R&S®SMW-K78
Radar Echo Generation
User Manual

1177.6252.02 — 02

Test & Measurement

User Manual

ROHDE&SCHWARZ

This document describes the following software options:

- R&S®SMW-78
  1414.1833.02

This manual describes firmware version FW 3.50.103.xx and later of the R&S®SMW200A.

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

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1 Preface

1.1 About this Manual

This user manual provides all the information **specific to the Radar Echo Generation option R&S SMW-K78**. All general instrument functions and settings common to all applications and operating modes are described in the main R&S SMW user manual.

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

- **Welcome to the Radar Echo Generation option R&S SMW-K78**
  Introduction to and getting familiar with the option
- **About the Radar Echo Generation option**
  Background information on basic terms and principles in the context of the signal generation
- **Radar Echo Generation Configuration and Settings**
  A concise description of all functions and settings available to configure signal echo generation with their corresponding remote control command
- **How to Generate a Echo Signal with the Radar Echo Generation Option**
  The basic procedure to perform signal echo generation tasks and step-by-step instructions for more complex tasks or alternative methods
  As well as detailed examples to guide you through typical signal echo generation scenarios and allow you to try out the application immediately
- **Remote Control Commands**
  Remote commands required to configure and perform signal echo generation in a remote environment, sorted by tasks
  (Commands required to set up the instrument or to perform common tasks on the instrument are provided in the main R&S SMW User Manual)
  Programming examples demonstrate the use of many commands and can usually be executed directly for test purposes
- **Glossary**
  Alphabetical list of often used terms and abbreviations
- **List of remote commands**
  Alphabetical list of all remote commands described in the manual
- **Index**

1.2 Documentation Overview

This section provides an overview of the R&S SMW user documentation. You find it on the product page at:

www.rohde-schwarz.com/product/SMW200A > "Downloads"

Getting started manual

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

Online help including tutorials

The online help offers quick, context-sensitive access to the complete information for the base unit and the software options directly on the instrument.

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

User manual

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

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

The **online version** of the user manual provides the complete contents for immediate display on the Internet.

Service manual

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

The service manual is available for registered users on the global Rohde & Schwarz information system (GLORIS, https://gloris.rohde-schwarz.com).

Instrument security procedures manual

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

Basic safety instructions

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

Data sheet and brochure

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

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

Release notes and open source acknowledgment (OSA)

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

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

See www.rohde-schwarz.com/product/SMW200A > "Downloads" > "Firmware"

Application notes, application cards, white papers, etc.

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

1.3 Conventions Used in the Documentation

1.3.1 Typographical Conventions

The following text markers are used throughout this documentation:

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

1.3.2 Conventions for Procedure Descriptions

When describing how to operate the instrument, several alternative methods may be available to perform the same task. In this case, the procedure using the touchscreen is described. Any elements that can be activated by touching can also be clicked using an additionally connected mouse. The alternative procedure using the keys on the instrument or the on-screen keyboard is only described if it deviates from the standard operating procedures.

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

1.3.3 Notes on Screenshots

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

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

2 Welcome to the Radar Echo Generation Option

The R&S SMW-K78 is a firmware application that adds functionality to generate a single or multiple radar echo signals for radar tests.

The R&S SMW-K78 features include:

- Radar echo generation for any input in real time
- Simulation of up to 12 independent virtual static or moving objects
- 160 MHz RF bandwidth throughout the entire frequency range up to 40 GHz
- Excellent RF performance of signal generator and analyzer
- Possibility to add interferers and noise
- Internal generator solution, no need for external PC
- Intuitive and easy to use graphical user interface

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

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

www.rohde-schwarz.com/product/SMW200A > "Downloads" > "Manuals".

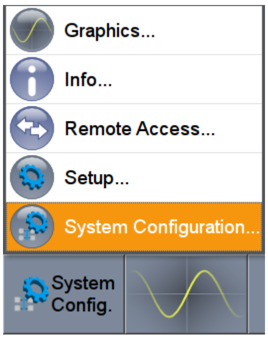
Installation

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

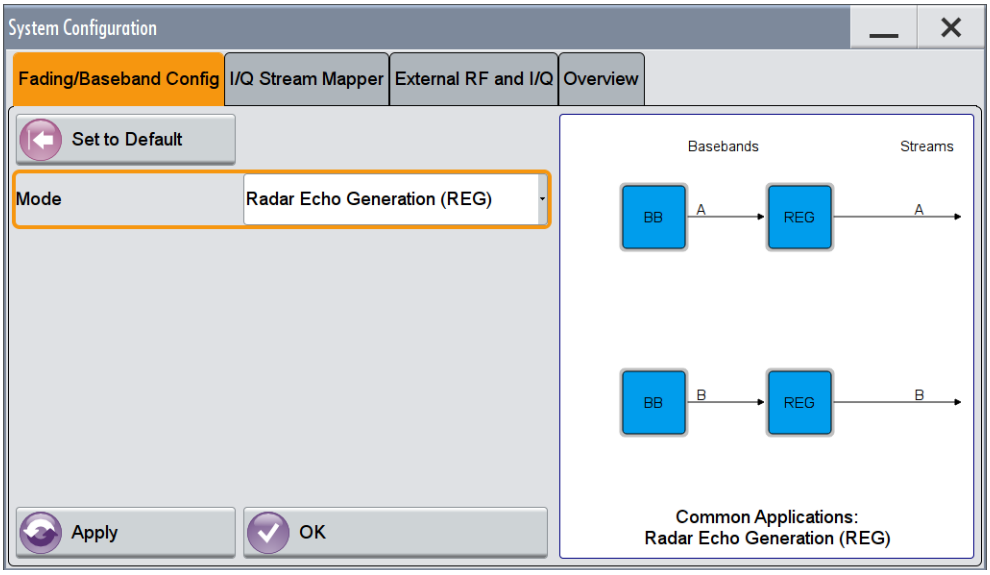
2.1 Accessing the Radar Echo Generation Dialog

To open the dialog with Radar Echo Generation settings

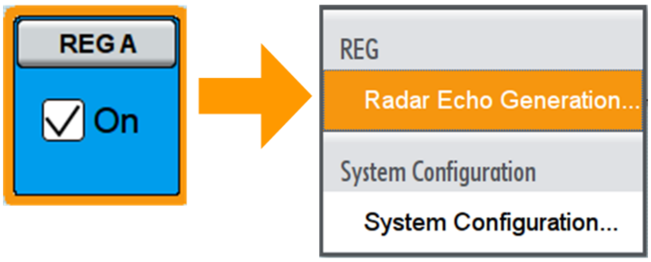
1. In the block diagram of the R&S SMW, select "System Config > System Configuration".



2. Select "Fading/Baseband Config > Mode > Radar Echo Generation (REG)".



3. Select "Apply" and confirm with "OK".
4. In the block diagram, select "REG > Radar Echo Generation".



A dialog box opens that displays the provided general settings.

The signal echo generation is not started immediately.

For more information, see Chapter 5, "How to Generate Radar Echo Signals", on page 46.

2.2 Scope

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

In particular, it includes:

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

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

3 About the Radar Echo Generation Option

Testing of radar system with real targets can be a complex task, including expensive and not reproducible field tests, or involving specially designed hardware. A novel approach is to use standard test and measurement equipment instead, for example the combination of the R&S SMW and the R&S FSW signal analyzer.

This description focuses on the functionality of the Radar Echo Generation (R&S SMW-K78) option. It explains how the radar echo generator receives, manipulates, and retransmits radar waveforms to the radar under test.

3.1 Required Options and Equipment

R&S SMW

R&S SMW base unit equipped with:

- Option Baseband Generator (R&S SMW-B10) and
  Option Baseband main module, with two I/Q paths (R&S SMW-B13T)
  (incl. two digital interfaces CODER)
- Option Frequency (R&S SMW-B10x)
- Option Fading Simulator (R&S SMW-B14)
- Option Radar Echo Generation (R&S SMW-K78)

This configuration is sufficient for the generation of up to 6 echoes.

For more information, see data sheet.

R&S FSW

R&S®FSW signal and spectrum analyzer equipped with:

- R&S®FSW-B17 Digital Baseband Interface
- R&S®FSW-B160 160 MHz Analysis Bandwidth or any of the options R&S®FSW-B80/-B320/-B500

For more information, see data sheet.

Required additional equipment and cables

As a rule, always use short cable of good quality:

- One R&S®SMU-Z6 cable for connecting the digital I/Q interfaces of the R&S SMW and the R&S FSW
- 2 BNC cables: for feeding the external reference frequency and the trigger signal
- USB or LAN cable for connecting the R&S FSW and the R&S SMW
- Depending on the test setup, one of the following:
  - 2 RF cables (for conducted tests)
  - Rx and Tx antennas (for over-the-air OTA tests)

- Optional, an external attenuator to protect the input stage of the R&S FSW

3.2 The Principle of Echo Generation with R&S SMW-K78

If equipped with the Radar Echo Generation (REG) option, the R&S SMW can work as an echo generator together with the R&S FSW signal analyzer. An example of this solution is the test setup shown on Figure 3-1. The figure illustrates the radar echo generation with **real radar signal** as a principle.

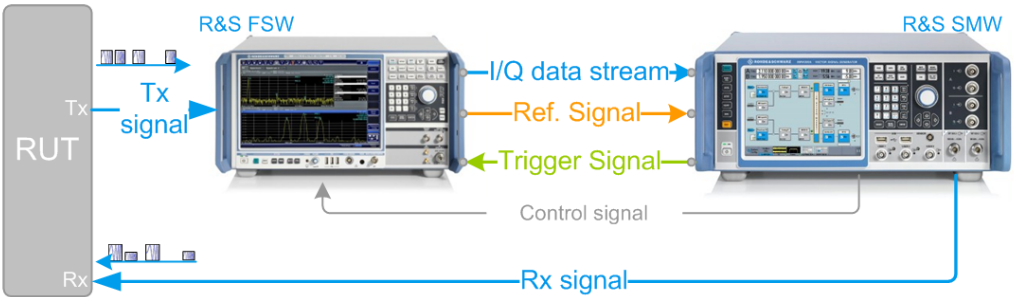


Figure 3-1: Radar echo generation with R&S FSW, R&S SMW, and real radar signal (conducted test)

RUT	= Radar under test
Tx signal	= Transmitted (original) radar signal
Rx signal	= Modified signal, fed back to the radar
I/Q data stream	= Digital baseband data stream
Ref. Signal	= 10 MHz common reference frequency signal to synchronize the R&S SMW to the R&S FSW
Trigger Signal	= Required to estimate the system latency of the system (blind zone (BZ))
Control signal	= USB (or LAN) connection for remote control of the analyzer from the R&S SMW

The R&S FSW acts as a downconverter. It captures the transmitted analog radar signal from the RUT (Tx signal) and converts it to a digital baseband signal. The R&S FSW provides the digital signal via the digital I/Q interface to the R&S SMW. The R&S SMW processes the received original signal (Tx signal), but changes the signal according to the individual objects. The R&S SMW simulates **range** by delaying the received radar signal. It simulates **velocity** by adding Doppler frequency shifts to the original signal and radar cross sections (**RCS**) by attenuating the signal. The modified signal (Rx signal) is up-converted and fed back to the radar receiver [3].

The combination of the R&S FSW and the R&S SMW equipped with the option R&S SMW-K78 is commonly referred as radar echo generator (**REG**).

In the test setup on Figure 3-1, there is a cable connection between the RUT and the measurement equipment. Throughout this description, this setup is referred as a **conducted test**. The RUT and the REG can also be located several meters away from each other. To transmit and receive the signal, both the RUT and the REG are equipped with transmit and receive antennas. An example of this setup is illustrated on Figure 3-2. This kind of setup is referred as an **over-the-air (OTA) test**, where the distance between the RUT and the REG is referred as OTA distance.

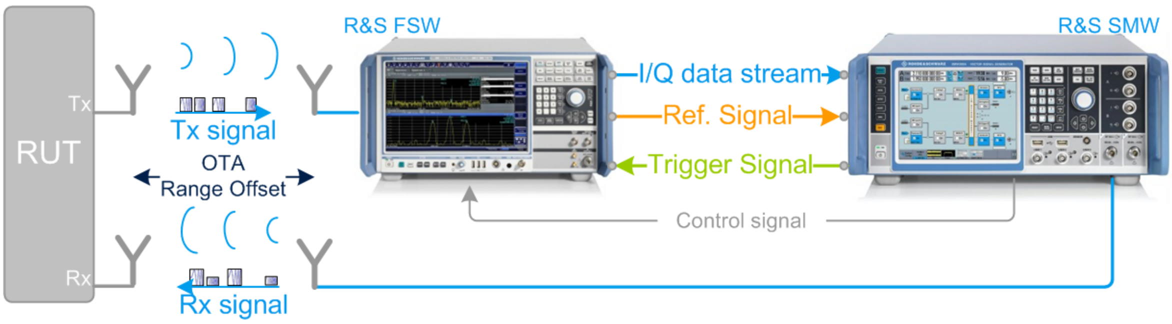


Figure 3-2: Radar echo generation with real radar signal (over-the-air tests)

OTA = Over-the-air
OTA Range Offset = Distance between the RUT and the REG antennas

Alternatively to the two previous examples, the radar signals can be created **internally** in the R&S SMW. The R&S SMW can play waveforms created with the R&S Pulse Sequencer software or custom waveforms, that are loaded in the ARB generator. In this case, a standalone R&S SMW is sufficient, for example for radar receiver tests (see Figure 3-3). The characteristics of the objects can be imposed on the original signal in the same way as in the tests with real radar signal.

Figure 3-3: Radar echo generation with R&S SMW and ARB-based radar signals created by R&S Pulse Sequencer

RUT = Radar under test
Rx signal = Modified test signal, transmitted to the radar

One of the advantages of this solution is the fact, that it is independent of the transmitter and the Tx signal of the radar system.

See:

- Chapter 5, "How to Generate Radar Echo Signals", on page 46 for step-by-step instructions.
- Chapter 4, "Radar Echo Generation Configuration and Settings", on page 26 for description of the related settings.

3.3 Analyzer and Receiver Overload Protection

WARNING

Risk of overloading

Signal strength outside the permissible input ranges may overload and damage the signal analyzer R&S FSW and the radar receiver.

Always check the specifications for permissible input ranges.

Follow the following general precautions:

- Connect an external attenuator to protect the input stage of the analyzer.
- Observe the theoretical dynamic power range of the scenario before activating the REG.
  (see "Ext. Attenuator (Analyzer)" on page 30)
- To protect the radar inputs from overloading, limit the output power at the RF outputs of the R&S SMW.
  Set the parameter "RF A or RF B > RF Level > Level > Limit" to the maximum allowed receive power at the radar input.

For more information, see:

- The R&S SMW user manual
- The documentation of the radar under test (RUT)
- The R&S FSW user manual [4].

3.4 Important Parameters and Interdependencies

This section is an overview of most important parameters of the radar echo generator and the cross-reference between them. The section provides explanation of the used equations and the calculation principles, together with information on the related settings.

Radar parameter	Designation	R&S SMW simulates it as	Formula
Radar cross section (RCS)	σ	Level attenuation	"Radar equation" on page 17 Chapter 3.4.2, "Radar Received Power P_{Rx} Calculation", on page 16
Range	R	Signal delay	Chapter 3.4.4, "Delay Calculation", on page 22
Object velocity	v	Doppler frequency shift	Chapter 3.4.3, "Doppler Frequency Shift Calculation", on page 22

Background knowledge on radar principles, radar testing, and common terms in the context of the radar systems is assumed.

For related information, see:

- White Paper 1MA239: "Radar Waveforms for A&D and Automotive Radar" for an overview of the radar waveforms
- Application note 1MA256: "Real-time Radar Target Generation" for information on radar testing
- Application note 1MA127: "Introduction to Radar System and Component Tests" for an overview of the radar measurements

3.4.1 Simulated Objects Types

The R&S SMW equipped with one Radar Echo Generation option can generate the echo signal of up to 12 independent static or moving objects. In context of this firmware, a **static object** is an object with a zero object velocity. Static objects are placed at a user-defined distance (range) from the radar.

A **moving object** is an object that approaches to or moves away from the radar with a constant user-defined velocity (i.e. the acceleration is zero). The Doppler frequency shift is a positive or negative value to indicate the direction of the movement. The object can move back and forth between two user-defined positions (start range and end range). Its trajectory is a straight radial line leading out of the radar antennas.

A **static + moving object** is an artificial object, provided to simulate the combination of constant range and positive velocity.

The objects are placed on a plain area. Elevation (altitude) and angle information is not required. An isotropic antenna is assumed so that enabled objects are always visible.

3.4.2 Radar Received Power P_{Rx} Calculation

In the radar theory, the power returned to the radar P_{Rx} is given by the radar equation. The illustration on Figure 3-4 shows the influence of the radar parameters on the radar received power P_{Rx}.

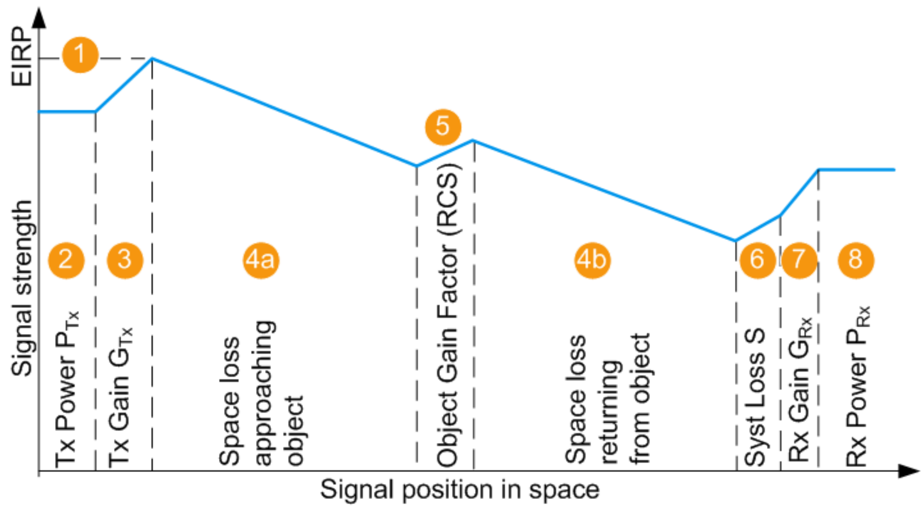


Figure 3-4: Variation of the signal strength

1 = Equivalent isotopically radiated power (EIRP) of the radar; if G_{Tx} = 0 dBi, EIRP = P_{Tx}
2,3,7 = Radar parameters, see Radar under test (RUT) settings
4a,4b = Signal attenuation, simulated by the selected (Start) Range and End Range
5 = Radar cross-section (RCS), see Radar Cross-Section RCS Setup Settings
6 = Gain to compensate for cable loss (see "System Loss" on page 30)
2 to 7 = Configurable values
8 = Power of the Rx signal returned to the radar antenna P_{Rx}, calculated according to Radar equation

Radar equation

The power of the signal Rx returned to the radar antenna P_{Rx} is calculated as follows:

P_{Rx} [dBm] =

$$= P_{Tx} + G_{Tx} + G_{Rx} + S + \sigma_j + 20*\log_{10}(c_0) - 20*\log_{10}(f) - 40*\log_{10}(R_j) - 30*\log_{10}(4\pi)$$

Where:

- P_{Rx} is the power of the whole scenario, calculated as the sum of the $P_{Rx,j}$ values; $P_{Rx,j}$ is the calculated Rx power per object j
- P_{Tx} is the radar transmitter power
(see "Radar under test (RUT) settings" on page 30)
- G_{Tx} and G_{Rx} are the antenna gains of the transmitting and the receiving antennas of the RUT
(see "Radar under test (RUT) settings" on page 30 and "OTA tests settings" on page 29)
- S is the system loss
(see "OTA tests settings" on page 29)
- σ_j is the radar cross section (RCS), or scattering coefficient of the object
(see Chapter 4.5, "Radar Cross-Section RCS Setup Settings", on page 42)
- R_j is the range
(see "(Start) Range" on page 39 and "End Range" on page 39)
- f is the dedicated frequency
(see "Dedicated Frequency" on page 35)

- $c_0 \approx 3*10^8$ m/s is the speed of light

The resulting $P_{Rx,j}$ [dB] for the start and end range of each object is displayed with the parameters:
- Radar Rx Power (Start)
- Radar Rx Power (End)

3.4.2.1 Calculating the REG Input and Output Levels ($RefLevel_{Analyzer}$ and $Level_{R\&S\ SMW}$)

Figure 3-4 illustrates the theoretical P_{Rx} calculation. When you generate radar echo signal with the REG, the output level at the R&S SMW RF output is set so that the RUT receives the power P_{Rx}, as it is calculated with the radar equation.

The illustration on Figure 3-5 resembles the same information as Figure 3-4, but it also depicts the level at the REG input and output. The illustration assumes the case, where:
- The Tx output of the RUT is connected over cable to the input of the analyzer
- The RF output of the R&S SMW is connected over cable to the Rx input of the RUT

The following applies:
- The signal at the REG input is $RefLevel_{Analyzer} = P_{Tx}$
- The signal at the REG output is $Level_{R\&S\ SMW} = P_{Rx}$

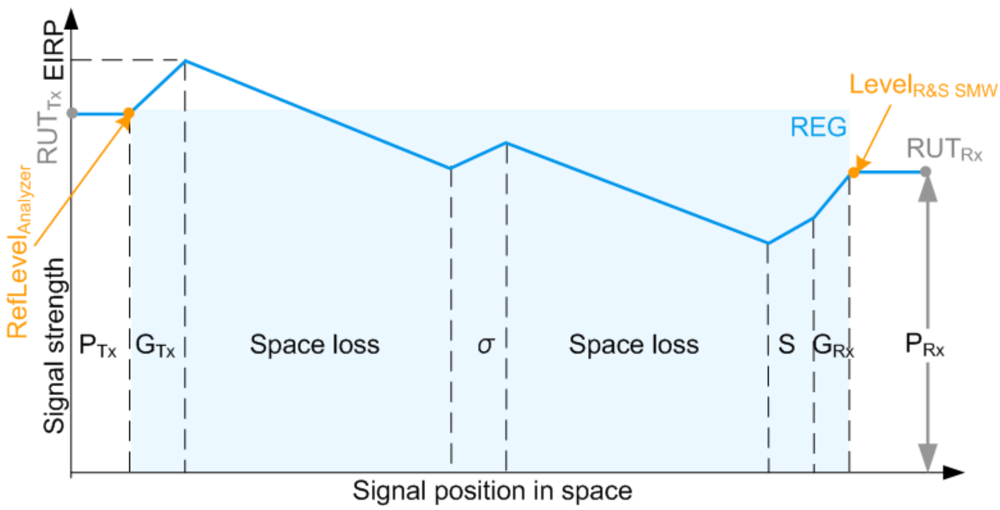


Figure 3-5: P_Rx calculation (simplified representation, "Ext. Attenuator A = 0 dB", "Test Setup = Conducted")

EIRP, P_{Tx}, G_{Tx}, G_{Rx}	= Radar parameters
Space loss	= Signal attenuation, simulated by the selected "Range"
σ	= Radar cross-section (RCS)
S	= Gain to compensate for cable loss
P_{Rx}	= Power of the Rx signal returned to the radar antenna, calculated according to Radar equation
$RefLevel_{Analyzer}$	= Signal input level at the analyzer; if "Ext. Attenuator A = 0 dB", $RefLevel_{Analyzer} = P_{Tx}$

$Level_{R\&S\ SMW}$ = Signal level at the REG output; if "Test Setup = Conducted", $Level_{R\&S\ SMW} = P_{Rx}$
RUT_{Tx} = P_{Tx} is the signal level at the RUT output
RUT_{Rx} = P_{Rx} is the signal level at the RUT input; $P_{Rx} \leq P_{Rx\ max}$, where $P_{Rx\ max}$ is the set with the parameter "RF A or RF B > RF Level > Level > Limit" (see Chapter 3.3, "Analyzer and Receiver Overload Protection", on page 15)

In practice, the RUT output is not directly connected to the REG input. The signal level at the R&S SMW RF outputs is configured in the way that the power level received by the RUT is **the calculated P_{Rx} of the whole scenario**. Connected external attenuator, antenna gains of the Rx and Tx antennas connected to the measurement equipment, distance between the antennas are considered automatically.

All these parameters are considered by the level settings in the signal analyzer and the output level of the R&S SMW. Figure 3-6 and Figure 3-7 illustrate this principle.

$RefLevel_{Analyzer}$ calculation

The reference level ($RefLevel_{Analyzer}$) depends on the external attenuation A and on the test setup. The $RefLevel_{Analyzer}$ is calculated as follows:

- **"Test Setup > Conducted Test"**
  $RefLevel_{Analyzer}$, [dBm] = P_{Tx} - A
  Where:
  – P_{Tx} is the radar transmitter power
  (see "Radar under test (RUT) settings" on page 30)
  – A is the attenuation of the external attenuator
  (see "Ext. Attenuator (Analyzer)" on page 30)

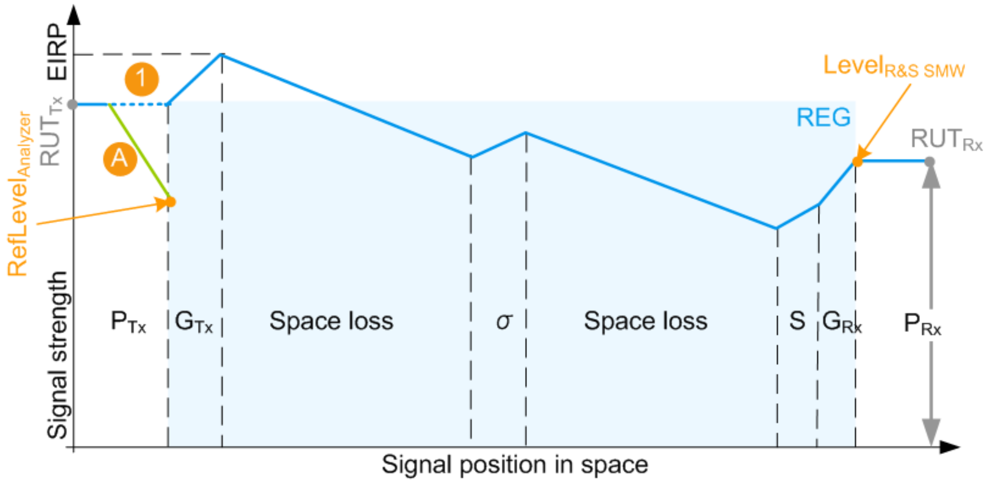


Figure 3-6: P_Rx calculation (simplified representation, "Ext. Attenuator A = A dB", "Test Setup = Conducted")

A = External attenuation
1 = External attenuation merely protects the input of the analyzer; in does not change the calculated P_{Rx} value

- **"Test Setup > OTA Test"**
  $RefLevel_{Analyzer}$, [dBm] = $P_{Tx} + G_{Tx} + G_{Rx\_REG} + 20\log_{10}(c_0) - 20\log_{10}(f) - 20\log_{10}(4\pi) - 20\log_{10}(R_{OTA}) - A$

Where:

– P_{Tx} is the radar transmitter power
(see "Radar under test (RUT) settings" on page 30)
– G_{Tx} and G_{Rx_REG} are the antenna gains of the transmitting at the radar and the receiving antennas at the REG
(see "Radar under test (RUT) settings" on page 30 and "OTA tests settings" on page 29)
– f is the dedicated frequency
(see "Dedicated Frequency" on page 35)
– $c_0 \approx 3*10^8$ m/s is the speed of light
– A is the attenuation of the external attenuator
(see "Ext. Attenuator (Analyzer)" on page 30)
– R_{OTA} is the distance between the transmitting and receiving antennas of the RUT and the REG
(see "OTA tests settings" on page 29)

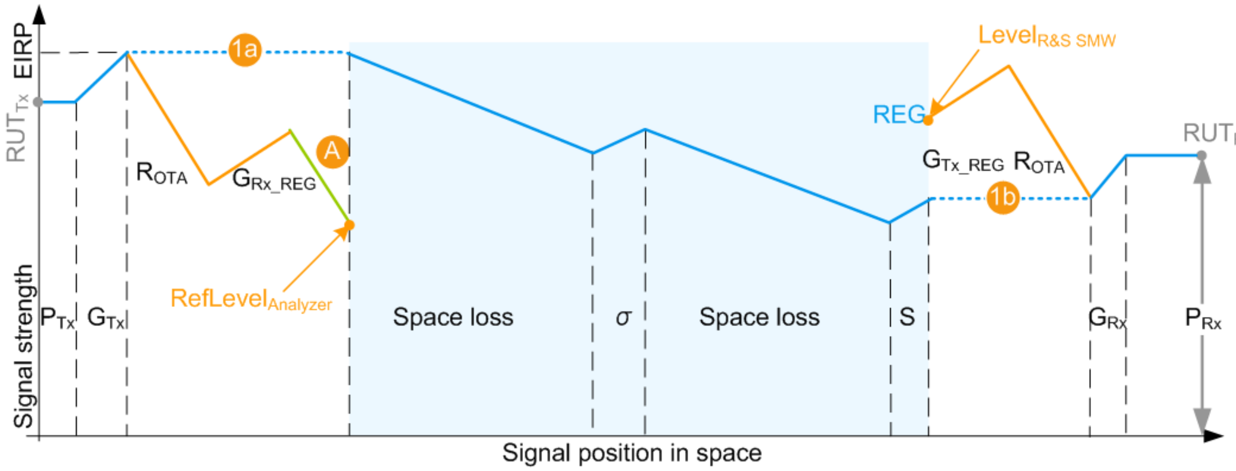


Figure 3-7: P_Rx calculation (simplified representation, "Ext. Attenuator A = A dB", "Test Setup = OTA")

A = External attenuation
1a, 1b = External attenuation A, R_{OTA}, G_{Rx_REG}, and G_{Tx_REG} do not change the calculated P_{Rx} value

$Level_{R\&S\ SMW}$ calculation

The signal power level at the RF outputs of the R&S SMW is configured in the way that **the power level received by the RUT is the calculated P_{Rx} of the whole scenario**. This is true irrespectively of the test setup and whether the $P_{Rx,j}$ values are calculated with the Radar equation or manually.

The calculated $Level_{R\&S\ SMW}$ is indicated with the parameter Level for Simulation. The displayed value considers also the following:

- Enabled level offset ("RF > RF Level > Offset")
- Current signal routing ("System Configuration > I/Q Stream Mapper > Stream A/B to RF A/B")

3.4.2.2 Setting the REG Input and Output Levels ($RefLevel_{Analyzer}$ and $Level_{R\&S\ SMW}$)

The reference level of the analyzer $RefLevel_{Analyzer}$ is important value for the calculation of the required output level at the R&S SMW. The analyzer and the R&S SMW must be properly connected.

Correct calculation and leveling

We recommend that you connect the instruments via USB (or LAN) and configure their settings from the R&S SMW and the REG dialog.

Do not change the level settings of both, the generator and the analyzer manually. Use the following alternatives instead:

- Set the parameter "System Loss" to compensate for additional attenuation.
- Set the parameter "RF > RF Level > Offset" to add a level shift.

$RefLevel_{Analyzer}$ adjustment

To ensure correct leveling *at the beginning of the simulation*, the R&S SMW performs the following:

- Calculates the required reference level ($RefLevel_{Analyzer}$) depending on the Test Setup.
- Verifies whether the calculated reference level is within the permissible value range of the analyzer.
  (see the status indication in the parameter Set Ref. Level on Analyzer)
- Verifies whether the current reference level in the analyzer is equal to the calculated value.
  If an update is indicated, select "Set Ref. Level on Analyzer" to set the level to the calculated $RefLevel_{Analyzer}$ value.

The R&S SMW does not monitor the reference level in the analyzer during operation. Subsequent changes of the reference level value are not considered.

$Level_{R\&S\ SMW}$ adjustment

To ensure correct leveling, the R&S SMW performs the following:

- Calculates the required output level $Level_{R\&S\ SMW}$ and indicates it with the parameter Level for Simulation.
  (see "$Level_{R\&S\ SMW}$ calculation" on page 20)
- Verifies whether the calculated level is within the permissible value range.
  (see the status indication in the parameter Adjust Dedicated Level)
- Identifies the dedicated connectors, i.e. all connectors to that the signal of the REG block is routed.
  ("System Configuration > I/Q Stream Mapper > Stream A/B to RF A/B")
- Verifies whether the current output level at the dedicated connector is equal to the calculated value.

If an update is indicated, select "Adjust Dedicated Level" to set the output level to the calculated value.

3.4.3 Doppler Frequency Shift Calculation

The Doppler frequency shift f_D of the signal returning for an object is calculated as follows:

$f_D = m*2*v*f/c_0$

Where:

- m is a coefficient that indicates whether the object is approaching to or departing from the radar:
  – m = -1, if "End Range" ≥ "Start Range" (departing object)
  – m = 1 otherwise (approaching object)
- |v| is the velocity of the object in the direction of travel and is given by the absolute value of the radial velocity.
  (see "Object Velocity" on page 40)
- f is the dedicated frequency
  (see "Dedicated Frequency" on page 35)
- $c_0 \approx 3*10^8$ m/s is the speed of light

Because objects move with a constant velocity, the absolute values of the Doppler frequency shift f_D is a constant value and is calculated once. The Doppler frequency of a moving object that moves one way and then stops is f_D during the movement and f_D = 0 at the distance "End Range". The Doppler frequency of an object that moves fort and backwards alternates between the 2 values $\pm f_D$; see the example on Figure 4-5.

3.4.4 Delay Calculation

The delay τ of each returned pulse is calculated as follows:

$\tau_j = 2*(R_j - R_{OTA}) / c_0$

Where:

- R_j is the range per object j
  (see "(Start) Range" on page 39 and "End Range" on page 39)
- R_{OTA} is the distance between the transmitting and receiving antennas of the RUT and the REG
  (see "OTA tests settings" on page 29)
  R_{OTA} = 0, if "Test Setup" on page 28 > "Conducted Test" is used.
- $c_0 \approx 3*10^8$ m/s is the speed of light

The signal delay τ_j is a function of the range R_j.

For static objects and static + moving objects, the signal delay τ_j is a constant value and has to be calculated once. For moving objects, the delay is calculated along the whole trajectory, i.e. form the "Start Range" to the "End Range" values.

Eliminating the blind zone BZ effect for pulse sequences with a constant PRF

The minimum delay τ_j depends on the blind zone (BZ) of the REG (see "System Latency (Blind Zone/ BZ)" on page 33). The theoretical minimum range R_{min} is the distance at that the radar and the object are colocated and can be achieved only if the $t_{BZ} = 0$.

The blind zone (also referred as system latency) is the processing time of the REG for each incoming pulse, that is the time it takes the R&S SMW and the R&S FSW to process the radar signal. Per default, the $\tau_j \geq t_{BZ}$. The first retransmitted pulse is sent after the system latency time period has elapsed, see Figure 3-8.

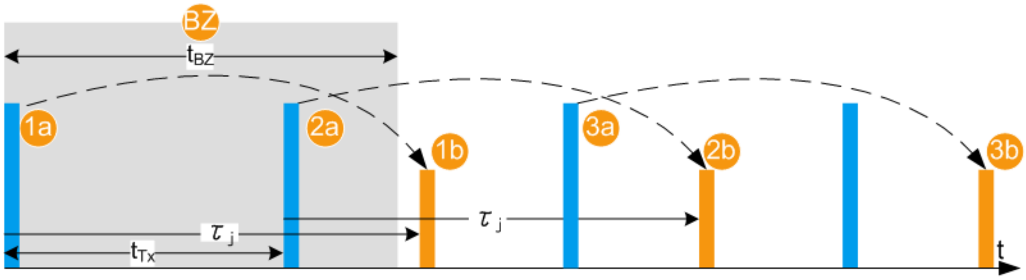


Figure 3-8: Effect of the blind zone (BZ)

BZ	= Blind zone of the 1st pulse
t_{BZ}	= Blind zone duration
1a, 1b	= 1st Tx pulse and first Rx pulse (echo), retransmitted to the RUT
2a and 2b, 3a and 3b	= Tx and Rx pulse pairs
τ_j	= Delay
t_{Tx}	= 1/PRF is the pulse repetition interval

If the radar signal is a pulse sequence with a constant known pulse repetition frequency (PRF), the bind zone limitation can be overcome. With enabled parameter Use Radar Range Ambiguity to reduce Min. Range, the REG retransmits the first echo so that once received in the RUT, this echo looks like it is the response of a subsequent (n^{th}) transmit pulse. The delay is, however, $\tau_j < t_{BZ}$. The n^{th} pulse is indicated with the parameter Fist Echo to Pulse#. The value depends on the PRF, t_{BZ} and the range R_j.

This process is illustrated on Figure 3-9. The example uses the same sequence as on Figure 3-8 but $\tau_j < t_{BZ}$. The software calculated the value $\Delta\tau_j = t_{BZ} - \tau_j$ and determines the earliest possible time point, after that an echo can be retransmitted. In this example, the first echo pulse is the response of the 2^{nd} transmitted pulse.

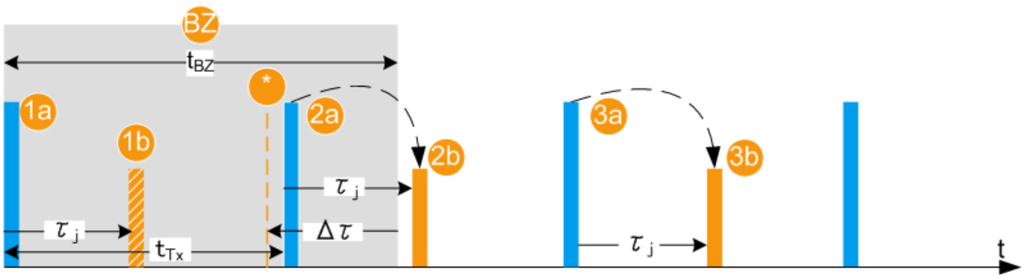


Figure 3-9: Effect of the parameter "Use Radar Range Ambiguity to Reduce min. Range = On"

BZ	=	Blind zone of the 1st pulse
t_{BZ}	=	Blind zone duration
PRF	=	Pulse repetition frequency; a known constant value
t_{Tx}	=	1/PRF is the pulse repetition interval
τ_j	=	Delay
$\Delta\tau$	=	$t_{BZ} - \tau_j$
1a, 2a, 1b	=	Pulses and echoes during the blind zone of the 1st pulse
1b	=	Theoretical echo of the 1st Tx pulse (not transmitted)
*	=	The earliest possible time point, after that an echo can be retransmitted
2a	=	Tx pulse, as transmitted by the RUT; this pulse number is indicated with the parameter Fist Echo to Pulse#
2b	=	Rx pulse (echo), retransmitted to the RUT
3a and 3b	=	Tx and Rx pulse pairs

3.4.5 System Latency Calibration

The REG system latency can be estimated automatically or set manually.

Manual calibration

The REG blind zone is set manually with the parameter System Latency (Blind Zone/BZ).

See "To estimate the system latency time roughly" on page 55 for an example on how to estimate and correct the system latency manually.

Automatic calibration

If the trigger signal of the R&S SMW is fed to the analyzer, the system latency can be estimated automatically. The trigger output connector depends on the test setup up and the signal routing ("System Configuration > I/Q Stream Mapper"). Observe the Show Trigger Connector information and connect the indicated output.

The system latency is measured once, after the automatic calibration is selected. The estimated value corresponds to the processing time of the REG, i.e. the processing time of the R&S SMW and the analyzer. The value is measured for the current REG configuration, in particular the selected signal routing. Do not change the signal routing afterwards.

The estimated value can deviate form the real system latency. Errors in the system latency result in a constant offset applied to all objects. System latency errors can be compensated by adding a correction value (Correction Values).

See:

- Data sheet for information on the system latency calibration error
- Figure 5-1 and Figure 5-2 for an overview of the default connectors and connections
- To estimate the system latency time roughly for general example on how to compensate for system latency errors

3.5 General Recommendations

Consider the following general recommendations for best results:

1. Use short connection cables
2. Connect all required cables between the REG and the RUT: reference frequency, data, control, trigger, RF signals
3. Follow the rules for overload protection
4. Configure the "System Configuration" settings, in particular the signal routing form the BB IN block to the REG blocks and to the RF outputs.
5. Set the RF frequency and if necessary a level limit and a level offset.
6. Do not change the parameter "I/Q Modulator > Digital Impairments > I/Q Delay". A value different than 0 adds an extra delay. When observed on the RUT, all objects are shifted with a constant delay
7. Set the reference frequency source
8. Configure the Radar Setup settings. Configure one ore more object.
9. Adjust the REG input level
10. Adjust the REG output level
11. Adjust the RF at the analyzer
12. If necessary, estimate the system latency automatically

For step-by-step instructions, see Chapter 5, "How to Generate Radar Echo Signals", on page 46.

4 Radar Echo Generation Configuration and Settings

This section describes the related settings.

The remote commands required to define these settings are described in Chapter 6, "Remote-Control Commands", on page 57.

For step-by-step instructions, see Chapter 5, "How to Generate Radar Echo Signals", on page 46.

The Radar Echo Generation settings are grouped into several tabs. The "Radar Setup" tab comprises the settings of your test setup, like the setup type, RUT Tx power, antenna gains at the transmitter and the receiver side, or attenuations. The "Simulation Setup" tab is where you calibrate the REG. In the "Object Configuration" tab, you can describe the objects for that the echoes are generated. If at least one object is configured and the REG is activated, the graph in the "Object Preview" tab visualizes the variation of the received power.

- Radar Setup Settings....................26
- Overview Test Setup....................31
- Simulation Setup Settings....................32
- Object Configuration Settings....................36
- Radar Cross-Section RCS Setup Settings....................42
- Object Preview Settings....................44

4.1 Radar Setup Settings

This dialog provides access to the default and the "Save/Recall" settings, and to the power and antenna gain parameters of the radar and the radar echo generator (REG). The power and gain parameters are required to calculate the received power Rx.

Access:

1. In the block diagram of the R&S SMW, select "System Config > System Configuration > Fading/Baseband Config > Mode > Radar Echo Generation".
2. Select "Apply" and confirm with "OK".
3. Close the "System Configuration" dialog.
4. In the block diagram, select "REG > Radar Echo Generation"

   The Radar Echo Generation dialog box opens and displays the "Radar Setup" settings.

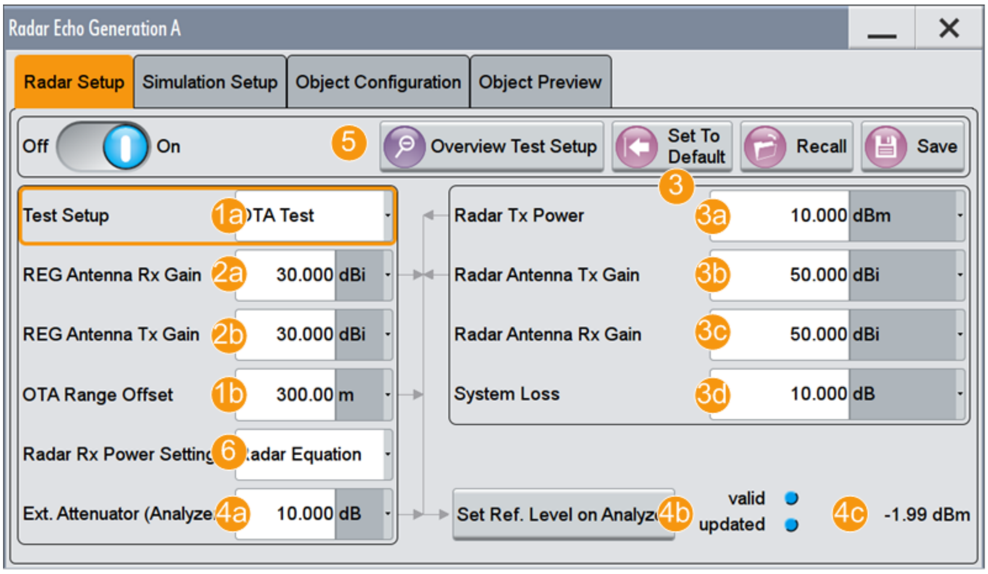


Figure 4-1: "Radar Setup": Understanding the displayed information

1a, 1b	= Test setup type; in this example: test setup with real radar signal, incl. R&S SMW, and signal analyzer; the radar signal is transmitted over the air (OTA)
2a, 2b	= Radar echo generator (REG) settings
3, 3a, 3b, 3c, 3d	= Radar under test (RUT) settings
4a, 4b, 4c	= External attenuator and analyzer-related settings
5	= Test setup overview, see Figure 4-2
6	= General decision on the radar Rx power settings calculation, see Chapter 3.4.2, "Radar Received Power P_{Rx} Calculation", on page 16

Settings:

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Overview Test Setup.......28
Set to Default.......28
Save/Recall.......28
Test Setup.......28
OTA tests settings.......29
└ REG Antenna Rx Gain.......29
└ REG Antenna Tx Gain.......29
└ OTA Range Offset.......29
Radar Rx Power Setting.......29
Radar under test (RUT) settings.......30
└ Radar Tx Power.......30
└ Radar Antenna Tx Gain.......30
└ Radar Antenna Rx Gain.......30
└ System Loss.......30
Ext. Attenuator (Analyzer).......30
Set Ref. Level on Analyzer.......30

State

Enables/disables the Radar Echo Generation.

Remote command:
[:SOURce<hw>]:REGenerator[:STATe] on page 60

Overview Test Setup
Opens a dialog that illustrates the required (and connected) equipment and cables for the configuration selected with the parameter "Test Setup", see Chapter 4.2, "Overview Test Setup", on page 31.

The displayed information resumes the settings selected in the "Radar Setup" dialog.

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

Parameter	Value
State	Off
Test Setup	Conducted
Tx Power of Radar	0 dBm
Radar Rx Power Settings	Radar Equation
Radar Antenna Tx and Rx Gain	50 dBi
System loss	0 dB

Remote command:
[:SOURce<hw>]:REGenerator:PRESet on page 60

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

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

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

Remote command:
[:SOURce<hw>]:REGenerator:CATalog? on page 60
[:SOURce<hw>]:REGenerator:STORe on page 60
[:SOURce<hw>]:REGenerator:LOAD on page 61

Test Setup
Selects how the radar signal is fed from the RUT to the signal analyzer and fed back form the R&S SMW to the RUT.

Tip: Use the "Overview Test Setup" function to retrieve more information on the current setup.

See for example Figure 4-2.

Tip: Use the parameter "System Loss" to compensate for system or cable loss.

"Conducted Test"
The radar signal is transmitted over cables; there is a cable connection between the RUT and the radar echo generator (REG).

"OTA Test" The transmission is performed over-the-air (OTA); there is no cable connection but Tx and Rx antennas are used in both the RUT and the REG.

Remote command:
[:SOURce<hw>]:REGenerator:RADar:TSETup on page 62

OTA tests settings
If a "Test Setup > OTA Test" is used, the following parameters are required for the calculation of the Rx signal power, the ranges and the reference level of the analyzer.

The calculation is performed according to the Radar equation.

REG Antenna Rx Gain ← OTA tests settings
Sets the gain of receiving antenna that is connected to the REG (G_{Rx_REG}).

Remote command:
[:SOURce<hw>]:REGenerator:RADar:ANTenna:REG:GAIN:RX on page 63

REG Antenna Tx Gain ← OTA tests settings
Sets the gain of transmitting antenna that is connected to the REG (G_{Tx_REG}).

Remote command:
[:SOURce<hw>]:REGenerator:RADar:ANTenna:REG:GAIN:TX on page 63

OTA Range Offset ← OTA tests settings
Sets the distance between the transmitting and receiving antennas of the RUT and the REG (R_{OTA}).

Remote command:
[:SOURce<hw>]:REGenerator:RADar:OTA:OFFSet on page 64

Radar Rx Power Setting
Determines how the radar receive power is calculated.

"Radar Equation"
The radar Rx power is calculated according to the radar equation, see Chapter 3.4.2, "Radar Received Power P_{Rx} Calculation", on page 16.
Each object is described by its radar cross-section (RCS).
To select the applied model and its settings, select "Object Configuration > RCS...".
See Chapter 4.5, "Radar Cross-Section RCS Setup Settings", on page 42.

"Manual" The radar equation is not used; you set the $P_{Rx,\,j}$ value of each object instead.
See Radar Rx Power.
This parameter is useful if your test situation requires a specific Rx power.

Remote command:
[:SOURce<hw>]:REGenerator:RADar:POWer:MODE on page 63

Radar under test (RUT) settings
Refer to the product documentation of the RUT for information on its characteristics.

The following input parameters are required for the calculation of the Rx signal power P_{Rx} of the signal returning to the radar antenna.

The calculation is performed for each object and according to the Radar equation.

Radar Tx Power ← Radar under test (RUT) settings
Sets the radar transmit power P_{Tx}.

If the "Radar Antenna Tx Gain = 0 dBi", the P_{Tx} value corresponds to the EIRP of the radar (see Figure 3-4).

Remote command:
[:SOURce<hw>]:REGenerator:RADar:POWer:TX on page 62

Radar Antenna Tx Gain ← Radar under test (RUT) settings
Sets the antenna gain of transmitting antenna G_{Tx}

Remote command:
[:SOURce<hw>]:REGenerator:RADar:ANTenna:GAIN:TX on page 63

Radar Antenna Rx Gain ← Radar under test (RUT) settings
Sets the antenna gain of receiving antenna G_{Rx}

Remote command:
[:SOURce<hw>]:REGenerator:RADar:ANTenna:GAIN:RX on page 63

System Loss ← Radar under test (RUT) settings
Gain to compensate for system or cable loss.

Remote command:
[:SOURce<hw>]:REGenerator:RADar:POWer:LOSS on page 63

Ext. Attenuator (Analyzer)
The parameter is enabled only if a R&S FSW is connected to the R&S SMW.

Connect an external attenuator to reduce the radar Tx power and to protect the input stage of the analyzer, see Chapter 3.3, "Analyzer and Receiver Overload Protection", on page 15.

Set the parameter to the attenuation (A) of your external attenuator.

Remote command:
[:SOURce<hw>]:REGenerator:RADar:ANALyzer:POWer:ATTenuator on page 64

Set Ref. Level on Analyzer
Indicates the calculated reference level and sets this level in the R&S FSW; see Chapter 3.4.2.1, "Calculating the REG Input and Output Levels ($RefLevel_{Analyzer}$ and $Level_{R\&S SMW}$)", on page 18.

The operation "Set Ref. Level on Analyzer" is enabled and a value is displayed only if a R&S FSW is connected to the R&S SMW.

Status LED and status information indicate the following:

- **Valid + blue LED**: the calculated reference level is within the permissible value range of the R&S FSW.
- **Valid + orange LED**: indicates that the reference level is outside the permissible value range; the operation "Set Ref. Level on Analyzer" is disabled.
- **Update + orange LED**: the reference level of the R&S FSW deviates from the calculated value; execute the operation "Set Ref. Level on Analyzer".
- **Update + blue LED**: the reference level of the R&S FSW is equal to the calculated value.

Remote command:
`[:SOURce<hw>]:REGenerator:RADar:ANALyzer:POWer:REFerence?` on page 64
`[:SOURce<hw>]:REGenerator:RADar:ANALyzer:POWer:APPLy` on page 65
`[:SOURce<hw>]:REGenerator:RADar:ANALyzer:STATus?` on page 65

4.2 Overview Test Setup

Access:

1. Select "REG > Radar Echo Generation > Overview Test Setup"

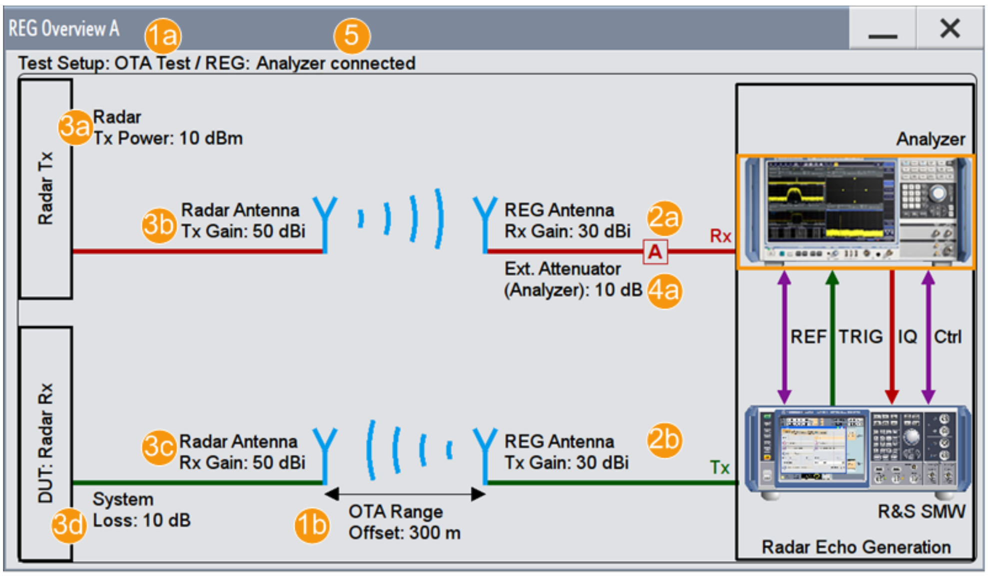


Figure 4-2: Overview Test Setup: Understanding the displayed information

1a	= Test setup type, incl. information on the detected connected analyzer
1b	= Distance between the antennas
2a, 2b	= REG settings
3a, 3b, 3c, 3d	= RUT settings
4a	= External attenuator
5	= Status of the physical connection to the analyzer

The displayed information depends on the setup and resumes the settings selected in the "Radar Setup" dialog, see Figure 4-1.

2. In the diagram, select the R&S SMW or the R&S FSW.
Use the context menu to show the physical location of the connectors.

For example, the test setup shown on Figure 4-2 requires the following connections:
- **REF:** R&S FSW REF OUT to R&S SMW REF IN
- **IQ:** R&S FSW DIG BASEBAND OUTPUT to R&S SMW DIG I/Q on the CODER board
- **TRIG:** R&S SMW USER 4 to R&S FSW TRIGGER 3
- **Ctrl:** R&S SMW USB (Type A) to R&S FSW USB DEVICE, alternative connect the instruments via LAN
- R&S SMW RF A to REG Tx antenna

See also:
- Figure 3-1
- "To connect the R&S FSW to the R&S SMW" on page 47

Show DIG I/Q IN/OUT, reference frequency, trigger, RF connector
Opens the "Find Connector" dialog and displays the physical location of the connectors on the front/rear panel of the R&S SMW and R&S FSW.

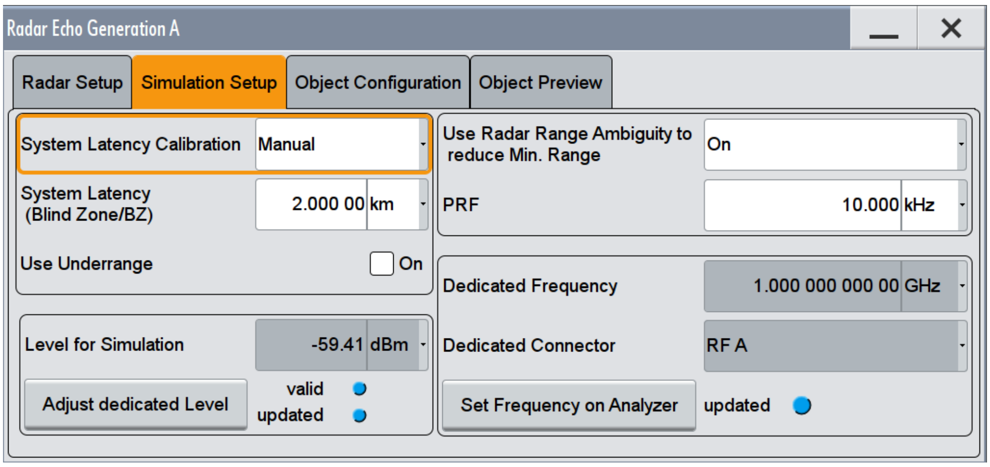
A blinking LED on the front/rear panel indicates the selected connector, too.

The required connections depend on the test setup.

4.3 Simulation Setup Settings

Access:

► Select "REG > Radar Echo Generation > Simulation Setup".



Settings:

System Latency Calibration ... 33
System Latency (Blind Zone/ BZ) ... 33
Use Underrange ... 34
Calibration Successful ... 34
Correction Values ... 34
Use Radar Range Ambiguity to reduce Min. Range ... 34
PRF ... 34
Level for Simulation ... 35
Adjust Dedicated Level ... 35
Dedicated Frequency ... 35
Dedicated Connector ... 35
Set Frequency on Analyzer ... 36

System Latency Calibration

Determines how the system latency is estimated.

"Automatic" This value is enabled only if a R&S FSW is connected to the R&S SMW.
If an analyzer is connected to the R&S SMW, the system latency can be estimated automatically. The value corresponds to the processing time of the REG, that is the processing time of the R&S SMW and the analyzer.
If necessary, you can enter a correction value (see Correction Values).
For more information, see Chapter 3.4.5, "System Latency Calibration", on page 24.

"Manual" Sets the blind zone value manually, see System Latency (Blind Zone/ BZ).
See also "To estimate the system latency time roughly" on page 55.

Remote command:
`[:SOURce<hw>]:REGenerator:SIMulation:CALibration:MODE` on page 66

System Latency (Blind Zone/ BZ)

("System Latency Calibration > Manual")

The system latency (also referred as blind zone) is the processing time of the REG *for each incoming Tx pulse* transmitted by the RUT. Per default, the first retransmitted pulse is sent after the system latency time period has elapsed.

To simulate objects that are closer to the radar than the BZ of the REG, enable the parameter Use Radar Range Ambiguity to reduce Min. Range.

See also:
- "Eliminating the blind zone BZ effect for pulse sequences with a constant PRF" on page 23
- "To estimate the system latency time roughly" on page 55.

Remote command:
`[:SOURce<hw>]:REGenerator:SIMulation:LATency[:BZ]` on page 66

Use Underrange
Enable this parameter to simulate objects at a range closer than 2.1 km.

This minimum range value corresponds to the "Blind Zone/BZ" (see data sheet).

"Off"	$Range_{min}$ = 2.1 km This value is also the min value of the parameter (Start) Range/End Range.
"On"	$Range_{min}$ = System Latency (Blind Zone/ BZ) + Correction Values Where "Correction Value" is required in System Latency Calibration > "Automatic" mode.

Remote command:
`[:SOURce<hw>]:REGenerator:SIMulation:CALibration:URANge`
on page 66

Calibration Successful
The parameter is enabled only if a R&S FSW is connected to the R&S SMW.

If the system latency is estimated automatically, the color LED indicates the calibration status:
- **Blue LED:** successful calibration
- **Orange LED:** calibration failure

Note: Unsuccessful calibration.
If the calibration fails, check the cabling between the R&S SMW and the R&S FSW.

Check in particular the connection between the DIG I/Q interfaces and the cable supling the trigger signal, see Figure 3-1.

See also Chapter 3.4.5, "System Latency Calibration", on page 24.

Remote command:
`[:SOURce<hw>]:REGenerator:SIMulation:CALibration[:STATe]?`
on page 67

Correction Values
Adds a correction to the automatically estimated system latency value.

Remote command:
`[:SOURce<hw>]:REGenerator:SIMulation:CALibration:CORRection`
on page 67

Use Radar Range Ambiguity to reduce Min. Range
Enable this parameter to simulate objects closer to the radar than the minimal range (BZ) for a constant PRF.

For more information, see Figure 3-9.

Remote command:
`[:SOURce<hw>]:REGenerator:SIMulation:MINRange[:STATe]` on page 68

PRF
Sets the pulse repetition frequency (PRF).

Remote command:
`[:SOURce<hw>]:REGenerator:SIMulation:PRF` on page 68

Level for Simulation
Show the calculated level value for the signal at the RF output ($Level_{R\&S\ SMW}$).

The level is calculated for the current scenario settings, incl. test setup, objects settings, enabled level offset ("RF > RF Level > Offset") etc. The level is calculated so that the RUT receives the power P_{Rx}, as it is calculated with the radar equation.

See:
- "$Level_{R\&S\ SMW}$ adjustment" on page 21
- Chapter 3.4.2, "Radar Received Power P_{Rx} Calculation", on page 16

Remote command:
`[:SOURce<hw>]:REGenerator:SIMulation:LEVel?` on page 69

Adjust Dedicated Level
Sets the output level ("Status bar > Level") to the value displayed with the parameter Level for Simulation. The affected output connector depends on the signal routing ("System Configuration > I/Q Stream Mapper").

If the test setup requires a level offset, always set the value "RF > RF Level > Offset" before selecting "Adjust Dedicated Level".

Status LED and status information indicate the following:
- **Valid + blue LED**: the calculated output level is within the permissible value range of the R&S SMW.
- **Valid + orange LED**: indicates that the reference level is outside the permissible value range; the operation "Adjust Dedicated Level" is disabled.
- **Update + orange LED**: the output level ("Status bar > Level") deviates from the calculated value; execute the operation "Adjust Dedicated Level".
- **Update + blue LED**: the output level of the R&S SMW is equal to the calculated value.

See:
- "$Level_{R\&S\ SMW}$ adjustment" on page 21
- Chapter 3.4.2, "Radar Received Power P_{Rx} Calculation", on page 16

Remote command:
`[:SOURce<hw>]:REGenerator:SIMulation:LEVel:APPLy` on page 70
`[:SOURce<hw>]:REGenerator:SIMulation:LEVel:UPDated[:STATus]?`
on page 70
`[:SOURce<hw>]:REGenerator:SIMulation:LEVel:VALid[:STATus]?`
on page 70

Dedicated Frequency
Displays the dedicated RF frequency that is used for the calculation of the Doppler shift and the P_{Rx}.

The value also includes enabled "Frequency Offset" in the "I/Q Stream Mapper".

See "Radar equation" on page 17.

Remote command:
`[:SOURce<hw>]:REGenerator:SIMulation:FREQuency` on page 69

Dedicated Connector
Displays the connector used to determine the Dedicated Frequency.

Remote command:
[:SOURce<hw>]:REGenerator:SIMulation:CONNector on page 68

Set Frequency on Analyzer
The parameter is enabled only if a R&S FSW is connected to the R&S SMW.

Sets the frequency indicated with the parameter Dedicated Frequency in the connected analyzer.

The color LED indicates the update status:
- **Blue LED:** Analyzer frequency is updated; it matches the "Dedicated frequency" value
- **Orange LED:** Analyzer frequency differs from "Dedicated frequency" value.

Remote command:
[:SOURce<hw>]:REGenerator:SIMulation:ANALyzer:FREQuency:APPLy on page 69
[:SOURce<hw>]:REGenerator:SIMulation:ANALyzer:STATus on page 69

4.4 Object Configuration Settings

Access:

► Select "REG > Radar Echo Generation > Object Configuration".

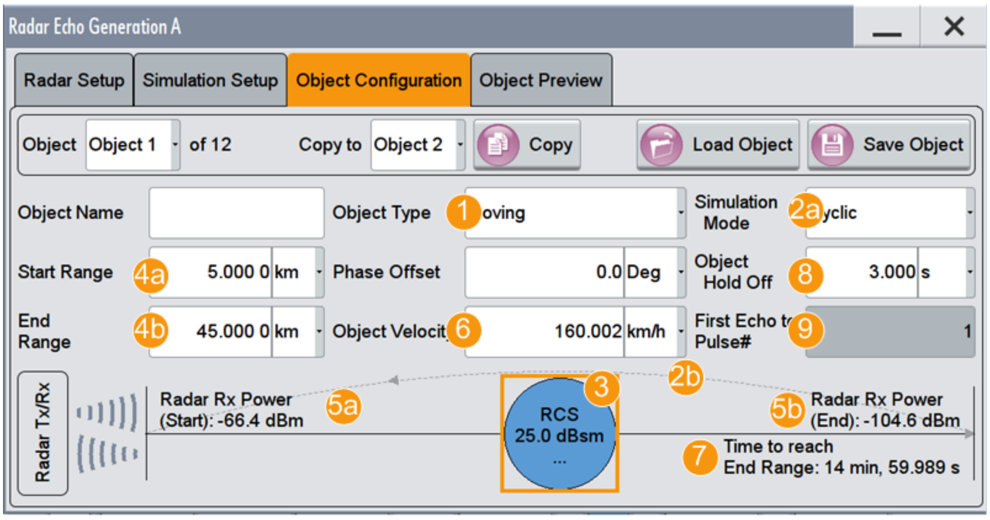


Figure 4-3: Object Configuration: Understanding the displayed information

1	= Moving object
2a, 2b	= Movement mode selection and indication of the trajectory
3	= Access to the "RCS Setup" dialog, see Chapter 4.5, "Radar Cross-Section RCS Setup Settings", on page 42
4a,4b and 5a,5b	= Start and end range and the calculated radar Rx power

6, 7	=	Object velocity and the duration of a single movement form the start to the end range
8	=	Delays the object appearance
9	=	If Use Radar Range Ambiguity to reduce Min. Range is enabled, the parameter indicates the first pulse for that an echo is generated

The visualization depends on the selected "Object Type".
You can configure up to 12 objects individually, store their configuration into files, and load these files for quick setup later.

Settings:

Object # of 12....37
Copy to....37
Copy....37
Load/Save Object....38
Object Name....38
Object Type....38
Simulation Mode....38
Radar Rx Power (Start)....39
Radar Rx Power (End)....39
Time to Reach End Range....39
(Start) Range....39
End Range....39
Phase Offset....40
Object Velocity....40
Direction....40
Object Hold Off....40
Fist Echo to Pulse#....41
Radar Rx Power....41
Radar Rx Power Dedicated to....41
RCS....42

Object # of 12

Selects the number of the current object.

If the "Copy" function is used, this object is also the object whose settings are applied to the other objects.

Remote command:
`[:SOURce<hw>]:REGenerator:OBJect:COPY:SOURce` on page 72

Copy to

Selects the objects whose settings are to be overwritten.

Remote command:
`[:SOURce<hw>]:REGenerator:OBJect:COPY:DESTination` on page 72

Copy

Triggers the copy function.

Remote command:
`[:SOURce<hw>]:REGenerator:OBJect:COPY:EXECute` on page 72

Load/Save Object

Accesses the "File Select" dialog for storing and loading the object settings from a file.

You can configure several objects and store their configuration in files, for example to build an object library. Use the "Save/Recall" on page 28 function to store the common scenario settings in a file.

Remote command:
[:SOURce<hw>]:REGenerator:OBJect:CATalog? on page 71
[:SOURce<hw>]:REGenerator:OBJect<ch>:STORe on page 71
[:SOURce<hw>]:REGenerator:OBJect<ch>:LOAD on page 72

Object Name

Enter a name to indicate the object.

Remote command:
[:SOURce<hw>]:REGenerator:OBJect<ch>:NAME on page 73

Object Type

Sets the object type or disables it.

Further settings depend on the object type.

See also Chapter 3.4.1, "Simulated Objects Types", on page 16.

"Off" Disables the object, for example to exclude the object temporary from the simulation.

"Static" Static objects are described with a fixed range and no velocity.

"Static + Moving" These artificial objects are described with a fixed range and a velocity.

"Moving" Moving object are described with different start and end range and a velocity.

Remote command:
[:SOURce<hw>]:REGenerator:OBJect<ch>:TYPE on page 73

Simulation Mode

Describes how the object moves.

Observe the graphical indication on the display.

"One Way" The object moves from the start to the end range once.
Once the end range is reached, the object is simulated as a static one.

"Cyclic" The object moves cyclically form the start to the end range.
Once the end range is reached, the movement restarts; the object jumps from the end to the start range.

"Round Trip" The object moves back and forth between the start and end range.

Remote command:
[:SOURce<hw>]:REGenerator:OBJect<ch>:SIMMode on page 73

Radar Rx Power (Start)

Indicates the radar Rx power P_{Rx} at the beginning of the simulation. The value is calculated according to the Radar equation for the Start Range R.

If the Radar Rx Power Setting > "Manual" is used, the $P_{Rx,j}$ is a user-defined value (see "Radar Rx Power" on page 41).

Remote command:
[:SOURce<hw>]:REGenerator:OBJect<ch>:POWer:RX on page 73
[:SOURce<hw>]:REGenerator:OBJect<ch>:POWer:RX:STARt? on page 74

Radar Rx Power (End)

Indicates the radar Rx power P_{Rx} at the farthest distance a moving object reaches. The value is calculated according to the Radar equation for the End Range.

If the Radar Rx Power Setting > "Manual" is used, the $P_{Rx,j}$ is a user-defined value (see "Radar Rx Power" on page 41).

Remote command:
[:SOURce<hw>]:REGenerator:OBJect<ch>:POWer:RX:END? on page 74

Time to Reach End Range

Indicates how long it takes that the object moves from the Start Range to the End Range position.

The value is calculated as follows:

"Time to Reach End Range" = ("End Range" - "Start Range") / "Object velocity"

Remote command:
[:SOURce<hw>]:REGenerator:OBJect<ch>:TIME:TOENd? on page 76

(Start) Range

Sets the distance between the object and the radar (range, R) at the beginning of the simulation.

Static objects are simulated at a constant "Range".

Moving objects slide with the selected Object Velocity from the Start Range towards the End Range. Further movement depends on the selected Simulation Mode.

The value is required for the calculation of the radar start Rx power P_{Rx} according to the Radar equation.

Ranges are simulated by adding a delay to the signal.

The minimum start range R_{min} has to fulfill the following:

R_{min} ≥ BZ + OTA Range Offset + Correction Values

Where "Correction Value" is required in System Latency Calibration > "Automatic" mode.

Remote command:
[:SOURce<hw>]:REGenerator:OBJect<ch>:RANGe:STARt on page 75

End Range

Sets the farthest distance to the radar a moving object reaches.

Moving objects slide with the selected Object Velocity from the Start Range towards the End Range. Further movement depends on the selected Simulation Mode.

The value is required for the calculation of the radar end Rx power P_{Rx} according to the Radar equation.

Ranges are simulated by adding a delay to the signal.

The minimum end range R_{min} has to fulfill the following:

R_{min} ≥ BZ + OTA Range Offset + Correction Values

Where "Correction Value" is required in System Latency Calibration > "Automatic" mode.

Remote command:
`[:SOURce<hw>]:REGenerator:OBJect<ch>:RANGe:END` on page 75

Phase Offset
Enables a phase offset between the transmitted pulse and the echo signal.

Use this parameter to simulate a phase shift introduced by reflection at an object.

Remote command:
`[:SOURce<hw>]:REGenerator:OBJect<ch>:PHASe[:OFFSet]` on page 76

Object Velocity
Sets the speed of a moving object in the direction of travel.

Velocity is simulated by applying a Doppler frequency shift to the signal.

See also "Direction" on page 40.

Remote command:
`[:SOURce<hw>]:REGenerator:OBJect<ch>:OVELocity` on page 75

Direction
Sets the direction of travel of a static + moving object, that is whether it is approaching to or departing from the radar.

Remote command:
`[:SOURce<hw>]:REGenerator:OBJect<ch>:DIRection` on page 75

Object Hold Off
Enters a time delay form the simulation start time to the moment at that an object appears for the first time.

The simulation start time is the moment you activate the REG, that is "REG" > State > "On". The appearance accuracy of the first object is ≤50 ms. The difference in the time of appearance between any two objects is ≤1 ms.

Example:

Two objects with the following time of appearance:
- "Time Object#1 Appears = 3 s"
- "Time Object#2 Appears = 4.001 s"

Object#1 appears (3 s + ≤50 ms) after the simulation start time. Object#2 appears 1.001 s after the object#1.

Remote command:
[:SOURce<hw>]:REGenerator:OBJect<ch>:HOLD:OFF on page 76

Fist Echo to Pulse#
Indicates the number of the first pulse for that an echo signal is generated.

The value is calculated as a function of the BZ, the delay τ and the PRF, see Figure 3-9.

Remote command:
[:SOURce<hw>]:REGenerator:OBJect<ch>:FEPNumber? on page 77

Radar Rx Power
If Radar Rx Power Setting > "Manual" is used, this parameter sets the Rx power of each object.

The radar equation is not used; you set the $P_{Rx,\ j}$ value instead.

If a moving object is simulated, set also the parameter Radar Rx Power Dedicated to.

See also Figure 3-4.

Remote command:
[:SOURce<hw>]:REGenerator:OBJect<ch>:POWer:RX on page 73

Radar Rx Power Dedicated to
If Radar Rx Power Setting > "Manual" is used, defines how the Rx power of a moving object is calculated at its start and end positions.

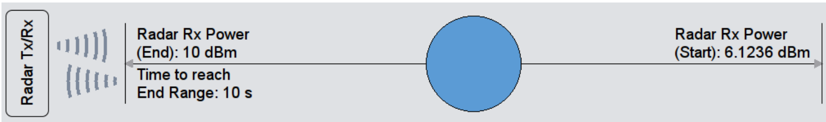
"All Range" The Rx power of the moving object is constant value, set as follows:
$P_{Rx,\ jStartRange} = P_{Rx,\ jEndRange}$ = Radar Rx Power

"Start Range" The value set with the parameter "Radar Rx Power" corresponds to the Rx power at the start range:
$P_{Rx,\ jStartRange}$ = Radar Rx Power
The Rx Power at the end range is calculated depending on the distance between both positions.

"End Range" The calculation is analog to the calculation in the "Radar Rx Power Dedicated to > Start Range" case.

Example:
- "Radar Setup > Radar Rx Power Settings = Manual"
- "Object Configuration > Object Type = Moving"
- "Start Range = 5 km"
- "End Range = 4 km"
- "Radar Rx Power = 10 dBm"
- "Radar Rx Power Dedicated to > End Range"

Observe the visualization and the displayed value.



- The displayed information confirms that the object is arriving toward the RUT.
  Its "End Range" < "Start Range".
- Radar Rx Power $P_{Rx, jEndRange}$ = 10 dBm
- Radar Rx Power $P_{Rx, jStartRange}$ = 6.12 dBm

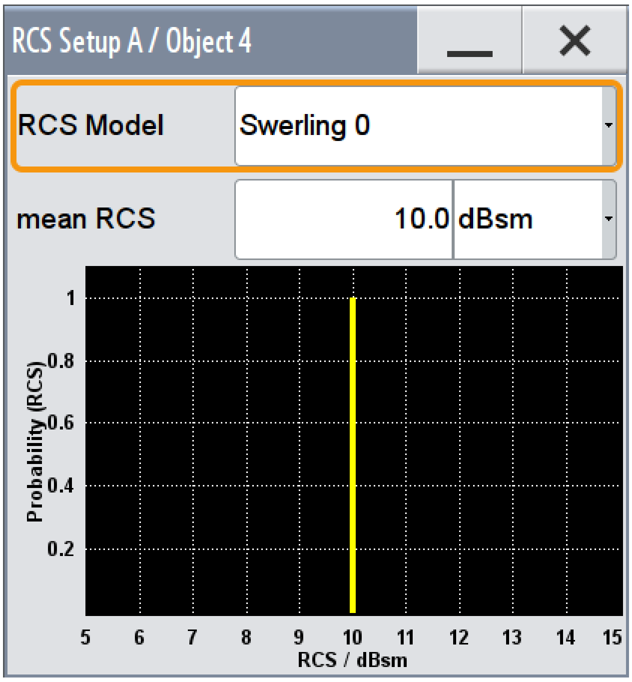
Remote command:
[:SOURce<hw>]:REGenerator:OBJect<ch>:POWer:RX:DEDication
on page 74

RCS
Accesses the "RCS Setup" dialog for selecting the applied model, see Chapter 4.5, "Radar Cross-Section RCS Setup Settings", on page 42.

4.5 Radar Cross-Section RCS Setup Settings

Access:

1. Select "REG > Radar Echo Generation > Object Configuration"
2. Select the number of the particular object, for example "Object = 4".
3. In the diagram, click the "RCS" circle.



4. In the "RCS Setup" dialog, select the applied model and its settings.

   The dialog displays a graph of the RCS probability distribution function. For the "Swerling 0" model, this RCS probability is 1 at the "mean RCS" value and zero elsewhere.

Settings:

RCS Model..43
mean RCS..43

RCS Model

Selects the model used to describe the radar cross-section (RCS) of the selected object.

"Swerling 0" Standard model used to describe the statistical properties of the RCS as a function of the mean RCS value.

"Swerling I, II, III, IV"
Reserved for future use.

Remote command:
[:SOURce<hw>]:REGenerator:OBJect<ch>:RCS:MODel on page 75

mean RCS

Sets the mean RCS value required for the RCS calculation.

Remote command:
[:SOURce<hw>]:REGenerator:OBJect<ch>:RCS:MEAN on page 76

4.6 Object Preview Settings

Access:

1. In the block diagram, select "REG > Radar Echo Generation > Object Preview".
2. Select "Diagram Type > Range/Velocity View".

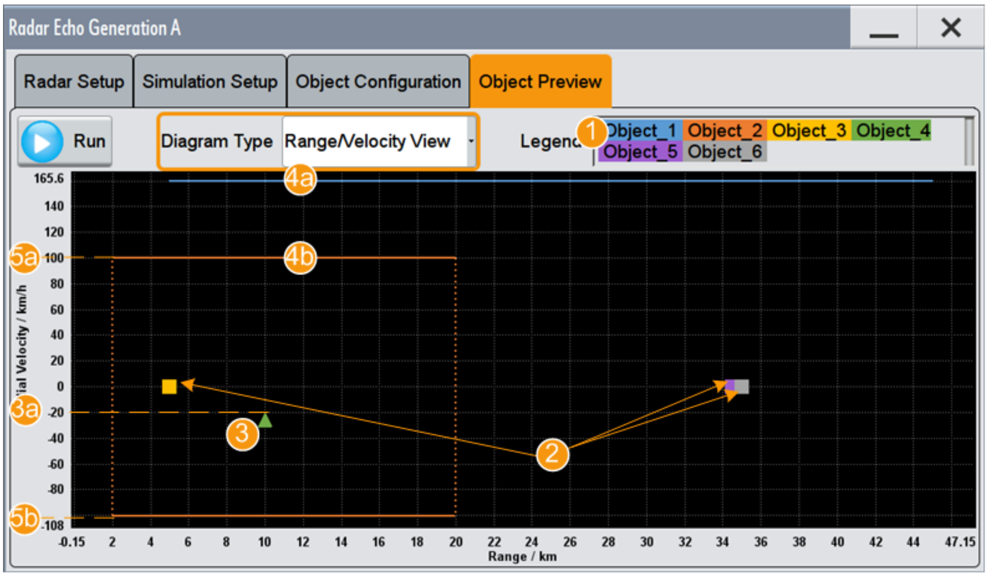


Figure 4-4: "Object Preview > Range/Velocity View": Understanding the displayed information

1	= Legend that indicates the object and the assigned colors
2	= Static objects; static objects have different "Ranges" and "Velocity = 0 km/h"
3, 3a	= Moving + static object; moving + static objects have "Range" and "Velocity≠0 km/h"; the negative velocity value indicates an approaching object (see Direction)
4a, 4b	= Range variation of moving objects with different "Velocity"
Colored arrows	= Indicate the direction of travel of the moving objects
4a	= Object that moves "One Way" or "Cyclic"
4b	= Object that moves fort and backwards ("Round Trip")
5a, 5b	= The Doppler frequency alternates between the two values $\pm f_D$ and so does the "Velocity" (see Chapter 3.4.3, "Doppler Frequency Shift Calculation", on page 22)

3. Select "Diagram Type > Radar Rx Power View".

   The diagram shows the variation of the radar Rx power (P_{Rx}) as a function of the range. It gives information on the min and max value the P_{Rx}, that is the theoretical dynamic power range of the scenario.

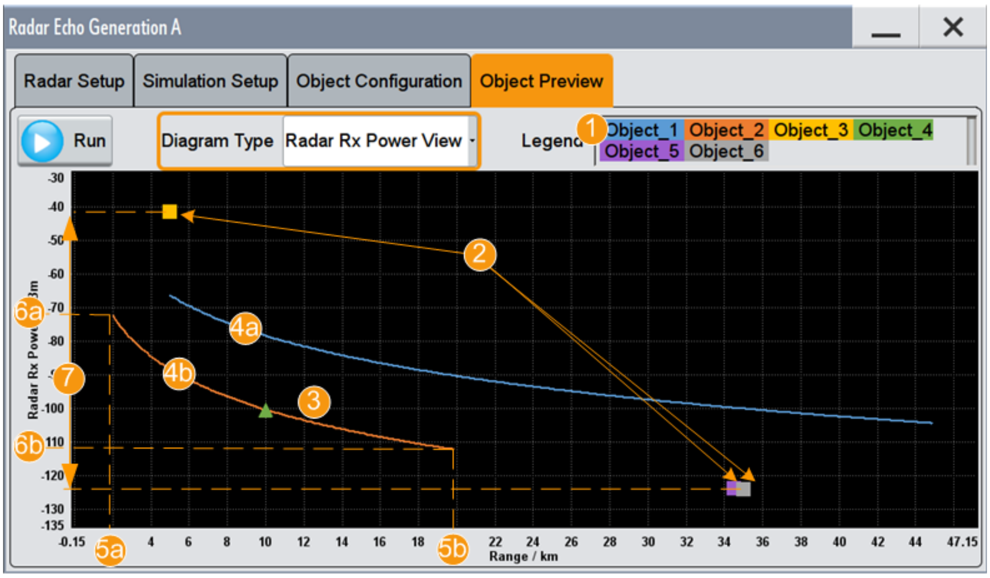


Figure 4-5: "Object Preview > Radar Rx Power View": Understanding the displayed information

1 = Legend that indicates the object and the assigned colors
2 = Static objects
3 = Moving + static object
5a,5b = Start and end range of one object
4a,4b = P_{Rx} variation over the range
6a,6b = Max and min value of P_{Rx} (per object)
7 = Theoretical dynamic power range of the scenario, where the max value is the $P_{Rx, 3}$ (static object) and the min value is the $P_{Rx, 6}$ (static object)

Both diagrams visualize *all active* objects, where different colors are assigned to each object. Moving + static objects are indicates with triangles; the static objects with squares.
Static objects are displayed at their "Range". Moving objects slide between the "Start Range" and "End Range", where the speed is relative to the object velocity.

Remote command:

[:SOURce<hw>]:REGenerator:DIAGram:STATe on page 77

Settings:

Diagram Type.....45

Diagram Type

Switches between the "Radar Rx Power View" and "Range/Velocity View".

See Chapter 4.6, "Object Preview Settings", on page 44.

Remote command:
[:SOURce<hw>]:REGenerator:DIAGram:TYPE on page 77

5 How to Generate Radar Echo Signals

This section shows you how to use the R&S SMW to generate radar echo signals. If there are several possibilities to connect the instruments or to configure the settings, the most common one of them is shown.

In the following, we assume that:

- The R&S SMW is equipped all options required to generate 24 echoes (see Chapter 3.1, "Required Options and Equipment", on page 12)
- All required cables are available (see "Required additional equipment and cables" on page 12)
- A **conducted test setup** is used (see Figure 5-1)

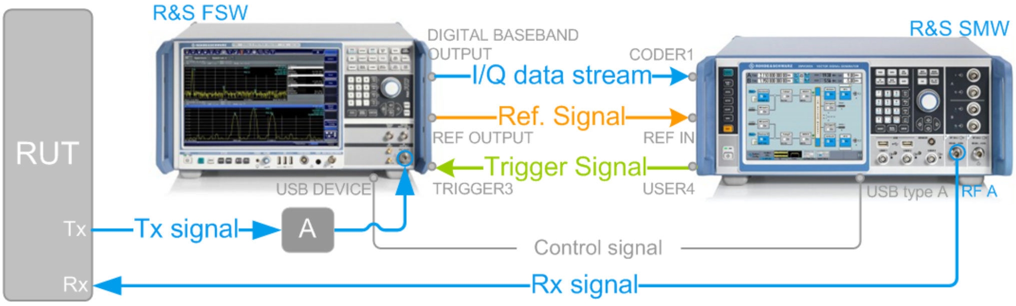


Figure 5-1: Example of conducted test setup (front panel view)

RUT	= Radar under test
Tx signal	= Transmitted (original) radar signal
Rx signal	= Modified signal, fed back to the radar
I/Q data stream	= Digital baseband data stream
Ref. Signal	= 10 MHz common reference frequency signal to synchronize the R&S SMW to the R&S FSW
Trigger Signal	= Required to estimate the system latency of the system (blind zone (BZ))
Control signal	= USB (or LAN) connection for remote control of the analyzer from the R&S SMW
A	= External attenuator to protect the R&S FSW input stage
DIG BASEBAND OUTPUT, CODER1	= Digital IQ connectors (rear panel)
REF IN, REF OUTPUT	= Reference frequency signal connectors (rear panel)
TRIGGER3, USER4	= Connectors for trigger signal (rear panel)
USB (Type A), USB DEVICE	= USB connectors (rear panel)

Try out the following:

- "To connect the RUT and the REG (conducted test)" on page 47
- "To connect the R&S FSW to the R&S SMW" on page 47
- "To enable the R&S SMW to use the external reference frequency of the R&S FSW" on page 47
- "To configure the connection to the R&S FSW" on page 48
- "To configure the R&S SMW to simulate 6 echoes" on page 51
- "To extend the setup and generate up to 24 echoes" on page 53

- "To deactivate the subset of objects configured in the one of the REG blocks" on page 55
- "To estimate the system latency time roughly" on page 55

To connect the RUT and the REG (conducted test)

Required connectors are located on the front panels, see Figure 5-1.

WARNING

Risk of overloading

Signal strength outside the permissible input ranges may overload and damage the signal analyzer R&S FSW and the radar receiver.

Always check the specifications for permissible input ranges.

Connect the following:

1. RUT Tx output to the external attenuator.
2. The external attenuator to R&S FSW RF INPUT.
3. R&S SMW RF A to the RUT Rx input.

To connect the R&S FSW to the R&S SMW

Required connectors are located on the rear panels.

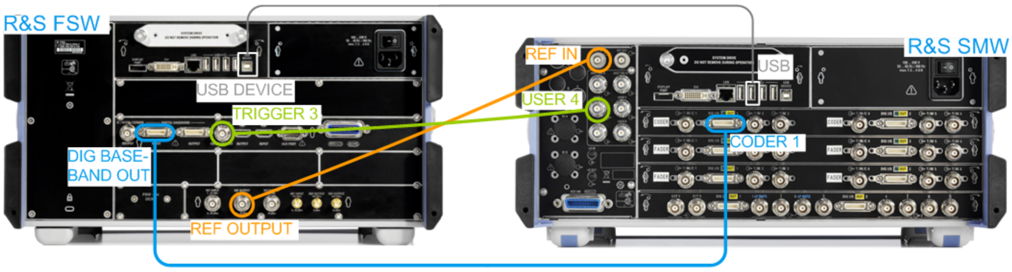


Figure 5-2: Example of test setup (rear panel view)

Connect the following:

1. R&S FSW REF OUTPUT to R&S SMW REF IN
2. R&S FSW DIG IQ OUT to R&S SMW CODER1
3. R&S SMW USER4 to R&S FSW TRIGGER 3
4. R&S SMW USB (Type A) to R&S FSW USB DEVICE (Type B)

To enable the R&S SMW to use the external reference frequency of the R&S FSW

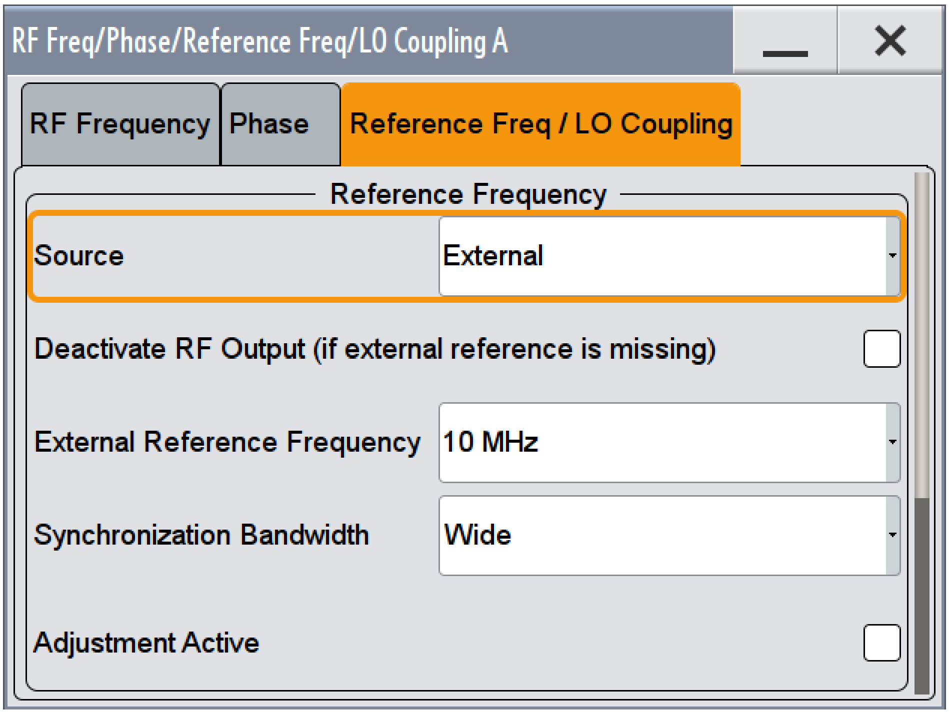
In the R&S SMW, perform the following:

1. On the front panel, press PRESET.

2. In the status bar, tap on the "Int Ref".

   The "Ref. Frequency /LO Coupling" dialog opens.

3. Set "Reference Frequency > Source > External".

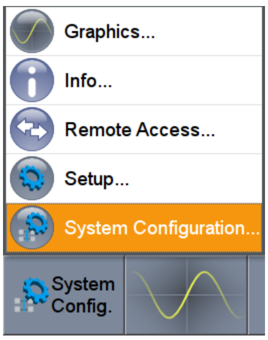


   The R&S SMW is synchronized to the reference frequency of the R&S FSW.

4. Use the default settings and close the dialog.

Always configure the R&S FSW from the R&S SMW and the REG dialog.

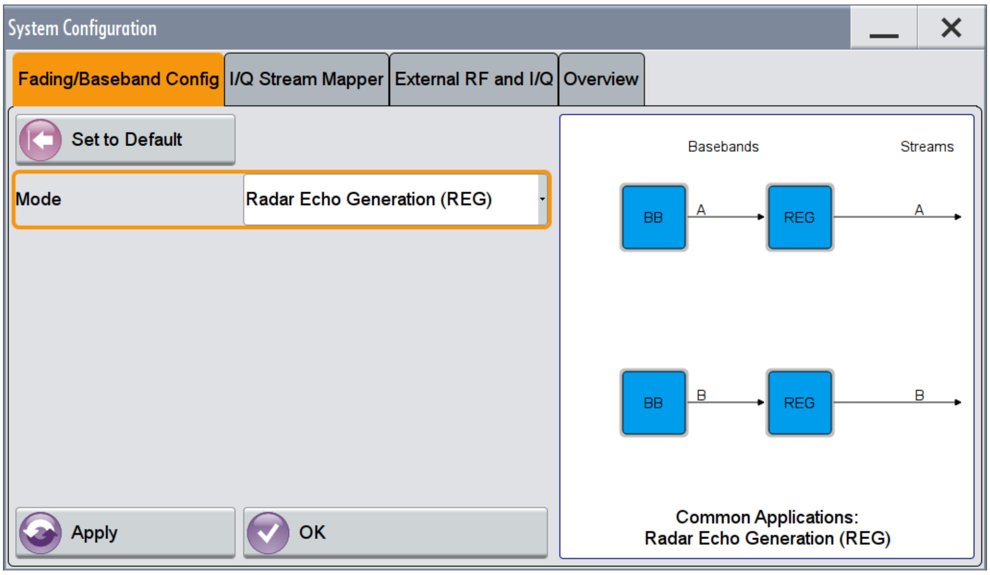
Do not change the level settings of both, the generator and the analyzer manually. Use the parameter "System Loss" to compensate for system or cable loss.



To configure the connection to the R&S FSW

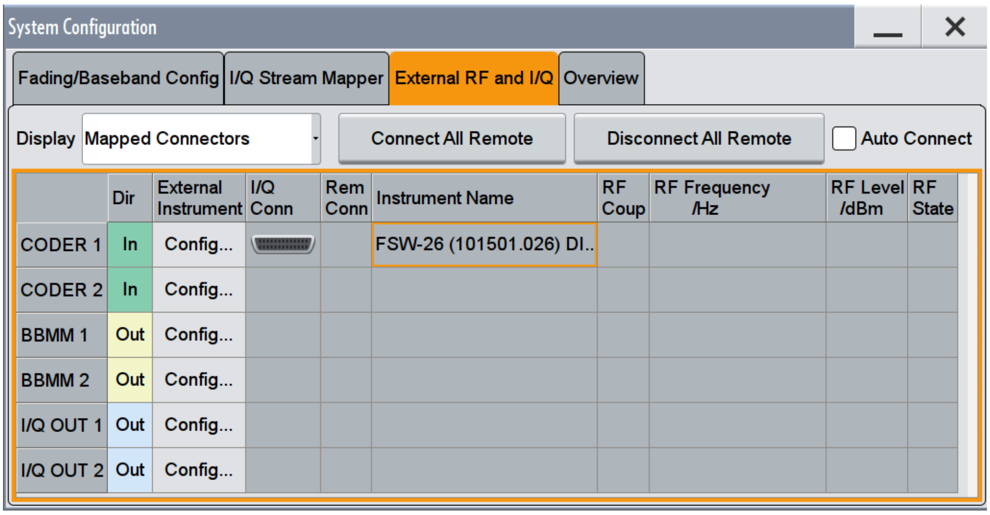
In the R&S SMW, perform the following:

1. In the block diagram, select "System Config > System Configuration".
2. Select "Fading/Baseband Config > Mode > Radar Echo Generation (REG)".



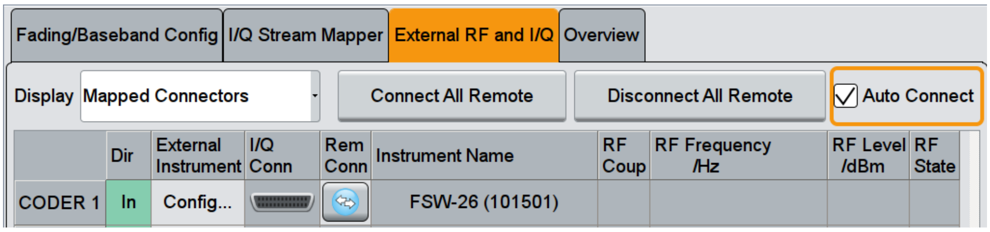
3. Select "Apply".
4. Select "External RF and I/Q".

   If the R&S FSW is connected to the R&S SMW as shown on Figure 5-1, the R&S SMW automatically detects it.



   The "External RF and I/Q" indicates that the analyzer is connected to the CODER1 connector of the R&S SMW. The remote connection is, however, not active.

5. Select "Auto Connect > On".
   Tip: If the "Auto Connect" fails, select "CODER1 > External Instrument > Config > Remote Config > Detect" and confirm with "Apply and Connect".



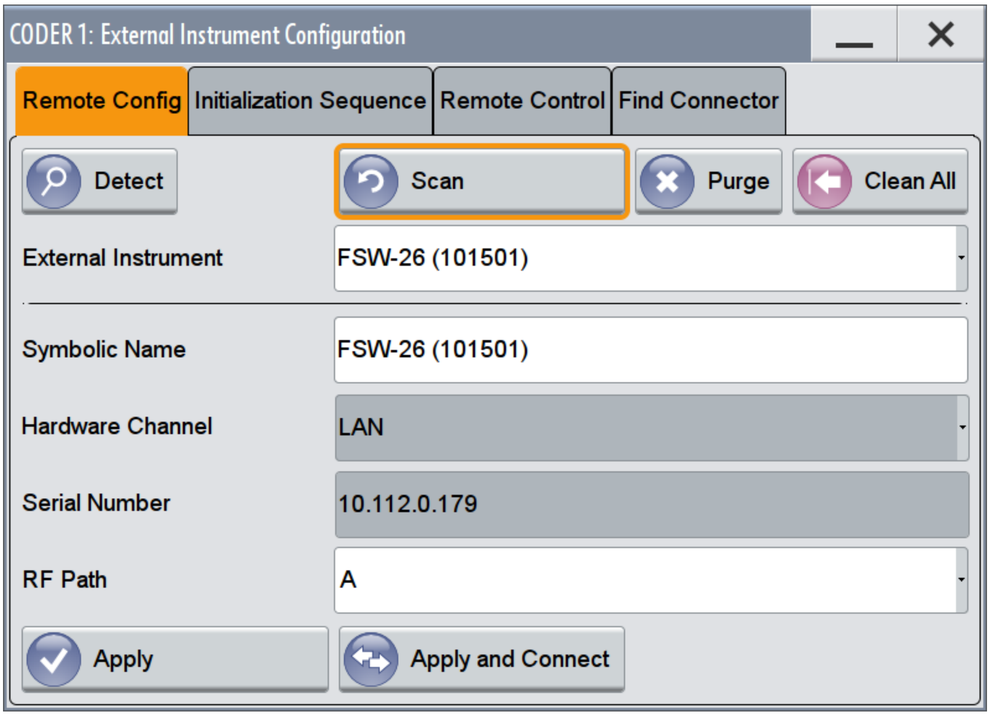
The R&S SMW performs the following:

- Activates the remote connection to the R&S FSW.
- Sends the command `DEVice:PRESet`.
- Sends a SCPI sequence to the R&S FSW a sets its settings as required for the test setup.
- Activates the "BB Input" block where the R&S FSW is connected (in this example, "BB Input A > On").
- In the "BB Input" block, sets the "Sampling Rate".

Note: We recommend that you do not change the analyzer settings.

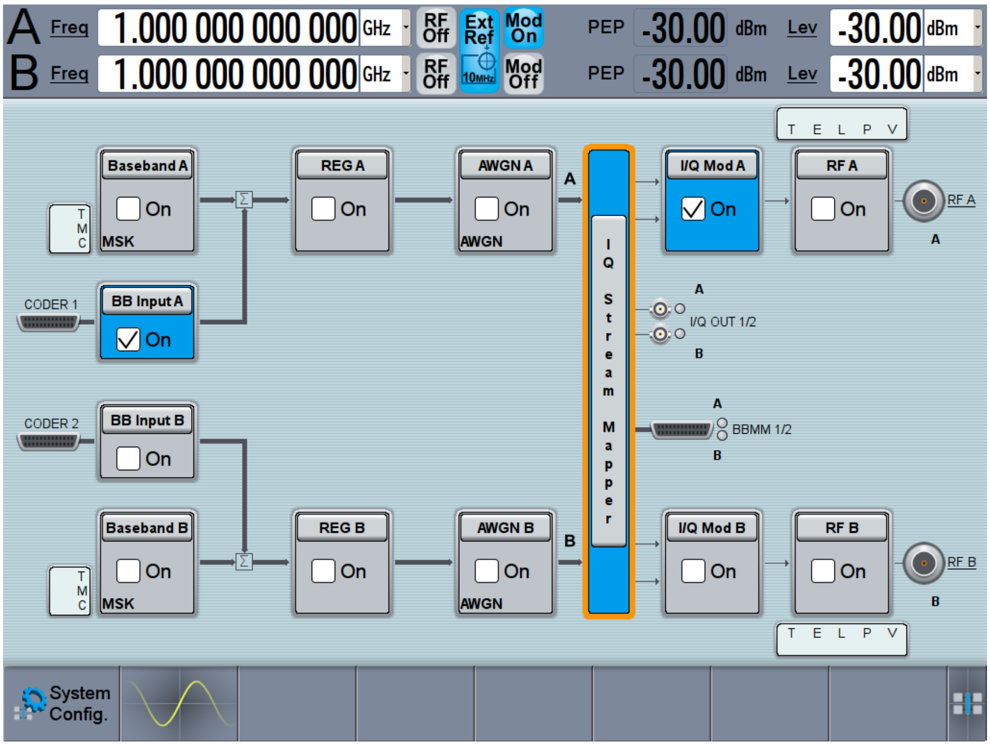
6. Perform the following, only if you connect the R&S SMW and the R&S FSW over **LAN**, with dedicated connection or over a network:

   a) Select CODER 1 > "External Instrument > Config > Remote Config > Scan".
   b) Select the R&S FSW in the External Instrument list.
   c) Confirm with "Apply and Connect".



7. Close the dialogs.

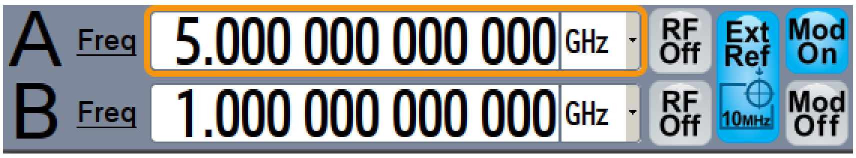
   The "I/Q Modulator" is activated automatically.
   The block diagram resembles the following.



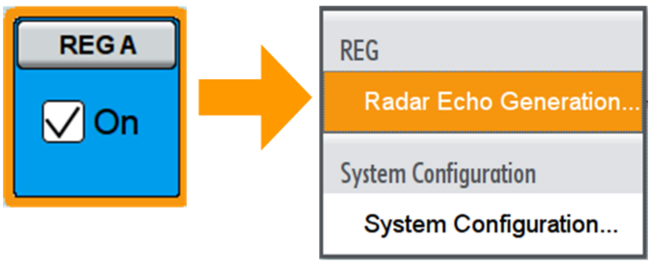
To configure the R&S SMW to simulate 6 echoes

In the R&S SMW, perform the following:

1. On the status bar, select the "A Freq." field and enter the radar frequency.



2. In the block diagram, select "REG A > Radar Echo Generation".



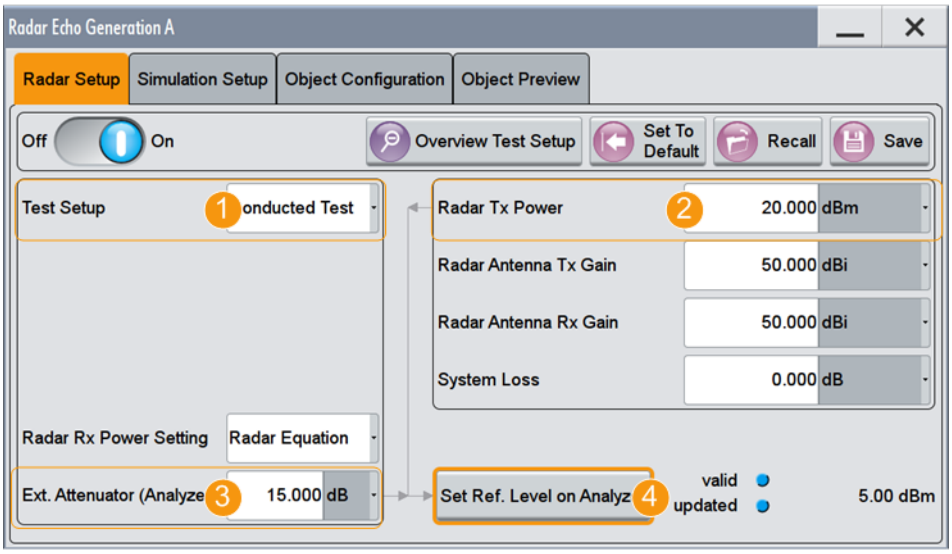
   The Radar Echo Generation dialog box opens and displays the "Radar Setup" settings.

3. In the "Radar Setup" dialog:

   a) Use the default "Test Setup > Conducted Test".

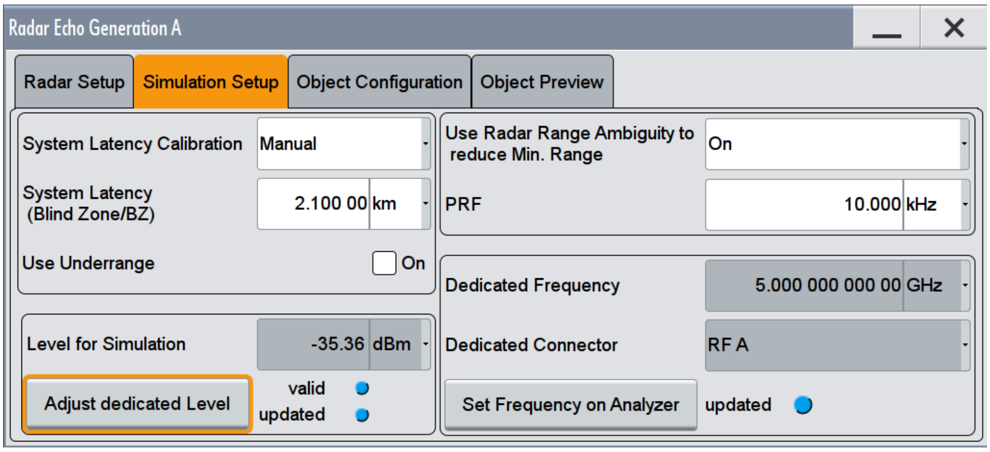
b) Set the settings influencing the reference level of the analyzer:
   - "Radar Tx Power"
   - "Ext. Attenuator (Analyzer)"

c) Execute "Set Ref. Level on Analzer".



4. Set the parameter "RF A > RF Level > Level > Limit" to protect the RUT input.
5. Select "Simulation Setup".

   The dialog shows that the "Dedicated Frequency = 5 GHz" as set with the parameter "Freq".
   The analyzer frequency, however, deviates from this value.
6. Execute "Set Frequency on Analyzer".
7. Select "Object Configuration" and configure the objects as required.
   See for example the example on Figure 4-3.
   For detailed explanation of all functions, see Chapter 4, "Radar Echo Generation Configuration and Settings", on page 26.
8. In the "Simulation Setup" dialog, observe the value of the parameter "Level for Simulation".
   The output signal level at the RF A connector ("Status Bar > RF A > Level") deviates from this value.
9. Execute "Adjust dedicated Level".



10. Close the dialog.
11. In the block diagram, select "REG > State > On".
12. Select "RF A > On".

    The signal output starts when the RF output is activated. The start moment cannot be synchronized.
    To add a start delay to the objects, use the parameter Object Hold Off.

To extend the setup and generate up to 24 echoes

This example extends the previous configurations. It shows how to route the real radar signal to both R&S SMW paths, so that you can generate up to 24 echoes from the same input signal.

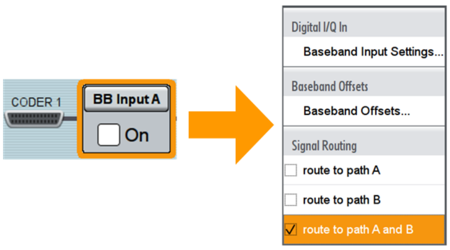
The instruments are connected as illustrated on Figure 5-1. The digital signal is fed at the CODER1 connector of the R&S SMW.

For an overview of the required options, see the data sheet. See also Chapter 3.1, "Required Options and Equipment", on page 12.

We assume, that the REG is configured and that there is at least one active object, with settings different than the default settings.

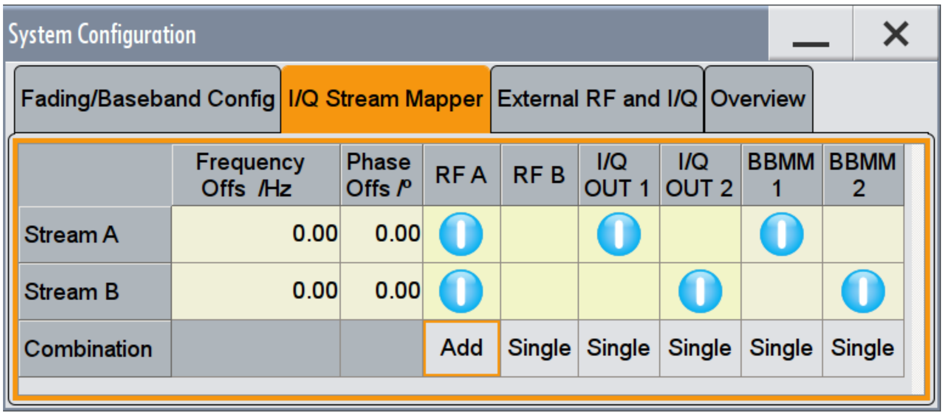
In the R&S SMW, perform the following:

1. In the block diagram, select "Baseband Input A > Signal Routing > route to path A and B".



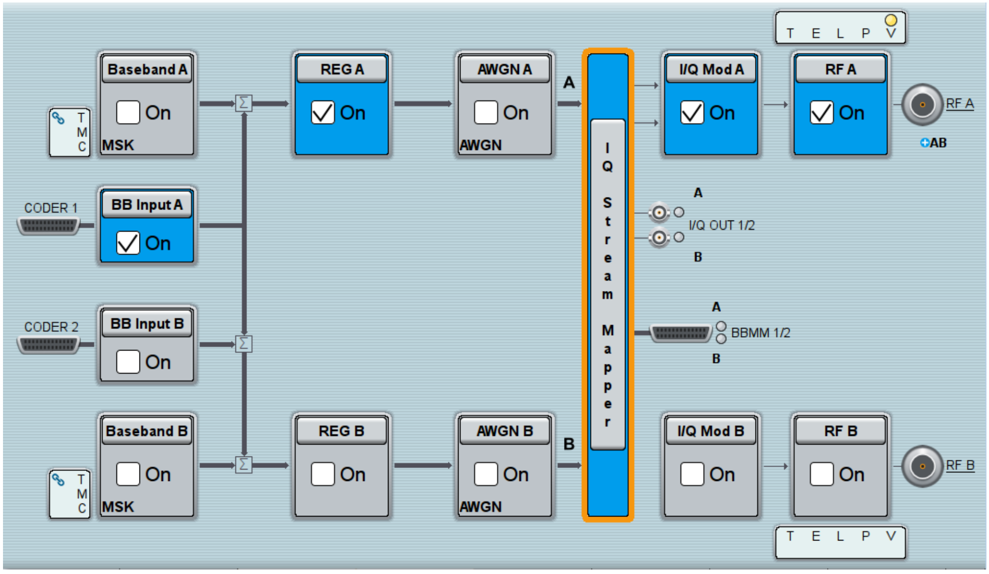
    The input radar signal is routed to both paths. That is, you can configure up to 12 objects per REG block.

2. In the block diagram, select "IQ Stream Mapper" and perform the following:
   a) In the stream mapping table, for "RF A" select "Combination > Add".
   b) Route "Stream B to RF A" and disable it for "RF B".



   c) Close the dialog.

   The signal streams of both paths are output at the RF A connector.



3. Use the "Save/Recall" function to store the settings of the first REG and load it in the second one:
   a) In the block diagram, select "REG A > Radar Echo Generation".
   b) Select "Save", enter a file name, and confirm with "Save".
      The settings of the entire dialog are stored in a file.
   c) In the block diagram, select "REG B > Radar Echo Generation".
   d) Select "Recall", navigate to the file with settings, select it and confirm with "Select".

   The configuration of REG B is the same as in the REG A, also concerning the object configuration. REG B is, however, not activated ("REG B > State > Off").

4. In the RUT, observe the received signal.

The RUT detects the objects as configured in the first REG.
The RUT also receives its own signal; this signal is unmodified but delayed because of the REG "System Latency" time, see "To estimate the system latency time roughly" on page 55.

5. In the R&S SMW, open "REG B > Radar Echo Generation" dialog, adjust the objects settings and set "Radar Setup > State > On".

   The RUT detects the up to 24 objects, as activated in "REG A" and "REG B" blocks.

To deactivate the subset of objects configured in the one of the REG blocks

To deactivate the objects in e.g. REG A, use one of the following alternatives:

1. Disable the REG and the stream at the RF output:
   a) Select "REG A > Off"
   b) Select "IQ Stream Mapper > Stream A > RF A > Off".
2. Route the digital input signal only to the other REG.
   That is, select "BB Input A > Signal Routing > route to path B".
3. To deactivate a single object, disable it.
   That is, select "REG > Radar Echo Generation > Objects Configuration > Object# > Obect Type > Off".

To estimate the system latency time roughly

This example shows you how to estimate the system latency time of the REG and set the value manually. It also provides hints on how to verify and correct the value.

The exact calibration procedure is, however, beyond the scope of this description.

1. Follow the instructions described in:
   - "To connect the RUT and the REG (conducted test)" on page 47
   - "To connect the R&S FSW to the R&S SMW" on page 47
   - "To enable the R&S SMW to use the external reference frequency of the R&S FSW" on page 47
   - "To configure the connection to the R&S FSW" on page 48
2. In the block diagram of R&S SMW, select "RF A > On".

   The R&S SMW receives the digital baseband signal ("BB Input A > On") and outputs it unmodified at the RF A output.
3. In the RUT, observe the received signal.

   The RUT receives its own signal. The signal is unmodified but delayed because of the REG "System Latency" time.
4. Measure the signal delay for example with an oscilloscope.

5. In the block diagram R&S SMW, select "REG A > Radar Echo Generation > Simulation Setup".
6. Select "System Latency Calibration > Manual".
7. Set the parameter "System Latency" to the measured value, for example "System Latency = 13.342 µs".
   This value corresponds to a "Blind Zone = 2 km".
8. To verify the value, configure one static object at a define range and measure the range in the RUT.
   For example:
   a) Select "Object Configuration > Object#1 > Object Type > Static " and set "Range = 3 km".
   b) In the RUT, observe the measured range value.

   The RUT measures, for example, a range of 3.1 km.
   There is a difference ΔBZ = $Range_{RUT}$ - $Range_{REG}$ = 0.1 km
9. Correct the "System Latency (Blinz Zone)" value with the ΔBZ.
   Set "Blind Zone = 2 km + 0.1 km = 2.1 km".

   The measured range value in the RUT should match the expected range.

6 Remote-Control Commands

The following commands are required to perform signal generation with the option R&S SMW-K78 in a remote environment. We assume that the R&S SMW has already been set up for remote operation in a network as described in the R&S SMW documentation. A knowledge about the remote control operation and the SCPI command syntax are assumed.

Conventions used in SCPI command descriptions

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

Common Suffixes

The following common suffixes are used in the remote commands:

Suffix	Value range	Description
SOURce<hw>	[1]|4	Available baseband signals Only SOURce1 possible, if the keyword ENTity is used
OBJect<ch>	1 to 12	Objects Max. value depends on the installed options

Sending commands to the connected R&S FSW analyzer

Commands that contain the keyword ANALyzer can be used only if a R&S FSW is connected to the R&S SMW.

The following commands specific to the R&S SMW-K78 option are described here:

- Programming Example.....57
- General Commands.....60
- Radar Setup Commands.....62
- Simulation Setup Commands.....65
- Object Configuration Commands.....70
- Preview Diagram Commands.....77

6.1 Programming Example

This example shows you how to configure the Radar Echo Generation in a remote environment.

We assume that a R&S FSW is connected to the R&S SMW as described in Chapter 5, "How to Generate Radar Echo Signals", on page 46.

```
SOURce1:ROSCillator:SOURce EXT
```

```
SCONfiguration:MODE REG
SCONfiguration:APPLy
SCONfiguration:EXTernal:REMote:SCAN
SCONfiguration:EXTernal:CODer1:REMote:ISELect "FSW (102030)","A","FSW (102030)","A"
SCONfiguration:EXTernal:CODer1:REMote:INITialization:PREDefined:FILE "REG_init_analyzer"
SCONfiguration:EXTernal:CODer1:REMote:CONNect

SOURce1:BBIN:STATe?
// 1

SOURce1:REGenerator:PRESet
SOURce1:REGenerator:UNIT:LENGth KM
SOURce1:REGenerator:RADar:TSETup OTA
SOURce1:REGenerator:RADar:POWer:TX 10
SOURce1:REGenerator:RADar:ANTenna:GAIN:TX 50
// SOURce1:REGenerator:RADar:ANTenna:GAIN:RX 50
SOURce1:POWer:LIMit:AMPLitude 5
SOURce1:REGenerator:RADar:POWer:LOSS 10
SOURce1:REGenerator:RADar:POWer:MODE REQuation
SOURce1:REGenerator:RADar:ANALyzer:POWer:ATTenuator 10
SOURce1:REGenerator:RADar:ANTenna:REG:GAIN:RX 30
SOURce1:REGenerator:RADar:ANTenna:REG:GAIN:TX 30
SOURce1:REGenerator:RADar:OTA:OFFSet 300
SOURce1:REGenerator:RADar:ANALyzer:POWer:REFerence?
// -1.99020831627664
SOURce1:REGenerator:RADar:ANALyzer:POWer:APPLy
SOURce1:REGenerator:RADar:ANALyzer:STATus?
// UPT

SOURce1:REGenerator:SIMulation:CALibration:MODE MAN
SOURce1:REGenerator:SIMulation:LATency:BZ 2000
SOURce1:FREQuency:CW 5000000000
SOURce1:REGenerator:SIMulation:CONNector?
// RFA
SOURce1:REGenerator:SIMulation:FREQuency?
// 5000000000
SOURce1:REGenerator:SIMulation:ANALyzer:FREQuency:APPLy
SOURce1:REGenerator:SIMulation:ANALyzer:STATus?
// UPD
SOURce1:REGenerator:SIMulation:MINRange:STATe 1
SOURce1:REGenerator:SIMulation:PRF 10000
SOURce1:REGenerator:SIMulation:LEVel?
// 10.85
SOURce1:REGenerator:SIMulation:LEVel:VALid:STATus?
// 1
SOURce1:REGenerator:SIMulation:LEVel:UPDated:STATus?
// 0
SOURce1:REGenerator:SIMulation:LEVel:APPLy
SOURce1:POWer:LEVel:IMMediate:AMPLitude?
// 10.85
```

```
SOURce1:REGenerator:OBJect2:NAME "MovObj_2_20_100"
SOURce1:REGenerator:OBJect2:TYPE MOV
SOURce1:REGenerator:OBJect2:SIMMode ROUN
SOURce1:REGenerator:OBJect2:HOLD:OFF 2
SOURce1:REGenerator:OBJect2:RCS:MODel SWE0
SOURce1:REGenerator:OBJect2:RCS:MEAN 3
SOURce1:REGenerator:OBJect2:RANGe:STARt 2000
SOURce1:REGenerator:OBJect2:RANGe:END 20000
SOURce1:REGenerator:OBJect2:OVELocity 27.778
// value in m/s; 27.778 m/s = 100 km/h
SOURce1:REGenerator:OBJect2:PHASe:OFFSet 0
// value in deg

// the following commands change the units in the dialogs
// but not in the remote control commands
SOURce1:REGenerator:UNIT:TIME S
SOURce1:REGenerator:UNIT:ANGLe DEG
SOURce1:REGenerator:UNIT:VELocity KMH

SOURce1:REGenerator:OBJect2:TIME:TOENd?
// 647.995
// value in seconds; 647.995 s = 10 min 47,995s
SOURce1:REGenerator:OBJect2:POWer:RX:STARt?
// -66.46
SOURce1:REGenerator:OBJect2:POWer:RX:END?
// -106.46
SOURce1:REGenerator:OBJect2:FEPNumber?
// 3

SOURce1:REGenerator:OBJect3:TYPE STAT
SOURce1:REGenerator:OBJect3:RANGe:STARt 5000
SOURce1:REGenerator:OBJect3:RCS:MEAN 80

SOURce1:REGenerator:OBJect4:TYPE SMOV
SOURce1:REGenerator:OBJect4:RANGe:STARt 10000
SOURce1:REGenerator:OBJect4:RCS:MEAN 80
SOURce1:REGenerator:OBJect4:OVELocity 5.556
SOURce1:REGenerator:OBJect4:DIRection APPRoaching

SOURce1:REGenerator:DIAGram:STATe 1
SOURce1:REGenerator:DIAGram:TYPE POW

SOURce1:REGenerator:STATe 1
OUTPut1:STATe 1

SOURce1:REGenerator:STORe "/var/user/reg"
SOURce1:REGenerator:CATalog?
// reg
```

6.2 General Commands

[:SOURce<hw>]:REGenerator[:STATe] <State>

Enables/disables the Radar Echo Generation.

Parameters:

<State> 0 | 1 | OFF | ON

*RST: 0

Example: See Chapter 6.1, "Programming Example", on page 57.

Manual operation: See "State" on page 27

[:SOURce<hw>]:REGenerator:PRESet

Calls the default settings.

Example: See Chapter 6.1, "Programming Example", on page 57.

Usage: Event

Manual operation: See "Set to Default" on page 28

[:SOURce<hw>]:REGenerator:CATalog?

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

Return values:

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

Returns a string of file names separated by commas.

Example: See Chapter 6.1, "Programming Example", on page 57.

Usage: Query only

Manual operation: See "Save/Recall" on page 28

[:SOURce<hw>]:REGenerator:STORe <Filename>

Stores the current settings into the selected file; the file extension (`*.reg`) is assigned automatically.

Setting parameters:

<Filename> string

Example: See Chapter 6.1, "Programming Example", on page 57.

Usage: Setting only

Manual operation: See "Save/Recall" on page 28

[:SOURce<hw>]:REGenerator:LOAD <Filename>

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

Setting parameters:

<Filename> string

file name or complete file path; file extension can be omitted

Example: See Chapter 6.1, "Programming Example", on page 57.

Usage: Setting only

Manual operation: See "Save/Recall" on page 28

[:SOURce<hw>]:REGenerator:UNIT:ANGLe <Unit>

Sets the default unit for the parameter as displayed in the dialog.

Note: This command changes only the units displayed in the graphical user interface. While configuring the angle via remote control, the angle units must be specified.

Parameters:

<Unit> DEGree | DEGRee | RADian

*RST: DEGree

Example: See Chapter 6.1, "Programming Example", on page 57.

[:SOURce<hw>]:REGenerator:UNIT:LENGth <Unit>

Sets the default unit for the parameter as displayed in the dialog.

Note: This command changes only the units displayed in the graphical user interface. While configuring the range or the distance via remote control, the units must be specified.

Parameters:

<Unit> MI | NM | KM | M

*RST: M

Example: See Chapter 6.1, "Programming Example", on page 57.

[:SOURce<hw>]:REGenerator:UNIT:TIME <Unit>

Sets the default unit for the parameter as displayed in the dialog.

Note: This command changes only the units displayed in the graphical user interface. While configuring the time releted parameters via remote control, the time units must be specified.

Parameters:

<Unit> S | MS

*RST: S

Example: See Chapter 6.1, "Programming Example", on page 57.

[:SOURce<hw>]:REGenerator:UNIT:VELocity <Unit>

Sets the default unit for the parameter as displayed in the dialog.

Note: This command changes only the units displayed in the graphical user interface. While configuring the velocity via remote control, the velocity units must be specified.

Parameters:

<Unit> MPS | KMH | MPH | NMPH

*RST: MPS

Example: See Chapter 6.1, "Programming Example", on page 57.

6.3 Radar Setup Commands

[:SOURce<hw>]:REGenerator:RADar:TSETup.................... 62
[:SOURce<hw>]:REGenerator:RADar:POWer:TX.................... 62
[:SOURce<hw>]:REGenerator:RADar:POWer:LOSS.................... 63
[:SOURce<hw>]:REGenerator:RADar:POWer:MODE.................... 63
[:SOURce<hw>]:REGenerator:RADar:ANTenna:GAIN:RX.................... 63
[:SOURce<hw>]:REGenerator:RADar:ANTenna:GAIN:TX.................... 63
[:SOURce<hw>]:REGenerator:RADar:ANTenna:REG:GAIN:RX.................... 63
[:SOURce<hw>]:REGenerator:RADar:ANTenna:REG:GAIN:TX.................... 63
[:SOURce<hw>]:REGenerator:RADar:OTA:OFFSet.................... 64
[:SOURce<hw>]:REGenerator:RADar:ANALyzer:POWer:ATTenuator.................... 64
[:SOURce<hw>]:REGenerator:RADar:ANALyzer:POWer:REFerence?.................... 64
[:SOURce<hw>]:REGenerator:RADar:ANALyzer:POWer:APPLy.................... 65
[:SOURce<hw>]:REGenerator:RADar:ANALyzer:STATus?.................... 65

[:SOURce<hw>]:REGenerator:RADar:TSETup <TestSetup>

Sets the test setup type.

Parameters:

<TestSetup> CONDucted | OTA

*RST: CONDucted

Example: See Chapter 6.1, "Programming Example", on page 57.

Manual operation: See "Test Setup" on page 28

[:SOURce<hw>]:REGenerator:RADar:POWer:TX <Power>

Sets the radar transmit power P_{Tx}.

Parameters:
<Power> float

Range: -50 to 100
Increment: 0.001
*RST: 0

Example: See Chapter 6.1, "Programming Example", on page 57.

Manual operation: See "Radar Tx Power" on page 30

[:SOURce<hw>]:REGenerator:RADar:POWer:LOSS <PowerLoss>

Additional loss to compensate for system or cable loss.

Parameters:
<PowerLoss> float

Range: 0 to 100
Increment: 0.001
*RST: 0

Example: See Chapter 6.1, "Programming Example", on page 57.

Manual operation: See "System Loss" on page 30

[:SOURce<hw>]:REGenerator:RADar:POWer:MODE <Mode>

Sets how the radar receive power is calculated.

Parameters:
<Mode> REQuation | MANual

*RST: REQuation

Example: See Chapter 6.1, "Programming Example", on page 57.

Example:
```
SOURce1:REGenerator:RADar:POWer:MODE MANual
SOURce1:REGenerator:OBJect2:POWer:RX -114.4
```

Manual operation: See "Radar Rx Power Setting" on page 29

[:SOURce<hw>]:REGenerator:RADar:ANTenna:GAIN:RX <GainRx>
[:SOURce<hw>]:REGenerator:RADar:ANTenna:GAIN:TX <GainTx>
[:SOURce<hw>]:REGenerator:RADar:ANTenna:REG:GAIN:RX <GainRx>
[:SOURce<hw>]:REGenerator:RADar:ANTenna:REG:GAIN:TX <GainTx>

Sets the antenna gain.

Parameters:
<GainTx> float

Range: 0 to 100
Increment: 0.001
*RST: 0

Example: See Chapter 6.1, "Programming Example", on page 57.

Manual operation: See "REG Antenna Tx Gain" on page 29

[:SOURce<hw>]:REGenerator:RADar:OTA:OFFSet <OtaOffset>

Sets the OTA (over-the-air) distance.

Parameters:

<OtaOffset> float

Range: 0 to 5000
Increment: 0.01
*RST: 0

Example: See Chapter 6.1, "Programming Example", on page 57.

Manual operation: See "OTA Range Offset" on page 29

[:SOURce<hw>]:REGenerator:RADar:ANALyzer:POWer:ATTenuator <PowerAttenuator>

Sets the attenuation of the external attenuator.

The command can be used only if a R&S FSW is connected to the R&S SMW.

Parameters:

<PowerAttenuator> float

Range: -58 to 358
Increment: 0.001
*RST: 10

Example: See Chapter 6.1, "Programming Example", on page 57.

Manual operation: See "Ext. Attenuator (Analyzer)" on page 30

[:SOURce<hw>]:REGenerator:RADar:ANALyzer:POWer:REFerence?

Queries the reference level of the analyzer.

The command can be used only if a R&S FSW is connected to the R&S SMW.

Return values:

<PowerReference> float

Range: -400 to 500
Increment: 0.01
*RST: -10

Example: See Chapter 6.1, "Programming Example", on page 57.

Usage: Query only

Manual operation: See "Set Ref. Level on Analyzer" on page 30

[:SOURce<hw>]:REGenerator:RADar:ANALyzer:POWer:APPLy

Sets the referenece level of the analyzer.

The command can be used only if a R&S FSW is connected to the R&S SMW.

Example: See Chapter 6.1, "Programming Example", on page 57.

Usage: Event

Manual operation: See "Set Ref. Level on Analyzer" on page 30

[:SOURce<hw>]:REGenerator:RADar:ANALyzer:STATus?

Queries the reference level status.

The command can be used only if a R&S FSW is connected to the R&S SMW.

Return values:

<AnalyzerStatus> NCONected | INValid | VALid | UPDated

NCONected
Analyzer is not connected

INValid
Reference level outside the permissible level range of the analyzer

VALid
Reference level within the permissible level range of the analyzer; value not set

UPDated
Refence level is updated

Example: See Chapter 6.1, "Programming Example", on page 57.

Usage: Query only

Manual operation: See "Set Ref. Level on Analyzer" on page 30

6.4 Simulation Setup Commands

[:SOURce<hw>]:REGenerator:SIMulation:CALibration:MODE.......66
[:SOURce<hw>]:REGenerator:SIMulation:LATency[:BZ].......66
[:SOURce<hw>]:REGenerator:SIMulation:CALibration:URANge.......66
[:SOURce<hw>]:REGenerator:SIMulation:CALibration[:STATe]?.......67
[:SOURce<hw>]:REGenerator:SIMulation:CALibration:CORRection.......67
[:SOURce<hw>]:REGenerator:SIMulation:MINRange[:STATe].......68
[:SOURce<hw>]:REGenerator:SIMulation:PRF.......68
[:SOURce<hw>]:REGenerator:SIMulation:CONNector.......68
[:SOURce<hw>]:REGenerator:SIMulation:FREQuency.......69
[:SOURce<hw>]:REGenerator:SIMulation:ANALyzer:FREQuency:APPLy.......69
[:SOURce<hw>]:REGenerator:SIMulation:ANALyzer:STATus.......69
[:SOURce<hw>]:REGenerator:SIMulation:LEVel?.......69

[:SOURce<hw>]:REGenerator:SIMulation:LEVel:APPLy..70
[:SOURce<hw>]:REGenerator:SIMulation:LEVel:UPDated[:STATus]?..................................70
[:SOURce<hw>]:REGenerator:SIMulation:LEVel:VALid[:STATus]?......................................70

[:SOURce<hw>]:REGenerator:SIMulation:CALibration:MODE <CalMode>

Sets how the system latency is estimated.

Parameters:

<CalMode> MANual | AUTomatic

`AUTomatic` mode can be used only if a R&S FSW is connected to the R&S SMW.

*RST: AUTomatic

Example: See Chapter 6.1, "Programming Example", on page 57.

Manual operation: See "System Latency Calibration" on page 33

[:SOURce<hw>]:REGenerator:SIMulation:LATency[:BZ] <BlindZone>

Sets the system latency value manually.

Parameters:

<BlindZone> float

Range: 0 to 3000
Increment: 0.01
*RST: 0

Example: See Chapter 6.1, "Programming Example", on page 57.

Manual operation: See "System Latency (Blind Zone/ BZ)" on page 33

[:SOURce<hw>]:REGenerator:SIMulation:CALibration:URANge <useUnderRange>

Allows you to simulate objects at a range closer than 2.1 km.

Parameters:

<useUnderRange> 0 | 1 | OFF | ON

*RST: 0

Example:

```
SOURce1:REGenerator:SIMulation:CALibration:MODE MAN
SOURce1:REGenerator:SIMulation:CALibration:URANge 0
SOURce1:REGenerator:OBJect12:TYPE STAT
SOURce1:REGenerator:OBJect12:RANGe:STARt 1300
SOURce1:REGenerator:OBJect12:RANGe:STARt?
// 2400
// Range min [m] = 2400 = BZ + 300

SOURce1:REGenerator:SIMulation:CALibration:URANge 1
SOURce1:REGenerator:SIMulation:LATency:BZ 1000
SOURce1:REGenerator:OBJect12:RANGe:STARt 1300
SOURce1:REGenerator:OBJect12:RANGe:STARt?
// 1300
// Range min [m] = 1300 = 1000 + 300

SOURce1:REGenerator:SIMulation:CALibration:MODE AUT
SOURce1:REGenerator:SIMulation:LATency:BZ?
// 1900
SOURce1:REGenerator:SIMulation:CALibration:CORRection -100
SOURce1:REGenerator:SIMulation:CALibration:URANge 0
SOURce1:REGenerator:OBJect12:RANGe:STARt 1300
SOURce1:REGenerator:OBJect12:RANGe:STARt?
// 2100
// Range min [m] = 2100 = BZ + 300 + CORRection
SOURce1:REGenerator:SIMulation:CALibration:URANge 1
SOURce1:REGenerator:OBJect12:RANGe:STARt 1000
SOURce1:REGenerator:OBJect12:RANGe:STARt?
// 2100
// no effect on the min Range value
```

Manual operation: See "Use Underrange" on page 34

[:SOURce<hw>]:REGenerator:SIMulation:CALibration[:STATe]?

Queries the status of the automatic system calibration process.

Return values:

<CalibrationStat> FAILed | SUCCess

Example: See [:SOURce<hw>]:REGenerator:SIMulation:CALibration:CORRection on page 67

Usage: Query only

Manual operation: See "Calibration Successful" on page 34

[:SOURce<hw>]:REGenerator:SIMulation:CALibration:CORRection <CorrValue>

Adds a correction to the automatically estimated system latency value.

Parameters:

<CorrValue> float

Range: -10 to 10
Increment: 0.01
*RST: 0

Example:

```
SOURce1:REGenerator:SIMulation:CALibration:MODE AUTomatic
SOURce1:REGenerator:SIMulation:CALibration:STATe?
// SUCC
SOURce1:REGenerator:SIMulation:CALibration:CORRection 1
```

Manual operation: See "Correction Values" on page 34

[:SOURce<hw>]:REGenerator:SIMulation:MINRange[:STATe] <State>

Enables the simulation of delays that are shorter than the system latency ($\tau < t_{BZ}$).

Parameters:

<State> 0 | 1 | OFF | ON

*RST: 0

Example: See Chapter 6.1, "Programming Example", on page 57.

Manual operation: See "Use Radar Range Ambiguity to reduce Min. Range" on page 34

[:SOURce<hw>]:REGenerator:SIMulation:PRF <PRF>

Sets the pulse repetition frequency (PRF).

Parameters:

<PRF> integer

Range: 1 to 1E6
*RST: 10E3

Example: See Chapter 6.1, "Programming Example", on page 57.

Manual operation: See "PRF" on page 34

[:SOURce<hw>]:REGenerator:SIMulation:CONNector <Connector>

Queries the instrument connector used to set the frequency `[:SOURce<hw>]:REGenerator:SIMulation:FREQuency`.

Parameters:

<Connector> RFA | RFB | BBMM1 | BBMM2 | IQOUT1 | IQOUT2 | FAD1 | FAD2 | FAD3 | FAD4 | DEF

*RST: RFA

Example: See Chapter 6.1, "Programming Example", on page 57.

Manual operation: See "Dedicated Connector" on page 35

[:SOURce<hw>]:REGenerator:SIMulation:FREQuency <Frequency>

Queries the RF frequency that is used for the calculation of the Doppler shift and the P_{Rx}.

Parameters:

<Frequency> float

Range: 100E3 to 100E9
Increment: 0.01
*RST: 0

Example: See Chapter 6.1, "Programming Example", on page 57.

Manual operation: See "Dedicated Frequency" on page 35

[:SOURce<hw>]:REGenerator:SIMulation:ANALyzer:FREQuency:APPLy

Sets the analyzer frequency.

The command can be used only if a R&S FSW is connected to the R&S SMW.

Example: See Chapter 6.1, "Programming Example", on page 57.

Usage: Event

Manual operation: See "Set Frequency on Analyzer" on page 36

[:SOURce<hw>]:REGenerator:SIMulation:ANALyzer:STATus

Queries the frequency status.

The command can be used only if a R&S FSW is connected to the R&S SMW.

Parameters:

<Status> VALid | UPDated

Example: See Chapter 6.1, "Programming Example", on page 57.

Manual operation: See "Set Frequency on Analyzer" on page 36

[:SOURce<hw>]:REGenerator:SIMulation:LEVel? <Level>

Queries the calculated level value.

Parameters:

<Level> float

Range: -541 to 591
Increment: 0.01
*RST: -30

Example: See Chapter 6.1, "Programming Example", on page 57.

Usage: Query only

Manual operation: See "Level for Simulation" on page 35

[:SOURce<hw>]:REGenerator:SIMulation:LEVel:APPLy

Sets the output level at the dedicated connector to the calculated level. To query the calculated level, use the command `[:SOURce<hw>]:REGenerator:SIMulation:LEVel?`.

Example: See Chapter 6.1, "Programming Example", on page 57.

Usage: Event

Manual operation: See "Adjust Dedicated Level" on page 35

[:SOURce<hw>]:REGenerator:SIMulation:LEVel:UPDated[:STATus]? <Status>

Queries whether the current output level at the dedicated connector is equal to the calculated level.

To query the calculated level, use the command `[:SOURce<hw>]:REGenerator:SIMulation:LEVel?`.

Parameters:

<Status> 0 | 1 | OFF | ON

Example: See Chapter 6.1, "Programming Example", on page 57.

Usage: Query only

Manual operation: See "Adjust Dedicated Level" on page 35

[:SOURce<hw>]:REGenerator:SIMulation:LEVel:VALid[:STATus]? <Status>

Queries whether the calculated output level is within the permissible value range for the dedicated connector.

Parameters:

<Status> 0 | 1 | OFF | ON

Example: See Chapter 6.1, "Programming Example", on page 57.

Usage: Query only

Manual operation: See "Adjust Dedicated Level" on page 35

6.5 Object Configuration Commands

[:SOURce<hw>]:REGenerator:OBJect:CATalog? ... 71
[:SOURce<hw>]:REGenerator:OBJect<ch>:STORe ... 71
[:SOURce<hw>]:REGenerator:OBJect<ch>:LOAD ... 72
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[:SOURce<hw>]:REGenerator:OBJect<ch>:FEPNumber?......77

[:SOURce<hw>]:REGenerator:OBJect:CATalog?

Queries files with object setting in the default directory. Listed are files with the file extension `*.reg_obj`.

Return values:

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

Returns a string of file names separated by commas.

Example:

```
SOURce1:REGenerator:OBJect:CATalog?
// Obj2
SOURce1:REGenerator:OBJect2:STORe "/var/user/MovObj_5_10_100"
SOURce1:REGenerator:OBJect:CATalog?
// MovObj_5_10_100, Obj2
SOURce1:REGenerator:OBJect3:LOAD "/var/user/MovObj_5_10_100"
```

Usage: Query only

Manual operation: See "Load/Save Object" on page 38

[:SOURce<hw>]:REGenerator:OBJect<ch>:STORe <Filename>

Stores the current settings into the selected file; the file extension (`*.reg_obj`) is assigned automatically.

Setting parameters:

<Filename> string

Example: See [:SOURce<hw>]:REGenerator:OBJect:CATalog? on page 71

Usage: Setting only

Manual operation: See "Load/Save Object" on page 38

[:SOURce<hw>]:REGenerator:OBJect<ch>:LOAD <Filename>

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

Setting parameters:

<Filename> string

Example: See `[:SOURce<hw>]:REGenerator:OBJect:CATalog?` on page 71

Usage: Setting only

Manual operation: See "Load/Save Object" on page 38

[:SOURce<hw>]:REGenerator:OBJect:COPY:SOURce <Source>

Selects the object whose settings are copied.

Parameters:

<Source> 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 11 | 12 | 10

*RST: 1

Example: See `[:SOURce<hw>]:REGenerator:OBJect:COPY:EXECute` on page 72

Manual operation: See "Object # of 12" on page 37

[:SOURce<hw>]:REGenerator:OBJect:COPY:DESTination <Destination>

Sets the object whose settings are overwritten.

Parameters:

<Destination> ALL | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 12 | 11 | 10

*RST: 2

Example: See `[:SOURce<hw>]:REGenerator:OBJect:COPY:EXECute` on page 72.

Manual operation: See "Copy to" on page 37

[:SOURce<hw>]:REGenerator:OBJect:COPY:EXECute

Copies the settings of one selected object to the other one.

Example:

```
SOURce1:REGenerator:OBJect:COPY:SOURce 2
SOURce1:REGenerator:OBJect:COPY:DESTination 3
SOURce1:REGenerator:OBJect:COPY:EXECute
```

Usage: Event

Manual operation: See "Copy" on page 37

[:SOURce<hw>]:REGenerator:OBJect<ch>:NAME <Name>

Enter a symbolic name.

Parameters:

<Name>	string
Example:	See Chapter 6.1, "Programming Example", on page 57.
Manual operation:	See "Object Name" on page 38

[:SOURce<hw>]:REGenerator:OBJect<ch>:TYPE <Type>

Sets the object type or disables it.

Parameters:

<Type>	OFF | STATic | MOVing | SMOVing *RST: OFF
Example:	See Chapter 6.1, "Programming Example", on page 57.
Manual operation:	See "Object Type" on page 38

[:SOURce<hw>]:REGenerator:OBJect<ch>:SIMMode <Mode>

Describes how the object moves.

Parameters:

<Mode>	ONEWay | CYCLic | ROUNdtrip *RST: ROUNdtrip
Example:	See Chapter 6.1, "Programming Example", on page 57.
Manual operation:	See "Simulation Mode" on page 38

[:SOURce<hw>]:REGenerator:OBJect<ch>:POWer:RX <RadarPowerRx>

In `[:SOURce<hw>]:REGenerator:RADar:POWer:MODEMANual` mode, sets the Rx power of each object.

Parameters:

<RadarPowerRx>	float Range: -145 to 30 Increment: 0.01 *RST: 0
Example:	See `[:SOURce<hw>]:REGenerator:RADar:POWer:MODE` on page 63
Manual operation:	See "Radar Rx Power (Start)" on page 39

[:SOURce<hw>]:REGenerator:OBJect<ch>:POWer:RX:DEDication <Dedication>

In [:SOURce<hw>]:REGenerator:RADar:POWer:MODE MANual mode and for moving objects, defines how to interpret the value P_{RX} set with the command [:SOURce<hw>]:REGenerator:OBJect<ch>:POWer:RX.

Parameters:

<Dedication> STARt | END | ALL

STARt
$P_{Rx, jStartRange} = P_{RX}$

END
$P_{Rx, jEndRange} = P_{RX}$

ALL
$P_{Rx, jStartRange} = P_{Rx, jEndRange} = P_{RX}$

*RST: ALL

Example:

```
SOURce1:REGenerator:RADar:POWer:MODE MAN
SOURce1:REGenerator:OBJect1:TYPE MOV
SOURce1:REGenerator:OBJect1:RANGe:STARt 5000
SOURce1:REGenerator:OBJect1:RANGe:END 4000
SOURce1:REGenerator:OBJect1:POWer:RX 10

SOURce1:REGenerator:OBJect1:POWer:RX:DEDication END
SOURce1:REGenerator:OBJect1:POWer:RX:STARt?
// 6.12359947967774
SOURce1:REGenerator:OBJect1:POWer:RX:END?
// 10

SOURce1:REGenerator:OBJect1:POWer:RX:DEDication ALL
SOURce1:REGenerator:OBJect1:POWer:RX:STARt?
// 10
SOURce1:REGenerator:OBJect1:POWer:RX:END?
// 10
```

Manual operation: See "Radar Rx Power Dedicated to" on page 41

[:SOURce<hw>]:REGenerator:OBJect<ch>:POWer:RX:STARt?
[:SOURce<hw>]:REGenerator:OBJect<ch>:POWer:RX:END?

Queries the radar Rx power P_{Rx}.

Return values:

<RadarPowerRxEnd> float

Range: -465 to 578
Increment: 0.01
*RST: 0

Example: See Chapter 6.1, "Programming Example", on page 57.

Usage: Query only

Manual operation: See "Radar Rx Power (End)" on page 39

[:SOURce<hw>]:REGenerator:OBJect<ch>:RANGe:STARt <RangeStart>
[:SOURce<hw>]:REGenerator:OBJect<ch>:RANGe:END <RangeEnd>

Sets the distance between the object and the radar.

Parameters:

<RangeEnd> float

Range: 2100 to 10000000
Increment: 0.1
*RST: 4000

Example: See Chapter 6.1, "Programming Example", on page 57.

Manual operation: See "End Range" on page 39

[:SOURce<hw>]:REGenerator:OBJect<ch>:OVELocity <ObjectVelocity>

Sets the speed of a moving object.

Parameters:

<ObjectVelocity> float

Range: 0.001 to 1.5E11
Increment: 0.001
*RST: 100
Default unit: m/s

Example: See Chapter 6.1, "Programming Example", on page 57.

Manual operation: See "Object Velocity" on page 40

[:SOURce<hw>]:REGenerator:OBJect<ch>:DIRection <Direction>

Sets the object direction of a static+moving object.

Parameters:

<Direction> APPRoaching | DEParting

*RST: APPRoaching

Example: See Chapter 6.1, "Programming Example", on page 57.

Manual operation: See "Direction" on page 40

[:SOURce<hw>]:REGenerator:OBJect<ch>:RCS:MODel <Model>

Set the model that describes the radar cross-section (PCS) of the object.

Parameters:

<Model> SWE0 | SWE1 | SWE2 | SWE3 | SWE4

*RST: SWE0

Example: See Chapter 6.1, "Programming Example", on page 57.

Manual operation: See "RCS Model" on page 43

[:SOURce<hw>]:REGenerator:OBJect<ch>:RCS:MEAN <Mean>

Sets the mean RCS value required for the RCS calculation.

Parameters:

<Mean> float

Range: -60 to 100
Increment: 0.1
*RST: 10

Example: See Chapter 6.1, "Programming Example", on page 57.

Manual operation: See "mean RCS" on page 43

[:SOURce<hw>]:REGenerator:OBJect<ch>:HOLD:OFF <HoldOff>

Enters a time delay form the simulation start time to the moment at that an object appears for the first time.

Parameters:

<HoldOff> float

Range: 0 to 35999.999
Increment: 0.001
*RST: 0
Default unit: s

Example: See Chapter 6.1, "Programming Example", on page 57.

Manual operation: See "Object Hold Off" on page 40

[:SOURce<hw>]:REGenerator:OBJect<ch>:TIME:TOENd?

Queries the time it takes that the object moves from its start to its end range position.

Return values:

<TimeToEnd> float

Range: 0 to 1E15
Increment: 0.001
*RST: 0
Default unit: s

Example: See Chapter 6.1, "Programming Example", on page 57.

Usage: Query only

Manual operation: See "Time to Reach End Range" on page 39

[:SOURce<hw>]:REGenerator:OBJect<ch>:PHASe[:OFFSet] <Offset>

Sets a phase offset between the transmitted pulse and the echo signal.

Parameters:

<Offset> float

Range: 0 to 359.9
Increment: 0.1
*RST: 0

Example: See Chapter 6.1, "Programming Example", on page 57.

Manual operation: See "Phase Offset" on page 40

[:SOURce<hw>]:REGenerator:OBJect<ch>:FEPNumber?

Queries the number of the first pulse for that an echo signal is generated.

Return values:

<FirstEchoToPuls> integer

Range: 0 to 100E6
*RST: 0

Example: See Chapter 6.1, "Programming Example", on page 57.

Usage: Query only

Manual operation: See "Fist Echo to Pulse#" on page 41

6.6 Preview Diagram Commands

[:SOURce<hw>]:REGenerator:DIAGram:STATe 77
[:SOURce<hw>]:REGenerator:DIAGram:TYPE 77

[:SOURce<hw>]:REGenerator:DIAGram:STATe <State>

Starts the objects preview on the diagram.

Parameters:

<State> 0 | 1 | OFF | ON

*RST: 0

Example: See Chapter 6.1, "Programming Example", on page 57.

[:SOURce<hw>]:REGenerator:DIAGram:TYPE <Type>

Sets the diagram type.

Parameters:

<Type> VELocity | POLar | POWer

Range: VELocity|POWer
*RST: VELocity

Example: See Chapter 6.1, "Programming Example", on page 57.

Manual operation: See "Diagram Type" on page 45

Glossary: Terms and Abbreviations

A

ARB: Arbitrary Waveform Generator
An I/Q modulation source forming an integral part of the supported signal generators. The ARB allows the playback and output of any externally calculated modulation signal in the form of waveform file as well as the generation of multi carrier or multi segment signals from waveform files.

AWGN: Additive white gaussian noise

B

BW: Bandwidth

BZ: Blind zone
The minimum required distance to the object so that it can be detected.

D

DUT: Device under test

E

EIRP: Equivalent isotopically radiated power

F

FFT: Fast Fourier transform

FM: Frequency modulation

G

Gain: Antenna gain is a measure of the antenna's ability to concentrate electromagnetic energy in a narrow beam.

GUI: Graphical User Interface

P

PRF: Pulse repetition frequency

PRI: Pulse repetition interval
Defines the overall time of a pulse cycle.

PRT: Pulse repetition time

PW: Pulse width

R

RADAR: Radio Detecting and Ranging

RCS: Radar cross section, RCS or σ
The RCS is a measure of the energy that an object intercepts and scatters back towards the radar.

RUT: Radar under test

V

VSG: Vector Signal Generator

Glossary: Specifications, References, Documents with Further Information

Symbols

[1]: Rohde & Schwarz
Application note 1MA127: "Introduction to Radar System and Component Tests"

[2]: Rohde & Schwarz
White Paper 1MA239: "Radar Waveforms for A&D and Automotive Radar"

[3]: Rohde & Schwarz
Application note 1MA256: "Real-time Radar Target Generation"

[4]: Rohde & Schwarz
R&S FSW user manual available for download from the Rohde & Schwarz website, on the R&S FSW product page at http://www.rohde-schwarz.com/product/FSW.html

[5]: Rohde & Schwarz
R&S SMW user manual available for download from the Rohde & Schwarz website, on the R&S SMW product page at http://www.rohde-schwarz.com/product/SMW200A.html

List of Commands

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