

# R&S<sup>®</sup> SMW-K131

## LoRa

### User Manual



1178956102



**ROHDE & SCHWARZ**

User Manual

Version 02

This document describes the following software option:

- R&S®SMW-K131  
1414.6464.02

This manual describes firmware version FW 4.70.026.xx and later of the R&S®SMW200A.

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# 1 Preface

## 1.1 About this Manual

This user manual provides all the information **specific to the LoRa option R&S SMW-K131**. 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 LoRa option R&S SMW-K131**  
Introduction to and getting familiar with the option
- **About the LoRa**  
Background information on basic terms and principles in the context of the signal generation
- **LoRa 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 reference material such as application notes and specifications
- **List of remote commands**  
Alphabetical list of all remote commands described in the manual
- **Index**

### Contents and scope

This description assumes R&S SMW equipped with all available options. Depending on your model and the installed options, some of the functions may not be available on your instrument.

### 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 usage scenarios.

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

## 1.2 Documentation Overview

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

[www.rohde-schwarz.com/manual/smw200a](http://www.rohde-schwarz.com/manual/smw200a)

### 1.2.1 Getting Started Manual

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

### 1.2.2 User Manuals and Help

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

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

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

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

### 1.2.3 Tutorials

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

### 1.2.4 Service Manual

Describes the performance test for checking 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, <https://gloris.rohde-schwarz.com>).

### 1.2.5 Instrument Security Procedures

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

### 1.2.6 Basic Safety Instructions

Contains safety instructions, operating conditions and further important information. The printed document is delivered with the instrument.

### 1.2.7 Data Sheets and Brochures

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

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

See [www.rohde-schwarz.com/brochure-datasheet/smw200a](http://www.rohde-schwarz.com/brochure-datasheet/smw200a)

### 1.2.8 Release Notes and Open Source Acknowledgment (OSA)

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

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

See [www.rohde-schwarz.com/firmware/smw200a](http://www.rohde-schwarz.com/firmware/smw200a)

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

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

See [www.rohde-schwarz.com/application/smw200a](http://www.rohde-schwarz.com/application/smw200a) and [www.rohde-schwarz.com/manual/smw200a](http://www.rohde-schwarz.com/manual/smw200a)

## 2 Welcome to the LoRa Option

The R&S SMW-K131 is a firmware application that adds functionality to generate signals in accordance with LoRa modulation.

The R&S SMW-K131 features

- Generation of LoRa up-/downlink signals
- Generation of waveforms for LoRa up-/downlink signals
- Frame configuration including modulation, coding and data configuration
- Impairing the output signal:
  - Adding symbol timing error and frequency offset
  - Applying a frequency drift to the carrier frequency of the output signal

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

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

[www.rohde-schwarz.com/manual/SMW200A](http://www.rohde-schwarz.com/manual/SMW200A)

### Installation

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

## 2.1 Accessing the LoRa Dialog

### To open the dialog with LoRa settings

- ▶ In the block diagram of the R&S SMW, select "Baseband > LoRa".

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, it 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.

## 2.3 Notes on Screenshots

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

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

## 3 About the LoRa Option

### 3.1 Required Options

The basic equipment layout for generating LoRa signals includes the options:

- Option Standard or Wideband Baseband Generator (R&S SMW-B10/-B9) per signal path
- Option Baseband main module, one/two I/Q paths to RF (R&S SMW-B13/-B13T) or Option Wideband baseband main module two I/Q paths to RF (R&S SMW-B13XT)
- Option LoRa (R&S SMW-K131) per signal path
- Frequency option (e.g. R&S SMW-B1003)

To play back a signal from a waveform file created by the simulation software R&S WinIQSIM2, the corresponding R&S WinIQSIM2 digital standard option must be installed.

For more information, see data sheet.

### 3.2 About LoRa

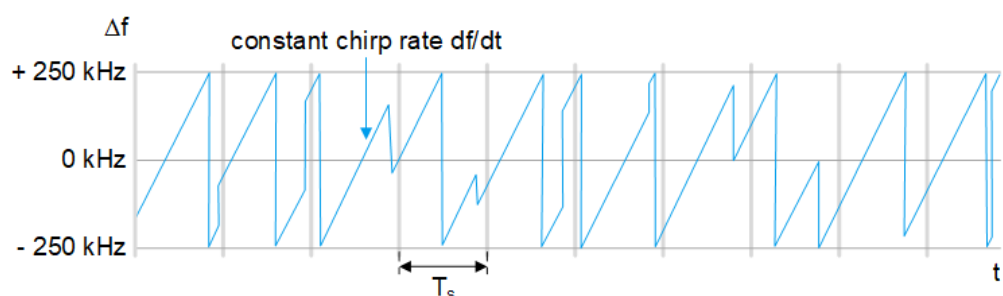
The term LoRa refers to a "Long Range" end-to-end communication technology based on a PHY with a proprietary modulation scheme. The standard is owned by Semtech Corporation, Camarillo California, USA.

#### Modulation

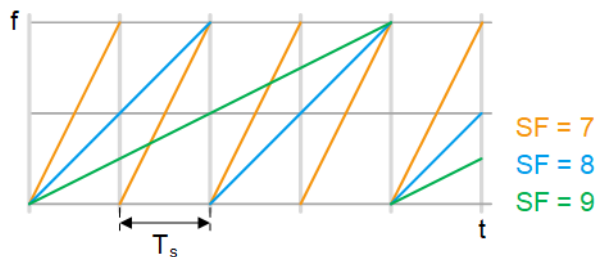
LoRa modulation is based on a proprietary CSS modulation scheme. The modulation scheme is used to encode data onto swept frequency chirps, i.e. rapid changes of the modulation frequency.

A chirp (compressed high intensity radar pulse) is a signal whose frequency changes at a fixed rate (chirp rate). Each modulation symbol is represented as a rapid change in the frequency of the chirp.

The spreading factor represents the number of encoded bits per symbol and thus the change in frequency per unit time.



The higher the spreading factor, the lower the change in frequency per unit time.



Chirp rate  $R_C$ , signal bandwidth  $\Delta f$ , spreading factor  $SF$ , sample rate  $R_S$ , symbol duration  $T_S$ , bit rate  $R_B$  and coding rate  $CR$  are linked as in the equations below. Furthermore, typical values are given for  $SF$ ,  $\Delta f$  and  $CR$ .

$$\text{Symbol rate: } R_S = 1 / T_S = \Delta f / 2^{SF} \quad | \quad 125 \text{ kHz} \leq \Delta f \leq 500 \text{ kHz};$$

$$\text{Chirp rate: } R_C = R_S * 2^{SF} = \Delta f \quad | \quad 7 \leq SF \leq 12;$$

$$\text{Bit rate: } R_B = SF * \Delta f / 2^{SF} * 4 / (4 + CR) \quad | \quad 1 \leq CR \leq 4$$

A coding rate  $CR = 0$  corresponds to no coding.

For related settings, see "[Modulation and Coding Configuration](#)" on page 19.

### Channel allocation

LoRa communication channels can be freely attributed by the network following the spectrum allocation rules defined by the regional radio regulation authorities. In Europe, the allocation rules are defined by [ETSI](#) in the specifications [ETSI Specification EN 300 220-1](#) and [CEPT/ERC Recommendation 70-03](#). In North America, the allocation rules are defined by [FCC](#) in the [FCC Specification 47 Part 15.247](#).

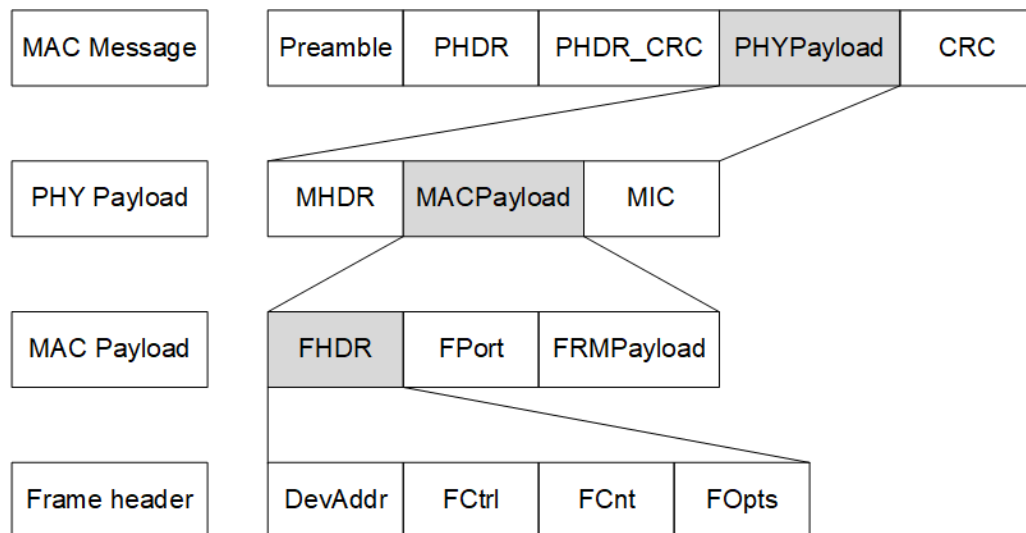
For detailed info about regional LoRa performance requirements, see [LoRaWAN Regional Parameters Specification](#).

**Table 3-1: Example: LoRaWAN regional parameters for Europe and North America**

Parameter	Europe (ETSI)	North America (FCC)
Frequency band	863 MHz to 869 MHz	902 MHz to 928 MHz
Number of channels	Up- and downlink: 10	Uplink: 64 x 125 kHz and 8 x 500 kHz Downlink: 8 x 500 kHz
Channel bandwidth	Uplink: 125 kHz and 250 kHz Downlink 125 kHz	Uplink: 125 kHz and 500 kHz Downlink: 500 kHz
TX power	Uplink: 14 dBm (20 dBm allowed) Downlink: 14 dBm	Uplink: 20 dBm (30 dBm allowed) Downlink: 27 dBm
Spreading factor	Uplink: 7 to 12	Uplink: 7 to 12
Data rate	250 bit/s to 50000 bit/s	980 bit/s to 21900 bit/s
Link budget	Uplink: 155 dB Downlink: 155 dB	Uplink: 154 dB Downlink: 157 dB

For related settings, see [Chapter 4.1, "General Settings"](#), on page 15.

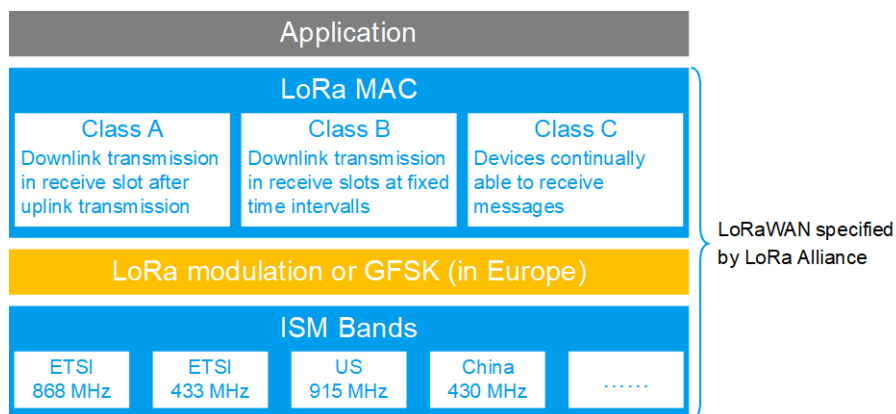
**Message and frame structure**



For related settings, see [Chapter 4.2, "Frame Configuration Settings"](#), on page 18.

### 3.3 About LoRaWAN

The LoRa Alliance, Inc. specifies a wide area network (WAN) stack for long range communication as shown in [Figure 3-1 \(1MA295\)](#). The LoRa modulation physical layer enables the long-range communication link. The LoRa MAC and application layers affect battery lifetime of the end-device, network capacity, quality of service and security.



**Figure 3-1: LoRaWAN stack**

**Network architecture**

A LoRaWAN architecture has a star-shaped structure as shown in Figure 3-2 (1MA295). End-devices exchange data with the network server via gateways. Also, the network server is connected to application servers, on which typically IoT applications run.

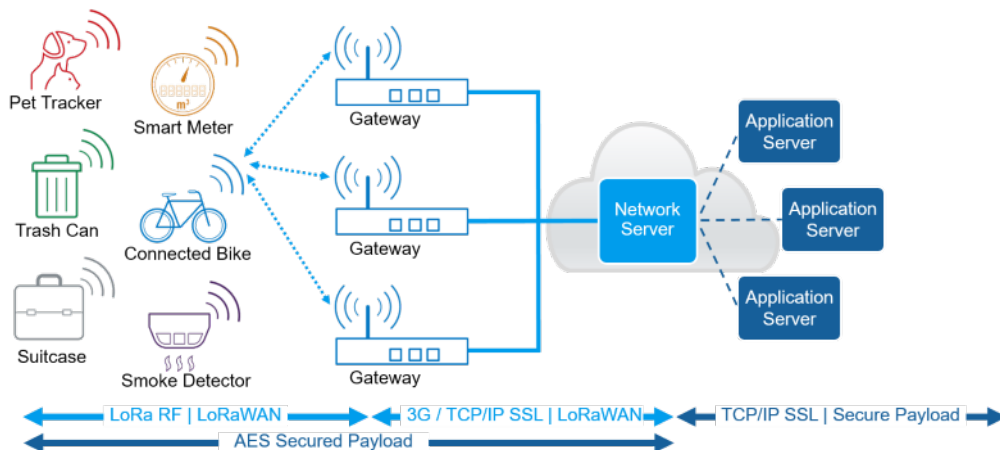


Figure 3-2: LoRaWAN network architecture

For more information, see the [LoRaWAN Specification](#).

**Device communication classes**

There are three classes specified for LoRaWAN compliant devices:

- **Class A:** Bi-directional end-devices (mandatory support)  
Bi-directional communication between LoRa network server and receiver. A scheduled uplink transmission slot (Transmit) is followed by two downlink receive slots (Rx 1 and Rx 2).

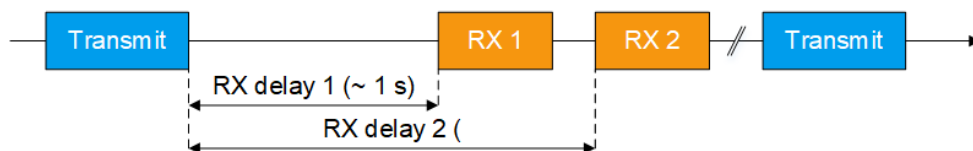


Figure 3-3: Class A communication

- **Class B:** Bi-directional end-devices with scheduled receive slots (optional support)  
Besides Class A communication, more downlink receive slots (Rx) are available due to a time synchronized periodic beacon signal (Beacon) from network gateway.

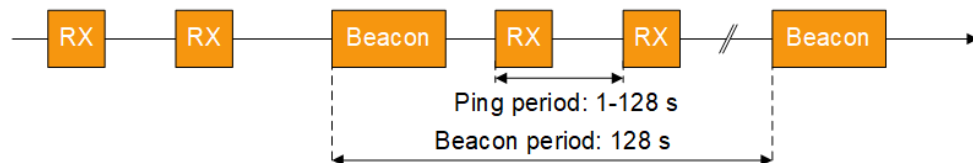


Figure 3-4: Class B communication

- **Class C:** Bi-directional end-devices with maximal receive slots (optional support) Besides Class A and B communication, there are continuously open receive slots except during transmission.

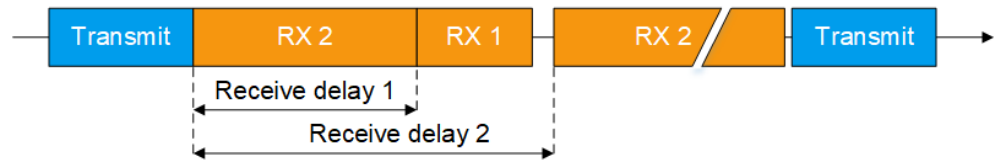


Figure 3-5: Class C communication

Typically, power consumption increases and latency decreases from Class A to Class C communication.

### Key features and applications

Devices compliant with the LoRa technology and operating in a LoRaWAN offer the following key features:

- **Long range:** outdoor coverage of up to 30 miles/48.3 km (line of sight)
- **Low power consumption:** battery lifetime of up to 20 years
- **Low cost:** low-cost end-devices and open software

The key features meet the requirements for IoT applications in rural areas.

## 4 LoRa Configuration and Settings

Access:

- ▶ Select "Baseband > LoRa".

The remote commands required to define these settings are described in [Chapter 7, "Remote-Control Commands"](#), on page 37.

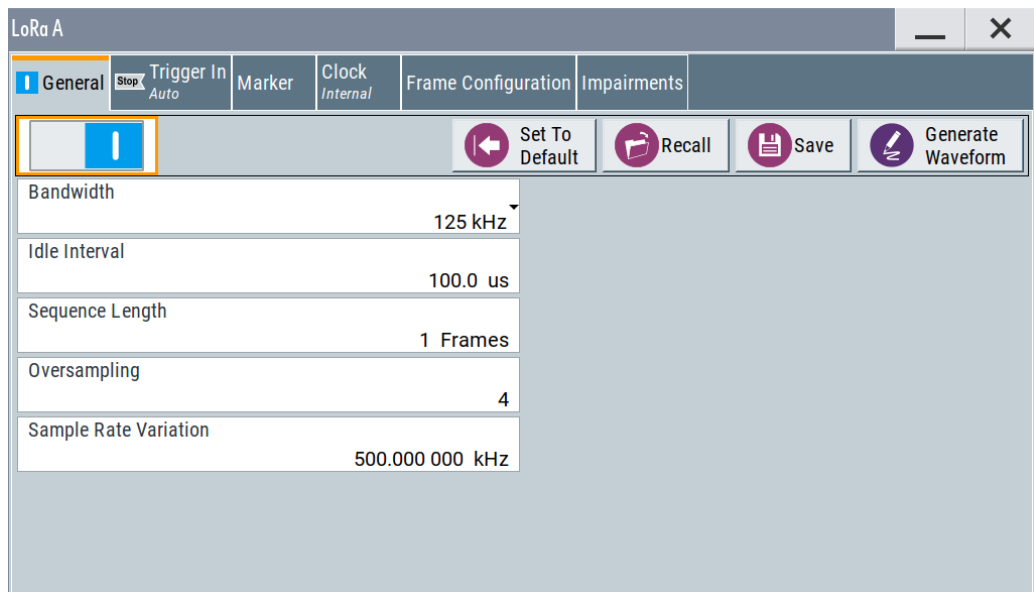
Settings:

- [General Settings](#)..... 15
- [Frame Configuration Settings](#)..... 18
- [Impairments Settings](#)..... 21

### 4.1 General Settings

Access:

- ▶ Select "Baseband > LoRa".



This tab comprises the standard general settings.

Settings:

- [State](#)..... 16
- [Set to Default](#)..... 16
- [Save/Recall](#)..... 16
- [Generate Waveform File](#)..... 16

Bandwidth.....	17
Idle Interval.....	17
Sequence Length.....	17
Oversampling.....	17
Sample Rate Variation.....	17

**State**

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

Remote command:

[ :SOURce<hw> ] :BB:LORA:STATe on page 44

**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 the "Set to Default"
"Bandwidth"	125 kHz
"Idle Interval"	100.0 us
"Sequence Length"	1 frame
"Oversampling"	4
"Sample Rate Variation"	500.000 000 kHz

Remote command:

[ :SOURce<hw> ] :BB:LORA:PRESet on page 41

**Save/Recall**

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

The filename and the directory, in which the settings are stored, are user-definable; the file extension is however predefined.

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

Remote command:

[ :SOURce<hw> ] :BB:LORA:SETTing:CATalog on page 42

[ :SOURce<hw> ] :BB:LORA:SETTing:STORe on page 42

[ :SOURce<hw> ] :BB:LORA:SETTing:LOAD on page 42

[ :SOURce<hw> ] :BB:LORA:SETTing:DELeTe on page 42

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

Remote command:

`[ :SOURce<hw> ] :BB:LORA:WAVEform:CREate` on page 44

### Bandwidth

Sets the channel bandwidth.

The [sample rate](#) and FFT size are calculated internally and updated automatically.

Remote command:

`[ :SOURce<hw> ] :BB:LORA:BWIDth` on page 41

### Idle Interval

Sets the time of the interval separating two frames.

Remote command:

`[ :SOURce<hw> ] :BB:LORA:IINTerval` on page 41

### Sequence Length

Sets the sequence length of the signal in number of frames. The signal is calculated in advance and output in the arbitrary waveform generator.

Remote command:

`[ :SOURce<hw> ] :BB:LORA:SLENgth` on page 43

### Oversampling

Sets the oversampling factor of the generated waveform. The ARB generator of the R&S SMW requires low oversampling factors and still provides excellent signal quality in terms of EVM and ACP.

A reduced sample rate saves significantly the amount of memory or allows an increased signal cycle time, and vice versa.

Remote command:

`[ :SOURce<hw> ] :BB:LORA:OSAMpling` on page 43

### Sample Rate Variation

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

When changing values of the affecting parameters, the sample rate is reset according to the equations below:

- [Impairments](#) disabled:  
Sample rate = [Bandwidth](#) \* [Oversampling](#)
- [Impairments](#) enabled:  
Sample rate = ( [abs\(Freq. drift deviation\)](#) + [abs\(Freq. offset](#) + ( [bandwidth](#) \* [over-sampling](#)) / 2 ) \* 2

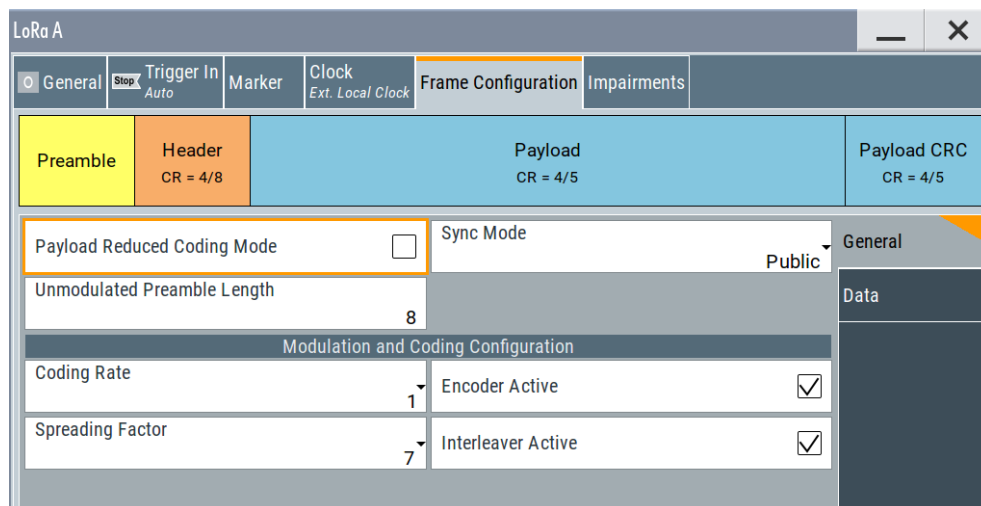
Remote command:

`[ :SOURce<hw> ] :BB:LORA:SRATe:VARIation` on page 43

## 4.2 Frame Configuration Settings

Access:

- Select "Baseband > LoRa > Frame Configuration".



This tab comprises the general and data settings to configure the frame structure.

### Settings

Payload Reduced Coding Mode.....	18
Unmodulated Preamble Length.....	19
Sync Mode.....	19
Modulation and Coding Configuration.....	19
L Coding Rate.....	19
L Spreading Factor.....	19
L Encoder Active.....	19
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Data.....	19
L Data Length.....	20
L Data Source.....	20
L Payload CRC.....	21
L Header Configuration.....	21
L Header Active.....	21
L Compressed Mode.....	21
L Burst Mode.....	21
L Reserved Bit.....	21

### Payload Reduced Coding Mode

Activates the payload reduced coding mode.

Remote command:

[ :SOURCE<hw> ] :BB:LORA:FConfiguration:PRCMode:STATE on page 47

**Unmodulated Preamble Length**

Sets the unmodulated preamble length.

Remote command:

[\[:SOURCE<hw>\]:BB:LORA:FCONfiguration:UPLength](#) on page 48

**Sync Mode**

Sets the synchronization mode of the preamble.

Public            A preamble with a public sync word is generated.

Private           A preamble with a private sync word is generated.

Remote command:

[\[:SOURCE<hw>\]:BB:LORA:FCONfiguration:SMODE](#) on page 48

**Modulation and Coding Configuration**

Configures the modulation and coding information in the frame configuration.

**Coding Rate ← Modulation and Coding Configuration**

Sets the coding rate. The coding rate  $R_{\text{Coding}}$  is calculated as follows:

$$R_{\text{Coding}} = 4 / (4 + \text{"Coding Rate"})$$

"Coding Rate = 0" corresponds to no coding, i.e.  $R_{\text{Coding}} = 1$ .

Remote command:

[\[:SOURCE<hw>\]:BB:LORA:FCONfiguration:CRATE](#) on page 45

**Spreading Factor ← Modulation and Coding Configuration**

Sets the spreading factor for the modulation.

Remote command:

[\[:SOURCE<hw>\]:BB:LORA:FCONfiguration:SFACTOR](#) on page 48

**Encoder Active ← Modulation and Coding Configuration**

Activates encoding of the modulation symbols.

Remote command:

[\[:SOURCE<hw>\]:BB:LORA:FCONfiguration:EACTIVE:STATE](#) on page 46

**Interleaver Active ← Modulation and Coding Configuration**

Activates the interleaver in the frame.

Remote command:

[\[:SOURCE<hw>\]:BB:LORA:FCONfiguration:IACTIVE:STATE](#) on page 47

**Data**

Access:

Select "Baseband > LoRa> Frame Configuration > Data".

Configures header and payload data settings.

The screenshot shows the 'LoRa A' configuration window with the 'Frame Configuration' tab selected. The frame structure is defined as follows:

Field	Value
Preamble	
Header	CR = 4/8
Payload	CR = 4/5
Payload CRC	CR = 4/5

Configuration parameters:

- Data Length: 16 bytes
- Data Source: PN 9
- Payload CRC:
- Header Configuration:
  - Header Active:
  - Burst Mode:
  - Compressed Mode:
  - Reserved Bit:

**Data Length ← Data**

Sets the data length of the payload in the frame.

Remote command:

[\[:SOURCE<hw>\]:BB:LORA:FCONfiguration:DLEnGth](#) on page 46

**Data Source ← Data**

Selects the data source for the payload.

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:LORA:FCONfiguration:DATA](#) on page 45

[\[:SOURCE<hw>\]:BB:LORA:FCONfiguration:DATA:DPATtern](#) on page 45

[\[:SOURCE<hw>\]:BB:LORA:FCONfiguration:DATA:DSElection](#) on page 46

#### **Payload CRC ← Data**

Activates a cyclic redundancy check (CRC) of the payload.

The "Payload CRC" bits are appended to the payload of the frame.

Remote command:

[\[:SOURCE<hw>\]:BB:LORA:FCONfiguration:PCRC:STATe](#) on page 47

#### **Header Configuration ← Data**

Configures the header information in the payload.

#### **Header Active ← Header Configuration ← Data**

Activates the header data in the frame.

Remote command:

[\[:SOURCE<hw>\]:BB:LORA:FCONfiguration:HACTIVE:STATe](#) on page 47

#### **Compressed Mode ← Header Configuration ← Data**

Activates the compressed mode of the header data in the frame.

Remote command:

[\[:SOURCE<hw>\]:BB:LORA:FCONfiguration:CMODE:STATe](#) on page 44

#### **Burst Mode ← Header Configuration ← Data**

Activates the burst mode of header data in the frame.

Remote command:

[\[:SOURCE<hw>\]:BB:LORA:FCONfiguration:BMODE:STATe](#) on page 44

#### **Reserved Bit ← Header Configuration ← Data**

Enables the reserved bit in the frame header.

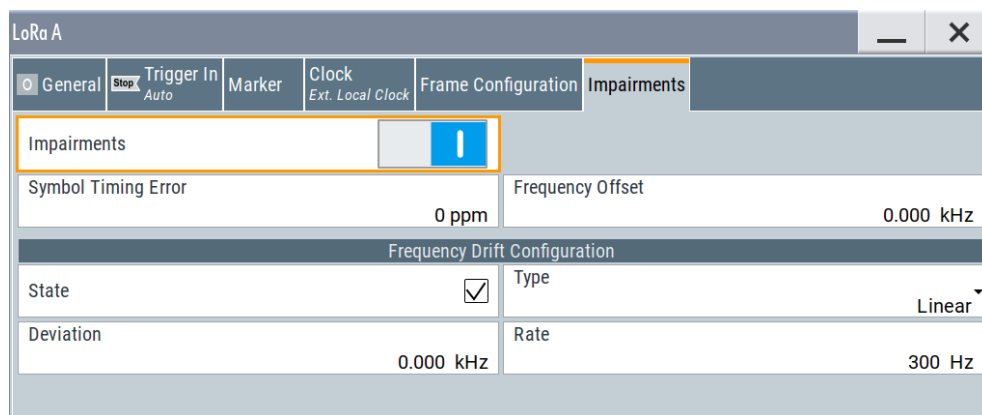
Remote command:

[\[:SOURCE<hw>\]:BB:LORA:FCONfiguration:RBIT:STATe](#) on page 47

## 4.3 Impairments Settings

Access:

- ▶ Select "Baseband > LoRa > Impairments".



This tab comprises the impairments settings for the signal.

## Settings

Impairments.....	22
Symbol Timing Error.....	22
Frequency Offset.....	22
Frequency Drift Configuration.....	22
L State.....	22
L Deviation.....	23
L Type.....	23
L Rate.....	23

### Impairments

Activates the impairments settings.

Impairments change the signal to simulate a non-ideal transmitter.

Remote command:

`[ :SOURce<hw> ] :BB:LORA:IMPairments:STATe` on page 50

### Symbol Timing Error

Sets the symbol timing error.

The set error corresponds to applying a deviation to the transmitter symbol clock.

Remote command:

`[ :SOURce<hw> ] :BB:LORA:IMPairments:STERror` on page 50

### Frequency Offset

Sets the carrier frequency offset.

Remote command:

`[ :SOURce<hw> ] :BB:LORA:IMPairments:FOFFset` on page 50

### Frequency Drift Configuration

Configures carrier frequency drift settings of the signal.

#### State ← Frequency Drift Configuration

Activates carrier frequency drift settings.

Remote command:

`[ :SOURCE<hw> ] :BB:LORA:IMPAIRMENTS:FDRIFT:STATE` on page 49

#### **Deviation ← Frequency Drift Configuration**

Sets the maximum deviation of the carrier signal from the center frequency during the frequency drift procedure.

Remote command:

`[ :SOURCE<hw> ] :BB:LORA:IMPAIRMENTS:FDDEVIATION` on page 49

#### **Type ← Frequency Drift Configuration**

Sets the type of frequency drift, i.e. how the carrier signal drifts around the center frequency.

Linear                      Linear frequency drift.

Sine                         Sine frequency drift.

Remote command:

`[ :SOURCE<hw> ] :BB:LORA:IMPAIRMENTS:FDTYPE` on page 49

#### **Rate ← Frequency Drift Configuration**

Sets the rate of the carrier frequency drift.

A rate of, e.g., 300 Hz implies, that the carrier signal drifts 300 times per second around the center frequency.

Remote command:

`[ :SOURCE<hw> ] :BB:LORA:IMPAIRMENTS:FDRATE` on page 49

## 5 Signal Generation Control

This section lists settings provided for configuring the baseband filter, for defining the signal generation start and for generating signals necessary for synchronization with other instruments.

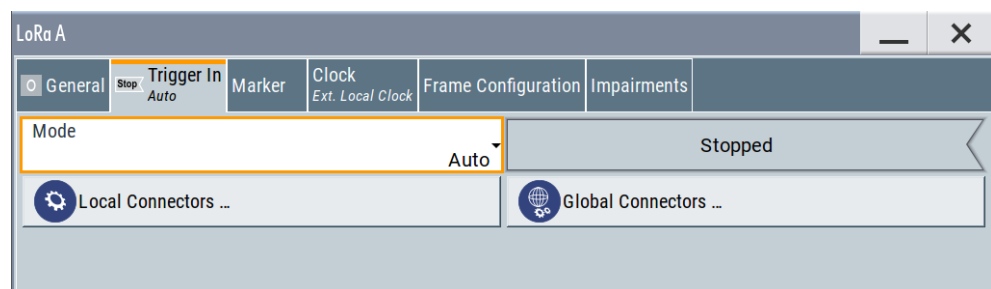
It covers the following topics:

- [Trigger Settings](#).....24
- [Marker Settings](#).....29
- [Clock Settings](#).....30
- [Local and Global Connector Settings](#).....31

### 5.1 Trigger Settings

Access:

- ▶ Select "Baseband > LoRa > Trigger In".



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



This section focuses on the available settings.

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





### Routing and enabling a trigger

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

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

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


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

### Settings:

<a href="#">Trigger Settings Common to All Basebands</a> .....	25
<a href="#">Trigger Mode</a> .....	25
<a href="#">Signal Duration Unit</a> .....	26
<a href="#">Trigger Signal Duration</a> .....	26
<a href="#">Running/Stopped</a> .....	26
<a href="#">Arm</a> .....	26
<a href="#">Execute Trigger</a> .....	26
<a href="#">Trigger Source</a> .....	27
<a href="#">Sync. Output to External Trigger/Sync. Output to Trigger</a> .....	27
<a href="#">External Trigger Inhibit</a> .....	28
<a href="#">External Trigger Delay</a> .....	28

### Trigger Settings Common to All Basebands

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

The icon  indicates that common trigger settings are applied.

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

### Trigger Mode

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

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

- "Auto"  
The signal is generated continuously.
- "Retrigger"  
The signal is generated continuously. A trigger event (internal or external) causes a restart.
- "Armed Auto"  
The signal is generated only when a trigger event occurs. Then the signal is generated continuously.

An "Arm" stops the signal generation. A subsequent trigger event (internal or external) causes a restart.

- "Armed Retrigger"

The signal is generated only when a trigger event occurs. Then the signal is generated continuously. Every subsequent trigger event causes a restart.

An "Arm" stops signal generation. A subsequent trigger event (internal or external) causes a restart.

- "Single"

The signal is generated only when a trigger event occurs. Then the signal is generated once to the length specified at "Signal Duration".

Every subsequent trigger event (internal or external) causes a restart.

Remote command:

`[ :SOURce<hw> ] :BB:LORA [ :TRIGger ] :SEQuence` on page 51

### Signal Duration Unit

Defines the unit for describing the length of the signal sequence to be output in the "Single" trigger mode.

Remote command:

`[ :SOURce<hw> ] :BB:LORA:TRIGger:SLUNit` on page 54

### Trigger Signal Duration

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

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

Remote command:

`[ :SOURce<hw> ] :BB:LORA:TRIGger:SLENgth` on page 54

### Running/Stopped

With enabled modulation, displays the status of signal generation for all trigger modes.

- "Running"

The signal is generated; a trigger was (internally or externally) initiated in triggered mode.

- "Stopped"

The signal is not generated and the instrument waits for a trigger event.

Remote command:

`[ :SOURce<hw> ] :BB:LORA:TRIGger:RMODe` on page 53

### Arm

Stops the signal generation until subsequent trigger event occurs.

Remote command:

`[ :SOURce<hw> ] :BB:LORA:TRIGger:ARM:EXECute` on page 53

### Execute Trigger

For internal trigger source, executes trigger manually.

Remote command:

`[ :SOURce<hw> ] :BB:LORA:TRIGger:EXECute` on page 53

### Trigger Source

The following sources of the trigger signal are available:

- "Internal"  
The trigger event is executed manually by the "Execute Trigger".
- "Internal (Baseband A/B)"  
The trigger event is provided by the trigger signal from the other basebands. If common trigger settings are applied, this trigger source is disabled.
- "External Global Trigger"  
The trigger event is the active edge of an external trigger signal provided and configured at the USER x connectors.
- "External Local Trigger"  
The trigger event is the active edge of an external trigger signal provided and configured at the local T/M/C connector.  
With coupled trigger settings, the signal has to be provided at the T/M/C1/2/3 connectors.
- "External Local Clock"  
The trigger event is the active edge of an external local clock signal provided and configured at the local T/M/C connector.  
With coupled trigger settings, the signal has to be provided at the T/M/C1 connector.
- "Baseband Sync In"  
Option: R&S SMW-B9  
In master-slave mode, slave instruments are triggered by the active edge of the synchronization signal.

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

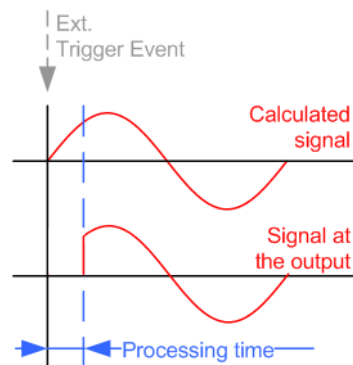
Remote command:

[\[:SOURce<hw>\]:BB:LORA:TRIGger:SOURce](#) on page 51

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

Enables signal output synchronous to the trigger event.

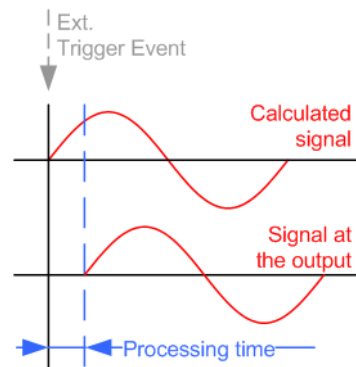
- "On"  
Corresponds to the default state of this parameter.  
The signal calculation starts simultaneously with the trigger event. Because of the processing time of the instrument, the first samples are cut off and no signal is output. After elapsing of the internal processing time, the output signal is synchronous to the trigger event.



- "Off"

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

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



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

Remote command:

`[ :SOURce<hw> ] :BB:LORA:TRIGger [ :EXTernal ] :SYNChronize:OUTPut`  
on page 52

#### External Trigger Inhibit

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

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

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

Remote command:

`[ :SOURce<hw> ] :BB:LORA:TRIGger [ :EXTernal ] :INHibit` on page 52  
`[ :SOURce<hw> ] :BB:LORA:TRIGger:OBASeband:INHibit` on page 53

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

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

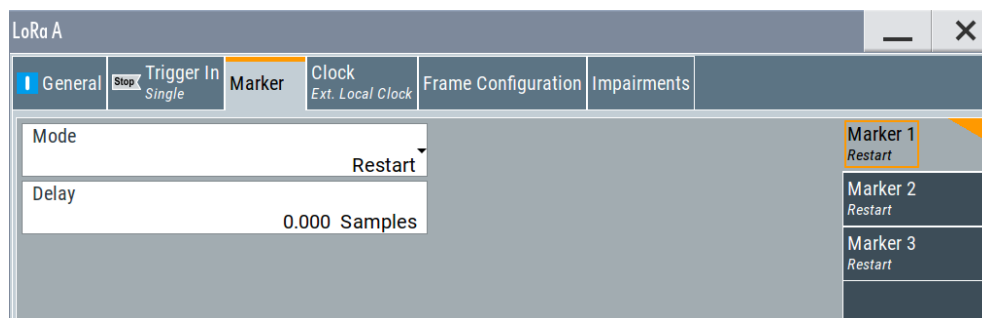
Remote command:

`[ :SOURce<hw> ] :BB:LORA:TRIGger [ :EXTernal ] :DELay` on page 52  
`[ :SOURce<hw> ] :BB:LORA:TRIGger:OBASeband:DELay` on page 53

## 5.2 Marker Settings

Access:

- ▶ Select "Baseband > LoRa > Marker".



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



This section focuses on the available settings.

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



### Routing and enabling a marker

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

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

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

### Settings:

<a href="#">Marker Mode</a> .....	29
<a href="#">Marker x Delay</a> .....	30

### Marker Mode

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

- "Restart"            A marker signal is generated at the start of each ARB sequence.
- "Frame "            A frame clock with the frame period specified under "Period" is generated on the output connector. The marker signal is generated after every specified number of frames.

"Pulse" A regular marker signal is generated. The pulse frequency is defined by entering a divider. The frequency is derived by dividing the sample rate by the divider. The input box for the divider opens when "Pulse" is selected, and the resulting pulse frequency is displayed below it. The maximum pulse frequency is half the symbol rate.

Remote command:

`[ :SOURce<hw> ] :BB:LORA:TRIGger:OUTPut<ch>:PULSe:DIVider` on page 56

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

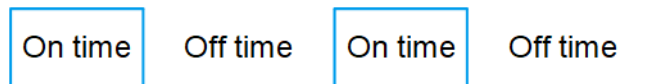
on page 56

"Pattern" A marker signal that is defined by a bit pattern is generated. The pattern has a maximum length of 64 bits and is defined in an input field which opens when pattern is selected.

Remote command:

`[ :SOURce<hw> ] :BB:LORA:TRIGger:OUTPut<ch>:PATtern` on page 55

"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.



Remote command:

`[ :SOURce<hw> ] :BB:LORA:TRIGger:OUTPut<ch>:ONTime` on page 55

`[ :SOURce<hw> ] :BB:LORA:TRIGger:OUTPut<ch>:OFFTime` on page 55

Remote command:

`[ :SOURce<hw> ] :BB:LORA:TRIGger:OUTPut<ch>:MODE` on page 54

### Marker x Delay

Delays the marker signal at the marker output relative to the signal generation start.

Variation of the parameter "Marker x Delay" causes signal recalculation.

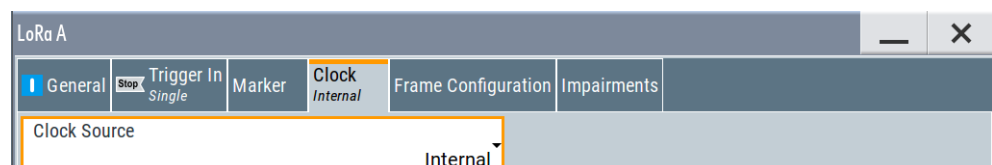
Remote command:

`[ :SOURce<hw> ] :BB:LORA:TRIGger:OUTPut<ch>:DELay` on page 55

## 5.3 Clock Settings

Access:

- ▶ Select "Baseband > LoRa > Clock".



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



This section focuses on the available settings.

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



### Defining the clock

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

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

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

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

### Settings:

<a href="#">Clock Source</a> .....	31
<a href="#">Clock Mode</a> .....	31
<a href="#">Measured External Clock</a> .....	31

#### Clock Source

Selects the clock source.

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

Remote command:

[\[:SOURce<hw>\]:BB:LORA:CLOCK:SOURce](#) on page 57

#### Clock Mode

Sets the type of externally supplied clock.

Remote command:

[\[:SOURce<hw>\]:BB:LORA:CLOCK:MODE](#) on page 57

#### Measured External Clock

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

Remote command:

[CLOCK:INPut:FREQuency?](#)

## 5.4 Local and Global Connector Settings

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



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



## 6 Generating LoRa Test Signals

The section describes how to set up and configure the R&S SMW for LoRa signal generation for simple receiver tests.

See also:

- Application note [1MA295](#), for a comprehensive overview on LoRa device characterization, including Tx measurements.
- [Chapter 7.1, "Programming Examples"](#), on page 38, for remote command configuration examples.

### 6.1 Generating Rx Sensitivity Test Signals

#### Rx sensitivity test setup

The R&S SMW generates a LoRa test signal. The LoRa DUT receives and demodulates the test signal. The LoRa Test Tool, installed on an external PC, analyzes the demodulation data in terms of **PER** analysis.



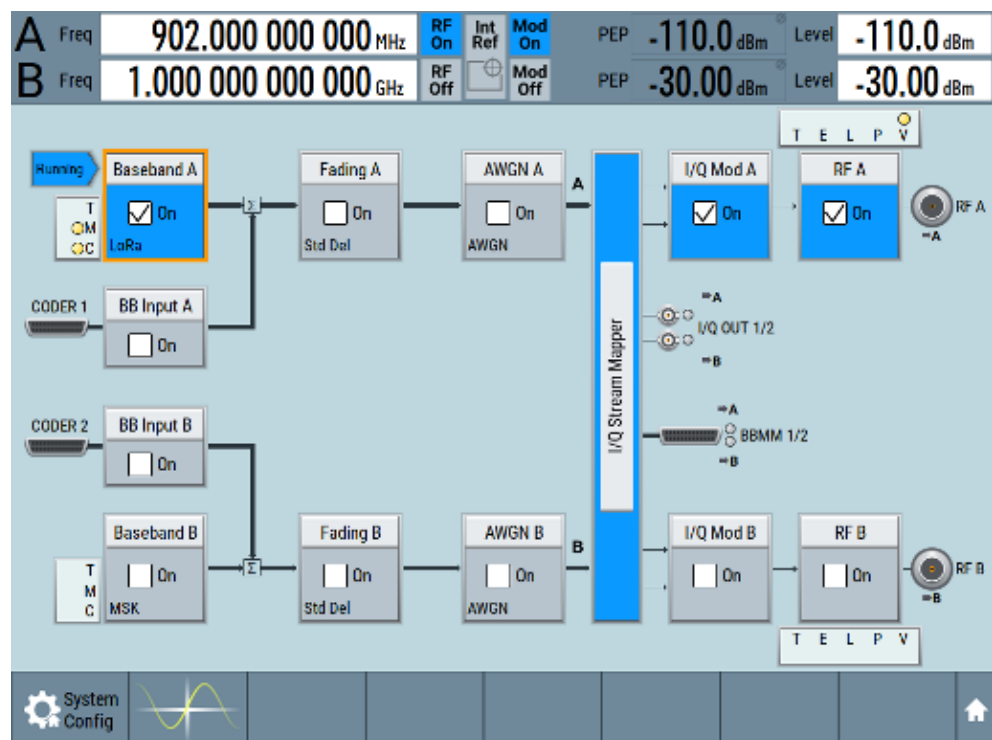
**Figure 6-1: Test setup for Rx sensitivity test**

- 1 = R&S SMW generating the RF signal
- 2 = LoRa DUT receiving the RF signal
- 3 = External PC with LoRa Test Tool for PER analysis
- Blue arrow = LoRa test RF signal path
- Orange arrow = Connection for LoRa DUT control and analysis via LoRa Test Tool at the external PC

#### To perform an Rx sensitivity test

1. Preset the R&S SMW.
2. Select "Baseband > LoRa".
3. Configure "General" settings of the LoRa test signal, e.g. the "Bandwidth" compatible with the DUT.

4. Select "Frame Configuration > General" to configure modulation and coding parameters, e.g. "Coding Rate" and "Spreading Factor".
5. Select "Frame Configuration > Data" to configure payload, e.g. "Data Length" and "Data Source".
6. Set "General > State > On" to activate LoRa baseband modulation.
7. In the block diagram, set "I/Q Mod > On" and "RF > On" to activate I/Q modulation and signal generation.
8. On the "Status Bar", set "Frequency" and "Level".



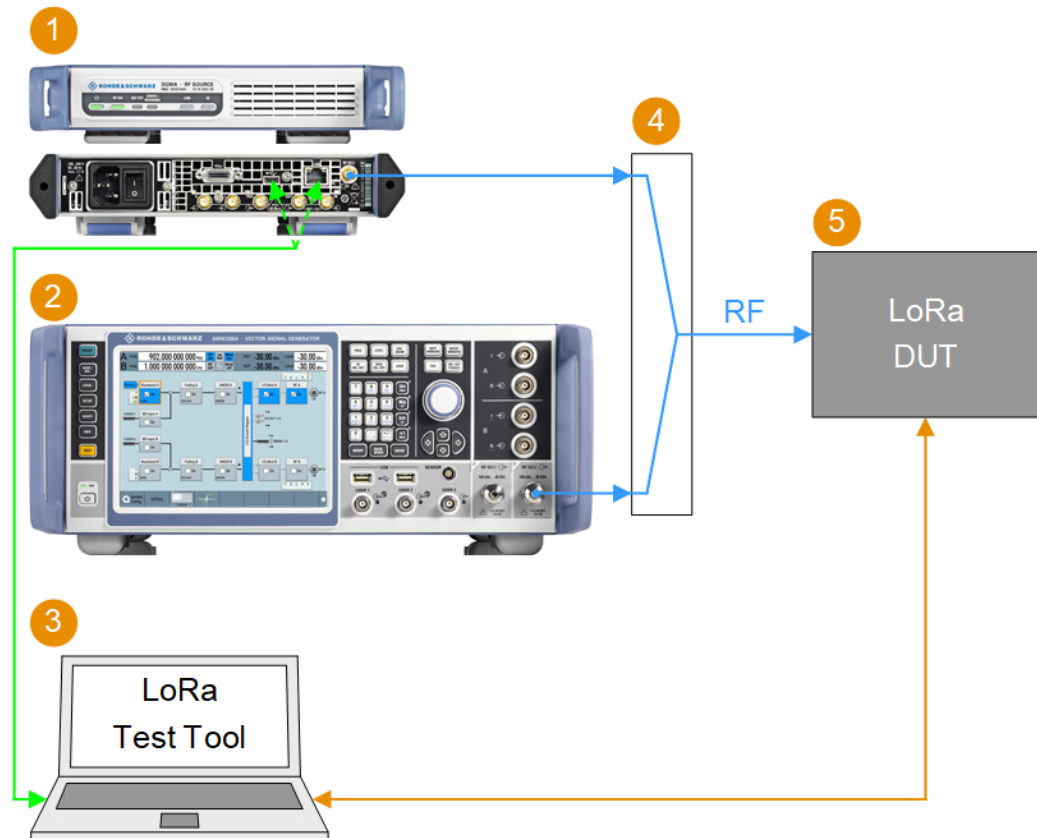
9. Configure the DUT for reception of the LoRa test signal generated at the R&S SMW.
10. Gradually reduce the level of the LoRa test signal.
11. Monitor the [PER](#) at the DUT, e.g. at an external PC with an analysis software (LoRa Test Tool).

The Rx sensitivity level corresponds to a specified PER value, e.g. "Level > -137 dBm" with PER = 1 %. The level depends on the spreading factor.

## 6.2 Generating Blocking Test Signals

### Blocking test setup

The R&S SMW generates a LoRa test signal, the wanted signal. A second signal generator, e.g. an R&S SGS, generates an interfering *CW* signal, the unwanted signal. Both signals are combined via an RF power combiner. The LoRa DUT receives and demodulates the combined signal. The LoRa Test Tool, installed on external PC, analyzes the demodulation data in terms of *PER* analysis.



**Figure 6-2: Test setup for blocking test**

- 1 = R&S SGS generating an interfering RF signal, the unwanted signal
- 2 = R&S SMW generating a LoRa test signal, the wanted signal
- 3 = External PC with R&S SGS control software and with LoRa Test Tool for PER analysis
- 4 = RF power combiner combining the interfering RF signal and the LoRa test signal
- 5 = LoRa DUT receiving the combined RF signal
- Blue arrow = LoRa test signal path
- Green arrow = Connection for R&S SGS control via R&S SGMA-GUI control software at the external PC
- Orange arrow = Connection for LoRa DUT control and analysis via LoRa Test Tool at the external PC

### To perform an adjacent channel blocking test

1. To generate the wanted signal, configure the R&S SMW as in "[To perform an Rx sensitivity test](#)" on page 33.

2. To generate the adjacent channel blocking signal at the second signal generator, e.g. the R&S SGS, proceed as follows:
  - a) Preset the R&S SGS.
  - b) Set the frequency as specified.  
The frequency value is typically a few hundred kilohertz higher/lower than the frequency of the wanted signal.
  - c) Set the level as specified.  
The level values for uplink and downlink can differ.
3. At the R&S SMW, increase the level of the wanted signal.
4. Monitor the **PER** at the DUT, e.g. with an analysis software (LoRa Test Tool).  
The adjacent channel blocking level is the wanted signal level, that corresponds to a specified PER value, typically PER < 1 %.

#### To perform an on-channel blocking test

1. To generate the wanted signal, configure the R&S SMW as in "[To perform an Rx sensitivity test](#)" on page 33.
2. To generate the on-channel blocking signal at the second signal generator, e.g. the R&S SGS, proceed as follows:
  - a) Preset the R&S SGS.
  - b) Set the frequency, that is the same frequency as the wanted signal ([step 8](#)).
  - c) Set the level as specified.  
The level values for uplink and downlink can differ.
3. At the R&S SMW, increase the level of the wanted signal.
4. Monitor the **PER** at the DUT, e.g. with an analysis software (LoRa Test Tool).  
The on-channel blocking level is the wanted signal level, that corresponds to a specified PER value, typically PER < 1 %.

See also:

- [R&S SGS100A user manual](#)
- [R&S SGMA-GUI Software](#) software for control of the R&S SGS

## 7 Remote-Control Commands

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



### Conventions used in SCPI command descriptions

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

### Common suffixes

The following common suffixes are used in the remote commands:

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



### 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.

The following commands specific to the R&S SMW-K131 option are described here:

- [Programming Examples](#).....38
- [General Commands](#).....41
- [Frame Configuration Commands](#).....44
- [Impairments Commands](#).....49
- [Trigger Commands](#).....51
- [Marker Commands](#).....54
- [Clock Commands](#).....56

## 7.1 Programming Examples

The corresponding sections of the same title provide simple programming examples for the R&S SMW. 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 examples as simple as possible, only the "clean" SCPI syntax elements are reported. Non-executable command lines (for example comments) start with two // characters.

At the beginning of the most remote control program, an instrument (p)reset is recommended to set the R&S SMW 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.

### Example: Storing current configuration

```
SOURcel:BB:LORA:SETTing:STORe "/var/user/my_settings"  
*RST  
SOURcel:BB:LORA:SETTing:CATalog?  
// my_lora, lora  
SOURcel:BB:LORA:SETTing:LOAD "/var/user/lora"  
SOURcel:BB:LORA:STATe 1  
SOURcel:BB:LORA:SETTing:DEL "my_lora"  
SOURcel:BB:LORA:WAVEform:CREate "/var/user/my_lora_wv"
```

### Example: Generating a LoRa signal

```
SOURcel:BB:LORA:PRESet  
// Configure LoRa general settings: Bandwidth, idle interval time, sequence  
// length and sampling parameters  
SOURcel:BB:LORA:BWIDth BW125  
SOURcel:BB:LORA:IINTERval 0.0001  
SOURcel:BB:LORA:SEnGth 1  
SOURcel:BB:LORA:OSAMpling 4  
SOURcel:BB:LORA:SRATe:VARiation 500000  
SOURcel:BB:LORA:STATe 1  
// Configure the carrier signal, e.g. for ETSI compliant devices.  
SOURcel:FREQuency:CW 868500000  
SOURcel:POWer:POWer 14  
OUTPut1:STATe 1
```

**Example: Configuring LoRa frame parameters**

```
SOURcel:BB:LORA:PRESet
// Configure preamble and synchronization parameters.
SOURcel:BB:LORA:FCONfiguration:PRCMode:STATe 0
SOURcel:BB:LORA:FCONfiguration:SMODE PUBL
SOURcel:BB:LORA:FCONfiguration:UPLength 8

// Configure modulation and coding parameters.
SOURcel:BB:LORA:FCONfiguration:CRATe CR1
SOURcel:BB:LORA:FCONfiguration:EACTive:STATe 1
SOURcel:BB:LORA:FCONfiguration:SFACToR SF7
SOURcel:BB:LORA:FCONfiguration:IACTive:STATe 1

// Configure data, header and payload parameters.
SOURcel:BB:LORA:FCONfiguration:DLENgth 16
SOURcel:BB:LORA:FCONfiguration:PCRC:STATe 1
SOURcel:BB:LORA:FCONfiguration:DATA PN9
SOURcel:BB:LORA:FCONfiguration:HACTive:STATe 1
SOURcel:BB:LORA:FCONfiguration:BMODE:STATe 0
SOURcel:BB:LORA:FCONfiguration:CMODE:STATe 0
SOURcel:BB:LORA:FCONfiguration:RBIT:STATe 0
```

**Example: Configuring impairments to LoRa modulation**

```
SOURcel:BB:LORA:PRESet
// Configure symbol timing error and frequency offset.
SOURcel:BB:LORA:IMPairments:STERror 0
SOURcel:BB:LORA:IMPairments:FOFFset 0
// Configure frequency drift parameters.
SOURcel:BB:LORA:IMPairments:FDTYpe LIN
SOURcel:BB:LORA:IMPairments:FDDeviatiOn 0
SOURcel:BB:LORA:IMPairments:FDRate 300
SOURcel:BB:LORA:IMPairments:FDRift:STATe 1
// Activate the impairment settings.
SOURcel:BB:LORA:IMPairments:STATe 1
```

**Example: Trigger configuration**

```

SOURCE1:BB:LORA:TRIGGER:SOURCE INTERNAL
SOURCE1:BB:LORA:TRIGGER:SEQUENCE ARETRIGGER
SOURCE1:BB:LORA:STAT ON
SOURCE1:BB:LORA:TRIGGER:EXECUTE
SOURCE1:BB:LORA:TRIGGER:ARM:EXECUTE
SOURCE1:BB:LORA:TRIGGER:RMODE?
// stopped
SOURCE1:BB:LORA:TRIGGER:EXECUTE
SOURCE1:BB:LORA:TRIGGER:RMODE?

// run
SOURCE1:BB:LORA:TRIGGER:SEQUENCE SING
SOURCE1:BB:LORA:TRIGGER:SLUNIT SAMP
SOURCE1:BB:LORA:TRIGGER:SLLENGTH 25777
SOURCE1:BB:LORA:TRIGGER:SEQUENCE ARET
SOURCE1:BB:LORA:TRIGGER:SOURCE EGT1
SOURCE1:BB:LORA:TRIGGER:EXTERNAL:SYNCHRONIZE:OUTPUT 1
SOURCE1:BB:LORA:TRIGGER:EXTERNAL:INHIBIT 100
SOURCE1:BB:LORA:TRIGGER:EXTERNAL:DELAY 10

// SOURCE:BB:LORA:TRIGGER:SOURCE INTB
// The internal trigger signal from the other path must be used.
// SOURCE:BB:LORA:TRIGGER:OBASBAND:DELAY 25
// SOURCE:BB:LORA:TRIGGER:OBASBAND:INHIBIT 10

```

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

```

// Configure marker 1 settings.
SOURCE:BB:LORA:TRIGGER:OUTPUT1:MODE RAT
SOURCE:BB:LORA:TRIGGER:OUTPUT1:ONTIME 10
SOURCE:BB:LORA:TRIGGER:OUTPUT1:OFFTIME 20
// Configure marker 2 settings.
SOURCE:BB:LORA:TRIGGER:OUTPUT2:MODE?
// RESTART
SOURCE:BB:LORA:TRIGGER:OUTPUT2:DELAY 16384
// Configure marker 3 settings.
SOURCE:BB:LORA:TRIGGER:OUTPUT3:MODE PATT
SOURCE:BB:LORA:TRIGGER:OUTPUT3:PATTERN #H2,2

```

**Example: Clock settings**

```

SOURCE1:BB:LORA:CLOCK:SOURCE ELCL
SOURCE1:BB:LORA:CLOCK:MODE SAMP
CLOCK:INPUT:FREQUENCY?
// 1000000

```



## 7.2 General Commands

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---

### `[:SOURce<hw>]:BB:LORA:BWIDth <Bw>`

Sets the channel bandwidth.

#### Parameters:

`<Bw>` BW7 | BW10 | BW15 | BW20 | BW31 | BW41 | BW62 | BW125 |  
 BW250 | BW500  
 \*RST: BW125

**Example:** See [Example "Generating a LoRa signal"](#) on page 38.

**Manual operation:** See ["Bandwidth"](#) on page 17

---

### `[:SOURce<hw>]:BB:LORA:IINTerval <IInterval>`

Sets the time of the interval separating two frames.

#### Parameters:

`<IInterval>` float  
 Range: 0 to 1  
 Increment: 0.1E-6  
 \*RST: 100E-6  
 Default unit: s

**Example:** See [Example "Generating a LoRa signal"](#) on page 38.

**Manual operation:** See ["Idle Interval"](#) on page 17

---

### `[:SOURce<hw>]:BB:LORA: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:LORA:STATe`.

**Example:** See [Example "Generating a LoRa signal"](#) on page 38.

**Usage:** Event  
**Manual operation:** See ["Set to Default"](#) on page 16

**[ :SOURce<hw>]:BB:LORA:SETTing:CATalog <Catalog>**

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

**Parameters:**  
 <Catalog> <filename1>,<filename2>,...  
 Returns a string of filenames separated by commas.

**Example:** See [Example "Storing current configuration"](#) on page 38.

**Manual operation:** See ["Save/Recall"](#) on page 16

**[ :SOURce<hw>]:BB:LORA:SETTing:DELeTe <Filename>**

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

**Parameters:**  
 <Filename> "<filename>"  
 Filename or complete file path; file extension can be omitted

**Example:** See [Example "Storing current configuration"](#) on page 38.

**Manual operation:** See ["Save/Recall"](#) on page 16

**[ :SOURce<hw>]:BB:LORA:SETTing:LOAD <Filename>**

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

**Parameters:**  
 <Filename> "<filename>"  
 Filename or complete file path; file extension can be omitted

**Example:** See [Example "Storing current configuration"](#) on page 38.

**Manual operation:** See ["Save/Recall"](#) on page 16

**[ :SOURce<hw>]:BB:LORA:SETTing:STORE <Filename>**

Saves the current settings into the selected file; the file extension (\*.lora) is assigned automatically.

**Setting parameters:**  
 <Filename> "<filename>"  
 Filename or complete file path

**Example:** See [Example "Storing current configuration"](#) on page 38.

**Usage:** Setting only  
**Manual operation:** See ["Save/Recall"](#) on page 16

**[[:SOURce<hw>]:BB:LORA:SLENgth <SLength>**

Sets the sequence length of the signal in number of frames. The signal is calculated in advance and output in the arbitrary waveform generator.

**Parameters:**

<SLength> integer  
 Range: 1 to dynamic  
 \*RST: 1

**Example:** See [Example "Generating a LoRa signal"](#) on page 38.

**Manual operation:** See ["Sequence Length"](#) on page 17

**[[:SOURce<hw>]:BB:LORA:OSAMpling <OSampling>**

Sets the oversampling factor of the generated waveform.

A reduced sample rate saves significantly the amount of memory or allows an increased signal cycle time, and vice versa.

**Parameters:**

<OSampling> integer  
 Range: 1 to 32  
 \*RST: 4

**Example:** See [Example "Generating a LoRa signal"](#) on page 38.

**Manual operation:** See ["Oversampling"](#) on page 17

**[[:SOURce<hw>]:BB:LORA:SRATe:VARiation <Variation>**

Sets the sample rate of the signal.

A variation of this parameter affects the ARB clock rate; all other signal parameters remain unchanged. When changing values of the affecting parameters, the sample rate is reset.

**Parameters:**

<Variation> float  
 Range: 4E2 to 20E6  
 Increment: 1E-3  
 \*RST: 1E6

**Example:** See [Example "Generating a LoRa signal"](#) on page 38.

**Manual operation:** See ["Sample Rate Variation"](#) on page 17

---

**[[:SOURce<hw>]:BB:LORA: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:**            See [Example "Generating a LoRa signal"](#) on page 38.

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

---

**[[:SOURce<hw>]:BB:LORA:WAVEform:CREate <Filename>**

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

**Parameters:**

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

**Example:**            See [Example "Storing current configuration"](#) on page 38.

**Usage:**                Setting only

**Manual operation:**    See ["Generate Waveform File"](#) on page 16

---

## 7.3 Frame Configuration Commands

---

**[[:SOURce<hw>]:BB:LORA:FCONfiguration:BMODE:STATe <State>**

Activates the burst mode of header data in the frame.

**Parameters:**

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

**Example:**            See [Example "Configuring LoRa frame parameters"](#) on page 39.

**Manual operation:**    See ["Burst Mode"](#) on page 21

---

**[[:SOURce<hw>]:BB:LORA:FCONfiguration:CMODE:STATe <State>**

Activates the compressed mode of the header data in the frame.

**Parameters:**

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

**Example:**            See [Example "Configuring LoRa frame parameters"](#) on page 39.

**Manual operation:** See ["Compressed Mode"](#) on page 21

---

**[[:SOURce<hw>]:BB:LORA:FCONfiguration:CRATe <CRate>**

Sets the coding rate.

**Parameters:**

<CRate> CR0 | CR1 | CR2 | CR3 | CR4  
 CR<x> = 0 to 4  
 The coding rate  $R_{\text{Coding}}$  is calculated as follows:  
 $R_{\text{Coding}} = 4 / (4 + \text{CR}\langle x \rangle)$   
 "CR0" corresponds to no coding, i.e.  $R_{\text{Coding}} = 1$ .  
 \*RST: CR1

**Example:** See [Example "Configuring LoRa frame parameters"](#) on page 39.

**Manual operation:** See ["Coding Rate"](#) on page 19

---

**[[:SOURce<hw>]:BB:LORA:FCONfiguration:DATA <Data>**

Sets the data source for the payload data in a LoRa frame.

**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. There is a choice of different lengths of random sequence.  
**DLISt**  
 A data list is used. The data list is selected with the aid of command `SOURce:BB:LORA:DATA DLISt`.  
**ALL0 | ALL1**  
 Internal 0 or 1 data is used.  
**PATtern**  
 Internal data is used. The bit pattern for the data is defined with the aid of command `:SOURce:BB:LORA:DATA PATtern`.  
 \*RST: PN9

**Example:** See [Example "Configuring LoRa frame parameters"](#) on page 39.

**Manual operation:** See ["Data Source"](#) on page 20

---

**[[:SOURce<hw>]:BB:LORA:FCONfiguration:DATA:DPATtern <DPattern>, <BitCount>**

Sets the data pattern, if the `data source` `PATt` is selected.

**Parameters:**

<DPattern>	numeric
	*RST: #H0
<BitCount>	integer
	Range: 1 to 64
	*RST: 1

**Example:** See [Example "Configuring LoRa frame parameters"](#) on page 39.

**Manual operation:** See ["Data Source"](#) on page 20

**[[:SOURce<hw>]:BB:LORA:FCONfiguration:DATA:DSElection <DSelection>**

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

The data list is only used, if the `data source DLIS` is selected.

**Parameters:**

<DSelection>	string
	Filename incl. file extension or complete file path

**Example:** See [Example "Configuring LoRa frame parameters"](#) on page 39.

**Manual operation:** See ["Data Source"](#) on page 20

**[[:SOURce<hw>]:BB:LORA:FCONfiguration:DLENgth <DLength>**

Sets the data length of the payload in the frame.

**Parameters:**

<DLength>	integer
	Range: 1 to 255
	*RST: 16

**Example:** See [Example "Configuring LoRa frame parameters"](#) on page 39.

**Manual operation:** See ["Data Length"](#) on page 20

**[[:SOURce<hw>]:BB:LORA:FCONfiguration:EACTIVE:STATE <State>**

Activates encoding of the modulation symbols.

**Parameters:**

<State>	0   1   OFF   ON
	*RST: 1

**Example:** See [Example "Configuring LoRa frame parameters"](#) on page 39.

**Manual operation:** See ["Encoder Active"](#) on page 19

---

**[[:SOURce<hw>]:BB:LORA:FCONfiguration:HACTive:STATe <State>**

Activates the header data in the frame.

**Parameters:**

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

**Example:**            See [Example "Configuring LoRa frame parameters"](#) on page 39.

**Manual operation:**    See ["Header Active"](#) on page 21

---

**[[:SOURce<hw>]:BB:LORA:FCONfiguration:IACTive:STATe <State>**

Activates the interleaver in the frame.

**Parameters:**

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

**Example:**            See [Example "Configuring LoRa frame parameters"](#) on page 39.

**Manual operation:**    See ["Interleaver Active"](#) on page 19

---

**[[:SOURce<hw>]:BB:LORA:FCONfiguration:PCRC:STATe <State>**

Activates a cyclic redundancy check (CRC) of the payload.

**Parameters:**

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

**Example:**            See [Example "Configuring LoRa frame parameters"](#) on page 39.

**Manual operation:**    See ["Payload CRC"](#) on page 21

---

**[[:SOURce<hw>]:BB:LORA:FCONfiguration:PRCMode:STATe <State>**

Activates the payload reduced coding mode.

**Parameters:**

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

**Example:**            See [Example "Configuring LoRa frame parameters"](#) on page 39.

**Manual operation:**    See ["Payload Reduced Coding Mode"](#) on page 18

---

**[[:SOURce<hw>]:BB:LORA:FCONfiguration:RBIT:STATe <State>**

Enables the reserved bit in the frame header.

**Parameters:**

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

**Example:** See [Example "Configuring LoRa frame parameters"](#) on page 39.

**Manual operation:** See ["Reserved Bit"](#) on page 21

**[ :SOURce<hw> ]:BB:LORA:FCONfiguration:SMODE <SMode>**

Sets the synchronization mode of the preamble.

**Parameters:**

<SMode> PRIVate | PUBLic

**PRIVate**

A preamble with a public sync word is generated.

**PUBLic**

A preamble with a private sync word is generated.

\*RST: PUBLic

**Example:** See [Example "Configuring LoRa frame parameters"](#) on page 39.

**Manual operation:** See ["Sync Mode"](#) on page 19

**[ :SOURce<hw> ]:BB:LORA:FCONfiguration:SFACtor <Sf>**

Sets the spreading factor for the modulation.

**Parameters:**

<Sf> SF6 | SF7 | SF8 | SF9 | SF10 | SF11 | SF12

\*RST: SF7

**Example:** See [Example "Configuring LoRa frame parameters"](#) on page 39.

**Manual operation:** See ["Spreading Factor"](#) on page 19

**[ :SOURce<hw> ]:BB:LORA:FCONfiguration:UPLength <PLength>**

Sets the unmodulated preamble length.

**Parameters:**

<PLength> integer

Range: 6 to 8

\*RST: 8

**Example:** See [Example "Configuring LoRa frame parameters"](#) on page 39.

**Manual operation:** See ["Unmodulated Preamble Length"](#) on page 19



## 7.4 Impairments Commands

---

**[:SOURce<hw>]:BB:LORA:IMPairments:FDDeviation <FDDeviation>**

Sets the frequency deviation of the frequency drift.

**Parameters:**

<FDDeviation>            integer  
                                  Range:        -200E3 to 200E3  
                                  \*RST:        0

**Example:**                See [Example "Configuring impairments to LoRa modulation"](#) on page 39.

**Manual operation:**    See ["Deviation"](#) on page 23

---

**[:SOURce<hw>]:BB:LORA:IMPairments:FDRate <FDRate>**

Sets the rate of the carrier frequency drift.

**Parameters:**

<FDRate>                 integer  
                                  Range:        160 to 1.6E3  
                                  \*RST:        300

**Example:**                See [Example "Configuring impairments to LoRa modulation"](#) on page 39.

**Manual operation:**    See ["Rate"](#) on page 23

---

**[:SOURce<hw>]:BB:LORA:IMPairments:FDRift:STATE <State>**

Activates frequency drift settings in the payload.

**Parameters:**

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

**Example:**                See [Example "Configuring impairments to LoRa modulation"](#) on page 39.

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

---

**[:SOURce<hw>]:BB:LORA:IMPairments:FDType <FDType>**

Sets the frequency drift type.

**Parameters:**

<FDType>                 LINear | SINE  
                                  **LINear**  
                                  Generation of frequency drift is set linear.

**SINE**

Generation of frequency drift is set sinusoid.

\*RST: LINear

**Example:** See [Example "Configuring impairments to LoRa modulation"](#) on page 39.

**Manual operation:** See ["Type"](#) on page 23

**[:SOURce<hw>]:BB:LORA:IMPairments:FOFFset <FOffset>**

Sets the frequency offset.

**Parameters:**

<FOffset> integer  
 Range: -200E3 to 200E3  
 \*RST: 0

**Example:** See [Example "Configuring impairments to LoRa modulation"](#) on page 39.

**Manual operation:** See ["Frequency Offset"](#) on page 22

**[:SOURce<hw>]:BB:LORA:IMPairments:STATe <State>**

Activates impairments settings in the payload.

**Parameters:**

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

**Example:** See [Example "Configuring impairments to LoRa modulation"](#) on page 39.

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

**[:SOURce<hw>]:BB:LORA:IMPairments:STERror <STError>**

Sets symbol timing error.

**Parameters:**

<STError> integer  
 Range: -300 to 300  
 \*RST: 0

**Example:** See [Example "Configuring impairments to LoRa modulation"](#) on page 39.

**Manual operation:** See ["Symbol Timing Error"](#) on page 22

## 7.5 Trigger Commands

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---

### `[:SOURce<hw>]:BB:LORA[:TRIGger]:SEQuence <Sequence>`

Sets the trigger mode.

#### Parameters:

`<Sequence>`            AUTO | RETRigger | AAUto | ARETrigger | SINGLE  
                          \*RST:        AUTO

**Example:**            See [Example "Trigger configuration"](#) on page 40.

**Manual operation:** See ["Trigger Mode"](#) on page 25

---

### `[:SOURce<hw>]:BB:LORA:TRIGger:SOURce <Source>`

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

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

**Parameters:**  
 <TrigSource> INTB|INTernal|OBASeband|EGT1|EGT2|EGC1|EGC2|ELTRigger|INTA|ELCLock|BEXternal|EXternal | BBSY  
 \*RST: INTernal

**Example:** See [Example "Trigger configuration"](#) on page 40.

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

**Manual operation:** See ["Trigger Source"](#) on page 27

**[ :SOURce<hw>]:BB:LORA:TRIGger[:EXternal]:SYNChronize:OUTPut <Output>**  
 Enables signal output synchronous to the trigger event.

**Parameters:**  
 <Output> 0 | 1 | OFF | ON  
 \*RST: 1

**Example:** See [Example "Trigger configuration"](#) on page 40.

**Manual operation:** See ["Sync. Output to External Trigger/Sync. Output to Trigger"](#) on page 27

**[ :SOURce<hw>]:BB:LORA:TRIGger[:EXternal]:DELay <Delay>**  
 Sets the trigger delay.

**Parameters:**  
 <Delay> float  
 Range: 0 to 2147483647  
 Increment: 0.01  
 \*RST: 0

**Example:** See [Example "Trigger configuration"](#) on page 40.

**Manual operation:** See ["External Trigger Delay"](#) on page 28

**[ :SOURce<hw>]:BB:LORA:TRIGger[:EXternal]:INHibit <Inhibit>**  
 Specifies the duration by which a restart is inhibited.

**Parameters:**  
 <Inhibit> integer  
 Range: 0 to dynamic  
 \*RST: 0

**Example:** See [Example "Trigger configuration"](#) on page 40.

**Manual operation:** See ["External Trigger Inhibit"](#) on page 28

---

**[[:SOURce<hw>]:BB:LORA:TRIGger:OBASeband:DELay <Delay>**

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

**Parameters:**

<Delay> float  
 Range: 0 to 2147483647  
 Increment: 0.01  
 \*RST: 0  
 Default unit: samples

**Example:** See [Example "Trigger configuration"](#) on page 40.

**Manual operation:** See ["External Trigger Delay"](#) on page 28

---

**[[:SOURce<hw>]:BB:LORA:TRIGger:OBASeband:INHibit <Inhibit>**

For triggering via the other path, specifies the duration by which a restart is inhibited.

**Parameters:**

<Inhibit> integer  
 Range: 0 to 67108863  
 \*RST: 0

**Example:** See [Example "Trigger configuration"](#) on page 40.

**Manual operation:** See ["External Trigger Inhibit"](#) on page 28

---

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

Stops signal generation; a subsequent trigger event restarts signal generation.

**Example:** See [Example "Trigger configuration"](#) on page 40.

**Usage:** Event

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

---

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

Executes a trigger.

**Example:** See [Example "Trigger configuration"](#) on page 40.

**Usage:** Event

**Manual operation:** See ["Execute Trigger"](#) on page 26

---

**[[:SOURce<hw>]:BB:LORA:TRIGger:RMODE <RMode>**

Queries the signal generation status.

**Parameters:**

<RMode> STOP | RUN  
 \*RST: STOP

**Example:** See [Example "Trigger configuration"](#) on page 40.

**Manual operation:** See ["Running/Stopped"](#) on page 26

**[:SOURce<hw>]:BB:LORA:TRIGger:SLENgth <SLength>**

Defines the length of the signal sequence that is output in the `SINGLE` trigger mode

**Parameters:**

<SLength> integer  
 Range: 1 to dynamic  
 \*RST: 1

**Example:** See [Example "Trigger configuration"](#) on page 40.

**Manual operation:** See ["Trigger Signal Duration"](#) on page 26

**[:SOURce<hw>]:BB:LORA:TRIGger:SLUNit <SIUnit>**

Defines the unit for the entry of the signal sequence length.

**Parameters:**

<SIUnit> SEQUENCE | SAMPLE  
 \*RST: SEQUENCE

**Example:** `SOURce1:BB:LORA:TRIGger:SEQUence SING`

`SOURce1:BB:LORA:TRIGger:SLUNit SEQ`

`SOURce1:BB:LORA:TRIGger:SLENgth 2`

**Manual operation:** See ["Signal Duration Unit"](#) on page 26

## 7.6 Marker Commands

<code>[:SOURce&lt;hw&gt;]:BB:LORA:TRIGger:OUTPut&lt;ch&gt;:MODE</code> .....	54
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<code>[:SOURce&lt;hw&gt;]:BB:LORA:TRIGger:OUTPut&lt;ch&gt;:ONTime</code> .....	55
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<code>[:SOURce&lt;hw&gt;]:BB:LORA:TRIGger:OUTPut&lt;ch&gt;:PATtern</code> .....	55
<code>[:SOURce&lt;hw&gt;]:BB:LORA:TRIGger:OUTPut&lt;ch&gt;:PULSe:DIVider</code> .....	56
<code>[:SOURce&lt;hw&gt;]:BB:LORA:TRIGger:OUTPut&lt;ch&gt;:PULSe:FREQUency?</code> .....	56

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

Defines the signal for the selected marker output.

**Parameters:**

<Mode>            REStart | PULSe | PATTern | RATio | TRIGger | FRAMe  
 \*RST:            REStart

**Example:**        See [Example "Configure and enable standard marker signals"](#) on page 40.

**Manual operation:** See ["Marker Mode"](#) on page 29

**[:SOURce<hw>]:BB:LORA:TRIGger:OUTPut<ch>:DELay <Delay>**

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

**Parameters:**

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

**Example:**        See [Example "Configure and enable standard marker signals"](#) on page 40.

**Manual operation:** See ["Marker x Delay"](#) on page 30

**[:SOURce<hw>]:BB:LORA:TRIGger:OUTPut<ch>:ONTime <OnTime>**  
**[:SOURce<hw>]:BB:LORA:TRIGger:OUTPut<ch>:OFFTime <OffTime>**

Sets the number of samples during which the marker output is on or off.

**Parameters:**

<OffTime>         integer  
 Range:            1 to 16777215  
 \*RST:            1

**Example:**        See [Example "Configure and enable standard marker signals"](#) on page 40.

**Manual operation:** See ["Marker Mode"](#) on page 29

**[:SOURce<hw>]:BB:LORA:TRIGger:OUTPut<ch>:PATtern <Pattern>, <BitCount>**

Sets the bit pattern defining the marker signal.

**Parameters:**

<Pattern>         numeric  
 \*RST:            #H2  
 <BitCount>       integer  
 Range:            1 to 64  
 \*RST:            2

**Example:** See [Example "Configure and enable standard marker signals"](#) on page 40.

**Manual operation:** See ["Marker Mode"](#) on page 29

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

Set the pulse divider for marker mode PULSe.

**Parameters:**

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

**Example:** See [\[:SOURce<hw>\]:BB:LORA:TRIGger:OUTPut<ch>:PULSe:FREQuency?](#) on page 56.

**Manual operation:** See ["Marker Mode"](#) on page 29

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

Queries the pulse frequency.

The return value depends on the [pulse divider](#), which is the [sample rate](#) divided by the pulse divider.

**Return values:**

<Frequency> float  
 Range: 2 to 1024  
 Increment: 1E-3  
 \*RST: 2

**Example:**

```
SOURce1:BB:LORA:TRIGger:OUTPut1:MODE PULSe
SOURce1:BB:LORA:TRIGger:OUTPut1:PULSe:DIVider 4
SOURce1:BB:LORA:SRATe:VARiatiOn?
// 500000
SOURce1:BB:LORA:TRIGger:OUTPut1:PULSe:FREQuency?
// 125000
```

**Usage:** Query only

**Manual operation:** See ["Marker Mode"](#) on page 29

## 7.7 Clock Commands

[\[:SOURce<hw>\]:BB:LORA:CLOCK:SOURce.....](#)57  
[\[:SOURce<hw>\]:BB:LORA:CLOCK:MODE.....](#)57



---

**[ :SOURce<hw>]:BB:LORA:CLOCK:SOURce <Source>**

Selects the clock source:

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

**Parameters:**

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

**Example:**           See [Example "Clock settings"](#) on page 40.

**Manual operation:** See ["Clock Source"](#) on page 31

---

**[ :SOURce<hw>]:BB:LORA:CLOCK:MODE <Mode>**

Sets the type of externally supplied clock.

**Parameters:**

<Mode>                SAMPLE | MSAMPLE  
\*RST:            SAMPLE

**Example:**           See [Example "Clock settings"](#) on page 40.

**Options:**

**Manual operation:** See ["Clock Mode"](#) on page 31

## Glossary: Abbreviations and Definitions

### C

**CEPT:** European Conference of Postal and Telecommunications Administrations

**CSS:** Chirp Spread Spectrum

**CW:** Continuous Wave

### E

**ECO:** European Communications Office

**ERC:** European Radiocommunications Committee

**ETSI:** European Telecommunications Standards Institute

### F

**FCC:** Federal Communications Commission

### I

**IoT:** Internet of Things

### L

**LoRa:** Long Range

**LoRaWAN:** Long Range Wide Area Network

### P

**PER:** Packet Error Rate

**PHY:** Physical layer

### R

**REC:** Physical layer

### W

**WAN:** [LoRaWAN](#)

# Glossary: Specifications and References

## Symbols

**1MA295:** Rohde&Schwarz  
Application Note 1MA295: Characterization of LoRa Devices  
<https://www.rohde-schwarz.com/appnote/1MA295>

## C

**CEPT/ERC Recommendation 70-03:** "Relating to the use of Short Range Devices (SRD)"  
Available at ECO data base  
<https://www.ecodocdb.dk/download/25c41779-cd6e/Rec7003e.pdf>

## E

**ETSI Specification EN 300 220-1:** "Short Range Devices (SRD) operating in the frequency range 25 MHz to 1000 MHz"  
[https://www.etsi.org/deliver/etsi\\_en/300200\\_300299/30022001/](https://www.etsi.org/deliver/etsi_en/300200_300299/30022001/)

## F

**FCC Specification 47 Part 15.247:** "47 CFR 15.247 - Operation within the bands 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz."  
<https://www.govinfo.gov/content/pkg/CFR-2010-title47-vol1/pdf/CFR-2010-title47-vol1-sec15-247.pdf>

## L

**LoRaWAN Regional Parameters Specification:** "LoRaWAN™ 1.1 Regional Parameters"  
<https://lora-alliance.org/resource-hub/lorawan-1-1-regional-parameters-v11ra>

**LoRaWAN Specification:** "LoRaWAN™ 1.1 Specification"  
<https://lora-alliance.org/resource-hub/lorawan-1-1-specification-v11>

## R

**R&S SGMA-GUI Software:** Software for control of R&S SGS  
<https://www.rohde-schwarz.com/software/sgs100a/>

**R&S SGS100A user manual:** <https://www.rohde-schwarz.com/manual/sgs100a/>

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