R&S®SMW-K555
Bandwidth Extension
User Manual

1179577602
Version 03

ROHDE&SCHWARZ
Make ideas real

This document describes the following software options and accessory options:

- R&S®SMW-K555 Bandwidth Extension (1414.6229.xx)
- R&S®SMW-ZKK Combiner Kit 40 GHz (1434.7908.02)
- R&S®SMW-ZKV Combiner Kit 67 GHz (1434.7989.02)

The following abbreviations are used throughout this manual: R&S®SMW200A is abbreviated as R&S SMW.

Contents

1 Welcome to the Bandwidth Extension option

The R&S SMW-K555 option Bandwidth Extension is a firmware application that allows extension of the modulation bandwidth to up to 4 GHz.

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 SMW 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 SMW service manual.

1.1 Key features

- Extension of the modulation bandwidth of an RF signal to up to 4 GHz
- Support of single instrument setups and dual instrument setups:
    - Single R&S SMW instrument setup with extended bandwidth from RF paths A and B
    - Dual R&S SMW instrument setup with extended bandwidth from single RF paths of each instrument
- Support of output clock rates of up to 4.8 GHz
- Automatic alignment for synchronization of the RF output signal:
    - RF ports alignment including local oscillator (LO) phase corrections
    - Bandwidth extension setup alignment including RF level corrections and skew corrections due to different cable lengths
- Support of baseband signals for ARB and the following digital standards:
    - Multi Carrier Continuous Wave (MCCW) Signal Generation (R&S SMW-K61)
    - OFDM Signal Generation (R&S SMW-K114)
    - IEEE 802.11ad/ay (R&S SMW-K177)
- Support of Frontend Control (R&S SMW-K553) and external frontends to transmit upconverted RF signals with 4 GHz bandwidth

1.2　Accessing the Bandwidth Extension dialog

To open the dialog with Bandwidth Extension settings

1. In the block diagram of the R&S SMW, select "System Config > System Configuration".

2. Select "Multi Instrument > Bandwidth Extension".

   The dialog provides general settings for bandwidth extension.

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

1.3　What's new

This manual describes firmware version FW 5.20.043.xx and later of the R&S®SMW200A.

Compared to the previous version, it provides the new features listed below.

- Extended bandwidth using a single R&S SMW instrument, see Chapter 3.1, "Test setups", on page 13 and Chapter 3.2.1, "Connecting a single R&S SMW", on page 17.
- Extended bandwidth using multiple R&S SMW instruments, see Chapter 3.1, "Test setups", on page 13 and Chapter 3.2.2, "Connecting multiple R&S SMW instruments", on page 20.
- Compatibility of option R&S SMW-K555 with option R&S SMW-K177 to generate 4 GHz bandwidth 802.11ay signals, see Chapter 1.1, "Key features", on page 5.
- Editorial changes

1.4　Documentation overview

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

www.rohde-schwarz.com/manual/smw200a

1.4.1　Getting started manual

Introduces the R&S SMW 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.

1.4.2　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 SMW is not included.

The contents of the user manuals are available as help in the R&S SMW. 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.

1.4.3　Tutorials

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

1.4.4　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

1.4.5　Instrument security procedures

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

1.4.6　Printed safety instructions

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

1.4.7 Data sheets and brochures

The data sheet contains the technical specifications of the R&S SMW. It also lists the options 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

1.4.8 Release notes and open source acknowledgment (OSA)

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

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

See www.rohde-schwarz.com/firmware/smw200a

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

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

See www.rohde-schwarz.com/application/smw200a and www.rohde-schwarz.com/manual/smw200a

1.4.10 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

1.5 Scope

(i) 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 SMW user manual.

1.6 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 Bandwidth Extension option

2.1 Required options

The basic equipment layout for Bandwidth Extension includes the options for each R&S SMW:

- Wideband baseband main module (R&S SMW-B13XT)
- Two path instrument including the following options per instrument path:
  - Wideband baseband generator (R&S SMW-B9)
  - Baseband extension to 1 GHz RF (R&S SMW-K525)
  - Baseband extension to 2 GHz RF (R&S SMW-K527)
- Frequency options:
  - First path: Minimum configuration requires R&S SMW-B1006
  - Second path: Minimum configuration requires R&S SMW-B2006

  For full alignment functionality, we recommend that you install options R&S SMW-B1020/B2020 or higher, see "Signal generator" on page 13.
- Bandwidth Extension (R&S SMW-K555)
- Optional combiner kit options:
  - Combiner Kit 40 GHz (R&S SMW-ZKK)
    For RF output frequencies up to 40 GHz
  - Combiner Kit 67 GHz (R&S SMW-ZKV)
    For RF output frequencies up to 67 GHz
- Optional digital standards supporting extended bandwidth signals:
  - Multi Carrier Continuous Wave (MCCW) Signal Generation (R&S SMW-K61)
  - OFDM Signal Generation (R&S SMW-K114)
- Optional frontend control (R&S SMW-K553) and an external frontend
  For output of upconverted RF signals with extended bandwidth

For more information, see data sheet.

2.2 About Bandwidth Extension

Equipped with option R&S SMW-K555, the R&S SMW allows you to extend bandwidths of I/Q modulated signals.

Principle

A practical approach is to superimpose RF signals with center frequencies close to each other. The bandwidths of the modulated baseband signal overlap. The figure Figure 2-1 illustrates the superposition of two adjacent baseband signals band A (bandwidth $f_{BW\,A}$, center frequency $f_{c\,A}$) and band B (bandwidth $f_{BW\,B}$, center frequency $f_{c\,B}$).
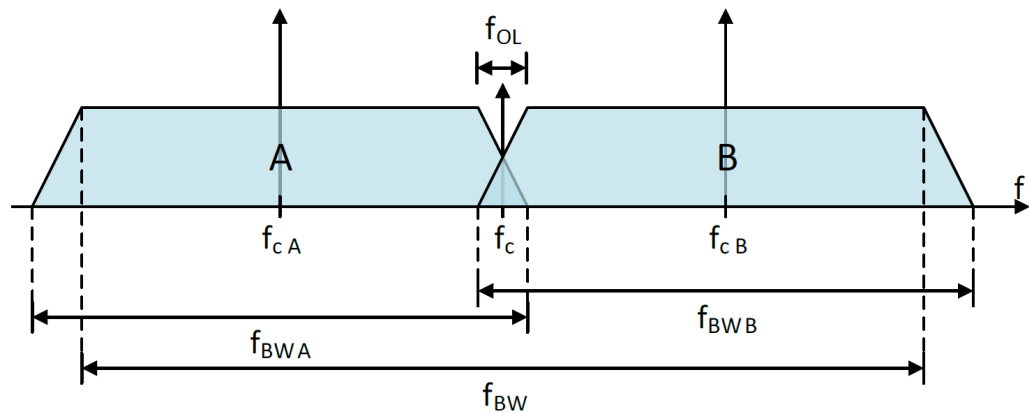
Figure 2-1: Bandwidth extension without phase corrections

A   = Band A
B   = Band B
$f_{BW\,A}$ = Bandwidth band A
$f_{BW\,B}$ = Bandwidth band B
f_{BW} = Extended bandwidth of band A and band B
$f_{c\,A}$ = Center frequency band A
$f_{c\,B}$ = Center frequency band B
f_c = Center frequency of band A and band B
f_{OL} = Bandwidth overlap between band A and band B

Ideally, the resulting baseband signal has an extended bandwidth $f_{BW} = f_{BW\,A} + f_{BW\,B}$ at center frequency f_c. In reality, destructive interference effects occur at the bandwidth overlap f_{OL} and result in a signal level drop at f_c. To compensate the signal level drop, phase corrections are added so that signal level of the resulting band A+B is constant over the whole bandwidth range f_{BW}.
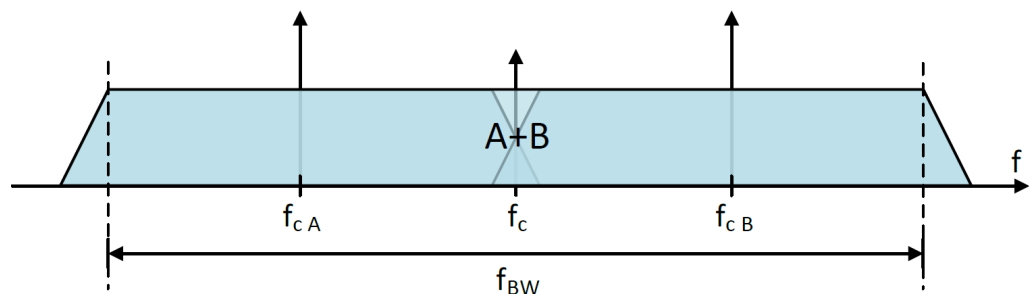

Figure 2-2: Bandwidth extension with phase corrections

A+B = Extended band A+B with corrected overlap
f_{BW} = Extended bandwidth of band A and band B
$f_{c\,A}$ = Center frequency band A
$f_{c\,B}$ = Center frequency band B
f_c = Center frequency of band A and band B

About phase corrections

You can obtain phase correction data, for example, from a coupled alignment source after combining the baseband signals. The alignment source can be a power sensor or

a spectrum analyzer. Also, this alignment source has direct feedback (LAN) to the baseband signal source that is the R&S SMW. For test setups, see Chapter 3.1, "Test setups", on page 13.

3 Generating RF signals with extended bandwidth

This chapter provides an overview on how to prepare, configure and operate the R&S SMW or multiple R&S SMW instruments for generation of extended bandwidth signals. It covers the following topics:

3.1 Test setups

This chapter provides an overview on test setups for bandwidth extension. Test setups can include one or more R&S SMW vector signal generators. In this description, all test setups also include a power combiner and a directional coupler.

For alignment of the RF output signal of R&S SMW, you can either use a power sensor or a vector signal analyzer.

Signal generator

One R&S SMW vector signal generator equipped with relevant options, see Chapter 2.1, "Required options", on page 10.

Instruments equipped with frequency options below R&S SMW-B1020/B2020 have an electronic reference circuit with limited alignment functionality. For full alignment functionality, we recommend that you install options R&S SMW-B1020/B2020 or higher, see Table 3-1.

Table 3-1: R&S SMW variant and alignment performance

Frequency option	Reference circuit	Alignment performance
R&S SMW-B1012/B2012 and lower	Electronic	Measurement device: SIgnal analyzer only Setup alignment: Level corrections only RF ports alignment: Full alignment
R&S SMW-B1020/B2020 and higher	Mechanical	Measurement device: SIgnal analyzer or power sensor Setup alignment: Full alignment RF ports alignment: Full alignment

Power combiner

To combine RF signals of your test setup, you have to install a power combiner. For correct operation, use a power combiner that supports the frequency range of your RF

output signal. For example, use the combiner kit R&S SMW-ZKK, if your test setup generates RF signals with a maximum frequency of 40 GHz.

Directional coupler

To automate alignment of your test setup, you can use a directional coupler. For correct operation, use a directional coupler with an output coupling factor that is not higher than 10 dB. For higher coupling factors, the coupling loss is too large to align power levels.

Power sensor

To align the power levels for synchronization of the RF output signal ("Align RF Ports"), use a diode sensor. Using thermal sensors can cause erroneous alignment. For example, use a diode sensor of the R&S NRP family. You find the diode sensors on the product page at:

www.rohde-schwarz.com/product/nrp_s_sn

Signal analyzer

To align the local oscillator (LO) phase for synchronization of the RF output signal ("Align Setup"), use a vector signal analyzer. For correct operation, make sure that this analyzer supports an analysis bandwidth that fits your RF output signal. For example, use an R&S FSW equipped with option R&S FSW-B4001 for analysis of up to 4 GHz bandwidth signals. The minimum required equipment is R&S FSW-B2001 for analysis of up to 2 GHz bandwidth signals. You find the signal analyzer on the product page at:

www.rohde-schwarz.com/product/fsw

The following test setups are described:

3.1.1 Single R&S SMW with sensor

This test setup includes a single R&S SMW, a power combiner, a directional coupler, a power sensor and the device under test (DUT).
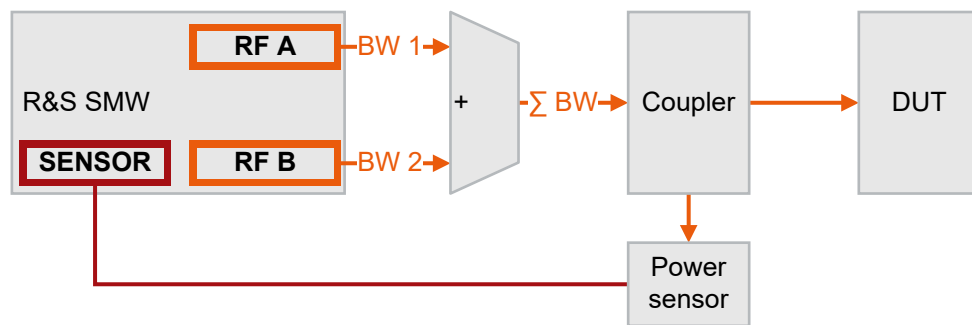
Figure 3-1: Test setup: R&S SMW and power sensor

BW 1   = Bandwidth of the path A output signal
BW 2   = Bandwidth of the path B output signal
Σ BW   = Extended bandwidth signal after combining path A and path B output signals
+   = Power combiner
Coupler   = Directional coupler
Power sensor = Sensor of the R&S NRP family
SENSOR   = Connection between R&S SMW and power sensor

3.1.2 Single R&S SMW with signal analyzer

This test setup includes a single R&S SMW, a power combiner, a directional coupler, a vector signal analyzer and the device under test (DUT).
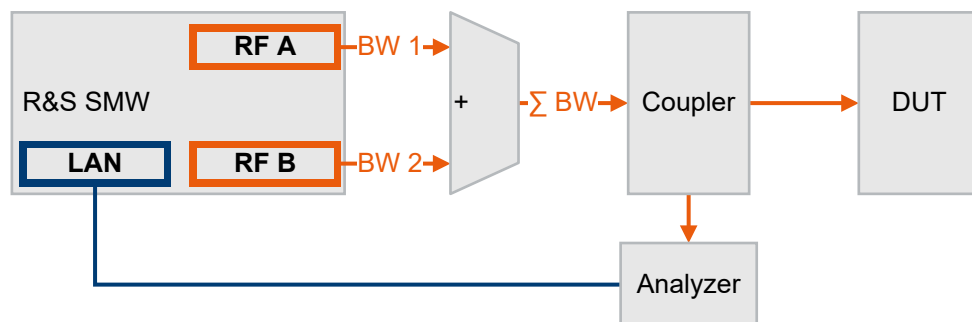

Figure 3-2: Test setup: R&S SMW with signal analyzer

BW 1   = Bandwidth of the path A output signal
BW 2   = Bandwidth of the path B output signal
Σ BW   = Extended bandwidth signal after combining path A and path B output signals
+   = Power combiner
Coupler   = Directional coupler
Analyzer   = Vector signal analyzer, e.g. R&S FSW
LAN   = Connection between R&S SMW and vector signal analyzer

3.1.3 Dual R&S SMW with sensor

This test setup includes two R&S SMW instruments, a primary R&S SMW and a secondary R&S SMW. Also, it includes a power combiner, a directional coupler, a power sensor and the device under test (DUT).
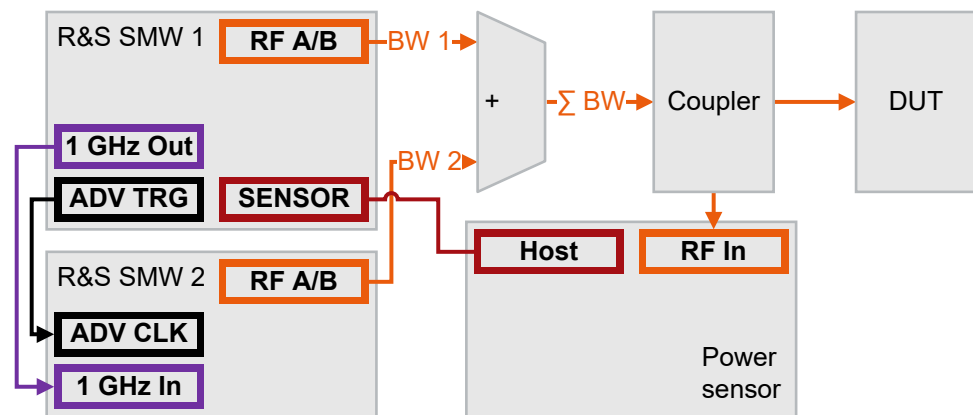
Figure 3-3: Test setup: R&S SMW and power sensor

R&S SMW 1   = Primary R&S SMW
R&S SMW 2   = Secondary R&S SMW
BW 1   = Bandwidth of the primary R&S SMW RF output signal
BW 2   = Bandwidth of the secondary R&S SMW RF output signal
Σ BW   = Extended bandwidth signal after combining path A and path B output signals
+   = Power combiner
Coupler   = Directional coupler
Power sensor   = Sensor of the R&S NRP family
SENSOR/Host   = Connection between R&S SMW and power sensor
ADV TRG/CLK   = Connection to synchronize primary and secondary R&S SMW
1 GHz Out/1GHz In = Connection reference signals between primary R&S SMW and secondary R&S SMW

3.1.4 Dual R&S SMW with signal analyzer

This test setup includes two R&S SMW instruments, a primary R&S SMW and a secondary R&S SMW. Also, it includes a power combiner, a directional coupler, a vector signal analyzer and the device under test (DUT).
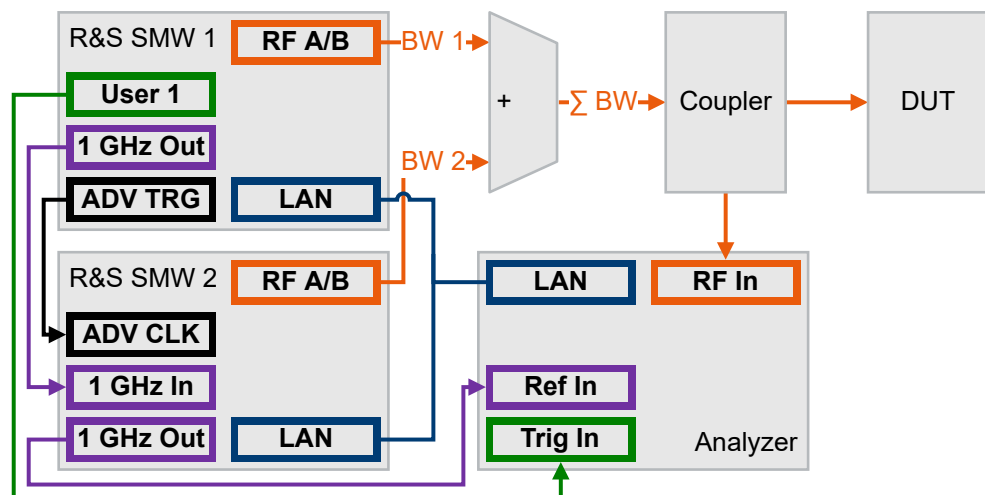

Figure 3-4: Test setup: Dual R&S SMW with signal analyzer

R&S SMW 1	= Primary R&S SMW
R&S SMW 2	= Secondary R&S SMW
BW 1	= Bandwidth of the primary R&S SMW RF output signal
BW 2	= Bandwidth of the secondary R&S SMW RF output signal
Σ BW	= Extended bandwidth signal after combining primary and secondary R&S SMW RF output signals
+	= Power combiner
Coupler	= Directional coupler
Analyzer	= Vector signal analyzer, e.g. R&S FSW
LAN	= Connection between R&S SMW and vector signal analyzer
ADV TRG/CLK	= Connection to synchronize primary and secondary R&S SMW
1 GHz In/1 GHz Out/Ref In	= Connection reference signals between primary, secondary R&S SMW and analyzer
User 1/Trig In	= Connection to trigger setup alignment between primary R&S SMW and analyzer

3.2 Connecting the R&S SMW

3.2.1 Connecting a single R&S SMW

This chapter provides step-by-step instructions for connecting the R&S SMW with components and instruments of a bandwidth extension setup. Connecting procedures for relevant connector types are summarized. Connecting to these connector types is analogous for all instruments. The step-by-step instructions cover the following topics:

- "To connect a power combiner" on page 17
- "To connect a directional coupler" on page 19
- "To connect an R&S NRP power sensor" on page 19
- "To connect a signal analyzer" on page 20

To connect a power combiner

The following step-by-step instruction describes how to connect R&S SMW to a power combiner. Also, it describes how to connect the power combiner and a directional coupler. The R&S SMW is switched on and connected to power.

For prerequisites of the power combiner, see "Power combiner" on page 13.

1. Use high-quality RF cables.
   See "Cable selection and electromagnetic interference (EMI)" in the R&S SMW Getting Started.

2. Use short RF cables of equal length for connection between R&S SMW and power combiner.

3. For correct operation, use one of the following combiner kits:

   - R&S SMW-ZKK for RF output signals of up to 44 GHz
   - R&S SMW-ZKV for RF output signals of up to 67 GHz

4. Establish the RF connections.
   Step (d) and following steps of this step-by-step instruction assume a connection to an R&S SMW-ZKV combiner kit. Connecting other power combiners is analogous.

   a) Ensure that the RF connector of the R&S SMW is compatible with the RF connectors of the power combiner and the directional coupler.

   b) Inspect the RF connectors carefully. Look for metal particles, contaminants and defects.
      If you notice damages at the RF connector, do not proceed, because the risk of damaging the mating connector is too high.

   c) Connect the RF cables.
      See chapter "Connecting to RF" in the R&S SMW Getting Started.

   d) First, start connecting the cable ends with the power combiner.
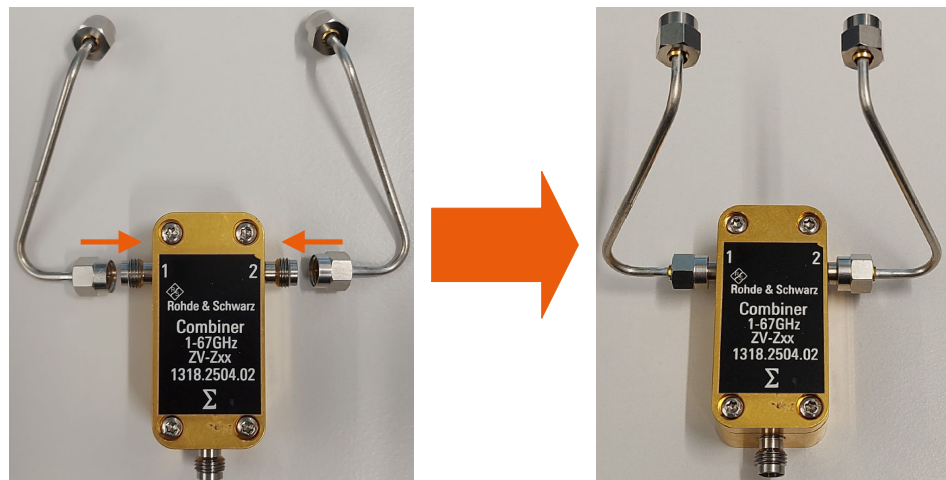
   e) Connect both the cable ends with the RF output connectors of the R&S SMW.
      The figure below shows a power combiner connected to both RF connectors of a single R&S SMW.

   f) Connect the power combiner with the directional coupler.

   The tables Table 3-2 and Table 3-3 provide an overview of relevant connections.

To connect a directional coupler

Use a directional coupler to automate alignment.

For prerequisites of the directional coupler, see "Directional coupler" on page 14.

► Establish the RF connections to the directional coupler as described in the other step-by-step instructions:

- Direction from the power combiner: "To connect a power combiner" on page 17
- Direction to the measurement device:
  - Sensor: "To connect an R&S NRP power sensor" on page 19
  - Analyzer: "To connect a signal analyzer" on page 22

The tables Table 3-4 and Table 3-5 provide an overview of relevant connections.

To connect an R&S NRP power sensor

The following step-by-step instruction describes how to connect R&S SMW to an R&S NRP power sensor as alignment source. Also, it describes how to connect the power sensor and a directional coupler. The R&S SMW is switched on and connected to power.

For prerequisites of the power sensor, see "Power sensor" on page 14.

1. Use all cables delivered with the R&S NRP power sensor. Other connections can require additional cables.

   a) For the control connection, use the cable R&S NRP-ZK6 as delivered with the R&S NRP power sensor.
   b) For the RF connection, use a high-quality cable.

   See "Cable selection and electromagnetic interference (EMI)" in the R&S SMW getting started.

2. Insert the host connector of the power sensor into the "SENSOR" of the R&S SMW.

3. Establish the RF connection between power sensor and directional coupler.

   a) Ensure that the RF connector of the directional coupler is compatible with the RF connector of the power sensor.
   b) Inspect both RF connectors carefully. Look for metal particles, contaminants and defects.
      If you notice damages at either RF connector, do not proceed, because the risk of damaging the mating connector is too high.
   c) Insert the RF connector of the power sensor straight into the RF output of the directional coupler. Take care not to tilt it.

   The table Table 3-2 provides an overview of relevant connections.

Table 3-2: Connections single R&S SMW with power sensor

Signal	R&S SMW	Power combiner	Power sensor	Directional coupler
Sensor control	"SENSOR"	-	Host connector	-
RF Out	"RF A" and "RF B"	"RF In" (from R&S SMW)	RF connector	"RF In" (from power combiner)
RF In	-	"RF Out" (to directional coupler)		"RF Out" (to power sensor)

For more information, see chapter "Connecting the R&S NRP" in the R&S NRP Getting Started.

To connect a signal analyzer

The following step-by-step instruction describes how to connect R&S SMW and a directional coupler to an Rohde & Schwarz signal analyzer as alignment source. The R&S SMW and signal analyzer are switched on and connected to power.

For prerequisites of the signal analyzer, see "Signal analyzer" on page 14.

1. Connect "RF Input 50Ω" connector of the signal analyzer to the RF output of the directional coupler.

2. Establish a LAN connection between R&S SMW and signal analyzer.
    How to: Chapter "Connecting to LAN" in the R&S SMW user manual

    The table Table 3-3 provides an overview of relevant connections.

Table 3-3: Connections single R&S SMW with signal analyzer

Signal	R&S SMW	Power combiner	Signal analyzer	Directional coupler
RF Out	"RF A" and "RF B"	"RF In" (from R&S SMW)	-	"RF In" (from power combiner)
RF In	-	"RF Out" (to directional coupler)	"RF Input 50Ω"	"RF Out" (to signal analyzer)
LAN	"LAN"	-	"LAN"	-

3.2.2 Connecting multiple R&S SMW instruments

This chapter provides step-by-step instructions for connecting the R&S SMW with components and instruments of a bandwidth extension setup. Connecting procedures for relevant connector types are summarized. Connecting to these connector types is analogous for all instruments. The step-by-step instructions cover the following topics:

-
-
-
-
-

To connect the R&S SMW instruments

1. Connect "1 GHz Out" reference output connector of the primary R&S SMW instrument to the "1 GHz In" reference input connector of the secondary R&S SMW instrument.
   If your test setup has more than two R&S SMW instruments, proceed connecting in a daisy chain manner.
   How to: Chapter "Connecting to RF coaxial connectors" in the R&S SMW user manual

2. Connect "ADV TRG" output connector of the primary R&S SMW instrument to the "ADV CLK" input connector of the secondary R&S SMW instrument.
   If your test setup has more than two R&S SMW instruments, proceed connecting in a daisy chain manner.
   How to: Chapter "Connecting to RF coaxial connectors" in the R&S SMW user manual

3. Establish a LAN connection between the R&S SMW instruments.
   How to: Chapter "Connecting to LAN" in the R&S SMW user manual

To connect a power combiner

The instructions for connecting a power combiner are the same as for single R&S SMW instrument setup, see "To connect a power combiner" on page 17.

To connect a directional coupler

The instructions for connecting a directional coupler are the same as for single R&S SMW instrument setup, see "To connect a directional coupler" on page 19.

To connect an R&S NRP power sensor

The instructions for connecting a power sensor are the same as for single R&S SMW instrument setup, see "To connect an R&S NRP power sensor" on page 19.

Table 3-4: Connections dual R&S SMW with power sensor

Signal	Prim. R&S SMW	Sec. R&S SMW	Power combiner	Power sensor	Directional coupler
Sensor control	"SENSOR"	-	-	Host connector	-
RF Out	"RF A" or "RF B"	"RF A" or "RF B"	"RF In" (from R&S SMW)	RF connector	"RF In" (from power combiner)
RF In	-		"RF Out" (to directional coupler)		"RF Out" (to power sensor)

To connect a signal analyzer

The following step-by-step instruction describes how to connect R&S SMW and a directional coupler to an Rohde & Schwarz signal analyzer as alignment source. The R&S SMW and signal analyzer are switched on and connected to power.

For prerequisites of the signal analyzer, see "Signal analyzer" on page 14.

1. Connect "RF Input 50Ω" connector of the signal analyzer to the RF output of the directional coupler.

2. Establish a LAN connection between R&S SMW and signal analyzer.
   How to: Chapter "Connecting to LAN" in the R&S SMW user manual

   The table Table 3-5 provides an overview of relevant connections.

Table 3-5: Connections dual R&S SMW with signal analyzer

Signal	Prim. R&S SMW	Sec. R&S SMW	Power combiner	Signal analyzer	Directional coupler
RF Out	"RF A" or "RF B"	"RF A" or "RF B"	"RF In" (from prim. & sec. R&S SMW)	-	"RF In" (from power combiner)
RF In	-	-	"RF Out" (to directional coupler)	"RF Input 50Ω"	"RF Out" (to signal analyzer)
LAN	"LAN"	"LAN"	-	"LAN"	-
Synchroniza-tion	"ADV TRG"	"ADV CLK"	-	-	-
Ref Out	"1 GHz Out"	"1 GHz In"	-	-	-
Ref In		"1 GHz Out"		"REF INPUT" 1 GHz	-
Trigger	"USER 1"	-	-	"TRIGGER INPUT"	-

3.3 Configuring the R&S SMW

This chapter provides step-by-step instructions on how to configure the R&S SMW for bandwidth extension. These instructions cover the following topics:

- "To create a bandwidth extension setup file" on page 23
- "To load a bandwidth extension setup" on page 24
- "To align the setup with a signal analyzer" on page 26
- "To configure RF ports of a single R&S SMW" on page 29
- "To align RF ports with a power sensor" on page 32
- "To align RF ports with a signal analyzer" on page 30
- "To align the setup with user-defined corrections" on page 34

To create a bandwidth extension setup file

The following procedure describes how to create, edit and save a bandwidth extension setup file.

1. Select "System Configuration" > "Multi Instrument" > Bandwidth Extension".
   By default, no setup is loaded. The block diagram of the test setup shows the notification "no setup loaded".
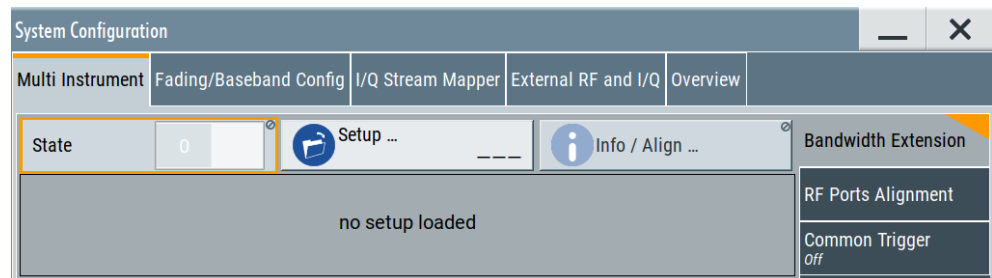
2. To create a bandwidth extension setup file, proceed as follows:
   a) Select "Setup".
      The bandwidth extension setup file-select dialog opens.
   b) In this dialog, select "New".
   c) Enter the filename, for example, "File Name > test_4GHz".
   d) Select "Ok".

   The firmware saves the file `test_4GHz` to the default directory `/var/user/` and adds the file extension `*.bwsa`.

3. To edit a bandwidth extension setup file, proceed as follows:
   a) Select the file.
   b) Select "Edit"

   The "Bandwidth Extension Setup File Editor" dialog opens with settings to configure RF ports and align the setup.
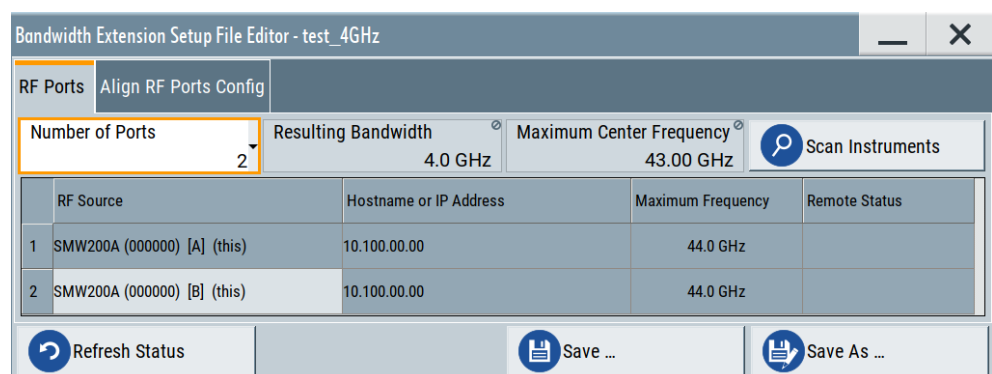
   See also Chapter 4.2, "Setup file editor settings", on page 42.

4. Optionally, configure RF ports.

5. Optionally, configure settings for RF ports alignment. You have two options:
   - "To align RF ports with a signal analyzer" on page 30

- "To align RF ports with a power sensor" on page 32

6. Select "Save".

If your bandwidth extension setup file is correct, proceed with instruction "To align the setup with a signal analyzer" on page 26.
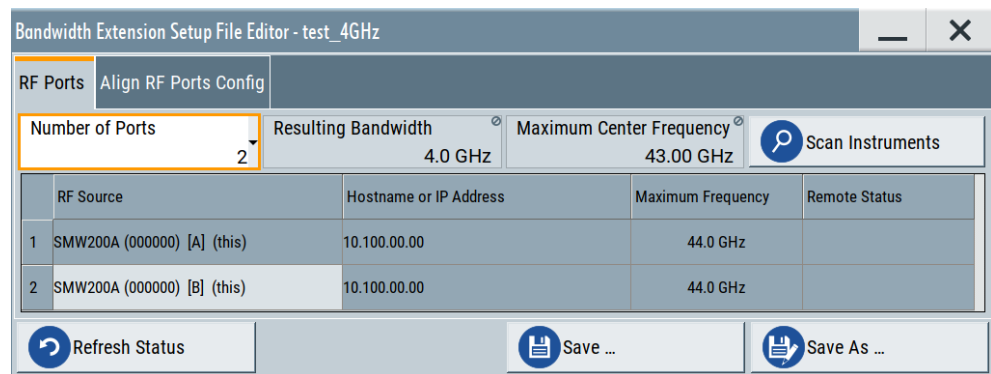
To load a bandwidth extension setup

If you save a configured bandwidth extension setup to a file, you can load this configuration to the R&S SMW.

1. To load a bandwidth extension file, select "Setup".
   In the opening file-select dialog, you can select files with file extension `*.bwsa`.

   The following steps use the file `test_4GHz.bwsa`, see "To create a bandwidth extension setup file" on page 23.
   This file provides a configuration for a 4 GHz bandwidth extension setup including a single R&S SMW (serial number: 000000) and a power combiner. The two RF ports correspond to path "A" and path "B" of this R&S SMW.

Bandwidth Extension Setup File Editor - test_4GHz			— ✕
RF Ports	Align RF Ports Config		

Number of Ports		Resulting Bandwidth ⊘	Maximum Center Frequency ⊘	🔍 Scan Instruments
	2	4.0 GHz	43.00 GHz	

	RF Source	Hostname or IP Address	Maximum Frequency	Remote Status
1	SMW200A (000000) [A] (this)	10.100.00.00	44.0 GHz	
2	SMW200A (000000) [B] (this)	10.100.00.00	44.0 GHz	

↻ Refresh Status	💾 Save …	💾 Save As …

2. Optionally, preview bandwidth extension setup characteristics in the pane to the right of the file list.
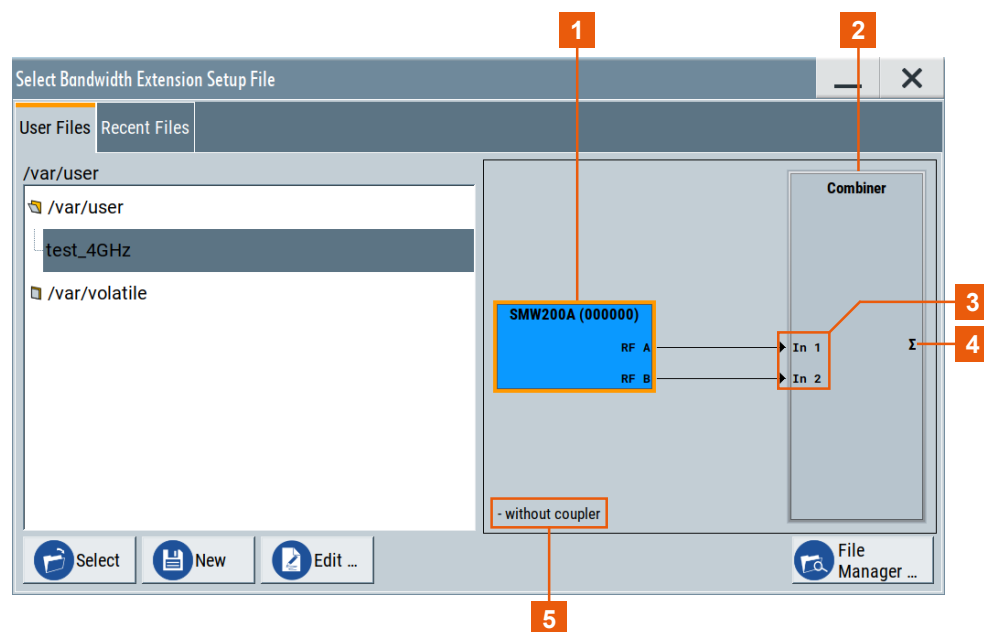
Figure 3-5: Preview of setup file test_4GHz.bwsa

1 = Single R&S SMW using both RF ports "RF A" and "RF B"
2 = Power combiner with two RF inputs and one output
3 = Power combiner inputs "In 1" and "In 2"
4 = Power combiner output "Σ"
5 = No active directional coupler

3. To load the file, click "Select".

    The dialog closes and the bandwidth extension setup is displayed in more detail in the setup info pane.
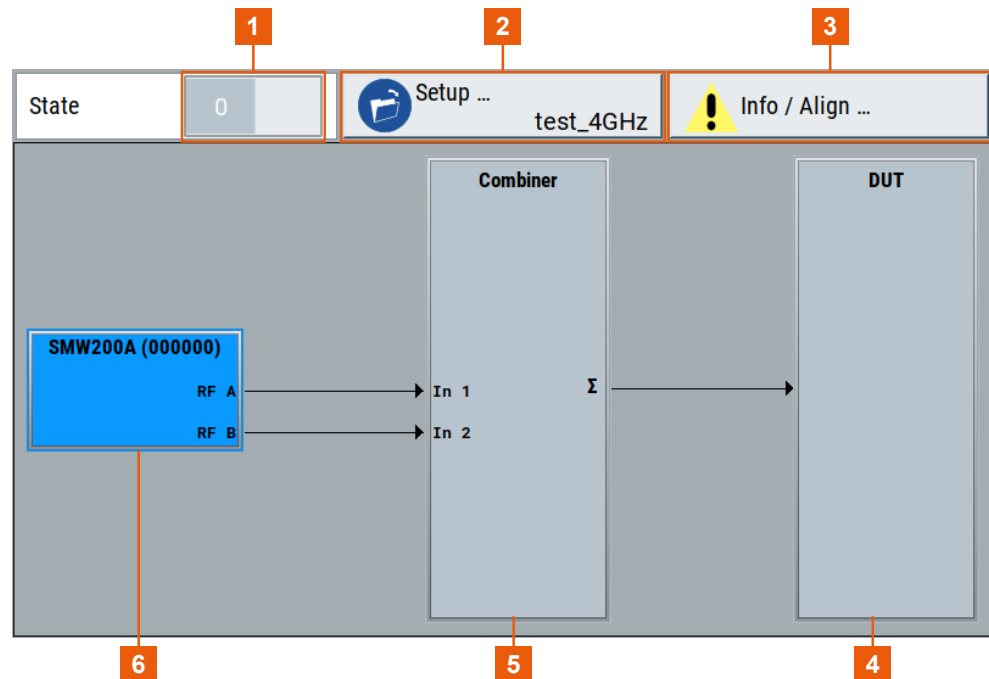
Figure 3-6: BW extension control and setup info (no coupler)

1 = Bandwidth extension state
2 = Bandwidth extension setup file: test_4GHz.bwsa
3 = Setup alignment info, alignment status and access to setup alignment wizard
4 = Device under test (DUT)
5 = Power combiner
6 = Signal generator block

For bandwidth extension setups with a directional coupler, see the following figures:

- Figure 3-9 with a coupled analyzer
- Figure 3-10 with a coupled power sensor

The "Info / Align" button indicates that the setup is not aligned:
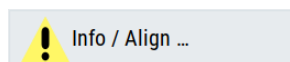
If your bandwidth extension setup file is correct, proceed with instruction "To align the setup with a signal analyzer" on page 26.

To align the setup with a signal analyzer

This step-by-step instruction describes how to execute an alignment of your bandwidth extension setup. Typically, align the setup once assuming that you do not change the cabling or connected devices in your setup.

The signal analyzer is switched-on and connected to the R&S SMW via LAN, see "To connect a signal analyzer" on page 20. For prerequisites of the signal analyzer, see "Signal analyzer" on page 14.

1. Load a bandwidth extension setup file.

See "To load a bandwidth extension setup" on page 24.

2. In the general settings of the "Bandwidth Extension" side-tab, execute the following:

   a) Activate bandwidth extension ("State" > "On").
   Before aligning for the first time, the setup is not aligned. An exclamation mark displays a non-aligned setup on the "Info / Align" button.

   b) Select "Info / Align".

   The "Setup Info / Align" dialog opens and displays a non-configured alignment.
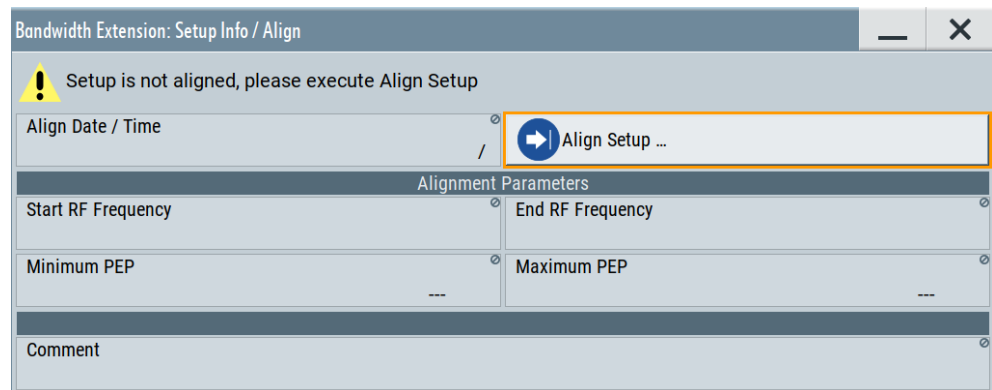
3. Select "Align Setup".

   The "Align Setup Wizard" dialog opens and guides you through the steps to configure the measurement device, to align power levels and cable lengths.
   The measurement device is a signal analyzer.

4. In the "Instrument" list, select you signal analyzer.
   If not listed, scan your network to add your signal analyzer.

5. If detected, select the signal analyzer in the "Instrument" selection.

   The hostname of the signal analyzer is added automatically.

6. To add the signal analyzer manually, proceed as follows:

   a) Select "Instrument" > "New".
   b) Specify hostname or IP address of the signal analyzer.
   c) Optionally, add a comment to document the equipment of your setup, for example: *SMW-B1020 (000000), FSW-67 (100000), power combiner, directional coupler,* etc.

7. To verify your test setup, select "Next".

The dialog provides instructions and settings on how to proceed with setup alignment. Also, it previews of the test setup as configured in test setup file editor. In figure Figure 3-7, the test setup consists of an R&S SMW (serial number: 000000), a power combiner and an R&S FSW-67 (serial number: 100000) as measurement device. No directional coupler is active.
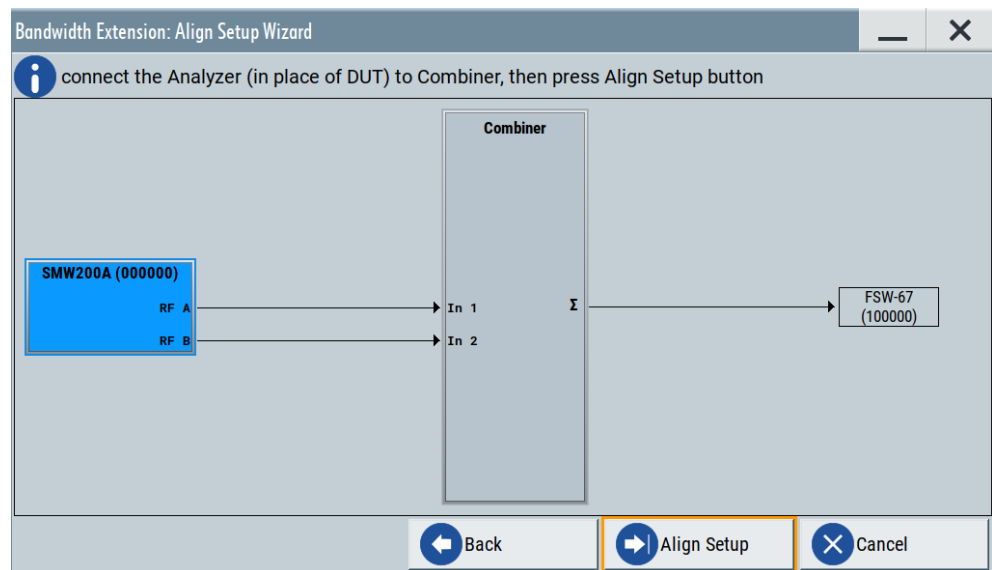

Figure 3-7: BW extension setup without coupler

In figure Figure 3-8, the test setup also uses a directional coupler.
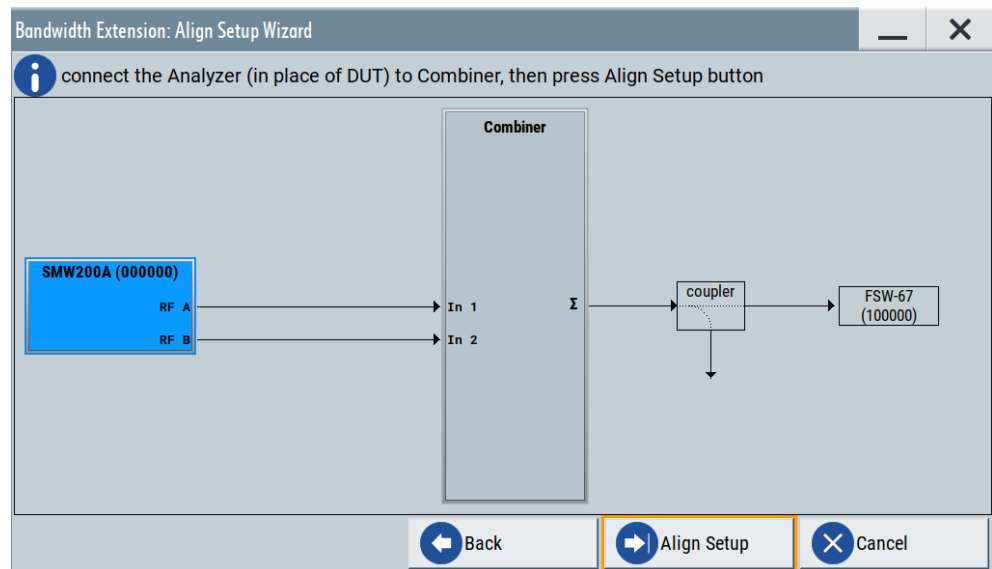
Figure 3-8: BW extension setup with coupler

8. Select "Align Setup".

   Selection triggers the actual setup alignment procedure. The R&S SMW displays the "Busy" in the status bar.

9. Wait until the alignment procedure finishes. Setup alignment can take several minutes.

   If the alignment finishes, the wizard closes and the setup info button displays no conflict anymore.
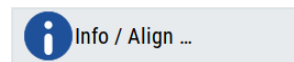
   After setup alignment check, if the RF ports configuration is correct, see "To configure RF ports of a single R&S SMW" on page 29.

   Continue with aligning the RF ports. You have two options:
   ● "To align RF ports with a power sensor" on page 32
   ● "To align RF ports with a signal analyzer" on page 30

To configure RF ports of a single R&S SMW

1. Edit a bandwidth extension setup file.
   See steps (1) and (3) in "To create a bandwidth extension setup file" on page 23.

   The "RF Ports" tab of the dialog "Bandwidth Extension Setup File Editor" opens.
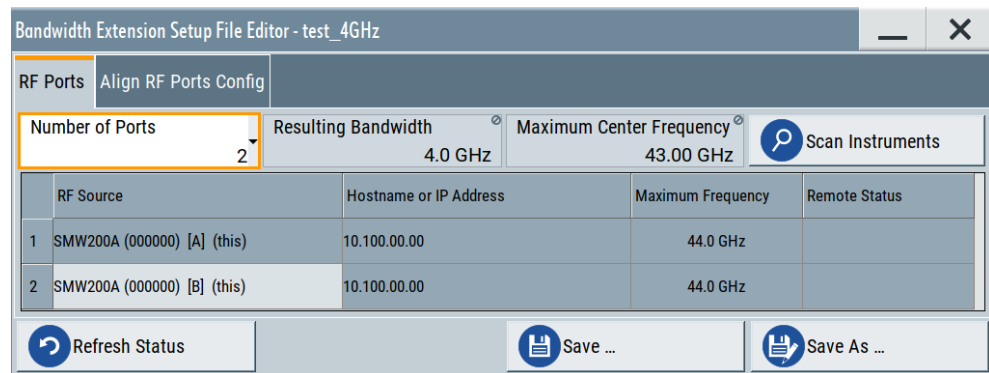
2. Check the settings for a single R&S SMW:

- "Number of RF Ports" > "2"
  The setting is fixed for a single R&S SMW.
- "Resulting Bandwidth" = "4.0 GHz"
  The value depends on installed bandwidth options, see Chapter 2.1, "Required options", on page 10.
- "Maximum Center Frequency" = "43.00 GHz"
  The value depends on installed frequency options, see Chapter 2.1, "Required options", on page 10.
- RF sources for two ports: R&S SMW path A and path B
  "(this)" indicates that the firmware uses the configuration of your R&S SMW.
- Hostname or IP address of the R&S SMW: "10.100.00.00"
- "Maximum Frequency" = "44.0 GHz"
  The value depends on installed frequency options at the R&S SMW, see Chapter 2.1, "Required options", on page 10.
- Remote status: ⟳ (connected), ⚠ (connection error)

To align RF ports with a signal analyzer

The signal analyzer is switched-on and connected to the R&S SMW via LAN, see "To connect a signal analyzer" on page 20.

For prerequisites of the signal analyzer, see "Signal analyzer" on page 14.

1. Edit a bandwidth extension setup file.
   See steps (1) and (3) in "To create a bandwidth extension setup file" on page 23.

2. Select "Align Config".

3. Select "Measurement Device" > "Analyzer".

4. Optionally, scan your network to add your signal analyzer.

5. If detected, select the signal analyzer in the "Instrument" selection.

   The hostname of the signal analyzer is added automatically.

6. To add the signal analyzer manually, proceed as follows:

   a) Select "Instrument" > "New".

   b) Specify hostname or IP address of the signal analyzer.

7. Optionally, activate "Use Coupler", if you use a directional coupler to automate alignment.

8. Check your setup for RF ports alignment in the setup info pane.
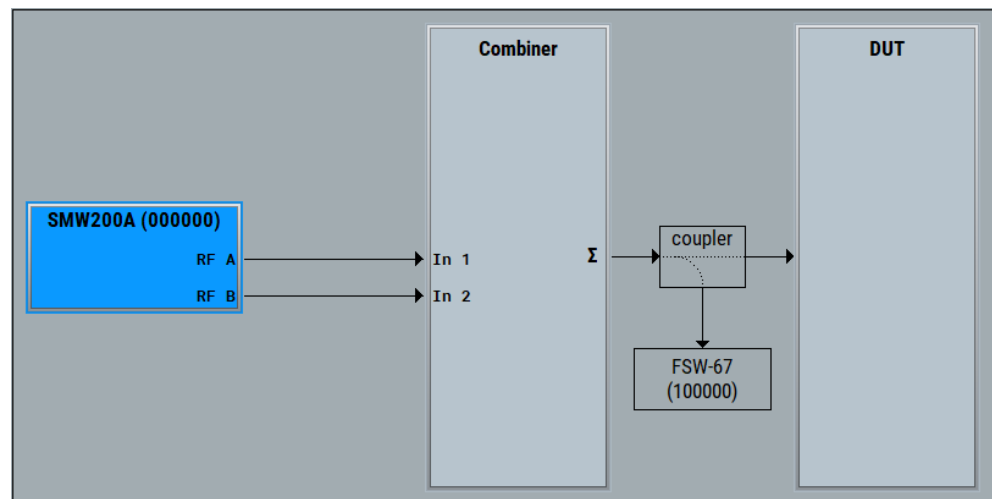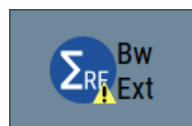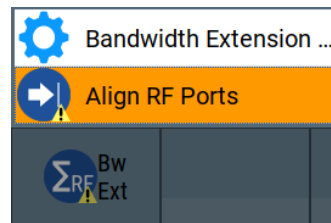   For an example, see Figure 3-9.


Figure 3-9: BW extension setup with coupled analyzer (FSW-67)

9. Activate the bandwidth extension setup configuration ("State > On").

   The taskbar of the R&S SMW displays the softkey "Bw Ext". The softkey indicates that the RF ports are not aligned.

10. Select "Bw Ext".

11. Select "Align RF Ports".

The alignment procedure applies corrections to the local oscillator (LO) phase. If the alignment runs correctly, the "Bw Ext" softkey displays no errors.
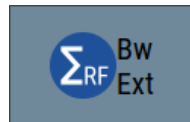
ⓘ If you change parameters of the RF output signal at the R&S SMW, the RF ports are not aligned anymore. For example, if you change the frequency or the level of the RF output signal. Also, RF ports are not aligned if you change the bandwidth extension setup file.

Align the RF ports again.

To align RF ports with a power sensor

The power sensor is an R&S NRP-type power sensor connected to the R&S SMW, see "To connect an R&S NRP power sensor" on page 19.

1. Edit a bandwidth extension setup file.
   See steps (1) and (3) in "To create a bandwidth extension setup file" on page 23.

2. Select "Align RF Ports Config".

3. Select "Measurement Device" > "NRP Sensor".

4. To add your power sensor, select "Sensor Mapping".
   See chapter "Connecting R&S NRP power sensors to the R&S SMW user manual".

5. Specify the sensor ID that is also the device ID to identify the R&S NRP power sensor.

6. Check the parameter "Sensor Name" for your power sensor.
   In the figure below, the power sensor is an R&S NRP40S (serial number: 100000).
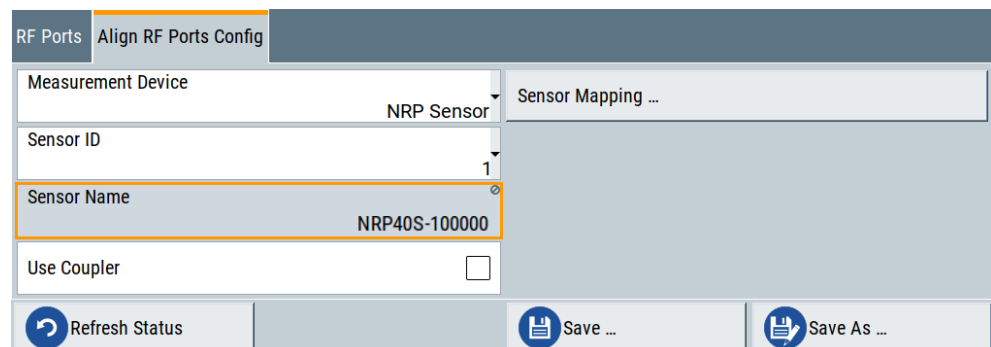
7. Optionally, activate "Use Coupler", if you use a directional coupler to automate alignment.

8. Check your setup for RF ports alignment in the setup info pane.
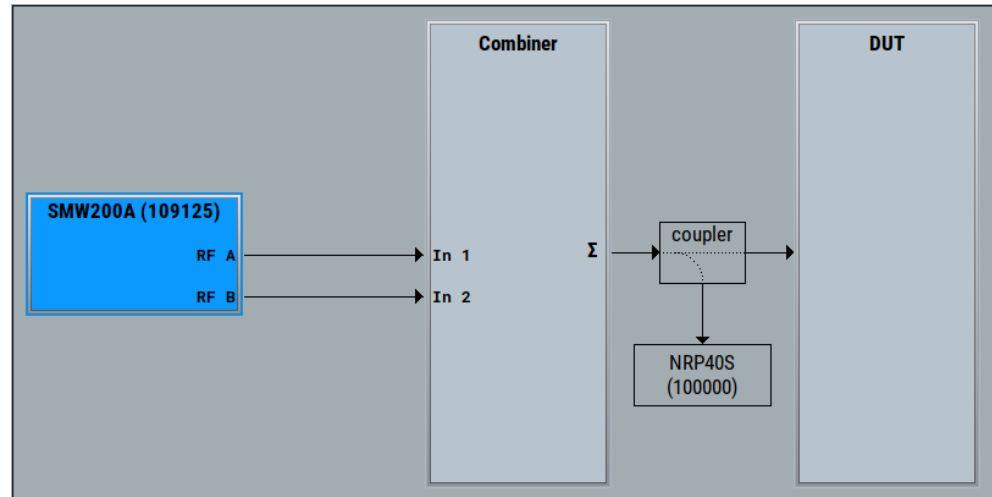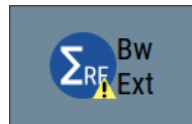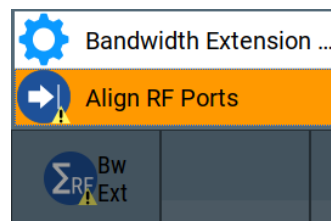   For an example, see Figure 3-10.

*Figure 3-10: BW extension setup with coupled sensor (NRP40S)*

9. Activate the bandwidth extension setup configuration ("State > On").

   The taskbar of the R&S SMW displays the softkey "Bw Ext". The softkey indicates that the RF ports are not aligned.

10. Select "Bw Ext".

11. Select "Align RF Ports".

The alignment procedure applies corrections to the local oscillator (LO) phase. If the alignment runs correctly, the "Bw Ext" softkey displays no errors.
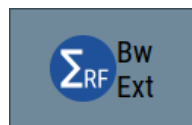
(i) If you change parameters of the RF output signal at the R&S SMW, the RF ports are not aligned anymore. For example, if you change the frequency or the level of the RF output signal. Also, RF ports are not aligned if you change the bandwidth extension setup file.

Align the RF ports again.

To align the setup with user-defined corrections

Optionally, add user-defined corrections of I/Q delay and phase of individual RF sources. You can also use these corrections for manual setup alignment, for example if you have no alignment source.

1. Select "Info / Align ...".

2. Select "Current Corrections".

3. Set additional I/Q delays and additional phase values to the RF sources at RF ports 1 and 2.

Setup Alignment	Current Corrections					
◄ Reset User Corrections						
	RF Source	IQ Delay (ps)	Additional IQ Delay (ps)	Phase (deg)	Additional Phase (deg)	Level (dB)
1	SMW200A (000000) [A] (this)	0	10	0.0	0.1	4.41
2	SMW200A (000000) [B] (this)	164	5	110.5	0.2	4.26

3.4 Generating signals with extended bandwidth

This chapter provides step-by-step instructions on how to generate signals with extended bandwidth at the R&S SMW. These instructions cover the following topics:

- "To activate a bandwidth extension setup" on page 34
- "To generate an ARB signal with extended bandwidth" on page 35
- "To upconvert an RF output signal with extended bandwidth" on page 37

To activate a bandwidth extension setup

The R&S SMW is configured and aligned for bandwidth extension, see Chapter 3.3, "Configuring the R&S SMW", on page 22.

1. Select "System Configuration" > "Multi Instrument" > Bandwidth Extension".

2. Select "State > On".

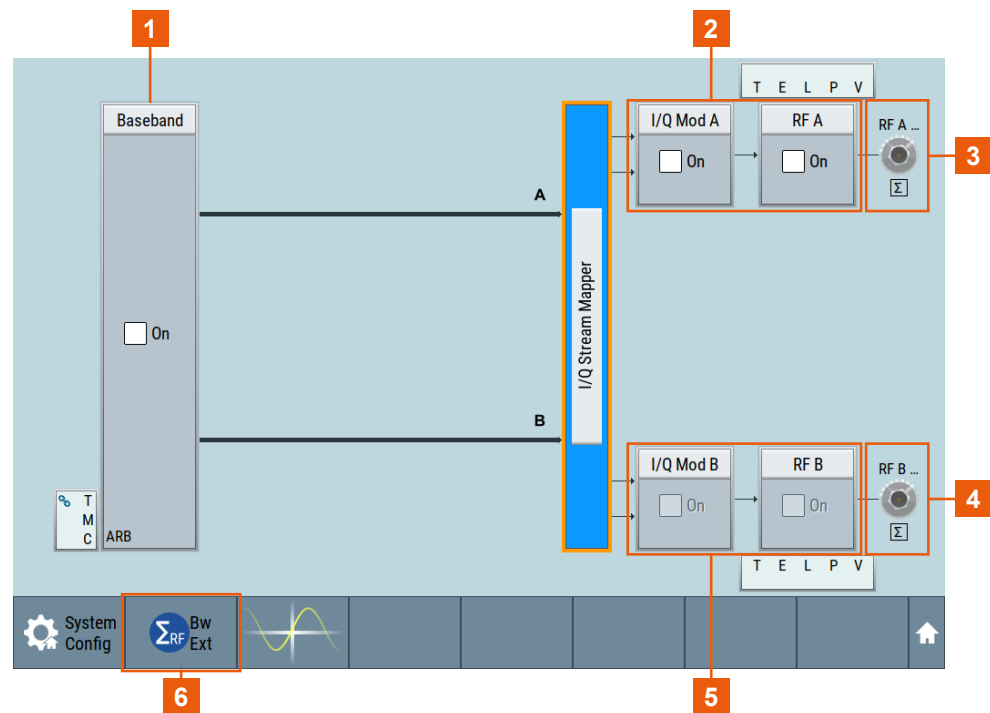   The block diagram of the R&S SMW adjusts automatically for a bandwidth extension setup.

Figure 3-11: Active bandwidth extension and R&S SMW block diagram

1 = One baseband block for both signal paths "A" and "B"
2 = Configurable settings for signal path A
3 = Configurable output "RF A" for signal path A
4 = Read-only output "RF B" for signal path B
5 = Read-only settings for signal path B
6 = "Bw Ext" softkey displaying an aligned setup
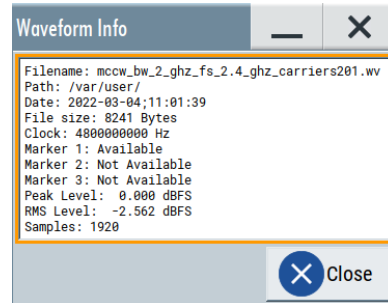
To generate an ARB signal with extended bandwidth

The R&S SMW is configured and aligned for bandwidth extension. Also bandwidth extension is active, see "To activate a bandwidth extension setup" on page 34.

1. Select "Baseband > ARB".

2. In the "General" tab, load a waveform file with extended bandwidth.
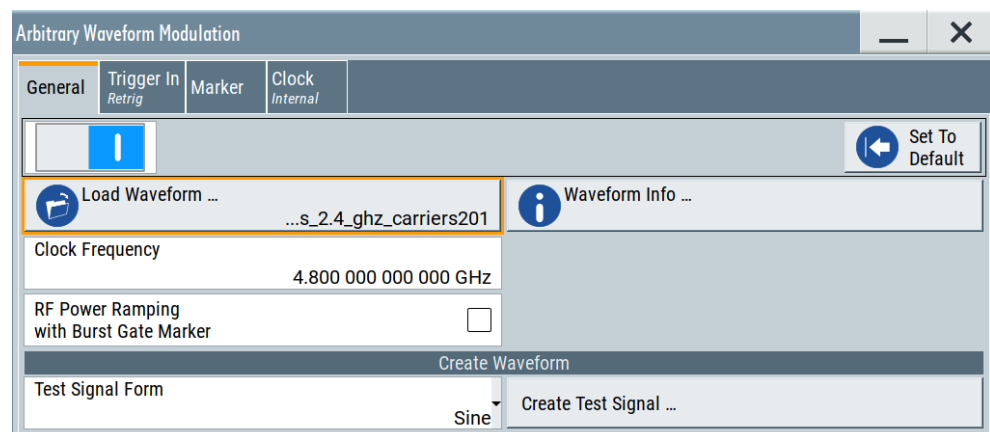
The "Clock Frequency" reads out the ARB clock rate automatically from the waveform file. You can load waveforms with up to 4.8 GHz clock frequency.

3. Optionally, to monitor further properties of the waveform file, select "Waveform Info".

4. Select "State > On".

The waveform is processed and played.

5. To define the RF output signal with extended bandwidth, configure the following for signal path A.

   a) In the taskbar, set "Frequency > 6 GHz" and "Level > 0 dBm".
   b) In the block diagram, select "RF A > On".

The R&S SMW generates an ARB signal with 4 GHz bandwidth at 6 GHz RF output frequency and 0 dBm RF level.

To upconvert an RF output signal with extended bandwidth

Equipped with option R&S SMW-K553 and connected to an external frontend, the R&S SMW can also output upconverted RF signals with extended bandwidth.

The R&S SMW is configured and aligned for bandwidth extension. Also bandwidth extension is active and the R&S SMW generates an ARB RF output signal, see "To generate an ARB signal with extended bandwidth" on page 35.

1. In the block diagram, select "RF A > Off".

2. Connect an external frontend that is suitable for converting IF signals with extended bandwidth f_{BW} ($f_{BW} \geq 4$ GHz).
   For example, connect an R&S FE170ST. See section "To connect an R&S FE170ST" in the "R&S SMW-K553 Frontend Control User Manual".

3. Configure the R&S SMW for frontend control. See chapter "Controlling external frontends" in the "R&S SMW-K553 Frontend Control User Manual".

4. Set frequency and level of the upconverted RF output signal with extended bandwidth. Configure the following for signal path A.

   a) In the taskbar, set "Frequency > 110 GHz" and "Level > 0 dBm".
   b) In the block diagram, select "RF A > On".

   The R&S SMW generates an ARB signal with 4 GHz bandwidth at 110 GHz RF output frequency and 0 dBm RF level. In the block diagram, to the right of the "RF" block, the icon ▦ "FE170ST ..." indicates that the R&S FE170ST outputs RF signal.
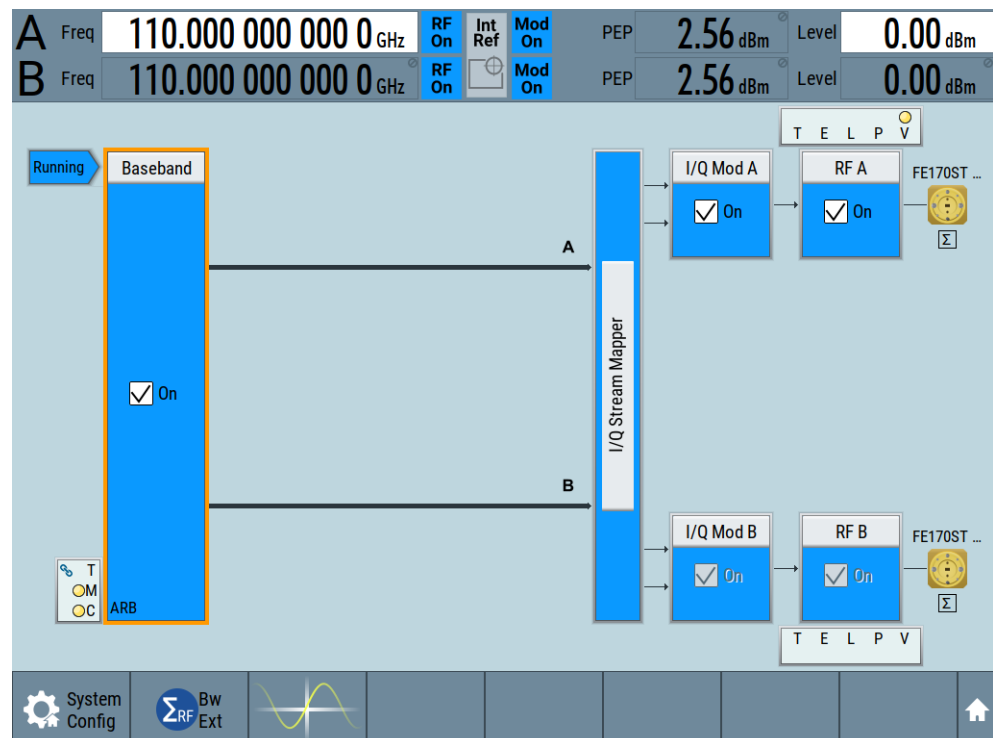

Figure 3-12: R&S SMW with connected external frontend R&S FE170ST

For more information, see the "R&S SMW-K553 Frontend Control User Manual".

4 Bandwidth Extension configuration and settings

Access:

► Select "System Configuration" > "Multi Instrument" > Bandwidth Extension".

The dialog provides settings to configure settings of the bandwidth extension setup and setup alignment.

The remote commands required to define these settings are described in Chapter 5, "Remote control commands", on page 55.

To operate the R&S SMW with extended bandwidth

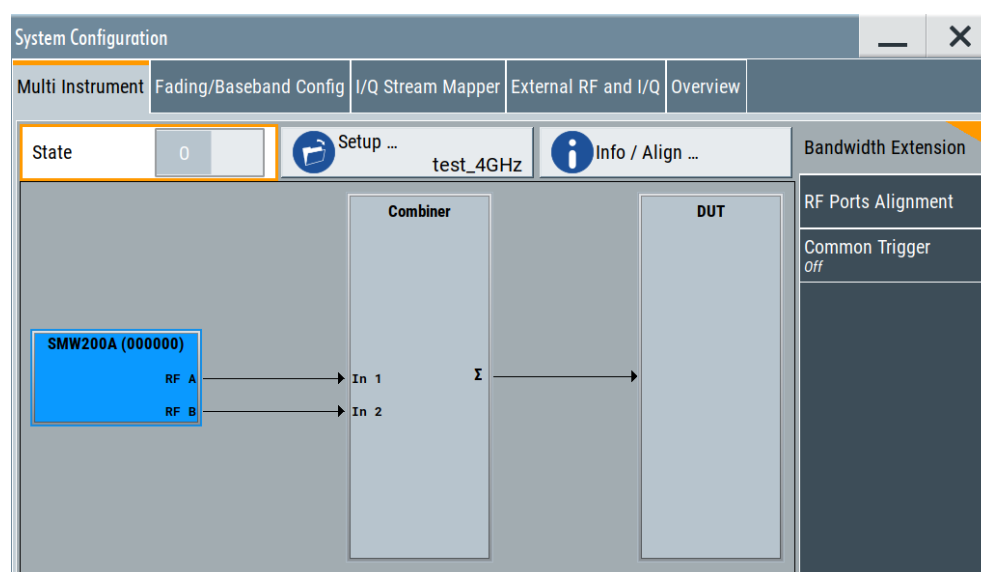See Chapter 3, "Generating RF signals with extended bandwidth", on page 13.

Settings:

4.1 General settings

Access:

► Select "System Configuration" > "Multi Instrument" > Bandwidth Extension".

The "Bandwidth Extension" side-tab provides general settings to configure settings of the bandwidth extension setup. Also it provides access to settings for setup and RF ports alignment.

Settings:

State

Activates bandwidth extension.

Activation requires a loaded bandwidth extension setup file, see "Setup" on page 40.

Remote command:

:SCONfiguration:BEXTension:STATe on page 56

Setup

Accesses a standard file-select dialog to load and save a configuration of a bandwidth extension setup.

If a setup file with extension *.bwsa is loaded, the button also displays the filename.

The setup file is an archive file containing setup description file (*.xml) and the correction files (*.ucor and *.asc).

Remote command:

:SCONfiguration:BEXTension:SETup:FILE on page 56

Info / Align

Accesses the "Setup Info / Align" dialog that provides information on alignment parameters of the bandwidth. See Chapter 4.3, "Setup info and alignment settings", on page 48.

The alignment procedures include power level corrections and consider cable length corrections. The procedure duration can take several minutes and depends on frequency range and level range of the combined RF output signal.
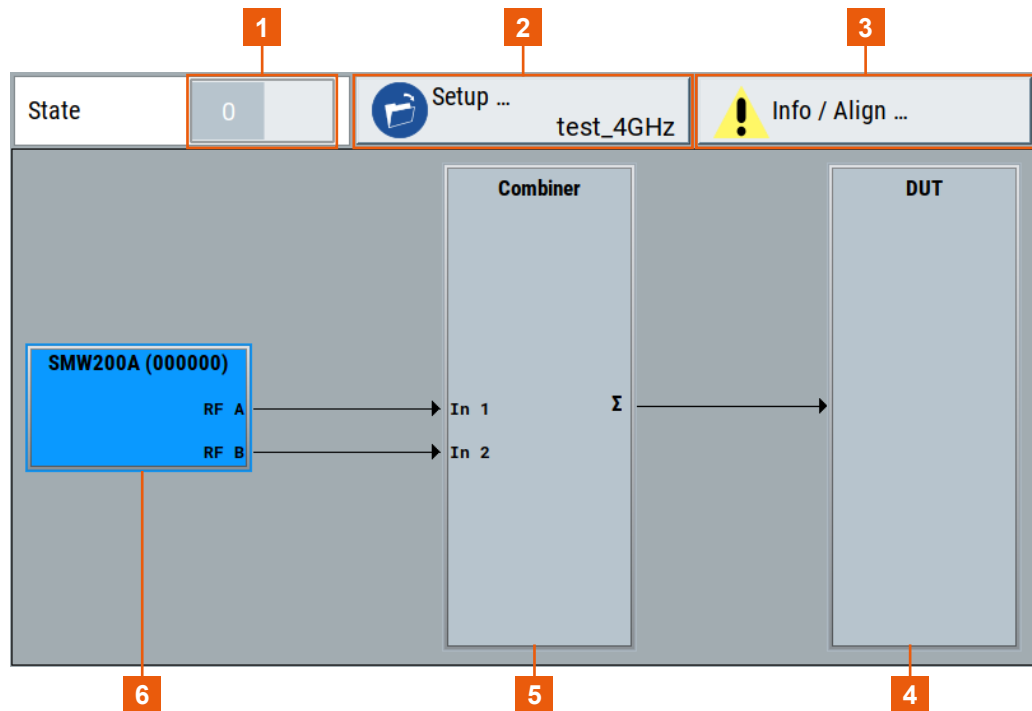
In the current firmware, you can align the two internal baseband signals of path A and path B of the R&S SMW.

Remote command:

n.a.

Setup info

Displays information on the loaded bandwidth extension setup in a block diagram.

1 = Bandwidth extension state
2 = Bandwidth extension setup file
3 = Alignment info, alignment status and access to setup alignment wizard
4 = Device under test (DUT)
5 = Power combiner
6 = Signal generator block

Signal generator block ← Setup info

Displays the instrument name and the serial number of the R&S SMW and configured RF outputs.

When selecting the block, accesses settings for checking the hostname or IP address of the R&S SMW and accessing the setup file editor.
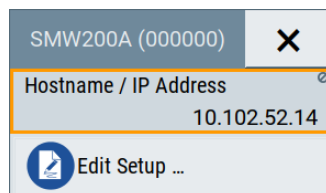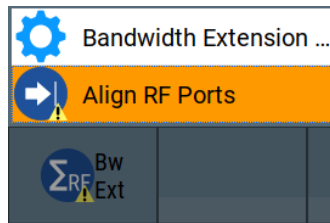

Remote command:
n.a.

Align RF Ports

Requires an active bandwidth extension setup ("State" > "On").

Triggers alignment of the RF ports and considers cable length corrections.

Remote command:
`:SCONfiguration:BEXTension:ALIGn:RFPorts` on page 58
`:SCONfiguration:BEXTension:ALIGn:STATus?` on page 58

4.2 Setup file editor settings

Access:

1. Select "System Configuration" > "Multi Instrument" > Bandwidth Extension".

2. Select "Setup".
   A file select dialog opens. Listed are only files with extension `*.bswa` that define a bandwidth extension setup.

3. To create a file, select "New".

4. Enter the filename without extension, e.g., `test_4GHz`

5. Select "OK".

   The list displays the file.

6. Select "Edit".

   The dialog provides settings to edit and save bandwidth extension setup files.

How to: "To create a bandwidth extension setup file" on page 23

Settings:

4.2.1 Common settings

Access:

► Edit a bandwidth extension file as described in Chapter 4.2, "Setup file editor settings", on page 42.

The dialog provides common settings to save the configuration of the bandwidth extension setup in a file.

Settings:

Refresh Status

Checks the current configuration of the bandwidth extension setup file.

Checking the status includes the following:
- Connection and configuration of the instrument and instrument paths that are assigned to the RF ports.
- Connection and configuration of the measurement device for RF ports alignment

Remote command:
n.a.

Save

Saves the current configuration of the bandwidth extension setup file.

Selecting "Save Setup" overwrites a previous configuration of the file. If you change the configuration of the file, the dialog header displays "*" after the file name.

If you want to save the current configuration in another file, select "Save Setup as". See "Save As" on page 43.

Remote command:
n.a.

Save As

Saves the current configuration of the bandwidth extension setup in a new file.

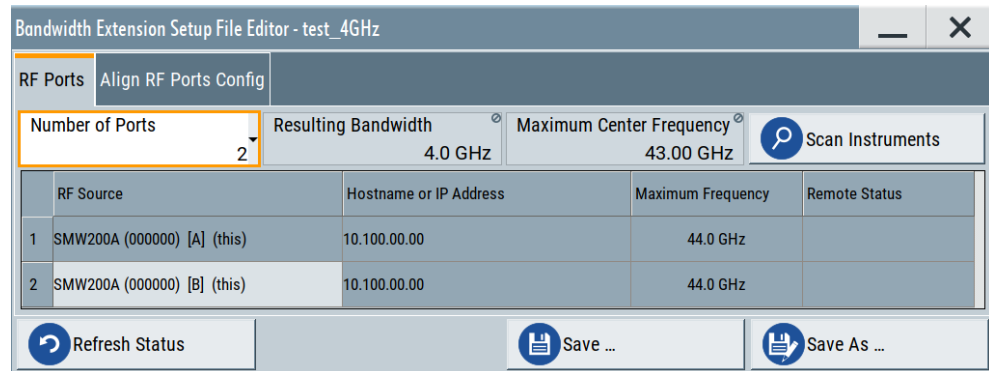A file-select dialog opens. In this dialog, specify the storage location and select "Save".

Remote command:
n.a.

4.2.2 RF ports settings

Access:

1. Edit a bandwidth extension file as described in Chapter 4.2, "Setup file editor settings", on page 42.

2. Select "RF Ports".

Bandwidth Extension Setup File Editor - test_4GHz					—	✕

RF Ports | Align RF Ports Config

Number of Ports		Resulting Bandwidth ⊘	Maximum Center Frequency ⊘	🔍 Scan Instruments
	2	4.0 GHz	43.00 GHz	

	RF Source	Hostname or IP Address	Maximum Frequency	Remote Status
1	SMW200A (000000) [A] (this)	10.100.00.00	44.0 GHz	
2	SMW200A (000000) [B] (this)	10.100.00.00	44.0 GHz	

↺ Refresh Status		💾 Save …	💾 Save As …

The dialog provides settings to configure RF ports of a single R&S SMW or multiple instruments.

Settings:

Number of Ports

Displays the number of RF ports.

Remote command:
n.a.

Resulting Bandwidth

Displays the resulting bandwidth that is the extended bandwidth.

Remote command:
n.a.

Maximum Center Frequency

Displays the maximum center frequency of the combined signal with extended bandwidth.

Remote command:

n.a.

Scan Instruments

Scans the network for connected, supported instruments.

Remote command:

`:SCONfiguration:EXTernal:REMote:SCAN`

RF port table

Represents the RF ports configuration; there is one table row per RF port.

Port Name ← RF port table

Add an alias name for the RF port.

Remote command:

n.a.

RF Source ← RF port table

Indicates the physical instrument which the RF port belongs to.

Remote command:

`:SCONfiguration:BEXTension:CORRection:PORT<ch>:SOURce?` on page 63

Hostname / IP Address ← RF port table

Displays/sets the IP address or hostname of the connected external instrument.

Remote command:

n.a.

Maximum Frequency ← RF port table

Displays the maximum frequency at the RF port.

Remote command:

n.a.

Remote Status ← RF port table

Indicates the remote connection status.

|	
↻	The RF port belongs to a secondary instrument; the remote connection to the secondary instrument can be established. The remote connection is active during the time in that the correction files are transferred to the secondary instruments. The term **secondary** instrument describes a signal generator connected in a primary-secondary mode and receiving the multi-instrument trigger from the primary instrument (see "System Configuration > Multi Instrument > Common Trigger > Multi Instrument Trigger = Secondary").
⚠ and yellow background	At least one of the secondary instruments cannot be reached, that is the remote connection to it cannot be established. Check the "Hostname / IP Address" of the secondary instrument and select "Refresh" to check the status.

Remote command:
n.a.

4.2.3 Align RF ports configuration settings

Access:

1. Edit a bandwidth extension file as described in Chapter 4.2, "Setup file editor settings", on page 42.

2. Select "Align RF Ports Config".
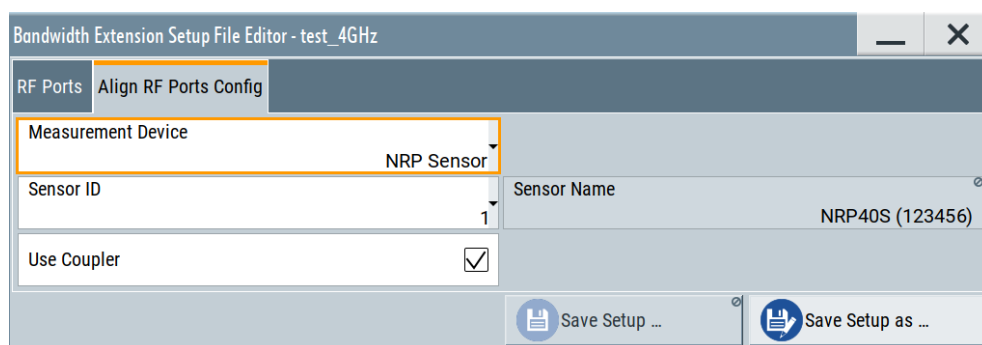
The dialog provides settings to align RF ports characteristics of the bandwidth extension setup. Alignment includes phase corrections within the combined RF output signal with extended bandwidth.

Settings:

Measurement Device

Selects the measurement device. This device is the source instrument for RF ports alignment.

You can select an R&S NRP sensor or a vector signal analyzer.

"None"　　　　No source instrument for RF ports alignment.
　　　　　　　Use this setting, if you run a separate alignment of the LO phases of the RF output signals.

"NRP Sensor"　Selects an R&S NRP sensor for RF ports alignment. For sensor settings, see "Sensor settings" on page 47.

"Analyzer"   Selects a vector signal analyzer for RF ports alignment. For analyzer settings, see "Analyzer settings" on page 47.

Remote command:

n.a.

Sensor settings

Sensor settings require "Measurement Device" > "NRP Sensor".

Sensor ID ← Sensor settings

Sets the ID number of the used R&S NRP sensor.

Remote command:

n.a.

Sensor Name ← Sensor settings

Displays the name of the used R&S NRP sensor.

Remote command:

n.a.

Analyzer settings

Analyzer settings require "Measurement Device" > "Analyzer".

Scan Analyzers ← Analyzer settings

Scans the network for connected, supported vector signal analyzers.

Remote command:

n.a.

Instrument ← Analyzer settings

Selects an instrument from a list as a result from "Scan Analyzers".

To add instruments manually, select "Instrument" > "New" and set their hostname or IP address.

How to: "To connect a signal analyzer" on page 20

Remote command:

n.a.

Hostname or IP Address ← Analyzer settings

Displays or sets the hostname or IP address of the vector signal analyzer.

Remote command:

n.a.

Use Coupler

Optimizes RF ports alignment by coupling with a directional coupler.

Activate this setting, if your test setup includes a directional coupler and if you want to automate the alignment procedure.

Make sure that the output coupling factor

Remote command:

n.a.

4.3 Setup info and alignment settings

Access:

1. Load a bandwidth extension setup file.
   See "To load a bandwidth extension setup" on page 24.

2. Select "Info / Align".

   The dialog displays information on the setup alignment configuration and provides user correction settings and setup alignment settings.

How to: "To align the setup with a signal analyzer" on page 26

4.3.1 Setup alignment settings

Access:

1. Load a bandwidth extension setup file.
   See "To load a bandwidth extension setup" on page 24.

2. Select "Info / Align".

3. Select "Setup Alignment".
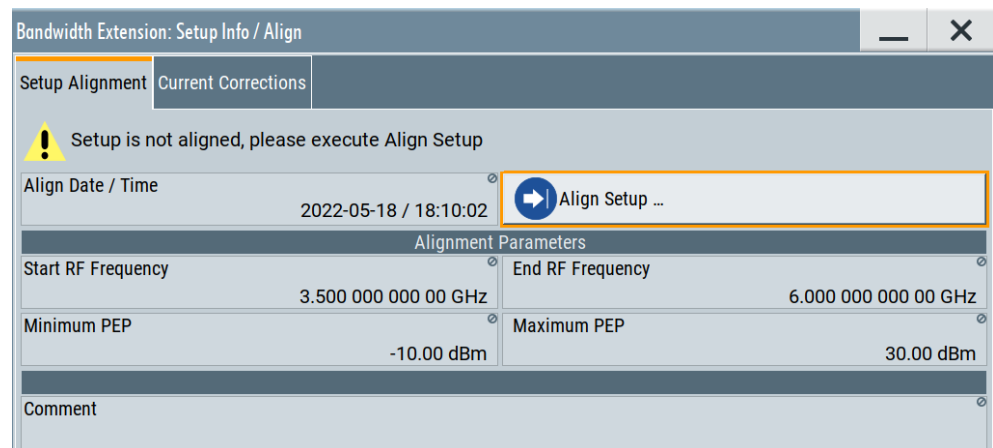
The tab displays information on the setup alignment configuration and provides access to settings for alignment of the bandwidth extension setup.

Settings:

Align Date / Time

Displays the date and time of the last setup alignment procedure.

Remote command:

:SCONfiguration:BEXTension:INFO:ALIGn:DATE? on page 59

:SCONfiguration:BEXTension:INFO:ALIGn:TIME? on page 60

Align Setup

Accesses the "Align Setup" wizard for alignment of the bandwidth extension setup. See
Chapter 4.4, "Align setup wizard settings", on page 52.

Alignment Parameters

Displays all relevant parameters for alignment.

Start RF Frequency ← Alignment Parameters

Sets/displays the start frequency of the alignment procedure.

Make sure, that the measurement device supports this start frequency.

Remote command:

:SCONfiguration:BEXTension:INFO:ALIGn:FREQuency:MINimum?
on page 59

End RF Frequency ← Alignment Parameters

Sets/displays the end frequency of the alignment procedure.

Make sure, that the measurement device supports this end frequency.

Remote command:

:SCONfiguration:BEXTension:INFO:ALIGn:FREQuency:MAXimum?
on page 59

Minimum PEP ← Alignment Parameters

Sets/displays the minimum peak envelope power (PEP) of the alignment procedure.

Make sure, that the measurement device supports this power value.

Remote command:

:SCONfiguration:BEXTension:INFO:ALIGn:PEP:MINimum? on page 60

Maximum PEP ← Alignment Parameters

Sets/displays the minimum peak envelope power (PEP) of the alignment procedure.

Make sure, that the measurement device supports this power value.

Remote command:

:SCONfiguration:BEXTension:INFO:ALIGn:PEP:MAXimum? on page 60

Comment

Enters/displays free input of the alignment setup.

Use this input field to specify characteristics of the alignment or the bandwidth extension setup.

Remote command:
:SCONfiguration:BEXTension:INFO:ALIGn:COMMent? on page 58

4.3.2 Current corrections settings

Access:

1. Load a bandwidth extension setup file.
   See "To load a bandwidth extension setup" on page 24.

2. Select "Info / Align".

3. Select "Current Corrections".

The tab displays information on alignment parameters and provides settings to configure user-defined corrections.
The values of the alignment parameters result from setup alignment and RF ports alignment. If these values are not suitable for your application, you can add user-defined corrections. These corrections are additional IQ delays and phase values for each RF path.

Settings:

Reset User Corrections
Resets all previous RF ports user-defined correction settings.

User-defined corrections are additional IQ delays and phase values for each RF path.

Remote command:
:SCONfiguration:BEXTension:CORRection:RESet on page 63

Current corrections table

Provides current corrections and user-defined corrections in a table.

RF Source ← Current corrections table

Indicates the physical instrument which the RF port belongs to.

Remote command:

`:SCONfiguration:BEXTension:CORRection:PORT<ch>:SOURce?` on page 63

IQ Delay (ps) ← Current corrections table

Displays the IQ delay at the selected RF port.

The delay results from setup alignment and indicates the difference between RF paths before combining. If you adjust the frequency or level of the RF output signal with extended bandwidth, the setup alignment also updates the IQ delay.

Remote command:

`:SCONfiguration:BEXTension:CORRection:PORT<ch>:IQDelay?` on page 61

Additional IQ Delay (ps) ← Current corrections table

Sets an additional IQ delay as an offset to the IQ delay from setup alignment at the selected RF port.

You can add I/Q delays for each RF source.

Remote command:

`:SCONfiguration:BEXTension:CORRection:PORT<ch>:IQDelay:ADDitional` on page 62

Phase (deg) ← Current corrections table

Displays the phase between the synthesizers of the RF paths at the selected RF port.

The phase results from RF ports alignment. The value is static until you align the RF ports again.

Remote command:

`:SCONfiguration:BEXTension:CORRection:PORT<ch>:PHASe?` on page 62

Additional Phase (deg) ← Current corrections table

Sets an additional phase as an offset of the current phase from RF ports alignment at the selected RF port.

You can add phase values for each RF source.

Remote command:

`:SCONfiguration:BEXTension:CORRection:PORT<ch>:IQDelay:ADDitional` on page 62

Level (dB) ← Current corrections table

Displays the corrected power level of each RF path at the selected RF port.

The level results from RF ports alignment. If you change the frequency or level of RF output signal with extended bandwidth, the RF ports alignment also adjusts the level of each RF path.

Remote command:
`:SCONfiguration:BEXTension:CORRection:PORT<ch>:LEVel?` on page 62

4.4 Align setup wizard settings

Access:

1. Load a bandwidth extension setup file.
   See "To load a bandwidth extension setup" on page 24.

2. Select "Info / Align".

3. Select "Align Setup".

The dialog provides settings for alignment of the bandwidth extension setup.

How to: "To align the setup with a signal analyzer" on page 26

Settings:

Analyzer configuration settings
Provides settings to configure the analyzer for setup alignment. Typically, use a vector signal analyzer for alignment, for example, the R&S FSW.

Instrument ← Analyzer configuration settings

Selects an instrument from a list as a result from "Scan Analyzers".

To add instruments manually, select "Instrument" > "New" and set their hostname or IP address.

How to: "To connect a signal analyzer" on page 20

Remote command:

n.a.

Scan Analyzers ← Analyzer configuration settings

Scans the network for connected, supported vector signal analyzers.

Remote command:

n.a.

Hostname or IP Address ← Analyzer configuration settings

Displays or sets the hostname or IP address of the vector signal analyzer.

Remote command:

n.a.

Alignment Parameters

Sets all relevant parameters for alignment.

Start RF Frequency ← Alignment Parameters

Sets/displays the start frequency of the alignment procedure.

Make sure, that the measurement device supports this start frequency.

Remote command:

`:SCONfiguration:BEXTension:INFO:ALIGn:FREQuency:MINimum?`
on page 59

End RF Frequency ← Alignment Parameters

Sets/displays the end frequency of the alignment procedure.

Make sure, that the measurement device supports this end frequency.

Remote command:

`:SCONfiguration:BEXTension:INFO:ALIGn:FREQuency:MAXimum?`
on page 59

Minimum PEP ← Alignment Parameters

Sets/displays the minimum peak envelope power (PEP) of the alignment procedure.

Make sure, that the measurement device supports this power value.

Remote command:

`:SCONfiguration:BEXTension:INFO:ALIGn:PEP:MINimum?` on page 60

Maximum PEP ← Alignment Parameters

Sets/displays the minimum peak envelope power (PEP) of the alignment procedure.

Make sure, that the measurement device supports this power value.

Remote command:

`:SCONfiguration:BEXTension:INFO:ALIGn:PEP:MAXimum?` on page 60

Comment

Enters/displays free input of the alignment setup.

Use this input field to specify characteristics of the alignment or the bandwidth extension setup.

Remote command:

:SCONfiguration:BEXTension:INFO:ALIGn:COMMent? on page 58

5 Remote control commands

The following commands are required to generate signals with the Bandwidth Extension option in a remote environment. We assume that the R&S SMW has already been set up for remote operation in a network as described in the R&S SMW documentation. A knowledge about the remote control operation and the SCPI command syntax is 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 SMW user manual.

Common suffixes

The following common suffixes are used in the remote commands:

Suffix	Value range	Description
`ENTity<ch>`	1 to 4	Entity in a multiple entity configuration with separate baseband sources `ENTity3|4` require option R&S SMW-K76
`SOURce<hw>`	[1] to 4	Available baseband signals Only `SOURce1` possible, if the keyword `ENTity` is used

ⓘ **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 SMW 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/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 chapters describe the commands specific to the Bandwidth Extension option.

5.1 General commands

The `SCONfiguration:BEXTension` subsystem contains the commands for configuration of a bandwidth extension setup.

Example: Loading a bandwidth extension setup file

```
SCONfiguration:BEXTension:SETup:FILE?
// Response: ""
// No file loaded. Load a file with extension *.bwsa, e.g. the file "test_4GHz.bswa".
SCONfiguration:BEXTension:SETup:FILE test_4GHz
// Query if the file is loaded.
SCONfiguration:BEXTension:SETup:FILE?
// Response: "test_4GHz"
SCONfiguration:BEXTension:STATe 1
```

Commands

:SCONfiguration:BEXTension:SETup:FILE <SetupFile>

Loads the selected file from the default or the specified directory. Loaded are files with extension `*.bwsa`.

Parameters:

<SetupFile>   "<filename>"

Filename or complete file path; file extension can be omitted.

Example: See Example"Loading a bandwidth extension setup file" on page 56.

Manual operation: See "Setup" on page 40

:SCONfiguration:BEXTension:STATe <State>

Activates bandwidth extension.

Parameters:

<State>   1 | ON | 0 | OFF

*RST: 0

Example:	See Example"Loading a bandwidth extension setup file" on page 56.
Manual operation:	See "State" on page 40

5.2 Alignment commands

The `SCONfiguration:BEXTension:ALIGn` subsystem contains the commands for aligning a bandwidth extension setup.

Example: Aligning the bandwidth extension setup and RF ports

```
SCONfiguration:BEXTension:ALIGn:STATus?
// Repsonse: "NALigned"
// RF ports are not aligned. Continue with alignment of the RF ports.
SCONfiguration:BEXTension:ALIGn:RFPorts
// Triggers RF ports alignment.
SCONfiguration:BEXTension:ALIGn:STATus?
// Repsonse: "ALIGned"
// RF ports are aligned.
SCONfiguration:BEXTension:STATe 1
```

Example: Querying setup alignment information

```
// Query date and time of the last setup alignment procedure.
SCONfiguration:BEXTension:INFO:ALIGn:DATE?
// Response: "2022,3,31"
// 31 march 2022
SCONfiguration:BEXTension:INFO:ALIGn:TIME?
// Response: "6,0,0"
// 06:00:00 (HH:MM:SS)
SCONfiguration:BEXTension:INFO:ALIGn:FREQuency:MINimum?
// Response in Hz: "3500000000"
// The start frequency is 3.5 GHz.
SCONfiguration:BEXTension:INFO:ALIGn:FREQuency:MAXimum?
// Response in Hz: "6000000000"
// The stop frequency is 6 GHz.
SCONfiguration:BEXTension:INFO:ALIGn:PEP:MINimum?
// Response in dBm: "-11"
// The minimum level is -11.00 dBm.
SCONfiguration:BEXTension:INFO:ALIGn:PEP:MAXimum?
// Response in dBm: "30"
// The maximum level is 30.00 dBm.
SCONfiguration:BEXTension:INFO:ALIGn:COMMent?
// Response: "Single SMW, FSW-67, no coupler"
```

Commands

:SCONfiguration:BEXTension:ALIGn:RFPorts

Requires an active measurement device.

Triggers alignment of the RF ports and considers phase corrections. If you use an analyzer as a measurement device, RF ports alignment also considers cable length corrections.

Example:	See Example"Aligning the bandwidth extension setup and RF ports" on page 57.
Usage:	Event
Manual operation:	See "Align RF Ports" on page 41

:SCONfiguration:BEXTension:ALIGn:STATus?

Queries the alignment status of the bandwidth extension setup.

Return values:

<AlignedStatus>	NALigned | ALIGned
	NALigned Setup is not aligned.
	ALIGned Setup is aligned.
	*RST: NALigned
Example:	See Example"Aligning the bandwidth extension setup and RF ports" on page 57.
Usage:	Query only
Manual operation:	See "Align RF Ports" on page 41

:SCONfiguration:BEXTension:INFO:ALIGn:COMMent?

Queries commenting information on the setup alignment.

The information specifies characteristics of the aligment or the bandwidth extension setup.

Return values:

<Comment>	string
Example:	See Example"Querying setup alignment information" on page 57.
Usage:	Query only
Manual operation:	See "Comment" on page 49

:SCONfiguration:BEXTension:INFO:ALIGn:DATE?

Queries the date of the last setup alignment procedure.

Return values:

<AlignDate>	string
Example:	See Example"Querying setup alignment information" on page 57.
Usage:	Query only
Manual operation:	See "Align Date / Time" on page 49

:SCONfiguration:BEXTension:INFO:ALIGn:FREQuency:MAXimum?

Queries the end frequency of the setup aligment procedure.

Make sure, that the measurement device supports this end frequency.

Return values:

<MaxFreq>	float
	Range: 3.5E9 to 67E9 Increment: 0.01 *RST: n.a. (factory preset: 3.5E9)
Example:	See Example"Querying setup alignment information" on page 57.
Usage:	Query only
Manual operation:	See "End RF Frequency" on page 49

:SCONfiguration:BEXTension:INFO:ALIGn:FREQuency:MINimum?

Queries the start frequency of the setup aligment procedure.

Return values:

<MinFreq>	float
	Range: 3.5E9 to 67E9 Increment: 0.01 *RST: n.a. (factory preset: 3.5E9)
Example:	See Example"Querying setup alignment information" on page 57.

Usage: Query only

Manual operation: See "Start RF Frequency" on page 49

:SCONfiguration:BEXTension:INFO:ALIGn:PEP:MAXimum?

Queries the maximum peak envelope power (PEP) of the setup aligment procedure.

Make sure, that the measurement device supports this power value.

Return values:
<MaxPep>   float

Range: -145 to 30
Increment: 0.01
*RST: n.a. (factory preset: 30)

Example: See Example"Querying setup alignment information"
on page 57.

Usage: Query only

Manual operation: See "Maximum PEP" on page 49

:SCONfiguration:BEXTension:INFO:ALIGn:PEP:MINimum?

Queries the start frequency of the setup aligment procedure.

Make sure, that the measurement device supports this start frequency.

Return values:
<MinPep>   float

Range: -145 to 30
Increment: 0.01
*RST: n.a. (factory preset: -30)

Example: See Example"Querying setup alignment information"
on page 57.

Usage: Query only

Manual operation: See "Minimum PEP" on page 49

:SCONfiguration:BEXTension:INFO:ALIGn:TIME?

Queries the time of the last setup alignment procedure.

Return values:
<AlignTime>   string

Example: See Example"Querying setup alignment information"
on page 57.

Usage: Query only

Manual operation: See "Align Date / Time" on page 49

5.3 User correction commands

The `SCONfiguration:BEXTension:CORRection` subsystem contains the commands for applying user-defined corrections to a bandwidth extension setup.

Example: Applying user-defined corrections to RF ports

```
// Reset all previous correction settings.
SCONfiguration:BEXTension:CORRection:RESet
// Query the RF source instrument at port 1.
SCONfiguration:BEXTension:CORRection:PORT1:SOURce?
// Response: "SMW200A (123456) [A] (this)"
// ********************************************************************************
// The RF source at port one is your R&S SMW with serial number
// 123456 and the RF output of path A.
// Query the current IQ delay.
SCONfiguration:BEXTension:CORRection:PORT1:IQDelay?
// Repsonse in seconds: "0.000000000005"
// The current IQ delay is 5 picoseconde.
// Set an additional IQ delay of 10 picoseconds.
SCONfiguration:BEXTension:CORRection:PORT1:IQDelay:ADDitional 10ps
// Query the current phase in degrees.
SCONfiguration:BEXTension:CORRection:PORT1:PHASe?
// Response in degrees: "0.12"
// Define an additional phase.
SCONfiguration:BEXTension:CORRection:PORT1:PHASe:ADDitional 0.15
SCONfiguration:BEXTension:CORRection:PORT1:LEVel?
// Response in dB: "-10"
```

Commands

:SCONfiguration:BEXTension:CORRection:PORT<ch>:IQDelay?

Queries the IQ delay at the selected RF port.

Return values:

<IqDelay>   float

Example: See Example"Applying user-defined corrections to RF ports" on page 61.

Usage: Query only

Manual operation: See "IQ Delay (ps)" on page 51

:SCONfiguration:BEXTension:CORRection:PORT<ch>:IQDelay:ADDitional
    <AdditionalDelay>

Sets an additional IQ delay as an offset to the current IQ delay at the selected RF port.

Parameters:

<AdditionalDelay>	float

Range:	0 to 1E-9
Increment:	1E-12
*RST:	n.a. (factory preset: 0)

Example:	See Example"Applying user-defined corrections to RF ports" on page 61.
Manual operation:	See "Additional IQ Delay (ps)" on page 51 See "Additional Phase (deg)" on page 51

:SCONfiguration:BEXTension:CORRection:PORT<ch>:LEVel?

Queries the power level of the RF signal at the selected RF port.

Return values:

<Level>	float

Example:	See Example"Applying user-defined corrections to RF ports" on page 61.
Usage:	Query only
Manual operation:	See "Level (dB)" on page 51

:SCONfiguration:BEXTension:CORRection:PORT<ch>:PHASe?

Queries the phase of the RF signal at the selected RF port.

Return values:

<Phase>	float

Example:	See Example"Applying user-defined corrections to RF ports" on page 61.
Usage:	Query only
Manual operation:	See "Phase (deg)" on page 51

:SCONfiguration:BEXTension:CORRection:PORT<ch>:PHASe:ADDitional
    <AdditionalPhase>

Sets an additional phase as an offset of the current phase of the RF signal at the selected RF port.

Parameters:

<AdditionalPhase>   float

Range: -360 to 360
Increment: 0.1
*RST: n.a. (factory preset: 0)

Example: See Example"Applying user-defined corrections to RF ports"
on page 61.

:SCONfiguration:BEXTension:CORRection:PORT<ch>:SOURce?

Queries the RF source of the RF port.

Return values:

<RfSourceName>   string

Example: See Example"Applying user-defined corrections to RF ports"
on page 61.

Usage: Query only

Manual operation: See "RF Source" on page 45

:SCONfiguration:BEXTension:CORRection:RESet

Resets all previous RF ports user-defined correction settings.

Example: See Example"Applying user-defined corrections to RF ports"
on page 61.

Usage: Event

Manual operation: See "Reset User Corrections" on page 50

List of commands

Index