R&S®SMCVB-KV5x
Multi-Satellite GNSS Waveforms
User Manual

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Version 03

ROHDE&SCHWARZ
Make ideas real

This document describes the following software options:

- R&S®SMCVB-KV50 Multi-Satellite GPS Waveforms (1434.5770.xx)
- R&S®SMCVB-KV51 Multi-Satellite Galileo Waveforms (1434.5792.xx)
- R&S®SMCVB-KV52 Multi-Satellite GLONASS Waveforms (1434.5811.xx)
- R&S®SMCVB-KV53 Multi-Satellite BeiDou Waveforms (1434.5834.xx)

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The following abbreviations are used throughout this manual: R&S®SMCV100B is abbreviated as R&S SMCV100B.

Contents

1 Welcome to the R&S SMCVB-KV5x options

The R&S SMCVB-KV5x options are waveform libraries that provide waveform files in accordance with GPS, Galileo, GLONASS and BeiDou global navigation satellite systems (GNSS).

This user manual contains a reference description of the functionality that the waveform library provides. All functions not discussed in this manual are described in the R&S SMCV100B user manual. The latest version is available at:

www.rohde-schwarz.com/manual/SMCV100B

1.1 Key features

The R&S SMCVB-KV5x options feature:

- Numerous waveform files in accordance with the following GNSS standards: GPS, Galileo, GLONASS and BeiDou
- Efficient use with dedicated waveforms
- Dedicated signals for position fixing of GNSS receivers for production tests

1.2 Installation

You can find detailed installation instructions in the supplement document of the R&S SMCV100B user manual and in the R&S SMCV100B user manual describing firmware versions FW 4.90.002.xx and later of the R&S SMCV100B.

1.3 What's new

Compared to the previous version, it provides the new features listed below:

- GNSS simulation start time, see Chapter 2.3, "Simulation date and time", on page 9.
- Loading and playing GNSS waveform files, see "To work with a GNSS waveform file at the R&S SMCV100B" on page 10.
- GNSS waveform file names, see Chapter 2.4, "File naming conventions", on page 9 and Chapter 2.5, "Waveform files", on page 10.
- Editorial changes

1.4 Documentation overview

This section provides an overview of the R&S SMCV100B user documentation. Unless specified otherwise, you find the documents on the R&S SMCV100B product page at:

www.rohde-schwarz.com/manual/smcv100b

1.4.1 Getting started manual

Introduces the R&S SMCV100B 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.

1.4.2 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 SMCV100B is not included.

The contents of the user manuals are available as help in the R&S SMCV100B. 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.

1.4.3 Service manual

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

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

https://gloris.rohde-schwarz.com

1.4.4 Instrument security procedures

Deals with security issues when working with the R&S SMCV100B in secure areas. It is available for download on the Internet.

1.4.5 Printed safety instructions

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

1.4.6 Data sheets and brochures

The data sheet contains the technical specifications of the R&S SMCV100B. 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/smcv100b

1.4.7 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/smcv100b

1.4.8 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/smcv100b

2 Available waveform files

This chapter contains the description of the available waveform files including signal information, simulation location and simulation time.

2.1 Signal information

Frequency bands

All waveform files simulate GNSS signals in the L1 band (GPS, Galileo), G1 band (GLONASS) and B1 band (BeiDou). For details, see Table 2-1.

Table 2-1: GNSS signal information

GNSS	Signal	Band	Center frequency / MHz
GPS	C/A	L1	1575.42
Galileo	E1 OS	L1	1575.42
GLONASS	C/A	G1	1602 ± k*0.5625[1)]
BeiDou	B1I	B1	1561.098

[1)] k is the frequency number (FDMA) with -7 ≤ k ≤ 13.

At the R&S SMCV100B, set a suitable RF output frequency. For example, a frequency value that matches the center frequency of the GNSS signal.

Power levels

The simulated satellite constellation includes satellites with the same power levels relative to the total power of the output GNSS waveform signal. The satellites have a reference power of -120 dBm resulting in a relative satellite power of 0 dB.

2.2 Simulation location

The simulation location is a city with a predefined geographic location. This location is defined by longitude, latitude and altitude in decimal format. The table below provides an overview of all cities and their location.

City	Longitude [deg]	Latitude [deg]	Altitude [m]
Beijing	116.3913889	39.9055556	60
Bogota	-74.0756820	4.5980670	2640
Moscow	37.6155556	55.7522222	200
Munich	11.5833333	48.1500000	508

City	Longitude [deg]	Latitude [deg]	Altitude [m]
New York	-74.0063889	40.7141667	1
Seoul	126.9877939	37.5514997	265
Taipei	121.5147581	25.0223439	10
Tokyo	139.7450581	35.6838611	45

2.3 Simulation date and time

The simulation date for all waveform files is May 1, 2020. The UTC simulation start differs because improving the time to first fix (TTFF) requires GNSS system-dependent time optimizations. The table below lists the simulation start time in format HH:MM:SS (HH = hour, MM = minutes, SS = seconds) for each GNSS.

GNSS	Simulation start
BeiDou	15:59:30
Galileo	08:59:25
GLONASS	15:59:25
GPS	08:59:25

2.4 File naming conventions

The main GNSS simulation parameters are coded in the file name with file extension `*.wv`: `<GNSS>_<City>_<SimulationLength>_<Date>.wv`. The table below lists all parameters within the name of the waveform files.

Parameter	Description
`<GNSS>`	Simulated GNSS: `BEID` = BeiDou, `GAL` = Galileo, `GLON` = GLONASS, `GPS` = GPS
`<City>`	Simulated location (e.g. `<City>=Munich`): For all cities, see Chapter 2.2, "Simulation location", on page 8.
`<SimulationLength>`	The simulation length is 60 seconds for all waveform files (`<SimulationLength>=60s`).
`<Date>`	Simulation date is May 1, 2020 (`<Date>=2020_05_01`). See also Chapter 2.3, "Simulation date and time", on page 9.

2.5 Waveform files

This chapter lists all waveform files of the R&S SMCVB-KV5x options. The subchapters are listed in alphabetical order and correspond to the names of the waveform files.

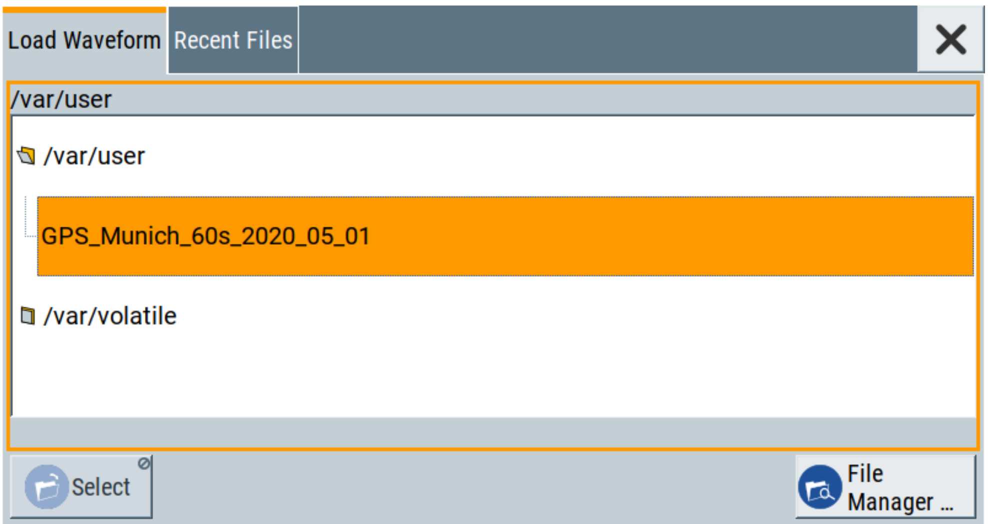
Each subchapter provides information on the following waveform file parameters.

- Simulated GNSS, simulation location, simulation length and date, see Chapter 2.4, "File naming conventions", on page 9.
- Simulated satellites including space vehicle IDs of the simulated GNSS
- Positional dilution of precision (PDOP)
- Horizontal dilution of precision (HDOP)

To work with a GNSS waveform file at the R&S SMCV100B

This step-by-step instruction provides information on how to load and play a GNSS waveform at the ARB application of the R&S SMCV100B. As an example, the file `GPS_Munich_60s_2020_05_01.wv` is used from the waveform library option R&S SMCVB-KV50 Multi-Satellite GPS Waveforms.

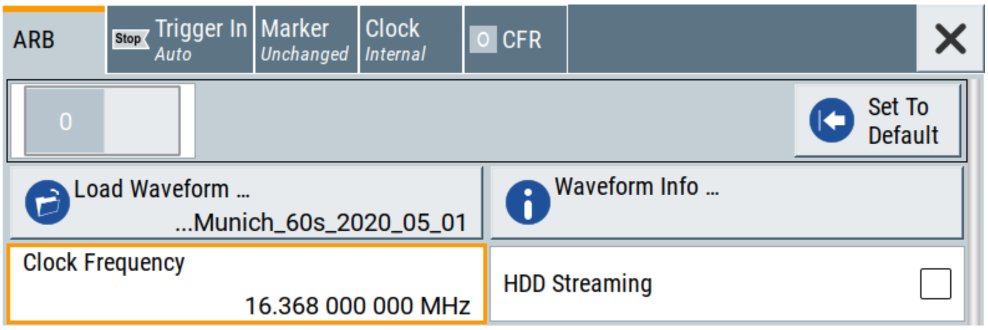
1. Save the waveform file from your GNSS waveform library.
   - You can save it to a USB storage device and connect the device to the R&S SMCV100B.
     See also chapter "How to work with waveform libraries" in the R&S SMCV100B user manual.
   - You can save it to the internal memory of the R&S SMCV100B.
     See also chapter "How to transfer files from and to the instrument" in the R&S SMCV100B user manual.
2. At the R&S SMCV100B, select "Baseband > ARB > File".
3. In the opening file select dialog, navigate to the storage location of the waveform file.



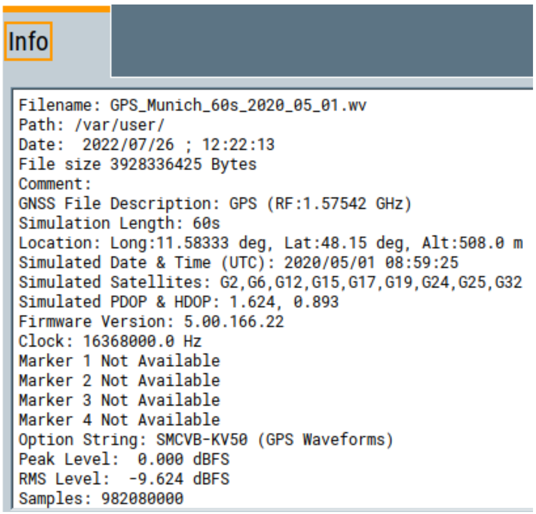
If selected, a tooltip displays additional information on the file.

date: 2022/07/26 ; 12:22:13
samples: 982080000
clock: 16368000.0
comment: GNSS File Description: GPS (RF:1.57542 GHz) Simulation Length: 60s Location: Long:11.58333 deg, Lat:48.15 deg, Alt:508.0 m Simulated Date & Time (UTC): 2020/05/01 08:59:25 Simulated Satellites: G2,G6,G12,G15,G17,G19,G24,G25,G32 Simulated PDOP & HDOP: 1.624, 0.893 Firmware Version: 5.00.166.22

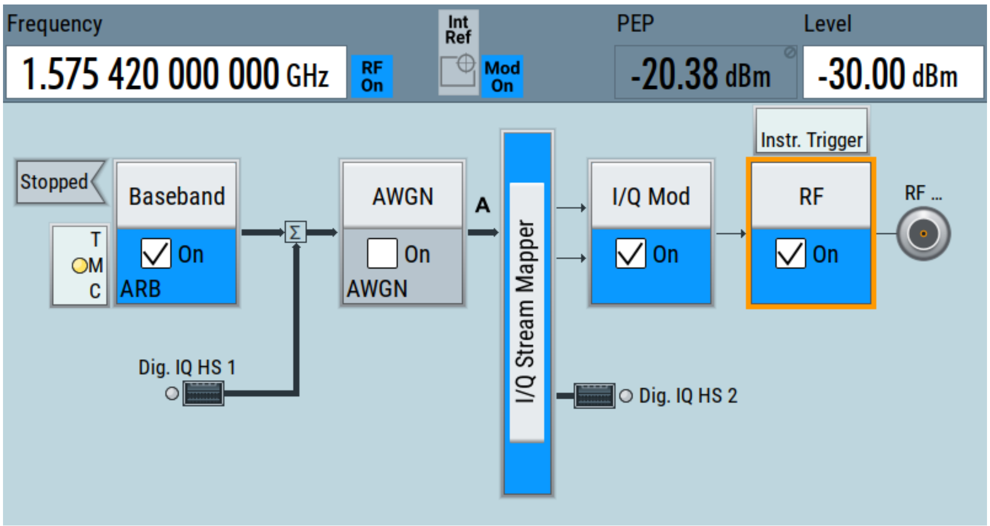
4. Press "Select" to close the dialog and load the file.
   In the "ARB" dialog, the "Clock Frequency" changes automatically as specified in the waveform file.



5. Optionally, open the "Waveform Info" dialog to get a comprehensive overview on waveform file properties.



6. To play the file, select "ARB > State > On".
7. In the block diagram, select "RF > On".


Frequency
1.575 420 000 000 GHz
RF On
Int Ref
Mod On
PEP
-20.38 dBm
Level
-30.00 dBm
Instr. Trigger
Stopped
Baseband
On
ARB
T
M
C
AWGN
On
AWGN
A
I/Q Stream Mapper
I/Q Mod
On
RF
On
RF ...
Dig. IQ HS 1
Dig. IQ HS 2

Files

2.5.1 BEID_Beijing_60s_2020_05_01.wv

Parameter	Value
Simulated satellites	B6, B8, B9, B13, B16, B20, B23, B25, B29, B30, B32, B37, B38, B39, B41
PDOP	1.476
HDOP	0.898

2.5.2 BEID_Bogota_60s_2020_05_01.wv

Parameter	Value
Simulated satellites	B11, B12, B14, B21, B24, B26, B33, B34, B42, B43, B44
PDOP	1.691
HDOP	0.976

2.5.3 BEID_Moscow_60s_2020_05_01.wv

Parameter	Value
Simulated satellites	B6, B9, B13, B16, B19, B20, B24, B26, B29, B30, B32, B35, B38, B39
PDOP	1.436
HDOP	0.814

2.5.4 BEID_Munich_60s_2020_05_01.wv

Parameter	Value
Simulated satellites	B13, B19, B20, B24, B26, B29, B35, B39, B44
PDOP	1.861
HDOP	1.076

2.5.5 BEID_New York_60s_2020_05_01.wv

Parameter	Value
Simulated satellites	B12, B24, B25, B26, B34, B35, B44
PDOP	2.302
HDOP	1.151

2.5.6 BEID_Seoul_60s_2020_05_01.wv

Parameter	Value
Simulated satellites	B6, B8, B9, B13, B16, B20, B23, B25, B29, B30, B32, B37, B38, B39, B41
PDOP	1.464
HDOP	0.841

2.5.7 BEID_Taipei_60s_2020_05_01.wv

Parameter	Value
Simulated satellites	B6, B8, B9, B13, B16, B20, B23, B27, B29, B30, B32, B37, B38, B39, B41
PDOP	1.423
HDOP	0.826

2.5.8 BEID_Tokyo_60s_2020_05_01.wv

Parameter	Value
Simulated satellites	B6, B8, B9, B13, B16, B20, B23, B25, B29, B30, B32, B37, B38, B39, B41
PDOP	1.466
HDOP	0.824

2.5.9 GAL_Beijing_60s_2020_05_01.wv

Parameter	Value
Simulated satellites	E3, E5, E13, E15, E21, E27, E30
PDOP	2.277
HDOP	1.106

2.5.10 GAL_Bogota_60s_2020_05_01.wv

Parameter	Value
Simulated satellites	E1, E4, E9, E11, E12, E24, E31, E36
PDOP	1.817
HDOP	0.954

2.5.11 GAL_Moscow_60s_2020_05_01.wv

Parameter	Value
Simulated satellites	E1, E4, E9, E13, E15, E21, E26, E27
PDOP	1.77
HDOP	0.958

2.5.12 GAL_Munich_60s_2020_05_01.wv

Parameter	Value
Simulated satellites	E1, E4, E9, E13, E15, E19, E21, E26, E31
PDOP	1.593
HDOP	0.816

2.5.13 GAL_New York_60s_2020_05_01.wv

Parameter	Value
Simulated satellites	E1, E4, E5, E9, E24, E31, E36
PDOP	2.558
HDOP	1.331

2.5.14 GAL_Seoul_60s_2020_05_01.wv

Parameter	Value
Simulated satellites	E3, E5, E13, E15, E21, E27, E30
PDOP	2.292
HDOP	0.991

2.5.15 GAL_Taipei_60s_2020_05_01.wv

Parameter	Value
Simulated satellites	E3, E8, E13, E15, E21, E27, E30
PDOP	2.261
HDOP	1.128

2.5.16 GAL_Tokyo_60s_2020_05_01.wv

Parameter	Value
Simulated satellites	E3, E5, E13, E15, E21, E27, E30
PDOP	2.329
HDOP	0.992

2.5.17 GLON_Beijing_60s_2020_05_01.wv

Parameter	Value
Simulated satellites	R3, R4, R5, R12, R13, R18, R19, R20
PDOP	1.677
HDOP	0.957

2.5.18 GLON_Bogota_60s_2020_05_01.wv

Parameter	Value
Simulated satellites	R1, R8, R10, R11, R21, R23
PDOP	3.649
HDOP	1.316

2.5.19 GLON_Moscow_60s_2020_05_01.wv

Parameter	Value
Simulated satellites	R3, R4, R5, R10, R11, R19, R20, R21
PDOP	2.11
HDOP	1.009

2.5.20 GLON_Munich_60s_2020_05_01.wv

Parameter	Value
Simulated satellites	R3, R4, R5, R9, R10, R11, R19, R20, R21
PDOP	1.874
HDOP	0.824

2.5.21 GLON_New York_60s_2020_05_01.wv

Parameter	Value
Simulated satellites	R2, R10, R11, R12, R20, R21
PDOP	2.445
HDOP	1.554

2.5.22 GLON_Seoul_60s_2020_05_01.wv

Parameter	Value
Simulated satellites	R2, R3, R4, R12, R13, R14, R18, R19
PDOP	2.714
HDOP	1.178

2.5.23 GLON_Taipei_60s_2020_05_01.wv

Parameter	Value
Simulated satellites	R3, R4, R13, R14, R17, R18, R19
PDOP	3.18
HDOP	1.23

2.5.24 GLON_Tokyo_60s_2020_05_01.wv

Parameter	Value
Simulated satellites	R2, R3, R4, R12, R13, R14, R18, R19
PDOP	2.646
HDOP	0.917

2.5.25 GPS_Beijing_60s_2020_05_01.wv

Parameter	Value
Simulated satellites	G1, G3, G6, G17, G19, G22, G28
PDOP	2.626
HDOP	1.526

2.5.26 GPS_Bogota_60s_2020_05_01.wv

Parameter	Value
Simulated satellites	G10, G14, G18, G20, G21, G25, G26, G31, G32
PDOP	1.795
HDOP	1.025

2.5.27 GPS_Moscow_60s_2020_05_01.wv

Parameter	Value
Simulated satellites	G2, G6, G12, G17, G19, G24, G25, G32
PDOP	1.828
HDOP	1.014

2.5.28 GPS_Munich_60s_2020_05_01.wv

Parameter	Value
Simulated satellites	G2, G6, G12, G15, G17, G19, G24, G25, G32
PDOP	1.624
HDOP	0.893

2.5.29 GPS_New York_60s_2020_05_01.wv

Parameter	Value
Simulated satellites	G1, G10, G12, G14, G20, G22, G25, G31, G32
PDOP	1.749
HDOP	0.969

2.5.30 GPS_Seoul_60s_2020_05_01.wv

Parameter	Value
Simulated satellites	G1, G3, G6, G17, G19, G22, G28
PDOP	2.645
HDOP	1.527

2.5.31 GPS_Taipei_60s_2020_05_01.wv

Parameter	Value
Simulated satellites	G1, G2, G3, G4, G6, G9, G17, G19, G22, G28, G30
PDOP	1.479
HDOP	0.78

2.5.32 GPS_Tokyo_60s_2020_05_01.wv

Parameter	Value
Simulated satellites	G1, G3, G4, G6, G11, G17, G19, G22, G28
PDOP	1.887
HDOP	1.039

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