

R&S® AFQ100B-K264

Digital Standard ECMA-368 IEEE

802.15 3a (Ultra Wide Band)

Operating Manual



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This document describes the following software options:

- R&S®AFQ100B-K264
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The following abbreviations are used throughout this manual: R&S®AFQ is abbreviated as R&S AFQ, R&S®WinIQSIM2 is abbreviated as R&S WinIQSIM2

Contents

1	Preface	5
1.1	Documentation Overview.....	5
1.2	Typographical Conventions.....	6
2	Introduction	7
2.1	Physical Layer MB-OFDM.....	7
2.1.1	Band Groups.....	7
2.1.2	Band Hopping.....	8
2.1.3	UWB MB-OFDM Parameters.....	8
2.1.4	Transport Modes.....	10
2.2	UWB MB-OFDM Frame Structure and PPDU Format.....	11
2.2.1	PLCP Preamble.....	12
2.2.2	PLCP Header.....	12
2.2.3	PSDU.....	12
2.3	Protection.....	12
2.3.1	Data Scrambler.....	13
2.3.2	Convolutional Encoder.....	13
2.3.3	Bit Interleaving.....	13
2.3.4	Constellation Mapping and OFDM Modulator.....	14
3	UWB MB-OFDM User Interface	15
3.1	General Settings for UWB MB-OFDM Signals.....	15
3.2	PPDU Configuration.....	21
3.2.1	PSDU Settings.....	22
3.2.2	PLCP Preamble and PLCP Header.....	24
3.2.3	PPDU Graph.....	26
3.3	MAC Header.....	26
3.4	Resampling/Clipping.....	33
3.4.1	Resampling.....	34
3.4.2	Clipping.....	34
3.5	Marker Settings.....	35
4	Remote-Control Commands	37

4.1	General Commands.....	37
4.2	Clipping Settings.....	44
4.3	Marker Settings.....	46
4.4	PPDU Settings.....	49
	List of Commands.....	61
	Index.....	63

1 Preface

1.1 Documentation Overview

The user documentation for the R&S WinIQSIM2 consists of the following parts:

- Online Help system on the instrument,
- Documentation CD-ROM with:
 - Online help system (*.chm) as a standalone help,
 - Software Manual and User Manuals for the options,
 - Data sheet and specifications,
 - Links to useful sites on the R&S internet.

Online Help

The Online Help is embedded in the instrument's firmware. It offers quick, context-sensitive access to the complete information needed for operation and programming. The online help contains help on operating the R&S WinIQSIM2 and all available options.

Software Manual and User Manuals

The Software Manual is delivered with the software in PDF format on the Documentation CD-ROM. It provides the information needed to set up and start working with the software, as well as a detailed description of all instrument functions. Furthermore, it provides an introduction to remote control and a complete description of the remote control commands with programming examples. Basic operations and an example of setup are described.

The User Manuals are a supplement to the Software Manual. User Manuals are provided for each additional (software) option.

In the individual option manuals, the specific instrument functions of the option are described in detail. For additional information on default settings and parameters, refer to the data sheets. Basic information on operating the R&S WinIQSIM2 is not included in the option manuals.

Release Notes

The release notes describe new and modified functions, eliminated problems, and last minute changes to the documentation. The corresponding firmware version is indicated on the title page of the release notes. The current release notes are provided in the Internet.

Web Help

The web help provides online access to the complete information on operating the R&S WinIQSIM2 and all available options, without downloading. The content of the web help corresponds to the user manuals for the latest product version.

The web help is available from the R&S WinIQSIM2 product page at the Downloads > Web Help area.

1.2 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.
<i>Input</i>	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.

2 Introduction

The R&S WinIQSIM2 enables you to generate UWB MB-OFDM signals in accordance with the WiMedia Alliance and MultiBand OFDM Alliance Unapproved Release Candidate Version 1.2.

A brief description of the standard is given in the following. For a detailed description see the corresponding WiMedia Alliance and MultiBand OFDM Alliance specifications.

The R&S WinIQSIM2 simulates UWB MB-OFDM at the physical layer. A sequence of data packets with the frame structure defined by the standard is generated. A MAC header can be activated.

The following list gives an overview of the key feature provided by the R&S WinIQSIM2 for generating a UWB MB-OFDM signal:

- Physical Layer mode MB-OFDM
- Data rates 53.3 Mbps, 80 Mbps, 106.7 Mbps, 160 Mbps, 200 Mbps, 320 Mbps, 400 Mbps, 480 Mbps
- Modulation according to the standard:
 - QPSK for data rates from 53.3 to 200 Mbps
 - DCM for data rates from 320 to 480 Mbps
- Support of all standard compliant Time-Frequency Codes (TFC1 to TFC10), as well as configuration of user-definable hopping sequences.
- Generation of frames for both standard frame and burst mode
- Standard compliant and user-definable cover synchronization sequence, minimum and short inter-frame spacing interval duration for both burst and standard mode
- Data scrambling, bit interleaving and convolutional encoding can be activated or deactivated.
- Clipping for reducing the crest factor.

2.1 Physical Layer MB-OFDM

In the MB-OFDM (Multiband Orthogonal Frequency Division Multiplexing) approach, the available spectrum of 7.5 GHz (3100...10600 MHz) is divided into 14 bands, 528 MHz each. The information transmitted on each 528 MHz band is modulated using OFDM. OFDM distributes the data over 122 useful subcarriers with 4.125 MHz subcarrier spacing.

2.1.1 Band Groups

To achieve a MB-OFDM, the 528 MHz bands are grouped together into 6 band groups as shown on the figure below.

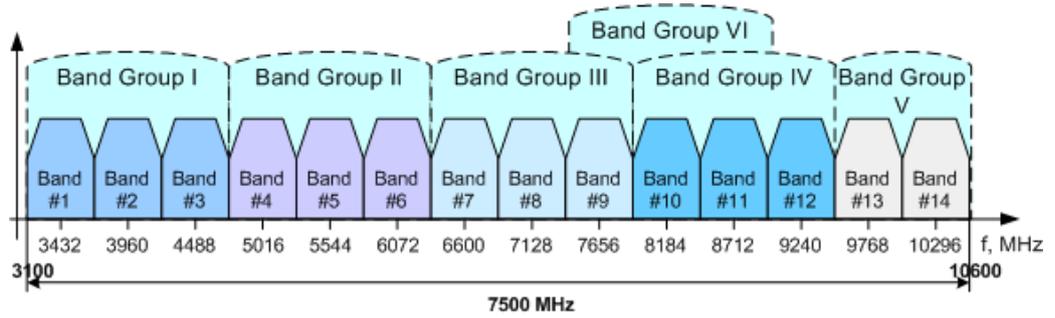


Fig. 2-1: MB-OFDM Frequency Band Plan

2.1.2 Band Hopping

A total number of 49 logical channels are achieved with the help of TFCs (Time-Frequency Code). For each of the band group 1, 2, 3, 4 and 6, 10 TFCs are defined. However, only three TFCs are used in band group 5.

The combination for the band group and TFC defines the band hopping within the selected band group. The band switching time is 9.47 ns.

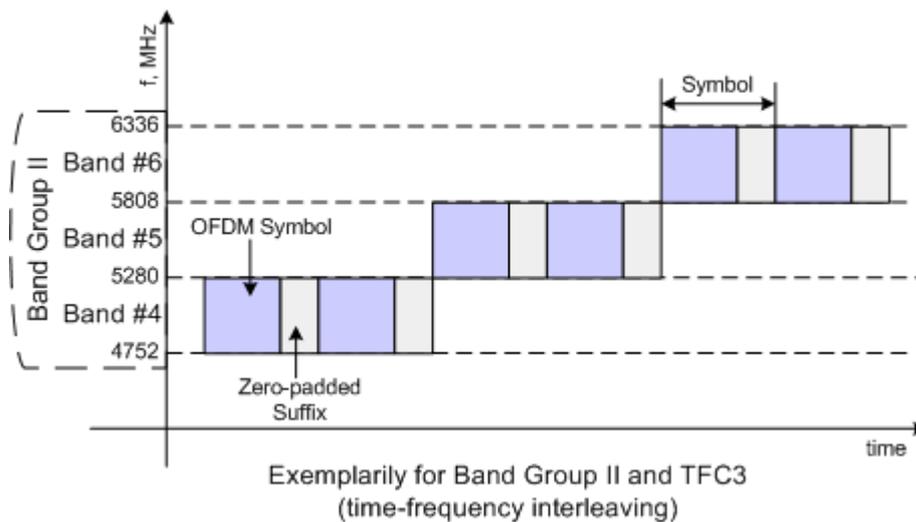


Fig. 2-2: Band Hopping

2.1.3 UWB MB-OFDM Parameters

The table below gives an overview of the main UWB MB-OFDM parameters.

Table 2-1: Parameters of UWB MB-OFDM modulation

Parameters	Value
Number of data subcarriers	100
Number of pilot subcarriers	12

Parameters	Value
Total of subcarriers used	122
Subcarrier frequency spacing	4.125 MHz
IFFT/FFT period	242.42 ns
Zero padded suffix duration	70.08 ns
Symbol interval	312.5 ns
Number of samples per zero padding suffix	37
Total number of samples per symbol	165
Symbol rate	3.2 MHz
Subcarrier modulation	QPSK (for data rates \leq 200 Mbps) DCM (for data rates $>$ 200 Mbps)
Code rates	1/3, 1/2, 5/8, 3/4

A 128 point IFFT is used to generate the 122 subcarriers (12 pilot subcarrier, 110 data subcarriers and 10 guard subcarriers). Six of the 128 possible carriers are not used (null subcarrier). One is the carrier in the middle of the band, which would otherwise be impaired by the carrier leakage of the I/Q modulator, the others are the remaining carriers at the upper and lower end of the spectrum. The figure below shows an example of the Band #1 (3168 - 3696 MHz).

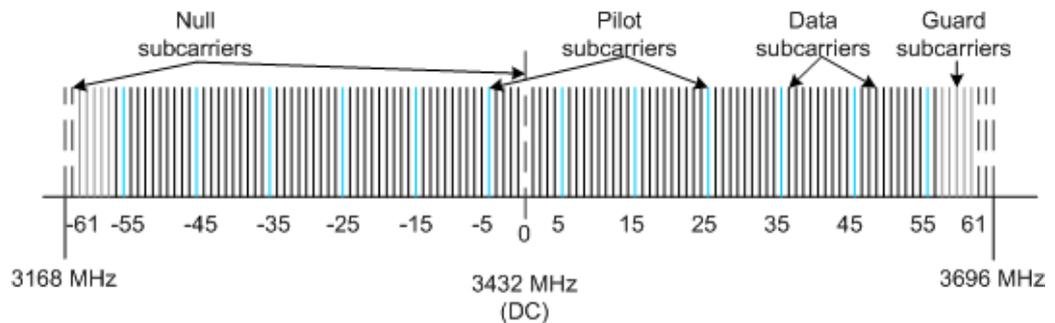


Fig. 2-3: Structure of UWB MB-OFDM Signal

The required subcarrier spacing of 4.125 MHz is implicitly observed when the time signal generated by the IFFT with a sampling rate of 528 MHz is output. An OFDM symbol generated in this way would have a period of 242.42 ns. To compensate for multipath propagation, a so-called zero-padded suffix with a duration of 70.08 ns is attached to each symbol so that a total symbol interval of 312.5 ns is obtained.

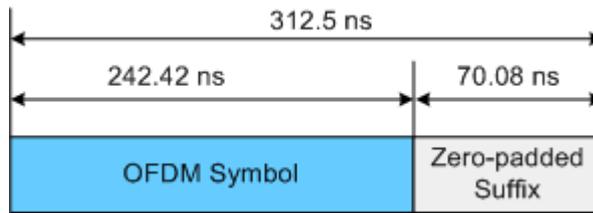


Fig. 2-4: OFDM Symbol

Either QPSK or DCM (Dual-Carrier Modulation) modulation can be used on the subcarriers. Prior to the modulation, the raw data are convolutionally coded with code rates of 1/3, 1/2, 5/8 and 3/4 being possible.

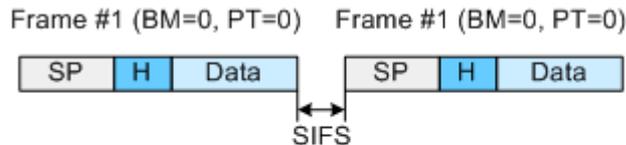
2.1.4 Transport Modes

At the physical level, the standard defines transmission of the frames in two modes, a standard (single frame) mode and a burst mode.

- Standard mode**

In standard transport mode, a single frame will be transmitted.

In this mode, the frames are separated by a SIFS (Short Inter Frame Spacing) interval.



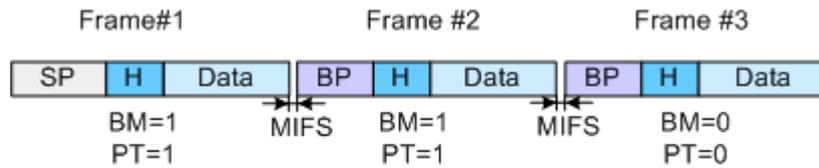
SP - Standard Preamble BM - Burst Mode
 BP - Burst Preamble PT - Preamble Type
 H - Header SIFS - Short Inter Frame Spacing

Fig. 2-5: Standard Transport Mode

- Burst mode**

A burst of frames from the same source will be transmitted.

The frames in the burst are separated by a minimum inter-frame separation interval (MIFS).



Exemplarily for Data Rate > 200Mbps, Burst Preamble Used
 and # Frames per Burst = 3

Fig. 2-6: Burst Transport Mode

2.2 UWB MB-OFDM Frame Structure and PPDU Format

The UWB MB-OFDM frame structure is very similar to the frame structure of other wireless formats, such as WLAN, etc.

The table below gives an overview of the UWB MB-OFDM physical parameters, related to the frame structure.

Table 2-2: Frame Structure of UWB MB-OFDM

Parameters	Value
PLCP Preamble Length	30 Symbols (standard preamble) 18 Symbols (burst preamble)
PLCP Preamble Duration	9.375 μ s (standard preamble) 5.625 μ s (burst preamble)
Packet/Frame Synchronization Length	24 Symbols (standard preamble) 12 Symbols (burst preamble)
Channel Estimation Sequence	6 Symbols (standard and burst preamble)
PLCP Header Duration	3.75 μ s
PLCP Header Rate	39.4 Mbps
PSDU Data Rate	53.3 Mbps, 80 Mbps, 106.7 Mbps, 160 Mbps, 200 Mbps, 320 Mbps, 400 Mbps, 480 Mbps
PSDU Frame Payload	0(standard preamble)/ 1(burst preamble)...4095 bytes

The data packet on the physical layer is referred to as PPDU (PLCP Protocol Data Unit). A PPDU consists of three components; the PLCP (Physical Layer Convergence Protocol) preamble, the PLCP header and the PSDU (PLCP Service Data Unit), which contains the actual information data (coming from higher layers).

The PLCP preamble and header are used for synchronization and signaling purposes, and are themselves divided into fields.

The figure below shows the frame structure (also indicated in the "PPDU Configuration" submenu).

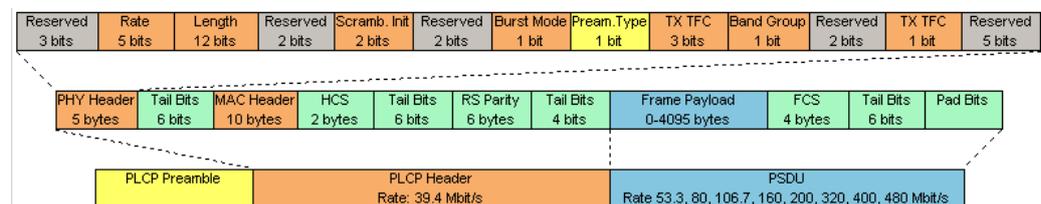


Fig. 2-7: UWB MB-OFDM Frame Structure

2.2.1 PLCP Preamble

Each frame starts with the PLCP preamble for time synchronization and channel estimation purposes. There are two PLCP preambles defined, a standard preamble for frames in standard mode and a burst preamble for frames in burst mode respectively.

The standard PLCP preamble is 9.375 µs long and thus corresponds to the duration of 30 OFDM symbols.

The burst PLCP preamble is 5.625 µs long that corresponds to the duration of 18 OFDM symbols.

Both the standard and the burst preamble can be subdivided into two parts: a packet/frame synchronization sequence and a channel sequence each created by spreading an appropriate base sequence with a cover sequence.

2.2.2 PLCP Header

The PLCP Header is sent at 39.4 Mbps and carries information about the data rate, the data length, the transport mode and preamble type, as well as the MAC Header.

Prior to scrambling, the PLCP Header is protected with shortened Reed-Solomon code (23, 17) and Header Check Sequence ($x^{16}+x^{12}+x^5+1$). Tail bits are added to reset the convolutional encoder to zero.

2.2.3 PSDU

The user data in the data section of the frame is finally taken to the receiver. The data section can be transmitted with one of the defined data rates between 53.3 and 480 Mbps. The data section of the frame is subdivided into the fields Payload, FCS (Frame Check Sequence), tail and pad bits.

The 6 tail bits are used to reset the convolutional coder to zero. The data field must be filled with the full number of OFDM symbols and is therefore rounded up. Additional bits that may be available are set to 0 as pad bits.

2.3 Protection

The R&S Signal Generator simulates UWB MB-OFDM signals in accordance with ECMA 368 on the physical layer. In the standard, the MAC sublayer provides the input data for this layer. The following graph illustrates the signal generation process.

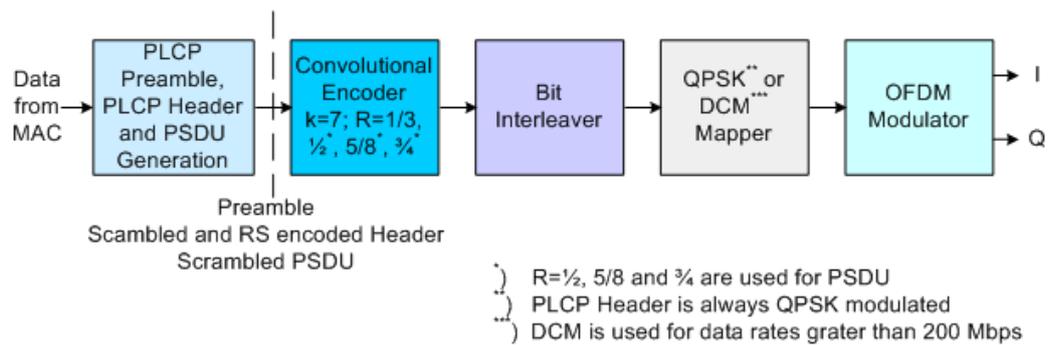


Fig. 2-8: Principle of UWB MB-OFDM signal generation

The scrambled and RS encoded PLCP Header and the scrambled PSDU are subjected to usual signal processing consisting of convolutional coding, interleaving, subcarrier modulation, pilot carrier generation and OFDM modulation.

2.3.1 Data Scrambler

Data from the source (the next higher protocol layer, the MAC) must first be scrambled, i.e. multiplied with a PN sequence. The standard defines a side-stream scrambler. The scrambling sequence is given by the following generator polynomial:

$$g(D)=1+D^{14}+D^{15}$$

The start value of the register is determined from the seed identifier contained in the PLCP Header.

2.3.2 Convolutional Encoder

A subsequent convolutional coder adds redundancies to the bits. The coder uses the rate $R=1/3$, has 64 possible states ($k = 7$) and is described by the polynomials $g_0=133_8$, $g_1=165_8$ and $g_2=171_8$.

To obtain the data rates of 53.3 to 480 Mbps defined by the standard, different channel code rates are required. Bits generated by the convolutional coder are therefore punctured (i.e. omitted) depending on the setting so that 1/2, 1/3, 3/4 or 5/8 code rates are attained.

Increasing the redundancy by channel coding is generally mandatory in case of OFDM modulations since complete subcarriers may be eliminated by frequency selective fading so that the loss of bits on the transmission path is in many cases unavoidable.

The PLCP header always has a data rate of 39.4 Mbps, and is therefore always encoded with rate $R=1/3$.

2.3.3 Bit Interleaving

To increase the performance of the convolutional coder, the coded data are interleaved in the next step. Employing frequency diversity within a band and across subcarriers

and time domain spreading, three interleaver stages ensure robustness against burst errors.

The adjacent bits of the convolutional coder are first symbol interleaved, i.e. the coded and padded bit stream is distributed across 6 consecutive OFDM symbols.

The second stage is the inter-symbol tone interleaving, which distributes the bits across the data subcarrier within one OFDM symbol.

Finally, the bits are cyclically shifted in successive OFDM symbols.

2.3.4 Constellation Mapping and OFDM Modulator

The coded and interleaved data sequence is mapped onto a complex constellation.

The PLCP header is always QPSK-modulated. Depending on the data rate, the useful carriers are subjected to a QPSK or DCM modulation. For data rate between 53.3 Mbps and 200 Mbps, the data sequence is mapped onto a QPSK constellation. A dual-carrier modulation (DCM) is employed for data with data rates between 320 Mbps and 480 Mbps.

3 UWB MB-OFDM User Interface



To access the dialog for setting the UWB MB-OFDM digital standard, select "Baseband Block > UWB MB-OFDM" or use the menu tree under "Baseband".

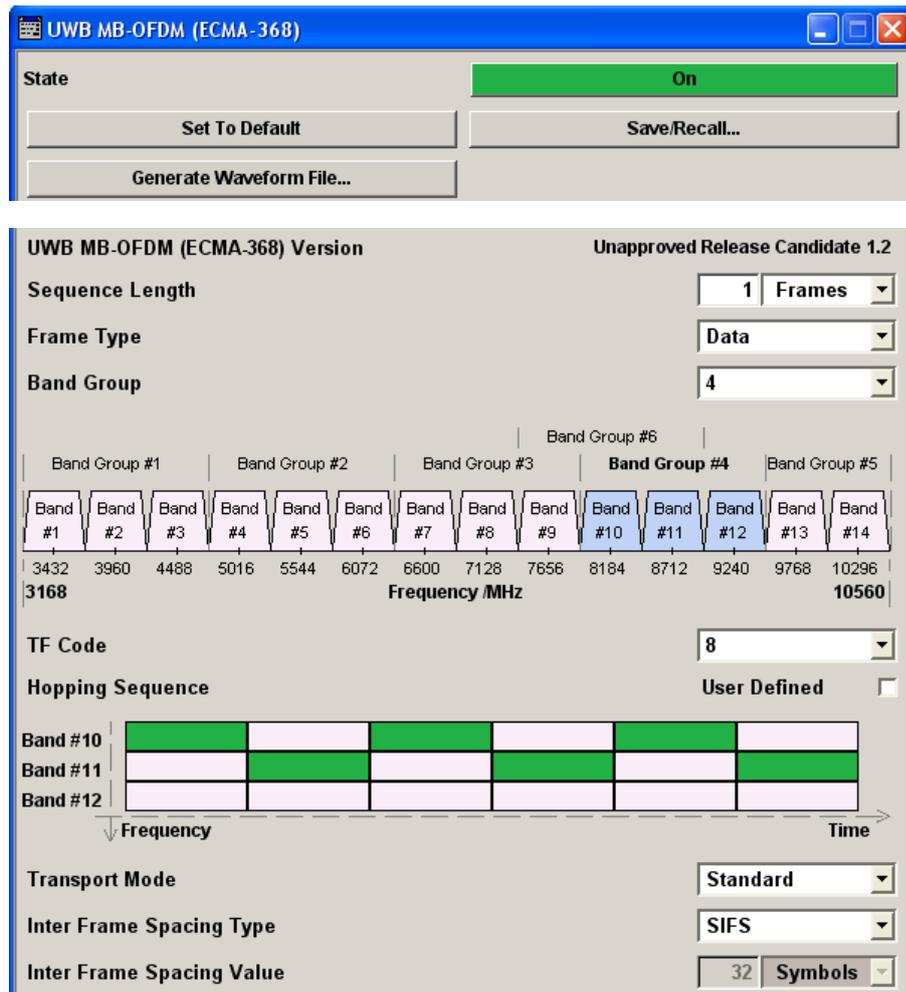
3.1 General Settings for UWB MB-OFDM Signals

The menu is split into several sections for configuring the standard.

The upper section of the menu is where the UWB MB-OFDM digital standard is enabled and the default settings are called.

In the middle section the sequence length, the frame type, the band group, the time-frequency code and the transport mode are selected.

The buttons of the lower menu section lead to submenus for configuring the PPDU and for setting the filter, clipping and marker parameters.





State

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

Remote command:

[:SOURce<hw>] :BB:UWBMB:STATe on page 42

Set to default

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

Parameter	Value
State	Not affected by "Set to default"
UWB MB-OFDM (ECMA-368) Version	Unapproved release Candidate 1.2
Sequence Length	1 Frame
Frame Type	Data
Band Group	I
TF Code	1
Hopping Sequence	User Defined Off
Transport Mode	Standard
Inter Frame Spacing Type	SIFS
Inter Frame Spacing Value	32 Symbols
Filter	Cosine
Clipping	Off
PPDU Configuration (QPSK, 200 Mbps)	
PDSU Data Rate	200 Mbps
PDSU Modulation	QPSK
PSDU Data Length	2048 bytes
PSDU Data Source	PN9
PLCP Cover Sequence	TF Code 1
PLCP Standard Preamble	++++ +++++ +++++ +++++ +---
Scrambler	On
Convolutional Encoder	On

Parameter	Value
Bit Interleaver	On
MAC Header	Off

Remote command:

[:SOURce<hw>] :BB:UWBMB:PRESet on page 40

Save/Recall

Calls the "Save/Recall" menu.

From the "Save/Recall" menu the "File Select" windows for saving and recalling UWB MB-OFDM configurations and the "File Manager" can be called.



UWB MB-OFDM configurations are stored as files with the predefined file extension * .uwb. The file name and the directory they are stored in are user-definable.

The complete settings in the "UWB MB-OFDM" menu are saved and recalled.

- "Recall UWB MB-OFDM setting" Opens the "File Select" window for loading a saved UWB MB-OFDM configuration. The configuration of the selected (highlighted) file is loaded by pressing the "Select" button.
- "Save UWB MB-OFDM setting" Opens the "File Select" window for saving the current UWB MB-OFDM signal configuration. The name of the file is specified in the "File name" entry field, the directory selected in the "save into" field. The file is saved by pressing the "Save" button.
- "File Manager" Calls the "File Manager". The "File Manager" is used to copy, delete and rename files and to create new directories.

Remote command:

[:SOURce<hw>] :BB:UWBMB:SETTing:CATalog? on page 40

[:SOURce<hw>] :BB:UWBMB:SETTing:LOAD on page 41

[:SOURce<hw>] :BB:UWBMB:SETTing:STORe on page 41

[:SOURce<hw>] :BB:UWBMB:SETTing:DELeTe on page 41

Generate Waveform File...

Calls the "Generate Waveform" menu. This menu is used to store the current UWB MB-OFDM signal as ARB signal in a waveform file.

This file can be loaded in the "ARB" menu and processed as multicarrier or multisegment signal.

The file name is entered in the submenu. The file is stored with the predefined file extension * .wv. The file name and the directory it is stored in are user-definable.

Remote command:

[:SOURce<hw>] :BB:UWBMB:WAVeform:CREate on page 44

UWB MB-OFDM (ECMA-368) Version

Displays the current version of the UWB MB-OFDM standard.

The default settings and parameters provided are oriented towards the specifications of the version displayed.

Remote command:

`[:SOURCE<hw>] :BB:UWBMb:VERSion?` on page 43

Sequence Length

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

Remote command:

`[:SOURCE<hw>] :BB:UWBMb:SEnGth` on page 42

Frame Type

Selects the frame type of the generated signal. The selection defines parameters of the MAC layer, e.g. the Frame Type and ACK Policy bit fields of the MAC Header.

"Data"	Frames containing useful data.
"Beacon"	Beacon frames will be generated. Beacons are used for synchronization to a shared channel.
"Control"	Control frames will be generated.
"Command"	Command frames will be generated.
"Aggregated"	Aggregated frames will be generated. The payload of these frames contains an aggregation header and multiple MSDUs (MAC service data units).

Remote command:

`[:SOURCE<hw>] :BB:UWBMb:FTYPE` on page 38

Band Group

Selects the band group for which a signal will be generated.

The selection of band group defines the signal parameter Time-Frequency Code ("TF Code"). The combination for the parameters "Band Group" and "TF Code" defines the band hopping within the selected band group (see also [chapter 2.1, "Physical Layer MB-OFDM"](#), on page 7). The currently selected hopping sequence is displayed in the TFC Graph.

Remote command:

`[:SOURCE<hw>] :BB:UWBMb:BGRoup` on page 38

Band Group Graph

In the band group graph, the currently selected band group is highlighted.

Remote command:

n.a.

TF Code

Selects the time-frequency code of the generated signal.

The value of the parameter "TF Code" depends on the selected "Band Group".

For band groups 1, 2, 3, 4 and 6, one of 10 possible TF Codes can be selected.

For band group 5 only three TF Codes (TF Code 5, 6 and 8) are enabled.

Depending on the standard TF Code selected here, the parameter [Cover Sequence \(Sync.\)](#) will be set.

The combination for the parameters "Band Group" and "TF Code" defines the band hopping within the selected band group (see also [chapter 2.1, "Physical Layer MB-OFDM"](#), on page 7).

The currently selected hopping sequence is displayed in the TFC Graph.

However, the user is enabled to re-configure any standard TF Code hopping sequence by simply double click on a band in the TFC Graph.

This will automatically enable parameter "Hopping Sequence User Defined" and the configured user hopping sequence will be saved as the last used user hopping sequence.

Disabling the parameter "Hopping Sequence User Defined" restores the last used standard TF Code pattern.

Any further enabling of the parameter "Hopping Sequence User Defined" restores the last used user hopping sequence.

The configuration of used redefined hopping sequence does not affect the selection made for the parameter "Cover Sequence".

Remote command:

[\[:SOURCE<hw>\]:BB:UWBMb:TFCode](#) on page 43

Hopping Sequence User Defined

Indicates a user definable hopping sequence. This parameter triggers the TFC Graph to display the last user defined hopping sequence.

The re-configuration of any standard TF Code hopping sequence by simply double click on a band in the TFC Graph automatically enables parameter "Hopping Sequence User Defined".

The configured user hopping sequence is saved as the last used user hopping sequence.

Disabling the parameter "Hopping Sequence User Defined" restores the last used standard TF Code pattern.

Any further enabling of the parameter "Hopping Sequence User Defined" restores the last used user hopping sequence.

Remote command:

[\[:SOURCE<hw>\]:BB:UWBMb:HSEquence:USER\[:STATE\]](#) on page 39

[\[:SOURCE<hw>\]:BB:UWBMb:HSEquence](#) on page 39

TFC Graph

The TFC graph indicates the selected band hopping mechanism, according to the selection made for the parameters "TF Code", "Band Group" and "Hopping Sequence User Defined".

The user is also enabled to re-configure any standard TF Code hopping sequence by simply double click on a band in the TFC Graph.

Remote command:

[:SOURce<hw>] :BB:UWBMb:HSEquence:USER [:STATe] on page 39

[:SOURce<hw>] :BB:UWBMb:HSEquence on page 39

Transport Mode

Selects the transport mode of the signal.

The selection defines the values enabled for the parameters "PLCP Preamble" and "Data Length".

- | | |
|------------|--|
| "Standard" | <p>In standard transport mode, a single frame will be transmitted. The frames are separated by a short inter-frame separation interval (SIFS).
According to the standard, the duration of the SIFS is 32 symbols but you can change it (see Inter Frame Spacing Value).
A frame in a standard mode uses always the Standard Preamble.</p> |
| "Burst" | <p>A burst of frames from the same source will be transmitted. The frames in the burst are separated by a minimum inter-frame separation time (MIFS).
According to the standard, the duration of the MIFS is 6 symbols but you can change it.
For "Data Rates" ≤ 200Mbps, all the frames will have a "Standard Preamble".
For "Data Rates" > 200Mbps, only the first frame uses the Standard Preamble; the rest of the frame may use standard or burst preamble (see Burst Preamble and Burst Preamble Used).
For burst transport mode the data length cannot be 0, i.e. the minimum Data Length is 1 byte.</p> |

Remote command:

[:SOURce<hw>] :BB:UWBMb:TMODe on page 43

Inter Frame Spacing Type

Selects the type of the Inter Frame Spacing Interval.

- | | |
|--------|--|
| "SIFS" | <p>Short Inter Frame Spacing Interval (SIFS) is the interval between two frames in standard transmission mode.
According to the standard, SIFS has duration of 32 Symbols.</p> |
| "MIFS" | <p>Minimum Inter Frame Spacing Interval (MIFS) is the interval between two frames in burst transmission mode.
According to the standard, MIFS has duration of 6 Symbols.</p> |
| "User" | <p>The duration of the Inter Frame Spacing interval can be defined by the user (see "Inter Frame Spacing Value" on page 20).</p> |

Remote command:

[:SOURce<hw>] :BB:UWBMb:IFS:TYPE on page 39

Inter Frame Spacing Value

Displays the duration in symbols of the Inter Frame Spacing interval, depending on the selection made for the parameter "Inter Frame Spacing Type".

For "Inter Frame Spacing Type" set to SIFS or MIFS, the value is read-only.

For "Inter Frame Spacing Type" set to User, the duration can be defined by the user.

Remote command:

[:SOURce<hw>] :BB:UWBMb:IFS:VALUE on page 40

PPDU Configuration

Calls the menu for configuration of the PPDU. The current setting is displayed next to the button.

The menu is described in [chapter 3.2, "PPDU Configuration"](#), on page 21.

Remote command:

n.a.

Resampling/Clipping...

Calls the menu for setting the clipping and resampling. The current setting is displayed next to the button.

The menu is described in [chapter 3.4, "Resampling/Clipping"](#), on page 33.

Remote command:

n.a.

Marker...

Calls the menu for configuring the marker signals (see [chapter 3.5, "Marker Settings"](#), on page 35).

Remote command:

n.a.

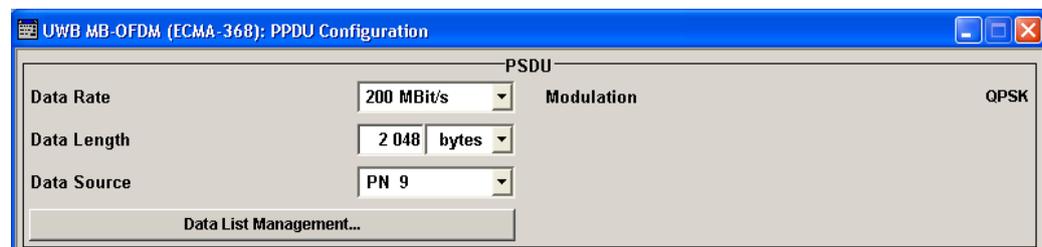
3.2 PPDU Configuration

In the upper section of the menu, the parameters of the data part (PSDU) such as data rate, data length, and data source are set.

In the middle section, the PLCP Preamble and PLCP Header are configured.

In the lower section, enabling and disabling of the scrambler, bit interleaver and convolution encoder is possible.

A graph in the lower sections illustrates the structure of the PPDU.



For standard transport mode (see [Transport Mode](#)), the minimum data length is 0 bytes.

For burst transport mode however, the data length cannot be 0, i.e. the minimum data length is 1 byte.

Remote command:

[:SOURce<hw>] :BB:UWBMb:PPDU:DLENgth on page 52

Data Source

Selects the data source for the data field.

"All 0, All 1" 0 data or 1 data is internally generated.

"PNxx" PRBS data in accordance with the IUT-T with period lengths between 2^9-1 and $2^{23}-1$ are internally generated.

"Pattern" A user-definable bit pattern with a maximum length of 64 bits is internally generated.

The bit pattern is defined in the "Pattern" input box.

Data Pattern	0000 0000 0000 0000 0011 1111 1111 1111 1111
--------------	---

"Data List..." Data lists will be used.

Data lists can be generated internally in the data editor or externally. Data lists are selected in the "File Select" window, which is called by means of the "Data List Management" button.

The "File Manager" is used to transmit external data lists to the R&S Signal Generator, and can be called within every File Select window by means of the "File Manager" button.

Remote command:

[:SOURce<hw>] :BB:UWBMb:PPDU:DATA on page 51

[:SOURce<hw>] :BB:UWBMb:PPDU:DATA:PATtern on page 52

[:SOURce<hw>] :BB:UWBMb:PPDU:DATA:DSElect on page 52

Data List Management...

Calls the "Data List Management" menu. This menu is used to create and edit a data list.



All data lists are stored as files with the predefined file extension *.dm_iqd. The file name and the directory they are stored in are user-definable.

Note: All data lists are generated and edited by means of the `SOURce:BB:DM` subsystem commands. Files containing data lists usually end with *.dm_iqd. The data lists

are selected as a data source for a specific function in the individual subsystems of the digital standard.

Remote command:

[:SOURce<hw>] :BB:UWBMb:PPDU:DATA on page 51

[:SOURce<hw>] :BB:UWBMb:PPDU:DATA:DSElect on page 52

3.2.2 PLCP Preamble and PLCP Header

Cover Sequence (Sync.)

Selects which cover sequence will be used to spread the packet/frame synchronization sequence of the PLCP preamble.

The parameter is automatically set depending on the selection made for the parameter "TF Code". However, the Cover Sequence is always enabled for re-configuration.

"For TF Code 1...10" Standard compliant cover sequence will be used to spread the synchronization sequence of the PLCP preamble (see tables below). Each of the cover sequences can be selected, irrespective of the selected "Band Group".

The cover sequence for standard preamble is a 24 symbols long sequence. A "+" corresponds to 1 and a "-" to -1 respectively.

Table 3-2: Cover Sequences for Standard Preamble

For TF Code 1, 2	++++ +++++ +++++ +++++ +++++ +---
For TF Code 3, 4	++++ +++++ +++++ +++++ +++- +-+-
For TF Code 5,6,7	---- -+ -+- -+- -+- -+- -+-
For TF Code 8,9,10	++- +- -+- +- -+- +++++ +- -

The cover sequence for burst preamble is a 12 symbols long sequence. A "+" corresponds to 1 and a "-" to -1 respectively.

Table 3-3: Cover Sequences for Burst Preamble

For TF Code 1, 2	++++ +++++ +---
For TF Code 3, 4	++++ +++- +-+-
For TF Code 5,6,7	---+ +- -+-
For TF Code 8,9,10	++- +++++ +- -

If one of the standard compliant cover sequences is selected, the used sequence is displayed as "Standard Preamble" and/or "Burst Preamble", depending on the selected "Transport Mode".

"User" The cover sequence can be defined by the user. Depending on the selected "Transport Mode", either the "Standard Preamble" and/or the "Burst Preamble" will be enabled for configuration.

Remote command:

[:SOURce<hw>] :BB:UWBMb:PPDU:CSSync on page 51

Standard Preamble

Displays the selected cover sequence used to spread the packet/frame synchronization sequence of the PLCP preamble.

The standard preamble is a 24 symbols long sequence. A "+" corresponds to 1 and a "-" to -1 respectively. The displayed sequence depends on the selected "Cover Sequence" (see [table 3-2](#)).

Note: This parameter is configurable only if the parameter "Cover Sequence (Sync.)" is set to User.

Remote command:

[:SOURCE<hw>] :BB:UWBMb:PPDU:SPreamble on page 60

Burst Preamble

Displays the selected cover sequence used to spread the packet/frame synchronization sequence of the PLCP preamble.

Note: This parameter is enabled only for "Burst Transport Mode", "Data Rate" greater than 200 Mbps and enabled "Burst Preamble Used".

The burst preamble is a 12 symbols long sequence. A "+" corresponds to 1 and a "-" to -1 respectively. The displayed sequence depends on the selected "Cover Sequence" (see [table 3-3](#)).

Note: This parameter is configurable only if the parameter "Cover Sequence (Sync.)" is set to User.

According to the standard, applying a Burst preamble for data rates greater than 200 Mbps is optional. Whether the selected Burst Preamble or a Standard Preamble will be used, can be configured with parameter "Burst Preamble Used".

Remote command:

[:SOURCE<hw>] :BB:UWBMb:PPDU:BPreamble on page 50

Burst Preamble Used

Enables/disables using of burst preamble.

Note: This parameter is enabled only for "Burst Transport Mode" and "Data Rate" greater than 200 Mbps.

According to the standard, applying a Burst preamble for data rates greater than 200 Mbps is optional.

"Burst Preamble Used" defines whether a burst preamble selected with a combination of the parameters "Cover Sequence" and "Burst Preamble" or a selected "Standard Preamble" will be used.

Remote command:

[:SOURCE<hw>] :BB:UWBMb:PPDU:BPreamble:USED on page 50

Configure MAC Header...

Calls the menu for configuration of the MAC Header.

The menu is described in [chapter 3.3, "MAC Header"](#), on page 26.

Remote command:

n.a.

Scrambler

Activates/deactivates the scrambler.

See [chapter 2.3.1, "Data Scrambler"](#), on page 13.

Remote command:

[:SOURce<hw>] :BB:UWBMb:PPDU:SCRambler:STATe on page 60

Convolutional Encoder

Activates/deactivates the coder.

See [chapter 2.3.2, "Convolutional Encoder"](#), on page 13.

Remote command:

[:SOURce<hw>] :BB:UWBMb:PPDU:ENCoder:STATe on page 53

Bit Interleaver

Activates/deactivates the interleaver.

See [chapter 2.3.3, "Bit Interleaving"](#), on page 13.

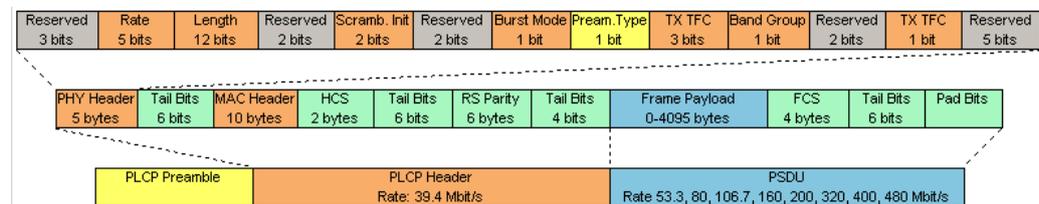
Remote command:

[:SOURce<hw>] :BB:UWBMb:PPDU:ILEaver:STATe on page 53

3.2.3 PPDU Graph

The frame graph in the lower part of the menu indicates the configuration of the PPDU.

A packet contains a PLCP Preamble, PLCP Header and PSDU payload. The general packet structure is described in [chapter 2.2, "UWB MB-OFDM Frame Structure and PPDU Format"](#), on page 11.

**3.3 MAC Header**

In the real UWB system, a MAC (medium access control) header is transmitted in the PSDU prior to the actual data section. This header comprises control information of the MAC layer and checksum for protection of the PSDU. In the MAC Header menu, several MAC fields can be configured.

MAC Header

Activates/deactivates the generation of the MAC Header for the PSDU.

If the MAC header is deactivated, all the MAC fields are set to 0.

If the MAC header is activated, most of the MAC header fields are enabled for operation. Exceptions are the MAC Frame Control Fields. The values of these fields are set automatically depending on the selection made for the parameter [Frame Type](#).

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

All values of the MAC fields are entered in hexadecimal form with LSB in right notation. In the data stream, the values are output standard-conformal with the LSB coming first.

Remote command:

[\[:SOURCE<hw>\]:BB:UWBMb:PPDU:MAC:SCONtrol:STATe](#) on page 59

Frame Control (hex)

Enters the value of the frame control field.

The Frame control field has a length of 2 bytes (16 bits) and is used to define the protocol version, the frame type, ACK policy, etc.

As an alternative, the individual bits can be set in the lower part of the graph.

The value of parameter "Frame Control" is automatically set according to the settings for the "MAC Frame Control Field" and vice versa.

Remote command:

[\[:SOURCE<hw>\]:BB:UWBMb:PPDU:MAC:FCONtrol](#) on page 54

Reserved

Sets the reserved bits.

Remote command:

[:SOURce<hw>] :BB:UWBMb:PPDU:MAC:FCONtrol:REServed on page 55

Retry

Sets the Retry bit.

Note: This parameter is enabled for data, aggregated data and command frames only. A value of 1 indicates that the current frame is a retransmission of an earlier frame.

Remote command:

[:SOURce<hw>] :BB:UWBMb:PPDU:MAC:FCONtrol:RETRy on page 55

Frame Subtype/ Delivery ID

Sets the frame Subtype/ Delivery ID bits. This field is used to assist a receiver in the proper processing of received frames.

Note: This parameter is not enabled for bacon frames.

For data and aggregated data frames, this field is used as Delivery ID. For control and command frames, this field is used as Frame Subtype.

Table 3-4: Control Frame Subtypes

Value	Frame Subtype
0000	Imm-Ack (Immediate Acknowledgement)
0001	B-ACK (Block Acknowledgement)
0010	RTS (Request to Send)
0011	CTS (Clear to Send)
0100	UDA (Unused DRP Reservation Announcement)
0101	UDR (Unused DRP Reservation Response)
0110 ... 1101	Reserved
1110	Application-specific
1111	Reserved

Table 3-5: Command Frame Subtypes

Value	Frame Subtype
0000	DRP (Distributed Reservation Protocol) Reservation Request
0001	DRP reservation Response
0010	Probe
0011	Pair-wise Temporal Key (PTK)
0100	Group Temporal Key (GTK)
0101	Range Measurement
0110 ... 1101	Reserved

Value	Frame Subtype
1110	Application-specific
1111	Reserved

The value of the Frame Subtype determines the allowed value of "Secure" bit.

Remote command:

[:SOURce<hw>] :BB:UWBMb:PPDU:MAC:FCONtrol:SUBType on page 56

Frame Type

Displays the value of the frame type bits. This parameter is automatically set depending on the selection made for the parameter "Frame Type".

Table 3-6: Frame Types

Value	Frame Type
000	Beacon Frame
001	Control Frame
010	Command Frame
011	Data Frame
100	Aggregated data frame
101, 110, 111	Reserved

Remote command:

[:SOURce<hw>] :BB:UWBMb:PPDU:MAC:FCONtrol:TYPE? on page 56

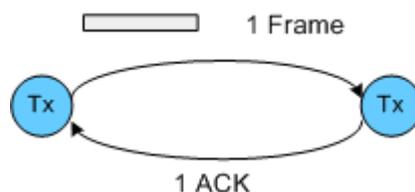
ACK Policy

Sets the ACK Policy bit, i.e. sets the type of acknowledgement requested by the transmitter. Acknowledgement policy is used if a verification of frame delivery is necessary.

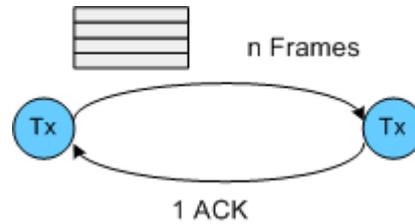
"00" "No-ACK Policy" is a transmission without acknowledgement. The frames are considered as successfully transmitted. This policy can be used for frames that do not require guaranteed delivery or for delay sensitive frames.



"01" "Imm-ACK Policy" is a transmission with an immediate individual acknowledgement of each frame after correct reception.



"10" "B(lock)-ACK Policy" allows a single-frame acknowledgement of multiple frame transmission. The acknowledgement frame is sent after receiving a request (B-ACK Request) from the transmitter.



"11" "B-ACK Request" indicates the last frame of a multiple frame transmission with B-ACK Policy. Upon receiving such a frame, the receiver answers with single frame.

Remote command:

[\[:SOURCE<hw>\]:BB:UWBMb:PPDU:MAC:FCONtrol:APOLicy](#) on page 54

Secure

Sets the secure bit.

A value of 1 indicates a secure frame. A Secure frame has special frame payload format and is protected with temporal keys.

The allowed value of the secure bit depends on the "Frame Type" and "Frame Sub-type".

Remote command:

[\[:SOURCE<hw>\]:BB:UWBMb:PPDU:MAC:FCONtrol:SECure](#) on page 56

Protocol Version

Enters protocol version.

Protocol Version must be set to 0 to be standard compliant.

Remote command:

[\[:SOURCE<hw>\]:BB:UWBMb:PPDU:MAC:FCONtrol:PVERsion](#) on page 55

Destination Address (hex)

Enters the destination address of the intended receiver.

Receiver can be:

- a single device by unicast transmission
- a group of devices for a multicast transmission or
- all devices in case of broadcast.

The destination address is 2 bytes long. The value is in hexadecimal form.

Remote command:

[\[:SOURCE<hw>\]:BB:UWBMb:PPDU:MAC:DADDRESS](#) on page 54

Source Address (hex)

Enters the address of the transmitter.

The source address is 2 bytes long. The value is in hexadecimal form.

Remote command:

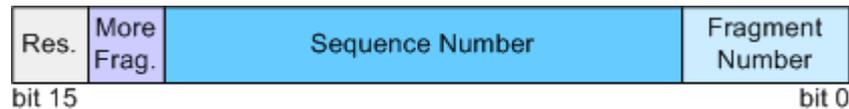
[\[:SOURCE<hw>\]:BB:UWBMb:PPDU:MAC:SADDRESS](#) on page 57

Sequence Control

Activates/deactivates the sequence control field.

Note: Sequence Control is not enabled for control frames.

The sequence control field has a length of 2 bytes and is divided in four parts, the fragment number field (3 bits), the sequence number field (11 bits), the more fragments bit (1 bit) and one reserved bit.



A long user data stream to be transmitted is first split up into MSDUs (MAC Service Data Units) which can either be transmitted as PSDU frames or further divided into fragments. The sequence number and the fragment number are then used to number the individual sub packets of the user data stream to be transmitted. Thus, all PSDUs are assigned a consecutive number. This allows the receiver to arrange the data packets in the correct order, to determine whether an incorrectly transmitted packet was retransmitted and to find out whether packets are missing.

If the receiver can detect a frame without an error and does not request a retransmission, the sequence number is incremented by 1 for each frame (the field is reset to 0 at the latest after a count of 1024). The fragment number field is incremented by 1 when another fragment of the current MPDU is transmitted. The start count for the transmission (normally 0) and the number of frames required to increment the corresponding counter can be defined for both numbers. This is done with the parameters "Start Number" and "Incremented every ... frame(s)" (see below).

Example:

An error-free transmission of 50 frames (no frame retransmission) is to be simulated. The sequence number should be incremented by 1 for each frame. Since no frame is fragmented, the fragment counter can always remain at 0.

In this case the following values have to be set:

If it is to be simulated that some frames are received incorrectly or if the response of the receiver should be tested when the same frame arrives several times, the number of frames required to increment the sequence number can be set to 2, for example.

Remote command:

`[:SOURce<hw>] :BB:UWBMb:PPDU:MAC:SCONtrol:STATe` on page 59

`[:SOURce<hw>] :BB:UWBMb:PPDU:MAC:SCONtrol:FRAGment:START`

on page 58

`[:SOURce<hw>] :BB:UWBMb:PPDU:MAC:SCONtrol:FRAGment:INCRement`

on page 57

`[:SOURce<hw>] :BB:UWBMb:PPDU:MAC:SCONtrol:FRAGment:MORE` on page 57

`[:SOURce<hw>] :BB:UWBMb:PPDU:MAC:SCONtrol:SEQuence:START`

on page 58

`[:SOURce<hw>] :BB:UWBMb:PPDU:MAC:SCONtrol:SEQuence:INCRement`

on page 58

Start Number

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

Remote command:

`[:SOURce<hw>] :BB:UWBMb:PPDU:MAC:SCONtrol:FRAGment:START`

on page 58

`[:SOURce<hw>] :BB:UWBMb:PPDU:MAC:SCONtrol:SEQuence:START`

on page 58

Increment Every

Defines the number of frames required to increment the counter of the fragment bits or the sequence bits of the sequence control (see example above).

Remote command:

`[:SOURce<hw>] :BB:UWBMb:PPDU:MAC:SCONtrol:FRAGment:INCRement`

on page 57

`[:SOURce<hw>] :BB:UWBMb:PPDU:MAC:SCONtrol:SEQuence:INCRement`

on page 58

More Fragments

Enables/disables sending of More Fragments.

Disabling of More Fragments sets the value of the bit to 0, i.e. the current fragment is the sole or the final fragment of the current MSDU or MCDU.

Enabling of More Fragments sets the value of the More Fragments bit to 1.

Remote command:

[:SOURce<hw>] :BB:UWBMb:PPDU:MAC:SCONtrol:FRAGment:MORE on page 57

Access Info

Sets the access information for the security functions.

Remote command:

[:SOURce<hw>] :BB:UWBMb:PPDU:MAC:AINFo on page 53

Frame Body

Indicates the length of the user data (frame body).

Remote command:

n.a.

FCS

Indicates the length of the check sum. The FCS is 4 bytes long that corresponds to a CRC polynomial of degree 31.

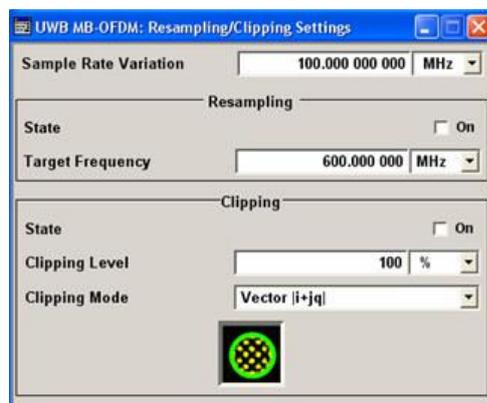
Remote command:

n.a.

3.4 Resampling/Clipping

The "Resampling/Clipping..." menu is reached via the UWB MB-OFDM main menu.

The sample rate variation, the resampling and clipping ("Clipping" section) are defined in this menu.



3.4.1 Resampling

Sample Rate Variation

Sets the sample rate of the signal.

A variation of this parameter only affects the ARB clock rate; all other signal parameters remain unchanged.

The sample rate depends on the selected digital standard and on the configured instrument. If the configured instrument is changed, the value range of this parameter is changed as well.

The default sample rate of the UWB MB-OFDM signal is 528 MHz.

Remote command:

[\[:SOURce<hw>\]:BB:UWBMb:SRATe:VARiation](#) on page 45

State Resampling

Enables/disables resampling of the signal.

Resampling has to be performed to match the waveform's sample rate to the one supported by an instrument.

If the resampling is activated, the software resampler interpolates the waveform to a clock rate of the frequency selected with the parameter "Target Frequency".

Remote command:

[\[:SOURce<hw>\]:BB:UWBMb:RESampling:STATe](#) on page 46

Target Frequency

Sets the target frequency for the resampled signal.

The target frequency has to be lower or equal to the maximum clock frequency of the target instrument.

Remote command:

[\[:SOURce<hw>\]:BB:UWBMb:RESampling:TF](#) on page 46

3.4.2 Clipping

The settings for clipping are collected in the "Clipping" section.

Clipping State

Switches baseband clipping on and off.

Baseband clipping is a very simple and effective way of reducing the crest factor of the UWB MB-OFDM signal.

High crest factors entail two basic problems:

- The nonlinearity of the power amplifier (compression) causes intermodulation which expands the spectrum (spectral regrowth).
- Since the level in the D/A converter is relative to the maximum value, the average value is converted with a relatively low resolution. This results in a high quantization noise.

Both effects increase the adjacent-channel power.

With baseband clipping, all the levels are limited to a settable value ("Clipping Level"). This level is specified as a percentage of the highest peak value. Since clipping is done prior to filtering, the procedure does not influence the spectrum. The EVM however increases. Since clipping the signal not only changes the peak value but also the average value, the effect on the crest factor is unpredictable.

Remote command:

`[:SOURCE<hw>] :BB:UWBMb:CLIPping:STATe` on page 45

Clipping Level

Sets the limit for clipping.

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

Remote command:

`[:SOURCE<hw>] :BB:UWBMb:CLIPping:LEVel` on page 44

Clipping Mode

Selects the clipping method. A graphic illustration of the way in which these two methods work is given in the menu.

"Vector $|i + jq|$ " The limit is related to the amplitude $|I + jQ|$. The I and Q components are mapped together, the angle is retained.



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



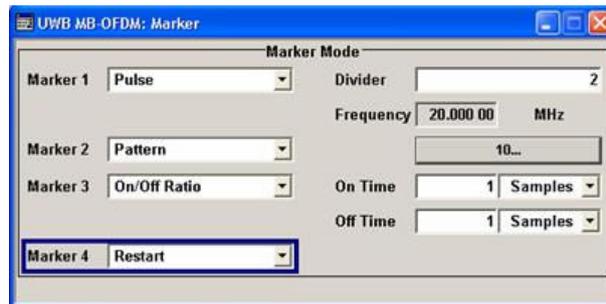
Remote command:

`[:SOURCE<hw>] :BB:UWBMb:CLIPping:MODE` on page 45

3.5 Marker Settings

The "Marker" dialog can be reached via the UWB MB-OFDM main menu.

The "Marker Mode" section is where the marker signals at the MARKER output connectors are configured.



Marker x Mode

Selects a marker signal for the associated MARKER output.

- "Restart" A marker signal is generated at the start of each signal sequence (period = selected number of frames).
- "Frame Start" A marker signal is generated at the start of each frame (period = PPDU).
- "Pulse" A regular marker signal is generated. The clock frequency is defined by entering a divider. The frequency is derived by dividing the chip rate by the divider. The input box for the divider opens when "Pulse" is selected, and the resulting pulse frequency is displayed below it.

Remote command:

`[:SOURce<hw>] :BB:UWBMb:TRIGger:OUTPut<ch>:PULSe:DIVider`

on page 48

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

on page 48

- "Pattern" A marker signal that is defined by a bit pattern is generated. The pattern has a maximum length of 32 bits and is defined in an input field which opens when "pattern" is selected.

Remote command:

`[:SOURce<hw>] :BB:UWBMb:TRIGger:OUTPut<ch>:PATtern` on page 48

- "ON/OFF ratio" A regular marker signal that is defined by an ON/OFF ratio is generated. A period lasts one ON and OFF cycle. The ON time and OFF time are each expressed as a number of samples and are set in an input field which opens when "ON/OFF ratio" is selected.



Remote command:

`[:SOURce<hw>] :BB:UWBMb:TRIGger:OUTPut<ch>:ONTime` on page 47

`[:SOURce<hw>] :BB:UWBMb:TRIGger:OUTPut<ch>:OFFTime` on page 47

Remote command:

`[:SOURce<hw>] :BB:UWBMb:TRIGger:OUTPut<ch>:MODE` on page 47

4 Remote-Control Commands

The following commands are required to perform signal generation with the UWB MB-OFDM option in a remote environment. We assume that the R&S WinIQSIM2 has already been set up for remote operation in a network as described in the R&S WinIQSIM2 documentation. A knowledge about the remote control operation and the SCPI command syntax are assumed.

The commands for defining the frame configuration are described in the next section. The commands are divided up in this way to make the comprehensive `SOURce:BB:UWBMb` subsystem clearer.

Common Suffixes

The following common suffixes are used in remote commands:

Suffix	Value range	Description
<code>SOURce<hw></code>	[1]	available baseband signals
<code>OUTPut<ch></code>	1 .. 4	available markers



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, i.e. storing and loading settings, creating and accessing data lists, accessing files in a particular directory, etc.
- Information on regular trigger, marker and clock signals as well as filter settings, if appropriate.
- General instrument configuration, such as configuring networks and remote operation
- Using the common status registers

For a description of such tasks, see the R&S WinIQSIM2 operating manual.

The following commands specific to the UWB MB-OFDM are described here:

4.1 General Commands

<code>[:SOURce<hw>]:BB:UWBMb:BGRoup</code>	38
<code>[:SOURce<hw>]:BB:UWBMb:FTYPE</code>	38
<code>[:SOURce<hw>]:BB:UWBMb:HSEQUence</code>	39
<code>[:SOURce<hw>]:BB:UWBMb:HSEQUence:USER[:STATE]</code>	39
<code>[:SOURce<hw>]:BB:UWBMb:IFS:TYPE</code>	39
<code>[:SOURce<hw>]:BB:UWBMb:IFS:VALUE</code>	40
<code>[:SOURce<hw>]:BB:UWBMb:PRESet</code>	40
<code>[:SOURce<hw>]:BB:UWBMb:SETTING:CATalog?</code>	40

<code>[:SOURce<hw>]:BB:UWBMb:SETTing:DELeTe</code>	41
<code>[:SOURce<hw>]:BB:UWBMb:SETTing:LOAD</code>	41
<code>[:SOURce<hw>]:BB:UWBMb:SETTing:STORE</code>	41
<code>[:SOURce<hw>]:BB:UWBMb:SETTing:STORe:FAST</code>	42
<code>[:SOURce<hw>]:BB:UWBMb:SLENgth</code>	42
<code>[:SOURce<hw>]:BB:UWBMb:STATe</code>	42
<code>[:SOURce<hw>]:BB:UWBMb:TFCode</code>	43
<code>[:SOURce<hw>]:BB:UWBMb:TMODe</code>	43
<code>[:SOURce<hw>]:BB:UWBMb:VERSiOn?</code>	43
<code>[:SOURce<hw>]:BB:UWBMb:WAVeform:CREate</code>	44

`[:SOURce<hw>]:BB:UWBMb:BGRoup <BGroup>`

Selects the band group for which a signal will be generated.

Parameters:

`<BGroup>` BG1 | BG2 | BG3 | BG4 | BG5 | BG6
***RST:** BG1

Example: BB:UWBM:BGR BG2
 sets the band group 2.

Manual operation: See "[Band Group](#)" on page 18

`[:SOURce<hw>]:BB:UWBMb:FTYPE <FTYPE>`

Selects the frame type of the generated signal.

Parameters:

`<FTYPE>` DATA | BEACon | CONTrol | COMMand | AGGRegate

DATA

Frames containing useful data.

BEACon

Beacons are used for synchronization to a shared channel.

CONTrol

Control frames will be generated.

COMMand

Command frames will be generated.

AGGRegate

Aggregated frames will be generated. The payload of these frames contains an aggregation header and multiple MSDUs (MAC service data units).

***RST:** DATA

Example: BB:UWBM:FTYP CONTR
 sets the frame type to control.

Manual operation: See "[Frame Type](#)" on page 18

[:SOURCE<hw>]:BB:UWBMb:HSEquence <HSequence>

Sets a user defined hopping sequence.

Parameters:

<HSequence> string

Example:

BB:UWBM:HSEQ:USER:STAT ON

enables defining of user hopping sequence.

BB:UWBM:BGR BG1

selects the band group the hopping sequence will be defined for.

BB:UWBM:HSEQ 1,2,3,1,2,3

enables defining of user hopping sequence.

Manual operation: See ["Hopping Sequence User Defined"](#) on page 19

[:SOURCE<hw>]:BB:UWBMb:HSEquence:USER[:STATE] <State>

Enables/disables defining of user hopping sequence.

Parameters:

<State> 0 | 1 | OFF | ON

*RST: 0

Example:

BB:UWBM:HSEQ:USER:STAT ON

enables defining of user hopping sequence.

BB:UWBM:BGR BG1

selects the band group the hopping sequence will be defined for.

BB:UWBM:HSEQ 1,2,3,1,2,3

enables defining of user hopping sequence.

Manual operation: See ["Hopping Sequence User Defined"](#) on page 19

[:SOURCE<hw>]:BB:UWBMb:IFS:TYPE <Type>

Selects the frame type of the inter frame spacing interval.

Parameters:

<Type> SIFS | MIFS | USER

*RST: SIFS

Example:

BB:UWBM:TMOD BURST

sets the transmission mode to burst.

BB:UWBM:IFS:TYPE MIFS

sets the inter frame spacing type to MIFS.

BB:UWBM:IFS:VAL?

queries the duration of the inter frame spacing interval.

Response: '6'

Manual operation: See ["Inter Frame Spacing Type"](#) on page 20

[:SOURce<hw>]:BB:UWBMb:IFS:VALUE <Value>

Sets the duration in symbols of the inter frame spacing interval.

Parameters:

<Value> integer
 Range: 0 to 99
 Increment: 1
 *RST: 32(for SIFS); 6(for MIFS)

Example:

```
BB:UWBM:IFS:TYPE MIFS
sets the inter frame spacing type to MIFS.
BB:UWBM:IFS:VAL?
queries the duration of MIFS.
Response: '6'
BB:UWBM:IFS:TYPE SIFS
sets the inter frame spacing type to SIFS.
BB:UWBM:IFS:VAL?
queries the duration of SIFS.
Response: '32'
BB:UWBM:IFS:TYPE USER
sets the inter frame spacing type to User.
BB:UWBM:IFS:VAL 10
sets the inter frame spacing duration to 10 symbols.
```

Manual operation: See "[Inter Frame Spacing Value](#)" on page 20

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

Produces a standardized default for the UWB MB-OFDM standard.

All UWB MB-OFDM settings are preset.

Example: BB:UWBM:PRES
 resets all the UWB MB-OFDM settings to default values.

Usage: Event

Manual operation: See "[Set to default](#)" on page 16

[:SOURce<hw>]:BB:UWBMb:SETTING:CATalog?

Reads out the files with UWB MB-OFDM settings in the default directory. The default directory is set using command `M MEM:CDIRectory`. A path can also be specified, in which case the files in the specified directory are read. Only files with the file extension `*.uwb` will be listed.

Return values:

<Catalog> string

Example: `MMEM:CDIR 'D:\user\uwb'`
sets the default directory to D:\user\uwb.
`BB:UWBM:SETT:CAT?`
reads out all the files with UWB MB-OFDM settings in the default directory.
Response: 'uwb_1', 'uwb_2'
the files uwb_1 and uwb_2 are available.

Usage: Query only

Manual operation: See "[Save/Recall](#)" on page 17

[:SOURCE<hw>]:BB:UWBMb:SETTING:DELETE <Filename>

Deletes the selected file with UWB MB-OFDM settings. The directory is set using command `MMEM:CDIRECTORY`. A path can also be specified, in which case the files in the specified directory are read. The file extension may be omitted. Only files with the file extension `*.uwb` will be deleted.

Setting parameters:

<Filename> string

Example: `BB:UWBM:SETT:DEL 'uwb_2'`
deletes file uwb_3.

Usage: Setting only

Manual operation: See "[Save/Recall](#)" on page 17

[:SOURCE<hw>]:BB:UWBMb:SETTING:LOAD <Filename>

Loads the selected file with UWB MB-OFDM settings.. The directory is set using command `MMEM:CDIRECTORY`. A path can also be specified, in which case the files in the specified directory are read. The file extension may be omitted. Only files with the file extension `*.uwb` will be loaded.

Setting parameters:

<Filename> string

Example: `BB:UWBM:SETT:LOAD 'uwb_1'`
loads file uwb_1.

Usage: Setting only

Manual operation: See "[Save/Recall](#)" on page 17

[:SOURCE<hw>]:BB:UWBMb:SETTING:STORE <Filename>

Stores the current UWB MB-OFDM settings into the selected file. The directory is set using command `MMEM:CDIRECTORY`. A path can also be specified, in which case the files in the specified directory are read. Only the file name has to be entered. UWB MB-OFDM settings are stored as files with the specific file extensions `*.uwb`.

Setting parameters:

<Filename> string

Example:

BB:UWBM:SETT:STOR 'uwb_3'
stores the current settings into file uwb_3.

Usage:

Setting only

Manual operation: See ["Save/Recall"](#) on page 17

[:SOURce<hw>]:BB:UWBMb:SETTING:STORe:FAST <Fast>

Determines whether the instrument performs an absolute or a differential storing of the settings.

Enable this function to accelerate the saving process by saving only the settings with values different to the default ones.

Note: This function is not affected by the "Preset" function.

Parameters:

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

[:SOURce<hw>]:BB:UWBMb:SLENGth <SLength>

Selects the number of frames.

Parameters:

<SLength> integer
Range: 1 frame to 10000 frames
*RST: 1

Example:

BB:UWBM:SLEN 4
selects the generation of 4 frames.

Manual operation: See ["Sequence Length"](#) on page 18

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

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

Parameters:

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

Example:

SOURce1:BB:UWBMb:STATe ON

Manual operation: See ["State"](#) on page 16

[:SOURce<hw>]:BB:UWBMb:TFCODE <TfCode>

Selects the time-frequency code (TF Code) of the generated signal.

Note: For band group 5 (BB:UWBM:BGR BG5) only TFC5, TFC6, TFC8 and User are allowed.

Parameters:

<TfCode> TFC1 | TFC2 | TFC3 | TFC4 | TFC5 | TFC6 | TFC7 | TFC8 |
TFC9 | TFC10
*RST: TFC1

Example:

BB:UWBM:BGR BG5
sets the band group of the generated signal to 5.
BB:UWBM:TFC TFC5
sets the time-frequency code of the generated signal to TF Code 5.

Manual operation: See "[TF Code](#)" on page 18

[:SOURce<hw>]:BB:UWBMb:TMODE <TMode>

Selects the transport mode of the signal.

Parameters:

<TMode> STANdard | BURSt
*RST: STANdard

Example:

BB:UWBM:TMOD BURSt
sets the transport mode of the generated signal to Burst.

Manual operation: See "[Transport Mode](#)" on page 20

[:SOURce<hw>]:BB:UWBMb:VERSion?

The command queries the version of the WB MB-OFDM standard underlying the definitions.

Return values:

<Version> string

Example:

BB:UWBM:VERS?
queries the UWB MB-OFDM version.
Response: '1st Edition, Dec. 2005'
The version used is the 1st Edition, Dec. 2005

Usage: Query only

Manual operation: See "[UWB MB-OFDM \(ECMA-368\) Version](#)" on page 18

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

Creates a waveform using the current settings of the "UVW MB-OFDM" menu. The file name is entered with the command. The file is stored with the predefined file extension * .wv. The file name and the directory it is stored in are user-definable.

Setting parameters:

<Filename> string

Example:

BB:UWBM:STAT ON

activates modulation in accordance with the UBW MB-OFDM standard.

MMEM:CDIR 'D:\user\waveform'

sets the default directory to D:\user\waveform.

BB:UWBM:WAV:CRE 'uwb_1'

creates the waveform file uwb_1.wv in the default directory.

Usage: Setting only

Manual operation: See "[Generate Waveform File...](#)" on page 17

4.2 Clipping Settings

[:SOURce<hw>]:BB:UWBMb:CLIPping:LEVel.....	44
[:SOURce<hw>]:BB:UWBMb:CLIPping:MODE.....	45
[:SOURce<hw>]:BB:UWBMb:CLIPping:STATe.....	45
[:SOURce<hw>]:BB:UWBMb:SRATe:VARiation.....	45
[:SOURce<hw>]:BB:UWBMb:RESampling:STATe.....	46
[:SOURce<hw>]:BB:UWBMb:RESampling:TF.....	46

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

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

Level clipping is activated with SOUR:BB:UWBM:CLIP:STAT ON

Parameters:

<Level> integer

Range: 0 PCT to 100 PCT

Increment: 1

*RST: 100 PCT

Example:

BB:UWBM:CLIP:LEV 80PCT

sets the limit for level clipping to 80% of the maximum level.

BB:UWBM:CLIP:STAT ON

activates level clipping.

Manual operation: See "[Clipping Level](#)" on page 35

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

Sets the method for level clipping (Clipping).

Parameters:

<Mode> VECTor | SCALar

VECTor

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

SCALar

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

*RST: VECTor

Example:

BB:UWBM:CLIP:MODE SCAL

selects the absolute maximum of all the I and Q values as the reference level.

BB:UWBM:CLIP:LEV 80PCT

sets the limit for level clipping to 80% of this maximum level.

BB:UWBM:CLIP:STAT ON

activates level clipping.

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

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

Activates level clipping (Clipping). The value is defined with the command [SOURce:]BB:UWBMb:CLIPping:LEVel, the mode of calculation with the command [SOURce:]BB:UWBMb:CLIPping:MODE.

Parameters:

<State> 0 | 1 | OFF | ON

*RST: OFF

Example:

BB:UWBM:CLIP:STAT ON

activates level clipping.

Manual operation: See "[Clipping State](#)" on page 34

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

Sets the sample rate of the signal.

A variation of this parameter only affects the ARB clock rate; all other signal parameters remain unchanged.

Parameters:

<Variation> float

Range: 400 Hz to 40 MHz

*RST: 40 MHz

Example:

BB:UWBM:SRAT:VAR 4 MHz

sets the sample rate of the signal to 4 MHz.

Manual operation: See ["Sample Rate Variation"](#) on page 34

[:SOURce<hw>]:BB:UWBMb:RESampling:STATe <State>

Enables/disables resampling of the signal.

Resampling has to be performed to match the waveform's sample rate to the one supported by an instrument.

If the resampling is activated, the software resampler interpolates the waveform to a clock rate of the frequency selected with the command `BB:UWBM:RES:TF`.

Parameters:

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

Example: `BB:UWBM:RES:STAT ON`
 enables resampling.

Manual operation: See ["State Resampling"](#) on page 34

[:SOURce<hw>]:BB:UWBMb:RESampling:TF <Tf>

Sets the target frequency for the resampled signal.

The target frequency has to be lower or equal to the maximum clock frequency of the target instrument.

Parameters:

<Tf> integer
 Range: 100 MHz to 600 MHz
 *RST: 100 MHz

Example: `BB:UWBM:RES:TF 300`
 sets the target frequency to 300 MHz.

Manual operation: See ["Target Frequency"](#) on page 34

4.3 Marker Settings

This section lists the remote control commands, necessary to configure the markers.

OUTPut<ch>

The numeric suffix to `OUTPut` distinguishes between the available markers.

[:SOURce<hw>]:BB:UWBMb:TRIGger:OUTPut<ch>:MODE	47
[:SOURce<hw>]:BB:UWBMb:TRIGger:OUTPut<ch>:OFFTime	47
[:SOURce<hw>]:BB:UWBMb:TRIGger:OUTPut<ch>:ONTime	47
[:SOURce<hw>]:BB:UWBMb:TRIGger:OUTPut<ch>:PATTern	48
[:SOURce<hw>]:BB:UWBMb:TRIGger:OUTPut<ch>:PULSe:DIVider	48
[:SOURce<hw>]:BB:UWBMb:TRIGger:OUTPut<ch>:PULSe:FREQUENCY?	48

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

Defines the signal for the selected marker output.

Parameters:

<Mode>

REStart | FRAMe | PULSe | PATTeRn | RATIo

REStart

A marker signal is generated at the start of each signal sequence (period = selected number of frames; the sequence length is set with command `SOUR:BB:UWBMb:SLen`).

FRAMe

A marker signal is generated at the start of each frame (period = PPDU).

PATTeRn

A marker signal is generated according to the user defined pattern (command

`SOURce:BB:UWBMb:TRIGger:OUTPut:PATTeRn`).

PULSe

A pulsed marker signal is generated. The pulse frequency

RATIo

A marker signal corresponding to the Time Off / Time On specifications in the commands

`SOURce:BB:UWBMb:TRIGger:OUTPut:OFFT` and

`SOURce:BB:UWBMb:TRIGger:OUTPut:ONT` is generated.

*RST: REStart

Example:

`BB:UWBM:TRIG:OUTP2:MODE FRAM`

selects the frame marker signal on output MARKER 2.

Manual operation: See "[Marker x Mode](#)" on page 36

[[:SOURce<hw>]:BB:UWBMb:TRIGger:OUTPut<ch>:OFFTime <OffTime>

[[:SOURce<hw>]:BB:UWBMb:TRIGger:OUTPut<ch>:ONTTime <OnTime>

Sets the number of samples in a period (ON time + OFF time) during which the marker signal in setting `SOURce:BB:UWBMb:TRIGger:OUTPut:MODE RATIo` on the marker outputs is ON.

Parameters:

<OnTime>

integer

Range: 1 to $2^{24} - 1$ (16 777 215)

Increment: 1

*RST: 1

Example:

`BB:UWBM:TRIG:OUTP2:MODE FRAM`

selects a ratio marker signal on output MARKER 2.

`BB:UWBM:TRIG:OUTP2:ONT 200`

sets an ON time of 200 chips for marker 2.

Manual operation: See "[Marker x Mode](#)" on page 36

[:SOURce<hw>]:BB:UWBMb:TRIGger:OUTPut<ch>:PATTern <Pattern>

Defines the bit pattern used to generate the marker signal in the setting

SOURce:BB:UWBMb:TRIGger:OUTPut:MODE PATTern.

0 is marker off, 1 is marker on.

Parameters:

<Pattern> 32 bit pattern
*RST: #B,1

Example:

BB:UWBM:TRIG:OUTP2:PATT #B000000011111111,15
sets a bit pattern.

BB:UWBM:TRIG:OUTP2:MODE PATT

activates the marker signal according to a bit pattern on output
MARKER 2.

Manual operation: See "[Marker x Mode](#)" on page 36

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

Sets the divider for Pulse marker mode (SOUR:BB:UWBM:TRIG:OUTP:MODE PULSe).

The resulting pulse frequency is derived by dividing the symbol rate by the divider.

Parameters:

<Divider> integer
Range: 2 to 1024
*RST: 2

Example:

BB:UWBM:TRIG:OUTP2:PULS:DIV 10

sets the divider to 2 for the marker signal on output MARKER 2.

BB:UWBM:TRIG:OUTP2:FREQ?

queries the resulting pulse frequency of the marker signal.

Response: '4 000 000'

the resulting pulse frequency is 4 MHz.

Manual operation: See "[Marker x Mode](#)" on page 36

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

Queries the pulse frequency of the pulsed marker signal in the setting

SOURce:BB:UWBMb:TRIGger:OUTPut:MODE PULSe. The pulse frequency is
derived by dividing the symbol rate by the divider.

Return values:

<Frequency> float

- Example:** `BB:UWBM:TRIG:OUTP2:PULS:DIV 2`
sets the divider marker signal on output MARKER 2 to the value 2.
- `BB:UWBM:TRIG:OUTP2:MODE PULS`
enables the pulsed marker signal.
- `BB:UWBM:TRIG:OUTP2:PULS:FREQ?`
queries the pulse frequency of the marker signal.
- Response: '20 000 000'
the resulting pulse frequency is 20 MHz.
- Usage:** Query only
- Manual operation:** See "[Marker x Mode](#)" on page 36

4.4 PPDU Settings

The `SOURCE:BB:UWBM:PPDU` system contains commands for setting the characteristics of the data packet on the physical layer (PPDU).

<code>[:SOURCE<hw>]:BB:UWBMb:PPDU:BPreamble</code>	50
<code>[:SOURCE<hw>]:BB:UWBMb:PPDU:BPreamble:USED</code>	50
<code>[:SOURCE<hw>]:BB:UWBMb:PPDU:CSSync</code>	51
<code>[:SOURCE<hw>]:BB:UWBMb:PPDU:DATA</code>	51
<code>[:SOURCE<hw>]:BB:UWBMb:PPDU:DATA:DSElect</code>	52
<code>[:SOURCE<hw>]:BB:UWBMb:PPDU:DATA:PATtern</code>	52
<code>[:SOURCE<hw>]:BB:UWBMb:PPDU:DLEngh</code>	52
<code>[:SOURCE<hw>]:BB:UWBMb:PPDU:DRATe</code>	53
<code>[:SOURCE<hw>]:BB:UWBMb:PPDU:ENCOder:STATe</code>	53
<code>[:SOURCE<hw>]:BB:UWBMb:PPDU:ILEaver:STATe</code>	53
<code>[:SOURCE<hw>]:BB:UWBMb:PPDU:MAC:AINFo</code>	53
<code>[:SOURCE<hw>]:BB:UWBMb:PPDU:MAC:DADdress</code>	54
<code>[:SOURCE<hw>]:BB:UWBMb:PPDU:MAC:FCONtrol</code>	54
<code>[:SOURCE<hw>]:BB:UWBMb:PPDU:MAC:FCONtrol:APOLicy</code>	54
<code>[:SOURCE<hw>]:BB:UWBMb:PPDU:MAC:FCONtrol:PVERsion</code>	55
<code>[:SOURCE<hw>]:BB:UWBMb:PPDU:MAC:FCONtrol:REServed</code>	55
<code>[:SOURCE<hw>]:BB:UWBMb:PPDU:MAC:FCONtrol:RETRY</code>	55
<code>[:SOURCE<hw>]:BB:UWBMb:PPDU:MAC:FCONtrol:SECure</code>	56
<code>[:SOURCE<hw>]:BB:UWBMb:PPDU:MAC:FCONtrol:SUBType</code>	56
<code>[:SOURCE<hw>]:BB:UWBMb:PPDU:MAC:FCONtrol:TYPE?</code>	56
<code>[:SOURCE<hw>]:BB:UWBMb:PPDU:MAC:SADdress</code>	57
<code>[:SOURCE<hw>]:BB:UWBMb:PPDU:MAC:SCONtrol:FRAGment:INCRement</code>	57
<code>[:SOURCE<hw>]:BB:UWBMb:PPDU:MAC:SCONtrol:FRAGment:MORE</code>	57
<code>[:SOURCE<hw>]:BB:UWBMb:PPDU:MAC:SCONtrol:FRAGment:STARt</code>	58
<code>[:SOURCE<hw>]:BB:UWBMb:PPDU:MAC:SCONtrol:SEQuence:INCRement</code>	58
<code>[:SOURCE<hw>]:BB:UWBMb:PPDU:MAC:SCONtrol:SEQuence:STARt</code>	58
<code>[:SOURCE<hw>]:BB:UWBMb:PPDU:MAC:SCONtrol:STATe</code>	59
<code>[:SOURCE<hw>]:BB:UWBMb:PPDU:MAC:STATe</code>	59

[:SOURCE<hw>]:BB:UWBMb:PPDU:MODulation?	59
[:SOURCE<hw>]:BB:UWBMb:PPDU:SCRambler:STAtE	60
[:SOURCE<hw>]:BB:UWBMb:PPDU:SPReamble	60

[:SOURCE<hw>]:BB:UWBMb:PPDU:BPreable <BPreable>

Selects the burst preamble. The burst preamble is a 12 symbols long sequence. A "+" corresponds to 1 and a "-" to -1 respectively.

Note:

This parameter is enabled for configuration only for Cover Sequence set to User, Burst Transport Mode, Data Rate greater than 200 Mbps and enabled Burst Preamble.

For Cover Sequence set to one of the standard compliant sequences, burst preamble is read-only.

Parameters:

<BPreable> string
 *RST: ++++++++---

Example:

```
BB:UWBM:TMOD BURS
selects burst transport mode.
BB:UWBM:PPDU:CSS TFC3
sets the packet/frame synchronization cover sequence to TFC3.
BB:UWBM:PPDU:BPR?
queries the burst preamble.
Response: '++++++-+-+'
BB:UWBM:PPDU:CSS USER
sets the packet/frame synchronization cover sequence to user-
defined.
BB:UWBM:PPDU:DRAT DR320M
sets the data rate to 320 Mbps.
BB:UWBM:PPDU:BPR:USED ON
enables using the burst preamble.
BB:UWBM:PPDU:BPR "+-+-+-+-+-"
sets the burst preamble to '+-+-+-+-'.
```

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

[:SOURCE<hw>]:BB:UWBMb:PPDU:BPreable:USED <Used>

Enables/disables using of burst preamble.

Note:

This parameter is enabled only for Burst Transport Mode and Data Rate greater than 200 Mbps.

Parameters:

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

Example: BB:UWBM:TMOD BURSt
selects burst transport mode.
BB:UWBM:PPDU:DRAT DR320M
sets the data rate to 320 Mbps.
BB:UWBM:PPDU:BPR:USED OFF
enables using the burst preamble.

Manual operation: See "[Burst Preamble Used](#)" on page 25

[:SOURce<hw>]:BB:UWBMB:PPDU:CSSync <CsSync>

Selects which cover sequence will be used to spread the packet/frame synchronization sequence of the PLCP preamble.

Parameters:

<CsSync> TFC1 | TFC2 | TFC3 | TFC4 | TFC5 | TFC6 | TFC7 | TFC8 |
TFC9 | TFC10 | USER
*RST: TFC1

Example: BB:UWBM:PPDU:CSSync TFC3
sets the packet/frame synchronization cover sequence to TFC3.

Manual operation: See "[Cover Sequence \(Sync.\)](#)" on page 24

[:SOURce<hw>]:BB:UWBMB:PPDU:DATA <Data>

Determines the data source for the data field.

Parameters:

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

PNxx

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

DLISt

A data list is used. The data list is selected with the command
BB:UWBMB:PPDU:DATA:DSElect.

ZERO | ONE

Internal 0 and 1 data is used.

PATtern

Internal data is used. The bit pattern for the data is defined by
the command BB:UWBMB:PPDU:DATA:PATtern.

*RST: PN9

Example: BB:UWBM:PPDU:DATA PATT
selects as the data source for the data fields of burst 0, the bit
pattern defined with the following command.
BB:UWBM:PPDU:DATA:PATT #H3F,8
defines the bit pattern.

Manual operation: See "[Data Source](#)" on page 23

[:SOURCE<hw>]:BB:UWBMb:PPDU:DATA:DSElect <DSelect>

Selects the data list for the DLISt data source selection.

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

Parameters:

<DSelect> string

Example:

```
BB:UWBM:PPDU:DATA DLIS
selects the Data Lists data source.
MMEMoRY:CDIR 'D:\Lists\DM\IqData'
selects the directory for the data lists.
BB:UWBM:PPDU:MAC:DATA:DSEL 'uwb_list1'
selects file uwb_list1 as the data source. This file must be in
the directory D:\Lists\DM\IqData and have the file exten-
sion *.dm_iqd.
```

Manual operation: See ["Data Source"](#) on page 23

[:SOURCE<hw>]:BB:UWBMb:PPDU:DATA:PATtern <Pattern>

Determines the bit pattern for the PATtern selection. The maximum length is 64 bits.

Parameters:

<Pattern> integer
*RST: 0

Example:

```
BB:UWBM:PPDU:DATA PATT
selects as the data source for the data fields of burst 0, the bit
pattern defined with the following command.
BB:UWBM:PPDU:MAC:DATA:PATT #H3F,8
defines the bit pattern.
```

Manual operation: See ["Data Source"](#) on page 23

[:SOURCE<hw>]:BB:UWBMb:PPDU:DLENgth <DLength>

Sets the data length in bytes.

Parameters:

<DLength> integer
Range: 0 (standard transport mode) / 1 (burst transport mode) to 4095 Bytes
*RST: 2048

Example:

```
BB:UWBM:PPDU:DLEN 256
sets a data length of 256.
```

Manual operation: See ["Data Length"](#) on page 22

[[:SOURce<hw>]:BB:UWBMb:PPDU:DRATe <DRate>

Selects the data rate of the PSDU. The selection of the PSDU bit rate automatically determines the code rate of the convolutional coder and the subcarrier modulation.

Parameters:

<DRate> DR53M3 | DR80M | DR106M7 | DR160M | DR200M | DR320M |
DR400M | DR480M
*RST: 200

Example: BB:UWBM:PPDU:DRAT DR320M
sets a data rate to 320 Mbps.

Manual operation: See "[Data Rate](#)" on page 22

[[:SOURce<hw>]:BB:UWBMb:PPDU:ENCoder:STATe <State>

Activates/deactivates the coder.

Parameters:

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

Example: BB:UWBM:PPDU:ENC OFF
deactivates the coder.

Manual operation: See "[Convolutional Encoder](#)" on page 26

[[:SOURce<hw>]:BB:UWBMb:PPDU:ILEaver:STATe <State>

Activates/deactivates the interleaver.

Parameters:

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

Example: BB:UWBM:PPDU:ILE OFF
deactivates the interleaver.

Manual operation: See "[Bit Interleaver](#)" on page 26

[[:SOURce<hw>]:BB:UWBMb:PPDU:MAC:AINFo <AInfo>

Sets the access information for security functions.

The destination address is 2 bytes long.

Parameters:

<AInfo> integer
Range: #H0000,16 to #HFFFF,16
*RST: #H0000,16

Example: BB:UWBM:PPDU:MAC:AINF #H1FA5,16
set the access information to H1FA5,16.

Manual operation: See ["Access Info"](#) on page 33

[:SOURce<hw>]:BB:UWBMb:PPDU:MAC:DADDRESS <DAddress>

Enters the destination address of the intended receiver.

The destination address is 2 bytes long. The value is in hexadecimal form.

Parameters:

<DAddress> integer
 Range: #H0000,16 to #HFFFF,16
 *RST: #H0000,16

Example: BB:UWBM:PPDU:MAC:DADD #H8F5A,16
 set the value for the destination address.

Manual operation: See ["Destination Address \(hex\)"](#) on page 30

[:SOURce<hw>]:BB:UWBMb:PPDU:MAC:FCONTROL <FControl>

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

Parameters:

<FControl> integer
 Range: #H0000,16 to #HFFFF,16
 *RST: #HC000,16

Example: BB:UWBM:PPDU:MAC:FCON #H100A,16
 sets the value of the frame control field.

Manual operation: See ["Frame Control \(hex\)"](#) on page 27

[:SOURce<hw>]:BB:UWBMb:PPDU:MAC:FCONTROL:APOLICY <APolicy>

Sets the ACK Policy bit, i.e. sets the type of acknowledgement requested by the transmitter. Acknowledgement policy is used if a verification of frame delivery is necessary.

The ACK Policy field has a length of 2 bits.

Parameters:

<APolicy> integer
 Range: #H0,2 to #H3,2
 *RST: #H0,2

Example: BB:UWBM:PPDU:MAC:FCON:APOL #H2,2
 sets the acknowledgement type to Block-ACK.

Manual operation: See ["ACK Policy"](#) on page 29

[:SOURce<hw>]:BB:UWBMb:PPDU:MAC:FCONtrol:PVERsion <PVersion>

Enters protocol version.

The Protocol Version field has a length of 3 bits. Protocol Version must be set to 0 to be standard compliant.

Parameters:

<PVersion> integer
 Range: #H0,3 to #H7,3
 *RST: #H0,3

Example: BB:UWBM:PPDU:MAC:FCON:PVER #H1,3
 sets the value of the Protocol Version field.

Manual operation: See "[Protocol Version](#)" on page 30

[:SOURce<hw>]:BB:UWBMb:PPDU:MAC:FCONtrol:REServed <Reserved>

Sets the reserved bits.

The Reserved field has a length of 2 bits.

Parameters:

<Reserved> integer
 Range: #H0,2 to #H3,2
 *RST: #H0,2

Example: BB:UWBM:PPDU:MAC:FCON:RES #H1,2
 sets the value of the Reserved field.

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

[:SOURce<hw>]:BB:UWBMb:PPDU:MAC:FCONtrol:RETRy <Retry>

Sets the Retry bit.

Note:

This parameter is enabled for data, aggregated data and command frames only.

A value of 1 indicates that the current frame is a retransmission of an earlier frame.

The Retry field has a length of 1 bit.

Parameters:

<Retry> 0 | 1
 *RST: 0

Example: BB:UWBM:FTYP DATA
 sets the frame type to data.
 BB:UWBM:PPDU:MAC:FCON:RETR 1
 sets the value of the Retry field to 1, i.e. the current frame is a retransmission of an earlier frame.

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

[:SOURCE<hw>]:BB:UWBMB:PPDU:MAC:FCONTROL:SECURE <Secure>

Sets the secure bit.

A value of 1 indicates a secure frame. The Secure field has a length of 1 bit.

Parameters:

<Secure> 0 | 1
 *RST: 0

Example:

BB:UWBMB:PPDU:MAC:FCON:SEC 1
 sets the value of the Secure field to 1, i.e. the current frame is a secure frame.

Manual operation: See "[Secure](#)" on page 30

[:SOURCE<hw>]:BB:UWBMB:PPDU:MAC:FCONTROL:SUBTYPE <Subtype>

Sets the frame Subtype/ Delivery ID bits.

This field is used to assist a receiver in the proper processing of received frames.

Note:

This parameter is not enabled for bacon frames.

For data and aggregated data frames, this field is used as Delivery ID.

For control and command frames, this field is used as Frame Subtype.

The Frame Subtype/ Delivery ID field has a length of 4 bits.

Parameters:

<Subtype> integer
 Range: #H0,4 to #HF,4
 *RST: #H0,4

Example:

BB:UWBMB:FTYP CONT
 sets the frame type to control.
 BB:UWBMB:PPDU:MAC:FCON:SUBT #H3,4
 sets the frame subtype to CTS (Clear to Send).
 BB:UWBMB:FTYP COMM
 sets the frame type to control.
 BB:UWBMB:PPDU:MAC:FCON:SUBT #H3,4
 sets the frame subtype to PTK (Pair-wise Temporal Key).

Manual operation: See "[Frame Subtype/ Delivery ID](#)" on page 28

[:SOURCE<hw>]:BB:UWBMB:PPDU:MAC:FCONTROL:TYPE?

Queries the frame type set with the command BB:UWBMB:FTYPE.

The Frame Type (Frame Control) field has a length of 3 bits.

Return values:

<Type> integer

Example: BB:UWBM:FTYP AGGR
sets the frame type to aggregated.
BB:UWBM:PPDU:MAC:FCON:TYPE?
queries the frame type.
Response: '#H4,3'

Usage: Query only

Manual operation: See "[Frame Type](#)" on page 29

[:SOURCE<hw>]:BB:UWBMb:PPDU:MAC:SADDRESS <SAddress>

Enters the address of the transmitter.

The source address is 2 bytes long. The value is in hexadecimal form.

Parameters:

<SAddress> integer
Range: #H0000,16 to #HFFFF,16
*RST: #H0000,16

Example: BB:UWBM:PPDU:MAC:SADD #H5A3B,16
set the value for the destination address.

Manual operation: See "[Source Address \(hex\)](#)" on page 30

[:SOURCE<hw>]:BB:UWBMb:PPDU:MAC:SCONTROL:FRAGMENT:INCREMENT <Increment>

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

Parameters:

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

Example: BB:UWBM:PPDU:MAC:SCON:FRAG:INCR 2
two packets are required to increment the counter of the fragment bits.

Manual operation: See "[Sequence Control](#)" on page 31

[:SOURCE<hw>]:BB:UWBMb:PPDU:MAC:SCONTROL:FRAGMENT:MORE <More>

Enables/disables sending of More Fragments.

Parameters:

<More> 0 | 1
*RST: 0

Example: BB:UWBM:PPDU:MAC:SCON:FRAG:MORE 0
current fragment is the sole or the final fragment of the current MSDU or MCDU.

Manual operation: See ["Sequence Control"](#) on page 31

[:SOURCE<hw>]:BB:UWBMb:PPDU:MAC:SCONtrol:FRAGment:STARt <Start>

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

Parameters:

<Start> integer
Range: #H0,1 to #H7,1
*RST: #H0,1

Example: BB:UWBM:PPDU:MAC:SCON:FRAG:STAR #H4,1
sets the start value of the fragment bits of the sequence control.

Manual operation: See ["Sequence Control"](#) on page 31

**[:SOURCE<hw>]:BB:UWBMb:PPDU:MAC:SCONtrol:SEQuence:INCRement
<Increment>**

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

Parameters:

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

Example: BB:UWBM:PPDU:MAC:SCON:SEQ:INCR 2
two packets are required to increment the counter of the sequence bits.

Manual operation: See ["Sequence Control"](#) on page 31

[:SOURCE<hw>]:BB:UWBMb:PPDU:MAC:SCONtrol:SEQuence:STARt <Start>

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

Parameters:

<Start> integer
Range: #H0,11 to #HFFF,11
*RST: #H0,12

Example: BB:UWBM:PPDU:MAC:SCON:SEQ:STAR #HFF,11
sets the start value of the sequence bits of the sequence control.

Manual operation: See ["Sequence Control"](#) on page 31

[:SOURce<hw>] :BB:UWBMb:PPDU:MAC:SCONtrol:STATe <State>

Activates/deactivates the sequence control field.

Note:

Sequence Control is not enabled for control frames.

Parameters:

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

Example: BB:UWBM:PPDU:MAC:SCON:SEQ:STAT ON
 activates sequence control field.

Manual operation: See "[MAC Header](#)" on page 27

[:SOURce<hw>] :BB:UWBMb:PPDU:MAC:STATe <State>

Activates/deactivates the generation of the MAC Header.

Parameters:

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

Example: BB:UWBM:PPDU:MAC:SCON:STAT ON
 activates the generation of the MAC Header.

[:SOURce<hw>] :BB:UWBMb:PPDU:MODulation?

Queries the modulation type. The modulation mode depends on the selected PSDU data rate. (SOURce:BB:UWBM:PPDU:DRAT).

Return values:

<Modulation> QPSK | DCM

Example: BB:UWBM:PPDU:DRAT DR80M
 sets a data rate to 80 Mbps
 BB:UWBM:PPDU:MOD?
 queries the modulation mode.
 Response: "QPSK"
 BB:UWBM:PPDU:DRAT DR320M
 sets a data rate to 320 Mbps
 BB:UWBM:PPDU:MOD?
 queries the modulation mode.
 Response: "DCM"

Usage: Query only

Manual operation: See "[Modulation](#)" on page 22

[[:SOURce<hw>]:BB:UWBMb:PPDU:SCRambler:STATe <State>

Activates/deactivates the scrambler.

Parameters:

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

Example: BB:UWBM:PPDU:SCR OFF
 deactivates the scrambler.

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

[[:SOURce<hw>]:BB:UWBMb:PPDU:SPReamble <SPreamble>

Selects the standards preamble. The standard preamble is a 24 symbols long sequence. A "+" corresponds to 1 and a "-" to -1 respectively.

Note:

This parameter is enabled for configuration only for Cover Sequence set to User.

For Cover Sequence set to one of the standard compliant sequences, standard preamble is read-only.

Parameters:

<SPreamble> string
 *RST: ++++++++-----

Example: BB:UWBM:TMOD STAN
 selects standard transport mode.
 BB:UWBM:PPDU:CSS TFC3
 sets the packet/frame synchronization cover sequence to TFC3.
 BB:UWBM:PPDU:SPR?
 queries the standard preamble.
 Response: '+++++++-----'
 BB:UWBM:PPDU:CSS USER
 sets the packet/frame synchronization cover sequence to user-defined.
 BB:UWBM:PPDU:SPR "++++-----"
 'sets the standard preamble to '+-+-+-+-+-----'.

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

List of Commands

[[:SOURCE<hw>]:BB:UWBMB:BGRoup.....	38
[[:SOURCE<hw>]:BB:UWBMB:CLIPping:LEVel.....	44
[[:SOURCE<hw>]:BB:UWBMB:CLIPping:MODE.....	45
[[:SOURCE<hw>]:BB:UWBMB:CLIPping:STATe.....	45
[[:SOURCE<hw>]:BB:UWBMB:FTYPe.....	38
[[:SOURCE<hw>]:BB:UWBMB:HSEQuence.....	39
[[:SOURCE<hw>]:BB:UWBMB:HSEQuence:USER[:STATe].....	39
[[:SOURCE<hw>]:BB:UWBMB:IFS:TYPE.....	39
[[:SOURCE<hw>]:BB:UWBMB:IFS:VALUE.....	40
[[:SOURCE<hw>]:BB:UWBMB:PPDU:BPREamble.....	50
[[:SOURCE<hw>]:BB:UWBMB:PPDU:BPREamble:USED.....	50
[[:SOURCE<hw>]:BB:UWBMB:PPDU:CSSync.....	51
[[:SOURCE<hw>]:BB:UWBMB:PPDU:DATA.....	51
[[:SOURCE<hw>]:BB:UWBMB:PPDU:DATA:DSElect.....	52
[[:SOURCE<hw>]:BB:UWBMB:PPDU:DATA:PATtern.....	52
[[:SOURCE<hw>]:BB:UWBMB:PPDU:DLENgth.....	52
[[:SOURCE<hw>]:BB:UWBMB:PPDU:DRATe.....	53
[[:SOURCE<hw>]:BB:UWBMB:PPDU:ENCoder:STATe.....	53
[[:SOURCE<hw>]:BB:UWBMB:PPDU:ILEaver:STATe.....	53
[[:SOURCE<hw>]:BB:UWBMB:PPDU:MAC:AINFo.....	53
[[:SOURCE<hw>]:BB:UWBMB:PPDU:MAC:DADdress.....	54
[[:SOURCE<hw>]:BB:UWBMB:PPDU:MAC:FCONtrol.....	54
[[:SOURCE<hw>]:BB:UWBMB:PPDU:MAC:FCONtrol:APOLicy.....	54
[[:SOURCE<hw>]:BB:UWBMB:PPDU:MAC:FCONtrol:PVERsion.....	55
[[:SOURCE<hw>]:BB:UWBMB:PPDU:MAC:FCONtrol:REServed.....	55
[[:SOURCE<hw>]:BB:UWBMB:PPDU:MAC:FCONtrol:RETRy.....	55
[[:SOURCE<hw>]:BB:UWBMB:PPDU:MAC:FCONtrol:SECure.....	56
[[:SOURCE<hw>]:BB:UWBMB:PPDU:MAC:FCONtrol:SUBTYpe.....	56
[[:SOURCE<hw>]:BB:UWBMB:PPDU:MAC:FCONtrol:TYPE?.....	56
[[:SOURCE<hw>]:BB:UWBMB:PPDU:MAC:SADdress.....	57
[[:SOURCE<hw>]:BB:UWBMB:PPDU:MAC:SCONtrol:FRAGment:INCRement.....	57
[[:SOURCE<hw>]:BB:UWBMB:PPDU:MAC:SCONtrol:FRAGment:MORE.....	57
[[:SOURCE<hw>]:BB:UWBMB:PPDU:MAC:SCONtrol:FRAGment:STARt.....	58
[[:SOURCE<hw>]:BB:UWBMB:PPDU:MAC:SCONtrol:SEQuence:INCRement.....	58
[[:SOURCE<hw>]:BB:UWBMB:PPDU:MAC:SCONtrol:SEQuence:STARt.....	58
[[:SOURCE<hw>]:BB:UWBMB:PPDU:MAC:SCONtrol:STATe.....	59
[[:SOURCE<hw>]:BB:UWBMB:PPDU:MAC:STATe.....	59
[[:SOURCE<hw>]:BB:UWBMB:PPDU:MODulation?.....	59
[[:SOURCE<hw>]:BB:UWBMB:PPDU:SCRambler:STATe.....	60
[[:SOURCE<hw>]:BB:UWBMB:PPDU:SPREamble.....	60
[[:SOURCE<hw>]:BB:UWBMB:PRESet.....	40
[[:SOURCE<hw>]:BB:UWBMB:RESampling:STATe.....	46
[[:SOURCE<hw>]:BB:UWBMB:RESampling:TF.....	46
[[:SOURCE<hw>]:BB:UWBMB:SETTing:CATalog?.....	40
[[:SOURCE<hw>]:BB:UWBMB:SETTing:DELete.....	41
[[:SOURCE<hw>]:BB:UWBMB:SETTing:LOAD.....	41
[[:SOURCE<hw>]:BB:UWBMB:SETTing:STORe.....	41

[:SOURCE<hw>]:BB:UWBMb:SETTing:STORe:FAST.....	42
[:SOURCE<hw>]:BB:UWBMb:SLENgth.....	42
[:SOURCE<hw>]:BB:UWBMb:SRATe:VARiatiOn.....	45
[:SOURCE<hw>]:BB:UWBMb:STATe.....	42
[:SOURCE<hw>]:BB:UWBMb:TFCODE.....	43
[:SOURCE<hw>]:BB:UWBMb:TMODe.....	43
[:SOURCE<hw>]:BB:UWBMb:TRIGger:OUTPut<ch>:MODE.....	47
[:SOURCE<hw>]:BB:UWBMb:TRIGger:OUTPut<ch>:OFFTime.....	47
[:SOURCE<hw>]:BB:UWBMb:TRIGger:OUTPut<ch>:ONTime.....	47
[:SOURCE<hw>]:BB:UWBMb:TRIGger:OUTPut<ch>:PATTern.....	48
[:SOURCE<hw>]:BB:UWBMb:TRIGger:OUTPut<ch>:PULSe:DIVider.....	48
[:SOURCE<hw>]:BB:UWBMb:TRIGger:OUTPut<ch>:PULSe:FREQUency?.....	48
[:SOURCE<hw>]:BB:UWBMb:VERSion?.....	43
[:SOURCE<hw>]:BB:UWBMb:WAVeform:CREate.....	44

Index

A

Access Info 33, 53
ACK Policy 29, 54

B

Band Group 18, 20, 38, 43
Band Group Graph 18
Bit Interleaver 26, 53
Burst Preamble 25, 50
Burst Preamble Used 25, 50

C

Clipping Level 35, 44
Clipping Mode 35, 45
Convolutional Encoder 26, 53
Cover Sequence (Sync.) 24, 51
Crest factor - Clipping 34, 44
Crest factor – Clipping 45

D

Data Length 22, 52
Data List Management 23
Data Pattern 23
Data Rate 22, 53
Data Source 23
Default Settings 16, 40
Delete UWB MB-OFDM settings 17, 41
Delivery ID 28, 56
Destination Address 30, 54
Documentation Overview 5

E

Edit Data List 23

F

FCS 33
Filter, Clipping 21
Frame Body 33
Frame Control 27, 54
Frame Subtype 28, 56
Frame Type 18, 56
Frame Types 29, 38

G

Generate Waveform File 17

H

Hopping Sequence 39
Hopping Sequence State 39
Hopping Sequence User Defined 19

I

Increment every 32, 57, 58
Inter Frame Spacing Type 20, 39
Inter Frame Spacing Value 20, 40

L

Load UWB MB-OFDM settings 17, 41

M

Marker 21
Marker Mode 36, 47
Modulation 22, 59
More Fragments 33, 57

O

ON/OFF Ratio Marker 36, 47

P

Pattern 23, 52
PPDU Configuration 21
Protocol Version 30, 55
PSDU Data Source 51
Pulse Divider Marker 36, 48
Pulse Frequency Marker 36, 48

R

Recall UWB MB-OFDM settings 17, 41
Resampling State 34, 46
Reserved 28, 55
Retry 28, 55

S

Sample Rate Variation 34, 45
Save UWB MB-OFDM settings 17, 41
Save-Recall 17, 40
Scrambler 26, 60
Secure 30, 56
Sequence Control 31, 59
Sequence Length 18, 42
Set to default 16, 40
Source Address 30, 57
Standard Preamble 25, 60
Standard Settings 16, 40
Start Number 32, 58
State 16
State - Clipping 34, 45

T

Target Frequency 34, 46
TF Code 18, 43
TFC 18, 43
TFC Graph 19
Time-frequency Code 18, 43

V

Version 18, 43

W

Waveform File 17