News from Rohde & Schwarz

New generation of radios for civil and military air traffic control

Mobile radiomonitoring systems – powerful and fully automatic

Test system for the certification of WiMAX end products

2006/III
191

ROHDE&SCHWARZ

44897

A new generation of radios for use in civil and military air traffic control is the successor to the renowned R&S®Series 200. Owing to their fully modular and digital design, the radios are extremely reliable, compact and prepared for future digital transmission standards (page 52).

The R&S®TS8970 test system uses validated test cases to certify WiMAX end products that are manufactured in accordance with the IEEE802.16e-2005 specification (page 26).

MOBILE RADIO

Protocol testers

Radiocommunications testers

WPAN / WLAN / WMAN / WWAN

Conformance test systems

GENERAL PURPOSE

Signal generators

Signal analyzers

The new microwave EMC test system is so compact that it can easily be integrated into laboratories and set up wherever required (page 37).

Despite its compact size, the R&S®UMS 100 is a powerful and complete monitoring system. It covers the frequency range from 100 kHz to 6 GHz with just two antennas (page 46).

Published by Rohde & Schwarz GmbH & Co. KG · Mühldorfstrasse 15 · 81671 München
Support Center: Tel. (+49) 01805 12 42 42 · E-mail: customersupport@rohde-schwarz.com
Fax (+49 89) 41 29-137 77 · Editor and layout: Ludwig Drexl, Redaktion – Technik (German)
English translation: Dept. 9MC7 · Photos: Rohde & Schwarz · Printed in Germany · Circulation (German, English, French and Chinese) 80 000 approx. 4 times a year · ISSN 0028-9108 · Supply free of charge through your nearest Rohde & Schwarz representative · Reproduction of extracts permitted if source is stated and copy sent to Rohde & Schwarz München.

R&S®CRTU-W Protocol Tester

HSUPA: Increased uplink resources – thoroughly tested

HSUPA, the data turbo for the uplink, increases data rates in UMTS networks to 5.76 Mbit/s. Using the R&S®CRTU-W L1 test software, new uplink channels (E-DPCCH / E-DPDCH) can be received, and their associated downlink channels (E-AGCH, E-RGCH, and E-HICH) can be generated.

HSUPA: 5.76 Mbit/s in the uplink

High speed uplink packet access (HSUPA), also referred to as enhanced uplink (EUL) in 3GPP, increases the data rate of mobile user equipment (UE) toward the base station to 5.76 Mbit/s. The optional 2 ms subframe structure reduces delay time, which is an important aspect in time-critical packet services.

HSUPA achieves these higher data rates because of the new uplink channels E-DPCCH / E-DPDCH (enhanced dedicated physical control / data channel). In addition, multiple E-DPDCH can transmit in the uplink (multicode). The new control channels in the downlink allow HSUPA to assume a key role by rapidly assigning uplink resources, i. e. the maximum possible transmit power that the UE may currently use [1], [2], [3], [4]. The base station determines the assignment of resources (grants) and conveys this information to the mobile UE on the enhanced uplink absolute grant channel (E-AGCH) and the enhanced uplink relative grant channel (E-RGCH). The hybrid automatic repeat request (HARQ) method, which is already included in HSDPA technology, is also used in HSUPA. The associated reverse channel is the enhanced uplink HARQ indicator channel (E-HICH).

Thoroughly tested with new test software

The new R&S®CRTU-W L1 test software supports HSUPA while high speed downlink packet access (HSDPA) is running simultaneously [5]. The combination of HSDPA and HSUPA is referred to as HSPA (high speed packet access). It is now possible to comprehensively test mobile UE to verify that it complies with the new requirements of packet-oriented connections in WCDMA.

The software includes predefined channel combinations that provide direct access to testing HSUPA chipsets and UE (FIG 1). The two cells of the R&S®CRTU-W protocol tester can be configured as serving cells, cells of serving RLS, or as cells of non-serving RL (see box). Depending on the selected configuration, the parameters of the E-AGCH, E-RGCH, and E-HICH are avail-

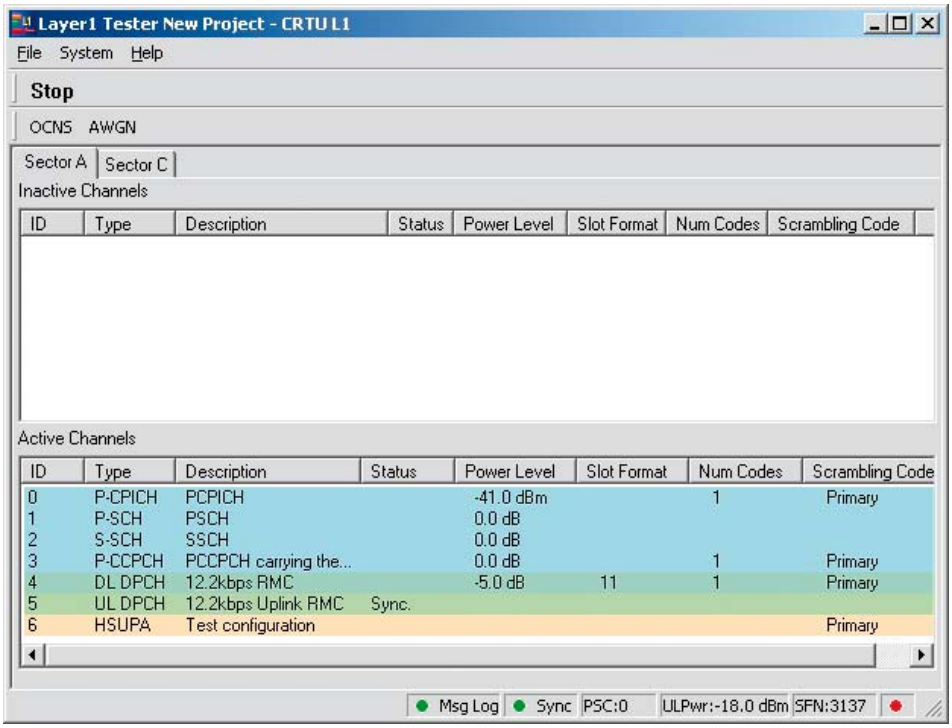


FIG 1
The basic parameters of the WCDMA cell and channels can be defined in the main menu of the R&S®CRTU-W L1 software.

Details about HSUPA and HSPA

HSUPA is the high-speed expansion for the uplink, which will be introduced with Release 6 of the 3GPP UMTS specification. The use of HARQ and a fast resource assignment mechanism increase spectral efficiency compared with the existing WCDMA method. By reducing redundancy in error correction, the data rate can achieve peak values of up to 5.76 Mbit/s.

HSPA combines the expansions for the downlink (HSDPA) and the uplink (HSUPA). In the future, it will be possible to set up fully packet-oriented connections. The signaling channels of the higher protocol layers can then be transmitted via HSPA channels, making the configuration of dedicated data channels (DCH) unnecessary. This solution paves the way for further optimization of the physical control channels. High data rate and short delay time are essential in time-critical applications (mobile gaming or voice over IP). In addition to the 10 ms frame structure, a 2 ms subframe structure can be optionally used, provided the UE supports this subframe structure. FIG 2 shows the different UE categories. The maximum size of the transport block and the frame structure determine the maximum data rate.

Soft handover for HSUPA is also supported. In this case, the cells in the E-DCH soft handover are classified as serving cells, cells of serving radio link sets (RLS), or cells of non-serving radio links (RL) (FIG 3). A cell of the serving Node B is either a serving cell or a cell of a serving radio link set (RLS).

E-DCH category	Max. number of transmitted E-DCH codes	Minimum spreading factor	Transmission time interval (TTI)	Max. number of E-DCH transport block bits that are transmitted in an E-DCH TTI	Data rate
1	1	4	nur 10 ms	7110	0.71 Mbit/s
2	2	4	10 ms	14484	1.45 Mbit/s
2	2	4	2 ms	2798	1.4 Mbit/s
3	2	4	nur 10 ms	14484	1.45 Mbit/s
4	2	2	10 ms	20000	2 Mbit/s
4	2	2	2 ms	5772	2.89 Mbit/s
5	2	2	nur 10 ms	20000	2 Mbit/s
6	4	2	10 ms	20000	2 Mbit/s
6	4	2	2 ms	11484	5.74 Mbit/s

FIG 2 HSUPA categories of mobile user equipment. The maximum transmission speed is a key characteristic of the different categories. Support of the 10 ms frame structure is mandatory. The shorter 2 ms subframe structure is specified for only a few categories. If four codes are to be transmitted simultaneously, two of them should have a spreading factor of 2, the other two a spreading factor of 4.

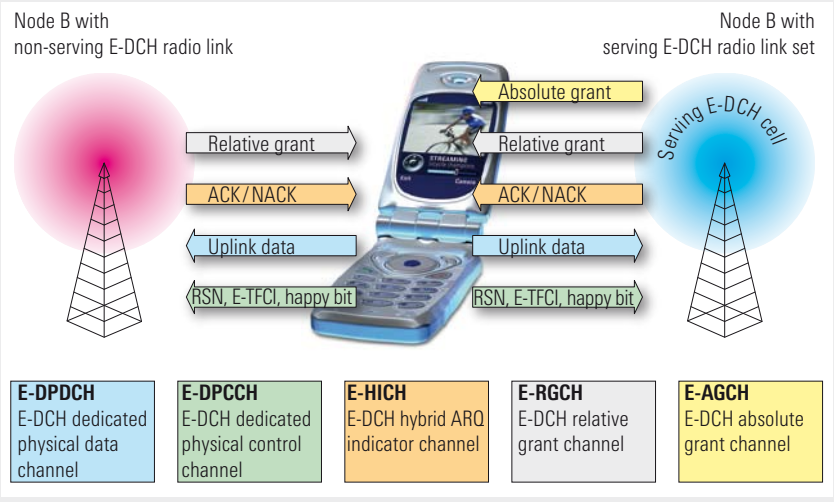


FIG 3
Overview of the HSUPA channel structure.

able. The timing of the HSUPA channels is automatically set in this configuration; the test software supports the 10 ms frame structure and the optional 2 ms subframe structure.

The E-AGCH is used to signal the "absolute grant", i. e. the maximum transmit power that is currently possible. An enhanced uplink radio network temporary identity (E-RNTI) is transmitted together with the absolute grant to ensure that the UE is unambiguously addressed. As the test software supports the primary and secondary E-RNTI, specific switchover algorithms can be tested in the UE. For a 2 ms subframe structure, activating and deactivating individual HARQ processes can be signaled via the absolute grant scope.

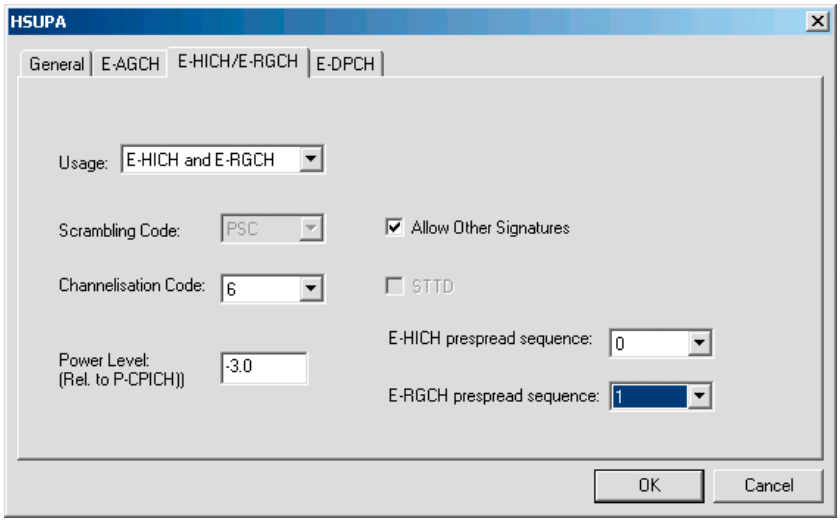


FIG 4 Definition of the HSUPA downlink control channels E-HICH and E-RGCH.

The relative classification of resources (relative grant) is transmitted in the E-RGCH (FIG 4). This channel can contain information for each frame or subframe on how to adapt the current resources by entering different bit patterns (1: up, 0: down, — (DTX): hold). The E-HICH and the E-RGCH are identical in structure. The menu layout is similar to that of the E-RGCH, allowing different bit patterns to be transmitted: 1: ACK, 0: NACK, — (DTX): NACK (in cell of non-serving RLS).

The uniform use of HSPA (see box on page 5) basically makes the use of dedicated physical data channels (DPDCH) unnecessary; nevertheless, measures must still be taken to ensure that the mobile UE does not transmit at more than the required power (closed loop power control). For this reason, the fractional dedicated physical control channel (F-DPCCH) was introduced in the downlink in Release 6; it controls the power of different UE in a time division multiplex method. The R&S®CRTU-W thus also supports the F-DPCCH.

Another benefit of the R&S®CRTU-W L1 test software is its capability to analyze uplink channels. In addition to all data of the DCH transport channels and the physical DPCCH control channel, E-DPCCH information can be recorded and analyzed. The information for the E-DPCCH may be provided as raw bit information, or as evaluated signaling of the individual E-TFCI, happy bit, and RSN fields.

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

REFERENCES
[1] 3GPP specification TS 25.211, Physical channels and mapping of transport channel onto physical channels (FDD)
[2] 3GPP specification TS 25.213, Spreading and modulation (FDD)
[3] 3GPP specification TS 25.214, Physical layer procedures (FDD)
[4] 3GPP specification TS 25.306, UE radio access capabilities
[5] Protocol Testers R&S®CRTU-W / -M: Layer 1 tests for WCDMA and HSDPA made easy. News from Rohde & Schwarz (2005) No. 187, pp 12–14

Other means for analyzing the E-DCH are in the pipeline. In the future, the user can either record the bit content directly after demodulation (direct data logging), or after the decoding stage at the E-DCH level.

Summary

With the HSUPA expansion, the R&S®CRTU-W L1 test software offers a broad scope of capabilities for testing the Release 6 functionality of mobile phones. The R&S®CRTU-W protocol tester additionally generates the HSUPA downlink channels for monitoring the UE resources and the indicator channel for the HARQ protocol. The new uplink control channel E-DPCCH can be thoroughly analyzed.

Uwe Bäder

R&S®CMU 200 Universal Radio Communication Tester

Ample new functionality for measurements on GSM mobile phones

With the latest software version, the R&S®CMU 200 universal radio communication tester offers an extensive range of new functions that help to cut manufacturing times on the production floor and to test and verify the latest developments in mobile radio in the lab.

I/Q-versus-slot measurement

Using the I/Q-versus-slot measurement, for example, the characteristic of a mobile phone's output stage can be determined very quickly. From this characteristic, a precorrection characteristic for the mobile phone is generated. In practice it may be useful to repeat the measurement several times to calculate an average precorrection characteristic. This previously required restarting the measurement several times both on the mobile phone and the tester. To reduce test times, the R&S®CMU 200 now makes it possible to carry out this measurement in several steps with only one start being required. On completion of each step, the tester waits until the trigger condition for the next step is fulfilled. A complete measurement sequence can thus be run on the mobile phone several times, yielding all results required to form an average (FIG 1) while the measurement has to be started only once.

BLER and uplink TBF

BLER measurements are very time-consuming for reasons inherent in the procedure. The R&S®CMU 200 therefore provides a new connection mode for packet data links that allows BLER and transmitter measurements to be performed simultaneously on the mobile phone, thus reducing measurement time.

Power-versus-time measurement

The R&S®CMU 200 features an intelligent and flexible power-versus-time measurement capable of analyzing up to four GSM timeslots simultaneously. In addition to the standard filter bandwidths of 500 kHz (GMSK) and 600 kHz (EDGE), a bandwidth of 1 MHz can now be set. Even very fine peaks in the RF signal power characteristic of a mobile phone can thus be detected and displayed.

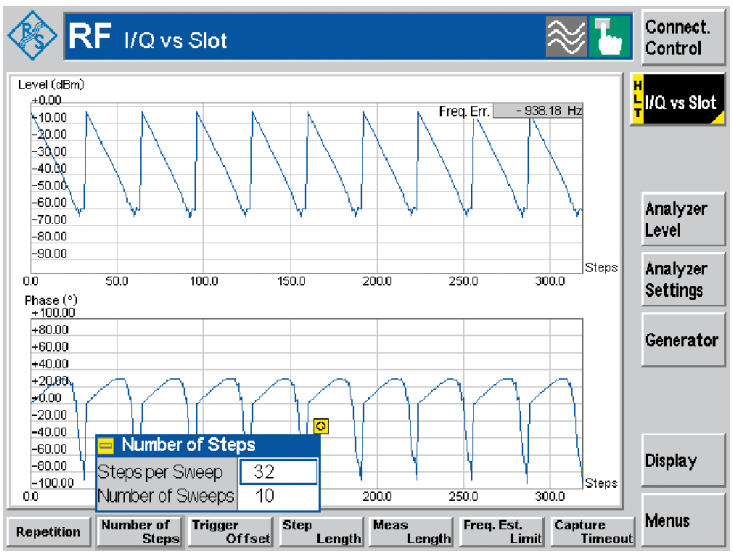


FIG 1
In the I/Q-versus-slot measurement, several test sequences can be executed as submeasurements in a single test run. The number of submeasurements and the test points for each submeasurement can be defined by the user. After each submeasurement, the tester waits until the trigger condition for the next submeasurement is fulfilled. On completion of the test run, all results are displayed in a straightforward manner.

Synchronization of several R&S®CMU 200 testers

For R&D and quality assurance applications, it is sometimes necessary to offer the mobile phone several GSM cells that must be time-synchronized. This can easily be implemented with the R&S®CMU 200. One R&S®CMU 200 acts as a master, the others as slaves. The master outputs a defined trigger signal at a user-defined frame number during the GSM signaling. The trigger signal time-synchronizes all R&S®CMU 200 units in the network (FIG 2). For each slave, a separate signaling offset rel-

ative to the master can be defined. The offset can be set via the parameters "Frame Number", "Slot" and "1/4 Symb. Offset" in a range of over two million frames with a resolution of ¼ symbol. And the R&S®CMU 200 offers even further convenient functions. Its timing can be modified by introducing a defined drift, i. e. the timing can be shifted by ¼ symbol for a user-definable frame division (FIG 4).

Repeated FACCH/SACCH

The standardization bodies have defined new signaling modes. In the "Repeated FACCH" mode, each FACCH block is transmitted twice in the downlink. By retransmitting the block immediately, transmission errors in signaling can be reduced (FIG 3). If a mobile phone cannot decode the first FACCH block error-free, it attempts to decode the retransmitted block. If this also fails, the mobile phone attempts to retrieve the information error-free from the two errored blocks. By using the combined information of two errored blocks, signaling stability can be increased.

The same principle is employed in the "Repeated SACCH" mode, with the difference that SACCH blocks are retransmitted only on request. Whereas "Repeated FACCH" is used only in the downlink, "Repeated SACCH" is used in the uplink and the downlink.

The R&S®CMU 200 supports both signaling modes. The tester not only adapts the signaling procedure to the type of mobile phone under test, but also the FACCH FER measurement, taking into account the different responses of the various types of phones, depending on whether or not they support the "Repeated FACCH" mode.

To determine how many times a mobile phone has requested retransmission of a SACCH block, the R&S®CMU 200 provides the "Repeated DL SACCH" measurement (FIG 5).

Enhanced power control (EPC)

The standardization bodies have defined a new signaling mode also for the power control of mobile phones. The previous control mechanism via the SACCH allowed the mobile phone power to be varied every 480 ms. Using the new EPC mode, the power can be varied every 120 ms. The enhanced power control mode is currently being implemented in the development labs of the mobile phone manufacturers. The R&S®CMU 200 supports tests of the new power control mode even today.

Summary

The functions described here are only a few of the enhancements offered by the new software of the R&S®CMU 200. Many more new functions such as the two speech codecs (GSM-8PSK-AMR and WB-AMR, page 19) and the CMR performance measurement will be available after the update. The R&S®CMU 200 is keeping pace with the rapid development of mobile radio, supporting applications in all areas, whether production, development, or quality assurance.

Rudolf Schindlmeier

The R&S®CMU 200 is keeping pace with the rapid development of mobile radio, offering an extensive range of new functions that are described in this issue:

- **Page 10** The new version of the R&S®CMUgo software increases throughput in service.
- **Page 14** With firmware version 4.20, the R&S®CMU 200 can request the mobile phone to send the reception quality of neighboring cells of other mobile radio networks now also in the GSM standard and evaluate the information returned.
- **Page 16** With a new signaling option, the R&S®CMU 200 covers all test scenarios relevant in the development and production of 1xEV-DO access terminals.
- **Page 19** The R&S®CMU 200 – the trailblazer when it comes to voice functionality – expands its position with two new voice codecs.
- **Page 22** The R&S®CMU 200 now also supports discontinuous transmission (DTX) in the downlink, as well as the important "performance of bad frame indication" (BFI) test case.
- **Page 24** Two new options expand the functionality of the R&S®CMU 200, adding capability to test WCDMA-HSDPA data applications.

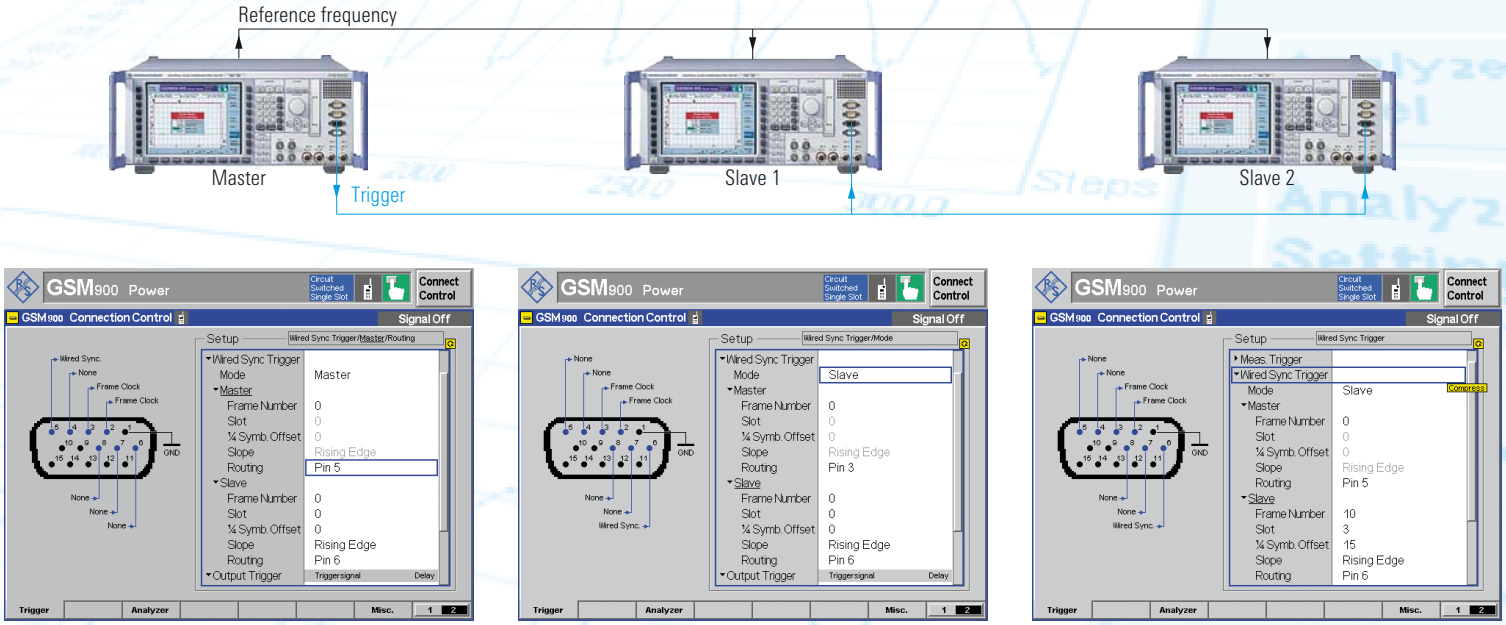


FIG 2 Several R&S®CMU 200 units can be connected to form a network of time-synchronous GSM cells. For each R&S®CMU 200, a separate timing offset can be defined.

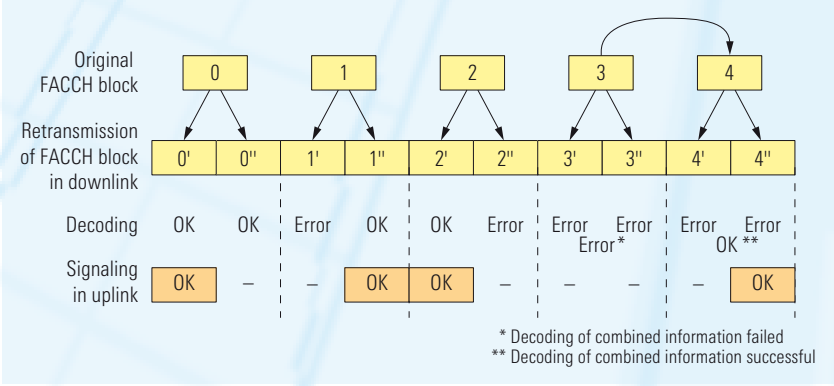


FIG 3
Immediate retransmission of the FACCH block reduces transmission errors in signaling. If neither of the two blocks can be decoded correctly, the mobile phone attempts to retrieve the message error-free from the combined information of the two errored FACCH blocks.

FIG 4 The R&S®CMU 200 timing can be shifted by introducing a defined drift of ¼ symbol for a definable frame division. The timing offset can be used to test a mobile phone's ability to stay synchronized.

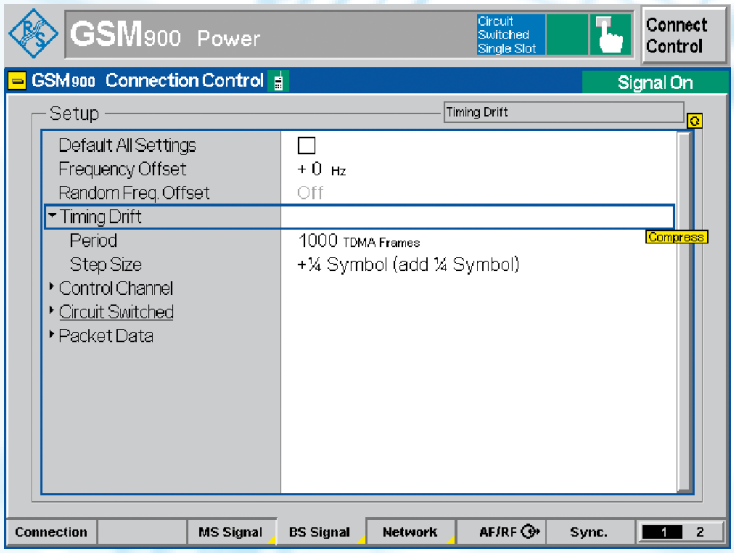


FIG 5 In the "Repeated SACCH" mode, signaling blocks are retransmitted only on request. The "Repeated DL SACCH" measurement determines the number of retransmission requests issued by the mobile phone for a specific downlink level.

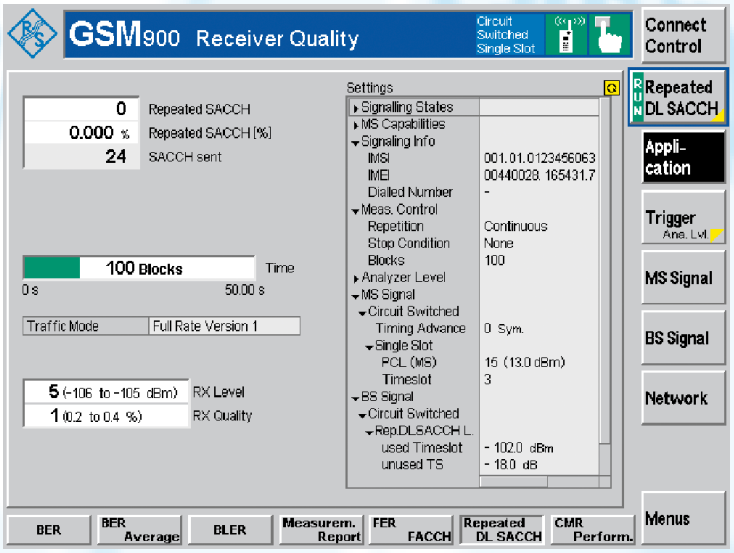


FIG 1 Efficiently testing and repairing a large number of mobile phones from a wide variety of manufacturers: This is accomplished by the R&S®CMU 200, assisted by the R&S®CMU-Z10 antenna coupler, the R&S®CMU-Z11 shielding cover and the free R&S®CMUgo software.

R&S®CMU 200 Universal Radio Communication Tester

New software increases throughput in service

The new version of the R&S®CMUgo software offers important new functions and speeds up the repair of mobile phones – and ensures even more accurate test results.

Emphasis on automatic functions

Achieving high throughput in service when repairing and testing mobile phones requires not only a fast mobile radio tester from the R&S®CMU family (R&S®CMU 200 V02 / V10, [1]) but also a speed-optimized final test. For the final test makes up a major portion of the overall repair process and therefore presents the greatest potential for optimization. Whereas manufacturer-specific software is usually necessary for such tasks as calibration, for example, the final test requires universal test-sequence tools that can be used to test mobile phones of all manufactur-

ers. This is exactly what version 1.8 of the R&S®CMUgo software is optimized for, as it offers important new automatic functions for recognizing telephones and assigning test sequences and can thus increase repair volumes. Moreover, it now provides even more accurate measurement results with tests performed using the R&S®CMU-Z10 antenna coupler [2].

Automatic assignment of test sequences

A test sequence can be assigned to a specific telephone in an initialization file or conventionally by means of a bar code. Any desired bar code character string can be specified; the only important thing is that it be uniquely assignable to a telephone type. This can be done, for example, by reading in the type approval code (TAC). The TAC is the first eight digits of the international mobile equipment ID (IMEI), with which every mobile telephone is uniquely identifiable. Using the TAC is advantageous, since with most repair procedures the IMEI has already been read in and printed out as a bar code in a work order.

In the bar code scanner mode, the R&S®CMUgo software operates in a loop; the scanned bar code serves as a selection criterion for the test sequence and confirms the start of the test. After the first telephone has been tested, the software waits for the next bar code and then handles each telephone in succession. The user therefore need not worry about selecting the appropriate test sequence and can efficiently and quickly repair a large number of different telephones from a variety of manufacturers.

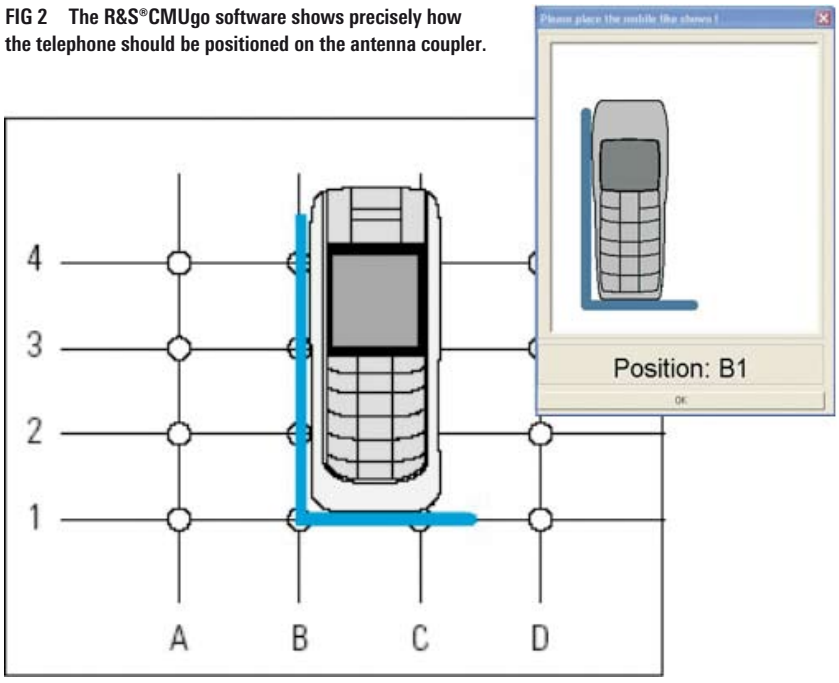
Automatic compensation of attenuation values

For the final test, the telephone is usually linked to the mobile radio tester via the R&S®CMU-Z10 antenna coupler and is thus driven under real conditions by signaling messages via the air interface (FIG 1). The near-field characteristics of the air interface depend on the telephone, producing different attenuation values that have to be compensated to ensure the accuracy of the test results. The individual attenuation values of previously measured mobile phones are stored – detached from the test sequences – in a separate database. As a result, the test sequences are purely standard-referenced and can be used in the same functionality for each telephone type.

With GSM/WCDMA mobile phones, the attenuation values can be linked to the corresponding TAC or are connected to a selection list in the shortcut mode of the software. The CDMA2000® and 1xEV-DO standards specify no unique recognition characteristics for mobile phones, which is why only the shortcut mode can be used for these devices.

After recognizing the type of telephone, the R&S®CMUgo software shows the user the position coordinates on which the telephone is to be placed (FIG 2). The optimal position was determined with reference telephones. A database containing the attenuation values of conventional mobile phones from a wide range of manufacturers is available for downloading. The innovative positioning system of the R&S®CMU-Z10 antenna coupler and the clear information provided by the software allow the user to position each telephone quickly and exactly. The telephones' positioning coordinates and attenuation values stored in the database are selected in such a way that the measurements with all mobile radio standards and frequencies are made using minimum attenuation values.

FIG 2 The R&S®CMUgo software shows precisely how the telephone should be positioned on the antenna coupler.



Linking the test sequences with the TAC

In this mode, which is only practical for GSM and WCDMA mobile phones, at first only standard attenuation values are set at the start of a test sequence, i. e. when a telephone is initialized and registered (FIG 3). For this purpose, the telephone must be positioned in the center of the antenna coupler. After an initial connection has been set up for the registration, the R&S®CMUgo software queries the IMEI of the telephone, from which it determines the TAC. Subsequently it finds an attenuation value assigned to the TAC in the database, loads it and continues the test sequence as soon as the user has acknowledged the positioning prompt. The test now runs using the telephone-specific attenuation values.

Shortcut mode

This mode provides a quick means of manually selecting test sequences, but also makes it possible to link them to sets of attenuation values in a separate database (FIG 4). This means of indexing test sequences and attenuation values is designed primarily for CDMA2000® and 1xEV-DO mobile phones, since such phones have no unique characteristics for automatic recognition. In special cases, however, this mode is also useful for GSM and WCDMA mobile phones, for it allows correct attenuation values to be manually assigned when the TAC is not enough for automatically determining the physical characteristic, e. g. with models that feature more than one antenna configuration or if telephones are to be tested without their housing.

To configure a shortcut list, the R&S®CMUgo software provides a straightforward menu containing the available test sequences. Each sequence can be assigned a user-defined abbreviation and a set of attenuation values (see pointers #1 and #2 in FIG 5). First, the sequence to be used is selected. Then the attenuation values to be used are defined within the "initialization / registration" procedure of a selected test sequence. If an entry in the database is available, the information indicating the position of the telephone on the antenna coupler and the corresponding attenuation values are transferred. Now the test runs using the telephone-specific attenuation values.

Other software features

Although the R&S®CMUgo software not only provides powerful functions for servicing mobile phones but also fulfills requirements in research and development, it is very straightforward. Test sequences for every mobile radio standard supported by the R&S®CMU 200 are put together with just a few mouse clicks. Input fields are available for configuring all essential RF parameters; tolerances for the individual measurements can be changed. If no special requirements for tolerances exist, the software uses the tolerances defined in the specification.

The graphical, user-friendly display makes it easy to work with the test configuration, even without in-depth technical knowledge. The contents of the test protocol can be configured in a great variety of ways. Display modes with the output of tolerance values or only with the display of measured values are available. If desired, only a summary of the test is output. The R&S®CMUgo software can be configured to automatically save test reports on a file server with a possible database link or to export the test reports to other conventional data formats such as XML.

Fernando Schmitt; Thomas Lutz

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

REFERENCES

[1] Universal Radio Communication Tester R&S®CMU 200: Cost-efficient models for service and production. News from Rohde & Schwarz (2006) No. 189, pp. 14–15

[2] Antenna Coupler R&S®CMU-Z10 / Shielding Cover R&S®CMU-Z11: Practical and indispensable accessories for testing mobile phones. News from Rohde & Schwarz (2002) No. 175, pp. 18–19

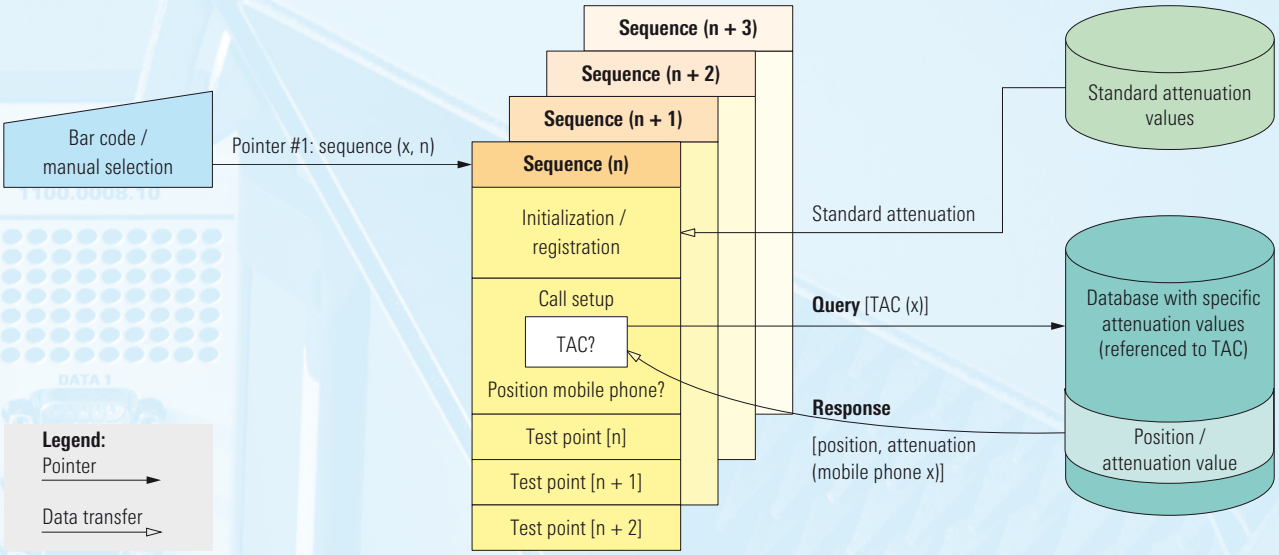
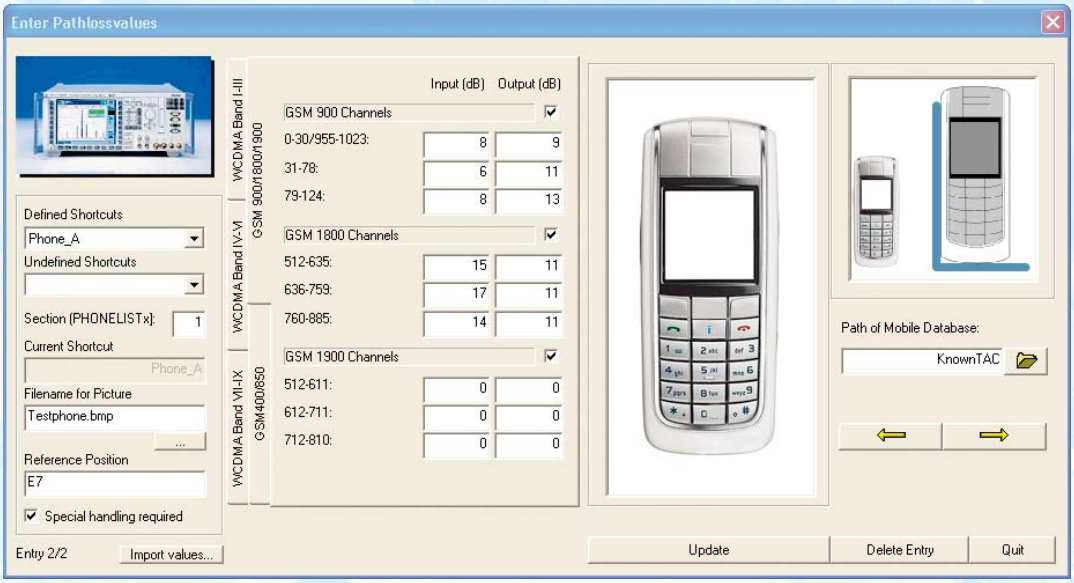


FIG 3 Flowchart of the mode in which the attenuation values are automatically set as a function of the TAC.

FIG 4 Database containing attenuation values that are selected by means of shortcuts.



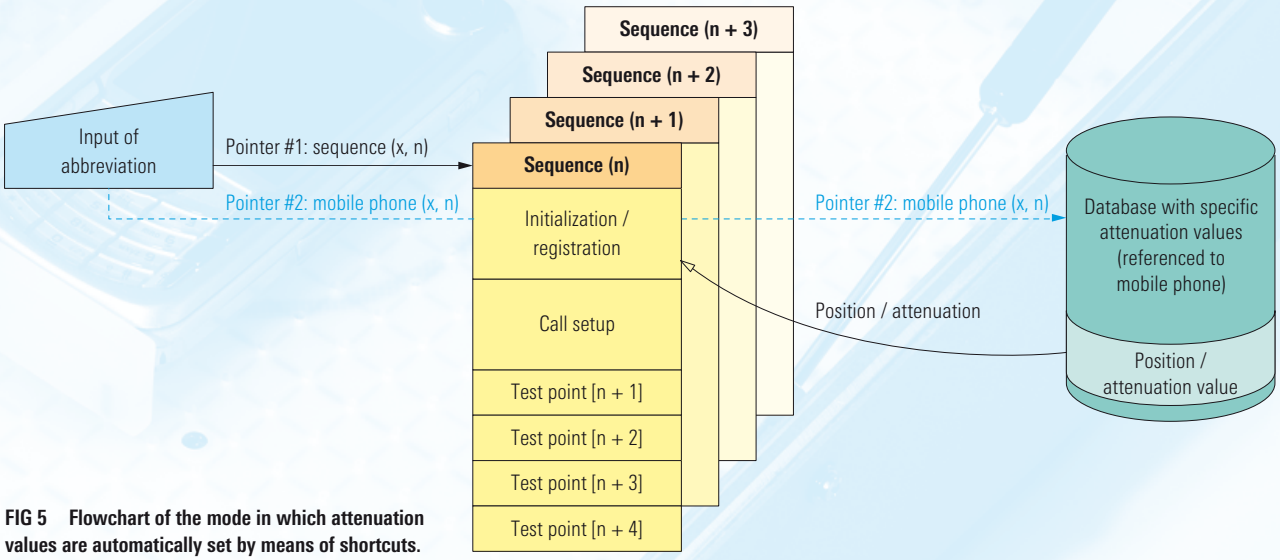


FIG 5 Flowchart of the mode in which attenuation values are automatically set by means of shortcuts.

R&S®CMU 200 Universal Radio Communication Tester

Enhanced measurement report for inter-RAT cell changes

With firmware version 4.20, the R&S®CMU 200 universal radio communication tester can request the mobile phone to send the reception quality of neighboring cells of other mobile radio networks now also in the GSM standard and evaluate the information returned. The reception quality of neighboring cells is a decisive criterion in the cell reselection procedure.

How good is reception in neighboring cells?

Mobile phones with multi-RAT capability must measure not only the reception quality of the current cell, but also that of the neighboring cells of other mobile radio networks (radio access technologies or RAT) during an active call. The evaluation of this measurement is necessary in order to perform an inter-RAT cell change, e. g. from GSM to UMTS.

With the new HSDPA and HSUPA transmission methods developed for the WCDMA standard, the number of GSM / WCDMA-compatible mobile phones put on the market will steadily increase. Such mobile phones must be capable, for example, of measuring the reception quality of WCDMA neighboring cells and report the results to the base station during a GSM connection.

The R&S®CMU 200 is preconfigured for all measurements required on such mobile phones. It can request the mobile phone to send the results of the measurement of up to six WCDMA FDD neighboring cells, and display and evaluate the information returned.

Detailed quality report to base station

The TS 44018 3GPP specification stipulates that the mobile phone should signal the reception quality of the current cell and the neighboring cells to the base station using either a measurement report (MR) or an enhanced measurement report (EMR). The MR includes the measurement of the current GSM cell and the six best valid GSM neighboring cells. The EMR additionally includes three criteria for characterizing the current GSM cell:

- MEAN_BEP (mean bit error probability)
- CV_BEP (coefficients for the variation of the bit error probability)
- NBR_RCVE_BLOCKS (number of correctly decoded data blocks during a measurement period)

The base station can in addition request the measurement of several predefined WCDMA neighboring cells. The R&S®CMU 200 tests the performance of mobile phones with respect to these characteristics. FIGs 1 and 2 show the evaluation of the EMR of a GSM cell and three WCDMA FDD neighboring cells.

Definition of neighboring cells and evaluation criteria

The user can define the WCDMA FDD neighboring cells of which the receive quality is to be evaluated by selecting the RF channel and the primary scrambling code (FIG 3). Moreover, the WCDMA FDD evaluation criteria can be configured (FIG 4). The mobile phone performs the measurements on the WCDMA FDD neighboring cells during a GSM connection.

Shuhua Wang

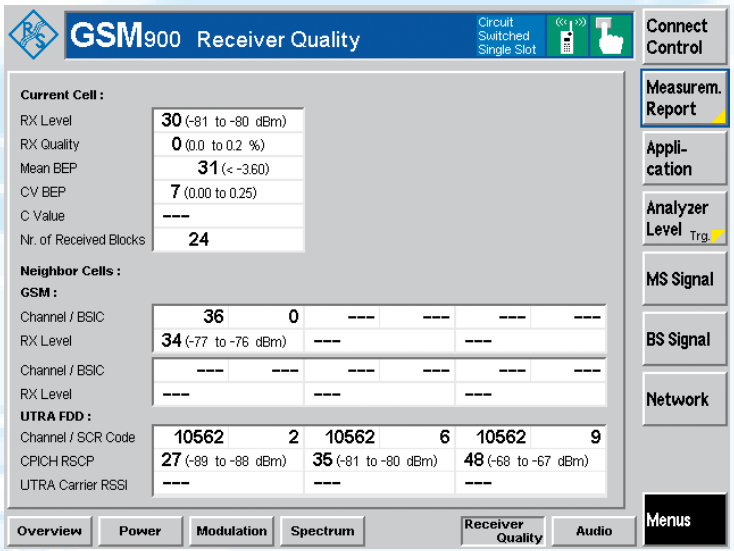


FIG 1 Enhanced measurement report of RSCP in CPICH.

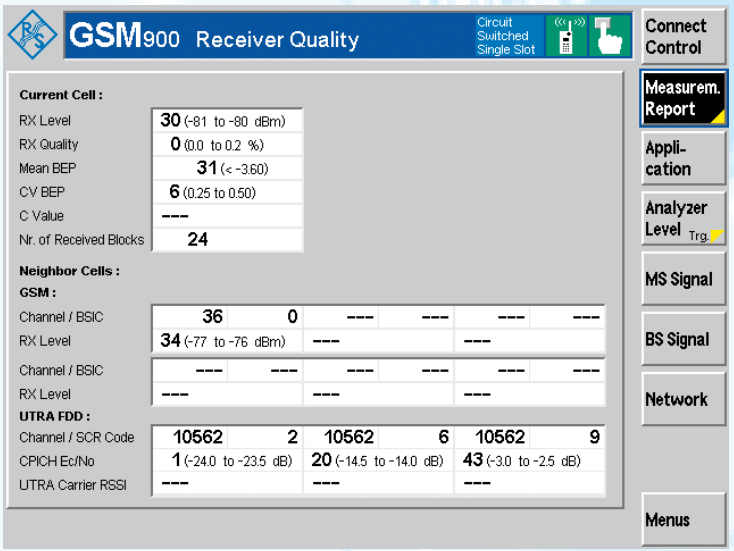


FIG 2 EMR with E_C/N_0 in CPICH.

FIG 3 Definition of RF channels and primary scrambling codes for 3G neighboring cells.

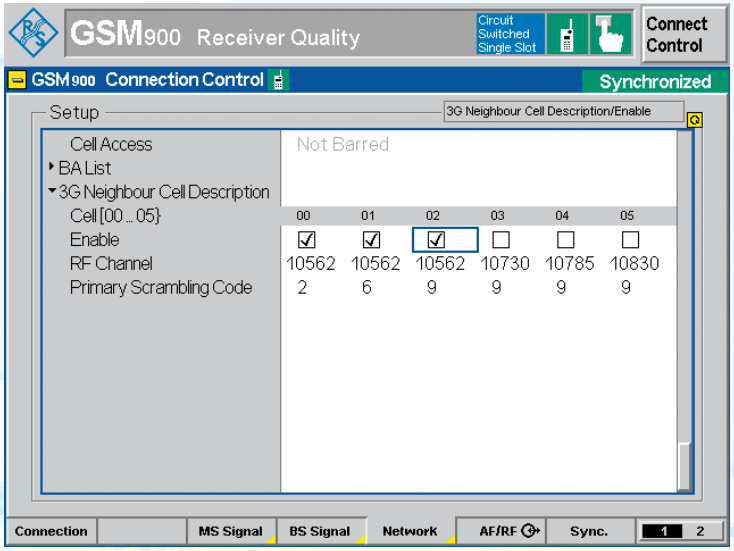
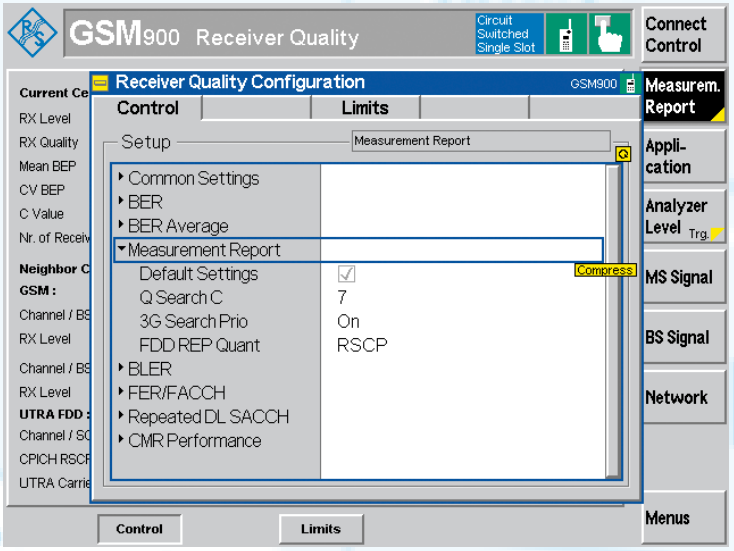


FIG 4 Configuration of WCDMA FDD evaluation criteria.



Abbreviations

CPICH	Common pilot channel
CV_BEP	Coefficient of variation of bit error probability
E_c	Chip energy
EMR	Enhanced measurement report
FDD	Frequency division duplex
HSPA	High-speed packet access
HSUPA	High speed uplink packet access
MEAN_BEP	Mean bit error probability
NBR_RCVE_BLOCKS	Number of correctly decoded blocks
MR	Measurement report
N_0	Noise power density
RAT	Radio access technology
RSCP	Received signal code power

R&S®CMU 200 Universal Radio Communication Tester

Powerful signaling for CDMA2000® 1xEV-DO

The CDMA2000® 1xEV-DO mobile radio standard is gaining in importance worldwide; the first networks using the enhanced CDMA2000® 1xEV-DO Rev. A variant were already put into commercial use in the second half of 2006. With a new signaling option, the R&S®CMU 200 covers all test scenarios relevant in the development and production of 1xEV-DO access terminals, thus presenting an all-in-one test solution for both CDMA2000® 1x and 1xEV-DO. It is already preconfigured to handle 1xEV-DO Rev. A.

CDMA2000® widely in use

The CDMA2000® 1xEV-DO standard has evolved from the well-known CDMA2000® 1x 3G mobile radio standard, which is not only widely used in North and South America and Asia but is also becoming increasingly important in Eastern Europe in the 450 MHz band. There are over 275 million subscribers using CDMA2000® (1x and 1xEV-DO) worldwide.

CDMA2000® 1xEV-DO (referred to as EV-DO in the following) has been developed in order to make full use of the advantages of an all-IP network; the air interface has been optimized for data transmission only ("evolution – data optimized"). The EV-DO access terminals currently being sold are nearly exclusively multimode devices, supporting both the existing CDMA2000® 1x standard and the new technology.

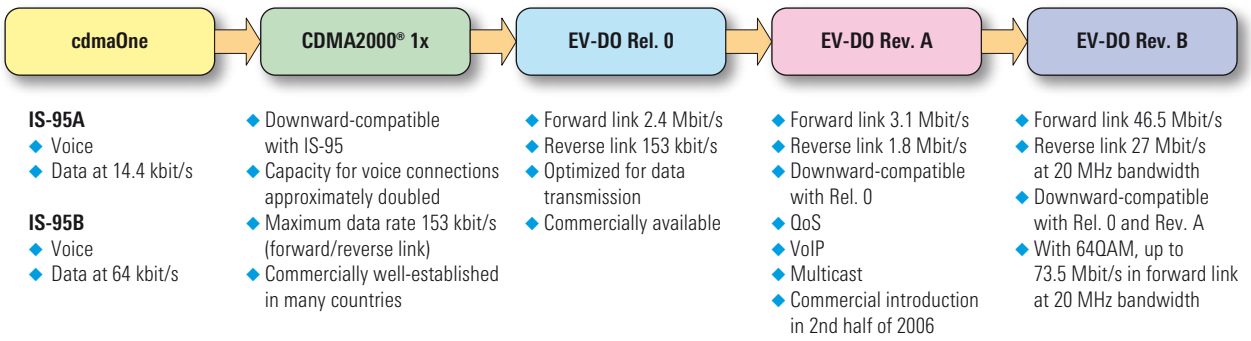
Attractive upgrade path for network operators

The spectral characteristics have not changed with respect to CDMA2000® 1x, which enables in-band migration. The protocol stack, however, is completely different from that of CDMA2000®.

This makes the upgrade path very attractive for network operators, since the measures necessary to modify the radio access network (RAN) are more or less reduced to exchanging a channel card. Network operators, therefore, are installing hybrid mobile radio networks that support both CDMA2000® 1x and CDMA2000® 1x EV-DO, which allows them to optimize the capacity for voice connections while at the same time offering modern, profitable data services.

EV-DO Rel. 0 supports data rates up to 2.4 Mbit/s in the forward link (from the base station to the mobile station) and 153.6 kbit/s in the reverse link (from the mobile station to the base station). Unlike CDMA2000® 1x, EV-DO uses a time division multiple access method.

FIG 1 Evolution of the CDMA2000® family of standards.



Similar to HSDPA, EV-DO employs hybrid ARQ (automatic repeat request), higher-order modulation modes (up to 16QAM), adaptive modulation and coding as well as receiver diversity.

EV-DO Revision A (TIA-856-A) is the first stage in a series of planned upgrades of the EV-DO standard (FIG 1). Revision A increases capacity in the forward link, supports realtime applications and quality of service (QoS), and provides substantial improvements for the reverse link (FIG 2). The main differences between EV-DO Release 0 and the new Revision A are:

- Improvements to reverse link (regarding peak data rate and sector throughput)
- Improved QoS mechanisms
- Expanded broadcast / multicast applications

Improved adaptation of the data packet size to the data rate as well as the introduction of new packet types have boosted the peak data rate in the forward link from 2.4 Mbit/s (Release 0) to 3.1 Mbit/s and in the reverse link from 153 kbit/s (Release 0) to 1.8 Mbit/s. With these characteristics, EV-DO Rev. A offers performance comparable to that of the HSUPA (high speed uplink packet access) technology, which is an expansion of the WCDMA standard. The first EV-DO Rev. A networks were put into commercial use in the second half of 2006. With the introduction of EV-DO Rev. A and a number of improvements to the core network, operators can now offer voice over Internet protocol (VoIP) services as well as videotelephony and video conferences with several subscribers.

Forward link	Reverse link
Shorter data packets for applications with lower data rates and short latency (e. g. VoIP, gaming)	Higher-order modulation modes (QPSK, 8PSK) for higher data rates
Larger data packets for data rates up to 3.072 Mbit/s	Multicode reverse transmission – a 1xEV-DO mobile station (access terminal) can transmit on multiple code channels
Nearly twice as many active subscribers	Optional reverse auxiliary pilot – additional pilot channel for high data rates and multicode transmission
Additional data packet types and rates for the control channel	Reverse hybrid ARQ for more efficient use of available capacity and transmission link
Additional MAC channel (ARQ) to support reverse hybrid ARQ	Enhanced access channel
Multicast data packets – sub packets for various subscribers are included in a larger data packet	MAC layer ARQ – handles the detection of missing data packets and retransmission
Broadcast channel	

FIG 2 New features in the physical / MAC layer for CDMA2000® 1xEV-DO Rev. A.

Options for the R&S®CMU 200 for CDMA2000® 1xEV-DO signaling

1xEV-DO signaling for the R&S®CMU 200 is based on the **optional R&S®CMU-B83 (Var. 22) CDMA2000® signaling unit**. To upgrade the mobile radio tester to include full 1xEV-DO functionality, the following options are required:

R&S®CMU-B83 (Var. 22)	**CDMA2000® signaling unit**
R&S®CMU-B89	1xEV-DO signaling module for CDMA2000® for the R&S®CMU-B83 (Var. 22) signaling unit
R&S®CMU-B87	Interface for CDMA2000® data test
R&S®CMU-K839	Software option: 450 MHz band
R&S®CMU-K849	Software option: cellular band
R&S®CMU-K859	Software option: PCS band
R&S®CMU-K869	Software option: IMT 2000 bands

The **R&S®CMU-U83 (Var. 22) option** is a favorably priced upgrade for instruments already equipped with the previous version, i. e. Var. 12, of the R&S®CMU-B83 CDMA2000® signaling unit. The R&S®CMU-U83 (Var. 22) is required for the R&S®CMU-B89 1xEV-DO signaling module.

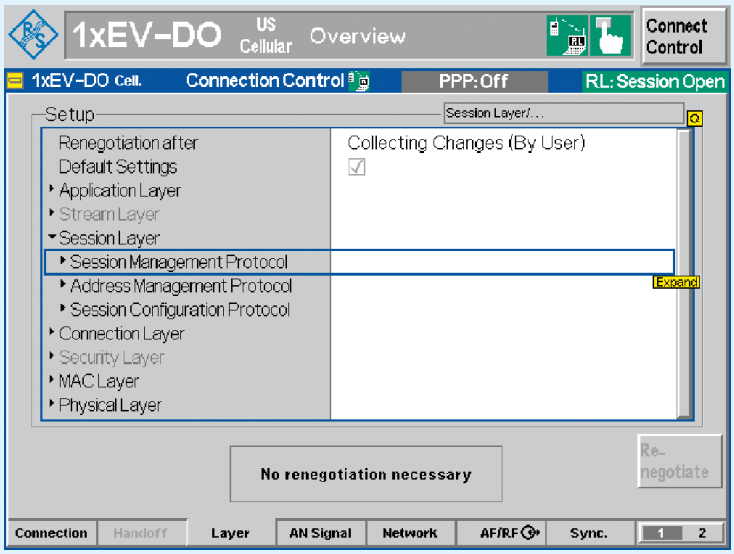


FIG 3
The R&S®CMU 200 offers comprehensive configuration parameters for CDMA2000® 1xEV-DO signaling.

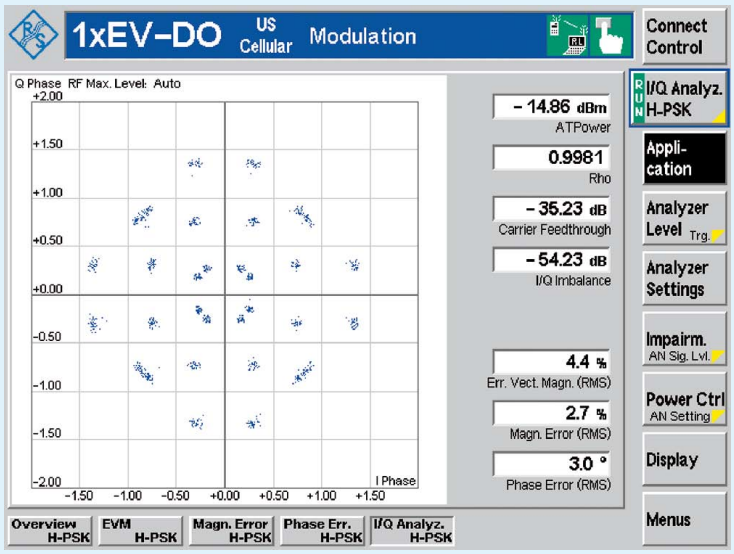


FIG 4
Constellation diagram of a CDMA2000® 1xEV-DO signal.

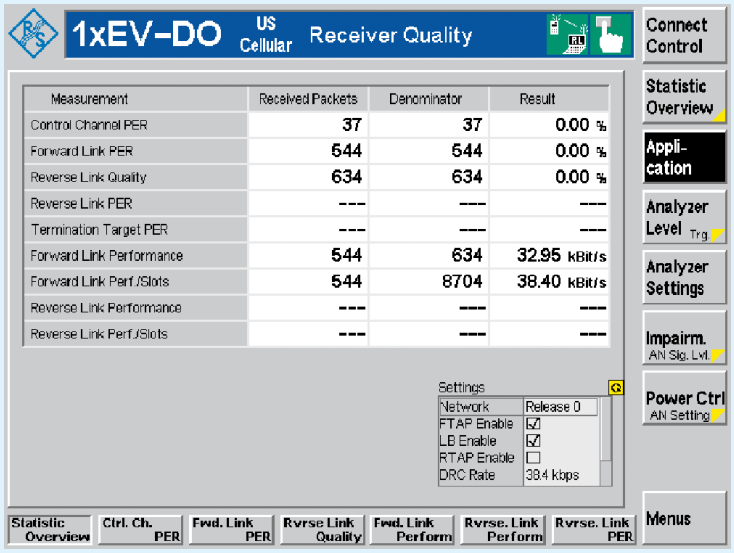


FIG 5
Menu with list of results of receiver measurements.

The R&S®CMU 200 stands ready

Rohde & Schwarz has therefore systematically expanded its R&S®CMU 200 product portfolio to offer complete EV-DO signaling in addition to the well-established test solution optimized for production applications. The EV-DO functionality will be expanded step by step to include EV DO Rev. A functionality. The R&S®CMU 200 supports all currently defined band classes, including the extended IMT 2000 band classes and the various expansions and modifications of the 450 MHz band. The comprehensive set of parameters is easy to configure, and the setup menu is organized in accordance with the layer structuring of the EV-DO protocol stack (FIG 3). The R&S®CMU 200 supports several connection types, e. g. forward / reverse test application protocol (FTAP / RTAP), default signaling application, and default packet application. The EV-DO option for the R&S®CMU 200 not only offers all required transmitter measurements, including modulation, fast spectrum measurement, code domain power, and various types of power measurements (FIG 4), but also comprehensive receiver measurements based on FTAP / RTAP connections (FIG 5), including the following:

- Statistical overview – all FTAP / RTAP-based measurements at a glance
- Control channel PER, forward / reverse link PER
- Reverse link quality
- Forward / reverse link performance

Separate receiver and transmitter measurements

Using FTAP- and RTAP-based measurements, the quality of the receiver and the transmitter of a DUT can be tested separately, i. e. without the receiver and transmitter mutually influencing each other.

With an FTAP connection, the quality of a DUT receiver is determined up to a maximum data rate of 2.4 Mbit/s. In this measurement, the DUT returns, via the reverse link, statistics and counts of received packets and errored packets that provide information about the connection quality. The EV-DO option of the R&S®CMU 200 evaluates the information received in various ways, e. g. by carrying out packet error and performance measurements to determine the actual throughput as a function of the packet size.

With an RTAP connection, the R&S®CMU 200 not only determines the quality of the DUT's transmitter and modulator, but also checks the number of packet errors and performs statistical evaluations. This can be done for data rates ranging from 9.6 kbit/s up to the maximum rate of 153.6 kbit/s. The DUT can thus be tested not only at a fixed data rate but also over a data rate range.

Wide variety of applications

The EV-DO option provides the basis for extensive end-to-end data test applications (support of simple / mobile IP). Using the default packet application, the R&S®CMU 200 can operate as a host for an incoming dial-up IP connection. If the R&S®CMU-B87 option is installed, an external server can be used as a data source for end-to-end tests.

In conjunction with a baseband fading simulator from Rohde & Schwarz, more accurate and cost-effective solutions can be implemented than by using an RF fader.

Summary

With the CDMA2000® 1xEV-DO option, the R&S®CMU 200 hardware and software concept proves its flexibility now also for the 3GPP2 technologies. The R&S®CMU 200 is thus optimally prepared to handle the new 1xEV-DO Rev. A evolution of the CDMA2000® family of standards.

Robert Macketanz; Thomas Rösner

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

REFERENCES

– Universal Radio Communication Tester R&S®CMU 200: CDMA2000® – a new challenge for 3G mobile radio testers. News from Rohde & Schwarz (2002) No. 173, pp 4–8
– Universal Radio Communication Tester R&S®CMU 200: Transmitter and receiver measurements for CDMA2000® 1xEV-DO. News from Rohde & Schwarz (2003) No. 179, pp 10–12

R&S®CMU 200 Universal Radio Communication Tester

Blazing trails with voice codecs: GSM-8PSK-AMR and WB-AMR

The R&S®CMU 200 universal radio communication tester – the trailblazer when it comes to voice functionality – expands its position with two new voice codecs.

GSM-8PSK-AMR

The adaptive multirate (AMR) voice codec has established itself as a standard, since it allows data rate and error protection to be dynamically adapted to connection quality. The R&S®CMU 200 provided the necessary measurement equipment for this right from the start [1]. Currently eight full-rate and six half-rate voice codecs are specified for GSM-AMR. Half rate is used to reduce network load in the short term, for example during large-scale events such as the Soccer World Cup, when many subscribers within one cell want to make calls at the same time.

A major disadvantage of the AMR half-rate voice codec is that up to now only the data rates from 4.75 kbit/s to 7.95 kbit/s can be used with it (FIG 1); however, the best voice quality is achieved at 12.2 kbit/s. This disadvan-

Data rates	Full-rate GMSK channels	Half-rate GMSK channels	Half-rate 8PSK channels
12.2 kbit/s	TCH_AFS_12.2	–	O-TCH_AHS_12.2
10.2 kbit/s	TCH_AFS_10.2	–	O-TCH_AHS_10.2
7.95 kbit/s	TCH_AFS_7.95	TCH_AHS_7.95	O-TCH_AHS_7.95
7.40 kbit/s	TCH_AFS_7.40	TCH_AHS_7.40	O-TCH_AHS_7.40
6.70 kbit/s	TCH_AFS_6.70	TCH_AHS_6.70	O-TCH_AHS_6.70
5.90 kbit/s	TCH_AFS_5.90	TCH_AHS_5.90	O-TCH_AHS_5.90
5.15 kbit/s	TCH_AFS_5.15	TCH_AHS_5.15	O-TCH_AHS_5.15
4.75 kbit/s	TCH_AFS_4.75	TCH_AHS_4.75	O-TCH_AHS_4.75
Traffic mode	AMR full-rate GMSK	AMR half-rate GMSK	AMR half-rate 8PSK

FIG 1 AMR data rates and channels.

tage is now avoided with the higher 8PSK modulation mode known from the EGPRS standard, which makes enough bits available at the AMR data rates of 10.2 kbit/s and 12.2 kbit/s to provide sufficient error protection. You can thus enjoy optimal voice quality now even when making calls with a half-rate connection.

All measurements supported by the R&S®CMU 200 mobile radio tester with GMSK-AMR are, of course, also available for 8PSK-AMR as well (FIGs 2 and 3). 8PSK-AMR is an expansion of the R&S®CMU-K45 option. The signaling test for the 8PSK-AMR voice codec requires the R&S®CMU-B21v14 and R&S®CMU-U65v04 hardware options. Together with the R&S®CMU-B52v14 and R&S®CMU-B41 options, audio measurements are also possible [2].

Wideband AMR

Today's voice telephony is still burdened by its past. For example, the limited audio bandwidth of 300 Hz to 3.4 kHz was – due to the state of the art at the time – retained during the transition from analog to digital systems.

The new wideband AMR (WB-AMR) voice codec changes all this now. It uses an audio bandwidth of 50 Hz to

FIG 2 Example of the configuration of an 8PSK-AMR channel.

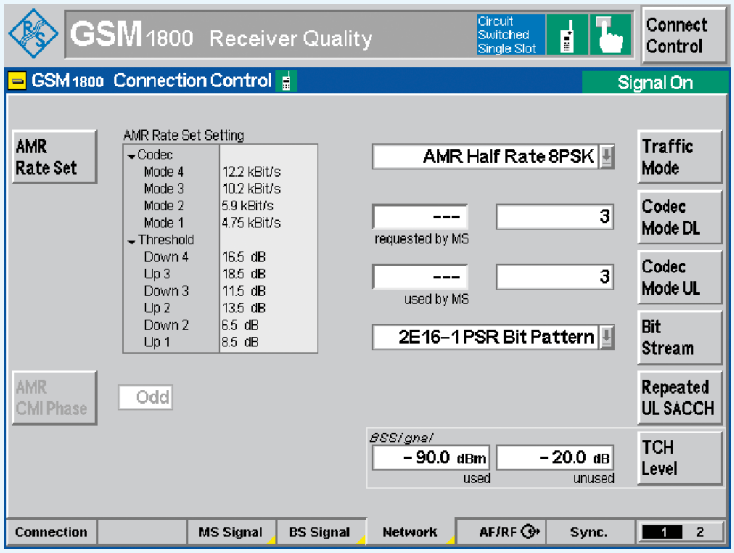
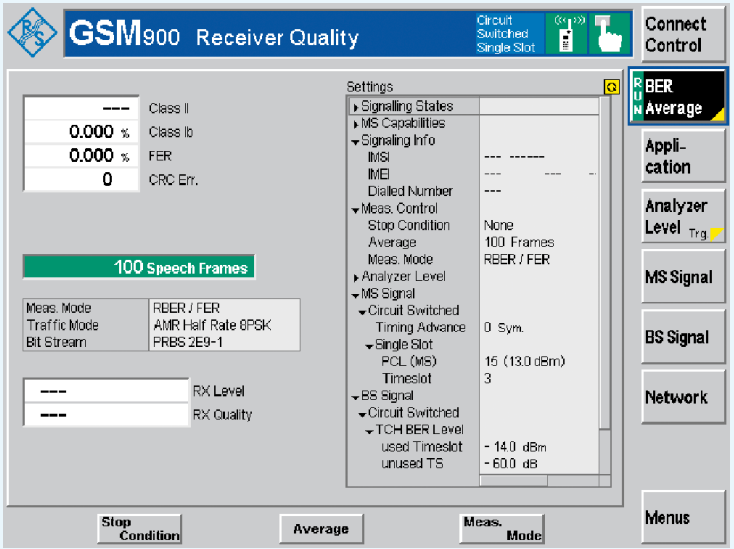


FIG 3 BER measurement on an 8PSK-AMR channel.



7 kHz, which provides a much more natural sound than previous methods. This voice codec is therefore especially suitable for phone conferences. It can even transmit music in an acceptable quality. Like the AMR voice codec, which is also referred to as narrowband AMR (NB-AMR), WB-AMR is specified across systems. The R&S®CMU 200 supports this voice codec initially for WCDMA. As in the case of NB-AMR, several data rates – altogether nine between 6.60 kbit/s and 23.85 kbit/s – are specified with WB-AMR. WB-AMR is based on the same principle as NB-AMR; as the connection quality becomes poorer, the data rate decreases and error protection increases.

To test the WB-AMR voice codec, the R&S®CMU 200 applies the successful, well-known operating concept also used for NB-AMR. Calls can thus be set up using only a single data rate or a rate set (FIGs 4 and 5).

A big advantage for users is that no new hardware is needed for an R&S®CMU 200 that is already equipped for WCDMA. With the R&S®CMU-K46 software option, the instrument can perform all WB-AMR signaling tests. And with the R&S®CMU-B41 and R&S®CMU-B52v14 options, audio measurements on the WB-AMR voice codec are also possible. Together with the R&S®UPV audio analyzer, the acoustic characteristics of mobile phones can also be measured [3].

Summary

It is still to be seen whether the two new voice codecs will establish themselves on the market. WB-AMR in particular provides manufacturers of UMTS telephones with an excellent means of distinguishing their systems from others by delivering better voice quality. The R&S®CMU 200 is now the first mobile radio tester to offer the necessary test applications for both voice codecs.

Peter Sterly

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

REFERENCES

[1] Universal Radio Communication Tester R&S®CMU 200: Signalling and measurements on GSM-AMR mobile phones. News from Rohde & Schwarz (2003) No. 178, pp. 28–29

[2] Universal Radio Communication Tester R&S®CMU 200: Audio measurements on mobile phones. News from Rohde & Schwarz (2001) No. 172, pp. 18–19

[3] Audio Analyzer R&S®UPL: Measuring the acoustic characteristics of 3G mobile phones. News from Rohde & Schwarz (2002) No. 173, pp. 15–17

FIG 4 Example of the configuration of a WB-AMR WCDMA channel with several data rates.

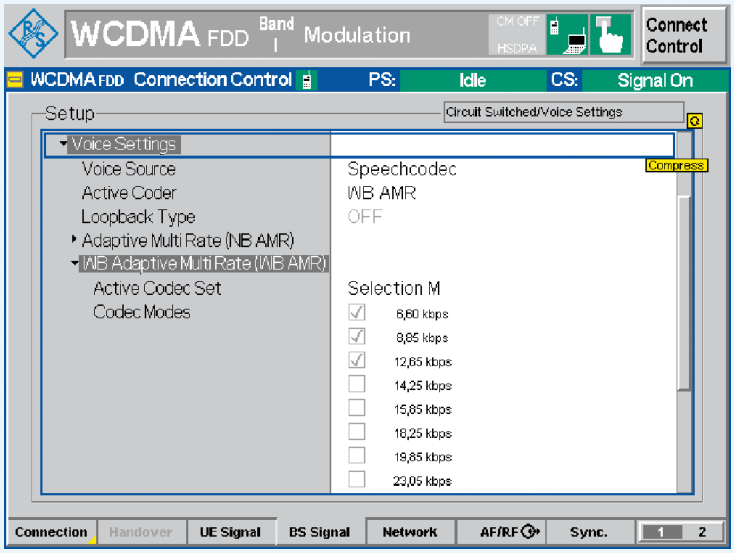
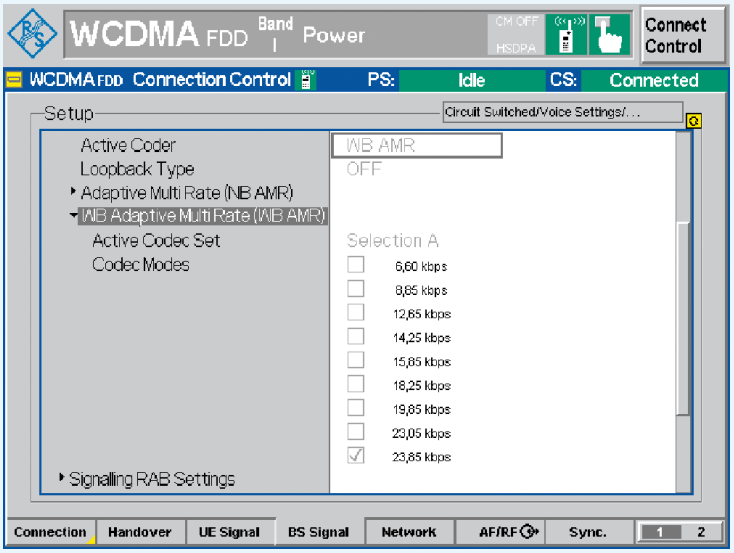


FIG 5 Example of the configuration of a WB-AMR WCDMA channel with 23.85 kbit/s.



R&S®CMU 200 Universal Radio Communication Tester

Downlink DTX and BFI measurements

The R&S®CMU 200 now also supports discontinuous transmission (DTX) in the downlink, as well as the important "performance of bad frame indication" (BFI) test case.

Downlink DTX

Telephone calls as a rule do not utilize the full capacity of a duplex link. In most cases, the two subscribers speak alternately, i. e. only 50 % of the link capacity is utilized on average. Practical experience has shown that in some cases no more than 20 % of the link capacity is used for speech transmission.

To reduce this waste of resources, discontinuous transmission (DTX) has been introduced for GSM. This method causes the mobile phone to stop transmitting when there is a pause in the conversation, i. e. there is no voice input to the mobile phone. This also saves battery power in the mobile phone. During pauses, the mobile phone only sends the minimum information required to maintain the link. To this effect, the phone transmits data via a control channel (SACCH) and sends SID speech frames at regular intervals (FIG 1).

The receiver uses the information from the SID frames to generate comfort noise during speech pauses by simulating the noise that would be present during speech transmission. This is considerably more pleasant for the subscriber at the receiving end than the total silence that would occur with the loudspeaker switched off completely.

The R&S®CMU 200 previously supported DTX only in the uplink. As already mentioned, the information from the SID frames transmitted by the mobile phone during a speech pause (referred to as DTX period in the following) causes the speech codec in the R&S®CMU 200 to generate comfort noise. With firmware V4.20 installed and the R&S®CMU-B21v14 signaling unit

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

REFERENCES
[*] Universal Radio Communication Tester R&S®CMU 200: Measuring bit error rate on GSM mobiles. News from Rohde & Schwarz (2000) No. 169, pp 11–13

FIG 1 104 TDMA multiframes without DTX (top) and with DTX for full-rate speech channel.

TCH Speech 0	TCH Speech 1	TCH Speech 2	TCH Speech 3	TCH Speech 4	TCH Speech 5	TCH Speech 6	TCH Speech 7	TCH Speech 8	TCH Speech 9	TCH Speech 10	TCH Speech 11	SACCH 12	TCH Speech 13	TCH Speech 14	TCH Speech 15	TCH Speech 16	TCH Speech 17	TCH Speech 18	TCH Speech 19	TCH Speech 20	TCH Speech 21	TCH Speech 22	TCH Speech 23	TCH Speech 24	Idle 25
TCH Speech 26	TCH Speech 27	TCH Speech 28	TCH Speech 29	TCH Speech 30	TCH Speech 31	TCH Speech 32	TCH Speech 33	TCH Speech 34	TCH Speech 35	TCH Speech 36	TCH Speech 37	SACCH 38	TCH Speech 39	TCH Speech 40	TCH Speech 41	TCH Speech 42	TCH Speech 43	TCH Speech 44	TCH Speech 45	TCH Speech 46	TCH Speech 47	TCH Speech 48	TCH Speech 49	TCH Speech 50	Idle 51
TCH Speech 52	TCH Speech 53	TCH Speech 54	TCH Speech 55	TCH Speech 56	TCH Speech 57	TCH Speech 58	TCH Speech 59	TCH Speech 60	TCH Speech 61	TCH Speech 62	TCH Speech 63	SACCH 64	TCH Speech 65	TCH Speech 66	TCH Speech 67	TCH Speech 68	TCH Speech 69	TCH Speech 70	TCH Speech 71	TCH Speech 72	TCH Speech 73	TCH Speech 74	TCH Speech 75	TCH Speech 76	Idle 77
TCH Speech 78	TCH Speech 79	TCH Speech 80	TCH Speech 81	TCH Speech 82	TCH Speech 83	TCH Speech 84	TCH Speech 85	TCH Speech 86	TCH Speech 87	TCH Speech 88	TCH Speech 89	SACCH 90	TCH Speech 91	TCH Speech 92	TCH Speech 93	TCH Speech 94	TCH Speech 95	TCH Speech 96	TCH Speech 97	TCH Speech 98	TCH Speech 99	TCH Speech 100	TCH Speech 101	TCH Speech 102	Idle 103

0	1	2	3	4	5	6	7	8	9	10	11	SACCH 12	13	14	15	16	17	18	19	20	21	22	23	24	Idle 25
26	27	28	29	30	31	32	33	34	35	36	37	SACCH 38	39	40	41	42	43	44	45	46	47	48	49	50	Idle 51
TCH SID 52	TCH SID 53	TCH SID 54	TCH SID 55	TCH SID 56	TCH SID 57	TCH SID 58	TCH SID 59	60	61	62	63	SACCH 64	65	66	67	68	69	70	71	72	73	74	75	76	Idle 77
78	79	80	81	82	83	84	85	86	87	88	89	SACCH 90	91	92	93	94	95	96	97	98	99	100	101	102	Idle 103

and R&S®CMU-B52v14 speech codec options fitted, the R&S®CMU 200 can now send SID frames also in the downlink.

In the echo/loop mode this works even if the optional speech codec is not installed. The R&S®CMU 200 previously transmitted neutral FACCH filler frames during speech pauses of the mobile phone to replace the missing speech frames. The R&S®CMU 200 was, however, not able to return received SID frames in half-rate and adaptive multirate (AMR) operation due to the channel structure. This problem has been overcome with the R&S®CMU 200 now supporting DTX in the downlink. The mobile radio tester now returns to the mobile phone exactly the information it has received, i.e. a speech frame, an SID frame, or a speech pause.

The downlink DTX is configured via three additional parameters (FIG 2). "Handset DTX Enable" switches DTX in the optional speech codec on or off. With DTX switched on, the codec will generate either speech or SID frames, depending on the audio input signal. Irrespective of whether the speech codec option is installed, the filler signal sent by the R&S®CMU 200 during a speech pause can be configured by means of the other two parameters. "BFI/DTX Filling Signal – Type" defines the signal to be sent during a speech pause; either a pseudo-random sequence or dummy bursts can be sent. "BFI/DTX Filling Signal – Level" defines the level of the filler signal relative to the useful signal. The signal thus defined is also used for the test case described below, which relies on the support of downlink DTX.

BFI test

Supporting downlink DTX, the R&S®CMU 200 can now also perform the bad frame indication (BFI) test. This test is an integral part of the 3GPP TS 51.010 GSM test specification (section 14.1.x). The R&S®CMU 200 performs it on all known speech channels (FIG 3). According to the test specification, a mobile phone may fail to detect maximally one speech frame per second during a DTX period. The R&S®CMU 200 simulates a base station in DTX operation, i.e. it generates a signal as shown in FIG 1. The test is performed using the mechanisms known from BER measurements. For the test, loop A in the mobile phone is closed. If the phone receives speech frames containing non-correctable class 1a bit errors – caused by the filler signal sent by the tester – while the loop is closed, it will return these frames as erased frames. In a normal BER measurement, these frames would increase the frame error rate (FER) [*]. The BFI test, however, basically functions like an inverse FER measurement. It is not the erased frames that are counted but the number of times the mobile phone erroneously returns a speech frame while it is expected to return erased frames only.

Peter Sterly

FIG 2 Typical configuration of DTX/BFI parameters.

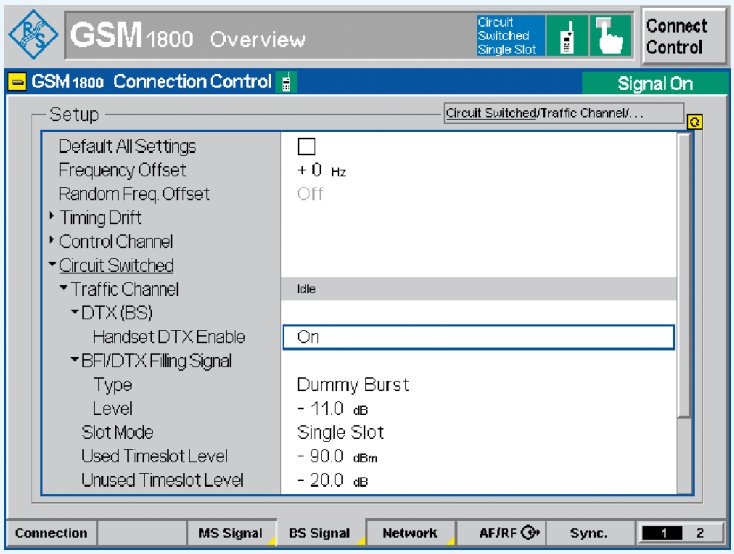
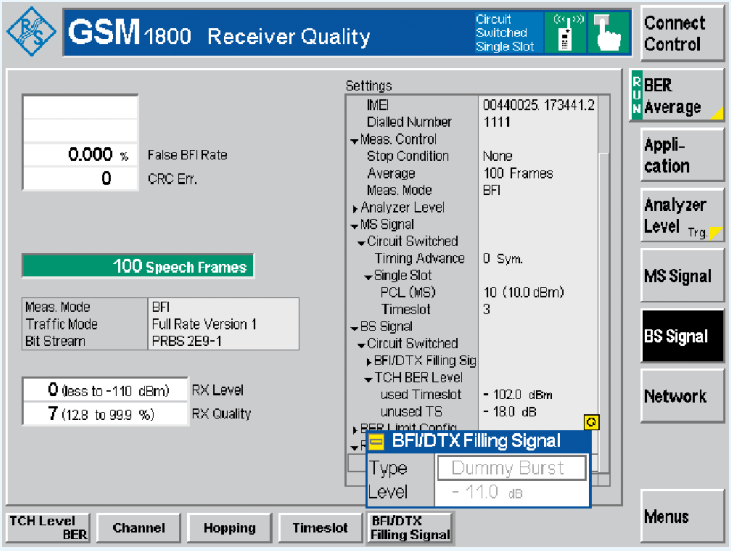


FIG 3 In-progress BFI measurement for full-rate version 1 speech channel.



R&S®CMU 200 Universal Radio Communication Tester

WCDMA/HSDPA data applications

Two new options expand the functionality of the R&S®CMU 200 to enable it to test WCDMA/HSDPA data applications (data end-to-end) in development and production.

Test setup made very easy

The new V4.20 version of the WCDMA firmware and the two new options R&S®CMU-K64 and -K60 now enable the R&S®CMU200 to handle HSDPA data applications in addition to WCDMA data applications. In HSDPA data end-to-end operation, the same extensive setting capabilities as in the HSDPA test mode are thus available. Depending on the options installed on the mobile radio tester and the capabilities of the DUT, transmission rates in the megabit range are achieved in the downlink.

The R&S®CMU 200 includes the ping and FTP server data applications for providing initial results quickly. The DUT is connected to the tester and to a PC that handles network dial-in. A dial-up connection that addresses the DUT as a modem is established on the PC. In the case of successful dial-in and thus setup of a data end-to-end connection, you can already send an echo request with a ping command to the R&S®CMU 200.

If the connection has been set up properly, the tester responds to the request accordingly.

With the FTP server in the R&S®CMU 200 (FIG 1), you can then exchange large files. Since the FTP server allows you to access some files in the tester, it is possible to immediately start download without previously uploading a file. This simple test setup is sufficient for testing downlink transmission rates in the megabit range.

For further data applications, the tester is connected to a network. Since all TCP/IP settings can be easily adapted, you can integrate the R&S®CMU 200 into a network (FIGs 2 and 3) without any problems. This setup allows you to use data applications available from your own network, e. g. HTTP transfer, video streaming, and MMS, thus enabling the R&S®CMU 200 to also test DUT-internal applications such as web browser, multimedia player, and the MMS function (FIG 4).

Extensive measurements

Extensive setting and measurement capabilities are also available for HSDPA data end-to-end connections. Handover to another frequency or band can be performed, for example, and the various RF parameters can be configured. In addition to the transmitter measurements you are already familiar with, you can also carry out HSDPA measure-

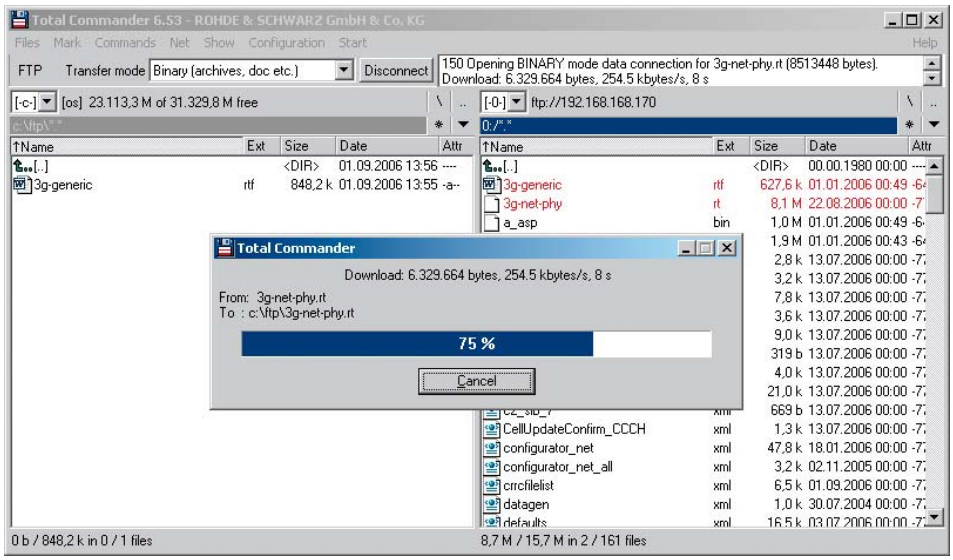


FIG 1
File transmission from the internal FTP server of the R&S®CMU 200. The downlink transmission rate here is 2 Mbit/s.

ments. For example, the Receiver Quality / HSDPA ACK measurement enables the tester to display the current data throughput for layer 1 as well as the ACK, NACK and DTX values of the data end-to-end connection.

Since the Receiver Quality / RLC BLER measurement has been expanded significantly, it is now possible to display data throughput versus time (FIG 5). At the same time, the tester displays statistics about the transmitted protocol data units (PDUs) and service data units (SDUs) of the radio link controller (RLC). This provides you with an informative analysis of data transmission in the downlink and uplink at a glance.

Peter Steinseifer

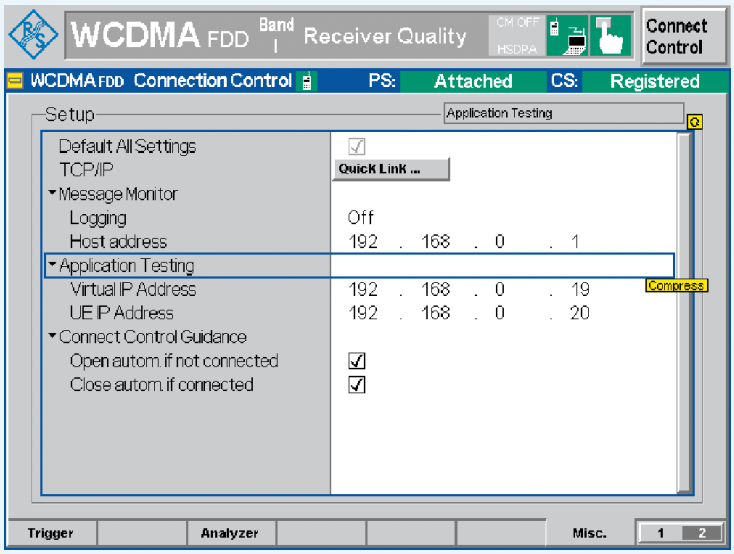


FIG 2 IP settings for application testing: The virtual IP address is required for data transport between the WCDMA protocol stack and the Ethernet interface of the R&S®CMU-B21v14 universal signaling unit. The UE IP address is assigned to the DUT during connection setup with the R&S®CMU200.

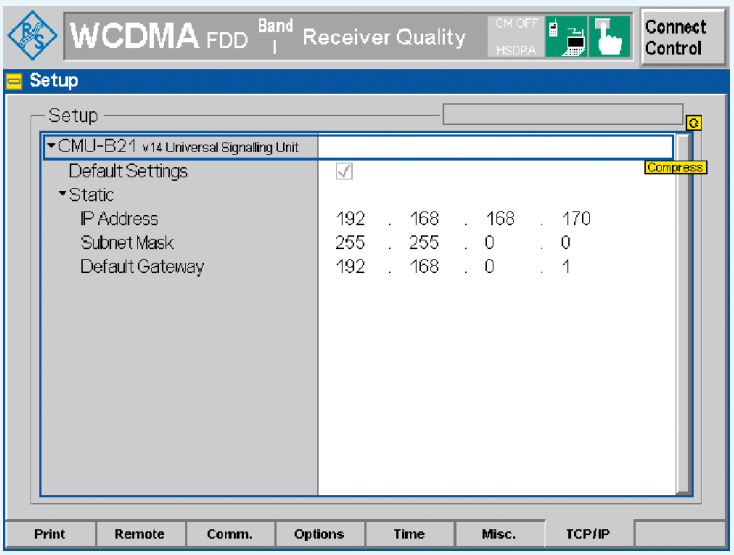


FIG 3 The IP settings of the R&S®CMU-B21v14 universal signaling unit.

FIG 4 Example of test setup for checking the video stream application between a mobile phone and an external video streaming server.

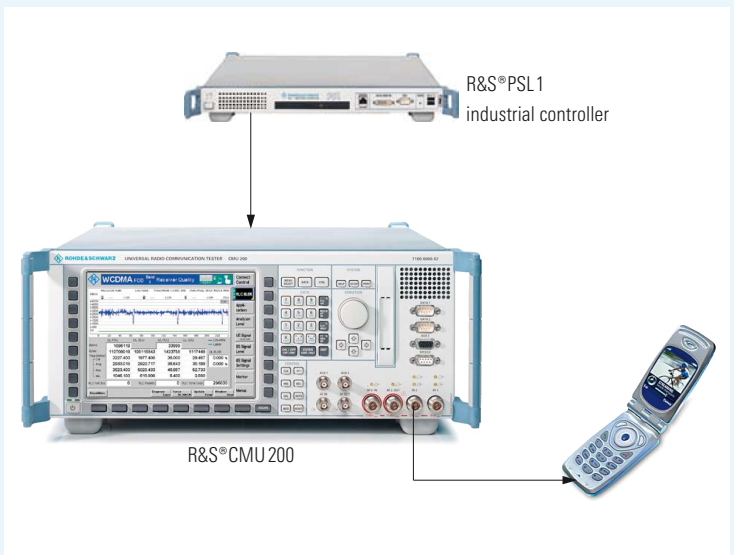
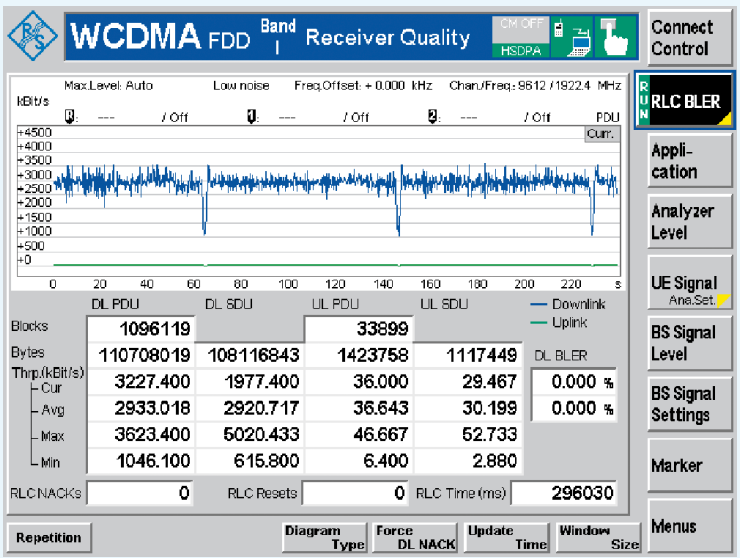


FIG 5 Example of Receiver Quality / RLC BLER measurement during an HSDPA data end-to-end connection.



R&S®TS8970 WiMAX Radio Conformance Test System

Benchmark for the certification of WiMAX end products

The WiMAX Forum™ (WMF) has selected Rohde&Schwarz as a manufacturer of radio conformance test testers (RCTT) in compliance with the IEEE 802.16e mobile WiMAX standard. The R&S®TS8970 test system (FIG 1) uses validated test cases to certify WiMAX end products that are manufactured in accordance with the IEEE802.16e-2005 specification.

WiMAX – the mobile broadband access

WiMAX (worldwide interoperability for microwave access) is the synonym for the implementation of the IEEE802.16 standard, which enables wireless broadband access to data networks (e.g. to IP or ATM networks). WiMAX was originally planned as a wireless alternative for wireline broadband access (e.g. ADSL), thus as a cost-efficient last-mile solution in the form of a radio interface. Accordingly, the IEEE802.16-2004 specification initially defined this air interface only for stationary operation. However, the standard was soon expanded for mobile applications, yielding the IEEE802.16e-2005 recommendation.

The IEEE802.16 WiMAX standard describes the two lowest layers of the open system interconnection (OSI) reference model for communications, also known as the PHY(sical) layer and MAC layer (data link layer). WiMAX specifies various transmission technologies for the PHY layer on the air interface. In addition to two single-carrier (SC) methods for the frequency range from 10 GHz to 66 GHz and sub 11 GHz, the OFDM and OFDMA variants of the multi-

FIG 1
The R&S®TS8970 WiMAX test system covers the frequency range from 400 kHz to 6 GHz.

44472/1w

carrier method are very useful for mobile applications in the frequency range up to 6 GHz. FIG 2 shows the scope of the IEEE 802.16 specification; FIG 3 lists the different WiMAX PHY variants.

This functional expansion not only gives mobile WiMAX the potential to expand second-generation (e. g. GSM, GPRS, EGPRS) and third-generation (UMTS, C2K) cellular mobile radio technologies to include mobile broadband access types. As an application of its own, it also stands ready to offer all voice and data applications that are common in cellular systems. The first commercial networks in accordance with the IEEE 802.16e-2005 mobile WiMAX standard are currently being set up in Korea and the USA.

WiMAX Forum™ ensures conformance

The objective of the WiMAX Forum™ (www.wimaxforum.org) is to deploy the IEEE 802.16 standard in real applications. As an industry association consisting of manufacturers and network operators, the WiMAX Forum™ handles all aspects not covered in the purely technical IEEE specification. The certification program for WiMAX products constitutes a major part of the forum's work (base stations and subscriber stations) and its purpose is to ensure worldwide availability and reliability of WiMAX services. A related certification working group (CWG) is specifically responsible for the following:

- Defining certification and test procedures
- Specifying test cases
- Selecting test houses
- Selecting conformance test systems

WiMAX products are tested for compliance with three criteria: protocol conformance, radio conformance, and interoperability. With regard to the last of these three criteria, products from different manufacturers are evaluated for interoperability in one test network. In contrast, the first two criteria require specific test systems.

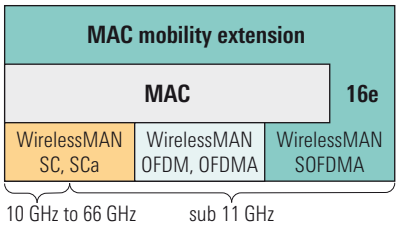


FIG 2 IEEE 802.16 layers 1 and 2 in accordance with the OSI reference model.

R&S®TS 8970 – the WiMAX radio conformance test system

When selecting a radio conformance test tester (RCTT) for the IEEE 802.16e-2005 mobile WiMAX standard, the WiMAX Forum™ chose the R&S®TS 8970 test system from Rohde & Schwarz. Accordingly, the test system was first presented to the public at the WiMAX conferences in Vienna and Korea in May 2006. Concurrently with the ongoing specification work by the WiMAX Forum™, Rohde & Schwarz is implementing all necessary test cases on the R&S®TS 8970.

Of course, with respect to signal generation (R&S®SMU 200A) and signal analysis (R&S®FSQ), the R&S®TS 8970 test system is based on high-end instruments from Rohde & Schwarz and exclusively uses their WiMAX-specific options: R&S®SMx-K49 and R&S®FSQ-K93 [1], [2]. An OEM base-station and mobile-station emulator is used for the required signaling. A fully automatic RF switching matrix up to 6 GHz ensures test-case-specific signal switching between the test system and the DUT.

Just like the R&S®TS 895x 2G and 3G certification test systems from Rohde & Schwarz, the R&S®TS 8970 is operated using the tried-and-tested R&S®RS-PASS system software [3], [4]. Owing to its modular and standard-independent architecture, the soft-

FIG 3 The WiMAX PHY variants.

IEEE 802.16 PHY	Transmission technology	Operating frequency	Application
WirelessMAN-SC (2004)	Single-carrier method	10 GHz to 66 GHz	Backhaul network microwave links
WirelessMAN-SCa (2004)	Single-carrier method	<11 GHz	Stationary subscriber access
WirelessMAN-OFDM (2004)	256 FFT OFDM	<11 GHz	Stationary subscriber access
WirelessMAN-OFDMA (2004)	2048 FFT OFDMA multiple access via subchannels	<11 GHz	Stationary subscriber access
WirelessMAN-SOFDMA (2005)	Scalable OFDMA: 128 FFT, 512 FFT, 1024 FFT	<11 GHz	Mobile subscriber access

ware was able to be implemented in the R&S®TS 8970 immediately. The system-specific applications (e. g. fully automatic RF path compensation, system selftest), as well as all administrative and control programs (e. g. version browser, test and sequence editor, parameter and result administration) were able to be used straightaway. Additionally, initial WiMAX-specific test cases were quickly developed using the basic R&S®RS-PASS routines (FIG 4). Moreover, the R&S®TS 8970 features another first: complete instrument control via Ethernet.

Summary

The R&S®TS 8970 test system expands the Rohde & Schwarz product portfolio for mobile radio certification at just the right time and for a promising technology. The use of tried-and-tested test system architectures as well as the company's outstanding range of self-manufactured products enabled Rohde & Schwarz to make its RCTT solution available in line with WiMAX Forum™ expectations. The thoroughly modular hardware and software architecture offers the necessary flexibility for the test cases to be implemented and makes the R&S®TS 8970 a reliable platform for a successful future in mobile WiMAX.

Heinz Mellein

More information at www.rohde-schwarz.com (search term: TS8970)

REFERENCES

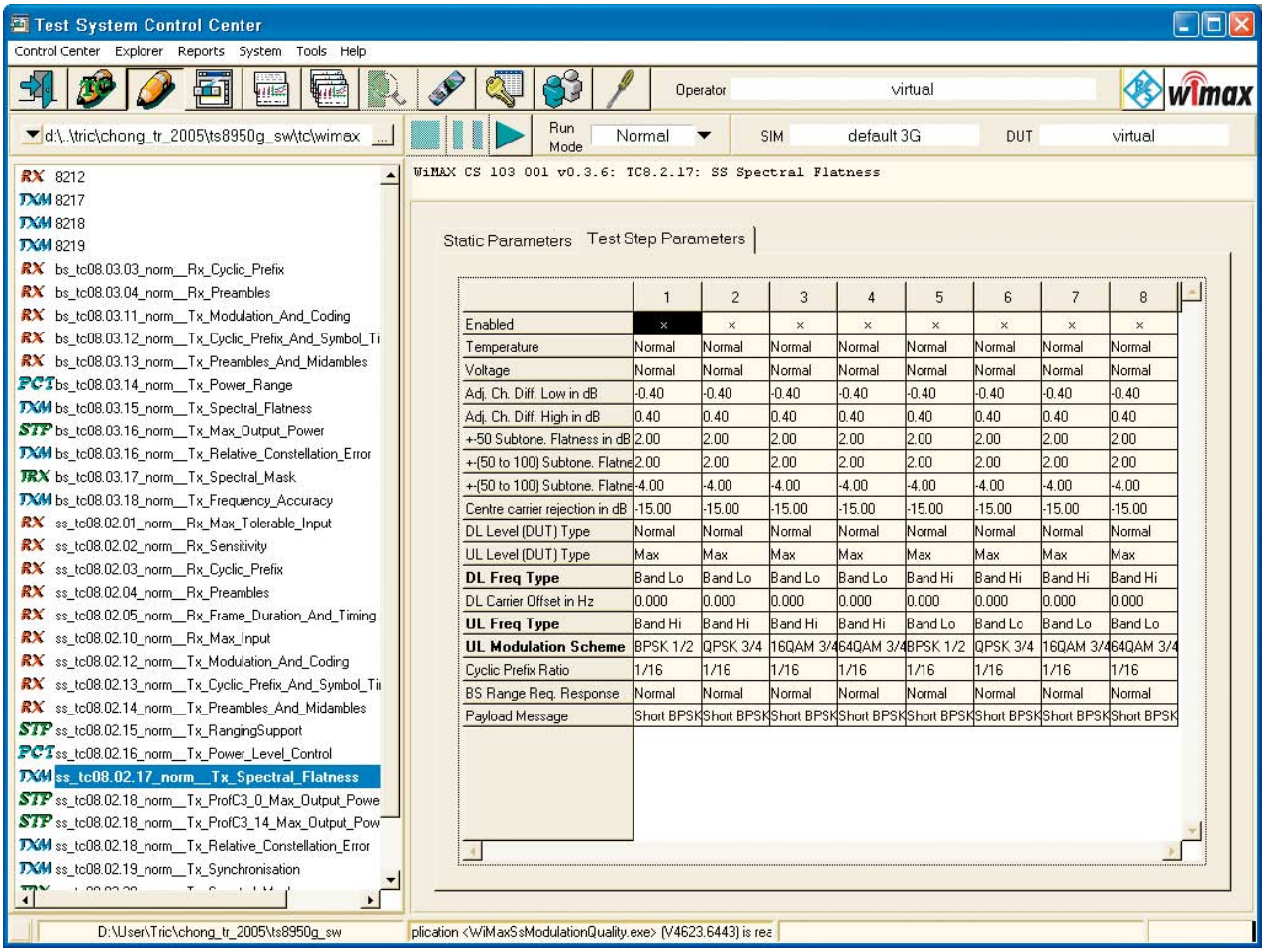
[1] Signal Generator R&S®SMU 200 A / Signal Analyzer R&S®FSQ: Complete test solution for WiMAX applications. News from Rohde & Schwarz (2005) No. 187, pp 33–37

[2] 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

[3] RF Test Systems R&S®TS 8950 G / TS 8955G: Reliable RF testing of GSM, GPRS and EDGE mobile phones. News from Rohde & Schwarz (2002) Nr. 174, pp 4–7

[4] Prequalification Tester R&S®TS 8955: GSM, EGPRS and WCDMA receiver measurements at a mouse click. News from Rohde & Schwarz (2004) No. 181, pp 4–7

FIG 4 R&S®RS-PASS operating interface on the R&S®TS 8970 test system.



	1	2	3	4	5	6	7	8
Enabled	×	×	×	×	×	×	×	×
Temperature	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal
Voltage	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal
Adj. Ch. Diff. Low in dB	-0.40	-0.40	-0.40	-0.40	-0.40	-0.40	-0.40	-0.40
Adj. Ch. Diff. High in dB	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40
+-50 Subtone. Flatness in dB	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
+-(50 to 100) Subtone. Flatne	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
+-(50 to 100) Subtone. Flatne	-4.00	-4.00	-4.00	-4.00	-4.00	-4.00	-4.00	-4.00
Centre carrier rejection in dB	-15.00	-15.00	-15.00	-15.00	-15.00	-15.00	-15.00	-15.00
DL Level (DUT) Type	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal
UL Level (DUT) Type	Max	Max	Max	Max	Max	Max	Max	Max
DL Freq Type	Band Lo	Band Lo	Band Lo	Band Lo	Band Hi	Band Hi	Band Hi	Band Hi
DL Carrier Offset in Hz	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
UL Freq Type	Band Hi	Band Hi	Band Hi	Band Hi	Band Lo	Band Lo	Band Lo	Band Lo
UL Modulation Scheme	BPSK 1/2	QPSK 3/4	16QAM 3/4	64QAM 3/4	BPSK 1/2	QPSK 3/4	16QAM 3/4	64QAM 3/4
Cyclic Prefix Ratio	1/16	1/16	1/16	1/16	1/16	1/16	1/16	1/16
BS Range Req. Response	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal
Payload Message	Short BPSK	Short BPSK	Short BPSK	Short BPSK	Short BPSK	Short BPSK	Short BPSK	Short BPSK

44555/1

FIG 1 The analog R&S®SMA100A signal generator generates spectrally purest signals up to 6 GHz. Equipped with a new option, it also generates high-precision VOR/ILS signals for tests on air navigation receivers.

R&S®SMA100A Signal Generator

Frequency doubled: spectrally purest signals now up to 6 GHz

The analog R&S®SMA100A signal generator is outstanding for its excellent signal quality and high setting speed. It is now available even up to 6 GHz. Moreover, equipped with a new option, the R&S®SMA100A can generate VOR/ILS signals for tests on air navigation receivers.

High-end analog signal generator

The R&S®SMA100A (FIG 1) is a premium-class analog signal generator [*]. Its extreme signal purity, high output power, and very short frequency and level setting times make it a highly versatile tool. The instrument is available with a wear-free, fully electronic attenuator, which allows the output level to be set from –145 dBm to +18 dBm (3 GHz) or +15 dBm (6 GHz) (R&S®SMA-B103 / -B106 options). It can also be equipped with frequency options without attenuator (R&S®SMA-B103L / -B106L) for applications that require only a limited level range – for example, if the generator is to be used as a local oscillator substitute in ATE test systems, or for measuring mixers.

Up to 6 GHz, the R&S®SMA100A features high maximum output power as standard, thus making the use of external amplifiers in many cases superfluous (FIG 2). Equipped with the R&S®SMA-B103 / -B106 frequency options (with electronic attenuator), the generator includes integrated overvoltage protection up to 6 GHz as standard, which is a unique feature on the mar-

ket. The maximum permissible reverse power is 50 W for ≤3 GHz and 10 W for ≤6 GHz. The maximum permissible DC voltage is 50 V.

Its extremely short frequency and level setting times make the R&S®SMA100A ideal for applications in production, where reduced setting times ensure shorter test times and thus increase throughput.

The generator features very low SSB phase noise (FIGs 3 and 4) of typ. –135 dBc (1 Hz) at f = 1 GHz and 20 kHz carrier offset or typ. –140 dBc (1 Hz) (with the R&S®SMA-B22 enhanced phase noise and FM / φM option). Its broadband noise of typ. –160 dBc (1 Hz) at 10 MHz carrier offset and f = 1 GHz is also very low.

In addition, nonharmonic noise signals are excellently suppressed (typ. –100 dBc at >10 kHz carrier offset, f < 1500 MHz with the R&S®SMA-B22 enhanced phase noise performance and FM / φM option). Owing to a wide frequency division range, the excellent SSB phase noise of the generator is available down to carrier frequencies of 6.6 MHz, allowing the R&S®SMA100A to be used as a substitute for reference oscillators or crystals, for example.

Due to its very high spectral purity, the R&S®SMA100A is an excellent signal source, for example for generating noise signals for mobile radio applications (inband rejection tests, blocking tests), as a reference source in phase noise test systems, or as a source of very pure signals for testing mixed signal ICs (A/D and D/A converters).

Instrument settings stored on CompactFlash™

For use in security-critical applications, the generator can be equipped with an option for ejecting the CompactFlash™ card (R&S®SMA-B80 option). The memory card and the signal generator can thus be stored separately. The instrument can be removed from the security area without any problem as the instrument settings are stored on the memory card and will not leave the closed area.

The current operating manual can be downloaded from the Rohde&Schwarz Internet pages. It includes a chapter called "Resolving Security Issues When Working With the R&S®SMA100A in Secure Areas" which explicitly describes the generator's features for users with high security requirements. It also details the different memory types and locations where user-specific data is stored in the generator.

Tests on air navigation receivers

Equipped with the new R&S®SMA-K25 option, the R&S®SMA100A generates avionics signals (VOR/ILS) in line with the ICAO standard. The receiver operates in the following modes:

- VOR
- ILS glide slope signal (ILS-GS)
- ILS localizer signal (ILS-LOC)
- Marker beacon (MKR-BCN)
- Automatic direction finding (ADF)

Because of its low modulation errors and very high level accuracy, the R&S®SMA100A is the ideal source for generating high-precision VOR/ILS signals for tests on air navigation receivers when equipped with this option.

Thomas Rieger; Günther Klage

Condensed data of the R&S®SMA100A

Frequency range	9 kHz to 3 GHz / 6 GHz
Level	
Range	–145 dBm to +18 dBm (up to 28 dBm overrange)
Setting times for frequency and level	<3 ms
Setting times in list mode / fast hopping mode	<450 µs
Spectral purity (at f = 1 GHz)	
Nonharmonics	
(carrier offset > 10 kHz, f ≤ 1500 MHz)	<–80 dBc (typ. –90 dBc)
	<–90 dBc (typ. –100 dBc) with R&S®SMA-B22 option
SSB phase noise	
(300 kHz carrier offset,	<–131 dBc (typ. –135 dBc)
1 Hz measurement bandwidth)	<–136 dBc (typ. –140 dBc) with R&S®SMA-B22 option
Broadband noise (carrier offset > 10 MHz,	
1 Hz measurement bandwidth,	
750 MHz < f ≤ 1500 MHz)	<–153 dBc (typ. –160 dBc)
Modulation modes	
AM	standard
FM / φM	with R&S®SMA-B20 / -B22 options
Pulse	standard
VOR/ILS	with R&S®SMA-K25 option
Clock generation	
Frequency range	100 kHz to 1.5 GHz (with R&S®SMA-B29 option)
Interfaces	IEEE 488.2, LAN (10/100BaseT), 1 × USB, 1 × USB slave

More information, product brochure and specifications at www.rohde-schwarz.com (search term: SMA100A)

REFERENCES

[*] Signal Generator R&S®SMA100A: Analog signal generator that meets virtually every requirement. News from Rohde&Schwarz (2006) No. 189, pp 30–34

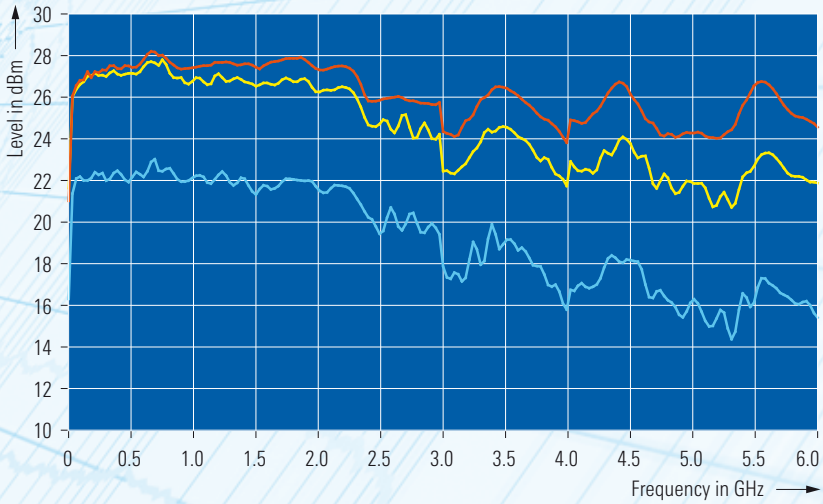


FIG 2 Maximum output power across the entire frequency range at different level modes (orange: without attenuator, yellow: high-power mode, blue: normal mode).

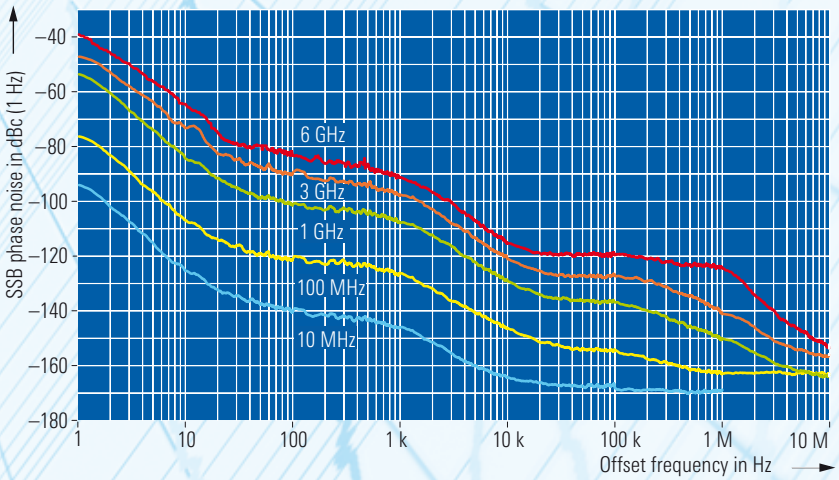


FIG 3 Typical SSB phase noise of the R&S®SMA100A with internal reference oscillator (base unit).

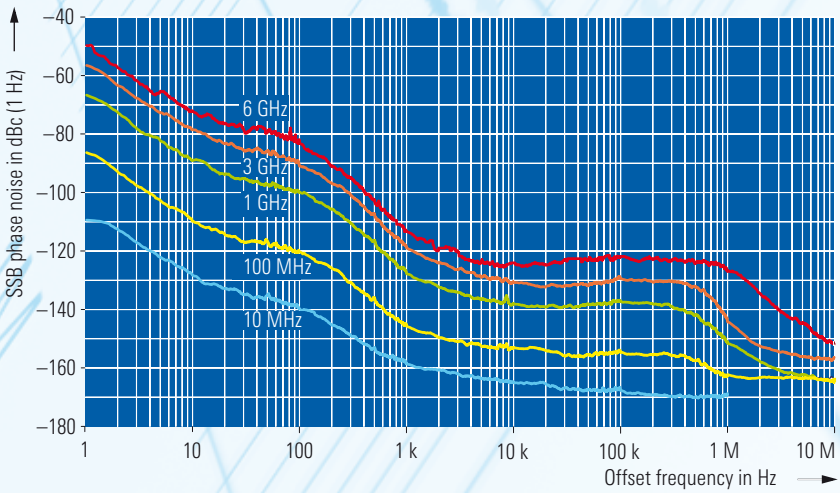


FIG 4 Typical SSB phase noise of the R&S®SMA100A with internal reference oscillator and the R&S®SMA-B22 enhanced phase noise and FM / φM option.

R&S®FSMR Measuring Receiver / R&S®FSU Spectrum Analyzer

Optional enhancements for vector signal analysis

General vector signal analysis functions that were previously provided only by the R&S®FSQ signal analyzer are now also available for the R&S®FSMR calibration measuring receiver and the R&S®FSU spectrum analyzer.

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

R&S®FSMR-B73 option for the R&S®FSMR measuring receiver

The R&S®FSMR measuring receiver, an expert for calibrating signal generators, focuses primarily on testing level and modulation characteristics, especially evaluating modulation errors. Compared with analog methods such as AM, FM and φM, digital modulation methods have significantly gained in importance.

The R&S®FSMR has always taken this situation into account because it could be equipped with standard-specific options for determining modulation errors in signals of the GSM/EDGE (R&S®FS-K5), 3GPP (R&S®FS-K7x), CDMA2000® (R&S®FS-K8x), TD-SCDMA, or Bluetooth® standards. Equipped with the R&S®FSMR-B73 option, the measuring receiver can also analyze digitally modulated signals (up to 256QAM) with a symbol rate up to 25 Msymbol/s – irrespective of the mobile radio standard. This standard-independent evaluation of the modulation characteristics of signal generators is possible because important settings such as modulation mode (PSK, QAM, MSK, FSK, 8VSB, etc), symbol rates, and filtering are user-definable. The option displays key parameters such as EVM, I/Q offset, quadrature error, or I/Q imbalance in an easy-to-read table (FIG 1).

In addition to predefined settings for the most important standards, you can store customized configurations as default settings (user-defined standards). Thus, it becomes easier to make recurring settings, which in turn will yield measurement results faster and reduce the danger of incorrect measurements due to operating errors.

Owing to its low inherent EVM, the R&S®FSMR-B73 option can even determine minor modulation errors accurately.

FIG 1 The numeric result display provides the key quality parameters of a modulator in an easy-to-read table. Signal generator performance can thus be quickly and efficiently verified.

R&S®FSU-B73 option for the R&S®FSU spectrum analyzer

Compared with a combination of the R&S®FSQ signal analyzer and the R&S®FSQ-K70 option, the R&S®FSU-B73 option is a more cost-efficient and narrowband solution to complement the R&S®FSU spectrum analyzer family. The option enhances the spectrum analyzer's scope of applications when it comes to highly accurate and flexible measurements of the modulation parameters of digitally modulated signals. Existing instruments can be retrofitted with the R&S®FSU-U73 option.

	R&S®FSU with R&S®FSU-B73	R&S®FSMR with R&S®FSMR-B73	R&S®FSQ with R&S®FSQ-K70
Maximum symbol rate	6.4 Msymbol/s	25 Msymbol/s	25 Msymbol/s, with R&S®FSQ-B72: 81.6 Msymbol/s
I/Q demodulation bandwidth	7 MHz	28 MHz	28 MHz, with R&S®FSQ-B72: 120 MHz
Inherent EVM (QPSK, 1 MHz symbol rate, 1 GHz carrier frequency)	<0.5%	<0.5%	<0.5%
YIG filter bypass in the microwave reception range > 3.6 GHz	no	standard: without YIG filter, with R&S®FSMR-B2 or R&S®FSMR-B223: yes	yes
Functionality	same as with R&S®FSQ-K70	same as with R&S®FSQ-K70	
120 MHz bandwidth expansion	no	no	with R&S®FSQ-B72
I/Q data memory	16 Msamples	16 Msamples	16 Msamples
Recording length for GSM/EDGE signal	15.4 s	15.4 s	15.4 s
Memory extension for I/Q data	no	no	with R&S®FSQ-B100 and R&S®FSQ-B102 up to 705 Msamples
Recording length for GSM/EDGE signal with memory extension	–	–	678.5 s

FIG 2 Comparison of the key characteristics of the vector signal analysis functions in the R&S®FSU, R&S®FSMR, and R&S®FSQ.

Compared with the solution for the R&S®FSQ, the maximum settable symbol rate and the behavior in the frequency range above 3.6 GHz (FIG 2) are different with the new option. The R&S®FSU's maximum symbol rate with specified inherent EVM is 6.4 Msymbol/s.

The tracking preselection, i.e. the YIG filter, is bypassed in the VSA mode in the R&S®FSQ above 3.6 GHz as it causes group delay and amplitude-frequency response. This, in turn, leads to significantly higher residual EVM if the symbol rates are high. Owing to its lower maximum symbol rate, the R&S®FSU does not need such a bypass.

Scope of functions similar to the R&S®FSQ spectrum analyzer

You won't have to do without the extensive range of functions of the R&S®FSQ-K70 option when using the new options for the measuring receiver and the spectrum analyzer. In general lab applications, constellation and eye diagrams as well as error signals need to be displayed. Moreover, extensive functionality for setting burst and synchronization parameters is required. This allows you to define and position the section of a burst to be analyzed, as well as demodulate and measure bursts that contain different modulation modes, for example.

Additional evaluation capabilities are beneficial when troubleshooting a generator or the user-specific setup. Both options perform analyses that by far exceed normal vector signal analysis functions, for example spectral and statistical evaluations of measurement and error signals, determination of the AM/AM and AM/φM distortion parameters directly from the modulated signal, or analysis of customer-specific modulation constellations.

The statistical evaluation of the modulation summary table includes average values as well as the standard deviation across the number of measurements, providing additional information that is useful for determining the measurement error.

The two new options show that the platform concept provides maximum function and operation uniformity, thus ensuring optimum interoperability between the different families of instruments.

Herbert Schmitt

R&S®FSQ Signal Analyzer

More bandwidth for analyzing digital transmission systems

Bandwidths of advanced digital transmission systems are steadily increasing. By offering a modulation bandwidth of 120 MHz over the entire frequency range, the R&S®FSQ-B72 broadband option now also provides sufficient capacity in the frequency range up to 3.6 GHz for analyzing mobile radio, wireless, and satellite communications systems.

Excellent dynamic range, level linearity and phase linearity

Bandwidths of modern transmission standards are increasing rapidly: While a bandwidth of 20 MHz was sufficient for WLAN 802.11g yesterday, the IEEE 802.16e WiMAX standard now requires 28 MHz, and 40 MHz and more are planned for the future. In mobile radio, the number of transmission channels for each transmit unit of the base station is also continuously growing. The algorithms for linearizing power amplifiers make use of the complex frequency spectrum around the carrier signals, including fifth-order or even seventh-order intermodulation products. At channel bandwidths of 5 MHz for UMTS, for example, the required analysis bandwidth quickly reaches 80 MHz and more.

Users of the R&S®FSQ signal analyzer therefore require the available modulation bandwidth to be a multiple of the useful signal bandwidth at the best possible dynamic range (FIG 1), level linearity and phase linearity. And this is exactly where the R&S®FSQ-B72 [*] option excels:

- 120 MHz modulation bandwidth over the entire frequency range
- 0.15 dB level linearity in the range from 0 dB to –70 dB
- ±2° phase linearity up to 80 MHz bandwidth (±3° up to 120 MHz)
- >60 dBc (typ. 68 dBc) suppression of third-order intermodulation products
- >60 dBc (typ. 70 dBc) spurious-free dynamic range
- >135 dBfs signal-to-noise ratio, referenced to 1 Hz bandwidth

Taking UMTS signals as an example, the advantages become very clear. While up to now the R&S®FSQ was able to record the characteristics of a maximum of twelve channels simultaneously, it will in future easily handle 20 channels and more at a 10 dB higher dynamic range and with significantly improved linearity (FIG 2).

This opens up completely new possibilities for developers of multicarrier power amplifiers (MCPA), for example, to characterize the properties of the components used. The same applies to the production and verification of base stations, since with the R&S®FSQ-B72 option sufficient bandwidth is always available regardless of the transmission standard. Even with WiMAX signals, it is possible to record three adjacent transmission channels simultaneously with the transmit signal.

New memory extensions for the R&S®FSQ signal analyzer enlarge its I/Q memory depth to a maximum of 705 Msamples – unrivaled among signal analyzers (page 36).

Excerpt from the specifications for the R&S®FSQ-B72 option.

Demodulation bandwidth (entire frequency range)	120 MHz
Sampling rate, selectable	10 kHz to 326.4 MHz
Level linearity (0 dB to –70 dB)	<0.15 dB
Phase linearity, bandwidth up to 80 MHz up to 120 MHz	±2° ±3°

Today, the R&S®FSQ-B72 option already plays an important role in the monitoring of communications and TV satellites, as the task here is to ensure the signal quality of transponders with a bandwidth of 36 MHz and 72 MHz. Up to now, this has been possible in the RF range, but in the future the complete analysis bandwidth of 120 MHz will also be available in the preferred IF range at 2 GHz.

Summary

The new characteristics of the R&S®FSQ-B72 option put the R&S®FSQ in the first row of signal analyzers in terms of dynamic range, level linearity and phase linearity at wide bandwidths.

Manfred Müller; Ottmar Steffke

FIG 1 Excellent dynamic range of the R&S®FSQ-B72 option at a bandwidth of 120 MHz, displayed as a spectrum using the R&S®FS-K7 option.

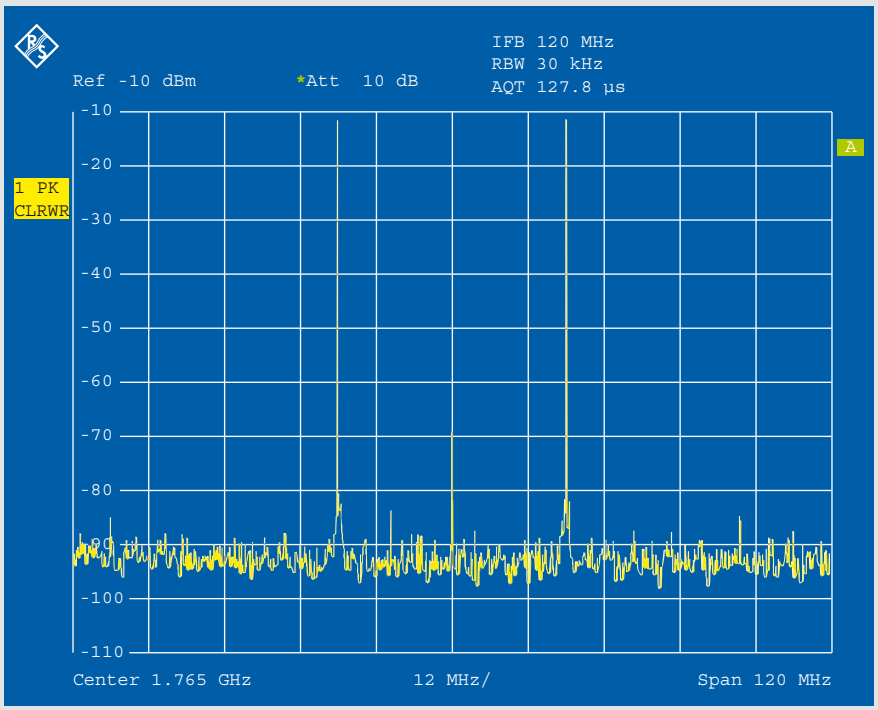
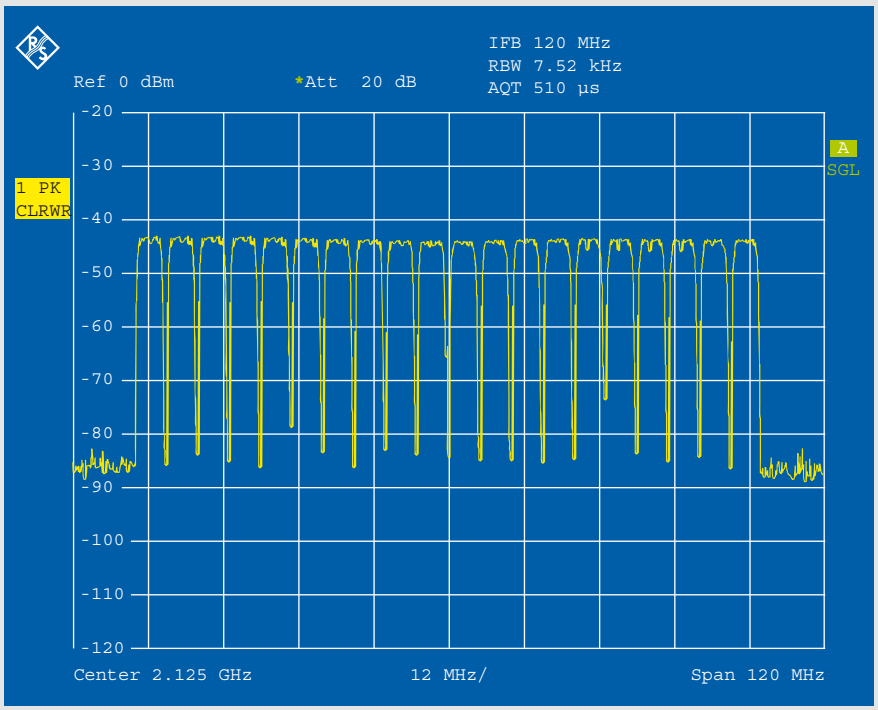


FIG 2 Twenty UMTS channels with 5 MHz channel spacing, generated with the R&S®SMU200A vector signal generator (two paths) by means of a power combiner.



More information, product brochure and specifications at www.rohde-schwarz.com (search term: FSQ)

REFERENCES

[*] Signal Analyzer R&S®FSQ: Broadband signal analysis up to 120 MHz. News from Rohde&Schwarz (2004) No. 181, pp 30–31

R&S®FSQ Signal Analyzer

The signal analyzer with the largest memory for I/Q data

Increasing signal bandwidths and sampling rates mean that greater amounts of memory are needed for recording measurement values, because there is just no room for compromise when it comes to recording time. With the R&S®FSQ-B100 and -B102 I/Q memory extensions, the R&S®FSQ signal analyzer now offers memory space for up to 705 Msamples.

Well prepared for long-term analysis

No matter if the quality of a modulator is to be measured in the baseband or if mixer and amplifier characteristics have to be measured at the RF: At some point, you will reach a state in transmitter and receiver system development where I/Q data has to be recorded and evaluated over a longer period of time. Developers are particularly interested in characteristic sections of a signal at the modulation level, e. g. transients or phase discontinuities but also in spurious signals resulting from switching processes or crosstalk.

To perform a successful analysis, you will definitely need enough I/Q data memory space to record data over a longer period of time even at wide bandwidths and the resulting high sampling rates.

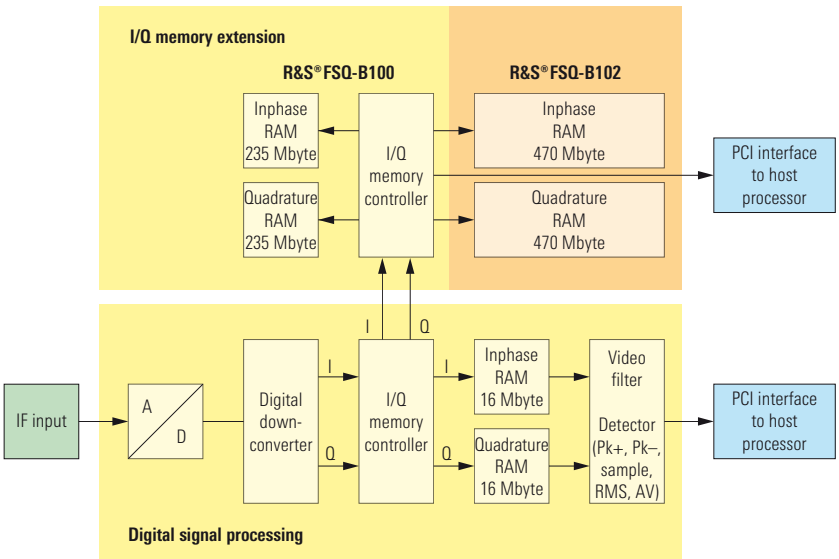
The 16 Msamples of the I/Q memory included in the basic R&S®FSQ were designed to meet a wide variety of applications. At a channel bandwidth of 200 kHz, for example, the GSM standard specifies a sampling rate of 1 MHz. This means that, at a memory depth of 16 Msamples, a recording time of 16 s is possible, which corresponds to approx. 30 000 bursts. For broadband signals recorded at a sampling rate of 81.6 MHz, however, the maximum recording time available is approx. 200 ms. More memory space is therefore required for longer recording times.

With the R&S®FSQ-B100 and -B102 options, you can now expand the available I/Q memory in two configurations accommodating 235 Msamples or 705 Msamples. This is possible due to a newly developed memory extension which can be equipped or retrofitted with memory modules in two stages (FIG). The memory modules are linked to the digital downconverter of the base unit via a fast data interface and to the CPU via the PCI bus. Thus, the entire I/Q memory is directly accessible for firmware applications such as the R&S®FSQ-K70 vector signal analysis option, the R&S®FS-K72 3GPP BTS analysis option or the R&S®FS-K82 CDMA2000® analysis option. Of course, the data can also be read out via the 100 Mbit LAN interface for evaluation on an external control PC.

The I/Q memory depth of max. 705 Msamples has so far been unique for signal analyzers. The R&S®FSQ thus attains the recording times required for long-term analysis even at wide bandwidths (120 MHz with the R&S®FSQ-B72 option).

Jochen Eulner; Ottmar Steffke

Connection of the R&S®FSQ-B100 and -B102 I/Q memory extensions to the signal processing unit in the R&S®FSQ.



Compact microwave test system for all EMC measurements in the laboratory

In 2004, Philips opened the new center for ElectroMagnetics and Cooling (EM&C) in Eindhoven (The Netherlands). In addition to conventional EMC test setups and systems (e.g. an anechoic chamber with a 10 m test range), Philips, in cooperation with Rohde&Schwarz, also designed a compact and versatile system for testing wireless communications systems in the frequency range from 800 MHz to 40 GHz.

Photo: Authors

FIG 1 The new microwave EMC test system is so compact that it can easily be integrated into laboratories and set up wherever required.

Close cooperation

The cooperation between Philips and Rohde&Schwarz in this project was only logical since both companies have many years of intensive experience in the field of EMC standardization. And Philips already knew and appreciated the products and systems from Rohde&Schwarz.

The complete process, starting with project definition and budgeting and resulting in the implementation and commissioning of the system, took four years. Both companies worked closely on specification and development. Rohde&Schwarz provided all hardware and software as well as the new compact R&S®RLINE measuring facility (FIG 1).

Increasing demand for EMC test equipment

There is an enormously high level of worldwide sales activity in the field of units and modules for wireless communications, e.g. mobile phones, WLAN and Bluetooth® components as well as

More information and data sheets on the comprehensive product range for EMC measurements at www.rohde-schwarz.com (search term: type designation)

modules for use in the automotive industry. The demand for providing comprehensive EMC tests to ensure that these components comply with all relevant standards and do not impair other users is thus very high.

FIG 2 A log-periodic antenna and three horn antennas cover the frequency range from 800 MHz to 40 GHz.

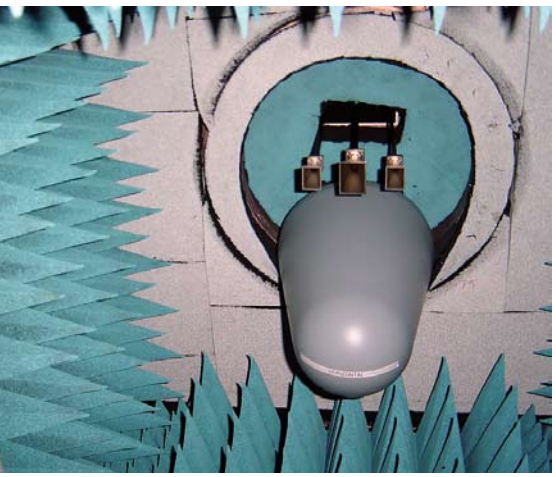


Photo: Authors

FIG 3 With the aid of manipulators made of low permittivity materials, the EUT can be rotated around all axes.

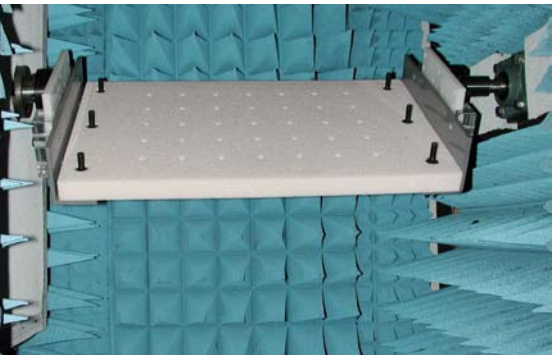


Photo: Authors

A basic Philips principle is that not only the appropriate EMC expertise must be available on site but all required T&M equipment as well – including EMC measurement solutions that can already be used during the design phase. In particular, a compact system was required that can be easily integrated into standard laboratories, set up wherever required and which yields results comparable to those of conventional EMC measurement solutions.

System concept

These requirements resulted in the development of the new test system. For this reason, Rohde&Schwarz specially designed the compact R&S®RLINE measuring facility, which is only as large as a system rack. The EMS power amplifiers and EMI preamplifiers are integrated on top of the measuring facility to ensure minimum cable loss. All T&M equipment is located in a 19" rack. The system covers the frequency range from 800 MHz to 40 GHz, is ideal for a wide range of applications, supports all relevant standards for wireless applications, and can generate and measure all required test signals.

Main components

The system is controlled via a PC and the **R&S®EMC32 EMC measurement software**. This tried and tested software controls fully automated tests over the complete frequency range, but also offers interactive testing – an indispensable feature for use in development.

The **R&S®RLINE** is a compact fully anechoic room provided with antennas to generate electromagnetic fields or to receive the radiated emission. A log-periodic antenna and three horn antennas cover the frequency range from 800 MHz to 40 GHz (FIG 2). They allow vertically and horizontally polarized radiation. With the aid of manipulators made of low permittivity materials, the EUT can be rotated around all axes (FIG 3).

An **R&S®SMR40 signal generator**, two arbitrary waveform generators, and three broadband power amplifiers generate or amplify the signals with the required modulation and corresponding levels in accordance with immunity standards. A homogeneous field strength of at least 10 V/m is available when the EUT is located at the maximum distance allowed.

The test system was used to analyze various modules for the following standards: WLAN, IEEE 802.11x, GSM, DCS, DECT, Bluetooth®, ZigBee, etc. These analyses resulted in the definition of a unified disturbance source (UDS) which is able to simulate most of the interfering signals of RF-carrier-based wireless products and standards without a large number of RF test generators being required during immunity testing. The two arbitrary waveform generators as well as the R&S®SMR signal generator are fully sufficient for generating all necessary signals.

The **R&S®FSP40 spectrum analyzer** with low-noise amplifiers and bandpass/highpass filters measures the radiated spurious emissions (RSE). With this powerful unit, you can also analyze the RF signal envelope, amplitude probability distribution, repetition rate and duty cycle, and generate disturbance profiles.

Mart Coenen (Philips);
Ulrich Konietzko

R&S®EMC32-S EMC Measurement Software

Immunity measurements in reverberation chambers

New options expand the R&S®EMC32-S EMC measurement software for immunity measurements in reverberation chambers in accordance with EN61000-4-21 as well as for manufacturer-specific measurement methods (GMW3097 and Ford).

Alternative to anechoic chambers

During conformance tests, electronic devices and systems (e.g. vehicles) are exposed to electromagnetic interference fields. These immunity measurements are normally made in an anechoic chamber above 80 MHz (radiated). For a complete test, the EUT has to be radiated from different sides and also with horizontally and vertically polarized signals.

Since investments in an anechoic chamber infrastructure are high and the measurements to be performed are complex, alternative test methods are in demand throughout the world. One alternative, quite common particularly in the USA but also in Europe, is the reverberation chamber which is mainly used in military applications. For a description of how the reverberation chamber operates and the associated measurements, see the generic standard EN61000-4-21. The manufacturer-specific standards GMW3097 and Ford ES-XW7T-1A278-AC for measurements in the automotive field are related to this generic standard. Reverberation chambers are also approved for military EMS measurements in accordance with the MIL-STD-461E and RTCA DO 160D standards.

How reverberation chambers work

A reverberation chamber principally operates like a cavity resonator into which RF energy is injected. The modes (cavity resonances) excited in the resonator form the electromagnetic field to which the EUT is subjected. To generate a statistically uniform and isotropic electrical field, a unit referred to as a tuner (stirrer) is used which turns and thus changes the mode distribution in the chamber. The advantage of this mode modification is that all sides of the EUT are subjected to the statistically homogeneous electrical field which means that neither a turning device is required for the EUT nor that the antenna polarization has to be modified. The transmitting antenna is not oriented toward the EUT but radiates toward a corner of the chamber.

A distinction is made between the mode-tuned method, where the tuner is turned in defined stages, and the mode-stirred method, where the stirrer is turned continuously. The following discussion addresses solely the mode-tuned method (where the number of tuner positions must be large enough to obtain a statistical field distribution).

When performing measurements with pulse-modulated interfering signals, the chamber must have a certain capacity (Q factor of cavity resonator). This is due to the structure and characteristics of the chamber (shielding panels, antennas). This factor limits the minimum pulse width of the pulse-modulated signal and is determined during calibration.

Test system for measurements in reverberation chambers

For EMS measurements in reverberation chambers, Rohde&Schwarz offers a standard system solution which can conveniently be configured with the R&S®EMC32 measurement software (FIG 1). Depending on the frequency range, a log-periodic or horn antenna generates the electrical field in the chamber. An antenna of the same type is used to mea-

More information and data sheet at www.emc32.rohde-schwarz.com

REFERENCES
- DIN EN61000-4-21, Verfahren für die Prüfung in der Modenverwirbelungskammer [methods for performing measurements in reverberation chambers], August 2004
- GMW 3097, Revision 4, February 2004.
- Versatile EMS and EMI measurements for the automobile sector: EMC Measurement Software R&S®EMC32-A: News from Rohde&Schwarz (2003) No. 178, pp 36–40
- "Required Amplifier Power in Automotive Radar Pulse Measurements", EE-Evaluation Engineering (http://www.evaluationengineering.com/archive/articles/0806/0806 required_amplifier.asp), August 2006

sure the received power. This antenna is connected to a spectrum analyzer, e. g. to the R&S®FSP7. While the chamber is being calibrated, the field strength (x, y, z, and |xyz|) is measured with a broadband field probe. A positioning device moves the mode tuner to the desired positions by remote control. Depending on the required field strength and the desired frequency range, several power amplifiers are used to generate the power fed to the reverberation chamber. The R&S®SML03 signal generator together with an R&S®AM300 function generator creates the RF signal and the radar pulse packets stipulated in the GMW3097 and Ford standards. An R&S®NRVD power meter evaluates the power. The R&S®TS-RSP switching unit establishes the signal paths between the generator and the amplifier and those required for measuring the forward and reflected power.

Options for all measurement methods

The key component of the system is the R&S®EMC32-S EMC measurement software which, together with the new R&S®EMC32-K3 and R&S®EMC32-K4 options, covers the measurement method in accordance with EN61000-4-21 in the reverberation chamber. These options are available with software version 6 or later (FIG 2).

The R&S®EMC32-K3 option provides all evaluation algorithms for calibrating the reverberation chamber and for EUT testing. It requires the R&S®EMC32-K4 EMS automatic test functionality option. The EMS automatic test (FIG 3) further automates the measurement since additional loop parameters can be defined for the actual frequency scan (test sequencer). The following loop parameters can be used for measurements in a reverberation chamber:

- Tuner position
- Sensor position (only for calibration)
- Modulation (only for EUT test)
- Antenna frequency range (switching of transmitting/receive antennas)

Easy chamber calibration

In contrast to anechoic chambers (homogeneous areas), reverberation chambers have a defined test volume that is usually cuboid in shape. The field distribution for both the unloaded and maximum loaded reverberation chamber (loaded with absorber material) is determined for this test volume. This measurement is performed only when putting the chamber into operation and repeated only in the case of structural modifications to the chamber or to the test volume.

During the calibration, the field probe is positioned to the eight corners of the test volume and the receive antenna is set up at different positions within the test volume. The EMS automatic test then performs a frequency scan at each tuner position (FIG 4).

The calibration yields parameters (standard deviation of field strength, maximum load factor, and insertion loss) providing information on the performance of the chamber (FIG 5). Also a table with the averaged normalized maximum E field strength is created. When performing measurements on the EUT, these values are useful in calculating the required RF power for creating the desired interference field in accordance with the following formula:

$$P_{Input} = \left[\frac{E_{Test}}{\overleftrightarrow{E} \times \sqrt{CLF}} \right]^2$$

E_{Test} required field strength for EUT test

$\overleftrightarrow{E}$ averaged normalized maximum E field strength

CLF chamber loading factor

EUT tests in the reverberation chamber

Prior to performing a test, the loading of the reverberation chamber by the EUT has to be evaluated. The loading must not be higher than maximum loading determined during the calibration. Otherwise, false measurement results will be obtained (attenuation of cavity resonances).

The EMS automatic test processes the configured loops for all mode tuner positions and modulation modes. This is done for each test frequency. Moreover, you can define whether the R&S®EMC32 software searches for the immunity threshold when detecting an EUT malfunction (susceptibility method) or whether it only documents EUT faults without changing the test level (qualification method).

During the measurement, EUT faults can either be detected automatically by the EUT monitoring system or marked manually by the user in the R&S®EMC32 software using the keyboard. You can evaluate the individual immunity threshold for each EUT fault. The measurement software then performs a worst-case analysis over all mode tuner positions and modulation modes, i. e. only one frequency scan is required (FIGs 6 and 7).

After completion of the test, you will obtain a table with all detected faults and also a graphical overview with the immunity thresholds of all tested systems.

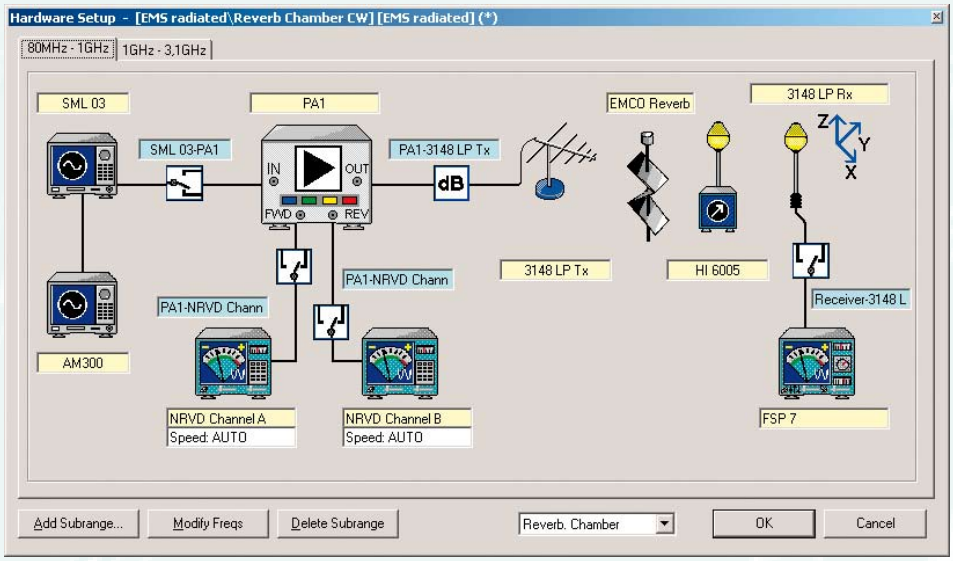


FIG 1 Measurements in a reverberation chamber: With the R&S®EMC32 software, you can conveniently make device configurations (in this example for the frequency range from 80 MHz to 1 GHz).

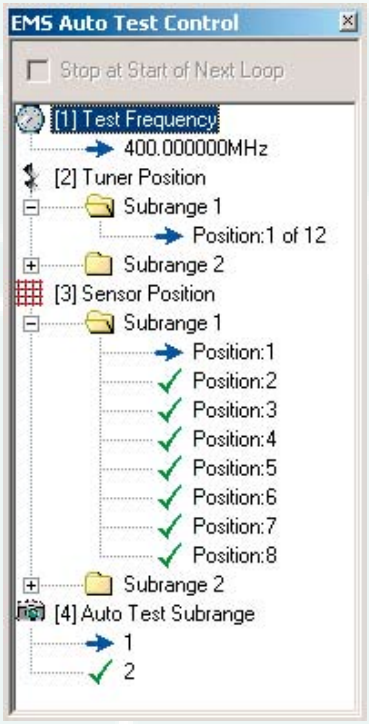


FIG 4 Dialog of EMS automatic test during calibration.

R&S®EMC32-S	Basic package for EMS measurements
R&S®EMC32-K1	Enhanced EMS functionality for automotive/MIL measurements
R&S®EMC32-K3	Expansion modules for performing measurements in reverberation chambers in accordance with EN 61000-4-21 (R&S®EMC32-K4 also required)
R&S®EMC32-K4	EMS automatic test functionality
R&S®EMC32-K6	Measurements in accordance with MIL-STD-461E CS103/4/5
R&S®EMC32-K7	Generic driver for RF generators, power meters and oscilloscopes
R&S®EMC32-U6	Upgrade of R&S®EMC32-S (earlier than V 6.0) to V 6.x

FIG 2 Available expansion modules for the R&S®EMC32 EMC measurement software.

FIG 3 Flowchart for EMS automatic test.

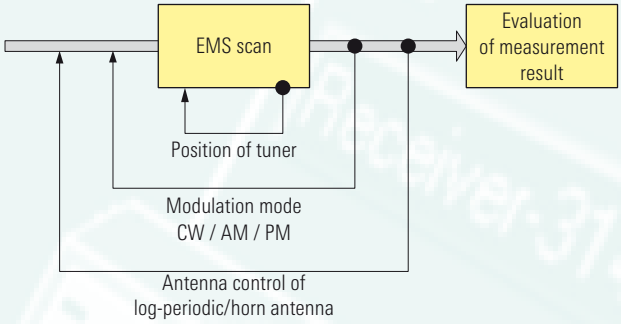


FIG 5 Result of calibration in a reverberation chamber.

Table Editor - [Reverb Calibration UNLOADED 400 MHz-3]

(6) 1.000000 | Frequency | Frequency

Name	Frequency	ACF	Insertion Loss	Standard Deviation X	Standard Deviation Y	Standard Deviation Z	Standard Deviation XYZ	P Input	P Ave Rec	P Max Rec	Avg Norm Max E-Field	Estimated E-Field	E-field Delta
Unit	MHz	dB	dB	dB	dB	dB	dB	dBm	dBm	dBm	V/m/SQR(W)	V/m/SQR(W)	dB
Interpol.	Lin	Lin	Lin	Lin	Lin	Lin	Lin	Lin	Lin	Lin	Lin	Lin	Lin
1	400.000000	10.993	6.373	2.476	2.895	1.739	2.483	39.980	28.987	35.450	49.726	40.954	1.686
2	419.764000	11.731	7.506	1.335	2.763	2.653	2.438	40.022	28.291	34.121	41.419	37.847	0.784
3	440.504539	11.157	6.605	1.336	2.867	2.698	2.637	40.017	28.860	34.528	48.987	44.367	0.860
4	462.269869	12.140	7.016	2.203	1.360	2.064	1.994	40.003	27.862	34.728	55.470	44.280	1.957
5	485.110623	12.518	7.411	1.666	1.961	1.874	2.186	40.016	27.498	34.667	46.555	44.297	0.432
6	509.079939	11.718	7.228	1.810	2.156	1.351	1.732	40.009	28.291	34.490	55.334	47.564	1.314
7	534.233578	12.320	7.714	1.783	1.852	1.832	1.696	40.007	27.687	34.046	46.943	47.020	-0.014
8	560.630060	13.064	8.002	1.342	1.733	1.343	1.699	39.989	26.925	33.894	49.339	47.355	0.356
9	588.330791	13.628	8.935	1.359	1.270	2.055	1.778	40.031	26.404	32.720	46.487	45.039	0.275
10	617.400215	13.556	8.633	1.702	2.568	2.331	2.174	39.986	26.430	33.599	51.627	48.990	0.455
11	647.905960	13.608	8.590	2.278	2.393	1.765	2.188	40.062	26.454	32.938	47.372	51.801	-0.776

35 | 13

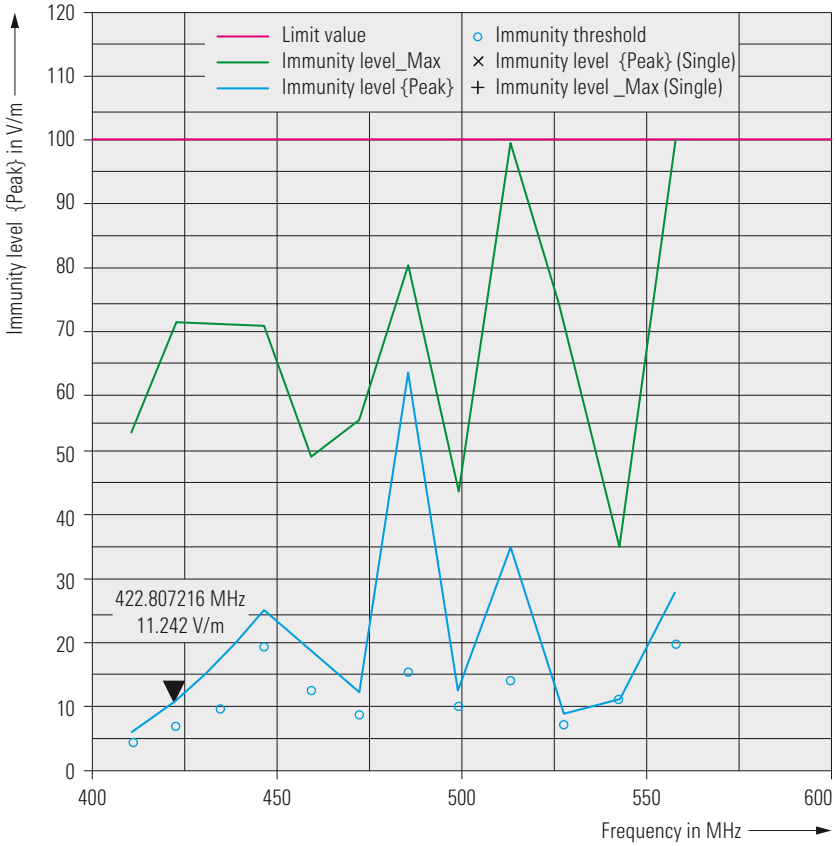


FIG 6 Graphical result of EUT testing with determination of immunity thresholds.

Summary

Measurements in reverberation chambers are an attractive alternative to EMS measurements in anechoic chambers. The tried and tested R&S®EMC32-S software used for measurements in anechoic chambers together with its new R&S®EMC32-K3 / -K4 expansion options cover all EMS measurement tasks in reverberation chambers in accordance with the EN61000-4-21 standard. This includes the calibration of the test chamber and EUT testing. Since the software is modular in structure, it can be easily adapted to any standard modifications or manufacturer-specific test methods. Owing to its open EUT monitoring interface, it supports automated EUT testing and is thus future-oriented.

Robert Gratzl

FIG 7 Result of EUT testing in a table with determination of immunity thresholds.

Table Editor - [TempTests\EMS radiated\Run 1 411-557MHz\Result Table_EutFailures]

(6) 1.000000 | Frequency | Frequency

Name	Frequency	EUT Failure Mode	GO Value	Thres. Imm. Level	Target Imm. Level	Margin	Ampl. Power	Gen. Level	Tuner Positions	Tuner Position
Unit	MHz			V/m	V/m	dB	W	dBm		
Detector										
1	411.245531	Deviation Exceeded	-	4.37	100.00	-27.2	0.122	-41.4	12	2
2	422.807216	Deviation Exceeded	-	6.98	100.00	-23.1	0.287	-37.2	12	4
3	434.693945	Deviation Exceeded	-	9.84	100.00	-20.1	0.454	-35.1	12	3
4	446.914855	Deviation Exceeded	-	19.54	100.00	-14.2	1.546	-29.0	12	5
5	459.479342	Deviation Exceeded	-	12.54	100.00	-18.0	0.590	-32.9	12	9
6	472.397065	Deviation Exceeded	-	8.79	100.00	-21.1	0.277	-36.5	12	6
7	485.677954	Deviation Exceeded	-	15.55	100.00	-16.2	0.883	-31.1	12	9
8	499.332220	Deviation Exceeded	-	9.89	100.00	-20.1	0.430	-34.6	12	6
9	513.370359	Deviation Exceeded	-	14.08	100.00	-17.0	1.291	-29.9	12	11
10	527.803164	Deviation Exceeded	-	7.18	100.00	-22.9	0.553	-32.9	12	1
11	542.641731	Deviation Exceeded	-	11.18	100.00	-19.0	1.436	-28.1	12	12
12	557.897467	Deviation Exceeded	-	19.89	100.00	-14.0	3.368	-24.1	12	2

12 | 10

FIG 1 The R&S®ETX-T DTV monitoring receiver.

R&S®ETX-T DTV Monitoring Receiver

Monitoring DVB-T/H single frequency networks

Transmitters in DVB-T/H single frequency networks must operate under strictly specified conditions. The R&S®ETX-K10 option for the R&S®ETX-T DTV monitoring receiver makes sure that these specifications are met (FIG 1).

Advantage of single frequency networks

DVB-T/H transmitter networks are able to broadcast several programs at a single frequency. They do this economically and across the entire network. You can also use them as single frequency networks (SFN) in which all transmitters send the same program content at exactly the same frequency and same time. Advantage: While, in analog terrestrial transmission, the simultaneous reception of the same frequencies in adjoining regions may cause unwanted cancelation or amplification of the signals, you can profit from this overlapping in single frequency networks with digital modulation to improve reception. This "positive" interference allows you to get by with a lower transmit power. Single frequency networks thus make efficient use of the scarce frequency resource, leave more room for frequency planning, and allow you to carry out a far more accurate coverage planning and, last but not least, contribute to cost-efficient operation, particularly in areas with difficult geographic conditions.

DVB-T/H signals in single frequency networks are received at different times due to distance-dependent path delays. The signals have a guard interval of time-specific length so that the receivers can compensate different path delays. All the signals have to be received during this guard interval. In a single frequency

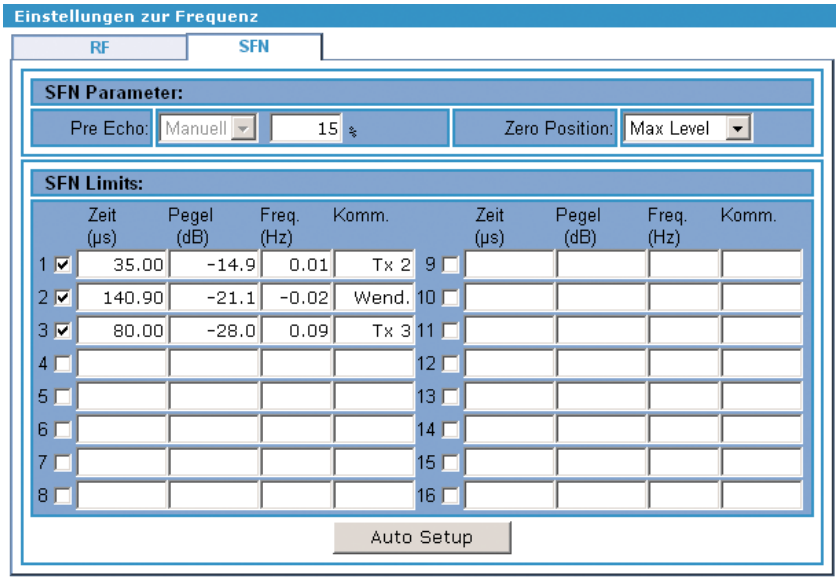


FIG 2 Selection of pulses to be monitored.

network, the length of the guard interval determines the maximum permissible distance difference of two transmitters to the receiver at which theoretically undisturbed reception is still possible. To optimize single frequency networks – e. g. to take special ranges of individual transmitters into account – an individual delay can additionally be set for each transmitter.

Only a small step from an intact transmitter to a failure

To ensure that all transmitters comply with the time-specific synchronization and the transmit frequency, they are linked to a reference time standard. GPS information is provided for this purpose. But if GPS fails, for example, an intact transmitter may soon become the source of a failure. In this case, the transmit frequency and the set delay time of the transmitter will slowly drift and violate the limits of the guard interval. The signal of the transmitter concerned will then be superimposed on the signals of the other transmitters and will cause interference. It will thus become a co-channel interferer.

Similar problems occur if the delay time, the guard interval, or even the transmit frequency is incorrectly set due to an operator error on site. This may result in reduced radio coverage, a loss of synchronization at a receiver, or even the complete failure of the single frequency network.

Recognizing changes automatically and early

The R&S®ETX-K10 option for the R&S®ETX-T [*] monitoring receiver solves this problem. It can automatically monitor transmitter signals, recognize changes in the network early on, and immediately respond to faults. For monitoring, the option uses the highly precise measurement offered by the channel impulse response provided in the R&S®ETX-T and compares the permanently measured channel impulse responses with a reference. It records the individual transmitter signals as pulses with an accuracy of ≤0.5 dB in the level range and of ≤20 ns in the time domain. With a patented method, the option determines the frequency drift for every measured transmit pulse – with reference to the main transmitter – with an accuracy of <0.3 Hz. This is more than sufficient since the permissible frequency drift in single frequency networks is ≤1 Hz.

Central monitoring of transmission areas

The R&S®ETX-T monitoring receiver – which is available for the 2k and 8k FFT modes – has a selective frontend. This makes it ideal for direct monitoring at the transmitter and also within a transmission area. You need to select a monitoring location where the antenna can receive all the transmitters of the single frequency network. Since the determined signal delays and frequency drifts are referenced to the main pulse (i. e. to the strongest transmit signal), you need to make sure that the main pulse is stable. You can do this by using an antenna with a suitable directional pattern. The R&S®ETX-T can then be easily addressed via its LAN interface and can be integrated into central monitoring systems via the simple network management protocol (SNMP).

Configuration at the press of a button

The channel impulse response used as a reference is configured at the press of a button. With Auto Setup, you can add up to 16 measured pulses to a table (FIG 2). Pulses relevant for monitoring can be selected individually and can be furnished with a comment. Since the receiver can be operated in the Scan mode to monitor several frequencies,

the R&S®ETX-K10 option allows you to define an individual reference for each frequency. You can then activate monitoring for the desired frequencies in a separate frequency list.

Fast error detection and signaling

A straightforward diagram shows the measured pulses and frequency drifts (FIG 3). The frames within this diagram mark the position of the pulses selected as a reference. The size of the frames corresponds to the tolerances for level, signal delay, and frequency drift that have been defined for all pulses. The color of the frames clearly indicates the current state of the single frequency network. A green frame indicates that the pulses are within tolerance, and a red frame indicates impermissible drifts.

In case of an error, the option sends SNMP traps to a parent monitoring system or generates an alarm report that informs you which pulses caused the alarm. The interferer is thus identified and a potential transmitter network failure can be prevented by taking immediate action.

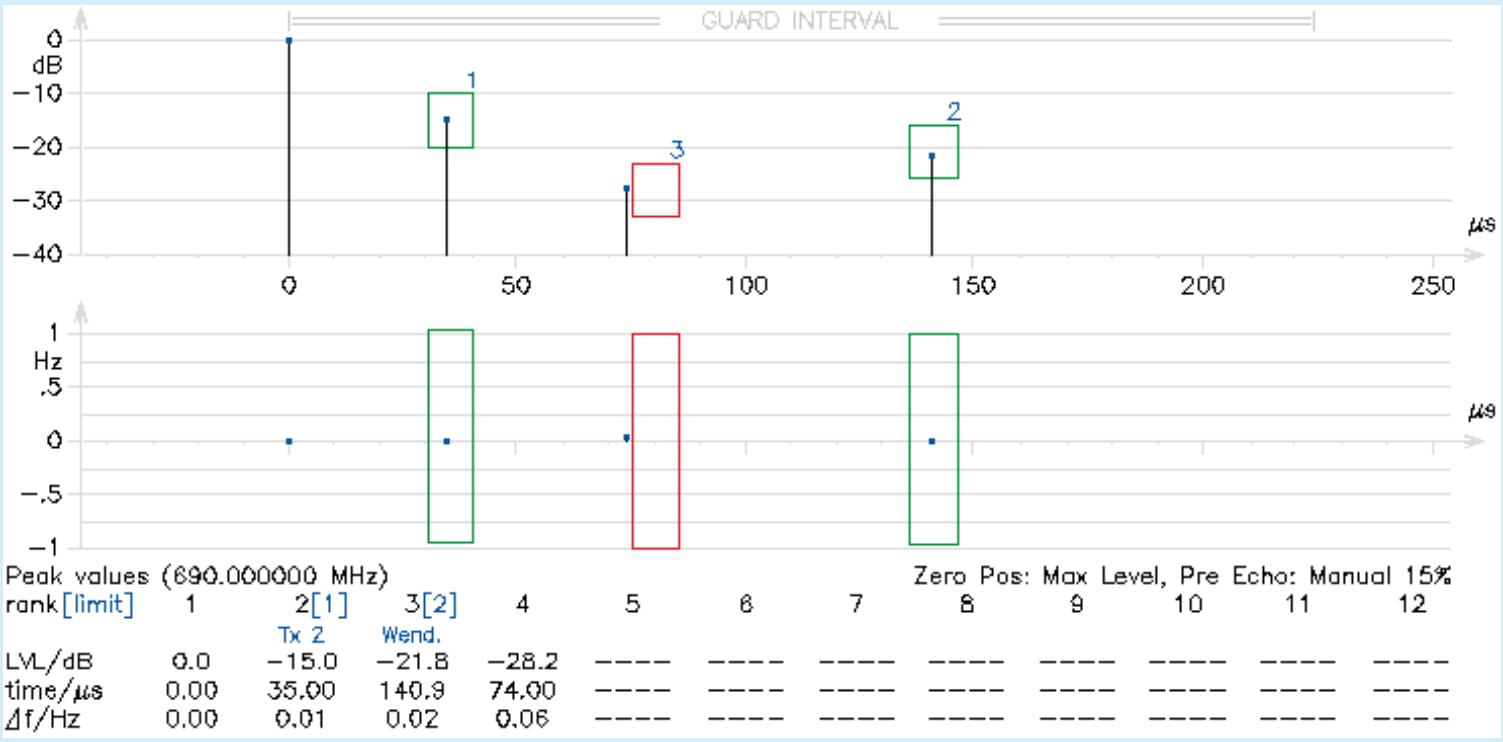
Werner Dürport

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

REFERENCES

[*] DTV Monitoring Receiver R&S®ETX-T: Trust is good, control is better – DVB-T monitoring. News from Rohde&Schwarz (2005) No. 188, pp 38–41

FIG 3 Checking the state of an SFN at a glance: Pulse number 3 is out of tolerance.



R&S®UMS100 Monitoring System

A new generation of fully automatic radiomonitoring systems

The drastic increase in radiocommunications traffic and the occupancy of ever higher frequencies pose special challenges for people who are responsible for planning, monitoring, and coordinating this volume of traffic. The new unattended R&S®UMS100 monitoring system is an excellent tool for handling these demanding tasks.

All-in-one solution – powerful, fully automatic and compact

The new R&S®UMS100 monitoring system is the right tool for handling the complex requirements that are due to the drastic increase in wireless communications (see box below). It is the first member of a new generation of compact yet extremely powerful, and fully automatic monitoring systems from Rohde&Schwarz. The basic model covers the frequency range from 20 MHz to 1300 MHz. Two optional frequency extensions are available: the HF option (100 kHz to 20 MHz) and the SHF option (1300 MHz to 6000 MHz). Only two antennas are required in order to cover the entire frequency range from 100 kHz to 6 GHz (FIG 1).

The most important components of the system are the RF frontend, a processor board, and the communications module. All components are accommodated in a weatherproof container, which is again integrated in another box, thus providing additional mechanical protection. The ventilation slots in the outer box provide permanent air circulation, which cools the system. The connectors for antennas, power, and communications are protected since they are located on the bottom of the system.

The integrated processor not only controls the receiver but also immediately analyzes the measurement results. Plus, it can respond quickly and flexibly on its own if necessary (e.g. if a new, unknown signal occurs), without requiring personnel to intervene.

Wireless communications steadily increasing

The conversion from analog to digital broadcasting technology is in full swing, at times requiring parallel operation as well. This not only applies to radio and TV transmitters but also to aeronautical radiocommunications and civil authorities radio. The full-coverage introduction of the next generation of mobile phones (UMTS/WCDMA) which is currently taking place also makes a significant number of new transmitters necessary. In addition to a rapidly growing number of hot spots for wireless Internet access, some companies are already planning to provide full coverage for individual municipal areas, e.g. New York Central Park, or for entire cities such as San Francisco.

Especially in rural areas and in regions with poor infrastructure, radio standards such as WiFi and WiMAX are increasingly being used as an attractive alternative to cabled solutions such as DSL. As a result, even sparsely populated areas must increasingly be included in monitoring and planning.

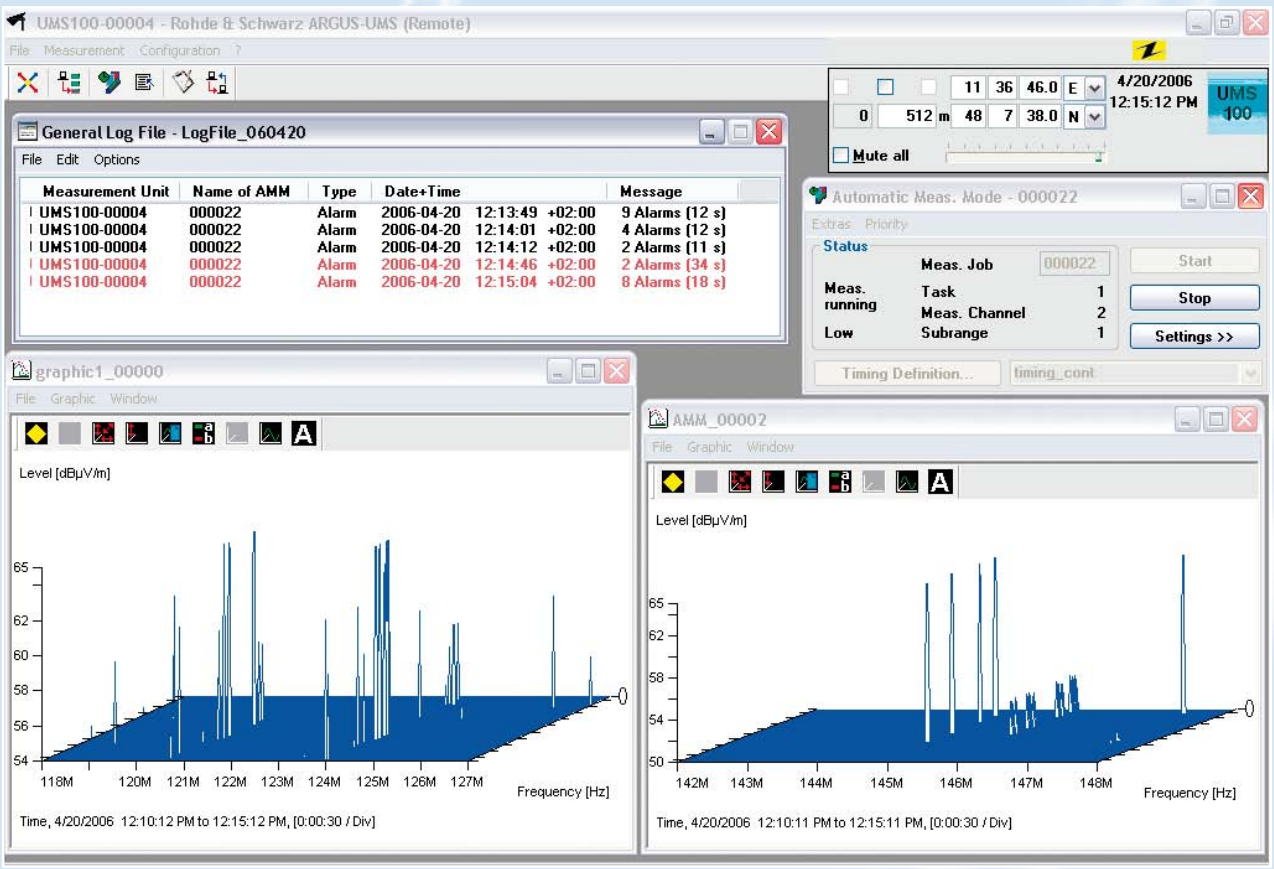
Many of these radio technologies are limited in range or have a pronounced directional characteristic, thus making mobile measurement systems necessary. The enormous need for additional frequencies can only be partially compensated for by the considerably more efficient digital methods. Therefore, it is increasingly necessary to resort to ever higher frequency ranges – the traditional limit of 3 GHz was exceeded long ago.

Regulatory authorities, the police, and other governmental organizations – as well as private security companies – therefore require mobile, fully automatic monitoring systems that are able to cover a wide frequency range.

44437/4

FIG 1
Despite its compact size, the R&S®UMS100 is a powerful and complete monitoring system. It covers the 100 kHz to 6 GHz frequency range with just two antennas.

FIG 2 The R&S®ARGUS-UMS control software with the results of automatic measurements and an alarm report.



The standard components used in the system yield an outstanding price/performance ratio. Due to its low weight and compact size, the system can be easily transported and installed. During normal operation, the R&S®UMS 100 has a maximum power consumption of only 25 W, which allows it to be battery-operated for extended periods of time without any problem.

Power is supplied either from a 110 V to 230 V AC source or a 10 V to 30 V DC source. Both supply voltages can stand ready at the same time, ensuring that automatic switchover to battery operation takes place in the event of an AC power failure without in-progress measurements being interrupted. The DC voltage connector also allows the system to be easily integrated into vehicles.

The R&S®UMS 100 is ideal for the following tasks:

- Automated long-term measurements
- Monitoring of licensed transmitters to determine whether they are in compliance with the operating license
- Searching for unknown / unlicensed or interfering transmitters
- Monitoring of large areas (borders, coastal regions, airports, industrial facilities)
- Monitoring of rooms and buildings to detect illegal transmitters
- Determining the actual use of the spectrum as a basis for spectrum management

Centrally controlled

The monitoring systems are efficiently and conveniently remote-controlled via a central or regional monitoring control center. Control is handled by the R&S®ARGUS spectrum monitoring software [*], which has a long history of successful operation and which is continuously being enhanced. All measurement and analysis tasks can be carried out quickly and easily via the software's intuitive, easy-to-operate graphical user interface. All measurement values are provided in a table and as graphs (FIG 2).

You can choose between the automatic mode, which is ideally suited for long-term measurements and regularly recurring routine tasks, and the interactive mode, which displays all measurement results live in the control center. A monitoring station is also able to operate large R&S®UMS 100 networks without any problem.

The major advantages of the R&S®UMS 100 monitoring systems become clear especially in the automatic mode: A control center sets up a connection to the R&S®UMS 100 to define the measurement tasks. You can define a variety of measurements, each of them with customized instrument settings and schedules for when they should be performed. You can preset multiple measurements to run at the same time, since an integrated intelligent resource management system (IRM) optimally distributes the available resources to handle and accomplish the various measurement tasks. After the measurement has been defined, you can clear down the connection and the control center can handle further tasks, e. g. determine new measurements for other systems.

Sophisticated alarm mechanism

The R&S®UMS 100 monitoring systems are equipped with a sophisticated alarm mechanism. For monitoring purposes, a measurement is initially performed in the frequency range that has been set. The results will be stored as a reference spectrum and then compared with the subsequent measurements. If a measurement value exceeds the user-defined threshold, an alarm response is triggered, e. g. the automatic analysis of the signal that triggered the alarm, including AF recording.

Alternatively or additionally, an alarm message is sent to the control center, where the operator defines further actions. The operator can directly access the monitoring station and identify the unknown transmitter by listening to the demodulated audio signal or more accurately analyze and locate the signal that triggered the alarm by using auxiliary systems such as DF stations or other mobile monitoring systems.

All measurement results can be stored directly in the R&S®UMS 100 as well as in a database at the control center. Authorized users can retrieve them at any time for offline analysis.

Remote control via LAN or wireless operation

You can choose between remote control via a LAN or wireless remote control via a mobile phone network. The sophisticated client/server architecture of the software reduces the network load to an absolute minimum, making even a narrowband GSM connection completely sufficient for the tasks at hand. As with the power supply, where both AC and DC connectors are provided, both LAN and mobile phone are also always included for remote control, ensuring maximum flexibility for all situations and applications.

The R&S®UMS 100 is a complete system that has been specifically optimized for fully automatic operation. Therefore, no connection to the control center is

necessary for the entire measurement period. A connection is briefly required only when defining measurement tasks and when checking the results. This keeps both network infrastructure and overhead costs low. If an alarm is triggered, the R&S®UMS100 automatically sets up a connection to the control center, transmits all required data, and then disconnects.

The equipment supplied includes the complete measurement system with antenna(s), a solid metal tripod, and material for mounting the system on a mast, wall, or ceiling. You merely need to provide a suitable location, the power supply, and a network connection via a LAN or GSM network. The R&S®UMS100 will then be ready for use within a very short period of time.

Summary

By developing the R&S®UMS100 monitoring systems, Rohde&Schwarz now provides a fundamentally new solution. The systems are compact, cost-efficient, exceptionally powerful, and also extremely versatile. Owing to their integrated sophisticated measurement and analysis functions, the monitoring systems are an excellent tool for handling the difficult measurement requirements encountered in today's communications scenarios.

Thomas Krenz

Ukrastotnaglyad (UCRF), the Ukrainian frequency authority, subjected the R&S®UMS100 radiomonitoring system to comprehensive testing – with the results being resoundingly positive (for details, see Newsgrams on page 59).

More information and data sheet at www.rohde-schwarz.com (search term: UMS100)

REFERENCES

[*] Spectrum Monitoring Software R&S®ARGUS: The successful "classic" now available as version 5. News from Rohde&Schwarz (2003) No. 177, pp 46–50

Digital Radio Mondiale (DRM) is the new digital broadcasting standard for frequencies below 30 MHz. The current version of the R&S®ARGUS spectrum monitoring software now also provides a decoder for ITU-compliant DRM measurements.

R&S®ARGUS Spectrum Monitoring Software

ITU-compliant measurements for Digital Radio Mondiale

DRM – a new broadcasting standard

Digitization of broadcasting worldwide has not slowed down. A successful standard in the frequency range up to 30 MHz is Digital Radio Mondiale (DRM). DRM primarily offers sound broadcasting applications, but can also be used for data services (for details, see box on page 51).

Like all other broadcasting transmitters, DRM transmitters must be planned and licensed. As soon as broadcasting starts, the individual national regulatory authorities are responsible for verifying that the licensing conditions are complied with; moreover, they have to locate and eliminate interference where required. The new DRM module for R&S®ARGUS was specifically developed to handle these tasks.

R&S®ARGUS ready for DRM

R&S®ARGUS is the standard software from Rohde & Schwarz for ITU-compliant measurement and evaluation tasks; the software is successfully deployed around the world and continuously developed and updated. The current version 5.2.2 can now be equipped with a special module for measuring and analyzing DRM signals.

The digital, I/Q-demodulated data stream of the receiver, e. g. of the R&S®ESMB or R&S®EM510 from Rohde & Schwarz, is used as an input signal. As these instruments are already installed in many monitoring stations, there are usually no additional purchasing costs for hardware; only the R&S®ARGUS software module needs to be added.

The software features a well-structured user interface, conveniently presenting all measurement values and further information at a glance (FIG 1). The user merely selects the DRM transmitter frequency; all other settings are handled by R&S®ARGUS. With DRM, as is common with digital modulation methods, multiple services can transmit on the same frequency; in the next step, users can select which of the maximally four services is to be analyzed.

The software displays the most important data such as name and ID of the current service, language, and type of program, as well as data rates and alternative frequencies. The receive level as well as the signal-to-noise ratio and various synchronization and checksum status displays provide information about the quality of the received signal.

The key technical parameters that describe a DRM signal – such as DRM mode and bandwidth, interleaver depth, error correction, DC offset, sample frequency offset, Doppler shift, and delay – are measured and displayed in realtime. All these values can be stored so that they will be available for subsequent offline analysis or documentation. The software also displays numerous parameters graphically – for example, delay, Doppler shift or sample rate history, the SNR spectrum, and the constellation diagram (FIG 2).

In addition to the audio signal, DRM can transmit auxiliary information such as simple text messages as well as multimedia content, for example NewsService Journaline® (FIG 3), or images in multimedia object transfer (MOT) protocol format. All this information can be displayed directly by the software, stored, and displayed again when needed.

Like all other measurement parameters, demodulated audio signals can be stored and replayed when needed. The signals are replayed in sync with the measurement results. Thus, variations in audio quality can be directly correlated with changes in technical parameters, for example.

Automatic measurement mode

In addition to these interactive actions, all measurements can run automatically during user-definable periods. Especially during the setup phase, many DRM transmitters do not yet broadcast around the clock but only a few hours per day. In this case, the automatic measurement mode (AMM) of R&S®ARGUS is the ideal solution. The measurements can be adapted to the current transmission plan as needed. If a transmitter is not in operation at the moment, the monitoring system can perform other tasks. When broadcasting does start, R&S®ARGUS promptly triggers the predefined measurements fully automatically – no user assistance required.

Another advantage provided by the automated measurements is the integrated alarm mechanism. The user can define a specific upper and lower limit for each measurement parameter and for each frequency. While the measurement is running, the software compares the results with the reference values. If the limits are violated (overshoot/undershoot), an alarm is triggered. This may be an entry in a log file, or an acoustic signal. The measurement can also be started fully automatically to thoroughly analyze the signal that triggered the alarm.

DRM up to 120 MHz in the future

At present, DRM transmitters broadcast approximately 800 hours of programming each day worldwide, with the trend increasing. The DRM consortium has decided to expand the frequency range up to 120 MHz in the next few years. This means a lot of work for the regulatory authorities. But with R&S®ARGUS, they can easily step up to the plate.

Thomas Krenz

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

Digital Radio Mondiale

DRM is a new standard for digital broadcasting below 30 MHz. A major advantage over analog broadcast transmitters in this frequency range is the outstanding quality of the audio signal, which is virtually equal to FM quality. As with other digital transmission methods, a wide variety of additional information can be transmitted in addition to the audio signal. For example, it is possible to display the title and artist of the song currently being played. Moreover, news, weather forecasts, and traffic information as well as images and even web pages can be transmitted.

Since existing AM frequency bands can be used and since AM transmitters require only minor modifications to be DRM-compatible, the use of the DRM standard is set to expand. The DRM signal is defined in such a way that it fits into existing AM frequency plans with 9 kHz or 10 kHz bandwidth. There are also other modes that use only 4.5 kHz or 5 kHz bandwidth. To achieve good audio quality despite these comparatively narrow bandwidths, highly efficient audio compression methods such as MPEG-4 AAC, MPEG-4 CELP, and HVXC are used.

The coded orthogonal frequency division multiplex (COFDM) method is used for transmission. This method allows, for example, the number of carriers to be varied in order to flexibly respond to requirements such as coverage, quality, and bandwidth.

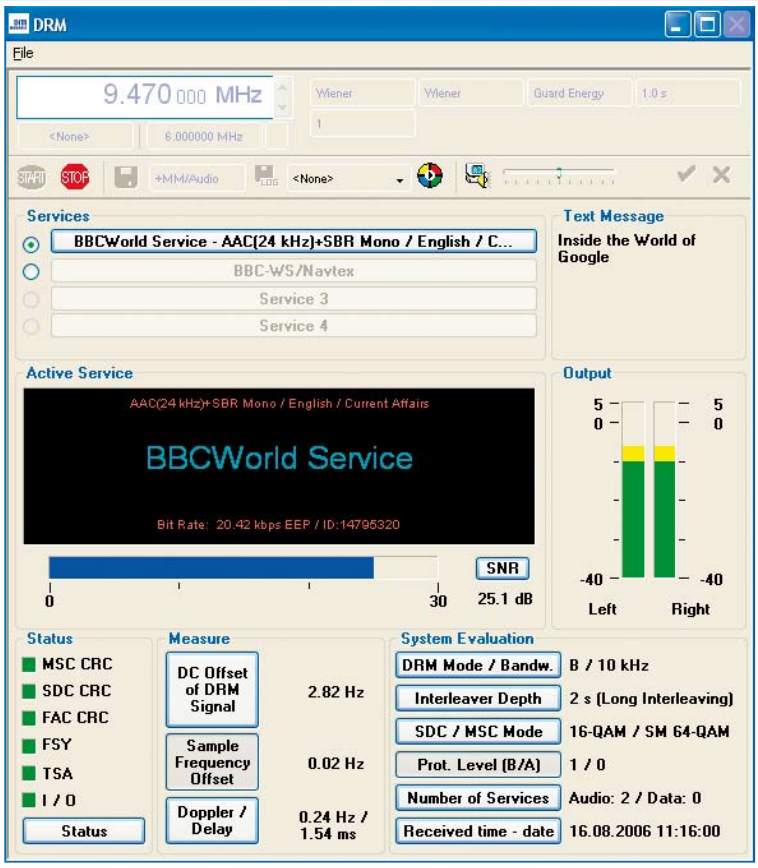


FIG 1 Key parameters at a glance: the R&S®ARGUS software user interface.

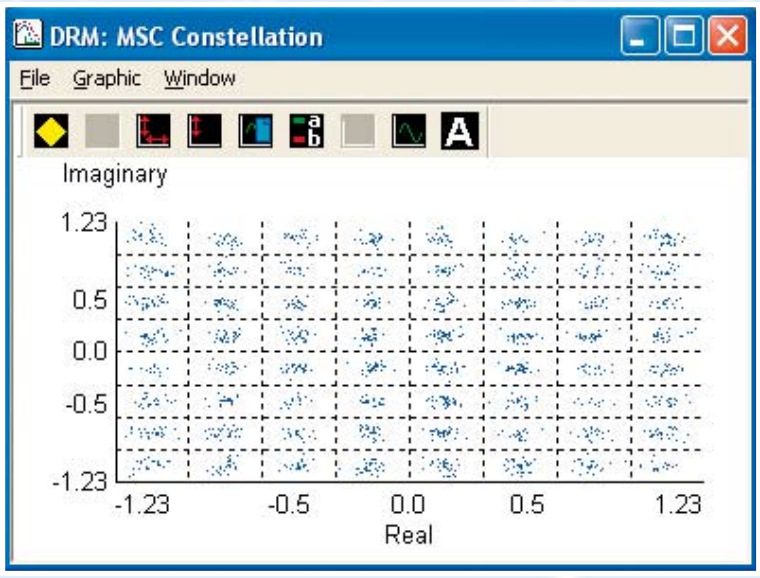


FIG 2 Constellation diagram.

FIG 3
R&S®ARGUS also displays the multimedia content of DRM transmissions, such as NewsService Journaline®.


ROHDE&SCHWARZ
XU 4200 · VHF TRANSCEIVER
POWER
USB
DC
AC
VOP
GO
CARR
VSWR
SQ
MOD

Ready for tomorrow's requirements: next generation of ATC radios

The new R&S®Series 4200 radios for use in civil and military air traffic control (ATC) are completely modular and digital in design. The radios are therefore extremely reliable and compact and also prepared to handle future digital transmission standards. They are the successor generation to the renowned R&S®Series 200.

Digital technology to overcome shortage of resources

The strong increase in air traffic especially in Europe with its densely populated areas has pushed radiocommunications systems in air traffic control to their full capacity. Moreover, the range from 118 MHz to 137 MHz in the VHF band allocated by the International Civil Aviation Organization (ICAO) for radiocommunications between air traffic controllers and pilots cannot be expanded due to other frequency allocations.

To overcome this shortage of frequency resources, air navigation service providers (ANSPs) are currently introducing a new service – controller pilot data link communications (CPDLC). Using CPDLC, air traffic controllers and pilots can exchange data telegrams in addition to communicating by voice. Routine messages, in particular, such as flight level releases, will in the future be communicated by means of data telegrams rather than voice transmission and displayed on the pilot's cockpit terminal. This method saves resources, as data telegrams occupy a channel only for a fraction of the time that would be required for the same information sent as voice messages.

Data telegrams will be exchanged on a separate frequency in the aeronautical radio band. This reduces the load on the voice channels and significantly enhances safety and efficiency in air traffic control. In the past few years, data transmission methods referred to as VHF data link (VDL) were standardized for the communication of messages. Of the methods available, VDL mode 2 has become firmly established (see box on page 54).

ATC voice communication is via voice channels with a frequency spacing of 25 kHz or 8.33 kHz and uses double sideband amplitude modulation (AM-DSB). Military ATC takes place in the UHF band from 225 MHz to 400 MHz. Since there is hardly any shortage of frequency resources in this range, the introduction of digital data transmission methods has not been envisaged so far. Tactical communications already employ digital and encrypted transmission methods for data exchange.

Ready for the future in civil and military ATC

To meet future requirements, Rohde&Schwarz has developed a new generation of radios for air traffic control. The R&S®Series 4200 (FIG 1) is prepared to handle future digital transmission methods via the air interface as well as digital transmission methods on the network side. Like the renowned R&S®Series 200, radios of the R&S®Series 4200 offer extremely high reliability, while providing even better RF performance and lower operating costs owing to their thoroughly digital design. The radio equipment meets, and even surpasses, relevant standards defined in ICAO Annex 10 and ETSI 300 676.

FIG 1 R&S®Series 4200 multichannel transceiver for the VHF range.

Adjustment-free modules

R&S®Series 4200 radio equipment can be configured in various ways and with various frequency ranges to yield complete radio systems for air traffic control (FIGs 2 and 3). All models of the R&S®Series 4200 come in identical housing that can be integrated into 19" system racks or into operator consoles, for example in a tower; the various models differ only with respect to the modules they use.

- Multichannel transmitter module (VHF or UHF version)
- Multichannel receiver module (VHF or UHF version)
- Power supply module for AC and DC operation

A transmitter, for example, consists of a transmitter module and a power supply module, a receiver contains a receiver module, and a transceiver a transmitter and a receiver and a power supply module (FIG 4). This concept greatly simplifies logistics and spare parts stock-keeping. An optional VDL processor will be available in the future.

Each module is accommodated in a separate metal cassette for optimum electromagnetic shielding. Modules can be replaced by the customer's service personnel. There is no need to return equipment to a Rohde&Schwarz support center since no calibrations or adjustments are necessary.

Open-ended for future needs

The R&S®Serie 4200 stands out for its thoroughly digital design – all essential functions are software-implemented. The advantages are obvious: It is no longer necessary to set jumpers or DIP switches to adapt the radio equipment to different system environments. No adjustments of components or modules are required either. Full calibration is

Technical features of VHF data link (VDL) modes

ICAO has approved three VDL modes for the digital transmission of voice and data. The key features of the various modes are listed in the table below.

VDL mode 2 is currently being introduced in Europe for data transmission between air traffic controller workstations and the cockpit (CPDLC). It will be binding for air traffic above flight level 285 as of 2009. It is expected that VDL mode 2 will also be adopted in other regions. The American VDL mode 3 is believed to have little chance of success. The future of VDL mode 4 is still unclear; yet mode 4 offers great potential for navigation and surveillance applications.

	VDL mode 2	VDL mode 3	VDL mode 4
Modulation	D8PSK	D8PSK	GFSK
Data rate	31.5 kbit/s	31.5 kbit/s	19.2 kbit/s
Medium access control	CSMA	TDMA	STDMA
Support of digital voice	no	yes	no
Applications	AOC / ATC (CPDLC)	ATC (voice and CPDLC)	navigation and surveillance

	Transceiver	Transmitter	Receiver
VHF	R&S®XU 4200	R&S®SU 4200	R&S®EU 4200
UHF	R&S®XD 4200	R&S®SD 4200	R&S®ED 4200

FIG 2
Models of the R&S®Series 4200.

Abbreviations

AOC	Aeronautical operational communications
ATC	Air traffic control
AVLC	Aviation VHF link control
CSMA	Carrier sense multiple access
D8PSK	Differential 8 phase shift keying
GFSK	Gaussian frequency shift keying
HDLC	High-level data link control
I^2C	Inter-integrated circuit
ICAO	International Civil Aviation Organization
OCXO	Oven-controlled crystall oscillator
RS	Reed-Solomon
STDMA	Self-organizing time division multiple access
TCXO	Temperature-compensated crystal oscillator
TDMA	Time division multiple access

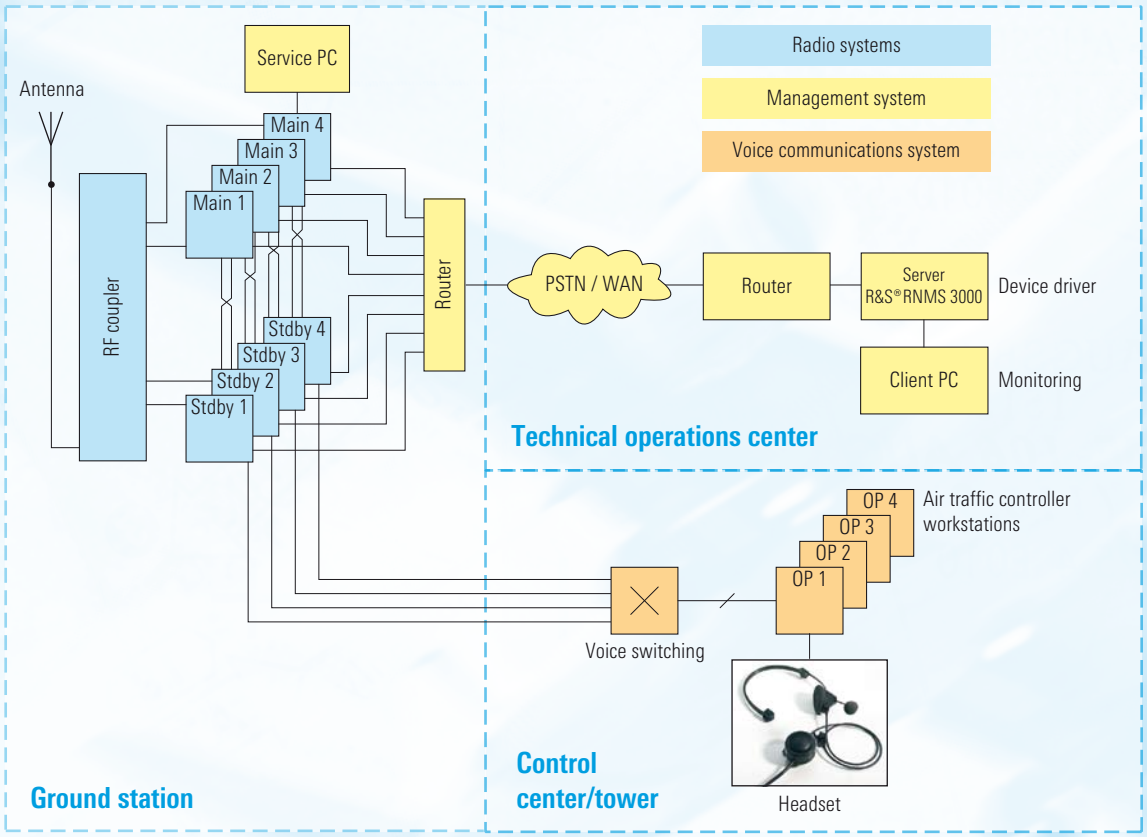


FIG 3
Basic diagram of a communications system using multiple radio channels.

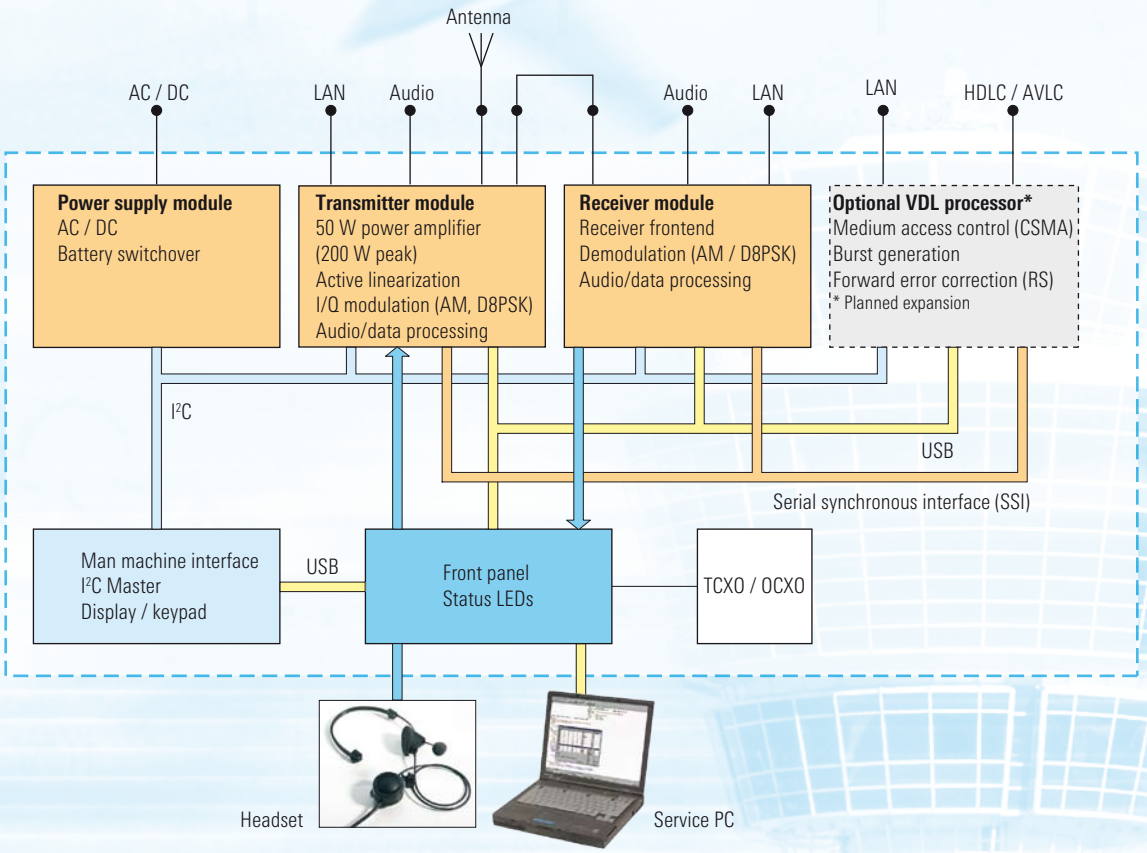


FIG 4
Modular architecture of the R&S®Series 4200. The figure shows an R&S®XU4200 VHF transceiver, which contains all modules.

performed during production, and correction values are stored in EEPROMS.

The basic configuration of the radio equipment can be performed conveniently on a service PC connected to the USB port. All settings can be made via a straightforward graphical user interface.

The thoroughly digital design of the R&S®Series 4200 makes it possible to implement customer-specific functions quickly and cost-efficiently – simply by modifying the software. Even complex changes that previously called for a hardware modification can be implemented. It will thus be possible to add, also in the future, new functions to R&S®Series 4200 radio equipment, such as ones that do not yet exist or that may be needed only later during the equipment's life.

Universal operability

Operation of R&S®Series 4200 radio equipment is simple. This applies both to local control via the front panel or a PC connected to the USB interface, and remote control via the TCP/IP interface. For local control on the front panel, an LCD and a keypad are provided. All important parameters can be configured and displayed directly on the radio. Together with a headset and an antenna, it can thus also be operated as a standalone unit.

The R&S®ZS4200 service and maintenance tool is available for putting R&S®Series 4200 radio equipment into operation and servicing it. Using this PC-based tool, the operator can configure the equipment, read error and event memories, and display equipment data such as the serial number or the software version. All parameters and data can be stored to the local memory and also transferred to another radio – a feature that is very helpful when a radio has to be replaced. Each radio can be assigned a name, which can be displayed. All radios in a network can thus be quickly and unambiguously identified.

Some settings can be blocked via the R&S®ZS4200 service and maintenance tool to prevent modification of the equipment setup. For example, the operator can "freeze" the set frequency so that it cannot be varied either via the front panel or by remote control. It is also possible to disable local control completely. In this case, the radio equipment can only be operated by remote control.

Sophisticated remote control concept for nationwide networks

All R&S®Series 4200 radios are equipped with an IP interface for remote configuration and monitoring. In larger networks, the radios are assigned to a server – or several servers to provide redundancy – via which they communicate with a client. The servers and clients may be distributed nationwide, allowing the architecture of the management system to be designed to match the customer's operational requirements. Rohde&Schwarz offers the R&S®RNMS3000 RCMS radio network management system for remote control and monitoring of radio systems. It offers a convenient graphical user interface that informs the operator at a glance about the current status of all radios in a network.

All radios of the R&S®Series 4200 come with built-in test routines that continuously monitor compliance with nominal parameter values. Deviations from nominal are immediately signaled to the radio network management system. The radios can be parameterized as required for their intended use or operated in a test mode for carrying out maintenance.

Summary

The R&S®Series 4200 is a new generation of versatile and compact radios for air navigation service providers. Their modular architecture and thoroughly digital design make the radios future-proof and ensure low cost of operation.

Bernhard Maier

More information and data sheets at www.rohde-schwarz.com (search term: Series 4200)

R&S®Series 4200 product brochure

R&S®XU4200 data sheet

R&S®RNMS3000 RCMS data sheet

R&S®ZS4200 data sheet

A pioneer of radio frequency engineering – 100th anniversary of Dr Lothar Rohde's birth

Born in Leverkusen, Lothar Rohde acquired his love for radio frequency engineering and fine arts at an early age – namely, from his father, who in addition to his profession as a chemist had also been a ham radio enthusiast and a gifted musician. Following in his father's footsteps, the son studied physics in Cologne and Jena, earning his doctorate in 1931 under the supervision of Professor Esau. In 1933, Lothar Rohde, doctor of philosophy and natural sciences, together with his university friend Hermann Schwarz, likewise a doctor of philosophy and natural sciences, founded the "Physikalisch-Technische Entwicklungs-Labor Dr Rohde und Dr Schwarz", which later evolved into Rohde&Schwarz – today a global company with approximately 6900 employees.

21435/4

Dr Lothar Rohde in 1972, 39 years after the foundation of the company.

Throughout his life, Dr Lothar Rohde was an engineer in the best sense of the word. Numerous patents and publications testify to his scientific genius. He was always in search of things that were new or not yet available, and had an unerring instinct for what was needed. He first devoted himself to RF test and measurement, which at the time was still quite undeveloped, and later to radio technology. The first development to come from the newly founded lab was a loss-factor measurement instrument for RF ceramics. There was no such thing as "not possible". His R&D colleagues knew this, and it has remained a motto in the company ever since. Dr Rohde was always tuned in to the customer and returned home from every trip with an idea for a new product that he wanted to see developed immediately.

In addition, he cultivated national and international contacts. It thus comes as no surprise that he was a founding member of the Bavarian Export Club, the German Electrical and Electronic Manufacturers' Association (ZVEI) and the German section of the Institute of Electrical and Electronics Engineers (IEEE). For his commitment, he received the Great Order of Merit of the Federal Republic of Germany from the German President in 1967, and the Technical University of Munich awarded him an honorary doctorate.

Dr Rohde also loved classical music and was an excellent pianist. He promoted young musicians and invited them to house concerts. On his 70th birthday, he thanked his well-wishers with an autographed record entitled "Rohde plays Chopin".

The energetic cofounder of Rohde&Schwarz was active in the company until shortly before his death in 1985. And he always remained in search of new, interesting applications and ideas for products that made it possible to venture considerably farther than before. For example, even at 79 he inspired the development of a small, portable broadband monitoring receiver that – later produced in large numbers – became an international success. Pushing Limits – although the cofounder of Rohde&Schwarz did not yet know this slogan, he always acted in accordance with it. Today the company's employees continue to work successfully by this slogan in his spirit.

The 100th anniversary of Dr Rohde's birth was on October 4, 2006.

Georg Schmidt (Gerotron), Alexander Wörner (Rohde & Schwarz), Dr Helmut Leier (Daimler-Chrysler AG), Winfried Mayer (Ulm University), Arnold Gronau (Ulm University) and Lutz B. Balluschk (Rohde & Schwarz). Leier, Mayer, and Gronau form the winning team.

△

Rohde & Schwarz sponsors innovation award for solutions from automotive sector

In mid-October, Gerotron, the organizer of EEEfCOM, presented the innovation award sponsored by Rohde & Schwarz to the winning team in the research association category. The team from Ulm was the lucky winner of the R&S®ZVB network analyzer, worth more than 40 000 euros. All in all, prizes worth 250 000 euros were awarded.

This year was the first time that a joint venture consisting of research and industry took part. The winning team concentrated on road traffic safety: Automobile drivers are increasingly benefiting from driver assistance systems. The winning proposal exploits the advantages of high-resolution radar systems for use in automobiles. In addition, its simple hardware architecture contributes to a more cost-efficient solution. At Ulm University, it was successfully implemented on a demonstration system at a frequency of 24 GHz.

This award has been offered once a year since 2002 at EEEfCOM. The award is then presented at RadiotecC, which is a trade fair including a developer forum for RF electronics and mobile radio, at the Adlershof Science and Technology Park (WISTA) in Berlin.

Mobile TV for Finland …

Rohde & Schwarz will supply the Finnish network operator and license holder Digita Oy with DVB-H transmitters. Digita Oy is the leading commercial distributor of TV and sound broadcasting programs in Finland. After Italy, Finland is now the second European country with a commercial DVB-H network. Broadcast operations will first be started in the large urban centers of Helsinki, Turku, and Oulu. In 2007, coverage is also scheduled for other areas.

… and DVB-T as well as DAB for Norway

Rohde & Schwarz Norway has signed a contract with Norkring AS to supply transmitters and monitoring systems. The objective is to provide Norway with a nationwide DVB-T network by the end of 2009. Rohde & Schwarz is the only supplier. The DVB-T project will include approx. 1400 transmitters, transposers, and gap fillers at more than 400 sites. The contract also contains a blanket agreement on transmitters that are required for expanding the DAB network.

R&S BICK Mobilfunk expands TETRA mobile radio network in Morocco

In July 2006, the Canadian company S.M. Group International contracted R&S BICK Mobilfunk to expand the existing *ACCESSNET*®-T network for the Moroccan security authority DGSN (Direction Générale de la Sûreté Nationale).

The TETRA network provided in Rabat and Casablanca by the Rohde & Schwarz subsidiary already meets the high security requirements of DGSN. This fact significantly contributed to the decision to expand the network.

As part of the expansion, the two existing *ACCESSNET*®-T networks in Rabat and Casablanca will be connected with each other. The highway between the two cities will receive radio coverage. The job also includes setting up networks in Tangier and Tetouan as well as providing coverage for the coastal

Josef Wolf (center), Director of the Spectrum and Network Analyzers and EMC Test Subdivision, cutting the cake. Jochen Wolle (left), who developed the software for the first spectrum analyzer, and Christian Evers, former R&S®FSA frontend developer, lend a hand.

◁ Twenty years of spectrum analysis from Rohde & Schwarz

The portfolio of spectrum analyzers at Rohde & Schwarz currently covers 33 instruments. In 1986, the electronics company successfully entered the field of spectrum analysis with its first spectrum analyzer, the R&S®FSA. Since then, the company has continued to fulfill its role as a pioneer in developing innovative solutions. At electronica 2006 in Munich, the anniversary was celebrated with a spectrum analyzer birthday cake.

Festive buffet in the Rohde & Schwarz Technology Center during the International Telecommunication Union (ITU) meeting.

road between these two cities. R&S BICK Mobilfunk is currently installing the network expansion, which will be put into operation in spring 2007.

Ukrainian frequency authority tests monitoring system

Ukrastotnaglyad (UCRF), the Ukrainian frequency authority, subjected the R&S®UMS100 radiomonitoring system to comprehensive testing – with the results being resoundingly positive.

In particular, the system was fully tested for its suitability to perform measurements in the range from 3 GHz to 6 GHz. In the Kiev municipal area, it was possible, for example, to receive and determine different WiMAX base stations. The detection range received high marks, even if the R&S®UMS100 was not located directly in the radiation sector of the WiMAX transmitter stations.

UCRF can envisage using these compact radiomonitoring systems at locations where leasing space to set up conventional systems is a prolonged process and thus financially unsound or where frequencies beyond 3 GHz have to be monitored.

The results of the test phase were presented in July at an ITU seminar in Kiev on "Trends in the development of national radiomonitoring systems". In a parallel exhibit, the participants were able to observe live measurements on the R&S®UMS100. The director of the frequency authority, Pavlo Slobodyanyuk, thanked Rohde & Schwarz for its skilled and reliable support during the test phase.

The R&S®UMS100 monitoring system is described in detail on page 46 of this issue.

ITU at Rohde & Schwarz

In October 2006, Rohde & Schwarz was host for an International Telecommunication Union (ITU) meeting for the second time in eight years.

A total of 140 experts from industry, governmental organizations, and international associations, as well as from the ITU Radiocommunication Bureau, discussed technical means of ensuring the most efficient and interference-free use of the available electromagnetic spectrum, which is very limited worldwide.

New radio technologies are continuously emerging and competing for worldwide acceptance. Yet, the spectrum cannot be expanded. "These two aspects make our work really fascinating: We offer reliable test systems to make user equipment ready for new standards – and we specialize in solutions for monitoring the busy traffic in the spectrum", says Rohde & Schwarz President and COO Christian Leicher.

The ITU Radiocommunication Sector (ITU-R) therefore concerns itself with regulations for managing and monitoring the electromagnetic spectrum. In doing so, ITU combines the interests of national regulatory authorities, industry, network operators, and end users.

Rohde & Schwarz holds SDR Forum meeting

In September 2006, the 50th general meeting of the SDR Forum (software defined radio) took place at Rohde & Schwarz in Munich. More than 60 members and guests gathered in the new Rohde & Schwarz Technology Center. For three days, participants reported on and discussed developments in the field of software defined radio including new, future approaches such as "cognitive radio" in the plenum and in various working groups.

The SDR Forum is an international non-profit association consisting of companies, research centers, and authorities that promotes the development, adoption, and use of SDR technology – both in the civil and military sectors. The forum consists of the Board of Directors and various committees which are again made up of several working groups. Rohde & Schwarz became a member of the SDR Forum in 1997. The company heads working groups and is also represented on the Board of Directors.

Herbert Rewitzer, Executive Vice President and Head of the Radiocommunications Systems Division, held the opening address at the meeting.

www.rohde-schwarz.com

Europe: customersupport@rohde-schwarz.com · **North America:** customer.support@rsa.rohde-schwarz.com · **Asia:** customersupport.asia@rohde-schwarz.com

News from Rohde & Schwarz 191 (2006/III) · PD 5210.5521.72