# R&S®SMW-K114
# 5G Air Interface Candidates
# User Manual

1177.6246.02 ─ 01

Test & Measurement

User Manual

ROHDE&SCHWARZ

This document describes the following software options:

- R&S®SMW-K114
  1414.1985.02

This manual describes firmware version FW 3.20.390.xx and later of the R&S®SMW200A.


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The following abbreviations are used throughout this manual: R&S®SMW200A is abbreviated as R&S SMW

# Contents

# 1 Preface

## 1.1 About this Manual

This user manual provides all the information **specific to the option 5G Air Interface Candidates**. All general instrument functions and settings common to all applications and operating modes are described in the main R&S SMW user manual.

The main focus in this manual is on the provided settings and the tasks required to generate a signal. The following topics are included:

- **Welcome to the 5G Air Interface Candidates option R&S SMW-K114**
  Introduction to and getting familiar with the option
- **About the 5G Air Interface Candidates option**
  Background information on basic terms and principles in the context of the signal generation
- **5G Air Interface Candidates Configuration and Settings**
  A concise description of all functions and settings available to configure signal generation with their corresponding remote control command
- **Remote Control Commands**
  Remote commands required to configure and perform signal generation in a remote environment, sorted by tasks
  (Commands required to set up the instrument or to perform common tasks on the instrument are provided in the main R&S SMW user manual)
  Programming examples demonstrate the use of many commands and can usually be executed directly for test purposes
- **Glossary**
  Alphabetical list of often used terms and abbreviations
- **List of remote commands**
  Alphabetical list of all remote commands described in the manual
- **Index**

## 1.2 Documentation Overview

The user documentation for the R&S SMW consists of the following parts:

- Getting started, printed manual
- Online help system on the instrument, incl. tutorials
- User manuals and online manual, see the product page
- Service manual, provided on the internet for registrated users
- Instrument security procedures, see the product page
- General safety instructions, printed brochure
- Release notes, see the product page (download > firmware)

- Data sheet and brochures, see the product page (download > brochures and data sheets)
- Application notes, provided on the internet

You find the user documentation on the R&S SMW product page mainly at:
http://www.rohde-schwarz.com/product/SMW200A.html > "Downloads" > "Manuals"
Additional download paths are stated directly in the following abstracts of the documentation types.

### Getting Started

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.

### Online Help and Tutorials

The **online help** offers quick, context-sensitive access to the information needed for operation and programming. It contains the description for the base unit and the software options.

The **tutorials** offer guided examples and demonstrations on operating the R&S SMW.

### User Manual and Online Manual

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

- **Base unit** manual
  Contains the description of the graphical user interface, an introduction to remote control, the description of all SCPI remote control commands, programming examples, and information on maintenance, instrument interfaces and error messages. Includes the contents of the getting started manual.
- **Software option** manuals
  Describe the specific functions of an option. Basic information on operating the R&S SMW is not included.

The **online manual** provides the contents of the user manual for immediate display on the internet.

### Service Manual

Describes the performance test for checking the rated specifications, module replacement and repair, firmware update, troubleshooting and fault elimination, and contains mechanical drawings and spare part lists.

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

### Instrument Security Procedures

Deals with security issues when working with the R&S SMW in secure areas.

**Data Sheets and Brochures**

The data sheet contains the technical specifications of the R&S SMW. Brochures provide an overview of the instrument and deal with the specific characteristics, see http://www.rohde-schwarz.com/product/SMW200A.html > "Download" > "Brochures and Data Sheets".

**General Safety Instructions**

Contains basic safety instructions in English, Spanish, German and French.

**Release Notes**

Describes the firmware installation, new and modified features and fixed issues according to the current firmware version. You find the latest version at:

http://www.rohde-schwarz.com/product/SMW200A.html > "Downloads" > "Firmware"

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

These documents deal with special applications or background information on particular topics, see http://www.rohde-schwarz.com/appnotes.

## 1.3 Conventions Used in the Documentation

### 1.3.1 Typographical Conventions

The following text markers are used throughout this documentation:

| Convention | Description |
|---|---|
| "Graphical user interface elements" | All names of graphical user interface elements on the screen, such as dialog boxes, menus, options, buttons, and softkeys are enclosed by quotation marks. |
| KEYS | Key names are written in capital letters. |
| `File names, commands, program code` | File names, commands, coding samples and screen output are distinguished by their font. |
| *Input* | Input to be entered by the user is displayed in italics. |
| Links | Links that you can click are displayed in blue font. |
| "References" | References to other parts of the documentation are enclosed by quotation marks. |

### 1.3.2 Conventions for Procedure Descriptions

When describing how to operate the instrument, several alternative methods may be available to perform the same task. In this case, the procedure using the touchscreen

is described. Any elements that can be activated by touching can also be clicked using an additionally connected mouse. The alternative procedure using the keys on the instrument or the on-screen keyboard is only described if it deviates from the standard operating procedures.

The term "select" may refer to any of the described methods, i.e. using a finger on the touchscreen, a mouse pointer in the display, or a key on the instrument or on a keyboard.

### 1.3.3 Notes on Screenshots

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

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 Welcome to the 5G Air Interface Candidates Option

The R&S SMW-K114 is a firmware application that adds functionality to generate pre-release 5G signals in accordance with the 5GNOW project specification 5GNOW D3.x.

The R&S SMW-K114 key features are:

- Support of the proposed 5G waveforms GFDM, UFMC, FBMC, f-OFDM
- 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

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 the R&S SMW product page >"Downloads" > "Manuals".

**Installation**

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

## 2.1 Accessing the 5G Air Interface Candidates Dialog

**To open the dialog with 5G Air Interface Candidates settings**

► In the block diagram of the R&S SMW, select "Baseband > 5G Candidates".

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".

## 2.2 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, this includes:

- Managing settings and data lists, like storing 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.

# 3 About 5G Air Interface Candidates Option

The 5G Air Interface Candidates option enables you to create waveforms according to the modulation schemes proposed by 5GNOW D3.x.

## 3.1 Overview of Proposed Modulation Schemes

The section gives a brief overview of the techniques and methods considered as key candidate 5G waveforms.

### 3.1.1 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 3-1 ([1]).

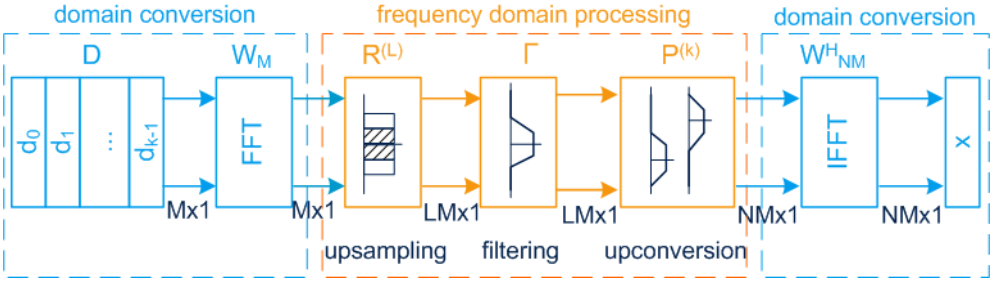



***Figure 3-1: Optimized GFDM transmitter model (from [1])***

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 on its diagonal the time samples of the filter pulse; 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
$W^H_{NM}$ = IFFT matrix that converts the signal from the frequency domain back to the time domain
x = $W^H_{NM}\Sigma_k P^{(k)}\Gamma R^{(L)} W_M d_k$

As shown on Figure 3-1, in GFDM a time-frequency response is divided into k subcarriers and M symbols.

**Related settings**

- Chapter 4.2.1, "Physical Setting", on page 21
- Chapter 4.2.2, "Filter Settings", on page 24
- Chapter 4.2.3, "Modulation Configuration Settings", on page 27

## 3.1.2 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 subcarries 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 3-2 ([2]).

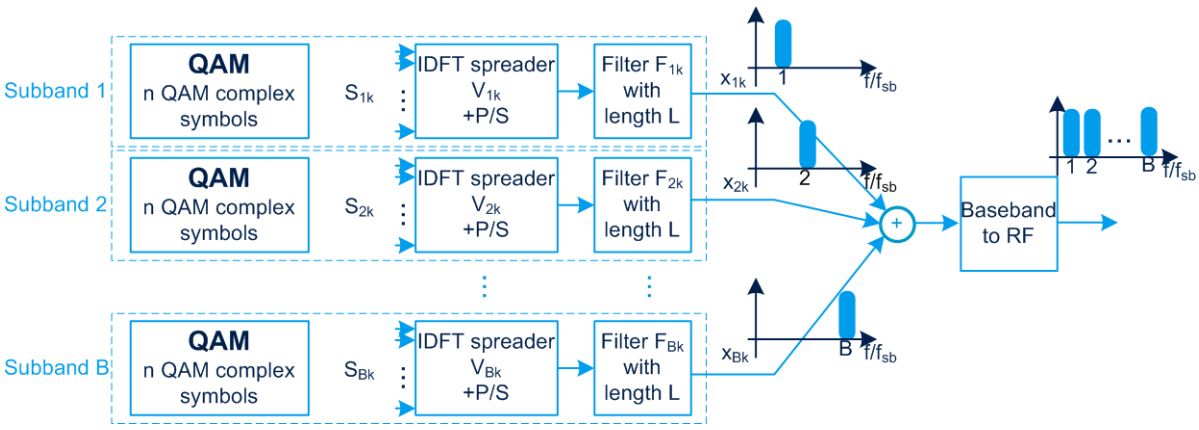



***Figure 3-2: UFMC system model (from [2])***

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 4.2.1, "Physical Setting", on page 21
- Chapter 4.2.2, "Filter Settings", on page 24
- Chapter 4.2.3, "Modulation Configuration Settings", on page 27

### 3.1.3 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.

Each subcarrier is shaped with a root raised cosine (RRC) filter with a rolloff factor of 1. The subcarriers are OQAM pre-processed to maintain orthogonality between adjacent subcarriers. The cyclic prefix is optional.

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

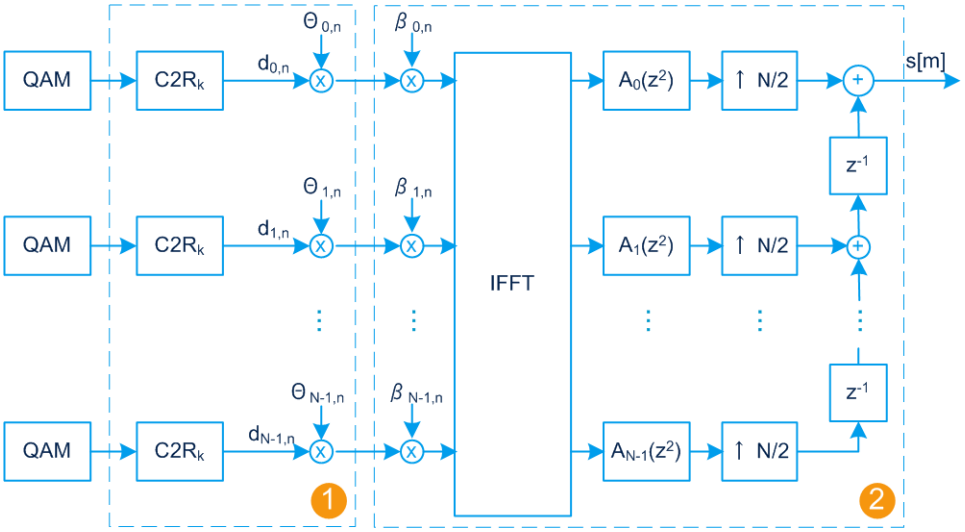



***Figure 3-3: FBMC transmitter model (from [3])***

1 = OQAM pre-processing (symbol staggering)
2 = Synthesis filter bank
N = Total number of subcarriers
k = 1,..., N is the subcarrier index
C2R = Complex to real conversion
⊗ = Complex multiplication by a factor Θ
IFFT = Inverse Fast Fourier Transformation
$A_k(z)$ = 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

#### Related settings

- Chapter 4.2.1, "Physical Setting", on page 21
- Chapter 4.2.2, "Filter Settings", on page 24
- Chapter 4.2.3, "Modulation Configuration Settings", on page 27

### 3.1.4 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 4.2.1, "Physical Setting", on page 21
- Chapter 4.2.2, "Filter Settings", on page 24
- Chapter 4.2.3, "Modulation Configuration Settings", on page 27

### 3.1.5 Filtering

All proposed modulation methods utilize filtering for signal shaping, but the filters are applied different.

| Modulation methods | Time domain filtering | Frequency domain filtering |
|---|---|---|
| GFDM | Per frame | Per subcarrier |
| UFMC | Per symbol | Per subband |
| FBMC | In polyphase | Per subcarrier |
| f-OFDM | Per frame | Per subband |

Each modulation method propose a filter with different characteristics, like filter type and filter length L. The proposed 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 filter
- f-OFDM:
  Soft truncation filter

Additionally, you can load a user-defined filter described in a file, see "User filter file format (*.dat files)" on page 14.

**User filter file format (*.dat files)**

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**

```
coeffs = chebwin(74,60); %filter order 74, stopband-att 60dB

coeffs = coeffs./max(abs(coeffs)); %normalize filter if not the case yet

fid = fopen('chebfilter.dat','w');
fprintf(fid,'%1.6f\n',[real(coeffs) imag(coeffs)].');
fclose(fid);
```

**Related settings**

- Chapter 4.2.2, "Filter Settings", on page 24

## 3.2 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 3-4 is an illustration of a codebook.

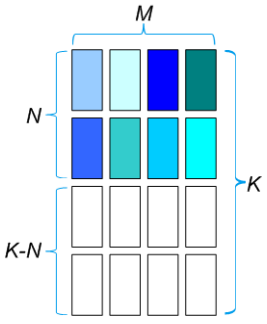



***Figure 3-4: SCMA encoding parameters***

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 3-5 illustrates the principle of the SCMA encoding.

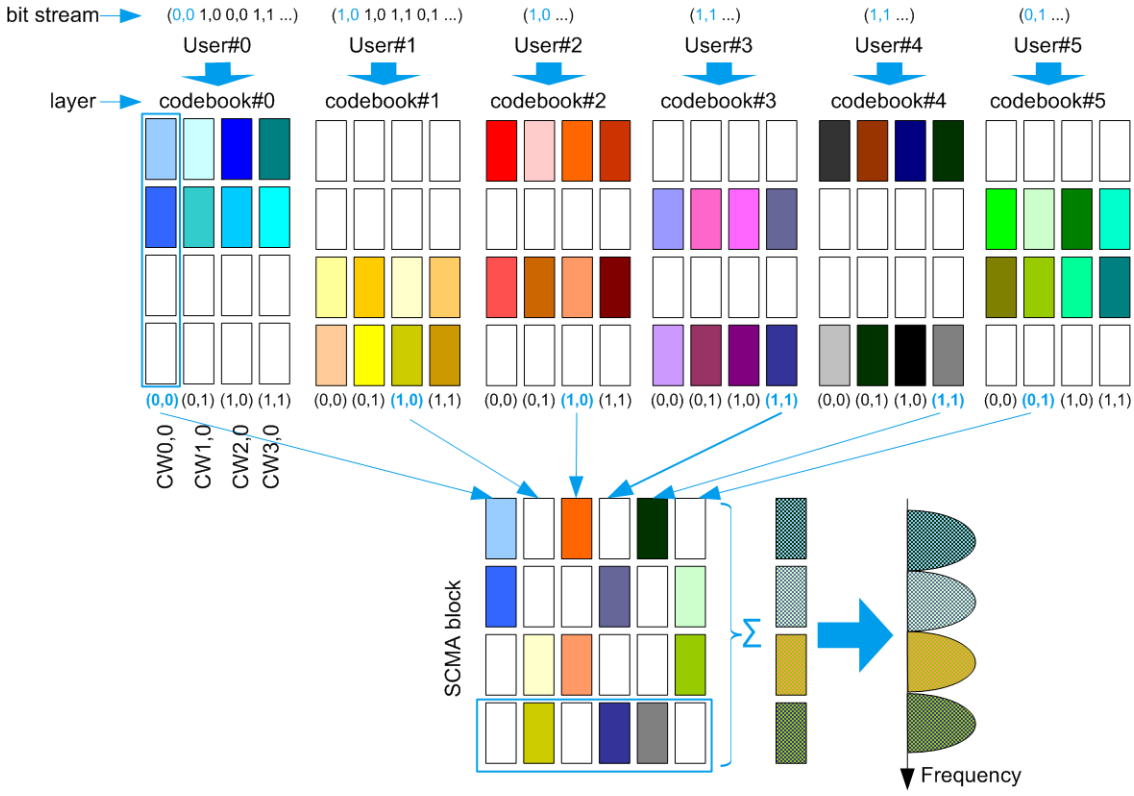



***Figure 3-5: SCMA encoding example (K = 4, N = 2, J = 6)***

User#x = 6 users
codebook#x = 6 codebooks or layers
bit stream = Binary input data per user, for example User#0 sends bits (0,0)
CWy,x = Codeword#y form 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 CW0,0 from the user-specific codebook#0. The 6 codewords of

the 6 users are combined; note that max. 3 symbols overlap. The combined signal of 6 users is spread over the subcarriers; the spreading factor is 4.

#### SCMA parametrization

The SCMA implementation in R&S SMW-K114 is illustrated Figure 3-4. it uses the following fix parameters:

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

#### Related settings

- Chapter 4.3.3, "SCMA Settings", on page 34
- Chapter 4.3.2, "Allocations Settings", on page 30

## 3.3 Physical Layer Parametrization

#### Data allocation

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

Related settings:

- Chapter 4.3, "Allocation Settings", on page 28

#### 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 22

# 4 5G Air Interface Candidates Configuration and Settings

Access:

► Select "Baseband > 5G Candidates".

The remote commands required to define these settings are described in Chapter 4, "5G Air Interface Candidates Configuration and Settings", on page 18.

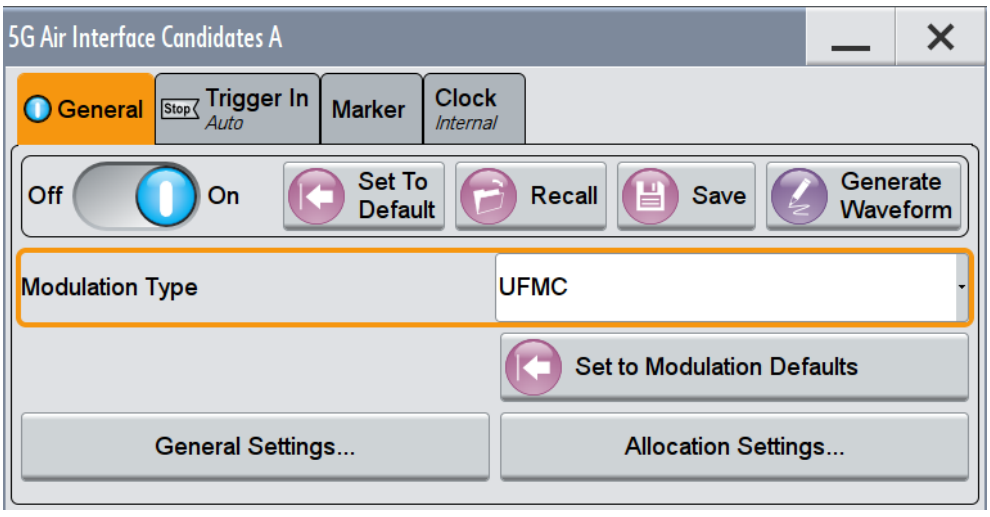
**Settings:**



## 4.1 5G General Settings

Access:

► Select "Baseband > 5G Candidates".




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

Remote command:
`[:SOURce<hw>]:BB:C5G:STATe` on page 49

**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 | UFMC |

Remote command:
`[:SOURce<hw>]:BB:C5G:PRESet` on page 50

**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 file name 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:C5G:SETTing:CATalog` on page 50
`[:SOURce<hw>]:BB:C5G:SETTing:LOAD` on page 50
`[:SOURce<hw>]:BB:C5G:SETTing:STORe` on page 50
`[:SOURce<hw>]:BB:C5G:SETTing:DEL` on page 51

**Generate Waveform File**
With enabled signal generation, triggers the instrument to store the current settings as an ARB signal in a waveform file. Waveform files can be further processed by the ARB and/or as a multi-carrier or a multi-segment signal.

The file name and the directory it is stored in are user-definable; the predefined file extension for waveform files is `*.wv`.

Remote command:
[:SOURce<hw>]:BB:C5G:WAVeform:CREate on page 51

**Modulation Type**
Selects the modulation type.

"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 3.1.2, "UFMC", on page 12.

"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 3.1.1, "GFDM", on page 11.

"FBMC" Filter Bank Multi Carrier
This modulation uses staggered modulated multitone filter bank (SMT FBMC) method where the subcarriers are OQAM modulated.
See Chapter 3.1.3, "FBMC", on page 13.

"f-OFDM" Filtered-OFDM
The filtered OFDM (f-OFDM) modulation is a technique similar to the UFMC modulation.
See Chapter 3.1.4, "f-OFDM", on page 14.

Remote command:
[:SOURce<hw>]:BB:C5G:MODulation on page 51

**Set to Modulation Defaults**
Calls the default settings for the selected Modulation Type.

Remote command:
[:SOURce<hw>]:BB:C5G:MODPreset on page 51

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

For description, see:
- Chapter 4.2.1, "Physical Setting", on page 21
- Chapter 4.2.2, "Filter Settings", on page 24
- Chapter 4.2.3, "Modulation Configuration Settings", on page 27

Remote command:
n.a.

**Allocation Settings…**
Accesses the "Allocation Settings" dialog, see Chapter 4.3, "Allocation Settings", on page 28.

Remote command:
n.a.

## 4.2 General Settings

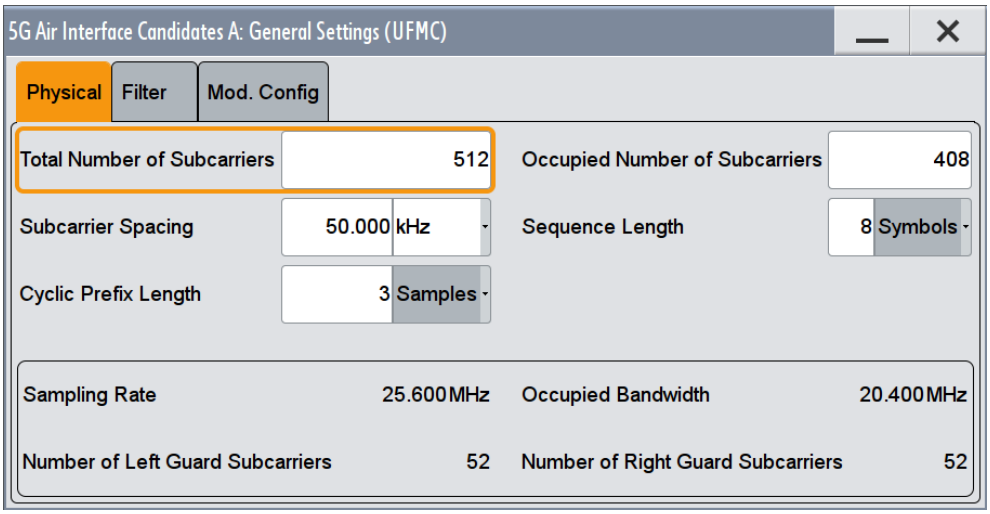


### 4.2.1 Physical Setting

Access:

► Select "5G Candidates > General Settings".

The physical settings are common to all modulation schemes.




**Settings:**



**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:

"Total Number of Subcarriers" * Subcarrier Spacing ≤ $Bandwidth_{max}$

The available baseband bandwidth depends on the installed options, see data sheet.

Remote command:
`[:SOURce<hw>]:BB:C5G:NSUBcarriers` on page 52

**Occupied Number of Subcarriers**
Sets the number of occupied subcarriers.

The maximum number of occupied subcarriers is calculated as follows:

"Occupied Number of Subcarriers"$_{max}$ = 0.8 * Total Number Of Subcarriers

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

Remote command:
`[:SOURce<hw>]:BB:C5G:NOCCupied` on page 52

**Subcarrier Spacing**
Sets the frequency distance between the carrier frequencies of the subcarriers.

The subcarriers are evenly distributed within the available bandwidth. All subcarrier 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:C5G:SCSPace` on page 53

**Sequence Length**
Sets the sequence length of the signal in number of symbols.

The maximum number of symbols is calculated as follows:

"Sequence Length"$_{max}$ = $ARB_{MemorySize}$ /Sampling Rate.

The available ARB memory size depends on the installed options, see data sheet.

Remote command:
`[:SOURce<hw>]:BB:C5G:SEQLength` on page 53

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

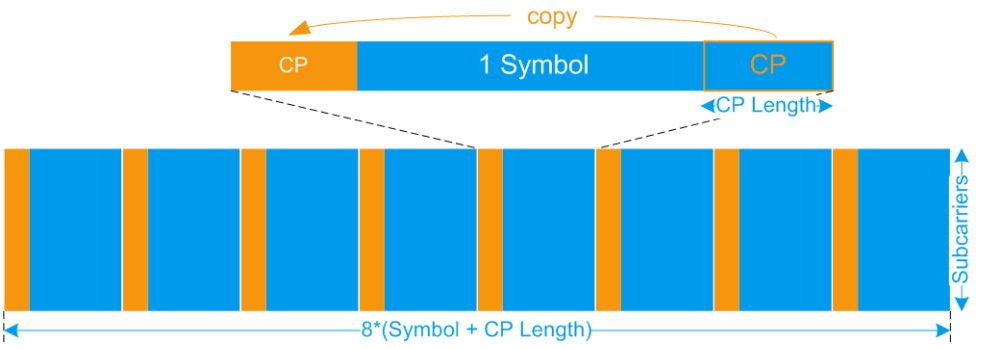



*Figure 4-1: Principle of cyclic prefix calculation in f-OFDM*

| | |
|---|---|
| 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 | = Sequence Length*CP Length + $Samples_{CompleteSignal}$ |
| $Samples_{CompleteSignal}$ | = Total Number Of Subcarriers * Sequence Length is the number of samples without CP |

- **UFMC, GFDM, FBMC**
  If a "CP Length ≠ 0" is selected, then last samples of the complete signal are pre-pended to the signal.

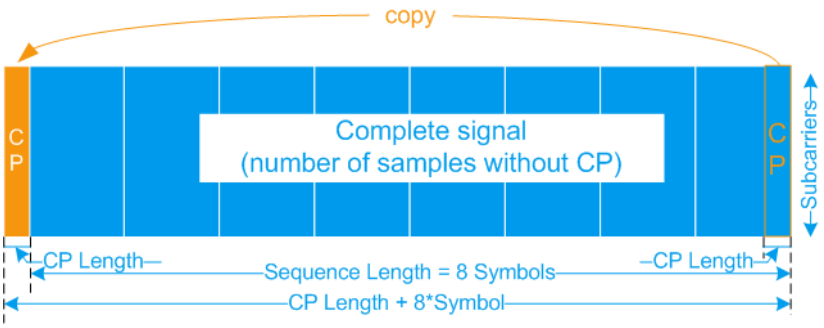



*Figure 4-2: Principle of cyclic prefix calculation in UFMC, GFDM, and FBMC*

| | |
|---|---|
| CP | = Cyclic prefix |
| CP Length | = Selected number of samples |
| Subcarriers | = Total Number Of Subcarriers |
| Sequence Length | = Selected number of symbols; 8 symbols in this example |
| $Samples_{CompleteSignal}$ | = Total Number Of Subcarriers * Sequence Length |
| Total Number of Samples | = CP Length + $Samples_{CompleteSignal}$ |

Remote command:
`[:SOURce<hw>]:BB:C5G:CPLength` on page 53

**Sampling Rate**
Displays the sampling rate.

The value is calculate as follows:

"Sampling Rate" = Total Number Of Subcarriers * Subcarrier Spacing

Remote command:
[:SOURce<hw>]:BB:C5G:SAMPling? on page 53

**Occupied Bandwidth**
Displays the occupied bandwidth.

The value is calculate as follows:

"Occupied Bandwidth" = Occupied Number of Subcarriers * Subcarrier Spacing

Remote command:
[:SOURce<hw>]:BB:C5G:BWOCcupied? on page 54

**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:

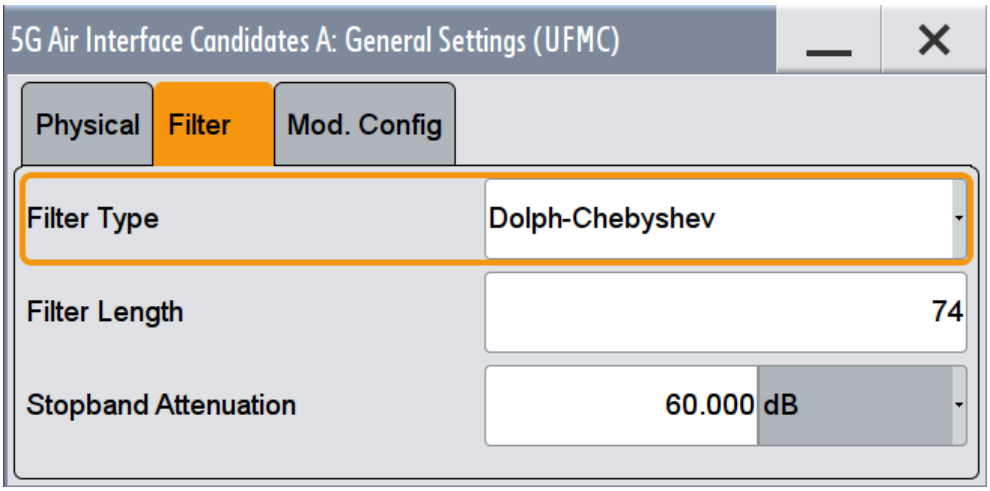
- "Number Of Left Guard Subcarriers" is the rounded up value of (Total Number Of Subcarriers - Occupied Number of Subcarriers) / 2
- "Number Of Right Guard Subcarriers" = Total Number Of Subcarriers - "Number Of Left Guard Subcarriers"

Remote command:
[:SOURce<hw>]:BB:C5G:LGUard? on page 54
[:SOURce<hw>]:BB:C5G:RGUard? on page 54

### 4.2.2 Filter Settings

Access:

1. Select "5G Candidates > Modulation Type > for example UFMC".
2. Select "5G Candidates > General Settings".
3. Select "Filter".




The filter settings depend on the selected modulation scheme.

**Settings:**



**Filter Type**
Sets the filter type.

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

- GFDM:
  Root Cosine, Root Raised Cosine, Dirichlet, and Rectangular filters
- UFMC:
  Dolph-Chebyshev filter
- FBMC:
  Root Raised Cosine filter
- f-OFDM:
  Soft truncation filter

Additionally, you can load a user-defined filter described in a file, see Chapter 3.1.5, "Filtering", on page 14.

Remote command:
`[:SOURce<hw>]:BB:C5G:FILTer:TYPE` on page 55

**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.

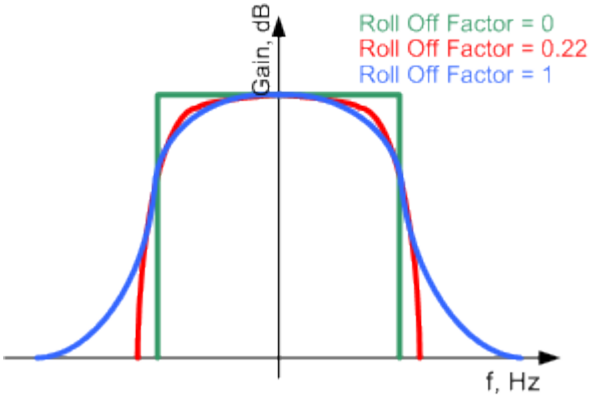



*Figure 4-3: Example of the frequency response of a filter with different rolloff factors*

Remote command:
[:SOURce<hw>]:BB:C5G:FILTer:ROLLoff on page 56

**Filter Length**
"Filter Length" (L) changes the filter shape in the time domain.

Remote command:
[:SOURce<hw>]:BB:C5G:FILTer:LENGth on page 56

**Stopband Attenuation**
The UFMC 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" (side-lobe attenuation) affects the shape in the frequency domain.

Remote command:
[:SOURce<hw>]:BB:C5G:FILTer:SBATtenuation on page 56

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

The following parameters affect the shape of the filter window:

"Filter Length (L)"
Changes the shape in the time domain.

"Windowing Method"
Affects the shape in the frequency domain.
The Hamming windowing method is optimized for better side-lobes suppression.

"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".

Remote command:
[:SOURce<hw>]:BB:C5G:FILTer:WINDowing on page 57
[:SOURce<hw>]:BB:C5G:FILTer:CUTTrans on page 56

**User Filter Length**
Indicates the number of filter coefficients in the user filter file, see "User filter file format (*.dat files)" on page 14.

Remote command:
[:SOURce<hw>]:BB:C5G:FILTer:ULENgth? on page 57

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

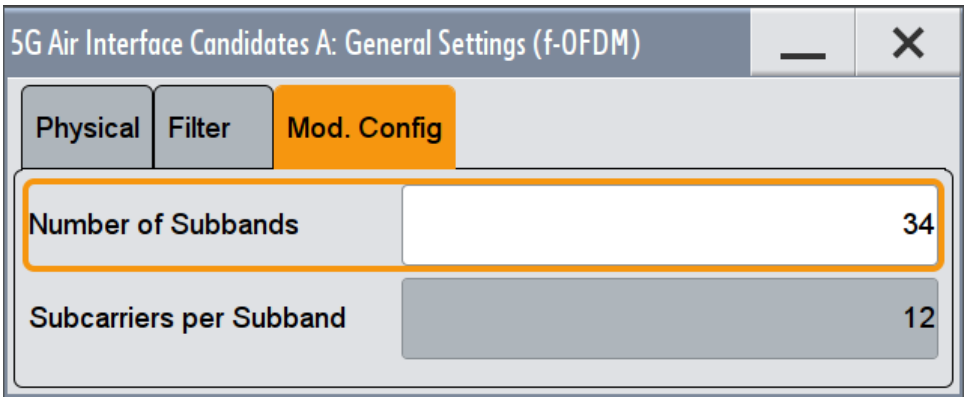
User filters are described in files with extension *.dat, see "User filter file format (*.dat files)" on page 14.

Remote command:
[:SOURce<hw>]:BB:C5G:FILTer:USELection on page 57
[:SOURce<hw>]:BB:C5G:FILTer:UCATalog? on page 57

### 4.2.3 Modulation Configuration Settings

Access:

1. Select "5G Candidates > Modulation Type > for example UFMC".
2. Select "5G Candidates > General Settings".
3. Select "Modulation Configuration".




The provided settings depend on the selected modulation type.

**Settings:**



**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:

Subcarriers per Subband = Occupied Number of Subcarriers / Number of Sub-bands

Remote command:
[:SOURce<hw>]:BB:C5G:UFMC:NSUBand on page 58
[:SOURce<hw>]:BB:C5G:FOFDm:NSUBand on page 58

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

It is calculated as:

Subcarriers per Subband = Occupied Number of Subcarriers / Number of Sub-bands

Remote command:
[:SOURce<hw>]:BB:C5G:SUBCarriers? on page 58

**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.

Remote command:
[:SOURce<hw>]:BB:C5G:UFMC:PREequal on page 59

**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:C5G:GFDM:DBSYmbols on page 58

**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.

## 4.3 Allocation Settings

Access:

1. Select "5G Candidates > Modulation Type > for example UFMC".
2. Select "5G Candidates > 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 scheme.

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

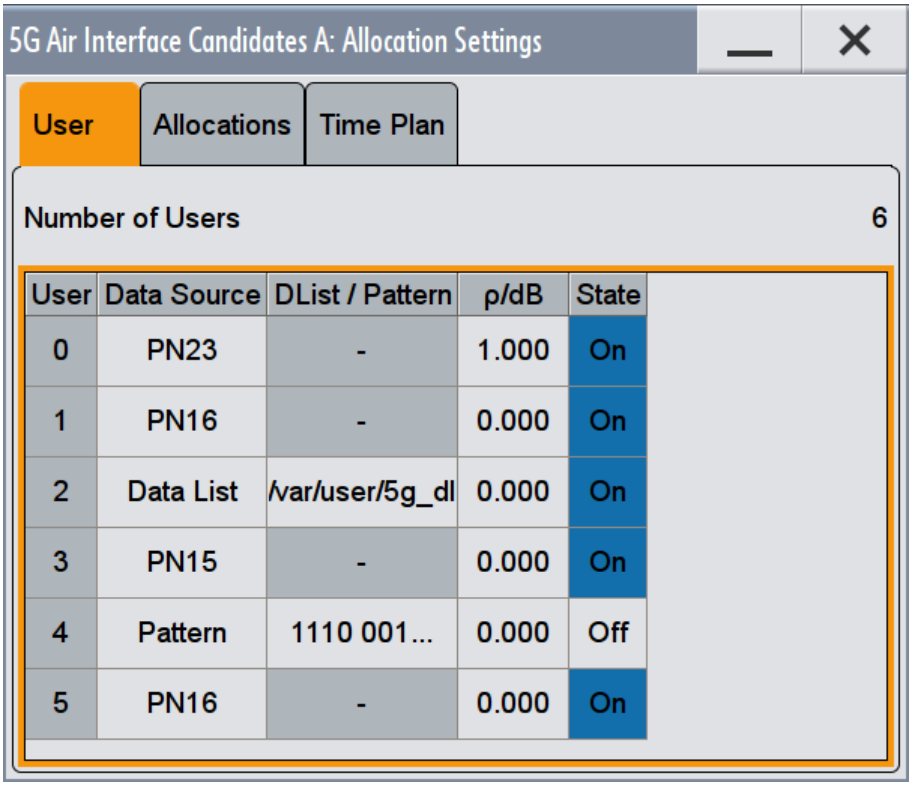
**Settings:**



### 4.3.1 User Settings

Access:

1. Select "5G Candidates > Modulation Type > for example UFMC".
2. Select "5G Candidates > Allocation Settings".




**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:C5G:USER<ch0>:DATA` on page 59
`[:SOURce<hw>]:BB:C5G:USER<ch0>:LIST` on page 59
`[:SOURce<hw>]:BB:C5G:USER<ch0>:PATTern` on page 60

**ρ / dB**
Boosts the user with the selected power offset relative to the other users.

Remote command:

`[:SOURce<hw>]:BB:C5G:USER<ch0>:PWR` on page 60

**State**
Enables the individual users.

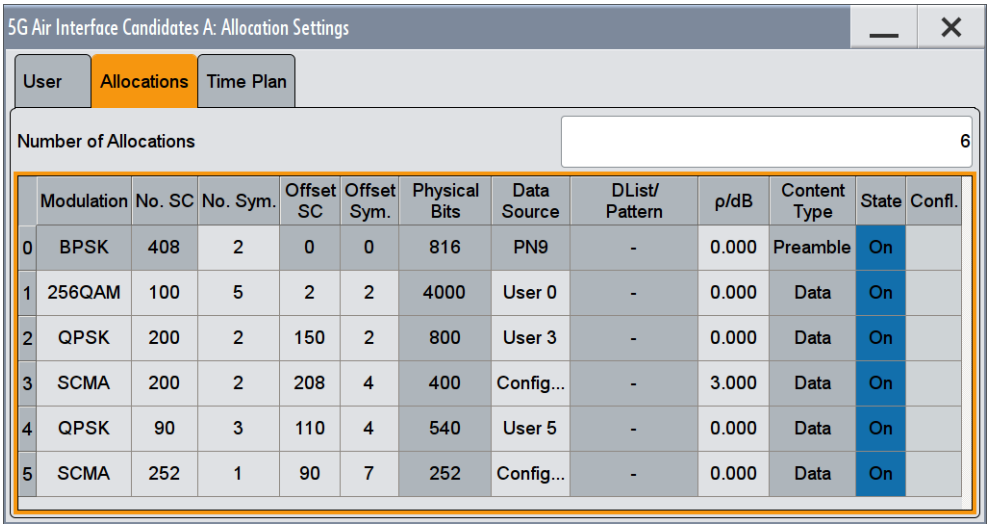
Remote command:

`[:SOURce<hw>]:BB:C5G:USER<ch0>:STATe` on page 60

### 4.3.2 Allocations Settings

Access:

1. Select "5G Candidates > Modulation Type > for example UFMC".
2. Select "5G Candidates > Allocation Settings".
3. Select "Allocations".




| | Modulation | No. SC | No. Sym. | Offset SC | Offset Sym. | Physical Bits | Data Source | DList/ Pattern | ρ/dB | Content Type | State | Confl. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | BPSK | 408 | 2 | 0 | 0 | 816 | PN9 | - | 0.000 | Preamble | On | |
| 1 | 256QAM | 100 | 5 | 2 | 2 | 4000 | User 0 | - | 0.000 | Data | On | |
| 2 | QPSK | 200 | 2 | 150 | 2 | 800 | User 3 | - | 0.000 | Data | On | |
| 3 | SCMA | 200 | 2 | 208 | 4 | 400 | Config... | - | 3.000 | Data | On | |
| 4 | QPSK | 90 | 3 | 110 | 4 | 540 | User 5 | - | 0.000 | Data | On | |
| 5 | SCMA | 252 | 1 | 90 | 7 | 252 | Config... | - | 0.000 | Data | On | |

**Number of Allocations**
Sets the number of scheduled allocations.

Remote command:
`[:SOURce<hw>]:BB:C5G:NALLoc` on page 63

**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.

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:C5G:ALLoc<ch0>:MODulation` on page 63

**No. SC**
Sets the number of allocated subcarriers, that is the allocated bandwidth.

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

Remote command:
`[:SOURce<hw>]:BB:C5G:ALLoc<ch0>:SCNO` on page 63

**No. Sym.**
Sets the allocation size in the time domain as number of symbols.

Remote command:
[:SOURce<hw>]:BB:C5G:ALLoc<ch0>:SYNO on page 64

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

Remote command:
[:SOURce<hw>]:BB:C5G:ALLoc<ch0>:SCOFfset on page 64

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

Remote command:
[:SOURce<hw>]:BB:C5G:ALLoc<ch0>:SYOFfset on page 64

**Phys Bits**
Displays the allocation size in bits.

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

Remote command:
[:SOURce<hw>]:BB:C5G:ALLoc<ch0>:PHYSbits? on page 64

**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 4.3.3, "SCMA Settings", on page 34. |

"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:C5G:ALLoc<ch0>:DATA` on page 65
`[:SOURce<hw>]:BB:C5G:ALLoc<ch0>:LIST` on page 65
`[:SOURce<hw>]:BB:C5G:ALLoc<ch0>:PATTern` on page 65

**ρ / dB**

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

Remote command:

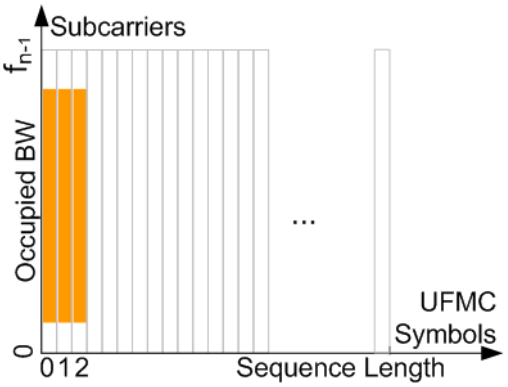
`[:SOURce<hw>]:BB:C5G:ALLoc<ch0>:PWR` on page 65

**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 22.

Remote command:
[:SOURce<hw>]:BB:C5G:ALLoc<ch0>:CONTent? on page 66

**State**
Enables the allocation.

Remote command:
[:SOURce<hw>]:BB:C5G:ALLoc<ch0>:STATe on page 66

**Conflict**
Indicates a conflict, if allocations overlap.

To visualize the allocations, use the Time Plan.

Remote command:
[:SOURce<hw>]:BB:C5G:ALLoc<ch0>:CONFlict? on page 66

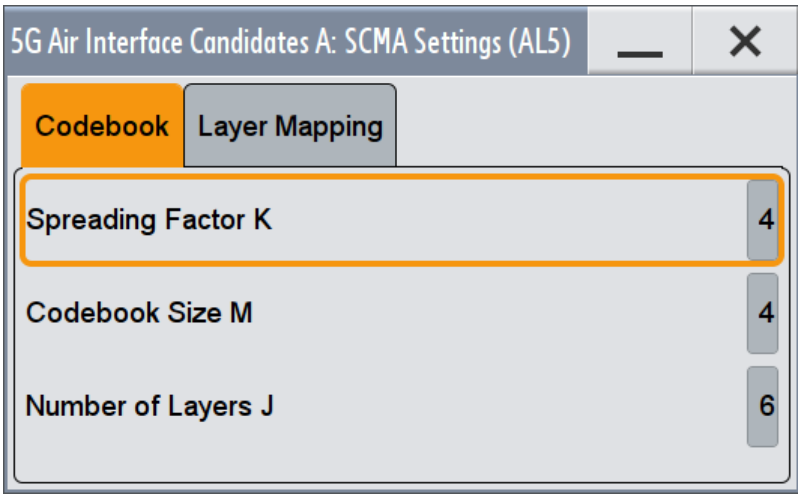
### 4.3.3 SCMA Settings

Access:

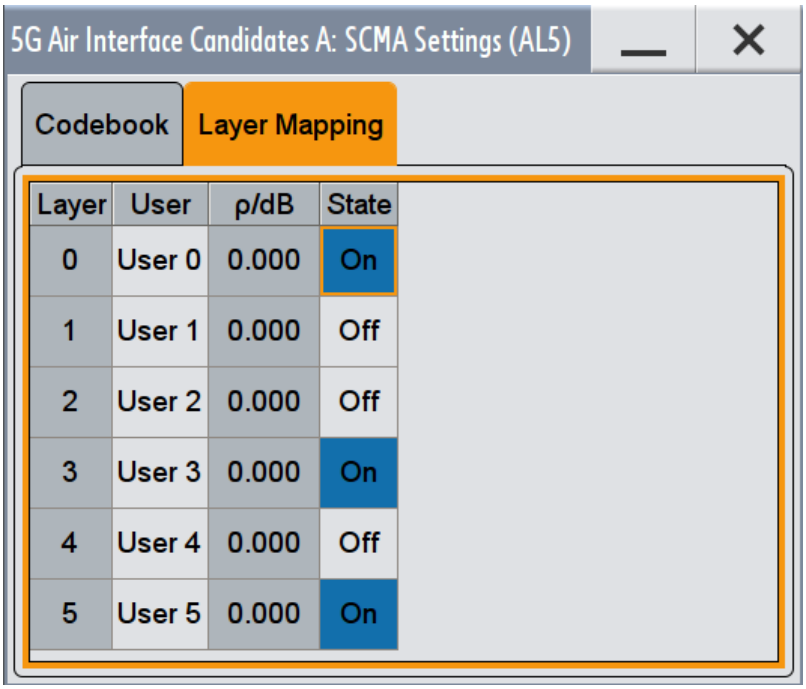
1. Select "5G Candidates > Modulation Type > for example UFMC".
2. Select "5G Candidates > Allocation Settings > Allocations".

3. Select "Alloc# > Modulation > SCMA".
4. Select "Data Source > Config".

   The "Codebook" dialog opens.




5. Select "Layer Mapping".




**Codebook**
Displays the codebook parameters.

See Figure 3-4.

**Spreading Factor K ← Codebook**
Displays the used spreading factor K.

Remote command:
[:SOURce<hw>]:BB:C5G:ALLoc<ch0>:SCMA:SPRead? on page 67

**Codebook Size M ← Codebook**
Displays the codebook size M.

Remote command:
[:SOURce<hw>]:BB:C5G:ALLoc<ch0>:SCMA:CODebook? on page 67

**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:

$$J = \begin{pmatrix} K \\ N \end{pmatrix}$$

Where:
- K is the spreading factor
- N is the number of non-zero elements, see Figure 3-4.

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

Remote command:
[:SOURce<hw>]:BB:C5G:ALLoc<ch0>:SCMA:NLAYers? on page 67

**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 3-5.

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

Remote command:
[:SOURce<hw>]:BB:C5G:ALLoc<ch0>:SCMA:LAYer<st0>:USER on page 68

**ρ / dB ← Layer Mapping**
Provided for future use.

Remote command:
[:SOURce<hw>]:BB:C5G:ALLoc<ch0>:SCMA:LAYer<st0>:PWR? on page 68

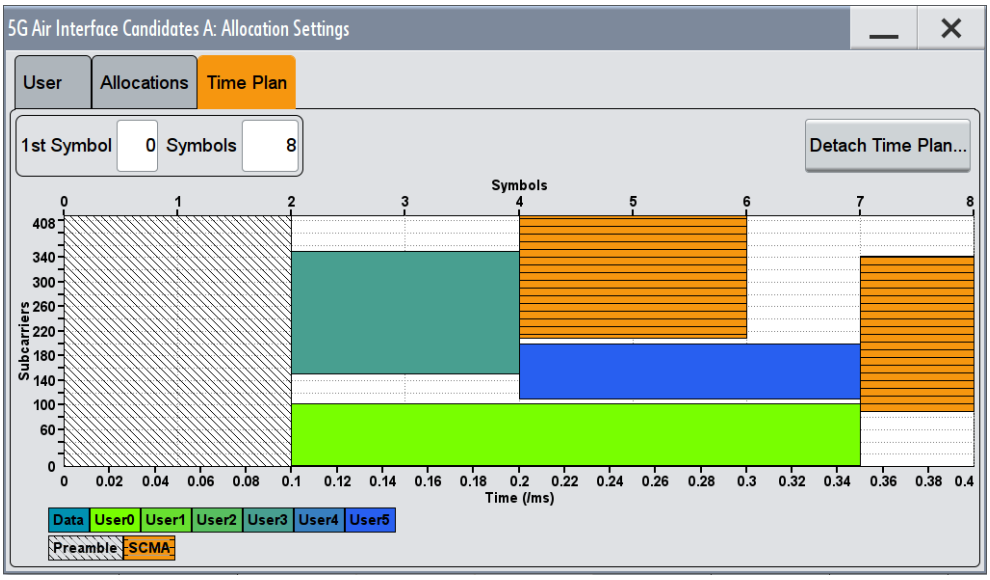
**State ← Layer Mapping**
Enables the individual layers (codebooks).

Remote command:
[:SOURce<hw>]:BB:C5G:ALLoc<ch0>:SCMA:LAYer<st0>:STATe on page 68

### 4.3.4 Time Plan

Access:

1. Select "5G Candidates > Modulation Type > for example UFMC".
2. Select "5G Candidates > 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.

**First 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.

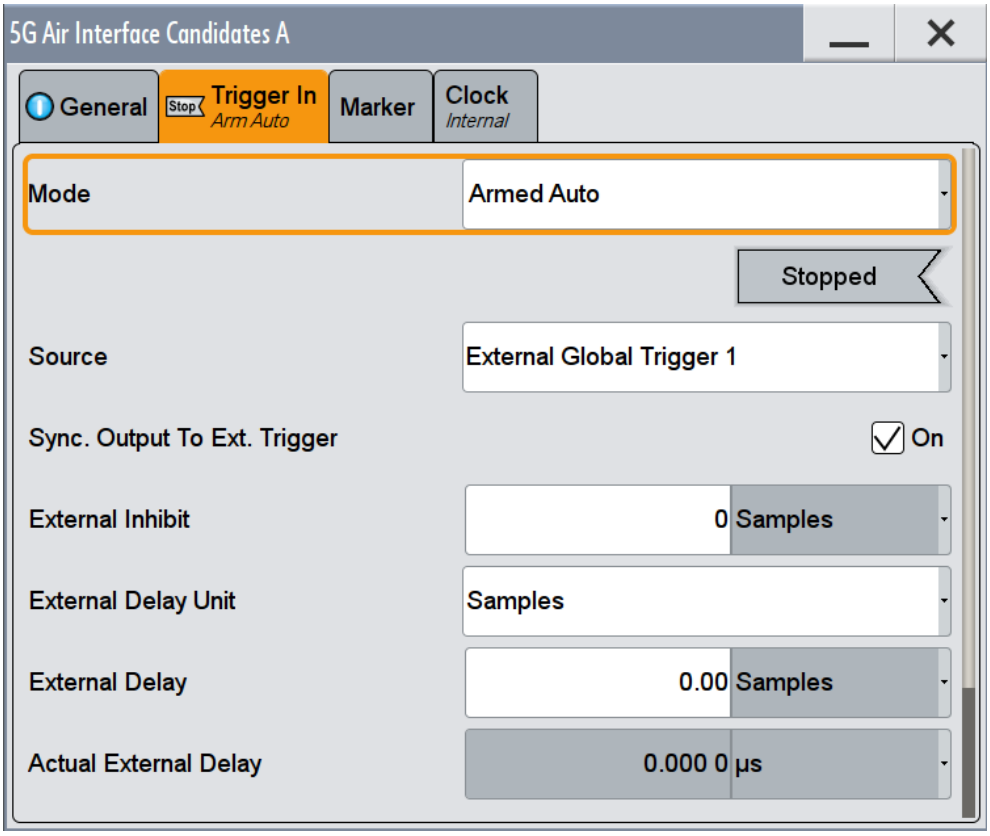
**Detach Time Plan**
Opens the time plan in a separate window.

Remote command:
n.a.

## 4.4 Trigger Settings

Access:

► Select "5G Candidates > Trigger In".




This tab provides access to the settings necessary to select and configure the trigger, like trigger source, mode, trigger delay, trigger suppression, 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 but can be mapped to one or more globally shared USER or local T/M/(C) connectors.

Use the Local and Global Connector Settings to configure the signal mapping as well as 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, i.e. select the "Trigger In > Mode" and "Trigger In > Source"
- Define the connector, USER or T/M/(C), the selected signal is provided at, i.e. configure the Local and Global Connector Settings.

**Settings:**



**Trigger Settings Common to All Basebands**

To enable simultaneous signal generation in all basebands, the R&S SMW couples the trigger settings in the available basebands in any instrument's configuration involving signal routing with signal addition (e.g. MIMO configuration, routing and summing of basebands and/or 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 with 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 with 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:C5G[:TRIGger]:SEQuence` on page 70

**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:C5G:TRIGger:SLUNit` on page 72

**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 deliberately output part of the signal, an exact sequence of the signal, or a defined number of repetitions of the signal.

Remote command:
`[:SOURce<hw>]:BB:C5G:TRIGger:SLENgth` on page 71

**Running/Stopped ← Trigger Settings Common to All Basebands**
For 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:C5G:TRIGger:RMODe?` on page 71

**Arm ← Trigger Settings Common to All Basebands**
Stops the signal generation until subsequent trigger event occurs.

Remote command:
`[:SOURce<hw>]:BB:C5G:TRIGger:ARM:EXECute` on page 72

**Execute Trigger ← Trigger Settings Common to All Basebands**
For internal trigger source, executes trigger manually.

Remote command:
[:SOURce<hw>]:BB:C5G:TRIGger:EXECute on page 72

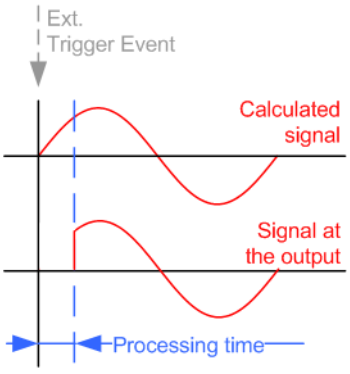
**Trigger Source ← Trigger Settings Common to All Basebands**
The following sources of the trigger signal are available:

- "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 1 / 2"
  The trigger event is the active edge of an external trigger signal provided and configured at the global USER connectors.
- "External Global Clock 1 / 2"
  The trigger event is the active edge of an external global clock signal provided and configured at the global USER 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/C 1/2/3 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/C 1 connector.

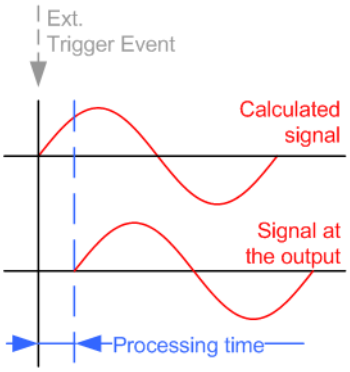
Remote command:
[:SOURce<hw>]:BB:C5G:TRIGger:SOURce on page 70

**Sync. Output to External Trigger ← Trigger Settings Common to All Basebands**
For an external trigger signal, enables/disables the output of a signal synchronous to the external trigger event.

"On" Corresponds to the default state of this parameter.
The signal calculation starts simultaneously with the external trigger event but because of the instrument's processing time 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 and starts with sample 0, i.e. the complete signal is output.
This mode is recommended for triggering of short signal sequences with signal duration comparable with the processing time of the instrument.




Remote command:
[:SOURce<hw>]:BB:C5G:TRIGger:EXTernal:SYNChronize:OUTPut on page 72

**External Trigger Inhibit ← Trigger Settings Common to All Basebands**
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:C5G:TRIGger[:EXTernal]:INHibit on page 75
[:SOURce<hw>]:BB:C5G:TRIGger:OBASeband:INHibit on page 74

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

The parameter Actual External Delay displays the delay converted in time.

Remote command:
[:SOURce<hw>]:BB:C5G:TRIGger:DELay:UNIT on page 72

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

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

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

Remote command:
[:SOURce<hw>]:BB:C5G:TRIGger[:EXTernal]:DELay on page 74
[:SOURce<hw>]:BB:C5G:TRIGger:EXTernal:TDELay on page 74
[:SOURce<hw>]:BB:C5G:TRIGger:OBASeband:DELay on page 73
[:SOURce<hw>]:BB:C5G:TRIGger:OBASeband:TDELay on page 73

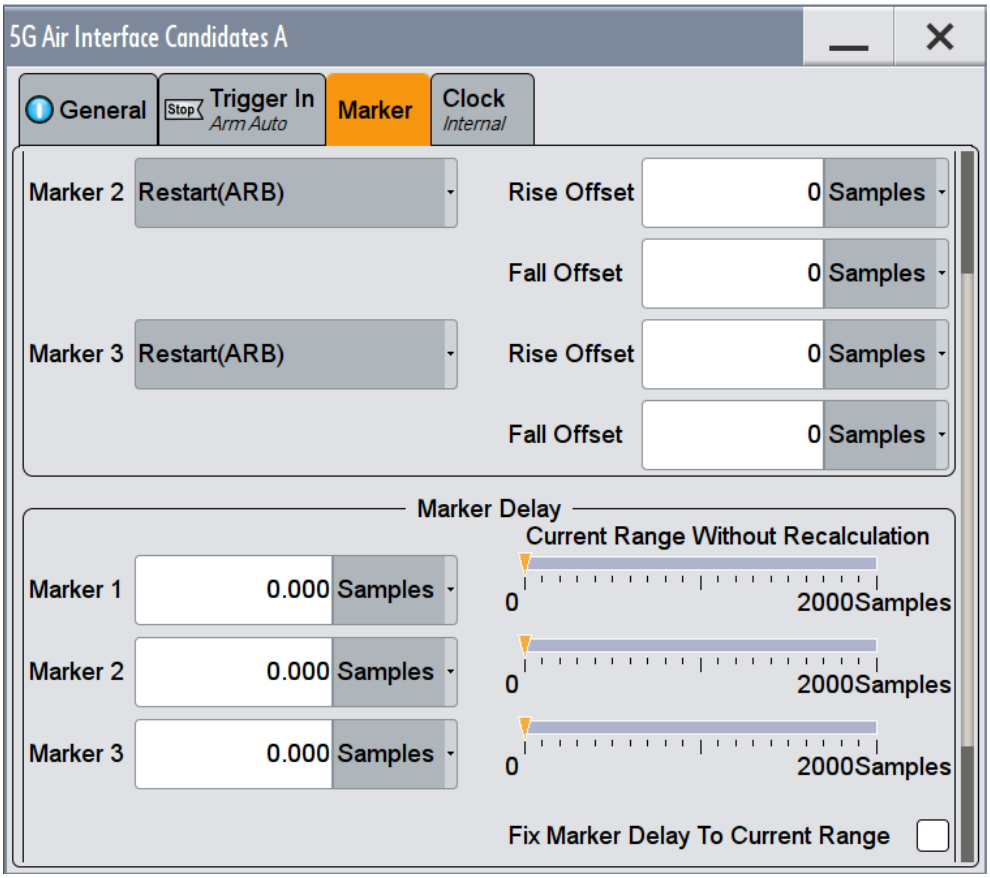
**Actual External Delay**
Indicates the resulting external trigger delay in "Time" unit.

Remote command:
[:SOURce<hw>]:BB:C5G:TRIGger:EXTernal:RDELay? on page 74
[:SOURce<hw>]:BB:C5G:TRIGger:OBASeband:RDELay? on page 73

## 4.5 Marker Settings

Access:

► Select "5G Candidates > 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 but can be mapped to one or more globally shared USER or local T/M/(C) 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, USER or T/M/(C), the selected signal is output at, i.e. configure the Local and Global Connector Settings.

**Settings:**



**Marker Mode**

Marker configuration for up to 3 marker channels. 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; the settings are self-explanatory.

"Restart (ARB)" A marker signal is generated at the start of each ARB sequence.

Remote command:

`[:SOURce<hw>]:BB:C5G:TRIGger:OUTPut<ch>:MODE` on page 76

**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:C5G:TRIGger:OUTPut<ch>:FOFFset` on page 76

`[:SOURce<hw>]:BB:C5G:TRIGger:OUTPut<ch>:ROFFset` on page 76

**Marker x Delay**

Defines the delay between the marker signal at the marker outputs relative to the signal generation start.

"Marker x" For the corresponding marker, sets the delay as a number of symbols.

Remote command:
`[:SOURce<hw>]:BB:C5G:TRIGger:OUTPut<ch>:DELay` on page 76

"Current Range without Recalculation"
Displays the dynamic range within which the delay of the marker signals can be set without restarting the marker and the signal.
Move the setting mark to define the delay.

Remote command:
`[:SOURce<hw>]:BB:C5G:TRIGger:OUTPut<ch>:DELay:MINimum?` on page 77
`[:SOURce<hw>]:BB:C5G:TRIGger:OUTPut<ch>:DELay:MAXimum?` on page 77

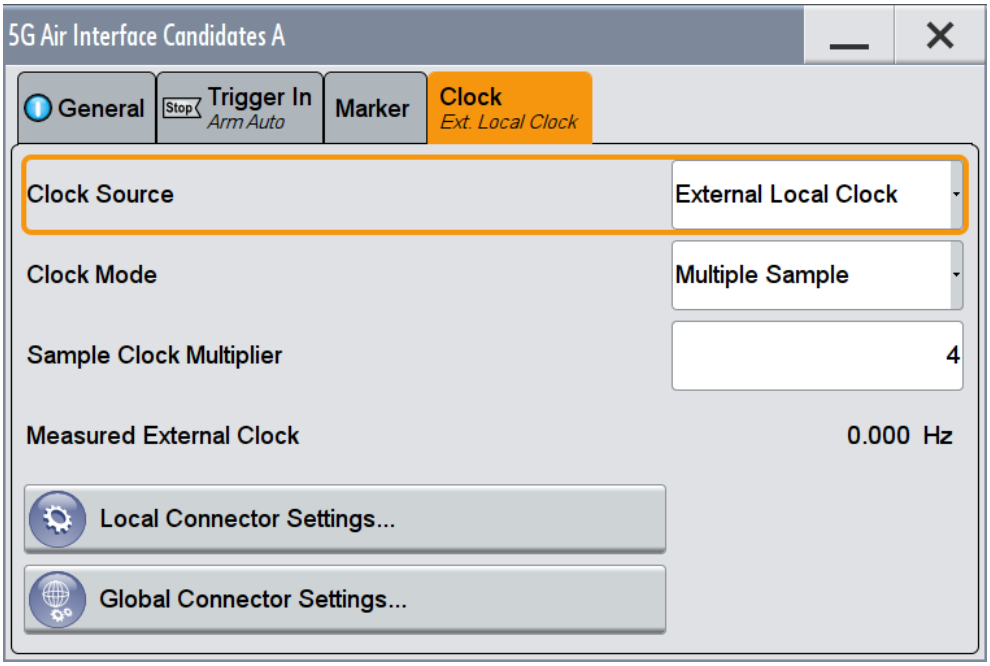
"Fix marker delay to current range"
Restricts the marker delay setting range to the dynamic range.

Remote command:
`[:SOURce<hw>]:BB:C5G:TRIGger:OUTPut:DELay:FIXed` on page 76

## 4.6 Clock Settings

Access:

► Select "5G Candidates > 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 but can be mapped to one or more globally shared USER and the two local T/M/C connectors.

Use the Local and Global Connector Settings to configure the signal mapping and 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, USER or T/M/C, the selected signal is provided at, that is configure the Local and Global Connector Settings.

**Settings:**



**Clock Source**

Selects the clock source.

- "Internal"
  The instrument uses its internal clock reference.
- "External Global Clock 1/2"
  The instrument expects an external clock reference at the global USER connector, as configured in the "Global Connector Settings" dialog.
- "External Local Clock"
  The instrument expects an external clock reference at the local T/M/C connector.

Remote command:

`[:SOURce<hw>]:BB:C5G:CLOCk:SOURce` on page 77

**Clock Mode**

Enters the type of externally supplied clock.

Remote command:

`[:SOURce<hw>]:BB:C5G:CLOCk:MODE` on page 78

**Clock Multiplier**

Enters the multiplication factor for clock type "Multiple".

Remote command:

`[:SOURce<hw>]:BB:C5G:CLOCk:MULTiplier` on page 78

**Measured External Clock**

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

Remote command:
`CLOCk:INPut:FREQuency?`

## 4.7 Local and Global Connector Settings

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

For more information, refer to the description R&S SMW User Manual, section "Local and Global Connectors".

# 5 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<br>`ENTity3\|4` require option R&S SMW-K76 |
| `SOURce<hw>` | [1]\|4 | Available baseband signals<br>Only `SOURce1` possible, if the keyword `ENTity` is used |
| `OUTPut<ch>` | 1 .. 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 5G Air Interface Candidates option are described here:



## 5.1 General Commands

**Example: Storing current configuration**

```
SOURce1:BB:C5G:SETTing:STORe "/var/user/5g_ufmc_scma"
*RST
SOURce1:BB:C5G:SETTing:CATalog?
// 5g_ufmc_scma, 5g
SOURce1:BB:C5G:SETTing:LOAD "/var/user/5g_ufmc_scma"
SOURce1:BB:C5G:NALLoc?
// 6
SOURce1:BB:C5G:SETTing:DEL "5g"
```



---

**[:SOURce<hw>]:BB:C5G:STATe** <State>

Activates the standard.

**Parameters:**

<State> 0 | 1 | OFF | ON

*RST: 0

**Example:** See Example "Generating a UFMC waveform" on page 61.

**Manual operation:** See "State" on page 19

---

**[:SOURce<hw>]:BB:C5G: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:C5G:STATe`.

**Example:** See Example "Generating a UFMC waveform" on page 61.

**Usage:** Event

**Manual operation:** See "Set to Default" on page 19

---

**[:SOURce<hw>]:BB:C5G:SETTing:CATalog**

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

**Return values:**

<FileNames> <filename1>,<filename2>,...

Returns a string of file names separated by commas.

**Example:** See Example "Storing current configuration" on page 49.

**Manual operation:** See "Save/Recall" on page 19

---

**[:SOURce<hw>]:BB:C5G: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 49.

**Manual operation:** See "Save/Recall" on page 19

---

**[:SOURce<hw>]:BB:C5G: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 49.

**Manual operation:** See "Save/Recall" on page 19

---

**[:SOURce<hw>]:BB:C5G: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 49.

**Manual operation:** See "Save/Recall" on page 19

---

**[:SOURce<hw>]:BB:C5G:WAVeform:CREate** <Filename>

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

**Parameters:**

<Filename> string

file name or complete file path; file extension is assigned automatically

**Example:** See Example "Generating a UFMC waveform" on page 61.

**Manual operation:** See "Generate Waveform File" on page 19

---

**[:SOURce<hw>]:BB:C5G:MODulation** <ModType>

Selects the modulation type.

**Parameters:**

<ModType> UFMC | FBMC | GFDM | FOFDm

*RST: GFDM

**Example:** See Example "Generating a UFMC waveform" on page 61.

**Manual operation:** See "Modulation Type" on page 20

---

**[:SOURce<hw>]:BB:C5G:MODPreset**

Calls the default settings for the selected moduilation type, see `[:SOURce<hw>]:BB:C5G:MODulation` on page 51.

**Example:** See Example "Generating a UFMC waveform" on page 61.

**Usage:** Event

**Manual operation:** See "Set to Modulation Defaults" on page 20

---

**[:SOURce<hw>]:BB:C5G: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 UFMC waveform" on page 61.

## 5.2 Physical Settings Commands



---

**[:SOURce<hw>]:BB:C5G:NSUBcarriers** <NoOfSubCarr>

Sets the number of available subcarriers.

**Parameters:**

<NoOfSubCarr> integer

Range: 128 to 16384
*RST: Depends on the selected modulation

**Example:** See Example "Generating a UFMC waveform" on page 61.

**Manual operation:** See "Total Number Of Subcarriers" on page 21

---

**[:SOURce<hw>]:BB:C5G:NOCCupied** <NumOccSc>

Sets the number of occupied subcarriers.

**Parameters:**

<NumOccSc> integer

Range: 1 to 13107
*RST: Depends on the selected modulation

**Example:** See Example "Generating a UFMC waveform" on page 61.

**Manual operation:** See "Occupied Number of Subcarriers" on page 22

---

**[:SOURce<hw>]:BB:C5G: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: 0.05
Default unit: MHz

**Example:** See Example "Generating a UFMC waveform" on page 61.

**Manual operation:** See "Subcarrier Spacing" on page 22

---

**[:SOURce<hw>]:BB:C5G:SEQLength** <SeqLen>

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

**Parameters:**

<SeqLen> integer

Range: 1 to 1000
*RST: 8

**Example:** See Example "Generating a UFMC waveform" on page 61.

**Manual operation:** See "Sequence Length" on page 22

---

**[:SOURce<hw>]:BB:C5G:CPLength** <CpLength>

Sets the cyclic prefix length as number of samples.

**Parameters:**

<CpLength> integer

Range: 0 to 8192
*RST: 128

**Example:** See Example "Generating a UFMC waveform" on page 61.

**Manual operation:** See "Cyclic Prefix Length" on page 22

---

**[:SOURce<hw>]:BB:C5G: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 UFMC waveform" on page 61.

**Usage:** Query only

**Manual operation:** See "Sampling Rate" on page 23

---

**[:SOURce<hw>]:BB:C5G: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 UFMC waveform" on page 61.

**Usage:** Query only

**Manual operation:** See "Occupied Bandwidth" on page 24

---

**[:SOURce<hw>]:BB:C5G:LGUard?**

Queries the number of left guard subcarriers.

**Return values:**

<LeftGuardSC> integer

Range: 0 to 1000
*RST: 52

**Example:** See Example "Generating a UFMC waveform" on page 61.

**Usage:** Query only

**Manual operation:** See "Number Of Left/Right Guard Subcarriers" on page 24

---

**[:SOURce<hw>]:BB:C5G:RGUard?**

Queries the number of right guard subcarriers.

**Return values:**

<RightGuardSC> integer

Range: 0 to 1000
*RST: 51

**Example:** See Example "Generating a UFMC waveform" on page 61.

**Usage:** Query only

**Manual operation:** See "Number Of Left/Right Guard Subcarriers" on page 24

## 5.3 Filter Commands

**Example: Filter settings**

```
SOURce1:BB:C5G:MODulation FOFD
SOURce1:BB:C5G:FILTer:LENGth 74
SOURce1:BB:C5G:FILTer:WINDowing HANN
SOURce1:BB:C5G:FILTer:CUTTrans 1

SOURce1:BB:C5G:MODulation GFDM
SOURce1:BB:C5G:FILTer:TYPE?
// DIR
SOURce1:BB:C5G:FILTer:ROLLoff?
// 0.1
SOURce1:BB:C5G:FILTer:TYPE USER
SOURce1:BB:C5G:FILTer:UCATalog?
// my_filter
SOURce1:BB:C5G:FILTer:USELection "/var/user/my_filter.dat"
```



---

**[:SOURce<hw>]:BB:C5G:FILTer:TYPE** <FilterType>

Sets the baseband filter type.

**Parameters:**

<FilterType> RC | RRC | DIRichlet | RECT | DCH | STRunc | USER

*RST: DCH

**Example:** See Example "Generating a UFMC waveform" on page 61.

**Manual operation:** See "Filter Type" on page 25

**[:SOURce<hw>]:BB:C5G: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 55.

**Manual operation:** See "Rolloff Factor" on page 25

**[:SOURce<hw>]:BB:C5G:FILTer:LENGth** <FilterLength>

Sets the filter length.

**Parameters:**

<FilterLength> integer

Range: 1 to 800
*RST: Deppends on the filter type

**Example:** See Example "Generating a UFMC waveform" on page 61.

**Manual operation:** See "Filter Length" on page 26

**[:SOURce<hw>]:BB:C5G: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 UFMC waveform" on page 61.

**Manual operation:** See "Stopband Attenuation" on page 26

**[:SOURce<hw>]:BB:C5G: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 55.

**Manual operation:** See "Soft truncation filter parameters" on page 26

**[:SOURce<hw>]:BB:C5G:FILTer:WINDowing** <Windowing>

Sets the windowing method.

**Parameters:**

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

**Example:** See Example "Filter settings" on page 55.

**Manual operation:** See "Soft truncation filter parameters" on page 26

**[:SOURce<hw>]:BB:C5G: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 61.

**Usage:** Query only

**Manual operation:** See "Load User Filter" on page 26

**[:SOURce<hw>]:BB:C5G: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 extenssion

**Example:** See Example "Filter settings" on page 55.

**Manual operation:** See "Load User Filter" on page 26

**[:SOURce<hw>]:BB:C5G:FILTer:ULENgth?**

Queries the filter length.

**Return values:**

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

**Example:** See Example "Filter settings" on page 55.

**Usage:** Query only

**Manual operation:** See "User Filter Length" on page 26

## 5.4 Modulation Commands



**[:SOURce<hw>]:BB:C5G: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 61.

**Usage:** Query only

**Manual operation:** See "Subcarriers per Subband" on page 27

**[:SOURce<hw>]:BB:C5G: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:C5G:GFDM:DBSYmbols 8
```

**Manual operation:** See "Data Block Size" on page 28

**[:SOURce<hw>]:BB:C5G:FOFDm:NSUBand** <FofdmNSubands>

Sets the number of f-OFDM sub-bands.

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

**Example:**
```
SOURce1:BB:C5G:FOFDm:NSUBand 34
```

**Manual operation:** See "Number of Sub-bands" on page 27

**[:SOURce<hw>]:BB:C5G: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 61.

**Manual operation:** See "Number of Sub-bands" on page 27

---

**[:SOURce<hw>]:BB:C5G: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 61.

**Manual operation:** See "Subband Filter Pre-equalization" on page 28

## 5.5 User Commands



---

**[:SOURce<hw>]:BB:C5G:USER<ch0>:DATA** <Datasource>

Sets the data source per user.

**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 61.

**Manual operation:** See "Data Source" on page 29

---

**[:SOURce<hw>]:BB:C5G:USER<ch0>:LIST** <DataList>

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

**Parameters:**

<DataList> string

file name incl. file extension or complete file path

**Example:** See Example "Generating a UFMC waveform" on page 61.

**Manual operation:** See "Data Source" on page 29

---

**[:SOURce<hw>]:BB:C5G:USER<ch0>:PATTern** <Pattern>

Sets a bit pattern as a data source.

**Parameters:**

<Pattern> 64 Bit

**Example:** See Example "Generating a UFMC waveform" on page 61.

**Manual operation:** See "Data Source" on page 29

---

**[:SOURce<hw>]:BB:C5G: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 UFMC waveform" on page 61.

**Manual operation:** See "ρ / dB" on page 30

---

**[:SOURce<hw>]:BB:C5G:USER<ch0>:STATe** <State>

Activates the user.

**Parameters:**

<State> 0 | 1 | OFF | ON

*RST: 1

**Example:** See Example "Generating a UFMC waveform" on page 61.

**Manual operation:** See "State" on page 30

## 5.6 Allocation Commands

**Example: Generating a UFMC waveform**

```
*RST

SOURce1:BB:C5G:PRESet
SOURce1:BB:C5G:MODulation UFMC
// SOURce1:BB:C5G:MODPreset
SOURce1:BB:C5G:NSUBcarriers 512
SOURce1:BB:C5G:NOCCupied 408
SOURce1:BB:C5G:SCSPace 0.05
SOURce1:BB:C5G:SEQLength 8
SOURce1:BB:C5G:CPLength 10
SOURce1:BB:C5G:RGUard?
// 52
SOURce1:BB:C5G:LGUard?
// 52
SOURce1:BB:C5G:BWOCcupied?
// 20.4
SOURce1:BB:C5G:SAMPling?
// 25.6
SOURce1:BB:C5G:SRATe:VARiation?
// 15360000

SOURce1:BB:C5G:FILTer:TYPE DCH
SOURce1:BB:C5G:FILTer:LENGth 74
SOURce1:BB:C5G:FILTer:SBATtenuation 60
SOURce1:BB:C5G:UFMC:NSUBand 34
SOURce1:BB:C5G:SUBCarriers?
// 12
SOURce1:BB:C5G:UFMC:PREequal?
// 0

// User settings
SOURce1:BB:C5G:USER0:DATA PN23
SOURce1:BB:C5G:USER0:PWR 1
SOURce1:BB:C5G:USER0:STATe 0
SOURce1:BB:C5G:USER0:STATe 1
// file 5g_datalist.dm_iqd must exsist in the default directory
SOURce1:BB:C5G:USER2:DATA DLIS
SOURce1:BB:C5G:USER2:LIST "/var/user/5g_datalist.dm_iqd"
SOURce1:BB:C5G:USER4:DATA PATT
SOURce1:BB:C5G:USER4:PATTern #H1C4A9,17
SOURce1:BB:C5G:USER4:STATe 0

// Allocation settings
SOURce1:BB:C5G:NALLoc 6
SOURce1:BB:C5G:ALLoc0:CONTent?
```

```
// PRE
SOURce1:BB:C5G:ALLoc0:SYNO 2
SOURce1:BB:C5G:ALLoc1:CONTent?
// DATA
SOURce1:BB:C5G:ALLoc1:MODulation QAM256
SOURce1:BB:C5G:ALLoc1:SCNO 100
SOURce1:BB:C5G:ALLoc1:SCOFfset 2
SOURce1:BB:C5G:ALLoc1:SYOFfset 2
SOURce1:BB:C5G:ALLoc1:DATA USER0
SOURce1:BB:C5G:ALLoc1:PHYSbits?
// 4000
SOURce1:BB:C5G:ALLoc1:STATe 1
SOURce1:BB:C5G:ALLoc2:SCNO 200
SOURce1:BB:C5G:ALLoc2:SYNO 2
SOURce1:BB:C5G:ALLoc2:SCOFfset 150
SOURce1:BB:C5G:ALLoc2:SYOFfset 2
SOURce1:BB:C5G:ALLoc2:DATA USER3
SOURce1:BB:C5G:ALLoc3:MODulation SCMA
SOURce1:BB:C5G:ALLoc3:SCNO 200
SOURce1:BB:C5G:ALLoc3:SYNO 2
SOURce1:BB:C5G:ALLoc3:SCOFfset 208
SOURce1:BB:C5G:ALLoc3:SYOFfset 4
SOURce1:BB:C5G:ALLoc3:PWR 3
SOURce1:BB:C5G:ALLoc4:CONFlict?
// 1
SOURce1:BB:C5G:ALLoc4:SCNO 90
SOURce1:BB:C5G:ALLoc4:SYNO 3
SOURce1:BB:C5G:ALLoc4:SCOFfset 110
SOURce1:BB:C5G:ALLoc4:SYOFfset 4
SOURce1:BB:C5G:ALLoc4:DATA USER5
SOURce1:BB:C5G:ALLoc5:MODulation SCMA
SOURce1:BB:C5G:ALLoc5:SCNO 252
SOURce1:BB:C5G:ALLoc5:SCOFfset 90
SOURce1:BB:C5G:ALLoc5:SYOFfset 7
SOURce1:BB:C5G:ALLoc3:SCMA:CODebook?
// 4
SOURce1:BB:C5G:ALLoc3:SCMA:NLAYers?
// 6
SOURce1:BB:C5G:ALLoc3:SCMA:SPRead?
// 4
SOURce1:BB:C5G:ALLoc3:SCMA:LAYer1:USER USER1
SOURce1:BB:C5G:ALLoc3:SCMA:LAYer1:STATe 0
SOURce1:BB:C5G:ALLoc3:SCMA:LAYer1:PWR?
// 0
SOURce1:BB:C5G:ALLoc3:SCMA:LAYer2:STATe 0
SOURce1:BB:C5G:ALLoc3:SCMA:LAYer4:STATe 0
SOURce1:BB:C5G:ALLoc5:SCMA:LAYer0:STATe 0
SOURce1:BB:C5G:ALLoc5:SCMA:LAYer3:STATe 0
SOURce1:BB:C5G:ALLoc5:SCMA:LAYer5:STATe 0
SOURce1:BB:C5G:ALLoc4:CONFlict?
```

```
// 0
SOURce1:BB:C5G:ALLoc5:CONFlict?
// 0

SOURce1:BB:C5G:STATe
SOURce1:BB:C5G:WAVeform:CREate "/var/user/5g_ufmc.wv"
```



**[:SOURce<hw>]:BB:C5G:NALLoc** <NoOfAlloc>

Sets the number of scheduled allocations.

**Parameters:**

<NoOfAlloc> integer

Range: 0 to 30
*RST: 2

**Example:** See Example "Generating a UFMC waveform" on page 61.

**Manual operation:** See "Number of Allocations" on page 31

**[:SOURce<hw>]:BB:C5G:ALLoc<ch0>:MODulation** <BaseModType>

Sets the modulation type of an allocation.

**Parameters:**

<BaseModType> BPSK | QPSK | QAM16 | QAM64 | QAM256 | SCMA

*RST: QPSK

**Example:** See Example "Generating a UFMC waveform" on page 61.

**Manual operation:** See "Modulation" on page 31

**[:SOURce<hw>]:BB:C5G:ALLoc<ch0>:SCNO** <NoOfSubcarriers>

Sets the number of allocated subcarriers.

**Parameters:**

<NoOfSubcarriers> integer

Range: 1 to 13107
*RST: 1

**Example:** See Example "Generating a UFMC waveform" on page 61.

**Manual operation:** See "No. SC" on page 31

---

**[:SOURce<hw>]:BB:C5G: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 UFMC waveform" on page 61.

**Manual operation:** See "No. Sym." on page 31

---

**[:SOURce<hw>]:BB:C5G: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 UFMC waveform" on page 61.

**Manual operation:** See "Offset SC" on page 32

---

**[:SOURce<hw>]:BB:C5G: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 UFMC waveform" on page 61.

**Manual operation:** See "Offset Sym." on page 32

---

**[:SOURce<hw>]:BB:C5G:ALLoc<ch0>:PHYSbits?**

Queries the allocation size in bits.

**Return values:**
<PhysicalBits> integer

**Example:** See Example "Generating a UFMC waveform" on page 61.

**Usage:** Query only

**Manual operation:** See "Phys Bits" on page 32

---

**[:SOURce<hw>]:BB:C5G: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 61.

**Manual operation:** See "Data Source" on page 32

---

**[:SOURce<hw>]:BB:C5G: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 61.

**Manual operation:** See "Data Source" on page 32

---

**[:SOURce<hw>]:BB:C5G:ALLoc<ch0>:PATTern** <Pattern>

Sets a bit pattern as data source.

**Parameters:**
<Pattern> 64 bit

**Example:** See Example "Generating a UFMC waveform" on page 61.

**Manual operation:** See "Data Source" on page 32

---

**[:SOURce<hw>]:BB:C5G: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 UFMC waveform" on page 61.

**Manual operation:** See "ρ / dB" on page 33

---

**[:SOURce<hw>]:BB:C5G:ALLoc<ch0>:CONTent?**

Queries the content type.

**Return values:**

<ContentType> DATA | PREamble

**Example:** See Example "Generating a UFMC waveform" on page 61.

**Usage:** Query only

**Manual operation:** See "Content Type" on page 33

---

**[:SOURce<hw>]:BB:C5G:ALLoc<ch0>:STATe** <State>

Enables the allocation.

**Parameters:**

<State> 0 | 1 | OFF | ON

*RST: 0

**Example:** See Example "Generating a UFMC waveform" on page 61.

**Manual operation:** See "State" on page 34

---

**[:SOURce<hw>]:BB:C5G:ALLoc<ch0>:CONFlict?**

Returns `1`, if allocations overlap.

**Return values:**

<Conflict> 0 | 1 | OFF | ON

**Example:** See Example "Generating a UFMC waveform" on page 61.

**Usage:** Query only

**Manual operation:** See "Conflict" on page 34

## 5.7 SCMA Commands



**[:SOURce<hw>]:BB:C5G:ALLoc<ch0>:SCMA:NLAYers?**

Queires the number of layers.

**Return values:**
<NoOfLayers> integer

Range: 0 to 6
*RST: 6

**Example:** See Example "Generating a UFMC waveform" on page 61.

**Usage:** Query only

**Manual operation:** See "Number of Layers J" on page 36

**[:SOURce<hw>]:BB:C5G:ALLoc<ch0>:SCMA:SPRead?**

Queries the spreading factor.

**Return values:**
<SpreadFac> integer

Range: 0 to 4
*RST: 4

**Example:** See Example "Generating a UFMC waveform" on page 61.

**Usage:** Query only

**Manual operation:** See "Spreading Factor K" on page 35

**[:SOURce<hw>]:BB:C5G:ALLoc<ch0>:SCMA:CODebook?**

Queries the codebook size.

**Return values:**
<Codebook> integer

Range: 0 to 4
*RST: 4

**Example:** See Example "Generating a UFMC waveform" on page 61.

**Usage:** Query only

**Manual operation:** See "Codebook Size M" on page 36

**[:SOURce<hw>]:BB:C5G:ALLoc<ch0>:SCMA:LAYer<st0>:PWR?**

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

**Return values:**

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

**Example:** See Example "Generating a UFMC waveform" on page 61.

**Usage:** Query only

**Manual operation:** See "ρ / dB" on page 36

**[:SOURce<hw>]:BB:C5G:ALLoc<ch0>:SCMA:LAYer<st0>:STATe** <State>

Enables the layer (codebook).

**Parameters:**

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

**Example:** See Example "Generating a UFMC waveform" on page 61.

**Manual operation:** See "State" on page 36

**[:SOURce<hw>]:BB:C5G:ALLoc<ch0>:SCMA:LAYer<st0>:USER** <ScmaLayerUser>

Maps the users to the layers.

**Parameters:**

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

**Example:** See Example "Generating a UFMC waveform" on page 61.

**Manual operation:** See "User" on page 36

## 5.8 Trigger Commands

### Example: Configure and enable triggering

```
SOURce:BB:C5G:TRIGger:SEQuence SINGle
SOURce:BB:C5G:TRIGger:SLENgth 200

// the first 200 samples of the current waveform will be output after
// the next trigger event
// SOURce:BB:C5G:TRIGger:SEQuence ARETrigger
// SOURce:BB:C5G:TRIGger:SOURce EGT1
// external trigger signal must be provided at the USER connector
// SOURce:BB:C5G:TRIGger:EXTernal:SYNChronize:OUTPut ON
// SOURce:BB:C5G:TRIGger:EXTernal:DELay 200
// SOURce:BB:C5G:TRIGger:EXTernal:INHibit 100

// SOURce:BB:C5G:TRIGger:SOURce INTB
// the internal trigger signal from the other path must be used
// SOURce:BB:C5G:TRIGger:OBASeband:DELay 25
// SOURce:BB:C5G:TRIGger:OBASeband:INHibit 10

SOURce:BB:C5G:TRIGger:SEQuence AAUTo
SOURce:BB:C5G:TRIGger:SOURce INTernal
SOURce:BB:C5G:STAT ON
SOURce:BB:C5G:TRIGger:EXEC
```

### Example: Specifying delay and inhibit values in time units

```
SOURce1:BB:C5G:CLOCk 1000000
SOURce1:BB:C5G:TRIGger:SEQuence AAUT
SOURce1:BB:C5G:TRIGger:SOURce EGT1
SOURce1:BB:C5G:TRIGger:DELay:UNIT SAMP
SOURce1:BB:C5G:TRIGger:EXTernal1:DELay 100
SOURce1:BB:C5G:TRIGger:EXTernal1:RDELay?
// Response: 100

SOURce1:BB:C5G:TRIGger:DELay:UNIT TIME
SOURce1:BB:C5G:TRIGger:EXTernal1:TDELay 0.00001
SOURce1:BB:C5G:TRIGger:EXTernal1:RDELay?
// Response: 0.00001

SOURce1:BB:C5G:TRIGger:DELay:UNIT SAMP
SOURce1:BB:C5G:TRIGger:EXTernal1:DELay 10
```

**[:SOURce<hw>]:BB:C5G[: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 69.

**Manual operation:** See "Trigger Mode" on page 39

**[:SOURce<hw>]:BB:C5G:TRIGger:SOURce** <TrigSource>

Selects the trigger signal source and determines the way the triggering is executed. Provided are internal triggering by a command, external trigger signal via one of the provided local or global connectors and triggering by a signal from the other paths.

**Parameters:**

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

**INTernal**
Internal

**INTA | INTB**
Internal trigger from the other baseband

**EGT1 | EGT2**
External global trigger

**EGC1 | EGC2**
External global clock

**ELTRigger**
External local trigger

**ELCLock**
External local clock

**OBASeband|BEXTernal|EXTernal**
Provided only for backward compatibility with other R&S 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)

*RST: INTernal

**Example:** See Example "Configure and enable triggering" on page 69.

**Manual operation:** See "Trigger Source" on page 41

---

**[:SOURce<hw>]:BB:C5G:TRIGger:RMODe?**

Queries the status of waveform output.

**Return values:**

<TrigRunMode> STOP | RUN

*RST: STOP

**Example:** See Example "Configure and enable triggering" on page 69.

**Usage:** Query only

**Manual operation:** See "Running/Stopped" on page 40

---

**[:SOURce<hw>]:BB:C5G: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 69.

**Manual operation:** See "Trigger Signal Duration" on page 40

---

**[:SOURce<hw>]:BB:C5G: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 69.

**Manual operation:** See "Signal Duration Unit" on page 40

---

**[:SOURce<hw>]:BB:C5G:TRIGger:EXECute**

Executes an internal trigger event.

**Example:** See Example "Configure and enable triggering" on page 69.

**Usage:** Event

**Manual operation:** See "Execute Trigger" on page 40

---

**[:SOURce<hw>]:BB:C5G:TRIGger:ARM:EXECute**

Stops (arms) waveform output.

**Example:** See Example "Configure and enable triggering" on page 69.

**Usage:** Event

**Manual operation:** See "Arm" on page 40

---

**[:SOURce<hw>]:BB:C5G:TRIGger:EXTernal:SYNChronize:OUTPut** <TrigSyncOutpSta>

Enables/disables output of the signal synchronous to the external trigger event.

**Parameters:**

<TrigSyncOutpSta> 0 | 1 | OFF | ON

*RST: 1

**Example:** See Example "Configure and enable triggering" on page 69.

**Manual operation:** See "Sync. Output to External Trigger" on page 41

---

**[:SOURce<hw>]:BB:C5G: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 69.

**Manual operation:** See "External Delay Unit" on page 42

---

**[:SOURce<hw>]:BB:C5G:TRIGger:OBASeband:DELay** <TrigIntOthDelay>

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

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

**Example:** See Example "Configure and enable triggering" on page 69.

**Manual operation:** See "Trigger Delay/Specified Trigger Delay" on page 42

---

**[:SOURce<hw>]:BB:C5G:TRIGger:OBASeband:RDELay?**

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

**Return values:**
<IntOthRDelay> float
Range: 0 to 688
Increment: 250E-12
*RST: 0

**Example:** See Example "Specifying delay and inhibit values in time units" on page 69.

**Usage:** Query only

**Manual operation:** See "Actual External Delay" on page 43

---

**[:SOURce<hw>]:BB:C5G:TRIGger:OBASeband:TDELay** <IntOthTimeDelay>

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

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

**Example:** See Example "Specifying delay and inhibit values in time units" on page 69.

**Manual operation:** See "Trigger Delay/Specified Trigger Delay" on page 42

---

**[:SOURce<hw>]:BB:C5G: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 69.

**Manual operation:** See "External Trigger Inhibit" on page 42

---

**[:SOURce<hw>]:BB:C5G:TRIGger[:EXTernal]:DELay** <TrigExtDelay>

Specifies the trigger delay.

**Parameters:**

<TrigExtDelay> float

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

**Example:** See Example "Configure and enable triggering" on page 69.

**Manual operation:** See "Trigger Delay/Specified Trigger Delay" on page 42

---

**[:SOURce<hw>]:BB:C5G: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

**Example:** See Example "Specifying delay and inhibit values in time units" on page 69.

**Manual operation:** See "Trigger Delay/Specified Trigger Delay" on page 42

---

**[:SOURce<hw>]:BB:C5G:TRIGger:EXTernal:RDELay?**

Queries the time (in seconds) an external trigger event is delayed for.

**Return values:**

<TrigExtTimeResD> float

Range: 0 to 688
Increment: 250E-12
*RST: 0

**Example:** See Example "Specifying delay and inhibit values in time units" on page 69.

**Usage:** Query only

**Manual operation:** See "Actual External Delay" on page 43

---

**[:SOURce<hw>]:BB:C5G: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 69.

**Manual operation:** See "External Trigger Inhibit" on page 42

## 5.9 Marker Commands

**Example: Configure and enable standard marker signals**

```
SOURce:BB:C5G:TRIGger:OUTPut2:MODE?
// RESTart
SOURce:BB:C5G:TRIGger:OUTPut2:FOFFset 10
SOURce:BB:C5G:TRIGger:OUTPut2:ROFFset 20

SOURce:BB:C5G:TRIGger:OUTPut3:DELay 16

SOURce:BB:C5G:TRIGger:OUTPut:DELay:FIXed ON
SOURce:BB:C5G:TRIGger:OUTPut1:DELay:MINimum?
// 0
SOURce:BB:C5G:TRIGger:OUTPut1:DELay:MAXimum?
// 2000
```

**[:SOURce<hw>]:BB:C5G: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 75.

**Manual operation:** See "Marker Mode" on page 44

**[:SOURce<hw>]:BB:C5G:TRIGger:OUTPut<ch>:ROFFset** <MarkRiseOffs>
**[:SOURce<hw>]:BB:C5G: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 75.

**Manual operation:** See "Rise/Fall Offset" on page 44

**[:SOURce<hw>]:BB:C5G: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: 1E-3
*RST: 0
Default unit: Samples

**Example:** See Example "Configure and enable standard marker signals" on page 75.

**Manual operation:** See "Marker x Delay" on page 44

**[:SOURce<hw>]:BB:C5G:TRIGger:OUTPut:DELay:FIXed** <MarkDelFix>

Restricts the marker delay setting range to the dynamic range. The setting always affects every marker.

**Parameters:**

<MarkDelFix> 0 | 1 | OFF | ON

*RST: 0

**Example:** See Example "Configure and enable standard marker signals" on page 75.

**Manual operation:** See "Marker x Delay" on page 44

---

**[:SOURce<hw>]:BB:C5G:TRIGger:OUTPut<ch>:DELay:MINimum?**
**[:SOURce<hw>]:BB:C5G:TRIGger:OUTPut<ch>:DELay:MAXimum?**

Queries the marker delay.

**Return values:**

<MarkDelMax> float

Range: 0 to 16777215
Increment: 1E-3
*RST: 2000

**Example:** See Example "Configure and enable standard marker signals" on page 75.

**Usage:** Query only

**Manual operation:** See "Marker x Delay" on page 44

## 5.10 Clock Commands

**Example: Clock settings**

```
SOURce:BB:C5G:CLOCk:SOURce EGC1
SOURce:BB:C5G:CLOCk:MODE MSAM
SOURce:BB:C5G:CLOCk:MULTiplier 4
CLOCk:INPUt:FREQuency?
```



---

**[:SOURce<hw>]:BB:C5G:CLOCk:SOURce** <ClockSour>

Selects the clock source.

**Parameters:**

<Source> INTernal | EGC1 | EGC2 | ELCLock | EXTernal

**INTernal**
The instrument uses its internal clock reference

**EGC1|EGC2**
External global clock

**ELCLock**
External local clock

**EXTernal**
`EXTernal = EGC1`
Setting only; provided for backward compatibility with other R&S signal generators.

*RST: INTernal

**Example:** See Example "Clock settings" on page 77.

**Manual operation:** See "Clock Source" on page 46

---

**[:SOURce<hw>]:BB:C5G:CLOCk:MODE** <ClockMode>

Enters the type of externally supplied clock.

**Parameters:**

<ClockMode> SAMPle | MSAMp

*RST: SAMPle

**Example:** See Example "Clock settings" on page 77.

**Manual operation:** See "Clock Mode" on page 46

---

**[:SOURce<hw>]:BB:C5G:CLOCk:MULTiplier** <ClockSampMult>

Specifies the multiplier.

**Parameters:**

<ClockSampMult> integer

Range: 1 to 64
*RST: 4

**Example:** See Example "Clock settings" on page 77.

**Manual operation:** See "Clock Multiplier" on page 46

# 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: 5G Specifications, References, Documents with Further Information

## Symbols

**[1]:** Michailow, N.; Gaspar, I.; Krone, S.; Lentmaier, M.; Fettweis, G.
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**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

# Index

## Symbols



## A



## B



## C



## D



## E



## F



## G



## I



## L

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## P



## R



## S



## T



## U



## W