

R&S[®]SMW-K114

OFDM Signal Generation

User Manual



1177624602
Version 19

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This document describes the following software options:

- R&S®SMW-K114 OFDM Signal Generation (1414.1985.xx)

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

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

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1 Welcome to the OFDM Signal Generation option

The options R&S SMW-K114 is a firmware application that adds functionality to generate the following:

- User-defined OFDM signals
- 5G NR test signals in accordance with the [5G NOW](#) project specification [5G NOW D3.x](#).

With the provided settings, you can generate any of the specified waveform types and parameterize the signals. For example, you can select the pulse shaping filters, the subcarrier spacing and the number of carriers. Moreover, you can set the used modulation and data content and enable preamble and cyclic prefix generation. Configuration of the sparse code multiple access (SCMA) settings is supported, too.

The generated signal is suitable for testing of components or receivers with user-defined OFDM signals, realistic 5G physical layer signals.

R&S SMW-K114 key features

- Support of GFDM, UFMC, FBMC, f-OFDM and OFDM real-time signal generation
- Support of GFDM, UFMC, FBMC, f-OFDM and OFDM waveforms
- Support of the proposed filter types
- Flexible resource allocation, independent of the frame-type structure
- Flexibly switching between different modulation formats, filters, symbol rates
- Support of multiple access schemes such as SCMA
- Optional use of a cyclic prefix or a preamble
- Internal signal generator solution, no need for external PC
- For f-OFDM and OFDM modulations, automatic generation of configuration file for upload in the R&S®VSE-K96.
- Optional discrete Fourier transform spread OFDM (DFT-s-OFDM) for data allocations
- Optional zero padding on a sample level

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

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

www.rohde-schwarz.com/manual/SMW200A

Installation

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

1.1 Accessing the OFDM Signal Generation dialog

To open the dialog with OFDM Signal Generation settings

- ▶ In the block diagram of the R&S SMW200A, select "Baseband" > "OFDM Signal Generation".

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 5.30.175.xx and later of the R&S®SMW200A.

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

- Padding zero samples for OFDM modulation scheme:
 - For the padding principle, see "[Padding with zero samples](#)" on page 25.
 - For related settings, see "[Zero Padding Samples](#)" on page 35, "[Zero Padding Repetition after Symbols](#)" on page 36 and "[Symbol Offset Zero Padding](#)" on page 36.
- Editorial changes

1.3 Documentation overview

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

www.rohde-schwarz.com/manual/smw200a

1.3.1 Getting started manual

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

1.3.2 User manuals and help

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

- Base unit manual

Contains the description of all instrument modes and functions. It also provides an introduction to remote control, a complete description of the remote control commands with programming examples, and information on maintenance, instrument interfaces and error messages. Includes the contents of the getting started manual.

- **Software option manual**
Contains the description of the specific functions of an option. Basic information on operating the R&S SMW200A is not included.

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

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

1.3.3 Tutorials

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

1.3.4 Service manual

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

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

<https://gloris.rohde-schwarz.com>

1.3.5 Instrument security procedures

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

1.3.6 Printed safety instructions

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

1.3.7 Specifications and product brochures

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

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

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

1.3.8 Calibration certificate

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

1.3.9 Release notes and open source acknowledgment

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

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

www.rohde-schwarz.com/firmware/smw200a

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

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

www.rohde-schwarz.com/application/smw200a

For some application sheets, see also:

www.rohde-schwarz.com/manual/smw200a

1.3.11 Videos

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



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

HOME VIDEOS SHORTS PLAYLISTS COMMUNITY CHANNELS ABOUT

Figure 1-1: Product search on YouTube

1.4 Scope



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

In particular, it includes:

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

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

1.5 Notes on screenshots

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

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

2 About OFDM Signal Generation option

The OFDM Signal Generation option enables you to create waveforms according to the following modulation schemes OFDM, f-OFDM, GFDM, UPMC and FBMC.

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2.1 Required options

The basic equipment layout for generating OFDM signals includes the:

- Standard or wideband Baseband Generator (R&S SMW-B10/-B9)
- Baseband main module (R&S SMW-B13) or wideband baseband main module (R&S SMW-B13XT)
- Frequency option (e.g. R&S SMW-B1003)
- Digital standard OFDM Signal Generation (R&S SMW-K114)

You can generate signals via playback of waveform files at the signal generator. To create the waveform file with 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, for example, R&S SMW-K255 for playing LTE waveforms.
- If supported, install the real-time option of the digital standard, for example, R&S SMW-K55 for playing LTE waveforms.

For more information, refer to the specifications document.

2.2 Overview of modulation schemes

The section gives a brief overview of the techniques and methods.

2.2.1 OFDM

The OFDM modulation is similar to the [f-OFDM](#) modulation. Other as in the f-OFDM, the OFDM does not use subbands and there is no predefined filtering.

For OFDM symbol sequences, you can add zero padding samples, see ["Padding with zero samples"](#) on page 25.

Related settings

- [Chapter 3.2.1, "Physical settings"](#), on page 31
- [Chapter 3.2.3, "Modulation configuration settings"](#), on page 40

2.2.2 f-OFDM

The filtered OFDM (f-OFDM) modulation is a technique similar to the [UFMC](#) modulation. Other as in the UFMC, in the f-OFDM uses frame-based filtering.

The method is also known as Spectrum Filtered-OFDM.

Related settings

- [Chapter 3.2.1, "Physical settings"](#), on page 31
- [Chapter 3.2.2, "Filter settings"](#), on page 37
- [Chapter 3.2.3, "Modulation configuration settings"](#), on page 40

2.2.3 GFDM

The Generalized Frequency Division Multiplexing (GFDM) is a method in which the data is processed on a two-dimensional block structure, both in the time domain and in the frequency domain. The GFDM waveform is a non-orthogonal, asynchronous multi-carrier waveform.

In GFDM, subcarriers are independent single carriers; they can have different bandwidth, pulse shape and modulation. Each subcarrier is shaped with an individual transmit filter and then modulated with the subcarrier center frequency. The modulation is performed on a per data block, where the data block size is a configurable value. The commonly used filters are the root-raised cosine filters.

The implementation principle is illustrated on [Figure 2-1](#) ([1]).

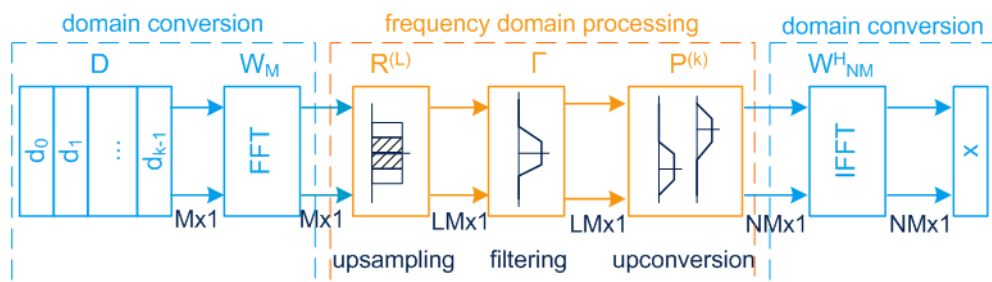


Figure 2-1: Optimized GFDM transmitter model (from [1])

- D = Matrix of input symbols, QPSK, BPSK, or QAM modulated
 d_k = Input vector
k = Number of active subcarrier
M = Number of symbols (block size).
N = FFT size
 W_M = FFT matrix
 $R^{(L)}$ = Upsampling matrix with upsampling factor L

- Γ = A diagonal matrix containing the time samples of the filter pulse on its diagonal; the filtering is an element wise multiplication in the frequency domain.
- $P^{(k)}$ = A permutation matrix that applies a frequency shift and moves the block input vectors to the position of the subcarriers.
- W_{NM}^H = IFFT matrix that converts the signal from the frequency domain back to the time domain
- $x = W_{NM}^H \sum_k P^{(k)} \Gamma R^{(L)} W_M d_k$

As shown in [Figure 2-1](#), in GFDM a time-frequency response is divided into k subcarriers and M symbols.

Related settings

- [Chapter 3.2.1, "Physical settings"](#), on page 31
- [Chapter 3.2.2, "Filter settings"](#), on page 37
- [Chapter 3.2.3, "Modulation configuration settings"](#), on page 40

2.2.4 UFMC

The Universal Filtered Multi-Carrier (UFMC) technique is similar to the known OFDM technique but the UFMC adds one extra filtering step in the signal processing chain.

In UFMC, several consecutive subcarriers are bundled into subbands. All subbands have an equal size. Each subband is shaped with an individual Dolph-Chebyshev filter. The modulation uses an optional cyclic prefix for symbol separation.

[Figure 2-2](#) ([2]) illustrates the system model of UFMC.

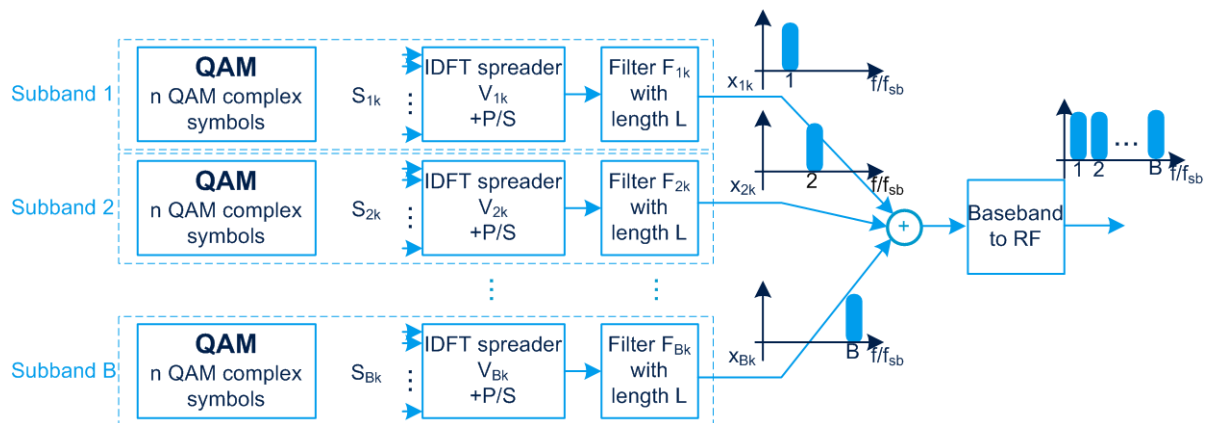


Figure 2-2: UFMC system model (from [2])

- Subband = Group of consecutive subcarriers
- B = Number of subbands
- k = Number of active subcarriers
- S_{Bk} = Vector of input symbols, QPSK, BPSK, or QAM modulated
- IDFT = IFFT operation to transfer the n QAM symbols to the time domain
- P/S = Parallel to serial conversion
- F_{Bk} = Subband filters with filter length L
- X_{Bk} = Output per subband; outputs are added.

The result is a UFMC waveform that is a non-orthogonal, asynchronous multicarrier waveform.

Related settings

- Chapter 3.2.1, "Physical settings", on page 31
- Chapter 3.2.2, "Filter settings", on page 37
- Chapter 3.2.3, "Modulation configuration settings", on page 40

2.2.5 FBMC

In the Filter Bank Multi-Carrier (FBMC) system, the filtering is applied on a per subcarrier basis.

The FBMC uses a synthesis-analysis filter bank method. Different implementations of FBMC are discussed: Staggered modulated multitone (SMT FBMC), cosine modulated multitone (CMT FBMC), and filtered multitone (FMT FBMC). The main focus is on the SMT FBMC implementation.

In FBMS, adjacent subcarriers do overlap. The number of superimposing symbols in time is referred as overlapping factor K . To maintain the orthogonality between the adjacent subcarrier, the subcarriers are **OQAM** pre-processed. The cyclic prefix is optional.

For the implementation principle, see [Figure 2-3](#) or [3].

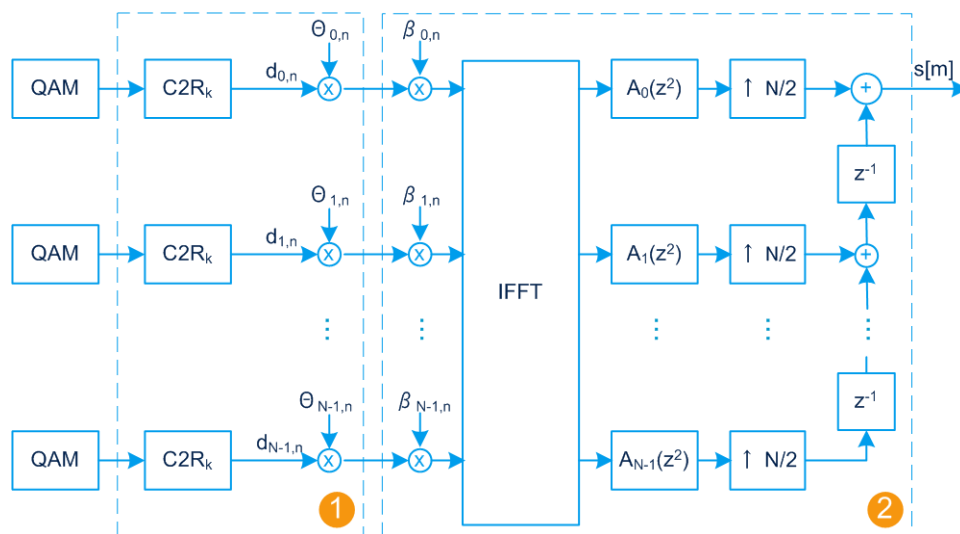


Figure 2-3: FBMC transmitter model (from [3])

- 1 = OQAM pre-processing (symbol staggering).
- 2 = Synthesis filter bank
- N = Total number of subcarriers
- k = 1 to N , is the subcarrier index
- C2R = Complex to real conversion
- \otimes = Complex multiplication by a factor Θ : Shifts the in-phase (I) components of the QAM symbols compared to the quadrature (Q) components
- IFFT = Inverse fast Fourier transform
- $A_k(z)$ = Polyphase filtering per subcarrier
- $N/2$ = Upsampling by the factor $N/2$

Z^{-1} = Individual delays for each subcarrier
 $s[m]$ = Transmit signal (the sum of all subcarriers).
 K = Overlapping factor; defines the number of superimposing symbols in time.

OQAM pre-processing

Orthogonal QAM is a method that shifts the in-phase components of the QAM modulated symbols by $T/2$ (a half of the symbol length) compared to the quadrature (Q) components. The shift alternates between the subcarriers. For example, if in the subcarrier $N-1$ the I component is shifted, then in the neighbor subcarriers ($N-2$ and N) the Q component is shifted.

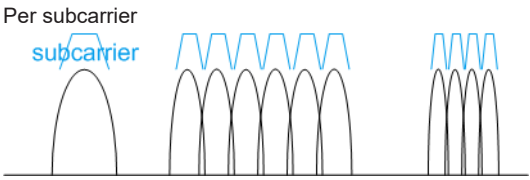
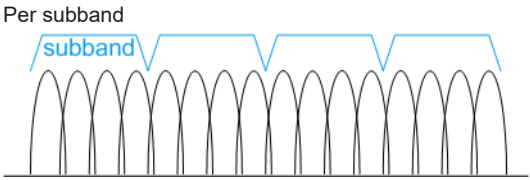
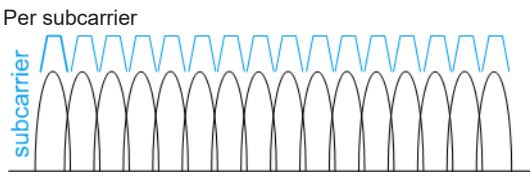
Related settings

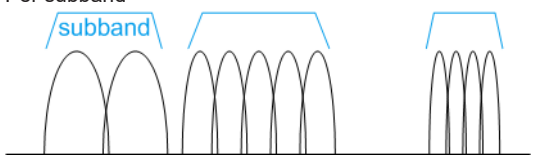
- [Chapter 3.2.1, "Physical settings"](#), on page 31
- [Chapter 3.2.2, "Filter settings"](#), on page 37
- [Chapter 3.2.3, "Modulation configuration settings"](#), on page 40

2.2.6 Filtering

The modulation types utilize filtering for signal shaping, but the filters are applied differently.

Table 2-1: Filtering per modulation type

Modulation type	Time domain filtering	Frequency domain filtering
GFDM	Per frame	Per subcarrier 
UFMC	Per symbol	Per subband 
FBMC	Per K overlapping symbols (in this implementation, $K = 4$)	Per subcarrier 

Modulation type	Time domain filtering	Frequency domain filtering
f-OFDM	Per frame	Per subband 
OFDM	none	none

Each modulation type proposes a prototype filter with different characteristics, like filter type and filter length L . The proposed prototype filter types per modulation type are as follows:

- GFDM:
Root cosine, root-raised cosine, Dirichlet, and rectangular filters
- UPMC:
Dolph-Chebyshev filter
- FBMC:
Root-raised cosine, Phydias filter
- f-OFDM:
Soft truncation filter
- OFDM
No default filter

For UPMC, f-OFDM and OFDM, you can also load a user-defined filter described in a file. See "[User filter file format \(*.dat files\)](#)" on page 19.

Proposed prototype filters

Prototype filters can be designed in several ways, where each approach aims to fully different requirements. In general, filters are designed to have good spectral characteristics and to be easy to be implemented.

GFDM relies on standard filter types with low complexity but with known drawbacks. A prototype filter with a rectangular frequency response suffers from an infinitely long impulse response in time. A root-raised cosine filter improves the sidelobe suppression.

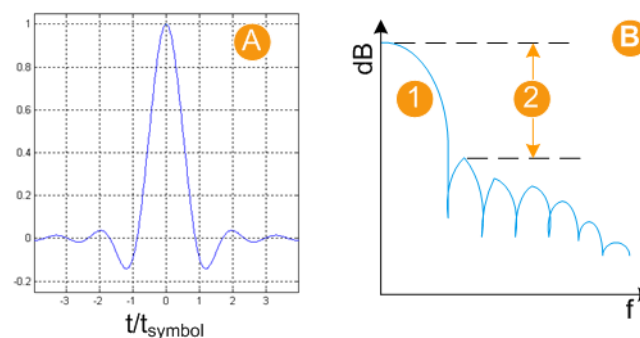


Figure 2-4: Example of filter characteristics: Root cosine filter with Roll Off Factor = 0.5

- A = Filter impulse response
- B = Filter frequency response
- 1 = Mainlobe
- 2 = Sidelobe suppression

Adjusting the filter parameters can change the filter shape. For example, changing the filter rolloff factor influences the steepness of the filter slopes.

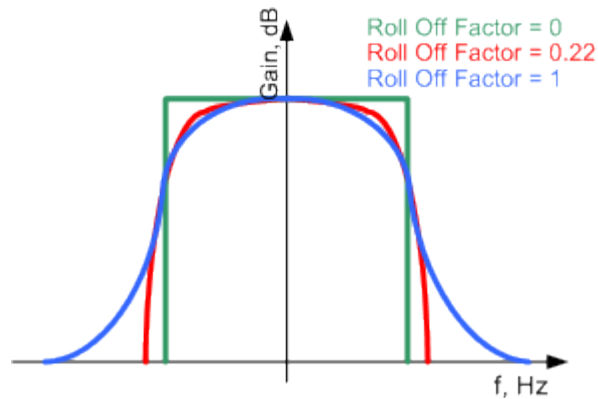


Figure 2-5: Example of the frequency response of a filter with different rolloff factors

In **f-OFDM**, the sidelobe suppression is improved by applying a soft truncation window function. The modulation uses Hamming windowing functions and Hanning windowing functions. Optionally, the transient response of the filter is cut at the beginning and the end of the signal. The drawback of this operation is that it increases the out-of-band emissions.

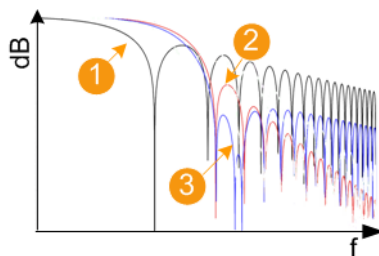


Figure 2-6: Effect of the windowing function

- 1 = Rectangular filter
- 2 = Hanning window
- 3 = Hamming window

As shown in [Figure 2-6](#), the soft truncation improves the sidelobe suppression but results in a wider mainlobe.

UFMC proposes another windowing function with promising characteristics, the Dolph-Chebyshev. The Dolph-Chebyshev window is characterized by the filter length L in the time domain and by the stopband attenuation (that is the desirable sidelobe suppression) in the frequency domain.

In **FBMC**, the initial prototype filter is a root-raised cosine (RRC) filter with a rolloff factor of 1. The Phydys project [3] proposes an extra prototype filter designed using a

frequency sampling technique. This prototype filter is described by a few filter coefficients that do not depend on the filter length.

For overlapping factor $K = 4$, the filter coefficients are [[3], 5GNOW D3.x]:

- $P_0 = 1$
- $P_1 = 0.97195981$
- $P_2 = 1/\sqrt{2}$
- $P_3 = \sqrt{1 - P_1^2}$

The filter time response is calculated as:

$$p_m = P_0 + 2 \sum_{k=1}^{K-1} (-1)^k P_k \cos \left(\frac{2\pi k}{KN_c} (m+1) \right)$$

Figure 2-7: Phydias filter: Time response calculation

$m = 0$ to $KN_c - 2$
 $K = 4$ is the overlapping factor.
 N = Number of subcarriers
 n = Symbol number
 T = Symbol period
 k = Subcarrier number

The stopband attenuation of the Phydias filter exceeds 60 dB for the frequency range of more than 10 subcarrier spacings [[3], 5GNOW D3.x].

User filter file format (*.dat files)

For UPMC, f-OFDM and OFDM, you can define your own filters in from user filter files. These files are ASCII files with a simple format and file extension *.dat.

These files describe filters as a sequence of normalized filter coefficients. Each coefficient is defined as a pair of I and Q samples. The I and Q components alternate at each file line. The I and Q values vary between - 1 and + 1.

The user filter file can contain up to 800 coefficients. Once loaded in the software, the file is evaluated and the parameter **User Filter Length** shows the number of coefficients.

You can create user filter files for example with MATLAB, see for example the following MATLAB script.

Example: To generate a user filter file (script)

```

Function [b, n] = generateUserFilter(filterSets, destPath)
% generateUserFilter returns the filter coefficients of a user-defined (baseband-)filter,
% whose are stored to a .dat file and can be
% loaded as an user filter in R&S SMW
%
% where:
% filterSets.fftSize is the used FFT size that is used for the OFDM modulation
% filterSets.nOccSubcarrier is the number of occupied subcarriers
% filterSets.transRegionRatio controls the steepness of the filter
% with regards to the ratio of fftSize/2
% filterSets.rp passband ripple in percentage
% filterSets.rs stopband attenuation ripple in percentage
%
% Example use:
% [b n] = RsFilt.generateUserFilter(struct('fftSize',4096, 'nOccSubcarrier',3376),'.');
%
% b - complex filter coefficients
% n - filter order

if (~isfield(filterSets,'transRegionRatio'))
    filterSets.transRegionRatio = 0.07;
end

if (~isfield(filterSets,'rp'))
    filterSets.rp = 0.0001;
end

if (~isfield(filterSets,'rs'))
    filterSets.rs = 60;
end

% steepness of filter
transRegion = filterSets.transRegionRatio * filterSets.fftSize/2; %in
%, controls steepness of filter slopes, relative to nyquist frequency

% cutoff frequencies
f = [filterSets.nOccSubcarrier/2 filterSets.nOccSubcarrier/2+transRegion];

% ripples in dB
dev = [(10^(filterSets.rp/20)-1)/(10^(filterSets.rp/20)+1) 10^(-filterSets.rs/20)];

% estimate filter order
[n,fo,ao,w] = firpmord(f,[1 0],dev,filterSets.fftSize);

% make filter symmetric
n = n + mod(n,2)

% generate filter coefficients
b = firpm(n,fo,ao,w);

```

```

% fvtool(b); %displays filter response

%% write filter out into .dat filter coefficient file
coeffsOut = zeros(2*length(b),1);
coeffsOut(1:2:end) = real(b); coeffsOut(2:2:end) = imag(b);
% serialize complex coefficients

if (exist('destPath'))
    dlmwrite([destPath '\smw_user_filter_' num2str(length(b))
            'taps_' num2str(filterSets.nOccSubcarrier)
            'scs_' num2str(filterSets.fftSize) 'fft.dat'],coeffsOut);
end

end

end

```

Related settings

- [Chapter 3.2.2, "Filter settings"](#), on page 37

2.3 Supported multiple access schemes

Multiple access schemes are offered to assign the individual allocations to different users.

Sparse Code Multiple Access (SCMA) is a non-orthogonal multiple access technology that is considered as a key candidate 5G multiple access scheme. This technique adds a CDMA (code division multiple access) component to the orthogonal division multiple access technology OFDMA. SCMA uses multilayer sparse codewords to separate users that share common time and frequency resources.

In comparison to LTE, SCMA combines modulation mapping and spreading into one operation. Each layer implies a unique codebook. The binary input data are mapped directly to the multilayer codeword and then spread over the subcarriers.

SCMA encoding and parameters dependency

The example in [Figure 2-8](#) is an illustration of a codebook.

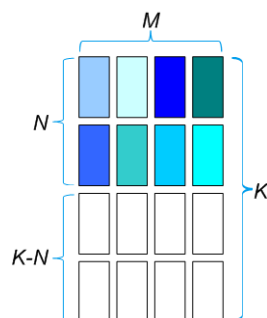


Figure 2-8: SCMA encoding parameters

M = 4 is the codebook size (that is the number of codewords)
K = 4 is the spreading factor (that is the spread codeword length)
N = 2 is the number of non-zero elements.
K-N = 2 is the number of zero elements.

The number of layers J (that is also the number of *unique* codebooks) is calculated as follows:

$$J = \binom{K}{N}$$

The number of layers gives the number of unique combinations that are possible for the given codeword length (K) and the number of non-zero elements (N). For K = 4 and N = 2, the maximum number of layers is J = 6. In SCMA, you can assign a user to several layers but you can assign each layer only to a single user. The maximum number of users corresponds to the number of layers and is also 6.

SCMA encoding parameterization

The SCMA implementation in R&S SMW-K114 is illustrated [Figure 2-8](#). It uses the following fix parameters:

- Number of layers = 6
- Codebook size = 4
- Spreading factor = 4

The example in [Figure 2-9](#) illustrates the principle of the SCMA encoding.

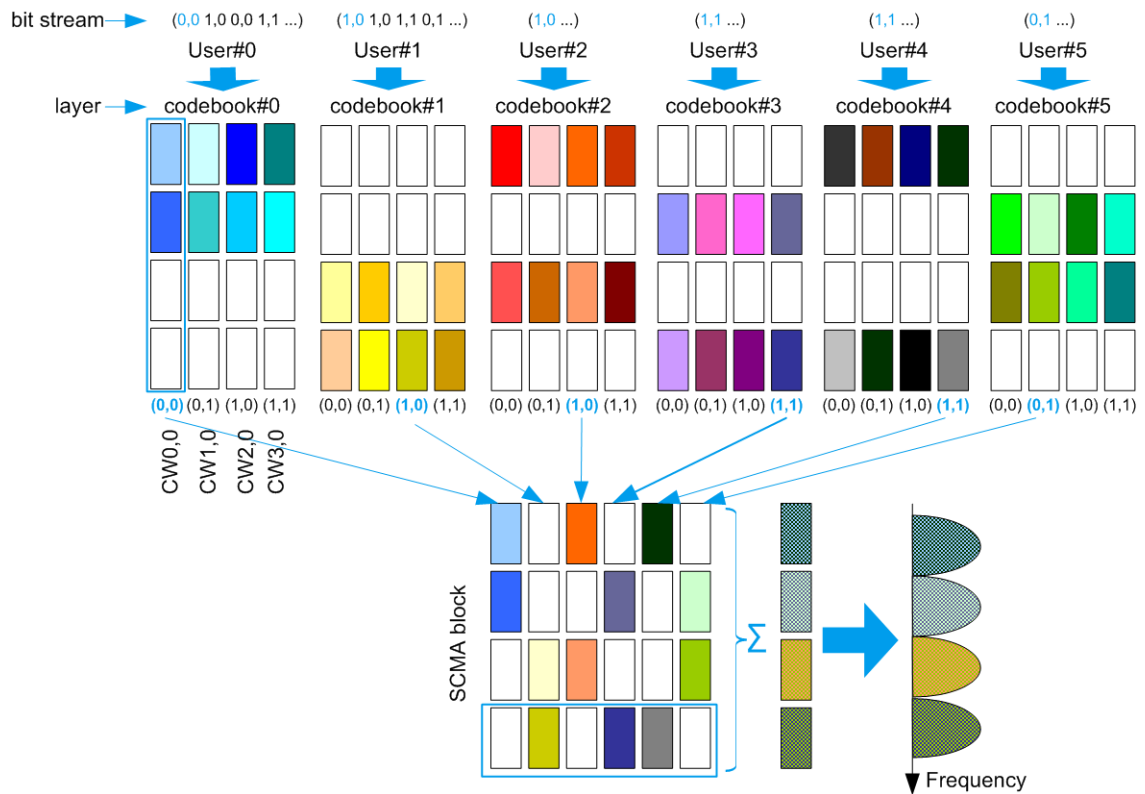


Figure 2-9: SCMA encoding example ($K = 4$, $N = 2$, $J = 6$)

User#x = 6 users
 Codebook#x = 6 codebooks or layers
 Bitstream = Binary input data per user, for example User#0 sends bits (0,0).
 CWy,x = Codeword#y from codebook#x
 Σ = Combining the symbols

In this example, each user is assigned to one layer (codebook). The bits that the users are transmitting are highlighted. For example, User#0 sends bits (0,0) that correspond to codeword CW0,0 from the user-specific codebook#0. The 6 codewords of the 6 users are combined; note that max. 3 symbols overlap. The combined signal of 6 users is spread over the subcarriers; the spreading factor is 4.

Related settings

- [Chapter 3.3.4, "SCMA settings"](#), on page 51
- [Chapter 3.3.2, "Allocations settings"](#), on page 45

2.4 Physical layer parameterization

Data allocation and modulation

You can modulate input data symbols using modulation schemes:

- Base modulation with constellations: BPSK, QPSK, 16QAM, 64QAM, 256QAM, SCMA
- Custom modulated I/Q data from files containing other modulation schemes, like CAZAC sequences for instance. See "[Custom I/Q file format \(*.iqw or *.dat files\)](#)" on page 24.
- Zadoff-Chu sequence
- Custom constellation with individual constellation points

Related settings:

- "[Constellation](#)" on page 46
- [Chapter 3.3.5, "Zadoff-Chu settings"](#), on page 54
- [Chapter 3.3.6, "Constellation points settings"](#), on page 55

Custom I/Q file format (*.iqw or *.dat files)

Custom I/Q files are files in one of the following formats:

- ***.dat files**
ASCII files with simple format and file extension `*.dat`.
The file content is a sequence of pairs of I and Q samples. The I and Q components alternate at each file line. The I and Q values vary between - 1 and + 1.
- ***.iqw files**
Binary files containing complex I/Q data of 32-bit floating point data type.
The file contents are I/Q samples described as paired alternating I and Q values (IQIQIQ).

Related settings:

- "[Data Source](#)" on page 47

Cyclic prefix (CP)

A guard time called cyclic prefix (CP) can optionally be used. Note that the CP calculation depends on the used modulation scheme.

Related settings:

- "[Cyclic Prefix Length](#)" on page 32
- For f-OFDM, also:
 - "[Alt. Cyclic Prefix Length](#)" on page 34
 - "[CP No. Symbols/Alt. CP No. Symbols](#)" on page 34

Sequence length calculation

The sequence length depends on the modulation type and is expressed in the number of symbols or in the number of samples.

Calculation of the sequence length as number of samples and per modulation type is as follows:

- **f-OFDM/OFDM**

Sequence Length [Samples] = ("Total Number of Subcarriers"*"Sequence Length" [Symbols] + "Cyclic Prefix Length"*"CP No. Symbols" + "Alt. Cyclic Prefix Length"*"Alt. CP No. Symbols")

- **UFMC**

Sequence Length [Samples] = "Cyclic Prefix Length" + ("Total Number of Subcarriers" + "Filter Length" - 1)*("Sequence Length" [Symbols])

- **FBMC**

– If "Cut Transient Response = Off":

Sequence Length [Samples] = ("Sequence Length" [Symbols] + "Overlap Factor" - 0.5)*"Total Number of Subcarriers" + "Cyclic Prefix Length"

– If "Cut Transient Response = On":

Sequence Length [Samples] = ("Sequence Length" [Symbols] + "Overlap Factor" - 0.5)*"Total Number of Subcarriers" + "Cyclic Prefix Length" - "Total Number of Subcarriers"*"Overlap Factor"

Where "Overlap Factor = 4"

- **GFDM**

Sequence Length [Samples] = "Cyclic Prefix Length" + "Total Number of Subcarriers"*"Sequence Length" [Symbols]

Padding with zero samples

For the OFDM modulation scheme, you can insert zero samples into a sequence of symbols also called padding. Define the start of insertion of the first zero sample via an offset t_{Offset} . Set the number of zero samples after t_{Offset} for padding. Set the repetition via t_{Rep} for padding again within a symbol sequence. The figure [Figure 2-10](#) illustrates padding for an OFDM symbol sequence.

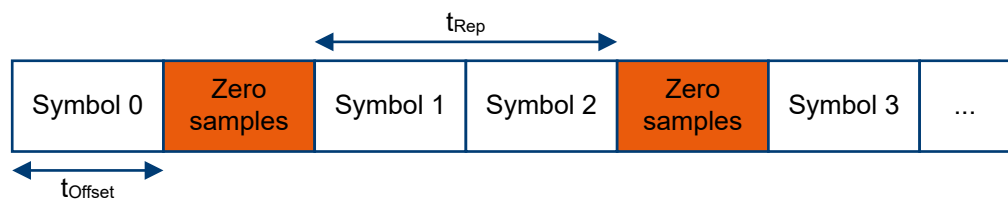


Figure 2-10: OFDM symbol sequence with zero padding samples

Symbol x = OFDM symbol: x is the symbol number

t_{Offset} = Symbol offset before adding zero padding samples

Zero samples = One or more zero samples for padding

t_{Rep} = Number of skipped between repeated zero padding samples

Related settings:

- For the offset t_{Offset} , see ["Symbol Offset Zero Padding"](#) on page 36.
- For the zero samples, see ["Zero Padding Samples"](#) on page 35.
- For the repetition t_{Offset} , see ["Zero Padding Repetition after Symbols"](#) on page 36.

2.5 Generating configuration files for R&S®VSE-K96

If you generate f-OFDM signals or OFDM signals, the R&S SMW200A automatically creates a *.xml file. You can use this file for measurements with Rohde & Schwarz signal analyzer, for example R&S®VSE-K96.

R&S®VSE-K96 processes the waveforms, generated with R&S SMW200A, differently, depending on the allocation content:

- **Pilots:**
For f-OFDM and OFDM, the R&S®VSE-K96 requires pilot allocations for the signal analysis. The analyzer needs the pilots to decode the channel coding properly.
- **Data:**
The data allocations contain the resource elements of the corresponding modulation.
If you use the generated *.xml settings file, the information on the pilots and data allocations is transmitted automatically.
- **Reserved:**
The signal analyzer perceives reserved allocations as general OFDM modulated signals. The allocation content can be any user-defined information.

To create, transfer and use the settings file

1. In the R&S SMW200A, configure the signal as required.
2. Enable signal generation ("State > On").
The *.xml settings file is created automatically.
It is saved in the user directory as /var/user/K114/
Exported_K114_settings_K96.xml.
3. Connect to the user directory of the R&S SMW200A via USB, LAN, ftp or any other access methods.
Open, for example, the \\<R&S SMW200A IP Address>\share\K114\
See also, chapter "File and Data Management" in the R&S SMW200A user manual.
4. Copy the Exported_K114_settings_K96.xml file
5. Transfer and load it in the R&S®VSE-K96
Required settings are performed automatically, so that you can start analyzing the signal.

3 OFDM Signal Generation configuration and settings

Access:

- ▶ Select "Baseband" > "OFDM Signal Generation".

The remote commands required to define these settings are described in [Chapter 3, "OFDM Signal Generation configuration and settings"](#), on page 27.

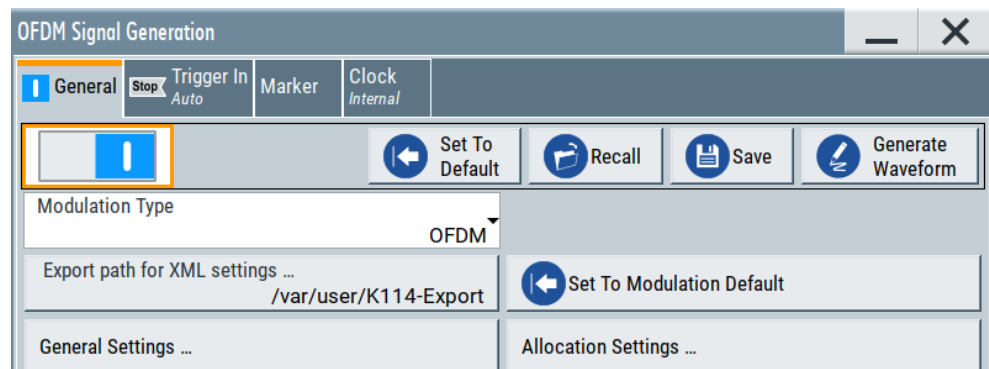
Settings:

• General settings	27
• General settings	30
• Allocation settings	42
• Trigger settings	57
• Marker settings	63
• Clock settings	65
• Local and global connectors settings	66

3.1 General settings

Access:

- ▶ Select "Baseband" > "OFDM Signal Generation" > "General".



This dialog provides the standard general settings, to the default and the "Save"/"Recall" settings, as well as selecting the modulation type and access to dialogs with further settings.

Settings:

State	28
Set To Default	28
Save/Recall	28

Generate Waveform.....	28
Modulation Type.....	28
Export path for XML settings	29
Set To Modulation Default.....	30
General Settings	30
Allocation Settings	30

State

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

Remote command:

[:SOURce<hw>] :BB:OFDM:STATe on page 69

Set To Default

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

Parameter	Values
State	Not affected by "Set to Default"
Modulation Type	OFDM

Remote command:

[:SOURce<hw>] :BB:OFDM:PRESet on page 69

Save/Recall

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

The filename and the directory are user-definable; the file extension is predefined.

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

Remote command:

[:SOURce<hw>] :BB:OFDM:SETTing:CATalog on page 69

[:SOURce<hw>] :BB:OFDM:SETTing:LOAD on page 69

[:SOURce<hw>] :BB:OFDM:SETTing:STORe on page 70

[:SOURce<hw>] :BB:OFDM:SETTing:DEL on page 70

Generate Waveform

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:OFDM:WAVEform:CREate on page 70

Modulation Type

Selects the modulation type.

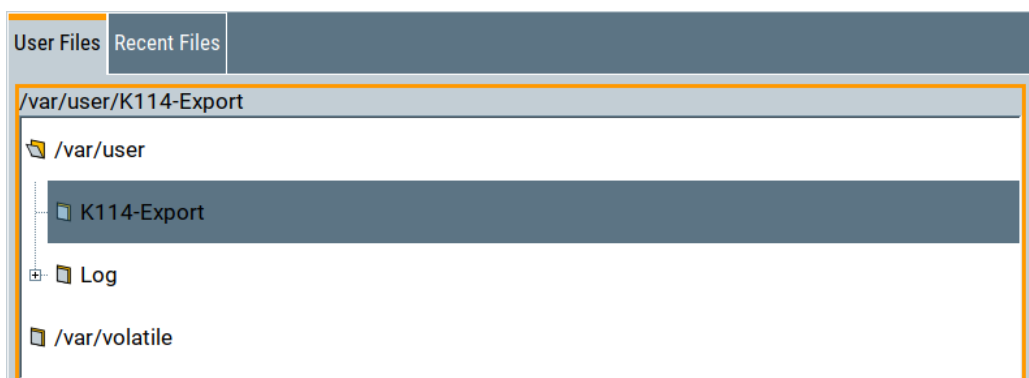
"OFDM"	<p>You can create your own OFDM signal, for example configure the allocations as required.</p> <p>If you enable baseband signal generation, also creates a *.xml setting file for this modulation type. See also Chapter 2.5, "Generating configuration files for R&S®VSE-K96", on page 26.</p>
"f-OFDM"	<p>Filtered OFDM (f-OFDM) modulation is a technique similar to the UFMC modulation.</p> <p>See Chapter 2.2.1, "OFDM", on page 12.</p> <p>If you enable baseband signal generation, also creates a *.xml setting file for this modulation type. For more information, see Chapter 2.5, "Generating configuration files for R&S®VSE-K96", on page 26.</p>
"UFMC"	<p>Universal Filtered Multi-Carrier (UFMC) is similar to OFDM but each subband has an additional filter. The modulation uses an optional cyclic prefix and a Dolph-Chebyshev filter.</p> <p>See Chapter 2.2.4, "UFMC", on page 14.</p>
"GFDM"	<p>Generalized Frequency Division Multiplexing (GFDM) provides data processing on a two-dimensional block structure, both in time and frequency domain. Each subcarrier is pulse-shaped with a transmit filter and then modulated.</p> <p>See Chapter 2.2.3, "GFDM", on page 13.</p>
"FBMC"	<p>Filter Bank Multi-Carrier (FBMC) modulation uses the staggered modulated multitone filter bank (SMT FBMC) method that modulates the subcarriers via the OQAM modulation scheme.</p> <p>See Chapter 2.2.5, "FBMC", on page 15.</p>

Remote command:

`[:SOURce<hw>] :BB:OFDM:MODulation` on page 70

Export path for XML settings ...

Opens a standard "File Select" dialog to specify the output path of the created *.xml settings file.



By default, the output path `/var/user/K114-Export` and output file `Exported_K114_settings_K96.xml` are specified.

If modulation is enabled ("State" > "On"), the *.xml settings file is created automatically. You can use this file for measurements with Rohde & Schwarz signal analyzer, for example R&S®VSE-K96.

See also [Example "Default "Exported_K114_settings_K96.xml" file"](#) on page 111.

Remote command:

[:SOURce<hw>] :BB:OFDM:OUTPath on page 71

Set To Modulation Default

Calls the default settings for the selected [Modulation Type](#).

Remote command:

[:SOURce<hw>] :BB:OFDM:MODPreset on page 71

General Settings ...

Opens the "General Settings" dialog of the selected modulation.

For a description, see the following sections:

- [Chapter 3.2.1, "Physical settings"](#), on page 31
- [Chapter 3.2.2, "Filter settings"](#), on page 37
- [Chapter 3.2.3, "Modulation configuration settings"](#), on page 40

Remote command:

n.a.

Allocation Settings ...

Opens the "Allocation Settings" dialog, see [Chapter 3.3, "Allocation settings"](#), on page 42.

Remote command:

n.a.

3.2 General settings

- [Physical settings](#)..... 31
- [Filter settings](#)..... 37
- [Modulation configuration settings](#)..... 40

3.2.1 Physical settings

Access:

- ▶ Select "OFDM Signal Generation" > "General Settings".

Physical		Filter	
Total Number of Subcarriers	64	Occupied Number of Subcarriers	53
Subcarrier Spacing	312.500 0 kHz	Sequence Length	10 Symbols
Cyclic Prefix Length	16 Samples	CP No. Symbols	1 Symbols
Alt. Cyclic Prefix Length	0 Samples	Alt. CP No. Symbols	0 Symbols
Cyclic Suffix Length	0 Samples	DFT-S (skip non-data)	0
DC Mode	Utilize	Zero Padding Samples	0
Zero Padding Repetition after Symbols	10	Symbol Offset Zero Padding	0
Sampling Rate	20.000 MHz	Occupied Bandwidth	16.563 MHz
Number of Left Guard Subcarriers	6	Number of Right Guard Subcarriers	5

The tab provides physical settings. Most of these settings are common to all modulation types but can differ within their application. For settings that are unique for a specific modulation type, the description states this modulation type.

Settings:

Total Number of Subcarriers/FFT Size	31
Occupied Number of Subcarriers	32
Subcarrier Spacing	32
Sequence Length	32
Cyclic Prefix Length	32
Alt. Cyclic Prefix Length	34
CP No. Symbols/Alt. CP No. Symbols	34
Cyclic Suffix Length	35
DFT-S (skip non-data)	35
DC Mode	35
Zero Padding Samples	35
Zero Padding Repetition after Symbols	36
Symbol Offset Zero Padding	36
Sampling Rate	36
Occupied Bandwidth	36
Number of Left Guard Subcarriers/Number of Right Guard Subcarriers	37

Total Number of Subcarriers/FFT Size

Sets the number of available subcarriers that is the FFT size.

The maximum number of subcarriers depends on the selected "Subcarrier Spacing" as follows:

$$\text{"Total Number of Subcarriers"} * \text{Subcarrier Spacing} \leq \text{Bandwidth}_{\text{max}}$$

The available baseband bandwidth depends on the installed options, see specifications document.

See also [Chapter 2.4, "Physical layer parameterization"](#), on page 24 for an overview of this cross-reference between the parameters.

Remote command:

`[:SOURCE<hw>] :BB:OFDM:NSUBcarriers` on page 73

Occupied Number of Subcarriers

Sets the number of occupied subcarriers.

The maximum number of occupied subcarriers is calculated as follows:

$$\text{"Occupied Number of Subcarriers"}_{\text{max}} = 0.83 * \text{Total Number of Subcarriers/FFT Size}$$

For the UPMC modulation, the "Occupied Number of Subcarriers" has to be a multiple of the selected [Number of Subbands](#).

See also [Chapter 2.4, "Physical layer parameterization"](#), on page 24 for an overview of this cross-reference between the parameters.

Remote command:

`[:SOURCE<hw>] :BB:OFDM:NOCCupied` on page 73

Subcarrier Spacing

Sets the frequency distance between the carrier frequencies of the subcarriers.

The subcarriers are evenly distributed within the available bandwidth. All subcarriers span the same bandwidth and there is no frequency gap between adjacent subcarriers. The parameter also sets the subcarrier bandwidth.

See also [Chapter 2.4, "Physical layer parameterization"](#), on page 24 for an overview of this cross-reference between the parameters.

Remote command:

`[:SOURCE<hw>] :BB:OFDM:SCSPace` on page 73

Sequence Length

Sets the sequence length of the signal in number of symbols.

See also ["Sequence length calculation"](#) on page 24.

Remote command:

`[:SOURCE<hw>] :BB:OFDM:SEQLength` on page 73

Cyclic Prefix Length

Sets the cyclic prefix (CP) length as the number of samples.

The maximum value equals the total number of subcarriers, see ["Total Number of Subcarriers/FFT Size"](#) on page 31. The maximum number of symbols that can be used as a CP is calculated as follows:

$$\text{"Cyclic Prefix Length"}_{\text{max}} = 0.5 * \text{Total Number of Subcarriers/FFT Size}$$

The cyclic prefix calculation depends on the modulation scheme:

- **f-OFDM/OFDM**

Similar to the calculation in LTE, the cyclic prefix is applied as a *cyclic extension to each symbol*.

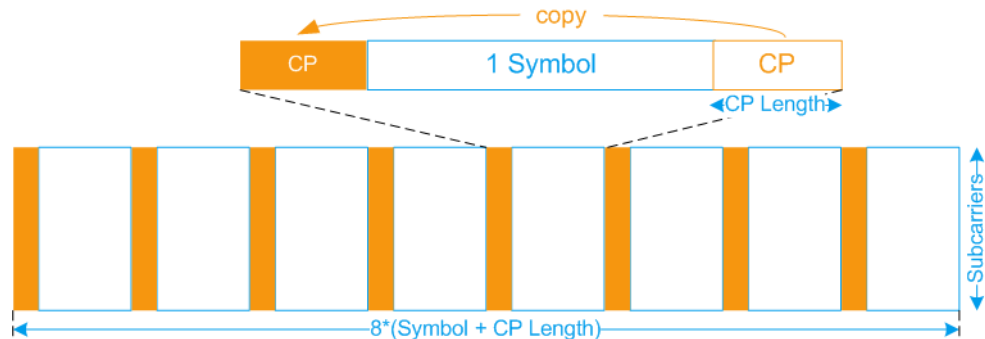


Figure 3-1: Principle of cyclic prefix calculation in f-OFDM/OFDM (default configuration with CP No. Symbols = 0, Alt. Cyclic Prefix Length = 0)

CP	= Cyclic prefix
CP Length	= Selected number of samples
Subcarriers	= Total Number of Subcarriers/FFT Size
Sequence Length	= Selected number of symbols; 8 symbols in this example
Total number of samples	= Calculated as described in "Sequence length calculation" on page 24

To apply different CP to a certain number of symbols or to use an alternating CP pattern, use the combination of the parameters *Alt. Cyclic Prefix Length* and *CP No. Symbols/Alt. CP No. Symbols*.

- **UFMC, GFDM, FBMC**

If a "CP Length \neq 0" is selected, then last samples of the complete signal are prepended to the signal.

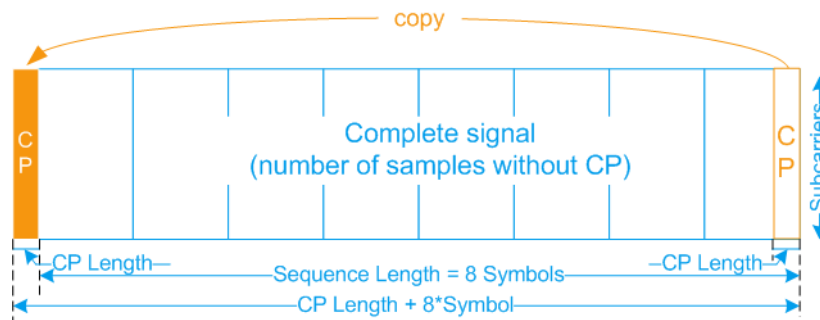


Figure 3-2: Principle of cyclic prefix calculation in UFMC, GFDM, and FBMC

CP	= Cyclic prefix
CP Length	= Selected number of samples
Subcarriers	= Total Number of Subcarriers/FFT Size
Sequence Length	= Selected number of symbols; 8 symbols in this example
Total number of samples	= Calculated as described in "Sequence length calculation" on page 24

Remote command:

[:SOURce<hw>] :BB:OFDM:CPLength on page 74

Alt. Cyclic Prefix Length

For f-OFDM/OFDM, you can modify the default CP assignment where the same CP is applied to each symbol and enable additional alternative CP, see [Figure 3-3](#).

Both cyclic prefix (CP) lengths are set as the number of samples. The parameters [CP No. Symbols/Alt. CP No. Symbols](#) determine for how many symbols each of the CP is applied. These parameters thus define a pattern of alternating cyclic prefixes.

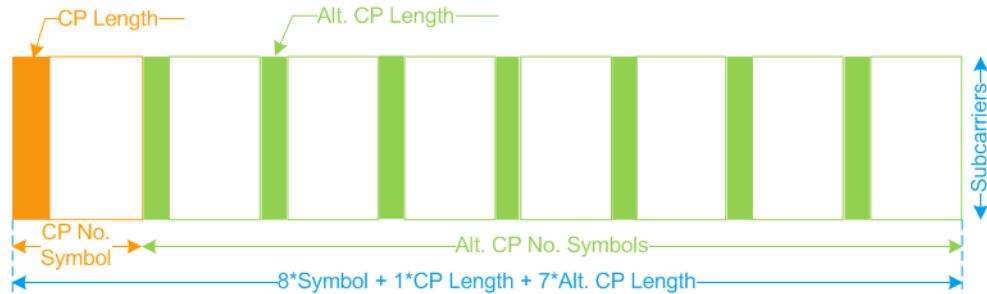


Figure 3-3: Dynamic cyclic prefixes in f-OFDM/OFDM (example with Alt. Cyclic Prefix Length ≠ Cyclic Prefix Length, CP No. Symbols = 1, Alt. CP No. Symbols = 7)

CP	= Cyclic prefix
CP Length	= CP duration as number of samples, e.g 160 samples
Alt. CP Length	= Duration of the alternative CP as number of samples, e.g 144 samples
CP No. Symbol	= 1 (number of symbols for that the selected CP length is applied).
Alt. CP No. Symbols	= 7 (number of symbols for that the selected Alt. CP length is applied).
Sequence Length	= Selected number of symbols; 8 symbols in this example
Subcarriers	= Occupied Number of Subcarriers , e.g. 400 so that the Occupied Bandwidth = 20 MHz

Total number of samples = Calculated as described in "[Sequence length calculation](#)" on page 24

Remote command:

`[:SOURce<hw>] :BB:OFDM:ACPLength` on page 74

CP No. Symbols/Alt. CP No. Symbols

For f-OFDM/OFDM, these parameters determine for how many symbols each of the CP ([Cyclic Prefix Length](#) and [Alt. Cyclic Prefix Length](#)) is applied.

See also [Figure 3-3](#).

0	Disables the corresponding CP. Thus, even if a CP length different than zero is set but an alternative CP length with "Alt. CP No. Symbols ≠ 0" is configured, the CP length is ignored, if "CP No. Symbols = 0". The alternative CP length is applied or all symbols in the sequence.
---	---

Example:

If:

- "Sequence Length = 8"
- "Cyclic Prefix Length = 160" and "CP No. Symbols = 0"
- "Alt. Cyclic Prefix Length = 144" and "Alt. CP No. Symbols = 2"

Then a CP of 144 samples is applied to all 8 symbols.

Other than 0 The value ranges of the parameters are calculated as follows:
 "CP No. Symbols" + "Alt. CP No. Symbols" ≤ "Sequence Length"
 If the sum is shorter than the "Sequence Length", the defined CP pattern is applied cyclically within this sequence length. Unused CP length values are discarded.

Example:

If:

- "Sequence Length = 8"
- "Cyclic Prefix Length = 160" and "CP No. Symbols = 2"
- "Alt. Cyclic Prefix Length = 144" and "Alt. CP No. Symbols = 3"

Then the CP = 160 samples is applied to symbols 1, 2, 6 and 7 and the CP = 144 samples - to symbols 3, 4, 5 and 8.

Remote command:

[:SOURce<hw>] :BB:OFDM:CPSYmbols on page 75

[:SOURce<hw>] :BB:OFDM:ACPSYmbols on page 75

Cyclic Suffix Length

Sets the cyclic suffix length in samples. The maximum value equals the total number of subcarriers, see "Total Number of Subcarriers/FFT Size" on page 31.

Remote command:

[:SOURce<hw>] :BB:OFDM:CSLength on page 75

DFT-S (skip non-data)

Activates discrete Fourier transform spread OFDM (DFT-s-OFDM) uplink scheme. Use this precoding setting to reduce crest factors of generated OFDM signals that contain data allocations.

If activated, applies a DFT on all data allocations. These allocations use "Content Type" > "Data", see "Content Type" on page 48. All non-data allocations are added after DFT, for example, when mapping the pilots.

Remote command:

[:SOURce<hw>] :BB:OFDM:DFTS:STATE on page 75

DC Mode

Sets the DC subcarrier mode.

- | | |
|------------|---|
| "Utilize" | Uses the DC subcarrier for all allocations. |
| "Puncture" | Replaces the DC subcarrier by zeroes for all allocations. |
| "Skip" | Skips the DC subcarrier during the discrete Fourier transform (DFT). In this mode, you cannot activate "DFT-S (skip non-data)", see "DFT-S (skip non-data)" on page 35. The LTE standard, for example, uses this mode as a skipping method. |

Remote command:

[:SOURce<hw>] :BB:OFDM:DCMode on page 75

Zero Padding Samples

Requires "Modulation Type" > "OFDM".

Sets the number of zero samples for padding. The instrument inserts these zero samples before the modulation symbols. See also ["Padding with zero samples"](#) on page 25.

The maximum number of zero samples equals the total number of subcarriers minus one sample, see ["Total Number of Subcarriers/FFT Size"](#) on page 31.

Remote command:

[\[:SOURce<hw>\]:BB:OFDM:ZSAMPles](#) on page 76

Zero Padding Repetition after Symbols

Requires "Modulation Type" > "OFDM".

Sets the repetition of inserted zero samples. This repetition defines the number of symbols between repeating zero samples.

The maximum number of repetitions equals the sequence length, see ["Sequence Length"](#) on page 32.

Remote command:

[\[:SOURce<hw>\]:BB:OFDM:RSAMPles](#) on page 76

Symbol Offset Zero Padding

Requires "Modulation Type" > "OFDM".

Sets the symbol offset that is the number of skipped symbols before inserting the zero padding samples.

The maximum offset equals the sequence length minus one symbol, see ["Sequence Length"](#) on page 32.

Remote command:

[\[:SOURce<hw>\]:BB:OFDM:OFFSet](#) on page 76

Sampling Rate

Displays the sampling rate.

The value is derived as follows:

"Sampling Rate" = [Total Number of Subcarriers/FFT Size](#) * [Subcarrier Spacing](#)

Remote command:

[\[:SOURce<hw>\]:BB:OFDM:SAMPling?](#) on page 77

Occupied Bandwidth

Displays the occupied bandwidth.

The value is derived as follows:

"Occupied Bandwidth" = [Occupied Number of Subcarriers](#) * [Subcarrier Spacing](#)

Some settings result in a higher "Occupied Bandwidth" than the maximum bandwidth of the R&S SMW200A. If the maximum bandwidth is exceeded, a warning message indicates the maximum supported bandwidth given the installed hardware options.

The figure below shows an example of the R&S SMW200A equipped with maximum bandwidth of 160 MHz (R&S SMW-K522). "Occupied Number of Subcarriers > 55" and "Subcarrier Spacing = 3.125 MHz" result in "Occupied Bandwidth = 171.875 MHz". The warning message displays the supported maximum bandwidth.

Sampling Rate	200.000 MHz	⚠ More than 160 MHz is not supported!	Occupied Bandwidth	171.875 MHz
Number of Left Guard Subcarriers	5		Number of Right Guard Subcarriers	4

Remote command:

`[:SOURce<hw>] :BB:OFDM:BWOCcupied?` on page 77

Number of Left Guard Subcarriers/Number of Right Guard Subcarriers

Displays the number of left guard and right guard subcarriers.

The number of guard subcarriers is calculated as follows:

- "Number Of Left Guard Subcarriers" is the rounded up value of $(\text{Total Number of Subcarriers/FFT Size} - \text{Occupied Number of Subcarriers}) / 2$
- "Number Of Right Guard Subcarriers" = $\text{Total Number of Subcarriers/FFT Size} - \text{Number Of Left Guard Subcarriers}$

Remote command:

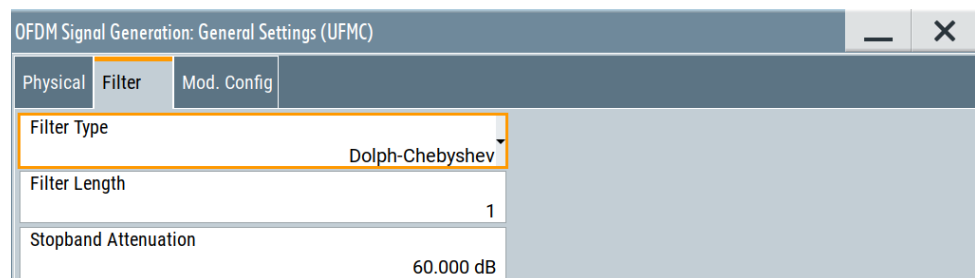
`[:SOURce<hw>] :BB:OFDM:LGUard?` on page 77

`[:SOURce<hw>] :BB:OFDM:RGUard?` on page 78

3.2.2 Filter settings

Access:

1. Select "OFDM Signal Generation" > "General".
2. Select the modulation type.
Select, for example, "Modulation Type" > "UFMC".
3. Select "General Settings".
4. Select "Filter".



This tab provides settings to configure filters. The filter settings depend on the selected modulation scheme.

See also [Chapter 2.2.6, "Filtering"](#), on page 16.

Settings:

Filter Type.....	38
Rolloff Factor.....	38
Filter Length.....	39
Stopband Attenuation.....	39
Windowing Method.....	39
Cut Transient Response.....	39
User Filter Length.....	40
Load User Filter.....	40

Filter Type

Sets the filter type. The available types depend on the selected modulation type.

See also [Chapter 2.2.6, "Filtering"](#), on page 16.

"None"	Requires "Modulation Type" > "OFDM" or "f-OFDM". No filtering applied.
"User"	Requires "Modulation Type" > "OFDM", "f-OFDM" or "UFMC". Loads a user-defined file from a file, see "User filter file format (*.dat files)" on page 19.
"Soft Truncation"	Requires "Modulation Type" > "f-OFDM". Soft truncation filter
"Dolph-Chebyshev"	Requires "Modulation Type" > "UFMC". Dolph-Chebyshev filter
"Raised Cosine"/"Dirichlet"/"Rectangular"	Requires "Modulation Type" > "GFDM". Raised cosine filter, Dirichlet filter or rectangular filter
"Root Raised Cosine"	Requires "Modulation Type" > "FBMC" or "GFDM". Root raised cosine filter
"Phydyas"	Requires "Modulation Type" > "FBMC". Phydyas filter

Remote command:

[\[:SOURCE<hw>\]:BB:OFDM:FILTer:TYPE](#) on page 79

Rolloff Factor

Sets the filter parameter.

The rolloff factor affects the steepness of the filter slopes. A "Rolloff Factor = 0" results in the steepest slopes; values near to 1 make the slopes more flat.

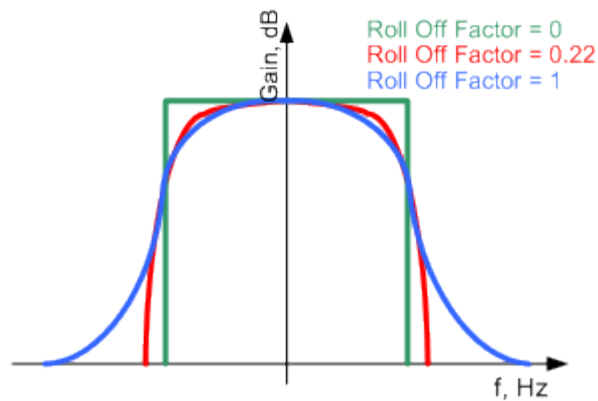


Figure 3-4: Example of the frequency response of a filter with different rolloff factors

Remote command:

`[:SOURCE<hw>] :BB:OFDM:FILTer:ROLLoff` on page 79

Filter Length

Set the number of filter tabs and changes the filter shape in the time domain.

Remote command:

`[:SOURCE<hw>] :BB:OFDM:FILTer:LENGth` on page 80

Stopband Attenuation

The UPMC modulation uses a Dolph-Chebyshev window to filter each subband.

The following parameters affect the shape of the Dolph-Chebyshev window:

- **Filter Length** (L) changes the shape in the time domain
- "Stopband Attenuation" or sidelobe attenuation affects the shape in the frequency domain.

See also "[Proposed prototype filters](#)" on page 17.

Remote command:

`[:SOURCE<hw>] :BB:OFDM:FILTer:SBATtenuation` on page 80

Windowing Method

The f-OFDM modulation uses a soft truncation window to filter each subband.

The windowing model affects the shape in the frequency domain. The Hamming windowing method, for example, is optimized for better sidelobe suppression.

The following parameters also affect the shape of the filter window:

- **Filter Length**
- **Cut Transient Response**

See also "[Proposed prototype filters](#)" on page 17.

Remote command:

`[:SOURCE<hw>] :BB:OFDM:FILTer:WINDowing` on page 81

Cut Transient Response

Cuts the transient response of the filtering operation at the beginning and end of the signal. The length of the cut samples depends on the selected **Filter Length**.

See also ["Proposed prototype filters"](#) on page 17.

Remote command:

`[:SOURCE<hw>] :BB:OFDM:FILTer:CUTTrans` on page 80

User Filter Length

Indicates the number of filter coefficients in the user filter file, see ["User filter file format \(*.dat files\)"](#) on page 19.

Remote command:

`[:SOURCE<hw>] :BB:OFDM:FILTer:ULENgtH?` on page 81

Load User Filter

Accesses the dialog "Select List File User Filter" for loading a user-defined filter file.

User filters are described in files with extension *.dat, see ["User filter file format \(*.dat files\)"](#) on page 19.

Remote command:

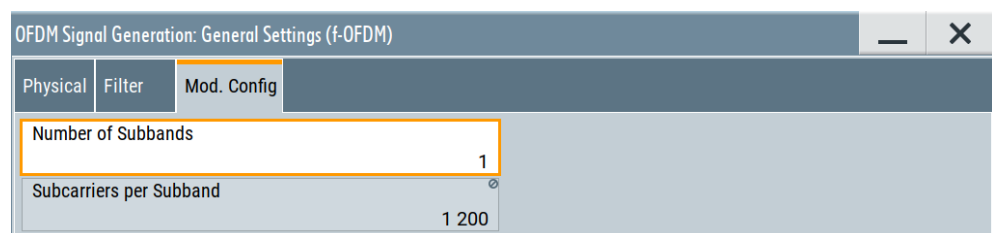
`[:SOURCE<hw>] :BB:OFDM:FILTer:USELectioN` on page 81

`[:SOURCE<hw>] :BB:OFDM:FILTer:UCATalog?` on page 81

3.2.3 Modulation configuration settings

Access:

1. Select "OFDM Signal Generation" > "General".
2. Select the modulation type.
Select, for example, "Modulation Type" > "UFMC".
3. Select "General Settings".
4. Select "Mod. Config".



This tab provides settings to configure the modulation for modulation types "f-OFDM", "UFMC", "FBMC" and "GFDM". The provided settings depend on the selected modulation type.

Settings:

Number of Subbands..... 41
 Subcarriers per Subband..... 41
 Subband Filter Pre-equalization..... 41
 Datablock Size..... 42
 Overlap Factor..... 42

Number of Subbands

Requires "Modulation Type" > "f-OFDM"/"UFMC".

Sets the number of subbands. A subband is a group of adjacent subcarriers. The number of subcarriers in one subband is calculated as follows:

$$\text{Subcarriers per Subband} = \text{Occupied Number of Subcarriers} / \text{Number of Subbands}$$

Remote command:

[:SOURce<hw>] :BB:OFDM:UFMC:NSUBand on page 83

[:SOURce<hw>] :BB:OFDM:FOFDm:NSUBand on page 82

Subcarriers per Subband

Requires "Modulation Type" > "f-OFDM"/"UFMC".

Indicates the number of adjacent subcarriers within a subband. This number calculated as follows:

$$\text{Subcarriers per Subband} = \text{Occupied Number of Subcarriers} / \text{Number of Subbands}$$

Remote command:

[:SOURce<hw>] :BB:OFDM:SUBCarriers? on page 82

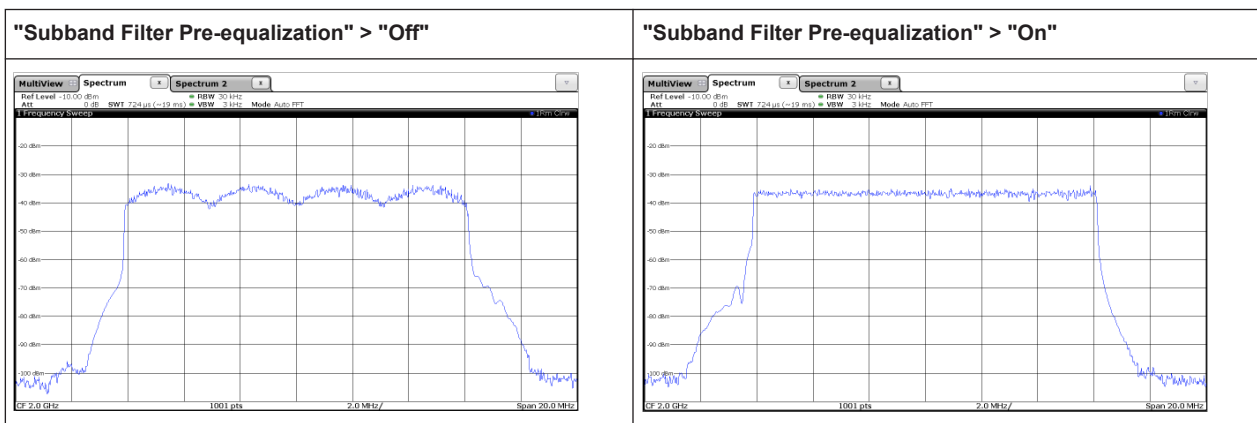
Subband Filter Pre-equalization

Requires "Modulation Type" > "UFMC".

Applies a filter pre-equalization according to the specification 5GNOW D3.x.

It equalizes the non-ideal filter response of the subband filter by increasing or decreasing the power of outer and inner subcarriers of a subband.

Table 3-1: Effect of filter pre-equalization on the UFMC modulation (Number of Subbands = 4)



Remote command:

[:SOURce<hw>] :BB:OFDM:UFMC:PREequal on page 83

Datablock Size

Requires "Modulation Type" > "GFDM".

Sets data block size M in terms of symbols per data block.

The "Datablock Size" is a value between 1 and the [Sequence Length](#) value and must be a common divisor of the "Sequence Length".

Remote command:

[:SOURce<hw>] :BB:OFDM:GFDM:DBSYmbols on page 82

Overlap Factor

Requires "Modulation Type" > "FBMC".

Describes the number of overlapping (superimposed) symbols in time on the same subcarrier.

This parameter influences the filter length.

Remote command:

n.a.

3.3 Allocation settings

Access:

1. Select "OFDM Signal Generation" > "General".
2. Select the modulation type.
Select, for example, "Modulation Type" > "UFMC".
3. Select "General Settings" > "Allocation Settings".

The main part of the "Allocation Settings" dialog is the allocation table where the individual allocations can be defined. Each allocation can use a different constellation or modulation type and data source.

The allocations can differ in the number of symbols, the occupied number of subcarriers, and the individual position within the resource grid. You can assign individual users to the allocations, where each user uses an individual data source and individual multiple access schemes.

Monitoring allocations in resource grids

The time plan displays a resource grid representation of configured allocations. This representation differs per modulation type and allocation:

- The "Time Plan" tab shows individual allocations on the time-frequency grid, see [Chapter 3.3.7, "Time plan"](#), on page 56.

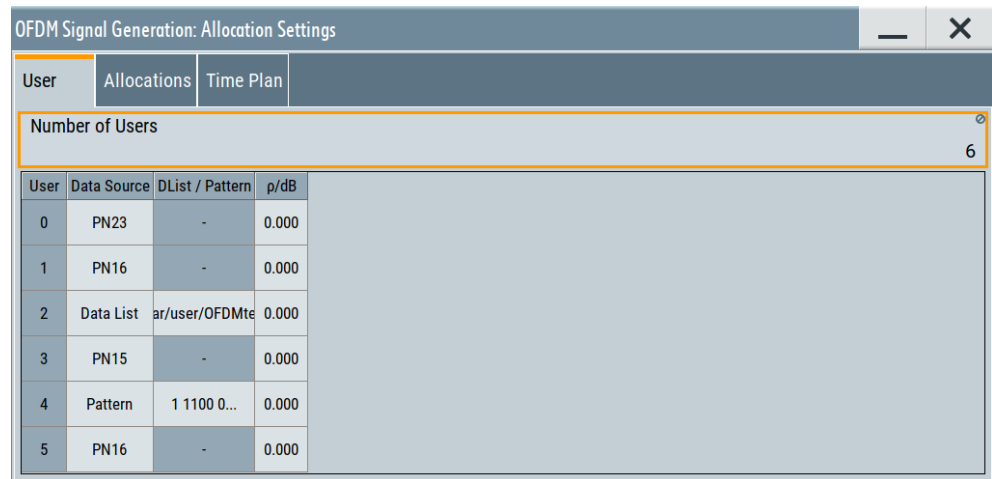
Settings:

- [User settings](#)..... 43
- [Allocations settings](#)..... 45
- [Split pattern settings](#)..... 50
- [SCMA settings](#)..... 51
- [Zadoff-Chu settings](#)..... 54
- [Constellation points settings](#)..... 55
- [Time plan](#)..... 56

3.3.1 User settings

Access:

- ▶ Select "User".



Settings:

- [Number of Users](#)..... 43
- [User](#)..... 43
- [Data Source](#)..... 44
- [p\(dB\)](#)..... 44

Number of Users

Indicates the maximum number of users that can be configured.

Any configured user can be deactivated.

Remote command:

n.a.

User

Displays the consecutive number of the user.

Remote command:

Via suffix USER<ch0>

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 set the bit pattern.
- "Data List"/"Select Data List"
Binary data from a list file, internally or externally generated.
Select "Select Data List" to open the standard "Select List" dialog. The dialog lists file with file extension *.dm_iqd if existing.
 - Navigate to the list file and tap "Select" to select the file.
 - Use the "New" and "Edit" functions to create a data list internally or to edit an existing one.
 - Use the standard "File Manager" function to transfer external data lists to the instrument.

See also:

- Section "About data signals" in the R&S SMW200A user manual.
- Section "File and data management" in the R&S SMW200A user manual.
- Section "Data list editor" in the R&S SMW200A user manual.

Remote command:

[:SOURce<hw>] :BB:OFDM:USER<ch0>:DATA on page 83

[:SOURce<hw>] :BB:OFDM:USER<ch0>:LIST on page 83

[:SOURce<hw>] :BB:OFDM:USER<ch0>:PATtern on page 84

p(dB)

Boosts the user with the selected power offset relative to the other users.

Remote command:

[:SOURce<hw>] :BB:OFDM:USER<ch0>:PWR on page 84

3.3.2 Allocations settings

Access:

- ▶ Select "Allocations".

OFDM Signal Generation: Allocation Settings														
User	Allocations	Time Plan												
Number of Allocations														6
	Constellation	Mod. Order	No. SC	No. Sym.	Offs. SC	Offs. Sym.	Physical Bits	Data Source	DList/Pattern /IQ Src.	ρ(dB)	Content Type	Split Pattern	State	Conf.
0	BPSK	2	53	2	0	0	106	PN16	-	0.000	Pilot	Config...	On	⚠
1	256QAM	256	53	6	0	2	2544	PN16	-	0.000	Data	Config...	On	
2	SCMA	-	53	2	0	8	212	Config...	-	0.000	Data	Config...	On	
3	Custom IQ	-	1	1	0	0	-	-		0.000	Data	Config...	On	⚠
4	ZadoffChu	-	1	1	0	0	-	Config...	-	0.000	Data	Config...	On	⚠
5	Custom Constellation	4	1	1	0	0	2	PN16	-	0.000	Data	Config...	On	⚠

This tab provides settings to configure the number of allocations and individual allocation settings in a table. Each row represents a configuration of an individual allocation. For each allocation, configure base modulation type or constellation, subcarriers and symbols, data source, power offset and time-frequency resources.

Use the "Time Plan" to visualize the allocations as resource grids, see [Chapter 3.3.7, "Time plan"](#), on page 56.

Settings:

Number of Allocations.....	45
Allocation number AL#.....	46
Constellation.....	46
Modulation Order.....	46
No. SC.....	46
No. Sym.....	47
Offs. SC.....	47
Offs. Sym.....	47
Physical Bits.....	47
Data Source.....	47
ρ(dB).....	48
Content Type.....	48
Split Pattern.....	50
State.....	50
Conflict.....	50

Number of Allocations

Sets the number of scheduled allocations.

Remote command:

[:SOURce<hw>] :BB:OFDM:NAALoc on page 88

Allocation number AL#

Displays the consecutive number of the allocation.

Remote command:

n.a.

Constellation

Sets the constellation that is the base modulation type of the selected allocation.

"BPSK"/"QPSK"

Binary or quaternary phase shift keying

"16QAM"/"64QAM"/"256QAM"

16, 64 or 256 quadrature amplitude modulation

"SCMA"

Sparse code multiple access

"Custom IQ"

Custom modulation of I/Q data from files

You can load files with predefined file syntax and file extension, see ["Custom I/Q file format \(*.iqw or *.dat files\)"](#) on page 24.

"ZadoffChu"

Zadoff-Chu sequence

Also configure sequence settings such as the sequence length, the sequence number and the cyclic shifts, see [Chapter 3.3.5, "Zadoff-Chu settings"](#), on page 54.

"Custom Constellation"

Custom constellation with user-defined constellation points

Also configure modulation order and coordinates of individual constellation points, see [Chapter 3.3.6, "Constellation points settings"](#), on page 55.

Remote command:

[:SOURce<hw>] :BB:OFDM:ALLoc<ch0>:MODulation on page 88

Modulation Order

Sets/displays the modulation order of the allocation.

Setting the modulation order requires "Constellation" > "Custom Constellation", see ["Constellation"](#) on page 46.

In the allocation table, this parameter accesses constellation points settings of the selected allocation, see [Chapter 3.3.6, "Constellation points settings"](#), on page 55.

Remote command:

[:SOURce<hw>] :BB:OFDM:ALLoc<ch0>:MOOR on page 89

No. SC

Sets the number of allocated subcarriers that is the allocated bandwidth.

For "Modulation Type" > "SCMA", the number of allocated subcarriers is a multiple of the spreading factor K. See ["Spreading Factor K"](#) on page 52.

Remote command:

[:SOURce<hw>] :BB:OFDM:ALLoc<ch0>:SCNO on page 89

No. Sym.

Sets the allocation size in the time domain and expresses the time in the number of symbols.

Remote command:

[:SOURce<hw>] :BB:OFDM:ALLoc<ch0>:SYNO on page 89

Offs. SC

Sets the start subcarrier of the selected allocation. It shifts the allocated bandwidth in the frequency domain.

Remote command:

[:SOURce<hw>] :BB:OFDM:ALLoc<ch0>:SCOFFset on page 90

Offs. Sym.

Sets the start symbol of the selected allocation. It shifts the allocation in the time domain.

Remote command:

[:SOURce<hw>] :BB:OFDM:ALLoc<ch0>:SYOFFset on page 90

Physical Bits

Displays the allocation size in bits.

The value depends on the allocation size and the used modulation type.

Remote command:

[:SOURce<hw>] :BB:OFDM:ALLoc<ch0>:PHYSbits? on page 90

Data Source

Selects the data source for the allocation.

"User x"	Use the User settings dialog to configure the data sources for the "User 1 to 6".
"Config"	If "Modulation" > "SCMA", opens a dialog with further settings, see Chapter 3.3.4, "SCMA settings" , on page 51.
"I/Q Source"	For "Modulation" > "Custom I/Q", select "Select IQ Source" to access the standard "Select List" dialog. Select a suitable file with the file extension the *.dat or *.iqw. Use the standard "File Manager" function to transfer external data lists to the instrument. For information on the file format, see "Custom I/Q file format (*.iqw or *.dat files)" on page 24.

"All 0"/"All 1"/"PNxx"/"Pattern"/"Data List"/"Select DList"

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 set the bit pattern.
- "Data List"/"Select Data List"
Binary data from a list file, internally or externally generated.
Select "Select Data List" to open the standard "Select List" dialog.
The dialog lists file with file extension *.dm_iqd if existing.
 - Navigate to the list file and tap "Select" to select the file.
 - Use the "New" and "Edit" functions to create a data list internally or to edit an existing one.
 - Use the standard "File Manager" function to transfer external data lists to the instrument.

See also:

- Section "About data signals" in the R&S SMW200A user manual.
- Section "File and data management" in the R&S SMW200A user manual.
- Section "Data list editor" in the R&S SMW200A user manual.

Remote command:

[:SOURce<hw>] :BB:OFDM:ALLoc<ch0>:DATA on page 90

[:SOURce<hw>] :BB:OFDM:ALLoc<ch0>:LIST on page 91

[:SOURce<hw>] :BB:OFDM:ALLoc<ch0>:PATTern on page 91

[:SOURce<hw>] :BB:OFDM:ALLoc<ch0>:CIQFile on page 91

p(dB)

Sets the power offset for an individual allocation relative to the other allocations.

Positive values imply an amplification, negative values imply an attenuation.

Remote command:

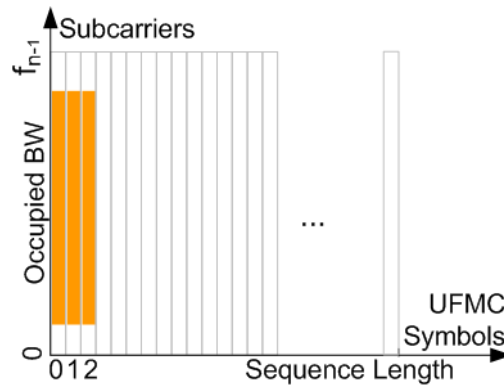
[:SOURce<hw>] :BB:OFDM:ALLoc<ch0>:PWR on page 91

Content Type

Sets the content type.

"Data" The allocation contains the data.
To set the data source, see "[Data Source](#)" on page 47.

"Preamble" Fixed setting for "Modulation Type" > "UFMC". Use preambles to synchronize the R&S SMW200A and external instrument, for example, an Rohde & Schwarz signal analyzer. The preamble spans the entire occupied bandwidth. The preamble is part of the first symbol or symbols that you set via the number of symbols, see "No. Sym." on page 47. The preamble symbols contain BPSK-modulated pseudo random binary sequence data (PN9). The pseudo-random generation restarts at the beginning of each symbol, so that the preamble symbols are identical.



The remaining symbols are filled with the data source and modulated as selected with the parameters [Data Source](#) and [Constellation](#). To set the preamble length, use the parameter [No. Sym.](#)

Note: Do not mistake the preamble with the cyclic prefix, see "[Cyclic Prefix Length](#)" on page 32.

"Pilot" Requires "Modulation Type" > "OFDM"/"f-OFDM". Enables generation of pilot signals. Use these pilot signals for measurements with the Rohde & Schwarz signal analyzer, for example R&S VSE-K96.

See also the following:

- "[Modulation Type](#)" on page 28
- [Chapter 2.5, "Generating configuration files for R&S®VSE-K96"](#), on page 26

"Reserved" If OFDM modulation is used, you can mark allocations as reserved, so that they are perceived as general OFDM modulated signals by the analyzer. The allocation configuration and content is user-defined. The signal generation is as for any other allocation content. This setting affects the content of the automatically created *.xml settings file and hence the way that the signal analyzer processes the generated signal.

See also [Chapter 2.5, "Generating configuration files for R&S®VSE-K96"](#), on page 26.

Remote command:

[:SOURce<hw>] :BB:OFDM:ALLoc<ch0>:CONTent on page 92

Split Pattern

Accesses split pattern settings for the selected allocation, see [Chapter 3.3.3, "Split pattern settings"](#), on page 50.

Remote command:

`[:SOURce<hw>] :BB:OFDM:ALLoc<ch0>:PATtern` on page 91

State

Enables the allocation.

Remote command:

`[:SOURce<hw>] :BB:OFDM:ALLoc<ch0>:STATe` on page 92

Conflict

A warning icon indicates a conflict, for example, if allocations overlap.

To visualize the allocations, see ["Monitoring allocations in resource grids"](#) on page 42.

Remote command:

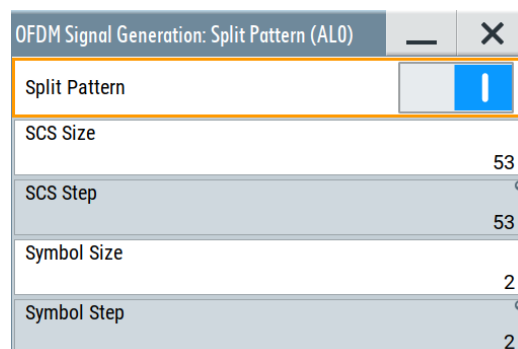
`[:SOURce<hw>] :BB:OFDM:ALLoc<ch0>:CONFLict?` on page 92

3.3.3 Split pattern settings

Access:

1. Select "Allocations".
2. Select "AL#" > "Split Pattern" > "Config".

The "Split Pattern" dialog of the selected allocation "(AL#)" opens. It allows you to configure subcarrier spacing (SCS) size and SCS step and symbol size and symbol step.

**Settings:**

Split Pattern	51
SCS Size	51
SCS Step	51
Symbol Size	51
Symbol Step	51

Split Pattern

Activates split pattern settings for the selected allocation.

Remote command:

[:SOURce<hw>] :BB:OFDM:ALLoc<ch0>:SPLT:STATe on page 95

SCS Size

Sets the subcarrier spacing (SCS) size.

The maximum SCS size equals the number of subcarriers of the selected allocation, see "No. SC" on page 46.

Remote command:

[:SOURce<hw>] :BB:OFDM:ALLoc<ch0>:SPLT:SCS:SIZE on page 95

SCS Step

Sets/displays the subcarrier spacing (SCS) step.

Setting requires SCS sizes smaller than the set number of subcarriers of the selected allocation, see "SCS Size" on page 51.

Remote command:

[:SOURce<hw>] :BB:OFDM:ALLoc<ch0>:SPLT:SCS:STEP on page 96

Symbol Size

Sets the symbol size.

The maximum symbol size equals the number of symbols of the selected allocation, see "No. Sym." on page 47.

Remote command:

[:SOURce<hw>] :BB:OFDM:ALLoc<ch0>:SPLT:SYM:SIZE on page 96

Symbol Step

Sets or displays the symbol step.

Setting requires symbol sizes smaller than the number of symbols of the selected allocation.

Remote command:

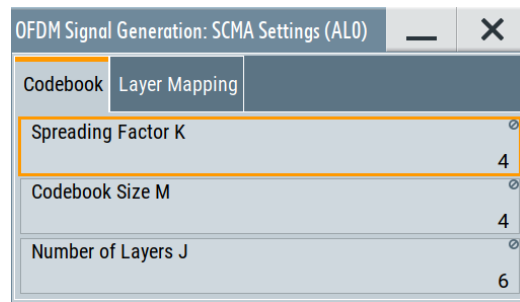
[:SOURce<hw>] :BB:OFDM:ALLoc<ch0>:SPLT:SYM:STEP on page 96

3.3.4 SCMA settings

Access:

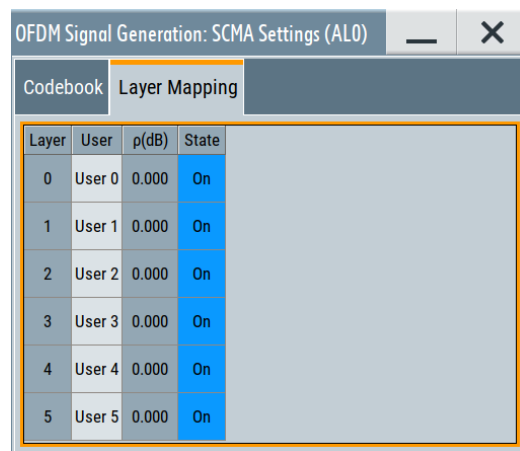
1. Select "Allocations".
2. Select "AL#" > "Constellation" > "SCMA".
3. Select "Data Source" > "Config".

The "SCMA Settings" dialog of the selected allocation "(AL#)" opens. In the "Codebook" tab, configure spreading factor, codebook size and number of layers.



4. Select "Layer Mapping".

In the "Layer Mapping" tab, assign users to individual layers and configure the state of these layers.



Settings:

Codebook.....	52
L Spreading Factor K.....	52
L Codebook Size M.....	53
L Number of Layers J.....	53
Layer Mapping.....	53
L Layer.....	53
L User.....	53
L ρ (dB).....	53
L State.....	53

Codebook

The tab displays the codebook parameters.

See [Figure 2-8](#).

Spreading Factor K ← Codebook

Displays the used spreading factor K.

Remote command:

[:SOURce<hw>] :BB:OFDM:ALLoc<ch0>:SCMA:SPRead? on page 93

Codebook Size M ← Codebook

Displays the codebook size M.

Remote command:

[\[:SOURCE<hw>\]:BB:OFDM:ALLoc<ch0>:SCMA:CODEbook?](#) on page 93

Number of Layers J ← Codebook

Displays the resulting number of layers J.

The number of layers (that is also the number of codebooks) is calculated as follows:

$$J = \binom{K}{N}$$

Where:

- K is the spreading factor
- N is the number of non-zero elements, see [Figure 2-8](#).

With the predefined settings, the number of layers is J = 6.

Remote command:

[\[:SOURCE<hw>\]:BB:OFDM:ALLoc<ch0>:SCMA:NLAYers?](#) on page 93

Layer Mapping

The tab provides settings to configure the user to layer-mapping.

Layer ← Layer Mapping

Indicates the layer number.

With the predefined settings, the number of layers is J = 6, see ["Number of Layers J"](#) on page 53.

User ← Layer Mapping

Maps the users to the layers and sets the codebook per user, see for example [Figure 2-9](#).

One user can be assigned to several layers, whereas each layer can be assigned to exact one user.

Remote command:

[\[:SOURCE<hw>\]:BB:OFDM:ALLoc<ch0>:SCMA:LAYer<st0>:USER](#) on page 94

p(dB) ← Layer Mapping

Provided for future use.

Remote command:

[\[:SOURCE<hw>\]:BB:OFDM:ALLoc<ch0>:SCMA:LAYer<st0>:PWR?](#) on page 93

State ← Layer Mapping

Enables the individual layers (codebooks).

Remote command:

[\[:SOURCE<hw>\]:BB:OFDM:ALLoc<ch0>:SCMA:LAYer<st0>:STATE](#) on page 94

3.3.5 Zadoff-Chu settings

Access:

1. Select "Allocations".
2. Select "AL#" > "Constellation" > "ZadoffChu".
3. Select "Data Source" > "Config".

The "ZadoffChu Settings" dialog of the selected allocation "(AL#)" opens. It provides settings to configure sequence length, number of sequences and cyclic shifts of the Zadoff-Chu sequence.

OFDM Signal Generation: ZadoffChu Settings (AL0)	
Sequence Length	1
Sequence Number	0
Cyclic Shift	0

Settings:

Sequence Length.....	54
Sequence Number.....	54
Cyclic Shift.....	54

Sequence Length

Sets the length of the Zadoff-Chu sequence.

The maximum sequence length equals the number of subcarriers of the allocation, see "No. SC" on page 46.

Remote command:

[:SOURce<hw>] :BB:OFDM:ALLoc<ch0>:ZAD:SLEN on page 97

Sequence Number

Sets the sequence number within the Zadoff-Chu sequence.

Remote command:

[:SOURce<hw>] :BB:OFDM:ALLoc<ch0>:ZAD:SNUMber on page 97

Cyclic Shift

Sets the cyclic shift of the Zadoff-Chu sequence.

Remote command:

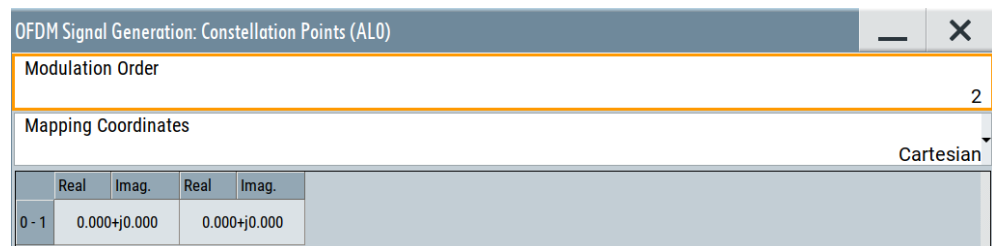
[:SOURce<hw>] :BB:OFDM:ALLoc<ch0>:ZAD:CYCShift on page 97

3.3.6 Constellation points settings

Access:

1. Select "Allocations".
2. Select "AL#" > "Constellation" > "Custom Constellation".
3. Select "Mod. Order".

The "Constellation Points" dialog of the selected allocation "(AL#)" opens. It provides settings to configure the modulation order, the reference coordinate system and constellation point coordinates of an individual allocation.



Settings:

Modulation Order.....	55
Mapping Coordinates.....	55
Constellation coordinates table.....	55

Modulation Order

Sets/displays the modulation order of the allocation.

Setting the modulation order requires "Constellation" > "Custom Constellation", see "Constellation" on page 46.

In the allocation table, this parameter accesses constellation points settings of the selected allocation, see [Chapter 3.3.6, "Constellation points settings"](#), on page 55.

Remote command:

[:SOURce<hw>] :BB:OFDM:ALLoc<ch0>:MOOR on page 89

Mapping Coordinates

Sets the reference coordinate system of the constellation points.

"Cartesian" Cartesian coordinate system with real part and imaginary part coordinates.

"Cylindrical" Cylindrical coordinate system with magnitude and phase coordinates.

Remote command:

n.a.

Constellation coordinates table

Sets coordinates for individual constellation points.

You can set real part (x-axis) and imaginary part (y-axis) coordinates for a Cartesian coordinate system. Or you can set phase and magnitude coordinates for a cylindrical coordinate system. See "[Mapping Coordinates](#)" on page 55.

Remote command:

[:SOURce<hw>] :BB:OFDM:ALLoc<ch0>:CONPoint<st0>:REAL on page 99

[:SOURce<hw>] :BB:OFDM:ALLoc<ch0>:CONPoint<st0>:IMAG on page 98

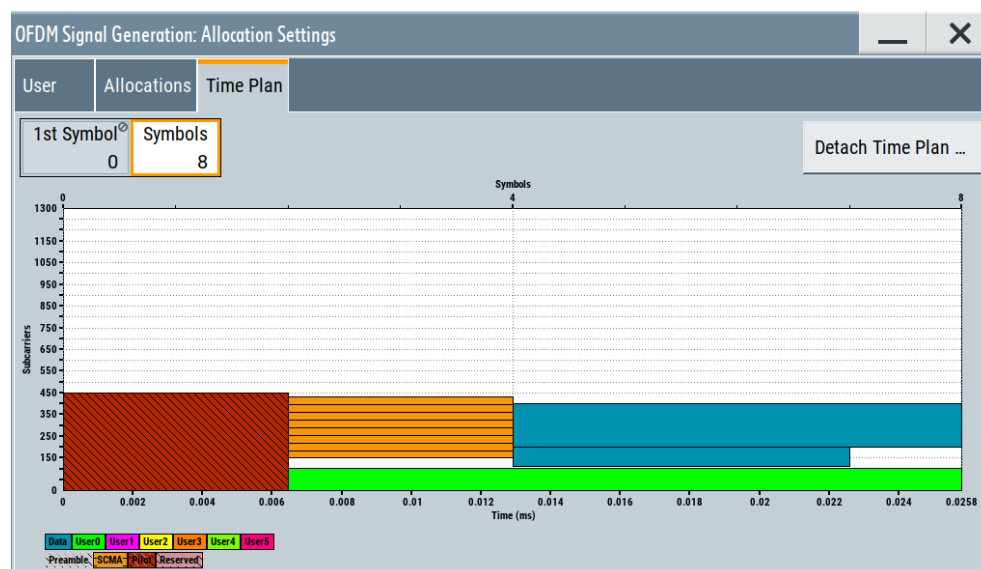
[:SOURce<hw>] :BB:OFDM:ALLoc<ch0>:CONPoint<st0>:MAGN on page 99

[:SOURce<hw>] :BB:OFDM:ALLoc<ch0>:CONPoint<st0>:PHASe on page 99

3.3.7 Time plan

Access:

1. Select "Allocation Settings".
2. Select "Time Plan".



The tab provides a time-frequency resource grid representation of configured allocations. The x-axis shows the time domain in milliseconds (lower axis) or in number of symbols (upper axis part). The y-axis shows the frequency domain with the number of occupied subcarriers as the smallest frequency granularity.

Also, the tab provides settings to configure the displayed number of symbols and to detach the time-frequency plan ("Time Plan").

Settings:

1st Symbol.....	57
Symbols.....	57
Detach Time Plan.....	57

1st Symbol

Selects the number of the first displayed symbol.

Remote command:

n.a.

Symbols

Sets the number of displayed symbols.

The maximum number of symbols is set with the parameter [Sequence Length](#).

Remote command:

n.a.

Detach Time Plan

Opens the time plan in a separate window.

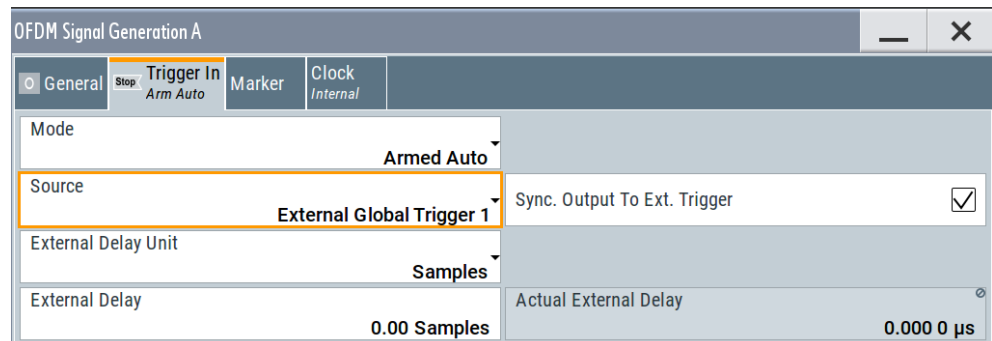
Remote command:

n.a.

3.4 Trigger settings

Access:

- ▶ Select "OFDM Signal Generation" > "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 also provides 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 3.7, "Local and global connectors settings"](#), on page 66.

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 SMW200A starts baseband signal generation after the configured trigger event.

About baseband trigger signals

This section focuses on the available settings.

For detailed information on baseband trigger signals, see section "About trigger signals" in the R&S SMW200A user manual.

Settings:

Trigger settings common to all basebands.....	58
Mode.....	58
Signal Duration Unit.....	59
Signal Duration.....	59
Running/Stopped.....	59
Time Based Trigger.....	60
Trigger Time.....	60
Arm.....	60
Execute Trigger.....	60
Source.....	60
Sync. Output to External Trigger/Sync. Output to Trigger.....	61
External Inhibit/Trigger Inhibit.....	62
(External) Delay Unit.....	62
(Specified) External Delay/(Specified) Trigger Delay.....	62
Actual Trigger Delay/Actual External Delay.....	63

Trigger settings common to all basebands

To enable simultaneous signal generation in all basebands, the R&S SMW200A 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 the trigger mode. The mode determines the effect of a trigger event on the signal generation.

For more information, see chapter "About trigger signals" in the R&S SMW200A 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:OFDM\[:TRIGger\]:SEQuence](#) on page 101

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:OFDM:TRIGger:SLUNit](#) on page 104

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:OFDM:TRIGger:SLENgth](#) on page 103

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:OFDM:TRIGger:RMODe?](#) on page 102

Time Based Trigger

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

Activates time-based triggering with a fixed time reference.

The R&S SMW200A 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 SMW200A user manual.

Remote command:

[\[:SOURce<hw>\]:BB:OFDM:TRIGger:TIME\[:STATe\]](#) on page 103

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 SMW200A. 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 SMW200A user manual.

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

Remote command:

[\[:SOURce<hw>\]:BB:OFDM:TRIGger:TIME:DATE](#) on page 102

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

Remote command:

[\[:SOURce<hw>\]:BB:OFDM:TRIGger:TIME:TIME](#) on page 103

Arm

Stops the signal generation until subsequent trigger event occurs.

Remote command:

[\[:SOURce<hw>\]:BB:OFDM:TRIGger:ARM:EXECute](#) on page 104

Execute Trigger

For internal trigger source, executes the trigger manually.

Remote command:

[\[:SOURce<hw>\]:BB:OFDM:TRIGger:EXECute](#) on page 104

Source

The following sources of the trigger signal are available:

- "Internal"
The trigger event is internal. Tap "Execute Trigger" to trigger signal generation manually.
- "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.
- "Baseband Sync In"
Requires "Multi Instrument Trigger" > "Secondary" for primary-secondary instrument mode.
Triggers signal generation at the secondary instrument by the active edge of the baseband synchronization signal of the primary instrument.

"External Local Clock/Trigger" require R&S SMW-B10.

How to: ["Routing and activating a trigger signal"](#) on page 57

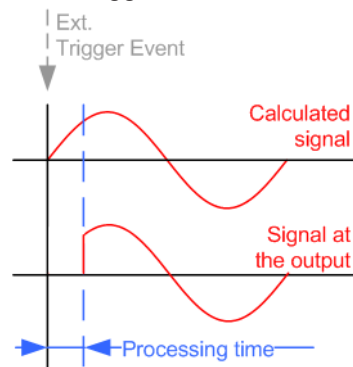
Remote command:

`[:SOURce<hw>] :BB:OFDM:TRIGger:SOURce` on page 101

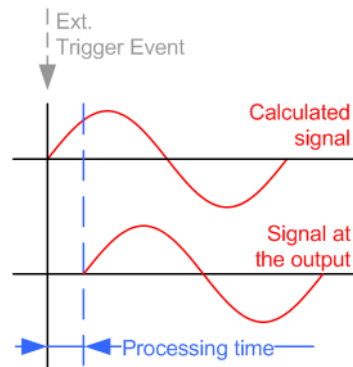
Sync. Output to External Trigger/Sync. Output to Trigger

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.



In primary-secondary instrument mode, this setting ensures that once achieved, synchronization is not lost if the baseband signal sampling rate changes.

Remote command:

`[:SOURce<hw>] :BB:OFDM:TRIGger:EXTernal:SYNChronize:OUTPut`
on page 104

External Inhibit/Trigger Inhibit

Applies for an 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 on signals, modulation formats and filters" in the user manual.

Remote command:

`[:SOURce<hw>] :BB:OFDM:TRIGger[:EXTernal]:INHibit` on page 107
`[:SOURce<hw>] :BB:OFDM:TRIGger:OBASeband:INHibit` on page 106

(External) Delay Unit

Determine whatever the trigger delay is expressed in samples or directly defined as a time period (seconds).

To specify the delay, use the parameter [\(Specified\) External Delay/\(Specified\) Trigger Delay](#).

The parameter [Actual Trigger Delay/Actual External Delay](#) displays the delay converted in time.

Remote command:

`[:SOURce<hw>] :BB:OFDM:TRIGger:DELay:UNIT` on page 105

(Specified) External Delay/(Specified) Trigger Delay

The name of the parameter and the units the delay is expressed in, changes depending on the parameter [\(External\) Delay Unit](#).

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
- Compensate delays and align the signal generation start in multi-instrument setup

For more information, see chapter "Basics on ..." in the R&S SMW200A user manual.

The parameter displays the delay converted in time.

Remote command:

`[:SOURce<hw>] :BB:OFDM:TRIGger [:EXTernal] :DELay` on page 106

`[:SOURce<hw>] :BB:OFDM:TRIGger:EXTernal:TDELay` on page 106

`[:SOURce<hw>] :BB:OFDM:TRIGger:OBASeband:DELay` on page 105

`[:SOURce<hw>] :BB:OFDM:TRIGger:OBASeband:TDELay` on page 105

Actual Trigger Delay/Actual External Delay

Indicates the resulting trigger delay in "Time" unit.

Remote command:

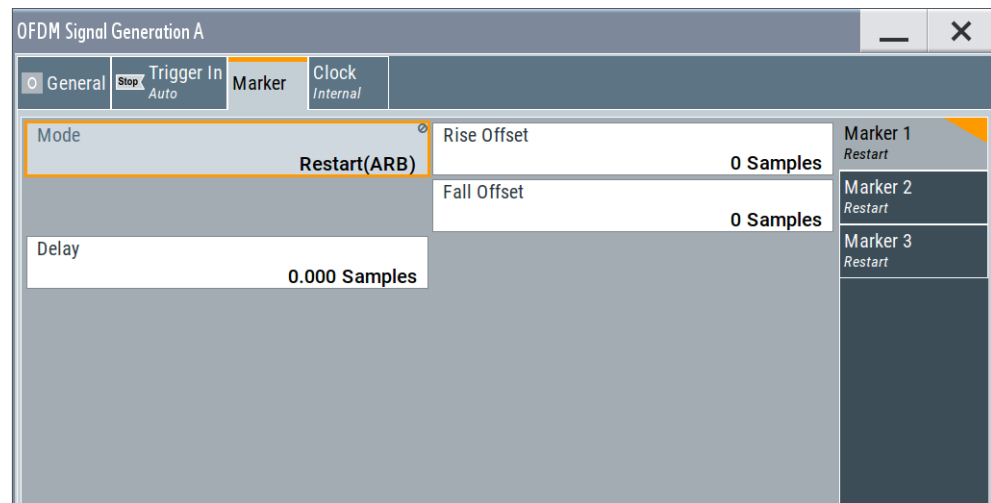
`[:SOURce<hw>] :BB:OFDM:TRIGger:EXTernal:RDELay?` on page 107

`[:SOURce<hw>] :BB:OFDM:TRIGger:OBASeband:RDELay?` on page 105

3.5 Marker settings

Access:

- ▶ Select "OFDM Signal Generation" > "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 3.7, "Local and global connectors settings"](#), on page 66.
You can map marker signals to one or more USER x or T/M connectors.
3. Enable baseband signal generation. In the block diagram, set "Baseband" > "On".
The R&S SMW200A adds the marker signal to the baseband signal. Also, R&S SMW200A outputs this signal at the configured USER x connector.

About marker output signals

This section focuses on the available settings.

For detailed information on baseband trigger signals, see section [About trigger signals](#) in the R&S SMW200A user manual.

Settings:

Mode.....	64
Rise Offset/Fall Offset.....	64
Delay.....	64

Mode

Sets the marker mode that defines the shape and periodicity of the marker signals.

You can configure marker modes for up to 3 markers. The marker configuration changes with the selected marker mode.

How to: ["Routing and activating a marker signal"](#) on page 64

"Restart (ARB)"

A marker signal is generated at the start of each ARB sequence.

Remote command:

[\[:SOURce<hw>\]:BB:OFDM:TRIGger:OUTPut<ch>:MODE](#) on page 108

Rise Offset/Fall Offset

Shifts the rising or falling ramp of the marker by the selected number of samples. Positive values shift the rising ramp to later positions; negative values shift it to earlier positions.

Remote command:

[\[:SOURce<hw>\]:BB:OFDM:TRIGger:OUTPut<ch>:FOFFset](#) on page 108

[\[:SOURce<hw>\]:BB:OFDM:TRIGger:OUTPut<ch>:ROFFset](#) on page 108

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:OFDM:TRIGger:OUTPut<ch>:DELay](#) on page 108

3.6 Clock settings

Access:

- ▶ Select "OFDM Signal Generation" > "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 the clock signal.
2. For external clock signals, define the connector for the signal input. See [Chapter 3.7, "Local and global connectors settings"](#), on page 66.

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 SMW200A starts baseband signal generation with a symbol rate that equals the clock rate.

About clock signals

This section focuses on the available settings.

For detailed information on baseband trigger signals, see section "About trigger signals" in the R&S SMW200A user manual.

Settings:

Clock Source	65
Clock Mode	66
Measured External Clock	66

Clock Source

Selects the clock source.

- "Internal"
The instrument uses its internal clock reference.
- "External Local Clock"
Option: R&S SMW-B10
The instrument expects an external clock reference at the local T/M/C connector.

"External Local Clock" requires R&S SMW-B10.

Remote command:

[:SOURce<hw>] :BB:OFDM:CLOCK:SOURce on page 109

Clock Mode

Option: R&S SMW-B10

Sets the type of externally supplied clock.

Remote command:

[:SOURce<hw>] :BB:OFDM:CLOCK:MODE on page 109

Measured External Clock

Provided for permanent monitoring of the enabled and externally supplied clock signal.

Remote command:

CLOCK:INPut:FREQuency?

3.7 Local and global connectors settings

Opens 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 of baseband signal configuration dialogs that you can open via the "Baseband" block in the block diagram. These tabs are available, for example, for "ARB" baseband signals.



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

4 Remote-control commands

The following commands are required to perform signal generation with the option R&S SMW200A-K114 in a remote environment. We assume that the R&S SMW200A has already been set up for remote operation in a network as described in the R&S SMW200A documentation. A knowledge about the remote control operation and the SCPI command syntax are assumed.



Conventions used in SCPI command descriptions

For a description of the conventions used in the remote command descriptions, see section "Remote Control Commands" in the R&S SMW200A user manual.

Common Suffixes

The following common suffixes are used in the remote commands:

Suffix	Value range	Description
ENTity<ch>	1 to 4	Entity in a multiple entity configuration with separate baseband sources ENTity3 4 require option R&S SMW-K76
SOURce<hw>	[1] to 4	Available baseband signals Only SOURce1 possible, if the keyword ENTity is used
OUTPut<ch>	1 to 3	Available markers
USER<ch>	0 to 5	Available users
ALLoc<ch0>	0 to 499	Available allocations
CONPoint<st0>	0 to 4095	Available constellation points for custom constellation



Using SCPI command aliases for advanced mode with multiple entities

You can address multiple entities configurations by using the SCPI commands starting with the keyword SOURce or the alias commands starting with the keyword ENTity.

Note that the meaning of the keyword SOURce<hw> changes in the second case.

For details, see section "SCPI Command Aliases for Advanced Mode with Multiple Entities" in the R&S SMW200A user manual.

Programming examples

This description provides simple programming examples. The purpose of the examples is to present **all** commands for a given task. In real applications, one would rather reduce the examples to an appropriate subset of commands.

The programming examples have been tested with a software tool which provides an environment for the development and execution of remote tests. To keep the example as simple as possible, only the "clean" SCPI syntax elements are reported. Non-executable command lines (e.g. comments) start with two // characters.

At the beginning of the most remote control program, an instrument preset or reset is recommended to set the instrument to a definite state. The commands `*RST` and `SYSTem:PRESet` are equivalent for this purpose. `*CLS` also resets the status registers and clears the output buffer.

The following commands specific to the R&S SMW200A-K114 option are described here:

• General commands	68
• Physical commands	72
• Filter commands	78
• Modulation commands	82
• User commands	83
• Allocation commands	85
• Trigger commands	100
• Marker commands	108
• Clock commands	109

4.1 General commands

Example: Saving current configuration

```
SOURce1:BB:OFDM:SETTing:STORe "/var/user/5g_ufmc_scma"
*RST
SOURce1:BB:OFDM:SETTing:CATalog?
// Response: "5g_ufmc_scma", "5g"
SOURce1:BB:OFDM:SETTing:LOAD "/var/user/5g_ufmc_scma"
SOURce1:BB:OFDM:NALLoc?
// 6
SOURce1:BB:OFDM:SETTing:DEL "5g"
```

Example: Saving a configuration to an XML file

```
SOURce1:BB:OFDM:MODulation OFDM
SOURce1:BB:OFDM:OUTPath "/var/user/K114-Export/"
SOURce1:BB:OFDM:STATe 1
// Query the created *.xml file.
SOURce1:BB:OFDM:OUTPath? "/var/user/K114-Export/Exported_K114_settings_K96"
```

[:SOURce<hw>]:BB:OFDM:STATe	69
[:SOURce<hw>]:BB:OFDM:PRESet	69
[:SOURce<hw>]:BB:OFDM:SETTing:CATalog	69
[:SOURce<hw>]:BB:OFDM:SETTing:LOAD	69
[:SOURce<hw>]:BB:OFDM:SETTing:STORe	70
[:SOURce<hw>]:BB:OFDM:SETTing:DEL	70
[:SOURce<hw>]:BB:OFDM:WAVEform:CREate	70
[:SOURce<hw>]:BB:OFDM:MODulation	70

[:SOURce<hw>]:BB:OFDM:MODPreset.....	71
[:SOURce<hw>]:BB:OFDM:OUTPath.....	71
[:SOURce<hw>]:BB:OFDM:SRATe:VARiation.....	71

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

Activates the standard.

Parameters:

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

Example: See [Example "Generating a UPMC waveform"](#) on page 85.

Manual operation: See ["State"](#) on page 28

[:SOURce<hw>]:BB:OFDM: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 `SOURce<hw>:BB:OFDM:STATe`.

Example: See [Example "Generating a UPMC waveform"](#) on page 85.

Usage: Event

Manual operation: See ["Set To Default"](#) on page 28

[:SOURce<hw>]:BB:OFDM:SETTing:CATalog

Queries the files with settings in the default directory. Listed are files with the file extension *.c5g.

Example: See [Example "Saving current configuration"](#) on page 68.

Manual operation: See ["Save/Recall"](#) on page 28

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

Loads the selected file from the default or the specified directory. Loaded are files with extension *.c5g.

Parameters:

<Filename> string
 file name or complete file path; file extension can be omitted

Example: See [Example "Saving current configuration"](#) on page 68.

Manual operation: See ["Save/Recall"](#) on page 28

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

Stores the current settings into the selected file; the file extension (*.c5g) is assigned automatically.

Parameters:

<Filename> string
 file name or complete file path

Example: See [Example "Saving current configuration"](#) on page 68.

Manual operation: See ["Save/Recall"](#) on page 28

[[:SOURce<hw>]:BB:OFDM:SETTing:DEL <Filename>

Deletes the selected file from the default or specified directory. Deleted are files with the file extension *.c5g.

Parameters:

<Filename> string
 file name or complete file path; file extension can be omitted

Example: See [Example "Saving current configuration"](#) on page 68.

Manual operation: See ["Save/Recall"](#) on page 28

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

Stores the current settings as an ARB signal in a waveform file (*.wv).

Parameters:

<Filename> string
 file name or complete file path; file extension is assigned automatically

Example: See [Example "Generating a UPMC waveform"](#) on page 85.

Manual operation: See ["Generate Waveform"](#) on page 28

[[:SOURce<hw>]:BB:OFDM:MODulation <ModType>

Selects the modulation type.

Parameters:

<ModType> UPMC | FBMC | GFDM | FOFDm | OFDM

UPMC

Universal Filtered Multi-Carrier modulation, see [Chapter 2.2.4, "UPMC"](#), on page 14.

FBMC

Filter Bank Multi-Carrier modulation, see [Chapter 2.2.5, "FBMC"](#), on page 15.

GFDM

Generalized Frequency Division Multiplexing, see [Chapter 2.2.3, "GFDM"](#), on page 13.

FOFDm

Filtered-OFDM modulation, see [Chapter 2.2.2, "f-OFDM"](#), on page 13.

OFDM

Orthogonal Frequency-Division Multiplexing modulation, see [Chapter 2.2.1, "OFDM"](#), on page 12.

*RST: OFDM

Example: See [Example "Generating a UPMC waveform"](#) on page 85.

Manual operation: See ["Modulation Type"](#) on page 28

[:SOURce<hw>]:BB:OFDM:MODPreset

Calls the default settings for the selected modulation type, see [\[:SOURce<hw> \]:BB:OFDM:MODulation](#) on page 70.

Example: See [Example "Generating a UPMC waveform"](#) on page 85.

Usage: Event

Manual operation: See ["Set To Modulation Default"](#) on page 30

[:SOURce<hw>]:BB:OFDM:OUTPath <K114OutputPath>

Specifies the output path and output file of the exported OFDM signal generation settings.

By default, the output path is `/var/user/K114-Export` and the output file is `Exported_K114_settings_K96.xml`.

See also [Example "Default "Exported_K114_settings_K96.xml" file"](#) on page 111.

Parameters:

<K114OutputPath> string

Example: See [Example "Saving a configuration to an XML file"](#) on page 68.

Manual operation: See ["Export path for XML settings ..."](#) on page 29

[:SOURce<hw>]:BB:OFDM:SRATe:VARiation <SymRateVar>

Sets the symbol rate variation of the signal.

Parameters:

<SymRateVar> float

Range: 400 to 4E7

Increment: 1E-3

*RST: 15.360000E6

Example: See [Example "Generating a UPMC waveform"](#) on page 85.

4.2 Physical commands

Example: Configuring zero padding

```
// Zero padding requires the OFDM modulation type.
:SOURce1:BB:OFDM:MODulation OFDM

// Query the total number of subcarriers.
:SOURce1:BB:OFDM:NSUBcarriers?
// Response: "64"
:SOURce1:BB:OFDM:ZSAMPles 100
// Setting is out of range.
:SOURce1:BB:OFDM:ZSAMPles?
// Response in samples: "63"
// Clips the number of zero samples to 63. The maximum number of zero samples
// equals the total number of subcarriers minus one sample.
:SOURce1:BB:OFDM:RSAMPles 10
// Repeats insertion of the next zero samples after ten symbols.
:SOURce1:BB:OFDM:OFFSet 9
// Sets an offset of nine symbols before first insertion of the zero samples.
:SOURce1:BB:OFDM:SEQLength?
// Response in symbols: "10"
:SOURce1:BB:OFDM:SEQLength 8
:SOURce1:BB:OFDM:RSAMPles?
// Response: "8"
// The repetition reduces to eight symbols because the maximum repetition
// equals the sequence length.
:SOURce1:BB:OFDM:OFFSet?
// Response: "7"
// The symbol offset for padding reduces to seven symbols because the maximum
// symbol offset equals the sequence length minus one symbol.
```

Commands:

[:SOURce<hw>]:BB:OFDM:NSUBcarriers	73
[:SOURce<hw>]:BB:OFDM:NOCCupied	73
[:SOURce<hw>]:BB:OFDM:SCSPace	73
[:SOURce<hw>]:BB:OFDM:SEQLength	73
[:SOURce<hw>]:BB:OFDM:CPLength	74
[:SOURce<hw>]:BB:OFDM:ACPLength	74
[:SOURce<hw>]:BB:OFDM:ACPSymbols	75
[:SOURce<hw>]:BB:OFDM:CPSymbols	75
[:SOURce<hw>]:BB:OFDM:CSPLength	75
[:SOURce<hw>]:BB:OFDM:DFTS:STATe	75
[:SOURce<hw>]:BB:OFDM:DCMode	75
[:SOURce<hw>]:BB:OFDM:ZSAMPles	76

[:SOURce<hw>]:BB:OFDM:OFFSet.....	76
[:SOURce<hw>]:BB:OFDM:RSAMples.....	76
[:SOURce<hw>]:BB:OFDM:SAMPLing?.....	77
[:SOURce<hw>]:BB:OFDM:BWOCcupied?.....	77
[:SOURce<hw>]:BB:OFDM:LGUard?.....	77
[:SOURce<hw>]:BB:OFDM:RGUard?.....	78

[:SOURce<hw>]:BB:OFDM:NSUBcarriers <NoOfSubCarr>

Sets the number of available subcarriers.

Parameters:

<NoOfSubCarr> integer
 Range: 64 to 16384
 *RST: 64

Example: See [Example"Generating a UPMC waveform"](#) on page 85.

Manual operation: See ["Total Number of Subcarriers/FFT Size"](#) on page 31

[:SOURce<hw>]:BB:OFDM:NOCCupied <NumOccSc>

Sets the number of occupied subcarriers.

Parameters:

<NumOccSc> integer
 Range: 1 to 13107
 *RST: 53

Example: See [Example"Generating a UPMC waveform"](#) on page 85.

Manual operation: See ["Occupied Number of Subcarriers"](#) on page 32

[:SOURce<hw>]:BB:OFDM:SCSPace <SubCarSp>

Sets the frequency distance between the carrier frequencies of the subcarriers.

Parameters:

<SubCarSp> float
 Range: 0.001 to 2
 Increment: 1E-6
 *RST: 0.3125
 Default unit: MHz

Example: See [Example"Generating a UPMC waveform"](#) on page 85.

Manual operation: See ["Subcarrier Spacing"](#) on page 32

[:SOURce<hw>]:BB:OFDM:SEQLength <SeqLen>

Sets the sequence length of the signal in number of symbols.

Parameters:

<SeqLen> integer
 Range: 1 to 1000
 *RST: 10

Example: See [Example "Generating a UPMC waveform"](#) on page 85.

Manual operation: See ["Sequence Length"](#) on page 32

[:SOURce<hw>]:BB:OFDM:CPLength <CpLength>

Sets the cyclic prefix length as number of samples. The maximum length equals the total number of subcarriers:

[\[:SOURce<hw>\]:BB:OFDM:NSUBcarriers](#) on page 73

Parameters:

<CpLength> integer
 Range: 0 to depends on settings
 *RST: 16

Example: See [Example "Generating a UPMC waveform"](#) on page 85.

Example: See also [\[:SOURce<hw>\]:BB:OFDM:ACPLength](#) on page 74.

Manual operation: See ["Cyclic Prefix Length"](#) on page 32

[:SOURce<hw>]:BB:OFDM:ACPLength <CpLength>

For f-OFDM/OFDM, enables additional alternative CP.

Parameters:

<CpLength> integer
 Range: 0 to 8192
 *RST: 0

Example:

```
SOURce1:BB:OFDM:MODulation FOFD
SOURce1:BB:OFDM:NSUBcarriers 512
SOURce1:BB:OFDM:NOCCupied 400
SOURce1:BB:OFDM:SCSPace 0.05
SOURce1:BB:OFDM:SEQLength 8

SOURce1:BB:OFDM:CPLength1 160
SOURce1:BB:OFDM:CPSymbols1 1
SOURce1:BB:OFDM:CPLength2 144
SOURce1:BB:OFDM:CPSymbols2 7
// the CP in the first symbol is 1600 samples long
// the other 7 symbols use a CP with 144 samples
```

Manual operation: See ["Alt. Cyclic Prefix Length"](#) on page 34

[:SOURce<hw>]:BB:OFDM:ACPSymbols <CPSymbols>

[:SOURce<hw>]:BB:OFDM:CPSymbols <CPSymbols>

For f-OFDM/OFDM, defines number of symbols on that the cyclic prefix/the alternative cyclic prefix is applied.

Parameters:

<CPSymbols> integer
 Range: 0 to 8192
 *RST: 1

Example: See [\[:SOURce<hw>\]:BB:OFDM:ACPLength](#) on page 74.

Manual operation: See "CP No. Symbols/Alt. CP No. Symbols" on page 34

[:SOURce<hw>]:BB:OFDM:CSLength <CycSuffLen>

Sets the cyclic suffix length. The maximum length equals the total number of subcarriers:

[\[:SOURce<hw>\]:BB:OFDM:NSUBcarriers](#) on page 73

Parameters:

<CycSuffLen> integer
 Range: 0 to depends on settings
 *RST: 0

Example: See [Example "Generating a UPMC waveform"](#) on page 85.

Manual operation: See "Cyclic Suffix Length" on page 35

[:SOURce<hw>]:BB:OFDM:DFTS:STATE <DftsState>

Activates discrete Fourier transform spread OFDM (DFT-s-OFDM) uplink scheme.

Parameters:

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

Example: See [Example "Generating a UPMC waveform"](#) on page 85.

Manual operation: See "DFT-S (skip non-data)" on page 35

[:SOURce<hw>]:BB:OFDM:DCMode <DCMode>

Sets the DC subcarrier mode.

Parameters:

<DCMode> UTIL | PUNC | SKIP

UTIL

Uses the DC subcarrier for all allocations.

PUNC

Replaces the DC subcarrier by zeroes for all allocations.

SKIP

Skips the DC subcarrier in the discrete Fourier transformation (DFT).

*RST: UTIL

Example: See [Example "Generating a UPMC waveform"](#) on page 85.

Manual operation: See ["DC Mode"](#) on page 35

[:SOURce<hw>]:BB:OFDM:ZSAmPles <ZeroSamples>

Requires OFDM modulation type:

:SOURce1:BB:OFDM:MODulation OFDM

Sets the number of samples for zero padding. The instrument inserts these zero samples before the modulation symbols. See also ["Padding with zero samples"](#) on page 25.

The maximum number equals the total number of subcarriers minus one sample, see [\[:SOURce<hw>\]:BB:OFDM:NSUBcarriers](#) on page 73.

Parameters:

<ZeroSamples> integer
 Range: 0 to 16384
 *RST: 0

Example: See [Example "Configuring zero padding"](#) on page 72.

Manual operation: See ["Zero Padding Samples"](#) on page 35

[:SOURce<hw>]:BB:OFDM:OFFSet <Offset>

Requires OFDM modulation type:

:SOURce1:BB:OFDM:MODulation OFDM

Sets the symbol offset that is the number of skipped symbols before inserting the zero padding samples.

The maximum offset equals the sequence length minus one symbol, see [\[:SOURce<hw>\]:BB:OFDM:SEQLength](#) on page 73.

Parameters:

<Offset> integer
 Range: 0 to 2399
 *RST: 0

Example: See [Example "Configuring zero padding"](#) on page 72.

Manual operation: See ["Symbol Offset Zero Padding"](#) on page 36

[:SOURce<hw>]:BB:OFDM:RSAmPles <RepForSamples>

Requires OFDM modulation type:

```
:SOURce1:BB:OFDM:MODulation OFDM
```

Sets the repetition of inserted zero samples. This repetition defines the number of symbols between repeating zero samples.

The maximum number of repetitions equals the sequence length, see [:SOURce<hw>] :BB:OFDM:SEQLength on page 73.

Parameters:

```
<RepForSamples> integer
                Range:    1 to 2400
                *RST:     10
```

Example: See [Example"Configuring zero padding"](#) on page 72.

Manual operation: See ["Zero Padding Repetition after Symbols"](#) on page 36

[:SOURce<hw>] :BB:OFDM:SAMPLing?

Queries the sampling rate.

Return values:

```
<SampRate> float
            Range:    0.001 to 1000
            Increment: 1E-3
            *RST:     25.6
            Default unit: MHz
```

Example: See [Example"Generating a UPMC waveform"](#) on page 85.

Usage: Query only

Manual operation: See ["Sampling Rate"](#) on page 36

[:SOURce<hw>] :BB:OFDM:BWOCcupied?

Queries the occupied bandwidth.

Return values:

```
<OccBw> float
        Range:    0.001 to 1000
        Increment: 1E-3
        *RST:     20.45
        Default unit: MHz
```

Example: See [Example"Generating a UPMC waveform"](#) on page 85.

Usage: Query only

Manual operation: See ["Occupied Bandwidth"](#) on page 36

[:SOURce<hw>] :BB:OFDM:LGUard?

Queries the number of left guard subcarriers.

Return values:

<LeftGuardSC> integer
 Range: 0 to 1000
 *RST: 52

Example: See [Example "Generating a UPMC waveform"](#) on page 85.

Usage: Query only

Manual operation: See ["Number of Left Guard Subcarriers/Number of Right Guard Subcarriers"](#) on page 37

[:SOURce<hw>]:BB:OFDM:RGUard?

Queries the number of right guard subcarriers.

Return values:

<RightGuardSC> integer
 Range: 0 to 1000
 *RST: 51

Example: See [Example "Generating a UPMC waveform"](#) on page 85.

Usage: Query only

Manual operation: See ["Number of Left Guard Subcarriers/Number of Right Guard Subcarriers"](#) on page 37

4.3 Filter commands

Example: Configuring filter settings

```
SOURce1:BB:OFDM:MODulation FOFD
SOURce1:BB:OFDM:FILTer:LENGth 74
SOURce1:BB:OFDM:FILTer:WINDowing HANN
SOURce1:BB:OFDM:FILTer:CUTTrans 1

SOURce1:BB:OFDM:MODulation GFDM
SOURce1:BB:OFDM:FILTer:TYPE?
// DIR
SOURce1:BB:OFDM:FILTer:ROLLoff?
// 0.1
SOURce1:BB:OFDM:FILTer:TYPE USER
SOURce1:BB:OFDM:FILTer:UCATalog?
// my_filter
SOURce1:BB:OFDM:FILTer:USELection "/var/user/my_filter.dat"
```

[:SOURce<hw>]:BB:OFDM:FILTer:TYPE	79
[:SOURce<hw>]:BB:OFDM:FILTer:ROLLoff	79
[:SOURce<hw>]:BB:OFDM:FILTer:LENGth	80

<code>[:SOURce<hw>]:BB:OFDM:FILTer:SBATtenuation</code>	80
<code>[:SOURce<hw>]:BB:OFDM:FILTer:CUTTrans</code>	80
<code>[:SOURce<hw>]:BB:OFDM:FILTer:WINDowing</code>	81
<code>[:SOURce<hw>]:BB:OFDM:FILTer:UCATalog?</code>	81
<code>[:SOURce<hw>]:BB:OFDM:FILTer:USELection</code>	81
<code>[:SOURce<hw>]:BB:OFDM:FILTer:ULENght?</code>	81

`[:SOURce<hw>]:BB:OFDM:FILTer:TYPE <FilterType>`

Sets the baseband filter type. See also [Chapter 2.2.6, "Filtering"](#), on page 16.

Parameters:

<code><FilterType></code>	RC RRC DIRichlet RECT DCH STRunc USER PHYDyas NONE
RC DIRichlet RECT	Requires modulation type GFDM. Raised cosine filter, Dirichlet filter or rectangular filter
RRC	Requires modulation types FBMC or GFDM. Root raised cosine filter
DCH	Requires modulation type UPMC. Dolph-Chebyshev filter
STRunc	Requires modulation type f-OFDM. Soft truncation filter
USER	Requires modulation types OFDM, f-OFDM or UPMC. User-defined filter from a file. See also "User filter file format (*.dat files)" on page 19.
PHYDyas	Requires modulation type FBMC. Phydyas filter
NONE	Requires modulation types OFDM or f-OFDM. No filtering applied.
<code>*RST:</code>	DCH

Example: See [Example "Generating a UPMC waveform"](#) on page 85.

Manual operation: See ["Filter Type"](#) on page 38

`[:SOURce<hw>]:BB:OFDM:FILTer:ROLLoff <RollOff>`

Sets the filter parameter.

Parameters:

<RollOff> float
 Range: 0 to 1
 Increment: 0.001
 *RST: 0.1

Example: See [Example"Configuring filter settings"](#) on page 78.

Manual operation: See ["Rolloff Factor"](#) on page 38

[:SOURCE<hw>]:BB:OFDM:FILTer:LENGth <FilterLength>

Sets the filter length.

Parameters:

<FilterLength> integer
 Range: 1 to 800
 *RST: Depends on the filter type

Example: See [Example"Generating a UPMC waveform"](#) on page 85.

Manual operation: See ["Filter Length"](#) on page 39

[:SOURCE<hw>]:BB:OFDM:FILTer:SBATtenuation <StBAttenuation>

Sets the attenuation in the filter stop band.

Parameters:

<StBAttenuation> float
 Range: 10 to 120
 Increment: 0.001
 *RST: 60

Example: See [Example"Generating a UPMC waveform"](#) on page 85.

Manual operation: See ["Stopband Attenuation"](#) on page 39

[:SOURCE<hw>]:BB:OFDM:FILTer:CUTTrans <CutTransResp>

Cuts the transient response of the filtering operation at the beginning and end of the signal.

Parameters:

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

Example: See [Example"Configuring filter settings"](#) on page 78.

Manual operation: See ["Cut Transient Response"](#) on page 39

[:SOURce<hw>]:BB:OFDM:FILTer:WINDowing <Windowing>

Sets the windowing method.

Parameters:

<Windowing> NONE | HANNing | HAMMing
*RST: HANNing

Example: See [Example"Configuring filter settings"](#) on page 78.

Manual operation: See ["Windowing Method"](#) on page 39

[:SOURce<hw>]:BB:OFDM:FILTer:UCATalog?

Queries the user filter files in the default directory. Only files with the file extension *.dat are listed.

Example: See [Example"Generating a UPMC waveform"](#) on page 85.

Usage: Query only

Manual operation: See ["Load User Filter"](#) on page 40

[:SOURce<hw>]:BB:OFDM:FILTer:USElection <UserSel>

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

Parameters:

<UserSel> string
Complete file path including file name and file extension

Example: See [Example"Configuring filter settings"](#) on page 78.

Manual operation: See ["Load User Filter"](#) on page 40

[:SOURce<hw>]:BB:OFDM:FILTer:ULENgtH?

Queries the filter length.

Return values:

<UserFilterLen> integer
Range: 1 to 800
*RST: 0

Example: See [Example"Configuring filter settings"](#) on page 78.

Usage: Query only

Manual operation: See ["User Filter Length"](#) on page 40

4.4 Modulation commands

[:SOURce<hw>]:BB:OFDM:SUBCarriers?	82
[:SOURce<hw>]:BB:OFDM:GFDM:DBSYmbols	82
[:SOURce<hw>]:BB:OFDM:FOFDm:NSUBand	82
[:SOURce<hw>]:BB:OFDM:UFMC:NSUBand	83
[:SOURce<hw>]:BB:OFDM:UFMC:PREequal	83

[\[:SOURce<hw>\]:BB:OFDM:SUBCarriers?](#)

Queries the number of subcarriers per subband.

Return values:

<SubcPerSubband> integer
 Range: 1 to 16384
 *RST: 1

Example: See [Example "Generating a UFMC waveform"](#) on page 85.

Usage: Query only

Manual operation: See ["Subcarriers per Subband"](#) on page 41

[\[:SOURce<hw>\]:BB:OFDM:GFDM:DBSYmbols](#) <GFDMDbSymbols>

Sets data block size in terms of symbols per data block.

The maximum size is the sequence length, see [\[:SOURce<hw>\]:BB:OFDM:SEQLength](#) on page 73.

Parameters:

<GFDMDbSymbols> integer
 Range: 1 to depends on settings
 *RST: 8

Example: `SOURce1:BB:OFDM:GFDM:DBSYmbols 8`

Manual operation: See ["Datablock Size"](#) on page 42

[\[:SOURce<hw>\]:BB:OFDM:FOFDm:NSUBand](#) <FofdmNSubands>

Sets the number of f-OFDM subbands.

Parameters:

<FofdmNSubands> integer
 Range: 1 to 1500
 *RST: 6

Example: `SOURce1:BB:OFDM:FOFDm:NSUBand 34`

Manual operation: See ["Number of Subbands"](#) on page 41

[[:SOURce<hw>]:BB:OFDM:UFMC:NSUBBand <NSubbands>

Sets the number of UPMC subbands.

Parameters:

<NSubbands> integer
 Range: 1 to 1500
 *RST: 6

Example: See [Example"Generating a UPMC waveform"](#) on page 85.

Manual operation: See ["Number of Subbands"](#) on page 41

[[:SOURce<hw>]:BB:OFDM:UFMC:PREEqual <UfmcPreEqual>

Applies a filter pre-equalization.

Parameters:

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

Example: See [Example"Generating a UPMC waveform"](#) on page 85.

Manual operation: See ["Subband Filter Pre-equalization"](#) on page 41

4.5 User commands

[:SOURce<hw>]:BB:OFDM:USER<ch0>:DATA	83
[:SOURce<hw>]:BB:OFDM:USER<ch0>:LIST	83
[:SOURce<hw>]:BB:OFDM:USER<ch0>:PATTern	84
[:SOURce<hw>]:BB:OFDM:USER<ch0>:PWR	84

[[:SOURce<hw>]:BB:OFDM:USER<ch0>:DATA <Datasource>

Sets the data source per user.

Parameters:

<Datasource> PN9 | PN11 | PN15 | PN16 | PN20 | PN21 | PN23 | PATTern |
 DLISt | ZERO | ONE
 *RST: PN16

Example: See [Example"Generating a UPMC waveform"](#) on page 85.

Manual operation: See ["Data Source"](#) on page 44

[[:SOURce<hw>]:BB:OFDM:USER<ch0>:LIST <DataList>

Selects an existing data list file from the default directory or from the specific directory.

Parameters:

<DataList> string
file name incl. file extension or complete file path

Example: See [Example "Generating a UPMC waveform"](#) on page 85.

Manual operation: See ["Data Source"](#) on page 44

[:SOURce<hw>]:BB:OFDM:USER<ch0>:PATTern <Pattern>, <BitCount>

Sets a bit pattern as a data source.

Parameters:

<Pattern> numeric
*RST: #H0

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

Example: See [Example "Generating a UPMC waveform"](#) on page 85.

Manual operation: See ["Data Source"](#) on page 44

[:SOURce<hw>]:BB:OFDM:USER<ch0>:PWR <Power>

Applies a power offset.

Parameters:

<Power> float
Range: -80 to 10
Increment: 1E-3
*RST: 0

Example: See [Example "Generating a UPMC waveform"](#) on page 85.

Manual operation: See ["p\(dB\)"](#) on page 44

4.6 Allocation commands

Example: Generating a UFMC waveform

```
// *****
// Call the default settings.
// *****
*RST
// Presets the instrument.
// Alternatively, preset the OFDM baseband settings only.
SOURcel:BB:OFDM:PRESet
// Alternatively, preset only modulation parameters for the set modulation mode.
// For example, preset universal filtered multi-carrier modulation settings.
SOURcel:BB:OFDM:MODulation UFMC
SOURcel:BB:OFDM:MODPreset

// *****
// Configure physical settings of the modulation mode.
// *****
SOURcel:BB:OFDM:NSUBcarriers 512
SOURcel:BB:OFDM:NOCCupied 408
SOURcel:BB:OFDM:SCSPace 0.05
SOURcel:BB:OFDM:SEQLength 8
SOURcel:BB:OFDM:CPLength 10
SOURcel:BB:OFDM:RGUard?
// Response: "52"
SOURcel:BB:OFDM:LGUard?
// Response: "52"
SOURcel:BB:OFDM:BWOCcupied?
// Response: "20.4"
SOURcel:BB:OFDM:CSLength?
// Response: "0"
// No cyclic suffix configured.
SOURcel:BB:OFDM:DFTS:STATe?
// Response: "0"
// DFT-s-OFDM for data allocations is deactivated.
SOURcel:BB:OFDM:DCM?
// Response: "UTIL"
// Uses the DC subcarrier for all allocations.
SOURcel:BB:OFDM:SAMPLing?
// Response: "25.6"
SOURcel:BB:OFDM:SRATe:VARiation?
// Response: "15360000"

// *****
// Configure filter settings of the modulation mode.
// *****
SOURcel:BB:OFDM:FILTer:TYPE DCH
SOURcel:BB:OFDM:FILTer:LENGth 74
SOURcel:BB:OFDM:FILTer:SBAttenuation 60
```

```

SOURCE1:BB:OFDM:UFMC:NSUBand 34
SOURCE1:BB:OFDM:SUBCarriers?
// Response: "12"
SOURCE1:BB:OFDM:UFMC:PREequal?
// Response: "0"

// *****
// Configure user settings. Available users are always active.
// *****
SOURCE1:BB:OFDM:USER0:DATA PN23
SOURCE1:BB:OFDM:USER0:PWR 1
// Load the file 5g_datalist.dm_iqd from the default directory.
SOURCE1:BB:OFDM:USER2:DATA DLIS
SOURCE1:BB:OFDM:USER2:LIST "/var/user/5g_datalist.dm_iqd"
SOURCE1:BB:OFDM:USER4:DATA PATT
SOURCE1:BB:OFDM:USER4:PATTern #H1C4A9,17

// *****
// Configure allocation settings
// *****
SOURCE1:BB:OFDM:NALLoc 7
// Configure allocation 0 settings.
SOURCE1:BB:OFDM:ALLoc0:CONTent?
// Response: "PRE"
SOURCE1:BB:OFDM:ALLoc0:SYNO 2

// Configure allocation 1 setting susing 256QAM modulation..
SOURCE1:BB:OFDM:ALLoc1:CONTent?
// Response: "DATA"
SOURCE1:BB:OFDM:ALLoc1:MODulation QAM256
SOURCE1:BB:OFDM:ALLoc1:SCNO 100
SOURCE1:BB:OFDM:ALLoc1:SCOFFset 2
SOURCE1:BB:OFDM:ALLoc1:SYOFFset 2
SOURCE1:BB:OFDM:ALLoc1:DATA USER0
SOURCE1:BB:OFDM:ALLoc1:PHYSbits?
// Response: "4000"
SOURCE1:BB:OFDM:ALLoc1:STATe 1

// Configure allocation 2 settings.
SOURCE1:BB:OFDM:ALLoc2:MODulation
SOURCE1:BB:OFDM:ALLoc2:SCNO 200
SOURCE1:BB:OFDM:ALLoc2:SYNO 2
SOURCE1:BB:OFDM:ALLoc2:SCOFFset 150
SOURCE1:BB:OFDM:ALLoc2:SYOFFset 2
SOURCE1:BB:OFDM:ALLoc2:DATA USER3
// Configure allocation 3 settings using sparse code multiple access modulation.
SOURCE1:BB:OFDM:ALLoc3:MODulation SCMA
SOURCE1:BB:OFDM:ALLoc3:SCNO 200
SOURCE1:BB:OFDM:ALLoc3:SYNO 2
SOURCE1:BB:OFDM:ALLoc3:SCOFFset 208
SOURCE1:BB:OFDM:ALLoc3:SYOFFset 4
SOURCE1:BB:OFDM:ALLoc3:PWR 3

```

```

// Configure allocation 4 settings.
SOURCE1:BB:OFDM:ALLOc4:CONFLICT?
// Response: "1"
SOURCE1:BB:OFDM:ALLOc4:SCNO 90
SOURCE1:BB:OFDM:ALLOc4:SYNO 3
SOURCE1:BB:OFDM:ALLOc4:SCOFFset 110
SOURCE1:BB:OFDM:ALLOc4:SYOFFset 4
SOURCE1:BB:OFDM:ALLOc4:DATA USER5
// Configure allocation 5 settings using sparse code multiple access modulation.
SOURCE1:BB:OFDM:ALLOc5:MODulation SCMA
SOURCE1:BB:OFDM:ALLOc5:SCNO 252
SOURCE1:BB:OFDM:ALLOc5:SCOFFset 90
SOURCE1:BB:OFDM:ALLOc5:SYOFFset 7
SOURCE1:BB:OFDM:ALLOc5:SCMA:CODEbook?
// Response: "4"
SOURCE1:BB:OFDM:ALLOc5:SCMA:NLAYers?
// Response: "6"
SOURCE1:BB:OFDM:ALLOc5:SCMA:SPRead?
// Response: "4"
SOURCE1:BB:OFDM:ALLOc5:SCMA:LAYer1:USER USER1
SOURCE1:BB:OFDM:ALLOc5:SCMA:LAYer1:STATe 0
SOURCE1:BB:OFDM:ALLOc5:SCMA:LAYer1:PWR?
// Response: "0"
SOURCE1:BB:OFDM:ALLOc5:SCMA:LAYer2:STATe 0
SOURCE1:BB:OFDM:ALLOc5:SCMA:LAYer4:STATe 0
SOURCE1:BB:OFDM:ALLOc5:SCMA:LAYer0:STATe 0
SOURCE1:BB:OFDM:ALLOc5:SCMA:LAYer3:STATe 0
SOURCE1:BB:OFDM:ALLOc5:SCMA:LAYer5:STATe 0
// Response: "0"
SOURCE1:BB:OFDM:ALLOc5:CONFLICT?
// Response: "0"
// Configure allocation 6 settings using a Zadoff-Chu sequence for modulation.
SOURCE1:BB:OFDM:ALLOc6:MODulation ZAD
SOURCE1:BB:OFDM:ALLOc6:SCNO 2
SOURCE1:BB:OFDM:ALLOc6:SYNO 2
SOURCE1:BB:OFDM:ALLOc6:SCOFFset 0
SOURCE1:BB:OFDM:ALLOc6:SYOFFset 0
SOURCE1:BB:OFDM:ALLOc6:DATA PN16
SOURCE1:BB:OFDM:ALLOc6:ZAD:SNUMber 2
SOURCE1:BB:OFDM:ALLOc6:ZAD:SLENGth 1
SOURCE1:BB:OFDM:ALLOc6:ZAD:CYCShift 1

SOURCE1:BB:OFDM:STATe 1
SOURCE1:BB:OFDM:WAVEform:CREate "/var/user/5g_ufmc.wv"

```

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• Zadoff-Chu commands	96
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4.6.1 General commands

<code>[:SOURce<hw>]:BB:OFDM:NALLoc</code>	88
<code>[:SOURce<hw>]:BB:OFDM:ALLoc<ch0>:MODulation</code>	88
<code>[:SOURce<hw>]:BB:OFDM:ALLoc<ch0>:MOOR</code>	89
<code>[:SOURce<hw>]:BB:OFDM:ALLoc<ch0>:SCNO</code>	89
<code>[:SOURce<hw>]:BB:OFDM:ALLoc<ch0>:SYNO</code>	89
<code>[:SOURce<hw>]:BB:OFDM:ALLoc<ch0>:SCOFset</code>	90
<code>[:SOURce<hw>]:BB:OFDM:ALLoc<ch0>:SYOFset</code>	90
<code>[:SOURce<hw>]:BB:OFDM:ALLoc<ch0>:PHYSbits?</code>	90
<code>[:SOURce<hw>]:BB:OFDM:ALLoc<ch0>:DATA</code>	90
<code>[:SOURce<hw>]:BB:OFDM:ALLoc<ch0>:LIST</code>	91
<code>[:SOURce<hw>]:BB:OFDM:ALLoc<ch0>:PATtern</code>	91
<code>[:SOURce<hw>]:BB:OFDM:ALLoc<ch0>:CIQFile</code>	91
<code>[:SOURce<hw>]:BB:OFDM:ALLoc<ch0>:PWR</code>	91
<code>[:SOURce<hw>]:BB:OFDM:ALLoc<ch0>:CONTent</code>	92
<code>[:SOURce<hw>]:BB:OFDM:ALLoc<ch0>:STATe</code>	92
<code>[:SOURce<hw>]:BB:OFDM:ALLoc<ch0>:CONFlit?</code>	92

`[:SOURce<hw>]:BB:OFDM:NALLoc <NoOfAlloc>`

Sets the number of scheduled allocations.

Parameters:

`<NoOfAlloc>` integer
 Range: 0 to 500
 *RST: 1

Example: See [Example "Generating a UFMC waveform"](#) on page 85.

Manual operation: See ["Number of Allocations"](#) on page 45

`[:SOURce<hw>]:BB:OFDM:ALLoc<ch0>:MODulation <BaseModType>`

Sets the modulation type of an allocation.

Parameters:

`<BaseModType>` BPSK | QPSK | QAM16 | QAM64 | QAM256 | SCMA | CIQ |
 ZADoffchu | CUSConst

BPSK|QPSK

Binary/quaternary phase shift keying

QAM16|QAM64|QAM256

Quadrature amplitude modulation 16/64/256

SCMA

Sparse code multiple access

CIQ

Custom IQ data file, loaded with the command `[:
 SOURce<hw>]:BB:OFDM:ALLoc<ch0>:CIQFile`.

ZADoffchu

Zadoff-Chu sequence

CUSConst

Custom constellation

*RST: QPSK

Example: See [Example"Generating a UPMC waveform"](#) on page 85.**Example:** See [Example"Configuring custom modulation settings"](#) on page 98.**Manual operation:** See ["Constellation"](#) on page 46**[:SOURce<hw>]:BB:OFDM:ALLOc<ch0>:MOOR <ModOrder>**

Sets/queries the modulation order of the allocation.

Setting requires custom constellation modulation, see [\[:SOURce<hw>\]:BB:OFDM:ALLOc<ch0>:MODulation](#) on page 88.**Parameters:**

<ModOrder> integer
 Range: 2 to 4096
 *RST: 2

Example: See [Example"Configuring custom modulation settings"](#) on page 98.**Manual operation:** See ["Modulation Order"](#) on page 46**[:SOURce<hw>]:BB:OFDM:ALLOc<ch0>:SCNO <NoOfSubcarriers>**

Sets the number of allocated subcarriers.

Parameters:

<NoOfSubcarriers> integer
 Range: 1 to 13107
 *RST: 1

Example: See [Example"Generating a UPMC waveform"](#) on page 85.**Manual operation:** See ["No. SC"](#) on page 46**[:SOURce<hw>]:BB:OFDM:ALLOc<ch0>:SYNO <NoOfSymbols>**

Sets the allocation size as number of symbols.

Parameters:

<NoOfSymbols> integer
 Range: 0 to 1000
 *RST: 1

Example: See [Example"Generating a UPMC waveform"](#) on page 85.**Manual operation:** See ["No. Sym."](#) on page 47

[:SOURce<hw>]:BB:OFDM:ALLoc<ch0>:SCOffset <ScOffset>

Sets the start subcarrier of the selected allocation.

Parameters:

<ScOffset> integer
 Range: 0 to 13106
 *RST: 0

Example: See [Example "Generating a UPMC waveform"](#) on page 85.

Manual operation: See ["Offs. SC"](#) on page 47

[:SOURce<hw>]:BB:OFDM:ALLoc<ch0>:SYOffset <SymOffset>

Sets the start symbol of the selected allocation.

Parameters:

<SymOffset> integer
 Range: 0 to 999
 *RST: 0

Example: See [Example "Generating a UPMC waveform"](#) on page 85.

Manual operation: See ["Offs. Sym."](#) on page 47

[:SOURce<hw>]:BB:OFDM:ALLoc<ch0>:PHYSbits?

Queries the allocation size in bits.

Return values:

<PhysicalBits> integer

Example: See [Example "Generating a UPMC waveform"](#) on page 85.

Usage: Query only

Manual operation: See ["Physical Bits"](#) on page 47

[:SOURce<hw>]:BB:OFDM:ALLoc<ch0>:DATA <Datasource>

Selects the data source for the selected allocation.

Parameters:

<Datasource> USER1 | USER2 | USER3 | USER4 | PN9 | PN11 | PN15 |
 PN16 | PN20 | PN21 | PN23 | PATtern | DLISt | ZERO | ONE |
 USER5 | USER0
 *RST: PN16

Example: See [Example "Generating a UPMC waveform"](#) on page 85.

Manual operation: See ["Data Source"](#) on page 47

[:SOURce<hw>]:BB:OFDM:ALLoc<ch0>:LIST <DataList>

Selects an existing data list file from the default directory or from the specific directory.

Parameters:

<DataList> string
 file name incl. file extension or complete file path

Example: See [Example "Generating a UPMC waveform"](#) on page 85.

Manual operation: See ["Data Source"](#) on page 47

[:SOURce<hw>]:BB:OFDM:ALLoc<ch0>:PATTern <Pattern>, <BitCount>

Sets a bit pattern as data source.

Parameters:

<Pattern> numeric
 *RST: #H0

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

Example: See [Example "Generating a UPMC waveform"](#) on page 85.

Manual operation: See ["Data Source"](#) on page 47
 See ["Split Pattern"](#) on page 50

[:SOURce<hw>]:BB:OFDM:ALLoc<ch0>:CIQFile <CustomIqFile>

Selects an existing file with custom I/Q data from the default directory or from the specific directory.

Parameters:

<CustomIqFile> string
 Filename including file extension or complete file path

Example: SOURce1:BB:OFDM:NALLoc 1
 SOURce1:BB:OFDM:ALLoc0:MODulation CIQ
 SOURce1:BB:OFDM:ALLoc0:CIQFile "/var/user/iq.iqw"

Manual operation: See ["Data Source"](#) on page 47

[:SOURce<hw>]:BB:OFDM:ALLoc<ch0>:PWR <Power>

Applies a power offset to the allocation relative to the others.

Parameters:

<Power> float
 Range: -80 to 10
 Increment: 1E-3
 *RST: 0

Example: See [Example "Generating a UPMC waveform"](#) on page 85.

Manual operation: See "[ρ\(dB\)](#)" on page 48

[:SOURce<hw>]:BB:OFDM:ALLoc<ch0>:CONTent <ContentType>

Sets the content type.

Parameters:

<ContentType> DATA | PREamble | PILot | REServed

DATA

Default value for FBMC and GFDM modulations.

PREamble

Default value for the first allocation of the UPMC modulation.

DATA|PILot|REServed

Selects the content type for f-OFDM/OFDM modulations.

*RST: DATA

Example: See [Example "Generating a UPMC waveform"](#) on page 85.

Manual operation: See "[Content Type](#)" on page 48

[:SOURce<hw>]:BB:OFDM:ALLoc<ch0>:STATe <State>

Enables the allocation.

Parameters:

<State> 1 | ON | 0 | OFF

*RST: 0

Example: See [Example "Generating a UPMC waveform"](#) on page 85.

Manual operation: See "[State](#)" on page 50

[:SOURce<hw>]:BB:OFDM:ALLoc<ch0>:CONFLict?

Returns 1, if allocations overlap.

Return values:

<Conflict> 1 | ON | 0 | OFF

Example: See [Example "Generating a UPMC waveform"](#) on page 85.

Usage: Query only

Manual operation: See "[Conflict](#)" on page 50

4.6.2 SCMA commands

[:SOURce<hw>]:BB:OFDM:ALLoc<ch0>:SCMA:NLAYers?	93
[:SOURce<hw>]:BB:OFDM:ALLoc<ch0>:SCMA:SPRead?	93
[:SOURce<hw>]:BB:OFDM:ALLoc<ch0>:SCMA:CODEbook?	93

[:SOURce<hw>]:BB:OFDM:ALLoc<ch0>:SCMA:LAYer<st0>:PWR?	93
[:SOURce<hw>]:BB:OFDM:ALLoc<ch0>:SCMA:LAYer<st0>:STATE	94
[:SOURce<hw>]:BB:OFDM:ALLoc<ch0>:SCMA:LAYer<st0>:USER	94

[\[:SOURce<hw>\]:BB:OFDM:ALLoc<ch0>:SCMA:NLAYers?](#)

Queries the number of layers.

Return values:

<NoOfLayers> integer
 Range: 0 to 6
 *RST: 6

Example: See [Example"Generating a UPMC waveform"](#) on page 85.

Usage: Query only

Manual operation: See ["Number of Layers J"](#) on page 53

[\[:SOURce<hw>\]:BB:OFDM:ALLoc<ch0>:SCMA:SPRead?](#)

Queries the spreading factor.

Return values:

<SpreadFac> integer
 Range: 0 to 4
 *RST: 4

Example: See [Example"Generating a UPMC waveform"](#) on page 85.

Usage: Query only

Manual operation: See ["Spreading Factor K"](#) on page 52

[\[:SOURce<hw>\]:BB:OFDM:ALLoc<ch0>:SCMA:CODEbook?](#)

Queries the codebook size.

Return values:

<Codebook> integer
 Range: 0 to 4
 *RST: 4

Example: See [Example"Generating a UPMC waveform"](#) on page 85.

Usage: Query only

Manual operation: See ["Codebook Size M"](#) on page 53

[\[:SOURce<hw>\]:BB:OFDM:ALLoc<ch0>:SCMA:LAYer<st0>:PWR?](#)

Applies a power offset to the selected layer relative to the others.

Return values:

<Power> float
 Range: -80 to 10
 Increment: 1E-3
 *RST: 0

Example: See [Example "Generating a UPMC waveform"](#) on page 85.

Usage: Query only

Manual operation: See "[p\(dB\)](#)" on page 53

[:SOURce<hw>]:BB:OFDM:ALLoc<ch0>:SCMA:LAYer<st0>:STATe <State>

Enables the layer (codebook).

Parameters:

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

Example: See [Example "Generating a UPMC waveform"](#) on page 85.

Manual operation: See "[State](#)" on page 53

**[:SOURce<hw>]:BB:OFDM:ALLoc<ch0>:SCMA:LAYer<st0>:USER
 <ScmaLayerUser>**

Maps the users to the layers.

Parameters:

<ScmaLayerUser> USER0 | USER1 | USER2 | USER3 | USER4 | USER5
 *RST: USER0

Example: See [Example "Generating a UPMC waveform"](#) on page 85.

Manual operation: See "[User](#)" on page 53

4.6.3 Split pattern commands

Example: Configuring split pattern settings

```
// Set split pattern subcarrier spacing (SCS) settings for allocation 0.
SOURCE1:BB:OFDM:ALLOC0:SPLT:SCS:SIZE 53
// Query SCS step.
SOURCE1:BB:OFDM:ALLOC0:SPLT:SCS:STEP?
// Response: "53"
// Set split pattern symbol settings for allocation 0.
SOURCE1:BB:OFDM:ALLOC0:SPLT:SYM:SIZE 2
// Query SCS step.
SOURCE1:BB:OFDM:ALLOC0:SPLT:SCS:STEP?
// Response: "2"
// Activate split pattern settings for allocation 0.
SOURCE1:OFDM:ALLOC0:SPLT:STATE 1
```

Commands

[:SOURCE<hw>]:BB:OFDM:ALLOC<ch0>:SPLT:STATE	95
[:SOURCE<hw>]:BB:OFDM:ALLOC<ch0>:SPLT:SCS:SIZE	95
[:SOURCE<hw>]:BB:OFDM:ALLOC<ch0>:SPLT:SCS:STEP	96
[:SOURCE<hw>]:BB:OFDM:ALLOC<ch0>:SPLT:SYM:SIZE	96
[:SOURCE<hw>]:BB:OFDM:ALLOC<ch0>:SPLT:SYM:STEP	96

[:SOURCE<hw>]:BB:OFDM:ALLOC<ch0>:SPLT:STATE <SplitPatState>

Activates split pattern settings for the selected allocation.

Parameters:

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

Example: See [Example"Configuring split pattern settings"](#) on page 95.

Manual operation: See ["Split Pattern"](#) on page 51

[:SOURCE<hw>]:BB:OFDM:ALLOC<ch0>:SPLT:SCS:SIZE <SplitPatScsSize>

Sets the subcarrier spacing (SCS) size.

The maximum SCS size equals the number of subcarriers of the selected allocation, see [\[:SOURCE<hw>\]:BB:OFDM:ALLOC<ch0>:SCNO](#) on page 89.

Parameters:

<SplitPatScsSize> integer
 Range: 1 to 13107
 *RST: 1

Example: See [Example"Configuring split pattern settings"](#) on page 95.

Manual operation: See ["SCS Size"](#) on page 51

[:SOURce<hw>]:BB:OFDM:ALLoc<ch0>:SPLT:SCS:STEP <SplitPatScsStep>

Sets/queries the subcarrier spacing (SCS) step.

Setting requires SCS sizes smaller than the set number of subcarriers of the selected allocation, see [:SOURce<hw>]:BB:OFDM:ALLoc<ch0>:SCNO on page 89.

Parameters:

<SplitPatScsStep> integer
 Range: 1 to 13107
 *RST: 1

Example: See [Example"Configuring split pattern settings"](#) on page 95.

Manual operation: See ["SCS Step"](#) on page 51

[:SOURce<hw>]:BB:OFDM:ALLoc<ch0>:SPLT:SYM:SIZE <SplitPatSymSize>

Sets the symbol size.

Parameters:

<SplitPatSymSize> integer
 Range: 1 to 1000
 *RST: 1

Example: See [Example"Configuring split pattern settings"](#) on page 95.

Manual operation: See ["Symbol Size"](#) on page 51

[:SOURce<hw>]:BB:OFDM:ALLoc<ch0>:SPLT:SYM:STEP <SplitPatSymStep>

Sets/queries the symbol step.

Setting requires symbol sizes smaller than the number of symbols of the selected allocation.

Parameters:

<SplitPatSymStep> integer
 Range: 1 to 1000
 *RST: 1

Example: See [Example"Configuring split pattern settings"](#) on page 95.

Manual operation: See ["Symbol Step"](#) on page 51

4.6.4 Zadoff-Chu commands

[:SOURce<hw>]:BB:OFDM:ALLoc<ch0>:ZAD:CYCShift.....	97
[:SOURce<hw>]:BB:OFDM:ALLoc<ch0>:ZAD:SLEN.....	97
[:SOURce<hw>]:BB:OFDM:ALLoc<ch0>:ZAD:SNUMber.....	97

[:SOURce<hw>]:BB:OFDM:ALLoc<ch0>:ZAD:CYCShift <CyclicShift>

Sets the cyclic shift of the Zadoff-Chu sequence.

The maximum number of cyclic shifts is the sequence length minus 1.

Parameters:

<CyclicShift> integer
 Range: 0 to 1023
 *RST: 0

Example: See [Example "Generating a UPMC waveform"](#) on page 85.

Manual operation: See ["Cyclic Shift"](#) on page 54

[:SOURce<hw>]:BB:OFDM:ALLoc<ch0>:ZAD:SLEN <SeqLength>

Sets the sequence length of the Zadoff-Chu sequence.

Parameters:

<SeqLength> integer
 Range: 2 to 13107
 *RST: 2

Example: See [Example "Generating a UPMC waveform"](#) on page 85.

Manual operation: See ["Sequence Length"](#) on page 54

[:SOURce<hw>]:BB:OFDM:ALLoc<ch0>:ZAD:SNUMber <SeqNumber>

Sets the sequence number within the Zadoff-Chu sequence.

The maximum sequence number is the sequence length minus 1.

Parameters:

<SeqNumber> integer
 Range: 1 to 13106
 *RST: 1

Example: See [Example "Generating a UPMC waveform"](#) on page 85.

Manual operation: See ["Sequence Number"](#) on page 54

4.6.5 Custom constellation commands

Example: Configuring custom modulation settings

```
// Set custom constellation for allocation 0.
SOURCE1:BB:OFDM:ALLOc0:MOD CUSConst
// Define modulation order and constellation points.
// For example, define a typical BPSK constellation.
// Set modulation order of 2.
SOURCE1:BB:OFDM:ALLOc0:MOOR 2
// Define real and imaginary part of the first constellation point.
SOURCE1:BB:OFDM:ALLOc0:CONPoint0:REAL 1
SOURCE1:BB:OFDM:ALLOc0:CONPoint0:IMAG 0
// Define real and imaginary part of the second constellation point.
SOURCE1:BB:OFDM:ALLOc0:CONPoint1:REAL -1
SOURCE1:BB:OFDM:ALLOc0:CONPoint1:IMAG 0
// Optionally, query constellation points in cylindrical coordinates.
SOURCE1:BB:OFDM:ALLOc0:CONPoint0:MAGNitude?
// Response: "1.414"
// The magnitude equals the square root of 2.
SOURCE1:BB:OFDM:ALLOc0:CONPoint0:PHASe?
// Response: "45"
// The phase is 45 degrees.
SOURCE1:BB:OFDM:ALLOc0:CONPoint1:MAGNitude?
// Response: "1.414"
// The magnitude equals the square root of 2.
SOURCE1:BB:OFDM:ALLOc0:CONPoint1:PHASe?
// Response: "225"
// The phase is 225 degrees.
```

Commands

[:SOURCE<hw>]:BB:OFDM:ALLOc<ch0>:CONPoint<st0>:IMAG	98
[:SOURCE<hw>]:BB:OFDM:ALLOc<ch0>:CONPoint<st0>:MAGN	99
[:SOURCE<hw>]:BB:OFDM:ALLOc<ch0>:CONPoint<st0>:PHASe	99
[:SOURCE<hw>]:BB:OFDM:ALLOc<ch0>:CONPoint<st0>:REAL	99

[\[:SOURCE<hw>\]:BB:OFDM:ALLOc<ch0>:CONPoint<st0>:IMAG <CustConstImag>](#)

Sets the imaginary part of the constellation point of the selected allocation.

The imaginary part equals the y-axis value in a cartesian coordinate system.

Parameters:

<CustConstImag>	float
	Range: -100 to 100
	Increment: 0.001
	*RST: 0

Example: See [Example "Configuring custom modulation settings"](#) on page 98.

Manual operation: See ["Constellation coordinates table"](#) on page 55

[:SOURce<hw>]:BB:OFDM:ALLoc<ch0>:CONPoint<st0>:MAGN
 <CustConstMagn>

Sets the magnitude of the constellation point of the selected allocation.

The magnitude value applies for a cylindrical coordinate system.

Parameters:

<CustConstMagn> float
 Range: 0 to 100
 Increment: 0.001
 *RST: 0

Example: See [Example"Configuring custom modulation settings"](#) on page 98.

Manual operation: See ["Constellation coordinates table"](#) on page 55

[:SOURce<hw>]:BB:OFDM:ALLoc<ch0>:CONPoint<st0>:PHASe
 <CustConstPhase>

Parameters:

<CustConstPhase> float
 Range: 0 to 360
 Increment: 0.1
 *RST: 0

Manual operation: See ["Constellation coordinates table"](#) on page 55

[:SOURce<hw>]:BB:OFDM:ALLoc<ch0>:CONPoint<st0>:REAL <CustConstReal>

Sets the real part of the constellation point of the selected allocation.

The real part equals the x-axis value in a cartesian coordinate system.

Parameters:

<CustConstReal> float
 Range: -100 to 100
 Increment: 0.001
 *RST: 0

Example: See [Example"Configuring custom modulation settings"](#) on page 98.

Manual operation: See ["Constellation coordinates table"](#) on page 55

4.7 Trigger commands

Example: Configuring trigger signals

```

SOURCE1:BB:OFDM:TRIGGER:SEQUENCE SINGLE
SOURCE1:BB:OFDM:TRIGGER:SLength 200
// Outputs the first 200 samples of the current waveform after the trigger event.
SOURCE1:BB:OFDM:TRIGGER:SEQUENCE ARETrigger
SOURCE1:BB:OFDM:TRIGGER:SOURCE EGT1
// Uses the external trigger signal from the USER connector.
SOURCE1:BB:OFDM:TRIGGER:EXTERNAL:SYNChronize:OUTPut ON
SOURCE1:BB:OFDM:TRIGGER:EXTERNAL:DElay 200
SOURCE1:BB:OFDM:TRIGGER:EXTERNAL:INHibit 100

SOURCE1:BB:OFDM:TRIGGER:SOURCE INTB
// Uses the internal trigger signal from the other path.
SOURCE1:BB:OFDM:TRIGGER:OBASeband:DElay 25
SOURCE1:BB:OFDM:TRIGGER:OBASeband:INHibit 10

SOURCE1:BB:OFDM:TRIGGER:SEQUENCE AAUTO
SOURCE1:BB:OFDM:TRIGGER:SOURCE INTernal
SOURCE1:BB:OFDM:STATE 1
SOURCE1:BB:OFDM:TRIGGER:EXEC

```

Example: Specifying delay and inhibit values in time units

```

SOURCE1:BB:OFDM:CLOCK 1000000
SOURCE1:BB:OFDM:TRIGGER:SEQUENCE AAUT
SOURCE1:BB:OFDM:TRIGGER:SOURCE EGT1
SOURCE1:BB:OFDM:TRIGGER:DElay:UNIT SAMP
SOURCE1:BB:OFDM:TRIGGER:EXTERNAL:DElay 100
SOURCE1:BB:OFDM:TRIGGER:EXTERNAL:RDElay?
// Response in seconds: "100"

SOURCE1:BB:OFDM:TRIGGER:DElay:UNIT TIME
SOURCE1:BB:OFDM:TRIGGER:EXTERNAL:TDElay 0.00001
SOURCE1:BB:OFDM:TRIGGER:EXTERNAL:RDElay?
// Response in seconds: "0.00001"
// Corresponds to 10 µs.
SOURCE1:BB:OFDM:TRIGGER:DElay:UNIT SAMP
SOURCE1:BB:OFDM:TRIGGER:EXTERNAL:DElay 10

```

[:SOURCE<hw>]:BB:OFDM[:TRIGGER]:SEQUENCE	101
[:SOURCE<hw>]:BB:OFDM:TRIGGER:SOURCE	101
[:SOURCE<hw>]:BB:OFDM:TRIGGER:RMODE?	102
[:SOURCE<hw>]:BB:OFDM:TRIGGER:TIME:DATE	102
[:SOURCE<hw>]:BB:OFDM:TRIGGER:TIME:TIME	103
[:SOURCE<hw>]:BB:OFDM:TRIGGER:TIME[:STATE]	103
[:SOURCE<hw>]:BB:OFDM:TRIGGER:SLength	103
[:SOURCE<hw>]:BB:OFDM:TRIGGER:SLUNit	104
[:SOURCE<hw>]:BB:OFDM:TRIGGER:EXECute	104

<code>[:SOURce<hw>]:BB:OFDM:TRIGger:ARM:EXECute</code>	104
<code>[:SOURce<hw>]:BB:OFDM:TRIGger:EXTErnal:SYNChronize:OUTPut</code>	104
<code>[:SOURce<hw>]:BB:OFDM:TRIGger:DELAy:UNIT</code>	105
<code>[:SOURce<hw>]:BB:OFDM:TRIGger:OBASeband:DELAy</code>	105
<code>[:SOURce<hw>]:BB:OFDM:TRIGger:OBASeband:RDELAy?</code>	105
<code>[:SOURce<hw>]:BB:OFDM:TRIGger:OBASeband:TDELAy</code>	105
<code>[:SOURce<hw>]:BB:OFDM:TRIGger:OBASeband:INHibit</code>	106
<code>[:SOURce<hw>]:BB:OFDM:TRIGger[:EXTErnal]:DELAy</code>	106
<code>[:SOURce<hw>]:BB:OFDM:TRIGger:EXTErnal:TDELAy</code>	106
<code>[:SOURce<hw>]:BB:OFDM:TRIGger:EXTErnal:RDELAy?</code>	107
<code>[:SOURce<hw>]:BB:OFDM:TRIGger[:EXTErnal]:INHibit</code>	107

`[:SOURce<hw>]:BB:OFDM[:TRIGger]:SEQUence <TrigMode>`

Sets the trigger mode.

Parameters:

`<TrigMode>` AUTO | RETRigger | AAUTo | ARETRigger | SINGLE
 *RST: AUTO

Example: See [Example "Configuring trigger signals"](#) on page 100.

Manual operation: See ["Mode"](#) on page 58

`[:SOURce<hw>]:BB:OFDM:TRIGger:SOURce <TrigSource>`

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

Provided are the following trigger sources:

- `INTeRnal`: Internal manual triggering of the instrument
- `INTA | INTB`: Internal triggering by a signal from the other basebands
- 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
- For secondary instruments (`SCONfiguration:MULTIinstrument:MODE SEC`), triggering via the external baseband synchronization signal of the primary instrument:
`SOURce1:BB:ARB:TRIGger:SOURce BBSY`
- `OBASeband | BEXTErnal | EXTErnal`: Setting only
 Provided only for backward compatibility with other Rohde & Schwarz signal generators. The R&S SMW200A accepts these values and maps them automatically as follows:
`EXTErnal = EGT1, BEXTErnal = EGT2, OBASeband = INTA or INTB`
 (depending on the current baseband)

Parameters:	
<TrigSource>	INTB INTernal OBASeband EGT1 EGT2 EGC1 EGC2 ELTRigger INTA ELCLock BEXTernal EXTernal BBSY *RST: INTernal
Example:	See Example"Configuring trigger signals" on page 100.
Options:	ELTRigger ELCLock require R&S SMW-B10. BBSY requires R&S SMW-B9.
Manual operation:	See "Source" on page 60

[:SOURce<hw>]:BB:OFDM:TRIGger:RMODE?

Queries the status of waveform output.

Return values:

<TrigRunMode> STOP | RUN
*RST: STOP

Example: See [Example"Configuring trigger signals"](#) on page 100.

Usage: Query only

Manual operation: See ["Running/Stopped"](#) on page 59

[:SOURce<hw>]:BB:OFDM: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 sub-chapter "Trigger Commands" of the chapter "SOURce:BB:ARB subsystem" in the R&S SMW200A user manual.

Manual operation: See ["Trigger Time"](#) on page 60

```
[ :SOURce<hw>]:BB:OFDM: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 sub-chapter "Trigger Commands" of the chapter "SOURce:BB:ARB subsystem" in the R&S SMW200A user manual.

Manual operation: See ["Trigger Time"](#) on page 60

```
[ :SOURce<hw>]:BB:OFDM:TRIGger:TIME[:STATE] <State>
```

Activates time-based triggering with a fixed time reference. If activated, the R&S SMW200A 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 sub-chapter "Trigger Commands" of the chapter "SOURce:BB:ARB subsystem" in the R&S SMW200A user manual.

Manual operation: See ["Time Based Trigger"](#) on page 60

```
[ :SOURce<hw>]:BB:OFDM:TRIGger:SLENgth <TrigSeqLen>
```

Defines the length of the signal sequence to be output in the SINGLE trigger mode.

Parameters:

<TrigSeqLen> integer
 Range: 1 to dynamic
 *RST: 1

Example: See [Example"Configuring trigger signals"](#) on page 100.

Manual operation: See ["Signal Duration"](#) on page 59

[:SOURce<hw>]:BB:OFDM:TRIGger:SLUNit <TrigSeqLenUnit>

Defines the unit for the entry of the length of the signal sequence to be output in the SINGLe trigger mode.

Parameters:

<TrigSeqLenUnit> SEQUENCE | SAMPLE
 *RST: SEQUENCE

Example: See [Example"Configuring trigger signals"](#) on page 100.

Manual operation: See ["Signal Duration Unit"](#) on page 59

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

Executes an internal trigger event.

Example: See [Example"Configuring trigger signals"](#) on page 100.

Usage: Event

Manual operation: See ["Execute Trigger"](#) on page 60

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

Stops (arms) waveform output.

Example: See [Example"Configuring trigger signals"](#) on page 100.

Usage: Event

Manual operation: See ["Arm"](#) on page 60

**[:SOURce<hw>]:BB:OFDM:TRIGger:EXTernal:SYNChronize:OUTPut
<TrigSyncOutpSta>**

Enables signal output synchronous to the trigger event.

Parameters:

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

Example: See [Example"Configuring trigger signals"](#) on page 100.

Manual operation: See ["Sync. Output to External Trigger/Sync. Output to Trigger"](#) on page 61

[:SOURce<hw>]:BB:OFDM:TRIGger:DElay:UNIT <TrigDelUnit>

Determines the unit that the trigger delay is expressed in.

Parameters:

<TrigDelUnit> SAMPLE | TIME
 *RST: SAMPLE

Example: See [Example"Specifying delay and inhibit values in time units"](#) on page 100.

Manual operation: See ["\(External\) Delay Unit"](#) on page 62

[:SOURce<hw>]:BB:OFDM:TRIGger:OBASeband:DElay <TrigIntOthDelay>

Specifies the trigger delay for triggering by the signal from the second path.

Parameters:

<TrigIntOthDelay> float
 Range: 0 to 2147483647
 Increment: 0.01
 *RST: 0

Example: See [Example"Configuring trigger signals"](#) on page 100.

Manual operation: See ["\(Specified\) External Delay/\(Specified\) Trigger Delay"](#) on page 62

[:SOURce<hw>]:BB:OFDM:TRIGger:OBASeband:RDElay?

Queries the time a trigger event from the other path is delayed.

Return values:

<IntOthRDelaySec> float
 Range: 0 to 688
 Increment: 250E-12
 *RST: 0

Example: See [Example"Specifying delay and inhibit values in time units"](#) on page 100.

Usage: Query only

Manual operation: See ["Actual Trigger Delay/Actual External Delay"](#) on page 63

[:SOURce<hw>]:BB:OFDM:TRIGger:OBASeband:TDElay <IntOthDelaySec>

Specifies the trigger delay for triggering by the signal from the other path.

Parameters:

<IntOthDelaySec> float
 Range: 0 to 688
 Increment: 250E-12
 *RST: 0
 Default unit: s

Example: See [Example"Specifying delay and inhibit values in time units"](#) on page 100.

Manual operation: See "[\(Specified\) External Delay/\(Specified\) Trigger Delay](#)" on page 62

[:SOURce<hw>]:BB:OFDM:TRIGger:OBASeband:INHibit <IntOthInhibit>

For triggering via the other path, specifies the number of samples by which a restart is inhibited.

Parameters:

<IntOthInhibit> integer
 Range: 0 to 67108863
 *RST: 0
 Default unit: Sample

Example: See [Example"Configuring trigger signals"](#) on page 100.

Manual operation: See "[External Inhibit/Trigger Inhibit](#)" on page 62

[:SOURce<hw>]:BB:OFDM:TRIGger[:EXTErnal]:DELay <TrigExtDelay>

Specifies the trigger delay.

Parameters:

<TrigExtDelay> float
 Range: 0 to 2147483647
 Increment: 0.01
 *RST: 0

Example: See [Example"Configuring trigger signals"](#) on page 100.

Manual operation: See "[\(Specified\) External Delay/\(Specified\) Trigger Delay](#)" on page 62

[:SOURce<hw>]:BB:OFDM:TRIGger:EXTErnal:TDELay <TrigExtTimeDel>

Specifies the trigger delay for external triggering. The value affects all external trigger signals.

Parameters:

<TrigExtTimeDel> float
 Range: 0 to 688
 Increment: 250E-12
 *RST: 0
 Default unit: s

Example: See [Example "Specifying delay and inhibit values in time units"](#) on page 100.

Manual operation: See ["\(Specified\) External Delay/\(Specified\) Trigger Delay"](#) on page 62

[:SOURce<hw>]:BB:OFDM:TRIGger:EXTernal:RDELay?

Queries the time (in seconds) an external trigger event is delayed for.

Return values:

<ResExtDelaySec> float
 Range: 0 to 688
 Increment: 250E-12
 *RST: 0

Example: See [Example "Specifying delay and inhibit values in time units"](#) on page 100.

Usage: Query only

Manual operation: See ["Actual Trigger Delay/Actual External Delay"](#) on page 63

[:SOURce<hw>]:BB:OFDM:TRIGger[:EXTernal]:INHibit <TrigExtInhibit>

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

Parameters:

<TrigExtInhibit> integer
 Range: 0 to dynamic
 *RST: 0

Example: See [Example "Configuring trigger signals"](#) on page 100.

Manual operation: See ["External Inhibit/Trigger Inhibit"](#) on page 62

4.8 Marker commands

Example: Activating a marker 2 signal

```
SOURce1:BB:OFDM:TRIGger:OUTPut2:MODE?
// Response: "REStart"
SOURce1:BB:OFDM:TRIGger:OUTPut2:FOFFset 10
SOURce1:BB:OFDM:TRIGger:OUTPut2:ROFFset 20
```

```
SOURce1:BB:OFDM:TRIGger:OUTPut2:DELay?
// Response in samples: "10"
```

```
[[:SOURce<hw>]:BB:OFDM:TRIGger:OUTPut<ch>:MODE..... 108
[:SOURce<hw>]:BB:OFDM:TRIGger:OUTPut<ch>:ROFFset..... 108
[:SOURce<hw>]:BB:OFDM:TRIGger:OUTPut<ch>:FOFFset..... 108
[:SOURce<hw>]:BB:OFDM:TRIGger:OUTPut<ch>:DELay..... 108
```

[[:SOURce<hw>]:BB:OFDM:TRIGger:OUTPut<ch>:MODE <MarkMode>

Defines the signal for the selected marker output.

Parameters:

<MarkMode> REStart
 *RST: REStart

Example: See [Example "Activating a marker 2 signal"](#) on page 108.

Manual operation: See ["Mode"](#) on page 64

[[:SOURce<hw>]:BB:OFDM:TRIGger:OUTPut<ch>:ROFFset <MarkRiseOffs>
[[:SOURce<hw>]:BB:OFDM:TRIGger:OUTPut<ch>:FOFFset <MarkFallOffs>

Shifts the rising or falling ramp of the marker by the selected number of samples.

Parameters:

<MarkFallOffs> integer
 Range: -640000 to 640000
 *RST: 0

Example: See [Example "Activating a marker 2 signal"](#) on page 108.

Manual operation: See ["Rise Offset/Fall Offset"](#) on page 64

[[:SOURce<hw>]:BB:OFDM:TRIGger:OUTPut<ch>:DELay <MarkDelay>

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

Parameters:

<MarkDelay> float
 Range: 0 to 16777215
 Increment: 0.001
 *RST: 0
 Default unit: Samples

Example: See [Example "Activating a marker 2 signal"](#) on page 108.

Manual operation: See ["Delay"](#) on page 64

4.9 Clock commands

Example: Configuring clock settings

```
SOURce1:BB:OFDM:CLOCK:SOURce ELCL
SOURce1:BB:OFDM:CLOCK:MODE SAMP
CLOCK:INPUt:FREQuency?
```

[\[:SOURce<hw>\]:BB:OFDM:CLOCK:SOURce](#)..... 109
[\[:SOURce<hw>\]:BB:OFDM:CLOCK:MODE](#)..... 109

[\[:SOURce<hw>\]:BB:OFDM:CLOCK:SOURce](#) <ClockSour>

Selects the clock source:

- `INTernal`: Internal clock reference
- `ELCLock`: External local clock
- `EXTernal` = `ELCLock`: Setting only
 Provided for backward compatibility with other Rohde & Schwarz signal generators

Parameters:

<ClockSour> INTernal|ELCLock|EXTernal
 *RST: INTernal

Example: See [Example "Configuring clock settings"](#) on page 109.

Options: ELCLock requires R&S SMW-B10.

Manual operation: See ["Clock Source"](#) on page 65

[\[:SOURce<hw>\]:BB:OFDM:CLOCK:MODE](#) <ClockMode>

Sets the type of externally supplied clock.

Parameters:

<ClockMode> SAMPlE
 *RST: SAMPlE

Example: See [Example "Configuring clock settings"](#) on page 109.

Options: R&S SMW-B10

Manual operation: See "[Clock Mode](#)" on page 66

Annex

A XML settings file

You can use the created *.xml file for OFDM signal analysis. See ["Export path for XML settings ..."](#) on page 29. Use the file for measurements with Rohde & Schwarz signal analyzer, for example R&S®VSE-K96.

Example: Default "Exported_K114_settings_K96.xml" file

The example shows the structure of the default file
Exported_K114_settings_K96.xml.

```
<?xml version="1.0" encoding="utf-8"?>
<FSK96ConfigurationFile>
  <GeneralParameters>
    <Name>OFDM_16MHzBW_312kHzSpacing</Name>
    <FFTSize>64</FFTSize>
    <NofSymbols>10</NofSymbols>
    <CyclicDelayDiversity>0</CyclicDelayDiversity>
    <CyclicPrefixLength>16</CyclicPrefixLength>
    <StartCarrierIndex>0</StartCarrierIndex>
    <Description>Automatically exported R&S SMW200A-K114 settings to K96 system
      configuration file.</Description>
  </GeneralParameters>
  <Preamble>
    <BlockLength>0</BlockLength>
    <FrameOffset>0</FrameOffset>
  </Preamble>
  <Constellations>
    <Constellation>
      <ID>0</ID>
      <Name>Zero</Name>
      <HumanReadableName>Zero</HumanReadableName>
      <ScalingFactor>1.0</ScalingFactor>
      <AllocationType>Zero</AllocationType>
      <IQSymbols>
        <IQ>
          <Re>0.000000</Re>
          <Im>0.000000</Im>
        </IQ>
      </IQSymbols>
    </Constellation>
    <Constellation>
      <ID>1</ID>
      <Name>DontCare</Name>
      <HumanReadableName>DontCare</HumanReadableName>
      <ScalingFactor>1.0</ScalingFactor>
```

```

    <AllocationType>DontCare</AllocationType>
  </Constellation>
<Constellation>
  <ID>2</ID>
  <Name>PilotConstellation</Name>
  <HumanReadableName>PilotConstellation</HumanReadableName>
  <ScalingFactor>1</ScalingFactor>
  <AllocationType>PilotConstellation</AllocationType>
  <IQSymbols>
    <IQ>
      <Re>-0.707107</Re>
      <Im>-0.707107</Im>
    </IQ>
    <IQ>
      <Re>-0.707107</Re>
      <Im>0.707107</Im>
    </IQ>
    <IQ>
      <Re>0.707107</Re>
      <Im>-0.707107</Im>
    </IQ>
    <IQ>
      <Re>0.707107</Re>
      <Im>0.707107</Im>
    </IQ>
  </IQSymbols>
</Constellation>
<Constellation>
  <ID>3</ID>
  <Name>QAM64</Name>
  <HumanReadableName>QAM64</HumanReadableName>
  <ScalingFactor>1</ScalingFactor>
  <AllocationType>DataConstellation</AllocationType>
  <IQSymbols>
    <IQ>
      <Re>-1.080123</Re>
      <Im>-1.080123</Im>
    </IQ>
    <!-- 62 I/Q pairs neglected (64 QAM) -->
    <IQ>
      <Re>1.080123</Re>
      <Im>1.080123</Im>
    </IQ>
  </IQSymbols>
</Constellation>
<Constellation>
  <ID>4</ID>
  <Name>PilotConstellation</Name>
  <HumanReadableName>PilotConstellation</HumanReadableName>
  <ScalingFactor>1</ScalingFactor>

```


Glossary: Terms and abbreviations

A

ARB: Arbitrary waveform generator

C

CoMP: Coordinated multipoint

F

f-OFDM: Filtered [OFDM](#)

Synonyms: [SF-OFDM](#), [UF-OFDM](#), [RB-F-OFDM](#)

FBMC: Filter-Bank multicarrier

FFT: Fast Fourier transform

G

GFDM: Generalized frequency division multiplexing

I

IFFT: Inverse [FFT](#)

N

NOMA: Non-orthogonal multiple access

O

OFDM: Orthogonal frequency division multiplexing

OQAM: Offset [QAM](#)

Q

QAM: Quadrature amplitude modulation

R

RB-F-OFDM: Resource block based filtered OFDM, see [f-OFDM](#).

Resource block (UFMC): [Subband \(UFMC\)](#)

S

SCMA: Sparse code multiple access

SF-OFDM: Spectrum filtered OFDM, see [f-OFDM](#).

SMT FBMC: Staggered modulated multitone [FBMC](#)

Subband (UFMC): In the context of the UFMC modulation, the term subband describes the smallest amount of resources that can be allocated to a user.
Synonyms: Resource block, Subcarrier

Subcarrier (UFMC): [Subband \(UFMC\)](#)

U

UF-OFDM: Universal filtered OFDM, see [UFMC](#).

UFMC: Universal filtered multicarrier

Glossary: Specifications, references and further information

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