R&S®SMW-K508
I/Q streaming
User Manual

1706841202
Version 01

ROHDE&SCHWARZ
Make ideas real

This document describes the following software options:

- R&S®SMW-K508 I/Q streaming (1434.8256.xx)

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1706.8412.02 | Version 01 | R&S®SMW-K508

Throughout this document, R&S® is indicated as R&S.

Contents

1 Welcome to the I/Q streaming options

The I/Q streaming option R&S SMW-K508 is a firmware application that allows high-speed streaming of I/Q data via the QSFP+ interface of the R&S SMW200A.

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 Key features

- Streaming of I/Q data from a commercial PC (host PC) with a network card
- Ultra-fast streaming of I/Q data over 40 Gbit Ethernet
- Quick setup and easy integration:
  - Flexible 40G optical connection (QSFP+) between host PC and R&S SMW200A
  - Standard data transfer via UDP/IP
- Limitless signal length of the waveform
- I/Q signal bandwidth up to 800 MHz
- Monitoring characteristics of the streaming status and information on the streamed waveform
- Monitoring streaming statistics including receive (RX) and transmit (TX) parameters and error statistics:
  - RX: Actual and minimum buffer level, upload segments, frames and data
  - TX: Reply frames
  - Occurred errors during streaming.

1.2 Accessing the I/Q streaming dialog

To open the dialog with I/Q streaming settings

1. In the block diagram of the R&S SMW200A, select "Baseband" > "ARB".

2. Select "Mode" > "Ethernet Streaming".

   The dialog provides general settings and statistics for I/Q streaming in the ARB application.

The R&S SMW200A does not start the application immediately. To start the application with the default settings, select "State" > "On".

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/@Rohde-Schwarz

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 I/Q streaming option

2.1 Required options

The basic equipment layout for I/Q streaming includes the options:

- Wideband baseband main module (R&S SMW-B13XT)
- Wideband baseband generator (R&S SMW-B9)
- I/Q streaming (R&S SMW-K508)
- Frequency option (e.g. R&S SMW-B1003)
- Optional, ARB memory extension to 2 GSample (R&S SMW-K515)

For more information, refer to the specifications document.

2.2 About I/Q streaming

Equipped with option R&S SMW-K508 I/Q streaming, the R&S SMW200A can stream waveforms or raw I/Q data of large files.

Streaming these files requires the installation of the R&S I/Q Player at an external host PC. Connect this PC to the R&S SMW200A using QSFP+ connectors for I/Q streaming of up to 1 GSamples/s signals, that translate to an average speed of 32 Gbits/s.

Test setup

Figure 2-1 shows a typical test setup including a host PC as the waveform source and the R&S SMW200A that is processing the waveform I/Q data.

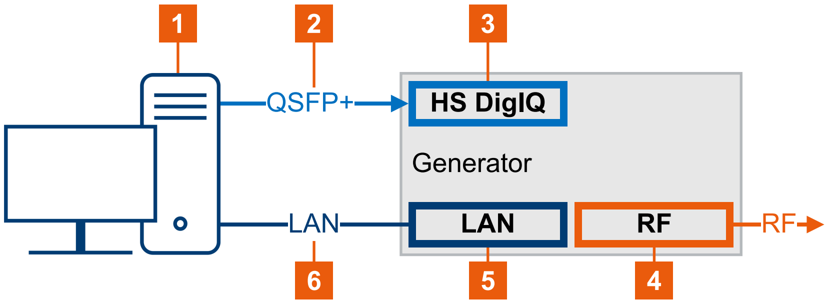


Figure 2-1: I/Q streaming test setup

1 = PC as I/Q streaming source with one or more network interface cards
2 = Ethernet connection via QSFP+ interfaces
3 = R&S SMW200A I/Q data input: "HS DIG I/Q"
4 = R&S SMW200A output: "RF A/RF B"
5 = Optional R&S SMW200A control (via SCPI): "LAN"
6 = Optional LAN connection for remote control operation

About the R&S I/Q Player

The R&S I/Q Player is an easy-to-use software to play waveform files at the host PC. After installation, you can load and play large waveform files. The R&S SMW200A streams the I/Q data of these waveform files to generate the baseband signal.

See Section 3.3, "Using the R&S I/Q Player", on page 13.

3 Streaming waveform files

This section provides information and step-by-step instructions to stream I/Q data. It covers the following topics:

3.1 Connecting the R&S SMW200A

This section provides step-by-step descriptions for connecting the R&S SMW200A with the host PC. The step-by-step descriptions cover the following topics:

- QSFP+ interface: "To connect to HS DIG I/Q" on page 11
- Optional LAN interface: "To connect to LAN" on page 11

To connect to HS DIG I/Q

At the host PC, you can connect up to three interface types of the Ethernet card to the QSFP+ interface (HS DIG I/Q) of the R&S SMW200A.

1. For connection, use a 56G QSFP+ active optical cable for connection, for example, from Mellanox MC220731V-003.
2. Connect the QSFP+ interface at the network card of the host PC to the QSFP+ interface ("HS DIG I/Q") of the baseband coder board (R&S SMW-B9):
   a) Hold the QSFP+ plug of the cable or adapter by its panes.
   b) Turn the QSFP+ cable, so that the release tab shows upwards.
   c) Insert and push the QSFP+ plug into the QSFP+ cage.

For a detailed description, see section "Connecting to HS DIG I/Q" in the R&S SMW200A user manual.

To connect to LAN

Optionally, connect the host PC and R&S SMW200A to LAN for remote control operation via the SCPI interface. Use this connection to configure RF signal settings of the R&S SMW200A like frequency and power level.

► Connect the LAN socket via an RJ-45 cable to the LAN.

For more information, see section "Connecting to LAN" in the R&S SMW200A user manual.

Table 3-1 and Figure 3-1 provide an overview on connections and the test setup.

Table 3-1: Host PC and R&S SMW200A connections

Signal	Host PC	R&S SMW200A
Data	Optical (40G): QSFP+	"HS DIG I/Q"
Control (SCPI)	LAN	"LAN"

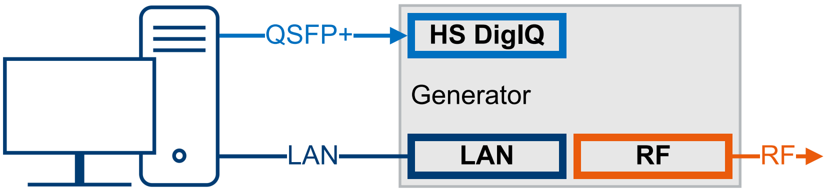


Figure 3-1: Test setup with host PC and R&S SMW200A

For a detailed description of the test setup, see "Test setup" on page 9.

3.2 Configuring the QSFP network

This section provides step-by-step instructions to configure the local QSFP+ network at the host PC and the R&S SMW200A. Before configuration, connect the host PC to the R&S SMW200A as described in Section 3.1, "Connecting the R&S SMW200A", on page 11. The step-by-step instructions cover the following topics:

To configure the Ethernet card

For correct I/Q data transfer from the host PC to the R&S SMW200A, make sure to configure the Ethernet card at the host PC as follows:

1. Install the latest driver version of the controller of the Ethernet card.
2. Configure the Ethernet network card, for example, set the correct mode of operation for data transfer.
   See the documentation of the manufacturer of the network card.
3. Optionally, adjust firewall settings to allow connection to the R&S SMW200A.

To configure the QSFP network settings

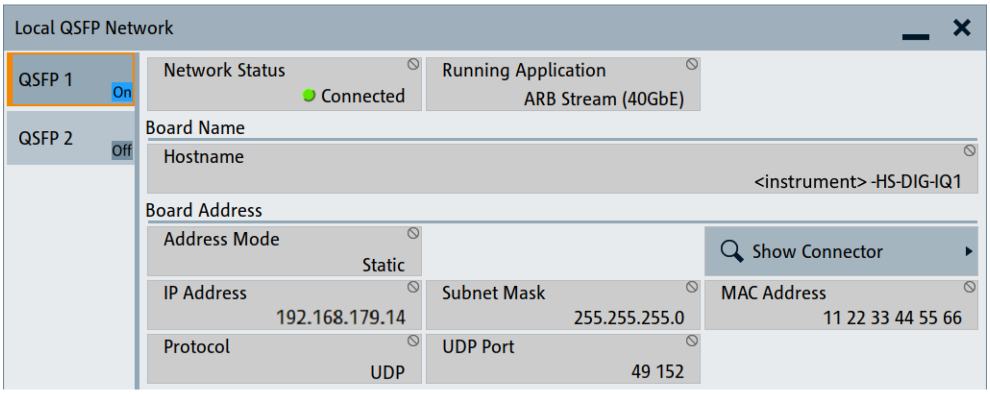
1. At the host PC, configure the QSFP network settings of the Ethernet controller:
   a) Configure for a static IP address with IP version IPv4. No DHCP is active.
      For example, set the IP address "192.168.179.9".
   b) Configure the subnet mask, for example, set "255.255.255.0".
   c) Configure the UDP port, for example, set "32551".
2. At the R&S SMW200A, open the QSFP network settings:
   a) Select "Baseband" > "ARB" > "Mode" > "Ethernet Streaming".

b) Select "Local QSFP Network Settings".
The "Local QSFP Network" dialog opens. By default, the IP address mode is static. No DHCP is active.

3. Configure the QSFP network settings:
   a) Assign a static IP address, for example, set the IP address "192.168.179.14".
   b) To ensure that the R&S SMW200A is in the same subnet, configure the same subnet mask as for the host PC (1b).
   c) Configure the UDP port, for example "49152".

4. Make sure that the dialog displays the "Network Status" > "Connected" for the R&S SMW200A.

   The figure below shows a valid configuration of an Ethernet connection between the host PC and the R&S SMW200A.



3.3 Using the R&S I/Q Player

This section describes how to install, configure and operate the R&S I/Q Player.

3.3.1 Installing the R&S I/Q Player

Required equipment

Playing I/Q data from the host PC requires dedicated hardware and software. To get maximum I/Q data throughput, Rohde & Schwarz recommends the following equipment:

- PC: Dell OptiPlex Tower Plus 7010 Intel Core i5 or higher
- Network card: Intel Corporation Ethernet Controller XL710 for 40GbE QSFP+
- System drive SSD:

- Memory: 1 TB
- Read speed: make sure that the speed is higher than the transmission rate of the streamed signal.

- QSFP+ cable: 56G QSFP+ optical cable
- Operating system: Linux Debian 11 or Windows

Open source acknowledgment

The software uses open source software packages. The open source acknowledgment (OSA) document provides verbatim license texts of the used open source software.

During installation, the installation wizard displays the OSA document. After installation, this document is also available as a PDF file in the directory of the R&S I/Q Player software.

To install the R&S I/Q Player

1. Download the R&S I/Q Player installation file `RS_IQPlayer-<version>.zip`.

   The following execution files are available depending on the operation system:
   - Example for a Windows installation file:
     `RS_IQPlayer-1.0.0-win64.exe`
   - Example for a Linux installation file:
     `RS_IQPlayer-1.0.0-Linux.deb`
2. For installation in Windows, proceed as follows:
   a) Execute the installation file.
   b) Follow the instructions in the installation wizard.
3. For installation in Linux, proceed as follows:
   a) Install the packages DPDK, Qt, boost and other packages as needed with the bash script `install-dependencies-linux.sh` in the folder `scripts` with the command `$sudo ./install-dependencies-linux.sh`.
   b) Install the `RS_IQPlayer-1.0.0-Linux.deb` file with the command `sudo dpkg -i RS_IQPlayer-1.0.0-Linux.deb`.

3.3.2 Playing I/Q data

This section describes how to prepare the host PC and the R&S I/Q Player to play I/Q data.

It covers the following topics:
- "To prepare the streaming configuration file" on page 15
- "To load and play a waveform file" on page 15
- "To configure the DPDK packages in Linux" on page 16

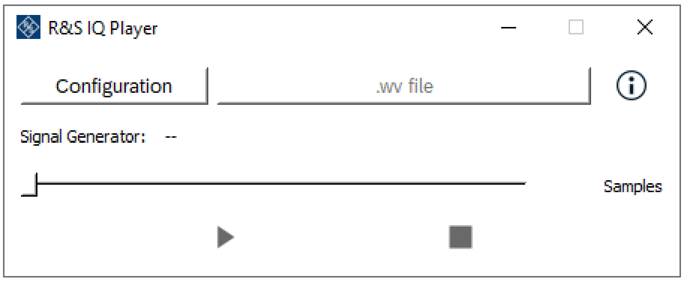
To prepare the streaming configuration file

This step-by-step instruction assumes that the host PC and the R&S SMW200A have a local QSFP network connection, see Section 3.2, "Configuring the QSFP network", on page 12.

1. In the zipped folder of the R&S I/Q Player, open the stream configuration file `Streaming_Configuration.txt`.
2. Enter the following parameters for a valid streaming configuration:
   a) `src_mac=`: MAC address of the host PC
   b) `dst_mac=`: MAC address of the R&S SMW200A
   c) `src_ipv4=`: IPv4 address of the host PC
   d) `dst_ipv4=`: IPv4 address of the R&S SMW200A
   e) `src_udp_port=`: UDP port at the host PC
   f) `trigger_mode=`: Triggering mode to start streaming for filled buffers at the R&S SMW200A.
   Set `trigger_mode=siggen` to trigger from the R&S SMW200A. Set `trigger_mode=user` to trigger streaming automatically.
   g) `scpi_listening_port=`: Optional parameter to specify the port to send SCPI commands from the host PC to the R&S SMW200A.
   h) `dpdk_port_pci_addr=`: For Linux only. Sets the PCI address, for example `dpdk_port_pci_addr=0000:01:00.0`.

To load and play a waveform file

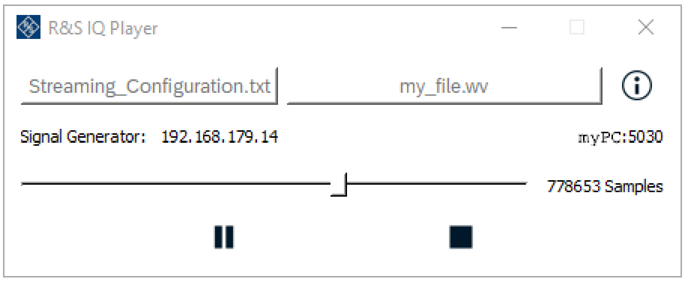
1. To open the R&S I/Q Player, select the file `rs_iqplayer.exe` in the installation directory.



   The R&S I/Q Player main dialog opens.
2. Select "Configuration" to load the streaming configuration file `Streaming_Configuration.txt`.
3. To load a waveform file from the SSD of the host PC, select ".wv file".
   Note: If you use multiple SSDs, place the waveform file on the high read speed SSD.
4. Select the waveform file from the file directory, for example the file `my_file.wv`.
5. Optionally, select ⓘ to check if the streaming setup is valid. Check the following information:

- Network configuration of the local QSFP network for the host PC and R&S SMW200A: MAC addresses, IPv4 address and UDP ports
- Waveform file information: sample rate, number of samples, RMS and peak offset

6. Select "Play", to play the waveform file.



The host PC transfers the I/Q data of the waveform file to the R&S SMW200A.

To configure the DPDK packages in Linux

This step-by-step instruction describes the DPDK package configuration in Linux. Execute this instruction every time you reboot the PC.

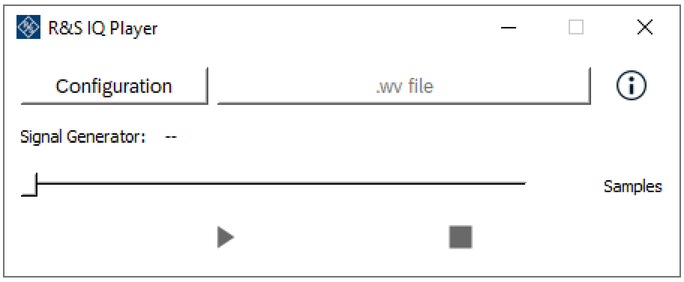
To automate the configuration, execute a helper bash script from the scripts folder `dpdk-setup-linux.sh`. Update the interface and PCI address with the correct values in the script.

1. Install the net-tools package via the following command:
   `sudo apt install net-tools`
2. Find the name of the network interface via the following command:
   `sudo ifconfig <dpdk_interface_name> down`
   For example, set `sudo ifconfig enp1s0np0 down`.
3. Proceed with the following command:
   `sudo modprobe vfio-pci`
4. Set the PCI address via the following command:
   `sudo dpdk-devbind.py -b vfio-pci <dpdk_port_pci_address>`.
   For example, set `sudo dpdk-devbind.py -b vfio-pci 0000:01:00.0`.
5. Proceed with the following command:
   `sudo dpdk-hugepages.py -p 1G --setup 2G`

3.3.3 R&S I/Q Player settings

Access:

► In the installation directory of the R&S I/Q Player, open the file `rs_iqplayer.exe`.



The dialog provides standard player settings to play waveform files. Select and load these files from the SSD on the host PC. Also, select the streaming configuration file and check information on the streaming status during waveform play.

Settings:

Configuration
Accesses the file directory to load the streaming configuration file `Streaming_Configuration.txt`.

Remote command:
`:IQPLayer:CONFig:LOAD` on page 40

.wv file
Accesses the file directory to load a waveform file.

Remote command:
`:IQPLayer:WAVeform:LOAD` on page 40

Info
Accesses a dialog that provides information on the following.

- Network configuration of the local QSFP network for the host PC and R&S SMW200A: MAC addresses, IPv4 address and UDP ports
- Waveform file information: sample rate, number of samples, RMS and peak offset
- DPDK PCI address (only for Linux)

Remote command:
n.a.

Signal Generator:
If you configure a valid streaming configuration, the field displays the IP address of the R&S SMW200A.

Remote command:
n.a.

<Host_PC_name>:<SCPI_port>
Displays the computer name and the SCPI port of the host PC, for example "myPC:5030".

Remote command:
`*IDN?` on page 40

Samples
Displays the number of samples that the player processed and streamed to the R&S SMW200A.

Remote command:
n.a.

Play/Pause/Continue/Stop
Standard player functions that require a loaded waveform file.

Remote command:
`:IQPLayer:STATe` on page 40

3.4 Streaming and monitoring I/Q data

This section provides step-by-step instructions to stream and monitor streamed I/Q data at the R&S SMW200A. These instructions cover the following topics:

To activate I/Q streaming

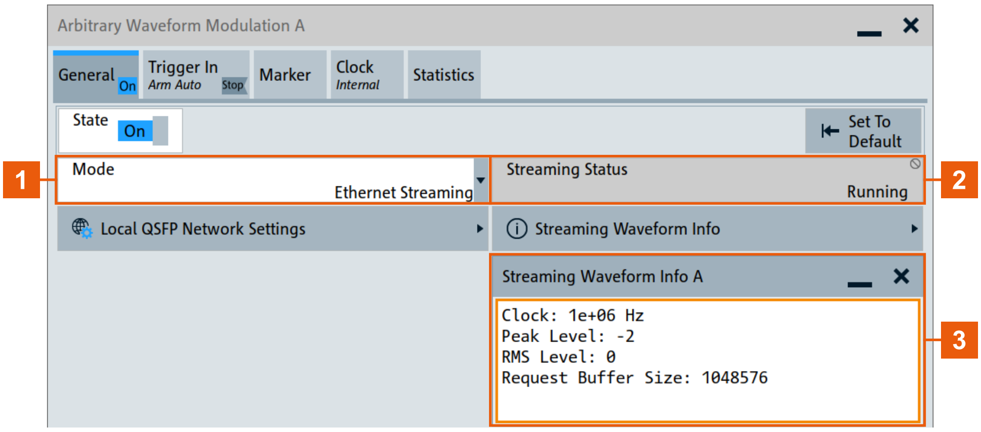
This step-by-step instruction assumes that the R&S I/Q Player at the host PC plays a waveform file, see "To load and play a waveform file" on page 15.

1. Select "Baseband" > "ARB".
2. Select "General" > "Mode" > "Ethernet Streaming".
3. Select "Local QSFP Network Settings" and verify the network information.
4. Select ARB "State" > "On".

To monitor the streamed waveform characteristics

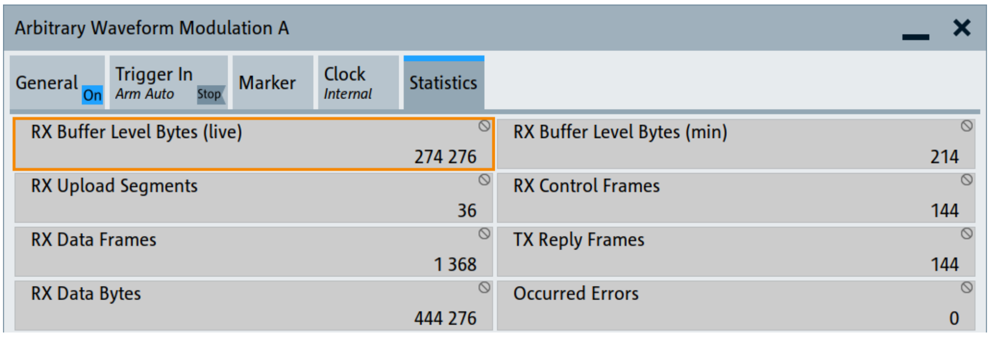
The following step-by-step instruction assumes that I/Q streaming is active at the R&S SMW200A.

1. In the "General" tab, monitor the streaming status, waveform count and additional information on the currently played waveform.



1 = ARB mode Ethernet streaming
2 = Streaming status: Running means that the R&S SMW200A streams I/Q data with no errors.
3 = Information on the streamed waveform: clock rate and power levels

2. In the "Statistics" tab, monitor the characteristics of the streamed waveform.



4 I/Q streaming configuration and settings

Access:

1. Select "Baseband" > "ARB".
2. Select "General" > "Mode" > "Ethernet Streaming".

   The dialog provides settings to configure settings and monitor characteristics to stream I/Q data.

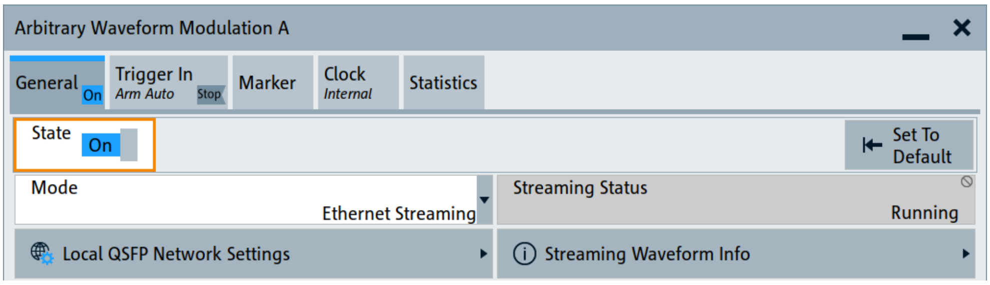
The remote commands required to define these settings are described in Section 6, "Remote control commands", on page 28.

Settings:

4.1 General settings

Access:

1. Select "Baseband" > "ARB".
2. Select "General" > "Mode" > "Ethernet Streaming".



This tab provides general ARB Ethernet streaming settings including setting the application to its default configuration.

Settings:

State

Activates ARB modulation. Switching on the ARB turns off all the other digital standards and digital modulation formats in the same signal path.

For more information, see section "ARB general settings" in the R&S SMW200A user manual.

Set To Default

Calls the default settings.

For more information, see section "ARB general settings" in the R&S SMW200A user manual.

Mode

Sets the mode of the ARB application.

"Standard" Standard ARB mode for playing waveform files using the internal baseband source.

"Ethernet Upload"
Requires R&S SMW-K507.
ARB mode for uploading waveform files using the external QSFP+ interface.

"Ethernet Streaming"
Requires R&S SMW-K508.
ARB mode for streaming waveform files using the external QSFP+ interface.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:MODE` on page 30

Streaming Status

Displays the status of the streamed I/Q data.

"Stopped" Streaming of I/Q data stopped or no streaming enabled.

"Configured" UDP command initiated state as in the streamed I/Q data.

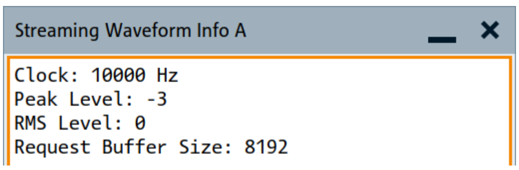
"Running" Streaming of I/Q data is enabled, no streaming errors.

"Stopped with Error"
Streaming of I/Q data stopped due to an error.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:ETHernet[:STReaming]:STATus?`
on page 30

Streaming Waveform Info

Accesses a dialog that displays further information on the processed waveform files.



For information on waveform tags, see section "Creating waveforms with tag file format" in the R&S SMW200A user manual.

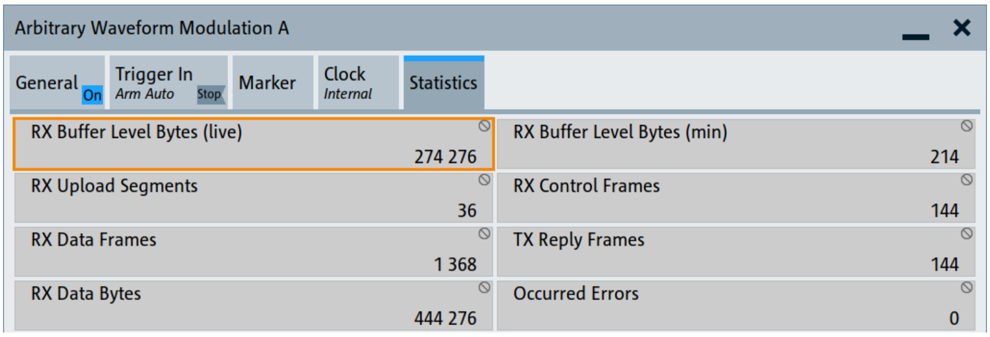
Remote command:
`[:SOURce<hw>]:BB:ARBitrary:ETHernet:WAVeform:INFO?` on page 31
`[:SOURce<hw>]:BB:ARBitrary:ETHernet:WAVeform:TAG?` on page 31

Local QSFP Network Settings
Accesses a dialog to configure the local QSFP+ network, see Section 4.3, "Local QSFP Network Settings", on page 24.

4.2 Statistics

Access:

1. Select "Baseband" > "ARB".
2. Select "General" > "Mode" > "Ethernet Streaming".
3. Select "Statistics".



This tab displays statistics of ARB Ethernet characteristics including receive (RX) buffer levels and statistics, transmit (TX) statistics and error statistics.

Settings:

RX Buffer Level Bytes (live)
Displays the current value of the received buffer level bytes within a streaming session.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:ETHernet:STATistics:RXBLive?
on page 33

RX Buffer Level Bytes (min)
Displays the minimum value of the received buffer level bytes within a streaming session.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:ETHernet:STATistics:RXBMin? on page 34

RX Upload Segments
Displays the number of received upload segments.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:ETHernet:STATistics:RXUSegments?
on page 35

RX Control Frames
Displays the number of received control frames.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:ETHernet:STATistics:RXCFrames?
on page 34

RX Data Frames
Displays the number of received data frames.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:ETHernet:STATistics:RXDFrames?
on page 34

RX Data Bytes
Displays the total received data payload in bytes.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:ETHernet:STATistics:RXDBytes?
on page 34

TX Reply Frames
Displays the number of transmitted reply frames.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:ETHernet:STATistics:TXRFrames?
on page 35

Occurred Errors
Displays the number of errors that occurred during an ARB Ethernet session.

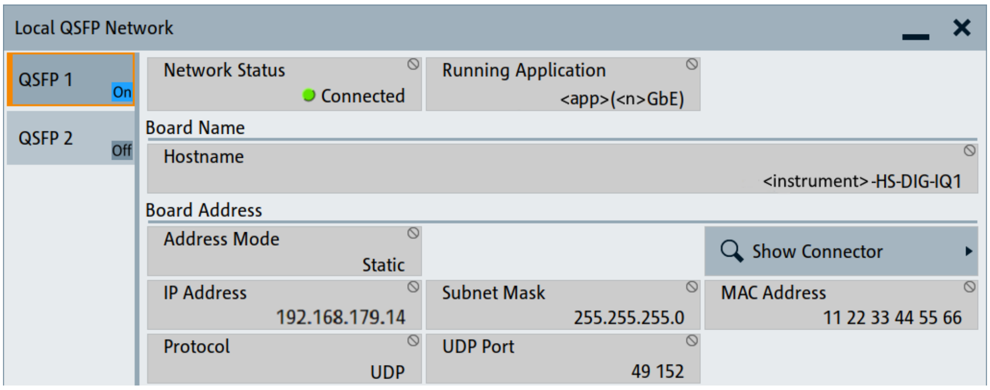
These errors include, for example, loss of packets, packet flow errors, ARB configuration errors and protocol errors. For error history details, open the "Info / Notifications" dialog: Select "System Config" > "Info / Notifications" > "History".

Remote command:
[:SOURce<hw>]:BB:ARBitrary:ETHernet:STATistics:ERRors? on page 33

4.3 Local QSFP Network Settings

Access:

1. Select an application that provides the settings to configure a QSFP network:
   - Select "Baseband" > "Misc" > "Extended Sequencer".
     – R&S SMW-K506:
       Select "Mode" > "Agile Sequencing".
     – R&S SMW-K573:
       Select "Mode" > "Ethernet Streaming with Dynamic Offset Control".
   - R&S SMW-K507:
     Select "Baseband" > "ARB" > "General" > "Mode" > "Ethernet Upload".
   - R&S SMW-K508:
     Select "Baseband" > "ARB" > "General" > "Mode" > "Ethernet Streaming".
2. Select "Local QSFP Network Settings".



The dialog provides settings to configure the QSFP+ network environment and specific identification parameters of the instrument in the network.

The remote commands required to configure these settings are described in Section 6.3, "QSFP+ network commands", on page 36.

Settings:

Network Status
Displays the network status of the instrument that is connected to the network or disconnected.

Remote command:
`:SYSTem:COMMunicate:BB<hw>:QSFP:NETWork:STATus?` on page 37

Running Application
Displays the application and the Ethernet connection "<app> (<n>GbE)" that currently uses the QSFP+ network connection.

"ExtSeq Agile (10GbE)"/"ExtSeq HIL (40GbE)"
Requires R&S SMW-K506 or R&S SMW-K573.
Extended sequencer using 10 Gbit (agile sequencing) or 40 Gbit (dynamic offset control) Ethernet connection.

"ARB Upload (10GbE)"/"ARB Upload (40GbE)"
Requires R&S SMW-K507.
ARB Ethernet upload using 10 Gbit or 40 Gbit Ethernet connection.

"ARB Stream (40GbE)"
Requires R&S SMW-K508.
I/Q streaming using a 40 Gbit Ethernet connection.

Remote command:
`:SYSTem:COMMunicate:BB<hw>:QSFP:NETWork:APPLication?` on page 37

Hostname
Displays the host name. The host name consists of the R&S SMW200A short name `<instrument>`, the serial number `<serial number>` and the connector of the QSFP+ interface `<HS-DIG-IQx>`.

Each instrument is delivered with an assigned host name. This name is a logical name that you can use instead of the IP address to connect to a network. With the default network settings, the IP address is allocated by the DHCP server. This address can change each time the instrument is reconnected. Unlike the IP address, the host name does not change.

Note:
This function is password-protected. Unlock the protection level 1 to access it.

If you change the default network settings or the host name, the network connection can break. If you change the host name, be sure to use a unique name.

Remote command:
`:SYSTem:COMMunicate:BB<hw>:QSFP:NETWork[:COMMon]:HOSTname?` on page 37

Address Mode
Indicates that IP addresses are assigned in static mode, i.e. the IP address is assigned manually.

Remote command:
`:SYSTem:COMMunicate:BB<hw>:QSFP:NETWork:IPADdress:MODE` on page 38

IP Address

Assign the IP address manually.

Remote command:
:SYSTem:COMMunicate:BB<hw>:QSFP:NETWork:IPADdress on page 38

Subnet Mask

Assign the subnet mask manually.

Remote command:
:SYSTem:COMMunicate:BB<hw>:QSFP:NETWork[:IPADdress]:SUBNet:MASK on page 38

MAC Address

Displays the MAC (Media Access Control) address, a unique identifier of the network adapter in the R&S SMW200A.

Remote command:
:SYSTem:COMMunicate:BB<hw>:QSFP:NETWork:MACaddress? on page 38

Protocol

Displays the protocol for the network traffic that is the user datagram protocol (UDP).

The application uses UDP because it is a connectionless and unreliable transport protocol that requires no delivery of data. Also, UDP is faster than TCP because it does not require the overhead of establishing and maintaining a connection.

Remote command:
:SYSTem:COMMunicate:BB<hw>:QSFP:NETWork:PROTocol on page 39

UDP Port

Sets the UDP port number for the network traffic.

Remote command:
:SYSTem:COMMunicate:BB<hw>:QSFP:NETWork:PORT on page 39

5 Signal generation control

In this section, the signal generation control functionality for ARB Ethernet streaming mode is described. It includes trigger and marker settings. In particular, the difference of these settings compared to the standard ARB functionality is described.

Trigger settings

The trigger mode "Armed Auto" is supported only.

Marker settings

The standard marker modes "Unchanged", "Pulse", "Pattern" and "On/Off Ratio" are supported for each marker signal.

The marker delay is configurable in samples, the R&S SMW200A derives the delay time from the clock rate of the waveform file.

For a comprehensive description, see section "Trigger, marker and clock settings" in the R&S SMW200A user manual.

6 Remote control commands

The following commands are required to stream I/Q data with the I/Q streaming option 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 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 SMW200A 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 SMW200A user manual.

Programming examples

This section provides simple programming examples. The purpose of the examples is to present all commands for a given task. In real applications, you typically use an appropriate subset of these commands.

For verification and testing purposes, a software tool executed these programming examples. To keep the example as simple as possible, the examples report clean SCPI syntax elements. Non-executable command lines, for example comments, start with two characters `//`.

Before executing a SCPI sequence, most remote control programs reset or preset the instrument to a definite state. The commands `*RST` and `SYSTem:PRESet` are equivalent for this purpose. The command `*CLS` also resets the status registers and clears the output buffer.

The following sections describe the commands specific to the I/Q streaming option. Also, a dedicated section lists the R&S I/Q Player commands to control this application via SCPI.

6.1 General commands

Example: Configuring ARB Ethernet settings

This example requires an R&S SMW200A connected to a QSFP+ network, see Example "Configuring the QSFP+ network" on page 36.

```
// Query the ARB mode.
:SOURce1:BB:ARB:MODE?
// Response: "STAN"
// Standard ARB mode is enabled.

// Enable ARB Ethernet streaming mode for I/Q streaming.
:SOURce1:BB:ARB:MODE ESTReaming

// Query the I/Q streaming status.
:SOURce1:BB:ARB:ETHernet:STREaming:STATus?
// Response: "STOPped"
// No I/Q data is streamed. Activate ARB Ethernet streaming.
:SOURce1:BB:ARB:STATe 1
:SOURce1:BB:ARB:ETHernet:STREaming:STATus?
// Response: "RUNNing"

// Optionally, configure trigger settings to specify the start of I/Q streaming.
:SOURce1:BB:ARB:TRIGger:SEQuence?
// Response: "SINGle"
// Single trigger event to start signal generation.
:SOURce1:BB:ARB:TRIGger:SLENgth?
// Response: "1"
// Trigger signal length is one sequence.

// Optionally, monitor or reconfigure the settings for the first marker signal.
:SOURce1:BB:ARB:TRIGger:OUTPut1:MODE?
// Response: "UNCHanged"
// Marker mode unchanged is set. Switch to marker mode restart.
:SOURce1:BB:ARB:TRIGger:OUTPut1:MODE RESTart
```

If activated, you can monitor upload characteristics, see Example "Monitoring ARB Ethernet statistics" on page 32.

Commands:

[:SOURce<hw>]:BB:ARBitrary:MODE <ArbMode>

Defines the mode of the ARB application.

Parameters:

<ArbMode> STANdard | EUPLoad | ESTReaming

STANdard
ARB standard mode using a waveform file as an internal baseband source.

EUPLoad
ARB Ethernet upload mode for uploading waveform files via the external QSFP+ interface.

ESTReaming
ARB Ethernet streaming mode for I/Q streaming via the external QSFP+ interface.

*RST: STANdard

Example: See Example "Configuring ARB Ethernet settings" on page 29.

Options: EUPLoad requires R&S SMW-K507.
ESTReaming requires R&S SMW-K508.

Manual operation: See "Mode" on page 21

[:SOURce<hw>]:BB:ARBitrary:ETHernet[:STReaming]:STATus?

Queries the status of the streamed I/Q data.

Return values:

<Status> string

STOPped
Streaming of I/Q data stopped or no streaming enabled.

CONFigured
UDP command-initiated state as in the streamed I/Q data.

RUNNing
Streaming of I/Q data is enabled, no streaming errors.

ERRor
Streaming of I/Q data stopped due to an error.

Usage: Query only

Manual operation: See "Streaming Status" on page 21

[:SOURce<hw>]:BB:ARBitrary:ETHernet:WAVeform:INFO?

Queries information about the currently played waveform in a comma-separated list.

The table below list all parameters that are queried.

Parameter	Description
Waveform counter	Integer number of played waveforms
Comment	Waveform name or comment tag
Clock	Clock rate in Hz
Marker x	Marker mode for marker x. x can be 1 to 3.
Peak level	RF signal peak level
RMS level	RF signal RMS level
Samples	Number of played waveform samples

Example: See Example "Configuring ARB Ethernet settings" on page 29.

Usage: Query only

Manual operation: See "Streaming Waveform Info" on page 21

[:SOURce<hw>]:BB:ARBitrary:ETHernet:WAVeform:TAG? <TagName>

Queries waveform tags defined in the waveform file with extension `*.wv`.

Query results are returned in a comma-separated list. Listed are pairs `"<TagName>"<"<TagValue>">` for each tag.

Query parameters:

<TagName> string

Name of the waveform tag.

Return values:

<TagValue> string

Value of the waveform tag.

Example: See Example "Configuring ARB Ethernet settings" on page 29.

Usage: Query only

Manual operation: See "Streaming Waveform Info" on page 21

6.2 Statistics commands

The commands of the `BB:ARB:ETHernet:STATistics` subsystem provide statistical results for waveform upload. Results are available for receive (RX) direction (PC ⇒ R&S SMW200A) and transmit (TX) direction (R&S SMW200A ⇒ PC).

Example: Monitoring ARB Ethernet statistics

```
// Query ARB Ethernet characteristics in Rx direction.
:SOURce1:BB:ARBitrary:ETHernet:STATistics:RXUSegments?
// Response: "15790"
// The R&S SMW200A receives 15790 Rx upload segments.
:SOURce1:BB:ARBitrary:ETHernet:STATistics:RXCFrames?
// Response: "47470"
// The R&S SMW200A receives 47470 Rx control frames.
:SOURce1:BB:ARBitrary:ETHernet:STATistics:RXDFrames?
// Response: "31610"
// The R&S SMW200A receives 31610 Rx data frames.
:SOURce1:BB:ARBitrary:ETHernet:STATistics:RXDBytes?
// Response: "63220"
// The R&S SMW200A receives 63220 Rx data bytes.

// Query the current and minimum RX buffer level byte of the streaming session.
:SOURce1:BB:ARBitrary:ETHernet:STATistics:RXBLive?
// Response in bytes: 1024
:SOURce1:BB:ARBitrary:ETHernet:STATistics:RXBMin?
// Response in bytes: 2

// Query ARB Ethernet characteristics in Tx direction.
:SOURce1:BB:ARBitrary:ETHernet:STATistics:TXCFrames?
// Response: "89120"
// The R&S SMW200A sends 89120 Tx reply/acknowledegment frames.

// Query occured errors.
:SOURce1:BB:ARBitrary:ETHernet:STATistics:ERRors?
// Response: "0"
// No errors occured during the ARB Ethernet session.
```

Commands:

[:SOURce<hw>]:BB:ARBitrary:ETHernet:STATistics:ALL?

Queries all statistic results in a comma-separated list that contains the following parameters:

```
<RxUploadSegments>,<RxConrolFrames>,<RxDataFrames>,
<RxDataBytes>,<TxReplyFrames>,<OccuredErrors>
```

Return values:

<RxUploadSegment> integer

Number of Rx upload segments, see [:SOURce<hw>]:BB:ARBitrary:ETHernet:STATistics:RXUSegments? on page 35.

<RxControlFrames> integer

Number of Rx control frames, see [:SOURce<hw>]:BB:ARBitrary:ETHernet:STATistics:RXCFrames? on page 34.

<RxDataFrames> integer

Number of Rx data frames, see [:SOURce<hw>]:BB:ARBitrary:ETHernet:STATistics:RXCFrames? on page 34.

<RxDataBytes> integer

Number of Rx data bytes, see [:SOURce<hw>]:BB:ARBitrary:ETHernet:STATistics:RXDBytes? on page 34.

<TxReplyFrames> integer

Number of Tx reply frames, see [:SOURce<hw>]:BB:ARBitrary:ETHernet:STATistics:TXRFrames? on page 35.

Example: See Example "Monitoring ARB Ethernet statistics" on page 32.

Usage: Query only

[:SOURce<hw>]:BB:ARBitrary:ETHernet:STATistics:ERRors?

Queries the number of errors that occured during an ARB Ethernet session.

Return values:

<OccurredErrors> integer

*RST: 0

Example: See Example "Monitoring ARB Ethernet statistics" on page 32.

Usage: Query only

Manual operation: See "Occurred Errors" on page 23

[:SOURce<hw>]:BB:ARBitrary:ETHernet:STATistics:RXBLive?

Queries the current value of the received buffer level bytes within a streaming session.

Return values:

<BufferLevelLive> integer

*RST: 0

Example: See Example "Monitoring ARB Ethernet statistics" on page 32.

Usage: Query only

Manual operation: See "RX Buffer Level Bytes (live)" on page 22

[:SOURce<hw>]:BB:ARBitrary:ETHernet:STATistics:RXBMin?

Queries the minimum value of the received buffer level bytes within a streaming session.

Return values:
<BufferLevelMin> integer
*RST: 0

Example: See Example "Monitoring ARB Ethernet statistics" on page 32.

Usage: Query only

Manual operation: See "RX Buffer Level Bytes (min)" on page 23

[:SOURce<hw>]:BB:ARBitrary:ETHernet:STATistics:RXCFrames?

Queries the number of Rx control frames, that the R&S SMW200A receives from the PC.

Return values:
<ControlFrames> integer
*RST: 0

Example: See Example "Monitoring ARB Ethernet statistics" on page 32.

Usage: Query only

Manual operation: See "RX Control Frames" on page 23

[:SOURce<hw>]:BB:ARBitrary:ETHernet:STATistics:RXDBytes?

Queries the number of Rx data bytes, that the R&S SMW200A receives from the PC.

Return values:
<DataBytes> integer
*RST: 0

Example: See Example "Monitoring ARB Ethernet statistics" on page 32.

Usage: Query only

Manual operation: See "RX Data Bytes" on page 23

[:SOURce<hw>]:BB:ARBitrary:ETHernet:STATistics:RXDFrames?

Queries the number of data frames, that the R&S SMW200A receives from the PC.

Return values:

<DataFrames> integer

*RST: 0

Example: See Example "Monitoring ARB Ethernet statistics" on page 32.

Usage: Query only

Manual operation: See "RX Data Frames" on page 23

[:SOURce<hw>]:BB:ARBitrary:ETHernet:STATistics:RXUSegments?

Queries the number of Rx upload segments, that the R&S SMW200A receives from the PC.

Return values:

<UploadSegments> integer

*RST: 0

Example: See Example "Monitoring ARB Ethernet statistics" on page 32.

Usage: Query only

Manual operation: See "RX Upload Segments" on page 23

[:SOURce<hw>]:BB:ARBitrary:ETHernet:STATistics:TXRFrames?

Queries the number of Tx reply frames sent from R&S SMW200A to the PC.

Return values:

<ReplyBytes> integer

*RST: 0

Example: See Example "Monitoring ARB Ethernet statistics" on page 32.

Usage: Query only

Manual operation: See "TX Reply Frames" on page 23

6.3 QSFP+ network commands

Example: Configuring the QSFP+ network

```
// ********************************************************************************
// Configuring QSFP+ 1 network parameters at the connector HS DIG I/Q1.
// ********************************************************************************
// Set the IP address.
SYSTem:COMMunicate:BB1:QSFP:NETWork:IPADdress "127.0.0.1"
// Set the subnet mask.
SYSTem:COMMunicate:BB1:QSFP:NETWork:IPADdress:SUBNet:MASK 255.255.255.0
// Set the UDP Port.
SYSTem:COMMunicate:BB1:QSFP:NETWork:PORT 49152

// Query the QSFP+ network settings.
SYSTem:COMMunicate:BB1:QSFP:NETWork:STATus?
// Response: "1"
// The R&S SMW200A is connected.
SYSTem:COMMunicate:BB1:QSFP:NETWork:APPLication?
// Response: "ExtSeq (10GbE)" for extended sequencer, 10 Gbit Ethernet.
// Response: "ARB Upload (10GbE)" for ARB Ethernet upload, 10 Gbit Ethernet.
// Response: "ARB Stream (40GbE)" for ARB Ethernet streaming 40 Gbit Ethernet.
SYSTem:COMMunicate:BB1:QSFP:NETWork:HOSTname?
// Returns the hostname consisting of the R&S SMW200A short name, the
// serial number and the connector HS-DIG-IQx.
SYSTem:COMMunicate:BB1:QSFP:NETWork:IPADdress:MODE?
// Response: "STATic"
SYSTem:COMMunicate:BB1:QSFP:NETWork:MACaddress?
SYSTem:COMMunicate:BB1:QSFP:NETWork:PROTocol?
// Response: "UDP"

// ********************************************************************************
// Configuring QSFP+ 2 network parameters at the connector HS DIG I/Q2.
// ********************************************************************************
// Configure analogous as for the QSFP+ 1 network using the suffix BB<hw> = BB2.
```

Commands:

:SYSTem:COMMunicate:BB<hw>:QSFP:NETWork:STATus?

Queries the network configuration state.

Return values:
<NetworkStatus> 1 | ON | 0 | OFF
*RST: n.a. (no preset. default: 0)

Example: See Example "Configuring the QSFP+ network" on page 36.

Usage: Query only

Manual operation: See "Network Status" on page 25

:SYSTem:COMMunicate:BB<hw>:QSFP:NETWork:APPLication?

Queries a running application.

Return values:
<RunningApp> string
Returns the name of the running application.
ExtSeq (10GbE)
Extended sequencer at 10 Gbit Ethernet
ARB Upload (10/40GbE)
ARB Ethernet upload at 10 Gbit or 40 Gbit Ethernet
ARB Stream (40GbE)
ARB Ethernet streaming at 40 Gbit Ethernet

Example: See Example "Configuring the QSFP+ network" on page 36.

Usage: Query only

Options: ExtSeq (10GbE) requires R&S SMW-K506.
ARB Upload (10GbE)|ARB Upload (40GbE) require R&S SMW-K507.
ARB Stream (40GbE) requires R&S SMW-K508.

Manual operation: See "Running Application" on page 25

:SYSTem:COMMunicate:BB<hw>:QSFP:NETWork[:COMMon]:HOSTname?

Queries an individual hostname for the vector signal generator.

Note: We recommend that you do not change the hostname to avoid problems with the network connection. If you change the hostname, be sure to use a unique name.

This is a password-protected function. Unlock the protection level 1 to access it, see `:SYSTem:PROTect<ch>[:STATe]`.

Return values:
<Hostname> string

Example: See Example "Configuring the QSFP+ network" on page 36.

Usage: Query only

Manual operation: See "Hostname" on page 25

:SYSTem:COMMunicate:BB<hw>:QSFP:NETWork:IPADdress:MODE <IpAddressMode>

Displays the mode of the IP address.

Parameters:

<IpAddressMode> STATic

*RST: n.a. (factory preset: STATic)

Example: See Example "Configuring the QSFP+ network" on page 36.

Manual operation: See "Address Mode" on page 25

:SYSTem:COMMunicate:BB<hw>:QSFP:NETWork:IPADdress <IpAddress>

Sets the IP address.

Parameters:

<IpAddress> String

Range: 0.0.0.0 to ff.ff.ff.ff

Example: See Example "Configuring the QSFP+ network" on page 36.

Manual operation: See "IP Address" on page 26

:SYSTem:COMMunicate:BB<hw>:QSFP:NETWork[:IPADdress]:SUBNet:MASK <SubnetMask>

Sets the subnet mask.

Parameters:

<SubnetMask> String

Example: See Example "Configuring the QSFP+ network" on page 36.

Manual operation: See "Subnet Mask" on page 26

:SYSTem:COMMunicate:BB<hw>:QSFP:NETWork:MACaddress?

Queries the MAC address of the network adapter.

This is a password-protected function. Unlock the protection level 1 to access it, see `:SYSTem:PROTect<ch>[:STATe]` in the R&S SMW200A user manual.

Return values:

<MacAddress> string

Example: See Example "Configuring the QSFP+ network" on page 36.

Usage: Query only

Manual operation: See "MAC Address" on page 26

:SYSTem:COMMunicate:BB<hw>:QSFP:NETWork:PROTocol <Protocol>

Displays the communication protocol for the network traffic.

Parameters:

<Protocol> UDP

*RST: n.a. (factory preset: UDP)

Example: See Example "Configuring the QSFP+ network" on page 36.

Manual operation: See "Protocol" on page 26

:SYSTem:COMMunicate:BB<hw>:QSFP:NETWork:PORT <PortNumber>

Sets the port address used for network traffic.

Parameters:

<PortNumber> integer

Range: 0 to 65536

*RST: n.a. (factory preset: 49152)

Example: See Example "Configuring the QSFP+ network" on page 36.

Manual operation: See "UDP Port" on page 26

6.4 R&S I/Q Player commands

This section lists all commands to control the R&S I/Q Player at the host PC remotely via SCPI commands.

Example: Using the R&S I/Q player

```
// Query the name of the host PC and the SCPI port.
*IDN?
// Response: "MyPC:5030"
// Load the streaming configuration file.
:IQPLayer:CONFig:LOAD "Streaming_Configuration.txt"
// Load the waveform file.
:IQPLayer:WAVeform:LOAD "my_waveform.wv"
// Start waveform play.
:IQPLayer:STATe STARt
```

Commands:

***IDN?**

Queries the network endpoint information that is the name of the host PC and its SCPI port.

Return values:

<IdnString>	string String contains the following `<Host_PC_name>:<SCPI_port>`
Example:	See Example "Using the R&S I/Q player" on page 39.
Usage:	Query only
Manual operation:	See "<Host_PC_name>:<SCPI_port>" on page 18

:IQPLayer:CONFig:LOAD <Filename>

Loads the streaming configuration file of the I/Q player.

Setting parameters:

<Filename>	string
Example:	See Example "Using the R&S I/Q player" on page 39.
Manual operation:	See "Configuration" on page 17

:IQPLayer:WAVeform:LOAD <Filename>

Loads the waveform file to play at the I/Q player.

Setting parameters:

<Filename>	string
Example:	See Example "Using the R&S I/Q player" on page 39.
Manual operation:	See ".wv file" on page 17

:IQPLayer:STATe <IqPlayState>

Starts, stops, pauses or continues playing of the waveform file at the I/Q player.

Setting parameters:

<IqPlayState>	STARt | STOP | PAUSe | CONTinue
Example:	See Example "Using the R&S I/Q player" on page 39.
Manual operation:	See "Play/Pause/Continue/Stop" on page 18

6.5 Trigger, marker and clock commands

For trigger, marker and clock commands, see the corresponding subsections of this section "SOURce:BB:ARBitrary subsystem" in the R&S SMW200A user manual.

List of commands

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