R&S®SMW-K141/-K177
IEEE 802.11ad/ay
User Manual

1178260902
Version 14

ROHDE&SCHWARZ
Make ideas real

This document describes the following software options:

- R&S®SMW-K141 IEEE 802.11ad (1413.1333.xx)
- R&S®SMW-K177 IEEE 802.11ay (1434.8191.xx)

This manual describes firmware version FW 5.30.047.xx and later of the R&S®SMW200A.

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1178.2609.02 | Version 14 | R&S®SMW-K141/-K177

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

Contents

1 Welcome to the IEEE 802.11ad/ay options

The options R&S SMW-K141 and R&S SMW-K177 are firmware applications that add functionality to generate signals in accordance with the wireless LAN standards IEEE 802.11ad and IEEE 802.11ay.

R&S SMW-K141 key features

- Support of directional multi-Gigabit (DMG) Single Carrier (SC) PHY
- Configurable PPDU with the support of all modulation and coding schemes
- Configurable MAC header and FCS

R&S SMW-K177 key features

- Support of Enhanced directional multi-Gigabit (EDMG) Single Carrier (SC) PHY:
  - EDMG SC 2.16 GHz PPDU with modulation and coding schemes (MCS) 1 to 21 (transmit and receive)
  - EDMG SC 4.32 GHz PPDU with MCS 1 to 21 (transmit and receive)
- Single spatial stream (transmit and receive) in all channel widths that the EDMG STA supports
- Short, normal and long guard interval

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 Accessing the IEEE 802.11ad/ay dialog

To open the dialog with IEEE 802.11ad/ay settings

► In the block diagram, select "Baseband" > "IEEE 802.11ad/ay".

A dialog box opens that displays the provided general settings.

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

1.2 What's new

This manual describes firmware version FW 5.30.047.xx and later of the R&S®SMW200A.

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

- Time-based triggering, see "Time Based Trigger" on page 64 and "Trigger Time" on page 64.
- Editorial changes

1.3 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

1.3.1 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.

1.3.2 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 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.

1.3.3 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.

1.3.4 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 SMW 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 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

1.3.8 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

1.3.9 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

1.3.10 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

1.4 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 SMW 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 IEEE 802.11ad/ay options

The IEEE 802.11ad/ay options enable you to create signals according to the WLAN standards IEEE Std 802.11ad™-2012 and IEEE Std 802.11ay™-2021. This section lists required options and provides background information on IEEE 802.11ad/ay WLAN technology for signal generation on the R&S SMW.

You can find a more detailed description of the technology in 1MA220, from which parts of this description were taken.

2.1 Required options

Test setup with single R&S SMW instrument

The basic equipment layout for generating IEEE 802.11ad/ay signals with up to 2 GHz RF bandwidth includes the following options:

- Wideband baseband generator (R&S SMW-B9)
- Wideband baseband main module (R&S SMW-B13XT)
- RF bandwidth options:
  - Baseband extension to 1 GHz RF (R&S SMW-K525)
  - Baseband extension to 2 GHz RF (R&S SMW-K527)
    Requires option R&S SMW-K525.
- RF frequency 100 kHz to 67 GHz for RF path A (R&S SMW-B1067)
- Digital standard IEEE 802.11ad (R&S SMW-K141), per signal path
- Digital standard IEEE 802.11ay (R&S SMW-K177), per signal path
  Requires option R&S SMW-K141.

Test setup with multiple R&S SMW instruments

The equipment layout for generating IEEE 802.11ay signals with up to 4 GHz RF bandwidth requires multiple R&S SMW instruments equipped with the following options:

- R&S SMW basic equipment per instrument, see "Test setup with single R&S SMW instrument" on page 12.
- Bandwidth Extension (R&S SMW-K555) per instrument
  Requires R&S SMW-K525 and R&S SMW-K527 per instrument. Extends the RF bandwidth to 4 GHz.

Test setup with R&S SMW and I/Q upconverter

Former IEEE 802.11ad test setups with an R&S SMW and an I/Q upconverter include the following options:

- R&S SMW basic equipment, see "Test setup with single R&S SMW instrument" on page 12.
- RF frequency R&S SMW-B1003)

- R&S SZU100A I/Q upconverter with optional equipment:
  - Frequency option 57 GHz to 66 GHz, WR15 (R&S SZU-B1066)
  - Optional USB+IQ cable, combined differential IQ/USB cable (R&S SZU-Z1)
  - Optional, waveguide-coax-adapter WR15-1.85 (R&S WCA70) for cabled test setups
  - Optional, waveguide-to-waveguide adapter WR15, HP/A compatible (as test port saver)

You can generate signals via play-back of waveform files at the signal generator. To create the waveform file using R&S WinIQSIM2, you do not need a specific option.

To play back the waveform file at the signal generator, you have two options:

- Install the R&S WinIQSIM2 option of the digital standard, e.g. R&S SMW-K255 for playing LTE waveforms
- If supported, install the real-time option of the digital standard, e.g. R&S SMW-K55 for playing LTE waveforms

For more information, see data sheet.

2.2 About IEEE 802.11ad

This chapter provides basic information of the IEEE 802.11ad technology. For related information and further reading, see IEEE Std 802.11ad™-2012 standard specification.

Directional multi-gigabit (DMG) PHY modes

The R&S SMW-K141 option supports two modulation modes:

- DMG control PHY, see Chapter 2.2.1, "DMG control PHY mode", on page 14.
- DMG single carrier (SC) PHY, see Chapter 2.2.2, "DMG SC PHY", on page 14.
- DMG OFDM PHY is not supported.

All DMG PHYs use the same PPDU format, but they differ in how the individual fields are defined as well as in the coding and modulation that is used.

DMG PPDU format

Figure 2-1: DMG PPDU format

The DMG PPDU consists of the following common parts:

- Preamble
  The preamble consists of the short training field (STF) and the channel estimation (CE) field. It is required in every packet. It supports the receiver during automatic gain control (AGC), when recognizing the packet and estimating the frequency offset. The receiver can also use the known CE field to estimate the channel.

- Header
  The header is different for every PHY and contains additional important information for the receiver, such as the modulation mode (MCS), the length of the data field or a checksum.
- Data
  This part is used to transmit the actual data with different modulations (MCS). The length of the field varies (number of bytes/octets).
- Training for beamforming (TRN)
  An optional field that includes beamforming information and can be appended to all packets.

2.2.1 DMG control PHY mode

The control mode is used to exchange signaling and/or control messages to establish and monitor connections between the various devices. Support for this mode is therefore mandatory for all devices.

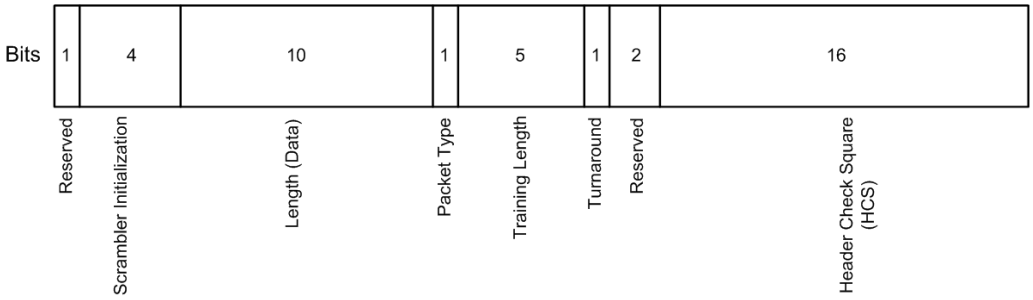


Figure 2-2: Control packet header

The control header is 40 bits long and includes the following fields:

- Scrambler initialization: provides the start point for the scrambler
- Length (data): specifies the length of the data field. For control, the range is 14 octets to 1023 octets.
- Packet type: specifies whether the beamforming training field is intended for the receiver or the transmitter. It carries no information when "Training Length = 0"
- Training length: specifies whether a beamforming training field is used and if so, how long it is
- HCS: provides a checksum per CRC for the header

2.2.2 DMG SC PHY

The single carrier (SC) mode supports data rates from 385 Mbit/s up to 4.620 Gbit/s.

Figure 2-3: Single carrier packet header

The header of the SC PHY mode is 64 bits long and includes the following fields:

- Scrambler initialization: provides the start point for the scrambler
- MCS: displays the modulation and coding scheme used in the data field
- Length (data): specifies the length of the data field. For control, the range is 1 octet to 262143 octets
- Packet type: specifies whether the beamforming training field is intended for the receiver or the transmitter. It carries no information when "Training Length = 0"
- Training length: specifies whether a beamforming training field is used and if so, how long it is
- Tone pairing type: specifies the tone pairing used for MCS13 to 17
- Last RSSI: displays the power level of the last received field
- HCS: provides a checksum per CRC for the header

2.3 About IEEE 802.11ay

This chapter provides basic information of the IEEE 802.11ay technology. For related information and further reading, see IEEE Std 802.11ay™-2021 standard specification.

Enhanced directional multi-gigabit (EDMG) PHY modes

The EDMG PHY modes are EDMG control, EDMG single carrier (SC) and EDMG orthogonal frequency division multiplexing (OFDM) modes. The R&S SMW-K177 option supports EDMG single carrier (SC) PHY, see Chapter 2.3.5, "EDMG and non-EDMG SC mode", on page 23.

The EDMG PHY adds support for multiple space-time streams, downlink multi-user (MU) transmissions and PPDU transmissions with multiple channel bandwidths. These bandwidths include 4.32 GHz, 6.48 GHz, 8.64 GHz, 2.16+2.16 GHz, and 4.32+4.32 GHz.

The channels making up a 2.16+2.16 GHz and 4.32+4.32 GHz PPDU transmission can be contiguous or noncontiguous. The maximum number of spatial streams per STA is eight. An MU PPDU transmission supports up to eight STAs. For

2.16+2.16 GHz and 4.32+4.32 GHz transmissions, the maximum number of spatial streams in each 2.16 GHz channel and 4.32 GHz channel, respectively, is four.

2.3.1 EDMG and non-EDMG format

EDMG PPDU format

All EDMG PHY modes have a single PPDU format. Figure 2-4 shows this EDMG PPDU format and all possible fields. Transmission of these fields depends on the PPDU type (SU PPDU or MU PPDU) or a part of an A-PPDU.

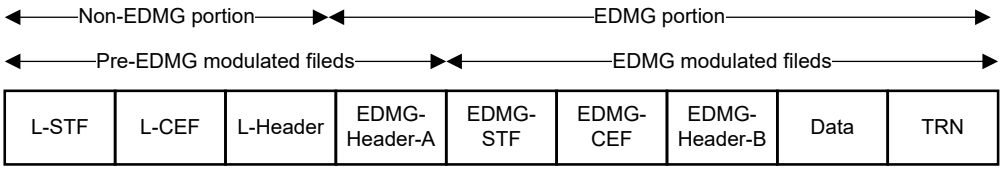


Figure 2-4: EDMG PPDU format

The EDMG PPDU starts with fields that belong to the non-EDMG portion as specified in the DMG PHY specification ("Directional multi-gigabit (DMG) PHY modes" on page 13). The other fields belong to the EDMG portion and are specific to EDMG PPDUs as specified in the EDMG PHY specification. For an overview and further reading, see Table 2-1.

Table 2-1: EDMG PPDU fields

Field	Description	Remark
L-STF	Non-EDMG Short Training field	Defined in chapter "Common Preamble" of the DMG PHY specification.
L-CEF	Non-EDMG Channel Estimation field	Defined in chapter "Common Preamble" of the DMG PHY specification.
L-Header	Non-EDMG Header field	Defined in chapter "Non-EDMG portion of EDMG format preamble" of the EDMG PHY specification.
EDMG-Header-A	EDMG Header A field	Defined in chapter "EDMG portion of EDMG format preamble" of the EDMG PHY specification. Includes two subfields EDMG-Header-A_1 and EDMG-Header-A_2.
EDMG-STF	EDMG Short Training field	Defined in chapter "EDMG portion of EDMG format preamble" of the EDMG PHY specification.
EDMG-CEF	EDMG Channel Estimation field	Defined in chapter "EDMG portion of EDMG format preamble" of the EDMG PHY specification.

Field	Description	Remark
EDMG-Header-B	EDMG Header B field	Defined in chapter "EDMG portion of EDMG format preamble" of the EDMG PHY specification. For EDMG MU PPDUs only.
Data	The Data field carries one or more PSDUs.	Data field content further defined by L-Header field, see Table 2-2.
TRN	Training sequence field	TRN-R (receive) or TRN-T (transmit) subfields

EDMG preamble

Like the EDMG PPDU, the EDMG preamble has a non-EDMG portion and an EDMG portion. For a single PPDU transmission, the fields of the non-EDMG portion and the EDMG-Header-A field of the EDMG portion form the pre-EDMG modulated field, see Figure 2-4. The subsequent fields in the PPDU form the EDMG modulated fields.

For an EDMG A-PPDU transmission, the fields of the non-EDMG portion and the EDMG-Header-A field of the EDMG portion of the first EDMG PPDU form the pre-EDMG modulated fields. Subsequent fields in the EDMG A-PPDU form the EDMG modulated fields. For 4.32 GHz, 6.48 GHz and 8.64 GHz EDMG PPDU transmissions, the pre-EDMG modulated fields are transmitted using the non-EDMG duplicate format.

The pre-EDMG modulated fields of each secondary channel have a relative delay compared to corresponding fields of the primary channel. This delay is between zero (inclusive) and the chip time duration T_c (inclusive). The relative delay of each secondary channel transmission can differ between channels but is maximum T_c.

The L-Header field further defines the content of the Data field. Bit values "B46" and "B37" distinguish if the data is part of a DMG MPDU/A-MPDU or an EDMG MPDU/A-MPDU, see Table 2-2.

Table 2-2: L-Header field values and data field content

B46	B37	Data field content
0	0	DMG MPDU
0	1	DMG A-MPDU
1	0	EDMG MPDU
1	1	EDMG A-MPDU

EDMG-Header-B field

The EDMG-Header-B is transmitted only in EDMG MU PPDUs and on a per STA basis. The EDMG-Header-B field is defined in the table Table 2-3. The value of the Spoofing Error Length Indicator subfield within all EDMG-Header-B fields present in an EDMG MU PPDU is the same. The transmitter sets reserved bits in the EDMG-Header-B field to 0 so that the receiver ignores them.

Table 2-3: EDMG-Header-B field structure and definition

Subfield	N_{bits}	Start bit	Description
Scrambler Seed	7	0	-
PSDU Length	22	7	Length of the PSDU field octets with range 1 to 4194302 (2^{22} - 1).
Base MCS	5	29	Generated from TXVECTOR parameter EDMG_MCS. Indicates the lowest index of the modulation and coding scheme to define the modulation and coding scheme of the spatial streams.
Differential EDMG-MCS	2	34	Generated from TXVECTOR parameter EDMG_MCS. The Base MCS field defines the modulation and coding scheme for the spatial stream 1
Superimposed Code Applied	1	36	Corresponds to TXVECTOR parameter LDPC_SUPERIMPOSED. If the LDPC code rate is 7/8 and this field is set to 0, it indicates puncturing code with codeword length 624 or 1248 is applied. If the LDPC code rate is 7/8 and this field is set to 1, it indicates that superimposed code with codeword length 672 or 1344 is applied. If the EDMG-MCS field indicates a value of 13 and the π/2-8-PSK Applied field is 1, then this field indicates the 7/8 code. This code is employed in the encoding procedure with codeword shortening to achieve the effective code rate of 5/6. In all other cases, this field is reserved.
Short/Long LDPC	1	37	Corresponds to the TXVECTOR parameter LDPC_CW_LENGTH. Indicates the LDPC codeword length used in the PSDU. Set to 0 for LDPC codeword of length 672, 624, 504, or 468. Set to 1 for LDPC codeword of length 1344, 1248, 1008, or 936.
STBC Applied	1	38	Corresponds to the TXVECTOR parameter STBC. If set to 1, indicates that STBC was applied at the transmitter. Otherwise, set to 0. If set to 1, the DCM BPSK Applied and the Phase Hopping fields are set to 0.
NUC Applied	1	39	Corresponds to the TXVECTOR parameter NUC_MOD. If this field is set to 1, π/2-64-NUC is applied at the transmitter for the MCSs indicated by the Base MCS and Differential EDMG-MCS fields, if supported. If an indicated MCS does not support π/2-64-NUC, then π/2-64-QAM uniform constellation is applied for this particular MCS. If set to 0, π/2-64-QAM uniform constellation is applied for MCSs signaled in the Base MCS and Differential EDMG-MCS fields.
π/2-8-PSK Applied	1	40	Corresponds to TXVECTOR parameter PSK_APPLIED. If this field is set to 1, π/2-8-PSK with corresponding LDPC shortening code with rates 2/3 or 5/6 is applied at the transmitter for MCS 12 or 13. The EDMG-MCS field indicates the MCS. If set to 0, π/2-16-QAM constellation with regular LDPC code with rates 1/2 or 5/8 is applied at the transmitter for MCS 12 or 13.

Subfield	N_{bits}	Start bit	Description
Spoofing Error Length Indicator	1	41	If set to 0 in an EDMG OFDM PPDU, indicates that the spoofing error is smaller than $T_{OFDM-SYM}$. This error is defined as the difference between the PPDU duration based on L-Header and the actual PPDU duration. $T_{OFDM-SYM} = T_{DFT} + T_{GI}$, T_{DFT} is the OFDM IDFT/DFT period and T_{GI} is the guard interval duration. The durations are determined by bits B2 and B3 of the Last RSSI field within the L-Header of the PPDU. Otherwise, if set to 1 in an EDMG OFDM PPDU, indicates that the spoofing error is greater than or equal to $T_{OFDM-SYM}$. For an EDMG SC PPDU, this field is reserved.
Beamformed	1	42	Corresponds to the TXVECTOR parameter BEAMFORMED. If set to 1, indicates active digital beamforming. Set to 0 otherwise.
Number of Transmit Chains	3	43	Corresponds to TXVECTOR parameter NUM_TX_CHAINS. The value of this field plus 1 indicates the number of transmit chains used in the transmission of the PPDU. The value of the field plus 1 also indicates the total number of orthogonal sequences in a TRN field. This field is reserved when the EDMG TRN Length field is 0, or when the EDMG Beam Tracking Request field is 1 and the PPDU is an EDMG BRP-RX PPDU.
Reserved	2	46	-
CRC	16	48	Header check sequence. Calculation of the header check sequence is defined in 20.3.7.

EDMG A-PPDU format

An EDMG A-PPDU is a concatenation of EDMG PPDUs and is available for single users (SU MPDU) only. Figure 2-5 shows the EDMG A-PPDU format and all possible fields.

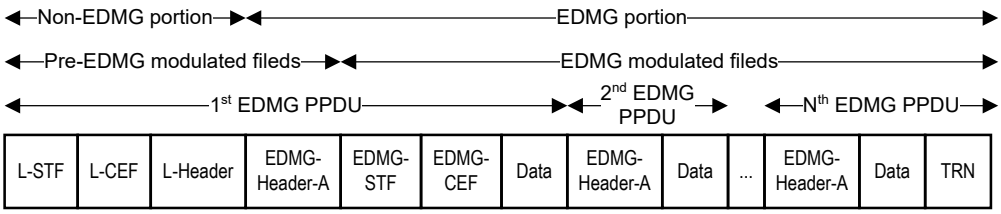


Figure 2-5: EDMG A-PPDU format

The first PPDU ("1st EDMG PPDU") includes the fields L-STF, L-CEF, L-Header, EDMG-Header-A, EDMG-STF, EDMG-CEF, and Data. Each subsequent PPDU includes EDMG-Header-A and Data fields only. The TRN field, if present, is appended only once at the end of an EDMG A-PPDU.

Transmission of these fields within an EDMG A-PPDU depends on the values of N_{CB} (number of contiguous 2.16 GHz channels) and N_{STS} (number of space-time streams

reported). The EDMG-Header-A field preceding a Data field defines the parameters of the PSDU transmitted in the Data field.

2.3.2 Channelization

EDMG stations (STAs) use the channelization as in Figure 2-6.

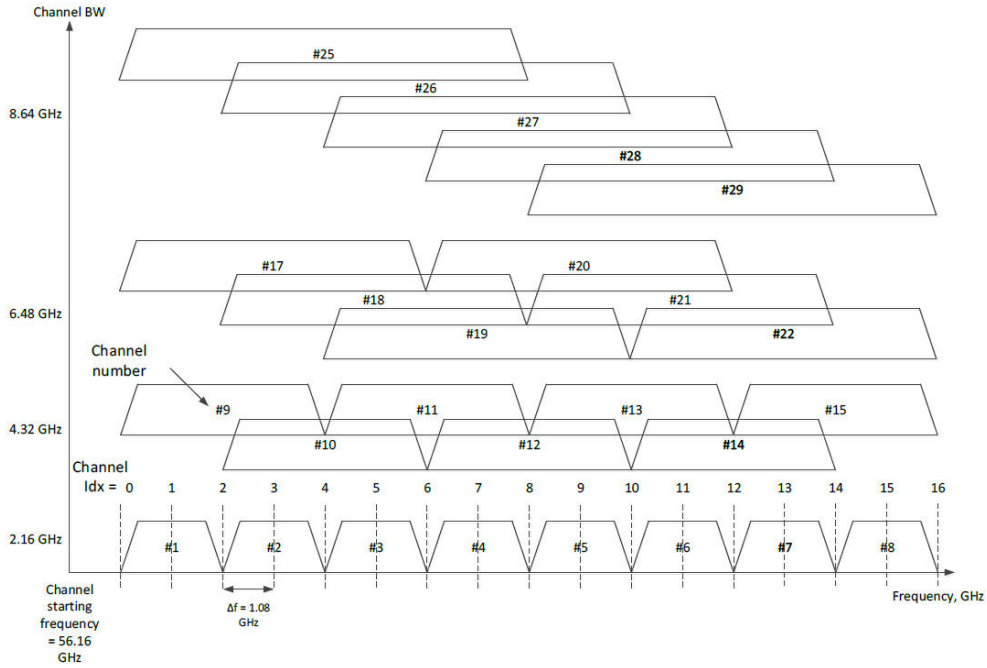


Figure 2-6: EDMG STA channelization

The center of the trapezoid shows the channel number defining the particular channel location. The support of the 2.16 GHz channel number 2, and the 4.32 GHz channel number 10 with channel number 2 as a primary channel is mandatory. The support of other channels is optional.

2.3.3 MIMO and beamforming

SU-MIMO beamforming

An EDMG STA is SU-MIMO capable if the SU-MIMO Supported subfield of the Beamforming Capability subelement in the EDMG Capabilities element of the STA is 1. The SU-MIMO beamforming protocol supports beamforming training for subsequent transmission and reception of multiple spatial streams between an SU-MIMO capable initiator and an SU-MIMO capable responder.

The SU-MIMO beamforming protocol enables the determination of transmit antenna settings and the corresponding receive antenna settings. Determination is for simultaneous transmission of multiple spatial streams from the initiator to the responder or

vice versa. You can also use the SU-MIMO beamforming protocol to enable transmit beamforming and receive beamforming operation. The beamforming operation is between the initiator and the responder.

During beamforming operation, a single spatial stream is transmitted through multiple DMG antennas using the determined transmit antenna settings. This single spatial stream is received through multiple DMG antennas using the determined corresponding receive antenna settings.

MU-MIMO beamforming

An EDMG STA is MU-MIMO capable if the MU-MIMO Supported subfield of the Beamforming Capability subelement in the EDMG Capabilities element of the STA is 1.

The MU-MIMO beamforming protocol enables an MU-MIMO capable initiator and one or more MU-MIMO capable responders in an MU group to establish an antenna configuration. This configuration allows the initiator to transmit an EDMG MU PPDU to the responders in the MU group.

During transmission, the mutual interference among the streams transmitted in the MU PPDU is minimized. In this context, the method of minimizing interference is implementation-dependent. Within a time division duplex (TDD) service period (SP), MU-MIMO beamforming is not allowed.

2.3.4 EDMG and non-EDMG control mode

Transmission and reception of 2.16 GHz PPDU using EDMG and non-EDMG control mode and 4.32 GHz PPDU using EDMG duplicate and non-EDMG duplicate control mode is mandatory.

Transmission and reception of a 2.16+2.16 GHz PPDU using EDMG and non-EDMG control mode is optional. Transmission and reception of a 6.48 GHz PPDU, 8.64 GHz PPDU, and 4.32+4.32 GHz PPDU using EDMG duplicate and non-EDMG duplicate control mode is optional.

Transmitter block diagrams

This section provides transmitter block diagrams for non-EDMG control mode (Figure 2-7) and EDMG control modes (Figure 2-8). Both the non-EDMG and EDMG control mode PPDUs are transmitted using MCS 0 and EDMG-MCS 0 modulation and coding schemes.

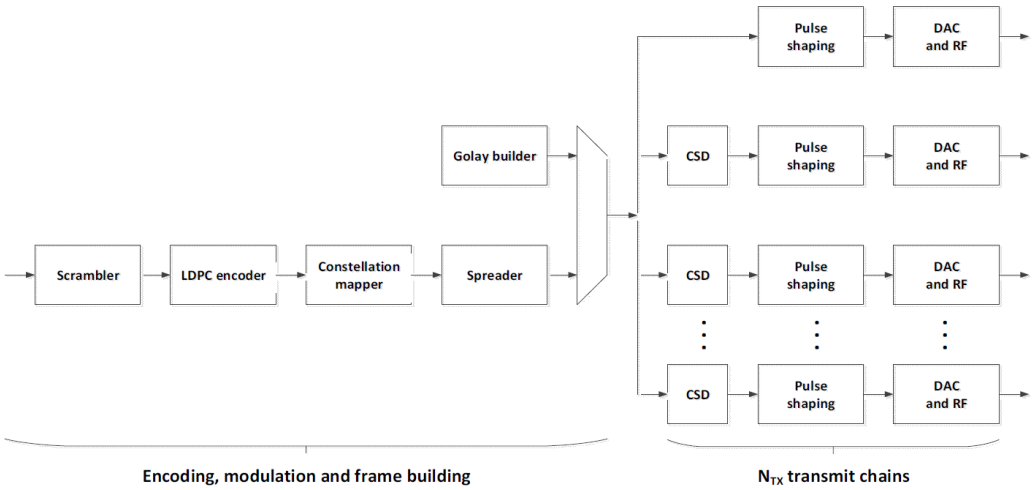


Figure 2-7: Non-EDMG PPDU transmission

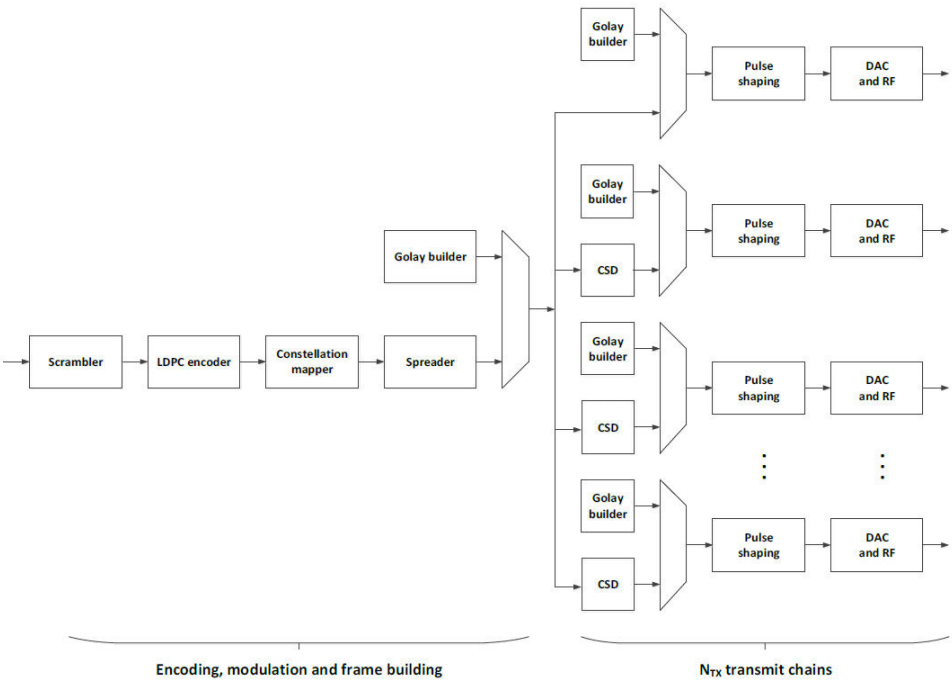


Figure 2-8: EDMG PPDU transmission

You can generate EDMG and non-EDMG control mode PPDU transmissions using a transmitter consisting of the following blocks:

- Scrambler scrambles the data to reduce the probability of long sequences of 0s and 1s.
- LDPC encoder encodes the data to enable error correction.
- Constellation mapper maps the sequence of bits to constellation points.
- Spreader spreads out a single constellation point to 32 chips applying the Ga Golay sequence of 4 length 32.

- Preamble builder builds π/2-BPSK modulated Ga and Gb Golay sequences comprising the L-STF, L-CEF, and TRN units.
- Cyclic shift diversity (CSD) prevents the signal from unintentional beamforming. CSD is specified per transmitter chain for EDMG and non-EDMG duplicate PPDU transmissions.
- Pulse shaping performs convolution of constellation points with shape filter impulse response with possible sampling rate change. For duplicate transmissions, pulse shaping can include a relative time delay between the primary and secondary channels. The exact definition of shape filter impulse response is implementation-dependent.

2.3.5 EDMG and non-EDMG SC mode

Transmission and reception of the following EDMG and non-EDMG single carrier (SC) modes are mandatory:

- 2.16 GHz SU PPDU using the EDMG SC mode MCS 1 to 5 and MCS 7 to 10 with single spatial stream
- 2.16 GHz PPDU using the non-EDMG SC mode MCS 1 to 4
- 4.32 GHz SU PPDU using the EDMG SC mode MCS 1 to 5 and MCS 7 to 10 with single spatial stream
- 4.32 GHz PPDU using the non-EDMG duplicate SC mode MCS 1 to 4

Transmission and reception of all other modes are optional.

Timing-related parameters

The table below provides an overview on timing-related parameters.

- N_{SPB}: number of symbols per SC symbol block
- N_{GI}: guard internal length for short, normal and long guard intervals
- F_c and $F_{c\ EDMG}$: DMG SC chip rate and EDMG SC chip rate
- T_c and $T_{c\ EDMG}$: DMG SC chip time duration and EDMG SC chip time duration
- N_{DFT}: DFT size
- T_{DFT}: SC IDFT/DFT period
- T_{GI}: guard internal duration for short, normal and long guard intervals

Parameter	N_{CB} = 1	N_{CB} = 2	N_{CB} = 3	N_{CB} = 4
N_{SPB} short GI	480	960	1440	1920
N_{SPB} normal GI	448	896	1344	1792
N_{SPB} long GI	384	768	1152	1536
$N_{GI\ short}$	32	64	96	128
$N_{GI\ normal}$	64	128	192	256
$N_{GI\ long}$	128	256	384	512

Parameter	N_{CB} = 1	N_{CB} = 2	N_{CB} = 3	N_{CB} = 4
F_c	1.76 GHz	1.76 GHz	1.76 GHz	1.76 GHz
$F_{c\ EDMG}$	1.76 GHz	3.53 GHz	5.28 GHz	7.04 GHz
T_c	0.57 ns	0.57 ns	0.57 ns	0.57 ns
$T_{c\ EDMG}$	0.57 ns	0.28 ns	0.19 ns	0.14 ns
N_{DFT}	512	1024	1536	2048
T_{DFT}	0.291 µs	0.291 µs	0.291 µs	0.291 µs
$T_{GI\ short}$	18.18 ns	18.18 ns	18.18 ns	18.18 ns
$T_{GI\ normal}$	36.36 ns	36.36 ns	36.36 ns	36.36 ns
$T_{GI\ long}$	72.72 ns	72.72 ns	72.72 ns	72.72 ns

Transmitter block diagrams

This section provides single carrier mode transmitter block diagrams for non-EDMG PPDU transmission (Figure 2-9), EDMG modulated fields of an SU PPDU transmission (Figure 2-10) and EDMG modulated fields of an MU PPDU transmission (Figure 2-11).

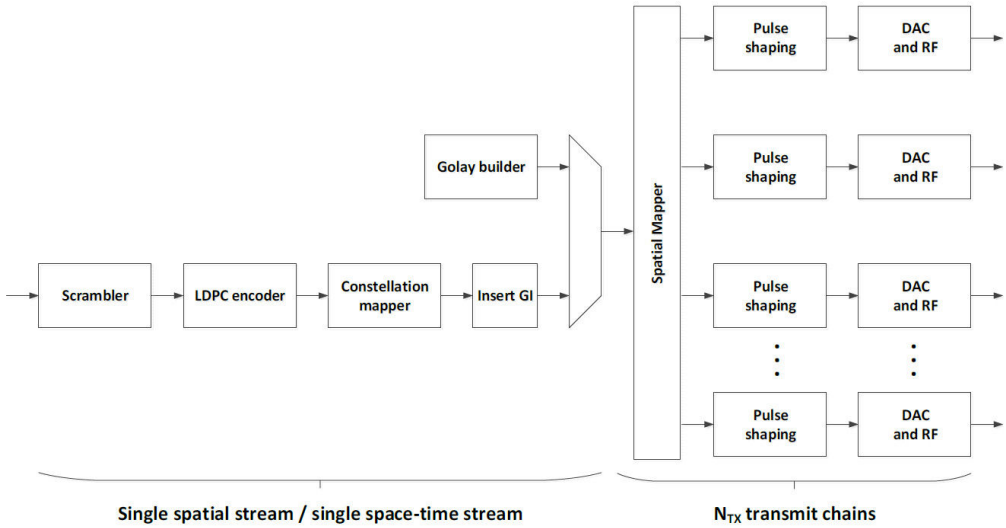


Figure 2-9: Non-EDMG SC PPDU transmission

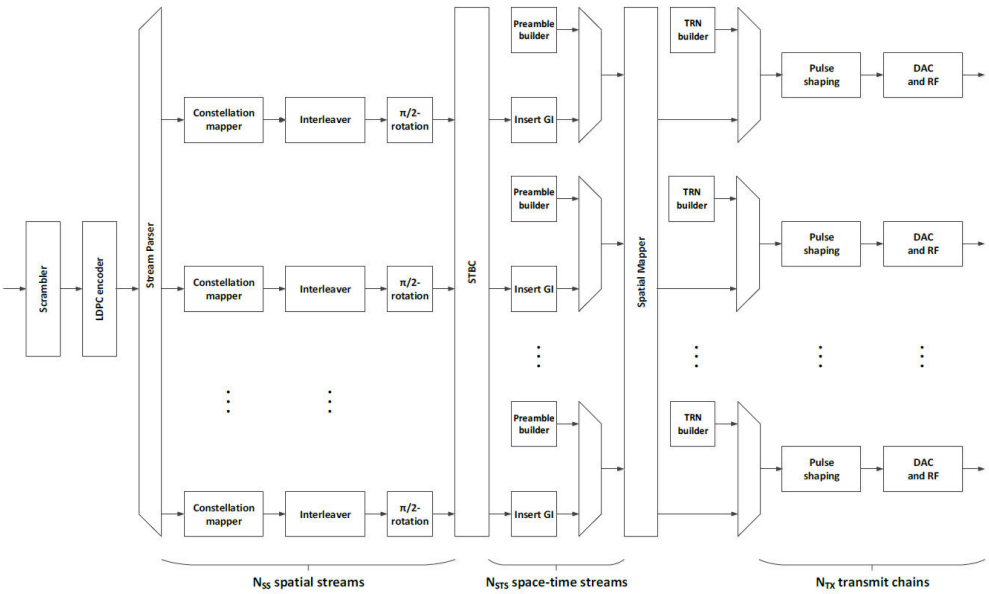


Figure 2-10: EDMG SC SU PPDU transmission

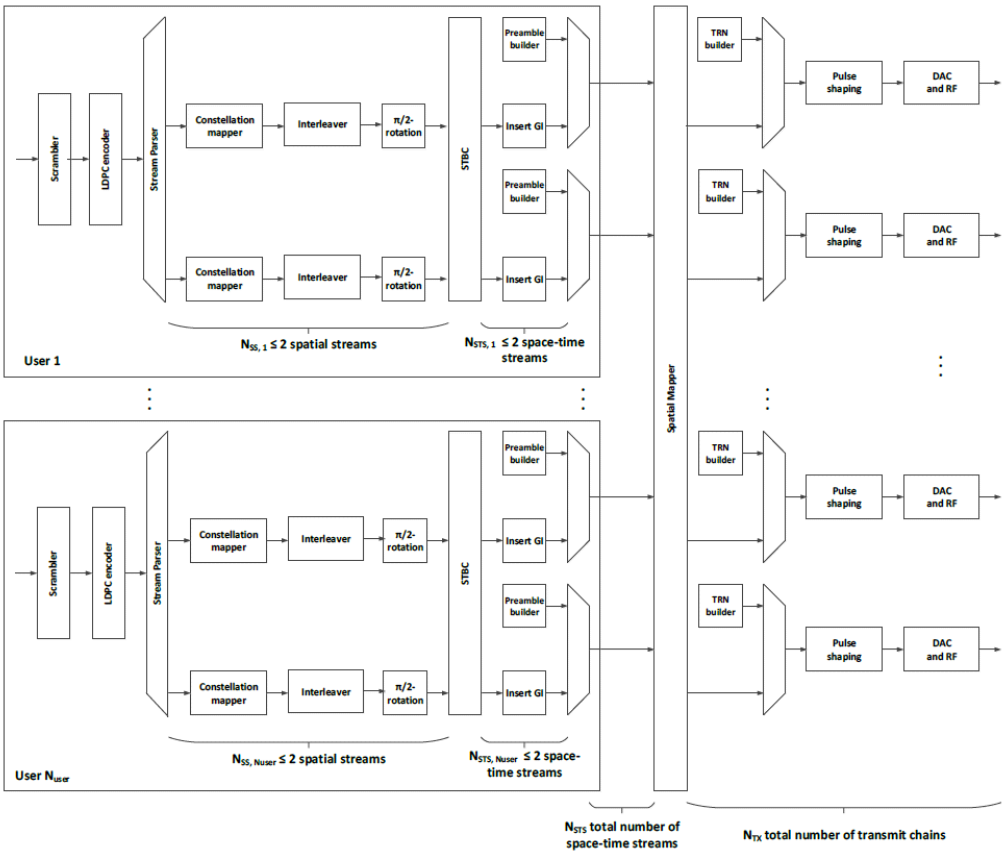


Figure 2-11: EDMG SC MU PPDU transmission

You can generate EDMG and non-EDMG SC PPDU transmissions using a transmitter consisting of the following blocks:

- Scrambler scrambles the data to reduce the probability of long sequences of 0s and 1s.
- LDPC encoder encodes the data to enable error correction. It pads the data with 0s to get an integer number of codewords and SC symbol blocks.
- Stream parser divides the output of the LDPC encoder into the groups of bits that are sent to different mapping devices. The sequence of the bits sent to different mapping devices is called a spatial stream
- Constellation mapper and π/2-rotation block map the sequence of bits in each spatial stream to constellation points (complex numbers).
- Interleaver performs interleaving inside an SC symbol block.
- STBC encoder spreads constellation points from N_{SS} spatial streams into N_{STS} space-time streams using a space-time block code. SC mode defines STBC schemes with $N_{STS} = 2 \times N_{SS}$.
- GI insertion prepends the SC symbol block with guard interval defined as a π/2-BPSK modulated Golay sequence.
- Preamble builder builds π/2-BPSK modulated Ga and Gb Golay sequences comprising the L-STF, L-CEF, EDMG-STF, and EDMG-CEF fields.
- Spatial mapper maps space-time streams to transmit chains. Mapping can include one of the following:
  - Direct mapping: constellation points from each space-time stream are mapped directly to the transmit chains.
  - Indirect mapping: constellation points from each space-time stream are mapped to each transmit chain.
  - Digital beamforming: each vector of constellation points from all the space-time streams is multiplied by a matrix of steering vectors to produce the input to the transmit chains.
- Cyclic shift diversity (CSD) prevents the signal transmission from unintentional beamforming. A cyclic shift is specified per transmitter chain for non-EDMG duplicate PPDU transmission.
- Pulse shaping performs convolution of constellation points with shape filter impulse response with possible sampling rate change. For duplicate channel transmission, pulse shaping can include a relative time delay between the primary and secondary channels. The exact definition of shape filter impulse 36 response is out of scope of this standard and is implementation-specific.

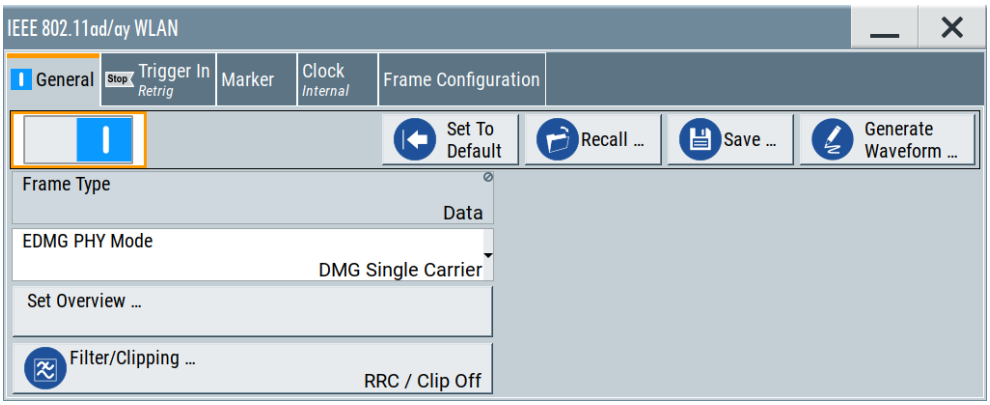
3 802.11ad/ay common settings

This chapter provides a description of settings that are common to 802.11ad and 802.11ay configuration.

3.1 General settings

Access:

► Select "IEEE 802.11ad/ay" > "General".



This tab provides settings to call the default settings, to save and recall settings, to check the frame type and to access further settings.

Settings:

State

Activates the IEEE 802.11ad/ay standard and deactivates all the other digital standards and digital modulation modes in the same baseband.

Remote command:
`[:SOURce<hw>]:BB:WLAD:STATe` on page 75

Set to Default
Calls the default settings. The values of the main parameters are listed in the following table.

Parameter	Value
"State"	Not affected by the "Set to Default"
"Frame Type"	"Data"
"DMG PHY Mode"	"Single Carrier"
"Filter"	"Cosine"
"Clipping"	Off
"Sequence Length"	"1 Frame"
"Idle Time"	0.001 ms
"MCS"	1

Remote command:
`[:SOURce<hw>]:BB:WLAD:PRESet` on page 74

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

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

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

Remote command:
`[:SOURce<hw>]:BB:WLAD:SETTing:CATalog?` on page 74
`[:SOURce<hw>]:BB:WLAD:SETTing:DELete` on page 74
`[:SOURce<hw>]:BB:WLAD:SETTing:LOAD` on page 74
`[:SOURce<hw>]:BB:WLAD:SETTing:STORe` on page 75

Generate Waveform File
With enabled signal generation, triggers the instrument to save the current settings of an arbitrary waveform signal in a waveform file with predefined extension `*.wv`. You can define the filename and the directory, in that you want to save the file.

Using the ARB modulation source, you can play back waveform files and/or process the file to generate multi-carrier or multi-segment signals.

Remote command:
`[:SOURce<hw>]:BB:WLAD:WAVeform:CREate` on page 75

Frame Type
Displays the frame type. All frames are data frames.

Remote command:
`[:SOURce<hw>]:BB:WLAD:FTYPe` on page 73

DMG PHY Mode/EDMG PHY Mode
Selects the DMG or EDMG physical layer (PHY) mode.

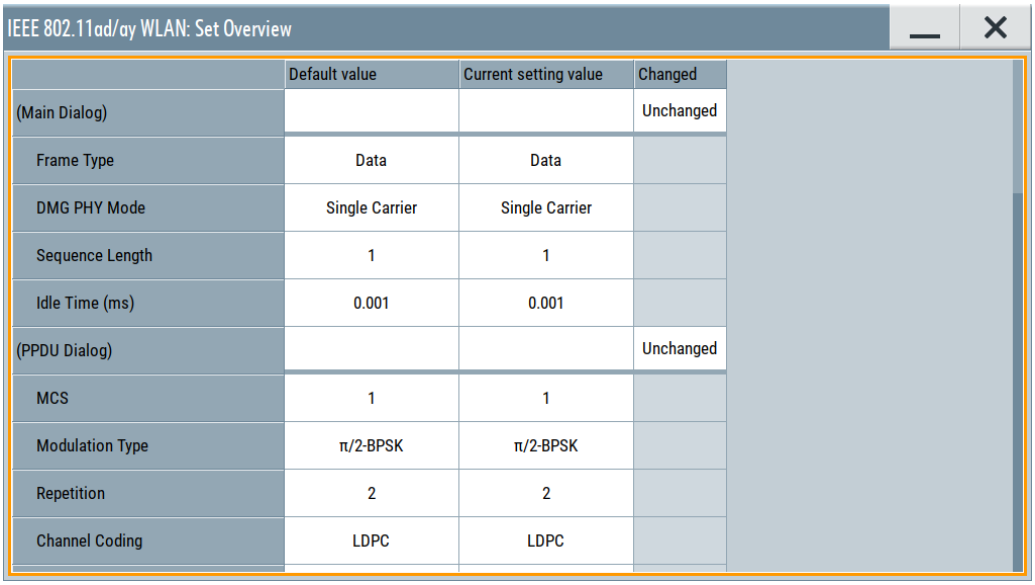
"DMG Control" DMG control PHY mode

"DMG Single Carrier"
DMG single carrier (SC) PHY mode

"EDMG Single Carrier"
EDMG single carrier (SC) PHY mode

Remote command:
`[:SOURce<hw>]:BB:WLAD:DPMode` on page 73

Set Overview
Accesses the "Set Overview" dialog. The dialog provides a comprehensive list of IEEE 802.11ad/ay settings in a table. For parameters, it displays the default value, current values and indicates changes to the default setting of the parameter.



	Default value	Current setting value	Changed
(Main Dialog)			Unchanged
Frame Type	Data	Data	
DMG PHY Mode	Single Carrier	Single Carrier	
Sequence Length	1	1	
Idle Time (ms)	0.001	0.001	
(PPDU Dialog)			Unchanged
MCS	1	1	
Modulation Type	π/2-BPSK	π/2-BPSK	
Repetition	2	2	
Channel Coding	LDPC	LDPC	

The columns of the table are as follows:

Dialog or parameter
Lists all IEEE 802.11ad/ay parameters separated for each settings dialog.

"Default value" Lists the default values of the IEEE 802.11ad/ay parameter.

"Current setting value"
Lists the current value of the IEEE 802.11ad/ay parameter.

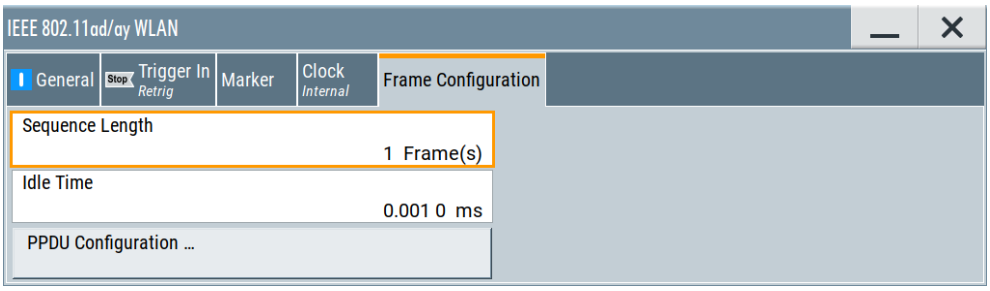
"Changed" Indicates deviations from the default value with the icon ⚠. If there are no changes, the field is empty. For table rows that denote a dialog name the field displays "Unchanged".

Filter/Clipping
Accesses the dialog for setting baseband filtering and clipping, see Chapter 6.1, "Filter/clipping settings", on page 59.

3.2 Frame configuration

Access:

► Select "IEEE 802.11ad/ay" > "Frame Configuration".



The dialog provides settings to configure the frame parameters.

Settings:

Sequence Length
Sets the sequence length.

The maximum sequence length depends on the selected "DMG PHY mode", configured frame length and available ARB waveform memory depending on the installed memory option.

Remote command:
`[:SOURce<hw>]:BB:WLAD:SLENgth` on page 91

Idle Time
Sets the idle time, the time delay between two frames.

Remote command:
`[:SOURce<hw>]:BB:WLAD:ITIMe` on page 91

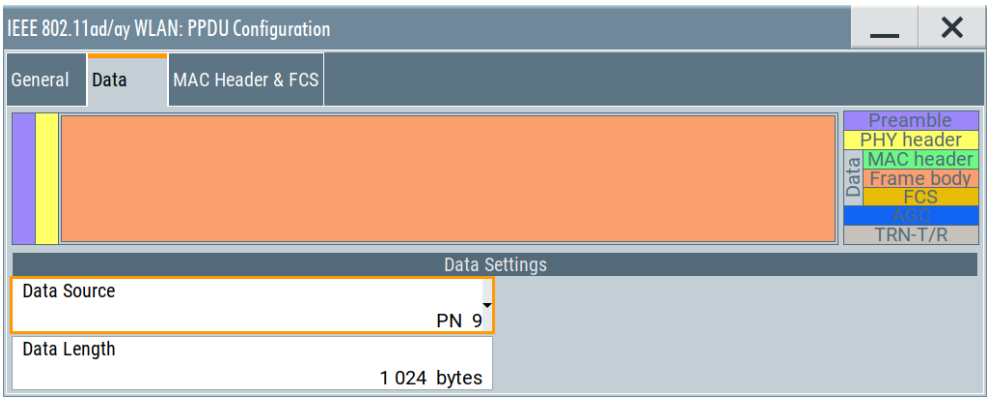
PPDU Configuration
Accesses the dialog for configuring the physical layer protocol data unit (PPDU). The PPDU configuration differs between the PHY formats:

- DMG format PPDU: Chapter 4.1, "PPDU configuration", on page 39
- EDMG format PPDU: Chapter 5.2, "PPDU configuration (frame block 1)", on page 46.

3.3 Data settings

Access:

1. Select "Frame Configuration" > "PPDU Configuration"
2. Select "Data".



The dialog provides configure data settings of a PPDU. These settings are common to 802.11ad and 802.11ay PPDUs.

For header settings, see the following sections:

- For a DMG format, see Chapter 4.1.2, "Header settings", on page 42.
- For an EDMG format, see Chapter 5.2.1, "General settings", on page 46.

Settings:

Data Source

The following standard data sources are available:

- "All 0, All 1"
  An internally generated sequence containing 0 data or 1 data.
- "PNxx"
  An internally generated pseudo-random noise sequence.
- "Pattern"
  An internally generated sequence according to a bit pattern.
  Use the "Pattern" box to define the bit pattern.
- "Data List/Select DList"
  A binary data from a data list, internally or externally generated.
  Select "Select DList" to access the standard "Select List" dialog.
  – Select the "Select Data List > navigate to the list file *.dm_iqd > Select" to select an existing data list.
  – Use the "New" and "Edit" functions to create internally new data list or to edit an existing one.

– Use the standard "File Manager" function to transfer external data lists to the instrument.

See also:
- Section "Modulation Data" in the R&S SMW user manual.
- Section "File and Data Management" in the R&S SMW user manual.
- Section "Data List Editor" in the R&S SMW user manual

Remote command:
`[:SOURce<hw>]:BB:WLAD:PCONfig:DATA` on page 92
`[:SOURce<hw>]:BB:WLAD:PCONfig:DATA:PATTern` on page 93
`[:SOURce<hw>]:BB:WLAD:PCONfig:DATA:DSELection` on page 93

Data Length
DMG format: Sets the size of the data field in bytes.

EDMG format: Sets the length of the data of PLCP service data unit (PSDU).

Remote command:
`[:SOURce<hw>]:BB:WLAD:PCONfig:DATA:LENGth` on page 93

A-MPDU Length
Displays the overall A-MPDU data length in bytes.

This length is the sum of the data lengths of all configured MPDUs.

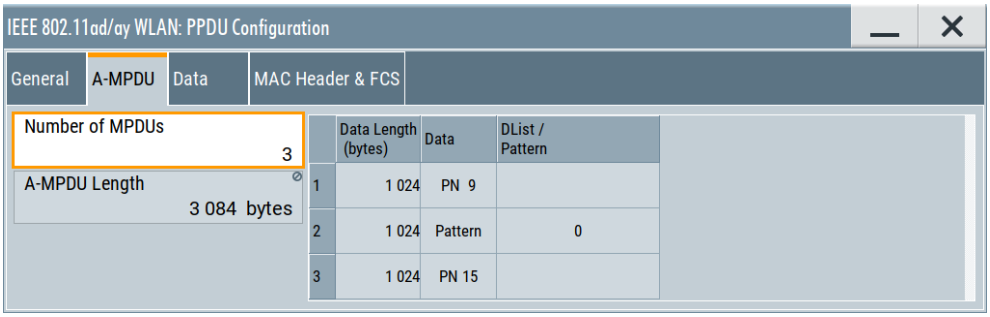
Remote command:
`[:SOURce<hw>]:BB:WLAD:PCONfig:DATA:LENGth` on page 93

3.4 A-MPDU settings

This chapter describes the settings of the aggregate MAC protocol data unit (A-MPDU). For the A-MPDU, multiple MPDUs are joined and sent with a single leading PHY header.

Access:

1. Select "IEEE 802.11ad/ay" > "Frame Configuration" > "PPDU Configuration".
2. Select the "Data" tab.
3. Select "Data Source" > "A-MPDU".
4. Select the "A-MPDU" tab.



The dialog provides settings to configure A-MPDU parameters.

Settings:

Number of MPDUs
Determines the number of MPDUs in the frame.

Remote command:
`[:SOURce<hw>]:BB:WLAD:PCONfig:MPDU:COUNt` on page 97

A-MPDU Length
Displays the overall A-MPDU data length in bytes.

This length is the sum of the data lengths of all configured MPDUs.

Remote command:
`[:SOURce<hw>]:BB:WLAD:PCONfig:DATA:LENGth` on page 93

A-MPDU data settings
Provides A-MPDU data settings in a table.

Each table row provides data length and data source settings for individual MPDUs. The number of table rows equals the number of MPDUs, see "Number of MPDUs" on page 33.

Data Length (bytes)
Displays the data length in bytes for the respective MPDU.

Remote command:
`[:SOURce<hw>]:BB:WLAD:PCONfig:MPDU<st>:DATA:LENGth` on page 97

Data/DList / Pattern
Selects the data source for the respective MPDU.

The following standard data sources are available:
- "All 0, All 1"
  An internally generated sequence containing 0 data or 1 data.
- "PNxx"
  An internally generated pseudo-random noise sequence.
- "Pattern"
  An internally generated sequence according to a bit pattern.
  Use the "Pattern" box to define the bit pattern.
- "Data List/Select DList"
  A binary data from a data list, internally or externally generated.
  Select "Select DList" to access the standard "Select List" dialog.
  – Select the "Select Data List > navigate to the list file *.dm_iqd > Select" to select an existing data list.

– Use the "New" and "Edit" functions to create internally new data list or to edit an existing one.
– Use the standard "File Manager" function to transfer external data lists to the instrument.

See also:
- Section "Modulation Data" in the R&S SMW user manual.
- Section "File and Data Management" in the R&S SMW user manual.
- Section "Data List Editor" in the R&S SMW user manual

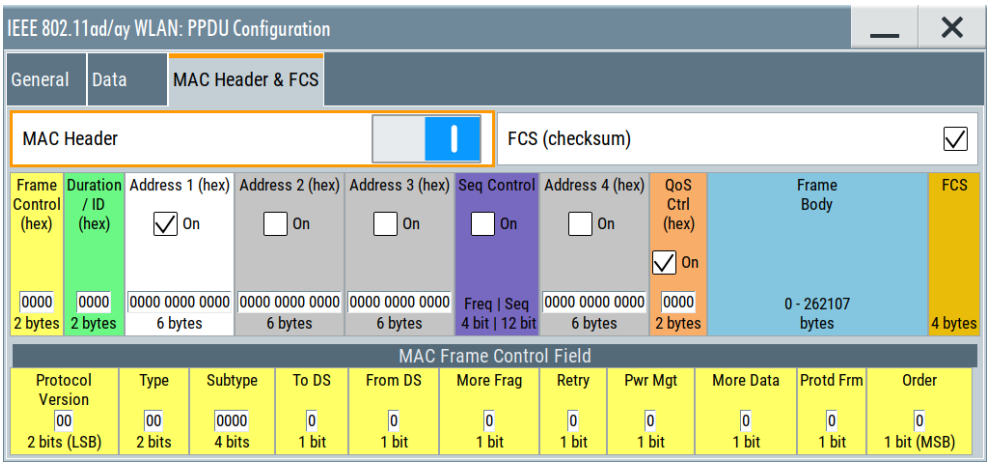
Remote command:
`[:SOURce<hw>]:BB:WLAD:PCONfig:MPDU<st>:DATA:SOURce` on page 98
`[:SOURce<hw>]:BB:WLAD:PCONfig:MPDU<st>:DATA:DSELection` on page 97
`[:SOURce<hw>]:BB:WLAD:PCONfig:MPDU<st>:DATA:PATTern` on page 98

3.5 MAC header and FCS settings

In the real IEEE 802.11 system, a MAC (medium access control) header is transmitted in the PPDU before the actual data section. This header comprises the control information of the MAC layer. It is also possible to protect the PPDU by a frame checksum. These two functions can be controlled in the dialog.

Access:

1. Select "IEEE 802.11ad/ay" > "Frame Configuration".
2. Select "Frame Configuration" > "PPDU Configuration".
3. Select "PPDU Configuration" > "MAC Header & FCS".



The dialog provides settings to configure the MAC header and the MAC frame control field.

Settings:

MAC Header

Activates the generation of the MAC header for the PPDU. If the MAC header is activated, all MAC header fields are enabled for operation.

The individual fields of the MAC header are described in the following.

All values of the MAC fields (except addresses) are entered in hexadecimal form with least significant bit (LSB) in right notation. In the data stream, the values are output standard-conformal with the LSB coming first.

Remote command:
`[:SOURce<hw>]:BB:WLAD:PCONfig:MAC:STATe` on page 102

FCS (checksum)

Activates/deactivates the calculation of the FCS (frame check sequence).

Remote command:
`[:SOURce<hw>]:BB:WLAD:PCONfig:MAC:FCS:STATe` on page 100

Duration Id

Enters the value of the duration ID field.

Depending on the frame type, the 2-byte duration ID field is used:

- To transmit the association identity of the station transmitting the frame
- To indicate the duration assigned to the frame type.

Remote command:
`[:SOURce<hw>]:BB:WLAD:PCONfig:MAC:DID` on page 99

MAC Address

Enters the value of the address fields 1 to 4.

The MAC header can contain up to four address fields, but you do not need all addresses. Each of the four address fields can be activated or deactivated. The fields are used for transmitting the basic service set identifier, the destination address, the source address, the receiver address and the transmitter address. Each address is 6 bytes (48 bit) long. The addresses can be entered in hexadecimal form in the entry field of each address field. The LSB is in left notation.

Remote command:
`[:SOURce<hw>]:BB:WLAD:PCONfig:MAC:ADDRess<st>:STATe` on page 99

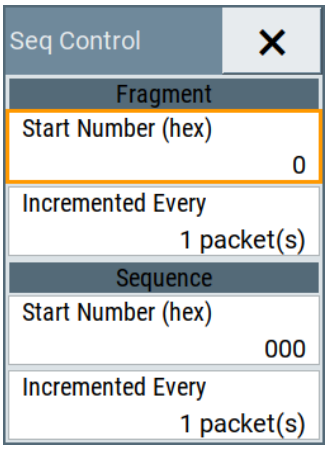
Sequence Control
Activates the sequence control field.

The sequence control field has a length of 2 bytes and is divided in two parts, the fragment number (4 bits) and the sequence number (12 bits) field. A long user data stream to be transmitted is first split up into MAC service data units (MSDU). The data units can either be transmitted as PSDU frames or further divided into fragments. The sequence number and the fragment number are then used to number the individual subpackets of the user data stream to be transmitted. Thus, all PSDUs are assigned a consecutive number. It allows the receiver to arrange the data packets in the correct order, to determine whether an incorrectly transmitted packet was retransmitted and to find out whether packets are missing.

If the receiver can detect a packet without an error and does not request a retransmission, the sequence number is incremented by 1 for each packet. The field is reset to 0 at the latest after a count of 4095. The fragment number field is incremented by 1 when another fragment of the current MPDU is transmitted. The start count for the transmission (normally 0) and the number of packets required to increment the corresponding counter can be defined for both numbers with the parameters "Start Number" and "Incremented every ... packet(s)".

Example:

An error-free transmission of 50 packets (no packet retransmission) is to be simulated. The sequence number must be incremented by 1 for each packet. Since no packet is fragmented, the fragment counter can always remain at 0. In this case the following values have to be set:



E.g., you want to simulate that some packets are received incorrectly, or to test the response of the receiver when the same packet arrives several times. Set the number of packets that are required to increment the sequence number to 2. Each packet is then automatically sent twice (with identical data).

Remote command:
`[:SOURce<hw>]:BB:WLAD:PCONfig:MAC:SCONtrol:STATe` on page 102

Start Number (hex)
Sets the start number of the fragment bits or the sequence bits of the sequence control field in hexadecimal represent.

Remote command:
`[:SOURce<hw>]:BB:WLAD:PCONfig:MAC:SCONtrol:SEQuence:STARt` on page 101
`[:SOURce<hw>]:BB:WLAD:PCONfig:MAC:SCONtrol:FRAGment:STARt` on page 101

Increment Every
Defines the number of packets required to increment the counter of the fragment bits or the sequence bits of the sequence control.

Remote command:
`[:SOURce<hw>]:BB:WLAD:PCONfig:MAC:SCONtrol:FRAGment:INCRement` on page 101
`[:SOURce<hw>]:BB:WLAD:PCONfig:MAC:SCONtrol:SEQuence:INCRement` on page 101

QoS Ctrl (hex)
Control field (2 bytes) with an embedded checkbox for activating the control mechanism of Quality of Service (QoS) data frames.

The QoS solicits an acknowledgement policy from the receiver, according to specific feedback rules. QoS control ensures a high level of transmission performance like high bit rate, low latency or low bit error probability.

Information on contents of the QoS control data frame is, for example, the end of service period or the presence of an A-MSDU subfield.

Remote command:
`[:SOURce<hw>]:BB:WLAD:PCONfig:MAC:QSControl:STATe` on page 101
`[:SOURce<hw>]:BB:WLAD:PCONfig:MAC:QSControl` on page 100

Frame Body
Indicates the length of the user data that is the frame body.

Remote command:
n.a.

FCS
Indicates the length of the check sum.

Remote command:
n.a.

Frame Control (hex)/MAC Frame Control Field

MAC Frame Control Field										
Protocol Version	Type	Subtype	To DS	From DS	More Frag	Retry	Pwr Mgt	More Data	Protd Frm	Order
00	00	0000	0	0	0	0	0	0	0	0
2 bits (LSB)	2 bits	4 bits	1 bit	1 bit	1 bit	1 bit	1 bit	1 bit	1 bit	1 bit (MSB)

Enters the value of the frame control field.

The MAC frame control field has a length of 2 bytes (16 bits) and is used to define the protocol version, the frame type, sub type, and its function, etc. As an alternative, the individual bits can be set in the lower part of the graph.

Remote command:

[:SOURce<hw>]:BB:WLAD:PCONfig:MAC:FCONtrol on page 100
[:SOURce<hw>]:BB:WLAD:PCONfig:MAC:FCONtrol:CFEXtension on page 100
[:SOURce<hw>]:BB:WLAD:PCONfig:MAC:FCONtrol:FDS on page 100
[:SOURce<hw>]:BB:WLAD:PCONfig:MAC:FCONtrol:MDATa on page 100
[:SOURce<hw>]:BB:WLAD:PCONfig:MAC:FCONtrol:MFRagments on page 100
[:SOURce<hw>]:BB:WLAD:PCONfig:MAC:FCONtrol:ORDer on page 100
[:SOURce<hw>]:BB:WLAD:PCONfig:MAC:FCONtrol:PFRame on page 100
[:SOURce<hw>]:BB:WLAD:PCONfig:MAC:FCONtrol:PMANagement on page 100
[:SOURce<hw>]:BB:WLAD:PCONfig:MAC:FCONtrol:PVERsion on page 100
[:SOURce<hw>]:BB:WLAD:PCONfig:MAC:FCONtrol:RETRy on page 100
[:SOURce<hw>]:BB:WLAD:PCONfig:MAC:FCONtrol:SUBType on page 100
[:SOURce<hw>]:BB:WLAD:PCONfig:MAC:FCONtrol:TDS on page 100
[:SOURce<hw>]:BB:WLAD:PCONfig:MAC:FCONtrol:TYPE on page 100

4 802.11ad configuration and settings

Access:

► Select "Baseband" > "IEEE 802.11ad/ay".

The remote commands required to define these settings are described in Chapter 7.6, "802.11ad frame configuration commands", on page 91.

Settings:

4.1 PPDU configuration

Access:

1. Select "IEEE 802.11ad/ay" > "General".
2. Select "DMG PHY Mode" > "DMG Control"/"DMG Single Carrier".
3. Select "Frame Configuration" > "PPDU Configuration"

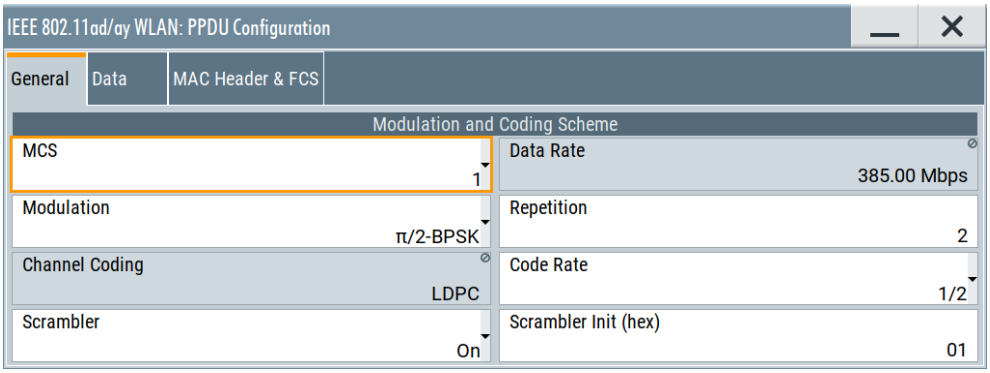
   This dialog provides settings to configure the physical layer protocol data unit (PPDU).

Settings:

4.1.1 General settings

Access:

► Select "PPDU Configuration" > "General".



The tab provides general settings to configure modulation and coding scheme of the 802.11ad PPDU. For the configuration of the stream settings, the modulation and coding scheme and the PSDU bit rate.

Settings:

MCS

Selects the modulation and coding scheme (MCS). Selectable MCS values depend on the DMG PHY mode.

The values of "MCS", "Modulation", "Code Rate", "Data Rate", "Repetition" and "Channel Coding" relate to each other and depend on the DMG/EDMG PHY mode.

If you change one these parameters, the R&S SMW firmware changes related parameters automatically. The tables Table 4-1 and Table 5-2 provide information on MCS characteristics as specified in the IEEE Std 802.11ad™-2012 standard and IEEE Std 802.11ay™-2021 standard.

Table 4-1: 802.11ad PHY modes and MCS

DMG PHY mode	MCS	Modulation	Repetition	Code rate	Data rate (Mbit/s)
DMG Control	0	DBPSK	1	3/4	27.5
DMG Single Carrier	1	π/2 BPSK	2	1/2	385
DMG Single Carrier	2	π/2 BPSK	1	1/2	770
DMG Single Carrier	3	π/2 BPSK	1	5/8	962.5
DMG Single Carrier	4	π/2 BPSK	1	3/4	1155
DMG Single Carrier	5	π/2 BPSK	1	13/16	1251.25
DMG Single Carrier	6	π/2 QPSK	1	1/2	1540
DMG Single Carrier	7	π/2 QPSK	1	5/8	1925
DMG Single Carrier	8	π/2 QPSK	1	3/4	2310
DMG Single Carrier	9	π/2 QPSK	1	13/16	2502.5
DMG Single Carrier	9.1	π/2 QPSK	1	7/8	2695
DMG Single Carrier	10	π/2 16QAM	1	1/2	3080
DMG Single Carrier	11	π/2 16QAM	1	5/8	3850
DMG Single Carrier	12	π/2 16QAM	1	3/4	4620
DMG Single Carrier	12.1	π/2 16QAM	1	13/16	5005

DMG PHY mode	MCS	Modulation	Repetition	Code rate	Data rate (Mbit/s)
DMG Single Carrier	12.2	π/2 16QAM	1	7/8	5390
DMG Single Carrier	12.3	π/2 64QAM	1	5/8	5775
DMG Single Carrier	12.4	π/2 64QAM	1	3/4	6390
DMG Single Carrier	12.5	π/2 64QAM	1	13/16	7507
DMG Single Carrier	12.6	π/2 64QAM	1	7/8	8085

Remote command:
`[:SOURce<hw>]:BB:WLAD:PCONfig:MCS` on page 94

Modulation
Selects the modulation type.

Remote command:
`[:SOURce<hw>]:BB:WLAD:PCONfig:MTYPe` on page 95

Data Rate
Displays the PPDU data rate.

Remote command:
`[:SOURce<hw>]:BB:WLAD:PCONfig:DATA:RATE?` on page 94

Repetition
Requires DMG SC mode and MCS values that have a specified repetition higher than 1, for example, "MCS" > "1".

Sets the number of repetitions.

Remote command:
`[:SOURce<hw>]:BB:WLAD:PCONfig:REPetition` on page 96

Channel Coding
Displays the channel coding type. The channel coding is low-density parity-check coding (LDPC) for all MCS.

Remote command:
`[:SOURce<hw>]:BB:WLAD:PCONfig:CODing:TYPE` on page 92

Code Rate
Sets the code rate of the forward error correction (FEC) code in use.

Remote command:
`[:SOURce<hw>]:BB:WLAD:PCONfig:CODing:RATE` on page 92

Scrambler
Activates scrambling.

Remote command:
`[:SOURce<hw>]:BB:WLAD:PCONfig:SCRambler:MODE` on page 96

Scrambler Init (hex)
Requires "Scrambler" > "On".

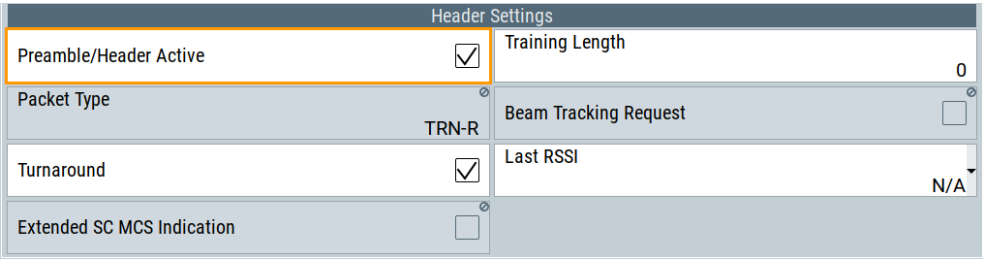
Enters the initialization value for the scrambler, which is then identical in each generated frame.

Remote command:
`[:SOURce<hw>]:BB:WLAD:PCONfig:SCRambler:PATTern` on page 96

4.1.2 Header settings

Access:

1. Select "Frame Configuration" > "PPDU Configuration"
2. Select "Data" tab > "Header Settings" panel.



The panel provides settings to configure the PPDU header. The parameters available for configuration depend on the selected "DMG PHY Mode".

Settings:

Preamble/Header Active
Activates the DMG/EDMG format preamble and signal fields of the frames in the current frame block.

The EDMG format preamble includes a non-EDMG portion and an EDMG portion. The non-EDMG portion of the EDMG format preamble includes the L-STF, L-CEF and L-Header fields. The EDMG portion of the EDMG format preamble includes the EDMG-Header-A, EDMG-STF, EDMGCEF and EDMG-Header-B fields.

Remote command:
`[:SOURce<hw>]:BB:WLAD:PCONfig:PREamble:STATe` on page 95

Packet Type
Displays or sets the packet type. Setting requires training length higher than zero, see "Training Length" on page 43.

Selectable packet types depend on the PHY format:
- DMG format: Packet type is a receive training packet (TRN-R) or transmit training packet (TRN-T).
- EDMG format: Packet type is a receive training packet (TRN-R), transmit training packet (TRN-T) or receive/transmit training packet (TRN-R/T).

"TRN-R"	Receive training packet. The data part of a packet is followed by one or more TRN-R subfields; or a packet is requesting that a TRN-R subfield is added to a future response packet.
"TRN-T"	Transmit training packet. The data part of a packet is followed by one or more TRN-T subfields.
"TRN-R/T"	Receive/transmit training packet. The data part of packet is followed by one or more TRN-R/T subfields.

Remote command:
`[:SOURce<hw>]:BB:WLAD:PCONfig:PTYPe` on page 95

Turnaround
Activates turnaround.

Remote command:
`[:SOURce<hw>]:BB:WLAD:PCONfig:TARound:STATe` on page 96

Training Length
Sets the length of the training field.

Remote command:
`[:SOURce<hw>]:BB:WLAD:PCONfig:TLENgth` on page 96

Beam Tracking Request
Activates beam tracking.

If "Training Length = 0", the beam tracking request field is reserved and it cannot be activated.

Remote command:
`[:SOURce<hw>]:BB:WLAD:PCONfig:BTRequest:STATe` on page 92

Last RSSI
Selects the last received signal strength indicator (RSSI), which is a measure of the power present in a received signal.

Remote command:
`[:SOURce<hw>]:BB:WLAD:PCONfig:LRSSi` on page 94

Extended SC MCS Indication
The value of this field indicates the length of the PSDU.

If the field is set to 0, it indicates the number of data octets in the PSDU.

If the field is set to 1, the length of the PSDU is calculated according to the equation:

$$Length = BaseLength1 - \frac{BaseLength2 - N}{4}$$

Where *N* is the number of data octets in the PSDU, and *BaseLength1*/*BaseLength2* are values that vary according to the selected MCS.

Remote command:
`[:SOURce<hw>]:BB:WLAD:PCONfig:EMINdication` on page 94

5 802.11ay configuration and settings

Access:

► Select "Baseband" > "IEEE 802.11ad/ay".

The "IEEE 802.11ad/ay" dialog provides general settings,

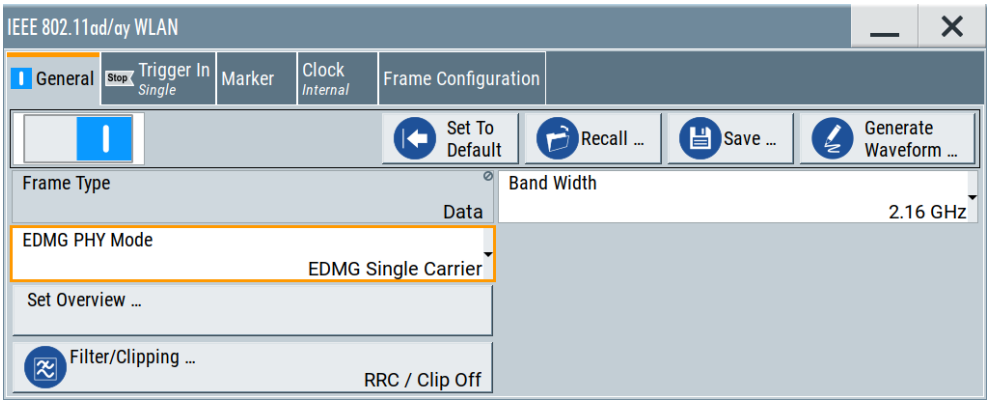
The remote commands required to define these settings are described in Chapter 7.7, "802.11ay frame configuration commands", on page 102.

Settings:

5.1 General settings

Access:

1. Select "IEEE 802.11ad/ay" > "General".
2. Select "EDMG PHY Mode" > "EDMG Single Carrier".



This tab provides 802.11ay general settings to configure the bandwidth.

Settings:

Bandwidth
Sets the bandwidth of the EDMG single carrier signal that is a multiple of 2.16 GHz.

"2.16 GHz" Standard single-carrier bandwidth.

"4.32 GHz" Requires R&S SMW-K555.
Enhanced single-carrier bandwidth.

Remote command:
`[:SOURce<hw>]:BB:WLAY:PCONfig:HDA:BW` on page 108

5.2 PPDU configuration (frame block 1)

Access:

1. Select "IEEE 802.11ad/ay" > "General".
2. Select "EDMG PHY Mode" > "EDMG Single Carrier".
3. Select "Frame Configuration" > "PPDU Configuration"

   This dialog provides settings to configure general settings and user settings for the first frame block. Also, it provides access to user-specific PPDU settings.

5.2.1 General settings

Access:

► Select "PPDU Configuration" > "General".

The tab provides settings to configure general PPDU settings for the first frame block of the 802.11ay EDMG PPDU. These settings include general, L-Header and EDMG-Header-A settings of the EDMG PPDU.

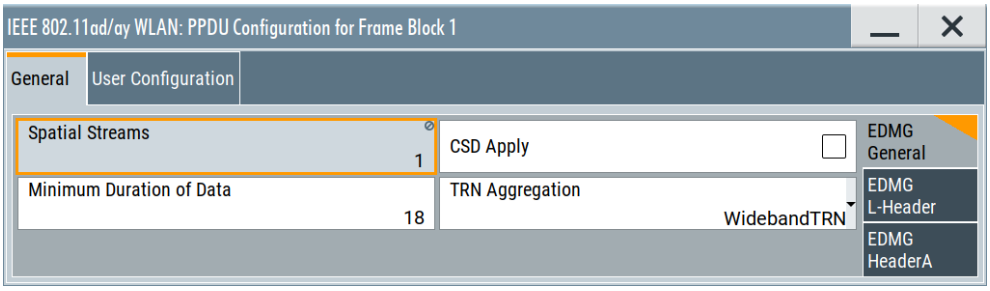
Settings:

5.2.1.1 EDMG general settings

Access:

1. Select "PPDU Configuration" > "General".

2. Select "EDMG General".



The tab provides general settings of the EDMG PPDU for the first frame block.

Settings:

Spatial Streams
Displays the number of spatial streams that is one spatial stream.

Remote command:
`[:SOURce<hw>]:BB:WLAY:PCONfig:SSNumber` on page 105

CSD Apply
Activates cyclic shift diversity (CSD) apply.

Remote command:
`[:SOURce<hw>]:BB:WLAY:PCONfig:CSDState` on page 104

Minimum Duration of Data
Sets the minimum duration of data.

Remote command:
`[:SOURce<hw>]:BB:WLAY:PCONfig:BSBNumber` on page 104

TRN Aggregation
Selects the training (TRN) aggregation mode.

The modes are defined by the 1-bit TRN Aggregation field of the EDMG-Header-A_2 subfield.

"WidebandTRN"
TRN Aggregation field is 0. The bandwidth (BW) field specifies that the TRN field of the PPDU is appended on a 2.16 GHz, 4.32 GHz, 6.48 GHz, or 8.64 GHz channel.

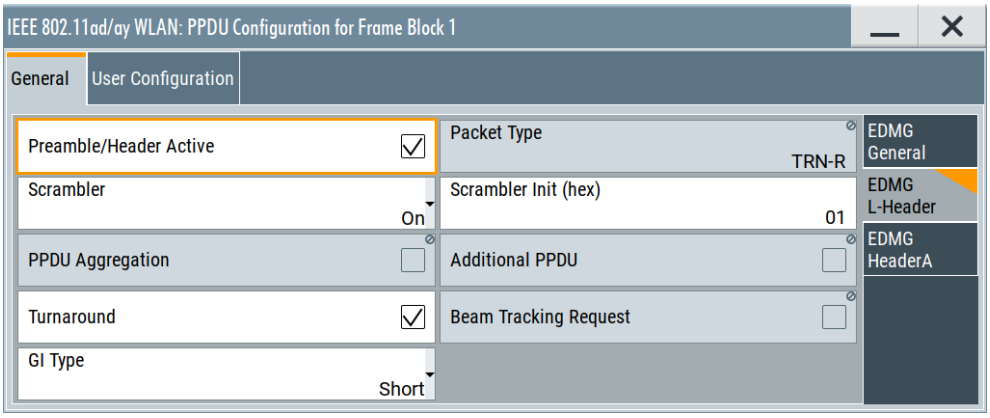
"AggregationTRN"
TRN Aggregation field is 1. The BW field specifies that the TRN field is transmitted over a 2.16+2.16 GHz or 4.32+4.32 GHz channel.

Remote command:
`[:SOURce<hw>]:BB:WLAY:PCONfig:TRAGgregate` on page 105

5.2.1.2 EDMG L-Header settings

Access:

1. Select "PPDU Configuration" > "General".
2. Select "EDMG L-Header".



The tab provides settings of the L-Header field of the EDMG PPDU.

Settings:

Preamble/Header Active
Activates the DMG/EDMG format preamble and signal fields of the frames in the current frame block.

The EDMG format preamble includes a non-EDMG portion and an EDMG portion. The non-EDMG portion of the EDMG format preamble includes the L-STF, L-CEF and L-Header fields. The EDMG portion of the EDMG format preamble includes the EDMG-Header-A, EDMG-STF, EDMGCEF and EDMG-Header-B fields.

Remote command:
`[:SOURce<hw>]:BB:WLAD:PCONfig:PREamble:STATe` on page 95

Packet Type
Displays or sets the packet type. Setting requires training length higher than zero, see "Training Length" on page 43.

Selectable packet types depend on the PHY format:

- DMG format: Packet type is a receive training packet (TRN-R) or transmit training packet (TRN-T).
- EDMG format: Packet type is a receive training packet (TRN-R), transmit training packet (TRN-T) or receive/transmit training packet (TRN-R/T).

"TRN-R" Receive training packet. The data part of a packet is followed by one or more TRN-R subfields; or a packet is requesting that a TRN-R subfield is added to a future response packet.

"TRN-T" Transmit training packet. The data part of a packet is followed by one or more TRN-T subfields.

"TRN-R/T" Receive/transmit training packet. The data part of packet is followed by one or more TRN-R/T subfields.

Remote command:
`[:SOURce<hw>]:BB:WLAD:PCONfig:PTYPe` on page 95

Scrambler
Activates scrambling.

Remote command:
`[:SOURce<hw>]:BB:WLAD:PCONfig:SCRambler:MODE` on page 96

Scrambler Init (hex)
Requires "Scrambler" > "On".

Enters the initialization value for the scrambler, which is then identical in each generated frame.

Remote command:
`[:SOURce<hw>]:BB:WLAD:PCONfig:SCRambler:PATTern` on page 96

PPDU Aggregation
Displays the PPDU aggregation state that is off.

Remote command:
`[:SOURce<hw>]:BB:WLAY:PCONfig:LHDR:PAGR:STATe` on page 106

Additional PPDU
Requires "PPDU Aggregation" > "On".

Activates an additional PPDU.

Remote command:
`[:SOURce<hw>]:BB:WLAY:PCONfig:LHDR:ADDP:STATe` on page 106

Turnaround
Activates turnaround.

Remote command:
`[:SOURce<hw>]:BB:WLAD:PCONfig:TARound:STATe` on page 96

Beam Tracking Request
Activates beam tracking.

If "Training Length = 0", the beam tracking request field is reserved and it cannot be activated.

Remote command:
`[:SOURce<hw>]:BB:WLAD:PCONfig:BTRequest:STATe` on page 92

GI Type
Selects the type of the guard interval (GI). You can select between GI types short, normal or long.

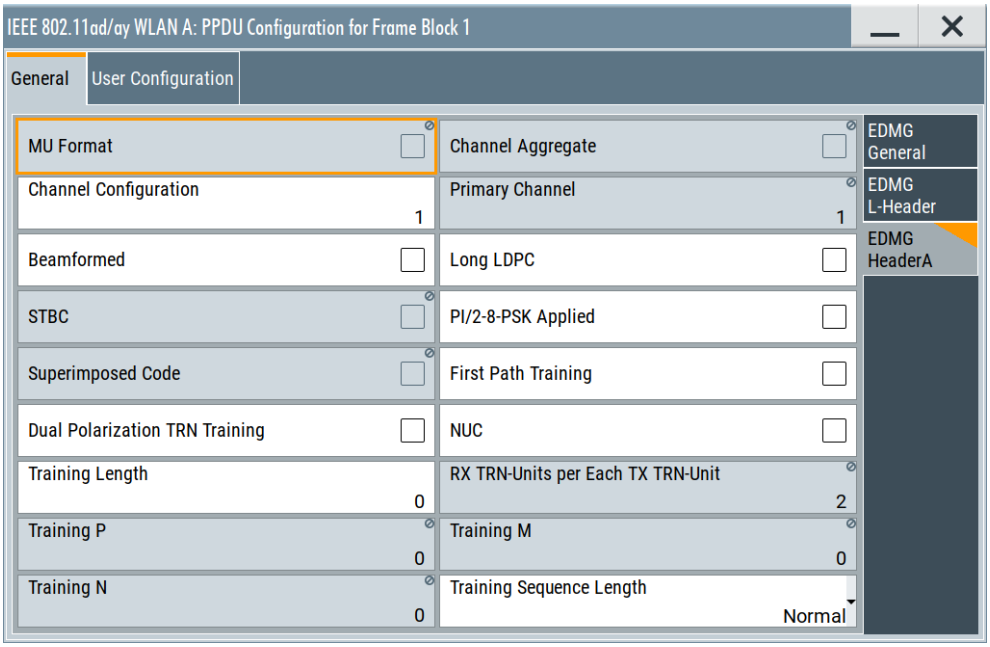
GI sequences and durations depend on EDMG PPDU type, the channel bandwidth and the number of spatial streams. They also affect the data rate, for example, see Table 5-2.

Remote command:
`[:SOURce<hw>]:BB:WLAY:PCONfig:LHDR:GITYpe` on page 106

5.2.1.3 EDMG-Header-A settings

Access:

1. Select "PPDU Configuration" > "General".
2. Select "EDMG-Header-A".



The tab provides settings of the EDMG-Header-A field of the EDMG PPDU.

Settings:

MU Format

Displays the multi-user (MU) format state that is off.

The current firmware supports single-user format only.

Remote command:

`[:SOURce<hw>]:BB:WLAY:PCONfig:HDA:MU:STATe` on page 109

Channel Aggregate

Displays the channel aggregate state that is off.

Remote command:

`[:SOURce<hw>]:BB:WLAY:PCONfig:HDA:AGGRegate:STATe` on page 107

Channel Configuration

Sets the channel configuration that is the configuration of 2.16 GHz and 4.32 GHz channels.

Channel configuration values depend on the channel bandwidth, see Table 5-1.

Table 5-1: Channels of an EDMG STA

Primary channel	Channel configuration	Channel bandwidth
1	1 9	2.16 GHz 4.32 GHz
2	2 10, 11	2.16 GHz 4.32 GHz
3	3 12, 13	2.16 GHz 4.32 GHz
4	4 14, 15	2.16 GHz 4.32 GHz
5	5 16, 17	2.16 GHz 4.32 GHz
6	6 18, 19	2.16 GHz 4.32 GHz

Primary channel	Channel configuration	Channel bandwidth
7	7 20, 21	2.16 GHz 4.32 GHz
8	8 22	2.16 GHz 4.32 GHz

See also "Bandwidth" on page 45.

Remote command:
`[:SOURce<hw>]:BB:WLAY:PCONfig:HDA:CCONfig` on page 108

Primary Channel
Displays the primary channel number as set via the channel configuration, see Table 5-1.

The primary channel number is a 3-bit field of the EDMG-Header-A_1 subfield.

Remote command:
`[:SOURce<hw>]:BB:WLAY:PCONfig:HDA:PCHannel?` on page 110

Beamformed
If activated, applies digital beamforming.

Remote command:
`[:SOURce<hw>]:BB:WLAY:PCONfig:HDA:BF:STATe` on page 107

Long LDPC
Activates long low-density parity-check (LDPC) codewords. If disabled, the firmware uses short LDPC codewords.

This setting relates to the TXVECTOR/RXVECTOR parameter LDPC_CW_TYPE and is specified in the Short/Long LDPC field of the EDMG-Header-A field. For codeword lengths, see the table below.

LDPC_CW_TYPE	Short/Long LDPC field	Codeword length
SHORT	0	672, 624, 504, 468
LONG	1	1344, 1248, 1008, 936

Remote command:
`[:SOURce<hw>]:BB:WLAY:PCONfig:HDA:LLDPc:STATe` on page 108

STBC
Displays the state of space-time block coding that is off.

Remote command:
`[:SOURce<hw>]:BB:WLAY:PCONfig:HDA:STBC:STATe` on page 110

PI/2-8-PSK Applied
Activates π/2-8PSK modulation.

If activated, applies LDPC shortening code with rates 2/3 or 5/6 at the transmitter for MCS 12 or 13, as indicated within the EDMG-MCS field. The bit in the π/2-8-PSK Applied field is 1. This 1-bit field is part of the EDMG-Header-A field.

If deactivated, applies π/2-16QAM modulation. Also, applies regular LDPC code with rates 1/2 or 5/8 at the transmitter for MCS 12 or 13. The bit in the π/2-8-PSK Applied field is 0.

Remote command:
`[:SOURce<hw>]:BB:WLAY:PCONfig:PSK:STATe` on page 105

Superimposed Code
If activated, applies superimposed code with LDPC codewords.

Activating requires an LDPC code rate of 7/8, see "Code Rate" on page 41.

Remote command:
`[:SOURce<hw>]:BB:WLAY:PCONfig:HDB:SIC:STATe` on page 112

First Path Training
Activates first path training.

If activated, indicates that the TRN field is used for first path beamforming training.

The first path training is a 1-bit subfield and is part of EDMG-MCS field. This subfield is reserved when the EDMG TRN Length field is zero.

Remote command:
`[:SOURce<hw>]:BB:WLAY:PCONfig:HDA:MCS:FPT:STATe` on page 109

Dual Polarization TRN Training
Activates dual polarization TRN training.

If activated, indicates that the TRN subfields have different polarization for the same antenna weight vector (AWV). If deactivated, indicates that the TRN field does not change polarization.

Remote command:
`[:SOURce<hw>]:BB:WLAY:PCONfig:HDA:MCS:DPT:STATe` on page 109

NUC
Activates nonuniform constellation (NUC) modulation.

If activated, the bit in the NUC Applied field is 1. This 1-bit field is part of the EDMG-Header-A field. If activated, also applies π/2-64NUC modulation at the transmitter for all MCSs indicated within the EDMG-MCS field.

If a differential EDMG-MCS does not support π/2-64-NUC, then π/2-64-QAM uniform constellation is applied for this particular MCS. If the bit in the NUC Applied field is 0, π/2-64-QAM uniform constellation is applied for all MCSs signaled in the EDMG-MCS field.

Remote command:
`[:SOURce<hw>]:BB:WLAY:PCONfig:HDA:NUC:STATe` on page 109

Training Length
Sets the length of the training field.

Remote command:
`[:SOURce<hw>]:BB:WLAD:PCONfig:TLENgth` on page 96

RX TRN-Units per Each TX TRN-Unit
Sets the number of receive (RX) TRN units per transmit (TX) TRN unit.

This field is an 8-bit field and is reserved, if the value of the EDMG TRN Length field is 0.

Otherwise, the value of this field plus one indicates the number of consecutive TRN-Units in the TRN field. During transmission or the TRN-Units, the transmitter remains with the same transmit antenna weight vector (AWV).

Remote command:
`[:SOURce<hw>]:BB:WLAY:PCONfig:HDA:RTPT` on page 110

Training P
Sets the bits in the 2-bit EDMG TRN-Unit P field.

"0"	Indicates zero TRN subfields.
"1"	Indicates one TRN subfield.
"2"	Indicates two TRN subfields.
"3"	Indicates four TRN subfields.

Remote command:
`[:SOURce<hw>]:BB:WLAY:PCONfig:HDA:TRNP` on page 111

Training M
Sets the bits in the 4-bit EDMG TRN-Unit M field.

Remote command:
`[:SOURce<hw>]:BB:WLAY:PCONfig:HDA:TRNM` on page 110

Training N
Sets the bits in the 2-bit EDMG TRN-Unit N field.

"0"	Indicates one TRN subfield.
"1"	Indicates two TRN subfields.
"2"	Indicates three TRN subfields, if EDMG TRN-Unit M is equal to 2, 5, 8, 11 or 14. Indicates eight TRN subfields, if EDMG TRN-Unit M is equal to 7 or 15.
"3"	Indicates four TRN subfields.

Remote command:
`[:SOURce<hw>]:BB:WLAY:PCONfig:HDA:TRNN` on page 111

Training Sequence Length
Sets training sequence length as set with the 2-bit subfield "Sequence Length" of the TRN field.

For an EDMG SC mode PPDU, this field is reserved, if the value of the EDMG TRN Length field is 0. Otherwise, this subfield indicates the length of the Golay sequence used to transmit the TRN subfields present in the TRN field of the PPDU. The subfield value 3 is reserved.

"Normal" Normal sequence length of 128 × N_{CB} with subfield value 0.

"Long" Long sequence length of 256 × N_{CB} with subfield value 1.

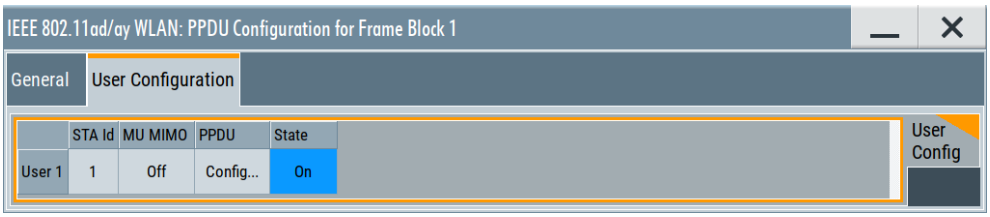
"Short" Short sequence length of 64 × N_{CB} with subfield value 2.

Remote command:
`[:SOURce<hw>]:BB:WLAY:PCONfig:HDA:TSL` on page 111

5.2.2 User Configuration settings

Access:

► Select "PPDU Configuration" > "User Configuration" > "User Config".



The tab provides PPDU user settings in a table and access to individual PPDU settings per user.

Settings:

User x
Displays the user number.

The number indicates the configuration for the individual user.

Remote command:
n.a.

STA Id
Sets the station ID, the 11 least significant bits of the association identifier (AID).

Remote command:
`[:SOURce<hw>]:BB:WLAY:PCONfig:UCONfig:USID` on page 113

MU MIMO
Displays if the current user uses multi-user (MU) MIMO.

All MU-MIMO users share one resource unit (RU) using different space time streams.

Remote command:
`[:SOURce<hw>]:BB:WLAY:PCONfig:UCONfig:MIMO:STATe` on page 112

PPDU
Accesses a dialog to configure individual PPDUs of the respective user.

For related settings, see the Chapter 5.3, "PPDU configuration per user", on page 56.

State
Activates the respective user.

The current firmware provides one user (one spatial stream) that is active. An SU PPDU is transmitted.

Remote command:
`[:SOURce<hw>]:BB:WLAY:PCONfig:UCONfig:USER:STATe` on page 113

5.3 PPDU configuration per user

Access:

1. Select "IEEE 802.11ad/ay" > "General".
2. Select "EDMG PHY Mode" > "EDMG Single Carrier".
3. Select "Frame Configuration" > "PPDU Configuration" > "User Configuration"
4. Select "User 1" > "PPDU" > "Config"

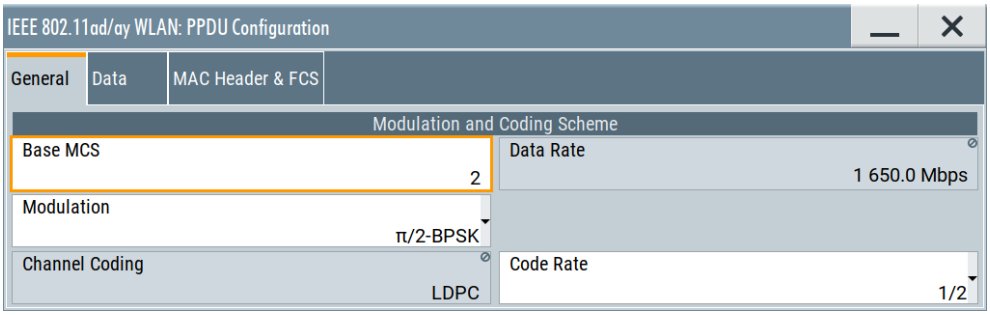
   The dialog provides settings to configure general settings, data settings, MAC header settings and frame check sequence (FCS) settings for a single-user (SU) PPDU.

5.3.1 General settings

Access:

1. Select "User 1" > "PPDU" > "Config".

2. Select "PPDU Configuration" > "General".



The tab provides settings to configure the modulation and coding scheme (MCS) of a SU PPDU.

Settings:

Base MCS

Selects the base modulation and coding scheme (MCS) for EDMG SC PHY mode.

The values of "MCS", "Modulation", "Code Rate", "Data Rate", "Repetition" and "Channel Coding" relate to each other and depend on the DMG/EDMG PHY mode.

If you change one these parameters, the R&S SMW firmware changes related parameters automatically. The tables Table 4-1 and Table 5-2 provide information on MCS characteristics as specified in the IEEE Std 802.11ad™-2012 standard and IEEE Std 802.11ay™-2021 standard.

Example: Base MCS and data rates

The table below provides exemplary relations between the Base MCS number, modulation type, repetition (Rep.), code rate (R_{code}) and related data for all guard interval (GI) types.

Some Base MCS provide more than one modulation type, depending on the EDMG-Header-A settings, if π/2-8-PSK modulation or nonuniform constellation (NUC) modulation is active. See Chapter 5.2.1.3, "EDMG-Header-A settings", on page 50.

Table 5-2: MCS for 802.11ay EDMG SC mode

Base MCS	Modulation	Rep.	R_{code}	Data rate (Mbit/s)		
				Short GI	Normal GI	Long GI
1	π/2-BPSK	2	1/2	N_{CB}×412.50	N_{CB}×385	N_{CB}×330.00
2	π/2-BPSK	1	1/2	N_{CB}×825	N_{CB}×770	N_{CB}×660
2	DCM π/2-BPSK	1	5/8	N_{CB}×1031.25	N_{CB}×962.5	N_{CB}×825

Base MCS	Modulation	Rep.	R_{code}	Data rate (Mbit/s)		
				Short GI	Normal GI	Long GI
12	π/2-16QAM	1	1/2	N_{CB}×3300	N_{CB}×3080	N_{CB}×2640
12	π/2-8PSK	1	2/3	N_{CB}×3300	N_{CB}×3080	N_{CB}×2640
17	π/2-64QAM	1	1/2	N_{CB}×4950	N_{CB}×4620	N_{CB}×3960
17	π/2-64NUC	1	1/2	N_{CB}×4950	N_{CB}×4620	N_{CB}×3960

Remote command:
`[:SOURce<hw>]:BB:WLAY:PCONfig:HDA:BMCS` on page 107

Data Rate
Displays the PPDU data rate.

Remote command:
`[:SOURce<hw>]:BB:WLAD:PCONfig:DATA:RATE?` on page 94

Modulation
Selects the modulation type.

Remote command:
`[:SOURce<hw>]:BB:WLAD:PCONfig:MTYPe` on page 95

Channel Coding
Displays the channel coding type. The channel coding is low-density parity-check coding (LDPC) for all MCS.

Remote command:
`[:SOURce<hw>]:BB:WLAD:PCONfig:CODing:TYPE` on page 92

Code Rate
Sets the code rate of the forward error correction (FEC) code in use.

Remote command:
`[:SOURce<hw>]:BB:WLAD:PCONfig:CODing:RATE` on page 92

5.3.2 Data settings

Data settings are common settings for DMG PHY modes and EDMG PHY modes, see Chapter 3.3, "Data settings", on page 31.

5.3.3 MAC header and FCS settings

MAC Header and FCS settings are common settings for DMG PHY modes and EDMG PHY modes, see Chapter 3.5, "MAC header and FCS settings", on page 34.

6 Signal generation control

This section lists settings for configuring the baseband filter, for defining the signal generation start and for generating signals necessary for synchronization with other instruments.

It covers the following topics:

6.1 Filter/clipping settings

Access:

► Select "IEEE 802.11ad/ay" > "General" > "Filter/Clipping".

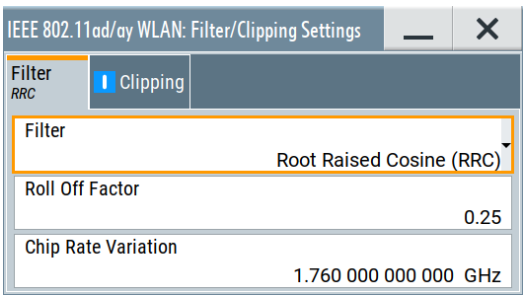
The dialog provides settings to configure the baseband filter, the chip rate and clipping.

Settings:

6.1.1 Filter settings

Access:

► Select "General" > "Filter/Clipping" > "Filter".



The tab provides settings to configure the baseband filter and the chip rate.

Settings:

Filter
Selects the baseband filter.

Remote command:
`[:SOURce<hw>]:BB:WLAD:FILTer:TYPE` on page 78

Rolloff Factor or BxT
Sets the filter parameter.

The filter parameter ("Roll off Factor" or "BxT") depends on the currently selected filter type. This parameter is preset to the default for each of the predefined filters.

Remote command:
`[:SOURce<hw>]:BB:WLAD:FILTer:PARameter:APCO25` on page 78
`[:SOURce<hw>]:BB:WLAD:FILTer:PARameter:COSine` on page 78
`[:SOURce<hw>]:BB:WLAD:FILTer:PARameter:GAUSs` on page 78
`[:SOURce<hw>]:BB:WLAD:FILTer:PARameter:PGAuss` on page 78
`[:SOURce<hw>]:BB:WLAD:FILTer:PARameter:RCOSine` on page 78
`[:SOURce<hw>]:BB:WLAD:FILTer:PARameter:SPHase` on page 78

Cut Off Frequency Factor
Requires "Filter" > "Lowpass (ACP optim.)"/"Lowpass (EVM optim.)".

Sets the value for the cutoff frequency factor. The cutoff frequency of the filter can be adjusted to reach spectrum mask requirements.

Remote command:
`[:SOURce<hw>]:BB:WLAD:FILTer:PARameter:LPASs` on page 78
`[:SOURce<hw>]:BB:WLAD:FILTer:PARameter:LPASSEVM` on page 78

Cut Off Frequency Shift
The cutoff frequency is a filter characteristic that defines the frequency at the 3 dB down point. The "Cut Off Frequency Shift" affects this frequency in the way that the filter flanks are "moved" and the transition band increases by "Cut Off Frequency Shift"*"Sample Rate".

- A "Cut Off Frequency Shift" = -1 results in a very narrow-band filter
- Increasing the value up to 1 makes the filter more broad-band
- By "Cut Off Frequency Shift" = 0, the -3 dB point is at the frequency determined by the half of the selected "Sample Rate".

Tip: Use this parameter to adjust the cutoff frequency and reach spectrum mask requirements.

Chip Rate Variation
Sets the chip rate.

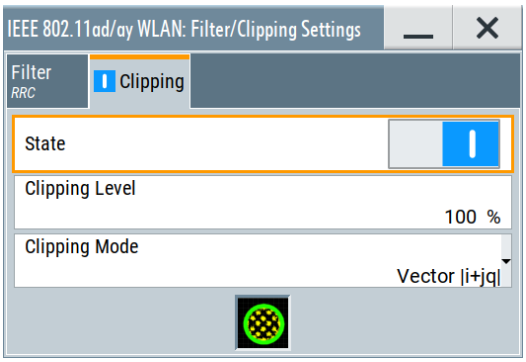
The chip rate entry changes the output clock, the modulation bandwidth and synchronization output signals. It does not affect the calculated chip sequence.

Remote command:
`[:SOURce<hw>]:BB:WLAD:SRATe:VARiation` on page 79

6.1.2 Clipping settings

Access:

► Select "General" > "Filter/Clipping" > "Clipping".



The dialog provides settings to configure clipping.

Settings:

State
Switches baseband clipping on and off.

Baseband clipping is a simple and effective way of reducing the crest factor of the signal. Since clipping is done before to filtering, the procedure does not influence the spectrum. The EVM however increases.

Remote command:
`[:SOURce<hw>]:BB:WLAD:CLIPping:STATe` on page 77

Clipping Level
Sets the limit for clipping.

This value indicates at what point the signal is clipped. It is specified as a percentage, relative to the highest level. 100% indicates that clipping does not take place.

Remote command:
`[:SOURce<hw>]:BB:WLAD:CLIPping:LEVel` on page 77

Clipping Mode
Selects the clipping method. The dialog displays a graphical illustration on how this two methods work.

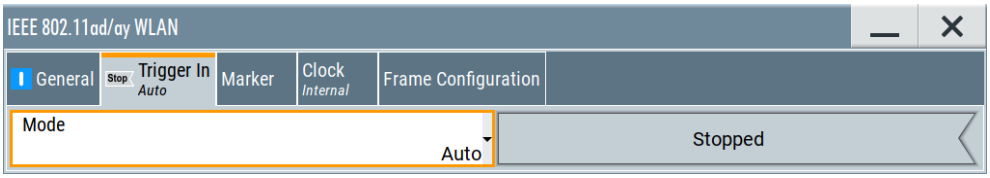
- "Vector | i + jq |"
  The limit is related to the amplitude | i + q |. The I and Q components are mapped together, the angle is retained.
- "Scalar | i | , | q |"
  The limit is related to the absolute maximum of all the I and Q values | i | + | q |. The I and Q components are mapped separately, the angle changes.

Remote command:
`[:SOURce<hw>]:BB:WLAD:CLIPping:MODE` on page 77

6.2 Trigger settings

Access:

► Select "Baseband" > "IEEE 802.11ad/ay" > "Trigger In".



This tab provides settings to select and configure the trigger, like trigger source, trigger mode and trigger delays, and to arm or trigger an internal trigger manually. The header of the tab displays the status of the trigger signal and trigger mode. As in the tabs "Marker" and "Clock", this tab provides also access to the settings of the related connectors.

Routing and activating a trigger signal

1. Define the effect of a trigger event and the trigger signal source.
   a) Select "Trigger In" > "Mode".
   b) Select "Trigger In" > "Source".
2. For external trigger signals, define the connector for signal input. See Chapter 6.5, "Local and global connectors settings", on page 71.
   You can map trigger signals to one or more USER x or T/M connectors.

   Local and global connectors settings allow you to configure the signal mapping, the polarity, the trigger threshold and the input impedance of the input connectors.
3. Activate baseband signal generation. In the block diagram, set "Baseband" > "On".

   The R&S SMW starts baseband signal generation after the configured trigger event.

About baseband trigger signals

This section focuses on the available settings.

For information on how these settings affect the signal, refer to section "Basics on ..." in the R&S SMW user manual.

Settings:

Trigger settings common to all basebands

To enable simultaneous signal generation in all basebands, the R&S SMW couples the trigger settings in the available basebands in any instrument's configuration involving signal routing with signal addition. For example, in MIMO configuration, routing and summing of basebands or of streams.

The icon indicates that common trigger settings are applied.

You can access and configure the common trigger source and trigger mode settings in any of the basebands. An arm or a restart trigger event applies to all basebands, too. You can still apply different delay to each of the triggers individually.

Mode

Selects trigger mode, i.e. determines the effect of a trigger event on the signal generation.

For more information, refer to chapter "Basics" in the R&S SMW user manual.

- "Auto"
  The signal is generated continuously.
- "Retrigger"
  The signal is generated continuously. A trigger event (internal or external) causes a restart.
- "Armed Auto"
  The signal is generated only when a trigger event occurs. Then the signal is generated continuously.
  An "Arm" stops the signal generation. A subsequent trigger event (internal or external) causes a restart.
- "Armed Retrigger"
  The signal is generated only when a trigger event occurs. Then the signal is generated continuously. Every subsequent trigger event causes a restart.

An "Arm" stops signal generation. A subsequent trigger event (internal or external) causes a restart.

- "Single"
  The signal is generated only when a trigger event occurs. Then the signal is generated once to the length specified at "Signal Duration".
  Every subsequent trigger event (internal or external) causes a restart.

Remote command:
`[:SOURce<hw>]:BB:WLAD[:TRIGger]:SEQuence` on page 83

Signal Duration Unit
Defines the unit for describing the length of the signal sequence to be output in the "Single" trigger mode.

Remote command:
`[:SOURce<hw>]:BB:WLAD:TRIGger:SLUNit` on page 82

Signal Duration
Requires trigger "Mode" > "Single".

Enters the length of the trigger signal sequence.

Use this parameter, for example, for the following applications:
- To output the trigger signal partly.
- To output a predefined sequence of the trigger signal.

Remote command:
`[:SOURce<hw>]:BB:WLAD:TRIGger:SLUNit` on page 82

Running/Stopped
With enabled modulation, displays the status of signal generation for all trigger modes.

- "Running"
  The signal is generated; a trigger was (internally or externally) initiated in triggered mode.
- "Stopped"
  The signal is not generated and the instrument waits for a trigger event.

Remote command:
`[:SOURce<hw>]:BB:WLAD:TRIGger:RMODe?` on page 81

Time Based Trigger
Requires trigger "Mode" > "Armed Auto"/"Single".

Activates time-based triggering with a fixed time reference.

The R&S SMW triggers signal generation when its operating system time ("Current Time") matches a specified time trigger ("Trigger Time"). As trigger source, you can use an internal trigger or an external global trigger.

How to: Chapter "Time-based triggering" in the R&S SMW user manual.

Remote command:
`[:SOURce<hw>]:BB:WLAD:TRIGger:TIME[:STATe]` on page 85

Trigger Time
Requires trigger "Mode" > "Armed Auto"/"Single".

Sets date and time for a time-based trigger signal.

Set a trigger time that is later than the "Current Time". The current time is the operating system time of the R&S SMW. If you set an earlier trigger time than the current time, time-based triggering is not possible.

How to: Chapter "Time-based triggering" in the R&S SMW user manual.

"Date" Sets the date of the time-based trigger in format YYYY-MM-DD.

Remote command:
`[:SOURce<hw>]:BB:WLAD:TRIGger:TIME:DATE` on page 84

"Time" Sets the time of the time-based trigger in format hh:mm:ss.

Remote command:
`[:SOURce<hw>]:BB:WLAD:TRIGger:TIME:TIME` on page 85

Arm

Stops the signal generation until subsequent trigger event occurs.

Remote command:
`[:SOURce<hw>]:BB:WLAD:TRIGger:ARM:EXECute` on page 80

Execute Trigger

For internal trigger source, executes trigger manually.

Remote command:
`[:SOURce<hw>]:BB:WLAD:TRIGger:EXECute` on page 80

Source

Selects the trigger source.

The following sources of the trigger signal are available:

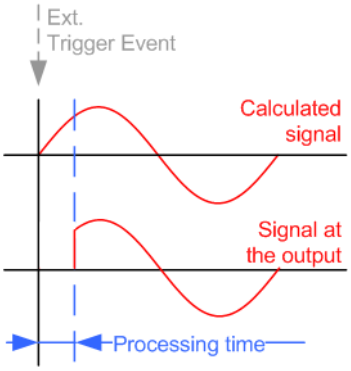
- "Internal"
  The trigger event is executed manually by the "Execute Trigger".
- "Internal (Baseband A/B)"
  The trigger event is provided by the trigger signal from the other basebands.
  If common trigger settings are applied, this trigger source is disabled.
- "External Global Trigger"
  The trigger event is the active edge of an external trigger signal provided and configured at the USER x connectors.
- "External Local Trigger"
  The trigger event is the active edge of an external trigger signal provided and configured at the local T/M/C connector.
  With coupled trigger settings, the signal has to be provided at the T/M/C1/2/3 connectors.
- "External Local Clock"
  The trigger event is the active edge of an external local clock signal provided and configured at the local T/M/C connector.
  With coupled trigger settings, the signal has to be provided at the T/M/C1 connector.

How to: "Routing and activating a trigger signal" on page 62

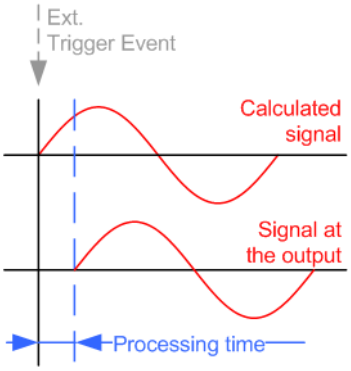
Remote command:
`[:SOURce<hw>]:BB:WLAD:TRIGger:SOURce` on page 82

Sync. Output to External Trigger/Sync. Output to Trigger
Enables signal output synchronous to the trigger event.

- "On"
  Corresponds to the default state of this parameter.
  The signal calculation starts simultaneously with the trigger event. Because of the processing time of the instrument, the first samples are cut off and no signal is output. After elapsing of the internal processing time, the output signal is synchronous to the trigger event.



- "Off"
  The signal output begins after elapsing of the processing time. Signal output starts with sample 0. The complete signal is output.
  This mode is recommended for triggering of short signal sequences. Short sequences are sequences with signal duration comparable with the processing time of the instrument.



Remote command:
`[:SOURce<hw>]:BB:WLAD:TRIGger:EXTernal:SYNChronize:OUTPut`
on page 80

External Inhibit/Trigger Inhibit
Applies for external trigger signal or trigger signal from the other path.

Sets the duration with that any following trigger event is suppressed. In "Retrigger" mode, for example, a new trigger event does not cause a restart of the signal generation until the specified inhibit duration does not expire.

For more information, see chapter "Basics" in the R&S SMW user manual.

Remote command:
`[:SOURce<hw>]:BB:WLAD:TRIGger[:EXTernal]:INHibit` on page 83
`[:SOURce<hw>]:BB:WLAD:TRIGger:OBASeband:INHibit` on page 81

External Delay/Trigger Delay
Delays the trigger event of the signal from:
- The external trigger source
- The other path
- The other basebands (internal trigger), if common trigger settings are used.

Use this setting to:
- Synchronize the instrument with the device under test (DUT) or other external devices
- Postpone the signal generation start in the basebands compared to each other

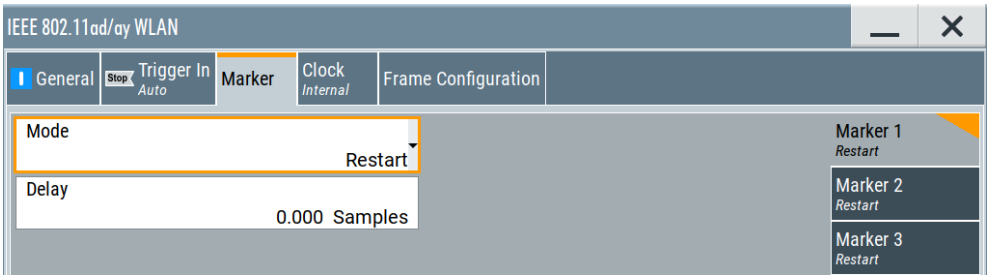
For more information, see chapter "Basics on ..." in the R&S SMW user manual.

Remote command:
`[:SOURce<hw>]:BB:WLAD:TRIGger[:EXTernal]:DELay` on page 83
`[:SOURce<hw>]:BB:WLAD:TRIGger:OBASeband:DELay` on page 80

6.3 Marker settings

Access:

► Select "IEEE 802.11ad/ay" > "Marker".



This tab provides settings to select and configure the marker output signal including marker mode and marker delay.

Routing and activating a marker signal

1. To define the signal shape of an individual marker signal "x", select "Marker" > "Marker x" > "Mode".
2. Optionally, define the connector for signal output. See Chapter 6.5, "Local and global connectors settings", on page 71.
   You can map marker signals to one or more USER x or T/M connectors.
3. Activate baseband signal generation. In the block diagram, set "Baseband" > "On".

The R&S SMW adds the marker signal to the baseband signal. Also, R&S SMW outputs this signal at the configured USER x connector.

About marker output signals

This section focuses on the available settings.

For information on how these settings affect the signal, refer to section "Basics on ..." in the R&S SMW user manual.

Settings:

Mode
Marker configuration for up to 3 markers. The settings are used to select the marker mode defining the shape and periodicity of the markers. The contents of the dialog change with the selected marker mode.

How to: "Routing and activating a marker signal" on page 67

"Restart" A marker signal is generated at the start of each signal sequence (period = all frame blocks).

"Frame" A marker signal is generated at the start of each frame in the single frame block.

Remote command:
`[:SOURce<hw>]:BB:WLAD:TRIGger:OUTPut<ch>:FINDex`
on page 87

"Frame Active Part"/"Frame Inactive Part"
A marker signal is generated to mark every active part of each frame. The active data transfer part (PPDU) of a frame period is marked with high, the inactive part (idle time) with low. This marker can be used to decrease the carrier leakage during inactive signal parts by feeding it into the pulse modulator.
Otherwise, the frame block and frame index are entered and the active part of the specific frame is masked.
The parameters "Rising Edge Shift"/"Falling Edge Shift" open when "Frame Active Part" or "Frame Inactive Part" is selected.
They shift the rising/falling edge of the marker the specified number of samples. Negative values result in a shift back of the marker edge.

Remote command:
`[:SOURce<hw>]:BB:WLAD:TRIGger:OUTPut<ch>:FESHift`
on page 87
`[:SOURce<hw>]:BB:WLAD:TRIGger:OUTPut<ch>:RESHift`
on page 90

"Pulse" A regular marker signal is generated. The clock frequency is defined by entering a divider. The frequency is derived by dividing the chip rate by the divider. The input box for the divider opens when "Pulse" is selected, and the resulting pulse frequency is displayed below it.

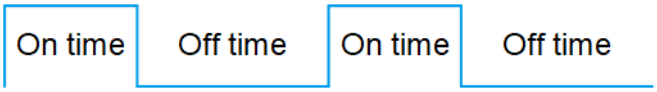
Remote command:
`[:SOURce<hw>]:BB:WLAD:TRIGger:OUTPut<ch>:PULSe:DIVider` on page 89
`[:SOURce<hw>]:BB:WLAD:TRIGger:OUTPut<ch>:PULSe:FREQuency?` on page 89

"Pattern" A marker signal that is defined by a bit pattern is generated. The pattern has a maximum length of 32 bits.

Remote command:
`[:SOURce<hw>]:BB:WLAD:TRIGger:OUTPut<ch>:PATTern` on page 89

"On/Off Ratio"

A regular marker signal that is defined by an ON/OFF ratio is generated. A period lasts one ON and OFF cycle.



Remote command:
`[:SOURce<hw>]:BB:WLAD:TRIGger:OUTPut<ch>:ONTime` on page 88
`[:SOURce<hw>]:BB:WLAD:TRIGger:OUTPut<ch>:OFFTime` on page 88

Remote command:
`[:SOURce<hw>]:BB:WLAD:TRIGger:OUTPut<ch>:MODE` on page 87

Delay

Delays the marker signal at the marker output relative to the signal generation start.

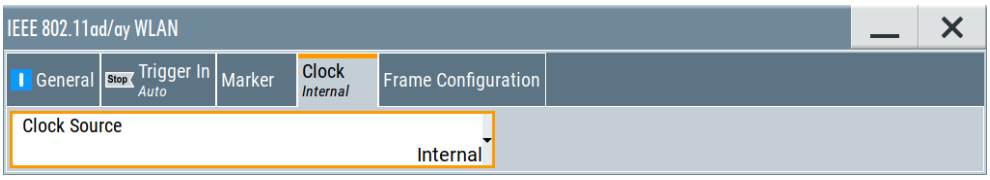
Variation of the parameter "Marker x" > "Delay" causes signal recalculation.

Remote command:
`[:SOURce<hw>]:BB:WLAD:TRIGger:OUTPut<ch>:DELay` on page 86

6.4 Clock settings

Access:

► Select "Baseband" > "IEEE 802.11ad/ay" > "Clock".



This tab provides settings to select and configure the clock signal, like the clock source and clock mode.

Defining the clock

1. Select "Clock" > "Source" to define the source of clock signal.
2. For external clock signals, define the connector for signal input. See Chapter 6.5, "Local and global connectors settings", on page 71.
   You can map clock signals to one or more USER x or T/M connectors.

   Local and global connectors settings allow you to configure the signal mapping, the polarity, the trigger threshold and the input impedance of the input connectors.
3. Activate baseband signal generation. In the block diagram, set "Baseband" > "On".

   The R&S SMW starts baseband signal generation with a symbol rate that equals the clock rate.

About clock signals

This section focuses on the available settings.

For information on how these settings affect the signal, refer to section "Basics on ..." in the R&S SMW user manual.

Settings:

Clock Source
Selects the clock source.

How to: "Defining the clock" on page 70

Remote command:
`[:SOURce<hw>]:BB:WLAD:CLOCk:SOURce` on page 90

6.5 Local and global connectors settings

Accesses a dialog to configure local connectors or global connectors.

The button is available in the following dialogs or tabs:

- "Trigger / Marker / Clock" dialog that is accessible via the "TMC" block in the block diagram.
- "Trigger In", "Marker" and "Clock" tabs that are accessible via the "Baseband" block in the block diagram.

See also chapter "Local and global connectors settings" in the user manual.

7 Remote-control commands

The following commands are required to perform signal generation with the IEEE 802.11ad/ay options 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 are assumed.

Conventions used in SCPI command descriptions

For a description of the conventions used in the remote command descriptions, see section "Remote Control Commands" in the R&S SMW user manual.

Common suffixes

The following common suffixes are used in the remote commands:

Suffix	Value range	Description
`SOURce<hw>`	[1] to 4	Available baseband signals
`OUTPut<ch>`	1 to 3	Available markers
`MPDU<st>`	1 to 64	Available aggregate MAC protocol data units (MPDU)

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 reset or preset is recommended to set the instrument to a definite state. The commands `*RST` and `SYSTem:PRESet` are equivalent for this purpose. `*CLS` also resets the status registers and clears the output buffer.

The following commands specific to the IEEE 802.11ad/ay are described here:

7.1 General commands

Example: Saving the current configuration

```
SOURce1:BB:WLAD:SETTing:STORe /var/user/wlanad_single_carrier
// Reset all instrument settings.
*RST
// Or reset 802.11ad/ay specific settings within this digital standard.
SOURce1:BB:WLAD:SETTing:PRESet
SOURce1:BB:WLAD:SETTing:CATalog?
// Response: "wlanad_single_carrier, wlanad_1"
SOURce1:BB:WLAD:SETTing:LOAD /var/user/wlanad_single_carrier
SOURce1:BB:WLAD:SLENgth?
// Response in number of frames: "1"
SOURce1:BB:WLAD:SETTing:DELete wlanad_1
```

Commands:

[:SOURce<hw>]:BB:WLAD:DPMode <DPMode>

Sets the DMG/EDMG PHY mode.

Parameters:

<DPMode> CONTrol | SINGle | ESINgle

CONTrol
DMG control PHY mode

SINGle
DMG SC PHY mode

ESINgle
EDMG SC PHY mode

*RST: SINGle

Example: See Example"Configuring EDMG general settings" on page 102.

Manual operation: See "DMG PHY Mode/EDMG PHY Mode" on page 29

[:SOURce<hw>]:BB:WLAD:FTYPe <FTYPE>

Queries the IEEE 802.11ad/ay frame type. All frames are data frames.

Parameters:
<FTYPE> DATA
*RST: DATA

Manual operation: See "Frame Type" on page 28

[:SOURce<hw>]:BB:WLAD:PRESet

Sets the parameters of the digital standard to their default values (`*RST` values specified for the commands).

Not affected is the state set with the command `:BB:WLAD:STATe`.

Example: See Example"Saving the current configuration" on page 73.

Usage: Event

Manual operation: See "Set to Default" on page 28

[:SOURce<hw>]:BB:WLAD:SETTing:CATalog?

Reads out the files with IEEE 802.11ad/ay settings in the default directory. The default directory is set using the command `MMEM:CDIRectory`. Only files with the file extension `*.wlanad` are listed.

Return values:
<Catalog> string

Example: See Example"Saving the current configuration" on page 73.

Usage: Query only

Manual operation: See "Save/Recall" on page 28

[:SOURce<hw>]:BB:WLAD:SETTing:DELete <Filename>

Deletes the selected file with IEEE 802.11ad/ay settings.

The directory is set using command `MMEM:CDIRectory`. A path can also be specified, in which case the files in the specified directory are read. The file extension may be omitted. Only files with the file extension `*.wlanad` are listed and can be deleted.

Setting parameters:
<Filename> string

Example: See Example"Saving the current configuration" on page 73.

Usage: Setting only

Manual operation: See "Save/Recall" on page 28

[:SOURce<hw>]:BB:WLAD:SETTing:LOAD <Filename>

Loads the selected file with IEEE 802.11ad/ay settings.

The directory is set using the command `MMEM:CDIRectory`. A path can also be specified, in which case the files in the specified directory are read. The file extension may be omitted. Only files with the file extension `*.wlanad` are loaded..

Setting parameters:
<Filename> string

Example: See Example"Saving the current configuration" on page 73.

Usage: Setting only

Manual operation: See "Save/Recall" on page 28

[:SOURce<hw>]:BB:WLAD:SETTing:STORe <Filename>

Stores the current IEEE 802.11ad/ay settings into the selected file.

The directory is set using the command `MMEM:CDIRectory`. A path can also be specified, in which case the files in the specified directory are read. Only the file name has to be entered. WLAD|WLAY settings are stored as files with the specific file extensions `*.wlanad`.

Setting parameters:
<Filename> string

Example: See Example"Saving the current configuration" on page 73.

Usage: Setting only

Manual operation: See "Save/Recall" on page 28

[:SOURce<hw>]:BB:WLAD:STATe <State>

Activates the standard and deactivates all the other digital standards and digital modulation modes in the same path.

Parameters:
<State> 1 | ON | 0 | OFF
*RST: 0

Manual operation: See "State" on page 27

[:SOURce<hw>]:BB:WLAD:WAVeform:CREate <Filename>

Creates a waveform using the current settings of the "IEEE 802.11ad/ay" dialog. The file name is entered with the command. The file is stored with the predefined file extension `*.wv`. The file name and the directory it is stored in are user-definable.

Setting parameters:
<Filename> string

Example: `MMEM:CDIR '/var/user/temp/waveform'`
Sets the default directory to /var/user/temp/waveform.
`BB:WLAD:WAV:CRE 'wlad_1'`
Creates the waveform file `wlad_1.wv` in the default directory.

Usage: Setting only

Manual operation: See "Generate Waveform File" on page 28

7.2 Filter/clipping commands

Example: Configuring filter and clipping settings

```
// ****************************************************************
// Configure filter settings.
// ****************************************************************
SOURce1:BB:WLAD:DPMode SINGle
SOURce1:BB:WLAD:FILTer:TYPE?
// Response: "RCOSine"
// Root cosine filter.
SOURce1:BB:WLAD:FILTer:ROLLoff?
// Response: "0.25"
// Rolloff factor is 0.25.

// Query chip rate variation.
SOURce1:BB:WLAD:SRATe:VARiation?
// Response in Hz: "1760E6"
// The chip rate variation is 1.76 GHz.

// ****************************************************************
// Configure clipping.
// ****************************************************************
SOURce1:BB:WLAD:CLIPping:LEVel?
// Response in percent: "100"
SOURce1:BB:WLAD:CLIPping:MODE?
// Response: "VECT"
// Clipping related to the amplitude |i+q|.
SOURce1:BB:WLAD:CLIPping:STATe 1
```

[:SOURce<hw>]:BB:WLAD:CLIPping:LEVel <Level>

Sets the limit for level clipping. This value indicates at what point the signal is clipped. It is specified as a percentage, relative to the highest level. 100% indicates that clipping does not take place.

Level clipping is activated with the command `SOUR:BB:WLAD:CLIP:STAT ON`.

Parameters:

<Level> integer

Range: 1 to 100
*RST: 100

Example: See Example"Configuring filter and clipping settings" on page 76.

Manual operation: See "Clipping Level" on page 61

[:SOURce<hw>]:BB:WLAD:CLIPping:MODE <Mode>

Sets the method for level clipping.

Parameters:

<Mode> VECTor | SCALar

VECTor
The reference level is the amplitude | i+jq |.

SCALar
The reference level is the absolute maximum of the I and Q values.

*RST: VECTor

Example: See Example"Configuring filter and clipping settings" on page 76.

Manual operation: See "Clipping Mode" on page 62

[:SOURce<hw>]:BB:WLAD:CLIPping:STATe <State>

Activates level clipping.

Parameters:

<State> 1 | ON | 0 | OFF

*RST: 0

Example: See Example"Configuring filter and clipping settings" on page 76.

Manual operation: See "State" on page 61

[:SOURce<hw>]:BB:WLAD:FILTer:PARameter:APCO25 <Apco25>
[:SOURce<hw>]:BB:WLAD:FILTer:PARameter:COSine <Cosine>
[:SOURce<hw>]:BB:WLAD:FILTer:PARameter:COSine:COFS <CoFs>
[:SOURce<hw>]:BB:WLAD:FILTer:PARameter:GAUSs <Gauss>
[:SOURce<hw>]:BB:WLAD:FILTer:PARameter:LPASs <LPass>
[:SOURce<hw>]:BB:WLAD:FILTer:PARameter:LPASSEVM <LPassevm>
[:SOURce<hw>]:BB:WLAD:FILTer:PARameter:PGAuss <PGauss>
[:SOURce<hw>]:BB:WLAD:FILTer:PARameter:RCOSine <RCosine>
[:SOURce<hw>]:BB:WLAD:FILTer:PARameter:SPHase <SPhase>

Sets filter parameters related to the filter type. The table below provides an overview.

Filter type	Parameter	Parameter name	Min	Max	Increment	Default
APCO25	Rolloff factor	<Apco25>	0.05	0.99	0.01	0.2
COSine	Cutoff frequency shift	<Cosf>	-1	1	0.01	-0.1
COSine	Rolloff factor	<Cosine>	0	1	0.01	0.1
GAUSs	BxT	<Gauss>	0.15	2.5	0.01	0.5
LPASs	Cutoff frequency factor	<LPass>	0.05	2	0.01	0.5
LPASSEVM	Cutoff frequency factor	<LPassEvm>	0.05	2	0.01	0.5
PGAuss	BxT	<PGauss>	0.15	2.5	0.01	0.5
RCOSine	Rolloff factor	<RCosine>	0	1	0.01	0.22
SPHase	BxT	<SPhase>	0.15	2.5	0.01	2

Parameters:

<SPhase> float

Range: 0.15 to 2.5
Increment: 0.01
*RST: 2

Example: See Example"Configuring filter and clipping settings" on page 76.

Manual operation: See "Rolloff Factor or BxT" on page 60

[:SOURce<hw>]:BB:WLAD:FILTer:TYPE <Type>

Selects the filter type.

Parameters:

<Type> RCOSine | COSine | GAUSs | LGAuss | CONE | COF705 | COEQualizer | COFequalizer | C2K3x | APCO25 | SPHase | RECTangle | PGAuss | LPASs | DIRac | ENPShape | EWPShape | LPASSEVM

*RST: RCOSine

Example: See Example"Configuring filter and clipping settings" on page 76.

Manual operation: See "Filter" on page 60

[:SOURce<hw>]:BB:WLAD:SRATe:VARiation <Variation>

Sets the sample rate variation.

Parameters:

<Variation> float

Range: 4E2 to 3000E6
Increment: 1E-3
*RST: 1760E6

Example: See Example"Configuring filter and clipping settings" on page 76.

Manual operation: See "Chip Rate Variation" on page 60

7.3 Trigger settings

Example: Configure and enable triggering

```
SOURce:BB:WLAD:TRIGger:SEQuence SINGle
SOURce:BB:WLAD:TRIGger:SLENgth 200

// the first 200 samples of the current waveform will be output after
// the next trigger event
SOURce:BB:WLAD:TRIGger:SEQuence ARETrigger
SOURce:BB:WLAD:TRIGger:SOURce EGT1
// external trigger signal must be provided at the USER connector
SOURce:BB:WLAD:TRIGger:EXTernal:SYNChronize:OUTPut ON
SOURce:BB:WLAD:TRIGger:EXTernal:DELay 200
SOURce:BB:WLAD:TRIGger:EXTernal:INHibit 100

SOURce:BB:WLAD:TRIGger:SOURce INTB
// the internal trigger signal from the other path must be used
SOURce:BB:WLAD:TRIGger:OBASeband:DELay 25
SOURce:BB:WLAD:TRIGger:OBASeband:INHibit 10

SOURce:BB:WLAD:TRIGger:SEQuence AAUTo
SOURce:BB:WLAD:TRIGger:SOURce INTernal
SOURce:BB:WLAD:STAT ON
SOURce:BB:WLAD:TRIGger:EXEC
```

[:SOURce<hw>]:BB:WLAD:TRIGger:ARM:EXECute

Stops signal generation for trigger modes Armed_Auto and Armed_Retrigger. A subsequent internal or external trigger event restart signal generation.

Example: See Example"Configure and enable triggering" on page 79.

Usage: Event

Manual operation: See "Arm" on page 65

[:SOURce<hw>]:BB:WLAD:TRIGger:EXECute

Executes a trigger. The internal trigger source must be selected using the command `BB:WLAD:TRIG:SOUR INT` and a trigger mode other than AUTO must be selected using the command `BB:WLAD:TRIG:SEQ`.

Example: See Example"Configure and enable triggering" on page 79.

Usage: Event

Manual operation: See "Execute Trigger" on page 65

[:SOURce<hw>]:BB:WLAD:TRIGger:EXTernal:SYNChronize:OUTPut <Output>

Enables signal output synchronous to the trigger event.

Parameters:

<Output> 1 | ON | 0 | OFF

*RST: 1

Example: See Example"Configure and enable triggering" on page 79.

Manual operation: See "Sync. Output to External Trigger/Sync. Output to Trigger" on page 66

[:SOURce<hw>]:BB:WLAD:TRIGger:OBASeband:DELay <Delay>

Stops signal generation for trigger modes Armed_Auto and Armed_Retrigger. A subsequent internal or external trigger event restart signal generation.

Parameters:

<Delay> float

Range: 0 to 65535
Increment: 0.01
*RST: 0

Example: See Example"Configure and enable triggering" on page 79.

Manual operation: See "External Delay/Trigger Delay" on page 67

[:SOURce<hw>]:BB:WLAD:TRIGger:OBASeband:INHibit <Inhibit>

Specifies the number of samples by which a restart is to be inhibited following a trigger event. This command applies only for triggering by the second path.

Parameters:

<Inhibit> integer

Range: 0 to 67108863
*RST: 0

Example: See Example"Configure and enable triggering" on page 79.

Manual operation: See "External Inhibit/Trigger Inhibit" on page 66

[:SOURce<hw>]:BB:WLAD:TRIGger:RMODe?

Queries the current status of signal generation for all trigger modes with IEEE 802.11ad/ay modulation on.

Return values:

<RMode> STOP | RUN

RUN
The signal is generated. A trigger event occurred in the triggered mode.

STOP
The signal is not generated. A trigger event did not occur in the triggered modes, or signal generation was stopped by the command `:BB:WLAD:TRIG:ARM:EXECute` (armed trigger modes only).

*RST: STOP

Example: See Example"Configure and enable triggering" on page 79.

Usage: Query only

Manual operation: See "Running/Stopped" on page 64

[:SOURce<hw>]:BB:WLAD:TRIGger:SLENgth <Slength>

Sets the length of the signal sequence to be output in the "Single" trigger mode (`SOUR:BB:WLAD:SEQ SING`). The input is made in terms of samples.

It is possible to output just part of the frame, an exact sequence of the frame, or a defined number of repetitions of the frame.

Parameters:

<Slength> integer

Range: 1 to 4294967295
*RST: 1

Example: See Example"Configure and enable triggering" on page 79.

[:SOURce<hw>]:BB:WLAD:TRIGger:SLUNit <Slunit>

Sets the unit for the entry of the length of the signal sequence (`SOUR:BB:WLAD:TRIG:SLEN`) to be output in the Single trigger mode (`SOUR:BB:WLAD:SEQ SING`).

Parameters:

<Slunit> SEQuence | SAMPle

SAMPle
Unit Sample. A single sample is generated after a trigger event.

SEQuence
Unit Sequence Length. A single sequence is generated after a trigger event.

*RST: SEQuence

Manual operation: See "Signal Duration Unit" on page 64
See "Signal Duration" on page 64

[:SOURce<hw>]:BB:WLAD:TRIGger:SOURce <Source>

Selects the trigger signal source and determines the way the triggering is executed. Provided are:

- Internal triggering by a command (`INTernal`)
- External trigger signal via one of the local or global connectors
  - `EGT1|EGT2`: External global trigger
  - `EGC1|EGC2`: External global clock
  - `ELTRigger`: External local trigger
  - `ELCLock`: External local clock
- Internal triggering by a signal from the other basebands (`INTA|INTB`)
- `OBASeband|BEXTernal|EXTernal`: Setting only
  Provided only for backward compatibility with other Rohde & Schwarz signal generators.
  The R&S SMW accepts these values and maps them automatically as follows:
  `EXTernal = EGT1`, `BEXTernal = EGT2`, `OBASeband = INTA or INTB`
  (depending on the current baseband)

Parameters:

<Source> INTB | INTernal | OBASeband | EGT1 | EGT2 | EGC1 | EGC2 | ELTRigger | INTA | ELCLock | BEXTernal | EXTernal | BBSY

*RST: INTernal

Example: See Example"Configure and enable triggering" on page 79.

Options: ELTRigger|ELCLock require R&S SMW-B10
BBSY require R&S SMW-B9

Manual operation: See "Source" on page 65

[:SOURce<hw>]:BB:WLAD:TRIGger[:EXTernal]:DELay <Delay>

Sets the trigger delay.

Parameters:

<Delay> float

Range: 0 to 2147483647
Increment: 0.01
*RST: 0

Example: See Example"Configure and enable triggering" on page 79.

Manual operation: See "External Delay/Trigger Delay" on page 67

[:SOURce<hw>]:BB:WLAD:TRIGger[:EXTernal]:INHibit <Inhibit>

Specifies the number of samples by which a restart is to be inhibited following an external trigger event.

Parameters:

<Inhibit> integer

Range: 0 to 37787200000
*RST: 0

Example: See Example"Configure and enable triggering" on page 79.

Manual operation: See "External Inhibit/Trigger Inhibit" on page 66

[:SOURce<hw>]:BB:WLAD[:TRIGger]:SEQuence <Sequence>

Selects the trigger mode.

Parameters:

<Sequence> AUTO | RETRigger | AAUTo | ARETrigger | SINGle

AUTO
The modulation signal is generated continuously.

RETRigger
The modulation signal is generated continuously. A trigger event (internal or external) causes a restart.

AAUTo
The modulation signal is generated only when a trigger event occurs. After the trigger event the signal is generated continuously. Signal generation is stopped with command SOUR:BB:WLAD:TRIG:ARM:EXEC and started again when a trigger event occurs.

ARETrigger
The modulation signal is generated only when a trigger event occurs. The device automatically toggles to RETRIG mode. Every subsequent trigger event causes a restart.
Signal generation is stopped with command `SOUR:BB:WLAD:TRIG:ARM:EXEC` and started again when a trigger event occurs.

SINGle
The modulation signal is generated only when a trigger event occurs. Then the signal is generated once to the length specified with command `SOUR:BB:WLAD:TRIG:SLEN`. Every subsequent trigger event causes a restart.

*RST: AUTO

Example: See Example"Configure and enable triggering" on page 79.

Manual operation: See "Mode" on page 63

[:SOURce<hw>]:BB:WLAD:TRIGger:TIME:DATE <Year>, <Month>, <Day>

Sets the date for a time-based trigger signal. For trigger modes single or armed auto, you can activate triggering at this date via the following command:

`SOURce<hw>:BB:<DigStd>:TRIGger:TIME:STATe`

`<DigStd>` is the mnemonic for the digital standard, for example, `ARB`. Time-based triggering behaves analogously for all digital standards that support this feature.

Parameters:

<Year> integer
Range: 1980 to 9999

<Month> integer
Range: 1 to 12

<Day> integer
Range: 1 to 31

Example: See example "Configure a time-based trigger signal" in the subchapter "Trigger Commands" of the chapter "SOURce:BB:ARB subsystem" in the R&S SMW user manual.

Manual operation: See "Trigger Time" on page 64

[:SOURce<hw>]:BB:WLAD:TRIGger:TIME:TIME <Hour>, <Minute>, <Second>

Sets the time for a time-based trigger signal. For trigger modes single or armed auto, you can activate triggering at this time via the following command:

`SOURce<hw>:BB:<DigStd>:TRIGger:TIME:STATe`

`<DigStd>` is the mnemonic for the digital standard, for example, `ARB`. Time-based triggering behaves analogously for all digital standards that support this feature.

Parameters:

<Hour> integer
Range: 0 to 23

<Minute> integer
Range: 0 to 59

<Second> integer
Range: 0 to 59

Example: See example "Configure a time-based trigger signal" in the subchapter "Trigger Commands" of the chapter "SOURce:BB:ARB subsystem" in the R&S SMW user manual.

Manual operation: See "Trigger Time" on page 64

[:SOURce<hw>]:BB:WLAD:TRIGger:TIME[:STATe] <State>

Activates time-based triggering with a fixed time reference. If activated, the R&S SMW triggers signal generation when its operating system time matches a specified time.

Specify the trigger date and trigger time with the following commands:

`SOURce<hw>:BB:<DigStd>:TRIGger:TIME:DATE`

`SOURce<hw>:BB:<DigStd>:TRIGger:TIME:TIME`

`<DigStd>` is the mnemonic for the digital standard, for example, `ARB`. Time-based triggering behaves analogously for all digital standards that support this feature.

Parameters:

<State> 1 | ON | 0 | OFF
*RST: 0

Example: See example "Configure a time-based trigger signal" in the subchapter "Trigger Commands" of the chapter "SOURce:BB:ARB subsystem" in the R&S SMW user manual.

Manual operation: See "Time Based Trigger" on page 64

7.4 Marker settings

Example: Configure and enable standard marker signals

```
SOURce:BB:WLAD:TRIGger:OUTPut2:MODE?
// Response: "RESTart"
SOURce:BB:WLAD:TRIGger:OUTPut2:FOFFset 10
SOURce:BB:WLAD:TRIGger:OUTPut2:ROFFset 20
SOURce:BB:WLAD:TRIGger:OUTPut3:DELay 16
```

Example: Configure and enable pulse marker signals

```
SOURce:BB:WLAD:TRIGger:OUTPut2:PULSe:DIVider 32
SOURce:BB:WLAD:TRIGger:OUTPut2:MODE PULSe
SOURce:BB:WLAD:TRIGger:OUTPut2:PULSe:FREQency?
// Response in Hz: "110000000"
// The pulse frequency is 110 MHz.
```

Example: Configure and enable frame marker signals

```
SOURce1:BB:WLAD:TRIGger:OUTPut1:MODE FAP
SOURce1:BB:WLAD:TRIGger:OUTPut1:FESHift 10
SOURce1:BB:WLAD:TRIGger:OUTPut1:RESHift 20
```

[:SOURce<hw>]:BB:WLAD:TRIGger:OUTPut<ch>:DELay <Delay>

Defines the delay between the signal on the marker outputs and the start of the signal.

Parameters:

<Delay> float

Range: 0 to 16777215
Increment: 0.001
*RST: 0
Default unit: samples

Example: See Example"Configure and enable standard marker signals" on page 86.

Manual operation: See "Delay" on page 69

[:SOURce<hw>]:BB:WLAD:TRIGger:OUTPut<ch>:FESHift <Shift>

Shifts the falling edge of the marker the specified number of samples. Negative values result in a shift back of the marker edge.

Parameters:

<Shift> integer

Range: -1000 to 1000
*RST: 0

Example: See Example"Configure and enable frame marker signals" on page 86.

Manual operation: See "Mode" on page 68

[:SOURce<hw>]:BB:WLAD:TRIGger:OUTPut<ch>:FINDex <FIndex>

Sets the frame index, the frame to be marked in the frame block.

Parameters:

<FIndex> integer

Range: 1 to 53687
*RST: 1

Manual operation: See "Mode" on page 68

[:SOURce<hw>]:BB:WLAD:TRIGger:OUTPut<ch>:MODE <Mode>

Sets the marker mode.

Parameters:

<Mode> RESTart | FBLock | FRAMe | FAPart | PULSe | PATTern | RATio | FIPart

RESTart
A marker signal is generated at the start of each signal sequence (period = all frame blocks).

FRAMe
Number of Frame Blocks = 1, that is, a marker signal is generated at the start of each frame in the single frame block. Otherwise, the frame block and frame index are entered and the specific frame is masked.

FBLock
Number of Frame Blocks = 1, that is, a marker signal is generated at the start of each frame block. Otherwise, a specific frame block index is given and the whole frame block is marked.

FAPart
Number of Frame Blocks = 1, that is, a marker signal is generated to mark every active part of each frame.
The active data transfer part (PPDU) of a frame period is marked with high, the inactive part (idle time) with low. This marker can be used to decrease the carrier leakage during inactive signal parts by feeding it into the pulse modulator.
Otherwise, the frame block and frame index are entered and the active part of the specific frame is masked.

PATTern
A marker signal is generated according to the user-defined pattern (command `SOURce:BB:WLAD:TRIGger:OUTPut:PATTern`).

PULSe
A pulsed marker signal is generated. The pulse frequency (= symbol rate/divider) is defined with the `SOUR:BB:WLAD:TRIG:OUTP:PULSe:DIVider` command and can be queried with the `SOUR:BB:WLAD:TRIG:OUTP:PULSe:FREQuency?` command.

RATio
A marker signal corresponding to the Time Off / Time On specifications in the commands `SOURce:BB:WLAD:TRIGger:OUTPut:OFFT` and `SOURce:BB:WLAD:TRIGger:OUTPut:ONT` is generated.

*RST: RESTart

Example: See Example"Configure and enable standard marker signals" on page 86.

Manual operation: See "Mode" on page 68

[:SOURce<hw>]:BB:WLAD:TRIGger:OUTPut<ch>:ONTime <OnTime>
[:SOURce<hw>]:BB:WLAD:TRIGger:OUTPut<ch>:OFFTime <OffTime>

Sets the duration during which the marker output is on or off.

*) If R&S SMW-B9 is installed, the minimum marker duration depends on the sample/symbol rate.

See chapter "Basics on ..." in the R&S SMW user manual.

Parameters:

<OffTime> integer

Range: 1 (R&S SMW-B10) / 1* (R&S SMW-B9) to 16777215

*RST: 1

Example: See Example"Configure and enable standard marker signals" on page 86.

Manual operation: See "Mode" on page 68

[:SOURce<hw>]:BB:WLAD:TRIGger:OUTPut<ch>:PATTern <Pattern>, <BitCount>

Defines the bit pattern used to generate the marker signal.

Parameters:

<Pattern> numeric

0 = marker off, 1 = marker on

*RST: #H0

<BitCount> integer

Range: 1 to 64
*RST: 1

Example:

```
SOURce1:BB:WLAD:TRIGger:OUTPut2:MODE PATT
SOURce1:BB:WLAD:TRIGger:OUTPut2:PATTern #H2,2
```

Manual operation: See "Mode" on page 68

[:SOURce<hw>]:BB:WLAD:TRIGger:OUTPut<ch>:PULSe:DIVider <Divider>

Sets the divider for the pulsed marker signal.

*) If R&S SMW-B9 is installed, the minimum marker duration depends on the sample/symbol rate.

See chapter "Basics on ..." in the R&S SMW user manual.

Parameters:

<Divider> integer

Range: 32 to 1024
*RST: 2

Example: See Example"Configure and enable pulse marker signals" on page 86.

Manual operation: See "Mode" on page 68

[:SOURce<hw>]:BB:WLAD:TRIGger:OUTPut<ch>:PULSe:FREQuency?

Queries the pulse frequency of the pulsed marker signal in the setting `SOURce:BB:WLAD:TRIGger:OUTPut:MODE PULSe`. The pulse frequency is derived by dividing the symbol rate by the divider.

Return values:

<Frequency> float

Range: 2 to 1024
Increment: 1E-3
*RST: 2

Example: See Example"Configure and enable pulse marker signals" on page 86.

Usage: Query only

Manual operation: See "Mode" on page 68

[:SOURce<hw>]:BB:WLAD:TRIGger:OUTPut<ch>:RESHift <Shift>

Shifts the rising edge of the marker the specified number of samples. Negative values result in a shift back of the marker edge.

Parameters:

<Shift> integer

Range: -1000 to 1000
*RST: 0

Example: See Example"Configure and enable frame marker signals" on page 86.

Manual operation: See "Mode" on page 68

7.5 Clock commands

Example: Configuring clock settings

```
SOURce1:BB:WLAD:CLOCk:SOURce?
// Response: "INT"
// The instrument usses its internal clock source.
```

Commands:

[:SOURce<hw>]:BB:WLAD:CLOCk:SOURce <Source>

Selects the clock source.

Parameters:

<Source> INTernal

INTernal
The instrument uses its internal clock reference.

*RST: INTernal

Example: See Example"Configuring clock settings" on page 90.

Options: ELCLock requires R&S SMW-B10

Manual operation: See "Clock Source" on page 70

7.6 802.11ad frame configuration commands

7.6.1 General commands

[:SOURce<hw>]:BB:WLAD:ITIMe <ITime>

Sets the idle time, the time delay between the frames.

Parameters:

<ITime> float

Range: 0 to 0.01
Increment: 1E-7
*RST: 1E-6

Manual operation: See "Idle Time" on page 30

[:SOURce<hw>]:BB:WLAD:SLENgth <SLength>

Sets the sequence length.

Parameters:

<SLength> integer

Range: 1 to 53687
*RST: 1

Manual operation: See "Sequence Length" on page 30

7.6.2 Frame block PPDU configuration

[:SOURce<hw>]:BB:WLAD:PCONfig:BTRequest:STATe <BTR>

Activates/deativates the beam tracking request.

Parameters:

<BTR> 1 | ON | 0 | OFF

*RST: 0

Manual operation: See "Beam Tracking Request" on page 43

[:SOURce<hw>]:BB:WLAD:PCONfig:CODing:RATE <Rate>

Sets the coding rate.

Parameters:

<Rate> CR1D2 | CR3D4 | CR5D8 | CR13D14 | CR13D16 | CR13D21 | CR13D28 | CR52D63 | CR7D8 | CR2D3 | CR5D6

*RST: CR1D2

Manual operation: See "Code Rate" on page 41

[:SOURce<hw>]:BB:WLAD:PCONfig:CODing:TYPE <Type>

Sets the channel coding type. You can set low-density parity-check (LDPC) coding only.

Parameters:

<Type> LDPC

LDPC
Low-density parity-check (LDPC) coding

*RST: LDPC

Manual operation: See "Channel Coding" on page 41

[:SOURce<hw>]:BB:WLAD:PCONfig:DATA <Data>

Sets the data source.

Parameters:

<Data> ZERO | ONE | PATTern | PN9 | PN11 | PN15 | PN16 | PN20 | PN21 | PN23 | DLISt | AMPDU

*RST: PN9

Manual operation: See "Data Source" on page 31

[:SOURce<hw>]:BB:WLAD:PCONfig:DATA:DSELection <DSelection>

Selects a data list, for the DLIST data source selection.

The lists are stored as files with the fixed file extensions `*.dm_iqd` in a directory of the user's choice. The directory applicable to the following commands is defined with the command `MMEMory:CDIR`. To access the files in this directory, you only have to give the file name without the path and the file extension.

Parameters:

<DSelection> string

Example: `BB:WLAD:FBL5:DATA DLIS`
Selects the data lists data source.
`MMEM:CDIR '/var/user/temp/Lists_DM'`
Selects the directory for the data lists.
`BB:WLAD:FBL5:DATA:DSEL 'dlist1'`
Selects file '`dlist1`' as the data source. This file must be in the directory `/var/user/temp/Lists_DM` and have the file extension `*.dm_iqd`.

Manual operation: See "Data Source" on page 31

[:SOURce<hw>]:BB:WLAD:PCONfig:DATA:LENGth <Length>

Sets the size of the data field in bytes.

The data length is related to the number of data symbols that is set with `:BB:WLAD:PCON:DATA:SYMB`. Whenever the data length changes, the number of data symbols is updated and vice versa.

Parameters:

<Length> integer

Range: 1 to 262107
*RST: 1024

Manual operation: See "Data Length" on page 32
See "A-MPDU Length" on page 32

[:SOURce<hw>]:BB:WLAD:PCONfig:DATA:PATTern <Pattern>, <BitCount>

Sets the data pattern if `:BB:WLAD:PCON:DATA PATT`.

Parameters:

<Pattern> numeric

*RST: #H0

<BitCount> integer

Range: 1 to 64
*RST: 1

Manual operation: See "Data Source" on page 31

[:SOURce<hw>]:BB:WLAD:PCONfig:DATA:RATE?

Queries the PPDU data rate.

Return values:

<Rate> float

Range: 0 to LONG_MAX
Increment: 0.01
*RST: 0

Usage: Query only

Manual operation: See "Data Rate" on page 41

[:SOURce<hw>]:BB:WLAD:PCONfig:EMINdication <ExtScMcsInd>

The value of this field indicates the length of the PSDU.

Parameters:

<ExtScMcsInd> 1 | ON | 0 | OFF

*RST: 0

Manual operation: See "Extended SC MCS Indication" on page 43

[:SOURce<hw>]:BB:WLAD:PCONfig:LRSSi <LRssi>

Sets the last RSSI.

Parameters:

<LRssi> NA | M68 | M67 | M65 | M63 | M61 | M59 | M57 | M55 | M53 | M51 | M49 | M47 | M45 | M43 | M42

*RST: NA

Manual operation: See "Last RSSI" on page 43

[:SOURce<hw>]:BB:WLAD:PCONfig:MCS <MCS>

Selects the modulation and coding scheme for all spatial streams.

Parameters:

<MCS> MCS0 | MCS1 | MCS2 | MCS3 | MCS4 | MCS5 | MCS6 | MCS7 | MCS8 | MCS9 | MCS10 | MCS11 | MCS12 | MCS13 | MCS14 | MCS15 | MCS16 | MCS17 | MCS18 | MCS19 | MCS20 | MCS21 | MCS22 | MCS23 | MCS24 | MCS25 | MCS26 | MCS27 | MCS28 | MCS29 | MCS30 | MCS31 | MCS91 | MCS121 | MCS122 | MCS125 | MCS123 | MCS124 | MCS126

*RST: MCS1

Manual operation: See "MCS" on page 40

[:SOURce<hw>]:BB:WLAD:PCONfig:MTYPe <MType>

Sets the modulation type.

Parameters:

<MType> DBPSK | SQPSK | QPSK | QAM16 | QAM64 | P2BPSK | P2QPSK | P2QAM16 | P2QAM64 | P2PSK8 | P2NUC64 | DCMP2BPSK

*RST: P2BPSK

Manual operation: See "Modulation" on page 41

[:SOURce<hw>]:BB:WLAD:PCONfig:PREamble:STATe <State>

Activates/deactivates the preamble and signal fields of the frames in the frame block.

Parameters:

<State> 1 | ON | 0 | OFF

*RST: 1

Manual operation: See "Preamble/Header Active" on page 42

[:SOURce<hw>]:BB:WLAD:PCONfig:PTYPe <PType>

Selects the packet type.

Selectable packet types depend on the PHY format:

- DMG format: Packet type is a receive training packet (TRN-R) or transmit training packet (TRN-T).
- EDMG format: Packet type is a receive training packet (TRN-R), transmit training packet (TRN-T) or receive/transmit training packet (TRN-R/T).

Parameters:

<PType> TRNR | TRNT | TRNTR

TRNR
Receive training packet. The data part of a packet is followed by one or more TRN-R subfields; or a packet is requesting that a TRN-R subfield is added to a future response packet.

TRNT
Transmit training packet. The data part of packet is followed by one or more TRN-T subfields.

TRNTR
Receive/transmit training packet. The data part of packet is followed by one or more TRN-R/T subfields.

*RST: TRNR

Manual operation: See "Packet Type" on page 43

[:SOURce<hw>]:BB:WLAD:PCONfig:REPetition <Rep>

Sets the repetition number.

Parameters:

<Rep> integer

Range: 1 to 2
*RST: 2

Manual operation: See "Repetition" on page 41

[:SOURce<hw>]:BB:WLAD:PCONfig:SCRambler:MODE <Mode>

Activates scrambling.

Parameters:

<Mode> 1 | ON | 0 | OFF

*RST: 1

Manual operation: See "Scrambler" on page 41

[:SOURce<hw>]:BB:WLAD:PCONfig:SCRambler:PATTern <Pattern>, <BitCount>

Sets the scrambler initialization value when `:BB:WLAD:PCON:SCR:MODE ON`.

Parameters:

<Pattern> numeric

*RST: #H0

<BitCount> integer

Range: 1 to 4
*RST: 1

Manual operation: See "Scrambler Init (hex)" on page 42

[:SOURce<hw>]:BB:WLAD:PCONfig:TARound:STATe <TAround>

Activates turnaround.

Parameters:

<TAround> 1 | ON | 0 | OFF

*RST: 1

Manual operation: See "Turnaround" on page 43

[:SOURce<hw>]:BB:WLAD:PCONfig:TLENgth <TLen>

Sets the training length.

Parameters:
<TLen> integer
Range: 0 to 16
*RST: 0

Manual operation: See "Training Length" on page 43

7.6.3 Frame block MPDU configuration

[:SOURce<hw>]:BB:WLAD:PCONfig:MPDU:COUNt <Count>

Sets the number of MPDUs in the frame.

Parameters:
<Count> integer
Range: 1 to 64
*RST: 1

Manual operation: See "Number of MPDUs" on page 33

[:SOURce<hw>]:BB:WLAD:PCONfig:MPDU<st>:DATA:DSELection <Filename>

Selects the data list for the DLISt data source selection.

The lists are stored as files with the fixed file extensions `*.dm_iqd` in a directory of the user's choice.

Parameters:
<Filename> string

Manual operation: See "Data/DList / Pattern" on page 33

[:SOURce<hw>]:BB:WLAD:PCONfig:MPDU<st>:DATA:LENGth <Length>

Determines the size of the data field in bytes.

Parameters:
<Length> integer
Range: 0 to 4096
*RST: 1024

Manual operation: See "Data Length (bytes)" on page 33

[:SOURce<hw>]:BB:WLAD:PCONfig:MPDU<st>:DATA:PATTern <Pattern>, <BitCount>

Determines the bit pattern for the PATTern selection.

Parameters:

<Pattern> numeric
*RST: #H0

<BitCount> integer
Range: 1 to 64
*RST: 1

Manual operation: See "Data/DList / Pattern" on page 33

[:SOURce<hw>]:BB:WLAD:PCONfig:MPDU<st>:DATA:SOURce <Source>

Selects the data source.

Parameters:

<Source> ZERO | ONE | PATTern | PN9 | PN11 | PN15 | PN16 | PN20 | PN21 | PN23 | DLISt

PNxx
The pseudo-random sequence generator is used as the data source. Different random sequence lengths can be selected.

DLISt
A data list is used. The data list is selected with the command `BB:WLAD:FBL<ch>:MPDU<st>:DATA:DSEL`

ZERO | ONE
Internal 0 or 1 data is used.

PATTern
Internal data is used. The bit pattern for the data is defined by the command `BB:WLAD:FBL<ch>:MPDU<st>:DATA:PATT`.

*RST: PN9

Manual operation: See "Data/DList / Pattern" on page 33

7.6.4 MAC header configuration

[:SOURce<hw>]:BB:WLAD:PCONfig:MAC:ADDRess<st> <Address>

Sets the value of the address fields 1 ... 4. Exactly 48 bits must be entered. Each address is 6 bytes (48 bit) long. The addresses can be entered in hexadecimal form in the entry field of each address field. The least significant byte (LSB) is in left notation.

Parameters:

<Address> 48 bits

Example: `BB:WLAD:PCON:MAC:ADDR2 #H124836C7EA54,48`
Set the value for address field 2.

[:SOURce<hw>]:BB:WLAD:PCONfig:MAC:ADDRess<st>:STATe <State>

Activates/deactivates the selected address field.

Parameters:

<State> 1 | ON | 0 | OFF
*RST: 0

Manual operation: See "MAC Address" on page 35

[:SOURce<hw>]:BB:WLAD:PCONfig:MAC:DID <Did>

Sets the value of the duration ID field. Depending on the frame type, the 2-byte field Duration/ID is used to transmit the association identity of the station transmitting the frame or it indicates the duration assigned to the frame type. Exactly 16 bit must be entered.

Parameters:

<Did> 16 bits

Manual operation: See "Duration Id" on page 35

[:SOURce<hw>]:BB:WLAD:PCONfig:MAC:FCONtrol <FControl>

Sets the value of the frame control field. The frame control field has a length of 2 bytes (16 bits) and is used to define, for example, the protocol version, the frame type, and its function. As an alternative, the individual bits can be set.

Parameters:
<FControl> 16 bits

Manual operation: See "Frame Control (hex)/MAC Frame Control Field" on page 37

[:SOURce<hw>]:BB:WLAD:PCONfig:MAC:FCONtrol:CFEXtension <Extension>
[:SOURce<hw>]:BB:WLAD:PCONfig:MAC:FCONtrol:FDS <Fds>
[:SOURce<hw>]:BB:WLAD:PCONfig:MAC:FCONtrol:MDATa <MData>
[:SOURce<hw>]:BB:WLAD:PCONfig:MAC:FCONtrol:MFRagments <MFragments>
[:SOURce<hw>]:BB:WLAD:PCONfig:MAC:FCONtrol:ORDer <Order>
[:SOURce<hw>]:BB:WLAD:PCONfig:MAC:FCONtrol:PFRame <ProtdFrm>
[:SOURce<hw>]:BB:WLAD:PCONfig:MAC:FCONtrol:PMANagement <PManagement>
[:SOURce<hw>]:BB:WLAD:PCONfig:MAC:FCONtrol:PVERsion <PVersion>
[:SOURce<hw>]:BB:WLAD:PCONfig:MAC:FCONtrol:RETRy <Retry>
[:SOURce<hw>]:BB:WLAD:PCONfig:MAC:FCONtrol:SUBType <Subtype>
[:SOURce<hw>]:BB:WLAD:PCONfig:MAC:FCONtrol:TDS <Tds>
[:SOURce<hw>]:BB:WLAD:PCONfig:MAC:FCONtrol:TYPE <Type>

Set the value of the individual bits of the frame control field.

Parameters:
<Type> 2 bits

Manual operation: See "Frame Control (hex)/MAC Frame Control Field" on page 37

[:SOURce<hw>]:BB:WLAD:PCONfig:MAC:FCS:STATe <State>

Activates/deactivates the calculation of the frame check sequence (FCS) .

Parameters:
<State> 1 | ON | 0 | OFF
*RST: 0

Manual operation: See "FCS (checksum)" on page 35

[:SOURce<hw>]:BB:WLAD:PCONfig:MAC:QSControl <QsControl>

Sets the value for the QoS control field.

Parameters:
<QsControl> 16 bits

Manual operation: See "QoS Ctrl (hex)" on page 37

[:SOURce<hw>]:BB:WLAD:PCONfig:MAC:QSControl:STATe <State>

Enables/disables the QoS control.

Parameters:
<State> 1 | ON | 0 | OFF
*RST: 1

Manual operation: See "QoS Ctrl (hex)" on page 37

[:SOURce<hw>]:BB:WLAD:PCONfig:MAC:SCONtrol:FRAGment:INCRement <Increment>

Sets the number of packets required to increment the counter of the fragment bits of the sequence control.

Parameters:
<Increment> integer
Range: 0 to 1024
*RST: 1

Manual operation: See "Increment Every" on page 37

[:SOURce<hw>]:BB:WLAD:PCONfig:MAC:SCONtrol:FRAGment:STARt <Start>

Sets the start number of the fragment bits of the sequence control.

Parameters:
<Start> 4 bits

Manual operation: See "Start Number (hex)" on page 36

[:SOURce<hw>]:BB:WLAD:PCONfig:MAC:SCONtrol:SEQuence:INCRement <Increment>

Sets the number of packets required to increment the counter of the sequence bits of the sequence control.

Parameters:
<Increment> integer
Range: 0 to 1024
*RST: 1

Manual operation: See "Increment Every" on page 37

[:SOURce<hw>]:BB:WLAD:PCONfig:MAC:SCONtrol:SEQuence:STARt <Start>

Sets the start number of the fragment bits of the sequence control.

Parameters:
<Start> 12 bits

Manual operation: See "Start Number (hex)" on page 36

[:SOURce<hw>]:BB:WLAD:PCONfig:MAC:SCONtrol:STATe <State>

Activates/deactivates the sequence control.

Parameters:
<State> 1 | ON | 0 | OFF
*RST: 0

Manual operation: See "Sequence Control" on page 36

[:SOURce<hw>]:BB:WLAD:PCONfig:MAC:STATe <State>

Activates/deactivates the generation of the MAC Header.

Parameters:
<State> 1 | ON | 0 | OFF
*RST: 0

Manual operation: See "MAC Header" on page 35

7.7 802.11ay frame configuration commands

Example: Configuring EDMG general settings

```
// ****************************************************************************
// Set for EDMG SC PHY mode and configure general settings.
// ****************************************************************************
SOURce1:BB:WLAD:DPMode ESINgle
SOURce1:BB:WLAY:PCONfig:HDA:BW?
// Response: "BW216"
// Channel bandwidth is 2.16 GHz.
```

Example: Configuring EDMG header settings

```
// ****************************************************************************
// Configure and monitor L-Header settings.
// ****************************************************************************
// Query the PPDU aggregation state.
SOURce1:BB:WLAY:PCONfig:LHDR:PAGR:STATe?
// Response: "0"
// PPDU aggrgation is off.
SOURce1:BB:WLAY:PCONfig:LHDR:ADDP:STATe?
// Response: "0"
// No addtional PDDU is active.
SOURce1:BB:WLAY:PCONfig:LHDR:GITYpe NORMal
// Sets normal guard interval length.
```

```
// ******************************************************************************
// Configure EDMG-Header-A and EDMG-Header-B settings.
// ******************************************************************************
SOURce1:BB:WLAY:PCONfig:HDA:MU:STATe?
// Response: "0"
// Multi-user (MU) state is off. The PPDU is a single-user (SU) PPDU.
SOURce1:BB:WLAY:PCONfig:HDA:AGGRegate:STATe?
// Response: "0"
// Channel aggregate state is off.
// Set a channel configuration of 3.
SOURce1:BB:WLAY:PCONfig:HDA:CCONfig 3
// The associated primary channel is 3.
SOURce1:BB:WLAY:PCONfig:HDA:PCHannel?
// Response: "3"
SOURce1:BB:WLAY:PCONfig:HDA:BF:STATe?
// Response: "0"
// Digital beamforming is off.
// Set for base MCS 2.
SOURce1:BB:WLAY:PCONfig:HDA:BMCS 2
// Query related parameters modulation type, code rate and data rate.
SOURce1:BB:WLAD:PCONfig:MTYPe?
// Response: "P2BPSK"
// The modulation type is π/2-BPSK modulation.
SOURce1:BB:WLAD:PCONfig:CODing:RATE?
// Response: "CR1D2"
// Code rate is 1/2.
SOURce1:BB:WLAD:PCONfig:DATA:RATE?
// Response in Mbit/s: "770"
```

Example: Configuring user settings

```
// ******************************************************************************
// Set for EDMG SC PHY mode and configure general settings.
// ******************************************************************************
SOURce1:BB:WLAY:PCONfig:UCONfig:MIMO:STATe?
// Response: "0"
// MIMO is off. The PPDU is a SU PPDU.
SOURce1:BB:WLAY:PCONfig:UCONfig:USER:STATe?
// Response: "1"
SOURce1:BB:WLAY:PCONfig:UCONfig:USID?
// Response: "1"
// User 1 state is active and the station ID is 1.
SOURce1:BB:WLAY:PCONfig:UCONfig:USRNumber?
// Response: "1"
SOURce1:BB:WLAY:PCONfig:SSNumber?
// Response: "1"
// No other users are active, because there is only one spatial stream.
```

Example: Configuring data and MCS settings

```
// ****************************************************************************
// Set the base MCS 1 for user 1.
// ****************************************************************************
SOURce1:BB:WLAY:PCONfig:HDA:BMCS 1
// Query modulation type and code rate, guard interval and data rate.
SOURce1:BB:WLAD:PCONfig:MTYPE?
// Response: "P2BPSK"
// π/2-BPSK modulation is active.

SOURce1:BB:WLAD:PCONfig:CODing:RATE?
// Response: "CR1D2"
// Coding rate is 1/2.
SOURce1:BB:WLAD:PCONfig:CODing:TYPE?
// Response: "LDPC"
SOURce1:BB:WLAY:PCONfig:LHDR:GITYpe?
// Response "NORMal"
SOURce1:BB:WLAD:PCONfig:DATA:RATE?
// Response in Mbit/s: "412.5"
```


7.7.1 EDMG general commands

[:SOURce<hw>]:BB:WLAY:PCONfig:BSBNumber <BrpMinScBlkNum>

Sets the minimum duration of data.

Parameters:

<BrpMinScBlkNum> integer

Range: 1 to 18
*RST: 1

Example: See Example"Configuring EDMG general settings" on page 102.

Manual operation: See "Minimum Duration of Data" on page 47

[:SOURce<hw>]:BB:WLAY:PCONfig:CSDState <CsdState>

Activates cyclic shift diversity (CSD).

Parameters:
<CsdState> 1 | ON | 0 | OFF
*RST: 0

Example: See Example"Configuring EDMG general settings" on page 102.

Manual operation: See "CSD Apply" on page 47

[:SOURce<hw>]:BB:WLAY:PCONfig:PSK:STATe <PSKState>

Activates π/2-8PSK modulation.

If activated, the bit in the π/2-8-PSK Applied field is 1. If deactivated, applies π/2-16QAM modulation. The bit in the π/2-8-PSK Applied field is 0.

Parameters:
<PSKState> 1 | ON | 0 | OFF
*RST: 0

Manual operation: See "PI/2-8-PSK Applied" on page 52

[:SOURce<hw>]:BB:WLAY:PCONfig:SSNumber <SSNum>

Queries the number of spatial streams.

Parameters:
<SSNum> integer
Range: 1 to 8
*RST: 1

Example: See Example"Configuring EDMG general settings" on page 102.

Manual operation: See "Spatial Streams" on page 47

[:SOURce<hw>]:BB:WLAY:PCONfig:TRAGgregate <TrnAggregate>

Sets the training (TRN) aggregation mode.

The modes are defined by the 1-bit TRN Aggregation field of the EDMG-Header-A_2 subfield.

Parameters:
<TrnAggregate> WB | ATRN

WB
WidebandTRN
TRN Aggregation field is 0. The bandwidth (BW) field specifies that the TRN field of the PPDU is appended on a 2.16 GHz, 4.32 GHz, 6.48 GHz, or 8.64 GHz channel.

ATRN
AggregationTRN
TRN Aggregation field is 1. The BW field specifies that the TRN field is transmitted over a 2.16+2.16 GHz or 4.32+4.32 GHz channel.

*RST: WB

Example: See Example"Configuring EDMG general settings" on page 102.

Manual operation: See "TRN Aggregation" on page 47

7.7.2 L-Header commands

[:SOURce<hw>]:BB:WLAY:PCONfig:LHDR:ADDP:STATe <AddiPpdu>

If PPDU aggregation is active, activates an additional PPDU.

See `[:SOURce<hw>]:BB:WLAY:PCONfig:LHDR:PAGR:STATe` on page 106.

Parameters:
<AddiPpdu> 1 | ON | 0 | OFF

*RST: 0

Example: See Example"Configuring EDMG header settings" on page 102.

Manual operation: See "Additional PPDU" on page 49

[:SOURce<hw>]:BB:WLAY:PCONfig:LHDR:GITYpe <GiType>

Selects the type of the guard interval (GI). You can select between GI types short, normal or long.

Parameters:
<GiType> SHORT | NORMAL | LONG

*RST: SHORT

Example: See Example"Configuring EDMG header settings" on page 102.

Manual operation: See "GI Type" on page 50

[:SOURce<hw>]:BB:WLAY:PCONfig:LHDR:PAGR:STATe <PpduAggregate>

Queries the PPDU aggregation state that is off.

Parameters:
<PpduAggregate> 1 | ON | 0 | OFF

*RST: 0

Example: See Example"Configuring EDMG header settings" on page 102.

Manual operation: See "PPDU Aggregation" on page 49

7.7.3 EDMG-Header-A commands

[:SOURce<hw>]:BB:WLAY:PCONfig:HDA:AGGRegate:STATe <Aggregate>

Queries the channel aggregate state that is off.

Parameters:
<Aggregate> 1 | ON | 0 | OFF
*RST: 0

Example: See Example"Configuring EDMG header settings" on page 102.

Manual operation: See "Channel Aggregate" on page 51

[:SOURce<hw>]:BB:WLAY:PCONfig:HDA:BF:STATe <Beamforming>

If activated, applies digital beamforming.

Parameters:
<Beamforming> 1 | ON | 0 | OFF
*RST: 0

Example: See Example"Configuring EDMG header settings" on page 102.

Manual operation: See "Beamformed" on page 52

[:SOURce<hw>]:BB:WLAY:PCONfig:HDA:BMCS <BaseMcs>

Selects the modulation and coding scheme (MCS) for all spatial streams.

The current firmware supports MSC for EDMG SC mode only, see Table 5-2, for example.

Parameters:

<BaseMcs> integer

Range: 1 to 21
*RST: 1

Example: See Example"Configuring EDMG header settings" on page 102.

Manual operation: See "Base MCS" on page 57

[:SOURce<hw>]:BB:WLAY:PCONfig:HDA:BW <Bw>

Sets the bandwidth of the EDMG single carrier signal that is a multiple of 2.16 GHz.

Parameters:

<Bw> BW216 | BW432

BW216
2.16 GHz bandwidth

BW432
Requires R&S SMW-K555. 4.32 GHz bandwidth

*RST: BW216

Example: See Example"Configuring EDMG header settings" on page 102.

Manual operation: See "Bandwidth" on page 45

[:SOURce<hw>]:BB:WLAY:PCONfig:HDA:CCONfig <ChannelConfig>

Sets the channel configuration that is the configuration 2.16 GHz and 4.32 GHz channels.

Parameters:

<ChannelConfig> integer

Range: 1 to 176
*RST: 1

Example: See Example"Configuring EDMG header settings" on page 102.

Manual operation: See "Channel Configuration" on page 51

[:SOURce<hw>]:BB:WLAY:PCONfig:HDA:LLDPc:STATe <Lpdc>

Activates long low-density parity-check (LDPC) codewords. If disabled, the firmware uses short LDPC codewords.

Parameters:

<Lpdc> 1 | ON | 0 | OFF

*RST: 0

Example: See Example"Configuring EDMG header settings" on page 102.

Manual operation: See "Long LDPC" on page 52

[:SOURce<hw>]:BB:WLAY:PCONfig:HDA:MCS:DPT:STATe <DualPolarTrn>

Activates dual polarisation TRN training.

Parameters:
<DualPolarTrn> 1 | ON | 0 | OFF
*RST: 0

Example: See Example"Configuring EDMG header settings" on page 102.

Manual operation: See "Dual Polarization TRN Training" on page 53

[:SOURce<hw>]:BB:WLAY:PCONfig:HDA:MCS:FPT:STATe <FirPathTrning>

Activates first path training.

Parameters:
<FirPathTrning> 1 | ON | 0 | OFF
*RST: 0

Example: See Example"Configuring EDMG header settings" on page 102.

Manual operation: See "First Path Training" on page 53

[:SOURce<hw>]:BB:WLAY:PCONfig:HDA:MU:STATe <MuState>

Queries the multi-user (MU) format state that is off.

Parameters:
<MuState> 1 | ON | 0 | OFF
*RST: 0

Example: See Example"Configuring EDMG header settings" on page 102.

Manual operation: See "MU Format" on page 51

[:SOURce<hw>]:BB:WLAY:PCONfig:HDA:NUC:STATe <Nuc>

Activates nonuniform constellation (NUC) modulation.

Parameters:
<Nuc> 1 | ON | 0 | OFF
*RST: 0

Example: See Example"Configuring EDMG header settings" on page 102.

Manual operation: See "NUC" on page 53

[:SOURce<hw>]:BB:WLAY:PCONfig:HDA:PCHannel?

Queries the primary channel number as set via the channel configuration, see Table 5-1.

Return values:

<PrimaryCha> float

Range: 1 to 8
*RST: 1

Example: See Example"Configuring EDMG header settings" on page 102.

Usage: Query only

Manual operation: See "Primary Channel" on page 52

[:SOURce<hw>]:BB:WLAY:PCONfig:HDA:RTPT <RxTrnTxTrn>

Sets the number of receive (RX) TRN units per transmit (TX) TRN unit.

Parameters:

<RxTrnTxTrn> integer

Range: 1 to 255
*RST: 1

Example: See Example"Configuring EDMG header settings" on page 102.

Manual operation: See "RX TRN-Units per Each TX TRN-Unit" on page 54

[:SOURce<hw>]:BB:WLAY:PCONfig:HDA:STBC:STATe <STBC>

Queries the state of space-time block coding that is off.

Parameters:

<STBC> 1 | ON | 0 | OFF

*RST: 0

Example: See Example"Configuring EDMG header settings" on page 102.

Manual operation: See "STBC" on page 52

[:SOURce<hw>]:BB:WLAY:PCONfig:HDA:TRNM <TrnM>

Sets the bits in the 4-bit EDMG TRN-Unit M field.

Parameters:

<TrnM> integer

Range: 0 to 15
*RST: 0

Example: See Example"Configuring EDMG header settings" on page 102.

Manual operation: See "Training M" on page 54

[:SOURce<hw>]:BB:WLAY:PCONfig:HDA:TRNN <TrnN>

Sets the bits in the 2-bit EDMG TRN-Unit N field.

Parameters:

<TrnN> integer

Range: 0 to 3
*RST: 0

Example: See Example"Configuring EDMG header settings" on page 102.

Manual operation: See "Training N" on page 54

[:SOURce<hw>]:BB:WLAY:PCONfig:HDA:TRNP <TrnP>

Sets the bits in the 2-bit EDMG TRN-Unit P field.

Parameters:

<TrnP> integer

Range: 0 to 3
*RST: 0

Example: See Example"Configuring EDMG header settings" on page 102.

Manual operation: See "Training P" on page 54

[:SOURce<hw>]:BB:WLAY:PCONfig:HDA:TSL <TrnSeqLen>

Sets training sequence length as set with the 2-bit subfield "Sequence Length" of the TRN field.

Parameters:

<TrnSeqLen> NORMAL | LONG | SHORT

NORMAL
Normal sequence length of 128 × N_{CB} with subfield value 0.

LONG
Long sequence length of 256 × N_{CB} with subfield value 1.

SHORT
Short sequence length of 64 × N_{CB} with subfield value 2.

*RST: NORMAL

Example: See Example"Configuring EDMG header settings" on page 102.

Manual operation: See "Training Sequence Length" on page 54

7.7.4 EDMG-Header-B commands

[:SOURce<hw>]:BB:WLAY:PCONfig:HDB:DMCS <DiffMcs>

Sets the differential EDMG modulation and coding scheme (MCS).

The corresponding field is a 2-bit field after the Base MCS field of the EDMG-Header-B field.

Parameters:

<DiffMcs> integer

Range: 0 to 3
*RST: 0

Example: See Example"Configuring EDMG header settings" on page 102.

[:SOURce<hw>]:BB:WLAY:PCONfig:HDB:SCRS <ScraSeed>

Sets the scrambler seed value.

The corresponding field is a 7-bit field at the beginning of the EDMG-Header-B field.

Parameters:

<ScraSeed> integer

Range: 0 to 63
*RST: 0

Example: See Example"Configuring EDMG header settings" on page 102.

[:SOURce<hw>]:BB:WLAY:PCONfig:HDB:SIC:STATe <SuperimposedCod>

If activated, applies superimposed code with LDPC codewords.

Parameters:

<SuperimposedCod> 1 | ON | 0 | OFF

*RST: 0

Example: See Example"Configuring EDMG header settings" on page 102.

Manual operation: See "Superimposed Code" on page 53

7.7.5 User commands

[:SOURce<hw>]:BB:WLAY:PCONfig:UCONfig:MIMO:STATe <MimoState>

Queries if the current user uses multi-user (MU) MIMO.

All MU-MIMO users share one resource unit (RU) using different space time streams.

Parameters:
<MimoState> 1 | ON | 0 | OFF
*RST: 0

Example: See Example"Configuring user settings" on page 103.

Manual operation: See "MU MIMO" on page 55

[:SOURce<hw>]:BB:WLAY:PCONfig:UCONfig:USER:STATe <UsrState>

Activates the respective user.

The current firmware provides one user (one spatial stream) that is active.

There are no suffixes to specify more users. An SU PPDU is transmitted.

Parameters:
<UsrState> 1 | ON | 0 | OFF
*RST: 0

Example: See Example"Configuring user settings" on page 103.

Manual operation: See "State" on page 56

[:SOURce<hw>]:BB:WLAY:PCONfig:UCONfig:USID <UsrStateId>

Sets the station ID, the 11 least significant bits of the association identifier (AID).

Parameters:
<UsrStateId> integer
Range: 1 to 2047
*RST: 1

Example: See Example"Configuring user settings" on page 103.

Manual operation: See "STA Id" on page 55

[:SOURce<hw>]:BB:WLAY:PCONfig:USRNumber <UsrNum>

Queries the number of users.

The maximum number of users equals the maximum number of spatial streams that is 8.

Parameters:
<UsrNum> integer
Range: 1 to 8
*RST: 1

Example: See Example"Configuring user settings" on page 103.

Glossary: Abbreviations and terms

A

A-MPDU: Aggregate MPDU

D

DMG: Directional multi-gigabit

DTP: Dynamic tone pairing

E

EDMG: Enhanced directional multi-gigabit

F

FEC: Forward error correction

M

MAC: Media access control

MCS: Modulation and coding scheme

MPDU: MAC protocol data unit

MSDU: MAC service data unit

N

NUC: Nonuniform constellation

Q

QAM: Quadrature amplitude modulation

QoS: Quality of service

R

RSSI: Received signal strength indicator

S

SPC: Single parity check

Glossary: Specifications and references

Symbols

1MA220: Rohde & Schwarz white paper 1MA220 "802.11ad - WLAN at 60 GHz A Technology Introduction"

I

IEEE Std 802.11ad™-2012: "Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications"
Amendment 3: Enhancements for Very High Throughput in the 60 GHz Band

IEEE Std 802.11ay™-2021: "Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications"
Amendment 2: Enhanced Throughput for Operations in License-exempt Bands above 45 GHz

List of commands

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