

R&S[®]SMW-K114

OFDM Signal Generation

User Manual



1177624602
Version 12

ROHDE & SCHWARZ
Make ideas real



This document describes the following software options:

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

This manual describes firmware version FW 4.80.041.xx and later of the R&S®SMW200A.

© 2020 Rohde & Schwarz GmbH & Co. KG

Mühlhofstr. 15, 81671 München, Germany

Phone: +49 89 41 29 - 0

Email: info@rohde-schwarz.com

Internet: www.rohde-schwarz.com

Subject to change – data without tolerance limits is not binding.

R&S® is a registered trademark of Rohde & Schwarz GmbH & Co. KG.

Trade names are trademarks of the owners.

1177.6246.02 | Version 12 | R&S®SMW-K114

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

Contents

1	Welcome to the OFDM Signal Generation Option.....	5
1.1	Accessing the OFDM Signal Generation Dialog.....	6
1.2	Documentation Overview.....	6
1.2.1	Getting Started Manual.....	6
1.2.2	User Manuals and Help.....	6
1.2.3	Tutorials.....	7
1.2.4	Service Manual.....	7
1.2.5	Instrument Security Procedures.....	7
1.2.6	Printed Safety Instructions.....	7
1.2.7	Data Sheets and Brochures.....	7
1.2.8	Release Notes and Open Source Acknowledgment (OSA).....	7
1.2.9	Application Notes, Application Cards, White Papers, etc.....	8
1.3	Scope.....	8
1.4	Notes on Screenshots.....	8
2	About OFDM Signal Generation Option.....	9
2.1	Required Options.....	9
2.2	Overview of Modulation Schemes.....	9
2.2.1	OFDM.....	9
2.2.2	f-OFDM.....	10
2.2.3	GFDM.....	10
2.2.4	UFMC.....	11
2.2.5	FBMC.....	12
2.2.6	Filtering.....	13
2.3	Supported Multiple Access Schemes.....	18
2.4	Physical Layer Parameterization.....	21
2.5	Generating Configuration Files for R&S®VSE-K96.....	22
3	OFDM Signal Generation Configuration and Settings.....	24
3.1	General Settings.....	24
3.2	General Settings.....	27
3.2.1	Physical Settings.....	27
3.2.2	Filter Settings.....	32

3.2.3	Modulation Configuration Settings.....	35
3.3	Allocation Settings.....	37
3.3.1	User Settings.....	37
3.3.2	Allocations Settings.....	39
3.3.3	SCMA Settings.....	44
3.3.4	Time Plan.....	46
3.4	Trigger Settings.....	48
3.5	Marker Settings.....	53
3.6	Clock Settings.....	54
3.7	Local and Global Connector Settings.....	56
4	Remote-Control Commands.....	57
4.1	General Commands.....	58
4.2	Physical Settings Commands.....	61
4.3	Filter Commands.....	65
4.4	Modulation Commands.....	68
4.5	User Commands.....	69
4.6	Allocation Commands.....	72
4.7	SCMA Commands.....	78
4.8	Trigger Commands.....	80
4.9	Marker Commands.....	87
4.10	Clock Commands.....	88
	Annex.....	90
A	XML Settings File.....	90
	Glossary: List of the Terms and Abbreviations.....	93
	Glossary: Specifications, References, Documents with Further Information.....	95
	List of commands.....	96
	Index.....	98

1 Welcome to the OFDM Signal Generation Option

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

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

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

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

The R&S SMW-K114 key features are:

- 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, automatically generation of configuration file for upload in the R&S®VSE-K96.

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

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

www.rohde-schwarz.com/manual/SMW200A

Installation

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

1.1 Accessing the OFDM Signal Generation Dialog

To open the dialog with OFDM Signal Generation settings

- ▶ In the block diagram of the R&S SMW, 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 Documentation Overview

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

www.rohde-schwarz.com/manual/smw200a

1.2.1 Getting Started Manual

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

1.2.2 User Manuals and Help

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

- Base unit manual
Contains the description of all instrument modes and functions. It also provides an introduction to remote control, a complete description of the remote control commands with programming examples, and information on maintenance, instrument interfaces and error messages. Includes the contents of the getting started manual.
- Software option manual
Contains the description of the specific functions of an option. Basic information on operating the R&S SMW is not included.

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

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

1.2.3 Tutorials

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

1.2.4 Service Manual

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

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

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

1.2.5 Instrument Security Procedures

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

1.2.6 Printed Safety Instructions

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

1.2.7 Data Sheets and Brochures

The data sheet contains the technical specifications of the R&S SMW. It also lists the options and their order numbers and optional accessories.

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

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

1.2.8 Release Notes and Open Source Acknowledgment (OSA)

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

The open-source acknowledgment document provides verbatim license texts of the used open source software.

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

1.2.9 Application Notes, Application Cards, White Papers, etc.

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

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

1.3 Scope



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

In particular, it includes:

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

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

1.4 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, UFMC and FBMC.

• Required Options	9
• Overview of Modulation Schemes	9
• Supported Multiple Access Schemes	18
• Physical Layer Parameterization	21
• Generating Configuration Files for R&S®VSE-K96	22

2.1 Required Options

The basic equipment layout for generating OFDM signals includes the:

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

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

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

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

For more information, see data sheet.

2.2 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 sub-bands and there is no predefined filtering.

Related settings

- [Chapter 3.2.1, "Physical Settings"](#), on page 27
- [Chapter 3.2.3, "Modulation Configuration Settings"](#), on page 35

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 27
- [Chapter 3.2.2, "Filter Settings"](#), on page 32
- [Chapter 3.2.3, "Modulation Configuration Settings"](#), on page 35

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 time and in frequency domain. The GFDM waveform is a non-orthogonal, asynchronous multi-carrier waveform.

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

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

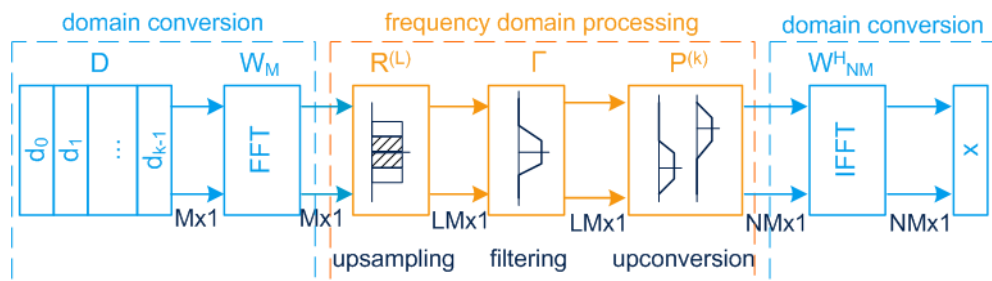


Figure 2-1: Optimized GFDM transmitter model (from [1])

- D = Matrix of input symbols, QPSK, BPSK, or QAM modulated
 d_k = Input vector
 k = Number of active subcarrier
 M = Number of symbols (block size)
 N = FFT size
 W_M = FFT matrix
 $R^{(L)}$ = Upsampling matrix with upsampling factor L
 Γ = Diagonal matrix containing the time samples of the filter pulse on its diagonal; the filtering is an element wise multiplication in the frequency domain
 $P^{(k)}$ = 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 on [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 27
- [Chapter 3.2.2, "Filter Settings"](#), on page 32
- [Chapter 3.2.3, "Modulation Configuration Settings"](#), on page 35

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.

The system model of UFMC is illustrated on [Figure 2-2](#) ([2]).

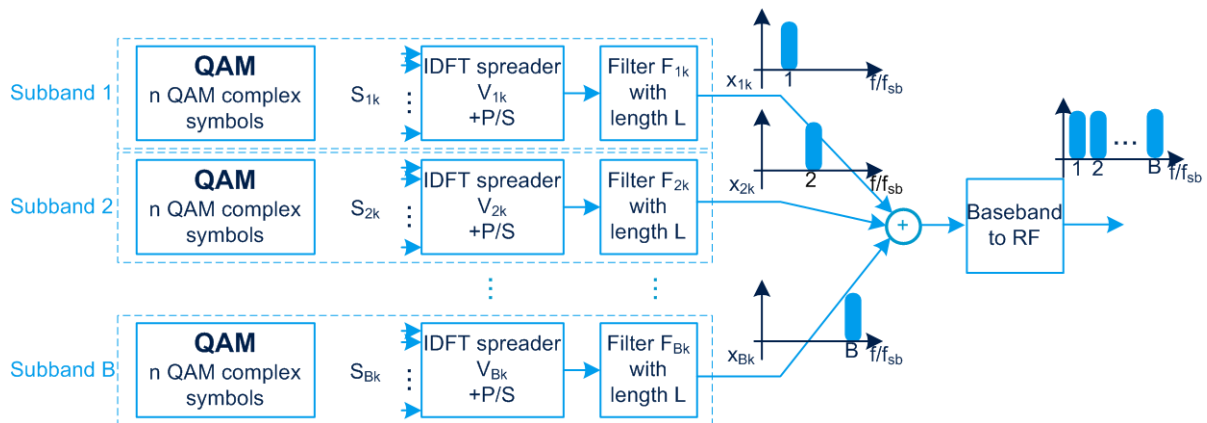


Figure 2-2: UFMC system model (from [2])

- 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 resulting UFMC waveform is a non-orthogonal, asynchronous multi-carrier waveform.

Related settings

- [Chapter 3.2.1, "Physical Settings"](#), on page 27
- [Chapter 3.2.2, "Filter Settings"](#), on page 32
- [Chapter 3.2.3, "Modulation Configuration Settings"](#), on page 35

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.

The implementation principle is illustrated on ([3]).

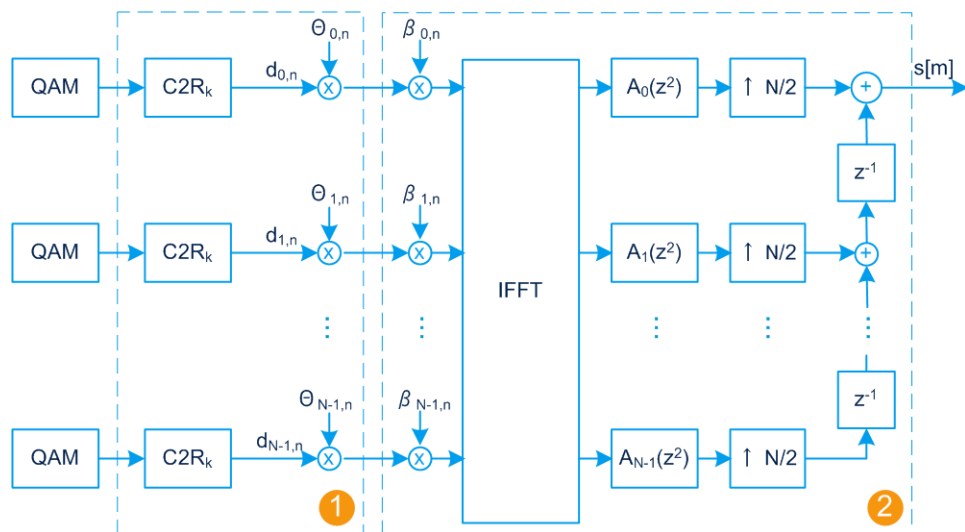


Figure 2-3: FBMC transmitter model (from [3])

- 1 = OQAM pre-processing (symbol staggering)
- 2 = Synthesis filter bank
- N = Total number of subcarriers
- k = $1, \dots, N$ is the subcarrier index
- C2R = Complex to real conversion
- \otimes = Complex multiplication by a factor Θ : Shifts the in-phase (I) components of the QAM symbols compared to the quadrature (Q) components
- IFFT = Inverse fast Fourier transform
- $A_k(z)$ = Polyphase filtering per subcarrier
- $N/2$ = Upsampling by the factor $N/2$
- Z^{-1} = Individual delays, added on each subcarrier
- $s[m]$ = Transmit signal (the sum of all subcarriers)
- K = Overlapping factor; defines number of superimposing symbols in time

OQAM pre-processing

Orthogonal QAM is 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 is applied alternating between the subcarrier. 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.

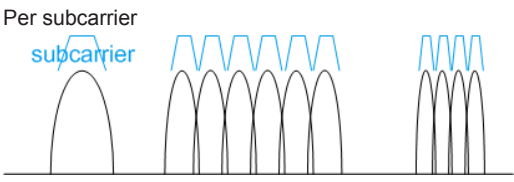
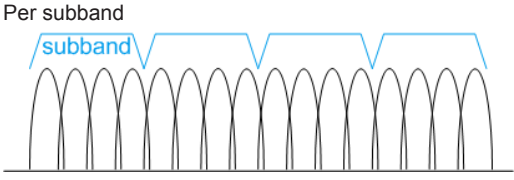
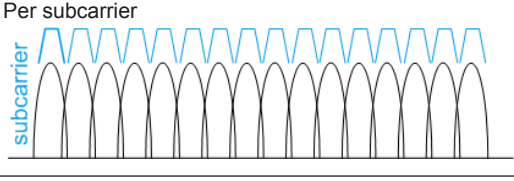
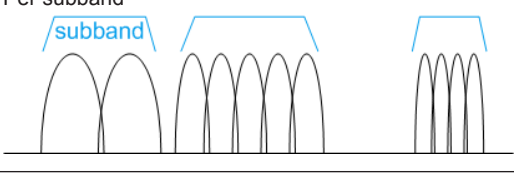
Related settings

- [Chapter 3.2.1, "Physical Settings"](#), on page 27
- [Chapter 3.2.2, "Filter Settings"](#), on page 32
- [Chapter 3.2.3, "Modulation Configuration Settings"](#), on page 35

2.2.6 Filtering

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

Table 2-1: Overview of time and frequency domain filtering per modulation method

Modulation methods	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 
f-OFDM	Per frame	Per subband 
OFDM	none	none

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

- GFDM:
Root cosine, root raised cosine, Dirichlet, and rectangular filters
- UFMC:

- Dolph-Chebyshev filter
- FBMC:
 - Root raised cosine, Phydyas filter
- f-OFDM:
 - Soft truncation filter
- OFDM
 - No default filter

For UFMC, 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 16.

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 drawback. A prototype filter with rectangular frequency response suffers from an infinitely long impulse response in time. A root raised cosine filter improves the side lobe suppression.

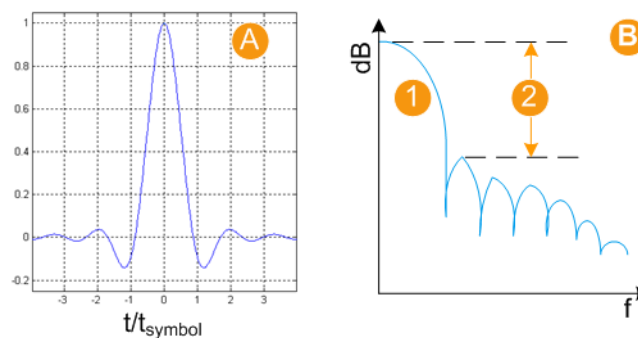


Figure 2-4: Example of filter characteristics: Root cosine filter with Rolloff Factor = 0.5

- A = Filter impulse response
- B = Filter frequency response
- 1 = Main lobe
- 2 = Side lobe suppression

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

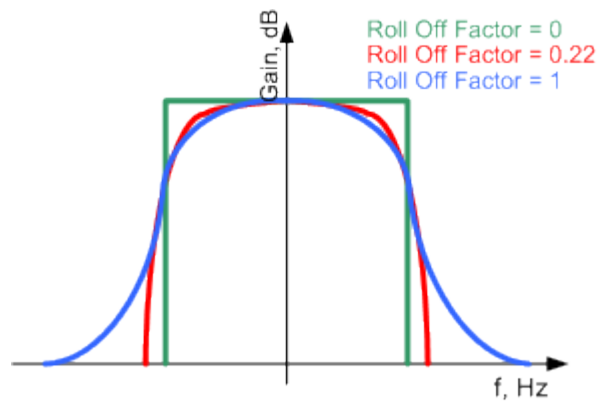


Figure 2-5: Example of the frequency response of a filter with different rolloff factors

In **f-OFDM**, the side lobe suppression is improved by applying a soft truncation window function. The modulation uses the commonly known Hamming 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.

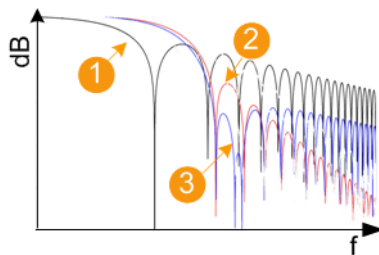


Figure 2-6: Effect of the windowing function

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

As shown on [Figure 2-6](#), the soft truncation improves the side lobe suppression but results in a wider main lobe.

UFMC proposes another windowing function with promising characteristics, the Dolph-Chebyshev. The Dolph-Chebyshev window is characterized by the filter length L in time domain and by the stopband attenuation (that is the desirable side lobe 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 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: Phydys 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 Phydys filter exceeds 60 dB for the frequency range of more than 10 subcarrier spacings [[3], 5GNOW D3.x].

User filter file format (*.dat files)

Additionally to the proposed prototype filter, for UPMC, f-OFDM and OFDM, you can define your own filters.

User filter files are ASCII files with 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.

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: Script that generates user filter file

```

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 32

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 multi-layer 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 corresponds to *unique* codebook. The binary input data are mapped directly to the multiple layers complex codeword and then spread over the subcarriers.

SCMA encoding and parameters dependency

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

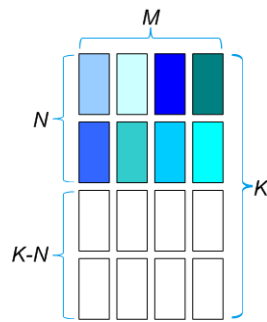


Figure 2-8: SCMA encoding parameters

- 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 number of non-zero elements (N). For $K = 4$ and $N = 2$, the maximum number of layers is $J = 6$. In SCMA, one user can be assigned to several layers, whereas each layer can be assigned to exact one user. Hence, the maximum number of users corresponds to the number of layers and is also 6.

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

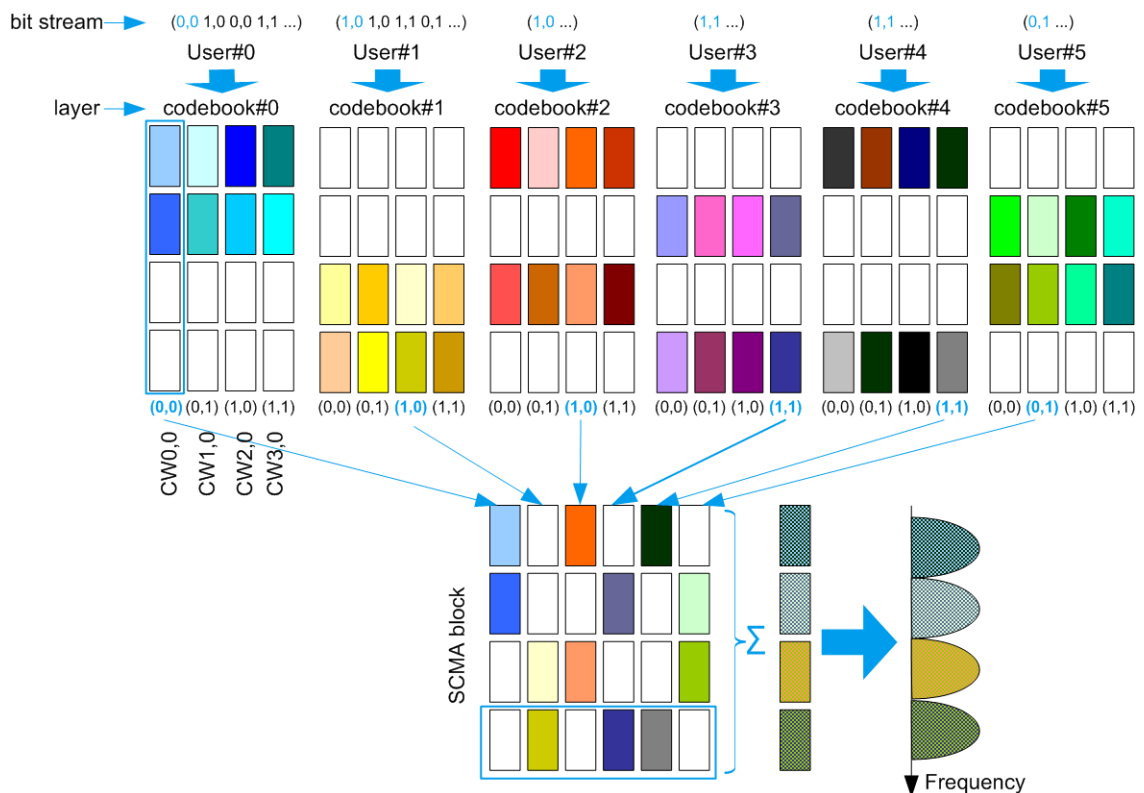


Figure 2-9: SCMA encoding example ($K = 4$, $N = 2$, $J = 6$)

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_{y,x} = Codeword#y from codebook#x
 Σ = Combining the symbols

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

SCMA parameterization

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

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

Related settings

- [Chapter 3.3.3, "SCMA Settings"](#), on page 44
- [Chapter 3.3.2, "Allocations Settings"](#), on page 39

2.4 Physical Layer Parameterization

Data allocation

The input symbols can be modulated in one of the base modulations: BPSK, QPSK, 16QAM, 64QAM, 256QAM and SCMA.

Additionally to the base modulation, you can load files with custom modulated I/Q data and configure allocations modulated in other modulation schemes, like CAZAC sequences for instance. See "[Custom I/Q file format \(*.iqw or *.dat files\)](#)" on page 21.

Related settings:

- [Chapter 3.3, "Allocation Settings"](#), on page 37

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:

- ["Modulation"](#) on page 41

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 29
- For f-OFDM, also:
 - ["Alt. Cyclic Prefix Length"](#) on page 30
 - ["CP No. Symbols/Alt. CP No. Symbols"](#) on page 31

Sequence length calculation

The sequence length depends on the modulation method. Sequence length can be expressed as number of symbols or as number of samples.

Calculation of the sequence length as number of **samples** and per modulation method 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]

2.5 Generating Configuration Files for R&S®VSE-K96

If you generate f-OFDM or OFDM modulated signals, the R&S SMW creates automatically an *.xml settings 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 SMW, 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:**

Signal analyzer perceives reserved allocations as general OFDM modulated signals. The allocation content can be any user-defined information.

How to create, transfer and use the settings file

1. In the R&S SMW, 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 SMW via USB, LAN, ftp or any other access methods.
Open, for example, the `\\<R&S SMW IP Address>\share\K114\`.
See also, chapter "File and Data Management" in the R&S SMW user manual.
4. Copy the `Exported_K114_settings_K96.xml` file
5. Transfer and load it in the R&S®VSE-K96
Required settings are performed automatically, so that you can start analyzing the signal.

3 OFDM Signal Generation Configuration and Settings

Access:

- ▶ Select "Baseband > OFDM Signal Generation".

The remote commands required to define these settings are described in [Chapter 3](#), "OFDM Signal Generation Configuration and Settings", on page 24.

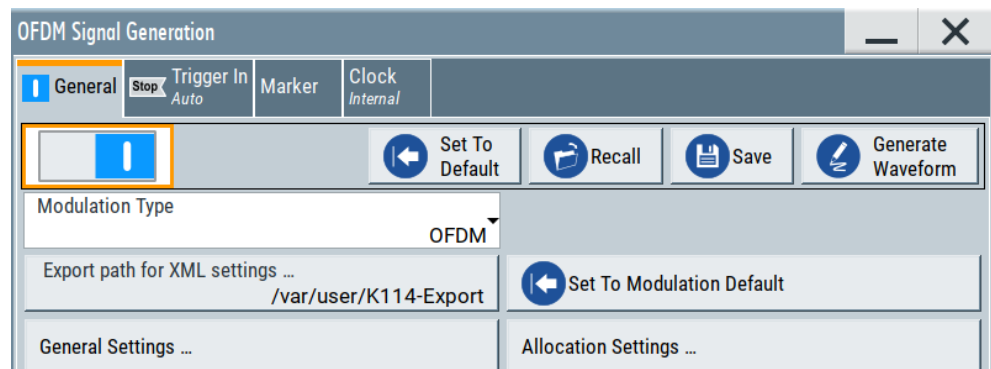
Settings:

• General Settings	24
• General Settings	27
• Allocation Settings	37
• Trigger Settings	48
• Marker Settings	53
• Clock Settings	54
• Local and Global Connector Settings	56

3.1 General Settings

Access:

- ▶ Select "Baseband > OFDM Signal Generation".



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

Settings:

State	25
Set to Default	25
Save/Recall	25

Generate Waveform File.....	25
Modulation Type.....	26
Export path for XML settings.....	26
Set to Modulation Default.....	27
General Settings.....	27
Allocation Settings.....	27

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 59

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 59

Save/Recall

Accesses 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, in which the settings are stored, are user-definable; the file extension is predefined.

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

Remote command:

[:SOURce<hw>] :BB:OFDM:SETTing:CATalog on page 59

[:SOURce<hw>] :BB:OFDM:SETTing:LOAD on page 59

[:SOURce<hw>] :BB:OFDM:SETTing:STORe on page 59

[:SOURce<hw>] :BB:OFDM:SETTing:DEL on page 60

Generate Waveform File

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

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

Remote command:

[:SOURce<hw>] :BB:OFDM:WAVEform:CREate on page 60

Modulation Type

Selects the modulation type.

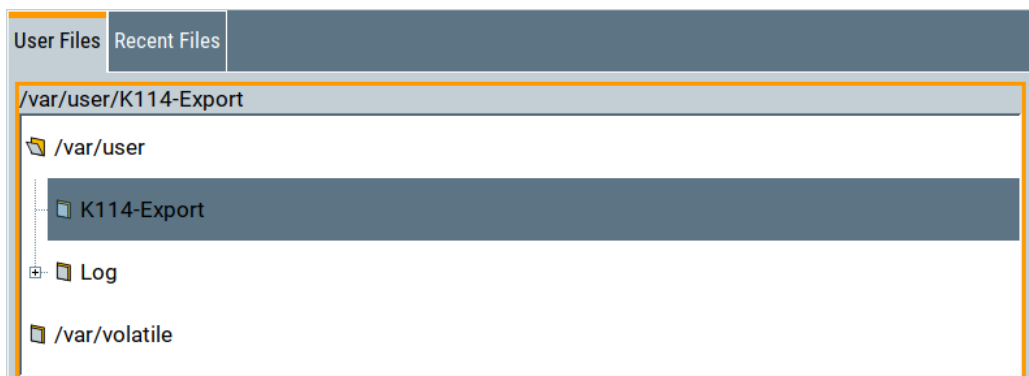
- | | |
|----------|---|
| "OFDM" | You can create your own OFDM signal, for example configure the allocations as required.
For more information, see Chapter 2.5, "Generating Configuration Files for R&S®VSE-K96" , on page 22. |
| "f-OFDM" | Filtered-OFDM
The filtered OFDM (f-OFDM) modulation is a technique similar to the UFMC modulation.
See Chapter 2.2.1, "OFDM" , on page 9.
An *.xml setting file is created for this modulation type, too.
For more information, see Chapter 2.5, "Generating Configuration Files for R&S®VSE-K96" , on page 22. |
| "UFMC" | Universal Filtered Multi-Carrier
UFMC is similar to OFDM but an additional filter is applied to each subband. The modulation used an optional cyclic prefix and a Dolph-Chebyshev filter.
See Chapter 2.2.4, "UFMC" , on page 11. |
| "GFDM" | Generalized Frequency Division Multiplexing
Data processing is performed on a two-dimensional block structure, both in time and frequency domain.
Each subcarrier is pulse-shaped with a transmit filter and then modulated.
See Chapter 2.2.3, "GFDM" , on page 10. |
| "FBMC" | Filter Bank Multi-Carrier
This modulation uses staggered modulated multitone filter bank (SMT FBMC) method where the subcarriers are OQAM modulated.
See Chapter 2.2.5, "FBMC" , on page 12. |

Remote command:

`[:SOURCE<hw>] :BB:OFDM:MODulation` on page 60

Export path for XML settings

Accesses 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` is specified.

If modulation "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 90.

Remote command:

`[:SOURCE<hw>] :BB:OFDM:OUTPath` on page 61

Set to Modulation Default

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

Remote command:

`[:SOURCE<hw>] :BB:OFDM:MODPreset` on page 60

General Settings...

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

For description, see:

- [Chapter 3.2.1, "Physical Settings"](#), on page 27
- [Chapter 3.2.2, "Filter Settings"](#), on page 32
- [Chapter 3.2.3, "Modulation Configuration Settings"](#), on page 35

Remote command:

n.a.

Allocation Settings...

Accesses the "Allocation Settings" dialog, see [Chapter 3.3, "Allocation Settings"](#), on page 37.

Remote command:

n.a.

3.2 General Settings

- [Physical Settings](#).....27
- [Filter Settings](#).....32
- [Modulation Configuration Settings](#).....35

3.2.1 Physical Settings

Access:

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

The physical settings are common to all modulation schemes.

OFDM Signal Generation: General Settings (OFDM)	
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
Sampling Rate	20.000 MHz
Occupied Bandwidth	16.563 MHz
Number of Left Guard Subcarriers	6
Number of Right Guard Subcarriers	5

Settings:

Total Number Of Subcarriers.....	28
Occupied Number of Subcarriers.....	28
Subcarrier Spacing.....	29
Sequence Length.....	29
Cyclic Prefix Length.....	29
Alt. Cyclic Prefix Length.....	30
CP No. Symbols/Alt. CP No. Symbols.....	31
Sampling Rate.....	31
Occupied Bandwidth.....	31
Number Of Left/Right Guard Subcarriers.....	32

Total Number Of Subcarriers

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 data sheet.

Remote command:

`[:SOURce<hw>] :BB:OFDM:NSUBcarriers` on page 62

Occupied Number of Subcarriers

Sets the number of occupied subcarriers.

The maximum number of occupied subcarriers is calculated as follows:

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

For the UPMC modulation, the "Occupied Number of Subcarriers" has to be a multiple of the selected **Number of Sub-bands**.

Remote command:

`[:SOURce<hw>] :BB:OFDM:NOCCupied` on page 62

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. Hence, the parameter "Subcarrier Spacing" sets also the subcarrier bandwidth.

Remote command:

[:SOURce<hw>] :BB:OFDM:SCSPace on page 62

Sequence Length

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

See also "Sequence length calculation" on page 21.

Remote command:

[:SOURce<hw>] :BB:OFDM:SEQLength on page 62

Cyclic Prefix Length

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

The maximum number of symbols that can be used as a CP is calculated as follows:

"Cyclic Prefix Length"_{max} = 0.5*Total Number Of Subcarriers

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*.

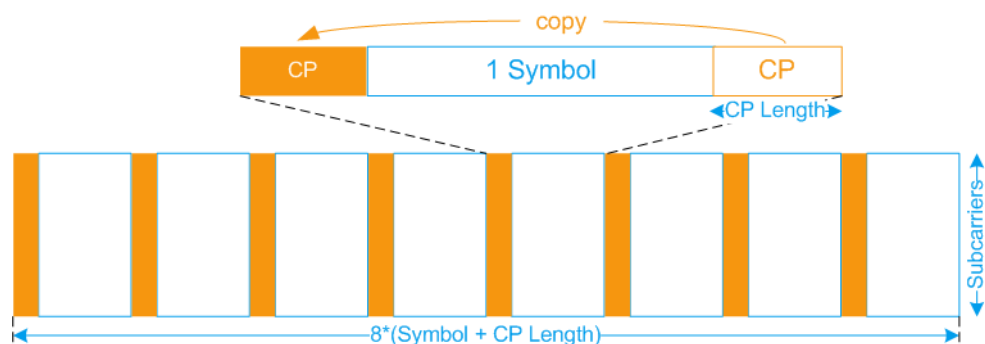


Figure 3-1: Principle of cyclic prefix calculation in f-OFDM/OFDM (default configuration with CP No. Symbols = 0, Alt. Cyclic Prefix Length = 0)

CP = Cyclic prefix
 CP Length = Selected number of samples
 Subcarriers = Total Number Of Subcarriers
 Sequence Length = Selected number of symbols; 8 symbols in this example
 Total number of samples = Calculated as described in "Sequence length calculation" on page 21

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 ≠ 0" is selected, then last samples of the complete signal are prepended to the signal.

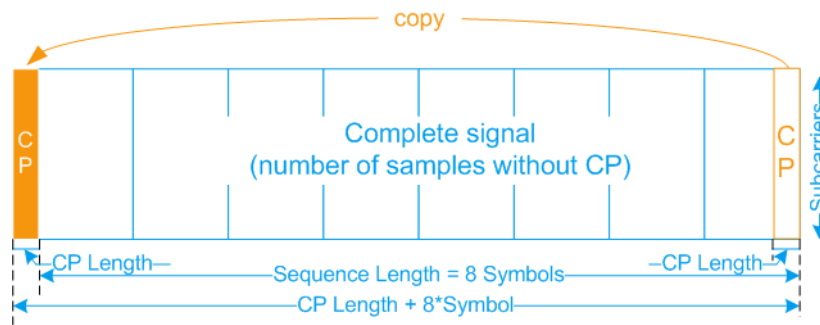


Figure 3-2: Principle of cyclic prefix calculation in UPMC, GFDM, and FBMC

CP = Cyclic prefix
 CP Length = Selected number of samples
 Subcarriers = Total Number Of Subcarriers
 Sequence Length = Selected number of symbols; 8 symbols in this example
 Total number of samples = Calculated as described in "Sequence length calculation" on page 21

Remote command:

[:SOURCE<hw>] :BB:OFDM:CPLength on page 63

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 number of samples. The parameters CP No. Symbols/Alt. CP No. Symbols determine for how many symbols each of the CP is applied. These parameters thus define a pattern of alternating cyclic prefixes.

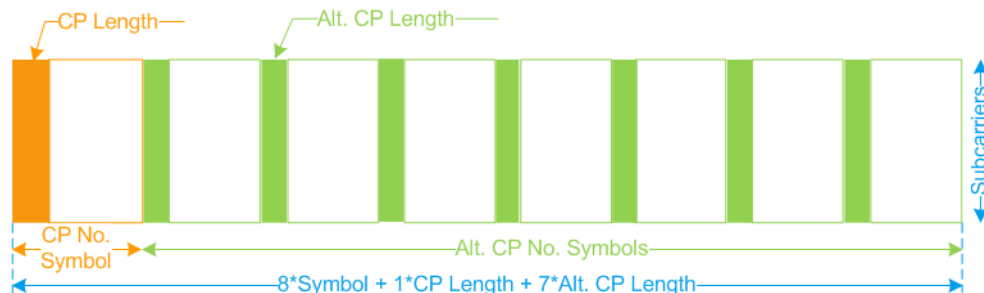


Figure 3-3: Dynamic cyclic prefixes in f-OFDM/OFDM (example with Alt. Cyclic Prefix Length ≠ Cyclic Prefix Length, CP No. Symbols = 1, Alt. CP No. Symbols = 7)

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

Total number of samples = Calculated as described in "Sequence length calculation" on page 21

Remote command:

[:SOURCE<hw>] :BB:OFDM:ACPLength on page 63

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 63

[\[:SOURCE<hw>\]:BB:OFDM:ACPSymbols](#) on page 63

Sampling Rate

Displays the sampling rate.

The value is derived as follows:

"Sampling Rate" = [Total Number Of Subcarriers](#) * [Subcarrier Spacing](#)

Remote command:

[\[:SOURCE<hw>\]:BB:OFDM:SAMPLING?](#) on page 64

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

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

Remote command:

[\[:SOURCE<hw>\]:BB:OFDM:BWOc cupied?](#) on page 64

Number Of Left/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 $(\text{Total Number Of Subcarriers} - \text{Occupied Number of Subcarriers}) / 2$
- "Number Of Right Guard Subcarriers" = $\text{Total Number Of Subcarriers} - \text{Number Of Left Guard Subcarriers}$

Remote command:

[\[:SOURCE<hw>\]:BB:OFDM:LGUard?](#) on page 64

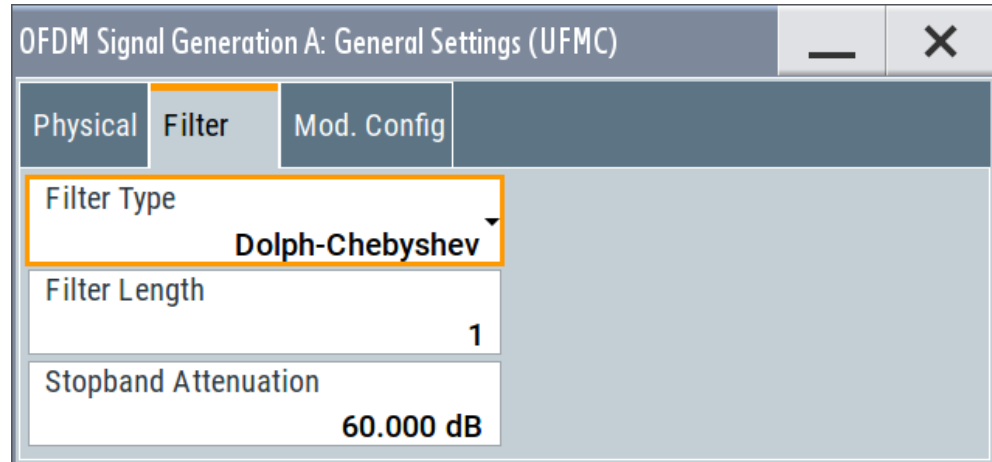
[\[:SOURCE<hw>\]:BB:OFDM:RGUard?](#) on page 65

3.2.2 Filter Settings

Access:

1. Select "OFDM Signal Generation > Modulation Type > for example UFMC".
2. Select "OFDM Signal Generation > General Settings".

3. Select "Filter".



The filter settings depend on the selected modulation scheme.
See also [Chapter 2.2.6, "Filtering"](#), on page 13.

Settings:

Filter Type	33
Roll-off Factor	34
Filter Length	34
Stopband Attenuation	34
Windowing Method	34
Cut Transient Response	35
User Filter Length	35
Load User Filter	35

Filter Type

Sets the filter type.

The available types depend on the selected "Modulation Type":

- OFDM
 - None
- f-OFDM:
 - Soft truncation filter
- GFDM:
 - Root cosine, root raised cosine, Dirichlet, and rectangular filters
- UFMC:
 - Dolph-Chebyshev filter
- FBMC:
 - Root raised cosine, Phydias filter

Additionally, you can load a user-defined filter described in a file.

See also [Chapter 2.2.6, "Filtering"](#), on page 13.

Remote command:

`[:SOURCE<hw>] :BB:OFDM:FILTer:TYPE` on page 65

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.

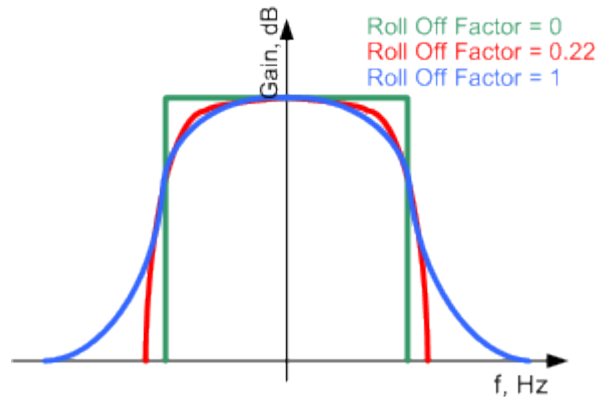


Figure 3-4: Example of the frequency response of a filter with different rolloff factors

Remote command:

`[:SOURCE<hw>] :BB:OFDM:FILTer:ROLLoff` on page 66

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 66

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" (sidelobe attenuation) affects the shape in the frequency domain.

See also "[Proposed prototype filters](#)" on page 14.

Remote command:

`[:SOURCE<hw>] :BB:OFDM:FILTer:SBATtenuation` on page 66

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 side-lobes suppression.

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

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

See also "[Proposed prototype filters](#)" on page 14.

Remote command:

`[:SOURCE<hw>] :BB:OFDM:FILTer:WINDowing` on page 67

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 14.

Remote command:

`[:SOURce<hw>] :BB:OFDM:FILTer:CUTTrans` on page 67

User Filter Length

Indicates the number of filter coefficients in the user filter file, see "[User filter file format \(*.dat files\)](#)" on page 16.

Remote command:

`[:SOURce<hw>] :BB:OFDM:FILTer:ULENgtH?` on page 67

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 16.

Remote command:

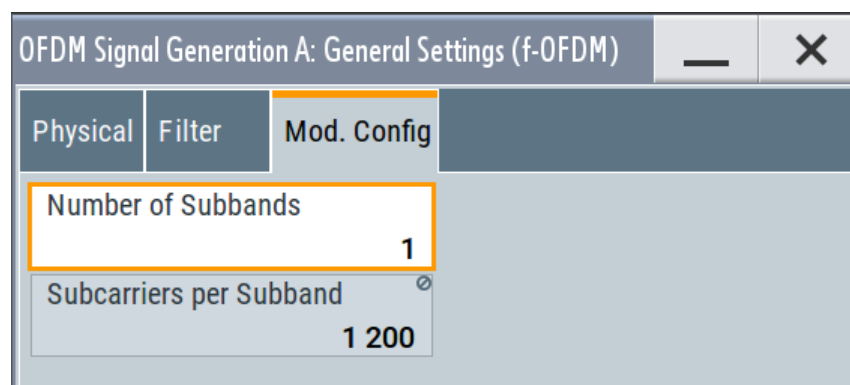
`[:SOURce<hw>] :BB:OFDM:FILTer:USELectioN` on page 67

`[:SOURce<hw>] :BB:OFDM:FILTer:UCATalog?` on page 67

3.2.3 Modulation Configuration Settings

Access:

1. Select "OFDM Signal Generation > Modulation Type > for example UPMC".
2. Select "OFDM Signal Generation > General Settings".
3. Select "Modulation Configuration".



The provided settings depend on the selected modulation type.

Settings:

Number of Sub-bands.....	36
Subcarriers per Subband.....	36
Subband Filter Pre-equalization.....	36
Data Block Size.....	36
Overlap Factor K.....	37

Number of Sub-bands

In UFMC and f-OFDM, sets the number of sub-bands.

A sub-band is a group of adjacent subcarriers. The number of subcarriers in one sub-band is calculated as follows:

$$\text{Subcarriers per Subband} = \text{Occupied Number of Subcarriers} / \text{Number of Sub-bands}$$

Remote command:

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

[:SOURce<hw>] :BB:OFDM:FOFDm:NSUBand on page 68

Subcarriers per Subband

In UFMC and f-OFDM, indicates the number of adjacent subcarriers within a sub-band.

It is calculated as:

$$\text{Subcarriers per Subband} = \text{Occupied Number of Subcarriers} / \text{Number of Sub-bands}$$

Remote command:

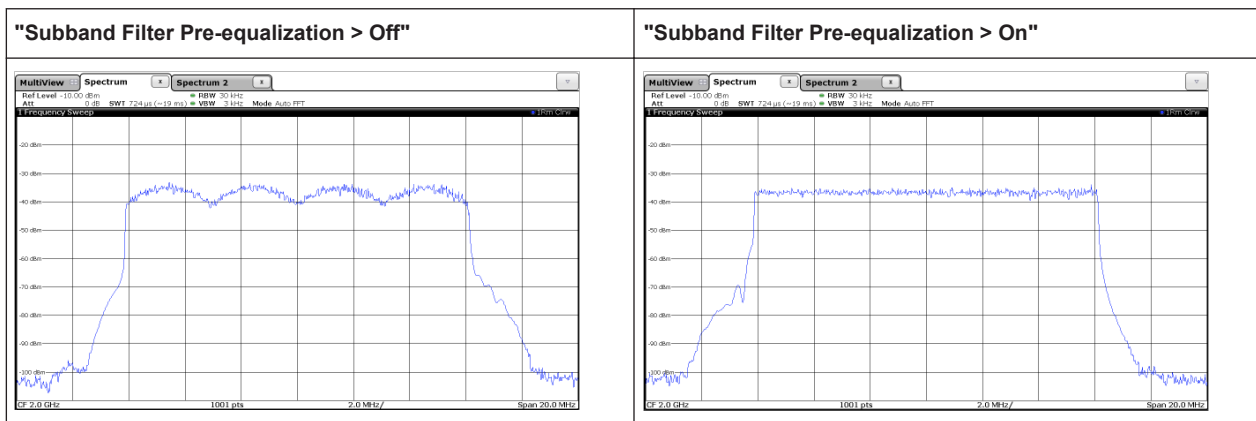
[:SOURce<hw>] :BB:OFDM:SUBCarriers? on page 68

Subband Filter Pre-equalization

In 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 69

Data Block Size

In GFDM, sets data block size M in terms of symbols per data block.

The "Data Block 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 68

Overlap Factor K

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 > Modulation Type > for example UPMC".
2. Select "OFDM Signal Generation > 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 different (base) modulation type and data source. The allocations can differ in the used number of symbols, the occupied number of subcarriers, and the individual position within the time-frequency-grid. Different users can be assigned to the allocations, where each user uses individual data source and multiple access schemes.

The "Time Plan" shows individual allocations on the time-frequency-grid.

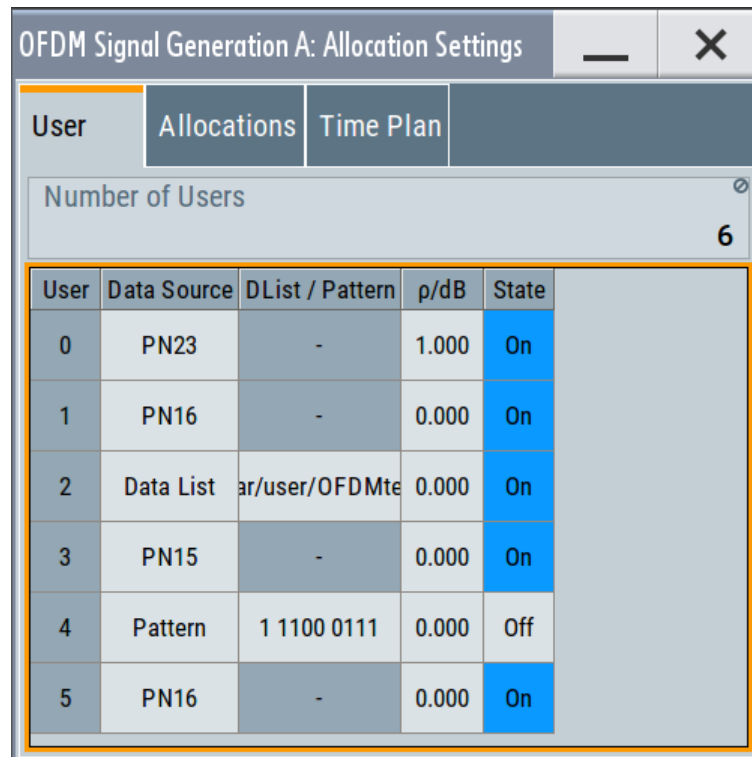
Settings:

- [User Settings](#).....37
- [Allocations Settings](#).....39
- [SCMA Settings](#).....44
- [Time Plan](#).....46

3.3.1 User Settings

Access:

1. Select "OFDM Signal Generation > Modulation Type > for example UPMC".
2. Select "OFDM Signal Generation > Allocation Settings".

**Settings:**

Number of Users.....	38
User.....	38
Data Source.....	38
p / dB.....	39
State.....	39

Number of Users

Indicates the maximum number of users that can be configured.
Any configured user can be deactivated.

User

Displays the consecutive number of the user.

Data Source

The following standard data sources are available:

- "All 0, All 1"
An internally generated sequence containing 0 data or 1 data.
- "PNxx"
An internally generated pseudo-random noise sequence.
- "Pattern"
An internally generated sequence according to a bit pattern.
Use the "Pattern" box to define the bit pattern.
- "Data List/Select DList"
A binary data from a data list, internally or externally generated.

Select "Select DList" to access the standard "Select List" dialog.

- Select the "Select Data List > navigate to the list file *.dm_iqd > Select" to select an existing data list.
- Use the "New" and "Edit" functions to create internally new data list or to edit an existing one.
- Use the standard "File Manager" function to transfer external data lists to the instrument.

See also:

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

Remote command:

[:SOURce<hw>] :BB:OFDM:USER<ch0>:DATA on page 69

[:SOURce<hw>] :BB:OFDM:USER<ch0>:LIST on page 70

[:SOURce<hw>] :BB:OFDM:USER<ch0>:PATTern on page 70

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 70

State

Enables the individual user.

Remote command:

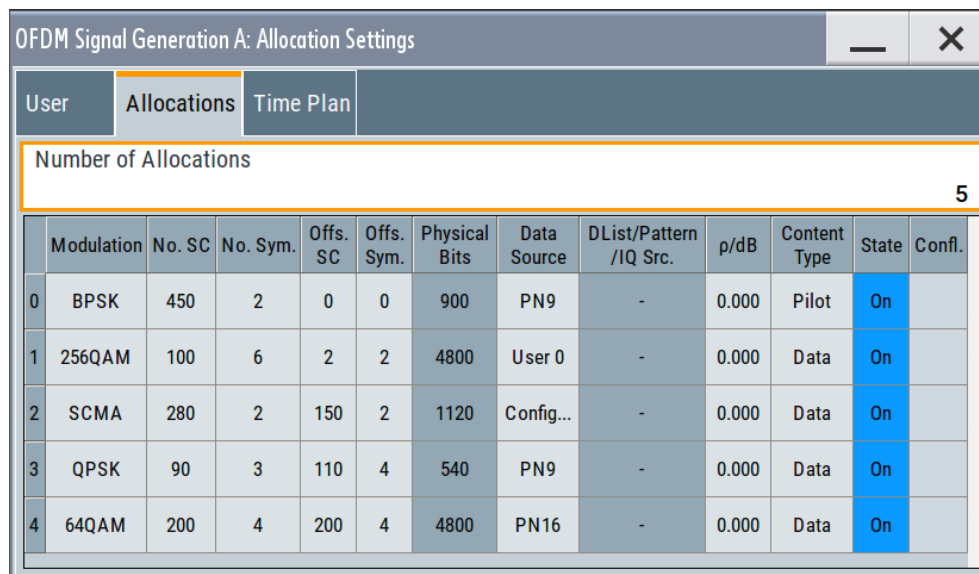
[:SOURce<hw>] :BB:OFDM:USER<ch0>:STATe on page 70

3.3.2 Allocations Settings

Access:

1. Select "OFDM Signal Generation > Modulation Type > for example UFMC".
2. Select "OFDM Signal Generation > Allocation Settings".

3. Select "Allocations".



In this dialog, you can configure the individual allocations so that each allocation uses different base modulation type, data source, power offset and time-frequency resources.

Use the [Time Plan](#) to visualize the resulting resource grid assignments.

Settings:

[Number of Allocations](#)..... 40

[Alloc. #](#)..... 40

[Modulation](#)..... 41

[No. SC](#)..... 41

[No. Sym](#)..... 41

[Offset SC](#)..... 41

[Offset Sym](#)..... 41

[Phys Bits](#)..... 41

[Data Source](#)..... 41

[ρ / dB](#)..... 42

[Content Type](#)..... 42

[State](#)..... 43

[Conflict](#)..... 44

Number of Allocations

Sets the number of scheduled allocations.

Remote command:

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

Alloc. #

Displays the consecutive number of the allocation.

Remote command:

n.a.

Modulation

The input symbols can be modulated in one of the base modulations: BPSK, QPSK, 16QAM, 64QAM, 256QAM and SCMA.

Additionally, you can load files with custom modulated I/Q data. Custom I/Q files are files with predefined file syntax and extension, see "[Custom I/Q file format \(*.iqw or *.dat files\)](#)" on page 21.

If "Data Source > User x", changing this parameter sets also the parameter "Modulation" of all allocations, belonging to the same user.

Remote command:

`[:SOURce<hw>] :BB:OFDM:ALLoc<ch0>:MODulation` on page 74

No. SC

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

If SCMA is used, the number of allocated subcarriers must be a multiple of the spreading factor K (see [Spreading Factor K](#)).

Remote command:

`[:SOURce<hw>] :BB:OFDM:ALLoc<ch0>:SCNO` on page 75

No. Sym.

Sets the allocation size in the time domain as number of symbols.

Remote command:

`[:SOURce<hw>] :BB:OFDM:ALLoc<ch0>:SYNO` on page 75

Offset 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 75

Offset 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 75

Phys Bits

Displays the allocation size in bits.

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

Remote command:

`[:SOURce<hw>] :BB:OFDM:ALLoc<ch0>:PHYSbits?` on page 76

Data Source

Selects the data source for the allocation.

"User x" Use the [User Settings](#) dialog to configure the data sources for the "User 1 to 6".

- "Config" If "Modulation > SCMA", opens a dialog with further settings, see [Chapter 3.3.3, "SCMA Settings"](#), on page 44.
- "I/Q Source" For "Modulation > Custom I/Q", select "Select IQ Source" to access the standard "Select List" dialog.
Select the "Select IQ Source > navigate to a *.dat or *.iqw file > Select" to select an existing file.
Use the standard "File Manager" function to transfer external data lists to the instrument.
For information on the file format, see ["Custom I/Q file format \(*.iqw or *.dat files\)"](#) on page 21.
- "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 define the bit pattern.
 - "Data List/Select DList"
A binary data from a data list, internally or externally generated.
Select "Select DList" to access the standard "Select List" dialog.
 - Select the "Select Data List > navigate to the list file *.dm_iqd > Select" to select an existing data list.
 - Use the "New" and "Edit" functions to create internally new data list or to edit an existing one.
 - Use the standard "File Manager" function to transfer external data lists to the instrument.
- See also:
- Section "Modulation Data" in the R&S SMW user manual.
 - Section "File and Data Management" in the R&S SMW user manual.
 - Section "Data List Editor" in the R&S SMW user manual

Remote command:

[\[:SOURce<hw>\]:BB:OFDM:ALLoc<ch0>:DATA](#) on page 76

[\[:SOURce<hw>\]:BB:OFDM:ALLoc<ch0>:LIST](#) on page 76

[\[:SOURce<hw>\]:BB:OFDM:ALLoc<ch0>:PATTern](#) on page 76

[\[:SOURce<hw>\]:BB:OFDM:ALLoc<ch0>:CIQFile](#) on page 77

p / dB

Boosts the allocation with the selected power offset relative to the others.

Remote command:

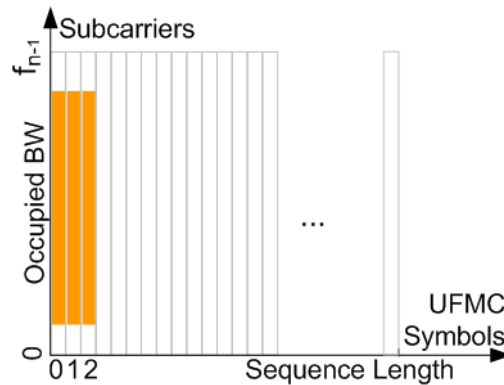
[\[:SOURce<hw>\]:BB:OFDM:ALLoc<ch0>:PWR](#) on page 77

Content Type

Indicates content type.

- "Data" The allocation contains the data, selected with the parameter [Data Source](#).

"Preamble" If UFMC modulation is used, the first allocation is always a preamble. Preambles are required to synchronize the R&S SMW and Rohde & Schwarz signal analyzer. The preamble spans the entire occupied bandwidth and is located on the first up to 3 symbols, as set with the parameter [No. Sym.](#). The preamble symbols are filled with a pseudo-random sequence (PN9) and are BPSK modulated. 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 [Modulation](#). 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 29.

"Pilot" If OFDM modulation is used, enables generation of pilot signals. Pilots are used by measurements with the Rohde & Schwarz signal analyzer, for example R&S®VSE-K96.

See also:

- [Modulation Type](#) > "f-OFDM".
- [Chapter 2.5, "Generating Configuration Files for R&S®VSE-K96"](#), on page 22

"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 merely affects the content of the automatically created *.xml settings file and hence the way the signal analyzer processes the generated signal.

See also [Chapter 2.5, "Generating Configuration Files for R&S®VSE-K96"](#), on page 22.

Remote command:

[\[:SOURCE<hw>\]:BB:OFDM:ALLoc<ch0>:CONTent](#) on page 77

State

Enables the allocation.

Remote command:

[:SOURce<hw>] :BB:OFDM:ALLoc<ch0>:STATe on page 77

Conflict

Indicates a conflict, if allocations overlap.

To visualize the allocations, use the [Time Plan](#).

Remote command:

[:SOURce<hw>] :BB:OFDM:ALLoc<ch0>:CONFlIct? on page 78

3.3.3 SCMA Settings

Access:

1. Select "OFDM Signal Generation > Modulation Type > for example UPMC".
2. Select "OFDM Signal Generation > Allocation Settings > Allocations".
3. Select "Alloc# > Modulation > SCMA".
4. Select "Data Source > Config".

The "Codebook" dialog opens.

Codebook	Layer Mapping
Spreading Factor K	4
Codebook Size M	4
Number of Layers J	6

5. Select "Layer Mapping".

Layer	User	ρ /dB	State
0	User 0	0.000	On
1	User 1	0.000	Off
2	User 2	0.000	Off
3	User 3	0.000	On
4	User 4	0.000	Off
5	User 5	0.000	On

Settings:

Codebook.....	45
L Spreading Factor K.....	45
L Codebook Size M.....	45
L Number of Layers J.....	45
Layer Mapping.....	46
L Layer.....	46
L User.....	46
L ρ / dB.....	46
L State.....	46

Codebook

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 78

Codebook Size M ← Codebook

Displays the codebook size M.

Remote command:

`[:SOURce<hw>] :BB:OFDM:ALLoc<ch0>:SCMA:CODEbook?` on page 79

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 78

Layer Mapping

Comprises the user to layer mapping settings:

Layer ← Layer Mapping

Indicates the layer number.

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

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 80

p / dB ← Layer Mapping

Provided for future use.

Remote command:

`[:SOURCE<hw>] :BB:OFDM:ALLoc<ch0>:SCMA:LAYer<st0>:PWR?` on page 79

State ← Layer Mapping

Enables the individual layers (codebooks).

Remote command:

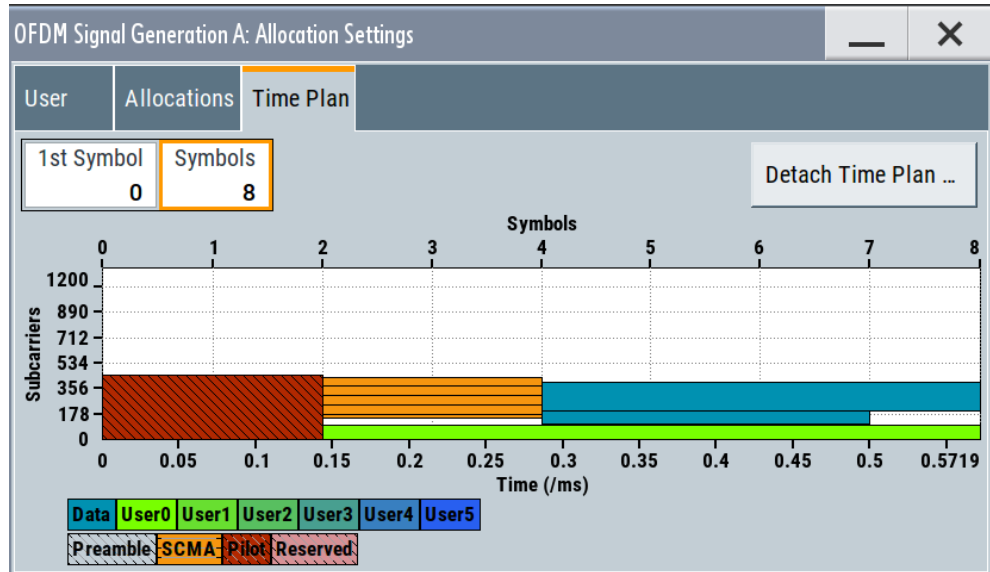
`[:SOURCE<hw>] :BB:OFDM:ALLoc<ch0>:SCMA:LAYer<st0>:STATE` on page 79

3.3.4 Time Plan

Access:

1. Select "OFDM Signal Generation > Modulation Type > for example UPMC".
2. Select "OFDM Signal Generation > Allocation Settings".

3. Select "Time Plan".



The x-axis shows allocation in the time domain, expressed in both time and number of symbols. The y-axis shows the occupied subcarriers as smallest allocation granularity in the frequency domain.

Settings:

1st Symbol.....	47
Symbols.....	47
Detach Time Plan.....	47

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.

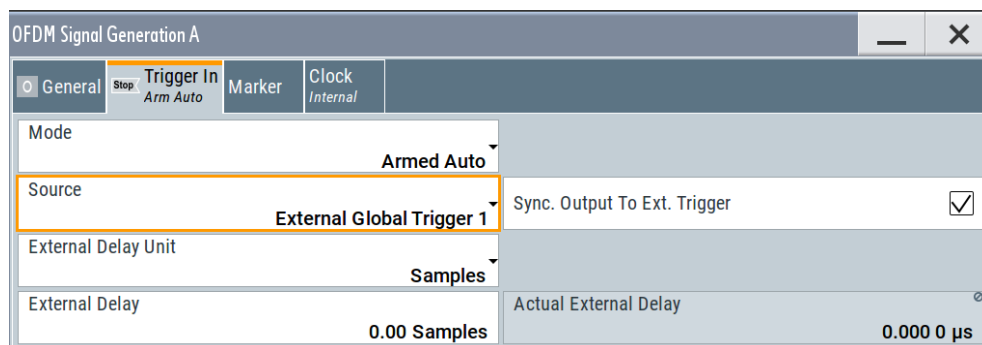
Remote command:

n.a.

3.4 Trigger Settings

Access:

- ▶ Select "OFDM Signal Generation > Trigger In".



This tab provides access to the settings necessary to select and configure the trigger, like trigger source and mode, and to arm or trigger an internal trigger manually. The current signal generation status is displayed in the header of the tab together with information on the enabled trigger mode. As in the "Marker" and "Clock" tabs, this tab provides also access to the settings of the related connectors.



This section focuses on the available settings.

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



Routing and enabling a trigger

The provided trigger signals are not dedicated to a particular connector. Trigger signals can be mapped to one or more USER x or T/M connectors.

Use the [Local and Global Connector Settings](#) to configure the signal mapping, the polarity, the trigger threshold and the input impedance of the input connectors.

To route and enable a trigger signal, perform the following *general steps*:

- Define the signal source and the effect of a trigger event. Select the "Trigger In > Mode" and "Trigger In > Source".
- Define the connector where the selected signal is provided. Use the "Global Connectors" settings.


Settings:

Trigger Settings Common to All Basebands	49
L Trigger Mode	49
L Signal Duration Unit	49
L Trigger Signal Duration	50
L Running/Stopped	50
L Arm	50
L Execute Trigger	50

L Trigger Source.....	50
L Sync. Output to External Trigger/Sync. Output to Trigger.....	51
L External / Trigger Inhibit.....	52
(External) Delay Unit.....	52
(Specified) External Delay/(Specified) Trigger Delay.....	52
Actual Trigger Delay/Actual External Delay.....	52

Trigger Settings Common to All Basebands

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

The icon  indicates that common trigger settings are applied.

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

Trigger Mode ← Trigger Settings Common to All Basebands

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

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

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

Remote command:

[\[:SOURce<hw>\]:BB:OFDM\[:TRIGger\]:SEquence](#) on page 81

Signal Duration Unit ← Trigger Settings Common to All Basebands

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 83

Trigger Signal Duration ← Trigger Settings Common to All Basebands

Enters the length of the signal sequence to be output in the "Single" trigger mode.

Use this parameter to output part of the signal deliberately, an exact sequence of the signal, or a defined number of repetitions of the signal.

Remote command:

[\[:SOURce<hw>\]:BB:OFDM:TRIGger:SLENgth](#) on page 82

Running/Stopped ← Trigger Settings Common to All Basebands

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 82

Arm ← Trigger Settings Common to All Basebands

Stops the signal generation until subsequent trigger event occurs.

Remote command:

[\[:SOURce<hw>\]:BB:OFDM:TRIGger:ARM:EXECute](#) on page 83

Execute Trigger ← Trigger Settings Common to All Basebands

For internal trigger source, executes trigger manually.

Remote command:

[\[:SOURce<hw>\]:BB:OFDM:TRIGger:EXECute](#) on page 83

Trigger Source ← Trigger Settings Common to All Basebands

The following sources of the trigger signal are available:

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

Option: R&S SMW-B9

In master-slave mode, slave instruments are triggered by the active edge of the synchronization signal.

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

Remote command:

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

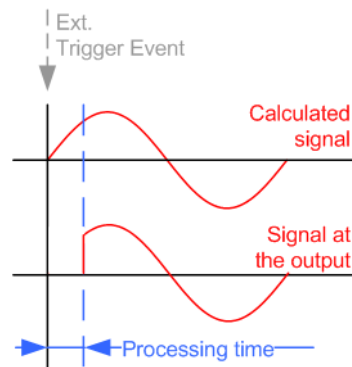
Sync. Output to External Trigger/Sync. Output to Trigger ← Trigger Settings Common to All Basebands

Enables signal output synchronous to the trigger event.

- "On"

Corresponds to the default state of this parameter.

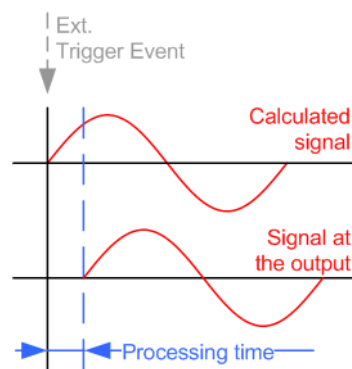
The signal calculation starts simultaneously with the trigger event. Because of the processing time of the instrument, the first samples are cut off and no signal is output. After elapsing of the internal processing time, the output signal is synchronous to the trigger event.



- "Off"

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

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



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

Remote command:

[\[:SOURCE<hw>\]:BB:OFDM:TRIGGER:EXTERNAL:SYNCHRONIZE:OUTPUT](#)
on page 83

External / Trigger Inhibit ← Trigger Settings Common to All Basebands

Applies for external trigger signal or trigger signal from the other path.

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

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

Remote command:

[\[:SOURCE<hw>\]:BB:OFDM:TRIGGER\[:EXTERNAL\]:INHIBIT](#) on page 86

[\[:SOURCE<hw>\]:BB:OFDM:TRIGGER:OBASBAND:INHIBIT](#) on page 85

(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 84

(Specified) External Delay/(Specified) Trigger Delay

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

Delays the trigger event of the signal from:

- The external trigger source
- The other path
- The other basebands (internal trigger), if common trigger settings are used.

Use this setting to:

- Synchronize the instrument with the device under test (DUT) or other external devices
- Postpone the signal generation start in the basebands compared to each other
- Compensate delays and align the signal generation start in multi-instrument setup

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

The parameter displays the delay converted in time.

Remote command:

[\[:SOURCE<hw>\]:BB:OFDM:TRIGGER\[:EXTERNAL\]:DELAY](#) on page 85

[\[:SOURCE<hw>\]:BB:OFDM:TRIGGER:EXTERNAL:TDELAY](#) on page 85

[\[:SOURCE<hw>\]:BB:OFDM:TRIGGER:OBASBAND:DELAY](#) on page 84

[\[:SOURCE<hw>\]:BB:OFDM:TRIGGER:OBASBAND:TDELAY](#) on page 84

Actual Trigger Delay/Actual External Delay

Indicates the resulting trigger delay in "Time" unit.

Remote command:

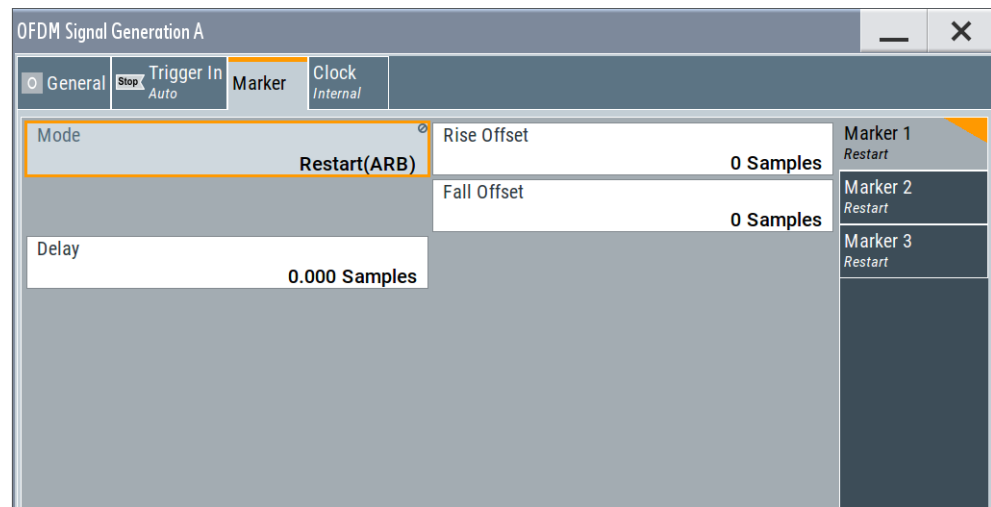
[:SOURce<hw>] :BB:OFDM:TRIGger:EXTernal:RDElay? on page 86

[:SOURce<hw>] :BB:OFDM:TRIGger:OBASeband:RDElay? on page 84

3.5 Marker Settings

Access:

- ▶ Select "OFDM Signal Generation > Marker".



This tab provides access to the settings necessary to select and configure the marker output signal, like the marker mode or marker delay settings.



This section focuses on the available settings.

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



Routing and enabling a marker

The provided marker signals are not dedicated to a particular connector. They can be mapped to one or more USER x or T/M connectors.

To route and enable a marker signal, perform the following *general steps*:

- Define the shape of the generated marker, i.e. select the "Marker > Mode".
- Define the connector where the selected signal is provided.
Use the [Local and Global Connector Settings](#).

Settings:

Marker Mode.....	54
Rise/Fall Offset	54
Marker x Delay.....	54

Marker Mode

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

"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 87

Rise/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 87

`[:SOURce<hw>] :BB:OFDM:TRIGger:OUTPut<ch>:ROFFset` on page 87

Marker x 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 87

3.6 Clock Settings

Access:

- ▶ Select "OFDM Signal Generation > Clock".



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



This section focuses on the available settings.

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



Defining the clock

The provided clock signals are not dedicated to a particular connector. They can be mapped to one or more USER x and T/M/C connectors.

Use the [Local and Global Connector Settings](#) to configure the signal mapping, the polarity, the trigger threshold, and the input impedance of the input connectors.

To route and enable a trigger signal, perform the following *general steps*:

- Define the signal source, that is select the "Clock > Source".
- Define the connector where the selected signal is provided.
Use the [Local and Global Connector Settings](#).

Settings:

Clock Source	55
Clock Mode	55
Measured External Clock	55

Clock Source

Selects the clock source.

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

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

Remote command:

[\[:SOURce<hw>\]:BB:OFDM:CLOCK:SOURce](#) on page 88

Clock Mode

Option: R&S SMW-B10

Sets the type of externally supplied clock.

Remote command:

[\[:SOURce<hw>\]:BB:OFDM:CLOCK:MODE](#) on page 88

Measured External Clock

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

Remote command:

[CLOCK:INPut:FREQuency?](#)

3.7 Local and Global Connector Settings

Each of the "Trigger In", "Marker" and "Clock" dialogs and the "Trigger Marker Clock" dialog provides a quick access to the related connector settings.



See also chapter "Local and Global Connector Settings" in the user manual.

4 Remote-Control Commands

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



Conventions used in SCPI command descriptions

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

Common Suffixes

The following common suffixes are used in the remote commands:

Suffix	Value range	Description
ENTity<ch>	1 to 4	Entity in a multiple entity configuration with separate baseband sources ENTity3 4 require option R&S SMW-K76
SOURce<hw>	[1] to 4	Available baseband signals Only SOURce1 possible, if the keyword ENTity is used
OUTPut<ch>	1 to 3	Available markers
USER<ch>	0 to 5	Available users
ALLoc<ch0>	0 to 30	Number of allocations



Using SCPI command aliases for advanced mode with multiple entities

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

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

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

Programming examples

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

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

At the beginning of the most remote control program, an instrument (p)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 SMW-K114 option are described here:

• General Commands.....	58
• Physical Settings Commands.....	61
• Filter Commands.....	65
• Modulation Commands.....	68
• User Commands.....	69
• Allocation Commands.....	72
• SCMA Commands.....	78
• Trigger Commands.....	80
• Marker Commands.....	87
• Clock Commands.....	88

4.1 General Commands

Example: Storing current configuration

```
SOURce1:BB:OFDM:SETTing:STORe "/var/user/5g_ufmc_scma"
*RST
SOURce1:BB:OFDM:SETTing:CATalog?
// 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 ON
// Query the created *.xml file.
SOURce1:BB:OFDM:OUTPath? "/var/user/K114-Export/Exported_K114_settings_K96"
```

[SOURce<hw>]:BB:OFDM:STATe.....	59
[SOURce<hw>]:BB:OFDM:PRESet.....	59
[SOURce<hw>]:BB:OFDM:SETTing:CATalog.....	59
[SOURce<hw>]:BB:OFDM:SETTing:LOAD.....	59
[SOURce<hw>]:BB:OFDM:SETTing:STORe.....	59
[SOURce<hw>]:BB:OFDM:SETTing:DEL.....	60
[SOURce<hw>]:BB:OFDM:WAVEform:CREate.....	60
[SOURce<hw>]:BB:OFDM:MODulation.....	60
[SOURce<hw>]:BB:OFDM:MODPreset.....	60
[SOURce<hw>]:BB:OFDM:OUTPath.....	61
[SOURce<hw>]:BB:OFDM:SRATe:VARiation.....	61

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

Activates the standard.

Parameters:

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

Example: See [Example "Generating a UPMC waveform"](#) on page 72.

Manual operation: See ["State"](#) on page 25

[: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 72.

Usage: Event

Manual operation: See ["Set to Default"](#) on page 25

[: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 "Storing current configuration"](#) on page 58.

Manual operation: See ["Save/Recall"](#) on page 25

[: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 "Storing current configuration"](#) on page 58.

Manual operation: See ["Save/Recall"](#) on page 25

[: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 "Storing current configuration"](#) on page 58.

Manual operation: See ["Save/Recall"](#) on page 25

[: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 "Storing current configuration"](#) on page 58.

Manual operation: See ["Save/Recall"](#) on page 25

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

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

Parameters:

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

Example: See [Example "Generating a UPMC waveform"](#) on page 72.

Manual operation: See ["Generate Waveform File"](#) on page 25

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

Selects the modulation type.

Parameters:

<ModType> UPMC | FBMC | GFDM | FOFDM | OFDM
*RST: OFDM

Example: See [Example "Generating a UPMC waveform"](#) on page 72.

Manual operation: See ["Modulation Type"](#) on page 26

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

Calls the default settings for the selected modulation type, see [\[:SOURce<hw>\]:BB:OFDM:MODulation](#) on page 60.

Example: See [Example "Generating a UPMC waveform"](#) on page 72.

Usage: Event

Manual operation: See ["Set to Modulation Default"](#) on page 27

[: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 `/var/user/K114-Export` and output file `Exported_K114_settings_K96.xml` is specified.

See also [Example "Default "Exported_K114_settings_K96.xml" file"](#) on page 90.

Parameters:

<K114OutputPath> string

Example: See [Example "Saving a configuration to an *.xml file"](#) on page 58.

Manual operation: See ["Export path for XML settings"](#) on page 26

[: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 72.

4.2 Physical Settings Commands

[:SOURce<hw>]:BB:OFDM:NSUBcarriers	62
[:SOURce<hw>]:BB:OFDM:NOCCupied	62
[:SOURce<hw>]:BB:OFDM:SCSPace	62
[:SOURce<hw>]:BB:OFDM:SEQLength	62
[:SOURce<hw>]:BB:OFDM:CPLength	63
[:SOURce<hw>]:BB:OFDM:ACPLength	63
[:SOURce<hw>]:BB:OFDM:ACPSymbols	63
[:SOURce<hw>]:BB:OFDM:CPSYmbols	63
[:SOURce<hw>]:BB:OFDM:SAMPLing?	64
[:SOURce<hw>]:BB:OFDM:BWOCCupied?	64
[:SOURce<hw>]:BB:OFDM:LGUard?	64
[:SOURce<hw>]:BB:OFDM:RGUard?	65

[: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 72.

Manual operation: See ["Total Number Of Subcarriers"](#) on page 28

[: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 72.

Manual operation: See ["Occupied Number of Subcarriers"](#) on page 28

[: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 72.

Manual operation: See ["Subcarrier Spacing"](#) on page 29

[: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 72.

Manual operation: See ["Sequence Length"](#) on page 29

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

Sets the cyclic prefix length as number of samples.

Parameters:

<CpLength> integer
 Range: 0 to 8192
 *RST: 16

Example: See [Example "Generating a UPMC waveform"](#) on page 72.

Example: See also [\[:SOURce<hw>\]:BB:OFDM:ACPLength](#) on page 63.

Manual operation: See ["Cyclic Prefix Length"](#) on page 29

[: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 30

[: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 63.

Manual operation: See ["CP No. Symbols/Alt. CP No. Symbols"](#) on page 31

[: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 72.

Usage: Query only

Manual operation: See ["Sampling Rate"](#) on page 31

[: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 72.

Usage: Query only

Manual operation: See ["Occupied Bandwidth"](#) on page 31

[: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 72.

Usage: Query only

Manual operation: See ["Number Of Left/Right Guard Subcarriers"](#) on page 32

[[: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 72.

Usage: Query only

Manual operation: See ["Number Of Left/Right Guard Subcarriers"](#) on page 32

4.3 Filter Commands

Example: Filter settings

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

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

[:SOURce<hw>]:BB:OFDM:FILTer:TYPE	65
[:SOURce<hw>]:BB:OFDM:FILTer:ROLLoff	66
[:SOURce<hw>]:BB:OFDM:FILTer:LENGth	66
[:SOURce<hw>]:BB:OFDM:FILTer:SBATtenuation	66
[:SOURce<hw>]:BB:OFDM:FILTer:CUTTrans	67
[:SOURce<hw>]:BB:OFDM:FILTer:WINDowing	67
[:SOURce<hw>]:BB:OFDM:FILTer:UCATalog?	67
[:SOURce<hw>]:BB:OFDM:FILTer:USElection	67
[:SOURce<hw>]:BB:OFDM:FILTer:ULENGth?	67

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

Sets the baseband filter type.

Parameters:

<FilterType> RC | RRC | DIRichlet | RECT | DCH | STRunc | USER |
 PHYDyas | NONE
 *RST: DCH

Example: See [Example "Generating a UPMC waveform"](#) on page 72.

Manual operation: See ["Filter Type"](#) on page 33

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

Sets the filter parameter.

Parameters:

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

Example: See [Example "Filter settings"](#) on page 65.

Manual operation: See ["Rolloff Factor"](#) on page 34

[: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 72.

Manual operation: See ["Filter Length"](#) on page 34

[: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 72.

Manual operation: See ["Stopband Attenuation"](#) on page 34

[: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> 0 | 1 | OFF | ON
*RST: 0

Example: See [Example "Filter settings"](#) on page 65.

Manual operation: See ["Cut Transient Response"](#) on page 35

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

Sets the windowing method.

Parameters:

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

Example: See [Example "Filter settings"](#) on page 65.

Manual operation: See ["Windowing Method"](#) on page 34

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

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

Example: See [Example "Generating a UFMC waveform"](#) on page 72.

Usage: Query only

Manual operation: See ["Load User Filter"](#) on page 35

[: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 incl file name and file extension

Example: See [Example "Filter settings"](#) on page 65.

Manual operation: See ["Load User Filter"](#) on page 35

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

Queries the filter length.

Return values:

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

Example: See [Example "Filter settings"](#) on page 65.

Usage: Query only

Manual operation: See ["User Filter Length"](#) on page 35

4.4 Modulation Commands

[:SOURce<hw>]:BB:OFDM:SUBCarriers?	68
[:SOURce<hw>]:BB:OFDM:GFDM:DBSYmbols	68
[:SOURce<hw>]:BB:OFDM:FOFDm:NSUBand	68
[:SOURce<hw>]:BB:OFDM:UFMC:NSUBand	69
[:SOURce<hw>]:BB:OFDM:UFMC:PREequal	69

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

Queries the number of subcarriers per subband.

Return values:

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

Example: See [Example "Generating a UFMC waveform"](#) on page 72.

Usage: Query only

Manual operation: See ["Subcarriers per Subband"](#) on page 36

[:SOURce<hw>]:BB:OFDM:GFDM:DBSYmbols <GFDMDbSymbols>

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

Parameters:

<GFDMDbSymbols> integer
 Range: 1 to 50
 *RST: 8

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

Manual operation: See ["Data Block Size"](#) on page 36

[:SOURce<hw>]:BB:OFDM:FOFDm:NSUBand <FofdmNSubands>

Sets the number of f-OFDM sub-bands.

Parameters:

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

Example:

SOURce1:BB:OFDM:FOFDm:NSUBand 34

Manual operation: See ["Number of Sub-bands"](#) on page 36

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

Sets the number of UFMC sub-bands.

Parameters:

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

Example:

See [Example "Generating a UFMC waveform"](#) on page 72.

Manual operation: See ["Number of Sub-bands"](#) on page 36

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

Applies a filter pre-equalization.

Parameters:

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

Example:

See [Example "Generating a UFMC waveform"](#) on page 72.

Manual operation: See ["Subband Filter Pre-equalization"](#) on page 36

4.5 User Commands

[:SOURce<hw>]:BB:OFDM:USER<ch0>:DATA	69
[:SOURce<hw>]:BB:OFDM:USER<ch0>:LIST	70
[:SOURce<hw>]:BB:OFDM:USER<ch0>:PATtern	70
[:SOURce<hw>]:BB:OFDM:USER<ch0>:PWR	70
[:SOURce<hw>]:BB:OFDM:USER<ch0>:STATe	70

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

Sets the data source per user.

Parameters:

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

Example: See [Example "Generating a UPMC waveform"](#) on page 72.

Manual operation: See ["Data Source"](#) on page 38

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

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

Parameters:

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

Example: See [Example "Generating a UPMC waveform"](#) on page 72.

Manual operation: See ["Data Source"](#) on page 38

[: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 72.

Manual operation: See ["Data Source"](#) on page 38

[: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 72.

Manual operation: See ["p / dB"](#) on page 39

[:SOURce<hw>]:BB:OFDM:USER<ch0>:STATe <State>

Activates the user.

Parameters:

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

Example: See [Example "Generating a UPMC waveform"](#) on page 72.

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

4.6 Allocation Commands

Example: Generating a UFMC waveform

```

*RST

SOURcel:BB:OFDM:PRESet
SOURcel:BB:OFDM:MODulation UFMC
// SOURcel:BB:OFDM:MODPreset
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?
// 52
SOURcel:BB:OFDM:LGUard?
// 52
SOURcel:BB:OFDM:BWOCcupied?
// 20.4
SOURcel:BB:OFDM:SAMpling?
// 25.6
SOURcel:BB:OFDM:SRATe:VARiation?
// 15360000

SOURcel:BB:OFDM:FILTer:TYPE DCH
SOURcel:BB:OFDM:FILTer:LENGth 74
SOURcel:BB:OFDM:FILTer:SBAttenuation 60
SOURcel:BB:OFDM:UFMC:NSUBband 34
SOURcel:BB:OFDM:SUBCarriers?
// 12
SOURcel:BB:OFDM:UFMC:PREequal?
// 0

// User settings
SOURcel:BB:OFDM:USER0:DATA PN23
SOURcel:BB:OFDM:USER0:PWR 1
SOURcel:BB:OFDM:USER0:STATe 0
SOURcel:BB:OFDM:USER0:STATe 1
// file 5g_datalist.dm_iqd must exist in the default directory
SOURcel:BB:OFDM:USER2:DATA DLIS
SOURcel:BB:OFDM:USER2:LIST "/var/user/5g_datalist.dm_iqd"
SOURcel:BB:OFDM:USER4:DATA PATT
SOURcel:BB:OFDM:USER4:PATTern #H1C4A9,17
SOURcel:BB:OFDM:USER4:STATe 0

// Allocation settings
SOURcel:BB:OFDM:NALLoc 6
SOURcel:BB:OFDM:ALLoc0:CONTent?

```

```

// PRE
SOURCE1:BB:OFDM:ALLOc0:SYNO 2
SOURCE1:BB:OFDM:ALLOc1:CONTent?
// 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?
// 4000
SOURCE1:BB:OFDM:ALLOc1:STATe 1
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
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
SOURCE1:BB:OFDM:ALLOc4:CONFLict?
// 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
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:ALLOc3:SCMA:CODEbook?
// 4
SOURCE1:BB:OFDM:ALLOc3:SCMA:NLAYers?
// 6
SOURCE1:BB:OFDM:ALLOc3:SCMA:SPRead?
// 4
SOURCE1:BB:OFDM:ALLOc3:SCMA:LAYer1:USER USER1
SOURCE1:BB:OFDM:ALLOc3:SCMA:LAYer1:STATe 0
SOURCE1:BB:OFDM:ALLOc3:SCMA:LAYer1:PWR?
// 0
SOURCE1:BB:OFDM:ALLOc3:SCMA:LAYer2:STATe 0
SOURCE1:BB:OFDM:ALLOc3: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
SOURCE1:BB:OFDM:ALLOc4:CONFLict?

```

```
// 0
SOURCE1:BB:OFDM:ALLOc5:CONFLict?
// 0

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

<code>[:SOURCE<hw>]:BB:OFDM:NALLOc</code>	74
<code>[:SOURCE<hw>]:BB:OFDM:ALLOc<ch0>:MODulation</code>	74
<code>[:SOURCE<hw>]:BB:OFDM:ALLOc<ch0>:SCNO</code>	75
<code>[:SOURCE<hw>]:BB:OFDM:ALLOc<ch0>:SYNO</code>	75
<code>[:SOURCE<hw>]:BB:OFDM:ALLOc<ch0>:SCOFFset</code>	75
<code>[:SOURCE<hw>]:BB:OFDM:ALLOc<ch0>:SYOFFset</code>	75
<code>[:SOURCE<hw>]:BB:OFDM:ALLOc<ch0>:PHYSbits?</code>	76
<code>[:SOURCE<hw>]:BB:OFDM:ALLOc<ch0>:DATA</code>	76
<code>[:SOURCE<hw>]:BB:OFDM:ALLOc<ch0>:LIST</code>	76
<code>[:SOURCE<hw>]:BB:OFDM:ALLOc<ch0>:PATtern</code>	76
<code>[:SOURCE<hw>]:BB:OFDM:ALLOc<ch0>:CIQFile</code>	77
<code>[:SOURCE<hw>]:BB:OFDM:ALLOc<ch0>:PWR</code>	77
<code>[:SOURCE<hw>]:BB:OFDM:ALLOc<ch0>:CONTent</code>	77
<code>[:SOURCE<hw>]:BB:OFDM:ALLOc<ch0>:STATe</code>	77
<code>[:SOURCE<hw>]:BB:OFDM:ALLOc<ch0>:CONFLict?</code>	78

`[: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 72.

Manual operation: See ["Number of Allocations"](#) on page 40

`[:SOURCE<hw>]:BB:OFDM:ALLOc<ch0>:MODulation <BaseModType>`

Sets the modulation type of an allocation.

Parameters:

`<BaseModType>` BPSK | QPSK | QAM16 | QAM64 | QAM256 | SCMA | CIQ
CIQ
 Custom IQ data file, loaded with the command `[:SOURCE<hw>]:BB:OFDM:ALLOc<ch0>:CIQFile`.
 *RST: QPSK

Example: See [Example "Generating a UPMC waveform"](#) on page 72.

Manual operation: See ["Modulation"](#) on page 41

[: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 72.

Manual operation: See ["No. SC"](#) on page 41

[: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 72.

Manual operation: See ["No. Sym."](#) on page 41

[: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 72.

Manual operation: See ["Offset SC"](#) on page 41

[: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 72.

Manual operation: See ["Offset Sym."](#) on page 41

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

Queries the allocation size in bits.

Return values:

<PhysicalBits> integer

Example: See [Example "Generating a UFMC waveform"](#) on page 72.

Usage: Query only

Manual operation: See ["Phys Bits"](#) on page 41

[[: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 UFMC waveform"](#) on page 72.

Manual operation: See ["Data Source"](#) on page 41

[[: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 UFMC waveform"](#) on page 72.

Manual operation: See ["Data Source"](#) on page 41

[[: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 UFMC waveform"](#) on page 72.

Manual operation: See ["Data Source"](#) on page 41

[: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 incl. 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 41

[: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 72.

Manual operation: See ["p / dB"](#) on page 42

[: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 72.

Manual operation: See ["Content Type"](#) on page 42

[:SOURce<hw>]:BB:OFDM:ALLoc<ch0>:STATe <State>

Enables the allocation.

Parameters:

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

Example: See [Example "Generating a UPMC waveform"](#) on page 72.

Manual operation: See ["State"](#) on page 43

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

Returns 1, if allocations overlap.

Return values:

<Conflict> 0 | 1 | OFF | ON

Example: See [Example "Generating a UPMC waveform"](#) on page 72.

Usage: Query only

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

4.7 SCMA Commands

[:SOURce<hw>]:BB:OFDM:ALLoc<ch0>:SCMA:NLAYers?	78
[:SOURce<hw>]:BB:OFDM:ALLoc<ch0>:SCMA:SPRead?	78
[:SOURce<hw>]:BB:OFDM:ALLoc<ch0>:SCMA:CODEbook?	79
[:SOURce<hw>]:BB:OFDM:ALLoc<ch0>:SCMA:LAYer<st0>:PWR?	79
[:SOURce<hw>]:BB:OFDM:ALLoc<ch0>:SCMA:LAYer<st0>:STATe	79
[:SOURce<hw>]:BB:OFDM:ALLoc<ch0>:SCMA:LAYer<st0>:USER	80

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

Queires the number of layers.

Return values:

<NoOfLayers> integer
 Range: 0 to 6
 *RST: 6

Example: See [Example "Generating a UPMC waveform"](#) on page 72.

Usage: Query only

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

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

Queries the spreading factor.

Return values:

<SpreadFac> integer
 Range: 0 to 4
 *RST: 4

Example: See [Example "Generating a UPMC waveform"](#) on page 72.

Usage: Query only

Manual operation: See ["Spreading Factor K"](#) on page 45

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

Queries the codebook size.

Return values:

<Codebook> integer
 Range: 0 to 4
 *RST: 4

Example: See [Example "Generating a UPMC waveform"](#) on page 72.

Usage: Query only

Manual operation: See ["Codebook Size M"](#) on page 45

[:SOURce<hw>]:BB:OFDM:ALLoc<ch0>:SCMA:LAYer<st0>:PWR?

Applies a power offset to the selected layer relative to the others.

Return values:

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

Example: See [Example "Generating a UPMC waveform"](#) on page 72.

Usage: Query only

Manual operation: See ["p / dB"](#) on page 46

[:SOURce<hw>]:BB:OFDM:ALLoc<ch0>:SCMA:LAYer<st0>:STATe <State>

Enables the layer (codebook).

Parameters:

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

Example: See [Example "Generating a UPMC waveform"](#) on page 72.

Manual operation: See ["State"](#) on page 46

```
[: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 72.

Manual operation: See ["User"](#) on page 46

4.8 Trigger Commands

Example: Configure and enable triggering

```
SOURce:BB:OFDM:TRIGger:SEQuence SINGLE  
SOURce:BB:OFDM:TRIGger:SLENgth 200  
  
// the first 200 samples of the current waveform will be output after  
// the next trigger event  
// SOURce:BB:OFDM:TRIGger:SEQuence ARETrigger  
// SOURce:BB:OFDM:TRIGger:SOURce EGT1  
// external trigger signal must be provided at the USER connector  
// SOURce:BB:OFDM:TRIGger:EXTernal:SYNChronize:OUTPut ON  
// SOURce:BB:OFDM:TRIGger:EXTernal:DELay 200  
// SOURce:BB:OFDM:TRIGger:EXTernal:INHibit 100  
  
// SOURce:BB:OFDM:TRIGger:SOURce INTB  
// the internal trigger signal from the other path must be used  
// SOURce:BB:OFDM:TRIGger:OBASeband:DELay 25  
// SOURce:BB:OFDM:TRIGger:OBASeband:INHibit 10  
  
SOURce:BB:OFDM:TRIGger:SEQuence AAUTO  
SOURce:BB:OFDM:TRIGger:SOURce INTernal  
SOURce:BB:OFDM:STAT ON  
SOURce: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: 100

SOURCE1:BB:OFDM:TRIGGER:DELAY:UNIT TIME
SOURCE1:BB:OFDM:TRIGGER:EXTERNAL:TDELAY 0.00001
SOURCE1:BB:OFDM:TRIGGER:EXTERNAL:RDELAY?
// Response: 0.00001

SOURCE1:BB:OFDM:TRIGGER:DELAY:UNIT SAMP
SOURCE1:BB:OFDM:TRIGGER:EXTERNAL:DELAY 10

```

[:SOURCE<hw>]:BB:OFDM[:TRIGGER]:SEQUENCE.....	81
[:SOURCE<hw>]:BB:OFDM:TRIGGER:SOURCE.....	82
[:SOURCE<hw>]:BB:OFDM:TRIGGER:RMODE?.....	82
[:SOURCE<hw>]:BB:OFDM:TRIGGER:SLNGTH.....	82
[:SOURCE<hw>]:BB:OFDM:TRIGGER:SLUNIT.....	83
[:SOURCE<hw>]:BB:OFDM:TRIGGER:EXECUTE.....	83
[:SOURCE<hw>]:BB:OFDM:TRIGGER:ARM:EXECUTE.....	83
[:SOURCE<hw>]:BB:OFDM:TRIGGER:EXTERNAL:SYNCHRONIZE:OUTPUT.....	83
[:SOURCE<hw>]:BB:OFDM:TRIGGER:DELAY:UNIT.....	84
[:SOURCE<hw>]:BB:OFDM:TRIGGER:OBASBAND:DELAY.....	84
[:SOURCE<hw>]:BB:OFDM:TRIGGER:OBASBAND:RDELAY?.....	84
[:SOURCE<hw>]:BB:OFDM:TRIGGER:OBASBAND:TDELAY.....	84
[:SOURCE<hw>]:BB:OFDM:TRIGGER:OBASBAND:INHIBIT.....	85
[:SOURCE<hw>]:BB:OFDM:TRIGGER[:EXTERNAL]:DELAY.....	85
[:SOURCE<hw>]:BB:OFDM:TRIGGER:EXTERNAL:TDELAY.....	85
[:SOURCE<hw>]:BB:OFDM:TRIGGER:EXTERNAL:RDELAY?.....	86
[:SOURCE<hw>]:BB:OFDM:TRIGGER[:EXTERNAL]:INHIBIT.....	86

[:SOURCE<hw>]:BB:OFDM[:TRIGGER]:SEQUENCE <TrigMode>

Sets the trigger mode.

Parameters:

<TrigMode> AUTO | RETRigger | AAUTo | ARETRigger | SINGLE
 *RST: AUTO

Example: See [Example "Configure and enable triggering"](#) on page 80.

Manual operation: See ["Trigger Mode"](#) on page 49

[[:SOURce<hw>]:BB:OFDM:TRIGger:SOURce <TrigSource>

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

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

Parameters:

<TrigSource> INTB|INTernal|OBASeband|EGT1|EGT2|EGC1|EGC2|ELTRigger|INTA|ELCLock|BEXTernal|EXTernal | BBSY
 *RST: INTernal

Example: See [Example "Configure and enable triggering"](#) on page 80.

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

Manual operation: See ["Trigger Source"](#) on page 50

[[:SOURce<hw>]:BB:OFDM:TRIGger:RMODE?

Queries the status of waveform output.

Return values:

<TrigRunMode> STOP | RUN
 *RST: STOP

Example: See [Example "Configure and enable triggering"](#) on page 80.

Usage: Query only

Manual operation: See ["Running/Stopped"](#) on page 50

[[: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 "Configure and enable triggering"](#) on page 80.

Manual operation: See ["Trigger Signal Duration"](#) on page 50

[: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 "Configure and enable triggering"](#) on page 80.

Manual operation: See ["Signal Duration Unit"](#) on page 49

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

Executes an internal trigger event.

Example: See [Example "Configure and enable triggering"](#) on page 80.

Usage: Event

Manual operation: See ["Execute Trigger"](#) on page 50

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

Stops (arms) waveform output.

Example: See [Example "Configure and enable triggering"](#) on page 80.

Usage: Event

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

**[:SOURce<hw>]:BB:OFDM:TRIGger:EXTernal:SYNChronize:OUTPut
<TrigSyncOutpSta>**

Enables signal output synchronous to the trigger event.

Parameters:

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

Example: See [Example "Configure and enable triggering"](#) on page 80.

Manual operation: See ["Sync. Output to External Trigger/Sync. Output to Trigger"](#) on page 51

[:SOURce<hw>]:BB:OFDM:TRIGger:DELAy:UNIT <TrigDelUnit>

Determines the units 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 81.

Manual operation: See ["\(External\) Delay Unit"](#) on page 52

[:SOURce<hw>]:BB:OFDM:TRIGger:OBASeband:DELAy <TrigIntOthDelay>

Specifies the trigger delay for triggering by the signal from the second path.

Parameters:

<TrigIntOthDelay> float
 Range: 0 to 2147483647
 Increment: 0.01
 *RST: 0

Example: See [Example "Configure and enable triggering"](#) on page 80.

Manual operation: See ["\(Specified\) External Delay/\(Specified\) Trigger Delay"](#) on page 52

[:SOURce<hw>]:BB:OFDM:TRIGger:OBASeband:RDELAy?

Queries the time a trigger event from the other path is delayed.

Return values:

<IntOthRDelaySec> float
 Range: 0 to 688
 Increment: 250E-12
 *RST: 0

Example: See [Example "Specifying delay and inhibit values in time units"](#) on page 81.

Usage: Query only

Manual operation: See ["Actual Trigger Delay/Actual External Delay"](#) on page 52

[:SOURce<hw>]:BB:OFDM:TRIGger:OBASeband:TDELAy <IntOthDelaySec>

Specifies the trigger delay for triggering by the signal from the other path.

Parameters:

<IntOthDelaySec> float
 Range: 0 to 688
 Increment: 250E-12
 *RST: 0
 Default unit: s

Example: See [Example "Specifying delay and inhibit values in time units"](#) on page 81.

Manual operation: See ["\(Specified\) External Delay/\(Specified\) Trigger Delay"](#) on page 52

[:SOURce<hw>]:BB:OFDM:TRIGger:OBASeband:INHibit <IntOthInhibit>

For triggering via the other path, specifies the number of samples by which a restart is inhibited.

Parameters:

<IntOthInhibit> integer
 Range: 0 to 67108863
 *RST: 0
 Default unit: Sample

Example: See [Example "Configure and enable triggering"](#) on page 80.

Manual operation: See ["External / Trigger Inhibit"](#) on page 52

[: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 "Configure and enable triggering"](#) on page 80.

Manual operation: See ["\(Specified\) External Delay/\(Specified\) Trigger Delay"](#) on page 52

[: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 81.

Manual operation: See ["\(Specified\) External Delay/\(Specified\) Trigger Delay"](#) on page 52

[: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 81.

Usage: Query only

Manual operation: See ["Actual Trigger Delay/Actual External Delay"](#) on page 52

[: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 "Configure and enable triggering"](#) on page 80.

Manual operation: See ["External / Trigger Inhibit"](#) on page 52

4.9 Marker Commands

Example: Configure and enable standard marker signals

```
SOURce:BB:OFDM:TRIGger:OUTPut2:MODE?
// REStart
SOURce:BB:OFDM:TRIGger:OUTPut2:FOFFset 10
SOURce:BB:OFDM:TRIGger:OUTPut2:ROFFset 20
```

[:SOURce<hw>]:BB:OFDM:TRIGger:OUTPut<ch>:MODE	87
[:SOURce<hw>]:BB:OFDM:TRIGger:OUTPut<ch>:ROFFset	87
[:SOURce<hw>]:BB:OFDM:TRIGger:OUTPut<ch>:FOFFset	87
[:SOURce<hw>]:BB:OFDM:TRIGger:OUTPut<ch>:DELay	87

[: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 "Configure and enable standard marker signals"](#) on page 87.

Manual operation: See ["Marker Mode"](#) on page 54

[: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 "Configure and enable standard marker signals"](#) on page 87.

Manual operation: See [" Rise/Fall Offset "](#) on page 54

[:SOURce<hw>]:BB:OFDM:TRIGger:OUTPut<ch>:DELay <MarkDelay>

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

Parameters:

<MarkDelay> float
 Range: 0 to 16777215
 Increment: 0.001
 *RST: 0
 Default unit: Samples

Example: See [Example "Configure and enable standard marker signals"](#) on page 87.

Manual operation: See ["Marker x Delay"](#) on page 54

4.10 Clock Commands

Example: Clock settings

```
SOURce:BB:OFDM:CLOCK:SOURce ELCL
SOURce:BB:OFDM:CLOCK:MODE SAMP
CLOCK:INPUt:FREQuency?
```

[\[:SOURce<hw>\]:BB:OFDM:CLOCK:SOURce](#)..... 88
[\[:SOURce<hw>\]:BB:OFDM:CLOCK:MODE](#)..... 88

[\[:SOURce<hw>\]:BB:OFDM:CLOCK:SOURce](#) <ClockSour>

Selects the clock source:

- `INTernal`: Internal clock reference
- `ELCLock`: External local clock
- `EXTernal` = `ELCLock`: Setting only
 Provided for backward compatibility with other Rohde & Schwarz signal generators

Parameters:

<ClockSour> INTernal|ELCLock|EXTernal
 *RST: INTernal

Example: See [Example "Clock settings"](#) on page 88.

Options: ELCLock requires R&S SMW-B10

Manual operation: See ["Clock Source"](#) on page 55

[\[:SOURce<hw>\]:BB:OFDM:CLOCK:MODE](#) <ClockMode>

Sets the type of externally supplied clock.

Parameters:

<ClockMode> SAMPlE
 *RST: SAMPlE

Example: See [Example "Clock settings"](#) on page 88.

Options: R&S SMW-B10

Manual operation: See ["Clock Mode"](#) on page 55

Annex

A XML Settings File

You can use the created *.xml file for OFDM signal analysis. See ["Export path for XML settings"](#) on page 26. 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 SMW-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: List of the 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 Multi-carrier

FFT: Fast Fourier Transformation

G

GFDM: Generalized Frequency Division Multiplexing

I

IFFT: Inverse Fast Fourier Transformation

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 filter bank

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 [f-OFDM](#)

UFMC: Universal Filtered Multi-Carrier

Universal Filtered OFDM (UF-OFDM): [UFMC](#)

Glossary: Specifications, References, Documents with 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 5th 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

List of commands

[:SOURce<hw>]:BB:OFDM:ACPLength.....	63
[:SOURce<hw>]:BB:OFDM:ACPSymbols.....	63
[:SOURce<hw>]:BB:OFDM:ALLOc<ch0>:CIQFile.....	77
[:SOURce<hw>]:BB:OFDM:ALLOc<ch0>:CONFlIct?.....	78
[:SOURce<hw>]:BB:OFDM:ALLOc<ch0>:CONTEnt.....	77
[:SOURce<hw>]:BB:OFDM:ALLOc<ch0>:DATA.....	76
[:SOURce<hw>]:BB:OFDM:ALLOc<ch0>:LIST.....	76
[:SOURce<hw>]:BB:OFDM:ALLOc<ch0>:MODulation.....	74
[:SOURce<hw>]:BB:OFDM:ALLOc<ch0>:PATTErn.....	76
[:SOURce<hw>]:BB:OFDM:ALLOc<ch0>:PHYSbits?.....	76
[:SOURce<hw>]:BB:OFDM:ALLOc<ch0>:PWR.....	77
[:SOURce<hw>]:BB:OFDM:ALLOc<ch0>:SCMA:CODEbook?.....	79
[:SOURce<hw>]:BB:OFDM:ALLOc<ch0>:SCMA:LAYer<st0>:PWR?.....	79
[:SOURce<hw>]:BB:OFDM:ALLOc<ch0>:SCMA:LAYer<st0>:STATE.....	79
[:SOURce<hw>]:BB:OFDM:ALLOc<ch0>:SCMA:LAYer<st0>:USER.....	80
[:SOURce<hw>]:BB:OFDM:ALLOc<ch0>:SCMA:NLAYers?.....	78
[:SOURce<hw>]:BB:OFDM:ALLOc<ch0>:SCMA:SPREad?.....	78
[:SOURce<hw>]:BB:OFDM:ALLOc<ch0>:SCNO.....	75
[:SOURce<hw>]:BB:OFDM:ALLOc<ch0>:SCOFFset.....	75
[:SOURce<hw>]:BB:OFDM:ALLOc<ch0>:STATE.....	77
[:SOURce<hw>]:BB:OFDM:ALLOc<ch0>:SYNO.....	75
[:SOURce<hw>]:BB:OFDM:ALLOc<ch0>:SYOFFset.....	75
[:SOURce<hw>]:BB:OFDM:BWOCCupied?.....	64
[:SOURce<hw>]:BB:OFDM:CLOCK:MODE.....	88
[:SOURce<hw>]:BB:OFDM:CLOCK:SOURce.....	88
[:SOURce<hw>]:BB:OFDM:CPLength.....	63
[:SOURce<hw>]:BB:OFDM:CPSYmbols.....	63
[:SOURce<hw>]:BB:OFDM:FILTEr:CUTTTrans.....	67
[:SOURce<hw>]:BB:OFDM:FILTEr:LENGth.....	66
[:SOURce<hw>]:BB:OFDM:FILTEr:ROLLoff.....	66
[:SOURce<hw>]:BB:OFDM:FILTEr:SBATtenuation.....	66
[:SOURce<hw>]:BB:OFDM:FILTEr:TYPE.....	65
[:SOURce<hw>]:BB:OFDM:FILTEr:UCATalog?.....	67
[:SOURce<hw>]:BB:OFDM:FILTEr:ULENGth?.....	67
[:SOURce<hw>]:BB:OFDM:FILTEr:USELectIon.....	67
[:SOURce<hw>]:BB:OFDM:FILTEr:WINDowIng.....	67
[:SOURce<hw>]:BB:OFDM:FOFDm:NSUBand.....	68
[:SOURce<hw>]:BB:OFDM:GFDM:DBSYmbols.....	68
[:SOURce<hw>]:BB:OFDM:LGUard?.....	64
[:SOURce<hw>]:BB:OFDM:MODPreset.....	60
[:SOURce<hw>]:BB:OFDM:MODulation.....	60
[:SOURce<hw>]:BB:OFDM:NALLOc.....	74
[:SOURce<hw>]:BB:OFDM:NOCCupied.....	62
[:SOURce<hw>]:BB:OFDM:NSUBcarriers.....	62
[:SOURce<hw>]:BB:OFDM:OUTPath.....	61
[:SOURce<hw>]:BB:OFDM:PRESet.....	59
[:SOURce<hw>]:BB:OFDM:RGUard?.....	65

[:SOURce<hw>]:BB:OFDM:SAMPling?	64
[:SOURce<hw>]:BB:OFDM:SCSPace	62
[:SOURce<hw>]:BB:OFDM:SEQLength	62
[:SOURce<hw>]:BB:OFDM:SETTing:CATalog	59
[:SOURce<hw>]:BB:OFDM:SETTing:DEL	60
[:SOURce<hw>]:BB:OFDM:SETTing:LOAD	59
[:SOURce<hw>]:BB:OFDM:SETTing:STORe	59
[:SOURce<hw>]:BB:OFDM:SRATe:VARiAtion	61
[:SOURce<hw>]:BB:OFDM:STATe	59
[:SOURce<hw>]:BB:OFDM:SUBCarriers?	68
[:SOURce<hw>]:BB:OFDM:TRIGger:ARM:EXECute	83
[:SOURce<hw>]:BB:OFDM:TRIGger:DELay:UNIT	84
[:SOURce<hw>]:BB:OFDM:TRIGger:EXECute	83
[:SOURce<hw>]:BB:OFDM:TRIGger:EXTeRnal:RDELay?	86
[:SOURce<hw>]:BB:OFDM:TRIGger:EXTeRnal:SYNChRize:OUTPut	83
[:SOURce<hw>]:BB:OFDM:TRIGger:EXTeRnal:TDELay	85
[:SOURce<hw>]:BB:OFDM:TRIGger:OBASeband:DELay	84
[:SOURce<hw>]:BB:OFDM:TRIGger:OBASeband:INHibit	85
[:SOURce<hw>]:BB:OFDM:TRIGger:OBASeband:RDELay?	84
[:SOURce<hw>]:BB:OFDM:TRIGger:OBASeband:TDELay	84
[:SOURce<hw>]:BB:OFDM:TRIGger:OUTPut<ch>:DELay	87
[:SOURce<hw>]:BB:OFDM:TRIGger:OUTPut<ch>:FOFFset	87
[:SOURce<hw>]:BB:OFDM:TRIGger:OUTPut<ch>:MODE	87
[:SOURce<hw>]:BB:OFDM:TRIGger:OUTPut<ch>:ROFFset	87
[:SOURce<hw>]:BB:OFDM:TRIGger:RMODE?	82
[:SOURce<hw>]:BB:OFDM:TRIGger:SLENgth	82
[:SOURce<hw>]:BB:OFDM:TRIGger:SLUNit	83
[:SOURce<hw>]:BB:OFDM:TRIGger:SOURce	82
[:SOURce<hw>]:BB:OFDM:TRIGger[:EXTeRnal]:DELay	85
[:SOURce<hw>]:BB:OFDM:TRIGger[:EXTeRnal]:INHibit	86
[:SOURce<hw>]:BB:OFDM:UFMC:NSUBand	69
[:SOURce<hw>]:BB:OFDM:UFMC:PREequal	69
[:SOURce<hw>]:BB:OFDM:USER<ch0>:DATA	69
[:SOURce<hw>]:BB:OFDM:USER<ch0>:LIST	70
[:SOURce<hw>]:BB:OFDM:USER<ch0>:PATtern	70
[:SOURce<hw>]:BB:OFDM:USER<ch0>:PWR	70
[:SOURce<hw>]:BB:OFDM:USER<ch0>:STATe	70
[:SOURce<hw>]:BB:OFDM:WAVEform:CREate	60
[:SOURce<hw>]:BB:OFDM[:TRIGger]:SEQuence	81

Index

Symbols

*.dat file	
Filter	16
I/Q data	21
*.iqw file	21

A

Allocation	
Boost	42
Conflict	44
Content type	42
Data source	41
Modulation	41
Number	40
Physical bits	41
Power offset	42
State	43
Subcarrier number	41
Subcarrier offset	41
Symbol number	41
Symbol offset	41
Allocation number	40
Application cards	8
Application notes	8
Arm	50
Armed_Auto	49
Armed_Retrigger	49
Attenuation	
Side-lobe attenuation	34
Stopband	34
Auto	49

B

Bandwidth	
Occupied	31
Brochures	7

C

Catalog	
User filter	35
Clock	
Mode	55
Source	55
Codebook	45
Codebook size M	45
Common trigger settings	49
Conventions	
SCPI commands	57
Coupled trigger settings	49
Custom I/Q data	
File format	21
Cyclic prefix, CP	
As in LTE	30
Calculation principle	29
Dynamic	30
Enable	29
Enable CP pattern	30, 31
Length	29

D

Data block size	36
Data sheets	7
Default settings	
OFDM Signal Generation	25
Delay	
Marker	54
Trigger	52
Delete	
User filter	35
Documentation overview	6
Dolph-Chebichev window	
Length	34
Shaping	34
Side-lobe attenuation	34

E

Export OFDM settings for R&S VSE-K96	26
External trigger	52
External trigger delay	52

F

f-OFDM	
Filter parameters	34
Factor K	37
FBMC types	
CMT, FMT, SMT	12
FFT size	28
Filter	
Cut transient response	35
Dolph-Chebichev	33
f-OFDM	34
GFDM	33
Length	34
Side-lobe attenuation	34
UFMC	33
Windowing method, f-OFDM	34
Filter length	
FBMC	37
Filter Pre-equalization	
Activate	36
First symbol	
Time plan	47

G

Generate	
Waveform file	25
Getting started	6

H

Help	6
------	---

I

I/Q files	
*.dat file	21
*.iqw file	21
Installation	5
Instrument help	6

Instrument security procedures 7

L

Layer

Power offset 46
State 46

Layer mapping

Settings 46
User 46

Left guard

Number of subcarriers 32

Load

User filter 35

M

Marker

Offset, fall 54
Offset, rise 54

Marker Delay

..... 54

Measured external clock

..... 55

Modulation type

..... 26

N

Number

Left guard subcarriers 32
Right guard subcarriers 32

Number of layers J

..... 45

O

OFDM

Settings file automatically created 26

Open source acknowledgment (OSA)

..... 7

OQAM

Principle 12

P

Pilot

Signal analyzer 42

PN9

Preamble 42

Preamble symbols

Number 42

R

Raised cosine filter

see Cosine filter 33

Release notes

..... 7

Resource blocks

Number 36

Retrigger

..... 49

Right guard

Number of subcarriers 32

Roll-off

see rolloff 34

Rolloff factor

GFDM 34

Root raised cosine filter

see Root Cosine 33

RRC filter

see Root Cosine filter 33

S

Safety instructions

..... 7

Sampling rate

..... 31

Save/Recall

OFDM Signal Generation 25

Script

Generate user filter 16

Security procedures

..... 7

Sequence length

..... 29

Service manual

..... 7

Set to default

5G candidates 25

Settings file

Analysis with R&S VSE-K96 26

Signal duration unit

..... 49

Signal generation status

..... 50

Single

..... 49

Soft truncation

Length 34

Soft truncation window

Windowing method 34

Spreading factor K

..... 45

Standard settings

OFDM Signal Generation 25

State

OFDM Signal Generation 25

Sub-bands

Number 36

Subband

Filter Pre-equalization 36

Subcarriers

Bandwidth 29

Number of active

..... 28

Number of available

..... 28

Occupied

..... 28

Spacing

..... 29

Subchannel

Number 36

Superimposed symbols

Faktor K 37

Symbols

Time plan 47

Synchronization

Signal analyzer 42

T

Time plan

Open in a new window 47

Trigger

Sync. output 51

Trigger delay

..... 52

Actual

..... 52

Expressed in time

..... 52

Resulting

..... 52

Unit

..... 52

Trigger mode

..... 49

Trigger signal duration

..... 50

Trigger source

..... 50

Tutorials

..... 7

U

UFMC

Filter parameters 34

User	
Boost	39
Data source	38
How many	38
Power offset	39
State	39
User filter	
Create file	16
File format	16
Script	16
User manual	6
User to layer mapping	46

W

Waveform file	
Create	25
White papers	8
Windowing method	
Hamming	34
Hanning	34