

# R&S<sup>®</sup>SMM-K114

## OFDM Signal Generation

### User Manual



1179195802  
Version 09

**ROHDE & SCHWARZ**  
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This document describes the following software options:

- R&S®SMM-K114 OFDM Signal Generation (1441.1824.xx)

This manual describes firmware version FW 5.30.175.xx and later of the R&S®SMM100A.

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1179.1958.02 | Version 09 | R&S®SMM-K114

The following abbreviations are used throughout this manual: R&S®SMM100A is abbreviated as R&S SMM

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# 1 Welcome to the OFDM Signal Generation option

The options R&S SMM-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 NR project specification 5G NR 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 SMM-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 SMM100A user manual. The latest version is available at:

[www.rohde-schwarz.com/manual/SMM100A](http://www.rohde-schwarz.com/manual/SMM100A)

## Installation

You can find detailed installation instructions in the delivery of the option or in the R&S SMM100A 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 SMM100A, 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®SMM100A.

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 SMM100A user documentation. Unless specified otherwise, you find the documents at:

[www.rohde-schwarz.com/manual/smm100a](http://www.rohde-schwarz.com/manual/smm100a)

### 1.3.1 Getting started manual

Introduces the R&S SMM100A 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 SMM100A is not included.

The contents of the user manuals are available as help in the R&S SMM100A. 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 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>

### 1.3.4 Instrument security procedures

Deals with security issues when working with the R&S SMM100A in secure areas. It is available for download on the internet.

### 1.3.5 Printed safety instructions

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

### 1.3.6 Specifications and product brochures

The specifications document, also known as the data sheet, contains the technical specifications of the R&S SMM100A. 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/smm100a](http://www.rohde-schwarz.com/brochure-datasheet/smm100a)

### 1.3.7 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.

### 1.3.8 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/smm100a](http://www.rohde-schwarz.com/firmware/smm100a)

### 1.3.9 Application notes, application cards, white papers, etc.

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

For some application sheets, see also:

[www.rohde-schwarz.com/application/smm100a](http://www.rohde-schwarz.com/application/smm100a)

### 1.3.10 Videos

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



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

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*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 SMM100A 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.

• <a href="#">Required options</a> .....	12
• <a href="#">Overview of modulation schemes</a> .....	12
• <a href="#">Supported multiple access schemes</a> .....	21
• <a href="#">Physical layer parameterization</a> .....	24
• <a href="#">Generating configuration files for R&amp;S®VSE-K96</a> .....	26

### 2.1 Required options

The basic equipment layout for generating OFDM signals includes the:

- Baseband Generator(R&S SMM-B9)
- Frequency option (e.g. R&S SMM-B1006)
- Baseband real-time extension (R&S SMM-K520)
- Digital standard OFDM Signal Generation (R&S SMM-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 SMM-K255 for playing LTE waveforms.
- If supported, install the real-time option of the digital standard, for example, R&S SMM-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

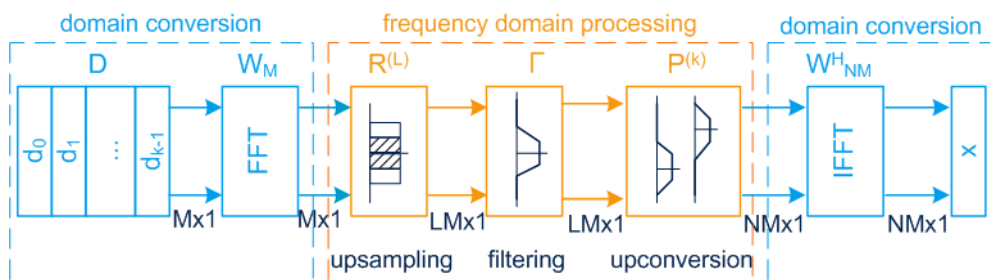
- [Chapter 3.2.1, "Physical settings"](#), on page 31
- [Chapter 3.2.2, "Filter settings"](#), on page 37
- [Chapter 3.2.3, "Modulation configuration settings"](#), on page 40

## 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  
 $\Gamma$  = 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

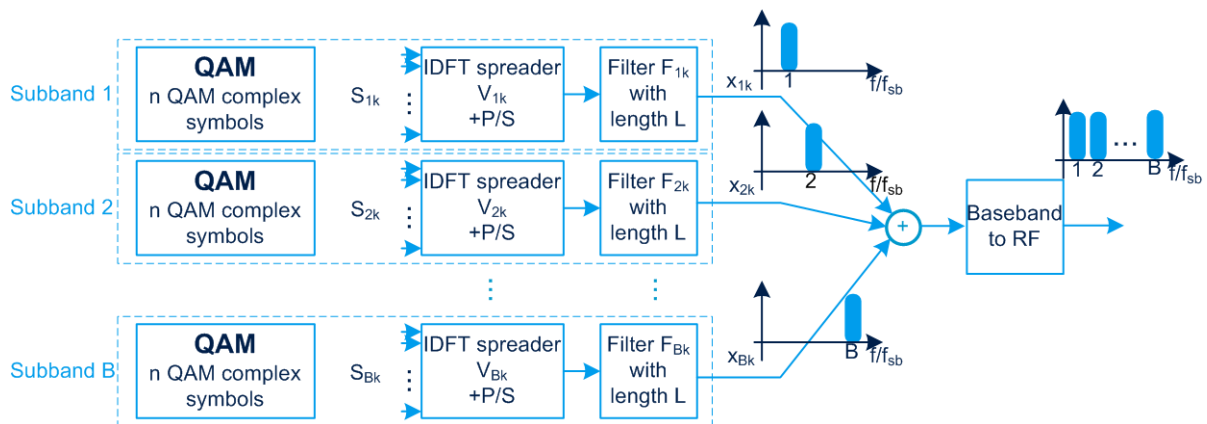
- [Chapter 3.2.1, "Physical settings"](#), on page 31
- [Chapter 3.2.2, "Filter settings"](#), on page 37
- [Chapter 3.2.3, "Modulation configuration settings"](#), on page 40

## 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

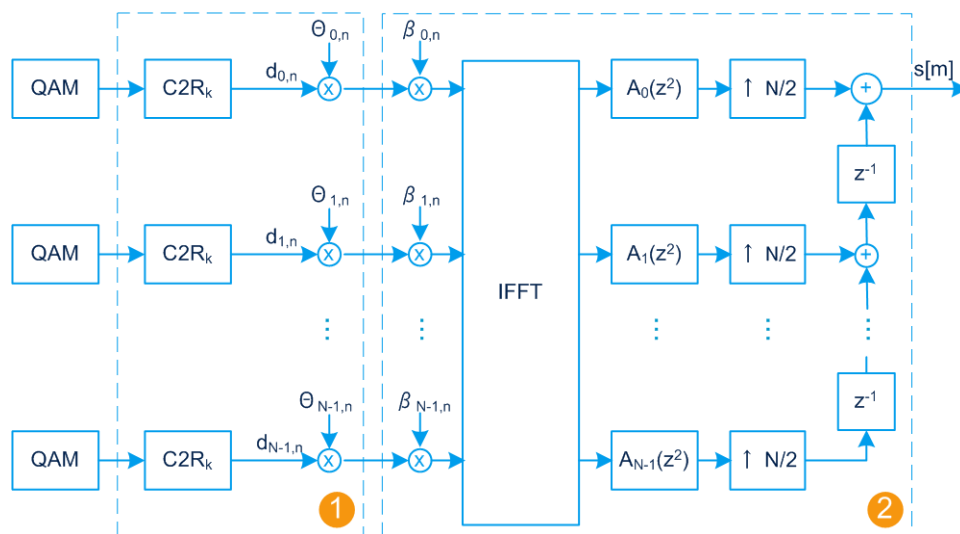
**2.2.5 FBMC**

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  $\Theta$ : 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.

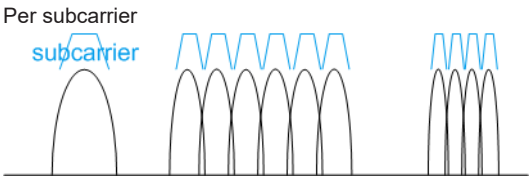
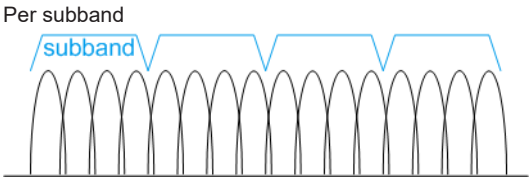
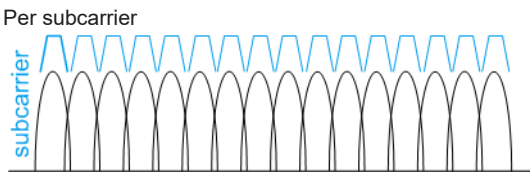
### Related settings

- [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

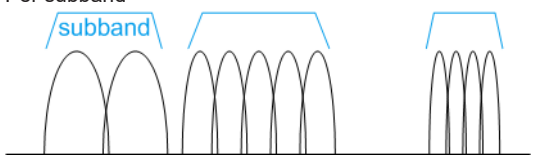
## 2.2.6 Filtering

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, Phydys 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.

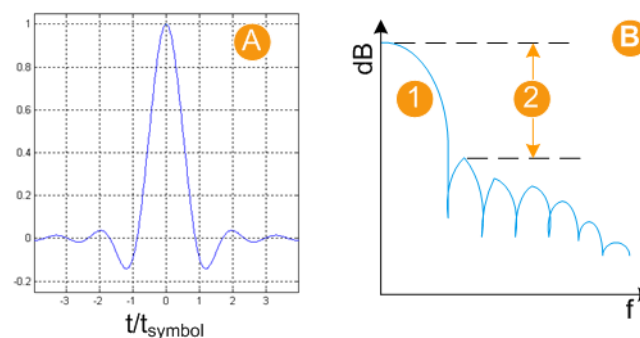


Figure 2-4: Example of filter characteristics: Root cosine filter with Roll Off Factor = 0.5

- 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.

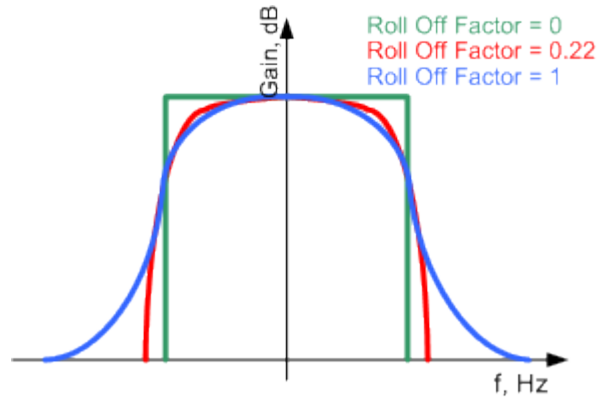


Figure 2-5: Example of the frequency response of a filter with different rolloff factors

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.

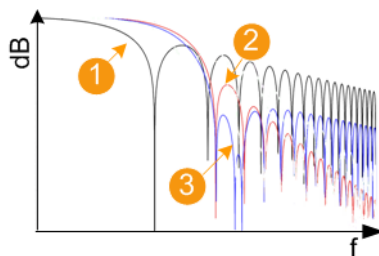


Figure 2-6: Effect of the windowing function

- 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

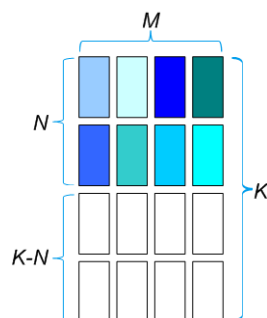
Multiple access schemes are offered to assign the individual allocations to different users.

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:

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

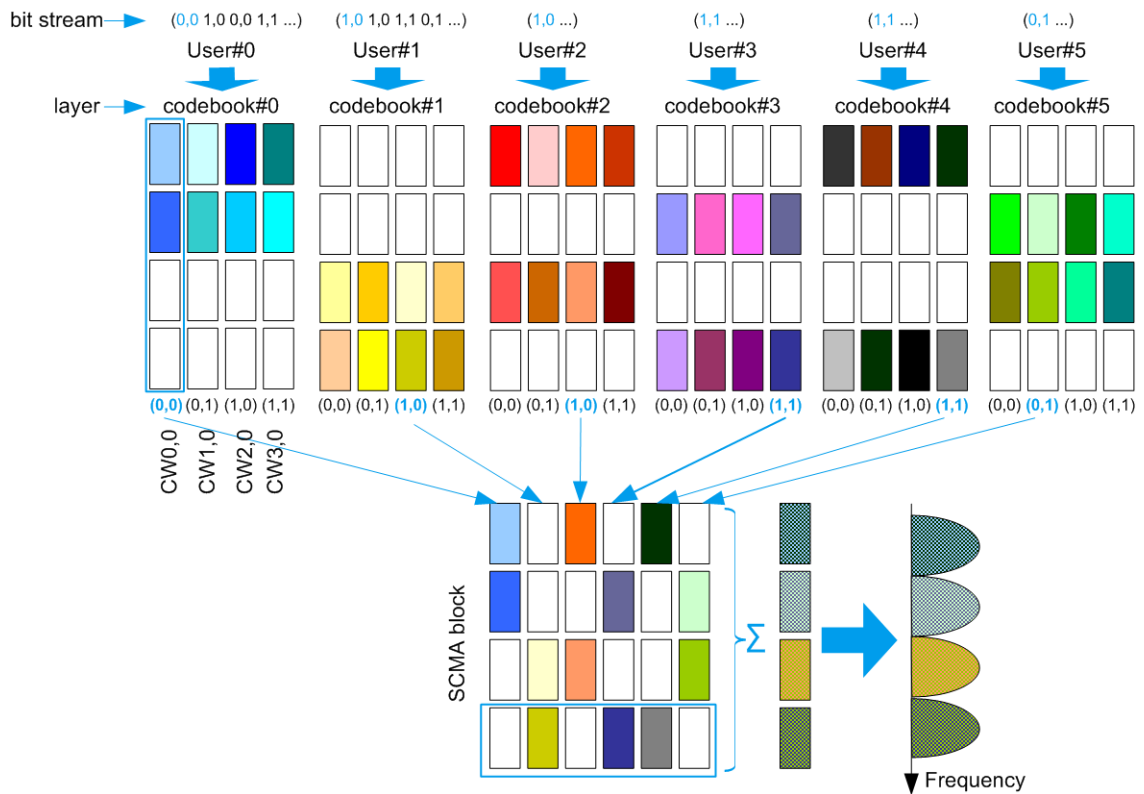
The number of layers gives the number of unique combinations that are possible for the given codeword length (K) and the number of non-zero elements (N). For K = 4 and N = 2, the maximum number of layers is J = 6. In SCMA, you can assign a user to several layers but you can assign each layer only to 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 SMM-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).  
 CW<sub>y,x</sub> = Codeword#y from codebook#x  
 $\Sigma$  = 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 CW<sub>0,0</sub> 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"

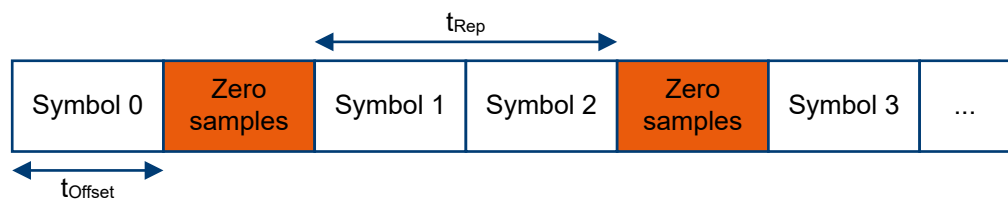
Where "Overlap Factor = 4"

- **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  $t_{\text{Offset}}$ . Set the number of zero samples after  $t_{\text{Offset}}$  for padding. Set the repetition via  $t_{\text{Rep}}$  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

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

Zero samples = One or more zero samples for padding

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

Related settings:

- For the offset  $t_{\text{Offset}}$ , see ["Symbol Offset Zero Padding"](#) on page 36.
- For the zero samples, see ["Zero Padding Samples"](#) on page 35.
- For the repetition  $t_{\text{Offset}}$ , 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 SMM100A 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 SMM100A, 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 SMM100A, 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 SMM100A via USB, LAN, ftp or any other access methods.  
Open, for example, the \\<R&S SMM100A IP Address>\share\K114\.
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.

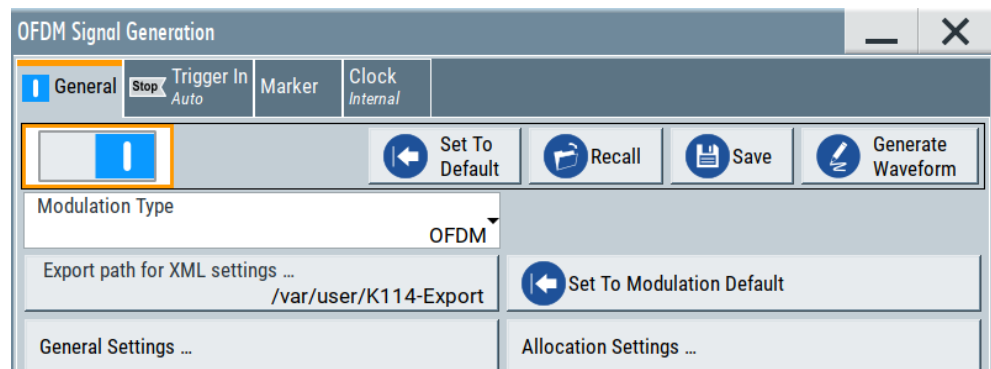
**Settings:**

• <a href="#">General settings</a> .....	27
• <a href="#">General settings</a> .....	30
• <a href="#">Allocation settings</a> .....	42
• <a href="#">Trigger settings</a> .....	57
• <a href="#">Marker settings</a> .....	63
• <a href="#">Clock settings</a> .....	64
• <a href="#">Local and global connectors settings</a> .....	65

### 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:**

<a href="#">State</a> .....	28
<a href="#">Set To Default</a> .....	28
<a href="#">Save/Recall</a> .....	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 67

### 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 68

### 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 SMM100A user manual.

Remote command:

[ :SOURce<hw> ] :BB:OFDM:SETTing:CATalog on page 68

[ :SOURce<hw> ] :BB:OFDM:SETTing:LOAD on page 68

[ :SOURce<hw> ] :BB:OFDM:SETTing:STORe on page 68

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

### 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 69

### Modulation Type

Selects the modulation type.

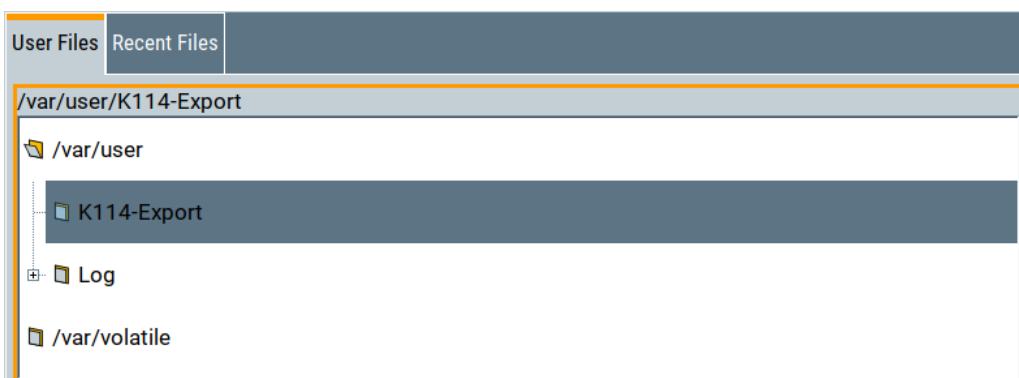
"OFDM"	<p>You can create your own OFDM signal, for example configure the allocations as required.</p> <p>If you enable baseband signal generation, also creates a *.xml setting file for this modulation type. See also <a href="#">Chapter 2.5, "Generating configuration files for R&amp;S®VSE-K96"</a>, on page 26.</p>
"f-OFDM"	<p>Filtered OFDM (f-OFDM) modulation is a technique similar to the UFMC modulation.</p> <p>See <a href="#">Chapter 2.2.1, "OFDM"</a>, 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 <a href="#">Chapter 2.5, "Generating configuration files for R&amp;S®VSE-K96"</a>, 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 <a href="#">Chapter 2.2.4, "UFMC"</a>, 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 <a href="#">Chapter 2.2.3, "GFDM"</a>, 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 <a href="#">OQAM</a> modulation scheme.</p> <p>See <a href="#">Chapter 2.2.5, "FBMC"</a>, on page 15.</p>

Remote command:

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

#### 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 107.

Remote command:

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

#### Set To Modulation Default

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

Remote command:

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

#### 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 71

### 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 72

### 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 72

### 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 72

### 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:

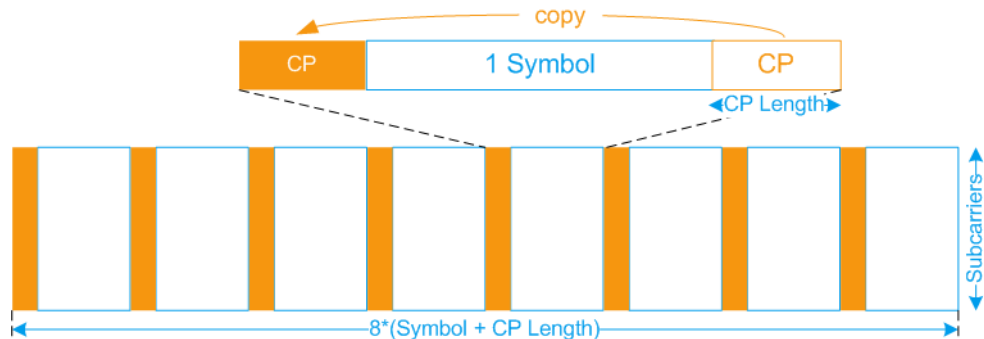
$$\text{"Cyclic Prefix Length"}_{\text{max}} = 0.5 * \text{Total Number of Subcarriers/FFT Size}$$



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*.



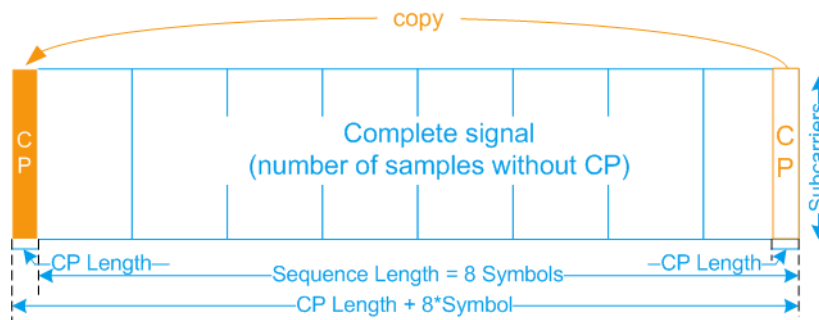
**Figure 3-1: Principle of cyclic prefix calculation in f-OFDM/OFDM (default configuration with CP No. Symbols = 0, Alt. Cyclic Prefix Length = 0)**

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

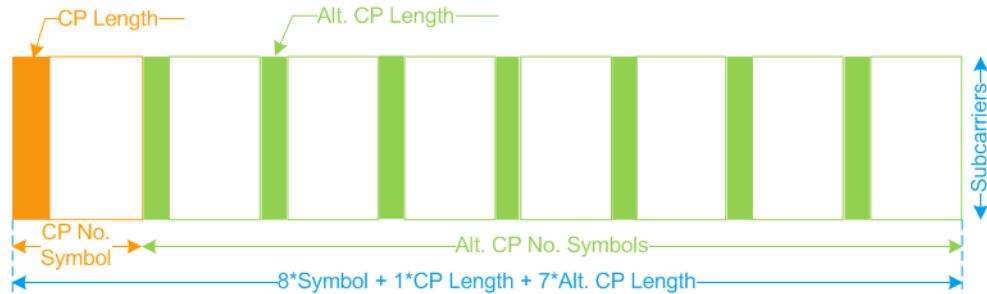
Remote command:

[ :SOURce<hw> ] :BB:OFDM:CPLength on page 73

### 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	= <a href="#">Occupied Number of Subcarriers</a> , e.g. 400 so that the <a href="#">Occupied Bandwidth</a> = 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 73

### 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 73

`[ :SOURce<hw> ] :BB:OFDM:ACPSymbols` on page 73

#### 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 74

#### 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 74

#### 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 " <a href="#">DFT-S (skip non-data)</a> " on page 35. The LTE standard, for example, uses this mode as a skipping method. |

Remote command:

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

#### 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 75

### 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 75

### 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 75

### 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 76

### 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 SMM100A. 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 SMM100A equipped with maximum bandwidth of 1000 MHz (R&S SMM-K522). "Occupied Number of Subcarriers > 55" and "Subcarrier Spacing = 18.75 MHz" result in "Occupied Bandwidth = 1.03125 MHz". The warning message displays the supported maximum bandwidth.

Sampling Rate	1.200 000 GHz	! More than 1000 MHz is not supported!	Occupied Bandwidth	1.031 250 GHz
Number of Left Guard Subcarriers	5		Number of Right Guard Subcarriers	4

Remote command:

`[ :SOURce<hw> ] :BB:OFDM:BWOCcupied?` on page 76

### 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:

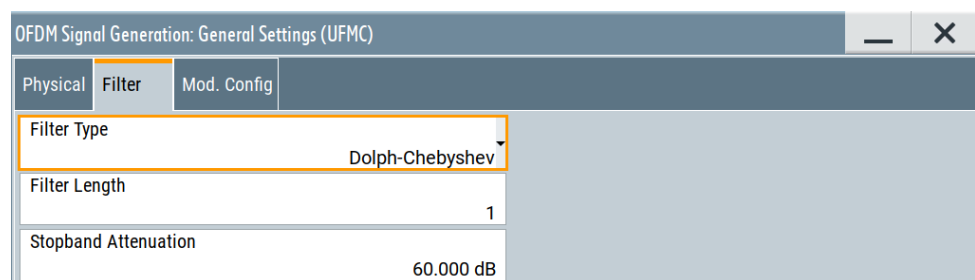
`[ :SOURce<hw> ] :BB:OFDM:LGUard?` on page 76

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

## 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 <a href="#">"User filter file format (*.dat files)"</a> 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 78

**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.

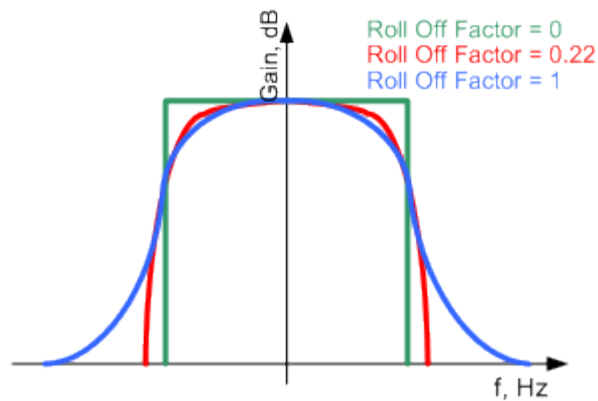


Figure 3-4: Example of the frequency response of a filter with different rolloff factors

Remote command:

`[ :SOURCE<hw> ] :BB:OFDM:FILTer:ROLLoff` on page 78

### 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 79

### 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 79

### 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 79

### 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 79

### 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 80

### 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:

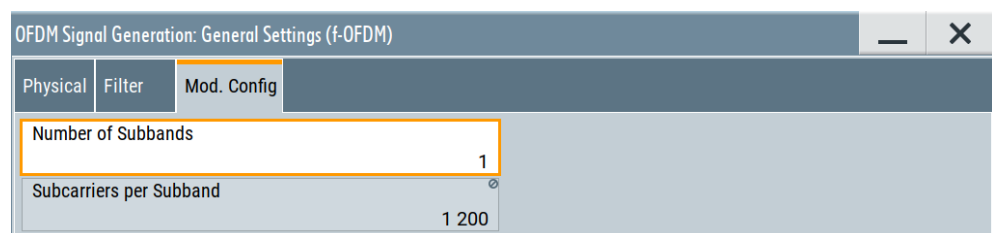
`[ :SOURCE<hw> ] :BB:OFDM:FILTer:USELectioN` on page 80

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

## 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 81

[ :SOURce<hw> ] :BB:OFDM:FOFDm:NSUBand on page 81

**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 80

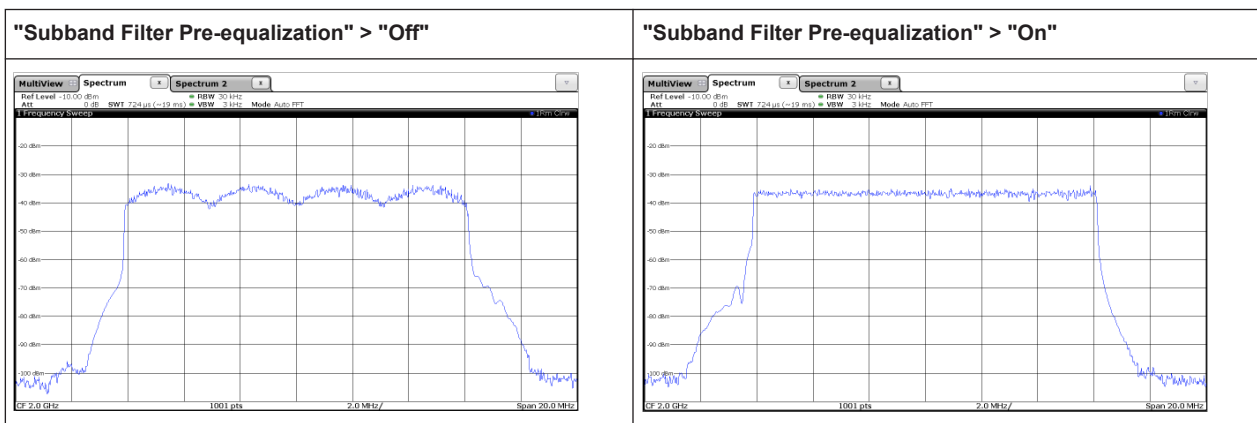
**Subband Filter Pre-equalization**

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 82

**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 81

**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.

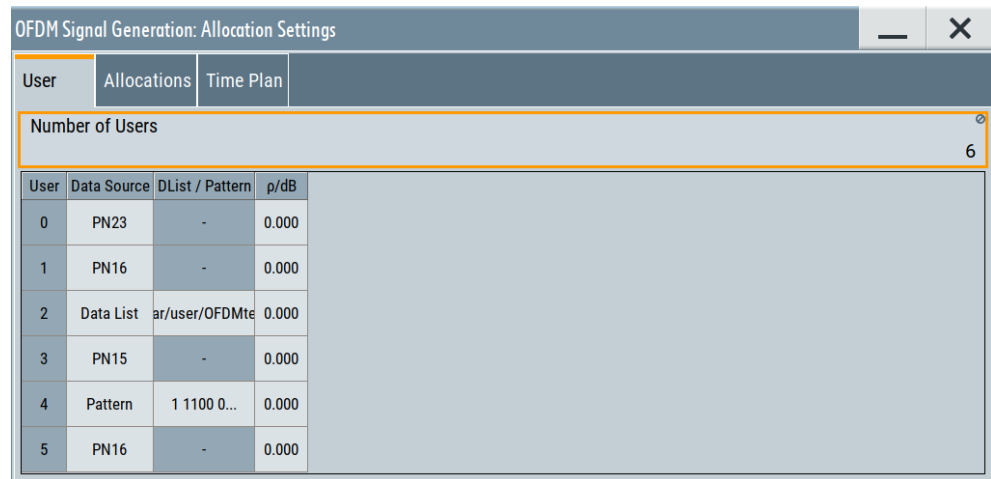
**Settings:**

- [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 SMM100A user manual.
- Section "File and data management" in the R&S SMM100A user manual.
- Section "Data list editor" in the R&S SMM100A user manual.

Remote command:

[ :SOURce<hw> ] :BB:OFDM:USER<ch0>:DATA on page 82

[ :SOURce<hw> ] :BB:OFDM:USER<ch0>:LIST on page 82

[ :SOURce<hw> ] :BB:OFDM:USER<ch0>:PATtern on page 82

### 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 83

### 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 86

### 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 87

### 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 87

### 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 88

**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 88

**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 88

**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 88

**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 89

**Data Source**

Selects the data source for the allocation.

"User x"	Use the <a href="#">User settings</a> dialog to configure the data sources for the "User 1 to 6".
"Config"	If "Modulation" > "SCMA", opens a dialog with further settings, see <a href="#">Chapter 3.3.4, "SCMA settings"</a> , 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 <a href="#">"Custom I/Q file format (*.iqw or *.dat files)"</a> 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 SMM100A user manual.
- Section "File and data management" in the R&S SMM100A user manual.
- Section "Data list editor" in the R&S SMM100A user manual.

Remote command:

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

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

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

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

**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 90

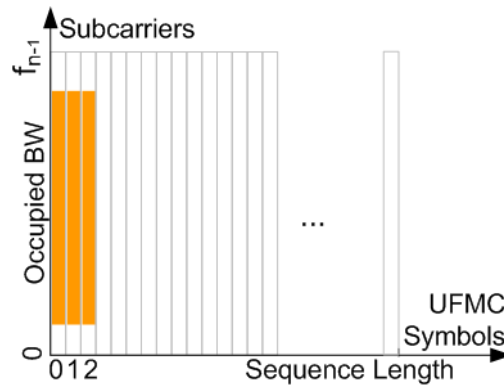
**Content Type**

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 SMM100A 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 90

**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 89

**State**

Enables the allocation.

Remote command:

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

**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:

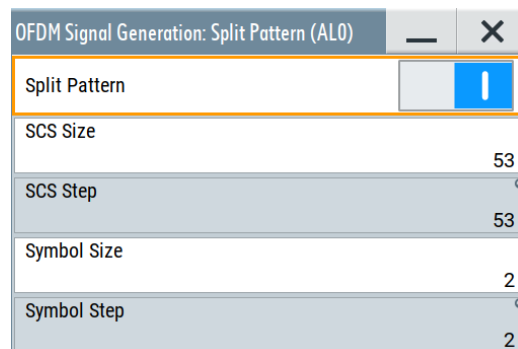
`[ :SOURce<hw> ] :BB:OFDM:ALLoc<ch0>:CONFLict?` on page 91

**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:**

<a href="#">Split Pattern</a> .....	51
<a href="#">SCS Size</a> .....	51
<a href="#">SCS Step</a> .....	51
<a href="#">Symbol Size</a> .....	51
<a href="#">Symbol Step</a> .....	51

**Split Pattern**

Activates split pattern settings for the selected allocation.

Remote command:

[ :SOURce<hw> ] :BB:OFDM:ALLoc<ch0>:SPLT:STATe on page 93

**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 94

**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 94

**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 94

**Symbol Step**

Sets or displays the symbol step.

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

Remote command:

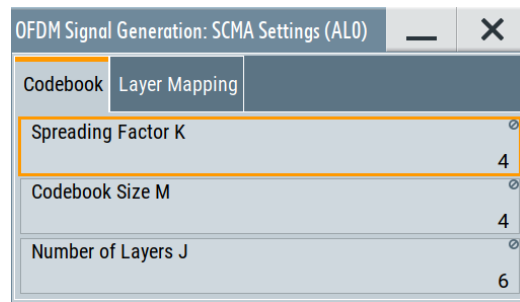
[ :SOURce<hw> ] :BB:OFDM:ALLoc<ch0>:SPLT:SYM:STEP on page 94

**3.3.4 SCMA settings**

Access:

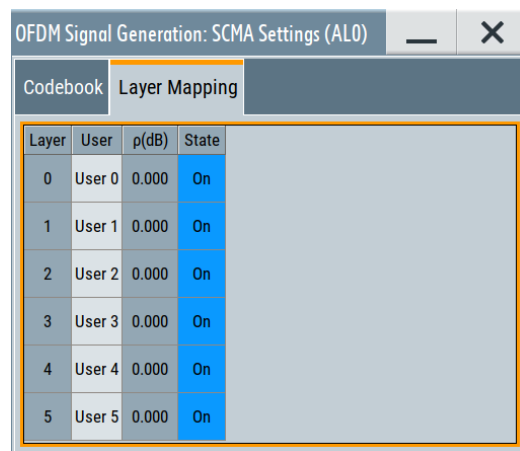
1. Select "Allocations".
2. Select "AL#" > "Constellation" > "SCMA".
3. Select "Data Source" > "Config".

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 $\rho$ (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 92

**Codebook Size M ← Codebook**

Displays the codebook size M.

Remote command:

[\[:SOURCE<hw>\]:BB:OFDM:ALLoc<ch0>:SCMA:CODEbook?](#) on page 92

**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 91

**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 93

**p(dB) ← Layer Mapping**

Provided for future use.

Remote command:

[\[:SOURCE<hw>\]:BB:OFDM:ALLoc<ch0>:SCMA:LAYer<st0>:PWR?](#) on page 92

**State ← Layer Mapping**

Enables the individual layers (codebooks).

Remote command:

[\[:SOURCE<hw>\]:BB:OFDM:ALLoc<ch0>:SCMA:LAYer<st0>:STATE](#) on page 92

### 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 (ALO)	
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 95

#### Sequence Number

Sets the sequence number within the Zadoff-Chu sequence.

Remote command:

[ :SOURce<hw> ] :BB:OFDM:ALLoc<ch0>:ZAD:SNUMber on page 95

#### Cyclic Shift

Sets the cyclic shift of the Zadoff-Chu sequence.

Remote command:

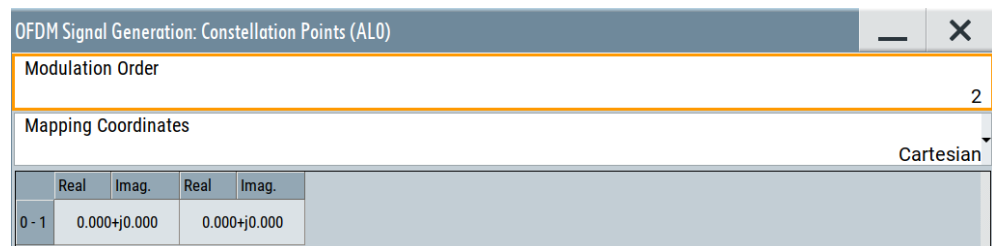
[ :SOURce<hw> ] :BB:OFDM:ALLoc<ch0>:ZAD:CYCShift on page 95

### 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 87

#### 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 97

[ :SOURce<hw> ] :BB:OFDM:ALLoc<ch0>:CONPoint<st0>:IMAG on page 96

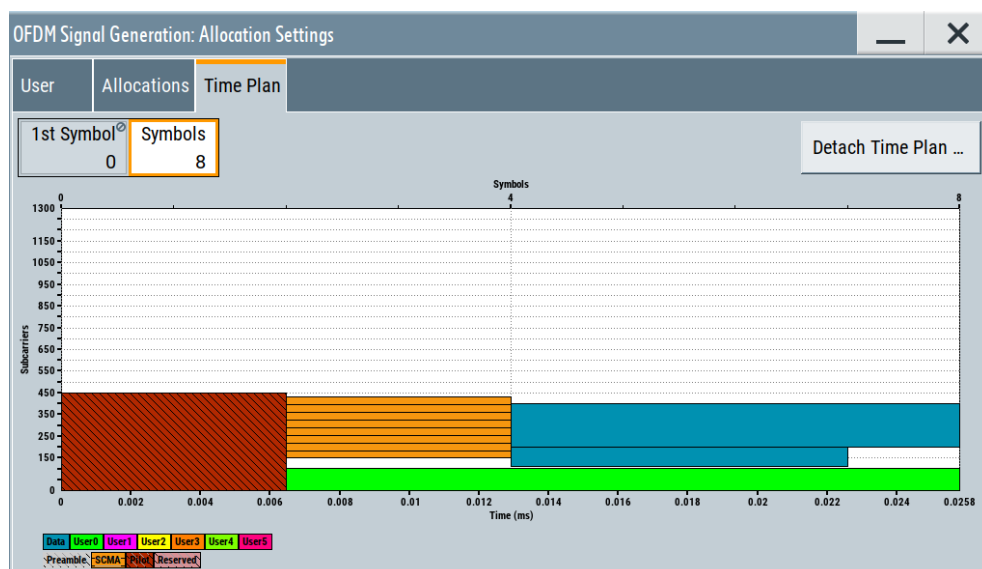
[ :SOURce<hw> ] :BB:OFDM:ALLoc<ch0>:CONPoint<st0>:MAGN on page 97

[ :SOURce<hw> ] :BB:OFDM:ALLoc<ch0>:CONPoint<st0>:PHASe on page 97

### 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.

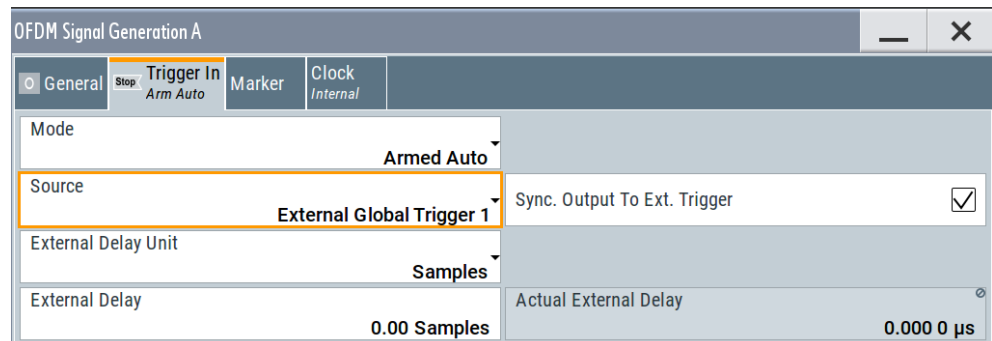
Remote command:

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 65.

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 SMM100A 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 SMM100A user manual.

#### Settings:

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

#### 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 SMM100A 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 99

### 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 102

### 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:SEnGth](#) on page 101

### 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 100

### Time Based Trigger

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

Activates time-based triggering with a fixed time reference.

The R&S SMM100A 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 SMM100A user manual.

Remote command:

[\[:SOURce<hw>\]:BB:OFDM:TRIGger:TIME\[:STATe\]](#) on page 101

### 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 SMM100A. 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 SMM100A 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 100

"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 100

### Arm

Stops the signal generation until subsequent trigger event occurs.

Remote command:

`[ :SOURce<hw> ] :BB:OFDM:TRIGger:ARM:EXECute` on page 102

### Execute Trigger

For internal trigger source, executes the trigger manually.

Remote command:

`[ :SOURce<hw> ] :BB:OFDM:TRIGger:EXECute` on page 102

### Source

The following sources of the trigger signal are available:

- "Internal"  
The trigger event is internal. Tap "Execute Trigger" to trigger signal generation manually.
- "External Global Trigger"  
The trigger event is the active edge of an external trigger signal provided and configured at the User x connectors.
- "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.

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

Remote command:

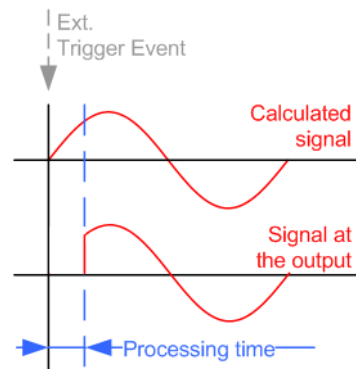
`[ :SOURce<hw> ] :BB:OFDM:TRIGger:SOURce` on page 99

### 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 out-

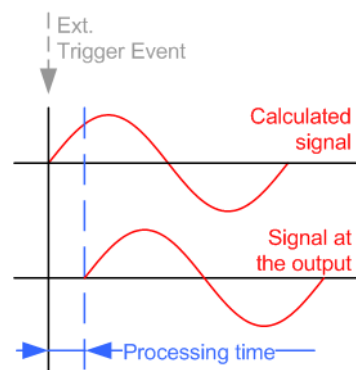
put. After elapsing of the internal processing time, the output signal is synchronous to the trigger event.



- "Off"

The signal output begins after elapsing of the processing time. Signal output starts with sample 0. The complete signal is output.

This mode is recommended for triggering of short signal sequences. Short sequences are sequences with signal duration comparable with the processing time of the instrument.



Remote command:

`[ :SOURce<hw> ] :BB:OFDM:TRIGger:EXTernal:SYNChronize:OUTPut`  
on page 102

### External Inhibit/Trigger Inhibit

Applies for an external trigger signal.

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 104

### (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 102

#### **(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

Use this setting to:

- Synchronize the instrument with the device under test (DUT) or other external devices

For more information, see chapter "Basics on ..." in the R&S SMM100A user manual.

The parameter displays the delay converted in time.

Remote command:

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

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

#### **Actual Trigger Delay/Actual External Delay**

Indicates the resulting trigger delay in "Time" unit.

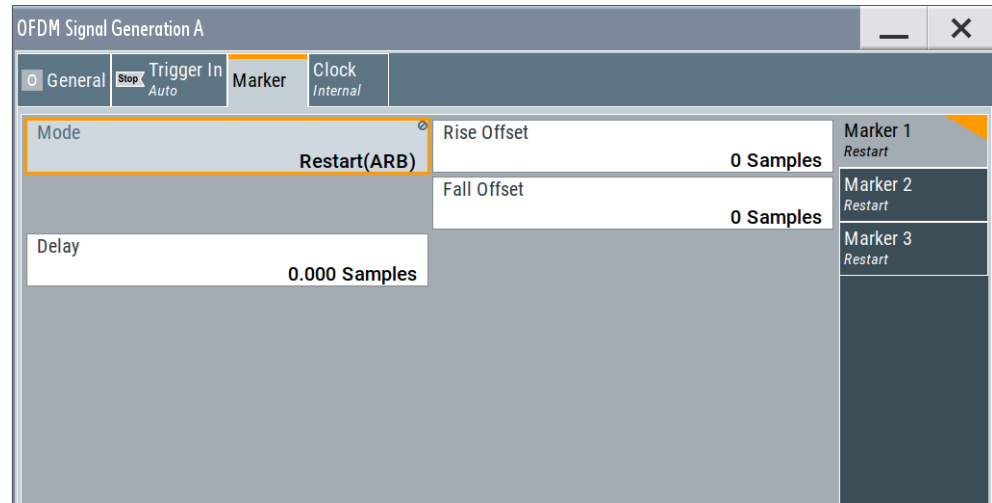
Remote command:

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

## 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 65.  
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 SMM100A adds the marker signal to the baseband signal. Also, R&S SMM100A 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 SMM100A 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 63

"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 104

**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 105

`[ :SOURce<hw> ] :BB:OFDM:TRIGger:OUTPut<ch>:ROFFset` on page 105

**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.

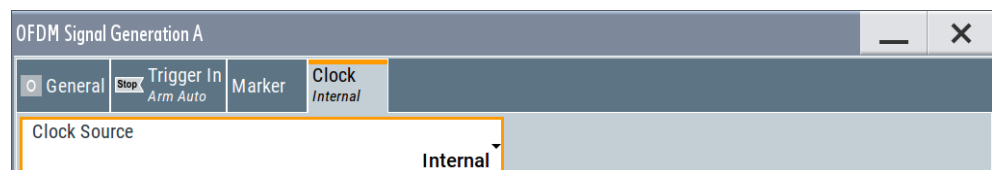
Remote command:

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

## 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 65. 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 SMM100A 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 SMM100A user manual.

#### Settings:

[Clock Source](#).....65

#### Clock Source

Selects the clock source.

- "Internal"  
The instrument uses its internal clock reference.

Remote command:

[\[:SOURce<hw>\]:BB:OFDM:CLOCK:SOURce](#) on page 105

## 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 SMM100A-K114 in a remote environment. We assume that the R&S SMM100A has already been set up for remote operation in a network as described in the R&S SMM100A 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 SMM100A user manual.

### Common Suffixes

The following common suffixes are used in the remote commands:

Suffix	Value range	Description
ENTity<ch>	1	Optional keyword, provided for compatibility with R&S®SMW200A  ENTity1:SOURce1 = SOURce1
SOURce<hw>	1	Available baseband signals
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

### 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 SMM100A-K114 option are described here:

- [General commands](#).....67
- [Physical commands](#).....70
- [Filter commands](#).....77

• <a href="#">Modulation commands</a> .....	80
• <a href="#">User commands</a> .....	82
• <a href="#">Allocation commands</a> .....	83
• <a href="#">Trigger commands</a> .....	98
• <a href="#">Marker commands</a> .....	104
• <a href="#">Clock commands</a> .....	105

## 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"
```

<a href="#">[:SOURce&lt;hw&gt;]:BB:OFDM:STATe</a> .....	67
<a href="#">[:SOURce&lt;hw&gt;]:BB:OFDM:PRESet</a> .....	68
<a href="#">[:SOURce&lt;hw&gt;]:BB:OFDM:SETTing:CATalog</a> .....	68
<a href="#">[:SOURce&lt;hw&gt;]:BB:OFDM:SETTing:LOAD</a> .....	68
<a href="#">[:SOURce&lt;hw&gt;]:BB:OFDM:SETTing:STORe</a> .....	68
<a href="#">[:SOURce&lt;hw&gt;]:BB:OFDM:SETTing:DEL</a> .....	69
<a href="#">[:SOURce&lt;hw&gt;]:BB:OFDM:WAVEform:CREate</a> .....	69
<a href="#">[:SOURce&lt;hw&gt;]:BB:OFDM:MODulation</a> .....	69
<a href="#">[:SOURce&lt;hw&gt;]:BB:OFDM:MODPreset</a> .....	70
<a href="#">[:SOURce&lt;hw&gt;]:BB:OFDM:OUTPath</a> .....	70
<a href="#">[:SOURce&lt;hw&gt;]:BB:OFDM:SRATe:VARiation</a> .....	70

---

### **[: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 83.

**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 83.

**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 67.

**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 67.

**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 67.

**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 67.

**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 auto-  
                                   matically

**Example:**                    See [Example "Generating a UFMC waveform"](#) on page 83.

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

---

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

Selects the modulation type.

**Parameters:**

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

**UFMC**

Universal Filtered Multi-Carrier modulation, see [Chapter 2.2.4, "UFMC"](#), 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 UFMC waveform"](#) on page 83.

**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 69.

**Example:** See [Example "Generating a UPMC waveform"](#) on page 83.

**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 107.

**Parameters:**

<K114OutputPath> string

**Example:** See [Example "Saving a configuration to an XML file"](#) on page 67.

**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 83.

## 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?
// Reponse 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:

<a href="#">[:SOURce&lt;hw&gt;]:BB:OFDM:NSUBcarriers</a> .....	71
<a href="#">[:SOURce&lt;hw&gt;]:BB:OFDM:NOCCupied</a> .....	72
<a href="#">[:SOURce&lt;hw&gt;]:BB:OFDM:SCSPace</a> .....	72
<a href="#">[:SOURce&lt;hw&gt;]:BB:OFDM:SEQLength</a> .....	72
<a href="#">[:SOURce&lt;hw&gt;]:BB:OFDM:CPLength</a> .....	73
<a href="#">[:SOURce&lt;hw&gt;]:BB:OFDM:ACPLength</a> .....	73
<a href="#">[:SOURce&lt;hw&gt;]:BB:OFDM:ACPSymbols</a> .....	73
<a href="#">[:SOURce&lt;hw&gt;]:BB:OFDM:CPSymbols</a> .....	73
<a href="#">[:SOURce&lt;hw&gt;]:BB:OFDM:CSLength</a> .....	74
<a href="#">[:SOURce&lt;hw&gt;]:BB:OFDM:DFTS:STATe</a> .....	74
<a href="#">[:SOURce&lt;hw&gt;]:BB:OFDM:DCMode</a> .....	74
<a href="#">[:SOURce&lt;hw&gt;]:BB:OFDM:ZSAMPles</a> .....	75
<a href="#">[:SOURce&lt;hw&gt;]:BB:OFDM:OFFSet</a> .....	75
<a href="#">[:SOURce&lt;hw&gt;]:BB:OFDM:RSAMPles</a> .....	75
<a href="#">[:SOURce&lt;hw&gt;]:BB:OFDM:SAMPling?</a> .....	76
<a href="#">[:SOURce&lt;hw&gt;]:BB:OFDM:BWOCcupied?</a> .....	76
<a href="#">[:SOURce&lt;hw&gt;]:BB:OFDM:LGUard?</a> .....	76
<a href="#">[:SOURce&lt;hw&gt;]:BB:OFDM:RGUard?</a> .....	77

---

### **[\[:SOURce<hw>\]: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 83.

**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 83.

**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 83.

**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 83.

**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 71

**Parameters:**

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

**Example:** See [Example "Generating a UPMC waveform"](#) on page 83.

**Example:** See also [\[:SOURce<hw>\]:BB:OFDM:ACPLength](#) on page 73.

**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 73.

**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 71

**Parameters:**

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

**Example:** See [Example "Generating a UPMC waveform"](#) on page 83.

**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 83.

**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 83.

**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 71.

**Parameters:**

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

**Example:** See [Example "Configuring zero padding"](#) on page 70.

**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 72.

**Parameters:**

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

**Example:** See [Example "Configuring zero padding"](#) on page 70.

**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 72.

**Parameters:**

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

**Example:** See [Example "Configuring zero padding"](#) on page 70.

**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 83.

**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 83.

**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 83.

<b>Usage:</b>	Query only
<b>Manual operation:</b>	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 83.

**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"
```

<a href="#">[:SOURce&lt;hw&gt;]:BB:OFDM:FILTer:TYPE</a> .....	78
<a href="#">[:SOURce&lt;hw&gt;]:BB:OFDM:FILTer:ROLLoff</a> .....	78
<a href="#">[:SOURce&lt;hw&gt;]:BB:OFDM:FILTer:LENGth</a> .....	79
<a href="#">[:SOURce&lt;hw&gt;]:BB:OFDM:FILTer:SBATenuation</a> .....	79
<a href="#">[:SOURce&lt;hw&gt;]:BB:OFDM:FILTer:CUTTrans</a> .....	79
<a href="#">[:SOURce&lt;hw&gt;]:BB:OFDM:FILTer:WINDowing</a> .....	79
<a href="#">[:SOURce&lt;hw&gt;]:BB:OFDM:FILTer:UCATalog?</a> .....	80
<a href="#">[:SOURce&lt;hw&gt;]:BB:OFDM:FILTer:USELection</a> .....	80
<a href="#">[:SOURce&lt;hw&gt;]:BB:OFDM:FILTer:ULENGth?</a> .....	80

---

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

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

**Parameters:**

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

**Example:** See [Example "Generating a UPMC waveform"](#) on page 83.

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

---

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

Sets the filter parameter.

**Parameters:**

<b>&lt;RollOff&gt;</b>	float
	Range: 0 to 1
	Increment: 0.001
	*RST: 0.1

**Example:** See [Example "Configuring filter settings"](#) on page 77.

**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 83.

**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 83.

**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 77.

**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 77.

**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 UFMC waveform"](#) on page 83.

**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 77.

**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 77.

**Usage:** Query only

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

## 4.4 Modulation commands

<a href="#">[:SOURce&lt;hw&gt;]:BB:OFDM:SUBCarriers?</a> .....	80
<a href="#">[:SOURce&lt;hw&gt;]:BB:OFDM:GFDM:DBSYmbols</a> .....	81
<a href="#">[:SOURce&lt;hw&gt;]:BB:OFDM:FOFDm:NSUBand</a> .....	81
<a href="#">[:SOURce&lt;hw&gt;]:BB:OFDM:UFMC:NSUBand</a> .....	81
<a href="#">[:SOURce&lt;hw&gt;]:BB:OFDM:UFMC:PREequal</a> .....	82

**[:SOURce<hw>]:BB:OFDM:SUBCarriers?**

Queries the number of subcarriers per subband.



**Return values:**

<SubPerSubband> integer  
 Range: 1 to 16384  
 \*RST: 1

**Example:** See [Example "Generating a UPMC waveform"](#) on page 83.

**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 72.

**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:UPMC:NSUBand <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 83.

**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 UFMC waveform"](#) on page 83.

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

## 4.5 User commands

[\[:SOURce<hw>\]:BB:OFDM:USER<ch0>:DATA](#)..... 82

[\[:SOURce<hw>\]:BB:OFDM:USER<ch0>:LIST](#)..... 82

[\[:SOURce<hw>\]:BB:OFDM:USER<ch0>:PATTern](#)..... 82

[\[:SOURce<hw>\]:BB:OFDM:USER<ch0>:PWR](#)..... 83

---

**[ :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 UFMC waveform"](#) on page 83.

**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 UFMC waveform"](#) on page 83.

**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 83.

**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 83.

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

## 4.6 Allocation commands

### Example: Generating a UPMC 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 UPMC
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"
SOURCE1:BB:OFDM:BWOCcupied?
// Response: "20.4"
SOURCE1:BB:OFDM:CSLength?
// Response: "0"
// No cyclic suffix configured.
SOURCE1:BB:OFDM:DFTS:STATe?
// Response: "0"
// DFT-s-OFDM for data allocations is deactivated.
SOURCE1:BB:OFDM:DCM?
// Response: "UTIL"
// Uses the DC subcarrier for all allocations.
SOURCE1:BB:OFDM:SAMPling?
// Response: "25.6"
SOURCE1:BB:OFDM:SRATe:VARiation?
// Response: "15360000"

// *****
// Configure filter settings of the modulation mode.
// *****
SOURCE1:BB:OFDM:FILTer:TYPE DCH
SOURCE1:BB:OFDM:FILTer:LENGTh 74
SOURCE1: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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#### 4.6.1 General commands

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---

**[: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 UPMC waveform"](#) on page 83.

**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 83.

**Example:** See [Example "Configuring custom modulation settings"](#)  
 on page 96.

**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 87.

**Parameters:**

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

**Example:** See [Example "Configuring custom modulation settings"](#) on page 96.

**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 83.

**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 83.

**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 83.

**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 83.

**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 83.

**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 83.

**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 83.

**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 83.

**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 83.

**Manual operation:** See ["p\(dB\)"](#) 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 83.

**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 83.

**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 83.

**Usage:** Query only

**Manual operation:** See ["Conflict"](#) on page 50

## 4.6.2 SCMA commands

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**[: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 83.

**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 UFMC waveform"](#) on page 83.

**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 UFMC waveform"](#) on page 83.

**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 UFMC waveform"](#) on page 83.

**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 83.

**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 83.

**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.....	93
[ :SOURce<hw>]:BB:OFDM:ALLoc<ch0>:SPLT:SCS:SIZE.....	94
[ :SOURce<hw>]:BB:OFDM:ALLoc<ch0>:SPLT:SCS:STEP.....	94
[ :SOURce<hw>]:BB:OFDM:ALLoc<ch0>:SPLT:SYM:SIZE.....	94
[ :SOURce<hw>]:BB:OFDM:ALLoc<ch0>:SPLT:SYM:STEP.....	94

---

```
[ :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 93.

**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 88.

**Parameters:**

<SplitPatScsSize> integer  
 Range: 1 to 13107  
 \*RST: 1

**Example:** See [Example "Configuring split pattern settings"](#) on page 93.

**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 88.

**Parameters:**

<SplitPatScsStep> integer  
 Range: 1 to 13107  
 \*RST: 1

**Example:** See [Example "Configuring split pattern settings"](#) on page 93.

**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 93.

**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 93.

**Manual operation:** See ["Symbol Step"](#) on page 51

#### 4.6.4 Zadoff-Chu commands

<a href="#">[:SOURce&lt;hw&gt;]:BB:OFDM:ALLoc&lt;ch0&gt;:ZAD:CYCShift.....</a>	95
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<a href="#">[:SOURce&lt;hw&gt;]:BB:OFDM:ALLoc&lt;ch0&gt;:ZAD:SNUMber.....</a>	95

---

**[: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 83.

**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 83.

**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 83.

**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

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<a href="#">[:SOURCE&lt;hw&gt;]:BB:OFDM:ALLOC&lt;ch0&gt;:CONPoint&lt;st0&gt;:MAGN</a> .....	97
<a href="#">[:SOURCE&lt;hw&gt;]:BB:OFDM:ALLOC&lt;ch0&gt;:CONPoint&lt;st0&gt;:PHASE</a> .....	97
<a href="#">[:SOURCE&lt;hw&gt;]:BB:OFDM:ALLOC&lt;ch0&gt;:CONPoint&lt;st0&gt;:REAL</a> .....	97

---

**[\[:SOURCE<hw>\]: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 96.

**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 96.

**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 96.

**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: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
```

<code>[:SOURce&lt;hw&gt;]:BB:OFDM[:TRIGger]:SEQuence</code> .....	99
<code>[:SOURce&lt;hw&gt;]:BB:OFDM:TRIGger:SOURce</code> .....	99
<code>[:SOURce&lt;hw&gt;]:BB:OFDM:TRIGger:RMODE?</code> .....	100
<code>[:SOURce&lt;hw&gt;]:BB:OFDM:TRIGger:TIME:DATE</code> .....	100
<code>[:SOURce&lt;hw&gt;]:BB:OFDM:TRIGger:TIME:TIME</code> .....	100
<code>[:SOURce&lt;hw&gt;]:BB:OFDM:TRIGger:TIME[:STATe]</code> .....	101
<code>[:SOURce&lt;hw&gt;]:BB:OFDM:TRIGger:SLENgth</code> .....	101
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<code>[:SOURce&lt;hw&gt;]:BB:OFDM:TRIGger:EXTernal:SYNChronize:OUTPut</code> .....	102
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<code>[:SOURce&lt;hw&gt;]:BB:OFDM:TRIGger[:EXTernal]:DELAy</code> .....	103
<code>[:SOURce&lt;hw&gt;]:BB:OFDM:TRIGger:EXTernal:TDELAy</code> .....	103
<code>[:SOURce&lt;hw&gt;]:BB:OFDM:TRIGger:EXTernal:RDELAy?</code> .....	103
<code>[:SOURce&lt;hw&gt;]:BB:OFDM:TRIGger[:EXTernal]:INHibit</code> .....	104

---

### `[: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 98.

**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
- External trigger signal via one of the local or global connectors:
  - `EGT1 | EGT2`: External global trigger
  - `EGC1 | EGC2`: External global 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 SMM100A accepts these values and maps them automatically as follows:  
`OBASeband = INTA, BEXTernal = EGT2, EXTernal = EGT1`

**Parameters:**

<TrigSource>           INTernal|EGT1|EGT2|EGC1|EGC2|EXTernal|BBSY  
 \*RST:           INTernal

**Example:**           See [Example "Configuring trigger signals"](#) on page 98.

**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 98.

**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 SMM100A user manual.

**Manual operation:** See ["Trigger Time"](#) on page 59

**[: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 SMM100A user manual.

**Manual operation:** See ["Trigger Time"](#) on page 59

**[ :SOURCE<hw> ] : BB : OFDM : TRIGGER : TIME [ : STATE ] <State>**

Activates time-based triggering with a fixed time reference. If activated, the R&S SMM100A 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 SMM100A user manual.

**Manual operation:** See ["Time Based Trigger"](#) on page 59

**[ :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 98.

**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 98.

**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 98.

**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 98.

**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 98.

**Manual operation:** See ["Sync. Output to External Trigger/Sync. Output to Trigger"](#) on page 60

---

**[[: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 98.

**Manual operation:** See "[\(External\) Delay Unit](#)" on page 61

**[: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 98.

**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 98.

**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 98.
- Usage:** Query only
- Manual operation:** See ["Actual Trigger Delay/Actual External Delay"](#) on page 62

**[: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 98.
- Manual operation:** See ["External Inhibit/Trigger Inhibit"](#) on page 61

## 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"
```

<a href="#">[:SOURce&lt;hw&gt;]:BB:OFDM:TRIGger:OUTPut&lt;ch&gt;:MODE</a> .....	104
<a href="#">[:SOURce&lt;hw&gt;]:BB:OFDM:TRIGger:OUTPut&lt;ch&gt;:ROFFset</a> .....	105
<a href="#">[:SOURce&lt;hw&gt;]:BB:OFDM:TRIGger:OUTPut&lt;ch&gt;:FOFFset</a> .....	105
<a href="#">[:SOURce&lt;hw&gt;]:BB:OFDM:TRIGger:OUTPut&lt;ch&gt;:DELay</a> .....	105

**[: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 104.
- 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 104.

**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: 1
                    *RST:     0
                    Default unit: Samples
```

**Example:** See [Example "Activating a marker 2 signal"](#) on page 104.

**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..... 105
[:SOURce<hw>]:BB:OFDM:CLOCK:MODE..... 106
```

---

```
[:SOURce<hw>]:BB:OFDM:CLOCK:SOURce <ClockSou>
```

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  
\*RST:           INTernal

**Example:**           See [Example "Configuring clock settings"](#) on page 105.

**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 105.

# 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 SMM100A-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

## Symbols

**[1]:** Michailow, N.; Gaspar, I.; Krone, S.; Lentmaier, M.; Fettweis, G.  
"Generalized Frequency Division Multiplexing: Analysis of an Alternative Multi-Carrier Technique for Next Generation Cellular Systems", Aug. 2012

**[2]:** Schaich, F.; Wild, T.; Chen, Y.  
"Waveform contenders for 5G - suitability for short packet and low latency transmissions," VTC Spring, May 2014.

**[3]:** Viholainen, A.; Bellanger, M.; Huchard, M.  
"PHYDYAS – PHYsical layer for DYnamic AccesS and cognitive radio", Report D5.1, Jan. 2009

**5GNOW:** Project 5<sup>th</sup> Generation Non-orthogonal Waveforms for Asynchronous Signaling  
<http://www.5gnow.eu>

**5GNOW D3.x:** 5G Waveform Candidate Selection, Version D3.2  
Final 5GNOW Transceiver and frame structure concept, Version D3.3



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[:SOURce<hw>]:BB:OFDM:ALLOc<ch0>:SPLT:SYM:STEP.....	94
[:SOURce<hw>]:BB:OFDM:ALLOc<ch0>:STATe.....	91
[:SOURce<hw>]:BB:OFDM:ALLOc<ch0>:SYNO.....	88
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