Fading Simulator R&S®SMW-B14/-B15/-K71/-K72/-K73/-K74/-K75/-K820/-K821/-K822/-K823 User Manual

1175682602
Version 30

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This document describes the following software options:

- R&S®SMW-B14 Fading simulator (1413.1500.02)
- R&S®SMW-B15 Fading simulator and signal processor (1414.4710.xx)
- R&S®SMW-K71 Dynamic fading (1413.3532.xx)
- R&S®SMW-K72 Enhanced models (1413.3584.xx)
- R&S®SMW-K73 MIMO-OTA enhancements (1414.2300.xx)
- R&S®SMW-K74 MIMO-fading/routing (1413.3632.xx)
- R&S®SMW-K75 Higher-order MIMO (1413.9576.xx)
- R&S®SMW-K820 Customized dynamic fading (1414.2581.xx)
- R&S®SMW-K821 MIMO subsets (1414.4403.xx)
- R&S®SMW-K822 Fading BW extension (1414.6712.xx)
- R&S®SMW-K823 Fading BW extension (1414.6735.xx)

This manual describes firmware version FW 5.30.175.xx and later of the R&S®SMW200A.

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The following abbreviations are used throughout this manual: R&S®SMW200A is abbreviated as R&S SMW, R&S®WinIQSIM2 is abbreviated as R&S WinIQSIM2; the license types 02/03/07/11/13/16/12 are abbreviated as xx.

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1 Welcome to the fading simulator

The hardware option R&S SMW-B14/B15 in combination with the firmware applications R&S SMW-K71/-K72/-K73/-K74/-K75/-K820/-K821/-K822/-K823 add functionality to simulate fading propagation conditions.

Key features

The most important features at a glance:

- Simulation of real time fading conditions in SISO and MIMO modes.
- Main characteristics in SISO mode:
  - Maximal bandwidth B_{max} = 160 MHz (R&S SMW-B14), 200 MHz (R&S SMW-B15), 400 MHz (R&S SMW-K822) and 800 MHz (R&S SMW-K823)
  - Up to 20 fading paths in SISO mode in two independent channels
- Support of versatile MIMO configurations, like 2x2, 2x8 and 4x4 MIMO channels with up to 64 MIMO channels
  - 20 paths per MIMO channel
  - Sampling rate and maximal bandwidth depend on the MIMO mode and the installed option (R&S SMW-B14/-B15/-K822/-K823)
- Simulation of multiple entity MIMO scenarios, like 4x2x2 MIMO or 8xSISO (8x1x1) configurations
- A wide range of presets based on the test specifications of the major mobile radio standards, incl. Rel. 15 and Rel. 16 5G new radio channel models
- Graphical presentation of the defined fading paths

For more information, refer to the specifications document.

This user manual contains a description of the functionality that the application provides, including remote control operation.

All functions not discussed in this manual are the same as in the base unit and are described in the R&S SMW200A user manual. The latest version is available at:

www.rohde-schwarz.com/manual/SMW200A

Installation

You can find detailed installation instructions in the delivery of the option or in the R&S SMW200A service manual.

1.1 Accessing the fading simulator

To access and configure the "Fading Simulator" settings

Depending on the installed options:

1. Option: **R&S SMW-B14**
   a) In the block diagram of the R&S SMW200A, select "Fading > Fading Settings".
2. Option: **R&S SMW-B15**
   a) In the block diagram of the R&S SMW200A, select "I/Q Stream Mapper > Fading/Baseband Config > Mode = Advanced".
   b) Select "Signal Outputs = Analog & Digital"
   c) Confirm with "Apply".
   d) In the block diagram of the R&S SMW200A, select "Fading > Fading Settings".

   A dialog box opens that display the provided general settings.

The signal generation is not started immediately. To start signal generation with the default settings, select "Fading > State > On".

For information, see:

- Chapter 2, "About the fading simulator", on page 18
- Chapter 3, "Fading settings", on page 28
- Chapter 4, "Signal routing settings", on page 91
- Chapter 5, "Multiple input multiple output (MIMO)", on page 95

1.2 What's new

This manual describes firmware version FW 5.30.175.xx and later of the R&S®SMW200A.

Compared to the previous version, it provides the following new features:

- Update of the DAB standards, see Chapter A.8, "DAB standards", on page 277.

1.3 Documentation overview

This section provides an overview of the R&S SMW200A user documentation. Unless specified otherwise, you find the documents at:

www.rohde-schwarz.com/manual/smw200a

1.3.1 Getting started manual

Introduces the R&S SMW200A and describes how to set up and start working with the product. Includes basic operations, typical measurement examples, and general information, e.g. safety instructions, etc. A printed version is delivered with the instrument.

1.3.2 User manuals and help

Separate manuals for the base unit and the software options are provided for download:

- Base unit manual
  Contains the description of all instrument modes and functions. It also provides an introduction to remote control, a complete description of the remote control commands with programming examples, and information on maintenance, instrument interfaces and error messages. Includes the contents of the getting started manual.
- Software option manual
  Contains the description of the specific functions of an option. Basic information on operating the R&S SMW200A is not included.

The contents of the user manuals are available as help in the R&S SMW200A. The help offers quick, context-sensitive access to the complete information for the base unit and the software options.

All user manuals are also available for download or for immediate display on the internet.

1.3.3 Tutorials

The R&S SMW200A provides interactive examples and demonstrations on operating the instrument in the form of tutorials. A set of tutorials is available directly on the instrument.

1.3.4 Service manual

Describes the performance test for checking compliance with rated specifications, firmware update, troubleshooting, adjustments, installing options and maintenance.

The service manual is available for registered users on the global Rohde & Schwarz information system (GLORIS):

https://gloris.rohde-schwarz.com

1.3.5 Instrument security procedures

Deals with security issues when working with the R&S SMW200A in secure areas. It is available for download on the internet.

1.3.6 Printed safety instructions

Provides safety information in many languages. The printed document is delivered with the product.

1.3.7 Specifications and product brochures

The specifications document, also known as the data sheet, contains the technical specifications of the R&S SMW200A. It also lists the firmware applications and their order numbers, and optional accessories.

The brochure provides an overview of the instrument and deals with the specific characteristics.

See www.rohde-schwarz.com/brochure-datasheet/smw200a

1.3.8 Calibration certificate

The document is available on https://gloris.rohde-schwarz.com/calcert. You need the device ID of your instrument, which you can find on a label on the rear panel.

1.3.9 Release notes and open source acknowledgment

The release notes list new features, improvements and known issues of the current software version, and describe the software installation.

The software uses several valuable open source software packages. An open source acknowledgment document provides verbatim license texts of the used open source software.

www.rohde-schwarz.com/firmware/smw200a

1.3.10 Application notes, application cards, white papers, etc.

These documents deal with special applications or background information on particular topics.

www.rohde-schwarz.com/application/smw200a

For some application sheets, see also:

www.rohde-schwarz.com/manual/smw200a

1.3.11 Videos

Find various videos on Rohde & Schwarz products and test and measurement topics on YouTube: https://www.youtube.com/@RohdeundSchwarz

On the menu bar, search for your product to find related videos.

Figure 1-1: Product search on YouTube

1.4 Scope

Tasks (in manual or remote operation) that are also performed in the base unit in the same way are not described here.

In particular, it includes:

- Managing settings and data lists, like saving and loading settings, creating and accessing data lists, or accessing files in a particular directory.
- Information on regular trigger, marker and clock signals and filter settings, if appropriate.
- General instrument configuration, such as checking the system configuration, configuring networks and remote operation
- Using the common status registers

For a description of such tasks, see the R&S SMW200A user manual.

1.5 Notes on screenshots

When describing the functions of the product, we use sample screenshots. These screenshots are meant to illustrate as many as possible of the provided functions and possible interdependencies between parameters. The shown values may not represent realistic usage scenarios.

The screenshots usually show a fully equipped product, that is: with all options installed. Thus, some functions shown in the screenshots may not be available in your particular product configuration.

2 About the fading simulator

Equipped with the required options, the R&S SMW200A allows you to superimpose real time fading on the baseband signal at the output of the baseband block. In R&S SMW200A equipped with standard baseband (R&S SMW-B10) and fitted with all the possible fading options, there are up to 20 fading paths in SISO mode available. There are also 20 fading paths per MIMO channel in 4x4 MIMO mode available.

2.1 Required options

R&S SMW200A equipped with standard baseband (R&S SMW-B10)

The equipment layout for simulating fading effects in non-MIMO configurations:

- Option baseband generator (R&S SMW-B10) per signal path
- Option baseband main module, one/two I/Q paths to RF (R&S SMW-B13/B13T)
- Option fading simulator (R&S SMW-B14) per signal path
  (sufficient for simulation of fading paths with standard delay and paths with enhanced resolution)
- Additional options that extend the fading functionality:
  – Option dynamic fading (R&S SMW-K71) per signal path
    (required for the simulation of dynamic fading conditions, like birth death propagation, moving propagation, two-channels interferes, high-speed train and customized fading conditions)
  – Option extended statistic functions (R&S SMW-K72) per signal path
    (required for additional fading profiles and some of the predefined test scenarios)
  – Option MIMO-OTA enhancements (R&S SMW-K73) per signal path
    (required for full support of antenna radiation patterns, inverse channel matrix and the geometric-based channel model)
  – Option customized fading (R&S SMW-K820) per signal path
    (required for import of dynamic fading list)

The equipment layout for simulating fading effects in MIMO configurations:

- Two options baseband generator (R&S SMW-B10)
- Option two I/Q paths to RF (R&S SMW-B13T)
- At least two options fading simulator (R&S SMW-B14)
- Option MIMO fading (R&S SMW-K74)
  (required for the configuration of LxMxN MIMO scenarios, with L ≤ 2 and up to 16 channels, like 1x2x8 or 1x4x4 scenarios)
- Option higher-order MIMO (R&S SMW-K75)
  (required for the configuration of higher-order LxMxN MIMO scenarios, with L ≤ 2 and up to 32 channels like 2x4x4)
- Option multiple entities (R&S SMW-K76)

(required for the configurations with more than two entities, like 8x1x1 scenarios)

The equipment layout for simulating fading effects in higher-order MIMO configurations, like 1x8x8:

- Two options baseband generator (R&S SMW-B10)
- Option two I/Q paths to RF (R&S SMW-B13T)
- Four options fading simulator (R&S SMW-B14
- Option MIMO fading (R&S SMW-K74)
- Option higher-order MIMO (R&S SMW-K75)
- Option MIMO subsets (R&S SMW-K821)
  (required for the simulation of up to 32 channels (i.e. a subset of the MIMO channels) in a 1x8x8 MIMO scenario)

For more information, refer to the specifications document.

R&S SMW200A equipped with wideband baseband (R&S SMW-B9)

- Option baseband wideband generator (R&S SMW-B9) per signal path
- Option baseband main module (R&S SMW-B13XT)
- Option fading simulator (R&S SMW-B15) per signal path
  (sufficient for simulation of fading paths with standard delay and paths with enhanced resolution)
- Additional options that extend the fading functionality:
  – Option dynamic fading (R&S SMW-K71) per signal path
    (required for the simulation of dynamic fading conditions, like birth death propagation, moving propagation, two-channels interferes, high-speed train and customized fading conditions)
  – Option extended statistic functions (R&S SMW-K72) per signal path
    (required for additional fading profiles and some of the predefined test scenarios)
  – Option MIMO-OTA enhancements (R&S SMW-K73) per signal path
    (required for full support of antenna radiation patterns, inverse channel matrix and the geometric-based channel model)
  – Option-customized fading (R&S SMW-K820) per signal path
    (required for import of dynamic fading list)

The equipment layout for simulating fading effects in MIMO configurations:

- Option baseband wideband generator (R&S SMW-B9) per signal path
- Option baseband main module (R&S SMW-B13XT)
- At least two options fading simulator (R&S SMW-B15)
- Option MIMO fading (R&S SMW-K74)
  (required for the configuration of MIMO scenarios with up to 16 channels, like 1x2x8 or 1x4x4 scenarios)
- Option higher-order MIMO (R&S SMW-K75)
  (required for the configuration of higher-order MIMO scenarios with up to 64 channels)
- Option multiple entities (R&S SMW-K76)

(required for the configurations with more than two entities, like 2x1x1 scenarios)
- Option 400 MHz fading bandwidth (R&S SMW-K822)
- Option 800 MHz fading bandwidth (R&S SMW-K823)

The equipment layout for simulating fading effects in higher-order MIMO configurations, like 1x8x8 or 1x4x4 with one instrument:
- Two options baseband generator (R&S SMW-B9)
- Option baseband main module (R&S SMW-B13XT)
- Four options fading simulator (R&S SMW-B15)
- Option MIMO fading (R&S SMW-K74)
- Option higher-order MIMO (R&S SMW-K75)
(required for 1x8x8 MIMO configurations with one instrument)
- Option MIMO subsets (R&S SMW-K821)
(required for simulating of all MIMO channels simulated)
- Option MIMO subsets (R&S SMW-K822)
(required for the configuration of 1x4x4 MIMO scenarios, all MIMO channels simulated)

For more information, refer to the specifications document.

2.2 Overview of the functions provided by the fading simulator

This section summarizes the key functions of the fading simulator to emphasize the way it is suitable for test setups during research, development, and quality assurance involving mobile radio equipment.

Flexible configuration for support of different test scenarios

You can use the provided fading channels and configure them differently for different test scenarios. Use the same input signal and two separate output signals, for example, to simulate a frequency diversity. Or use separate input signals and sum them after fading, to simulate a network handover, for instance.

See also Chapter 4, "Signal routing settings", on page 91.

Predefined fading scenarios

The fading simulator is equipped with a wide range of presets based on the test specifications of the major mobile radio standards. For more complex tests, all the parameters of the supplied fading configurations can be user-defined as required.

See also "Standard / Test Case" on page 31.

Repeatable test conditions

To ensure the repeatability of the tests, the fading process is always initiated from a defined starting point.

A restart can be triggered from internal baseband trigger, so that the start of the baseband signal generation and the fading processes are synchronized.

See also Chapter 3.2, "Restart settings", on page 38.

Graphical presentation

The path graph displays the current defined fading paths and supports you to configure the desired fading channel.

See also Chapter 3.5, "Path graph", on page 56.

Simulation of diverse fading effects

During transmission of a signal from the transmitter to the receivers, diverse fading effects occur. In the fading simulator, you can simulate these effects separately or in combination.

Using the fading configurations for example, you can define up to 20 fading paths with different delays as they would occur on a transmission channel due to different propagation paths.

See also Chapter 3.4, "Path table", on page 44.

Predefined fast fading profile for different fading scenarios

The fading simulator provides a wide range of fast fading profiles. You can define the fading conditions per generated fading path. The fast fading profiles simulate fast fluctuations of the signal power level which arise due to variation between constructive and destructive interference during multipath propagation.

See also "Configuration" on page 31 and "Profile" on page 49

Simulation of slow fading effect

"Lognormal" and "Suzuki Fading" are slow fading profiles suitable to simulate slow level changes which can occur, due to shadowing effects (for example tunnels, buildings blocks or hills).

See also Chapter 3.4, "Path table", on page 44.

Simulation of dynamic configurations

Delay variations (whether sudden or slow) do not become important until we reach the fast modulation standards, such as the 3GPP FDD or EUTRA/LTE standards. The delay variations start to play a role if they are on the order of magnitude of the transmitted symbols so that transmission errors can arise.

The provided dynamic configurations simulate dynamic propagation in conformity with test cases defined in the 3GPP and MediaFlo specifications.

See also:

- Chapter 3.6, "Birth death propagation", on page 57
- Chapter 3.7, "Moving propagation", on page 63
- Chapter 3.10, "High-speed train", on page 81

- Chapter 3.8, "Two channel interferer", on page 71

Insertion loss for correct drive at the baseband level

The insertion loss is a method to provide a drive reserve and to keep the output power constant. In the R&S SMW200A, the used insertion loss is not a fixed value but is dynamically adjusted for different measurement tasks. Thus, you can define the way the range for insertion loss is determined.

See also Chapter 3.3, "Insertion loss configuration, coupled parameters and global fader coupling", on page 39.

Support of versatile MIMO configurations

See also Chapter 5, "Multiple input multiple output (MIMO)", on page 95.

2.3 Definition of commonly used terms

Fading Simulator

Each option R&S SMW200A-B14 provides the hardware of one fading simulator, i.e. for each installed fading simulator option, one hardware fader board is available. One, two or four fading simulators can be installed. The provided fading functionality, however, depends on the installed firmware options.

Fading channel

A fading channel is the term describing the signal between a transmit (Tx) and a receive (Rx) antenna, scattered in various paths.

In a 2x2 MIMO fading configuration, there are four fading channels between the transmit (Tx) and the receive (Rx) antennas. In this description, each fading channel is represented as a block with name following the naming convention "$F_{<Tx><Rx>}$", where Tx and Rx are the antennas (e.g. A and B in a 2x2 MIMO configuration).

An instrument equipped with the R&S SMW200A-K74 option simulates up to 16 MIMO fading channels, as it is, for instance required for 4x4 MIMO receiver tests.

If the option R&S SMW200A-K75 is installed, the number of MIMO channels increases to 32.

Fading path (tap)

Each fading channel consists of up to 20 fading paths.

The Figure 2-1 illustrates an example of single-channel fading with three transmission paths.

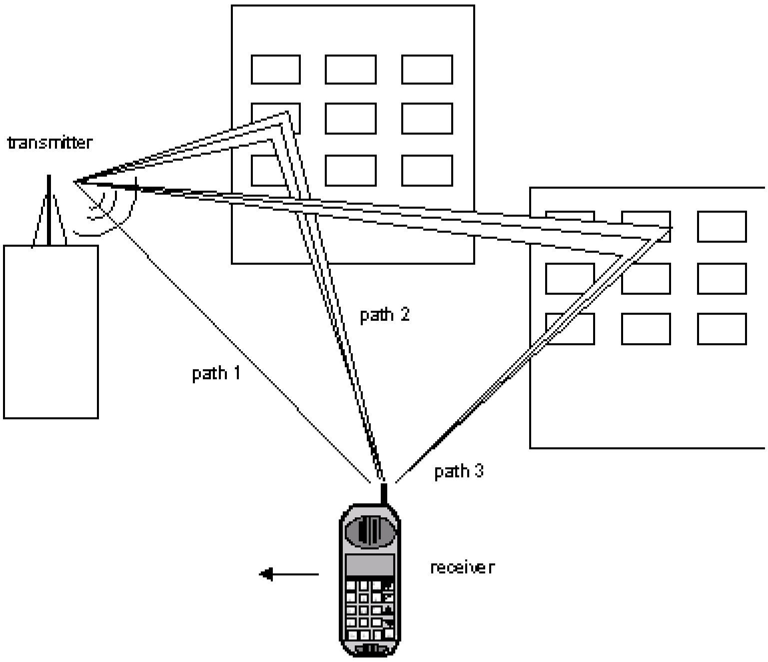


Figure 2-1: Example of single-channel fading with three transmission paths (SISO configuration)

Path 1 = Represents the discrete component that is a direct line-of-sight (LOS) transmission between the transmitter and receiver (pure Doppler fading profile)

Paths 2 and 3 = Represent the distributed components that are signals which are scattered due to obstacles (Rayleigh fading profile).

Distributed components, like the paths 2 and 3, consists of several signal echoes and are referred to as "taps".

The Figure 2-2 illustrates an example of two-channel fading with three transmission paths (taps) per channel.

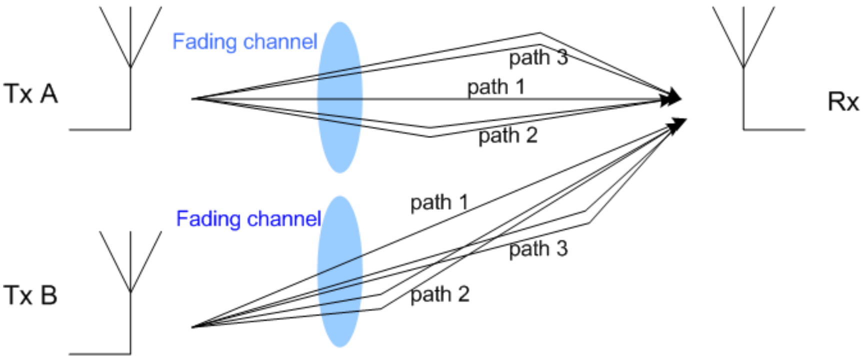


Figure 2-2: Example of two-channel fading with three transmission paths each

The R&S SMW200A supports 20 fading paths per installed fading simulator.

Path group

In this implementation, a group of paths builds a "path group". In the R&S SMW200A, the 20 fading paths are divided in 4 path groups. Each group consists of 3 fine and 2 standard delay paths.

A basic delay can be set per path group and an additional delay per path. The total delay per path is the sum of the basic delay of the respective group and of the additional delay of the path.

For more information, see:

- Chapter 2.4, "Characteristics of R&S SMW-B14 and R&S SMW-B15", on page 25
- "Basic Delay" on page 51.

Fading profile

The fading profile determines which transmission path or which radio hop is simulated.

The following is a list of the basic fading profiles implemented in the Fading Simulator.

- **Static Path**
  A static path is an unfaded signal that is a signal with constant amplitude and no Doppler shift; though this signal can undergo attenuation (loss) or delay.
- **Constant Phase**
  A suitable fading profile to simulate a reflection of an obstacle. Simulated is a transmission signal with constant amplitude and no Doppler shift, but with rotating phase.
- **Pure Doppler**
  A fading profile that simulates a direct transmission path on which Doppler shift is occurring due to movement of the receiver.
  See Path 1 on the Figure 2-1.
- **Rayleigh**
  A suitable fading profile to simulate a radio hop which arises as a result of scatter caused by obstacles in the signal path, like buildings.
  See also the conditions of the Paths 2 and 3 on the Figure 2-1.
  The resulting received amplitude varies over time. The probability density function for the magnitude of the received amplitude is characterized by a Rayleigh distribution. This fading spectrum is "Classical".
- **Rice**
  A fading profile that simulates a Rayleigh radio hop along with a strong direct signal, i.e. applies a combination of distributed and discrete components (see Figure 2-1).
  The probability density of the magnitude of the received amplitude is characterized by a Rice distribution. The fading spectrum of an unmodulated signal involves the superimposition of the classic Doppler spectrum (Rayleigh) with a discrete spectral line (pure Doppler).
  The ratio of the power of the two components (Rayleigh and pure Doppler) is configurable, see parameter Power Ratio.
  Example: The Figure 2-3 shows a baseband signal with QPSK modulation and a rectangular filter which was subjected to Rician fading (one path). As a result of the

luminescence setting on the oscilloscope, the variation in phase and amplitude of the constellation points caused by the fader is clearly visible.

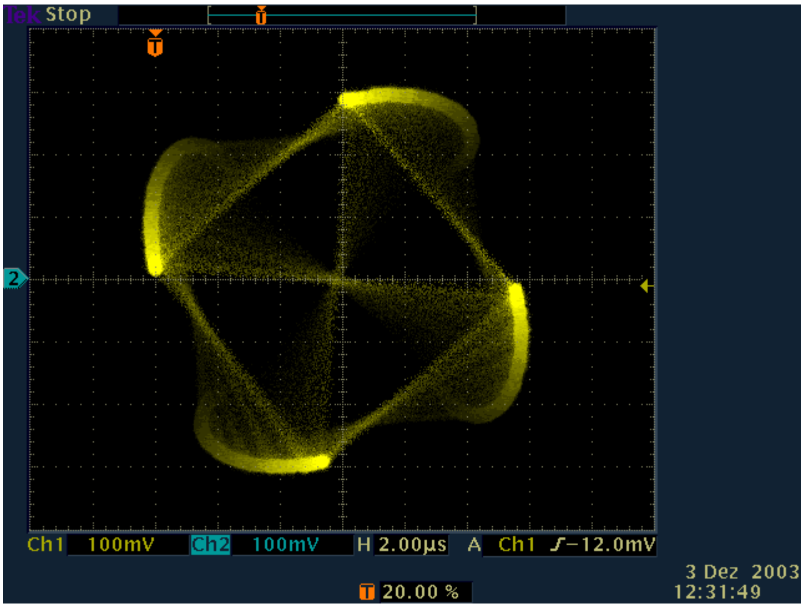


Figure 2-3: Effect of a Rician fading on a baseband signal with QPSK modulation

MIMO correlation models

The R&S SMW200A supports the following ways to simulate spatial correlated MIMO channels:

- By description of transmit and receive correlation matrix with direct definition of matrix coefficients or based on the Kronecker assumption
- By definition of clusters at the transmitter and receiver end using channel parameter like angle spread or angle of arrival/departure (AoA/AoD).

See Chapter 5.3, "Fading settings in MIMO configuration", on page 99

2.4 Characteristics of R&S SMW-B14 and R&S SMW-B15

The fading simulator includes hardware boards that influence several signal characteristics. This section lists the characteristics that influence the value ranges of major signal parameters.

For details and characteristics on each of the options, see data sheet.

Table 2-1: R&S SMW-B14

Fading channels (depends on LxMxN)	Fading clock rate	Signal band-width	Basic delay range	Basic delay resolution	Additional delay range	Additional delay reso-lution
1 to 8	200 MHz	160 MHz	Group 1: 0 s Group 2 to 4: 0 s to 0.671 s	5 ns	Fine delay path 1: 0 to 40.9 us Fine delay paths 2 to 3: 0 to 20 us Std. delay paths 4 to 5: 0 to 20 us	Fine delay paths 1 to 3: 2.5 ps Std. delay paths 4 to 5: 5 ns
9 to 16	100 MHz	80 MHz		10 ns		Fine delay paths 1 to 3: 5 ps Std. delay paths 4 to 5: 10 ns
17 to 32	50 MHz	40 MHz		20 ns		Fine delay paths 1 to 3: 10 ps Std. delay paths 4 to 5: 20 ns

Table 2-2: R&S SMW-B15, without R&S SMW-K822

Fading channels (depends on LxMxN)	Fading clock rate	Signal band-width	Basic delay range	Basic delay resolution	Additional delay range	Additional delay reso-lution
1 to 8	250 MHz	200 MHz	Group 1: 0 s Group 2 to 4: 0 s to 0.536 s	4 ns	Fine delay path 1: 0 to 32.72 us Fine delay paths 2 to 3: 0 to 16 us Std. delay paths 4 to 5: 0 to 16 us	Fine delay paths 1 to 3: 2 ps Std. delay paths 4 to 5: 4 ns
9 to 16	250 MHz	200 MHz		10 ns		Fine delay paths 1 to 3: 4 ps Std. delay paths 4 to 5: 8 ns
17 to 32	125 MHz	100 MHz		20 ns		Fine delay paths 1 to 3: 8 ps Std. delay paths 4 to 5: 16 ns
33 to 64	62.25 MHz	50 MHz	-	-	-	-

Table 2-3: R&S SMW-B15 and R&S SMW-K822/-K823

Fading channels (depends on LxMxN)	Fading clock rate	Signal bandwidth	Basic delay range	Basic delay resolution	Additional delay range	Additional delay resolution
1 to 8 R&S SMW-B15/-K822	500 MHz	400 MHz	Group 1: 0 s Group 2 to 4: 0 s to 0.536 s	4 ns	Std. delay path 1: 0 to 32.72 us Fine delay paths 2 to 3: 0 to 16 us Std. delay paths 4 to 5: 0 to 16 us	Std. delay path 1: 2 ns Std. delay paths 2 to 5: 4 ns
1 to 4 R&S SMW-B15/-K823	1000 MHz	800 MHz				Std. delay path 1: 1 ns Std. delay paths 4 to 5: 8 ns

Related settings

- LxMxN settings: Chapter 5.1, "Multiple entity MxN MIMO test configurations", on page 96
- "Fading Clock Rate" on page 34
- "Basic Delay" on page 51
- "Additional Delay" on page 51

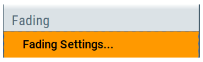
The difference in the system clocks and the delay resolutions also affects the used fading paths and the preset values in some of the predefined fading profiles, see Chapter A, "Predefined fading settings", on page 243.

2.5 Further signal processing

During further signal routing, you can also offset the faded signals or apply noise to them.

For more information, refer to sections "Adding Noise to the Signal" and "Impairing the Signal" in the R&S SMW200A User Manual.

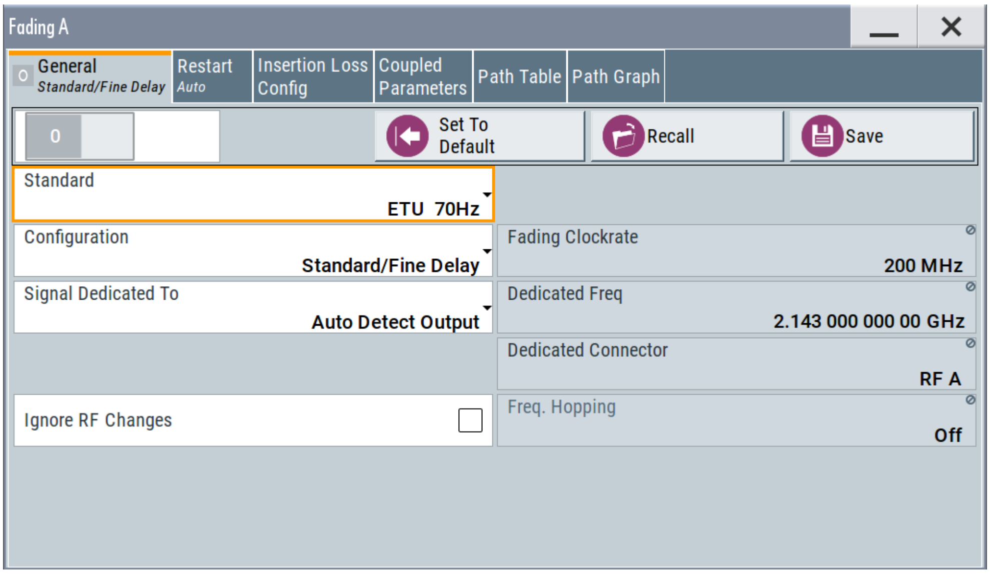
3 Fading settings



The "Fading" dialog allows you to configure multipath fading signals. Regardless of the current "System Configuration > Mode", to access this dialog, proceed as follows:

► Select "Block Diagram > Fading > Fading Settings".

The "Fading" dialog opens and displays the general settings.



The dialog is divided into several tabs, logically grouping the available setting.

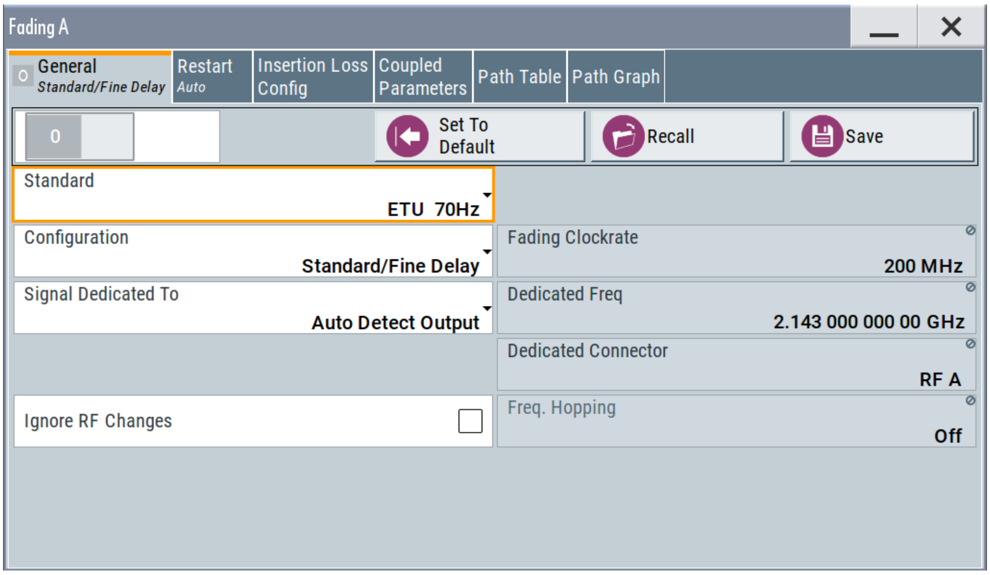
The remote commands required to define these settings are described in Chapter 6, "Remote-control commands", on page 150.

Settings:

- General settings...29
- Restart settings..38
- Insertion loss configuration, coupled parameters and global fader coupling.......... 39
- Path table..44
- Path graph...56
- Birth death propagation...57
- Moving propagation...63
- Two channel interferer...71
- Customized dynamic fading..77
- High-speed train...81
- Custom fading profile.. 87

3.1 General settings

► To access this dialog, select the "Fading > Fading Settings".



Apart from the standard "Set to Default" and "Save/Recall" functions, the dialog provides the settings to:

- In "System Configurations" with more than two entities, the dialog consists of more than one side tabs; one tab per entity. The tab name indicates the fader state the settings are related to.
  See also Chapter 5.1, "Multiple entity MxN MIMO test configurations", on page 96.
- Select a predefined fading profile according to the common mobile radio standards

Settings:

State....................30
Copy To / Entity....................30
Set to Default....................30
Save/Recall....................31
Standard / Test Case....................31
Configuration....................31
Moving Channels....................34
Fading Clock Rate....................34
Signal Dedicated To....................34
Dedicated Frequency....................37
Dedicated Connector....................37
Virtual RF....................37
Ignore RF Changes < 5PCT....................37
Freq. Hopping....................38

State

- Option: R&S SMW-B14
  Enables the fading simulator.
- Option: R&S SMW-B15
  Enabled if "System Config > Fading/Baseband Config > Mode = Advanced" is selected and "Apply" executed.

If activated, the fading process is initiated for the enabled paths.

A selectable trigger ("Restart > Mode") can be used to restart the fading process. The fading process always begins at a fixed starting point after each restart. This helps to achieve repeatable test conditions.

Remote command:
[:SOURce<hw>]:FSIMulator[:STATe] on page 170

Copy To / Entity
Option: R&S SMW-K76

In "System Configurations" with multiple entities, copies the settings of the current fading simulator to all or to the selected entities.

See also Chapter 5.1, "Multiple entity MxN MIMO test configurations", on page 96.

Remote command:
[:SOURce<hw>]:FSIMulator:SISO:COPY on page 153

Set to Default
Activates the default settings of the fading simulator.

By default, a path is activated with a Rayleigh profile and a slow speed. All the other paths are switched off.

The following table provides an overview of the settings. The preset value is indicated for each parameter in the description of the remote-control commands.

Table 3-1: Default values

Parameter	Value
State	Off
Standard	User
Configuration	Standard Delay
Signal Dedicated to	RF Output
Speed Unit	km/h
Restart Event	Auto
Ignore RF Changes	Off
Frequency Hop. Mode	Off
Insertion Loss	
Insertion Loss Mode	Normal
Coupled Parameters	
All States	Off

Parameter	Value
Path Configuration	
State of path 1	On
State of all other paths	Off
Profile	Rayleigh
Delays	0
Speed of path 1	Slow
Speed of all other paths	0

Remote command:
[:SOURce<hw>]:FSIMulator:PRESet on page 157

Save/Recall
Accesses the "Save/Recall" dialog, that is the standard instrument function for saving and recalling the complete dialog-related settings in a file. The provided navigation possibilities in the dialog are self-explanatory.

The settings are saved in a file with predefined extension. You can define the filename and the directory, in that you want to save the file.

See also, chapter "File and Data Management" in the R&S SMW200A user manual.

The R&S SMW200A stores fading configurations in files with file extension `*.fad`.

The dialog displays the name of a currently loaded user settings file. The file name is displayed as long as you do not modify the settings.

Remote command:
[:SOURce]:FSIMulator:CATalog? on page 170
[:SOURce<hw>]:FSIMulator:LOAD on page 171
[:SOURce<hw>]:FSIMulator:STORe on page 171
[:SOURce]:FSIMulator:DELETE on page 171

Standard / Test Case
Selects predefined fading settings according to the test scenarios defined in the common mobile radio standards.

For an overview of the predefined standards, along with the underlying test scenarios, the enabled settings and the required options, see Chapter A, "Predefined fading settings", on page 243.

If one of the predefined parameters is modified, "User" is displayed. "User" is also the default setting.

Remote command:
[:SOURce<hw>]:FSIMulator:STANdard on page 162
[:SOURce<hw>]:FSIMulator:STANdard:REFerence on page 169

Configuration
Selects the fading configuration.

Note: The dynamic fading configurations "Birth Death Propagation", and "2 Channel Interferer" are disabled in MIMO configurations.

Depending on which configuration is selected, the further settings the "Fading" dialog change, particularly the path table.

Note: A separate path table is associated with each configuration, i.e. each time you select a new configuration, the instrument changes not only the bandwidth but loads a new path table.
Each changing in the configuration interrupts the fading process and restarts the calculation. If the instrument is fitted with more than one fading simulators, they are all affected.

"Standard/Fine Delay"
In the R&S SMW200A, the 20 fading paths are divided in 4 path groups. Each group consists of 3 fine and 2 standard delay paths.
The standard and fine delay configurations differ in terms of the resolution of the path-specific delay, see Chapter 2.4, "Characteristics of R&S SMW-B14 and R&S SMW-B15", on page 25.
The "Standard/Fine Delay" configuration is sufficient for classical fading with simulation of the level fluctuations. A delay configuration with the provided characteristics occurs in the received signal as a result of a typical multipath propagation and the propagation conditions.
The propagation conditions themselves vary depending on the location and timing.

"Birth Death Propagation"
Option: R&S SMW-K71
In the "Birth Death Propagation" configuration, the fading simulator simulates dynamic propagation conditions in conformity with the test case 3GPP, 25.104-320, annex B4. Two paths are simulated which appear ("Birth") or disappear ("Death") in alternation at arbitrary points in time (see Chapter 3.6, "Birth death propagation", on page 57).

"Moving Propagation"

Option: R&S SMW-K71

In the "Moving Propagation" configuration and number of "Moving Channels" set to "One", the fading simulator simulates dynamic propagation conditions in conformity with the test case 3GPP TS25.104, annex B3. Two paths are simulated: Path 1 has fixed delay, while the delay of path 2 varies slowly in a sinusoidal fashion.

Two additional predefined moving propagation scenarios according to the 3GPP TS36.141, annex B.4 can be configured: the "ETU200Hz Moving" and the "Pure Doppler Moving". To configure one of these scenarios for 3GPP or LTE, select the corresponding item under "Standard > 3GPP or LTE > Moving Propagation".

Note: The moving propagation conditions enabled by selecting the "Standard > 3GPP or LTE > Moving Propagation > Ref. + Mov. Channels" are identical to the conditions configured by enabling of "Moving Propagation Configuration" and number of "Moving Channels" set to "One".

See Chapter 3.7, "Moving propagation", on page 63 for more information.

"2 Channel Interferer"

Option: R&S SMW-K71

In the "2 Channel Interferer" configuration, the fading simulator simulates test case 5 and 6 from MediaFlo.

Two paths are simulated: Path 1 has fixed delay, while the delay of path 2 varies slowly in a sinusoidal fashion or appears or disappears in alternation at arbitrary points in time (hopping).

See Chapter 3.8, "Two channel interferer", on page 71 for more information.

"High Speed Train"

Option: R&S SMW-K71

In the High-Speed Train configuration, the fading simulator simulates propagation conditions in conformity with the test case 3GPP 25.141, annex D.4A and 3GPP 36.141, annex B.3.

The instrument simulates all the three scenarios as defined in the test specification. Additionally, user-defined HST conditions can be configured by selecting different profile and setting up the speed and the initial distances.

See Chapter 3.10, "High-speed train", on page 81 for more information.

"Customized Dynamic"

Option: R&S SMW-K820

In this configuration, you can load dynamic fading list files that describe the variation of the fading parameters path loss, Doppler shift and delay over time. With suitable fading lists, customized High-Speed Train scenarios can be simulated.

See Chapter 3.9, "Customized dynamic fading", on page 77.

Remote command:
[:SOURce<hw>]:FSIMulator:CONFiguration on page 152
[:SOURce<hw>]:FSIMulator:BIRThdeath:STATe on page 188
[:SOURce<hw>]:FSIMulator:MDELay:STATe on page 198
[:SOURce<hw>]:FSIMulator:TCINterferer[:STATe] on page 220
[:SOURce<hw>]:FSIMulator:HSTRain:STATe on page 193
[:SOURce<hw>]:FSIMulator:CDYNamic:STATe on page 238

Moving Channels
Option: R&S SMW-K71

This parameter determines whether only one or several moving channels are simulated.

"One" In this mode, the fading simulator simulates dynamic propagation conditions in conformity with the test case 3GPP TS25.104, annex B3.

"All" Per default, one moving channel with Rayleigh distribution and one tap is simulated.
Additional taps and paths can be enabled and configured in the "Path Table".

Remote command:
[:SOURce<hw>]:FSIMulator:MDELay:CHANnel:MODE on page 194

Fading Clock Rate
Displays the clock rate used by the fading simulator for the signal processing.

The value depends on the selected "System Configuration" and influences the bandwidth of the generated signal.

Remote command:
[:SOURce<hw>]:FSIMulator:CLOCk:RATE? on page 154

Signal Dedicated To
Defines the frequency to that the signal of the whole Fader block is dedicated.

Example: How the R&S SMW200A determines the frequency used for the calculation of the Doppler Shift

This example shows how the R&S SMW200A determines the fader frequency in "Signal Dedicated To > Auto Detect Output" mode.

- In the "System Configuration > Fading/Baseband Config" dialog, enable a 2x2x2 MIMO configuration with "Baseband Sources > Coupled per Entity".
- In the "I/Q Stream Mapper":
  - route "Stream A/B > RF A/B", "Stream A/D und > BBMM 2" and "Stream B/C > BBMM 1" ("Combination > Add")
  - enable a "Frequency Offset = 5 MHz" for Stream D
- Connect an R&S®SGT100A to the BBMM**2** connector of the R&S SMW200A.
  In the "External RF and IQ" dialog, configure this connection and set the frequency of the connected instrument, e.g. "RF Frequency = 1.950 GHz".
- In the Status Bar, set "Freq A = 2.143 GHz"

The settings of your instrument should resemble the example on Figure 3-1.

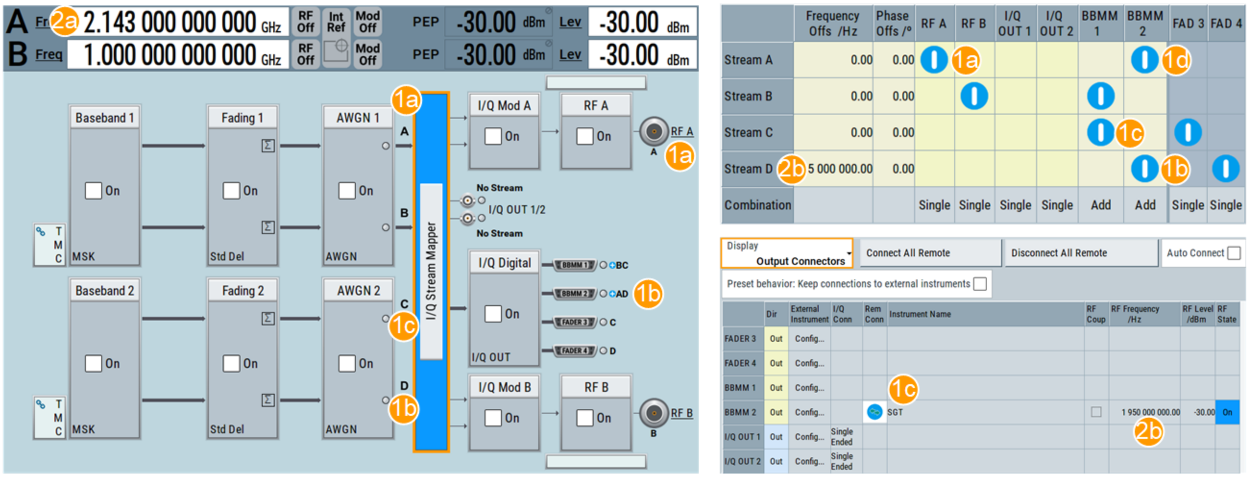


Figure 3-1: Settings influencing the calculation of the Doppler Shift

1a, 1d	= Routing of Stream A ("primary" for "Fading 1")
1b	= Routing of Stream D ("primary" stream for "Fading 2" but not for "Fading 1")
1c	= Routing of Stream C; an external device is not connected
2a	= Frequency RF A, i.e. the frequency of Stream A
2b	= Parameters influencing the frequency of Stream D

In this configuration, Stream A is the "primary" stream for the "Fading 1"; Stream D is the "primary" for "Fading 2", because of the connected external device.

Note that:

- Although Stream C is first stream of "Fading 2" it is not the "primary" one, because there is no external device connected to the BBMM1 or to the FAD3 connector.
- Although an external device is connected to BBMM2, it is not the "primary" for the "Fading 1", because the streams are evaluated "left to right" and "up to down".

Observe the values of the parameter "Dedicated Frequency" for Fader 1 and Fader 2. The settings of your instrument should resemble the example on Figure 3-2.

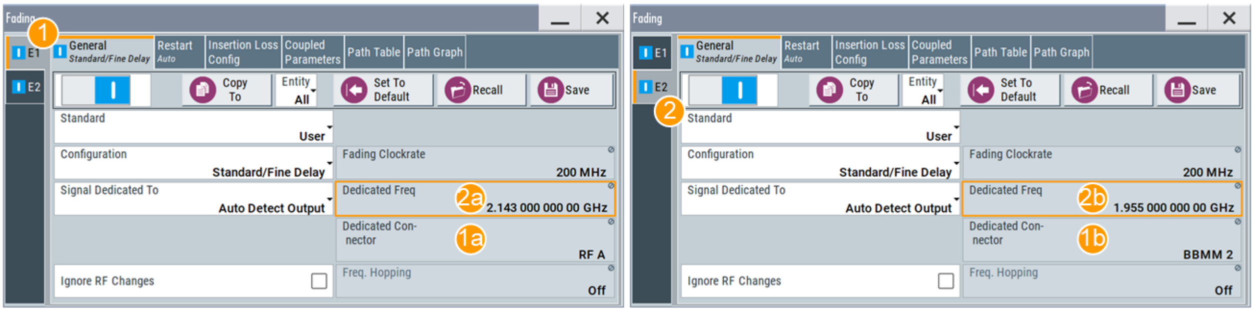


Figure 3-2: "Dedicated Frequency" and "Dedicated Connector": understanding the displayed information

1 = Fader 1
2 = Fader 2
1a = "Dedicated Connector = RF A" because Stream A ("primary") is routed to RF A
1b = "Dedicated Connector = BBMM 2" because Stream D is routed to BBMM 2 and an external instrument is connected to this interface
2a = "Dedicated Frequency = Freq A = 2.143 GHz"
2b = "Dedicated Frequency = RF Frequency$_{\text{External RF instrument}}$ + Frequency Offset = 1.95 GHz + 5 MHz = 1.955 GHz"

"Auto Detect Output"

The Doppler shift is calculated based on the actual RF frequency, that is *dynamically detected* depending on:

- The current signal routing in the "Stream Mapper", in particular the routing and the enabled "Frequency Offset" of the first ("primary") stream of each "Fader"
  Note: The RF frequencies and the "Frequency Offset" of all other streams are ignored.
- The external instrument connected to the output interface the "primary" stream is routed to
  ("System Configuration > External RF and I/Q")
- The "RF Frequency" of the connected instrument
  ("System Configuration > External RF and I/Q")

The R&S SMW200A continuously monitors these parameters, calculates the frequency and displays:

- The Dedicated Frequency
- The Dedicated Connector

A warning message informs you if the detection fails; the "Dedicated Frequency" is set to 1 GHz.

"Baseband Output"

Sets the fader frequency *manually*. The Doppler shift is calculated based on a select "Virtual RF" frequency.
If you use an external I/Q modulator to upconvert the generated faded baseband signal, set the value of the parameter Virtual RF to the modulation frequency of the external I/Q modulator.

Remote command:
`[:SOURce<hw>]:FSIMulator:SDEStination` on page 161

Dedicated Frequency
In Signal Dedicated To > "Auto Detect Output" mode, displays the dedicated RF frequency (incl. enabled "Frequency Offset" in the "I/Q Stream Mapper"), used for the calculation of the Doppler Shift.

A warning message informs you if the estimation fails; the "Dedicated Frequency" is set to 1 GHz.

See also:
- Example"How the R&S SMW200A determines the frequency used for the calculation of the Doppler Shift" on page 35
- Dedicated Connector.

Note: The "Dedicated Frequency" cannot be updated if the RF frequency varies fast, for example if an "RF Frequency Sweep" or a "List Mode" is active and the parameter Ignore RF Changes < 5PCT is disabled.
For more details, see the data sheet.

Remote command:
`[:SOURce<hw>]:FSIMulator:FREQuency` on page 154

Dedicated Connector
In Signal Dedicated To > "Auto Detect Output" mode, displays the connector used to determine the Dedicated Frequency.

See Example"How the R&S SMW200A determines the frequency used for the calculation of the Doppler Shift" on page 35.

Remote command:
`[:SOURce<hw>]:FSIMulator:FREQuency:DETect?` on page 161

Virtual RF
In Signal Dedicated To > "Baseband Output" mode, sets manually the frequency used for the calculation of the Doppler shift.

This parameter is useful if:
- A user-defined Fader frequency is required
- An external I/Q modulator is used to upconvert the generated faded baseband signal.

Remote command:
`[:SOURce<hw>]:FSIMulator:FREQuency` on page 154

Ignore RF Changes < 5PCT
This function is password-protected. Unlock the protection level 1 to access it.

Selects whether variation in the RF frequency (also in the frequency of connected external devices) that are smaller than 5% are to be ignored or not for the fading.

"On" Enables faster frequency hopping because small frequency changes do not result in a short-term switch-off of the fader and a restart of the fading process.

Remote command:
`[:SOURce<hw>]:FSIMulator:IGNore:RFCHanges` on page 155

Freq. Hopping
This function is password-protected. Unlock the protection level 1 to access it.

Activates frequency hopping and determines the behavior of the fading simulator after a frequency hop.

In real-world receivers, one of the reasons for frequency hopping could be that due to a change in the location of the receiver, the original carrier is no longer accessible.

In the fading simulator, frequency hopping is implemented by switching of the carrier frequency. The fading simulator is temporarily deactivated until the variation in the RF frequency is completed. The fading process starts then again at the new frequency.

The instrument provides two modes for frequency hopping, that mainly differ in terms of the behavior when hopping back to a prior frequency.

Prior to activating frequency hopping, list mode must be activated in the "List Mode" dialog (State On). The target frequencies of the hops are determined by the frequency values in the selected list. The time until the next frequency hop is determined by the entered "Dwell Time". The HOP signal which marks the time point of the frequency hop can be output on one of the USER connectors. These settings are available only for the delay configurations.

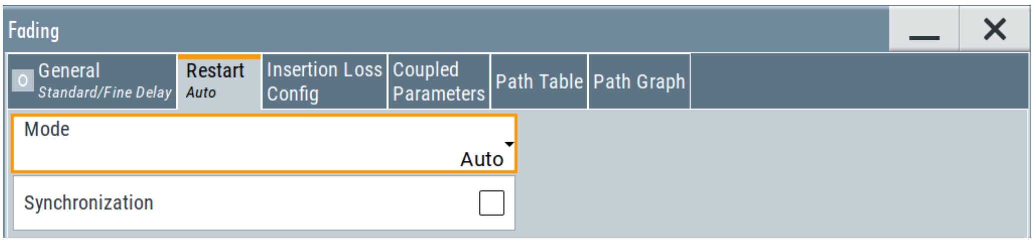
For detailed information, refer to sections "Varying the RF Signal in List or Sweep Mode" and "Local and Global Connectors" in the R&S SMW200A user manual.

Remote command:
[:SOURce<hw>]:FSIMulator:HOPPing:MODE on page 155

3.2 Restart settings

Access:

► Select "Fading > Restart".



Mode..38
Synchronization..39

Mode
Selects the event which leads to a restart of the fading.

To achieve repeatable test conditions, after each restart the fading process starts at a fixed starting point. The fading process then passes through identical random processes for a particular setting.

"Auto" The modulation signal is continually faded.

"Baseband Trigger"
In MIMO scenarios, this setting restarts the fading process synchronous with the baseband trigger signal. Thus, the start of the baseband signal generation and the fading processes are synchronized.

This setting is useful in the following situations:
- If repeatability of tests with baseband and fading signal is required.
- For triggering of the fading simulations in multi-instruments setups, for example when calculating 8x8 or 4x4 MIMO signals with two R&S SMW200A.

See R&S SMW200A User Manual, section "How to Generate a 8x8 MIMO Signal with Two R&S SMW200A"

"Armed Auto" Not supported in the current version.

Remote command:
[:SOURce<hw>]:FSIMulator:RESTart:MODE on page 157

Synchronization
Couples the fading simulators so that if both blocks are active, a subsequent restart event in any of them causes a simultaneous restart of the other.

Restart event can be caused by a start/stop alternation or a parameter change that results in a signal recalculation and therefore a process restart.

Remote command:
[:SOURce]:FSIMulator:SYNChronize:STATe on page 160

3.3 Insertion loss configuration, coupled parameters and global fader coupling

The fading process increases the crest factor of the signal, and this increase must be considered in the drive at the baseband level. Especially when multiple paths are superimposed or if there is statistical influences on a path, an insertion loss is required to provide a drive reserve. If the full drive level is reached nevertheless, the I/Q signals are limited to the maximum available level (clipping).

This section describes the setting, provided to control of the insertion loss and to simplify the operation in dual-channel fading.

Impact of the Fading Simulator on the Crest Factor of the Signal

The crest factor is a figure that measures the difference in level between the peak envelope power (PEP) and average power value (RMS) in dB. Hence, either increasing the peak value or decreasing the RMS value results in a higher crest factor. In this implementation, the instrument keeps the peak value as close as possible to the full drive level (multiplier peak > 1) but the fading simulator reduces the RMS value by the additional crest factor due to fading (multiplier RMS). The ratio of these two multipliers is a value, known as the *insertion loss*.

The instrument derives the crest factor of the signal at the output of the fading simulator based on the crest factor of the signal at the input of the "Fading" block and the insertion loss.

Signal generation →	**Fading** →	**Resulting signal**
Crest factor a = Peak value a / RMS value a	Insertion loss = Multiplier peak / Multiplier RMS	Crest factor b = Peak value b / RMS value b = Crest factor a x Insertion loss

Overview of the provided modes and the main differences between them

In the R&S SMW200A, the used insertion loss is not a fixed value but is dynamically adjusted for different measurement tasks. For any of the predefined standards/test cases, the instrument selects an optimal range for the insertion loss. In a user-defined fading configuration, you define the way the range for insertion loss is determined.

From the following available modes, select the one most fitting to your application:

- "Normal"
  In this mode, the instrument calculates the required insertion loss value in a way, that a full drive is permitted, i.e the signal is not clipped at the maximum level.
  The mode results in a high signal quality, but the RMS level is lower than the maximum level. Adjacent channel power (ACP) measurements, however, require a higher dynamic range and a lower insertion loss.
- "Low ACP"
  In this mode, the instrument outputs the signal with a higher level relative to the maximum drive, i.e. greater S/N ratio. However, this mode decreases the signal quality because of a higher percentage of clipping.
  It is recommended that you enable this mode only for fading paths with Rayleigh profile, as only this profile ensures a statistical distribution of level fluctuation. The other fading profiles are characterized by a non-statistical level fluctuations and a "Low ACP" mode leads to an enormous increase of clipping.
  Irrespectively of the selected fading profile, you still can and have to monitor the percentage of clipped samples.
- "User"
  This mode relays on a manually defined value. Depending on your particular application, you can find a favorable insertion loss configuration with the desired signal dynamic range and acceptable clipping rate.

Regardless of the selected mode and the path loss settings, the instrument adjust the insertion loss within this range to keep the output power constant. However, the maximum available output power of the R&S SMW200A is reduced by up to 18 dB.

Prerequisites for correct insertion loss adaptation

For correct automatic adaptation of the insertion loss, the processes involved in the fading simulation have to be *statistically independent* of each other. This applys to the paths among themselves as well as the paths relative to the input signal. Correct automatic adaptation of the insertion loss is not possible, if statistically correlated processes occur. Examples if statistically correlated processes are the fading of modulation signals with symbol rates approximating the delay differences of the fading paths. A correlation requires, that you measure the level again and manually corrected it, e.g. by enabling of a suitable level offset.

The following are two examples explaining the possible reasons for correlation.

Example: Correlated processes resulting from the used modulation signal and the selected fading configuration

The instrument is configured to generate a QPSK signal with a symbol rate of 1 Msymb/s is generated and the PRBS 9 sequence as the data source.

Enabled is a fading configuration, consisting of two paths with a Rayleigh profile, identical speed and a resulting delay of 0 us and 1 us, respectively.

The symbol rates of the modulation signal are in the range of the delay differences of the fading paths. The autocorrelation of the modulation data (PRBS 9) to the adjacent symbol is not equal to 0. The fading process is therefore statistically not independent of the process of generating the modulation signal. The automatic calculation of the insertion loss is not correct.

Example: Correlated processes within the fading simulator

Enabled is a fading configuration, consisting of two paths with a pure Doppler profile and a resulting Doppler shift of 100 Hz. The start phases of the two paths differ.

This causes super impositions, which in the worst case (e.g. with a phase setting of 0° and 180°) can lead to the deletion of the signal. Automatic calculation of the insertion loss is not possible.

The related settings are summarized in dialog "Fading > Insertion Loss Config/Coupled Parameters > Insertion Loss Configuration", see Chapter 3.3.1, "Insertion loss configuration settings", on page 41.

Coupling Fading Parameters

In standard mode ("System Configuration > Mode > Standard"), you can couple a subset of parameters and adjust them jointly. With enabled coupling, the setting of one of the Fading blocks are transferred to the second fading simulator. A subsequent change in the settings of one of the fading simulators results in settings adaptation in the other.

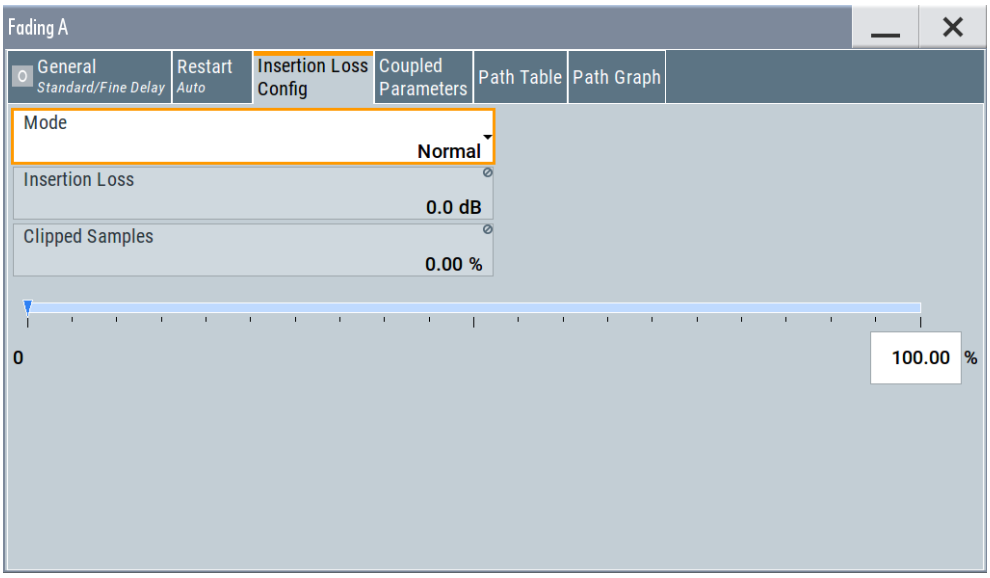
Logically, coupled parameters are available in instruments equipped with more than one Fading Simulator (i.e. more than one R&S SMW200A-B14 options).

The related settings are grouped in dialog "Fading > Insertion Loss Config/Coupled Parameters > Coupled Parameters", see Chapter 3.3.2, "Coupled parameters and global fader coupling settings", on page 43.

3.3.1 Insertion loss configuration settings

Access:

► Select "Fading > Insertion Loss Config/Coupled Parameters".



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Insertion Loss Mode

Sets the mode for determining the insertion loss.

"Mode Normal" The insertion loss for a path of the fading simulator is automatically chosen so that even when lognormal fading is switched on, overdrive occurs only rarely in the fading simulator. This setting is recommended for bit error rate tests (BERTs). The current insertion loss is displayed under "Insertion Loss".

"Mode Low ACP"
The insertion loss is automatically chosen so that an overdrive occurs with an acceptable probability. "Low ACP" mode is only recommended for fading paths with Rayleigh profile as only in this case statistical distribution of level fluctuation is ensured. For other fading profiles, non-statistical level fluctuations occur which lead to an enormous increase of clipping. However, monitoring the percentage of clipped samples is recommended for Rayleigh paths also.
The current insertion loss is displayed under "Insertion Loss".

"Mode User" Any value for the minimum insertion loss in the range from 0 dB to 18 dB can be selected. Desired value is entered under "Insertion Loss". This mode is provided to ensure optimization of the dynamic range and signal quality for any application. Display of the clipping rate for any value which is entered enables estimation of the signal quality for the specified signal dynamic range.

Remote command:
`[:SOURce<hw>]:FSIMulator:ILOSs:MODE` on page 156

Insertion Loss

Displays the current insertion loss in the "Normal" and "Low ACP" modes.

Entry of the insertion loss in "User" mode.

Remote command:
[:SOURce<hw>]:FSIMulator:ILOSs[:LOSS] on page 156

Clipped Samples

Displays the samples whose level is clipped as a %.

If the full drive level is reached for an insertion loss which is too low, the I/Q signals are limited to the maximum available level (clipping).

Remote command:
[:SOURce<hw>]:FSIMulator:ILOSs:CSAMples? on page 156

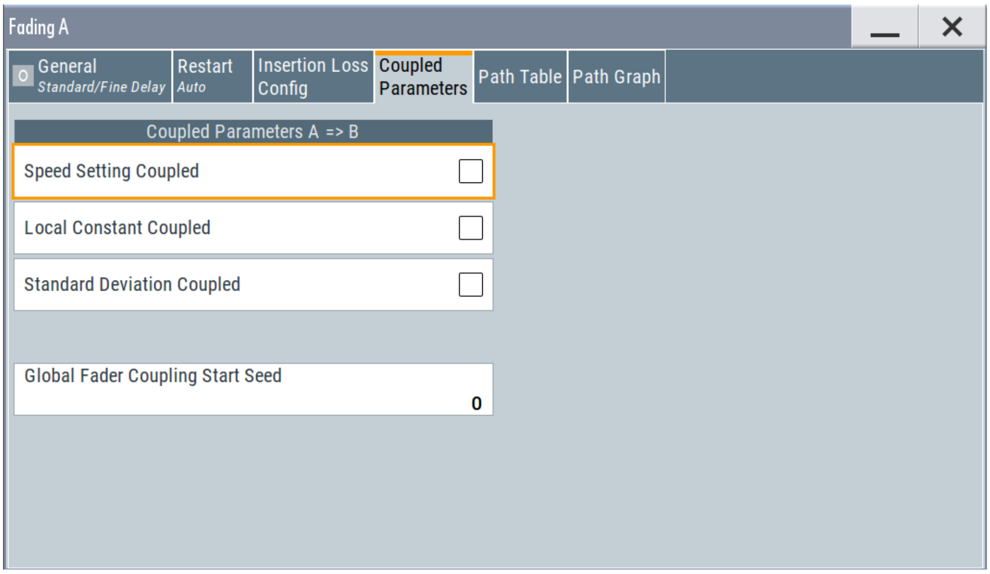
0 ... 100 %

Graphically displays the samples whose level is clipped as a %. The scale resolution is determined by entering the maximum value as a %.

3.3.2 Coupled parameters and global fader coupling settings

Access:

► Select "Fading > Insertion Loss Config/Coupled Parameters".



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└ Local Constant Coupled...44
└ Standard Deviation Coupled..44
Start Seed...44

Coupled Parameters
(available in "System Configuration > Mode > Standard")

Speed Setting Coupled ← Coupled Parameters
Sets the speed of the paths for both faders. The parameter Common Speed For All Paths is also coupled.

Remote command:
`[:SOURce<hw>]:FSIMulator:COUPle:SPEed` on page 172

Local Constant Coupled ← Coupled Parameters
With lognormal fading, the parameter Local Constant is coupled for the paths of both faders.

Remote command:
`[:SOURce<hw>]:FSIMulator:COUPle:LOGNormal:LCONstant` on page 171

Standard Deviation Coupled ← Coupled Parameters
With lognormal fading, the parameter Standard Deviation is coupled for the paths of both faders.

Remote command:
`[:SOURce<hw>]:FSIMulator:COUPle:LOGNormal:CSTD` on page 171

Start Seed
Enters the start seed for random processes inside the fading simulator. This value is global for the instrument but each fading path uses a different start seed. The autocorrelation of different seeds is more than seven days apart. If two instruments run with the same seed, fading processes will be identical after a retrigger of the fading simulator.

While working in MIMO mode that requires two instruments, set the start seeds of the instruments to different values.

Remote command:
`[:SOURce<hw>]:FSIMulator:GLOBal:SEED` on page 155

3.4 Path table

Access:

1. Select "Fading > Fading Settings > Path Table".

   The path table provides the individual path and group parameters.

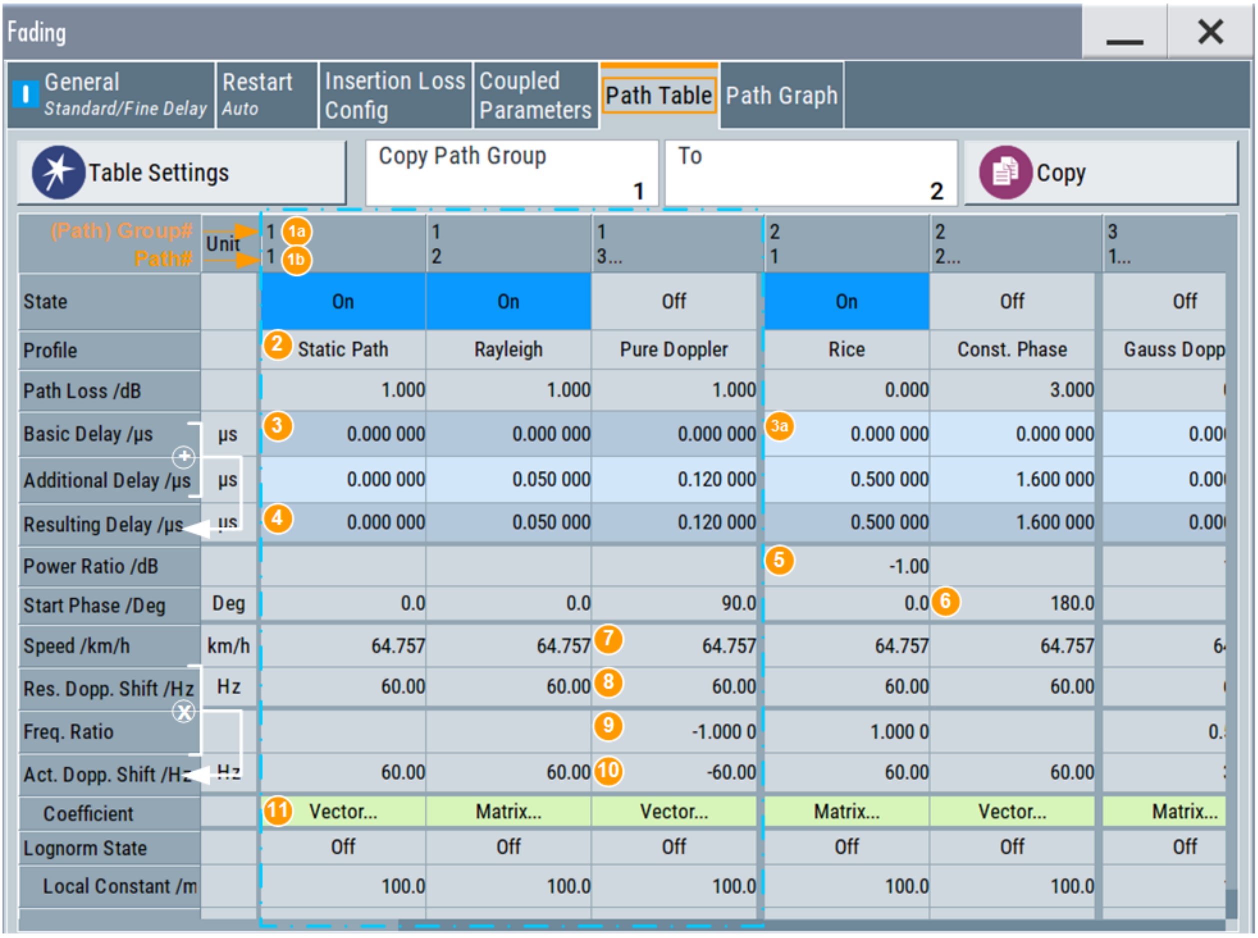


Figure 3-3: Fading Path Table: Understanding the displayed information

1a/1b = Path group number (displayed in the first row) and path number (second row in the table header). The example shows 4 groups with different number of active paths (the first group is marked with a blue border).
2 = Fading profile, assigned per fading path
3/3a = Common group delay of a path group ("Basic Delay" is always 0 for group 1); adjustable for the other groups (light grey background)
4 = Resulting delay per path, calculated as the sum of the common group delay and the path-specific delay
5 = Adjustable parameter for paths with Rice, WM Rice of Gauss Doppler fading
6 = Adjustable parameter for paths with Pure Doppler and constant Phase fading
7 = For moving receivers, selected speed v or calculated as a function of the resulting Doppler shift f_D
8 = Set resulting Doppler shift f_D or calculated as $f_D=f_{RF}*v/c$, where f_{RF} is the selected RF and c the speed of light
9 = Frequency ratio cosφ is ratio of the actual Doppler shift f_A and the resulting Doppler shift f_D
10 = Actual Doppler shift f_A calculated as $f_A=f_D*\cos\varphi t$
10 = Pure display parameters are on a dark background
11 = Access to a "Vector" or a "MIMO Matrix" for configuration of the correlation between the channels

2. To display all five paths per each group, change the settings as follows:
   a) Select "Table Settings".

b) In the "Path Table Settings" dialog, select "Path Filter > All Paths".

Cross-reference between the fading parameters

Consider the following interdependencies:

- Delay parameters
  Resulting Delay = Basic Delay + Additional Delay
- Parameters influencing the Doppler shift calculation:
  Resulting Doppler Shift f_D calculated as:

  $f_D = (v/c)*f_{RF}$, where:

  – v is the Speed of the moving receiver

  – f_{RF} is the frequency of the RF output signal or the Virtual RF

  – $c=2.998*10^8$m/s is the speed of light

  For "Fading Profile > Pure Doppler, Gauss Doppler or Rice", the Actual Doppler Shift f_A calculated as:

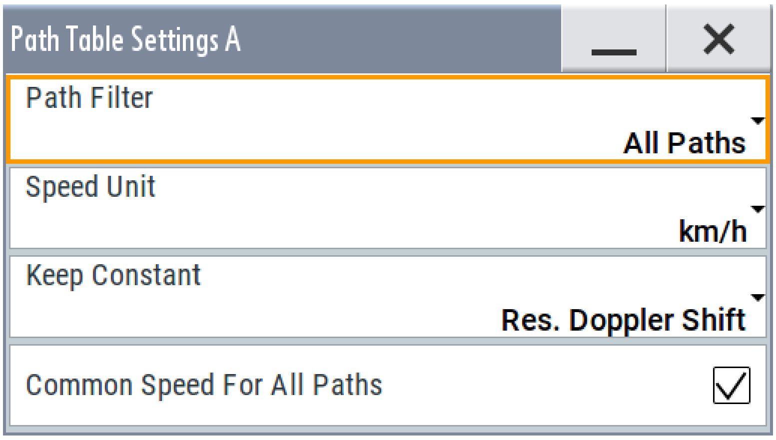
  $f_A = f_D*\cos\varphi t$, where:

  – cosφt is the Frequency Ratio and φ is the angle of incidence

  – f_D is the Resulting Doppler Shift

3.4.1 Table settings

► To access this dialog, select "Fading > Fading Settings > Path Table > Table Settings".



The provided functions facilitate settings configuration and navigation in the path table, like suppression of the indication of disabled paths, quick change of the speed unit.

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Keep Constant....................47
Common Speed For All Paths....................47

Path Filter
Suppresses the indication of the disabled paths.

Remote command:
n.a.

Speed Unit
Toggles between the available units for speed. The value always remains unchanged but the display is automatically adapted to the selected unit.

Note: The remote control command changes only the units displayed in the graphical user interface. While configuring the speed via remote control, the speed units must be specified.

Remote command:
`[:SOURce<hw>]:FSIMulator:SPEed:UNIT` on page 162

Keep Constant
Selects whether to keep the speed or the resulting Doppler shift constant in case of frequency changes. If a constant speed is selected, the Doppler shift is calculated as function of the speed and the frequency and vice versa.

Remote command:
`[:SOURce<hw>]:FSIMulator:KCONstant` on page 157

Common Speed For All Paths
In delay configurations, activates/deactivates the same speed in all paths.

If Speed Setting Coupled is enabled, this parameter is also coupled in both faders.

"On"	In this default state, a change of speed in a path automatically results in a change of speed in all of the other paths.
"Off"	When switching from "Off" to "On", the speed entry for path 1 of group 1 is used for all of the paths.

Remote command:
`[:SOURce<hw>]:FSIMulator:CSPeed` on page 172

3.4.2 Copy path group settings

The provided "Copy Path Group" settings enable you to copy the settings of one to a second fading group.

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Copy Path Group
Selects a group whose settings are to be copied.

Remote command:
`[:SOURce<hw>]:FSIMulator:COPY:SOURce` on page 153

To
Selects a group whose setting is to be overwritten.

Remote command:
`[:SOURce<hw>]:FSIMulator:COPY:DESTination` on page 153

Copy
Triggers a copy procedure.

Remote command:
`[:SOURce<hw>]:FSIMulator:COPY:EXECute` on page 153

3.4.3 Path table settings

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Frequency Ratio....53
Actual Doppler Shift....54
Correlation Path....54
Correlation Coefficient....55
Correlation Coefficient Phase....55
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Local Constant....55
Standard Deviation....56

State Path
Activates a fading path.

After activating, the fading process is initiated for this path with the selected fading profile. However, the fading simulator must be switched on.

Remote command:
`[:SOURce<hw>]:FSIMulator[:STATe]` on page 170
`[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:STATe` on page 183
`[:SOURce<hw>]:FSIMulator:MDELay:DEL30:GROup<st>:PATH<ch>:STATe` on page 183
`[:SOURce<hw>]:FSIMulator:HSTRain:PATH:STATe` on page 191

Profile

Determines the fading profile for the selected path. The fading profile determines which transmission path or which radio hop is simulated.

See also "Fading profile" on page 24.

Depending on which profile is selected, certain parameters are available in the path table and others are not available.

With correlated paths, the profile setting must agree. When correlation is activated, the setting of the path for which correlation is switched on is accepted for both paths. Afterwards, the most recent modification applies to both paths (no matter in which path it was made).

"Static Path" Simulated is a static transmission path which can undergo attenuation (loss) or delay.

"Pure Doppler" Simulated is a transmission path with an individual direct connection from the transmitter to the moving receiver (discrete component).
The actual Doppler shift is determined by the Speed and Frequency Ratio parameters.
Tip: In MIMO configuration, use the Relative gain vector matrix settings to configure beamforming.

"Rayleigh" Simulated is a radio hop in which many highly scattered subwaves arrive at a moving receiver.

"Rice" Simulated is a radio hop in which a strong direct wave (discrete component) arrives at a moving receiver in addition to many highly scattered subwaves.
Use the parameter Power Ratio to set the ratio of the power of the two components (Rayleigh and pure Doppler).

"Const. Phase" Simulated is one transmission path with the set constant phase rotation, attenuation (loss) or delay.

"Gauss1" Option: R&S SMW-K72
Sum of two Gaussian functions and is used for excess delay times in the following range:
0.5 µs to 2 µs, (0.5 µs < τ_l < 2 µs).
$S(\tau_l,f) = G(A, -0.8f_d, 0.05f_d) + G (A_1, +0.4f_d, 0.1f_d)$
where A_1 is 10 dB below A.

"Gauss2" Option: R&S SMW-K72
Sum of two Gaussian functions and is used for paths with delays in excess of 2 µs, (τ_l > 2 µs).
$S(\tau_l,f) = G(B, +0.7f_d, 0.1f_d) + G (B1, -0.4f_d, 0.15f_d)$
where B_1 is 15 dB below B.

"Gauss DAB" Option: R&S SMW-K72
Composed of a Gaussian function and is used for special DAB profiles.
$S(\tau_l,f) = G(A, \pm 0.7f_d, 0.1f_d)$
where + $0.7f_d$ applies for even path numbers and $0.7f_d$ for odd, except path 1.

"Gauss Doppler"
Option: R&S SMW-K72
Sum of a Gaussian function and a pure Doppler component.
$S(\tau_l,f) = G(0.1A; 0; 0.08f_d) + \delta(f-0.5f_d)$

"Gauss (0.08 fd)"
Option: R&S SMW-K72
Composed of a Gaussian function with a standard deviation of $0.08*f_d$.
$S(\tau_l,f) = G(A; f; 0.08f_d)$

"Gauss (0.1 fd)"
Option: R&S SMW-K72
Composed of a Gaussian function with a standard deviation of $0.1*f_d$.
$S(\tau_l,f) = G(A; f; 0.1f_d)$

"Gauss (Watters)"
Option: R&S SMW-K72
Gauss (Watterson) fading profile.

"WM Doppler"
Option: R&S SMW-K72
The WiMAX Doppler fading profile is a rounded Doppler PSD model according to IEEE 802.16a.

"WM Rice"
Option: R&S SMW-K72
The WiMAX Rice fading profile is according to IEEE 802.16a.

"Bell Shape tgn Indoor/Bell Shape tgn Moving Vehicle"
Both Bell Shape fading profiles describe the indoor wireless channels according to IEEE 802.11n and IEEE 802.11ac.
The profiles are called after the resulting Doppler power spectrum that has a shape very similar to a "Bell". The second fading profile includes a Doppler component that represents a reflection from a moving vehicle.

"SCM"
Option: R&S SMW-K73
The SCM profile is a geometry-based channel model that improves the accuracy of the simulated channel model.
To access the settings, select "SCM Profile > SCM Data", see Chapter 5.3.7, "SCM fading profile", on page 117

"Custom"
Option: R&S SMW-K72
Customized Doppler fading profile developed by Cohda-Wirless; the profile describes the channels for testing of IEEE 802.11p signals.
To access the required settings, select "Custom", see Chapter 3.11, "Custom fading profile", on page 87.

Remote command:
`[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:PROFile` on page 182
`[:SOURce<hw>]:FSIMulator:MDELay:DEL30:GROup<st>:PATH<ch>:PROFile` on page 182

Path Loss
Enters the loss for the selected path.

Remote command:
[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:LOSS
on page 181

Basic Delay
Option: R&S SMW-B14

Sets the basic delay.

Within a path group, all of the paths are jointly delayed by this value.

The path delay is calculates as:

Resulting Delay = Basic Delay + Additional Delay

The "Basic Delay" for group 1 is always 0. Thus, for the paths in group 1, the "Resulting Delay" is equal to the "Additional Delay".

See also Chapter 2.4, "Characteristics of R&S SMW-B14 and R&S SMW-B15", on page 25.

Remote command:
[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:BDELay
on page 174

Additional Delay
Sets the Additional Delay per path.

Remote command:
[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:ADELay
on page 173

Resulting Delay
Displays the Resulting Delay for the path.

Remote command:
[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:RDELay?
on page 174

Power Ratio
("Fading Profile > Rice, WM Rice, Gauss Doppler")

Enters the power ratio of the discrete component and distributed component.

The total power consisting of the two components is always constant. At a high power ratio, the discrete (Doppler) component prevails. At a low power ratio, the distributed (Rayleigh) component prevails.

Remote command:
[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:PRATio
on page 181

Frequency Spread
("Fading Profile > Gauss Watterson")

Sets the frequency spread for the Gauss Watterson fading.

Remote command:
[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:FSPRead
on page 180

Frequency Shift
("Fading Profile > Gauss Watterson")

Enters the frequency shift for the Gauss Watterson fading.

Remote command:
[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:FSHift
on page 179

Const. Phase
Enters the phase by which the path is multiplied.

Remote command:
[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:CPHase
on page 176

Start Phase
("Fading Profile > Pure Doppler, WM Doppler")

A transmission path with the set start phase rotation is simulated which can undergo attenuation (loss) or delay.

Remote command:
[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:CPHase
on page 176

Speed
Enters the speed *v* of the moving receiver.

The Resulting Doppler Shift f_D is calculated as:

$f_D = (v/c)*f_{RF}$, where

f_{RF} is the frequency of the RF output signal or the virtual RF frequency and $c=2.998*10^8$m/s is the speed of light

Example:

If v = 100 km/h and f_{RF} = 1 GHz, the f_D = 92.66 Hz

Consider the following interdependencies:
- If the speed is changed, the resulting Doppler shift is automatically modified.
- If "Path Table Settings > Common Speed in All Paths > On", a change of speed in one path automatically results in a change of speed in all of the other paths of the fader.
- In the "Fading Profile > Pure Doppler/Rice/Gauss Doppler", the actual Doppler Shift f_A is a function of the selected speed v and also of the parameter Frequency Ratio.
  See also "Cross-reference between the fading parameters" on page 46
- In "System Configuration > Mode > Standard", you can couple the speed for the paths of both faders.

- With correlated paths, the speed setting must agree. When correlation is activated, the settings of the path for which correlation is switched on are accepted for both paths. Afterwards, the most recent modification applies to both paths (no matter in which path it was made). The same applies to all paths of the two faders when coupling is activated.

Remote command:
`[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:SPEed`
on page 183

Resulting Doppler Shift
If "Table Settings > Keep Constant > Speed", this parameter displays the resulting Doppler shift f_D.

The value depends on the selected:
- Speed
- RF frequency f_{RF} or the Virtual RF
- For "Fading Profile > Pure, Gauss Doppler or Rice", the "Actual Doppler Shift" depends also on the selected Frequency Ratio.

See "Cross-reference between the fading parameters" on page 46.

To set the Doppler shift, enable "Table Settings > Keep Constant > Resulting Doppler Shift". In this case, the "Speed" is calculated as a function of the selected "Resulting Doppler Shift" and the RF frequency f_{RF}.

Remote command:
`[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:FDOPpler[:RESulting]` on page 177

Frequency Ratio
("Fading Profile > Pure, Gauss Doppler or Rice")

Sets the ratio of the actual Doppler Shift f_A to the Resulting Doppler Shift f_D.

The actual Doppler shift is a function of the simulated angle of incidence of the discrete component (see Figure 3-4) and is calculated as:

$f_A = f_D * \cos\varphi t$, where:

$\cos\varphi t$ is the "Frequency Ratio" and $f_D = (v/c) * f_{RF}$ is the Resulting Doppler Shift.

Negative values indicate a receiver that is going away from the transmitter, and positive values a receiver that is approaching the transmitter.

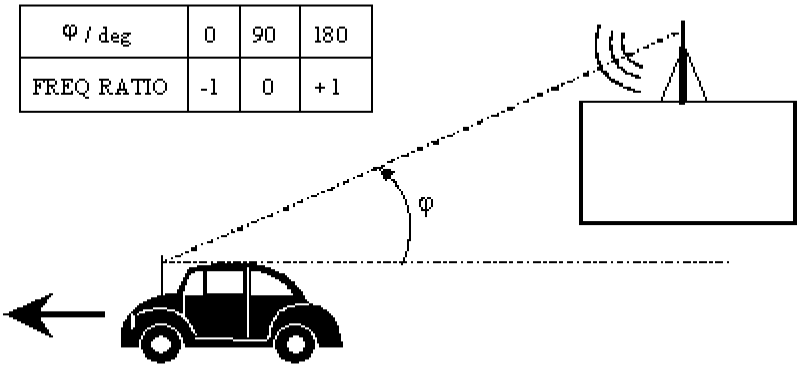


Figure 3-4: Doppler shift as a function of the angle of incidence

See also "Cross-reference between the fading parameters" on page 46

With correlated paths, the speed setting of the Frequency Ratio must agree. When correlation is activated, the settings of the path for which correlation is switched on are accepted for both paths. Afterwards, the most recent modification applies to both paths (no matter in which path it was made).

Remote command:
`[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:FRATio`
on page 179

Actual Doppler Shift
("Fading Profile > Pure Doppler, Gauss Doppler, Rice")

Displays the actual Doppler shift f_A. The value depends on Frequency Ratio and Resulting Doppler Shift.

See also "Cross-reference between the fading parameters" on page 46.

Remote command:
`[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:FDOPpler:ACTual?` on page 178

Correlation Path
Switches on correlation to the corresponding path of the second fader for dual-channel fading.

Setting correlation necessitates synchronous signal processing on both channels. This means the settings of the following parameters for the correlated fading paths must agree:

- "Profile"
- "Speed"
- "Frequency Ratio"
- "Lognormal Parameters"
- "Resulting Doppler Shift"
- "Actual Doppler Shift"

When correlation is activated, the settings of the path for which correlation is switched on are accepted for both paths. Afterwards, the most recent modification applies to both paths (no matter in which path it was made).

Correlated paths in dual-channel fading with the same input signal simulate the receiving conditions experienced by a receiver having two antennas in which the received signals exhibit a certain degree of correlation due to a similar environment.

Remote command:
[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:CORRelation:STATe on page 176

Correlation Coefficient
Sets the magnitude of the complex correlation coefficient as a percentage.

The higher the entered percentage, the greater the correlation of the statistical fading processes for the two correlated paths. Highly correlated ambient conditions for the signal are simulated in this manner.

Each fader has a maximum of 20 paths.

With correlated paths, the coefficient setting must agree. When correlation is activated, the setting of the path for which correlation is switched on is accepted for both paths. Afterwards, the most recent modification applies to both paths (no matter in which path it was made).

Remote command:
[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:CORRelation:COEFficient on page 175

Correlation Coefficient Phase
Sets the phase of the complex correlation coefficient in degrees.

With correlated paths, the coefficient phase setting must agree. When correlation is activated, the setting of the path for which correlation is switched on is accepted for both paths. Afterwards, the most recent modification applies to both paths (no matter in which path it was made).

Remote command:
[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:CORRelation:PHASe on page 176

Lognormal State
Switches lognormal fading on/off (slow fading).

Simulated is an additional slow fluctuation of the received amplitude of a moving receiver. This can occur due to peculiarities in the landscape or topography (e.g. when driving through a depression). Lognormal fading has a multiplicative effect on the path loss. The multiplication factor is time-variable and logarithmically normally distributed. If a Rayleigh profile is set simultaneously, what we obtain is Suzuki fading.

Note: Since the slow level fluctuation is not taken into account statistically in the computation of the insertion loss, the output power can deviate from the displayed power.

Remote command:
[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:LOGNormal:STATe on page 181

Local Constant
Enters the Local Constant for lognormal fading.

The Local Constant L and the speed v of the moving receiver determine the limit frequency f_L for lognormal fading:

$f_L = v/L$.

The power density spectrum of an unmodulated carrier consists of a discrete spectral line at f_{RF} and a frequency-dependent continuous component for which the following applies:

$$S(f) = const * e^{-0.5*\left(\frac{f - f_{RF}}{f_L}\right)}$$

The lower setting limit is a function of the (virtual) RF frequency f_{RF} and is calculated as follows:

$L_{min} = 12*10^9 / f_{RF}$

Remote command:
`[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:LOGNormal:LCONstant` on page 180

Standard Deviation
Enters the standard deviation in dB for lognormal fading.

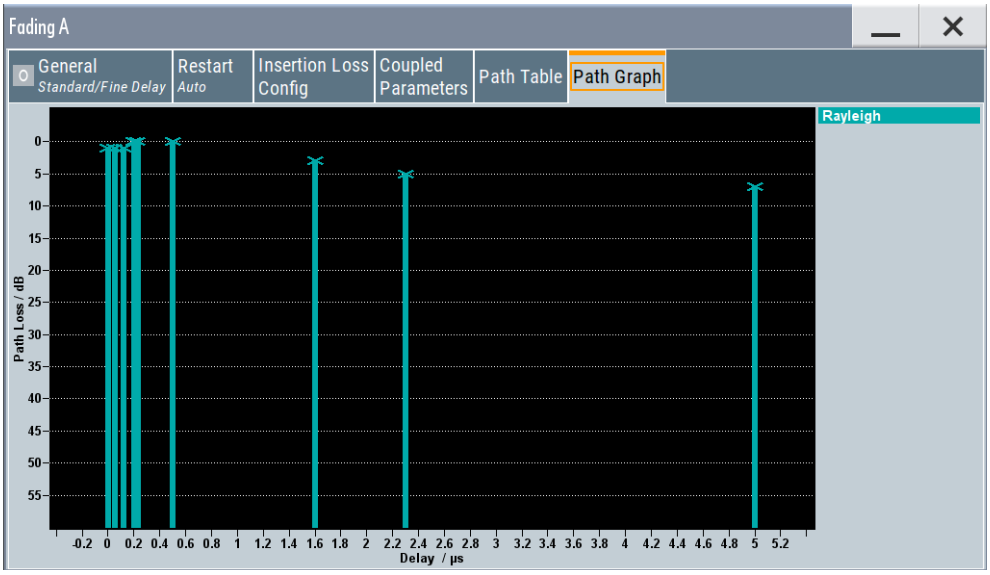
Remote command:
`[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:LOGNormal:CSTD` on page 180

3.5 Path graph

To access the graphical representation of the configured path,

► select "Fading > Path Graph".

The path graph provides a quick overview of the paths as they are configured in the delay modes.



The signal delay is plotted on the x-axis. The minimum value is 0 s. The maximum value is equal to the maximum delay, determined by the sum of max. Basic Delay and max. Additional Delay. The relative path power is plotted on the y-axis, with 0 dB corresponding to the maximum power on the path (path loss = 0 dB).

Each path is represented by a bar. The color of the bar indicates the fading profile of the path. The color coding for the individual profiles is shown right next to the graphics. The "Path Loss" can be read off from the height of the bar. The minimum value is 0 dB, and the maximum value is – 50 dB.

3.6 Birth death propagation

In the "Birth Death Propagation" configuration, the fading simulator simulates dynamic propagation conditions in conformity with the test case 3GPP, 25.104-xxx, annex B4. Here, the behavior of a receiver is tested when it is confronted with the sudden disappearance and reappearance of a signal. This can occur, for example, when a pedestrian making a call walks around the corner of a building.

Two paths are simulated which appear ("Birth") or disappear ("Death") in alternation at arbitrary points in time. The points in time fall within a grid of integer delays [-5, -4, -3, -2, -1, 0, 1, 2, 3, 4, 5] µs. After a certain time ("Hopping Dwell"), a path disappears from a given grid position and appears simultaneously at another randomly chosen grid position. During this hop, the second path remains stable at its grid position. After a further "Hopping Dwell" elapses, the second path changes its position. Now, the first path remains at its position and so on. The two paths never appear at the same time position at the same time (see Figure 3-5).

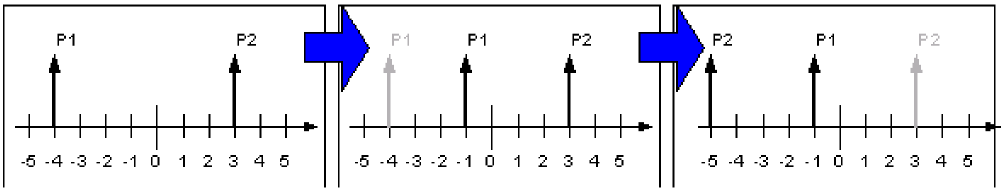


Figure 3-5: Example of a sequence of hops in Birth Death Propagation

Since it is not possible to generate negative time values (delays), the actual hop range is from 0 to 10 µs.

According to annex B4, each path has the same loss and phase and no Doppler shift. The time until the position of a path is changed is also specified (see Table 3-2).

Table 3-2: Default parameter values (Birth Death Propagation)

"Profile"	Pure Doppler
"Path Loss"	0 dB
"Min. Delay"	0 µs
"Delay Grid"	1 µs
"Positions"	11
"Max. Delay"	10 µs
"Hopping Dwell"	191 ms
"Speed"	0 m/s
"Frequency Ratio"	1.0

Path Graph

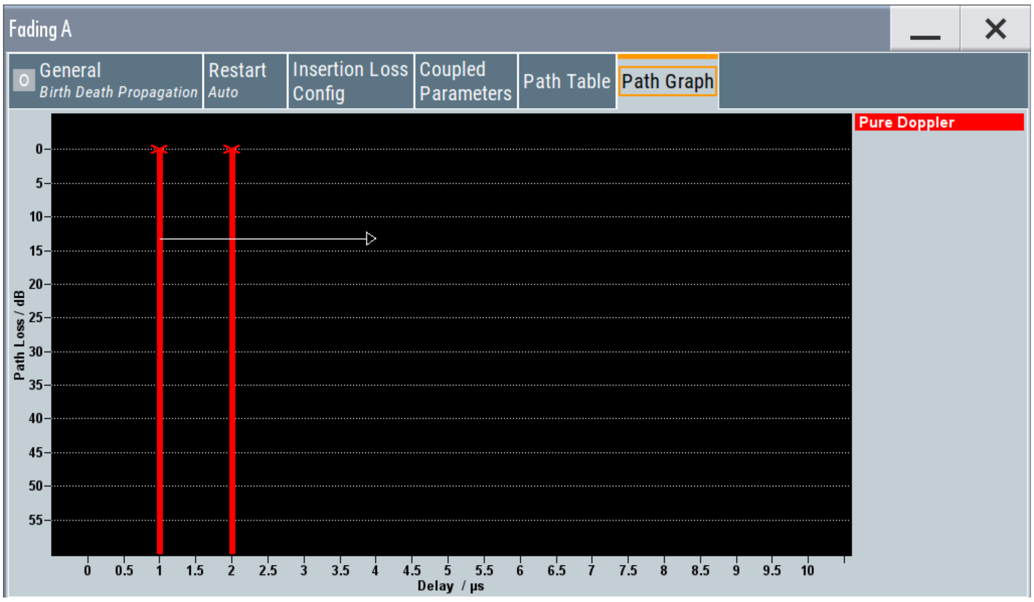
The graphical display of the fading paths in Birth Death Propagation mode shows as an example the changing positions of the two paths within the delay grid. The displayed position change does not correspond to the actual delay hops of the real signal. An arrow indicates the direction of the delay hop of the path that will next change its position, with the head of the arrow marking the new position.

The delay grid is plotted on the x-axis. The permissible delay range and the delay offset are shown in the graphics (see the "Min Delay" and the "Delay Range" indication on the graph). The path power is plotted on the y-axis, with 0 dB corresponding to the maximum power on the path (path loss = 0 dB). The scaling of the axes and the displayed path power match the real settings.

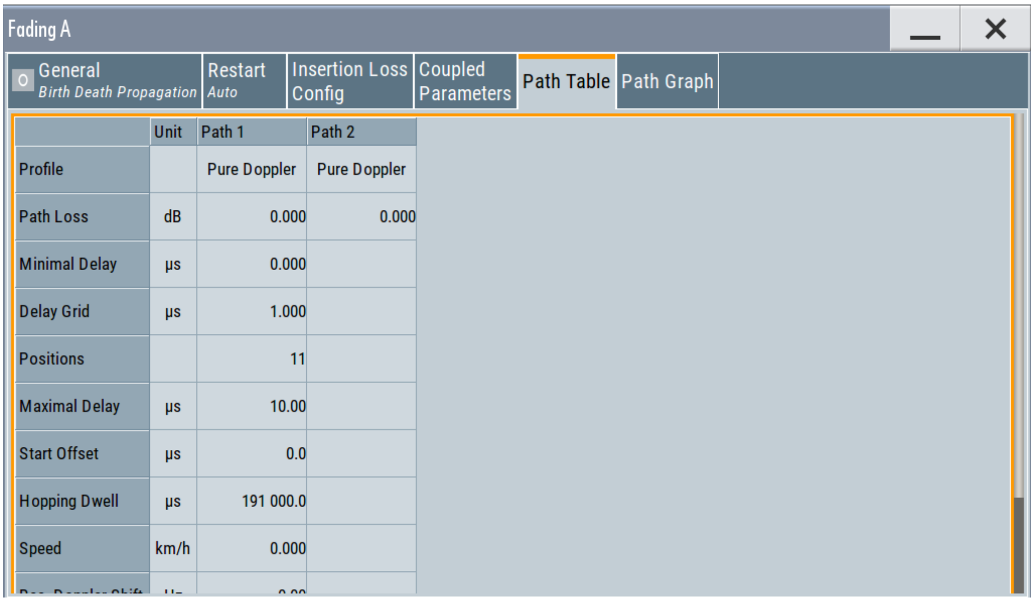
The scaling of the x-axis depends on the set delay range. It always starts at 0 µs and rages up to 40 µs at the most (= maximum for delay range). The minimum delay corresponds to the start value of the delay range. The maximum delay is defined by the minimum delay, the delay grid and the number of possible hop positions.

Max Delay = (Positions – 1) x Delay Grid + Min. Delay

The (mean) delay offset is calculated from the minimum and maximum delay ((max. delay - min. delay)/2).



The Table 3-2 lists the default values for Birth Death Propagation. However, these parameters can also be set for further tests in the fading path table.



Settings:

Profile...60
Path Loss...60
Min Delay...60
Delay Grid...60
Positions...60
Maximum Delay...61

Start Offset....61
Hopping Dwell....61
Speed....62
Resulting Doppler Shift....62
Frequency Ratio....62
Actual Doppler Shift....63

Profile

Displays the fading profile for birth death propagation. The fading profile has a fixed setting to "Pure Doppler".

A transmission path is simulated in which there is an individual direct connection from the transmitter to the moving receiver (discrete component). The Doppler frequency shift is determined by the "Speed" and "Frequency Ratio" parameters.

Remote command:
`[:SOURce<hw>]:FSIMulator:BIRThdeath:PATH<ch>:PROFile` on page 185

Path Loss

Enters the loss for the selected path.

Remote command:
`[:SOURce<hw>]:FSIMulator:BIRThdeath:PATH<ch>:LOSS` on page 185

Min Delay

Enters the minimum delay for the two fading paths.

The minimum delay corresponds to the start value of the delay range.

The delay range is defined by the minimum delay, the delay grid and the number of possible hop positions. It can be in the range between 0 and 40 us.

0 us < (Positions – 1) x Delay Grid + Min. Delay < 40 us

The scaling of the X-axis is adapted according to the entry (see "Path Graph" on page 58).

Invalid entries are rejected, the next possible value is entered.

Remote command:
`[:SOURce<hw>]:FSIMulator:BIRThdeath:DELay:MINimum` on page 184

Delay Grid

Enters the delay grid. The value defines the resolution for the possible hop positions of the two fading paths in the delay range.

The scaling of the X-axis is adapted according to the entry (see "Path Graph" on page 58).

Invalid entries are rejected, the next possible value is entered.

Remote command:
`[:SOURce<hw>]:FSIMulator:BIRThdeath:DELay:GRID` on page 184

Positions

Enters the number of possible hop positions in the delay range.

The scaling of the X-axis is adapted according to the entry (see "Path Graph" on page 58).

Invalid entries are rejected, the next possible value is entered.

Remote command:
[:SOURce<hw>]:FSIMulator:BIRThdeath:POSitions on page 186

Maximum Delay
Indication of the maximum delay. The maximum delay corresponds to the stop value of the delay range (see "Path Graph" on page 58).

The maximum delay is defined by the minimum delay, the delay grid and the number of possible hop positions.

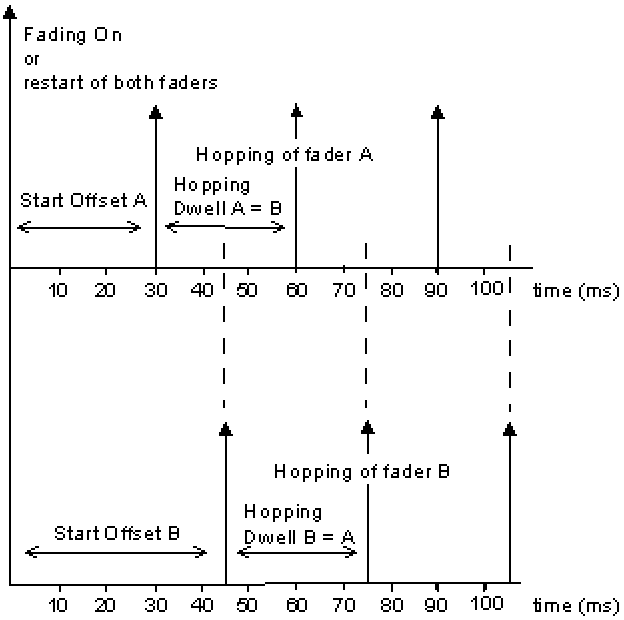
Max Delay = (Positions – 1) x Delay Grid + Min. Delay

Remote command:
[:SOURce<hw>]:FSIMulator:BIRThdeath:DELay:MAXimum? on page 184

Start Offset
Enters the timing offset by which the start of "Birth Death Propagation" is offset with respect to when fading is switched on or a restart as a result of a restart trigger.

This allows the user to precisely displace birth death events with respect to one another during two-channel fading. This is required in some 3GPP base station tests.

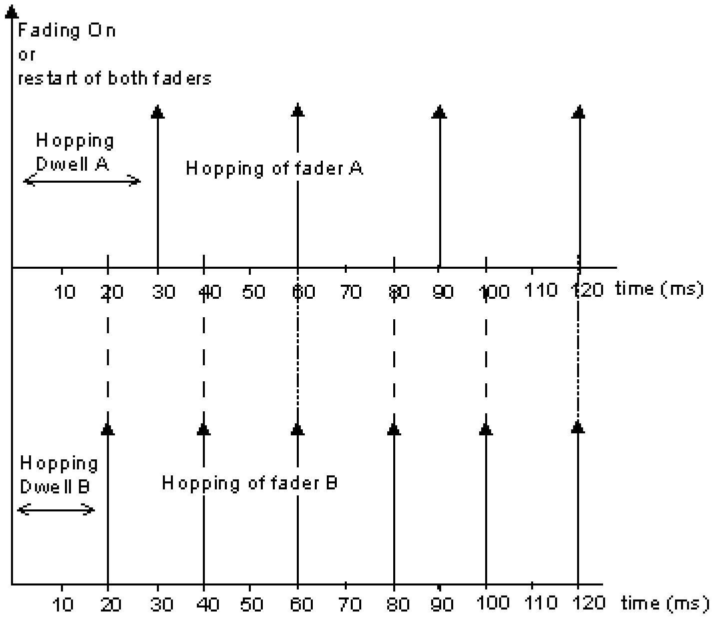
If the same hopping dwell time is entered in both faders, the offset will take place by a constant value.



Remote command:
[:SOURce<hw>]:FSIMulator:BIRThdeath:SOFFset on page 186

Hopping Dwell
Enters the time until the next change in the delay of a path (birth death event).

During two-channel fading, the dwell times of the two channels can be set independently. This causes the hop time points of the two channels to coincide repeatedly. This is a way of simulating tough receiving conditions as arise when two receiving channels simultaneously change frequency (see figure).



Remote command:
[:SOURce<hw>]:FSIMulator:BIRThdeath:HOPPing:DWELl on page 185

Speed
Enters the speed v of the moving receiver.

The resulting Doppler shift is dependent on the speed v and the entered ratio of the actual Doppler shift to the set Doppler shift f_D. This ratio is determined in the "Frequency Ratio" line. The resulting Doppler frequency can be read off from the "Res. Doppler Shift" line. It may not exceed the maximum Doppler frequency.

If the speed is changed, the resulting Doppler shift is automatically modified.

Remote command:
[:SOURce<hw>]:FSIMulator:BIRThdeath:SPEed on page 186

Resulting Doppler Shift
Displays the resulting Doppler shift.

Remote command:
[:SOURce<hw>]:FSIMulator:BIRThdeath:PATH<ch>:FDOPpler? on page 187

Frequency Ratio
Enters the ratio of the actual Doppler shift to the Doppler shift set with the "Speed" parameter.

Remote command:
[:SOURce<hw>]:FSIMulator:BIRThdeath:FRATio on page 187

Actual Doppler Shift
Displays the actual Doppler shift.

The actual Doppler frequency is determined by the selected "Speed" and "Frequency Ratio" (i.e. the ratio of the actual Doppler frequency to the resulting Doppler frequency).

Remote command:
`[:SOURce<hw>]:FSIMulator:BIRThdeath:PATH<ch>:FDOPpler:ACTual?`
on page 188

3.7 Moving propagation

In the "3GPP/LTE Moving Propagation" configuration, the fading simulator simulates dynamic propagation conditions in conformity with the test case 3GPP TS25.104, annex B3 or 3GPP TS36.141, annex B.4.

The fading simulator enables configuration according to three predefined moving scenarios. The first one represents moving conditions with one reference and one moving channel whereas in the other two all paths are moving.

The predefined scenarios are as follow:

- "Ref. + Mov. Channel" - Simulation of moving propagation conditions in accordance to the 3GPP TS25.104, annex B3.
  (see Chapter 3.7.1, "Moving propagation conditions for testing of baseband performance", on page 63)
- "ETU200Hz Moving" - Simulation of moving propagation conditions in accordance to the scenario 1 described in 3GPP TS36.141, annex B.4.
  (see Chapter 3.7.2, "Moving propagation conditions for testing the UL timing adjustment performance", on page 66)
- "Pure Doppler Moving" - Simulation of moving propagation conditions in accordance to the scenario 2 described in 3GPP TS36.141, annex B.4.
  (see Chapter 3.7.2, "Moving propagation conditions for testing the UL timing adjustment performance", on page 66)

It is also possible to adjust some of the parameters of these predefined scenarios and simulate user-definable moving propagation conditions.

3.7.1 Moving propagation conditions for testing of baseband performance

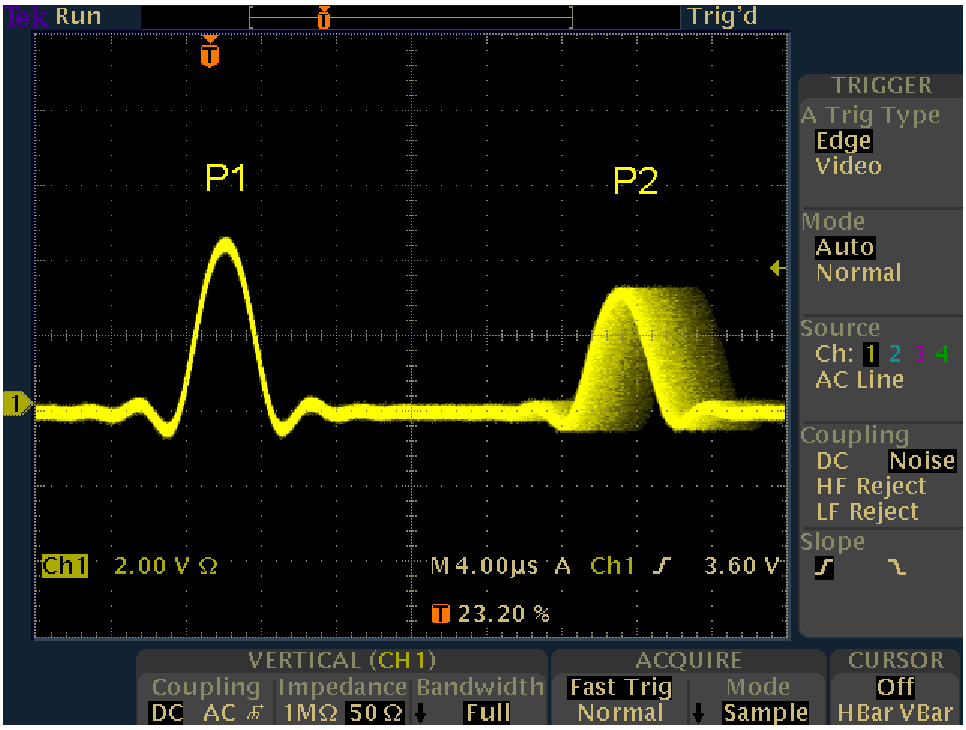
Simulating moving propagation conditions for testing of baseband performance

► To simulate moving propagation conditions for testing of baseband performance in accordance to the 3GPP TS25.104, annex B3:

  a) select "Configuration > Moving Propagation" and "Moving Channels > One" or
  b) select "Standard > 3GPP > Moving Propagation > Ref. + Mov. Channel".

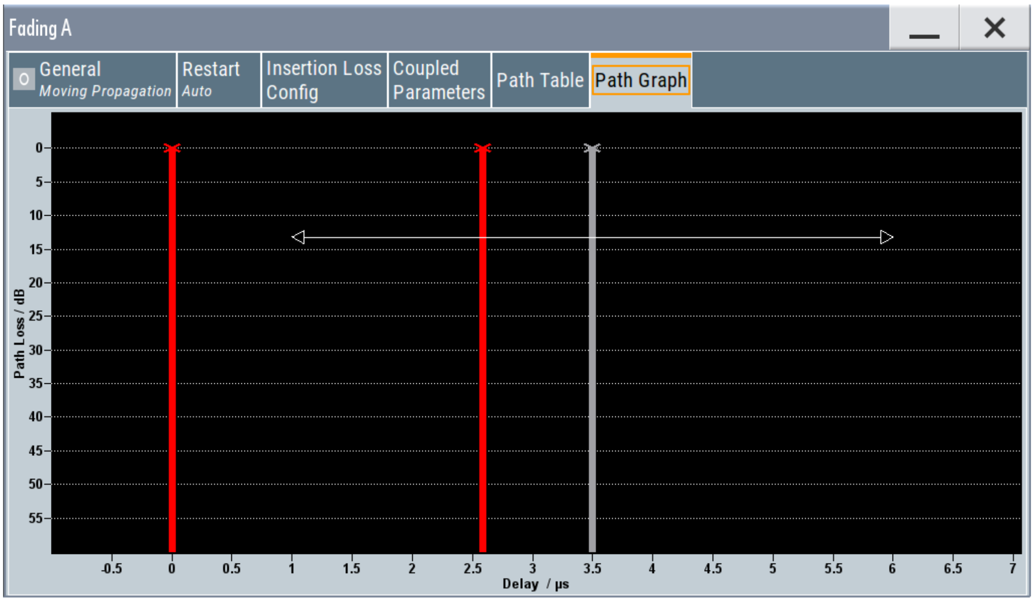
Here, the behavior of a receiver is tested in response to slow delay variations in a signal. Two paths are simulated: Path 1 has fixed delay (Reference Path, P1), while the delay of path 2 varies slowly in a sinusoidal fashion (Moving Path, P2). The two paths have no fading profile. They have the same level, the same phase and no Doppler shift.

The following figure illustrates a baseband signal with ASK modulation (only one 1 bit, then many 0 bits) which was subjected to moving propagation. Path P1 remains still while path P2 moves in time relative to it. As a result of the luminescence setting on the oscilloscope, the way in which P2 wanders over time is clearly visible.



The graphical display of the fading paths in Moving Propagation mode shows as an example the changing positions of the moving path with respect to the stationary reference path. The displayed position change does not correspond to the actual delay changes of the real signal.

The delay grid is plotted on the x-axis. The permissible delay range for the moving path is shown in the graphics by the horizontal arrow. The grey path indicates the set start delay for the Moving Path. The path power is plotted on the y-axis, with 0 dB corresponding to the maximum power on the path (path loss = 0 dB). The scaling of the axes and the displayed path power match the real settings.



The delay $\Delta\tau_{one}$ of the moving path obeys the following equation:

$$\Delta\tau_{one} = \text{"}Delay\text{"} + \frac{\text{"}Variation(Pk\,Pk)\text{"}}{2} * \sin\frac{2\pi t}{\text{"}VariationPeriod\text{"}}$$

Where the values relate to the values proposed in the test case 3GPP, 25.104xxx, annex B3 as follows:

- Variation (Peak-Peak) = A
- Delay = B + A/2
- Variation Period = 2π /Δ ω

The Table 3-3 list the settings required to attain the values proposed in the test case 3GPP TS25.104, annex B3.

Table 3-3: Default parameter values (Moving Propagation)

Reference Path:	"Delay"	0 us
	"Path Loss"	0 dB
	"State"	On
Moving Path:	"Variation (Pk Pk)"	5 us
	"Variation Period"	157 s
	"Delay"	3.5 us
	"Path Loss"	0 dB
	"State"	On

These default values can be changed in the Path Table dialog.

3.7.2 Moving propagation conditions for testing the UL timing adjustment performance

The purpose of the uplink timing adjustments testing is to verify whether the base station sends timing advance commands and whether the base station estimates appropriate the uplink transmission timing.

Simulating moving propagation conditions

To simulate moving propagation conditions for testing the UL timing adjustment performance in conformity with the test cases "Moving propagation conditions", as defined in 3GPP 36.141, annex B.4:

► Select "Standard > LTE > Moving Propagation > ETU200Hz Moving or Pure Doppler Moving"

The Figure 3-6 illustrates the moving propagation conditions for the test of the UL timing adjustment performance.

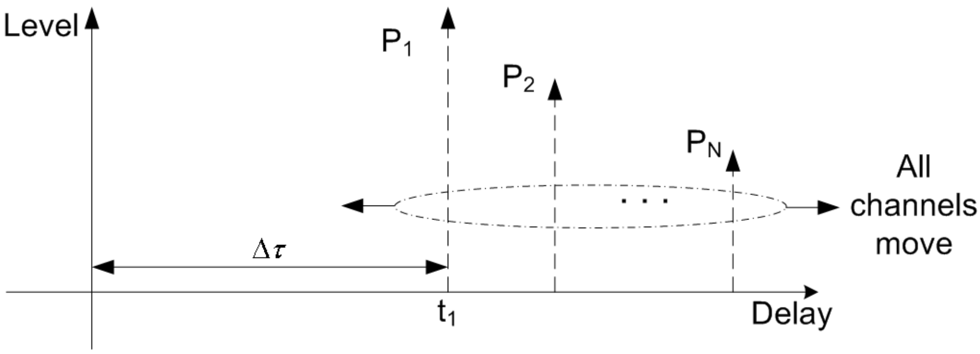


Figure 3-6: Moving Propagation Conditions

Use the parameter "Additional Delay" to configure the relative timing among all paths. The time difference between the reference timing and the first path is according to the following equation:

$$\Delta\tau_{all} = \frac{\text{"}Variation(Pk\ Pk)\text{"}}{2} * \sin\frac{2\pi t}{\text{"}Variation\ Period\text{"}}$$

The 3GPP specification defines the uplink timing adjustments requirements for normal and extreme conditions. The following two scenarios for the testing of UL timing advance are specified:

- Scenario 1: ETU200 ("ETU200Hz Moving") is the scenario for testing in normal conditions.
  This scenario considers ETU channel model and UE speed of 120km/h.
- Scenario 2: AWGN ("Pure Doppler Moving") is the extreme conditions optional scenario.
  The scenario corresponds to AWGN channel model and UE speed of 350km/h.

The fading simulator generates the signals for these scenarios in according to the parameters defined in the 3GPP specification (see table Table 3-4). However, the fading simulator also allows the re-configuration of some of the predefined values.

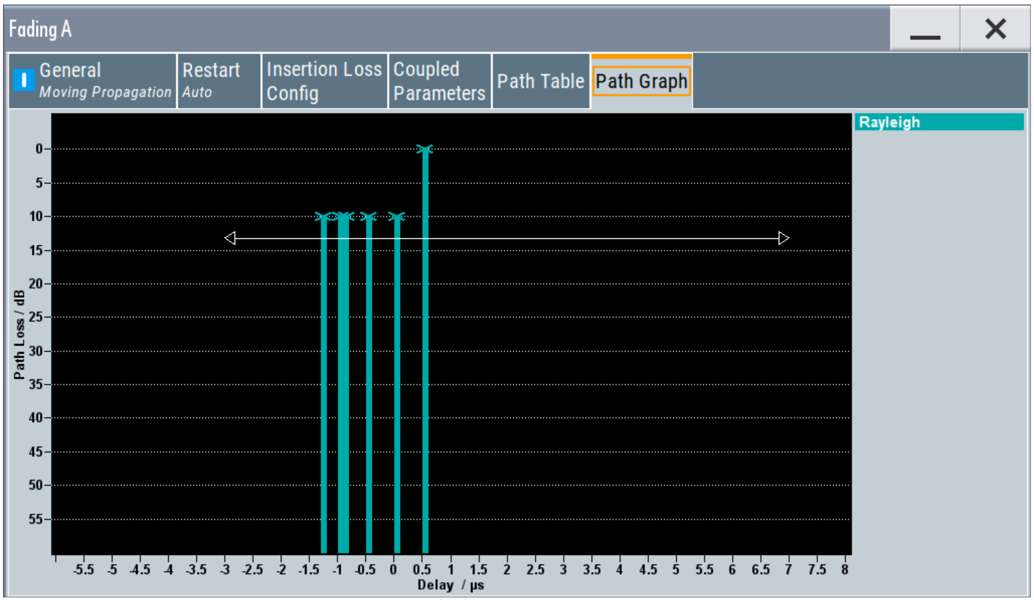
Table 3-4: Default parameter values

Parameter	Scenario 1	Scenario 2
Channel Model	ETU200Hz Moving	Pure Doppler
UE speed	120 km/h	350 km/h
CP length	Normal	Normal
"Variation (Peak-Peak)"	10 µs	10 µs
Δω	0.04 1/s	0.13 1/s
"Variation Period" = 2π/Δω	157.1 s	48.3 s

3.7.2.1 Scenario 1

Here, the behavior of a moving receiver is tested, i.e. the simulated scenario represents a moving receiver that changes its distance to the base station. The Fading Simulator generates the signal as a sequence of complete cycles of approach towards to the BS antenna and moving away from it.

Per default, three Rayleigh path groups with three paths each are simulated. All paths move.



The path group 1 has a fixed delay ("Basic Delay = 0 s"); the "Basic Delay" of the other two path groups can be configured. The relative timing among all paths is determined by the parameter "Additional Delay".

The three path groups have the same phase and speed; the Doppler shift is calculated as a function of the selected speed.

3.7.2.2 Scenario 2

One path without a fading profile (Pure Doppler) is simulated. The path has constant level and constant speed.

3.7.3 Path tables moving propagation

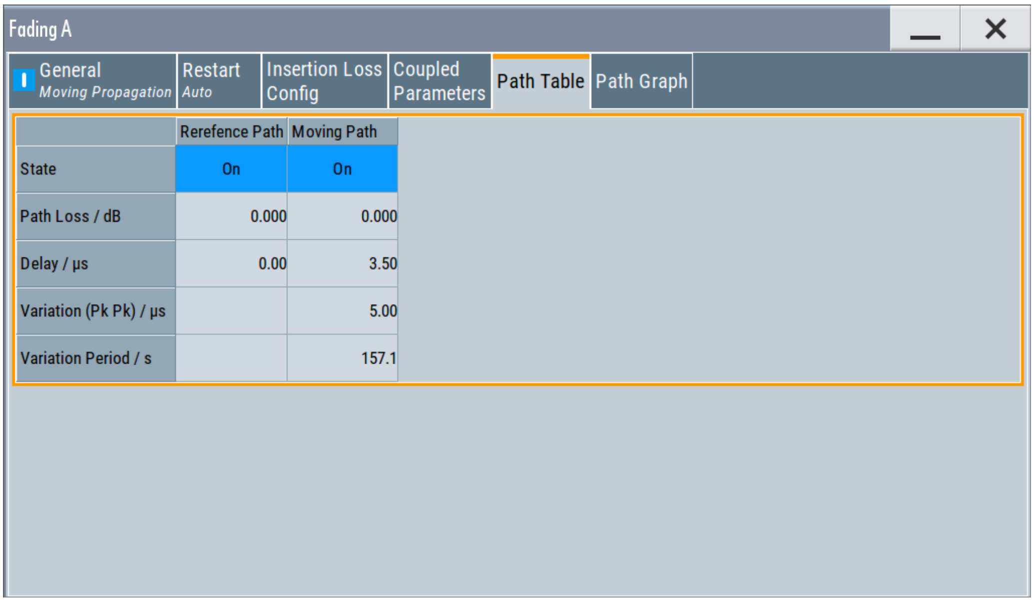
The parameters available for configuration depend on the selected number of Moving Channels, one or all.

3.7.3.1 One moving channel

► To access the settings for configuring the moving and the reference path for the moving propagation with one moving channel, perform on of the following:

a) select "Fading > Standard > 3GPP > Ref. + Mov. Channel"

b) select "Fading > Configuration > Moving Propagation" and "Moving Channels > One".



Settings:

Reference Path Settings........ 69
└ State........ 69
└ Path Loss........ 69
└ Delay........ 69
Moving Path Settings........ 69
└ State........ 69
└ Path Loss........ 69

└ Delay..69
└ Variation (Peak-Peak)..69
└ Variation Period..70

Reference Path Settings
The following settings are provided:

State ← Reference Path Settings
Activates reference path P1 for moving propagation.

Remote command:
`[:SOURce<hw>]:FSIMulator:MDELay:REFerence:STATe` on page 197

Path Loss ← Reference Path Settings
Enters the loss for the reference path.

Remote command:
`[:SOURce<hw>]:FSIMulator:MDELay:REFerence:LOSS` on page 197

Delay ← Reference Path Settings
Enters the delay for the reference path.

Remote command:
`[:SOURce<hw>]:FSIMulator:MDELay:REFerence:DELay` on page 197

Moving Path Settings
The following settings are provided:

State ← Moving Path Settings
Activates moving fading path P2 for moving propagation.

Remote command:
`[:SOURce<hw>]:FSIMulator:MDELay:MOVing:STATe` on page 196

Path Loss ← Moving Path Settings
Enters the loss for the moving fading path.

Remote command:
`[:SOURce<hw>]:FSIMulator:MDELay:MOVing:LOSS` on page 196

Delay ← Moving Path Settings
Enters the average delay for the moving fading path.

The delay of the moving path slowly varies sinusoidal within the set variation range around this delay.

Remote command:
`[:SOURce<hw>]:FSIMulator:MDELay:MOVing:DELay:MEAN` on page 195

Variation (Peak-Peak) ← Moving Path Settings
Enters the range for the delay of the moving fading path for moving propagation. The delay of the moving path slowly varies sinusoidal within this range around the set mean delay.

Remote command:
[:SOURce<hw>]:FSIMulator:MDELay:MOVing:DELay:VARiation on page 195

Variation Period ← Moving Path Settings

Period duration for delay variation. A complete variation cycle is passed through in this time.

Remote command:
[:SOURce<hw>]:FSIMulator:MDELay:MOVing:VPERiod on page 196

3.7.3.2 All moving channels

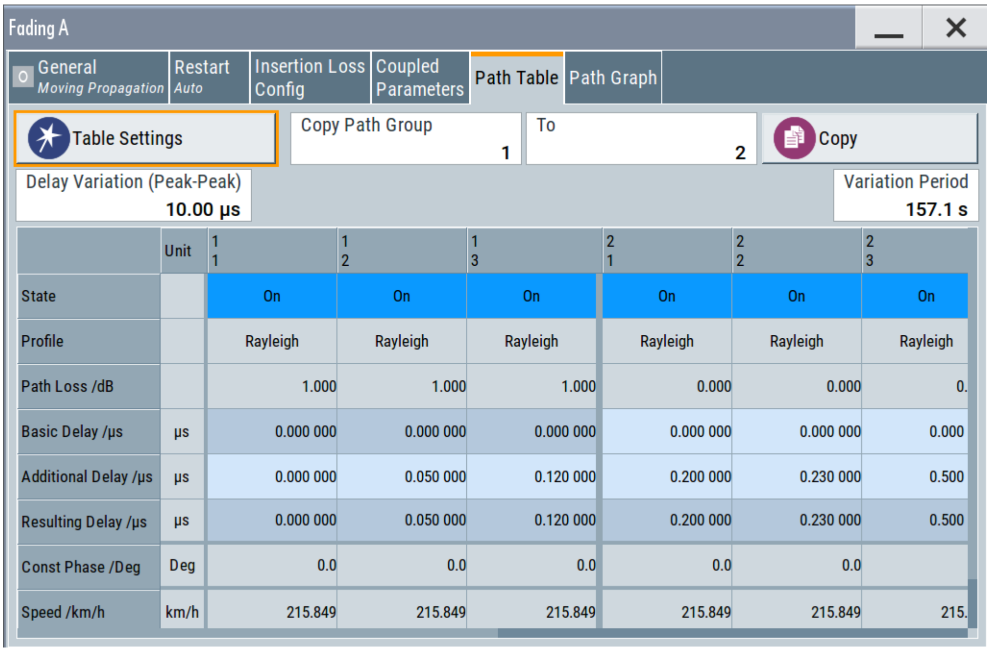
► To access the settings for configuring the moving path groups and their paths, perform one of the following:

a) select "Fading > Standard > LTE > Moving Propagation > ETU200Hz Moving"

b) select "Fading > Standard > LTE > Moving Propagation > Pure Doppler Moving"

c) select "Fading > Configuration > Moving Propagation" and "Moving Channels > All".

The number and the parameters of the predefined paths depend on the selected scenario.



The most parameters in the "Path Table" correspond to the parameters described in Chapter 3.4, "Path table", on page 44.

Settings:

Delay Variation (Peak-Peak)....71
Variation Period....71

Delay Variation (Peak-Peak)
Enters the range for the delay of the moving fading paths for moving propagation with all moving channels. The delay of the moving path slowly varies sinusoidal within this range around the set mean delay.

Remote command:
`[:SOURce<hw>]:FSIMulator:MDELay:ALL:MOVing:DELay:VARiation` on page 194

Variation Period
Period duration for delay variation. A complete variation cycle is passed through in this time.

Remote command:
`[:SOURce<hw>]:FSIMulator:MDELay:ALL:MOVing:VPERiod` on page 193

3.8 Two channel interferer

In the "2 Channel Interferer" configuration, the fading simulates dynamic propagation in conformity with the test cases 5 and 6 from MediaFlo. Here, path 1 has a fixed delay while the delay of path two either varies slowly in a sinusoidal way or appears in alternation at arbitrary points in time. Thus, 2 channel interferer fading can be considered as a combination of birth death propagation fading and moving propagation fading. The main difference is the broader range of propagation obtainable with 2 channel interferer fading.

Each of the fading profiles "Static Path", "Pure Doppler" and "Rayleigh" can be allocated to the two paths.

Predefined Setting

The Table 3-5 and Table 3-6 list the settings required to attain the values proposed in the MediaFlo test case 5 and 6.

Table 3-5: Test Case 5

Reference Path:	"Profile"	Static Path
	"Relative Delay"	10 us
	"Average Power"	-3 dB
	"Fading Type"	Rayleigh, 60 km/h
	"Doppler Spectrum"	Classic 6 dB
	"Static Delay"	40 us
Moving Path:	"Profile"	Hopping

	"Relative Delay"	0/110 us
	"Average Power"	-3 dB
	"Fading Type"	Static
	"Doppler Spectrum"	N/A
	"Dwell Time"	2.9 s

Table 3-6: Test Case 6

Reference Path:	"Profile"	Static Path
	"Relative Delay"	100 us
	"Average Power"	-3 dB
	"Fading Type"	Static
	"Doppler Spectrum"	N/A
Moving Path:	"Profile"	Sliding
	"Relative Delay"	0/200 us
	"Average Power"	-3 dB
	Fading Type	Rayleigh, 3 km/h
	"Doppler Spectrum"	Classic 6 dB
	"Period"	160 s

How to use the provides settings and configure a 2 channel interfering signal

The following are two examples on how to configure a "2 Channel Interferer" conditions. See how to:

- "To enable a hopped moving mode" on page 72
- "To enable a sliding moving mode" on page 73

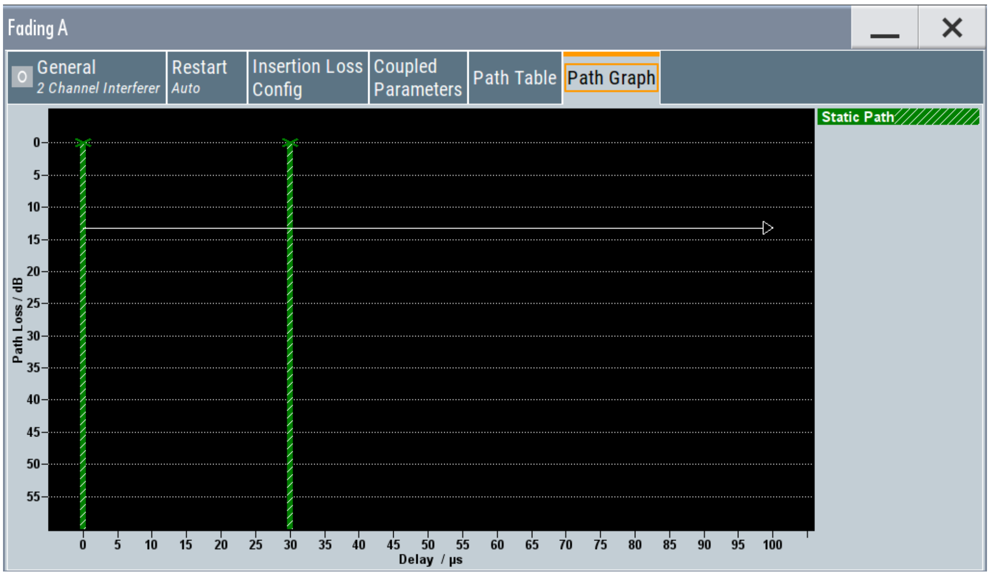
To enable a hopped moving mode

Enable a 2 channel interfering signal with the following settings:

1. Reference Path:
   a) "Delay Min = 30 µs"
   b) "Profile = Static Path"
   c) "Path Loss = 0 dB"
2. Moving Path:
   a) "Delay Min = 0 µs"
   b) "Profile = Static Path"
   c) "Path Loss = 0 dB"
   d) "Delay Max = 100 µs"
   e) "Moving Mode > Hopping"
3. Enable "Reference Path > State > On" and "Moving Path > State > On"

4. Open the "Fading > Path Graph" view.

   The following figure shows the resulting path graph.



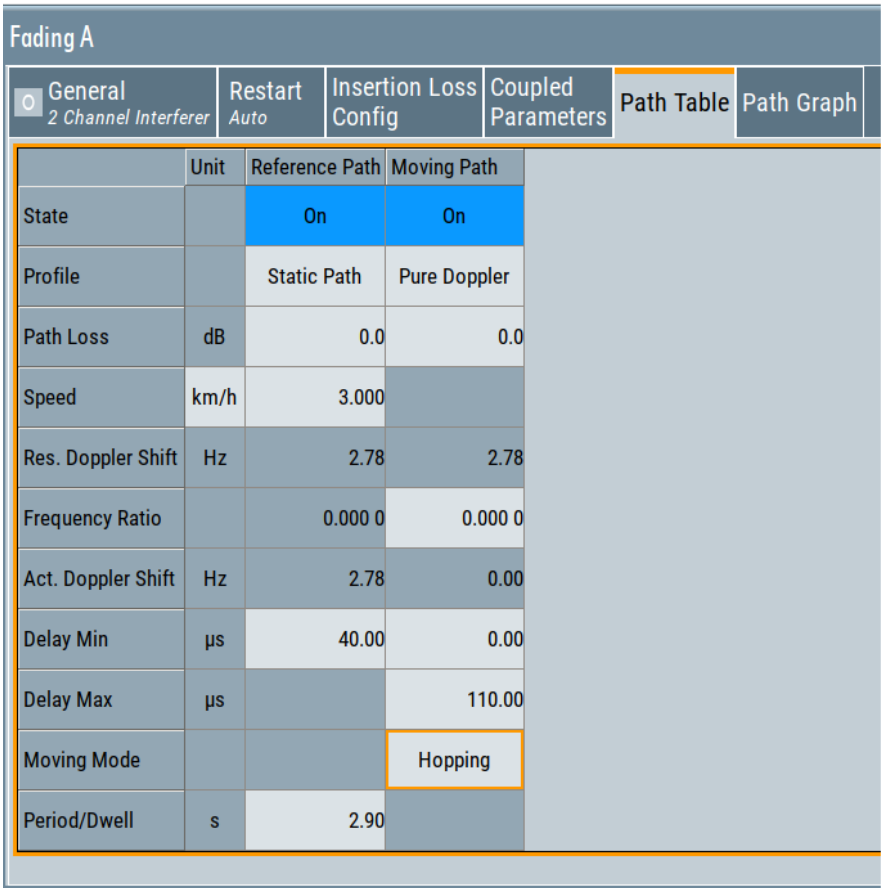
To enable a sliding moving mode

1. Use the settings of "To enable a hopped moving mode" on page 72.
2. Change the "Moving Mode > Sliding".
3. Open the "Fading > Path Graph" view.

The moving path slides from the minimum delay (30 us) to the maximum delay (100 us) and back. The grey bar indicates the mean delay of the moving path. The horizontal arrow indicates the permissible delay range for the moving path.
The displayed position change does not correspond to the actual delay changes of the real signal.

2 Channel Interferer Settings

The Table 3-5 and Table 3-6 list the default values for "2 Channel Interferer" configuration. You can use these default values and/or adjust the provided settings in the fading path table.



Settings:

State.....74
Profile.....75
Path Loss.....75
Speed.....75
Freq. Ratio.....75
Res. Doppler Shift.....75
Act. Doppler Shift.....76
Delay Min.....76
Delay Max (Moving Path).....76
Moving Mode (Moving Path).....76
Period/Dwell.....76

State

Activates/deactivates either the reference path or the moving path for 2 channel interferer fading.

Remote command:
[:SOURce<hw>]:FSIMulator:TCINterferer[:STATe] on page 220
[:SOURce<hw>]:FSIMulator:TCINterferer:REFerence|MOVing:STATe
on page 223

Profile
Selects the fading profile either for the reference path or the moving path to be used for 2 channel interferer fading.

Remote command:
[:SOURce<hw>]:FSIMulator:TCINterferer:REFerence|MOVing:FDOPpler?
on page 222

Path Loss
Sets the attenuation of either the reference path or moving path to be used for 2 channel interferer fading.

Remote command:
[:SOURce<hw>]:FSIMulator:TCINterferer:REFerence|MOVing:LOSS
on page 223

Speed
(Rayleigh only)

Enters the speed v of the moving receiver. The unit for entering the speed under "Speed Unit" can be chosen in the upper section of the menu.

The resulting Doppler shift is dependent on the speed v and the entered ratio of the actual Doppler shift to the set Doppler shift f_D. This ratio is determined in the "Frequency Ratio" line. The resulting Doppler frequency can be read off from the "Res. Doppler Shift" line. It may not exceed the maximum Doppler frequency.

If the speed is changed, the resulting Doppler shift is automatically modified.

Remote command:
[:SOURce<hw>]:FSIMulator:TCINterferer:SPEed on page 221

Freq. Ratio
Enters the ratio of the actual Doppler shift to the Doppler shift set with the "Speed" parameter.

Remote command:
[:SOURce<hw>]:FSIMulator:TCINterferer:REFerence|MOVing:FRATio
on page 222

Res. Doppler Shift
Displays the actual Doppler shift.

The actual Doppler frequency is determined by the entered "Speed" and the entered ratio of the actual Doppler frequency to the set Doppler frequency ("Frequency Ratio").

Remote command:
[:SOURce<hw>]:FSIMulator:TCINterferer:REFerence|MOVing:FDOPpler?
on page 222

Act. Doppler Shift
Displays the actual Doppler shift.

Remote command:
`[:SOURce<hw>]:FSIMulator:TCINterferer:REFerence|MOVing:FDOPpler:ACTual?` on page 222

Delay Min
Enters the minimum delay for either the reference path or the moving path.

The minimum delay of the moving path corresponds to the start value of the delay range.

The delay range is defined by the minimum delay and the maximum delay.

The scaling of the x-axis is adapted according to the entry.

Invalid entries are rejected, the next possible value is entered.

Remote command:
`[:SOURce<hw>]:FSIMulator:TCINterferer:REFerence|MOVing:DELay:MINimum` on page 221

Delay Max (Moving Path)
Enters the maximum delay for the moving path.

The maximum delay of the moving path corresponds to the end value of the delay range.

The delay range is defined by the minimum delay and the maximum delay.

The scaling of the x-axis is adapted according to the entry.

Invalid entries are rejected, the next possible value is entered.

Remote command:
`[:SOURce<hw>]:FSIMulator:TCINterferer:REFerence|MOVing:DELay:MAXimum` on page 220

Moving Mode (Moving Path)
Selects the Type of moving applied to the moving path.

"Sliding" The reference path has a fix delay while the delay of the moving path varies slowly in a sinusoidal way.

"Hopping" The reference path has a fix delay while the delay of the moving path appears or disappears in alternation at arbitrary points in time.

Remote command:
`[:SOURce<hw>]:FSIMulator:TCINterferer:REFerence|MOVing:MMODe` on page 220

Period/Dwell
Enters either the dwell time or the period of a complete cycle for the moving path depending on the selected Moving Mode (Moving Path).

"Moving Mode"	"Period Dwell"
"Sliding"	sets the period for a complete cycle of the moving path
"Hopping"	sets the dwell time of the moving path

The gradient of the delay/period ratio may not fall below 6µs/s, that is, the minimum value of the period depends on the value of the delay.

If the value for the delay is increased in a way that the value for the gradient falls below 6µs/s, the value for the period is recalculated automatically.

Example:

"Delay Min" = 20 us, "Delay Max" = 120 us, "Moving Mode = Sliding"

[("Delay max" - "Delay min")/2]*2π)/"Period/Dwell" = 6

"Period/Dwell" = 314/6 = 52.36 s

The value cannot be decreased below this value.

Remote command:
`[:SOURce<hw>]:FSIMulator:TCINterferer:PERiod` on page 221

3.9 Customized dynamic fading

Option: R&S SMW-K820

Customized dynamic fading (CDF) allows you to import dynamic fading list files and to vary the fading parameters path loss, Doppler shift and delay over time.

Customized dynamic fading is a suitable solution in the following cases:

- If advanced dynamic fading models like the customized high-speed train scenarios (cHST) are required.
- If a simulation based on measured real-world channel conditions is required
  Such requirements are, for example, the UE tests in the context of performance analysis.

Depending on the used configuration, the following types of dynamic fading list files are supported:

- "Customized dynamic fading with *.fad_udyn files for SISO and MIMO configurations" on page 77
- "Human-readable customized dynamic fading files for SISO configurations" on page 78

Customized dynamic fading with *.fad_udyn files for SISO and MIMO configurations

This fading configuration consists of up to 12 fading paths that you can activate individually. All fading paths use Rayleigh fading profile but you can also assign a pure Doppler profile or static fading profile to the first four paths.

The dynamic fading list files are application-specific list files in a Rohde & Schwarz proprietary file format in binary form and with the predefined file extension `*.fad_udyn`. Such files can originate, for example, from drive test measurements. Convert the measurement results in the required binary file format before loading the files in fading simulator.

Human-readable customized dynamic fading files for SISO configurations

Fading configurations like 1x1x1 or 2x1x1 SISO consist of one fading channel or up to 12 fading paths. You can assign the dynamic fading list files to the second, third or forth fading paths. These paths can use a pure Doppler, Rayleigh or static fading profile.

The following applies for the dynamic fading list files:

- Mandatory keyword `customer` in the filename.
  `*customer*.fad_udyn`, where * stays for user-defined filename.
- Mandatory file extension `*.fad_udyn`.
- Predefined file structure, see Example"Customized dynamic fading file content" on page 78.
  - Mandatory file heading with syntax
    `Interval[us] Delay[ms] Fd[kHz] Pathloss[dB]`, where:
    `Interval[us]` gives the time in µs, relative to the fader start. File content is repeated when last time interval is reached.
    `Delay[ms]` is the actual delay in ms
    `Fd[kHz]` is the Doppler frequency in kHz
    `Pathloss[dB]` is the path loss in dB
  - File contains four columns separated by blanks
    Each file row can vary the fading parameters delay, Doppler shift and path loss over time

Example: Customized dynamic fading file content

```
Interval[us] Delay[ms] Fd[kHz] Pathloss[dB]
100 7.534877 47.055121 15.554548
100 7.534874 47.055121 15.554545
100 7.534873 47.055121 15.554542
...
```

Creating and converting human-readable customized dynamic fading files

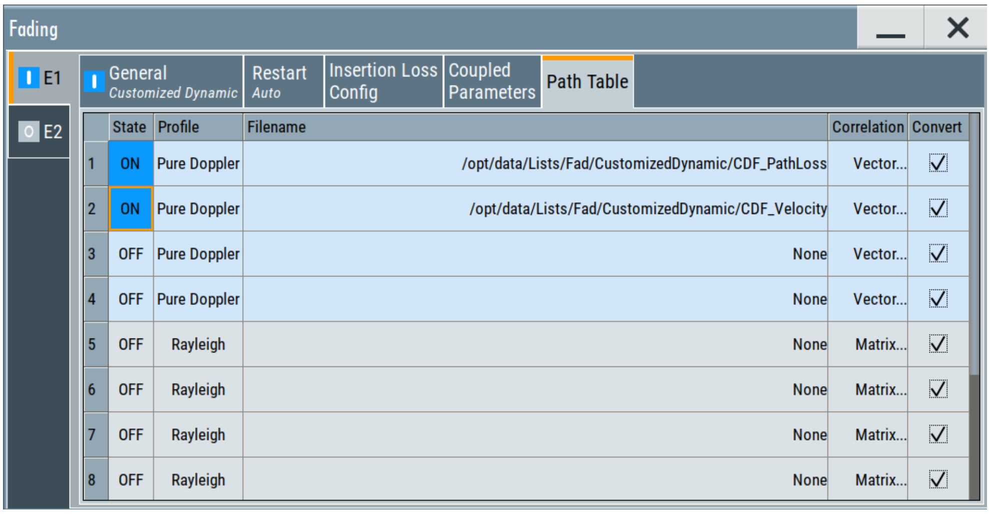
1. Create a human-readable customized dynamic fading file with any text editor.
2. Rename the file afterwards to follow the naming convention. Add the mandatory extension.
   See "Human-readable customized dynamic fading files for SISO configurations" on page 78.
3. Load the file in the fading simulator. See "Configuring and enabling "Customized Dynamic" fading profiles" on page 79.

4. In the "Path Table", select "Convert > On" to convert the file into the Rohde & Schwarz proprietary file format.
5. Enable fading simulator. Set "Fading > General > State > On".

   The R&S SMW200A converts the file into the Rohde & Schwarz proprietary file format and saves on the hard drive.
   As long as the file content remains unchanged, converting the file once, after it is loaded for the first time, is sufficient. Each time you start the fading simulator with enabled custom fading, the R&S SMW200A loads the file automatically from the hard drive.

Configuring and enabling "Customized Dynamic" fading profiles

1. Select "Fading > General Setting > Configuration > Customized Dynamic"
2. Select "Path Table".



   The displayed settings and the number of fading paths depend on the configuration (SISO or MIMO).

3. To load a fading list file, select "Filename > Select Predefined File".
   Select on of the predefined files, e.g. `CDF_PathLoss`.
4. To load user-defined `*.fad_udyn` files, transfer them to the R&S SMW200A. Load them accordingly.
5. Only if you load a custom fading list with filename like `*customer*.fad_udyn` for the first time, set "Convert > On".
6. Enable fading simulator. Set "Fading > General > State > On".

Settings:

State......80
Profile......80
Filename......80
Correlation......80
Convert......81

State

If a fading list file is loaded, this parameter activates the path.

Each change of the state of a path causes a restart of the fader and therefore a restart of all dynamic lists.

Remote command:
`[:SOURce<hw>]:FSIMulator:CDYNamic:PATH<ch>:STATe` on page 240

Profile

Sets the used profile. Per default, all fading paths use Rayleigh profile.

"Static Path"	Fading profile for all paths.
"Pure Doppler"	Fading profile for paths 1 to 4.
"Rayleigh"	Fading profile for all paths.

Remote command:
`[:SOURce<hw>]:FSIMulator:CDYNamic:PATH<ch>:PROF` on page 240

Filename

You can load predefined or user-defined application-specific fading list files.

The fading list files are files in a Rohde & Schwarz proprietary file format and with the predefined file extension `*.fad_udyn`.

Such files can originate, for example, from drive test measurements. Convert the measurement results in the required file format before loading the file in the file simulator.

Remote command:
`[:SOURce<hw>]:FSIMulator:CDYNamic:CATalog?` on page 239
`[:SOURce<hw>]:FSIMulator:CDYNamic:CATalog:USER?` on page 239
`[:SOURce<hw>]:FSIMulator:CDYNamic:PATH<ch>:DATA:DSELect`
on page 239
`[:SOURce<hw>]:FSIMulator:CDYNamic:DELete` on page 240

Correlation

In MIMO configurations, access dialogs to configure the correlation settings:

"Vector"	For the "Pure Doppler" paths, opens the "Relative Tap Gain Vector" dialog where you can configure the phase shift of the selected path. For description, see Chapter 5.3.3, "Relative gain vector matrix settings", on page 107.
"Matrix"	For the "Rayleigh" paths, opens the "Correlation Matrix" dialog. Available is only the "Matrix Mode > Individual", see Chapter 5.3.2, "Correlation matrix table", on page 105.

Convert
If enabled, files with filename like `*customer*.fad_udyn` are converted into the Rohde & Schwarz proprietary file format when the fading simulator is enabled. Converted files are saved on the hard drive.

As long as the file content remains unchanged, converting the file once, after it is loaded for the first time, is sufficient. Each time you start the fading simulation with enabled custom fading, the R&S SMW200A loads the file automatically from the hard drive.

If `*customer*.fad_udyn` files are used but there is no converted file available and you try to enable fading simulation, an error message appears.

If you use predefined `*.fad_udyn` files or user-defined application-specific fading list files created from drive test measurements for examples, the convert function has no effect. Set "Convert > Off" in this case.

See:
- "Human-readable customized dynamic fading files for SISO configurations" on page 78.
- "Creating and converting human-readable customized dynamic fading files" on page 78.

Remote command:
`[:SOURce<hw>]:FSIMulator:CDYNamic:PATH<ch>:CONVert:STATe`
on page 241

3.10 High-speed train

In the "High Speed Train" configuration, the fading simulator simulates propagation conditions in conformity with the test case "High-speed train conditions", as defined in 3GPP TS 25.141, annex D.4A and 3GPP TS 36.141, annex B.3. Here, the behavior of a receiver in high-speed train conditions is tested, i.e. the simulated scenario represents a fast moving receiver that drives past an antenna. The fading simulator generates the signal as a seq uence of complete cycles of approach towards to the BS antenna and departure from it.

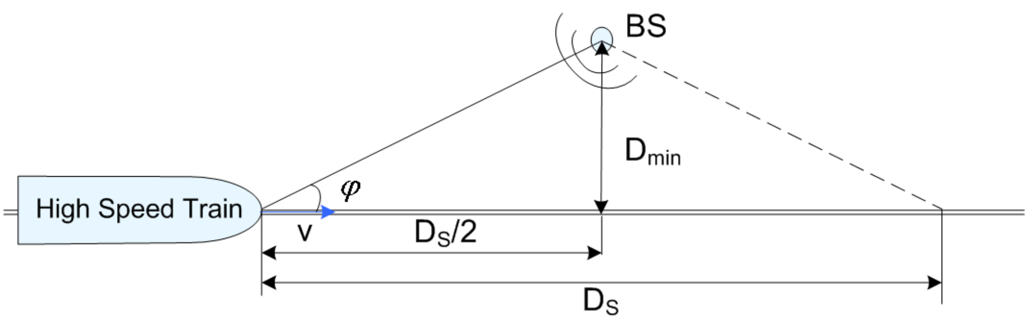


Figure 3-7: High-speed train propagation

Three high-speed scenarios are defined:
- Scenario 1: Open space

- Scenario 2: Tunnel with leaky cable
- Scenario 3: Tunnel for multi-antennas

3.10.1 Scenario 1 and scenario 3

For each of the scenarios 1 and 3, one path without a fading profile is simulated (Pure Doppler). The path has constant level, no delay and variable Doppler shift.

The Doppler shift for these scenarios is calculated as follows:

$$f_A(t) = f_D \cos \varphi(t)$$

Where $f_A(t)$ is the actual Doppler shift and f_D is the maximum Doppler frequency.

The cosine of angle is given by:

$$\cos \varphi(t) = \frac{D_s/2 - vt}{\sqrt{D_{\min}{}^2 + (D_s/2 - vt)^2}}, \quad 0 \le t \le D_s/v$$

Where:

- $D_S/2$ is the distance in meters between the train and the BS at the beginning of the simulation
- D_{min} is the minimum distance in meters between the BS and the railway track
- v is the velocity of the train in m/s
- t is time in seconds

For scenario 1 and for BS with receiver diversity, the Doppler shift variation is the same between the antennas.

3.10.2 Scenario 2

Scenario 2 is not defined for EUTRA/LTE test cases.

For scenario 2, one Rician fading propagation channel with Rician factor K=10 dB and with one tap is simulated. The Rician factor *K* is defined as the ratio between the dominant signal power and the variant of the other weaker signals (see "K (Rician factor)" on page 86).

3.10.3 High-speed train scenario parameters

The Table 3-7 gives an overview of the parameters of the HST test scenarios according to the test case "High-speed train conditions".

Table 3-7: Parameters for high-speed train conditions

Parameter	Value		
	Scenario 1	Scenario 2	Scenario 3
D_S	1000 m	Infinity	300 m
D_{min}	50 m	-	2 m
K	-	10 dB	-
v	350 km/h	300 km/h	300 km/h
f_D	1340 Hz	1150 Hz	1150 Hz

The Figure 3-8 and Figure 3-9 show the trajectory of the Doppler shift for scenario 1 and 3 for the test parameters specified in the test case. For these two scenarios, the Doppler shift trajectories for any user-defined parameters are also displayed in the "3GPP HST" dialog.

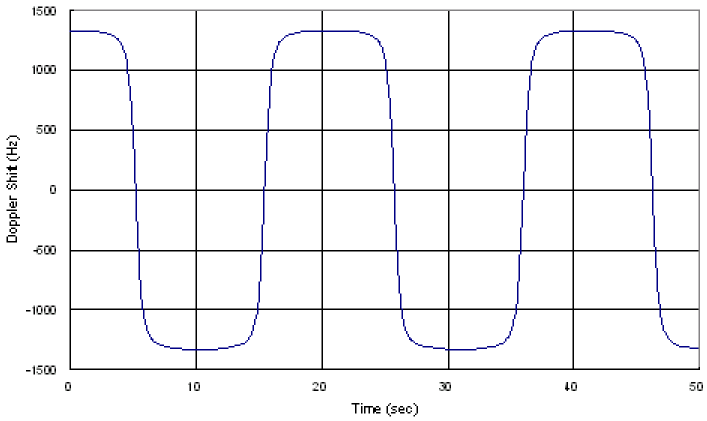


Figure 3-8: Doppler shift trajectory for scenario 1

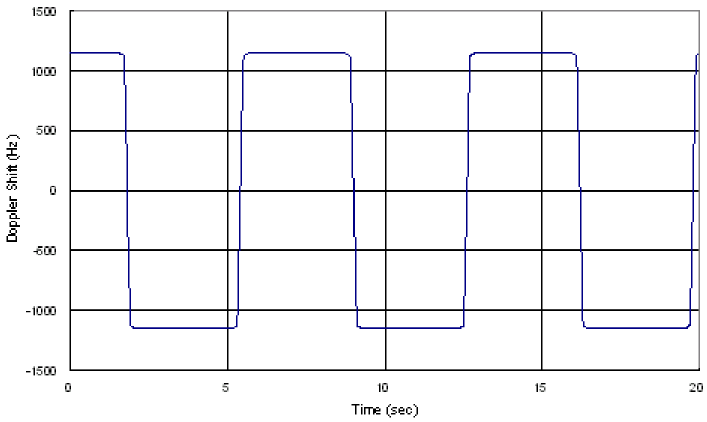


Figure 3-9: Doppler shift trajectory for scenario 3

Doppler shift calculation

The HST scenarios are defined for the UE and for the BS tests. In the fading simulator, the same standards are used for both test cases. Consider however, the following difference in the calculation of the Doppler shift:

- In *HST UE tests*, the resulting Doppler shift is based *only* on the used DL frequency.
- In *HST BS tests*, the DL signal itself already contains a Doppler shift. The UE synchronizes on this shifted DL frequency. The simulated UL signal contains a Doppler shift, too.
  The resulting Doppler shift is then based *on both*, the UL and the DL frequency.

To enable the fading simulator to consider the DL Doppler shift, use the following two parameters:
- Consider DL RF
- Virtual DL RF

General recommendations on performing HST BS tests

The following is a list of the general steps required to enable the fading simulator to generate the signal required for the HST BS tests

1. Set the "RF Frequency" of the instrument to the F_{UL}, as defined in the specification.
2. Enable a high-speed train scenario with extension "(DL+UL)" in its name.
3. If not enabled, activate the parameter "Fading > (HST) Path Table > Consider DL RF > On".
4. Set the value of the parameter "Fading > (HST) Path Table > Virtual DL RF" to the F_{DL}, as defined in the specification.

Example: Configuring the fading simulator to generate an HST BS test signal according to 3GPP TS 36.104

For frequency band 1 tests, the specification defines: F_{DL} = 2.14 GHz and F_{UL} = 1.95 GHz. The resulting Doppler shift is F_D = 1140 Hz.

- In the status bar, select "Frequency = F_{UL} = 1.95 GHz"
- Select "Fading A > Fading Settings > Standards" and navigate to the required high-speed train scenario "3GPP > High Speed Train > HST 3 Tunnel Multi Antenna (DL +UL)"
- If not enabled, activate the parameter "Fading > Path Table > Consider DL RF > On".
- Select "Fading > Path Table > Virtual DL RF = F_{DL} = 2.14 GHz"
- Select "Fading > Fading Settings > State > On"
- Use the command `[:SOURce<hw>]:FSIMulator:HSTRain:FDOPpler?` to query the resulting Doppler shift.

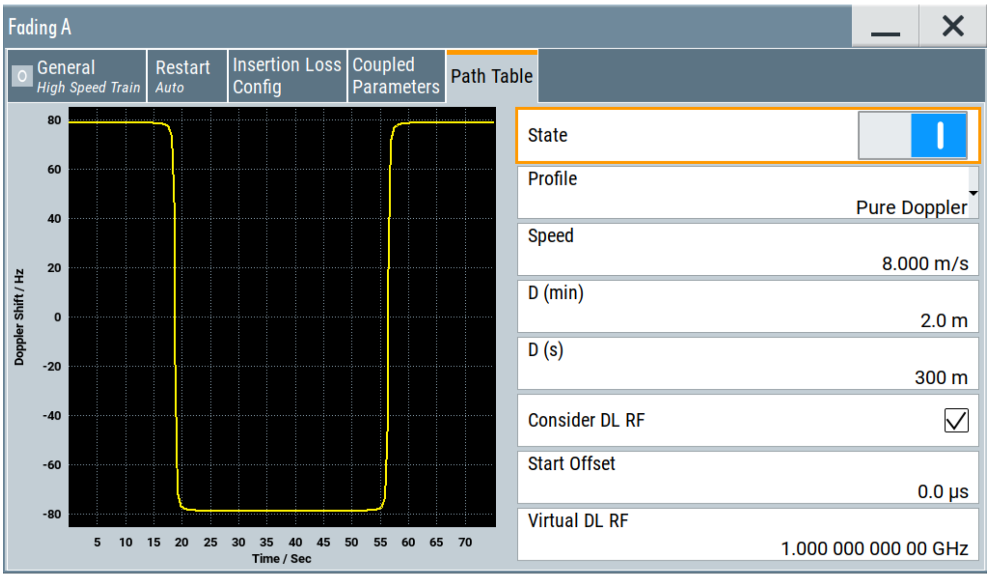
Compare the example below and the Doppler shift trajectory specified in the 3GPP TS36.104.

High-speed train scenario settings

To access these settings:

1. Select "Fading > Fading Settings > Standards".
2. Navigate to the required high-speed train scenario, e.g. "3GPP > High Speed Train > HST 3 Tunnel Multi Antenna (DL+UL)"

   The "3GPP HST" dialog displays the default values of the high-speed train scenarios and allows you to adjust them for further tests.



Settings:

State....85
Profile....85
Speed....86
D (min)....86
D (S)....86
K (Rician factor)....86
Consider DL RF....86
Start Offset....87
Virtual DL RF....87

State

Activates/deactivates simulation of high-speed train propagation according to the selected scenario.

Remote command:
`[:SOURce<hw>]:FSIMulator:HSTRain:STATe` on page 193

Profile

Determines the fading profile for the selected scenario. The fading profile determines which transmission path is simulated.

Although both scenarios 1 and 3 are specified as pure Doppler paths without a fading profile and scenario 2 as a Rician fading, in this fading simulator you can change the fading profile.

"Static Path" A static transmission path with no attenuation (loss) or delay is simulated.

"Pure Doppler" A transmission path is simulated in which there is an individual direct connection from the transmitter to the moving receiver (discrete component).
The simulated path has a constant delay and attenuation (no loss).
The Doppler frequency shift is determined only by the parameters Speed, D (min) and D (S).
Tip: Use the SCPI command `[:SOURce<hw>]:FSIMulator:HSTRain:FDOPpler?` to query the Doppler frequency shift.

"Rayleigh" A radio hop is simulated in which many highly scattered subwaves arrive at a moving receiver.

"Rice" One Rician fading propagation channel with K (Rician factor) and with one tap is simulated.

Remote command:
`[:SOURce<hw>]:FSIMulator:HSTRain:PROFile` on page 191

Speed
Sets the velocity parameter, i.e. the speed of the moving receiver.

Remote command:
`[:SOURce<hw>]:FSIMulator:HSTRain:SPEed` on page 190

D (min)
For "Profile > Static Path or Pure Doppler", sets the parameter D_{min} to define the distance between the BS and the railway track.

Remote command:
`[:SOURce<hw>]:FSIMulator:HSTRain:DISTance:MINimum` on page 190

D (S)
For "Profile > Static Path or Pure Doppler", sets the parameter D_S and define the initial distance $D_S/2$ between the train and the BS at the beginning of the simulation.

Remote command:
`[:SOURce<hw>]:FSIMulator:HSTRain:DISTance:STARt` on page 190

K (Rician factor)
For scenario 2, sets the Rician factor K that is defined as the ratio between the dominant signal power and the variant of the other weaker signals.

Remote command:
`[:SOURce<hw>]:FSIMulator:HSTRain:KFACtor` on page 191

Consider DL RF
Enables the selection of virtual downlink frequency (DL RF).

By default, this parameter is enabled for the HST (DL+UL) standards. For detailed description, see "Doppler shift calculation" on page 84.

Note: While performing HST BS tests and "Consider DL RF > Off", the DL Doppler shift is not considered by the calculation of the UL Doppler shift.

Remote command:
`[:SOURce<hw>]:FSIMulator:HSTRain:DOWNlink:FREQuency:STATe` on page 192

Start Offset
Set a value greater than zero to shift the HST profile in time.

Remote command:
`[:SOURce<hw>]:FSIMulator:HSTRain:SOFFset` on page 192

Virtual DL RF
Sets the virtual downlink frequency. For HST BS tests, enter the F_{DL} defined in the specification. The value is used by the calculation of the UL Doppler shift.

For detailed description, see "Doppler shift calculation" on page 84

Remote command:
`[:SOURce<hw>]:FSIMulator:HSTRain:DOWNlink:FREQuency` on page 192

3.11 Custom fading profile

The custom fading profile requires R&S SMW-K72.

The custom fading profile allows you to modify the classical Jakes and Flat fading profiles. These modified profiles are required by the IEEE 802.11p channel models.

A frequency offset f_{offset} can be applied to shift the spectrum of the original profile. Two cut-off frequencies, f_l (lower) and f_u (upper), can be configured to set the lower and upper cut-off frequencies of the resulting spectrum, see Figure 3-10.

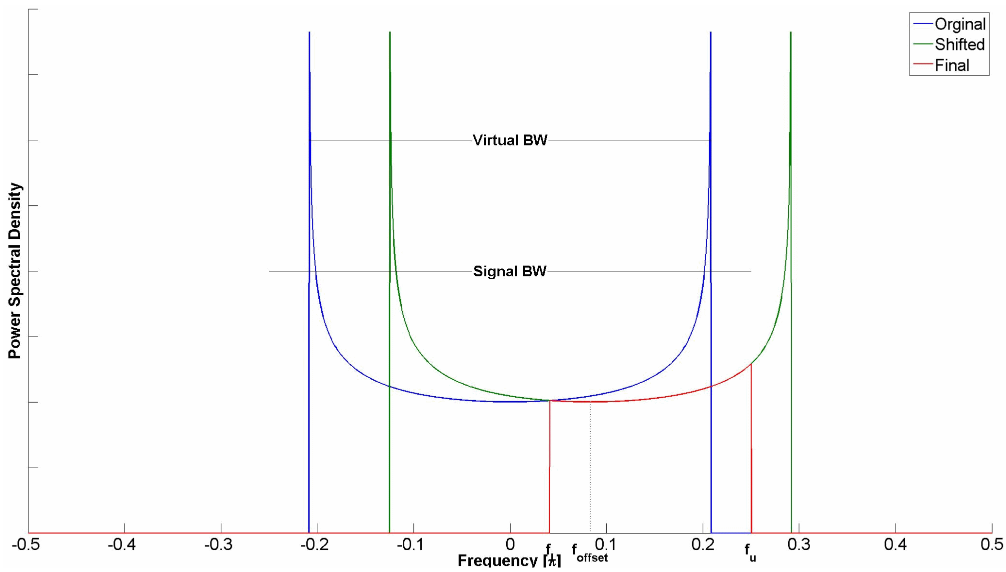


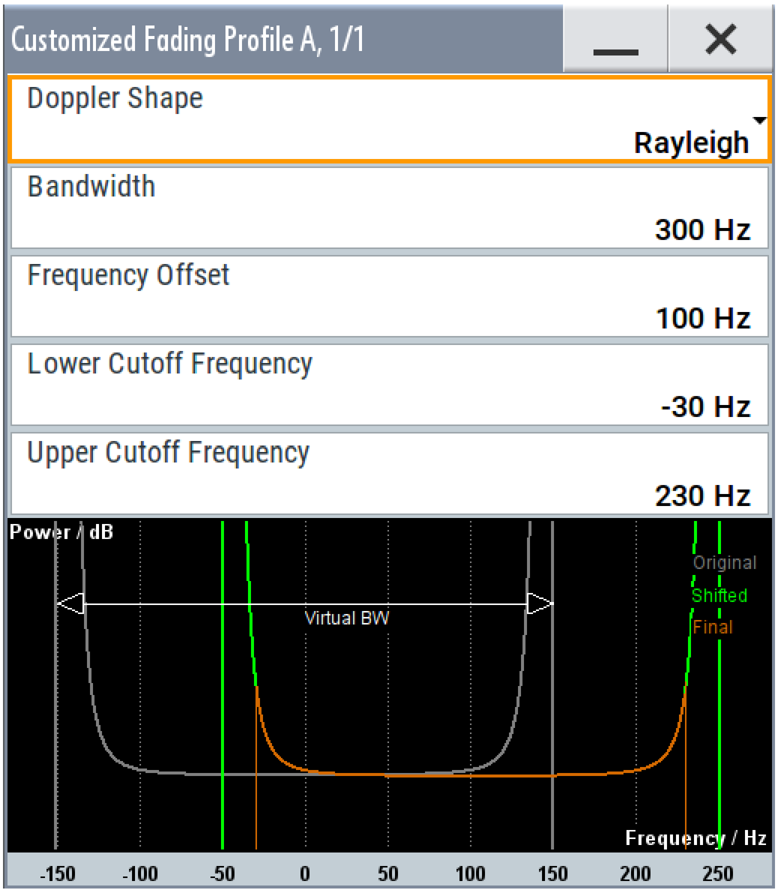
Figure 3-10: Resulting asymmetric Doppler spectrum

In the fading simulator, all these required profile parameters are configurable, see "Custom fading profile settings" on page 88.

Custom fading profile settings

To access these settings:

1. Select "Fading > Fading Settings > Path Table"
2. Select "Profile > Custom"
3. Select "Custom Profile > Custom Data"



Settings:

Doppler Shape....................89
Bandwidth....................89
Frequency Offset....................89
Lower/Upper Cutoff Frequency....................90

Doppler Shape

Sets the Doppler shape ("Flat" or "Rayleigh") of the virtual profile.

Remote command:

`[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:CUSTom:DSHape` on page 224

Bandwidth

Sets the bandwidth of the original Doppler profile from which the resulting profile is created, see Figure 3-10.

Remote command:

`[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:CUSTom:DATA` on page 224

Frequency Offset

Sets the frequency offset f_{offset} used to shift the original profile, see Figure 3-10.

Remote command:
[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:CUSTom:DATA on page 224

Lower/Upper Cutoff Frequency

Sets the lower and upper cut-off frequencies, f_l and f_u, that depend on the original profile bandwidth Bandwidth.

The following applies:

- $f_u \leq f_{offset} + Bandwidth/2$
- $f_l \geq f_{offset} - Bandwidth/2$
- $f_u - f_l \geq 1\ Hz$
- 50 Hz ≤ Bandwidth ≥ 40 kHz

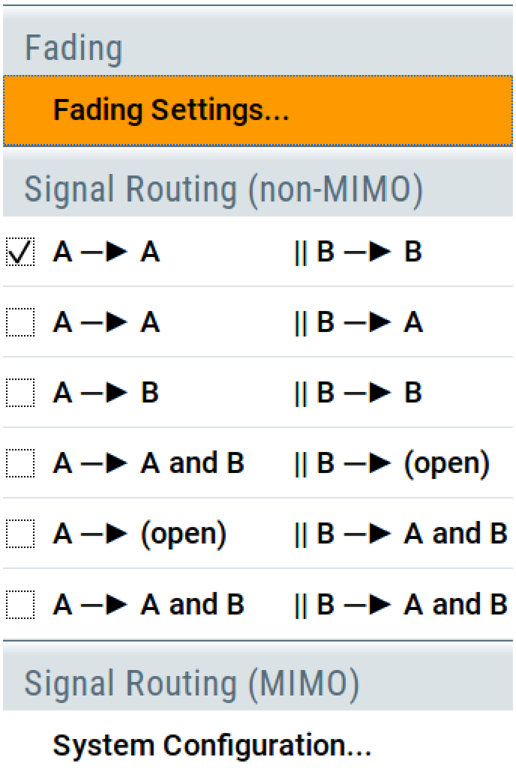
Where the highest possible absolute cut-off frequency is 4 kHz.

Remote command:
[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:CUSTom:DATA on page 224

4 Signal routing settings

To route the signal in standard (non-MIMO) configuration

1. Select "System Configuration > Mode > Standard".
2. Select "Fading > Signal Routing (non-MIMO)".



To route the signal in MIMO configuration

Option: R&S SMW-B14/-B15/-K74 and optionally R&S SMW-K75/-K76

▶ Follow the instructions in Chapter 5.2, "How to enable LxMxN MIMO test configurations", on page 96.

To generate SISO signal with 400 MHz or 800 MHz fading bandwidth

Option: R&S SMW-B15/-K822/-K823

▶ Select SISO configuration by following the instructions in:
   - "To enable MIMO configuration with 400 MHz fading bandwidth" on page 98.
   - "To enable MIMO configuration with 800 MHz fading bandwidth" on page 99.

This section describes the settings related to the fading bandwidth and simulation.

For comprehensive description of all settings in the "System Configuration" dialog and information on how to define the I/Q stream-mapping, connect external instruments, etc.:

See section "Signal routing and system configuration" in the R&S SMW200A user manual.

BB Bandwidth....92
CA Bandwidth.... 92
Signal Routing....92

BB Bandwidth

Requires R&S SMW-B15/-K822/-K823.

Sets the baseband signal bandwidth that the fading simulator supports.

The value range and the maximum available bandwidth depend on the installed options and the selected MIMO configuration.

For example:

- In MIMO configurations with fewer than 8 channels, the max. baseband bandwidth is 400 MHz.
- In MIMO configurations with fewer than 4 channels, the max. baseband bandwidth is 800 MHz.

For more information, refer to the specifications document.

Remote command:
`:SCONfiguration:BBBW` on page 241

CA Bandwidth

Option: R&S SMW-B15/-K822/-K823

Indicates the resulting channel aggregation (CA) bandwidth, calculated based on the MIMO configuration and the "BB Bandwidth".

The "CA Bandwidth" represents the signal bandwidth at the stream mapper.

For more information, refer to the specifications document.

Remote command:
`:SCONfiguration:CABW?` on page 242

Signal Routing

In "System Configuration > Mode > Standard", defines the signal routing for the fading signal at the output of the fading simulator.

Note: Signal routing for MIMO setups is performed with the settigns in the "System Configuration" dialog, see Chapter 5.2, "How to enable LxMxN MIMO test configurations", on page 96.
In remote control, however, all available signal routing settings are configured with the command `[:SOURce<hw>]:FSIMulator:ROUTe`.

In "System Configuration > Mode > Standard", the input signal of the fading simulator is defined by the setting "Baseband > Signal Routing". An instrument equipped with two fading simulators and two baseband blocks, the input signal of each of the fading simulator can be:

- the signal from a single baseband block,
- the summation signal from both baseband blocks or
- each a signal from one of the two baseband blocks.

The following is a list of the routing settings for an instrument equipped with two baseband blocks, two signal paths and two options fading simulator (R&S SMW200A-B14).

"A to A/ B to B" Dual-channel fading. The fading signal from fader A is output on baseband path A and the fading signal from fader B is output on baseband path B.
The R&S SMW200A can be operated like two instruments; two independently configured signals are routed to the instrument's output.

This configuration is also suitable for transmit or receive diversity tests:
- Use the signal of one of the baseband generators to simulate the receiving conditions of a receiver with two antennas, like a high-quality car radio or UMTS base station.
- Correlate the paths of the two fading simulators, i.e. the two fading channels. You can simulate the conditions of receiver with two antennas which receive statistically correlated signals. Such condition appears, e.g., in a car with two antennas when the two received signals exhibit a degree of correlation due to a similar environment, like an underpass or hills.

"A to A/B to A" Dual-channel fading. The fading signal from fader A and the fading signal from fader B are both output on baseband path A.

This configuration is suitable for the simulation of:
- mobile radio network handover in the handheld device
- testing of filtering out the own signal if there is simultaneous presence of a strong signal from another standard.

To simulate the required conditions, configure each of the baseband signals according to the desired standard and route them to the fading simulator. After fading, the two signals with widely divergent signal strengths are output on a common output path.

"A to B / B to B"
Dual-channel fading. The fading signal from fader A and the fading signal from fader B are both output on baseband path B.

"A to A and B / B to A and B"
Dual-channel fading. The fading signal from fader A and the fading signal from fader B are output on baseband path A and baseband path B.
The possible applications are analogous to the "A to A / B to A" routing. With this routing however, the signal at the output of the fading simulator is split up and routed to both paths. The processing of these two paths after the fading can be differently. To simulate a further degradation of the receiving conditions, for instance, use the provided function to superimpose the signal of one of the paths by noise or destroy it.

"A to A and B / B (open)"
The fading signal from fader A is output on baseband path A and baseband path B. The signal from fader B is not output, the signal flow of baseband B is interrupted.

"A (open)/ B to A and B"
The fading signal from fader B is output on baseband path A and baseband path B. The signal from fader A is not output, the signal flow of baseband A is interrupted.

Remote command:
[:SOURce<hw>]:FSIMulator:ROUTe on page 157

5 Multiple input multiple output (MIMO)

If the instrument is equipped with the required options, the R&S SMW200A supports versatile MIMO configurations.

Section Chapter 2.1, "Required options", on page 18 provides an overview; for detailed information, refer to the R&S SMW200A data sheet.

Multiple input multiple output (MIMO) refers to a multi-channel method where two or more simultaneous channel inputs and channel outputs are being used for boosting data rates. The benefits of an MIMO system became visible only if the data signal is tested in fading conditions. The MIMO fading option considers this special form of multipath propagation in channel simulation.

Depending on the number of the transmitting and receiving antennas used in a MIMO system, different MxN MIMO test configurations are specified. The term MxN is a representation of a MIMO system, where M is the number of the transmitting Tx antennas and N the number of the receiving Rx antennas. Throughout this description, we also use the term LxMxN as a short form of the used system configuration. In this case, L represents the number of entities, M the number of basebands (Tx antennas) and N the number of streams (Rx antennas).

Normally, the simulation of a system with two or more transmitting and/or receiving antennas requires two or more signal generators and/or fading simulator. The MIMO fading option (R&S SMW-K74) in combination with up to four Fading simulator options (R&S SMW-B14) enables you to simulate MIMO receiver tests scenarios with up to 8 Tx or up to 8 Rx antennas with one single instrument. (See also Chapter 5.1, "Multiple entity MxN MIMO test configurations", on page 96).

Configurations with more than two entities and the higher-order MIMO configurations require the additional options multiple entities (R&S SMW-K76) and higher order MIMO (R&S SMW-K75).

Abstract representation of the signal routing

2x2 MIMO system	**Preview diagram**	**Block diagram**

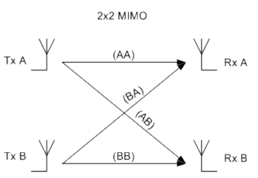
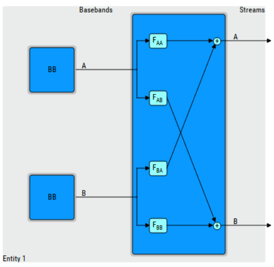
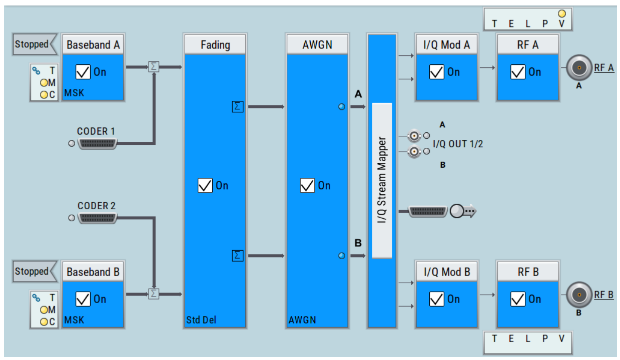

		

Illustration of the principle	Detailed representation of the signal processing Each $F_{<Tx><Rx>}$ block represents one MIMO channel	"High level" representation The Fading simulator is displayed as one single block; the number of the input basebands (M) and the output streams (N) indicate the MxN MIMO configuration.

The representation of a multi-entity MIMO configuration is even more abstract (see also Chapter 5.1, "Multiple entity MxN MIMO test configurations", on page 96).

5.1 Multiple entity MxN MIMO test configurations

Equipped with the MIMO fading option (R&S SMW200A-K74), the instrument enables the simulation of versatile MIMO tests scenarios with one single instrument.

The supported MIMO scenarios depend on:

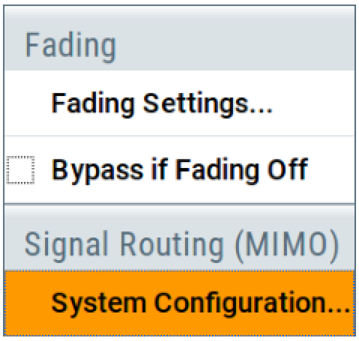
- The installed options, in particular on the number of options fading simulator (R&S SMW-B14/B15), i.e. on the number of the available [Fader] boards
- On the availability of the options multiple entities (R&S SMW-K76) and higher order MIMO (R&S SMW-K75).

For more information, refer to the specifications document.

5.2 How to enable LxMxN MIMO test configurations

Option: R&S SMW-B14/-B15/-K74 and optionaly R&S SMW-K75/-K76

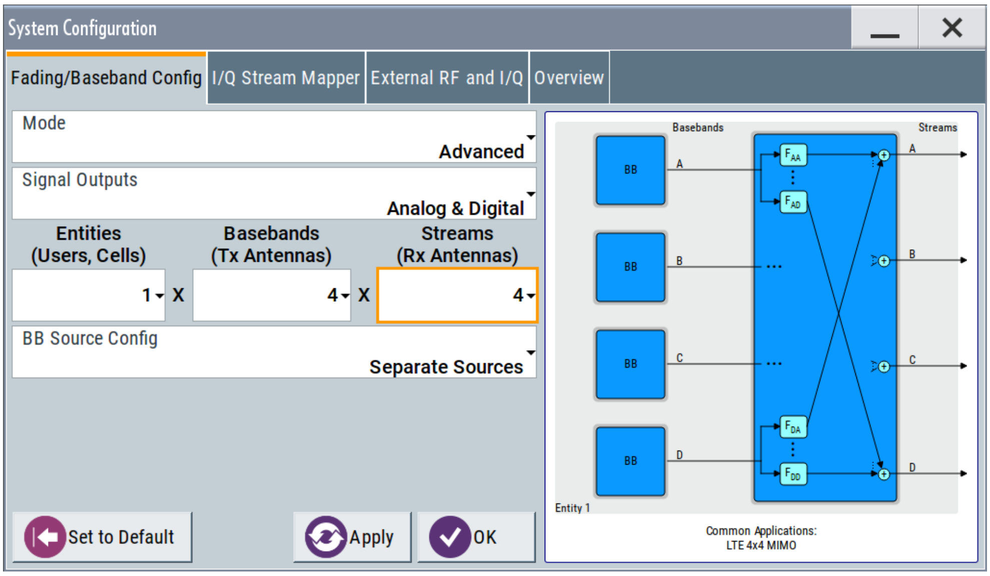
Select and configure a MIMO scenario before you define the further fading settings or the signal routing through the instrument.



To enable a MIMO scenario

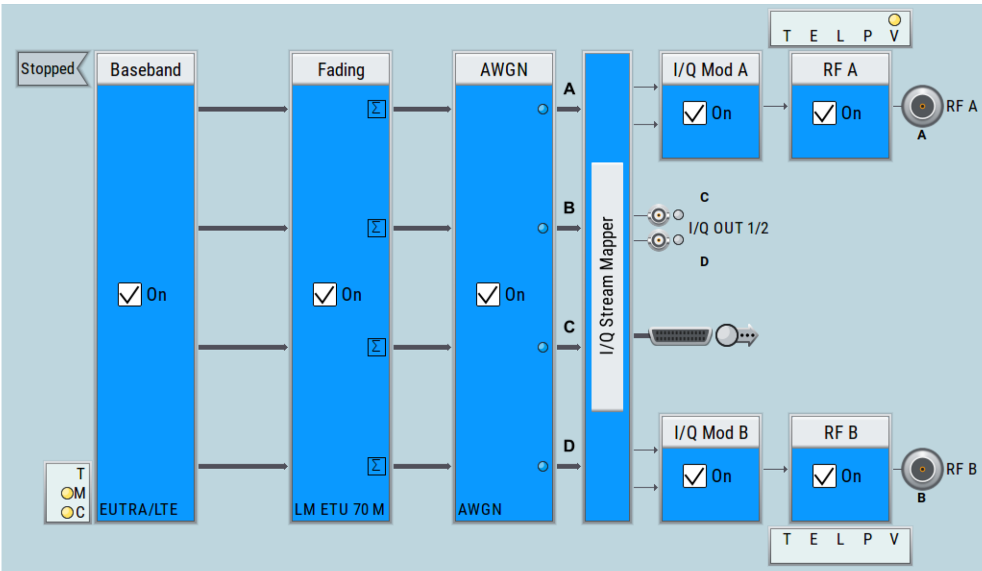
1. Select "Fading > MIMO > System Configuration"
2. In the "System Configuration > Fading/Baseband Configuration" dialog, enable "Mode > Advanced"
3. Define the MIMO scenario, e.g. to configure a 1x4x4 MIMO select:
   a) "Entities (Users, Cells) = 1"
   b) "Basebands (Rx Antennas) = 4"
   c) "Streams (Tx Antennas) = 4"
   d) "BB Source Config > Coupled Sources"

   The preview diagram displays a detailed view of the signal routing for the current selected configuration, together with short description of the possible application of this configuration.

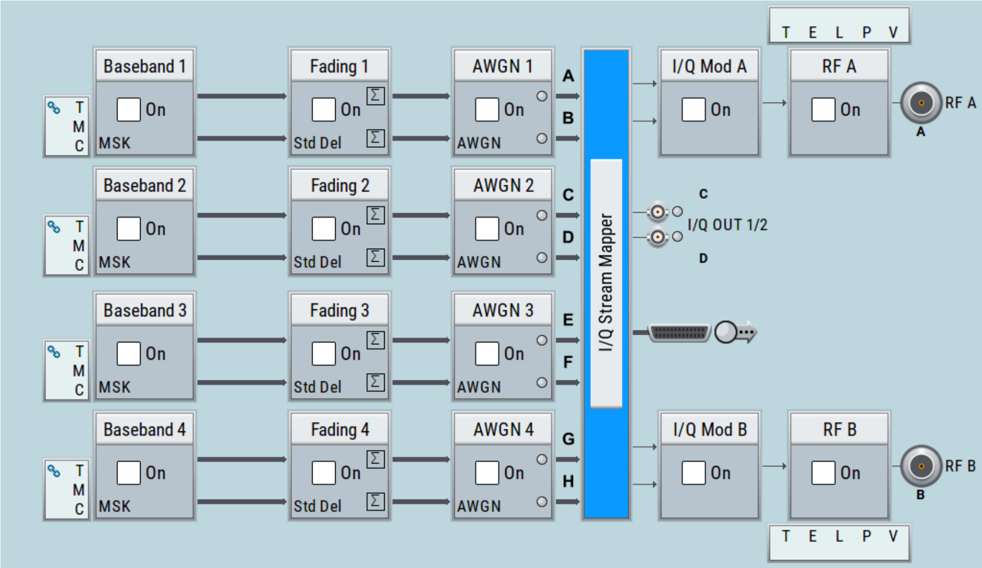


4. Select "Fading/Baseband Configuration > Apply" to trigger the instrument to use the selected configuration and close the dialog.

   The block diagram displays the configured signal routing.



5. To enable a multiple-entities configuration, select "System Configuration > Fading/ Baseband Configuration" and enable for example:
   a) "Mode > Advanced"
   b) "Entities (Users, Cells) = 4", "Basebands (Rx Antennas) = 2", "Streams (Tx Antennas) = 2"
   c) "BB Source Config > Coupled Sources per Entity"
   d) "Apply".



Refer to Chapter 5.3, "Fading settings in MIMO configuration", on page 99 for description on the provided MIMO fading settings.

To route the signal in MIMO mode

In MIMO mode, the signal routing is performed upon the selected MIMO configuration.

► Configure the instrument for a MIMO scenario.
See "To enable a MIMO scenario" on page 96.

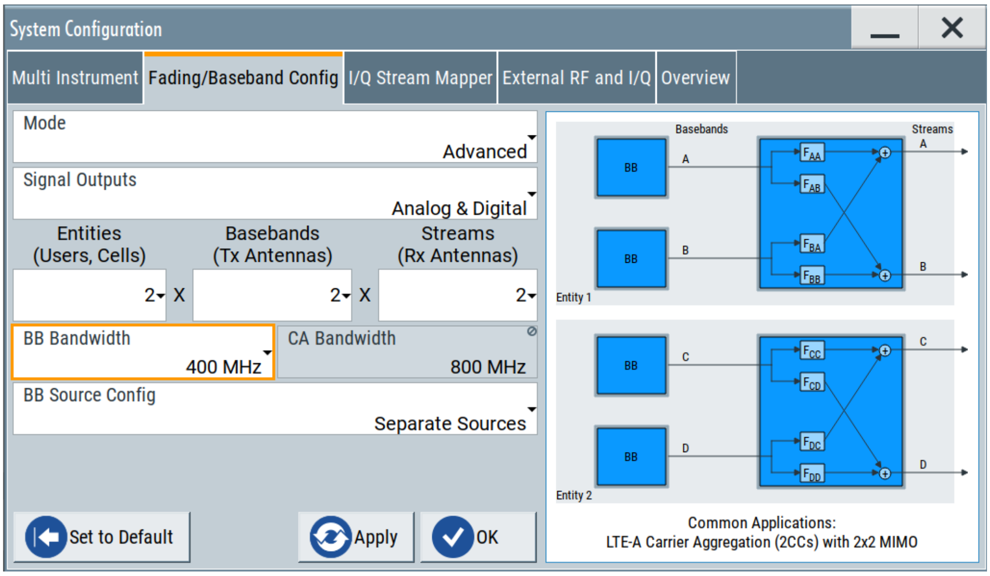
The signal routing is fixed and depends on the selected MIMO configuration.

To enable MIMO configuration with 400 MHz fading bandwidth

Option: R&S SMW-B15/-K74/-K822

1. Select "Fading > MIMO > System Configuration"
2. In the "System Configuration > Fading/Baseband Configuration" dialog, enable "Mode > Advanced"
3. Enable a MIMO scenario with up to 8 channels, e.g. 2x2x2 MIMO.
4. Select "BB Bandwidth = 400 MHz".

   The parameter "CA Bandwidth" indicates the aggregated channel bandwidth at the stream mapper.



5. Select "Apply".
6. Change the MIMO configuration, e.g. select 2x2x4 MIMO.

   The "BB Bandwidth" is set automatically to the maximum bandwidth for the selected MIMO configuration. The resulting "CA Bandwidth" is updated, too.

To enable MIMO configuration with 800 MHz fading bandwidth

Option: R&S SMW-B15/-K74/-K822/-K823

1. Follow the instructions listed in "To enable MIMO configuration with 400 MHz fading bandwidth" on page 98.
2. Enable a MIMO scenario with up to 4 channels, e.g. 1x2x2 MIMO.
3. Select "BB Bandwidth = 800 MHz".
4. Select "Apply".

5.3 Fading settings in MIMO configuration

The MIMO fading settings are available if a MIMO scenario is configured.

1. Configure the instrument for a MIMO scenario. See "To enable a MIMO scenario" on page 96.
2. You can access the dialog for configuring the MIMO settings of all MIMO channel via each of the "Fading" blocks.
   Select "Fading > Fading Settings".

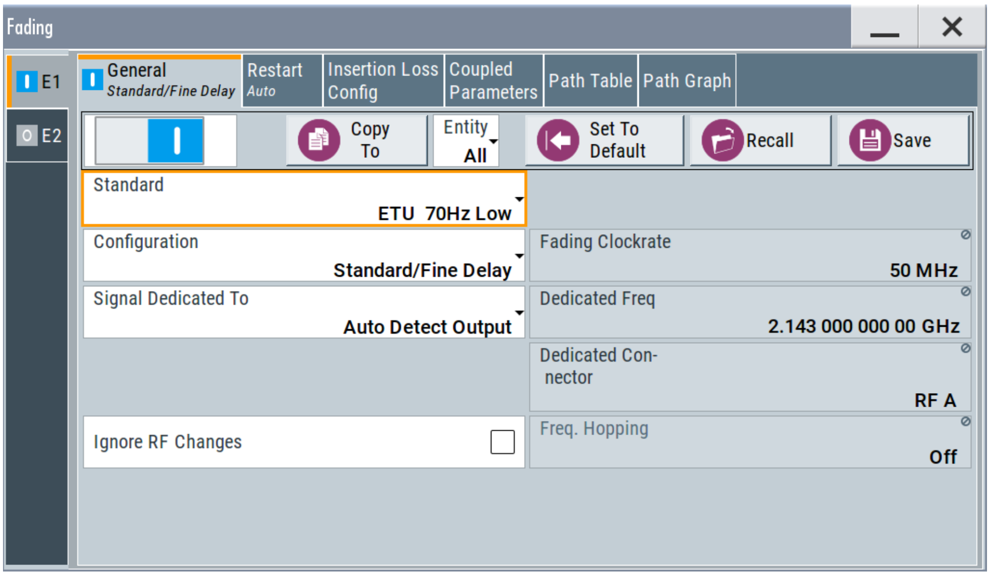


Figure 5-1: General settings in System Configuration > 2x2x2 (multi entity mode, L=2)

In "System Configurations" with multiple entities (L > 1), the dialog consists of more than one side tabs; one tab per entity. The tab name indicates the fader state the settings are related to.

3. Select "Path Table".

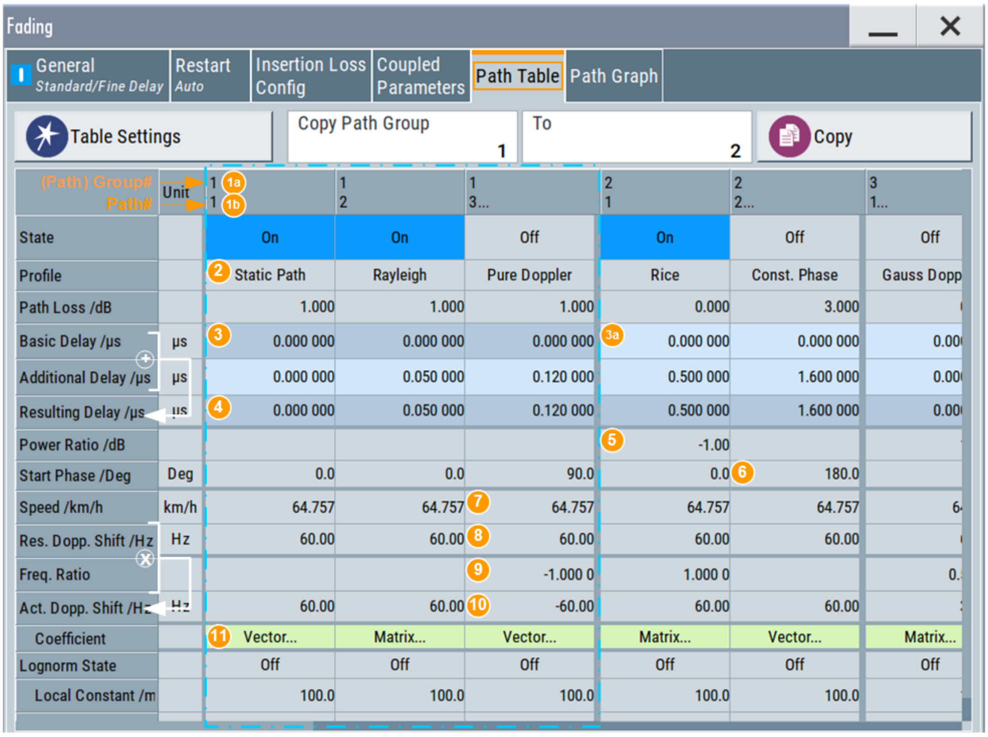


Figure 5-2: Path table settings in single entity mode (L=1): Understanding the displayed information

1a/1b = Path group number (displayed in the first row) and path number (second row in the table header); the example shows 4 groups with different number of active paths (the first group is marked with a blue border)
2 = Fading profile, assigned per fading path
3/3a = Common group delay of a path group ("Basic Delay" is always 0 for group 1); adjustable for the other groups (light gray background)
4 = Resulting delay per path, calculated as the sum of the common group delay and the path-specific delay.
5 = Adjustable parameter for paths with Rice fading
6 = Pure display parameters are on a dark background
7 = Access to a "Vector" or a "MIMO Matrix" for configuration of the correlation between the channels

4. In the path table, navigate to the row "Coefficient".
   For the corresponding path, select "Matrix" or "Vector".

   The "Fading: Correlation Matrix" dialog comprises the parameters necessary to adjust the correlation between the channels. You can define the correlation in one of the following ways:
   - In "Matrix Mode > Individual"

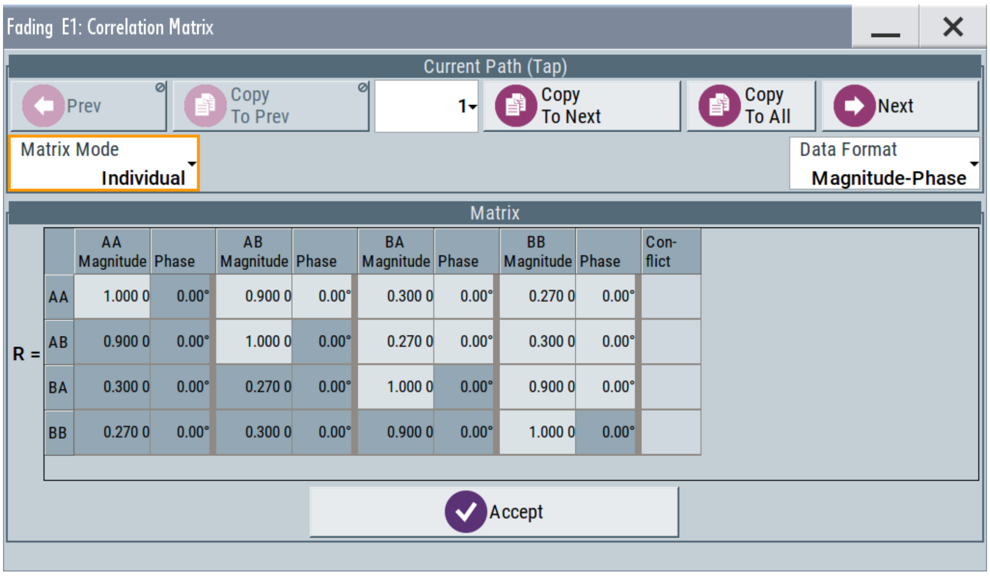


Figure 5-3: Correlation matrix in an individual matrix mode

     In this mode, you can adjust the matrix coefficients directly in the coefficient matrix.
   - In "Matrix Mode > Kronecker"

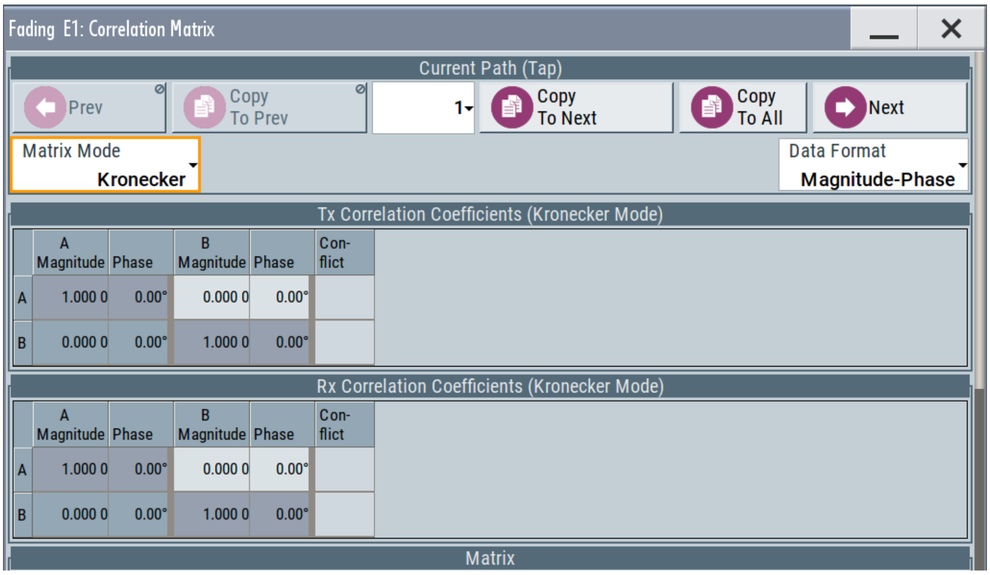


Figure 5-4: Correlation matrix in the kronecker mode

The definition of the correlation matrix settings is based on the kronecker assumption, i.e defined are the Rx and Tx antenna correlation coefficients. The instrument calculates automatically the resulting correlation matrix and displays it.

See Chapter 5.3.4, "Kronecker mode correlation coefficients", on page 109.

- In "Matrix Mode > AoA/AoD"

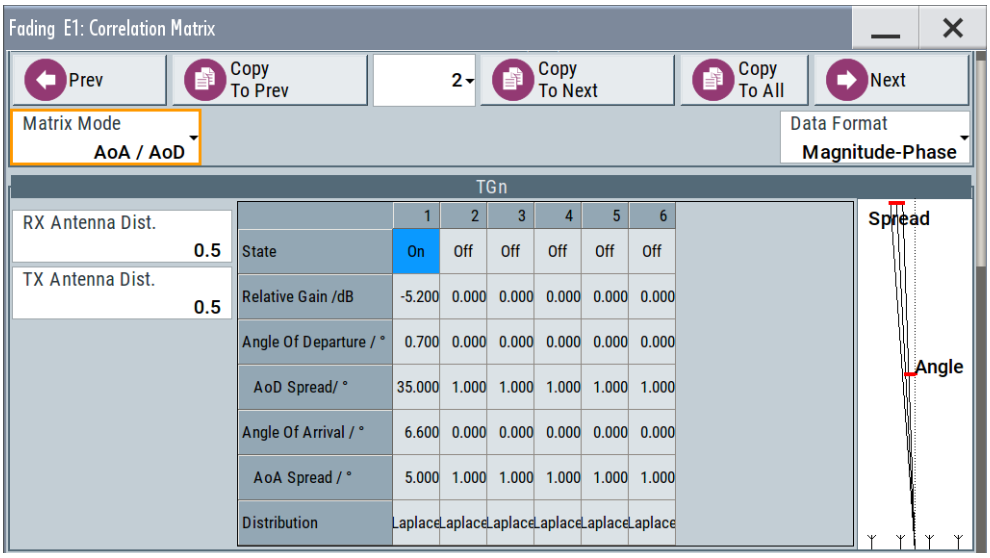
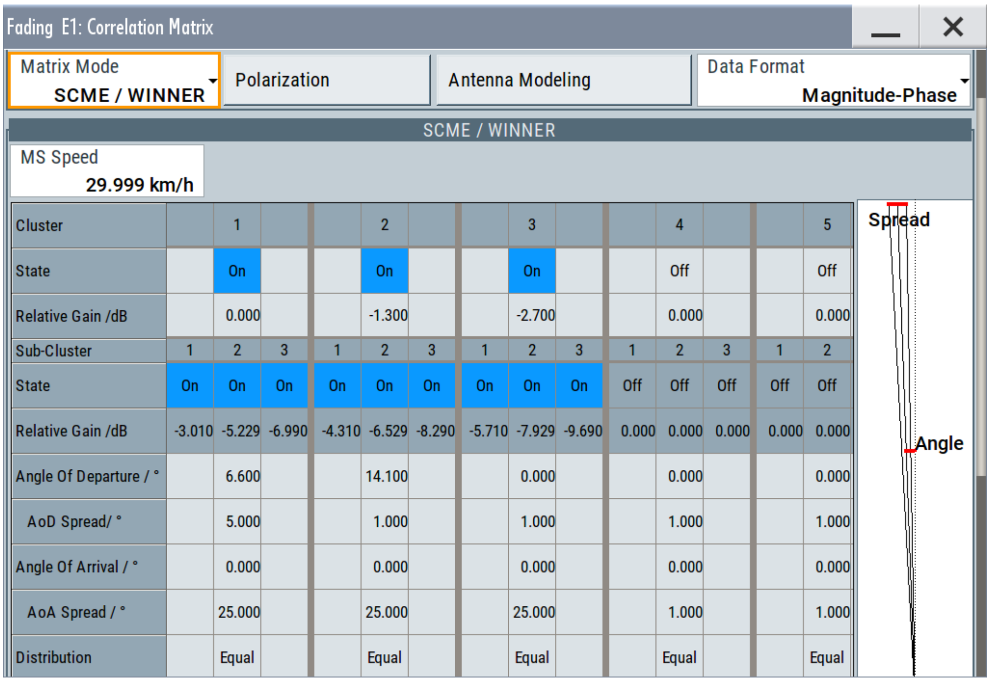


Figure 5-5: Correlation matrix in TGn format (AoA/AoD mode)

See Chapter 5.3.5, "TGn/TGac channel models settings", on page 111.

- In "Matrix Mode > SCME/WINNER"



See:
– Chapter 5.3.6, "SCME/WINNER model settings", on page 113
– Chapter 5.3.8, "MIMO OTA testing related settings", on page 131

- For static paths and paths with "Pure Doppler" fading profile, the corresponding settings are grouped in the "Relative Tap Gain Vector" dialog.

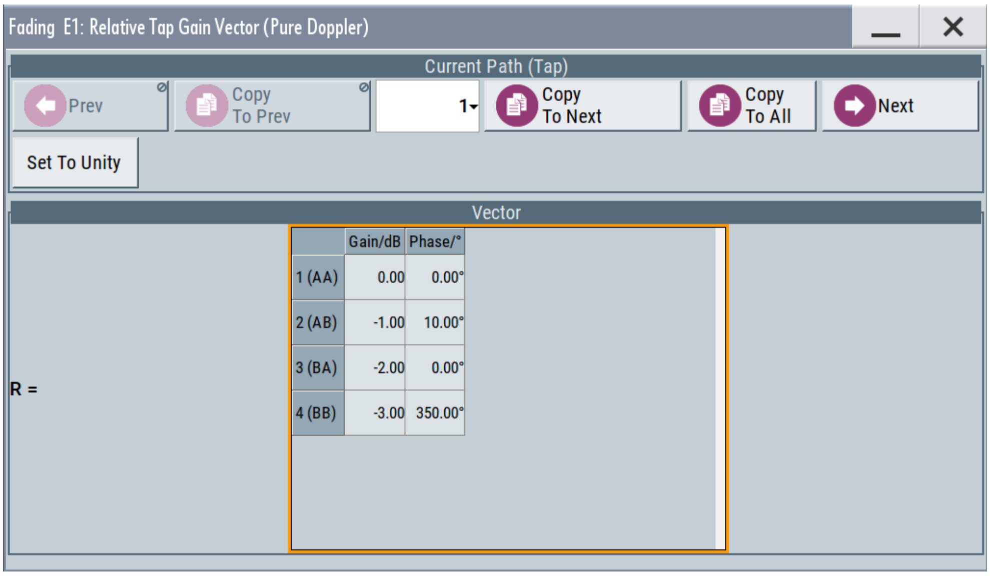


Figure 5-6: Relative tap gain vector

This dialog provides additional parameters to simulate a gain weighting and phase shift between the signals with constant fading transmitted among the different Tx antennas.
See Chapter 5.3.3, "Relative gain vector matrix settings", on page 107.

5.3.1 Current path (Tap) settings

Prev
Displays the previous tap relative to the current tap. If tap 1 is the current tap, this button is disabled.

Remote command:
`n.a.`

Copy To Prev
Copies the matrix values of the current tap to the next lower tap. If tap 1 is the current tap, this button is disabled.

Remote command:
`[:SOURce<hw>]:FSIMulator:MIMO:COPY:PREVious` on page 201

Current Path (Tap) #
Selects the tap to be displayed.

Remote command:
`[:SOURce<hw>]:FSIMulator:MIMO:TAP` on page 201

Copy To Next
Copies the matrix values of the current tap to the next higher tap. If the current tap is the last tap, this button is disabled.

Remote command:
`[:SOURce<hw>]:FSIMulator:MIMO:COPY:NEXT` on page 200

Copy To All
Copies the matrix values of the current tap all taps.

Remote command:
`[:SOURce<hw>]:FSIMulator:MIMO:COPY:ALL` on page 200

Next
Displays the next tap relative to the current tap. If the current tap is the last tap, this button is disabled.

Remote command:
`n.a.`

Matrix Mode
Selects the input mode for the Rx and Tx correlation values.

"Individual" Allows entering the correlation values individually.

"Kronecker" Opens additional input fields for entering the Rx correlation and Tx correlation values, see Chapter 5.3.4, "Kronecker mode correlation coefficients", on page 109.
The matrix values are calculated automatically.

"AoA / AoD" Opens additional input fields for defining the Rx and TX correlation parameters based on the Spatial Channel Model (SCM), see Chapter 5.3.5, "TGn/TGac channel models settings", on page 111.
The matrix values are calculated automatically.

"SCME / WINNER" Opens additional input fields for defining the parameters of the Spatial Channel Model Extended (SCME) model, see Chapter 5.3.6, "SCME/WINNER model settings", on page 113.
The matrix values are calculated automatically.

Remote command:
`[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:MATRix:MODE` on page 204

Polarization, Antenna Modeling
Accesses the corresponding tab in the "Antenna Model" dialog, see Chapter 5.3.6, "SCME/WINNER model settings", on page 113.

Data Format
Selects the matrix representation format. The data format can be changed at every time. The matrix table is updated immediately.

"Magnitude-Phase" Displays the matrix values as value pairs of magnitude and phase.

"Real-Imag" Displays the matrix values as complex numbers.

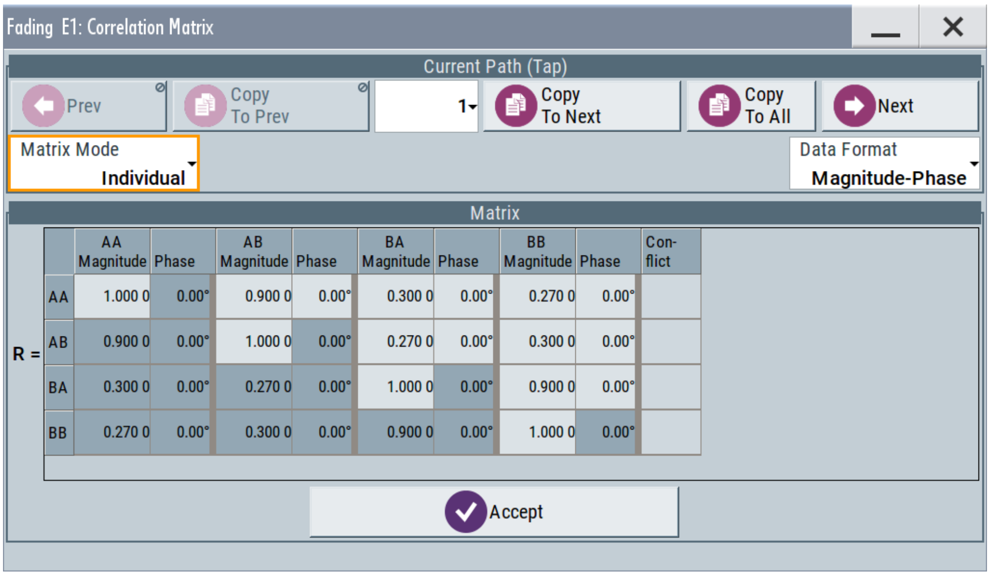
Remote command:
`n.a.`

5.3.2 Correlation matrix table

The correlation matrix table displays the values for the transmitter/receiver correlation. The correlation matrix is valid for the selected fading path. To adjust the values, edit the matrix elements directly, use the correlation coefficients of the Kronecker Mode, define the TGn/TGac parameters of the AoA /AoD mode or use the SCME/WINNER mode.

To access the settings of the correlation matrix in table form:

1. Enable a MIMO configuration
2. Select the "Fading > Path Table > Matrix" and navigate to "Fading: Correlation Matrix > Matrix".



Defining the matrix values individually

In individual matrix mode, you have to define the matrix values manually. Irrespectively of the selected data format, you have to enter valid correlation values.

Impossible calculation and conflict settings

The individual direct definition of the matrix elements may lead to impossible calculation due to inappropriate values and/or settings conflict.

You have to change the corresponding values.

The Figure 5-7 uses a 2x2 MIMO matrix to depict the basic configuration principle.

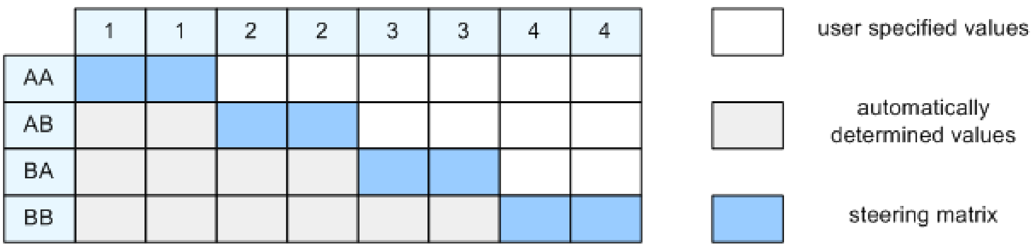


Figure 5-7: Simplified representation of a 2x2 MIMO matrix

To define the matrix, set the only the value pairs in the diagonal and upper triangle (a total of 10 value pairs in this example, see Figure 5-7). The instrument exploits the complex conjugate symmetry across the diagonal and determines automatically the remaining value pairs in the lower triangle.

By default, the values in the matrix diagonal are set to 1. Use values different than 1 to simulate antennas with different power level (steering).

Settings:

Real/Magnitude 107
Phase/Imag 107
Conflict 107
Accept 107

Real/Magnitude
Enters the value for the real/ratio part of the correlation.

Remote command:
`[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:MATRix:ROW<di>:COLumn<st>:MAGNitude` on page 205

Phase/Imag
Enters the value for the phase/imaginary part of the correlation.

Remote command:
`[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:MATRix:ROW<di>:COLumn<st>:PHASe` on page 204

Conflict
Indicates a matrix conflict.

Remote command:
`[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:MATRix:CONFlict?` on page 204

Accept
Accepts the values for the phase/imaginary and the real/ration part of the correlation.

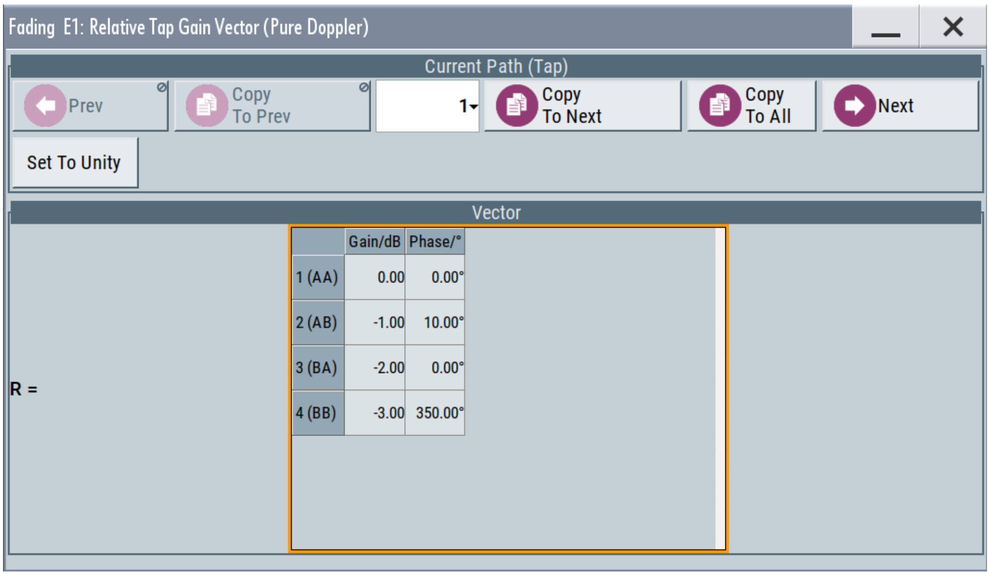
Remote command:
`[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:MATRix:ACCept` on page 203

5.3.3 Relative gain vector matrix settings

The "Fading: Relative Tap Gain Vector" dialog is available for static paths and paths with "Pure Doppler Fading Profile". This dialog provides additional parameters to simulate a gain weighting or phase shift between the signals with constant fading transmitted over the different Tx antennas.

Access:

1. Enable a MIMO configuration and select "Fading > Path Table > Profile > Static or Pure Doppler".
2. Select "Path Table > Coefficient > Vector".



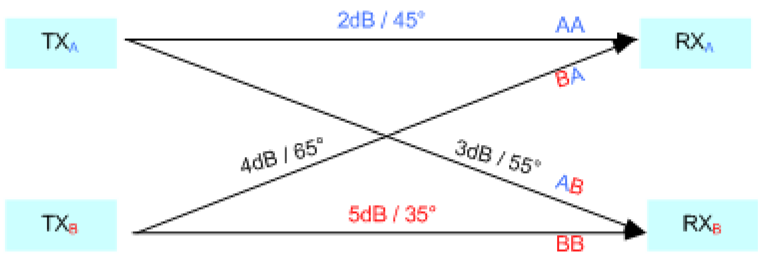
Use this function to simulate beamforming signal.

Example:

This example illustrates the phase shift between the signals with a start phase of 45 degrees, power level of 2 dB, and the gain and phase settings as follow:

- "AA Gain > 0", "AA Phase > 0"
- "AB Gain > -1", "AB Phase > 10"
- "BA Gain > -2", "BA Phase > 20"
- "BB Gain > -3", "BB Phase > 350"

Resulting simulation:



Settings:

Set to Unity..108
Gain..109
Phase..109

Set to Unity

Presets the vector matrix to an unitary matrix.

Remote command:
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:PRESet on page 205

Gain
(disabled if customized dynamic fading R&S SMW-K820 is used)

Defines the relative gain of the selected path.

A gain value of 0 dB means no loss, and e.g. -3 dB is loss in this path.

Remote command:
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor<st>:GAIN on page 205

Phase
Defines the phase shift of the selected path.

Remote command:
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor<st>:PHASe
on page 206

5.3.4 Kronecker mode correlation coefficients

► To access the settings of the correlation matrix in Kronecker mode, enable a MIMO configuration, select the "Fading > Path Table > Matrix" and select "Fading: Correlation Matrix > Matrix Mode > Kronecker".

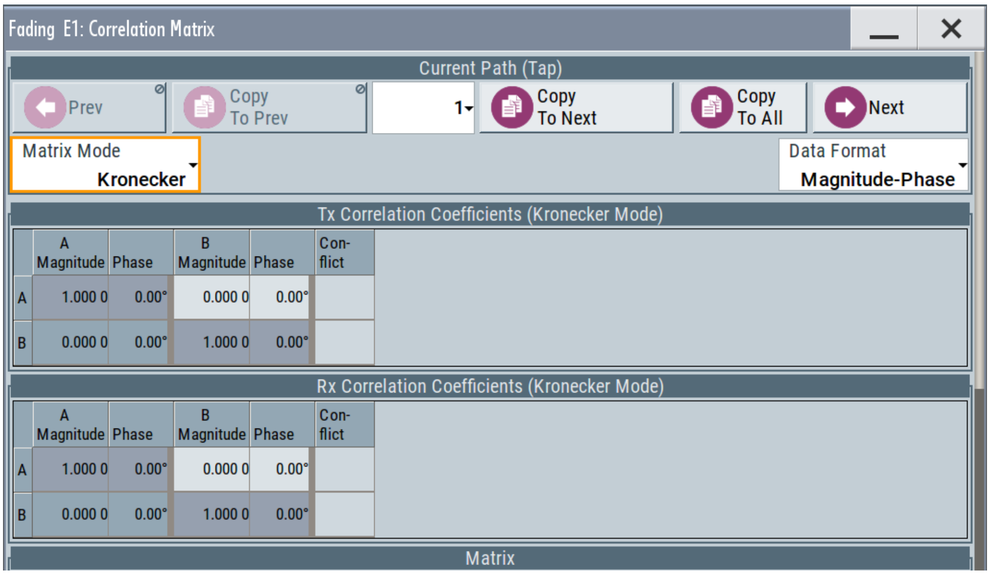


Figure 5-8: Correlation matrix in Kronecker mode

Calculating of the matrix values based on the Kronecker assumption

In Kronecker mode, it is sufficient that you specify one Tx and one Rx correlation per MIMO channel. The instrument automatically computes the full correlation matrix according to the formula:

$$R_l = R_{\mathrm{Tx}}^{(l)} \otimes R_{\mathrm{Rx}}^{(l)}, \text{ where } R_{\mathrm{Tx}}^{(l)} = \begin{bmatrix} 1 & \rho_{\mathrm{Tx}}^{(l)} \\ \rho_{\mathrm{Tx}}^{(l)*} & 1 \end{bmatrix} \text{ and } \mathrm{R}_{\mathrm{Rx}}^{(l)} = \begin{bmatrix} 1 & \rho_{\mathrm{Rx}}^{(l)} \\ \rho_{\mathrm{Rx}}^{(l)*} & 1 \end{bmatrix}$$

where $\rho^{(l)}{}_{Rx}$ and $\rho^{(l)}{}_{Tx}$ are the R_x and T_x correlations.

The evaluation of the Kronecker product ⊗ leads to:

$$R_l = \begin{bmatrix} 1 & \rho_{\mathrm{Rx}}^{(l)} & \rho_{\mathrm{Tx}}^{(l)} & \rho_{\mathrm{Tx}}^{(l)}\rho_{\mathrm{Rx}}^{(l)} \\ \rho_{\mathrm{Rx}}^{(l)*} & 1 & \rho_{\mathrm{Tx}}^{(l)}\rho_{\mathrm{Rx}}^{(l)*} & \rho_{\mathrm{Tx}}^{(l)} \\ \rho_{\mathrm{Tx}}^{(l)*} & \rho_{\mathrm{Tx}}^{(l)*}\rho_{\mathrm{Rx}}^{(l)} & 1 & \rho_{\mathrm{Rx}}^{(l)} \\ \rho_{\mathrm{Tx}}^{(l)*}\rho_{\mathrm{Rx}}^{(l)*} & \rho_{\mathrm{Tx}}^{(l)*} & \rho_{\mathrm{Rx}}^{(l)*} & 1 \end{bmatrix}$$

Which and how many coefficients are available, depends on the selected MIMO configuration, e.g. any of the 2x2, 4x2, and 3x2 MIMO configurations, requires only one Rx correlation coefficient AB, whereas there are six Rx correlation coefficients in case of 2x4 MIMO configuration.

Settings:

Tx Correlation Coefficients, Magnitude/Real....110
Tx Correlation Coefficients, Phase/Imag....110
Rx Correlation Coefficients, Magnitude/Real....111
Rx Correlation Coefficients, Phase/Imag....111

Tx Correlation Coefficients, Magnitude/Real

Enters the value for the real/ratio part of the transmitter correlation ($\rho^{(l)}{}_{Tx}$).

The available Tx correlation coefficients depends on the selected MIMO mode.

Remote command:
For "Data Format > Magnitude-Phase"
`[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:KRONecker:CORRelation:TX:ROW<di>:COLumn<st>:MAGNitude` on page 203
For "Data Format > Real-Imag"
`[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:KRONecker:CORRelation:TX:ROW<di>:COLumn<st>:REAL` on page 203

Tx Correlation Coefficients, Phase/Imag

Enters the value for the phase/imaginary part of the transmitter correlation ($\rho^{(l)}{}_{Tx}$).

The available Tx correlation coefficients depends on the selected MIMO mode.

Remote command:
For "Data Format > Ratio-Phase"
`[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:KRONecker:CORRelation:TX:ROW<di>:COLumn<st>:PHASe` on page 202

For "Data Format > Real-Imag"
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:KRONecker:CORRelation:TX:ROW<di>:COLumn<st>:IMAGinary on page 202

Rx Correlation Coefficients, Magnitude/Real

Enters the value for the real/ratio part of the receiver correlation ($\rho^{(l)}{}_{Rx}$).

The available Rx correlation coefficients depends on the selected MIMO mode.

Remote command:
For "Data Format > Magnitude-Phase"
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:KRONecker:CORRelation:RX:ROW<di>:COLumn<st>:MAGNitude on page 203
For "Data Format > Real-Imag"
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:KRONecker:CORRelation:RX:ROW<di>:COLumn<st>:REAL on page 203

Rx Correlation Coefficients, Phase/Imag

Enters the value for the phase/imaginary part of receiver correlation ($\rho^{(l)}{}_{Rx}$).

The available Rx correlation coefficients depends on the selected MIMO mode.

Remote command:
For "Data Format > Ratio-Phase"
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:KRONecker:CORRelation:RX:ROW<di>:COLumn<st>:PHASe on page 202
For "Data Format > Real-Imag"
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:KRONecker:CORRelation:RX:ROW<di>:COLumn<st>:IMAGinary on page 202

5.3.5 TGn/TGac channel models settings

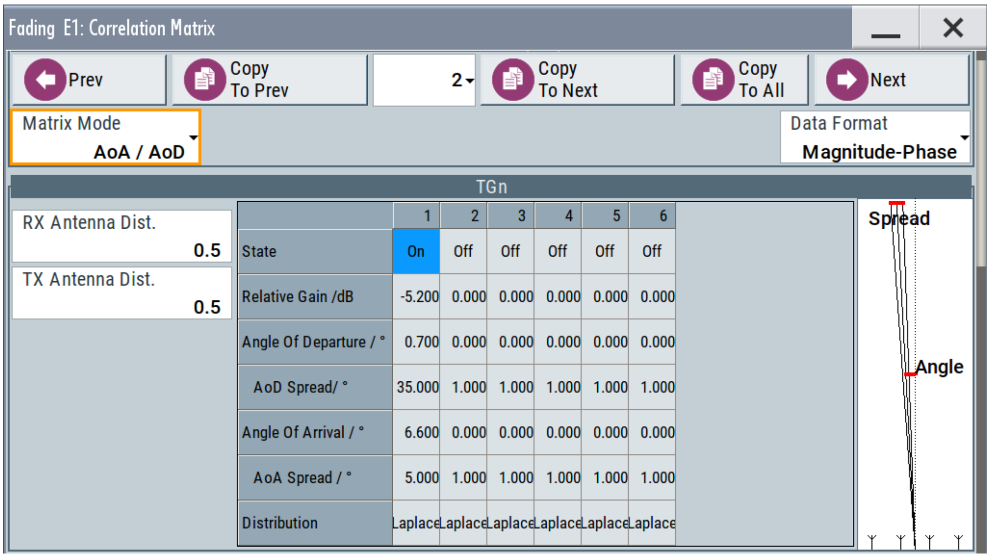
TGn and TGac channel models are specified for the evaluation of IEEE 802.11n and IEEE 802.11ac systems respectively.

These channel models are based on the so called rays, which are defined at the BS and MS side by their AoA (Angle of Arrival) and the AoD (Angle of Departure). The rays are distributed according to the selected statistic function and angle spread (AS).

In this implementation, one fading path consists by default of one ray but you can define up to six rays per path. The AoA (Angle of Arrival) / AoD (Angle of Departure) parameters, i.e. AoA/AoD angles, angle spreads (AS) and distribution of the rays, as well as the distances between the antennas at the Tx and the Rx side, are configurable.

To access the dialog with TGn/TGac settings

1. Enable a MIMO configuration, select the "Fading > Path Table > Matrix".
2. Select "Fading: Correlation Matrix > Matrix Mode > AoA/AoD".



Settings:

RX/TX Antenna Distance....112
Ray State....112
Relative Gain /dB....112
Angle of Arrival (AoA)....113
AoA Spread....113
Angle of Departure (AoD)....113
AoD Spread....113
Distribution....113

RX/TX Antenna Distance

Determines the distance between the Tx and Rx antennas as function of the wave length lambda and is calculated as follow:

*Physical Antenna Distance = "RX/TX Antenna Distance" * λ*, where

the wave length *λ = c / "Frequency"* and *c* is the speed of light.

Remote command:

[:SOURce<hw>]:FSIMulator:MIMO:TGN:ANTenna:DISTance:RX on page 207

[:SOURce<hw>]:FSIMulator:MIMO:TGN:ANTenna:DISTance:TX on page 207

Ray State

Enables/disables the selected ray.

Remote command:

[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:TGN:RAY<st>:STATe on page 209

Relative Gain /dB

Sets the relative gain (in dB) of the selected ray.

Remote command:

[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:TGN:RAY<st>:GAIN on page 208

Angle of Arrival (AoA)
Sets the AoA (Angle of Arrival) of the selected ray.

Remote command:
`[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:TGN:RAY<st>:ARRival:ANGLe` on page 208

AoA Spread
Sets the AoA (Angle of Arrival) spread (AS) of the selected ray.

Remote command:
`[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:TGN:RAY<st>:ARRival:SPRead` on page 208

Angle of Departure (AoD)
Sets the AoD (Angle of Departure) of the selected ray.

Remote command:
`[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:TGN:RAY<st>:DEParture:ANGLe` on page 208

AoD Spread
Sets the AoD (Angle of Departure) spread (AS) of the selected ray.

Remote command:
`[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:TGN:RAY<st>:DEParture:SPRead` on page 208

Distribution
Select one of the proposed statistical functions to determine the distribution of the selected ray.

Tip: Use this parameter to simulate ray scattering due to obstacles with different surface (see also Chapter 6.7, "TGn settings", on page 206).

Remote command:
`[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:TGN:DISTribution` on page 207

5.3.6 SCME/WINNER model settings

Option: R&S SMW-K72/-K73

The SCME and WINNER II channel models are developed by WINNER [1]. The original model is the SCM (Spatial Channel Model) and the SCME (SCM Extension) is its first extension. The WINNER II is the final published model.

The SCME and WINNER II channel models offer Cluster Delay Line (CDL) models for reduced complexity simulations. These CDL models can be simulated in the SCME/WIINER matrix mode. A channel correlation matrix is calculated from the CDL parameters and the channel is stochastically simulated.

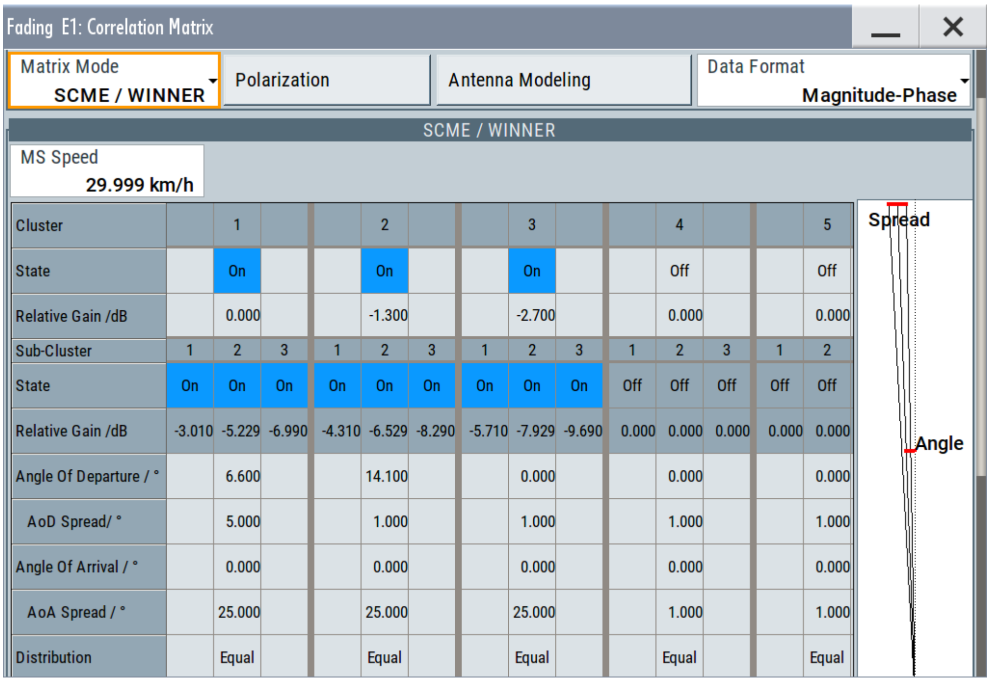
This section describes the settings of the SCME/WINNER model. For information on the antenna modeling and polarization, see:

- Chapter 5.3.8, "MIMO OTA testing related settings", on page 131.

- See also Chapter A.16, "SCM and SCME channel models for MIMO OTA", on page 309.

Access:

1. Enable a MIMO configuration.
   See "To enable a MIMO scenario" on page 96.
2. Select "Fading > Path Table > Matrix"
3. In the required "Tap", select "Fading: Correlation Matrix > Matrix Mode > SCME / WINNER"



With the provided settings, you can define up to 20 clusters, each of which comprising of up to 3 subclusters.
A cluster is defined with its AoA (Angle of Arrival) / AoD (Angle of Departure) parameters. These are the AoA/AoD angles, angle spreads (AS) and a relative gain. If a subcluster is enabled, it is also attenuated. The three subclusters powers are fixed ratios of the total cluster power (see Subcluster > Relative Gain /dB)
Different Power Azimuth Spectrum (PAS) distributions can be used to describe the distribution of the selected cluster. However, usually the clusters simulated in one path have the same distribution.

Settings:

MS Speed........115
MS DoT (Direction of Travel)........115
Cluster State........115
Relative Gain /dB........115
Subcluster > State........115
Subcluster > Relative Gain /dB........115

Angle of Departure (AoD)....116
AoD Spread....116
Angle of Arrival (AoA)....116
AoA Spread....116
Distribution....116

MS Speed
Sets the speed of the mobile station.

This value determines the value of the parameter "Speed" (see Path Table > Speed).

Remote command:
`[:SOURce<hw>]:FSIMulator:MIMO:SCWI:TAP<st>:SPEed` on page 212

MS DoT (Direction of Travel)
Sets the direction of travel of the mobile station.

If LOS (line-of-sight) is simulated, then this parameter sets the value of the parameter Frequency Ratio for the Rice fading profile.

Remote command:
`[:SOURce<hw>]:FSIMulator:MIMO:SCWI:TAP<st>:DOT` on page 212

Cluster State
Enables/disables the selected cluster.

Remote command:
`[:SOURce<hw>]:FSIMulator:MIMO:SCWI:CLUSter<ch>:TAP<st>:STATe`
on page 212

Relative Gain /dB
Sets the relative gain (in dB) of the selected cluster.

Remote command:
`[:SOURce<hw>]:FSIMulator:MIMO:SCWI:CLUSter<ch>:GAIN` on page 212

Subcluster > State
If the corresponding cluster is enabled, you can enable up to 3 subclusters.

A cluster is composed of 20 spatially separated subpaths with equal powers. The subpaths are occasionally split to subsets or subclusters (also known as mid-paths) having different resolvable delays. In the SCME and WINNER II models, one cluster can be split into 3 subclusters. Each subcluster consists of 10, 6 and 4 subpaths. Hence, the subcluster power is 10/20, 6/20 and 4/20 relative power to the total cluster power.

See also "Relative Gain /dB" on page 115.

Remote command:
`[:SOURce<hw>]:FSIMulator:MIMO:SCWI:CLUSter<ch>:TAP<st>:SUBCluster<di>:STATe` on page 214

Subcluster > Relative Gain /dB
Displays the resulting relative attenuation, applied on an enabled subcluster. The value is determined based on the select "Relative Gain" of the cluster and is calculated as follows:

$RelativeGain_{Sub\text{-}Cluster} = RelativeGain_{Cluster} + GainFactor$

The used gain factors are values in dB and are listed in Table 5-1.

The values are part of the SCME Urban Micro-Cell (SCME UMi) and SCME Urban Macro-Cell (SCME UMa) models according to TR 37.977.

Table 5-1: Overview: Gain factors and default relative gain values per subcluster

Sub-Cluster number	Gain Factor, W	Gain Factor, dB
1	10/20	-3.01
2	6/20	-5.229
3	4/20	-6.99

Remote command:
`[:SOURce<hw>]:FSIMulator:MIMO:SCWI:CLUSter<ch>:TAP<st>:SUBCluster<di>:GAIN?` on page 214

Angle of Departure (AoD)
Sets the AoD (Angle of Departure) of the selected cluster.

Remote command:
`[:SOURce<hw>]:FSIMulator:MIMO:SCWI:CLUSter<ch>:DEParture:ANGLe` on page 213

AoD Spread
Sets the AoD (Angle of Departure) spread (AS) of the selected cluster.

Remote command:
`[:SOURce<hw>]:FSIMulator:MIMO:SCWI:CLUSter<ch>:DEParture:SPRead` on page 213

Angle of Arrival (AoA)
Sets the AoA (Angle of Arrival) of the selected cluster.

Remote command:
`[:SOURce<hw>]:FSIMulator:MIMO:SCWI:CLUSter<ch>:ARRival:ANGLe` on page 213

AoA Spread
Sets the AoA (Angle of Arrival) spread (AS) of the selected cluster.

Remote command:
`[:SOURce<hw>]:FSIMulator:MIMO:SCWI:CLUSter<ch>:ARRival:SPRead` on page 213

Distribution
To set the distribution of the selected cluster, select one of the power azimuth spectrum (PAS) distributions. All clusters of the same tap must have the same distribution.

Tip: Use this parameter to simulate rays scattered due to obstacles with different surface (see also Chapter 6.7, "TGn settings", on page 206).

Remote command:
[:SOURce<hw>]:FSIMulator:MIMO:SCWI:CLUSter<ch>:DISTribution
on page 213

5.3.7 SCM fading profile

Option: R&S SMW-K73

Spatial channel model (SCM)

The spatial channel model (SCM) is a 2D geometry-based channel model specified in the 3GPP TR 25.996.

In the SCM fading profile, the channel coefficients are not calculated from a MIMO correlation matrix but given by an equation. This equation depends on geometrical parameters, like the angle of arrival and departure, and angular spread and their statistical behavior. The illustration on Figure 5-9 outlines the main SCM parameters. For detailed description of the SCM model, see TR 25.996.

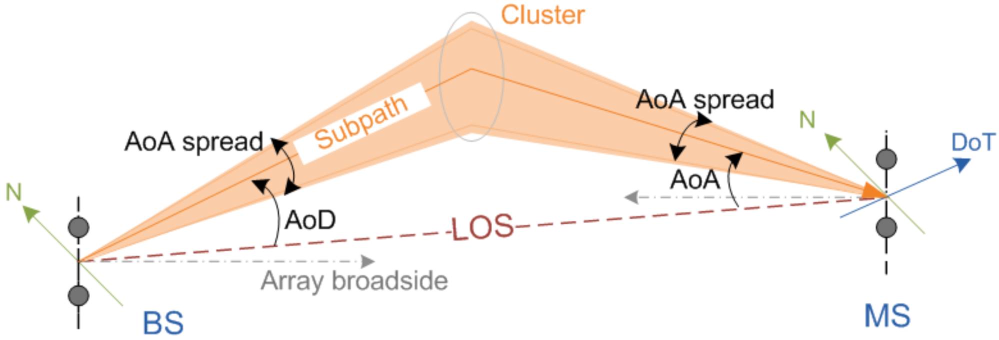


Figure 5-9: SCM angular parameters (simplified representation)

BS = Base station antenna array
MS = Mobile station antenna array
N = North: absolute reference direction used to define the antenna orientation (array broadside)
DoT = Direction of travel of the mobile station
LOS = Line-of-sight
AoD = Angle of departure
AoA = Angle of arrival
Cluster = Group of 20 spatially separated subpaths with equal powers; one cluster can be split into three subclusters, where the subclusters consist of 10, 6 and 4 subpaths.

3D geometry-based channel model

The 3D geometry-based channel model is specified in the 3GPP TR 36.873.

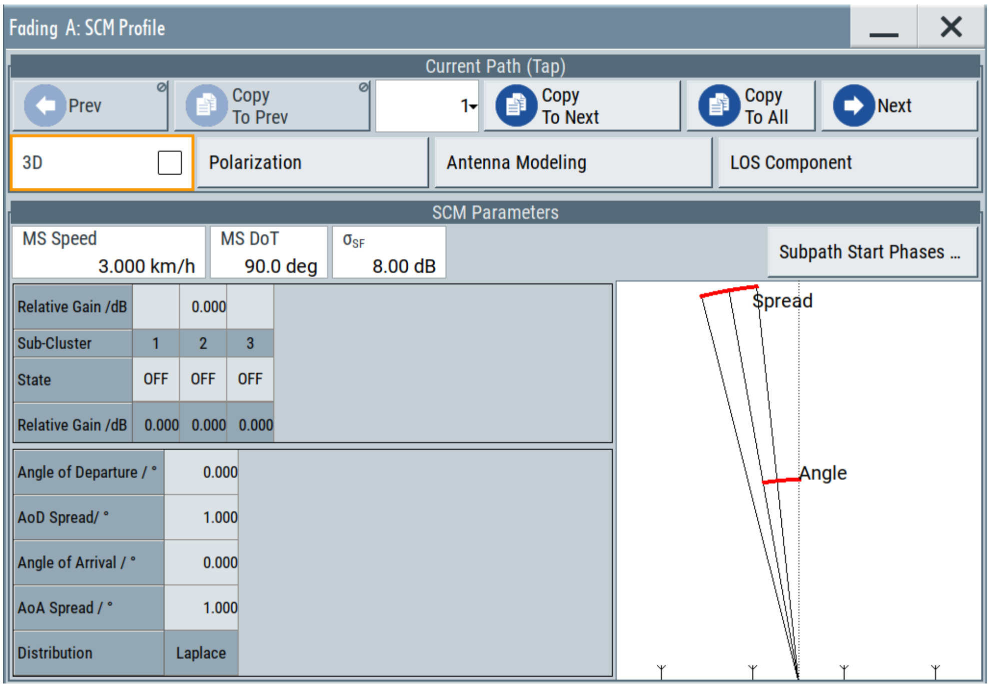
The model is an extension to the 2D spatial channel model (SCM). The following additional parameters are provided:

- Zenith of Departure/Arrival
- Zenith angular spread for Departure/Arrival
- DoT (direction of travel)

- Antenna array configurations comprising row and column number larger or equal to one (see Chapter 5.3.7.4, "Antenna modeling settings", on page 123)
- Additional antenna pattern files for 3D, based on the predefined antenna patterns files for the 2D model (see "Antenna Pattern" on page 126)

Access:

1. Enable a MIMO configuration.
   See "To enable a MIMO scenario" on page 96.
2. Select "Fading > Path Table > Path# > Profile > SCM".
3. Select "SCM Profile > SCM Data".



The provided parameters are similar to the parameters in SCME/WINNER matrix mode, like the angle, channel polarization and antenna modeling settings provided for MIMO-OTA testing. You can configure one SCM cluster per fading path but the channel and antenna parameters are common for all paths.

For background information on the antenna modeling and channel polarization, see:

- "Antenna Modeling" on page 133
- "Channel polarization" on page 134

- SCM cluster settings.. 119
- 3D channel model.. 121
- Channel polarization settings.. 122
- Antenna modeling settings.. 123
- LOS component settings... 127
- Subpath start phases... 129

5.3.7.1 SCM cluster settings

MS Speed....119
MS DoT (Direction of Travel)....119
σ_{SF}....119
Relative Gain /dB....119
Subcluster > State....119
Subcluster > Relative Gain /dB....120
Angle of Departure (AoD)....120
AoD Spread....120
Angle of Arrival (AoA)....120
AoA Spread....120
Distribution....120

MS Speed

Sets the speed of the mobile station.

This value determines the value of the parameter "Speed" (see "Path Table" > Speed).

Remote command:
`[:SOURce<hw>]:FSIMulator:SCM:SPEed` on page 228

MS DoT (Direction of Travel)

Sets the direction of travel of the mobile station, see Figure 5-9.

Remote command:
`[:SOURce<hw>]:FSIMulator:SCM:DOT` on page 229

σ_{SF}

Sets the lognormal shadow fading standard deviation, applied as a common parameter to the paths.

Remote command:
`[:SOURce<hw>]:FSIMulator:SCM:SIGMa` on page 229

Relative Gain /dB

Sets the relative gain (in dB) of the selected cluster.

Remote command:
`[:SOURce<hw>]:FSIMulator:SCM:TAP<st>:GAIN` on page 231

Subcluster > State

Enables up to 3 subclusters.

A cluster is composed of 20 spatially separated subpaths with equal powers. The subpaths are occasionally split to subsets or subclusters (also known as mid-paths) having different resolvable delays. In the SCM model, one cluster can be split into 3 subclusters, where the subclusters consist of 10, 6 and 4 subpaths. Hence, the subcluster power is 10/20, 6/20 and 4/20 relative power to the total cluster power.

See also "Subcluster > Relative Gain /dB" on page 120.

Remote command:
`[:SOURce<hw>]:FSIMulator:SCM:TAP<st>:SUBCluster<di>:STATe`
on page 231

Subcluster > Relative Gain /dB
Displays the resulting relative attenuation, applied on an enabled subcluster. The value is determined based on the select "Relative Gain" of the cluster and is calculated as follows:

$RelativeGain_{Sub-Cluster} = RelativeGain_{Cluster} + GainFactor$

The used gain factors are values in dB and are listed in "Subcluster > Relative Gain /dB" on page 120.

Table 5-2: Overview: Gain factors and default relative gain values per subcluster

Sub-Cluster number	Gain factor, W	Subpath number	Gain factor, dB
1	10/20	1, 2, 3, 4, 5, 6, 7, 8, 19, 20	-3.01
2	6/20	9, 10, 11, 12, 17, 18	-5.229
3	4/20	13, 14, 15, 16	-6.99

Remote command:
`[:SOURce<hw>]:FSIMulator:SCM:TAP<st>:SUBCluster<di>:GAIN` on page 231

Angle of Departure (AoD)
Sets the AoD (angle of departure) of the cluster.

Remote command:
`[:SOURce<hw>]:FSIMulator:SCM:TAP<st>:DEParture:ANGLe` on page 230

AoD Spread
Sets the AoD (angle of departure) spread (AS) of the cluster.

Remote command:
`[:SOURce<hw>]:FSIMulator:SCM:TAP<st>:DEParture:SPRead` on page 230

Angle of Arrival (AoA)
Sets the AoA (angle of arrival) of the cluster.

Remote command:
`[:SOURce<hw>]:FSIMulator:SCM:TAP<st>:ARRival:ANGLe` on page 230

AoA Spread
Sets the AoA (angle of arrival) spread (AS) of the cluster.

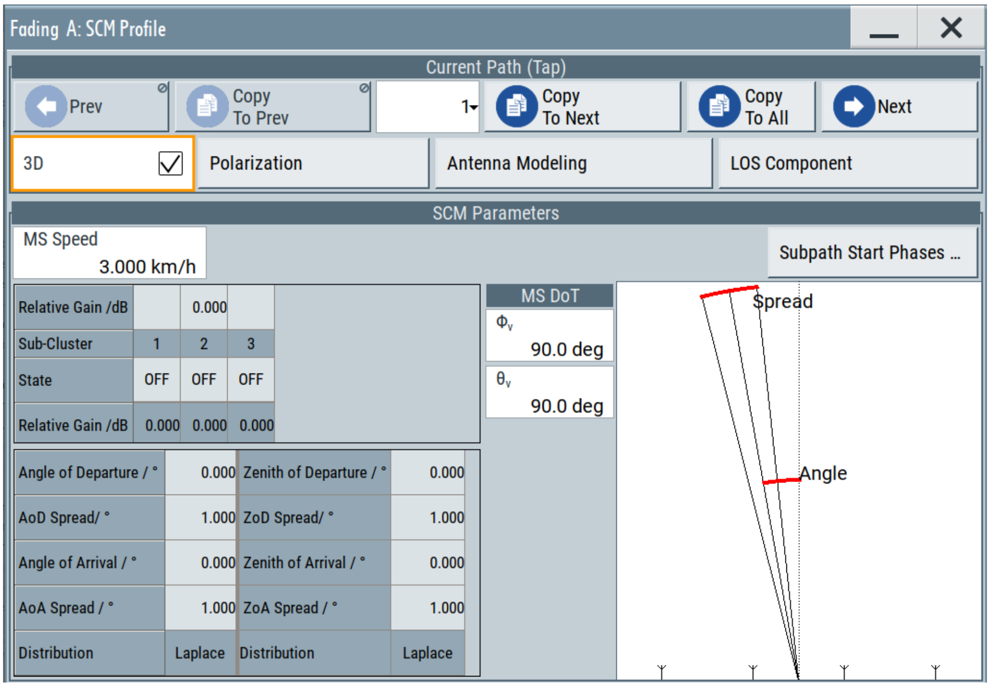
Remote command:
`[:SOURce<hw>]:FSIMulator:SCM:TAP<st>:ARRival:SPRead` on page 230

Distribution
Displays the distribution of the cluster.

5.3.7.2 3D channel model

Access:

1. Enable a MIMO configuration.
   See "To enable a MIMO scenario" on page 96.
2. Select "Fading > Path Table > Path# > Profile > SCM".
3. Select "SCM Profile > 3D > On".



Most of the settings are the same as for the 2D SCM model.
In the following, listed are only the dedicated 3D model setting: the zenith dimension and its parameters.

Settings

3D....................121
MS DoT > φ_v/Θ_v....................122
Zenith of Departure....................122
ZoD Spread....................122
Zenith of Arrival (ZoA)....................122
ZoA Spread....................122

3D

Enables the 3D geometry-based channel model.

Remote command:
`[:SOURce<hw>]:FSIMulator:SCM:D3Mode:STATe` on page 228

MS DoT > φ_v/Θ_v

Sets the direction of travel of the mobile station as travel azimuth angle (φ_v) and elevation angle (Θ_v).

Remote command:
[:SOURce<hw>]:FSIMulator:SCM:PHI on page 229
[:SOURce<hw>]:FSIMulator:SCM:THETa on page 229

Zenith of Departure

Sets the zenith of departure (ZoD) of the cluster.

Remote command:
[:SOURce<hw>]:FSIMulator:SCM:TAP<st>:DEParture:ZENith:ANGLe on page 230

ZoD Spread

Sets the ZoD (zenith of departure) spread of the cluster.

Remote command:
[:SOURce<hw>]:FSIMulator:SCM:TAP<st>:DEParture:ZENith:SPRead on page 230

Zenith of Arrival (ZoA)

Sets the ZoA (zenith of arrival) of the cluster.

Remote command:
[:SOURce<hw>]:FSIMulator:SCM:TAP<st>:ARRival:ZENith:ANGLe on page 230

ZoA Spread

Sets the ZoA (zenith of arrival) spread of the cluster.

Remote command:
[:SOURce<hw>]:FSIMulator:SCM:TAP<st>:ARRival:ZENith:SPRead on page 230

5.3.7.3 Channel polarization settings

Access:

1. Enable a MIMO configuration.
   See "To enable a MIMO scenario" on page 96.
2. Select "Fading > Path Table > Path# > Profile > SCM".
3. Select "SCM Profile > SCM Data"
4. Select "Polarization".
5. Select "Channel Poliarization > On".
6. Set the XPR (cross polarization power ratios) values.

Settings:

Note: In multi-entity configurations, like, for example, 2x4x4 or 4x2x2, the settings in the dialogs "Channel Polarization" and "Rx Antenna Array Structure" **apply to all entities**.

Channel Polarization State....................123
Vertical/Horizontal Cross Polarization Power Ratio.................... 123

Channel Polarization State

Enables/disables simulation of channel polarization.

Remote command:

`[:SOURce<hw>]:FSIMulator:SCM:POLarization:STATe` on page 232

Vertical/Horizontal Cross Polarization Power Ratio

Sets the cross polarization power ratio (XPR) in dB.

$XPR_v = P/P_{vvhv}$ and $XPR_h = P/P_{hhvh}$, where $XPR_v = XPR_h = XPR$.

Remote command:

`[:SOURce<hw>]:FSIMulator:SCM:POLarization:PRATio:HORizontal`
on page 232

`[:SOURce<hw>]:FSIMulator:SCM:POLarization:PRATio:VERTical`
on page 232

5.3.7.4 Antenna modeling settings

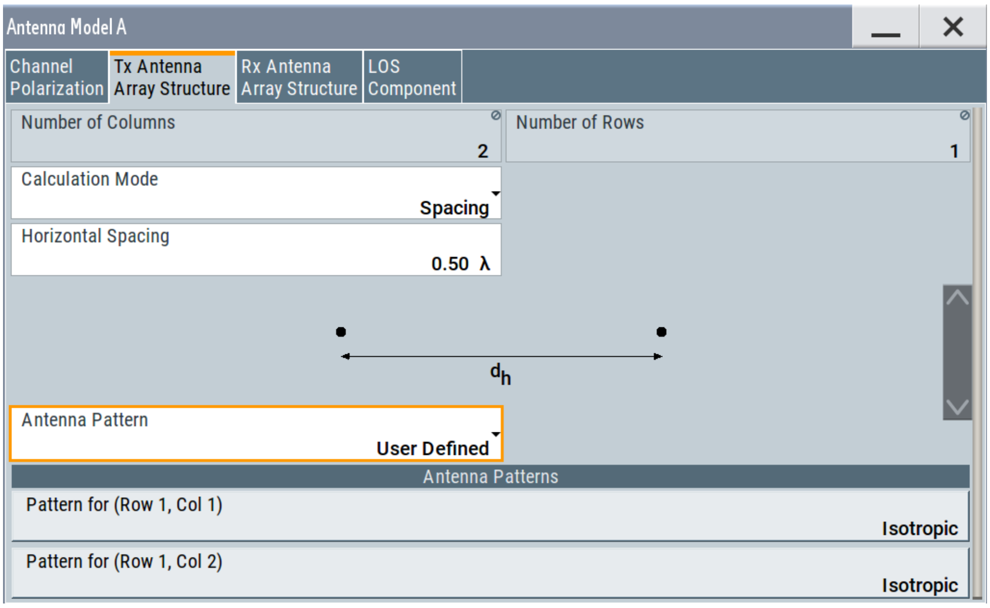
Access:

1. Enable a MIMO configuration.
   See "To enable a MIMO scenario" on page 96.
2. Select "Fading > Path Table > Path# > Profile > SCM".

3. Select "SCM Profile > SCM Data"
4. Select "Antenna Modeling".
5. Configure the base station (BS) antenna settings, for example:
   - "Tx Antenn Array Structure > Calculation Mode > Spacing", if the spacing (i.e. the physical distance) between the antenna elements is a known value.
   - "Horizontal Spacing = 0.5*λ"
     For mobile devices, however, the measured characteristics are the antenna radiation pattern, gain and relative phase.
     To use the relative phase instead of the antenna spacing, *provide the relative phase information in the antenna pattern file*. When this file is loaded, the relative phase information is extracted from it and used in the calculations.
     See also Figure 5-14.

   a) To load custom antenna pattern for the transmit or the receive antenna:
      - "Select Antenna Pattern > User Defined".
      - For each antenna element, navigate to the antenna pattern file and load it.

   The selected 2D antenna pattern file describes the BS and MS antenna gains of each array element.



   A figure displays the structure of the current antenna array. The number of columns and rows in the array are set automatically, depending on the selected MIMO configuration.

Settings:

Antenna Structure 125
Number of Rows (M)/Columns (N) 125
Calculation Mode 125
Horizontal Spacing 126
Vertical Spacing 126

Antenna array..126
Antenna Pattern...126
User Defined Antenna Patterns per Row, Column..127

Antenna Structure

If 3D > "On", sets the antenna array structure.

See "Antenna array" on page 133.

Remote command:
`[:SOURce<hw>]:FSIMulator:SCM:ANTenna:TX:STRucture` on page 233 `[:SOURce]:FSIMulator:SCM:ANTenna:RX:STRucture` on page 233

Number of Rows (M)/Columns (N)

Sets the number of rows (M) and the number of columns (N) in the antenna array, see "Antenna Modeling" on page 133.

The number of Tx and Rx antennas is set automatically according to the selected LxMxN MIMO configuration ("System Configuration > LxMxN"). Supported are configurations with L = 1, 2 or 4 even number of Tx and Rx antennas.

See section "Signal Routing and System Configuration" in the R&S SMW200A user manual.

Remote command:
`[:SOURce]:FSIMulator:SCM:ANTenna:RX:COLumns[:SIZE]` on page 234
`[:SOURce]:FSIMulator:SCM:ANTenna:RX:ROWS[:SIZE]?` on page 234
`[:SOURce<hw>]:FSIMulator:SCM:ANTenna:TX:COLumns[:SIZE]` on page 234
`[:SOURce<hw>]:FSIMulator:SCM:ANTenna:TX:ROWS[:SIZE]?` on page 234

Calculation Mode

Selects how the phase information is calculated.

See Figure 5-14.

"Spacing" The phase information is calculated from the spacing between the antenna elements.
The spacing (i.e. the physical distance) between the antenna elements is set with the parameter Horizontal Spacing .

"Relative Phase"
If the loaded antenna pattern file contains the required information, the relative phase is extracted from the antenna pattern file.

See:
- "Antenna element spacing or relative phase" on page 133
- Chapter B, "Antenna pattern file format", on page 349.

"Analog Beamforming"
In this mode, the composite antenna pattern of an antenna array comprising gain and phase can be used to simulate analog beamforming. The co-polarized antenna elements of the array are combined to a single RF port.

Remote command:
`[:SOURce]:FSIMulator:SCM:ANTenna:RX:CALC:MODE` on page 233
`[:SOURce<hw>]:FSIMulator:SCM:ANTenna:TX:CALC:MODE` on page 233

Horizontal Spacing

For "Calculation Mode > Spacing", sets the distance (d_h) between the antennas in the antenna array normalized by the wavelength λ.

It is calculated as follows:

d_h = "Horizontal Spacing" * λ

Where:

- λ is the wavelength calculated as λ = c/"Frequency"
- *c* is the speed of light
- "Frequency" is the center frequency.

See also "Antenna element spacing or relative phase" on page 133.

Remote command:

[:SOURce<hw>]:FSIMulator:SCM:ANTenna:TX:ESPacing:HORizontal on page 234

[:SOURce]:FSIMulator:SCM:ANTenna:RX:ESPacing:HORizontal on page 234

Vertical Spacing

If 3D > "On", "Calculation Mode > Spacing" and "Number of Rows ≥ 2", sets the distance (d_v) between the antennas in the antenna array normalized by the wavelength λ.

It is calculated as follows:

d_v = "Vertical Spacing" * λ

Where:

- λ is the wavelength calculated as λ = c/"Frequency"
- *c* is the speed of light
- "Frequency" is the center frequency.

See also "Antenna element spacing or relative phase" on page 133.

Remote command:

[:SOURce<hw>]:FSIMulator:SCM:ANTenna:TX:ESPacing:VERTical on page 234

[:SOURce]:FSIMulator:SCM:ANTenna:RX:ESPacing:VERTical on page 234

Antenna array

Graphical representation of the current antenna array.

Each dot indicates a single antenna element.

The spacing between the antenna elements is indicated, if "Calculation Mode > Spacing" is used.

Antenna Pattern

Antenna patterns are files that describe the 2D or 3D antenna radiation pattern.

The following predefined antenna patterns are available:

- "Isotropic"
- "Dipole"
- "3 Sectors" and "6 Sectors"
  These two sector antenna patterns are required for the BS testing, as specified in the TR 25.996.

- "Dual Polarization Isotropic"

You can also load custom antenna pattern, see "User Defined Antenna Patterns per Row, Column" on page 127.

Remote command:
[:SOURce<hw>]:FSIMulator:SCM:ANTenna:TX:PATTern on page 234
[:SOURce]:FSIMulator:SCM:ANTenna:RX:PATTern on page 234

User Defined Antenna Patterns per Row, Column
Indicates the custom antenna pattern file per antenna element.

To change the used file for an antenna element:
- Select a predefined or "User File"
- Navigate to the antenna pattern file and load it.

Antenna pattern files are XML files with file predefined file syntax and extension `*.ant_pat`.

They describe the antenna pattern as an array with typical resolutions of 1 degree to 5 degrees for the azimuth. These files contain the gain values for a given azimuth. For an isotropic antenna radiating energy equally in all directions, the array elements are all 0 dB.

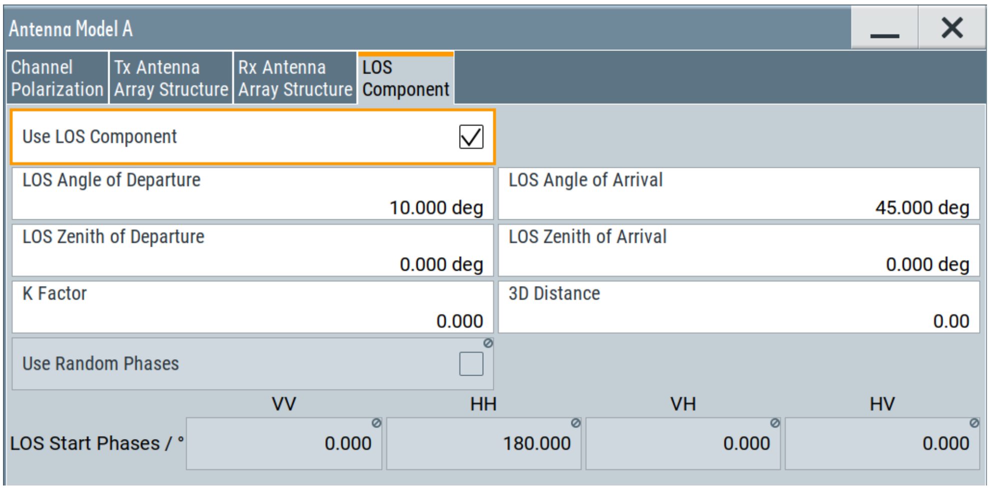
Remote command:
[:SOURce<hw>]:FSIMulator:SCM:ANTenna:TX:ANTenna<di>:PFILe
on page 235
[:SOURce]:FSIMulator:SCM:ANTenna:RX:ANTenna<di>:PFILe on page 235

5.3.7.5 LOS component settings

Access:

1. Enable a MIMO configuration.
   See "To enable a MIMO scenario" on page 96.
2. Select "Fading > Path Table > Path# > Profile > SCM".
3. Select "SCM Profile > SCM Data"

4. Select "LOS Component".



The LOS modeling is based on the ricean K factor. It is defined as the ratio of power in the LOS component to the total power in the diffused non line-of-sight (NLOS) component.

Settings:

Use LOS Component....................128
LOS Angle of Departure (AoD)....................128
LOS Angle of Arrival (AoA)....................128
LOS Zenith of Departure....................129
LOS Zenith of Arrival....................129
K Factor....................129
3D Distance....................129
Use Random Phases....................129
LOS Start Phases....................129

Use LOS Component

Adds a line-of-sight (LOS) component to the cluster.

The LOS component is supported only in the first fading path.

To activate the LOS component:
- Set "Path Table > Fading Path#1 > State > On" and set "Profile > SCM".
- Set "SCM Data > LOS Component Settings > Use LOS Component > On".

Remote command:
`[:SOURce<hw>]:FSIMulator:SCM:LOS:STATe` on page 235

LOS Angle of Departure (AoD)

Sets the AoD (angle of departure) of the LOS component.

Remote command:
`[:SOURce<hw>]:FSIMulator:SCM:LOS:DEParture[:ANGLe]` on page 235

LOS Angle of Arrival (AoA)

Sets the AoA (angle of arrival) of the LOS component.

Remote command:
[:SOURce<hw>]:FSIMulator:SCM:LOS:ARRival[:ANGLe] on page 235

LOS Zenith of Departure
If 3D > "On", sets the ZoD (zenith of departure) of the LOS component.

Remote command:
[:SOURce<hw>]:FSIMulator:SCM:LOS:DEParture:ZENith:ANGLe on page 235

LOS Zenith of Arrival
If 3D > "On", sets the ZoA (zenith of arrival) of the LOS component.

Remote command:
[:SOURce<hw>]:FSIMulator:SCM:LOS:ARRival:ZENith:ANGLe on page 235

K Factor
Sets the ricean K factor.

The K factor is defined as the ratio of power in the LOS component to the total power in the diffused non line-of-sight (NLOS) component.

Remote command:
[:SOURce<hw>]:FSIMulator:SCM:LOS:KFACtor on page 236

3D Distance
If 3D > "On", sets the distance between the base station (BS) and the user terminal (UT).

The value is used to calculate the phase shift of the LOS component.

Remote command:
[:SOURce<hw>]:FSIMulator:SCM:LOS:DISTance on page 236

Use Random Phases
If enabled, random subpath start phases are selected.

Remote command:
[:SOURce<hw>]:FSIMulator:SCM:LOS:RANDom:PHASe:STATe on page 236

LOS Start Phases
Sets the start phase in degree of the LOS signal per MIMO channel.

Remote command:
[:SOURce<hw>]:FSIMulator:SCM:LOS:RANDom:PHASe:VV on page 237
[:SOURce<hw>]:FSIMulator:SCM:LOS:RANDom:PHASe:HH on page 237
[:SOURce<hw>]:FSIMulator:SCM:LOS:RANDom:PHASe:VH on page 237
[:SOURce<hw>]:FSIMulator:SCM:LOS:RANDom:PHASe:HV on page 237

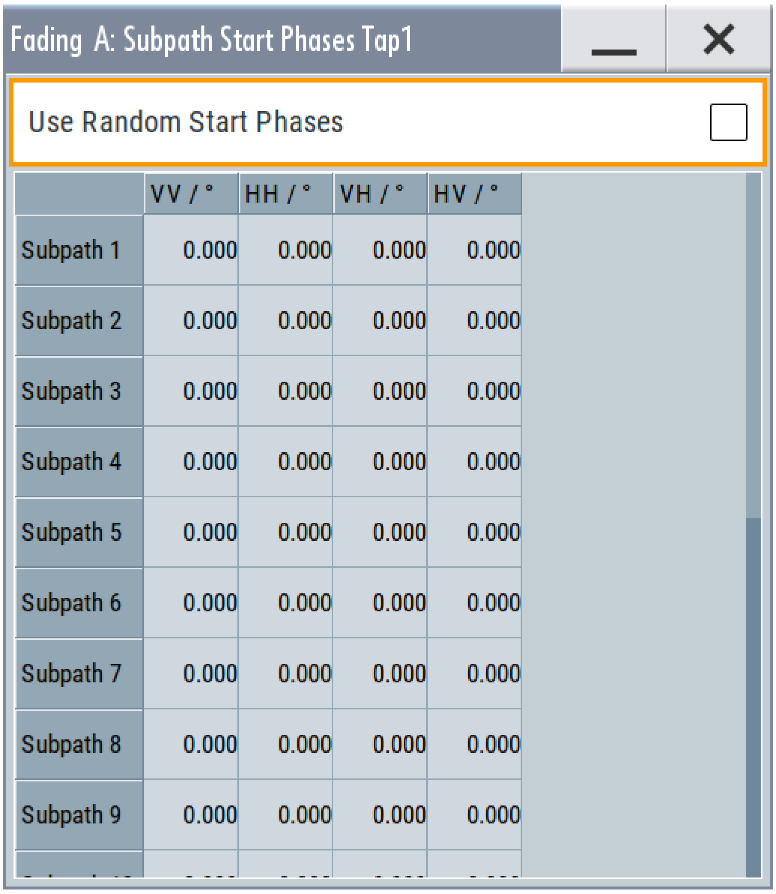
5.3.7.6 Subpath start phases

Access:

1. Enable a MIMO configuration.

See "To enable a MIMO scenario" on page 96.

2. Select "Fading > Path Table > Path# > Profile > SCM".
3. Select "SCM Profile > SCM Data"
4. Select "Subpath Start Phases".



Settings:

Use Random Phases.. 130
Subpath # > VV/HH/VH/HV Phase...130

Use Random Phases

If enabled, random start phases are selected.

Remote command:

`[:SOURce<hw>]:FSIMulator:SCM:TAP<st>:SUBPath:STATe` on page 232

Subpath # > VV/HH/VH/HV Phase

Sets the phase per subpath.

A total number of 20 subpaths are supported.

Remote command:
[:SOURce<hw>]:FSIMulator:SCM:TAP<st>:SUBPath<di>:PHASe:HH
on page 237
[:SOURce<hw>]:FSIMulator:SCM:TAP<st>:SUBPath<di>:PHASe:HV
on page 237
[:SOURce<hw>]:FSIMulator:SCM:TAP<st>:SUBPath<di>:PHASe:VH
on page 237
[:SOURce<hw>]:FSIMulator:SCM:TAP<st>:SUBPath<di>:PHASe:VV
on page 237

5.3.8 MIMO OTA testing related settings

The MIMO OTA testing is a term describing radiated testing of mobile devices. The signal is transmitted over-the-air (OTA) to a mobile device placed in an anechoic chamber. The mobile devices are tests in a real-word like conditions.

This section introduces the main concept of the two-stage method. You find the complete description of this method in the TR 37.977 specification.

About the MIMO OTA two stage method

According to TR 37.977, the method consists of two stages:

- **Acquiring the complex antenna radiation pattern of the DUT**

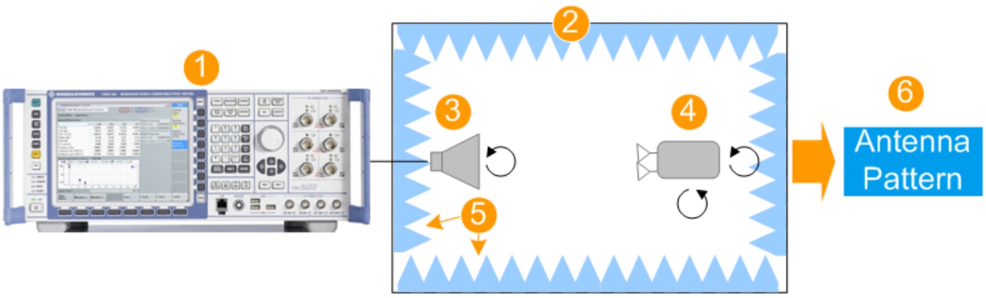


Figure 5-10: MIMO OTA testing: stage 1 [TR 37.977]

1 = Base station (BS) emulator
2 = Test chamber
3 = Reference antenna
4 = MIMO DUT (mobile device)
5 = Anechoic material
6 = Measurement result: antenna radiation pattern

  The measurement is performed in an over-the-air (OTA) test setup. The DUT is placed in an anechoic chamber.
  The antenna radiation pattern is measured of each antenna element.

- **Convolving the antenna pattern with the channel model**
  The measured antenna pattern is loaded into the MIMO channel emulator. The DUT performance is measured with throughput tests.

Figure 5-11: MIMO OTA testing: stage 2 (conducted setup)

1 = BS emulator
2 = Channel emulator
3 = DUT with standard antenna ports (as for conducted conformance tests)
4 = Connection between the BS and the channel emulator ([DIG I/Q] interface)
5 = Cable connection between the BS emulator and the DUT
6 = Antenna radiation pattern, as measured in stage 1
7 = Measurement result

The measurements in this second stage can be performed in a conducted or in a radiated (OTA) setup.
The radiated tests assure that the self-interference effects between the antenna elements of the DUT are also considered.

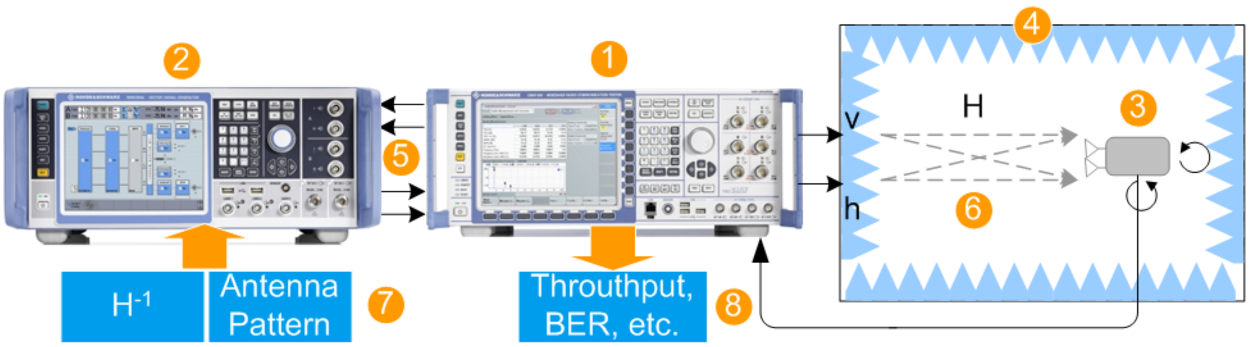


Figure 5-12: MIMO OTA testing: stage 2 (radiated setup)

1 = BS emulator
2 = Channel emulator
3 = MIMO DUT
4 = Anechoic chamber
5 = Connection between the BS and the channel emulator ([DIG I/Q] interface)
v, h = Probe antennas with vertical (v) and horizontal (h) polarization, co-located in the anechoic chamber
H = Radiated channel matrix of the chamber
6 = Radiated connection to the DUT
7 = Antenna radiation pattern (as measured in stage 1) and the inverted channel matrix H^{-1} of the chamber
8 = Measurement result

The test setup consists of a BS emulator, a channel emulator, a DUT placed in an anechoic or a reverberation chamber and a reference antenna. In the examples on Figure 5-10, Figure 5-11 and Figure 5-12, the R&S®CMW acts as BS emulator and the

R&S SMW200A as a channel simulator. Approved RF cables are used for all connections.

In the two-stage method, the R&S SMW200A takes over the convolving of the antenna pattern with standard compliant channel model (SCME UMi and UMa). If the channel matrix H of the chamber is known, the R&S SMW200A can apply the inverse channel matrix H^{-1}. The signal received at the DUT antennas is thus the same as in the cable-conducted method.

Antenna Modeling

The antenna modeling includes the definition of the:

- Antenna array structure
  (see "Antenna array" on page 133)
- Antenna polarization
  (see "Antenna polarization" on page 134)
- Antenna radiation pattern
  (see Chapter B, "Antenna pattern file format", on page 349)

Antenna array

The antenna model is based on a **2D planar antenna array** structure. The antenna elements are placed in the vertical and horizontal direction in an array composed of N columns and M rows (see Figure 5-13). The antenna elements are uniformly spaced.

The horizontal and vertical spacings between the antenna columns are d_h*λ and d_v*λ. The spacing between the antenna pairs of cross-polarized antennas is denoted as cross polarized antenna spacing d_{xp}*λ.

In the current firmware version, the antenna elements are placed on a single row and vertical spacing is not supported.

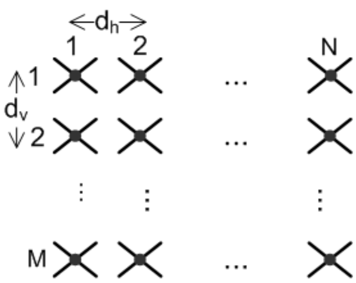


*Figure 5-13: 2D planar antenna array structure where each column is a cross-polarized 45° antenna with dxp= 0*λ*

The user interface illustrates the selected antenna array similarly.

Antenna element spacing or relative phase

If the **spacing between** the antenna elements is unknown, the antenna **relative phase** can be used instead (see Figure 5-14). Which information is used is defined with the parameter Calculation Mode.

If Calculation Mode > "Relative Phase", the following applies:

- If *all* selected antenna pattern files contain the relative phase information, it is extracted from there.
  (see Chapter B, "Antenna pattern file format", on page 349)
- If *one* of the selected antenna pattern files contain relative phase information, this information is used. The relative phase values in all other selected antenna pattern files are assumed to be zero.
- If *none* of the selected antenna pattern files contain relative phase information, the following settings apply: "Spacing = 0.5*λ".

Antenna polarization

The polarization of an antenna describes the orientation of the electric wave radiated by the antenna.

According to TR 25.996, using antenna polarization requires that the antenna complex response for both vertical and horizontal components is known.

Provide the antenna polarization information in one of the following ways:

- Described in the **antenna pattern file** and extracted from there

  To use this way:
  - Create and load an antenna pattern file containing **both** the horizontal and vertical polarization antenna radiation patterns
    (see Chapter B, "Antenna pattern file format", on page 349)
  - Activate channel polarization Channel Polarization State > "On"
  - Select Antenna Polarization Mode > "Separate AP".
- Selected with the parameter **"Antenna Polarization Slant Angle"**

  To use this way:
  - Load an antenna pattern file containing **only one** antenna pattern.
  - Activate channel polarization Channel Polarization State > "On"
  - Select Antenna Polarization Mode > "Single AP with Slant Angle".
  - Set the parameter "Antenna Polarization Slant Angle".

Available polarization angles are:

- Horizontal polarization
- Vertical polarization
- Cross-polarization 90°
- Cross-polarization 45°

Channel polarization

The channel correlation polarization matrix is computed from the antenna element polarization angles and the XPR (cross polarization power ratio of a propagation channel) values.

See:

- "Antenna polarization" on page 134
- "Vertical/Horizontal Cross Polarization Power Ratio" on page 138.

Channel correlation matrix

The total **channel correlation matrix R** is the result of the element-wise product of the polarization correlation matrix R_P and the spatial correlation matrix R_S:

$R = R_P * R_S$.

In the following, we assume that:

- The elements of the channel polarization matrix are uncorrelated
- The transmitter and the receiver ends are uncorrelated

The polarization and spatial correlation matrices, R_P and R_S are calculated as follows:

- **Spatial correlation matrix R_S**
  The spatial correlation matrix depends on the spatial characteristics of the channel:
  – Antenna radiation patterns at the transmitter and the receiver ends
  – Antenna spacing
  – Power azimuth spectrum PAS of the clusters

  The correlation between antenna array elements n and m is calculated according to the Schumacher model [2].

$$\rho_{n,m} \frac{\int_{-\pi}^{\pi} e^{-j2\pi\frac{d}{\lambda}\sin\emptyset} PAS(\emptyset)\sqrt{G_n(\emptyset)G_m(\emptyset)}d\emptyset}{\sqrt{\int_{-\pi}^{\pi} PAS(\emptyset)G_n(\emptyset)d\emptyset}\sqrt{\int_{-\pi}^{\pi} PAS(\emptyset)G_m(\emptyset)d\emptyset}}$$

Figure 5-14: Schumacher model for calculation the correlation between antenna array elements [2]

$\rho_{n,m}$	= Correlation between antenna array elements
m, n	= Antenna array elements
d	= Antenna spacing between the two antenna elements
λ	= Wavelength of the signal
PAS (Ø)	= Power azimuth spectrum of the impinging signal
G_n (Ø), G_m(Ø)	= Antenna radiation patterns, characterized by a power gain, for antenna elements n and m

  Note: The magnitude $e^{-j2\pi d/\lambda(\sin\emptyset)}$ is also the relative phase resulting form the spacing **d** and the angle Ø. For a known relative phase φ, the magnitude is calculated as $e^{j\varphi}$.
  If the transmitter and the receiver ends are uncorrelated, then the total spatial channel correlation matrix is the Kroneker product of the two correlation matrices.
  $R_S=R_{Rx}\otimes R_{Tx}$

- **Polarization correlation matrix R_P**
  Three matrices describe the polarization of the system: channel polarization S, the transmitter and the receiver antenna array polarizations P_{Tx} and P_{Rx}.

Related settings

See:

- Chapter 5.3.8.2, "Antenna model settings", on page 139

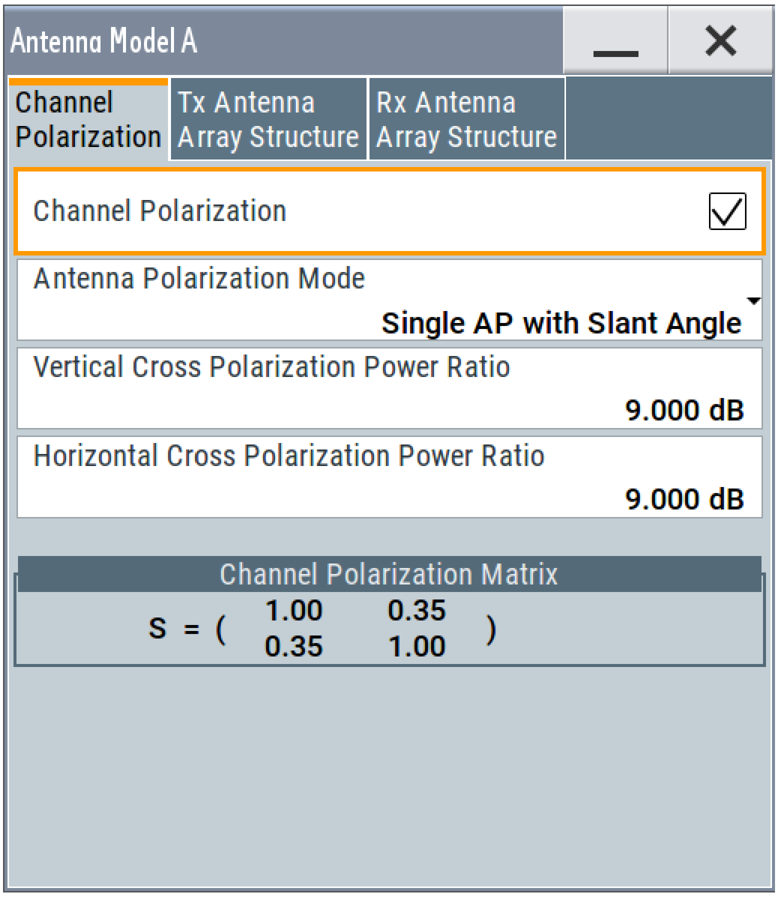
- Chapter 5.3.8.1, "Channel polarization settings", on page 136
- Chapter 5.3.9, "Inverse channel matrix", on page 145

See also:
- Chapter B, "Antenna pattern file format", on page 349
- Chapter 5.3.6, "SCME/WINNER model settings", on page 113
- Chapter A.16, "SCM and SCME channel models for MIMO OTA", on page 309

5.3.8.1 Channel polarization settings

Access:

1. Enable a MIMO configuration, e.g. a 2x2 MIMO scenario.
   See "To enable a MIMO scenario" on page 96.
2. Select "Fading > Path Table > Matrix"
3. In the required "Tap", select "Fading: Correlation Matrix > Matrix Mode > SCME / WINNER"
4. Select "Fading: Correlation Matrix > Polarization".



5. Select "Channel Polarization > On".

6. Set the XPR (cross polarization power ratios) values.
   Note: In multi-entity configurations, like, for example, 2x4x4 or 4x2x2, the settings in the dialogs "Channel Polarization" and "Rx Antenna Array Structure" **apply to all entities**.
7. Set the parameter "Antenna Polarization Mode", depending on the information in the used antenna pattern files.
   For example, if your files contain both vertical and horizontal gain information, select "Antenna Polarization Mode > Separate AP".
8. Load the antenna pattern files.
   See "User Defined Antenna Patterns per Row, Column" on page 144.

   The calculated channel polarization matrix is displayed.

   See also:
   - Chapter B, "Antenna pattern file format", on page 349
   - "Channel correlation matrix" on page 135

Settings:

Channel Polarization State....137
Antenna Polarization Mode....137
Vertical/Horizontal Cross Polarization Power Ratio....138
S....138

Channel Polarization State

Enables/disables simulation of channel polarization.

Remote command:
`[:SOURce<hw>]:FSIMulator:MIMO:ANTenna:MODeling[:STATe]` on page 214

Antenna Polarization Mode

Sets way the software extracts or calculates the antenna polarization patterns.

"Single AP with Slant Angle"
: The antenna pattern file contains one antenna radiation pattern.
The antenna polarization is calculated from the provided antenna pattern and the polarization angle, as selected with the parameter Antenna Polarization Slant Angle.
See also "Antenna polarization" on page 134.

"Separate AP" Option: R&S SMW-K73
The antenna pattern file has to describe two antenna radiation patterns, one for each polarization (see Chapter B, "Antenna pattern file format", on page 349).
The correlation between any two channels for the same path is calculated as follows [3]:

$$E\{h_{pm}(t)h_{qn}^{*}(t)\} = \sqrt{P_{pm}P_{qn}}\left(\gamma_{mn}^{Tx(v)}\gamma_{pq}^{Rx(v)} + \frac{1}{XPD}\gamma_{mn}^{Tx(h)}\gamma_{pq}^{Rx(v)} + \frac{1}{XPD}\gamma_{mn}^{Tx(v)}\gamma_{pq}^{Rx(h)} + \gamma_{mn}^{Tx(h)}\gamma_{pq}^{Rx(h)}\right)$$

Figure 5-15: Calculation of the correlation between channels [3]

P_{pm}, P_{qn} = Powers transferred through the subchannels (Tx_p - Rx_m) and (Tx_q - Rx_n); in this implementation, $P_{pm} = P_{qn} = 1$
γ_{mn}^{Tx}, γ_{pq}^{Rx} = Correlation coefficient between antenna elements in the transmitter and receiver array; values per polarization
Tx, Rx = Transmitter and receiver array
v, h = Vertical and horizontal polarization
n, m / p, q = Antenna elements in the transmitter/receiver array

Remote command:
`[:SOURce<hw>]:FSIMulator:MIMO:ANTenna:PATTern:MODE` on page 215

Vertical/Horizontal Cross Polarization Power Ratio
Sets the cross polarization power ratio (XPR) in dB.

$XPR_v = P/P_{vvhv}$ and $XPR_h = P/P_{hhvh}$, where $XPR_v = XPR_h = XPR$.

The resulting channel polarization matrix S is displayed.

Remote command:
`[:SOURce]:FSIMulator:MIMO:ANTenna:POLarization:PRATio:HORizontal`
on page 215
`[:SOURce]:FSIMulator:MIMO:ANTenna:POLarization:PRATio:VERTical`
on page 215

S
Displays the resulting *channel polarization* matrix S calculated as:

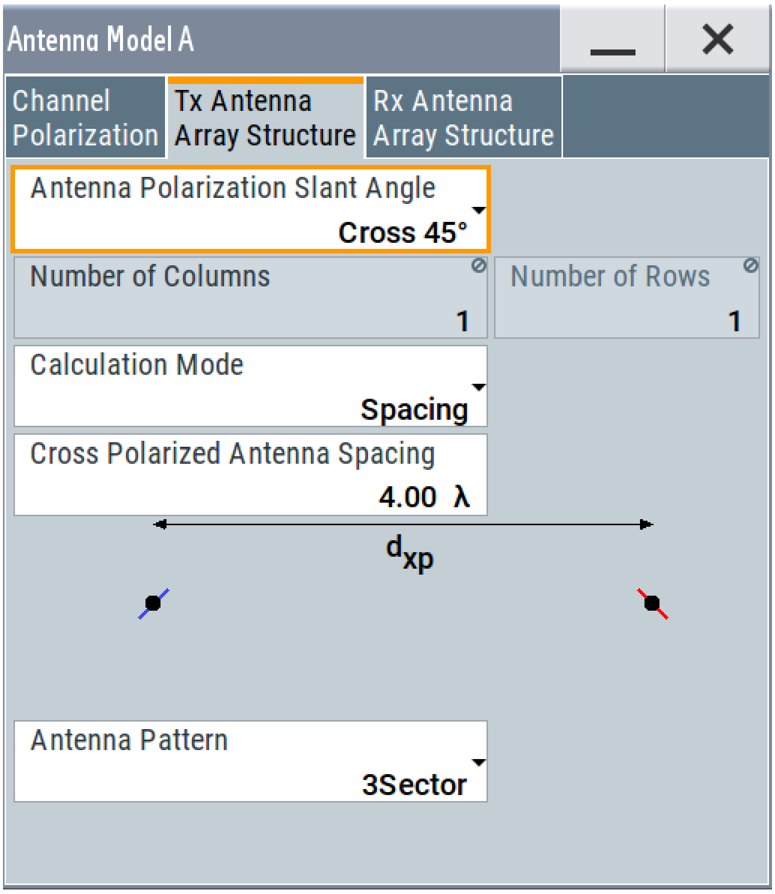
$$S = \begin{bmatrix} S_{vv} & S_{vh} \\ S_{hv} & S_{hh} \end{bmatrix}$$

Where:
- $S_{vv} = S_{hh} = 1$
- S_{vh} and S_{hv} are commonly designated as S_{xy} and are calculated from the equation
  E{Sxy²} = Pxy
  where:
  – E is the expectation, i.e. the mean power per polarization component
  – $\mathbf{P_{xy}}$ values are derived from the selected Vertical/Horizontal Cross Polarization Power Ratio XPR.
- It is assumed that the elements of the channel polarization matrix are uncorrelated, i.e.:
  E{SijSlk*} = 0 for i != j, k != l

5.3.8.2 Antenna model settings

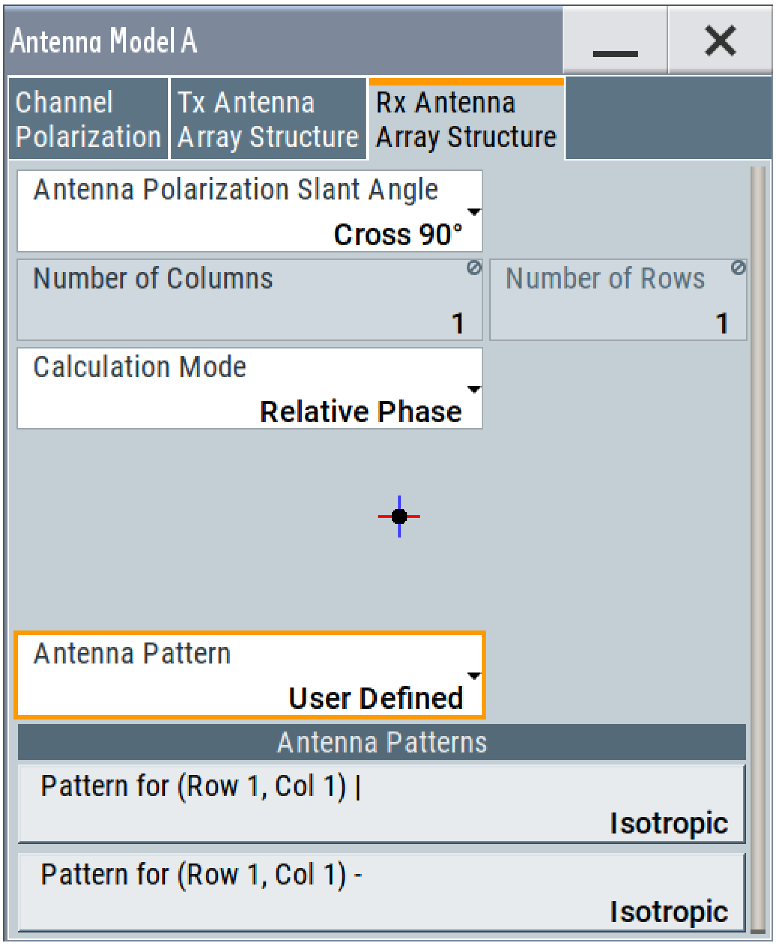
Access:

1. Enable a MIMO configuration, e.g. a 2x2 MIMO scenario.
   See "To enable a MIMO scenario" on page 96.
2. Select "Fading > Path Table > Matrix"
3. In the required "Tap", select "Fading: Correlation Matrix > Matrix Mode > SCME / WINNER"
4. Select "Fading: Correlation Matrix > Antenna Modeling".
5. Configure the base station (BS) antenna settings, for example:
   - "Antenna Polarization Slant Angle > Cross 45°"
   - "Calculation Mode > Spacing", if the spacing (i.e. the physical distance) between the antenna elements is a known value.
   - "Horizontal Spacing = 4*λ"
   - "Antenna Pattern > 3Sector"



A figure displays the structure of the current antenna array. The number of columns and rows in the array are set automatically, depending on the selected MIMO configuration.

6. To configure the mobile station (MS) antenna settings, select "Rx Antenna Array Structure".
Note: In multi-entity configurations, like, for example, 2x4x4 or 4x2x2, the settings in the dialogs "Channel Polarization" and "Rx Antenna Array Structure" **apply to all entities**.



Sometimes, it is difficult to determine the antenna spacing of the mobile device; instead the relative phase is measured.
To use the relative phase instead of the antenna spacing, provide the relative phase information in the antenna pattern file. When this file is loaded, the relative phase information is extracted from it and used in the calculations.
See also Figure 5-14.

7. To load custom antenna pattern for the transmit or the receive antenna:
   - "Select Antenna Pattern > User File".
   - For each antenna element, navigate to the antenna pattern file and load it.

The selected 2D antenna pattern file describes the BS and MS antenna gains of each array element.

Depending on its format, the antenna pattern file contains the following information:
- Antenna gain information only

- Antenna gain and phase information
- Horizontal and vertical gain information
- Horizontal and vertical gain and phase information.

See also:
- Chapter B, "Antenna pattern file format", on page 349
- "Antenna Modeling" on page 133.
- "Channel correlation matrix" on page 135

Settings:

Antenna Polarization Slant Angle....................141
Number of Rows (M)/Columns (N)....................142
Calculation Mode....................142
Horizontal Spacing....................143
Cross-Polarized Antenna Spacing....................143
Antenna Array....................143
Antenna Pattern....................144
User Defined Antenna Patterns per Row, Column....................144

Antenna Polarization Slant Angle

The information on the antenna polarization at the Tx and Rx ends is required to calculate the channel polarization.

Note: In multi-entity configurations, like, for example, 2x4x4 or 4x2x2, the settings in the dialogs "Channel Polarization" and "Rx Antenna Array Structure" **apply to all entities**.

If channel polarization is activated (Channel Polarization State > "On"), specify the antenna polarization in one of the following ways:
- Described in the **antenna pattern file** and extracted from there.
  One antenna radiation pattern for each polarization if necessary.
  (The parameter "Antenna Polarization Slant Angle" is not necessary and not available.)
- Selected with the parameter **"Antenna Polarization Slant Angle"**

For information on the prerequisites and how to use these two ways, see "Antenna polarization" on page 134.

The following polarizations are available:
- Horizontal polarization
- Vertical polarization
- Cross-polarization 90°
- Cross-polarization 45°

A graph displays the structure of the current antenna array.

See also:
- Chapter B, "Antenna pattern file format", on page 349.
- Chapter A.16, "SCM and SCME channel models for MIMO OTA", on page 309

Remote command:
`[:SOURce]:FSIMulator:MIMO:ANTenna:RX:POLarization:ANGLe`
on page 215
`[:SOURce<hw>]:FSIMulator:MIMO:ANTenna:TX:POLarization:ANGLe`
on page 215

Number of Rows (M)/Columns (N)
Sets the number of rows (M) and the number of columns (N) in the antenna array, see "Antenna Modeling" on page 133.

Note: In this firmware version, only one-dimensional arrays are supported.
The antenna elements are places in one row and only the horizontal spacing is considered.

The number of Tx and Rx antennas is set automatically according to the selected MxN MIMO configuration ("System Configuration > LxMxN").

See section "Signal Routing and System Configuration" in the R&S SMW200A user manual.

Note: In multi-entity configurations, like, for example, 2x4x4 or 4x2x2, the settings in the dialogs "Channel Polarization" and "Rx Antenna Array Structure" **apply to all entities**.

Example:

In an 1x4x2 MIMO configuration, there are 4 Tx and 2 Rx antennas.

The "Tx Antenna Array" consists of 4 antennas:
- if "Antenna Polarization Slant Angle > Horizontal/Vertical", these 4 antennas are placed in a row (4x1 array)
- if "Antenna Polarization Slant Angle > Cross-Polarization 45°/90°", there are exact 2 columns and 1 row.

The "Rx Antenna Array" contains exact 2 antennas, that can be distributed in one the following ways:
- if "Antenna Polarization Slant Angle > Horizontal/Vertical", in 2 columns and 1 row (2x1array)
- if "Antenna Polarization Slant Angle > Cross-Polarization 45°/90°", there is exact 1 column and 1 row

In both arrays, a spacing d_{xp} can also exist between the cross polarized antenna elements.

Remote command:
`[:SOURce]:FSIMulator:MIMO:ANTenna:RX:COLumn:SIZE` on page 215
`[:SOURce<hw>]:FSIMulator:MIMO:ANTenna:TX:ROWS:SIZE` on page 216

Calculation Mode
Selects how the correlation between the antenna elements is calculated: based on the spacing between the antenna elements or on the relative phase.

See Figure 5-14.

Note: In multi-entity configurations, like, for example, 2x4x4 or 4x2x2, the settings in the dialogs "Channel Polarization" and "Rx Antenna Array Structure" **apply to all entities**.

"Spacing" The spacing (i.e. the physical distance) between the antenna elements is set with the parameter Horizontal Spacing or Cross-Polarized Antenna Spacing.

"Relative Phase"

Option: R&S SMW-K73

If the loaded antenna pattern file contains the required information, the relative phase is extracted from the antenna pattern file.

See:

- "Antenna element spacing or relative phase" on page 133
- Chapter B, "Antenna pattern file format", on page 349.

Remote command:
`[:SOURce]:FSIMulator:MIMO:ANTenna:RX:CALC:MODE` on page 216
`[:SOURce<hw>]:FSIMulator:MIMO:ANTenna:TX:CALC:MODE` on page 216

Horizontal Spacing

For "Calculation Mode > Spacing", sets the distance (d_h) between the antennas in the antenna array normalized by the wavelength *λ*.

It is calculated as follows:

d_h = "Horizontal Spacing" * λ

Where the wavelength is λ = c/"Frequency" and *c* is the speed of light.

See also "Antenna element spacing or relative phase" on page 133.

Note: In multi-entity configurations, like, for example, 2x4x4 or 4x2x2, the settings in the dialogs "Channel Polarization" and "Rx Antenna Array Structure" **apply to all entities**.

Remote command:
`[:SOURce<hw>]:FSIMulator:MIMO:ANTenna:TX:ESPacing:HORizontal`
on page 216
`[:SOURce]:FSIMulator:MIMO:ANTenna:RX:ESPacing:HORizontal`
on page 216

Cross-Polarized Antenna Spacing

For "Calculation Mode > Spacing", set the distance (d_{xp}) between the two antenna elements of a cross-polarized antenna pair normalized by the wavelength λ .

It is calculated as follows:

d_{xp}= "Cross Polarized Antenna Spacing" * λ.

Where the wavelength is λ = c/"Frequency" and *c* is the speed of light.

Note: In multi-entity configurations, like, for example, 2x4x4 or 4x2x2, the settings in the dialogs "Channel Polarization" and "Rx Antenna Array Structure" **apply to all entities**.

Remote command:
`[:SOURce<hw>]:FSIMulator:MIMO:ANTenna:TX:ESPacing:CROSs`
on page 216
`[:SOURce]:FSIMulator:MIMO:ANTenna:RX:ESPacing:CROSs` on page 216

Antenna Array

Graphical representation of the current antenna array.

Each dot indicates a single antenna element. Small lines indicate the used polarization, if "Antenna Polarization Mode > Single AP with Slant Angle" is used.

The spacing between the antenna elements is indicated, if "Calculation Mode > Spacing" is used.

Antenna Pattern
Antenna patterns are files that describe the 2D antenna radiation pattern.

Note: In multi-entity configurations, like, for example, 2x4x4 or 4x2x2, the settings in the dialogs "Channel Polarization" and "Rx Antenna Array Structure" **apply to all entities**.

The following predefined antenna patterns are available:
- "Isotropic"
- "Dipole"
- "3 Sectors" and "6 Sectors"
  These two sector antenna patterns are required for the BS testing, as specified in the TR 25.996.
- "Dipole +45°/-45°"

The predefined files do not contain polarization and relative phase information. They are suitable, in the following cases:
- Calculation Mode > "Spacing" or "Relative Phase"
  (See "Antenna element spacing or relative phase" on page 133 for information on file handling in the second case.)
- Antenna Polarization Mode > "Single AP with Slant Angle"
- Standard / Test Case > "3GPP/LTE MIMO" > "SCME UMa/Umi"

You can also load custom antenna pattern, see "User Defined Antenna Patterns per Row, Column" on page 144.

Remote command:
`[:SOURce<hw>]:FSIMulator:MIMO:ANTenna:TX:PATTern` on page 217
`[:SOURce]:FSIMulator:MIMO:ANTenna:RX:PATTern` on page 217

User Defined Antenna Patterns per Row, Column
Indicates the custom antenna pattern file per antenna element.

Note: In multi-entity configurations, like, for example, 2x4x4 or 4x2x2, the settings in the dialogs "Channel Polarization" and "Rx Antenna Array Structure" **apply to all entities**.

To change the used file for an antenna element:
- Select a predefined or "User File"
- Navigate to the antenna pattern file and load it.

Antenna pattern files are XML files with file predefined file syntax and extension `*.ant_pat`.

They describe the antenna pattern as an array with typical resolutions of 1 degree to 5 degrees for the azimuth. These files contain the gain values for a given azimuth. For an isotropic antenna radiating energy equally in all directions, the array elements are all 0 dB.

Antenna pattern files can also contain the following information:
- Separate antenna patterns per antenna polarization
- Relative phase description, also per antenna polarization.

Note: Always use antenna pattern files that are suitable for the current setting.

The following features require a fully described antenna pattern file
- Calculation Mode > "Relative Phase"
- Antenna Polarization Mode > "Separate AP"
- Use Inverse Channel Matrix > "On".

For description of the file format, see Chapter B, "Antenna pattern file format", on page 349.

Remote command:
`[:SOURce]:FSIMulator:MIMO:ANTenna:PATTern:CATalog?` on page 217
`[:SOURce]:FSIMulator:MIMO:ANTenna:PATTern:CATalog:USER?`
on page 217
`[:SOURce<hw>]:FSIMulator:MIMO:ANTenna:TX:ANTenna<di>:PFILe`
on page 218
`[:SOURce]:FSIMulator:MIMO:ANTenna:RX:ANTenna<di>:PFILe` on page 218

5.3.9 Inverse channel matrix

Option: R&S SMW-B14 and R&S SMW-K73

Some test cases, like for example the MIMO OTA tests, specify actions to be taken to counteract the channel response of the channel between the test equipment and the DUT.

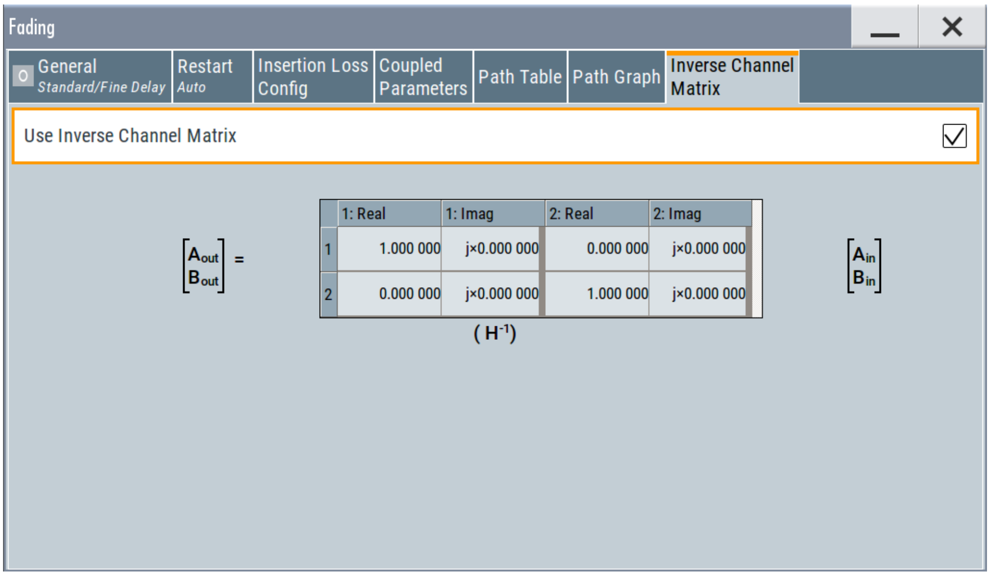
The process includes measuring the channel response matrix and applying the inverted version of this channel matrix to the generated signal. In the MIMO OTA tests using radiated tests for instance, signal generated in this way is received by the DUT as if a conducted test is used.

The inverse channel matrix is specified for the following test situations but can apply inverse channel matrix in any 2x2 MIMO scenario:

- MIMO OTA radiated testing
  See
- Applying SCM fading porfiles
  See Chapter 5.3.7, "SCM fading profile", on page 117.

Access:

1. Enable a **2x2 MIMO** configuration.
2. Select "Fading > Inverse Channel Matrix"



How to counteract the channel matrix of an anechoic chamber

To counteract the anechoic chamber channel matrix of the setup on Figure 5-12 for example, apply the inverse channel matrix of the radiated channel. The radiated channel is the channel between the antenna probes and the DUT antennas inside the chamber.

Perform the following general steps:

1. Establish a radiated (over-the-air) MIMO connection to the DUT.
2. Measure the transmission matrix in the anechoic chamber.
3. Calculate the inverse matrix (H^{-1}). Enter the inverse matrix values.
4. In the R&S SMW200A, enable a **2x2 MIMO** configuration.
5. Select "Fading > Inverse Channel Matrix"
6. Select "Use Inverse Channel Matrix > On".
7. Enter the calculated inverse matrix values.

   The complex elements of the inverse channel matrix are applied on the transmitted signal to compensate for chamber effects.

Settings

Use Inverse Channel Matrix....................146
Complex Matrix Elements (Real/Imag)....................147

Use Inverse Channel Matrix

Applies a 2x2 inverse channel matrix on the signal to compensate for chamber effects.

Enter the four inverse matrix values, see Complex Matrix Elements (Real/Imag).

Remote command:
[:SOURce<hw>]:FSIMulator:MIMO:ANTenna:INVerse:MATRix:STATe
on page 218

Complex Matrix Elements (Real/Imag)
Sets the 4 complex elements (h_{00}, h_{01}, h_{10}, h_{11}) of the inverse channel matrix.

$$\begin{bmatrix} A_{out} \\ B_{out} \end{bmatrix} = \begin{bmatrix} h_{00} & h_{01} \\ h_{10} & h_{11} \end{bmatrix} \begin{bmatrix} A_{in} \\ B_{in} \end{bmatrix}$$

A_{in}, B_{in} = Faded channel signals
A_{out}, B_{out} = Output signal of the channel emulator

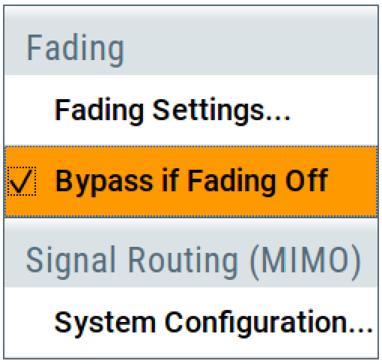
The supported matrix size is 2x2.

Remote command:
[:SOURce<hw>]:FSIMulator:MIMO:ANTenna:INVerse:MATRix:ROW<st>:COLumn<ch>:REAL on page 218
[:SOURce<hw>]:FSIMulator:MIMO:ANTenna:INVerse:MATRix:ROW<st>:COLumn<ch>:IMAGin on page 218

5.4 Bypassing a deactivated fading simulator

To access this setting, proceed as follows:

1. Enable "Fading > Signal Routing (MIMO) > System Configuration > Mode > Advanced".
2. Select "Fading > Off".
3. Select "Fading > Bypass if Fading Off > On".



The fading simulator is disabled and the input basebands bypass it.

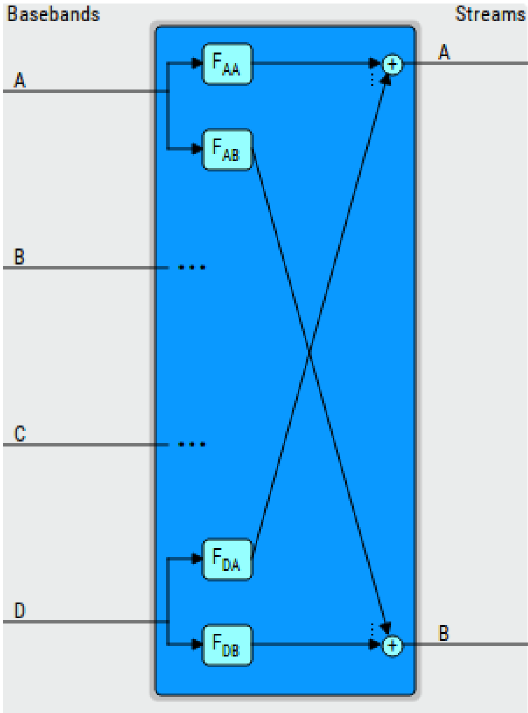
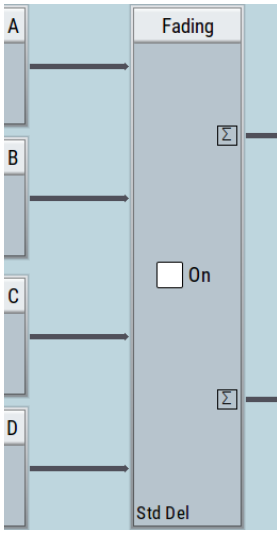
Impact of the parameter on the calculation of the output streams

The parameter determines the way the output streams are calculated, if the fading simulator is disabled:

- Disabled parameter "Bypass if Fading Off" (default state)
  The fading simulator itself is disabled, but each output stream is still the linear combination of the input baseband signals and depend on the current MIMO configuration.

Example:
In a 4x2 MIMO system, for instance, the two output streams A and B are calculated from all the four input basebands. This instrument state is indicated by the sum symbols Σ at each output streams.

Table 5-3: Representation of the instrument state Bypass if Fading Off > Off

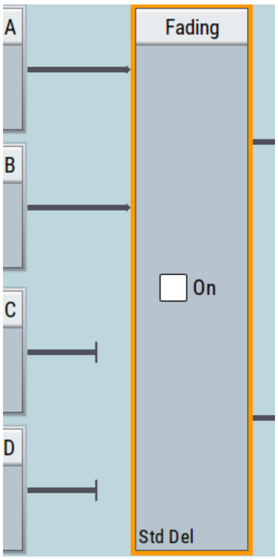
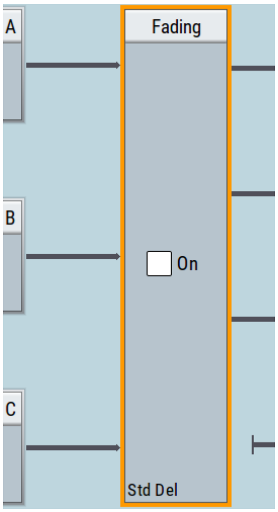
In the "System Configuration" preview diagram	In the block diagram
	

- Enabled parameter "Bypass if Fading Off"
  Bypasses the "Fading" block, i.e. the fading simulator is disabled and the basebands bypass unchanged the fading block.
  Depending on the MIMO configuration, the block diagram visualizes this behavior different (see Table 5-4). The absence of the sum symbols confirms the selection, too.

Example:

- In a 4x2 MIMO system, for instance, the two output streams A and B are identical to the two input baseband signals A and B.
  The basebands C and D are not processed.
- Vice versa, in a 3x4 MIMO system, the three output streams A, B and C are identical to the three basebands.
  The stream D is a zero stream that starts after the "Fading" block.

Table 5-4: Bypass if Fading Off > On: Representation in the block diagram

MxN MIMO configuration, where M>N	MxN MIMO configuration, where M<N
	

"Bypass if Fading Off > ON" during troubleshooting

While performing troubleshooting, enable this parameter to exclude the impact of the fading in the signal processing.

SCPI command:

`[:SOURce]:FSIMulator:BYPass:STATe` on page 152

6 Remote-control commands

This subsystem contains the commands necessary to configure the fading simulator in a remote environment. We assume that the R&S SMW200A has already been set up for remote operation in a network as described in the R&S SMW200A documentation. A knowledge about the remote control operation and the SCPI command syntax are assumed.

Conventions used in SCPI command descriptions

For a description of the conventions used in the remote command descriptions, see section "Remote Control Commands" in the R&S SMW200A user manual.

Required Options

All SCPI commands described in this section, require at least the R&S SMW-B14 option. For better overview, this option is not listed at each command. Also required options, however, are listed.

The dynamic fading configurations (Birth Death, Moving Propagation, 2 Channel Interferer and High-Speed Train) are available with option R&S SMW-K71.

See also Chapter 2.1, "Required options", on page 18.

Common Suffixes

The following common suffixes are used in remote commands:

Suffix	Value range	Description
ENTity<ch>	1 to 8	Entity in a multiple entity configuration ENTity3|4|5|6|7|8 require option R&S SMW-K76
SOURce<hw>	[1]|2 to 8	Available faders SOURce3|4|5|6|7|8 require option R&S SMW-K76 Only SOURce1 possible, if the keyword ENTity is used
GROup<st>	[1]|2 to 4	Available fading path groups
PATH<ch>	[1]|2 to 5	Available fading paths
TAP<ch>	[1] to 10	Available MIMO taps
RAY<st>	[1] to 6	Available TGn clusters/rays
CLUSter<ch>	[1] to 20	Available SCME/WIMMER clusters

Using SCPI command aliases for advanced mode with multiple entities

You can address multiple entities configurations by using the SCPI commands starting with the keyword `SOURce` or the alias commands starting with the keyword `ENTity`.

Note that the meaning of the keyword `SOURce<hw>` changes in the second case.

For details, see section "SCPI Command Aliases for Advanced Mode with Multiple Entities" in the R&S SMW200A user manual.

Programming examples

This description provides simple programming examples. The purpose of the examples is to present **all** commands for a given task. In real applications, one would rather reduce the examples to an appropriate subset of commands.

The programming examples have been tested with a software tool which provides an environment for the development and execution of remote tests. To keep the example as simple as possible, only the "clean" SCPI syntax elements are reported. Non-executable command lines (e.g. comments) start with two // characters.

At the beginning of the most remote control program, an instrument preset or reset is recommended to set the instrument to a definite state. The commands `*RST` and `SYSTem:PRESet` are equivalent for this purpose. `*CLS` also resets the status registers and clears the output buffer.

The following commands specific to the fading simulator are described here:

- General settings....................151
- Delay modes....................173
- Birth death....................184
- High-speed train....................188
- Moving propagation....................193
- MIMO settings....................198
- TGn settings....................206
- SCME/WINNER and antenna model settings....................209
- Two channel interferer....................219
- Custom fading profile....................223
- SCM fading profile....................225
- Customized dynamic fading....................237
- Fading bandwidth....................241

6.1 General settings

[:SOURce]:FSIMulator:BYPass:STATe....................152
[:SOURce<hw>]:FSIMulator:CONFiguration....................152
[:SOURce<hw>]:FSIMulator:SISO:COPY....................153
[:SOURce<hw>]:FSIMulator:COPY:DESTination....................153
[:SOURce<hw>]:FSIMulator:COPY:EXECute....................153
[:SOURce<hw>]:FSIMulator:COPY:SOURce....................153
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[:SOURce<hw>]:FSIMulator:CLOCk:RATE?....................154

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[:SOURce<hw>]:FSIMulator:HOPPing:MODE 155
[:SOURce<hw>]:FSIMulator:IGNore:RFCHanges 155
[:SOURce<hw>]:FSIMulator:ILOSs:CSAMples? 156
[:SOURce<hw>]:FSIMulator:ILOSs:MODE 156
[:SOURce<hw>]:FSIMulator:ILOSs[:LOSS] 156
[:SOURce<hw>]:FSIMulator:KCONstant 157
[:SOURce<hw>]:FSIMulator:PRESet 157
[:SOURce<hw>]:FSIMulator:RESTart:MODE 157
[:SOURce<hw>]:FSIMulator:ROUTe 157
[:SOURce]:FSIMulator:SYNChronize:STATe 160
[:SOURce<hw>]:FSIMulator:SDEStination 161
[:SOURce<hw>]:FSIMulator:FREQuency:DETect? 161
[:SOURce<hw>]:FSIMulator:SPEed:UNIT 162
[:SOURce<hw>]:FSIMulator:STANdard 162
[:SOURce<hw>]:FSIMulator:STANdard:REFerence 169
[:SOURce<hw>]:FSIMulator[:STATe] 170
[:SOURce]:FSIMulator:CATalog? 170
[:SOURce<hw>]:FSIMulator:LOAD 171
[:SOURce]:FSIMulator:DELETE 171
[:SOURce<hw>]:FSIMulator:STORe 171
[:SOURce<hw>]:FSIMulator:COUPle:LOGNormal:CSTD 171
[:SOURce<hw>]:FSIMulator:COUPle:LOGNormal:LCONstant 171
[:SOURce<hw>]:FSIMulator:COUPle:SPEed 172
[:SOURce<hw>]:FSIMulator:CSPeed 172

[:SOURce]:FSIMulator:BYPass:STATe <BypState>

Enables/disables bypassing of the fading simulator if the simulator is deactivated.

Parameters:

<BypState> 1 | ON | 0 | OFF

*RST: 0

[:SOURce<hw>]:FSIMulator:CONFiguration <Configuration>

Selects the fading configuration.

To activate the selected fading configuration, use the command for switching the state.

Parameters:

<Configuration> STANdard | BIRThdeath | MDELay | TCInterferer | HSTRain | CDYNamic

Defines the configuration: Standard delay, birth death propagation, moving propagation, two channel interferer, high-speed train and customized dynamic fading propagation.

*RST: STANdard

Example:

```
SOURce1:FSIMulator:CONFiguration MDELay
SOURce1:FSIMulator:MDELay:STATe ON
```

Selects and activates the moving propagation configuration

Options: BIRThdeath|MDELay|TCInterferer|HSTRain require R&S SMW-K71
CDYNamic requires R&S SMW-K820

Manual operation: See "Configuration" on page 31

[:SOURce<hw>]:FSIMulator:SISO:COPY <CopyToDest>

Parameters:

<CopyToDest> FADB | FADA | FADC | FADD | FADF | FADE | FADG | FADH | ALL

*RST: ALL

Example: `SOURce1:FSIMulator:SISO:COPY ALL`

Options: R&S SMW-K76

Manual operation: See "Copy To / Entity" on page 30

[:SOURce<hw>]:FSIMulator:COPY:DESTination <Destination>

Selects a group whose settings will be overwritten.

Parameters:

<Destination> integer

Range: 1 to 4 (Standard Delay)/ 8 (Fine Delay)
*RST: 2

Example: See `[:SOURce<hw>]:FSIMulator:COPY:SOURce` on page 153

Manual operation: See "To" on page 48

[:SOURce<hw>]:FSIMulator:COPY:EXECute

Copies the settings of a fading path group to the selected one.

Example: See `[:SOURce<hw>]:FSIMulator:COPY:SOURce` on page 153

Usage: Event

Manual operation: See "Copy" on page 48

[:SOURce<hw>]:FSIMulator:COPY:SOURce <Source>

Sets the group whose settings are to be copied.

Parameters:

<Source> integer

Range: 1 to 8
*RST: 1

Example:

```
FSIM:DEL:STAT ON
FSIM:COPY:DEST 4
FSIM:COPY:SOUR 1
FSIM:COPY:EXEC
// copies the settings from group 1 to group 4
```

Manual operation: See "Copy Path Group" on page 47

[:SOURce<hw>]:FSIMulator:FREQuency <Frequency>

- If `[:SOURce<hw>]:FSIMulator:SDEStination` **RF** is selected, queries the estimated RF frequency.
- If `[:SOURce<hw>]:FSIMulator:SDEStination` **BB** is selected, sets the frequency used for the calculation of the Doppler shift.

Parameters:

<Frequency> float

Range: 1E5 to 100E9
Increment: 0.01
*RST: 1E9
Default unit: Hz

Example:

```
SOURce1:FSIMulator:SDEStination RF
SOURce1:FSIMulator:FREQuency?

SOURce1:FSIMulator:SDEStination BB
SOURce1:FSIMulator:FREQuency 2143200000
```

Manual operation: See "Dedicated Frequency" on page 37
See "Virtual RF" on page 37

[:SOURce<hw>]:FSIMulator:CLOCk:RATE?

Queries the clock rate the fading simulator is using for the signal processing.

Return values:

<ClocRate> CR200 | CR100 | CR050 | CR025 | CR250 | CR125 | CR062 | CR500 | CR1G

CR200 = 200 MHz, CR100 = 100 MHz, CR050 = 50 MHz, CR025 = 25 MHz
CR250 = 250 MHz, CR125 = 125 MHz, CR062 = 62.5 MHz, CR500 = 500 MHz, CR1G = 1GHz
The value depends on the selected "System Configuration" and influences the bandwidth of the generated signal.

RST: depends on the installed options
*) CR200M (R&S SMW-B10)/CR250M (R&S SMW-B9)

Usage: Query only

Options: CR250|CR125|CR062|CR500|CR1G require R&S SMW-B9/B15

Manual operation: See "Fading Clock Rate" on page 34

[:SOURce<hw>]:FSIMulator:GLOBal:SEED <Seed>

This command enters the fading start seed. This value is global for the instrument.

Parameters:

<Seed> integer

Range: 0 to 9
*RST: 0

Example: `FSIM:GLOB:SEED 2`
Sets the start seed to 2

Manual operation: See "Start Seed" on page 44

[:SOURce<hw>]:FSIMulator:HOPPing:MODE <Mode>

This is a password-protected function. Unlock the protection level 1 to access it.

Activates frequency hopping and determines how fading is resumed after a frequency hop.

Note: Activate list mode and load the frequency table befor activating frequency hopping.

Parameters:

<Mode> OFF | IBANd | OOBand

OFF
Frequency hopping is deactivated.

IBANd
Activates an in-band frequency hopping.

OOBand
Activates an out of band frequency hopping.

*RST: OFF

Example: `FSIM:HOPP:MODE OFF`

Manual operation: See "Freq. Hopping" on page 38

[:SOURce<hw>]:FSIMulator:IGNore:RFCHanges <RfChanges>

This is a password-protected function. Unlock the protection level 1 to access it.

Sets if frequency changes < 5% are ignored. This enables faster frequency hopping.

Parameters:

<RfChanges> 1 | ON | 0 | OFF

*RST: 0

Example: `FSIM:IGN:RFCH ON`
Ignores frequency changes < 5% for the fading.

Manual operation: See "Ignore RF Changes < 5PCT" on page 37

[:SOURce<hw>]:FSIMulator:ILOSs:CSAMples?

This command queries the share of samples which were clipped due to the insertion loss setting.

Return values:
<CSamples> string

Example: `FSIM:ILOS:CSAM?`
Queries the share of samples which were clipped.
`Response: 11`
11% of the samples were clipped.

Usage: Query only

Manual operation: See "Clipped Samples" on page 43

[:SOURce<hw>]:FSIMulator:ILOSs:MODE <Mode>

This command sets the insertion loss of the fading simulator.

Parameters:
<Mode> NORMal | LACP | USER

NORMal
The minimum insertion loss for a path of the fading simulator is set to a fixed value of 18 dB.

*RST: NORMal

Example: `FSIM:ILOS:MODE USER`
Chooses the user-defined setting for the insertion loss.
`FSIM:ILOS 4 dB`
sets the minimum insertion loss to 4 dB.

Manual operation: See "Insertion Loss Mode" on page 42

[:SOURce<hw>]:FSIMulator:ILOSs[:LOSS] <Loss>

This command sets the user-defined insertion loss of the fading simulator when "User" is selected.

In the "Normal" and "Low ACP" modes, the current setting of the value can be queried.

Parameters:
<Loss> float

Range: -3 to 30
Increment: 0.1
*RST: 0
Default unit: dB

Example: `FSIM:ILOS:MODE USER`
Chooses the user-defined setting for the insertion loss.
`FSIM:ILOS 4 dB`
sets the minimum insertion loss to 4 dB.

Manual operation: See "Insertion Loss" on page 43

[:SOURce<hw>]:FSIMulator:KCONstant <KConstant>

Selects whether to keep the speed or the resulting Doppler shift constant in case of frequency changes.

Parameters:

<KConstant> SPEed | DSHift

*RST: SPEed

Example: `FSIM:KCON SPE`
Keeps the speed constant in case of frequency changes.

Manual operation: See "Keep Constant" on page 47

[:SOURce<hw>]:FSIMulator:PRESet

Sets the default settings (`*RST` values) for fading simulation.

Example: `SOURce1:FSIMulator:PRESet`

Usage: Event

Manual operation: See "Set to Default" on page 30

[:SOURce<hw>]:FSIMulator:RESTart:MODE <Mode>

Selects how a restart of fading simulation is triggered.

Parameters:

<Mode> AUTO | BBTRigger | AAUT

BBTRigger
Restarts the fading process synchronously with received baseband trigger signal.

AAUT
Not supported in the current version.

*RST: AUTO

Manual operation: See " Mode" on page 38

[:SOURce<hw>]:FSIMulator:ROUTe <Route>

Selects on which baseband path the faded signal is output. The input signal of the fader is selected with command `SOURce:BB:ROUTe`.

For one-path instruments this command is query only. It returns value FAA (Fader A always outputs the signal on baseband A).

Note: All MIMO configurations are enabled only in `:SCONfiguration:MODE ADVanced`.

:SCONfiguration:MODE	:SCONfiguration:FADing <FadConfig>	[:SOURce<hw>]:FSIMulator:ROUTe
STANdard	FAAFBNone FAAFBB FAAFBA FABFBB FAABFBN FANFBAB FAABFBAB	FAMAXAB FAAFBB FAAFBA FABFBB FAMAXAB FBMAXAB FAABFBAB
ADVanced	MIMO1X2 MIMO1X3 MIMO1X4 MIMO2X2 MIMO2X3 MIMO2X4 MIMO3X1 MIMO3X2 MIMO3X3 MIMO3X4 MIMO4X1 MIMO4X2 MIMO4X3 MIMO4X4 MIMO1X8 MIMO8X1 MIMO2X8 MIMO8X2 MIMO2X1 MIMO4X8 MIMO8X4	FA1A2BFB1A2BM12 FA1A2BFB1A2BM13 FA1A2BFB1A2BM14 FA1A2BFB1A2B|FA1A2BFB1A2BM22 FA1A2BFB1A2BM23 FA1A2BFB1A2BM24 FA1A2BFB1A2BM31 FA1A2BFB1A2BM32 FA1A2BFB1A2BM33 FA1A2BFB1A2BM34 FA1A2BFB1A2BM41 FA1A2BFB1A2BM42 FA1A2BFB1A2BM43 FA1A2BFB1A2BM44 FA1A2BFB1A2BM18 FA1A2BFB1A2BM81 FA1A2BFB1A2BM28 FA1A2BFB1A2BM82 FA1A2BFB1A2BM21 FA1A2BFB1A2BM48 FA1A2BFB1A2BM84
	MIMO2X1X2 MIMO2X2X1 MIMO2X2X2 MIMO2X1X3 MIMO2X1X4 MIMO2X2X3 MIMO2X3X1 MIMO2X3X2 MIMO2X4X1	FA1A2BFB1A2BM212 FA1A2BFB1A2BM221 FA1A2BFB1A2BM222 FA1A2BFB1A2BM213 FA1A2BFB1A2BM214 FA1A2BFB1A2BM223 FA1A2BFB1A2BM231 FA1A2BFB1A2BM232 FA1A2BFB1A2BM241

:SCONfiguration:MODE	:SCONfiguration:FADing <FadConfig>	[:SOURce<hw>]:FSIMulator:ROUTe
	MIMO3X1X2 MIMO3X2X1 MIMO3X2X2 MIMO4X1X2 MIMO4X2X1 MIMO4X2X2	FA1A2BFB1A2BM312 FA1A2BFB1A2BM321 FA1A2BFB1A2BM322 FA1A2BFB1A2BM412 FA1A2BFB1A2BM421 FA1A2BFB1A2BM422
	SISO3X1X1 SISO4X1X1 SISO5X1X1 SISO6X1X1 SISO7X1X1 SISO8X1X1	FAAFBB311 FAAFBB411 FAAFBB511 FAAFBB611 FAAFBB711 FAAFBB811
	MIMO2X2X4 MIMO2X4X2 MIMO2X4X4 MIMO2X3X3 MIMO2X3X4 MIMO2X4X3	FA1A2BFB1A2BM224 FA1A2BFB1A2BM242 FA1A2BFB1A2BM244 FA1A2BFB1A2BM233 FA1A2BFB1A2BM234 FA1A2BFB1A2BM243
	MIMO8X8	FA1A2BFB1A2BM88

Parameters:

<Route> FAA | FAMAXAB | FAAFBA | FAAFBB | FABFBB | FBMAXAB | FAABFBAB | FA1A2BFB1A2B | FA1A2BFB1A2BM22 | FA1A2BFB1A2BM24 | FA1A2BFB1A2BM42 | FA1A2BFB1A2BM23 | FA1A2BFB1A2BM32 | FA1A2BFB1A2BM12 | FA1A2BFB1A2BM33 | FA1A2BFB1A2BM34 | FA1A2BFB1A2BM43 | FA1A2BFB1A2BM44 | FA1A2BFB1A2BM18 | FA1A2BFB1A2BM81 | FA1A2BFB1A2BM28 | FA1A2BFB1A2BM82 | FA1A2BFB1A2BM21 | FA1A2BFB1A2BM212 | FA1A2BFB1A2BM221 | FA1A2BFB1A2BM222 | FA1A2BFB1A2BM13 | FA1A2BFB1A2BM31 | FA1A2BFB1A2BM14 | FA1A2BFB1A2BM41 | FAMAXA | FA1A2BFB1A2BM224 | FA1A2BFB1A2BM242 | FA1A2BFB1A2BM48 | FA1A2BFB1A2BM84 | FA1A2BFB1A2BM88 | FA1A2BFB1A2BM312 | FA1A2BFB1A2BM321 | FA1A2BFB1A2BM322 | FA1A2BFB1A2BM412 | FA1A2BFB1A2BM421 | FA1A2BFB1A2BM422 | FAAFBB311 | FAAFBB411 | FAAFBB511 | FAAFBB611 | FAAFBB711 | FAAFBB811 | FA1A2BFB1A2BM213 | FA1A2BFB1A2BM214 | FA1A2BFB1A2BM223 | FA1A2BFB1A2BM231 | FA1A2BFB1A2BM232 | FA1A2BFB1A2BM241 |

FA1A2BFB1A2BM244 | FA1A2BFB1A2BM233 | FA1A2BFB1A2BM234 | FA1A2BFB1A2BM243

FAA
The faded modulation signal of fader A is placed on baseband path A.

FAAFBB
The faded modulation signal of fader A is placed on baseband path A and the faded modulation signal of fader B is placed on baseband path B.

FAAFBA
The faded modulation signal of fader A and B is placed on baseband path A.

FABFBB
The faded modulation signal of fader A and B is placed on baseband path B.

FAABFBAB
The faded modulation signal of fader A and B is placed on baseband paths A and B.

FAMAXA
The faded modulation signal of fader A is placed on baseband path A.

FBMAXB
The faded modulation signal of fader B is placed on baseband path B.

FAMAXAB
The faded modulation signal of fader A is placed on baseband paths A and B.

FBMAXAB
The faded modulation signal of fader B is placed on baseband paths A and B.

FA1A2BFB1A2B|FA1A2BFB1A2BM22| ... |FAAFBB811
Sets a MIMO mode

Example:

```
SOURce1:FSIMulator:MIMO:CAPability?
// "M2X2,M2X4,M4X2,M2X3,M3X2,M1X2,..."
SOURce1:FSIMulator:ROUTe FA1A2BFB1A2BM24
// selects a 1x2X4 MIMO configuration
```

Options: See data sheet.

Manual operation: See "Signal Routing" on page 92

[:SOURce]:FSIMulator:SYNChronize:STATe <State>

Couples the fading simulators so that if both blocks are active, a subsequent restart event in any of them causes a simultaneous restart of the other.

Restart event can be caused by a start/stop alternation or a parameter change that results in a signal recalculation and therefore a process restart.

Parameters:

<State> 1 | ON | 0 | OFF

*RST: 0

Example:

```
SOURce1:FSIMulator:STATe 1
SOURce2:FSIMulator:STATe 1
SOURce:FSIMulator:SYNChronize:STATe 1
SOURce1:FSIMulator:STATe 0
SOURce2:FSIMulator:STATe 1
// the fading simulators restart simultaneously
```

Manual operation: See " Synchronization" on page 39

[:SOURce<hw>]:FSIMulator:SDEStination <SDestination>

Defines the frequency to that the signal of the whole Fader block is dedicated.

Parameters:

<SDestination> RF | BB

RF
The Doppler shift is calculated based on the actual RF frequency, that is *dynamically estimated*.
To query the estimated dedicated frequency, use the command `[:SOURce<hw>]:FSIMulator:FREQuency`.
To query the output connector, use the command `[:SOURce<hw>]:FSIMulator:FREQuency:DETect?` on page 161.

BB
Set the fader frequency *manually* by means of the command `[:SOURce<hw>]:FSIMulator:FREQuency`.

*RST: RF

Example: See `[:SOURce<hw>]:FSIMulator:FREQuency` on page 154

Manual operation: See "Signal Dedicated To" on page 34

[:SOURce<hw>]:FSIMulator:FREQuency:DETect?

Queries the output interface the steam used to estimate the dedicated frequency is mapped to.

Return values:

<DetectPrimary> RFA | BBMM1 | RFB | BBMM2 | IQOUT1 | IQOUT2 | FAD1 | FAD2 | FAD4 | FAD3 | DEF

Example:

```
:SOURce1:FSIMulator:FREQ:DETect?
```

Usage: Query only

Manual operation: See "Dedicated Connector" on page 37

[:SOURce<hw>]:FSIMulator:SPEed:UNIT <Unit>

This command chooses the default unit for the parameter speed as displayed in the dialog.

Note: The remote control command changes only the units displayed in the graphical user interface. While configuring the speed via remote control, the speed units must be specified.

Parameters:

<Unit> MPS | KMH | MPH | NMPH

*RST: KMH

Example: `FSIM:SPE:UNIT MPS`

Sets meters per second as the default unit for the speed parameter as displayed in the graphical user interface.

Manual operation: See "Speed Unit" on page 47

[:SOURce<hw>]:FSIMulator:STANdard <Standard>

Selects a predefined fading simulator setting which complies with the test specifications found in the common mobile radio standards.

For a detailed summary of all the default settings, see Chapter A, "Predefined fading settings", on page 243.

Standard/test case	<Predefined_Standard>	Description
-	USER	USER parameter cannot be set. A query returns this value if a user-defined Fading setting was loaded or if one of the associated settings was changed after the selection of a standard
CDMA See Chapter A.1, "CDMA standards", on page 243	CDMA0 | CDMA3 | CDMA8 | CDMA30 | C1DMA30 | CDMA100	CDMA 5 (0 km/h), CDMA6 (3km/h), CDMA1 (8 km/h), CDMA2 (30 km/h), CDMA3 (30 km/h, 1 path), CDMA4 (100km/h)
GSM See Chapter A.2, "GSM standards", on page 246	GTU1P5 | G6TU1P5 | GTU3P6 | G6TU3P6 | GTU3 | G6TU3 | GTU6 | G6TU6 | GTU50 | G6TU50 | G6TU100 | G6TU60	GSM Typical Urban 1.5/3/3.6/6/50/60/100 km/h, 6 and 12 path
	GHT100 | G6HT100 | GHT120 | G6HT120 | GHT200 | G6HT200	GSM Hilly Terrain 100/120 km/h, 6 and 12 path
	GRA130 | GRA250 | GRA300 | GRA500	GSM Rural Area 130/250/300/500 km/h, 6 path
	GET50 | GET60 | GET100	GSM Equal Test 50/60/100 km/h, 6 path
	GTI5	GSM typical case for small cells, 5km/h, 2 path

Standard/test case	<Predefined_Standard>	Description
NADC See Chapter A.3, "NADC standards", on page 251	NADC8 | NADC50 | NADC100	NADC 8/50/100 km/h, 2 path
DCS1800/PCS1900 See Chapter A.4, "PCN standards", on page 252	P6TU1 | PTU1 | P6TU50 | PTU50	Typical Urban 1.5/50 km/h, 6 and 12 path
	P6HT100 | PHT100	Hilly Terrain 100 km/h, 6 and 12 path
	PRA130	Rural Area 130 km/h, 6 path
	PET50 | PET100	Equal Test 50/100 km/h, 6 path
TETRA See Chapter A.5, "TETRA standards", on page 257	TTU | T6TU	TETRA Typical Urban 50km/h, 2 path and 6 path
	TBU	TETRA 2 path
	THT | T6HT	TETRA Hilly Terrain 200 km/h, 2 path and 6 path
	T4ET	TETRA Equal Test 200 km/h, 4 path
	TDR	TETRA Direct Mode Rural Propagation Model 1 path
	TDU	TETRA Mode Urban Propagation Model 1 path
3GPP FDD See Chapter A.6, "3GPP standards", on page 261	G3C1 | G3C2 | G3C3 | G3C4	3GPP FDD Test Case x (BS)
	G3UEC1 | G3UEC2 | G3UEC3 | G3UEC4 | G3UEC5 | G3UEC6	3GPP FDD UE Test Case x (UE)
	G3UEC7SE	3GPP FDD UE Sector (UE)
	G3UEC7BE	3GPP FDD Beam (UE)
	G3UEC8CQ	3GPP FDD CQI (UE)
	G3UEPA3 | G3UEPB3	3GPP FDD Pedestrian A 4 path / B 6 path (UE)
	G3UEVA3 | G3UEVA30 | G3UEVA120	3GPP FDD Vehicular A 6 path (UE)
	G3MBSFN3	3GPP MBSFN
	G3TU3 | G3TU50 | G3TU120	3GPP FDD Typical Urban 20 path
	G3HT120	3GPP FDD Hilly Terrain 20 path
	G3RA120 | G3RA250	3GPP FDD Rural Area 10 path

Standard/test case	<Predefined_Standard>	Description
	BD1	3GPP Birth Death 2 path
Moving Propagation	MD1	3GPP Moving Propagation "Ref. + Moving Channel", 2path
See Chapter A.15, "3GPP/LTE moving propagation", on page 307	MPLTEETU200	3GPP Moving Propagation scenario 1 "ETU200Hz", according to the test case 3GPP TS36.141, annex B4.
	MPLTEPDOPP	3GPP Moving Propagation scenario 2 "AWGN", according to the test case 3GPP TS36.141, annex B4.
3GPP High-Speed Train scenarios	G3HST1OS | G3HST1OSDU	3GPP HST1 "Open space", according to the test case 3GPP TS25.141, annex D.4A and 3GPP TS36.141, annex B.3
See Chapter A.14, "3GPP/LTE high speed train", on page 306	G3HST2TLC | G3HST2TLCDU	3GPP HST2 "Tunnel with leaky cable", according to the test case 3GPP TS25.141, annex D.4A
	G3HST3TMA | G3HST3TMADU	3GPP HST3 "Tunnel for multi-antennas", according to the test case 3GPP TS25.141, annex D.4A and 3GPP TS36.141, annex B.3
SCME/Geo SCME UMi 3kmh/30kmh SCME/Geo SCME UMa 3kmh/30kmh See Chapter A.16, "SCM and SCME channel models for MIMO OTA", on page 309	G3SCMEUMA3 | G3SCMEUMA30 | G3SCMEUMI3 | G3SCMEUMI30 GEOSCMEUMA3|GEOSCMEUMA30|GEOSCMEUMI3|GEOSCMEUMI30	SCME/Geo SCME Urban Micro/Macro-Cell Channel, 3 km/h and 30 km/h
WLAN See Chapter A.7, "WLAN standards", on page 272	HL2A | HL2B | HL2C | HL2D | HL2E	WLAN HyperLan 18 path
DAB See Chapter A.8, "DAB standards", on page 277	DABRA04 | DABRA06	DAB Rural Area 4 and 6 path
	DABTU12 | DABTU06	DAB Typical Urban 12 and 6 path
	DABSFN	DAB Single Frequency Network (in the VHF range) 7 path
WiMAX See Chapter A.9, "WIMAX standards", on page 279	WMITUOIPA | WMITUOIPB | WMITUVA60 | WMITUVA120	Wimax ITU OIP-A, ITU OIP-B, ITU V-A-60, ITU V-A-120

Standard/test case	<Predefined_Standard>	Description
	WMSUI1A360P90 | WMSUI1A360P75 | WMSUI1A030P90 | WMSUI1A030P75	SUI 1 (omi ant. 90/75%), SUI 1 (30 ant. 90/75%)
	WMSUI2A360P90 | WMSUI2A360P75 | WMSUI2A030P90 | WMSUI2A030P75	SUI 2 (omi ant. 90/75%), SUI 2 (30 ant. 90/75%)
	WMSUI3A360P90 | WMSUI3A360P75 | WMSUI3A030P90 | WMSUI3A030P75	SUI 3 (omi ant. 90/75%), SUI 3 (30 ant. 90/75%)
	WMSUI4A360P90 | WMSUI4A360P75 | WMSUI4A030P90 | WMSUI4A030P75	SUI 4 (omi ant. 90/75%), SUI 4 (30 ant. 90/75%)
	WMSUI5A360P90 | WMSUI5A360P75 | WMSUI5A360P50 | WMSUI5A030P90 | WMSUI5A030P75 | WMSUI5A030P50	SUI 5 (omi ant. 90/75/50%), SUI 5 (30 ant. 90/75/50%)
	WMSUI6A360P90 | WMSUI6A360P75 | WMSUI6A360P50 | WMSUI6A030P90 | WMSUI6A030P75 | WMSUI6A030P50 |	SUI 6 (omi ant. 90/75/50%), SUI 6 (30 ant. 90/75/50%)
WiMAX-MIMO See Chapter A.12, "WIMAX-MIMO standards", on page 297	WMITUPB3L | WMITUPB3M | WMI-TUPB3H | WMITUVA60L | WMI-TUVA60M | WMITUVA60H	ITU PB Low/Medium/High, ITU VA Low/Medium/High
LTE See Chapter A.10, "LTE standards", on page 292	LTEEPA1 | LTEEPA5 LTEEVA5 | LTEEVA70 LTEETU1 | LTEETU5 | LTEETU30 | LTEETU70 | LTEETU200 | LTEETU300 | LTEETU600 LTEMBSFN5	LTE EPA 1/5Hz, LTE EVA 5/70Hz, LTE ETU 1/5/30/70/200/300/600Hz LTE MBSFN 5Hz
LTE HST See Chapter A.10.7, "HST 1 500 A/B, HST 3 500 A/B", on page 295	HST1LTE500A | HST3LTE500A | HST1LTE500B | HST3LTE500B	LTE HST 1 500 A/B LTE HST 3 500 A/B

Standard/test case	<Predefined_Standard>	Description
LTE-MIMO See Chapter A.11, "LTE-MIMO standards", on page 295	LMEPA1L | LMEPA1M | LMEPA1H | LMEPA5L | LMEPA5M | LMEPA5H LMEVA5L | LMEVA5M | LMEVA5H | LMEVA70L | LMEVA70M | LMEVA70H LMETU1L | LMETU1M | LMETU1H | LMETU5L | LMETU5M | LMETU5H | LMETU30L | LMETU30M | LMETU30H | LMETU70L | LMETU70M | LMETU70H | LMETU200L | LMETU200M | LMETU200H | LMETU300L | LMETU300M | LMETU300H | LMETU600L | LMETU600M | LMETU600H	LTE EPA 1/5Hz Low/Medium/High, LTE EVA 5/70Hz Low/Medium/High, LTE ETU 1/30/70/300/600Hz Low/Medium/High
1xEVDO See Chapter A.13, "1xevdo standards", on page 302	EVDO1CH1 | EVDO1CH1BC5 | EVDO1CH2 | EVDO1CH2BC5 | EVDO1CH3 | EVDO1CH3BC5 | EVDO1CH4 | EVDO1CH4BC5 | EVDO1CH5 | EVDO1CH5BC5	1xEVDO Chan. 1/2/3/4/5
WATTERSON See Chapter A.17, "Watterson standards", on page 312	WATTI1 | WATTI3 | WATTI2	Watterson I1, I2, I3
802.11n-SISO See Chapter A.18, "802.11n-SISO standards", on page 314	WLANNSMODA | WLANNSMODB | WLANNSMODC | WLANNSMODD | WLANNSMODE | WLANNSMODF	802.11n SISO Model A/B/C/D/E/F
802.11n-MIMO See Chapter A.19, "802.11n-MIMO standards", on page 315	WLANNMODA | WLANNMODB | WLANNMODC | WLANNMODD | WLANNMODE | WLANNMODF	802.11n MIMO Model A/B/C/D/E/F
802.11ac-SISO See Chapter A.21, "802.11ac-SISO standards", on page 335	WLANACSMODA|WLANACSMODB|WLANACSMODC|WLANACSMODD|WLANACSMODE|WLANACSMODF	802.11ac SISO Model A/B/C/D/E/F
802.11ac-MIMO See Chapter A.20, "802.11ac-MIMO standards", on page 325	WLANACMODA | WLANACMODB | WLANACMODC | WLANACMODD | WLANACMODE | WLANACMODF	802.11ac MIMO Model A/B/C/D/E/F
802.11p See Chapter A.22, "802.11p channel models", on page 336	WLANPRURALLOS | WLANPURBANAPPLOS | WLANPURBANCRONLOS | WLANPHIGHWAYNLOS | WLANPHIGHWAYLOS	802.11p Channel models: Rural LOS, Urban Approaching LOS, Urban Crossing NLOS, Highway LOS, Highway NLOS

Standard/test case	<Predefined_Standard>	Description
5G NR See Chapter A.23, "5G NR standards", on page 338.	TDLA30D5L | TDLA30D5M | TDLA30D5MA | TDLA30D5H | TDLA30D10L | TDLA30D10M | TDLA30D10MA | TDLA30D10H | TDLB100D400L | TDLB100D400M | TDLB100D400MA | TDLB100D400H | TDLC300D100L | TDLC300D100M | TDLC300D100MA | TDLC300D100H | TDLA30D75L | TDLA30D75M | TDLA30D75MA | TDLA30D75H | TDLA30D300L | TDLA30D300M | TDLA30D300MA | TDLA30D300H | TDLA30D35L | TDLA30D35M | TDLA30D35MA | TDLA30D35H | TDLC60D300L | TDLC60D300M | TDLC60D300MA | TDLC60D300H TDLA30D10S | TDLA30D35S | TDLA30D75S | TDLA30D300S | TDLB100D400S | TDLC60D300S | TDLC300D100 | STDLC300D400S | TDLC300D600S | TDLC300D600L | TDLC300D600M | TDLC300D600H | TDLC300D1200S | TDLC300D1200L | TDLC300D1200M | TDLC300D1200H FR1CDLAUMA | FR1CDLCUMA | FR1CDLCUMA4 | FR1CDLAUMI | FR1CDLCUMI | FR1CDLCUMI2 | FR2CDLAINO | FR2CDLCUMI | FR1CDLBUMA | FR1CDLBUMI NTNTDLA100D200L| NTNTDLA100D200M| NTNTDLA100D200H| NTNTDLC5D200L| NTNTDLC5D200M| NTNTDLC5D200H	5G New Radio models TDLA30-5/10 Hz, TDLB100-400 Hz, TDLC300-100 Hz, TDLA30-75/300 Hz, TDLA30-35/10 Hz, TDLC60-300/10 Hz Low/ Medium/Medium A/High TDLA30-5/10/35/75/300 Hz, TDLB100-400 Hz, TDLC60-300 Hz, TDLC300-100 Hz SISO, TDLC300-400 Hz SISO, TDLC300-600 Hz SISO, TDLC300-600 Hz Low/ Medium/High, TDLC300-1200 Hz SISO, TDLC300-1200 Hz Low/Medium/High FR1 and FR2 CDL models FR1 NTN TDL models:
5G NR High-Speed Train scenarios See Chapter A.25, "5G NR high speed train", on page 345.	HST1NR35015|HST1NR35030| HST3NR35015|HST3NR35030 HST1NR50015|HST1NR50030| HST3NR50015|HST3NR50030	HST1/HST3 350 km/h 15/30 kHz HST1/HST3 500 km/h 15/30 kHz
5G NR Moving propagation See Chapter A.26, "5G NR moving propagation", on page 346.	MPX15|MPX30 MPY15|MPY30|MPY120 MPZ15|MPZ30 |MPNTNX15|MPNTNX30|	MP X 15/30kHz SCS MP Y 15/30/120kHz SCS MP Z 15/30kHz SCS
5G NR MIMO OTA See Chapter A.24, "5G NR MIMO OTA channel models", on page 343	FR1CDLAUMA|FR1CDLBUMA| FR1CDLCUMA FR1CDLCUMA4 FR1CDLAUMI|FR1CDLBU-MIFR1CDLCUMI FR1CDLCUMI2 FR2CDLAINO|FR2CDLCUMI	FR1 CDL-A/-B/-C UMa 2x2 FR1 CDL-C UMa 4x4 FR1 CDL-A/-B/-C UMi 4x4 FR1 CDL-C UMi 2x2 FR2 CDL-A InO, FR2 CDL-C UMi

Parameters:

<Standard> USER | CDMA8 | CDMA30 | C1DMA30 | CDMA100 | CDMA0 | CDMA3 | G6TU3 | GTU3 | G6TU50 | GTU50 | G6HT100 | GHT100 | GRA250 | GET50 | GET100 | HL2A | HL2B | HL2C | HL2D | HL2E | NADC8 | NADC50 | NADC100 | P6TU1 | PTU1 | P6TU50 | PTU50 | P6HT100 | PHT100 | PRA130 | PET50 | PET100 | TTU | TBU | THT | T4ET | G3C1 | G3C2 | G3C3 | G3C4 | G3UEC4 | G3UEC5 | G3UEC6 | G3UEC7SE | G3UEC7BE | G3UEC8CQ | G3UEPA3 | G3UEPB3 | G3UEVA30 | G3UEVA120 | G3TU3 | G3TU50 | G3TU120 | G3HT120 | G3RA120 | G3RA250 | BD1 | MP1 | DABRA04 | DABRA06 | DABTU12 | DABTU06 | DABSFN | WMSUI1A360P90 | WMSUI1A360P75 | WMSUI1A030P90 | WMSUI1A030P75 | WMSUI2A360P90 | WMSUI2A360P75 | WMSUI2A030P90 | WMSUI2A030P75 | WMSUI3A360P90 | WMSUI3A360P75 | WMSUI3A030P90 | WMSUI3A030P75 | WMSUI4A360P90 | WMSUI4A360P75 | WMSUI4A030P90 | WMSUI4A030P75 | WMSUI5A360P90 | WMSUI5A360P75 | WMSUI5A360P50 | WMSUI5A030P90 | WMSUI5A030P75 | WMSUI5A030P50 | WMSUI6A360P90 | WMSUI6A360P75 | WMSUI6A360P50 | WMSUI6A030P90 | WMSUI6A030P75 | WMSUI6A030P50 | WMITUOIPA | WMITUOIPB | WMITUVA60 | TDU | TDR | WMITUVA120 | GET60 | G6HT120 | G6HT200 | GRA130 | GRA300 | GRA500 | G6TU1P5 | G6TU3P6 | G6TU6 | G6TU60 | G6TU100 | GHT120 | GHT200 | GTU1P5 | GTU3P6 | GTU6 | GTU60 | GTU100 | LMEPA5L | LMEPA5M | LMEPA5H | LMEVA5L | LMEVA5M | LMEVA5H | LMEVA70L | LMEVA70M | LMEVA70H | LMETU70L | LMETU70M | LMETU70H | LMETU300L | LMETU300M | LMETU300H | WMITUPB3L | WMITUPB3M | WMITUPB3H | WMITUVA60L | WMITUVA60M | WMITUVA60H | EVDO1CH1 | EVDO1CH1BC5 | EVDO1CH2 | EVDO1CH2BC5 | EVDO1CH3 | EVDO1CH3BC5 | EVDO1CH4 | EVDO1CH4BC5 | EVDO1CH5 | EVDO1CH5BC5 | G3HST1OS | G3HST2TLC | G3HST3TMA | MPLTEETU200 | MPLTEPDOPP | T6TU | T6HT | LTEEPA5 | LTEEVA5 | LTEEVA70 | LTEETU70 | LTEETU300 | G3UEC1 | G3UEC2 | G3UEC3 | G3UEVA3 | G3MBSFN3 | WATTI1 | WATTI3 | WATTI2 | GTI5 | G3HST1OSDU | G3HST2TLCDU | G3HST3TMADU | LTEMBSFN5 | LTECQI5 | LTEETU30 | LMETU30L | LMETU30M | LMETU30H | WLANNMODA | WLANNMODB | WLANNMODC | WLANNMODD | WLANNMODE | WLANNMODF | WLANACMODA | WLANACMODB | WLANACMODC | WLANACMODD | WLANACMODE | WLANACMODF | WLANNSMODA | WLANNSMODB | WLANNSMODC | WLANNSMODD | WLANNSMODE | WLANNSMODF | WLANACSMODA | WLANACSMODB | WLANACSMODC | WLANACSMODD | WLANACSMODE | WLANACSMODF | G3SCMEUMA3 | G3SCMEUMA30 | G3SCMEUMI3 | G3SCMEUMI30 | WLANPRURALLOS | WLANPURBANAPPLOS | WLANPURBANCRONLOS |

WLANPHIGHWAYNLOS | WLANPHIGHWAYLOS | LTEEPA1 | LTEETU1 | LTEETU600 | LMEPA1L | LMEPA1M | LMEPA1H | LMETU1L | LMETU1M | LMETU1H | LMETU600L | LMETU600M | LMETU600H | GEOSCMEUMA3 | GEOSCMEUMA30 | GEOSCMEUMI3 | GEOSCMEUMI30 | TDLA30D5L | TDLA30D5M | TDLA30D5H | TDLA30D10L | TDLA30D10M | TDLA30D10H | TDLB100D400L | TDLB100D400M | TDLB100D400H | TDLC300D100L | TDLC300D100M | TDLC300D100H | TDLA30D75L | TDLA30D75M | TDLA30D75H | TDLA30D300L | TDLA30D300M | TDLA30D300H | TDLA30D5MA | TDLA30D10MA | TDLB100D400MA | TDLC300D100MA | TDLA30D75MA | TDLA30D300MA | TDLA30D5S | TDLA30D10S | TDLB100D400S | TDLC300D100S | TDLA30D75S | TDLA30D300S | TDLA30D35S | TDLC60D300S | TDLA30D35L | TDLA30D35M | TDLA30D35MA | TDLA30D35H | TDLC60D300L | TDLC60D300M | TDLC60D300MA | TDLC60D300H | HST1NR35015 | HST1NR35030 | HST3NR35015 | HST3NR35030 | MPY15 | MPY30 | FR1CDLAUMA | FR1CDLCUMA | FR1CDLAUMI | FR1CDLCUMI | FR2CDLAINO | FR2CDLCUMI | FR1CDLBUMA | FR1CDLBUMI | HST1NR50015 | HST1NR50030 | HST3NR50015 | HST3NR50030 | HST1LTE500A | HST3LTE500A | HST1LTE500B | HST3LTE500B | LTEETU5 | LTEETU200 | LMETU5L | LMETU5M | LMETU5H | LMETU200L | LMETU200M | LMETU200H | TDLC300D600L | TDLC300D600M | TDLC300D600H | TDLC300D1200L | TDLC300D1200M | TDLC300D1200H | TDLC300D400S | TDLC300D600S | TDLC300D1200S | MPX15 | MPX30 | MPZ15 | MPZ30 | FR1CDLCUMI2 | FR1CDLCUMA4 | MPY120 | MPNTNX15 | MPNTNX30 | NTNTDLA100D200L | NTNTDLA100D200M | NTNTDLA100D200H | NTNTDLC5D200L | NTNTDLC5D200M | NTNTDLC5D200H

*RST: USER

Example: `FSIM:STAN THT`

Manual operation: See "Standard / Test Case" on page 31

Option: see the corresponding section in Chapter A, "Predefined fading settings", on page 243.

[:SOURce<hw>]:FSIMulator:STANdard:REFerence <Reference>

Queries the reference in the standard for the selected test case.

Parameters:

<Reference> string

Example:
```
FSIM:STAN WC1BUP2
// Selects settings in acc. with 3GPP FDD Test Case 1 (2 fading paths)
FSIM:STAN:REF?
// "3GPP TS 25.101 V6.2.0 (2003-09), annex B2.2"
```

Manual operation: See "Standard / Test Case" on page 31

[:SOURce<hw>]:FSIMulator[:STATe] <State>

Activates fading simulation.

Parameters:

<State> 1 | ON | 0 | OFF

*RST: 0

Example: Option:R&S SMW-B14
```
FSIM ON
// Activates fading simulation
```

Example: Option:R&S SMW-B15
```
SCONfiguration:MODE ADV
SCONfiguration:APPLy
FSIM ON
// Activates fading simulation
```

Manual operation: See "State" on page 30
See "State Path" on page 48

[:SOURce]:FSIMulator:CATalog?

Queries the files with settings in the default directory. Listed are files with the file extension `*.fad`.

Return values:

<FileNames> <filename1>,<filename2>,...

Returns a string of filenames separated by commas.

Example:
```
SOURce1:FSIMulator:STORe "/var/user/delay_3gpp"
*RST
SOURce1:FSIMulator:CATalog?
// Birth_3gpp, delay_3gpp, fad_test
SOURce1:FSIMulator:LOAD "/var/user/fad_test"
SOURce1:FSIMulator:STATe 1
SOURce1:FSIMulator:DELETE "Birth_3gpp"
```

Usage: Query only

Manual operation: See "Save/Recall" on page 31

[:SOURce<hw>]:FSIMulator:LOAD <Filename>

Loads the selected file from the default or the specified directory. Loaded are files with extension `*.fad`.

Setting parameters:

<Filename> "<filename>"

Filename or complete file path; file extension can be omitted

Example: See `[:SOURce]:FSIMulator:CATalog?` on page 170.

Usage: Setting only

Manual operation: See "Save/Recall" on page 31

[:SOURce]:FSIMulator:DELETE <Filename>

Deletes the specified file containing a fading setting from the default directory. The default directory is set with the command `MMEM:CDIRectory`. A path can also be specified. Only files with the file ending `*.fad` are deleted.

Note: This command is only valid with DELETE in the long form as DEL is used as short form of header keyword DELay.

Setting parameters:

<Filename> string

Example: See `[:SOURce]:FSIMulator:CATalog?` on page 170

Usage: Setting only

Manual operation: See "Save/Recall" on page 31

[:SOURce<hw>]:FSIMulator:STORe <Filename>

Saves the current settings into the selected file; the file extension (`*.fad`) is assigned automatically.

Setting parameters:

<Filename> "<filename>"

Filename or complete file path

Example: See `[:SOURce]:FSIMulator:CATalog?` on page 170.

Usage: Setting only

Manual operation: See "Save/Recall" on page 31

[:SOURce<hw>]:FSIMulator:COUPle:LOGNormal:CSTD <Cstd>
[:SOURce<hw>]:FSIMulator:COUPle:LOGNormal:LCONstant <LConstant>

(available in "System Configuration > Mode > Standard")

Couples the lognormal fading setting.

Parameters:

<LConstant> 1 | ON | 0 | OFF

*RST: 0

Example:

```
SCONfiguration:MODE STANdard

SOURce1:FSIMulator:CONFiguration STAN
SOURce1:FSIMulator:DEL:GROup1:PATH1:PROFile PDOP
SOURce1:FSIMulator:DEL:GROup1:PATH1:SPEed 1111.111
SOURce1:FSIMulator:STATe 1
SOURce1:FSIMulator:COUPle:SPEed 1
SOURce1:FSIMulator:CSPeed 1

SOURce2:FSIMulator:CONFiguration STAN
SOURce2:FSIMulator:STATe 1
SOURce2:FSIMulator:DEL:GROup1:PATH1:SPEed?
// 1111.111

SOURce1:FSIMulator:COUPle:LOGNormal:LCONstant 1
SOURce1:FSIMulator:COUPle:LOGNormal:CSTD 1
SOURce1:FSIMulator:DEL:GROup1:PATH1:LOGNormal:STATe 1
SOURce1:FSIMulator:DEL:GROup1:PATH1:LOGNormal:LCONstant 150
SOURce2:FSIMulator:DEL:GROup1:PATH1:LOGNormal:LCONstant?
// 150
SOURce1:FSIMulator:DEL:GROup1:PATH1:LOGNormal:CSTD 2
SOURce2:FSIMulator:DEL:GROup1:PATH1:LOGNormal:CSTD?
// 2
```

Manual operation: See "Local Constant Coupled" on page 44

[:SOURce<hw>]:FSIMulator:COUPle:SPEed <Speed>

(available in "System Configuration > Mode > Standard")

Couples the setting for the speed for the paths of both faders.

Parameters:

<Speed> 1 | ON | 0 | OFF

*RST: 0

Example: See `[:SOURce<hw>]:FSIMulator:COUPle:LOGNormal:LCONstant` on page 171

Manual operation: See "Speed Setting Coupled" on page 44

[:SOURce<hw>]:FSIMulator:CSPeed <CSpeed>

Determines whether the same speed is set for all of the activated fading paths.

Parameters:

<CSpeed> 1 | ON | 0 | OFF

*RST: 1

Example: See [:SOURce<hw>]:FSIMulator:COUPle:LOGNormal:LCONstant on page 171

Manual operation: See "Common Speed For All Paths" on page 47

6.2 Delay modes

[:SOURce<hw>]:FSIMulator:MDELay:DEL30:GROup<st>:PATH<ch>:ADELay....................173
[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:ADELay.......................... 173
[:SOURce<hw>]:FSIMulator:MDELay:DEL30:GROup<st>:PATH<ch>:BDELay....................174
[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:BDELay.......................... 174
[:SOURce<hw>]:FSIMulator:MDELay:DEL30:GROup<st>:PATH<ch>:RDELay?..................174
[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:RDELay?........................ 174
[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:CORRelation:COEFficient..175
[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:CORRelation:PHASe........ 176
[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:CORRelation:STATe..........176
[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:CPHase..........................176
[:SOURce<hw>]:FSIMulator:MDELay:DEL30:GROup<st>:PATH<ch>:FDOPpler................. 177
[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:FDOPpler[:RESulting]....... 177
[:SOURce<hw>]:FSIMulator:MDELay:DEL30:GROup<st>:PATH<ch>:FDOPpler:ACTual?.....178
[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:FDOPpler:ACTual?........... 178
[:SOURce<hw>]:FSIMulator:MDELay:DEL30:GROup<st>:PATH<ch>:FRATio.....................179
[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:FRATio........................... 179
[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:FSHift............................. 179
[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:FSPRead........................180
[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:LOGNormal:CSTD............ 180
[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:LOGNormal:LCONstant.....180
[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:LOGNormal:STATe............181
[:SOURce<hw>]:FSIMulator:MDELay:DEL30:GROup<st>:PATH<ch>:LOSS........................181
[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:LOSS............................. 181
[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:PRATio........................... 181
[:SOURce<hw>]:FSIMulator:MDELay:DEL30:GROup<st>:PATH<ch>:PROFile.................... 182
[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:PROFile...........................182
[:SOURce<hw>]:FSIMulator:MDELay:DEL30:GROup<st>:PATH<ch>:SPEed.......................183
[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:SPEed............................ 183
[:SOURce<hw>]:FSIMulator:MDELay:DEL30:GROup<st>:PATH<ch>:STATe....................... 183
[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:STATe..............................183
[:SOURce<hw>]:FSIMulator:DELay|DEL:STATe... 183

[:SOURce<hw>]:FSIMulator:MDELay:DEL30:GROup<st>:PATH<ch>:ADELay <ADelay>
[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:ADELay <ADelay>

Sets the path-specific delay ("Additional Delay") of the selected path.

Parameters:

<ADelay> float

Range: depends on the installed options*
Increment: depends on the installed options*
*RST: 0
*) See Chapter 2.4, "Characteristics of R&S SMW-B14 and R&S SMW-B15", on page 25.

Example:

```
SOURce1:FSIMulator:CONFiguration STAN
SOURce1:FSIMulator:DEL:GROup2:PATH2:STATe 1
SOURce1:FSIMulator:DEL:GROup2:PATH2:ADElay 10E-6
// sets a delay of 10 us for path 2 of the fading group 2
```

Manual operation: See "Additional Delay" on page 51

[:SOURce<hw>]:FSIMulator:MDELay:DEL30:GROup<st>:PATH<ch>:BDELay <BDelay>
[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:BDELay <BDelay>

Sets the basic group delay.

Parameters:

<BDelay> float

Range: depends on the installed options*
Increment: depends on the installed options*
*RST: 0
*) See Chapter 2.4, "Characteristics of R&S SMW-B14 and R&S SMW-B15", on page 25.

Example:

```
SOURce1:FSIMulator:CONFiguration STAN
SOURce1:FSIMulator:DEL:GROup2:PATH2:STATe 1
SOURce1:FSIMulator:DEL:GROup2:PATH2:BDElay 1E-3
// sets a delay of 1 ms for path 2 of the fading group 2
```

Options: R&S SMW-B14

Manual operation: See "Basic Delay" on page 51

[:SOURce<hw>]:FSIMulator:MDELay:DEL30:GROup<st>:PATH<ch>:RDELay?
[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:RDELay?

Queries the resulting delay of the paths for the selected fading configuration. The Resulting Delay is the sum of the Basic Delay (`SOURce:FSIM:...:BDELay`) and the Additional Delay (`SOURce:FSIM:...:ADELay`).

Return values:

<RDelay> float

Sum of the values set with the commands [:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:BDELay and [:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:ADELay.

Range: depends on the installed options*
Increment: 10E-9
*RST: 0

*) See Chapter 2.4, "Characteristics of R&S SMW-B14 and R&S SMW-B15", on page 25.

Example:

```
SOURce1:FSIMulator:CONFiguration STAN
SOURce1:FSIMulator:DEL:GROup2:PATH1:STATe 1
SOURce1:FSIMulator:DEL:GROup2:PATH2:BDELay 2E-4
// sets a delay of 200 us for the fading group 2
SOURce1:FSIMulator:DEL:GROup2:PATH2:ADELay 1E-5
// sets an additonal delay
SOURce1:FSIMulator:DEL:GROup2:PATH2:RDELay?
// 0.00021
```

Usage: Query only

Manual operation: See "Resulting Delay" on page 51

[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:CORRelation:COEFficient <Coefficient>

Determines the magnitude of the complex correlation coefficient. The higher the entered percentage, the greater the correlation of the statistical fading processes for the two paths. Highly correlated ambient conditions for the signal are simulated in this manner.

Sets the correlation coefficient of the correlated path of the second fader also to the entered value.

Parameters:

<Coefficient> float

Range: 0 to 100
Increment: 0.1
*RST: 100
Default unit: PCT

Example:

`FSIM:DEL:STAT ON`

Activates the "Standard Delay" fading configuration.

`FSIM:DEL:GRO2:PATH:CORR:STAT ON`

switches on the correlation of fading path 1 of group 2 of fader A to fading path 1 of group 2 of fader B.

`FSIM:DEL:GRO2:PATH:CORR:COEF 95`

specifies a correlation coefficient of 95% for the two paths.

Manual operation: See "Correlation Coefficient" on page 55

**[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:CORRelation:
PHASe** <Phase>

Determines the phase of the complex correlation coefficient.

Sets the phase of the correlation coefficient of the correlated path of the second fader also to the entered value.

Parameters:

<Phase> float

Range: 0 to 359.9
Increment: 0.05
*RST: 0
Default unit: DEG

Example:

`FSIM:DEL:STAT ON`
Activates the "Standard Delay" fading configuration.
`FSIM:DEL:GRO2:PATH:CORR:STAT ON`
switches on the correlation of fading path 1 of group 2 of fader A to fading path 1 of group 2 of fader B.
`FSIM:DEL:GRO2:PATH:CORR:PHAS 5`
specifies a phase of the correlation coefficient equal to 5 DEG for the two paths.

Manual operation: See "Correlation Coefficient Phase" on page 55

**[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:CORRelation:
STATe** <State>

Enables correlation of the paths of the first fader. The suffix in `SOURce` defines the fader on which path settings the correlation is based.

When correlation is activated, the settings of the correlation parameters, the profile, the speed and the lognormal parameters are the same for both paths.

Parameters:

<State> 1 | ON | 0 | OFF

*RST: 0

Example:

`SOURce1:FSIMulator:DELay:STATe ON`
`SOURce1:FSIMulator:DELay:GROup2:PATH1:`
`CORRelation:STATe ON`
Enables correlation of fading path 1 of group 2 of fader A to fading path 1 of group 2 of fader B.

Manual operation: See "Correlation Path" on page 54

[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:CPHase
<CPhase>

Sets the start phase rotation.

Parameters:

<CPhase> float

Range: 0 to 359.9
Increment: 0.1
*RST: 0
Default unit: DEG

Example:

```
FSIM:DEL:STAT ON
```
Activates the Standard Delay fading configuration.
```
FSIM:DEL:GRO1:PATH1:PROF RICE
```
selects the Rice fading profile for fading path 1 of group 1.
```
FSIM:DEL:GRO1:PATH:CPH 5DEG
```
sets a start phase rotation of 5 DEG for fading path 1 of group 2.
The path is multiplied by this phase.

Manual operation: See "Const. Phase" on page 52
See "Start Phase" on page 52

[:SOURce<hw>]:FSIMulator:MDELay:DEL30:GROup<st>:PATH<ch>:FDOPpler <FDoppler>
[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:FDOPpler[:RESulting] <FDoppler>

Queries the resulting Doppler frequency for the fading configuration.

The Doppler frequency is determined by the selected speed (`[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:SPEed`).

For the Pure Doppler and Rice Fading profiles, the actual Doppler shift is a function of the selected ratio of the Doppler shift to the Doppler frequency (`[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:FRATio`). Use the command `[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:FDOPpler:ACTual?` to query the actual Doppler shift.

Parameters:

<FDoppler> float

Range: 0 to max*
Increment: 0.01
*RST: 0
Default unit: Hz
*) Option:
R&S SMW-B14 max = 4000
R&S SMW-B15 max deppends on the System Configuration LxMxN and profile as follows:
Lx1x1 with L = 1 to 8: max = 4000
1x2x2/2x2x2/2x2x1/2x1x2/3x2x2/4x2x2/1x2x4/1x4x2: max = 4000
1x2x8/1x8x2/1x4x4/2x4x4/2x2x4: max = 2000
1x8x4/1x4x8/2x4x4: max = 600
1x8x8 (subset 1 or 2): max = 300 (R&S SMW-K821)
1x8x8 (all absets): max = 150 (R&S SMW-B15/K75)
`[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:PROFile` `BELLindoor|BELVehicle`: max = 50

Example:

```
SOURce1:FSIMulator:CONFiguration STAN
SOURce1:FSIMulator:DEL:GROup1:PATH1:PROFile RICE
SOURce1:FSIMulator:DEL:GROup1:PATH1:FRATio 1
SOURce1:FSIMulator:DEL:GROup1:PATH1:FDOPpler:RESulting?
// Response:  2.77968967451476
// set a frequency ratio for the first fading path of group 1.
// I.e. set an angle of incidence of about 45° with respect to
// a receiver that is going away from the transmitter
SOURce1:FSIMulator:DEL:GROup1:PATH1:FRATio -0.71
SOURce1:FSIMulator:DEL:GROup1:PATH1:FDOPpler:RESulting?
// Response:  2.77968967451476
SOURce1:FSIMulator:DELay:GROup1:PATH1:FDOPpler:ACTual?
// Response:  -1.97
```

Manual operation: See "Resulting Doppler Shift" on page 53

[:SOURce<hw>]:FSIMulator:MDELay:DEL30:GROup<st>:PATH<ch>:FDOPpler:ACTual?
[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:FDOPpler:ACTual?

Queries the actual Doppler shift.

For the Pure Doppler and Rice Fading profiles, the actual Doppler shift is a function of the selected ratio of the Doppler shift to the Doppler frequency (`[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:FRATio`).

Return values:

<ActDoppler> float

Range: -4000.0 to 4000
Increment: 0.01
*RST: 0

Example: See [:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:FDOPpler[:RESulting] on page 177

Usage: Query only

Manual operation: See "Actual Doppler Shift" on page 54

[:SOURce<hw>]:FSIMulator:MDELay:DEL30:GROup<st>:PATH<ch>:FRATio <FRatio>
[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:FRATio <FRatio>

For Rice, pure Doppler and Gauss Doppler fading, sets the ratio of the actual Doppler frequency to the set Doppler frequency. The Frequency Ratio serves as a measure of the angle of incidence between the transmitter and receiver.

Parameters:

<FRatio> float

Range: -1 to 1
Increment: 0.0001
*RST: 0

Example: See [:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:FDOPpler[:RESulting] on page 177

Manual operation: See "Frequency Ratio" on page 53

[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:FSHift <FShift>

Sets the frequency shift for the Gauss Watterson fading.

Parameters:

<FShift> float

Range: -10 to 10
Increment: 0.0001
*RST: 0

Example:

```
FSIM:DEL:GRO:PATH2:PROF WATT
FSIM:DEL:GRO:PATH2:FS?
```

Manual operation: See "Frequency Shift" on page 52

[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:FSPRead <FSpread>

Sets the frequency spread for the Gauss Watterson fading.

Parameters:

<FSpread> float

Range: 1E-4 to 30
Increment: 1E-4
*RST: 0.1

Example:
```
FSIM:DEL:GRO:PATH2:PROF WATT
FSIM:DEL:GRO:PATH2:FSPR?
```

Manual operation: See "Frequency Spread" on page 51

[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:LOGNormal:CSTD <Cstd>

Sets the standard deviation for lognormal fading.

Parameters:

<Cstd> integer

Range: 0 to 12
*RST: 0
Default unit: dB

Example:
`FSIM:DEL:STAT ON`
Activates the `Standard Delay` fading configuration.
`FSIM:DEL:GRO:PATH2:LOGN:STAT ON`
selects lognormal fading for fading path 2 of group 1.
`FSIM:DEL:GRO:PATH2:LOGN:CSTD 2`
sets a standard deviation of 2 dB for fading path 2 of group 1.

Manual operation: See "Standard Deviation " on page 56

[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:LOGNormal:LCONstant <LConstant>

Sets the Local Constant for lognormal fading.

Parameters:

<LConstant> float

Range: 0 to 200
Increment: 0.1
*RST: 100
Default unit: m

Example: `FSIM:DEL:STAT ON`
Activates the Standard Delay fading configuration.
`FSIM:DEL:GRO:PATH2:LOGN:STAT ON`
selects lognormal fading for fading path 2 of group 1.
`FSIM:DEL:GRO:PATH2:LOGN:LCON 100`
sets a Local Constant of 100 m for the second fading path of group 1.

Manual operation: See "Local Constant" on page 55

[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:LOGNormal:STATe <State>

Enables/ disables a lognormal fading.

Parameters:
<State> 1 | ON | 0 | OFF
*RST: 0

Example: `FSIM:DEL:STAT ON`
Activates the "Standard Delay" fading configuration.
`FSIM:DEL:GRO:PATH2:LOGN:STAT ON`
activates lognormal fading for fading path 2 of group 1.

Manual operation: See "Lognormal State" on page 55

[:SOURce<hw>]:FSIMulator:MDELay:DEL30:GROup<st>:PATH<ch>:LOSS <Loss>
[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:LOSS <Loss>

Sets the loss of the paths.

Parameters:
<Loss> float
Range: 0 to 50
Increment: 0.001
*RST: 10|0
Default unit: dB

Example: `FSIM:DEL:STAT ON`
Activates the "Standard Delay" fading configuration.
`FSIM:DEL:GRO:PATH2:LOSS 2 dB`
sets a loss of 2 dB for fading path 2 of group 1.

Manual operation: See "Path Loss" on page 50

[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:PRATio <PRatio>

Sets the power ratio of the discrete and distributed components for Rice fading (`:SOURce:FSIMulator:DELay:GROup:PATH2:PROFile RICE`).

Parameters:

<PRatio> float

Range: -30 to 30
Increment: 0.01
*RST: 0
Default unit: dB

Example:
`FSIM:DEL:STAT ON`
Activates the "Standard Delay" fading configuration.
`FSIM:DEL:GRO:PATH2:PROF RICE`
sets the Rice fading profile for fading path 2 of group 1.
`FSIM:DEL:GRO:PATH2:PRAT -15`
sets a power ratio of –15 dB. The distributed (Rayleigh) component prevails. The total power of the two components remains constant.

Manual operation: See "Power Ratio" on page 51

[:SOURce<hw>]:FSIMulator:MDELay:DEL30:GROup<st>:PATH<ch>:PROFile <Profile>

[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:PROFile <Profile>

Selects the fading profile for the paths.

Parameters:

<Profile> SPATh | RAYLeigh | PDOPpler | RICE | CPHase | OGAUs | TGAUs | DGAUs | WDOPpler | WRICe | GDOPpler | GFD8 | GFD1 | WATTerson | CUSTom | SCM | BELLindoor | BELVehicle

SPAT
static transmission path

PDOPpler | RAYLeigh | RICE | CUSTom | SCM
pure Doppler | Rayleigh | Rice | Custom | SCM

CPHase
constant phase

OGAUs | TGAUs | DGAUs | GDOPpler | GFD8 | GFD1
GAUS1 | GAUS2 | GAUSDAB | Gauss Doppler | Gauss (0.08 f_d) | Gauss (0.01 f_d)

WATTerson
Gauss (Watterson)

WDOPpler | WRICe
WiMAX Doppler | WiMAX Rice

BELLindoor|BELVehicle
Bell Shape tgn Indoor, Bell Shape tgn Moving Vehicle

*RST: RAYLeigh

Options:
OGAUs|TGAUs|DGAUs|GDOPpler|GFD8|GFD1|WATTerson|WDOPpler|WRICe require R&S SMW-K72
SCM require R&S SMW-K73
CUSTom require R&S SMW-K820

Manual operation: See "Profile" on page 49

[:SOURce<hw>]:FSIMulator:MDELay:DEL30:GROup<st>:PATH<ch>:SPEed <Speed>
[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:SPEed <Speed>

Sets the speed v of the moving receiver.

Parameters:

<Speed> float

Range: 0 to dynamic
Increment: 0.001
*RST: 0.83333

Example:
`FSIM:DEL:STAT ON`
Activates the "Standard Delay" fading configuration.
`FSIM:DEL:GRO:PATH2:SPE 2MPS`
sets a speed of 2 m/s for the moving receiver for fading path 2 of group 1.

Manual operation: See "Speed" on page 52

[:SOURce<hw>]:FSIMulator:MDELay:DEL30:GROup<st>:PATH<ch>:STATe <State>
[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:STATe <State>

Activates the selected path.

Parameters:

<State> 1 | ON | 0 | OFF

*RST: 0

Example:
`FSIM:DEL:STAT ON`
Activates the "Standard Delay" fading configuration.
`FSIM:DEL:GRO:PATH2:STAT ON`
Activates fading path 2 in group 1.

Manual operation: See "State Path" on page 48

[:SOURce<hw>]:FSIMulator:DELay|DEL:STATe <State>

Activates the fading configurations.

Note: Changing the configuration will cause an interruption in the fading process, followed by a restart after about one second.

Parameters:

<State> 1 | ON | 0 | OFF

*RST: 0

Example:
`FSIM:DEL:STAT ON`
Activates the "Standard Delay" fading configuration for fader A and switches on fading for path A.

6.3 Birth death

Option: R&S SMW-K71

[:SOURce<hw>]:FSIMulator:BIRThdeath:DELay:GRID..184
[:SOURce<hw>]:FSIMulator:BIRThdeath:DELay:MINimum..184
[:SOURce<hw>]:FSIMulator:BIRThdeath:DELay:MAXimum?...184
[:SOURce<hw>]:FSIMulator:BIRThdeath:HOPPing:DWELl...185
[:SOURce<hw>]:FSIMulator:BIRThdeath:PATH<ch>:LOSS..185
[:SOURce<hw>]:FSIMulator:BIRThdeath:PATH<ch>:PROFile...185
[:SOURce<hw>]:FSIMulator:BIRThdeath:POSitions...186
[:SOURce<hw>]:FSIMulator:BIRThdeath:SOFFset..186
[:SOURce<hw>]:FSIMulator:BIRThdeath:SPEed...186
[:SOURce<hw>]:FSIMulator:BIRThdeath:FRATio...187
[:SOURce<hw>]:FSIMulator:BIRThdeath:PATH<ch>:FDOPpler?......................................187
[:SOURce<hw>]:FSIMulator:BIRThdeath:PATH<ch>:FDOPpler:ACTual?............................188
[:SOURce<hw>]:FSIMulator:BIRThdeath:STATe...188

[:SOURce<hw>]:FSIMulator:BIRThdeath:DELay:GRID <Grid>

Sets the delay grid for both paths with birth death propagation fading.

Parameters:

<Grid> float

Range: 1E-9 to dynamic
Increment: 1E-9
*RST: 1E-6

Example: `FSIM:BIRT:DEL:GRID 0.00001`
Sets a delay grid of 10 us.

Manual operation: See "Delay Grid" on page 60

[:SOURce<hw>]:FSIMulator:BIRThdeath:DELay:MINimum <Minimum>
[:SOURce<hw>]:FSIMulator:BIRThdeath:DELay:MAXimum?

Queries the minimum/maximum delay for both paths with birth death propagation fading.

Return values:

<Maximum> float

Range: 0 to max

Example: `FSIM:BIRT:DEL:MIN 0.000012`
Sets a minimum delay of 12 us.
`FSIM:BIRT:DEL:GRID 0.000002`
sets a delay grid of 2 us.
`FSIM:BIRT:POS 9`
sets 9 possible hop positions.
`FSIM:BIRT:DEL:MAX?`
queries the maximum delay.
`Response: 0.000028`
the maximum delay is 28 us. The delay range lies between +12 and +28 us. There are 9 hop positions on a 2 us grid available.

Usage: Query only

Manual operation: See "Maximum Delay" on page 61

[:SOURce<hw>]:FSIMulator:BIRThdeath:HOPPing:DWELl <Dwell>

Sets the time until the next change in the delay of a path (birth death event).

Parameters:

<Dwell> float

Range: 1E-3 to 429.49672950
Increment: 100E-9
*RST: 191E-3

Example: `FSIM:BIRT:HOPP:DWEL 210 ms`
Sets a dwell time of 210 ms until the next change in the delay of a fading path.

Manual operation: See "Hopping Dwell" on page 61

[:SOURce<hw>]:FSIMulator:BIRThdeath:PATH<ch>:LOSS <Loss>

Sets the loss of the paths with birth death propagation.

Parameters:

<Loss> float

Range: 0 to 50
Increment: 0.001
*RST: 0
Default unit: dB

Example: `FSIM:BIRT:PATH2:LOSS 4 dB`
Sets a loss of 4 dB for the second fading path.

Manual operation: See "Path Loss" on page 60

[:SOURce<hw>]:FSIMulator:BIRThdeath:PATH<ch>:PROFile <Profile>

This command queries the fading profile. In birth death propagation, the pure Doppler profile is used.

Parameters:

<Profile> PDOPpler

*RST: PDOPpler

Example: `FSIM:BIRT:PATH2:PROF?`

Queries the profile of the second fading path.

Manual operation: See "Profile" on page 60

[:SOURce<hw>]:FSIMulator:BIRThdeath:POSitions <Positions>

Sets the number of possible hop positions in the delay range.

0 us < (`...:BIRT:POS` – 1) x `...:DEL:GRID` + `...:DEL:MIN` < 40 us

Parameters:

<Positions> integer

Range: 3 to 50

*RST: 11

Example: `FSIM:BIRT:POS 11`

Sets 11 possible delay positions.

Manual operation: See "Positions" on page 60

[:SOURce<hw>]:FSIMulator:BIRThdeath:SOFFset <Soffset>

Sets the time until the start of the next birth death event. With dual-channel fading, this allows the user to intentionally displace the birth death events of the two faders with respect to one another.

Parameters:

<Soffset> float

Range: 0 to 429

Increment: 100E-9

*RST: 0

Example: `FSIM:BIRT:SOFF 21E-6`

Sets a start offset of 21 us.

Manual operation: See "Start Offset" on page 61

[:SOURce<hw>]:FSIMulator:BIRThdeath:SPEed <Speed>

Sets the speed of the moving receiver for birth death propagation.

The default speed unit is m/s. Units different than the default one must be specified.

Parameters:
<Speed> float

Range: 0 to dynamic
Increment: 0.001
*RST: 0
Default unit: m/s

Example:
```
SOURce1:FSIMulator:BIRThdeath:SPEed 100 KMH
SOURce1:FSIMulator:BIRThdeath:PATH1:FDOPpler?
// 92.6574343641427
SOURce1:FSIMulator:BIRThdeath:FRATio 1
SOURce1:FSIMulator:BIRThdeath:PATH1:FDOPpler:ACTual?
// 92.66
SOURce1:FSIMulator:BIRThdeath:FRATio 0.5
SOURce1:FSIMulator:BIRThdeath:PATH1:FDOPpler:ACTual?
// 46.33
```

Manual operation: See "Speed" on page 62

[:SOURce<hw>]:FSIMulator:BIRThdeath:FRATio <FRatio>

Sets the ratio of the actual Doppler frequency to the set Doppler frequency with birth death propagation fading.

Parameters:
<FRatio> float

Range: -1 to 1
Increment: 0.0001
*RST: 1

Example: See [:SOURce<hw>]:FSIMulator:BIRThdeath:SPEed on page 186

Manual operation: See "Frequency Ratio" on page 62

[:SOURce<hw>]:FSIMulator:BIRThdeath:PATH<ch>:FDOPpler?

Queries the resulting Doppler frequency with birth death propagation.

Return values:
<FDoppler> float

Range: 0 to 1000
Increment: 0.01
*RST: 0

Example: See [:SOURce<hw>]:FSIMulator:BIRThdeath:SPEed on page 186

Usage: Query only

Manual operation: See "Resulting Doppler Shift" on page 62

[:SOURce<hw>]:FSIMulator:BIRThdeath:PATH<ch>:FDOPpler:ACTual?

Queries the actuial Doppler frequency.

Return values:

<ActDoppler>	float Range: -1600 to 1600 Increment: 0.01 *RST: 0
Example:	See `[:SOURce<hw>]:FSIMulator:BIRThdeath:SPEed` on page 186
Usage:	Query only
Manual operation:	See "Actual Doppler Shift" on page 63

[:SOURce<hw>]:FSIMulator:BIRThdeath:STATe <State>

This command selects the birth death propagation fading configuration and switches the fading simulation on and off.

Parameters:

<State>	1 | ON | 0 | OFF *RST: 0
Example:	`SOUR2:FSIM:BIRT:STAT ON` Selects birth death propagation for fader B and switches on fading in path B.
Manual operation:	See "Configuration" on page 31

6.4 High-speed train

Option: R&S SMW-K71.

Example: Enabling and configuring a high-speed train propagation

The following is an example of how to configure the settings without using a predefined standard.

```
SOURce1:FSIMulator:CONFiguration HSTRain
SOURce1:FSIMulator:HSTRain:PROFile PDOPpler
SOURce1:FSIMulator:HSTRain:SPEed 100kmh
SOURce1:FSIMulator:HSTRain:FDOPpler?
// Response in Hz: "92.657"
SOURce1:FSIMulator:HSTRain:DISTance:MINimum 20m
SOURce1:FSIMulator:HSTRain:DISTance:STARt 2000m
SOURce1:FSIMulator:HSTRain:PATH:STATe ON
SOURce1:FSIMulator:HSTRain:STATe ON
```

Example: Querying doppler shifts for high-speed train profiles

The following is an example of how to configure the settings without using a predefined standard.

```
SOURce1:FSIMulator:CONFiguration HSTRain
// Set static path profile.
SOURce1:FSIMulator:HSTRain:PROFile SPATh
SOURce1:FSIMulator:HSTRain:SPEed 4300kmh
SOURce1:FSIMulator:HSTRain:SPEed?
// Response in m/s: "1199.17"
SOURce1:FSIMulator:HSTRain:FDOPpler?
// Response in Hz: "4000"

// Set pure Doppler profile.
SOURce1:FSIMulator:HSTRain:PROFile PDOPpler
SOURce1:FSIMulator:HSTRain:SPEed 205058kmh
SOURce1:FSIMulator:HSTRain:SPEed?
// Response in m/s: "56960.567"
SOURce1:FSIMulator:HSTRain:FDOPpler?
// Response in Hz: "190000"
Pure Doppler profile offers Doppler shifts of up to 190 kHz.
```

Example: Configuring a high-speed train scenario for BS tests

The following is an example of how to configure fading simulator to generate an HST BS test signal according to 3GPP TS36.104.

For frequency Band 1 tests, the specification defines:

F_{DL} = 2.14 GHz, F_{UL} = 1.95 GHz and F_D = 1140 Hz

```
SOURce1:FSIMulator:PRESet
SOURce1:FSIMulator:STANdard G3HST1OSDU
SOURce1:FREQuency:CW 1.95E9
SOURce1:FSIMulator:HSTRain:DOWNlink:FREQuency:STATe ON
SOURce1:FSIMulator:HSTRain:DOWNlink:FREQuency 2.14E9
SOURce1:FSIMulator:HSTRain:SOFFSet 0
SOURce1:FSIMulator:HSTRain:PATH:STATe ON
SOURce1:FSIMulator:HSTRain:STATe ON
SOURce1:FSIMulator:HSTRain:FDOPpler?
// Response in Hz: 1136.893
```

Commands

[:SOURce<hw>]:FSIMulator:HSTRain:DISTance:MINimum.. 190
[:SOURce<hw>]:FSIMulator:HSTRain:DISTance:STARt.. 190
[:SOURce<hw>]:FSIMulator:HSTRain:SPEed... 190
[:SOURce<hw>]:FSIMulator:HSTRain:FDOPpler?... 191
[:SOURce<hw>]:FSIMulator:HSTRain:PATH:STATe... 191
[:SOURce<hw>]:FSIMulator:HSTRain:PROFile... 191
[:SOURce<hw>]:FSIMulator:HSTRain:KFACtor... 191
[:SOURce<hw>]:FSIMulator:HSTRain:DOWNlink:FREQuency:STATe................................ 192

[:SOURce<hw>]:FSIMulator:HSTRain:DOWNlink:FREQuency..192
[:SOURce<hw>]:FSIMulator:HSTRain:SOFFset.. 192
[:SOURce<hw>]:FSIMulator:HSTRain:STATe...193

[:SOURce<hw>]:FSIMulator:HSTRain:DISTance:MINimum <Minimum>

Sets the parameter D_{min}, i.e. the distance between the BS and the railway track.

Parameters:

<Minimum> float

Range: 1 to 100
Increment: 0.1
*RST: 2

Example: See Example"Enabling and configuring a high-speed train propagation" on page 188

Manual operation: See "D (min)" on page 86

[:SOURce<hw>]:FSIMulator:HSTRain:DISTance:STARt <Start>

Sets the parameter D_S, i.e. the initial distance D_S/2 between the train and the BS at the beginning of the simulation.

Parameters:

<Start> integer

Range: 20 to 2000
*RST: 300

Example: See Example"Enabling and configuring a high-speed train propagation" on page 188

Manual operation: See "D (S)" on page 86

[:SOURce<hw>]:FSIMulator:HSTRain:SPEed <Speed>

Sets the velocity parameter , i.e. the speed of the moving receiver in m/s.

Parameters:

<Speed> float

Range: 0.001 to depends on settings
Increment: 0.001
*RST: 83.333

Example: See Example"Enabling and configuring a high-speed train propagation" on page 188.

Example: See Example"Querying doppler shifts for high-speed train profiles" on page 189.

Manual operation: See "Speed" on page 86

[:SOURce<hw>]:FSIMulator:HSTRain:FDOPpler?

Queries the maximum Doppler Shift for the selected configuration.

Return values:

<FDoppler> float

Range: 0 to depends on settings
Increment: 0.01
*RST: 0

Example: See Example"Querying doppler shifts for high-speed train profiles" on page 189.

Usage: Query only

[:SOURce<hw>]:FSIMulator:HSTRain:PATH:STATe <State>

Activates/deactivates the selected path for the High Speed Train fading configurations.

Parameters:

<State> 1 | ON | 0 | OFF

*RST: 1

Example: See Example"Enabling and configuring a high-speed train propagation" on page 188

Manual operation: See "State Path" on page 48

[:SOURce<hw>]:FSIMulator:HSTRain:PROFile <Profile>

Determines the fading profile for the selected scenario. The fading profile determines which transmission path is simulated.

Parameters:

<Profile> SPATh | PDOPpler | RAYLeigh

*RST: PDOPpler

Example: See Example"Enabling and configuring a high-speed train propagation" on page 188

Manual operation: See "Profile" on page 85

[:SOURce<hw>]:FSIMulator:HSTRain:KFACtor <KFactor>

Sets the Rician factor K for high speed train scenario 2.

Parameters:

<KFactor> float

Range: -30 to 30
Increment: 0.01
*RST: 10

Example:
```
SOURce1:FSIMulator:PRESet
SOURce1:FSIMulator:STANdard G3HST2TLC
SOURce1:FSIMulator:HSTRain:KFACtor 10
```

Manual operation: See "K (Rician factor)" on page 86

[:SOURce<hw>]:FSIMulator:HSTRain:DOWNlink:FREQuency:STATe <HstDlFreqState>

Enables the definition of virtual downlink frequency.

Parameters:

<HstDlFreqState> 1 | ON | 0 | OFF

*RST: 0

Example: See Example"Configuring a high-speed train scenario for BS tests" on page 189

Manual operation: See "Consider DL RF" on page 86

[:SOURce<hw>]:FSIMulator:HSTRain:DOWNlink:FREQuency <HstDlFreq>

Sets the virtual downlink frequency, necessary to calculate the UL Doppler shift.

Parameters:

<HstDlFreq> float

Range: 100E3 to 6E9
Increment: 0.01
*RST: 1E9

Example: See Example"Configuring a high-speed train scenario for BS tests" on page 189

Manual operation: See "Virtual DL RF" on page 87

[:SOURce<hw>]:FSIMulator:HSTRain:SOFFset <StartOffset>

Shifts the high speed train profile in time.

The maximum possible shift is calculated as max = $2*D_S/v$,where:

- D_S is the distance in meters between the train and the BS at the beginning of the simulation
- v is the velocity of the train in m/s

Parameters:

<StartOffset> float

Range: 0 to 429.49672950
Increment: 100E-9
*RST: 0

Example: See Example"Configuring a high-speed train scenario for BS tests" on page 189.

Manual operation: See "Start Offset" on page 87

[:SOURce<hw>]:FSIMulator:HSTRain:STATe <State>

Activates/deactivates simulation of High Speed Train propagation according to the selected scenario 1 or 3.

Parameters:

<State> 1 | ON | 0 | OFF

*RST: 0

Example: See Example"Enabling and configuring a high-speed train propagation" on page 188

Manual operation: See "Configuration" on page 31
See "State" on page 85

6.5 Moving propagation

Option: R&S SMW-K71.

[:SOURce<hw>]:FSIMulator:MDELay:ALL:MOVing:VPERiod....................193
[:SOURce<hw>]:FSIMulator:MDELay:ALL:MOVing:DELay:VARiation....................194
[:SOURce<hw>]:FSIMulator:MDELay:CHANnel:MODE....................194
[:SOURce<hw>]:FSIMulator:MDELay:DEL30:GROup<st>:PATH<ch>:CPHase....................195
[:SOURce<hw>]:FSIMulator:MDELay:MOVing:DELay:MEAN....................195
[:SOURce<hw>]:FSIMulator:MDELay:MOVing:DELay:VARiation....................195
[:SOURce<hw>]:FSIMulator:MDELay:MOVing:LOSS....................196
[:SOURce<hw>]:FSIMulator:MDELay:MOVing:STATe....................196
[:SOURce<hw>]:FSIMulator:MDELay:MOVing:VPERiod....................196
[:SOURce<hw>]:FSIMulator:MDELay:REFerence:DELay....................197
[:SOURce<hw>]:FSIMulator:MDELay:REFerence:LOSS....................197
[:SOURce<hw>]:FSIMulator:MDELay:REFerence:STATe....................197
[:SOURce<hw>]:FSIMulator:MDELay:STATe....................198

[:SOURce<hw>]:FSIMulator:MDELay:ALL:MOVing:VPERiod <VPeriod>

Sets the speed of the delay variation of the moving fading paths for moving propagation with all moving channels. A complete cycle comprises one pass through this "Variation Period".

Parameters:

<VPeriod> float

Range: 5 to 200
Increment: 0.1
*RST: 25

Example: `FSIM:CONF MDEL`
Selects a moving propagation configuration.
`FSIM:MDEL:CHAN:MODE ALL`
enables all moving channels.
`FSIM:MDEL:STAT ON`
activates the moving propagation for fader A.
`FSIM:MDEL:ALL:MOV:VPER 50 s`
sets the period for the delay variation to 100 s.

Manual operation: See "Variation Period" on page 71

[:SOURce<hw>]:FSIMulator:MDELay:ALL:MOVing:DELay:VARiation <Variation>

This command enters the range for the delay of the moving fading paths for moving propagation with all moving channels. The delay of the moving path slowly varies sinusoidally within this range.

Parameters:

<Variation> float

Range: 0.3E-6 to 10E-6
Increment: 10E-9
*RST: 5E-6

Example: `FSIM:CONF MDEL`
Selects a moving propagation configuration.
`FSIM:MDEL:CHAN:MODE ALL`
enables all moving channels.
`FSIM:MDEL:STAT ON`
activates the moving propagation for fader A.
`FSIM:MDEL:ALL:MOV:DEL:VAR 1E-5`
sets the range 10 us for the delay of the moving fading path.

Manual operation: See "Delay Variation (Peak-Peak)" on page 71

[:SOURce<hw>]:FSIMulator:MDELay:CHANnel:MODE <Mode>

Determines whether only one or several moving channels are simulated.

Parameters:

<Mode> ONE | ALL

*RST: ONE

Example: `FSIM:CONF MDEL`
Selects a moving propagation configuration.
`FSIM:MDEL:CHAN:MODE ALL`
enables all moving channels.

Manual operation: See "Moving Channels" on page 34

[:SOURce<hw>]:FSIMulator:MDELay:DEL30:GROup<st>:PATH<ch>:CPHase <CPhase>

These commands determine the phase for constant phase fading for the "Standard Delay", and "Moving Propagation All Moving Channels" fading configurations.

Parameters:

<CPhase> float

Range: 0 to 359.9
Increment: 0.1
*RST: 0

Example:
`FSIM:DEL:STAT ON`
Activates the `Standard Delay` fading configuration.
`FSIM:DEL:GRO2:PATH:PROF CPH`
selects the `Constant Phase` fading profile for fading path 1 of group 2.
`FSIM:DEL:GRO2:PATH:CPH 5DEG`
sets a phase of 5 DEG for fading path 1 of group 2. The path is multiplied by this phase.

[:SOURce<hw>]:FSIMulator:MDELay:MOVing:DELay:MEAN <Mean>

Sets the mean delay of the moving fading path for moving propagation.

Parameters:

<Mean> float

Range: 0 to 40E-6
Increment: 10E-9
*RST: 3.5E-6

Example:
`FSIM:MDEL:STAT ON`
Sets moving propagation.
`FSIM:MDEL:MOV:DEL:VAR 1E-5`
sets the range 10 us (+/- 5 us) for the variation of the delay of the moving fading path.
`FSIM:MDEL:MOV:DEL:MEAN 9E-6`
sets the mean delay of the moving path to 9 us.
`FSIM:MDEL:MOV:VPER 105`
sets a period of 105 s for the sinusoidal variation of the delay of the moving path. The delay of the moving path now varies once sinusoidal in 105 s between 4 us and 14 us.

Manual operation: See "Delay" on page 69

[:SOURce<hw>]:FSIMulator:MDELay:MOVing:DELay:VARiation <Variation>

Enters the range for the delay of the moving fading path for moving propagation. The delay of the moving path slowly varies sinusoidal within this range.

Parameters:

<Variation> float

Range: 0.3E-6 to dynamic
Increment: 10E-9
*RST: 5E-6

Example: `FSIM:MDEL:MOV:DEL:VAR 1E-5`
Sets the range 10 us for the delay of the moving fading path.

Manual operation: See "Variation (Peak-Peak)" on page 69

[:SOURce<hw>]:FSIMulator:MDELay:MOVing:LOSS <Loss>

Sets the insertion loss of the moving path for moving propagation.

Parameters:

<Loss> float

Range: 0 to 50
Increment: 0.001
*RST: 0

Example: `FSIM:MDEL:MOV:LOSS 12 dB`
Sets the loss for the moving fading path.

Manual operation: See "Path Loss" on page 69

[:SOURce<hw>]:FSIMulator:MDELay:MOVing:STATe <State>

This command activates the moving fading path for moving propagation.

Parameters:

<State> 1 | ON | 0 | OFF

*RST: 1

Example: `FSIM:MDEL:STAT ON`
Sets moving propagation.
`FSIM:MDEL:MOV:STAT ON`
activates the moving path for moving propagation.

Manual operation: See "State" on page 69

[:SOURce<hw>]:FSIMulator:MDELay:MOVing:VPERiod <VPeriod>

This command sets the speed of the delay variation of the moving fading path for moving propagation. A complete cycle comprises one pass through this "Variation Period".

Parameters:

<VPeriod> float

Range: 10 to 500
Increment: 0.1
*RST: 157

Example: `FSIM:MDEL:MOV:VPER 100 s`
Sets the period for the delay variation to 100 s.

Manual operation: See "Variation Period" on page 70

[:SOURce<hw>]:FSIMulator:MDELay:REFerence:DELay <Delay>

This command enters the delay of the reference path for moving propagation.

Parameters:

<Delay> float

Range: 0 to 40E-6
Increment: 10E-9
*RST: 0

Example: `FSIM:MDEL:REF:DEL 1E-5`
Sets the range to 10 us for the delay of the reference path.

Manual operation: See "Delay" on page 69

[:SOURce<hw>]:FSIMulator:MDELay:REFerence:LOSS <Loss>

Sets the loss of the reference path for moving propagation.

Parameters:

<Loss> float

Range: 0 to 50
Increment: 0.001
*RST: 0

Example: `FSIM:MDEL:REF:LOSS 12 dB`
Sets the insertion loss for the reference path.

Manual operation: See "Path Loss" on page 69

[:SOURce<hw>]:FSIMulator:MDELay:REFerence:STATe <State>

This command activates the reference path for moving propagation.

Parameters:

<State> 1 | ON | 0 | OFF

*RST: 1

Example: `FSIM:MDEL:STAT ON`
Sets moving propagation.
`FSIM:MDEL:REF:STAT ON`
activates the reference path for moving propagation.

Manual operation: See "State" on page 69

[:SOURce<hw>]:FSIMulator:MDELay:STATe <State>

This command activates the moving propagation fading configuration. The paths and the fading simulator must be switched on separately (`SOURce:FSIMulator:MDELay:MOVing|REFerence:STATe ON` and `SOURce:FSIMulator ON`).

Parameters:

<State> 1 | ON | 0 | OFF

*RST: 0

Example: `FSIM:MDEL:STAT ON`

Sets moving propagation for fader A.

Manual operation: See "Configuration" on page 31

6.6 MIMO settings

The MIMO configurations require additional options:

- For up to 2x2 MIMO configurations, 2x option R&S SMW-B14/B15 and R&S SMW-K74
- The LxMxN MIMO configurations with M > 2 or N > 2 require 4xR&S SMW-B14/B15 and R&S SMW-K74
- Higher-order MIMO configurations require R&S SMW-K75
- Multi entity LxMxN configurations with L > 2 require also R&S SMW-K76

The options above apply to all commands in this section. If further options are required, there are listed in the corresponding command.

Example: Enabling an 1x8x8 MIMO configuration with two R&S SMW200A

In the following, we assume that the two R&S SMW200A are connected and configured as required.

The example uses R&S SGS as RF extensions and the internal baseband signal of the first R&S SMW200A as trigger source for both instruments. If you use common external trigger source, consider to adapt the proposed configuration.

```
*RST
// Select 8x8 MIMO and set MIMO subset.
SCONfiguration:MODE ADV
SCONfiguration:FADing MIMO8X8
SCONfiguration:MIMO:SUBSet SET1

SCONfiguration:APPLy
// The instrument generates streams A to D.
// Configure connectors for synchronous baseband triggering.
// Alternatively, use an external common trigger source.
SOURce1:INPut:USER6:DIRection OUTP
OUTPut1:USER6:SIGNal MTR
```

```
// Configure the fading simulator.
// Enable synchronization of the fading process to the baseband trigger.
SOURce1:FSIMulator:RESTart:MODE BBTR
SOURce1:FSIMulator:STATe 1

// Configure the baseband signal incl. trigger settings.
// Synchronize baseband triggering for an external common trigger source.
// Adapt configuratiom.
SOURce1:BB:EUTRa:TRIGger:SEQuence ARET
SOURce1:BB:EUTRa:TRIGger:SOURce EGT1
SOURce1:BB:EUTRa:STATe 1

// Set frequency and level of the RF signal.
SOURce1:FREQuency:CW 1950000000
SOURce2:FREQuency:CW 1950000000
SOURce1:POWer:POWer -50
SOURce2:POWer:POWer -50
// Connect and configure the RF extensions, for example, R&S SGS.
SOURce1:IQ:OUTPut:ANALog:STATe 1
SOURce2:IQ:OUTPut:ANALog:STATe 1

// Activate the IQ and RF outputs.
SOURce2:IQ:STATe 1
SOURce1:IQ:STATe 1
OUTPut2:STATe 1
OUTPut1:STATe 1

// Save the configuration.
*SAV 1
MMEMory:STORe:STATe 1,"/var/user/8x8_MIMO_Subset1.savrcl.txt"

// Transfer to file to the second instrument
// Load the configuration and change the subset.
SCONfiguration:MIMO:SUBSet SET2

// Trigger the baseband signal generation and hence the fading process.
OUTPut1:USER6:TRIGger:IMMediate
```

Commands

[:SOURce<hw>]:FSIMulator:MIMO:CAPability?....200
[:SOURce<hw>]:FSIMulator:MIMO:COPY:NEXT....200
[:SOURce<hw>]:FSIMulator:MIMO:COPY:ALL....200
[:SOURce<hw>]:FSIMulator:MIMO:COPY:PREVious....201
[:SOURce<hw>]:FSIMulator:MIMO:MDLoad....201
[:SOURce<hw>]:FSIMulator:MIMO:MDSTore....201
[:SOURce<hw>]:FSIMulator:MIMO:TAP....201
[:SOURce<hw>]:FSIMulator:MIMO:SUBSet....201
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:KRONecker:CORRelation:RX:ROW<di>:COLumn<st>:IMAGinary....202
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:KRONecker:CORRelation:TX:ROW<di>:COLumn<st>:IMAGinary....202

[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:KRONecker:CORRelation:RX:ROW<di>:COLumn<st>:PHASe........ 202
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:KRONecker:CORRelation:TX:ROW<di>:COLumn<st>:PHASe........ 202
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:KRONecker:CORRelation:RX:ROW<di>:COLumn<st>:MAGNitude........ 203
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:KRONecker:CORRelation:TX:ROW<di>:COLumn<st>:MAGNitude........ 203
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:KRONecker:CORRelation:RX:ROW<di>:COLumn<st>:REAL........ 203
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:KRONecker:CORRelation:TX:ROW<di>:COLumn<st>:REAL........ 203
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:MATRix:ACCept........ 203
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:MATRix:CONFlict?........ 204
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:MATRix:MODE........ 204
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:MATRix:ROW<di>:COLumn<st>:PHASe........ 204
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:MATRix:ROW<di>:COLumn<st>:MAGNitude... 205
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:PRESet........ 205
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor<st>:GAIN........ 205
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor<st>:PHASe........ 206

[:SOURce<hw>]:FSIMulator:MIMO:CAPability?

Queries the supported MIMO configurations.

Return values:
<MimoCapability> string

Example: `:SOURce1:FSIMulator:MIMO:CAPability?`
`Response: "M2X2,M2X4,M4X2,M2X3,M3X2,M1X2,..."`

Usage: Query only

[:SOURce<hw>]:FSIMulator:MIMO:COPY:NEXT

Copies the matrix values of the current tap to the subsequent tap. If the current tap is the last tap, the command is discarded.

See also `[:SOURce<hw>]:FSIMulator:MIMO:COPY:ALL` on page 200.

Usage: Event

Manual operation: See "Copy To Next" on page 104

[:SOURce<hw>]:FSIMulator:MIMO:COPY:ALL

Applies the matrix values of the current tap to all taps.

Usage: Event

Manual operation: See "Copy To All" on page 104

[:SOURce<hw>]:FSIMulator:MIMO:COPY:PREVious

This command copies the matrix values of the current tap to the next lower tap.

Example: `FSIM:MIMO:COPY:PREV`
Copies the settings of the current tap to the next lower tap.

Usage: Event

Manual operation: See "Copy To Prev" on page 104

[:SOURce<hw>]:FSIMulator:MIMO:MDLoad <MDLoad>

Loads file with saved MIMO settings.

Setting parameters:
<MDLoad> string

Example: `FSIM:MIMO:MDL 'MIMO_Settings'`
Loads the settings file.

Usage: Setting only

[:SOURce<hw>]:FSIMulator:MIMO:MDSTore <MDStore>

Saves the MIMO settings in a file.

Setting parameters:
<MDStore> string

Example: `FSIM:MIMO:MDST 'MIMO_Settings'`
Saves the MIMO settings in a file.

Usage: Setting only

[:SOURce<hw>]:FSIMulator:MIMO:TAP <Tap>

Sets the current tap.

Parameters:
<Tap> TAP1 | TAP2 | TAP3 | TAP4 | TAP5 | TAP6 | TAP7 | TAP8 | TAP9 | TAP10 | TAP11 | TAP12 | TAP13 | TAP14 | TAP15 | TAP16 | TAP17 | TAP18 | TAP19 | TAP20

*RST: TAP1

Example: `SORce1:FSIMulator:MIMO:TAP TAP15`

Manual operation: See "Current Path (Tap) #" on page 104

[:SOURce<hw>]:FSIMulator:MIMO:SUBSet <Subset>

In 8x8 or 4x4 MIMO configuration with higher fading bandwidth, sets the subset of MIMO channels that is calculated by the particular R&S SMW200A.

Parameters:

<Subset> SET2 | SET1 | ALL

*RST: SET1 (R&S SMW-B10)/ALL(R&S SMW-B9)

Example: See Example"Enabling an 1x8x8 MIMO configuration with two R&S SMW200A" on page 198.

Options: ALL requires R&S SMW-B9
SET2|SET1 requires R&S SMW-K821/K822.

[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:KRONecker:CORRelation:RX:ROW<di>:COLumn<st>:IMAGinary <Imaginary>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:KRONecker:CORRelation:TX:ROW<di>:COLumn<st>:IMAGinary <Imaginary>

Sets the value for the imaginary part of the receiver/transmitter correlation.

Note: If the values for the real part and the imaginary part are both set to 0, the phase value is set to 0 when changing the data format.

Parameters:

<Imaginary> float

Range: -1 to 1
Increment: 0.001
*RST: 0

Example: `SOURce1:FSIMulator:MIMO:TAP2:KRONecker:CORRelation:TX:ROW1:COLumn2:IMAGinary 0.5`
Sets the imaginary part of the Tx correlation AB to 0.5.

Manual operation: See "Tx Correlation Coefficients, Phase/Imag" on page 110

[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:KRONecker:CORRelation:RX:ROW<di>:COLumn<st>:PHASe <Phase>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:KRONecker:CORRelation:TX:ROW<di>:COLumn<st>:PHASe <Phase>

Sets the value for the phase of the receiver/transmitter correlation.

Note: If the values for the real part and the imaginary part are both set to 0, the phase value is set to 0 when changing the data format.

Parameters:

<Phase> float

Range: 0 to 360
Increment: 0.02
*RST: 0

Example: `SOURce1:FSIMulator:MIMO:TAP2:KRONecker:CORRelation:TX:ROW1:COLumn2:PHASe 30`
Sets the phase of the Tx correlation AB to 30 degrees.

Manual operation: See "Tx Correlation Coefficients, Phase/Imag" on page 110

[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:KRONecker:CORRelation:RX:ROW<di>:COLumn<st>:MAGNitude <Magnitude>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:KRONecker:CORRelation:TX:ROW<di>:COLumn<st>:MAGNitude <Magnitude>

Sets the ratio of the receiver/transmitter correlation.

Note: If the values for the real part and the imaginary part are both set to 0, the phase value is set to 0 when changing the data format.

Parameters:

<Magnitude> float

Range: 0 to 1
Increment: 1E-4
*RST: 0

Example: `SOURce1:FSIMulator:MIMO:TAP2:KRONecker:CORRelation:TX:ROW1:COLumn2:MAGNitude 0.5`
Sets the ratio of the Tx correlation AB to 0.5.

Manual operation: See "Tx Correlation Coefficients, Magnitude/Real" on page 110

[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:KRONecker:CORRelation:RX:ROW<di>:COLumn<st>:REAL <Real>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:KRONecker:CORRelation:TX:ROW<di>:COLumn<st>:REAL <Real>

Sets the value for the real part of the receiver/transmitter correlation.

Note: If the values for the real part and the imaginary part are both set to 0, the phase value is set to 0 when changing the data format.

Parameters:

<Real> float

Range: -1 to 1
Increment: 0.001
*RST: 0

Example: `SOURce1:FSIMulator:MIMO:TAP2:KRONecker:CORRelation:TX:ROW1:COLumn2:REAL 0.5`
Sets the value for the real part of the Tx correlation AB to 0.5.

Manual operation: See "Tx Correlation Coefficients, Magnitude/Real" on page 110

[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:MATRix:ACCept

Accepts the values for the phase/imaginary and the real/ration part of the correlation.

Example: `FSIM:MIMO:TAP2:MATR:ACC`

Usage: Event

Options: R&S SMW-K71/-K74

Manual operation: See "Accept" on page 107

[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:MATRix:CONFlict?

Queries whether there is a matrix conflict or not.

Return values:

<Conflict> 1 | ON | 0 | OFF

Example: `FSIM:MIMO:TAP2:MATR:CONF?`
Queries whether there is a matrix conflict or not

Usage: Query only

Options: R&S SMW-K71/-K74

Manual operation: See "Conflict" on page 107

[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:MATRix:MODE <Mode>

Sets the input mode for the Rx and Tx correlation values (matrix mode).

Parameters:

<Mode> INDividual | KRONecker | AOAaod | SCWI
*RST: INDividual

Example: `FSIM:MIMO:TAP2:MATR:MODE IND`
Selects the matrix mode individual.

Options: R&S SMW-K71/-K74

Manual operation: See "Matrix Mode" on page 104

[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:MATRix:ROW<di>:COLumn<st>:PHASe <Phase>

Sets the value for the phase/imaginary part of the correlation.

Suffix:

<di> 1 to 4

<st> 1 to 4

Parameters:

<Phase> float
Range: 0 to 360
Increment: 0.02
*RST: 0

Example: `FSIM:MIMO:TAP2:MATR:ROW1:COL1:PHAS 90`
Sets the correlation value to the specified value.

Options: R&S SMW-K71/-K74

Manual operation: See "Phase/Imag" on page 107

[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:MATRix:ROW<di>:COLumn<st>:MAGNitude <Magnitude>

Determines the value for the real/magnitude part of the correlation.

Suffix:

<di>	1 to 4
<st>	1 to 4

Parameters:

<Magnitude> float

Range: 0 to 1
Increment: 0.0001
*RST: 1

Example: `FSIM:MIMO:TAP2:MATR:ROW1:COL1:MAGN 0.5`
Sets the correlation value to the specified value.

Options: R&S SMW-K71/-K74

Manual operation: See "Real/Magnitude" on page 107

[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:PRESet

The command presets the vector matrix to an unitary matrix.

Example: `FSIM:MIMO:TAP2:GVEC:PRES`
Resets the gain vector matrix.

Usage: Event

Manual operation: See "Set to Unity" on page 108

[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor<st>:GAIN <Gain>

Sets the relative gain in the selected path.

Suffix:

<st>	1 to 8

Parameters:

<Gain> float

Range: -50 to 0
Increment: 0.01
*RST: 0

Example: `SOURce1:FSIMulator:MIMO:TAP2:GVECtor1:GAIN -3`
Decreases the level in path AA by 3 dB.

Manual operation: See "Gain" on page 109

[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor<st>:PHASe <Phase>

Sets the phase shift of the selected path.

Suffix:

<st> 1 to 8

Parameters:

<Phase> float

Range: 0 to 360
Increment: 0.02
*RST: 0

Example: `SOURce1:FSIMulator:MIMO:TAP2:GVECtor1:PHASe 45`
Shifts the phase in path AA by 45 degree.

Options: R&S SMW-K820

Manual operation: See "Phase" on page 109

6.7 TGn settings

Option: R&S SMW-K74.

Example: Simulating one path TGn fading with two rays with different distributions

In the following example we assume that a MIMO fading configuration is enabled, e.g 2x2 MIMO. One MIMO path is activated, the default path settings are used.

```
// ******************************************************************
// Enable the corresponding matrix mode and set the relevant SCM settings
// ******************************************************************

SOURce:FSIMulator:MIMO:TAP:MATRix:MODE AOAaod
SOURce:FSIMulator:MIMO:TGN:ANTenna:DISTance:RX 0.5
SOURce:FSIMulator:MIMO:TGN:ANTenna:DISTance:TX 0.5

// ******************************************************************
// Set ray#1 to simulate signal scattered by
// obstacles causing static fading distribution, e.g. a building
// ******************************************************************
SOURce:FSIMulator:MIMO:TAP:TGN:RAY1:GAIN 0
SOURce:FSIMulator:MIMO:TAP:TGN:RAY1:ARRival:ANGLe 72
SOURce:FSIMulator:MIMO:TAP:TGN:RAY1:ARRival:SPRead 5
SOURce:FSIMulator:MIMO:TAP:TGN:RAY1:DEParture:ANGLe 15
SOURce:FSIMulator:MIMO:TAP:TGN:RAY1:DEParture:SPRead 3
SOURce:FSIMulator:MIMO:TAP:TGN:DIStribution EQUal
SOURce:FSIMulator:MIMO:TAP:TGN:RAY1:STATe ON

// ******************************************************************
```

```
// Set ray#2 to simulate signal scattered by
// obstacles causing Gaussian fading distribution, e.g. a tree
// ******************************************************************
SOURce:FSIMulator:MIMO:TAP:TGN:RAY2:GAIN -10
SOURce:FSIMulator:MIMO:TAP:TGN:RAY2:ARRival:ANGLe 23
SOURce:FSIMulator:MIMO:TAP:TGN:RAY2:ARRival:SPRead 7
SOURce:FSIMulator:MIMO:TAP:TGN:RAY2:DEParture:ANGLe 25
SOURce:FSIMulator:MIMO:TAP:TGN:RAY2:DEParture:SPRead 5
SOURce:FSIMulator:MIMO:TAP:TGN:DISTribution GAUSs
SOURce:FSIMulator:MIMO:TAP:TGN:RAY2:STATe ON

// ******************************************************************
// Query the resulting matrix correlation coefficients with the
// SOURce:FSIMulator:MIMO:TAP:MATRix:... commands
// ******************************************************************
```

Commands

[:SOURce<hw>]:FSIMulator:MIMO:TGN:ANTenna:DISTance:RX....................................... 207
[:SOURce<hw>]:FSIMulator:MIMO:TGN:ANTenna:DISTance:TX....................................... 207
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:TGN:DISTribution.. 207
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:TGN:RAY<st>:ARRival:ANGLe...................... 208
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:TGN:RAY<st>:DEParture:ANGLe.................. 208
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:TGN:RAY<st>:ARRival:SPRead..................... 208
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:TGN:RAY<st>:DEParture:SPRead................. 208
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:TGN:RAY<st>:GAIN.................................... 208
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:TGN:RAY<st>:STATe.................................. 209

[:SOURce<hw>]:FSIMulator:MIMO:TGN:ANTenna:DISTance:RX <DistanceRx>
[:SOURce<hw>]:FSIMulator:MIMO:TGN:ANTenna:DISTance:TX <DistanceTx>

Sets the RX/TX antenna distance in the SCM fading model.

Parameters:

<DistanceTx> float

Range: 0.1 to 2
Increment: 0.1
*RST: 0.5

Example: See Example"Simulating one path TGn fading with two rays with different distributions" on page 206.

Manual operation: See "RX/TX Antenna Distance" on page 112

[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:TGN:DISTribution <Distribution>

Selects one of the proposed statistical functions to determine the distribution of the selected cluster.

Parameters:

<Distribution> LAPLace | GAUSs | EQUal

*RST: EQUal

Example: See Example"Simulating one path TGn fading with two rays with different distributions" on page 206.

Manual operation: See "Distribution" on page 113

[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:TGN:RAY<st>:ARRival:ANGLe <ArrAngle>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:TGN:RAY<st>:DEParture:ANGLe <DepAngle>

Sets the AoA (Angle of Arrival) / AoD (Angle of Departure) of the selected ray.

Parameters:

<DepAngle> float

Range: 0 to 359.999
Increment: 0.001
*RST: 0

Example: See Example"Simulating one path TGn fading with two rays with different distributions" on page 206.

Manual operation: See "Angle of Departure (AoD)" on page 113

[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:TGN:RAY<st>:ARRival:SPRead <ArrSpread>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:TGN:RAY<st>:DEParture:SPRead <DepSpread>

Sets the AoD (Angle of Departure) / AoA (Angle of Arrival) spread (AS) of the selected ray.

Parameters:

<DepSpread> float

Range: 0.1 to 75
Increment: 0.001
*RST: 0.1

Example: See Example"Simulating one path TGn fading with two rays with different distributions" on page 206.

Manual operation: See "AoD Spread" on page 113

[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:TGN:RAY<st>:GAIN <Gain>

Sets the relative gain (in dB) of the selected ray.

Parameters:

<Gain> float

Range: -50 to 0
Increment: 0.001
*RST: 0

Example: See Example"Simulating one path TGn fading with two rays with different distributions" on page 206.

Manual operation: See "Relative Gain /dB" on page 112

[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:TGN:RAY<st>:STATe <RayState>

Enables/disables the selected ray.

Parameters:

<RayState> 1 | ON | 0 | OFF

*RST: 0

Example: See Example"Simulating one path TGn fading with two rays with different distributions" on page 206.

Manual operation: See "Ray State" on page 112

6.8 SCME/WINNER and antenna model settings

Option: R&S SMW-K72/-K73.

Example: Configuring the settings in SCME/WINNER mode

The following is a simple example of how to configure the settings.

You can also load the configuration of predefined SCME models automatically, see:

- Chapter A.16, "SCM and SCME channel models for MIMO OTA", on page 309
- [:SOURce<hw>]:FSIMulator:STANdard on page 162

```
// Enable 2x2 MIMO configuration
SCONfiguration:MODE ADVanced
SCONfiguration:FADing MIMO2X2
SCONfiguration:APPLy

// select SCME/WINNER matrix mode
// configure the spacial channel model
SOURce1:FSIMulator:MIMO:TAP TAP1
SOURce1:FSIMulator:MIMO:TAP1:MATRix:MODE SCWI
SOURce1:FSIMulator:MIMO:SCWI:TAP1:SPEed 30kmh
SOURce1:FSIMulator:DEL:GROup1:PATH1:SPEed?
// Response:  8.333
SOURce1:FSIMulator:MIMO:SCWI:TAP1:DOT 120
SOURce1:FSIMulator:DEL:GROup1:PATH1:FRATio?
// Response: -0.5
SOURce1:FSIMulator:MIMO:SCWI:CLUSter1:TAP1:STATe 1
SOURce1:FSIMulator:MIMO:SCWI:CLUSter1:TAP1:SUBCluster1:STATe 1
SOURce1:FSIMulator:MIMO:SCWI:CLUSter1:GAIN 0
SOURce1:FSIMulator:MIMO:SCWI:CLUSter1:TAP1:SUBCluster1:GAIN?
// Response: -3.01029995663981
```

```
SOURce1:FSIMulator:DEL:GROup1:PATH1:LOSS?
// Response: 3.01
SOURce1:FSIMulator:MIMO:SCWI:CLUSter1:ARRival:ANGLe 0.7
SOURce1:FSIMulator:MIMO:SCWI:CLUSter1:DEParture:ANGLe 6.6
SOURce1:FSIMulator:MIMO:SCWI:CLUSter1:DEParture:SPRead 5
SOURce1:FSIMulator:MIMO:SCWI:CLUSter1:ARRival:SPRead 35
SOURce1:FSIMulator:MIMO:SCWI:CLUSter1:DISTribution LAPL

SOURce1:FSIMulator:STATe 1
```

Example: Configuring MIMO-OTA settings

The following is a simple example of how to configure and enable an antenna model.

```
SOURce:FSIMulator:STANdard G3SCMEUMI30
SOURce:FSIMulator:MIMO:TAP1:MATRix:MODE SCWI

// configure the Tx antenna array (BS)
SOURce:FSIMulator:MIMO:ANTenna:TX:PATTern SEC3
SOURce:FSIMulator:MIMO:ANTenna:TX:CALC:MODE SPAC
SOURce:FSIMulator:MIMO:ANTenna:TX:ESPacing:HORIzontal 0.5
SOURce:FSIMulator:MIMO:ANTenna:TX:COLumn:SIZE?
// ANT02
SOURce:FSIMulator:MIMO:ANTenna:TX:ROWS:SIZE?
// ANT02
SOURce:FSIMulator:MIMO:ANTenna:TX:PATTern SEC3

// configure the Rx antenna array (MS)
SOURce:FSIMulator:MIMO:ANTenna:RX:PATTern ISO
SOURce:FSIMulator:MIMO:ANTenna:RX:COLumn:SIZE?
// ANT02
SOURce1:FSIMulator:MIMO:ANTenna:RX:ROWS:SIZE?
// ANT02
SOURce:FSIMulator:MIMO:ANTenna:RX:CALC:MODE REL
// query predefined antenna pattern files (*.ant_pat)
SOURce:FSIMulator:MIMO:ANTenna:PATTern:CATalog?
// 3Sector,6Sector,Dipole,Isotropic
// query existing user defined antenna pattern files (*.ant_pat)
SOURce:FSIMulator:MIMO:ANTenna:PATTern:CATalog:USER? "/var/user"
//  ant1_phases_pol,ant2_phases_pol
SOURce:FSIMulator:MIMO:ANTenna:RX:PATTern USER
SOURce:FSIMulator:MIMO:ANTenna:RX:ANTenna1:PFILe "/var/user/ant1_phases_pol"
SOURce:FSIMulator:MIMO:ANTenna:RX:ANTenna2:PFILe "/var/user/ant2_phases_pol"

// apply inverse channel matrix
SOURce:FSIMulator:MIMO:ANTenna:INVerse:MATRix:STATe 1
SOURce:FSIMulator:MIMO:ANTenna:INVerse:MATRix:ROW1:COLumn2:REAL 0.3
SOURce:FSIMulator:MIMO:ANTenna:INVerse:MATRix:ROW2:COLumn1:IMAGin -0.82

// enable channel polarization
```

```
SOURce:FSIMulator:MIMO:ANTenna:MODeling:STATe 1
SOURce:FSIMulator:MIMO:ANTenna:PATTern:MODE SEP
SOURce:FSIMulator:MIMO:ANTenna:POLarization:PRATio:VERTical 9
SOURce:FSIMulator:MIMO:ANTenna:POLarization:PRATio:HORizontal 9
// SOURce:FSIMulator:MIMO:ANTenna:PATTern:MODE SING
// SOURce:FSIMulator:MIMO:ANTenna:TX:POLarization:ANGLe POLCROSS45
// SOURce:FSIMulator:MIMO:ANTenna:TX:ESPacing:CROSs 0
```

Commands

[:SOURce<hw>]:FSIMulator:MIMO:SCWI:TAP<st>:SPEed....212
[:SOURce<hw>]:FSIMulator:MIMO:SCWI:TAP<st>:DOT....212
[:SOURce<hw>]:FSIMulator:MIMO:SCWI:CLUSter<ch>:TAP<st>:STATe....212
[:SOURce<hw>]:FSIMulator:MIMO:SCWI:CLUSter<ch>:GAIN....212
[:SOURce<hw>]:FSIMulator:MIMO:SCWI:CLUSter<ch>:ARRival:ANGLe....213
[:SOURce<hw>]:FSIMulator:MIMO:SCWI:CLUSter<ch>:DEParture:ANGLe....213
[:SOURce<hw>]:FSIMulator:MIMO:SCWI:CLUSter<ch>:ARRival:SPRead....213
[:SOURce<hw>]:FSIMulator:MIMO:SCWI:CLUSter<ch>:DEParture:SPRead....213
[:SOURce<hw>]:FSIMulator:MIMO:SCWI:CLUSter<ch>:DISTribution....213
[:SOURce<hw>]:FSIMulator:MIMO:SCWI:CLUSter<ch>:TAP<st>:SUBCluster<di>:STATe....214
[:SOURce<hw>]:FSIMulator:MIMO:SCWI:CLUSter<ch>:TAP<st>:SUBCluster<di>:GAIN?....214
[:SOURce<hw>]:FSIMulator:MIMO:ANTenna:MODeling[:STATe]....214
[:SOURce<hw>]:FSIMulator:MIMO:ANTenna:PATTern:MODE....215
[:SOURce]:FSIMulator:MIMO:ANTenna:POLarization:PRATio:HORizontal....215
[:SOURce]:FSIMulator:MIMO:ANTenna:POLarization:PRATio:VERTical....215
[:SOURce]:FSIMulator:MIMO:ANTenna:RX:POLarization:ANGLe....215
[:SOURce<hw>]:FSIMulator:MIMO:ANTenna:TX:POLarization:ANGLe....215
[:SOURce]:FSIMulator:MIMO:ANTenna:RX:COLumn:SIZE....215
[:SOURce]:FSIMulator:MIMO:ANTenna:RX:ROWS:SIZE....215
[:SOURce<hw>]:FSIMulator:MIMO:ANTenna:TX:COLumn:SIZE....216
[:SOURce<hw>]:FSIMulator:MIMO:ANTenna:TX:ROWS:SIZE....216
[:SOURce]:FSIMulator:MIMO:ANTenna:RX:CALC:MODE....216
[:SOURce<hw>]:FSIMulator:MIMO:ANTenna:TX:CALC:MODE....216
[:SOURce]:FSIMulator:MIMO:ANTenna:RX:ESPacing:CROSs....216
[:SOURce<hw>]:FSIMulator:MIMO:ANTenna:TX:ESPacing:CROSs....216
[:SOURce]:FSIMulator:MIMO:ANTenna:RX:ESPacing:HORizontal....216
[:SOURce<hw>]:FSIMulator:MIMO:ANTenna:TX:ESPacing:HORizontal....216
[:SOURce]:FSIMulator:MIMO:ANTenna:PATTern:CATalog?....217
[:SOURce]:FSIMulator:MIMO:ANTenna:PATTern:CATalog:USER?....217
[:SOURce]:FSIMulator:MIMO:ANTenna:RX:PATTern....217
[:SOURce<hw>]:FSIMulator:MIMO:ANTenna:TX:PATTern....217
[:SOURce]:FSIMulator:MIMO:ANTenna:RX:ANTenna<di>:PFILe....218
[:SOURce<hw>]:FSIMulator:MIMO:ANTenna:TX:ANTenna<di>:PFILe....218
[:SOURce<hw>]:FSIMulator:MIMO:ANTenna:INVerse:MATRix:STATe....218
[:SOURce<hw>]:FSIMulator:MIMO:ANTenna:INVerse:MATRix:ROW<st>:COLumn<ch>:REAL....218
[:SOURce<hw>]:FSIMulator:MIMO:ANTenna:INVerse:MATRix:ROW<st>:COLumn<ch>:IMAGin....218

[:SOURce<hw>]:FSIMulator:MIMO:SCWI:TAP<st>:SPEed <Speed>

Sets the speed of the mobile station.

Parameters:

<Speed> float

Range: 0 to 27778
Increment: 0.001
*RST: 0.83333

Example: See Example"Configuring the settings in SCME/WINNER mode" on page 209

Manual operation: See "MS Speed" on page 115

[:SOURce<hw>]:FSIMulator:MIMO:SCWI:TAP<st>:DOT <DotAngle>

Sets the direction of travel of the mobile station.

Parameters:

<DotAngle> float

Range: 0 to 359.9
Increment: 0.1
*RST: 90

Example: See Example"Configuring the settings in SCME/WINNER mode" on page 209

Manual operation: See "MS DoT (Direction of Travel)" on page 115

[:SOURce<hw>]:FSIMulator:MIMO:SCWI:CLUSter<ch>:TAP<st>:STATe <State>

Enables/disables the selected cluster.

Parameters:

<State> 1 | ON | 0 | OFF

*RST: 0

Example: See Example"Configuring the settings in SCME/WINNER mode" on page 209

Manual operation: See "Cluster State" on page 115

[:SOURce<hw>]:FSIMulator:MIMO:SCWI:CLUSter<ch>:GAIN <Gain>

Sets the relative gain (in dB) of the selected cluster.

Parameters:

<Gain> float

Range: -50 to 0
Increment: 0.001
*RST: 0

Example: See Example"Configuring the settings in SCME/WINNER mode" on page 209

Manual operation: See "Relative Gain /dB" on page 115

[:SOURce<hw>]:FSIMulator:MIMO:SCWI:CLUSter<ch>:ARRival:ANGLe <Angle>
[:SOURce<hw>]:FSIMulator:MIMO:SCWI:CLUSter<ch>:DEParture:ANGLe <Angle>

Sets the AoA (angle of arrival) / AoD (angle of departure) of the selected cluster.

Parameters:

<Angle> float

Range: 0 to 359.999
Increment: 0.001
*RST: 0

Example: See Example"Configuring the settings in SCME/WINNER mode" on page 209

Manual operation: See "Angle of Departure (AoD)" on page 116

[:SOURce<hw>]:FSIMulator:MIMO:SCWI:CLUSter<ch>:ARRival:SPRead <Spread>
[:SOURce<hw>]:FSIMulator:MIMO:SCWI:CLUSter<ch>:DEParture:SPRead <Spread>

Sets the AoA (angle of arrival) / AoD (angle of departure) spread (AS) of the selected cluster.

Parameters:

<Spread> float

Range: 1 to 75
Increment: 0.001
*RST: 1

Example: See Example"Configuring the settings in SCME/WINNER mode" on page 209

Manual operation: See "AoD Spread" on page 116

[:SOURce<hw>]:FSIMulator:MIMO:SCWI:CLUSter<ch>:DISTribution <Distribution>

Sets one of the Power Azimuth Spectrum (PAS) distributions.

Parameters:

<Distribution> LAPLace | GAUSs | EQUal

*RST: EQUal

Example: See Example"Configuring the settings in SCME/WINNER mode" on page 209

Manual operation: See "Distribution" on page 116

[:SOURce<hw>]:FSIMulator:MIMO:SCWI:CLUSter<ch>:TAP<st>:SUBCluster<di>:STATe <State>

If the corresponding cluster is enabled, enables the sub-clusters.

Suffix:
<di> 1 to 3
sub-cluster number

Parameters:
<State> 1 | ON | 0 | OFF
*RST: 0

Example:
```
SOURce1:FSIMulator:MIMO:SCWI:CLUSter2:TAP1:STATe 1
SOURce1:FSIMulator:MIMO:SCWI:CLUSter2:TAP1:SUBCluster2:STATe 1
```

Manual operation: See "Subcluster > State" on page 115

[:SOURce<hw>]:FSIMulator:MIMO:SCWI:CLUSter<ch>:TAP<st>:SUBCluster<di>:GAIN?

Queries the resulting relative gain of an enabled sub-cluster.

Suffix:
<di> 1 to 3
sub-cluster number

Return values:
<Gain> float
Range: -50 to 0
Increment: 0.001
*RST: 0

Example:
```
SOURce1:FSIMulator:MIMO:SCWI:CLUSter2:TAP1:STATe 1
SOURce1:FSIMulator:MIMO:SCWI:CLUSter2:TAP1:SUBCluster2:STATe 1
SOURce1:FSIMulator:MIMO:SCWI:CLUSter2:GAIN 0
SOURce1:FSIMulator:MIMO:SCWI:CLUSter2:TAP1:SUBCluster2:GAIN?
// Response: -5.299
```

Usage: Query only

Manual operation: See "Subcluster > Relative Gain /dB" on page 115

[:SOURce<hw>]:FSIMulator:MIMO:ANTenna:MODeling[:STATe] <AntennaState>

Enables/disables simulation of channel polarization.

Parameters:
<AntennaState> 1 | ON | 0 | OFF
*RST: 0

Example: See Example"Configuring MIMO-OTA settings" on page 210

Manual operation: See "Channel Polarization State" on page 137

[:SOURce<hw>]:FSIMulator:MIMO:ANTenna:PATTern:MODE <AntModPatMode>

Sets way the software extracts or calculates the antenna polarization patterns.

Parameters:

<AntModPatMode> SEParate | SINGle

*RST: SINGle

Example: See Example"Configuring MIMO-OTA settings" on page 210

Options: SEParate requires option R&S SMW-K73

Manual operation: See "Antenna Polarization Mode" on page 137

[:SOURce]:FSIMulator:MIMO:ANTenna:POLarization:PRATio:HORizontal <AntPolPowRatHor>
[:SOURce]:FSIMulator:MIMO:ANTenna:POLarization:PRATio:VERTical <AntPolPowRatVer>

Sets the cross polarization power ratio (XPR) in dB.

Parameters:

<AntPolPowRatVer> float

Range: 0 to 20
Increment: 0.001
*RST: 9

Example: See Example"Configuring MIMO-OTA settings" on page 210

Manual operation: See "Vertical/Horizontal Cross Polarization Power Ratio" on page 138

[:SOURce]:FSIMulator:MIMO:ANTenna:RX:POLarization:ANGLe <AntRxPolAngle>
[:SOURce<hw>]:FSIMulator:MIMO:ANTenna:TX:POLarization:ANGLe <AntTxPolAngle>

Set the antenna element polarization slant angle.

Parameters:

<AntTxPolAngle> POLCROSS45 | POLCROSS90 | POLCO0 | POLCO90

POLCROSS45 | POLCROSS90
cross-poliarization 45°/90°

POLCO0 | POLCO90
co-poliarization 0°/90° (vertical/horizontal poliarization)

*RST: POLCO0

Example: See Example"Configuring MIMO-OTA settings" on page 210

Manual operation: See "Antenna Polarization Slant Angle" on page 141

[:SOURce]:FSIMulator:MIMO:ANTenna:RX:COLumn:SIZE <AntModRxColSize>
[:SOURce]:FSIMulator:MIMO:ANTenna:RX:ROWS:SIZE <AntModRxRowSize>

[:SOURce<hw>]:FSIMulator:MIMO:ANTenna:TX:COLumn:SIZE <AntModTxColSize>
[:SOURce<hw>]:FSIMulator:MIMO:ANTenna:TX:ROWS:SIZE <AntModTxRowSize>

Sets the number of rows and the number of columns in the antenna array.

Parameters:

<AntModTxRowSize> ANT01 | ANT02 | ANT03 | ANT04 | ANT08

*RST: ANT01

Example: See Example"Configuring MIMO-OTA settings" on page 210

Manual operation: See "Number of Rows (M)/Columns (N)" on page 142

[:SOURce]:FSIMulator:MIMO:ANTenna:RX:CALC:MODE <AntModCalcRxMod>
[:SOURce<hw>]:FSIMulator:MIMO:ANTenna:TX:CALC:MODE <AntModCalcRxMod>

Set how the distance between the antenna elements is defined: based on the physical distance or on the relative phase.

Parameters:

<AntModCalcRxMod> SPACing | RELativphase

SPACing
To set the distance, use the corresponding command, for example `[:SOURce<hw>]:FSIMulator:MIMO:ANTenna:TX:ESPacing:HORizontal`.

RELativphase
Load an antenna pattern file that contains the relative phase description.
See Chapter B, "Antenna pattern file format", on page 349

*RST: SPACing

Example: See Example"Configuring MIMO-OTA settings" on page 210

Options: RELativphase requires option R&S SMW-K73

Manual operation: See "Calculation Mode" on page 142

[:SOURce]:FSIMulator:MIMO:ANTenna:RX:ESPacing:CROSs <Cross>
[:SOURce<hw>]:FSIMulator:MIMO:ANTenna:TX:ESPacing:CROSs <Cross>
[:SOURce]:FSIMulator:MIMO:ANTenna:RX:ESPacing:HORizontal <AntRxEspacHori>
[:SOURce<hw>]:FSIMulator:MIMO:ANTenna:TX:ESPacing:HORizontal <AntTxEspacHori>

Sets the polarized distance between the antennas in the antenna array.

Parameters:

<AntTxEspacHori> float

Range: 0 to 10
Increment: 0.01
*RST: 0.5

Example: See Example"Configuring MIMO-OTA settings" on page 210.

Manual operation: See "Horizontal Spacing" on page 143

[:SOURce]:FSIMulator:MIMO:ANTenna:PATTern:CATalog?

Queries the available predefined antenna pattern files (`*.ant_pat`).

To query the user-defined antenna pattern files, use the command `[:SOURce]:FSIMulator:MIMO:ANTenna:PATTern:CATalog:USER?`.

Return values:
<Catalog> string
Files names without file extension.

Example: See Example"Configuring MIMO-OTA settings" on page 210

Usage: Query only

Manual operation: See "User Defined Antenna Patterns per Row, Column" on page 144

[:SOURce]:FSIMulator:MIMO:ANTenna:PATTern:CATalog:USER? [<CatDir>]

Queries the user-defined antenna pattern files (`*.ant_pat`) in the specified directory.

Query parameters:
<CatDir> string
File path

Return values:
<Catalog> string
Files names without file extension.

Example: See Example"Configuring MIMO-OTA settings" on page 210

Manual operation: See "User Defined Antenna Patterns per Row, Column" on page 144

[:SOURce]:FSIMulator:MIMO:ANTenna:RX:PATTern <AntRxPattDesc>
[:SOURce<hw>]:FSIMulator:MIMO:ANTenna:TX:PATTern <AntTxPattDesc>

Sets the antenna pattern mode.

Parameters:
<AntTxPattDesc> ISOtropic | USER | SEC3 | SEC6 | DIPole | DPISotripic
*RST: ISOtropic

Example: See Example"Configuring MIMO-OTA settings" on page 210

Manual operation: See "Antenna Pattern" on page 144

[:SOURce]:FSIMulator:MIMO:ANTenna:RX:ANTenna<di>:PFILe <RxPattern>
[:SOURce<hw>]:FSIMulator:MIMO:ANTenna:TX:ANTenna<di>:PFILe <TxPattern>

Selects the antenna pattern file (`*.ant_pat`) per antenna.

Querry the existing files with the command `[:SOURce]:FSIMulator:MIMO:ANTenna:PATTern:CATalog:USER?`.

Suffix:

<di> 1 to 8
Value range depends on the selected system configuration, i.e. the number of Tx and Rx antennas in the antenna array

Parameters:

<TxPattern> string
Complete file path, incl. the filename; the file extension can be omitted

Example: See Example"Configuring MIMO-OTA settings" on page 210

Manual operation: See "User Defined Antenna Patterns per Row, Column" on page 144

[:SOURce<hw>]:FSIMulator:MIMO:ANTenna:INVerse:MATRix:STATe <AntModInvMatrix>

Applies the inverse channel matrix to compensate for chamber effects.

To set the matrix values, use the commands `[:SOURce<hw>]:FSIMulator:MIMO:ANTenna:INVerse:MATRix:ROW<st>:COLumn<ch>:REAL` and `[:SOURce<hw>]:FSIMulator:MIMO:ANTenna:INVerse:MATRix:ROW<st>:COLumn<ch>:IMAGin`.

Parameters:

<AntModInvMatrix> 1 | ON | 0 | OFF
*RST: 0

Example: See Example"Configuring MIMO-OTA settings" on page 210

Options: R&S SMW-B14 and R&S SMW-K73

Manual operation: See "Use Inverse Channel Matrix" on page 146

[:SOURce<hw>]:FSIMulator:MIMO:ANTenna:INVerse:MATRix:ROW<st>:COLumn<ch>:REAL <AntModInvMatRea>
[:SOURce<hw>]:FSIMulator:MIMO:ANTenna:INVerse:MATRix:ROW<st>:COLumn<ch>:IMAGin <AntModInvMatIma>

Sets the complex elements of the inverse channel matrix.

Suffix:

<st> 1 | 2
Number of row and columns
Current matrix size is 2x2

Parameters:

<AntModInvMatIma> float

Range: -1 to 1
Increment: 0.01
*RST: 0

Example: See Example"Configuring MIMO-OTA settings" on page 210

Options: R&S SMW-B14 and R&S SMW-K73

Manual operation: See "Complex Matrix Elements (Real/Imag)" on page 147

6.9 Two channel interferer

Option: R&S SMW-K71.

Example: Enabling a two channel interferer fading configuration

The following is a simple example of how to configure and enable a two channel interferer fading configuration.

```
SOURce1:FSIMulator:CONFiguration TCI

SOURce1:FSIMulator:TCInterferer:REFerence:PROFile PDOP
SOURce1:FSIMulator:TCInterferer:REFerence:LOSS 1
SOURce1:FSIMulator:TCInterferer:REFerence:SPEed 2
SOURce1:FSIMulator:TCInterferer:REFerence:FRATio 0.5
SOURce1:FSIMulator:TCInterferer:REFerence:DELay:MINimum 0.00003
SOURce1:FSIMulator:TCInterferer:PERiod 160

SOURce1:FSIMulator:TCInterferer:MOVing:PROFile SPAT
SOURce1:FSIMulator:TCInterferer:REFerence:LOSS 0
SOURce1:FSIMulator:TCInterferer:MOVing:DELay:MINimum 0.00003
SOURce1:FSIMulator:TCInterferer:MOVing:DELay:MAXimum 0.00011
SOURce1:FSIMulator:TCInterferer:MOVing:MMODe SLID

SOURce1:FSIMulator:TCInterferer:REFerence:STATe 1
SOURce1:FSIMulator:TCInterferer:MOVing:STATe 1
SOURce1:FSIMulator:TCINterferer:STATe 0
SOURce1:FSIMulator:STATE 1

SOURce1:FSIMulator:TCINterferer:REFerence:FDOPpler?
// 3.33564095198152
SOURce1:FSIMulator:TCINterferer:REFerence:FDOPpler:ACTual?
```

Commands

[:SOURce<hw>]:FSIMulator:TCINterferer[:STATe] 220
[:SOURce<hw>]:FSIMulator:TCINterferer:REFerence|MOVing:DELay:MAXimum 220
[:SOURce<hw>]:FSIMulator:TCINterferer:REFerence|MOVing:MMODe 220

[:SOURce<hw>]:FSIMulator:TCINterferer:PERiod.. 221
[:SOURce<hw>]:FSIMulator:TCINterferer:SPEed.. 221
[:SOURce<hw>]:FSIMulator:TCINterferer:REFerence|MOVing:DELay:MINimum................. 221
[:SOURce<hw>]:FSIMulator:TCINterferer:REFerence|MOVing:FDOPpler?......................... 222
[:SOURce<hw>]:FSIMulator:TCINterferer:REFerence|MOVing:FDOPpler:ACTual?...............222
[:SOURce<hw>]:FSIMulator:TCINterferer:REFerence|MOVing:FRATio...............................222
[:SOURce<hw>]:FSIMulator:TCINterferer:REFerence|MOVing:LOSS.................................223
[:SOURce<hw>]:FSIMulator:TCINterferer:REFerence|MOVing:PROFile............................ 223
[:SOURce<hw>]:FSIMulator:TCINterferer:REFerence|MOVing:STATe............................... 223

[:SOURce<hw>]:FSIMulator:TCINterferer[:STATe] <State>

Activates the 2 channel interferer fading configuration.

The paths and the fading simulator must be switched on separately, see `[:SOURce<hw>]:FSIMulator:TCINterferer:REFerence|MOVing:STATe` and `[:SOURce<hw>]:FSIMulator[:STATe]`.

Parameters:

<State> 1 | ON | 0 | OFF

*RST: 0

Example: See Example"Enabling a two channel interferer fading configuration" on page 219

Manual operation: See "Configuration" on page 31
See "State" on page 74

[:SOURce<hw>]:FSIMulator:TCINterferer:REFerence|MOVing:DELay:MAXimum <Maximum>

Sets the maximum delay for the moving path.

Parameters:

<Maximum> float

Range: dynamic to 0.001
Increment: 20E-9
*RST: 110E-6

Example: see Example"Enabling a two channel interferer fading configuration" on page 219

Manual operation: See "Delay Max (Moving Path)" on page 76

[:SOURce<hw>]:FSIMulator:TCINterferer:REFerence|MOVing:MMODe <MMode>

Selects the type of moving applied to the moving path.

Parameters:

<MMode> SLIDing | HOPPing

*RST: HOPPing

Example: see Example"Enabling a two channel interferer fading configuration" on page 219

Manual operation: See "Moving Mode (Moving Path)" on page 76

[:SOURce<hw>]:FSIMulator:TCINterferer:PERiod <Period>

Sets either the dwell time or the period for a complete cycle of the moving path.

Parameters:

<Period> float

Range: 0.1 to 10
Increment: 0.01
*RST: 2.9 s (for hopping mode) / 160 s (for sliding mode)

Example: See Example"Enabling a two channel interferer fading configuration" on page 219

Manual operation: See "Period/Dwell" on page 76

[:SOURce<hw>]:FSIMulator:TCINterferer:SPEed <Speed>

Sets the speed *v* of the moving receiver for 2 channel interferer fading.

Parameters:

<Speed> float

Range: 0 to 27778 (dynamic)
Increment: 0.001
*RST: 0.83333

Example: See Example"Enabling a two channel interferer fading configuration" on page 219

Manual operation: See "Speed" on page 75

[:SOURce<hw>]:FSIMulator:TCINterferer:REFerence|MOVing:DELay:MINimum <Minimum>

Sets the minimum delay for the reference path and the moving path.

Parameters:

<Minimum> float

Range: 0 to dynamic
Increment: 20E-9
*RST: 0

Example: See Example"Enabling a two channel interferer fading configuration" on page 219

Manual operation: See "Delay Min" on page 76

[:SOURce<hw>]:FSIMulator:TCINterferer:REFerence|MOVing:FDOPpler?

Queries the Doppler frequency of the reference and moving path with 2 channel interferer fading.

Return values:

<FDoppler> float

Range: 0 to 1000
Increment: 0.01
*RST: 0

Example: See Example"Enabling a two channel interferer fading configuration" on page 219

Usage: Query only

Manual operation: See "Profile" on page 75
See "Res. Doppler Shift" on page 75

[:SOURce<hw>]:FSIMulator:TCINterferer:REFerence|MOVing:FDOPpler:ACTual?

Queries the actual Doppler shift.

Return values:

<ActDoppler> float

Range: -1600 to 1600
Increment: 0.01
*RST: 0

Example: See Example"Enabling a two channel interferer fading configuration" on page 219.

Usage: Query only

Manual operation: See "Act. Doppler Shift" on page 76

[:SOURce<hw>]:FSIMulator:TCINterferer:REFerence|MOVing:FRATio <FRatio>

Sets the ratio of the actual Doppler frequency to the set Doppler frequency for the reference and moving path with 2 channel interferer fading.

Parameters:

<FRatio> float

Range: -1 to 1
Increment: 0.0001
*RST: 0

Example: See Example"Enabling a two channel interferer fading configuration" on page 219

Manual operation: See "Freq. Ratio" on page 75

[:SOURce<hw>]:FSIMulator:TCINterferer:REFerence|MOVing:LOSS <Loss>

Seta the loss of the reference and moving path with 2 channel interferer fading.

Parameters:

<Loss> float

Range: 0 to 50
Increment: 0.1
*RST: 0

Example: See Example"Enabling a two channel interferer fading configuration" on page 219

Manual operation: See "Path Loss" on page 75

[:SOURce<hw>]:FSIMulator:TCINterferer:REFerence|MOVing:PROFile <Profile>

Sets the fading profile to be used for the reference and moving path with 2 channel interferer fading.

Parameters:

<Profile> SPATh | PDOPpler | RAYLeigh

*RST: SPATh

Example: See Example"Enabling a two channel interferer fading configuration" on page 219

[:SOURce<hw>]:FSIMulator:TCINterferer:REFerence|MOVing:STATe <State>

Activate the reference and moving path of the 2 channel interferer fading configuration.

The 2 channel interferer fading configuration and the fading simulator must be switched on separately, see `[:SOURce<hw>]:FSIMulator:TCINterferer[:STATe]` on page 220 and .`[:SOURce<hw>]:FSIMulator[:STATe]`

Parameters:

<State> 1 | ON | 0 | OFF

*RST: 0

Example: See Example"Enabling a two channel interferer fading configuration" on page 219

Manual operation: See "State" on page 74

6.10 Custom fading profile

Option: R&S SMW-K72.

Example: Enabling, configuring and disabling a custom fading profile

The following is a simple example of how to configure, enable and disable a custom profile.

```
SOURce1:FSIMulator:DELay:GROup1:PATH2:PROFile CUSTom
SOURce1:FSIMulator:DEL:GROup1:PATH2:CUSTom:DATA 200,100,100,200

SOURce1:FSIMulator:DEL:GROup1:PATH2:CUSTom:DSHape FLAT

SOURce1:FSIMulator:DEL:GROup1:PATH2:PROFile RAYL
```

Commands

[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:CUSTom:DSHape............. 224
[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:CUSTom:DATA.................. 224

[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:CUSTom: DSHape <DopplerShape>

Sets the doppler shape of the virtual profile.

Parameters:

<DopplerShape> FLAT | RAYLeigh

*RST: RAYLeigh

Example: See Example"Enabling, configuring and disabling a custom fading profile" on page 224

Manual operation: See "Doppler Shape" on page 89

[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:CUSTom:DATA <Bandwidth>, <OffsetFreq>, <LowerCutFreq>, <UpperCutFreq>

Sets the parameters of the custom fading profile.

Parameters:

<Bandwidth> float

Range: 50 to 40000
Increment: 1
*RST: 200
Default unit: Hz

<OffsetFreq> float

Range: -23950 to 23950
Increment: 1
*RST: 0
Default unit: Hz

<LowerCutFreq> float

Range: -4000 to 3950
Increment: 1
*RST: 0
Default unit: Hz

<UpperCutFreq> float

Range: -3950 to 4000
Increment: 1
*RST: 100
Default unit: Hz

Example: See Example"Enabling, configuring and disabling a custom fading profile" on page 224

Manual operation: See "Bandwidth" on page 89
See "Frequency Offset" on page 89
See "Lower/Upper Cutoff Frequency" on page 90

6.11 SCM fading profile

Option: R&S SMW-K73.

Example: Configuring the SCM fading profile settings

The following is a simple example of how to configure the settings.

```
// Enable 2x2 MIMO configuration
SCONfiguration:MODE ADV
SCONfiguration:FADing MIMO2X2
SCONfiguration:APPLy

// select SCM fading profile
SOURce1:FSIMulator:DEL:GROup1:PATH1:PROFile SCM
SOURce1:FSIMulator:MIMO:TAP1 TAP1
SOURce1:FSIMulator:SCM:SPEed 8.333
SOURce1:FSIMulator:SCM:DOT 120
SOURce1:FSIMulator:SCM:SIGMa 8

SOURce1:FSIMulator:SCM:TAP1:DEParture:ANGLe 6.6
SOURce1:FSIMulator:SCM:TAP1:DEParture:SPRead 5
SOURce1:FSIMulator:SCM:TAP1:ARRival:ANGLe 25
SOURce1:FSIMulator:SCM:TAP1:ARRival:SPRead 1
SOURce1:FSIMulator:SCM:TAP1:SUBCluster1:STATe 1
SOURce1:FSIMulator:SCM:TAP1:SUBCluster2:STATe 1
SOURce1:FSIMulator:SCM:TAP1:SUBCluster3:STATe 1
SOURce1:FSIMulator:SCM:TAP1:SUBCluster1:GAIN?
// -3.01029995663981


// SOURce1:FSIMulator:SCM:TAP1:SUBPath1:STATe 0
// SOURce1:FSIMulator:SCM:TAP1:SUBPath1:PHASe:VV 135
SOURce1:FSIMulator:SCM:TAP1:SUBPath1:STATe 1

SOURce1:FSIMulator:SCM:LOS:STATe 1
SOURce1:FSIMulator:SCM:LOS:DEParture:ANGLe 5
```

```
SOURce1:FSIMulator:SCM:LOS:ARRival:ANGLe 30
SOURce1:FSIMulator:SCM:LOS:KFACtor -15
SOURce1:FSIMulator:SCM:LOS:RANDom:PHASe:STATe 1
// configure the Tx antenna array (BS)
SOURce1:FSIMulator:SCM:ANTenna:TX:COLumns:SIZE?
// R02

SOURce1:FSIMulator:SCM:ANTenna:TX:ROWS:SIZE?
// R01

SOURce1:FSIMulator:SCM:ANTenna:TX:CALC:MODE SPAC
SOURce1:FSIMulator:SCM:ANTenna:TX:ESPacing:HORizontal 0.5
SOURce1:FSIMulator:SCM:ANTenna:TX:PATTern SEC3
// configure the Rx antenna array (MS)
SOURce1:FSIMulator:SCM:ANTenna:RX:CALC:MODE REL
SOURce1:FSIMulator:SCM:ANTenna:RX:PATTern ISO

// apply inverse channel matrix
SOURce1:FSIMulator:MIMO:ANTenna:INVerse:MATRix:STATe 1
SOURce1:FSIMulator:MIMO:ANTenna:INVerse:MATRix:ROW1:COLumn2:REAL 0.3
SOURce1:FSIMulator:MIMO:ANTenna:INVerse:MATRix:ROW2:COLumn1:IMAGin -0.82

// enable channel polarization
SOURce1:FSIMulator:SCM:POLarization:STATe 1
SOURce1:FSIMulator:SCM:POLarization:PRATio:VERTival 9
SOURce1:FSIMulator:SCM:POLarization:PRATio:HORizontal 9

SOURce1:FSIMulator:STATe 1
```

Example: Configuring the 3D geometry-based channel model

Option: R&S SMW-K73.

The following is a simple example on how to configure the settings.

```
SCONfiguration:MODE ADV
SCONfiguration:FADing MIMO2X2
SCONfiguration:APPLy

SOURce1:FSIMulator:DEL:GROup1:PATH1:PROFile SCM
SOURce1:FSIMulator:MIMO:TAP1 TAP1
SOURce1:FSIMulator:SCM:D3Mode:STATe 1
SOURce1:FSIMulator:SCM:TAP1:SUBCluster1:STATe 1
SOURce1:FSIMulator:SCM:PHI 45
SOURce1:FSIMulator:SCM:THETa 45
SOURce1:FSIMulator:SCM:TAP1:DEParture:ANGLe 10
SOURce1:FSIMulator:SCM:TAP1:DEParture:SPRead 1
SOURce1:FSIMulator:SCM:TAP1:ARRival:ANGLe 25
SOURce1:FSIMulator:SCM:TAP1:ARRival:SPRead 2
SOURce1:FSIMulator:SCM:TAP1:DEParture:ZENith:ANGLe 20
SOURce1:FSIMulator:SCM:TAP1:DEParture:ZENith:SPRead 2
```

```
SOURce1:FSIMulator:SCM:TAP1:ARRival:ZENith:ANGLe 10
SOURce1:FSIMulator:SCM:TAP1:ARRival:ZENith:SPRead 1
SOURce1:FSIMulator:SCM:LOS:STATe 1
SOURce1:FSIMulator:SCM:LOS:DEParture:ZENith:ANGLe 10
SOURce1:FSIMulator:SCM:LOS:ARRival:ZENith:ANGLe 10
SOURce1:FSIMulator:SCM:LOS:DISTance 10

SOURce1:FSIMulator:SCM:ANTenna:TX:STRucture CROSS
SOURce1:FSIMulator:SCM:ANTenna:TX:COLumns:SIZE R01
SOURce1:FSIMulator:SCM:ANTenna:TX:CALC:MODE SPAC
SOURce1:FSIMulator:SCM:ANTenna:TX:PATTern ISO

SOURce1:FSIMulator:SCM:ANTenna:RX:STRucture LIN
SOURce1:FSIMulator:SCM:ANTenna:RX:COLumns:SIZE R01
SOURce1:FSIMulator:SCM:ANTenna:RX:CALC:MODE SPAC
SOURce1:FSIMulator:SCM:ANTenna:RX:ESPacing:VERTical 5
```

Commands

[:SOURce<hw>]:FSIMulator:SCM:D3Mode:STATe....228
[:SOURce<hw>]:FSIMulator:SCM:SPEed....228
[:SOURce<hw>]:FSIMulator:SCM:DOT....229
[:SOURce<hw>]:FSIMulator:SCM:SIGMa....229
[:SOURce<hw>]:FSIMulator:SCM:PHI....229
[:SOURce<hw>]:FSIMulator:SCM:THETa....229
[:SOURce<hw>]:FSIMulator:SCM:TAP<st>:ARRival:ZENith:ANGLe....230
[:SOURce<hw>]:FSIMulator:SCM:TAP<st>:DEParture:ZENith:ANGLe....230
[:SOURce<hw>]:FSIMulator:SCM:TAP<st>:ARRival:ANGLe....230
[:SOURce<hw>]:FSIMulator:SCM:TAP<st>:DEParture:ANGLe....230
[:SOURce<hw>]:FSIMulator:SCM:TAP<st>:ARRival:ZENith:SPRead....230
[:SOURce<hw>]:FSIMulator:SCM:TAP<st>:DEParture:ZENith:SPRead....230
[:SOURce<hw>]:FSIMulator:SCM:TAP<st>:ARRival:SPRead....230
[:SOURce<hw>]:FSIMulator:SCM:TAP<st>:DEParture:SPRead....230
[:SOURce<hw>]:FSIMulator:SCM:TAP<st>:GAIN....231
[:SOURce<hw>]:FSIMulator:SCM:TAP<st>:SUBCluster<di>:STATe....231
[:SOURce<hw>]:FSIMulator:SCM:TAP<st>:SUBCluster<di>:GAIN....231
[:SOURce<hw>]:FSIMulator:SCM:TAP<st>:SUBPath:STATe....232
[:SOURce<hw>]:FSIMulator:SCM:POLarization:STATe....232
[:SOURce<hw>]:FSIMulator:SCM:POLarization:PRATio:HORizontal....232
[:SOURce<hw>]:FSIMulator:SCM:POLarization:PRATio:VERTical....232
[:SOURce]:FSIMulator:SCM:ANTenna:RX:STRucture....233
[:SOURce<hw>]:FSIMulator:SCM:ANTenna:TX:STRucture....233
[:SOURce]:FSIMulator:SCM:ANTenna:RX:CALC:MODE....233
[:SOURce<hw>]:FSIMulator:SCM:ANTenna:TX:CALC:MODE....233
[:SOURce]:FSIMulator:SCM:ANTenna:RX:COLumns[:SIZE]....234
[:SOURce]:FSIMulator:SCM:ANTenna:RX:ROWS[:SIZE]?....234
[:SOURce<hw>]:FSIMulator:SCM:ANTenna:TX:COLumns[:SIZE]....234
[:SOURce<hw>]:FSIMulator:SCM:ANTenna:TX:ROWS[:SIZE]?....234
[:SOURce]:FSIMulator:SCM:ANTenna:RX:ESPacing:VERTical....234
[:SOURce<hw>]:FSIMulator:SCM:ANTenna:TX:ESPacing:VERTical....234
[:SOURce]:FSIMulator:SCM:ANTenna:RX:ESPacing:HORizontal....234

[:SOURce<hw>]:FSIMulator:SCM:ANTenna:TX:ESPacing:HORizontal................................234
[:SOURce]:FSIMulator:SCM:ANTenna:RX:PATTern...234
[:SOURce<hw>]:FSIMulator:SCM:ANTenna:TX:PATTern..234
[:SOURce]:FSIMulator:SCM:ANTenna:RX:ANTenna<di>:PFILe..235
[:SOURce<hw>]:FSIMulator:SCM:ANTenna:TX:ANTenna<di>:PFILe.................................235
[:SOURce<hw>]:FSIMulator:SCM:LOS:STATe...235
[:SOURce<hw>]:FSIMulator:SCM:LOS:ARRival:ZENith:ANGLe...235
[:SOURce<hw>]:FSIMulator:SCM:LOS:DEParture:ZENith:ANGLe......................................235
[:SOURce<hw>]:FSIMulator:SCM:LOS:ARRival[:ANGLe]...235
[:SOURce<hw>]:FSIMulator:SCM:LOS:DEParture[:ANGLe]...235
[:SOURce<hw>]:FSIMulator:SCM:LOS:KFACtor...236
[:SOURce<hw>]:FSIMulator:SCM:LOS:DISTance...236
[:SOURce<hw>]:FSIMulator:SCM:LOS:RANDom:PHASe:STATe......................................236
[:SOURce<hw>]:FSIMulator:SCM:LOS:RANDom:PHASe:HH..237
[:SOURce<hw>]:FSIMulator:SCM:LOS:RANDom:PHASe:HV..237
[:SOURce<hw>]:FSIMulator:SCM:LOS:RANDom:PHASe:VH..237
[:SOURce<hw>]:FSIMulator:SCM:LOS:RANDom:PHASe:VV..237
[:SOURce<hw>]:FSIMulator:SCM:TAP<st>:SUBPath<di>:PHASe:HH...............................237
[:SOURce<hw>]:FSIMulator:SCM:TAP<st>:SUBPath<di>:PHASe:HV...............................237
[:SOURce<hw>]:FSIMulator:SCM:TAP<st>:SUBPath<di>:PHASe:VH...............................237
[:SOURce<hw>]:FSIMulator:SCM:TAP<st>:SUBPath<di>:PHASe:VV...............................237

[:SOURce<hw>]:FSIMulator:SCM:D3Mode:STATe <ThreeDMode>

Enables the 3D geometry-based channel model.

Parameters:

<ThreeDMode> 1 | ON | 0 | OFF

*RST: 0

Example: See Example"Configuring the 3D geometry-based channel model" on page 226.

Manual operation: See "3D" on page 121

[:SOURce<hw>]:FSIMulator:SCM:SPEed <Speed>

Sets the speed of the mobile station.

Parameters:

<Speed> float

Range: 0 to 27778
Increment: 0.001
*RST: 0.83333

Example: See Example"Configuring the SCM fading profile settings" on page 225.

Manual operation: See "MS Speed" on page 119

[:SOURce<hw>]:FSIMulator:SCM:DOT <DirOfTravel>

Sets the direction of travel of the mobile station.

Parameters:

<DirOfTravel> float

Range: 0 to 359.9
Increment: 0.1
*RST: 90

Example: See Example"Configuring the SCM fading profile settings" on page 225.

Manual operation: See "MS DoT (Direction of Travel)" on page 119

[:SOURce<hw>]:FSIMulator:SCM:SIGMa <Sigma>

Sets the lognormal shadow fading standard deviation, applied as a common parameter to the paths.

Parameters:

<Sigma> float

Range: 0 to 20
Increment: 0.01
*RST: 8

Example: See Example"Configuring the SCM fading profile settings" on page 225.

Manual operation: See "σ_{SF}" on page 119

[:SOURce<hw>]:FSIMulator:SCM:PHI <ScmPhi>

Sets the travel azimuth angle.

Parameters:

<ScmPhi> float

Range: 0 to 359.9
Increment: 0.1
*RST: 90

Example: See Example"Configuring the 3D geometry-based channel model" on page 226.

Manual operation: See "MS DoT > φ_v/Θ_v" on page 122

[:SOURce<hw>]:FSIMulator:SCM:THETa <ScmTheta>

Sets the elevation angle.

Parameters:

<ScmTheta> float

Range: 0 to 179.9
Increment: 0.1
*RST: 90

Example: See Example"Configuring the 3D geometry-based channel model" on page 226.

Manual operation: See "MS DoT > φ_v/Θ_v" on page 122

[:SOURce<hw>]:FSIMulator:SCM:TAP<st>:ARRival:ZENith:ANGLe <ArrZenith>
[:SOURce<hw>]:FSIMulator:SCM:TAP<st>:DEParture:ZENith:ANGLe <ZenithDeparture>
[:SOURce<hw>]:FSIMulator:SCM:TAP<st>:ARRival:ANGLe <Angle>
[:SOURce<hw>]:FSIMulator:SCM:TAP<st>:DEParture:ANGLe <Angle>

Sets the AoA (angle of arrival) / AoD (angle of departure) of the cluster.

Parameters:

<Angle> float

Range: 0 to 359.999
Increment: 0.001
*RST: 0

Example: See Example"Configuring the SCM fading profile settings" on page 225.

Manual operation: See "Angle of Departure (AoD)" on page 120

[:SOURce<hw>]:FSIMulator:SCM:TAP<st>:ARRival:ZENith:SPRead <ArrZenSpr>

Sets the ZoA (zenith of arrival) spread of the cluster.

Parameters:

<ArrZenSpr> float

Range: 0 to 75
Increment: 0.001
*RST: 1

Example: See Example"Configuring the SCM fading profile settings" on page 225.

Manual operation: See "ZoA Spread" on page 122

[:SOURce<hw>]:FSIMulator:SCM:TAP<st>:DEParture:ZENith:SPRead <DepZenSpread>
[:SOURce<hw>]:FSIMulator:SCM:TAP<st>:ARRival:SPRead <Spread>
[:SOURce<hw>]:FSIMulator:SCM:TAP<st>:DEParture:SPRead <Spread>

Sets the AoA (angle of arrival) / AoD (angle of departure) spread (AS) of the cluster.

Parameters:

<Spread> float

Range: 1 to 75
Increment: 0.001
*RST: 1

Example: See Example"Configuring the SCM fading profile settings" on page 225.

Manual operation: See "AoD Spread" on page 120

[:SOURce<hw>]:FSIMulator:SCM:TAP<st>:GAIN <Gain>

Sets the relative gain (in dB) of the cluster.

Parameters:

<Gain> float

Range: -50 to 0
Increment: 0.001
*RST: 0

Example: See Example"Configuring the SCM fading profile settings" on page 225.

Manual operation: See "Relative Gain /dB" on page 119

[:SOURce<hw>]:FSIMulator:SCM:TAP<st>:SUBCluster<di>:STATe <State>

Enables the sub-clusters.

Suffix:

<di> 1 to 3
sub-cluster number

Parameters:

<State> 1 | ON | 0 | OFF

*RST: 0

Example: See Example"Configuring the SCM fading profile settings" on page 225.

Manual operation: See "Subcluster > State" on page 119

[:SOURce<hw>]:FSIMulator:SCM:TAP<st>:SUBCluster<di>:GAIN <Gain>

Queries the resulting relative gain of an enabled sub-cluster.

Suffix:

<di> 1 to 3
sub-cluster number

Parameters:

<Gain>	float Range: -50 to 0 Increment: 0.001 *RST: 0

Example: See Example"Configuring the SCM fading profile settings" on page 225.

Manual operation: See "Subcluster > Relative Gain /dB" on page 120

[:SOURce<hw>]:FSIMulator:SCM:TAP<st>:SUBPath:STATe <State>

If enabled, random start phases are selected.

Parameters:

<State>	1 | ON | 0 | OFF *RST: 1

Example: See Example"Configuring the SCM fading profile settings" on page 225.

Manual operation: See "Use Random Phases" on page 130

[:SOURce<hw>]:FSIMulator:SCM:POLarization:STATe <State>

Enables/disables simulation of channel polarization.

Parameters:

<State>	1 | ON | 0 | OFF *RST: 0

Example: See Example"Configuring the SCM fading profile settings" on page 225.

Manual operation: See "Channel Polarization State" on page 123

[:SOURce<hw>]:FSIMulator:SCM:POLarization:PRATio:HORizontal <RatioHorizontal>
[:SOURce<hw>]:FSIMulator:SCM:POLarization:PRATio:VERTical <RatioVertical>

Sets the cross polarization power ratio (XPR) in dB.

Parameters:

<RatioVertical>	float Range: 0 to 20 Increment: 0.001 *RST: 9

Example: See Example"Configuring the SCM fading profile settings" on page 225.

Manual operation: See "Vertical/Horizontal Cross Polarization Power Ratio" on page 123

[:SOURce]:FSIMulator:SCM:ANTenna:RX:STRucture <AntennaRxStruct>
[:SOURce<hw>]:FSIMulator:SCM:ANTenna:TX:STRucture <AntennaStruct>

Sets the antenna array structure.

Parameters:

<AntennaStruct> LIN | CROSS

*RST: LIN

Example: See Example"Configuring the 3D geometry-based channel model" on page 226.

Manual operation: See "Antenna Structure" on page 125

[:SOURce]:FSIMulator:SCM:ANTenna:RX:CALC:MODE <Mode>
[:SOURce<hw>]:FSIMulator:SCM:ANTenna:TX:CALC:MODE <Mode>

Set how the phase information is calculated

Parameters:

<Mode> SPACing | RELativphase | BFORming

SPACing
The phase information is calculated from the spacing between the antenna elements.
To set the distance, use the corresponding command, for example `[:SOURce<hw>]:FSIMulator:SCM:ANTenna:TX:ESPacing:HORizontal`.

RELativphase
Load an antenna pattern file that contains the relative phase description.
See Chapter B, "Antenna pattern file format", on page 349

BFORming
Composite antenna pattern of an antenna array comprising gain and phase is used to simulate analog beamforming.
To set the distance, use the corresponding command, for example `[:SOURce<hw>]:FSIMulator:SCM:ANTenna:TX:ESPacing:HORizontal`.

*RST: SPACing

Example: See Example"Configuring the SCM fading profile settings" on page 225.

Options: R&S SMW-K73

Manual operation: See "Calculation Mode" on page 125

[:SOURce]:FSIMulator:SCM:ANTenna:RX:COLumns[:SIZE] <NumRxCol>
[:SOURce]:FSIMulator:SCM:ANTenna:RX:ROWS[:SIZE]?
[:SOURce<hw>]:FSIMulator:SCM:ANTenna:TX:COLumns[:SIZE] <NumTxCol>
[:SOURce<hw>]:FSIMulator:SCM:ANTenna:TX:ROWS[:SIZE]?

Queries the number of rows and the number of columns in the antenna array.

Return values:

<NumTxRows> R01 | R02 | R03 | R04 | R08

*RST: R02

Example: See Example"Configuring the SCM fading profile settings" on page 225.

Usage: Query only

Manual operation: See "Number of Rows (M)/Columns (N)" on page 125

[:SOURce]:FSIMulator:SCM:ANTenna:RX:ESPacing:VERTical <AntenRxSpacVert>
[:SOURce<hw>]:FSIMulator:SCM:ANTenna:TX:ESPacing:VERTical <AntTxSpacVertic>
[:SOURce]:FSIMulator:SCM:ANTenna:RX:ESPacing:HORizontal <SpacingHoriz>
[:SOURce<hw>]:FSIMulator:SCM:ANTenna:TX:ESPacing:HORizontal <Horizontal>

Sets the distance between the antennas in the antenna array.

Parameters:

<Horizontal> float

Range: 0 to 10
Increment: 0.01
*RST: 0.5

Example: See Example"Configuring the SCM fading profile settings" on page 225.

Manual operation: See "Horizontal Spacing" on page 126

[:SOURce]:FSIMulator:SCM:ANTenna:RX:PATTern <TypeOfPattern>
[:SOURce<hw>]:FSIMulator:SCM:ANTenna:TX:PATTern <Pattern>

Sets the antenna pattern mode.

Parameters:

<Pattern> ISOtropic | USER | SEC3 | SEC6 | DIPole | DPISotripic

*RST: ISOtropic

Example: See Example"Configuring the SCM fading profile settings" on page 225.

Manual operation: See "Antenna Pattern" on page 126

[:SOURce]:FSIMulator:SCM:ANTenna:RX:ANTenna<di>:PFILe <Filename>
[:SOURce<hw>]:FSIMulator:SCM:ANTenna:TX:ANTenna<di>:PFILe <Filename>

Selects the antenna pattern file (`*.ant_pat`) per antenna.

Querry the existing files with the command `[:SOURce]:FSIMulator:MIMO:ANTenna:PATTern:CATalog:USER?`.

Suffix:

<di> 1 to 8
Value range depends on the selected system configuration, i.e. the number of Tx and Rx antennas in the antenna array

Parameters:

<Filename> string
Complete file path, incl. the filename; the file extension can be omitted

Example:

```
// query existing user defined antenna pattern files (*.ant_pat)
SOURce:FSIMulator:MIMO:ANTenna:PATTern:CATalog:USER? "/var/user"
//  ant1,ant2
SOURce:FSIMulator:SCM:ANTenna:TX:PATTern USER
SOURce:FSIMulator:SCM:ANTenna:TX:ANTenna1:PFILe "/var/user/ant1"
SOURce:FSIMulator:SCM:ANTenna:TX:ANTenna2:PFILe "/var/user/ant2"
```

Manual operation: See "User Defined Antenna Patterns per Row, Column" on page 127

[:SOURce<hw>]:FSIMulator:SCM:LOS:STATe <State>

Adds a line-of-sight (LOS) component to the cluster.

Parameters:

<State> 1 | ON | 0 | OFF
*RST: 0

Example: See Example"Configuring the SCM fading profile settings" on page 225.

Manual operation: See "Use LOS Component" on page 128

[:SOURce<hw>]:FSIMulator:SCM:LOS:ARRival:ZENith:ANGLe <LosZenithOfArr>
[:SOURce<hw>]:FSIMulator:SCM:LOS:DEParture:ZENith:ANGLe <LosZenithDepar>
[:SOURce<hw>]:FSIMulator:SCM:LOS:ARRival[:ANGLe] <Angle>
[:SOURce<hw>]:FSIMulator:SCM:LOS:DEParture[:ANGLe] <Angle>

Sets the AoD and AoA of the LOS component.

Parameters:

<Angle> float

Range: 0 to 359.999
Increment: 0.001
*RST: 0

Example: See Example"Configuring the SCM fading profile settings" on page 225.

Manual operation: See "LOS Angle of Departure (AoD)" on page 128

[:SOURce<hw>]:FSIMulator:SCM:LOS:KFACtor <Factor>

Sets the ricean K factor.

Parameters:

<Factor> float

Range: -50 to 0
Increment: 0.001
*RST: 0

Example: See Example"Configuring the SCM fading profile settings" on page 225.

Manual operation: See "K Factor" on page 129

[:SOURce<hw>]:FSIMulator:SCM:LOS:DISTance <Los3dDistance>

Sets the distance between the base station (BS) and the user terminal (UT).

Parameters:

<Los3dDistance> float

Range: 0 to 1000
Increment: 0.01
*RST: 0

Example: See Example"Configuring the 3D geometry-based channel model" on page 226.

Manual operation: See "3D Distance" on page 129

[:SOURce<hw>]:FSIMulator:SCM:LOS:RANDom:PHASe:STATe <State>

If enabled, random subpath start phases are selected.

Parameters:

<State> 1 | ON | 0 | OFF

*RST: 0

Example: See Example"Configuring the SCM fading profile settings" on page 225.

Manual operation: See "Use Random Phases" on page 129

[:SOURce<hw>]:FSIMulator:SCM:LOS:RANDom:PHASe:HH <PhaseHH>
[:SOURce<hw>]:FSIMulator:SCM:LOS:RANDom:PHASe:HV <PhaseHV>
[:SOURce<hw>]:FSIMulator:SCM:LOS:RANDom:PHASe:VH <PhaseVH>
[:SOURce<hw>]:FSIMulator:SCM:LOS:RANDom:PHASe:VV <PhaseVV>
[:SOURce<hw>]:FSIMulator:SCM:TAP<st>:SUBPath<di>:PHASe:HH <PhaseHH>
[:SOURce<hw>]:FSIMulator:SCM:TAP<st>:SUBPath<di>:PHASe:HV <PhaseHV>
[:SOURce<hw>]:FSIMulator:SCM:TAP<st>:SUBPath<di>:PHASe:VH <PhaseVH>
[:SOURce<hw>]:FSIMulator:SCM:TAP<st>:SUBPath<di>:PHASe:VV <PhaseVV>

Sets the start phase in degree of the LOS signal / the subpath per MIMO channel.

Suffix:
<di> 1 to 20
Subpath number

Parameters:
<PhaseVV> float

Range: 0 to 359.999
Increment: 0.001
*RST: 0

Example: See Example"Configuring the SCM fading profile settings" on page 225.

Manual operation: See "Subpath # > VV/HH/VH/HV Phase" on page 130

6.12 Customized dynamic fading

Option: R&S SMW-K820.

Example: Configuring the customized dynamic fading settings

```
SCONfiguration:MODE ADV
SCONfiguration:FADing MIMO2X2
SCONfiguration:APPLy

SOURce1:FSIMulator:CONFiguration CDYN
SOURce1:FSIMulator:CDYNamic:PATH1:PROF PDOPpler
SOURce1:FSIMulator:CDYNamic:PATH5:PROF?
// RAYLeigh
SOURce1:FSIMulator:CDYNamic:CATalog?
// Urban_PureDoppler,Urban_Rayleigh_1,Urban_Rayleigh_2

SOURce1:FSIMulator:CDYNamic:PATH1:DATA:DSELect "Urban_PureDoppler.fad_udyn"
SOURce1:FSIMulator:CDYNamic:PATH5:DATA:DSELect "Urban_Rayleigh_1"

MMEMory:CDIRectory "/var/user/cdf"
SOURce1:FSIMulator:CDYNamic:CATalog:USER?
// dynList_sys1_ch1_PG1_path1, my_cdf
SOURce1:FSIMulator:CDYNamic:DELete "/var/user/cdf/my_cdf"
```

```
SOURce1:FSIMulator:CDYNamic:PATH3:DATA:DSELect "/var/user/cdf/dynList_sys1_ch1_PG1_path1"

SOURce1:FSIMulator:MIMO:TAP1 TAP5
SOURce1:FSIMulator:MIMO:TAP5:MATRix:ROW1:COLumn1:MAGNitude 0.5
SOURce1:FSIMulator:MIMO:TAP5:MATRix:ROW1:COLumn1:PHASe 0
SOURce1:FSIMulator:MIMO:TAP5:MATRix:ACCept

SOURce1:FSIMulator:CDYNamic:PATH1:CONVert:STATe 0
SOURce1:FSIMulator:CDYNamic:PATH5:CONVert:STATe 0
SOURce1:FSIMulator:CDYNamic:PATH3:CONVert:STATe 0

SOURce1:FSIMulator:CDYNamic:PATH1:STATe 1

SOURce1:FSIMulator:STATe 1
```

Example: Using human-readable customized dynamic fading files

Option: R&S SMW-K820.

We assume you have created a file with the required contend and renamed is as described in Chapter 3.9, "Customized dynamic fading", on page 77.

The file `Urban_customer.fad_udyn` is transfered to the R&S SMW200A.

```
SCONfiguration:MODE STD

SOURce1:FSIMulator:CONFiguration CDYN
SOURce1:FSIMulator:CDYNamic:PATH1:PROF PDOPpler
SOURce1:FSIMulator:CDYNamic:CATalog:USER?
// MyUrban_PureDoppler,Urban_customer

SOURce1:FSIMulator:CDYNamic:PATH1:DATA:DSELect "Urban_cusotmer.fad_udyn"

SOURce1:FSIMulator:CDYNamic:PATH1:CONVert:STATe 1
SOURce1:FSIMulator:CDYNamic:PATH1:STATe 1
SOURce1:FSIMulator:STATe 1
```

Commands

[:SOURce<hw>]:FSIMulator:CDYNamic:STATe....238
[:SOURce<hw>]:FSIMulator:CDYNamic:CATalog?....239
[:SOURce<hw>]:FSIMulator:CDYNamic:CATalog:USER?....239
[:SOURce<hw>]:FSIMulator:CDYNamic:PATH<ch>:DATA:DSELect....239
[:SOURce<hw>]:FSIMulator:CDYNamic:DELete....240
[:SOURce<hw>]:FSIMulator:CDYNamic:PATH<ch>:PROF....240
[:SOURce<hw>]:FSIMulator:CDYNamic:PATH<ch>:STATe....240
[:SOURce<hw>]:FSIMulator:CDYNamic:PATH<ch>:CONVert:STATe....241

[:SOURce<hw>]:FSIMulator:CDYNamic:STATe <State>

Activates the customized dynamic fading configuration.

Parameters:

<State> 1 | ON | 0 | OFF

*RST: 0

Example: See Example"Configuring the customized dynamic fading settings" on page 237

Manual operation: See "Configuration" on page 31

[:SOURce<hw>]:FSIMulator:CDYNamic:CATalog?

Queries the predefined files with customized dynamic fading settings. Listed are files with the file extension `*.fad_udyn`.

Return values:

<FileNames> <filename1>,<filename2>,...

Returns a string of filenames separated by commas.

Example: See Example"Configuring the customized dynamic fading settings" on page 237

Usage: Query only

Manual operation: See "Filename" on page 80

[:SOURce<hw>]:FSIMulator:CDYNamic:CATalog:USER?

Queries the files with user-defined customized dynamic fading settings in the default directory. Listed are files with the file extension `*.fad_udyn`.

Return values:

<FileNames> <filename1>,<filename2>,...

Returns a string of filenames separated by commas.

Example: See Example"Configuring the customized dynamic fading settings" on page 237

Usage: Query only

Manual operation: See "Filename" on page 80

[:SOURce<hw>]:FSIMulator:CDYNamic:PATH<ch>:DATA:DSELect <Filename>

Loads the selected file from the default or the specified directory. Loaded are files with extension `*.fad_udyn`.

Suffix:

<ch> 1 to 12
Fading path

Parameters:

<Filename> "<filename>"

Filename or absolute file path; file extension can be omitted.

Example: See Example"Configuring the customized dynamic fading settings" on page 237

Manual operation: See "Filename" on page 80

[:SOURce<hw>]:FSIMulator:CDYNamic:DELete <Filename>

Deletes the specified file. Deleted are user-defined files with file extension `*.fad_udyn`.

Setting parameters:

<Filename> "<filename>"
Complete file path and file name; file extension can be omitted.

Example: See Example"Configuring the customized dynamic fading settings" on page 237

Usage: Setting only

Manual operation: See "Filename" on page 80

[:SOURce<hw>]:FSIMulator:CDYNamic:PATH<ch>:PROF <Prof>

Sets the fading profile.

Suffix:

<ch> 1 to 12
Fading path

Parameters:

<Prof> PDOPpler | RAYLeigh | SPATh

PDOPpler
Pure Doppler profile available in the first four paths (`PATH1|2|3|4`)

RAYLeigh
Rayleigh profile available for all paths

SPATh
Static path profile available for all paths

*RST: PDOPpler

Example: See Example"Configuring the customized dynamic fading settings" on page 237

Manual operation: See "Profile" on page 80

[:SOURce<hw>]:FSIMulator:CDYNamic:PATH<ch>:STATe <State>

Activates the selected path, if a customized dynamic file is selected.

Suffix:

<ch> 1 to 12
Fading path

Parameters:

<State> 1 | ON | 0 | OFF
*RST: 0

Example: See Example"Configuring the customized dynamic fading settings" on page 237

Manual operation: See "State" on page 80

[:SOURce<hw>]:FSIMulator:CDYNamic:PATH<ch>:CONVert:STATe <CdynConvertFile>

Enable to convert files with filename like `*customer*.fad_udyn` into the Rohde & Schwarz proprietary file format when the fading simulator is enabled.

Parameters:

<CdynConvertFile> 1 | ON | 0 | OFF
*RST: 1

Example: See Example"Using human-readable customized dynamic fading files" on page 238.

Manual operation: See "Convert" on page 81

6.13 Fading bandwidth

Option: R&S SMW-B15/-K822/-K823

Example: Enbaling signal with 400 MHz fading bandwidth

The following is a simple example on how to configure the settings.

```
SCONfiguration:MODE ADV
SCONfiguration:FADing MIMO2x2x2
SCONfiguration:BBBW BB400
SCONfiguration:CABW?
// BB800
SCONfiguration:APPLy
SCONfiguration:FADing MIMO2x2x4
SCONfiguration:BBBW?
// BB200
SCONfiguration:CABW?
// BB800
```

Commands

:SCONfiguration:BBBW <Bandwidth>

Sets the bandwidth of the baseband signal at the inputs of the fading simulator.

The available values depend on the selected MIMO configuration.

For example:

- In MIMO configurations with fewer than 8 channels, the max. baseband bandwidth is 400 MHz.
- In MIMO configurations with fewer than 4 channels, the max. baseband bandwidth is 800 MHz.

See user manual R&S®SMW-B14/-K71/-K72/-K73/-K74/-K75/-K820/-K821/-K822/-K823 Fading Simulation.

Parameters:

<Bandwidth> BB040 | BB050 | BB080 | BB100 | BB160 | BB200 | BB800 | BB400 | BB500 | BB1G | BB2G | BB120 | BBOUTDEF | BB240

BB040|BB050 ...
Bandwidth in MHz, e.g. 40 MHz.

BB1G|BB2G
1 GHz, 2 GHz bandwidth.
Available in SISO configurations.

BBOUTDEF
Bandwidth determined by the signal at the HS DIG I/Q.

Example: See Example"Enbaling signal with 400 MHz fading bandwidth" on page 241.

Options: R&S SMW-K822
BB800 requires R&S SMW-K823

Manual operation: See "BB Bandwidth" on page 92

:SCONfiguration:CABW?

Queries the resulting channel aggregation bandwidth, i.e. the signal bandwidth at the outputs of the stream mapper.

The value is calculated automatically and depends on the selected configuration, the installed options and the selected baseband bandwidth (`:SCONfiguration:BBBW`).

See user manual R&S®SMW-B14/-K71/-K72/-K73/-K74/-K75/-K820/-K821/-K822/-K823 Fading Simulation.

Return values:

<Bandwidth> BB800 | BB200

*RST: depends on options

Example: See Example"Enbaling signal with 400 MHz fading bandwidth" on page 241.

Usage: Query only

Options: R&S SMW-K822/K823

Manual operation: See "CA Bandwidth" on page 92

Annex

A Predefined fading settings

The predefined fading settings correspond to the test scenarios defined in the common mobile radio standards. The following tables provide a listing of the predefined standards along with the underlying test scenarios and the enabled settings.

As listed in Chapter 2.4, "Characteristics of R&S SMW-B14 and R&S SMW-B15", on page 25, there is a difference in the system clocks and the delay resolutions depending on which of the options is installed. These differences also affect the used fading paths and the preset values in some of the predefined fading profiles.

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A.1 CDMA standards

Option: R&S SMW-B14/B15

A.1.1 CDMA 1 (8km/h - 2 path)

Table A-1: C.S0011-A_MS_Minimum_Performance_Spec.pdf

	Path 1	Path 2
Profile [Type]	Rayleigh	Rayleigh
Loss [dB]:	0	0
Delay [ns]:	0	2000
LogNormal	off	off
Correlated with:	off	off
Power Ratio [dB]:	0	0
Freq Ratio:	0	0
Speed [km/h]:	8	8

also with 15km/h in band class 5

A.1.2 CDMA 2 (30km/h - 2 path)

Table A-2: C.S0011-A_MS_Minimum_Performance_Spec.pdf

	Path 1	Path 2
Profile [Type]	Rayleigh	Rayleigh
Loss [dB]:	0	0
Delay [ns]:	0	2000
LogNormal	off	off
Correlated with:	off	off
Power Ratio [dB]:	0	0
Freq Ratio:	0	0
Speed [km/h]:	30	30

also with 14km/h in band classes 1,4,6,8

also with 58km/h in band class 5

A.1.3 CDMA 3 (30km/h - 1 path)

Table A-3: C.S0011-A_MS_Minimum_Performance_Spec.pdf

	Path 1
Profile [Type]	Rayleigh
Loss [dB]:	0

	Path 1
Delay [ns]:	0
LogNormal	off
Correlated with:	off
Power Ratio [dB]:	0
Freq Ratio:	0
Speed [km/h]:	30

also with 58km/h in band class 5

A.1.4 CDMA 4 (100km/h - 3 path)

Table A-4: C.S0011-A_MS_Minimum_Performance_Spec.pdf

	Path 1	Path 2	Path 3
Profile [Type]	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	0	0	3
Delay [ns]:	0	2000	14500
LogNormal	off	off	off
Correlated with:	off	off	off
Power Ratio [dB]:	0	0	0
Freq Ratio:	0	0	0
Speed [km/h]:	100	100	100

also with 192km/h in band class 5

A.1.5 CDMA 5 (0km/h - 2 path)

Table A-5: C.S0011-A_MS_Minimum_Performance_Spec.pdf

	Path 1	Path 2
Profile [Type]	Rayleigh	Rayleigh
Loss [dB]:	0	0
Delay [ns]:	0	2000
LogNormal	off	off
Correlated with:	off	off
Power Ratio [dB]:	0	0

	Path 1	Path 2
Freq Ratio:	0	0
Speed [km/h]:	0	0

A.1.6 CDMA 6 (3km/h - 1 path)

Table A-6: C.S0011-A_MS_Minimum_Performance_Spec.pdf

	Path 1
Profile [Type]	Rayleigh
Loss [dB]:	0
Delay [ns]:	0
LogNormal	off
Correlated with:	off
Power Ratio [dB]:	0
Freq Ratio:	0
Speed [km/h]:	3

A.2 GSM standards

Option: R&S SMW-B14/B15

A.2.1 GSM TU3 (6 path)

	Path 1	Path 2	Path 3	Path 4	Path 5	Path 6
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	3	0	2	6	8	10
Delay [ns]:	0	200	500	1600	2300	5000
LogNormal	off	off	off	off	off	off
Corr with	off	off	off	off	off	off
Power Ratio [dB]:	0	0	0	0	0	0
Freq Ratio:	0	0	0	0	0	0
Speed [km/h]:	3	3	3	3	3	3

A.2.2 GSM TU50 (6 path)

	Path 1	Path 2	Path 3	Path 4	Path 5	Path 6
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	3	0	2	6	8	10
Delay [ns]:	0	200	500	1600	2300	5000
LogNormal	off	off	off	off	off	off
Corr with	off	off	off	off	off	off
Power Ratio [dB]:	0	0	0	0	0	0
Freq Ratio:	0	0	0	0	0	0
Speed [km/h]:	50	50	50	50	50	50

A.2.3 GSM HT100 (6 path)

	Path 1	Path 2	Path 3	Path 4	Path 5	Path 6
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	0	1,5	4,5	7,5	8	17,7
Delay [ns]:	0	100	300	500	15000	17200
LogNormal	off	off	off	off	off	off
Corr with	off	off	off	off	off	off
Power Ratio [dB]:	0	0	0	0	0	0
Freq Ratio:	0	0	0	0	0	0
Speed [km/h]:	100	100	100	100	100	100

A.2.4 GSM RA250 (6 path)

	Path 1	Path 2	Path 3	Path 4	Path 5	Path 6
Profile [Type]	Rice	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	0	4	8	12	16	20
Delay [ns]:	0	100	200	300	400	500
LogNormal	off	off	off	off	off	off
Corr with	off	off	off	off	off	off
Power Ratio [dB]:	6,88	0	0	0	0	0
Freq Ratio:	0,7	0	0	0	0	0
Speed [km/h]:	250	250	250	250	250	250

There has been a change in the specifications TS8916B, Baseline Change from 5.1.0 to 5.2.0. The power ratio for path 1 with Rice fading is now no longer referred only to Rayleigh of path 1. Instead, it is referred to the total power of all of the paths.

The preset value used in the instrument of 6.88 fulfills this requirement. It does not conform to the value given in the specification since the instrument always determines the power ratio for one path. By taking into account the power of the other paths in calculating this value, however, the required power ratio for all six paths is achieved.

A.2.5 GSM ET50 (EQ50) (6 path)

	Path 1	Path 2	Path 3	Path 4	Path 5	Path 6
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	0	0	0	0	0	0
Delay [ns]:	0	3200	6400	9600	12800	16000
LogNormal	off	off	off	off	off	off
Corr with	off	off	off	off	off	off
Power Ratio [dB]:	0	0	0	0	0	0
Freq Ratio:	0	0	0	0	0	0
Speed [km/h]:	50	50	50	50	50	50

A.2.6 GSM ET60 (EQ60) (6 path)

	Path 1	Path 2	Path 3	Path 4	Path 5	Path 6
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	0	0	0	0	0	0
Delay [ns]:	0	3200	6400	9600	12800	16000
LogNormal	off	off	off	off	off	off
Corr with	off	off	off	off	off	off
Power Ratio [dB]:	0	0	0	0	0	0
Freq Ratio:	0	0	0	0	0	0
Speed [km/h]:	60	60	60	60	60	60

A.2.7 GSM ET100 (EQ100) (6 path)

	Path 1	Path 2	Path 3	Path 4	Path 5	Path 6
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	0	0	0	0	0	0
Delay [ns]:	0	3200	6400	9600	12800	16000
LogNormal	off	off	off	off	off	off
Corr with	off	off	off	off	off	off
Power Ratio [dB]:	0	0	0	0	0	0
Freq Ratio:	0	0	0	0	0	0
Speed [km/h]:	100	100	100	100	100	100

A.2.8 GSM TU3 (12 path)

	Path 1	Path 2	Path 3	Path 4	Path 5	Path 6
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	4	3	0	2,6	3	5
Delay [ns]:	0	100	300	500	800	1100
LogNormal	off	off	off	off	off	off
Corr with	off	off	off	off	off	off
Power Ratio [dB]:	0	0	0	0	0	0
Freq Ratio:	0	0	0	0	0	0
Speed [km/h]:	3	3	3	3	3	3
	Path 7	**Path 8**	**Path 9**	**Path 10**	**Path 11**	**Path 12**
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	7	5	6,5	8,6	11	10
Delay [ns]:	1300	1700	2300	3100	3200	5000
LogNormal	off	off	off	off	off	off
Corr with	off	off	off	off	off	off
Power Ratio [dB]:	0	0	0	0	0	0
Freq Ratio:	0	0	0	0	0	0
Speed [km/h]:	3	3	3	3	3	3

A.2.9 GSM TU50 (12 path)

	Path 1	Path 2	Path 3	Path 4	Path 5	Path 6
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	4	3	0	2,6	3	5
Delay [ns]:	0	100	300	500	800	1100
LogNormal	off	off	off	off	off	off
Corr with	off	off	off	off	off	off
Power Ratio [dB]:	0	0	0	0	0	0
Freq Ratio:	0	0	0	0	0	0
Speed [km/h]:	50	50	50	50	50	50
	Path 7	**Path 8**	**Path 9**	**Path 10**	**Path 11**	**Path 12**
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	7	5	6,5	8,6	11	10
Delay [ns]:	1300	1700	2300	3100	3200	5000
LogNormal	off	off	off	off	off	off
Corr with	off	off	off	off	off	off
Power Ratio [dB]:	0	0	0	0	0	0
Freq Ratio:	0	0	0	0	0	0
Speed [km/h]:	50	50	50	50	50	50

A.2.10 GSM HT100 (12 path)

	Path 1	Path 2	Path 3	Path 4	Path 5	Path 6
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	10	8	6	4	0	0
Delay [ns]:	0	100	300	500	700	1000
LogNormal	off	off	off	off	off	off
Corr with	off	off	off	off	off	off
Power Ratio [dB]:	0	0	0	0	0	0
Freq Ratio:	0	0	0	0	0	0
Speed [km/h]:	100	100	100	100	100	100
	Path 7	**Path 8**	**Path 9**	**Path 10**	**Path 11**	**Path 12**
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	4	8	9	10	12	14

	Path 1	Path 2	Path 3	Path 4	Path 5	Path 6
Delay [ns]:	1300	15000	15200	15700	17200	20000
LogNormal	off	off	off	off	off	off
Corr with	off	off	off	off	off	off
Power Ratio [dB]:	0	0	0	0	0	0
Freq Ratio:	0	0	0	0	0	0
Speed [km/h]:	100	100	100	100	100	100

A.2.11 GSM TI5

	Path 1	Path 2
Profile [Type]	Rayleigh	Rayleigh
Loss [dB]:	0	0
Delay [ns]:	0	400
LogNormal	off	off
Corr with	off	off
Power Ratio [dB]:	0	0
Freq Ratio:	0	0
Speed [km/h]:	5	5

A.3 NADC standards

Option: R&S SMW-B14/B15

Path 2 should be placed in its own group (delay max. 40 000 ns).

A.3.1 NADC 8 (2 path)

	Path 1	Path 2
Profile [Type]	Rayleigh	Rayleigh
Loss [dB]:	0	0
Delay [ns]:	0	41200
LogNormal	off	off
Corr with	off	off

	Path 1	Path 2
Power Ratio [dB]:	0	0
Freq Ratio:	0	0
Speed [km/h]:	8	8

A.3.2 NADC 50 (2 path)

	Path 1	Path 2
Profile [Type]	Rayleigh	Rayleigh
Loss [dB]:	0	0
Delay [ns]:	0	41200
LogNormal	off	off
Corr with	off	off
Power Ratio [dB]:	0	0
Freq Ratio:	0	0
Speed [km/h]:	50	50

A.3.3 NADC 100 (2 path)

	Path 1	Path 2
Profile [Type]	Rayleigh	Rayleigh
Loss [dB]:	0	0
Delay [ns]:	0	41200
LogNormal	off	off
Corr with	off	off
Power Ratio [dB]:	0	0
Freq Ratio:	0	0
Speed [km/h]:	100	100

A.4 PCN standards

Option: R&S SMW-B14/B15

A.4.1 PCN TU1.5 (6 path)

Same as GSM Tux

	Path 1	Path 2	Path 3	Path 4	Path 5	Path 6
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	3	0	2	6	8	10
Delay [ns]:	0	200	500	1600	2300	5000
LogNormal	off	off	off	off	off	off
Corr with	off	off	off	off	off	off
Power Ratio [dB]:	0	0	0	0	0	0
Freq Ratio:	0	0	0	0	0	0
Speed [km/h]:	1,5	1,5	1,5	1,5	1,5	1,5

A.4.2 PCN TU50 (6 path)

Same as GSM TU50

	Path 1	Path 2	Path 3	Path 4	Path 5	Path 6
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	3	0	2	6	8	10
Delay [ns]:	0	200	500	1600	2300	5000
LogNormal	off	off	off	off	off	off
Corr with	off	off	off	off	off	off
Power Ratio [dB]:	0	0	0	0	0	0
Freq Ratio:	0	0	0	0	0	0
Speed [km/h]:	50	50	50	50	50	50

A.4.3 PCN HT100 (6 path)

Same as GSM

	Path 1	Path 2	Path 3	Path 4	Path 5	Path 6
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	0	1,5	4,5	7,5	8	17,7
Delay [ns]:	0	100	300	500	15000	17200
LogNormal	off	off	off	off	off	off
Corr with	off	off	off	off	off	off

	Path 1	Path 2	Path 3	Path 4	Path 5	Path 6
Power Ratio [dB]:	0	0	0	0	0	0
Freq Ratio:	0	0	0	0	0	0
Speed [km/h]:	100	100	100	100	100	100

A.4.4 PCN RA130 (6 path)

	Path 1	Path 2	Path 3	Path 4	Path 5	Path 6
Profile [Type]	Rice	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	0	4	8	12	16	20
Delay [ns]:	0	100	200	300	400	500
LogNormal	off	off	off	off	off	off
Corr with	off	off	off	off	off	off
Power Ratio [dB]:	6,47	0	0	0	0	0
Freq Ratio:	0,7	0	0	0	0	0
Speed [km/h]:	130	130	130	130	130	130

A.4.5 PCN ET50 (EQ50) (6 path)

Same as GSM

	Path 1	Path 2	Path 3	Path 4	Path 5	Path 6
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	0	0	0	0	0	0
Delay [ns]:	0	3200	6400	9600	12800	16000
LogNormal	off	off	off	off	off	off
Corr with	off	off	off	off	off	off
Power Ratio [dB]:	0	0	0	0	0	0
Freq Ratio:	0	0	0	0	0	0
Speed [km/h]:	50	50	50	50	50	50

A.4.6 PCN ET60 (EQ60) (6 path)

Same as GSM

	Path 1	Path 2	Path 3	Path 4	Path 5	Path 6
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	0	0	0	0	0	0
Delay [ns]:	0	3200	6400	9600	12800	16000
LogNormal	off	off	off	off	off	off
Corr with	off	off	off	off	off	off
Power Ratio [dB]:	0	0	0	0	0	0
Freq Ratio:	0	0	0	0	0	0
Speed [km/h]:	60	60	60	60	60	60

A.4.7 PCN ET100 (EQ100) (6 path)

	Path 1	Path 2	Path 3	Path 4	Path 5	Path 6
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	0	0	0	0	0	0
Delay [ns]:	0	3200	6400	9600	12800	16000
LogNormal	off	off	off	off	off	off
Corr with	off	off	off	off	off	off
Power Ratio [dB]:	0	0	0	0	0	0
Freq Ratio:	0	0	0	0	0	0
Speed [km/h]:	100	100	100	100	100	100

A.4.8 PCN TU1.5 (12 path)

Same as GSM Tux

	Path 1	Path 2	Path 3	Path 4	Path 5	Path 6
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	4	3	0	2,6	3	5
Delay [ns]:	0	100	300	500	800	1100
LogNormal	off	off	off	off	off	off
Corr with	off	off	off	off	off	off

	Path 1	Path 2	Path 3	Path 4	Path 5	Path 6
Power Ratio [dB]:	0	0	0	0	0	0
Freq Ratio:	0	0	0	0	0	0
Speed [km/h]:	1,5	1,5	1,5	1,5	1,5	1,5
	Path 7	**Path 8**	**Path 9**	**Path 10**	**Path 11**	**Path 12**
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	7	5	6,5	8,6	11	10
Delay [ns]:	1300	1700	2300	3100	3200	5000
LogNormal	off	off	off	off	off	off
Corr with	off	off	off	off	off	off
Power Ratio [dB]:	0	0	0	0	0	0
Freq Ratio:	0	0	0	0	0	0
Speed [km/h]:	1,5	1,5	1,5	1,5	1,5	1,5

A.4.9 PCN TU50 (12 path)

Same as GSM

	Path 1	Path 2	Path 3	Path 4	Path 5	Path 6
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	4	3	0	2,6	3	5
Delay [ns]:	0	100	300	500	800	1100
LogNormal	off	off	off	off	off	off
Corr with	off	off	off	off	off	off
Power Ratio [dB]:	0	0	0	0	0	0
Freq Ratio:	0	0	0	0	0	0
Speed [km/h]:	50	50	50	50	50	50
	Path 7	**Path 8**	**Path 9**	**Path 10**	**Path 11**	**Path 12**
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	7	5	6,5	8,6	11	10
Delay [ns]:	1300	1700	2300	3100	3200	5000
LogNormal	off	off	off	off	off	off
Corr with	off	off	off	off	off	off

	Path 1	Path 2	Path 3	Path 4	Path 5	Path 6
Power Ratio [dB]:	0	0	0	0	0	0
Freq Ratio:	0	0	0	0	0	0
Speed [km/h]:	50	50	50	50	50	50

A.4.10 PCN HT100 (12 path)

Same as GSM

	Path 1	Path 2	Path 3	Path 4	Path 5	Path 6
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	10	8	6	4	0	0
Delay [ns]:	0	100	300	500	700	1000
LogNormal	off	off	off	off	off	off
Corr with	off	off	off	off	off	off
Power Ratio [dB]:	0	0	0	0	0	0
Freq Ratio:	0	0	0	0	0	0
Speed [km/h]:	100	100	100	100	100	100
	Path 7	**Path 8**	**Path 9**	**Path 10**	**Path 11**	**Path 12**
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	4	8	9	10	12	14
Delay [ns]:	1300	15000	15200	15700	17200	20000
LogNormal	off	off	off	off	off	off
Corr with	off	off	off	off	off	off
Power Ratio [dB]:	0	0	0	0	0	0
Freq Ratio:	0	0	0	0	0	0
Speed [km/h]:	100	100	100	100	100	100

A.5 TETRA standards

Option: R&S SMW-B14/B15

A.5.1 TETRA TU50 (2 path)

EN300 392-2

	Path 1	Path 2
Profile [Type]	Rayleigh	Rayleigh
Loss [dB]:	0	22,3
Delay [ns]:	0	5000
LogNormal	off	off
Corr with	off	off
Power Ratio [dB]:	0	0
Freq Ratio:	0	0
Speed [km/h]:	50	50

A.5.2 TETRA TU50 (6 path)

	Path 1	Path 2	Path 3	Path 4	Path 5	Path 6
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	3.00	0	2.0	6.0	8.0	10.0
Delay [ns]:	0	0	0	0	0	0
LogNormal	off	off	off	off	off	off
Corr with	off	off	off	off	off	off
Power Ratio [dB]:	0	0	0	0	0	0
Freq Ratio:	0	0	0	0	0	0
Speed [km/h]:	50	50	50	50	50	50

A.5.3 TETRA BU50 (2 path)

EN300 392-2

	Path 1	Path 2
Profile [Type]	Rayleigh	Rayleigh
Loss [dB]:	0	3
Delay [ns]:	0	5000
LogNormal	off	off

	Path 1	Path 2
Corr with	off	off
Power Ratio [dB]:	0	0
Freq Ratio:	0	0
Speed [km/h]:	50	50

A.5.4 TETRA HT200 (2 path)

	Path 1	Path 2
Profile [Type]	Rayleigh	Rayleigh
Loss [dB]:	0	8,6
Delay [ns]:	0	15000
LogNormal	off	off
Corr with	off	off
Power Ratio [dB]:	0	0
Freq Ratio:	0	0
Speed [km/h]:	200	200

A.5.5 TETRA HT200 (6 path)

	Path 1	Path 2	Path 3	Path 4	Path 5	Path 6
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	0	2	4	7	6	12
Delay [ns]:	0	200	400	600	15000	17200
LogNormal	off	off	off	off	off	off
Corr with	off	off	off	off	off	off
Power Ratio [dB]:	0	0	0	0	0	0
Freq Ratio:	0	0	0	0	0	0
Speed [km/h]:	200.02	200.02	200.02	200.02	200.02	200.02

A.5.6 TETRA ET200 (4 path)

EN300 392-2, Equalizer Test

Note:Path 3 and 4 should be placed in their own group (delay max. 40 000 ns)

	Path 1	Path 2	Path 3	Path 4
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	0	0	10,2	16
Delay [ns]:	0	11600	73200	99300
LogNormal	off	off	off	off
Corr with	off	off	off	off
Power Ratio [dB]:	0	0	0	0
Freq Ratio:	0	0	0	0
Speed [km/h]:	200	200	200	200

A.5.7 TETRA DU 50 (1Path)

ETSI EN 300 396-2 V1.2.1

	Path 1
Profile [Type]	Rice
Loss [dB]:	0
Delay [ns]:	0
LogNormal	off
Corr with	off
Power Ratio [dB]:	0
Freq Ratio:	0,7
Speed [km/h]:	50

A.5.8 TETRA DR 50 (1Path)

ETSI EN 300 396-2 V1.2.1

	Path 1
Profile [Type]	Rayleigh
Loss [dB]:	0
Delay [ns]:	0
LogNormal	off
Corr with	off

	Path 1
Power Ratio [dB]:	0
Freq Ratio:	0
Speed [km/h]:	50

A.6 3GPP standards

Option: R&S SMW-K71

VAx are typical fading profiles, with x representing the speed, such as VA3 represents 3 km/h.

These standards define a certain combination of channels with a specific doppler frequency. Basically, the maximum possible doppler frequency of a path is determined by the RF output frequency and the speed of the moving mobile receiver. However, if you change the RF frequency in a VAx standard, the doppler frequency remains the same, thus resulting in individual speed settings.

Refer also to Chapter A.6.12, "3GPP mobile VA3, 3GPP mobile VA30, 3GPP mobile VA120", on page 266 for VAx fading profiles.

A.6.1 3GPP case 1 (UE/BS)

Table A-7: 3GPP TS 25.101 V6.2.0 (2003-09), annex B2.2 and 3GPP TS 25.141 V6.3.0 (2003-09), annex D.2

	Path 1	Path 2
Profile [Type]	Rayleigh	Rayleigh
Loss [dB]:	0	10
Delay [ns]:	0	976
LogNormal	off	off
Corr with	off	off
Power Ratio [dB]:	0	0
Freq Ratio:	0	0
Speed [km/h]:	3	3

A.6.2 3GPP case 2 (UE/BS)

Table A-8: 3GPP TS 25.101 V6.2.0 (2003-09), annex B2.2 and 3GPP TS 25.141 V6.3.0 (2003-09), annex D.2

	Path 1	Path 2	Path 3
Profile [Type]	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	0	0	0
Delay [ns]:	0	976	20000
LogNormal	off	Off	off
Corr with	off	Off	off
Power Ratio [dB]:	0	0	0
Freq Ratio:	0	0	0
Speed [km/h]:	3	3	3

A.6.3 3GPP case 3 (UE/BS)

3GPP TS 25.101 V6.2.0 (2003-09), annex B2.2 and 3GPP TS 25.141 V6.3.0 (2003-09), annex D.2

	Path 1	Path 2	Path 3	Path 4
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	0	3	6	9
Delay [ns]:	0	260	521	781
LogNormal	off	off	off	off
Corr with	off	off	off	off
Power Ratio [dB]:	0	0	0	0
Freq Ratio:	0	0	0	0
Speed [km/h]:	120	120	120	120

A.6.4 3GPP case 4 (UE)

3GPP TS 25.101 V6.2.0 (2003-09), annex B2.2

	Path 1	Path 2
Profile [Type]	Rayleigh	Rayleigh
Loss [dB]:	0	0
Delay [ns]:	0	976
LogNormal	off	off

	Path 1	Path 2
Corr with	off	off
Power Ratio [dB]:	0	0
Freq Ratio:	0	0
Speed [km/h]:	3	3

A.6.5 3GPP case 5 (UE)

3GPP TS 25.101 V6.2.0 (2003-09), annex B2.2

	Path 1	Path 2
Profile [Type]	Rayleigh	Rayleigh
Loss [dB]:	0	10
Delay [ns]:	0	976
LogNormal	off	off
Corr with	off	off
Power Ratio [dB]:	0	0
Freq Ratio:	0	0
Speed [km/h]:	50	50

A.6.6 3GPP case 6 (UE) and case 4 (BS)

3GPP TS 25.101 V6.2.0 (2003-09), annex B2.2 and 3GPP TS 25.141 V6.3.0 (2003-09), annex D.2

	Path 1	Path 2	Path 3	Path 4
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	0	3	6	9
Delay [ns]:	0	260	521	781
LogNormal	off	off	off	off
Corr with	off	off	off	off
Power Ratio [dB]:	0	0	0	0
Freq Ratio:	0	0	0	0
Speed [km/h]:	250	250	250	250

A.6.7 3GPP mobile case 7 (UE-Sector)

Table A-9: 3GPP TS 25.101 V6.2.0 (2003-09), annex B2.2

	Path 1	Path 2	Path 3	Path 4	Path 5	Path 6
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	0	4.3	6.6	2	7	7.5
Delay [ns]:	0	260	1040	4690	7290	14580
LogNormal	off	off	off	off	off	off
Corr with	off	off	off	off	off	off
Power Ratio [dB]:	0	0	0	0	0	0
Freq Ratio:	0	0	0	0	0	0
Speed [km/h]:	50	50	50	50	50	50

A.6.8 3GPP mobile case 7 (UE-Beam)

3GPP TS 25.101 V6.2.0 (2003-09), annex B2.2

	Path 4	Path 5	Path 6
Profile [Type]	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	0	0.3	0.9
Delay [ns]:	4690	7290	14580
LogNormal	off	off	off
Corr with	off	off	off
Power Ratio [dB]:	0	0	0
Freq Ratio:	0	0	0
Speed [km/h]:	50	50	50

A.6.9 3GPP mobile case 8 (UE, CQI)

3GPP TS 25.101 V6.2.0 (2003-09), annex B2.2, Table B.1C;

	Path 1	Path 2
Profile [Type]	Rayleigh	Rayleigh
Loss [dB]:	0	10
Delay [ns]:	0	976
LogNormal	off	off

	Path 1	Path 2
Corr with	off	off
Power Ratio [dB]:	0	0
Freq Ratio:	0	0
Speed [km/h]:	30	30

A.6.10 3GPP mobile PA3

3GPP TS 25.101 V6.2.0 (2003-09), annex B2.2, ITU Pedestrian A (HSDPA)

	Path 1	Path 2	Path 3	Path 4
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	0	9.7	19.2	22.8
Delay [ns]:	0	110	190	410
LogNormal	off	off	off	off
Corr with	off	off	off	off
Power Ratio [dB]:	0	0	0	0
Freq Ratio:	0	0	0	0
Speed [km/h]:	3	3	3	3

A.6.11 3GPP mobile PB3

3GPP TS 25.101 V6.2.0 (2003-09), annex B2.2, ITU Pedestrian B (HSDPA)

	Path 1	Path 2	Path 3	Path 4	Path 5	Path 6
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	0	0.9	4.9	8	7.8	23.9
Delay [ns]:	0	200	800	1200	2300	3700
LogNormal	off	off	off	off	off	off
Corr with	off	off	off	off	off	off
Power Ratio [dB]:	0	0	0	0	0	0
Freq Ratio:	0	0	0	0	0	0
Speed [km/h]:	3	3	3	3	3	3

A.6.12 3GPP mobile VA3, 3GPP mobile VA30, 3GPP mobile VA120

Table A-10: 3GPP TS 25.101 V6.2.0 (2003-09), annex B2.2, ITU vehicular A (HSDPA)

	Path 1	Path 2	Path 3	Path 4	Path 5	Path 6
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	0	1	9	10	15	20
Delay [ns]:	0	310	710	1090	1730	2510
LogNormal	off	off	off	off	off	off
Corr with	off	off	off	off	off	off
Power Ratio [dB]:	0	0	0	0	0	0
Freq Ratio:	0	0	0	0	0	0
Speed [km/h]:	3 | 30 | 120 [1)]	3 | 30 | 120 [1)]	3 | 30 | 120 [1)]	3 | 30 | 120 [1)]	3 | 30 | 120 [1)]	3 | 30 | 120 [1)]

[1)] Speed of the respective standard VAx: VA3 = 3 km/h, VA30 = 30 km/h and VA120 = 120 km/h.

A.6.13 3GPP MBSFN propagation channel profile (18 path)

Table A-11: 3GPP 3GPP TS 36.521-1 respectivelly TS36.101 V9.8.0

	Path 1	Path 2	Path 3	Path 4	Path 5	Path 6
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	0	1.5	1.4	3.6	0.6	7.0
Delay [ns]:	0	30	150	310	370	1090
LogNormal	off	off	off	off	off	off
Corr with	off	off	off	off	off	off
Power Ratio [dB]:	0	0	0	0	0	0
Frequency [Hz]: *	3	3	3	3	3	3

Table A-12: 3GPP 3GPP TS 36.521-1 respectivelly TS36.101 V9.8.0 (Cont.)

	Path 7	Path 8	Path 9	Path 10	Path 11	Path 12
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	10.0	11.5	11.4	13.6	10.6	17.0
Delay [ns]:	12490	12520	12640	12800	12860	13580

	Path 7	Path 8	Path 9	Path 10	Path 11	Path 12
LogNormal	off	off	off	off	off	off
Corr with	off	off	off	off	off	off
Power Ratio [dB]:	0	0	0	0	0	0
Frequency [Hz]: *	3	3	3	3	3	3

Table A-13: 3GPP 3GPP TS 36.521-1 respectivelly TS36.101 V9.8.0 (Cont.)

	Path 13	Path 14	Path 15	Path 16	Path 17	Path 18
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	20.0	21.5	21.4	23.6	20.6	27.0
Delay [ns]:	27490	27520	27640	27800	27860	28580
LogNormal	off	off	off	off	off	off
Corr with	off	off	off	off	off	off
Power Ratio [dB]:	0	0	0	0	0	0
Frequency [Hz]: *	3	3	3	3	3	3

A.6.14 3GPP birth death

3GPP TS 25.101 V6.2.0 (2003-09), annex B2.4

	Path 1	Path 2
Profile [Type]	Static	Static
Loss [dB]:	0	0
Delay [ns]:	0 to 10us	0 to 10us
LogNormal	off	off
Corr with	off	off
Power Ratio [dB]:	0	0
Freq Ratio:	1	1
Speed [km/h]:	0	0

Dwell: 191ms

(Mean)-Offset: 5 us

A.6.15 3GPP TUx

Table A-14: 3GPP TS 25.943 V5.1.0 (2002-06)

	Path 1	Path 2	Path 3	Path 4	Path 18
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	7.6	10.1	10.2	5.7	16.3
Delay [ns]:	217	512	514	0	1230
LogNormal	off	off	off	off	off
Corr with	off	off	off	off	off
Power Ratio [dB]:	0	0	0	0	0
Freq Ratio:	0	0	0	0	0
Speed [km/h]:	3	3	3	3	3

Table A-15: 3GPP TS 25.943 V5.1.0 (2002-06) (Cont.)

	Path 6	Path 7	Path 8	Path 9	Path 10
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	10.2	11.5	13.4	21.5	21.6
Delay [ns]:	517	674	882	1820	1840
LogNormal	off	off	off	off	off
Corr with	off	off	off	off	off
Power Ratio [dB]:	0	0	0	0	0
Freq Ratio:	0	0	0	0	0
Speed [km/h]:	3	3	3	3	3

Table A-16: 3GPP TS 25.943 V5.1.0 (2002-06) (Cont.)

	Path 11	Path 12	Path 13	Path 14	Path 15
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	16.9	17.1	17.4	22.1	22.6
Delay [ns]:	1287	1311	1349	1880	1940
LogNormal	off	off	off	off	off
Corr with	off	off	off	off	off
Power Ratio [dB]:	0	0	0	0	0
Freq Ratio:	0	0	0	0	0
Speed [km/h]:	3	3	3	3	3

Table A-17: 3GPP TS 25.943 V5.1.0 (2002-06) (Cont.)

	Path 16	Path 19	Path 5	Path 17	Path 20
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	19	19	19.8	23.5	24.3
Delay [ns]:	1533	1540	1620	2050	2140
LogNormal	off	off	off	off	off
Corr with	off	off	off	off	off
Power Ratio [dB]:	0	0	0	0	0
Freq Ratio:	0	0	0	0	0
Speed [km/h]:	3	3	3	3	3

A.6.16 3GPP HTx

Table A-18: 3GPP TS 25.943 V5.1.0 (2002-06)

	Path 1	Path 2	Path 3	Path 4	Path 5	Path 6	Path 7	Path 8	Path 9	Path 10
Profile [Type]	Ray-leigh	Ray-leigh	Ray-leigh	Ray-leigh	Ray-leigh	Ray-leigh	Ray-leigh	Ray-leigh	Ray-leigh	Ray-leigh
Loss [dB]:	8.9	10.2	11.5	3.6	17.6	11.8	12.7	13	25.8	26.2
Delay [ns]:	356	441	528	0	15000	546	609	625	16880	16980
Log-Normal	off	off	off	off	off	off	off	off	off	off
Corr with	off	off	off	off	off	off	off	off	off	off
Power Ratio [dB]:	0	0	0	0	0	0	0	0	0	0
Freq Ratio:	0	0	0	0	0	0	0	0	0	0
Speed [km/h]:	100	100	100	100	100	100	100	100	100	100

Table A-19: 3GPP TS 25.943 V5.1.0 (2002-06) (Cont.)

	Path 11	Path 12	Path 13	Path 14	Path 15	Path 16	Path 17	Path 18	Path 19	Path 20
Profile [Type]	Ray-leigh	Ray-leigh	Ray-leigh	Ray-leigh	Ray-leigh	Ray-leigh	Ray-leigh	Ray-leigh	Ray-leigh	Ray-leigh
Loss [dB]:	16.2	17.3	17.7	29	29.9	22.7	24.1	25.8	30	30.7

	Path 11	Path 12	Path 13	Path 14	Path 15	Path 16	Path 17	Path 18	Path 19	Path 20
Delay [ns]:	842	916	941	17620	17830	16172	16492	16876	17850	18020
Log-Normal	off	off	off	off	off	off	off	off	off	off
Corr with	off	off	off	off	off	off	off	off	off	off
Power Ratio [dB]:	0	0	0	0	0	0	0	0	0	0
Freq Ratio:	0	0	0	0	0	0	0	0	0	0
Speed [km/h]:	100	100	100	100	100	100	100	100	100	100

A.6.17 3GPP RAx

Table A-20: 3GPP TS 25.943 V5.1.0 (2002-06)

	Path 1	Path 2	Path 3	Path 4	Path 5
Profile [Type]	Pure Dop	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	5.2	6.4	8.4	9.3	10
Delay [ns]:	0	42	101	129	149
LogNormal	off	off	off	off	off
Corr with	off	off	off	off	off
Power Ratio [dB]:	0	0	0	0	0
Freq Ratio:	0.7	0	0	0	0
Speed [km/h]:	250	250	250	250	250

Table A-21: 3GPP TS 25.943 V5.1.0 (2002-06) (Cont.)

	Path 6	Path 7	Path 8	Path 9	Path 10
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	13.1	15.3	18.5	20.4	22.4
Delay [ns]:	245	312	410	469	528
LogNormal	off	off	off	off	off
Corr with	off	off	off	off	off
Power Ratio [dB]:	0	0	0	0	0

	Path 6	Path 7	Path 8	Path 9	Path 10
Freq Ratio:	0	0	0	0	0
Speed [km/h]:	250	250	250	250	250

A.6.18 3GPP birth death

3GPP TS 25.101 V6.2.0 (2003-09), annex B2.4

	Path 1	Path 2
Profile [Type]	Static	Static
Loss [dB]:	0	0
Delay [ns]:	0…10us	0…10us
LogNormal	off	off
Corr with	off	off
Power Ratio [dB]:	0	0
Freq Ratio:	1	1
Speed [km/h]:	0	0

Dwell: 191ms

(Mean)-Offset: 5 us

A.6.19 Reference + moving channel

See Chapter A.15.1, "Reference + moving channel", on page 308.

A.6.20 HST1 open space, HST1 open space (DL+UL)

See Chapter A.14.1, "HST1 open space, HST1 open space (DL+UL)", on page 306.

A.6.21 HST2 tunnel leaky cable

See Chapter A.14.2, "HST2 tunnel leaky cable, HST2 tunnel leaky cable (DL+UL)", on page 306.

A.6.22 HST3 tunnel multi antennas, HST3 tunnel multi antennas (DL+UL)

See Chapter A.14.3, "HST3 tunnel multi antennas, HST3 tunnel multi antennas (DL +UL)", on page 307.

A.7 WLAN standards

Option: R&S SMW-B14/B15

A.7.1 WLAN / hyperlan/2 model a

	Path 1	Path 2	Path 3	Path 4	Path 5	Path 6	Path 7	Path 8	Path 9
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	2,6	0,9	1,7	0	3,5	4,3	7,8	6,1	6,9
Delay [ns]:	30	10	20	0	40	50	90	70	80
LogNor-mal	off	off	off	off	off	off	off	off	off
Corr with	off	off	off	off	off	off	off	off	off
Power Ratio [dB]:	0	0	0	0	0	0	0	0	0
Freq Ratio:	0	0	0	0	0	0	0	0	0
Speed [km/h]:	10,8	10,8	10,8	10,8	10,8	10,8	10,8	10,8	10,8
	Path 10	**Path 11**	**Path 12**	**Path 13**	**Path 14**	**Path 15**	**Path 16**	**Path 17**	**Path 18**
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	5,2	4,7	7,3	9,9	12,5	13,7	18	22,4	26,7
Delay [ns]:	60	110	140	170	200	240	290	340	390
LogNor-mal	off	off	off	off	off	off	off	off	off
Corr with	off	off	off	off	off	off	off	off	off
Power Ratio [dB]:	0	0	0	0	0	0	0	0	0
Freq Ratio:	0	0	0	0	0	0	0	0	0
Speed [km/h]:	10,8	10,8	10,8	10,8	10,8	10,8	10,8	10,8	10,8

Corresp. to a typical office environment for NLOS conditions and an average rms delay spread of 50ns

A.7.2 WLAN / hyperlan/2 model b

	Path 1	Path 2	Path 3	Path 4	Path 5	Path 6	Path 7	Path 8	Path 9
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	3,9	3	0	2,6	3,5	1,3	2,6	5,6	3,4
Delay [ns]:	30	10	50	0	20	80	110	230	180
LogNor-mal	off	off	off	off	off	off	off	off	off
Corr with	off	off	off	off	off	off	off	off	off
Power Ratio [dB]:	0	0	0	0	0	0	0	0	0
Freq Ratio:	0	0	0	0	0	0	0	0	0
Speed [km/h]:	10,8	10,8	10,8	10,8	10,8	10,8	10,8	10,8	10,8
	Path 10	**Path 14**	**Path 12**	**Path 15**	**Path 11**	**Path 13**	**Path 16**	**Path 17**	**Path 18**
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	3,9	7,7	9,9	12,1	14,3	15,4	18,4	20,7	24,6
Delay [ns]:	140	280	330	380	430	490	560	640	730
LogNor-mal	off	off	off	off	off	off	off	off	off
Corr with	off	off	off	off	off	off	off	off	off
Power Ratio [dB]:	0	0	0	0	0	0	0	0	0
Freq Ratio:	0	0	0	0	0	0	0	0	0
Speed [km/h]:	10,8	10,8	10,8	10,8	10,8	10,8	10,8	10,8	10,8

Corresp. to a typical large open space and office environments for NLOS conditions and an average rms delay spread of 100ns

A.7.3 WLAN / hyperlan/2 model c

	Path 4	Path 2	Path 5	Path 1	Path 3	Path 6	Path 7	Path 10	Path 9
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	3,3	3,6	3,9	4,2	0	0,9	1,7	2,6	1,5
Delay [ns]:	0	10	20	30	50	80	110	140	180
LogNor-mal	off	off	off	off	off	off	off	off	off
Corr with	off	off	off	off	off	off	off	off	off
Power Ratio [dB]:	0	0	0	0	0	0	0	0	0
Freq Ratio:	0	0	0	0	0	0	0	0	0
Speed [km/h]:	10,8	10,8	10,8	10,8	10,8	10,8	10,8	10,8	10,8
	Path 8	**Path 14**	**Path 12**	**Path 13**	**Path 11**	**Path 15**	**Path 16**	**Path 17**	**Path 18**
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	3	4,4	5,9	5,3	7,9	9,4	13,2	16,3	21,2
Delay [ns]:	230	280	330	400	490	600	730	880	1050
LogNor-mal	off	off	off	off	off	off	off	off	off
Corr with	off	off	off	off	off	off	off	off	off
Power Ratio [dB]:	0	0	0	0	0	0	0	0	0
Freq Ratio:	0	0	0	0	0	0	0	0	0
Speed [km/h]:	10,8	10,8	10,8	10,8	10,8	10,8	10,8	10,8	10,8

A.7.4 WLAN / hyperlan/2 model d

	Path 4	Path 2	Path 5	Path 1	Path 3	Path 6	Path 7	Path 10	Path 9
Profile [Type]	Rice	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	0	10	10,3	10,6	6,4	7,2	8,1	9	7,9
Delay [ns]:	0	10	20	30	50	80	110	140	180
LogNor-mal	off	off	off	off	off	off	off	off	off
Corr with	off	off	off	off	off	off	off	off	off
Power Ratio [dB]:	10	0	0	0	0	0	0	0	0
Freq Ratio:	0	0	0	0	0	0	0	0	0
Speed [km/h]:	10,8	10,8	10,8	10,8	10,8	10,8	10,8	10,8	10,8
	Path 8	**Path 14**	**Path 12**	**Path 13**	**Path 11**	**Path 15**	**Path 16**	**Path 17**	**Path 18**
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	9,4	10,8	12,3	11,7	14,3	15,8	19,6	22,7	27,6
Delay [ns]:	230	280	330	400	490	600	730	880	1050
LogNor-mal	off	off	off	off	off	off	off	off	off
Corr with	off	off	off	off	off	off	off	off	off
Power Ratio [dB]:	0	0	0	0	0	0	0	0	0
Freq Ratio:	0	0	0	0	0	0	0	0	0
Speed [km/h]:	10,8	10,8	10,8	10,8	10,8	10,8	10,8	10,8	10,8

Corresponds to a typical office environment for "LOS" conditions. A 10db spike at 0 delay has been added resulting in an average rms delay spread of 140ns

A.7.5 WLAN / hyperlan/2 model e

	Path 5	Path 2	Path 3	Path 4	Path 1	Path 6	Path 7	Path 8	Path 9
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	4,9	5,1	5,2	0,8	1,3	1,9	0,3	1,2	2,1
Delay [ns]:	0	10	20	40	70	100	140	190	240
LogNor-mal	off	off	off	off	off	off	off	off	off
Corr with	off	off	off	off	off	off	off	off	off
Power Ratio [dB]:	0	0	0	0	0	0	0	0	0
Freq Ratio:	0	0	0	0	0	0	0	0	0
Speed [km/h]:	10,8	10,8	10,8	10,8	10,8	10,8	10,8	10,8	10,8
	Path 10	**Path 11**	**Path 15**	**Path 13**	**Path 14**	**Path 12**	**Path 16**	**Path 17**	**Path 18**
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	0	1,9	2,8	5,4	7,3	10,6	13,4	17,4	20,9
Delay [ns]:	320	430	560	710	880	1070	1280	1510	1760
LogNor-mal	off	off	off	off	off	off	off	off	off
Corr with	off	off	off	off	off	off	off	off	off
Power Ratio [dB]:	0	0	0	0	0	0	0	0	0
Freq Ratio:	0	0	0	0	0	0	0	0	0
Speed [km/h]:	10,8	10,8	10,8	10,8	10,8	10,8	10,8	10,8	10,8

Corresponds to a typical large open space environment for NLOS conditions and an average rms delay spread of 250ns

A.8 DAB standards

Option: R&S SMW-K72

A.8.1 DAB RA (4 Taps)

	Path 1	Path 2	Path 3	Path 4
Profile [Type]	Rice	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	0	2	10	20
Delay [ns]:	0	200	400	600
LogNormal	off	off	off	off
Corr with	off	off	off	off
Power Ratio [dB]:	6.47	0	0	0
Freq Ratio:	0.7	0	0	0
Speed [km/h]:	120	120	120	120

Tap 2: S(d) = 0,1 +/- 0,02

A.8.2 DAB RA (6 Taps)

	Path 1	Path 2	Path 3	Path 4	Path 5	Path 6
Profile [Type]	Rice	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	0	4	8	12	16	20
Delay [ns]:	0	100	200	300	400	500
LogNormal	off	off	off	off	off	off
Corr with	off	off	off	off	off	off
Power Ratio [dB]:	6.47	0	0	0	0	0
Freq Ratio:	0.7	0	0	0	0	0
Speed [km/h]:	120	120	120	120	120	120

A.8.3 DAB TU (12 Taps)

	Path 1	Path 2	Path 3	Path 4	Path 5	Path 6
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Gaus1	Gaus1
Loss [dB]:	4	3	0	2,6	3	5
Delay [ns]:	0	100	300	500	800	1100
LogNormal	off	off	off	off	off	off
Corr with	off	off	off	off	off	off
Power Ratio [dB]:	0	0	0	0	0	0
Freq Ratio:	0	0	0	0	0	0
Speed [km/h]:	25	25	25	25	25	25
	Path 7	**Path 8**	**Path 9**	**Path 10**	**Path 11**	**Path 12**
Profile [Type]	Gaus1	Gaus1	Gaus2	Gaus2	Gaus2	Gaus2
Loss [dB]:	7	5	6,5	8,6	11	10
Delay [ns]:	1300	1700	2300	3100	3200	5000
LogNormal	off	off	off	off	off	off
Corr with	off	off	off	off	off	off
Power Ratio [dB]:	0	0	0	0	0	0
Freq Ratio:	0	0	0	0	0	0
Speed [km/h]:	25	25	25	25	25	25

Tap 6: S(d) = 1,0 +/- 0,1

A.8.4 DAB TU (6 Taps)

	Path 1	Path 2	Path 3	Path 4	Path 5	Path 6
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Gaus1	Gaus2	Gaus2
Loss [dB]:	3	0	2	6	8	10
Delay [ns]:	0	200	500	1600	2300	5000
LogNormal	off	off	off	off	off	off
Corr with	off	off	off	off	off	off

	Path 1	Path 2	Path 3	Path 4	Path 5	Path 6
Power Ratio [dB]:	0	0	0	0	0	0
Freq Ratio:	0	0	0	0	0	0
Speed [km/h]:	25	25	25	25	25	25

Tap 3: S(d) = 1,0 +/- 0,1

A.8.5 DAB SFN (VHF)

	Path 1	Path 2	Path 3	Path 4	Path 5	Path 6	Path 7
Profile [Type]	Rayleigh	GausDAB	GausDAB	GausDAB	GausDAB	GausDAB	GausDAB
Loss [dB]:	0	13	18	22	26	31	32
Delay [ns]:	0	100000	220000	290000	385000	480000	600000
LogNor-mal	off	off	off	off	off	off	off
Corr with	off	off	off	off	off	off	off
Power Ratio [dB]:	0	0	0	0	0	0	0
Freq Ratio:	0	0	0	0	0	0	0
Speed [km/h]:	60	60	60	60	60	60	60

Needs both Fading Boards combined, i.e. Signal Routing "A->A(max paths) || B->B(unfaded)" or "A->A(unfaded) || B->B(max paths)".

Do not use Group 5.

A.9 WIMAX standards

- WiMAX SUI x
  Option: R&S SMW-K72
- WiMAX ITU
  Option: R&S SMW-B14/B15

A.9.1 SUI 1 (omni ant., 90%)

	Path 1	Path 2	Path 3
Profile [Type]	WMRice	WMDopp	WMDopp
Loss [dB]:	0	15	20
Delay [ns]:	0	400	900
LogNormal	off	off	off
Corr with	off	off	off
Power Ratio [dB]:	6,0206	0	0
Freq Ratio:	0,4	0,3	0,5
Speed [km/h]:	0.05	0.04	0.06

K-fact. = 4 ->> 10lg4 = 6,02

A.9.2 SUI 1 (omni ant., 75%)

	Path 1	Path 2	Path 3
Profile [Type]	WMRice	WMDopp	WMDopp
Loss [dB]:	0	15	20
Delay [ns]:	0	400	900
LogNormal	off	off	off
Corr with	off	off	off
Power Ratio [dB]:	13,0103	0	0
Freq Ratio:	0,4	0,3	0,5
Speed [km/h]:	0.05	0.04	0.06

A.9.3 SUI 1 (30° ant., 90%)

	Path 1	Path 2	Path 3
Profile [Type]	WMRice	WMDopp	WMDopp
Loss [dB]:	0	21	32
Delay [ns]:	0	400	900
LogNormal	off	off	off
Corr with	off	off	off
Power Ratio [dB]:	12,0412	0	0

	Path 1	Path 2	Path 3
Freq Ratio:	0,4	0,3	0,5
Speed [km/h]:	0.05	0.04	0.06

A.9.4 SUI 1 (30° ant., 75%)

	Path 1	Path 2	Path 3
Profile [Type]	WMRice	WMDopp	WMDopp
Loss [dB]:	0	21	32
Delay [ns]:	0	400	900
LogNormal	off	off	off
Corr with	off	off	off
Power Ratio [dB]:	18,57332	0	0
Freq Ratio:	0,4	0,3	0,5
Speed [km/h]:	0.05	0.04	0.06

K-fact. = 72

A.9.5 SUI 2 (omni ant., 75%)

	Path 1	Path 2	Path 3
Profile [Type]	WMRice	WMDopp	WMDopp
Loss [dB]:	0	12	15
Delay [ns]:	0	400	1100
LogNormal	off	off	off
Corr with	off	off	off
Power Ratio [dB]:	10,41393	0	0
Freq Ratio:	0,2	0,15	0,25
Speed [km/h]:	0.03	0.02	0.03

A.9.6 SUI 2 (30° ant., 90%)

	Path 1	Path 2	Path 3
Profile [Type]	WMRice	WMDopp	WMDopp
Loss [dB]:	0	18	27

	Path 1	Path 2	Path 3
Delay [ns]:	0	400	1100
LogNormal	off	off	off
Corr with	off	off	off
Power Ratio [dB]:	9,0309	0	0
Freq Ratio:	0,2	0,15	0,25
Speed [km/h]:	0.03	0.02	0.03

K=8

A.9.7 SUI 2 (30° ant., 75%)

	Path 1	Path 2	Path 3
Profile [Type]	WMRice	WMDopp	WMDopp
Loss [dB]:	0	18	27
Delay [ns]:	0	400	1100
LogNormal	off	off	off
Corr with	off	off	off
Power Ratio [dB]:	15,56303	0	0
Freq Ratio:	0,2	0,15	0,25
Speed [km/h]:	0.03	0.02	0.03

K=36

A.9.8 SUI 3 (omni ant., 90%)

	Path 1	Path 2	Path 3
Profile [Type]	WMRice	WMDopp	WMDopp
Loss [dB]:	0	5	10
Delay [ns]:	0	400	900
LogNormal	off	off	off
Corr with	off	off	off
Power Ratio [dB]:	0	0	0
Freq Ratio:	0,4	0,3	0,5
Speed [km/h]:	0.05	0.04	0.06

A.9.9 SUI 3 (omni ant., 75%)

	Path 1	Path 2	Path 3
Profile [Type]	WMRice	WMDopp	WMDopp
Loss [dB]:	0	5	10
Delay [ns]:	0	400	900
LogNormal	off	off	off
Corr with	off	off	off
Power Ratio [dB]:	8,45098	0	0
Freq Ratio:	0,4	0,3	0,5
Speed [km/h]:	0.05	0.04	0.06

K=7

A.9.10 SUI 3 (30° ant., 90%)

	Path 1	Path 2	Path 3
Profile [Type]	WMRice	WMDopp	WMDopp
Loss [dB]:	0	11	22
Delay [ns]:	0	400	900
LogNormal	off	off	off
Corr with	off	off	off
Power Ratio [dB]:	4,771213	0	0
Freq Ratio:	0,4	0,3	0,5
Speed [km/h]:	0.05	0.04	0.06

K=3

A.9.11 SUI 3 (30° ant., 75%)

	Path 1	Path 2	Path 3
Profile [Type]	WMRice	WMDopp	WMDopp
Loss [dB]:	0	11	22
Delay [ns]:	0	400	900
LogNormal	off	off	off
Corr with	off	off	off

	Path 1	Path 2	Path 3
Power Ratio [dB]:	12,78754	0	0
Freq Ratio:	0,4	0,3	0,5
Speed [km/h]:	0.05	0.04	0.06

K=19

A.9.12 SUI 4 (omni ant., 90%)

	Path 1	Path 2	Path 3
Profile [Type]	WMDopp	WMDopp	WMDopp
Loss [dB]:	0	4	8
Delay [ns]:	0	1500	4000
LogNormal	off	off	off
Corr with	off	off	off
Power Ratio [dB]:	0	0	0
Freq Ratio:	0,2	0,15	0,25
Speed [km/h]:	0.03	0.02	0.03

K=0 (no Rice-component)

A.9.13 SUI 4 (omni ant., 75%)

	Path 1	Path 2	Path 3
Profile [Type]	WMRice	WMDopp	WMDopp
Loss [dB]:	0	4	8
Delay [ns]:	0	1500	4000
LogNormal	off	off	off
Corr with	off	off	off
Power Ratio [dB]:	0	0	0
Freq Ratio:	0,2	0,15	0,25
Speed [km/h]:	0.03	0.02	0.03

K=1

A.9.14 SUI 4 (30° ant., 90%)

	Path 1	Path 2	Path 3
Profile [Type]	WMRice	WMDopp	WMDopp
Loss [dB]:	0	10	20
Delay [ns]:	0	400	1100
LogNormal	off	off	off
Corr with	off	off	off
Power Ratio [dB]:	0	0	0
Freq Ratio:	0,2	0,15	0,25
Speed [km/h]:	0.03	0.02	0.03

K=1

A.9.15 SUI 4 (30° ant., 75%)

	Path 1	Path 2	Path 3
Profile [Type]	WMRice	WMDopp	WMDopp
Loss [dB]:	0	10	20
Delay [ns]:	0	400	1100
LogNormal	off	off	off
Corr with	off	off	off
Power Ratio [dB]:	6,9897	0	0
Freq Ratio:	0,2	0,15	0,25
Speed [km/h]:	0.03	0.02	0.03

K=5

A.9.16 SUI 5 (omni ant., 90%)

	Path 1	Path 2	Path 3
Profile [Type]	WMDopp	WMDopp	WMDopp
Loss [dB]:	0	5	10
Delay [ns]:	0	4000	10000
LogNormal	off	off	off
Corr with	off	off	off

	Path 1	Path 2	Path 3
Power Ratio [dB]:	0	0	0
Freq Ratio:	0,2	0,15	0,25
Speed [km/h]:	0.03	0.02	0.03

K=0 (no Rice-component)

A.9.17 SUI 5 (omni ant., 75%)

	Path 1	Path 2	Path 3
Profile [Type]	WMDopp	WMDopp	WMDopp
Loss [dB]:	0	5	10
Delay [ns]:	0	4000	10000
LogNormal	off	off	off
Corr with	off	off	off
Power Ratio [dB]:	0	0	0
Freq Ratio:	0,2	0,15	0,25
Speed [km/h]:	0.03	0.02	0.03

K=0 (no Rice-component)

A.9.18 SUI 5 (omni ant., 50%)

	Path 1	Path 2	Path 3
Profile [Type]	WMRice	WMDopp	WMDopp
Loss [dB]:	0	5	10
Delay [ns]:	0	4000	10000
LogNormal	off	off	off
Corr with	off	off	off
Power Ratio [dB]:	3,0103	0	0
Freq Ratio:	0,2	0,15	0,25
Speed [km/h]:	0.03	0.02	0.03

K=2

A.9.19 SUI 5 (30° ant., 90%)

	Path 1	Path 2	Path 3
Profile [Type]	WMDopp	WMDopp	WMDopp
Loss [dB]:	0	11	22
Delay [ns]:	0	4000	10000
LogNormal	off	off	off
Corr with	off	off	off
Power Ratio [dB]:	0	0	0
Freq Ratio:	0,2	0,15	0,25
Speed [km/h]:	0.03	0.02	0.03

K=0 (no Rice-component)

A.9.20 SUI 5 (30° ant., 75%)

	Path 1	Path 2	Path 3
Profile [Type]	WMRice	WMDopp	WMDopp
Loss [dB]:	0	11	22
Delay [ns]:	0	4000	10000
LogNormal	off	off	off
Corr with	off	off	off
Power Ratio [dB]:	3,0103	0	0
Freq Ratio:	0,2	0,15	0,25
Speed [km/h]:	0.03	0.02	0.03

K=2

A.9.21 SUI 5 (30° ant., 50%)

	Path 1	Path 2	Path 3
Profile [Type]	WMRice	WMDopp	WMDopp
Loss [dB]:	0	11	22
Delay [ns]:	0	4000	10000
LogNormal	off	off	off
Corr with	off	off	off

	Path 1	Path 2	Path 3
Power Ratio [dB]:	8,45098	0	0
Freq Ratio:	0,2	0,15	0,25
Speed [km/h]:	0.03	0.02	0.03

K=7

A.9.22 SUI 6 (omni ant., 90%)

	Path 1	Path 2	Path 3
Profile [Type]	WMDopp	WMDopp	WMDopp
Loss [dB]:	0	10	14
Delay [ns]:	0	14000	20000
LogNormal	off	off	off
Corr with	off	off	off
Power Ratio [dB]:	0	0	0
Freq Ratio:	0,4	0,3	0,5
Speed [km/h]:	0.05	0.04	0.06

K=0 (no Rice-component)

A.9.23 SUI 6 (omni ant., 75%)

	Path 1	Path 2	Path 3
Profile [Type]	WMDopp	WMDopp	WMDopp
Loss [dB]:	0	10	14
Delay [ns]:	0	14000	20000
LogNormal	off	off	off
Corr with	off	off	off
Power Ratio [dB]:	0	0	0
Freq Ratio:	0,4	0,3	0,5
Speed [km/h]:	0.05	0.04	0.06

K=0 (no Rice-component)

A.9.24 SUI 6 (omni ant., 50%)

	Path 1	Path 2	Path 3
Profile [Type]	WMRice	WMDopp	WMDopp
Loss [dB]:	0	10	14
Delay [ns]:	0	14000	20000
LogNormal	off	off	off
Corr with	off	off	off
Power Ratio [dB]:	0	0	0
Freq Ratio:	0,4	0,3	0,5
Speed [km/h]:	0.05	0.04	0.06

K=1

A.9.25 SUI 6 (30° ant., 90%)

	Path 1	Path 2	Path 3
Profile [Type]	WMDopp	WMDopp	WMDopp
Loss [dB]:	0	16	26
Delay [ns]:	0	14000	20000
LogNormal	off	off	off
Corr with	off	off	off
Power Ratio [dB]:	0	0	0
Freq Ratio:	0,4	0,3	0,5
Speed [km/h]:	0.05	0.04	0.06

K=0 (no Rice-component)

A.9.26 SUI 6 (30° ant., 75%)

	Path 1	Path 2	Path 3
Profile [Type]	WMRice	WMDopp	WMDopp
Loss [dB]:	0	16	26
Delay [ns]:	0	14000	20000
LogNormal	off	off	off
Corr with	off	off	off

	Path 1	Path 2	Path 3
Power Ratio [dB]:	3,0103	0	0
Freq Ratio:	0,4	0,3	0,5
Speed [km/h]:	0.05	0.04	0.06

K=2

A.9.27 SUI 6 (30° ant., 50%)

	Path 1	Path 2	Path 3
Profile [Type]	WMRice	WMDopp	WMDopp
Loss [dB]:	0	16	26
Delay [ns]:	0	14000	20000
LogNormal	off	off	off
Corr with	off	off	off
Power Ratio [dB]:	6,9897	0	0
Freq Ratio:	0,4	0,3	0,5
Speed [km/h]:	0.05	0.04	0.06

K=5

A.9.28 ITU OIP-A

	Path 1 (Path 4)	Path 2	Path 3	Path 4 (Path 1)
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	0	9,7	19,2	22,8
Delay [ns]:	0	110	190	410
LogNormal	off	off	off	off
Corr with	off	off	off	off
Power Ratio [dB]:	0	0	0	0
Freq Ratio:	0	0	0	0
Speed [km/h]:	-	-	-	-

A.9.29 ITU OIP-B

	Path 1	Path 2	Path 3	Path 4	Path 5	Path 6
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	0	0,9	4,9	8	7,8	23,9
Delay [ns]:	0	200	800	1200	2300	3700
LogNormal	off	off	off	off	off	off
Corr with	off	off	off	off	off	off
Power Ratio [dB]:	0	0	0	0	0	0
Freq Ratio:	0	0	0	0	0	0
Speed [km/h]:	-	-	-	-	-	-

A.9.30 ITU V-A 60

	Path 1 (Path 4)	Path 2	Path 3	Path 4 (Path 1)	Path 5 (Path 7)	Path 6
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	0	1	9	10	15	20
Delay [ns]:	0	310	710	1090	1730	2510
LogNormal	off	off	off	off	off	off
Corr with	off	off	off	off	off	off
Power Ratio [dB]:	0	0	0	0	0	0
Freq Ratio:	0	0	0	0	0	0
Speed [km/h]:	60	60	60	60	60	60

A.9.31 ITU V-A 120

	Path 1 (Path 4)	Path 2	Path 3	Path 4 (Path 1)	Path 5 (Path 7)	Path 6
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	0	1	9	10	15	20
Delay [ns]:	0	310	710	1090	1730	10000

	Path 1 (Path 4)	Path 2	Path 3	Path 4 (Path 1)	Path 5 (Path 7)	Path 6
LogNormal	off	off	off	off	off	off
Corr with	off	off	off	off	off	off
Power Ratio [dB]:	0	0	0	0	0	0
Freq Ratio:	0	0	0	0	0	0
Speed [km/h]:	120	120	120	120	120	120

A.10 LTE standards

Option: R&S SMW-B14/B15

A.10.1 CQI 5Hz

CQI Tests according to 3GPP 36.521.1 Version 9.1.0, B2.4

	Path 1	Path 2
Profile [Type]	Const. Phase	Pure Doppler
Loss [dB]:	0	0
Delay [ns]:	0	450
LogNormal	off	off
Corr with	off	off
Power Ratio [dB]:	0	0
Freq Ratio:	0	0
Speed [Hz]:	0	5 Hz

A.10.2 EPA (Extended pedestrian A)

Table A-22: 3GPP TR36.803

	Path 4	Path 2	Path 3	Path 1	Path 5
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh	
Loss [dB]:	0	1	2	3	
Delay [ns]:	0	30	70	90	
LogNormal	off	off	off	off	
Corr with	off	off	off	off	

	Path 4	Path 2	Path 3	Path 1	Path 5
Power Ratio [dB]:	0	0	0	0	
Frequency [Hz]: *					
	Path 6	**Path 7**	**Path 8**	**Path 9**	**Path 10**
Profile [Type]	Rayleigh	Rayleigh	Rayleigh		
Loss [dB]:	17.2	20.8	8		
Delay [ns]:	190	410	110		
LogNormal	off	off	off		
Corr with	off	off	off		
Power Ratio [dB]:	0	0	0		
Frequency [Hz]: *					

*) **Frequency [Hz] = 1 Hz or 5 Hz**

A.10.3 EVA (Extended vehicular A)

Table A-23: 3GPP TR36.803

	Path 4	Path 2	Path 3	Path 1	Path 11
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	0	1.5	1.4	3.6	0.6
Delay [ns]:	0	30	150	310	370
LogNormal	off	off	off	off	off
Corr with	off	off	off	off	off
Power Ratio [dB]:	0	0	0	0	0
Frequency [Hz]: *					
	Path 6	**Path 7**	**Path 8**	**Path 12**	**Path 10**
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh	
Loss [dB]:	9.1	7	12	16.9	
Delay [ns]:	710	1090	1730	2510	
LogNormal	off	off	off	off	
Corr with	off	off	off	off	

	Path 4	Path 2	Path 3	Path 1	Path 11
Power Ratio [dB]:	0	0	0	0	
Frequency [Hz]: *					

***) Frequency [Hz] = 5 Hz or 70 Hz**

A.10.4 ETU (Extended typical urban)

Table A-24: 3GPP TR36.803

	Path 5	Path 2	Path 3	Path 4	Path 1
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	1	1	1	0	0
Delay [ns]:	0	50	120	200	230
LogNormal	off	off	off	off	off
Corr with	off	off	off	off	off
Power Ratio [dB]:	0	0	0	0	0
Frequency [Hz]: *					
	Path 6	**Path 7**	**Path 8**	**Path 9**	**Path 10**
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	0	3	5	7	
Delay [ns]:	500	1600	2300	5000	
LogNormal	off	off	off	off	
Corr with	off	off	off	off	
Power Ratio [dB]:	0	0	0	0	
Frequency [Hz]: *					

***) Frequency [Hz] = 1 Hz, 5 Hz, 30 Hz, 70 Hz, 200 Hz, 300 Hz or 600 Hz**

A.10.5 MBSFN propagation channel profile (5 hz)

See Chapter A.6.13, "3GPP MBSFN propagation channel profile (18 path)", on page 266.

* All fading paths use "Frequency = 5 Hz" and "Speed = 5.4 km/h".

A.10.6 HST 1 open space

See Chapter A.14.1, "HST1 open space, HST1 open space (DL+UL)", on page 306.

A.10.7 HST 1 500 A/B, HST 3 500 A/B

According to 3GPP TS 36.141, Release 16.

The following applies to all HST scenarios:

- "Signal Dedicated to = Baseband Output"
- "Consider DL RF = Yes"

Fading scenario	HST1-LTE500a	HST1-LTE500b	HST3-LTE500a	HST3-LTE500b
Virtual RF [MHz]	2010	1880	2010	1880
Profile	Pure Doppler	Pure Doppler	Pure Doppler	Pure Doppler
Speed [km/h]:	500	500	500	500
D_{min} [m]	50	50	2	2
D_s [m]	1000	1000	300	300
Virtual DL RF [MHz]	2010	1880	2010	1880

A.10.8 HST 3 tunnel multi antennas

See Chapter A.14.3, "HST3 tunnel multi antennas, HST3 tunnel multi antennas (DL +UL)", on page 307.

A.10.9 ETU 200Hz moving

See Chapter A.15.2, "ETU 200Hz moving (UL timing adjustment, scenario 1)", on page 308.

A.10.10 Pure doppler moving

See Chapter A.15.3, "Pure doppler moving (UL timing adjustment, scenario 2)", on page 309.

A.11 LTE-MIMO standards

Option: R&S SMW-K74

A.11.1 EPA (Extended pedestrian A)

See Chapter A.10.2, "EPA (Extended pedestrian A)", on page 292.

A.11.2 EVA (Extended vehicular A)

	Path 1	Path 2	Path 3	Path 11	Path 12
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	0	1.5	1.4	3.6	0.6
Delay [ns]:	0	30	150	310	370
LogNormal	off	off	off	off	off
Corr with	off	off	off	off	off
Power Ratio [dB]:	0	0	0	0	0
Frequency [Hz]: *					
	Path 6	**Path 7**	**Path 8**	**Path 13**	**Path 10**
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	9.1	7	12	16.9	
Delay [ns]:	710	1090	1730	2510	
LogNormal	off	off	off	off	
Corr with	off	off	off	off	
Power Ratio [dB]:	0	0	0	0	
Frequency [Hz]: *					

A.11.3 ETU (Extended typical urban)

See Chapter A.10.4, "ETU (Extended typical urban)", on page 294.

A.11.4 MIMO parameter

Table A-25: R-High

real	imaginary	real	imaginary	real	imaginary	real	imaginary
1	0	-0.4193	0.24	0.5297	0.7013	-0.3904	-0.1669
-0.4193	-0.24	1	0	-0.0538	-0.4212	0.5297	0.7013

real	imaginary	real	imaginary	real	imaginary	real	imaginary
0.5297	-0.7013	-0.0538	0.4212	1	0	-0.4193	0.24
-0.3904	0.1669	0.5297	-0.7013	-0.4193	-0.24	1	0

Table A-26: R-Medium

real	imaginary	real	imaginary	real	imaginary	real	imaginary
1	0	0	0	0.7264	0	0	0
0	0	1	0	0	0	-0.7264	0
0.7264	0	0	0	1	0	0	0
0	0	-0.7264	0	0	0	1	0

Table A-27: R-Low

real	imaginary	real	imaginary	real	imaginary	real	imaginary
1	0	0	0	0	0	0	0
0	0	1	0	0	0	0	0
0	0	0	0	1	0	0	0
0	0	0	0	0	0	1	0

The MIMO correlation matrices for the high, medium and low antenna correlation for the 1x2, 2x2 and 4x2 MIMO configurations are calculated according to 3GPP TS36.101, annex B2.3.2.

A.11.5 HST3 tunnel multi antennas

See Chapter A.14.3, "HST3 tunnel multi antennas, HST3 tunnel multi antennas (DL +UL)", on page 307.

A.12 WIMAX-MIMO standards

Option: R&S SMW-K74

A.12.1 ITU pedestrian b 3

	Path 1	Path 2	Path 3	Path 4	Path 5	Path 6
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	0	0,9	4,9	8	7,8	23,9
Delay [ns]:	0	200	800	1200	2300	3700

	Path 1	Path 2	Path 3	Path 4	Path 5	Path 6
LogNormal	off	off	off	off	off	off
Corr with	off	off	off	off	off	off
Power Ratio [dB]:	0	0	0	0	0	0
Speed [km/h]:	3	3	3	3	3	3

Table A-28: MIMO Parameter - High Correlation

	real	imaginary	real	imaginary	real	imaginary	real	imaginary
TAP 1	1	0	-0,1468	0,4156	0,0303	0,7064	-0,298	-0,0911
	-0,1468	-0,4156	1	0	0,28913	-0,1163	0,0303	0,7064
	0,0303	-0,7064	0,28913	0,11629	1	0	-0,1468	0,4156
	-0,298	0,09111	0,0303	-0,7064	-0,1468	-0,4156	1	0
TAP 2	1	0	-0,4467	0,4227	-0,4007	-0,6073	0,4357	0,10191
	-0,4467	-0,4227	1	0	-0,0777	0,44066	-0,4007	-0,6073
	-0,4007	0,6073	-0,0777	-0,4407	1	0	-0,4467	0,4227
	0,4357	-0,1019	-0,4007	0,6073	-0,4467	-0,4227	1	0
TAP 3	1	0	-0,2906	0,4347	-0,6664	0,262	0,07976	-0,3658
	-0,2906	-0,4347	1	0	0,30755	0,21355	-0,6664	0,262
	-0,6664	-0,262	0,30755	-0,2135	1	0	-0,2906	0,4347
	0,07976	0,36582	-0,6664	-0,262	-0,2906	-0,4347	1	0
TAP 4	1	0	-0,4273	0,4259	-0,6522	0,2088	0,18976	-0,367
	-0,4273	-0,4259	1	0	0,36761	0,18855	-0,6522	0,2088
	-0,6522	-0,2088	0,36761	-0,1886	1	0	-0,4273	0,4259
	0,18976	0,36699	-0,6522	-0,2088	-0,4273	-0,4259	1	0
TAP 5	1	0	-0,7026	-0,3395	-0,5378	-0,4866	0,21266	0,52447
	-0,7026	0,3395	1	0	0,54306	0,1593	-0,5378	-0,4866
	-0,5378	0,4866	0,54306	-0,1593	1	0	-0,7026	-0,3395
	0,21266	-0,5245	-0,5378	0,4866	-0,7026	0,3395	1	0
TAP 6	1	0	-0,45	0,4222	-0,4564	-0,5655	0,44413	0,06178
	-0,45	-0,4222	1	0	-0,0334	0,44717	-0,4564	-0,5655
	-0,4564	0,5655	-0,0334	-0,4472	1	0	-0,45	0,4222
	0,44413	-0,0618	-0,4564	0,5655	-0,45	-0,4222	1	0

Table A-29: MIMO Parameter - Medium Correlation

	real	imaginary	real	imaginary	real	imaginary	real	imaginary
TAP 1-TAP 6	1	0	0	0	0,7264	0	0	0
	0	0	1	0	0	0	-0,7264	0
	0,7264	0	0	0	1	0	0	0
	0	0	-0,7264	0	0	0	1	0

Table A-30: MIMO Parameter - Low Correlation

	real	imaginary	real	imaginary	real	imaginary	real	imaginary
TAP 1	1	0	0	0	0,02201	0,51313	0	0
	0	0	1	0	0	0	-0,022	-0,5131
	0,02201	-0,5131	0	0	1	0	0	0
	0	0	-0,022	0,51313	0	0	1	0
TAP 2	1	0	0	0	-0,2911	-0,4411	0	0
	0	0	1	0	0	0	0,29107	0,44114
	-0,2911	0,44114	0	0	1	0	0	0
	0	0	0,29107	-0,4411	0	0	1	0
TAP 3	1	0	0	0	-0,4841	0,19032	0	0
	0	0	1	0	0	0	0,48407	-0,1903
	-0,4841	-0,1903	0	0	1	0	0	0
	0	0	0,48407	0,19032	0	0	1	0
TAP 4	1	0	0	0	-0,4738	0,15167	0	0
	0	0	1	0	0	0	0,47376	-0,1517
	-0,4738	-0,1517	0	0	1	0	0	0
	0	0	0,47376	0,15167	0	0	1	0
TAP 5	1	0	0	0	-0,3907	-0,3535	0	0
	0	0	1	0	0	0	0,39066	0,35347
	-0,3907	0,35347	0	0	1	0	0	0
	0	0	0,39066	-0,3535	0	0	1	0
TAP 6	1	0	0	0	-0,3315	-0,4108	0	0
	0	0	1	0	0	0	0,33153	0,41078
	-0,3315	0,41078	0	0	1	0	0	0
	0	0	0,33153	-0,4108	0	0	1	0

A.12.2 ITU vehicular A-60

	Path 1	Path 2	Path 3	Path 4 (Path 7)	Path 5 (Path 8)	Path 6
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	0	1	9	10	15	20
Delay [ns]:	0	310	710	1090	1730	2510
LogNormal	off	off	off	off	off	off
Corr with	off	off	off	off	off	off
Power Ratio [dB]:	0	0	0	0	0	0
Speed [km/h]:	60	60	60	60	60	60

Table A-31: MIMO Parameter - High Correlation

	real	imagi-nary	real	imagi-nary	real	imagi-nary	real	imagi-nary
TAP 1	1	0	-0,2366	0,4312	0,6883	0,1211	-0,2151	0,26814
	-0,2366	-0,4312	1	0	-0,1106	-0,3254	0,6883	0,1211
	0,6883	-0,1211	-0,1106	0,32545	1	0	-0,2366	0,4312
	-0,2151	-0,2681	0,6883	-0,1211	-0,2366	-0,4312	1	0
TAP 2	1	0	0,1388	0,2343	-0,3508	-0,5926	0,09016	-0,1644
	0,1388	-0,2343	1	0	-0,1875	-6E-05	-0,3508	-0,5926
	-0,3508	0,5926	-0,1875	6E-05	1	0	0,1388	0,2343
	0,09016	0,16445	-0,3508	0,5926	0,1388	-0,2343	1	0
TAP 3	1	0	-0,6443	0,365	0,3884	-0,5604	-0,0457	0,50283
	-0,6443	-0,365	1	0	-0,4548	0,2193	0,3884	-0,5604
	0,3884	0,5604	-0,4548	-0,2193	1	0	-0,6443	0,365
	-0,0457	-0,5028	0,3884	0,5604	-0,6443	-0,365	1	0
TAP 4	1	0	-0,362	0,4331	0,1899	0,6795	-0,363	-0,1637
	-0,362	-0,4331	1	0	0,22555	-0,3282	0,1899	0,6795
	0,1899	-0,6795	0,22555	0,32822	1	0	-0,362	0,4331
	-0,363	0,16373	0,1899	-0,6795	-0,362	-0,4331	1	0
TAP 5	1	0	-0,7074	0,3372	-0,3933	-0,565	0,46874	0,26706
	-0,7074	-0,3372	1	0	0,0877	0,5323	-0,3933	-0,565
	-0,3933	0,565	0,0877	-0,5323	1	0	-0,7074	0,3372

	real	imaginary	real	imaginary	real	imaginary	real	imaginary
	0,46874	-0,2671	-0,3933	0,565	-0,7074	-0,3372	1	0
TAP 6	1	0	-0,4405	0,4238	-0,4383	-0,58	0,43888	0,06974
	-0,4405	-0,4238	1	0	-0,0527	0,44124	-0,4383	-0,58
	-0,4383	0,58	-0,0527	-0,4412	1	0	-0,4405	0,4238
	0,43888	-0,0697	-0,4383	0,58	-0,4405	-0,4238	1	0

Table A-32: MIMO Parameter - Medium Correlation

	real	imaginary	real	imaginary	real	imaginary	real	imaginary
TAP 1-TAP 6	1	0	0	0	0,7264	0	0	0
	0	0	1	0	0	0	-0,7264	0
	0,7264	0	0	0	1	0	0	0
	0	0	-0,7264	0	0	0	1	0

Table A-33: MIMO Parameter - Low Correlation

	real	imaginary	real	imaginary	real	imaginary	real	imaginary
TAP 1	1	0	0	0	0,49998	0,08797	0	0
	0	0	1	0	0	0	-0,5	-0,088
	0,49998	-0,088	0	0	1	0	0	0
	0	0	-0,5	0,08797	0	0	1	0
TAP 2	1	0	0	0	-0,2548	-0,4305	0	0
	0	0	1	0	0	0	0,25482	0,43046
	-0,2548	0,43046	0	0	1	0	0	0
	0	0	0,25482	-0,4305	0	0	1	0
TAP 3	1	0	0	0	0,28213	-0,4071	0	0
	0	0	1	0	0	0	-0,2821	0,40707
	0,28213	0,40707	0	0	1	0	0	0
	0	0	-0,2821	-0,4071	0	0	1	0
TAP 4	1	0	0	0	0,13794	0,49359	0	0
	0	0	1	0	0	0	-0,1379	-0,4936
	0,13794	-0,4936	0	0	1	0	0	0
	0	0	-0,1379	0,49359	0	0	1	0
TAP 5	1	0	0	0	-0,3907	-0,3535	0	0

	real	imagi-nary	real	imagi-nary	real	imagi-nary	real	imagi-nary
	0	0	1	0	0	0	0,39066	0,35347
	-0,3907	0,35347	0	0	1	0	0	0
	0	0	0,39066	-0,3535	0	0	1	0
TAP 6	1	0	0	0	-0,3184	-0,4213	0	0
	0	0	1	0	0	0	0,31838	0,42131
	-0,3184	0,42131	0	0	1	0	0	0
	0	0	0,31838	-0,4213	0	0	1	0

A.13 1xevdo standards

Option: R&S SMW-B14/B15

According to 3GPP2 C.S0032-A v2.0

A.13.1 1xevdo chan. 1

	Path 1	Path 2
Profile [Type]	Rayleigh	Rayleigh
Loss [dB]:	0	0
Delay [ns]:	0	2000
LogNormal	off	off
Corr with	off	off
Power Ratio [dB]:	0	0
Freq Ratio:	0	0
Speed [km/h]:	8	8

A.13.2 1xevdo chan. 1 (Bd. 5, 11)

	Path 1	Path 2
Profile [Type]	Rayleigh	Rayleigh
Loss [dB]:	0	0
Delay [ns]:	0	2000
LogNormal	off	off
Corr with	off	off

	Path 1	Path 2
Power Ratio [dB]:	0	0
Freq Ratio:	0	0
Speed [km/h]:	15	15

A.13.3 1xevdo chan. 2

	Path 1
Profile [Type]	Rayleigh
Loss [dB]:	0
Delay [ns]:	0
LogNormal	off
Corr with	off
Power Ratio [dB]:	0
Freq Ratio:	0
Speed [km/h]:	3

A.13.4 1xevdo chan. 2 (Bd. 5, 11)

	Path 1
Profile [Type]	Rayleigh
Loss [dB]:	0
Delay [ns]:	0
LogNormal	off
Corr with	off
Power Ratio [dB]:	0
Freq Ratio:	0
Speed [km/h]:	6

A.13.5 1xevdo chan. 3

	Path 1
Profile [Type]	Rayleigh
Loss [dB]:	0

	Path 1
Delay [ns]:	0
LogNormal	off
Corr with	off
Power Ratio [dB]:	0
Freq Ratio:	0
Speed [km/h]:	30

A.13.6 1xevdo chan. 3 (Bd. 5, 11)

	Path 1
Profile [Type]	Rayleigh
Loss [dB]:	0
Delay [ns]:	0
LogNormal	off
Corr with	off
Power Ratio [dB]:	0
Freq Ratio:	0
Speed [km/h]:	58

A.13.7 1xevdo chan. 4

	Path 1	Path 2	Path 3
Profile [Type]	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	0	0	3
Delay [ns]:	0	2000	14500
LogNormal	off	off	off
Corr with	off	off	off
Power Ratio [dB]:	0	0	0
Freq Ratio:	0	0	0
Speed [km/h]:	100	100	100

A.13.8 1xevdo chan. 4 (Bd. 5, 11)

	Path 1	Path 2	Path 3
Profile [Type]	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	0	0	3
Delay [ns]:	0	2000	14500
LogNormal	off	off	off
Corr with	off	off	off
Power Ratio [dB]:	0	0	0
Freq Ratio:	0	0	0
Speed [km/h]:	192	192	192

A.13.9 1xevdo chan. 5

	Path 1	Path 2
Profile [Type]	Rayleigh	Rayleigh
Loss [dB]:	0	0
Delay [ns]:	0	2000
LogNormal	off	off
Corr with	off	off
Power Ratio [dB]:	0	0
Freq Ratio:	0	0
Speed [km/h]:	0	0

A.13.10 1xevdo chan. 5 (Bd. 5, 11)

	Path 1	Path 2
Profile [Type]	Rayleigh	Rayleigh
Loss [dB]:	0	0
Delay [ns]:	0	2000
LogNormal	off	off
Corr with	off	off
Power Ratio [dB]:	0	0

	Path 1	Path 2
Freq Ratio:	0	0
Speed [km/h]:	0	0

A.14 3GPP/LTE high speed train

Option: R&S SMW-K74 and R&S SMW-K71

A.14.1 HST1 open space, HST1 open space (DL+UL)

3GPP TS25.141, annex D.4A "High Speed Train" and 3GPP TS36.141, annex B.3 "High Speed Train"

The HST DL+UL standards consider the downlink and the uplink. That is, if a doppler shift occurs in the downlink, the mobile receiver synchronizes to that shifted frequency. The uplink to the base station then results in a doppler shift enlarged by a factor based on the sum of the DL and UL frequency.

	Path 1
Profile [Type]	Pure Doppler
Loss [dB]:	0
Delay [ns]:	0
LogNormal	off
Corr with	off
Power Ratio [dB]:	-
Freq Ratio:	
Speed [km/h]:	350km/h
D_{min}	50m
D_s	1000m

A.14.2 HST2 tunnel leaky cable, HST2 tunnel leaky cable (DL+UL)

3GPP TS25.141, annex D.4A "High Speed Train"

The HST DL+UL standards consider the downlink and the uplink. That is, if a doppler shift occurs in the downlink, the mobile receiver synchronizes to that shifted frequency. The uplink to the base station then results in a doppler shift enlarged by a factor based on the sum of the DL and UL frequency.

	Path 1
Profile [Type]	Rice
Loss [dB]:	10
Delay [ns]:	0
LogNormal	off
Corr with	off
Power Ratio [dB]:	0
Freq Ratio:	1
Speed [km/h]:	300km/h

A.14.3 HST3 tunnel multi antennas, HST3 tunnel multi antennas (DL+UL)

3GPP TS25.141, annex D.4A "High Speed Train" and 3GPP TS36.141, annex B.3A "High Speed Train"

The HST DL+UL standards consider the downlink and the uplink. That is, if a doppler shift occurs in the downlink, the mobile receiver synchronizes to that shifted frequency. The uplink to the base station then results in a doppler shift enlarged by a factor based on the sum of the DL and UL frequency.

	Path 1
Profile [Type]	Pure Doppler
Loss [dB]:	0
Delay [ns]:	0
LogNormal	off
Corr with	off
Power Ratio [dB]:	-
Freq Ratio:	
Speed [km/h]:	300km/h
D_{min}	2m
D_s	300m

A.15 3GPP/LTE moving propagation

Option: R&S SMW-K71

A.15.1 Reference + moving channel

Table A-34: 3GPP TS 25.101, annex B2.3

	Path 1	Path 2
Profile [Type]	Static	Static
Loss [dB]:	0	0
Delay [ns]:	0	1 to 6us
LogNormal	off	off
Corr with	off	off
Power Ratio [dB]:	0	0
Freq Ratio:	1	1
Speed [km/h]:	0	0

Period: 157,0796s = 2*PI/0.04

(Mean)-Delay: 3.5µs

A.15.2 ETU 200Hz moving (UL timing adjustment, scenario 1)

Table A-35: 3GPP TS36.141, annex B.4 "Moving Propagation Conditions"

	Path 1	Path 2	Path 3	Path 4	Path 5
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	1	1	1	0	0
Delay [ns]:	0	50	120	200	230
LogNormal	off	off	off	off	off
Corr with	off	off	off	off	off
Power Ratio [dB]:	0	0	0	0	0
Doppler [Hz]:					
Speed [km/h]:	120	120	120	120	120

	Path 6	Path 7	Path 8	Path 9
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	0	3	5	7
Delay [ns]:	500	1600	2300	5000
LogNormal	off	off	off	off
Corr with	off	off	off	off
Power Ratio [dB]:	0	0	0	0

	Path 6	Path 7	Path 8	Path 9
Doppler [Hz]:				
Speed [km/h]:	120	120	120	120

Period: 157,0796s = 2*PI/0.04

Amplitude: 5us = 10us/2

A.15.3 Pure doppler moving (UL timing adjustment, scenario 2)

Table A-36: 3GPP TS36.141, annex B.4 "Moving Propagation Conditions"

	Path 1
Profile [Type]	Pure Doppler
Loss [dB]:	0
Delay [ns]:	0
LogNormal	off
Corr with	off
Power Ratio [dB]:	0
Doppler [Hz]:	
Speed [km/h]:	350

Period: 48,33s = 2*PI/0.13

Amplitude: 5µs = 10µs/2

A.16 SCM and SCME channel models for MIMO OTA

Option: R&S SMW-K72

The SCM/SCME models define 6 clusters characterized by the delay, the AoA/AoD, AS and PAS shape.

These channel models are defined for 2x2 MIMO configuration and cannot be loaded in other MIMO configurations.

SCME models

The following antenna polarization and antenna pattern settings apply for all **SCME** models.

Antenna settings	Polarization	Distance (d_a)	Antenna pattern
Tx	Cross 45°	0	Dipole
Rx	Horizontal	0.5λ	Isotropic

Geo SCME models

The following antenna polarization and antenna pattern settings apply for all **Geo SCME**:

- "Polarization = On"
- "LOS component = Off"
- "σ_{SF} = 8 dB"
- "Use random start phases = On"

Antenna settings	Distance (d_a)	Antenna pattern
Tx	0	Dipole +45°/-45°
Rx	0.5λ	Vertical dipole

A.16.1 SCME/Geo SCME urban micro-cell channel (UMi) 3 km/h and 30 km/h

Tap	Path 4	Path 2	Path 3	Path 1	Path 16	Path 6
Cluster	1			2		
Profile [type]:	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	3	5.2	7	4.3	6.5	8.3
Delay [ns]:	0	5	10	285	290	295
Fine delay required:	0	0	0	0	0	0
AoA [°]:	0.7			-13.2		
AoD [°]:	6.6			14.1		

Tap	Path 7	Path 8	Path 13	Path 10	Path 11	Path 12
Cluster	3			4		
Profile [type]:	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	5.7	7.9	9.7	7.3	9.5	11.3
Delay [ns]:	205	210	215	660	665	670
Fine delay required:	0	0	0	0	0	0
AoA [°]:	146.1			-30.5		
AoD [°]:	50.8			38.4		

Tap	Path 9	Path 18	Path 15	Path 5	Path 17	Path 14
Cluster	5			6		
Profile [type]:	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	9	11.2	13	11.4	13.6	15.4
Delay [ns]:	800	810	820	920	930	940
Fine delay required:	0	0	0	0	0	0
AoA [°]:	-11.4			-1.1		
AoD [°]:	6.7			40.3		

Delay spread [ns]:	294
Cluster AS AoD / AS AoA [°]:	5 /35
Cluster PAS shape:	Laplacian
Total AS AoD / AS AoA [°]:	18.2 /67.8
Mobile speed [km/h] / direction of travel [°]:	3, 30 /120
XPR[1)] [dB]:	9

[1)] XPR = cross polarization power ratio in the selected propagation channel

A.16.2 SCME/Geo SCME urban macro-cell channel (UMa) 3 km/h and 30 km/h

Tap	Path 1	Path 2	Path 3	Path 4	Path 5	Path 6
Cluster	1			2		
Profile [type]:	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	3	5.2	7	5.2	7.4	9.2
Delay [ns]:	0	5	10	360	365	370
Fine delay required:	0	0	0	0	0	0
AoA [°]:	66			46		
AoD [°]:	82			81		

Tap	Path 7	Path 8	Path 9	Path 10	Path 11	Path 12
Cluster	3			4		
Profile [type]:	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh

Tap	Path 7	Path 8	Path 9	Path 10	Path 11	Path 12
Loss [dB]:	4.7	6.9	8.7	8.2	10.4	12.2
Delay [ns]:	255	260	265	1040	1045	1050
Fine delay required:	0	0	0	0	0	0
AoA [°]:	143			33		
AoD [°]:	80			99		

Tap	Path 13	Path 14	Path 15	Path 16	Path 17	Path 18
Cluster	5			6		
Profile [type]:	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	12.1	14.3	16.1	15.5	17.7	19.5
Delay [ns]:	2730	2735	2740	4600	4605	4610
Fine delay required:	0	0	0	0	0	0
AoA [°]:	-91			-19		
AoD [°]:	102			107		

Delay spread [ns]:	839.5
Cluster AS AoD / AS AoA [°]:	2 / 35
Cluster PAS shape:	Laplacian
Total AS AoD / AS AoA [°]:	7.8 / 62.6
Mobile speed [km/h] / direction of travel [°]:	3, 30 / 120
XPR[1)] [dB]:	9

[1)] XPR = cross polarization power ratio in the selected propagation channel

A.17 Watterson standards

Option: R&S SMW-K72

A.17.1 Watterson I1

	Path 1	Path 2	Path 3	Path 4	Path 5
Profile [Type]	Gauss-Watter-son	Gauss-Watter-son	Gauss-Watter-son	Gauss-Watter-son	Gauss-Watterson
Loss [dB]:	4.1	4.3	1.2	7.2	13.5
Delay [ns]:	40000	40000	40000	290000	1139000
LogNormal	off	off	off	off	off
Corr with	off	off	off	off	off
Freq. Spread:	0.0073	0.0318	0.0272	0.144	0.34
Freq Shift [Hz]:	0.0022	0.017	0.0094	0.0089	-0.167
Speed [km/h]:					

Tap 2: S(d) = 0,1 +/- 0,02

A.17.2 Watterson I2

	Path 1	Path 2	Path 3	Path 4	Path 5	Path 6
Profile [Type]	Gauss-Wat-terson	Gauss-Wat-terson	Gauss-Wat-terson	Gauss-Wat-terson	Gauss-Watter-son	Gauss-Watter-son
Loss [dB]:	4.1	5.5	1.7	5.9	17.6	12.6
Delay [ns]:	40000	40000	40000	290000	590000	1126000
LogNormal	off	off	off	off	off	off
Corr with	off	off	off	off	off	off
Freq. Spread:	0.0064	0.0084	0.0153	0.18	0.334	0.336
Freq Shift [Hz]:	-0.0008	0.0127	0.0071	0.0159	0.108	0.118
Speed [km/h]:						

Tap 3: S(d) = 0,1 +/- 0,02

A.17.3 Watterson I3

	Path 1	Path 2	Path 3	Path 4	Path 5
Profile [Type]	Gauss-Watter-son	Gauss-Watter-son	Gauss-Watter-son	Gauss-Watter-son	Gauss-Watterson
Loss [dB]:	3.8	5.7	1.6	10.8	10.6
Delay [ns]:	445000	445000	445000	750000	750000
LogNormal	off	off	off	off	off
Corr with	off	off	off	off	off
Freq. Spread:	0.034	0.032	0.0658	0.0104	0.013
Freq Shift [Hz]:	0.0764	0.0134	0.0989	0.121	0.141
Speed [km/h]:					

	Path 6	Path 7	Path 8	Path 9
Profile [Type]	Gauss-Watterson	Gauss-Watterson	Gauss-Watterson	Gauss-Watterson
Loss [dB]:	7.7	12.9	10.4	8.5
Delay [ns]:	750000	1088000	1088000	1088000
LogNormal	off	off	off	off
Corr with	off	off	off	off
Freq. Spread:	0.0229	0.0149	0.0206	0.0335
Freq Shift [Hz]:	0.131	0.121	0.151	0.014
Speed [km/h]:				

Tap 6: S(d) = 1,0 +/- 0,1

A.18 802.11n-SISO standards

Option: R&S SMW-B14/B15

These fading profiles are implemented as the IEEE 802.11n-MIMO models, expect that:

- Correlation Path = Off
- Coefficient, % = 100
- Phase, deg = 0

See Chapter A.19, "802.11n-MIMO standards", on page 315.

A.19 802.11n-MIMO standards

Option: R&S SMW-K71

According to IEEE 802.11-03/940r4

Rx Antenna Distance = 1

Tx Antenna Distance = 0.5

Distribution = Laplace

Profile = Bell Shape tgn Indoor, exception Model F, Path 3 where the Profile = Bell Shape tgn Moving Vehicle

Speed = 1.2 km/h, exception Model F, Path 3 where Speed = 40 km/h

A.19.1 Model a

Tap:	**Path 1**
Cluster	
Profil [Typ]	Bell Shape tgn Indoor
Loss [dB]	0
Delay [ns]	0
AoA	45
AS (A)	40
AoD	45
AS (D)	40
Speed [km/h]	1.2

A.19.2 Model b

Tap:	**Path 4**	**Path 2**	**Path 3**		**Path 1**	
Cluster			1	2	1	2
Profil [Typ]	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor
(Relative) Loss [dB]:	0	5.4	10.8	3.2	16.2	6.3
Delay [ns]:	0	10	20	20	30	30
AoA:	4.3	4.3	4.3	118.4	4.3	118.4
AS (A):	14.4	14.4	14.4	25.2	14.4	25.2
AoD:	225.1	225.1	225.1	106.5	225.1	106.5

Tap:	Path 4	Path 2	Path 3		Path 1	
AS (D):	14.4	14.4	14.4	25.4	14.4	25.4
Speed [km/h]	1.2	1.2	1.2	1.2	1.2	1.2
Distribution	Laplace	Laplace	Laplace	Laplace	Laplace	Laplace

Tap:	Path 5		Path 6	Path 7	Path 8	Path 9
Cluster	1	2				
Profil [Typ]	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor
(Relative) Loss [dB]:	21.7	9.4	12.5	15.6	18.7	21.8
Delay [ns]:	40	40	50	60	70	80
AoA:	4.3	118.4	118.4	118.4	118.4	118.4
AS (A):	14.4	25.2	25.2	25.2	25.2	25.2
AoD:	225.1	106.5	106.5	106.5	106.5	106.5
AS (D):	14.4	25.4	25.4	25.4	25.4	25.4
Speed [km/h]	1.2	1.2	1.2	1.2	1.2	1.2
Distribution	Laplace	Laplace	Laplace	Laplace	Laplace	Laplace

A.19.3 Model c

Tap:	Path 4	Path 2	Path 3	Path 1	Path 5	Path 6
Cluster						
Profil [Typ]	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor
(Relative) Loss [dB]:	0	2.1	4.3	6.5	8.6	10.8
Delay [ns]:	0	10	20	30	40	50
AoA:	290.3	290.3	290.3	290.3	290.3	290.3
AS (A):	24.6	24.6	24.6	24.6	24.6	24.6
AoD:	13.5	13.5	13.5	13.5	13.5	13.5
AS (D):	24.7	24.7	24.7	24.7	24.7	24.7
Speed [km/h]	1.2	1.2	1.2	1.2	1.2	1.2
Distribution	Laplace	Laplace	Laplace	Laplace	Laplace	Laplace

Tap:	Path 10	Path 10	Path 8	Path 8	Path 9	Path 9
Cluster	1	2	1	2	1	2
Profil [Typ]	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor
(Relative) Loss [dB]:	13	5	15.2	7.2	17.3	9.3
Delay [ns]:	60	60	70	70	80	80
AoA:	290.3	332.3	290.3	332.3	290.3	332.3
AS (A):	24.6	22.4	24.6	22.4	24.6	22.4
AoD:	13.5	56.4	13.5	56.4	13.5	56.4
AS (D):	24.7	22.5	24.7	22.5	24.7	22.5
Speed [km/h]	1.2	1.2	1.2	1.2	1.2	1.2
Distribution	Laplace	Laplace	Laplace	Laplace	Laplace	Laplace

Tap:	Path 7	Path 7	Path 11	Path 12	Path 13	Path 14
Cluster	1	2				
Profil [Typ]	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor
(Relative) Loss [dB]:	19.5	11.5	13.7	15.8	18	20.2
Delay [ns]:	90	90	110	140	170	200
AoA:	290.3	332.3	332.3	332.3	332.3	332.3
AS (A):	24.6	22.4	22.4	22.4	22.4	22.4
AoD:	13.5	56.4	56.4	56.4	56.4	56.4
AS (D):	24.7	22.5	22.5	22.5	22.5	22.5
Speed [km/h]	1.2	1.2	1.2	1.2	1.2	1.2
Distribution	Laplace	Laplace	Laplace	Laplace	Laplace	Laplace

A.19.4 Model d

Tap:	Path 4	Path 2	Path 3	Path 1	Path 5	Path 6
Cluster						
Profil [Typ]	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor
(Relative) Loss [dB]:	0	0.9	1.7	2.6	3.5	4.3

Tap:	Path 4	Path 2	Path 3	Path 1	Path 5	Path 6
Delay [ns]:	0	10	20	30	40	50
AoA:	158.9	158.9	158.9	158.9	158.9	158.9
AS (A):	27.7	27.7	27.7	27.7	27.7	27.7
AoD:	332.1	332.1	332.1	332.1	332.1	332.1
AS (D):	27.4	27.4	27.4	27.4	27.4	27.4
Speed [km/h]	1.2	1.2	1.2	1.2	1.2	1.2
Distribution	Laplace	Laplace	Laplace	Laplace	Laplace	Laplace

Tap:	Path 10	Path 8	Path 9	Path 7	Path 11	
Cluster					1	2
Profil [Typ]	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor
(Relative) Loss [dB]:	5.2	6.1	6.9	7.8	9	6.6
Delay [ns]:	60	70	80	90	110	110
AoA:	158.9	158.9	158.9	158.9	158.9	320.2
AS (A):	27.7	27.7	27.7	27.7	27.7	31.4
AoD:	332.1	332.1	332.1	332.1	332.1	49.3
AS (D):	27.4	27.4	27.4	27.4	27.4	32.1
Speed [km/h]	1.2	1.2	1.2	1.2	1.2	1.2
Distribution	Laplace	Laplace	Laplace	Laplace	Laplace	Laplace

Tap:	Path 12		Path 13		Path 14	
Cluster	1	2	1	2	1	2
Profil [Typ]	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor
(Relative) Loss [dB]:	11.1	9.5	13.7	12.1	16.3	14.7
Delay [ns]:	140	140	170	170	200	200
AoA:	158.9	320.2	158.9	320.2	158.9	320.2
AS (A):	27.7	31.4	27.7	31.4	27.7	31.4
AoD:	332.1	49.3	332.1	49.3	332.1	49.3
AS (D):	27.4	32.1	27.4	32.1	27.4	32.1

Tap:	Path 12		Path 13		Path 14	
Speed [km/h]	1.2	1.2	1.2	1.2	1.2	1.2
Distribution	Laplace	Laplace	Laplace	Laplace	Laplace	Laplace

Tap:	Path 15			Path 16		
Cluster	1	2	3	1	2	3
Profil [Typ]	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor
(Relative) Loss [dB]:	19.3	17.4	18.8	23.2	21.9	23.2
Delay [ns]:	240	240	240	290	290	290
AoA:	158.9	320.2	276.1	158.9	320.2	276.1
AS (A):	27.7	31.4	37.4	27.7	31.4	37.4
AoD:	332.1	49.3	275.9	332.1	49.3	275.9
AS (D):	27.4	32.1	36.8	27.4	32.1	36.8
Speed [km/h]	1.2	1.2	1.2	1.2	1.2	1.2
Distribution	Laplace	Laplace	Laplace	Laplace	Laplace	Laplace

Tap:	Path 17		Path 18
Cluster	2	3	
Profil [Typ]	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor
(Relative) Loss [dB]:	25.5	25.2	26.7
Delay [ns]:	340	340	390
AoA:	320.2	276.1	276.1
AS (A):	31.4	37.4	37.4
AoD:	49.3	275.9	275.9
AS (D):	32.1	36.8	36.8
Speed [km/h]	1.2	1.2	1.2
Distribution	Laplace	Laplace	Laplace

A.19.5 Model e

Tap:	Path 4	Path 2	Path 5	Path 1	Path 3	
Cluster					1	2
Profil [Typ]	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Moving Vehicle	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor
(Relative) Loss [dB]:	2.6	3	3.5	3.9	4.5	1.8
Delay [ns]:	0	10	20	30	50	50
AoA:	163.7	163.7	163.7	163.7	163.7	251.8
AS (A):	35.8	35.8	35.8	35.8	35.8	41.6
AoD:	105.6	105.6	105.6	105.6	105.6	293.1
AS (D):	36.1	36.1	36.1	36.1	36.1	42.5
Speed [km/h]	1.2	1.2	1.2	1.2	1.2	1.2
Distribution	Laplace	Laplace	Laplace	Laplace	Laplace	Laplace

Tap:	Path 6		Path 7		Path 10	
Cluster	1	2	1	2	1	2
Profil [Typ]	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor
(Relative) Loss [dB]:	5.6	3.2	6.9	4.5	8.2	5.8
Delay [ns]:	80	80	110	110	140	140
AoA:	163.7	251.8	163.7	251.8	163.7	251.8
AS (A):	35.8	41.6	35.8	41.6	35.8	41.6
AoD:	105.6	293.1	105.6	293.1	105.6	293.1
AS (D):	36.1	42.5	36.1	42.5	36.1	42.5
Speed [km/h]	1.2	1.2	1.2	1.2	1.2	1.2
Distribution	Laplace	Laplace	Laplace	Laplace	Laplace	Laplace

Tap:	Path 9			Path 8		
Cluster	1	2	3	1	2	3
Profil [Typ]	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor
(Relative) Loss [dB]:	9.8	7.1	7.9	11.7	9.9	9.6

Tap:	Path 9			Path 8		
Delay [ns]:	180	180	180	230	230	230
AoA:	163.7	251.8	80	163.7	251.8	80
AS (A):	35.8	41.6	37.4	35.8	41.6	37.4
AoD:	105.6	293.1	61.9	105.6	293.1	61.9
AS (D):	36.1	42.5	38	36.1	42.5	38
Speed [km/h]	1.2	1.2	1.2	1.2	1.2	1.2
Distribution	Laplace	Laplace	Laplace	Laplace	Laplace	Laplace

Tap:	Path 14			Path 12		
Cluster	1	2	3	1	2	3
Profil [Typ]	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor
(Relative) Loss [dB]:	13.9	10.3	14.2	16.1	14.3	13.8
Delay [ns]:	280	280	280	330	330	330
AoA:	163.7	251.8	80	163.7	251.8	80
AS (A):	35.8	41.6	37.4	35.8	41.6	37.4
AoD:	105.6	293.1	61.9	105.6	293.1	61.9
AS (D):	36.1	42.5	38	36.1	42.5	38
Speed [km/h]	1.2	1.2	1.2	1.2	1.2	1.2
Distribution	Laplace	Laplace	Laplace	Laplace	Laplace	Laplace

Tap:	Path 15			Path 11		
Cluster	1	2	3	1	2	3
Profil [Typ]	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor
(Relative) Loss [dB]:	18.3	14.7	18.6	20.5	18.7	18.1
Delay [ns]:	380	380	380	430	430	430
AoA:	163.7	251.8	80	163.7	251.8	80
AS (A):	35.8	41.6	37.4	35.8	41.6	37.4
AoD:	105.6	293.1	61.9	105.6	293.1	61.9
AS (D):	36.1	42.5	38	36.1	42.5	38

Tap:	Path 15			Path 11		
Speed [km/h]	1.2	1.2	1.2	1.2	1.2	1.2
Distribution	Laplace	Laplace	Laplace	Laplace	Laplace	Laplace

Tap:	Path 13				Path 16		Path 17	Path 18
Cluster	1	2	3	4	2	4	4	4
Profil [Typ]	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor
(Relative) Loss [dB]:	22.9	19.9	22.8	20.6	22.4	20.5	20.7	24.6
Delay [ns]:	490	490	490	490	560	560	640	730
AoA:	163.7	251.8	80	182	251.8	182	182	182
AS (A):	35.8	41.6	37.4	40.3	41.6	40.3	40.3	40.3
AoD:	105.6	293.1	61.9	275.7	293.1	275.7	275.7	275.7
AS (D):	36.1	42.5	38	38.7	42.5	38.7	38.7	38.7
Speed [km/h]	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Distribu-tion	Laplace	Laplace	Laplace	Laplace	Laplace	Laplace	Laplace	Laplace

A.19.6 Model f

Tap:	Path 4	Path 2	Path 5	Path 1	Path 3	
Cluster					1	2
Profil [Typ]	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor
(Relative) Loss [dB]:	3.3	3.6	3.9	4.2	4.6	1.8
Delay [ns]:	0	10	20	30	50	50
AoA:	315.1	315.1	315.1	315.1	315.1	180.4
AS (A):	48	48	48	48	48	55
AoD:	56.2	56.2	56.2	56.2	56.2	183.7
AS (D):	41.6	41.6	41.6	41.6	41.6	55.2
Speed [km/h]	1.2	1.2	40	1.2	1.2	1.2
Distribution	Laplace	Laplace	Laplace	Laplace	Laplace	Laplace

Tap:	Path 6		Path 7		Path 10	
Cluster	1	2	1	2	1	2
Profil [Typ]	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor
(Relative) Loss [dB]:	5.3	2.8	6.2	3.5	7.1	4.4
Delay [ns]:	80	80	110	110	140	140
AoA:	315.1	180.4	315.1	180.4	315.1	180.4
AS (A):	48	55	48	55	48	55
AoD:	56.2	183.7	56.2	183.7	56.2	183.7
AS (D):	41.6	55.2	41.6	55.2	41.6	55.2
Speed [km/h]	1.2	1.2	1.2	1.2	1.2	1.2
Distribution	Laplace	Laplace	Laplace	Laplace	Laplace	Laplace

Tap:	Path 9			Path 8		
Cluster	1	2	3	1	2	3
Profil [Typ]	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor
(Relative) Loss [dB]:	8.2	5.3	5.7	9.5	7.4	6.7
Delay [ns]:	180	180	180	230	230	230
AoA:	315.1	180.4	74.7	315.1	180.4	74.7
AS (A):	48	55	42	48	55	42
AoD:	56.2	183.7	153	56.2	183.7	153
AS (D):	41.6	55.2	47.4	41.6	55.2	47.4
Speed [km/h]	1.2	1.2	1.2	1.2	1.2	1.2
Distribution	Laplace	Laplace	Laplace	Laplace	Laplace	Laplace

Tap:	Path 11			Path 13		
Cluster	1	2	3	1	2	3
Profil [Typ]	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor
(Relative) Loss [dB]:	11	7	10.4	12.5	10.3	9.6
Delay [ns]:	280	280	280	330	330	330
AoA:	315.1	180.4	74.7	315.1	180.4	74.7

Tap:	Path 11			Path 13		
AS (A):	48	55	42	48	55	42
AoD:	56.2	183.7	153	56.2	183.7	153
AS (D):	41.6	55.2	47.4	41.6	55.2	47.4
Speed [km/h]	1.2	1.2	1.2	1.2	1.2	1.2
Distribu-tion	Laplace	Laplace	Laplace	Laplace	Laplace	Laplace

Tap:	Path 12				Path 14			
Cluster	1	2	3	4	1	2	3	4
Profil [Typ]	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor
(Relative) Loss [dB]:	14.3	10.4	14.1	8.8	16.7	13.8	12.7	13.3
Delay [ns]:	400	400	400	400	490	490	490	490
AoA:	315.1	180.4	74.7	251.5	315.1	180.4	74.7	251.5
AS (A):	48	55	42	28.6	48	55	42	28.6
AoD:	56.2	183.7	153	112.5	56.2	183.7	153	112.5
AS (D):	41.6	55.2	47.4	27.2	41.6	55.2	47.4	27.2
Speed [km/h]	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Distribu-tion	Laplace	Laplace	Laplace	Laplace	Laplace	Laplace	Laplace	Laplace

Tap:	Path 15				
Cluster	1	2	3	4	5
Profil [Typ]	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor
(Relative) Loss [dB]:	19.9	15.7	18.5	18.7	12.9
Delay [ns]:	600	600	600	600	600
AoA:	315.1	180.4	74.7	251.5	68.5
AS (A):	48	55	42	28.6	30.7
AoD:	56.2	183.7	153	112.5	291
AS (D):	41.6	55.2	47.4	27.2	33
Speed [km/h]	1.2	1.2	1.2	1.2	1.2
Distribution	Laplace	Laplace	Laplace	Laplace	Laplace

Tap:	Path 16		Path 17	Path 18
Cluster	2	5	6	6
Profil [Typ]	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor
(Relative) Loss [dB]:	19.9	14.2	16.3	21.2
Delay [ns]:	730	730	880	1050
AoA:	180.4	68.5	246.2	246.2
AS (A):	55	30.7	38.2	38.2
AoD:	183.7	291	62.3	62.3
AS (D):	55.2	33	38	38
Speed [km/h]	1.2	1.2	1.2	1.2
Distribution	Laplace	Laplace	Laplace	Laplace

A.20 802.11ac-MIMO standards

Option: R&S SMW-K71

The 802.11ac-MIMO channel models are conform for channel bandwidth ≤ 40 MHz.

According to IEEE 802.11-03/940r4

Rx Antenna Distance = 1

Tx Antenna Distance = 0.5

Distribution = Laplace

Profile = Bell Shape tgn Indoor, exception Model F, Path 3 where the Profile = Bell Shape tgn Moving Vehicle

Speed = 0.089 km/h, exception Model F, Path 3 where Speed = 40 km/h

A.20.1 Model A (≤ 40 MHz)

Tap:	Path 1
Cluster	
Profil [Typ]	Bell Shape tgn Indorr
Loss [dB]	0
Delay [ns]	0
AoA	45

Tap:	Path 1
AS (A)	40
AoD	45
AS (D)	40
Speed [km/h]	0.089

A.20.2 Model B (≤ 40 MHz)

Tap:	Path 4	Path 2	Path 3		Path 1	
Cluster			1	2	1	2
Profil [Typ]	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr
(Relative) Loss [dB]:	0	5.4	10.8	3.2	16.2	6.3
Delay [ns]:	0	10	20	20	30	30
AoA:	4.3	4.3	4.3	118.4	4.3	118.4
AS (A):	14.4	14.4	14.4	25.2	14.4	25.2
AoD:	225.1	225.1	225.1	106.5	225.1	106.5
AS (D):	14.4	14.4	14.4	25.4	14.4	25.4
Speed [km/h]	0.089	0.089	0.089	0.089	0.089	0.089
Distribution	Laplace	Laplace	Laplace	Laplace	Laplace	Laplace

Tap:	Path 5		Path 6	Path 7	Path 8	Path 9
Cluster	1	2				
Profil [Typ]	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr
(Relative) Loss [dB]:	21.7	9.4	12.5	15.6	18.7	21.8
Delay [ns]:	40	40	50	60	70	80
AoA:	4.3	118.4	118.4	118.4	118.4	118.4
AS (A):	14.4	25.2	25.2	25.2	25.2	25.2
AoD:	225.1	106.5	106.5	106.5	106.5	106.5
AS (D):	14.4	25.4	25.4	25.4	25.4	25.4
Speed [km/h]	0.089	0.089	0.089	0.089	0.089	0.089
Distribution	Laplace	Laplace	Laplace	Laplace	Laplace	Laplace

A.20.3 Model C (≤ 40 MHz)

Tap:	Path 4	Path 2	Path 3	Path 1	Path 5	Path 6
Cluster						
Profil [Typ]	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr
(Relative) Loss [dB]:	0	2.1	4.3	6.5	8.6	10.8
Delay [ns]:	0	10	20	30	40	50
AoA:	290.3	290.3	290.3	290.3	290.3	290.3
AS (A):	24.6	24.6	24.6	24.6	24.6	24.6
AoD:	13.5	13.5	13.5	13.5	13.5	13.5
AS (D):	24.7	24.7	24.7	24.7	24.7	24.7
Speed [km/h]	0.089	0.089	0.089	0.089	0.089	0.089
Distribution	Laplace	Laplace	Laplace	Laplace	Laplace	Laplace

Tap:	Path 10	Path 10	Path 8	Path 8	Path 9	Path 9
Cluster	1	2	1	2	1	2
Profil [Typ]	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr
(Relative) Loss [dB]:	13	5	15.2	7.2	17.3	9.3
Delay [ns]:	60	60	70	70	80	80
AoA:	290.3	332.3	290.3	332.3	290.3	332.3
AS (A):	24.6	22.4	24.6	22.4	24.6	22.4
AoD:	13.5	56.4	13.5	56.4	13.5	56.4
AS (D):	24.7	22.5	24.7	22.5	24.7	22.5
Speed [km/h]	0.089	0.089	0.089	0.089	0.089	0.089
Distribution	Laplace	Laplace	Laplace	Laplace	Laplace	Laplace

Tap:	Path 7	Path 7	Path 11	Path 12	Path 13	Path 14
Cluster	1	2				
Profil [Typ]	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr
(Relative) Loss [dB]:	19.5	11.5	13.7	15.8	18	20.2
Delay [ns]:	90	90	110	140	170	200

Tap:	Path 7	Path 7	Path 11	Path 12	Path 13	Path 14
AoA:	290.3	332.3	332.3	332.3	332.3	332.3
AS (A):	24.6	22.4	22.4	22.4	22.4	22.4
AoD:	13.5	56.4	56.4	56.4	56.4	56.4
AS (D):	24.7	22.5	22.5	22.5	22.5	22.5
Speed [km/h]	0.089	0.089	0.089	0.089	0.089	0.089
Distribution	Laplace	Laplace	Laplace	Laplace	Laplace	Laplace

A.20.4 Model D (≤ 40 MHz)

Tap:	Path 4	Path 2	Path 3	Path 1	Path 5	Path 6
Cluster						
Profil [Typ]	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr
(Relative) Loss [dB]:	0	0.9	1.7	2.6	3.5	4.3
Delay [ns]:	0	10	20	30	40	50
AoA:	158.9	158.9	158.9	158.9	158.9	158.9
AS (A):	27.7	27.7	27.7	27.7	27.7	27.7
AoD:	332.1	332.1	332.1	332.1	332.1	332.1
AS (D):	27.4	27.4	27.4	27.4	27.4	27.4
Speed [km/h]	0.089	0.089	0.089	0.089	0.089	0.089
Distribution	Laplace	Laplace	Laplace	Laplace	Laplace	Laplace

Tap:	Path 10	Path 8	Path 9	Path 7	Path 11	
Cluster					1	2
Profil [Typ]	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr
(Relative) Loss [dB]:	5.2	6.1	6.9	7.8	9	6.6
Delay [ns]:	60	70	80	90	110	110
AoA:	158.9	158.9	158.9	158.9	158.9	320.2
AS (A):	27.7	27.7	27.7	27.7	27.7	31.4
AoD:	332.1	332.1	332.1	332.1	332.1	49.3
AS (D):	27.4	27.4	27.4	27.4	27.4	32.1

Tap:	Path 10	Path 8	Path 9	Path 7	Path 11	
Speed [km/h]	0.089	0.089	0.089	0.089	0.089	0.089
Distribution	Laplace	Laplace	Laplace	Laplace	Laplace	Laplace

Tap:	Path 12		Path 13		Path 14	
Cluster	1	2	1	2	1	2
Profil [Typ]	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr
(Relative) Loss [dB]:	11.1	9.5	13.7	12.1	16.3	14.7
Delay [ns]:	140	140	170	170	200	200
AoA:	158.9	320.2	158.9	320.2	158.9	320.2
AS (A):	27.7	31.4	27.7	31.4	27.7	31.4
AoD:	332.1	49.3	332.1	49.3	332.1	49.3
AS (D):	27.4	32.1	27.4	32.1	27.4	32.1
Speed [km/h]	0.089	0.089	0.089	0.089	0.089	0.089
Distribution	Laplace	Laplace	Laplace	Laplace	Laplace	Laplace

Tap:	Path 15			Path 16		
Cluster	1	2	3	1	2	3
Profil [Typ]	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr
(Relative) Loss [dB]:	19.3	17.4	18.8	23.2	21.9	23.2
Delay [ns]:	240	240	240	290	290	290
AoA:	158.9	320.2	276.1	158.9	320.2	276.1
AS (A):	27.7	31.4	37.4	27.7	31.4	37.4
AoD:	332.1	49.3	275.9	332.1	49.3	275.9
AS (D):	27.4	32.1	36.8	27.4	32.1	36.8
Speed [km/h]	0.089	0.089	0.089	0.089	0.089	0.089
Distribution	Laplace	Laplace	Laplace	Laplace	Laplace	Laplace

Tap:	Path 17		Path 18
Cluster	2	3	
Profil [Typ]	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr
(Relative) Loss [dB]:	25.5	25.2	26.7
Delay [ns]:	340	340	390
AoA:	320.2	276.1	276.1
AS (A):	31.4	37.4	37.4
AoD:	49.3	275.9	275.9
AS (D):	32.1	36.8	36.8
Speed [km/h]	0.089	0.089	0.089
Distribution	Laplace	Laplace	Laplace

A.20.5 Model E (≤ 40 MHz)

Tap:	Path 4	Path 2	Path 5	Path 1	Path 3	
Cluster					1	2
Profil [Typ]	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr
(Relative) Loss [dB]:	2.6	3	3.5	3.9	4.5	1.8
Delay [ns]:	0	10	20	30	50	50
AoA:	163.7	163.7	163.7	163.7	163.7	251.8
AS (A):	35.8	35.8	35.8	35.8	35.8	41.6
AoD:	105.6	105.6	105.6	105.6	105.6	293.1
AS (D):	36.1	36.1	36.1	36.1	36.1	42.5
Speed [km/h]	0.089	0.089	0.089	0.089	0.089	0.089
Distribution	Laplace	Laplace	Laplace	Laplace	Laplace	Laplace

Tap:	Path 6		Path 7		Path 10	
Cluster	1	2	1	2	1	2
Profil [Typ]	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr
(Relative) Loss [dB]:	5.6	3.2	6.9	4.5	8.2	5.8

Tap:	Path 6		Path 7		Path 10	
Delay [ns]:	80	80	110	110	140	140
AoA:	163.7	251.8	163.7	251.8	163.7	251.8
AS (A):	35.8	41.6	35.8	41.6	35.8	41.6
AoD:	105.6	293.1	105.6	293.1	105.6	293.1
AS (D):	36.1	42.5	36.1	42.5	36.1	42.5
Speed [km/h]	0.089	0.089	0.089	0.089	0.089	0.089
Distribution	Laplace	Laplace	Laplace	Laplace	Laplace	Laplace

Tap:	Path 9			Path 8		
Cluster	1	2	3	1	2	3
Profil [Typ]	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr
(Relative) Loss [dB]:	9.8	7.1	7.9	11.7	9.9	9.6
Delay [ns]:	180	180	180	230	230	230
AoA:	163.7	251.8	80	163.7	251.8	80
AS (A):	35.8	41.6	37.4	35.8	41.6	37.4
AoD:	105.6	293.1	61.9	105.6	293.1	61.9
AS (D):	36.1	42.5	38	36.1	42.5	38
Speed [km/h]	0.089	0.089	0.089	0.089	0.089	0.089
Distribution	Laplace	Laplace	Laplace	Laplace	Laplace	Laplace

Tap:	Path 14			Path 12		
Cluster	1	2	3	1	2	3
Profil [Typ]	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr
(Relative) Loss [dB]:	13.9	10.3	14.2	16.1	14.3	13.8
Delay [ns]:	280	280	280	330	330	330
AoA:	163.7	251.8	80	163.7	251.8	80
AS (A):	35.8	41.6	37.4	35.8	41.6	37.4
AoD:	105.6	293.1	61.9	105.6	293.1	61.9
AS (D):	36.1	42.5	38	36.1	42.5	38

Tap:	Path 14			Path 12		
Speed [km/h]	0.089	0.089	0.089	0.089	0.089	0.089
Distribution	Laplace	Laplace	Laplace	Laplace	Laplace	Laplace

Tap:	Path 15			Path 11		
Cluster	1	2	3	1	2	3
Profil [Typ]	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr
(Relative) Loss [dB]:	18.3	14.7	18.6	20.5	18.7	18.1
Delay [ns]:	380	380	380	430	430	430
AoA:	163.7	251.8	80	163.7	251.8	80
AS (A):	35.8	41.6	37.4	35.8	41.6	37.4
AoD:	105.6	293.1	61.9	105.6	293.1	61.9
AS (D):	36.1	42.5	38	36.1	42.5	38
Speed [km/h]	0.089	0.089	0.089	0.089	0.089	0.089
Distribution	Laplace	Laplace	Laplace	Laplace	Laplace	Laplace

Tap:	Path 13				Path 16		Path 17	Path 18
Cluster	1	2	3	4	2	4	4	4
Profil [Typ]	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr
(Relative) Loss [dB]:	22.9	19.9	22.8	20.6	22.4	20.5	20.7	24.6
Delay [ns]:	490	490	490	490	560	560	640	730
AoA:	163.7	251.8	80	182	251.8	182	182	182
AS (A):	35.8	41.6	37.4	40.3	41.6	40.3	40.3	40.3
AoD:	105.6	293.1	61.9	275.7	293.1	275.7	275.7	275.7
AS (D):	36.1	42.5	38	38.7	42.5	38.7	38.7	38.7
Speed [km/h]	0.089	0.089	0.089	0.089	0.089	0.089	0.089	0.089
Distribu- tion	Laplace	Laplace	Laplace	Laplace	Laplace	Laplace	Laplace	Laplace

A.20.6 Model F (≤ 40 MHz)

Tap:	Path 4	Path 2	Path 5	Path 1	Path 3	
Cluster					1	2
Profil [Typ]	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Moving Vehicle	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr
(Relative) Loss [dB]:	3.3	3.6	3.9	4.2	4.6	1.8
Delay [ns]:	0	10	20	30	50	50
AoA:	315.1	315.1	315.1	315.1	315.1	180.4
AS (A):	48	48	48	48	48	55
AoD:	56.2	56.2	56.2	56.2	56.2	183.7
AS (D):	41.6	41.6	41.6	41.6	41.6	55.2
Speed [km/h]	0.089	0.089	40	0.089	0.089	0.089
Distribution	Laplace	Laplace	Laplace	Laplace	Laplace	Laplace

Tap:	Path 6		Path 7		Path 10	
Cluster	1	2	1	2	1	2
Profil [Typ]	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr
(Relative) Loss [dB]:	5.3	2.8	6.2	3.5	7.1	4.4
Delay [ns]:	80	80	110	110	140	140
AoA:	315.1	180.4	315.1	180.4	315.1	180.4
AS (A):	48	55	48	55	48	55
AoD:	56.2	183.7	56.2	183.7	56.2	183.7
AS (D):	41.6	55.2	41.6	55.2	41.6	55.2
Speed [km/h]	0.089	0.089	0.089	0.089	0.089	0.089
Distribution	Laplace	Laplace	Laplace	Laplace	Laplace	Laplace

Tap:	Path 9			Path 8		
Cluster	1	2	3	1	2	3
Profil [Typ]	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr
(Relative) Loss [dB]:	8.2	5.3	5.7	9.5	7.4	6.7

Tap:	Path 9			Path 8		
Delay [ns]:	180	180	180	230	230	230
AoA:	315.1	180.4	74.7	315.1	180.4	74.7
AS (A):	48	55	42	48	55	42
AoD:	56.2	183.7	153	56.2	183.7	153
AS (D):	41.6	55.2	47.4	41.6	55.2	47.4
Speed [km/h]	0.089	0.089	0.089	0.089	0.089	0.089
Distribution	Laplace	Laplace	Laplace	Laplace	Laplace	Laplace

Tap:	Path 11			Path 13		
Cluster	1	2	3	1	2	3
Profil [Typ]	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr
(Relative) Loss [dB]:	11	7	10.4	12.5	10.3	9.6
Delay [ns]:	280	280	280	330	330	330
AoA:	315.1	180.4	74.7	315.1	180.4	74.7
AS (A):	48	55	42	48	55	42
AoD:	56.2	183.7	153	56.2	183.7	153
AS (D):	41.6	55.2	47.4	41.6	55.2	47.4
Speed [km/h]	0.089	0.089	0.089	0.089	0.089	0.089
Distribu-tion	Laplace	Laplace	Laplace	Laplace	Laplace	Laplace

Tap:	Path 12				Path 14			
Cluster	1	2	3	4	1	2	3	4
Profil [Typ]	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr
(Relative) Loss [dB]:	14.3	10.4	14.1	8.8	16.7	13.8	12.7	13.3
Delay [ns]:	400	400	400	400	490	490	490	490
AoA:	315.1	180.4	74.7	251.5	315.1	180.4	74.7	251.5
AS (A):	48	55	42	28.6	48	55	42	28.6
AoD:	56.2	183.7	153	112.5	56.2	183.7	153	112.5
AS (D):	41.6	55.2	47.4	27.2	41.6	55.2	47.4	27.2

Tap:	Path 12				Path 14			
Speed [km/h]	0.089	0.089	0.089	0.089	0.089	0.089	0.089	0.089
Distribu-tion	Laplace	Laplace	Laplace	Laplace	Laplace	Laplace	Laplace	Laplace

Tap:	Path 15				
Cluster	1	2	3	4	5
Profil [Typ]	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr
(Relative) Loss [dB]:	19.9	15.7	18.5	18.7	12.9
Delay [ns]:	600	600	600	600	600
AoA:	315.1	180.4	74.7	251.5	68.5
AS (A):	48	55	42	28.6	30.7
AoD:	56.2	183.7	153	112.5	291
AS (D):	41.6	55.2	47.4	27.2	33
Speed [km/h]	0.089	0.089	0.089	0.089	0.089
Distribution	Laplace	Laplace	Laplace	Laplace	Laplace

Tap:	Path 16		Path 17	Path 18
Cluster	2	5	6	6
Profil [Typ]	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr
(Relative) Loss [dB]:	19.9	14.2	16.3	21.2
Delay [ns]:	730	730	880	1050
AoA:	180.4	68.5	246.2	246.2
AS (A):	55	30.7	38.2	38.2
AoD:	183.7	291	62.3	62.3
AS (D):	55.2	33	38	38
Speed [km/h]	0.089	0.089	0.089	0.089
Distribution	Laplace	Laplace	Laplace	Laplace

A.21 802.11ac-SISO standards

Option: R&S SMW-B14/B15

These fading profiles are implemented as the IEEE 802.11ac-MIMO models, expect that:

- Correlation Path = Off
- Coefficient, % = 100
- Phase, deg = 0

See Chapter A.20, "802.11ac-MIMO standards", on page 325.

A.22 802.11p channel models

Option: R&S SMW-B14/B15

According to C2C-CC TF Antennae & Wireless Performance – Whitepaper Vs 1.0

- Fading Profile = Custom
- Doppler Shape = Rayleigh
- Bandwidth = 2*abs(f_d)
- Frequency Offset = 0 Hz
- for fd > 0:
  – Lower Cutoff Frequency = 0
  – Upper Cutoff Frequency = f_d

  for fd < 0:
  – Lower CutOff Frequency = -f_d
  – Upper CutOff Frequency = 0

A.22.1 Rural LOS

This channel model is intended primarily as a reference result. It applies in very open environments where other vehicles, buildings and large fences are absent.

	Path 1	Path 2	Path 3
Profile [Type]	Static	Custom	Custom
(Relative) Loss [dB]:	0	14	17
Delay [ns]:	0	83	183
f_D [Hz]	0	492	-295

A.22.2 Urban approaching LOS

Two vehicles approaching each other in an urban setting with buildings nearby.

	Path 1	Path 2	Path 3	Path 4
Profile [Type]	Static	Custom	Custom	Custom
(Relative) Loss [dB]:	0	8	10	15
Delay [ns]:	0	117	183	333
f_D [Hz]	0	236	-157	492

A.22.3 Urban crossing NLOS

Two vehicles approaching an Urban blind intersection with other traffic present. Buildings/fences present on all corners.

	Path 1	Path 2	Path 3	Path 4
Profile [Type]	Static	Custom	Custom	Custom
(Relative) Loss [dB]:	0	3	5	10
Delay [ns]:	0	267	400	533
f_D [Hz]	0	295	-98	591

A.22.4 Highway LOS

Two cars following each other on Multi-lane inter-region roadways such as German autobahns and USA Interstates. Signs, overpasses, hill-sides and other traffic present.

	Path 1	Path 2	Path 3	Path 4
Profile [Type]	Static	Custom	Custom	Custom
(Relative) Loss [dB]:	0	10	15	20
Delay [ns]:	0	100	167	500
f_D [Hz]	0	689	-492	886

A.22.5 Highway NLOS

As for Highway LOS but with occluding trucks present between the vehicles.

	Path 1	Path 2	Path 3	Path 4
Profile [Type]	Static	Custom	Custom	Custom
(Relative) Loss [dB]:	0	2	5	7

	Path 1	Path 2	Path 3	Path 4
Delay [ns]:	0	200	433	700
f_D [Hz]	0	689	-492	886

A.23 5G NR standards

Option: R&S SMW-B14/B15; MIMO profiles require R&S SMW-K74.

According to 3GPP TS 38.101-4 and TS 38.141-1.

The following settings apply to all paths:

- Path state = On; "Path x (off)" explicitly states inactive paths
- Profile type = Rayleigh
- LogNormal = Off
- Corr with = Off
- Power ratio = 0 dB
- Speed = 0 km/h

Channel models naming convention

The names of the channel models follow the syntax:

`FR<1|2> TDL<A|B|C><delay spread, ms>-<Doppler, Hz> <Low/Med/Med A/High/SISO>`, where:

- FR designates the frequency band (FR1 below 6GHz, FR2 above 6GHz)
- Low/Med/Med A/High indicates the MIMO correlation matrix
- SISO designates the non-MIMO case; SISO and MIMO profiles are identical but in the SISO case correlation matrix is not relevant.

- FR1 TDLA30-5/10 SISO/Low/Med/Med A/High....338
- FR1 TDLB100-400 SISO/Low/Med/Med A/High....339
- FR1 TDLC300-100 SISO/Low/Med/High....340
- FR1 TDLC300-400 SISO....340
- FR1 TDLC300-600 SISO/Low/Med/High....340
- FR1 TDLC300-1200 SISO/Low/Med/High....341
- FR1 NTN TDLA100-200 Low/Med/High....341
- FR1 NTN TDLC5-200 Low/Med/High....342
- FR2 TDLA30-35/75/300 SISO/Low/Med/Med A/High....342
- FR2 TDLC60-300 SISO/Low/Med/Med A/High....342
- MIMO parameter....343

A.23.1 FR1 TDLA30-5/10 SISO/Low/Med/Med A/High

This profile has Doppler frequencies of 5 Hz or 10 Hz (f_C = 1 GHz) for all paths.

Parameter	Path 1	Path 2	Path 3	Path 4	Path 5
"Path Loss (dB)"	0	5.1	9.6	15.5	5.1
"Resulting Delay (ns)"	10	15	25	0	20
Fine delay required	1	1	1	0	0
	Path 6	**Path 7**	**Path 8**	**Path 9** (off)	**Path 10** (off)
"Path Loss (dB)"	8.2	13.1	11.5	0	0
"Resulting Delay (ns)"	50	65	75	0	0
Fine delay required	1	1	1	0	0
	Path 11	**Path 12**	**Path 13**	**Path 14** (off)	**Path 15** (off)
"Path Loss (dB)"	11	16.2	16.6	0	0
"Resulting Delay (ns)"	105	135	150	0	0
Fine delay required	1	1	1	0	0
	Path 16	**Path 17** (off)	**Path 18** (off)	**Path 19** (off)	**Path 20** (off)
"Path Loss (dB)"	26.2	-	-	-	-
"Resulting Delay (ns)"	290	-	-	-	-
Fine delay required	1	-	-	-	-

A.23.2 FR1 TDLB100-400 SISO/Low/Med/Med A/High

Not supported in 4x4, 2x8 and 8x2 MIMO configurations. This profile has a Doppler frequency of 400 Hz (f_C = 1 GHz) for all paths.

Parameter	Path 1	Path 2	Path 3	Path 4	Path 5
"Path Loss (dB)"	2.2	0.6	0.3	0	0.6
"Resulting Delay (ns)"	10	30	35	0	20
Fine delay required	1	1	1	0	0
	Path 6	**Path 7**	**Path 8**	**Path 9**	**Path 10**
"Path Loss (dB)"	1.2	5.9	0.8	2.2	7.1
"Resulting Delay (ns)"	45	55	170	120	480
Fine delay required	1	1	1	0	0
	Path 11	**Path 12**	**Path 13** (off)	**Path 14** (off)	**Path 15** (off)
"Path Loss (dB)"	6.3	7.5	-	-	-
"Resulting Delay (ns)"	245	330	-	-	-
Fine delay required	1	1	-	-	-

A.23.3 FR1 TDLC300-100 SISO/Low/Med/High

These profiles have a Doppler frequency of 100 Hz (f_C = 1 GHz) for all paths.

Parameter	Path 1	Path 2	Path 3	Path 4	Path 5
"Path Loss (dB)"	0	7.7	2.5	6.9	9.9
"Resulting Delay (ns)"	65	70	190	0	200
Fine delay required	1	1	1	0	0
	Path 6	**Path 7**	**Path 8**	**Path 9**	**Path 10**
"Path Loss (dB)"	2.4	6.6	13	8	7.1
"Resulting Delay (ns)"	195	325	1045	240	520
Fine delay required	1	1	1	1	0
	Path 11	**Path 12**	**Path 13** (off)	**Path 14** (off)	**Path 15** (off)
"Path Loss (dB)"	14.2	16	-	-	-
"Resulting Delay (ns)"	1510	2595	-	-	-
Fine delay required	1	1	-	-	-

A.23.4 FR1 TDLC300-400 SISO

These profiles have a Doppler frequency of 400 Hz (f_C = 1 GHz) for all paths.

Parameter	Path 1	Path 2	Path 3	Path 4	Path 5
"Path Loss (dB)"	0	7.7	2.5	6.9	9.9
"Resulting Delay (ns)"	65	70	190	0	200
Fine delay required	1	1	1	0	0
	Path 6	**Path 7**	**Path 8**	**Path 9**	**Path 10**
"Path Loss (dB)"	2.4	6.6	13	8	7.1
"Resulting Delay (ns)"	195	325	1045	240	520
Fine delay required	1	1	1	1	0
	Path 11	**Path 12**	**Path 13** (off)	**Path 14** (off)	**Path 15** (off)
"Path Loss (dB)"	14.2	16	-	-	-
"Resulting Delay (ns)"	1510	2595	-	-	-
Fine delay required	1	1	-	-	-

A.23.5 FR1 TDLC300-600 SISO/Low/Med/High

These profiles have a Doppler frequency of 600 Hz (f_C = 1 GHz) for all paths.

Parameter	Path 1	Path 2	Path 3	Path 4	Path 5
"Path Loss (dB)"	0	7.7	2.5	6.9	9.9
"Resulting Delay (ns)"	65	70	190	0	200
Fine delay required	1	1	1	0	0
	Path 6	**Path 7**	**Path 8**	**Path 9**	**Path 10**
"Path Loss (dB)"	2.4	6.6	13	8	7.1
"Resulting Delay (ns)"	195	325	1045	240	520
Fine delay required	1	1	1	1	0
	Path 11	**Path 12**	**Path 13** (off)	**Path 14** (off)	**Path 15** (off)
"Path Loss (dB)"	14.2	16	-	-	-
"Resulting Delay (ns)"	1510	2595	-	-	-
Fine delay required	1	1	-	-	-

A.23.6 FR1 TDLC300-1200 SISO/Low/Med/High

These profiles have a Doppler frequency of 1200 Hz (f_C = 1 GHz) for all paths.

Parameter	Path 1	Path 2	Path 3	Path 4	Path 5
"Path Loss (dB)"	0	7.7	2.5	6.9	9.9
"Resulting Delay (ns)"	65	70	190	0	200
Fine delay required	1	1	1	0	0
	Path 6	**Path 7**	**Path 8**	**Path 9**	**Path 10**
"Path Loss (dB)"	2.4	6.6	13	8	7.1
"Resulting Delay (ns)"	195	325	1045	240	520
Fine delay required	1	1	1	1	0
	Path 11	**Path 12**	**Path 13** (off)	**Path 14** (off)	**Path 15** (off)
"Path Loss (dB)"	14.2	16	-	-	-
"Resulting Delay (ns)"	1510	2595	-	-	-
Fine delay required	1	1	-	-	-

A.23.7 FR1 NTN TDLA100-200 Low/Med/High

These profiles have a Doppler frequency of 200 Hz (f_C = 1 GHz) for all paths.

Parameter	Path 1	Path 2	Path 3	Path 4 (off)	Path 5 (off)
"Path Loss (dB)"	0	4.7	6.5	-	-

"Resulting Delay (ns)"	0	110	285	-	-
Fine delay required	0	1	1	-	-

A.23.8 FR1 NTN TDLC5-200 Low/Med/High

These profiles have a Doppler frequency of 200 Hz (f_C = 1 GHz) for all paths.

Parameter	**Path 1**	**Path 2**	**Path 3**	**Path 4** (off)	**Path 5** (off)
"Path Loss (dB)"	0.6	8.9	21.5	-	-
"Resulting Delay (ns)"	0	0	60	-	-
Fine delay required	0	0	1	-	-

A.23.9 FR2 TDLA30-35/75/300 SISO/Low/Med/Med A/High

The fading profile uses the same path settings as the settings defined for the FR1 TDLA30-5/10 Hz profiles. For the FR2 profiles merely the Doppler frequency changes to 35 Hz, 75 Hz and 300 Hz.

See Chapter A.23.1, "FR1 TDLA30-5/10 SISO/Low/Med/Med A/High", on page 338.

A.23.10 FR2 TDLC60-300 SISO/Low/Med/Med A/High

These profiles have a Doppler frequency of 300 Hz for all paths.

Parameter	**Path 1**	**Path 2**	**Path 3**	**Path 4**	**Path 5**
"Path Loss (dB)"	7.8	0.3	0	8.9	14.5
"Resulting Delay (ns)"	0	15	40	50	55
Fine delay required	0	1	0	1	1
	Path 6	**Path 7**	**Path 8**	**Path 9**	**Path 10**
"Path Loss (dB)"	8.5	10.2	121.1	13.9	15.2
"Resulting Delay (ns)"	75	80	130	210	300
Fine delay required	1	1	1	1	0
	Path 11	**Path 12**	**Path 13** (off)	**Path 14** (off)	**Path 15** (off)
"Path Loss (dB)"	16.9	19.4	-	-	-
"Resulting Delay (ns)"	360	520	-	-	-
Fine delay required	0	9	-	-	-

A.23.11 MIMO parameter

The MIMO correlation matrices for the high, medium and low antenna correlation are configured according to TS 38.101-4, section B.2.3.

A.24 5G NR MIMO OTA channel models

Option: R&S SMW-B14/B15; MIMO profiles require R&S SMW-K72/-K73/-K74.

According to 3GPP TR 38.827.

The CDL channel models are defined for FR1 and FR2 MIMO-OTA testing. The following applies for fading standards:

- The fading profile for all models and all paths is SCM.
- All channel models are 3D channel models with enabled channel polarization
- 5G NR MIMO OTA standards are available for the specified LxMxN system configuration (see Chapter 5, "Multiple input multiple output (MIMO)", on page 95).
- A set of predefined 3D antenna patterns is available and used for each predefined scenario. The file selection of the antenna pattern also considers the fader dedicated frequency for FR1 models.
- UE velocity v is defined as follows:
  – for FR1, v = 30km/h
  – for FR2, v = 3 km/h (InO) and v = 12 km/h (UMi).
- Subpath start phases are preset for each predefined scenario.
- The DoT value for CDL-B is selected according to R4-1915060.
- SCM model parameters and the per cluster parameters are set automatically.

Channel models naming convention

The names of the channel models follow the syntax:

`FR<1|2> CDL<A|B|C> <Umi|Uma|InO>`, where:

- FR designates the frequency band (FR1 below 7.125 GHz, FR2 above 24.250 6GHz)
- UMi = Urban micro-cell
- UMa = Urban macro-cell
- InO = Indoor office

A.24.1 FR1 CDL-A/-B/-C UMa 2x2

- "System Configuration = 1x2x2"
- Velocity [km/h] = 30 km/h

	CDL-A	CDL-B	CDL-C
DoT [phi,theta]	182.17°, 90°	90°, 90°	65°, 90°

A.24.2 FR1 CDL-A/-B/-C UMi 4x4

- "System Configuration = 1x4x4"
- Velocity [km/h] = 30 km/h

	CDL-A	CDL-B	CDL-C
DoT [phi,theta]	135°, 90°	90°, 90°	127.05°, 90°

A.24.3 FR1 CDL-C UMa 4x4

- "System Configuration = 1x4x4"
- Velocity [km/h] = 30 km/h

	CDL-A	CDL-B	CDL-C
DoT [phi,theta]	182.17°, 90°	90°, 90°	65°, 90°

A.24.4 FR1 CDL-C UMi 2x2

- "System Configuration = 1x2x2"
- Velocity [km/h] = 30 km/h

	CDL-A	CDL-B	CDL-C
DoT [phi,theta]	135°, 90°	90°, 90°	127.05°, 90°

A.24.5 FR2 CDL-A InO

- "System Configuration = 1x2x2"
- Velocity [km/h] = 12 km/h
- DoT [phi,theta] = 74.11°, 90°

A.24.6 FR2 CDL-C UMi

- "System Configuration = 1x2x2"
- Velocity [km/h] = 3 km/h
- DoT [phi,theta] = 112.51°, 90°

A.25 5G NR high speed train

Option: R&S SMW-K74 and R&S SMW-K71

The following applies to all HST scenarios:

- "Signal Dedicated to = Baseband Output"
- "Consider DL RF = Yes"

A.25.1 HST1 NR350 15 khz/30 khz SCS

3GPP TS 38.104, TS 38.141-1 and TS 38.141-2

Fading scenario	HST1 NR350 15 kHz SCS	HST1 NR350 30 kHz SCS
Virtual RF [MHz]	1950	3600
Profile	Pure Doppler	Pure Doppler
Speed [km/h]:	350	350
D_{min} [m]	150	150
D_s [m]	700	1000
Virtual DL RF [MHz]	1950	3600

A.25.2 HST1 NR500 15 khz/30 khz SCS

3GPP TS 38.104, TS 38.141-1 and TS 38.141-2

Fading scenario	HST1 NR500 15 kHz SCS	HST1 NR500 30 kHz SCS
Virtual RF [MHz]	1750	3600
Profile	Pure Doppler	Pure Doppler
Speed [km/h]:	500	500
D_{min} [m]	150	150
D_s [m]	700	700
Virtual DL RF [MHz]	1850	3600

A.25.3 HST3 NR350 15 khz/30 khz SCS

3GPP TS 38.104, TS 38.141-1 and TS 38.141-2

Fading scenario	HST1 NR350 15 kHz SCS	HST1 NR350 30 kHz SCS
Virtual RF [MHz]	1950	3600
Profile	Pure Doppler	Pure Doppler

Fading scenario	HST1 NR350 15 kHz SCS	HST1 NR350 30 kHz SCS
Speed [km/h]:	350	350
D_{min} [m]	2	2
D_s [m]	300	300
Virtual DL RF [MHz]	2140	3600

A.25.4 HST3 NR500 15 khz/30 khz SCS

3GPP TS 38.104, TS 38.141-1 and TS 38.141-2

Fading scenario	HST1 NR500 15 kHz SCS	HST1 NR500 30 kHz SCS
Virtual RF [MHz]	1750	3600
Profile	Pure Doppler	Pure Doppler
Speed [km/h]:	500	500
D_{min} [m]	2	2
D_s [m]	300	300
Virtual DL RF [MHz]	1850	3600

A.26 5G NR moving propagation

Option: R&S SMW-K71

- MP X 15kHz/30kHz SCS....346
- MP Y 15kHz/30kHz/120kHz SCS....347
- MP Z 15kHz/30kHz SCS....347
- MP NTN X 15kHz/30kHz SCS....348

A.26.1 MP X 15kHz/30kHz SCS

3GPP TS 38.141-1 and TS 38.141-2

Table A-37: MP X 15kHz/30kHz SCS channel model: common parameters for all paths

	MP X 15kHz SCS	MP X 30kHz SCS
Delay variation (peak-peak) (µs)	10	5
Variation period (s)	157.1	78.5
Profile	Static	Static
Fine delay (ns)	0	0
Lognormal	Off	Off

	MP X 15kHz SCS	MP X 30kHz SCS
Corr with	Off	Off
Doppler shift (Hz) (keep constant)	400	400
Speed (km/h) (f_C = 1 GHz)	431.701	431.701

Table A-38: MP X 15kHz/30kHz SCS channel model: path losses and delays

Parameter	Path 1	Path 2	Path 3	Path 4	Path 5	Path 6
"Path Loss (dB)"	0	7.7	2.5	6.9	9.9	2.4
"Resulting Delay (ns)"	65	70	190	0	200	195
	Path 7	**Path 8**	**Path 9**	**Path 10**	**Path 11**	**Path 12**
"Path Loss (dB)"	6.6	13	8	7.1	14.2	16
"Resulting Delay (ns)"	325	1045	240	520	1510	2595

A.26.2 MP Y 15kHz/30kHz/120kHz SCS

3GPP TS 38.104 and TS 38.141-2

Table A-39: MP Y 15kHz/30kHz/120kHz SCS channel model: common parameters for path 1

	MP Y 15kHz SCS	MP Y 30kHz SCS	MP Y 120kHz SCS
Delay variation (peak-peak) (µs)	10	5	1.25
Variation period (s)	48.3	24.2	6
Profile	Static	Static	Static
Loss (dB)	0	0	0
Delay (ns)	0	0	0
Fine delay (ns)	0	0	0
Lognormal	Off	Off	Off
Corr with	Off	Off	Off
Doppler shift (Hz) (f_C = 1 GHz)	324.30	324.30	324.30
Speed (km/h) (keep constant)	350	350	350

A.26.3 MP Z 15kHz/30kHz SCS

3GPP TS 38.141-1 and TS 38.141-2

Table A-40: MP Z 15kHz/30kHz SCS channel model: common parameters for path 1

	MP Z 15kHz SCS	MP Z 30kHz SCS
Delay variation (peak-peak) (µs)	10	5
Variation period (s)	34.9	17.4

	MP Z 15kHz SCS	MP Z 30kHz SCS
Profile	Static	Static
Loss (dB)	0	0
Delay (ns)	0	0
Fine delay (ns)	0	0
Lognormal	Off	Off
Corr with	Off	Off
Doppler shift (Hz) (f_C = 1 GHz)	463.28	463.28
Speed (km/h) (keep constant)	500	500

A.26.4 MP NTN X 15kHz/30kHz SCS

3GPP TS 38.181

Table A-41: MP NTN X 15kHz/30kHz SCS channel model: common parameters for all paths

	MP NTN X 15kHz SCS	MP NTN X 30kHz SCS
Delay variation (peak-peak) (µs)	10	5
Variation period (s)	157.1	78.5
Profile	Rayleigh	Rayleigh
Fine delay (ns)	0	0
Lognormal	Off	Off
Corr with	Off	Off
Doppler shift (Hz) (keep constant)	200	200
Speed (km/h) (f_C = 1 GHz)	215.849	215.849

Table A-42: MP NTN X 15kHz/30kHz SCS channel model: path losses and delays

Parameter	Path 1	Path 2	Path 3	Path 4 (off)	Path 5 (off)	Path 6 (off)
"Path Loss (dB)"	0	4.7	6.5	-	-	-
"Resulting Delay (ns)"	0	110	285	-	-	-

B Antenna pattern file format

Antenna pattern files are XML files in the Rohde & Schwarz proprietary antenna pattern file format. These files use the predefined file extension `*.ant_pat`. They describe the antenna power response matrix as an array with resolutions of 1 degree to 5 degrees for both the elevation and the azimuth angels. In their minimum format, antenna pattern files contain only the loss values for a given azimuth angle. For an isotropic antenna for instance, that radiates the energy equally in all directions, the array elements are all 0 dB.

Antenna pattern files can also include the relative phase and antenna polarization information.

Parsing of antenna pattern files containing relative phase and polarization information requires option R&S SMW-K73.

The antenna pattern file format uses a generic file structure for both 2D and 3D antenna models (see Figure B-1). It can be seen as a table with the following parts:

- Header row comprising the azimuth angles (`<az_values>`)
- First column defining the zenith angles (`<zenith>`)
- A data part describing the antenna power response (`<power>`).

The table can have different number of columns (1 to n), depending on the azimuth resolution (`<az_res>`). The number of rows depends on the zenith resolution (`<elev_res>`).

The `<is3D>` element defines if the pattern is a 2D or a 3D antenna model; if `<is3D = "1">` a three-dimensional antenna pattern description is required.

Depending on the antenna type, there are three possibilities to describe the antenna power response:

- Single polarized antenna
  Antenna power only (`<hasPolInfo>` and `<hasPhaseInfo>` are not specified)
  See 1) on Figure B-1
- Dual-polarized antenna
  Vertical and horizontal power descriptions (`<hasPolInfo="1" hasPhaseInfo="0">`)
  See 2) on Figure B-1
- Dual-polarized antenna
  Vertical and horizontal relative phase descriptions, additional to the vertical and horizontal power descriptions (`<hasPolInfo="1" hasPhaseInfo="1">`)
  See 2) on Figure B-1

For details on the file syntax, see Table B-1.

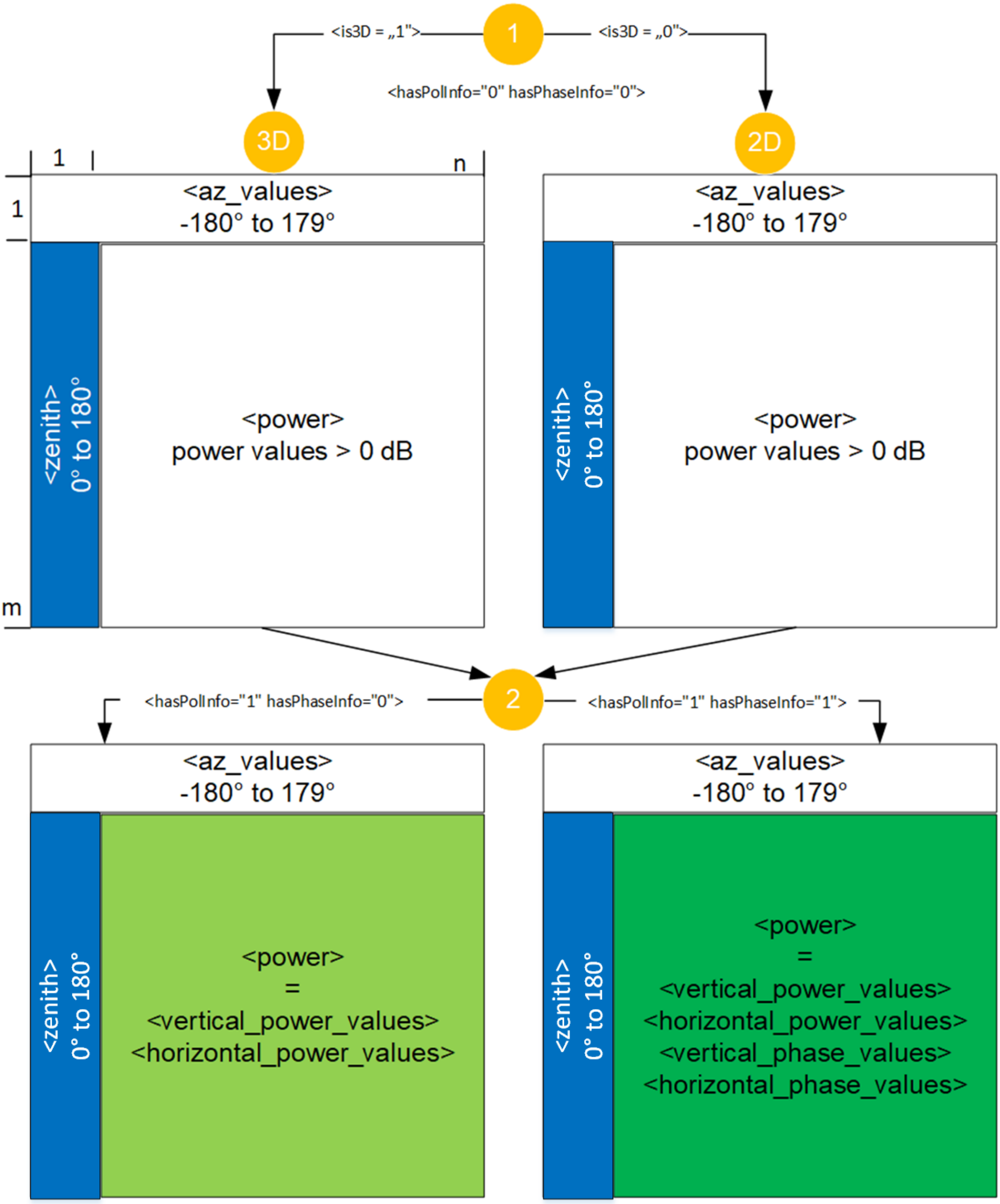


Figure B-1: File format structure

1 = 3D antenna model, if is3D="1" and 2D - if is3D="0"
1 to n = Number of columns, depending on <az_res>
1 to m = Number of rows, depending on <elev_res>
2 = Combination of <hasPolInfo> and <hasPhaseInfo> and the meaning for the <data> part

Example: Antenna with three sectors (3Sectors.ant_pat) as specified in TR 25.996 (extract)

According to TR 25.996, the 3 sector antenna pattern is used for each sector. The following equation describes the antenna pattern:

$A(\Theta) = -\min[12(\Theta/\Theta_{3dB})^2, A_m]$

Where:

- $-180° \leq \Theta < 180°$ is the angle between the direction of interest and the boresight of the antenna
- Θ_{3dB} is the 3 dB beamwidth in degrees
- A_m is the maximum attenuation

For the 3 sector scenario Θ = 70 deg and A_m = 40 dB.

Note: The antenna pattern files define the antenna **power** and not the antenna gain.

```
<?xml version="1.0" encoding="ISO-8859-1"?>
<antenna_pattern>
  <antenna_descr count="1">
 </antenna_descr>
    <az_res> 1.00000000e+000 </az_res>
    <elev_res> 1.00000000e+000 </elev_res>
 <data>
  <!-- list of the azimuth values <az_values> -->
     -179.5,-178.5,-177.5,...   -89.5,   -88.5,   -87.5,   -86.5,...178.5,179.5
  <!-- <power_values> -->
     -89.5,   40,    40,    40,...3.92e+01,3.84e+01,3.75e+01,3.66e+01,...   40,40
  </data>
</antenna_pattern>
```

Example: Antenna pattern with polarization and relative phase information (extract)

This example contains comments for better understanding. Comments are indicated with <!-- and -->.

```
<?xml version="1.0" encoding="ISO-8859-1"?>
<antenna_pattern>
  <antenna_descr>
    <antenna hasPhaseInfo="1" hasPolInfo="1"/>
 </antenna_descr>
 <az_res> 1.00000 </az_res>
 <elev_res> 1.00000 </elev_res>
 <data>
  <!-- list of the azimuth values <az_values> -->
      -180.0,-179.0... 0... 179.0,179.0
  <!-- vertical polarization <vertical_power_values> -->
          0,9.722102564,9.150142134... 12.79746154... 10.0064906,9.722102564
  <!-- horizontal polarization <horizontal_power_values> -->
          0,25.53114835,25.53776203... 25.3327381... 25.48485262,25.53114835
  <!-- vertical relative phase <vertical_phase_values> -->
          0,3.203435487,3.271611926... 3.767874967... 3.139292698,3.203435487
  <!-- horizontal relative phase <horizontal_phase_values> -->
          0,0.624420629,0.632933957... 0.56246144... 0.615821973,0.624420629
```

Example: Antenna pattern for 3D channel model (extract)

This example contains comments for better understanding. Comments are indicated with <!-- and -->.

```
<?xml version="1.0" encoding="ISO-8859-1"?>
<antenna_pattern>
 <antenna_descr>
  <antenna    hasPhaseInfo="0" hasPolInfo="1" is3D="1"/>
 </antenna_descr>
 <az_res> 1.00000 </az_res>
 <elev_res> 2.00000 </elev_res>
 <data>

<-- list of the azimuth values <az_values> -->
      -180.0,-179.0... 0... 179.0,179.0
  <!-- vertical polarization <vertical_power_values> -->
           0.0, 5.33e+01, 5.33e+01, 5.33e+01, ... 5.33e+01
  <!-- horizontal polarization <horizontal_power_values> -->
          2.0, 5.32e+01, 5.32e+01, 5.32e+01, ... 5.32e+01
```

File syntax

The Table B-1 describes the used tags and parameters.

*Table B-1: Format of *.ant_pat file*

Tag name	Parameter	Description
<antenna_pat-tern>		Defines antenna pattern file
<antenna_descr>		Contains the descriptions of the antennas
	<count>	Number of antenna patterns; value = 1 always
<antenna>		Descriptions of the individual antenna
	<hasPolInfo>	Indicates if the file contains the vertical and horizontal power information or not. ● "0": single polarized antenna, power information only (Antenna polarization is set with the parameter Antenna Polarization Slant Angle) ● "1": dual polarized antenna, vertical and horizontal power information included The **vertical and horizontal power** descriptions are mandatory
	<hasPhaseInfo>	Indicates if the file contains relative phase description or not. ● "0": no relative phase information ● "1": relative phase information included The **relative phase** description is mandatory If also `<hasPolInfo="1">`, **both** the vertical and the horizontal relative phase descriptions are mandatory
	<is3D>	Indicates if the file describes a 3D antenna model or not. ● "0": 2D model ● "1": 3D model
<az_res>		Azimuth resolution of the antenna pattern description (`<data>` tag) Value in degrees integer divider of 360 Value range: - 180° to 179°
<elev_res>		Elevation resolution of the `<data>` tag Value in degrees integer divider of 180
<data>		Antenna pattern description as an array with: ● [1 + 360/`<az_res>`] columns – **2D** antenna model: The **first** column indicates the elevation angle used to create the 2D pattern out of the 3D pattern. It is usually 0°. – **3D** antenna model The **first** column indicates the **zenith**. It is value in the range 0 to 180° ● 2 to 5 rows, depending on the `<hasPolInfo>` and the `<hasPhaseInfo>` tags The first row lists the azimuth angles `<az_values>`*). The second row describes antenna power response in terms of **loss values** in dB; the power values are positive values, calculated as: *20*log$_{10}$(LinearGain)* If `<hasPolInfo="1">`, the descriptions of the **vertical and horizontal power response** of the antenna is mandatory. Required are two rows, for the vertical and the horizontal information; always in this order. If `<hasPhaseInfo="1">`, the **relative phase** description is mandatory. Required are one or, if `<hasPolInfo="1">`, two rows - for the vertical and the horizontal information; always in this order. Allowed are values in the range 0 rad to 2pi rad.

*) If the azimuth angles (<az_values>) are given with lower resolution that the resolution specified with the <az_res> element, an interpolation is applied.

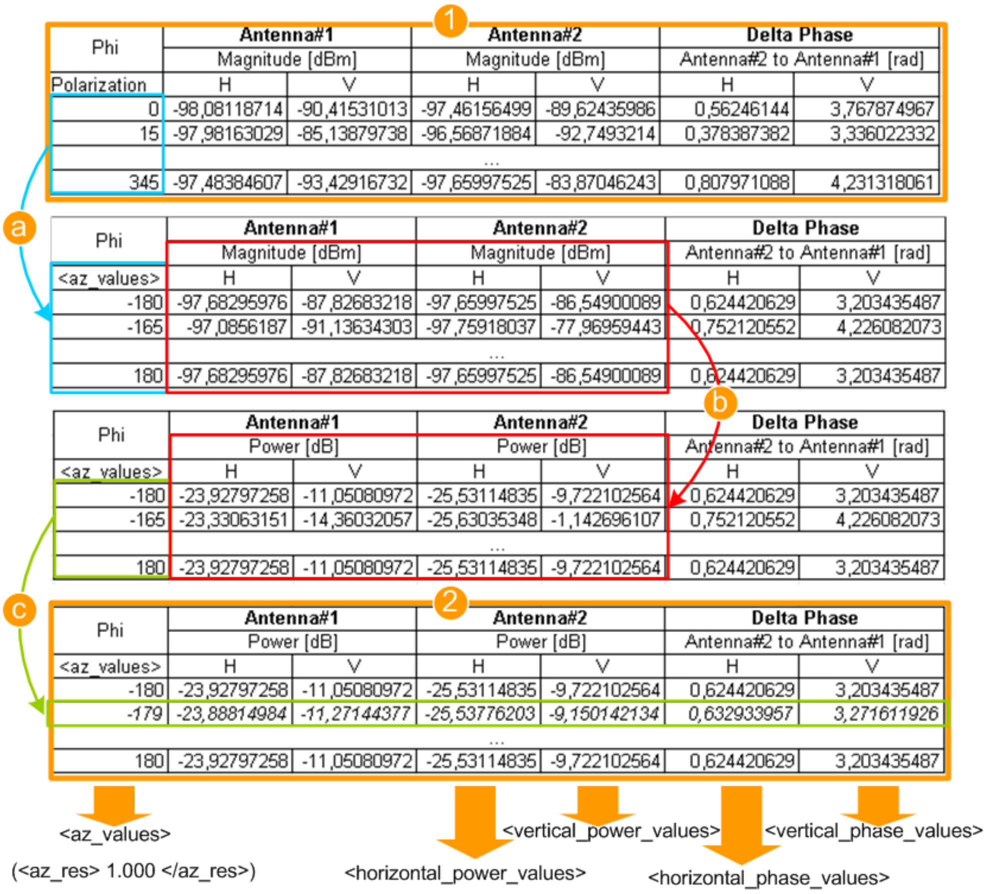
How to create an antenna pattern file from the measured values

The radiated antenna pattern of the DUT is the measurement result of the stage 1 in the two stage MIMO OTA test method (see "About the MIMO OTA two stage method" on page 131). The following is an overview of the general steps required to convert the measured antenna pattern values into the Rohde & Schwarz 2D antenna pattern format.

General steps

1. Convert the azimuth value to the values range of -180° to 180°.
2. Convert the magnitude values expressed in dBm into loss values expressed in dB. Calculate the required power values as *20*log$_{10}$(LinearGain)*
3. Interpolate the values to achieve an azimuth resolution of 1°.
4. Create the 2D antenna pattern file.

   The example on Figure B-2 illustrates the required steps.



Phi	Antenna#1 Magnitude [dBm]		Antenna#2 Magnitude [dBm]		Delta Phase Antenna#2 to Antenna#1 [rad]	
Polarization	H	V	H	V	H	V
0	-98,08118714	-90,41531013	-97,46156499	-89,62435986	0,56246144	3,767874967
15	-97,98163029	-85,13879738	-96,56871884	-92,7493214	0,378387382	3,336022332
			...			
345	-97,48384607	-93,42916732	-97,65997525	-83,87046243	0,807971088	4,231318061

Phi	Antenna#1 Magnitude [dBm]		Antenna#2 Magnitude [dBm]		Delta Phase Antenna#2 to Antenna#1 [rad]	
<az_values>	H	V	H	V	H	V
-180	-97,68295976	-87,82683218	-97,65997525	-86,54900089	0,624420629	3,203435487
-165	-97,0856187	-91,13634303	-97,75918037	-77,96959443	0,752120552	4,226082073
			...			
180	-97,68295976	-87,82683218	-97,65997525	-86,54900089	0,624420629	3,203435487

Phi	Antenna#1 Power [dB]		Antenna#2 Power [dB]		Delta Phase Antenna#2 to Antenna#1 [rad]	
<az_values>	H	V	H	V	H	V
-180	-23,92797258	-11,05080972	-25,53114835	-9,722102564	0,624420629	3,203435487
-165	-23,33063151	-14,36032057	-25,63035348	-1,142696107	0,752120552	4,226082073
			...			
180	-23,92797258	-11,05080972	-25,53114835	-9,722102564	0,624420629	3,203435487

Phi	Antenna#1 Power [dB]		Antenna#2 Power [dB]		Delta Phase Antenna#2 to Antenna#1 [rad]	
<az_values>	H	V	H	V	H	V
-180	-23,92797258	-11,05080972	-25,53114835	-9,722102564	0,624420629	3,203435487
-179	*-23,88814984*	*-11,27144377*	*-25,53776203*	*-9,150142134*	*0,632933957*	*3,271611926*
			...			
180	-23,92797258	-11,05080972	-25,53114835	-9,722102564	0,624420629	3,203435487

Figure B-2: Converting custom data into the Rohde & Schwarz 2D antenna pattern file format

1	= Input file (extract, shows the first two and the last row)
H, V	= Horizontal and vertical polarization values
a	= Convert angle value for 0° to 360 ° to <az_values> = -180° to 179°
b	= Convert magnitude values [dBm] to power [dB]
c	= Interpolate the values
2	= Converted and interpolated values to achieve azimuth resolution of 1°
<horizontal_power_values>, <vertical_power_values>	= Power values > 0 dB

The example shows how to create the antenna pattern file of antenna #2.
An extract of antenna pattern file content is listed in Example"Antenna pattern with polarization and relative phase information (extract)" on page 352. The created file contains relative phase information and the description of the vertical and the horizontal polarizations (<antenna **hasPhaseInfo="1" hasPolInfo="1"**/>).

Create the antenna pattern file of antenna #1 in the same way but set the <vertical_phase_values> = <horizontal_phase_values> = 0.

Glossary: Specifications and references

Symbols

[1]: http://www.ist-winner.org

[2]: Laurent Schumacher, et al, "Closed-Form Expressions for the Correlation Coefficient of Directive Antennas Impinged by a Multimodal Truncated Laplacian PAS" IEEE Transactions on wireless communications, P.1351-1359, Vol. 4, No. 4, 2005

[3]: 3GPP TSG RAN
R4-136801 "Analysis of relative phase impact on two-stage results"

T

TGac: IEEE 802.11-09/0308r3
IEEE P802.11 Wireless LAN "**TGac** Channel Model Addendum"

TGn: IEEE 802.11-03/940r
IEEE P802.11 Wireless LAN "**TGn** Channel Models"

TR 25.996: "Spatial channel model for Multiple Input Multiple Output (MIMO) simulations"

TR 36.873: "Study on channel model for frequency spectrum above 6 GHz"

TR 37.977: "Verification of radiated multi-antenna reception performance of User Equipment (UE)"

TR 38.827: "Study on radiated metrics and test methodology for the verification of multi-antenna reception performance of NR User Equipment (UE)"

TS 34.114: "User Equipment (UE) / Mobile Station (MS) Over The Air (OTA) antenna performance; Conformance testing"

TS 38.101-4: "User Equipment (UE) radio transmission and reception; Part 4: Performance requirements"

TS 38.104: "Base Station (BS) radio transmission and reception"

TS 38.141-1: "Base Station (BS) conformance testing Part 1: Conducted conformance testing"

TS 38.141-2: "Base Station (BS) conformance testing Part 2: Radiated conformance testing"

TS 38.181: "Satellite Access Node (SAN) conformance testing (Release 17)"

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