

# R&S® DST200

## RF Diagnostic Chamber

### User Manual



1515.1421.02 – 05

This manual describes the RF Diagnostic Chamber R&S®DST200, order number 1510.9047.02, including the following options and accessories:

- "Filter Panel, LP & FO", R&S®DST-B101, order number 1514.7778.02
- "Interface Panel, RF", R&S®DST-B102, order number 1514.7784.02
- "Filter Panel, USB 2.0", R&S®DST-B103, order number 1514.7990.02
- "Filter Panel, 100 V to 240 V, AC", R&S®DST-B104, order number 1516.8407.02
- "Positioner for Calibration Antennas", R&S®DST-B120, order number 1516.8659.02
- "Elevated EUT Table", R&S®DST-B130, order number 1515.1467.02
- "Manual 3D Positioner", R&S®DST-B150, order number 1515.1480.02
- "Automated 3D Positioner", R&S®DST-B160, order number 1516.8007.02
- "Large Automated 3D Positioner", R&S®DST-B165, order number 1519.3506.02
- "Cross-Polarized Vivaldi Test Antenna", R&S®DST-B215, order number 1527.3576.02
- "Circular-Polarized Test Antenna", R&S®DST-B220, order number 1518.4509.02
- "Test Antenna Kit", R&S®DST-B231, order number 1518.5328.02
- "Linear-Polarized Communication Antenna", R&S®DST-B270, order number 1518.4515.02
- "2 Communication Antennas + 1 Power Splitter", R&S®DST-B272, order number 1518.4609.02
- "Shipping Container", R&S®DST-Z5, order number 1518.9530.02
- "RF Cable 18 GHz, 1.5 m", R&S®DST-Z18, order number 1515.1473.02
- "EUT Holder for R&S®DST-B160", R&S®DST-Z160, order number 1518.5205.02
- "EUT Holder for R&S®DST-B165", R&S®DST-Z165, order number 1519.3941.02
- "Upgrade Kit for R&S®DST-B160", R&S®DST-U165, order number 1519.3935.02
- "Over-the-Air (OTA) Performance Measurement Software", R&S®AMS32, order number 1508.6650.02
- "EMC Measurement Software", R&S®EMC32-EB, order number 1300.7010.02

The front door of the RF Diagnostic Chamber is available with either left-hand mounting (selection R&S®DST-S100A, order number 1515.1396.02) or right-hand mounting (selection R&S®DST-S100B, order number 1515.1396.03).

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The following abbreviations are used throughout this manual: R&S®DST200 is abbreviated as R&S DST200, options R&S®DST-Bxxx as R&S DST-Bxxx and options R&S®DST-Zxxx as R&S DST-Zxxx. The instruments R&S®CMWxxx and R&S®CMU200 are abbreviated as R&S CMWxxx and R&S CMU200; R&S®TS8991, R&S®EMC32 and R&S®AMS32 as R&S TS8991, R&S EMC32 and R&S AMS32, respectively.

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# 1 Documentation Overview

The documentation of the R&S DST200 RF Diagnostic Chamber consists of several documents that are available for download off the product homepage (<http://www2.rohde-schwarz.com/product/DST200.html>).

## **R&S DST200 User Manual**

The User Manual contains a comprehensive description of the functionality of the RF Diagnostic Chamber and all its hardware options.

It is delivered as a printed document with the R&S DST200 and also available on the internet as a pdf document. For the latest version of the User Manual, visit the product homepage.

## **R&S DST200 Application Sheets**

Application sheets contain a particular aspect of the R&S DST200 functionality and shows a typical application example.

Application sheets are available on the internet as pdf documents.

## **Additional documents**

The product homepage also provides additional documents that are referenced in this User Manual, for example the RF Parameter Tables required to perform the reference path loss measurement.

## 2 Safety Instructions

This R&S DST200 RF Diagnostic Chamber has been designed and tested in accordance with the EC Certificate of Conformity and has left the manufacturer's plant in a condition fully complying with safety standards.

---

### **CAUTION**

#### General safety instructions

To maintain this condition and to ensure safe operation, you must observe all instructions and warnings given in this manual. Please notice in particular the instructions below on this page.

---

1. In order to comply with local EMC regulations, it may be necessary in some places to have the front door closed when using the RF Diagnostic Chamber. It is the user's responsibility to ensure that the chamber is used in compliance with local regulations.
2. The RF Diagnostic Chamber must be stabilized, either by means of four screws through the feet or by the balancing weight in the slot at the back. Otherwise it may tilt forward when the front door is opened.
3. In view of its weight, at least two persons are required to carry the RF Diagnostic Chamber. The front door must be closed and the locking handle must be fastened in CLOSED position whenever the RF Diagnostic Chamber is carried or shipped. Use a cable tie or Velcro® strip to fix the locking handle to the carrying handle on the left side of the chamber.
4. The metallic EMI/EMC shielding gaskets around the joint of the front door are expendable parts that must be regularly cleaned and need to be exchanged if they are visibly corroded or damaged; see [Chapter 6, "Maintenance"](#), on page 61.
5. When mounting a connector module (one of the feed throughs R&S DST-B101, DST-B102, R&S DST-B103), ensure that the contact surfaces are clean and the EMI/EMC shielding gaskets are in correct position.
6. When leaving the RF Diagnostic Chamber in a storage room that can be accessed by small children or when disposing of the chamber, always remove the locking handle to ensure that the chamber can be opened from inside.
7. Do not apply more than 50 W power to the diagnostic chamber over a period of more than 1 hour when it is closed.

Please also read [Chapter 3, "RF Diagnostic Chamber Features"](#), on page 7 for more detailed information about safety-related issues.

## 3 RF Diagnostic Chamber Features

The RF Diagnostic Chamber R&S DST200 is a fully enclosed, RF-shielded anechoic chamber for interference-free and reflection-free tests of mobile phones (MS) and other devices with radio interfaces. R&S DST200 is particularly suited for over-the-air (OTA) performance tests and receiver sensitivity degradation (desense) tests in line with the CTIA, CWG and PTCRB standards. Automated measurements may be performed in combination with the R&S TS8991 OTA Performance Test System and the R&S AMS32 OTA software.

The chamber is also appropriate for general receiver and transmitter tests using a radio communication tester, e.g. a wideband radio communication tester of the R&S CMW family or a Universal Radio Communication Tester R&S CMU200.

You can equip the R&S DST200 with one or more antennas of various types. The antennas are available as hardware options.

- R&S DST-B215 (Cross-polarized Test Antenna)
- R&S DST-B220 (Circular-polarized Test Antenna)
- R&S DST-B231 (Test Antenna Kit)
- R&S DST-B270 and -B272 (Linear-polarized Communication Antenna)

Using an antenna is necessary for transmission of RF signals between the equipment under test (EUT) and the test instruments. For more information see [Chapter 3.4, "Antennas for the R&S DST200"](#), on page 26.

The EUT is placed on a positioning device inside the chamber. Delivered with the base unit is an EUT table. In addition, various other positioning devices are available as hardware options.

- R&S DST-B130 (Elevated EUT Table)
- R&S DST-B150 (Manual 3D Positioner)
- R&S DST-B160 and -B165 (Automated 3D Positioner)

Due to the absorbing walls of the chamber and the distance between the test antenna and the positioning device, measurements can be performed under free-space conditions. On its right wall, below the top cover, the chamber provides one or more RF connectors for the RF connection of the antenna to the test instruments.

You can equip the R&S DST200 with several options and accessories to connect data, power and RF cables.

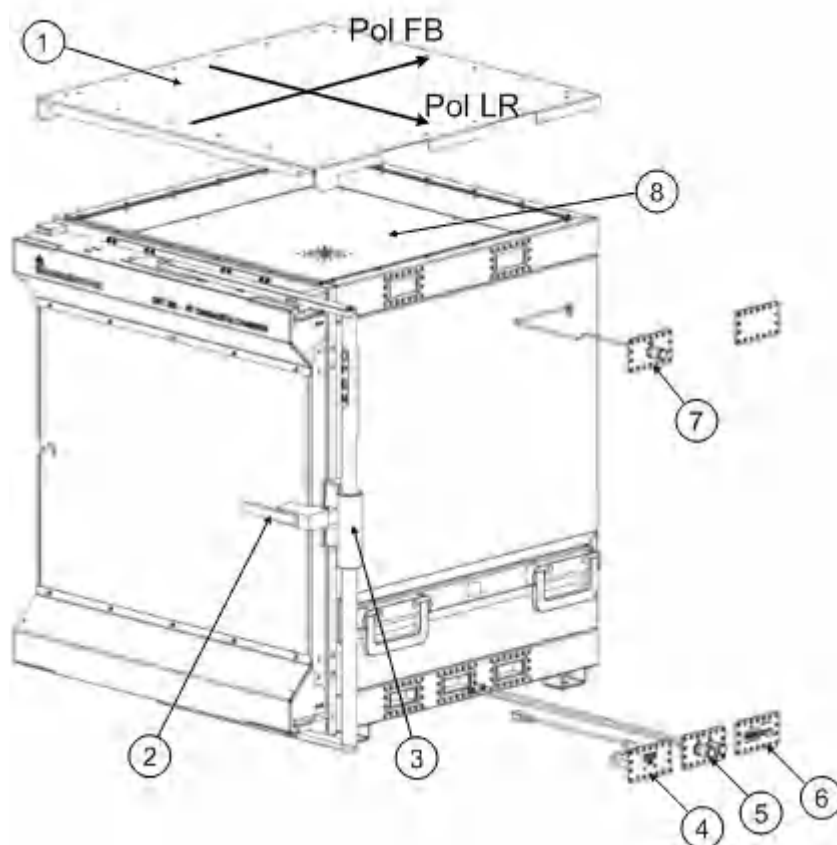
- R&S DST-B101 (Filter Panel LP & FO)
- R&S DST-B102 (Interface Panel RF)
- R&S DST-B103 (Filter Panel USB 2.0)
- R&S DST-B104 (Filter Panel 100 V to 240 V AC)
- R&S DST-Z18 (RF Cable 18 GHz, 1.5 m)

The panels are mounted at the positions shown in figure [Figure 3-1](#). For more information see [Chapter 3.2.5, "Mounting Filter and Interface Panels"](#), on page 18.

The present manual describes the positioning and use of the chamber, the installation of hardware options, and the functional check. The technical specifications of the RF Diagnostic Chamber are listed in the data sheet PD 5214.3600.22.

### 3.1 RF Diagnostic Chamber

The RF Diagnostic Chamber consists of several (re-)movable parts, including the options mentioned above.



**Figure 3-1: RF Diagnostic Chamber with accessories**

- 1 = top cover
  - 2 = door latch
  - 3 = locking handle
  - 4 = filter panel, USB 2.0 (R&S DST-B103)
  - 5 = interface panel, 2xN / 2xRF (R&S DST-B102)
  - 6 = filter panel, D-Sub 9 / fibre optic (R&S DST-B101)
  - 7 = RF ANT connector (R&S DST-B220 and -B231)
  - 8 = upper compartment (mounting of test antenna)
- FB = Polarization Front-Back  
LR = Polarization Left-Right



### 3.1.1 Positioning the RF Diagnostic Chamber

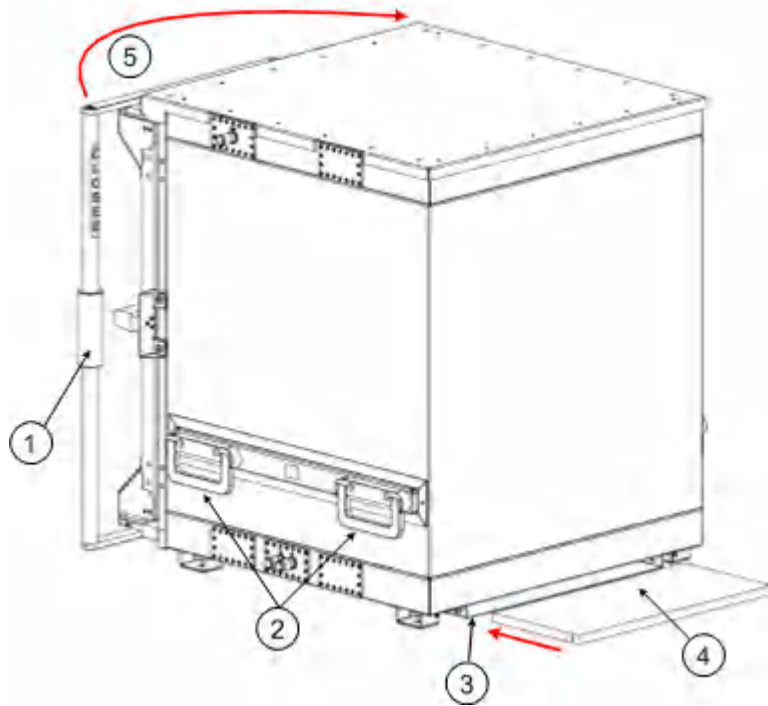
The RF Diagnostic Chamber is intended for operation on a flat, stable surface. Apply one of the following methods to ensure a stable position:

- Screw the four feet of the chamber to the surface.
- Ensure that the balancing weight is in the slot at the back of the chamber and affixed by the two screws on either side. For more information see [Figure 3-2](#).

#### **CAUTION**

##### **Risk of injury**

If the RF Diagnostic Chamber is not properly stabilized as described above, it may tilt forward when the front door is opened.



**Figure 3-2: Position of balancing weight**

- 1 = locking handle
- 2 = carrying handles
- 3 = balancing weight slot
- 4 = balancing weight
- 5 = turn handle to lock door

In view of its weight (see data sheet), at least two persons are required to carry the RF Diagnostic Chamber using the four handles on both side walls. If you wish to remove the balancing weight for easier transport, open the two screws on either side and remove it from the slot.

Never use the locking handle to carry the R&S DST200 RF Diagnostic Chamber.

**NOTICE****Protecting R&S DST200 during transportation**

For best protection against damage of R&S DST200 during transportation a shipping container (accessory R&S DST-Z5, stock number 1518.9530.02) can be ordered from Rohde & Schwarz. The multiple-use container provides a solid shell to encapsulate the whole R&S DST200.

### 3.1.2 Opening and Closing the Front Door

The RF Diagnostic Chamber is accessible by the front door. A U-shaped joint around the front side of the chamber accommodates metallic EMI/EMC shielding gaskets which ensure a good, continuous electrical contact. The 2-stage opening and closing mechanism of the door ensures a planar movement into the U-shaped joint. This protects the shielding gaskets from mechanical damage and increases their lifetime. It also provides a self-cleaning effect so that the shielding effectiveness is maintained even after a long time of use.

The RF Diagnostic Chamber is available with either left-hand front door mounting (selection R&S DST-S100A, order no. 1515.1396.02) or right-hand mounting (selection R&S DST-S100B, order no. 1515.1396.03). The two selections are symmetric to each other; [Figure 3-2](#) shows a door with a left-hand mounting (hinges on the left side).

To open the front door,

1. Make sure that the RF Diagnostic Chamber is properly stabilized as described in [Chapter 3.1.1, "Positioning the RF Diagnostic Chamber"](#), on page 9.
2. Turn the locking handle to the OPEN position as shown in [Figure 3-1](#).
3. Pull the door latch in forward direction to release the closing mechanism.

To close the door,

1. Push the wing of the door against the front side of the chamber **until the latch is closed**.
2. Push the locking handle towards the CLOSED direction.

**CAUTION****Risk of damage or injury**

For safety reasons, the door also opens while the door latch is closed and the handle is in the OPEN position. It remains locked as long as the handle is CLOSED. Read the general [Safety Instructions](#) when shipping the chamber or when disposing of the chamber.

### 3.1.3 Replacing the Shielding Gaskets

The EMI/EMC shielding gaskets in the U-shaped joint around the front side of the chamber and the contact strips of the connector units and antenna are expendable parts which must be replaced if they are visibly corroded or damaged. It is recommended to use a plastic screwdriver for this purpose to avoid scratching the groove and the walls of the RF Diagnostic Chamber.

#### Replacing the gaskets at the front side

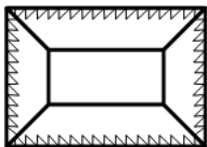
The U-shaped joint at the front side contains a band of clip-on gaskets. To replace the gaskets,

1. Carefully lift the clip-on gaskets from the groove starting at the corners.
2. Clean the empty groove using a soft cloth soaked in ethyl alcohol (see also [Chapter 6, "Maintenance"](#), on page 61).
3. Cut the clip-on gaskets to cover the whole length of the groove.
4. Exercise care when placing the clip-on gaskets in position, as bent fingers will deteriorate the shielding effectiveness.

#### Replacing the contact strips

The connector units and the antenna are shielded by four self-adhesive metal contact strips. After removing the connector unit,

1. Remove the old gaskets using a plastic screwdriver.
2. Clean the contact surface below the gaskets using a soft cloth soaked in ethyl alcohol (see also [Chapter 6, "Maintenance"](#), on page 61).
3. Place the new gaskets in position, with the teeth towards the rectangular opening as shown below.



New EMI/EMC gaskets are available as expendable parts. For more information see [Chapter 6.1, "Spare Parts"](#), on page 61 and [Chapter 6, "Maintenance"](#), on page 61.

### 3.1.4 Accessing the Upper Compartment

The upper compartment accommodate the connecting RF cable between the antenna connector(s) at the top of the right-hand wall and the test antenna. An additional connector module can be mounted at the second upper connector port. Moreover, it is possible to place additional circuitry (e.g. an amplifier) into the upper compartment. The antenna and the antenna cable(s) are available as expendable parts (see [Chap-](#)

ter 6.1, "Spare Parts", on page 61), however, there is no need to access or remove the test antenna for normal use of the RF Diagnostic Chamber.

### NOTICE

#### Shielding effectiveness

Always use optimally shielded RF cables inside the upper compartment. Semi-rigid cables are recommended.

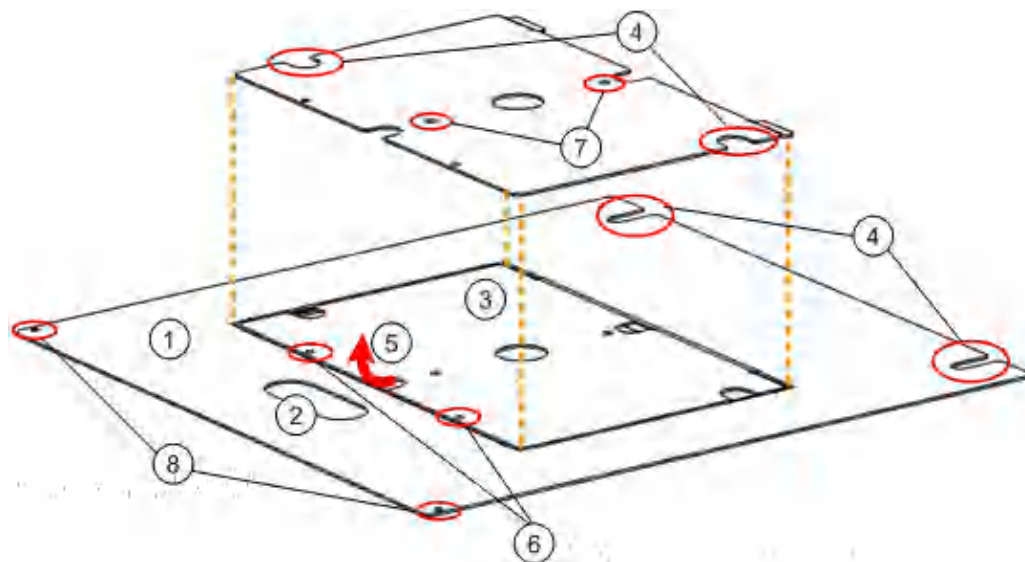
It is possible to use the RF Diagnostic Chamber with an open cover plate. The shielding effectiveness specified in the data sheet applies to a closed upper compartment.

To access the upper compartment, remove all screws at the top side and lift the cover.

### 3.1.5 Accessing the Lower Compartment

The lower compartment provides room for cables from the EUT to additional connector modules, including possible converters.

The lower compartment is covered by a metal plate that serves as the floor panel of the chamber. The panel consists of a frame and a removable centerpiece and is covered by three pieces of absorber material. The frame of the floor panel has two notches in the back to guide cables from the test space to the lower compartment. It also has a grip hole in the front for easy removal.



**Figure 3-3: Floor panel of the R&S DST200**

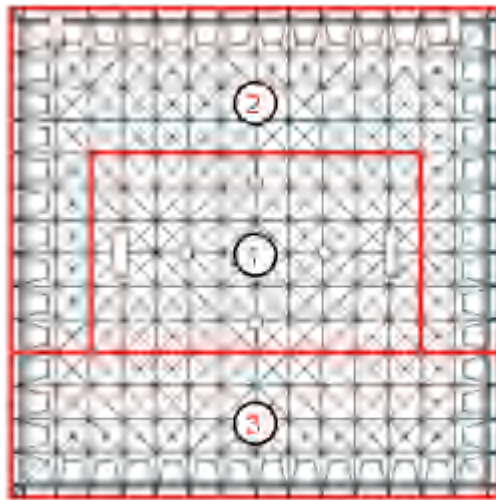
- 1 = Floor panel
- 2 = Grip hole
- 3 = Centerpiece
- 4 = Notches for guiding cables
- 5 = Lift the mounting plate and pull it out

- 6 = Screw to fixate the centerpiece
- 7 = Holes for mounting the positioning equipment
- 8 = Screw to fixate floor panel

Basically, it is sufficient to remove the centerpiece of the floor panel to access the lower compartment. However, it is also possible to remove the complete floor panel.

To remove the centerpiece and access the lower compartment,

1. Open the front door completely.  
For more information see [Chapter 3.1.2, "Opening and Closing the Front Door"](#), on page 10.
2. Remove the absorbers bottom C and A.



**Figure 3-4: Floor plan of the bottom absorbers**

- 1 = Absorber bottom A
- 2 = Absorber bottom B
- 3 = Absorber bottom C

3. Remove the positioning device if one is installed.
4. Unscrew the screws on either side of the centerpiece.
5. Lift the floor panel centerpiece until the hinges at the back become loose.
6. Pull out the centerpiece without damaging the EMI/EMC shielding gaskets around the joint of the door.

If necessary, you can also remove the extra absorber panel.

Proceed in reverse order to close the lower compartment and make the chamber ready for use.



### Removing the whole floor panel

Alternatively, you can also remove the whole floor panel. Instead of unscrewing and removing the centerpiece, remove the floor absorbers, unscrew the floor panel and pull it out with the grip located at the front of the floor panel.

If you do so, make sure not to damage any parts of the chamber door.

## NOTICE

### Position of the positioning device

The four feet of the positioning devices establish a firm connection to the base plate. To ensure that the table remains at a stable position relative to the chamber and the test antenna, always affix the base plate using the two screws.

The positioning devices and absorbers panels are available as expendable parts (see [Chapter 6.1, "Spare Parts"](#), on page 61).

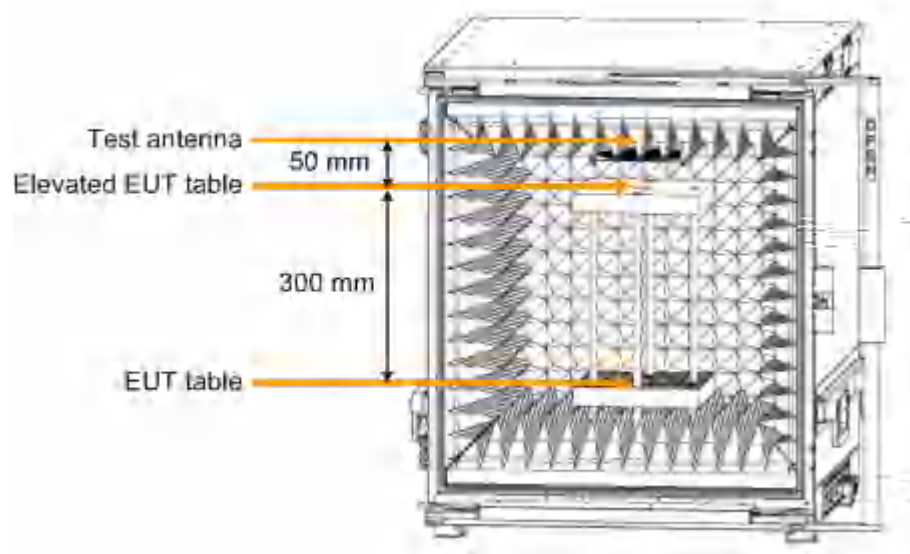
## 3.1.6 Installing the EUT and Connecting the Test Equipment

The purpose of the EUT table inside the RF Diagnostic Chamber is to hold EUTs in the zone far away from the antenna, where an EUT is placed outside the reactive near-field region of an antenna and the RF field is approximately homogeneous. Due to these field characteristics, EUT testing provides reproducible results. To perform measurements at a specific EUT orientation, use one of the 3D positioners described in [Chapter 3.3, "3D Positioners for the R&S DST200"](#), on page 19.

### Elevated EUT table

The Elevated EUT Table (option R&S DST-B130) is used to place the EUT to a position close to the test antenna below the cover of the RF Diagnostic Chamber. This reduces the path loss between the test antenna and EUT, at the expense of field uniformity. In this case the test antenna is located in the reactive near-field region of the EUT enabling RF detection of its EMI sources. For examples of the electric field strength radiated by the test antenna within the chamber refer to the R&S DST200 product brochure, no. PD 5214.3600.12.

The Elevated EUT Table is mounted **on top** of the EUT table (supplied with every chamber) as shown below.



**Figure 3-5: Mounting the elevated EUT table**

The center point of the elevated EUT table is 300 mm above the center of the EUT table. Its distance from the test antenna is approximately 50 mm.

#### **Radiated connection to the test equipment**

The outer antenna connectors on the right wall of the R&S DST200 RF Diagnostic Chamber can be connected to the RF connectors of the test equipment (e.g. R&S CMW500, RF1 COM connector). No additional cable is needed, since the antenna will ensure the internal RF connection to the EUT.

### **NOTICE**

#### **RF connection**

The RF transmissions and the path loss depend on the RF connection between the antenna connector and the RF input/output of the test instrument. To limit RF emissions, it is recommended to use the high-quality RF cable supplied with the RF Diagnostic Chamber.

For best results, especially at frequencies above 3 GHz, an optimized cable (accessory R&S DST-Z18, stock number 1515.1473.02) can be ordered from Rohde & Schwarz.

In addition, you can also use optional connections. For more information see [Chapter 3.2, "Interfaces and Filter Panels for the R&S DST200"](#), on page 15.

## **3.2 Interfaces and Filter Panels for the R&S DST200**

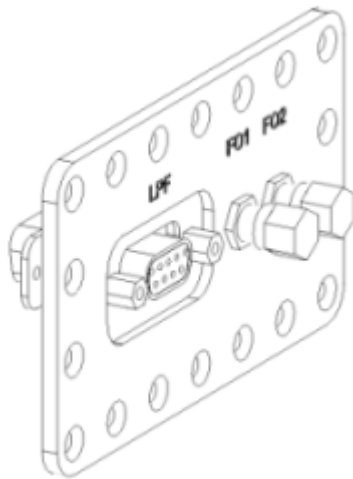
You can equip the R&S DST200 with various interfaces and filter panels.

- [Chapter 3.2.1, "LP&FO Filter Panel \(R&S DST-B101\)"](#), on page 16

- Chapter 3.2.2, "RF Interface Panel (R&S DST-B102)", on page 16
- Chapter 3.2.3, "USB Filter Panel (R&S DST-B103)", on page 17
- Chapter 3.2.4, "Power Interface Panel (R&S DST-B104)", on page 18
- R&S DST200-Z18: The "RF Cable 18 GHz, 1.5 m" is an RF cable with a high shielding effectiveness.  
For more information see "[RF connection](#)" on page 15.

### 3.2.1 LP&FO Filter Panel (R&S DST-B101)

The LP & FO filter panel (R&S DST-B101) provides an additional 9-pin D-Sub connector with integrated low-pass filter and a 2x FSMA fibre optic interface for the DC supply and the AF or data signals of the EUT.



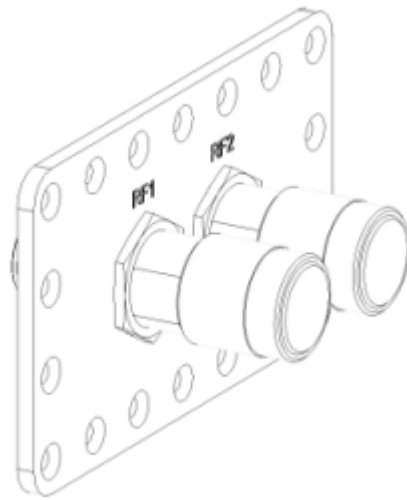
An integrated low-pass filter ensures high shielding effectiveness of the D-Sub connector. The FSMA connectors are particularly suited for connections with high data rates; a typical example is a LAN connection to the EUT. A LAN to fibre optic converter is placed outside the RF Diagnostic Chamber, a second converter for the connection of the EUT may be placed inside the lower compartment.

The filter panel is required to provide shielded interface for power supply and control cabling of the automated 3D positioners (R&S DST-B160 and -B165).

### 3.2.2 RF Interface Panel (R&S DST-B102)

The RF interface panel provides two additional RF connectors (type N) for tests with several RF signals.



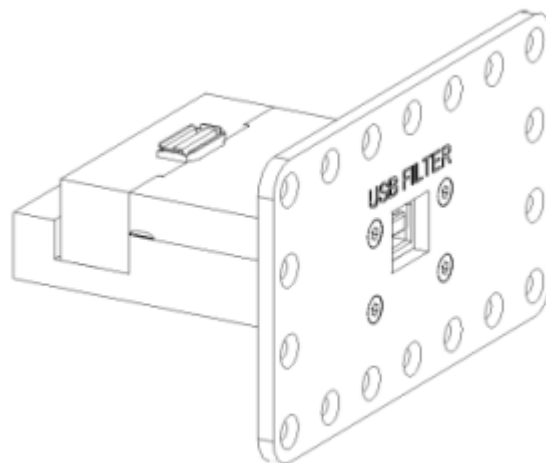


Together with antenna connectors, the RF interface panel allows you to supply the EUT with up to four independent RF signals. An additional RF feed through is also suited for connecting a reference antenna.

The filter panel is required to provide shielded RF connection of the R&S DST-B270 linear-polarized communication antenna to test equipment.

### 3.2.3 USB Filter Panel (R&S DST-B103)

The USB filter panel provides an additional USB 2.0 data connection. An integrated low-pass filter ensures high shielding effectiveness of the USB connector. Use shielded USB cables according to standard USB 2.0 to establish the connection to the EUT and an external controller

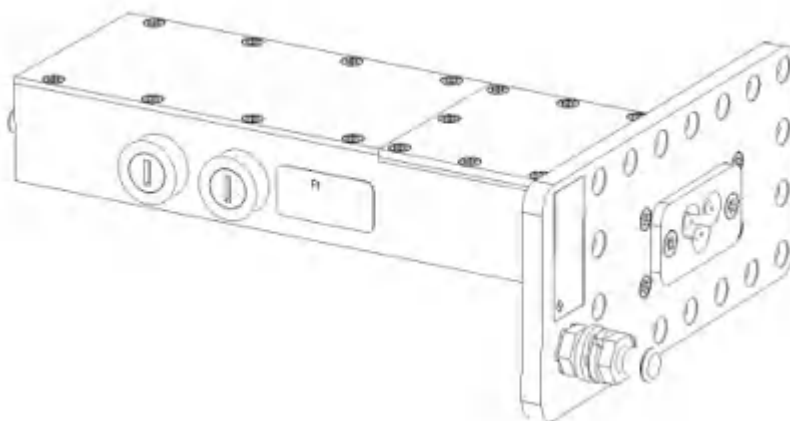


**NOTICE****Connecting USB cables and shielding requirements**

The "USB 2.0 Feed Through" is a passive module that causes no radiation. To avoid interference from the external connecting line, use a shielded USB cable that is equipped with EMI ferrite attenuators.

**3.2.4 Power Interface Panel (R&S DST-B104)**

The Power interface panel supplies the R&S DST200 with filtered AC power.



Make sure not to violate the current limitations. For more information refer to the data sheet.

**⚠ WARNING****Shock hazard**

To prevent electric shock, make sure to ground the R&S DST-B104 before connecting it to the AC power supply.

Grounding requires a grounding conductor of at least 4 mm<sup>2</sup> in size.

**3.2.5 Mounting Filter and Interface Panels**

The RF Diagnostic Chamber R&S DST200 is delivered with integrated test antenna. The N-connector unit labeled "RF ANT" (R&S DST-B220 and -B231) or "Pol. FB" and "Pol. LR" (R&S DST-B215) ensures the RF connection between the antenna and the external test equipment; it always occupies the connector port at the top of the right-hand wall, towards the front door of the chamber (see [Figure 3-1](#)). Additional filter and interface panels can be mounted at any of the four remaining module ports at the top

and bottom of the right-hand wall. Select the position of the panels according to your needs.

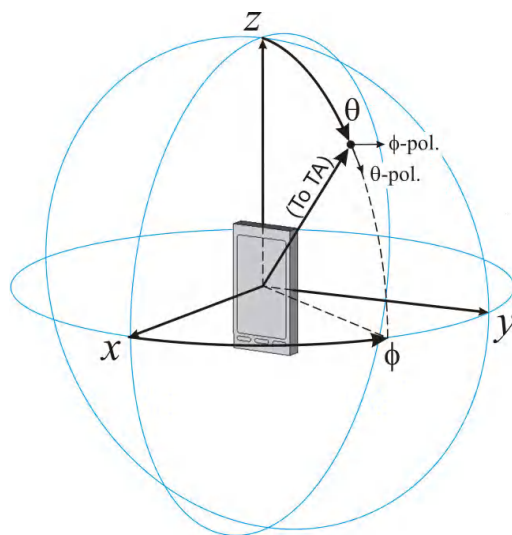
The connector units are delivered with spare EMI/EMC shielding gaskets. When mounting a unit, ensure that the contact surfaces at the unit and the RF Diagnostic Chamber are clean and the gaskets are in correct position, with the teeth to the outside of the chamber opening (see [Chapter 3.1.3, "Replacing the Shielding Gaskets"](#), on page 11). Apply the connector module to the module port and affix it using the 18 screws delivered with the module. Fix the screws progressively in cycles in order to achieve uniform contact.

To remove a connector module, simply unscrew the 18 screws. Use a blank plate to cover every unused module port.

To connect the additional feed throughs to the antenna or to the EUT, you will usually have to access the upper and/or lower compartments of the RF Diagnostic Chamber. Proceed as described in [Chapter 3.1.4, "Accessing the Upper Compartment"](#), on page 11 and [Chapter 3.1.5, "Accessing the Lower Compartment"](#), on page 12.

### 3.3 3D Positioners for the R&S DST200

The 3D Positioners for the R&S DST200 holds the EUT at a specific angular orientation. Measurements at well-defined orientations are often required in the product design process. CTIA - The Wireless Association specifies appropriate spherical coordinates for the EUT orientation; refer to the "CTIA Certification, Test Plan for Mobile Station Over the Air Performance, Method of Measurement for Radiated RF Power and Receiver Performance, Rev. 3.1".



**Figure 3-6: Spherical coordinate system of EUT**

The following 3D positioning devices are available.

- R&S DST-B150 (manual 3D positioner)
- R&S DST-B160 or -B165 (automated 3D positioners)

Basically, the manual and automated 3D positioners work the same in that they provide angular orientations of the EUT in close agreement with the spherical coordinate system defined in the CTIA Test Plan. The only difference is that the center of the coordinate system shall be located at the geometrical center of the EUT. The coordinate system is presented in [Figure 3-6](#). The display and the keypad of the EUT points into the +x direction



Throughout the remainder of this manual and in the R&S AMS32 system software the following terms are synonymous to define angular positions of the EUT:

elevation = theta =  $\theta$

azimuth = phi =  $\phi$

The 3D positioning devices replace the EUT table delivered with the R&S DST200. In case of the manual 3D positioner, it is sufficient to just replace the table with the positioner. The automated 3D positioner is delivered with a customized base plate that you have to install instead of the one the R&S DST200 is delivered with. For more information on installing the automated 3D positioner see [Chapter 3.3.2, "Automated 3D Positioners \(R&S DST-B160 / -B165\)"](#), on page 21.

The 3D positioners are designed to position the EUT below the test antennas installed at the top of the R&S DST200 RF diagnostic chamber. The EUT itself is held by a rubber band to the EUT holder that is delivered with the 3D positioners.

### Orientation of the EUT

The orientation of the EUT is variable. In case of the manual 3D positioner you have to align the orientation manually. When you use an automated 3D positioner, you can control the EUT orientation via PC with the R&S AMS32 system software. Aligning the EUT works as follows.

- If you turn the elevation rotator of the positioning device, you align the EUT position on the  $\theta$ -axis.  
The position on the  $\theta$ -axis is indicated on a label on the elevation rotator.
- If you turn the azimuth rotator of the positioning device, you align the EUT position on the  $\phi$ -axis.  
The position on the  $\phi$ -axis is indicated on a label on the azimuth rotator.

## 3.3.1 Manual 3D Positioner (R&S DST-B150)

### 3.3.1.1 Overview

If you turn the manual 3D positioner to a position where both angles are at  $0^\circ$  (home position),

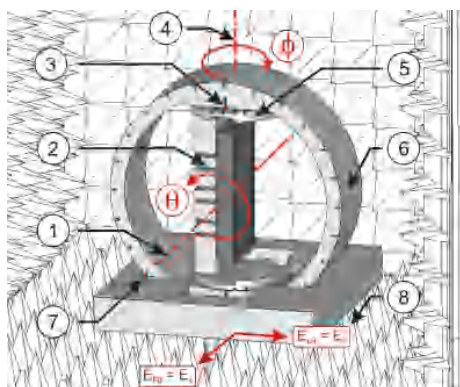
- the EUT is in a vertical position
- the face of the EUT points to the right side of the R&S DST200 RF Diagnostic Chamber in case of the manual 3D positioner in 'X' orientation

- the face of the EUT points to the rear side of the R&S DST200 RF Diagnostic Chamber in case of the manual 3D positioner in 'Y' orientation

In case of the manual 3D positioner the elevation rotator can be placed either in 'X' or 'Y' orientation. The orientation can be changed by turning the elevation rotator around the vertical axis by 90°. At the same time  $\theta$  and  $\phi$  polarizations of the test antenna are exchanged. For 'Y' orientation the EUT position on the  $\theta$ -axis is shown at the ' $\theta$ -REF Y' label. For 'X' orientation the EUT position on the  $\theta$ -axis is shown at the ' $\theta$ -REF X' label.

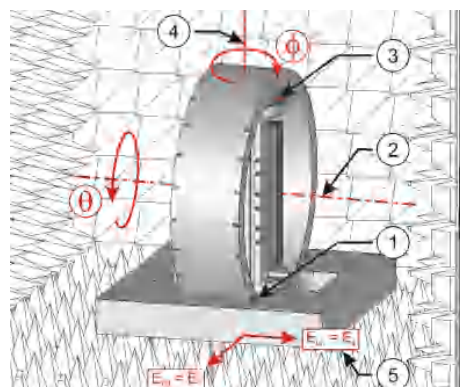
**Table 3-1: Manual 3D positioner in 'X' and 'Y' orientation with EUT at the home position ( $\theta = \phi = 0$ )**

#### 'X' orientation



- 1 = Elevation axis
- 2 = EUT holder
- 3 = Read  $\phi$  value
- 4 = Azimuth axis
- 5 = Azimuth rotator
- 6 = Elevation rotator
- 7 = Read  $\theta$  value
- 8 = Field polarization

#### 'Y' orientation



- 1 = Read  $\theta$  value
- 2 = Elevation axis
- 3 = Read  $\phi$  value
- 4 = Azimuth axis
- 5 = Field polarization

### 3.3.2 Automated 3D Positioners (R&S DST-B160 / -B165)

Instead of the EUT tables or the manual 3D positioner, you can use an automated 3D positioner (R&S DST-B160 or -B165) to test an EUT at various orientations in relation to an antenna. The automated 3D positioner has the advantage that you do not have to open the chamber every time you need to change the position of the EUT. Instead you control the positioner remotely with the R&S AMS32 or R&S EMC32 system software.

The automated 3D positioners are available in a standard and a large version.

- The R&S DST-B160 has a round EUT mobile unit suited for measurements on smaller devices like cell phones or smartphones.
- The R&S DST-B165 has a bigger square mobile unit also suited for measurements on larger devices like tablet computers or netbooks with a maximum weight of 800 g.

Except for the size of the mobile unit, the functionality and handling of the positioners are the same.



If the automated 3D positioner R&S DST-B160 is already available, the upgrade kit R&S DST-U165 can be used to upgrade the existing positioner to the version R&S DST-B165.

---

### 3.3.2.1 Overview

If you turn the automated 3D positioner to a position where both angles are at 0° (home position),

- the EUT is in a vertical position
- the face of the EUT points to the front side of the R&S DST200 RF Diagnostic Chamber in case of the automated 3D positioner

---

#### **NOTICE**

##### **Risk of damaging the automated 3D positioner**

Do not turn the elevation and azimuth rotators of the automated 3D positioner manually. Manual turning may cause damage of the positioner. To work with the positioner use R&S AMS32 system software.

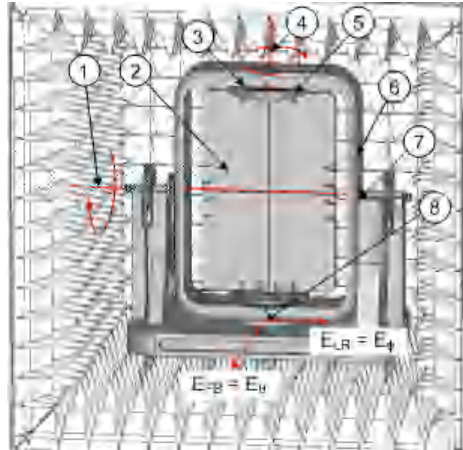
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**Table 3-2: EUT holder on an automated 3D positioner**

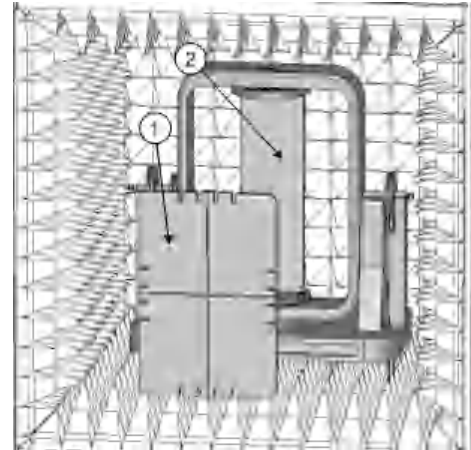
**Automated 3D positioner with EUT at the home position ( $\theta = \phi = 0$ )**

**Mounting of EUT holder on automated 3D positioner**

Note that the pictures show the R&S DST-B165 as an example. The principles are the same for the R&S DST-B160.



- 1 = Elevation axis
- 2 = EUT holder
- 3 = Read  $\phi$  value
- 4 = Azimuth axis
- 5 = Azimuth rotator
- 6 = Elevation rotator
- 7 = Read  $\theta$  value
- 8 = Field polarization



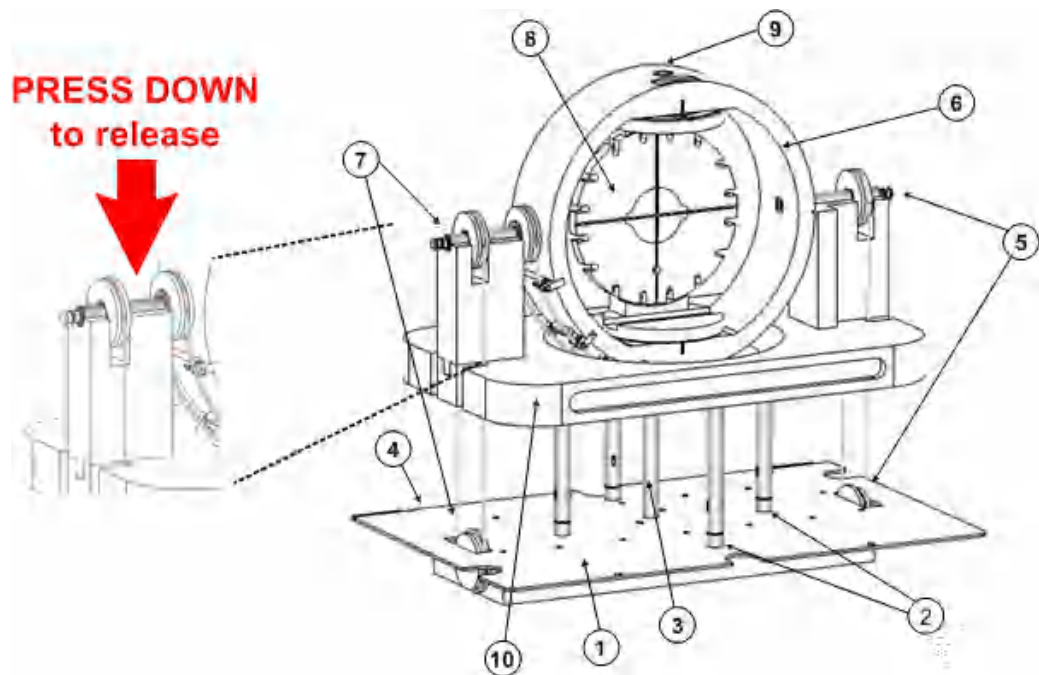
- 1 = EUT holder
- 2 = R&S DST-B160 is mounted with a positioning pin
- 2 = R&S DST-B165 is mounted with a guide rail

Two EUT holders are delivered with R&S DST-B160. For quick and more reproducible tests of several EUTs more EUT holders can be advantageous. Then each EUT can be mounted on a separate EUT holder which in turn can be quickly snapped into the azimuth rotator of R&S DST-B160 / -B165. An additional EUT holder is available as accessory R&S DST-Z160 / -Z165.

### 3.3.2.2 Installation

The automated 3D positioner uses a modular concept that allows to configure it according to your needs





**Figure 3-7: Overview of the automated 3D positioner**

= Note that the figure shows an R&S DST-B160. The configuration of the R&S DST-B165 is basically the same.

- 1 = Motor unit
- 2 = Feet of the positioner
- 3 = Waveguide for optical sensor signals
- 4 = Hinges to attach the foundation to the R&S DST200 floor panel
- 5 = Belt drive for elevation axis adjustment
- 6 = Elevation rotator (mobile unit)
- 7 = Long belt drive for azimuth axis adjustment
- 8 = Azimuth rotator with EUT holder that you can snap on
- 9 = Elevation optical reflector
- 10 = Mobile unit support
- n/a = Azimuth optical reflector on the bottom side of the azimuth rotator (not visible)

- The whole system rests on feet that are stuck into the cover of the motor unit. The cover is compatible to the other positioning devices. Thus, if you remove the automated 3D positioner from the motor unit, you can use it for the other devices as well.  
For instructions on how to install the centerpiece of the R&S DST200 floor panel see [Chapter 3.1.5, "Accessing the Lower Compartment"](#), on page 12.
- The rotators (one for the azimuth position on the  $\phi$ -axis, one for the elevation position on the  $\theta$ -axis) rest on a table attached to the system feet. The azimuth rotator also serves as a mount for the EUT holder
- The EUT holder is a snap-in system. If you attach the EUT with a rubber band or a similar fastener device to its mount, you can easily snap it to the azimuth rotator. The EUT holder is delivered with low permittivity distance plates. The plates can be used to align the geometrical center of the EUT with the origin of the coordinate system for the EUT.



- The rotators are controlled by belt drives. One belt drive controls the position of the EUT on the azimuth axis. The other belt drive control the position on the elevation axis.  
You can remove the belts by pushing down the mounts the belt wheels rest on. Remove the belts only if you want to remove the positioning system from the cover of the motor unit, e.g. if you want to use another positioning device like the EUT table.
- The belts are powered by two motors that are built into the motor unit.  
To supply the motors with power you have to connect it to an AC outlet via the D-Sub port on the back of the motor unit. The port is in a location that the cabling has to be guided through the lower compartment of the R&S DST200.

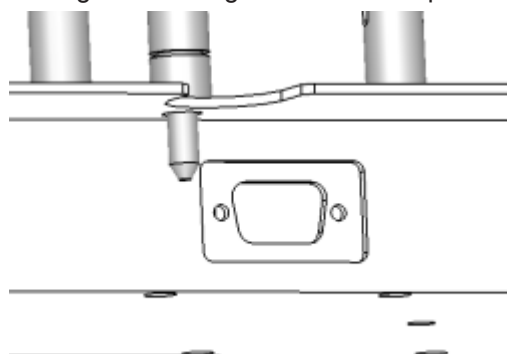


Figure 3-8: D-Sub port on the back of the motor unit

For more information on how access the lower compartment of the R&S DST200 see [Chapter 3.1.5, "Accessing the Lower Compartment"](#), on page 12.

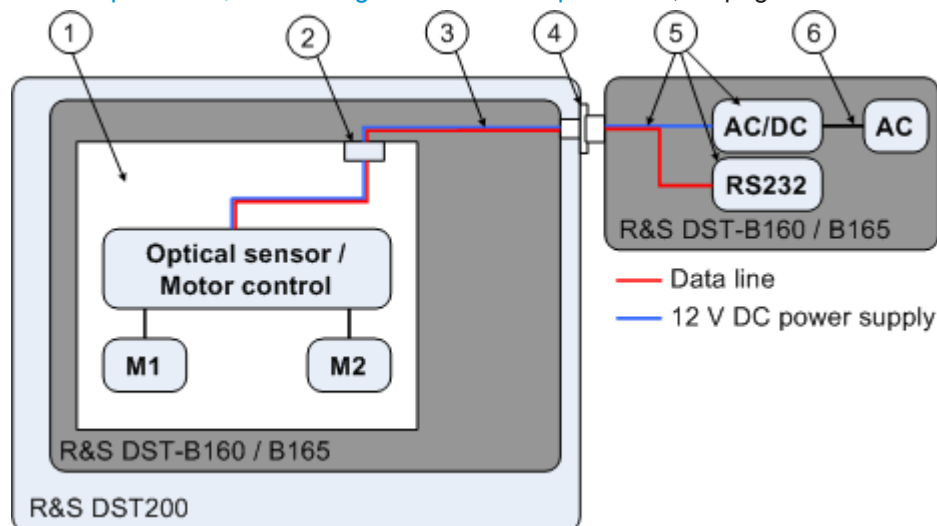


Figure 3-9: Electrical block diagram of R&S DST-B160 and -B165 automated 3D positioner

- 1 = Motor unit
- 2 = 9-pin D-Sub filter
- 3 = Data and +12 VDC power supply cable (cable motor box)
- 4 = R&S DST-B101 filter panel, 9-pin D-Sub, fiber-optic

- 5 = AC/DC power converter, RS232 data interface, data and DC power supply cables (cable RS232)
- 6 = AC power cable

M(x) = Motor, one for each belt drive

- A motor unit with an integrated D-Sub filter provides shielded environment for both motors supply and control signals. Accordingly radiated and conducted EMI emission of the automated 3D positioner is minimized.
- An optical sensor in the center of the centerpiece.
- Two optical reflectors on the top and bottom of the positioner to determine the exact position of the EUT on the  $\phi$ - and  $\theta$ -axis.
- The cable that supplies the motor with power also contains cabling to connect the positioning system to the computer that controls the position of the EUT.  
For details on the cabling within the automated 3D positioner see [Figure 3-9](#).

### 3.3.2.3 Functional Check

1. Start the R&S AMS32 software.
2. Configure the test PC.
  - a) Open the "Device List" in the "Extras" menu.
  - b) Open the dialog box to define the characteristics for the "DST200 Elevation Positioner" device by double-clicking on it.
  - c) In the "Homing" tab, press the "Auto Calibration" button to determine correction factors automatically.

Read elevation ( $\theta$ ) and azimuth ( $\phi$ ) angles on the scales glued to both rotators of the positioner. The automated 3D positioner should be at the angle  $\phi = \theta = 0$  deg with the accuracy defined in the data sheet.

In case of errors at homing or calibration of the positioner the optical sensor tube and the reflectors should be checked for dirt or dust.

## 3.4 Antennas for the R&S DST200

### 3.4.1 Test Antennas

You can equip the R&S DST200 with various test antennas that are available as hardware options.

- Cross-polarized test antenna (R&S DST-B215)
- Circular-polarized test antenna (R&S DST-B220)
- Test antenna kit (R&S DST-B231)

### 3.4.1.1 Cross-Polarized Test Antenna (R&S DST-B215)

The R&S DST-B215 cross-polarized test antenna radiates dual linear-polarized fields. The polarization directions are associated with the RF ports of the antenna polarization Front → Back (FB) and polarization Left → Right (LR). The directions of the electric fields for each polarization are shown in [Figure 3-1](#) and also labeled on the antenna PCB.

The main radiation direction of the antenna points down towards the quiet zone center of all positioning devices.

A quiet zone is the space inside a 3D positioner where an EUT can be held. The center of the quiet zone is at the cross-section of the elevation and azimuth axes.

The antenna is designed to enable testing of vector radiation characteristics of an EUT. In addition, its polarization diversity can be used to provide two orthogonal data streams necessary for MIMO OTA testing such as noise-limited OTA performance in transmit diversity mode. For more information on that topic see the R&S Application Brochure "OTA performance measurements of MIMO-enabled devices" available for download on the Internet ([http://www2.rohde-schwarz.com/file\\_17212/TS8991\\_app-bro\\_en.pdf](http://www2.rohde-schwarz.com/file_17212/TS8991_app-bro_en.pdf))

For more information on antenna installation see [Chapter 3.4.1.4, "Installing Test Antennas"](#), on page 28.

**Table 3-3: Antenna polarization in the EUT coordinate system**

3D Positioner	R&S DST-B150		R&S DST-B160 /-B165
	x orientation	y orientation	
Pol. FB	$\phi$ (phi)	$\theta$ (theta)	$\theta$
Pol. LR	$\theta$ (theta)	$\phi$ (phi)	$\phi$

The antenna connectors for both polarizations are available at the interface panel mounted at the right side of the R&S DST200 RF Diagnostic Chamber. The N female connectors are labeled "Pol. FB" and "Pol. LR".



#### Antenna polarization in the R&S AMS32 software "Hardware Configuration"

If "Great Circle Cut (two-axis MAPS)" is used as the "Hardware System Type", the H port of the antenna indicates theta polarization and the V port of the antenna indicates phi polarization.



You can find the "Hardware System Type" in the "System" tab of the "Extras" → "Options" → "OTA Options" menu.

### 3.4.1.2 Circular-Polarized Test Antenna (R&S DST-B220)

The R&S DST-B220 test antenna radiates a circular-polarized field.

The antenna phase center is located in the center of the antenna PCB. The location of the phase center does not change over the frequency range of operation. The main radiation direction is normal to the antenna PCB and it points to the quiet zone center of all positioning devices. In this way the variation of the EUT coupling to the test antenna is minimized as a function of the location and orientation of the EUT.

The antenna connector is available at the interface panel mounted at the right side of R&S DST200 RF Diagnostic Chamber. The N female connector is labeled "RF ANT".



#### Circular polarization of the test antenna

Since the test antenna has nominally a circular polarization, it verifies two linear polarization characteristics of the EUT simultaneously. In an EUT radiation measurement, the output power  $P_{TA}$  at the RF ANT connector depends on both orthogonal components in the horizontal plane of the EUT's radiated field ( $E_{FB}$  and  $E_{LR}$ ) incident on the test antenna. In the case where the EUT is illuminated by the test antenna, the input power  $P_{TA}$  at the RF ANT connector creates two orthogonal field components in the horizontal plane incident on the EUT.

#### 3.4.1.3 Test Antenna Kit (R&S DST-B231)

The R&S DST-B231 test antenna kit allows the installation of application-specific test antennas inside the R&S DST200 at the same location as for R&S DST-B215 and R&S DST-B220. The antenna element is designed to be fixed by screws, using the four mounting holes in the metal antenna base plate. The two RF absorber parts included in the test antenna kit must be installed to avoid reflections from the antenna base plate.

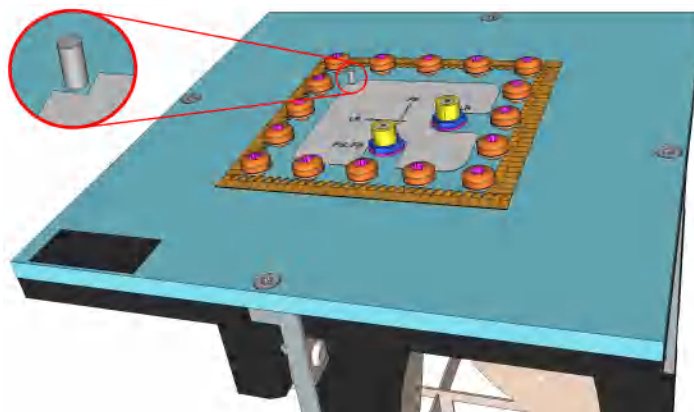
The antenna connector is available externally at the interface panel mounted at the right side of the R&S DST200 RF diagnostic chamber. The N connector (female) is labeled "RF ANT".

#### 3.4.1.4 Installing Test Antennas

Test antennas are screwed to the ceiling of the diagnostic chamber.

1. Remove the top cover as described in [Chapter 3.1.4, "Accessing the Upper Compartment"](#), on page 11.
2. Position the antenna in the right direction.  
Test antennas have a small metal pin on the top that determine the way you have to align the antenna. Position the antenna in a way that the positioning pin fits into the corresponding hole in the ceiling of the R&S DST200.
3. Screw the antenna to the ceiling of the chamber.  
Note that you have to open the upper compartment of the R&S DST200 to be able to screw the antenna on from outside the chamber.

4. Position the interface panel with one (circular-polarized antenna) or two (cross-polarized antenna) N female feedthroughs at the upper part of the right side wall of the chamber.
5. Screw the interface panel to the right wall of the chamber.
6. Connect the antenna output to the RF output of the R&S DST200 with one (circular-polarized) or two (cross-polarized) semi-rigid cables.  
Circular-polarized antennas have one output.  
Cross-polarized antennas have two outputs ("FB" and "LR" connector):



*Figure 3-10: Cover with two connectors for cross-polarized antennas (detail: positioning pin)*

7. Close the upper compartment by reattaching the top cover of the R&S DST200.



#### Removing the antenna

When removing the antenna,

- hold on to the antenna to prevent it from falling down
- make sure not to damage the connectors or the positioning pin.

### 3.4.2 Communication Antennas

You can equip the R&S DST200 with linear-polarized communication antennas that are available as hardware options.

- Linear-Polarized Test Antenna (R&S DST-B270)
- 2 Communication Antennas (R&S DST-B272, delivered with the required power splitter)

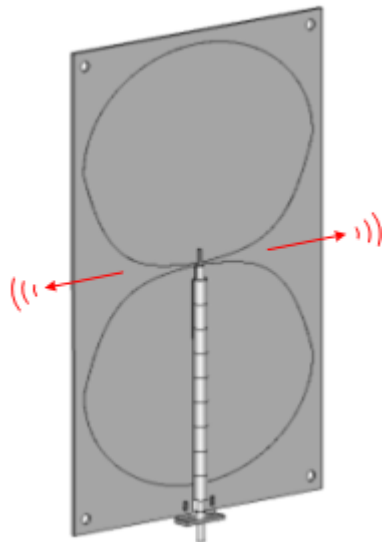
The two-piece communication antenna is made of two individual linear-polarized communication antennas, connected with a power splitter for more stable measurements in case of non-isotropic radio patterns. Apart from that, the characteristics are the same as those of the single-piece linear-polarized communication antenna.

### 3.4.2.1 Overview

The communication antenna radiates a linear-polarized electric field along the longer edge of the antenna PCB. The main radiation direction is along an exponential taper of the antenna. It was designed to provide an auxiliary radiation element to support a wide variety of applications, such as:

- Carrying UL or DL signal during radiated power or sensitivity tests.
- Radiating source of additional communication technologies during co-existence tests.
- Radiating source of interference signals.
- Antenna to provide additional radiation directions for MIMO measurements.

Very low thickness of the antenna allows easy installation at the edge of the cubical test space inside the R&S DST200. A traveling wave structure of the antenna provides ultra wideband frequency operation.



*Figure 3-11: Main radiation directions of communication antenna (R&S DST-B270)*

To connect communication antenna to the external RF instrument the interface panel R&S DST-102 is required. Then the antenna connector is available at the interface panel mounted at the right side of R&S DST200 RF Diagnostic Chamber. The N female connectors are labeled "RF1" or "RF2". Single interface panel R&S DST-102 allows connection up to two communication antennas.

### 3.4.2.2 Installing Communication Antennas

Communication antennas are simply stuck into the corners or edges of the chamber.

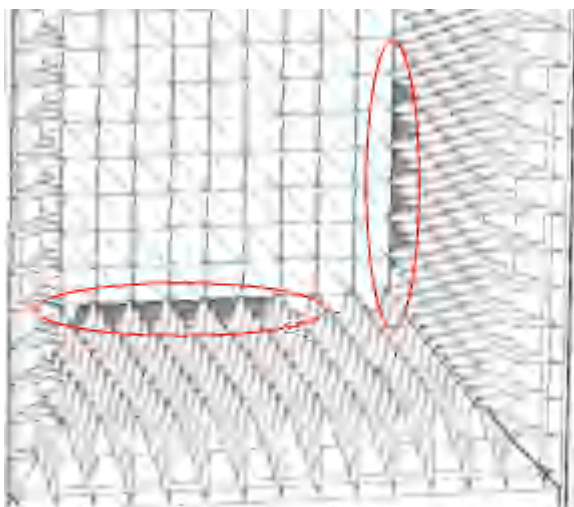
The R&S DST-B270 should be stuck to the rear right edge and the R&S DST-B272 to rear right and bottom edge. The antennas of the R&S DST-B272 should be connected

to port 1 and 2 of the power splitter. The splitter can be placed into the bottom compartment.

The common port of the power splitter is connected to port RF1 of the interface panel R&S DST-B102.

The absorber panels inside the chamber provide enough foothold for the antenna to hold on its own. Thus, it is sufficient to just stick it in between the panels as shown in [Figure 3-12](#).

To achieve maximum radiated coupling the EUT and the center of the communication antenna should be at the same height.



*Figure 3-12: Installation of communication antenna into the chamber (RF cable is not shown)*

### 3.4.3 Functional Check

These instructions apply to the R&S DST200 antennas R&S DST-B215, -B220, -B231, -B270 and -B272.

The technical data of the RF Diagnostic Chamber and the antennas are listed in the R&S DST200 data sheet, see PD 5214.3600.22. To check compliance with the rated VSWR specifications of the antenna, you can use one of the following measurement devices:

- Network analyzer with the necessary frequency range **or**
- Spectrum analyzer with the necessary frequency range and a tracking generator and reflection measurement bridge

The frequency range depends on the frequency range of the antenna and is specified in the datasheet.

1. For network analyzers: Connect the RF cable to the network analyzer and calibrate the analyzer for a reflection measurement.

2. Connect the analyzer (or the bridge) to the **closed** chamber using the antenna connector and the RF cable.
3. Measure the VSWR at different frequencies.

The VSWR must be below the value specified in the data sheet across the entire frequency range of the antenna.

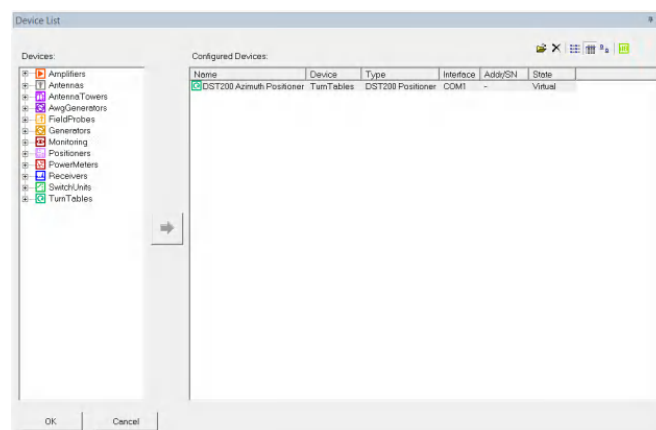
The RF shielding complies with the rated specifications provided that the cover plate is mounted, the front door is completely closed, and the EMI/EMC shielding gaskets are in place and not corroded or damaged. For more information see [Chapter 3.1.3, "Replacing the Shielding Gaskets"](#), on page 11.

### 3.5 Configuring a Test PC

You can control the automated 3D positioner available for the R&S DST200 RF Diagnostic Chamber (R&S DST-B16x) with an external control computer that is equipped with the R&S AMS32 or R&S EMC32 system software. Both system software should be in version 9.00 or higher. In the following the presented procedure is valid for both system software. R&S EMC32 system software does not require step "3. Configuration of OTA options".

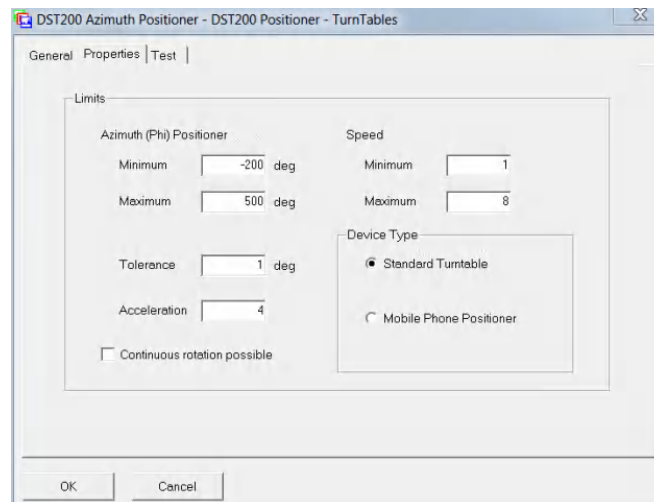
#### Configuring the control computer

1. Start the R&S AMS32 software.
2. Configure positioner drivers.
  - a) Open the "Device List" in the "Extras" menu.
  - b) In the "Device List", register a first "DST200 Positioner" device from the device class "TurnTables" and rename it to "DST200 Azimuth Positioner".

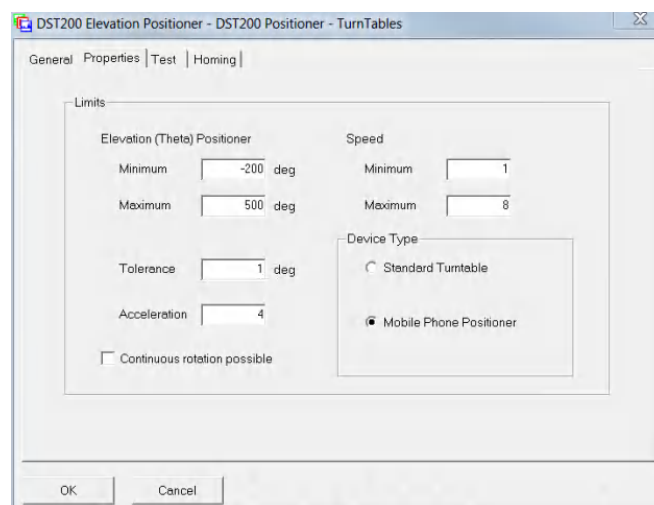




- c) Open the dialog box to define the characteristics of the device by double-clicking on it.  
In the "Properties" tab, select "Standard Turntable" as the device type. Set the "Tolerance" to 1 and "Acceleration" to 4.

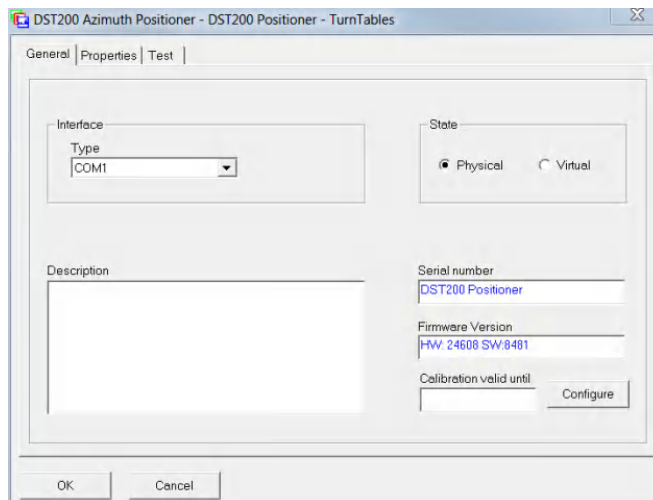


- d) In the "Device List", register a second "DST200 Positioner" device from the device class "TurnTables" and rename it to "DST200 Elevation Positioner". In the "Properties" tab, select "Mobile Phone Positioner" as the device type. Set the "Tolerance" to 1 and "Acceleration" to 4.

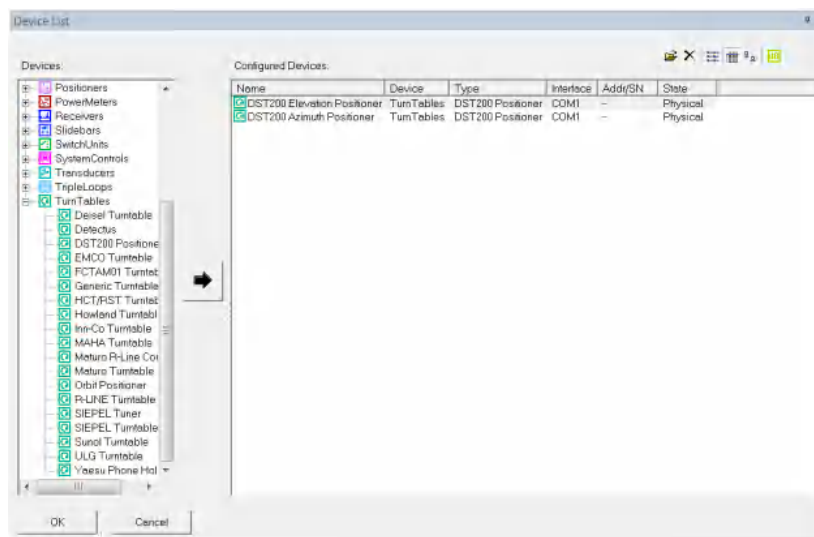


- e) In the "General" tab, select "COM1" as the "Interface Type" for both positioners ("DST200 Azimuth Positioner" and "DST200 Elevation Positioner"). The RS232 cable of R&S DST-B16x shall be connected to the COM interface of the Test PC. Change the number of the COM interface if necessary.
- f) Connect the RS232 cable.

- g) In the "General" tab, set the "State" for both positioners to "Physical".



- h) Finally registration and configuration of both positioners is completed.

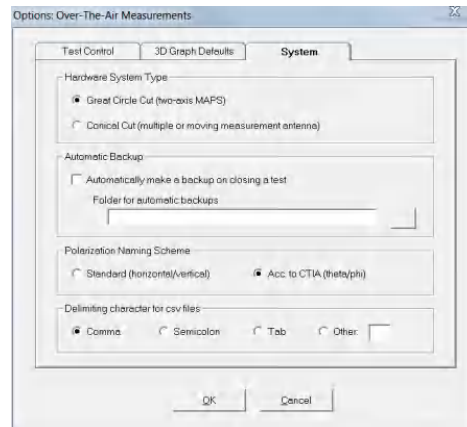


**Figure 3-13: Registered drivers for R&S DST200 elevation and azimuth positioners in R&S AMS32**

### 3. Configure OTA options

- Open the "OTA Options" in the "Extras"→"Options..." menu.
- In the "System" tab, select "Great Circle Cut (two-axis MAPS)" as the "Hardware System Type".

- c) Select "Acc. To CTIA (theta/phi)" as "Polarization Naming Scheme".



### Performing automatic calibration

Azimuth and elevation correction values are found automatically by performing Auto Calibration. They are unique for a given sample of the automated 3D positioner. The correction values assure proper gear ratio between motor drives and actual orientation of the EUT holder. To perform auto calibration:

1. Open the "Device List" in the "Extras" menu.
2. Open the dialog box to define the characteristics for the "DST200 Elevation Positioner" device by double-clicking on it.
3. In the "Homing" tab, press the "Auto Calibration" button to determine correction factors automatically.

The software saves the results to a file. It is stored under `\EMC32\Logs\DSTposCommands.log`. The file contains two sections, one for the results of the azimuth rotator and one for the results of the elevation rotator.

Normally auto calibration shall be performed only once at the first configuration of the R&S DST200 positioner drivers in R&S AMS32 software. It needs to be repeated when the test PC is changed or the positioner is maintained.

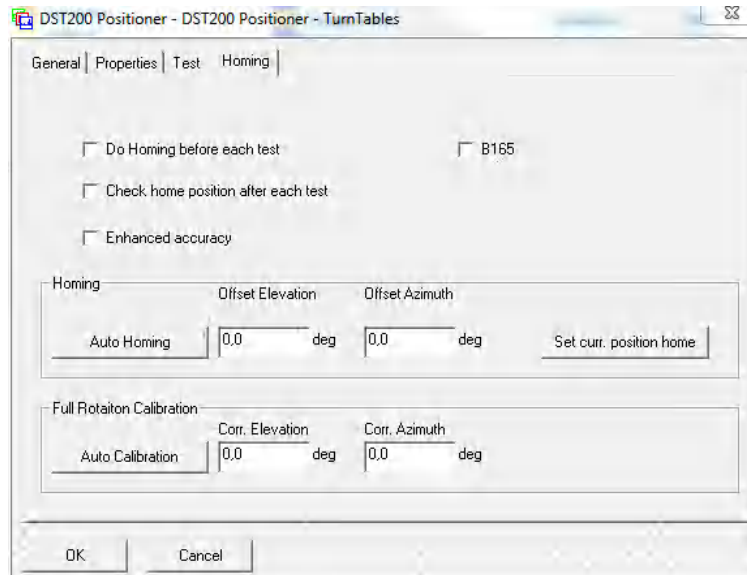
### Defining offset angles for the azimuth and elevation rotators

The actual home position of the EUT should correspond to the one that has been specified (azimuth = elevation = 0). If the actual home position deviates from the specified one, you can define an offset angle to move the EUT to the right position.

1. Open the "Device List" in the "Extras" menu.
2. Open the dialog box to define the characteristics for the "DST200 Elevation Positioner" device by double-clicking on it.
3. In the "Homing" tab, set the "Offset Elevation" and the "Offset Azimuth" to 0°.
4. Press the "Auto Homing" button.

After the homing procedure is done, check the offset of both rotators (read the angle labels on the positioner).

5. If there is an offset, proceed as follows.
  - a) In the "Test" tab, set appropriate values for the "New Position" for both rotators to achieve azimuth = elevation = 0° on the angle labels.
  - b) In the "Homing" tab of the "DST200 Elevation Positioner" device, enter the offset values you have found in the "Offset Elevation" and "Offset Azimuth" fields.
  - c) Press the "Set Curr. Position" button to correct the home position.



The R&S DST-B160 automated positioner is ready for operation with R&S AMS32 after performing auto calibration and defining offset angles for azimuth and elevation rotators.

## 4 Reference Path Loss Measurement

Over-the-air (OTA) measurements attempt to determine the performance of radio transmitters and receivers in a test environment which closely simulates the conditions in which the devices will be used. OTA tests for mobile phones have been promoted and specified by CTIA - The Wireless Association®; refer to the "CTIA Certification, Test Plan for Mobile Station Over the Air Performance, Method of Measurement for Radiated RF Power and Receiver Performance, Rev. 3.1".

An important preparatory stage of any OTA measurement consists of removing the test system's influence from the radiated power and sensitivity results. To this end the equipment under test (EUT) is replaced by a reference antenna with known gain characteristics, and a reference path loss measurement is performed. The reference measurement is combined with the known gain of the reference antenna to determine an **isotropic** reference correction for the power and sensitivity results. The remainder of this section outlines how to perform the reference path loss measurement using the RF Diagnostic Chamber in combination with a vector network analyzer. For a detailed description of the measurement method refer to section "Range Reference Requirements" in the CTIA certification document.

The reference path loss measurement is different from the path loss measurement described in [Chapter 5.2, "Path Loss Measurement"](#), on page 48 where the EUT (typically, a mobile phone) provides the information about the path loss values.

### 4.1 Background

The purpose of the reference path loss measurement is to relate the measured radiated power or sensitivity of the EUT to the same quantities from an ideal isotropic radiator. We define the total reference path loss PL of the RF Diagnostic Chamber as the difference:

$$PL = P_{RA} - P_{TA, ISO}$$

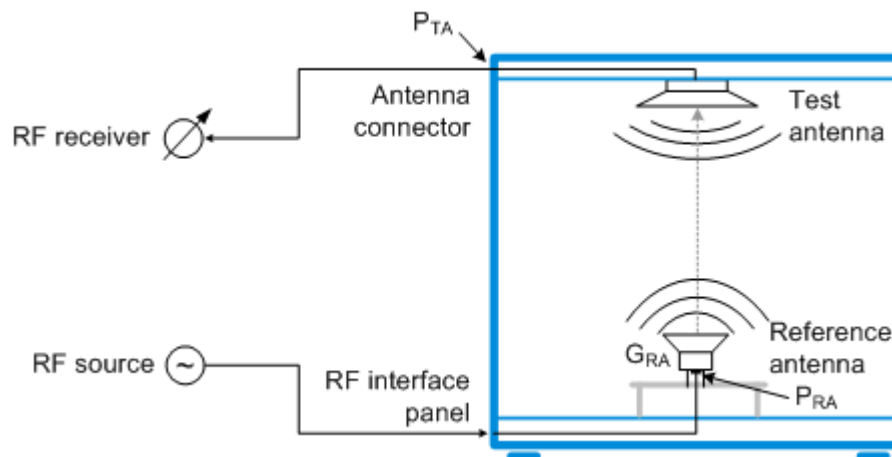
where  $P_{RA}$  is the input power and  $P_{TA, ISO}$  is the output power, assuming that the chamber is equipped with an isotropic radiator. As shown in [Figure 5-4](#) and in [Figure 4-1](#),  $P_{TA, ISO}$  depends on the propagation loss along the cable, the test antenna and in free space.

Most conveniently, the RF input signal for the reference path loss measurement is fed to an additional RF feed through (the "Double N Connector" R&S DST-B102 mounted at one of the lower connector ports); the RF output signal is tapped at the antenna connector of the respective antenna being measured.



#### Disturbance due to cabling

Watch that the connecting cable does not disturb the radiation pattern of the isotropic radiator (or reference antenna, see below). The cable must be either outside the radiated field or perpendicular to the electric field **E**.



**Figure 4-1: Schematic test setup for reference path loss measurement**

In practice, the ideal isotropic radiator is replaced by a calibrated reference antenna. The (known) gain of the reference antenna  $G_{RA}$  is defined as the difference between the antenna's actual radiated power and the ideal isotropic power, hence:

$$PL = G_{RA} + P_{RA} - P_{TA}$$

In the equation above,  $P_{TA}$  denotes the output power of the RF Diagnostic Chamber in the presence of the reference antenna, including the effect of the antenna's radiation characteristics. The power difference  $P_{RA} - P_{TA}$  can be measured as described below. Together with the known value of  $G_{RA}$  this determines the total reference path loss PL.



#### **Polarization of the reference antenna**

Make sure to align the polarization of the reference antenna to that of the test or communication antenna before beginning with the calibration procedure.

In addition, do not move the antenna to another position after you have calibrated the test setup or else calibration becomes invalid.

## **4.2 Measurement**

The principle of the following measurement procedure is valid for all R&S DST200 antennas when a calibration plane is selected at the appropriate antenna connector. For more information see [Chapter 3.4, "Antennas for the R&S DST200"](#), on page 26.

A vector network analyzer (VNA) is ideally suited for the reference path loss measurement, because the required steps are all part of its basic functionality. A typical VNA can perform most of the calculations by itself. To measure the power difference  $P_{RA} - P_{TA}$ ,

1. Calibrate the connecting cables between the VNA source port and the input connector of the reference antenna and between the antenna connector of the chamber and the VNA receiver port.

2. Measure the connected RF Diagnostic Chamber in transmission.

### Cable calibration

The suggested test setup uses port 1 of the VNA as a source port, port 2 as a receive port. Calibration is performed with all cables connected to both analyzer ports. For best accuracy, use high-quality RF cables and perform a full two-port calibration. Connect the required calibration standards successively to the cable ends as required by the selected calibration type.

The calibrated VNA results will relate to the cable ends. Calibration moves the "reference plane" from the VNA ports towards the input and output connectors of the chamber.

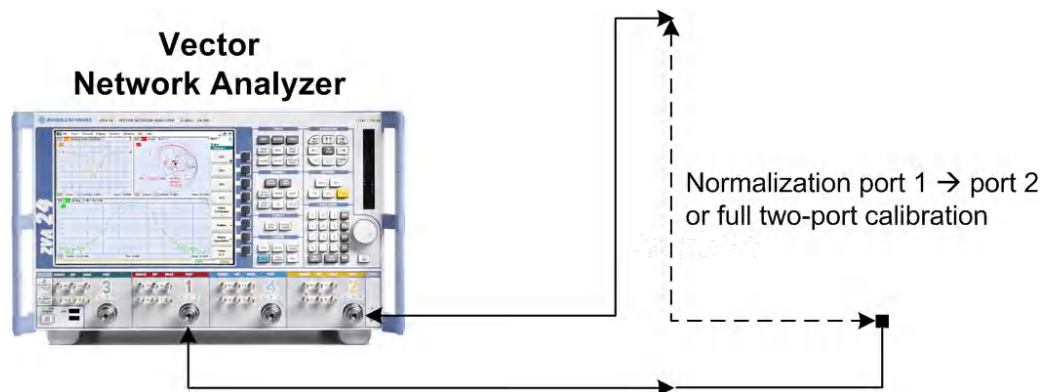


Figure 4-2: VNA test setup for cable calibration

### Transmission measurement

Apply the calibration and connect the cable ends to the input connector of the reference antenna and the antenna connector of the RF Diagnostic Chamber. Measure the forward transmission coefficient  $S_{21}$ , converted to a dB-magnitude value (this is the preset measurement mode of many VNAs). The power difference  $P_{RA} - P_{TA}$  is equal to the negative of the transmission coefficient:

$$P_{RA} - P_{TA} = -|S_{21}|$$

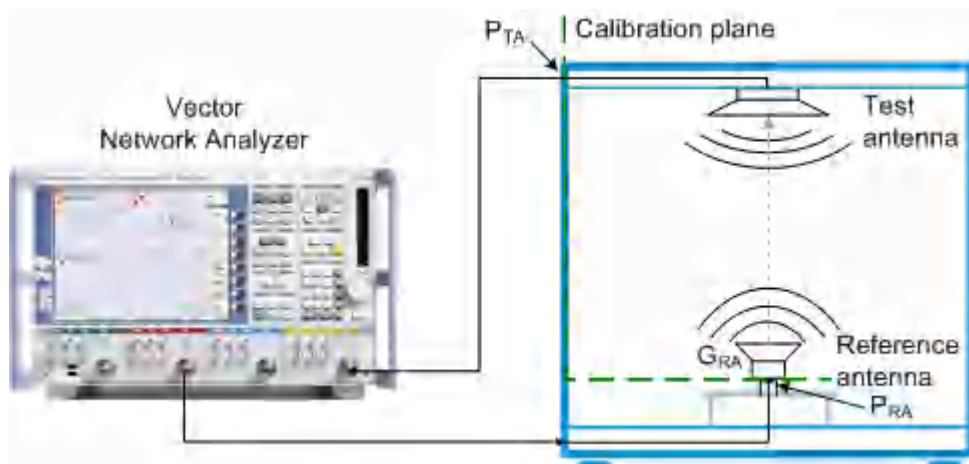


Figure 4-3: VNA test setup for transmission measurement

### Reference path loss calculation

To determine the reference path loss, add the antenna gain to the VNA results:

$$PL = G_{RA} - |S_{21}|$$

Reference path loss values must be acquired for all test frequencies, most easily by configuring an appropriate frequency sweep at the VNA. The path loss values must be stored and used to correct the OTA performance test results.

## 4.3 R&S DST-B120 Positioner for Calibration Antennas

The R&S DST-B120 positioner (order number 1516.8659.02) can be used to support height and orientation adjustment during path loss calibration of the R&S DST200. The calibration antenna that is used for this procedure is positioned in the chamber as the reference antenna (which replaces the EUT). In the remainder of this chapter, the calibration antenna is therefore called the reference antenna.



The R&S DST-B120 positioner kit is designed for the following reference antennas:

- R&S TS-RANT3 (order no. 1516.4224.02) for calibration from 400 MHz to 3 GHz
- R&S TS-RANT18 (order no. 1516.4218.02) for calibration from 3 GHz to 18 GHz

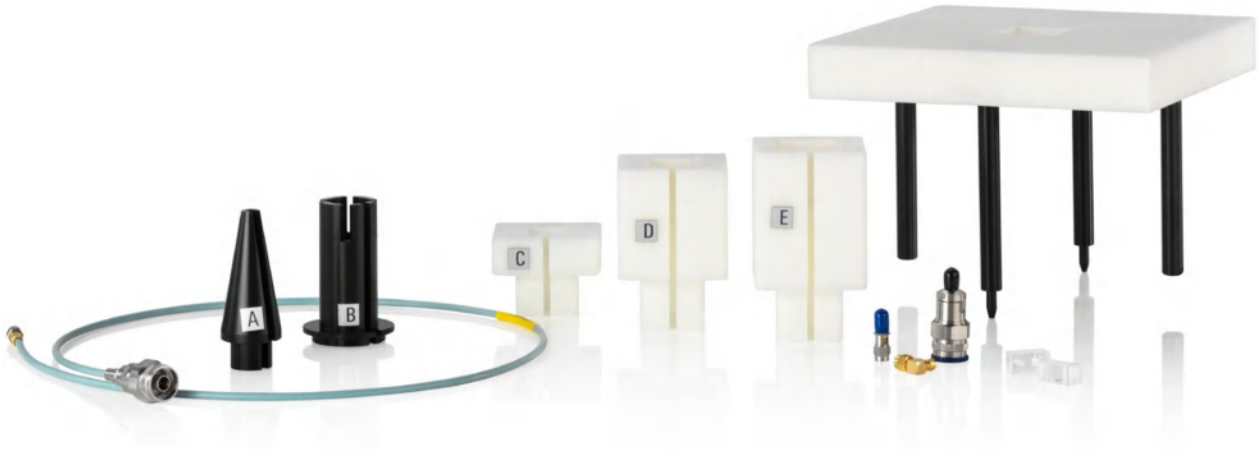
These antennas must be ordered separately, they are not included in the R&S DST-B120 positioner kit.

The positioner kit shown in [Figure 4-4](#) consists of a base table, an RF cable, RF connectors and several adapters. They are used to position the reference antenna in the center of the EUT positioners, for example in the center of rotation of the automated 3D positioner R&S DST-B160.





Note that a **VNA** is required for the path loss calibration of the R&S DST200 with the R&S DST-B120.



**Figure 4-4: R&S DST-B120 positioner kit for calibration antennas**

Left	= RF cable with N(m) and SMA(m) connectors
A	= Conical adapter A
B	= Cylindrical adapter B
C	= Height adapter C
D	= Height adapter D
E	= Height adapter E
Rear right	= Base table
Small parts (1 <sup>st</sup> from left)	= 6 dB attenuator (SMA, 18 GHz, 2 W, 50 ohm)
Small parts (2 <sup>nd</sup> from left)	= 90° SMA adapter (m/f)
Small parts (3 <sup>rd</sup> from left)	= Straight SMA(f) - N(m) adapter (18 GHz, 50 ohm)
Small parts (4 <sup>th</sup> from left)	= Antenna hold block (2 pieces) with 2 DIN 965 polyamid countersunk flat head screws M3x16

The various height adapters are used to place the different reference antennas in the center of the various positioners. Placed correctly, the reference antenna is at the right distance D from the test antenna (see [Figure 4-7](#)). These distances D, measured from the center of the various positioners to the test antenna, are as follows:

- D = 190 mm for the R&S DST-B165
- D = 270 mm for the R&S DST-B160
- D = 350 mm for the flat EUT table

The height adjustments require various combinations of height adapters for different reference antennas and different positioners (see [Table 4-1](#)). For a detailed description on how to perform the calibration at various heights, see the test instruction document [R&S DST200 - Path Loss Determination in the RF Diagnostic Chamber](#).

### Installation procedure

To install the kit and prepare the system for calibration, follow these steps:

1. Open the door of the R&S DST200 chamber.

2. Remove two absorber panels from the front and center of the floor inside the chamber. (The center panel has a centered hole.)  
The metal mounting plate becomes visible.
3. Remove the mounting plate to open the lower compartment of the R&S DST200.
4. Connect the N connector of the RF cable (included in the R&S DST-B120 kit) to the "RF1" N connector in the lower compartment.
5. Insert the mounting plate back into the chamber. Before putting it down, from below the plate, thread the loose end of the RF cable through the centered hole in the mounting plate.
6. Bring the mounting plate back into place to cover the lower compartment.
7. Mount adapter A on the top of adapter B.
8. Thread the RF cable through the combined adapters A + B from below.
9. Mount the combined adapters A + B on the centered hole of the mounting plate.
10. Thread the RF cable through the centered hole of the absorber panel from below.
11. Push the absorber panel back into place, down to the mounting plate (left in [Figure 4-5](#)). Adapter A helps you to do this without damaging the absorber panel.
12. Remove adapter A (right hand picture in [Figure 4-5](#)).



**Figure 4-5: Mounting adapter B with the help of adapter A (here shown without the RF cable)**

Left = Insert the combined adapter A + B through the hole in the absorber panel  
 Right = Once the adapters stick out through the absorber panel, remove adapter A

13. Put the front absorber panel back to its place inside the R&S DST200 chamber.  
**Note:** This completes the mechanical preparation in the lower part of the chamber. The following [step 14](#) to [step 19](#) are required to **calibrate the VNA at the system's reference planes**, before the path loss calibration is performed.
14. Attach the SMA(f) - N(m) adapter (3587.7835.00, included in the R&S DST-B120 kit) to the SMA(m) connector at the end of the RF cable that comes out of adapter B.  
 The N(m) connector of this adapter is the *first reference plane* "RA" (see  $P_{RA}$  in [Figure 4-3](#)).

15. Connect an RF cable with suitable connectors to any port of the VNA, for example port 1. This cable must be long enough to reach the connector "RF1" on the outside of the R&S DST200.
16. Connect the remote end of this RF cable to the N connector "RF1".
17. Connect another RF cable with suitable connectors to any other port of the VNA, for example port 2. This cable must be long enough to reach the N connectors "Pol. FB" and "Pol. LR" for test antenna feed at the top of the R&S DST200. Do **not** connect this cable to any of those test antenna feed connectors. The N(m) connector at the loose end of this cable is the *second calibration plane* "TA" (see  $P_{TA}$  in [Figure 4-3](#)).
18. Connect the two loose cable ends (with N connectors, which represent the reference planes "RA" and "TA") to a calibration unit, for example the R&S ZV-Z53.
19. Calibrate the VNA at both reference planes with the following recommended settings:
  - Start frequency: 400 MHz
  - Stop frequency: 18 GHz
  - Frequency step width: 2 MHz
  - Channel base power: 20 dBm
  - Measurement bandwidth: 1 kHz

**Note:** This completes the VNA calibration at the reference planes. The following [step 20](#) to [step 28](#) are required to **position the reference antenna** for a path loss calibration.
20. Prepare the base table for use: Mount its four legs as shown in [Figure 4-6](#) and make sure that the two longer legs, which are extended by a pin, stand opposite of each other.



Figure 4-6: Base table with mounted legs

21. Distinguish between two cases:
  - **Case 1:** For a path loss calibration on the **flat EUT table**, do **not** insert the base table into the chamber
  - **Case 2:** For a path loss calibration on one of the **automated 3D positioners** R&S DST-B160 or R&S DST-B165, **insert** the base table into the R&S DST200 chamber as follows:

- Orient the table, to position the two extended legs (with pins at the lower ends) at the front and rear side.
  - Stick all four legs of the base table into holes in the absorber panels.
  - Make sure that the two pins are inserted into the two small holes in the metal mounting plate below the absorber panels.
22. Distinguish between another two cases:
- **Case A:** To prepare a calibration with reference antenna R&S TS-RANT3, leave the SMA-N adapter mounted at the end of the RF cable that comes out of adapter B.
  - **Case B:** To prepare a calibration with reference antenna R&S TS-RANT18, remove the SMA-N adapter from the end of the RF cable that comes out of adapter B.
23. Connect the RF cable that comes out of adapter B (with or without SMA-N adapter) to the selected reference antenna.
24. Inside the R&S DST200, mount the reference antenna at a height that is equivalent with the center of the selected positioner. Depending on the selected reference antenna and positioner, mount the antenna onto the base table and height adapters (from [Figure 4-4](#)) in the following arrangement:

*Table 4-1: Table and height adapter arrangements for various reference antennas & positioners*

Positioner → Antenna ↴	Flat EUT table (D = 350 mm)	R&S DST-B160 (D = 270 mm)	R&S DST-B165 (D = 190 mm)
R&S TS-RANT3	adapter B (no base table)	base table + adapter D	base table + adapter D + E
R&S TS-RANT18	adapter B (no base table)	base table + adapter C	base table + adapter C + E

**Note:** Always completely insert the antenna and all adapters down to the mechanical stop.

25. Connect the RF cable from the second calibration plane ("TA") to either the "LR" or the "FB" polarization connector of the test antenna.  
Make sure to select the correct test antenna polarization connector to match the reference antenna orientation.
26. Terminate the other polarization connector of the test antenna with 50 ohm coaxial load (not included in the R&S DST-B120 kit).
27. Connect the RF feed cable to the test antenna.
28. Fully close the R&S DST200 chamber with outer handle.

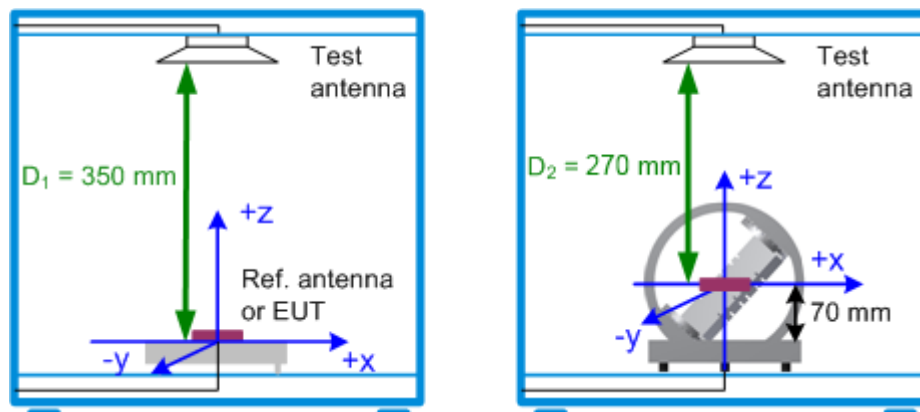
The path loss calibration can now be performed for both polarizations at the selected height between test and reference antenna, as described in the test instruction document [R&S DST200 - Path Loss Determination in the RF Diagnostic Chamber](#).

## 4.4 Generic RF Parameters: R&S DST-B220

You can download a set of measured antenna factors (AF), reference path loss values (PL) and transducer factors (TRD) from the R&S DST200 homepage (<http://www.rohde-schwarz.com/product/DST200.html>).

The measured values are valid for any linear-polarized electrical field in the horizontal plane ( $E_z = 0$ ) incident on the test antenna (AF, PL) or the EUT (TRD, PL). The EUT is positioned at the origin of the rectangular coordinate system of the chamber, once on the top surface of the standard EUT table, once in the center of the manual or automated 3D positioner. For more information see [Chapter 3.3, "3D Positioners for the R&S DST200"](#), on page 19.

The two distances  $D_1 = 350$  mm and  $D_2 = 270$  mm are the distances between the reference antenna / receiver and the test antenna.



**Figure 4-7: Definition of distances between test antenna and reference antenna**

The uncertainty  $U$  is the sum of the expanded uncertainty of the gain of the reference antenna utilized for determining the RF parameters, and the maximum uncertainty due to an imperfect axial ratio of the test antenna.

The test antenna factor AF ([dB/m], for EMI applications) is obtained as:

$$AF = E_{TA} - V_{TA}$$

where  $E_{TA}$  [dB $\mu$ V/m] is the electric field strength with horizontal polarization incident on the test antenna, and  $V_{TA}$  [dB $\mu$ V] is the output voltage at RF ANT. AF was determined using the standard EUT table (distance  $D_1$ ).

The reference path loss PL ([dB], for OTA applications) is measured as described in [Chapter 4.1, "Background"](#), on page 37:

$$PL = G_{RA} + P_{RA} - P_{TA}$$

The antenna transducer factor TRD ([dBV/m/sqrt(W)], for EMS applications) is given by:

$$TRD = E_{EUT} - 0.5 * P_{TA}$$

where  $E_{EUT}$  [dBV/m] is the electric field strength with horizontal polarization at the EUT location ( $D_1$  or  $D_2$ ) when the test antenna is fed with  $P_{TA}$  [dBW] into the RF ANT connector.



#### RF parameters

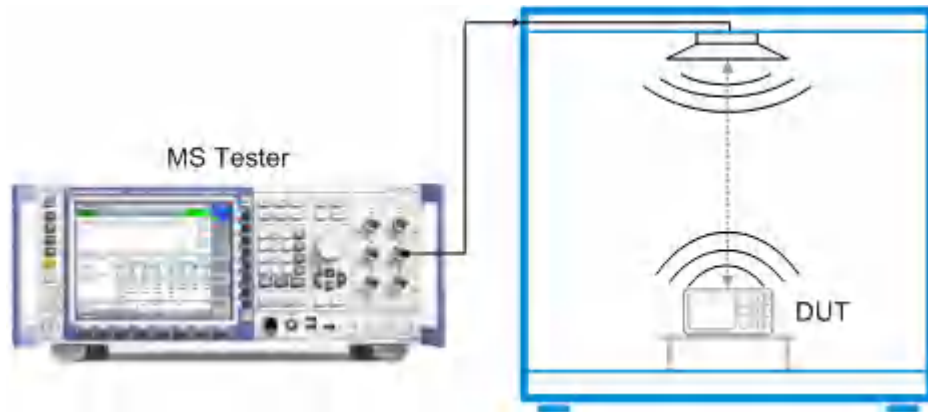
A comprehensive set of RF parameters is available for download from the product homepage (<http://www.rohde-schwarz.com/product/DST200.html>) of the R&S DST200. These values are generic values collected in a specific R&S DST200 sample measurement. To obtain the values specific for your RF Diagnostic Chamber, use a calibrated reference antenna and perform the reference path loss measurement as described in [Chapter 4.2, "Measurement"](#), on page 38.

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## 5 Test Scenarios

### 5.1 Desense and Self-Interference Tests

The basic test setup for receiver and transmitter tests in an interference-free and reflection-free environment is shown below. The equipment under test (typically, a mobile station, but also any other device with a radio interface) is placed on the EUT table inside the RF Diagnostic Chamber. The bidirectional RF connector RF ANT is connected to a radio communication tester. The tester serves as a base station simulator (BSS) providing a downlink/forward link signal for receiver tests and measuring the uplink signal from the EUT.



*Figure 5-1: Basic test setup for receiver and transmitter tests*

Knowledge of the RF path loss in downlink and uplink direction is essential for this type of measurement; see [Chapter 5.2, "Path Loss Measurement"](#), on page 48.

Desense is the degradation of receiver performance, which is typically caused by in-band or out-of-band signals or broadband noise. The receiver performance is characterized by the sensitivity level, i.e. the minimum RF input signal level where the Bit Error Rate is below a given threshold value. Receiver desense results in an increased sensitivity level. The following figure shows a desense test in the GSM900 band. The two sharp peaks are caused by self-interference on two particular channels.

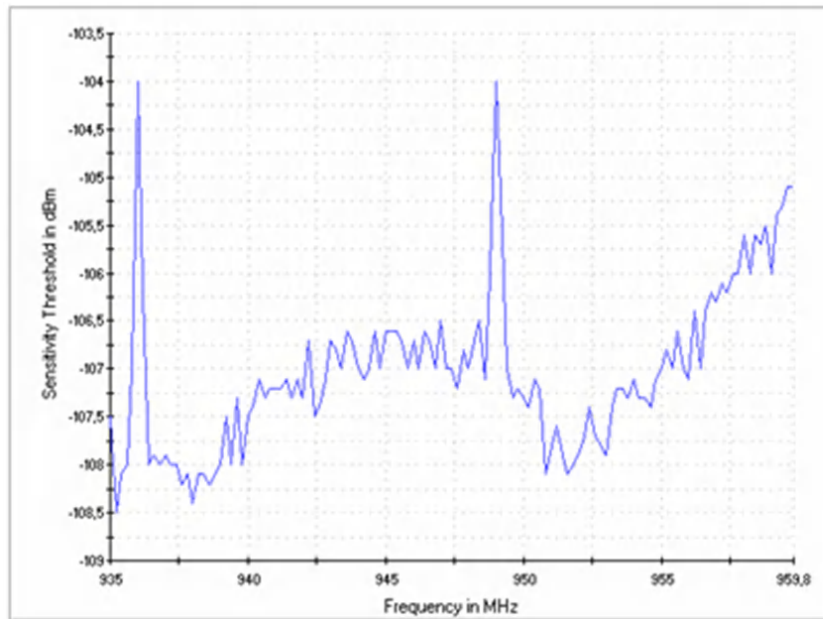


Figure 5-2: GSM desense test

### Coexistence tests

The following figure shows a test setup for a Bluetooth® / GSM coexistence test with the RF Diagnostic Chamber and two radio communication testers. The R&S CBT Bluetooth® tester maintains a connection to the EUT and measures the sensitivity level. An R&S CMW500 is used to set up a parallel GSM connection which may (or may not) adversely affect the Bluetooth® sensitivity level.

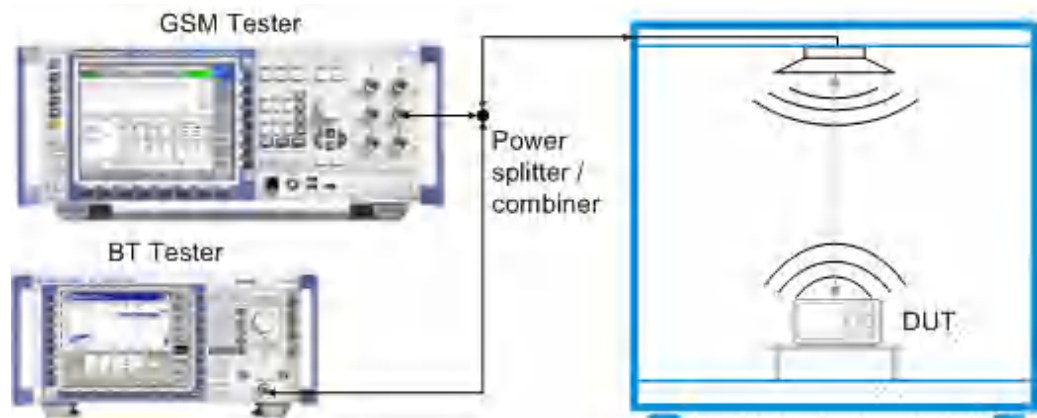


Figure 5-3: Test setup for Bluetooth / GSM coexistence tests

## 5.2 Path Loss Measurement

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 RF Diagnostic Chamber (including its connection to the RF ANT connector), the loss  $PL_A$  introduced by the antenna, and any loss  $PL_{ext}$  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.

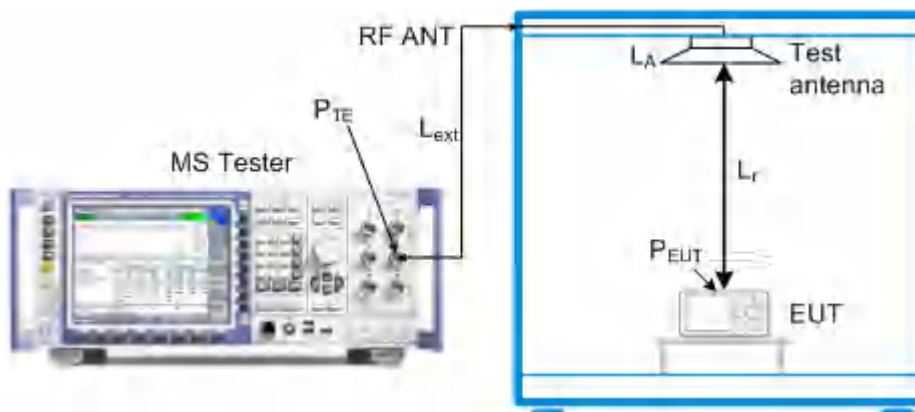


Figure 5-4: Path loss

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

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

Each R&S DST200 antenna model (R&S DST-B215, R&S DST-B220, R&S DST-B231 and R&S DST-B270) provides different path loss. If you use a cross-polarized antenna (R&S DST-B215), you should measure the path loss for each electric field polarization separately.

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, R&S DST200 antenna model and EUT type

The path loss values depend on the R&S DST200 antenna model (R&S DST-B215, R&S DST-B220, R&S DST-B231 and R&S DST-B270) and the EUT type. If a cross-polarized antenna (R&S DST-B215) is used, the path loss for each field polarization should be measured separately. Results for a particular EUT type (e.g. a mobile phone) should be determined using a fully functional and proven device ("golden" device); they may then be applied to all EUTs of the same type. The path loss value changes as a function of EUT orientation for EUTs with non-isotropic radiation pattern. 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 [Chapter 4, "Reference Path Loss Measurement"](#), on page 37.

## 5.2.1 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.

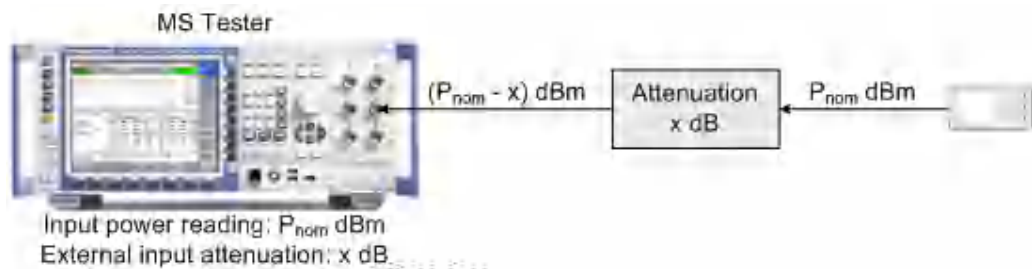


Figure 5-5: Definition of input path loss

## 5.2.2 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.

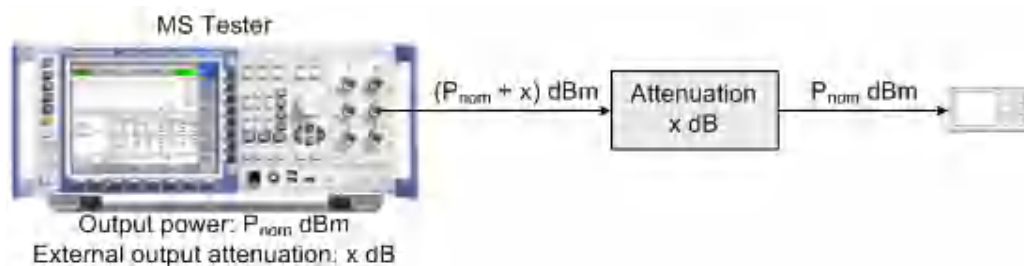


Figure 5-6: Definition of output path loss

### 5.2.3 Determining Path Loss Values: R&S CMW

External input and output attenuation factors are reported in the configuration dialogs of the different measurement and generator/signaling firmware applications of the R&S CMW. The procedure for determining the path loss values is analogous for all networks; for an overview refer to [Chapter 5.2.3.4, "Other Network Standards"](#), on page 53. The following example shows the necessary steps for a WiMAX mobile phone.



The following example requires an R&S CMW tester (model R&S CMW500 or R&S CMW270) equipped with the "WiMAX Measurements" and the "WiMAX Signaling" firmware applications. If no signaling application is available for a given network standard, you have to determine the received signal power and the transmitter output power of your EUT by external means.

#### 5.2.3.1 Preparatives

In the following example, the EUT is a WiMAX MS supporting a 10 MHz bandwidth. The procedure for other bandwidths is similar, however, some more R&S CMW settings may have to be adjusted.

1. Connect the N connector of your RF Diagnostic Chamber R&S DST200 to the bidirectional RF connector RF 1 COM of the R&S CMW, preferably using the high-quality RF cable supplied with the RF Diagnostic Chamber.
2. Place a fully functional and proven MS on the EUT table.
3. Switch on the R&S CMW and the MS.

#### 5.2.3.2 Input Path Loss

Determining the input path loss requires the "WiMAX Measurements" and the "WiMAX Signaling" firmware applications.

1. Access the "WiMAX Signaling" firmware application and establish a connection between the R&S CMW and the MS, using default settings.

When the R&S CMW shows the connection status "Network Entry Completed", press the "MS Channel Report" softkey.

- Open the "Results > MS Channel Report" section in the measurement dialog and read the "UL TX Power (Data Carrier Power)" result.

MS Channel Report	
CINR Mean	28.000 dB
CINR Deviation	12.000 dB
UL TX Power (Data Carrier Power)	-37.000 dBm
RSSI Mean	-50.00 dBm
RSSI Deviation	-3.50 dB

Figure 5-7: WiMAX Signaling: UL TX Power

- Open the "WiMAX Measurements" application and press ON | OFF to start the measurement.
- Open the "Multi Evaluation Configuration" dialog and enable an "Combined Signal Path" measurement scenario.

Scenario	Combined Signal Path	
RF Routing	RF-Rx 1	Connector: RF1 COM
External Attenuation (Input)	0.00 dB	
Frequency	3500.000000 MHz	
Expected Nominal Power	0.00 dBm	Ref.Level: 0.00 dBm
User Margin	0.00 dB	

Figure 5-8: WiMAX Measurement: RF Settings

- Close the configuration dialog and read the average "Subcarrier Power > Data" result from the "Measurement Overview" tables.

Subcarrier Power				
Data [dBm]	-69.65	-69.55	-69.76	-69.43
Pilots [dBm]	-69.55	-69.46	-69.56	-69.37

Figure 5-9: WiMAX Measurements: Subcarrier Power

- To determine the input path loss of your mobile phone, subtract the measured "Subcarrier Power > Data" from the reported "UL TX Power (Data Carrier Power)" of the MS. In the example above, the input path loss equals to approx.  $(-37.00 - (-69.65)) \text{ dB} = 32.65 \text{ dB}$ .
- Re-open the "Multi Evaluation Configuration" dialog and enter the input path loss as an "External Attenuation (Input)"; see [Figure 5-8](#).



For the example above we assume that the "UL TX Power" reported by the MS corresponds to the power of one subcarrier. Adjust the calculation if your MS uses a different definition of the "UL TX Power".

### 5.2.3.3 Output Path Loss

Determining the output path loss requires the "WiMAX Signaling" firmware application only.

1. Access the "WiMAX Signaling" firmware application and establish a connection between the R&S CMW and the MS, using default settings.

When the R&S CMW shows the connection status "Network Entry Completed", press the "MS Channel Report" softkey.

2. Open the "Results > MS Channel Report" section in the measurement dialog and read the "RSSI Mean" result.

MS Channel Report	
CINR Mean	20.000 dB
CINR Deviation	40.000 dB
UL TX Power (Data Carrier Pow...	-19.500 dBm
RSSI Mean	-80.000 dBm
RSSI Deviation	-101.000 dB

Figure 5-10: WiMAX Signaling: RSSI Mean

3. Expand the "General Settings > RF Output (Tx)" section and read the "Preamble Power".

RF Output (Tx)		FrontEnd 1
RF Routing		RF1 COM
External Attenuation		0.00 dB
Tx Power Data Carrier		-80.00 dBm
Preamble Power		-46.50 dBm

Figure 5-11: WiMAX Signaling: Preamble Power

4. To determine the output path loss of your mobile phone, subtract the reported "RSSI Mean" from the "Preamble Power" of the downlink signal. In the example above, the output path loss equals to  $(-46.5 - (-80.0)) \text{ dB} = 33.5 \text{ dB}$ .
5. Enter the path loss as an "External Attenuation". The R&S CMW will increase its "TX Power Data Carrier" to ensure a correct input power at the MS receiver.



The RSSI scale covers DL powers between  $-123 \text{ dBm}$  and  $-40 \text{ dBm}$ . The 1-dB step width of the RSSI scale and the accuracy of the RSSI measurement at the MS limits the accuracy of the measured output path loss values. Ensure that the "Preamble Power" of your DL signal is within the RSSI range.

### 5.2.3.4 Other Network Standards

The measurement method outlined above is also suitable for determining path loss values for other network standards. The necessary R&S CMW configuration and the essential settings are listed in [Table 5-1](#).

As a general rule, the R&S CMW must be equipped with a signaling application (option R&S CMW-KSxxx) plus a measurement application (option R&S CMW-KMxxx) for every measured network standard.

### Input path loss

After the R&S CMW has established a connection with the EUT, the reported EUT output power is displayed by some signaling applications. If the EUT does not report its output power, configure a known output power, for example by sending TPC commands to the EUT so that it sends at its known maximum power.

The R&S CMW input power can be determined using the measurement application.

The input path loss is the difference between the EUT output power and the measured input power:

$$\langle \text{Input path loss} \rangle = \langle \text{EUT output power} \rangle - \langle \text{R\&S CMW input power} \rangle$$

### Output path loss

The R&S CMW generator power corresponds to the downlink/forward signal power that the R&S CMW uses for the connection. It is defined in the configuration dialog of the signaling application.

For some network standards, the received signal level is reported by the EUT and displayed by the signaling application.

The output path loss is the difference between the two values:

$$\langle \text{Output path loss} \rangle = \langle \text{R\&S CMW generator power} \rangle - \langle \text{Received signal level of EUT} \rangle$$

In CDMA2000 and 1xEV-DO networks, the received signal level is not reported by the DUT. Instead, the output path loss can be determined in an access probe measurement, see notes in the following table.



### Accuracy considerations

The EUT reports its output power and the received signal power as digital values (power steps). Each value denotes a power range, which necessarily limits the accuracy of the measurement method. The accuracies quoted in the table correspond to the distance between the reported power steps.

---

Table 5-1: Path loss measurements for different network standards using the R&amp;S CMW

Standard	Software options <sup>1)</sup>	Input path loss		Output path loss			Resolution
		EUT output power (UL)	R&S CMW input power (UL)	Resolution	R&S CMW generator power (DL)	Received signal level of EUT (DL)	
WiMAX	KS700 KM700	Reported UL TX Power (Data Carrier Power)	Subcarrier Power > Data	0.5 dB	TX Power Data Carrier	RSSI Mean (-40 dBm at max.)	1 dB
GSM	KS200 KM200	RF Settings > TCH/PDCH > Circuit Switched > PCL	Burst Power	1 dB	RF Settings > TCH/PDCH > Reference Level	RX Level (-48 dBm at max.)	1 dB
LTE	KS500/550 KM500/550	Known EUT power	TX Power	-	Downlink Power Levels > RS EPRE	RSRP (-44 dBm at max.)	1 dB
WCDMA	KS400 KM400	Known EUT power	UE Power (RMS)	-	RF Settings > RF Power Downlink > Output Power (lor) / dBm + Physical Downlink Settings > P-CPICH Level / dB	CPICH RSPC(-25 dBm at max.)	1 dB
CDMA2000	KS800 KM800	Known EUT power	MS Power (1.23 MHz BW)	-	CDMA power <sup>2)</sup>	<Power offset> - (MS Power (1.23 MHz BW) - <Input path loss> <sup>3)</sup> )	-
1xEV-DO	KS880 KM880	Known EUT power	AT Power (1.23 MHz BW)	-	CDMA power <sup>2)</sup>	<Power offset> - (AT Power (1.23 MHz BW) - <Input path loss> <sup>3)</sup> )	-

1) All listed options are R&S CMW-... options. Example: KS700 means R&S CMW-KS700.

2) See standard 3GPP2 C.S0011-A, "Range of Open Loop Output Power". To obtain access probes with constant power, configure the signaling application as follows: "Network > Access Probes > Access Probes: Ignore, Probe Increment 0 dB".

3) When transmitting access probes, the MS/AT applies the open loop condition: The sum of the mean input power plus the mean output power is equal to a constant "Open Loop Power Offset". The mean output power of the MS/AT is the access probe power measured by the R&S CMW plus the input path loss determined previously. Open loop power offset values are specified in standard TIA-1030-C, depending on the band class and the spreading rate. Consequently the path loss measurement must be repeated for different band classes.

## 5.2.4 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.

### 5.2.4.1 Preparatives (GSM or WCDMA)

1. Connect the N connector of your RF Diagnostic Chamber R&S DST200 to the bidirectional RF connector RF 2 of the R&S CMU200, preferably using the high-quality RF cable supplied with the RF Diagnostic Chamber.
2. Place a fully functional and proven MS on the EUT table.
3. Switch on the R&S CMU200 and the MS.

### 5.2.4.2 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.



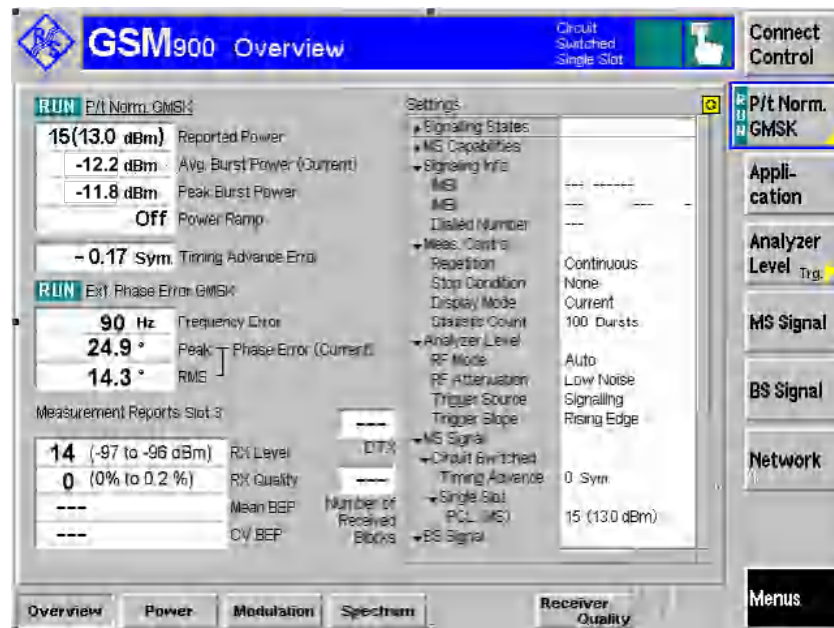


Figure 5-12: GSM900 Signaling: Overview dialog

3. 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.
4. 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.
5. 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](#)).

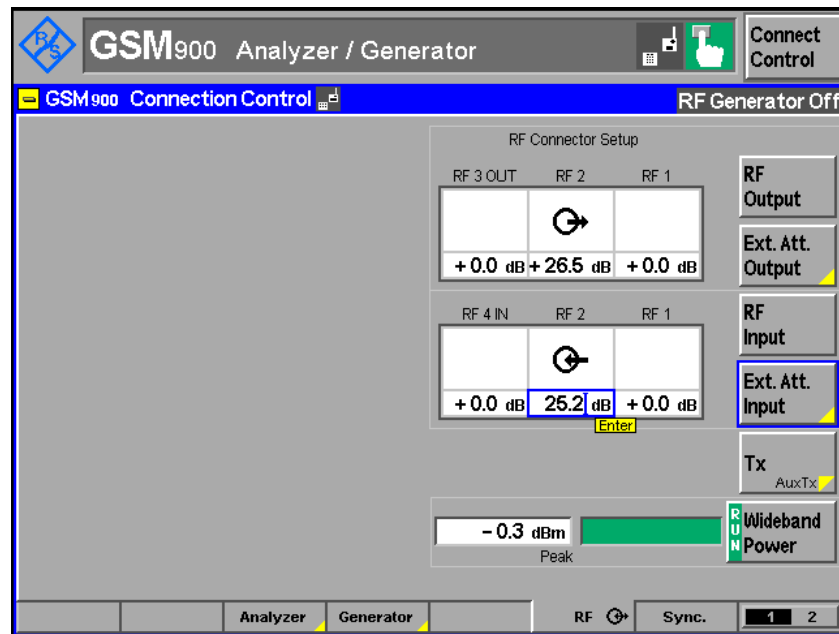


Figure 5-13: GSM900 Signaling: RF IN/OUT tab

#### 5.2.4.3 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.

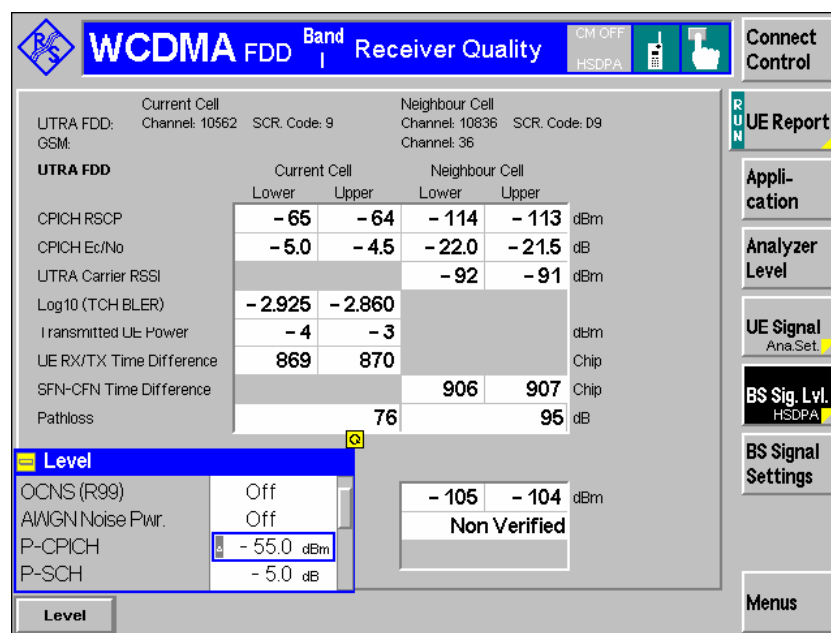


Figure 5-14: WCDMA Signaling: UE Report dialog

- 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.

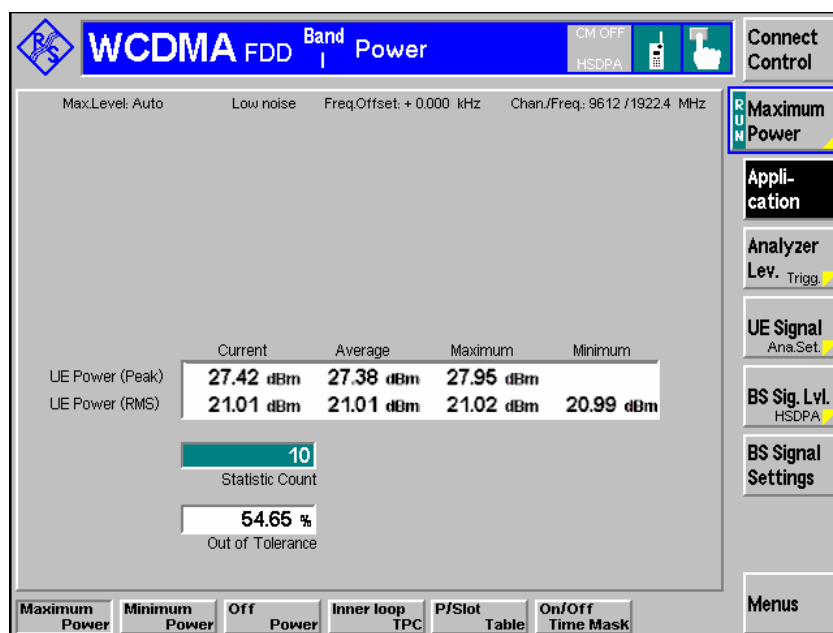


Figure 5-15: WCDMA Signaling: Maximum Power dialog

5. 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.  $(24 - 21) \text{ dB} = 3 \text{ dB}$ .
6. 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.

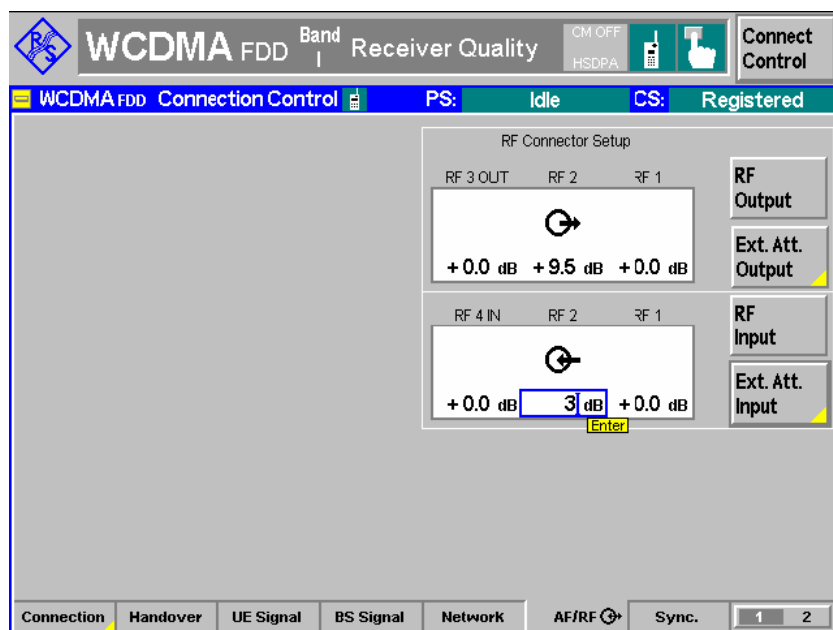


Figure 5-16: WCDMA Signaling: AF/RF IN/OUT tab

## 6 Maintenance

The outside of the RF Diagnostic Chamber can be cleaned sufficiently using a soft, lint-free dust cloth.

### Shielding gaskets at the front door

The front door and the EMI/EMC shielding gaskets around the door joint must be inspected at regular intervals. The purpose of the gaskets is to ensure a good, continuous electrical contact between the closed door and the front side of the chamber. To maintain the shielding effectiveness of the chamber, the gaskets must be regularly cleaned.

To clean the gaskets, gently wipe the contact surfaces with a clean cloth soaked in ethyl alcohol. If corrosion or discoloration persists, you can clean the surfaces using a non-scratch scrub sponge such as Scotch-Brite™. There is no need to coat the cleaned gaskets with lubricant or oil.

If corrosion still persists, replace the gaskets as described in [Chapter 3.1.3, "Replacing the Shielding Gaskets"](#), on page 11. Replace all gaskets with broken, bent, or missing fingers.

### Inspection intervals

The door and the shielding gaskets should be inspected every six months. Shorter inspection and cleaning intervals are recommended if the RF Diagnostic Chamber is used very frequently or if it is exposed to temperature change, humidity, or corrosive environments.

Positioning accuracy of R&S DST-B160 automated 3D positioner should be verified before each test session. The user shall perform Auto Homing operation using R&S AMS32 software package. The user should verify if azimuth and elevation rotator stay at the position 0 deg within the specification limits defined by the data sheet of the R&S DST200, see PD 5214.3600.22. If the position values exceed the limits the user shall contact the local R&S service engineer."

## 6.1 Spare Parts

The mechanical spare parts and expendables for the RF Diagnostic Chamber are listed below. To order these parts, please contact your local [Rohde & Schwarz service center](#).

**Table 6-1: List of expendable parts**

Part designation	Order number	Remarks
<b>R&amp;S DST200 RF Diagnostic Chamber</b>		
FEEDTHROUGH PANEL BLIND	1514.2101.00	See <a href="#">Chapter 3.2.5, "Mounting Filter and Interface Panels"</a> , on page 18
EUT TABLE	1514.7655.00	See <a href="#">Figure 3-5</a>

Part designation	Order number	Remarks
VELCRO FASTENER SET	1514.5823.00 <sup>1)</sup>	To mount ABSORBER WALL at the door and ABSORBER TOP at the top panel of the R&S DST200
ABSORBER TOP	1519.0059.00	
ABSORBER WALL	1519.0071.00 <sup>2)</sup>	
ABSORBER BOTTOM A	1519.0088.00	See <a href="#">Figure 3-4</a>
ABSORBER BOTTOM B	1519.0036.00	
ABSORBER BOTTOM C	1519.0042.00	
EMV GASKET SET	1518.5092.00 <sup>1)</sup>	See <a href="#">Chapter 3.1.3, "Replacing the Shielding Gaskets"</a> , on page 11
<b>R&amp;S DST-B16x Automated 3D Positioners</b>		
EUT HOLDER (DST-B160)	1518.5086.00	See <a href="#">Table 3-2</a>
EUT HOLDER (DST-B165)	1519.3906.00	
MOBILE UNIT SUPPORT (DST-B160)	1518.5163.00	See <a href="#">Figure 3-7</a>
MOBILE UNIT SUPPORT (DST-B165)	1519.3887.00	
MOBILE UNIT (DST-B160)	1518.5170.00	
MOBILE UNIT (DST-B165)	1519.3893.00	
MOTOR UNIT (DST-B160/-B165)	1518.5186.00	
CABLE RS232	1518.4744.00	See <a href="#">Figure 3-9</a>
CABLE MOTOR BOX	1518.4738.00	
<b>Other</b>		
R&S DST-B215 CROSS-POLARIZED TEST ANTENNA	1527.3576.02	Includes the whole option
R&S DST-B220 CIRCULAR-POLARIZED TEST ANTENNA	1518.4509.02	
R&S DST-B231 TEST ANTENNA KIT	1518.5328.02	
R&S DST-B270 LINEAR-POLARIZED COMMUNICATION ANTENNA	1518.4515.02	

1) Contains required quantity for the whole unit.

2) Four pieces required for the whole unit.

## Glossary: Frequently Used Terms and Abbreviations

### A

**AF:** Audio frequency **or** antenna factor

### C

**CTIA:** Cellular Telephone Industries Association

**CWG:** Converged Wireless Group

### D

**DC:** Direct current

**DL:** Downlink

### E

**EMI:** Electromagnetic Interference

**EMS:** Electromagnetic Susceptibility

**EUT:** Equipment under test

### M

**MS:** Mobile phone, mobile station

### O

**OTA:** Over-the-air (tests)

### P

**PC:** Personal computer

**PL:** Path loss

**PTCRB:** PCS Type Certification Review Board

### R

**RAM:** Radio absorbent material

**RF:** Radio frequency

### T

**TA:** Test antenna

**TRD:** Transducer factor

## **U**

**UL:** Uplink

## **V**

**VNA:** Vector network analyzer

**VSWR:** Voltage standing wave ratio



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