Products: R&S® CMW270 WiMAX Communication Tester,R&S® SMU200A, SMJ100A Vector Signal Generator, R&S® FSL, R&S® FSQ, R&S® FSG Spectrum Analyzers

Calibration and Verification of

SEQUANS COMMUNICATIONS

Wave 2 WiMAX chipsets

Application Note 1MA128

Rohde & Schwarz offers complete non signalling & signalling based Production Test Solutions for WiMAX Chipsets: From “single box” test solutions, using the R&S® CMW270 WiMAX Communication Tester, to traditional multi-instrument setups, using the R&S® SMJ100A Signal Generator together with the R&S® FSL Spectrum Analyser, Rohde&Schwarz provides a time and cost effective test solution. The implementation of chipset specific Auto Test Software enables automatic Rx/Tx measurements and the realisation of a fast calibration routine.

ROHDE & SCHWARZ

Contents

The following abbreviations are used in this Application Note for Rohde & Schwarz test equipment:

- The R&S®SMJ100A vector signal generator is referred to as the SMJ.
- The R&S®CMW 270 WiMAX Communication Tester is referred to as the CMW270.
- The R&S®FSL3/6 spectrum analyzers are referred to as the FSL.
- The R&S®CMWrun software is referred to as the CMWrun.

1 Overview

In this document Rohde&Schwarz is introducing two cost and time effective solutions for WiMAX chipset production lines: From a “single box” test solution, using the **CMW270**, to multi-instrument setup, using the **Signal Generator SMJ100A** together with the **Spectrum Analyser FSL**.

All instruments, which can be used, have integrated WiMAX personalities complying to the 802.16e-2005 standard. Through our cooperation with the chipset manufacturer, the Test Software (CMWrun) is customized to the chipset and enables our customers the realisation of fast calibration and verification routines with automatic Rx/Tx measurements.

Test Features

Calibration Measurement	Verification Measurement
Supports Sequans' Reference Calibration Tests • RSSI parameter • TX Output power • Flexible settings of frequencies (separated in static and variable part)	Supports Sequans' Reference Verification Tests • RSSI • CINR • Constellation Error (EVM) • TX Output Power • Flexible setting of frequencies and test depth

Benefits:

- Stability, repeatability and measurement speed is improved significantly
- The Test Software is customized to the requirements of specific chipset to speedup test processes.
- Flexible signal generation by utilizing integrated WiMAX personality for quick adoption to new measurement task.
- Cost effective solutions - please check pricing with the local R&S subsidiary.

2 Test Setups

Two different test setups are available.

CMW 270

The **CMW270 Mobile WiMAX Communication Tester** combines signal analysis and signal generation in a single instrument. For time optimized RF calibration in non-signaling mode, the CMW270 provides fast transmitter measurements and a versatile arbitrary waveform generator for receiver testing.

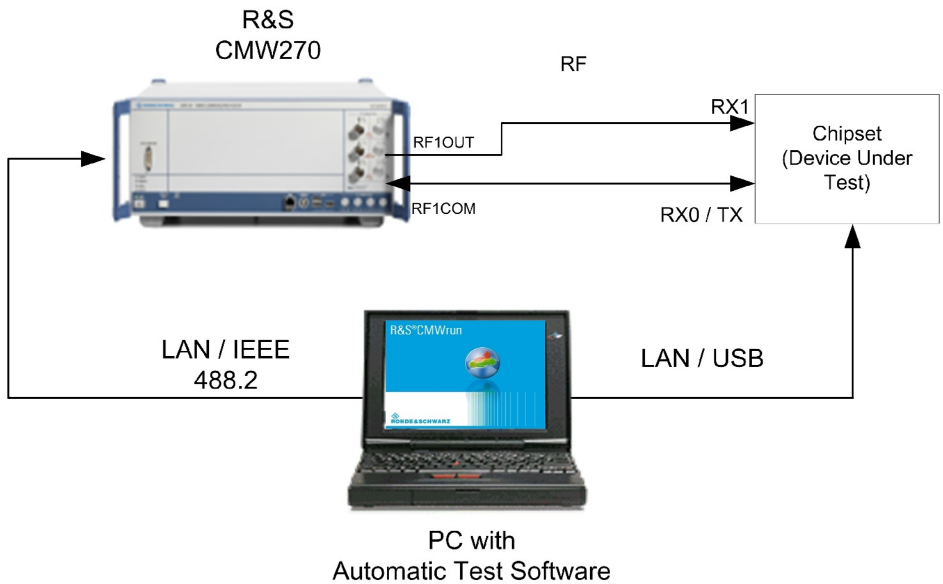

Fig. 1 - R&S Test Setup with CMW270 and CMWrun

Rohde&Schwarz's solution provides a manageable test setup: The Devices under Test (DUT) can be connected via USB or LAN to a notebook or PC. The CMW270 can be easily integrated into production lines by remote control via LAN or IEEE 488.2 (GPIB).

The software CMWrun is designed as a Sequencer for different Software Tests with R&S instruments. It is also used to control the R&S Test Solution for WiMAX Radio Conformance Testing.

FSL & SMJ100A

The alternative setup is based on **Spectrum Analyzer FSL and** the **Signal Generator SMJ100A** which can be remote-controlled via IEEE 488.2 (GPIB) or LAN. Figure 2 shows the principal test setup. This setup is intended for higher level accuracy esp. for Base Station testing. For generating the signals the arbitrary waveform generator or the WiMAX option for the and SMJ can be used. Also for the FSL the WiMAX option has to be available.

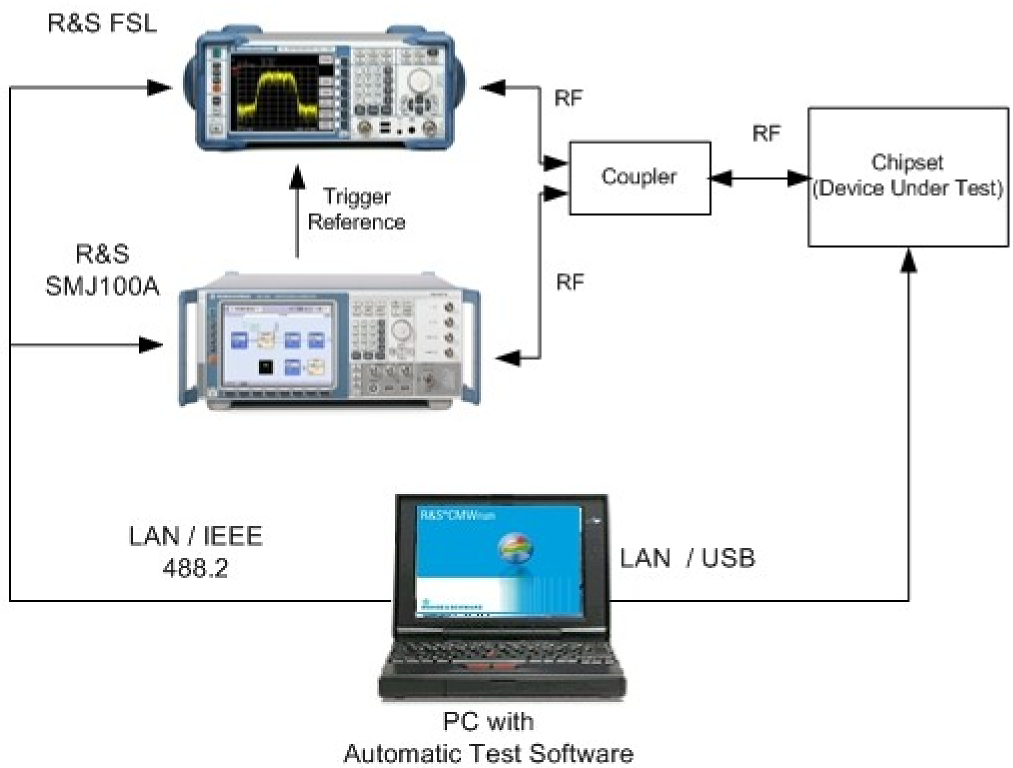

Fig. 2 - R&S Test Setup with the SMJ100A and FSL

3 Hardware and Software Requirements

Test & Measurement Instruments

- CMW270 WiMAX Communication Tester

or

- Signal Generator SMJ100A together with the Spectrum Analyser FSL

PC Hardware Requirements for Test Setups with CMWrun

	Minimum	Recommended
CPU	Intel® Pentium M Prozessor 1,4 GHz	Intel® Core™2 Duo Processor 2 GHz
RAM	512 MByte	1024 MByte
Hard disc	100 MByte free hard disc space	
Monitor	XGA colour monitor, resolution 1024x768 or better	
Remote Control	GBIP, LAN or USB	

DUT Control	Depending on the device

PC Software Requirements for R&S®CMWrun

OS	Windows XP32 Bit incl. Service Pack 2
OS add-ons	Administration rights Microsoft NET Framework 2.0 or higher
VISA	R&S VISA or different VISA solution

4 Installation Instructions

For the use of the Automated Test Software CMWrun together with the CMW270 for WiMAX chipset testing please follow the installation sequence on your local computer as per particulars given below:

1. Microsoft .NET Framework 2.0
2. R&S CMWrun
3. CMWrun will automatically install R&S VISA, if no VISA installed
4. FTP server

For further installation information and support please contact your local Rohde & Schwarz Application Engineer.

Instrument Settings

After connecting the measurement devices via LAN or GPIB according to the test setup and starting CMWrun, the connection to the measurement equipment has to be configured in the SCPI-Connection menu of CMWrun. The connection will remain open in subsequent test cases and tests.

CMWrun basic settings

CMWrun is based on a modular structure. Hence it is easy to configure the settings for a specific device under test.

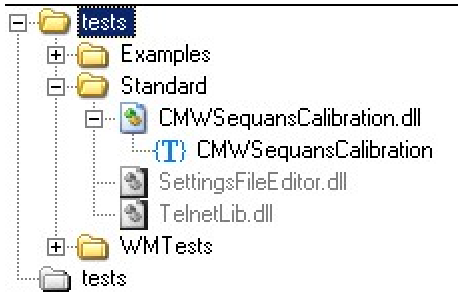

Fig. 3 - Delivered and used libraries

The CMWSequansCalibration.dll is the main component of the customized automated test. In this library Rohde&Schwarz implemented the specific parameter and settings for the Sequans chipset calibration and verification measurement according to [1].

The control of the chipset is done via Telnet which is provided in CMWrun via the module TelnetLib.dll. Additionally needed is SettingsFileEditor.dll for modifying the calibration file.

5 Calibration

Calibration routines are required to calibrate and balance the internal components of the DUT.

Following Wimax settings (as recommended by Sequans) will be used in calibration and verification:

- Bandwidth: 10 MHz
- Framelength: 5 ms
- FFT size: 1024
- Guard period: 1/8
- Uplink:
    - Number of symbols: 15
    - Slot count: 175
    - QPSK ½ for Calibration, flexible setting of modulation for verification
- Downlink:
    - QPSK ½, according to standard, continous signal for calibration
    - Flexible setting of modulation for verification, zone setting according to [1], sensitivity test

According to [1] the calibration is separated in static and a variable part. In the static part RX and TX corrections are measured over some more frequencies, in the variable part additionally the gain changes over a less amount of frequencies.

IQ Calibration

In the first step an IQ calibration is necessary. This is done automatically by the DUT. Additionally a calibration file is generated in the device and also copied via FTP to the controlling PC.

Calibration of the Tx characteristics

Tx Power calibration ensures that the DUT transmits the defined power levels after the calibration. The CMW270 is configured to measure the power of the signal. The expected level of the measurements are configured in CMWrun. In the static part the power is measured via demodulation of the WiMAX signal, in the variable part a CW signal (‘tone’) transmitted by the DUT is measured. The TX output power of the DUT is compared to the target power followed by an adjustment if necessary. The corrected values are stored in a calibration file on the controlling PC.

Calibration of the Rx characteristics

The CMW270 generates a specified continuous Wimax waveform at a defined frequency. The DUT measures the power and reports it to the control-software. Both are compared, in case of any differences, and the software provides the respective correction value and store it into the calibration file.

Calibration File

All calibration parameters are stored in the calibration.cfg file. In the last step the calibration file with the corrected values of Rx and Tx calibration is copied via FTP server to the DUT. The DUT loads this calibration file at the startup phase if available.

Testplan

The routines described above are chipset specific. Therefore it is necessary to create a specific Testplan for each device under test. The Testplan contains the main functionality. You can easily set up our test plan by selecting the desired test module provided by Rohde&Schwarz. For an example of calibration and verification measurements in a Testplan please refer to the next figure.

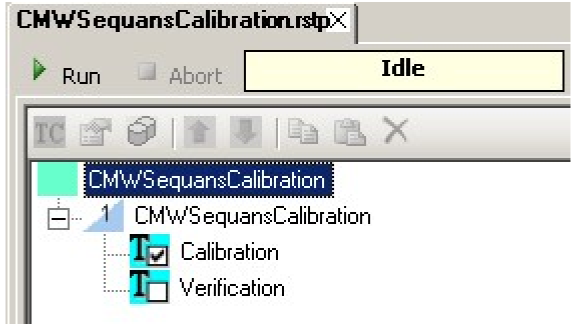

Fig. 4 - Creation of a new Testplan

Properties can be used to parameterize the Testplan. It is possible to edit the properties in the CMWrun by double-clicking the appropriate test.

Properties

To edit the properties double-click on the CMWSequansCalibration in the testplan.

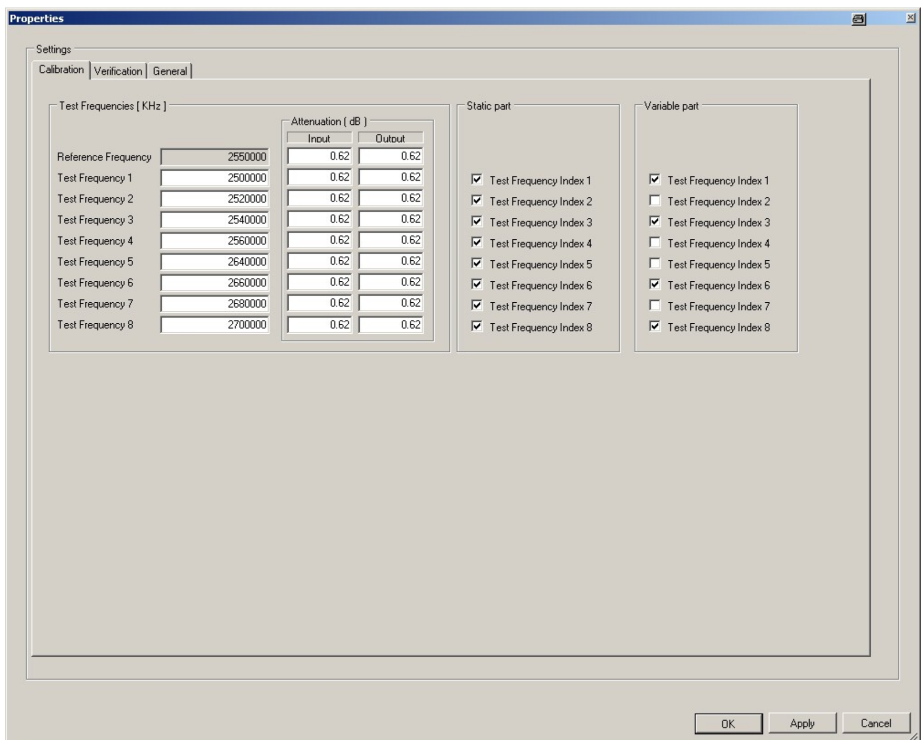

Fig. 5 - Properties of the Calibration Measurement

<u>Test Frequencies</u>

Here you can enter up to eight test frequencies in the range 2.5 GHz…2.7 GHz. The reference frequency is fixed to 2.55 GHz. The calibration is divided in a static and a variable part where you can select the wanted frequency indices. The default setting is recommended by Sequans.

External Attenuation

Depending on the test setup and the established connection between the DUT and the CMW270, the attenuation has to be configured. In the test setup the CMW is used as signal generator and signal analyzer. The attenuation for both functionalities can be entered for each test frequency.

6 Verification

Calibration routines are required to calibrate and balance the internal components of the DUT.

Following Wimax settings (as recommended by Sequans) will be used in calibration and verification:

- Bandwidth: 10 MHz
- Framelength: 5 ms
- FFT size: 1024
- Guard period: 1/8
- Uplink:
  - Number of symbols: 15
  - Slot count: 175
  - QPSK ½ for Calibration, flexible setting of modulation for verification
- Downlink:
  - QPSK ½, according to standard, continous signal for calibration
  - Flexible setting of modulation for verification, zone setting according to [1], sensitivity test

Verification with test mode (non-signaling)

The verification consist of two parts: RX Verification and TX Verification.

Common for both parts is the setup of the frequencies and the External attenuation.

<u>Test Frequencies</u>

Here you can enter up to eight test frequencies in the range 2.5 GHz…2.7 GHz.

External Attenuation

Depending on the test setup and the established connection between the DUT and the CMW270, the attenuation has to be configured. In the test setup the CMW is used as signal generator and signal analyser. The attenuation for both functionalities can be entered for each test frequency.

RX Verification

The following tests verify the receiver calibration. To perform these tests, the signal generator of the CMW270 is controlled by CMWrun to transmit a defined test signal with dedicated frequency/level settings. The level error and CINR will be measured by the device and reported back to the CMWrun.

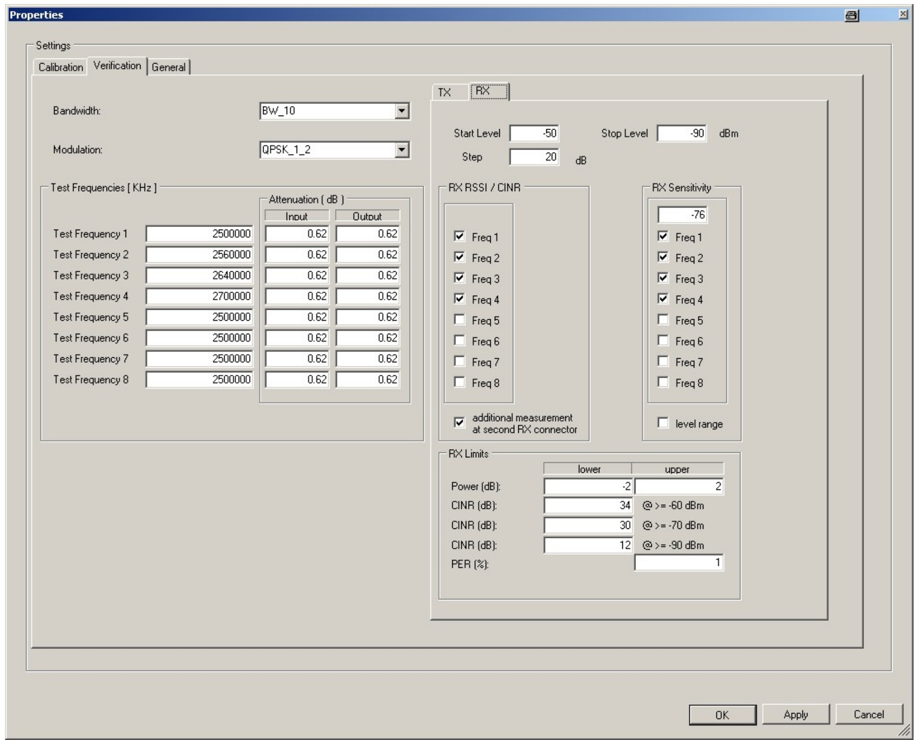

Fig. 6 - Properties of verification RX

RX Level

You can enter a RX start and a stop level and also the level steps and select on which frequencies shall be measured. With 'additional measurement at second RX connector' the measurement will also be done on the second RX connector of the DUT (RX1).

RX Sensitivity

You can select the frequencies for the sensitivity measurement. The measurement can be either done on one fixed downlink level which can be entered (e.g. -76.0 dBm for 64-QAM ¾ signal). At this level the limit check will be performed. With checking 'level range' the measurements is done on the levels taken from the RX level section. A special arbitrary file according to [1] is used.

RX Limits

You can enter the limits for CINR, power error and the PER. These limits are checked and displayed with a pass/fail indication in the measurement report.

Tx Verification

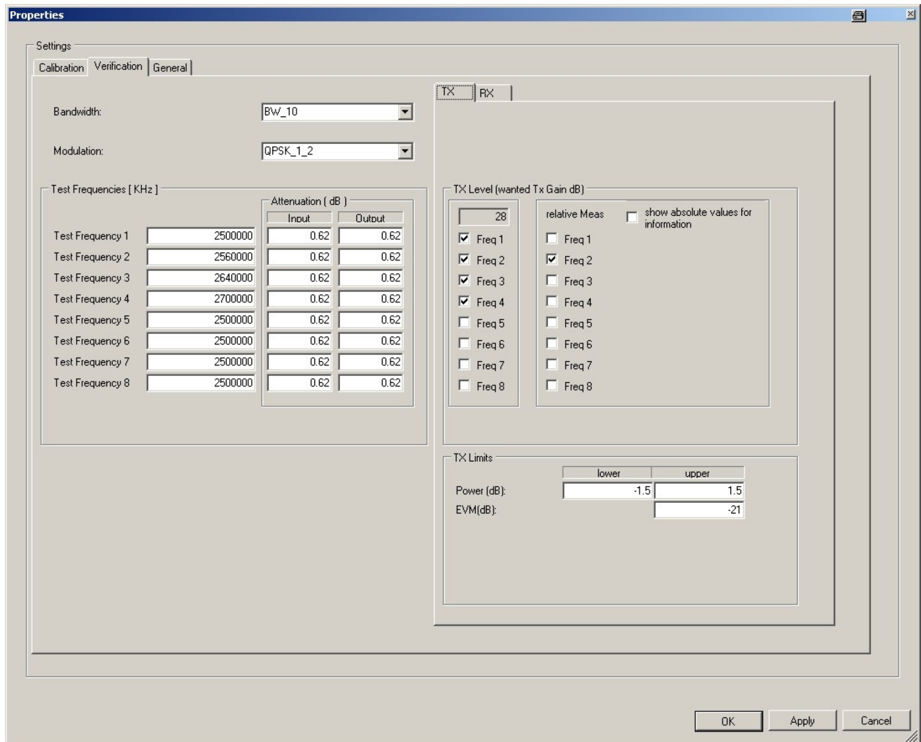

Fig. 7 - Properties of Verification TX

The purpose of this test is to verify the accuracy of the Tx Calibration on one absolute level (internal gain = 28.00 dB, which results in an absolute output level of around 21 dBm) and a relative power measurement across the Tx range. For both parts you can select the frequencies separately.

The relative measurement is taken in 1 dB steps from -17 dB gain up to +28 dB gain. After the measurement a post processing is done where the relative errors of certain steps (1 dB, 2 dB, 3 dB, 5 dB and 10 dB) are calculated and displayed. These limits are:

- Delta = 1 dB: 0.5 dB
- Delta = 2 dB: 1.0 dB
- Delta = 3 dB: 1.5 dB
- else: 2.0 dB

You can also enter the TX limits for the absolute power measurement and the EVM.

Verification with signaling

Test depth will be significantly improved by verification under signaling conditions, thus also verifying higher layer inter-working in a real world scenario in order to guarantee a positive end-user experience by assuring immediate and successfull connection to the WiMAX network.

Realtime signalling allows testing the full functionality of a mobile station like in mobile WiMAX network operation, i.e.:

- Receiver sensitivity (PER)
- WiMAX signalling test
    - Initial ranging
    - Network registration
    - Periodic ranging
    - Data transfer (MAC)
- Channel Reporting
    - CINR (carrier to interference and noise ratio)
    - RSSI(receive signal strength indicator)

For customers using the R&S CMW270, a dedicated signalling HW/SW option as well as a modul for CMWrun is available, making cost and resource intensive maintenance and adaptation of “Golden Sample Base Stations” within the production lines obsolete.

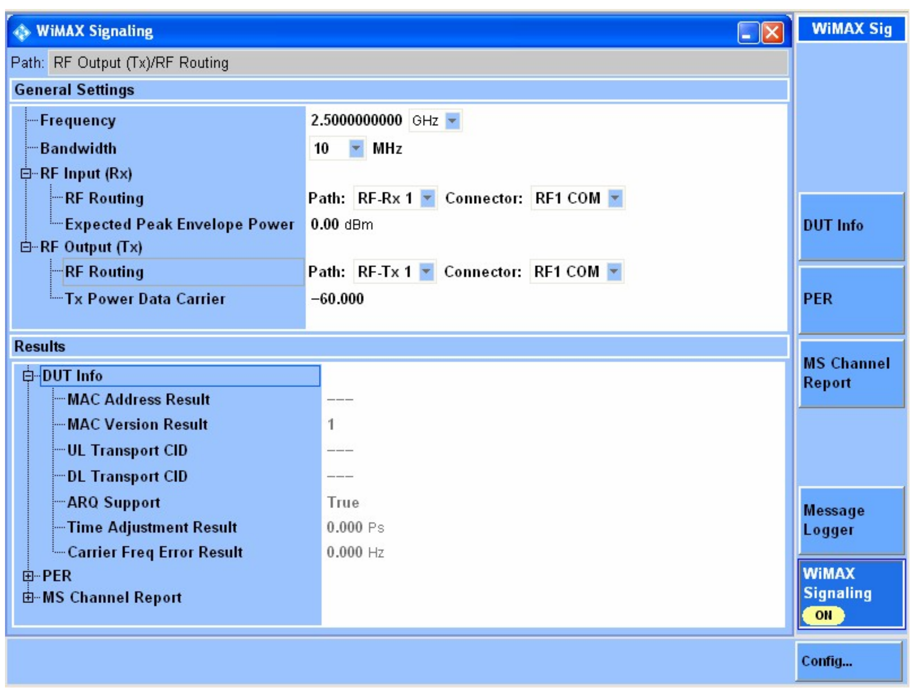

Fig. 8 – Operator interface of the R&S CMW-KS700 option for WiMAX signaling tests

Verification with signaling automatically works with all chipsets, as the communication is specified by the IEEE802.16e standard. As there's no special adaptation to the individual chipset necessary, this application note mainly discusses the non-signaling verification. Please ask your local Rohde & Schwarz representative for a signalling demonstration.

7 Measurement Report

CMWrun provides a Measurement Report for each Testplan. For the calibration it shows detailed information about measured and calculated values (according to [1]) which will be used in the calibration.cfg file. For the verification it shows the measured parameters in a table layout with limit checking.

Fig. 9 to Fig. 12 show some examples for the verification

Frequency = 2700000 kHz

Name *Condition*	Min	Max	Value	Unit	Status
RX0					
CINR @ *-40 dBm*	34		37.54	dB	Passed
CINR @ *-50 dBm*	34		37.66	dB	Passed
CINR @ *-70 dBm*	30		30.93	dB	Passed
CINR @ *-90 dBm*	12		12.04	dB	Passed
RSSI @ *-40 dBm*	-42.00	-38.00	-41.30	dBm	Passed
RSSI @ *-50 dBm*	-52.00	-48.00	-50.98	dBm	Passed
RSSI @ *-70 dBm*	-72.00	-68.00	-71.00	dBm	Passed
RSSI @ *-90 dBm*	-92.00	-88.00	-90.80	dBm	Passed

Fig. 9 - Report RX verification

Frequency = 2500000 kHz

Name *Condition*	Min	Max	Value	Unit	Status
Table					
PER *Level: -76 dBm , RSSI: -76.1 dBm*		1.00	0.00	%	Passed

Frequency = 2560000 kHz

Name *Condition*	Min	Max	Value	Unit	Status
Table					
PER *Level: -76 dBm , RSSI: -75.5 dBm*		1.00	0.00	%	Passed

Frequency = 2640000 kHz

Name *Condition*	Min	Max	Value	Unit	Status
Table					
PER *Level: -76 dBm , RSSI: -76.1 dBm*		1.00	0.00	%	Passed

Frequency = 2700000 kHz

Name *Condition*	Min	Max	Value	Unit	Status
Table					
PER *Level: -76 dBm , RSSI: -76.38 dBm*		1.00	0.00	%	Passed

Fig. 10 – Report RX verification: Sensitivity

Frequency = 2640000 kHz

Name *Condition*	Min	Max	Value	Unit	Status
Table					
Power Error @ *TxGain = 28, calc Power = 22.43*	-1.50	1.50	-0.39	dB	Passed

Frequency = 2700000 kHz

Name *Condition*	Min	Max	Value	Unit	Status
Table					
Power Error @ *TxGain = 28, calc Power = 22.55*	-1.50	1.50	-0.62	dB	Passed

Fig. 11 - Report TX absolute

Delta: 10

Name *Condition*	Min	Max	Value	Unit	Status
Table					
relative Error *-17*		2.00	0.09	dB	Passed
relative Error *-16*		2.00	0.11	dB	Passed
relative Error *-15*		2.00	0.14	dB	Passed
relative Error *-14*		2.00	0.20	dB	Passed
relative Error *-13*		2.00	0.21	dB	Passed
relative Error *-12*		2.00	0.36	dB	Passed
relative Error *-11*		2.00	0.30	dB	Passed
relative Error *-10*		2.00	0.41	dB	Passed
relative Error *-9*		2.00	0.44	dB	Passed
relative Error *-8*		2.00	0.41	dB	Passed
relative Error *-7*		2.00	0.40	dB	Passed
relative Error *-6*		2.00	0.48	dB	Passed
relative Error *-5*		2.00	0.41	dB	Passed
relative Error *-4*		2.00	0.33	dB	Passed
relative Error *-3*		2.00	0.31	dB	Passed
relative Error *-2*		2.00	0.21	dB	Passed
relative Error *-1*		2.00	0.17	dB	Passed
relative Error *0*		2.00	0.02	dB	Passed

Fig. 12 - Report relative TX (e.g. Delta = 10 dB)

8 Example: Testing Sequans SQN1130 + Maxim 2839 with CMW270

In cooperation with Sequans Rohde&Schwarz offers customized chipset test solutions for the Sequans SQN11xx WiMAX chipsets.

In the following we explain in detail the system settings for our test solution, the calibration and verification measurement and the approach for TX- and RX- measurements. This Application Note is focused on the CMW270. If support in testing the Sequans SQN1130 with the SMJ100A and the FSL is needed please contact your local Rohde & Schwarz Application or Sales Engineer.

CMW270
The all-in-one solution for IEEE 802.16e WiMAX mobile station testing:

- WiMAX mobile station testing in accordance with the IEEE 802.16e standard and the system profiles of the WiMAX Forum
- Non-signalling mode for time optimized RF Alignment
- Signal analyzer for transmitter measurements and versatile arbitrary waveform generator for receiver testing
- Base station emulation for RF verification with WiMAX real-time signalling
- RF generator and RF power meter for additional general-purpose measurement

9 Appendix

Literature

[1] Sequans Communications: Calibrating Maxim RFIC (S-Cube 4.4.0), Application Note, Revision 6, April 2008

[2] The IEEE 802.16 Working Group on Broadband Wireless Access Standards

http://www.ieee802.org/16

[3] Rohde & Schwarz: Application Note: 1MA96: WiMAX - General information about the standard 802.16

http://www.rohde-schwarz.com/appnote/1MA96

This application note is one of three papers dealing with the WiMAX standard, covering the theoretical aspects of WiMAX. It gives a detailed overview of the basic concepts of WiMAX (FFT, OFDM, frame structures, etc) and explains the physical standard parts of IEEE 802.16 standards 802.16-2004, corr1 and 802.16e.

[4] Rohde & Schwarz: Application Note: 1MA97: WiMAX - Generating and analyzing 802.16-2004 and 802.16e-2005 signals

http://www.rohde-schwarz.com/appnote/1MA97

This Application Note gives an introduction to measurements of WiMAX signals according to standards 80216-2004 and 802.16e-2005. It describes all kinds of signal generation from simple signals to multiple-zone signals, also under multipath environment (fading), and covers all signal measurements from power and spectrum analysis, crest factor and CCDF measurement down to bit pattern analysis and modulation measurements.

[5] Rohde & Schwarz: Application Note: 1EF57: WiMAX: 802.16-2004, 802.16e, WiBRO Introduction to WiMAX Measurements

http://www.rohde-schwarz.com/appnote/1EF57

The new WiMAX radio technology - worldwide interoperability for microwave access - is based on wireless transmission methods defined by the IEEE 802.16 standard. WiMAX has been developed to replace broadband cable networks such as DSL and to enable mobile broadband wireless access. Rohde & Schwarz offers a complete test solution for WiMAX applications by combining its Signal Generator R&S SMU200A and Signal Analyzer R&S FSQ plus the appropriate options.

RuS_WiMAX_OFDM is a 10 minutes video on WiMAX OFDM measurements.

Additional Information

This application note is updated from time to time. Please visit the website **1MA128** in order to download the latest versions.

Please send any comments or suggestions about this application note to **TM-Applications@rohde-schwarz.com**.

Ordering Information

WiMAX Communication Tester

R&S® CMW270	Base unit with following accessories: power cord, operating manual, documentation on CD ROM	1201.0002K75
R&S® CMW-B110A	Arbitrary waveform generator, H110A	1202.5508.02
R&S® CMW-B690A	Basic OCXO module, H690A	1202.5908.02
R&S® CMW-B690B	Highly stable OCXO module, H690B	1202.6004.02
R&S® CMW-B612A	IEEE bus interface module, H612A	1202.5608.02

CMWrun software

R&S® CMW-KT057 (1)	CMWrun WiMAX • Ready to use solution for R&S CMW270 mobile WiMAX signaling • Framework for non-signaling chipset calibration and verification applications. • Please contact your local Rohde & Schwarz representative for information on the individual chipset implementations (not part of delivery).	1203.4205.02

(1) Software licencing based on key code for instrument R&S® CMW270 or based on flexible external USB smart card reader. For licensing using a external hardware dongle please order the smart card reader R&S® CMWPC .

R&S® CMWPC	CMWPC smartcard for CMWPC	1201.0002K50

Vector Signal Generator

R&S® SMU200A		1141.2005.02
R&S® SMU-B10	Baseband with ARB (64 Msamples)	1141.7007.02
R&S® SMU-B13	Baseband Main Module	1141.8003.02
R&S® SMU-K49	Software: 802.16	1161.0366.02
R&S® SMJ100A		1403.4507.02
R&S® SMJ-B10	Baseband with ARB (64 Msamples)	1403.8902.02

Signal analyzer, spectrum analyzer, and options

R&S® FSQ3	20 Hz to 3.6 GHz	1155.5001.03
R&S® FSQ8	20 Hz to 8 GHz	1155.5001.08
R&S® FSQ26	20 Hz to 26.5 GHz	1155.5001.26
R&S® FSL3	9 kHz to 3 GHz	1300.2502.03
R&S® FSL6	9 kHz to 6 GHz	1300.2502.06
R&S®FS-K93	Software 802.16	1302.0736.02

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