

R&S[®]CMW-Z11 and R&S[®]CMU200

Determining the Path Loss

Application Sheet

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The following abbreviations are used throughout this guide: R&S® CMW is abbreviated as R&S CMW. The Accessories R&S® CMW-Zxx are abbreviated as R&S CMW-Zxx. R&S® CMU200 is abbreviated as R&S CMU200.

1 Path Loss Measurement

This application sheet describes how to determine the path loss for devices (e.g. mobile phones) tested in a Universal RF Shielding Box CMW-Z10 using a Universal Radio Communication Tester R&S CMU200.

RF signals are attenuated on their way from the equipment under test (EUT) to the test instrument and back. The total path loss in either direction includes the contribution of the range path loss PL_r due to the distance r between the EUT and the test antenna of the Universal RF Shielding Box (including its connection to the RF ANT connector), the loss PL_A introduced by the antenna, and any loss PL_{ex} in the signal path between RF ANT and the input/output connector of the test instrument. All these contributions may depend on the signal direction.

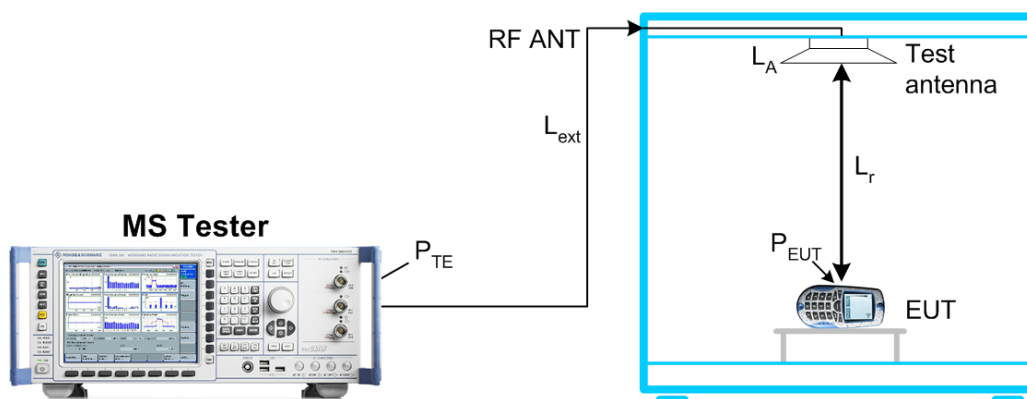


Fig. 1-1: Path loss

We define the total path loss for the two signal directions as the difference between transmitted and received powers:

- $Input\ path\ loss/dB = P_{EUT, out} - P_{TE, in}$
 $= \langle EUT\ output\ power \rangle / dBm - \langle RF\ input\ power\ at\ tester \rangle / dBm$
- $Output\ path\ loss/dB = P_{TE, out} - P_{EUT, in}$
 $= \langle Generator\ level\ of\ tester \rangle / dBm - \langle Received\ signal\ level\ at\ the\ EUT \rangle / dBm$

Once the path loss values are known for a given EUT type, position, and RF connection they can be reported to the test instrument as external attenuation factors ("External Attenuation (Input)", "External Attenuation (Output)"). The tester will then correct all power measurements by the reported input path loss and increase its RF generator level to compensate for the output path loss.

In the definitions above the sign of the input and output path loss is in accordance with the definition of external input and output attenuation factors ("Ext. Att. Input", "Ext. Att. Output") in the R&S CMW and R&S CMU200.



Path loss and EUT type, EUT position

The path loss values depend on the EUT type. Results for a particular EUT (e.g. a mobile phone) type should be determined using a fully functional and proven device ("golden" device); they may then be applied to all EUTs of the same type.

If the EUT is placed on the table inside the Universal RF Shielding Box, the RF field of the test antenna is circularly polarized and sufficiently homogeneous so that measurement results do not much depend on the exact position and orientation of the EUT antenna. Consequently, the path loss measurement procedure described in this chapter is sufficient for basic receiver and transmitter tests.

For over-the-air (OTA) performance tests, a more elaborate "reference path loss" measurement is required to remove the test system's influence from radiated power and sensitivity results; see application sheet 1ZKD-20.

1.1 Required Equipment

The coupling factors can be measured with the following equipment:

- Universal RF Shielding Box CMW-Z10 (with integrated test antenna and RF cable)
- Fully functional and proven EUT (mobile phone)
- Universal Radio Communication Tester R&S CMU200 with software options R&S CMU-K20/.../K26 (for GSM) or R&S CMU-K65/.../K69 (for WCDMA).

1.2 Input Path Loss

If an external input attenuation is reported to the test instrument, all EUT power readings are increased. The tester shows the actual EUT transmitter output power which is higher than the level at its input connectors.

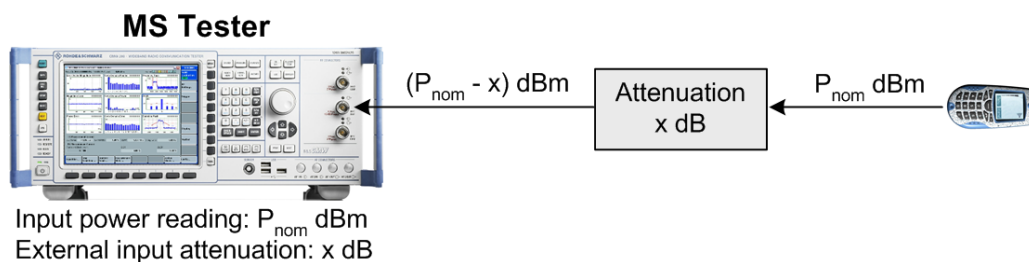


Fig. 1-2: Definition of input path loss

1.3 Output Path Loss

If an external output attenuation is reported to the test instrument, the generator power is increased relative to the nominal generator power setting. The actual signal power at

the input of the EUT, after attenuation by the test setup, is equal to the nominal generator power.

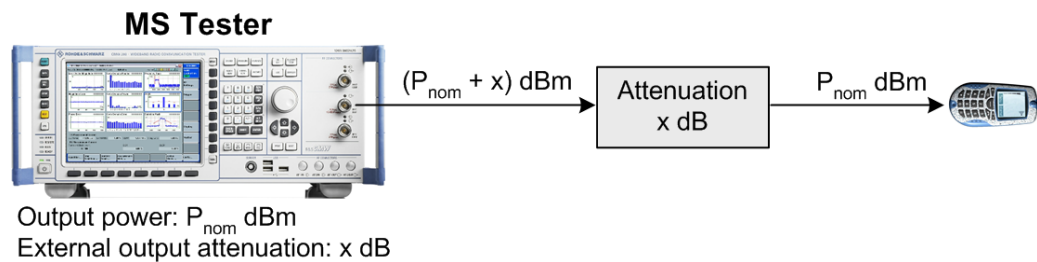


Fig. 1-3: Definition of output path loss

1.4 Determining Path Loss Values: R&S CMU200

External input and output attenuation factors are reported in the "RF IN/OUT" tab of the "Connection Control" dialog, which is provided for all network tests. The procedure for determining the path loss is analogous for all networks. The following examples show the necessary steps for a GSM mobile phone and a WCDMA UE.

1.4.1 Preparatives (GSM or WCDMA)

1. Connect the N connector of your Universal RF Shielding Box CMW-Z10 to the bidirectional RF connector RF 2 of the R&S CMU200, preferably using the high-quality RF cable supplied with the Universal RF Shielding Box.
2. Place a fully functional and proven MS on the EUT table.
3. Switch on the R&S CMU200 and the MS.

1.4.2 GSM Path Loss

1. For a GSM MS, access the GSMxxx-MS function group (where xxx corresponds to the GSM band of your MS), "Signaling" test mode, to establish a call between the R&S CMU200 and the MS, setting the MS to a definite Power Control Level (PCL). A PCL 15 for a GSM900 mobile phone corresponds to a nominal transmitter output power of 13 dBm. For more information refer to your operating manual for the GSMxxx-MS software options (R&S CMU-K20/-K21/-K22/-K23/-K24...), stock no. 1115.6088.12.
2. Open the "Overview" dialog to display all measurement results that are relevant for determining the path loss values.

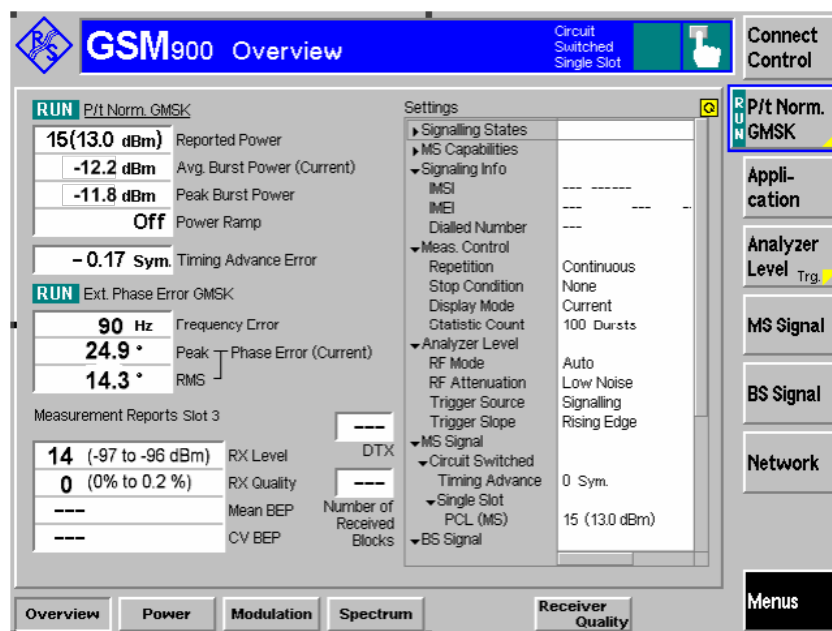


Fig. 1-4: GSM900 Signaling: Overview dialog

- To determine the output path loss of your mobile phone, subtract the reported "RX Level" at the MS from the output level of the R&S CMU ("BS Signal – TCH Level – Used TS"). In the example above, assuming a "Used TS" level of –70 dBm, the output path loss equals to $(-70.0 - (-96.5))$ dB = 26.5 dB.
- To determine the input path loss of your mobile phone, subtract the measured "Avg. Burst Power (Current)" from the "Reported Power" of the MS. In the example above, the input path loss equals to $(13.0 - (-12.2))$ dB = 25.2 dB.
- Press the "Connect. Control" softkey and the "RF IN/OUT" hotkey to report the path loss values to the R&S CMU200. Set the "Ext. Att. Output" equal to the output path loss and the "Ext. Att. Input" equal to the input path loss (see [GSM900 Signaling: RF IN/OUT tab](#)).

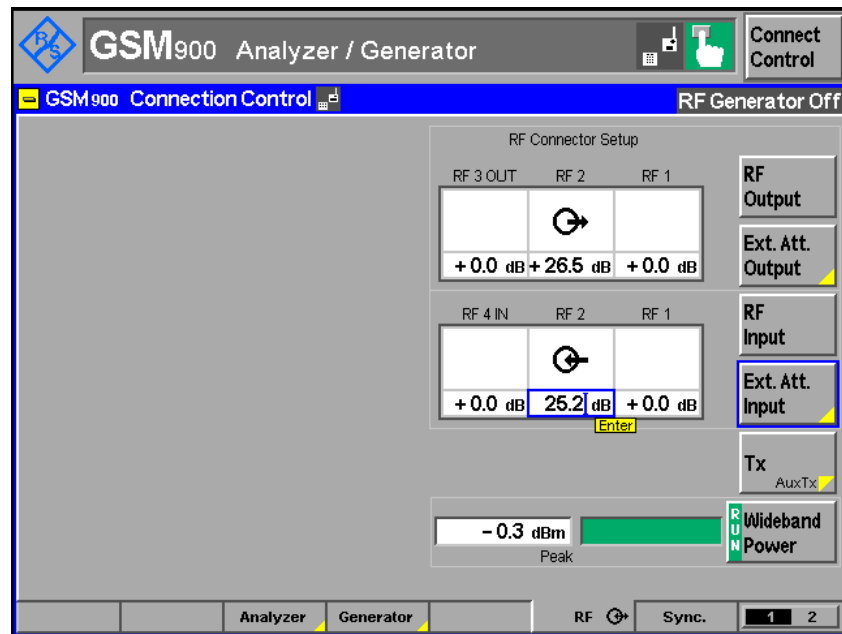


Fig. 1-5: GSM900 Signaling: RF IN/OUT tab

1.4.3 WCDMA Path Loss

1. For a WCDMA UE, access the "WCDMA UE" function group, "Signaling" test mode, to establish a call between the R&S CMU200 and the UE. Note the power class (1 to 4) of your UE, which is displayed in the "Connection" tab of the "Connection Control" dialog.
2. Open the "Receiver Quality" measurement dialog and select "Application – UE Report".

The UE reports various parameters characterizing the quality of the radio link, in particular the "CPICH RSCP" (Received Signal Code Power) of the current cell.

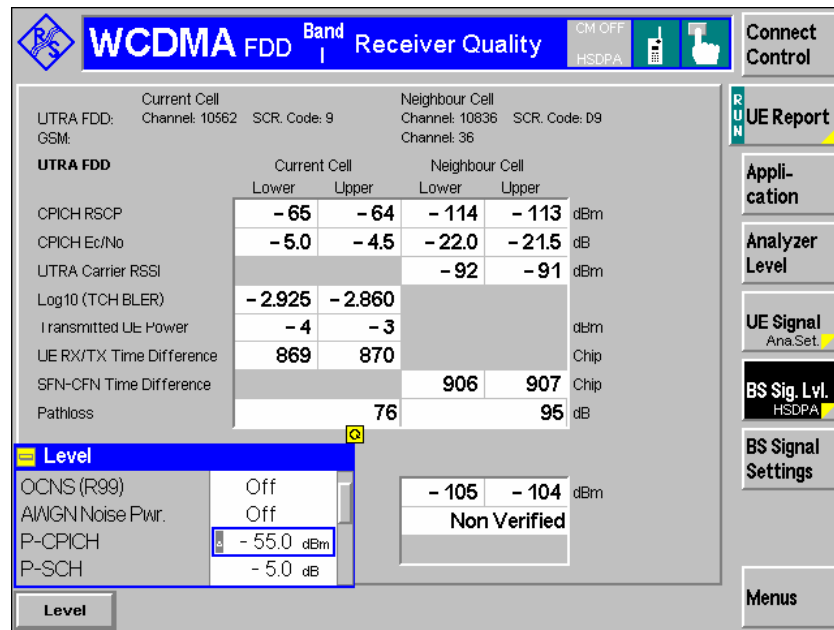


Fig. 1-6: WCDMA Signaling: UE Report dialog

- To determine the output path loss of your mobile phone, subtract the reported "CPICH RSCP" of the current cell from the P-CPICH output level of the R&S CMU ("BS Signal Lvl. – Level – P-CPICH"). In the example above, the output path loss equals to $(64.5 - 55.0) \text{ dB} = 9.5 \text{ dB}$.
- Open the "Power" measurement dialog and select "Application – Maximum Power" to command the UE to transmit at its maximum power.

The maximum UE transmitter output power depends on the UE power class; it is +33 dBm for power class 1, +27 dBm for power class 2, +24 dBm for power class 3, and +21 dBm for power class 4 UEs.

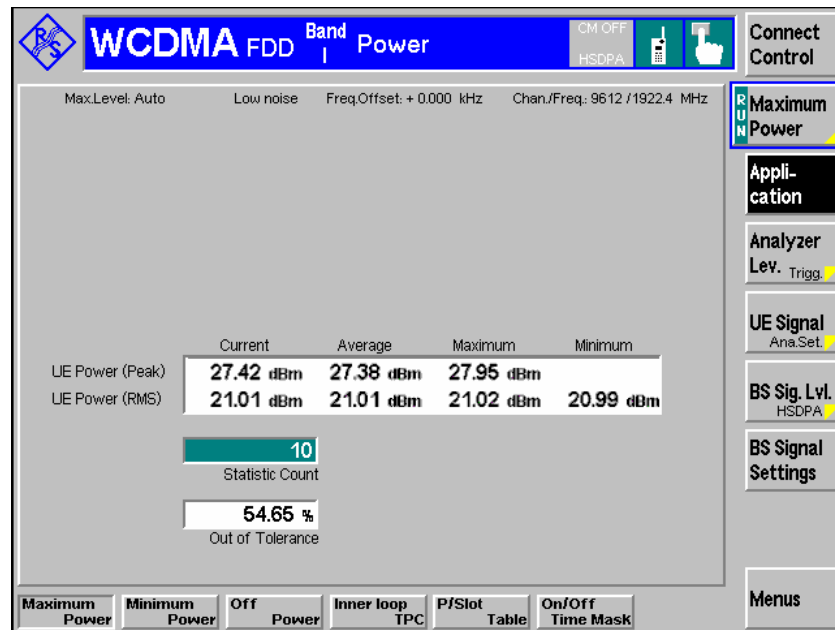


Fig. 1-7: WCDMA Signaling: Maximum Power dialog

- To determine the input path loss of your UE, subtract the measured "UE Power (RMS)" (preferably, the "Average" value) from the nominal maximum UE transmitter output power. In the example above, assuming a power class 3 UE, the input path loss equals to approx. $(24 - 21)$ dB = 3 dB.
- Press the "Connect. Control" softkey and the "AF/RF IN/OUT" hotkey to report the path loss values to the R&S CMU200. Set the "Ext. Att. Output" equal to the output path loss and the "Ext. Att. Input" equal to the input path loss.

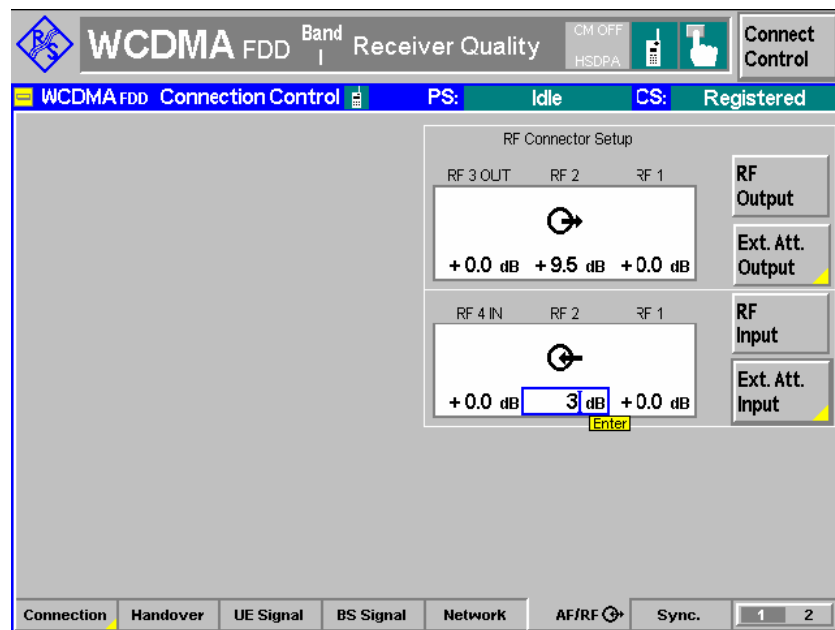


Fig. 1-8: WCDMA Signaling: AF/RF IN/OUT tab

1.5 Additional Information

A separate application sheet describes how to determine input and output path loss values using a Wideband Radio Communication Tester R&S CMW.

The Universal RF Shielding Box CMW-Z10 and its accessories are described in the operating manual, stock no. 1204.7095.12.