R&S®SMBVB-K151/-K152/-K153
ILS/VOR/DME
User Manual

1178917802
Version 10

ROHDE&SCHWARZ
Make ideas real

This document describes the following software options:

- R&S®SMBVB-K151 ILS (1423.8120.xx)
- R&S®SMBVB-K152 VOR (1423.8137.xx)
- R&S®SMBVB-K153 DME (1423.8143.xx)

This manual describes firmware version FW 5.30.305.57 and later of the R&S®SMBV100B.

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1178.9178.02 | Version 10 | R&S®SMBVB-K151/-K152/-K153

Throughout this document, R&S® is indicated as R&S.

Contents

1 Welcome to the avionics options

The avionics options are firmware applications that add functionality to generate signals in accordance with the related avionic standard.

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 SMBV100B user manual. The latest version is available at:

www.rohde-schwarz.com/manual/SMBV100B

Installation

You can find detailed installation instructions in the delivery of the option or in the R&S SMBV100B service manual.

1.1 Key features

Common key features and features that are specific to the avionic option are as follows:

ILS key features

Option R&S SMBVB-K151 is a firmware application that adds functionality to generate signals in accordance with the ground-based instrument landing system (ILS). It provides lateral and vertical guidance to an aircraft approaching and landing on a runway.

R&S SMBVB-K151 key features are:

- Emulation of instrument landing system (ILS)
- Generating ILS signal components: glide slope, localizer and marker beacons
- ICAO standard carrier frequencies and user-defined carrier frequencies
- Adjustable COM/ID settings.

VOR key features

The R&S SMBVB-K152 is a firmware application that adds functionality to generate signals in accordance with the VHF Omnidirectional radio range radio navigation system. VOR determines the aircraft position by receiving radio signals from a network of ground beacons.

R&S SMBVB-K152 key features are:

- Emulation of VHF omnidirectional radio range (VOR)
- ICAO standard carrier frequencies and user-defined carrier frequencies
- User-defined position settings
- Adjustable COM/ID settings

DME key features

The R&S SMBVB-K153 is a firmware application that adds functionality to generate signals in accordance with the distance measuring equipment (DME) for aircraft. DME measures the slant range distance between the vessel and a fixed ground-based station.

The most important R&S SMBVB-K153 features at a glance:

- DME system emulation
- Generating DME interrogation signals and reply signals
- ICAO standard carrier frequencies and user-defined carrier frequencies
- Adjustable COM/ID settings
- Testing echo rejection, velocity tracking and simulating flights

Real-time simulation

Changing a parameter in the avionic standards causes an instant signal change in the R&S SMBV100B. There is no extra measurement cycle to calculate the RMS value of the baseband signal to set the correct RF level.

If the avionics standard is activated for the first time, or after every subsequent on/off sequence, the measurement cycle will take place to determine the correct RF level. Every subsequent parameter change in the avionic standard is performed without another measurement cycle to provide a continuous signal output.

1.2 Accessing the avionics dialog

To open the dialog with avionics settings

► In the block diagram of the R&S SMBV100B, select "Baseband" > "ILS"/"VOR"/"DME".

A dialog box opens that displays the provided general settings of the selected standard.

The signal generation is not started immediately. To start signal generation with the default settings, select "State" > "On".

1.3 What's new

This manual describes firmware version FW 5.30.305.57 and later of the R&S®SMBV100B.

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

- Fixed input connector of the external trigger signal for DME signal generation, see "Input Source" on page 59.
- ILS signal generation of CSB (carrier and sidebands) signals only, see "ILS signals" on page 15 and "CSB signal" on page 18.
- ILS marker beacons COM/ID settings and remote commands removed since not supported.
- Editorial changes

1.4 Documentation overview

This section provides an overview of the R&S SMBV100B user documentation. Unless specified otherwise, you find the documents at:

www.rohde-schwarz.com/manual/smbv100b

1.4.1 Getting started manual

Introduces the R&S SMBV100B 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 SMBV100B is not included.

The contents of the user manuals are available as help in the R&S SMBV100B. 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 SMBV100B 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 Specifications and product brochures

The specifications document, also known as the data sheet, contains the technical specifications of the R&S SMBV100B. It also lists the firmware applications 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/smbv100b

1.4.7 Calibration certificate

The document is available on https://gloris.rohde-schwarz.com/calcert. You need the device ID of your instrument, which you can find on a label on the rear panel.

1.4.8 Release notes and open source acknowledgment

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

The software uses several valuable open source software packages. An open source acknowledgment document provides verbatim license texts of the used open source software.

www.rohde-schwarz.com/firmware/smbv100b

1.4.9 Application notes, application cards, white papers, etc.

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

For some application sheets, see also:

www.rohde-schwarz.com/application/smbv100b

1.4.10 Videos

Find various videos on Rohde & Schwarz products and test and measurement topics on YouTube: https://www.youtube.com/@Rohde-Schwarz

1.5 Scope

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

In particular, it includes:

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

For a description of such tasks, see the R&S SMBV100B user manual.

1.6 Notes on screenshots

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

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

2 About avionics

This section summarizes information on avionics standards supported at the R&S SMBV100B. Also, it links detailed information on the avionic standard supported at the R&S SMBV100B.

Overview of avionics standards

- **Landing systems:** ILS (Instrument Landing System)
  Landing systems are ground-based approach systems that provide precision guidance to aircraft approaching and landing on a runway.
  For more information, see Section 3, "Generating ILS signals", on page 14.
- **Radio/Flight navigation systems:** VOR (VHF Omnidirectional Radio), DME (Distance measuring equipment)
  The radio navigation systems are aircraft systems that support the pilots to determine the aircraft positions and stay on course.
  For more information, see Section 4, "Generating VOR signals", on page 38 and Section 5, "Generating DME signals", on page 48.

3 Generating ILS signals

This section provides information on instrument landing system (ILS) signal generation with the R&S SMBV100B. This information includes required options, background information on ILS, generation of ILS signals, configuration and settings.

3.1 Required options

The basic equipment layout for generating ILS signals includes:

- Base unit
- Baseband real-time extension (R&S SMBVB-K520)
- Digital standard ILS (R&S SMBVB-K151)

3.2 About ILS

During the landing approach, the aircraft uses the instrument landing system (ILS) to monitor the correct approach path to the runway.

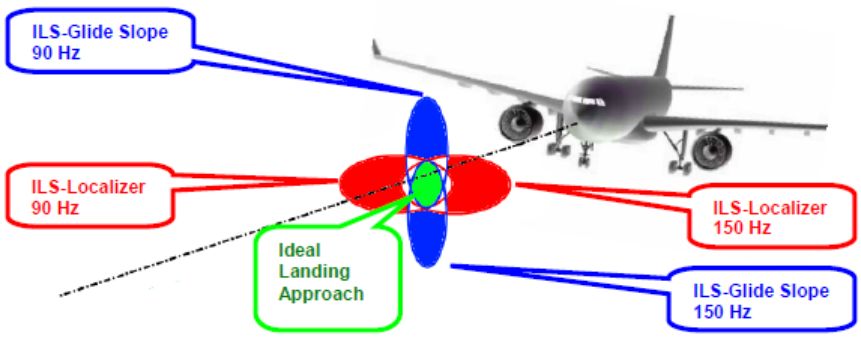


Figure 3-1: Approach navigation using instrument landing system (ILS) [1MA193]

An ILS consists of three independent components:

- The glide slope (GS) component is for vertical guidance.
- The localizer (LOC or LLZ) component is for horizontal guidance.
- Optionally, the marker beacons (MB) component to provide distance information from the runway.

ILS signals

ILS signals are amplitude modulated (AM) radio frequency signals. The carrier frequencies f_c range from about 100 MHz to 340 MHz, see Table 3-1. The modulation signals are tones with frequencies f_1 = 90 Hz and f_2 = 150 Hz.

During operation, an ILS sends a reference signal CSB (carrier and sidebands) and a signal for comparison SBO (sidebands only). The 90 Hz tone and the 150 Hz tone typically have the same modulation depth within these signals. Note that the R&S SMBV100B supports CSB signal generation only. The figures Figure 3-2 and Figure 3-3 illustrate the spectrum of the CSB signal and the SBO signal.

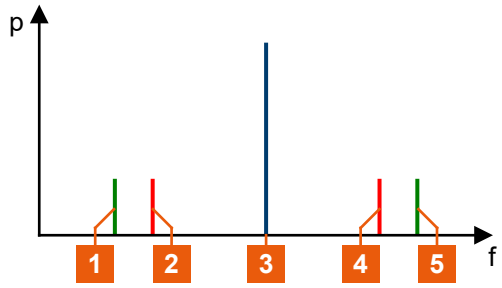


Figure 3-2: CSB signal spectrum

1, 5 = Lower sideband f_c - f_2 and upper sideband f_c + f_2
2, 4 = Lower sideband f_c - f_1 and upper sideband f_c + f_1
3 = Carrier f_c

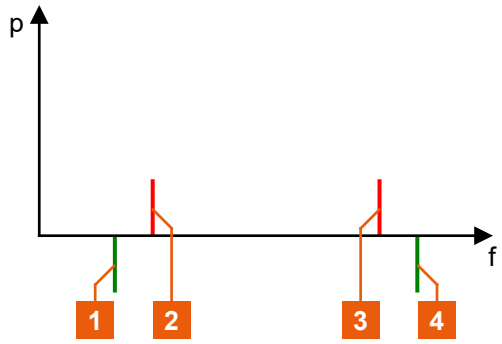


Figure 3-3: SBO signal spectrum

1, 4 = Inverted lower sideband f_c - f_2 and inverted upper sideband f_c + f_2
2, 3 = Lower sideband f_c - f_1 and upper sideband f_c + f_1

Glide slope component

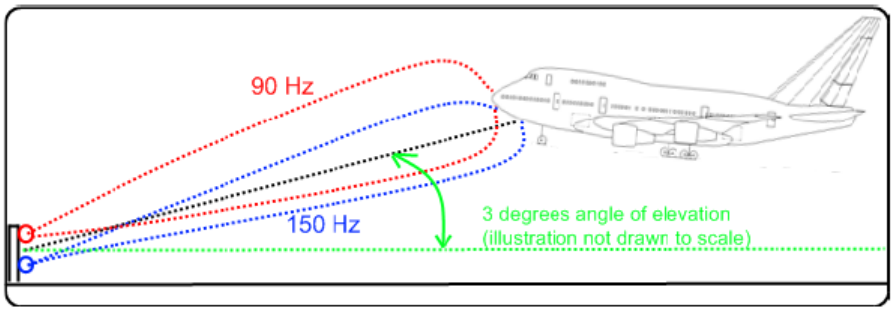
The glide slope transmitter is located near the end of the runway. The location is nearest to the start of the aircraft approach.

Typically, vertically aligned antennas transmit two intersecting main beams on top of one another at carrier frequencies between 329 MHz and 335 MHz, see Table 3-1.

The top beam is usually modulated at 90 Hz and the beam below at 150 Hz [1MA193]. The information on position is provided after demodulation of the beam signals by evaluating the difference in depth of modulation (DDM).

The following scenarios are possible:

- A predominance of the 90 Hz beam indicates that the aircraft is too high and needs to descend.
- A predominance of the 150 Hz beam indicates that the aircraft is too low and needs to climb.
- If the signal strength from both beams is equal, the aircraft is in the center and on the right course.

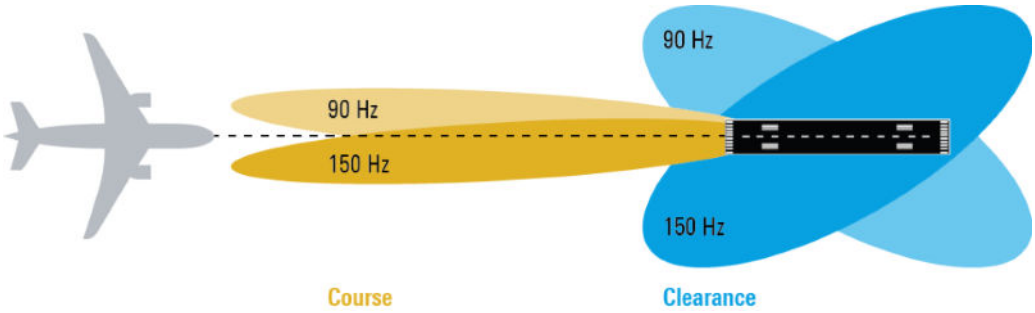


Localizer component

The localizer transmitter is located near the end of the runway (nearest to the start of the aircraft approach). Typically, horizontally aligned antennas transmit two intersecting main beams beside one another at carrier frequencies between 108 MHz and 112 MHz. As seen from the approaching aircraft coming in for a landing, the left beam is usually modulated at 90 Hz and the right beam at 150 Hz [1MA193].

The information on position is provided after demodulation of the beam signals by evaluating the difference in depth of modulation (DDM). The following scenarios are possible:

- Predominance of the 90 Hz beam: the aircraft is too far to the left and must turn to the right
- Predominance of the 150 Hz beam: the aircraft is too far to the right and must turn to the left
- The signal strength from both beams is equal: the aircraft is in the center, on the right course.



Marker beacons component

Marker beacon receivers are used for a rough distance measurement. They are available only for some ILS installations [1MA193].

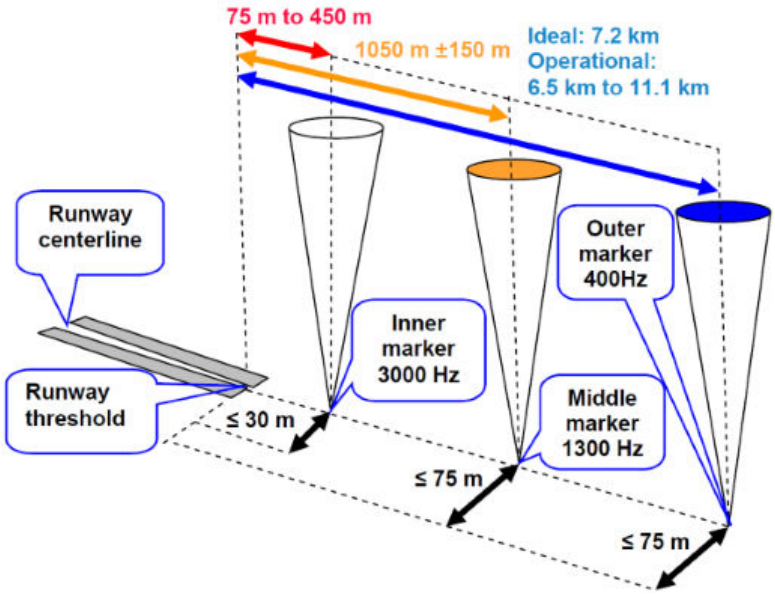


Figure 3-4: Marker beacon placement and distance to runway

Marker beacon receivers decode audio signals and provide output signals to identify one of the three marker beacons near the runway. They transmit a narrow beam width at 75 MHz carrier frequency in a vertical direction. Each of them has a different distinct modulation code to allow the receiver to identify which one it is flying over [1MA193].

The flight equipment typically supports both visual identification (color of the marker beacon) and audio tone identification to determine the current flight position. The audio pairing or visual pairing of marker beacons is as follows:

- The outer marker flashes BLUE in the cockpit at 400 Hz (“relaxed” tone).
- The middle marker flashes AMBER in the cockpit at 1300 Hz (“hurried” tone).
- The inner marker flashes WHITE in the cockpit at 3000 Hz (“urgent” tone).

Related Settings

- Section 3.3.2, "ILS glide slope settings", on page 20
- Section 3.3.3, "ILS localizer settings", on page 26
- Section 3.3.4, "ILS marker beacons settings", on page 35

ILS channel frequencies

The column notations in the table below are as follows:

- **Chan.** = ICAO channel number
- **LOC freq.** = ILS localizer frequency (MHz)
- **GS freq.** = ILS glide slope frequency (MHz)

Table 3-1: ILS ICAO channels and frequencies (MHz)

Chan.	LOC freq.	GS freq.	Chan.	LOC freq.	GS freq.	Chan.	LOC freq.	GS freq.
18X 18Y	108.10 108.15	334.70 334.55	32X 32Y	109.50 109.55	332.60 332.45	46X 46Y	110.90 110.95	330.80 330.65
20X 20Y	108.30 108.35	334.10 333.95	34X 34Y	109.70 109.75	333.20 333.05	48X 48Y	111.10 111.15	331.70 331.55
22X 22Y	108.50 108.55	329.90 329.75	36X 36Y	109.90 109.95	333.80 333.65	50X 50Y	111.30 111.35	332.30 332.15
24X 24Y	108.70 108.75	330.50 330.35	38X 38Y	110.10 110.15	334.40 334.25	52X 52Y	111.50 111.55	332.90 332.75
26X 26Y	108.90 108.95	329.30 329.15	40X 40Y	110.30 110.35	335.00 334.85	54X 54Y	111.70 111.75	333.50 333.35
28X 28Y	109.10 109.15	331.40 331.25	42X 42Y	110.50 110.55	329.60 329.45	56X 56Y	111.90 111.95	331.10 330.95
30X 30Y	109.30 109.35	332.00 331.85	44X 44Y	110.70 110.75	330.20 330.05			

3.3 ILS configuration and settings

Option: R&S SMBVB-K151

Access:

► Select "Baseband" > "ILS".

The remote commands required to define ILS settings are described in Section 7.3, "ILS commands", on page 99.

CSB signal

By default, the R&S SMBV100B generates an ILS glide slope signal. This signal is a CSB (carrier and sidebands) signal with a carrier frequency of 344.7 MHz or ICAO channel 18X. The dual-tone low-frequency signal has frequencies 90 Hz and 150 Hz and a balanced modulation at SDM of 80 %.

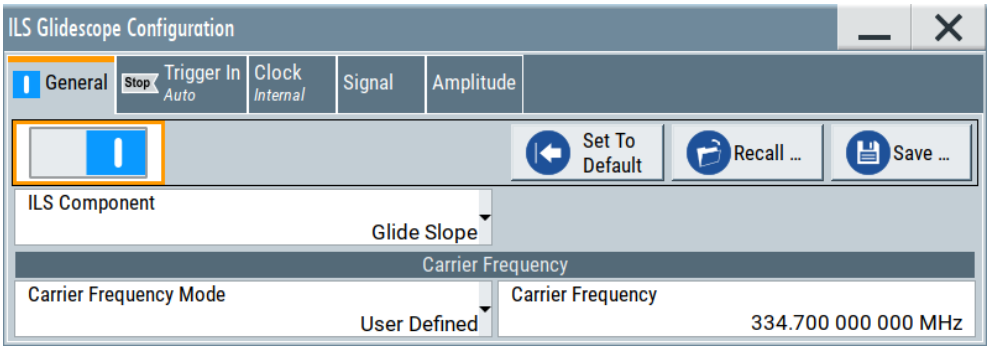
Settings:

3.3.1 General settings

This section provides settings to configure general ILS components.

Access:

► Select "ILS" > "General".



The dialog provides general settings of the ILS standard, the default and the "Save/Recall" settings.

Changing a parameter in the avionic standards causes an instant signal change in the R&S SMBV100B. There is no extra measurement cycle to calculate the RMS value of the baseband signal to set the correct RF level.

If the avionics standard is activated for the first time, or after every subsequent on/off sequence, the measurement cycle will take place to determine the correct RF level. Every subsequent parameter change in the avionic standard is performed without another measurement cycle to provide a continuous signal output.

Settings:

State
Activates the avionic standard.

Activation of the standard deactivates a previously active avionic standard. The "VOR/ILS/DME > Carrier Frequency" setting is applied automatically to the RF "Frequency" and displayed in the status bar.

Remote command:
`<subsystem>:STATe` on page 99

Set To Default
Calls the default settings. The table below lists the default values of the main parameters.

Standard	Parameter	Value
VOR/ILS/DME	State	Not affected by "Set to default"
VOR	Carrier Frequency Mode	User Defined
	Carrier Frequency	108.000000 MHz
ILS	ILS Component	Glide Slope (GS)
	ILS GS > Carrier Frequency Mode	User Defined
	ILS GS > Carrier Frequency	334.700000 MHz
DME	DME Mode	Interrogation
	Channel Mode	X Channel
	Carrier Frequency	1.025 GHz

Remote command:
`<subsystem>:PRESet` on page 97

Save/Recall
Opens 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 settings are saved in a file with a predefined extension. You can define the filename and the directory, in that you want to save the file.

See also section "Saving and recalling settings" in the R&S SMBV100B user manual.

Remote command:
`<subsystem>:SETTing:CATalog` on page 98
`<subsystem>:SETTing:DELete` on page 98
`<subsystem>:SETTing:LOAD` on page 98
`<subsystem>:SETTing:STORe` on page 98

ILS Component
Sets the ILS component.

"Glide slope" Enables the glide slope.

"Localizer" Enables the localizer.

"Marker Beacons"
Enables the marker beacons.

Remote command:
`[:SOURce<hw>][:BB]:ILS:TYPE` on page 99

3.3.2 ILS glide slope settings

Access:

1. Select "ILS" > "General".

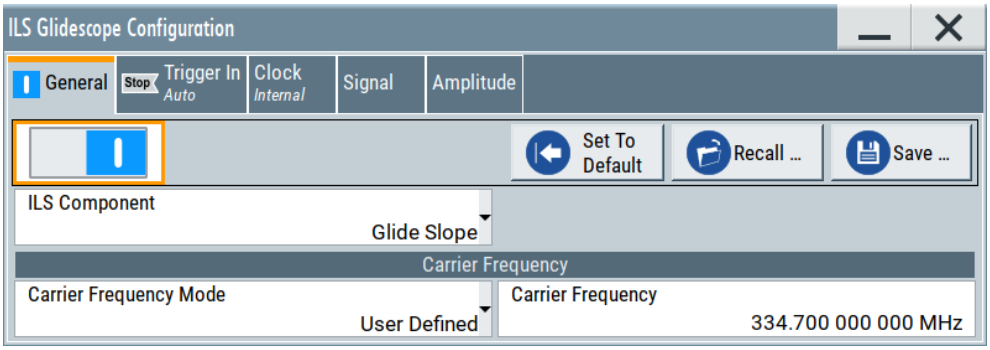
2. Select "ILS Component" > "Glide Slope".

Settings:

3.3.2.1 General settings

Access:

► Select "ILS" > "General".



This dialog provides carrier frequency settings related to the ILS glide slope component of the ILS signal.

Settings:

Carrier Frequency Mode
Sets the mode for the carrier frequency of the signal.

Select "Carrier Frequency Mode > ICAO" to set a standard ILS frequency channel. If you want to couple carrier frequencies of ILS glide slope and localizer components, enable Sync with Glide Slope/ Sync with Localizer.

"User Defined" Activates user-defined variation of the carrier frequency.

"ICAO" Activates variation in predefined steps according to standard ILS transmitting frequencies (see Table 3-1).

Remote command:
`[:SOURce<hw>][:BB]:ILS[:GS|GSLope]:FREQuency:MODE` on page 103

Carrier Frequency
Requires "Carrier Frequency Mode" > "User Defined".

Sets the carrier frequency of the signal.

Remote command:
`[:SOURce<hw>][:BB]:ILS[:GS|GSLope]:FREQuency` on page 103

ICAO Channel
Requires "Carrier Frequency Mode" > "ICAO".

Sets the ICAO channel and the corresponding transmitting frequency.

If avionic standard modulation is activated and you change the "RF Frequency", the frequency value of the closest ICAO channel is applied automatically. The "ICAO Channel" is also updated.

For an overview of the ILS ICAO channel frequencies, see Table 3-1.

Remote command:
`[:SOURce<hw>][:BB]:ILS[:GS|GSLope]:ICAO:CHANnel` on page 104

Sync with Glide Slope/ Sync with Localizer
Activates synchronization of the ILS glide slope with the ILS localizer carrier frequency or vice versa.

If "Carrier Frequency Mode" > "User", the ILS glide slope carrier frequency is applied to the ILS localizer carrier frequency or vice versa.

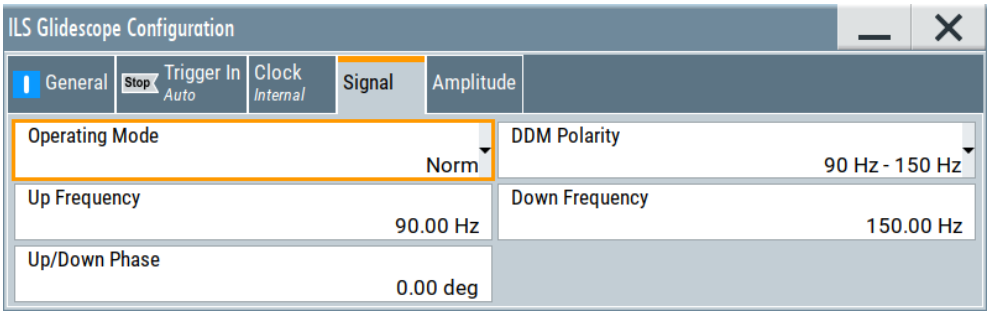
If "Carrier Frequency Mode" > "ICAO", the ILS glide slope ICAO channel is applied to the ILS localizer ICAO channel or vice versa. The ILS glide slope/localizer frequency of the ICAO channel (Table 3-1) is set automatically.

Remote command:
`[:SOURce<hw>][:BB]:ILS[:GS|GSLope]:FREQuency:SYNChronize[:STATe]` on page 103
`[:SOURce<hw>][:BB]:ILS:LOCalizer:FREQuency:SYNChronize[:STATe]` on page 113

3.3.2.2 Signal settings

Access:

1. Select "ILS Component" > "Glide Slope". See Section 3.3.2, "ILS glide slope settings", on page 20.
2. Select "ILS" > "Signal".



This dialog provides modulation signal settings related to the ILS glide slope component of the ILS signal.

Settings:

Operating Mode
Selects the operating mode for the ILS glide slope modulation signal.

"Norm" ILS glide slope modulation is active.

"90 Hz" Amplitude modulation of the output signal with the upper lobe signal component (90 Hz signal content) of the ILS glide slope signal.

The modulation depth of the 90 Hz signal results from the settings of the parameters Sum of Depth and DDM Depth according to:

- "Fly > Down"
  AM (90 Hz) = 0.5 × (SDM + DDM × 100 %)
- "Fly > Up"
  AM (90 Hz) = 0.5 × (SDM - DDM × 100 %)

"150 Hz" Amplitude modulation of the output signal with the lower lobe signal component (150 Hz signal content) of the ILS glide slope signal.

The modulation depth of the 150 Hz signal results from the settings of parameters Sum of Depth and DDM Depth according to:

- "Fly > Down"
  AM (150 Hz) = 0.5 × (SDM + DDM × 100 %)
- "Fly > Up"
  AM (150 Hz) = 0.5 × (SDM - DDM × 100 %)

Remote command:
`[:SOURce<hw>][:BB]:ILS[:GS|GSLope]:MODE` on page 105

DDM Polarity
Defines the polarity for DDM calculation, see "DDM Depth" on page 25.

Remote command:
`[:SOURce<hw>][:BB]:ILS[:GS|GSLope]:DDM:POLarity` on page 102

Up Frequency
Sets the modulation frequency of the upper antenna lobe.

Remote command:
`[:SOURce<hw>][:BB]:ILS[:GS|GSLope]:ULOBe[:FREQuency]` on page 106

Down Frequency
Sets the modulation frequency of the lower antenna lobe.

Remote command:
`[:SOURce<hw>][:BB]:ILS[:GS|GSLope]:LLOBe[:FREQuency]` on page 104

Up/Down Phase
Sets the phase between the modulation signals of the upper and lower antenna lobe.

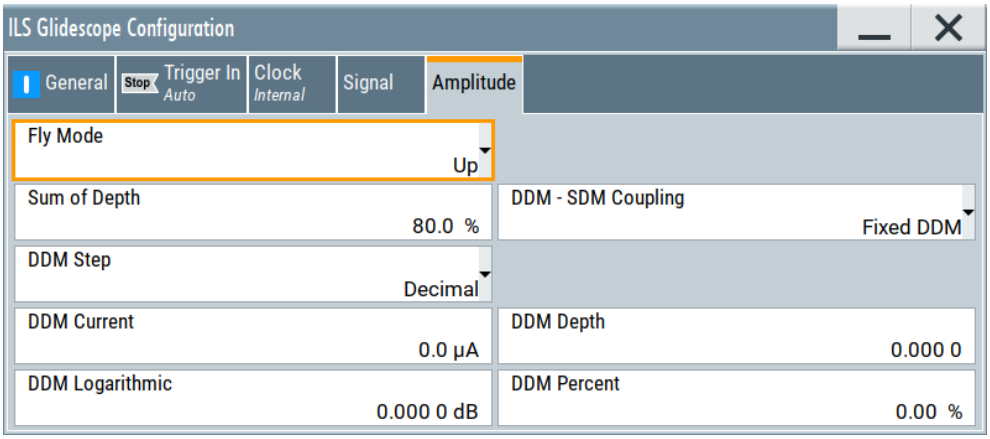
The zero crossing of the lower lobe (150Hz) signal serves as a reference. The angle refers to the period of the signal of the lower antenna lobe.

Remote command:
`[:SOURce<hw>][:BB]:ILS[:GS|GSLope]:PHASe` on page 105

3.3.2.3 Amplitude settings

Access:

1. Select "ILS Component" > "Glide Slope". See Section 3.3.2, "ILS glide slope settings", on page 20.
2. Select "ILS" > "Amplitude".



This dialog provides amplitude settings related to the ILS glide slope component of the ILS signal.

Settings:

Sum of Depth
Sets the arithmetic sum of the modulation depths of the upper lobe (90 Hz) and lower lobe (150 Hz) ILS glide slope signal contents.

The RMS modulation depth of the sum signal depends on the phase setting of both modulation tones.

Remote command:
[:SOURce<hw>][:BB]:ILS[:GS|GSLope]:SDM on page 105

Fly Mode
Selects the simulation mode for the ILS glide slope modulation signal. A change of the setting automatically changes the sign of the DDM value.

This setting simulates the direction in which the pilot has to correct the course.

"Up" The 150 Hz modulation signal is predominant, the DDM value is negative (the airplane is too low, it must climb).

"Down" The 90 Hz modulation signal is predominant, the DDM value is positive (the airplane is too high, it must descend).

Remote command:
[:SOURce<hw>][:BB]:ILS[:GS|GSLope]:DDM:DIRection on page 101

DDM Step
Selects the variation of the DDM values.

"Decimal" Decimal variation according to the current cursor position.

"Predifined" Variation in predefined steps according to the standardized DDM values.

Remote command:
[:SOURce<hw>][:BB]:ILS[:GS|GSLope]:DDM:STEP on page 102

DDM Current
Sets the current of the ILS indicating the instrument corresponding to the DDM value. The instrument current is calculated according to:

DDM Current µA = DDM Depth [%] × 857,125 µA

A variation of the instrument current automatically leads to a variation of the DDM value and the DDM value in dB.

Remote command:
[:SOURce<hw>][:BB]:ILS[:GS|GSLope]:DDM:CURRent on page 100

DDM Depth
Sets the difference in depth of modulation between the upper lobe (90 Hz) and the lower lobe (150 Hz) tone of the ILS glide slope modulation signal.

The DDM value is calculated with the formula:
- "DDM Polarity" > "90 Hz - 150 Hz":
  DDM = [AM (90 Hz) - AM (150 Hz)] / 100%
- "DDM Polarity" > "150 Hz - 90 Hz":
  DDM = [AM (150 Hz) - AM (90 Hz)] / 100%

A variation of the DDM value automatically leads to a variation of the value of the instrument current and the DDM value in dB.

Remote command:
[:SOURce<hw>][:BB]:ILS[:GS|GSLope]:DDM[:DEPTh] on page 102

DDM Logarithmic
Sets the DDM value in dB. The dB value is calculated according to:

DDM dB = 20 × LOG [(SDM+DDM×100%) / (SDM-DDM×100%)]

A variation of the value automatically leads to a variation of the DDM value and the instrument current.

Remote command:
`[:SOURce<hw>][:BB]:ILS[:GS|GSLope]:DDM:LOGarithmic` on page 101

DDM Percent
Sets the difference in depth of modulation between the upper lobe (90 Hz) and the lower lobe (150 Hz) tone of the ILS glide slope modulation signal.

The DDM value in percent is calculated as follows:
- "DDM Polarity" > "90 Hz - 150 Hz":
  DDM = [AM (90 Hz) - AM (150 Hz)]
- "DDM Polarity" > "150 Hz - 90 Hz":
  DDM = [AM (150 Hz) - AM (90 Hz)]

A variation of the DDM value automatically leads to a variation of the value of the instrument current and the DDM value in dB.

Remote command:
`[:SOURce<hw>][:BB]:ILS[:GS|GSLope]:DDM:PCT` on page 101

DDM - SDM Coupling
Selects if the DDM value is fixed or is changed with a change of sum of modulation depths (SDM, see below).

"Fixed DDM" The absolute DDM value stays constant, if the SDM is changed.

"Coupled to SDM"
The absolute DDM value changes, if the SDM is changed. The DDM value expressed in dB stays constant.

Remote command:
`[:SOURce<hw>][:BB]:ILS[:GS|GSLope]:DDM:COUPling` on page 100

3.3.3 ILS localizer settings

Access:

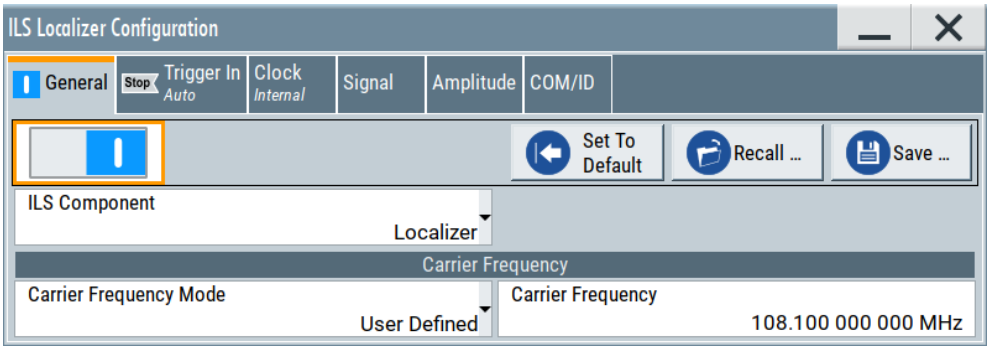
1. Select "ILS" > "General".
2. Select "ILS Component" > "Localizer".

Settings:

3.3.3.1 General settings

Access:

► Select "ILS > General".



This dialog provides carrier frequency settings of the ILS localizer component of the ILS signal.

Settings:

Carrier Frequency Mode
Sets the mode for the carrier frequency of the signal.

"User Defined" Activates user-defined variation of the carrier frequency.

"ICAO" Activates variation in predefined steps according to standard ILS transmitting frequencies (see Table 3-1).
Select the ICAO Channel to set a standard ILS frequency channel. If you want to couple carrier frequencies of ILS glide slope and localizer components, enable General settings.

Remote command:
`[:SOURce<hw>][:BB]:ILS:LOCalizer:FREQuency:MODE` on page 113

Carrier Frequency
Requires "Carrier Frequency Mode" > "User Defined".

Sets the carrier frequency of the signal.

Remote command:
`[:SOURce<hw>][:BB]:ILS:LOCalizer:FREQuency` on page 113

ICAO Channel
Requires "Carrier Frequency Mode > ICAO".

Sets the ICAO channel and the corresponding transmitting frequency.

If avionic standard modulation is activated and you change the "RF Frequency", the frequency value of the closest ICAO channel is applied automatically. The "ICAO Channel" is also updated.

For an overview of the ILS ICAO channel frequencies, see Table 3-1.

Remote command:
`[:SOURce<hw>][:BB]:ILS:LOCalizer:ICAO:CHANnel` on page 114

Sync with Glide Slope/ Sync with Localizer
Activates synchronization of the ILS glide slope with the ILS localizer carrier frequency or vice versa.

If "Carrier Frequency Mode" > "User", the ILS glide slope carrier frequency is applied to the ILS localizer carrier frequency or vice versa.

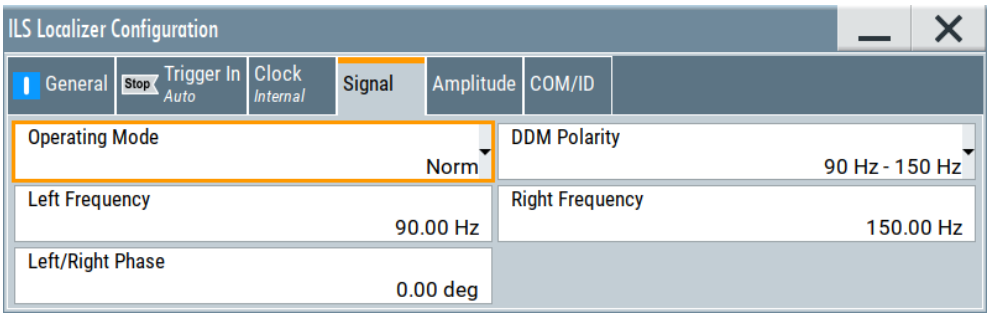
If "Carrier Frequency Mode" > "ICAO", the ILS glide slope ICAO channel is applied to the ILS localizer ICAO channel or vice versa. The ILS glide slope/localizer frequency of the ICAO channel (Table 3-1) is set automatically.

Remote command:
`[:SOURce<hw>][:BB]:ILS[:GS|GSLope]:FREQuency:SYNChronize[:STATe]` on page 103
`[:SOURce<hw>][:BB]:ILS:LOCalizer:FREQuency:SYNChronize[:STATe]` on page 113

3.3.3.2 Signal settings

Access:

1. Select "ILS Component" > "Localizer". See Section 3.3.3, "ILS localizer settings", on page 26.
2. Select "ILS" > "Signal".



This dialog provides audio signal and modulation settings related to the ILS localizer component of the ILS signal.

Settings:

Operating Mode
Selects the operating mode for the ILS localizer modulation signal.

"Norm" ILS localizer modulation is active.

"90 Hz" Amplitude modulation of the output signal with the left lobe (90 Hz) signal component of the ILS localizer signal.

The modulation depth of the 90 Hz signal results from the settings of parameters Sum of Depth and DDM Depth according to:

- "Fly > Right"
  AM (90 Hz) = 0.5 × (SDM + DDM × 100 %)
- "Fly > Left"
  AM (90 Hz) = 0.5 × (SDM - DDM × 100 %)

"150 Hz" Amplitude modulation of the output signal with the right lobe (150 Hz) signal component of the ILS localizer signal.

The modulation depth of the 150 Hz signal results from the settings of parameters Sum of Depth and DDM Depth according to:

- "Fly" = "Right"
  AM (150 Hz) = 0.5 × (SDM + DDM × 100 %)
- "Fly" = "Left"
  AM (150 Hz) = 0.5 × (SDM - DDM × 100 %)

Remote command:
`[:SOURce<hw>][:BB]:ILS:LOCalizer:MODE` on page 114

DDM polarity
Defines the polarity for DDM calculation, see "DDM Depth" on page 31.

Remote command:
`[:SOURce<hw>][:BB]:ILS:LOCalizer:DDM:POLarity` on page 112

Left Frequency
Sets the modulation frequency of the antenna lobe arranged at the left viewed from the air plane.

Remote command:
`[:SOURce<hw>][:BB]:ILS:LOCalizer:LLOBe[:FREQuency]` on page 114

Right Frequency
Sets the modulation frequency of the antenna lobe arranged at the right viewed from the air plane.

Remote command:
`[:SOURce<hw>][:BB]:ILS:LOCalizer:RLOBe[:FREQuency]` on page 115

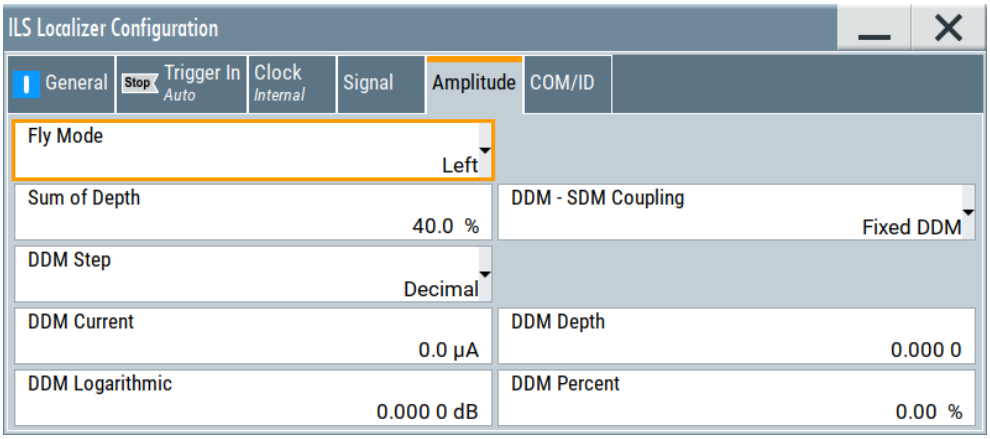
Left/Right Phase
Sets the phase between the modulation signals of the left and right antenna lobe. The zero crossing of the right lobe (150 Hz) signal serves as a reference. The angle refers to the period of the signal of the right antenna lobe.

Remote command:
`[:SOURce<hw>][:BB]:ILS:LOCalizer:PHASe` on page 115

3.3.3.3 Amplitude settings

Access:

1. Select "ILS Component" > "Localizer". See Section 3.3.3, "ILS localizer settings", on page 26.
2. Select "ILS" > "Amplitude".



This dialog provides amplitude settings related to the ILS localizer component of the ILS signal.

Settings:

Fly Mode
Selects the simulation mode for the ILS localizer modulation signal. A change of the setting automatically changes the sign of the DDM value.

This setting simulates the direction in which the pilot has to correct the course.

"Left" The 150 Hz modulation signal is predominant, the DDM value is negative (the airplane is too far to the right, it must turn to the left).

"Right" The 90 Hz modulation signal is predominant, the DDM value is positive (the airplane is too far to the left, it must turn to the right).

Remote command:
`[:SOURce<hw>][:BB]:ILS:LOCalizer:DDM:DIRection` on page 110

Sum of Depth
Sets the arithmetic sum of the modulation depths of the left lobe (90 Hz) and right lobe (150 Hz) ILS localizer signal contents.

The RMS modulation depth of the sum signal depends on the phase setting of both modulation tones.

The "Sum of Depth" and "COM/ID > Depth" must be smaller than 100 %.

Remote command:
`[:SOURce<hw>][:BB]:ILS:LOCalizer:SDM` on page 115

DDM - SDM Coupling
Selects if the DDM value is fixed or is changed with a change of sum of modulation depths (SDM, see below).

"Fixed DDM" The absolute DDM value stays constant, if the SDM is changed.

"Coupled to SDM" The absolute DDM value changes, if the SDM is changed. The DDM value expressed in dB stays constant.

Remote command:
`[:SOURce<hw>][:BB]:ILS:LOCalizer:DDM:COUPling` on page 110

DDM Step
Selects the variation step of the DDM values.

"Decimal" Decimal variation according to the current cursor position.

"Predifined" Variation in predefined steps according to the standardized DDM values.

Remote command:
`[:SOURce<hw>][:BB]:ILS:LOCalizer:DDM:STEP` on page 112

DDM Current
Sets the current of the ILS indicating instrument corresponding to the DDM value. The instrument current is calculated according to:

DDM µA = DDM × 967.75 µA

A variation of the instrument current automatically leads to a variation of the DDM value and the DDM value in dB.

Remote command:
`[:SOURce<hw>][:BB]:ILS:LOCalizer:DDM:CURRent` on page 110

DDM Depth
Sets the difference in depth of modulation (DDM) between the signal of the left lobe (90 Hz) and the right lobe (150 Hz) of the ILS localizer modulation signal.

The DDM value in percent is calculated as follows:

- "DDM Polarity > 90 Hz - 150 Hz" (default setting):
  DDM = [AM (90 Hz) - AM (150 Hz)] / 100 %
- "DDM Polarity > 150 Hz - 90 Hz":
  DDM = [AM (150 Hz) - AM (90 Hz)] / 100 %

A variation of the DDM value automatically leads to a variation of the DDM value in dB and the value of the instrument current.

Remote command:
`[:SOURce<hw>][:BB]:ILS:LOCalizer:DDM[:DEPTh]` on page 112

DDM Logarithmic
Sets the DDM value in dB. The dB value is calculated according to:

DDM dB = 20 × LOG [(SDM + DDM × 100 %) / (SDM - DDM × 100 %)]

A variation of the value automatically leads to a variation of the DDM value and the instrument current.

Remote command:
`[:SOURce<hw>][:BB]:ILS:LOCalizer:DDM:LOGarithmic` on page 111

DDM Percent
Sets the difference in depth of modulation between the signal of the left lobe (90 Hz) and the right lobe (150 Hz).

The DDM value in percent is calculated by the following formulas:

- "DDM Polarity > 90 Hz - 150 Hz" (default setting):
  DDM = [AM (90 Hz) - AM (150 Hz)]
- "DDM Polarity > 150 Hz - 90 Hz":
  DDM = [AM(150 Hz) - AM (90 Hz)]

A variation of the DDM value automatically leads to a variation of the DDM value in dB and the value of the instrument current.

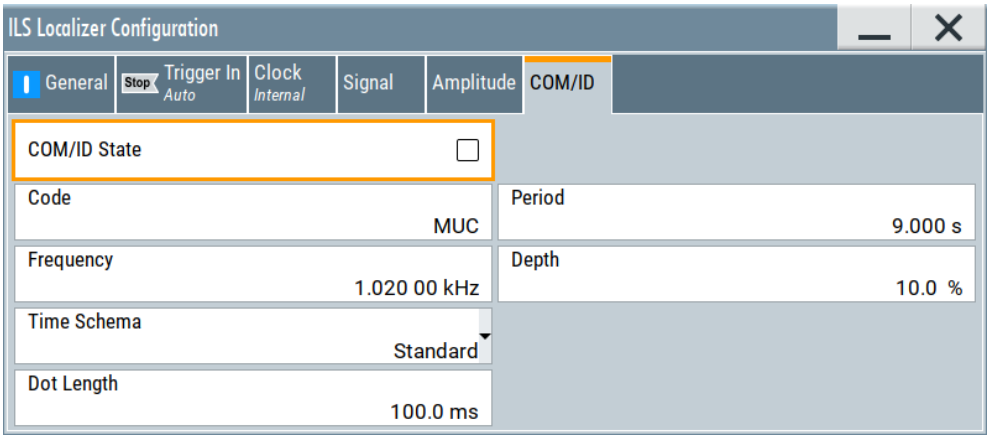
Remote command:
`[:SOURce<hw>][:BB]:ILS:LOCalizer:DDM:PCT` on page 111

3.3.3.4 COM/ID settings

Access:

1. Select "ILS Component" > "Localizer". See Section 3.3.3, "ILS localizer settings", on page 26.

2. Select "ILS" > "COM/ID".



This dialog provides COM/ID settings related to the ILS localizer component of the ILS signal.

Settings:

COM/ID State
Enables/disables the COM/ID signal.

See also Section A, "Morse code settings", on page 160.

Remote command:
`[:SOURce<hw>][:BB]:ILS:LOCalizer:COMid[:STATe]` on page 109

Code
Sets the coding of the COM/ID signal by the international short name of the airport (e.g. MUC for the Munich airport).

The COM/ID tone is sent according to the selected code, see Section A, "Morse code settings", on page 160.

If no coding is set, the COM/ID tone is sent uncoded (key down).

Remote command:
`[:SOURce<hw>][:BB:ILS]:LOCalizer:COMid:CODE` on page 107

Frequency
Sets the frequency of the COM/ID signal.

Remote command:
[:SOURce<hw>][:BB]:ILS:LOCalizer:COMid:FREQuency on page 108

Period
Sets the period of the COM/ID signal.

Remote command:
[:SOURce<hw>][:BB]:ILS:LOCalizer:COMid:PERiod on page 108

Depth
Sets the AM modulation depth of the COM/ID signal.

Note: The sum of Sum of Depth and COM/ID > Depth must be smaller than 100 %.

Remote command:
[:SOURce<hw>][:BB]:ILS:LOCalizer:COMid:DEPTh on page 107

Time Schema
Sets the time schema of the Morse code for the COM/ID signal.

"Standard" The set dot length determines the length of the dash, the symbol space and letter space of the Morse code.

"User" You can set each length value separately.

Remote command:
[:SOURce<hw>][:BB]:ILS:LOCalizer:COMid:TSCHema on page 109

Dot Length
Sets the length of a Morse code dot.

If "Time Schema" > "Standard", the dot length value determines also the length of the dash (= 3 times the dot length), symbol space (= dot length) and letter space (= 3 times the dot length).

Remote command:
[:SOURce<hw>][:BB]:ILS:LOCalizer:COMid:DOT on page 108

Dash Length
Requires "Time Schema" > "User".

Sets the length of a Morse code dash.

Remote command:
[:SOURce<hw>][:BB]:ILS:LOCalizer:COMid:DASH on page 107

Symbol Space
Requires "Time Schema" > "User".

Sets the length of the Morse code symbol space.

Remote command:
[:SOURce<hw>][:BB]:ILS:LOCalizer:COMid:SYMBol on page 109

Letter Space
Requires "Time Schema" > "User".

Sets the length of a Morse code letter space.

Remote command:
[:SOURce<hw>][:BB]:ILS:LOCalizer:COMid:LETTer on page 108

3.3.4 ILS marker beacons settings

Access:

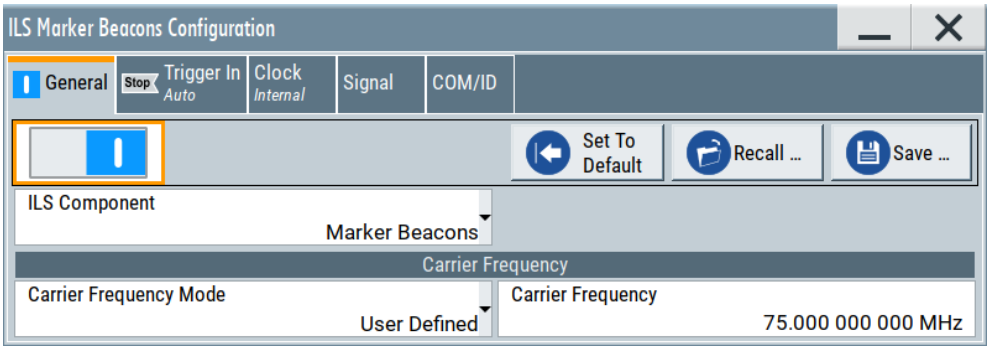
1. Select "ILS > General".
2. Select "ILS Component > Marker Beacons".

Settings:

3.3.4.1 General settings

Access:

1. Select "ILS Component > Marker Beacons".
   See Section 3.3.4, "ILS marker beacons settings", on page 35.
2. Select "ILS > General".



This dialog provides carrier frequency settings related to the ILS marker beacons component of the ILS signal.

Settings:

Carrier Frequency Mode
Sets the mode for the carrier frequency of the signal.

"User Defined" Activates user-defined variation of the carrier frequency.

"Predefined" Activates variation of the carrier frequency by integer 25 kHz steps.

Remote command:
[:SOURce<hw>][:BB:ILS]:MBEacon:FREQuency:MODE on page 116

Carrier Frequency
Requires "Carrier Frequency Mode > User Defined".

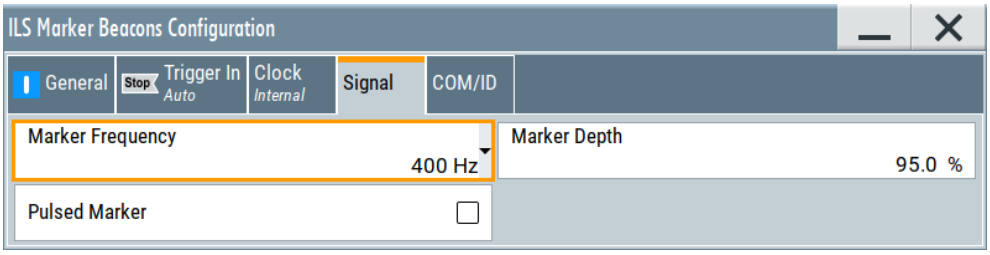
Sets the carrier frequency of the signal.

Remote command:
[:SOURce<hw>][:BB:ILS]:MBEacon:FREQuency on page 116

3.3.4.2 Signal settings

Access:

1. Select "ILS Component" > "Marker Beacons". See Section 3.3.4, "ILS marker beacons settings", on page 35.
2. Select "ILS" > "Signal".



This dialog provides signal settings related to the ILS marker beacons component of the ILS signal.

Settings:

Marker Frequency
Sets the modulation frequency of the marker signal.

Remote command:
[:SOURce<hw>][:BB:ILS]:MBEacon:MARKer:FREQuency on page 116

Marker Depth
Sets the modulation depth of the marker signal.

Remote command:
[:SOURce<hw>][:BB:ILS]:MBEacon[:MARKer]:DEPTh on page 117

Pulsed Marker
Activates the modulation of a pulsed marker signal (morse coding).

"On" Modulation of pulsed marker signals (morse coding). The duty cycle, the marker on- and off-times depend on the frequency of the marker signal (Table 3-2).

Table 3-2: ILS marker beacons marker signals and morse coding

Signal	Freq.	On	Off	Morse rate	Duty cycle
Outer marker	400 Hz	375 ms	125 ms	2 dots/s	75 %
Middle marker	1300 Hz	1st: 375 ms 2nd: 83 ms	1st: 125 ms 2nd: 83 ms	1.5 dots/s	68.8 %
Inner marker	3000 Hz	83 ms	83 ms	6 dots/s	50 %

"Off" Modulation of a continuous non-coded marker signal.

Remote command:
`[:SOURce<hw>][:BB:ILS]:MBEacon[:MARKer]:PULSed` on page 117

4 Generating VOR signals

This section provides information on very high frequency (VHF) omnidirectional radio range (VOR) signal generation with the R&S SMBV100B. This information includes required options, background information on VOR, generation of VOR signals, configuration and settings.

4.1 Required options

The basic equipment layout for generating VOR signals includes:

- Base unit
- Baseband real-time extension (R&S SMBVB-K520)
- Digital standard VOR (R&S SMBVB-K152)

For more information, refer to the specifications document.

4.2 About VOR

Very high frequency (VHF) omnidirectional radio range (VOR) is used for radio navigation and helps the aircraft to determine its position and stay on course.

A VOR system consists of a ground transmission station and a VOR receiver on the board of the aircraft.

The transmitter stations operate at VHF frequencies of 108 MHz to 118 MHz (see Table 4-1), with the code identification (COM/ID) transmitting on a modulation tone of 1.020 kHz. It emits two types of signals:

- An omnidirectional reference signal (REF) that can consist of two parts:
  - 30 Hz frequency modulated (FM) sine wave on subcarrier 9.96 kHz from amplitude modulation (AM) carrier
  - 1020 Hz AM modulated sine wave morse code
- A directional positioning signal, variable (VAR): 30 Hz AM modulated sine waves with variable phase shift.

The position of the aircraft is determined by measuring azimuth as the difference in phase of those two signals. The magnetic north is defined as the reference point, for which both signals are exactly in phase.

Related settings

For VOR settings at the R&S SMBV100B, see Section 4, "Generating VOR signals", on page 38.

Channel frequencies

The column notations in the table below are as follows:

- **Channel** = ICAO channel number
- **Frequency** = VOR Interrogation frequency (MHz)

Table 4-1: VOR ICAO channels and frequencies (MHz)

Channel	Frequency	Channel	Frequency	Channel	Frequency	Channel	Frequency
17X	108.00	57X	112.00	87Y	114.00	107X	116.00
17Y	108.05	57Y	112.05	87Y	114.05	107Y	116.05
19X	108.20	58X	112.10	88X	114.10	108X	116.10
19Y	108.25	58Y	112.15	88Y	114.15	108Y	116.15
21X	108.40	59X	112.20	89X	114.20	109X	116.20
21Y	108.45	59Y	112.25	89Y	114.25	109Y	116.25
23X	108.60	70X	112.30	90X	114.30	110X	116.30
23Y	108.65	70Y	112.35	90Y	114.35	110Y	116.35
25X	108.80	71X	112.40	91X	114.40	111X	116.40
25Y	108.85	71Y	112.45	91Y	114.45	111Y	116.45
27X	109.00	72X	112.50	92X	114.50	112X	116.50
27Y	109.05	72Y	112.55	92Y	114.55	112Y	116.55
29X	109.20	73X	112.60	93X	114.60	113X	116.60
29Y	109.25	73Y	112.65	93Y	114.65	113Y	116.65
31X	109.40	74X	112.70	94X	114.70	114X	116.75
31Y	109.45	74Y	112.75	94Y	114.75	114Y	116.75
33X	109.60	75X	112.80	95X	114.80	115X	116.80
33Y	109.65	75Y	112.85	95Y	114.85	115Y	116.85
35X	109.80	76X	112.90	96X	114.90	116X	116.90
35Y	109.85	76Y	112.95	96Y	114.95	116Y	116.95
37X	110.00	77X	113.00	97X	115.00	117X	117.00
37Y	110.05	77Y	113.05	97Y	115.05	117Y	117.05
39X	110.20	78X	113.10	98X	115.10	118X	117.10
39Y	110.25	78Y	113.15	98Y	115.15	118Y	117.15
41X	110.40	79X	113.20	99X	115.20	119X	117.20
41Y	110.45	79Y	113.25	99Y	115.25	119Y	117.25
43X	110.60	80X	113.30	100X	115.30	120X	117.30
43Y	110.65	80Y	113.35	100Y	115.35	120Y	117.35
45X	110.80	81X	113.40	101X	115.40	121X	117.40
45Y	110.85	81Y	113.45	101Y	115.45	121Y	117.45
47X	111.00	82X	113.50	102X	115.50	122X	117.50
47Y	111.05	82Y	113.55	102Y	115.55	122Y	117.55

Channel	Frequency	Channel	Frequency	Channel	Frequency	Channel	Frequency
49X 49Y	111.20 111.25	83X 83Y	113.60 113.65	103X 103Y	115.60 115.65	123X 123Y	117.60 117.65
51X 51Y	111.40 111.45	84X 84Y	113.70 113.75	104X 104Y	115.70 115.75	124X 124Y	117.70 117.75
53X 53Y	111.60 111.65	85X 85Y	113.80 113.85	105X 105Y	115.80 115.85	125X 125Y	117.80 117.85
55X 55Y	111.80 111.85	86X 86Y	113.90 113.95	106X 106Y	115.90 115.95	126X 126Y	117.90 117.95

4.3 VOR configuration and settings

Option: R&S SMBVB-K152

Access:

► Select "Baseband" > "VOR".

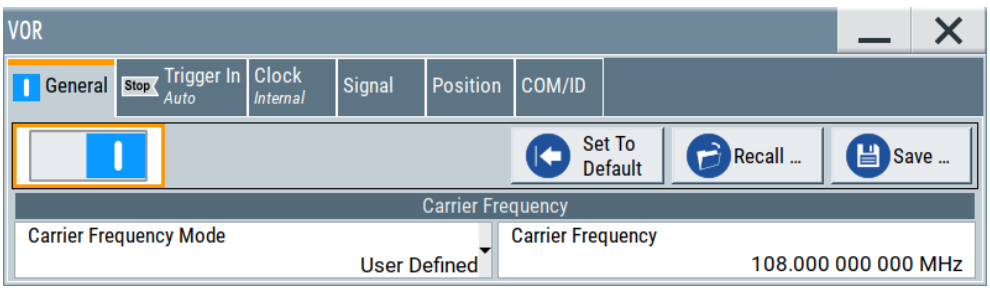
The remote commands required to define VOR settings are described in Section 7.4, "VOR commands", on page 117.

Settings

4.3.1 General settings

Access:

► Select "VOR" > "General".



This dialog provides general settings of the VOR standard, the default and the "Save/Recall" settings.

By default, a VOR modulation signal is set on an RF carrier with a frequency of 108 MHz or ICAO channel 17X. The 9.96 kHz subcarrier signal is frequency modulated with a 30.00 Hz reference signal. The COM/ID signal has 1.02 kHz frequency, the variable phase signal 30.00 Hz frequency.

Changing a parameter in the avionic standards causes an instant signal change in the R&S SMBV100B. There is no extra measurement cycle to calculate the RMS value of the baseband signal to set the correct RF level.

If the avionics standard is activated for the first time, or after every subsequent on/off sequence, the measurement cycle will take place to determine the correct RF level. Every subsequent parameter change in the avionic standard is performed without another measurement cycle to provide a continuous signal output.

Settings:

State
Activates the avionic standard.

Activation of the standard deactivates a previously active avionic standard. The "VOR/ILS/DME > Carrier Frequency" setting is applied automatically to the RF "Frequency" and displayed in the status bar.

Remote command:
`<subsystem>:STATe` on page 99

Set To Default
Calls the default settings. The table below lists the default values of the main parameters.

Standard	Parameter	Value
VOR/ILS/DME	State	Not affected by "Set to default"
VOR	Carrier Frequency Mode	User Defined
	Carrier Frequency	108.000000 MHz
ILS	ILS Component	Glide Slope (GS)
	ILS GS > Carrier Frequency Mode	User Defined
	ILS GS > Carrier Frequency	334.700000 MHz
DME	DME Mode	Interrogation
	Channel Mode	X Channel
	Carrier Frequency	1.025 GHz

Remote command:
`<subsystem>:PRESet` on page 97

Save/Recall
Opens 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 settings are saved in a file with a predefined extension. You can define the filename and the directory, in that you want to save the file.

See also section "Saving and recalling settings" in the R&S SMBV100B user manual.

Remote command:
`<subsystem>:SETTing:CATalog` on page 98
`<subsystem>:SETTing:DELete` on page 98
`<subsystem>:SETTing:LOAD` on page 98
`<subsystem>:SETTing:STORe` on page 98

Carrier Frequency Mode
Sets the mode for the carrier frequency of the signal.

"User Defined" Activates user-defined setting of the carrier frequency.

"ICAO" Activates ICAO-conform setting of the carrier frequency via the "ICAO Channel". For standard VOR transmitting frequencies, see Table 4-1.

Remote command:
`[:SOURce<hw>]:BB:VOR:FREQuency:MODE` on page 119

Carrier Frequency
Requires "Carrier Frequency Mode > User Defined".

Sets the carrier frequency of the signal.

Remote command:
`[:SOURce<hw>]:BB:VOR:FREQuency` on page 119

ICAO Channel
Requires "Carrier Frequency Mode" > "ICAO".

Sets the ICAO channel and the corresponding transmitting frequency.

If avionic standard modulation is activated and you change the "RF Frequency", the frequency value of the closest ICAO channel is applied automatically. The "ICAO Channel" is also updated.

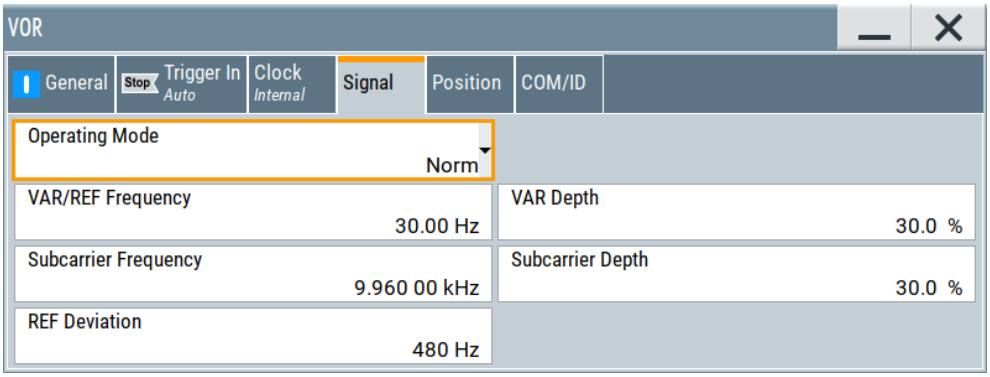
For an overview of the VOR ICAO channels and frequencies, see Table 4-1.

Remote command:
`[:SOURce<hw>][:BB]:VOR:ICAO:CHANnel` on page 119

4.3.2 Signal settings

Access:

► Select "VOR" > "Signal".



This dialog provides signal settings of the VOR modulation signal.

Settings:

Mode
Selects the operating mode for the VOR modulation signal.

"Norm" VOR modulation is active.

"Var" Amplitude modulation of the output signal with the VAR signal component (30Hz signal content) of the VOR signal. The modulation depth corresponds to the value set under VAR Depth.

"Subcarrier" Amplitude modulation of the output signal with the unmodulated FM carrier (9960Hz) of the VOR signal. The modulation depth corresponds to the value set under Subcarrier Depth.

"Subcarrier + FM" Amplitude modulation of the output signal with the frequency-modulated FM carrier (9960Hz) of the VOR signal. The frequency deviation corresponds to the value set under REF Deviation, the modulation depth corresponds to the value set under "Subcarrier Depth".

Remote command:
`[:SOURce<hw>][:BB]:VOR:MODE` on page 118

VAR/REF Frequency
Sets the frequency of the VAR signal and the REF signal. As the two signals must have the same frequency, the setting is valid for both signals.

Remote command:
[:SOURce<hw>][:BB]:VOR:VAR:FREQuency on page 121

VAR Depth
Sets the AM modulation depth of the 30 Hz VAR signal.

Note: The sum of "Subcarrier Depth", "VAR Depth" and COM/ID "Depth" must be smaller than 100 %.

Remote command:
[:SOURce<hw>][:BB]:VOR:VAR[:DEPTh] on page 121

Subcarrier Frequency
Sets the frequency of the FM carrier.

Remote command:
[:SOURce<hw>][:BB]:VOR:SUBCarrier[:FREQuency] on page 121

Subcarrier Depth
Sets the AM modulation depth of the FM carrier.

Note: The sum of "Subcarrier Depth", "VAR Depth" and COM/ID "Depth" must be smaller than 100 %.

Remote command:
[:SOURce<hw>][:BB]:VOR:SUBCarrier:DEPTh on page 120

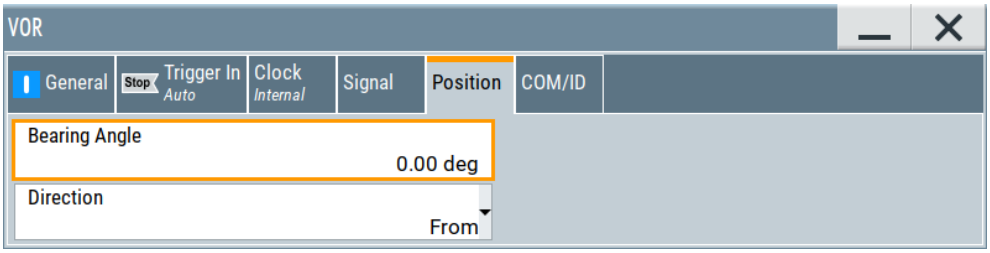
REF Deviation
Sets the frequency deviation of the reference signal on the FM carrier.

Remote command:
[:SOURce<hw>][:BB]:VOR:REFerence[:DEViation] on page 120

4.3.3 Position settings

Access:

► Select "VOR" > "Position".



This dialog provides position settings related to the VOR modulation signal.

Settings:

Bearing Angle
Sets the phase angle between the 30 Hz VAR signal and the 30 Hz reference signal.

The orientation of the angle depends on the set Direction.

Remote command:
`[:SOURce<hw>][:BB]:VOR[:BANGle]` on page 122

Direction
Sets the reference position of the phase information.

The angle set under "Bearing Angle" corresponds to the angle between the geographic north and the connection line from beacon to airplane.

"From" Selection of the beacon as a reference position.

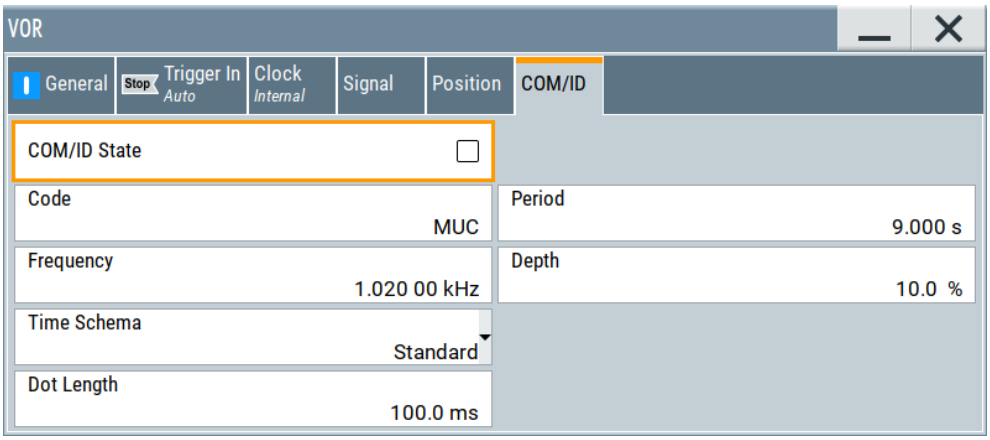
"To" Selection of the airplane position as a reference position.

Remote command:
`[:SOURce<hw>][:BB]:VOR[:BANGle]:DIRection` on page 122

4.3.4 COM/ID settings

Access:

► Select "VOR" > "COM/ID".



This dialog provides COM/ID signal settings related to the VOR signal.

Settings:

COM/ID State
Enables/disables the COM/ID signal.

See also Section A, "Morse code settings", on page 160.

Remote command:
`[:SOURce<hw>][:BB]:VOR:COMid[:STATe]` on page 126

Code
Sets the coding of the COM/ID signal by the international short name of the airport (e.g. MUC for the Munich airport).

The COM/ID tone is sent according to the selected code, see Section A, "Morse code settings", on page 160.

If no coding is set, the COM/ID tone is sent uncoded (key down).

Remote command:
`[:SOURce<hw>][:BB]:VOR:COMid:CODE` on page 123

Period
Sets the period of the COM/ID signal.

Remote command:
`[:SOURce<hw>][:BB]:VOR:COMid:PERiod` on page 125

Frequency
Sets the frequency of the COM/ID signal.

Remote command:
`[:SOURce<hw>][:BB]:VOR:COMid:FREQuency` on page 124

Depth
Sets the AM modulation depth of the COM/ID signal.

Note: The sum of Subcarrier Depth, VAR Depth and COM/ID > Depth must be smaller than 100 %.

Remote command:
`[:SOURce<hw>][:BB]:VOR:COMid:DEPTh` on page 123

Time Schema
Sets the time schema of the Morse code for the COM/ID signal.

"Standard" The set dot length determines the length of the dash, the symbol space and letter space of the Morse code.

"User" You can set each length value separately.

Remote command:
`[:SOURce<hw>][:BB]:VOR:COMid:TSCHema` on page 125

Dot Length
Sets the length of a Morse code dot.

If "Time Schema" > "Standard", the dot length value determines also the length of the dash (= 3 times the dot length), symbol space (= dot length) and letter space (= 3 times the dot length).

Remote command:
`[:SOURce<hw>][:BB]:VOR:COMid:DOT` on page 124

Dash Length
Requires "Time Schema" > "User".

Sets the length of a Morse code dash.

Remote command:
`[:SOURce<hw>][:BB]:VOR:COMid:DASH` on page 123

Symbol Space
Requires "Time Schema" > "User".

Sets the length of the Morse code symbol space.

Remote command:
`[:SOURce<hw>][:BB]:VOR:COMid:SYMBol` on page 125

Letter Space
Requires "Time Schema" > "User".

Sets the length of a Morse code letter space.

Remote command:
`[:SOURce<hw>][:BB]:VOR:COMid:LETTer` on page 124

5 Generating DME signals

This section provides information on distance measuring equipment (DME) signal generation with the R&S SMBV100B. This information includes required options, background information on DME, generation of DME signals, configuration and settings.

5.1 Required options

The basic equipment layout for generating DME signals includes:

- Base unit
- Baseband real-time extension (R&S SMBVB-K520)
- Digital standard DME (R&S SMBVB-K153)

5.2 About DME

Distance measurement equipment (DME) is a radar system which is used to determine the slant distance of an aircraft (= DME interrogator) to a ground station (= DME transponder). The aircraft antenna transmits shaped RF double pulses to the ground station. After a defined delay (= reply delay), the ground station replies by transmitting a defined pulse sequence to the aircraft. The receiver in the aircraft uses the round-trip time of the double pulses to determine the distance to the ground station.

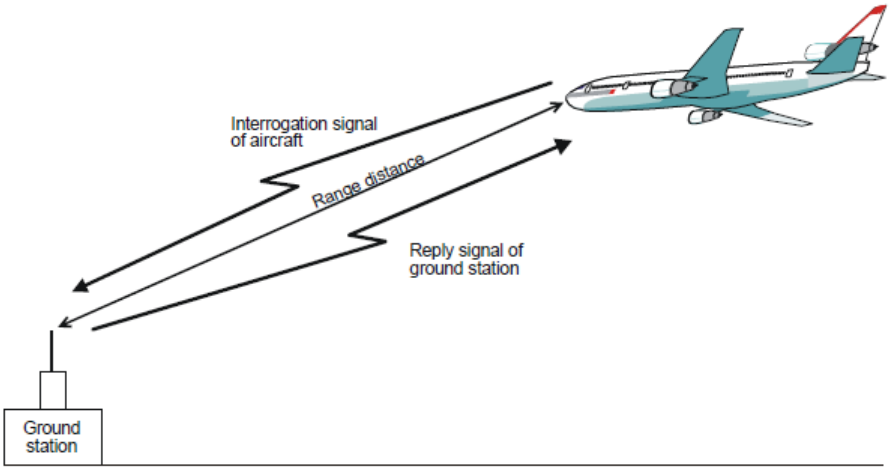


Figure 5-1: DME principle

Most DME ground stations are combined with a VOR system to allow an aircraft to determine its precise position relative to the ground station. The DME channels are

paired with the VOR channels. Channel frequencies range from 1025 MHz to 1150 MHz for the DME interrogator and 962 MHz to 1213 MHz for the DME transponder (see Table 5-1). The frequency difference between received and transmitted signal is always 63 MHz. The channel spacing between consecutive DME channels is always 1 MHz.

Each channel has two different codings (X and Y) that differ regarding their pulse spacing. The assignment of a channel and coding to a ground station always remains the same during operation and is determined by the respective national air traffic control authority.

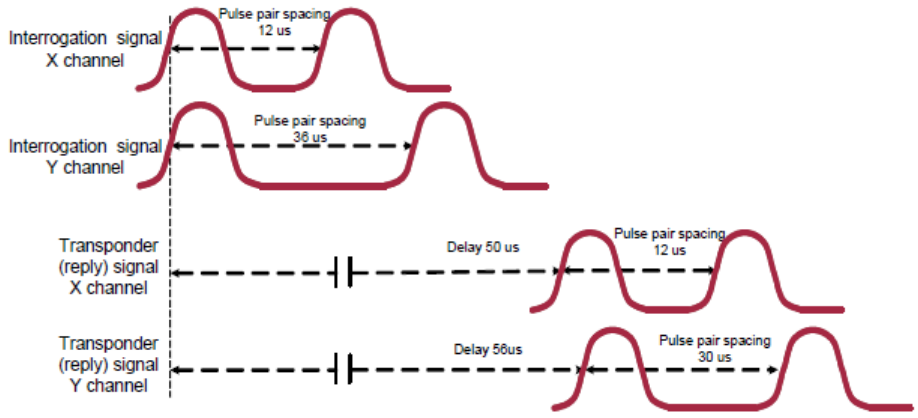


Figure 5-2: Time characteristic of DME signal envelope for X and Y channel

DME interrogator

The aircraft's DME interrogator sends a sequence of pulses that are received at the ground station and, after a defined delay time, are returned at a different frequency. The frequency offset between sent and received signal is always 63 MHz. The receiver in the aircraft filters its own pulse sequence out of all received pulses and in this way determines the time difference between the transmitted and received pulse. The time difference is used for the calculation of the slant range to the ground station. The distance is typically expressed in nautical miles (NM), where 1 NM corresponds to 1852.02 m and a signal round-trip time of 12.359 µs.

As a result, the precise position of the aircraft can be derived from the flight altitude and the azimuth angle between the aircraft and ground station (VOR system).

DME transponder

The DME transponder checks the validity of all received pulses (i.e. the pulse spacing must be consistent with the channel) in its "decoder". A single pulse, for example, is filtered out as an invalid interrogation and no reply to this pulse is sent.

For a valid double pulse reception, 2 consecutive pulses are received by the DME transponder. In this case, the receiver does not react to any further interrogations for 60 µs (= dead time) to ensure that it does not trigger again to its reply signal. The receiver is not ready to process new interrogation pulses until the reply double pulse has been fully transmitted. All pulse interrogations that are received at the DME ground

station during the dead time are not answered. The time gap between two consecutive pulses is always at least 60 µs.

A reply pulse is sent after a defined delay time after a valid interrogation pulse has been received.

Echo rejection

Due to reflection the wanted pulse pair is disturbed by echos. The echo pulse pairs are typically attenuated by a few decibels below and also delayed compared to the originally emitted pulse pair. Nevertheless distance measurements must be correct, unless the echo is too strong.

Velocity tracking

Due to movement, the received pulse pair has a Doppler shift in frequency. DME receivers are able to track this frequency shift.

The velocity is typically expressed in knots (kn): 1 kn corresponds to 0.5144 m/s.

Related settings

For DME settings at the R&S SMBV100B, see Section 5.3, "DME configuration and settings", on page 54.

Channel frequencies

The column notations in the table below are as follows:

- **Chan.** = ICAO channel number
- **VOR freq.** = VOR frequency (MHz)
- **DME int. freq.** = DME interrogation frequency (MHz)
- **DME rep. Freq.** = DME reply frequency (MHz)

Table 5-1: DME ICAO channels and frequencies (MHz)

Chan.	VOR freq.	DME Int. freq.	DME rep. freq.	Chan.	VOR freq.	DME Int. freq.	DME rep. freq.
1X 1Y		1025 1025	962 1088	64X 64Y		1088 1088	1151 1025
2X 2Y		1026 1026	963 1089	65X 65Y		1089 1089	1152 1026
3X 3Y		1027 1027	964 1090	66X 66Y		1090 1090	1153 1027
4X 4Y		1028 1028	965 1091	67X 67Y		1091 1091	1154 1028
5X 5Y		1029 1029	966 1092	68X 68Y		1092 1092	1155 1029
6X 6Y		1030 1030	967 1093	69X 69Y		1093 1093	1156 1030

Chan.	VOR freq.	DME Int. freq.	DME rep. freq.	Chan.	VOR freq.	DME Int. freq.	DME rep. freq.
7X 7Y		1031 1031	968 1094	70X 70Y	112.30 112.35	1094 1094	1157 1031
8X 8Y		1032 1032	969 1095	71X 71Y	112.40 112.45	1095 1095	1158 1032
9X 9Y		1033 1033	970 1096	72X 72Y	112.50 112.55	1096 1096	1159 1033
10X 10Y		1034 1034	971 1097	73X 73Y	112.60 112.65	1097 1097	1160 1034
11X 11Y		1035 1035	972 1098	74X 74Y	112.70 112.75	1098 1098	1161 1035
12X 12Y		1036 1036	973 1099	75X 75Y	112.80 112.85	1099 1099	1162 1036
13X 13Y		1037 1037	974 1100	76X 76Y	112.90 112.95	1100 1100	1163 1037
14X 14Y		1038 1038	975 1101	77X 77Y	113.00 113.05	1101 1101	1164 1038
15X 15Y		1039 1039	976 1102	78X 78Y	113.10 113.15	1102 1102	1165 1039
16X 16Y		1040 1040	977 1103	79X 79Y	113.20 113.25	1103 1103	1166 1040
17X 17Y	108.00 108.05	1041 1041	978 1104	80X 80Y	113.30 113.35	1104 1104	1167 1041
18X 18Y	108.10 108.15	1042 1042	979 1105	81X 81Y	113.40 113.45	1105 1105	1168 1042
19X 19Y	108.20 108.25	1043 1043	980 1106	82X 82Y	113.50 113.55	1106 1106	1169 1043
20X 20Y	108.30 108.35	1044 1044	981 1107	83X 83Y	113.60 113.65	1107 1107	1170 1044
21X 21Y	108.40 108.45	1045 1045	982 1108	84X 84Y	113.70 113.75	1108 1108	1171 1045
22X 22Y	108.50 108.55	1046 1046	983 1109	85X 85Y	113.80 113.85	1109 1109	1172 1046
23X 23Y	108.60 108.65	1047 1047	984 1110	86X 86Y	113.90 113.95	1110 1110	1173 1047
24X 24Y	108.70 108.75	1048 1048	985 1111	87X 87Y	114.00 114.05	1111 1111	1174 1048

Chan.	VOR freq.	DME Int. freq.	DME rep. freq.	Chan.	VOR freq.	DME Int. freq.	DME rep. freq.
25X	108.80	1049	986	88X	114.10	1112	1175
25Y	108.85	1049	1112	88Y	114.15	1112	1049
26X	108.90	1050	987	89X	114.20	1113	1176
26Y	108.95	1050	1113	89Y	114.25	1113	1050
27X	109.00	1051	988	90X	114.30	1114	1177
27Y	109.05	1051	1114	90Y	114.35	1114	1051
28X	109.10	1052	989	91X	114.40	1115	1178
28Y	109.15	1052	1115	91Y	114.45	1115	1052
29X	109.20	1053	990	92X	114.50	1116	1179
29Y	109.25	1053	1116	92Y	114.55	1116	1053
30X	109.30	1054	991	93X	114.60	1117	1180
30Y	109.35	1054	1117	93Y	114.65	1117	1054
31X	109.40	1055	992	94X	114.70	1118	1181
31Y	109.45	1055	1118	94Y	114.75	1118	1055
32X	109.50	1056	993	95X	114.80	1119	1182
32Y	109.55	1056	1119	95Y	114.85	1119	1056
33X	109.60	1057	994	96X	114.90	1120	1183
33Y	109.65	1057	1120	96Y	114.95	1120	1057
34X	109.70	1058	995	97X	115.00	1121	1184
34Y	109.75	1058	1121	97Y	115.05	1121	1058
35X	109.80	1059	996	98X	115.10	1122	1185
35Y	109.85	1059	1122	98Y	115.15	1122	1059
36X	109.90	1060	997	99X	115.20	1123	1186
36Y	109.95	1060	1123	99Y	115.25	1123	1060
37X	110.00	1061	998	100X	115.30	1124	1187
37Y	110.05	1061	1124	100Y	115.35	1124	1061
38X	110.10	1062	999	101X	115.40	1125	1188
38Y	110.15	1062	1125	101Y	115.45	1125	1062
39X	110.20	1063	1000	102X	115.50	1126	1189
39Y	110.25	1063	1126	102Y	115.55	1126	1063
40X	110.30	1064	1001	103X	115.60	1127	1190
40Y	110.35	1064	1127	103Y	115.65	1127	1064
41X	110.40	1065	1002	104X	115.70	1128	1191
41Y	110.45	1065	1128	104Y	115.75	1128	1065
42X	110.50	1066	1003	105X	115.80	1129	1192
42Y	110.55	1066	1129	105Y	115.85	1129	1066

Chan.	VOR freq.	DME Int. freq.	DME rep. freq.	Chan.	VOR freq.	DME Int. freq.	DME rep. freq.
43X	110.60	1067	1004	106X	115.90	1130	1193
43Y	110.65	1067	1130	106Y	115.95	1130	1067
44X	110.70	1068	1005	107X	116.00	1131	1194
44Y	110.75	1068	1131	107Y	116.05	1131	1068
45X	110.80	1069	1106	108X	116.10	1132	1195
45Y	110.85	1069	1132	108Y	116.15	1132	1069
46X	110.90	1070	1007	109X	116.20	1133	1196
46Y	110.95	1070	1133	109Y	116.25	1133	1070
47X	111.00	1071	1008	110X	116.30	1134	1197
47Y	111.05	1071	1134	110Y	116.35	1134	1071
48X	111.10	1072	1009	111X	116.40	1135	1198
48Y	111.15	1072	1135	111Y	116.45	1135	1072
49X	111.20	1073	1010	112X	116.50	1136	1199
49Y	111.25	1073	1136	112Y	116.55	1136	1073
50X	111.30	1074	1011	113X	116.60	1137	1200
50Y	111.35	1074	1137	113Y	116.65	1137	1074
51X	111.40	1075	1012	114X	116.70	1138	1201
51Y	111.45	1075	1138	114Y	116.75	1138	1075
52X	111.50	1076	1013	115X	116.80	1139	1202
52Y	111.55	1076	1139	115Y	116.85	1139	1076
53X	111.60	1077	1014	116X	116.90	1140	1203
53Y	111.65	1077	1140	116Y	116.95	1140	1077
54X	111.70	1078	1015	117X	117.00	1141	1204
54Y	111.75	1078	1141	117Y	117.05	1141	1078
55X	111.80	1079	1016	118X	117.10	1142	1205
55Y	111.85	1079	1142	118Y	117.15	1142	1079
56X	111.90	1080	1017	119X	117.20	1143	1206
56Y	111.95	1080	1143	119Y	117.25	1143	1080
57X	112.00	1081	1018	120X	117.30	1144	1207
57Y	112.05	1081	1144	120Y	117.35	1144	1081
58X	112.10	1082	1019	121X	117.40	1145	1208
58Y	112.15	1082	1145	121Y	117.45	1145	1082
59X	112.20	1083	1020	122X	117.50	1146	1209
59Y	112.25	1083	1146	122Y	117.55	1146	1083
60X		1084	1021	123X	117.60	1147	1210
60Y		1084	1147	123Y	117.65	1147	1084

Chan.	VOR freq.	DME Int. freq.	DME rep. freq.	Chan.	VOR freq.	DME Int. freq.	DME rep. freq.
61X 61Y		1085 1085	1022 1148	124X 124Y	117.70 117.75	1148 1148	1211 1085
62X 62Y		1086 1086	1023 1149	125X 125Y	117.80 117.85	1149 1149	1212 1086
63X 63Y		1087 1087	1024 1150	126X 126Y	117.90 117.95	1150 1150	1213 1087

5.3 DME configuration and settings

Option: R&S SMBVB-K153

Access:

► Select "Baseband" > "DME".

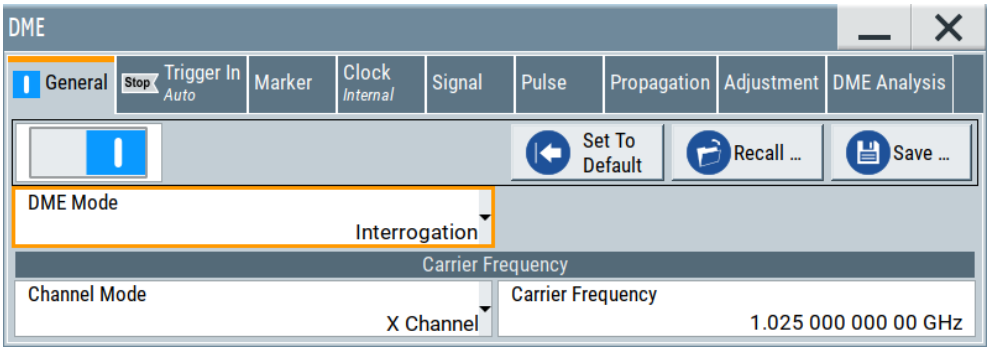
The remote commands required to define DME settings are described in Section 7.5, "DME commands", on page 126.

Settings:

5.3.1 General settings

Access:

► Select "DME" > "General".



This dialog provides general settings of the DME standard, like enabling the standard and selecting the DME mode.

By default, a DME interrogation mode signal with a carrier frequency of 1.025 GHz (ICAO channel 1X) is set. The pulse signal is of a sequence of $\cos^2$ shaped pulses, which is repeated every 48 Hz. A single pulse has a width of 3.5 µs, the period between two pulses is 12 µs.

Changing a parameter in the avionic standards causes an instant signal change in the R&S SMBV100B. There is no extra measurement cycle to calculate the RMS value of the baseband signal to set the correct RF level.

If the avionics standard is activated for the first time, or after every subsequent on/off sequence, the measurement cycle will take place to determine the correct RF level. Every subsequent parameter change in the avionic standard is performed without another measurement cycle to provide a continuous signal output.

Settings:

State
Activates the avionic standard.

Activation of the standard deactivates a previously active avionic standard. The "VOR/ILS/DME > Carrier Frequency" setting is applied automatically to the RF "Frequency" and displayed in the status bar.

Remote command:
`<subsystem>:STATe` on page 99

Set To Default
Calls the default settings. The table below lists the default values of the main parameters.

Standard	Parameter	Value
VOR/ILS/DME	State	Not affected by "Set to default"
VOR	Carrier Frequency Mode	User Defined
	Carrier Frequency	108.000000 MHz
ILS	ILS Component	Glide Slope (GS)
	ILS GS > Carrier Frequency Mode	User Defined
	ILS GS > Carrier Frequency	334.700000 MHz
DME	DME Mode	Interrogation
	Channel Mode	X Channel
	Carrier Frequency	1.025 GHz

Remote command:
`<subsystem>:PRESet` on page 97

Save/Recall
Opens 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 settings are saved in a file with a predefined extension. You can define the filename and the directory, in that you want to save the file.

See also section "Saving and recalling settings" in the R&S SMBV100B user manual.

Remote command:
`<subsystem>:SETTing:CATalog` on page 98
`<subsystem>:SETTing:DELete` on page 98
`<subsystem>:SETTing:LOAD` on page 98
`<subsystem>:SETTing:STORe` on page 98

DME Mode
Selects the DME mode. This mode determines the signal type that is simulated. The exact timing of the signal for each mode is determined by the selected X or Y channel.

The timing and shape of the pulses can be freely selected. By default these values are set according to the standard.

"Interrogation" The interrogation signal of the airborne transmitter is simulated.

"Reply" The reply signal of the ground based transponder is simulated. The trigger is automatically set to external and the default trigger delay either to 50 µs (channel X) or 56 µs (channel Y) depending on the selected channel.
The interval between the pulse pairs can be set to a fixed value (repetition rate) or to random generation (pulse squitter).

Remote command:
`[:SOURce<hw>][:BB]:DME:MODE` on page 127

Channel Mode
Sets the frequency channel.

Standard compliant X and Y channels differ in the spacing between the two pulses of the pulse pair and the reply delay of the ground station (see Table 5-1).

ICAO indicates the ICAO channel parameters below for selecting the correct channel.

Table 5-2: Pulse spacing and reply delay

Channel	Pulse spacing interrogation mode	Pulse spacing reply mode	Reply delay 1st pulse	Reply delay 2nd pulse
X	12 µs	12 µs	50 µs	50 µs
Y	36 µs	30 µs	56 µs	50 µs

Remote command:
`[:SOURce<hw>][:BB]:DME:CSUFfix` on page 128

Carrier Frequency
Requires "Channel Mode > X Channel/Y Channel".

Sets the carrier frequency of the signal.

Remote command:
`[:SOURce<hw>][:BB]:DME:FREQuency` on page 128

ICAO Channel
Requires "Channel Mode > ICAO".

Sets the ICAO channel and the corresponding transmitting frequency.

If avionic standard modulation is activated and you change the "RF Frequency", the frequency value of the closest ICAO channel is applied automatically. The "ICAO Channel" is also updated.

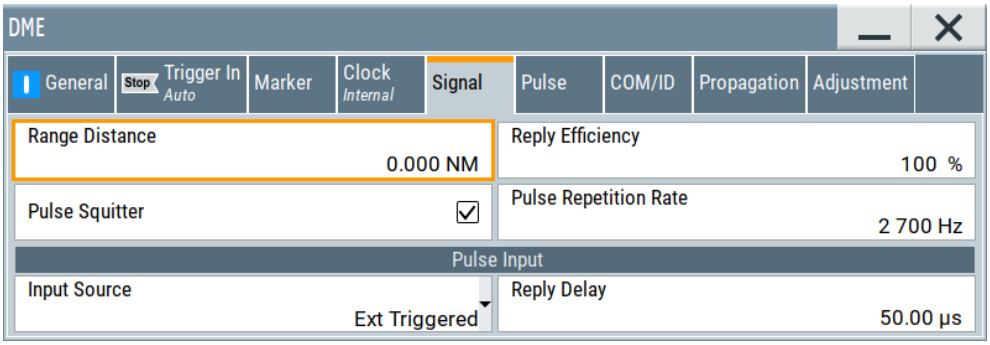
For an overview of the DME ICAO channels and frequencies, see Table 5-1.

Remote command:
`[:SOURce<hw>][:BB]:DME:ICAO:CHANnel` on page 129

5.3.2 Signal settings

Access:

► Select "DME" > "Signal".



This dialog provides signal settings of the DME signal.

Settings:

Range Distance
Requires "DME Mode" > "Reply".

Sets the simulated distance between the interrogator and the transponder for reply mode. The distance can be given in nautical miles (NM) or µs. 1 nm is 1852.01 meters and corresponds to a runtime of 12.359 µs.

The range distance and the external trigger delay are dependent according to:

"Range Distance" = ("Trigger Delay" – X/Y mode delay)/12.359 µs/nm, where

X mode delay = 50 µs, Y mode delay = 56 µs

Changing one value automatically changes the other value.

Remote command:
`[:SOURce<hw>][:BB]:DME:RDIStance` on page 131
`[:SOURce<hw>][:BB]:DME:RDIStance:UNIT` on page 132

Number of Replies for Efficiency Calculation
Requires "DME Mode" > "Reply".

Sets the total number of reply pulse pairs for statistical averaging of the reply efficiency. You can select between 10, 50 or 100 pulse pairs.

Use lower values for a more uniform distribution and higher values for a finer control over the reply efficiency. For example, 10 replies for efficiency calculation and a reply efficiency of 70 % result in 7 reply pulses out of 10 received trigger signals. The trigger signals are incoming interrogator pulse pairs at the power sensor.

Remote command:
`[:SOURce<hw>][:BB]:DME:EFFiciency:REPLies` on page 128

Reply Efficiency
Requires "DME Mode" > "Reply".

The reply efficiency is the probability that a pulse pair is transmitted in reaction to a trigger event. It defines the relation between reply pulse pairs and received trigger signals. The trigger signals are incoming interrogator pulse pairs at the power sensor.

For example, with a set efficiency of 50 %, on average, only every second trigger event leads to the generation of a reply pulse pair.

Remote command:
`[:SOURce<hw>][:BB]:DME:ANALysis:EFFiciency?` on page 141

Pulse Squitter
Enables squitter pulses.

If enabled, the Pulse Repetition Rate is automatically set to 2700 Hz.

Squitter pulses are random pulse pairs sent by a ground station if the average transmit pulse rate drops to values between 700 pulse pairs per second (pp/s). Squitter pulses ensure that a minimum pulse rate is provided. This setting is crucial for the proper monitoring and adjustment of important pulse parameters of the ground station.

Remote command:
`[:SOURce<hw>][:BB]:DME:SQUitter` on page 132

Pulse Repetition Rate
Sets the number of DME pulse pairs per second.

Remote command:
`[:SOURce<hw>][:BB]:DME:RATE` on page 131

Input Source
Selects the input of the DME pulses.

For "DME Mode" > "Interrogation", the setting selects the input for the reply pulses of a ground station.

For "DME Mode" > "Reply", the input of the interrogation pulses of an airplane is selected.

"Ext Triggered"
The R&S SMBV100B receives the pulses via the "User 2" connector on the rear panel. Make sure that you input only the pulse envelope of the demodulated signal at this connector.
If you want to receive modulated RF signals, use "Input Source" > "Ext Power Sensor".

"Ext Power Sensor"
A power sensor, for example, the R&S NRP-Z81, is the signal input for modulated RF pulses. The sensor receives the external DME signal. The sensor uses the 50 % voltage point of this signal to generate the trigger signal for the R&S SMBV100B.

Remote command:
`[:SOURce<hw>][:BB]:DME:PINPut:SOURce` on page 133

Reply Delay
Requires "DME Mode" > "Reply".

Sets the delay between the external trigger and the first DME output pulse (50% voltage point of first pulse).

The R&S SMBV100B simulates the defined delay of the DME transponder and twice the run time of the signal (from interrogator to transponder and back).

The reply delay is coupled to the Range Distance via:

Reply delay = Channel X/Y mode delay + range distance * 12.359 µs / NM, where:

X mode delay = 50 µs, Y mode delay = 56 µs

Changing one value automatically changes the other value.

Remote command:
`[:SOURce<hw>][:BB]:DME:PINPut:DELay` on page 133

Trigger Level
Requires "Input Source" > "Ext Power Sensor".

Displays the trigger level. This level is the 50% voltage point of the first pulse of the external DME interrogation signal.

If the trigger level is too low to be determined, the "Trigger Level" displays "---".

Remote command:
`[:SOURce<hw>][:BB]:DME:PINPut:TRIGger:LEVel?` on page 134
`[:SOURce<hw>][:BB]:DME:PINPut:TRIGger:LEVel:OK?` on page 134

Search Trigger Level
Requires "Input Source" > "Ext Power Sensor".

Executes a search procedure to determine the trigger level. This level is the 50% voltage point of the first pulse of the external DME interrogation signal.

Determination of the trigger point requires a connected power sensor. Use a power sensor, for example the R&S NRP-Z81, to receive the external DME signal. Repeat the trigger search function when changing the level of the external DME signal.

Remote command:
`[:SOURce<hw>][:BB]:DME:PINPut:TRIGger:SEARch?` on page 134

Zero
Activates auto-zeroing of the power sensor.

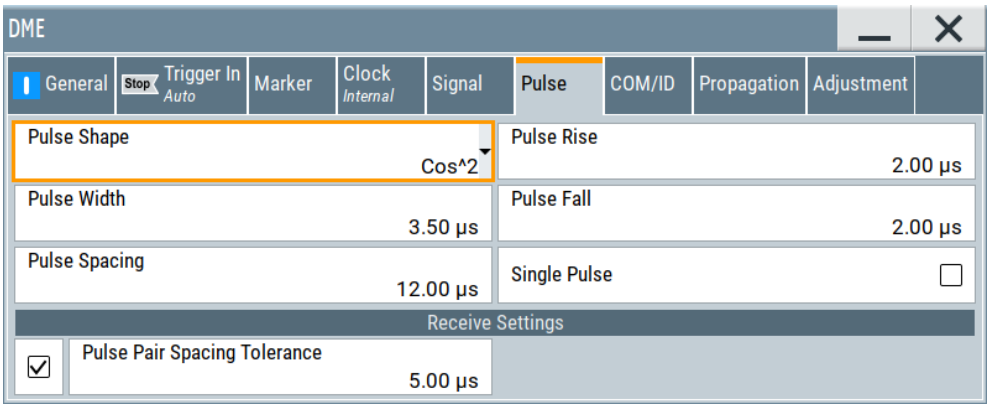
See also section "About zeroing" in the R&S SMBV100B user manual.

Remote command:
n.a.

5.3.3 Pulse settings

Access:

► Select "DME" > "Pulse".



This dialog provides pulse settings of the DME signal.

Settings:

Pulse Shape
Selects the pulse shape.

"Cos^2" The falling and the rising edge of the pulse are cos^2 shaped.

"Cos Cos^2" The rising edge is cos shaped and the falling edge is cos^2 shaped.

"Linear" The falling and the rising edge of the pulse are linearly shaped.

"Gauss" The pulse has a Gaussian form.

Remote command:
`[:SOURce<hw>][:BB]:DME:SHAPe` on page 136

Pulse Rise
Sets the rise time of the pulse (10% to 90% of the peak voltage).

Remote command:
[:SOURce<hw>][:BB]:DME:RISE on page 136

Pulse Width
Sets the pulse width (50% to 50% of peak voltage).

Remote command:
[:SOURce<hw>][:BB]:DME:WIDTh on page 137

Pulse Fall
Sets the fall time of the pulse (90% to 10% of peak voltage).

Remote command:
[:SOURce<hw>][:BB]:DME:FALL on page 135

Pulse Spacing
Sets the spacing between the first and second pulse of a pulse pair (the time between the half-voltage points on the leading edge of each pulse).

Remote command:
[:SOURce<hw>][:BB]:DME:PPS on page 135

Single Pulse
Activates generation of a single test pulse.

Remote command:
[:SOURce<hw>][:BB]:DME:SINGle on page 136

Receive Settings
Provides settings to activate pulse pair spacing and to set the pulse pair spacing tolerance.

Pulse Pair Spacing State ← Receive Settings
Activates pulse pair spacing.

If deactivated, the response is sent after the first pulse, without checking whether the second pulse is within the pulse pair spacing tolerance time.

Remote command:
[:SOURce<hw>]:BB:DME:PPST:ENABled on page 131

Pulse Pair Spacing Tolerance ← Receive Settings
Sets the pulse pair spacing tolerance.

Example:

"Pulse Pair Spacing Tolerance" = "12.00 µs":

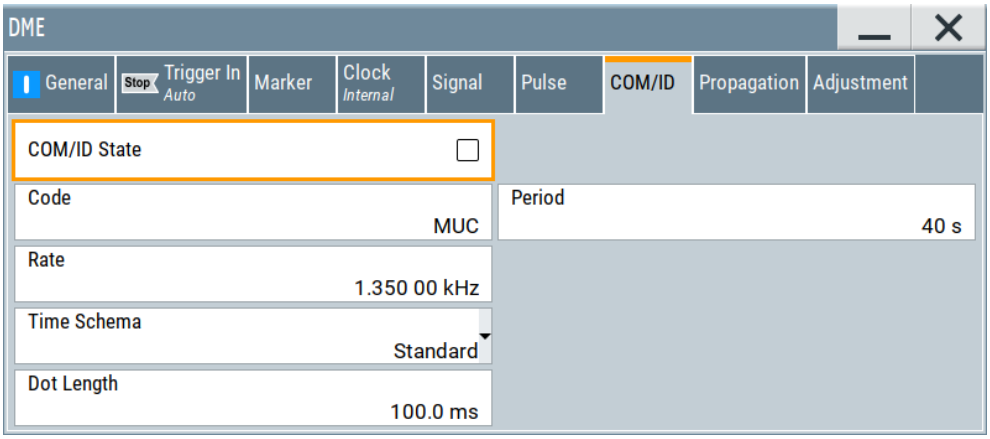
The DME transponder identifies a pulse pair with a spacing 11.5 µs to 12.5 µs as a valid interrogation pair and replies to it. Otherwise, no reply is generated.

Remote command:
[:SOURce<hw>][:BB]:DME:PPST on page 130

5.3.4 COM/ID settings

Access:

1. Select "DME" > "DME Mode" > "Reply".
2. Select "DME" > "COM/ID".



This dialog provides COM/ID signal settings of the DME reply signal.

Settings:

COM/ID State
Enables/disables the COM/ID signal.

The ID signal consists of a regular group of pulses that generates Morse code dots and dashes.

The transmission of the ground signal is interrupted every 40 seconds (ID period) and one ID sequence is transmitted instead. The "key down time" of the ground signal corresponds to the period of transmission for a dot or dash in the Morse code ID sequence (e.g. 100ms for a dot). During the key down times reply pulses are not transmitted, however, they are transmitted between the key down times.

See also Section A, "Morse code settings", on page 160.

Remote command:
`[:SOURce<hw>][:BB]:DME:ID[:STATe]` on page 151

Code
Sets the coding of the COM/ID signal by the international short name of the airport (e.g. MUC for the Munich airport).

The COM/ID tone is sent according to the selected code, see Section A, "Morse code settings", on page 160.

If no coding is set, the COM/ID tone is sent uncoded (key down).

Remote command:
`[:SOURce<hw>][:BB]:DME:ID:CODE` on page 148

Rate
Sets the pulse repetition rate of the COM/ID sequence.

Remote command:
`[:SOURce<hw>][:BB]:DME:ID:RATE` on page 150

Period
Sets the period of the COM/ID signal.

Remote command:
`[:SOURce<hw>][:BB]:DME:ID:PERiod` on page 150

Time Schema
Sets the time schema of the Morse code for the COM/ID signal.

"Standard"	The set dot length determines the length of the dash, the symbol space and letter space of the Morse code.
"User"	You can set each length value separately.

Remote command:
`[:SOURce<hw>][:BB]:DME:ID:TSCHema` on page 151

Dot Length
Sets the length of a Morse code dot.

If "Time Schema" > "Standard", the dot length value determines also the length of the dash (= 3 times the dot length), symbol space (= dot length) and letter space (= 3 times the dot length).

Remote command:
`[:SOURce<hw>][:BB]:DME:ID:DOT` on page 149

Dash Length
Requires "Time Schema" > "User".

Sets the length of a Morse code dash.

Remote command:
`[:SOURce<hw>][:BB]:DME:ID:DASH` on page 148

Symbol Space
Requires "Time Schema" > "User".

Sets the length of the Morse code symbol space.

Remote command:
[:SOURce<hw>][:BB]:DME:ID:SYMBol on page 151

Letter Space
Requires "Time Schema" > "User".

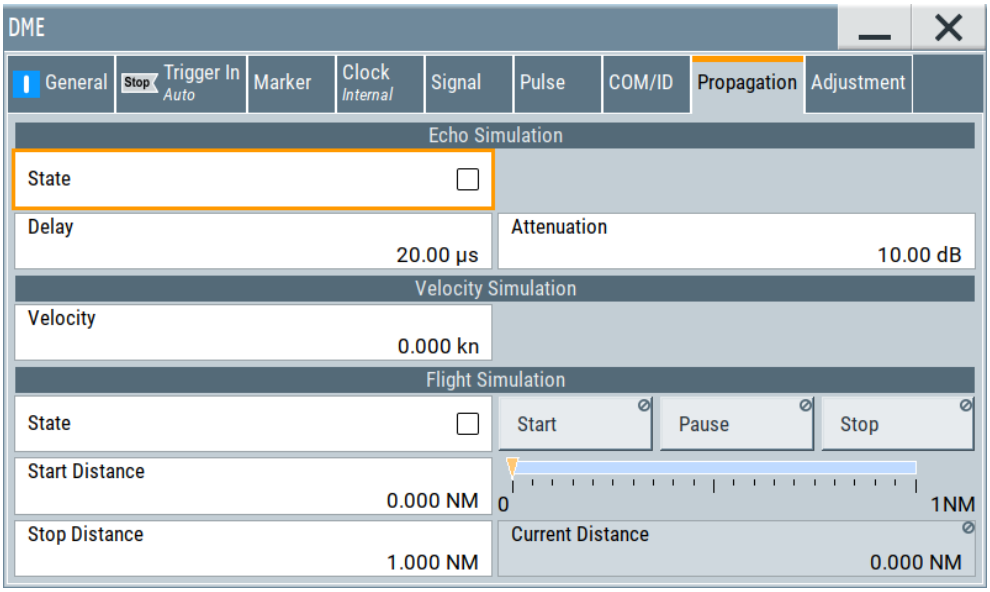
Sets the length of a Morse code letter space.

Remote command:
[:SOURce<hw>][:BB]:DME:ID:LETTer on page 149

5.3.5 Propagation settings

Access:

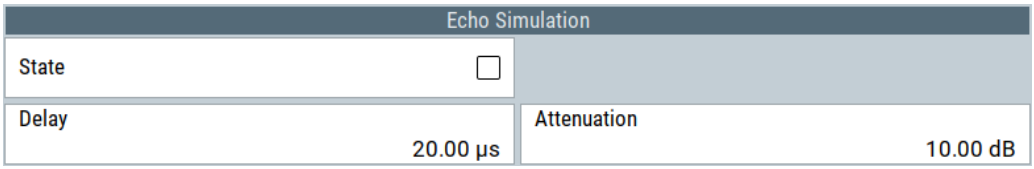
► Select "DME" > "Propagation".



This dialog provides propagation settings of the DME signal necessary for echo rejection testing, velocity tracking and flight simulation.

Settings:

Echo Simulation



Provides settings for DME echo simulation. You can activate the generation of the DME echo pulse pair signal and configure the delay and the attenuation of this signal.

State ← Echo Simulation
Activates the simulation of the DME echo pulse pair signal.

If enabled, the composite DME pulse signal consists of two pulse pairs: The original pulse pair and a delayed and attenuated copy of the original pulse pair. This copy, the echo pulse pair signal, has the same pulse configuration, see Section 5.3.3, "Pulse settings", on page 61.

Delay and attenuation of the echo pulse pair signal compared to the original pulse pair signal can be set.

Activation of the DME echo pulse pair signal deactivates DME squitter pulses (Pulse Squitter > Off).

Remote command:
`[:SOURce<hw>][:BB]:DME:ECHO` on page 137

Delay ← Echo Simulation
Sets the delay between the first original DME pulse pair and the delayed DME echo pulse pair.

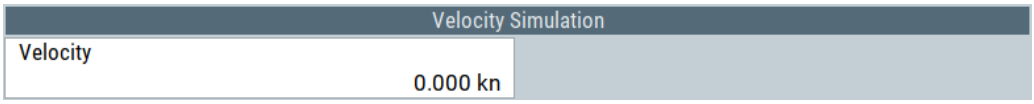
Remote command:
`[:SOURce<hw>][:BB]:DME:ECHO:DELay` on page 138

Attenuation ← Echo Simulation
Sets the attenuation of the DME echo pulse pair signal compared to the original DME pulse pair signal.

A positive attenuation leads to echo pulse pairs with reduced amplitude compared to the original pulse pairs.

Remote command:
`[:SOURce<hw>][:BB]:DME:ECHO:ATTenuation` on page 138

Velocity Simulation



Provides settings for velocity simulation. DME echo simulation is off. You can configure the velocity.

Velocity ← Velocity Simulation
Requires "State" > "Off" of the DME echo pulse signal.

Sets the velocity of the ground station (= DME transponder) relative to the aircraft (= DME interrogator).

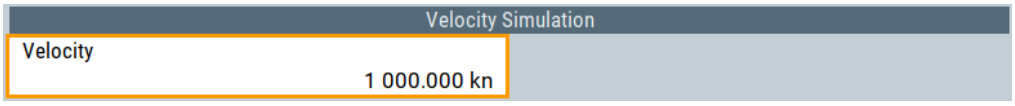
A positive/negative value v implies a positive/negative Doppler frequency shift Δf of the carrier frequency f_c:

$\Delta f = (v/c) \times f_c$

The speed of light c equals 3×10^8 m/s.

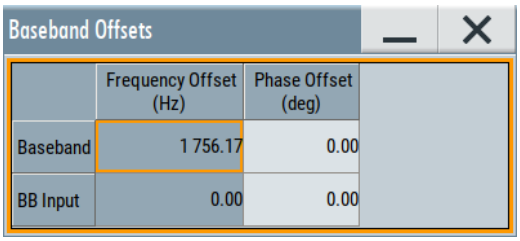
Example:

v = 1000 kn = 514.4 m/s; f_c = 1.025 GHz



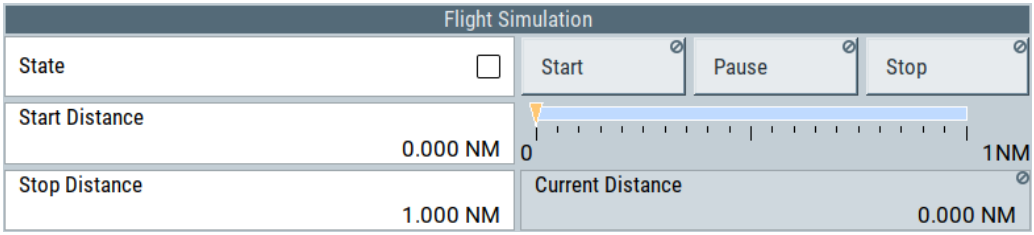
Expected frequency shift: $\Delta f = (514.4 / (3 \times 10^8)) \times 1.025 \times 10^9$ Hz = 1.756 kHz

To verify this frequency shift, select "Baseband" > "Baseband Offsets" > "Frequency Offset".



Remote command:
[:SOURce<hw>][:BB]:DME:VELocity on page 138

Flight Simulation



Provides settings for flight simulation. You can activate the simulation and monitor the current distance and propagation of the aircraft within a configurable start distance and stop distance.

If activated, the parameters range distance and the reply delay change dynamically during the simulation. See also "Range Distance" on page 58 and "Reply Delay" on page 60.

State ← Flight Simulation
Activates flight simulation. You can activate the simulation and monitor the current distance and propagation of the aircraft within a configurable start distance and stop distance.

Remote command:
`[:SOURce<hw>][:BB]:DME:FLIGht:STATe` on page 140
`[:SOURce<hw>][:BB]:DME:FLIGht:RSTatus?` on page 140

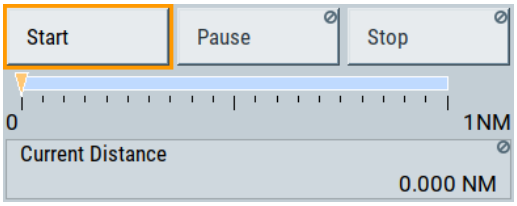
Start Distance ← Flight Simulation
Sets the start distance of the flight simulation.

Remote command:
`[:SOURce<hw>][:BB]:DME:FLIGht:DISTance:STARt` on page 139

Stop Distance ← Flight Simulation
Sets the stop distance of the flight simulation.

Remote command:
`[:SOURce<hw>][:BB]:DME:FLIGht:DISTance:STOP` on page 139

Flight simulation player settings ← Flight Simulation
Require flight simulation "State" > "On".



Provides standard player settings and monitoring aircraft distance evolution in a progress bar.

Start ← Flight simulation player settings ← Flight Simulation
Starts the flight simulation with a given start distance.

Remote command:
`[:SOURce<hw>][:BB]:DME:FLIGht:STARt` on page 140

Restart ← Flight simulation player settings ← Flight Simulation
Restarts a running or stopped flight simulation.

Remote command:
`[:SOURce<hw>][:BB]:DME:FLIGht:RESTart` on page 139

Pause ← Flight simulation player settings ← Flight Simulation
Pauses a running flight simulation.

Remote command:
`[:SOURce<hw>][:BB]:DME:FLIGht:PAUSe` on page 139

Resume ← Flight simulation player settings ← Flight Simulation
Resumes a running flight simulation.

Remote command:
`[:SOURce<hw>][:BB]:DME:FLIGht:RESume` on page 140

Stop ← Flight simulation player settings ← Flight Simulation
Stops the flight simulation and sets the distance position to the start distance.

Remote command:
`[:SOURce<hw>][:BB]:DME:FLIGht:STOP` on page 140

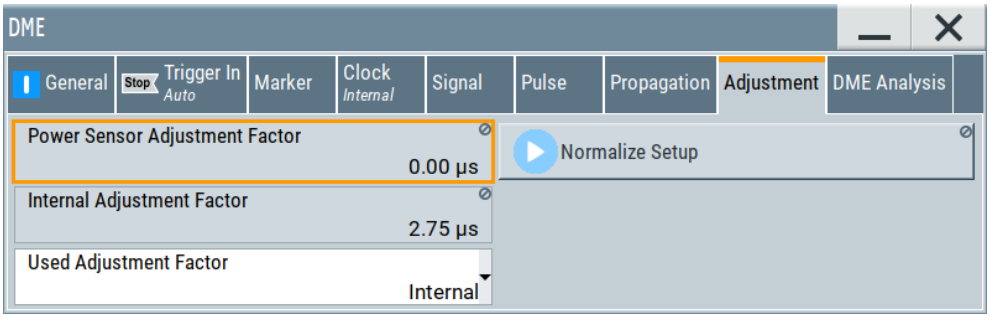
Current Distance ← Flight simulation player settings ← Flight Simulation
Displays the current distance of the aircraft.

Remote command:
`[:SOURce<hw>][:BB]:DME:FLIGht:DISTance:CURRent?` on page 138

5.3.6 Adjustment settings

Access:

► Select "DME" > "Adjustment".



This dialog provides adjustment settings to normalize the setup when triggering the R&S SMBV100B with a power sensor, for example, the R&S NRP-Z81.

For supported Rohde & Schwarz power sensors, see the data sheet. The following step-by-step instructions use the R&S NRP-Z81. These instructions are analogous for compatible power sensors.

To connect a power sensor with the R&S SMBV100B

1. Connect the "Host" connector of the power sensor with the "Sensor" connector on the front panel of the R&S SMBV100B.

a) Align the "Host" connector along a common axis with the "Sensor" connector.
b) Rotate the connecting cable, so that the red marking at the "Host" connector matches the position of the red marking at the "Sensor" connector.
The correct position is the left position as seen from the middle of the "Sensor" connector. See label "5" in Figure 5-3.
c) Insert the "Host" connector into the "Sensor" connector of your sensor hub.

2. Connect the "RF" connector of the R&S NRP-Z81 with the "RF 50Ω" output connector on the front panel of the R&S SMBV100B.

a) Before connecting, switch off the RF output of the R&S SMBV100B.
In the block diagram, select the block "RF" > "RF Level" > "RF ON" > "Off".
b) Align the "RF" connector along a common axis with the "RF 50Ω" output connector.
c) Tighten the "RF" connector of the power sensor.

Figure 5-3 illustrates the test setup.

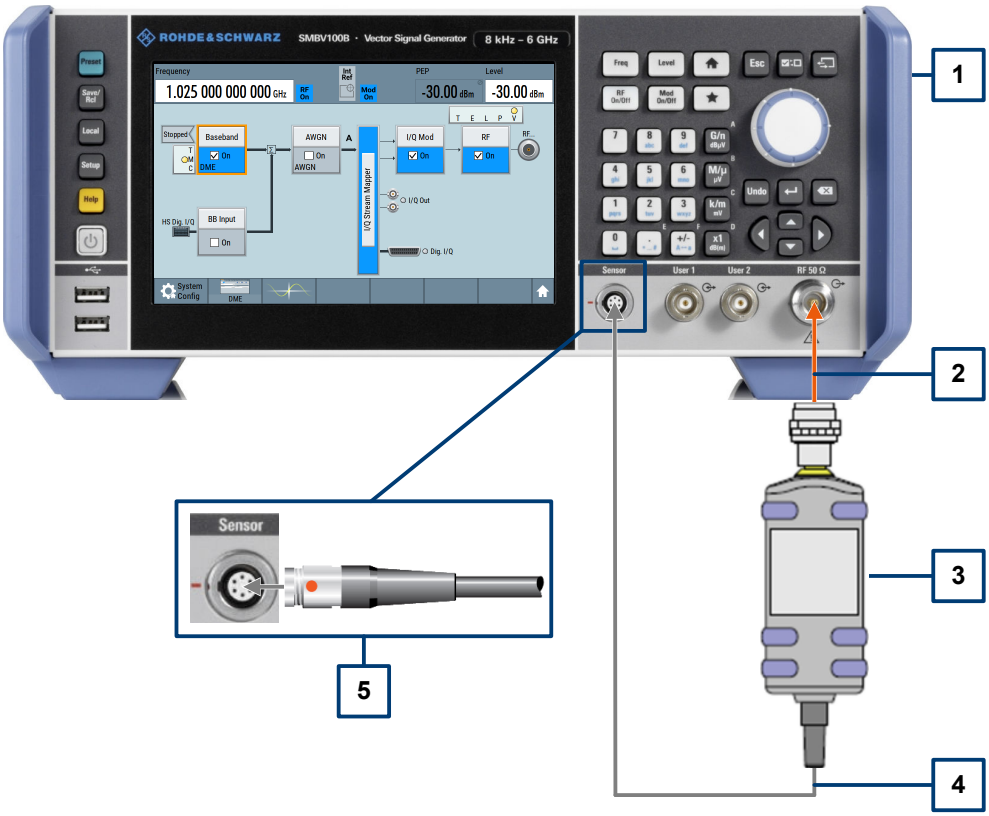


Figure 5-3: Test setup for normalization routine

1 = R&S SMBV100B
2 = RF connection
3 = Power sensor, for example, the R&S NRP-Z81
4 = Sensor control connection
5 = Red markings for "Host" connector (R&S NRP-Z81) with the "Sensor" connector (R&S SMBV100B)

To normalize the test setup

1. Connect the R&S SMBV100B and the power sensor as described in "To connect a power sensor with the R&S SMBV100B" on page 69.
2. To calibrate a measurement setup regarding external pulse input and internal processing delays, use "Normalize Setup".

For DME operation in combination with a power sensor as input channel, the exact trigger point has to be known. Knowing the trigger point can be used to compensate for the pulse shape and the internal delay of the sensor.

As shown in Figure 5-4, the R&S SMBV100B gets interrogation pulses from an external DUT using the same pulse shape. According to the settings, the R&S SMBV100B sends a reply pulse pair 50us after receiving the interrogation pulse pair.

To guarantee, that the 50% edge levels are exactly 50us separated from each other, the R&S SMBV100B has to start the reply pulse before the 50us reply delay period has elapsed.

Using the "Normalize Setup" calibration, an adjustment factor t is measured. This adjustment factor is considered, when generating the reply pulses. The signal output is started earlier to compensate for the trigger point of the sensor. This calibration works best, when both stations use the same pulse shape with the same timing characteristics.

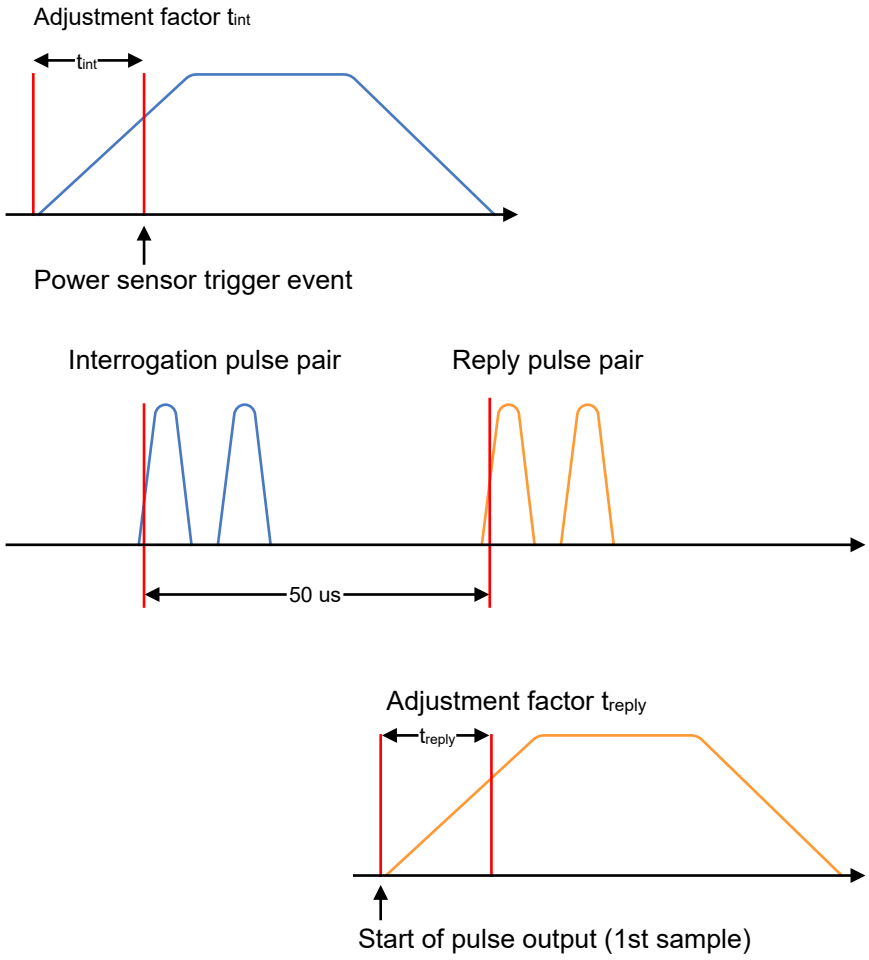


Figure 5-4: Normalization routine

Settings:

Normalize Setup
Requires direct connection between the R&S SMBV100B and a power sensor, for example, the R&S NRP-Z81. See Figure 5-3.

Triggers the start of the normalization routine.

The normalization routine measures the pulse propagation time within the test setup. The propagation time is the time difference between the pulse signal routing time and the time at which the shaped pulse reaches 50 % of the peak voltage. The pulse signal routing time includes the start of a pulse from the internal FPGA of the R&S SMBV100B through the RF chain, the power sensor, and back into the FPGA.

The propagation time value is subtracted from the desired delay to achieve an overall delay. The R&S SMBV100B uses the overall delay to start pulse generation such that the 50 % voltage level of the rising edge of the first pulse occurs at the desired delay.

If "Used Adjustment Factor" > "Power Sensor", this measured time is used rather than the calculated internal adjustment factor. Normalize Setup only measures the rise time of the pulse generated by the R&S SMBV100B.

R&S SMBVB-K153 assumes that the pulse shape of the DUT (when the R&S SMBV100B is in interrogation mode, the DUT is the ground transponder. When the R&S SMBV100B is in reply mode (the DUT is the aircraft interrogator), the rise time of the DUT matches the rise time of the generator. No correction is made for differences in the rise time of the DUT and rise time of the R&S SMBV100B.

See also Figure 5-4.

Remote command:
`[:SOURce<hw>][:BB]:DME:ANALysis:NORMalize?` on page 143

Power Sensor Adjustment Factor
Displays the power sensor adjustment factor determined during a normalization of the setup.

Remote command:
`[:SOURce<hw>][:BB]:DME:ANALysis:PSAFactor?` on page 147

Internal Adjustment Factor
Displays the internal adjustment factor, the mathematically calculated value of the time, when the pulse reaches its 50% level.

Remote command:
`[:SOURce<hw>][:BB]:DME:ANALysis:IAFactor?` on page 147

Used Adjustment Factor
Sets the used adjustment factor.

"Internal" The mathematically calculated value of the time, when the pulse reaches its 50% level. The power sensor trigger hysteresis and the small delay from the power sensor trigger output to the R&S SMBV100B are not considered by the calculation.

"Power Sensor" The adjustment factor measured during a normalization setup.

Remote command:
`[:SOURce<hw>][:BB]:DME:ANALysis:UAFactor` on page 147

5.3.7 DME Analysis settings

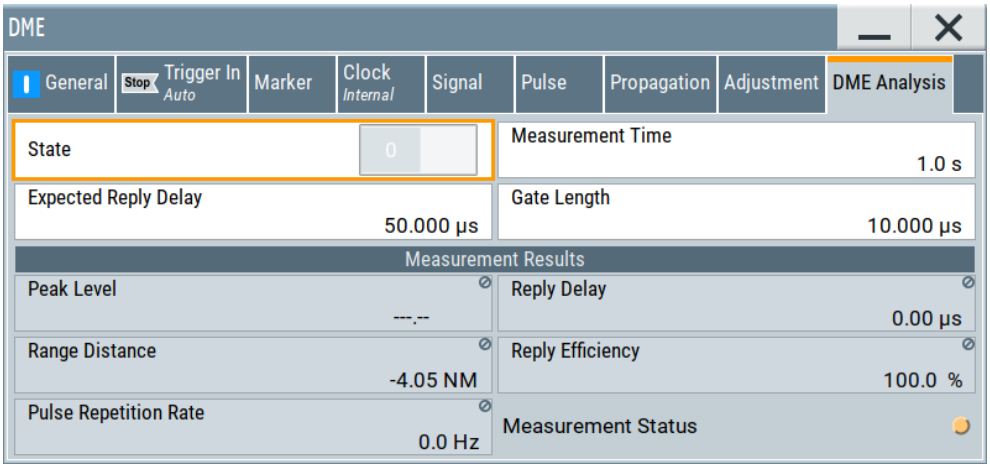
Configuring and displaying DME analysis settings and results require a connection between R&S SMBV100B and a power sensor, for example, the R&S NRP-Z81.

Access:

1. Connect a power sensor to the R&S SMBV100B.

How to: Chapter "Connecting power sensors to the R&S SMBV100B" in the R&S SMBV100B user manual.

2. Select "DME" > "DME Mode" > "Interrogation".
3. Select "DME" > "DME Analysis".



This dialog provides analysis settings and results related to the DME signal.

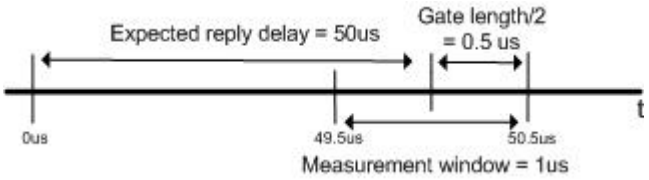
Settings:

State
Activates DME analysis. The R&S SMBV100B generates interrogation pulse pairs and starts an internal counter for time measurement.

The measurement gate settings determine the measurement window (expected reply delay +/- gate length/2). To evaluate the delay time and reply efficiency of reply pulses, the first pulse of the interrogation pulse pair requires the following. The 50% voltage point of the rising edge of the first pulse is within the measurement window. The delay measurement is averaged within the measurement cycle. The reply efficiency is calculated once for each measurement cycle.

Example: DME measurement time

The gate length is 1 µs and the expected reply delay is 50 µs. The measurement window lies in the range between 49.5 µs and 50.5 µs.



The measurement evaluates only pulse pairs whose 50% voltage point of the rising edge of the first pulse is within the measurement time.

Remote command:
`[:SOURce<hw>][:BB]:DME:ANALysis:STATe` on page 145
`[:SOURce<hw>][:BB]:DME:ANALysis:OK?` on page 144

Expected Reply Delay
Sets the expected reply delay. For an illustration between expected reply delay, gate length and measurement time, see Example "DME measurement time" on page 75.

Remote command:
`[:SOURce<hw>][:BB]:DME:ANALysis:GATE:EDELay` on page 142

Gate Length
Sets the gate length for the measurement window. For an illustration between expected reply delay, gate length and measurement time, see Example "DME measurement time" on page 75.

Remote command:
`[:SOURce<hw>][:BB]:DME:ANALysis:GATE[:LENGth]` on page 142

Measurement Time
Sets the time of the measurement cycle. For an illustration between expected reply delay, gate length and measurement time, see Example "DME measurement time" on page 75.

Remote command:
`[:SOURce<hw>][:BB]:DME:ANALysis:GATE:TIME` on page 143

Peak Level
Indicates the measured average peak level of all pulse pairs in a measurement cycle.

Remote command:
`[:SOURce<hw>][:BB]:DME:ANALysis:POWer?` on page 144
`[:SOURce<hw>]:BB:DME:ANALysis:POWer:OK?` on page 144

Range Distance
Indicates the measured average range distance of all valid pulse pairs in a measurement cycle.

If there are no valid measurements available in the set measurement window "invalid" is indicated.

Remote command:
[:SOURce<hw>][:BB]:DME:ANALysis:RDIStance? on page 145

Reply Delay
Indicates the measured average reply delay of all valid pulse pairs in a measurement cycle. If there are no valid measurements available in the set measurement window 'invalid' is indicated.

Remote command:
[:SOURce<hw>][:BB]:DME:ANALysis:TIME? on page 146
[:SOURce<hw>]:BB:DME:ANALysis:TIME:OK? on page 146

Reply Efficiency
Indicates the measured reply efficiency in percent. The measurement is the ratio of the number of measured valid reply pulse pairs to transmitted pulse pairs in a measurement cycle.

If there are no valid measurements available, "invalid" is indicated in the set measurement window.

Remote command:
[:SOURce<hw>][:BB]:DME:ANALysis:EFFiciency? on page 141
[:SOURce<hw>]:BB:DME:ANALysis:EFFiciency:OK? on page 142

Pulse Repetition Rate
Indicates the measured mean pulse repetition rate of the DME ground station.

If there are no valid measurements available in the set measurement window "invalid" is indicated.

Remote command:
[:SOURce<hw>][:BB]:DME:ANALysis:PRRate? on page 145

Measurement Status
Displays the status of the measure via a status icon.

If there are no valid measurements available in the set measurement window 'invalid' is indicated.

Remote command:
[:SOURce<hw>]:BB:DME:ANALysis:PRRate:OK? on page 145

6 Signal generation control

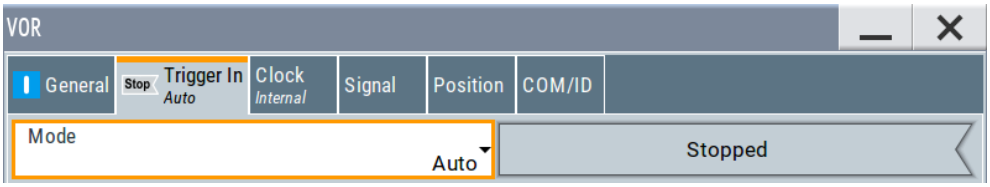
This section lists settings provided for defining the signal generation start and for generating signals necessary for synchronization with other instruments.

It covers the following topics:

6.1 Trigger settings

Access:

► Select "ILS"/"VOR"/"DME" > "Trigger In".



This tab provides settings to select and configure the trigger, like trigger source, trigger mode and trigger delays, and to arm or trigger an internal trigger manually. The header of the tab displays the status of the trigger signal and trigger mode. As in the tabs "Marker" and "Clock", this tab provides also access to the settings of the related connectors.

Routing and enabling a trigger signal

1. Select "Trigger In" > "Mode" to set the trigger mode.
   The mode determines the effect of a trigger event on the signal generation.
2. Select "Source" to set the trigger signal source. For example, set the internal baseband signal or an external trigger signal.
3. For external trigger signals, configure the connector for the signal input. See Section 6.4, "Global connectors settings", on page 86.
   You can map trigger signals to one or more User x connectors.

   Global connectors settings allow you to configure the signal mapping, the polarity, the trigger threshold and the input impedance of the input connectors.
4. Enable baseband signal generation. In the block diagram, set "Baseband" > "On".

   The R&S SMBV100B starts baseband signal generation after receiving the configured trigger event.

About baseband trigger signals

This section focuses on the available settings.

For detailed information, see section "Common characteristics of the baseband domain" in the R&S SMBV100B user manual.

Settings:

Mode
Selects the trigger mode. The mode determines the effect of a trigger event on the signal generation.

- "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]:ILS[:TRIGger]:SEQuence` on page 153
`[:SOURce<hw>]:BB:VOR[:TRIGger]:SEQuence` on page 153
`[:SOURce<hw>]:BB:DME[:TRIGger]:SEQuence` on page 153

Signal Duration
Requires trigger "Mode" > "Single".

Enters the length of the trigger signal sequence.

Use this parameter, for example, for the following applications:

- To output the trigger signal partly.
- To output a predefined sequence of the trigger signal.

Remote command:
[:SOURce<hw>][:BB]:ILS:TRIGger:SLENgth on page 155
[:SOURce<hw>]:BB:VOR:TRIGger:SLENgth on page 155
[:SOURce<hw>]:BB:DME:TRIGger:SLENgth on page 155

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]:ILS:TRIGger:RMODe? on page 154
[:SOURce<hw>]:BB:VOR:TRIGger:RMODe? on page 154
[:SOURce<hw>]:BB:DME:TRIGger:RMODe? on page 154

Time Based Trigger
Requires trigger "Mode" > "Armed Auto"/"Single".

Enables time-based triggering with a fixed time reference.

The R&S SMBV100B triggers signal generation when its operating system time ("Current Time") matches a specified time trigger ("Trigger Time"). As a trigger source, you can use an internal trigger or an external global trigger.

How to: See section "Time-based triggering" in the R&S SMBV100B user manual.

Remote command:
[:SOURce<hw>][:BB]:ILS:TRIGger:TIME[:STATE] on page 155
[:SOURce<hw>]:BB:VOR:TRIGger:TIME[:STATE] on page 155
[:SOURce<hw>]:BB:DME:TRIGger:TIME[:STATE] on page 155

Trigger Time
Requires trigger "Mode" > "Armed Auto"/"Single".

Sets date and time for a time-based trigger signal.

Set a trigger time that is later than the "Current Time". The current time is the operating system time of the R&S SMBV100B. If you set an earlier trigger time than the current time, time-based triggering is not possible.

How to: See section "Time-based triggering" in the R&S SMBV100B user manual.

"Date" Sets the date of the time-based trigger in format YYYY-MM-DD.

Remote command:
[:SOURce<hw>][:BB]:ILS:TRIGger:TIME:DATE on page 154
[:SOURce<hw>]:BB:VOR:TRIGger:TIME:DATE on page 154
[:SOURce<hw>]:BB:DME:TRIGger:TIME:DATE on page 154

"Time" Sets the time of the time-based trigger in format hh:mm:ss.

Remote command:
[:SOURce<hw>][:BB]:ILS:TRIGger:TIME:TIME on page 154
[:SOURce<hw>]:BB:VOR:TRIGger:TIME:TIME on page 154
[:SOURce<hw>]:BB:DME:TRIGger:TIME:TIME on page 154

Arm
Stops the signal generation until a subsequent trigger event occurs.

Remote command:
[:SOURce<hw>][:BB]:ILS:TRIGger:ARM:EXECute on page 156
[:SOURce<hw>]:BB:VOR:TRIGger:ARM:EXECute on page 156
[:SOURce<hw>]:BB:DME:TRIGger:ARM:EXECute on page 156

Execute Trigger
For internal trigger source, executes trigger manually.

Remote command:
[:SOURce<hw>][:BB]:ILS:TRIGger:EXECute on page 156
[:SOURce<hw>]:BB:VOR:TRIGger:EXECute on page 156
[:SOURce<hw>]:BB:DME:TRIGger:EXECute on page 156

Source
The following sources of the trigger signal are available:

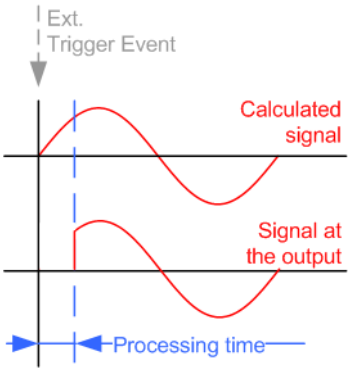
- "Internal"
  The trigger event is internal. Tap "Execute Trigger" to trigger signal generation manually.
- "External Global Trigger"
  The trigger event is the active edge of an external trigger signal provided and configured at the User x connectors.
- "Baseband""Sync In"
  Requires "Multi Instrument Trigger" > "Secondary" for primary-secondary instrument mode.
  Triggers signal generation at the secondary instrument by the active edge of the baseband synchronization signal of the primary instrument.

Remote command:
[:SOURce<hw>][:BB]:ILS:TRIGger:SOURce on page 153
[:SOURce<hw>]:BB:VOR:TRIGger:SOURce on page 153
[:SOURce<hw>]:BB:DME:TRIGger:SOURce on page 153

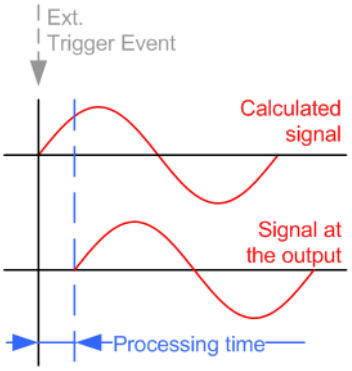
Sync. Output to External Trigger/Sync. Output to Trigger
Requires the input of an external trigger signal.

Enables the baseband signal output that is synchronous to the trigger event. This function is enabled by default.

- "On"
  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 primary-secondary instrument mode, this setting ensures that once achieved, synchronization is not lost if the baseband signal sampling rate changes.

Remote command:
`[:SOURce<hw>][:BB]:ILS:TRIGger:EXTernal:SYNChronize:OUTPut` on page 156
`[:SOURce<hw>]:BB:VOR:TRIGger:EXTernal:SYNChronize:OUTPut` on page 156
`[:SOURce<hw>]:BB:DME:TRIGger:EXTernal:SYNChronize:OUTPut` on page 156

External / Trigger Inhibit
Requires an external trigger signal.

Sets a time period to suppress trigger events. A trigger event within this period does not start or restart the signal generation.

After the time period expires, occurring trigger events start or restart the signal generation again.

Remote command:
`[:SOURce<hw>]:BB:VOR:TRIGger[:EXTernal<ch>]:INHibit` on page 157
`[:SOURce<hw>][:BB]:ILS:TRIGger[:EXTernal<ch>]:INHibit` on page 157
`[:SOURce<hw>]:BB:DME:TRIGger[:EXTernal<ch>]:INHibit` on page 157

External / Trigger Delay
Delays the trigger event of the signal from:
- The external trigger source

Use this setting to:
- Synchronize the instrument with the device under test (DUT) or other external devices.
- Compensate delays and align the signal generation start in a multi-instrument setup.

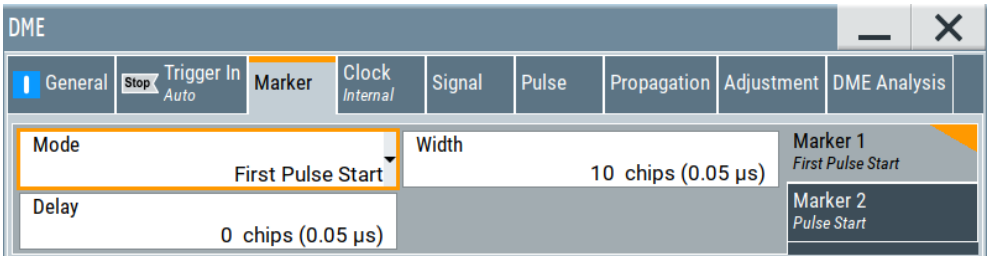
Remote command:
`[:SOURce<hw>]:BB:VOR:TRIGger[:EXTernal<ch>]:DELay` on page 157
`[:SOURce<hw>][:BB]:ILS:TRIGger[:EXTernal<ch>]:DELay` on page 157
`[:SOURce<hw>]:BB:DME:TRIGger[:EXTernal<ch>]:DELay` on page 157

6.2 DME marker settings

Option: R&S SMBVB-K153

Access:

► Select "DME" > "Marker".



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

Routing and activating a marker signal

1. To define the signal shape of an individual marker signal "x", select "Marker" > "Marker x" > "Mode".
2. Optionally, define the connector for signal output. See Section 6.4, "Global connectors settings", on page 86.
   You can map marker signals to one or more User x connectors.
3. Enable baseband signal generation. In the block diagram, set "Baseband"> "On".

   The R&S SMBV100B adds the marker signal to the baseband signal. Also, R&S SMBV100B outputs this signal at the configured User x connector.

About marker output signals

This section focuses on the available settings.

For detailed information, see section "Common characteristics of the baseband domain" in the R&S SMBV100B user manual.

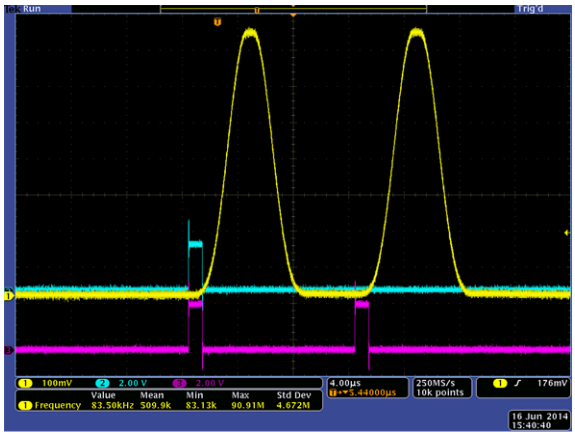
Settings:

Mode
Sets the marker mode that defines the shape and periodicity of the marker signal.

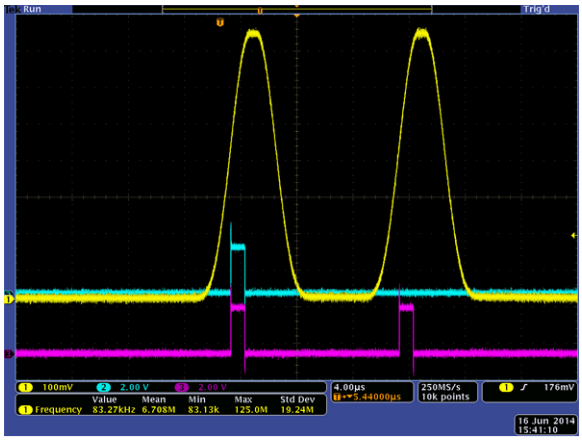
You can configure individual marker modes for each marker signal. The number of available markers is 3. The marker configuration changes with the selected marker mode.

How to: "Routing and activating a marker signal" on page 82

"First Pulse Start"/"Pulse Start"
Sets the marker at the beginning of the (first) pulse.

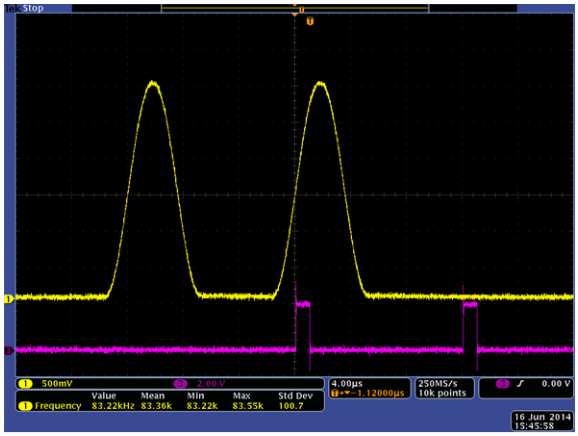


"First Pulse 50% Level"/"Pulse 50% Level"
Sets the marker to 50 percent of the maximum pulse level of the (first) pulse.



"Received Pulse"

Sets "Marker 2" on the received pulse.



Remote command:
[:SOURce<hw>][:BB]:DME:MARKer<ch>:MODE on page 158

Width
Sets the width of the selected marker.

Remote command:
[:SOURce<hw>][:BB]:DME:MARKer<ch>:WIDTh on page 159

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]:DME:MARKer<ch>:DELay on page 158

Processing Delay
Requires "Marker 2" > "Mode" > "Received Pulse".

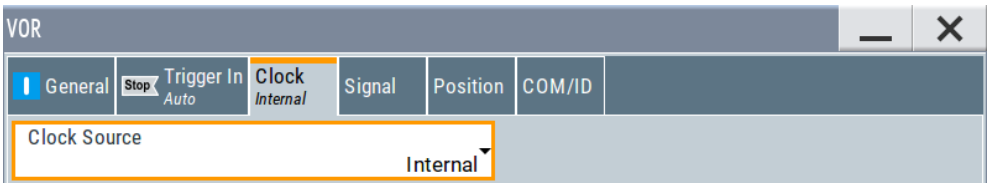
Displays the processing delay. The delay equals the time difference between the position of the markers for the interrogation pulse and for the reply pulse.

Remote command:
[:SOURce<hw>][:BB]:DME:MARKer<ch>:PDELay? on page 158

6.3 Clock settings

Access:

► Select "ILS"/"VOR"/"DME" > "Clock".



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

Defining the clock

1. Select "Clock" > "Source" to define the source of the clock signal.
2. For external clock signals, define the connector for the signal input. See Section 6.4, "Global connectors settings", on page 86.
   You can map clock signals to one or more User x connectors.

   Global connectors settings allow you to configure the signal mapping, the polarity, the trigger threshold and the input impedance of the input connectors.
3. Activate baseband signal generation. In the block diagram, set "Baseband" > "On".

   The R&S SMBV100B starts baseband signal generation with a symbol rate that equals the clock rate.

About clock signals

This section focuses on the available settings.

For detailed information, see section "Common characteristics of the baseband domain" in the R&S SMBV100B user manual.

Settings:

Clock Source
Selects the clock source.

- "Internal"
  The instrument uses its internal clock reference.

How to: "Defining the clock" on page 85

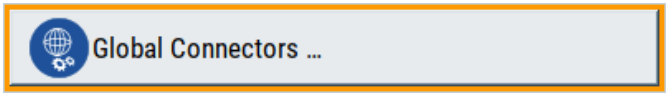
Remote command:
`[:SOURce<hw>][:BB]:ILS:CLOCk:SOURce` on page 159
`[:SOURce<hw>]:BB:VOR:CLOCk:SOURce` on page 159
`[:SOURce<hw>]:BB:DME:CLOCk:SOURce` on page 159

6.4 Global connectors settings

Opens a dialog to configure global connectors.

The button is available in the following dialogs or tabs:

- "Trigger / Marker / Clock" dialog that is accessible via the "TMC" block in the block diagram.
- "Trigger In", "Marker" and "Clock" tabs of baseband signal configuration dialogs that you can open via the "Baseband" block in the block diagram. These tabs are available, for example, for "ARB" baseband signals.



See also section "Global connectors settings" in the user manual.

7 Remote-control commands

The following commands are required to perform signal generation with the ILS/VOR/DME option in a remote environment. We assume that the R&S SMBV100B has already been set up for remote operation in a network as described in the R&S SMBV100B 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 SMBV100B user manual.

Placeholder <Subsystem>

To simplify the description of the remote control commands, the placeholder `<Subsystem>` is introduced. Depending on the avionic standard used as an entry standard, replace this placeholder `<Subsystem>` with for example `SOURce:BB:ILS` for ILS.

The replacement of the place holder `<Subsystem>` is mandatory, i.e. remote control commands containing this placeholder are not recognized and accepted by the instrument.

Example:

SCPI command `<subsystem>:STATe`:

- Entry Standard = DME
  `SOURce:BB:DME:STATe`
- Entry Standard = ILS
  `SOURce:BB:ILS:STATe`
- Entry Standard = VOR
  `SOURce:BB:VOR:STATe`
- Invalid command
  `<Subsystem>:STAT`

Common suffixes

The following common suffixes are used in remote commands:

Suffix	Value range	Description
`ENTity<ch>`	1	Optional keyword, provided for compatibility with R&S®SMW200A `ENTity1:SOURce1` = `SOURce1`
`SOURce<hw>`	1	Available baseband signals
`OUTPut<ch>`	1 to 3	Available markers

The following commands specific to the ILS/VOR/DME options are described here:

7.1 Programming examples

The following sections provide simple programming examples for the R&S SMBV100B. 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 reset or preset is recommended to set the R&S SMBV100B 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: Saving and recalling a configuration

This example shows how to query and load settings files, saved with the save/recall function for the VOR standard.

For other avionic standards, replace `VOR` by `ILS` or `DME`.

```
SOURce1:BB:VOR:PRESet
// Go to the "settings" directory.
MMEM:CDIR "/var/user/settings"
// List all files in the directory with extension *.vor.
SOURce1:BB:VOR:SETTing:CATalog?
// vor_17x_Norm, vor_17x_Norm_ComID

// Save the VOR configuration in the file "vor_18x_Norm.vor".
SOURce1:BB:VOR:SETTing:STORe "/var/user/settings/vor_18x_Norm"
// Delete the file "vor_17x_Norm.vor".
SOURce1:BB:VOR:SETTing:DELete "/var/user/settings/vor_17x_Norm"
SOURce1:BB:VOR:SETTing:CATalog?
// vor_18x_Norm, vor_17x_Norm_ComID

// Load the file "vor_18x_Norm.vor".
SOURce1:BB:VOR:SETTing:LOAD "/var/user/settings/vor_18x_Norm"
```

```
// Activate VOR signal generation.
SOURce1:BB:VOR:STATe 1
```

Example: Configure and generate a VOR signal

```
SOURce1:BB:VOR:PRESet

// Configure VOR general settings.
SOURce1:BB:VOR:FREQuency:MODE USER
SOURce1:BB:VOR:FREQuency 108000000
SOURce1:BB:VOR:FREQuency:MODE ICAO
SOURce1:BB:VOR:ICAO:CHANnel?
// Response: CH17X

// Configure VOR signal settings.
SOURce1:BB:VOR:MODE NORM
SOURce1:BB:VOR:VAR:FREQuency 30
SOURce1:BB:VOR:VAR:DEPTh 30
SOURce1:BB:VOR:SUBCarrier:FREQuency 9960
SOURce1:BB:VOR:SUBCarrier:DEPTh 30
SOURce1:BB:VOR:REFerence:DEViation 480

// Configure VOR position settings.
SOURce1:BB:VOR:BANGle 1
SOURce1:BB:VOR:BANGle:DIRection FROM

// Configure VOR COM/ID settings.
SOURce1:BB:VOR:COMid:PERiod 9
SOURce1:BB:VOR:COMid:FREQuency 1020
SOURce1:BB:VOR:COMid:DEPTh 11
SOURce1:BB:VOR:COMid:TSCHema USER
SOURce1:BB:VOR:COMid:DOT 0.11
SOURce1:BB:VOR:COMid:DASH 0.29
SOURce1:BB:VOR:COMid:SYMBol 0.11
SOURce1:BB:VOR:COMid:LETTer 0.29
SOURce1:BB:VOR:COMid:STATe 1

// Activate VOR signal generation.
SOURce1:BB:VOR:STATe 1
```

Example: Configure and generate an ILS glide slope signal

```
SOURce1:BB:ILS:PRESet

// Configure ILS localizer general settings.
SOURce1:BB:ILS:TYPE GS
SOURce1:BB:ILS:GS:FREQuency:MODE USER
SOURce1:BB:ILS:GS:FREQuency 334700000
SOURce1:BB:ILS:GS:FREQuency:MODE ICAO
SOURce1:BB:ILS:GS:ICAO:CHANnel?
// Response: CH18X
SOURce1:BB:ILS:GS:FREQuency:SYNChronize 1
```

```
SOURce1:BB:ILS:LOCalizer:ICAO:CHANnel?
// Response: CH18X
SOURce1:BB:ILS:LOCalizer:FREQuency?
// Response: 108100000

// Configure ILS glide slope signal settings.
SOURce1:BB:ILS:GS:MODE NORM
SOURce1:BB:ILS:GS:DDM:POLarity P90_150
SOURce1:BB:ILS:GS:ULOBe:FREQuency 90
SOURce1:BB:ILS:GS:LLOBe:FREQuency 150
SOURce1:BB:ILS:GS:PHASe 0

// Configure ILS glide slope amplitude settings.
SOURce1:BB:ILS:GS:DDM:DIRection UP
SOURce1:BB:ILS:GS:SDM 80
SOURce1:BB:ILS:GS:DDM:COUPling FIX
SOURce1:BB:ILS:GS:DDM:STEP DEC
SOURce1:BB:ILS:GS:DDM:CURRent 0
SOURce1:BB:ILS:GS:DDM:DEPTh 0
SOURce1:BB:ILS:GS:DDM:LOGarithmic 0
SOURce1:BB:ILS:GS:DDM:PCT 0

// Activate ILS signal generation.
SOURce1:BB:ILS:STATe 1
```

Example: Configure and generate an ILS localizer signal

```
SOURce1:BB:ILS:PRESet

// Configure ILS localizer general settings.
SOURce1:BB:ILS:TYPE LOC
SOURce1:BB:ILS:LOCalizer:FREQuency:MODE USER
SOURce1:BB:ILS:LOCalizer:FREQuency 108100000
SOURce1:BB:ILS:LOCalizer:FREQuency:SYNChronize 1
SOURce1:BB:ILS:GS:FREQuency?
// Response: 108100000
SOURce1:BB:ILS:LOCalizer:FREQuency:MODE ICAO
SOURce1:BB:ILS:LOCalizer:ICAO:CHANnel CH26Y
SOURce1:BB:ILS:GS:ICAO:CHANnel?
// Response: CH26Y
SOURce1:BB:ILS:GS:FREQuency?
// Response: 1089500000

// Configure ILS localizer signal settings.
SOURce1:BB:ILS:LOCalizer:MODE NORM
SOURce1:BB:ILS:LOCalizer:DDM:POLarity P90_150
SOURce1:BB:ILS:LOCalizer:LLOBe:FREQuency 90
SOURce1:BB:ILS:LOCalizer:RLOBe:FREQuency 150
SOURce1:BB:ILS:LOCalizer:PHASe 0

// Configure ILS localizer amplitude settings.
SOURce1:BB:ILS:LOCalizer:DDM:DIRection LEFT
SOURce1:BB:ILS:LOCalizer:SDM 40
```

```
SOURce1:BB:ILS:LOCalizer:DDM:COUPling FIX
SOURce1:BB:ILS:LOCalizer:DDM:STEP DEC
SOURce1:BB:ILS:LOCalizer:DDM:CURRent 0
SOURce1:BB:ILS:LOCalizer:DDM:DEPTh 0
SOURce1:BB:ILS:LOCalizer:DDM:LOGarithmic 0
SOURce1:BB:ILS:LOCalizer:DDM:PCT 0

// Configure ILS localizer COM/ID settings.
SOURce1:BB:ILS:LOCalizer:COMid:CODE "MUC"
SOURce1:BB:ILS:LOCalizer:COMid:PERiod 9
SOURce1:BB:ILS:LOCalizer:COMid:FREQuency 1020
SOURce1:BB:ILS:LOCalizer:COMid:DEPTh 10
SOURce1:BB:ILS:LOCalizer:COMid:TSCHema USER
SOURce1:BB:ILS:LOCalizer:COMid:DOT 0.11
SOURce1:BB:ILS:LOCalizer:COMid:DASH 0.29
SOURce1:BB:ILS:LOCalizer:COMid:SYMBol 0.11
SOURce1:BB:ILS:LOCalizer:COMid:LETTer 0.29
SOURce1:BB:ILS:LOCalizer:COMid:STATe 1

// Activate ILS signal generation.
SOURce1:BB:ILS:STATe 1
```

Example: Configure and generate an ILS marker beacons signal

```
SOURce1:BB:ILS:PRESet

// Configure ILS marker beacons general settings.
SOURce1:BB:ILS:TYPE MBE
SOURce1:BB:ILS:MBEacon:FREQuency:MODE USER
SOURce1:BB:ILS:MBEacon:FREQuency 75000000
SOURce1:BB:ILS:MBEacon:MARKer:FREQuency 400
SOURce1:BB:ILS:MBEacon:MARKer:DEPTh 95
SOURce1:BB:ILS:MBEacon:MARKer:PULSed?
// Response: "0"

// Configure ILS marker beacons COM/ID settings.
SOURce1:BB:ILS:MBEacon:COMid:CODE "MUC"
SOURce1:BB:ILS:MBEacon:COMid:PERiod 9
SOURce1:BB:ILS:MBEacon:COMid:FREQuency 1020
SOURce1:BB:ILS:MBEacon:COMid:DEPTh 5
SOURce1:BB:ILS:MBEacon:COMid:TSCHema USER
SOURce1:BB:ILS:MBEacon:COMid:DOT 0.11
SOURce1:BB:ILS:MBEacon:COMid:DASH 0.29
SOURce1:BB:ILS:MBEacon:COMid:SYMBol 0.11
SOURce1:BB:ILS:MBEacon:COMid:LETTer 0.29
SOURce1:BB:ILS:MBEacon:COMid:STATe 1

// Activate ILS signal generation.
SOURce1:BB:ILS:STATe 1
```

Example: Configuring and generating a DME interrogation mode signal

```
SOURce1:BB:DME:PRESet

// Configure DME general settings.
SOURce1:BB:DME:MODE INT
SOURce1:BB:DME:CSUFfix X
SOURce1:BB:DME:FREQuency 1025000000

// Configure DME signal settings.
SOURce1:BB:DME:SQUitter?
// Response: 0
SOURce1:BB:DME:RATE 48
SOURce1:BB:DME:PINPut:SOURce EXT

// Configure DME pulse settings.
SOURce1:BB:DME:SHAPe COS2
SOURce1:BB:DME:RISE 0.000002
SOURce1:BB:DME:WIDTh 0.0000035
SOURce1:BB:DME:FALL 0.000002
SOURce1:BB:DME:PPS 0.000012
SOURce1:BB:DME:SINGle 1
SOURce1:BB:DME:SINGle 0
SOURce1:BB:DME:PPST:ENABled 1
SOURce1:BB:DME:PPST 0.000005

// Configure DME propagation settings.
SOURce1:BB:DME:ECHO:DELay 0.00002
SOURce1:BB:DME:ECHO:ATTenuation 10
SOURce1:BB:DME:VELocity 10
SOURce1:BB:DME:ECHO ON

// Activate DME signal generation.
SOURce1:BB:DME:STATe 1
```

Example: Configuring and querying DME analysis settings and results

```
SOURce1:BB:DME:STATe 1

// Configure DME analysis settings.
SOURce1:BB:DME:ANALysis:GATE:EDELay 0.00005
SOURce1:BB:DME:ANALysis:GATE:LENGth 0.00001
SOURce1:BB:DME:ANALysis:GATE:TIME 1
SOURce1:BB:DME:ANALysis:STATe 1

// Query DME results.
// Query, if measurement results are available.
SOURce1:BB:DME:ANALysis:OK?
// Response: 1
// Query, if power measurement results are available.
SOURce1:BB:DME:ANALysis:POWer:OK?
// Response: 1
SOURce1:BB:DME:ANALysis:POWer?
```

```
// Response in dBm: -43.21
// Query reply delay.
SOURce1:BB:DME:ANALysis:TIME?
// Response in us: 0.02
// Query range distance.
SOURce1:BB:DME:ANALysis:RDIStance?
// Response in NM: -4.05
// Query reply efficiency.
SOURce1:BB:DME:ANALysis:EFFiciency?
// Responce in percent: 100
// Query pulse repetition rate.
SOURce1:BB:DME:ANALysis:PRRate?
// Responce in Hz: 47
```

Example: Configuring and generating a DME reply mode signal

```
SOURce1:BB:DME:PRESet

// Configure DME general settings.
SOURce1:BB:DME:MODE REPL
SOURce1:BB:DME:CSUFfix X
SOURce1:BB:DME:FREQuency 1025000000

// Configure DME signal settings.
SOURce1:BB:DME:RDIStance 10
// Set for 10 reply pulses.
SOURce1:BB:DME:EFFiciency:REPLies 10
// Set 70 percent reply efficiency: 7 correct and 3 false reply pulses.
SOURce1:BB:DME:EFFiciency 70
SOURce1:BB:DME:SQUitter 1
SOURce1:BB:DME:RATE 2700
SOURce1:BB:DME:PINPut:SOURce EXT
// The input source is externally triggered.
SOURce1:BB:DME:PINPut:DELay?
// Reply for 10 NM range distance in seconds: "0.00017359"
// The delay is about 173.6 microseconds.

// Search DME trigger levels determined via a power sensor.
SOURce1:BB:DME:PINPut:SOURce PSEN
SOURce1:BB:DME:PINPut:TRIGger:SEARch
// Executes the search trigger level procedure.
// Query, if the search procedure finds a valid trigger level.
SOURce1:BB:DME:PINPut:TRIGger:SEARch?
// Response: "0"
// The trigger level value is valid.
SOURce1:BB:DME:PINPut:TRIGger:LEVel?
// Response in dBm: "-3.45"
SOURce1:BB:DME:PINPut:TRIGger:LEVel:OK?
// Response: "1"
// The trigger level value is valid.
```

```
// Configure DME pulse settings.
SOURce1:BB:DME:SHAPe COS2
SOURce1:BB:DME:RISE 0.000002
SOURce1:BB:DME:WIDTh 0.0000035
SOURce1:BB:DME:FALL 0.000002
SOURce1:BB:DME:PPS 0.000012
SOURce1:BB:DME:SINGle 1
SOURce1:BB:DME:SINGle 0
SOURce1:BB:DME:PPST:ENABled? 0
SOURce1:BB:DME:PPST:ENABled 1
SOURce1:BB:DME:PPST 0.000002

// Configure DME COM/ID settings.
SOURce1:BB:DME:ID:CODE "MUC"
SOURce1:BB:DME:ID:PERiod 40
SOURce1:BB:DME:ID:RATE 1350
SOURce1:BB:DME:ID:TSCHema USER
SOURce1:BB:DME:ID:DOT 0.11
SOURce1:BB:DME:ID:DASH 0.29
SOURce1:BB:DME:ID:SYMBol 0.11
SOURce1:BB:DME:ID:LETTer 0.29
SOURce1:BB:DME:ID:STATe 1

// Activate DME signal generation.
SOURce1:BB:DME:STATe 1
```

Example: Determining the DME echo rejection

```
SOURce1:BB:DME:PRESet

// Configure e.g. ICAO channel 1X DME reply signal.
SOURce1:BB:DME:MODE REPL
SOURce1:BB:DME:CSUFfix ICAO
SOURce1:BB:DME:ICAO:CHANnel CH1X
SOURce1:BB:DME:CSUFfix X
SOURce1:BB:DME:FREQuency? 962000000
// Specify the DME reply signal.
SOURce1:BB:DME:RDIStance 30
SOURce1:BB:DME:PINPut:DELay? 0.00042077
SOURce1:BB:DME:EFFiciency 100
// Specify the DME echo pulse signal.
SOURce1:BB:DME:ECHO:DELay? 0.0000335
SOURce1:BB:DME:ECHO:ATTenuation 10
SOURce1:BB:DME:ECHO 1
// Output DME reply and echo signal at the RF connector.
SOURce1:BB:DME:STATe ON
SOURce1:POWer:POWer -50
OUTPut1:STATe 1

// Increase the echo signal level.
SOURce1:BB:DME:ECHO:ATTenuation 10
SOURce1:BB:DME:ECHO:ATTenuation 9
```

```
SOURce1:BB:DME:ECHO:ATTenuation 8
SOURce1:BB:DME:ECHO:ATTenuation 7
SOURce1:BB:DME:ECHO:ATTenuation 6
SOURce1:BB:DME:ECHO:ATTenuation 5
SOURce1:BB:DME:ECHO:ATTenuation 4
SOURce1:BB:DME:ECHO:ATTenuation 3
// Result: DUT locks on to the echo signal at -53 dBm.
```

Example: Simulating DME signals for velocity tracking

```
SOURce1:BB:DME:PRESet

// Velocity tracking test:
// Simulate DME ground station, e.g. ICAO channel 1X DME interrogation signal.
SOURce1:BB:DME:MODE INT
SOURce1:BB:DME:CSUFfix ICAO
SOURce1:BB:DME:ICAO:CHANnel CH1X
SOURce1:BB:DME:CSUFfix X
SOURce1:BB:DME:FREQuency? 962000000
// Specify the DME interrogation signal: e.g. 15 NM range distance, 1000 kn velocity
SOURce1:BB:DME:RDIStance 15
SOURce1:BB:DME:ECHO 0
SOURce1:BB:DME:VELocity 1000
// Output DME interrogation signal at the RF connector.
SOURce1:BB:DME:STATe 1
SOURce1:POWer:POWer -50
OUTPut1:STATe 1
// Verify that the DUT locks on the signal and maintains track.

// Outbound to inbound test:
// Simulate DME ground station, e.g. ICAO channel 1X DME interrogation signal.
SOURce1:BB:DME:MODE INT
SOURce1:BB:DME:CSUFfix ICAO
SOURce1:BB:DME:ICAO:CHANnel CH1X
SOURce1:BB:DME:CSUFfix X
SOURce1:BB:DME:FREQuency? 962000000
// Specify the DME interrogation signal: e.g. 200 kn velocity
SOURce1:BB:DME:VELocity 200
// Output DME interrogation signal at the RF connector.
SOURce1:BB:DME:STATe 1
SOURce1:POWer:POWer -50
OUTPut1:STATe 1
// Switch to DME reply signal mode.
SOURce1:BB:DME:MODE REPL

// Inbound to outbound test:
// Simulate DME ground station, e.g. ICAO channel 1X DME reply signal.
SOURce1:BB:DME:MODE REPL
SOURce1:BB:DME:CSUFfix ICAO
SOURce1:BB:DME:ICAO:CHANnel CH1X
SOURce1:BB:DME:CSUFfix X
SOURce1:BB:DME:FREQuency? 962000000
```

```
// Specify the DME reply signal: e.g. 200 kn velocity
SOURce1:BB:DME:VELocity 200
// Output DME reply signal at the RF connector.
SOURce1:BB:DME:STATe 1
SOURce1:POWer:POWer -50
OUTPut1:STATe 1
// Switch to DME interrogation signal mode.
SOURce1:BB:DME:MODE INT
```

Example: Simulating a DME flight scenario

```
SOURce1:BB:DME:PRESet

SOURce1:BB:DME:FLIGHt:DISTance:STARt 0
// Start distance is 0 nautical miles (NM)
SOURce1:BB:DME:FLIGHt:DISTance:STOP 1
// Stop distance is 1 NM.
// Set the velocity.
SOURce1:BB:DME:VELocity 100
SOURce1:BB:DME:FLIGHt:STATe 1
SOURce1:BB:DME:FLIGHt:STARt
// Query the current distance (NM).
SOURce1:BB:DME:FLIGHt:DISTance:CURRent?
// Response: 0.002
// Optionally, pause and resume or restart the flight simulation.
SOURce1:BB:DME:FLIGHt:PAUSe
SOURce1:BB:DME:FLIGHt:RESume
SOURce1:BB:DME:FLIGHt:RESTart
// Check running status to determine if current distance equals stop distance.
SOURce1:BB:DME:FLIGHt:RSTatus?
// Response: "IDLE"
// The simulation is in idle state. The flight simulation stops automatically.
SOURce1:BB:DME:FLIGHt:DISTance:CURRent?
// Response: 1.000
// Optionally, stop the flight simulation during simulation run.
SOURce1:BB:DME:FLIGHt:STOP
```

Example: Configuring trigger settings

```
SOURce1:BB:VOR:TRIGger:SEQuence AAUT
SOURce1:BB:VOR:TRIGger:SOURce EGT1
SOURce1:BB:VOR:TRIGger:EXTernal:SYNChronize:OUTPut 1
SOURce1:BB:VOR:TRIGger:EXTernal:INHibit 100
SOURce1:BB:VOR:TRIGger:DELay:UNIT SAMP
SOURce1:BB:VOR:TRIGger:EXTernal:DELay 10
SOURce1:BB:VOR:TRIGger:EXTernal:RDELay?
// Response in seconds: 0.00000065
SOURce1:BB:VOR:TRIGger:DELay:UNIT TIME
SOURce1:BB:VOR:TRIGger:EXTernal:TDELay 0.00001
SOURce1:BB:VOR:TRIGger:EXTernal:RDELay?
// Response in seconds: 0.00001
```

Example: Configuring DME marker settings

```
SOURce1:BB:DME:MARKer1:MODE PRECeived
SOURce1:BB:DME:MARKer1:WIDTh 10
SOURce1:BB:DME:MARKer1:DELay 1
SOURce1:BB:DME:MARKer1:PDELay?
// Response in seconds: 0.00000123
```

Example: Querying clock settings

```
SOURce1:BB:VOR:CLOCk:SOURce?
// Response: "INT"
```

7.2 General commands

<subsystem>:PRESet
[:SOURce<hw>]:BB:DME:PRESet
[:SOURce<hw>][:BB]:ILS:PRESet
[:SOURce<hw>]:BB:VOR: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:VOR|ILS|DME:STATe`.

Example: See Example "Saving and recalling a configuration" on page 88.

<subsystem>:SETTing:CATalog
[:SOURce<hw>][:BB]:DME:SETTing:CATalog?
[:SOURce<hw>][:BB]:ILS:SETTing:CATalog?
[:SOURce<hw>]:BB:VOR:SETTing:CATalog?

Queries the files with settings in the default directory. Listed are files with the file extension `*.ils/*.vor/*.dme`.

Example: SeeExample "Saving and recalling a configuration" on page 88 .

Usage: Query only

<subsystem>:SETTing:DELete
[:SOURce<hw>]:BB:DME:SETTing:DELete <Filename>
[:SOURce<hw>][:BB]:ILS:SETTing:DELete <Filename>
[:SOURce<hw>]:BB:VOR:SETTing:DELete <Filename>

Deletes the selected file from the default or the specified directory. Deleted are files with extension `*.ils/*.vor/*.dme`.

Setting parameters:
<Filename> string

Example: SeeExample "Saving and recalling a configuration" on page 88 .

Usage: Setting only

<subsystem>:SETTing:LOAD
[:SOURce<hw>]:BB:DME:SETTing:LOAD <Filename>
[:SOURce<hw>][:BB]:ILS:SETTing:LOAD <Filename>
[:SOURce<hw>]:BB:VOR:SETTing:LOAD <Filename>

Loads the selected file from the default or the specified directory. Loaded are files with extension `*.ils/*.vor/*.dme`.

Setting parameters:
<Filename> string

Example: See Example "Saving and recalling a configuration" on page 88.

Usage: Setting only

<subsystem>:SETTing:STORe
[:SOURce<hw>]:BB:DME:SETTing:STORe <Filename>
[:SOURce<hw>][:BB]:ILS:SETTing:STORe <Filename>
[:SOURce<hw>]:BB:VOR:SETTing:STORe <Filename>

Saves the current settings into the selected file; the file extension (`*.ils/*.vor/*.dme`) is assigned automatically.

Setting parameters:
<Filename> string

Example: See Example "Saving and recalling a configuration" on page 88.

Usage: Setting only

<subsystem>:STATe
[:SOURce<hw>]:BB:DME:STATe <State>
[:SOURce<hw>][:BB]:ILS:STATe <State>
[:SOURce<hw>]:BB:VOR:STATe <State>

Activates/deactivates the avionic standard.

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

Example: See Example "Configure and generate a VOR signal" on page 89.

7.3 ILS commands

The `SOURce:BB:ILS` subsystem contains all commands for configuring an ILS signal.

For a description of the trigger and clock commands, see the following sections:

- Section 7.6, "Trigger commands", on page 152
- Section 7.8, "Clock commands", on page 159

The following commands specific to the R&S SMBVB-K151 option are described here:

7.3.1 General settings

[:SOURce<hw>][:BB]:ILS:TYPE <Type>

Selects the ILS modulation type.

Parameters:
<Type> GS | LOCalize | GSLope | MBEacon
*RST: GS

Example: See Example "Configure and generate an ILS glide slope signal" on page 89.

Manual operation: See "ILS Component" on page 20

7.3.2 ILS glide slope commands

[:SOURce<hw>][:BB]:ILS[:GS|GSLope]:DDM:COUPling <Coupling>

Selects if the DDM value is fixed or is changed with a change of sum of modulation depths (SDM, see `[:SOURce<hw>][:BB]:ILS[:GS|GSLope]:SDM` on page 105).

Parameters:

<Coupling> FIXed | SDM

*RST: FIXed

Example: See Example "Configure and generate an ILS glide slope signal" on page 89.

Manual operation: See "DDM - SDM Coupling" on page 26

[:SOURce<hw>][:BB]:ILS[:GS|GSLope]:DDM:CURRent <Current>

Sets the DDM value alternatively as a current by means of the ILS indicating instrument. The instrument current is calculated according to:

DDM Current µA = DDM Depth [%] × 857,125 µA

A variation of the instrument current automatically leads to a variation of the DDM value and the DDM value in dB.

Parameters:

<Current> float

Range: -8.57125E-4 to 8.57125E-4
Increment: 1E-7
*RST: 0

Example: See Example "Configure and generate an ILS glide slope signal" on page 89.

Manual operation: See "DDM Current" on page 25

[:SOURce<hw>][:BB]:ILS[:GS|GSLope]:DDM:DIRection <Direction>

Sets the simulation mode for the ILS glide slope modulation signal. A change of the setting automatically changes the sign of the DDM value.

Parameters:

<Direction> UP | DOWN

UP
The 150 Hz modulation signal is predominant, the DDM value is negative (the airplane is too low, it must climb).

DOWN
The 90 Hz modulation signal is predominant, the DDM value is positive (the airplane is too high, it must descend).

*RST: UP

Example: See Example "Configure and generate an ILS glide slope signal" on page 89.

Manual operation: See "Fly Mode" on page 25

[:SOURce<hw>][:BB]:ILS[:GS|GSLope]:DDM:LOGarithmic <Logarithmic>

Sets the depth of modulation value for ILS glide slope modulation in dB.

See also `[:SOURce<hw>][:BB]:ILS[:GS|GSLope]:DDM[:DEPTh]` on page 102.

Parameters:

<Logarithmic> float

Range: -999.9 to 999.9
Increment: 1E-4
*RST: 0

Example: See Example "Configure and generate an ILS glide slope signal" on page 89.

Manual operation: See "DDM Logarithmic" on page 25

[:SOURce<hw>][:BB]:ILS[:GS|GSLope]:DDM:PCT <Pct>

Sets the difference in depth of modulation between the signal of the upper lobe (90 Hz) and the lower lobe (150 Hz). The maximum value equals the sum of the modulation depths of the 90 Hz and the 150 Hz tone.

See also `[:SOURce<hw>][:BB]:ILS[:GS|GSLope]:DDM[:DEPTh]` on page 102.

Parameters:

<Pct> float

Range: -80.0 to 80.0
Increment: 0.01
*RST: 0

Example: See Example "Configure and generate an ILS glide slope signal" on page 89.

Manual operation: See "DDM Percent" on page 26

[:SOURce<hw>][:BB]:ILS[:GS|GSLope]:DDM:POLarity <Polarity>

Sets the polarity for DDM calculation (see `[:SOURce<hw>][:BB]:ILS[:GS|GSLope]:DDM[:DEPTh]` on page 102).

The DDM depth calculation depends on the selected polarity:

- Polarity 90 Hz - 150 Hz (default setting):
  DDM = [AM (90 Hz) - AM (150 Hz)] / 100%
- Polarity 150 Hz - 90 Hz:
  DDM = [AM (150 Hz) - AM (90 Hz)] / 100%

Parameters:

<Polarity> P90_150 | P150_90

*RST: P90_150

Example: See Example "Configure and generate an ILS glide slope signal" on page 89.

Manual operation: See "DDM Polarity" on page 23

[:SOURce<hw>][:BB]:ILS[:GS|GSLope]:DDM:STEP <DdmStep>

Sets the variation of the difference in depth of modulation via the rotary knob.

Parameters:

<DdmStep> DECimal | PREDefined

*RST: DECimal

Example: See Example "Configure and generate an ILS glide slope signal" on page 89.

Manual operation: See "DDM Step" on page 25

[:SOURce<hw>][:BB]:ILS[:GS|GSLope]:DDM[:DEPTh] <Depth>

Sets the difference in depth of modulation between the signal of the upper/left lobe (90 Hz) and the lower/right lobe (150 Hz). The maximum value equals the sum of the modulation depths of the 90 Hz and the 150 Hz tone. The following is true:

```
ILS:GS|GSL:DDM:DEPTh = (AM(90Hz) - AM(150Hz))/100%
```

A variation of the DDM value automatically leads to a variation of the DDM value in dB and the value of the instrument current.

Parameters:

<Depth> float

Range: -0.8 to 0.8
Increment: 1E-4
*RST: 0

Example: See Example "Configure and generate an ILS glide slope signal" on page 89.

Manual operation: See "DDM Depth" on page 25

[:SOURce<hw>][:BB]:ILS[:GS|GSLope]:FREQuency <CarrierFreq>

Sets the carrier frequency of the signal.

Parameters:

<CarrierFreq> float

Range: 100E3 to 6E9
Increment: 0.01
*RST: 334.7E6

Example: See Example "Configure and generate an ILS glide slope signal" on page 89.

Manual operation: See "Carrier Frequency" on page 21

[:SOURce<hw>][:BB]:ILS[:GS|GSLope]:FREQuency:MODE <Mode>

Sets the mode for the carrier frequency of the signal.

Parameters:

<Mode> DECimal | USER | ICAO

DECimal|USER
Activates user-defined variation of the carrier frequency.

ICAO
Activates variation in predefined steps according to standard ILS transmitting frequencies (see Table 3-1).

*RST: USER

Example: See Example "Configure and generate an ILS glide slope signal" on page 89.

Manual operation: See "Carrier Frequency Mode" on page 21

[:SOURce<hw>][:BB]:ILS[:GS|GSLope]:FREQuency:SYNChronize[:STATe] <Mode>

Activates synchronization of the ILS glide slope ICAO channel with the ILS localizer ICAO channel.

The ILS glide slope/localizer frequency of the ICAO channel (Table 3-1) is set automatically.

Parameters:

<Mode> 0 | 1 | OFF | ON

*RST: 0

Example: See Example "Configure and generate an ILS glide slope signal" on page 89.

Manual operation: See "Sync with Glide Slope/ Sync with Localizer" on page 22

[:SOURce<hw>][:BB]:ILS[:GS|GSLope]:ICAO:CHANnel <Channel>

Sets the ICAO channel and the corresponding transmitting frequency.

If avionic standard modulation is activated and you change the "RF Frequency", the frequency value of the closest ICAO channel is applied automatically. The "ICAO Channel" is also updated.

The ICAO channel settings for ILS glide slope/localizer components are coupled. For an overview of the ILS ICAO channel frequencies, see Table 3-1.

Parameters:

<Channel> CH18X | CH18Y | CH20X | CH20Y | CH22X | CH22Y | CH24X | CH24Y | CH26X | CH26Y | CH28X | CH28Y | CH30X | CH30Y | CH32X | CH32Y | CH34X | CH34Y | CH36X | CH36Y | CH38X | CH38Y | CH40X | CH40Y | CH42X | CH42Y | CH44X | CH44Y | CH46X | CH46Y | CH48X | CH48Y | CH50X | CH50Y | CH52X | CH52Y | CH54X | CH54Y | CH56X | CH56Y

*RST: CH18X

Example: See Example "Configure and generate an ILS glide slope signal" on page 89.

Manual operation: See "ICAO Channel" on page 22

[:SOURce<hw>][:BB]:ILS[:GS|GSLope]:LLOBe[:FREQuency] <Frequency>

Sets the modulation frequency of the antenna lobe arranged at the bottom viewed from the air plane for the ILS glide slope modulation signal.

Parameters:

<Frequency> float

Range: 100 to 200
Increment: 0.05
*RST: 150

Example: See Example "Configure and generate an ILS glide slope signal" on page 89.

Manual operation: See "Down Frequency" on page 23

[:SOURce<hw>][:BB]:ILS[:GS|GSLope]:MODE <Mode>

Sets the operating mode for the ILS glide slope modulation signal.

Parameters:

<Mode> NORM | ULOBe | LLOBe

NORM
ILS glide slope modulation is active.

ULOBe
Amplitude modulation of the output signal with the upper lobe (90Hz) signal component of the ILS glide slope signal is active.

LLOBe
Amplitude modulation of the output signal with the lower lobe (150Hz) signal component of the ILS glide slope signal is active.

*RST: NORM

Example: See Example "Configure and generate an ILS glide slope signal" on page 89.

Manual operation: See "Operating Mode" on page 23

[:SOURce<hw>][:BB]:ILS[:GS|GSLope]:PHASe <Phase>

Sets the phase between the modulation signals of the upper and lower antenna lobe of the ILS glide slope signal.

Zero crossing of the lower lobe (150 Hz) signal serves as a reference. The angle refers to the period of the signal of the right antenna lobe.

Parameters:

<Phase> float

Range: -60 to 120
Increment: 0.01
*RST: 0.0

Example: See Example "Configure and generate an ILS glide slope signal" on page 89.

Manual operation: See "Up/Down Phase" on page 24

[:SOURce<hw>][:BB]:ILS[:GS|GSLope]:SDM <Sdm>

Sets the arithmetic sum of the modulation depths of the upper lobe (90 Hz) and lower lobe (150 Hz) for the ILS glide slope signal contents.

The RMS modulation depth of the sum signal depends on the phase setting of both modulation tones.

Parameters:

<Sdm> float

Range: 0 to 100
Increment: 0.1
*RST: 80

Example: See Example "Configure and generate an ILS glide slope signal" on page 89.

Manual operation: See "Sum of Depth" on page 24

[:SOURce<hw>][:BB]:ILS[:GS|GSLope]:ULOBe[:FREQuency] <Frequency>

Sets the modulation frequency of the antenna lobe arranged at the top viewed from the air plane for the ILS glide slope modulation signal.

Parameters:

<Frequency> float

Range: 60 to 120
Increment: 0.03
*RST: 90

Example: See Example "Configure and generate an ILS glide slope signal" on page 89.

Manual operation: See "Up Frequency" on page 23

7.3.3 ILS localizer commands

[:SOURce<hw>][:BB:ILS]:LOCalizer:COMid:CODE <Code>

Sets the coding of the COM/ID signal by the international short name of the airport (e.g. MUC for the Munich airport).

The COM/ID tone is sent according to the selected code, see Section A, "Morse code settings", on page 160.

If no coding is set, the COM/ID tone is sent uncoded (key down).

Parameters:
<Code> string

Example: See Example "Configure and generate an ILS localizer signal" on page 90.

Manual operation: See "Code" on page 33

[:SOURce<hw>][:BB]:ILS:LOCalizer:COMid:DASH <Dash>

Sets the length of a Morse code dash.

Parameters:
<Dash> float

Range: 0.05 to 1
Increment: 1E-4
*RST: 0.3

Example: See Example "Configure and generate an ILS localizer signal" on page 90.

Manual operation: See "Dash Length" on page 34

[:SOURce<hw>][:BB]:ILS:LOCalizer:COMid:DEPTh <Depth>

Sets the AM modulation depth of the COM/ID signal.

Parameters:
<Depth> float

Range: 0 to 100
Increment: 0.1
*RST: 10

Example: See Example "Configure and generate an ILS localizer signal" on page 90.

Manual operation: See "Depth" on page 34

[:SOURce<hw>][:BB]:ILS:LOCalizer:COMid:DOT <Dot>

Sets the length of a Morse code dot.

Parameters:

<Dot> float

Range: 0.05 to 1
Increment: 1E-4
*RST: 0.1

Example: See Example "Configure and generate an ILS localizer signal" on page 90.

Manual operation: See "Dot Length" on page 34

[:SOURce<hw>][:BB]:ILS:LOCalizer:COMid:FREQuency <Frequency>

Sets the frequency of the COM/ID signal.

Parameters:

<Frequency> float

Range: 0.1 to 20E3
Increment: 0.01
*RST: 1020

Example: See Example "Configure and generate an ILS localizer signal" on page 90.

Manual operation: See "Frequency" on page 33

[:SOURce<hw>][:BB]:ILS:LOCalizer:COMid:LETTer <Letter>

Sets the length of a Morse code letter space.

Parameters:

<Letter> float

Range: 0.05 to 1
Increment: 1E-4
*RST: 0.3

Example: See Example "Configure and generate an ILS localizer signal" on page 90.

Manual operation: See "Letter Space" on page 34

[:SOURce<hw>][:BB]:ILS:LOCalizer:COMid:PERiod <Period>

Sets the period of the COM/ID signal.

Parameters:

<Period> float

Range: 0 to 120
Increment: 1E-3
*RST: 9

Example: See Example "Configure and generate an ILS localizer signal" on page 90.

Manual operation: See "Period" on page 34

[:SOURce<hw>][:BB]:ILS:LOCalizer:COMid:SYMBol <Symbol>

Sets the length of the Morse code symbol space.

Parameters:

<Symbol> float

Range: 0.05 to 1
Increment: 1E-4
*RST: 0.1

Example: See Example "Configure and generate an ILS localizer signal" on page 90.

Manual operation: See "Symbol Space" on page 34

[:SOURce<hw>][:BB]:ILS:LOCalizer:COMid:TSCHema <TSchema>

Sets the time schema of the Morse code for the COM/ID signal.

Parameters:

<TSchema> STD | USER

STD
Activates the standard time schema of the Morse code.
The set `dot length` determines the `dash length`, which is 3 times the dot length.

USER
Activates the user-defined time schema of the Morse code.
Dot and dash length, as well as `symbol` and `letter space` can be set separately.

*RST: STD

Example: See Example "Configure and generate an ILS localizer signal" on page 90.

Manual operation: See "Time Schema" on page 34

[:SOURce<hw>][:BB]:ILS:LOCalizer:COMid[:STATe] <State>

Enables/disables the COM/ID signal.

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

Example: See Example "Configure and generate an ILS localizer signal" on page 90.

Manual operation: See "COM/ID State" on page 33

[:SOURce<hw>][:BB]:ILS:LOCalizer:DDM:COUPling <Coupling>

Selects if the DDM value is fixed or is changed with a change of sum of modulation depths (SDM, see `[:SOURce<hw>][:BB]:ILS:LOCalizer:SDM` on page 115).

Parameters:
<Coupling> FIXed | SDM
*RST: FIXed

Example: See Example "Configure and generate an ILS localizer signal" on page 90.

Manual operation: See "DDM - SDM Coupling" on page 31

[:SOURce<hw>][:BB]:ILS:LOCalizer:DDM:CURRent <Current>

Sets the DDM value alternatively as a current by means of the ILS indicating instrument. The instrument current is calculated according to:

DDM µA = DDM × 857,1 µA

A variation of the instrument current automatically leads to a variation of the DDM value and the DDM value in dB.

Parameters:
<Current> float
Range: -9.6775E-4 to 9.6775E-4
Increment: 1E-7
*RST: 0

Example: See Example "Configure and generate an ILS localizer signal" on page 90.

Manual operation: See "DDM Current" on page 31

[:SOURce<hw>][:BB]:ILS:LOCalizer:DDM:DIRection <Direction>

Sets the simulation mode for the ILS-LOC modulation signal. A change of the setting automatically changes the sign of the DDM value.

Parameters:
<Direction> LEFT | RIGHt

LEFT
The 150 Hz modulation signal is predominant, the DDM value is negative (the airplane is too far to the right, it must turn to the left).

RIGHT
The 90 Hz modulation signal is predominant, the DDM value is positive (the airplane is too far to the left, it must turn to the right).

*RST: LEFT

Example: See Example "Configure and generate an ILS localizer signal" on page 90.

Manual operation: See "Fly Mode" on page 30

[:SOURce<hw>][:BB]:ILS:LOCalizer:DDM:LOGarithmic <Logarithmic>

Sets the modulation depth in dB for the ILS localizer modulation signal.

See also `[:SOURce<hw>][:BB]:ILS:LOCalizer:DDM[:DEPTh]` on page 112.

Parameters:

<Logarithmic> float

Range: -999.9 to 999.9
Increment: 1E-4
*RST: 0

Example: See Example "Configure and generate an ILS localizer signal" on page 90.

Manual operation: See "DDM Logarithmic" on page 32

[:SOURce<hw>][:BB]:ILS:LOCalizer:DDM:PCT <Pct>

Sets the difference in depth of modulation between the signal of the left lobe (90 Hz) and the right lobe (150 Hz). The maximum value equals the sum of the modulation depths of the 90 Hz and the 150 Hz tone.

See also `[:SOURce<hw>][:BB]:ILS:LOCalizer:DDM[:DEPTh]` on page 112.

Parameters:

<Pct> float

Range: -80.0 to 80.0
Increment: 0.01
*RST: 0

Example: See Example "Configure and generate an ILS localizer signal" on page 90.

Manual operation: See "DDM Percent" on page 32

[:SOURce<hw>][:BB]:ILS:LOCalizer:DDM:POLarity <Polarity>

Sets the polarity for DDM calculation (see `[:SOURce<hw>][:BB]:ILS:LOCalizer:DDM[:DEPTh]`).

The DDM depth calculation depends on the selected polarity:

- Polarity 90 Hz - 150 Hz (default setting):
  DDM = [AM (90 Hz) - AM (150 Hz)] / 100%
- Polarity 150 Hz - 90 Hz:
  DDM = [AM (150 Hz) - AM (90 Hz)] / 100%

Parameters:

<Polarity> P90_150 | P150_90

*RST: P90_150

Example: See Example "Configure and generate an ILS localizer signal" on page 90.

Manual operation: See "DDM polarity" on page 29

[:SOURce<hw>][:BB]:ILS:LOCalizer:DDM[:DEPTh] <Depth>

Sets the difference in depth of modulation between the signal of the upper/left lobe (90 Hz) and the lower/right lobe (150 Hz). The maximum value equals the sum of the modulation depths of the 90 Hz and the 150 Hz tone.The following is true:

```
ILS:LOC:DDM:DEPTh = (AM(90Hz) - AM(150Hz))/100%
```

A variation of the DDM value automatically leads to a variation of the DDM value in dB and the value of the instrument current.

Parameters:

<Depth> float

Range: -0.4 to 0.4
Increment: 1E-4
*RST: 0

Example: See Example "Configure and generate an ILS localizer signal" on page 90.

Manual operation: See "DDM Depth" on page 31

[:SOURce<hw>][:BB]:ILS:LOCalizer:DDM:STEP <DdmStep>

Sets the variation step of the DDM values.

Parameters:

<DdmStep> DECimal | PREDefined

*RST: DECimal

Example: See Example "Configure and generate an ILS localizer signal" on page 90.

Manual operation: See "DDM Step" on page 31

[:SOURce<hw>][:BB]:ILS:LOCalizer:FREQuency <CarrierFreq>

Sets the carrier frequency of the signal.

Parameters:

<CarrierFreq> float

Range: 100E3 to 6E9
Increment: 0.01
*RST: 108.1E6

Example: See Example "Configure and generate an ILS localizer signal" on page 90.

Manual operation: See "Carrier Frequency" on page 27

[:SOURce<hw>][:BB]:ILS:LOCalizer:FREQuency:MODE <IlsLocFreqMode>

Sets the mode for the carrier frequency of the signal.

Parameters:

<Mode> DECimal | ICAO

DECimal
Activates user-defined variation of the carrier frequency.

ICAO
Activates variation in predefined steps according to standard ILS transmitting frequencies (see Table 3-1).

*RST: DECimal

Example: See Example "Configure and generate an ILS localizer signal" on page 90.

Manual operation: See "Carrier Frequency Mode" on page 27

[:SOURce<hw>][:BB]:ILS:LOCalizer:FREQuency:SYNChronize[:STATe] <Mode>

Activates synchronization of the ILS localizer ICAO channel with the ILS glide slope ICAO channel.

The ILS glide slope/localizer frequency of the ICAO channel (Table 3-1) is set automatically.

Parameters:

<Mode> 0 | 1 | OFF | ON

*RST: 0

Example: See Example "Configure and generate an ILS localizer signal" on page 90.

Manual operation: See "Sync with Glide Slope/ Sync with Localizer" on page 22

[:SOURce<hw>][:BB]:ILS:LOCalizer:ICAO:CHANnel <SelIcaoChan>

Sets the ICAO channel and the corresponding transmitting frequency.

If avionic standard modulation is activated and you change the "RF Frequency", the frequency value of the closest ICAO channel is applied automatically. The "ICAO Channel" is also updated.

The ICAO channel settings for ILS glide slope/localizer components are coupled. For an overview of the ILS ICAO channel frequencies, see Table 3-1.

Parameters:

<Channel> CH18X | CH18Y | CH20X | CH20Y | CH22X | CH22Y | CH24X | CH24Y | CH26X | CH26Y | CH28X | CH28Y | CH30X | CH30Y | CH32X | CH32Y | CH34X | CH34Y | CH36X | CH36Y | CH38X | CH38Y | CH40X | CH40Y | CH42X | CH42Y | CH44X | CH44Y | CH46X | CH46Y | CH48X | CH48Y | CH50X | CH50Y | CH52X | CH52Y | CH54X | CH54Y | CH56X | CH56Y

*RST: CH18X

Example: See Example "Configure and generate an ILS localizer signal" on page 90.

Manual operation: See "ICAO Channel" on page 27

[:SOURce<hw>][:BB]:ILS:LOCalizer:LLOBe[:FREQuency] <Frequency>

Sets the modulation frequency of the antenna lobe arranged at the left viewed from the air plane for the ILS localizer modulation signal.

Parameters:

<Frequency> float

Range: 60 to 120
Increment: 0.03
*RST: 90

Example: See Example "Configure and generate an ILS localizer signal" on page 90.

Manual operation: See "Left Frequency" on page 29

[:SOURce<hw>][:BB]:ILS:LOCalizer:MODE <Mode>

Sets the operating mode for the ILS localizer modulation signal.

Parameters:

<Mode> NORM | LLOBe | RLOBe

NORM
ILS localizer modulation is active.

LLOBe
Amplitude modulation of the output signal with the left lobe (90Hz) signal component of the ILS localizer signal is active.

RLOBe
Amplitude modulation of the output signal with the right lobe (150Hz) signal component of the ILS localizer signal is active.

*RST: NORM

Example: See Example "Configure and generate an ILS localizer signal" on page 90.

Manual operation: See "Operating Mode" on page 29

[:SOURce<hw>][:BB]:ILS:LOCalizer:PHASe <Phase>

Sets the phase between the modulation signals of the left and right antenna lobe of the ILS localizer signal.

The zero crossing of the right lobe (150 Hz) signal serves as a reference. The angle refers to the period of the signal of the right antenna lobe.

Parameters:

<Phase> float

Range: -60 to 120
Increment: 0.01
*RST: 0

Example: See Example "Configure and generate an ILS localizer signal" on page 90.

Manual operation: See "Left/Right Phase" on page 30

[:SOURce<hw>][:BB]:ILS:LOCalizer:RLOBe[:FREQuency] <Frequency>

Sets the modulation frequency of the antenna lobe arranged at the right viewed from the air plane for the ILS localizer modulation signal.

Parameters:

<Frequency> float

Range: 100 to 200
Increment: 0.05
*RST: 150

Example: See Example "Configure and generate an ILS localizer signal" on page 90.

Manual operation: See "Right Frequency" on page 29

[:SOURce<hw>][:BB]:ILS:LOCalizer:SDM <Sdm>

Sets the arithmetic sum of the modulation depths of the left lobe (90 Hz) and right lobe (150 Hz) for the ILS localizer signal contents.

The RMS modulation depth of the sum signal depends on the phase setting of both modulation tones.

Parameters:

<Sdm> float

Range: 0 to 100
Increment: 0.1
*RST: 40

Example: See Example "Configure and generate an ILS localizer signal" on page 90.

Manual operation: See "Sum of Depth" on page 31

7.3.4 ILS marker beacons commands

[:SOURce<hw>][:BB:ILS]:MBEacon:FREQuency <CarrierFreq>

Sets the carrier frequency for the ILS marker beacon signal.

Parameters:

<CarrierFreq> float

Range: 100E3 to 6E9
Increment: 0.01
*RST: 75E6

Example: See Example "Configure and generate an ILS marker beacons signal" on page 91.

Manual operation: See "Carrier Frequency" on page 36

[:SOURce<hw>][:BB:ILS]:MBEacon:FREQuency:MODE <Mode>

Sets the mode for the carrier frequency of the signal.

Parameters:

<Mode> USER | PREDefined

*RST: USER

Example: See Example "Configure and generate an ILS marker beacons signal" on page 91.

Manual operation: See "Carrier Frequency Mode" on page 35

[:SOURce<hw>][:BB:ILS]:MBEacon:MARKer:FREQuency <Frequency>

Sets the modulation frequency of the marker signal for the ILS marker beacon modulation signal.

Parameters:

<Frequency> 400 | 1300 | 3000

*RST: 400
Default unit: Hz

Example: See Example "Configure and generate an ILS marker beacons signal" on page 91.

Manual operation: See "Marker Frequency" on page 36

[:SOURce<hw>][:BB:ILS]:MBEacon[:MARKer]:DEPTh <Depth>

Sets the modulation depth of the marker signal for the ILS marker beacon signal.

Parameters:

<Depth> float

Range: 0 to 100
Increment: 0.1
*RST: 95

Example: See Example "Configure and generate an ILS marker beacons signal" on page 91.

Manual operation: See "Marker Depth" on page 36

[:SOURce<hw>][:BB:ILS]:MBEacon[:MARKer]:PULSed <Pulsed>

Activates the modulation of a pulsed marker signal (morse coding).

Parameters:

<Pulsed> 1 | ON | 0 | OFF

*RST: 0

Example: See Example "Configure and generate an ILS marker beacons signal" on page 91.

Manual operation: See "Pulsed Marker" on page 36

7.4 VOR commands

The `SOURce:BB:VOR` subsystem contains all commands for configuring a VOR signal.

For a description of the trigger and clock commands, see the following sections:

- Section 7.6, "Trigger commands", on page 152
- Section 7.8, "Clock commands", on page 159

The following commands specific to the R&S SMBVB-K152 option are described here:

7.4.1 VOR general commands

[:SOURce<hw>][:BB]:VOR:MODE <Mode>

Sets the operating mode for the VOR modulation signal.

Parameters:

<Mode> NORM | VAR | SUBCarrier | FMSubcarrier

NORM
VOR modulation is active.

VAR
Amplitude modulation of the output signal with the variable signal component (30Hz signal content) of the VOR signal.
The modulation depth of the 30 Hz signal can be set with `[:SOURce<hw>][:BB]:VOR:VAR[:DEPTh]`.

SUBCarrier
Amplitude modulation of the output signal with the unmodulated FM carrier (9960Hz) of the VOR signal.
The modulation depth of the 30 Hz signal can be set with `[:SOURce<hw>][:BB]:VOR:SUBCarrier:DEPTh`.

FMSubcarrier
Amplitude modulation of the output signal with the frequency modulated FM carrier (9960Hz) of the VOR signal.
The modulation depth of the 30 Hz signal can be set with `[:SOURce<hw>][:BB]:VOR:SUBCarrier:DEPTh`.
The frequency deviation can be set with `[:SOURce<hw>][:BB]:VOR:REFerence[:DEViation]`.

*RST: NORM

Example: See Example "Configure and generate a VOR signal" on page 89.

Manual operation: See "Mode" on page 43

7.4.2 VOR signal commands

[:SOURce<hw>]:BB:VOR:FREQuency <CarrierFreq>

Sets the carrier frequency of the signal.

Parameters:

<CarrierFreq> float

Range: 100E3 to 6E9
Increment: 0.01
*RST: 108E6

Example: See Example "Configure and generate a VOR signal" on page 89.

Manual operation: See "Carrier Frequency" on page 42

[:SOURce<hw>]:BB:VOR:FREQuency:MODE <Mode>

Sets the mode for the carrier frequency of the signal.

Parameters:

<Mode> DECimal | ICAO

DECimal
Activates user-defined variation of the carrier frequency.

ICAO
Activates variation in predefined steps according to standard VOR transmitting frequencies (see Table 4-1).

*RST: DECimal

Example: See Example "Configure and generate a VOR signal" on page 89.

Manual operation: See "Carrier Frequency Mode" on page 42

[:SOURce<hw>][:BB]:VOR:ICAO:CHANnel <Channel>

Sets the ICAO channel and the corresponding transmitting frequency.

If avionic standard modulation is activated and you change the "RF Frequency", the frequency value of the closest ICAO channel is applied automatically. The "ICAO Channel" is also updated.

The carrier frequency is set automatically to the value of the ICAO channel. For an overview of the VOR ICAO channel frequencies, see Table 4-1.

Parameters:

<Channel> CH17X | CH17Y | CH19X | CH19Y | CH21X | CH21Y | CH23X | CH23Y | CH25X | CH25Y | CH27X | CH27Y | CH29X | CH29Y | CH31X | CH31Y | CH33X | CH33Y | CH35X | CH35Y | CH37X | CH37Y | CH39X | CH39Y | CH41X | CH41Y | CH43X | CH43Y | CH45X | CH45Y | CH47X | CH47Y | CH49X | CH49Y | CH51X | CH51Y | CH53X | CH53Y | CH55X | CH55Y | CH57X | CH57Y | CH58X | CH58Y | CH59X | CH59Y | CH70X | CH70Y | CH71X | CH71Y | CH72X | CH72Y | CH73X | CH73Y | CH74X | CH74Y | CH75X | CH75Y | CH76X | CH76Y | CH77X | CH77Y | CH78X | CH78Y | CH79X | CH79Y | CH80X | CH80Y | CH81X | CH81Y | CH82X | CH82Y | CH83X | CH83Y | CH84X | CH84Y | CH85X | CH85Y | CH86X | CH86Y | CH87X | CH87Y | CH88X | CH88Y | CH89X | CH89Y | CH90X | CH90Y | CH91X | CH91Y | CH92X | CH92Y | CH93X | CH93Y | CH94X | CH94Y | CH95X | CH95Y | CH96X | CH96Y | CH97X | CH97Y | CH98X | CH98Y | CH99X | CH99Y | CH100X | CH100Y | CH101X | CH101Y | CH102X | CH102Y | CH103X | CH103Y | CH104X | CH104Y | CH105X | CH105Y | CH106X | CH106Y | CH107X | CH107Y | CH108X | CH108Y | CH109X | CH109Y | CH110X | CH110Y | CH111X | CH111Y | CH112X | CH112Y | CH113X | CH113Y | CH114X | CH114Y | CH115X | CH115Y | CH116X | CH116Y | CH117X | CH117Y | CH118X | CH118Y | CH119X | CH119Y | CH120X | CH120Y | CH121X | CH121Y | CH122X | CH122Y | CH123X | CH123Y | CH124X | CH124Y | CH125X | CH125Y | CH126X | CH126Y

*RST: CH17X

Example: See Example "Configure and generate a VOR signal" on page 89.

Manual operation: See "ICAO Channel" on page 42

[:SOURce<hw>][:BB]:VOR:REFerence[:DEViation] <Deviation>

Sets the frequency deviation of the reference signal on the FM carrier.

Parameters:

<Deviation> integer

Range: 0 to 960
*RST: 480
Default unit: Hz

Example: See Example "Configure and generate a VOR signal" on page 89.

Manual operation: See "REF Deviation" on page 44

[:SOURce<hw>][:BB]:VOR:SUBCarrier:DEPTh <Depth>

Sets the AM modulation depth of the FM carrier.

Parameters:

<Depth> float

Range: 0 to 100
Increment: 0.1
*RST: 30

Example: See Example "Configure and generate a VOR signal" on page 89.

Manual operation: See "Subcarrier Depth" on page 44

[:SOURce<hw>][:BB]:VOR:SUBCarrier[:FREQuency] <Frequency>

Sets the frequency of the FM carrier.

Parameters:

<Frequency> float

Range: 5E3 to 15E3
Increment: 0.01
*RST: 9.96E3

Example: See Example "Configure and generate a VOR signal" on page 89.

Manual operation: See "Subcarrier Frequency" on page 44

[:SOURce<hw>][:BB]:VOR:VAR:FREQuency <Frequency>

Sets the frequency of the variable and the reference signal. As the two signals must have the same frequency, the setting is valid for both signals.

Parameters:

<Frequency> float

Range: 10 to 60
Increment: 0.01
*RST: 30

Example: See Example "Configure and generate a VOR signal" on page 89.

Manual operation: See "VAR/REF Frequency" on page 43

[:SOURce<hw>][:BB]:VOR:VAR[:DEPTh] <Depth>

Sets the AM modulation depth of the 30 Hz variable signal.

Parameters:

<Depth> float

Range: 0 to 100
Increment: 0.1
*RST: 30

Example: See Example "Configure and generate a VOR signal" on page 89.

Manual operation: See "VAR Depth" on page 44

7.4.3 VOR position commands

[:SOURce<hw>][:BB]:VOR[:BANGle] <BAngle>

Sets the bearing angle between the VAR signal and the reference signal.

The orientation of the angle can be set with `[:SOURce<hw>][:BB]:VOR[:BANGle]:DIRection`.

Parameters:

<BAngle> float

Range: 0 to 360
Increment: 0.01
*RST: 0

Example: See Example "Configure and generate a VOR signal" on page 89.

Manual operation: See "Bearing Angle" on page 45

[:SOURce<hw>][:BB]:VOR[:BANGle]:DIRection <Direction>

Sets the reference position of the phase information.

Parameters:

<Direction> FROM | TO

FROM
The bearing angle is measured between the geographic north and the connection line from beacon to airplane.

TO
The bearing angle is measured between the geographic north and the connection line from airplane to beacon.

*RST: FROM

Example: See Example "Configure and generate a VOR signal" on page 89.

Manual operation: See "Direction" on page 45

7.4.4 VOR COM/ID commands

[:SOURce<hw>][:BB]:VOR:COMid:CODE <Code>

Sets the coding of the COM/ID signal by the international short name of the airport (e.g. MUC for the Munich airport).

The COM/ID tone is sent according to the selected code, see Section A, "Morse code settings", on page 160.

If no coding is set, the COM/ID tone is sent uncoded (key down).

Parameters:
<Code> string

Example: See Example "Configure and generate a VOR signal" on page 89.

Manual operation: See "Code" on page 46

[:SOURce<hw>][:BB]:VOR:COMid:DASH <Dash>

Sets the length of a Morse code dash.

Parameters:
<Dash> float

Range: 0.05 to 1
Increment: 1E-4
*RST: 0.3
Default unit: s

Example: See Example "Configure and generate a VOR signal" on page 89.

Manual operation: See "Dash Length" on page 47

[:SOURce<hw>][:BB]:VOR:COMid:DEPTh <Depth>

Sets the AM modulation depth of the COM/ID signal.

Parameters:

<Depth> float

Range: 0 to 100
Increment: 0.1
*RST: 10

Example: See Example "Configure and generate a VOR signal" on page 89.

Manual operation: See "Depth" on page 46

[:SOURce<hw>][:BB]:VOR:COMid:DOT <Dot>

Sets the length of a Morse code dot.

Parameters:

<Dot> float

Range: 0.05 to 1
Increment: 1E-4
*RST: 0.1
Default unit: s

Example: See Example "Configure and generate a VOR signal" on page 89.

Manual operation: See "Dot Length" on page 46

[:SOURce<hw>][:BB]:VOR:COMid:FREQuency <Frequency>

Sets the frequency of the COM/ID signal.

Parameters:

<Frequency> float

Range: 0.1 to 20E3
Increment: 0.01
*RST: 1020

Example: See Example "Configure and generate a VOR signal" on page 89.

Manual operation: See "Frequency" on page 46

[:SOURce<hw>][:BB]:VOR:COMid:LETTer <Letter>

Sets the length of a Morse code letter space.

Parameters:

<Letter> float

Range: 0.05 to 1
Increment: 1E-4
*RST: 0.3
Default unit: s

Example: See Example "Configure and generate a VOR signal" on page 89.

Manual operation: See "Letter Space" on page 47

[:SOURce<hw>][:BB]:VOR:COMid:PERiod <Period>

Sets the period of the COM/ID signal.

Parameters:

<Period> float

Range: 0 to 120
Increment: 1E-3
*RST: 9
Default unit: s

Example: See Example "Configure and generate a VOR signal" on page 89.

Manual operation: See "Period" on page 46

[:SOURce<hw>][:BB]:VOR:COMid:SYMBol <Symbol>

Sets the length of the Morse code symbol space.

Parameters:

<Symbol> float

Range: 0.05 to 1
Increment: 1E-4
*RST: 0.1
Default unit: s

Example: See Example "Configure and generate a VOR signal" on page 89.

Manual operation: See "Symbol Space" on page 47

[:SOURce<hw>][:BB]:VOR:COMid:TSCHema <Tschema>

Sets the time schema of the Morse code for the COM/ID signal.

Parameters:

<Tschema> STD | USER

STD
Activates the standard time schema of the Morse code.
The set `dot length` determines the `dash length`, which is 3 times the dot length.

USER
Activates the user-defined time schema of the Morse code.
Dot and dash length, as well as `symbol` and `letter space` can be set separately.

*RST: STD

Example: See Example "Configure and generate a VOR signal" on page 89.

Manual operation: See "Time Schema" on page 46

[:SOURce<hw>][:BB]:VOR:COMid[:STATe] <State>

Enables/disables the COM/ID signal.

Parameters:

<State> 1 | ON | 0 | OFF

*RST: 0

Example: See Example "Configure and generate a VOR signal" on page 89.

Manual operation: See "COM/ID State" on page 46

7.5 DME commands

The `SOURce:BB:DME` subsystem contains all commands for configuring a DME signal.

For a description of the trigger, marker and clock commands, see the following sections:

- Section 7.6, "Trigger commands", on page 152
- Section 7.7, "DME marker commands", on page 158
- Section 7.8, "Clock commands", on page 159

The following commands specific to the R&S SMBVB-K153 option are described here:

7.5.1 DME general commands

[:SOURce<hw>][:BB]:DME:MODE <Mode>

Selects the mode of the DME modulation. The mode determines the signal type that is simulated. The exact timing of the signal for each mode is determined by the channel selected with `[:SOURce<hw>][:BB]:DME:CSUFfix`.

Parameters:

<Mode> INTerrogation | REPLy

INTerrogation
The interrogation signal of the airborne transmitter is simulated.

REPLy
The reply signal of the ground based transponder is simulated. The trigger is automatically set to external and the default trigger delay either to 50 us (channel X) or 56 us (channel Y) depending on the selected channel (`[:SOURce<hw>][:BB]:DME:CSUFfix`).
The interval between the pulse pairs can be set to a fixed value (repetition rate, `[:SOURce<hw>][:BB]:DME:RATE`) or to random generation (pulse squitter, `[:SOURce<hw>][:BB]:DME:SQUitter`).
The trigger signal is input via the Pulse Ext connector.

*RST: INTerrogation

Example: See Example "Configuring and generating a DME interrogation mode signal" on page 92.

Manual operation: See "DME Mode" on page 56

7.5.2 DME signal commands

[:SOURce<hw>][:BB]:DME:CSUFfix <CSuffix>

Sets the channel that is simulated. Standard compliant X and Y channels differ in the spacing between the two pulses of the pulse pair and the delay of the ground station.

Parameters:

<CSuffix> X | Y | ICAO

*RST: X

Example: See Example "Configuring and generating a DME interrogation mode signal" on page 92.

Manual operation: See "Channel Mode" on page 57

[:SOURce<hw>][:BB]:DME:EFFiciency <Efficiency>

Sets the relation between reply pulse pairs and received trigger signals, e.g. with a set efficiency of 50% only every second trigger event leads to the generation of a reply pulse pair.

Parameters:

<Efficiency> integer

Range: 0 to 100
*RST: 100

Example: See Example "Configuring and generating a DME reply mode signal" on page 93.

[:SOURce<hw>][:BB]:DME:EFFiciency:REPLies <NoOfReplies>

Sets the number of reply pulses. Use this number to specify absolute values of false or correct pulses during reply efficiency measurements.

Parameters:

<NoOfReplies> 10 | 50 | 100

10, 50 or 100 reply pulses

*RST: 100

Example: See Example "Configuring and generating a DME reply mode signal" on page 93.

Manual operation: See "Number of Replies for Efficiency Calculation" on page 58

[:SOURce<hw>][:BB]:DME:FREQuency <CarreierFreq>

Sets the carrier frequency of the signal.

Parameters:

<CarreierFreq> float

Range: 100E3 to 6E9
Increment: 0.01
*RST: 1025E6

Example: See Example "Configuring and generating a DME interrogation mode signal" on page 92.

Manual operation: See "Carrier Frequency" on page 57

[:SOURce<hw>][:BB]:DME:ICAO:CHANnel <Channel>

Sets the ICAO channel and the corresponding transmitting frequency.

If avionic standard modulation is activated and you change the "RF Frequency", the frequency value of the closest ICAO channel is applied automatically. The "ICAO Channel" is also updated.

The carrier frequency is set automatically to the value of the ICAO channel. For an overview of the DME ICAO channel frequencies, see Table 5-1.

Parameters:

<Channel> CH1X | CH1Y | CH2X | CH2Y | CH3X | CH3Y | CH4X | CH4Y | CH5X | CH5Y | CH6X | CH6Y | CH7X | CH7Y | CH8X | CH8Y | CH9X | CH9Y | CH10X | CH10Y | CH11X | CH11Y | CH12X | CH12Y | CH13X | CH13Y | CH14X | CH14Y | CH15X | CH15Y | CH16X | CH16Y | CH17X | CH17Y | CH18X | CH18Y | CH19X | CH19Y | CH20X | CH20Y | CH21X | CH21Y | CH22X | CH22Y | CH23X | CH23Y | CH24X | CH24Y | CH25X | CH25Y | CH26X | CH26Y | CH27X | CH27Y | CH28X | CH28Y | CH29X | CH29Y | CH30X | CH30Y | CH31X | CH31Y | CH32X | CH32Y | CH33X | CH33Y | CH34X | CH34Y | CH35X | CH35Y | CH36X | CH36Y | CH37X | CH37Y | CH38X | CH38Y | CH39X | CH39Y | CH40X | CH40Y | CH41X | CH41Y | CH42X | CH42Y | CH43X | CH43Y | CH44X | CH44Y | CH45X | CH45Y | CH46X | CH46Y | CH47X | CH47Y | CH48X | CH48Y | CH49X | CH49Y | CH50X | CH50Y | CH51X | CH51Y | CH52X | CH52Y | CH53X | CH53Y | CH54X | CH54Y | CH55X | CH55Y | CH56X | CH56Y | CH57X | CH57Y | CH58X | CH58Y | CH59X | CH59Y | CH60X | CH60Y | CH61X | CH61Y | CH62X | CH62Y | CH63X | CH63Y | CH64X | CH64Y | CH65X | CH65Y | CH66X | CH66Y | CH67X | CH67Y | CH68X | CH68Y | CH69X | CH69Y | CH70X | CH70Y | CH71X | CH71Y | CH72X | CH72Y | CH73X | CH73Y | CH74X | CH74Y | CH75X | CH75Y | CH76X | CH76Y | CH77X | CH77Y | CH78X | CH78Y | CH79X | CH79Y | CH80X | CH80Y | CH81X | CH81Y | CH82X | CH82Y | CH83X | CH83Y | CH84X | CH84Y | CH85X | CH85Y | CH86X | CH86Y | CH87X | CH87Y | CH88X | CH88Y | CH89X | CH89Y | CH90X | CH90Y | CH91X | CH91Y | CH92X | CH92Y | CH93X | CH93Y | CH94X | CH94Y | CH95X | CH95Y | CH96X | CH96Y | CH97X | CH97Y | CH98X | CH98Y | CH99X | CH99Y | CH100X | CH100Y | CH101X | CH101Y | CH102X | CH102Y | CH103X | CH103Y | CH104X | CH104Y | CH105X | CH105Y | CH106X | CH106Y | CH107X | CH107Y | CH108X | CH108Y | CH109X | CH109Y | CH110X | CH110Y | CH111X | CH111Y | CH112X | CH112Y | CH113X | CH113Y | CH114X | CH114Y | CH115X | CH115Y | CH116X | CH116Y | CH117X | CH117Y | CH118X | CH118Y | CH119X | CH119Y | CH120X | CH120Y | CH121X | CH121Y | CH122X | CH122Y | CH123X | CH123Y | CH124X | CH124Y | CH125X | CH125Y | CH126X | CH126Y

*RST: CH1X

Example: See Example "Configuring and generating a DME interrogation mode signal" on page 92.

Manual operation: See "ICAO Channel" on page 57

[:SOURce<hw>][:BB]:DME:PPST <SpacTolerance>

Sets the pulse pair spacing tolerance.

You have to enable the pulse pair spacing tolerance with the command `[:SOURce<hw>][:BB]:DME:PPS` for this value to be considered.

Parameters:

<SpacTolerance> float

Range: 0 to (200E-6)/2
Increment: 20E-9
*RST: 5E-6

Example: See Example "Configuring and generating a DME reply mode signal" on page 93.

Manual operation: See "Pulse Pair Spacing Tolerance" on page 62

[:SOURce<hw>]:BB:DME:PPST:ENABled <TolerEnabled>

Enables the pulse pair spacing tolerance.

If this function is not enabled, the response is sent after the first pulse, without checking whether the second pulse is within the pulse pair spacing tolerance time.

You can set the pulse pair spacing tolerance with `[:SOURce<hw>][:BB]:DME:PPST`.

Parameters:

<TolerEnabled> 1 | ON | 0 | OFF

*RST: 1

Example: See Example "Configuring and generating a DME reply mode signal" on page 93.

Manual operation: See "Pulse Pair Spacing State" on page 62

[:SOURce<hw>][:BB]:DME:RATE <Rate>

If `[:SOURce<hw>][:BB]:DME:MODE` is set to *INTerrogation*, sets the pulse repetition rate.

If `[:SOURce<hw>][:BB]:DME:MODE` is set to *REPLy*, indicates the mean pulse repetition rate in squitter mode.

Parameters:

<Rate> integer

Range: 10 to 8000
*RST: 48

Example: See Example "Configuring and generating a DME reply mode signal" on page 93.

Manual operation: See "Pulse Repetition Rate" on page 59

[:SOURce<hw>][:BB]:DME:RDIStance <RDistance>

Sets the simulated distance between the interrogator and the transponder for reply mode (`:BB:DME:MODE:REPLy`).

The distance can be given in nautic miles (NM) or µs with the command [:SOURce<hw>][:BB]:DME:RDIStance:UNIT.

If the unit is not provided next to the value, the value is considered to be in the current unit (last unit set via GUI or the SCPI). The query always provides the value in the unit set with [:SOURce<hw>][:BB]:DME:RDIStance:UNIT.

The range distance and the external trigger delay are interdependent according to:

Range distance = (trigger delay – X/Y mode delay)/12.359 µs/nm

(X mode delay = 50 µs, Y mode delay is 56 µs)

Changing one value automatically changes the other value.

Parameters:

<RDistance> float

Range: -4.046 (X), -4.531 (Y) to 400
Increment: 0.001
*RST: 0

Example: See Example "Configuring and generating a DME reply mode signal" on page 93.

Manual operation: See "Range Distance" on page 58

[:SOURce<hw>][:BB]:DME:RDIStance:UNIT <Unit>

Sets the unit for the range distance that can be defined with the [:SOURce<hw>][:BB]:DME:RDIStance.

The distance can be given in nautic miles (NM) or µs. 1 nm is 1852.01 meters and corresponds to a run time of 12.359 µs.

Parameters:

<Unit> US | NM

*RST: NM

Example: See Example "Configuring and generating a DME reply mode signal" on page 93.

Manual operation: See "Range Distance" on page 58

[:SOURce<hw>][:BB]:DME:SQUitter <Squitter>

Activates/deactivates the random pulse repetition rate.

The average repetition rate is 2700 pp/s. The pulse spacing is distributed randomly in the range of 60 µs to about 1500 µs according to EUROCAE EN-54 6.2.12. The squitter pulses are constantly sent by the ground station in order to ensure proper operation and in order to ease synchronization of the aircraft interrogator to the ground station.

Parameters:

<Squitter> 1 | ON | 0 | OFF

*RST: 0

Example: See Example "Configuring and generating a DME reply mode signal" on page 93.

Manual operation: See "Pulse Squitter" on page 59

[:SOURce<hw>][:BB]:DME:PINPut:DELay <Delay>

Sets the delay between the external trigger and the first DME output pulse (50% voltage point of first pulse).

Setting takes effect, if `[:SOURce<hw>][:BB]:DME:PINPut:SOURce` is set to *EXTernal*.

For DME `reply mode`, this setting simulates the defined delay of the DME transponder and twice the run time of the signal (from interrogator to transponder and back). The delay is a measure of the range distance, thus, the two values are interdependent according to:

Delay = X/Y mode delay + range distance * 12.359 nm/µs

(X mode delay = 50 µs, Y mode delay is 56 µs)

Changing one value automatically changes the other value.

Parameters:

<Delay> float

Range: 4E-6 to 5E-3
Increment: 20E-9
*RST: 50E-6

Example: See Example "Configuring and generating a DME reply mode signal" on page 93.

Manual operation: See "Reply Delay" on page 60

[:SOURce<hw>][:BB]:DME:PINPut:SOURce <PulsInpSource>

Selects the trigger mode for DME modulation signals.

Parameters:

<PulsInpSource> EXTernal | PSENsor

EXTernal
The signals are triggered by an external trigger event. The trigger signal is supplied via the "User 2" connector.

PSENsor
The signals are triggered by a connected power sensor, for example, the R&S NRP-Z81.

*RST: EXTernal

Example: See Example "Configuring and generating a DME reply mode signal" on page 93.

Manual operation: See "Input Source" on page 59

[:SOURce<hw>][:BB]:DME:PINPut:TRIGger:LEVel?

Queries the last measured value of the trigger power level.

This level is the 50% voltage point of the first pulse of the external DME interrogation signal.

Return values:

<TriggerLevel> float

Range: -200 to 200
Increment: 0.01
*RST: 0

Example: See Example "Configuring and generating a DME reply mode signal" on page 93.

Usage: Query only

Manual operation: See "Trigger Level" on page 60

[:SOURce<hw>][:BB]:DME:PINPut:TRIGger:LEVel:OK?

Queries, if the search trigger level procedure determines a valid trigger level or not.

Use this query for quick check, if there is a valid trigger level without running the search trigger level procedure via the following command:

Return values:

<IsTrigLevOk> 1 | ON | 0 | OFF

1|ON
Valid trigger level

0|OFF
Invalid trigger level

*RST: n.a. (no preset. default: 0)

Example: See Example "Configuring and generating a DME reply mode signal" on page 93.

Usage: Query only

Manual operation: See "Trigger Level" on page 60

[:SOURce<hw>][:BB]:DME:PINPut:TRIGger:SEARch?

Determines the trigger level that is the 50% voltage point of first pulse of the external DME interrogation signal.

Determination of the trigger point requires a connected power sensor. Use a power sensor, for example the R&S NRP-Z81, to receive the external DME signal. Repeat the trigger search function when changing the level of the external DME signal.

Return values:

<Search> 1 | ON | 0 | OFF

1|ON
No trigger level found

0|OFF
Trigger level found

*RST: 0

Example: See Example "Configuring and generating a DME reply mode signal" on page 93.

Usage: Query only

Manual operation: See "Search Trigger Level" on page 60

7.5.3 DME pulse commands

[:SOURce<hw>][:BB]:DME:FALL <Fall>

Sets the fall time of the pulse (90% to 10% of peak voltage).

Parameters:

<Fall> float

Range: 0.5E-6 to 10E-6
Increment: 10E-9
*RST: 2E-6

Example: See Example "Configuring and generating a DME reply mode signal" on page 93.

Manual operation: See "Pulse Fall" on page 62

[:SOURce<hw>][:BB]:DME:PPS <Pps>

Sets the spacing between the first and second pulse of a pulse pair (time between half-voltage points on the leading edge of each pulse).

Available only for `[:SOURce<hw>][:BB]:DME:SINGle` *OFF*

Parameters:

<Pps> float

Range: 1E-6 to 200E-6
Increment: 20E-9
*RST: 12E-6

Example: See Example "Configuring and generating a DME reply mode signal" on page 93.

Manual operation: See "Pulse Spacing" on page 62

[:SOURce<hw>][:BB]:DME:RISE <Rise>

Sets the rise time of the pulse (10% to 90% of peak voltage).

Parameters:

<Rise> float

Range: 0.5E-6 to 10E-6
Increment: 10E-9
*RST: 2E-6

Example: See Example "Configuring and generating a DME reply mode signal" on page 93.

Manual operation: See "Pulse Rise" on page 61

[:SOURce<hw>][:BB]:DME:SHAPe <Shape>

Sets the pulse shape.

Parameters:

<Shape> COS2 | LIN | COS | GAUSs

COS2|
The rising edge is cos shaped and the falling edge is cos^2 shaped.

LIN
The falling and the rising edge of the pulse are shaped linear.

COS
The falling and the rising edge of the pulse are cos^2 shaped.

*RST: COS2

Example: See Example "Configuring and generating a DME reply mode signal" on page 93.

Manual operation: See "Pulse Shape" on page 61

[:SOURce<hw>][:BB]:DME:SINGle <Single>

Activates/deactivates generation of a single test pulse.

Parameters:
<Single> 1 | ON | 0 | OFF
*RST: 0

Example: See Example "Configuring and generating a DME reply mode signal" on page 93.

Manual operation: See "Single Pulse" on page 62

[:SOURce<hw>][:BB]:DME:WIDTh <Width>

Sets the pulse width (50% to 50% of peak voltage).

Parameters:
<Width> float
Range: 1E-6 to 100E-6
Increment: 20E-9
*RST: 3.5E-6

Example: See Example "Configuring and generating a DME reply mode signal" on page 93.

Manual operation: See "Pulse Width" on page 62

7.5.4 DME propagation commands

[:SOURce<hw>][:BB]:DME:ECHO <ExtendetState>

Enables the simulation of DME echo pulse pair signals.

Parameters:
<ExtendedState> 1 | ON | 0 | OFF
*RST: OFF

Example: See Example "Determining the DME echo rejection" on page 94.

Manual operation: See "State" on page 66

[:SOURce<hw>][:BB]:DME:ECHO:ATTenuation <EchoAtten>

Sets the attenuation of the DME echo pulse pair signal compared to the original DME pulse pair signal.

Parameters:

<EchoAtten> float

Range: 0 to 50
Increment: 0.01
*RST: 10
Default unit: dB

Example: See Example "Determining the DME echo rejection" on page 94.

Manual operation: See "Attenuation" on page 66

[:SOURce<hw>][:BB]:DME:ECHO:DELay <EchoDel>

Sets the delay between the first original DME pulse pair signal and second DME echo pulse pair signal.

Parameters:

<EchoDel> float

Range: 15.5E-6 to 204E-6
Increment: 1E-8
*RST: 20E-6

Example: See Example "Determining the DME echo rejection" on page 94.

Manual operation: See "Delay" on page 66

[:SOURce<hw>][:BB]:DME:VELocity <DmeVelocity>

Sets the delay between the DME echo pulse signal and the original DME pulse signal.

Parameters:

<DmeVelocity> float

Range: -1E4 to 1E4
Increment: 1E-3
*RST: 0

Example: See Example "Simulating DME signals for velocity tracking" on page 95.

Manual operation: See "Velocity" on page 67

[:SOURce<hw>][:BB]:DME:FLIGht:DISTance:CURRent?

Queires the current distance of the aircraft in the flight simulation.

Return values:
<CurrentDistance> float
Range: -400 to 400
Increment: 0.001
*RST: 0

Example: See Example "Simulating a DME flight scenario" on page 96.

Usage: Query only

Manual operation: See "Current Distance" on page 69

[:SOURce<hw>][:BB]:DME:FLIGht:DISTance:STARt <StartDistance>

Sets the start distance of the flight simulation.

Parameters:
<StartDistance> float
Range: -400 to 400
Increment: 0.001
*RST: 0

Example: See Example "Simulating a DME flight scenario" on page 96.

Manual operation: See "Start Distance" on page 68

[:SOURce<hw>][:BB]:DME:FLIGht:DISTance:STOP <StopDistance>

Sets the stop distance of the flight simulation.

Parameters:
<StopDistance> float
Range: -400 to 400
Increment: 0.001
*RST: 1

Example: See Example "Simulating a DME flight scenario" on page 96.

Manual operation: See "Stop Distance" on page 68

[:SOURce<hw>][:BB]:DME:FLIGht:PAUSe

Pauses a running flight simulation.

Example: See Example "Simulating a DME flight scenario" on page 96.

Usage: Event

Manual operation: See "Pause" on page 69

[:SOURce<hw>][:BB]:DME:FLIGht:RESTart

Restarts a running or stopped flight simulation.

Example: See Example "Simulating a DME flight scenario" on page 96.

Usage: Event

Manual operation: See "Restart" on page 68

[:SOURce<hw>][:BB]:DME:FLIGht:RESume

Resumes a running flight simulation.

Example: See Example "Simulating a DME flight scenario" on page 96.

Usage: Event

Manual operation: See "Resume" on page 69

[:SOURce<hw>][:BB]:DME:FLIGht:RSTatus?

Queries the status of the flight simulation.

Return values:

<RunningStatus> OFF | IDLE | RUNNing | PAUSed
*RST: OFF

Example: See Example "Simulating a DME flight scenario" on page 96.

Usage: Query only

Manual operation: See "State" on page 68

[:SOURce<hw>][:BB]:DME:FLIGht:STARt

Starts the flight simulation with a given start distance.

Example: See Example "Simulating a DME flight scenario" on page 96.

Usage: Event

Manual operation: See "Start" on page 68

[:SOURce<hw>][:BB]:DME:FLIGht:STATe <SimState>

Activates flight simulation.

Parameters:

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

Example: See Example "Simulating a DME flight scenario" on page 96.

Manual operation: See "State" on page 68

[:SOURce<hw>][:BB]:DME:FLIGht:STOP

Stops the flight simulation and sets the distance position to start distance.

Example: See Example "Simulating a DME flight scenario" on page 96.

Usage: Event

Manual operation: See "Stop" on page 69

7.5.5 DME analysis commands

[:SOURce<hw>][:BB]:DME:ANALysis:EFFiciency?

Queries the measured reply efficiency in percent. The measurement is the ratio of the number of measured valid reply pulse pairs to transmitted pulse pairs in a measurement cycle.

Return values:

<Efficiency> float

Range: 0 to 100
Increment: 0.1
*RST: 100

Example: See Example "Configuring and generating a DME interrogation mode signal" on page 92.

Usage: Query only

Manual operation: See "Reply Efficiency" on page 59
See "Reply Efficiency" on page 76

[:SOURce<hw>]:BB:DME:ANALysis:EFFiciency:OK?

Queries if there are valid reply efficiency measurement values available in the set measurement window.

Return values:

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

Example: See Example "Configuring and generating a DME interrogation mode signal" on page 92.

Usage: Query only

Manual operation: See "Reply Efficiency" on page 76

[:SOURce<hw>]:BB:DME:ANALysis:GATE:COUNt <Count>

Sets the number of pulse pairs which are sent from the R&S SMBV100B (= interrogator) to the ground station in one measurement cycle. Only reply pulses for which the 50% voltage point of the rising edge of the first pulse is within the measurement window are used to evaluate the delay time and reply efficiency.

Parameters:

<Count> integer
Range: 1 to 10000
Increment: 1
*RST: 100

Example: See Example "Configuring and generating a DME interrogation mode signal" on page 92.

[:SOURce<hw>][:BB]:DME:ANALysis:GATE:EDELay <Edelay>

Sets the expected reply delay. The expected reply delay and the gate length determine the measurement window (expected reply delay +/- gate length/2).

Parameters:

<Edelay> float
Range: 0 to 150E-6
Increment: 1E-7
*RST: 50E-6

Example: See Example "Configuring and generating a DME interrogation mode signal" on page 92.

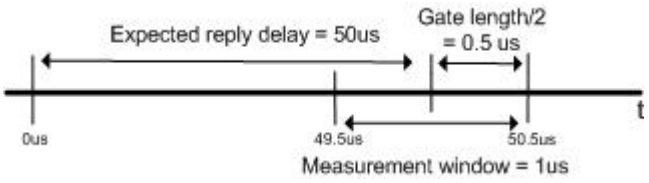
Manual operation: See "Expected Reply Delay" on page 75

[:SOURce<hw>][:BB]:DME:ANALysis:GATE[:LENGth] <Length>

Sets the gate length for the measurement window.

The measurement gate settings determine the measurement window (expected reply delay +/- gate length/2). Only reply pulses for which the 50% voltage point of the rising edge of the first pulse is within the measurement window are used to evaluate the delay time and reply efficiency. The delay measurement is averaged within the measurement cycle. The reply efficiency is calculated once for each measurement cycle.

The gate length is 1 µs and the expected reply delay is 50 µs. The measurement window lies in the range between 49.5 and 50.5 µs. Only pulse pairs are used for the measurement whose 50% voltage point of the rising edge of the first pulse is within this range.



Parameters:

<Length> integer

Range: 100E-9 to 326E-6
Increment: 100E-9
*RST: 10E-6

Example: See Example "Configuring and generating a DME interrogation mode signal" on page 92.

Manual operation: See "Gate Length" on page 75

[:SOURce<hw>][:BB]:DME:ANALysis:GATE:TIME <MeasurementTime>

Sets the DME analysis measurement time.

Parameters:

<MeasurementTime> float

Range: 0.1 to 20
Increment: 0.1
*RST: 1

Example: See Example "Configuring and generating a DME interrogation mode signal" on page 92.

Manual operation: See "Measurement Time" on page 75

[:SOURce<hw>][:BB]:DME:ANALysis:NORMalize?

Performs a normalization of the test setup. The delay due to the test setup is measured and subsequently considered in the reply measurements.

Return values:

<Normalize> 1 | ON | 0 | OFF

Example: See Example "Configuring and generating a DME interrogation mode signal" on page 92.

Usage: Query only

Manual operation: See "Normalize Setup" on page 72

[:SOURce<hw>][:BB]:DME:ANALysis:OK?

Queries if there are DME measurement values in the set measurement window.

Return values:

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

Example: See Example "Configuring and generating a DME interrogation mode signal" on page 92.

Usage: Query only

Manual operation: See "State" on page 74

[:SOURce<hw>][:BB]:DME:ANALysis:POWer?

Queries the measured average peak level of all valid pulse pairs in a measurement cycle.

Return values:

<Power> float
Range: -200 to 200
Increment: 0.01
*RST: 0

Example: See Example "Configuring and generating a DME interrogation mode signal" on page 92.

Usage: Query only

Manual operation: See "Peak Level" on page 75

[:SOURce<hw>]:BB:DME:ANALysis:POWer:OK?

Queries if there are peak level measurement values available in the set measurement window.

Return values:

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

Example: See Example "Configuring and generating a DME interrogation mode signal" on page 92.

Usage: Query only

Manual operation: See "Peak Level" on page 75

[:SOURce<hw>][:BB]:DME:ANALysis:PRRate?

Queries the measured mean pulse repetition rate of the DME ground station. All received pulses of the DME ground station are considered.

Return values:
<Rate> float
Range: 0 to 10000
Increment: 0.1
*RST: 0

Example: See Example "Configuring and generating a DME interrogation mode signal" on page 92.

Usage: Query only

Manual operation: See "Pulse Repetition Rate" on page 76

[:SOURce<hw>]:BB:DME:ANALysis:PRRate:OK?

Queries if there are valid pulse repetition measurement values available in the set measurement window.

Return values:
<Ok> 0 | 1 | OFF | ON
*RST: 1

Example: See Example "Configuring and generating a DME interrogation mode signal" on page 92.

Usage: Query only

Manual operation: See "Measurement Status" on page 76

[:SOURce<hw>][:BB]:DME:ANALysis:RDIStance?

Queries the measured average range distance of all valid pulse pairs in a measurement cycle.

Return values:
<RangeDistance> float

Example: See Example "Configuring and generating a DME interrogation mode signal" on page 92.

Usage: Query only

Manual operation: See "Range Distance" on page 75

[:SOURce<hw>][:BB]:DME:ANALysis:STATe <State>

Activates the DME analysis.

Activation requires a connection between R&S SMBV100B and a power sensor, for example, the R&S NRP-Z81.

Parameters:

<State> 1 | ON | 0 | OFF

*RST: 0

Example: See Example "Configuring and generating a DME interrogation mode signal" on page 92.

Manual operation: See "State" on page 74

[:SOURce<hw>][:BB]:DME:ANALysis:TIME?

Queries the measured average reply delay of all valid pulse pairs in a measurement cycle.

Return values:

<Time> float

Range: -1E-3 to 1E-3
Increment: 10E-9
*RST: 0

Example: See Example "Configuring and generating a DME interrogation mode signal" on page 92.

Usage: Query only

Manual operation: See "Reply Delay" on page 76

[:SOURce<hw>]:BB:DME:ANALysis:TIME:OK?

Queries if there are valid measurement values available in the set measurement window.

Return values:

<Ok> 0 | 1 | OFF | ON

Example: See Example "Configuring and generating a DME interrogation mode signal" on page 92.

Usage: Query only

Manual operation: See "Reply Delay" on page 76

[:SOURce<hw>]:BB:DME:ANALysis:TRIGger:SEARch?

Determines the trigger level = 50% voltage point of first pulse of the external DME interrogation signal.

Determination of the trigger point requires a connected power sensor. Use the R&S NRP-Z81 to receive the external DME signal. Repeat the trigger search function when changing the level of the external DME signal.

Return values:
<Search> 0 | 1 | OFF | ON
*RST: 0

Example: See Example "Configuring and generating a DME interrogation mode signal" on page 92.

Usage: Query only

[:SOURce<hw>][:BB]:DME:ANALysis:IAFactor?

Queries the internal adjustment factor, the mathematically calculated value of the time, when the pulse reaches its 50% level.

Return values:
<InternalAdjFact> float
Range: 0 to 200
Increment: 10E-9
*RST: 0

Example: See Example "Configuring and generating a DME interrogation mode signal" on page 92.

Usage: Query only

Manual operation: See "Internal Adjustment Factor" on page 73

[:SOURce<hw>][:BB]:DME:ANALysis:PSAFactor?

Queries the power sensor adjustment factor determined during a normalization of the setup. You can normalize the setup with `[:SOURce<hw>][:BB]:DME:ANALysis:NORMalize?`.

Return values:
<PowSensAdjFact> float
Range: 0 to 200
Increment: 10E-9
*RST: 0

Example: See Example "Configuring and generating a DME interrogation mode signal" on page 92.

Usage: Query only

Manual operation: See "Power Sensor Adjustment Factor" on page 73

[:SOURce<hw>][:BB]:DME:ANALysis:UAFactor <UsedFactor>

Sets which internal adjustment factor is used.

Parameters:
<UsedFactor> INTernal | PSENsor

INTernal
The mathematically calculated value of the time, when the pulse reaches its 50% level. Query the internal adjustment factor with `[:SOURce<hw>][:BB]:DME:ANALysis:IAFactor?`

PSENsor
The adjustment factor measured during a normalization setup. Query the power sensor adjustment factor with `[:SOURce<hw>][:BB]:DME:ANALysis:PSAFactor?`

*RST: INTernal

Example: See Example "Configuring and generating a DME interrogation mode signal" on page 92.

Manual operation: See "Used Adjustment Factor" on page 73

7.5.6 DME COM/ID commands

[:SOURce<hw>][:BB]:DME:ID:CODE <Code>

Sets the coding of the COM/ID signal by the international short name of the airport (e.g. MUC for the Munich airport).

The COM/ID tone is sent according to the selected code, see Section A, "Morse code settings", on page 160.

If no coding is set, the COM/ID tone is sent uncoded (key down).

Parameters:
<Code> string

Example: See Example "Configuring and generating a DME reply mode signal" on page 93.

Manual operation: See "Code" on page 64

[:SOURce<hw>][:BB]:DME:ID:DASH <Dash>

Sets the length of a Morse code dash.

Available only if [:SOURce<hw>][:BB]:DME:ID:TSCHema is set to *USER*.

Parameters:

<Dash> float

Range: 0.05 to 1
Increment: 1E-4
*RST: 0.3

Example: See Example "Configuring and generating a DME reply mode signal" on page 93.

Manual operation: See "Dash Length" on page 64

[:SOURce<hw>][:BB]:DME:ID:DOT <Dot>

Sets the length of a Morse code dot.

Parameters:

<Dot> float

Range: 0.05 to 1
Increment: 1E-4
*RST: 0.1

Example: See Example "Configuring and generating a DME reply mode signal" on page 93.

Manual operation: See "Dot Length" on page 64

[:SOURce<hw>][:BB]:DME:ID:LETTer <Letter>

Sets the length of a Morse code letter space.

Available only if [:SOURce<hw>][:BB]:DME:ID:TSCHema is set to *USER*.

Parameters:

<Letter> float

Range: 0.05 to 1
Increment: 1E-4
*RST: 0.3

Example: See Example "Configuring and generating a DME reply mode signal" on page 93.

Manual operation: See "Letter Space" on page 65

[:SOURce<hw>][:BB]:DME:ID:PPP[:STATe] <PairOfPulsePair>

Sets the state of the pair of pulse pairs for the ID signal generation. When enabled a pair of pulse pairs is transmitted during the set [:SOURce<hw>][:BB]:DME:ID:RATE.

Parameters:
<PairOfPulsePair> 1 | ON | 0 | OFF
*RST: 0

Example: See Example "Configuring and generating a DME reply mode signal" on page 93.

[:SOURce<hw>][:BB]:DME:ID:PPS <PulsePairSpacin>

Sets the morse pulse pair spacing.

Parameters:
<PulsePairSpacin> float
Range: 2E-6 to 300E-6
Increment: 20E-9
*RST: 100E-6

Example: See Example "Configuring and generating a DME reply mode signal" on page 93.

[:SOURce<hw>][:BB]:DME:ID:PERiod <Period>

Sets the period of the COM/ID signal.

Parameters:
<Period> integer
Range: 10 to 120
*RST: 40

Example: See Example "Configuring and generating a DME reply mode signal" on page 93.

Manual operation: See "Period" on page 64

[:SOURce<hw>][:BB]:DME:ID:PRESet

Sets the default settings for the ID signal.

Example: See Example "Configuring and generating a DME reply mode signal" on page 93.

Usage: Event

[:SOURce<hw>][:BB]:DME:ID:RATE <Rate>

Sets the pulse repetition rate of the ID sequence.

Parameters:
<Rate> float
Range: 100 to 10E3
Increment: 0.01
*RST: 1350

Example: See Example "Configuring and generating a DME reply mode signal" on page 93.

Manual operation: See "Rate" on page 64

[:SOURce<hw>][:BB]:DME:ID:SYMBol <Symbol>

Sets the length of the Morse code symbol space.

Available only if `[:SOURce<hw>][:BB]:DME:ID:TSCHema` is set to *USER*.

Parameters:

<Symbol> float

Range: 0.05 to 1
Increment: 1E-4
*RST: 0.1

Example: See Example "Configuring and generating a DME reply mode signal" on page 93.

Manual operation: See "Symbol Space" on page 64

[:SOURce<hw>][:BB]:DME:ID:TSCHema <TSchema>

Sets the time schema of the Morse code for the COM/ID signal.

Parameters:

<TSchema> STD | USER

*RST: STD

Example: See Example "Configuring and generating a DME reply mode signal" on page 93.

Manual operation: See "Time Schema" on page 64

[:SOURce<hw>][:BB]:DME:ID[:STATe] <State>

Enables/disables the COM/ID signal.

Parameters:

<State> 1 | ON | 0 | OFF

*RST: 0

Example: See Example "Configuring and generating a DME reply mode signal" on page 93.

Manual operation: See "COM/ID State" on page 63

7.6 Trigger commands

[:SOURce<hw>]:BB:DME[:TRIGger]:SEQuence <TriggerMode>
[:SOURce<hw>][:BB]:ILS[:TRIGger]:SEQuence <TriggerMode>
[:SOURce<hw>]:BB:VOR[:TRIGger]:SEQuence <TriggerMode>

Selects the trigger mode:

- `AUTO` = auto
- `RETRigger` = retrigger
- `AAUTo` = armed auto
- `ARETrigger` = armed retrigger
- `SINGle` = single

Parameters:

<TriggerMode> AUTO | RETRigger | AAUTo | ARETrigger | SINGle
*RST: AUTO

Example: See Example "Configuring trigger settings" on page 96.

Manual operation: See "Mode" on page 78

[:SOURce<hw>]:BB:DME:TRIGger:SOURce <TriggerSource>
[:SOURce<hw>][:BB]:ILS:TRIGger:SOURce <TriggerSource>
[:SOURce<hw>]:BB:VOR:TRIGger:SOURce <TriggerSource>

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

- `INTernal`: Internal manual triggering of the instrument
- External trigger signal via one of the global connectors:
  `EGT1`: External global trigger
- For secondary instruments (`SCONfiguration:MULTiinstrument:MODE SEC`), triggering via the external baseband synchronization signal of the primary instrument:
  `SOURce1:BB:ARB:TRIGger:SOURce BBSY`
- `EXTernal`: Setting only
  Provided only for backward compatibility with other Rohde & Schwarz signal generators. The R&S SMBV100B accepts this value and maps it automatically as follows:
  `EXTernal = EGT1`

Parameters:

<TriggerSource> INTernal|EGT1|EXTernal|BBSY
*RST: INTernal

Example: See Example "Configuring trigger settings" on page 96.

Manual operation: See "Source" on page 80

[:SOURce<hw>]:BB:DME:TRIGger:RMODe?
[:SOURce<hw>][:BB]:ILS:TRIGger:RMODe?
[:SOURce<hw>]:BB:VOR:TRIGger:RMODe?

Queries the signal generation status.

Return values:

<RunMode> STOP | RUN
*RST: STOP

Example: See Example "Configuring trigger settings" on page 96.

Usage: Query only

Manual operation: See "Running/Stopped" on page 79

[:SOURce<hw>]:BB:DME:TRIGger:TIME:DATE <Year>, <Month>, <Day>
[:SOURce<hw>][:BB]:ILS:TRIGger:TIME:DATE <Year>, <Month>, <Day>
[:SOURce<hw>]:BB:VOR:TRIGger:TIME:DATE <Year>, <Month>, <Day>

Sets the date for a time-based trigger signal. For trigger modes single or armed auto, you can activate triggering at this date via the following command:

`SOURce<hw>:BB:<DigStd>:TRIGger:TIME:STATe`

`<DigStd>` is the mnemonic for the digital standard, for example, `ARB`. Time-based triggering behaves analogously for all digital standards that support this feature.

Parameters:

<Year> integer
Range: 1980 to 9999

<Month> integer
Range: 1 to 12

<Day> integer
Range: 1 to 31

Example: See example "Configure a time-based trigger signal" in the subchapter "Trigger Commands" of the chapter "SOURce:BB:ARB subsystem" in the R&S SMBV100B user manual.

Manual operation: See "Trigger Time" on page 79

[:SOURce<hw>]:BB:DME:TRIGger:TIME:TIME <Hour>, <Minute>, <Second>
[:SOURce<hw>][:BB]:ILS:TRIGger:TIME:TIME <Hour>, <Minute>, <Second>
[:SOURce<hw>]:BB:VOR:TRIGger:TIME:TIME <Hour>, <Minute>, <Second>

Sets the time for a time-based trigger signal. For trigger modes single or armed auto, you can activate triggering at this time via the following command:

`SOURce<hw>:BB:<DigStd>:TRIGger:TIME:STATe`

`<DigStd>` is the mnemonic for the digital standard, for example, `ARB`. Time-based triggering behaves analogously for all digital standards that support this feature.

Parameters:

<Hour> integer
Range: 0 to 23

<Minute> integer
Range: 0 to 59

<Second> integer
Range: 0 to 59

Example: See example "Configure a time-based trigger signal" in the subchapter "Trigger Commands" of the chapter "SOURce:BB:ARB subsystem" in the R&S SMBV100B user manual.

Manual operation: See "Trigger Time" on page 79

[:SOURce<hw>]:BB:DME:TRIGger:TIME[:STATE] <State>
[:SOURce<hw>][:BB]:ILS:TRIGger:TIME[:STATE] <State>
[:SOURce<hw>]:BB:VOR:TRIGger:TIME[:STATE] <State>

Activates time-based triggering with a fixed time reference. If activated, the R&S SMBV100B triggers signal generation when its operating system time matches a specified time.

Specify the trigger date and trigger time with the following commands:

`SOURce<hw>:BB:<DigStd>:TRIGger:TIME:DATE`

`SOURce<hw>:BB:<DigStd>:TRIGger:TIME:TIME`

`<DigStd>` is the mnemonic for the digital standard, for example, `ARB`. Time-based triggering behaves analogously for all digital standards that support this feature.

Parameters:

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

Example: See example "Configure a time-based trigger signal" in the subchapter "Trigger Commands" of the chapter "SOURce:BB:ARB subsystem" in the R&S SMBV100B user manual.

Manual operation: See "Time Based Trigger" on page 79

[:SOURce<hw>]:BB:DME:TRIGger:SLENgth <SeqLength>
[:SOURce<hw>][:BB]:ILS:TRIGger:SLENgth <SeqLength>
[:SOURce<hw>]:BB:VOR:TRIGger:SLENgth <SeqLength>

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

Parameters:

<SeqLength> integer
Range: 1 samples to 2^32-1 samples
*RST: 100

Example: See Example "Configuring trigger settings" on page 96.

Manual operation: See "Signal Duration" on page 78

[:SOURce<hw>]:BB:DME:TRIGger:ARM:EXECute
[:SOURce<hw>][:BB]:ILS:TRIGger:ARM:EXECute
[:SOURce<hw>]:BB:VOR:TRIGger:ARM:EXECute

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

Example: See Example "Configuring trigger settings" on page 96.

Usage: Event

Manual operation: See "Arm" on page 80

[:SOURce<hw>]:BB:DME:TRIGger:EXECute
[:SOURce<hw>][:BB]:ILS:TRIGger:EXECute
[:SOURce<hw>]:BB:VOR:TRIGger:EXECute

Executes a trigger.

Example: See Example "Configuring trigger settings" on page 96.

Usage: Event

Manual operation: See "Execute Trigger" on page 80

[:SOURce<hw>]:BB:DME:TRIGger:EXTernal:SYNChronize:OUTPut <Output>
[:SOURce<hw>][:BB]:ILS:TRIGger:EXTernal:SYNChronize:OUTPut <Output>
[:SOURce<hw>]:BB:VOR:TRIGger:EXTernal:SYNChronize:OUTPut <Output>

Enables signal output synchronous to the trigger event.

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

Example: See Example "Configuring trigger settings" on page 96.

Manual operation: See "Sync. Output to External Trigger/Sync. Output to Trigger" on page 80

[:SOURce<hw>]:BB:DME:TRIGger:OBASeband:DELay <Delay>
[:SOURce<hw>][:BB]:ILS:TRIGger:OBASeband:DELay <Delay>
[:SOURce<hw>]:BB:VOR:TRIGger:OBASeband:DELay <Delay>

The command specifies the trigger delay (expressed as a number of samples) for triggering by the trigger signal from the second path.

Parameters:

<Delay> float

Range: 0 samples to 2^32-1 samples
Increment: 1 sample
*RST: 0 samples

Example: See Example "Configuring trigger settings" on page 96.

[:SOURce<hw>]:BB:DME:TRIGger:OBASeband:INHibit <Inhibit>
[:SOURce<hw>][:BB]:ILS:TRIGger:OBASeband:INHibit <Inhibit>
[:SOURce<hw>]:BB:VOR:TRIGger:OBASeband:INHibit <Inhibit>

Specifies the number of samples by which a restart is to be inhibited following a trigger event. This command applies only for triggering by the second path.

Parameters:

<Inhibit> integer

Range: 0 to 67108863
*RST: 0

Example: See Example "Configuring trigger settings" on page 96.

[:SOURce<hw>]:BB:DME:TRIGger[:EXTernal<ch>]:DELay <Delay>
[:SOURce<hw>][:BB]:ILS:TRIGger[:EXTernal<ch>]:DELay <Delay>
[:SOURce<hw>]:BB:VOR:TRIGger[:EXTernal<ch>]:DELay <Delay>

Sets the trigger delay.

Parameters:

<Delay> float

Range: 0 to 65535
Increment: 0.01
*RST: 0

Example: See Example "Configuring trigger settings" on page 96.

Manual operation: See "External / Trigger Delay" on page 82

[:SOURce<hw>]:BB:DME:TRIGger[:EXTernal<ch>]:INHibit <Inhibit>
[:SOURce<hw>][:BB]:ILS:TRIGger[:EXTernal<ch>]:INHibit <Inhibit>
[:SOURce<hw>]:BB:VOR:TRIGger[:EXTernal<ch>]:INHibit <Inhibit>

Specifies the duration by which a restart is inhibited.

Parameters:

<Inhibit> integer

Range: 0 to 67108863
*RST: 0

Example: See Example "Configuring trigger settings" on page 96.

Manual operation: See "External / Trigger Inhibit" on page 81

7.7 DME marker commands

[:SOURce<hw>][:BB]:DME:MARKer<ch>:DELay <Delay>

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

Parameters:

<Delay> integer

Range: 0 to 127
*RST: 0

Example: See Example "Configuring DME marker settings" on page 97.

Manual operation: See "Delay" on page 84

[:SOURce<hw>][:BB]:DME:MARKer<ch>:MODE <Mode>

Sets the mode for the selected marker.

Parameters:

<Mode> FPSTart | FP50P | PSTart | P50P | PRECeived

`FPSTart`: first pulse start
`FP50`: first pulse 50%
`PSTart`: pulse start
`P50`: pulse 50%
`PRECeived`: received pulse

*RST: PSTart

Example: See Example "Configuring DME marker settings" on page 97.

Manual operation: See "Mode" on page 83

[:SOURce<hw>][:BB]:DME:MARKer<ch>:PDELay?

Queries the marker processing delay, internally measured value. This command is available only for `"Marker 2 Mode > Received Pulse"`.

Return values:

<ProcessedDelay> float

Range: 0 to 1
Increment: 10E-9
*RST: 0

Example: See Example "Configuring DME marker settings" on page 97.

Usage: Query only

Manual operation: See "Processing Delay" on page 84

[:SOURce<hw>][:BB]:DME:MARKer<ch>:WIDTh <Width>

Sets the width of the corresponding marker in chips (0.05us).

Parameters:

<Width> integer

Range: 1 to 127
*RST: 10

Example: See Example "Configuring DME marker settings" on page 97.

Manual operation: See "Width" on page 84

7.8 Clock commands

[:SOURce<hw>]:BB:DME:CLOCk:SOURce <Source>
[:SOURce<hw>][:BB]:ILS:CLOCk:SOURce <Source>
[:SOURce<hw>]:BB:VOR:CLOCk:SOURce <Source>

Selects the clock source:

- `INTernal`: Internal clock reference

Parameters:

<Source> INTernal

*RST: INTernal

Example: See Example "Querying clock settings" on page 97.

Manual operation: See "Clock Source" on page 85

Annex

A Morse code settings

The COM/ID tone is sent according to the selected code (see Table A-1). The length of the Morse code can be varied. For selected standard time scheme, the selected dot length determines the setting of all other length parameters of the Morse code (dash length, symbol space and letter space) . For selected user time scheme, all length parameters of the code can be set independently. If no coding is entered, the COM/ID tone is sent uncoded (key down).

The following values are default values:

- A dot (.) has a tone duration of 100 ms
- A dash (-) has a tone duration of 300ms
- The time between two tones is 100ms
- The time between two letters is 300ms

After each word, a word space is entered. The word repetition rate is 7 words per minute. Since the word length can vary between 900 ms and 4500 ms, the word space between the words varies accordingly.

Example:

ID code = MUC

The word length = (300+100+300)+300+(100+100+100+100+300)+300+(300+100+100+100+300+100+100) = 3100 ms

Table A-1: Morse code

Letter	Morse code	Letter	Morse code
A	. -	N	- .
B	- . . .	O	- - -
C	- . - .	P	. - - .
D	- . .	Q	- - . -
E	.	R	. - .
F	. . - .	S	. . .
G	- - .	T	-
H	. . . .	U	. . -
I	. .	V	. . . -
J	. - - -	W	. - -
K	- . -	X	- . . -

Letter	Morse code	Letter	Morse code
L	. - . .	Y	- . - -
M	- -	Z	- - . .

Glossary: Specifications and references

Symbols

1GP74: Rohde & Schwarz Application Note 1GP74 "Test of DME/TACAN Transponders"

1MA193: Rohde & Schwarz Application Note 1MA193 "Aeronautical radio navigation measurement solutions"

V

Videos: Rohde & Schwarz "Test & Measurement Fundamentals" YouTube channel: https://www.youtube.com/playlist?list=PLKxVoO5jUTlvsVtDcqrVn0ybqBVlLj2z8
Videos:
Videos: "Understanding VOR", "Testing VOR with the R&S SMBV100B Signal Generator", "Understanding ILS", "Testing ILS with the R&S SMBV100B Signal Generator"

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