fading channels, thus allowing tests on 2 × 2 MIMO receivers by means of a single instrument. This eliminates the need for cabling as well as level adjustment between signal generators and fading simulator.

Dr Jan Prochnow

R&S®SMx Signal Generators / R&S®FSQ Signal Analyzers

Headed toward the next mobile radio generation with UMTS LTE

UMTS is entering a new phase. UMTS long term evolution (LTE) is paving the way for a new generation of mobile radio. The two options R&S®SMx-K55 for signal generators and R&S®FSQ-K100 for signal analyzers mean that powerful T&M equipment is already available today for the optimum launch of LTE.

The evolution of UMTS

At present, the step toward high-speed packet access (HSPA), which is the combination of high-speed downlink packet access (HSDPA) and high-speed uplink packet access (HSUPA), is on the agenda of many mobile radio operators. For end users, this will result primarily in higher data rates and faster data access in both transmission directions. Network operators will thus be able to offer more attractive data services.

In addition to these short- and medium-term enhancements to the UMTS network, network operators also expect a significantly longer-term perspective for the further development of UMTS. The standard must meet future mobile radio requirements and also remain competitive beyond the next ten years.

LTE requirements

In preparation, the 3GPP standardization committee started working on UMTS long term evolution (LTE) two years ago. This technology is also referred to as evolved UMTS terrestrial radio access (EUTRA) and is part of Release 8 of the 3GPP specifications. The objective of LTE is to provide a powerful packet-optimized mobile radio system that is able to achieve data rates of up to 100 Mbit/s in the downlink and 50 Mbit/s in the uplink. LTE can be operated in the same frequency bands as UMTS, thus providing scalable bandwidths up to 20 MHz. Although LTE will lead to numerous technical innovations, the technology is part of UMTS evolution. This is why LTE is also referred to as the 3.9th generation of digital mobile radio systems.

New transmission methods

With regard to LTE, 3GPP has decided to focus on new transmission methods and architecture models. LTE will not be based on WCDMA access, which has been used in UMTS so far. In the LTE downlink, the orthogonal frequency division multiple access (OFDMA) method is used, which is already used in WiMAX and DVB-T. OFDMA systems offer robust data transmission with good spectral efficiency. The transmission method in the LTE uplink is referred to as single carrier frequency division multiple access (SC-FDMA), which was selected due to its favorable signal characteristics. SC-FDMA signals typically feature lower crest factors than OFDMA signals and thus make it easier to develop power amplifiers for user equipment.

The use of multiple antenna systems (MIMO, multiple input multiple output) is another important feature of LTE (for details about MIMO, see page 9). Above all, the use of two transmit antennas at the base station end and two receive antennas at the user equipment end is relevant here. In a MIMO system, the available transmit antennas simultaneously transmit independent data streams on the same radio resource. These data streams can belong to one subscriber or to different subscribers. MIMO systems offer considerably higher data throughput and are therefore an important component of LTE.

In addition to physical transmission methods, the protocol architecture for LTE will also be completely reworked. LTE does not require dedicated channels, which assign a fixed resource to the subscriber for the entire duration of a connection. Instead, the LTE base station informs the subscriber about the resource that is available for a data transmission depending on what is needed. This shared channel principle is already implemented in HSDPA and is ideal for transmitting packet-oriented services.

Powerful T&M equipment for LTE required

According to the 3GPP schedule, the LTE specifications will be completed in autumn 2007. Manufacturers of components, chipsets, user equipment, and infrastructure are already preparing for LTE and have started development work. Efficient test and measurement solutions help them to meet the technical requirements of LTE and to gain experience with the new transmission methods early on. For the development of OFDMA, developers can partly use the know-how from other technologies such as WiMAX. However, components for SC-FDMA, e.g. power amplifiers, have to be completely redeveloped. It is therefore necessary for test and measurement solutions to support these transmission methods. In addition, the requirements arising from the multiple antenna systems that must be taken into account on both the transmitter end and receiver end must also be factored into the equation.

LTE signals with the R&S®SMx vector signal generators

Rohde & Schwarz offers the world's first signal generator solutions for LTE. The R&S®SMx-K55 option – which is available for the R&S®SMU 200 A, R&S®SMJ 100 A, R&S®SMATE 200 A, and R&S®AMU 200 A generators, as well as with the R&S®WinIQSIM2 software for the R&S®AFQ 100 A arbitrary waveform generator – makes it possible to intuitively and flexibly configure LTE signals. Various help functions are provided that allow the quick and time-efficient generation of LTE-compliant signals without having to set each signal parameter individually.

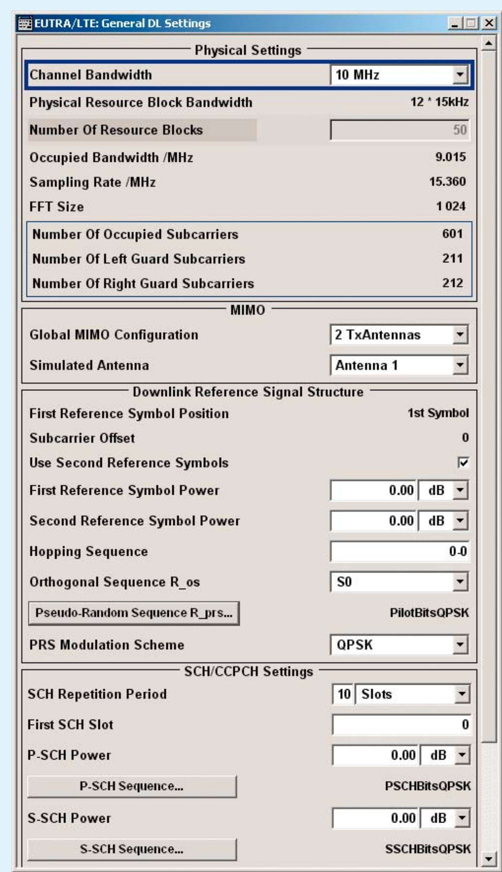
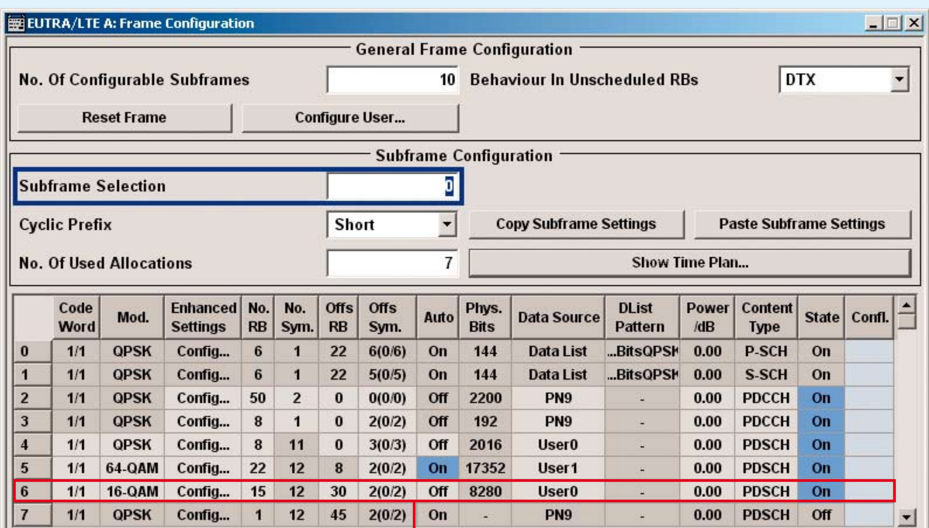


FIG 1 Extensive setting capabilities in the General DL Settings screen (R&S®SMx-K55).

Moreover, users can also customize the signal in detail. Owing to the extensive setting capabilities of the reference and synchronization signals (FIG 1), it is possible to comprehensively test prototype implementations even at this early stage of the still incomplete LTE specification (3GPP TS 36.211). The configuration of the individual allocations with different levels, modulations, and data content is performed in a table (FIG 2), and can be checked for consistency in the straightforward time schedule. The different channel types (P/S-SCH, PDCCH, PDSCH, CCPCH) are separated from each other by different colors (FIG 3).

The new option also takes the challenges with respect to MIMO into account. In the General DL Settings (FIG 1), you can define which of the up to four possible transmit antennas is to be simulated by the R&S®SMx-K55 option. The 2 × 2 MIMO, which has the highest priority with LTE, can already be implemented by using a dual-path R&S®SMU 200 A or R&S®AMU 200 A generator. Together with the new R&S®SMU-K 74 MIMO fading option (page 9), Rohde & Schwarz is thus the only manufacturer of T&M equipment worldwide that offers a complete 2 × 2 MIMO transmit signal including channel simulation as an unrivaled one-box solution.



	Code Word	Mod.	Enhanced Settings	No. RB	No. Sym.	Offs RB	Offs Sym.	Auto	Phys. Bits	Data Source	DList Pattern	Power /dB	Content Type	State	Confl.
0	1/1	QPSK	Config...	6	1	22	6(0/6)	On	144	Data List	...BitsQPSK	0.00	P-SCH	On	
1	1/1	QPSK	Config...	6	1	22	5(0/5)	On	144	Data List	...BitsQPSK	0.00	S-SCH	On	
2	1/1	QPSK	Config...	50	2	0	0(0/0)	Off	2200	PN9	-	0.00	PDCCH	On	
3	1/1	QPSK	Config...	8	1	0	2(0/2)	Off	192	PN9	-	0.00	PDCCH	On	
4	1/1	QPSK	Config...	8	11	0	3(0/3)	Off	2016	User0	-	0.00	PDSCH	On	
5	1/1	64-QAM	Config...	22	12	8	2(0/2)	On	17352	User1	-	0.00	PDSCH	On	
6	1/1	16-QAM	Config...	15	12	30	2(0/2)	Off	8280	User0	-	0.00	PDSCH	On	
7	1/1	QPSK	Config...	1	12	45	2(0/2)	On	-	PN9	-	0.00	PDSCH	Off	

FIG 2 Detailed configuration of the individual allocations in the downlink (R&S®SMx-K55 option).

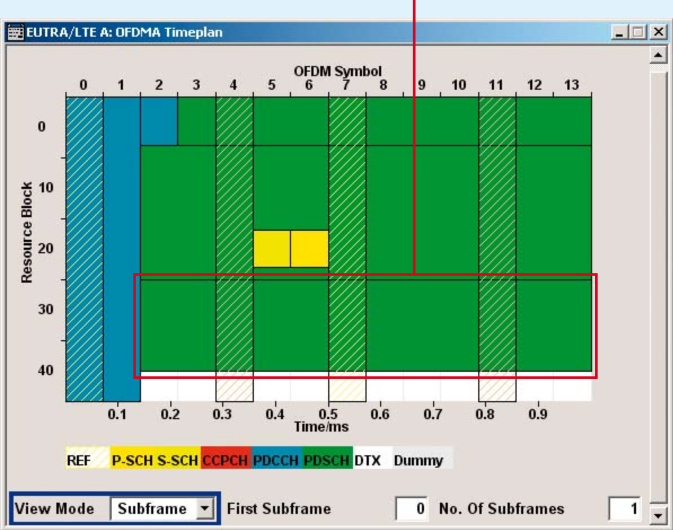


FIG 3 Graphical display of the various allocations in the time schedule (R&S®SMx-K55 option).

Measurements with the R&S®FSQ signal analyzer

For the development of LTE applications or components, it is necessary to analyze the appropriate RF characteristics exactly and in detail. However, analyzing the modulation quality of LTE OFDM signals is not possible using conventional spectrum analyzers. To measure transmission signals or to test receivers, you must have measurement equipment that has excellent demodulation characteristics, as provided by the high-end R&S®FSQ signal analyzer from Rohde & Schwarz, for example. The R&S®FSQ measures signals that have a bandwidth of 28 MHz (120 MHz with the R&S®FSQ-B72 option). Using the R&S®FSQ-K100 LTE analysis software, the R&S®FSQ can analyze the modulation quality of LTE base stations; with the optional R&S®FSQ-B71 baseband inputs, it can even do so directly in the baseband. It is thus possible to detect any deterioration in signal quality caused by the I/Q modulator or the transmission path.

The software allows the analysis of LTE signals, although standardization has not yet been completed. In the case of gaps in the specification, the software offers extensive capabilities for defining the appropriate parameters on your own. After the configuration for bandwidth and modulation type, the analyzer measures all necessary parameters that characterize LTE signals and displays the results in a table.

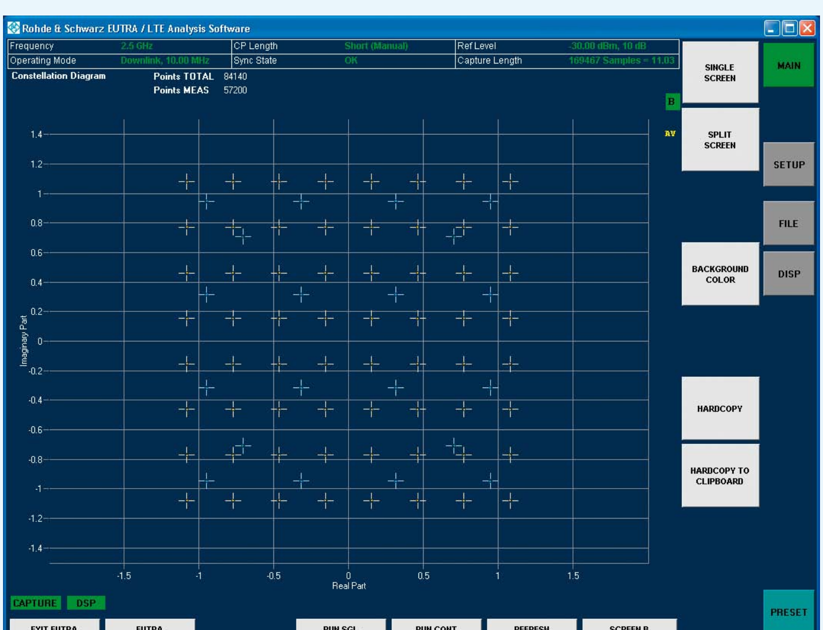
An important parameter is error vector magnitude (EVM), which allows the assessment of the modulation quality (FIG 4). EVM shows the deviation of a measured point in the constellation diagram from the ideal position which represents an I/Q value of a symbol of a specific OFDM carrier. Moreover, the software provides graphical analysis tools such as the constellation diagram

(FIG 5) or display of EVM versus frequency or time.

The R&S®SMx-K55 option for generating OFDMA signals in the downlink and the R&S®FSQ-K100 option for analyzing these signals have already been available since March 2007; the SC-FDMA technology in the uplink will be supported soon. Advances in the LTE specification by the 3GPP standardization committee, of which Rohde & Schwarz is also a member, will be implemented in the options in the near future and will be made available to customers as software updates.

FIG 4 EVM versus carrier with the R&S®FSQ-K100 LTE analysis software.

FIG 5 Display as constellation diagram with the R&S®FSQ-K100 LTE analysis software.

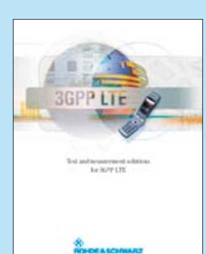


Summary – a complete T&M solution

A fundamental prerequisite for the optimum launch of LTE is to provide the best possible support for development work by means of powerful test and measurement equipment. The R&S®SMx signal generators and the R&S®FSQ signal analyzer mean that manufacturers of chipsets, components, user equipment, and infrastructure can already make use of T&M equipment for LTE today. Manufacturers benefit from the opportunity to help shape the new measurement solutions even at this early stage of development by defining specifications and test requirements. In the months ahead, the new technology will advance rapidly and pave the way for a new generation of mobile radio.

Christina Gessner, Johan Nilsson, Gerald Tietscher

For more information, see the "Test and measurement solutions for 3GPP LTE" brochure at www.rohde-schwarz.com (search term: 3GPP LTE)



R&S®CRTU-W Protocol Test Platform

Interoperability tests for 3G mobile phones

WCDMA networks are opening up a variety of new services. You can combine these services in a number of different ways and place a broad scope of demands on them. In WCDMA networks, you need complex signaling sequences between mobile radio network and terminal equipment. Since smooth interaction between the mobile radio network and the terminal equipment is a precondition for the success of these innovative services, network-specific signaling tests are crucial to ensure quality and functionality.

Certification and interoperability tests

The careful and standard-compliant implementation of new technologies in terminal equipment is critical for industry. Thus, network operators and terminal manufacturers have joined together to form the Global Certification Forum (GCF) – with a focus on Europe – and the PCS Type Certification Review Board (PTCRB) – with a focus on North America – in order to prepare uniform certification rules for terminal equipment. These rules do not cover network-specific aspects. To meet these requirements, network operators have developed their own network-specific interoperability tests (IOT). One example of such tests is seen in the reference inhouse tests (RIT) specified by NTT DoCoMo. Rohde&Schwarz provides such tests as executables by offering its R&S®CRTU-WR01 to R&S®CRTU-WR08 software options for the R&S®CRTU-W protocol test platform. Source codes and executables of the RIT scenarios are provided by the R&S®CRTU-WR51 to R&S®CRTU-WR58 options.

IOT scenarios cover the full scope of signaling: from the registration of terminal equipment and start of service (e.g. call setup) to call release. These tests are called vertical tests. They concentrate on network-specific services. Typical signaling sequences are tested with the specific configuration of the network parameters.

However, certification calls for horizontal tests since only one specific signaling functionality is tested – and this is done for all the configurations supported by the terminal equipment.

Proprietary test specifications are provided not only by NTT DoCoMo. Cingular Wireless in the USA also defined its own specific criteria for terminal acceptance. The R&S®CRTU-W protocol test platform from Rohde&Schwarz also supports these tests.

Early interoperability tests mean greater functional reliability

The introduction of new services usually requires new terminals with optimum product launch times. Due to the agreement processes in the committees, the corresponding certification tests are normally provided with a certain delay. This is where interoperability tests enter the picture: They allow you to test new functionalities at an early stage and before the mobile phone is launched. Since the R&S®CRTU-W can handle the increasing number of test packages, it is the ideal tool for verifying new technologies at an early stage. The R&S®CRTU-WZ22 to R&S®CRTU-WZ24 software packages, for example, offer approx. 60 protocol tests for HSUPA for use in research and development.

MLAPI – platform for customized tests

When equipped with a medium-level API (MLAPI) – which Rohde&Schwarz provides with its R&S®CRTU-WT02 option, the programming interface for C++ – the R&S®CRTU-W is an excellent platform for implementing network-specific

To obtain more information on how the R&S®CRTU-W is used for MBMS, see page 18. The user-friendly definition of signaling scenarios with the R&S®CRTU protocol test platform is described on page 21.

test cases. Although the MLAPI is a programming interface, its clear advantage is minimum programming effort for the implementation of test cases.

The signaling sequences required for protocol test cases are performed in layer 3 or higher. The MLAPI is located above the RRC configurator, also referred to as RRC stub (FIG 1). The PDUs of the peer-to-peer messages to the terminal unit can thus be used to automatically and uniformly configure the lower layers of the protocol stack in the R&S®CRTU-W, i. e. they do not have to be programmed in the actual scenario. The programming effort is thus reduced by up to 95 %. A test case can quite frequently be modified without having to change the source code or recompile.

In practice, you often merely modify the contents of the signaling messages. The easy-to-operate and efficient Message Composer (FIG 2) allows you to modify the contents of all test case protocol messages as required. The Message Composer makes use of the message description database (MDDB) which stores the protocol messages including the content. In the scenario, only the protocol message sequence is programmed. The corresponding contents of the messages are stored in the MDDB. The Message Composer minimizes the programming effort for modifying scenarios and – in many cases – eliminates programming altogether.

The tools for organizing, performing, and analyzing test campaigns for interoperability tests are the same as those offered by the R&S®CRTU-W for conformance tests. Test campaigns for MLAPI scenarios are organized with the Project Explorer, for example (FIG 3). The R&S®CRTU-W thus gives you the same "look and feel" no matter what application you use, and you can quickly master instrument operation.

Efficient implementation with the MLAPI on the R&S®CRTU-W

With more than 500 test cases already written for the MLAPI, the R&S®CRTU-W with its R&S®CRTU-WT02 C++ programming interface offers an ideal platform for efficiently implementing network-relevant test specifications such as the RIT tests from NTT DoCoMo or the tests from Cingular Wireless. Since new technologies such as HSUPA will soon be available for the MLAPI and since R&D scenarios will be developed, these scenarios can also form the basis for interoperability tests that are to be performed at a later time. The advantages: shorter testing times prior to the introduction of new technologies and / or market launch of terminal equipment in mobile radio networks, and greater reliability in the functionality of terminal equipment when it comes to the services to be offered.

Wolfgang Kalau

Abbreviations

IOT	Interoperability test
HSUPA	High-speed uplink packet access
MLAPI	Medium-level application programming interface
NAS	Non-access stratum
PDU	Protocol data unit
RIT	Reference inhouse test
RRC	Radio resource control

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

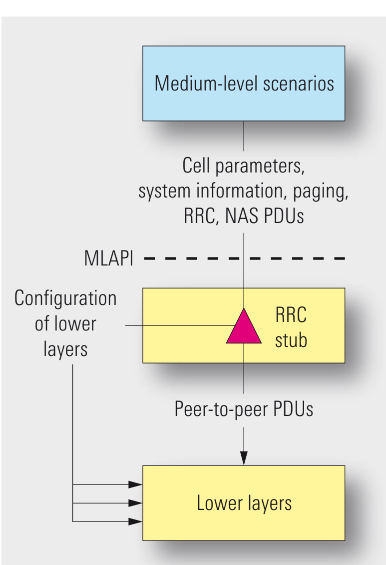


FIG 1
The interface between the medium-level scenario and the protocol stack minimizes the programming effort and allows maximum flexibility in protocol tests.

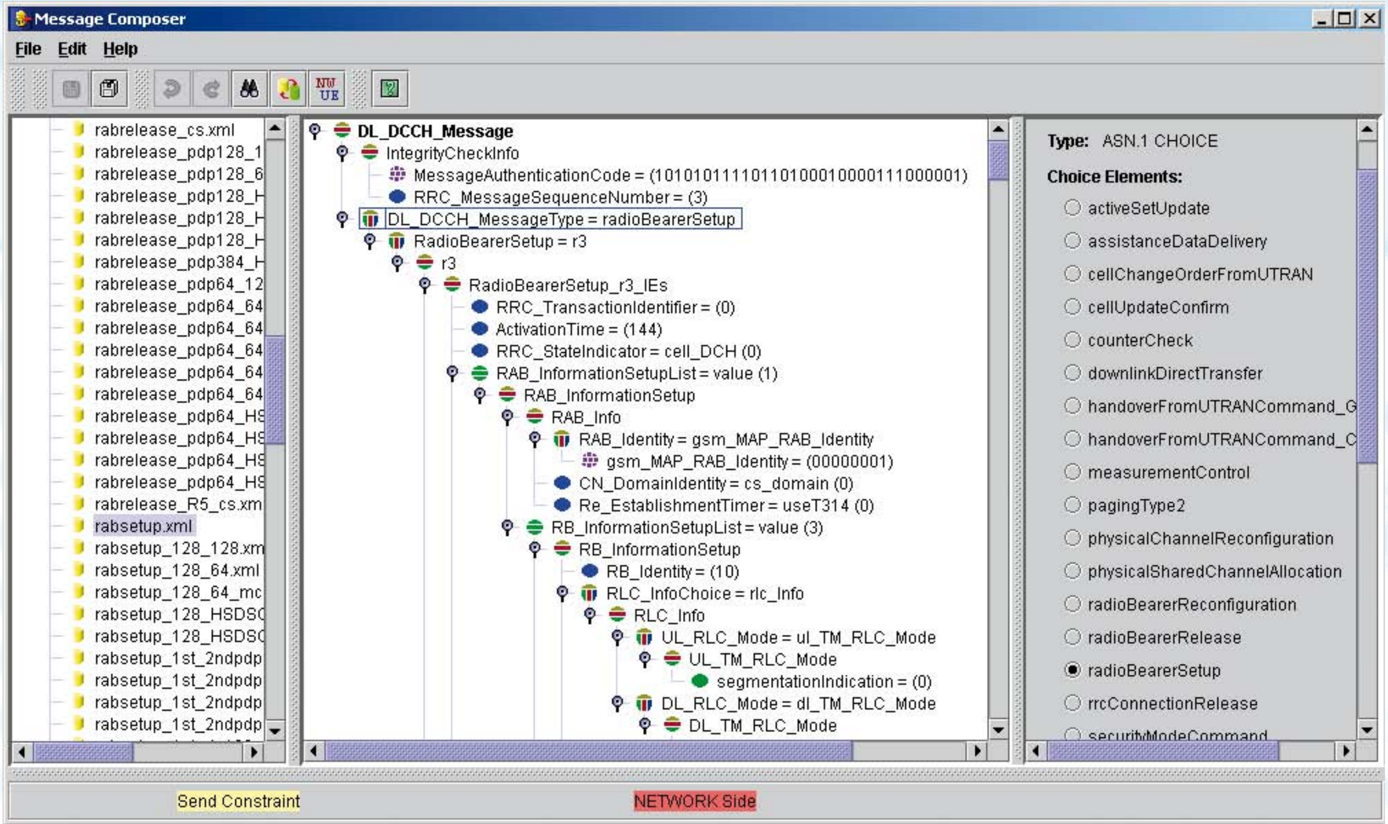
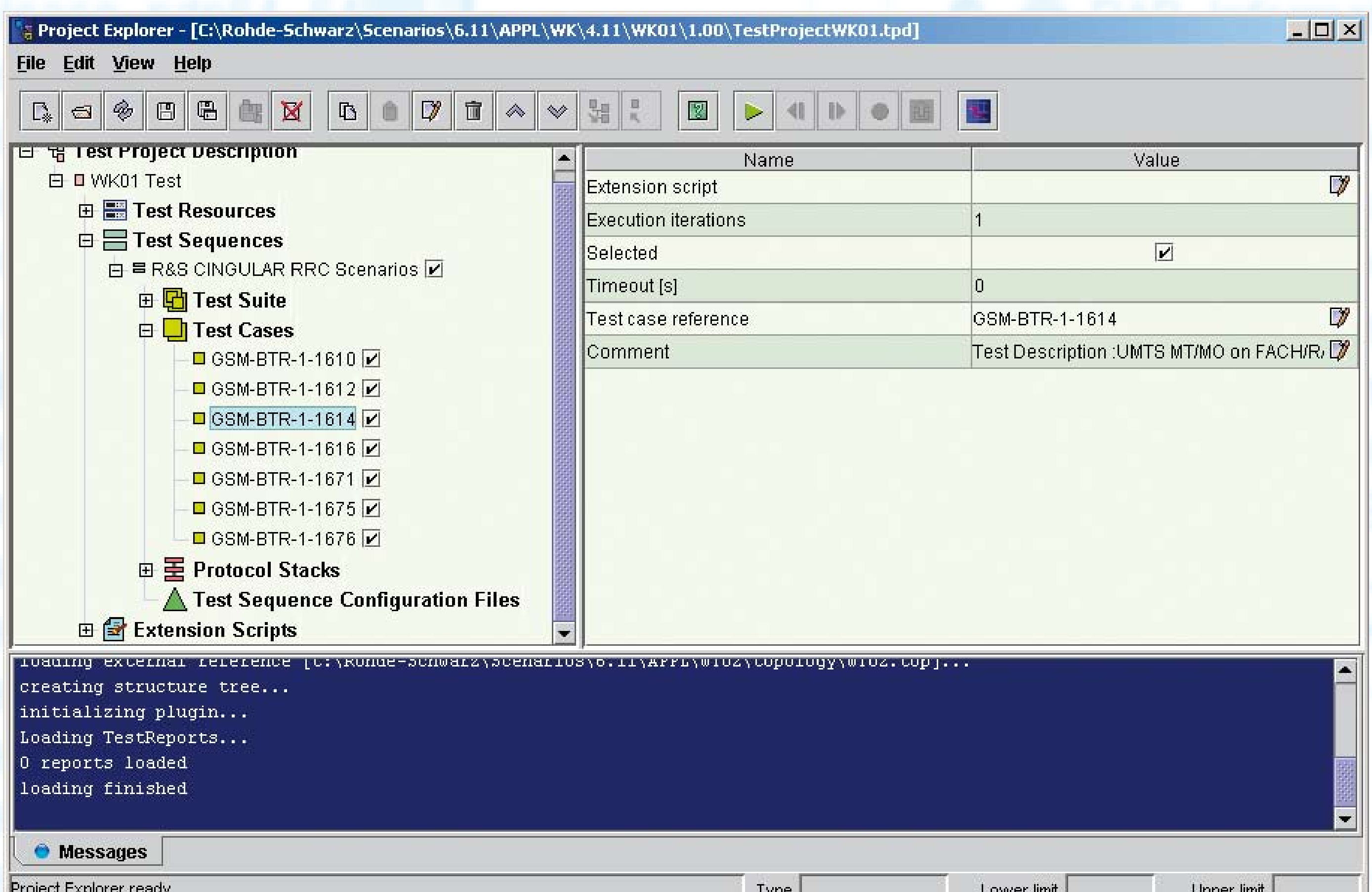


FIG 2 The Message Composer allows you to easily modify the contents of all test case protocol messages without having to change the source code.

FIG 3 With the Project Explorer, you can easily configure and perform test campaigns. The test results are stored in a straightforward structure.



R&S®CRTU-W Protocol Test Platform

Broadcasting multimedia content via UMTS

Rohde & Schwarz has developed a multimedia broadcast/multicast service (MBMS) test scenario for the R&S®CRTU-W protocol test platform. Manufacturers of mobile radio terminals and corresponding chipsets can now test the functionality of their products.

Powerful test environment

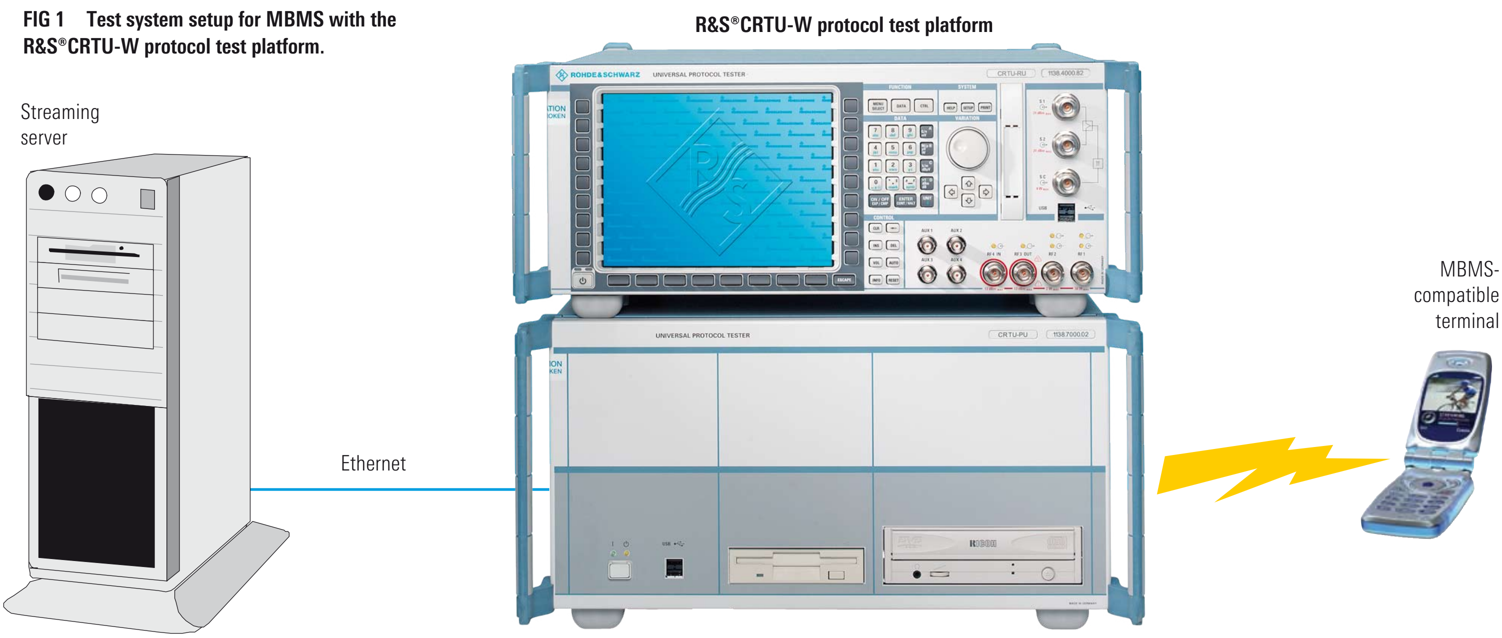
MBMS [1][2] is an expansion of UMTS defined in 3GPP release 6. It allows simultaneous broadcasting of various multimedia content to large receiver groups within a network (for details see box on right). This could already be demonstrated in real networks at this year's 3GSM World Congress in Barcelona [3]. With the R&S®CRTU-W protocol test platform, you can now test MBMS in the laboratory. Rohde & Schwarz is thus among the first to provide such a solution for the development of MBMS-capable terminal equipment. The solution offers a wide range of test system configurations and is thus a powerful test environment.

Detailed and reproducible tests

You can use the R&S®CRTU-W for a variety of MBMS tests. The integrated packet data convergence protocol (PDCP) data generator allows you to verify the basic characteristics of MBMS-compatible terminals. If an external streaming server is connected to the Ethernet interface of the tester, the system setup is capable of simulating a real 3G network (FIG 1). This system setup allows you to perform detailed and reproducible MBMS-compatibility tests of terminal equipment including the display of the transmitted video and audio data.

To use the MBMS functionality of the R&S®CRTU-W protocol test platform, you only have to update the software. Example scenarios are included in the R&S®CRTU-WT02 C++ programming

FIG 1 Test system setup for MBMS with the R&S®CRTU-W protocol test platform.



MBMS – overview of technical features

MBMS was standardized by the 3G Partnership Project (3GPP) as an expansion of UMTS and GSM networks. It allows the simultaneous and resource-saving broadcasting of various multimedia content to a random number of receivers within a mobile radio network. Established mobile radio services, e. g. voice connections or text messages (SMS), are not impaired by MBMS and can be used at the same time.

The use of the Internet protocol (IP) throughout MBMS helps ensure easy data transfer between the content provider and the receivers. The content provider can be situated in the mobile radio core network or can be connected via the public network (FIG 2).

The multicasting of IP packets allows the efficient and resource-saving transfer of data in the core network. The IP multicast protocol generates a distribution tree from a transmitter to all its receivers in the network. IP data is generated once at the transmitter and only replicated at the network nodes where the distribution tree branches off, e. g. at the serving GPRS support node (SGSN). Compared with the conventional transfer of IP data, during which each packet has to be separately generated and sent for each receiver, efficiency is thus clearly increased.

At the air interface, the MBMS content is always transmitted in the packet-switched mode. Data can be transmitted to individual receivers via dedicated DCH channel connections (point-to-point mode) but also to all the receivers in a cell by means of a broadcast channel (FACH channel, point-to-multipoint mode). Depending on the number of receivers in a cell, the most resource-saving option is activated at any time (FIG 3).

As MBMS implies, the expansion was mainly developed to transmit audio and video streams. However, its use is not limited to these streams: Text messages, pictures, and data can also be sent and content can be broadcast in a repetitive sequence (carousel mode).

An optional electronic program guide (EPG) provides information about the scheduled broadcasting of multimedia content, e. g. about radio or TV programs. It contains program information for users (e. g. content, broadcasting times, channels) as well as all information required for configuring the terminal. You can download the latest EPG from a specific website or directly receive it via SMS / MMS.

MBMS and DVB-H: comparison

MBMS and DVB-H are two different technologies with similar applications that compete with each other for the same target group. DVB-H (-H for handheld) is an expansion of the DVB-T TV standard for reception on portable units. The standard was designed as a broadcasting-only service for national or regional coverage areas. The reception equipment is based on state-of-the-art technology. Due to the optimization defined in the standard, the power consumption of reception equipment can be minimized. Since DVB-T transmit infrastructures are already available, it is not necessary to set up additional transmitter systems.

MBMS, on the contrary, is an expansion of the UMTS cellular mobile radio standard which can address individual cells as coverage areas in the network and thus covers small local user groups. It can also provide services that go beyond simple broadcasting. Although new terminals are required for MBMS, these terminals do not have to be equipped with additional receivers since MBMS reuses the existing physical interfaces of UMTS.

FIG 2 Simplified MBMS network architecture: The broadcast multicast switching center (BMSC) connects the UMTS network with content providers.

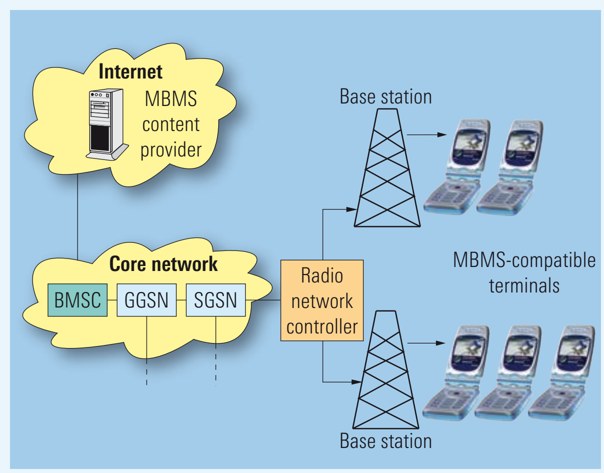
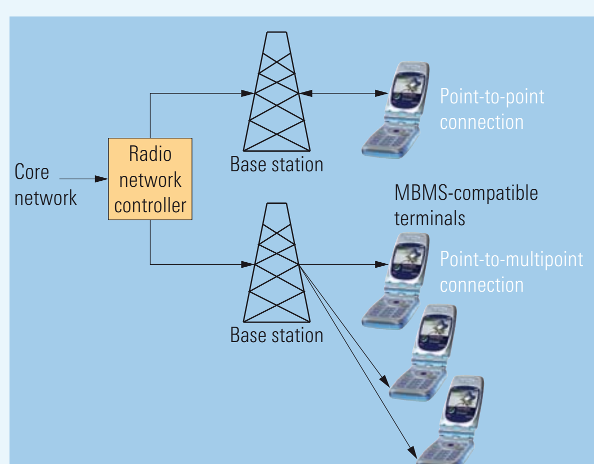


FIG 3 Network section with two UMTS cells: One cell uses point-to-multipoint transmission while the other cell uses point-to-point transmission.



interface. The R&S®CRTU-WZ08 option additionally allows you to perform more general and additional MBMS test cases. This software option also includes the complete source code: The customer can thus conveniently adapt the test cases to individual requirements. Plus, the first signaling conformance test cases for MBMS are available based on the 3GPP standard TS 34.123.

Characteristics of the R&S®CRTU-W test system

The R&S®CRTU-W protocol test platform allows you to test the MBMS compatibility of terminal equipment with the internal data generator and in conjunction with an externally connected streaming server. If an external PC is used, the streaming application implemented is user-selectable. The R&S®CRTU-W also supports a variety of multimedia content types, e.g. streams for video, audio, and text or a combination of all these. Depending on the software-specific equipment of the external server and the terminal equipment, IP data can also be transferred via MBMS by means of the FLUTE protocol [4].

The R&S®CRTU-W can transmit the internally generated or received data to up to four independent MBMS point-to-multipoint traffic channels (MTCH). A maximum data rate of 256 kbit/s is possible per channel. You can limit the maximum possible transmission rate by parameterizing the individual channels.

In addition to testing pure MBMS capabilities, you can also test other parallel services at the same time while MBMS is running, e.g. voice and packet-based connections or the reception and transmission of SMS and MMS messages.

The complete data transfer between the protocol test platform and the terminal equipment is recorded during the test run. You can thus thoroughly analyze the exchanged messages and data packets during the test run or immediately after it and quickly localize a functional error of the terminal.

Characteristics of the protocol stack used

For signaling, the R&S®CRTU-W supports the MBMS notification indicator channel (MICH) and the optional MBMS point-to-multipoint scheduling channel (MSCH). The physical channel MICH and the logical channel MSCH were introduced to keep the power consumption of terminal equipment to a minimum during MBMS reception. The MICH therefore informs the terminal that new information is available on the continuously operated MBMS control channel (MCCH). The MSCH, on the contrary, signals a status change on the MTCH, e.g. when a service is started or terminated.

Since the R&S®CRTU-W can manage up to four MTCHs, the incoming IP data has to be assigned to the available MTCHs. A configuration file in the protocol test platform maps the individual IP data streams to the corresponding MTCH. The R&S®CRTU-W can then assign every incoming IP packet to an MTCH by means of the destination addresses included.

Future prospects

The box on page 19 shows the specific pros and cons of DVB-H [5] and MBMS and how the two standards complement each other. The BCAST application enabler [6] is currently being developed to meet the requirements of both standards. The BCAST enabler provides uniform interfaces at the transmitter and receiver end and always offers the optimum technology for the reception of multimedia content. You do not have to bother about actual selections.

Although the MBMS standard has now been adopted, it will continue to be developed further. MBMS, which is going to be an integral part of the standard, is currently been expanded for long term evolution (LTE). With LTE, several base stations can be operated as a single frequency network, and reception can be improved by means of soft-combining.

Dr Ingo Gruber

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

REFERENCES
[1] 3GPP TS 22.146, "Multimedia Broadcast / Multicast Service (MBMS); Stage 1", October 2006
[2] 3GPP TS 23.246, "Multimedia Broadcast / Multicast Service (MBMS); Architecture and functional description", March 2007
[3] Press release: "Ericsson to showcase mobile TV using MBMS at 3GSM", February, 15, 2007, http://www.ericsson.com/ericsson/press/releases/20070208-1103347.shtml
[4] T. Paila, et. al., "FLUTE-File Delivery over Unidirectional Transport", IETF RFC 3926, October 2004
[5] EN 302 304 "Digital Video Broadcasting (DVB); Transmission System for Handheld Terminals (DVB-H)", November 2004
[6] Open Mobile Alliance, "Mobile Broadcast Services Architecture, Draft version 1.0", January 2007

User-friendly definition of 2G and 3G signaling scenarios

The R&S®CRTU enables you to create realistic protocol test scenarios by means of the interoperability tool suite (ITS) without requiring any special programming knowledge. ITS offers graphical tools that allow you to interactively create and operate a mobile radio network simulation and also import drive test data.

Tools to meet any requirement

The R&S®CRTU protocol test platform, which is used in the development and certification of GSM and WCDMA mobile phones, is not operated in the same manner as most measuring instruments. In contrast to generators, spectrum analyzers, or the R&S®CMU 200 universal radiocommunication tester from Rohde & Schwarz, you primarily use a mouse and keyboard rather than the front-panel control elements to define and start signaling scenarios and to analyze results on an external display.

The powerful graphical Windows® applications "Project Explorer" and "Message Analyzer" on the R&S®CRTU cover test execution and result analysis and make operation easy. Yet, thorough knowledge of the C++ programming language and experience in tree and tabular combined notation (TTCN) – for conformance test cases – are required in order to create protocol tests for R&D. Although these complex tools offer maximum flexibility and functionality, you not only need the knowledge mentioned above but also training on how to use the tools. However, they continue to be the tools of choice for conformance tests or in the early phase of mobile phone development.

Things are quite different in the growing interoperability test segment. Users in this segment, e. g. network operators, need easy-to-operate and efficient measuring instruments and are thus willing to do without sophisticated functionality and flexibility. Besides, many measurement applications do not require you to change every single value of a signaling message.

Fast and efficient

The interoperability tool suite (ITS) is fully tailored to meet these requirements. Even if you do not have any knowledge of the programming languages mentioned above, you can create your own signaling scenarios for the R&S®CRTU. The suite complements the existing programming interfaces for the R&S®CRTU and offers time-saving troubleshooting in 2G / 3G signaling scenarios (FIG 1).

The ITS currently consists of the following software tools:

- **ITS director** for interactive, graphical setup of test scenarios
- **ITS replay** for automatic generation of tests by reading drive test data

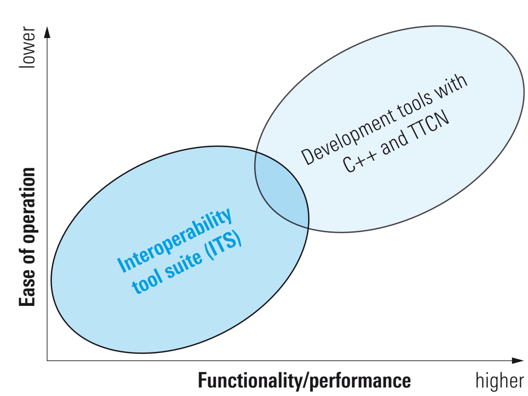


FIG 1 Diagrammatic comparison: tools for creating test scenarios with the R&S®CRTU.

ITS director – interactive, graphical setup of test scenarios

The first step is to graphically set up the mobile radio network to be simulated, which involves only a few mouse clicks and configuration dialogs (FIG 2). You can then start your signaling scenario. You can interactively operate the mobile phone and the network simulation, set up voice and video connections, use data connections, change the transmit power of the cells, or initiate handover between mobile radio cells. All activities and message contents between the mobile phone and the network are written to a file. Thus, the scenario can be played back as often as you want under the same conditions. In this mode, the mobile phone can be remote-controlled from the ITS director so that manual operation is not required. Recorded scenarios can be modified at a later time by simply clicking the individual signaling procedures. For example, you can change a simple voice call to a video call. The signaling message can of course be viewed in detail with the tried-and-tested Message Analyzer included in the R&S®CRTU – even during the test sequence.

ITS replay – from reality to simulation

With the ITS replay software tool, you have a second means of creating a test scenario without needing special programming knowledge. ITS replay uses results obtained during drive tests that were carried out in real mobile radio networks and creates a simulation for the R&S®CRTU (FIG 3).

To perform measurements in mobile radio networks, Rohde & Schwarz offers the R&S®TSMx radio network analyzers [1], test mobile phones, and the R&S®ROMES coverage measurement software [2]. The measurement data – including signaling information of the test mobile phone obtained during a drive test – is stored in a file.

A test scenario for ITS replay is created via the export function in R&S®ROMES. During the export, ITS replay determines the number and configuration of mobile radio cells based on the measurement data. The software tool independently generates any necessary procedures that are not already provided, e. g. registration in the network, thus giving you executable scenarios with almost no effort. The software tool uses the time stamps provided by the R&S®ROMES coverage measurement software and automatically makes the required changes, e. g. to SIM parameters.

The ITS replay software tool enables you to play back the recorded scenario and make the required changes. Thus, L3 messages can conveniently be changed via the Message Composer and the performance of mobile phones can be tested if network conditions have changed. If an error occurs in the mobile phone, new firmware can be added to the phone and the phone can be tested again with the same scenario.

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

REFERENCES

[1] R&S®TSMx Radio Network Analyzers: Radio network analyzers for all tasks and any budget. News from Rohde & Schwarz (2007) No. 192, pp 5–8

[2] R&S®ROMES3 Coverage Measurement Software: Acquisition, analysis and visualization of data in coverage measurements. News from Rohde & Schwarz (2000) No. 166, pp 29–32

Thus, you will quickly obtain a suite of test cases that can accommodate specific mobile phone types or network configurations and that allows you to automatically perform regression tests.

Summary

In combination with the R&S®CRTU protocol test platform, the interoperability tool suite (ITS) enables you to easily, quickly, and reliably create realistic signaling scenarios without needing special programming knowledge. Thus, the costs and time required for field tests can considerably be reduced. Network operators can create their own test suites for acceptance tests, and errors that occur in real networks can quickly be reproduced and analyzed in the laboratory. These new software tools make the R&S®CRTU even more efficient in development, conformance testing, and interoperability testing.

Reiner Götz

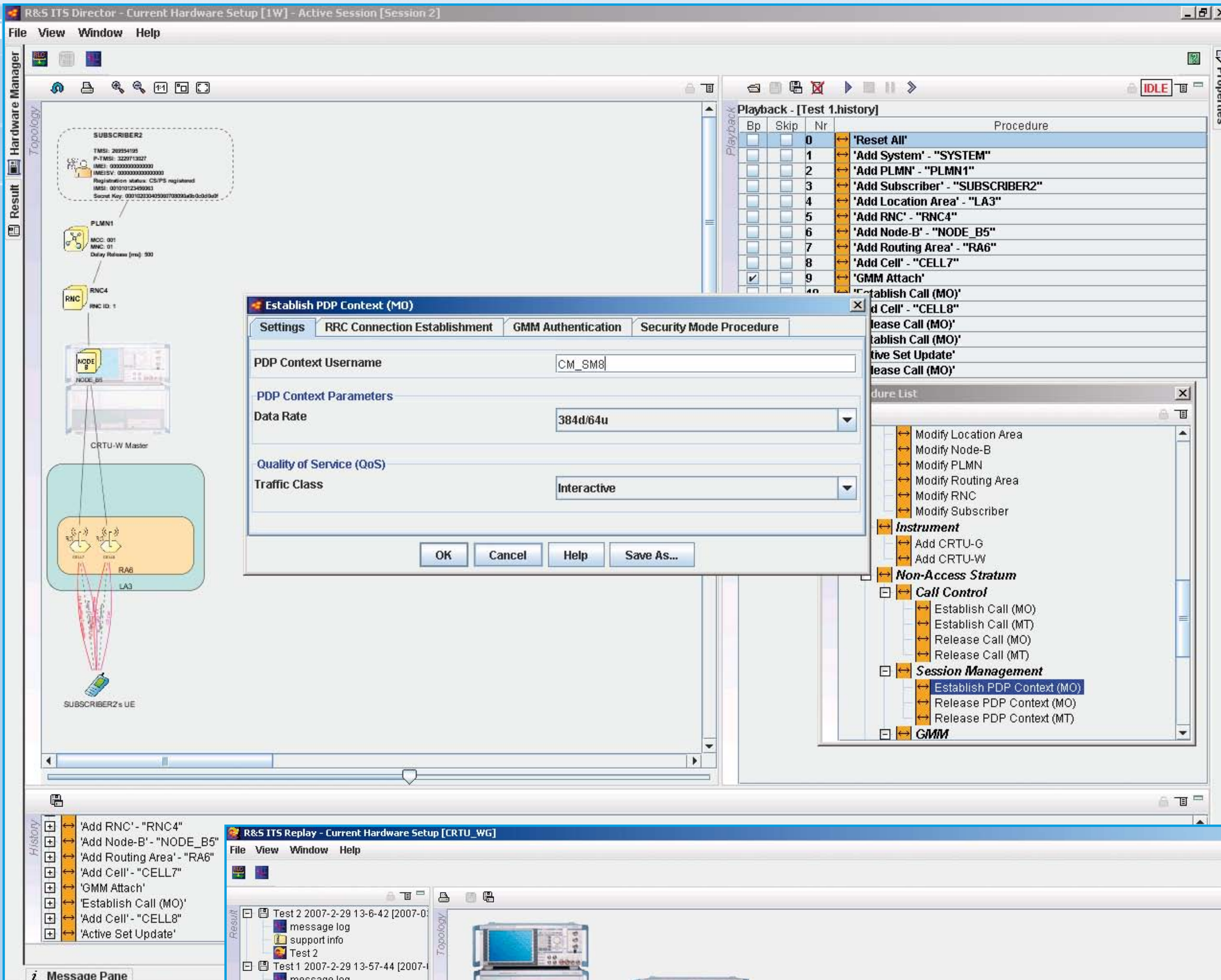


FIG 2 ITS director for interactive, graphical setup of test scenarios.

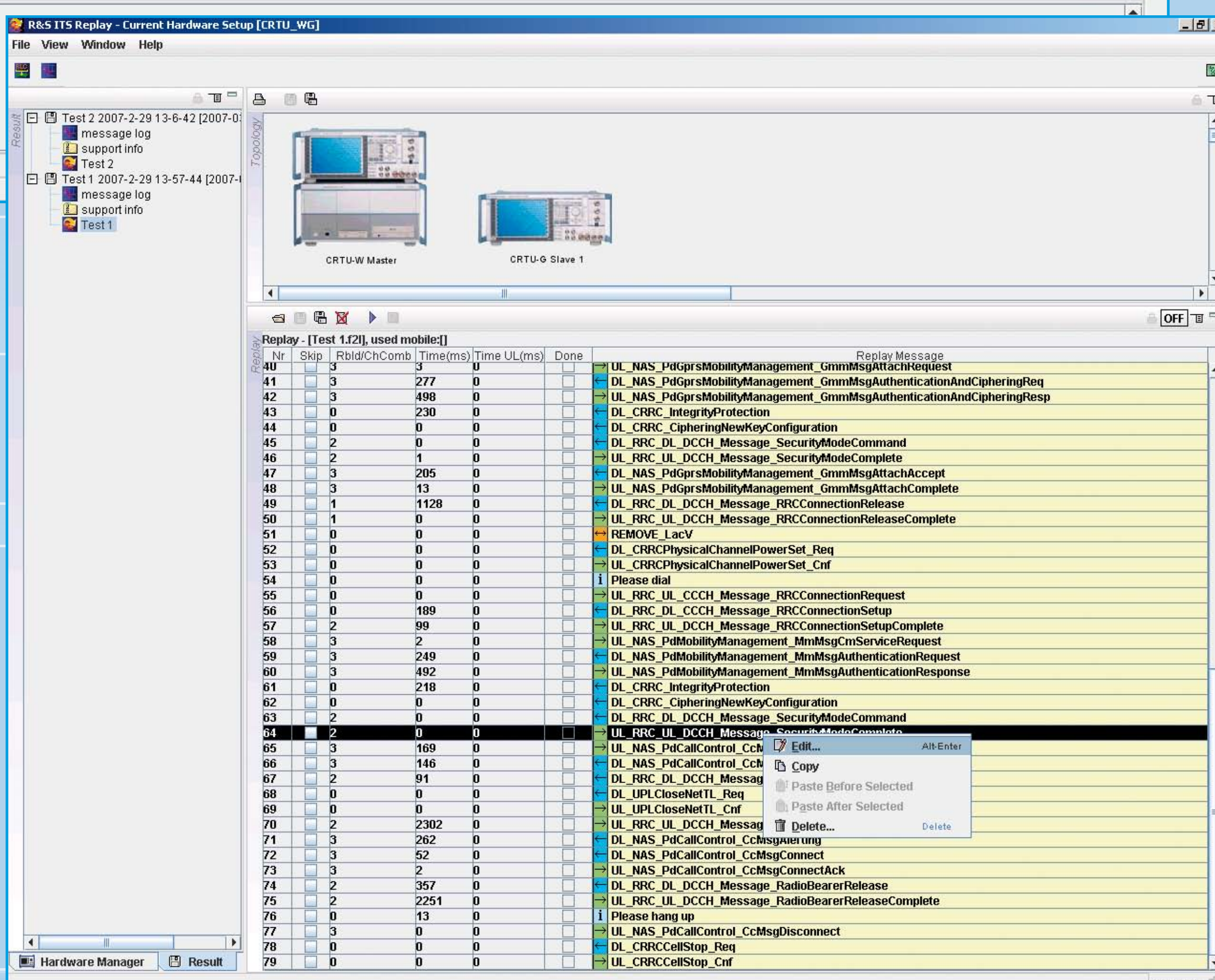


FIG 3 ITS replay can automatically generate tests by reading in drive test data.

R&S®CMU 200 Universal Radio Communication Tester

HSUPA data applications

In addition to the established WCDMA Release 99 and HSDPA transmission standards, the R&S®CMU 200 now offers capability to perform HSUPA end-to-end data tests. It is thus able to handle the latest expansion of the WCDMA standard, allowing mobile user equipment to be tested in a realistic scenario at an early stage of development.

End-to-end data tests – now also for HSUPA

The test setup and procedure for HSUPA end-to-end data connections (see box below) is the same as for WCDMA / HSDPA tests [1]. The device under test (DUT) is connected to the R&S®CMU 200 and initiates a packet-switched call setup. The radio tester establishes the call with the preset parameters. On the R&S®CMU 200 graphical user interface, you can select HSUPA for packet data transmission in the uplink. Downlink transmission can take place on a WCDMA Release 99 channel or an HSDPA channel – in other words, HSPA transmission (i. e. simultaneous HSDPA and HSUPA transmission) is possible. When the call has been set up successfully, a data application can be run. For example, files can be uploaded and downloaded between the tester and the DUT using the FTP server in the R&S®CMU 200. For other applications, e. g. video streaming, an external PC can be connected to the R&S®CMU 200 via Ethernet, and an end-to-end data connection can be set up between the DUT and the PC for any IP-based application.

Measurement functions for HSUPA

During an end-to-end data connection, the enhanced measurement functions of the R&S®CMU 200 can be used to analyze the signal sent by the DUT. For example, the various code domain power measurement functions detect the new E-DPCCH and E-DPDCH HSUPA channels and measure their gain factors (FIG 1). This measurement reveals whether the DUT transmits on the various channels with the correct gain factors. Similarly, all the known power, modulation, and spectrum measurements can also be used for testing the HSUPA uplink signal. The RLC BLER measurement is particularly suitable for end-to-end data connections. It displays the data throughput versus time at the RLC layer. The RLC BLER measurement in FIG 2 shows a UDP streaming application running in the uplink while an FTP data transfer is performed in parallel. The figure shows that the throughput of the streaming application varies about 1.2 Mbit/s, while data throughput of the FTP transmission is constantly high at nearly 2 Mbit/s. With the TTI value set to 10 ms, this is the maximum achievable throughput.

Comprehensive configuration options

The R&S®CMU 200 user interface allows a large number of parameters to be set for the HSUPA connection, both for the downlink signaling channels generated by the tester and the HSUPA uplink signal sent by the DUT. A key parameter is the TTI mode. The R&S®CMU 200 offers both the standard TTI value of 10 ms and the new value of 2 ms.

The grant values to be signaled to the DUT via the E-AGCH and E-RGCH channels (see box) can be defined. Constant values or user-defined patterns can be sent either once or continuously. Using the relevant R&S®CMU 200 measurement functions, the DUT's response to signaled grant values can be tested directly. The RLC BLER measurement, for example, reveals immediately whether a DUT reduces the data rate when a lower grant value is signaled. For the E-HICH, the R&S®CMU 200 can also send predefined patterns of retransmission requests.

What is HSUPA

HSUPA (high-speed uplink packet access) is an advancement of the WCDMA standard. It is included in Release 6 and optimized for packet-switched uplink transmission. A significant enhancement is the rapid allocation of uplink resources to mobile equipment by means of a grant value defining the power at which a mobile may send in the uplink. The base station signals the grant value via the E-AGCH and E-RGCH channels (enhanced absolute / enhanced relative grant channel). Moreover, an H-ARQ profile for rapid retransmission of errored data blocks is used. The H-ARQ profile is signaled via the E-HICH channel (enhanced H-ARQ indication channel). The transmission time intervals (TTIs) of data blocks can optionally be reduced from 10 ms to 2 ms in order to decrease the delay and increase the data rate. In the uplink, data is transported on one or several E-DPDCHs (enhanced dedicated physical data channels). A new control channel – E-DPCCH (enhanced dedicated physical control channel) – is also provided. For more information refer to [2].

The parameters defining the HSUPA uplink signal (FIG 3) are communicated to the DUT during call setup. These parameters include, for example, the gain factors for the uplink signal. They are set directly for the E-DPCCH channel and via reference E-TFCIs for the E-DPDCH channel. Moreover, the maximum number of retransmissions for the H-ARQ and further HSUPA-specific parameters can be set and the response of the DUT tested.

Stefan Russ

More information and data sheet at www.rohde-schwarz.com (search term: CMU200)

REFERENCES

[1] R&S®CMU200 Universal Radio Communication Tester: WCDMA/HSDPA data applications. News from Rohde & Schwarz (2006) No. 191, pp 24–25

[2] R&S®CRTU-W Protocol Tester: HSUPA: Increased uplink resources – thoroughly tested. News from Rohde & Schwarz (2006) No. 191, pp 4–6

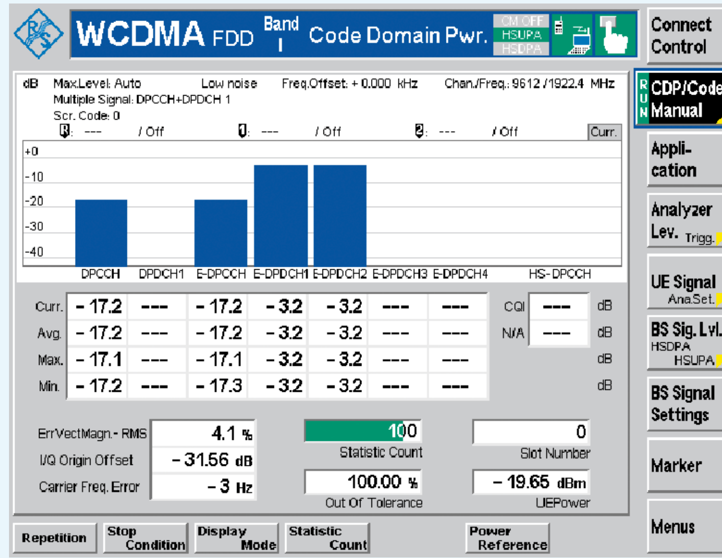


FIG 1 Code domain power measurement during an HSUPA end-to-end data connection. The R&S®CMU200 detects a DPCCH (Rel. 99) as well as an HSUPA E-DPCCH and two HSUPA E-DPDCH channels, and displays the measured relative powers.

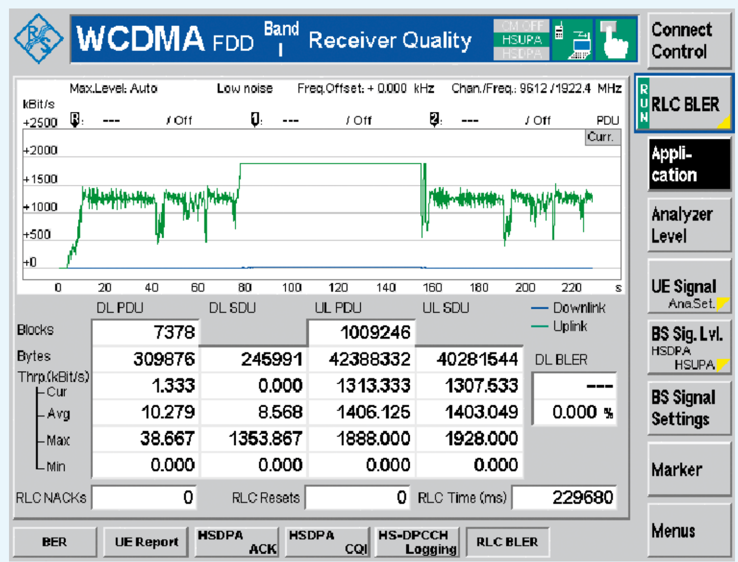


FIG 2 RLC BLER measurement during an HSUPA end-to-end data connection with two parallel data applications in the uplink: While a streaming application is running, a file is uploaded via FTP.

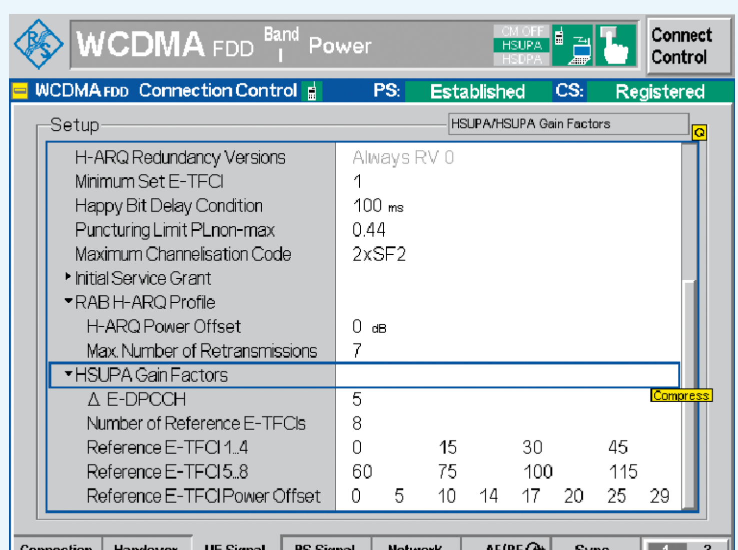


FIG 3 HSUPA uplink signal configuration on the R&S®CMU200 user interface. The parameters are signaled to the DUT during call setup.

R&S®UPV Audio Analyzer

Voice quality measurements in modern telephony

Intelligent coding methods with psycho-acoustic algorithms are used in modern mobile radiocommunications to ensure good voice quality despite low bit rates. A new software option for the R&S®UPV measures the quality of such voice signals.

PESQ detects voice quality

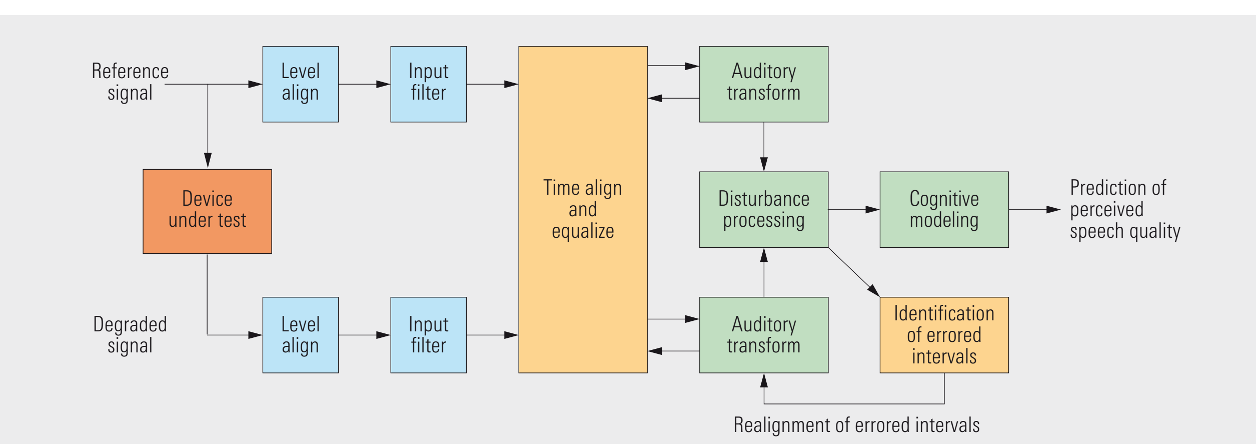
Manufacturers of mobile telephony equipment want to know how to measure the quality of voice signals at the receiver in cases where the data volume of the signals has been significantly reduced owing to the use of psycho-acoustic algorithms and coding and decoding no longer provide the original signal. One solution is offered by the perceptual evaluation of speech quality (PESQ), which is a measurement method that was published by the International Telecommunication Union (ITU) in 2001 as recommendation ITU-T P.862. PESQ is an algorithm that makes it possible to evaluate voice signals by comparing them with the reference signal. Rohde & Schwarz has licensed the implementation of this measurement from the Opticom GmbH company in Erlangen and offers it as the R&S®UPV-K61 software option for the R&S®UPV audio analyzer.

The principle of PESQ

The human sense of hearing lacks the ability to perceive specific sections of complex signals. All psycho-acoustic coding methods use this limitation to their advantage by omitting imperceptible sections during transmission in order to reduce data volume. In comparison to music, for example, voice signals can be compressed even further, since they are much more narrowband. By using suitable psycho-acoustic measurement methods, it must be possible to objectively verify whether the voice is subjected to impermissible changes in the signal processing chain.

To develop PESQ, a large of number of recorded voice samples spoken by a wide variety of speakers in various languages were used. These recordings were then compressed using a variety of voice coders – and thus different quality levels – and degraded by introduc-

FIG 1 Signal flow in PESQ measurement: The reference signal and the measurement signal are filtered, a potential time delay is compensated for, and both signals are then correlated. The measurement value is based on the underlying psycho-acoustic model.



ing typical network transmission disturbance. In a series of acoustic tests, a sufficiently large number of test listeners rated these samples on a scale ranging from 1 (poor) to 5 (excellent).

The objective of the development of PESQ was to provide a method that compares the original undegraded voice signal (reference signal) with the degraded signal (measurement signal) and outputs an objective measurement value that very closely correlates with the average value of the audio test results. During the PESQ measurement, a reference signal is applied to the input of the device under test, and the signal at the output is analyzed (FIG 1). Although this can affect the test setup (since the reference signal must be available at the R&S®UPV, which can make measurements via long distances impossible), the method offers very high accuracy and reproducibility. Moreover, the method is extremely insensitive to frequency responses and different signal levels (up to above 30 dB).

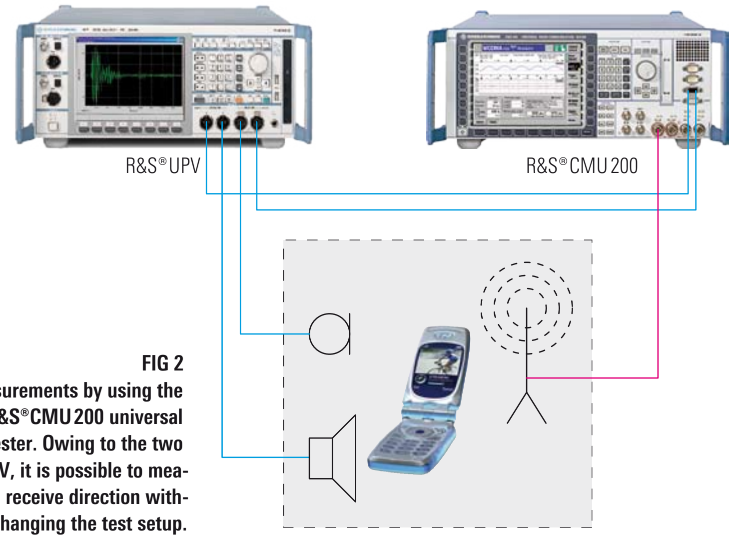


FIG 2
Acoustic PESQ measurements by using the R&S®UPV and the R&S®CMU 200 universal radio communication tester. Owing to the two channels in the R&S®UPV, it is possible to measure in the transmit and receive direction without changing the test setup.

Electrical and acoustic measurements

The R&S®UPV audio analyzer can be used in two different PESQ applications: For electrical measurements, the generator and the analyzer are connected to the device under test via cables. For acoustic measurements, coupling is provided via an artificial head.

Electrical measurements

Developers of advanced coding methods must optimize their algorithms for voice transmission. In addition to the conventional signal and distortion measurements, network operators need suitable T & M equipment. This is especially true for the new psycho-acoustic coding methods, for which the conventional sinewave test signals are no longer applicable. Measurements of this kind are usually performed on the electrical path directly at the connectors of the R&S®UPV.

With packet-oriented voice transmission, e. g. voice over IP (VoIP), the PESQ measurement provides an evaluation of the time delay between reference and measurement signal which would otherwise be very difficult to obtain. This time delay should be as constant and small as possible. This is a useful feature for providers of VoIP technologies, who increasingly have to focus their attention on this condition.

Acoustic measurements

Manufacturers of mobile phones have recognized that they can set themselves apart from the competition by giving greater attention to voice quality, which is primarily determined by the coding method in the mobile phone. The PESQ measurement for this purpose is performed under realistic conditions via an acoustic coupler attached to the phone.

In the case of acoustic measurements, the R&S®UPV can fully demonstrate its advantages: Due to its modules' excellent characteristics for analog signals, no PESQ-relevant quality impairments are caused in the measurement signal between the output and input signal – not even at large level differences. Moreover, the two channels of the audio analyzer can be used to perform measurements in both the transmit and receive direction by using the same test setup (FIG 2). By a simple switchover, it is possible to change from the transmit to the receive direction.

The special remote control characteristics of the R&S®UPV make it possible for a simple, automatic application program running on the audio analyzer to measure both directions in succession and to display the results in one and the same graphic.

Dr Valentin Illich

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

R&S®FSL / FSP / FSQ Spectrum / Signal Analyzers

Ready for virtually any broadband application

Rohde & Schwarz offers a complete product portfolio for generating and analyzing signals in WiMAX applications. The products cover virtually any requirement and excellently complement each other.

New standards – greater requirements

Ever higher data rates in wireless transmission methods also place more stringent requirements on the T&M equipment. The demodulation bandwidth is therefore an important parameter. For example, demodulation bandwidths of at least 5 MHz are necessary for measuring the modulation quality of 3GPP signals.

Development labs place the highest requirements on the equipment, where it is often not enough to analyze only a single signal. For realistic tests, it is also necessary to simulate multicarrier / multiband scenarios, which necessitates significantly wider demodulation bandwidths – a domain of high-end signal analyzers such as the R&S®FSQ.

In the past, measurements performed in production only required the demodulation of a narrowband channel. However, the emergence of new broadband transmission standards such as WLAN (802.11) and stationary or mobile WiMAX (802.16-2004, 802.16e-2005) with bandwidths up to 28 MHz are now requiring the use of signal analyzers with wider bandwidths in production as well – a field the R&S®FSL spectrum analyzer specializes in.

FIG 1 Typical values for EVM and ACLR of the R&S®FSL, R&S®FSP, and R&S®FSQ spectrum and signal analyzers in the case of a WiMAX signal with a bandwidth of 8.75 MHz at 3.5 GHz input frequency. The last row in the table shows the various demodulation bandwidths.

	R&S®FSL	R&S®FSP	R&S®FSQ
			
EVM	–37.5 dB	–46 dB	–54 dB
ACLR	59 dB	69 dB	81 dB
Demodulation bandwidth	20 MHz	9 MHz	120 MHz

High-end and cost-optimized solutions

Rohde & Schwarz offers the ideal T&M equipment for both development and production. A cost-efficient alternative for production now rounds out the company's product portfolio. When equipped with the R&S®FSL-K91 option for WLAN and the R&S®FSL-K93 option for WiMAX, the R&S®FSL is ideal for the analysis of these broadband signals. Owing to its demodulation bandwidth of up to 20 MHz, the R&S®FSL analyzes the modulation quality of all conventional broadband signals at unrivaled speed, accuracy, and cost-effectiveness. The measurement capabilities offered, the user interface, as well as the remote control commands are identical with the corresponding options of the high-end R&S®FSQ signal analyzer (R&S®FSQ-K91 [1], R&S®FSQ-K93 [2]), where only the technical parameters and the configuration may differ. Thus, another major advantage is offered: Measurement solutions developed in the lab can be quickly and easily transferred to production. Porting to different platforms is no longer necessary, and employees do not require special training for the various T&M solutions.

With regard to the production of WLAN and WiMAX equipment, the R&S®FSL is the instrument of choice when it comes to finding a compromise between price and technical capabilities. If the requirements placed on the dynamic range are between those of the R&S®FSL and the high-end R&S®FSQ, e. g. in the production of base stations, Rohde & Schwarz has developed a customized solution: the WiMAX option for the medium-class R&S®FSP spectrum analyzer. By offering the R&S®FSQ, R&S®FSP, and R&S®FSL spectrum and signal analyzers and the R&S®FSQ-/FSP-/FSL-K93 WiMAX options, Rohde & Schwarz provides cross-compatible T&M solutions for any application. Moreover, the solutions differ only in their technical parameters (FIG 1).

If you are performing measurements in the baseband, a further alternative is the R&S®FMU36 baseband signal analyzer together with the R&S®FSQ-K93 option. With respect to signal processing, this solution is basically identical with the R&S®FSQ (the R&S®FMU36 is presented on page 44).

Expanded scope of functions

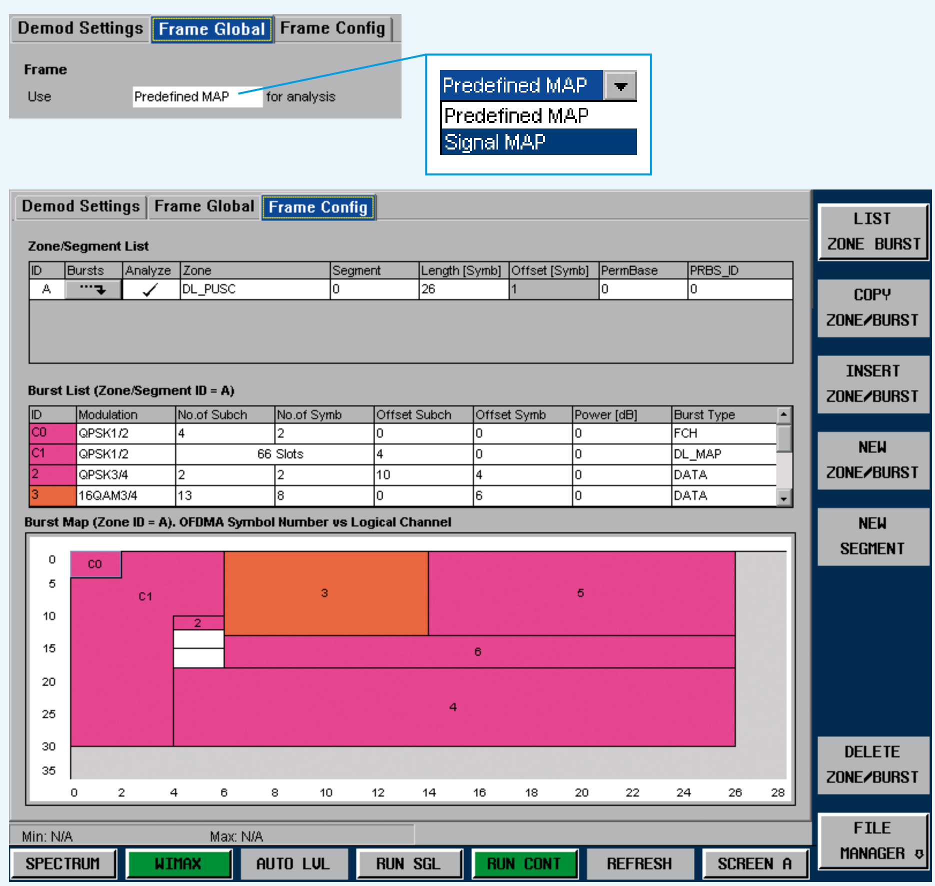
The various measurement capabilities of the R&S®FSL-/FSP-/FSQ-K93 options as well as the display of the measurement results have already been discussed in previous articles on this topic ([2], [3]). However, the well-planned further development of the options includes not only optimized analysis algorithms that allow most notably higher measurement speed and greater flexibility in application, but also an expanded scope of functions. For example, you can now change the mask for spectral measurements and adapt it to the various requirements of the regulatory authorities of different countries. This makes it possible to easily check whether the products can be used in the various sales regions. Moreover, a new function has been added to the options that far exceeds the normal use of vector signal analyzers for testing modulation characteristics. The DL map can now be decoded and used for demodulation. This allows you to measure DL signals without knowing the DL map and without dealing with the difficulties of entering. As a result, the measurement of transmit signals is significantly simplified, development work becomes more effective, and the setup of T&M equipment in production takes less time. Furthermore, you can determine whether the DL map was generated correctly. This function, similar to a sniffer[1)], may help you avoid having to invest in a costly instrument for this purpose. FIG 2 shows the simple operation. By defining the demodulation settings, you can specify whether a predefined DL map or the one present in the signal is to be used. The DL map can then be read and graphically displayed. The burst assignment as well as the modulation type of each burst can also be easily read (FIG 3).

Generators as well

The characterization of WiMAX instruments also requires generators in addition to signal analyzers. Rohde & Schwarz offers scalable solutions for this purpose. For example, the R&S®SMJ100A [4] together with the R&S®SMJ-K49 option is a cost-optimized instrument for generating signals in production. In this case as well, the setting capabilities, the user interface, and the remote

1) A sniffer is an instrument that analyzes and displays transmit signal data that is important for connection setup but without responding to it – as, for example, a full-fledged protocol tester or communications tester is able to do.

FIG 2 Automatic demodulation of a WiMAX signal. The burst assignment with the various modulation types can be displayed.



control commands are identical to those of the high-end R&S®SMU200A generator. The R&S®SMU200A offers significantly more capabilities such as fading, which is indispensable in development labs. To further simplify measurements on WiMAX modules, the individual signal settings of Rohde&Schwarz signal generators can be transferred to the Rohde&Schwarz signal analyzers – either directly via LAN or via an external storage medium. You only have to define the signal once in the generator, i.e. you do not have to configure the analyzer after you transfer the settings. This eliminates effort and errors, which can be very time-consuming due to the large number of WiMAX parameters involved.

Summary

Rohde&Schwarz provides a complete product portfolio for WiMAX – both for generating and analyzing signals. Moreover, the individual products optimally complement each other. The combination of the R&S®FSL and R&S®SMJ100A is often used in production shops, while the R&S®FSQ together with the R&S®SMU200A is intended more for development labs.

Dr Wolfgang Wendler; Johannes Steffens

More information and data sheets at www.rohde-schwarz.com (search term: type designation)

REFERENCES
[1] Signal Analyzer R&S®FSQ – The complete family of wireless LAN standards: 802.11 a, b, g, j, n. News from Rohde&Schwarz (2004), No. 183, pp 28–30
[2] Signal Generator R&S®SMU200A / Signal Analyzer R&S®FSQ: Complete test solution for WiMAX applications. News from Rohde&Schwarz (2005), No. 187, pp 33–37
[3] Signal Generators R&S®SMx / Analyzers R&S®FSQ / R&S®FSL: WiMAX goes mobile – new T&M solutions are required. News from Rohde&Schwarz (2006), No. 190, pp 24–27
[4] Vector Signal Generator R&S®SMJ100A: The all-purpose generator that redefines the medium segment. News from Rohde&Schwarz (2005), No. 186, pp 30–33

FIG 3
The green bar shows which parts of the signal have been analyzed and that the DL map has been detected. The constellation diagram shows the various modulation types.

FIG 1 Three new digital modules make the CompactPCI / PXI-based R&S®CompactTSVP test platform even more versatile.

CompactPCI / PXI-based R&S®CompactTSVP Test Platform

Comprehensive digital functional tests of electronic components

The modular R&S®CompactTSVP open test platform, which is CompactPCI / PXI-based, provides special cost benefits for T&M applications in the development, production, and quality assurance of electronic assemblies and components. Three new digital modules make it even more versatile (FIG 1).

Current trend: reduction of time to market

Ever shorter product development times call for T&M equipment that can quickly and easily be adapted to new requirements. It is therefore advantageous to provide the required T&M equipment in the form of highly compact modules that can be flexibly configured. Large additional investments can thus be avoided.

The modular R&S®CompactTSVP open test platform from Rohde & Schwarz, which is CompactPCI / PXI-based, has been tailored to meet these requirements. It offers special cost advantages for T&M applications in the development, production, and servicing of electronic assemblies or components. By adding the powerful, easy-to-operate, and standardized software components, you will benefit from versatile system solutions that considerably reduce time to market. This holds true not only for manual test stations, but also for fully automatic test stations where space is often limited.

As the test platform implements open industry standards such as CompactPCI / PXI and CAN throughout and features a unique system architecture, you are provided with an efficient portfolio of T&M functionalities as well as hardware and software communications interfaces.

Complex requirements in digital functional tests

To perform digital functional tests on electronic assemblies or components, the test system must simulate the input signals of a DUT as realistically as possible and check whether the DUT responds correctly. The wide diversity in customer applications is matched by the broad-scope requirements placed on stimulation signals in the implementation of digital interfaces. These requirements range from signals with relatively low data rates and levels above 24 V to signals with very high pattern rates in the MHz range and levels below 5 V. The number varies from a few bits for serial buses up to complex signals for parallel buses, where several modules may be used in sync to provide bus emulation. The hardware protocols to be implemented may comply with an industry standard (e.g. RS-232-C, CAN, I^2C, SPI), but may also be customer-specific (e.g. Flash programming, processor bus). It is not uncommon for the deterministic

WAGO Kontakttechnik relies on the R&S®TS-PIO 2 module

In a project at WAGO Kontakttechnik, in Minden, Germany, the unique capabilities of the R&S®TS-PIO 2 module proved their mettle. To achieve optimum test time, ten WAGO assemblies (FIG 2) had to be tested in parallel. The following functionalities had to be implemented:

- Ten constant voltage sources ±24 V / 20 mA
- Five constant current sources 0 V to 20 mA
- Ten voltage measurement channels ±24 V
- Ten current measurement channels 0 V to 20 mA

The R&S®TS-PIO 2 modules were required to operate at the highest of precision because the WAGO analog assemblies also had to be calibrated. All these criteria were met with only two R&S®TS-PIO 2 modules – and WAGO was able to reduce test time by an extremely impressive factor of 1/30.

FIG 2 DUT of WAGO Kontakttechnik.

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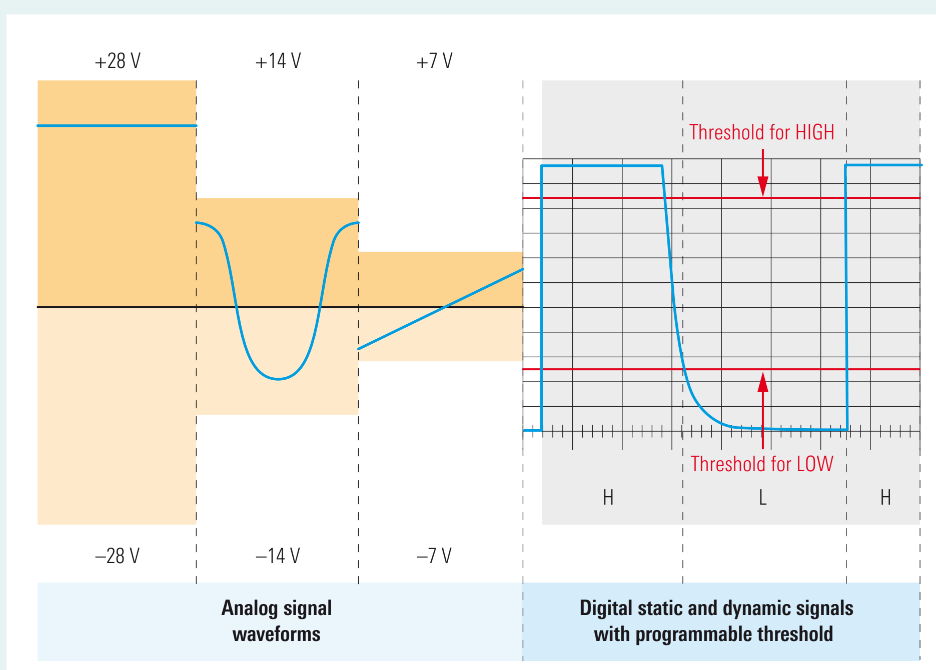
FIG 3 R&S®TS-PIO 2 analog / digital I/O module.

FIG 4 Operating modes of the R&S®TS-PIO 2 module.



simulation and time-synchronous recording of digital signals to also be accompanied by the need for additional protocols at the software level.

New digital modules expand the wide range of functions

When high levels and maximum precision are required: the R&S®TS-PIO2

A key characteristic of the R&S®TS-PIO2 analog/digital I/O module (FIG 3) is its floating I/O channels. They can prevent the latent danger of hum pickups, as may occur in ground-referenced measurements – especially when longer wiring arrangements are involved.

Featuring 16 precision analog inputs and outputs each, the module enables you to implement even complex measurement tasks. Both the stimulation and the acquisition of signals can be performed statically or dynamically (max. 5 kHz) (FIG 4). Other key criteria include:

- Multichannel voltage sources with levels up to ±27 V and optional current limiting
- Multichannel current sources with currents up to ±100 mA
- Digital output ports with programmable HIGH and LOW levels in the range ±27 V
- Multichannel generation of squarewave signals up to 40 kHz
- Precise, differential voltage measurements
- Multichannel current measurements (shunt resistors on the module)
- Digital input ports with programmable hysteresis in the range ±27 V
- Digital functional test of semiconductor components

For a look at how the R&S®TS-PIO2 module drastically reduces testing time at the WAGO Kontakttechnik company, see the box on page 32.

FIG 5 The R&S®TS-PDFT digital functional test module.

When industry standards and realtime capabilities are required: the R&S®TS-PDFT

A large challenge for many test systems is the implementation of deterministic timing for digital signals. If it is also necessary to provide industry-standard-compliant serial bus systems, high system costs are usually involved.

By using just one R&S®TS-PDFT digital functional test module (FIG 5), you can meet these highly diverse requirements and thus achieve a cost-efficient solution. Owing to an autonomous hardware control mechanism on the module, digital signals can be simultaneously stimulated and detected. Data widths and frequency (max. 20 MHz) can be set separately.

A local processor, which is also present on the module, allows efficient communication with the DUT. Interferences in application timing caused by the operating system of the system controller are therefore avoided right from the start. But the module offers even more interesting features:

- Digital output ports with programmable HIGH level in the range –3 V to +10 V and TRI state control (both features for each 8-bit port)
- Digital input ports with programmable hysteresis in the range 0 V to +9.5 V (for each 8-bit port)
- Multichannel generation of frequency signals or pulse width modulation with up to 50 kHz
- Frequency measurement or event counting of programmable input patterns with up to 12.5 MHz
- Communication with the DUTs via a
  - serial interface in accordance with CAN 2.0 B (ISO11519-2 and ISO11898); generation of cyclical CAN messages
  - serial, asynchronous interface (RS-232-C, K bus, TTL)
  - serial, synchronous interface (SPI, I²C)

If speed and memory depth are the main criteria: the R&S®TS-PHDT

Since the number of electronic assemblies containing intelligent, digital components is steadily growing, there is an increasing demand for simulating digital ▶

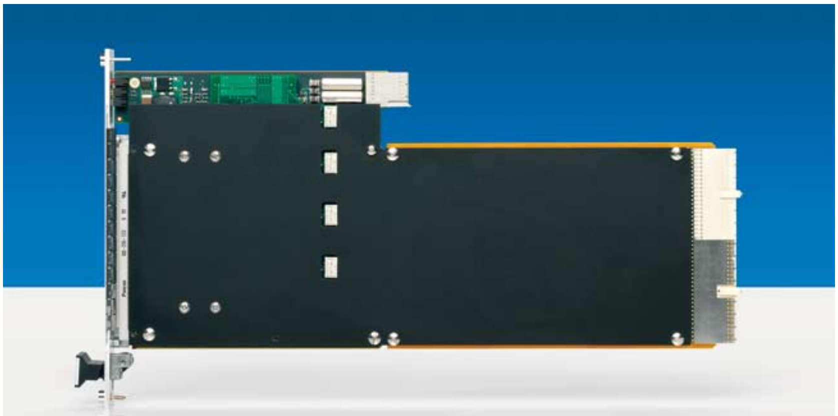

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FIG 6 The R&S®TS-PHDT high-speed digital test module.

data streams under realistic conditions. While digital in-circuit tests used to be state of the art, digital functional tests are now predominant. But these tests are possible only if the hardware used can provide the clock rates, memory depths, and analysis capability needed.

The data volume to be handled is often a special challenge: A large portion of the test time is consumed alone by the two steps of transferring recorded test data to the system controller and analyzing it.

The R&S®TS-PHDT high-speed digital test module (FIG 6) is the optimum solution to this problem. Its architecture was developed in close cooperation with the department developing inspection, measuring, and test equipment at a notable semiconductor manufacturer working in the automotive and communications electronics sector.

Owing to the local storage capacity of a remarkable 1.5 Gbyte (3 × 64 Msamples) for stimulus, nominal, and actual data, you can locally store all data required for testing a DUT. The data to be stimulated is transferred to the module in a single step during the initialization phase of the test system. To perform individual tests, you can also execute selected parts of the overall sequence.

The timing for stimulation and acquisition can be set separately in extremely small increments. The maximum pattern rate that can be implemented is 40 MHz. A signal referred to as a strobe signal, which is generated within one clock cycle, allows you to transfer data to the DUT.

Parallel to stimulation, the integrated analysis hardware compares nominal data with recorded actual data in realtime and documents the deviations that are detected. Pass/fail information, number of errors, failed channels, and additional information on erroneous steps are available in the error memory immediately after completion of a test. For further analysis, only the test data indicating errors needs to be transferred to the system controller. The resulting test performance is much higher than obtained with conventional hardware.

Compared to the R&S®TS-PDFT digital functional test module, the LOW levels of the outputs can additionally be programmed for each 8-bit port. Plus, one TRI state control for each output channel is possible, and even highly complex applications can be implemented.

Other key criteria are:

- Digital output ports with programmable HIGH and LOW level in the range −3 V to +10 V (for each 8-bit port) and TRI state control (for each channel)
- Digital input ports with programmable "forbidden zone" in the range 0 V to +9.5 V (for each 8-bit port)
- Digital functional test of electronic assemblies and components
- Programming of non-volatile DUT memories (microcontrollers, flash components)
- Simulation of digital control or processor buses

When "analog" and "switching" functions are required in addition to "digital"

In addition to the base units, numerous other Rohde & Schwarz modules (FIG 7) are available for implementing functional and in-circuit tests:

- **R&S®TS-PSC4** system controller
- **R&S®TS-PSC0** PCI interface kit
- **R&S®TS-PSAM** digital multimeter
- **R&S®TS-PICT** ICT extension module
- **R&S®TS-PFG** function generator module
- **R&S®TS-PAM** signal analyzer module
- **R&S®TS-PSU** power supply / load module
- **R&S®TS-PMB** switch matrix module B
- **R&S®TS-PSM1** power switching module 1
- **R&S®TS-PSM2** multiplex / switch module 2

In addition to the Rohde & Schwarz modules, hardware components complying with the CompactPCI and PXI standards may also be integrated into the system without any modifications being necessary.

System diagnostics ensure high efficiency

The selftest capability of all modules in the R&S®CompactTSVP product line is the basis for efficient system diagnostics and fast restoration of system functions. Since the detailed selftest report allows comprehensive system diagnostics, production downtimes can be avoided.

Owing to the generally bidirectional I/O interface of all digital modules, you can read back the signals on the output channels via the input channels.

Full-scope, user-ready software

In addition to software drivers, interactive user interfaces (soft panels) are provided. They enable you to perform almost all functions available in each module without having to write any routines yourself. Putting a test setup into operation thus becomes extremely easy and takes less time.

Summary

The CompactPCI / PXI-based R&S®CompactTSVP open test platform from Rohde & Schwarz is a flexible and highly efficient test solution that covers the full scope of digital functional testing necessary for electronic assemblies and components. Depending on the individual application, the test system can be flexibly expanded by adding measurement, stimulation, and switching modules from Rohde & Schwarz as well as OEM modules that conform to the CompactPCI / PXI standard.

Michael Grandauer

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

FIG 7 Ideal for production requirements: A variety of modules make the CompactPCI / PXI-based R&S®CompactTSVP test platform ideal for everyday use in production.

R&S®ZVL Vector Network Analyzer

Network analyzer and spectrum analyzer – two in one

The R&S®ZVL is the lightest and smallest vector network analyzer in its class. On top of this, it can be used as a full-featured spectrum analyzer if desired. This unique multipurpose instrument relies on the tried-and-tested operating concept of the R&S®ZVB and R&S®ZVA analyzer families. It offers the performance of a medium-class instrument at a price that is hard to beat.

Full-fledged analyzer in a highly compact box

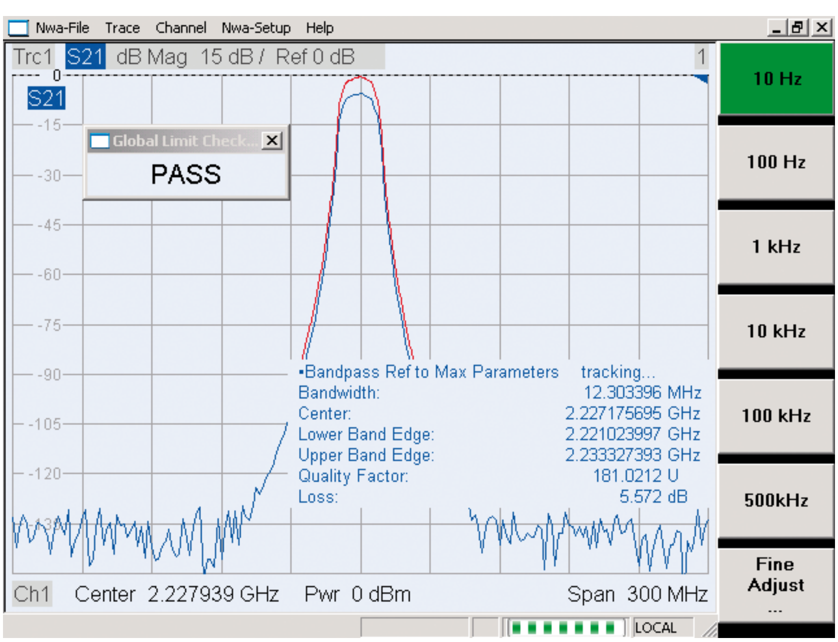
With a weight of only 7 kg and a depth of 37 cm, the R&S®ZVL (FIG 1, on right) is the lightest and most compact of the Rohde & Schwarz network analyzers – and unique in its class. It is easy to transport, and can be battery-operated for mobile applications. Yet it offers all the functionality you expect from a network analyzer, featuring a bidirectional test set that enables analysis of all four S-parameters. Plus, it features full spectrum analyzer capability (see page 38). The R&S®ZVL comes in two models, i.e. from 9 kHz to 3 GHz (R&S®ZVL3) and from 9 kHz to 6 GHz (R&S®ZVL6).

Multifaceted …

The R&S®ZVL can be used for a variety of applications. It is ideal for characterizing passive components such as filters, as well as for applications in production, installation, and service. Due to the instrument's high flexibility, the tuning of high-rejection base station filters poses no problem either. With a frequency range starting at 9 kHz, the analyzer is also ideal for cable measurements. This high versatility makes the R&S®ZVL an indispensable multipurpose tool.

The R&S®ZVL also features various calibration techniques to flexibly meet user's requirements in terms of accuracy and speed. The instrument offers transmission and reflection normalization, full one-port (OSM) and full two-port calibration (TOSM), as well as one-path two-port calibration for optimized speed.

FIG 2 Filter measurement with pass/fail evaluation.



… for filter measurements

Despite its extremely attractive price, the R&S®ZVL offers specifications almost as good as those of a medium-class instrument. With typically 123 dB dynamic range and measurement bandwidths from 10 Hz to 500 kHz, it easily satisfies the requirements commonly placed on filter measurements. The automatic band filter analysis function determines all relevant filter parameters such as filter bandwidth, center frequency, attenuation, and quality at the press of a button (FIG 2). Results can be evaluated by means of limit lines combined with pass/fail information. Limit lines can either be created by the user or from previously generated traces of known devices under test (DUTs).


DUAL MODE
7 kg only
ROHDE&SCHWARZ

Additional functions such as segmented sweep help to optimize filter measurements by combining two features that are normally incompatible: high measurement speed and wide dynamic range. With a segmented sweep, a sweep range is divided into frequency segments, and the sweep parameters such as the generator level, bandwidth, and number of measurement points per segment are separately defined for each segment. In this way, the measurement is optimally adapted to the DUT.

… at home in production

One of the main reasons in favor of using the R&S®ZVL in production is certainly its extremely favorable price. But there are many other features that make the R&S®ZVL attractive for use in production. For instance, the analyzer's wide dynamic range enables fast measurements even at larger measurement bandwidths without compromising on accuracy. Various sweep modes are available, e.g. linear, logarithmic, and segmented sweep. They can be chosen as required for the DUT to achieve the optimal measurement time. Several traces can be combined in a single diagram, which eliminates the need for calling several instrument setups – another time-saving feature.

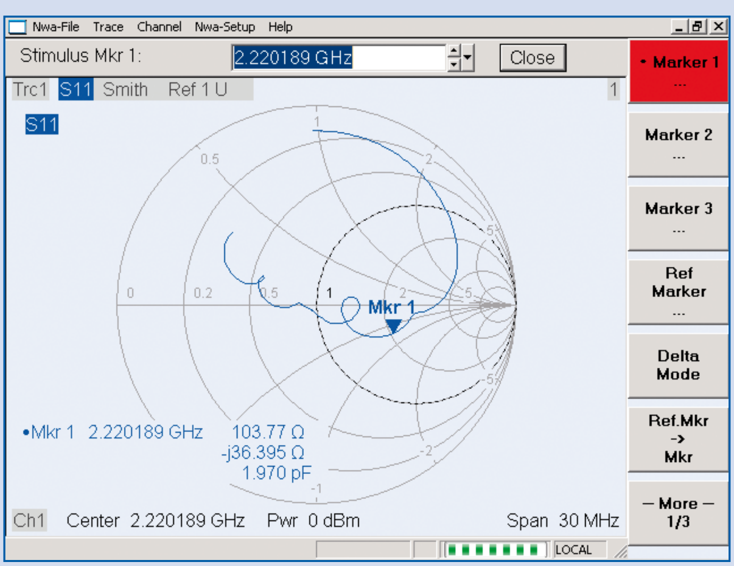
Network analyzer

The R&S®ZVL is a network and a spectrum analyzer in one (FIG 3). This unique combination of full spectrum and network analyzer functionality in a single box "kills two birds with one stone". You can switch between the network and the spectrum analyzer mode in no time. It is thus possible to analyze the S-parameters of a DUT, e.g. an amplifier, as well as its spectral characteristics without having to reconnect the DUT. Moreover, an R&S®NRP power sensor can be connected to the USB interface to measure power with high accuracy, e.g. the output power of the amplifier. In production, the instrument can be switched from one mode to the other by remote control.

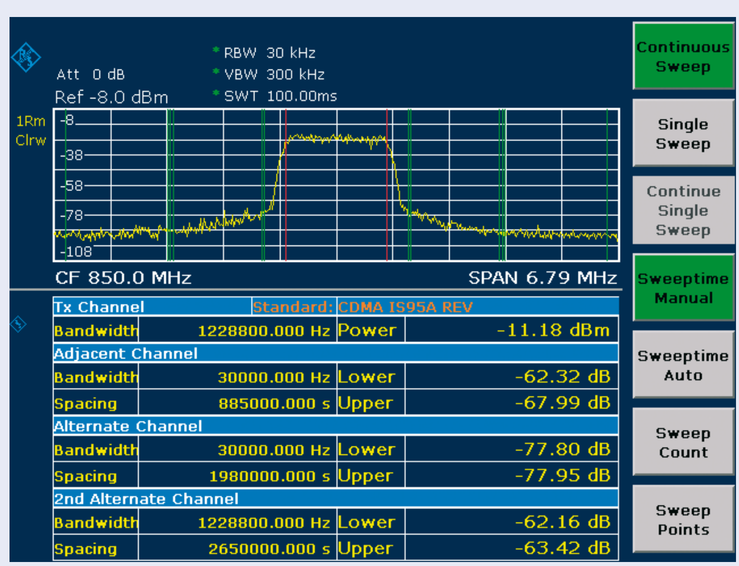
Spectrum analyzer

The spectrum analyzer functionality corresponds to that of the R&S®FSL spectrum analyzer. A variety of functions is available to characterize the DUT. Automatic channel power measurements determine the power within a defined bandwidth. Adjacent-channel power (ACP) measurements are performed for preset channel widths and spacings. For mobile radio measurements, all you have to do is select a radio standard. The instrument then automatically sets the relevant parameters, e.g. channel width and channel spacing. Results are thus obtained extremely fast and easily. On top of this, the gated sweep function makes it possible to analyze the modulation spectrum of burst signals that occur, for example, in GSM systems or WLANs.

FIG 3 In a single box: network analyzer …



… and spectrum analyzer.



… ideal for installation and service

What should the ideal instrument for installation and service be like? It must be small, lightweight, easy to operate, and capable of battery operation. The R&S®ZVL perfectly meets these requirements. Its optional battery pack allows operation independent of the AC supply. The battery pack can easily be removed and exchanged in order to extend the operating time. The instrument can also be powered from a vehicle's 12 V supply system. A carrying bag protects the analyzer against the effects of weather, and offers space for measurement accessories and an additional battery (FIG 4).

Preconfigured measurement routines can be conveniently loaded on site from the instrument's hard disk or a USB stick and then performed. Traces can be stored as screenshots in various formats. Likewise, measured values can be stored to the analyzer's hard disk or a USB stick in ASCII format or as an S-parameter file (s2p). All measurements can thus be prepared in advance and stored, and results can be documented quickly and comprehensively on completion of measurements, which minimizes the measurement time required on site.

Cross-platform operating concept

The R&S®ZVL operating concept combines highly versatile setting capabilities with easy and intuitive control. Various dialogs assist the user in setting the measurement parameters. The online help function provides information about the currently selected menu at the press of a button, including the corresponding remote control commands. Measured quantities can be shown in a single diagram or in several diagrams as required, i.e. all relevant test parameters can be displayed in any desired format (FIG 5).

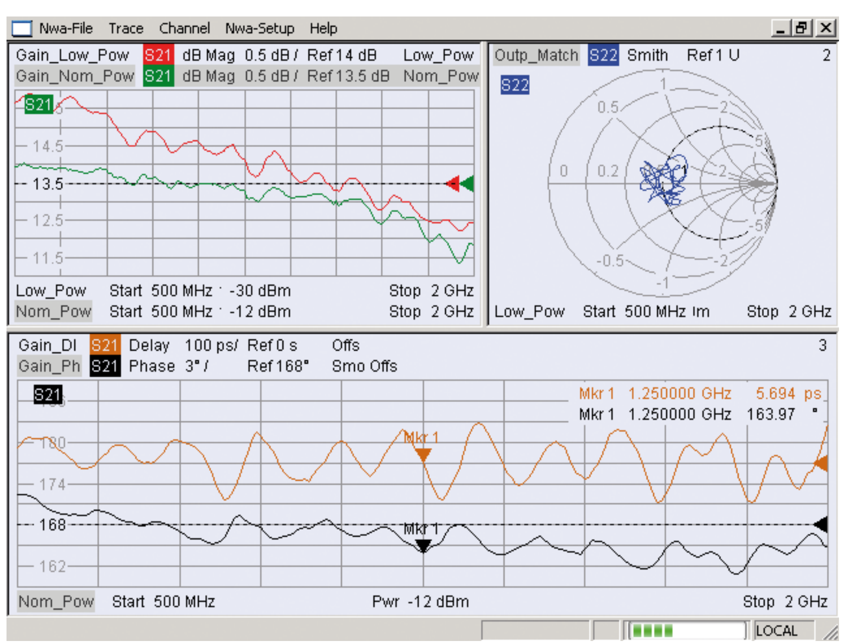
Traces can be assigned user-specific names, allowing their easy correlation to the various test parameters.

All instrument functions can be performed by means of hardkeys and softkeys or the mouse. Pressing the incorrect key inadvertently will have no serious consequences – due to the Undo / Redo function. With Undo, you can cancel several operating steps, a feature appreciated by trained as well as untrained users. Redo, in turn, can be used to cancel an Undo.

FIG 4 The R&S®ZVL in a handy carrying bag.

44947/6

FIG 5 Display of different test parameters in a single window. The example below shows results of an amplifier measurement.



A uniform operating concept and identical remote control commands for all network analyzers from Rohde & Schwarz make the R&S®ZVL a worthwhile investment. For example, if you use an analyzer of the R&S®ZVA, R&S®ZVB, or R&S®ZVT family in development, the specific measurement tasks can easily be transferred to the R&S®ZVL, and existing remote programs can be used to control the R&S®ZVL. This saves time and money, reduces training time, and eliminates potential error sources.

A long-term investment

Investments should be profitable over a maximum period of time. It is therefore vital that test equipment can be adapted and upgraded to handle future measurement tasks. The plug-and-play concept of the R&S®ZVL allows hardware options to be installed subsequently on site without having to recalibrate the instrument (FIG 6). This saves time and cost, and adds to the analyzer's range of functions. In cases where the R&S®ZVL is not able to handle a task, another member of the Rohde & Schwarz line of network analyzers can take over. This is no problem due to the uniform operating concept.

Summary

High-quality measuring equipment need not be expensive. The R&S®ZVL is proof of this. Combining network analyzer functionality with optional spectrum analyzer functionality, it offers an excellent price/performance ratio. Its good technical characteristics make the analyzer an ideal choice for applications in development, production, installation, and service. Plus, it sets standards in the lower price segment.

Andreas Henkel

44277/12

FIG 6 R&S®ZVL hardware options are simply plugged in; recalibration of the analyzer is not required.

Condensed data of the R&S®ZVL

Network analysis	
Frequency range	9 kHz to 3 GHz (R&S®ZVL3) 9 kHz to 6 GHz (R&S®ZVL6)
Dynamic range	>115 dB, typ. 123 dB
Output level range	–50 dBm to 0 dBm, typ. +10 dBm
Measurement bandwidths	10 Hz to 500 kHz
Measurement time	<75 ms (201 measurement points, 100 kHz bandwidth, full two-port calibration)
Measurement points per trace	2 to 4001
Weight (without battery)	<7 kg
Spectrum analysis (option)	
Frequency range	9 kHz to 3 GHz (R&S®ZVL3) 9 kHz to 6 GHz (R&S®ZVL6)
Resolution bandwidths	300 Hz to 10 MHz, optionally from 10 Hz
Displayed average noise level (DANL)	–152 dBm (1 Hz)
I/Q demodulation bandwidth	20 MHz
Total measurement uncertainty	<0.5 dB

More information, product brochure, and data sheet at www.rohde-schwarz.com (search term: ZVL)

Featuring a frequency range up to 18 GHz, the R&S®FSH18 follows in the footsteps of the internationally successful 3 GHz R&S®FSH3 and 6 GHz R&S®FSH6 models. It is the most lightweight handheld spectrum analyzer available on the market and is thus ideal for mobile use as well as for versatile applications in the microwave range.

R&S®FSH18 Spectrum Analyzer

The most lightweight handheld spectrum analyzer up to 18 GHz

Compact and durable

The R&S®FSH18 spectrum analyzer (FIG 1) is just as handy and robust as the R&S®FSH3 and the R&S®FSH6. Moreover, it comes with the same compact housing, which was especially designed for mobile applications. Weighing only 2.5 kg, the R&S®FSH18 is the most lightweight microwave handheld spectrum analyzer commercially available; plus, with three hours of battery power, its operating time is unparalleled in this class of instruments. These characteristics make it ideal for use at locations that are difficult to access and wherever a lightweight and compact analyzer would considerably facilitate everyday work. Due to its extended frequency range, the R&S®FSH18 is ideally suited for performing measurements on radar stations, air traffic control and satellite systems, as well as on microwave links. Its wide scope of functions includes the determination of spurious signals as well as general-purpose lab applications. The analyzer relies on the familiar and convenient operating concept of the R&S®FSHx family, making instrument operation a breeze. What's more, the R&S®FSH18 offers a transflective LC display, which makes for good readability even under extreme light conditions. The RF characteristics of the R&S®FSH18 are also impressive (for details, see "condensed data" on page 43). FIG 2 provides an overview of the R&S®FSHx family.

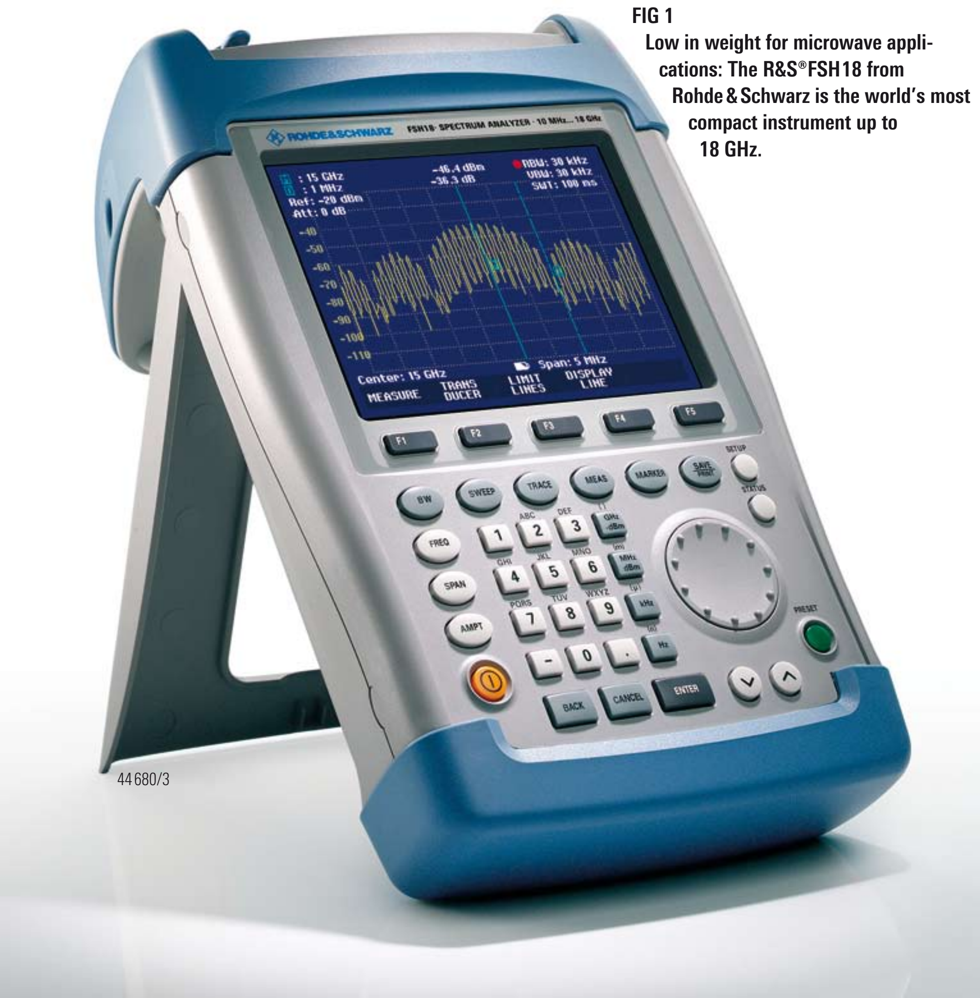


FIG 1
Low in weight for microwave applications: The R&S®FSH18 from Rohde & Schwarz is the world's most compact instrument up to 18 GHz.

New receive section up to 18 GHz

The R&S®FSH18 uses the same digital section as the R&S®FSH3, while its receive section with synthesizer is fresh out of development. Conventional analyzers covering this frequency range usually include two receive sections, i.e. one for the lower frequency range up to approximately 3 GHz, and a second receive path with a YIG filter for the upper frequency range. As the YIG filter alone consumes about 5 W power and approx. 5 cm³ of space, this solution was rejected from the start.

Instead, a continuous receive section from 10 MHz to 18 GHz with the first IF above the receive band was implemented in the R&S®FSH18. This new concept is highly beneficial as considerably less power and space are required. The receive section including synthesizer is located on a printed board measuring 9 cm × 13 cm and consumes about 4 W in power – not much more than the R&S®FSH6. With space at a premium, the high frequencies up to 41.85 GHz on the first local oscillator called for the use of new technologies. The microwave circuits were therefore not produced as single substrates but integrated directly on the printed board.

Model	Frequency range	Tracking generator	Output power of tracking generator	Preamplifier	Resolution bandwidth
R&S®FSH3, model .03	100 kHz to 3 GHz	–	–	✔	100 Hz to 1 MHz
R&S®FSH3, model .13	100 kHz to 3 GHz	✔	–20 dBm	–	1 kHz to 1 MHz
R&S®FSH3, model .23	100 kHz to 3 GHz	✔	–20 dBm to 0 dBm, adjustable in 1 dB steps	✔	100 Hz to 1 MHz
R&S®FSH6, model .06	100 kHz to 6 GHz	–	–	✔	100 Hz to 1 MHz
R&S®FSH6, model .26	100 kHz to 6 GHz	✔	–10 dBm (f <3 GHz), –20 dBm (f >3 GHz)	✔	100 Hz to 1 MHz
new **R&S®FSH18, model .18**	10 MHz to 18 GHz	–	–	–	100 Hz to 1 MHz

FIG 2 The R&S®FSH x family at a glance.

Highly accurate power measurement

The members of the R&S®FSH family are the only handheld spectrum analyzers worldwide that are able to perform high-precision terminating power measurements as well as directional power measurements by using external power sensors. The advantage is obvious – no additional power meters need to be brought along for applications in the field. For example, terminating power sensors will be used if the transmitter output power is to be measured on a directional coupler. The analyzer displays the measured power in dBm or W (FIG 3). Power sensors up to 8 GHz or 18 GHz are available. Up to 18 GHz, the measurement uncertainty is only 0.15 dB. As with thermal power sensors – but with a considerably wider dynamic range of 90 dB – the correct RMS value of the measured signal is obtained over the entire measurement range from –67 dBm to +23 dBm irrespective of the signal waveform. Additional measurement errors can thus be prevented, in particular with modulated signals.

Directional power sensors are used whenever the output power and antenna matching of RF transmitter systems are to be measured simultaneously. For this purpose, two directional power sensors with an upper frequency limit of 1 GHz or 4 GHz are provided. The directional power sensor is connected directly between the transmitter output and the antenna. The R&S®FSH18 simultaneously displays the power emitted by the transmitter in W or dBm and the return loss or the VSWR of the antenna under operating conditions (FIG 4). Because the maximum load is 120 W, a power attenuator is usually not required.

FIG 3 Terminating power measurement with the R&S®FSH18 spectrum analyzer and the R&S®FSH-Z18 power sensor.

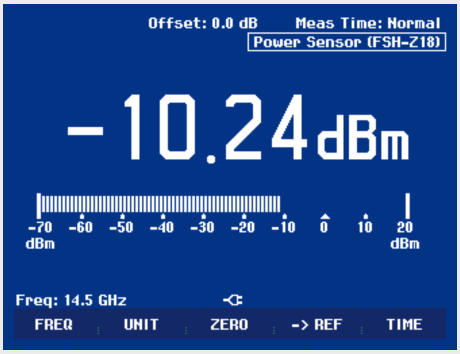


FIG 4 Simultaneous measurement of power and antenna matching using the R&S®FSH-Z44 directional power sensor.

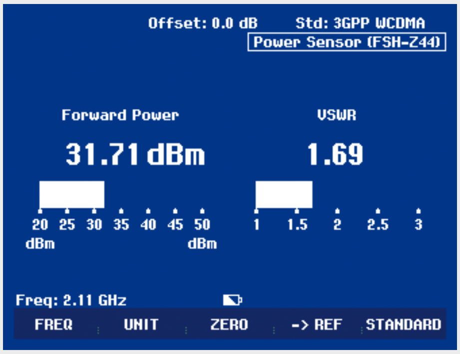


FIG 5 Level measurement on a specified channel in receiver mode.

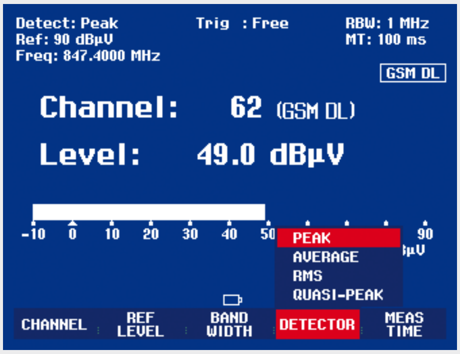


FIG 6 The R&S®FSH18 with the R&S®TS-EMF isotropic antenna.

Monitoring and precompliance EMC applications

Equipped with the R&S®FSH-K3 option, the spectrum analyzer can be operated as a receiver for monitoring and precompliance EMC applications. In this mode, the analyzer measures the signal level at a selected frequency or channel for a definable measurement time (FIG 5). Frequency is tuned via user-definable tables for channel spacing. In the scan mode, the R&S®FSH18 sequentially measures the level at various frequencies that are defined in a channel table, and displays the results in graphical form. For EMI emission measurements, the CISPR bandwidths of 200 Hz, 9 kHz, 120 kHz, and 1 MHz are available (–6 dB). Peak, average, RMS, and quasi-peak detectors can be selected in the receiver mode.

Field-strength measurements

When measuring electric field strength, the R&S®FSH18 takes into account the specific antenna factors of the connected antenna and displays the field strength directly in dBμV/m. If W/m² is selected, the analyzer calculates and displays the power flux density. Using the R&S®TS-EMF isotropic antenna (FIG 6), the spectrum analyzer is able to determine the direction-independent resultant field strength, which is not possible when a directional antenna is used. The antenna includes three orthogonally arranged antenna elements for measuring the resultant field strength. The R&S®FSH18 successively triggers each of the antenna elements and calculates the resultant field strength from the individual results. The calculation takes into account the antenna factors for each antenna element as well as the cable loss of the connecting cable.

Convenient documentation of measurement results

Like all R&S®FSH models, the R&S®FSH18 comes with the R&S®FSHView software as standard. R&S®FSHView allows the measurement result data that is stored in the analyzer to be conveniently transferred to a PC. The results can then be exported in various graphics formats or in ASCII format. The software additionally offers the following functions:

- Automatic storage of measurement results at selectable intervals
- Continuous transfer of the trace to the PC
- Printout of all relevant data
- Microsoft® Word macro for easy documentation of measurement results
- Subsequent setting or shifting of markers
- Editor for generating limit lines, channel tables, and antenna factors

Summary

The R&S®FSH18 is a powerful handheld spectrum analyzer up to 18 GHz that provides a wide range of functions. R&S®FSH18 users are sure to appreciate its low weight, ruggedness, ease of operation, and its long operating time on battery power in their daily work.

Rainer Wagner; Alexander Roth

More information, data sheet, and product brochure at www.rohde-schwarz.com (search term: FSH18)

Condensed data of the R&S®FSH18

Frequency range		10 MHz to 18 GHz
Resolution bandwidths	–3 dB	100 Hz to 1 MHz
	–6 dB, optional	200 Hz, 9 kHz, 120 kHz,1 MHz
Video bandwidths		10 Hz to 1 MHz
SSB phase noise		<–90 dBc at 100 kHz carrier offset
Displayed average noise level (at 100 Hz resolution bandwidth)		<–120 dBm, 50 MHz to 6 GHz <–118 dBm, 6 GHz to 8 GHz <–115 dBm, 8 GHz to 12 GHz <–110 dBm, 12 GHz to 16 GHz <–100 dBm, 16 GHz to 18 GHz
Detectors		Sample, Max/Min Peak, Auto Peak, RMS optional: Average, Quasi-Peak
Level measurement uncertainty		<1.5 dB up to 6 GHz <2.5 dB up to 14 GHz <3.0 dB up to 18 GHz
Standard measurement functions		channel power, TDMA power, occupied bandwidth (OBW), carrier/noise (C/N), electric field strength, noise marker, frequency counter, AM / FM audio demodulator
Battery operating time		typ. 3 h
Weight		2.5 kg

R&S®FMU 36 Baseband Signal Analyzer

All-in-one solution for RFID, baseband, and IF signals

The R&S®FMU 36 offers developers a variety of analysis capabilities as it includes an FFT spectrum analyzer and a time domain and vector signal analyzer. For applications such as RFID, where no RF measurements are required, it is a favorably priced solution for all measurement tasks to be performed on baseband and IF signals.

Wide range of applications

The R&S®FMU 36 baseband signal analyzer (FIG 4) combines a wide dynamic range at low frequencies with a large demodulation bandwidth. Since FFT analysis as well as vector signal and time domain analysis are combined, it is suitable for baseband measurements in wireless and mobile radio applications (e. g. chipset development) as well as for measurements on audio signals, in mechanical vibration analysis, on ADSL modems, on the IF stages of receivers, on DC supplies (noise voltage), and in systems with low carrier frequencies such as RFID (for an example, see box on page 47).

Widest dynamic range also at low frequencies

Owing to direct sampling (without IF conversion), the R&S®FMU 36 has an unrivaled dynamic range within its frequency range.

Low noise down to DC

Below 10 MHz, the inherent noise of the R&S®FMU 36 is up to 20 dB lower than that of an RF spectrum analyzer (FIG 2). You can thus perform sensitive noise and noise voltage measurements even without additional preamplifiers.

Low phase noise

The analyzer also excels with regard to phase noise and is clearly better than an RF spectrum analyzer (FIG 3). At 10 MHz, it attains –145 dBc (1 Hz) at an offset of 100 kHz.

Short measurement times

Due to its high intermodulation suppression, the analyzer can be operated at full-scale capacity, thus achieving the desired dynamic range with large measurement bandwidths. This reduces measurement times. The example in FIG 1 shows the inherent TOI measurement at 10.5 MHz and a carrier offset of 1 MHz. At a span of 4 MHz, an intermodulation ratio of –90 dBc is measured at a speed of 100 sweeps/s.

Excellent demodulation characteristics

The bandwidth of 72 MHz for complex signals (36 MHz in the baseband) covers all mobile radio and wireless standards and offers enough room to meet future requirements. The maximum symbol rate of 25 MHz used in vector signal analysis will be increased to 50 MHz in future firmware versions.

The I/Q result memory has a large capacity so that long sequences can be stored even if sampling rates are high. In its basic design (16 Msamples), the

Condensed data of the R&S®FMU 36

Frequency range	DC to 36 MHz
Resolution bandwidth	0.5 Hz to 20 MHz
Level measurement range	up to +25 dBm
Linearity	0.1 dB to –90 dBFS
Frequency response up to 36 MHz	<0.3 dB
Flatness of group delay	typ. 1 ns
ACPR for WCDMA 3GPP	typ. –73 dB
Noise floor	typ. –157 dBm (1 Hz)
S/N	typ. –147 dBc (1 Hz)
SSB phase noise (10 MHz, offset 10 kHz)	typ. –142 dBc (1 Hz)
Impedance	50 Ω / 1 MΩ, switch-selectable
I/Q memory	16 Msamples optional up to 705 Msamples
Standard firmware	FFT analyzer Vector signal analysis

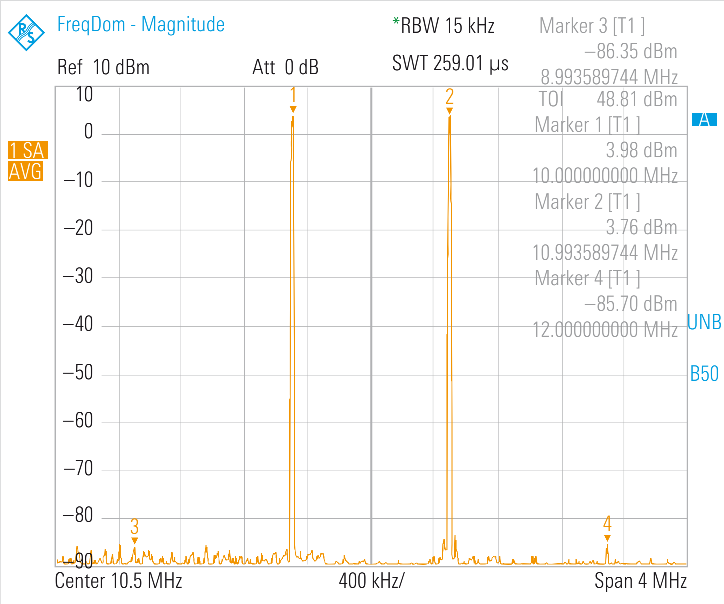


FIG 1 TOI measurement with 100 sweeps/s.

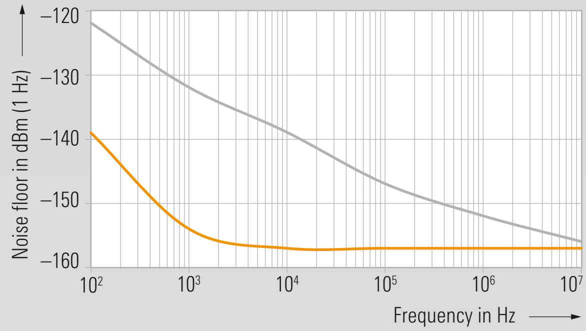


FIG 2 Comparison of noise floor in the R&S®FMU 36 (orange) with that of an RF spectrum analyzer (grey).

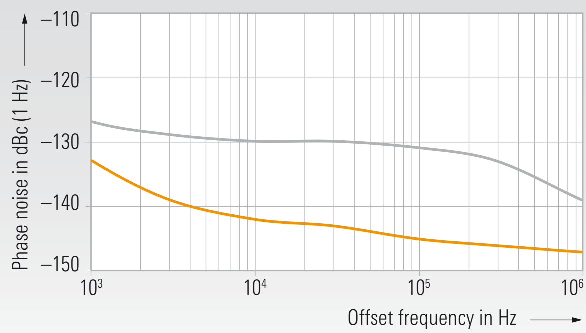


FIG 3 Comparison of phase noise at 10 MHz in the R&S®FMU 36 (orange) with that of an RF spectrum analyzer (grey).

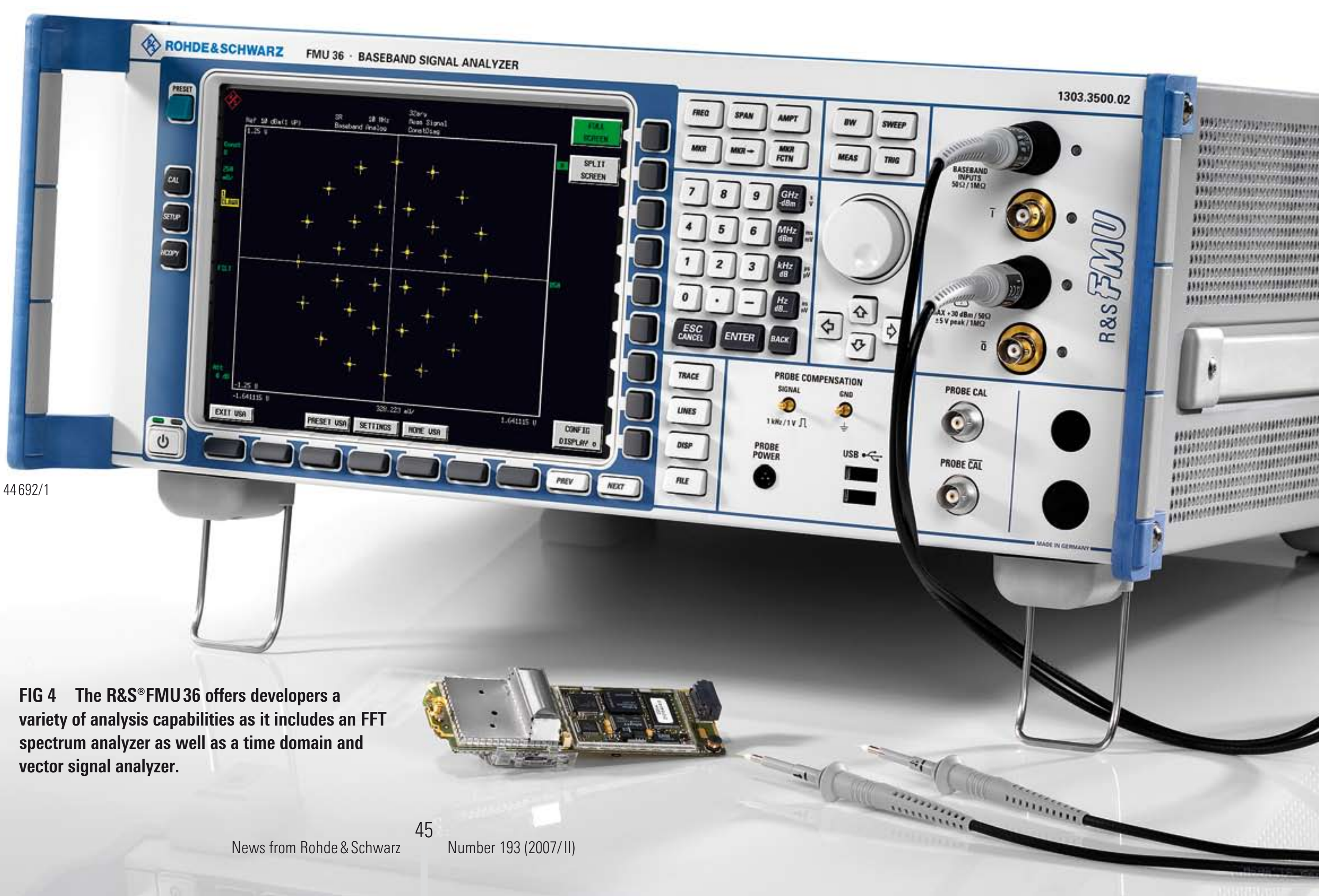


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FIG 4 The R&S®FMU 36 offers developers a variety of analysis capabilities as it includes an FFT spectrum analyzer as well as a time domain and vector signal analyzer.

R&S®FMU36 can already store up to 100 frames of a WCDMA signal. It can be extended to 705 Msamples. This allows a recording time of 8.5 s even at a maximum sampling rate of 81.6 MHz.

Flexible measurement inputs

To allow optimum matching to a source, the measurement inputs of the R&S®FMU36 are not limited to the common impedance of 50 Ω (single-ended). Baseband interfaces are usually differential and often do not support 50 Ω. The R&S®FMU36 meets this requirement with its balanced inputs that can be switched to 1 MΩ.

Comprehensive support of probes

Probes (R&S®FMU-Z1 option) that are fully supported by the analyzer up to the calibration at the probe tip are available to perform accurate and distortion-free measurements such as on chipsets. A typical example is the measurement on a printed board between baseband source and I/Q modulator where a 50 Ω test point is usually not available. Although the input impedance of the R&S®FMU36 can be switched over to 1 MΩ, measurements via a cable will cause extreme mismatch and high measurement uncertainties. The high-impedance probes normally used with oscilloscopes eliminate these drawbacks. The problems usually encountered in this approach such as incorrect level display or unknown frequency response are, however, unknown with the R&S®FMU36 which does the following:

- It identifies probes via their resistance coding and automatically takes the division factor into account in the level display.
- It supplies the appropriate signal for probe adjustment. The optimum and automatic setting of the time domain display with zoom is performed automatically.
- Probes are inserted into a female BNC via adapters and the analyzer measures the following at a keystroke:
  - Attenuation error
  - DC offset
  - Frequency response (magnitude and phase, FIG 5)

  The analyzer then compensates for the measured values digitally and saves the calibration data to the internal hard disk.

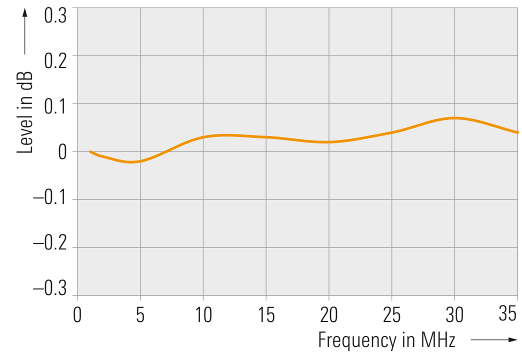


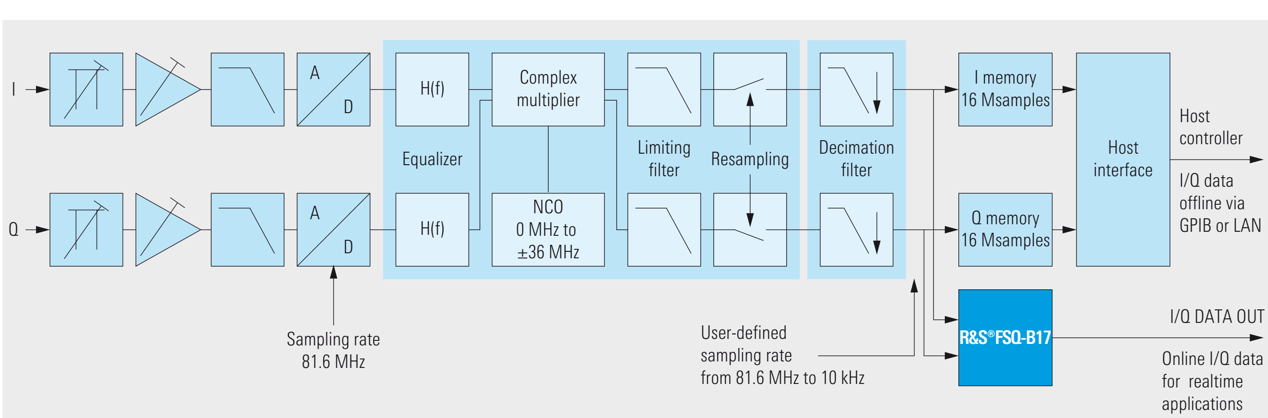
FIG 5 Typical frequency response with the R&S®FMU-Z1 high-impedance probe after calibration.

Online I/Q data

The R&S®FMU36 can process real (only I or Q) or complex (I + jQ) input signals. The analyzer converts IF and RF signals up to 36 MHz into the complex baseband using an NCO. To limit the data volume, the sampling rate can be adapted to the signal bandwidth (FIG 6). Data is stored in the I/Q memory and processed offline by the host controller.

If measurements that are not in line with standards are to be performed on a PC using the customer's own algorithms, the R&S®FMU36 provides the I/Q data via its IEC / IEEE bus or LAN interface. You can select any sampling

FIG 6 The block diagram of the R&S®FMU36 with the R&S®FSQ-B17 digital baseband interface option shows the essential components of analog and digital signal processing.



rate between 10 kHz and 81.6 MHz. Due to resampling and decimation with digital filters, the signals are always aliasing-free. For realtime applications, the I/Q data can also be output online via a low voltage differential signaling (LVDS) interface (R&S®FSQ-B17 option).

Calibrated within seven seconds

The excellent dynamic range (FIG 10) is supplemented by autocalibration to minimize the I/Q impairments. You only need seven seconds to measure

- gain imbalance
- quadrature error
- origin offset

using a reference signal and to calculate digital compensation filters.

Application example: measurements on RFID cards

RFID smart cards in accordance with ISO 14443 with a range of 10 cm, e. g. for employee ID cards, are widely used. They operate at 13.56 MHz, and the required test methods are described in ISO 10373-6. A test PCD (proximity coupling device) assembly with a PCD antenna and two sense coils in a bridge circuit (FIG 7) are used to perform the measurement. The main criterion here is to perform high-impedance measurements on this bridge – an ideal task for the R&S®FMU36.

To perform the measurement, the PCD feeds the PCD antenna and stimulates the card in the test PCD assembly. This card responds with a delay at a frequency offset of ±847 kHz. Tuned to the 12.713 MHz offset frequency, the R&S®FMU36 measures the frame delay time (FIG 8) and the transmit power of the card (load modulation, FIG 9) in the time domain magnitude mode. This measurement is only possible because the analyzer operates selectively in the time domain. The PCD transmits CW to supply the card even while the card is responding.

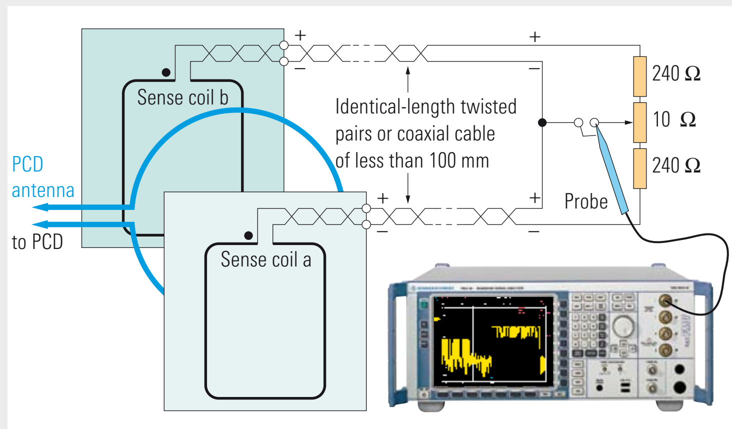


FIG 7 The R&S®FMU36 in an RFID test setup with a test PCD assembly in accordance with ISO 10373-6.

FIG 8 Frame delay time measurement of RFID card.

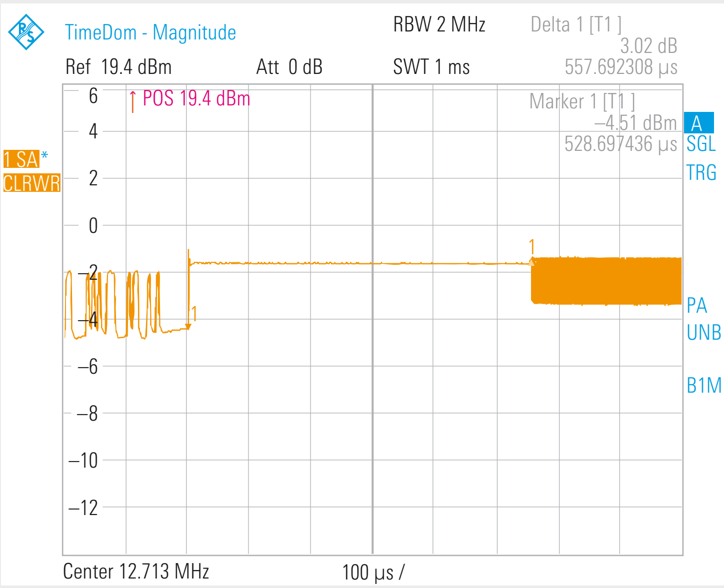
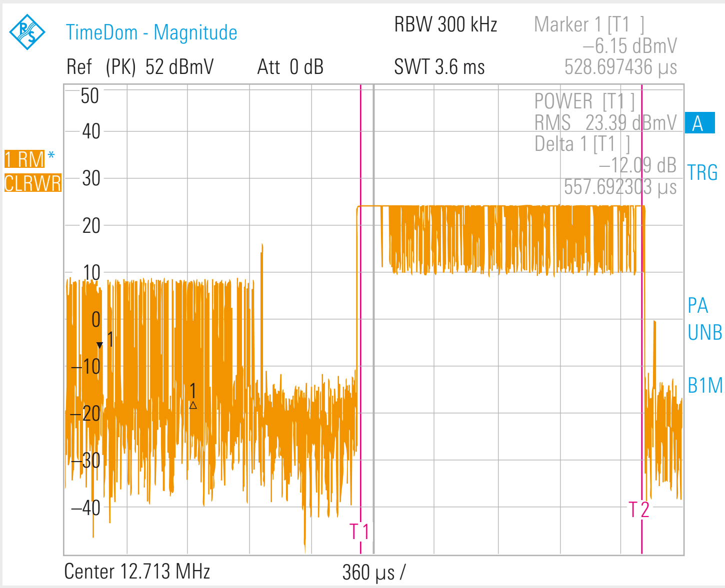


FIG 9 Right: Response of RFID card (card type B, BPSK); level measurement in dBmV between limiting lines. Left: The remnants of the signal coming from the PCD (amplitude shift keying).



The quality of this calibration (FIG 11) also makes the R&S®FMU 36 ideal for measurements on high-quality modulation sources, e.g. vector signal generators. The delay difference between I and Q is corrected to typ. 100 ps so that the analyzer is also ideal for phase difference measurements.

Custom-tailored options

With its variety of custom-tailored firmware options, the R&S®FMU 36 covers the complete wireless market: modulation measurements for WiMAX, WLAN, Bluetooth®, and analog modulation. It also covers the requirements for the CDMA standards including code domain power.

- 3GPP HSDPA BTS
- 3GPP WCDMA (FDD)
- GSM / GPRS / EDGE
- CDMA2000®
- 3GPP TD-SCDMA
- WiMAX 802.16-2004
- WiMAX 802.16e-2005
- WLAN 802.11a / b / g / j
- Bluetooth® 802.15.1
- AM / FM / φM demodulation

The most important hardware options:

- Digital baseband interface for outputting I/Q data in realtime
- I/Q memory extension up to 705 Msamples

The R&S®FMU 36 is a universal measuring instrument whose high versatility is virtually unrivaled.

Manfred Müller

FIG 10 73 dB dynamic range during ACPR measurement on a 3GPP WCDMA signal.

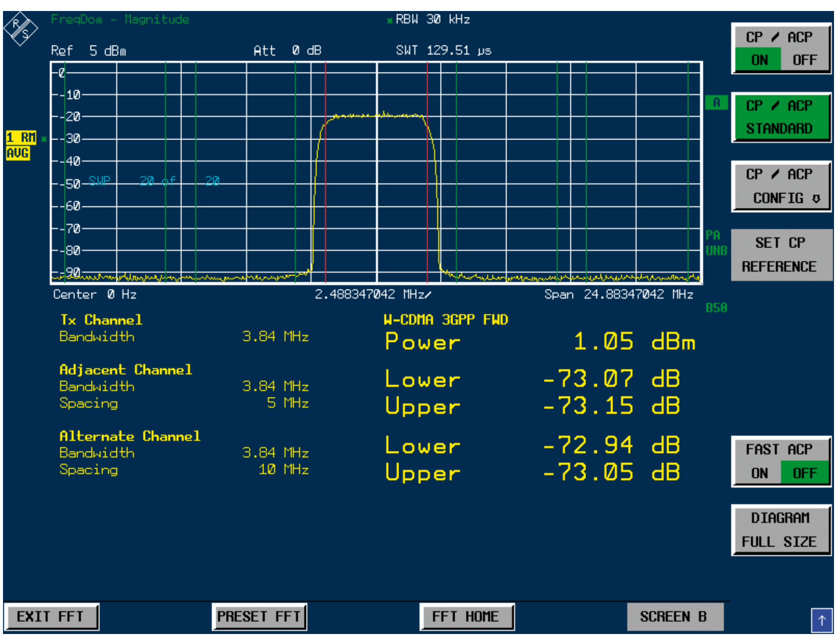
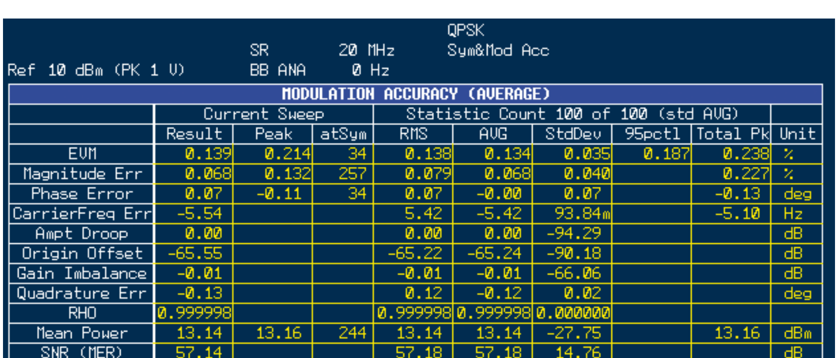


FIG 11 Smallest I/Q impairments at 5 MHz (corresponds to a QPSK with a symbol rate of 20 MHz), measured using the vector signal analysis in the R&S®FMU 36.


Ref 10 dBm (PK 1 V) SR BB ANA 20 MHz 0 Hz QPSK Sym&Mod Acc

MODULATION ACCURACY (AVERAGE)

	Current Sweep			Statistic Count 100 of 100 (std AVG)					
	Result	Peak	atSym	RMS	AVG	StdDev	95pctl	Total Pk	Unit
EVM	0.139	0.214	34	0.138	0.134	0.035	0.187	0.238	%
Magnitude Err	0.068	0.132	257	0.079	0.068	0.040		0.227	%
Phase Error	0.07	-0.11	34	0.07	-0.00	0.07		-0.13	deg
CarrierFreq Err	-5.54			5.42	-5.42	93.84m		-5.10	Hz
Ampt Droop	0.00			0.00	0.00	-94.29			dB
Origin Offset	-65.55			-65.22	-65.24	-90.18			dB
Gain Imbalance	-0.01			-0.01	-0.01	-66.06			dB
Quadrature Err	-0.13			0.12	-0.12	0.02			deg
RHO	0.999998			0.999998	0.999998	0.000000			
Mean Power	13.14	13.16	244	13.14	13.14	-27.75		13.16	dBm
SNR (MER)	57.14			57.18	57.18	14.76			dB

More information, data sheet, and product brochure at www.rohde-schwarz.com (search term: FMU)

FIG 1 Above 3.6 GHz, the measurement sensitivity of the R&S®ESU EMI test receivers can now be significantly increased by adding the new preamplifiers.

R&S®ESU EMI Test Receiver

Ready for the most stringent of standards when equipped with internal preamplifiers

Low-noise, internal preamplifiers for the R&S®ESU EMI test receivers significantly increase sensitivity above 3.6 GHz – with major benefits for your measurement work.

Maximum sensitivity required

The standard-compliant R&S®ESU EMI test receivers [1] (FIG1) already come equipped with an internal preamplifier that covers a frequency range of 1 kHz to 3.6 GHz. However, military standards (e.g. MIL-STD-461) as well as civil automotive standards (e.g. CISPR 25, class 5 for broadband interference) place the most stringent of requirements on the sensitivity of measuring equipment.

With the new R&S®ESU-B 24 preamplifier option, you can significantly increase measurement sensitivity above 3.6 GHz in the frequency ranges up to 8 GHz, 26 GHz, and 40 GHz. The test receivers are then ready for even the most stringent of requirements. FIG 3 shows the displayed average noise level (DANL) with the preamplifier switched on.

The increased measurement sensitivity makes it possible to better compensate for several aspects: the higher cable losses (under certain circumstances 20 dB to 30 dB in the range up to 30 GHz) that occur in the microwave range; the antenna factors of horn antennas with values of 40 dB in the range from 30 GHz to 40 GHz; and the sensitivity losses involved. In special cases, an additional external preamplifier [2] directly connected to the antenna may also be beneficial. With a gain of approx. 30 dB, the loss on the 20 m RF cable from the anechoic chamber to the control room can thus be compensated for.

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

REFERENCES
[1] EMI Test Receiver R&S®ESU: Maximum precision at unparalleled measurement speed. News from Rohde & Schwarz (2006) No. 190, pp 39–43
[2] EMI Test Receiver R&S®ESIB: Better system sensitivity through preamplifiers. News from Rohde & Schwarz (2003) No. 178, pp. 41–45

The R&S®ESU: always one step ahead

It is extremely difficult to reduce measurement time in everyday practice. For example, the CISPR 25 standard, which covers the automotive field and thus all supplier companies involved (e.g. suppliers of fans and engines), places particularly stringent requirements on the determination of broadband and narrowband interference emissions. It stipulates time-consuming measurements that are performed in EMC labs between 30 MHz and 1000 MHz. For example, the detection of pulse-like interference with a pulse frequency of 100 Hz requires a minimum measurement time of 10 ms. Owing to the sensitivity requirement in CISPR 25, this range is measured at a bandwidth of 9 kHz. This corresponds to a gapless measurement at a step size of 4 kHz. Approx. 242 500 measured values are obtained and approx. 40 minutes are required for a preview measurement. You have to be even more patient at a pulse frequency of 10 Hz and a minimum measurement time of 100 ms – where the preview measurement takes 6 h and 44 minutes.

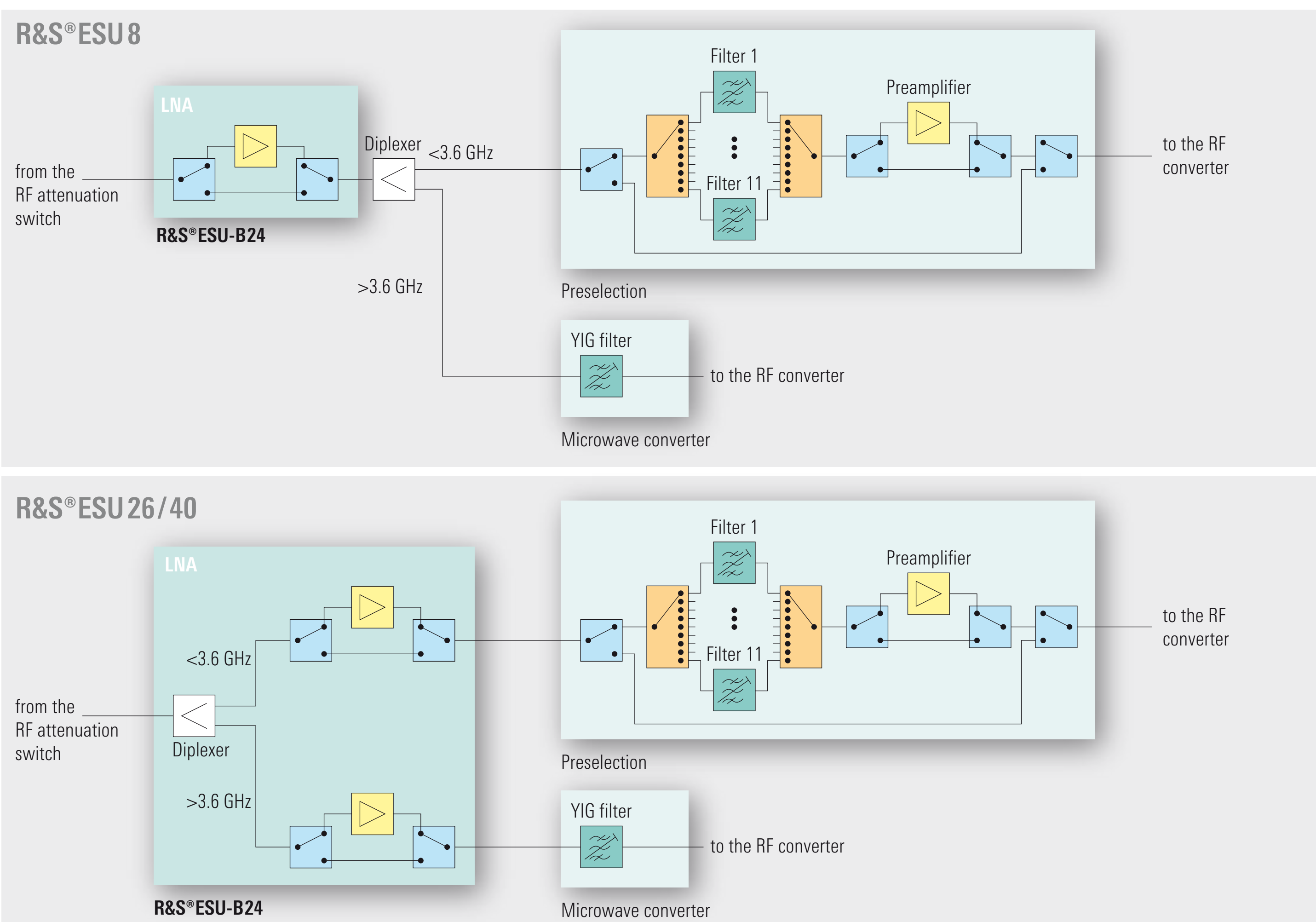
This is where the R&S®ESU EMI test receiver comes into the picture: With the R&S®ESU-K53 time domain scan option operating on an FFT basis, you can reduce the preview measurement time by a factor of more than 100. Instead of 40 minutes, the test receivers only need 20 seconds to perform this task.

Further reducing measurement time?

Measurements performed at higher sensitivity not only yield results that are more accurate; they also enable you to reduce measurement time. This may not sound plausible at first since a standard-compliant final measurement performed with the quasi-peak detector and a final measurement time of 1 s per frequency cannot be speeded up further. The only way to minimize measurement time is to limit the measurement to a few critical frequencies, which thus reduces the amount of data involved.

If you want to keep pace with the stringent requirements of standards such as applied in the automotive industry,

FIG 2 Block diagram of LNA module and integration into frontend.



the new R&S®ESU-B24 preamplifiers are a must. The measuring equipment is forced to work at the physical limit with respect to DANL especially when antenna factors must also be taken into account. Since sensitivity is increased by the low-noise preamplifier, the preview measurement can even be performed with the peak detector in such cases. If the measurement results are below the limit line defined in "CISPR 25:2002, class 5, quasi peak for broadband interferers" as shown in FIG 4, it may be possible to skip the entire final measurement – thus reducing measurement time yet again.

Volker Janssen

Structure of preamplifiers

In the signal path, the new internal preamplifiers with a nominal gain of 30 dB are inserted in front of the tracking YIG filter of the microwave converter (FIG 2). Frequencies below 3.6 GHz are routed to preselection; frequencies above 3.6 GHz are applied to the YIG filter. It has to be pointed out that preamplifiers can be switched on or off in both operating modes – in the test receiver mode and the spectrum analyzer mode – and can be selected via softkey or under LNA in the scan table. To optimally use the dynamic range and to avoid overloads, the preamplifier should only be used at small signal levels. The frequency response of the preamplifiers is internally stored in the EEPROMs and is automatically taken into account in the level display. The frequency response of the test receiver and the preamplifier is also measured when factory calibration is performed. For this reason, installation at the factory is recommended. If the preamplifier is installed at a later time, the instrument must be recalibrated.

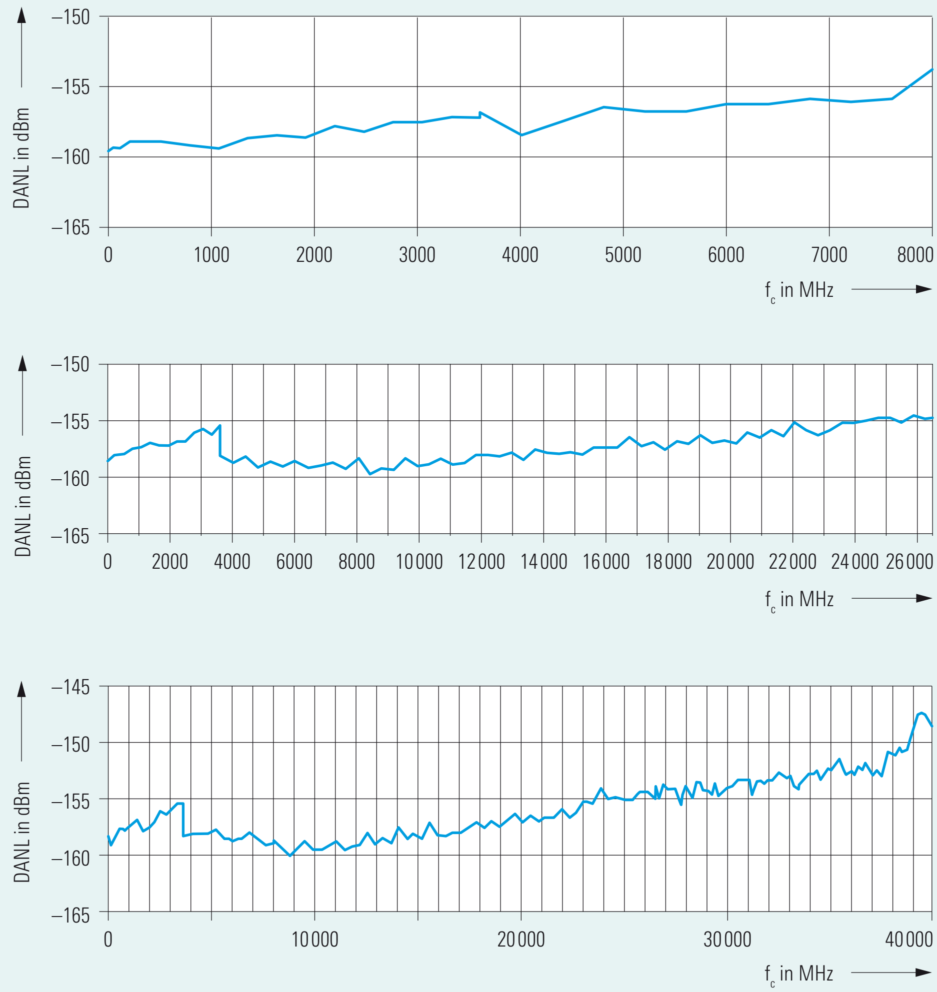
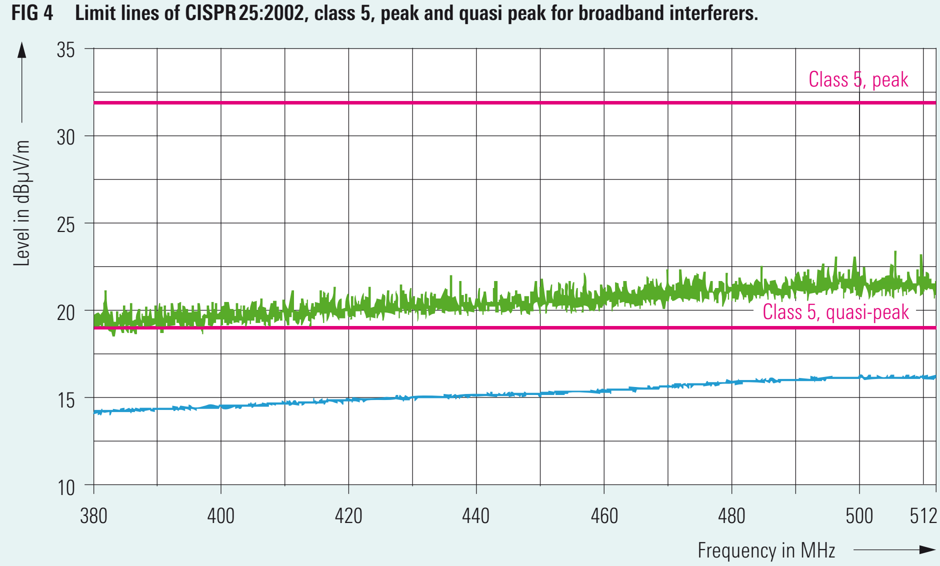


FIG 3 DANL with preamplifier switched on, normalized to a measurement bandwidth of 10 Hz, RF attenuation = 0 dB, average detector (Avg), preselector switched off, for all three frequency ranges of the R&S®ESU EMI test receivers.

FIG 4 Limit lines of CISPR 25:2002, class 5, peak and quasi peak for broadband interferers.



DVB-H playout system

Up to 40 % higher transmission capacity without compromising on quality

Rohde & Schwarz and the Fraunhofer Institute for Telecommunications, Heinrich Hertz Institute (HHI), have jointly developed an innovative system that allows the highly efficient use of channel capacity in DVB-H systems. The system was developed under a project designated "Integrated systems concepts for DVB-H playouts – IsyP" sponsored by the European Union.

To expand a DVB-T platform into a DVB-H transmit and receive chain, the following additional or modified equipment is required:

- R&S®AVE 264 DVB-H video and audio encoder for H.264 and AAC
- Electronic service guide (ESG) generator; data is played out using the ALC and FLUTE protocols (R&S®AVP 264-K3)
- R&S®DIP 010 DTV IP inserter and generator with time slicing to save power in mobile reception, and multiprotocol encapsulation forward error correction (MPE-FEC)
- Transmitters supporting the new 4k mode and capable of activating reserved TPS (transmission parameter signaling) bits for signaling time slicing and MPE-FEC information
- Terminals capable of handling all the above techniques

From DVB-T to DVB-H

The development of the digital DVB-T television standard toward DVB-H enables the mobile reception of data services on small, battery-powered terminals. The first DVB-H networks are already in service (see example on page 55).

In developing DVB-H, the key objectives were to provide mobile reception and to reduce energy consumption of the compact terminals to a minimum. A key priority in mobile reception is the optimum use of available channel capacity, i. e. to transmit a maximum of information at the required quality at minimum data rates. Channel capacity in DVB-T / DVB-H systems is at a premium. DVB-H systems therefore use QPSK modulation, which allows a channel data rate of approx. 5 Mbit/s.

CBR versus VBR

H.264 audio / video encoders compress data so that a DVB-H channel can normally transmit about ten mobile TV programs in good quality. With encoders operating at a constant bit rate (CBR), the compressed data stream is constant and the quality varies. With encoders using a variable bit rate (VBR), it is the other way round: the quality remains constant and the data rate varies.

With VBR encoders, it is possible to reduce the data rate without compromising on quality. DVB-H encoders usually operate independently of one another. Therefore, the maximum data rate must be reserved in the DVB-H transport stream for each encoder, which is an obstacle to the more effective use of transmission channels.

40 % increase in transmission capacity

The new DVB-H playout system from Rohde & Schwarz brings a clear improvement in terms of transmission capacity. The statistical multiplex manager, the audio/video encoders, and the IP encapsulator are matched to one another, enabling maximum reduction of the data rate (FIG 1). Moreover, the VBR encoders are coupled with each other, and their IP data streams are mapped to a channel with a constant data rate. The audio / video encoders and the IP encapsulator communicate with one another, thus enabling dynamic adaptation of the time slicing used in DVB-H to the individual data rates (adaptive time slicing).

The concept is impressive: A system using statistical multiplex provides approx. 40 % more transmission capacity without compromising on video quality, thus allowing 14 instead of 10 mobile TV programs to be transmitted in a DVB-H channel. It also optimizes the alignment of picture content to the burst structure in the time slicing pattern, enables terminal equipment to immediately access videos with the complete picture information, and considerably reduces the switching times between channels.

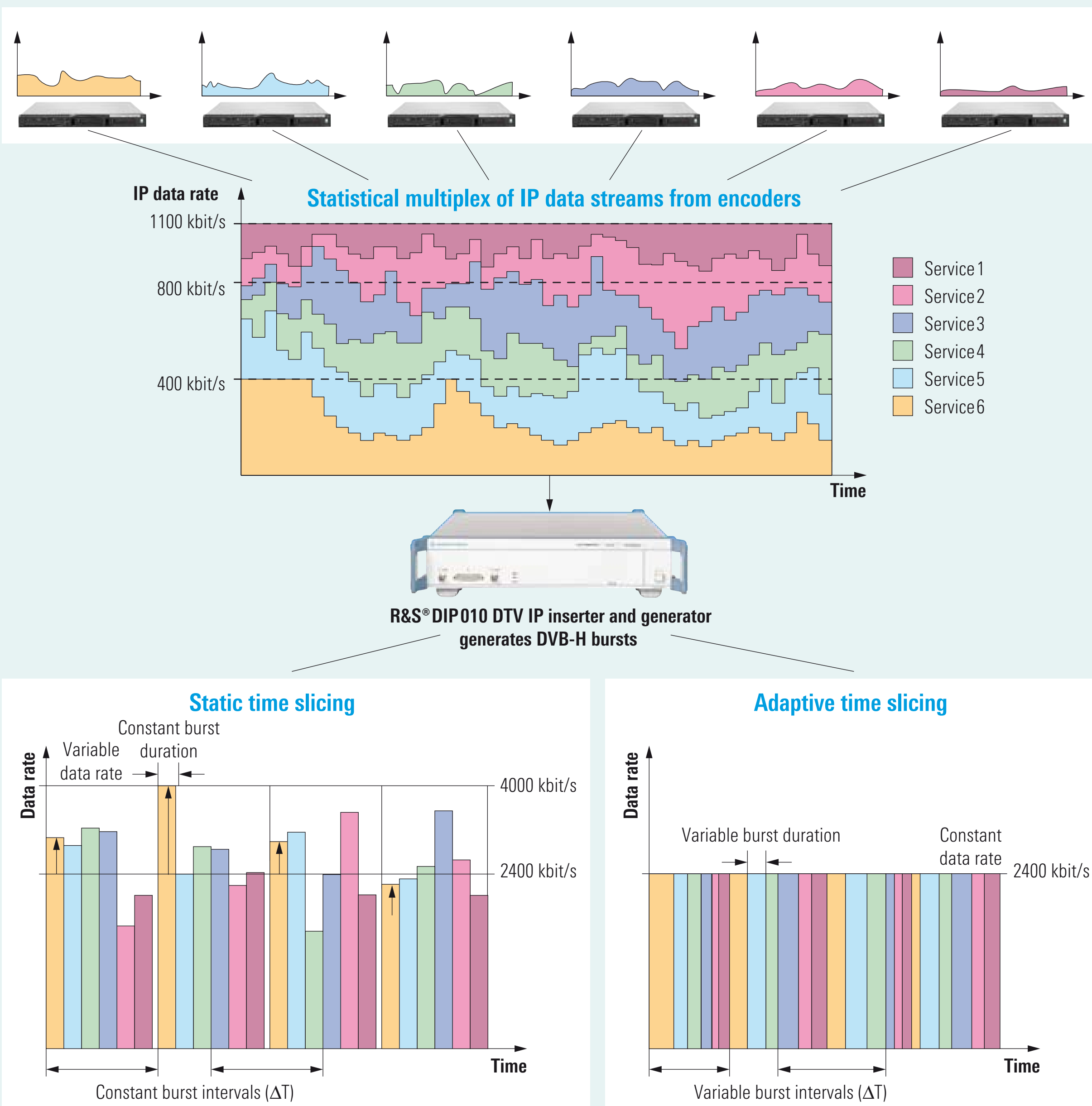
Principle of data reduction by means of statistical multiplex and adaptive time slicing

Time slicing is a method applied to the MPEG-2 transport stream, by which services are not transmitted continuously but in packets referred to as bursts. During the pauses (timeslots) between the bursts, the highly energy-consuming tuners of the terminals can be switched off. A typical pause duration, for example, is 2 s at a burst duration of 100 ms. The pause duration is signaled during the burst, thus enabling variable pause lengths.

In the case of **static time slicing**, which features encoders in a statistical multiplex, but no communication with the IP encapsulator, the data rate is variable since bursts have to be reserved to ensure a maximum data rate for each service (FIG 1, bottom left). The time structure (burst duration and burst interval (ΔT)) remains constant. With this method, transmission capacity is left unused, as the data rates reserved for the bursts are not always fully utilized.

In the case of **statistical multiplex with adaptive time slicing**, by contrast, all bursts have a constant data rate (FIG 1, bottom right). The burst duration and the burst interval are variable. With adaptive time slicing, reserved data rates are fully utilized. The data rates of the individual services must be known in advance. The extra transmission capacity thus gained can be used for transmitting other data services or audio/video services.

FIG 1 Principle of statistical multiplex with adaptive time slicing.



To implement the system (FIG 2), Rohde & Schwarz has developed or expanded the following components:

- **R&S®AVE 264 DVB-H video and audio encoder** for operation in a statistical multiplex system or as a standalone unit
- **R&S®AVP 264 DVB-H video and audio playout base unit** with the following options:
  – **R&S®AVP 264-K1 statistical multiplex manager**
  – **R&S®AVP 264-K2 SimulCrypt synchronizer** for encryption in line with ISMACryp 1.1 and ETSI TS 103 197 DVB SimulCrypt standards
  – **R&S®AVP 264-K3 ALC / FLUTE carousel** for playing out ESG data
- **R&S®DIP 010 DTV IP inserter and generator** with DVB-H option for IP encapsulation with adaptive time slicing and MPE-FEC

In addition to audio and video services, the DVB-H playout system from Rohde & Schwarz allows the integration of CBR services and ESG and other data services. Such additional services are transmitted in dedicated bursts in the time slicing pattern. DVB-H systems can subsequently be expanded by statistical multiplex and adaptive time slicing as required.

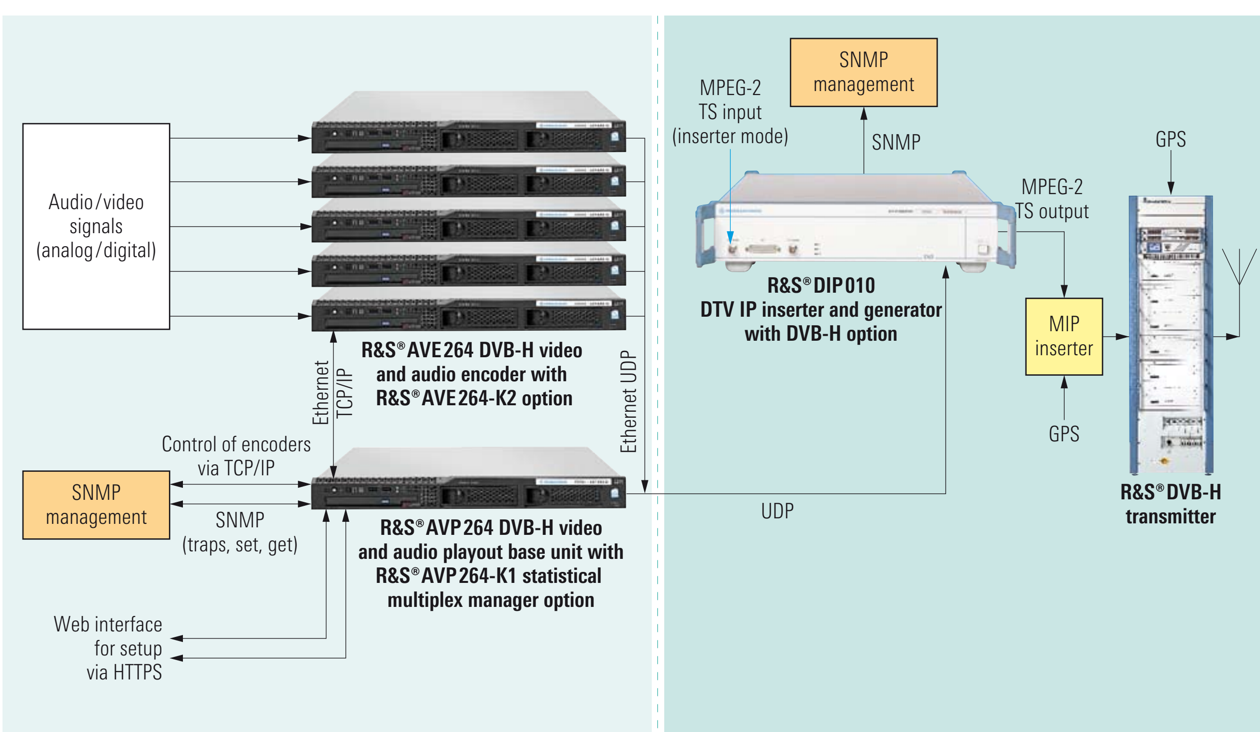
The IP inserter communicates with the statistical multiplex manager via a unidirectional link. It can therefore also be located separately from the encoders (decentralized playout). Various scenarios are thus possible for signal distribution in a statistical multiplex system and for the insertion of local contents.

Configuring a complete DVB-H system is a complex task – considering the large number of instruments involved and the new functionalities to be integrated. To verify that your DVB-H system is configured correctly, and thus to ensure that terminals from various manufacturers function properly, it is advisable to test the system with suitable measuring equipment, e. g. the R&S®DVM 400 digital video measurement system.

Torsten Görig; Denis Hagemeier

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

FIG 2 DVB-H playout system with statistical multiplex.



Rohde & Schwarz and T-Systems provide Qatar with DVB-H

Rohde & Schwarz has successfully set up the DVB-H pilot project from Qtel, Qatar's national mobile radio provider. It is the first DVB-H network in the Middle East.

The playout center in Rayyan.

The decision to cooperate with Rohde & Schwarz was made as a result of the positive experience gained with the TETRA network from R&S BICK Mobilfunk GmbH installed last year and also due to the optimum price/performance ratio. The complete DVB-H system was implemented by Rohde & Schwarz together with T-Systems Media & Broadcast, a company with wide-ranging experience in planning and integrating DVB-H networks into systems. Although deadlines were tight – the planning phase started in August 2006 – the network could already go into operation in mid-October, just before the Asian Games were started in December 2006.

Rohde & Schwarz was responsible for the turnkey solution including production, delivery and service. The scope of supplies included H.264 / AAC video / audio encoders of the R&S®AVE 264 series, the R&S®AVP 264-K3 FLUTE server, the R&S®DIP 010 data inserter for IP encapsulation, the medium-power transmitters of the R&S®NV 8200 family, and the gap fillers of the R&S®XV 7003 type. T-Systems Media & Broadcast was responsible for planning the network and the network coverage, for integrating the playout center from Rohde & Schwarz – including the electronic service guide (ESG) meta data – into the network, for ensuring signal distribution, and for installing and putting the network into operation. Network coverage was much better than expected, and all requirements were fully met.

The playout center from Rohde & Schwarz is prepared for statistical multiplex, a technique providing 30 to 40 percent additional data capacity. Owing to the open platform, future coding systems can be integrated any time and conformal DVB-H instruments can be added to the network. The network is rated for 20 to 25 video and audio DVB-H channels that can be received at home and elsewhere.

The complete network was set up as a single frequency network (SFN). Gap fillers are used to amplify the signal without significant delays so that synchronization can be maintained. These repeaters were specifically used to cover gaps in stadia, shopping malls etc.

With the first DVB-H network of the Middle East, Rohde & Schwarz achieved another success in setting up digital transmitter networks for mobile TV. In addition to DVB-H in Europe, the market leader has already implemented digital networks for MediaFLO™ in the USA and for T-DMB in Korea and China.

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T-Systems Business Services GmbH;
Eshwarahally Vikas

FIG 1 The R&S®SR 8100 1 kW transmitter.

R&S®SR 8000 VHF FM Low-Power Transmitters

Compact VHF transmitters for 100 W to 2.5 kW

The new generation of air-cooled R&S®SR 8000 FM transmitters covers a power range from 100 W to 2.5 kW. The transmitters feature outstanding technical parameters, an optimum cost/benefit ratio, high reliability, plus compact design.

Compact FM transmitters with high reliability

The R&S®SR 8010 100 W transmitter occupies only two height units in the rack and the R&S®SR 8100 1000 W transmitter only four height units. The R&S®SR 8250 A 2.5 kW transmitter, which consists of two modules, occupies eight height units and does not require any additional external components (FIG 1).

The transmitters include the following components:

- Digital exciter with integrated transmitter control unit
- Modulation input with integrated parallel remote control interface
- Power amplifier
- Housing with integrated cooling system

Digital exciter

The exciter is based on the successful concept of the R&S®SU 800 [1]. All aspects of signal processing – from the detection of the input signals to the integrated stereo coder and frequency modulation – are handled purely digitally.

Digital audio data can be fed in via the built-in AES/EBU interface. Tried-and-tested analog left / right interfaces as well as multiplex (MPX) are available for connecting external stereo coders. Optimal use is made of the interfaces due to the digital filters for suppressing interfering signal components and due to the fact that the input level can be adjusted.

If multiple signal feeds are applied simultaneously, standby can be implemented. It is possible to switch to standby feed either automatically or from a remote location.

Automatic limiters provide mechanisms to check peak deviation and average modulation power in line with ITU-R SM 1268-1. They are user-configurable and can also be switched off. The limiters monitor both values and dynamically adapt the level of the audio component in the MPX signal. Other components of the MPX signal such as pilot tone or RDS remain unchanged.

RDS or SCA signals can be fed in via two additional analog signal inputs. A pilot tone output for synchronizing external RDS coders is of course provided. XLR for analog left / right, AES/EBU, MPX, as well as BNC for additional signals are included as interfaces. For future applications such as operation in single frequency networks, the transmitter can be synchronized to external frequency references (10 MHz) or time references (1 pps).

Transmitter control unit

The operating concept is based on the R&S®NetCCU 800 control unit from the R&S®NR 8200 transmitter platform [2]. This standardization significantly reduces the effort for training the operating personnel as well as for operation and maintenance.

The transmitter can be controlled and monitored remotely by means of a web browser and the SNMP protocol via the Ethernet interface on the rear panel. All parameters required for operating and maintaining the transmitter can be retrieved. The Ethernet interface on the front panel can be used to connect the transmitter to a local PC, which only needs to have a web browser installed. No special operating software has to be installed.

The transmitter can be operated locally via the keyboard and the menu system on the display (FIG 2). The menu system has the same structure for both local and remote operation.

A floating parallel remote control interface is available for simple control tasks and to operate the transmitter's basic functions such as ON / OFF. Relay contacts are used to signal operating states such as "Output power present".

Systems with (n + 1) standby and passive standby can be set up without any problem. This is achieved by connecting the transmitter with an R&S®NetCCU 800 control unit that serves as an arbiter.

Power amplifier

Owing to their state-of-the-art MOSFET technology, the power amplifiers feature high efficiency and compact design. The amplifiers are equipped with harmonics filters to ensure compliance with the specifications for harmonics suppression. They are completely self-monitoring and self-protecting against overtemperature, VSWR that is too large, and transistor failure. Of course, lightning protection is integrated.

Housing with integrated cooling system

The transmitters are housed in compact 19" units with integrated cooling. The partly redundant fans on the rear panel of the instrument draw cooling air from the front through the housing. The transmitter control unit continuously monitors the fans, and any reduction in speed or failure is signaled. The fans can be accessed from outside the transmitter, thus allowing them to be easily replaced.

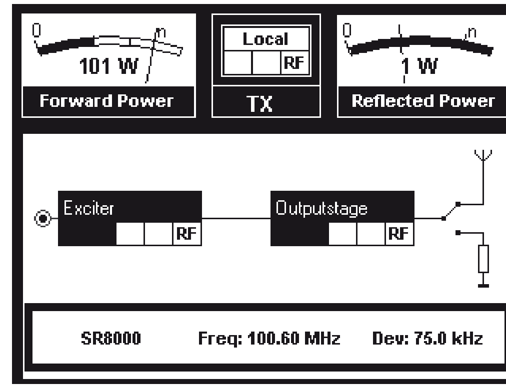


FIG 2 Main menu of the R&S®SR 8010 transmitters.

The transmitters of the R&S®SR 8000 family comply with the R&TTE Directive 1999/5/EC and meet the following standards: EN 60 215 for protection of personnel, EN 301 489-1 and EN 301 489-11 for electromagnetic compatibility (EMC), as well as EN 302 018-1 / -2 for RF requirements.

Falko Hesse

More information and data sheet at www.rohde-schwarz.com (search term: SR8000)

REFERENCES

[1] Exciter R&S®SU 800: Digital FM exciter – compact and versatile. News from Rohde & Schwarz (2005) No. 187, pp 54–55

[2] Family of VHF FM Transmitters R&S®NR 8200: Compact, air-cooled transmitters for 2.5 kW to 30 kW. News from Rohde & Schwarz (2005) No. 186, pp 44–45

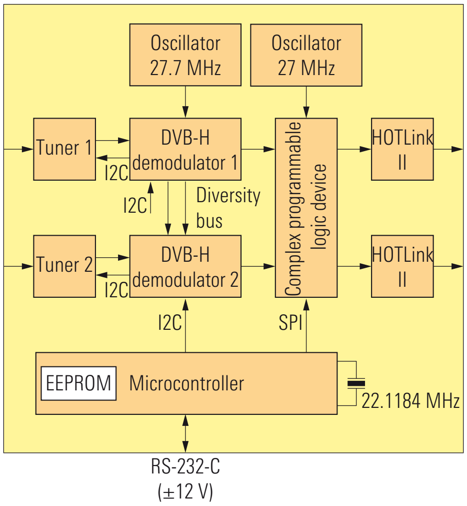
R&S®TSM-DVB DVB-T/H Diversity Test Receiver

Mobile system measures network coverage in a moving vehicle

The new R&S®TSM-DVB DVB-T/H diversity test receiver has been designed for mobile coverage measurements in digital terrestrial transmitter networks. While broadcasters have traditionally carried out stationary measurements, digital networks are now also making mobile measurements necessary. In combination with the R&S®ROMES coverage measurement software, the handy test receiver is ideal for this task.

FIG 1 Complete system for mobile measurements: tablet PC with the R&S®ROMES coverage measurement software, the R&S®TSM-DVB test receiver, two test antennas, and a GPS receiver.

FIG 2 The R&S®TSM-DVB DVB-T/H diversity test receiver with its two complete receive paths allows mobile DVB measurements at speeds of up to 150 km/h.



Optimum results with mobile and stationary measurements

Since DVB-T is not optimized for reception in a moving vehicle, – as is the case with GSM or UMTS – mobile coverage measurements are subject to significant limitations when performed with conventional receivers. The common 8K FFT mode, in particular, only allows measurements at walking speed in many cases since reception would otherwise be interrupted. The vehicle has to be stopped repeatedly in order to perform sample measurements; detailed information on actual coverage is practically impossible.

The R&S®TSM-DVB (FIG 1) makes all this a thing of the past. With its two sophisticated DVB-T receive paths for diversity reception (FIG 2) and two antennas, it considerably increases the receive power and even allows measurements at speeds of up to 150 km/h. Coverage measurements in city traffic and even on freeways are no longer a problem.

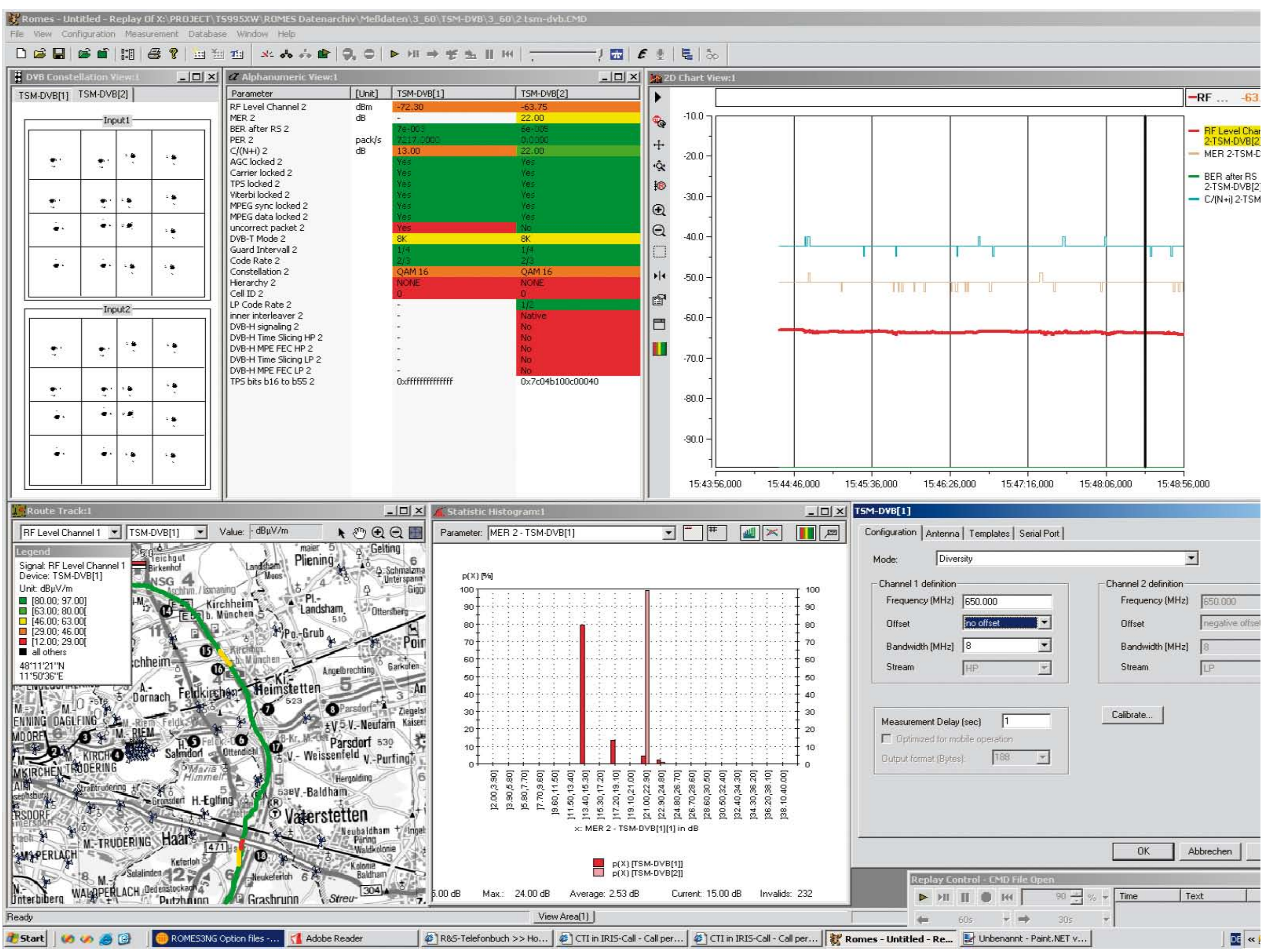
Rohde & Schwarz recommends a two-phase measurement concept to help ensure optimum DVB-T radio coverage. In the first phase, you perform mobile, fast, and cost-efficient overview measurements with the R&S®TSM-DVB. In the second phase, you perform detailed and high-precision stationary measurements with the R&S®EFA TV test receiver and an antenna raised on a 10 m mast in accordance with the CCIR guidelines.

Versatile and mobile solution

The R&S®TSM-DVB DVB-T/H diversity test receiver is integrated into a small robust aluminum case; its 12 V supply voltage is suitable for use in vehicles. Its low weight and high sensitivity (up to –92 dBm) also make it ideal for indoor applications. Measurement data such as bit error ratio, modulation error ratio, and carrier/noise ratio can be easily recorded and displayed with the R&S®ROMES coverage measurement software [1] (FIG 3). In combination with a laptop and a GPS receiver, a complete mobile coverage measurement system is provided. Owing to its modular software structure, the system can be expanded with the R&S®DVMD MPEG-2 measurement decoder [2] and the R&S®DVQ digital video quality analyzer [3]. With the R&S®TSM-DVB-Z4 MPEG decoder, which is available as an option, you can display the picture contents on the laptop. Rohde & Schwarz also offers customized solutions for integrating the instruments into racks, transit cases, or backpacks.

The R&S®TSM-DVB has two transport stream outputs. During diversity reception, the same transport stream is available at both outputs. When hierarchical reception is used, the high-priority (HP) transport stream can be output at one output and the low-priority (LP) transport stream at the other. But you can also

FIG 3 Typical screenshot of drive test results using the R&S®ROMES coverage measurement software.



operate the diversity test receiver as two autonomous receivers; in this case, two different transport streams are output.

The R&S®TSM-DVB is equipped with commercial tuners and demodulators. They not only have a favorable impact on the instrument's price, but also allow you to obtain practical information about reception capabilities with consumer equipment.

Model 10 for DVB-H networks

Model 10 of the R&S®TSM-DVB can also receive and measure signals in DVB-H networks. Digital video broadcasting for handheld terminals (DVB-H) is an enhancement of the DVB-T standard; the transmission parameters are optimized for reception with mobile equipment. Various manufacturers have already announced plans to launch instruments with an integrated DVB-H receiver. Although DVB-H is essentially compatible with DVB-T, DVB-T receivers cannot handle these signals. This is due to various enhancements made to DVB-H that were created to allow interference-free reception even when a vehicle is in motion. The bandwidth, for example, is limited to 5 MHz and allows you to use the frequency ranges of mobile radio networks. A method referred to as time slicing (FIG 4) reduces power consumption similar to the timeslot method used by GSM and enables the receiver to switch off its frontend intermittently. A new 4K mode is a good compromise between the 2K and 8K FFT modes. Moreover, a new Reed-Solomon error correction technique improves the carrier/noise ratio. Instead of MPEG-2, newer standards such as H.264 are used for video compression. They allow video transmission at a low bandwidth.

In DVB-H networks, model 10 can not only determine the measurement parameters already used in DVB-T and supply the parameter data in the transport stream. It also offers information about the (native or in-depth) inner interleaver used and about transmission parameter signaling (TPS) such as DVB-H signaling, time slicing, and MPE-FEC.

All this makes the R&S®TSM-DVB a universal receiver that enables you to perform trouble-free coverage measurements both in pure DVB-T or DVB-H networks and in combined networks.

Christian Christiansen

Measured parameters

- Signal strength
- Bit error ratio (BER)
- Modulation error ratio (MER)
- Packet error ratio (PER)
- Carrier/noise ratio (C/N)
- Status information: AGC locked, Carrier locked, TPS locked, Viterbi locked, MPEG Synchro locked, MPEG Data locked, Uncorrected MPEG Packet
- FFT mode
- Constellation
- Guard interval
- Hierarchy
- Code rate
- Cell identity (CI)
- Inner interleaver[1]: native, in-depth
- DVB-H TPS field[1]: DVB-H signaling, time slicing, MPE-FEC
- Constellation diagram[1]

Receive characteristics

- VHF channels: 5 to 12
- UHF channels: 21 to 69
- Bandwidth: 5[1] / 6 / 7 / 8 MHz
- Sensitivity (depending on the DVB-T mode): –20 dBm to –92 dBm
- FFT modes: 2K, 4K[1], and 8K

1) Model 10 of the R&S®TSM-DVB.

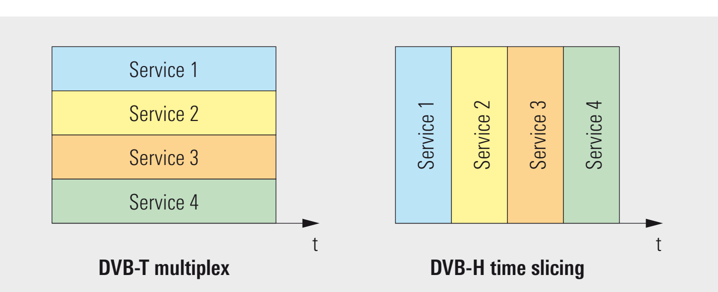


FIG 4 The time slicing method in DVB-H yields lower power consumption in mobile equipment as compared to DVB-T.

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

REFERENCES

[1] Coverage Measurement Software R&S®ROMES3: Acquisition, analysis and visualization of data in coverage measurements. News from Rohde & Schwarz (2000) No. 166, pp. 29–32

[2] MPEG-2 Generator R&S®DVG and MPEG-2 Measurement Decoder R&S®DVMD: Test equipment for digital TV in line with MPEG-2. News from Rohde & Schwarz (1996) No. 152, pp. 20–23

[3] Digital Video Quality Analyzer R&S®DVQ: The key to high picture quality. News from Rohde & Schwarz (2000) No. 168, pp. 20–21

R&S®EM 510 / R&S®EM 550 Digital Wideband Receivers

Maximum power from HF to UHF

The R&S®EM 510 and R&S®EM 550 receivers (FIG 1) cover the frequency ranges from 9 kHz to 32 MHz and 20 MHz to 3.6 GHz, respectively, and offer powerful digital signal processing in addition to excellent RF characteristics.

A strong duo – also in future signal scenarios

After the VXI-based R&S®EM 050 VHF / UHF digital wideband receiver [1] proved its mettle in multichannel systems, many customers soon began expressing an interest in receivers with the same characteristics but in 19" design. The strong demand was not only for receivers covering higher frequency ranges but also for digital receivers in the HF range due to the rapid increase in digital transmission methods. To meet this demand, Rohde & Schwarz developed the R&S®EM 550 VHF / UHF digital wideband receiver and the R&S®EM 510 HF digital wideband receiver – two instruments whose excellent RF characteristics, wide dynamic range, and powerful digital signal processing reflect the company's many years of experience in the development of professional radiomonitoring receivers.

FIG 1 A setup consisting of both the R&S®EM 550 and the R&S®EM 510 receiver as well as a PC provides you with a small system that covers HF to UHF, offers an excellent price/performance ratio, and already meets many requirements.

Innovation also in the HF range

The aspect that truly makes the R&S®EM 510 stand out is that it is designed as a direct receiver, i.e. the received signal goes directly to the A/D converter after it has passed through the instrument's extensive preselection. This adds unrivaled characteristics to the receiver in the HF range. In addition to a wide realtime bandwidth of 10 MHz, this concept significantly improves the reception of weak signals in critical scenarios, and the omission of the synthesizer allows higher scan speeds. Since the R&S®EM 510 and R&S®EM 550 use the same fast means of digital signal processing (DSP), the two receivers are basically identical with respect to characteristics and functions.

Dynamic range and sensitivity also in wideband operation

During the development of the two receivers, great importance was placed on excellent large-signal characteristics and high sensitivity – two aspects that are decisive in today's signal density when being able to clearly identify strong and weak signals is a must in critical scenarios. Thus, you can quickly find the right settings for successful radiomonitoring even under poor reception conditions. Furthermore, optimum reception conditions are ensured by matching preselection ranges with tracking or fixed bandpass, highpass, or lowpass filters.

While different applications often required different receivers in the past, the new receivers can process both narrowband and wideband transmissions without any performance loss.

Powerful digital signal processing

All IF processing is handled by powerful signal processors and field programmable gate arrays (FPGA). This technology allows the implementation of functions that are indispensable in modern radiomonitoring. The two new receivers provide many filters, various evaluation methods for level measurement, user-definable measurement times, a series of standard demodulators, functions for modulation and bandwidth measurements – to name only the most important features. Another advantage of this technology is the simultaneous availability of the demodulated signals in various formats and at different interfaces – both analog and digital. Moreover, the hardware used for signal processing provides ample room for future expansions.

Searching – detection

Since not all transmissions and their frequencies are always known beforehand, it is often necessary to first search for unknown signals in the frequency range. To do this, both receivers are equipped with extensive scan functions. Particularly noteworthy is the high-speed FFT scan (panorama scan), which offers scan speeds up to 34 GHz/s, irrespective of channel occupancy. The synthesizer is tuned in steps of 10 MHz and the FFT is calculated at each step. This allows unrivaled scan speeds even at high resolution. The FFT scan is especially advantageous when it is necessary to search for unknown signals, short-duration signals, or frequency-agile transmissions (e.g. hoppers, FIG 2). Particularly low probability of intercept (LPI) signals require maximum scan speeds. If the user-definable measurement time is also activated during the FFT scan (FIG 3), even interference signals with their mostly nonperiodic behavior can be reliably detected. This is particularly important when unwanted signals are causing interference to radio or navigation services that are relevant to security and the source of interference must be eliminated immediately.

Moreover, the receivers feature even further scan functions such as channel scan and memory scan. Channel scan (or frequency scan) is primarily used when you need to perform searches in a specific frequency range with fixed channel spacing, as is the case for example in tactical radio services or also in the classic FM broadcast band. Memory scan is applied to frequency lists that are user-programmable.

Demodulation – analysis

Featuring filter bandwidths from 100 Hz (150 Hz with the R&S®EM 550) to 10 MHz and the capability to also demodulate up to the maximum bandwidth of 10 MHz, the receivers are already well prepared for many signals. For example, FDM signals can be analyzed, and in the area of air traffic communications, all signals within the 10 MHz window are simultaneously audible. For civil services such as regulatory authorities, special functions such as the decoding of radio data service (RDS) content or the demodulation of analog TV transmitters (as bitmap picture on the PC) are available. Since the original sound is also audible, a TV transmitter can be quickly identified.

For further analyses, the receivers additionally provide IF panorama and video panorama. With IF panorama, the marked signal is located in the center, and the IF panorama is basically a zoom function with a user-definable span. This enables you to see the spectrum of the modulated signal (FIG 4) or, when a large span is involved, the signal environment. Even narrow pulses such as transmitted by radar systems can be dis-

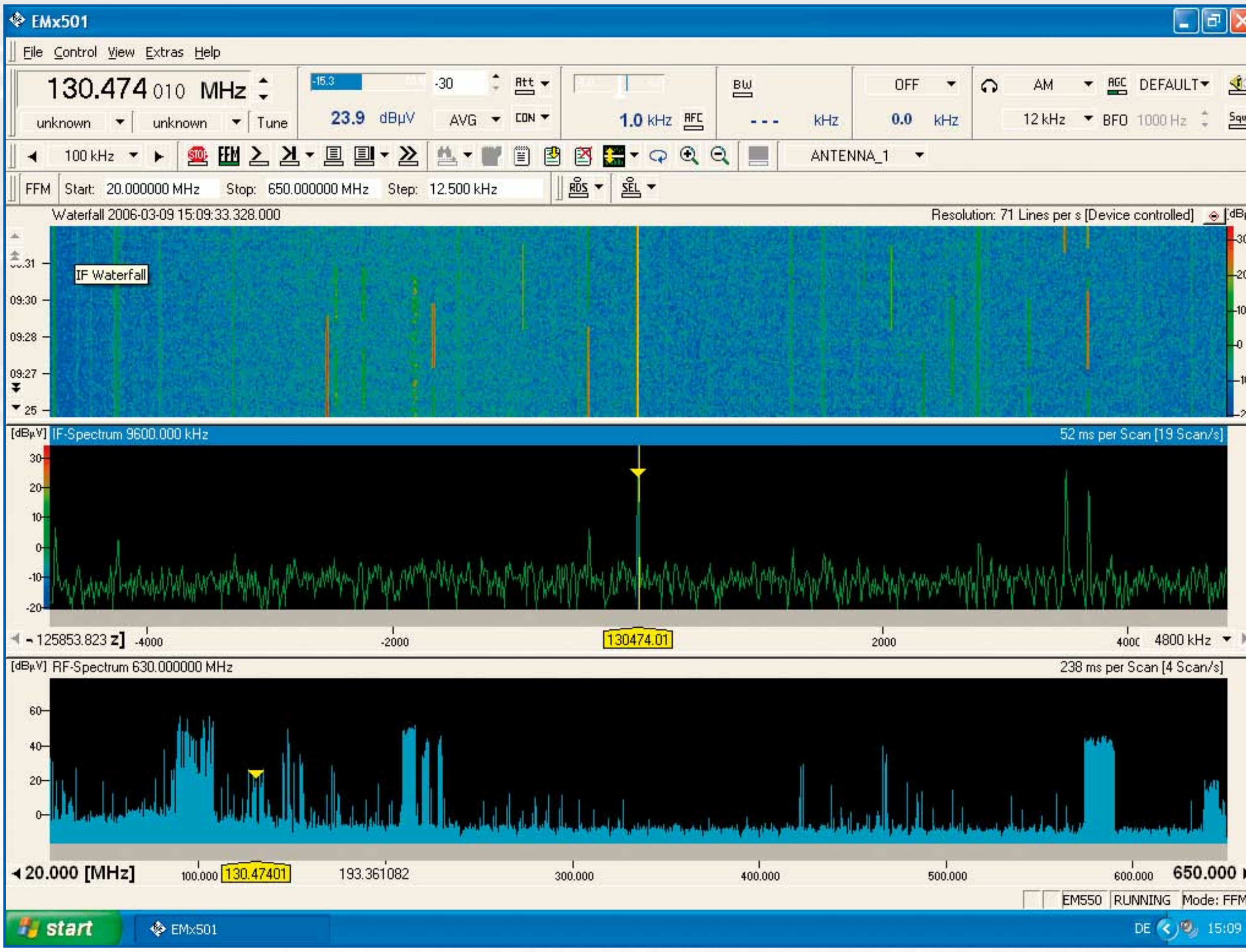


FIG 2
PC user interface of the R&S®EM510 and R&S®EM550 receivers showing FFT spectrum and IF spectrum with waterfall display.

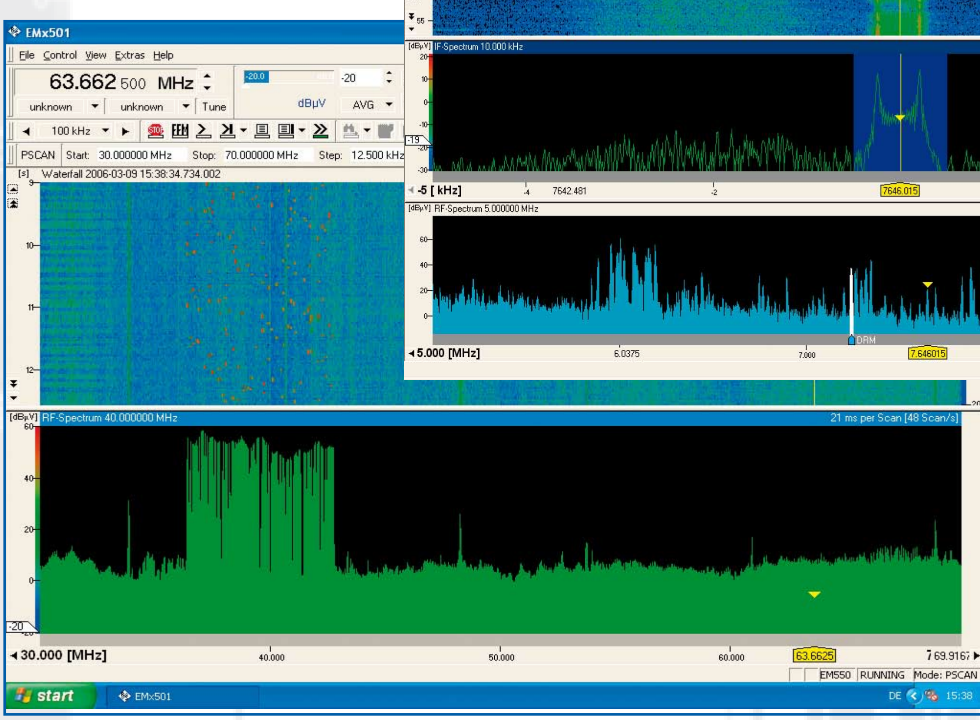


FIG 3
Detection of a hopper transmission.

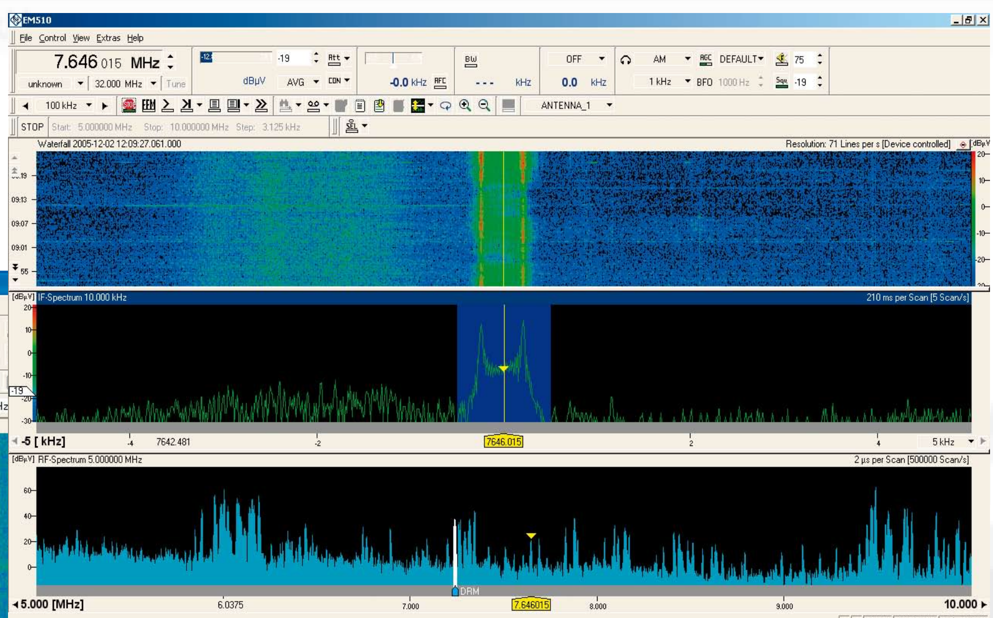


FIG 4
Spectrum of an FSK transmission, displayed in the IF panorama of the R&S®EM510.

played and measured. The IF panorama can also be used when the bandwidth of a signal is to be measured.

The video panorama makes the spectrum of the demodulated signal visible. Since the results are displayed in normal or squared format, diverse applications are possible. For example, baud rates in digital methods, chip rates in DSSS transmissions, and many other parameters can be reliably measured. Moreover, the visual assessment of the signal spectrum allows you to draw conclusions about the modulation type.

To analyze digital transmission methods, Rohde & Schwarz has developed a PC analysis software tool that opens up the full scope of digital signal processing capabilities when used together with the R&S®EM 510 and / or R&S®EM 550 receiver(s). Classification (detection of modulation type), vector analysis, bit stream analysis, and decoding are just a few of the many capabilities available. Measurements of new digital services such as DVB and DAB can also be performed on the basis of the new ITU recommendation SM 1600. Since, no hardware other than the receiver and PC is required, you enjoy the benefit of a small system that offers an excellent price/performance ratio and already meets many requirements.

Online – offline

Performing an online analysis of the received signals is not always possible or useful. In such cases, the digital baseband data can be recorded externally for later offline analysis where the recording time is only limited by the capacity of the storage medium. Of course, the PC analysis software mentioned earlier can use the recorded data for further processing. Data compatibility also allows access to the R&S®AMMOS analysis system [2].

Use in customer-specific systems

The receivers come with comprehensive control software for installation on a PC. Of course, you can also integrate the instruments into a monitoring system yourself. The necessary interfaces and commands are largely standardized and documented in the manual. A major customer benefit here is that all functions – even the fast panorama scan – run on the instrument.

The R&S®EM 510 and R&S®EM 550 are two powerful receivers that will do an excellent job of handling the tasks at hand for many years to come. Since internal signal processing can be adjusted via software, the receivers are also well prepared for future signal scenarios.

Christian Gottlob

More information and data sheet at www.rohde-schwarz.com (search term: EM510 / EM550)

REFERENCES

[1] VHF / UHF Receiver R&S®EM 050: Digital, VXI-based receiver for 20 MHz to 3.6 GHz. News from Rohde & Schwarz (2003) No. 178, pp 61 – 63

[2] Automatic Modular Monitoring System R&S®AMMOS: Seeing clearly through the thicket of signals. News from Rohde & Schwarz (2003) No. 178, pp 56 – 60

Condensed data	R&S®EM 510	R&S®EM 550
Frequency range	9 kHz to 32 MHz	20 MHz to 3600 MHz
Realtime bandwidth	10 MHz	10 MHz
3rd order intercept point	≥30 dBm, typ. 35 dBm	≥17 dBm (20 MHz to 300 MHz) ≥20 dBm (300 MHz to 3600 MHz)
Noise figure	≤15 dB, typ. 12 dB	≤12 dB (f < 2000 MHz) ≤15 dB (2000 MHz to 3000 MHz)
Digital filters for demodulation	30 filters, 100 Hz to 10 MHz	21 filters, 150 Hz to 10 MHz
Demodulation modes	AM, FM, CW, φM, pulse, LSB, USB, ISB, I/Q	AM, FM, CW, φM, pulse, LSB, USB, ISB, I/Q, TV (analog)
Scanning modes		
HF spectrum (panorama scan)	up to 34 GHz/s	up to 34 GHz/s
Frequency and memory scan	up to 1500 channels/s	up to 850 channels/s
Outputs / data output	FFT, IF, video spectrum; digital I/Q baseband; analog and digital video; analog and digital audio; IF controlled/uncontrolled (R&S®EM 550 only)	

Measuring and recording unknown satellite signals

The R&S®GSA family of systems from Rohde & Schwarz for satellite monitoring handles all tasks related to satellite signal interception. The R&S®GSA300, which is a new member of the family, measures the signal parameters, which can be used to analyze and identify unknown satellite-based voice and data links.

Satellite communications indispensable

Satellite-based communications (SatCom) are an integral part of the telecommunications infrastructure. In addition to international telephone communications and the distribution of radio and TV programs, some of the worldwide Internet and intranet traffic is handled via satellite. And that is not without reason: Satellite links are highly stable and flexible, and they are of major importance to users in areas where a terrestrial telecommunications infrastructure is not available.

Signal interception using the R&S®GSA300

System overview

The R&S®GSA satellite monitoring systems are specially designed to handle signals of communications satellites in geostationary orbits (FIG 1). They analyze standardized mobile SatCom signals implemented by INMARSAT (R&S®GSA9xx) and Thuraya (R&S®GSA6xx) as well as unknown signals (R&S®GSA300 analysis system). The R&S®GSA300 together with the R&S®GSA310 TDM demultiplexer can also analyze time division multiplex (TDM) data streams. By using the R&S®IntAs analysis software, operators can evaluate the intercepted satellite communications links. The intercepted data, e.g. from the Internet, is decoded and displayed by means of the R&S®DMT data monitoring tool.

Configuring the interception processing channel

The R&S®GSA300 analysis system determines technical parameters of unknown satellite radio signals such as frequency, modulation methods, and error correction methods. This is essential since you must have the correct technical parameters for configuring the interception processing channel (consisting of antenna, receiver, and demodulator) in order to successfully further process the raw data to be analyzed. FIG 3 shows the basic structure of the interception processing channel. The satellite signals reach the intercept system via

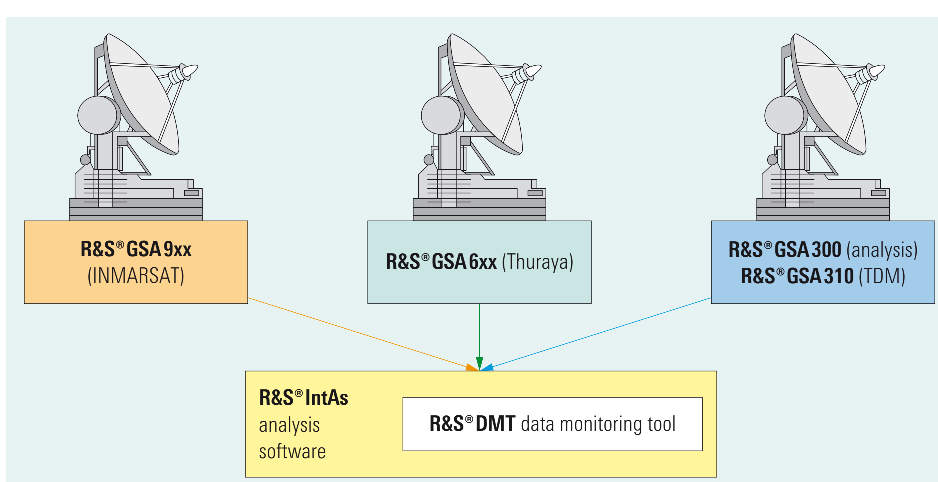


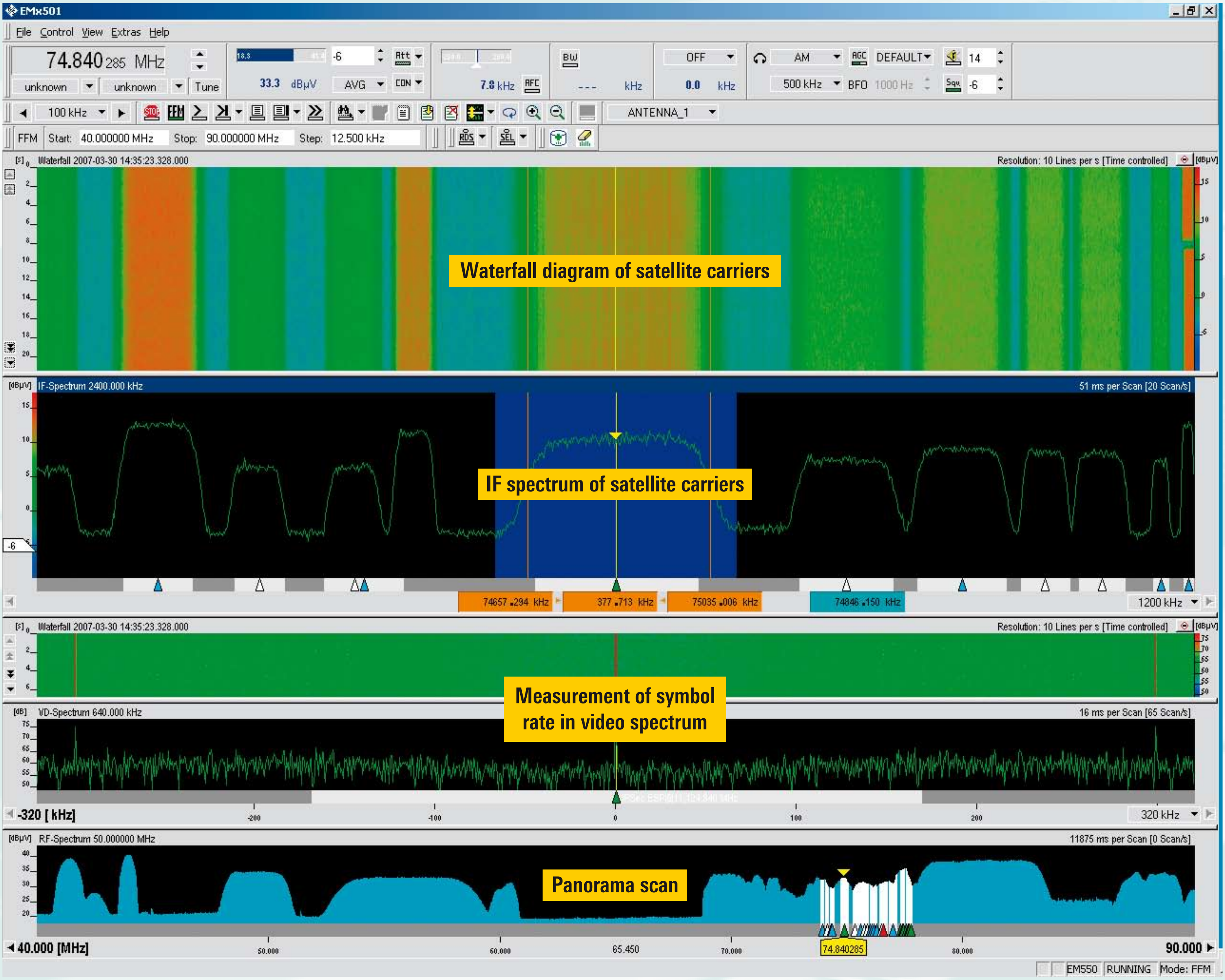
FIG 1 Overview of the SatMon family of systems from Rohde & Schwarz.

an antenna system. The intercept operators then measure the signal parameters with suitable receivers and essentially determine the modulation type and, if possible, the channel coding type. After successful demodulation and synchronization to the signal by the demodulator, the analysis of the received data stream starts.

Measurable signal parameters

Directly accessible signal parameters of satellite carriers include center frequency, bandwidth, and symbol rate. The intercept operators measure these parameters by means of the convenient receiver control (FIG 2), which provides a waterfall diagram that serves as a valuable tool for measuring the bandwidth in the IF spectrum and the symbol rate in the video spectrum. At the press of a button, the measurement results are transferred to a database, and the signal-related information measured for each carrier is stored. All new measurement results are entered in this satellite- and carrier-related database. The recorded content and the characteristics determined in the subsequent analysis are also stored in the database.

FIG 2 Receiver control of the R&S®GSA300 analysis system.



Demodulation and channel coding (FIG 4)

The measured symbol rate is the basis for determining further carrier-related parameters. The symbol rate value is tied to the data transmission rate of the carrier to be analyzed. The forward error correction (FEC) implemented, the modulation method (BPSK, QPSK, 8PSK), as well as further overhead on the net data stream determine the ratio between the symbol rate and the net data rate at the output of the demodulator and channel decoding unit. The symbol rate and the net data rate would be quantitatively the same only in the case of a two-valued modulation method (for example BPSK) and without additional redundancy through FEC. In practice, FEC and further overhead are always used.

The R&S®GSA300 features an automatic configuration function (AutoConfig) that makes the intercept operators' job quick and easy during analysis (FIG 5). This function determines modulation type, FEC, and other characteristics such as the appropriate frame synchronization largely without requiring operator input. However, one important step in the analysis is reserved for trained

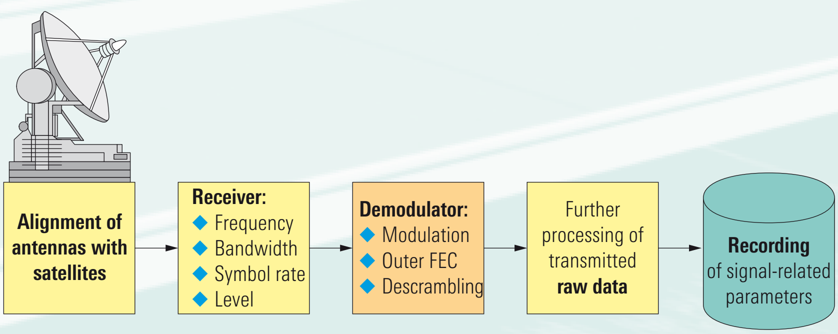


FIG 3 Basic structure of a SatMon interception processing channel.

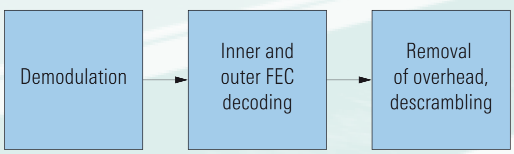


FIG 4 Demodulation and channel decoding.

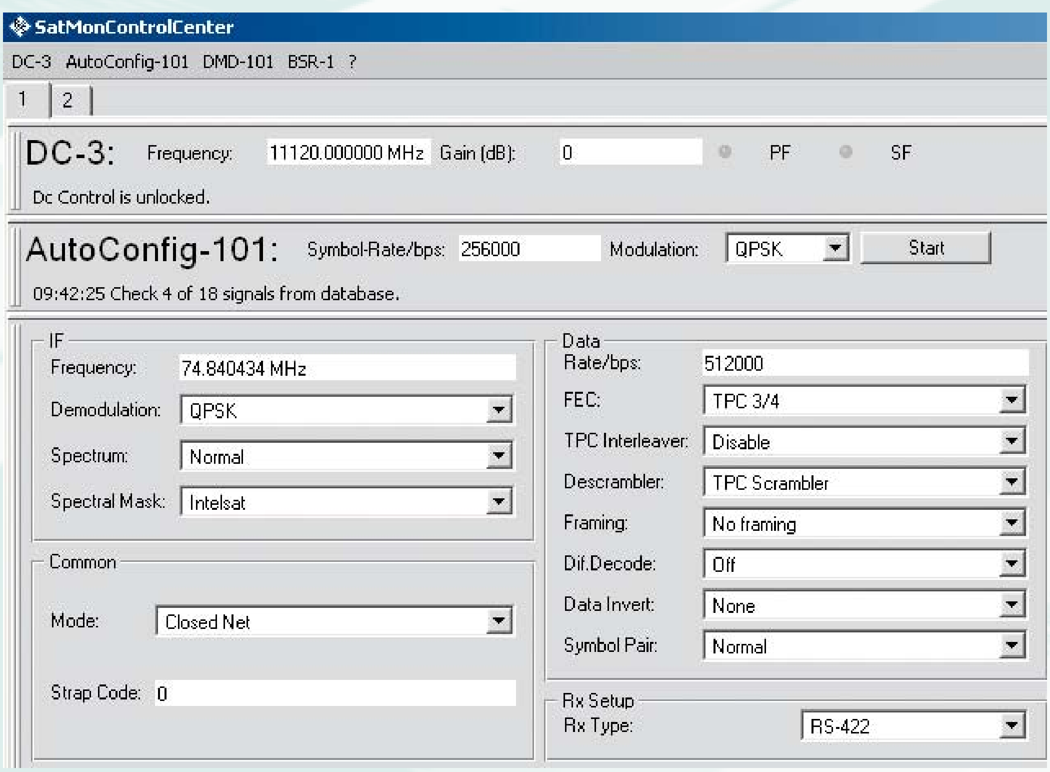


FIG 5 User interface of demodulator and channel decoder and the AutoConfig function.

intercept operators: validating the findings through observation and identification of frame structures. To perform the subsequent analysis of the raw data stream, intercept operators can display the bit stream and apply a data decoder or TDM demultiplexer to the raw data (FIGs 6 and 7). The analysis of all parameters related to demodulation and channel coding is finished when a satellite modem can be synchronized to the carrier signal by means of the automatically or manually determined parameters. In the subsequent analysis of the raw data stream, the intercept operators validate that the settings are correct.

Further processing of received raw data

By using suitable protocol decoders, intercept operators analyze short raw data recordings (snapshots) for obvious characteristics. For example, they look for identifiable protocol layers such as IP or TCP as well as for readable text. If they find such characteristics, they can regard the setting of the demodulation type, selection of the FEC, scrambler, framing, and further parameters as confirmed. At this point, an assessment of content for identification purposes can be performed.

Quite frequently, the satellite-transmitted raw data consists of a TDM stream (see box at right), which can only be decoded by means of a TDM demultiplexer. By using the flexible R&S®GSA310 demultiplexer, intercept operators can analyze TDM links with a wide variety of frame structures. The raw data must be analyzed in order to perform content-based identification. In addition to its SatCom applications, the R&S®GSA310 can also be used to measure and analyze terrestrial radio relay links.

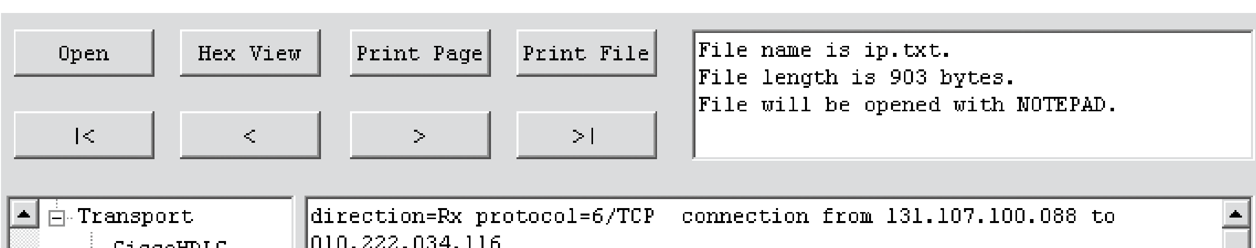
Multiplex (Latin: versatile, multiple, numerous) refers to a transmission method in telecommunications that can be used to combine multiple signals such as telephone, fax, or data links and transmit them simultaneously via one medium. The transmission medium can be a time division multiplex (TDM) link via radio (radio relay or satellite link). The primary rate multiplex method (E1 with 2 Mbit/s) is used in very many cases, e. g. in order to link telephone systems to ISDN in time division multiplexing.

Summary

The R&S®GSA300 analysis system is a convenient and time-saving tool for measuring and recording unknown satellite signals. When used in combination with the versatile R&S®GSA310 TDM demultiplexer, the R&S®GSA300 makes voice, fax, and data links in multiplex transmissions accessible for content-based identification.

Heiko Nickel

FIG 6 Example: Determining IP addresses.



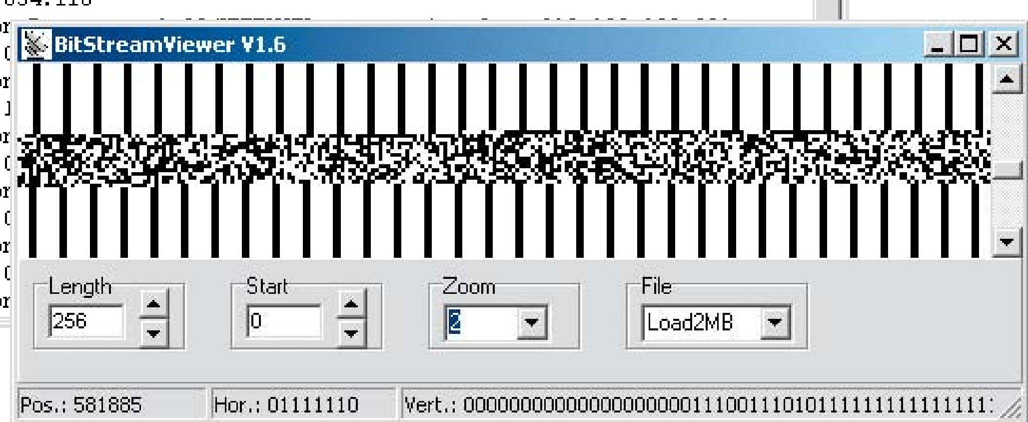
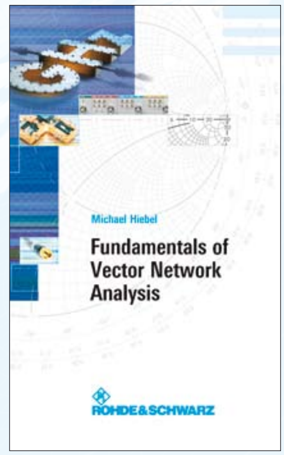


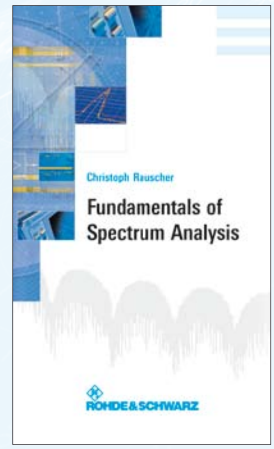
FIG 7 Bit stream display of recorded raw data.

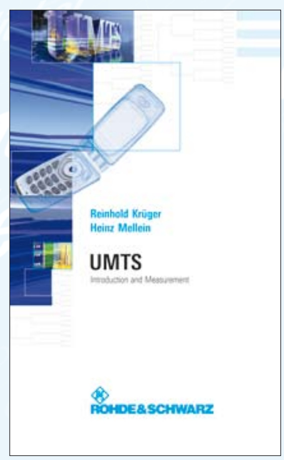
Books from Rohde & Schwarz – firsthand technical knowledge

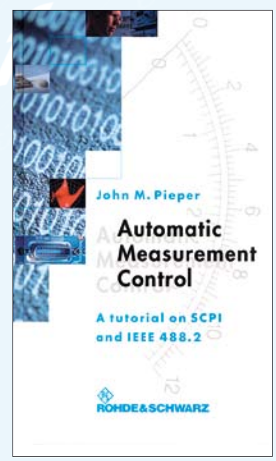
Like the natural sciences, the two highly dynamic fields of test & measurement and communications engineering are evolving at a rapid pace. As a result, news about the latest developments, methods, and knowledge first appears as articles in technical journals. It is usually not until much later that the information is included in books covering the main principles and fundamentals. However, many specialized fields of electrical engineering suffer from a lack of such books. Even when books exist, they are often too outdated to be of value to users confronted with cutting-edge tasks. Rohde & Schwarz is making an effort to fill this need by offering a selection of up-to-date books written by our own inhouse experts. Our authors are able to bring you the latest in theory and practice owing to their firsthand work at the forefront of research and development. Moreover, the books are well organized with the technical reader in mind. Our initial selection of books consists of four titles covering topics in test and measurement, and two of them are available in multiple languages. You can obtain the books from the Rohde & Schwarz Webshop or any bookstore.

www.books.rohde-schwarz.com









Title	Author	Language	Pages	ISBN number	Price
Fundamentals of Vector Network Analysis	Michael Hiebel	German	419	978-3-939837-05-3	€ 68.00
		English	419	978-3-939837-06-0	
		Chinese	404	978-3-939837-07-7	
Fundamentals of Spectrum Analysis	Christoph Rauscher	German	233	978-3-939837-00-8	€ 52.00
		English	223	978-3-939837-01-5	
		Italian	233	978-3-939837-08-4	
		Spanish	223	978-3-939837-03-9	
UMTS – Introduction and Measurement	Reinhold Krüger; Heinz Mellein	English	303	978-3-939837-04-6	€ 58.00
Automatic Measurement Control – A tutorial on SCPI and IEEE 488.2	John M. Pieper	English	295	978-3-939837-02-2	€ 34.00

Luc Haeberle (left) presents mobile reception by means of DVB-H to YB Dato' Chia Kwang Chye (third from left).

Minister impressed by mobile TV

In late March, Rohde & Schwarz presented a DVB-H playout and transmit system with live signal at the ABU DTV Symposium in Kuala Lumpur.

The live demonstration (the only one at the event) was also watched by YB Dato' Chia Kwang Chye, the Malaysian Deputy Minister of Information. Luc Haeberle, Area Manager of Sound and TV Broadcasting Equipment at ROHDE & SCHWARZ International GmbH, emphasized the major role of Rohde & Schwarz in the introduction of mobile TV standards worldwide and especially in the Asia / Pacific region.

DAB network launched in Ireland with transmitters from Rohde & Schwarz

As part of an initial setup phase, Rohde & Schwarz has delivered three DAB transmitters to Ireland's national broadcast provider, RTÉ Transmission Network Limited (RTÉNL).

Two 1 kW and one 500 W transmitters have been installed at Dublin's Three Rock Mountain site and at Clermont Cairn in County Louth. RTÉNL had already started a test phase last year in the Dublin metropolitan area using products from Rohde & Schwarz. A nationwide DAB network is in the planning stage.

O_2 makes TV in Ireland mobile with Rohde & Schwarz

For the first consumer trial of mobile TV in Ireland, Rohde & Schwarz supplied an air-cooled UHF high-power transmitter that has an output power of 1.3 kW.

The transmitter of the R&S®NV8200 product family that has been installed at Three Rock Mountain will enable 350 O_2 customers in the greater Dublin area to receive mobile TV in accordance with the DVB-H standard. Thirteen TV channels have joined the trial.

German Federal Network Agency measures field strengths with measurement stations from Rohde & Schwarz

In March 2007, the German Federal Network Agency (BNetzA) presented a new automatic measurement system in Bonn that is designed to permanently detect electromagnetic emissions of radio systems. Measurement stations from Rohde & Schwarz are part of the system.

The system measures electromagnetic fields (EMF) of radio systems in the frequency range from 9 kHz to 3 GHz. The frequency-selective detection ranges from modulated analog signals to pulsed digital broadband or radar signals. The data is transferred to BNetzA via a mobile radio network. The agency analyzes the data by means of software in line with Council Recommendation 1999/519/EC, dated July 12, 1999, governing the limitation of exposure of the general public to electromagnetic fields. The data is then published on the Internet pages of BNetzA, where anyone can read the limits of electromagnetic emissions of radio systems during a period of time for a specific place. The new system technology makes a significant contribution to the educational work of BNetzA. The expansion of the automatic measurement system with additional measurement stations from Rohde & Schwarz is planned.

One of the measurement stations from Rohde & Schwarz for the automatic measurement system of BNetzA.

Product manager Werner Dürport presents the award for the R&S®ETL.

Rohde & Schwarz receives Pick Hit Award …

The new R&S®ETL TV analyzer captured the Pick Hit 2007 award at NAB. Broadcast Engineering, an internationally renowned trade journal, bestows the prize annually for especially innovative products. The jury consists of experts from the broadcasting industry. For this reason, selection criteria include positive impact on everyday work and reasonable price.

… and a TVT STAR for A-VSB at NAB 2007

The live demonstration of a single frequency network (SFN) with advanced VSB technology conducted by Rohde & Schwarz and Samsung at NAB 2007 also won an award. The 2007 STAR (Superior Technology Award Recipient) is annually conferred at the trade fair by the journal TV Technology. The editors of the leading magazine of the broadcasting industry thus pay tribute to outstanding technological innovations at the broadcasting trade fair.

The jury was visibly impressed by live streaming. A low-power SFN transmitting from three different locations was used. The demonstration showed that a single frequency network (SFN) considerably improves coverage in areas between buildings or behind hills. In addition, the capability for mobile operation by means of A-VSB was presented.

New office in Vietnam

On April 1, 2007, Rohde & Schwarz Vietnam moved into new office space. The 19 employees from Hanoi had to look for new space in the existing building, since the staff had more than doubled in the last three years. The order intake is very satisfactory, due not least of all to broadcasting projects. Additional service space is now available for this purpose.

Bavarian economic delegation at Rohde & Schwarz Singapore

In late March, high-ranking representatives from Bavarian companies, the Bavarian Ministry of State, as well as the local German Embassy visited Rohde & Schwarz Singapore.

They learned about company development in Singapore over the last ten years. Boon Huat Lim, Managing Director of ROHDE & SCHWARZ Systems & Communications Asia Pte. Ltd., and Dr Klaus-Dieter Göpel, General Manager of the Rohde & Schwarz Headquarters in Singapore, presented the successful setup of the regional Support Center to the economic delegation. The company's tasks include providing applications to customers in the Asia / Pacific region and supporting them in calibration and system integration.

Host Boon Huat Lim (1st row, 3rd from right) and Dr Klaus-Dieter Göpel (1st row, 4th from right) provided information to secretary Hans Runck (2nd row, 7th from right) and others about the success of Rohde & Schwarz in Singapore.

Great interest in LTE seminar in the UK

All seats were filled at the Rohde & Schwarz office in Fleet, UK. The seminar on UMTS LTE attracted more than 60 software and hardware development engineers, technical consultants, employees of network operators, and chip manufacturers. The participants were enthusiastic about the in-depth information on this popular topic. The UK is always a leading contributor to the further development of this technology.

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